



Post Tropical Storm Ian and Hurricane Nicole Storm Report 2022

Overview

Shoreline change is a prime indicator of coastal environmental resource threats within parks. Change in shoreline position drives the alteration and replacement of established natural habitats, and shoreline retreat may destroy critical shorebird nesting habitat and infrastructure. The 2022 tropical cyclone season had a large and deleterious effect on the shoreline and infrastructure at Fort Matanzas National Monument (FOMA), which had considerably less shoreline erosion from 2017 to 2022. The park did not take a direct hit from the storms, but rather glancing blows from Tropical Storm Ian (September 29) after crossing the Florida Peninsula, and Hurricane Nicole (November 10) making landfall south of Vero Beach, adversely affecting the shoreline and infrastructure. This report outlines the shoreline movement from spring to fall 2022 (post Ian and Nicole) collected as a part of the National Park Service (NPS) Vital Signs Monitoring Program. Monitoring was conducted following the methods developed by the NPS Northeast Barrier Coast Network and consisted of mapping the high tide swash line using a global positioning system (GPS) unit in the spring and fall of each year. Shoreline change was calculated using the Digital Shoreline Analysis System (DSAS) developed by USGS.

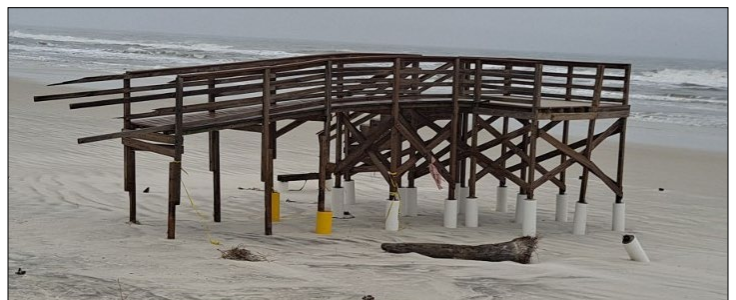
Data used in this report are available at [DataStore - SECN Coastal Shoreline Change Protocol Data \(nps.gov\)](#)



Erosional damage to the car ramp on the Atlantic beachfront at Fort Matanzas National Monument. NPS photo / Kurt Foote, FOMA Staff.



Top, damage to the Fort Matanzas National Monument beach access ramp due to shoreline erosion from Hurricane Nicole in November 2022 (NPS photo / Kurt Foote, FOMA staff). Bottom, beach access boardwalk before the storm on August 28, 2021 (Photo by Melanie Vervaeke).



Another view of the damaged beach access boardwalk at Fort Matanzas National Monument. NPS photo / Kurt Foote, FOMA staff.

Study Area

Fort Matanzas National Monument is 14 miles (22.5 kilometers) south of St. Augustine on the northeast Atlantic coast of Florida (Figure 1). The monument encompasses 298 acres (120.6 hectares) divided between the southern tip of Anastasia Island (108 acres; 43.7 hectares) and the northern end of Rattlesnake Island (190 acres; 76.9 hectares). Surveyed area is a section of shoreline at the southern tip of Anastasia Island, which comprises the Atlantic beachfront, the north end of Matanzas Inlet, and Matanzas River waterfront.

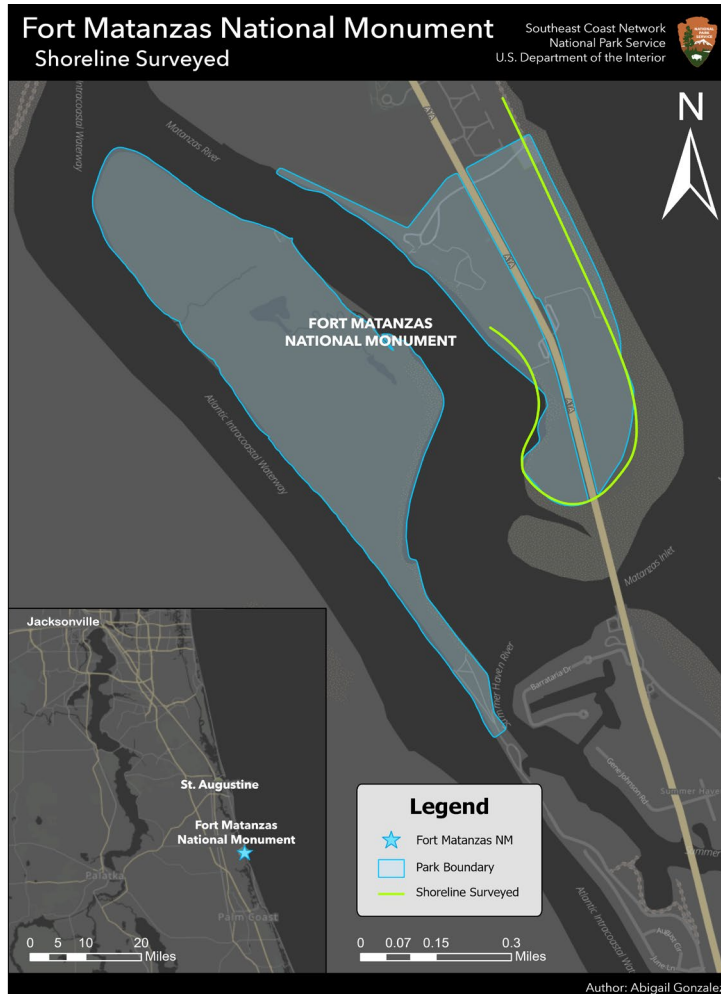


Figure 1. Map showing the boundaries of Fort Matanzas National Monument with the surveyed shoreline indicated.

Significant Findings

- The Southeast Coast Inventory and Monitoring Network surveyed 2.0 kilometers (1.2 miles) of shoreline for all survey events.
- The calculated average end point rate (EPR) from spring surveys of 2017 and 2021 was -2.3 meters/year (7.5 feet/year) with a standard deviation of 7.75 meters (25.4 feet). The EPR over this time had 77.6% of transects (156) showing a negative rate and 22.4% of transects (45) showing a positive rate. All but 10 of the measurements were within the shoreline change distance uncertainty range of the data (± 10 meters [32.8 feet]); all 10 of those were erosional between 2017 and 2022. See map and histogram (Figures 2 and 3).

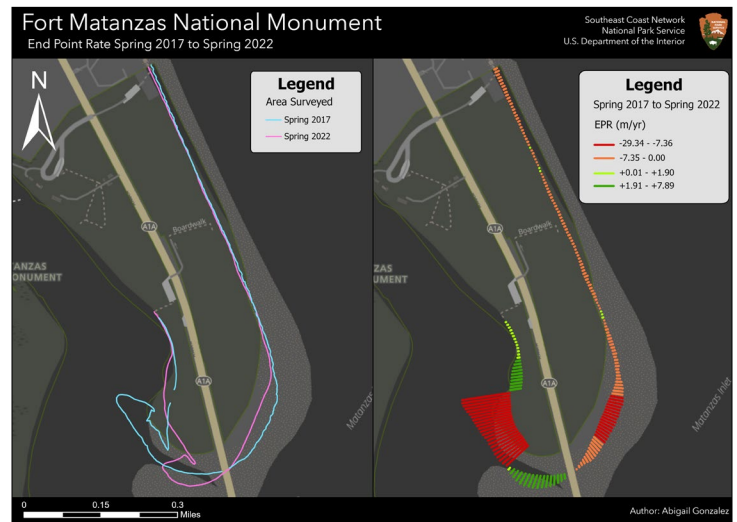


Figure 2. Maps of surveyed end point rates (meters/year) of Fort Matanzas National Monument. Left panel shows the outlines of the spring surveys in 2017 and 2022, right panel is the EPR for each transect created. Positive rates are shaded in green with negative rates shaded in warmer colors. Surveys have an uncertainty of ± 10 meters (32.8 feet).

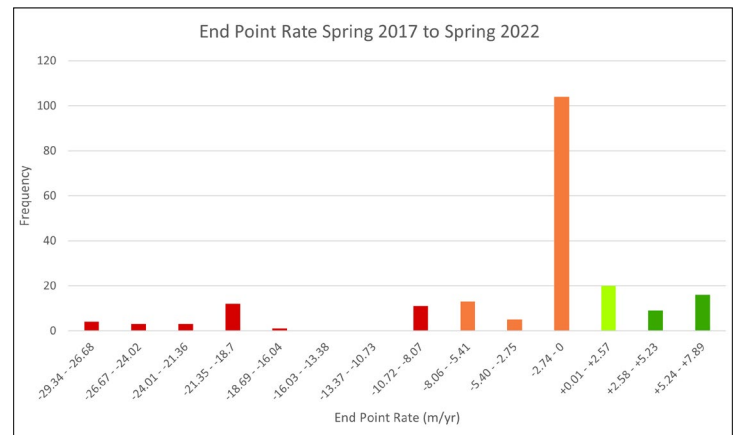


Figure 3. Histogram of transect endpoint rate using data collected during spring surveys at Fort Matanzas National Monument from 2017 to 2022. The rate of shoreline change is binned by 2.7 meters/year (8.8 feet/year) increments along the x-axis. Positive bins are shaded in green, warmer colors represent negative change. Surveys have an uncertainty of ± 10 meters (32.8 feet).

- The average net shoreline movement (NSM) for the survey at Fort Matanzas National Monument between spring and fall of 2022 was -27.0 meters (-88.6 feet) with a standard deviation of 12.9 meters (42.3 feet). For this survey 100% of the transects (203) were negative with 86% (174) of those being erosional (greater than the uncertainty range of ± 10 meters [32.8 feet]). See map and histogram (Figures 4 and 5).
- The maximum erosion for the 2022 surveys was -50.7 meters (-166.3 feet) recorded on the Atlantic side on the FOMA shoreline (Figure 4).

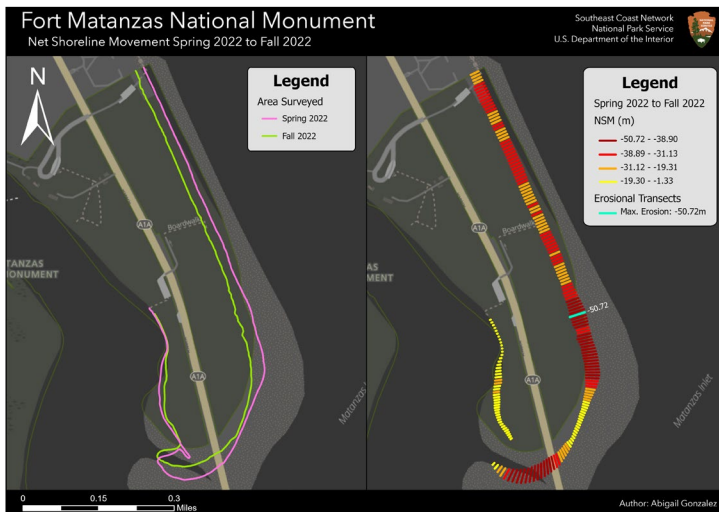


Figure 4. Full maps of surveyed net shoreline movement at Fort Matanzas National Monument. Left panel shows the outlines of the spring and fall 2022 surveys, right panel shows the NSM for each transect created, negative rates shaded in warmer colors. Maximum shoreline movement (highlighted transect), -50.7 meters (-166.3 feet). Surveys have an uncertainty of ± 10 meters (32.8 feet).

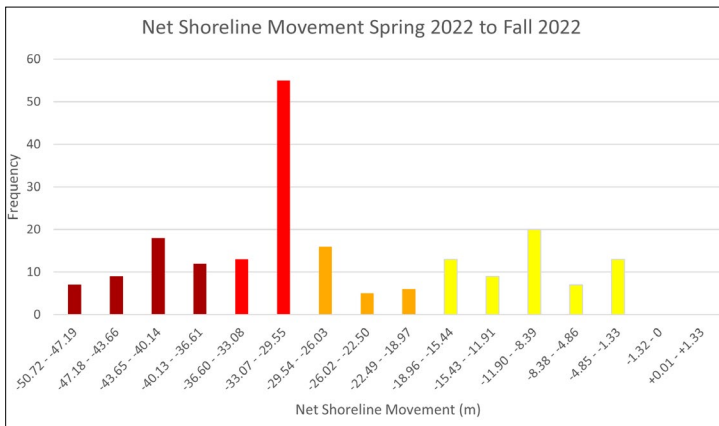


Figure 5. Histogram of net shoreline movement using data collected during spring and fall 2022 surveys at Fort Matanzas National Monument. The shoreline movement distance is binned by 3.5 meters (11.5 feet) increments along the x-axis. All bins greater than -10 meters (32.8 feet) are erosional, the more erosional change is indicated by warmer colors. Surveys have an uncertainty of ± 10 meters (32.8 feet).

Methods

The FOMA shoreline was mapped from its northern boundary on the Atlantic beachfront, around the north end of the Matanzas inlet to the pedestrian boardwalk on the Matanzas River. This survey followed the methods developed by the National Park Service Northeast Coast Barrier Network. The Digital Shoreline Analysis System (DSAS) was used to analyze the shoreline change. The uncertainty of the individual shoreline survey is ± 5 meters (16.4 feet). The comparisons deduced using two individual shoreline surveys will have an uncertainty of ± 10 meters (32.8 feet).

The high tide swash line is mapped using a Trimble® GPS unit. The data collected is post-processed using Pathfinder Office software to obtain higher accuracy data. The corrected data is exported as an ESRI shapefile. The ESRI shapefile is then edited, formatted, and uploaded to a personal geodatabase to analyze using DSAS.

The EPR was calculated in DSAS by dividing the net shoreline movement by the time elapsed between the March 10, 2017, and May 6, 2022, surveys. The two surveys were analyzed by calculating the distance the high-tide lines of two shorelines moved, along cross-shore transects spaced approximately 10 meters (32.8 feet) apart. The EPR is reported as a shoreline movement rate (meters/year). This analysis is termed “end point rate” in DSAS and has an uncertainty range of ± 10 meters.

The NSM was calculated by comparing the shoreline data collected on May 6, 2022, and November 15, 2022. The two shorelines were analyzed by calculating the distance the high tide line has moved from spring to fall 2022, along cross-shore transects spaced 10 meters. This analysis is termed “net shoreline movement” in DSAS and has an uncertainty range of ± 10 meters.

Water Levels

The shoreline surveys of the high tide swash line included in this brief were conducted during similar phases of the neap tide cycle to increase validity of temporal comparisons. The survey window was chosen based on the predicted tides using the closest National Ocean and Atmospheric Administration (NOAA) tide gage with predicted tides (Mayport, FL - Station ID: 8720218). The observed neap high tides at the time of the surveys used to calculate the five-year EPR were 1.5 meters (4.9 feet) on March 10, 2017, and 1.2 meters (3.8 feet) on May 6, 2022. The observed neap high tide levels to calculate the NSM for the spring (May 6) and fall (November 15) 2022 shoreline surveys were 1.2 meters (3.8 feet) on and 1.7 meters (5.6 feet), respectively.



Dune erosion at Fort Matanzas National Monument post Hurricane Nicole November 2022. NPS photo / Kurt Foote, FOMA staff.

About the Southeast Coast Network

In 1999, the National Park Service initiated a long-term ecological monitoring program, known as “Vital Signs Monitoring,” to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition. The overarching purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems.

The NPS Vital Signs Monitoring Program addresses five goals for all parks with significant natural resources:

- Determine the status and trends in selected indicators of the condition of park ecosystem,
- Provide early warning of abnormal conditions,
- Provide data to better understand the dynamic nature and condition of park ecosystems,
- Provide data to meet certain legal and Congressional mandates, and
- Provide a means of measuring progress towards performance goals.

The Southeast Coast Network (SECN) includes 18 administrative areas containing 20 park units, 15 of which contain significant and diverse natural resources. In total, SECN parks encompass more than 184,000 acres of federally-managed land across North Carolina, South Carolina, Georgia, Alabama, and Florida. The parks serve a wide diversity of cultural and natural resource missions and include: five national monuments, four national seashores, three national battlefield parks, two national historic parks, a national memorial, a national recreation area, an ecological and historic preserve, and a single national park. The parks range in size from slightly more than 20 acres to nearly 60,000 acres, and when considered with non-federal lands jointly managed with NPS, the network encompasses more than 253,000 acres.



Damage from Tropical Storm Ian at Fort Matanzas National Monument. NPS photo / Kurt Foote, FOMA staff.



Area of backdunes washed out at Fort Matanzas National Monument. NPS photo / Kurt Foote, FOMA staff.

For More Information

SECN Home Page:

<https://www.nps.gov/im/secn/index.htm>

SECN Reports & Publications:

<https://www.nps.gov/im/secn/reports-publications.htm>

About the NPS Inventory & Monitoring Program:

<https://www.nps.gov/im/index.htm>

Data Downloads via the Natural Resource Information Portal:

<https://irma.nps.gov/Portal/>

Data used in this report are available at [DataStore - SECN Coastal Shoreline Change Protocol Data \(nps.gov\)](#)



Fort Matanzas National Monument as Tropical Storm Ian comes ashore. NPS photo / FOMA staff.