

Memorandum – Coastal Engineering Review

Summary of Geologic Resources Inventory (GRI) Support Documents: Timucuan Ecological Historic Preserve (TIMU)

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 Timucuan Ecological & Historic Preserve can be downloaded from the NPS DataStore at: <https://irma.nps.gov/DataStore/Reference/Profile/2317174>.

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.

TIMU Literature Review Summary

TIMU spans a coastal landscape north and east of Jacksonville, Florida, and incorporates historic sites including Fort Caroline National Memorial and Kingsley Plantation. The literature review for this park includes 25 sources published between 2005 and 2023. 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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| ▪ Accretion | ▪ Geomorphology | ▪ Monitoring |
| ▪ Biodiversity | ▪ GIS | ▪ Natural resources |
| ▪ Biomass density | ▪ Habitat | ▪ Object modeling |
| ▪ Breakwater | ▪ Hydrodynamic | ▪ Oyster reef |
| ▪ Carbon sequestration | ▪ Hydrology | ▪ Pollution sources |
| ▪ Carbon stock | ▪ Inundation path | ▪ Restoration |
| ▪ Climate change | ▪ Invasive species | ▪ Salt marsh |
| ▪ Coastal habitat | ▪ Land cover transitions | ▪ Sea level rise |
| ▪ Cultural resources | ▪ Land cover | ▪ Seaside sparrow |
| ▪ Dredge | ▪ Land use change | ▪ Sediment condition |
| ▪ Environmental impact assessment | ▪ Landscape | ▪ Sediment transport |
| ▪ Exposure | ▪ Living shoreline | ▪ Shoreline change |
| ▪ Flood hazard | ▪ Mangrove | ▪ Shoreline erosion |
| ▪ Flood potential | ▪ Marsh habitat | ▪ Soil carbon |
| ▪ Flooding | ▪ Marsh migration | ▪ Soil |
| ▪ Geologic features | ▪ Marsh resilience | ▪ Spatiotemporal dynamics |
| ▪ Geologic processes | ▪ Marsh wren | ▪ Storm surge |
| ▪ Geology | ▪ Marsh | ▪ Tidal flats |

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| ▪ Tides | ▪ Vegetation | ▪ Watershed assessment |
| ▪ Topo bathymetry | ▪ Visitor experience | |
| ▪ Topography | ▪ Water quality | ▪ Wave impact |
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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.

TIMU Map Assessment

The information summarized below is based on information presented in the *Geologic Resources Inventory Scoping Summary Timucuan Ecological and Historic Preserve and Fort Caroline National Memorial, Florida* (Graham 2009), the *Timucuan Ecological and Historic Preserve and Fort Caroline National Memorial GRI¹ Ancillary Map Information Document* (NPS 2014a), and the NPS DataStore page data for the two TIMU GRI maps produced by GRD (NPS 2014a and NPS 2014b). Information on the TIMU GRI maps is presented table 1.

The scoping meeting summary (Graham 2009) identified a wide range of significant geologic resource management issues in TIMU (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.

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 1. Summary of GRI map products for TIMU

GRI Map Product	Citation	Data Layers	Sources
Digital Geologic-GIS Map	NPS 2014a	– TIFOGLG (Geologic Units) – TIFOGLGA (Geologic Contacts) – TIFOSEC (Geologic Cross Section Lines) – TIFOGPF (Geologic Point Features) – TIFOMIN (Mine Point Features)	<i>Geologic units and their related contacts were produced from:</i> Williams, C.P., Cichon, J.R. Hartman, L.M. and Apolinar, B., 2014, Geomorphology and Geology of Selected Coastal Regions in Northeastern Florida (Timucuan Ecological and Historic Preserve, and Fort Caroline National Memorial): Florida Geological Survey, preliminary digital data and map, scale 1:24,000. (GRI Source Map ID 75810).
Digital Geomorphic -GIS Map	NPS 2014b	– TIFGMRPH (Geomorphic Units) – TIFGMRPHA (Geomorphic Contacts) – TIFGGLF (Geomorphic Line Features)	<i>Geologic units and their related contacts were produced from:</i> Williams, C.P., Cichon, J.R. Hartman, L.M. and Apolinar, B., 2014, Geomorphology and Geology of Selected Coastal Regions in Northeastern Florida (Timucuan Ecological and Historic Preserve, and Fort Caroline National Memorial): Florida Geological Survey, preliminary digital data and map, scale 1:24,000. (GRI Source Map ID 75810).

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

Geologic Resource Management Issues	Digital Geologic- GIS Map	Digital Geomorphic - GIS Map	Data Gap
Potential closure of Fort George River due to accumulated sediment			X
Bank erosion		X	
Dredging of St. Johns River			X
Spoil site east of Ribault Monument			X
Disturbed lands			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?

Several data gaps exist in the GRI GIS datasets relative to the park geologic resource management concerns identified above. These gaps include potential closure of the Fort George River, bank erosion, dredging of the St. Johns River, the spoil site east of the Ribault Monument, and disturbed lands. Elevation and bathymetry data could be useful for addressing some of these management concerns; however, such data would require frequent updates to remain relevant.

The Geologic Resources Division (GRD) produced two GRI GIS datasets for Timucuan Ecological and Historic Preserve (TIMU). These datasets include (1) surficial sediment and geologic units, including geologic cross sections (GRI Digital Geologic Map of Timucuan Ecological and Historic Preserve, and Fort Caroline National Memorial, Florida; table 1), and (2) geomorphic units (GRI Digital Geomorphic Map of Timucuan Ecological and Historic Preserve, and Fort Caroline National Memorial, Florida; table 2).

The surficial sediment and geologic units identified in the GRI Digital Geologic GIS map of Timucuan Ecological and Historic Preserve and Fort Caroline National Memorial, Florida, are listed below, generally from youngest to oldest:

- Qh – Undifferentiated sediments
- Qbd – Beach ridge and dune
- Qu – Undifferentiated Quaternary sediments
- QTsu – Shelly sediments of Pliocene and Pleistocene
- Th – Hawthorn Group
- Thcc – Coosawhatchie Formation, Charlton Member
- Thc – Coosawhatchie Formation
- Thmh – Marks Head Formation
- Thpf – Penney Farms Formation
- To – Ocala Limestone)

The map also includes three geologic cross sections.

The geomorphic units present in the GRI Digital Geomorphic Map of Timucuan Ecological and Historic Preserve and Fort Caroline National Memorial, Florida are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qdn – Dunes).

- Supratidal Units
 - Qdn – Dunes
 - Qfd – Foredune
 - Qpd – Primary dunes
 - Qdr – Relict dune and ridge
 - Qsd – Secondary dunes
 - Qu – Upland
- Intertidal Beach Units
 - Qrsc – Relict spit complex
 - Qsb – Sand beach
 - Qsa – Sandstone
 - Qspi – Spits
- Intertidal Marsh Units
 - Qnw – Non-vegetated wetland
 - Qsm – Salt marsh
 - Qso – Salt ponds
 - Qtc – Tidal creek
- Intertidal/Subtidal Flat Units
 - Qb – Bioherms
 - Qcl – Channel levee
- Subtidal Units
 - Qetd – Ebb tide delta
 - Qftd – Flood tide delta
 - Qic – Inlet channel
- Qric – relict inlet channel
- Coastal-Riverine Units
 - Qfw – Freshwater wetland
 - Qol – Oxbow lakes
 - Qpn – Pond (natural)
 - Qs – Swamp
- Anthropogenic Units
 - Qdm – Dams
 - Qdma – Docks/Marinas/Anchorage
 - Qdc – Dredged channels
 - Qds – Dredged spoil
 - Qf – Fill
 - Qg – Groins
 - Qhs – Historic structures
 - Qi – Impoundments
 - Qj – Jetties
 - Ql – Landfills
 - Qp – Piers
 - Qpdp – Quarry/Borrow Pit
 - Qrr – Rip rap
 - Qses – Shoreline engineering structures
 - Qsp – Stormwater p

According to the *Paleontological Resource Inventory and Monitoring Report for the Southeast Coast Network* (Tweet et al. 2009), fossil specimens have been identified in archeological contexts at Timucuan Ecological and Historic Preserve (TIMU). These specimens are currently curated at the Florida Museum of Natural History (FLMNH) and the Southeast Archeological Center (SEAC). Oyster shells recovered from Fort George Island and dated to approximately 3,700 years before present are housed in the Environmental Archaeology Program collections at the FLMNH, University of Florida, Gainesville. Eleven specimens, or portions of specimens, were recovered from other archeological sites within TIMU and are curated at SEAC; these specimens have not yet been identified. Fossils may also be present in tabby structures at TIMU

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. Portions of Timucuan Ecological and Historic Preserve (TIMU) were affected by Hurricane Irma in 2017, Hurricane Ian in 2022, and Hurricane Idalia in 2023 (NPS 2024d). As a result, the GRI GIS datasets may not accurately represent geologic conditions following Hurricane Idalia.

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

- State of the River for the Lower St. Johns River Basin Report (St. Johns River Report 2024) – Provides relevant data and literature on the St. Johns River, including summaries of the status and trends of multiple environmental indicators.
- Florida Department of Environmental Protection Map Direct (Florida DEP 2024) – An online mapping database that includes a wide range of available mapping tools, such as sand placement events, water-quality data, and condition reports.
- U.S. Army Corps of Engineers (USACE), Jacksonville District (USACE 2024a) – Provides data collection and navigational dredging information for past and future projects, including hydrosurveys and channel-deepening studies conducted within the Jacksonville District.
 - Jacksonville Harbor Channel Deepening (USACE 2024b)
 - Northeast Florida Regional Sediment Management (Hodgens and Neves 2016) – Includes sediment transport data and recommendations for sediment management within the Fort George River and associated upland storage sites.

Reference List:

Florida Department of Environmental Protection (DEP)

2024 “Map Direct.” Available online: <https://ca.dep.state.fl.us/mapdirect/>. Accessed March 2024.

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- 2024a “Geologic Resources Inventory—Products.” National Park Service, Geologic Resources Division. Available online: <https://www.nps.gov/subjects/geology/geologic-resources-inventory-products.htm>. Accessed March 2024.
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- 2024d “Timucuan Fort Caroline Incident Reports.” Available online: <https://npshistory.com/morningreport/incidents/timu.htm>. Accessed March 2024.

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- 1997 *The relation between hydrogeology and water quality of the lower Floridan Aquifer in Duval County, Florida, and implications for monitoring movement of saline water*. Water Resources Investigation 96-4242. U.S. Geological Survey.

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- 1994 *Saltwater intrusion and quality of water in the Floridan aquifer system, northeastern Florida*. Water Resources Investigation 92-4174. Reston, VA: U.S. Geological Survey.

St. Johns River Report

- 2024 State of the River Report of the Lower St. Johns River Basin. Available online: <https://sjrr.domains.unf.edu/>. Accessed March 2024.

U.S. Army Corps of Engineers (USACE).

2024a “Jacksonville District Website.” Available online: <https://www.saj.usace.army.mil/>. Accessed March 2024.

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