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

Cape Lookout National Seashore
ECU Shackleford Banks Map

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Cape Lookout National Seashore

shkb_geomorphology.pdf

Version: 10/27/2015

Geologic Resources Inventory Ancillary Map Information Document for Cape Lookout National Seashore

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Geologic Resources Inventory Map Document

Cape Lookout National Seashore, North Carolina

Document to Accompany Digital Geologic-GIS Data

shkb_geomorphology.pdf

Version: 10/27/2015

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Cape Lookout National Seashore, North Carolina (calo).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

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 Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

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: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. 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: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Map and Source Map Citation

The GRI Digital Geologic-GIS Map of the Shackleford Banks, North Carolina (*GRI MapCode S*HKB) was produced from the following source,

Riggs, Stanley R., Ames, Dorothea V., and Mallinson, David J., 2015, Environmental and Geological Evolution of Shackleford Banks, Cape Lookout National Seashore, North Carolina: East Carolina University, Department of Geological Sciences, GIS data and final report to the U.S. National Park Service, scale 1:10,000 (*GRI Source Map ID 76012*).

Only geomorphic units and features, and man-made area features (i.e., Dredge spoil areas) were included in the GRI digital geologic-GIS map. Other man-made features that are not geologic or geomorphic (e.g., fenced area, building, dock or jetty) were not included with this map.

Map Unit List

The geomorphic units present in the digital geomprhic-GIS data produced for Cape Lookout National Seashore, North Carolina (calo) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., oc_beach - Ocean Beach). Information about each geologic unit is also presented in the GRI Geomorphic Unit Information (SHKBUNIT) table included with the GRI geomorphic-GIS data.

Cenozoic Era

Quaternary Period

Recent Epoch

inlet_bm - Inlet berm
inlet_flat - Inlet flat
inlet_spit - Inlet spit
inlet_tidal_sand_flat - Inlet tidal sand flat
fdune_ridge - Foredune ridge
high_interior_dune_field - High interior dune field
wet_veg_flat - Wet vegetated flat
int_flat - Interior flat
int_marsh - Interior marsh
veg_ridge - Vegetated ridge
veg_ridge_swale - Vegetated ridge-swale
tidal_swale - Tidal swale
pond - Pond
strandplain_beach - Strandplain beach
oc_beach - Ocean beach
intermit_fdune - Intermittent foredune
low_int_dune_field - Low interior dune field
veg_flat - Vegetated flat
sparse_veg_flat - Sparsely vegetated flat
iso_dune - Isolated dune
tidal_marsh - Tidal marsh
inlet_tidal_mud_flat - Inlet tidal mud flat
sand_flat - Sand flat
sand_shoal - Sand shoal
sand_shoal_marsh - Sand shoal marsh
subtidal_veg_flat - Subtidal vegetated flat
organic_bank - Organic bank
shell_bank - Shell bank
dredge_spoil - Dredge spoil

Map Unit Descriptions

Descriptions of all geomorphic units are presented below. Referenced figures, as well as text that refers to a study site, are found in the source report.

inlet_bm - Inlet berm

Inlet Berms occur along the sound shore of Beaufort Inlet where sand is deposited in response to the interaction between estuarine and oceanic wind and current dynamics (Figures A5 and A6). They generally occur as arcuate features that are sub-parallel to the estuarine shoreline with lateral ends having a recurved geometry, concave on the landward side. The Inlet Berm progrades into the adjacent inlet along the active shoreline, and also occur further inland as relict ridges. Inlet Berms tend to be 1 to 2 m high, less than 25 m wide, and are composed totally of sand. The active Inlet Berm generally is unvegetated, however, relict Inlet Berms are vegetated with shrub-scrub. Vegetation 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 (silverling), Iva frutescens (marsh elder), Myrica cerifera (wax myrtle), and Ilex vomitoria (yaupon holly).

inlet_flat - Inlet flat

The Inlet Flat is separated from Beaufort Inlet by the Inlet Berm. The Inlet Flat is a gently ramped surface that slopes gradually from the Ocean Beach berm towards the inlet and estuary (Figure A5). The Inlet Flat forms from the interaction between the waves and tidal currents during high-water overflow conditions associated with spring tides and small storm tides. Active portions of the Inlet Flat contain abundant tidal creeks. The most active portions of the flat adjacent to Beaufort Inlet are unvegetated. However, older portions are increasingly vegetated with mixed grasses that include *Spartina patens* (salt meadow hay). The vegetation grades upslope towards the south and east into *Borrichia frutescens* (sea oxeye), abundant *Juncus roemerianus* (black needlerush), and scattered *Myrica cerifera* (wax mytle) (Figure A7). Supra-tidal portions of the Inlet Flats with finer grained sediments will frequently be dominated by algal mats and S*alicornia sp.* (marsh glass wort).

inlet_spit - Inlet spit

The Inlet Spit occurs on the ocean side of both Beaufort and Barden's inlets and may consist of one or more shore parallel recurved ridges. At Beaufort Inlet erosion has all but obliterated the curved feature (Figures A5 and A8). However, at Barden's Inlet several shore-parallel recurved ridges extend up to a mile in length with height ranging from 1 to 5 meters. The active portions of these features result from regular overwash events and the spit forms by the combined interaction of waves and tidal currents during high water overflow conditions associated with spring tides or small storm tides. Sometimes, the higher ridges formed by previous storm events will be subsequently truncated, breached, or even enlarged by the accretion of secondary spits. An older Inlet Spit often will contain active dunes that develop after the spit is formed. Active Inlet Spits will be either unvegetated or grassed with Uniola paniculata (sea oats) and Spartina patens (salt meadow hay), while vegetation on older Inlet Spits often consists of mixed grasses and shrub-scrub.

inlet_tidal_sand_flat - Inlet tidal sand flat

The Inlet Tidal Sand Flat occurs adjacent to Beaufort Inlet on the estuarine side of Shackleford Island and form as semi-enclosed area behind the Inlet Berm that allows regular tidal flooding and ebbing (Figures 5A and A9). Generally there is no macro-vegetation, however, these flats are alive with micro-flora and macro-fauna.

fdune_ridge - Foredune ridge

The size of Foredune Ridge depends upon sand availability and shoreline erosion rates. The Foredune Ridge in the west portion of Shackleford Banks is high (up to 5 meters), steeply scarped, and fairly continuous from Shackleford Banks mile marker 51.6 west to mile marker 54.6 (Figure A10B). Foredune Ridges are unvegetated on the scarped ocean side, but the tops are dominated by sea oats (Uniola paniculata) (Figure A11) with increasing vegetation density and diversity landward as the impact of salt spray is diminished. Other plants that commonly occur on the north side of the Foredune Ridge include Spartina patens (salt meadow hay), Cakile edentula (sea rocket), Solidago sempervirens (golden rod), Myrica cerifera (wax myrtle), occasionally Juniper virginiana (eastern red cedar) and ground cover plants such as Hydrocotyle bonariensis (penny wort).

high_interior_dune_field - High interior dune field

The High Interior Dune Field is generally coincident with and north of the high Foredune Ridge that runs from mile marker 51.6 westward to mile marker 54.6 to 55 where it curves NW and extends to Back Sound. This vast area of high dunes range up to 9 meters in height (Figure A12 and A13) and covers the southern portion of the island where the sand dunes overrode pre-existing maritime forest. The dune fields are generally complex in geomorphic character that have been modified by erosional dynamics over the past decades by storms with multiple wind directions (tropical storms, nor 'esters, sou'westers, etc.) (Figure A13). The High Interior Dune Field is relatively stable today with an extensive cover of grass vegetation however, there are local areas with active blowouts and over-steepened slopes. The vegetation on the High Interior Dune Field is dominated by the grass Uniola paniculata (sea oats) and ground cover plant Hydrocotyle bonariensis (penny wort). Occasionally Juniper virginiana (eastern red cedar) occurs in small damp areas between the dunes. Ghost trees are common and occur either on the flats between the dunes or with their tops sticking out of the dunes.

wet_veg_flat - Wet vegetated flat

The Wet Vegetated Flat is a former Inlet Flat that now occurs within the main body of the island surrounded by the High Interior Dune Field (Figure A14). This low flat geomorphic feature (<1 m above MSL) formed within a former inter-tidal zone, but was cut off by formation of a Strandplain Beach and is no longer connected to estuarine dynamics. Thus, this flat now occurs at the fresh ground-water table and is frequently dominated by shallow, black-water ponds, especially after heavy rains. Due to the shallow fresh water table, the shrub-scrub vegetation tends to be very thick and lush (Figure A15) and includes the following species: Baccharis halimifolia (silverling), Myrica cerifera (wax myrtle), Iva frutescens (marsh-elder), Myrica pensylvanica (bayberry), Juniper virginiana (eastern red cedar), Spartina patens (salt meadow hay), Smilax sp. (cat brier), Toxicodendron radicans (poison ivy), and Partenocissus quinquefolia (Virginia creeper).

int_flat - Interior flat

The Interior Flat comprises a slightly undulating and low surface (generally <1 m above MSL) within the High Interior Dune Field (Figure A16). Major portions of the Interior Flat are at or close to the ground water table, occasionally contain shallow ephemeral ponds, and are often characterized by dense growth of shrub-scrub as described in the Wet Vegetated Flat (Figures A14 and A15). These low Interior Flats appear to be have slightly linear sections that may be the relict expressions of the swale features that occur on the northern portion of the island.

int_marsh - Interior marsh

Swales or interior flats that have been cut off from the estuarine dynamics long enough and surrounded by higher topography to prevent salt-water influx from storms can develop as Interior Marshes dominated by fresh, black-water. Historic maps show Mullet Pond connected to Back Sound. Today Mullet Pond is an inland pond dominated by fresh, black-water marsh containing abundant *Typha angustifora* (cat tail) and surrounded by higher land and shrub-scrub vegetation (Figure A17).

veg_ridge - Vegetated ridge

Shared description with veg_ridge_swale (Vegetated ridge-swale) and tidal_swale (Tidal swale).

These three geomorphic units differ in scale from one another. Vegetated Ridge and Swale geomorphic units occur as multiple sets of sub-parallel couplets consisting of forested sand ridges (up to 2 meters in height) interspersed by low inter-ridge swales dominated by wetland vegetation and that contain plant species that range from inter-tidal to supra-tidal in the up-slope directions. The sand ridges and associated swales tend to be linear to slightly curved features at various oblique angles to the estuarine shore where they are being truncated by sound-side erosion (Figure A18). Large-scale and forested sand ridges (up to 6 meters in height) are mapped as Vegetated Ridges and are oriented generally perpendicular to Back Sound (Figure A19). Maritime forest vegetation (Figure A20A) includes Pinus sp. (pine), Quercus virginiana (live oak), and Juniper virginiana (eastern red cedar and Ilex (Holly) community. The under-story of shrubs include Myrica cerifera (wax myrtle) and Ilex vomitoria (yaupon holly), along with various vines including Smilax sp. (cat brier), Toxicodendron radicans (poison ivy), and Vius rotundifola (muscadine grape). The shrubs and vines occur throughout the forest and are densest generally near the periphery. Where the swales have been inundated and drowned by sea-level rise and sound-side dynamics, they are subjected to daily astronomical tides and mapped as Tidal Swales. The swales grade laterally inland to Juncus roemerianis (black needlerush) marsh and thick shrub-scrub zones onto the forested ridges (Figure A20B).

veg_ridge_swale - Vegetated ridge-swale

Shared description with veg_ridge (Vegetated ridge) and tidal_swale (Tidal swale).

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tidal_swale - Tidal swale

***Shared description with veg_ridge (Vegetated ridge) and veg_ridge_swale (Vegetated ridge-swale).*

These three geomorphic units differ in scale from one another. Vegetated Ridge and Swale geomorphic units occur as multiple sets of sub-parallel couplets consisting of forested sand ridges (up to 2 meters in height) interspersed by low inter-ridge swales dominated by wetland vegetation and that contain plant species that range from inter-tidal to supra-tidal in the up-slope directions. The sand ridges and associated swales tend to be linear to slightly curved features at various oblique angles to the estuarine shore where they are being truncated by sound-side erosion (Figure A18). Large-scale and forested sand ridges (up to 6 meters in height) are mapped as Vegetated Ridges and are oriented generally perpendicular to Back Sound (Figure A19). Maritime forest vegetation (Figure A20A) includes Pinus sp. (pine), Quercus virginiana (live oak), and Juniper virginiana (eastern red cedar and Ilex (Holly) community. The under-story of shrubs include Myrica cerifera (wax myrtle) and Ilex vomitoria (yaupon holly), along with various vines including Smilax sp. (cat brier), Toxicodendron radicans (poison ivy), and Vius rotundifola (muscadine grape). The shrubs and vines occur throughout the forest and are densest generally near the periphery. Where the swales have been inundated and drowned by sea-level rise and sound-side dynamics, they are subjected to daily astronomical tides and mapped as Tidal Swales. The swales grade laterally inland to Juncus roemerianis (black needlerush) marsh and thick shrub-scrub zones onto the forested ridges (Figure A20B).

pond - Pond

Some Ponds occur within low depressions or swales and are non-tidal since they are not directly connected to the estuary (Figure A21). These Ponds can still be irregularly flooded by storm tides and thus the water can range from fresh to brackish, and even occasionally may become highly saline waters due to post-storm evaporation. Consequently, these Ponds are generally dominated by Juncus roemerianis (black needlerush) that grades upslope to Borrichia frutescens (sea oxeye), and to the adjacent inland shrub-scrub.

strandplain_beach - Strandplain beach

Strandplain Beaches form the Back Sound shoreline in areas where cross-barrier island sand features such as Vegetated Ridges, Ridge and Swales, or Vegetated Flats intersect the eroding estuarine shoreline (Figure A22). These beaches always have a high tide or storm beach along the eroding sediment scarp. If there is enough sand available, the Strandplain Beach can prograde away from the source and form sand spits across flooded swales or in front of marshes. Strandplain Beaches can also form adjacent to offshore sand shoals in the adjacent estuary. Generally there is no macro-vegetation on an active Strandplain Beach. However, wrack (dead marsh grass and submerged aquatic vegetation) is abundant on Strandplain Beaches and in adjacent marshes, deposited by storm tides.

oc_beach - Ocean beach

The geomorphic unit mapped as the Ocean Beach extends from the mean wet-dry line to the base of either a natural or a scarped foredune ridge (Figure A10). If no dune ridge is present then the beach extends to the beach berm crest, which is the high crest (berm crest Figure A23B) of an overwash ramp that separates the surface water flow between the ocean and back-barrier estuary. Macro-vegetation is rare within the active Ocean Beach unit. However, storm wrack commonly occurs along the upper swash lines associated with the storm beaches. The wrack may consist of offshore algae (Sargassum sp.), dune grasses, estuarine submerged aquatic vegetation, or estuarine marsh grasses.

The Ocean Beach west of mile 51.6 is backed by a high (up to 5 meters) and mostly continuous

Foredune Ridge, whereas on the east portion of Shackleford Island, from mile marker 51.6 to 48.6, the Ocean Beach is characterized by a wide and gentle beach backed by a low (2 to 3 meters), steeply scarped Intermittent Foredune (Figure A23A). This Intermittent Foredune is repeatedly broken by low (1 to 2 meters) berm crests formed by recent overwash fans (Figure A23B). The Ocean Beach through much of the east portion of Shackleford Banks, particularly at low tide between mile markers 48.5 and 5.0, expose an outcrop of *in situ* marsh peat (Figure A24A). The peat commonly contains shrub-scrub roots, has a radiocarbon age between 480 to 300 cal. years BP, and a δ13C of -26‰. The Ocean Beach from mile marker 48.5 to Barden's Inlet is characterized by a series of ocean shoreline beach ridges (Figure A24B). The change (nodal point) from shoreline recession west of mile marker 48.5 to shoreline accretion east of mile marker 48.5 is due to the growth of the hook on Cape Lookout in concert with the ebb-tide delta dynamics of Barden's Inlet.

intermittent_foredune - Intermittent foredune

The Intermittent Foredune (Figure A23A) occurs on the east portion of the island from Shackleford Banks mile marker 51.6 to 48.6, is characterized by low (2 to 3 meters) steep scarps that are repeatedly broken by low (1 to 2 meters) berm crests formed by recent overwash fans (Figure A23B). The Intermittent Foredune is being severely eroded along the ocean side and is unvegtated. However, the tops and landward side of the Intermittent Foredune are vegetated primarily by sea oats (Uniola paniculata). The density and diversity of the vegetation increases landward as the impact of salt spray is diminished. Other plants that commonly occur on the north side of the Intermittent Foredune include Spartina patens (salt meadow hay), Cakile edentula (sea rocket), Solidago sempervirens (golden rod), Myrica cerifera (wax myrtle), occasionally Juniper virginiana (eastern red cedar), and ground cover plants such as Hydrocotyle bonariensis (penny wort).

low_int_dune_field - Low interior dune field

This area of dunes range up to 2 meters in height and occurs north of and grades into the adjacent Intermittent Foredune in the region between Shackleford Banks mile marker 51.6 and 48.6. The dunes are generally complex in geomorphic character. The Low Interior Dune Field includes ramps formed during overwash events that slope gradually from the berm crest towards the Vegetated Flats (Figure A23A and 23B) along the estuarine shoreline. The ongoing overwash events supply new sand that is winnowed and blown to form scattered low dunes that are 1 to 2 meters high (Figure A25). The Low Interior Dune Field is mostly vegetated, except in areas of recent overwash. Vegetation is dominated by the grass *Uniola paniculata* (sea oats), ground cover plant *Hydrocotyle bonariensis* (penny wort), and *Gaillardia pulchella* (fire wheel). Occasionally *Juniper virginiana* (eastern red cedar) occurs in small damp areas between the dunes.

veg_flat - Vegetated flat

Shared description with sparse_veg_flat (Sparsely vegetated flat).

On the east portion of Shackleford Banks, the Low Interior Dune Fields flatten out on the estuarine side of the island and grade into either Sparsely Vegetated or Vegetated Flats. Sparsely Vegetated Flats are dominated by grasses (Figure A26A) that include Spartina patens (salt meadow hay), Uniola paniculata (sea oats), as well as the ground over plant Hydrocotyle bonariensis (penny wort), Gaillardia pulchella (fire wheel), and occasional patches of Juncus roemerianis (black needlerush), Iva frutescens (marsh elder), and Baccharis halimifolia (salt myrtle Vegetated Flats are dominated by shrub-scrub including Ilex vomitoria (Yaupon Holly), Myrica pensylvanica (bayberry), and Juniper virginiana (eastern red cedar) (Figure A26B). These are dense thickets that include vines such as Toxicodendron radicans (poison ivy) and Vius rotundifola (muscadine grape).

sparse_veg_flat - Sparsely vegetated flat

Shared description with veg_flat (Vegetated flat).

On the east portion of Shackleford Banks, the Low Interior Dune Fields flatten out on the estuarine side of the island and grade into either Sparsely Vegetated or Vegetated Flats. Sparsely Vegetated Flats are dominated by grasses (Figure A26A) that include Spartina patens (salt meadow hay), Uniola paniculata (sea oats), as well as the ground over plant Hydrocotyle bonariensis (penny wort), Gaillardia pulchella (fire wheel), and occasional patches of Juncus roemerianis (black needlerush), Iva frutescens (marsh elder), and Baccharis halimifolia (salt myrtle Vegetated Flats are dominated by shrub-scrub including Ilex vomitoria (Yaupon Holly), Myrica pensylvanica (bayberry), and Juniper virginiana (eastern red cedar) (Figure A26B). These are dense thickets that include vines such as Toxicodendron radicans (poison ivy) and Vius rotundifola (muscadine grape).

iso_dune - Isolated dune

Isolated Dunes occur on the estuarine side and in the two wide sections of east Shackleford Island. These dunes are situated within the Vegetated Flats and are generally surrounded by grassed areas that grade into very dense shrub-scrub (Figures A27A and A29). The dunes are composed of sand, irregular shaped, and range up to 3.6 m high (Figure A27B). The surface of the Isolated Dune may be covered by a shell lag. The known Native American midden sites do not occur on the dunes, but are on the Vegetated Flats adjacent to the Isolated Dunes.

tidal_marsh - Tidal marsh

Tidal Marshes occur on the east region of Shackleford Banks. These salt marshes are connected to Back Sound by main tidal channels fed by complex networks of smaller channels that sometimes lead to interior ponds (Figure A28A). Tidal Marshes are regularly flooded by astronomical tides and display major vegetation zonations. Vegetation closest to Back Sound consists dominantly of Spartina alterniflora (smooth cord grass) and Salicornia sp. (marsh glasswort) and grades upslope into the dominant Juncus roemerianus (black needlerush), then Borrichia frutescens (sea oxeye), and ultimately to shrub-scrub. Figure A28B is a close-up view of the Spartina portion of the low marsh that is flooded by the regular astronomical tides. Figure A28C is a close-up view of a tidal creek in the marsh.

inlet_tidal_mud_flat - Inlet tidal mud flat

The Inlet Tidal Mud Flat occurs adjacent to Barden's Inlet and is open to astronomical tidal flux through a complex of tidal channels that flow both from Barden's Inlet and Back Sound (Figure A29). The Inlet Tidal Mud Flat consists of organic-rich, fine sandy mud with micro-algae and the ubiquitous mud snail Ilyanassa obsoleta, Slight topographic elevations throughout the mud flat form small vegetated hummocks that include Spartina alterniflora (smooth cord grass) and Juncas roemerianus (black needlerush) (Figure A30). These are highly productive habitats that are filled with micro-organisms, as well as abundant infauna, epifauna, and epiflora.

sand_flat - Sand flat

Sand Flats are back-barrier features that are inter-tidal to sub-tidal flats and range from 0 to -0.3 m below mean sea level. Due to both astronomical and frequent wind tides, sand flats are frequently and irregularly exposed to sub-aerial conditions. These fine Sand Flats are rich habitats for burrowing infauna, abundant oysters (Ostrea virginica), and mud snails (Ilyanassa obsoleta) (Figure A31).

sand_shoal - Sand shoal

Shared description with sand_shoal_marsh (Sand Shoal Marsh), subtidal_veg_flat (Subtidal Vegetated Flat) and organic_bank)Organic Bank).

A vast sequence of shallow Sand Shoals occur as part of the flood-tide delta deposits within Barden's Inlet (Figure A32). Some of the higher portions of these Sand Shoals are sub-aerial and vegetated. These Sand Shoal Marshes are mostly a *Spartina alterniflora* (smooth cord grass) marsh (Figure A33). Subtidal Vegetated Flats are extensive in Back Sound and are dominated by submerged aquatic vegetation (SAV) The SAVs occur in protected areas and adjacent to shallow, but subtidal Organic Banks (Figure A34).

sand_shoal_marsh - Sand shoal marsh

Shared description with sand_shoal (Sand Shoal), subtidal_veg_flat (Subtidal Vegetated Flat) and organic_bank)Organic Bank).

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subtidal_veg_flat - Subtidal vegetated flat

Shared description with sand_shoal (Sand Shoal), sand_shoal_marsh (Sand Shoal Marsh) and organic_bank)Organic Bank).

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organic_bank - Organic bank

Shared description with sand_shoal (Sand Shoal), sand_shoal_marsh (Sand Shoal Marsh) and subtidal_veg_flat (Subtidal Vegetated Flat).

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shell_bank - Shell bank

The Shell Banks are composed primarily of oyster and clam shells and occur generally where Native American midden sites are cropping out in the shallow back-barrier flats or eroding estuarine shorelines (Figure A35). This is the case at CALO sites -2, -3, and -131.

dredge_spoil - Dredge spoil

Dredged material from the maintenance of Barden's Inlet has been disposed of in a series of sub-aerial islands in Back Sound on the east end of Shackleford Banks. These higher islands are often vegetated with grasses or shrub-scrub and contain major bird rookeries.

GRI Digital Data Credits

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

The information in this document was compiled from a GRI source map and intended to accompany the digital geologic-GIS map(s) and other digital data for Cape Lookout National Seashore, North Carolina (calo) developed by Stephanie O'Meara (Colorado State University) (see the GRI Digital Map and Source Map Citation section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map.

GRI finalization by Stephanie O'Meara.

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