U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Cape Hatteras National Seashore, Fort Raleigh National Historic Site and Wright Brothers National Memorial

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Cape Hatteras National Seashore, Fort Raleigh National Historic Site and Wright Brothers National Memorial.

caha_fora_wrbr_geomorphology.pdf

Version: 1/12/2021

Geologic Resources Inventory Map Document for Cape Hatteras National Seashore, Fort Raleigh National Historic Site and Wright Brothers National Memorial

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Geologic Resources Inventory Map Document

Cape Hatteras National Seashore, North Carolina

Document to Accompany Digital Geologic-GIS Data

caha_fora_wrbr_geomorphology.pdf

Version: 1/12/2021

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Cape Hatteras National Seashore (CAHA), Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR).

Attempts have been made to reproduce all aspects of the original source products, including the geomorphic units and their descriptions, graphics and other information present in the original publication(s).

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Citations** – A listing of all GRI digital geomorphic-GIS maps produced for Cape Hatteras National Seashore (CAHA), Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR) along with sources used in their completion.

3)**1:24,000 scale 2007 Mapping** (for Cape Hatteras National Seashore (CAHA), Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR)**)**

- 3a) **CAHA Map Unit List** – A listing of all geomorphic map units present on the GRI digital geomorphic-GIS maps for Cape Hatteras National Seashore (CAHA).
- 3b) **CAHA Map Unit Descriptions** – Descriptions for all geomorphic map units on the GRI digital geomorphic-GIS maps for Cape Hatteras National Seashore (CAHA).
- 3c) **FORA-WRBR Map Unit List** – A listing of all geomorphic map units present on the GRI digital geomorphic-GIS maps for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR).
- 3d) **FORA-WRBR Map Unit Descriptions** – Descriptions for all geomorphic map units on the GRI digital geomorphic-GIS maps for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR).

3e.) **Ancillary Source Map Information** – Reports associated with the 1:24,000 scale 2007 source maps by the North Carolina Geological Survey.

4)**1:10,000 scale 2006 (Detailed) Mapping** (for Cape Hatteras National Seashore (CAHA) and Wright Brothers National Memorial (WRBR))

4a) **Map Unit List** – A listing of all geomorphic map units present on the GRI digital geomorphic-GIS (detailed) maps for Cape Hatteras National Seashore (CAHA).

4b) **Map Unit Descriptions** – Descriptions for all geomorphic map units on the GRI digital geomorphic-GIS (detailed) maps for Cape Hatteras National Seashore (CAHA).

4c.) **Ancillary Source Map Information** – Reports associated with the 1:10,000 scale 2006 (detailed) source maps by East Carolina University.

5) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: 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 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.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://

www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geomorphic-GIS maps for Cape Hatteras National Seashore (CAHA), as well as for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR), are listed below. Two sets of geomoprhic maps were produced for Cape Hatteras National Seashore as well as for Wright Brothers National Memorial. One set of maps was produced from 1:24,000 scale 2007 North Carolina Geological Survey (NCGS) source maps that cover the park (as of 2007, the date of the source map publication), whereas the other set of maps was produced from 1:10,000 scale (more detailed) maps produced by East Carolina University (ECU). The latter set of maps cover select areas of the Cape Hatteras National Seashore, as well as Wright Brothers National Memorial. Both sets of maps have a compiled park extent or park map, as well as individual (component) maps from each source map plate/dataset. Only a 1:24,000 scale 2007 map, produced by the North Carolina Geological Survey, exist for Fort Raleigh National Historic Site.

1:24,000 2007 Maps

The compiled 1:24,000 scale 2007 geomorphic-GIS map produced from North Carolina Geological Survey (NCGS) source maps.

Digital Geomorphic-GIS Map of Cape Hatteras National Seashore (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode CAHA_geomorphology*)

Individual 1:24,000 scale 2007 (component) geomorphic maps produced by the North Carolina Geological Survey are listed below (alphabetically by map name). The source map for each component map is also listed. The full extent of each source map and all mapped geomorphic units and features were captured.

Digital Geomorphic-GIS Map of the Avon Area (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode AVON_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Avon Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey, digital publication, plate 4 of 6, scale 1:24,000. (*GRI Source Map ID 74592*).

Digital Geomorphic-GIS Map of the Bodie Island Area (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode BDIE_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Bodie Island Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey, digital publication, plate 1 of 6, scale 1:24,000. (*GRI Source Map ID 74589*).

Digital Geomorphic-GIS Map of the Buxton Area (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode BXTN_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Buxton Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey ,digital publication, plate 5 of 6, scale 1:24,000. (*GRI Source Map ID 74593*).

Digital Geomorphic-GIS Map of the Ocracoke Area (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode OCCK_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Ocracoke Island Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey, digital publication, plate 6 of 6, scale 1:24,000. (*GRI Source Map ID 74594*).

Digital Geomorphic-GIS Map of the Pea Island (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode PEAI_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Pea Island Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey, digital publication, plate 2 of 6, scale 1:24,000. (*GRI Source Map ID 74590*).

Digital Geomorphic-GIS Map of the Rodanthe Area (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode RDTH_geomorphology*)

Hoffman, Charles W., Coffey, Brian P., and Ward, Amy N., 2007, Geomorphology of Rodanthe Map Area, Cape Hatteras National Seashore: North Carolina Geological Survey, digital publication, plate 3 of 6, scale 1:24,000. (*GRI Source Map ID 74591*).

In addition to the 1:24,000 scale 2007 GRI digital geomorphic-GIS maps for Cape Hatteras National Seashore, 1:24,000 scale 2007 maps were also produced, as noted above, for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR). The source map for each GRI digital geomorphic-GIS map is also listed. The full extent of each source map and all mapped geomorphic units and features were captured.

Digital Geomorphic-GIS Map of the Fort Raleigh National Historic Site (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode FORA_geomorphology*)

Hoffman, Charles H., Coffey, Brian P., and Nickerson, John G., 2007, Geomorphology of Fort Raleigh National Historic Site Map Area, North Carolina: North Carolina Geological Survey, digital publication, scale 1:24,000. (*GRI Source Map ID 74816*).

Digital Geomorphic-GIS Map of the Wright Brothers National Memorial (1:24,000 scale 2007 mapping), North Carolina (*GRI MapCode WRBR_geomorphology*)

Hoffman, Charles W., Coffey, Brian P. and Nickerson, John G., 2007, Geomorphology of Wright Brothers National Memorial Map Area, North Carolina: North Carolina Geological Survey, digital publication, scale 1:24,000 (*GRI Source Map ID 74815*).

1:10,000 scale 2006 Maps

The compiled 1:10,000 scale (detailed) geomorphic-GIS map, produced from East Carolina University (ECU) source maps, as well as individual (component) maps that comprise the compiled map are listed below. The map, as well as individual component maps, are only available for certain areas of Cape Hatteras National Seashore,(CAHA), and thus do not provide complete coverage of the park.

Digital Geomorphic-GIS Map of Cape Hatteras National Seashore (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode CAHA_geomorphology_detailed*)

Individual 1:10,000 scale 2006 (component and detailed) geomorphic-GIS maps produced by East Carolina University (listed alphabetically by map name). The source map for each component map is also listed. The full extent of each source map and all mapped geomorphic units and features were captured.

Digital Geomorphic-GIS Map of the Buxton Inlet Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode BXTI_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Buxton Inlet Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74668*).

Digital Geomorphic-GIS Map of the Great Swash to Quork Hammock Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode GSQH_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Great Swash to Quork Hammock Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74670*).

Digital Geomorphic-GIS Map of the Hatteras Village to Frisco Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode HVFR_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Hatteras Village to Frisco Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74669*).

Digital Geomorphic-GIS Map of the Kitty Hawk to Whalebone Junction Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode KHWJ_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Kitty Hawk to Whalebone Junction Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74663*).

Digital Geomorphic-GIS Map of the Little Kinnakeet Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode LIKK_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Little Kinnakeet Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74667*).

Digital Geomorphic-GIS Map of the New Inlet to Rodanthe Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode NWIR_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (New Inlet to Rodanthe Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74665*).

Digital Geomorphic-GIS Map of the Ocracoke Village to The Plains Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode OCIS_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (Ocracoke Village to The Plains Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74671*).

Digital Geomorphic-GIS Map of the South Salvo to No Ache Island Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode SNAI_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (South Salvo to No Ache Island Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74666*).

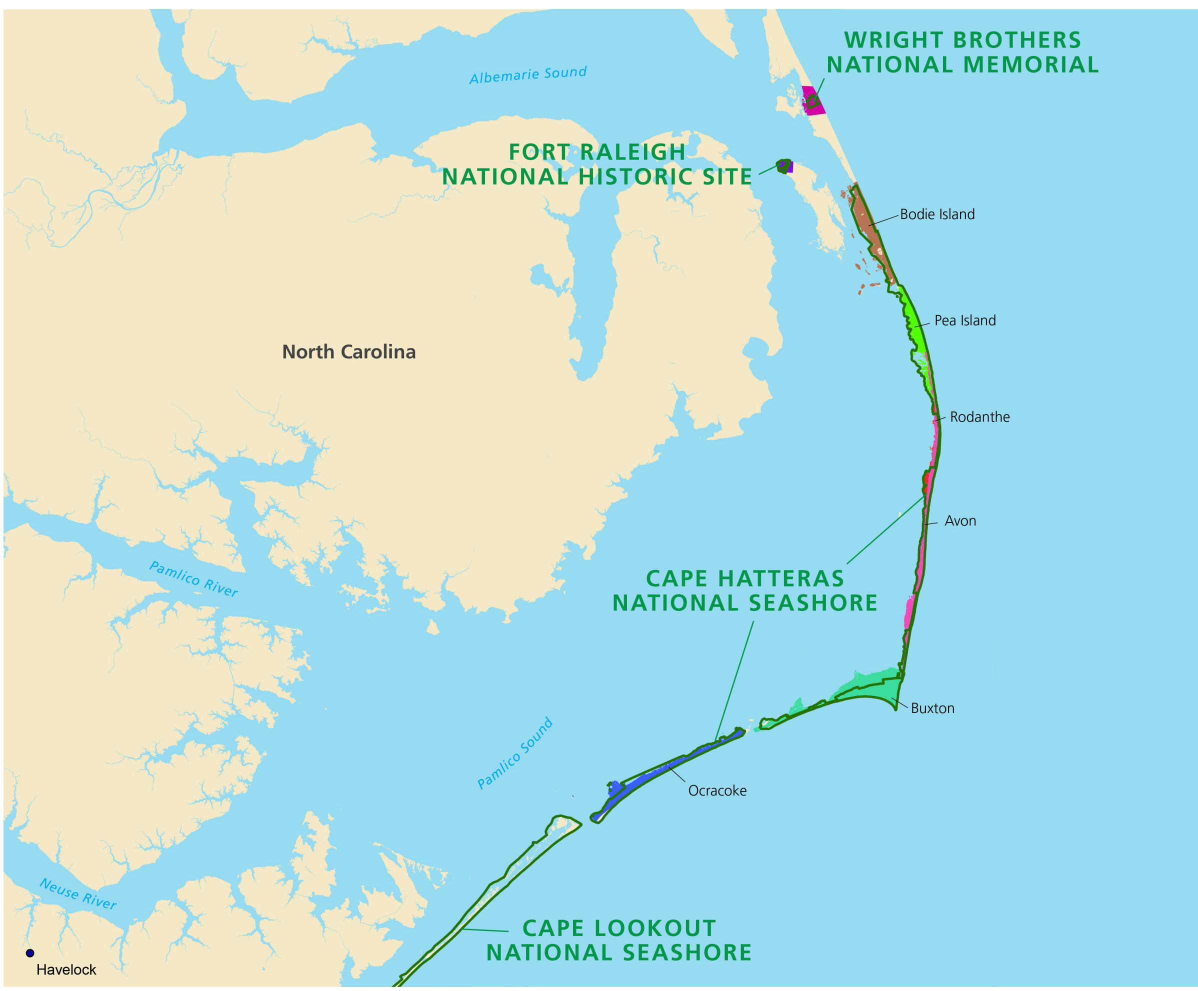
Digital Geomorphic-GIS Map of the South Nags Head to Oregon Inlet Area (1:10,000 scale 2006 mapping), North Carolina (*GRI MapCode SNOI_geomorphology_detailed*)

Ames, V., Dorothea and Riggs, Stanley R., 2006, Geomorphic Framework of the North Carolina Outer Banks (South Nags Head to Oregon Inlet Area digital data): East Carolina University, unpublished digital data, scale 1:10,000. (*GRI Source Map ID 74664*).

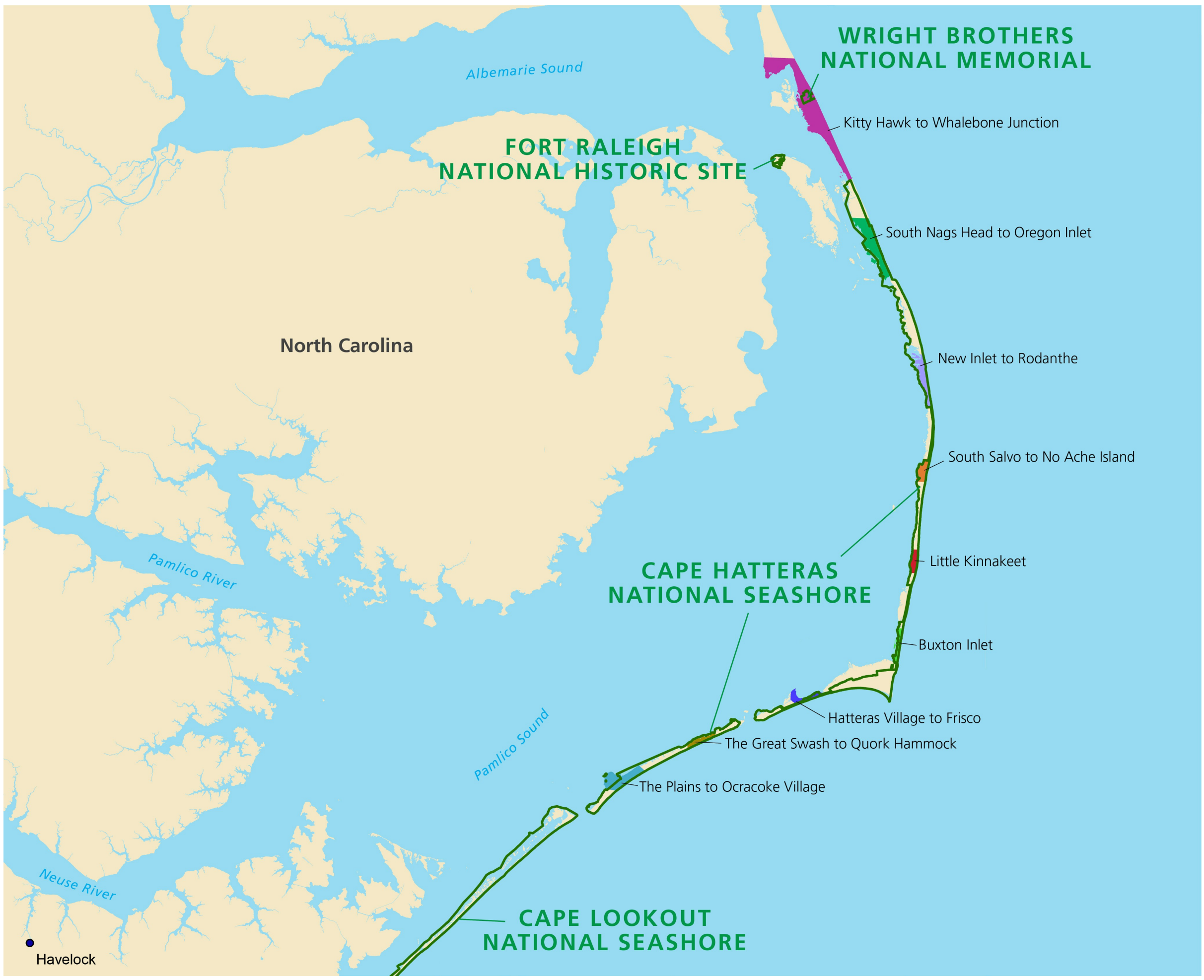
Additional information pertaining to each source map is also presented in the GRI Source Map Information (CAHAMAP, FORAMAP, and WRBRMAP) tables included with the respective GRI geomorphic-GIS datasets.

Index Map

The following index maps display the extents of the GRI digital geomorphic-GIS maps produced for Cape Hatteras National Seashore (CAHA), as well as for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR). The boundary for each park (as of December, 2020) is outlined in in green. The first index map displays the extent of GRI digital geomorphic-GIS maps produced from 1:24,000 scale 2007 mapping by the North Carolina Geological Survey (NCGS). These maps collectively provide complete coverage of Cape Hatteras National Seashore, Fort Raleigh National Historic Site and Wright Brothers National Memorial. Individual (component) maps, that collectively make the the 2007 1:24,000 scale GRI digital geomorphic-GIS map of Cape Hatteras National Seashore, are indicated by map name. Index map by Jake Suri (Colorado State University).



The second index map (below) displays the extent of the GRI digital geomorphic-GIS maps produced from 1:10, 000 scale 2006 mapping by East Carolina University (ECU). These maps, however, only provide coverage for certain parts of Cape Hatteras National Seashore and for Wright Brothers National Memorial. Mapped areas are indicated by name. Index map by Jake Suri (Colorado State University).



1:24,000 scale 2007 Mapping

CAHA Map Unit List

The geomorphic units present in the GRI digital geomorphic-GIS data produced from 1:24,000 scale 2007 North Carolina Geological Survey (NCGS) source maps for Cape Hatteras National Seashore (CAHA)are listed below. Units are listed with their assigned unit symbol and unit name (e.g., beach), and are grouped as per the source map unit groupings (e.g., Intertidal Map Units) and sub-groupings (e.g., Spit Complex). Information about each geomorphic unit is also presented in the GRI Geomorphic Unit Information (CAHAUNIT_geomorphology) table included with the GRI geomorphic-GIS data. Additional information concerning units is present in the NCGS CAHA 2007 Report associated with the source maps.

Quaternary Period

Holocene Epoch / Recent

Intertidal Map Units
- beach - Beach
- Spit Complex
  - sand_flat - Spit Complex, sand flat
  - ridge_swale - Spit Complex, ridge and swale
- pf_marsh - Marsh platform

Intertidal and Supratidal Map Units
- Beach and Fore-Island Dune Complex
  - dnesadl_bch - Beach and dune saddles

Supratidal Map Units
- Fore_island Dune Complex
  - dunerdge - Dune ridges
  - intswale_dr - Interdune swales
  - dnesadl_dr - Dune saddles
- Overwash Complex
  - owflat - Overwash flat
  - owfan - Overwash fans
  - owflt_owchn - Overwash flat and overwash channels
  - isodune - Isolated dunes
- intdune - Interior dune
- intmarsh - Interior marsh
- bk_br_bm - Back-barrier berm

Relict Map Units
- Relict Beach Ridge Complex
  - rel_bch_rdge - Relict beach ridge
- Relict Spit Complex
  - rel_spit - Relict spit
- water - Water Body

Anthropogenic Map Units
- airport_land - Airport/landing strip
- comm_indust - Commercial/industry facility
- drdge - Dredge spoil
- filled - Filled
- ersn_ctrl_st - Erosion control structure
- excavate - Excavation

dike - Dike
wtrfwl_impnd - Waterfowl impoundment

CAHA Map Unit Descriptions

Descriptions of all geomorphic units, as well as map unit groupings and sub-groupings, the latter if present on the source publication, for Cape Hatteras National Seashore (CAHA) are presented below. All descriptions were taken from the NCGS CAHA 2007 Report

Intertidal Map Units

beach - Beach (Recent)

Beach – Beach is mapped as the area between the ocean shoreline and the toe of the fore-island dune complex. The ocean shoreline used is the wet/dry line defined by the North Carolina Division of Coastal Management (NC DCM) from 1998 black and white aerial photography as part of their long-term erosion rate dataset (http://dcm2.enr.state.nc.us/Maps/ER_1998/SB_Factor.htm). The toe of the fore-island dune complex was delineated by a combination of slope (derived from the LiDAR DEM) and aerial imagery.

The narrow, steep profile of the North Carolina Outer Banks beaches (versus beaches elsewhere on the eastern and Gulf coasts of the U.S.) sometimes made it difficult to recognize the slope break between the fore island dune and the beach, so digital photography interpretation was applied as needed.

Storms and high lunar tides subject the beach area to periodic flooding, particularly near inlets, where the beach merges laterally with sand flats of the Spit Complex unit. The ephemeral nature of bedforms, plus insufficient resolution of available data layers prevented delineation of sub-environments within the beach zone.

Spit Complex

Spit Complex – Spit complexes include areas of sand flat and arcuate ridge/swale components. They occur adjacent to the three active inlets in the map area. The ***sand flat*** component of the spit complex is an unvegetated, low elevation (less than 4 feet), low relief feature subject to regular tidal flooding and overwash. Sand flats may contain areas of episodically ponded water, small isolated dunes, and seasonally may become encrusted with cyanobacterial algae. Sand flats merge with the beach unit along the shoreline away from the inlet, generally associated with the first development of the fore-island dune complex behind the beach.

The ***ridge and swale*** component of the spit complex, when present, is situated lateral to the sand flat and merges towards the island interior with the fore-island dune and overwash complexes. Ridges and swales typically trend subparallel to the axis of the barrier and then curve toward the back of the island (convex) as they approach the inlet. Ridges range from incipient features to well-formed continuous structures to heavily dissected remnants. Ridge axes are delineated with lines in the project GIS database, but these display only at scales of 1:12,000 and larger. Ridge and swale areas are interpreted to represent older, more stabilized portions of spit complexes.

sand_flat - Spit Complex, sand flat (Recent)

The ***sand flat*** component of the spit complex is an unvegetated, low elevation (less than 4 feet), low relief feature subject to regular tidal flooding and overwash. Sand flats may contain areas of episodically ponded water, small isolated dunes, and seasonally may become encrusted with cyanobacterial algae. Sand flats merge with the beach unit along the shoreline away from the inlet, generally associated with the first development of the fore-island dune complex behind the beach.

ridge_swale - Spit Complex, ridge and swale (Recent)

The ***ridge and swale*** component of the spit complex, when present, is situated lateral to the sand flat and merges towards the island interior with the fore-island dune and overwash complexes. Ridges and swales typically trend subparallel to the axis of the barrier and then curve toward the back of the island (convex) as they approach the inlet. Ridges range from incipient features to well-formed continuous structures to heavily dissected remnants. Ridge axes are delineated with lines in the project GIS database, but these display only at scales of 1:12,000 and larger. Ridge and swale areas are interpreted to represent older, more stabilized portions of spit complexes

pf_marsh - Marsh platform (Recent)

Marsh Platform – Marsh platform areas are extensive on the backside of and along tidal creeks that cut into the barrier islands. These areas are low-lying (generally less than 2-3 feet in elevation) and subject to regular tidal flooding. They are recognized by location along the sound side shoreline, green color on the CIR imagery, and low elevation. NC DCM wetlands mapping was used as a supporting indicator for the presence and areal extent of this unit. When present significantly inboard of back-island tidal creeks, these units often are developed in depressions associated with relict features, such as the swales between relict beach ridges in the Buxton area or mid-island lows behind former sand flats.

Marsh platforms are relatively stable features and are quite extensive in parts of the barrier system. *Juncus* and *Spatina Patens* are the dominant grass species that inhabit the platform. As the marsh elevation has increased in response to rising sea level, a peat layer up to several feet thick has developed. Where sediment supply is insufficient for marsh aggradation into the sound, wave energy is prone to undercut the peat and cause local shoreline recession. Updip (island-ward) areas are prone to storm overwash, which supplies sand to the marsh platform interior margin and raises the elevation above tidal influence. As this process progresses, the overwash complex builds onto the marsh platform area.

Intertidal and Supratidal Map Units

Beach and Fore-Island Dune Complex

dnesadl_bch - Beach and dune saddles (Recent)

No additional unit description provided. See Beach and Dune Saddles.

Supratidal Map Units

Fore-Island Dune Complex

Fore-Island Dune Complex – Fore-island dune complexes are shore parallel units of higher elevation that occur between the beach and island interior units. Subunits of the fore-island dune complex include: dune ridge, intradune swale, and dune saddle.

dunerdge - Dune ridges (Recent)

The most prominent and really extensive portions of the fore-island dune complex are linear, shore-parallel ***dune ridges.*** Locally, up to three distinct ridges, separated by intradune swales, were mapped using a combination of LiDAR DEM and slope layers with CIR imagery. Dune heights vary, but generally are less than 20 feet. Dune toe elevations are typically in the 6 to 8 foot range on the front (ocean) side and 4 to 8 feet on the back (island interior) side. See also Fore-Island Dune Complex.

dnesadl_dr - Dune saddles (Recent)

Dune saddles are gaps or breaks along dune ridge lines of the fore-island dune system. An elevation threshold of less than 10 feet was used to define saddle areas. However, this threshold has been lowered in some more extensive low-lying island segments, such as in the central Rodanthe map area.

Saddles are important features of the dune complex in that they represent potential high-water flow pathways or breech points along the ridge lines that would be vulnerable to coastal flooding during major storms. These also are well expressed on LiDAR DEM and elevation contour layers. Dune saddles are displayed only at scales of 1:12,000 and greater. See also Dune Ridges.

intswale_dr - Interdune swales (Recent)

Intradune swales are closed, relatively low areas lying within dune complexes. These features tend to occur between dune ridges as linear troughs often with bases less than 10 feet in elevation. They are well expressed on the LiDAR DEM and elevation contour layers. Intradune swales are displayed only at scales of 1:12,000 and greaterSee also Dune Ridges.

Overwash Complex

Overwash Complex – The overwash complex occurs behind the fore-island dune complex and in front of the marsh platform. This area is elevated relative to the marsh platform, tends to have low to moderate relief, typically ranges from 2 to 8 feet in elevation, and gradually decreases in elevation toward the sound side of the island. The overwash complex is a depositional feature that receives sand that is blown or washed over and through the fore-island dune complex—most notably by storm events. Locally, the overwash complex extends into the sound.

Vegetated overwash at lower elevations often exhibits reddish colors on the CIR imagery (indicative of leafy vegetation vs. the green color of the marsh platform grasses); this CIR expression corresponds closely with the shrub/scrub vegetation class on NC DCM wetlands mapping. Subunits mapped within the overwash complex include overwash flat, overwash fan, overwash channel, and isolated dunes.

owflat - Overwash flat (Recent)

Overwash flat is the dominant subunit. It represents the long-term accumulation of sand overwash behind the fore-island dune complex. Discrete events deposit sand in lobate forms, which wind, water, and man then rework to coalesce into a single geomorphic unit. See also Overwash Complex.

owfan - Overwash fans (Recent)

In the southeastern part of Ocracoke Island, well-defined ***overwash fans*** can be discerned using a combination on CIR imagery, LiDAR DEM, and elevation contour layers. Individual overwash fans and the linear ***overwash channels*** that cut through the fore-island dune during the storm event were mapped. See also Overwash Complex.

owflt_owchn - Overwash flat and overwash channels (Recent)

Linear ***overwash channels*** cut through the fore-island dune during the storm event were mapped.

Overwash channels are sufficiently preserved to permit mapping in a few other localities as well. These are displayed only at scales of 1:12,000 and greater. See also Overwash Complex and Overwash Flat.

isodune - Isolated dunes (Recent)

Locally, ***isolated dunes*** occur within or soundward of the overwash flat area. These appear to form due to a variety of origins including: 1) remnants of former fore-island dune ridges or large overwash fans, or 2) as constructional features caused by the trapping of sand by vegetation or man-made features such as sand fencing.

intdune - Interior dune (Recent)

Interior Dunes – Dunes occur in several areas soundward of the fore-island dune complex. These are distinguished from isolated dunes of the overwash complex by their larger scale. Interior dunes are significant geomorphic features of sizable areal extent, sometimes containing the points of maximum elevation for given islands. Their origins appear to be separate from fore-island dune building processes. The source of sand needed to construct these features is not readily apparent from the data layers used in this mapping.

Maximum elevations of interior dunes range from 10 to 90 feet, making them readily identifiable on the LiDAR DEM and elevation contour data layers. Most mapped interior dunes are vegetated and thus appear to be relatively stable features. Interior dunes range from isolated single ridges, as occur on Ocracoke Island, to more laterally extensive elevated features, such as on central Bodie Island.

intmarsh - Interior marsh (Recent)

Interior Marsh – Interior marshes lack a connection to the waters of the ocean or sound, but often are located adjacent to water bodies. The marsh vegetation appears as a bright green on the CIR imagery. DCM wetlands mapping interpreted many of these features as fresh water marshes; however this study lacks sufficient evidence to make that distinction. Interior marshes are most commonly developed in the swales of extensive relict beach ridge complexes, such as those in the Buxton area, or in interior lows behind the fore-island dune complex.

bk_br_bm - Back-barrier berm (Recent)

Back Barrier Berm – Back barrier berms are landforms that occur in the back portions of the barrier island system through much of the project area. They vary from very subtle linear features lying just slightly higher than the surrounding marsh platform to significant positive features (over 10 feet in elevation) with complex internal geometry. The LiDAR DEM and slope layers are useful in mapping these features. In addition, CIR imagery is particularly useful in recognizing back barrier berms, because reddish colors caused by leafy vegetation on the berms are different than the green color of the surrounding marsh grasses.

This NCGS mapping project and the companion studies being undertaken by Riggs and others at ECU appear to be the first studies to recognize and delineate such features. The detailed characterization of back barrier berms is ongoing research by the ECU group. Many berms form a broad arc in areas of apparent relict flood tidal deltas. This suggests that wave reworking of delta sand bodies may have facilitated berm development. Other berms are of less intuitive origin.

Relcit Map Units

Relict Beach Ridge Complex

Relict Beach Ridge Complex – Beach ridge complexes occur as sets of parallel ridges and swales within island interior portions of the Buxton area just west of Cape Hatteras. These ridges were originally mapped from aerial photography by J.J. Fisher (1967). Truncation of parallel dune sets by later dune sets oriented at a slightly different angle allow delineation of individual sets of relict beach ridges, also providing relative age relationships. Fisher identified thirteen sequences of ridge development in this area and termed this complex the “Hatteras group of relict beach ridges.” His analysis included dune ridges classified in this report as part of the modern fore-island dune complex.

The LiDAR elevation data show a maximum elevation in the Buxton relict beach ridge complex as about 30 feet; however, elevations more commonly range from 10-15 feet or less. Swale areas often contain interior marsh and isolated water bodies.
A large, very complex interior dune dominates the Buxton area landscape. The relationship of this feature to the relict beach ridge complex is not understood. It has a considerably different morphology with a “box work-like” pattern of spurs and connecting transverse ridges. It also reaches elevations approaching 60 feet.

Less pronounced ridge and swale topography forms a portion of complex barrier island in the Hatteras Village area. Despite considerable human modification to the landscape in this area, two sets of ridges can be recognized. Ridges in this area are less than 8 feet in elevation, with some barely rising above the enveloping marsh platform in the backmost portion of the island. There is no apparent correlation between these ridge sets and those across the open sound in the Buxton area.

rel_bch_rdge - Relict beach ridge (Recent)

Relict beach ridge axes are delineated with line work in the GIS database to aid in visualizing the patterns and trends they form. This layer only displays at scales of 1:12,000 and larger.

Relict Spit Complex

Relict Spit Complex – Some very subtle arcuate-shaped ridge and swale features located in mid- to back-island areas exhibit topography and geomorphic attributes characteristic of modern spit complexes; but they lack connection to an active inlet. These areas are interpreted as older, inactive spit complexes that developed adjacent to former inlets. Relict spit complexes are notable in the vicinity of Avon and to the south of Buxton.

rel_splt - Relict spit (Recent)

Relict spit ridge axes are delineated with line work in the GIS database to aid in visualizing the patterns and trends they form. This layer only displays at scales of 1:12,000 and larger.

water - Water body (Recent)

Water Body – Water bodies are readily apparent on the CIR imagery because the water absorbs the CIR wavelengths, making the water body appear black. Water bodies that appeared to be ephemeral features, such as on sand flats or in intradune swales, were not included in this map unit. The LiDAR DEM is not particularly helpful in recognition of these planar features, as the water response tends to introduce diffractive noise to the elevation data. However, the elevation contours do offer supporting evidence to the interpretation from CIR imagery.

Anthropogenic Map Units

There are extensive human modifications to portions of the landscape of Cape Hatteras National Seashore. To the extent possible, every effort was made to “see through” the modifications and interpret the underlying geomorphic unit. In many cases, development or modifications have significantly changed the “natural” landscape either beyond recognition or to the extent that mapping the interpreted original geomorphology would be inappropriate (for example, a filled marsh).

airport_land - Airport/landing strip (Recent)

Airport/Landing Strip – Airports/landing strips occur near in the Buxton, Ocracoke, and Wright Brothers memorial map areas.

comm_indust - Commercial/industry facility (Recent)

Commercial/Industrial Facility – Facilities such as marinas, ferry terminals, and other large developments are mapped in this category.

drdge - Dredge spoil (Recent)

Dredge Spoil – Dredging is a very common practice and has constructed and modified landforms throughout the map area. This map unit is reserved for specific positive relief features that can be confidently identified with a given waterway as the source for the spoil. Older spoil islands may not have been recognized, due to subsequent wave modification and vegetation.

filled - Filled (Recent)

Filled – Filling of low-lying areas for development purposes has been a common practice historically, especially of wetlands. Evidence of artificial fill includes linear boundaries, odd juxtaposition with or within the marsh platform, or atypically high elevations versus surrounding areas. It is a given that such areas occur in developed portions of the islands.

ersn_ctrl_st - Erosion control structure (Recent)

Erosion Control Structure – This unit was applied where the shoreline has been stabilized through hardening and the structure is massive enough to map at 1:24,000 scale. The terminal groin at the north end of Pea Island is an example.

excavate - Excavation (Recent)

Excavation – A limited number of low areas were recognized where it was either known through personal communication or inferred from the imagery and elevation data that the area had been artificially excavated.

dike - Dike (Recent)

Dike – This map unit applies to the dike built to contain water for the waterfowl impoundment areas within Pea island National Wildlife Refuge.

wtrfwl_impnd - Waterfowl impoundment (Recent)

Waterfowl Impoundment – Several large water-filled impoundments occur within the Pea Island National Wildlife Refuge.

FORA-WRBR Map Unit List

The geomorphic units present in the GRI digital geomorphic-GIS data produced from 1:24,000 scale 2007 North Carolina Geological Survey (NCGS) source maps for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., beach), and are grouped as per the source map unit groupings (e.g., Intertidal Map Units) and sub-groupings (e.g., Fore-Island Dune Complex). Information about each geomorphic unit is also presented in the GRI Geomorphic Unit Information (FORAUNIT_geomorphology and WRBRUNIT_geomorphology) tables included with the GRI geomorphic-GIS data. Additional information concerning units is present in the NCGS FORA-WRBR 2007 report associated with the source maps.

Quaternary Period

Holocene Epoch / Recent

Intertidal Map Units
- beach - Beach
- pf_marsh - Marsh platform

Supratidal Map Units
- Fore_island Dune Complex
- dunerdge - Dune ridge
- Overwash Complex
  - owflat - Overwash flat
  - isodune - Isolated dunes
- intdune - Interior dune
- intmarsh - Interior marsh
- water - Water body

Relict Map Units
- int_platform - Interior platform
  - int_plat1 - Interior platform 1
  - int_plat2 - Interior platform 2
- rel_dune - Relict dune
- carobay - Carolina bay

Anthropogenic Map Units
- airport_land - Airport/landing strip
- filled - Filled
- excavate - Excavation

FORA-WRBR Map Unit Descriptions

Descriptions of all geomorphic units, as well as map unit groupings and sub-groupings, the latter if present on the source publication, for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR) are presented below. All descriptions were taken from the NCGS FORA-WRBR 2007 report.

Intertidal Map Units

beach - Beach (Recent)

Beach – Beach is mapped as the area between the ocean shoreline and the toe of the fore-island dune complex. The ocean shoreline used is the wet/dry line defined by the North Carolina Division of Coastal Management (NC DCM) from 1998 black and white aerial photography as part of their long-term erosion rate dataset (http://dcm2.enr.state.nc.us/Maps/ER_1998/SB_Factor.htm). The toe of the fore-island dune complex was delineated by a combination of slope (derived from the LiDAR DEM) and aerial imagery. The narrow, steep profile of the North Carolina Outer Banks beaches (versus beaches elsewhere on the eastern and Gulf coasts of the U.S.) sometimes made it difficult to recognize the slope break between the fore island dune and the beach, so digital photography interpretation was applied as needed. Storms and high lunar tides subject the beach area to periodic flooding, particularly near inlets. The ephemeral nature of bedforms, plus insufficient resolution of available data layers prevented delineation of sub-environments within the beach zone.

pf_marsh - Marsh platform (Recent)

Marsh Platform – Marsh platform areas are extensive on the backside of and along tidal creeks that cut into the barrier islands. These areas are low-lying (generally less than 2-3 feet in elevation) and subject to regular tidal flooding. They are recognized by location along the sound side shoreline, green color on the CIR imagery, and low elevation. NC DCM wetlands mapping was used as a supporting indicator for the presence and areal extent of this unit. When present significantly inboard of back-island tidal creeks, these units often are developed in depressions associated with relict features, such as the swales between relict beach ridges in the Buxton area or mid-island lows behind former sand flats.

Marsh platforms are relatively stable features and are quite extensive in parts of the barrier system. Juncus and Spartina Patens are the dominant grass species that inhabit the platform. As the marsh elevation has increased in response to rising sea level, a peat layer up to several feet thick has developed. Where sediment supply is insufficient for marsh aggradation into the sound, wave energy is prone to undercut the peat and cause local shoreline recession. Updip (island-ward) areas are prone to storm overwash, which supplies sand to the marsh platform interior margin and raises the elevation above tidal influence. As this process progresses, the overwash complex builds onto the marsh platform area.

Supratidal Map Units

Fore-Island Dune Complex

Fore-Island Dune Complex – Fore-island dune complexes are shore parallel units of higher elevation that occur between the beach and island interior units. Subunits of the fore-island dune complex include: dune ridge, intradune swale, and dune saddle.

The most prominent and areally extensive portions of the fore-island dune complex are linear, shore-parallel ***dune ridges***. Locally, up to three distinct ridges, separated by intradune swales, were mapped using a combination of LiDAR DEM and slope layers with CIR imagery. Dune heights vary, but generally are less than 20 feet. Dune toe elevations are typically in the 6 to 8 foot range on the front (ocean) side and 4 to 8 feet on the back (island interior) side.

dunerdge - Dune ridge (Recent)

See Fore-Island Dune Complex (above) for the unit description.

Overwash Complex

Overwash Complex – The overwash complex occurs behind the fore-island dune complex and in front of the marsh platform. This area is elevated relative to the marsh platform, tends to have low to moderate relief, typically ranges from 2 to 8 feet in elevation, and gradually decreases in elevation toward the sound side of the island. The overwash complex is a depositional feature that receives sand that is blown or washed over and through the fore-island dune complex—most notably by storm events. Locally, the overwash complex extends into the sound.

Vegetated overwash at lower elevations often exhibits reddish colors on the CIR imagery (indicative of healthy, leafy vegetation vs. the green color of the marsh platform grasses); this CIR expression corresponds closely with the shrub/scrub vegetation class on NC DCM wetlands mapping. Subunits mapped within the overwash complex include overwash flat, overwash fan, overwash channel, and isolated dunes.

owflat - Outwash flat (Recent)

Overwash flat is the dominant subunit. It represents the long-term accumulation of sand overwash behind the fore-island dune complex. Discrete events deposit sand in lobate forms, which wind, water, and man then rework to coalesce into a single geomorphic unit.

isodune- Isolated dune (Recent)

Locally, ***isolated dunes*** occur within or soundward of the overwash flat area. These appear to form due to a variety of origins including: 1) remnants of former fore-island dune ridges or large overwash fans, or 2) as constructional features caused by the trapping of sand by vegetation or man-made features such as sand fencing.

intdune - Interior dune (Recent)

Interior Dune – Large dunes occur as significant geomorphic features soundward of the fore-island dune complex in the Wright Brothers map area. These are distinguished from isolated dunes of the overwash complex by their larger areal extent, and greater topographic relief (points of maximum elevation for the map area). Their origins appear to be separate from fore-island dune building processes. The source of sand needed to construct these features is not readily apparent from the data layers used in this mapping.

Maximum elevations of interior dunes range from 10 to about 90 feet, making them readily identifiable on the LiDAR DEM and elevation contour data layers. Most mapped interior dunes are vegetated and thus appear to be relatively stable features. Interior dunes in the Wright Brothers map area form as laterally extensive elevated features.

intmarsh- Interior marsh (Recent)

Interior Marsh – Interior marshes lack a connection to the waters of the ocean or sound, but often are located adjacent to water bodies. The marsh vegetation appears as a bright green on the CIR imagery. DCM wetlands mapping interpreted many of these features as fresh water marshes; however this study lacks sufficient evidence to make that distinction. Interior marshes are developed in lows within interior dunes in the southern Wright Brothers map area.

water - Water (Recent)

Water Body – Water bodies are readily apparent on the CIR imagery because the water absorbs the CIR wavelengths, making the water body appear black. Water bodies that appeared to be ephemeral features, such as on sand flats or in intradune swales, were not included in this map unit. The LiDAR DEM is not particularly helpful in recognition of these planar features, as the water response tends to introduce diffractive noise to the elevation data. However, the elevation contours do offer supporting evidence to the interpretation from CIR imagery.

Relict Map Units

Areas studied in this phase of geomorphic mapping contain several relict features that differ significantly than those identified elsewhere in mapping of the Cape Hatteras National Seashore (CAHA). In particular, the geomorphic features identified at Fort Raleigh may not have originated as part of a barrier island system, as the origin and age of Roanoke Island is not well understood. Hence, classification of features was more problematic than in the active barrier island complex to the east. Field-based investigation of geomorphology and stratigraphy in these areas should provide improved insight into the depositional origin of mapped features, but this work was beyond the budget and scope of the current study.

int_platform - Interior platform (Recent)

Interior Platform (FORA and WRBR) – This unit forms as elevated terraces that extend for several kilometers in the interior portions of islands, most commonly within the overwash complex. Interior platforms are relatively flat-topped areas that are several feet higher than the surrounding areas. The interior platforms mapped in the Wright Brothers map area average 10 feet in elevation, generally 3 feet higher than the surrounding overwash complex. Large interior dunes are developed within these units in the vicinity of the Wright Brothers Memorial. Two discrete interior platform terraces were mapped in the Fort Raleigh map area, a lower platform averaging 7 feet in elevation, and a higher platform averaging 9-10 feet in elevation. The higher platform terrace has relict interior dunes developed within the platform, especially in the northeastern edge of the Fort Raleigh map area.

The origin of interior platform units is uncertain, but it is very likely that their flattened, terrace-like expression resulted from erosional reworking of a relict positive topographic feature. Reworking of a relict beach ridge or inlet likely provided the additional sediments needed to generate the large interior dunes found in association with the interior platforms in the Wright Brothers map area. The multiple terraced platforms at Fort Raleigh may have developed as subtle escarpments that record the updip position of sea-level during earlier Holocene or Pleistocene eustatic rises. Similar escarpments are well developed elsewhere on the onshore portion of the North Carolina coastal plain.

int_plat1 - Interior platform 1 (Recent)

See int_platform - Interior platform (above) for the unit description.

int_plat2 - Interior platform 2 (Recent)

See int_platform - Interior platform (above) for the unit description.

rel_dune - Relict dune (Recent)

Relict Dune (FORA only) – Isolated to poorly connected units in the eastern portion of the Fort Raleigh map area with elevations greater than 15 ft have been mapped as relict dunes. Dunes are best developed in a near-linear belt across the northeastern map area. However, they do not retain internal geometries that hint to a depositional origin (due to a combination of heavy vegetation, anthropogenic activity, and surficial erosion of these relict features). Given that Roanoke Island is not part of the modern barrier island system and may not have formed in the same mechanism as barrier islands elsewhere in this study area, it would be presumptuous to interpret the geomorphic significance of relict dune features within the constraints of the modern and ancient dune complexes observed in other maps areas to the east.

carobay - Carolina bay (pre-Holocene?)

Carolina Bay (FORA only) – Subtle, elliptical topographic depressions are well documented across the eastern portion of the North Carolina coastal plain. These features are named Carolina Bays, which often are filled with either lakes or wetlands resulting from vegetative infilling of a relict lake. One subtle elliptical feature to the south of Fort Raleigh was tentatively mapped as a Carolina Bay, based on topographic expression on LiDAR DEM data.

The origin of these elliptical bodies is still highly contested. Interpretations include depressions caused by either fires in peat bogs (Ross, 1985), sinkhole generation from underlying limestones (LeGrand, 1953), glacial ice 'ejecta' from Pleistocene meteorite impacts to the north (Prouty, 1952), and stabilized interdune swales and lagoons on relict Pleistocene beach plains and dune fields (Price, 1958). Hence, the geomorphic significance of this feature in the map area is somewhat uncertain.

Anthropogenic Map Units

There are extensive human modifications to portions of the landscape of mapped areas. To the extent possible, every effort was made to "see through" the modifications and interpret the underlying geomorphic unit. In many cases, development or modifications have significantly changed the "natural" landscape either beyond recognition or to the extent that mapping the interpreted original geomorphology would be inappropriate (for example, a filled marsh).

airportland - Airport/Landing Strip (Recent)

Airport/Landing Strip – One airport/landing strip occurs in the Wright Brothers map area. It can clearly be recognized with CIR imagery.

filled - Filled (Recent)

Filled – Filling of low-lying areas for development purposes has been a common practice historically, especially of wetlands. Evidence of artificial fill includes linear boundaries, odd juxtaposition with or within the marsh platform, or atypically high elevations versus surrounding areas. It is a given that such areas occur in developed portions of the islands.

excavate - Excavation (Recent)

Excavation – A limited number of low areas were recognized where it was either known through personal communication or inferred from the imagery and elevation data that the area had been artificially excavated. Large excavations of sand dunes south of the Wright Brothers Memorial are clearly discernable with LiDAR DEM data, and have been validated by field-based studies in this map area by East Carolina University.

Ancillary Source Map Information

The following section presents reports associated with 1:24,000 scale 2007 North Carolina Geological Survey (NCGS) source data and maps.

Geomorphic Mapping of Cape Hatteras National Seashore (CAHA)

The 2007 NCGS report, Geomorphic Mapping of Cape Hatteras National Seashore (CAHA), is available here (NPS_CAHA_report_2007.pdf) as an embedded document (double-click link to open the document).

The report includes:

Executive Summary
Overview of Methods and Deliverable (to the NPS Geologic Resources Inventory (GRI) program)
- Background
- Data Layers Used
  - Base Map Layers
  - LiDAR Elevation Data
  - Digital Imagery
  - DCM Wetlands Mapping
  - Other Layers Used

Maps Units
CD-ROM (to the NPS Geologic Resources Inventory (GRI) program)
Acknowledgements
References

Geomorphic Mapping of Fort Raleigh National Historic Site and Wright Brothers National Memorial

The 2007 NCGS report, Geomorphic Mapping of Fort Raleigh National Historic Site and Wright Brothers National Memorial, is available here (NPS_FORA_WRBR_Report_2007.pdf) as an embedded document (double-click link to open the document).

The report includes:

Executive Summary
Overview of Methods and Deliverable (to the NPS Geologic Resources Inventory (GRI) program)
- Background
- Data Layers Used
  - Base Map Layers
  - LiDAR Elevation Data
  - Digital Imagery
  - DCM Wetlands Mapping
  - Other Layers Used

Maps Units
CD-ROM (to the NPS Geologic Resources Inventory (GRI) program)
Acknowledgements
References

1:10,000 scale 2006 Mapping

Map Unit List

The geomorphic units present in the GRI digital geomorphic-GIS data produced from 1:10,000 scale 2006 East Carolina University (ECU) source maps are listed below. Units are listed with their assigned unit symbol and unit name (e.g., BF_ocbeach), and are grouped as per the source map feature groupings (e.g., Beach Features) and feature sub-groupings (e.g., Upper Overwash Ramp). Information about each geomorphic unit is also presented in the GRI Geomorphic Unit Information (CAHAUNIT_detailed_geomorphology) table included with the GRI geomorphic-GIS data. Additional information concerning units is present in the ECU CAHA reports associated with the source maps.

Quaternary Period

Holocene Epoch / Recent

Beach Features (BF)
- BF_ocbeach - Ocean beach
- BF_spit_flt - Inlet spit and flat

Overwash-Plain Features (OF)
- Upper Overwash Ramp
  - UO_unveg - Upper overwash ramp, sparse to unvegetated
  - UO_grass - Upper overwash ramp, grass
  - UO_scrb_shrb - Upper overwash ramp, scrub shrub
  - UO_fdune - Upper overwash ramp, foredune
  - UO_urbdune - Upper overwash ramp, urban dune
- Middle Overwash Ramp
  - MO_unveg - Middle overwash ramp, sparse to unvegetated
  - MO_grass - Middle overwash ramp, grass
  - MO_scrb_shrb - Middle overwash ramp, scrub shrub
  - MO_forest - Middle overwash ramp, forest
  - MO_intmarsh - Middle overwash ramp, interior marsh
  - MO_isodune - Middle overwash ramp, isolated dunes
  - MO_rdune_br - Middle overwash ramp, ringed dunes and beach ridges
  - MO_urbandune - Middle overwash ramp, urban dune
  - MO_p_inl_spt - Middle overwash ramp, paleo-inlet spit
- Lower Overwash Ramp
  - LO_pf_marsh - Lower overwash ramp, platform marsh
  - LO_fring_brm - Lower overwash ramp, fringing berm
  - LO_spln_bch - Lower overwash ramp, strandplain beach
  - LO_bk_br_bm - Lower overwash ramp, back-barrier berm

Polydemic Features (PF)
- PF_tidal - Tidal creeks and tidal channels
- PF_pond - Ponds
- PF_trnv_rdge - Transverse ridges
- PF_dune_flat - Dune flat
- PF_dunef - Dune field
- PF_dune_unvg - Sparse to unvegetated dune field
- PF_dune_grss - Grass dune field
- PF_dune_fors - Forested dune field
- PF_dune_urb - Urbanized dune field
- PF_algal_flt - Algal flat
- PF_rdg_swl - Ridge and swale
- PF_swl_marsh - Swale marsh

PF_p_inl_spt - Paleo-inlet spit

Anthropic Features (AF)

AF_cn_dune_r - Constructed dune-ridges
AF_cn_idune - Constructed interior dune-ridges
AF_rd_prk - Road/parking areas
AF_drdge - Dredge channels/spoils
AF_excavate - Excavations
AF_an_overpr - Anthropic overprint

Map Unit Descriptions

Descriptions of all geomorphic map units are presented below. Descriptions are grouped as per source publication feature groupings. All descriptions were taken from the ECU CAHA reports.

Beach Features (BF)

BF_ocbeach - Ocean beach (Recent)

A. BF: OCEAN BEACH

Geomorphic Description:
The mapped beach is defined as that geomorphic unit that extends from the wet-dry line to the base of either a natural dune field or the base of a scarped dune or dune field. If no dunes are present then the beach extends to the island berm crest, which is the crest of an overwash island, represents the highest point on the overwash plain, and separates the surface water flow between the ocean and back-barrier estuary.

Dominant Vegetation:
Macroscopic vegetation is sparse within this unit. However, wrack commonly occurs along the upper swash lines associated with the storm beaches. The wrack may consist of offshore algae (*Sargassum spp.)*, dune grasses, estuarine submerged aquatic vegetation, or estuarine marsh grasses

BF_spit_flt - Inlet spit and flat (Recent)

B. BF: INLET SPIT and FLAT

Geomorphic Description:
An inlet spit and associated inlet flat consist of one or more sub-parallel ridges that occur adjacent to either a modern inlet or a paleo-inlet. They are dominated by curved ridge structures on a gentle ramped flat that result from regular overwash events and form by the combined interaction of waves and tidal currents during high water overflow conditions associated with high tides, spring tides, or small storm tides. Sometimes, the higher ridges that formed in response to previous storm events will be subsequently truncated, breached, or even enlarged by the accretion of secondary ridges. An older inlet spit often will contain small active dune fields that form after the spit is vegetated. A paleo-inlet spit no longer occurs as a beach feature, but occurs in different places on the barrier and is now classified as a polydemic feature.

Dominant Vegetation:
New and active inlet spits will be either unvegetated or grassed with *Spartina patens.* The vegetation on older inlet spits will often consist of mixed grasses that include *Spartina patens* and a small growth of scrub shrub.

Overwash-Plain Features (OF)

Upper Overwash Ramp

A. UPPER OVERWASH RAMP: UOR

Geomorphic Description:

The upper overwash ramp begins at the island berm crest, which is the highest point on the overwash dominated barrier island. The UOR extends either gently down-slope to the middle overwash ramp, more steeply to the lower overwash ramp, or occasionally directly into the adjacent estuary with an eroding sediment bank shoreline. The UOR is a slightly undulating, high and dry surface that frequently contains small isolated dunes, and is often characterized by a shell gravel pavement resulting from overwash events. Generally there is either a natural dune field or anthropic constructed dune-ridge that occurs on the UOR along the island berm crest. In the latter situation, the ocean side of the UOR begins at the depositional or scarped boundary at the top of the ocean beach. Since the major source of dune sands is directly off the beach, most of the natural dune fields occur superimposed upon the uppermost portion of the UOR.

UO_unveg - Upper overwash ramp, sparse to unvegetated (Recent)

UOR: Sparse to Unvegetated

Dominant Vegetation:

If the uppermost portion of the UOR is dominated by salty ground water or a relatively deep fresh water table, the surface is characterized by a xeric vegetation community. Xeric vegetation communities have low species diversity that are dominated by the sparse growth of *Gaillardia pulchella* (fire wheel), *Opuntia spp.* (prickly pear cactus), and scattered *Juniper virginiana* (eastern red cedar). Frequently within the xeric community the sand surface is covered by an irregular and splotchy growth of lichens and moss.

UO_grass - Upper overwash ramp, grass (Recent)

UOR: Grass

Dominant Vegetation:

As the UOR ramp decreases in elevation away from the ocean beach, fresh groundwater dominates and rises allowing an increased vegetative cover that grades successively from the xeric community to the grass flat and scrub shrub communities on the UOR ramp. The grass community is dominated by the following species.

Uniola paniculata (sea oat)
Spartina patens (salt meadow hay)
Andropogon scoparius (broomstraw rush)
Hydrocotye bonariensis (pennywort)
Cakile edentula (sea rocket)

UO_scrb_shrb - Upper overwash ramp, scrub shrub (Recent)

UOR: Scrub Shrub

Dominant Vegetation:

As the UOR ramp decreases in elevation away from the ocean beach, fresh groundwater dominates and rises relative to the land surface resulting in an increased vegetative cover that grades successively from the xeric community to the grass flat and scrub shrub communities on the UOR ramp. If the UOR is very wide with a significant natural dune field or constructed dune-ridge, an extensive scrub shrub community expands in the ocean ward direction. The scrub shrub community is dominated by the following species along with abundant grasses and vines.

Baccharis halimifolia (salt myrtle)

Myrica cerifera (wax myrtle)
Ilex vomitoria (yaupon holly)
Iva frutescens (marsh elder)
Myrica pensylvanica (bayberry)
Juniper virginiana (eastern red cedar)
Spartina patens (salt meadow hay)
Smilax spp. (cat brier)
Toxicodendron radicans (poison ivy)
Partenocissus quinquefolia (Virginia creeper)

UO_fdune - Upper overwash ramp, foredune (Recent)

A1. UOR: FOREDUNE
Geomorphic Description:
Natural fore dunes are frequently not present, particularly in the regions where constructed dune-ridges have been built and maintained by human efforts. In areas where the constructed dune-ridges have either not been built or have not been regularly maintained, natural fore dunes often form along the uppermost portion of the overwash plain. The size of fore dunes depends largely upon sand availability. The dunes have an irregular geometry and are variable in size and number. Since there are many different wind directions through the seasons of the year, any single dune is built and modified continuously through time with abundant blowouts, cut and fill structures, and scarping along the ocean side or along overwash channels through the dune field.

Dominant Vegetation:
Dunes are mostly vegetated with Uniola paniculata (sea oats). However, on the back side of a large dune field or as the distance from the ocean increases salt spray is diminished with a corresponding increase in vegetation diversity. Plants that commonly occur on the lee side of the dune field include *Spartina patens* (salt meadow hay), *Cakile edentula* (sea rocket), *Solidago sempervirens* (golden rod), *Myrica ce*rifera (wax myrtle), occasionally *Juniper virginiana* (eastern red cedar) and ground cover plants such as *Hydrocotyle bonariensis* (penny wort).

UO_urbdune - Upper overwash ramp, urban dune (Recent)

This unit is not present in the source map report, however, the unit is present in the source GIS data. No additional unit information is provided.

Middle Overwash Ramp

B. MIDDLE OVERWASH RAMP: MOR
Geomorphic Description:
The middle overwash ramp is a relatively flat and dry to slightly wet surface that slopes gently away from the UOR. Occasionally there is a dramatic step down from the UOR to the MOR. The latter situation occurs if the island segment is heavily vegetated. The dense scrub shrub or forest vegetation causes the storm surge flow to be disrupted and rapid deposition of sediments during overwash events. The step down is generally composed of sand with interbeds of beach shell gravel.

If the island is wide, the MOR may be very extensive. This situation is particularly true if there is a well developed molar-tooth structure with major tidal channels on the LOR. However, if the island is narrow, there may not be an MOR. In this situation the UOR is steep and drops directly onto the LOR (Fig. 3) or even into the back-barrier estuary with an eroding sediment bank shoreline supplying sand for development of an estuarine strandplain beach.

Vegetation on the MOR displays zonation down slope as a direct function of water table depth, frequency and magnitude of overwash events, and time since the last overwash event. Storm events that deposit new overwash sediment may also rip up and/or bury existing vegetation. The resulting increase in MOR elevation resets the clock with respect to the location and succession of dominant vegetation that emerges in the years following the overwash event.

MO_unveg - Middle overwash ramp, sparse to unvegetated (Recent)

MOR: Sparse to Unvegetated
Geomorphic Description:
Immediately a major storm event that delivers a new overwash fan across the MOR, the sediment surface is essentially an unvegetated flat. However, within subsequent years grasses begin to develop and the new overwash plain slowly evolves into one of the following dominant vegetation groups depending upon the subsequent storm and flooding pattern; elevation, width, and dissection of the MOR with tidal channels; and composition and location of the ground-water table.

MO_grass - Middle overwash ramp, grass (Recent)

MOR: Grass
Dominant Vegetation:
If the upper portion of the MOR frequently receives minor amounts of salt spray, aeolian sand, and overwash sediment, the flats will be dominated by *Spartina patens* (salt meadow hay) and *Andropogon scoparius* (broom straw).

MO_scrb_shrb - Middle overwash ramp, scrub shrub (Recent)

MOR: Scrub Shrub
Geomorphic Description:
If the upper portion of the MOR has not recently been impacted by major storm events and overwash sediment fans, the flats will be dominated by scrub shrub. Once the scrub shrub is established, the over flow of small overwash events is broken by the scrub shrub resulting in the overwash sediment being deposited as a series of stair-steps within the scrub shrub flat. Large overwash events can kill the scrub shrub, and erode out portions or all scrub shrub. Such an event resets the process of vegetation succession.
Dominant Vegetation:
The scrub shrub flat is dominated by the following species.
Baccharis halimifolia (salt myrtle)
Myrica cerifera (wax myrtle)
Ilex vomitoria (yaupon holly)
Iva frutescens (marsh elder)
Myrica pensylvanica (bayberry)
Juniper virginiana (eastern red cedar)
Spartina patens (salt meadow hay)
Smilax spp. (cat brier)
Toxicodendron radicans (poison ivy)
Partenocissus quinquefolia (Virginia creeper)

MO_forest - Middle overwash ramp, forest (Recent)

MOR: Forest
Geomorphic Description:

If the area has not recently been impacted by major storm events and overwash sediment fans, the scrub shrub flats can locally evolve into a forest dominated MOR characterized by larger growth with a well developed over story. Establishment of a forest within the MOR indicates that overwash events are rare either due to low frequency of major storm activity, low rates of ocean shoreline recession, and/or the presence of a large natural dune field or large constructed dune-ridges. However, if a large overwash event does occur, it can kill the forest trees and erode out large portions or all of the forest. Such an event resets the process of vegetation succession.

Dominant Vegetation:
The forested flat is dominated by *Pinus sp.* (pine), *Quercus virginiana* (live oak), and *Juniper virginiana* (eastern red cedar). The forested flats are almost always characterized with a major under-story of shrubs that include *Myrica cerifera* (wax myrtle) and *Ilex vomitoria* (yaupon holly), along with massive growths of various vines including *Smilax sp.* (cat brier), *Toxicodendron radicans* (poison ivy), and *Vius rotundifola* (muscadine grape). The shrubs and vines occur throughout the forest but their densest growth is generally near the periphery.

MO_intmarsh - Middle overwash ramp, interior marsh (Recent)

B1. MOR: Interior Marsh
Geomorphic Description:
The lower portion of the MOR is in the supra-tidal zone with a high water table that is frequently flooded by the irregular wind and storm tides with estuarine waters flowing through the associated tidal channels. This can result in the formation of vast algal mats and interior marsh. With time and subsequent overwash events, the elevation of the MOR increases and the irregularly flooded algal flats and interior marsh may evolve into dry grass flats.

The interior marsh is characterized by organic-rich sandy soil with a water table that fluctuates from a few inches below ground level to above ground level depending on the rainfall and irregular wind tides. The interior marsh of this irregularly flooded wind tidal system is roughly equivalent to the high marsh of the regularly flooded astronomically-tidal system. The interior marsh grades into the platform marsh of the LOR with a gentle decline in elevation that ranges from a few feet to a few inches above mean sea level. The interior marsh has a sand substrate, whereas the substrate in the platform marsh generally decreases in sand content and increases in the amount of organic matter forming a sandy peat substrate. Submerged aquatic vegetation (SAVs) and marsh-grass wrack get blown into the interior marsh through the tidal channels during storm flooding.

Dominant Vegetation:
The dominant vegetation of the interior marsh is extremely variable depending upon the frequency of flooding and the water chemistry. The higher salinity marsh plants include *Spartina alterniflora* (smooth cord grass), *Spartina patens* (salt meadow hay), *Juncus roemerianus* (black needlerush), *Distichlis spicata* (salt grass), and *Borrichia frutescens* (sea oxeye). Whereas *Scirpus robustus* (soft stemmed bulrush), *Cladium jamaicense* (saw grass), *Phragmites australis* (common reed), *Spartina cynosuroiodes* (giant cord grass), and *Typha angustifora* (cat tail) are dominant in the areas characterized by lower salinity to fresh water.

MO_isodune - Middle overwash ramp, isolated dunes (Recent)

B2. MOR: Isolated Dunes
Geomorphic Description:
Small-scale isolated dunes are common on the sparse to unvegetated portions of active MORs and within the algal flats that frequently occur on lower portions of the MOR. Isolated dunes in these habitats are particularly active and move across the flats during the dry season. These dunes may have almost any geometry due to the multiplicity of wind and water dynamics affecting the MOR. A

stabilized dune will generally increase in density and diversity of vegetation with time and inward toward the dune nucleus, until a major flood event occurs, when the dune is either destroyed or reworked into a regular ringed beach ridge as described in B3 below.

Dominant Vegetation:
With time the isolated dunes may become stabilized with plants that are dominated by either *Spartina patens* (salt meadow hay) or scrub shrub.

MO_rdune_br - Middle overwash ramp, ringed dunes and beach ridges (Recent)

B3. MOR: Ringed Dunes and Beach Ridges
Geomorphic Description:
If an isolated dune becomes stabilized by grasses on the sparse to unvegetated or algal flat dominated MOR, the isolated dune may increase in size through time by ringed accretion around either the entire dune or some portion of the dune. The grasses around the nucleus dune will trap smaller dunes during the dry seasons. The flats then become flooded during subsequent stormy seasons that rework the new perimeter dune sands forming beach ridges that ring all or part of the nucleus dune. The isolated ringed dunes can become quite large in size with numerous ringed structures around the perimeter. Flowing currents resulting from a major overwash event also can truncate the dunes, along with the development of blowouts within the nucleus dune resulting in complicated dune geometries. A major flood event may either severely truncate or destroy a ringed dune. The same process occurs if the MOR encroaches upon an older component of the barrier island such as Ocracoke Village. During dry periods, the wind blown sands are trapped against the stabilized land mass and reworked into a beach ridge by water during stormy periods that flood the MOR. The resulting beach ridges sub-parallel the portion of the land mass that has trapped the sands.

Dominant Vegetation:
Isolated ringed dunes on the MOR may initially be stabilized by *Spartina patens* (salt meadow hay), *Borrichia frutescens* (Sea Oxeye). If a stabilized ringed dune is large enough, the vegetation may increase in density and diversity with time to include scrub shrub.

MO_urbandune - Middle overwash ramp, urban dune (Recent)

This unit is not present in the source map report, however, the unit is present in the source GIS data. No additional unit information is provided.

MO_p_inl_spt - Middle overwash ramp, paleo-inlet spit (Recent)

B4. MOR: Paleo-Inlet Spit
Geomorphic Description:
If an inlet opens through a barrier island segment, the UOR will generally be eliminated and the existing MOR becomes the location for formation of inlet spits. An inlet spit consists of one or more sub-parallel ridges that occur adjacent to either an existing inlet or paleo-inlet. The spits occur as slightly curved ridge structures that are at oblique angles to the ocean shoreline. The spit geometry results from overflow current dynamics of regular, high spring tide and small storm tide overwash events that rework wind blown sands deposited along the inlet during dry periods. Higher inlet spit ridges that formed in response to a previous storm event may be truncated, breached, or develop an accreted secondary ridge by a subsequent tidal event. Older inlet spits may contain small active dune fields locally, particularly after they are vegetated. If the inlet closes with UOR reforming in front of the inlet spit, the inlet spit becomes a paleo-inlet spit preserved on the MOR.

Dominant Vegetation:
Vegetation is absent on an active inlet spit. However, as the inlet migrates one inlet spit may be abandoned with the development of a younger inlet spit. When abandoned, the older inlet spit will

become grassed and, with time, may even become vegetated with scrub shrub.

Lower Overwash Ramp

C. LOWER OVERWASH RAMP: LOR

Geomorphic Description:

The lower overwash ramp is a flat, wet, inter-tidal surface that extends into the back-barrier estuary. It generally comprises an extensive platform marsh with a thin (< 1 meter) sandy peat substrate on a fine sand base. If the island is wide, the LOR may be very extensive. This is particularly true if there is a well developed molar-tooth structure with tidal channels cutting through the LOR into the lowermost portion of the MOR. However, if the island is narrow, there may not be an MOR or even an LOR. In the latter case the UOR is steep and drops directly onto either the LOR or into the back-barrier estuary with a strandplain beach. The LOR is also characterized by strong vegetation zonation that occurs across the flat. The specific plant zonations are determined by the salinity gradients and water-level fluctuations caused by the regular astronomical tides (in the vicinity of inlets) and irregular wind tides that occur within the adjacent estuarine water body. The outer edge of the platform marsh is generally an erosional scarp along the higher energy, open shorelines and along the associated tidal channels. However, the marsh shorelines that are located within more protected embayments occur as gradual sloped ramps onto the shallow back-barrier shoals.

LO_pf_marsh - Lower overwash ramp, platform marsh (Recent)

C1. LOR: Platform Marsh

Geomorphic Description:

The platform marsh constitutes the major component of the LOR and is irregularly flooded by wind tides, except near inlets where the platform marsh is also flooded by small, regular astronomical tides. The platform marsh is characterized by a thin (< 1 meter) peat or sandy peat substrate that is permanently saturated with standing water and grades downward into a fine sand base. Tidal-creeks form extensive drainage networks within many of the platform marsh environments with occasional small ponds scattered within the marsh. The marshes have a low-diversity of vegetation that is strongly zoned subparallel to both the outer marsh perimeter and back-barrier berms that occur within the platform marsh.

Platform marshes have a minor slope towards the sound, where the marsh ends abruptly at the estuarine shoreline with an erosional, undercut scarp that ranges from a few cm to < 1 meter above the estuarine floor. In areas with enough sand, the sound-ward edge of the platform marsh may contain a strandplain beach in front of and burying the scarp. The outer perimeter of most platform marshes contains an elevated fringing berm just landward of and parallel to the erosional scarp. This fringing berm is generally < 1 meter high and is composed of a mixture of fine sand and wrack. Wrack plays a critical role in the platform marsh and occurs either as small to large, irregular patches or in shoreline parallel rows that represent different storm water levels. Wrack deposits are composed of either dead submerged aquatic vegetation or marsh vegetation, occur at varying distances within the marsh as a function of water-level elevation, and are products of specific events and therefore in various stages of decay. Depressions in the marsh result from wrack deposits that kill the dominant marsh vegetation and, in some cases, cause enough of a depression to pond water. Ponds may vary from hypo- to hyper-saline depending on groundwater flow, weather (wet versus dry season), and location relative to active inlets. Marsh plants that colonize a decomposing wrack pile or shallow pond are quite different from the marsh grasses that are dominant within the platform marshes.

Dominant Vegetation:

The dominant platform marsh grasses within the study area include a narrow fringe along the outer perimeter of either *Spartina patens* (salt meadow hay) or *Spartina alterniflora* (smooth cord grass). The outer fringe may be severely eroded and even stripped of vegetation. The eroded areas often have *Juncus roemerianus* (black needlerush) at the water’s edge, and *Salicornia bigelovi* (annual marsh glass wort) may colonize the stripped zone. The platform marsh grades inward to vast areas of *Juncas roemerianus* (black needlerush). In the proximity of major inlets, the *Spartina alterniflora* fringe becomes more expansive at the expense of *Spartina patens*, and replaces *Juncus roemerianus* (black needlerush) on most of the platform. Thick wrack deposits kill the underlying dominant platform marsh vegetation. As wrack decomposes, rows or patches of different plants locally re-colonize the denuded areas. The recolonizing vegetation is a function of elevation and salinity. The dominant plants that re-colonize a decaying wrack deposit include *Borrichia frutescens* (sea oxeye), *Salicornia bigelovi* (annual marsh glass wort), *Salicornia virginica* (perennial marsh glass wort), *Distichlis spicata* (salt grass), with a small growth of the scrub shrub *Myrica cerifera* (wax myrtle), *Iva frutescens* (marsh elder), and *Baccharis halimifolia* (salt myrtle). Depressions may form in the marsh as a result of multiple wrack deposits accumulating in the same area over time, preventing re-colonization and causing some peat compaction. If the resulting depressions are below mean sea level, they will pond the water. Ponds may vary from hypo- to hyper-saline depending on groundwater flow and weather (rainfall versus drought).

LO_fring_brm - Lower overwash ramp, fringing berm (Recent)

C2. LOR: Fringing Berm

Geomorphic Description:

Most sound-side shorelines within the platform marshes are comprised of scarped and undercut sandy peat banks that range from a few centimeters up to 1 m in height. Storms deposit one or more elongate fringing berms that are shore parallel and occur at regular distances from the sound shoreline. The most prominent fringing berm is generally < 10 m inside of the marsh perimeter and is a product of the average storm surge resulting from the most common winter storms. These fringing berms are up to 1 m thick and are 1 to 3 m wide rows of SAV wrack and/or marsh grass wrack mixed with sand and other debris. As the scarped marsh peat erodes along the shorelines through time, the fringing berm is systematically moved landward in response to the cumulative impact of the many annual winter storms. Depending upon the exposure, the marsh grasses in front of the fringing berm may be ripped off by the wave energy leaving a barren peat surface exposed. This barren peat surface frequently becomes colonized by *Salicornia bigelovi*.

Dominant Vegetation:

The fringing berms are generally dominated by *Spartina patens* (salt meadow hay) and *Spartina cynosuroides* (giant cord grass) with some woody shrubs including *Myrica cerifera* (wax myrtle), *Iva frutescens* (marsh elder), and *Baccharis halimifolia* (salt myrtle). The back side of the fringing berm drops off more abruptly on the island side with the fringing berm vegetation grading into vast areas of *Juncus roemerianus* (black needlerush). The fringing berm plant assemblage also occurs where the platform marsh forms the transition zone onto back-barrier berms.

LO_spln_bch - Lower overwash ramp, strandplain beach (Recent)

C3. LOR: Strandplain Beach

Geomorphic Description:

Small strandplain beaches frequently occur in front of the eroded scarps of the adjacent platform marshes. This is particularly the case in areas where cross-barrier island features (e.g., transverse ridges, ridge and swale complexes, etc.) intersect the estuarine shoreline or where back-barrier shoals are well developed within the adjacent estuary. The presence and development of a strandplain beach is often temporary and/or seasonal since its presence is in part a direct function of the frequency, abundance, and character of the storm patterns.

Dominant Vegetation:

Generally there is no macro-vegetation on an active strandplain beach. However, during extended calm periods, such as the warm summer months, various types of algae may temporarily stabilize the sand on these strandplain beaches. Vegetation on strandplain beaches is undifferentiated on the maps.

LO_bk_br_bm - Lower overwash ramp, back-barrier berm (Recent)

C4. LOR: Back-Barrier Berm

Geomorphic Description:

Back-barrier berms are sand deposits on top of the LOR in response to the interaction between estuarine and oceanic storm dynamics. They generally occur as major depositional features that are not sub-parallel to the estuarine shoreline like the small-scale fringing berms. Rather, these features are further inland and occur as ridges that are sub-parallel to the larger-scale overwash plain. Back-barrier berms tend to be < 2 m high, < 25 m wide, and are composed totally of clean sand. Occasionally the lateral ends adjacent to the tidal channels have a recurved geometry that turn into the island. Barrier island segments that have an LOR with a well developed molar-tooth structure, commonly have one or two arcuate back-barrier berms that occur on the platform marsh and extend the entire length of the large-scale lobate overwash plain. Individual back-barrier berms within this system occur along the width of the platform marsh and between adjacent tidal channels.

Dominant Vegetation:

Vegetation on back-barrier berms is primarily scrub shrub, particularly on the smaller and lower features. At the highest elevation the vegetation becomes sparse and consists mainly of *Juniper virginiana* (eastern red cedar) and *Spartina patens* (salt meadow hay), with large unvegetated areas of exposed sand. In addition, there may be abundant *Baccharis halimifola* (salt myrtle), *Iva frutescens* (marsh elder), *Myrica cerifera* (wax myrtle), and *Ilex vomitoria* (yaupon holly). Occasionally, some of the larger and higher back-barrier berms contain maritime forests consisting of various *Pinus spp*. (pine), *Quercus virginiana* (live oak), and *Juniper virginiana* eastern red cedar) that form an overhead canopy. Shrubs such as *Baccharis halimifola* (salt myrtle), *Iva frutescens* (marsh elder), *Myrica cerifera* (wax myrtle), and *Ilex vomitoria* (yaupon holly) grow as an under story and mainly near the forest periphery.

Polydemic Features (PF)

3. POLYDEMIC FEATURES (PF)

Polydemic features are those that “occur in or inhabit two or more regions” on the barrier island. Thus, polydemic features are products of processes that can occur within any portion of the overwash plain or over several different portions of the overwash plain of the simple barrier island model.

PF_tidal - Tidal creeks and tidal channels (Recent)

A. PF: TIDAL CREEKS and TIDAL CHANNELS

Geomorphic Description:

Tidal creeks are common in the platform marshes, particularly in the areas adjacent to major inlets where astronomical tides are prevalent. However, occasionally there are island segments where the tidal creeks extend from the LOR well into the MOR and even into the UOR. These island segments are generally characterized by rapidly eroding ocean shorelines where the UOR of the migrating barrier has moved landward onto the LOR in direct response to major storms and the resulting overwash events. The upper most reaches of these tidal creeks tend to be fresh water and fed directly from the groundwater occurring within the high portions of the UOR. Within an active overwash plain, the headwaters of tidal creeks will be completely buried by the overwash plain. The water flow onto and off the overwash plain carries significant volumes with enough energy to erode the tidal creeks occurring between segments of the platform marsh. With time these portions of the tidal creeks are eroded laterally and vertically to produce the tidal channels between the platform marsh segments. The resulting geomorphology is that of the classic molar-tooth structure. These shore perpendicular tidal channels connect the MOR directly with the estuary and move overwash water off the island during ocean-overwash events, and carry estuarine storm-tide water into the algal flats and interior marshes on the MOR. The tidal channels tend to be deep (up to 3 to 4 m) and extend all the way through the Platform Marsh with steeply scarped, peat shorelines along the edges. Each end of the tidal channel (inner and outer edge of the LOR) shallows, flattens, and broadens out into small-scale deltaic lobes.

Dominant Vegetation:
The tidal creek perimeters within the UOR and uppermost reaches of the MOR are generally dominated by fresh water with the perimeter marshes dominated by *Scirpus robustus* (soft stemmed bulrush), *Cladium jamaicense* (saw grass), Spartina *cynosuroiodes* (giant cord grass), *Typha angustifora* (cat tail), and *Phragmites australis* (common reed). The vegetation along the fringes of the tidal creek down slope towards the estuary become dominated by *Juncus roemerianus* (black needle rush) marsh grass that expands laterally into the platform marshes of the LOR. Vegetation in the tidal channels is undifferentiated on the maps.

PF_pond - Ponds (Recent)

B. PF: PONDS
Geomorphic Description:
Ponds form in many different places within the general overwash plain in response to very different sets of processes. Consequently, most ponds on barrier islands are extremely variable in water composition and tend to be ephemeral through time. The presence of many ponds is a direct function of the pattern, frequency, and abundance of both storms and rainfall. During times of frequent storms and abundant rainfall, most ponds will be filled with either salt or fresh water depending on their location within the barrier system. However during intermediate periods they may become wetland marshes and during periods of low rainfall, the ponds may become algal flats or even dry up completely. No attempt was made to try to separate these different conditions in the mapping process - they are generally mapped as ponds. The following is a general description of the more important pond features that occur on the simple barrier islands.

1. In regions without constructed dune-ridges, storm overwash channels flow through the frontal dune fields on the island berm crest of the UOR. These channels will frequently leave a series of shore-perpendicular, ephemeral ponds after the storm subsides. They will commonly fill in with subsequent wind blown sand or as a result of minor overwash events. These ponds initially contain salt water, but if they are persistent through time may become brackish and ultimately fresh water ponds controlled by rain and ground water.

2. Back-barrier berms that form on the platform marshes of the LOR are frequently breached by storm surges producing a series of smaller, elongate and shore-perpendicular tidal channels. After the storm surge recedes, the low depressions within the center of the tidal channels become a series of ponds in the back-barrier berms. These ponds tend to be more permanent and will generally contain salt water when they form but are quickly replaced and dominated by fresh water with time.

3. Active tidal channels between the platform marshes within the molar tooth structure on the LOR may become blocked on both the inside and outside as the fan delta sands build up and become stabilized by marsh grasses. Because these ponds are at MSL, they generally are reflooded by both spring and storm tides and generally remain brackish water through time.

4. Small, irregular, and shallow ponds occur frequently within the interior marshes of the MOR and the platform marshes of the LOR. In some marshes these ponds are extremely abundant and can form in several different ways.

a) Many platform marshes contain shallow ponds (< 0.5 m deep) that appear to form in response to large wrack accumulations, killing the underlying grasses. As the unvegetated patches in the marsh dry out, peat compaction in concert with possible oxidation of some peat, leaves shallow depressions that become water filled. This water is generally brackish with high salinity ranges from hypo- to hyper-saline depending upon season and weather conditions.

b) A few platform marshes appear to be in a constructive mode in which marsh grass is growing onto the shallow back-barrier sand shoals. The shallowest portions of the shoal have grown marsh grass leaving the slightly deeper areas (< 0.5 m) as ponds with gradual slopes around the edges. These ponds are interconnected with the adjacent estuary and have similar salinities.

c) Occasionally a platform marsh appears to be in a destructive mode with slightly deeper ponds (< 1 m). The edges of these ponds are erosional and consist of scarped peat that drops off abruptly into deeper water. This results in a platform marsh with a Swiss cheese fabric of ponds that have high salinity ranges from hypo- to hyper-saline depending upon season and weather conditions.

5. After an inlet through a barrier island closes, the flood-tide delta sand shoals quickly evolve into inter-tidal marsh islands that separate the many tidal channels occurring in a radiating pattern out from the main inlet channel. As the ocean shoreline recedes and the barrier migrates on top of the flood-tide delta, overwash begins to fill portions of the channels from the front side while storm surges fill portions of the channels from the estuarine side. What remains are long, linear, and relatively deep ponds that have varied orientations along the boundary between the MOR and LOR or occur within the flood-tide delta marshes.

Dominant Vegetation:
Vegetation in the ponds is undifferentiated on the maps. Also, no attempt was made to separate the different states of a pond (e.g., pond, marsh, algal flat) in the mapping process - they are mapped as ponds.

PF_trnv_rdge - Transverse ridges (Recent)

C. PF: TRANSVERSE RIDGES
Geomorphic Description:
Frequently, long, low, and fairly straight ridges form that are transverse to the barrier island. These transverse ridges can form in several different ways.

1. Waves on storm surge flood waters that are temporarily ponded on an overwash plain can rework the scattered and isolated dune sands into elongate beach ridges. When these beach ridges form they are often low (< 1 meter high), narrow (1 to 3 meters), and up to several hundred meters long.

2. Occasionally transverse ridges become large features that incorporate huge volumes of sand as elongate dune structures that run transverse across the UOR and MOR. These sediment-rich dune features may occur along active inlets on the inlet side of older inlet spits, or down-wind from unvegetated sandflats. In either case, during dry periods, aolian-driven sands accumulate along the edges of pre-existing structures. The sand is trapped and stabilized by dune vegetation. Subsequently, during stormy periods active overwash across the overwash plain or inlet spit can truncate the dune structure increasing the elongation and producing a complicated dune structure characterized by erosion and overwash blowouts. Large-volume transverse dune-ridges occurring within a barrier island may be important evidence for the existence of former inlets.

Dominant Vegetation:
Vegetation on the active transverse ridges consists of large unvegetated areas of exposed sand with some areas stabilized by *Uniola paniculata* (sea oat) and *Spartina patens* (salt meadow hay).

However, the older and less active portions of transverse dune ridges will be vegetated with primarily scrub shrub including *Baccharis halimifola* (salt myrtle), *Iva frutescens* (marsh elder), *Myrica cerifera* (wax myrtle), *Ilex vomitoria* (yaupon holly), and *Juniper virginiana* (eastern red cedar). Old transverse ridges are dominated by maritime forests consisting of various *Pinus spp*. (pine), *Quercus virginiana* (live oak), and *Juniper virginiana* (eastern red cedar) that form an overhead canopy along with massive growths of various vines including *Smilax sp.* (cat brier), *Toxicodendron radicans* (poison ivy), and *Vius rotundifola* (muscadine grape). The shrubs and vines occur throughout the forest but their densest growth is generally near the periphery.

PF_dune_flat - Dune flat (Recent)

D. PF: DUNE FLAT

Geomorphic Description:

If an island segment has ample sediment supply, aeolian processes during non-storm tide conditions can transport large volumes of sand landward of the island berm. This will result in a broad, rolling sand flat with an elevation significantly higher (2 to3 meters) than the island berm and UOR. The surface of the aeolian dune flat ranges from very flat to slightly undulating with < 2 m of relief in response to small-scale deflation and dune features. If there is enough sediment available to produce an aeolian dune field, it may be perched on top of a far more extensive aeolian dune flat. In this situation the dune flat forms a broad platform that generally encircles the perimeter of the dune field. Both the aeolian dune flat and dune field are very important features in the Kitty Hawk to Whalebone Junction site. Within this site, the aeolian dune flats have helped to build a generally higher barrier segment than most of the inlet and overwash dominated barrier segments. The consequence is an island segment that has been almost totally urbanized.

Dominant Vegetation:

The dominant vegetation on the pre-1930s aeolian dune flats was very different from the post-1930s vegetation character within the Kitty Hawk to Whalebone Junction site. Frost (2000) described the dominant vegetation based upon the regional photographs taken by the Wright Brothers between 1900 and 1912 in the Kill Devil Hills to Kitty Hawk island segments. Because the aeolian dune flats are composed of clean, well-sorted dune sands with generally higher elevations than overwash plains, a major fresh water aquifer frequently rises to the land surface. This results in broad damp areas and shallow ponds that are dominated by algae and fresh water marsh plants, respectively. The small dunes rose above the water table and were dominated by Spartina patens (salt meadow hay) during non-stormy periods. Also, the aeolian dune flats farthest from the ocean front tended to become stabilized by scrub shrub species and ultimately became forested with *Pinus spp*. (pine), *Ilex vomitoria* (yaupon holly), and *Quercus virginiana* (live oak), etc.

In the 1930s barrier island modification and urbanization began in serious. With construction of the first bridges and paving of NC Highway 12 in the early 1930s, initial building of constructed dune-ridges in the late 1930s, and extensive construction of ocean front motels and houses, the character of the vegetation on the aeolian dune flats changed dramatically. The beach, which was the major source of aeolian and overwash sand was cut off from the dune flats, resulting in a decrease in the effect of both wind and associated salt spray. In response, the aeolian dune flats quickly became stabilized sequentially with an extensive growth of scrub shrub and ultimately pine and live oak forests. Today, much of the dune flats are totally developed with lots, homes, and highly urbanized under-story of lawns and gardens and sometimes an upper-story of pine and live oak woods.

PF_dunef - Dune field (Recent)

E. DUNE FIELD: DF

Geomorphic Description:

Frequently, if an island segment has very large sediment supply available, a natural dune field will form on top of the aeolian dune flat. In the Kitty Hawk to Whalebone Junction site, the paleo-Roanoke River delta deposits associated with previous climatic conditions and sea-level stands produced large supplies of sediment from which to build sediment-rich or complex barrier island segments. Consequently, much of this barrier segment is dominated by the extensive development of dune fields.

Island segments with large sediment supplies are dominated by aeolian processes during non-storm tide conditions when winds transport large volumes of sand landward of the island berm. This results in development of an active dune field with dunes ranging from 3 to 25 meters and greater. During pre-urbanization in the 1930s, some large individual dunes formed (e.g.,Jockey’s Ridge) that ranged up to 45 m in elevation. The dune fields are generally complex in geomorphic character consisting of depositional dunes produced by different kinds of storms (tropical storms, winter nor’esters, summer so’westers, etc.) with multiple wind directions. The dune fields are further complicated by severe erosional dynamics in concert with the influence of upper water tables that result from the wet temperate climate conditions, both producing abundant over-steepened slopes. These dune fields frequently over-ride forested habitats on the back side of the barrier which still further complicates the depositional, erosional, and stabilization patterns within the dune field. The back barrier dune fields may contain numerous buried soil profiles. These buried soils reflect various shifts in past climatic conditions such as stormy and/or dry periods with fire resulting in an activation of dune deposition while non-stormy and/or wet periods resulting in vegetative stabilization of the dune fields (Havholm et al., 2004).

Dominant Vegetation:
The dominant vegetation on the natural dune fields pre-1930s was very different from the post-1930s vegetation character. Frost (2000) described the dominant vegetation based upon the regional photographs taken by the Wright Brothers between 1900 and 1912 in the Kill Devil Hills to Kitty Hawk island segments. At this time many of the natural dune fields were active and essentially barren of vegetation. This includes the dune fields in front of Kitty Hawk Woods and Kitty Hawk Bay and including the Kill Devil Hill, the dunes on the front side of Nags Head Woods and including Run Hill and Jockey’s Ridge, and the Seven Sisters dune field in Nags Head Cove and The Village of Nags Head. The minor vegetation that did exist on these active dunes consisted of scattered grasses including *Spartina patens* (salt meadow hay). The swales between many of the dunes consisted of damp areas dominated by shallow fresh water ephemeral ponds that were dominated by algae and fresh-water wetland vegetation.

With establishment of the Kill Devil Hill National Memorial in 1928, work began in 1929 to stabilize the Kill Devil Hill active dune utilized by the Wright Brothers with grass. Construction of the monument on top of Kill Devil Hill was dedicated in 1932. The Memorial was turned over to the National Park Service in 1933 and designated a National Historic Landmark in 2001. (NPS Historic Structure Report, 2002).

In the past (pre-1970s), the dune fields (e.g., Seven Sisters) occurring closest to the ocean front tended to be the most active while those furthest from the ocean tended to be heavily forested (e.g., Nags Head Woods). By the early 1970s, urbanization of the ocean front became complete and quickly moved sound ward and into the natural dune fields. Soon the remaining Kill Devil Hills were developed followed by Nags Head Cove, the north end of Jockey’s Ridge, and the Kitty Hawk dune field. Lastly the Village at Nags Head developed the southern half of the Seven Sister’s dune field. The urban development in front of the dune fields cut off the sand source from the beach, modified and raised the wind field, and with the construction of houses, pavement, grass, and urban gardens and trees on the dunes themselves, quickly stabilized the active dune fields. The major portion of Nags Head Woods dune field, which is situated on the back side of a wide island segment, has historically been heavily forested. Today, the high dunes generally contain a mature stand of mixed hardwood and pine forest with a perimeter zone of scrub-shrub on the low dune flank along the estuarine side. The scrub shrub zone generally constitutes the transition vegetation that occurs within the storm tide zone and grades down slope to the intertidal platform marsh of the LOR.

PF_dune_unvg - Sparse to unvegetated dune field (Recent)

See PF_dunef (Dune field) (above) for the unit description.

PF_dune_grss - Grass dune field (Recent)

See PF_dunef (Dune field) (above) for the unit description.

PF_dune_fors - Forested dune field (Recent)

See PF_dunef (Dune field) (above) for the unit description.

PF_dune_urb - Urbanized dune field (Recent)

See PF_dunef (Dune field) (above) for the unit description.

PF_algal_flt - Algal flat (Recent)

F. PF: ALGAL FLAT

Geomorphic Description:

In a natural, overwash dominated barrier segment dominated by recent overwash activity with a broad MOR, the lower supra-tidal portion may be dominated by an algal flat. This is particularly true when there is a well developed molar-tooth structure with tidal channels that dissect the LOR. The low elevation and high water table enable the irregular wind and storm tides to flood the MOR frequently with estuarine waters flowing through the tidal channels. This can result in the formation of vast algal mats on the supra-tidal portion of the flats. The algal flats form in response to highly fluctuating habitat conditions that can range from fresh ground water or rain water to hyper-saline waters due to local ponding and evaporation of ocean or estuarine waters. With time and subsequent overwash events, the elevation of the MOR increases and the irregularly flooded algal flats may be taken over by interior marsh or may shift to dry grass flats.

Algal flats can also occur in many other habitats and in smaller areas within a barrier island. Most of these occurrences are as ephermeral ponds or depressions characterized by fresh to hypo- to hyper-saline water conditions. As the water table within the ponds drops, the damp floor of the depression frequently will develop an algal mat. The algal mat periodically will get ripped up or buried by subsequent storm events. Hyper saline ponds may evaporate leaving salt flats that become vegetatively zoned with *Salicornia bigelovi* (annual marsh glass wort), and *Salicornia virginica* (perennial marsh glass wort) forming rings around the periphery of the depressions and in turn may be surrounded by an outer zone of *Distichlis spicata* (salt grass) and *Borrichia frutescens* (sea oxeye).

PF_rdg_swl - Ridge and swale (Recent)

G. PF: RIDGE AND SWALE

Geomorphic Description:

Ridge and swale geomorphic units occur as sets of sub-parallel couplets consisting of low, regular sand ridges and adjacent shallow low swales. The sand ridges tend to be linear to slightly curved, uniform features that rarely exceed 3 m in elevation. The beach ridges are shoreline features that formed by either a temporary higher stand of sea level or a series of storm surge deposits. On the maps that contain ridge and swale structures, the ridge crests are marked by a white line with black edges.

In between successive beach ridges are the lower swales that represent beach deposition during periods characterized by either slightly lowered sea level or non-stormy periods. The swales are generally dominated by wetlands and are filling with organic peat deposits that are thickest on the estuarine side and thin up onto the subsequent ridge. Many of the swales, particularly in the estuarine direction, contain open water down the center of the low swale. Over the years, many of the swales have been dredged and opened up as navigational channels with the dredge spoil disposed either on the adjacent marsh or on the low flank of the adjacent ridge. The most extensive and best developed sets of ridge and swale structures form Buxton Woods and Kitty Hawk Woods. Fisher (1967) recognized multiple sets of ridge and swale structures that occur at slightly different angles to the previous set bounded by a major erosional truncation. This suggests oscillating sets of events at several different time scales. Similar features occur on the land masses occupied by Ocracoke and Hatteras Villages. However, these ridge structures are rarely 2 m high, are spaced much further apart with wide marsh filled swales. In fact, many of the sand ridges have already been buried by the vertical growth of peat in response to the ongoing rise of sea level.

No ridge and swale structures are forming today on the northern Outer Banks. Rather, the ridge and swale structures that have been age dated indicate formation during a prior sea level highstand event (Mallinson et al., in review) that built a former barrier island sequence. These ridge and swale structures are not products of the present overwash-barrier island dynamics. Rather the remnant ridge and swale island segments were produced by processes prevailing in an earlier evolutionary stage of the barrier system. Most of the former barrier islands have since collapsed and started to reform the modern barrier islands about 500 years ago (Sager and Riggs, 1998; Riggs et al., 2000; Grand Pre, 2006; Culver et al., in review). Thus, the modern inlet and overwash dominated barrier island components have migrated into and become welded onto the older barrier island with its ridge and swale structures, exemplified by the Kitty Hawk Woods island segment.

Dominant Vegetation:
Because most of the ridge and swale structures are older and occur on the back side of barrier segments, they tend to be dominated by heavy vegetative cover, except where they have been urbanized. The sand ridges have historically been heavily forested with mature stands of mixed hardwood and pine. Since the sand ridges are not very high, the forest grades down-slope into an extensive growth of transition scrub shrub vegetation within supra-tidal zone where the adjacent swales are connected to the estuary.

The swales are dominated by wetland vegetation. Land-locked swales and those segments that are distant from the estuaries are dominated by swamp forests or linear ponds surrounded by swamp forest. If the swale is connected to the estuary, the swamp forest sequentially grades towards the estuary from swamp forest to fresh-water marshes to brackish-water marshes. The brackish marshes generally have a fresh-water zone immediately adjacent to the ridges due to groundwater discharge from the adjacent sand ridge. This grades outward into a middle zone dominated by *Juncus roemerianis* (black needlerush) and a broad outer zone dominated by *Spartina cynusoiroides* (giant cord grass) in the low brackish estuaries, *Spartina patens* (salt meadow hay) in the middle brackish estuaries, and *Spartina alternaflora* (smooth cord grass) in the high brackish estuaries.

PF_swl_marsh - Swale marsh (Recent)

See PF_rdg_swl (Ridge and swale) for a unit description.

PF_p_inl_spt - Paleo-inlet spit (Recent)

This unit is not present in the source map report, however, the unit is present in the source GIS data. No additional unit information is provided.

Anthropic Features (AF)

AF_cn_dune_r - Constructed dune-ridges (Recent)

A. AF: CONSTRUCTED DUNE-RIDGES and CONSTRUCTED INTERIOR DUNE-RIDGES
<u>Geomorphic Description:</u>
Constructed dune-ridges are linear, ocean-shoreline parallel ridges of sand that are built by transporting and bulldozing sand and then vegetated by planting grass. Size of the constructed dune-ridges is highly variable. In general they are built over long beach segments, are up to 15 m wide at the base, and range up to 5 m in height. The purpose for these structures is to prevent storm overwash and inlets from disrupting the barrier island infrastructure and to protect the building superstructures and associated roads. These structures are built on the normal beach—overwash plain profile that is in equilibrium with normal ocean dynamics. However, the newly constructed dune-ridges tend to be severely out of equilibrium and are rapidly scarped on the ocean side and readily breached by storm surges in an effort to bring the island back into an equilibrium profile.

The initial construction of dune ridges began in the late 1930s with the WPA and CCC work camps. The constructed dune-ridges were initially built over the entire distance between the Virginia state line and Ocracoke Inlet utilizing many different methods to trap sand. However, the constructed dune-ridges have not been maintained throughout this entire coastal stretch. The constructed dune-ridges have been rebuilt frequently in the urbanized areas and in narrow island segments where highway 12 occurs close to the ocean shoreline. Thus, there are some island segments that contain only partial or terminated ridges. However, many island segments have multiple constructed dune-ridges along with remnants of “going—to—sea” highways. In a few areas, where there is a satisfactory sand resource, the beaches tend to be very wide and shallow with low net erosion rates. Some initial constructed dune-ridges built within these wide beach segments have been modified into a natural dune field that is also usually quite wide and high and composed of many irregular shaped and scoured dunes with numerous small overflow channels.

Sand fencing is often used anywhere on an island to stop and trap moving sand. This results in long and linear constructed interior dune-ridges that are up to a 1 m high and often hundreds of meters long. This was done routinely in the earlier part of the 20th century on the unvegetated and algal flats within the middle overwash ramps in order to keep roads, ponds, etc. from sanding over. Many of these features still persist today since the islands have become highly vegetated due to minimizing overwash processes by the construction and maintenance of the ocean front dune ridges.

<u>Dominant Vegetation:</u>
The barrier dune ridges are planted with grass as soon as they are built or rebuilt or implanted with sand fencing in an effort to stabilize the structure. The preferred vegetation along the ocean front tends to be *Uniola paniculata* (sea oats) or *Ammophila breviligulata* (American beach grass). Within the island interior, the preferred stabilization vegetation tends to be *Spartina patens* (salt meadow hay). Frequently old constructed dune-ridges, or inner ridges in a two or three sequence of ridges, will become vegetated with scrub shrub including *Baccharis halimifola* (salt myrtle), *Iva frutescens* (marsh elder), *Myrica cerifera* (wax myrtle), *Ilex vomitoria* (yaupon holly), and *Juniper virginiana* (eastern red cedar).

AF_cn_idune - Constructed interior dune-ridges (Recent)

See AF_cn_dune_r (Constructed dune-ridges) for a unit description.

AF_rd_prk - Road/parking areas (Recent)

B. AF: ROADS/PARKING AREAS
Geomorphic Description:
Major highways in urban areas and paved roads and parking areas outside of the major urban areas are mapped. Paved and dirt roads and parking lots within urban areas, as well as dirt roads outside of the urban areas, are not mapped.

Dominant Vegetation:
Vegetation on the roads/parking lots is undifferentiated on the maps.

AF_drdge - Dredge channels/spoils (Recent)

C. AF: DREDGED CHANNELS/SPOIL
Geomorphic Description:
Any dredged channel or pit indicates removal of sediment. Sometimes the removed sediment was pumped or transported off site and deposited as fill material to raise land elevations for urban development. More often the sediment removed from dredged channels is deposited immediately adjacent to the structure being dredged. This results in either a linear ridge or a series of circular piles along one or both sides of the dredged channels. These dredge spoil piles generally raise the elevation of the adjacent land from a few centimeters up to 1 m and are generally mapped as one geomorphic unit with the dredged channel.

Dominant Vegetation:
If the spoil is utilized to raise land elevations for urban development, any kind of vegetation may result. However, if the spoil is placed within the marsh as linear ridges or concentric piles, the dominant vegetation will range from transition zone species, if it is still within the supra-tidal zone and including *Baccharis halimifolia* (salt myrtle), *Iva frutescens* (marsh elder), *Spartina patens* (salt meadow hay), and *Spartina cynosuroides* (giant cord grass) or scrub-shrub. If the spoil is above the supra-tidal zone, the vegetation will include *Myrica cerifera* (wax myrtle), *Ilex vomitoria* (yaupon holly), *Myrica pensylvanica* (northern bayberry), *Pinus spp.* (pine), *Juniper virginiana* (eastern red cedar), *Spartina patens* (salt meadow hay), *Smilax spp.* (cat brier), and *Toxicodendron radicans* (poison ivy).

AF_excavate - Excavations (Recent)

D. AF: EXCAVATIONS
Geomorphic Description:
Sand was commonly mined for construction of dune ridges or as fill material for roads or buildings elsewhere on the island. The resulting lakes or ponds are large and irregularly shaped features or are smaller square to rectangular structures. This category also includes the dredged coastal areas to produce harbors or marinas.

Dominant Vegetation:
If the excavated material is utilized to raise land elevations for urban development, any kind of vegetation may result. However, if the spoil is placed around the excavation as road bed, the dominant vegetation will include transition zone species if it is still within the supra-tidal zone and

including Baccharis halimifolia (salt myrtle), Iva frutescens (marsh elder), Spartina patens (salt meadow hay), and Spartina cynosuroides (giant cord grass) or scrub-shrub. If the spoil rises above the supra-tidal zone the vegetation will include *Myrica cerifera* (wax myrtle), *Ilex vomitoria* (yaupon holly), *Myrica pensylvanica* (northern bayberry), *Pinus spp.* (pine), *Juniper virginiana* (eastern red cedar), *Spartina patens* (salt meadow hay), *Smilax spp.* (cat brier), and *Toxicodendron radicans* (poison ivy).

AF_an_overpr - Anthropic overprint (Recent)

E. AF: ANTHROPIC OVERPRINT

Geomorphic Description:

This category includes all major urban areas consisting of a dense pattern of buildings and roads. All of the urban areas, as well as camp grounds, Coast Guard Stations, marinas, and cemeteries within the Cape Hatteras National Seashore, Pea Island Wildlife Refuge, Jockey's Ridge State Park, and Wright Brothers Historical Monument are included within a black line and mapped as an anthropic overprint. Only when geomorphic features remain in a recognizable and partially natural state within these highly modified areas are the geomorphic features mapped.

Dominant Vegetation:

Vegetation on the anthropic overprint is undifferentiated on the maps.

Ancillary Source Map Information

The following section present the two reports associated with the detailed 1:10,000 scale 2006 East Carolina University (ECU) source data and maps.

Barrier Island Evolution: A Model for Development of the Geomorphic Framework, North Carolina Outer Banks

The ECU report, Barrier Island Evolution: A Model for Development of the Geomorphic Framework, North Carolina Outer Banks (2006), is available here (Part_I_Geomorph_Model.pdf) as an embedded document (double-click link to open the document).

Below is the Table of Contents of the report.

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Geomorphic Framework of the North Carolina Outer Banks

The ECU report, Geomorphic Framework of the North Carolina Outer Banks (2006), is available here (Part_II_Gemorph_Text.pdf) as an embedded document (double-click link to open the document).

Below is the Table of Contents of the report.

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GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Quality control of this document by Ron Karpilo (Colorado State University).

The information in this document was compiled from GRI source maps, and is intended to accompany the GRI digital geomorphic-GIS maps and other digital data for Cape Hatteras National Seashore, (CAHA), as well as for Fort Raleigh National Historic Site (FORA) and Wright Brothers National Memorial (WRBR), developed by Stephanie O'Meara (see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geomorphic-GIS maps).

GRI finalization by Stephanie O'Meara.

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).