
Memorandum – Coastal Engineering Review

Summary of Geologic Resources Inventory (GRI) Support Documents: Fort Matanzas National Monument (FOMA)

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 between the NPS, Colorado State University, and the University of Alaska Fairbanks. It strives to advance science-based management of natural resources in the national parks and raise awareness about geology and the role that geologic features and processes play in the environment.

The GRI team, working closely with a variety of partners, provides 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 are designed to enhance stewardship of park resources by providing valuable information about geologic formations, processes, hazards, and links 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 assistance from EA Engineering, Science, and Technology, Inc., PBC (EA), with the following:

- Prepare park-specific literature reviews focused on geologic resources to provide a data resource for future work
- Prepare a literature review of service-wide and regional resources that could be useful to multiple parks
- Evaluate available digital geologic map data for each park and assess its relevance to coastal management needs

Literature Reviews

Introduction

The literature review for each park consists of an Excel spreadsheet listing all identified sources and PDF files for each source. The spreadsheet includes a link that opens the associated PDF file directly. These files for Fort Matanzas National Monument can be downloaded from the NPS DataStore at: <https://irma.nps.gov/DataStore/Reference/Profile/2317171>.

Methodology

To ensure consistency across parks, EA followed the steps below when searching for sources:

- Checked EA servers for project files already in EA possession or previously cataloged in literature reviews, annotated bibliographies, memorandum reference lists, and related materials.
- Reviewed the GRI Product Page (NPS 2024a) to identify GRI products previously compiled by the National Park Service for each park unit.
- Conducted 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
- Completed a general Google search focused on scholarly articles. When results were excessive, searches were refined by applying a publication date cutoff of 2016 or 2017.
- Reviewed the following resources relevant to multiple parks:
 - Coastal engineering inventories of select parks (NPS 2013)
 - The NPS Paleontology Library, a repository for electronic copies of geology and paleontology publications, reports, and other media, including the following paleontological resource inventory types:
 - Park-specific Paleontological Resource Inventories (NPS 2024b)
 - Service-wide 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)
- Reviewed reference lists from reports already identified, particularly those that were comprehensive, relevant, and/or recently published.
- Used the following resource topics as a starting point for search terms (this list is not exhaustive, and additional terms were added based on park-specific topics):

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|---------------------------|--------------------------------------|
| – 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 corresponding to a specific PDF file stored in the park folder. Each filename begins with the park four-letter identifier, followed by GRI, and then a sequential number (for example, FIIS GRI_001).

Column B, First-Level Grouping: One of the following groupings was selected from the list below to best match the document scope:

- General/natural resources
- Geology
- Coastal processes/geomorphology
- Habitat
- Engineering

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

Column D, Citation: These use a modified APA-style format. Examples are provided 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 includes the document title or a shortened version of the title and is linked directly to the associated PDF file.

Column F, Literature Review Summary: This includes the document abstract (if sufficiently concise) or a brief summary describing the scope and contents of the document, with a focus on relevance to geologic resources.

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

Column H, Notes: This is optional and is used to provide additional information, such as whether appendices are included as separate files or entries in the literature review.

FOMA Literature Review Summary

FOMA preserves the coquina watchtower, completed in 1742, which provided a strategic location for defending the southern approach to the Spanish military settlement of St. Augustine. The park preserves approximately 300 acres of coastal Florida, including dunes, marsh, and maritime forest. The literature review for this park includes nine sources published between 2006 and 2022. EA developed keywords based on the coastal resources addressed in each reviewed source. These keywords are provided in column G of the spreadsheet and include the following:

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|-----------------------|------------------------------------|----------------------------|
| ▪ Beach morphology | ▪ Groin | ▪ Oils |
| ▪ Beach nourishment | ▪ Habitat mapping | ▪ Pier |
| ▪ Breakwater | ▪ Headland control | ▪ Revetment |
| ▪ Bulkhead | ▪ I&M | ▪ Salt marsh |
| ▪ Climate change | ▪ Infrastructure | ▪ Seawall |
| ▪ Coastal engineering | ▪ Jetty | ▪ Sediment transport |
| ▪ Coastal habitat | ▪ Levee | ▪ Sill |
| ▪ Coastal hazards | ▪ LiDAR | ▪ SLR |
| ▪ Coastal processes | ▪ Mangrove | ▪ Soil resources inventory |
| ▪ Coastal structures | ▪ Matanzas Inlet | ▪ Soil survey |
| ▪ Dike | ▪ Monitoring | ▪ Vegetation mapping |
| ▪ Dredging | ▪ National Cooperative Soil Survey | |
| ▪ Erosion | | |
| ▪ Geology | ▪ Natural resources | |

In addition to park-specific literature reviews, a review was completed that includes service-wide and regional resources that may benefit multiple parks. 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

resources are ideally provided as PDF documents, some 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 foundation for understanding the range of geologic resources in each park, as well as relevant internal National Park Service guidance and resources. The methodology described above may be used 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 geographic information systems (GIS) data that meet park needs. These GIS data allow geologic information to be easily viewed and analyzed alongside other resource management information.

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 (all available on the NPS DataStore; some exceeding 20 years old) to each park's current coastal management needs. This assessment is based in part on EA's perspective as technical experts well versed in NPS management requirements.

Methodology

This work was completed without the use of GIS software and instead relied on review of the GRI Scoping Meeting Summary and the GRI Ancillary Map Information document, both available on NPS DataStore. For each park, EA's assessment focused on answering the following questions about the GRI digital geologic map(s):

1. Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) 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 may benefit multiple parks. These resources include vulnerability and monitoring protocols, climate change inventories and impacts, sea-level-rise scenarios and evaluations, coastal hazard assessments, and mapping tools that provide data for all parks. Although resources are ideally provided as PDF documents, some are only useful when accessed digitally (for example, mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a basis for understanding the range of geologic resources in each park, as well as

internal NPS guidance documents and resources that may be used. The methodology described above can be followed in future searches to update information, if desired.

FOMA Map Assessment

The information summarized below is based on information presented in the *Geologic Resources Inventory Scoping Summary Fort Matanzas National Monument, Florida* (Graham 2009), the *Castillo de San Marcos National Monument and Fort Matanzas National Monument GRI Ancillary Map Information Document* (NPS 2014a), and the NPS DataStore page data for the two unpublished FOMA GRI maps produced by GRD (NPS 2014a and NPS 2014b). Information specific to the two unpublished FOMA GRI maps is presented in table 1.

The scoping summary (Graham 2009) identified a wide range of significant geologic resource management issues in FOMA (table 2). Table 2 identifies each of the groups in the first column and identifies which existing GRI map products address them. Where existing maps provide incomplete information, the data-gap column is also shaded.

Table 1. Summary of GRI map products for FOMA

GRI Map Product	Citation	Data Layers	Sources
Unpublished Digital Geomorphic Map	NPS 2014a	– CAFGSUR (Surficial Units) – CAFGSURA (Surficial Contacts) – CAFGGLF (Geologic Line Features)	Map was produced from digital data from the following Florida Geological Survey preliminary digital data and map: Williams, C.P., Cichon, J.R. and Hartman, L.M., 2014, Geomorphology and Geology of Selected Coastal Regions in Northeastern Florida (Castillo de San Marcos National Monument and Fort Matanzas National Monument); Florida Geological Survey, preliminary digital data and map, scale 1:24,000. (GRI Source Map ID 75749).
Unpublished Digital Geologic Map	NPS2014b	– CAFGSUR (Surficial Units), CAFGSURA (Surficial Contacts) and CAFGGLF (Geologic Line Features)	Map was produced from digital data from the following Florida Geological Survey preliminary digital data and map: Williams, C.P., Cichon, J.R. and Hartman, L.M., 2014, Geomorphology and Geology of Selected Coastal Regions in Northeastern Florida (Castillo de San Marcos National Monument and Fort Matanzas National Monument); Florida Geological Survey, preliminary digital data and map, scale 1:24,000. (GRI Source Map ID 75749).

Table 2. Geologic Resource Management Issues Addressed in Existing GRI Map Products

Geologic Resource Management Issues	Unpublished Digital Geomorphic Map	Unpublished Digital Geologic Map	Data Gap
Dune system deterioration	X		
Aeolian issues – storms impacting dunes and cultural sites	X		
Changes in hydrology due to dredged material placement	X		
Matanzas River shoreline erosion (anthropogenic impacts)	X		
Sediment transport changes due to groin and revetment installations	X		
Impacts of climate change and sea level rise			X
Disturbed lands	X		
Groundwater quality			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?

Management concerns are generally addressed through the produced GIS maps; however, the maps do not include a comprehensive assessment of climate change and sea-level rise impacts or groundwater quality information. The map includes two geologic cross sections that depict depositional units and well locations but does not present water-quality data.

The surficial sediment and geologic units identified in the GRI Digital Geomorphic Map of Castillo de San Marcos National Monument and Fort Matanzas National Monument are listed below. Units are presented with their assigned unit symbol and name and are organized by geomorphic environment, consistent with the source map.

- Supratidal units
 - Qabbd – Active blowout/Blowout dune
 - Qdtf – Deflation troughs or flats
 - Qdn – Dunes
 - Qfd – Foredune
 - Qpd – Primary dunes
 - Qrdr – Relict dune and ridge
- Qsd – Secondary dune
- Intertidal Beach Units
 - Qc – Coquina
 - Qsb – Sand beach
 - Qwfod – Washover fan/Overwash deposits

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| <ul style="list-style-type: none">▪ Intertidal Marsh Deposits<ul style="list-style-type: none">– Qnw – Non-vegetated wetland– Qsm – Salt marsh– Qso – Salt ponds– Qtc – Tidal creek▪ Intertidal/Subtidal Flat Units<ul style="list-style-type: none">– Qb – Bioherms– Qcl – Channel levee– Qtf – Tidal flat Subtidal units– Qetd – Ebb tide delta– Qftd – Flood tide delta– Qic – Inlet channel▪ Coastal-Riverine Units<ul style="list-style-type: none">– Qfw – Freshwater wetland– Qol – Oxbow lakes– Qpn – Pond (natural)– Qs – Swamp | <ul style="list-style-type: none">▪ Anthropogenic Units<ul style="list-style-type: none">– Qdm – Dams– Qdma – Docks/Marinas/Anchorage– Qdc – Dredged channels– Qds – Dredged spoil– Qf – Fill– Qg – Groins– Qhs – Historic structures– Qi – Impoundments– Qj – Jetties– Qmd – Mosquito ditches– Qp – Piers– Qqbp – Quarry/Borrow pit– Qrr – Rip rap– Qsp – Stormwater ponds |
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The geologic units present in the GRI Digital Geologic Map of Castillo de San Marcos National Monument and Fort Matanzas National Monument are listed with their assigned unit symbol and unit name, from youngest to oldest. No description for water is provided.

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| <ul style="list-style-type: none">▪ Holocene Epoch<ul style="list-style-type: none">– Qh – Undifferentiated sediments▪ Pleistocene Epoch<ul style="list-style-type: none">– Qbd – Beach ridge and dune▪ Late Pleistocene Epoch<ul style="list-style-type: none">– Qa – Anastasia Formation▪ Pleistocene and Pliocene Epochs<ul style="list-style-type: none">– Qtsu – shelly sediments of Pliocene and Pleistocene | <ul style="list-style-type: none">▪ Middle Miocene Epoch<ul style="list-style-type: none">– Thc – Coosawhatchie Formation▪ Lower Miocene Epoch<ul style="list-style-type: none">– Thmh – Marks Head Formation– Thpf – Penney Farms Formation▪ Upper Eocene Epoch<ul style="list-style-type: none">– To – Ocala Limestone. |
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Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?

The source maps are dated 2014. Areas of Fort Matanzas were impacted by Hurricane Matthew in 2016, Hurricane Irma in 2017, and Hurricane Idalia in 2023 (NPS 2024c). The GRI GIS datasets may not accurately represent geologic conditions following these events.

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

Additional online sources of GIS information relevant to the park's identified geologic resource management issues include:

- NOAA Historical Hurricane Tracks (NOAA 2024)
- 2017 USACE FEMA Topobathy Lidar: Florida East Coast, Florida Keys, and Collier County (Irma) (NOAA OCM 2017a)
- 2016 USACE Post-Matthew Topobathy Lidar: Southeast Coast (VA, NC, SC, GA, FL) (NOAA OCM 2016a)
- 2016 USACE NCMP Topobathy Lidar: Florida East Coast (NOAA OCM 2016b)
- Digital Elevation Models and LiDAR data from NOAA Digital Coast: Data Access Viewer including:
 - USACE FEMA Post Nicole Topobathy Lidar: Florida (NOAA OCM 2022a) and Point Cloud files with Orthometric Vertical Datum NAVD88 using GEOID18 (NOAA OCM 2022b)
 - USGS Lidar: Florida Peninsular FDFEM (NOAA OCM 2024a)
 - USACE FEMA Topobathy Lidar: Florida East Coast, Florida Keys, and Collier County (Post Hurricane Irma) (NOAA OCM 2024b) and Point Cloud files with Orthometric Vertical Datum NAVD88 using GEOID18 (NOAA OCM 2017b)
 - USACE Post-Matthew Topobathy Lidar: Southeast Coast (VA, NC, SC, GA, and FL) (NOAA OCM 2024c) and Point Cloud files with Orthometric Vertical Datum NAVD88 using GEOID18 (NOAA OCM 2016c)
 - NOAA Sea Level Rise Viewer (NOAA OCM 2024d)

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