



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. Shoreline retreat may destroy cultural resources, facilities, and other infrastructure. The 2022 tropical cyclone season had a large and deleterious effect on the shoreline and infrastructure at Canaveral National Seashore (CANA), having shown little to no shoreline movement from 2017 to 2022. The park did not take a direct hit from storms, but rather glancing blows from Tropical Storm Ian after crossing the Florida Peninsula (September 29), and Hurricane Nicole making landfall south of the park at Vero Beach (November 10), adversely affected the shoreline and infrastructure. This report gives an overview of 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 consisted of mapping the high tide swash line using a global positioning system (GPS) unit following the methods developed by the NPS Northeast Barrier Coast Network. Shoreline change was calculated using the Digital Shoreline Analysis System (DSAS) developed by the United States Geological Survey (USGS).

Data used in this report are available at [DataStore - SECN Coastal Shoreline Change Protocol Data \(nps.gov\)](https://datastore.usgs.gov/datastore/SECN-Coastal-Shoreline-Change-Protocol-Data)



The south end of Playalinda, facing north, during the spring 2022 shoreline data collection effort. NPS photo / William C. Vervaeke, SECN staff.



Exposed root system of mature Coral bean (*Erythrina herbacea*) following erosion and dune loss resulting from Hurricane Nicole. Pre-storm dune level was approximately at the height of the knothole on left side of plant. NPS photo / Jimi Sadle, CANA staff.

Study Area

Canaveral National Seashore is a 24-mile (38.6-kilometer) stretch of shoreline on the east central coast of Florida. It has a single dune ridge that, before the 2022 storm season, averaged approximately 12 feet (3.7 meters) in height and, for most of its length, was quite stable, backed by a dense growth of saw palmetto (*Serenoa repens*) and other species of hardy shrubs and grasses.



Playalinda beach ramp located on the south end of Canaveral National Seashore post Tropical Storm Ian. NPS photo / Jimi Sadle, CANA staff.

Significant Findings

- All 38.6 kilometers (23.9 miles) of shoreline were surveyed for all survey events.
- The calculated end point rate (EPR) from spring surveys of 2017 and 2021 was 0.3 meters/year (1.1 feet/year) with a standard deviation of 0.7 meters (2.4 feet). The EPR over this time had 32.6% of transects (1,254) showing a negative rate and 67.4% of transects (2,595) showing a positive rate. All the measurements were within the shoreline change distance uncertainty range of the data (± 10 meters [32.8 feet]); meaning the shoreline at Canaveral National Seashore showed no significant movement between 2017 and 2022. See map and histogram (Figures 1, 2).
- The average net shoreline movement (NSM) for the survey at Canaveral National Seashore between spring and fall of 2022 was -15.0 meters (-49.2 feet) with a standard deviation of 5.7 meters (18.7 feet). For this survey, 100% of the transects (3,848) were negative with 80% (3,047) of those being erosional (greater than the uncertainty range of ± 10 meters [32.8 feet]). See map and histogram (Figures 3, 4). It is worth noting that shoreline movement in some areas may be greater than what was shown due to the high tide swash being on top of previously vegetated dunes making it difficult to consistently follow in some places (see photo below).
- The maximum erosion for the 2022 surveys was -35.2 meters (-115.5 feet) recorded at 20.9 kilometers or mile 14.0, between CANA grid markers 50 and 51 (Figure 5).



An eroded dune in Canaveral National Seashore in fall 2022 after Hurricane Nicole. NPS photo / Jimi Sadle, CANA staff.

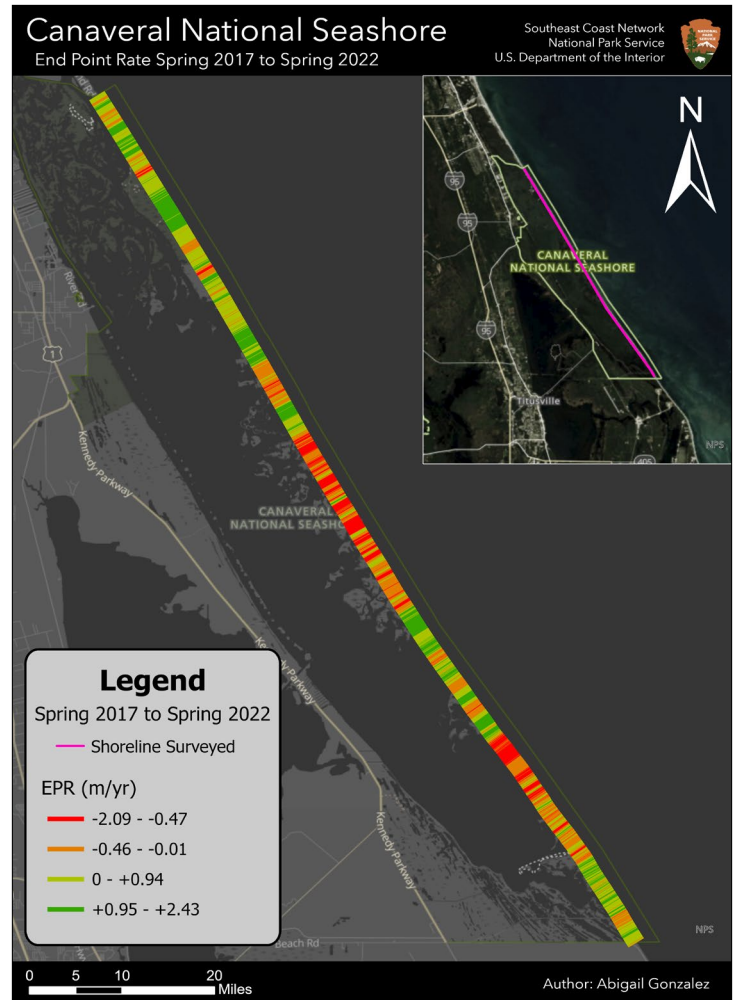


Figure 1. Full map of surveyed end point rates (meters/year) of Canaveral National Seashore using data collected during spring surveys in 2017 and 2022. Positive rates are shaded in green with negative rates shaded in warmer colors. Surveys have an uncertainty of ± 10 meters (32.8 feet).

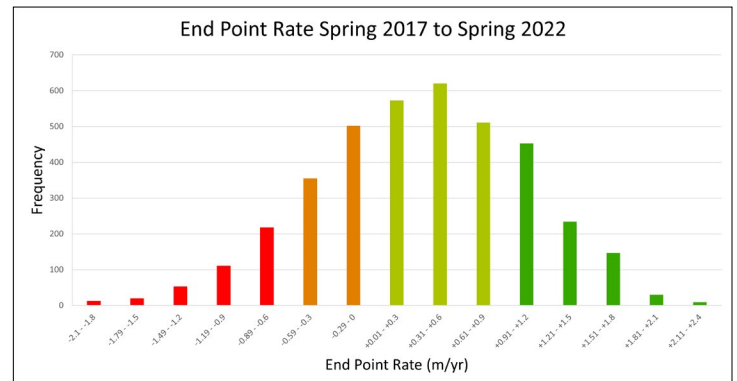


Figure 2. Histogram of transect endpoint rate using data collected during spring surveys at Canaveral National Seashore from 2017 to 2022. The rate of shoreline change is binned by 0.3 meter/year (1 foot/year) increments along the x-axis. Positive bins are shaded in green. Surveys have an uncertainty of ± 10 meters (32.8 feet).

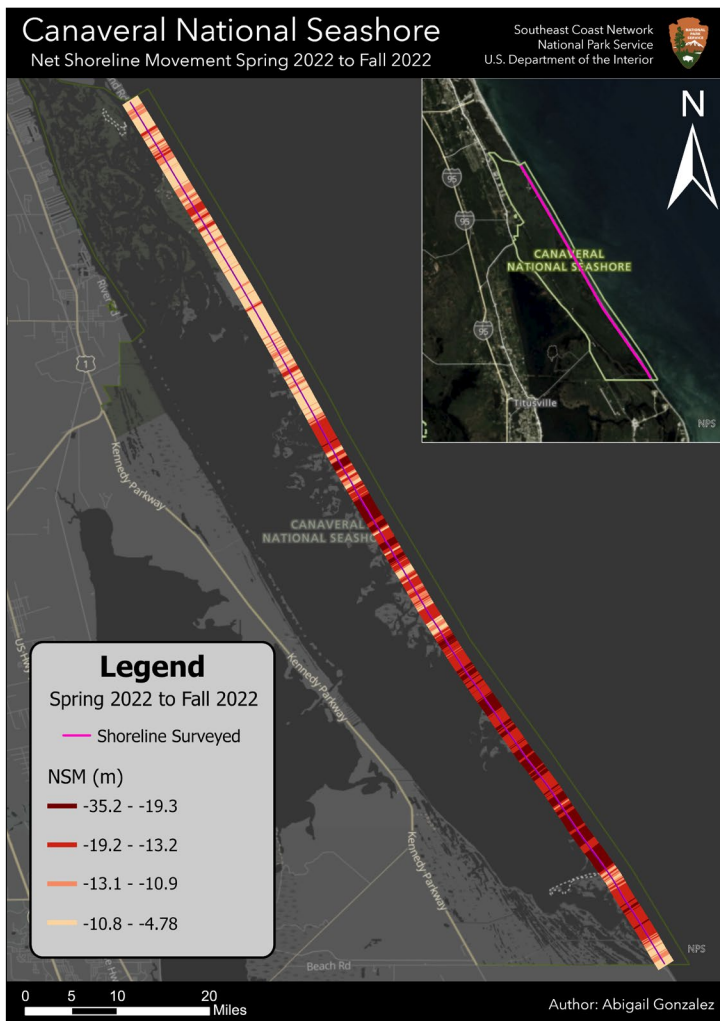


Figure 3. Full map of Canaveral National Seashore showing the net shoreline movement (meters) from spring 2022 to fall 2022, post Tropical Storm Ian and Hurricane Nicole. Warmer colors indicate higher negative and erosional points between surveys. Surveys have an uncertainty of ± 10 meters (32.8 feet).

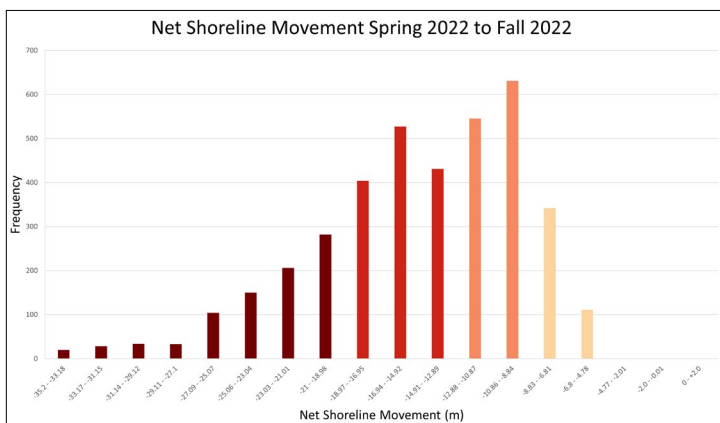


Figure 4. Histogram of net shoreline movement using data collected during spring and fall 2022 surveys at Canaveral National Seashore. The shoreline movement distance is binned by 2.0 meters (6.6 feet) increments along the x-axis. All bins greater than -10 meters (32.8 feet) are erosional the more erosional change is indicated by warmer colors. Surveys have an uncertainty of ± 10 meters (32.8 feet).



A still intact dune complex post Tropical Storm Ian, October 22, 2022. NPS photo / Jimi Sadle, CANA staff.

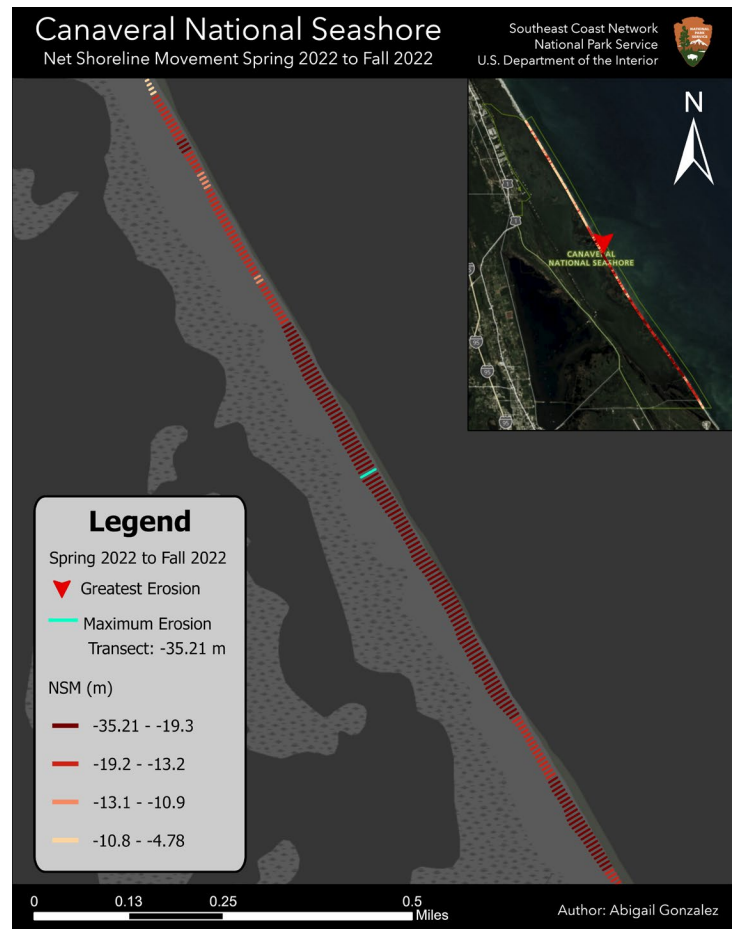


Figure 5. Map of Canaveral National Seashore showing the transect with the maximum shoreline movement (highlighted in blue), -35.2 meters (-115.5 feet), from spring 2022 to fall 2022, after Tropical Storm Ian and Hurricane Nicole. It was recorded at 20.9 kilometers (or mile 14.0), between CANA grid markers 50 and 51. Warmer colors indicate higher negative and erosional points between surveys. Surveys have an uncertainty of ± 10 meters (32.8 feet).

Methods

The shoreline was mapped along the oceanfront sandy shoreline of Canaveral National Seashore. The Digital Shoreline Analysis System (DSAS) was used to analyze the shoreline change for both EPR and NSM calculations. The uncertainty of each individual shoreline survey was ± 5 meters (16.4 feet). The comparisons of two individual shoreline surveys will have an uncertainty of ± 10 meters (32.8 feet).

Methods (continued)

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

The NSM was calculated by analyzing the shoreline data collected on April 12, 2022, and November 14, 2022. The NSM was obtained by calculating the distance the high tide line has moved from spring to fall 2022, along cross-shore transects spaced 10 meters (32.8 feet). The NSM has an uncertainty range of ± 10 meters.

The EPR was calculated using DSAS by dividing the NSM by the time elapsed between the March 9, 2017, and April 12, 2022, surveys. The EPR is reported as a shoreline movement rate (meters/year) 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 Oceanic and Atmospheric Administration (NOAA) tide gage with predicted tides (Trident Pier, FL - Station ID: 8721604). The observed neap high tides, at the time of the surveys used to calculate the five-year EPR, were 1.1 meters (3.6 feet) on March 9, 2017, and 1.0 meter (3.1 feet) on April 12, 2022. The observed neap high tide levels used to calculate the NSM for the spring (April 12) and fall (November 14) 2022 shoreline surveys were 1.0 meter (3.1 feet) on and 1.5 meters (4.7 feet), respectively.

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,



Sand deposition on shoreline of Mosquito Lagoon following tidal overwash resulting from Hurricane Nicole. NPS photo / Jimi Sadle, CANA staff.

- 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 eighteen administrative areas containing twenty park units, fifteen 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.

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 \(nps.gov\)](#)