

Memorandum – Coastal Engineering Review

Summary of Geologic Resources Inventory (GRI) Support Documents: Canaveral National Seashore (CANA)

February 2026

Review Request Summary

The Geologic Resource Inventory (GRI) is one of 12 baseline natural resource inventory efforts within the National Park Service (NPS) Inventory and Monitoring (I&M) Division. The GRI is a cooperative effort among the National Park Service, Colorado State University, and the University of Alaska Fairbanks. It strives to advance science based natural resource management and builds awareness of geology and the importance of geologic features and processes to park environments.

The GRI team works closely with a variety of partners to provide each of the approximately 270 parks in the I&M networks with a geologic scoping meeting, digital geologic map data and poster, and a park specific geologic report. These products support stewardship of park resources by providing information about geologic formations, processes, hazards, and connections among geology, history, and other natural resources. The National Park Service identified 13 coastal parks that have geologic scoping meeting summaries and at least one digital geologic map but do not have a traditional GRI report: Biscayne National Park (BISC), Cape Cod National Seashore (CACO), Canaveral National Seashore (CANA), Castillo de San Marcos National Monument (CASA), Cumberland Island National Seashore (CUIS), Fire Island National Seashore (FIIS), Fort Caroline National Memorial (FOCA), Fort Frederica National Monument (FOFR), Fort Matanzas National Monument (FOMA), Fort Pulaski National Monument (FOPU), Fort Sumter and Fort Moultrie National Historical Park (FOSU), Gateway National Recreation Area (GATE), and Timucuan Ecological and Historic Preserve (TIMU). As of spring 2024, the GRI team is transitioning to a proposal-based system and not all parks will receive a traditional report, including all 13 of the identified coastal parks. Many of these coastal parks were originally scoped in the early 2000s and have map products approaching or now exceeding 20 years old. Therefore, to provide a status update to the coastal parks in lieu of a traditional report, the GRI team requested help from EA Engineering, Science, and Technology, Inc., PBC (EA) with the following:

- Prepare literature reviews focused on geologic resources for each of these parks to provide a data resource for future work
- Prepare a literature review to include servicewide and regional resources that could be useful to multiple parks
- Evaluate available digital geologic map data for each of these parks and assess their relevance to the coastal management needs

Literature Reviews

Introduction

The literature review for each park consists of an Excel spreadsheet that lists all sources found and PDF files of each source listed in the spreadsheet. Within the spreadsheet, there is a link that will open the associated PDF file directly. These files for Canaveral National Seashore can be downloaded from the NPS DataStore at: <https://irma.nps.gov/DataStore/Reference/Profile/2315504>.

Methodology

When searching for sources, the following steps were followed for each park to ensure consistency in methods:

- EA checked their server for project files already in EA possession/already catalogued in previous literature reviews, annotated bibliographies, and memo reference lists.
- EA visited the GRI Product Page (NPS 2024a) to check for GRI products that the National Park Service has previously compiled for the park unit.
- EA completed an advanced search of NPS DataStore using the following methods:
 - In the Text Fields section, enter:
 - *Description* contains geolog*
 - OR *Title* contains geolog*
 - OR *Keyword* contains geolog*
 - In the Content Units section, enter the four-letter code for the park unit/select it from the list
- EA completed a general google search, focusing on scholarly articles. If providing overwhelming results, results were narrowed by using a publication date of 2016/2017 as a cutoff.
- EA reviewed the following links relevant to multiple parks:
 - Coastal engineering inventories of select parks (NPS 2013)
 - The NPS Paleontology Library is a repository for electronic copies of geology and paleontology publications, reports, and other media. There are three main paleontological resource inventory types:
 - Park-specific Paleontological Resource Inventories (NPS 2024b)
 - Servicewide Thematic Paleontological Resource Inventories (NPS 2023a)
 - I&M Network Based Paleontological Resource Inventories (NPS 2023b)
 - Shoreline Change Project maps for 88 ocean and Great Lake park units (NPS 2022).
- EA checked the reference lists of reports already found, particularly if the reference was comprehensive, relevant, and/or recently published.
- EA used the following resource topics as a starting point for search terms (but this list is not exhaustive, some terms were added based on park-specific topics):

- | | |
|---------------------------|--------------------------------------|
| – Surficial features | – Saltwater intrusion |
| – Hydrogeomorphic map | – Sediment transport |
| – Unconsolidated deposits | – Hydrology and hydrogeology |
| – Storm impacts | – Nearshore/seafloor/benthic habitat |
| – Erosion | – Shoreline evolution |
| – Overwash | – Paleontology/fossils |
| – Breaches | – Land disturbance |
| – Inlet formation | – Seismicity |
| – Sea level rise | – Waves, currents, and tides |
| – Marshes | – Wind |

Spreadsheet Details

Column A, File Name: Each row in this column includes a unique filename identifier that corresponds to a specific PDF file included in the park folder. Each filename begins with the park four-letter identifier, followed by GRI, followed by a number. For example, “FIIS GRI_001”.

Column B, First-level Grouping: One of the following groupings was selected from the list below that matches (as much as possible) the document scope:

- General/Natural Resources
- Geology
- Coastal Processes/Geomorphology
- Habitat
- Engineering

Column C, Date of Publication: This is included separately from the citation for ease of review.

Column D, Citation: Uses a modified APA-style citation format, examples are below.

Example of a journal article:

Schwab, W.C., W.E. Baldwin, C.J. Hapke, E.E. Lentz, P.T. Gayes, J.F. Denny, J.H. List, and J.C. Warner. 2013. Geologic Evidence for Onshore Sediment Transport from the Inner Continental Shelf: Fire Island, New York. *Journal of Coastal Research* Volume 29, Issue 3: pp. 526–544.

Example of an agency report:

US Army Corps of Engineers. 2007. *Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York Storm Damage Reduction Reformulation Study, Work Order 28, Inlet Modifications*. US Army Corps of Engineers, New York District, North Atlantic Division. 493 pp.

Column E, Short Title/Access: This field is the document title, or a shortened version, and is linked to the PDF file.

Column F, Literature Review Summary: This field is the document abstract (if concise enough) or a few sentences explaining the scope and contents of the document, focusing on geological resources relevance.

Column G, Keywords: This field consists of three to five keywords based on review of the document or keywords identified in the NPS DataStore.

Column H, Notes: This field is optional. For example, if appendices are included as separate files/entries in the literature review.

CANA Literature Review Summary

CANA protects one of the most extensive stretches of undeveloped beach on the east coast of Florida. A total of 16 sources are provided in the literature review for this park, dated from 1974 to 2023. EA developed keywords based on relevant coastal resources included in each reviewed source. They are provided in column G of the spreadsheet and include the following:

- | | | |
|------------------------------|--|--------------------|
| ▪ Barrier island | ▪ Geologic | ▪ Shoreline change |
| ▪ Barrier island complex | ▪ Geomorphology | ▪ Sonar |
| ▪ Bathymetry | ▪ Geophysical | ▪ Topography |
| ▪ Beach nourishment | ▪ Geographic Information Systems (GIS) | ▪ Vegetation |
| ▪ Biogeomorphologic feedback | ▪ Human impacts | ▪ Water quality |
| ▪ Biological resources | ▪ Hurricane | ▪ Wave climate |
| ▪ Climate change | ▪ Hydrogeology | ▪ Wetlands |
| ▪ Coastal ecosystem | ▪ Infrastructure | |
| ▪ Coastal geomorphology | ▪ Karst | |
| ▪ Coastal hydrology | ▪ Land use | |
| ▪ Coastal processes | ▪ Lidar | |
| ▪ Coastal water quality | ▪ Marsh | |
| ▪ Coastal zone | ▪ Oceanography | |
| ▪ Coastline shape | ▪ Paleo delta | |
| ▪ Continental shelf | ▪ Sand sources | |
| ▪ Cuspate coastline | ▪ Sea level rise | |
| ▪ Drainage reversal | ▪ Sea-floor borings | |
| ▪ Dune | ▪ Sediment | |
| ▪ Flexural uplift | ▪ Sediment quality | |
| | ▪ Seismic reflection | |

In addition to park-specific literature reviews, a review was completed that includes service wide and regional resources from which multiple parks could benefit. These resources include vulnerability assessment protocols, monitoring protocols, climate change inventories/impacts, sea level rise scenarios/evaluations, coastal hazard assessments, and mapping tools that provide data for all parks, among others. Although all resources are ideally provided as PDF documents, some of these resources are only useful when accessed digitally (e.g., mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a basis to understand the range of geologic resources in each park, as well as the potential internal guidance documents and resources the National Park Service has. The methodology laid out above can be followed for future searches to update information, if desired.

Geologic Map Assessment

Introduction

Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps, such as coastal or geologic hazard maps, may be used by the GRI to create digital GIS data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

The GRI team compiled Digital Geologic Maps for each of the 13 coastal parks: BISC, CACO, CANA, CASA, CUIS, FIIS, FOCA, FOFR, FOMA, FOPU, FOSU, GATE, and TIMU. As part of, and in parallel with, the GRI literature review process, EA assessed the relevance of the GRI GIS data sets (which are all available on the NPS DataStore; some of which are approaching 20 years old or more) to the current coastal management needs of each park mentioned above. This assessment is based in part on EA's perspective as technical experts well versed in NPS management needs.

Methodology

This work was done without the use of GIS software but instead by reviewing the GRI Scoping Meeting Summary and GRI Ancillary Map information document, both available on the NPS DataStore. For each park, EA's assessment aimed to answer the following questions about the digital geologic map(s) created by GRI:

1. Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) reasonably comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?
2. Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?
3. Does an online search yield any maps that are more relevant?

In addition to park-specific literature reviews, a review was completed that includes service wide and regional resources that multiple parks could benefit from. These resources range from vulnerability assessment protocols to monitoring protocols to climate change inventories/impacts, sea level rise scenarios/evaluations, to coastal hazard assessments, to mapping tools that provide data for all parks.

While all resources are ideally provided as pdf documents, some of these resources are only useful when access digitally (for example, mapping data).

It is understood that research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a basis to understand the range of geologic resources in each park as well as the potential internal guidance documents and resources NPS has that can be tapped. The methodology laid out above can be followed for future searches to update information, if desired.

CANA Map Assessment

The information summarized below is based on information presented in the *Canaveral National Seashore GRI¹ Scoping Meeting Summary* (Graham 2009), the *Canaveral National Seashore GRI Ancillary Map Information Document* (NPS 2021), and the NPS DataStore page data for the CANA GRI maps produced by GRD (NPS 2021). Information on the CANA GRI maps are presented in table 1.

The scoping meeting summary (Graham 2009) identified a wide range of significant geologic resource management issues in CANA (Table 2). Table 2 identifies each of the groups in the first column as well as which of the existing GRI map products that provide information on them. If an existing map provides incomplete information, this is indicated in the ‘data gap’ column.

Table 1. Summary of GRI map products for CANA

GRI Map Product	Citation	Data Layers	Sources
Digital Geologic-GIS Map	NPS 2021	– Geologic Units (CANAGLG) – Geologic Contacts (CANAGLGA) – Linear Excavation Features (CANAMFL) – Core Holes (CANAMIN) – Excavation Area Features (CANAMAF) – Excavation Area Feature Boundaries (CANAMAFA) – Geomorphic Units (CANAMRPH) – Geomorphic Unit Boundaries (CANAMRPHA) – Geomorphic Feature Areas (CANAGMFA) – Geomorphic Feature Area Boundaries (CANAGMFAA)	The GRI digital geologic-GIS map was produced from the following source: Parkinson, R.W., and R. Schaub. 2007. <i>Geologic Map of Canaveral National Seashore, scale 1:24,000, 7.5 Minute Series Quadrangles and Report</i> . National Park Service, National Aeronautics and Space Administration (NASA), RW Parkinson Inc. and Dynamic Corp., scale 1:24,000, 6 plates and report (Canaveral National Seashore (2007)) (GRI Source Map ID 7247).

¹ Note that the GRI program was briefly named the Geologic Resource Evaluation (GRE) program. The abbreviations GRI and GRE refer to the same program although products of different vintages may display either of the abbreviations.

Table 2. Geologic resource management issues addressed in existing GRI map products

Geologic Resource Management Issues	Digital Geologic-GIS Map	Data Gap
Aeolian issues (dune system)	X	
Coastal impacts from natural processes and anthropogenic sources		X
Climate change		X
Disturbed lands (lands in need of restoration)		X
Groundwater – salinity impacts on Mosquito Lagoon		X

Geologic Resource Management issues are provided in scoping meeting summary (Graham 2009)

Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) reasonably comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?

Although the maps that have been developed offer a comprehensive geologic survey of the park area, they lack several geologic resource issues identified in the CANA scoping summary including coastal issues (processes), impacts from climate change, disturbed lands, and groundwater data.

The source maps used in the 2021 Digital Geologic GIS Map of the Canaveral National Seashore are sourced from 7.5-minute series quadrangles from 2007. The map includes morphogenic units including lagoon features, cusped foreland, and barrier island features. It also includes anthropogenic features, such as infrastructure, excavated areas, and areas of deposition (dikes). Geologic map units include the following:

- OSi – Atlantic Ocean, Continental Shelf, inner shelf
- BOF – Barrier Island, Open Ocean, shoreface
- BOB – Barrier Island, Open Ocean, beach
- BOd – Barrier Island, Open Ocean, dune
- BPu – Barrier Island, Platform, upland
- BPw – Barrier Island, Platform, wetland
- Lniu – Lagoon, Natural Island, upland
- Lniw – Lagoon, Natural Island, wetland
- Lsiu – Lagoon, Spoil Island, upland
- Lsiw – Lagoon, Spoil Island, wetland
- Lmiu – Lagoon, Mixed Island, upland
- Lmiw – Lagoon, Mixed Island, wetland
- LSsc – Lagoon, Subtidal, continuous seagrass
- LSsd – Lagoon, Subtidal, discontinuous seagrass
- LSb – Lagoon, Subtidal, barren
- FRr – Cusped Foreland, Relict Beach Ridge Complex, ridge
- FRs – Cusped Foreland, Relict Beach Ridge Complex, swale
- FRu – Cusped Foreland, Relict Beach Ridge Complex, undifferentiated
- Qan – Anastasia Formation

Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?

Although the source map used in the GRI Digital Geologic GIS Map are relatively recent, CANA is often impacted by hurricanes, which have the power to drastically change the coastal landscape. According to

historical NPS Morning Reports and Incidents log, CANA has incurred damage from several storm systems over the years. In 2022 Hurricane Nicole caused extensive damage to infrastructure, and severe damage to the beach and dune areas (NPS 2024c). Even as recently as 2023, Hurricane Idalia brought in high winds and extensive rain, followed by Hurricane Franklin causing elevated tides and life-threatening rip currents. Based on the frequency of extreme storm events the source maps are not likely representative of the current landscape within CANA.

Does an online search yield any maps that that are more relevant?

Some publicly available interactive maps and resources listed below may provide information that can fill the gaps needed by park staff:

- NOAA Sea Level Rise Viewer (NOAA OCM 2024) – Mapping tool shows various projected sea level rise scenarios, the impacts to resources such as marsh migration, community vulnerability, high tide flooding, and local scenarios for a more precise view of sea level rise impacts.
- Coastal Geophysical Data Collected in 2016 Nearshore Cape Canaveral, Florida (USGS 2017) – This USGS Data Release includes the: 1) processed elevation point data (xyz) and digital elevation model (DEM), 2) processed images of backscatter and side scan sonar (SSS), and 3) chirp subbottom profile data (seggy and jpg).
- Historical and Projected Climate Change Trends for the US and US National Parks (Gonzalez et al. 2018) – Research published in Environmental Research Letters examined historical and projected trends in anthropogenic climate change for the United States and all 417 national parks units
- Assessment of estuarine water and sediment quality at Canaveral National Seashore: 2019 data summary (NPS 2020) – Assessment of water quality at Canaveral National Seashore-Mosquito Lagoon
- Florida Geomorphology Atlas (Florida Geological Survey Special Publication 2022)
- NOAA Historical Hurricane Tracks (NOAA 2024)

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