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Natural Resource Stewardship and Science

Monitoring Coastal Topography at Gulf Coast Network Parks

Protocol Implementation Plan

Natural Resource Report NPS/GULN/NRR—2017/1522

ON THIS PAGE
Photograph of surveyor measuring coastal topography at Padre Island National Seashore.

ON THE COVER
Photograph of visitor use area at Padre Island National Seashore.
Photograph courtesy of Joe Meiman, National Park Service.

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Natural Resource Report NPS/GULN/NRR—2017/1522

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Contents

Contents (continued)

Figures

Tables

Page

Abstract

Coastal geomorphology was ranked as one of the top vital signs for the Gulf Coast Network (GULN) to monitor following the Vital Sign prioritization process, which is documented in the Gulf Coast Network Vital Signs Monitoring Plan (Segura et al. 2007).

The Gulf Coast Network will follow Northeast Coastal and Barrier Network's methods for monitoring coastal geomorphology, documented in Psuty et al. (2012), at Gulf Islands (GUIS) and Padre Island (PAIS) National Seashores. These methods will be used to create a network of permanently established reference points that will allow for the collection of highly accurate elevation data along beach/dune transects. Profiles created from these elevation data will be tracked through space and time to better understand geomorphic processes and spatial patterns as they relate to park resources.

Surveys will be conducted biennially (every other year) in the spring and coincide with neap tides, carefully avoiding nesting shorebirds and potentially disruptive tropical storms. Data will be assembled in databases established by Northeast Coastal and Barrier Network for the storage and retrieval of profile dimensions. Likewise, NCBN methodologies for analysis will be used to examine long-term trends in temporal and spatial variation. "The overall goal is to create a replicable means of data gathering that is efficient, adheres to scientific principles, and meets the management needs of the barrier island parks" (Psuty et al. 2012, p. xiii).

Section 1. Introduction / Background

Coastal geomorphology was ranked as one of the top vital signs for monitoring following the Vital Sign prioritization process, which is documented in the *Gulf Coast Network Vital Signs Monitoring Plan* (Segura et al. 2007). The background and justifications for the Gulf Coast Network (GULN) to monitor coastal geomorphology align with those documented in Part 2, Coastal Topography, of the Northeast Coastal and Barrier Network's (NCBN) Coastal Geomorphology protocol, that states:

> *Changes in coastal topography, whether caused by erosion or accretion, vary both spatially and temporally. Understanding these variations is key to early recognition of potential problems affecting natural resources and cultural resources in coastal parks. For managers, an understanding of the spatial and temporal patterns of geomorphologic change is basic to optimal management of any coastal park because the interface of marine and land systems: (1) is highly dynamic and driven by multiple forcing mechanisms; (2) results in alterations to resource patterns and dynamics at habitat and ecosystem levels; and (3) can eventually result in the loss of static resources. The establishment of local, long-term monitoring programs provides metrics (SI, meters) to help understand the processes that are driving coastal change of beaches, dunes, and bluffs within the parks (Psuty et al. 2012, p. xiii).*

The Gulf Coast Network will follow Northeast Coastal and Barrier Network's methods for monitoring coastal geomorphology, documented in Psuty et al. (2012), at Gulf Islands (GUIS) and Padre Island (PAIS) National Seashores. These methods will be used to create a network of permanently established reference points that will allow for the collection of highly accurate elevation data along beach/dune transects. Profiles created from these elevation data will be tracked through space and time to better understand geomorphic processes and spatial patterns as they relate to park resources.

Profile transects will generally originate landward of the foredune ridge and extend shoreward, at an angle perpendicular to the normal shoreline, to an elevation of -0.04 meters (NAVD88). This elevation threshold will ensure that 0.0 meters (NAVD88) will be reached, allowing for the 2–4 centimeters (0.7–1.5 inches [in]) of vertical uncertainty that are associated with geodetic survey equipment as documented in Psuty et al. (2012, p. 19). Surveys will be conducted biennially (every other year) in the spring and coincide with neap tides, carefully avoiding nesting shorebirds and potentially disruptive tropical storms. Data will be assembled in databases established by Northeast Coastal and Barrier Network for the storage and retrieval of profile dimensions. Likewise, NCBN methodologies for analysis will be used to examine long-term trends in temporal and spatial variation. "The overall goal is to create a replicable means of data gathering that is efficient, adheres to scientific principles, and meets the management needs of the barrier island parks" (Psuty et al. 2012, p. xiii).

Gulf Coast Network's adaptation of Psuty et al. (2012) will incorporate minor modifications that are outlined below and are organized by Northeast Coastal and Barrier Network's coastal topography protocol section headings.

Monitoring Objective

GULN's monitoring objective is to identify the biennial and long-term trends and variability in time and space of beach/dune/bluff morphology. This contrasts with NCBN's objective that includes seasonal variability and annual surveying (Psuty et al. 2012, p. 14).

Monitoring Questions

The Gulf Coast Network's monitoring questions are: (1) What are the biennial dimensions of the coastal features? (2) What are the long-term, ten years or more, dimensions of the coastal features? (3) What are the directional displacements of the coastal features? (4) What are the spatial and temporal trends in the displacement of the coastal features? These questions differ from the NCBN's protocol in that it excludes seasonal variation, looks at biennial rather than annual dimensions of displacement, and uses a minimum of five survey events for trend analysis, that results in a reporting frequency of 10 years instead of five for question 2 (Psuty et al. 2012, p. 14).

Measuring Coastal Topography

Because Gulf-side and Sound-side geomorphology are influenced by different scales of wave and current processes, Gulf and Sound barrier island shorelines are not always parallel. Therefore, at some locations, a single transect extending perpendicular to the Gulf shoreline across the entire island will orient some transects such that they would not be perpendicular to the generalized Sound-side shoreline. Such is the case at Gulf Islands National Seashore's (GUIS, Gulf Island NS) Horn Island. Accordingly, two sets of transects will be drawn at Horn Island. One set will be perpendicular to the Gulf shoreline and extend generally southward from the vegetated core of the island. The other set will be perpendicular to the Sound shoreline and extend generally northward from the vegetated core of the island. This allowance is consistent with Psuty et al. (2012) and the point is highlighted here solely to explain the difference between the transect orientation at Horn Island versus other transects at Gulf Islands NS.

Monitoring Design

Establishment of the Spatial Monuments Network

Transects at Gulf Island NS will be established at Horn and Petit Bois Islands in Mississippi and at Fort Pickens and eastern Perdido Key in Florida. Padre Island National Seashore (PAIS, Padre Island NS) transects will be established in a series of clusters distributed along the entire length of the Gulf shoreline (see Section 5. Sampling Design and Monitoring Schedule).

Survey Frequency and Timing

In NCBN ocean parks, GPS surveys are conducted in early spring (mid-March to late April) and early fall (mid-September to late October), a period that coincides with the peak expression of seasonal beach variability (Psuty et al. 2012, p. 28). The peak summer expression at Gulf Islands and Padre Island National Seashores occurs in late summer (August to mid-September), before passages of northerlies (winds blowing from the north) begin to deflate dunes, widen beach profiles and create less discrete primary dune and shoreline features. Unfortunately, the Atlantic hurricane season, which includes the Gulf of Mexico, coincidentally peaks in the summer, running from June through November and peaking in September. Tropical storms or hurricanes (wind speeds greater than 39 mph) occur every 3–5 years at GULN seashore parks (Keim et al. 2007) and can dramatically alter typical geomorphological form. When storm-affected surveys are analyzed with non-affected surveys, short-term change will be highlighted, but resulting trends may be misleading.

As the network focus is on long term trends, coastal topography surveys will be conducted in only one season during the sampling year, avoiding the deflated winter season expression, but also avoiding tropical storm altered beach/dune system. April and May emerge as the ideal months to survey GULN coastal parks as this timeframe is between the winter season, characterized by dominant north winds, and the Atlantic hurricane season. The spring season also coincides with GULN vegetation monitoring efforts. Overlapping these monitoring projects in space and time will allow for logistical advantages for conducting field work and the potential for the topography data set to inform the vegetation data set, and vice versa. A maximum two-month survey window at each park will allow for flexible scheduling in case of unforeseen interferences. May is the preferred survey month because the beach-dune system is becoming more stable in the absence of northerlies. If possible, Padre Island NS should be surveyed in May. To avoid disturbing nesting shorebirds, GUIS biologists prefer that the network conduct shoreline surveys in April at Gulf Islands NS.

The Northeast Coastal and Barrier Network targets tidal conditions that coincide with low tide during a spring tide period. This allows maximum terrestrial exposure of the beach. Daily tidal ranges are far less in GULN coastal parks, 0.15–0.49 meters (0.5–1.6 feet [ft]), than NCBN coastal parks, 0.34–2.67 meters (1.1–8.8 ft) (Hammar-Klose and Theiler, E.R. 2001). Therefore, timing GULN surveys with spring tides is less important for maximizing terrestrial exposure. Planning around neap tides will lessen the tidal range even more, rendering beach exposure only slightly changed through the course of a day, and even the entire neap cycle (several days). As an outcome, the surveyor may utilize the entire daylight period, over the course of several days, to survey to the -0.04 meter (NAVD88) threshold without having to wade deep into the water. Surveying topography during neap tide periods offers the added advantage of being synchronous with GULN shoreline position monitoring (Bracewell 2016). Because neap tide periods allow for a long survey period with a reduced probability of needing to wade deep into the water, and the timeframe is coincident with shoreline position surveys, the Gulf Coast Network will target neap tide conditions for conducting topographic surveys.

Field Methods

Conducting the Topographic Survey:

The Northeast Coastal and Barrier Network requires at least one photo at each profile line, parallel to the general orientation of the dune ridge, so as to capture the general aspect of the dune feature (Psuty et al. 2012 p. 35). Additionally, the Gulf Coast Network will require photos at the transect intersection with the shoreline (wet/dry line) and at the dune crest.

Data Analysis and Reporting

Data Analysis and Reports

- The Northeast Coastal and Barrier Network’s annual reports include a seasonal comparison (Psuty et al. 2012, p. 33). Seasonal comparisons will not be reported because the Gulf Coast Network will only capture the spring season.

- The Northeast Coastal and Barrier Network produces annual reports to describe within season, as well as year-to-year variation (Psuty et al. 2012, p. 33). The Gulf Coast Network will produce similar reports on a biennial schedule, comparing the current year's survey with the previous survey.
- Similar to the Northeast Coastal and Barrier Network, the Gulf Coast Network will produce project trend reports, in consultation with locally knowledgeable coastal geology experts, after five within-season sampling events (Psuty et al. 2012, p. 39). NCBN's sampling frequency is twice per year (spring and fall seasons), the trend report occurs approximately every five years. In contrast, the GULN sampling frequency is every other year, within the spring season, resulting in a trend reporting frequency of approximately every ten years.

Personnel Requirements and Training

Roles and Responsibilities

- The Northeast Coastal and Barrier Network implements the protocol using local park staff and cooperators (Psuty et al. 2012, p. 41). The Gulf Coast Network staff or local cooperators will conduct the survey rather than park staff. Logistical support from parks will be necessary to access transect locations.
- The Gulf Coast Network will be responsible for procuring the GPS/GNSS equipment and software necessary for performing the survey, post-processing results, and conducting basic change analysis. This is similar to the NCBN approach, except that the NCBN parks provide their own GPS/GNSS equipment for the monitoring effort (Psuty et al. 2012, p. 41).

Section 2. Conceptual Framework for Monitoring

Barrier islands are geologically young features; the vast majority are less than 7,000 years in age, and most are probably less than 3,000 years old. Barrier-island formation is dependent upon the complex interaction among waves, currents, sea-level change, and the availability of sediment. They are a vital part of the coastal and estuarine habitats found in Gulf Coast Network parks. The subaerial portions of the barrier islands are composed of three general topographical zones: beach, dune, and back dune. Each zone provides critical habitat for several state- and federally- listed species. These systems serve as key stopover areas for migratory birds, nesting sites for sea turtles, year-round habitat for the Perdido Key beach mouse, and nesting and wintering habitat for shorebirds (Segura et al. 2007). Ecological stressors affecting geomorphic processes in Gulf Coast Network barrier island parks are documented in Table 1.

Table 1. Ecological context for the GULN coastal geomorphology vital sign (adapted from Segura et al. 2007).

Vital Sign	Issue	Potential Measures
	Dredge-and-spoil operations, coastal armoring, hydrologic modification, beach nourishment affecting sediment supply and transport	
	Water and oil and gas extraction affecting subsidence	
	Recreation (driving, foot-traffic) affecting erosion and altering geomorphic processes	
	Climate change and increased storm frequency altering geomorphic processes	

Measuring coastal topography is an established method for assessing geomorphic dimension and properties as presented in Table 1. Measuring the change in topography will yield spatially explicit information about the rates of erosion or accretion along the beach/dune system in shoreline parks.

The coastal geomorphology monitoring methods in Psuty et al. (2012) will be implemented by the Gulf Coast Network with minor modifications to collect highly accurate elevation data along transects. These elevation data will allow for the measurement of coastal geomorphic features and comparison of these features across time. Documenting changes in geomorphology will address an array of park management interests primarily related to the loss or gain of sediment and changes in profile feature dimension and location. Other GULN monitoring efforts at seashore parks that might be informed by monitoring coastal geomorphology include: Land Birds, Terrestrial Vegetation, Seagrasses, and Water Quality. As the islands of Gulf Islands and Padre Island National Seashores provide the foundation for almost all of these park's natural and cultural resources, a better understanding of the geomorphic change patterns through space and time will help park managers explain changes in biological communities and habitat availability. In addition to the primary focus of this effort, the information collected using this protocol will also be useful in the management of cultural assets and park infrastructure.

Section 3. Measurable Objectives

The measurable objective stated in Psuty et al. (2012) focuses on identification of seasonal, annual, and long-term (five years or more of protocol-derived data sets) trends and variability in time and space of beach/dune/bluff morphology in the network parks. Meeting this objective addresses the following questions:

- What are the seasonal dimensions of the coastal features?
- What are the annual dimensions of the coastal features?
- What are the long-term, five years or more, dimensions of the coastal features?
- What are the directional displacements of the coastal features?
- What are the spatial and temporal trends in the displacement of the coastal features?

The Gulf Coast Network will adopt a similar objective and set of monitoring questions:

- GULN's monitoring objective is to identify the biennial and long-term trends and variability in time and space of beach/dune/bluff morphology in network parks.
- GULN's monitoring questions are: (1) What are the biennial dimensions of the coastal features? (2) What are the long-term dimensions of the coastal features? (3) What are the directional displacements of the coastal features? (4) What are the spatial and temporal trends in the displacement of the coastal features?"

By focusing on long-term trends rather than seasonal variation and annual comparisons, the network will establish an achievable workload that is sustainable in the context of executing all GULN protocols. Routinely collecting dimensions every other year will address the network's stated monitoring objective to "Establish a current baseline condition and document changes in coastal barrier-island morphology, both gradual and storm-induced (Segura et al. 2007)."

Section 4. What's Being Measured and How

The Gulf Coast Network will be monitoring coastal topography using the same methods developed and approved for implementation in the Northeast Coastal and Barrier Network (Psuty et al. 2012) using Differentially Corrected Global Navigation Satellite Systems or DGNSS. This system, detailed in Tables 2a and 2b, combines the U.S. Global Positioning System (GPS) and other satellite-based positioning and timing systems for the collection of highly accurate location data in both horizontal (xy) and elevational (z) planes. These xyz positions will be captured as points along a fixed transect, established by physical benchmarks, and assembled into a profile to describe the general beach/dune morphology at a given location. The network will orchestrate analysis of data from a selected set of similarly spaced transects using methods developed by Rutgers University for the NCBN coastal topography protocol.

Table 2a. Monitoring methods and data elements.

Objective	Sampling Method	Data Collected	Analysis Tool	Derived Data
Dimensions of beach, berm and foredune and long-term trends in direction and displacement of coastal features	Differentially corrected Global Navigation Satellite Systems -DGNSS	XYZ positions of inflections in beach-dune profile	Rutgers University's '2D Analyst' (Psuty et al. 2012)	Profile area, beach width, foredune crest height, foredune width, foredune crest distance from benchmark

Table 2b. Monitoring design elements.

Objective	Area Sampled	Spatial Design	Temporal Design	Scale of Analysis
	GUIS MS Unit: Horn Island, Petit Bois Island	Potential transects were established using a random start, systematic approach. A framework of potential transects were spaced 1 km (0.6 mi) apart. Transects were sub-selected from the 1 km framework, also using an equal spacing rule – Five at Horn Island Sound-side (4 km spacing), Five at Horn Island Gulf-side (4 km spacing), Five at Petit Bois Island (2 km spacing), and One at USACE dredge disposal island west of Petit Bois.	Every two years	Whole-island
	GUIS FL Unit: West Santa Rosa Island and East Perdido Key	Potential transects were established using a random start, systematic approach. A framework of potential transects were spaced 1 km (0.6 mi) apart. All transects within 3 km (1.8) of Pensacola Pass were selected for monitoring.	Every two years	Westernmost three kilometers (1.9 mi) of Santa Rosa Island and Easternmost three kilometers (1.9 mi) of Perdido Key

Table 2b (continued). Monitoring design elements.

Objective	Area Sampled	Spatial Design	Temporal Design	Scale of Analysis
Dimensions of beach, berm and foredune and long-term trends in direction and displacement of coastal features (continued)	PAIS	Potential transects were established using a random start, systematic approach. A framework of potential transects were spaced 1 km (0.6 mi) apart. Selection of monitored transects is based on GULN index areas selected for vegetation/bird Monitoring and park's management interests.	Every two years	Index areas

Overview of Methods

Psuty et al. (2012) provides detailed SOPs to guide personnel through all aspects of monitoring and reporting changes in coastal topography. Specifically the protocol SOPs include:

- SOP 1. Equipment and Supplies
- SOP 2. Establishment of Benchmarks, Transects, and Geodatabases
- SOP 3. Survey Timing and Mission Planning
- SOP 4. Settings for Collection of Topography
- SOP 5. Conducting the Survey
- SOP 6. Initial Post-Processing
- SOP 7. Data Analysis and Reporting
- SOP 8. Data Management
- SOP 9. Revising the Protocol

The Gulf Coast Network will follow all SOPs documented in Psuty et al. (2012) with the following exceptions:

Survey Timing and GPS Mission Planning

Northeast Coastal and Barrier Network targets a six-week period from mid-March to late April for peak winter expression. Because the GULN's focus is on long-term monitoring and not on seasonal comparisons, a pre-hurricane season condition will be targeted to avoid sampling close to tropical storms. Topographic surveys will be planned to coincide with neap tide in the months of April and May. To avoid nesting shorebirds, April is preferred at Gulf Islands NS. At Padre Island NS, where shorebirds are less affected by surveyors, May is preferred. If it is not possible to conduct the survey during the prescribed month at either park, the next neap tide period will be chosen in consultation with the park. It is preferable to collect data outside of the prescribed survey period rather than not collect data.

Settings for Collection of Topography

- A statement will be added to ensure that the DGNSS unit only records data achieving 5-centimeter (1.9-in) vertical accuracy or better.

Conducting the Survey

- Surveyors will collect photos as prescribed in Psuty et al. (2012) with additional photos taken along the transect, and oriented both parallel and perpendicular to the transect at the berm crest and primary dune crest as outlined in GULN SOP CT05—*Conducting the survey* (Bracewell 2017a).

Data Analysis and Reporting

- Seasonal comparisons will not be addressed because GULN sampling will only include biennial surveys.
- Short-term reports regarding variation will occur every other year because GULN sampling is biennial.
- Long-term trend reports will be generated after five sampling events. Because GULN surveys will occur biennially, these reports will occur every ten years instead of every five years.

Section 5. Sampling Design and Monitoring Schedule

At both Padre Island and Gulf Islands National Seashores, potential profiles locations were generated in a GIS format to be perpendicular to the shoreline and spaced at 1-kilometer (0.6 miles [mi]) intervals with a random starting point within the park boundary. Selections were then made from this framework in collaboration with subject matter experts, along with park staff. Key elements in the selection process included: distribution of effort for long-term monitoring goals; logistical constraints; and maintaining a manageable workload for implementation by network staff. The framework is consistent with the NCBN sample design and allows for a flexible and adaptable approach as island morphology changes. A total of 47 topographic profiles will be collected in GULN parks: 24 at Gulf Islands NS and 23 at Padre Island NS (Tables 3 and 4).

With limited resources, it is not feasible to monitor enough topographic transects at GULN seashore parks to adequately measure geomorphic change on the whole-park scale. Several factors were considered when allocating coastal topography sampling sites at Gulf Islands NS and Padre Island NS, including adequate spatial distribution, park resource management interests or concerns, and pairing sites with extant GULN monitoring efforts. Additionally, as the focus of this protocol implementation plan is long-term monitoring that occurs on a biennial frequency, less prominent ephemeral geomorphic forms were avoided. The tips of the Mississippi barrier islands are representative of such areas, where year to year, several hundred meters of island may be exposed, submerged, or dramatically displaced. These regions are not necessarily representative of the long-term trends associated with the island core and should be avoided in sample design. With general guidance from the listed factors, index sites were selected in consultation with park personnel. Ultimately, all sites were chosen from a framework of transects equally spaced at a one-kilometer (0.6-mi) interval. This framework was established at the park-wide scale, allowing for expansion or modification of the proposed monitoring effort while maintaining a central design element. Based on the time requirements for NCBN’s implementation of their Coastal Topography Protocol at Assateague Island National Seashore (N. Winn, personal communication, March 2016) and Gateway National Recreation Area (A. Spahn, personal communication, March 2016), plus current GULN staffing and available resources, the maximum monitoring effort at each park was capped at 25 transects. A total of sixteen transects will be installed at GUIS Mississippi; ten at Horn Island and six at Petit Bois Island. Eight transects will be installed at GUIS Florida; four at Fort Pickens and four at the eastern end of Perdido Key. At Padre Island NS, twenty-three transects will be installed in clusters along the entire extent of the park’s Gulf shoreline. The rationale and methods used for distributing the coastal topography monitoring effort among several park sites are presented below.

Sample Distribution at Gulf Islands National Seashore Mississippi

Although all Gulf Islands NS barrier islands were considered for monitoring, the initial GULN effort will focus on Horn and Petit Bois Islands and not include Cat and Ship Islands. Cat Island was excluded from the initial monitoring plan because the National Park Service currently has limited ownership of the island and land-swaps between the NPS and other land owners are likely to occur within the next several years. East and West Ship Islands were also excluded from the initial monitoring plan while these islands undergo extensive sand nourishment as part of the Mississippi

Coastal Improvement Project (MsCIP). Furthermore, MsCIP includes a comprehensive long-term monitoring component outlined in the U.S. Army Corp of Engineer's *MsCIP Monitoring and Adaptive Management Plan* (USACE 2016). As network resources allow, sample sites on these islands may be considered in the future.

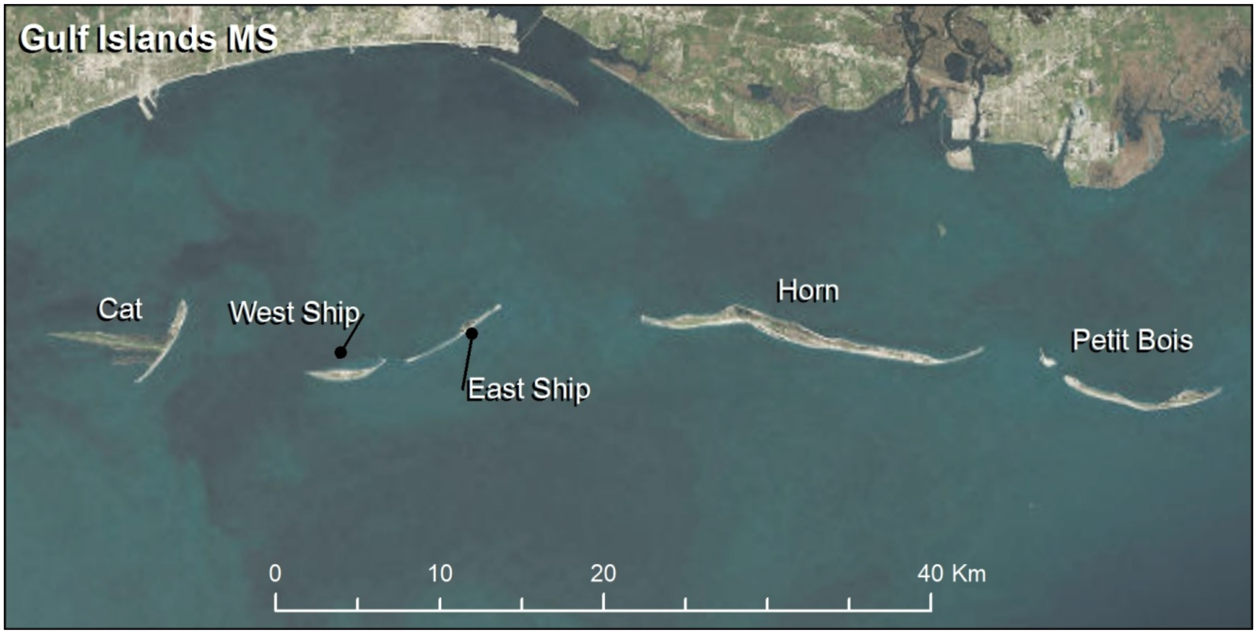

Figure 1. Areas considered for coastal topography monitoring at GUIS Mississippi.

With the exception of Fort Massachusetts and facilities associated with beach recreation at West Ship Island, most of the Mississippi barrier islands have a robust wilderness character and are considered key natural resource areas within the park. Within these island units of the park, resource managers seek a holistic ecological understanding of processes at the whole-island scale. Accordingly, resource management staff is primarily interested in a better understanding of changes in geomorphology on a whole-island scale and on an extended temporal scale. Is the island getting bigger or smaller, and at what rate? Also, at a finer scale, are different regions of the island changing at different rates? To address these questions, equally spaced sample sites were chosen to distribute monitoring effort across the extent of both Horn and Petit Bois Islands. These index sites will be used to describe island morphology at a variety of island sections that undergo different rates of change while being spaced such that a whole-island change may be intuited. Monitoring coastal geomorphic processes at this scale also supports GULN's ongoing breeding bird monitoring effort and planned vegetation monitoring effort, both of which distribute sampling locations across the entire vegetated portions of the islands.

Framework for Distributing Transects at Horn Island

As described in Psuty et al (2012), it is ocean-side beaches and foredune complexes that are monitored at NCBN parks, and monitoring transects are to be oriented perpendicular to the shoreline. The following points clarify the GULN interpretation and implementation of this design with respect to the Mississippi Barrier Islands. The Mississippi Sound and Gulf of Mexico sides of the Mississippi barrier islands are geomorphologically active and the Gulf Coast Network will monitor both sides. Ideally, a single transect crossing the entire island would be surveyed to measure both Sound and Gulf sides, as represented by the dashed red line in **Figure 2**. However, with regard to Horn Island, the Sound and Gulf shorelines are not always parallel (**Figure 2**). Because of this difference in aspect, Horn Island transects were established to be perpendicular to each shoreline segment so that the aspect of Sound-side transects are not determined by Gulf-side shorelines.

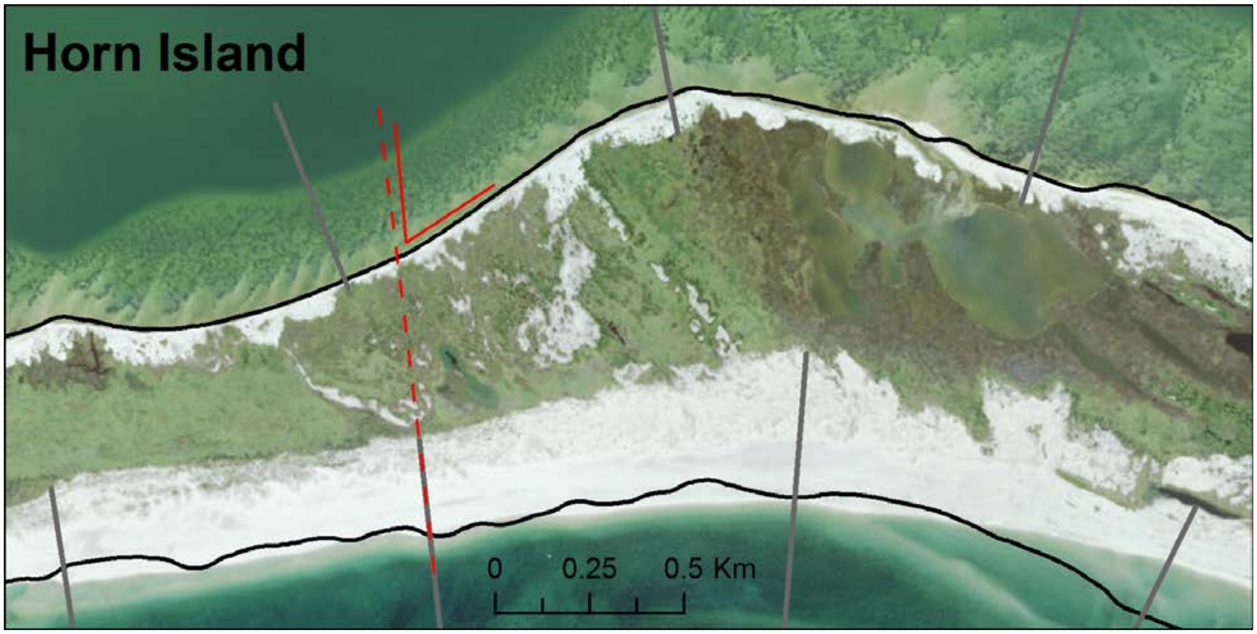

Figure 2. The differing orientation of the shoreline on the Gulf and Sound sides of some islands results in the creation of separate transects so as to maintain the orthogonal heading. In this case, the properly-oriented red dashed transect on the Gulf would not be perpendicular to the Sound-side shoreline.

With respect to transect length, the interior of Horn Island is relatively stable and there would be very little increase in the understanding of geomorphic change by extending transects into the island's core. Furthermore, the interior of Horn Island is densely vegetated and has numerous wetland ponds that pose a difficult and hazardous surveying environment. Accordingly, transects were trimmed to originate toward the center of the island, at a place where the dune field becomes less active and shrubby vegetation is established, then extend shoreward. A total of ten transects will be surveyed at Horn Island, five on the Mississippi Sound side and five on the Gulf of Mexico side (Figure 3).

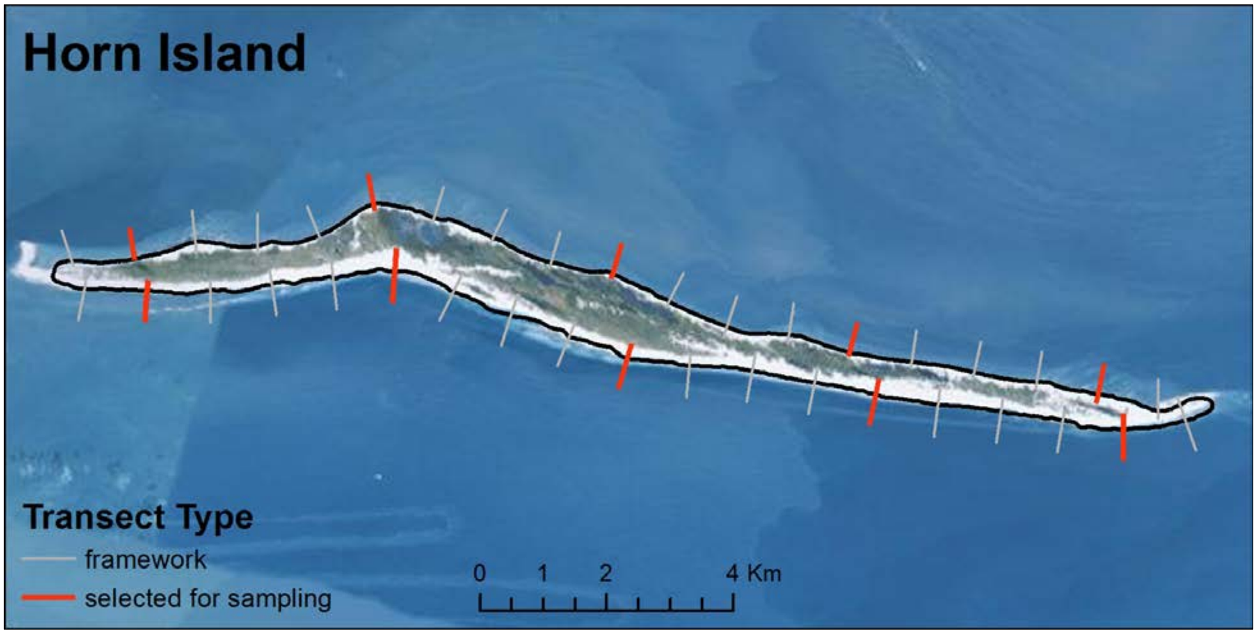

Figure 3. Selected transect sites for monitoring coastal topography at Horn Island. The framework of transects from which monitoring sites were selected for surveying are spaced at a 1-km (.6 mi) interval along a generalized shoreline. Every fourth transect was chosen from this framework so that monitoring effort would be distributed across the entire island.

Framework for Distributing Transects at Petit Bois Island

When compared with Horn Island, Petit Bois is narrower, has a smaller core-vegetated area and has variable cross-island elevations. Unlike Horn Island, where different geomorphic processes shape Gulf and Sound-side aspects independently, Petit Bois Gulf and Sound shorelines are roughly parallel. This symmetry indicates that a single, more significant, geomorphic process influences the whole island. Given these characteristics, it is appropriate to establish transects that cross the entire island rather than to establish shorter profile segments that solely capture the beach and foredune complex as is the case with Horn Island. Five equally spaced transects will be monitored at Petit Bois Island, plus one additional transect west of Horn Island Pass. The sixth transect lies on an Army Corps of Engineers dredge disposal site (Figure 4). This site's primary building material is sourced by the main body of Petit Bois Island that sloughs sediment into Pascagoula shipping channel by east to west currents. Even though its variations in elevation are heavily driven by anthropogenic processes, any discussion of the fluctuation in topographic elevation and sediment budget at Petit Bois Island should include estimates of the dimensional fluctuation of this dredged material.

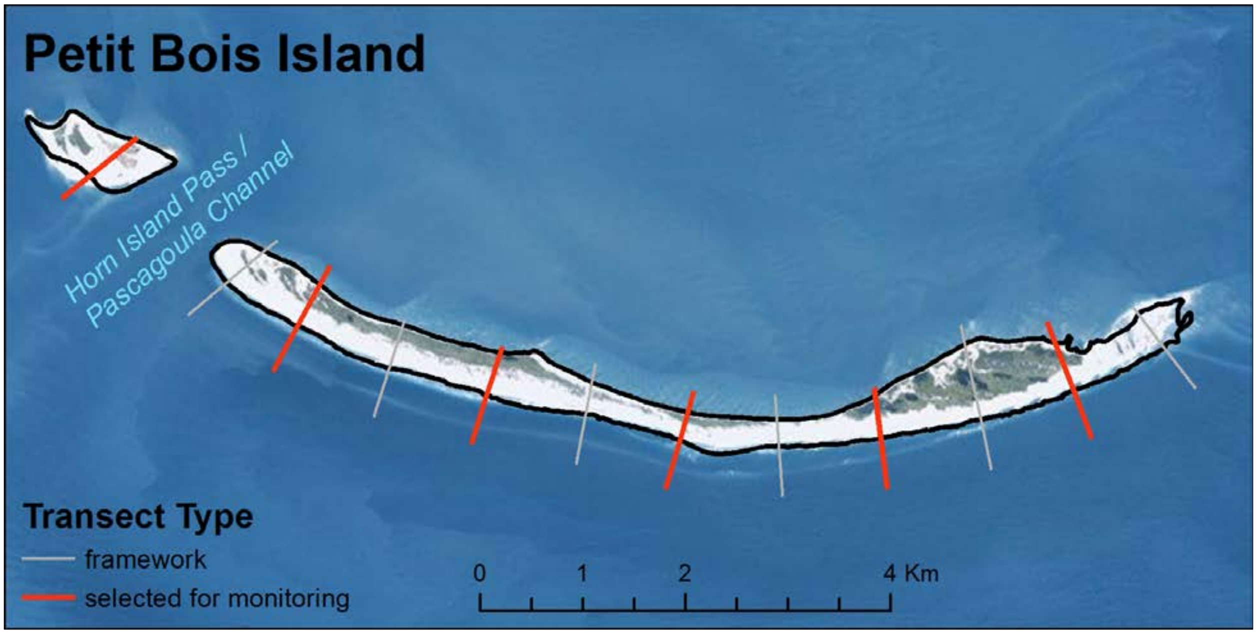

Figure 4. Selected transect sites for monitoring coastal topography at Petit Bois Island. The framework of transects from which monitoring sites were selected for surveying are spaced at a 1km interval along a generalized shoreline. Every other transect was chosen from this framework so that monitoring effort would be distributed across the entire island.

Planning for Island Movement

The westward migration of the Mississippi barrier islands is well established in studies by Otvos (1970) and more recently in Morton (2007). Given enough time, it is inevitable that the westward movement of the Mississippi barrier islands will render eastern transects completely submerged, and "lost" to the Gulf. By using a framework that includes evenly spaced transects that encompass entire islands, transects can be added if resources allow or discontinued if they become permanently submerged. Also, owing to their continuous nature, transects can shift shoreward or seaward while maintaining their aspect and thus allow for island erosion and accretion.

Sample Distribution at Gulf Islands National Seashore Florida

The Florida Units of Gulf Islands NS include three primary marine areas: Perdido Key, Fort Pickens, and Santa Rosa (Figure 5).

The Santa Rosa area is sandwiched between the incorporated and built-up areas of Pensacola Beach and Navarre. This stretch of seashore is heavily influenced by beach nourishment projects, driving the local geomorphic change across time, as much by anthropogenic processes as natural ones. Given its artificial character, park staff ranked Santa Rosa as a lower priority for monitoring. In contrast, Perdido Key's eastern end is undeveloped, providing refuge for numerous biological resources, and is an area of primary natural resource significance for the park. Likewise, the Fort Pickens area, across Pensacola Pass from Perdido Key, provides access to a pre-Civil War fort and is a foundational park natural and cultural resource and interpretive site. Pensacola Pass and adjacent areas are geomorphically active and, given the natural and historical significances of Perdido Key and Fort Pickens, this dynamic area emerged as a high priority for monitoring. To evaluate the geomorphology of park lands adjacent to Pensacola Pass, eight equally spaced transects will be monitored, four at Perdido Key and four at Fort Pickens (Figure 6, Table 3).

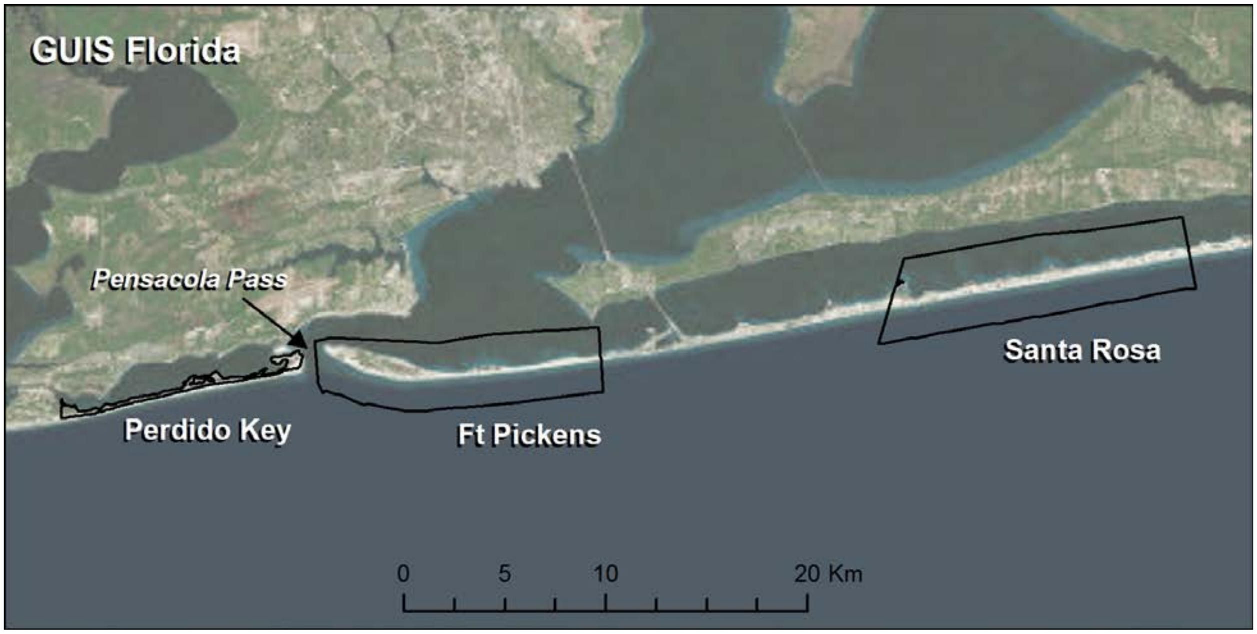

Figure 5. Areas considered for coastal topography monitoring at GUIS Florida.

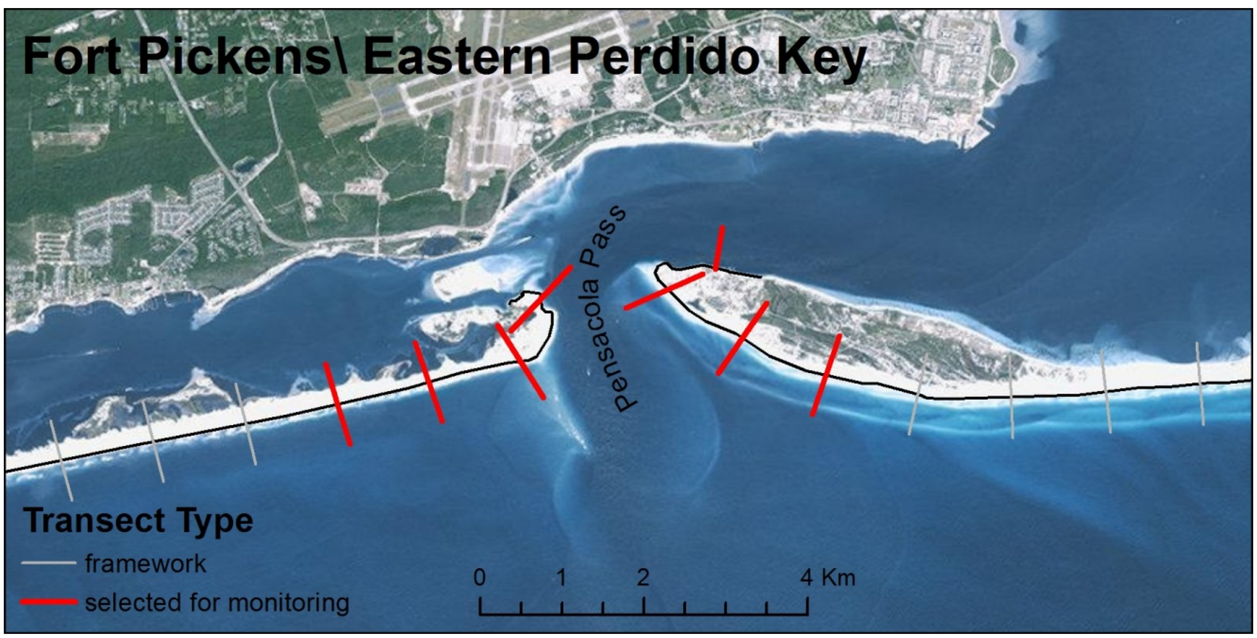

Figure 6. Selected transect sites for monitoring coastal topography at Fort Pickens and Perdido Key. The framework of transects from which monitoring sites were selected for surveying are spaced at a 1km interval along a generalized shoreline. Transects adjacent to Pensacola Pass were chosen from this framework.

Table 3. Distribution of GULN coastal topography monitoring transects at Gulf Islands NS.

GUIS Unit	Number of Transects	Description	Schedule
Horn Island	10	5 Sound-side, 5 Gulf-side	Even numbered years
Petit Bois Island	6	6 cross-island transects	Even numbered years
West End Santa Rosa (Ft Pickens)	4	4 transects clustered toward western end (Gulf-side)	Even numbered years
East End Perdido Key	4	4 transects clustered toward eastern end (Gulf-side)	Even numbered years

Sample Distribution at Padre Island National Seashore

At Padre Island NS, the network has established four clusters of co-located bird and vegetation monitoring plots, arranged in panels, along the approximately 70 miles (112.6 kilometers [km]) of Texas coastline that are protected by the park. These panels offer an index of a set of biological characteristics on the whole-island scale by concentrating effort in a few well-distributed sites. Likewise, installation of coastal topography transects in these established monitoring panels will provide insight into whole island geomorphic change, while directly providing geological context to biological monitoring efforts. Furthermore, working with clusters of transects is efficient and economical because it will minimize the need to move static GPS equipment, i.e., the Real-Time Kinematic (RTK) base station, while collecting elevation data. The network will monitor 12 transects associated with biological monitoring panels (Figure 7, Table 4). Most transects that are co-located with biological monitoring panels will be spaced at a 1-kilometer (0.6-mi) interval (Figures 8, 9 and 10). One exception is at panel 38, where the biological monitoring plots are distributed more north to south as a result of the island narrowing toward the south (Figure 11). Transects at panel 38 are spaced at a 2-kilometer (1.2 mi) interval to spread the geomorphological monitoring effort across a space that aligns with biological monitoring plots.

Along with broadening the context of biological monitoring panels, the park is interested in geomorphic changes at the Closed Beach area (Figure 7) and the beach north of the Port Mansfield Channel jetties (Figure 7). Closed Beach is a section of seashore approximately 4.5 miles (7.2 km) long that is closed to beach driving. The transects at Closed Beach focus monitoring effort on the area of the park with the most infrastructure and highest visitor use. Five transects will be monitored at Closed Beach (Figure 8).

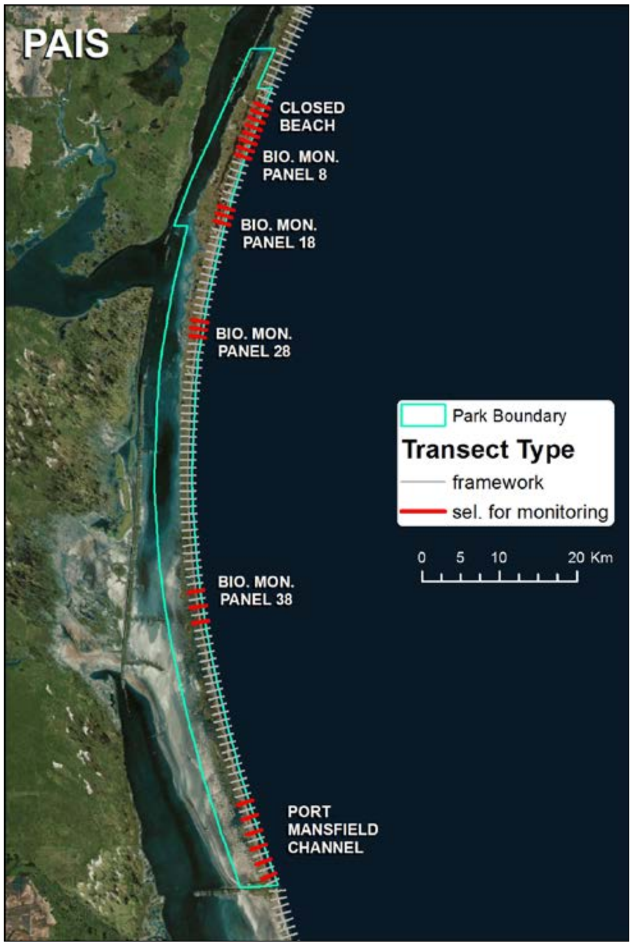

Figure 7. Distribution of GULN coastal topography monitoring transects at Padre Island NS.

Table 4. Distribution of GULN coastal topography monitoring transects at Padre Island NS.

PAIS Unit	Number of Transects	Description	Schedule
Closed Beach	5	Section closed to beach driving	Odd Numbered Years
GULN Biological Monitoring Panel 8	3	GULN Vegetation and Bird monitoring location	Odd Numbered Years
GULN Biological Monitoring Panel 18	3	GULN Vegetation and Bird monitoring location	Odd Numbered Years
GULN Biological Monitoring Panel 28	3	GULN Vegetation and Bird monitoring location	Odd Numbered Years
GULN Biological Monitoring Panel 38	3	GULN Vegetation and Bird monitoring location	Odd Numbered Years
North of Port Mansfield Channel	6	Section adjacent to North Jetty	Odd Numbered Years

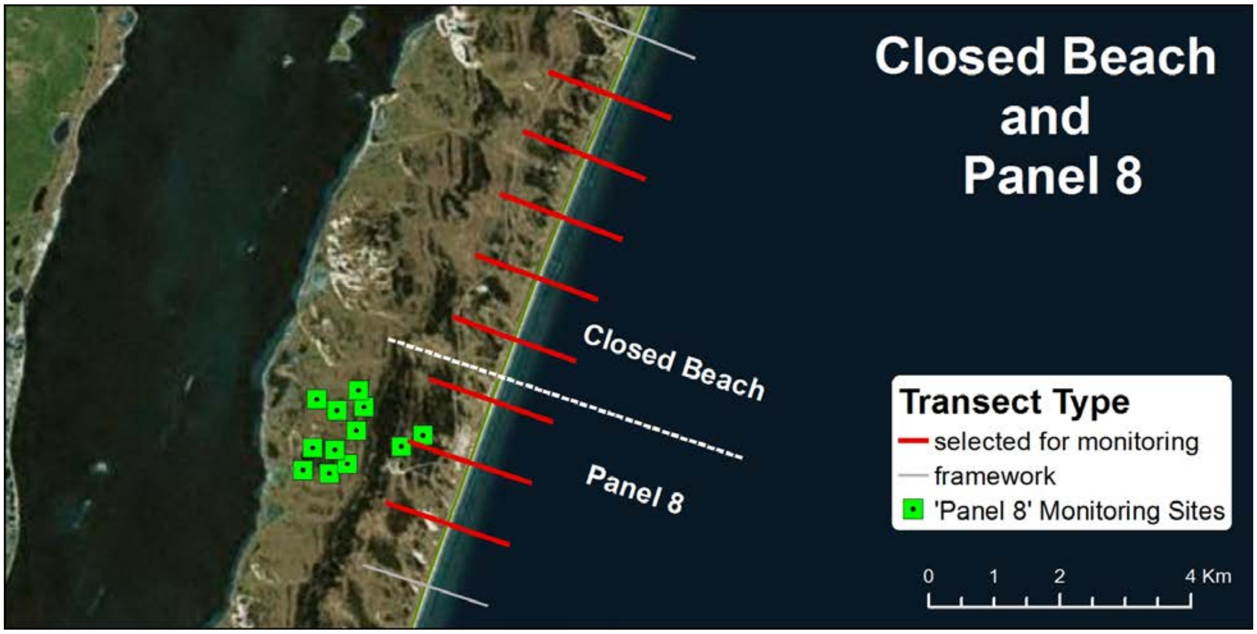

Figure 8. Monitoring Transects at Closed Beach include the five northernmost transects (approximately 1 kilometer [0.6 mi] spacing). The three southernmost transects are associated with GULN Monitoring Panel 8 (approximately 1 kilometer [0.6 mi] spacing).

Figure 9. Monitoring Transects at GULN biological monitoring panel 18 are spaced approximately 1 kilometer apart.

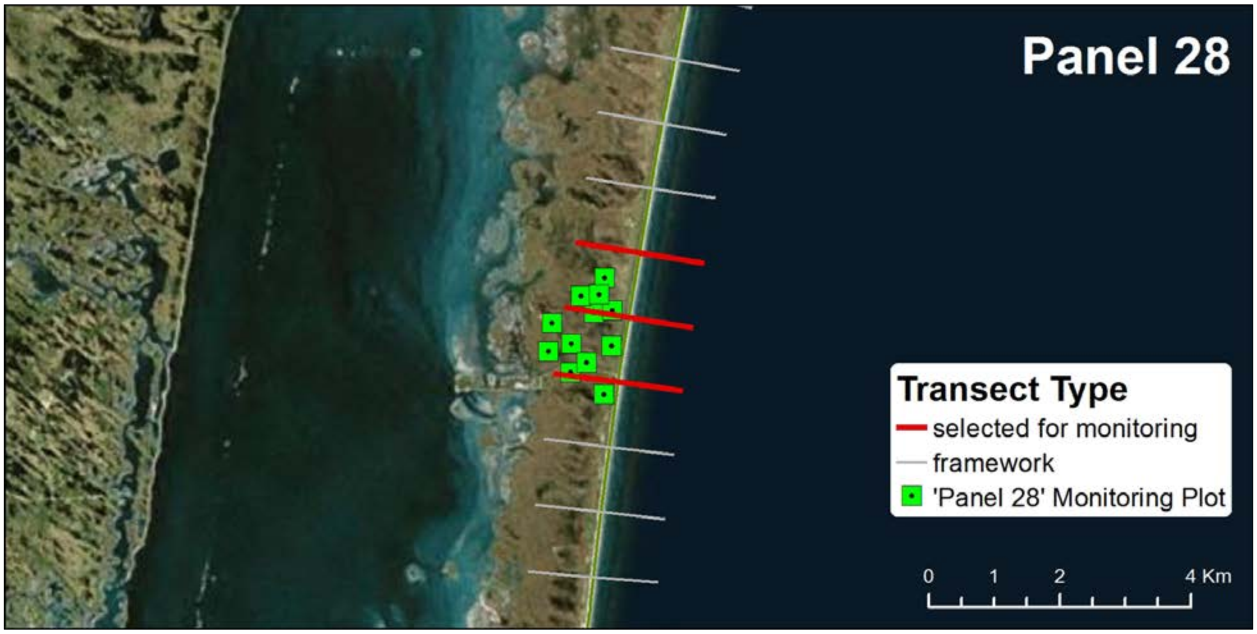

Figure 10. Monitoring Transects at GULN biological monitoring panel 28 are spaced approximately 1 kilometer (0.6 mi) apart.

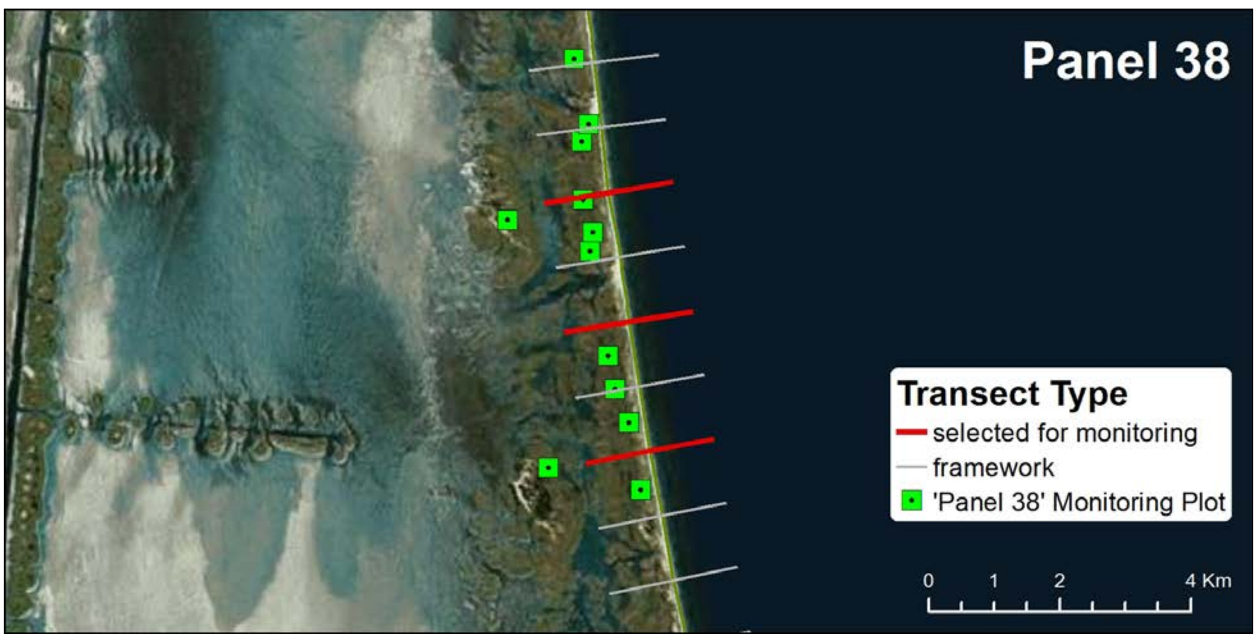

Figure 11. Monitoring Transects at GULN biological monitoring panel 38 are spaced approximately 2 kilometers (1.2 mi) apart.

The beach north of the jetties at Port Mansfield Channel is the only part of the park's Gulf-side shoreline that is undergoing a rapid rate of erosion (Paine et al. 2014). Six transects will be monitored in the dynamic region north of Port Mansfield Channel, helping to inform the park about the affect of the jetties on rates of geomorphic change (Figure 12). Note that selected transects are spaced every 2 kilometers (1.2 mi) so that survey effort is distributed through the area of accretion just north of the erosional area, thus providing a broader context to the understanding of sand transport throughout this southernmost section of the park.

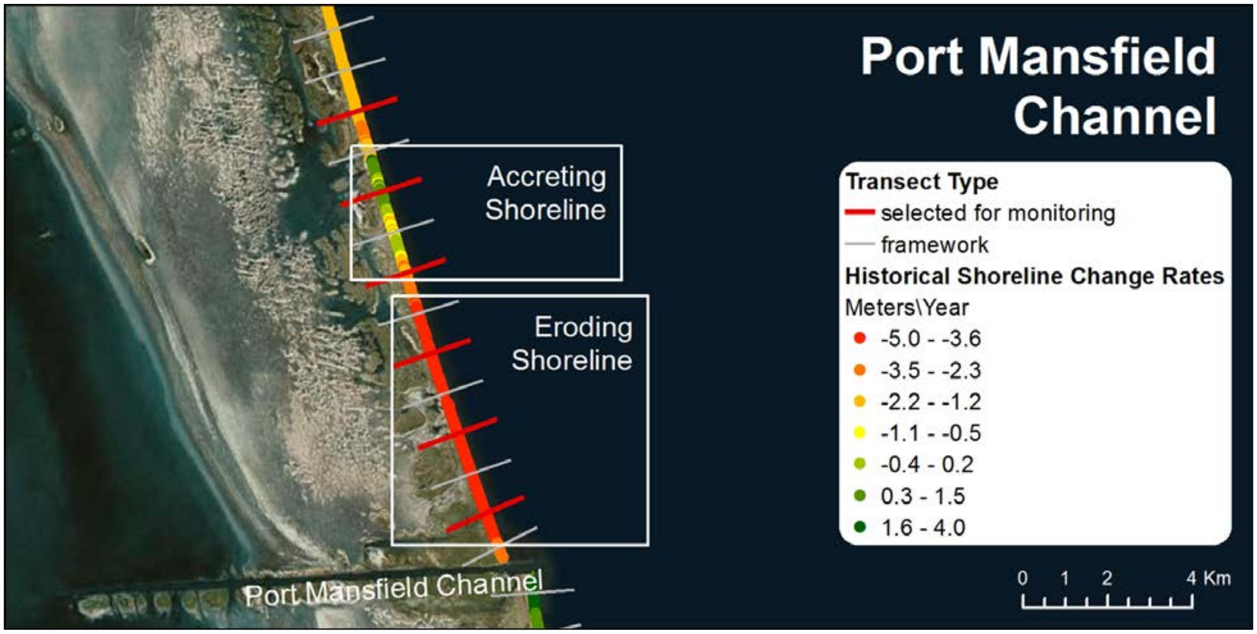

Figure 12. Monitoring transects north of Port Mansfield Channel Jetties. Historical shoreline change rates were calculated from the 1930's to 2007 along the Texas shoreline in Paine et al. (2014). Data accompanying this publication show that the shoreline along the zone immediately north of the Port Mansfield Channel north jetty has eroded, while the adjacent zone to the north of it has accreted. Here, transects are spaced approximately 2 kilometers apart so that surveys will capture both zones.

Section 6. Data Management, Analysis and Reporting

The Gulf Coast Network will follow the procedures outlined in 'SOP 8: Data Management' from Psuty et al. (2012) as summarized below:

1. Raw GPS data are exported to ESRI Feature Class.
2. FGDC compliant Metadata are created for ESRI Feature Class.
3. Field data forms are scanned and entered into Coastal Topography database. A third party will perform 100% check to verify data entry accuracy.
4. Photos are downloaded, renamed, and imported to database.
5. XYZ data are verified in a GIS and reconciled with field form data.
6. Verified XYZ coordinates table is imported from ESRI Feature Class to database.
7. Related files are archived annually (odd years PAIS, even years GUIS) and include: Coastal topography database, spatial data sets, field forms (.pdf), biennial report (.pdf), trend report (.pdf, every ten years).

The types and requisite processing steps for data to be collected as a part of the GULN coastal-topography monitoring protocol have been documented in Table 5. Table 5 also introduces the terms raw data, provisional data, and accepted data. Raw data are products from field data collection and are in their original form. Provisional data have undergone validation and verification steps and include the primary derivative products that will be used in analysis. Accepted data are products from the provisional data step that are fit for analysis and publication. Additionally, the Protocol Implementation Plan (PIP; this document), along with related SOPs and appendix items will be managed locally as long-term records and also posted to the 'Gulf Coast Network Coastal Topography Monitoring Project' on the NPS Integrated Resource Management Application (IRMA) portal (NPS 2017). Other ancillary documents and data sets associated with the PIP such as those downloaded for trip planning, e.g., tide predictions and weather data, will be managed locally as long-term records. Details about managing these and all associated PIP records can be found in GULN SOP CT08—*Data Management* (Bracewell 2017b).

Table 5. Data processing steps and products for the GULN coastal topography monitoring protocol.

Data Type	Process Step	Product Description	Product Type
Raw data	Download digital data and organize field forms	Trimble GPS/GNSS field data (topographic points, benchmarks)	.ssf files
Raw data	Download digital data and organize field forms	Field Forms	Paper field sheets
Raw data	Download digital data and organize field forms	Digital Photos	.jpg files
Provisional data	Post-processing and data entry	GNSS differential corrections performed in Trimble Pathfinder Office	.cor files
Provisional data	Post-processing and data entry	Differentially corrected files exported to ESRI Shapefile	.shp (1)
Accepted data	Post-processing and data entry	Photos renamed	.jpg
Provisional data	Post-processing and data entry	Field form data are verified and entered into database	.mdb file
Accepted data	Post-processing and data entry	100% cross-check performed with field data forms	.mdb file
Accepted data	Post-processing and data entry	Verified field forms are scanned	.pdf file
Provisional data	Data validation	Corrected GPS data (shapefiles) verified in GIS. Errors/outliers flagged and notation to explain error added to shapefile	.shp (2)
Accepted data	Data validation	Errors/outliers reconciled with field form and features meeting quality standards are exported as table format (ready for 2D Analyst)	.csv
Accepted data	Value added	Construction of the 2D Profile in 2DAnalyst from .csv file	.xls (1)
Accepted data	Value added	Geomorphic Measurements (Foredune Crest Height, Dune Crest Distance, etc.) summarized in Data Matrix table	.xls (2)
Accepted data	Local archive	Scanned field forms, raw GPS data and Provisional datasets archived locally.	.zip (1)
Accepted data	Local archive	Field forms managed as long-term records.	Paper field sheets
Accepted data	Offsite archive and publication	Monitoring database and Accepted Data (native formats) and reports are published to NPS Data Store	.zip (2)

Protocols for reporting will follow Psuty et al. (2012) with these exceptions:

1. Gulf Coast Network will not report on seasonal changes
2. Biennial event-based data summary reports will be generated in the fall of a survey year, occurring every other year for a given park (Table 6).

Long-term trend reports will be done in consultation with subject-matter experts and occur on a six-year cycle as outlined in Table 6. Content and formatting of these reports will follow guidance established in SOP 7 of Psuty et al. (2012). Principal metrics derived from an individual topographic profile include profile area, foredune crest height and foredune crest distance from benchmark. Basic requirements for trend reporting will include end-point comparisons and mean rate-of-change comparisons for each of the principal metrics at each profile. As stated in Psuty et al. (2012), “Trend analysis becomes more meaningful with a longer record of beach profile change.”

Table 6. Reporting Schedule.

Year	1	2	3	4	5	6	7	8	9	10	11	12
Park Surveyed	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS
Biennial Report	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS	GUIS	PAIS	–	–	GUIS	PAIS
Long-Term Report	–	–	–	–	–	–	–	–	GUIS	PAIS	–	–

Section 7. Budget

The estimated annual cost (based on FY2015 dollars) of implementation of the GULN coastal topography protocol is presented in Table 7. The minimum cost of a field day includes: team cost, travel cost, field supplies, and fuel cost. Consumable field supplies cost approximately $5 per day and include items such as baggies, flagging, hand cleaners, bug spray, sunblock, and batteries.

The estimated team cost is based on using one GS-11 (step 5) GIS specialist and one GS-07 (step 5) biologist/tech, using a 40% fringe benefits cost. This will be a mid-range estimate, as personnel may cost more or less due to step in grade. We will assume a team of these two personnel for conducting all topographic profile surveys.

Much of the project equipment (including hand-held radios and cameras,) may be shared among multiple projects; this is a separate network cost not apportioned here.

For every field day, there will be team prep time at the vehicle before heading out to the survey location, field travel time to the survey location, and field travel time back, followed by team stand-down and stowage time. Travel time to and between sites will vary and will be affected by distance and by conditions. This variation in travel time is accounted for, resulting in an anticipated five profiles per day average.

All projects involve data management. We will assume one GS-11 at $360.30 per day for data management cost. In general, we should assume that data management will be a relatively fixed cost regardless of number of profiles surveyed as survey preparation, data download, QA/QC, and basic reporting do not fluctuate much based on the amount of data collected. We initially assume that about ten days of data management will be required per sampling event.

Logistical support and site access assistance from parks is assumed in budget planning and includes transport by boat (GUIS), and UTV and/or other vehicles (GUIS and PAIS).

The following (Table 7) presents project cost estimations based on implementation using one field team plus standard data management support at the office and assumes about 25 profiles per park. The estimations are based on the costs and assumptions presented above and include:

1. Data management cost based on $360.30 per day;
2. A field team of two staff members costing approximately $603.84 per day;
3. Field consumables at $5.00 per profile;
4. Travel and lodging costs for the field team at a lodging rate of $114 per night, and a per diem rate of $59 per day totaling $346 per day per team; and
5. A government vehicle fuel estimate of $40 per day.

Table 7. Project cost estimations based on implementation using one field team plus standard data management support at the office and assumes about 25 profiles per park, five days of sampling; and two travel days. Lodging rate is based on summer allowance in Santa Rosa County, Florida. An allowance of 75% M&IE is calculated for start and end days of trip. *Additional costs may be incurred approximately every 10 years to produce trend reports. Based on similar work done through cooperative agreements in the GULN, assistance to generate two trend reports, one for GUIS and one for PAIS, will cost about $10,000.

Category	Sub-Category	Cost	Notes
	Two person field crew (7 days)	$4,226.88	Pay rate
	Data manager	$3,603.00	Pay rate
	Total Personnel Costs	$7,829.88	–
	Survey benchmark installation (Year 1—PAIS)	$7,000.00	Agreement with local university for installation of four geodetic benchmarks, plus travel costs for GULN to install transect benchmarks.
	Survey benchmark installation (Year 2—GUIS)	$7,000.00	Agreement with local university for installation of two geodetic benchmarks, plus travel costs for GULN to install transect benchmarks.
	UTV/ATV/Boat Maintenance	$0.00	Provided by park
	GNSS RTK Rental	$1,375.00	Survey grade GNSS equipment will be rented
	Field Consumables	$250.00	–
	Total Equipment Costs (Year 1)	$8,625.00	–
	Total Equipment Costs (Year 2)	$8,625.00	–
	Total Equipment Costs (Years 3+)	$1,625.00	–
	Lodging	$1,368.00	–
	M&IE	$678.50	–
	Fuel	$280.00	–
	Total Travel Costs	$2,326.50	–
	Total Annual Protocol Costs (Year 1)	$18,781.38	–
	Total Annual Protocol Costs (Year 2)	$18,781.38	–
	Total Annual Protocol Costs (Years 3+)	$11,781.38*	–

Section 8. Safety

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

Job hazard analyses (JHAs) were completed for all personnel who implement portions of the protocol in which risks and risk abatement strategies (including training needs) were identified. Risks and abatement strategies for all staff were synthesized to develop a protocol-level JHA. The protocol JHA was then used to perform a programmatic-level Green-Amber-Red (GAR) risk analysis to assess whether implementation of this protocol could be accomplished within an acceptable level of risk.

Specific safety concerns include:

- Crew members will spend many hours (and miles) driving to, between, and from sampling locations to conduct the requisite sampling.
- Crew members may be working in park areas outside of communications range (either by park radio or by cell phone).
- Crew members will frequently be exposed to extreme heat and humidity and will be working for extended periods of time in remote areas with potentially rapidly-changing and severe weather conditions.
- Crew members will be frequently exposed to toxic and thorny plants, stinging and biting insects, treacherous terrain, venomous and other hazardous animals, and potentially hazardous materials and debris left from pre-park land usage, such as old drilling and range equipment, fencing and piping, contaminated soils, and waste materials.
- In specific cases, crew members will be utilizing watercraft and UTV / ATV for site-access, and will be exposed to increased risks associated with use of this equipment.

Injury or loss of life while in transit to and from field sites and during sampling activities within sites—as well as while in transit to or from sampling sites via watercraft and UTV / ATV—are the most significant risks encountered when conducting this activity.

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

Safety procedures will be routinely reviewed with network staff and partners before field operations as prescribed in SOPs. Personnel-level JHAs for staff will be reviewed and revised annually as a part of the performance review cycle. Safety SOPs are reviewed at least annually and updated as necessary to ensure that they adequately mitigate risks to personnel, property, and the public.

In addition to protocol-specific safety procedures and guidelines, GULN staff will follow the general guidelines set forth in the NPS Occupational Safety and Health Program (National Park Service 2008).

Section 9. Standard Operating Procedures and Deviations from Source Protocols

To ensure consistent implementation of this protocol over time, standard operating procedures (SOPs) have been adopted from other networks, or developed as needed by the Gulf Coast Network (Table 8a and 8b). Technical aspects of the Gulf Coast Network's shoreline position monitoring will be primarily adopted from Psuty et al. (2012). Logistical challenges and worksite conditions are also similar to those encountered in NCBN parks. Accordingly, guiding safety procedures are being adapted from *Field Safety for the Ocean Shoreline Position Monitoring Protocol* (Skidds 2013). All SOPs are adopted from procedures approved and implemented programmatically through other monitoring efforts to the greatest extent possible. Project SOPs are available for download at the NPS Integrated Resource Management Applications portal at https://irma.nps.gov/DataStore/Reference/Profile/2238503 (NPS 2017).

Table 8a. Monitoring SOPs required to implement the NCBN coastal geomorphology (coastal topography) monitoring protocol at GULN parks.

Monitoring SOP and data store record	Citation	Explanation of Differences	GULN updated SOP	Link to Published Document IRMA record
SOP 1. Equipment and Supplies 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Added section about transportation requirements. Updated checklist to include additional auxiliary and safety items	Bracewell 2017. GULN SOP CT01—Equipment and Supplies	2242775
SOP 2. Establishment of Benchmarks, Transects, and Geodatabases 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Slight modifications to GIS database directory location and nomenclature to be consistent with GULN GIS DB practices.	Bracewell 2017. GULN SOP CT02—Establishment of Benchmarks, Transects, and Geodatabases	2242776
SOP 3. Survey Timing and Mission Planning 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Modifications to sections, 'Survey Windows' and 'Tide Condition' (revised list of nearby tide and weather stations). Changed suggested maximum PDOP value from 6.0 to 4.0. Changed preferred surveying period to neap tide. Changes to reflect single season surveying (spring).	Bracewell 2017. GULN SOP CT03—Survey Timing and Mission Planning	2242777
SOP 4. Settings for Collection of Topography 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Minor modifications including: Adjusted maximum PDOP from 6.0 to 4.0, Changed location of site for current coordinate systems from www.trimble .to Trimble Business Center's Coordinate System Mngr., Updated note about Spatial Ref System to NAD 83 2011.	Bracewell 2017. GULN SOP CT04—Settings for Collection of Topography	2242778
SOP 5. Conducting the Survey 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Minor modifications of Field data form and naming conventions. Modification to 'Photographic Record' Section to include methods for collecting additional required photos.	Bracewell 2017. GULN SOP CT05—Conducting the Survey	2242779

Table 8a (continued). Monitoring SOPs required to implement the NCBN coastal geomorphology (coastal topography) monitoring protocol at GULN parks.

Monitoring SOP and data store record	Citation	Explanation of Differences	GULN updated SOP	Link to Published Document IRMA record
SOP 6. Initial Post-Processing 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Modification to 'Photographic Record' Section to rename photos according to photographer position and photo angle. Minor modification to file naming conventions.	Bracewell 2017. GULN SOP CT06—Initial Post-Processing	2242780
SOP 7. Data Analysis and Reporting 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Modification to 'Quantifying Change by Comparison of the Dimensional Parameters' Section to exclude seasonal changes and to report biennial dimensions every two years.	Bracewell 2017. GULN SOP CT07—Data Analysis and Reporting	2242781
SOP 8. Data Management 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	Removed export to ascii step as this is not currently practiced with other GULN protocols. File types generated from this protocol are widely accessible through common software platforms. Removed section about exporting database data to excel for verification. A 100% check of entered field data will be performed within the database. Changed location of offsite backup and data distribution to IRMA	Bracewell 2017. GULN SOP CT08—Data Management	2242782
SOP 9. Revising the Protocol 2190640	Psuty et al. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II—coastal topography. National Park Service. Fort Collins, Colorado.	No modifications.	Bracewell 2017. GULN SOP CT09—Revising the Protocol	2242783

Table 8b. Safety standard operating procedures required to implement the NCBN coastal geomorphology (coastal topography) monitoring protocol at GULN parks.

SOP topic	Citation	Explanation of Differences	GULN updated SOPs	Link to Published Document IRMA record
Safety plan	Skidds, D. 2013. Field Safety for the Ocean Shoreline Position Monitoring Protocol	Added a note about GULN JHA for motorboat operation. Deleted part about MOU between network and park for designating POC. Replaced NCBN POC roles and procedures with GULN-specific procedures. Replaced NCBN accident reporting procedures with SER procedures. Added notes about Zika virus, Jellyfish, Stingrays and use of a PFD.	GULN SOP CT10—Field Safety for Monitoring Coastal Topography at Gulf Coast Network Parks Protocol Implementation Plan	2242786

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

NPS XXXXXX, September 2017

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U.S. Department of the Interior

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