



Monitoring Coastal Wetland Elevation in Southeast Coast Network Parks

Protocol Implementation Plan

Natural Resource Report NPS/SECN/NRR—2023/2591



ON THE COVER

Salt Marsh at Cape Hatteras National Seashore.

NPS / LISA COWART BARON

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Executive Summary

The National Park Service (NPS) Inventory and Monitoring Division has initiated coastal wetland elevation monitoring at or in the vicinity of Cape Hatteras National Seashore (CAHA), Cape Lookout National Seashore (CALO), Fort Pulaski National Monument (FOPU), Fort Frederica National Monument (FOFR), Cumberland Island National Seashore (CUIS), Timucuan Ecological and Historic Preserve (TIMU), Fort Matanzas National Monument (FOMA), and Canaveral National Seashore (CANA). This protocol implementation plan is based on the Northeast Coastal and Barrier Network protocol, *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* (Lynch et al. 2015) with the goal of ensuring NPS data are comparable with existing, contemporary, and future data sets collected by NPS monitoring networks and other monitoring programs.

The Southeast Coast Network's (SECN) coastal wetland monitoring effort collects surface elevation and marker horizon data at permanent monitoring stations in park salt marsh and mangrove wetlands to provide data to park resource managers on the status of, and trends in, coastal wetland conditions and abilities to adapt to sea level rise within the park and surrounding areas. In addition to sites located with park managed areas, multiple sites located within the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) are being monitored in a partnership with their system-wide wetland elevation monitoring program. The sites monitored through the GTMNERR partnership are near Fort Matanzas National Monument and Castillo de San Marcos National Monument (CASA), geographically located between Canaveral National Seashore and Timucuan Ecological and Historic Preserve. Similarly, other partnerships will be perused around other parks to better understand wetland elevation dynamics around those areas.

The purpose of this protocol implementation plan is twofold: to provide a monitoring framework for collecting scientifically sound data and to supply information to help evaluate the current status and trends in coastal wetland conditions. Understanding trends in coastal wetland condition and how stressors such as coastal storms and sea level rise affect them is important for managing these important ecosystems. Surface elevation and marker horizon data can be leveraged to determine if current management practices or environmental conditions are sustaining the desired functions and uses of the parks.

Data collected under this protocol implementation plan are stored in the NPS Surface Elevation Table (SET) Monitoring Database (NPS I&M 2017). In addition to utilizing customized data handling and reporting procedures, this plan and its accompanying standard operating procedures (SOPs) set guidelines for data to be made available internally to park resource managers and employees along with publication to larger audiences via peer-reviewed reports and briefing statements.

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Additional Notes

The previous SECN *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015) was largely based on preexisting monitoring efforts and borrowed heavily from published reports. The previous protocol had several shortcomings that hindered its utility for the parks and impeded the network's ability to effectively implement the protocol. In 2020, with concurrence from the SECN Steering Committee, the previous protocol was evaluated from safety and cost-benefit perspectives and rescoped to better serve the parks. The new protocol described herein utilizes (mostly) new and more accessible monitoring stations and removes vegetation and pore water monitoring components from sampling but still relies on well-documented and proven techniques and procedures used in the previous effort and nationwide to monitor changes in wetland surface elevation. This updated approach and protocol implementation plan (PIP) is based on the Northeast Coastal and Barrier Network Protocol, *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* (Lynch et al. 2015). This PIP will replace the SECN *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015) and will be used moving forward to monitor wetland elevation in SECN coastal parks.

Introduction and Background

Introduction

Coastal wetlands develop in low-lying areas and are primarily influenced by the surrounding tidal regime. Along the southeastern U.S. Atlantic coast, coastal wetlands are subjected to twice daily (diurnal) tidal flooding. This predictable inundation is important for successional development, species composition, and the stability and productivity of marine and brackish water ecosystems (Wiegert and Freeman 1990). Park lands within the Southeast Coast Network relevant to this effort include salt marsh and mangrove coastal wetlands. The transition between salt marsh and mangrove associations occurs at about 30°N in north-central Florida (Odum et al. 1982; Cavanaugh et al. 2019). From this point north, salt marsh, dominated primarily by cordgrass (*Spartina* spp.), is the most common vegetation association on low-energy coasts and sheltered intertidal areas.

Numerous fish, invertebrate, bird, and reptile species rely on estuarine habitats for a multitude of critical functions including refuge from predators, foraging, and reproduction (Odum et al. 1982; Kneib 1997; Sheaves 2005). Among estuarine habitats, emergent intertidal habitats are particularly important, as they link wetland surface and subtidal habitats during periods of tidal inundation (McIvor and Odum 1988; Rozas 1988). Because emergent intertidal habitats form an extensive and direct land-water interface, they may be substantially affected by climate change and sea-level rise (Najjar et al. 2000; Scavia et al. 2002; Craft et al. 2009). Ecosystem functions of coastal wetlands include both high primary productivity and high detrital production critical for fish nurseries and linked estuarine systems. Additionally, detrital decomposition is the major pathway for energy flow within coastal wetlands and coastal wetlands can be either a source or a sink for nutrients.

Wetlands within SECN parks vary widely from intermittent interdunal pools to riparian floodplains to vast salt marshes and emerging mangrove swamps. Coastal wetland systems are particularly sensitive to changes in sea level due to climate change. Within SECN parks, these areas are potentially affected by visitor uses, commercial and recreational fishing and ecosystem drivers from inland and upstream areas. The long-term stability of coastal wetland ecosystems will be increasingly affected by inland and upstream processes such as water use, changes in landscape dynamics, and their cumulative effects on incoming water quality and quantity (DeVivo et al. 2008).

The study of elevation change is critical to understanding the status of the coastal wetlands, their long-term viability in the face of a changing climate, and management needs for these ecosystems. Therefore, the Southeast Coast Network has identified coastal wetland elevation as one of its vital signs to monitor at eight coastal network parks (Figure 1, DeVivo et al. 2008). In DeVivo et al. 2008 this vital sign is referred to as “salt marsh elevation”; however, since the SECN parks also include mangrove ecosystems, this monitoring focus was changed to “coastal wetland elevation” monitoring to include mangrove ecosystems. The network plans to monitor rates of soil elevation change and accretion to determine if the coastal wetlands are keeping pace with relative sea-level rise (RSLR). The RSLR rates of the SECN coastal parks range from 2.23 to 6.25 millimeters (0.09–0.25 inches) annually (NOAA 2023). If the coastal wetland soil surface elevation is not increasing at a rate equal to or greater than the RSLR rate, the wetland is said to be experiencing an elevation deficit (Cahoon

and Guntenspergen 2010). Wetlands will migrate upslope in response to rising water levels, if possible. Due to steep elevation gradients and/or anthropogenic encroachment, such as bulkheads or roads, the coastal wetland may not be able to migrate upslope and can drown as sea-level rises. Areas where coastal wetlands are not able to migrate upslope will convert to shallow open water habitat (Borchert et al. 2018). The status and trends of coastal wetland elevation change will assist park resource managers in their decision-making process.

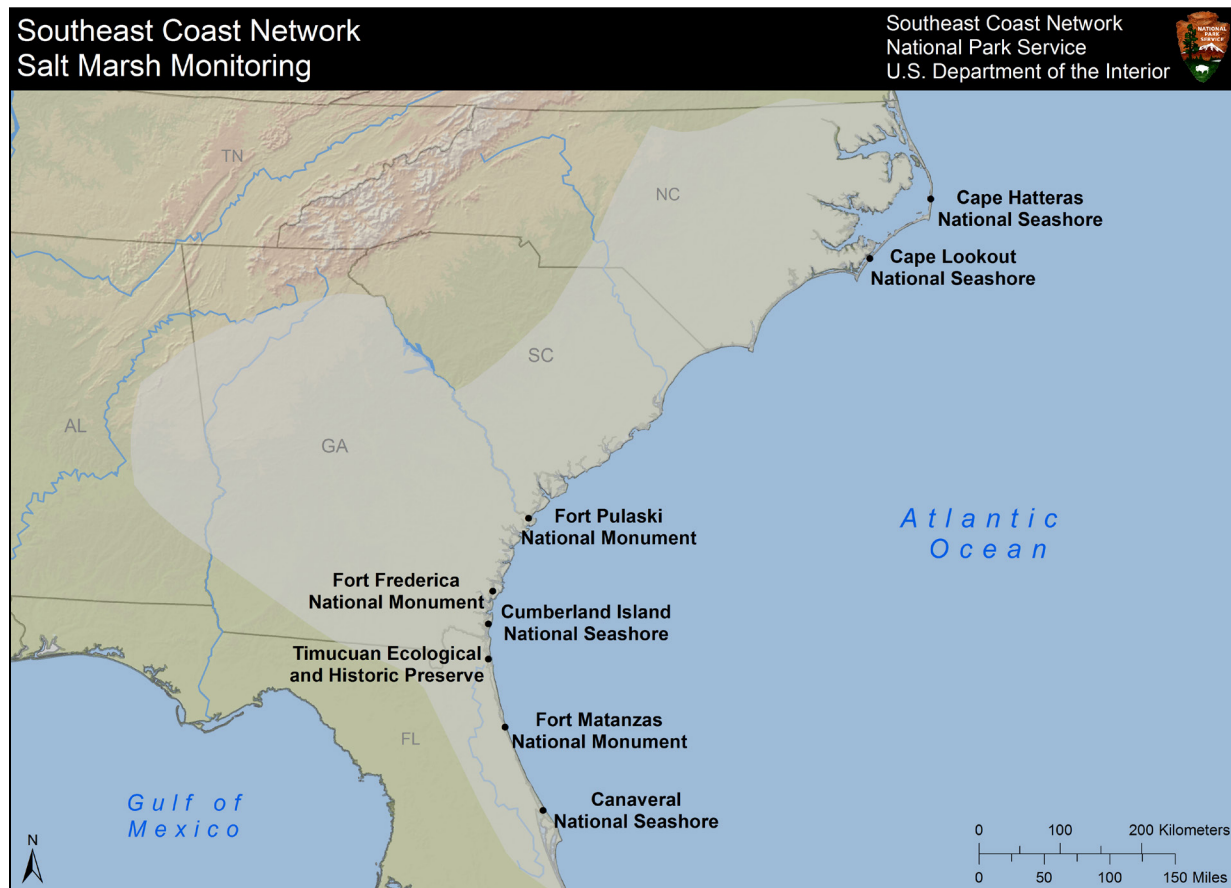


Figure 1. Map of Southeast Coast Network park units with significant coastal wetland systems.

Background

During 2014–2015, the sampling locations installed for the original SECN protocol (DeVivo et al. 2015) were visited and evaluated. From this evaluation, issues related to accessibility, safety, and sampling within the time frame specified in the protocol were identified. During the next three years (2015–2018), data collection was attempted at these sampling locations. The original issues identified could not be completely mitigated, except for the sampling locations at Cape Hatteras National Seashore and Cape Lookout National Seashore. It was determined these two sampling locations could be safely and efficiently sampled annually.

A proposal to formally evaluate this protocol was discussed and accepted during the FY2019 SECN steering committee meeting. During FY2019, the SECN coastal ecologist met with park resource

managers to discuss the parks' interest in continuing to collect data under this protocol and what changes to the protocol would be most beneficial to the parks. From those discussions, the following priorities were identified:

1. Long-term wetland vegetation distribution and change is a top priority among the coastal parks in the Southeast Coast Network.
2. Long-term wetland elevation change and accretion were of interest and importance to the parks related to their management concerns at specific areas of interest.
3. Soil porewater salinity was of less importance to the parks. Salinity changes could be pulled from SECN's continuous water-quality data monitoring and other nearby water quality sensors.

Once these priorities were identified, it was decided that the issue of wetland vegetation change would be addressed in a separate monitoring protocol at a more appropriate scale for management relevance. A document containing the notes from each of these park meetings is located in Appendix A. At the FY2020 SECN steering committee meeting, the steering committee and network board of directors agreed the network would install new tidal wetland elevation sampling locations that were easily and safely accessible to sample in areas of management interest to the parks. Initially, efforts would focus in parks where the initial sampling locations were not easily or safely accessible or did not exist within the park boundary. Once the new sites were installed and sampled for a period, the data would be evaluated to determine whether additional sampling locations could be added to the project design if future budgets allow.

During 2019 and 2020, the SECN coastal ecologist worked with the parks to identify new coastal wetland locations that met the needs of the park and satisfied the criteria identified by the network. Reconnaissance field visits were made to these sites, with the aid and input of park staff. The network's criteria for new sampling locations included:

- Location is within coastal wetland ecosystem.
- Accessible at low tide.
- Minimal, if any, infrastructure (e.g., platforms, board walks) required to perform long-term sampling.
- Sampling activities would not impact long-term monitoring viability at the site.
- Inundated within the regular tidal cycle, i.e., daily inundation.
- Important to the park's resources. This could be due to natural resources, such as area previously ditched and restored, or cultural resources, such as within proximity to an area of cultural significance.

Summaries of the field reconnaissance efforts were drafted and sent to the parks for approval. This document summarizes the results of these efforts (see Appendix B).

As part of the original protocol (DeVivo et al. 2015), the Southeast Coast Network partnered with the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) to collaborate and coordinate on wetland monitoring efforts in northeast Florida. The GTMNERR property boundaries

are north and south of Fort Matanzas NM. Six SET sites are located within the GTMNERR boundary and maintained and monitored by GTMNERR staff. Through the partnership, similar methodology is used in the coastal elevation data collection of these six SET sites (see: [SETr: Developing Tools and Visualizations to Track Changes in Wetland Surface Elevation | National Estuarine Research Reserve System Science Collaborative nerrssciencecollaborative.org](#)) (NERRS 2023). The partnership is ongoing and will provide park resource managers with additional information on the status and changes in coastal elevation in the southeastern U.S. and in the vicinity of several SECN park areas.

Protocol Source

This plan outlines how the Southeast Coast Network will monitor coastal wetland elevation and addresses how the data will be collected, managed, and reported. The implementation of this plan is based on the Northeast Coastal and Barrier Network (NCBN) Protocol, *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* (Lynch et al. 2015).

The main differences between the SECN PIP and the source protocol are listed below:

1. Lynch et al. (2015) samples in salt marsh and other brackish marsh habitats, whereas Southeast Coast Network sampling will occur in both salt marsh and mangrove habitats.
2. Lynch et al. (2015) describes various sample designs, including those for hypothesis testing and monitoring. The Southeast Coast Network will use sites based on park resource management needs and accessibility.
3. Lynch et al. (2015) states the typical sampling frequency is one to four times a year and suggests sampling twice a year (spring and fall) to determine seasonal variability. The Southeast Coast Network will sample twice per year (spring and fall). Event driven (tropical weather, fires, nor'easters) sampling may be conducted in addition to spring and fall readings.

Lynch et al. (2015) describes using a Microsoft Access database for their salt marsh data management. However, since the publication of the protocol, a new multi-region, multi-network database was developed as a cooperative effort between the Northeast Temperate Network (NETN), the Northeast Coastal and Barrier Network (NCBN), the National Capital Network (NCRN), the Southeast Coast Network (SECN), and the South Florida/Caribbean Network (SFCN). It is available at [DataStore - Surface Elevation Table \(SET\) Data Package \(nps.gov\)](#).

(<https://irma.nps.gov/DataStore/Reference/Profile/2298730>). See SOP 2.3.06 *Monitoring Coastal Wetland Elevation User Manual and Technical Documentation—Version 2.0* (Wright et al. 2023a) and SOP 2.3.07 *Monitoring Coastal Wetland Elevation Data Management and Database Technical Documentation—Version 2.1* (Wright et al. 2022) for more information about the database architecture and intended use. In addition, guidance for data QA/QC and data publication was published for this multi-network monitoring effort, SOP 2.3.05 *Coastal Wetland Elevation Data QA/QC and Data Publication—Version 1.0* (Wright et al. 2023b).

Conceptual Framework for Monitoring

At the local and landscape scales, the complexity of SECN park coastal wetland ecosystems was described in the Salt Marsh and Coastal Wetland Ecological Model of the SECN monitoring plan (DeVivo et al. 2008). Cahoon and Guntenspergen (2010) further discuss this complex system, highlighting the relationships between coastal wetlands, sea level rise, and climate change (Figure 2). Changes in coastal wetland extent, diversity, and quality are related to a combination of relative sea-level rise (RSLR), extreme weather events, altered hydrology, and wetland management (Table 1), as shown through the positive and negative feedback loops illustrated in Figure 2. Understanding the effects of multiple concurrent stressors affecting park coastal wetlands and mitigating the impacts of those stressors at multiple spatial and temporal scales, is an ongoing challenge for SECN park managers. Long-term monitoring of the coastal wetland surface elevation can help to address this management challenge by informing resource managers of the status and trends in coastal wetland health and the future management needs of these significant ecosystems.

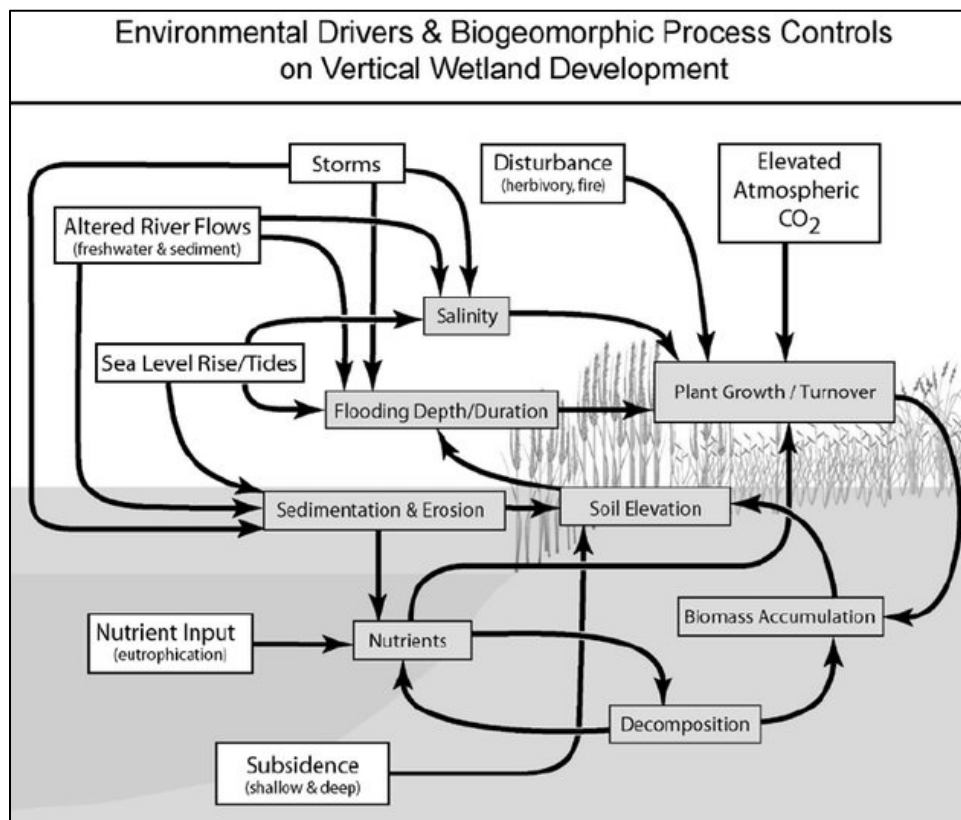


Figure 2. Conceptual model illustrating linkages and feedback relationships among factors controlling habitat stability and nutrient and carbon dynamics in coastal wetlands. External forcing functions that may destabilize the system are indicated in white boxes. Figure reproduced from Cahoon and Guntenspergen (2010).

Table 1. Factors affecting coastal wetlands in Southeast Coast Network Parks and potential measures for Vital Signs Monitoring.

Category	Issue	Potential Measures
Relative Sea Level Rise	During the 21st century, the IPCC projects that sea level rise will likely accelerate 2- to 5-fold compared to the global rate during the 1900s, very likely affecting natural ecosystems in the low-lying South Atlantic coastal zone (Burkett et al. 2001).	Wetland surface elevation change and accretion at sites twice each year. These measures will be compared to regional sea-level change rates (NOAA data).
Extreme Weather Events	Climate change is projected to increase the frequency and magnitude of landfalling storm events, which in turn is projected to increase vulnerability to coastal wetland inundation or loss.	Wetland surface elevation change and accretion at specific sites pre- and post-hurricane season. ¹ Hurricane impacts: (https://www.tidesandcurrents.noaa.gov/sltrends/sltrends.shtml [NOAA 2023])
Wetland Management	Anthropogenic impacts, such as dredging and road construction, can lead to sediment impacts in the wetland system.	Wetland surface elevation change and sediment accretion at impacted sites. ² Anthropogenic impacts, such as dredging and road construction.

¹ Denotes external information used to help understand the management and ecological context.

² Denotes potential measures that are not easily collected.

Monitoring Objectives

To characterize the effects of relative sea-level rise (RSLR) on coastal wetland communities, surface elevation and accretion must be accurately monitored. Both components are integral to the complete picture of surface elevation dynamics. The following three objectives will be monitored at sampling locations in all study areas of Cape Hatteras National Seashore (CAHA), Cape Lookout National Seashore (CALO), Fort Pulaski National Monument (FOPU), Fort Frederica National Monument (FOFR), Cumberland Island National Seashore (CUIS), Timucuan Ecological and Historic Preserve (TIMU), Fort Matanzas National Monument (FOMA), and Canaveral National Seashore (CANA).

1. Determine the magnitude, rate, and variability of change in ground surface elevation in SECN coastal wetland sites that are being monitored.
2. Determine the status, trends, and within-site variability in surface sediment accretion in SECN coastal wetland sites that are being monitored.
3. Document the relative effect of different drivers of elevation (sedimentation, erosion, subsidence, and biogenic accretion due to root and shoot growth) within sites to better inform parks to future wetland management strategies.

The listed objectives are in line with the Northeast Coastal and Barrier Network protocol, *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* (Lynch et al. 2015), which includes quantifying elevation change in wetlands with the surface elevation table and understanding the processes that influence elevation change, including vertical accretion. The SECN protocol implementation plan will focus on coastal wetland surface elevation and accretion, as described in the three objectives above.

In addition to the three monitoring objectives listed above, this plan includes the following analysis goals (listed below). These analysis goals are not included in Lynch et al. (2015) but are derived from the above two objectives and external data, such as storm events and relative sea-level rise data.

1. Determine effects of selected storm events on surface elevation in SECN coastal wetlands.
2. Determine if coastal wetland surface elevation sites are keeping pace with local relative sea level rise.

What is Being Measured and How

Implementation of the SECN Coastal Wetland Elevation Monitoring Protocol uses the methods described in the Northeast Coast Barrier Network Protocol, *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* and SOP 4: *Taking Measurements with the Surface Elevation Table—Version 1.00* (Lynch et al. 2015) to measure wetland surface elevation and accretion/erosion. Each coastal wetland monitoring site consists of three SET benchmarks, the minimum number per site suggested by Lynch et al. (2015). Each SET benchmark consists of a receiver for a rod surface elevation table instrument (RSET). The RSET attaches to the receiver and extends over the wetland surface. Nine pins inserted into the RSET are lowered to the wetland surface. The elevation of the wetland surface is measured from the height of the pins relative to the top of the table. The nine pin height measurements are performed by positioning the RSET in four directions, generally located 90° from each other. Thirty-six pin height measurements are recorded per benchmark. Because there are three benchmarks per wetland monitoring site, 108 pin height measurements are recorded per coastal wetland site. Over time, the surface elevation change within each site and between sites can be calculated to determine the rate of wetland elevation change. The wetland elevation change rate is then compared to the local RSLR rate to determine if the wetland sites are keeping up with sea-level rise.

Marker horizon data collection is used to measure the amount of surface deposition that has contributed to elevation change measured by the RSET. The method of measuring marker horizons is similar to the Lynch et al (2015) protocol, except the Southeast Coast Network will collect cores using a peat corer and by cutting sediment plugs, as opposed to using liquid nitrogen and “cryogenic coring” as described in SOP 5: *Establishing and Sampling Marker Horizons—Version 1.00* (Lynch et al. 2015). The peat corer will be inserted into the ground, rotated, and extracted from the ground, capturing the sediment core in the device (Figure 3). Three marker horizon plots of feldspar clay are established per benchmark location. Nine marker horizon plots are located at a site. Marker horizon plots are located near the RSET benchmark area and are established when the initial RSET surface elevation data are collected. During each sampling event, a small sediment core is collected from within the marker horizon plot. The amount of the sediment that accumulated on top of the feldspar clay is measured using calipers (see Standard Operating Procedures from Source Protocol section). Wetland elevation is influenced by multiple processes including sediment deposition, below ground biomass production, compaction, decomposition, and porewater exchange. Collecting marker horizon data allows us to better understand the sources of wetland surface elevation change at a given site (i.e., sedimentation or biogenic accretion, or surface versus subsurface). Marker horizon plots will be reapplied annually due to erosion or biological disturbance (e.g., crab burrows), where needed.



Figure 3. Picture of a marker horizon core collected at Cape Hatteras National Seashore using a peat corer. The white layer in the core is feldspar clay and the accumulation of sediment is being measured with calipers.

Each of the SET benchmark locations are surveyed with high precision GPS equipment to tie these locations into the vertical datum. Tying these locations into the vertical datum allows SECN to compare wetland elevation change between sites and parks. Periodically monitoring benchmark locations with GPS equipment allows the network to determine if deep subsidence or uplift, which the RSET is not designed to detect, is occurring at sites (Table 2).

Table 2. Sampling methods, locations, variables measured, and SECN parks that are part of the Monitoring Coastal Wetland Elevation protocol implementation plan.

Objective	Sampling Method	Sampling Frequency	Locations	Variables Measured	Parks
1. Surface Elevation Change	RSETs	Biannually	RSET	RSET Pin height to ground surface. Absolute elevation.	CAHA, CALO, TIMU, CANA, CUIS, FOMA, FOFR, FOPU (GTMNERR)
	Surveys of RSET benchmarks	Every 5 years	RSET	RSET Pin height to ground surface. Absolute elevation.	CAHA, CALO, TIMU, CANA, CUIS, FOMA, FOFR, FOPU (GTMNERR)
2. Accretion / Surface deposition	Sediment coring	Biannually	Marker Horizon Plots	Depth to marker horizon	CAHA, CALO, TIMU, CANA, CUIS, FOMA, FOFR, FOPU (GTMNERR)
3. Drivers of elevation change	Analysis of RSET and accretion data	As above	As above	Sedimentation, erosion, and biogenic accretion rates based on RSET and core data and corrected for deep subsidence or uplift	CAHA, CALO, TIMU, CANA, CUIS, FOMA, FOFR, FOPU (GTMNERR)

Sampling Design and Monitoring Schedule

There are several issues to consider when designing a field program for monitoring coastal wetland elevation dynamics. These issues include the specific monitoring objectives being addressed, and the resultant implications for site selection, sampling frequency, and the variables being measured. Upon the re-evaluation of this protocol in 2019, it was determined that a sentinel site approach (Smith and Gallagher 2011) would be used to access existing sites and select new site installations in critical areas of parks or areas that parks had an interest in monitoring. This project's design approach meets the objectives of the parks and protocol, but the ability to extrapolate findings beyond the immediate area being monitored is limited.

The sites previously installed at Cape Hatteras NS (CAHA) and Cape Lookout NS (CALO) will continue to be monitored following the review of the previous version of this protocol; however, in 2020, new site locations were identified at Canaveral NS (CANA), Fort Matanzas NM (FOMA), Timucuan E&HP (TIMU), Cumberland Island NS (CUIS), Fort Pulaski NM (FOPU), and Fort Frederica NM (FOFR). In 2022, an additional site was installed at Cape Hatteras NS. To preserve the wetland communities from human impact and maintain the public's viewshed within the park, permanent monitoring stations were established at locations outside of public view. See Introduction and Background section for more information on the criteria and process used in site selection.

Sample Locations

The number of sampling locations for each park was determined after consideration of park interest in the implementation of this vital sign at their park, park management needs, and areas of interest, hydrologic characteristics, safety concerns, accessibility, and the logistical issues regarding travel time and conducting monitoring activities.

The existing sites monitored under the previous version of this protocol at Cape Hatteras National Seashore and Cape Lookout National Seashore were retained after the protocol evaluation in 2019. For Canaveral NS, Fort Matanzas NM, Timucuan E&HP, Cumberland Island NS, Fort Pulaski NM, Fort Frederica NM and Cape Hatteras NS new or additional long-term monitoring sampling locations were selected through discussions and site visits with park staff and the SECN coastal ecologist. Initial reconnaissance meetings were performed to identify potential sampling locations of interest to the park and that met SECN's site selection criteria. Once potential site locations were identified, reconnaissance field site visits were conducted with park staff and the SECN coastal ecologist to determine if the potential sites met the park's priorities and SECN's accessibility criteria. Once the reconnaissance was performed, park and network staff discussed the potential sites and ranked them in order of priority for the park. The locations of new sites installed in FY20, FY21 and FY22 are listed with descriptions in Appendix B.

At each of the eight parks where the protocol is to be implemented, a minimum of one sampling site has been selected to address the monitoring objectives. Within each sample site, three replicate stations are established where sediment elevation and marker horizons are measured. In partnership with Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), six sites were installed within the GTMNERR at locations north and south of the FOMA boundary. All replicate

stations were chosen based on professional judgement and within 75 meters (246 feet [ft]). Within the GTMNERR, CAHA, and CALO sites, the replicates were all located within 75 meters of the selected site.

Monitoring Schedule

The statistical strength of the RSET device is that it ensures that the exact same patches of wetland surface are re-measured over time. This means RSET data are always a time series. The Southeast Coast Network also collects elevation and marker horizon measurements biannually during the spring and fall months. These periods were chosen so sampling events will occur during vegetation dormancy or low productivity periods and therefore minimize the below and above ground vegetation biomass production that can influence surface elevation. Additionally, this sampling scheme will allow for event-driven (cyclones or winter storms) elevation change to be interpreted. Static GNSS GPS surveys and associated leveling will be conducted at least every five years. If elevation numbers cannot be explained from one reading to the next (i.e., a change of more than 5.0 centimeters [1.9 inches {in}] between readings), the benchmarks will be reoccupied and leveled to eliminate deep subsidence as a possible source of error.

Data Management, Analysis, and Reporting

The data collected and processing steps involved in the SECN coastal wetland elevation monitoring project are listed in Table 3 and include the unprocessed data, entered and validated data, and analysis. Further discussion of these process steps is provided below.

Table 3. Monitoring objectives, sampling methods, locations, variables measured, and SECN parks that are part of the Protocol for Monitoring Coastal Wetland Elevation.

Data Quality Level	Data Processing Level 0 (Unprocessed)	Data Processing Level 1 (Entered/Validated)	Data Processing Level 2 (Analysis)
Raw	RSET, marker horizon, and survey data are collected on field data forms. Field quality assurance includes previous field notes and comparison against previous year's data. Paper field data forms are scanned, archived locally and managed as long-term program records.	Data recorded on field data forms are entered into the NPS SET database.	RSL and hurricane data are acquired from appropriate sources for use in analysis.
Provisional	–	Quality control check is performed on data entered into the database through a double entry process where the data are entered and compared to the field data forms. Associated field notes are reviewed for completeness.	–
Certified/Approved	–	Data are reviewed for quality control issues. Problematic data are flagged and annotated so the end user can make informed decisions on the use of these data in their analyses. Cumulative data packages are periodically published on the National Park Service Data Store in the public domain.	Relative elevation change is calculated and marker horizon data are compared to understand mechanisms of elevation change. Completed report are uploaded to the DataStore. Datasets, statistical code, and additional derivative data included in the analysis and reporting will also be available.

Processing and Workflow Steps

1. Unprocessed
 - a. Pin height and marker horizon data are collected in the field on field data forms.
 - b. Field data forms are scanned, archived locally, and managed as long-term program records.
2. Entered/Validated
 - a. Raw data are entered into the NPS SET database. The database incorporates double entry of elevation data for quality assurance of data entry. Marker horizon data are visually inspected for accuracy. After these checks, the data are designated as provisional by the person performing data entry.
 - b. Exploratory analysis is performed on the provisional data. Plots and graphs are generated, and data are flagged for inclusion or exclusion from analysis. All outliers and exclusions are documented, based on established criteria.
 - c. Certification and publication of the data set to the [NPS Integrated Resource Management Applications \(IRMA\) Portal](https://irma.nps.gov/Portal/) (https://irma.nps.gov/Portal/) occurs annually.
3. Analysis
 - a. Linear regression of elevation and accretion data will be performed to determine trends over time, as described in Lynch et al. (2015). Further discussion is currently underway through a multi-agency working group to determine how to proceed with analyzing SET data. An update will be made to the applicable standard operating procedure once a consensus is reached by the working group.
 - b. Once five years of data collection have been achieved at the site a trend report will be created with the certified data. Following the first trend report, an annual summary report will be created for each park. Then, every five years a trend report will be generated. In the trend report, regional sea-level rise and storm event data from external sources will be incorporated and presented with the surface elevation and accretion data.

Budget

The annual operating cost estimate for the SECN coastal wetland elevation monitoring protocol is listed in Table 4. The new site installations at Canaveral National Seashore, Fort Matanzas National Monument, Timucuan Ecological and Historic Preserve, Cumberland Island National Seashore, Fort Pulaski National Monument, and Fort Frederica National Monument were performed through an inter-agency agreement (IAA) with USGS in FY2020. The IAA was \$55,635, which included USGS personnel (2), travel, and equipment costs. The Southeast Coast Network provided all building and installation materials for the new sites, which were estimated to be approximately \$15,000, and additional labor to assist with installations. For ongoing monitoring and operations, there will be increased labor costs as shown in Table 4.

Table 4. Estimated annual operating costs of the SECN Coastal Wetland Elevation Monitoring Protocol (based on FY2023 dollars). Personnel costs were calculated at Step 5 of the highest GS level listed. Budget does not include support (i.e., personnel, housing) provided by parks.

Category	Position	Costs (FY 2020)	Notes
Personnel	SECN Coastal Ecologist	\$50,690	0.40 FTE GS-12
	SECN Coastal Technician	\$27,155	0.40 FTE GS-5/6/7
	SECN Data Manager ¹	\$13,382	0.10 FTE GS-12
	Total Personnel Costs	\$91,227	–
Equipment and Supplies	Equipment Maintenance	\$500	Replacement or procurement of RSET devices, peat corers, and pins
	Field Supplies	\$500	Miscellaneous field supplies
	Boat	\$500	Boat fuel and maintenance costs
	Total Equipment Costs	\$1,500	–
Travel ²	Travel: FOFR	\$1,724	GOV lodging not consistently available
	Travel: FOPU	\$1,493	No GOV lodging available
	Travel: CANA	\$1,544	GOV lodging not consistently available
	Travel: CUIS	\$385	Park provided lodging
	Travel: FOMA	\$821	No GOV lodging available
	Travel: CALO and CAHA	\$3,652	GOV lodging not consistently available
	Total Travel Costs	\$9,619	–

¹ A portion of all personnel's time is devoted to data management activities including data entry, analysis, and QA/QC.

² The SECN Coastal Program is currently duty stationed in Jacksonville, Florida; therefore, no travel is required to sample TIMU coastal wetland sites.

Table 4 (continued). Estimated annual operating costs of the SECN Coastal Wetland Elevation Monitoring Protocol (based on FY2023 dollars). Personnel costs were calculated at Step 5 of the highest GS level listed. Budget does not include support (i.e., personnel, housing) provided by parks.

Category	Position	Costs	
		(FY 2020)	Notes
Total Protocol Implementation Cost	–	\$102,346	–

¹ A portion of all personnel's time is devoted to data management activities including data entry, analysis, and QA/QC.

² The SECN Coastal Program is currently duty stationed in Jacksonville, Florida; therefore, no travel is required to sample TIMU coastal wetland sites.

Safety

Implementation of this protocol has multiple complex risks. Staff will continuously evaluate all risks at the programmatic, personnel, and site level.

Specific safety concerns include:

- Driving: Crew members will spend many hours (and miles) driving to, between, and from sampling locations to conduct the requisite sampling.
- Communication: Crew members will be regularly working in park areas outside of dependable communications range (either by park radio or by cell phone).
- Occupational: During installation and maintenance phases of protocol implementation crews will be using power equipment such as jackhammers in remote coastal wetlands (i.e. salt marshes and mangrove forest areas). At times, power tool use may require balancing on low platforms designed to protect the monitoring area.
- Occupational: During data collection visits personnel are required to perform tasks that utilize repeated awkward body positioning, climbing, and precarious body position.
- Weather: Crew members will be working outside in isolated areas. Therefore, weather, heat, cold, rain, and lightning can be a concern.

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 coastal wetland monitoring. In most field situations, this protocol can be safely implemented provided the Southeast Coast Network and partner staff implement it in accordance with the referenced SOPs and recommended risk abatement strategies detailed in JHAs. In addition to SOPs 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 by supervisors.

Safety procedures are routinely reviewed with network staff and partners before field operations as prescribed in the SOPs and annually during operational reviews. The JHAs are reviewed and revised annually as a part of the operational 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 NPS Reference Manual 50B, 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.
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, where appropriate, correct unsafe conditions and work practices.
6. Report unsafe/unhealthful conditions and/or operations to their 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 no later than the end of the work shift.
8. Participate in establishing a safe working culture, and practice safe work procedures, even when working alone.

Standard Operating Procedures from Source Protocol

Table 5 lists the SOPs from the Northeast Coastal and Barrier Network's *The Surface Elevation Table and Marker Horizon Technique* (Lynch et al. 2015) and clarification on what approaches were utilized to implement the protocol by the Southeast Coast Network (Table 5). The SECN safety SOPs are listed in Table 6, which replace the field safety SOP content in Lynch et al. (2015).

Table 5. Table listing the standard operating procedures (SOPs) from *The Surface Elevation Table and Marker Horizon Technique* (Lynch et al. 2015), notes, SECN SOP citation, and IRMA link if applicable.

Topic	Notes	SECN SOP	Link to Published Document/IRMA Record
Project Planning	SECN will use a sentinel site approach, where site locations were chosen based on park resource management input and accessibility. Additional explanation of site selection is in Appendix B.	–	2225005 SOP 1 therein
Sample Station Layout and Platform Options	Station locations were determined within site based on professional judgement. The temporary platforms option will be utilized to minimize impact to park wetlands.	–	2225005 SOP 2 therein
Installing an RSET Mark	Demolition Hammer and Generator used. Refusal 300 seconds see Table 3.2 in SOP 3.	–	2225005 SOP 3 therein
Taking Measurements with the Surface Elevation Table	Using original RSET instrument.	–	2225005 SOP 4 therein
Establishing and Sampling Marker Horizons	Marker horizons using approximately 0.25 square meter (2.69 square feet [ft ²]) plots and replaced as needed. Marker horizon data are collected using peat corer and cutting plugs instead of using liquid nitrogen.	–	2225005 SOP 5 therein
Surveying the SET Mark	Static GPS surveys will be performed to monitor SET benchmark movement.	–	2225005 SOP 6 therein

Table 5 (continued). Table listing the standard operating procedures (SOPs) from *The Surface Elevation Table and Marker Horizon Technique* (Lynch et al. 2015), notes, SECN SOP citation, and IRMA link if applicable.

Topic	Notes	SECN SOP	Link to Published Document/IRMA Record
Data Management	SECN will utilize the NPS SET database that has been developed to house SET and marker horizon data. SECN will be publishing all SET data yearly along with other networks.	Wright, W., K. Montenegro, A. Kozlowski, J. Patterson, and M. Prats. 2023. Coastal Wetland Elevation Database User Manual and Technical Documentation—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.3.06. National Park Service Inventory and Monitoring Division. Fort Collins, Colorado. Wright, W., A. Kozlowski, J. Patterson, A. Okunoye. 2022. Monitoring Coastal Wetland Elevation Data Management and Database Technical Documentation—Version 2.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.3.07. Southeast Coast Network, Athens, Georgia. Wright, W., D. Skidds, E. Cheng, and A. Kozlowski. 2023. Coastal Wetland Elevation Data QA/QC and Data Publication—Version 1.0. Inventory and Monitoring Division Standard Operating Procedure NPS/IMD/SOP—2.3.05. National Park Service Inventory and Monitoring Division. Fort Collins, Colorado.	2293214 2294179 2298702 2294781 (database)
SET and Marker Horizon Data Analysis	The analysis will be performed according to Lynch et al. (2015) and procedures being developed by an interagency working group.	—	2225005 SOP 8 therein
Field Safety	SECN has developed individual SOPs for field safety procedures that provide additional information specific for performing this protocol in SECN parks.	See Table 6	See Table 6

Table 5 (continued). Table listing the standard operating procedures (SOPs) from *The Surface Elevation Table and Marker Horizon Technique* (Lynch et al. 2015), notes, SECN SOP citation, and IRMA link if applicable.

Topic	Notes	SECN SOP	Link to Published Document/IRMA Record
Revising the Protocol or SOPs	SECN has a network-wide protocol revision SOP in place.	Wright, W. and S. E. Curry. 2021 Revision of Southeast Coast Network protocols and standard operating procedures—Version 3.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.1.01. National Park Service, Athens, Georgia.	2284603

Table 6. Table listing the SECN safety standard operating procedures (SOPs) that encompass the field safety topics from *The Surface Elevation Table and Marker Horizon Technique: A Protocol for Monitoring Wetland Elevation Dynamics* (Lynch et al. 2015).

Topic	Notes	SECN SOP	Link to Published Document/ IRMA Record
Injury	SECN has a network-wide injury SOP in place.	Starkey, E. N. 2021. Reporting of on-duty injury, illness, near misses, hazards and exposure— Version 5.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.01. Southeast Coast Network, Athens, Georgia.	2284673
Boat Operations	SECN has a network-wide boat operations SOP in place.	Southeast Coast Network. 2021. Safe operation of Southeast Coast Network watercraft—Version 2.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.02. Southeast Coast Network, Athens, Georgia..	2284674
Vehicle Use	SECN has a network-wide vehicle use SOP in place.	Southeast Coast Network. 2021. Vehicle Use and Operation— Version 2.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.03. Southeast Coast Network, Athens, Georgia..	2284675
Vehicle Accident	SECN has a network-wide vehicle accident SOP in place.	Southeast Coast Network. 2021. Motor vehicle accident reporting procedures—Version 2.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.04. Southeast Coast Network, Athens, Georgia.	2284676
Park Communication	SECN has a network-wide park communications SOP in place.	Southeast Coast Network. 2021. Communicating field operations with SECN parks—Version 3.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.07. Southeast Coast Network, Athens, Georgia.	2284677

Project Planning

The Lynch et al. (2015) project planning SOP outlines various options. The SOP is grouped into three sections: (1) Basic Terms, (2) Study Type, and (3) Selecting Sample Stations. The Southeast Coast Network designed its monitoring project to detect long-term trends in surface elevation and accretion. Based on cost and monitoring logistics, two coastal wetland sites can be installed at Canaveral NS, Timucuan E&HP, Cumberland Island NS, Fort Pulaski NM, Fort Frederica NM and one site at Fort Matanzas NM. The previously installed CAHA and CALO sites will continue to be sampled and no new sites will be installed at this time. The sample frame was defined as the coastal wetland area within each park that is subjected to daily tidal fluctuations. A sentinel site approach (Smith and Gallagher 2011) was taken where the sample frame was reviewed for accessible areas that did not require permanent structures for long-term sampling. Park input was provided to identify areas of natural resource management interest, proximity to culturally significant areas, or areas of other natural resource management concerns. As described above, the coastal wetland sites were selected based on SECN criteria, e.g., accessibility and safety, and park input on management areas of interest. Each coastal wetland site will have three SET (Surface Elevation Table) stations. The location of the SET stations at each site is chosen via professional judgment to be representative of the targeted habitat at that site.

Sample Station Layout and Platform Options

Of the suggestions in Lynch et al. (2015), the Southeast Coast Network has chosen to use temporary platforms at the coastal wetland sites, which is in accordance with what the Northeast Coastal and Barrier Network has implemented. No permanent platforms will be installed or maintained. Permanent stations already installed will be utilized until safe access is impossible then will be converted to use temporary platforms. Three marker horizon plots will be installed at each SET station. Fiberglass stakes will be used to mark the RSET sampling area and marker horizon plots.

Installing the RSET Mark

No SECN changes or modifications.

Taking Measurements with the Surface Elevation Table

Of those suggested in Lynch et al. (2015), the Southeast Coast Network uses the RSET device to collect surface elevation measurements, which is in accordance with what the Northeast Coastal and Barrier Network has implemented. The SECN SET sites will be sampled biannually in the spring and fall seasons. These seasons have been chosen to measure pre- and post-season vegetation growth effects and to capture any effects from annual weather events (tropical cyclones, floods and freezes). After initial change is assessed (approximately four to five years), ongoing status or trends may be monitored through annual sampling. The Northeast Coastal and Barrier Network samples biannually with the option of going to annual collection if the data or funding allows.

Establishing and Sampling Marker Horizons

Three marker horizon plots per SET station will be established, as stated in the Northeast Coastal and Barrier Network's SOP 5 *Establishing and Sampling Marker Horizons—Version 1.00* (Lynch et al. 2015). The marker horizons will be sampled using a peat corer or cutting a plug instead of using liquid nitrogen as suggested in Lynch et al. (2015). This adjustment was made due to poor recovery

at previous SET sites using liquid nitrogen. The Southeast Coast Network found that cores collected with a peat corer (Figure 3) provided more intact cores and better recovery, when feldspar was present at the marker horizon plot. Like the liquid nitrogen approach, a peat corer is inserted into the sediment (see methods in McKee and Vervaeke 2018). However, instead of pouring liquid nitrogen in to freeze the sediment and cut the frozen sediment to extract the core, the peat corer is rotated, slicing through the sediment, and capturing the sediment within the peat corer. The peat corer is then pulled out of the sediment and rotated to expose the captured sediment core. Because marker horizons (MH) tend to fade over time, often becoming unreadable after one and half to two years due to biomanipulation, erosion, and other disturbances, the Southeast Coast Network will modify the current method to use smaller MH plots (0.25 square meter [2.69 square feet {ft²}] instead of the 0.50 square meters [5.38 ft²] described in Lynch et al. [2015]) replaced at yearly intervals [after two sampling periods]) if needed due to difficulty of locating established MH plots. Plot replacement will be offset from original MH plots to avoid mixing old and new MH plots. All MH plots will continue to be sampled until no measurement can be taken, at which time the plot will be abandoned after not locating for two consecutive sampling events. This modification will allow for the continuous sampling of sedimentation in and around the sites without disruption.

Surveying the SET mark

No SECN changes or modifications.

Data Management

Lynch et al. (2015) describes using a Microsoft Access database to manage SET data. Since then, a new multi-region, multi-network database system has been designed and implemented. The new system uses a SQL backend and a web-based user interface for data entry. The new database is available at [DataStore - Surface Elevation Table \(SET\) Data Package \(nps.gov\)](https://irma.nps.gov/DataStore/Reference/Profile/2298730) (<https://irma.nps.gov/DataStore/Reference/Profile/2298730>). Processes and standard operating procedures for automating data QAQC, publication, and reporting are in development. For more information see SOP 2.3.07 *Monitoring Coastal Wetland Elevation Data Management and Database Technical Documentation—Version 2.1* (Wright et al. 2022).

SET and Marker Horizon Data Analysis

No SECN changes or modifications.

Field Safety

The Southeast Coast Network developed individual SOPs for field safety procedures that provide additional information specific for performing this protocol in SECN parks (Table 6).

Revising the Protocol or SOPs

The Southeast Coast Network has a network-wide protocol revision SOP in place (Wright and Curry 2021, Table 5).

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Appendix A. Protocol Redesign Justification and Meeting Notes

The Southeast Coast Network's *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015) was approved in 2014 and implemented from 2015 to 2019 with limited success. From the start of its implementation, multiple difficulties were encountered from both operational and logistical perspectives. For example, even though SECN personnel had successfully installed the SETs and constructed the required boardwalks in the targeted low-marsh areas over several seasons, monitoring from and maintaining these stations in a safe working condition was a challenge. While some repair and/or maintenance was expected and planned for, platforms/boardwalks needed repairs often in the first season of monitoring. In subsequent years, additional site visits—solely for re-construction and major repairs—were necessary prior to actual data collection trips since several sites always had major issues that prevented access. The harsh marsh environment, frequent hurricanes and storms, and occasional vandalism made the maintenance and monitoring of the platforms much more labor intensive and costly than originally planned. Even if staff could have maintained the network of sites and necessary infrastructure, safe access was also a concern. Although this type of monitoring is not an inherently unsafe activity, attempting to access low-marsh salt marsh sites on creek levees by small boat in areas with a 7-to-9-foot (2.1-to-2.7 meter) tidal range introduced a unique set of risks some SECN staff and steering committee members deemed not worth the value of the data being collected. Walking on slippery gangplanks connected to sometimes unstable boardwalks often covered with mud and algae while carrying heavy equipment was difficult to justify when employee safety is a programmatic priority.

Questions were also raised as to the validity and efficacy of monitoring marsh surface elevation levels at sites located on creek bank levies (areas where most of the originally-installed sites were located). Since these areas are known high sediment depositional areas, their value as representative areas of the salt marsh were questionable, especially in the bight area of the southeast coast (South Carolina to North Florida) where tidal ranges are maximum and strong tidal currents strongly influence sediment dynamics in these areas. Lastly, potential changes in salt marsh vegetation were noted as a major concern to parks and resource managers along the Atlantic coast. While this protocol addressed vegetation at the sub-site level at each SET station using a downward pointing tripod mounted camera, SECN staff and steering committee members believed addressing this issue at a larger spatial scale would be more appropriate and useful to park managers. Salt marsh vegetation will be addressed in a separate SECN protocol currently in development and will not be part of this revised effort.

During FY2019, SECN staff held multiple meetings with coastal park resource management staff to discuss the future of the SECN coastal wetland elevation monitoring effort. In-person meetings were held with the Georgia and Florida parks and a conference call was held to discuss monitoring efforts in the Outer Banks parks. The purpose of these meetings was to inform the park resource management staff of: (1) the use and implementation of the coastal wetland data collected in the

coastal wetland elevation monitoring project, (2) management actions that can be taken to address coastal wetland loss, and (3) discuss park management needs related to their wetland resources. The notes taken were sent to each park for approval and input after the meetings concluded. The park-approved notes from these meetings are provided below. Additional topics unrelated to coastal wetland elevation monitoring were also discussed but may have been omitted for brevity.

Cape Hatteras National Seashore and Cape Lookout National Seashore Meeting

Meeting Information

- Date: July 8, 2019
- Time: 1 p.m.
- Attendees: Tracy Valerius, Jon Altman, Lisa Cowart Baron, Kelsey Mack

Meeting Notes

- Water sampling
 - Porewater has not been very successful in the past
 - Only captures data for the day and time it was collected
 - This could be an inaccurate representation of the site due to many factors (rain, temperature, etc.)
 - Lisa suggests pulling data from nearby NOAA or USGS sondes
 - Current sondes for parks are at:
 - Cape Hatteras NS = Ocracoke
 - Cape Lookout NS = Shackleford dock
 - Tracy is interested in installing additional water quality sondes at Cape Hatteras NS
 - Cape Hatteras NS may be able to provide funds for their park
 - This may be too much for the network to take on as far as maintenance and data processing
 - Could this be accomplished through an IAA with USGS?
- Elevation
 - Cape Hatteras NS and Cape Lookout NS RSETs sites are accessible and can be accessed on foot
 - John asked about topography points to map elevation in marsh
 - This is successful in some ecosystems
 - Requires walking to different locations to collect elevation points
 - May cause too much disturbance in marsh areas that are very muddy
 - This may not be an issue at Cape Hatteras NS or Cape Lookout NS due to sandy sediment
 - This will be an issue at many other parks monitored by NPS I&M

- Lidar
 - At this time, technology may not be capable of producing an accurate representation of elevation in the saltmarsh due to the dense grasses.
- John thinks current RSET site was originally chosen because there has been a transition from sand to mudflat to marsh
- New site locations:
 - Cape Lookout National Seashore
 - Old NOAA RSET sites—located on S. Core
 - ◆ Pro: will not have to install new site
 - ◆ Con: John mentioned that he is not sure how long the sites will last
 - John is interested in seeing how the horse grazing affects the marshes on Shackleford Island
 - ◆ Tracy supported this
 - Portsmouth Village—N. Core
 - ◆ Cultural resource
 - ◆ Accessible via passenger ferry from Ocracoke
 - Cape Hatteras National Seashore
 - Lighthouses are an area of concern
 - Tracy is interested in Lisa's suggestions for new sites
 - ◆ Ocracoke
 - ◆ Hatteras
 - Tracy will talk with the Cultural Resource manager, Jamie, to get their input
- Vegetation
 - Cape Hatteras National Seashore and Cape Lookout National Seashore are supportive of remotely sensed analysis of vegetation change.

Cumberland Island National Seashore Meeting

Meeting Information

- Date: July 10, 2019
- Time: 2:30 p.m.
- Attendees: John Fry, Lisa Cowart Baron, Kelsey Mack

Meeting Notes

- Lisa's comments:
 - Target the parks interests
 - Sites in proximity to cultural resources
 - Site in proximity to recreational areas

- Sites under consideration for management
- Install new sites:
 - Located in higher marsh areas—this will help capture the transition of marsh vegetation over time
 - Accessible by foot
 - More sites spread out, rather than three nested together
 - Able to collect data in a reasonable timeframe
- Methodology:
 - Accretion:
 - Liquid nitrogen – has shown to be difficult in the field
 - Peat core—provides less of a sample than liquid nitrogen, but enough to detect feldspar layer
 - Vegetation:
 - Currently have five vegetation plots at each site that do not encompass the wetland vegetation types within the park and will not capture vegetation zone movement landward over time
 - Suggest remote analysis may provide more information for parks
 - Imagery usually taken by the state or county every 5–10 years
 - Water samples:
 - Porewater—only collects data at one point in time
 - Does not take other factors into consideration (rainfall, temperature, etc.)
 - Propose using sonde data—SECN sonde located at Sea Camp dock on Cumberland Island NS
 - Not located at RSET site, but will provide well rounded data for the area
- John Fry's comments:
 - Main priority of the park is vegetation spatial analysis:
 - How much wetland is the park losing/gaining?
 - Is there a transition occurring relative to low marsh/high marsh uplands?
- Potential new sites discussed:
 - Area in beach creek just near upland on south end of the island
 - Area just north of old Navy sites on Raccoon Key:
 - Will require wading across creek to access
 - Near dredge spoil area
 - Site near the middle Navy study:
 - Will be difficult to access

- Areas behind dunes on south end of the island:
 - Concern of shifting dunes impacting/burying RSET
- Cultural resources to keep in mind:
 - Fort St. Andrews
 - Brickhill Bluff
 - Plumb orchard
 - Dungeness
- Concern of horse grazing and trampling on south end of island:
 - John mentioned obtaining a clear depiction of what is going on in the marsh without the horse impacts
 - The park has previously implemented horse enclosure areas:
 - This may be an option to put around the RSET
 - To address this concern:
 - We could put two RSET's near each other
 - One enclosed; one not enclosed
- Navy Study:
 - RSET study looking at effects of dredging on the marsh
 - Report published in 2003
 - It would be interesting to relocate these sites:
 - No GPS coordinates were collected at the time, which would make this difficult
 - If located, these would not become I&M long-term monitoring locations
 - It would be interesting to take measurements at these sites to compare to previous data intermittently

Fort Frederica National Monument Meeting

Meeting Information

- Date: June 7, 2019
- Time: 1:30 p.m.
- Attendees: Steve Theus (park manager), Michael Seibert, Lisa Cowart Baron, Kelsey Mack

Meeting Notes

- Lisa Cowart Baron discussed report card and printed out power point presentation
- Current site:
 - Difficult to get to
 - Potential safety hazard
 - Platforms require many hours of maintenance

- Not representative of what the park wants
- Potential new sites:
 - Fort Frederica NM wants more sites in better locations:
 - Near the fort—will help park better preserve their cultural resource
 - Bloody marsh
 - Water monitoring station:
 - There is currently not a tidal gauge close to Fort Frederica National Monument
 - Collecting pore water data only tells what is happening at the time the data is collected
 - Long term monitoring may be more beneficial to the park
 - Install well at site?—this will need to be monitored monthly
 - Install sonde at dock
 - Fort Frederica NM has volunteers that would be willing to collect the data
 - ◆ Will Southeast Coast Network provide the sonde and training if the park monitors?
 - ◆ Who will process the data?
 - Fort Frederica National Monument and LCB will talk with Eric Starkey to hear his input on this idea
 - ◆ Can this be added to the networks monitoring schedule?
- Boat Wake Study:
 - Fort Frederica National Monument will be installing No Wake Zone buoys in front of the fort
 - Fort Frederica National Monument plans to look at how boat wakes are affecting their park beginning in the next few years:
 - They would like to compare the salt marsh monitoring data pre and post their boat wake study

Fort Matanzas National Monument Meeting

Meeting Information

- Date: June 19, 2019
- Time: 8:30 a.m.
- Attendees: Kurt Foote, Nikki Dix, Lisa Cowart Baron, Kelsey Mack Keira

Meeting Notes

- Current Sites:
 - Six sites within system are currently monitored by GTMNERR:
 - No current locations are within the park boundary

- GTMNERR RSET sites are not yet surveyed in – expected to take place this fall
- Three new sites were installed:
 - These sites are looking at how warming affects vegetation growth and decomposition
 - Greenhouse structures are constructed around each site – raise temps by 2 degrees
 - Southern most site is just north of Fort Matanzas National Monument
 - USGS assisted with installs of new sites
 - Ches—PhD student at University of Louisiana is also working full time for USGS
 - ◆ He is using these installs as part of his dissertation and would like to install more
 - ◆ See Nikki for more information and contact details
 - ◆ Ches Vervaeke: william_vervaeke@nps.gov (with SECN now)
- New SECN Sites:
 - I&M installed sites adjacent to the fort many years ago:
 - These sites were never used for monitoring
 - Extremely visible to the public
 - Removed by FOMA park staff
 - Kurt has concerns of visitors being able to see RSET from the fort as they overlook the marsh:
 - Lisa says the RSET itself should not be visible unless you know exactly where it is
 - No permanent platforms will be installed
 - PVC collar or plot markers may be the only visible components
 - ◆ GTMNERR uses grey PVC to make sites less visible
 - What the park wants:
 - Kurt is interested in capturing the transition of the salt marsh areas to mangroves
 - ◆ The park has seen a large number of mangroves beginning to move into their park
 - ◆ Mangroves can be seen moving into the park's areas of interest for RSET's
 - ◆ Nikki suggested selecting sentinel trees/vegetation plots at sites and collecting veg height, diameter width, etc. to monitor vegetation growth/change
 - Two RSET's
 - ◆ One located adjacent to the fort – access by park ferry
 - ◇ In proximity to the historical structure/cultural resource
 - ◇ The fort was originally built on a small island
 - ◇ The area around the island has since expanded to a vast salt marsh

- ◇ Kurt has noticed this expanded area beginning to erode back
 - ◇ Kurt mentioned that the park may only consider beneficial dredge if the fort is in direct danger – this RSET site could help provide good intel
- ◆ One located in proximity to visitor center adjacent to the ditched pond area
 - ◇ This location is within proximity to archeological sites and the historical structure (VC)
 - ◇ Lisa took photos of this site
 - ◇ Located just off of a trail in a salt marsh transition zone
 - ◇ Kurt will check this location at high tide to see extent of tidal change
- Vegetation mapping
 - Lisa suggests reviewing remote veg data that is collected by the county every three to five years
 - ◆ Nikki mentioned a website called Planning Matanzas that may have good vegetation data
 - ◆ St. Johns Water Management District did vegetation mapping of area in 2006
 - Drones
 - ◆ Nikki mentioned that GTMNERR will begin veg mapping via drone at their RSET sites
 - ◇ See Nikki for details and contact info for contractor
 - ◆ Fort Matanzas National Monument is hesitant on using drones in their park
 - ◇ Drones may be able to be launched from outside of the park and flown into the park to collect data
 - ◇ Reach out to Odie Anderson (SER) for more details

Fort Pulaski National Monument Meeting

Meeting Information

- Date: June 13, 2019
- Time: 10:30 a.m.
- Attendees: Candice Smith, Laura Waller, Lisa Cowart Baron, Kelsey Mack, Jean Butchart (GIP Intern), Doug Brown (FOPU Intern)

Meeting Notes

Salt Marsh/wetlands

- Current Sites:
 - Located in oyster creek:
 - Inaccessible near and at low tide
 - Laura brought up permitting—GA Coastal Marsh State Permit:

- Any marsh area at mean high tide or below in GA needs to go through this permitting process with the state (look into this for Fort Frederica National Monument as well)
 - All new and current sites will need to be permitted through the state!
- Park Systems:
 - Dike System:
 - Fort Pulaski NM is working with the Army Corp of Engineers to rehab the dike system
 - Ditch System:
 - Many areas have been blocked and water does not continuously flow
 - *Spartina*, sea oxide daisy, and phragmites are popping up in large numbers within areas of the failing ditch system in the middle of the island
 - Fort Pulaski NM has an intern conducting short term monitoring of hydrology on Cockspur Island (Gene)
- What the park wants:
 - Long term monitoring locations that are more spread out
 - Aerial imagery:
 - They have seen the vegetation shift drastically within the past four years and would like to document any future change
 - The park is currently focused on the hydrology and maintenance of Cockspur Island and its cultural resources:
 - They are more interested in short term monitoring on Cockspur Island
 - If the park could have three sites, ideally they would be located:
 - Two locations on McQueen's Island
 - The park does not know much about this area
 - They do not have the resources to look at this area on their own
 - There are some higher elevation locations we can check out that SECN could boat to and then walk on the marsh
 - Potential sites for this area that can be accessed from the road
 - Need to follow up with park and set up recon trip
 - One location on Cockspur island
 - 1 potential location was identified on SW side of island behind picnic area
 - ◆ This area shows a good transition from low to high marsh on a gradual slope
 - ◆ This area may sometimes be accessed by fishermen collecting fiddler crabs
 - ◆ Candice thinks if we move far enough away from the picnic area we will not see issues with visitors disturbing the study area

- Candice also suggested a location near the lighthouse on western side of the island
 - ◆ We did not scout this site
 - ◆ She mentioned it is only accessible to park staff via a narrow trail
 - ◆ Need to follow up during site recon trip with park

Guana Tolomato Matanzas National Estuarine Research Reserve Meeting

Meeting Information

- Date: June 5, 2019
- Time: 12 p.m.
- Attendees: Nikki Dix, Pamela Marcum, Lisa Cowart Baron, Kelsey Mack

Meeting Notes

General

- Lisa discussed report card and printed out power point presentation
- Developing consistent techniques:
 - What to do if you can't locate feldspar plot:
 - If the marsh is eroding you may not ever find the feldspar or clay (GTMNERR has seen this issue)
 - Current methods don't allow for negative values
 - Replacing feldspar may cause future issues if the feldspar that was previously unable to be located, is located at a later date (Lisa has experienced this issue)
 - There is currently no way to tell if the most current feldspar is being located
 - Can different colors be used?
 - GTMNERR has stopped collecting accretion data due to these issues
 - Laser leveling—potential new technique
 - Concerns about pore water:
 - 50/50 chance of successful pore water data collection at each site
- Current sites:
 - GTMNERR would like to continue monitoring the same sites
 - Use of rubber mats allow easier access to some plots
 - Vegetation:
 - *Juncus*—seems to be more sensitive and slow to recover after walked on or disturbed
 - *Spartina*—seems to recover more quickly
- Potential new sites:
 - At GTMNERR “the geomorphology of the area does not allow for textbook marsh sites:”

- Transitional areas are not present
- This may be the case for other parks as well – planning to install new sites in transitional zones may be difficult
- Data processing:
 - (Expected, Fall 2019) GTMNERR is in the process of developing an R package that can:
 - Auto generate graphs
 - Average all data points
 - Calculate standard error between platform averages

Timucuan Ecological and Historic Preserve Meeting

Meeting Information

- Date: June 10, 2019 and June 12, 2019
- Time: 8:30 a.m.
- Attendees: Lisa Cowart Baron and Dan Tardona

Salt Marsh/wetlands

- The park is supportive of one RSET per site and having more sites within the park
- The park is interested in sentinel salt marsh sites in proximity to culturally sensitive areas. Proposed locations include:
 - Cedar Point:
 - Potential site location on the south side of the dead-end road and off of trail.
 - High marsh vegetation present
 - Not common visitor spot
 - Kingsley Plantation:
 - Potential site location behind the maintenance shed
 - Would be in close proximity of proposed living shoreline located on the Fort George River along the Kingsley Plantation bulkhead
 - Would be especially of interest due to the dredging that is proposed for the Fort George Inlet down river from site. Would need to install during the next year.
 - Higher marsh site that contains succulents and sea oxide daisy vegetation migrating into upland tree line.
 - Theodore Roosevelt area:
 - Visited one potential site location, but the upland area had an increase in topography that would make migration of wetland vegetation difficult.
 - Need to check out other sites
- The park is interested in wetland vegetation being addressed via remotely sensed analysis of wetland vegetation zone distribution throughout the park.

Cape Canaveral National Seashore

The park is supportive of the Southeast Coast Network's consensus decision for the salt marsh protocol evaluation and would like to have salt marsh/mangrove/wetland monitoring conducted at their park. The park is supportive of more accessible site locations distributed throughout the park (as opposed to the three clumped stations of the current project design). If new sites are chosen, some areas of interest are:

- Northern end of park, at a restoration site, if not already being collected by other
- Different vegetation types (TBD)
- Pole troll zone area

The park is supportive of changing the vegetation method/approach to a larger scale vegetation collection that encompasses vegetation species/zone change for a three- to five-year data collection scale.

The park is ambiguous to the continued porewater salinity data collection using the same methods proposed in the current protocol. Dropping the measurement or using a nearby water level/salinity gauge for Mosquito Lagoon could suffice.

The park is interested in use/implementation of LiDAR, as the data collection accuracy of the technology use in wetlands advances.

Appendix B. Site Suitability Assessment Reports

This appendix contains information on the site selection process and site locations chosen for the SECN coastal wetland elevation monitoring project. Except for Cape Hatteras National Seashore and Cape Lookout National Seashore, each park determined its coastal wetland proposed site location at the park meetings performed during the summer of 2019 (see Introduction and Background, and Appendix A for more information). Information about the proposed and chosen coastal wetland monitoring site locations is described below for each park and listed with GPS coordinates at the end of this Appendix. The current coastal wetland elevation monitoring site location maps for Cape Hatteras NS and Cape Lookout NS are also included.

Cape Hatteras National Seashore

This site was chosen as part of the Southeast Coast Network's *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015). Since this site is accessible and of interest to the park, the network is going to continue sampling this site as part of this protocol and has added sites in Sandy Bay and on Ocracoke.

Cape Hatteras National Seashore Salt Marsh Sampling Locations

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



Figure B-1. Coastal wetland site and tide monitoring stations on Bodie Island near Cape Hatteras National Seashore in North Carolina. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Cape Hatteras National Seashore Salt Marsh Sampling Locations

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



Figure B-2. Coastal wetland site and tide monitoring stations in Sandy Bay near Cape Hatteras National Seashore in North Carolina. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Cape Hatteras National Seashore Salt Marsh Sampling Locations

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



Figure B-3. Coastal wetland site and tide monitoring stations on Ocrackoe Island near Cape Hatteras National Seashore in North Carolina. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Cape Lookout National Seashore

This site was chosen as part of the SECN *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015). The network will continue to sample this site as part of the protocol as it is accessible and of interest to the park.

Cape Lookout National Seashore Salt Marsh Sampling Locations

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



Figure B-4. Coastal wetland site and tidal monitoring stations on North Core near Cape Lookout National Seashore in North Carolina. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations are indicated (NOAA 2013).

Fort Pulaski National Monument

On February 3, 2020, FOPU park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-1). Based on the field reconnaissance, two sites were selected, U.S. 80 and Cockspur Island (Figure B-5). These two sites met the SECN criteria and are of interest to the park (Appendix A).

Table B-1. Table listing proposed coastal wetland locations at Fort Pulaski NM determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance, and if the potential site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Cockspur Island	West end of Cockspur Island accessible using service road.	Good site. Accessibility no problem. Need the combination for the fence. Public use not a concern. Can walk out to almost water's edge. <i>Spartina</i> and <i>Salicornia</i> present.	Yes
McQueen's Island	Marsh complex near an SECN veg plot. Note: will need boat.	Accessible at low tide. Organic marsh of <i>Spartina</i> . Some clumps of <i>Juncus</i> and <i>Distichlis</i> .	No
U.S. 80	Area located on U.S. 80 near McQueen's Island Trail Midpoint Entrance heading west before Bull River.	Good site. Accessible, but not easily accessible for public. <i>Spartina</i> present. Must park on the roadside, east of the bridge.	Yes
Lazaretto Creek	Salt marshes are on the north and south side of boat ramp road. Note: heavy public use; accretion area on the north side of fort.	Decided not to include due to high visitor use and social trails.	No

Fort Pulaski National Monument Salt Marsh Sampling Locations

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

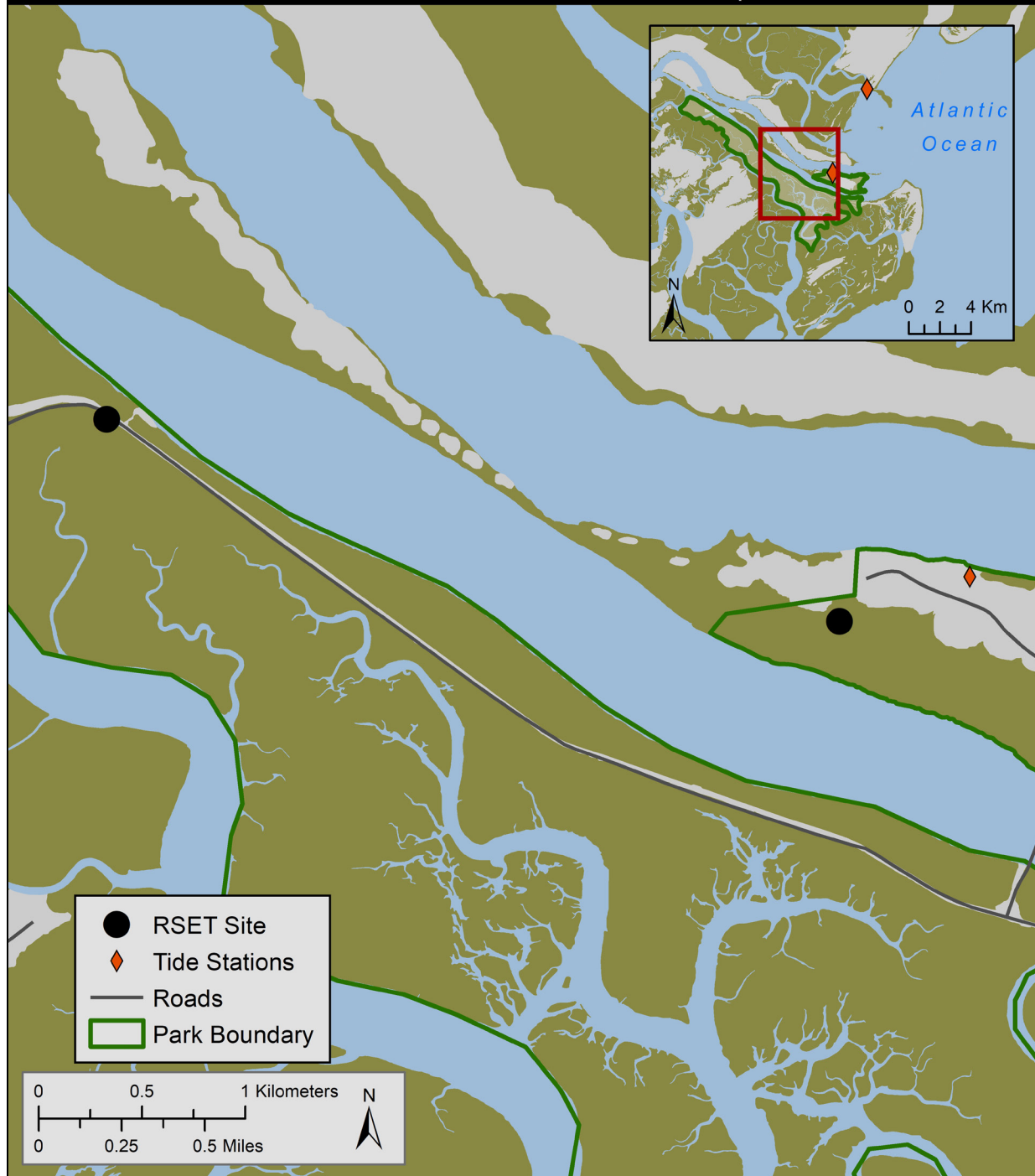


Figure B-5. Map of coastal wetland site locations at Fort Pulaski National Monument in Georgia. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Fort Frederica National Monument

On January 29, 2020, FOFR park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-2). Based on the field reconnaissance, two sites were selected, main park unit and bloody marsh (Figure B-6). These two sites met the SECN criteria and are of interest to the park.

Table B-2. Table listing proposed coastal wetland locations at Fort Frederica NM determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the site was selected.

Proposed Location	Description	Field Notes	Site Selected
New Property Acquisition	Salt marsh located adjacent to the park and newly acquired property.	Good site. Not selected because the other site is closer to the fort.	No
Main Park Unit	Salt marsh located adjacent to the park upland near the fort.	This location is closer to the fort than the new park property. This site is affected by the tidal fluctuations from Fort Frederica River.	Yes
Bloody Marsh	Area is of park interest due to cultural artifacts located nearby.	Marsh is different from the marsh located near the main park property and fort. This area is affected by a different water body.	Yes

Fort Frederica National Monument Salt Marsh Sampling Locations

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



Figure B-6. Map of coastal wetland site locations at Fort Frederica National Monument in Georgia. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Cumberland Island National Seashore

On February 4, 2020, CUIS park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-3). Based on the field reconnaissance, two sites were selected, Jetty 2 and Abram's Point (Figure B-7). These two sites met the SECN criteria and are of interest to the park.

Table B-3. Table listing proposed coastal wetland locations at Cumberland Island NS determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Jetty 1	Located on the south end of the island and accessed by driving down to the Jetty and then walking west over the primary dune line.	Mostly succulents. Vegetation is very patchy with marsh grass due to horse grazing.	No
Jetty 2	Located on the south end of the island and accessed by driving down to the Jetty and then walking west over the primary dune line. Located further west from Jetty 1.	Mostly succulents. Vegetation was patchy due to horse grazing, but not as bad as Jetty 1. There was some <i>Spartina</i> at the marsh edge.	yes
Marsh Boardwalk	Access this site by walking along east side of inner dune ridge; may be near the old lighthouse location; horse exclosures exist and everything inside is being monitored. Monitoring will stop eventually.	Would place RSETs along a transect, perpendicular to the upland. This would have the RSETs located in grazed area to ungrazed area. Would be nice to have at least 1 RSET within grazed area.	No. Back up if Abram's Point location is not approved
North End of Stafford Field	This site is accessed via a horse trail off the main road. It is higher priority due to cultural artifacts located nearby.	Site is less visible to visitors compared to Marsh Boardwalk Site. Potential wilderness which would most likely have us defer to the boardwalk site. John Fry was not sure about cultural artifacts being present near the site. The horse trail was somewhat difficult to see/follow.	No
Table Point	To access this location, park at the intersection of Lost Trail and Kings Bottom Trail, need to take 2 trails; there is another way to access the location via a horse trail.	This site is difficult to access. Had a hard time making our way to marsh. Very embayed site. Alternative site would be better due to access. Would need to make trail if used. Potential wilderness area, and likely not worth the effort. Disregard.	No

Table B-3 (continued). Table listing proposed coastal wetland locations at Cumberland Island NS determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Abram's Point	To access site, park near bridge and walk out towards marsh.	This site is also located in potential wilderness. Upland trees are 11.5 years old due to fire. Near old horse enclosure. Not as much horse grazing. Would be a better site compared to the Marsh Boardwalk site.	Yes
Terrapin Point	Located on the northern end of the island. The edge is soft ground. This site is different from other sites. The site doesn't have the transition qualities. Located near the old fort. Was a die off area. Now coming back. Lowest priority.	Does not have usual gradual elevation gradient. Has a lot of low spots. Generally similar elevation. A lot of succulents. Would include as a site if SECN installs 3 sites due to location and proximity to water way. Will need to access at falling/low tide.	No

Cumberland Island National Seashore
Salt Marsh Sampling Locations

Southeast Coast Network
National Park Service
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Figure B-7. Map of the coastal wetland locations at Cumberland Island National Seashore in Georgia. Salt marsh areas (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013) are indicated.

Timucuan Ecological and Historic Preserve

On January 28, 2020, TIMU park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-4). Based on the field reconnaissance, two sites were selected, Kingsley Plantation and Cedar Point (Figure B-8). These two sites met the SECN criteria and are of interest to the park.

Table B-4. Table listing proposed coastal wetland locations at Timucuan E&HP determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the potential site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Kingsley Planation	Area located behind the maintenance shed. No visitor access. Located near culturally significant buildings.	Checked out site to the southwest of the maintenance shed. There was some <i>Juncus</i> up near the higher elevation between some shrubby/tree vegetation. Most of the marsh was <i>Spartina alterniflora</i> . This site meets all SECN's criteria and is a priority for the park due to its proximity to the cultural structures.	Yes
Cedar Point	Located near culturally significant site. Accessed via park road with minimal visitor access.	Drove to end of cedar point road and accessed the trail road through the park gate. Need gate key. Drove down road staying on blue trail, veered left at fork of blue trail. This trail is a loop; however, the western side of the loop can be difficult for large trucks. Might be best to back out or turn around. Access site by parking vehicle near trail post marker. Walk through vegetation into marsh. <i>Spartina alterniflora</i> marsh was present. This site is of interest to the park due to its proximity to cultural resources, located a bit north of the site.	Yes
Fort Caroline	Located near the current fort structure in pocket marsh. There is a berm on the rive edge of the marsh.	Walked out into the marsh to the west of the fort. There is a small drop in elevation into the marsh. This marsh is different from the other sites, as it is a pocket of marsh between a small island and the upland of the fort. Collected a GPS point near the upland edge and down at the berm. There is a mix of <i>Juncus roemerianus</i> and <i>Spartina alterniflora</i> present within this marsh. There is a berm on the water's edge that allows tidal inundation but appears to protect the marsh. This site is lower priority compared to the other two visited.	No

Timucuan Ecological & Historic Preserve Salt Marsh Sampling Locations

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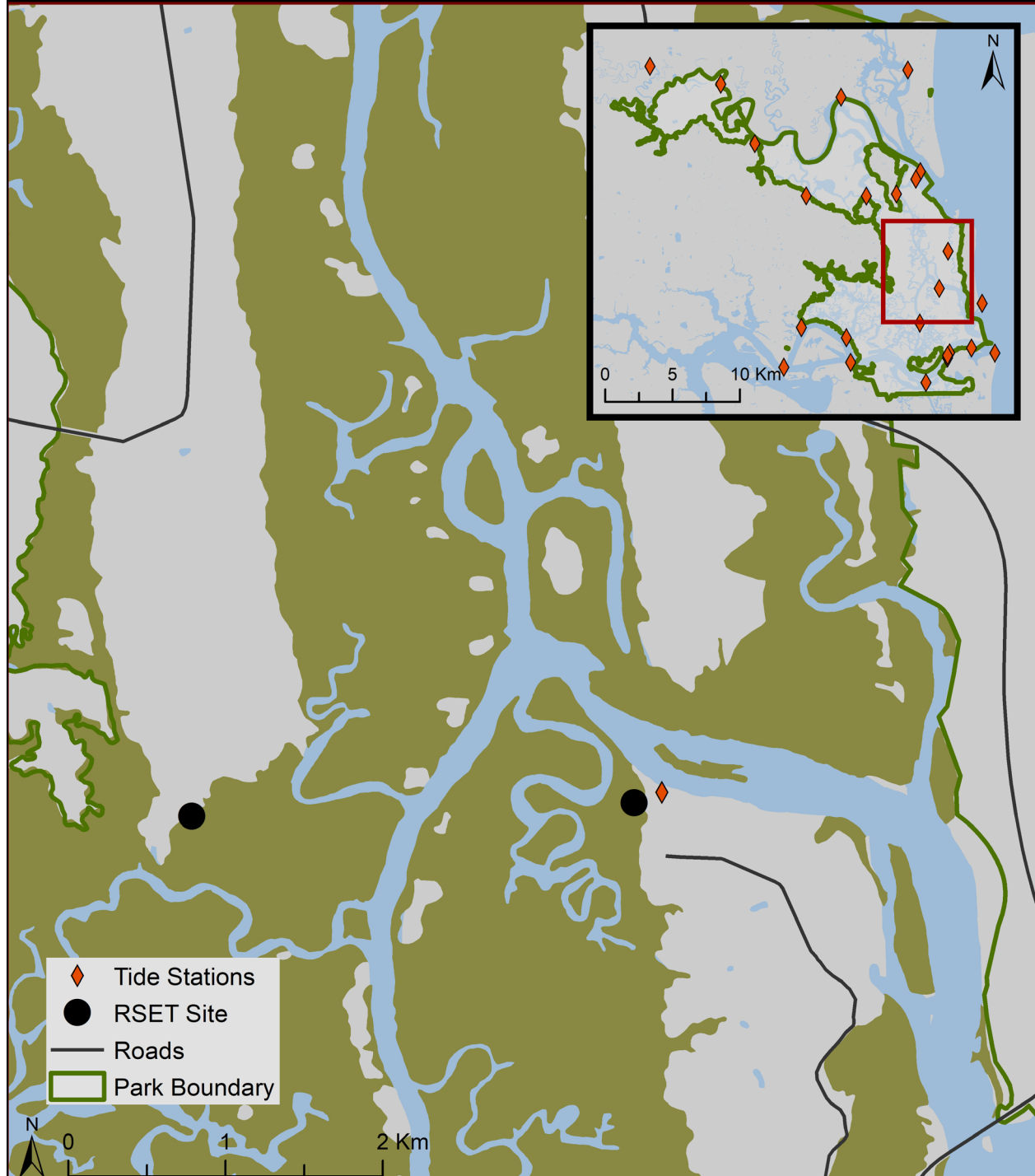


Figure B-8. Map of coastal wetland locations at Timucuan Ecological and Historic Preserve in Florida. Indicated are areas of salt marsh (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013).

Fort Matanzas National Monument and The Guana Tolomato National Estuarine Research Reserve

On January 16, 2020, FOMA park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-5). Multiple locations near the fort on Rattlesnake Island were checked. Visibility is a concern for the park and the site selected could not interfere with the visitor viewshed from the fort. To ensure the view from the fort would be unobstructed by the sampling site, one person stayed atop the fort to communicate which potential locations would meet the criteria. The last potential location was deemed the best as it was not visible from the top of the fort; it is hidden to park visitors by the palm and shrubs on the left side. Based on the field reconnaissance, this site was selected, located near Fort Matanzas (Figure B-9). This site met the SECN criteria and is of interest to the park. Additionally, the original six sites that were installed as part of the Southeast Coast Network's *Protocol for Monitoring Coastal Salt Marsh Elevation and Vegetation Communities in Southeast Coast Network Parks* (DeVivo et al. 2015) in partnership with the GTMNERR (Figure A-7) are located north and south of Fort Matanzas National Monument. As part of the ongoing partnership, the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) maintains and collects surface elevation and marker horizon data at these six coastal wetland elevation sites located north and south of Fort Matanzas NM.

Table B-5. Table listing proposed coastal wetland locations at Fort Matanzas NM determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the potential site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Rattlesnake Island 1	Salt marsh located adjacent to a creek connected to the Matanzas River.	The marsh area was small, and the site was not easily accessible due to the bank of the creek.	No
Rattlesnake Island 2	Salt marsh located between ponded water from Matanzas Creek and an upland.	Marsh was small. The water/marsh interface was lined with shrubs. The site did not exhibit the water to wetland to upland transition.	No
Rattlesnake Island 3	Salt marsh site located closest to the Fort. Site is accessible from ferry dock.	Site was not visible from lookout position on Fort. The site is adjacent to a creek from the Matanzas River on one side and upland on the other side.	Yes

Fort Matanzas National Monument Salt Marsh Sampling Locations

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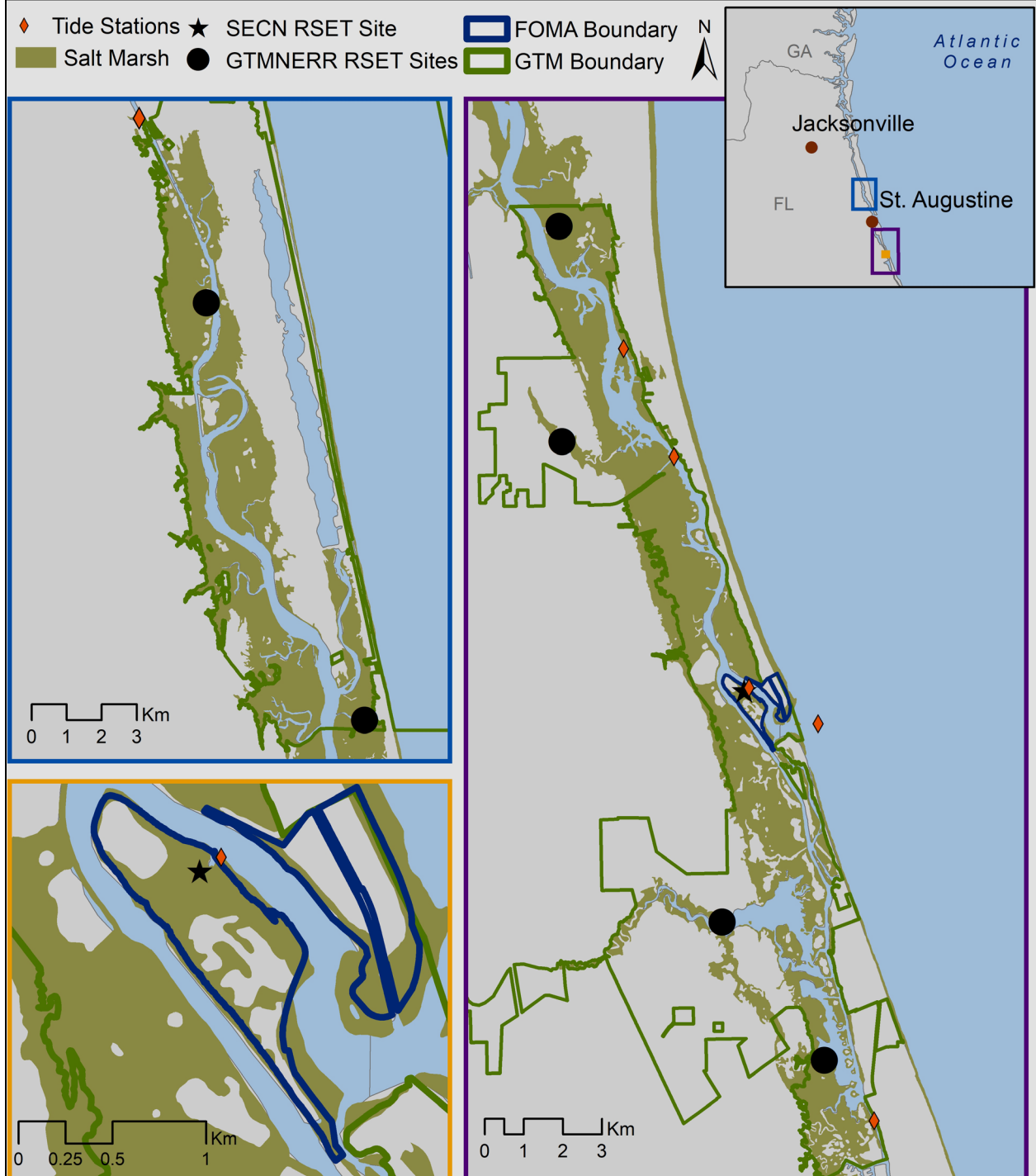


Figure B-9. Map of coastal wetland locations at Fort Matanzas National Monument and Guana Tolomato Matanzas National Estuarine Research Reserve in Florida. Indicated are areas of salt marsh (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013).

Canaveral National Seashore

On February 24 and 28, 2020, CANA park staff and SECN staff performed reconnaissance of the proposed coastal wetland site locations (Table B-6). Based on the field reconnaissance, two sites were selected, UCF Dock and Shipyard Island (Figure B-10). These two sites met the SECN criteria and are of interest to the park.

Table B-6. Table listing proposed coastal wetland locations at Canaveral NS determined during park scoping. Included is a description of the site, field notes collected during field reconnaissance and if the potential site was selected as a coastal wetland site for this protocol.

Proposed Location	Description	Field Notes	Site Selected
Shipyard Island	Restored mosquito ditches. Leveled elevation and restored it. It looks great. South of backcountry campsite. Mangroves and marsh.	Accessed at high tide. Went to campsite and walked over to other side and then south. Would need to create path for installation and sampling, which may cause social trail degradation.	Yes
SJWMD Site 1	Across from beach ramp 5 boat ramp. Previously installed by SJWMD as a control site.	Accessible. Very shallow approach. Appears to be inundated at higher high tides or storm tides. Currently not inundated at high tide. Stable footing. <i>Salicornia</i> and mangroves present.	No
SJWMD Site 2	Access from west side of lagoon using River Breeze Gone Fishing Mosquito Lagoon. Previously installed by SJWMD as a control site.	Inundated at high tide. All succulents and mangrove. Accessible, but iffy with the wind due to shallowness. Substrate not firm at water's edge.	No
UCF Dock	North of Feller's House. Marsh complex within mangroves adjacent to mainland.	Accessible by walking to the end of the dock. Not accessible to visitors from the park. Mangrove and <i>Salicornia</i> .	Yes
Old Daytona Beach Community College Bunkhouse	Building currently not used. Fishing dock in good condition nearby.	Elevation drops off quickly. Easily accessible from parking lot 7. Black mangroves present. Not ideal due to lack of elevation gradient.	No
Eldora House	Location south of Eldora House near to where a living shoreline was installed.	Small clumps of <i>Spartina</i> are present just south of Eldora House. Site is accessible. <i>Spartina</i> areas may not be representative of park vegetation. Further south from <i>Spartina</i> , where mangroves are located, there is not much of a gradient. Similar to Bunkhouse location.	No

Canaveral National Seashore Salt Marsh Sampling Locations

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Figure B-10. Map of coastal wetland site locations at Canaveral National Seashore in Florida. Indicated are areas of salt marsh (FWS 2013) and CO-OPS tidal monitoring stations (NOAA 2013).

Table B-7. SET site locations and install dates. [m=meters].

Park	Site	SET ID	Install	Latitude, Longitude (NAD83)	Depth (m)	Veg type*	Notes
CANA	UCF Pier	CANA 121 A	3-24-21	28.90696, -80.82034	27.82	AVGE	North of pier, near upland transition
	UCF Pier	CANA 121 B	3-24-21	28.90696, -80.82047	29.77	AVGE	North of pier, middle of marsh
	UCF Pier	CANA 121 C	3-24-21	28.90707, -80.82086	26.65	AVGE, BAMA	North of pier, 10 ft from water's edge
	Shipyard Island	CANA 221 A	3-23-21	28.94117, -80.84445	21.86	AVGE, LARA	Near campsite #3 just into marsh
	Shipyard Island	CANA 221 B	3-23-21	28.9412, -80.84441	23.54	AVGE, SPAL	Near campsite #3 farther into marsh
	Shipyard Island	CANA 221 C	3-23-21	28.94127, -80.84441	25.33	AVGE	Near campsite #3 farthest into marsh
FOMA	Fort	FOMA 021 A	3-19-21	29.71426, -81.23940	24.26	SPAL	—
	Fort	FOMA 021 B	3-19-21	29.71427, -81.23924	24.35	SPAL, BAMA	—
	Fort	FOMA 021 C	3-19-21	29.71437, -81.23923	26.37	BAMA, SPAL	—
TIMU	Cedar Point	TIMU 04 A	12-11-20	30.43826, -81.46968	18.71	SPAL	Northern most site
	Cedar Point	TIMU 04 B	12-11-20	30.43813, -81.46983	17.52	SPAL	—
	Cedar Point	TIMU 04 C	12-11-20	30.43798, -81.46991	25.60	SPAL	Southern most site
	Kingsley Plantation	TIMU 03 A	12-10-20	30.43963, -81.43999	18.89	SPAL	Northern most site
	Kingsley Plantation	TIMU 03 B	12-10-20	30.43946, -81.44000	15.76	SPAL	—
	Kingsley Plantation	TIMU 03 C	12-10-20	30.43935, -81.44008	20.19	SPAL	Southern most site
CUIS	Jetty 2	CUIS 121 A	4-6-21	30.71713, -81.45844	17.07	SPAL	Farthest into marsh
	Jetty 2	CUIS 121 B	4-6-21	30.71698, -81.45846	19.40	BAMA	—
	Jetty 2	CUIS 121 C	4-6-21	30.71683, -81.45850	16.87	SABI	Closest to dunes
	Abram's Point	CUIS 221 A	4-7-21	30.90740, -81.44801	23.92	SPAL	Southern most site

* Vegetation Key: AVGE, *Avicennia Germinans*; BAMA, *Batis maritima*; JURO, *Juncus romerianus*; LARA, *Laguncularia racemosa*; SABI, *Salicornia bigelovii*; SCRO, *Schoenoplectus robustus*; SPAL, *Spartina alterniflora*.

Table B-7 (continued). SET site locations and install dates. [m=meters].

Park	Site	SET ID	Install	Latitude, Longitude (NAD83)	Depth (m)	Veg type*	Notes
CUIS (cont'd)	Abram's Point	CUIS 221 B	4-7-21	30.90770, -81.44810	20.56	SPAL	–
	Abram's Point	CUIS 221 C	4-7-21	30.90793, -81.44823	21.76	SPAL	Northern most site
FOFR	Bloody Marsh	FOFR 121 A	4-8-21	31.15677, -81.37832	20.64	SPAL	Farthest into marsh
	Bloody Marsh	FOFR 121 B	4-8-21	31.15676, -81.37850	21.84	SPAL	–
	Bloody Marsh	FOFR 121 C	4-8-21	31.15672, -81.37876	23.15	SPAL	–
	Fort	FOFR 221 A	4-9-21	31.22572, -81.39288	19.45	SCRO	Before transition to JURO
	Fort	FOFR 221 B	4-9-21	31.22593, -81.39314	17.52	JURO	–
	Fort	FOFR 221 C	4-9-21	31.22587, -81.39327	21.10	JURO	–
FOPU	Cockspur Island	FOPU 121 A	5-4-21	32.03106, -80.90847	23.06	SPAL, SABI	–
	Cockspur Island	FOPU 121 B	5-4-21	32.03120, -80.90843	23.11	SPAL, SABI	–
	Cockspur Island	FOPU 121 C	5-4-21	32.03132, -80.90839	23.11	SPAL, SABI	–
	HWY 80	FOPU 221 A	5-5-21	32.03949, -80.94539	26.71	SPAL	–
	HWY 80	FOPU 221 B	5-5-21	32.03950, -80.94552	24.09	SPAL	–
	HWY 80	FOPU 221 C	5-5-21	32.03959, -81.94544	24.15	SPAL	–
CALO	Mullet Shoals	CALO 01 A	5-6-14	34.979454, -76.162758	26.82	JURO	–
	Mullet Shoals	CALO 01 B	5-7-14	34.979525, -76.162894	22.31	JURO	–
	Mullet Shoals	CALO 01 C	5-7-14	34.979597, -76.162992	17.07	JURO	–
CAHA	Bodie Island	CAHA 11 A	4-27-14	35.804885, -75.552174	28.04	JURO	–
	Bodie Island	CAHA 11 B	4-27-14	35.804773, -75.552132	28.04	JURO	–

* Vegetation Key: AVGE, *Avicennia Germinans*; BAMA, *Batis maritima*; JURO, *Juncus romerianus*; LARA, *Laguncularia racemosa*; SABI, *Salicornia bigelovii*; SCRO, *Schoenoplectus robustus*; SPAL, *Spartina alterniflora*.

Table B-7 (continued). SET site locations and install dates. [m=meters].

Park	Site	SET ID	Install	Latitude, Longitude (NAD83)	Depth (m)	Veg type*	Notes
CAHA (cont'd)	Bodie Island	CAHA 11 C	4-29-14	35.804791, -75.551967	28.00	JURO	–
	Sandy Bay	CAHA 122 A	10-13-22	35.22235, -75.65553	18.28	SPAL	Farthest east from parking area
	Sandy Bay	CAHA 122 B	10-13-22	35.22207, -75.65615	17.58	SPAL	–
	Sandy Bay	CAHA 122 C	10-13-22	35.22226, -75.65576	16.5	SPAL	Closest to parking area
	Scagg Cedars Road	CAHA 222 A	10-14-22	35.16266, -75.84644	19.06	JURO	–
	Scagg Cedars Road	CAHA 222 B	10-14-22	35.16276, -75.84635	18.22	JURO	–
	Scagg Cedars Road	CAHA 222 C	10-14-22	35.16281, -75.84623	18.25	JURO	Closest to parking area

* Vegetation Key: AVGE, *Avicennia Germinans*; BAMA, *Batis maritima*; JURO, *Juncus romerianus*; LARA, *Laguncularia racemosa*; SABI, *Salicornia bigelovii*; SCRO, *Schoenoplectus robustus*; SPAL, *Spartina alterniflora*.

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