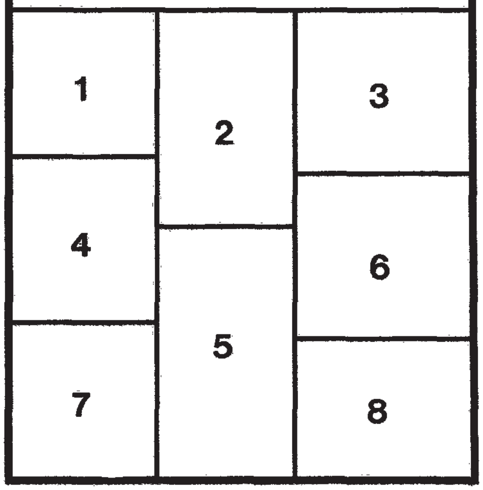
Soil Survey of the Outer Banks, North Carolina

Part I Text Material

THE PICTURES ON THE COVER



1. Currituck County—a Currituck Sound marsh island

2. Dare County—Bodie Island Lighthouse

3. Hyde County—Ocracoke Island

4. Carteret County—Cape Lookout Lighthouse

5. Onslow County—Swansboro harbor

6. Pender County—Topsail Island Beach

7. New Hanover County—Sand dunes at Kure Beach

8. Brunswick County—Smith Island near Southport

SOIL SURVEY
OUTER BANKS, NORTH CAROLINA

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

in cooperation with

NORTH CAROLINA
DEPARTMENT OF NATURAL AND ECONOMIC RESOURCES

AND

NORTH CAROLINA STATE UNIVERSITY
SOIL SCIENCE DEPARTMENT

This publication was partially funded by financial assistance from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration through the Coastal Resources Commission of the North Carolina Department of Natural and Economic Resources and by the United States National Park Service, Department of Interior.

ACKNOWLEDGEMENTS

The publication of this report was made possible through the efforts of the following federal, state and county agencies.

U.S. DEPARTMENT OF AGRICULTURE
- Soil Conservation Service
  - State Soil Scientist Office
  - State Resource Conservationist Office
  - Area Offices
  - Field Offices

STATE OF NORTH CAROLINA
- Department of Natural and Economic Resources
  - Division of Earth Resources
    - Administration Section-Resource Inventory Staff
    - Geology and Mineral Resources Section
  - Division of Marine Fisheries
  - Coastal Resources Commission

NORTH CAROLINA STATE UNIVERSITY
- Department of Soil Science
  - Agriculture Extension Service

COUNTY BOARDS OF COMMISSIONERS
- Carteret County
- Brunswick County

PART I
TEXT MATERIAL
SOIL SURVEY
OUTER BANKS, NORTH CAROLINA

This Soil Survey Report of the Outer Banks consists of two parts: Part I contains the descriptive material and Part II contains the soil maps.

JUNE 1977

PREFACE

In North Carolina, the State Land Policy Act and the Coastal Area Management Act of 1974 were created to provide policies and guidelines for land development and wise use of natural resources. If natural resources are to be conserved and used wisely, effective planning should include the interpretation of soil surveys and soil information. Therefore, the following soils data has been compiled in order to make resource information available for effective planning of the Outer Banks. Without an adequate factual basis for rational planning of North Carolina's Outer Banks, we cannot develop or manage our land in a manner that is consistent with its carrying capacities and its limitations. It is this objective that has motivated the North Carolina Department of Natural and Economic Resources, the United States Department of Agriculture, Soil Conservation Service, the Department of Soil Science at North Carolina State University, and the Coastal Resources Commission to cooperate in an effort which makes this document possible.

The soil maps and accompanying data provided in this document give a general idea of the soils of the Outer Banks, a means to compare different parts of the entire Outer Banks area, and an indication of the location of small areas that may be suitable for specific land use purposes. However, the data is intended for land use planning and the user is cautioned not to substitute this data if more specific data is needed for a particular purpose. In addition, suitability and limitation ratings presented in the interpretative tables do not preclude possible development. However, to use a soil rated "severe" or "very severe" for a specific land use, the unfavorable condition must be overcome by using appropriate land development measures. But <u>the precise nature of required measures can only be determined by an on-site evaluation of the area in question</u>. At any rate it is hoped that this information may serve as basic data in the future planning of private and public uses.

Some users of this report may wish further assistance in the interpretation of this publication; if so, more detailed interpretations of the data can be obtained by contacting the Division of Earth Resources, Department of Natural and Economic Resources, P.O. Box 27687, Raleigh, North Carolina 27611, or one of the following cooperating agencies:

1) Agricultural Extension Service
   Department of Soil Science
   North Carolina State University
   P.O. Box 5907
   Raleigh, North Carolina 27607

2) USDA Soil Conservation Service
   Federal Building - P.O. Box 27307
   310 New Bern Avenue
   Raleigh, North Carolina 27611

3) Coastal Resources Commission
   Department of Natural and Economic Resources
   P.O. Box 27687
   Raleigh, North Carolina 27611

4) Soil and Water Conservation District
   Offices in each county seat.

PART 1

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INTRODUCTION

A common misconception about the soils on the Outer Banks is that they are sandy on the beach side and "mucky" on the sound side. Contrary to this belief, thirty different soil mapping units have been identified on the Outer Banks, each with vegetation that varies from one mapping unit to another. The mapping unit with the least vegetation includes the sandy beach and foredune soils which are continuously shifting and being reshaped by wind and wave action. Next are the low-lying sandy soils west of the beach and foredunes which are usually wet since they receive salt spray blowing from the ocean. Soils on overwash flats, such as those at Portsmouth, have a salt content that is toxic to most of the vegetation of the Outer Banks. In contrast, numerous vegetative species flourish on older beach ridges located in protected areas near the sound side. Even here, though, vegetation differs gradually from the north to the south because of frequency of flooding and the salinity of the flood water. Hilly, sandy beach ridges, similar to those in the Nags Head area, are heavily forested with several species of tall-growing trees, while on the narrower Outer Banks in the south, the sandy soils contain small scrubby oaks that have been sculptured by salt spray from the ocean and by wind.

Physiography of the Outer Banks

Formed by a rising sea level on a low sloping coastal plain, the Outer Banks are a recent development in terms of the geologic time span. Over the past two million years, several ice ages resulted in huge volumes of water being stored in glacial masses at the poles, thereby causing the oceans to be several hundred feet lower than they are today. During the last ice age, the coastline of North Carolina was near the edge of the continental shelf, or from 20 to 60 miles further east from its present position.[1] Between 10 and 20 thousand years ago, however, the polar ice caps began to melt.

Consequently, the depth of the ocean increased, and the shoreline moved westward. Because of the low slope and relief characteristic of the North Carolina continental shelf, the rising sea rapidly flooded the coastal plain drainage system and created estuaries (drowned river valleys). Waves breaking far offshore then built a bar which, for one reason or another, became an emerged feature and which has since been driven shoreward.[2]

On the North Carolina coast, this has evolved into a long chain of barrier islands which extend from Virginia to South Carolina. These islands are the Outer Banks as we know them today. The present configuration of the Outer Banks is the result of the natural process cycles of inlet formation, of migration and closure, of oceanic overwash, and of dune development. The formative agents involved in the natural processes include waves, longshore currents, tides and tidal currents, and rivers and creeks that empty into the bays, sounds, and ocean. Today, the processes continue to move sediment and to reshape the barrier islands, causing the islands to migrate or "roll over" toward the west and closer to the mainland.

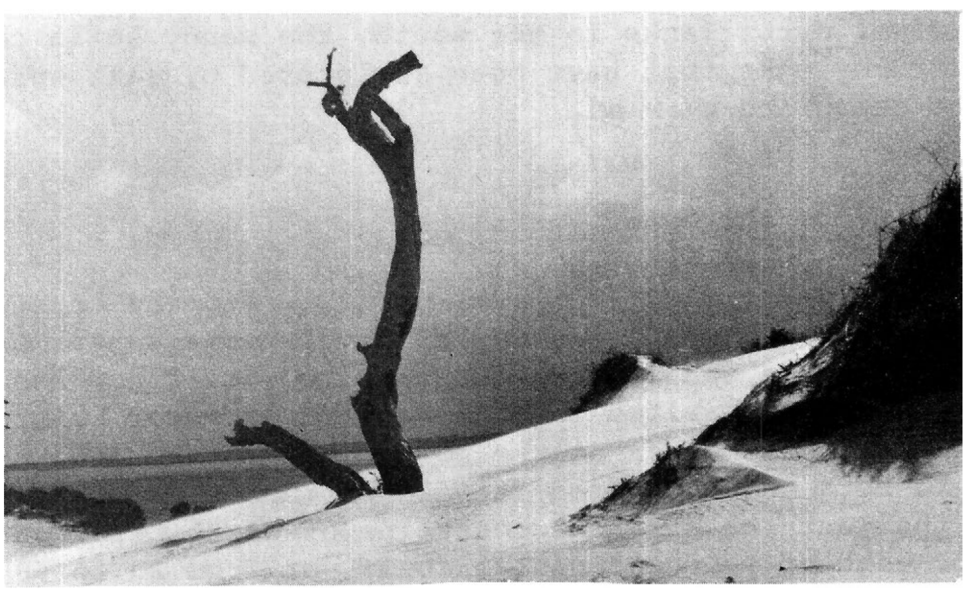

Fig. 1
Wind-blown sand has almost covered this weathered tree trunk on Duneland soil near the ocean.

Historical Highlights of the Outer Banks

Mariners, taking advantage of trade winds and Gulfstream currents near the North Carolina coast, probably made the earliest sightings of the Outer Banks. Observing both the ocean and the sound waters from the same sighting, Giovanni da Verrazzano, in 1524, reported that he had found a place where the Atlantic and Pacific Oceans were separated by only an isthmus.[3] For more than 150 years afterwards, Europeans searched fruitlessly for what had become known as "Verrazzano's Sea."

In the 1580's, the first English colony in the New World was established on Roanoke Island; and on August 18, 1587, Virginia Dare, the first child of English parents,was born in America. Shortly thereafter,Governor John White returned to England to procure needed supplies, but the Spanish Armada threat prevented his return until 1590. When he returned, he found that the houses had been "taken down" and that his fellow colonists had disappeared. The only clues to what had happened to the colonists were the letters "CRO" found carved on a tree by the sound, and the letters "CROATAN" carved on another tree near the fort. Today the fate of the "Lost Colony" still remains as much of a mystery as it was then.[4]

As far as can be determined, permanent settlement on the Outer Banks began in late 1664 on Collington Island. Here a "plantation" attempted to grow tobacco, to cultivate grapes and start a winery, and to raise hogs, but the only appreciable profit was from the sale of oil extracted from dead whales that washed ashore. Because the barrier islands provided excellent natural grazing lands with no need for fencing, raising cattle, horses, hogs, and sheep also became an important occupation.

One of the more fascinating developments in the history of the Outer Banks centers around the infamous pirate Blackbeard. Because of the hide-aways among the islands, he made the Outer Banks his headquarters while terrorizing coastal shipping and corrupting the highest colonial officials. In

1718, he had a fleet of four vessels manned by 400 pirates and captured 25 ships with valuable cargo. On November 22, 1718, Blackbeard was killed in a sloop battle between his vessel Adventure and two crafts which were fitted out by Virginia Governor Spotswood and under command of Lieutenant Robert Maynard. As great a mystery as the fate of the "Lost Colony," it is still unknown where Blackbeard hid his treasure.[5]

Since the Outer Banks were obviously "liable to the Depredations of an Enemy in Time of War, and Insults from Pirates and other rude People in Time of Peace," several military installations were constructed there. Fort Granville was built near Ocracoke Inlet in 1757, and during the Revolutionary War, Fort Hancock was built on Cape Lookout. Although Fort Hancock was not in service in the closing years of the war, it was an effective safeguard against British raids on the southern portion of the Banks. Between the Revolutionary and Civil Wars, Fort Macon on Bogue Banks and Forts Johnston and Caswell at the mouth of the Cape Fear River were built. During the Civil War, Forts Oregon, Ocracoke (Morgan), Hatteras, and Clark were built. By taking Fort Hatteras and Fort Clark in late summer, 1861, the Union won its first naval victory.[5]

As well as a strategic military location, the Outer Banks have also been a well-known resort area. Because the Outer Banks were relatively free from malaria which plagued the Carolinian Islands in the nineteenth century, the wealthy retreated to the Banks in the summer. In the 1830's a Perquimans County planter chose Nags Head as an ideal "watering" place. By 1838, Nags Head had a 200-room hotel, and it has remained a popular resort ever since.

Not far from this resort is Kitty Hawk, where the Wright Brothers were credited with powered-flight. The first of their four flights was on December 17, 1903, in a heavier-than-air, motor-driven flying machine. This flight lasted about 12 seconds and covered approximately 100 feet over the ground. The last flight lasted 57 seconds and covered 852 feet over the ground.[6]

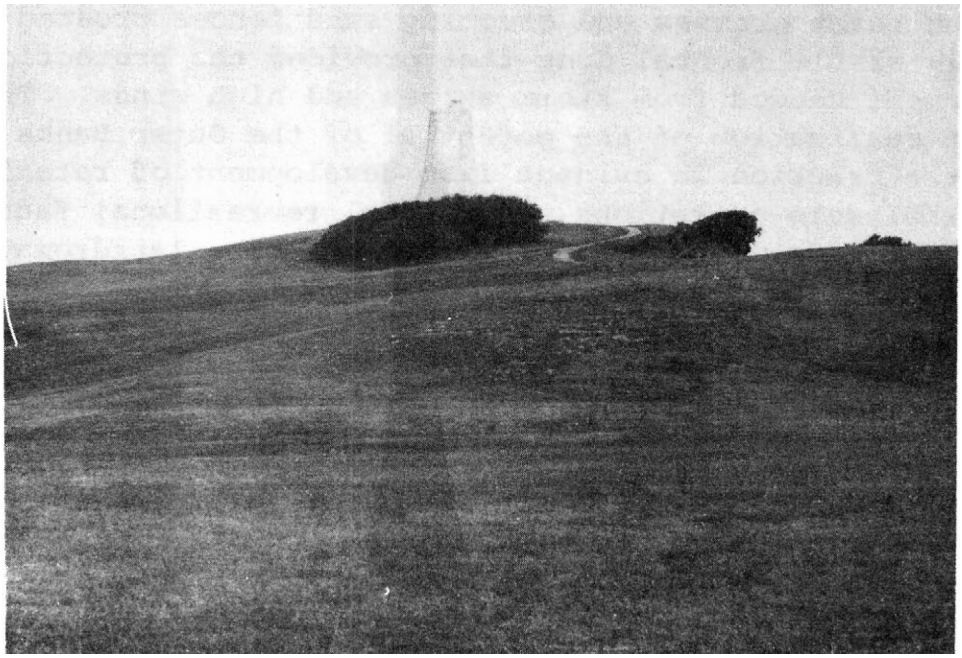

Fig. 2
The Wright Brothers Memorial stands on a large sand dune that has been stabilized with vegetation.

The Outer Banks also had a great era of commercial fishing between the Civil War and World War II. Prior to 1865, inadequate refrigeration and transportation prevented the development of commercial fishing.[7] Following World War II, overfishing, the rising cost of equipment, and foreign competition encouraged its decline. The industry is still an important part of the state's economy and can become more important with adequate investment and conservation practices.

Recent Developments and Man's Influence on the Outer Banks

Prior to the 1940's, the Outer Banks had a few permanent settlements. Following the appearance of bridges and improved transportation systems, however, large sections of the Banks experienced phenomenal growth. Another important catalyst responsible for the widespread development of the Outer Banks occurred in the 1930's with the Work Projects Administration's and Civilian Conservation Corps' dune establishment programs. Planting beach grasses and erecting sand fences created a relatively stable frontal dune that provided the protection development needed from storm surges and high winds. The subsequent realization of the potential of the Outer Banks as a tourist attraction is evident from development of retail and minor wholesale operations, commercial recreational facilities, rental cottages, motels, real estate offices, laundromats, boat basins, and fishing piers.

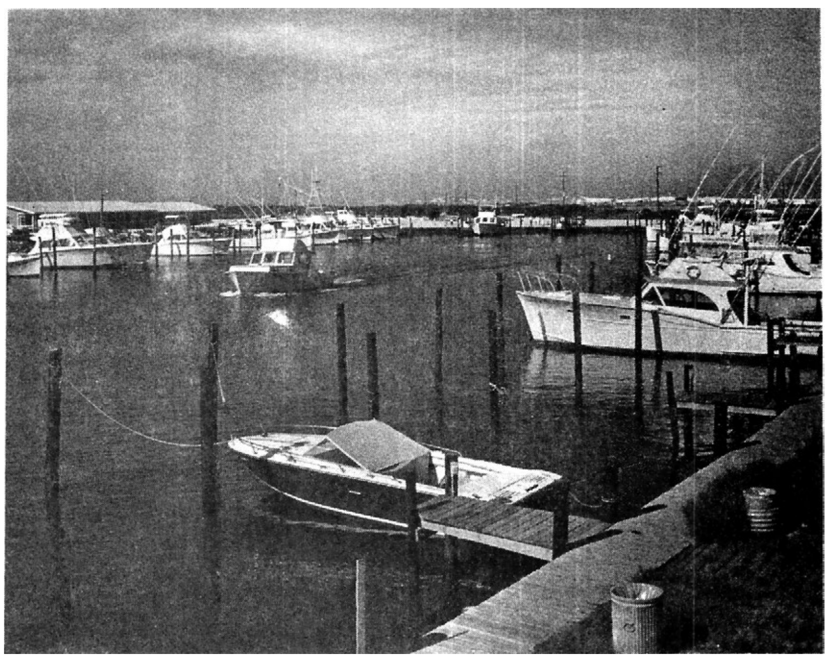

Fig. 3
Oregon Inlet fishing center at Cape Hatteras National Seashore.

Increases in personal income and the availability of leisure time have also accelerated the development in response to the desires of the tourist. Although the establishment of the Cape Hatteras National Seashore in 1953, and more recently the Cape Lookout National Seashore, has contributed to the

Fig. 4
Hang gliding is a popular sport at Jockey's Ridge sand dune, near Nags Head.

Fig. 5
Japanese black pine used as a screen and for landscaping a home in Nags Head.

tourist attraction of the Outer Banks, most of the summer flood of tourists are simply seeking the sun, sports, and relaxation that are abundantly available in the coastal communities. In addition to tourist trade in the last few years, more of the summer residents of the Banks have chosen to stay year-round; therefore, more substantial permanent structures have been built. The building trades have thus flourished from both expanded retail establishments and residential areas. As a result of the year-round influx of tourists and retirees, many Outer Bankers have had their incomes increased and are less dependent on seasonal trade.

Despite these commercial developments, however, many coastal citizens consider the influx of summer tourists and year-round residents a mixed blessing. Many of the new residents of the Outer Banks are not familiar with the peculiar and delicate nature of this unique natural system. Consequently, many problems are now being realized. Many of man's activities have led to head-on confrontations with nature. For example, waters are polluted from septic tank effluent and light industrial waste; erosion is accelerated as a result of reduction in vegetative covers and maritime forests; uncontrolled sediment deposition has resulted from manmade structures; and marsh destruction has been caused by excavation and filling operations. Plans for future development along the Outer Banks will need to recognize these problems and include measures to satisfactorily overcome or eliminate them. A large influx of people can easily exceed the "carrying capacity" of this scenic area and reduce its beauty, wilderness, and natural resources.

NATURAL ENVIRONMENT AND DEVELOPMENT ASPECTS

Land Use Planning

The Outer Banks is a vital part of the North Carolina coastal zone which is the broad interface between land and sea where land use affects the ecology of the ocean and vice-versa.[8] An area of great biological activity and significance, the coastal zone is one of the nation's most valuable resources. The seaward and landward boundaries are necessarily vague, and for management purposes they must eventually be arbitrarily determined. In North Carolina, 20 counties have been designated by the government as the Coastal Management Area. Eight of these counties include portions of the Outer Banks.

The need for comprehensive planning is more critical on the Outer Banks and in the coastal zone than in most inland areas because of several unique characteristics.[9] First, a large portion of the coastal zone is held in public trust by the State for use by all citizens. The publicly-owned submerged land, water, wildlife, and fishery resources are natural attractions which add to the value of the adjacent privately-owned land. A second characteristic is the extent to which land use activity in one area of the Outer Banks and coastal zone affects uses at great distances. For example, filling a marsh may reduce fish populations many miles away, perhaps even in other states. Similarly, land uses which produce pollutants often cause destruction of publicly-owned resources of the estuaries. A third unique characteristic of the coastal zone is that property lines are as difficult to determine as identifying where land and water meet. Basically, the conflict is between the right of ownership and development of private property, which may affect adjacent public waters, and the right of preservation of public trust resources.

Since soil limitations do exist, comprehensive planning at any level, whether local, regional, or statewide, should utilize soils information to decide how land can best be used and managed. This type of planning requires a soil survey of the area which maps the various soil types, identifies their physical and chemical properties, and interprets the properties in terms of land use planning. Consequently, the Coastal Resources Commission, Soil Conservation Service, and Department of Natural and Economic Resources have actively supported the production of the following Soil Survey for the Outer Banks.

Need for Soils Information

In order to make sound management decisions, technical information is needed on which to base those decisions. Existing pertinent information must be compiled and utilized, and research should be initiated to provide new information. One critical need for land use planning in the coastal zone is an environmental inventory which includes the resources that make up the physical, biological, and cultural environment.[10] To properly manage and allocate resources, it is necessary to have a thorough understanding of their location, quantity, and quality.

The soil is one of the basic resources that must be considered in the Coastal Management Area since soil properties greatly influence the way that land is used by man. Probably all the soils in the Outer Banks area could be modified to accommodate any selected use, but in many cases the costs (environmental, social, or monetary) would be excessive. Since misuse can lead to severe environmental problems, the cost of improperly planned modification is often borne not only by the developer, but also by the public. Therefore, it is desirable to recognize the limitations of certain soils and to evaluate their potential or suitability for uses such as septic tanks, land fills, waste disposal, urban development, industrial development, recreation, and highways.

On-site disposal of septic tank effluent is an example of an urban use of soils which often creates problems on the Outer Banks. Utilizing existing septic tank technology, many wet and/or impermeable soils in the area have severe limitations.

In some dry sandy soils, such as dune sand, the soil is too permeable to accommodate effluent; thus pollution of ground water and adjacent estuarine water is a problem. Even using current technology, it is difficult and/or expensive to overcome these limitations in a way that is not damaging to the environment. But when officials know these problems exist, requirements for development, such as minimum lot size or specifications for a municipal sewerage system, may be imposed. Then proper technical innovations can often make development environmentally acceptable.

From a land use planning point-of-view, soil analyses can indicate hazard areas to be avoided. The existence of certain soil types act as an indicator of periodic and/or dangerous storm flooding near inlets, in overwash areas, and in low-lying soundside locations. Sometimes the presence of a particular soil type associated invariably with a high seasonal water table signals that a certain area might not be suitable or comfortable for year-round habitation. Another planning consideration tied directly to soil type is load bearing capacity. On the Outer Banks this is extremely important because of the threat of storm wind and flood damage to structures. Many are constructed on pilings to minimize failures, but the depth to which these pilings are driven must be determined through a knowledge of the substratum below the subsoils profile.

THE RELATIONSHIP OF VEGETATION AND SOILS TO THE LANDSCAPE

Several factors interact to determine the types of vegetation and soils which occur on the barrier islands. Figures 1, 2, and 3 are generalized diagrams that show the relationship of vegetation and soils to the landscape on the northern, central, and southern parts of the North Carolina Outer Banks. The most distinct landscape division falls between the marsh and the sand strand. The major factor causing this division is topography.

The Sand Strand

The sand strand can be divided into three categories: the beach-foredune, the shrub zone, and the maritime forest (Figures 6, 7, and 8). The major soil differences are determined by relief, which affects the drainage; vegetation; and the length of time required for soil development to occur. The vegetative types are determined by relief, since it not only affects drainage but also dictates the amount of protection from wind, and by their location with respect to the ocean. Studies have shown that wind is an important environmental factor influencing coastal vegetation.[11] The wind carries salt spray from the ocean which kills susceptible plants, and it carries sand which is abrasive to plants and can bury them. Winds also cause flooding and erosion by water.[12]

The beach-foredune unit is constantly changed by the deposition of sands and by erosion caused by wind and ocean waves. The soil is wind-deposited sand with little or no profile development. The beach is bare except just above the high tide line where scattered clumps of sea-oats, seashore elder, and sea rocket are found. The foredune is built by grasses that trap the blowing sand. The major foredune plants are American beachgrass, sea-oats, bitter panicum, and seashore elder. In fact, the North Carolina coast serves as a transitional zone between American beachgrass and sea-oats, since Currituck Banks is the southern limit of the natural range

Figure 6

CHARACTERISTIC SOILS TYPES AND DOMINANT VEGETATION
SOUTHERN SECTION OF OUTER BANKS, N.C.

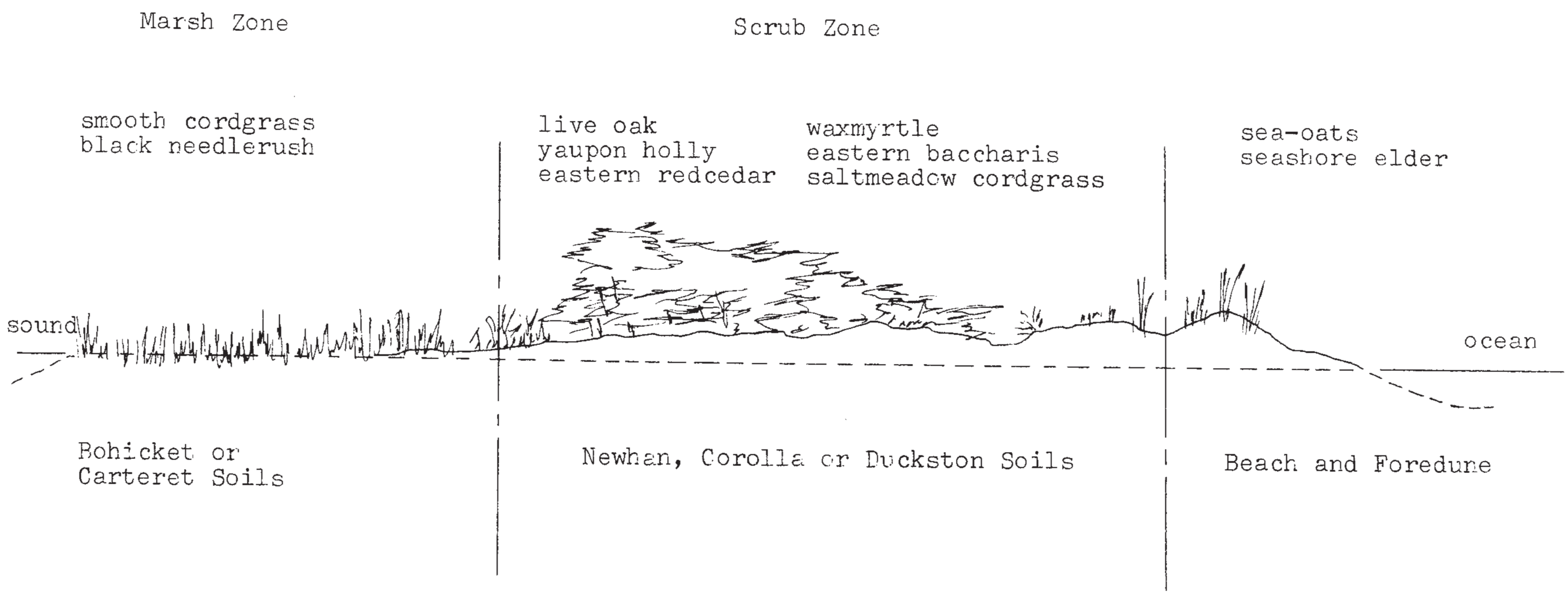

Figure 7

CHARACTERISTIC SOIL TYPES AND DOMINANT VEGETATION
CORE BANKS, NORTH CAROLINA

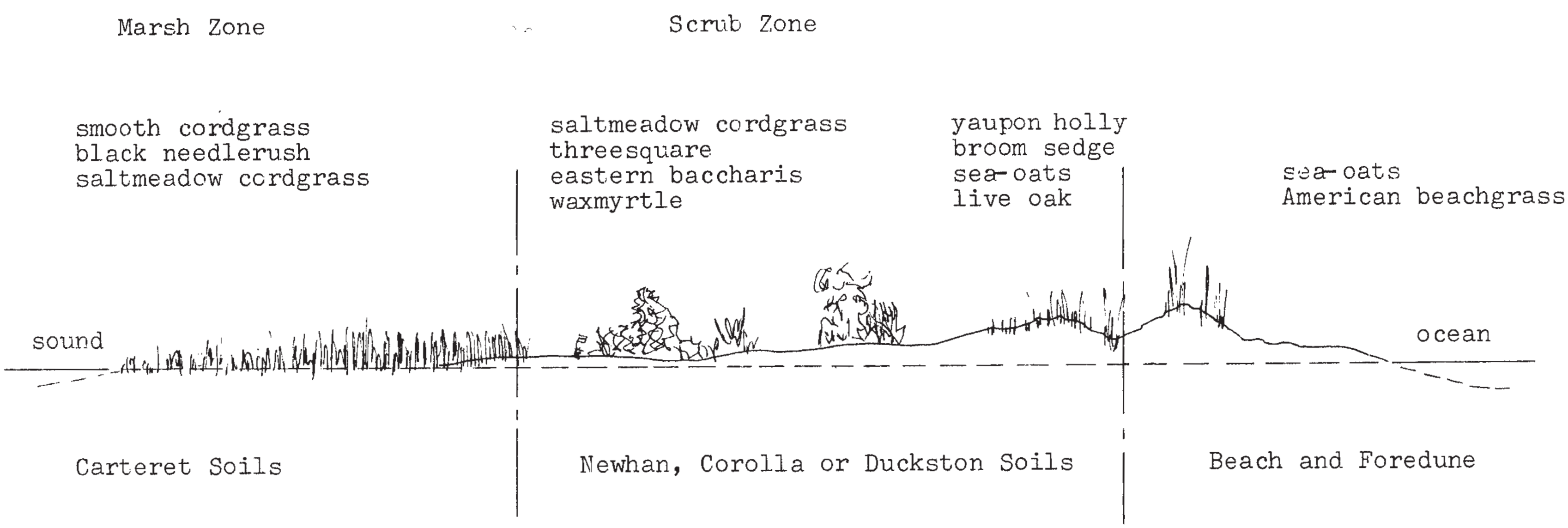

Figure 8

CHARACTERISTIC SOIL TYPES AND DOMINANT VEGETATION
NAGS HEAD WOODS & NORTH SECTION OF OUTER BANKS,
NORTH CAROLINA

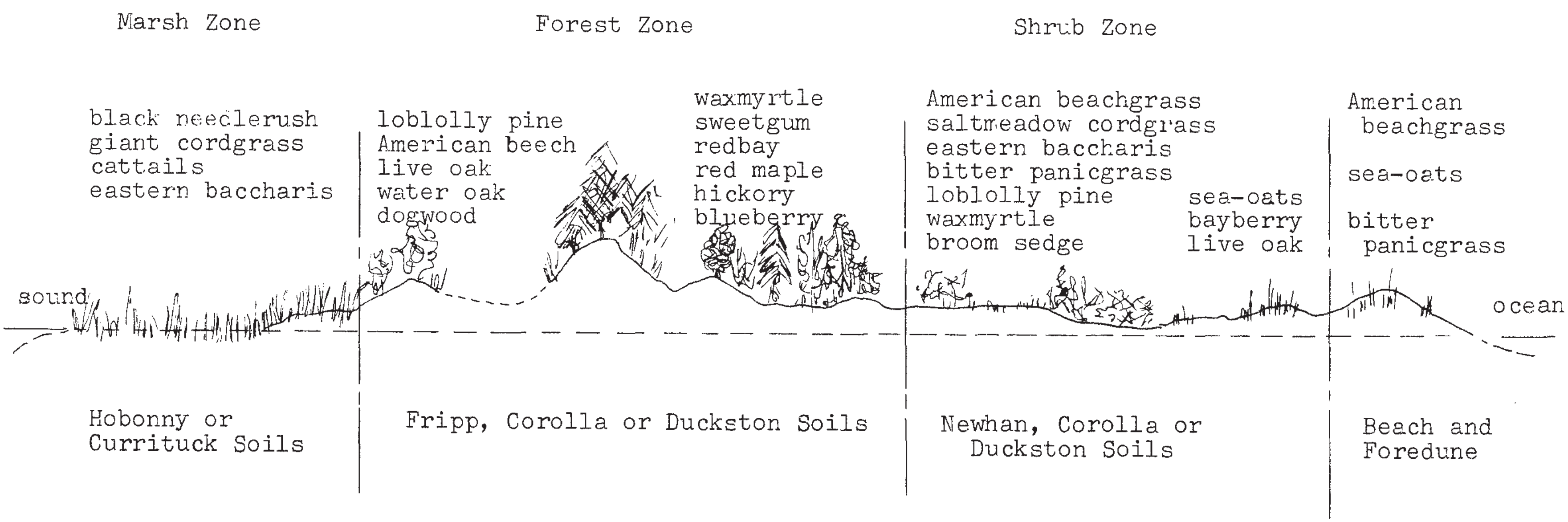

Fig. 9
Tolerant to ocean salt spray, sea-oats stabilize foredunes on the sand strand near the ocean.

Fig. 10
Breaks through foredunes on the Outer Banks result from natural erosion and man's activities.

for American beachgrass as well as the northern limit for sea-oats. Although American beachgrass has been transplanted successfully farther south, it eventually dies out and is replaced by sea-oats.

The animal community of the beach-foredune community is diverse. In the foredune area, small mammals and resident and migratory birds are common. Here, too, the American oyster catcher and royal tern use the dunes as nesting sites. The beach community itself is made up mostly of species such as ghost crabs and shore birds such as the black-bellied plover, the ruddy turnstone, whimbrels, willets, knots, gulls, and terns.

Behind the foredune is the shrub zone, an area characterized by grasses and scattered shrubs, which grades into a shrub thicket some distance from the ocean. The soils mapped in this zone are the Newhan, Corolla, and Duckston. The criterion that differentiates these soils from each other is drainage. The well-drained Newhan soils are on the higher, drier areas; the moderately well-drained Corolla soils are on the intermediate areas; and the poorly drained Duckston soils are on the lower, wetter areas. Newhan soils support American beachgrass, sea-oats, bitter panicum, live oak, and yaupon holly. The wetter Corolla soils support live oak, waxmyrtle, broom sedge, and saltmeadow cordgrass. Duckston soils, which occur in depressions, support a thick growth of saltmeadow cordgrass, eastern baccharis, and waxmyrtle. The relationship of the vegetation to the landscape and the ocean is an important factor in determining whether grass or shrub vegetation occurs on these soils. Only grasses grow near the ocean, except where a well-developed foredune provides protection from salt spray.

The wildlife found in the shrub zone consists mainly of birds and small mammals. For example, songbirds such as mockingbirds and wood thrushes frequent this area and the thickets of this zone provide good loafing and escape cover for small game species such as rabbits.

With increasing distance from the ocean, the effects of salt spray decrease and the shrub zone grades into maritime forest. Maritime forest is dominated by live oak, yaupon holly, eastern redcedar, and redbay. The soils in the forested areas exhibit better profile development and more accumulation of organic matter on the surface. Representative soils are Corolla, forested; Duckston, forested; and Fripp. Where the islands are so wide that salt spray is not a factor, some maritime forests develop which are similar in species composition to forests on the mainland. Examples of this situation occur at Nags Head Woods, Buxton Woods, and Pine Knoll Shores. The seed or fruit of the plants in these forests is used by various species of wildlife, making this one of the more desirable habitats within the Outer Banks ecosystem.

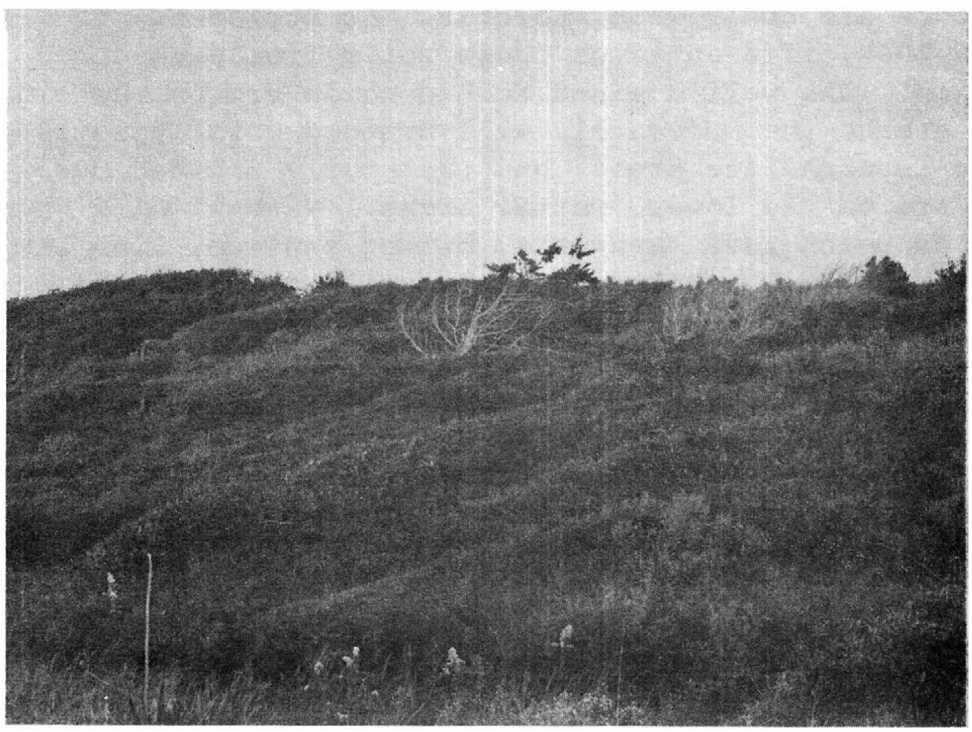

Fig. 11
Salt-sheared shrub vegetation on Newhan fine sand, Yaupon Beach, Brunswick County.

The Marsh

The main factors which produce differences in marsh soils are parent material, salinity, elevation, and vegetation. The plant communities which occur are determined primarily by frequency of flooding and salinity. Consequently, marshes can generally be divided into three categories: regularly flooded, irregularly flooded, and fresh marsh. The marsh soil mapping units and the dominant vegetation which occurs on them are listed in Table 1.

The extent of these marsh types varies along the barrier islands from north to south. The distance between inlets is an important factor in this distribution. From Cape Lookout north, the barrier islands are a considerable distance from the mainland, and the inlets are few and widely spaced. The large sounds behind the islands and the few inlets reduce the effect of lunar tides, except in the immediate vicinity of the inlets.

TABLE 1 - SOIL MAPPING UNITS FOR THE MARSHES OF THE NORTH CAROLINA BARRIER ISLANDS

MAPPING UNIT	TEXTURAL CLASS	SALINITY	DOMINANT VEGETATION
Bohicket soils, low	clayey	salt	smooth cordgrass
Bohicket soils, high	clayey	brackish	black needlerush
Carteret soils, low	sandy	salt	smooth cordgrass
Carteret soils, high	sandy	brackish	black needlerush
Carteret soils	sandy	variable	saltmeadow cordgrass
Currituck soils	organic	fresh	black needlerush
Currituck soils, high	sandy	fresh	saltgrass, saltmeadow cordgrass, black needlerush
Hobonny soils	organic	brackish	black needlerush
Levy soils	clayey	fresh	mixed species

Fluctuations in tide levels, then, are controlled mainly by wind direction and velocity which might produce irregular flooding. The predominant vegetation in these marshes is black needlerush and saltmeadow cordgrass. From Cape Lookout southward, the barrier islands are closer to the mainland, the sound is narrower, and the inlets more numerous. Consequently, the tide fluctuation is greater, and a larger area of marsh is flooded twice daily by the lunar tides. This area of regularly flooded marsh is dominated by smooth cordgrass.[13]

The absence of inlets on the northern part of the barrier islands causes the brackish-to-fresh-water conditions which exist in Currituck Sound and in the marshes of Currituck banks. Although Oregon Inlet is the most northern inlet which is open at present, other inlets have been open in the past on Currituck banks.[14] At least five have occurred since 1730.[6] These inlets, and those that undoubtedly preceded them, have certainly influenced the development of the marsh that is now present.

Three of the mapping units in the marshes of Currituck banks are characterized by organic surface horizons. These are Hobonny; Currituck; and Currituck soils, high. The thickness of the organic layer is the main feature which differentiates these soils from one another (Table 1, page 19). The vegetation on these soils is somewhat variable. Stands of black needlerush characterize a large portion of Hobonny soil. Vegetation is generally more diverse on the Currituck soil unit with black needlerush and giant cordgrass being the dominant species. The Currituck soils, high, are usually dominated by saltgrass and saltmeadow cordgrass with scattered black needlerush. The landward side of the marsh borders Currituck banks and is dominated by freshwater plants due to seepage and runoff from the forest and shrub areas. Freshwater marshes also occur in isolated, landlocked depressions. The vegetation is usually cattails and sawgrass. It should be noted that Levy soils were also mapped in the Currituck marshes. They are clayey and have a cover of mixed fresh water marsh species vegetation.

From Nags Head south, along the sound side of Bodie Island, Hatteras Island, and Core Banks, the marshes are sandy and generally divided into two soil units (Figure 2). The Carteret soils, low, are in a regularly flooded marsh covered by smooth cordgrass. These soils occur in a fringe area along the edge of the sound, except around inlets or sites of old inlets where more extensive stands have developed. The elevation zone is from about mean tide level to mean high tide. The Carteret soils, high, occur immediately above this zone in the area periodically flooded by storm tides. Carteret soils are characterized by black needlerush or saltmeadow cordgrass. Also, there is usually more organic matter accumulated under the black needlerush than the saltmeadow cordgrass.

On the sound side of the southern barrier islands, the regularly flooded marshes are more extensive; and around the mouth of rivers, such as the Cape Fear, the soil is clayey. One mapping unit is Bohicket soils, low, which includes extensive stands of smooth cordgrass. Higher areas support stands of black needlerush and are mapped as Bohicket soils, high. Both Bohicket soils are similar except for the different vegetation, which is a reflection of the regularity of flooding and soil elevation. The Carteret soils, low, and Carteret soils, high, were mapped where the marshes are sandy.

The biotic community present in a marsh is largely dependent on the factors of salinity, drainage, and temperature. The animal community of the open marsh is largely dependent on the degree and stage of flooding. Where flooded, species such as herons, egrets, geese, ducks, shore birds, gulls, and terns are common. During times when the community is not flooded, species such as muskrats, nutria, mink, diamondback terrapin, and the banded watersnake can be found. In the fresh marshes, raccoon, rails, and muskrats are common; but their value, when compared to waterfowl, is generally considered to be low.

SOILS OF THE OUTER BANKS

Guide to Mapping Units

MAP SYMBOL	MAPPING UNIT	DESCRIBED ON PAGE
1	Beach, occasionally flooded	27
2	Leon fine sand	28
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16	Levy soils	46
17	Madeland	47
18	Carteret soils, high[1]	48
19	Carteret soils[1]	50
20	Currituck soils[1]	50
21	Newhan fine sand	52
22	Newhan-Corolla complex	53
23	Duneland-Newhan complex	55
24	Newhan-Urban land complex	56
25	Wando fine sand	57
26	Conaby soils[1]	58
27	Echaw fine sand	60
28	Kureb fine sand	61
29	Currituck soils, high[1]	62
31	Bohicket soils, high[1]	63

[1]These areas were studied less intensively than others in field work.

NOTE: Mapping Unit 30 has been designated for a soil occurring on Roanoke Island and is not included in this report.

Descriptions of the Mapping Units

The kinds of soil (mapping units) shown on the detailed soil maps in Part II are described in this section. These descriptions together with the soil maps can be useful in determining the potential of a soil in planning land use and in developing soil resources.

National soil survey guidelines were used in this survey. The soils were studied in the field by soil scientists who walked over the land and, at selected intervals, examined the soil to depths of three to six feet. Information pertaining to the various soil properties, such as natural drainage, texture, type of parent material, thickness, and arrangement of each soil layer in the profile was noted. A profile shows the sequences of natural layers of horizons in a soil; it extends from the surface down into the parent material that has not been significantly changed either by leaching or by the action of plant roots.*

The soil scientists made comparisons between the profiles they studied and the kinds of vegetation growing on them. The soils that have similar properties and vegetation were grouped into like mapping units. The locations of the different units, as they occur on the landscape, are shown on the soil maps in Part II. Photo interpretation of vegetative communities was also helpful in drawing soil boundary lines on the maps, especially in inaccessible thickets and marshes.

A mapping unit, then, represents an area on the landscape which consists of a dominant soil, or soils, for which the unit is named. Most mapping units are dominated by a specific soil. However, there are slight variations within a soil just as there are differences in animals of a similar breed or plants of a particular variety. For this reason and because the boundaries between areas of unlike soils are not sharply defined but are gradual, small areas of other soils are normally present as inclusions within a specific delineation. Areas of a soil of about three acres or less are not delineated on the soil maps.

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* Soils are composed of different layers called horizons. The major horizons are A (surface-topsoil), B (subsoil), and C (substream). Vertical subdivision assigned downward within the major horizons is indicated by secondary arabic numbers and lower case letters. An example is A1, A21g, and A22g.

A soil complex consists of areas of two or more soils, that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two dominant soils, and the pattern and relative proportions are about the same in all areas. The name of the soil complex consists of the names of the dominant soils, joined by a hyphen. Corolla-Duckston complex is an example. The first soil listed in the complex is the most dominant soil.

An undifferentiated group is made up of two or more soils that commonly could be delineated individually but are shown as one unit because, for the purpose of the survey, there is little value in separating them. The pattern and proportion of these soils are not uniform. For the Outer Banks, the undifferentiated units have only one soil in the name of the unit because one soil makes up the dominant part of the unit. The other components are unclassified soils that are not named but are similar in use, management, and behavior. The word "soils" is used as the second part of the name to indicate that the unit was mapped at a lower intensity and is more variable than other units in the survey area. Hobonny soils is an example.

Miscellaneous land areas consist of lands where the soil materials have been disturbed, leveled, covered, or filled in such a manner as to alter the original soil profile. Madeland is an example.

The mapping unit descriptions provide a "bird's eye" view of the soil as it occurs on the landscape. The block diagram depicts the soil profile; that is, the sequence of layers from the surface downward to other underlying material. It is representative of the profile described for the series shown in Appendix 1, "Technical Descriptions of Soils."

The acreage of each mapping unit is shown, by county, in Table 2, pages 25 and 26. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual.[15]

TABLE 2 - MAPPING UNIT ACREAGES OF THE OUTER BANKS
(Acres by County)

Mapping Unit	Soil Name	Currituck	Dare	Hyde	Carteret	Onslow	Pender	N. Hanover	Brunswick	Total
1	Beach, occasionally flooded		471	449	3754					4,674
2	Leon fine sand				938				435	1,373
3	Beach-foredune association	1286	4565	945	111	1303	524	815	792	10,341
4	Bohicket soils, low					4799			7265	12,064
5	Tidal flats			370	2508					2,878
6	Carteret soils, low		1113	1115	3102	377	4640	4805	1934	17,086
7	Corolla fine sand	1314	4562	571	1203		142	402	505	8,699
8	Corolla fine sand, forested	415	2323							2,738
9	Corolla-Duckston complex	1136	1481	88	763	168			16	3,652
10	Dredge spoils		357	76	94	1709	1056	1243	1034	5,569
11	Hobonny soils		539							539
12	Duckston fine sand	1289	6683	1118	2488	334	23	201	421	12,557
13	Duckston fine sand, forested	554	1373							1,927
14	Duneland	746	638		19	222				1,625
15	Fripp fine sand		6187			55			951	7,193
16	Levy soil	3130								3,130
17	Madeland		497	20	69	202	65	520	591	1,964
18	Carteret soils, high		4439	356	2939	211	249	192	10	8,396
19	Carteret soils		2023	629						2,652
20	Currituck soils	5020	2907		49	58		6	11	8,051
21	Newhan fine sand	816	5773	348	814	1470	340	525	1794	11,880
22	Newhan-Corolla complex	1164	2011	356	1748	683	865	298	1021	8,146

Mapping Unit	Soil Name	Currituck	Dare	Hyde	Carteret	Onslow	Pender	N. Hanover	Brunswick	Total
23	Duneland-Newhan complex	996	1087		116	233			239	2,671
24	Newhan-Urban land complex		477					611		1,088
25	Wando fine sand					482			1724	2,206
26	Conaby soils		1923							1,923
27	Echaw fine sand				401					401
28	Kureb fine sand								841	841
29	Currituck soils, high	873								873
31	Bohicket soils, high					2000 *			262	2,262
	Totals	18,739	51,429	6,441	21,116	14,306	7,904	9,618	19,846	149,399

* Acreage is estimated.

NOTE: Acreage figures are not provided for water areas mapped with symbol "W."

1) Beach, occasionally flooded

The soil in this unit occurs mainly on small islands and on the northern side of inlets along the Outer Banks. In some areas, it extends from the ocean to the sounds. The mapping unit is generally smooth and nearly level, but some areas are hummocky with small dunes of fine sand. The soil is sandy throughout and has small to large amounts of shells and fragments of shells.

Mapped areas of this unit are above the areas covered by daily tides and are slightly higher than the Tidal flats. The depth to the water table is variable, but it is commonly within 1 to 3 feet of the surface.

Vegetation is sparse in this unit. It is restricted to the scattered small hummocks and consists of saltwort, sea-oats, and American beachgrass. The vegetative covering is limited because of the high salt content and the continual washing by flood waters.

Occasional tidal and storm flooding is a severe limitation to all uses other than beach-related recreational activity.

Fig. 12
Occasionally flooded beach at Oregon Inlet. These areas are usually void of vegetation except for sea-oats and American beachgrass.

2) <u>Leon fine sand</u>

The nearly level Leon soils are on flats above normal overflow and are mainly in the southern part of the survey area. They are sandy throughout and have a seasonal high water table at or near the surface. The native vegetation is loblolly pine, live oak, waxmyrtle, yaupon holly, greenbrier, muscadine grape, and redbay.

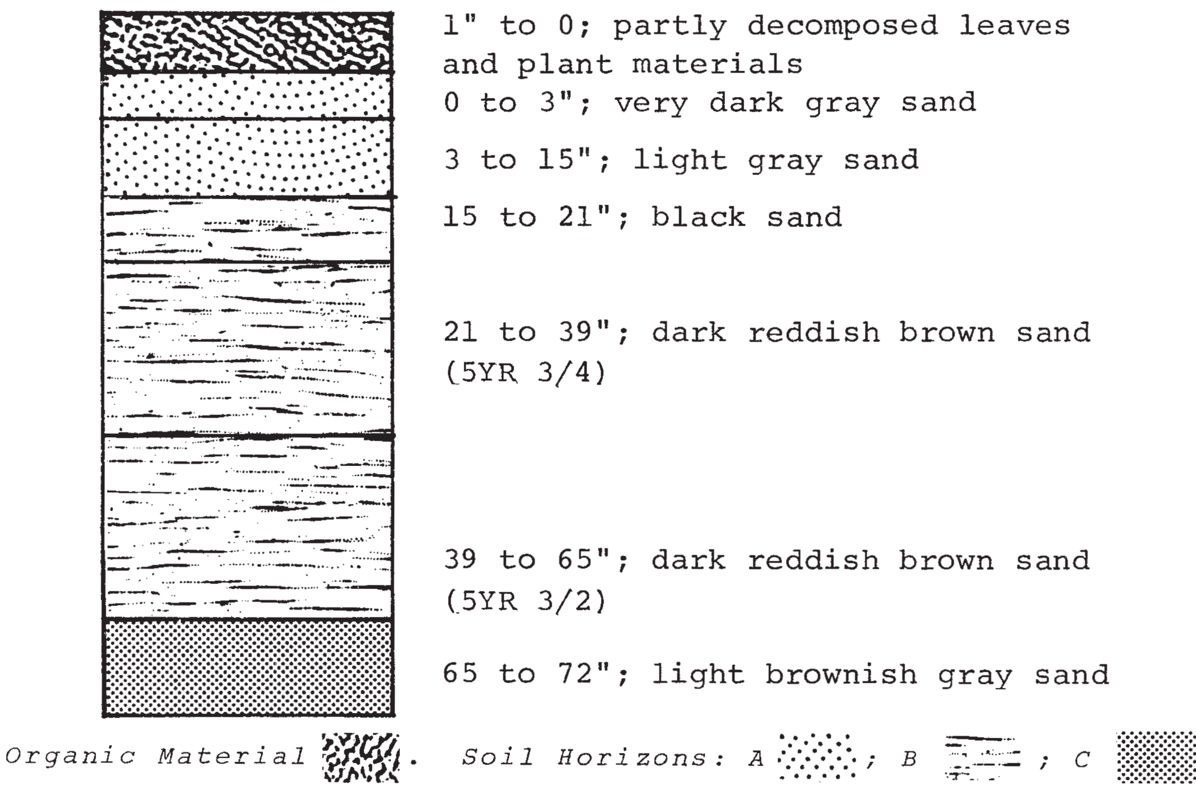


Fig. 13
Soil profile drawing of Leon fine sand.

Although water moves through the Leon soils readily, it is near the surface during periods of high rainfall but may drop to depths below 40 inches during the drier seasons. Areas of this soil that occupy the lower positions on the landscape may have standing water during wetter seasons.

3) Beach-Foredune Association

This mapping unit is mainly on the ocean side of the "banks" and islands; however, a few areas of beach are adjacent to the inlets. It is long and narrow and includes both the beach and the "frontal dune." A major portion of the foredune is covered with vegetation, consisting mainly of American beachgrass, sea-oats, coastal panicgrass, and bitter panicum.

The beaches are low-lying and are flooded daily by tidal action. The sand ranges from fine to very coarse in size but is chiefly fine. Shell fragment content ranges widely. The back portion of the beach (berm) is slightly higher and is less affected by normal tidal action. It also contains shell fragments and varies in sand sizes. The berm portion is quite variable and, in places, is practically nonexistent. The soft, fluffy, loose sand is susceptible to severe blowing, particularly in the broader areas. In some areas, this blowing supplies fine sand to the adjacent dunes. The beach is invariably void of vegetation.

Fig. 14

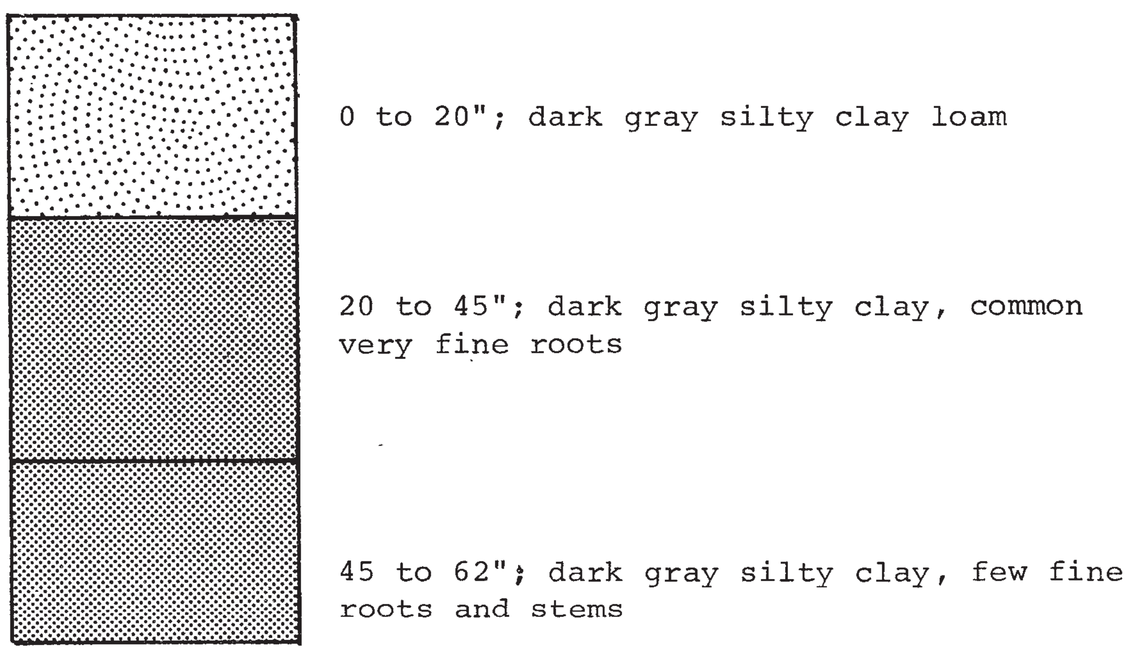
Beach and foredune in the southern portion of the Outer Banks. Where bare of vegetation, these soils are subject to severe blowing and wind erosion.

The foredune portion consists of a dune just landward and parallel to the beach. Its height ranges from about 3 to 20 feet. In some places it is absent or has been breached by tidal or wind action. Since the frontal dune serves as protection for the more landward areas during storm attack, some foredunes have been artifically constructed to function as such barriers.

Tidal flooding of the beaches is a severe limitation to all uses other than beach-related recreational activity. The foredune is subject to excessive erosion by wind and wave action unless vegetation can be established and maintained. In this survey area a line was not drawn between the beach and foredune because this area is changing constantly.

4) <u>Bohicket soils, low</u>

This mapping unit consists of very poorly drained, clayey, marsh soils. They occur in the southern part of the survey area where rivers and streams empty directly into the ocean. The Bohicket soils were formed in clayey sediments that were washed from the drainage areas of fresh water streams.



Soil Horizons: A ; C

Fig. 15
Soil profile drawing of Bohicket soils, low.

These soils are 1 to 3 feet above mean sea level and are flooded daily with sea waters. They are continuously wet, soft, and sticky. The vegetative cover is essentially a pure stand of smooth cordgrass.

Bohicket soils are limited for uses other than for wildlife, marine habitat, and esthetic purposes. Bohicket soils accumulate sulfides by reduction of sulfates from sea water. In a test sample from Brunswick County, the measured sulfide content was more than 1 percent. Upon drying, these acid sulfate soils will cause a sharp reduction in reaction (pH), thus, rendering the areas incapable of supporting vegetation.

5) Tidal flats

This mapping unit is on elongated-to-broad flats chiefly on the southern end of Ocracoke Island and throughout the Core Banks region. It separates areas almost void of vegetation from the vegetated Carteret marshes. The soil is sandy throughout and contains fragments of shells.

Fig. 16
Tidal flats are extensive on the northern part of Portsmouth Island. These areas have salt concentrations that are toxic to the growth of the more common vegetation on the Outer Banks.

Tidal flats receive periodic overwash waters from above normal tides. Consequently, salt content has accumulated in these units. In typical areas, measurements of more than 60 parts per thousand were common. The sparse vegetation consists of smooth cordgrass and saltwort.

Water moves through this soil readily; however, the seasonal high water table is at or near the surface. Tides of 2 to 4 feet above normal high tide are sufficient to flood most areas. In places, flooding becomes more frequent as sediments fill the inlets leading to this soil. These inlets are common where the beach and foredunes are either discontinuous or lacking.

6) Carteret soils, low

This mapping consists of very poorly drained, sandy, marsh soils. They occur from the South Carolina line to the Roanoke Sound but are more extensive in the southern part of the survey area. These Carteret soils have formed on the sound side of the barrier islands. They are flooded daily by ocean tides and are vegetated mainly with pure stands of smooth cordgrass.

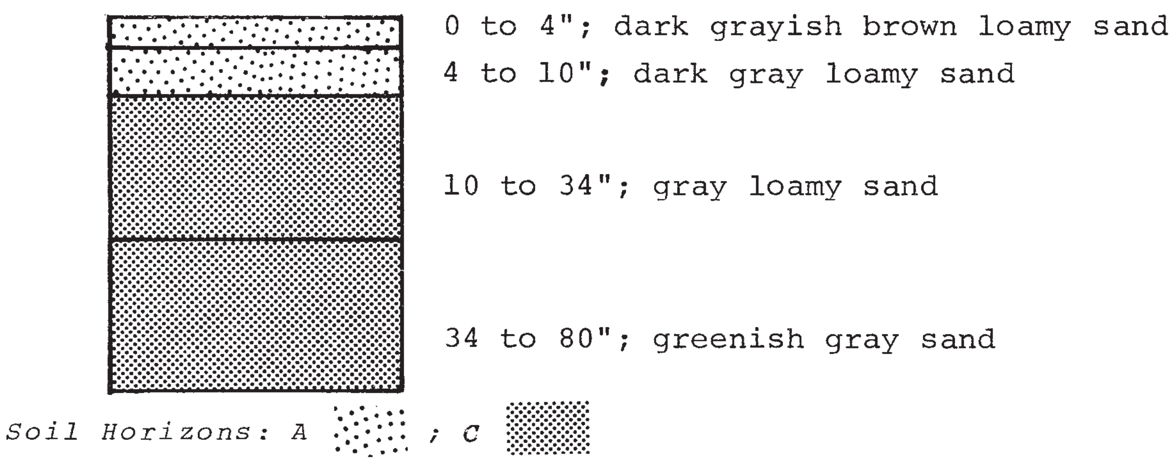


Fig. 17
Soil profile drawing of Carteret soils, low.

Salt contents that range from about 20 to 35 parts per thousand were measured in typical areas of this soil. Sulfur odor was also evident when the soil material was exposed to the air. Laboratory data of several samples showed a sulfur content of 0.01 percent or less in these sandy marsh soils.

Fig. 18
Low-lying Carteret soils are flooded daily by ocean tides. These areas of smooth cordgrass and other marsh species contribute to the productivity of the estuarine system.

In many places, small areas of this mapping unit are intermingled with areas of open water. The smooth cordgrass contributes substantially to the primary productivity of the estuarine system in relation to all other marsh species. This was the main reason for separating this mapping unit from the other Carteret units.

7) <u>Corolla fine sand</u>

The Corolla soils are on the broad, nearly level to gently sloping flats that lie behind the foredunes. These flats may extend to the forested area or even to the sounds where the banks are narrow. Also, they occupy smaller, irregularly-shaped troughs between areas of the Newhan soils. The soils have a thin surface layer that is very low in organic matter. They are moderately well-drained, sandy throughout, and generally contain an older buried surface layer within 80 inches of the surface. In some places, the soils contain a high percent of coarse sand and fragments of shells.

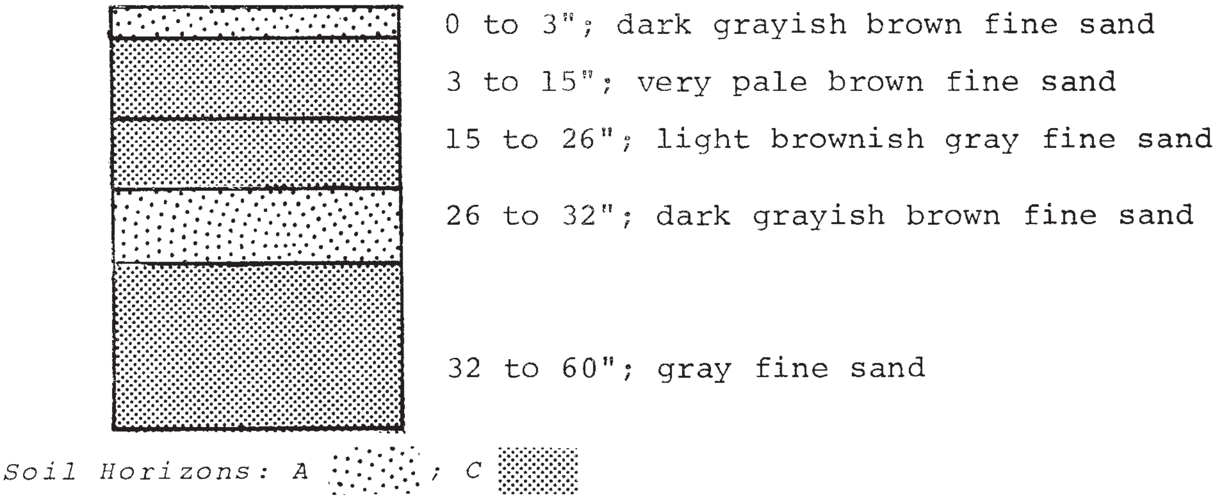


Fig. 19
Soil profile drawing of Corolla fine sand.

Water moves through the Corolla soils readily. Depth to the seasonal high water table fluctuates with seasonal changes. During the wetter seasons of the year, these soils may have water within 1½ feet of the surface. During the drier seasons of the year, the water table may be much lower; hence shallow-rooted plants may suffer from lack of moisture. A few of the

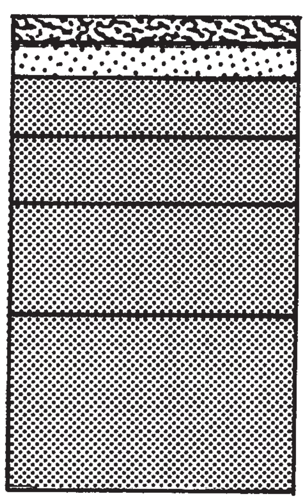
Fig. 20
Small pine and scrubby vegetation growing on Corolla soils near Pea Island.

lower-lying areas may have water standing on the surface for brief periods of time after high-intensity rains. Some areas adjacent to the sound may be flooded during stormy "southwesters." Areas of this soil that are behind breaches in the foredunes are flooded by salt water during storms.

Major plant species consist of saltmeadow cordgrass, bitter panicum, and silver-leaf croton in the areas receiving the higher amounts of salt spray. Areas less affected by the salt spray contain less salt-tolerant species such as largeleaf pennywort, seaside goldenrod, waxmyrtle, yaupon holly, northern bayberry, eastern baccharis, stunted live oak, loblolly pine, blueberry, wild olive, ragweed, seacoast bluestem, seashore elder, and sea rocket.

8) Corolla fine sand, forested

This mapping unit is on nearly level to gently sloping flats close to the sound and on narrow, gently sloping landscapes located between areas of the higher, forested Fripp soils. The soil characteristics are similar to the nonforested Corolla soils except for the following: a) this unit contains a higher percent of fine and medium sands, and b) the different soil layers are more pronounced, indicating slightly stronger soil development. These exceptions are particularly striking where this unit occurs near Buxton.



1" to 0; partly decomposed forest litter

0 to 3"; dark gray sand

3 to 11"; light brownish gray to pale brown fine sand

11 to 22"; pale brown to light yellowish brown sand

22 to 38"; very pale brown sand

38 to 60"; greenish gray sand

Organic Material . *Soil Horizons: A* ; *C*

Fig. 21
Soil profile drawing of Corolla fine sand, forested.

Fig. 22
Large water oaks in forested Corolla on a peninsula in northern Currituck County.

These soils are further from the ocean than nonforested Corolla soils. Thus, they are protected from salt spray and blowing sands. There is a greater variety of vegetation growing on these soils, and trees grow to a size that has commercial value. The major plant species include loblolly pine, live oak, persimmon, water oak, sweetgum, yaupon holly, Virginia creeper, and blueberry. In most places, loblolly pine is the dominant tree.

Water moves through the Corolla soils readily; however, during the wetter seasons of the year these soils may have water within 1½ feet of the surface. During the drier seasons of the year, the water table may be much lower, and shallow-rooted plants may suffer from lack of moisture. A few of the lower-lying areas may have water standing on the surface for brief periods after a high intensity rainfall.

Included in the mapping are small areas of Duckston soils that occupy the wetter depressions. Also included are small areas of Kureb soils that occupy the more sloping small knolls.

9) Corolla-Duckston complex

This mapping unit occurs on nearly level to slightly depressional areas that commonly lie just inland from the frontal dune. Where the land area is narrow, the unit may extend to the sound. This unit also occupies the wider, irregularly-shaped troughs between the higher-lying Newhan fine sand and Duneland mapping units. The two soils in this complex were mapped together because they occur in such small and intricate patterns that separation was not feasible at the scale used in mapping.

The Corolla soils are dominant. They are on the nearly level areas and the small hummocks. The soils characteristic of Corolla soils in this mapping unit are similar to those described for Corolla fine sand. During seasonal wet periods, the water table is within 1½ to 3 feet of the surface. The natural vegetation consists of sparse islands of saltmeadow cordgrass, northern bayberry, eveningprimrose, largeleaf pennywort, scrubby live oak, blueberry, wild olive, persimmon, ragweed, and Virginia creeper.

The Duckston soils are in the wetter, slightly lower depressional areas. Their soil characteristics are similar to those given in the Duckston fine sand mapping unit. The seasonal high water table is at or near the surface during wet periods.

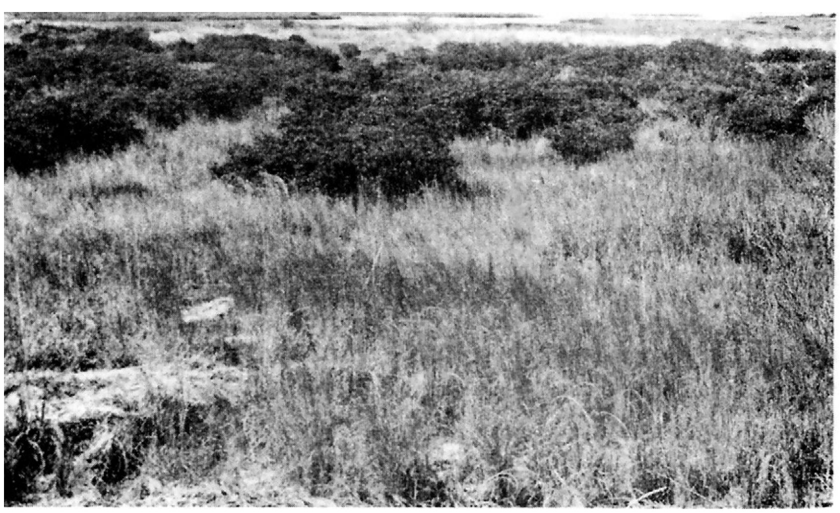


Fig. 23
Marsh grass growing on depressional areas of Duckston soils, adjacent to thickly vegetated Corolla soils.

Duckston soils are subject to occasional flooding for brief periods during high intensity rainfall or during high tides from the sound. The native vegetation consists of dense stands of saltmeadow cordgrass, waxmyrtle, and northern bayberry in areas affected by salt spray. Areas further from the influence of salt spray also include greenbrier, eastern baccharis, scattered black willow, blueberry, wild olive, and persimmon.

The soil characteristics and interpretations for each of the two soils in this complex are the same as those given for the individually mapped units (pages 33, 41). However, for most types of development, areas of the Corolla-Duckston complex would be judged slightly less desirable than individual areas of Corolla fine sand soils and more desirable than individual areas of Duckston fine sand soils.

10) <u>Dredge Spoil</u>

These areas are along the Intracoastal Waterway and are the result of dredging maintenance of the waterway. Most areas are composed primarily of sand and shells. Many have a "chocolate drop" or cone shape; others are somewhat flatter. They have been deposited on the surrounding soil which, for the most part, is marsh.

Most areas were not shaped and seeded after the dredging operation; thus, areas bare of vegetation or only sparsely covered with vegetation are common. A few of the older established areas are covered with trees and shrubs. These spoil areas range in height from 4 to 15 feet but most are less than 10 feet. The areas that are large enough to be of value as building sites or similar uses generally are filled and leveled to 6 to 8 feet above the original ground level.

These areas generally are droughty because of the sandy texture and the amount of shell fragments. They have poor filtering capacity for septic tank effluent, and there is a hazard of pollution in the underlying ground water and marshes.

A good choice of plants for stabilizing this soil is Coastal bermudagrass since it can be established and maintained with conventional methods. At any rate the acidity of these soils should

Fig. 24
Spoil piles along the Intracoastal Waterway in the southern portion of the Outer Banks. Most of these soils have severe limitations for development.

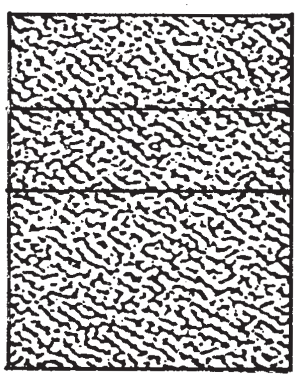
be checked by laboratory testing methods and lime should be added according to the results of the tests. In areas where there is blowing sand, American beachgrass or bitter panicum are preferred over Coastal bermudagrass for stabilization.

If this soil occurs along a channel with brackish water, smooth cordgrass can be used to stabilize the toe of the bank. Coastal bermudagrass (assuming it is not directly exposed to salt spray from the ocean) can also be used on the upper part of the slope.

11) Hobonny soils

This mapping unit consists of deep organic marsh soils that occur in the vicinity of Roanoke Island and Nags Head Woods. The organic layer is generally more than 51 inches in total thickness. It is highly decomposed (sapric) except for the surface layer, which consists of a dense mat of live and partially decayed black needlerush roots. Sandy soil material underlies the organic layer.

Hobonny soils are continually wet, soft, and viscous. They are commonly less than 3 feet above mean sea level and are flushed with both fresh water and brackish or slightly saline water during periods of high winds. In the typical mapping unit, measured salt content ranges from about 7 to 10 parts per thousand. When exposed to the air, the organic material gives off a strong sulfur odor.



0 to 16"; dense root mat and decaying fibers

16 to 30"; very dark grayish brown sapric material

30 to 60"; dark greenish gray sapric material

Organic Material

Fig. 25
Soil profile drawing of Hobonny soils.

Fig. 26
Black needlerush on wet and mucky Hobonny soils. These marshes provide sources of energy for marine life.

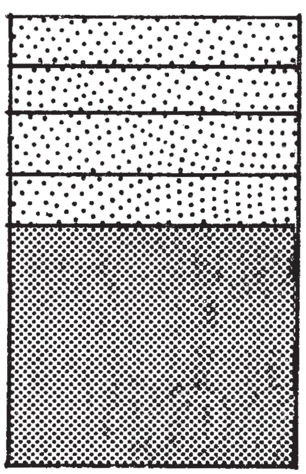
The dominant vegetation is black needlerush. However, the slightly elevated fringes adjacent to the sound support eastern baccharis, giant cordgrass, saltgrass, saltmeadow cordgrass, cattails, bulrush, and scattered clumps of stunted loblolly pine and live oaks.

These soils are limited for most uses other than wildlife habitat. They serve as an energy source for marine life in the surrounding sounds and estuaries.

12) <u>Duckston fine sand</u>

This mapping unit consists of poorly drained soils. They occupy the nearly level to slightly depressional flats that extend inland from the frontal dunes. Also, they are in the small, irregularly-shaped depressions between the Corolla and Newhan soils. The soils are sandy throughout. They contain a high percent of coarse sand, few to many fragments of shells, and a buried surface layer within 80 inches of the surface.

Native vegetation is dependent on proximity to the ocean. Areas affected by salt spray are dominantly vegetated by dense stands of saltmeadow cordgrass and scattered waxmyrtle. As the distance from the ocean spray increases, less salt-tolerant grasses and sedges occur along with greenbrier, eastern baccharis, black willow, redbay, three-square, scattered cattails, blueberry, wild olive, and Virginia creeper.



0 to 3"; very dark grayish brown fine sand
3 to 8"; dark grayish brown fine sand
8 to 13"; light brownish gray sand
13 to 17"; dark gray sand
17 to 60"; gray sand

Soil Horizons: A ; C

Fig. 27
Soil profile drawing of Duckston fine sand.

Fig. 28
Poorly drained Duckston soils in low areas. Beach cottages in the background are typical for many areas on the Outer Banks.

Water moves readily through this sandy soil. Depth to the seasonal high water table is variable. During wet seasons, water is at or near the surface, as compared to depths of 2 to 5 feet when rainfall is limited.

A few of the lower-lying areas may have water standing on the surface after high-intensity rains. Areas of this soil that are behind breaches in the foredunes are flooded by salt water during storms. In addition, areas adjacent to the sound are occasionally flooded by high wind tides.

13) <u>Duckston fine sand, forested</u>

This mapping unit is made up of the poorly drained forested soils. The soils occur on flats along the edge of the freshwater marshes in Currituck and Dare Counties. They are in the smaller depressions between the higher-lying areas of the forested Fripp and Corolla soils.

The Duckston soils have been formed in sandy marine sediments. Their surface layer contains a moderate amount of organic matter.

The major plant species include loblolly pine, water oak, sweetgum, redbay, greenbrier, red maple, and blackgum.

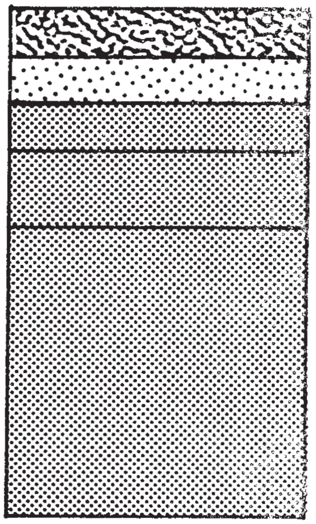


Fig. 29
Soil profile drawing of Duckston fine sand, forested.

Fig. 30
Duckston fine sand, forested, in background of a recently formed inlet.

Water moves through this soil readily; however, during the wetter seasons, water is at or near the surface. During the drier seasons, the water table is much lower. A few of the lower-lying areas may have water standing on the surface after high intensity rains. Also, areas adjacent to the sound may be occasionally flooded by wind tides.

14) Duneland

This mapping unit is made up of large areas of blowing sands. The surface has less than 15 percent vegetative cover. The dunes range in height from a few feet to over 100 feet in elevation. The most prominent of these is Jockey's Ridge. The water table is at great depths, and these soils are extremely droughty.

Fig. 31
Jockey's Ridge - the largest dune on the Outer Banks. These bare land features are subject to severe blowing and wind erosion.

Valleys between adjacent dunes have a high probability of being filled by the blowing sands. Most of these areas are difficult to revegetate because of the rapidly shifting sand.

15) Fripp fine sand

The Fripp soils are well drained to excessively drained. They are on the sandy ridges and on side slopes along portions of the sound side of the barrier islands. The rolling to steep ridges appear to be a series of older dunes that have been vegetated for more than 30 years. Many of the ridges are separated by small, narrow troughs that contain either ponded water, shallow organic soils, or poorly drained mineral soils. The differences in elevation between the troughs and the tops of the ridges range from 15 to 75 feet or more.

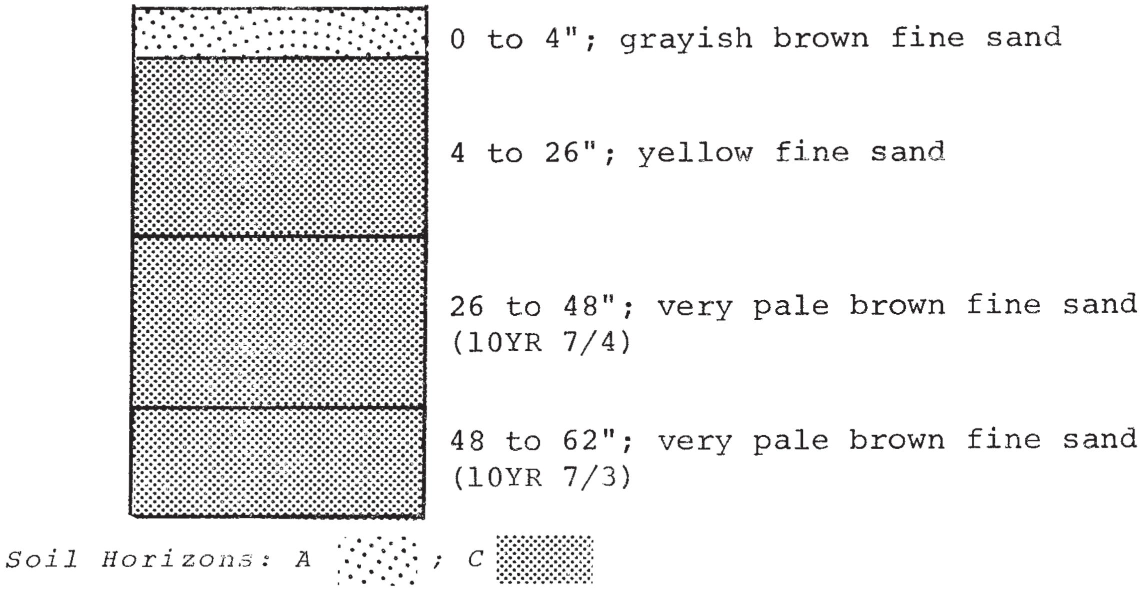


Fig. 32
Soil profile drawing of Fripp fine sand.

Water moves readily through the Fripp soils, and the seasonal high water table is usually several feet below the surface. Both soil fertility and available water capacity are rated low.

Fig. 33
Maritime forest - large pine and hardwoods grow on Fripp soils in the Nags Head Woods.

The dominant tree species are loblolly pine and live oak. Many of these trees have grown to sizes that have commercial value. Other species include American beech, cherrybark oak, hickory, flowering dogwood, American holly, cabbage palmetto, devilwood, yaupon holly, black cherry, eastern redcedar, blackgum, and muscadine grape.

16) <u>Levy soils</u>

This mapping unit consists of poorly-drained mineral soils on the isolated islands in Currituck Sound. The soils are formed in clayey marine sediments. They are continuously saturated, and footing is unstable where the root mat is thin. The surrounding water is fresh. Measured salt content was less than three parts per thousand in typical areas of this soil. These soils occur at elevations that range up to about 2 feet above sea level. They are flooded frequently by wind tides.

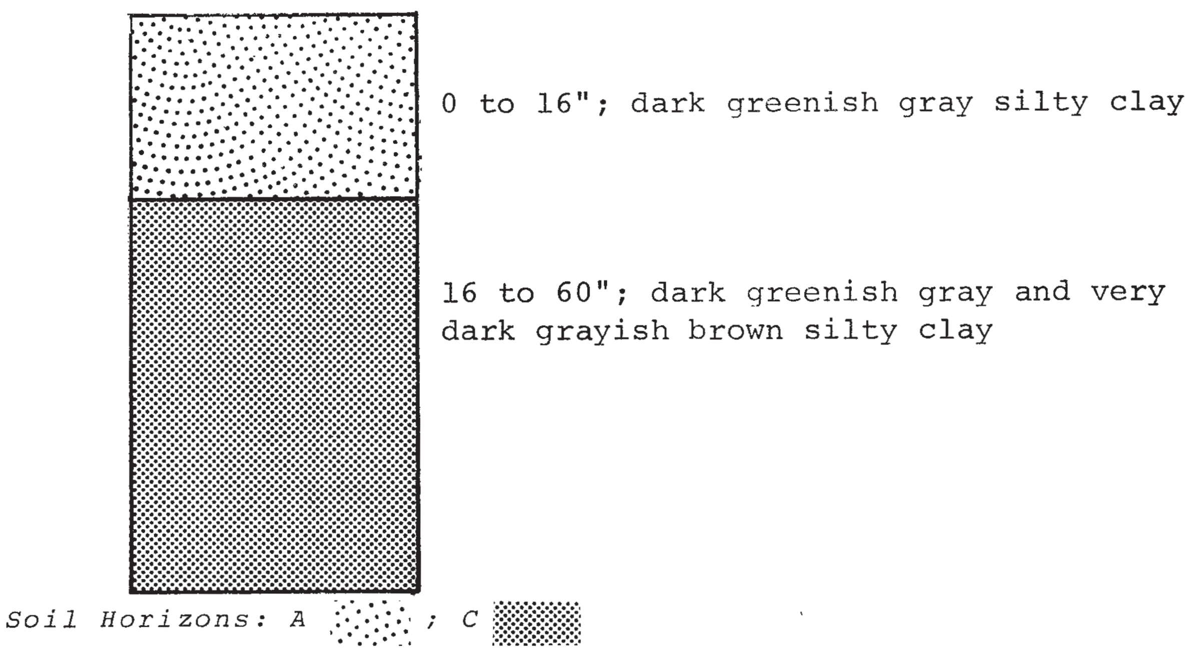


Fig. 34
Soil profile drawing of Levy soils.

The native vegetation includes saltmeadow cordgrass, black needlerush, saltgrass, eastern baccharis, waxmyrtle, and a variety of other weeds and grasses.

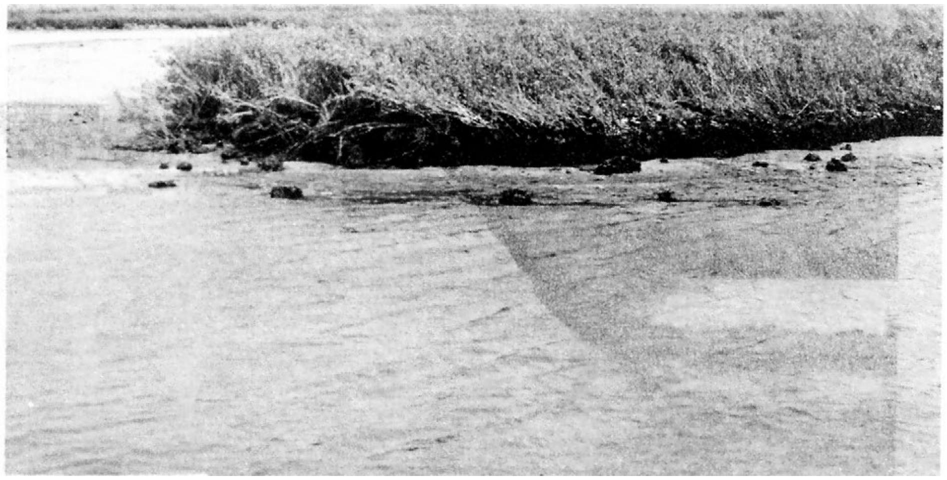


Fig. 35
Levy soils occur on islands and peninsulas in the sound waters. They have severe soil limitations for land uses except for wildlife habitat.

These soils are limited for uses other than wildlife and marine life habitat or esthetic purposes. They have a low supporting capacity for structures.

17) Madeland

This mapping unit is adjacent to the water on the sound side of the islands. The soil material has been pumped or dredged during the construction of canals and has been deposited between the canals to be used as building sites. Essentially, all of the material has been deposited over marsh. The average thickness of the soil material ranges from 3 to 6 feet. The water table fluctuates with changes in tide level; however, most areas have a water table 2 to 4 feet below the surface during high tide. The material is mainly sandy, but some areas contain up to 10 percent shells.

Water moves through the material readily and most areas are droughty. They generally have poor filtering capacity for septic tank effluent, and the potential hazard of ground water pollution is high.

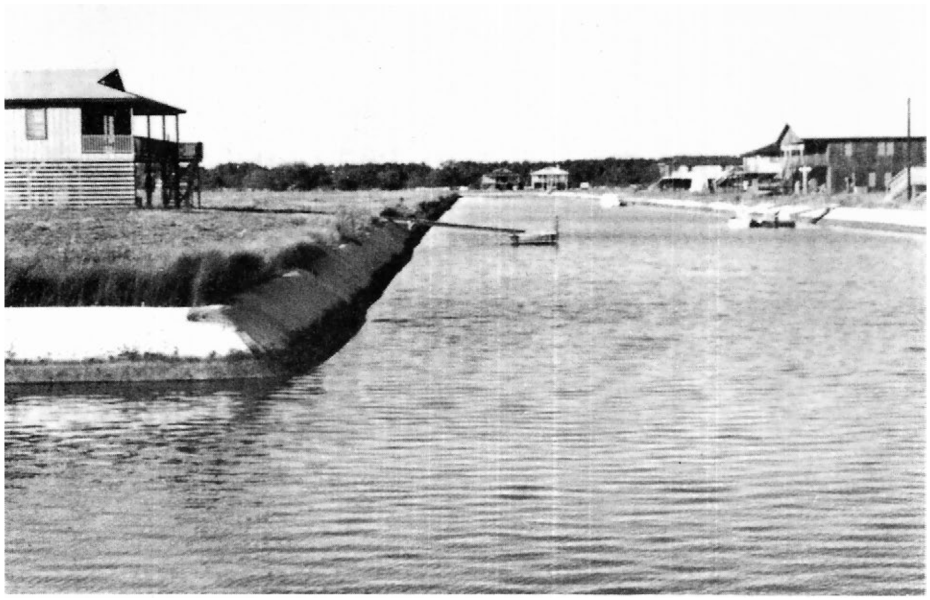


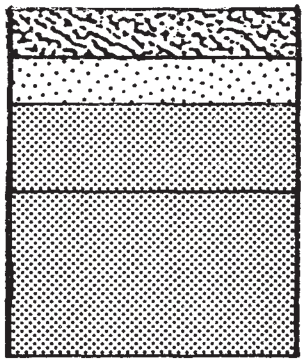
Fig. 36
Residential development on Madeland. These soils were built-up from materials excavated from canals and channels.

These areas are commonly used for homesites because of the access to the water. Landscaping of these areas usually requires technical assistance to help solve the associated problems.

These areas usually revegetate naturally with smooth cordgrass, largeleaf pennywort, and other grasses and sedges, if landowners have not attempted to establish lawns or other kinds of vegetation.

18) Carteret soils, high

This mapping unit consists of irregularly flooded salt marshes. They have been formed in sandy marine sediments, and the soils have variable amounts of shells. The largest areas of this soil start near Bogue Inlet and extend north to the Roanoke Sound. Most areas lie about 1 to 1½ feet above sea level. They flood at least monthly and in some areas may flood weekly with storm or wind tides. Salt contents that range from about 15 to 30 parts per thousand were measured in typical areas of this unit. The surface layer commonly contains a thick root mat. Where the soil material is exposed to the air, it gives off a sulfur odor.



5" to 0; black live and dead roots

0 to 5"; dark gray loamy sand

5 to 24"; gray sand

24 to 55"; dark gray sand

Organic Material . *Soil Horizons: A* ; *C*

Fig. 37
Soil profile drawing of Carteret soils, high.

Fig. 38
Black needlerush commonly occurs on soils such as Carteret soils, high. These soils are occasionally flooded by wind-driven tides.

The dominant vegetation is black needlerush; but some areas have scattered patches of saltmeadow cordgrass, bulrush, sea oxeye, marshelder, saltgrass, eastern baccharis, and three-square.

These areas are significant in the life cycles of some forms of marine life. They have a low support capacity for structures.

19) Carteret soils

These soils are on the sound side of the barrier islands. They were formed in sandy marine sediments with various amounts of shells. The elevation ranges from nearly sea level to 1 or 2 feet above sea level. These soils are flooded by saltwater during storm tides, but they are subsequently flushed by rain water. In typical mapping units, measured salt contents range from 10 to 25 parts per thousand.

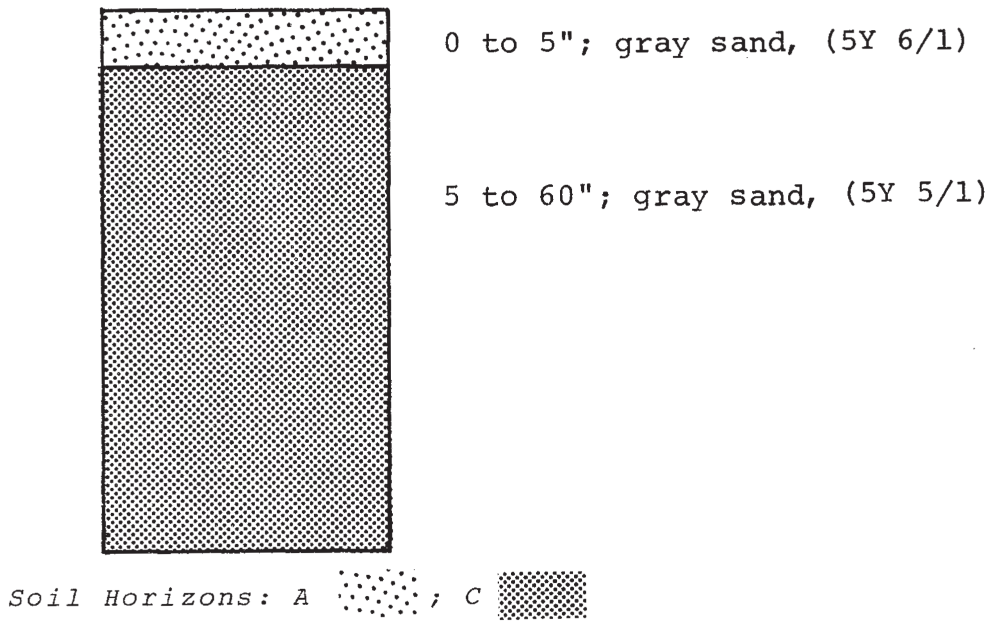


Fig. 39
Soil profile drawing of Carteret soils.

These areas are significant for wildlife habitat, particularly as winter feeding grounds for many migratory birds.

The native vegetation consists of almost pure stands of salt-meadow cordgrass.

20) Currituck soils

This mapping unit consists of shallow organic marsh soils. They are located in two principal areas. The primary area extends from the vicinity of Collington Island in Dare County north to the Virginia line. They also occur in depressional areas between the forested dunes near Buxton. These soils occur on the sound side of the barrier islands, with elevations at or slightly above sea level. They are wet and have a seasonal high water table near their surface throughout most of the year.

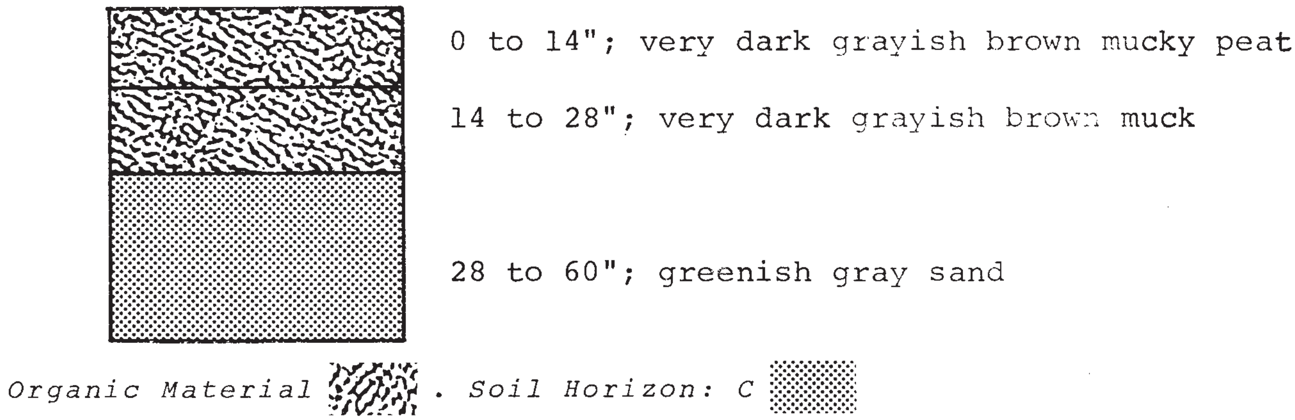


Fig. 40
Soil profile drawing of Carteret soils.

Fig.41
Large areas of marsh occur on Currituck soils north of Collington Island.

The organic layers are typically 18 to 36 inches thick, and they are underlain by sandy material. Areas of these soils adjacent to the sounds are flooded frequently by storm or wind tides. Measured salt content ranges from 0 to 4 parts per thousand in typical mapping units. The dominant vegetation is black needlerush. Other less extensive species include sawgrass, cattails, giant cordgrass, eastern baccharis, waxmyrtle, and black willow. Sawgrass is the predominant vegetation in areas between forested dunes.

These soils are ecologically significant as habitats for certain furbearing animals as well as for some migrating waterfowl.

21) Newhan fine sand

This mapping unit consists of well-drained to excessively drained sandy soils. The soils are droughty, and the natural fertility is low. They have a thin surface layer which contains a low amount of organic matter and plant fibers. The soils have formed in stratified sandy deposits that range from fine to coarse sand with varying amounts of shells.

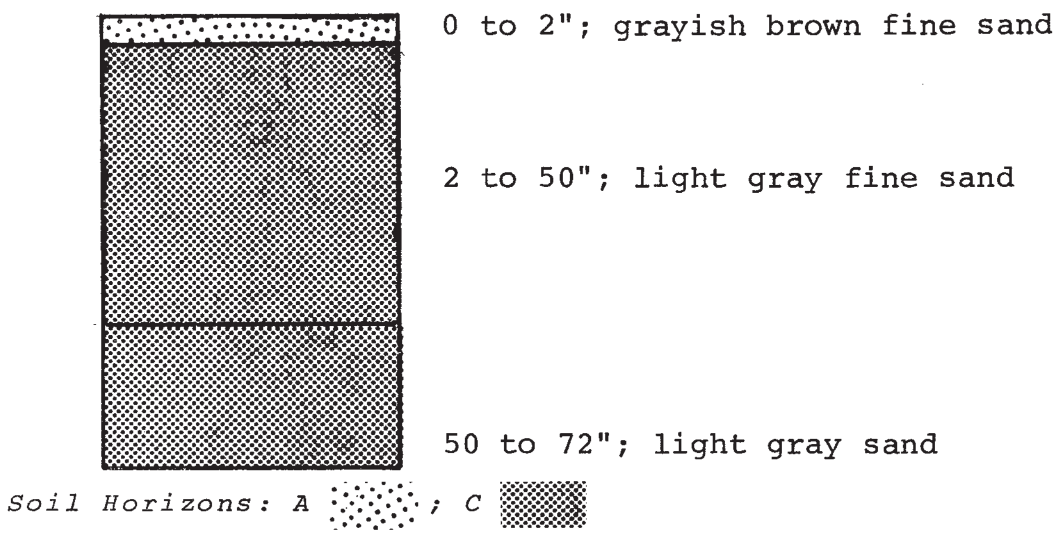


Fig. 42
Soil profile drawing of Newhan fine sand.

These soils usually occur in long ridges on dunes that parallel the ocean. Elevations range from 5 to 60 feet or more. Slopes vary from nearly level and smooth to steep and complex.

Typically, each mapping unit has more than 50 percent plant cover. The principal plants include American beachgrass, seashore elder, searocket, sea-oats, smooth cordgrass, bitter panicum, bluestem, and other species adapted to the effects of salt spray, blowing sand, and droughty soil conditions.

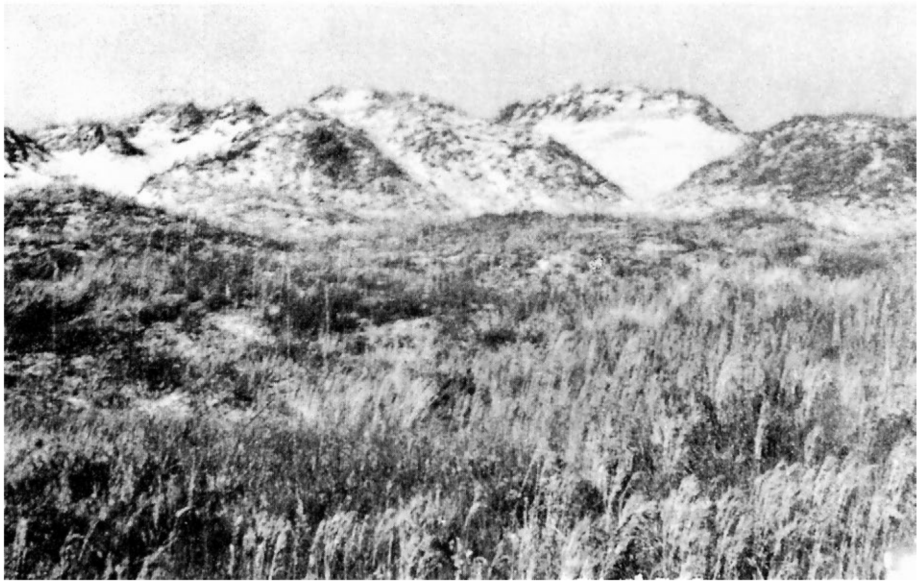


Fig. 43
These long ridges of Newhan fine sand are stabilized with grasses and scattered shrubs. A forested Corolla area is shown in the background.

The percolation of water is very rapid in the Newhan soils. Areas of this soil that are void of vegetation are subject to severe blowing. In order to stabilize these soils and prevent bare spots from blowing, a vegetative cover must be established and maintained. American beachgrass and bitter panicgrass are suitable for this purpose. After grasses have been established, shrubs can be planted in areas protected from salt spray. These species include waxmyrtle, northern bayberry, yaupon holly, and flameleaf sumac. These shrubs will provide a more permanent cover than the grasses, as well as an environment within which other native plants can become established.

22) Newhan-Corolla complex

This mapping unit consists of two soils, the dominant Newhan soils and the minor Corolla soils. They occur in such an intricate pattern on the landscape that it was not feasible to separate them at the scale used in mapping. In many places, this unit actually occupies the transitional zone between the higher-lying dunes to the east and the broad flats to the west. It consists of low dunes with short, complex slopes and the nearly level, intervening basins that separate the dunes.

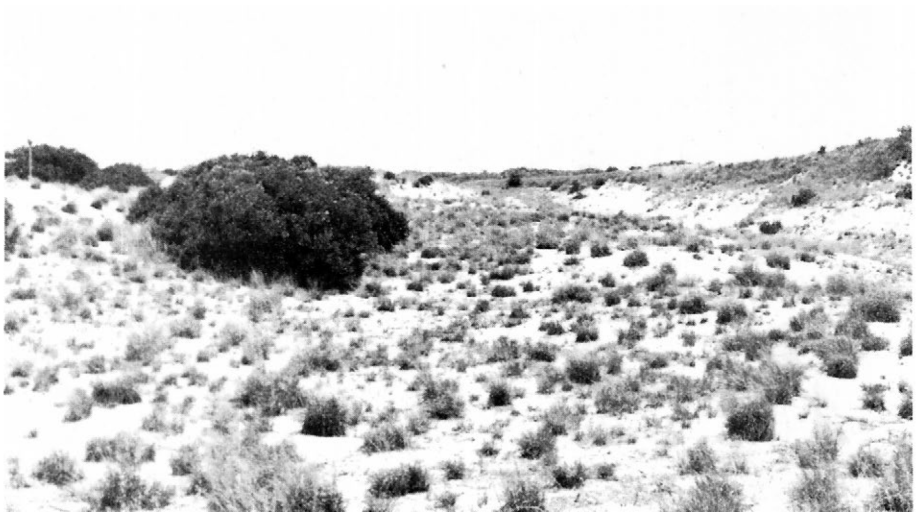


Fig. 44
Sparcely vegetated Corolla soils interspersed between higher-lying dunes and Newhan soils.

The Newhan soils are on the low dunes. They are well-drained to excessively drained, droughty, and have low natural fertility. They have a thin surface layer that is low in organic matter content and plant fibers. The soils have formed in stratified sandy deposits that contain mostly coarse sand and varying amounts of shell fragments. The water table is more than 7 feet below the surface. Vegetation common to the Newhan soils includes American beachgrass, seacoast bluestem, coastal panicgrass, bitter panicum, largeleaf pennywort, and ragweed.

The Corolla soils occupy the irregularly-shaped basins. They are moderately well-drained and sandy throughout and generally contain an older buried surface layer within 80 inches of the surface. The sandy material contains a high percent of coarse sand, along with varying amounts of shells or fragments of shells. During the winter, the Corolla soils typically have water within 15 to 20 inches of their surface. However, small areas where the seasonal high water table is at or near the surface are included in the mapping units. The common vegetation includes saltmeadow cordgrass, live oak, waxmyrtle, seashore elder, searocket, eveningprimrose, and largeleaf pennywort. The soils that lack sufficient vegetative cover are subject to soil blowing. To stabilize and prevent the soils from blowing, a vegetative cover must be established and maintained. American beachgrass and bitter panicum are suitable for this purpose. After stabilization has been accomplished, shrubs can be planted in areas protected from salt spray. Suitable species are waxmyrtle, northern bayberry, yaupon holly, ragweed, flameleaf sumac, and seacoast bluestem. The shrubs will provide not only a more permanent cover than the grass but also an environment within which other native plants can become established.

23) Duneland-Newhan complex

This mapping unit is in the immediate area of the dunes that parallels the ocean. A major portion of the unit is essentially bare of vegetative cover and is called Duneland. The minor Newhan soils are vegetated, but plant density is variable. Because of their intricate pattern of occurrence on the landscape, it was not feasible to separate these two soil conditions at the scale used in mapping. The soils are sandy and droughty, and water moves through them readily. Slopes are variable. They range from 2 to 30 percent or more, but as a rule, short complex slopes are more common. The water table is several feet below the surface.

Fig. 45
Bare dunes are subject to blowing. Fencing and silt screens in the background are typical structures used to control wind erosion.

Duneland occupies more than half of the mapping unit. It consists of areas of blowing sands with less than 15 percent vegetative cover. The sand material is composed of stratified layers of mostly fine and medium sand.

The minor occurring Newhan soils have more than half of their surface covered with vegetation. Their soil properties are the same as described in units 21 and 22.

The major limiting factor of the Duneland-Newhan complex that effects development and recreational uses is the blowing sand. Structures and plants on these areas are subject to either being undermined or covered by the sand. The potential for blowing sand on these areas is greater than that on areas mapped as Newhan fine sand, unit 21, but less than that for Duneland unit 14. Areas of Duneland-Newhan soils should be stabilized before development for homesites and recreational areas is considered. Once these areas are stabilized, the soil characteristics and interpretations for use would be the same as those given for the Newhan soils.

Only the most drought-tolerant plants should be used to stabilize these soil areas. American beachgrass and bitter panicum are suited for this purpose. After stabilization has been accomplished, shrubs can be planted in areas protected from salt spray. The best adapted species are waxmyrtle, northern bayberry, yaupon holly, and flameleaf sumac. The shrubs will provide a more permanent cover than the grasses as well as an environment within which other native plants can become established.

24) <u>Newhan-Urban land complex</u>

This mapping unit consists of areas of Newhan soils and urban land that are too intricately mixed to be separated at the scale used in mapping. They occupy developed areas such as Nags Head.

Newhan soils occupy more than half of the mapping unit. Their soil properties and interpretations are similar to those given for Newhan fine sand, unit 21.

The urban land portion of this mapping unit includes the area covered with buildings, driveways, streets, and parking lots. In these areas, the surface is covered with impervious material. Slope is generally modified to fit the site needs. The extent of site modification is variable. Many areas have had little disturbance while other areas have been cut, filled, or both. The urban land part of this mapping unit ranges from 15 to 50 percent, but typically covers about 20 percent of the land area.

25) Wando fine sand

The Wando soils are located mainly in the southern part of the Outer Banks. They are on the higher ridges and flats on the sound side of the barrier islands, commonly too far from the ocean to receive large amounts of salt spray. The soils are sandy and excessively drained. The seasonal high water table depth is commonly greater than 5 feet. Runoff is slow. Infiltration and permeability range from rapid to very rapid.

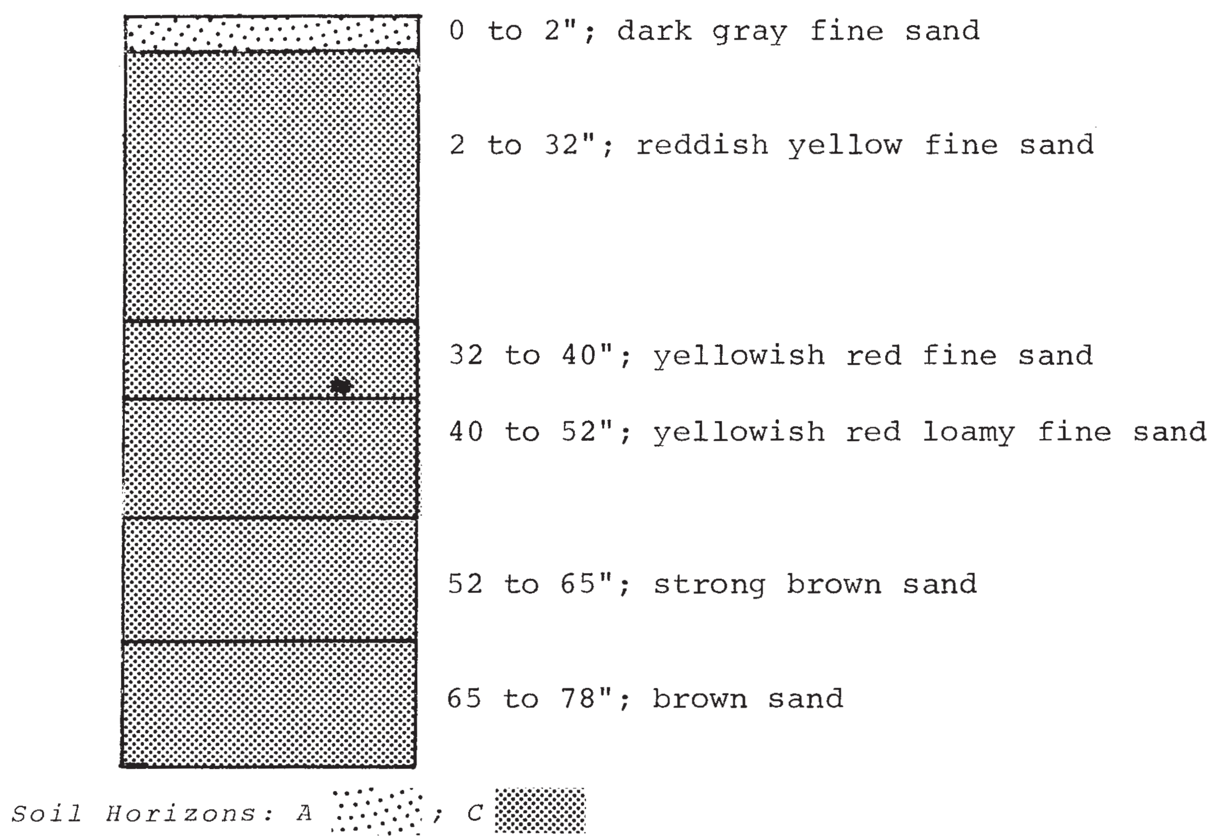


Fig. 46
Soil profile drawing of Wando fine sand.

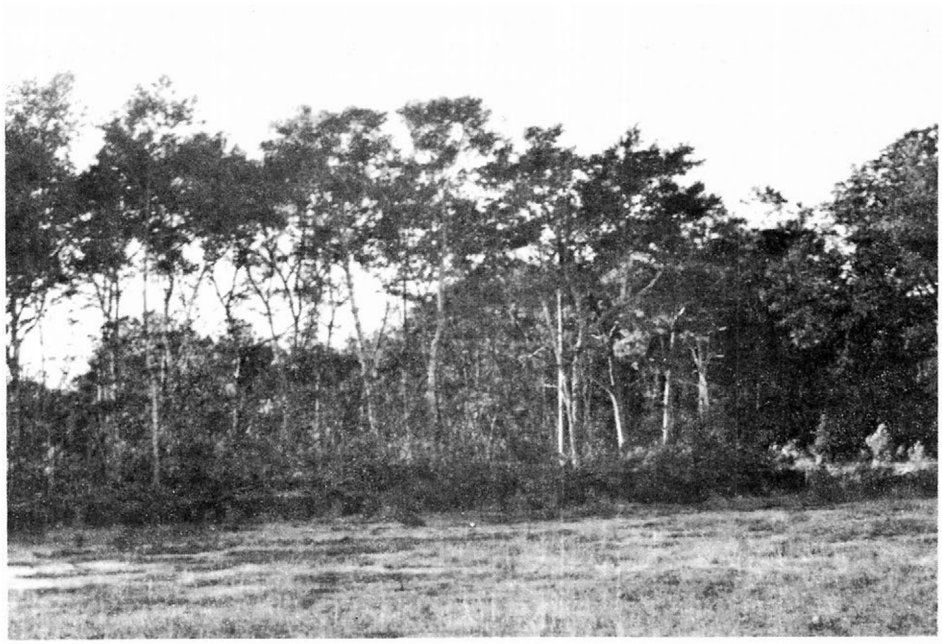


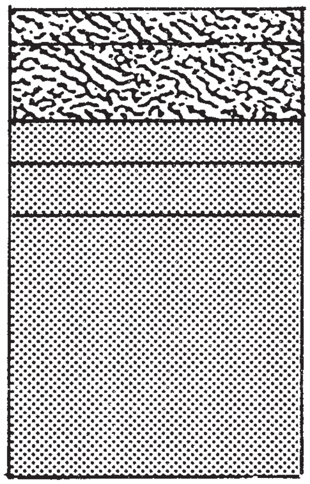
Fig. 47
This area of wooded Wando fine sand in Brunswick County has been cleared for development.

The native vegetation is loblolly pine, live oak, American holly, flowering dogwood, and hickory.

Part of this mapping unit has been cleared and is being used for truck crops. Blowing sands can be a hazard to these crops.

26) <u>Conaby soils</u>

The Conaby soils are in the troughs and depressions between the forested dunes. The areas are generally elongated and are parallel to the higher forested dunes. These soils have a seasonal high water table at or near the surface throughout most of the year. The surface layer is commonly 8 to 16 inches thick but may be as thick as 30 inches. The organic layer is highly decomposed and underlain by sand. In some areas these soils have a slight sulfur odor when exposed to air.



0 to 3"; black muck

3 to 14"; very dark gray muck

14 to 18"; grayish brown sand

18 to 23"; dark yellowish brown sand

23 to 60"; gray sand

Organic Material . *Soil Horizon:C*

Fig. 48
Soil profile drawing of Conaby soils.

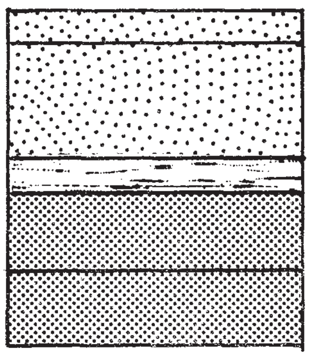
The dominant vegetation consists of baldcypress, sweetgum, red maple, waxmyrtle, redbay, greenbrier, and blackgum.

Fig. 49
Ponded water on a Conaby soil between ridges and dunes in the Nags Head Woods.

Conaby soils are very poorly suited for development because of the seasonal high water table and organic surface layers. These areas are ecologically significant as habitats for certain furbearing animals and as nesting grounds for some waterfowl species.

27) Echaw fine sand

The nearly level to gently sloping Echaw soils are on low ridges and mainly on islands such as Harkers Island. They are sandy throughout and have a seasonal high water table within 2½ to 5 feet of the surface. The soils have weakly cemented hardpan layers within 30 to 50 inches of the surface that cause water to perch above this layer for short periods following rainy spells. Water moves through the Echaw soils readily and they are droughty during dry periods.



Soil Horizons: A ; B ; C

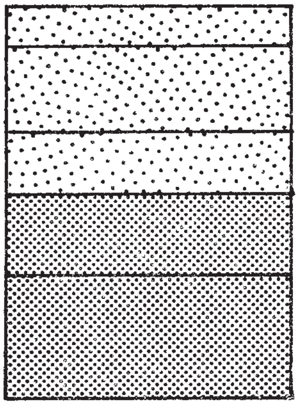
Fig. 50
Soil profile drawing of Echaw fine sand.

Fig.51
Live oak and scrubby vegetation sculptured from salt spray in Brunswick County.

The native vegetation is live oak, waxmyrtle, loblolly pine, and greenbrier.

28) Kureb fine sand

The nearly level to gently sloping Kureb soils occur on peninsulas between the Intracoastal Waterway and the dunes. They are sandy throughout and are excessively drained.



0 to 4"; very dark gray fine sand

4 to 20"; light brownish gray fine sand

20 to 28"; light yellowish brown and dark reddish brown fine sand

28 to 40"; light yellowish brown fine sand

40 to 62"; very pale brown fine sand

Soil Horizons: A ; C

Fig. 52
Soil profile drawing of Kureb fine sand.

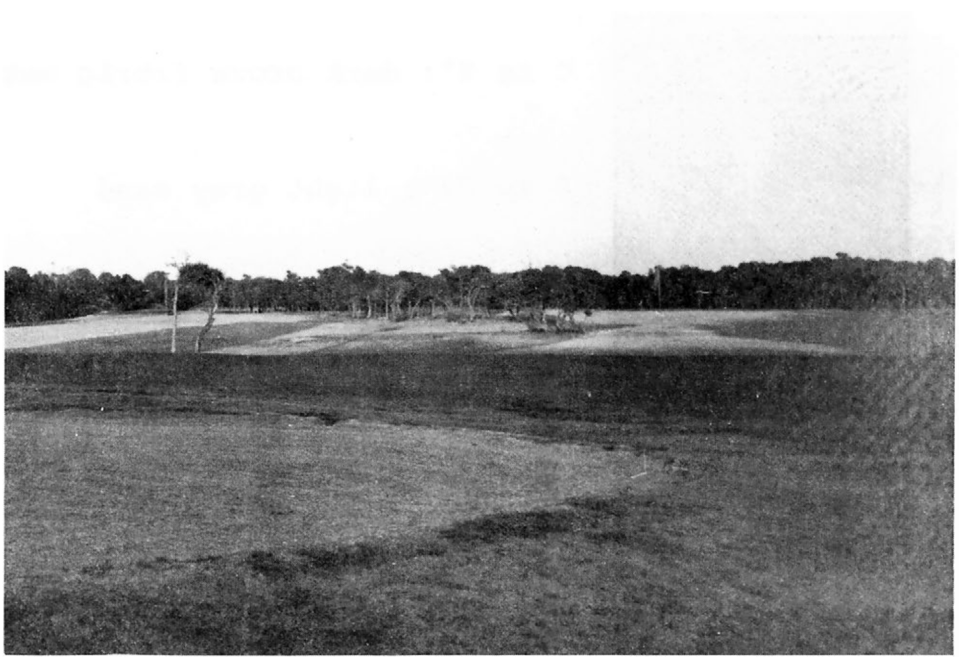


Fig. 53
A golf course has been developed on this Kureb sand in Brunswick County. Wooded Fripp is shown in the background.

Water moves through these soils rapidly, and available water capacity is very low. The seasonal high water table is below five feet. The soils are acid throughout.

In some places, vegetation on Kureb soils is sparce. The native vegetation is turkey oak and blackjack oak with sparse areas of live oak and longleaf pine. A few areas near the dunes may receive salt spray occasionally.

29) <u>Currituck soils, high</u>

This mapping unit occupies the low flats and slight depressions along the sound in Currituck County. The soils have a mucky surface layer that ranges up to about 10 inches thick. This is underlain by wet, grayish sand. The seasonal high water table is at or near the surface throughout the year. Irregular flooding is caused by the wind tides from the sound. In typical areas of this soil, measured salt content was generally less than 4 parts per thousand.

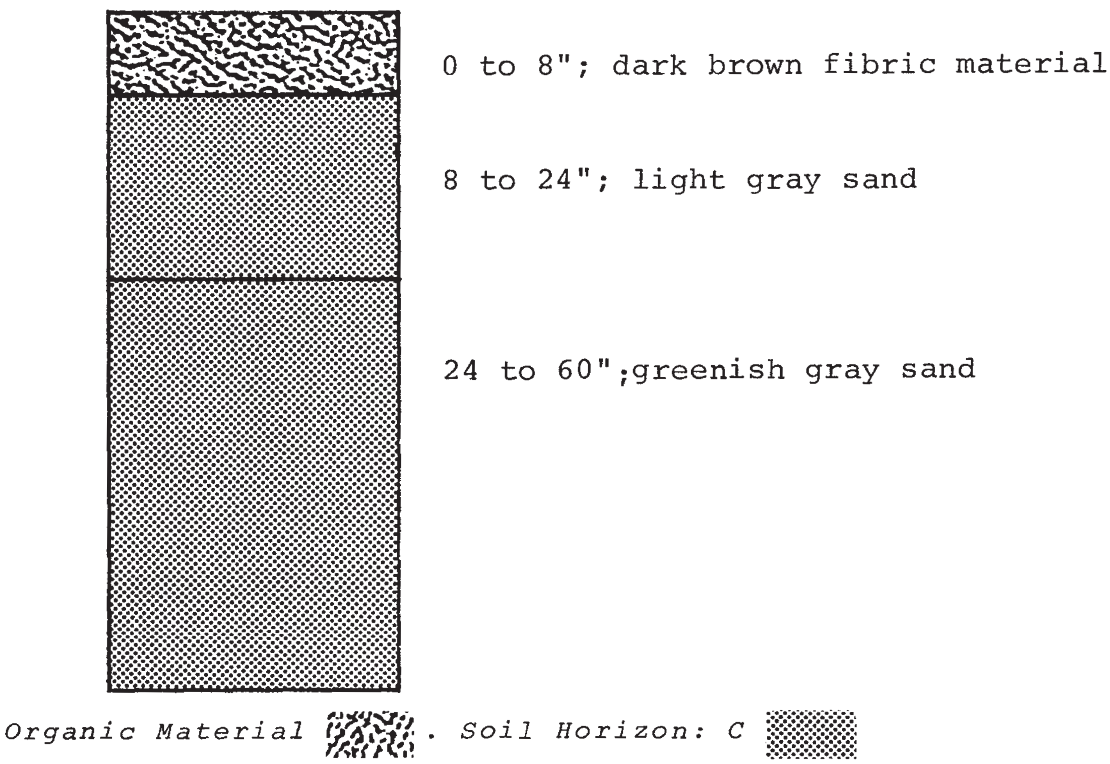


Fig. 54
Soil profile drawing of Currituck soils, high.

Fig. 55
Marsh grass growing on irregularly-flooded soils adjoining brackish waters in Currituck County.

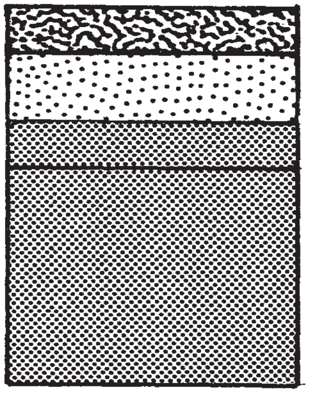
The dominant vegetation consists of saltmeadow cordgrass, saltgrass, three-square, bulrush, and cattails with scattered areas of waxmyrtle and eastern baccharis.

Currituck soils have a very severe rating for development because of the seasonal high water table and high probability of flooding. These soils are used for grazing cattle during summer months and are a habitat for certain furbearing animals and migratory waterfowl.

31) <u>Bohicket soils, high</u>

This mapping unit consists of irregularly flooded, clayey marsh soils. They occur in the southern part of the survey area where the rivers and streams empty directly into the ocean. In some places, they are adjacent to the Bohicket soils, low, that flood daily. In other places, they are the dominant marsh soil and are adjacent to the higher-lying sandy soils.

These soils are 2 to 5 feet above mean sea level. They are continuously wet, soft, and viscous. The vegetative cover is predominantly black needlerush or mixed black needlerush and smooth cordgrass.



10 to 0"; roots and partially decomposed organic matter

0 to 15"; very dark gray silty clay

15 to 25"; dark gray silty clay

25 to 62"; dark gray silty clay (with lenses of loamy sand)

Organic Material . *Soil Horizons: A* ; *C*

Fig. 56
Soil profile drawing of Bohicket soils, high

Fig. 57
Areas of mixed black needlerush and smooth cordgrass occur on higher-lying Bohicket soils.

These soils are limited for uses other than wildlife, marine life, and esthetic purposes. They accumulate sulfides by reduction of sulfates from sea water. In a test sample from Brunswick County, the measured sulfide content was more than one percent. Upon drying, these acid sulfate soils will cause a sharp reduction in reaction (pH), thus, rendering the area incapable of supporting vegetation.

Interpretative Table for Soils of the Outer Banks

Introduction - All soils have features such as slope, position on the landscape, depth to seasonal high water table, permeability, textural characteristics (sandy or clayey), surface covering, and type of vegetation. A combination of all of these observations and measurements of soil features provides the basis for predicting their behavior and effects for a specific land use (see Tables 3, 4, and 5). Terms used in these tables are defined in the following paragraphs.

Depth to the seasonal high water table (SHWT) - is the vertical distance from the surface of the soil to the highest level that groundwater (at atmospheric pressure) reaches in the soil in most years. Surface ponding is common in those soils that begin with zero inches in Table 3. It was not practical to provide measurement for water table depths that extent below 6 feet.

Flooding - refers to water that stands or flows on the surface as the result of ocean or sound overflow or seep ponding. Terms for the frequency of flooding for a natural unprotected soil are as follows:

None------ no reasonable possibility of flooding.
Rare------ flooding unlikely but possible under abnormal conditions.
Common---- flooding likely under normal conditions.
Frequent-- more often than once in 2 years. This frequency for the marsh soils ranges from daily to monthly. Regular flooding results from lunar tide overwash. Irregular flooding is caused by overwash of sound and ocean waters as strong westerly or easterly winds from storms push these bodies of water over grounds above the mean high water mark. Frequency of flooding varies with fluctuating weather conditions.

Estimates of permeability - are for soil material in its natural state and are based on field observations and on limited laboratory data.

Erosion potential - indicates the probability that disturbed land areas or exposed areas will erode when subjected to strong wind and water. Wind erosion on the Outer Banks is a serious problem in areas not protected with a good vegetative cover. Shifting, blowing sand covers roads and other manmade objects within a relatively short time period. Also the abrasive sand damages the vegetation that is present. Stabilization of these areas is difficult, costly, and in some areas may be impractical.

Soil limitation ratings - are indicated for "dwellings," "streets and roads", and "septic tank filter fields." A rating of slight means that soil properties are generally favorable for the stated use or that limitations are minor and can be easily overcome. A rating of moderate means that some soil properties are unfavorable but that limitations resulting from the properties can be overcome or modified by special planning, good design, and careful management. A rating of severe means that soil properties are unfavorable and that limitations resulting from the properties are too difficult to correct or overcome. Soils having this rating require major soil reclamation or special design for stated uses. However, a rating of severe is not intended to imply that a soil cannot be used for the specific purpose listed in Table 4. A rating of very severe is a subdivision of the severe rating and has one or more features so unfavorable for the rated use that the limitation is very difficult and expensive to overcome. Reclamation would be extremely difficult, requiring the soil material to be removed, replaced, or completely modified. A rating of very severe is confined to soils that require extreme alteration and that, for the most part, are not used for the purposes being rated.

The emphasis in rating soils for dwellings is on properties that effect foundations. Also considered beyond the effects related exclusively to foundations are slope, susceptibility to flooding, seasonal high water table, and other hydrologic conditions. It is important to note that on-site investigations are needed for interpretations relevant to detailed design of foundations and to specific placement of buildings and utility lines.

Soil features that affect location of local roads and streets on the Outer Banks are susceptibility to flooding, depth to a seasonal high water table, texture, ease of hauling and loading, and conventional drainage and erosion measures. The entire soil profile of undisturbed soils is evaluated. However, an on-site investigation should be made to evaluate the limitation rating of the site in order to determine soil modifications and design needed for a specific land use.

Criteria for rating soils for use as filter fields for septic tanks are properties that limit the absorption or treatment of effluent. The properties are slope, susceptibility to flooding, presence of a seasonal high water table, and permeability of the subsoil and underlying material. Past performance of existing filter fields is also important in determining the suitability of a site for the installation and design of a ground absorption sewage disposal system.

Soils on the Outer Banks were also rated for their suitability for producing wetland wildlife habitat. The ratings were made on the basis of weighting factors (environmental elements) that are appropriate for or contribute to wetland habitat. Ratings of good, fair, poor, or very poor are expressed as follows:

Good: Habitats are easily improved, maintained, or created. There are few or no soil limitations in habitat management, and satisfactory results can be expected.

Fair: Habitats can be improved, maintained, or created on these soils; but moderate soil limitations affect habitat management or development. A moderate intensity of management and fairly frequent attention may be required to assure satisfactory results.

Poor: Habitats can be improved, maintained, or created on these soils; but the soil limitations are severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable.

Very Poor: Under the prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitats. Unsatisfactory results are probable.

TABLE 3 - ESTIMATED SOILS PROPERTIES SIGNIFICANT TO ENGINEERING			
MAP SYMBOL, LAND TYPES	DEPTH TO SEASONAL HIGH WATER TABLE	FLOODING	PERMEABILITY
#1 Beach, occasionally flooded	1.0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#2 Leon fine sand	0 to 3.0'	Some surface ponding	Rapid 6.3"/hr
#3 Beach-Foredune Association	Beach-0 to 3.0' Foredunes 6.0'	Frequent Rare	Rapid 6.3"/hr
#4 Bohicket soils, low	0 to 3.0'	Frequent (daily)	Slow 0.06"/hr
#5 Tidal Flats	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#6 Carteret soils, low	0 to 3.0'	Frequent (daily)	Rapid 6.3"/hr
#7 Corolla fine sand	1.5 to 3.0'	Rare to Common-Storm tides	Very rapid 20"/hr
#8 Corolla fine sand, forested	1.5 to 3.0'	Rare-high storm tides	Very rapid 20"/hr
#9 Corolla-Duckston complex	1.0 to 3.0'	Rare to Common-Storm tides	Very rapid 20"/hr
#10 Dredge Spoil	3.0'	Rare-Storm tides	Rapid 6.3"/hr
#11 Hobonny soils	0 to 2.0'	Frequent (monthly)	Moderate 0.63 to 2.0"/hr
#12 Duckston fine sand	1.0 to 2.0'	Rare to Common Storm tides	Very rapid 20"/hr
#13 Duckston fine sand, forested	1.0 to 2.0'	Rare to Common Storm tides	Very rapid 20"/hr
#14 Duneland	6.0'	None	Very rapid 20"/hr
#15 Fripp fine sand	6.0'	Rare-storm tides	Rapid 6.3"/hr

TABLE 3 (Con'd)

MAP SYMBOL, LAND TYPES	DEPTH TO SEASONAL HIGH WATER TABLE	FLOODING	PERMEABILITY
#16 Levy soils	0 to 2.0'	Frequent (monthly)	Slow 0.06 - 0.2"/hr
#17 Madeland	3.0'	Rare-storm tides	Rapid 6.3"/hr
#18 Carteret soils, high	1.0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#19 Carteret soils	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#20 Currituck soils	0 to 3.0'	Frequent (monthly)	Rapid 6.3"/hr
#21 Newhan fine sand	6.0'	None	Very rapid 20"/hr
#22 Newhan-Corolla Complex	----See ratings	for individual soil	------
#23 Duneland-Newhan Complex	----See ratings	for individual soil	-----
#24 Newhan-Urban land complex	-----See ratings	for individual soil	-----
#25 Wando fine sand	6.0'	None	Very rapid 20"/hr
#26 Conaby soils	0 to 1.0'	Surface ponding	Rapid 6.3"/hr
#27 Echaw fine sand	2.5 to 5.0'	None	Rapid 6.3"/hr
#28 Kureb fine sand	6.0'	None	Rapid 6.3"/hr
#29 Currituck soils, high	0 to 2.0'	Frequent (monthly)	Rapid 6.3"/hr
#31 Bohicket soils, high	0 to 3.0'	Frequent (daily)	Slow 0.06"/hr

TABLE 4 - DEGREE AND KIND OF LIMITATION FOR STATED USE

MAP SYMBOL, LAND TYPES	DWELLINGS	STREETS & ROADS	SEPTIC TANK FILTER FIELD
#1 Beach, occasionally flooded	very severe-flooding	very severe-flooding	very severe-flooding
#2 Leon fine sand	severe-high water table	severe-high water table	very severe-high water table
#3 Beach-Foredune Association	very severe-flooding	very severe-flooding	very severe-flooding
#3 Bohicket soils, low	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#5 Tidal Flats	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#6 Carteret soils, low	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#7 Corolla fine sand	severe-wet	severe-wet	severe-wet[1]
#8 Corolla fine sand, forested	severe-wet	severe-wet	severe-wet[1]
#9 Corolla-Duckston complex	severe-wet	severe-wet	severe-wet[1]
#10 Dredge Spoil	severe	severe	severe[1]
#11 Hobonny soils	very severe-flooding-wet	very severe-flooding-wet	severe-flooding-wet
#12 Duckston fine sand	severe-wet	severe-wet	severe-wet[1]
#13 Duckston fine sand, forested	severe-wet	severe-wet	severe-wet[1]
#14 Duneland	severe-unstable due to blowing sand	severe-steep slope, blowing sand	severe-unstable due to blowing sand[1]
#15 Fripp fine sand	severe-floods	moderate-floods	slight[1]

TABLE 4 (Con'd)

MAP SYMBOL, LAND TYPES	DWELLINGS	STREETS & ROADS	SEPTIC TANK FILTER FIELD
#16 Levy soils	very severe-floods, wet	very severe-floods, wet	very severe-floods, wet
#17 Madeland	severe	severe	severe[1]
#18 Carteret soils, high	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding, wet
#19 Carteret soils	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#20 Currituck soils	very severe-flooding-wet	very severe-flooding-wet	very severe-flooding-wet
#21 Newhan fine sand	slight	slight	slight[1]
#22 Newhan-Corolla Complex	--------see ratings for individual soils --------		
#23 Duneland-Newhan Complex	--------see ratings for individual soils--------		
#24 Newhan-Urban land complex	--------see ratings for individual soils--------		
#25 Wando fine sand	slight	slight	slight[1]
#26 Conaby soils	very severe-floods, wet	very severe-floods, wet	very severe-floods, wet
#27 Echaw fine sand	moderate -wetness, blowing sand	moderate- wetness	severe- wetness[1]
#28 Kureb fine sand	slight	slight	slight[1]
#29 Currituck soils, high	very severe-floods, wet	very severe-floods, wet	very severe-floods, wet
#31 Bohicket soils, high	very severe-floods, wet	very severe-floods, wet	very severe-floods, wet

[1]The sandy soils are highly pervious with questionable filtering capacities. Thus, contamination of groundwater is possible.

TABLE 5 - WILDLIFE HABITAT SUITABILITY			
MAP SYMBOL, LAND TYPES	POTENTIAL FOR HABITAT ELEMENTS		POTENTIAL AS HABITAT FOR WET-LAND WILDLIFE
	WETLAND PLANTS	SHALLOW WATER	
#1 Beach, occasionally flooded	very poor	very poor	poor
#2 Leon fine sand	poor	poor	poor
#3 Beach-Foredune Association	very poor	very poor	very poor
#4 Bohicket soils, low	good	good	good
#5 Tidal Flats	very poor	very poor	poor
#6 Carteret soils, low	fair	good	fair
#7 Corolla fine sand	poor	very poor	poor
#8 Corolla fine sand, forested	poor	very poor	poor
#9 Corolla-Duckston complex	poor	poor	poor
#10 Dredge Spoil	poor	very poor	poor
#11 Hobonny soils	good	good	good
#12 Duckston fine sand	poor	poor	poor
#13 Duckston fine sand, forested	poor	poor	poor
#14 Duneland	very poor	very poor	very poor
#15 Fripp fine sand	very poor	very poor	very poor

TABLE 5 (Con'd)

MAP SYMBOL, LAND TYPES	POTENTIAL FOR HABITAT ELEMENTS		POTENTIAL AS HABITAT FOR WETLAND WILDLIFE
	WETLAND PLANTS	SHALLOW WATER	
#16 Levy soils	good	good	good
#17 Madeland	very poor	very poor	very poor
#18 Carteret soils, high	fair	good	fair
#19 Carteret soils	fair	good	fair
#20 Currituck soils	poor	good	good
#21 Newhan fine sand	very poor	very poor	very poor
#22 Newhan-Corolla Complex	--------see ratings for individual soils ---------		
#23 Duneland-Newhan Complex	--------see ratings for individual soils ----------		
#24 Newhan-Urban land Complex	--------see ratings for individual soils ----------		
#25 Wando fine sand	very poor	very poor	very poor
#26 Conaby soils	good	good	good
#27 Echaw fine sand	poor	very poor	very poor
#28 Kureb fine sand	very poor	very poor	very poor
#29 Currituck soils, high	poor	good	good
#31 Bohicket soils, high	good	good	good

Formation and Classification of the Soils

In this section the factors that affected the formation and morphology of the soils in the Outer Banks are discussed. The current system of classification is then explained, and the classification of the soil series by family, subgroup, and order is shown (Table 7, page 80).

Factors of soil formation - Soil is the product of certain environmental factors acting upon geologic material. The soil forming factors are parent material, climate, organisms, relief, and time. The influence of these factors is interdependent but by no means equal. In the Outer Banks soil survey area, these factors influence soil formation in varying degrees. Parent material, time, relief, and organisms (plants) are the factors which account for most of the soil differences and are interrelated in a complex manner. The climate affects soil development, but it is relatively similar over the survey area.

Fig. 58
Elements of erosion are exposing layers of sand in this dune profile.

The parent material of most of the soils in the area is sand of marine origin. Several hypotheses regarding the formation of the Outer Banks have been proposed, and recent evidence indicates that land features may be only several thousand years old.16 The silt and clay deposits which form the marshes on the southern part of the coast and some areas on Currituck Banks were apparently deposited even more recently. The relief of the sand deposits and the length of time they remain in place are effected greatly by wind and water. Examples are dunes which are frequently shifted by wind and sand which is transported by water. These processes occur during storms when overwash may occur and during the opening and closing of inlets. Numerous buried surface horizons provide evidence of these rapid changes in land form. This lack of stability limits the time available for soil development. The relief effects moisture available for plant growth since elevation changes of a few inches influence the vegetative types which occur in both the marsh and the dune areas; and the plants, in turn, influence soil development.

Plants are the most obvious organisms which effect soil formation; and their distribution on the barrier islands is affected by environmental factors such as shifting sand, salt spray, and relief. On the islands, stabilization by plants is necessary for soil development to occur. In the foredune area, only salt tolerant grasses such as sea-oats and American beachgrass can survive. On the landward side of the dunes, shrubs such as live oak, yaupon holly, and waxmyrtle are able to grow, usually exhibiting a characteristic sheared appearance due to windborne salt spray. Where the islands are sufficiently wide, forests develop that are similar in vegetative species and appearance to those on the mainland. Thus, position of vegetation on the landscape has an important influence on soil formation. A dune field close to the ocean supports only grass vegetation while the same parent material farther from the ocean eventually supports trees. Different soils develop in the two locations due to the influence of the vegetation and the longer period available for soil development at the stabilized wooded site.

Fig. 59
Cabbage palmetta grows in the dense maritime forest at Buxton Woods.

The climate of the barrier islands is modified by its proximity to the Atlantic Ocean. Temperatures are not as cold in winter and not as hot in summer as they are on the mainland. Winters are generally mild, and the freeze-free period is about 290 days on the central section of the Outer Banks.[17] Rainfall

Fig. 60
Compared to other thickly vegetated areas, sand dunes on the Core Banks are sometimes only sparsely covered by sea-oats.

is well-distributed throughout the year, with summer rainfall the greatest. The fall of the year is usually the driest period. The only weather station on the barrier islands is at Cape Hatteras; but data from Norfolk, Virginia, and Wilmington, North Carolina, may be used for general comparison of north to south differences (Table 6).

Tropical hurricanes are an important influence on the islands and come close enough to effect them on an average of about twice a year. This type of storm strikes the state with enough force to do damage to property on the average of about once in ten years.

The climate of the coastal barrier islands probably does not vary enough from north to south to produce different soils. The vegetation differences from Currituck Banks to Smith Island do, however, provide an indication of climate differences. Sea-oats reaches its extreme northern limit on Currituck Banks where American beachgrass reaches its southern limit. Northern bayberry ranges only as far south as Oregon Inlet, while on the extreme southern coast, Smith Island has some semi-tropical species such as cabbage palmetto.

In summary, the islands and their soils are not static but are subject to frequent changes, as a complex combination of environmental factor produce a dynamic landscape subject to rapid changes.

TABLE 6 - WEATHER DATA FROM THREE COASTAL LOCATIONS[17]

	Mean Annual Temperature Daily max °F	Mean Annual Temperature Daily min °F	Mean Annual Precipitation Inches	Mean Wind Speed MPH	Possible Sunshine % Days	Temperature days max 90°F and above	Temperature days min 32°F and below
Norfolk, VA	65.2	47.7	40.48	9.9	56	30	72
Hatteras, NC	68.6	55.7	54.47	11.6	63	3	33
Wilmington, NC	74.0	53.5	51.29	9.5	65	38	48

Classification of Soils - Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to each other and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land. The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available.[18]

The system of classification used has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the bases for classification are the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or the combined data from soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In Table 7, the soils of the survey areas are classified according to the system. Classes of the system are briefly discussed in the following paragraphs.

ORDER — Ten soil orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in sol. An example is Entisol.

SUBORDER — Each order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (Aqu. meaning water, plus ent. from Entisol).

GREAT GROUP Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes, and base status. The name of great groups ends with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Psammaquents (Psamm. meaning sandy horizons, plus aquent. the suborder of Entisols that have an aquic moisture regime).

SUBGROUP Each great group is divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades that have some properties that are representatives of the great groups but do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the group. The adjective Typic is used for the subgroup that is thought to typify the great group. An example is Typic Psammaquents.

FAMILY Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is mixed, thermic, Typic Psammaquents.

SERIES The series consists of a group of soils that is formed from a particular kind of parent material and has horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

TABLE 7 - SOIL SERIES CLASSIFIED BY HIGHER CATEGORIES

SERIES	FAMILY	SUBGROUP	ORDER
Beach, occasionally flooded[1]			
Beach-Foredune association[1]			
Bohicket	Fine, mixed, nonacid, thermic	Typic Sulfaquents	Entisols
Carteret	Mixed, thermic	Typic Psammaquents	Entisols
Conaby soils[2]	Coarse-loamy, mixed, nonacid, thermic	Histic Humaquepts	Inceptisols
Corolla	Mixed, thermic	Aquic Udipsamments	Entisols
Currituck	Sandy, or sandy-skeletal mixed, euic, thermic	Terric Medisaprists	Histosols
Dredge Spoil[1]			
Duckston	Mixed, thermic	Typic Psammaquents	Entisols
Duneland[1]			
Echaw[3]	Sandy, siliceous, thermic	Entic Haplohumonds	Spodosols
Fripp[4]	Mixed, thermic	Typic Udipsamments	Entisols
Hobonny[5]	Euic, thermic	Typic Medisaprists	Histosols
Kureb	Thermic, uncoated	Spodic Quartzipsamments	Entisols
Levy[6]	Fine, mixed, acid, thermic	Typic Hydraquents	Entisols
Leon	Sandy, siliceous, thermic	Aeric Haplaquods	Spodosols
Madeland[1]			
Newhan	Mixed, thermic	Typic Udipsamments	Entisols
Tidal flats[1]			
Wando	Mixed, thermic	Typic Udipsamments	Entisols

[1]Miscellaneous land areas are not classified in this soil survey.

[2]The Conaby soils lack the degree of soil development as defined for the series but the usefulness and behavior are essentially the same as other Conaby soils.

[3]The Echaw soils contain less clay and silt than currently defined for the series but usefulness and behavior are essentially the same as other Echaw soils.

[4]The Fripp soils contain more quartz than is currently defined for the series but the usefulness and behavior are essentially the same as other Fripp soils.

[5]The Hobonny soils are slightly less acid and are not in the flood plain as currently defined for the series but the usefulness and behavior are essentially the same as other Hobonny soils.

[6]The Levy soils contain slightly less clay than currently defined for the series but the usefulness and behavior are essentially the same as other Levy soils.

SOIL ANALYSIS AND METHODS

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Chemical and mineralogical properties of the soils on the Outer Banks of North Carolina have received little attention prior to this survey. Therefore, in order to properly classify the various soils identified in the field survey, samples representing several of the mapping units were taken by the soil scientist for laboratory studies. The following procedures describe how the various determinations were made.[1]

Particle Size Analysis

A twenty gram soil sample was pretreated with 35 percent hydrogen peroxide to remove organic matter. The sample was then dispersed with 20 mls of 10 percent calgon and stirred with an ultrasonic probe. The calgon was checked with samples containing other dispersing agents and was found to be as effective as NaOH or sodium metaphosphate.

The dispersed sample was washed on a 300-mesh sieve, with the silt and clay passing through the sieve into a 1-liter cylinder. The sand fraction retained on the sieve was dried and weighed. The clay fraction was obtained by pipetting a 25.1 ml sample at a depth of 5 cm and applying the numbers obtained to the following formula:

$$\% \text{ of pipetted fraction} = (A-B)\ KD$$

$$A = \text{wt(g) of pipetted fraction}$$

$$B = \text{wt correction for dispersing agent}$$

$$K = \frac{1,000}{\text{m/in pipette}}$$

$$D = \frac{100}{\text{g of } H_2O_2 \text{ treated ovendry total sample}}$$

[1]For more complete instruction on the techniques used, the reader is referred to Soil Conservation Service, 1972 rev., Soil Survey laboratory methods and procedures for collecting soil samples, U.S. Department of Agriculture SSIR No. 1, U.S. Government Printing Office, Washington, D.C. p.63.

Clay Mineralogy

To prepare slides of clay for X-ray diffraction analysis, a 5 cm sample of clay was siphoned from the 1,000 ml cylinder during the particle size procedure. The sample was separated into two test tubes; one was saturated with Mg and the other with K. After several washings with 95 percent ethanol and H_2O, the samples were free of chlorides and were placed on slides for X-ray diffraction on a GE XRD-7 diffractometer with nickel filtered copper K-alpha X-rays.

Sand Mineralogy

The sand fractions retained on the sieves in the particle size analysis procedure were dried and retained for optical examination. A small stainless steel spoonful (approximately 50 mg) of the sand fraction (usually FS) to be examined was placed on a petrographic glass slide and mixed thoroughly with five drops of immersion oil of index of refraction n = 1.544. Line counts were made with a Wild Model 21 petrographic microscope. Approximately 300 grains or more were counted in each sample.

Exchangeable Bases

Twenty-five gms of air-dried soil (< 2mm) were weighed into a 250 ml Erlenmeyer flask. Thirty-five ml of NH_4OAc were added and allowed to stand overnight. The contents were then transferred to a Buchner funnel and leached with 200 mls of NH_4OAc. The leachate was used for analysis of Na, K, Ca, and Mg by means of a flame photometer and an atomic absorption spectrophotometer.

Extractable Acidity (EA)

For this procedure, 5 gms of soil were placed in a 125 ml Erlenmeyer flask and equilibrated for 30 minutes in $BaCl_2$ buffer solution. This was then leached with 100 mls of $BaCl_2$ replacement solution. Extractable acidity was obtained by back titration with HCl.

Percent Base Saturation (Sum of Cation Method)

Percent base saturation was calculated by dividing the sums of exchangeable bases by the sum of exchangeable bases plus extractable acidity X 100.

$$\frac{(\text{meq. Na.} + \text{Ca.} + \text{Mg.} + \text{K})}{(\text{meq. Na.} + \text{Ca.} + \text{Mg.} + \text{K} + \text{EA})} \times 100$$

Cation Exchange Capacity (NH_4OAc pH 7 Method)

NH_4OAc cation exchange capacity determination involved leaching 10 gms of soil with various solutions and determining ammonium ions by using an ammonium electrode. First, the soil was leached with 250 mls NH_4OAc, then washed four times with 1N NH_4Cl, once with .25N NH_4Cl, and once with 200 mls of isopropyl alcohol. The sample was then leached with 225 mls of 10 percent acidified NaCl and made up to a 250 ml volume. Readings in ppm were taken using the ammonium electrode.

Organic Carbon Contents

To determine organic carbon, 1 gm (0.5 gm of less if high in organic matter) of soil was ground to pass an 80-mesh sieve and placed in a 500 ml Erlenmeyer flask. Twenty mls of concentrated H_2SO_4 were added along with 200 mls of H_2O. After adding 0.5 mls of 1,10 phenanthroline indicator, the solution was titrated with ferrous ammonium sulfate to a red-brown end point.

$$\text{\% organic carbon} = \frac{\text{m/blank-m/sample}}{\text{g sample}} \times \text{N of } Fe(NH_4)_2(SO_4)_2 \times \frac{.30}{.77}$$

$$\text{\% organic matter} = \text{\% organic cargon} \times 1.724$$

Fiber Content in Histosols

To determine fiber percentage in Histosols, a half-syringe was adjusted to $5cm^3$ and packed level full with moist soil. All the soil material was then placed on a 100 mesh sieve and washed with a stream of cold tap water. The washed fibers were then repacked into the syringe, and the volume recorded. Unrubbed fiber percentage is equal to the reading (cm^3) times 20.

Sulfur Content

Ten gms of soil, ground to pass a 20 mesh sieve, were shaken for 30 minutes with 50 mls of $Ca(H_2PO_4)_2.2H_2O$ extracin solution. The solution was next filtered, and 20 ml aliquots were evaporated to dryness. After cooking, 2 mls of 2:1 Nitric - perchloric acid was added, and the solution was heated to the white fuming stage. Twenty mls of acacia (25%) were then added, and sulfur content was determined by using the Beckman B spectrophotometer at 440 millimicrons wave length.

Specific Conductivity

A saturated paste, mixed, was prepared by adding water to a sample of soil. The saturated soil paste was placed into Buchner funnels and extracted. Conductivity of the saturated extract was determired by Wheatstone bridge.

NaCl

Salt content was determined by Model CD-50 Chloride Test Kit provided by Hach Chemical Company.

TABLE 8 - MINERAL ANALYSIS OF SELECTED SOILS OF THE OUTER BANKS[1]

SOIL NAME	DEPTH[2] INCHES	QUARTZ %	FELDSPAR %	OPAQUE %	UNKNOWN[3] %
Carteret soils, high	28-34	87.0	11.0	t	2.0
Carteret soils, high	28-34	90.0	6.0	t	4.0
Corolla fine sand[4]	15-24	96.7[6]	3.0	-	0.3
Corolla fine sand	-	98.1[6]	1.6	-	0.3
Corolla fine sand	-	95.1[6]	2.2	-	2.7
Corolla fine sand	-	95.1[6]	2.3	0.9	1.7
Currituck soils	20-48	94.0[7]	4.4	0.6	1.0
Duckston fine sand	-	95.0[7]	0.6	0.6	3.8
Fripp fine sand[4]	4-26	91.3	7.0	-	1.7
Fripp fine sand	-	91.4	3.7	-	4.9
Fripp fine sand	-	97.8	1.9	-	0.3
Fripp fine sand[5]	0-5	83	17	-	-
Fripp fine sand[5]	7-15	87	13	-	-
Fripp fine sand[5]	9-14	86	14	-	-
Fripp fine sand[5]	16-25	85	15	-	-
Fripp fine sand[5]	9-21	90	10	-	-
Kureb fine sand	20-28	98.9	0.8	0.3	-
Leon fine sand	15-22	97.5	0.8	0.6	1.1
Newhan fine sand	-	97.1[6]	2.6	0.3	-
Newhan fine sand	-	93.7[6]	2.1	0.7	3.5
Newhan fine sand	-	96.7[6]	2.7	0.2	0.4
Wando fine sand[4]	2-32	98.0[6]	1.0	1.0	-

[1]A major portion of this data was analyzed at School of Agriculture and Life Sciences, Department of Soil Science, N.C. State University, Raleigh, N.C.

[2]Samples lacking specific depths were sampled from the soil control sections (10 to 40 inches).

[3]The unknown column includes items such as shell fragments. There was only a trace of mica in these samples.

[4]Samples were from the typical profile.

[5]Data from "A Reconnaissance of the Geomorphology and Soils of Smith Island, N.C." By R.B. Daniels and E.E. Gamble, Research Soil Scientists, USDA, Soil Conservation Service, and N.C. State Univ.

[6]These soils are classified as Udipsamments but the mineral analysis data supports Quartzipsamments for these soils on the Outer Banks.

[7]These soils are classified as mixed mineralogy but the mineral analysis data supports siliceous and it is recommended that the classification of these soils be changed.

TABLE 9 - MINERAL ANALYSIS OF SELECTED SOILS ON SMITH ISLAND, N.C.[1]

SOIL NAME	DEPTH cm	HORIZON	WEATHERABLE MINERALS %
Fripp fine sand	0-10	A1-A2	7
	20-41	B2	4
	61-79	C1	7
	104-142	C22	7
Fripp fine sand	0-10	A1-A2	9
	10-23	A2	12
	23-38	B21(h)	10
	38-56	B22	8
	104-183	C1	6
	183-229	C2	5
Fripp fine sand	0-10	A1-A2	13
	10-36	A2	12
	36-56	B21(h)	11
	56-66	B22	8
	107-127	C2	8
Fripp fine sand	10-23	A2	16
	23-38	B1(h)	14
	38-64	B21	8
	91-112	C1	8
Fripp fine sand	13-38	A2	8
	61-84	B21	11
	122-147	C	9
Fripp fine sand	10-28	A2	8
	41-64	B22	5
	91-107	C1	9
Newhan fine sand	0-15	A1-A2	7
	15-30	C1	12
	51-76	C2	8
Corolla fine sand	0-8	A1	10
	8-28	C1	5

[1] Special soil study, "A Reconnaissance of the Geomorphology and Soils of Smith Island, North Carolina." By R.B. Daniels and E.E. Gamble, Research Soil Scientists, USDA, Soil Conservation Service, and N.C. State University. Analysis from Soil Survey Laboratory, Beltsville, Maryland.

TABLE 10- SELECTED PROPERTIES OF SOILS IN MARSHES OF THE OUTER BANKS, N.C. [1]

SOIL NAME	DEPTH INCHES	SAND %	SILT %	CLAY %	ORGANIC MATTER%	FIBER CONTENT UNRUBBED %	FIBER CONTENT RUBBED %	SULFUR %	pH WET	pH DRY	CE mmhol/ cm	NaCl %
Bohicket soils, low	0-20	0.5	57.9	41.6	8.1	-	-	10	7.6	3.4	46.4	-
	25-40	0.5	58.8	40.7	15.7	-	-	10	7.6	3.7	92.8	-
Bohicket soils, high[2]	0-20	0.5	42.2	57.3	10.6	-	-	10	7.4	5.1	75.0	-
	25-40	0.5	43.2	56.3	8.7	-	-	10	7.3	3.1	43.3	-
Carteret soils	0-25	-	-	-	-	-	-	-	-	-	28.9	-
	50-60	-	-	-	-	-	-	-	-	-	45.9	-
	100	-	-	-	-	-	-	-	-	-	17.7	-
Carteret soils	0-25	-	-	-	-	-	-	-	-	-	30.5	-
Carteret soils	0-10	90.2	9.5	0.3	2.2	-	-	0.03	5.6	5.2	33.0	-
	10-20	90.4	9.2	0.4	3.3	-	-	0.06	5.9	5.8	36.1	-
	20-30	96.0	3.6	0.4	1.1	-	-	0.03	5.5	5.0	39.8	-
	30-40	97.1	2.7	0.2	0.6	-	-	0.03	5.7	5.6	30.2	-
Carteret soils, high[2]	24-30	99.4	0.3	0.2	-	-	-	-	2.7	3.5	-	11
Carteret soils, high	18-24	98.6	1.0	0.4	-	-	-	-	3.3	4.4	-	17
Carteret soils, high	25-30	98.8	0.7	0.5	-	-	-	-	2.7	2.8	-	-
	40-46	-	-	-	-	-	-	0.01	3.0	3.1	-	4
Carteret soils, high	0-8	-	-	-	25.0	48	12	-	5.4	5.1	-	-
	28-34	98.7	1.0	0.3	-	-	-	0.01	7.4	6.5	-	7
Carteret soils, high	0-6	29.1	37.4	33.5	-	-	-	-	3.4	4.1	-	-
	28-34	99.1	0.2	0.6	-	-	-	-	2.5	3.3	-	11

TABLE 10 - SELECTED PROPERTIES OF SOILS IN MARSHES OF THE OUTER BANKS, N.C. [1] (con'd)

SOIL NAME	DEPTH INCHES	SAND %	SILT %	CLAY %	ORGANIC MATTER%	FIBER CONTENT UNRUBBED %	FIBER CONTENT RUBBED %	SULFUR %	pH WET	pH DRY	CE mmhol/cm	NaCl %
Currituck soils[2]	5-10	-	-	-	44.3	36	80	-	4.9	5.0	-	-
	18-24	-	-	-	42.3	4	36	-	4.2	4.5	-	<1
	30-36	-	-	-	-	-	-	-	2.6	3.1	-	<1
Currituck soils	12-18	99.1	0.5	0.4	-	-	-	-	2.6	2.6	-	-
	28-34	99.0	0.7	0.3	-	-	-	0.01	2.7	2.7	-	3
Currituck soils	4-12	2.8	51.2	46.0	41.0	-	-	-	3.6	3.4	-	-
	28-34	-	-	-	50.0	72	12	-	3.5	3.7	-	<1
Currituck soils	16-29	-	-	-	50.4	60	32	-	2.9	2.8	-	-
	38-44	-	-	-	55.4	40	16	-	5.3	4.9	-	<1
Currituck soils	10-20	-	-	-	49.6	32	12	-	4.6	4.3	-	-
	22-28	-	-	-	1.0	-	-	-	3.4	3.3	-	4
Currituck soils	22-30	-	-	-	46.3	40	8	-	2.7	3.4	-	-
	40-46	-	-	-	17.9	40	12	-	4.3	4.2	-	1
Currituck soils, high	4-9	-	-	-	25.7	68	16	-	5.1	5.1	-	-
	16-22	64.0	25.0	11.0	-	-	-	-	3.4	3.3	-	-
	30-36	99.8	0.1	0.1	-	-	-	0.005	2.8	2.8	-	2
Currituck soils, high	0-13	-	-	-	25.2	2	-	-	5.2	5.1	-	-
	13-20	99.2	0.8	-	-	-	-	-	2.3	2.7	-	-
	20-48	97.3	2.7	-	-	-	-	-	2.6	3.1	-	3
Hobonny soils[2]	18-26	-	-	-	69.2	40	16	-	4.0	4.2	-	-
	32-42	-	-	-		36	8	-	5.5	4.3	-	7
Hobonny soils	0-10	8.4	59.9	31.7	-	-	-	-	4.4	4.5	-	-
	28-36	-	-	-	51.0	40	4	-	5.1	4.5	-	22

TABLE 10 - SELECTED PROPERTIES OF SOILS IN MARSHES OF THE OUTER BANKS, N.C. [1] (con'd)

SOIL NAME	DEPTH INCHES	SAND %	SILT %	CLAY %	ORGANIC MATTER%	FIBER CONTENT UNRUBBED %	FIBER CONTENT RUBBED %	SULFUR %	pH WET	pH DRY	CE mmhol/ cm	NaCl %
Hobonny soils	18-24	-	-	-	41.6	50	10	-	5.5	5.6	-	-
	30-38	-	-	-	47.7	44	4	-	5.9	5.8	-	14
Hobonny soils	0-12	-	-	-	41.3	48	16	-	4.4	4.4	-	-
	28-32	-	-	-	29.5	44	20	-	5.8	5.2	-	-
	42-48	-	-	-	-	-	-	-	4.6	5.0	-	5
Levy soils[2]	18-24	2.5	74.9	22.6	-	-	-	-	4.1	5.1	-	-
	24-28	0.8	47.6	51.6	-	-	-	-	4.4	4.8	-	3
Levy soils	32-38	2.4	71.5	26.1	-	-	-	-	3.2	3.5	-	3

[1] This soil data was analyzed at School of Agriculture and Life Science, Department of Soil Science, North Carolina State University, Raleigh, North Carolina.

[2] Samples collected from typical profile - soil description included in report.

NOTE: Where data is not shown, the laboratory analysis was not determined or the analysis was not applicable.

SUMMARY

The "Outer Banks" of North Carolina extend approximately 350 miles between the Virginia and South Carolina state lines. Natural cyclic processes that began forming these barrier islands several thousand years ago are reshaping them today. Inlets open and close while sand dunes accumulate, shift with the wind, or stabilize under vegetative covers. During the course of the survey, a close correlation was found to exist between the soils, their occurrence, and the plant communities on the sand islands and the marshes. The differences between Outer Banks soils and vegetation along the southern banks and those of the northern banks can be related directly to a combination of geographical and environmental factors.

In the southern portion of the Outer Banks, the islands are more numerous and are smaller in size than in the northern portion. They are in close proximity to the mainland and in many cases are separated from the mainland only by the Atlantic Intracoastal Waterway and narrow strips of tidal marsh. Rivers and streams empty directly into the ocean instead of sounds. Thus, in the south, higher salt concentrations were found in the marsh soils.

Differences in vegetation and soils on the Outer Banks can also be illustrated by comparing the fine-textured Bohicket and Levy soils. The clayey Bohicket soils are regularly flooded with saline water, and they accumulate sulfides by reduction of sulfates from sea water. On drying, these acid sulfate soils exhibit a sharp drop in chemical reaction (pH). As a result, the major plant species growing on these marsh soils are smooth cordgrass with fringes of saltmeadow cordgrass and black needlerush. Moving north into the sounds, the salinity decreases and the water becomes brackish. Here organic and sandy marsh soils are common. Salt concentrations are less in the soils, and they do not accumulate sulfides like the Bohicket soils to the south.

The clayey Levy soils on the isolated islands in Currituck Sound are surrounded with freshwater. These soils are continuously wet and soft with very poor support capacity. The native vegetation includes a mixture of brackish and freshwater plants, such as saltmeadow cordgrass, black needlerush, saltgrass, eastern baccharis, waxmyrtle, and a variety of other weeds and grasses. In several places along the Currituck Banks, these fine-textured soils join the main barrier island for short intervals. This fact suggests two possibilities with respect to formation and development of the Outer Banks system in Currituck County. First, the Levy soils have probably developed from sediment deposited by Currituck Sound. And, as such, they are not a "true" Outer Banks feature. Secondly, the Currituck Banks are definitely migrating westward and are literally rolling over on the Currituck Sound islands. The higher-lying soils on the islands consist mainly of sand. Water moves freely through these sandy soils, and the soils are wet where the water table is near the surface. At higher elevations, the more sloping soils are dry since the water table is at a greater depth. Shifting, blowing sand is common on the dry soils that lack adequate vegetative cover.

Thus, the Outer Banks region of North Carolina is a complicated and diverse ecosystem. Because of its unique, complex nature, a variety of demands have been placed on its carrying capacity. For example, the success of the commercial and sports fishing industries depends greatly on the ability of the tidal marshes to provide food for fish and shellfish; while, on the other hand, the sand islands are in great demand for residential and resort development. Some controls appear to be necessary to protect the remaining beauty, resources, and social values of the Outer Banks. One control presently being implemented is the Coastal Area Management Act of 1974. Hopefully, this initial soil survey of the Outer Banks will provide a basic soil resource inventory that will lead to sound management decisions and to better land use.

APPENDIX I - TECHNICAL DESCRIPTIONS OF SOILS

On the following pages a representative profile description is given for each soil series. The descriptions are presented in numerical order; they were described from a small, three dimensional area of soil typical for the soil series in the survey area. The detailed descriptions of each horizon follow standards in the Soil Survey Manual.[15] Unless otherwise noted, colors described are for moist soils.

1. BEACH, OCCASIONALLY FLOODED - No description provided.

2. LEON FINE SAND - A typical profile of Leon sand is in Brunswick County, North Carolina; Yaupon Beach on McGlamey Road, 500 feet south of Yaupon Drive East (about 1/4 mile west of beach).

O1--1 inch to 0; partially decayed leaves and plant materials.

A1--0 to 3 inches; very dark gray (10YR 3/1) "salt and pepper" sand; weak fine granular structure; very friable; many fine and medium roots; extremely acid; abrupt smooth boundary.

A2--3 to 15 inches; light gray (10YR 7/2) sand; single grained; loose; few fine and medium roots; extremely acid; abrupt wavy boundary.

B21h--15 to 21 inches; black (N 2/; 5YR 2/1) sand; massive; very friable; few coarse roots; extremely acid; gradual wavy boundary.

B22h--21 to 39 inches; dark reddish brown (5YR 3/4) sand; single grained; loose; few coarse roots; extremely acid; gradual wavy boundary.

B23h--39 to 65 inches; dark reddish brown (5YR 3/2) sand; single grained; loose; few coarse roots; strongly acid.

C1--65 to 72 inches; light brownish gray (10YR 6/2) sand; single grained; loose; strongly acid.

The soils are sand or fine sand to depths of 72 inches or more.

The A1 horizon is black or very dark gray. When dry, this horizon has a "salt and pepper" appearance because of mixing of organic matter and white sand grains. Some pedons are mottled with dark yellowish brown and light yellowish brown.

3. BEACH-FOREDUNE ASSOCIATION - No description provided.

4. BOHICKET SOILS, low - A typical profile of Bohicket soils from an area of Bohicket silty clay loam is in Brunswick County and is about 250 yards from the south end of Oak Island Bridge; 50 feet east of bridge in a marsh.

A1g--0 to 20 inches; dark gray (5Y 4/1) silty clay loam; massive; sticky, slightly viscous, many very fine roots and common coarse cordgrass stems; moderately alkaline; gradual wavy boundary.

C1g--20 to 45 inches; dark gray (5Y 4/1) silty clay; massive; sticky, slightly viscous, common very fine roots and few coarse cordgrass stems; moderately alkaline; gradual wavy boundary.

C2g--45 to 62 inches; dark gray (5Y 4/1) silty clay; massive; sticky, slightly viscous, few fine roots and stem pieces; moderately alkaline.

These soils are continuously saturated with sea water. Soil salinity is high.

The A horizon is dark gray, gray, dark greenish gray, very dark gray, very dark brown, or black silty clay loam, silty clay, or clay.

The Cg horizon is light gray, greenish gray, dark greenish gray, very dark grayish brown, dark gray, gray, black, dark grayish brown, or very dark gray clay or silty clay.

5. TIDAL FLATS - No description provided.

6. CARTERET SOILS, low - A typical profile of Carteret soils, low from an area of Carteret loamy sand is in Carteret County; from junction of Atlantic Beach-Morehead City road at Atlantic Beach, 3,500 feet east on State Road 1201, 250 feet north of road in saltwater marsh.

A11--0 to 4 inches; dark grayish brown (2.5Y 4/2) loamy sand; weak medium granular structure; very friable; many fine roots; few medium gravel-size shell fragments; moderately alkaline; clear smooth boundary.

A12g--4 to 10 inches; dark gray (N 4/) loamy sand; weak medium granular structure; very friable; many fine roots; common sand and gravel-size shell fragments; moderately alkaline; gradual smooth boundary.

C1g--10 to 34 inches; gray (N 5/) loamy sand; massive; very friable; common fine roots in upper part; common sand-size shell fragments; neutral; gradual smooth boundary.

C2g--34 to 80 inches; greenish gray (5GY 5/1) sand; single grained; loose; common sand- and gravel-size shell fragments; moderately alkaline.

The Al horizon is dark gray, very dark gray, very dark grayish brown, dark grayish brown, dark olive gray, or dark greenish gray loamy sand or sand.

The Cg horizon is greenish gray, dark greenish gray, gray or dark gray loamy sand, sand, or gravelly sand. In some profiles, thin intermittent layers of clay loam or silty clay loam occur throughout the soil.

7. COROLLA FINE SAND - A typical pedon of Corolla fine sand is in Currituck County approximately 2.5 miles south of Virginia state line and 0.4 mile west of Atlantic Ocean.

Al--0 to 3 inches; dark grayish brown (10YR 5/2) fine sand; single grained; loose; few to many fine roots; neutral; clear wavy boundary.

Cl--3 to 15 inches; very pale brown (10YR 7/3) fine sand; few medium distinct yellowish red (5YR 4/6) mottles; single grained; loose; neutral gradual wavy boundary.

C2--15 to 26 inches; light brownish gray (10YR 6/2) fine sand; few fine distinct yellowish red mottles and fine streaks; single grained; loose; common dark opaque grains; neutral; gradual wavy boundary.

Alb--26 to 32 inches; dark grayish brown (10YR 4/2) fine sand; many medium faint grayish brown (10YR 5/2) mottles; single grained; loose; few fine roots; faint sulfur odor; neutral; gradual wavy boundary.

C3--32 to 60 inches; gray (5Y 6/1) fine sand; single grained; loose; few fine roots; moderate sulfur odor; neutral.

The Al horizon is grayish brown, dark grayish brown, dark gray, very dark gray, or very dark grayish brown. The Alb horizon is similar in color to the Al horizon.

The upper C horizons are very pale brown, pale brown, light yellowish brown, light brownish gray, brown, or grayish brown.

The lower C horizons are grayish brown, light brownish gray, gray, light olive gray, or light gray.

8. COROLLA FINE SAND, forested - A typical profile of Corolla fine sand, forested is in Currituck County, approximately 3/4 mile south of Virginia state line and 1/2 mile west of ocean.

01--1 inch to 0; partly decomposed forest litter.

Al--0 to 3 inches; dark gray (10YR 4/1) sand; single grained; loose; few to many fine roots; neutral; clear wavy boundary.

C1--3 to 11 inches; light brownish gray (10YR 6/2) to pale brown (10YR 6/3) fine sand; single grained; loose; neutral; clear wavy boundary.

C2--11 to 22 inches; pale brown (10YR 6/3) to light yellowish brown (10YR 6/4) sand; single grained; loose; neutral; gradual wavy boundary.

C3--22 to 38 inches; very pale brown (10YR 7/1) sand; single grained; loose; common brownish, whitish, and dark mineral grains; neutral; clear wavy boundary.

C4--38 to 60 inches; greenish gray (5GY 5/1) sand; single grained; loose; common dark opaque grains; neutral.

The A horizon is gray, grayish brown, dark grayish brown, dark gray, very dark gray, or very dark grayish brown.

The upper C horizons are very pale brown, pale brown, light yellowish brown, yellow, brownish yellow, and yellowish brown.

The lower C horizons are grayish brown, light brownish gray, gray, light olive gray, or light gray.

9. COROLLA-DUCKSTON complex

   a. Corolla - see description 7

   b. Duckston - see description 12

10. DREDGE SPOIL - No description provided.

11. HOBONNY SOILS - A typical profile of Hobonny soils from an area of Hobonny mucky peat is in Dare County, approximately two miles west of the Atlantic Ocean at Nags Head and 100 feet east of Roanoke Sound in a marsh.

0i1--0 to 16 inches; dense root mat and decaying fibers; estimated 60 percent live roots; strongly acid; gradual wavy boundary.

0a1--16 to 30 inches; very dark grayish brown (10YR 3/2) sapric material; about 65 percent unrubbed fibers, 5 percent rubbed; massive; friable; strong sulfur odor; squeezes easily between fingers; strongly acid; gradual wavy boundary.

0a2--30 to 60 inches; dark greenish gray (5GY 4/1) sapric material; about 50 percent unrubbed fibers, 5 percent rubbed; massive; friable; squeezes easily between fingers; strong sulfur odor; strongly acid.

The organic material in the surface layer is dark reddish brown, very dark grayish brown, dark grayish brown, grayish brown, or gray.

The underlying organic material is dark reddish brown, very dark brown, dark brown, very dark grayish brown, dark grayish brown, or dark greenish gray.

12. DUCKSTON FINE SAND - A typical profile of Duckston fine sand is in Dare County approximately one mile southeast of Wright Memorial at Kill Devil Hills, 0.25 mile west of beach and 150 feet east of U.S. 158 bypass.

A11--0 to 3 inches; very dark grayish brown (10YR 3/2) fine sand; single grained; loose; many fine and medium roots; medium acid; clear smooth boundary.

A12--3 to 8 inches; dark grayish brown (10YR 4/2) fine sand; common medium distinct yellowish brown (10YR 5/6) stains around roots; single grained; loose; many fine and medium roots; common dark brown milky minerals; medium acid; clear smooth boundary.

A13--8 to 13 inches; light brownish gray (10YR 6/2) sand; common medium distinct yellowish brown (10YR 5/6) stains around roots; single grained; loose; many fine and medium roots; common dark brown milky minerals; medium acid; clear smooth boundary.

Alb--13 to 17 inches; dark gray (10YR 4/1) sand; single grained; loose; few pieces of undecomposed plant materials; slightly acid; clear smooth boundary.

Cg--17 to 60 inches; gray (5Y 5/1) sand; single grained; common fine opaques; common minerals of various colors; neutral.

The A horizon is dark gray, dark grayish brown, very dark grayish brown, grayish brown, light brownish gray, or gray. The Alb horizon, where present, is similar to the A horizon and contains few to common pieces of undecomposed plant materials.

The Cg horizon is gray, grayish brown, light grayish brown, light gray, or olive gray.

13. DUCKSTON FINE SAND, forested - A typical profile of Duckston fine sand, forested is in Currituck County approximately 3,500 feet west of the Atlantic Ocean and 50 feet south of the North Carolina-Virginia state line at marker.

Oil--3 inches to 0; layer of pine needles, leaves, and twigs.

Al--0 to 3 inches; very dark grayish brown (10YR 3/2) fine sand; moderate medium granular structure; very friable; common fine roots; common clean sand grains; very strongly acid; clear smooth boundary.

C1--3 to 9 inches; grayish brown (10YR 5/2) sand; single grained; loose; few fine roots; few organic stains and coatings; very strongly acid; clear smooth boundary.

C2--9 to 17 inches; olive gray (5Y 5/2) sand; single grained; loose; few opaques; strongly acid; gradual wavy boundary.

C3g--17 to 60 inches; greenish gray (5GY 5/1) sand; single grained; loose; common opaques; slightly acid.

The A horizon is dark gray, dark grayish brown, very dark grayish brown, grayish brown, light brownish gray, or gray.

The C horizons are gray, grayish brown, light brownish gray, light gray, olive gray, or greenish gray.

14. DUNELAND - No description provided.

15. FRIPP FINE SAND - A typical profile of Fripp fine sand is in Dare County approximately 0.5 mile south of U. S. 158 and Kitty Hawk School, 150 feet west of state-maintained dirt road (Dogwood Trail).

A1--0 to 4 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; few fine and medium roots; neutral; clear wavy boundary.

C1--4 to 26 inches; yellow (10YR 7/6) fine sand; single grained; loose; neutral; clear wavy boundary.

C2--26 to 48 inches; very pale brown (10YR 7/4) fine sand; single grained; loose; neutral; clear wavy boundary.

C3--48 to 62 inches; very pale brown (10YR 7/3) fine sand; single grained; loose; neutral.

The A horizon is light gray, light brownish gray, grayish brown, or dark grayish brown fine sand or sand.

The upper C horizons are very pale brown, pale yellow, brown, strong brown, yellow, brownish yellow, and yellowish brown. The lower C horizons are light gray, white, very pale brown, pale yellow or yellow. The C horizon is sand or fine sand.

16. LEVY SOILS - A typical profile of Levy silty clay is in Currituck County on a marsh island, 4,000 feet north of Pine Island Hunt Club.

A1g--0 to 16 inches; dark greenish gray (5GY 4/1) silty clay; massive; very sticky, flows easily between fingers; common fine and medium live roots and fibers; strong sulfur odor, extremely acid; gradual diffuse boundary.

Cg--16 to 60 inches; dark greenish gray (5GY 4/1) and very dark grayish brown (10YR 3/2) silty clay; massive; sticky, flows easily between fingers; few reddish brown stains and "nodules" in upper part; strong sulfur odor; very strongly acid.

The A horizon is very dark gray, very dark grayish brown, dark gray, grayish brown, light brownish gray, dark greenish gray, or very pale brown silty clay loam, silty clay, or clay.

The C horizon to a depth of at least 40 inches below the mineral surface is very dark gray, very dark grayish brown, dark gray, dark greenish gray, greenish gray, dark grayish brown, gray, or light brownish gray clay or silty clay.

17. MADELAND - No description provided.

18. CARTERET SOILS, high - A typical profile of Carteret soils, high is in Onslow County, about 0.5 mile south of New River Inlet, and 0.5 mile west of county road 1568.

01--5 inches to 0; black (10YR 2/1) live and dead roots that form a root mat.

A1--0 to 5 inches; dark gray (N 4/) loamy sand; massive; loose, slightly sticky, slightly plastic; mildly alkaline; clear wavy boundary.

C1--5 to 24 inches; gray (N 6/) sand; single grained; loose, slightly sticky; slightly plastic; mildly alkaline; clear wavy boundary.

C2--24 to 55 inches; dark gray (N 4/) sand; single grained; loose; slightly sticky, slightly plastic; mildly alkaline.

The A1 horizon is dark gray, very dark gray, very dark grayish brown, dark grayish brown, dark olive gray, or dark greenish gray loamy sand or sand.

The Cg horizon is greenish gray, dark greenish gray, gray, or dark gray loamy sand, sand, or gravelly sand. In some profiles, thin intermittent layers of clay or silty clay loam occur throughout the soil.

19. CARTERET SOILS - A typical profile of Carteret soils from an area of Carteret sand is on Ocracoke Island, 50 feet west of N. C. Highway 12 across from the airstrip.

A1g--0 to 5 inches; gray (5Y 6/1) sand; few medium faint gray (N 5/) mottles; single grained; loose; many fine roots; common shell fragments; neutral; gradual wavy boundary.

Cg--5 to 60 inches; gray (5Y 5/1) sand; few medium faint gray (N 5/) mottles in upper few inches; single grained; loose; common fine roots in upper part; common shell fragments; neutral.

The Al horizon is gray, dark gray, or very dark gray sand or loamy sand.

The Cg horizon is gray, dark gray, or greenish gray sand or loamy sand.

20. CURRITUCK SOILS - A typical profile of Currituck soils is in Currituck County approximately 4.5 miles south of Corolla and 1.1 miles northwest of Currituck Shoot Club Hunting Lodge; 0.8 mile west of Atlantic Ocean, 450 feet west of woods and 50 feet north of improved hunting path, in marsh.

0el--0 to 14 inches; very dark grayish brown (10YR 3/2, broken face and rubbed) hemic material; about 80 percent fiber, 36 percent rubbed; massive; friable, many fine to coarse roots, mostly from black needlerush; almost 100 percent herbaceous; mineral content about 15 percent; very strongly acid; gradual wavy boundary.

0al--14 to 28 inches; very dark grayish brown (2.5YR 3/2, broken face and rubbed) sapric material; about 36 percent fibers, 4 percent rubbed; massive; very friable; common medium and coarse roots, mostly from black needlerush; almost 100 percent herbaceous; mineral content about 60 percent; extremely acid; clear wavy boundary.

IICg--28 to 60 inches; greenish gray (5GY 5/1) sand; single grained; loose; common medium flakes of mica; common fine opaque; extremely acid.

The 0e horizon is very dark brown, dark brown, very dark grayish brown, or dark grayish brown muck or mucky peat.

The 0a horizon is black, dark olive gray, greenish gray, dark greenish gray, very dark brown, very dark grayish brown, or dark grayish brown muck.

The IIC horizon is gray, dark gray, greenish gray, or dark greenish gray sand or loamy sand.

21. NEWHAN FINE SAND - A typical profile of Newhan fine sand is in New Hanover County, at the north end of Carolina Beach, about 0.4 mile north of Johnnie Mercer's fishing pier and 0.2 mile west of surf in beach dunes.

Al--0 to 2 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; few fine roots; mildly alkaline; clear wavy boundary.

C1--2 to 50 inches; light gray (10YR 7/2) fine sand; single grained; loose; sands are mainly rounded quartz grains; about 5 percent of the grains are black and dark brown; common fragments from colored marine shells; mildly alkaline; gradual wavy boundary.

C2--50 to 72 inches; light gray (10YR 7/2) sand; single grained; loose; sands are mainly rounded quartz grains; about 5 percent of the grains are black and dark brown; common small, medium and large fragments of marine shells; few whole shells; mildly alkaline.

The A horizon, where present, is gray or grayish brown fine sand or sand.

The C horizon is light gray or white fine sand or sand.

22. NEWHAN-COROLLA complex

    a. Newhan - see description 21

    b. Corolla - see description 7

23. DUNELAND-NEWHAN complex

    a. Duneland - No description provided.

    b. Newhan - see description 21

24. NEWHAN-URBAN LAND complex

    a. Newhan - see description 21

    b. Urban Land - No description provided.

25. WANDO FINE SAND - A typical profile of Wando fine sand is in Brunswick County, on Oak Island; 1,320 feet north of the intersection of 61 Street and Yaupon Drive, and 20 feet east of 61 Street in the woods.

A1--0 to 2 inches; dark gray (10YR 4/1) fine sand; single grained; loose; many fine and common medium roots; many uncoated sand grains giving a "salt and pepper" appearance; very strongly acid; clear smooth boundary.

C1--2 to 32 inches; reddish yellow (7.5YR 6/8) fine sand; single grained; loose; common fine and medium roots; strongly acid; gradual wavy boundary.

C2--32 to 40 inches; yellowish red (5YR 5/6) fine sand; single grained; loose; few fine and medium roots; medium acid; gradual wavy boundary.

C3--40 to 52 inches; yellowish red (5YR 5/6) loamy fine sand; single grained; loose; few medium weakly cemented red (2.5YR 4/6) concretions; medium acid; gradual wavy boundary.

C4--52 to 65 inches; strong brown (7.5YR 5/8) sand; single grained; loose; strongly acid; gradual wavy boundary.

C5--65 to 78 inches; brown (7.5YR 4/4) sand; single grained; loose; medium acid.

The A horizon is dark gray, brown, dark brown, reddish brown, dark reddish brown, or dark grayish brown.

The C horizon is reddish yellow, yellowish red, brown, strong brown, yellowish brown, brownish yellow, or yellow.

26. CONABY SOILS - A typical profile of Conaby soils from an area of Conaby muck is in Dare County approximately 1 3/4 miles north of Frisco, 2,500 feet east of N. C. 12 and 25 feet north of private road.

Oa1--0 to 3 inches; black (10YR 2/1, broken face and rubbed) sapric material; about 20 percent fiber, 10 percent rubbed; massive; friable; common fine roots; very strongly acid; clear wavy boundary.

Oa2--3 to 14 inches; very dark gray (10YR 3/1, broken face and rubbed) sapric material; about 5 percent fibers, less than 1 percent rubbed; massive; very friable; common fine roots; common clean sand grains and few pebbles; strongly acid; clear smooth boundary.

IIC1--14 to 18 inches; grayish brown (10YR 5/2) sand; single grained; loose; uncoated; few pebbles; very strongly acid; gradual wavy boundary.

IIC2--18 to 23 inches; dark yellowish brown (10YR 4/4) sand; single grained; loose; thin coatings of organic stains on sand grains; few pebbles; very strongly acid; gradual wavy boundary.

IIC3g--23 to 60 inches; gray (5Y 5/1) sand; single grained; loose; common pebbles and shell fragments; slightly acid.

The Oa horizons are black, very dark gray, very dark grayish brown, and dark reddish brown muck.

The upper IIC horizons are grayish brown, gray, dark yellowish brown, dark grayish brown, and very dark grayish brown sand.

The lower IIC horizons are gray, light gray, light olive gray, and olive gray sand.

27. ECHAW FINE SAND - A typical profile of Echaw fine sand is in Carteret County, on Harkers Island; 0.3 mile south of Harkers Island bridge on SR 1335; 50 feet east on unpaved road and 30 feet south of road.

A1--0 to 5 inches; gray (10YR 6/1) fine sand; weak fine granular structure; very friable; many fine and medium roots; very strongly acid; abrupt smooth boundary.

A2--5 to 46 inches; light gray (10YR 7/1) fine sand; single grained; loose; very strongly acid; abrupt smooth boundary.

B21h--46 to 51 inches; very dark brown (10YR 2/2) sand; massive; weakly cemented and brittle; medium acid; gradual wavy boundary.

C1 and B22h--51 to 80 inches; strong brown (7.5YR 5/6) sand; single grained; loose; many nodules and occasional lamellae about 1/2 inch thick of dark brown (7.5YR 3/2) sand that are weakly cemented and brittle; medium acid; gradual boundary.

C2--80 to 106 inches; very pale brown (10YR 7/3) sand; single grained; loose; medium acid.

The A1 horizon is gray, dark gray, or very dark gray. The A2 horizon is light gray, gray, or light brownish gray. The A horizon is loamy sand, loamy fine sand, fine sand, or sand.

The Bh horizon is very dark brown, dark brown, or very dark grayish brown loamy fine sand, loamy sand, fine sand, or sand.

The C horizon is very pale brown, pale brown, or gray loamy fine sand, loamy sand, fine sand, or sand.

28. KUREB FINE SAND - A typical profile of Kureb fine sand is in Brunswick County, on Long Beach; 50 feet south of intersection of Oak Island Drive and East Street; 25 feet west of road, in a wooded area.

A1--0 to 4 inches; very dark gray (10YR 3/1) "salt and pepper" fine sand; single grained; loose; common medium and coarse roots; abrupt wavy boundary.

A2--4 to 20 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; few fine and medium roots; abrupt smooth boundary.

A2 & Bh--20 to 28 inches; light yellowish brown (10YR 6/4) and dark reddish brown (5YR 3/4) fine sand; single grained and massive; loose and very friable; few fine roots; the Bh makes up about 20 percent of this horizon; gradual wavy boundary.

C1--28 to 40 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; few fine roots; gradual wavy boundary.

C2--40 to 62 inches; very pale brown (10YR 7/3) fine sand; single grained; loose.

Thickness of the sandy horizons is more than 80 inches. Soil reaction ranges from neutral to very strongly acid. All horizons are fine sand or sand. Silt plus clay is less than 5 percent. The Bh is intermittent bands, lumps, and vertical streaks scattered throughout the A2 horizon.

29. CURRITUCK SOILS, high - A typical profile of Currituck soils, high is in Currituck County, approximately four miles south of the Virginia state line and 3/4 mile west of the Atlantic Ocean.

Oi1--0 to 8 inches; dark brown (10YR 3/3) fibric material composed of live and partially decayed roots; gradual wavy boundary.

C1g--8 to 24 inches; light gray (5GY 6/1) sand; single grained; loose; few medium roots; few opaques; few medium flakes of mica; very strongly acid; gradual wavy boundary.

C2g--24 to 60 inches; greenish gray (5GY 5/1) sand; single grained; loose; few medium roots; few opaques; few medium flakes of mica; extremely acid.

The surface horizon is dark brown, black, very dark gray, very dark grayish brown, or dark reddish brown fibric material or muck.

The Cg horizons are gray, light gray, light olive gray, greenish gray, and olive gray sand.

31. BOHICKET SOILS, high - A typical profile of Bohicket soils, high is in Brunswick County about 100 feet from the south end of Oak Island Bridge, 75 feet west of bridge in a marsh.

O1--10 inches to 0; fine and medium roots and stems of black needlerush; and partially decomposed organic matter; clear wavy boundary.

A1g--0 to 15 inches; very dark gray (10YR 3/1) silty clay; massive; sticky, soil flows easily between fingers when squeezed; many fine roots and partially decomposed needlerush stems; moderately alkaline; gradual wavy boundary.

C1g--15 to 25 inches; dark gray (5YR 4/1) silty clay; massive; sticky, soil flows easily between fingers when squeezed; moderately alkaline; gradual wavy boundary.

C2g--25 to 62 inches; dark gray (5YR 4/1) silty clay with lenses of loamy sand; massive; sticky, soil flows easily between fingers when squeezed; moderately alkaline.

These soils are irregularly flooded and are continuously saturated with sea water. Soil salinity is high. The O1 horizon ranges from 4 to 12 inches.

The A1g horizon is very dark gray, dark greenish gray, or dark gray silty clay, clay or silty clay loam.

The Cg horizon is silty clay or clay. Sandy layers are common below 6 feet.

APPENDIX II
PLANTS COMMON TO THE OUTER BANKS[19,20]

COMMON NAME	SCIENTIFIC NAME
American Beachgrass	Ammophila breuiligulata
American Beech	Fagus grandifolia
American Holly	Ilex opaca
Baldcypress	Taxodium distichum
Bitter Panicum	Panicum amarum
Black Cherry	Prunus serotina
Black Needlerush	Juncus roemerianus
Black Willow	Salix nigra
Blackgum	Nyssa sylvatica
Blueberry	Vaccinium atrococcum
Bluejack Oak	Quercus incana
Broom Sedge	Cyperus flavescens
Bulrush	Scirpus Spp.
Cabbage Palmetto	Sabal palmetto
Cattail	Typha Spp.
Cherrybark Oak	Quercus Falcata pagodaefolia
Coastal Bermudagrass	Cynodon dactylon
Coastal panicgrass (ncns)	Panicum amarulum
Devilweed	
Devilwood	Osmanthus americanus
Eastern Baccharis	Baccharis halimifolia
Eastern Redcedar	Juniperus virginiana
Eveningprimrose	Oenothera humifusa
Flameleaf Sumac	Rhus copallina

COMMON NAME	SCIENTIFIC NAME
Flowering Dogwood	Cornus florida
Giant Cordgrass	Spartina cynosuriodes
Greenbrier	Smilax
Hickory	Carya Spp.
Largeleaf pennywort (ncns)	Hydrocotyle bonariensis
Live Oak	Quercus virginiana
Loblolly Pine	Pinus taeda
Longleaf Pine	Pinus palustris
Marshelder	Iva frutescens
Muscadine grape	Vitis rotundifolia
Northern Bayberry	Myrica pensylvanica
Persimmon	Diospyros virginiana
Ragweed	Ambrosia artemisiifolia
Red Maple	Acer rubrum
Redbay	Persea borbonia
Saltgrass	Distichlis spicate
Saltmeadow Cordgrass	Spartina patens
Saltwort	Sulicornia Spp.
Sawgrass	Cladium jamaicensis
Sea-oats	Uniola paniculata
Sea Oxeye	Borrichia frutescens
Sea Rocket	Cakile edentyla
Seacoast Bluestem	Andropogon scoparius var. littoralis
Seashore Elder	Iva imgricata
Seaside Goldenrod	
Silver-leaf Croton	Croton punctatus

COMMON NAME	SCIENTIFIC NAME
Smooth Cordgrass	Spartina alterniflora
Sweetgum	Liquidambar styraciflua
Three-square	Scirpus olneyi
Turkey Oak	Quercus laevis
Virginia Creeper	Parthenocissus quinquefolia
Water Oak	Quercus nigra
Waxmyrtle	Myrica cerifera
Wild Olive	Osmanthus americana
Yaupon Holly	Ilex vomitoria

APPENDIX III
PERMIT REQUIREMENTS FOR DEVELOPMENT ON THE OUTER BANKS

The Coastal Area Management Act of 1974 (GS 113A, Article 7) establishes a comprehensive program of land use planning and management of the twenty coastal counties of North Carolina, which includes that portion of the Outer Banks in eight of the twenty counties. The Act provided for the designation of Areas of Environmental Concern (AEC), and approval of standards and supervision of permits for development within such areas. Areas of Environmental Concern are areas where environmental conditions are such that special care needs to be exercised when such areas are altered or developed. A list of AEC type areas are included in the Act, with the provision that the Coastal Resources Commission (established in the NCDNER) select from the list specific AEC's in the twenty coastal counties.

The Coastal Area Management Act did not preclude development from taking place within AEC's. However, development must be compatible with the fragile nature or special land use limitations of the AEC's.

State laws vary widely regarding statewide development, and only several exist specifically for the Outer Banks. Most laws are not specific and in general only prohibit certain activities. Only a few require a permit for the construction of dwellings or excavations on private property. Other statutes indirectly regulate land or water resource use and may require a permit.

G.S. 14-128.1 creates criminal sanction for the unauthorized removal of certain ornamental plants. Prohibited activities include cutting, digging, removal, and transportation of the plants.

G.S. 14-129 (same as GS 14-128.1).

G.S. 14-129.1 prohibits the sale or barter of venus flytrap except when domestically cultivated or used for scientific research.

G.S. 14-130 prohibits erection of building or removal of timber from lands owned by the State or the State Board of Education.

G.S. 14-133 prohibits erection of islands and lumps in public (navigable) waters east of the "Atlantic Coast Line Railroad running from Wilmington to Weldon."

G.S. 14-134.1 prohibits unauthorized dumping on private land or public waters.

G.S. 68-42(1) prohibits parties from allowing their stock to run at-large on the Outer Banks of N. C. (2) exception is made for the Shackelford and Okracoke ponies in Hyde and Carteret Counties.

G.S. 74-39 requires registration of all mining operations, including a summary of conservation and land reclamation plans.

G.S. 74-46 requires a permit to engage in mining operations, which allows for supervision of surface and groundwater quality, air, and environmental quality, and requires a suitable reclamation plan.

G.S. 76-40(1) prohibits dumping of wastes in navigable waters. (2) prohibits erection of signs or other structures without a permit from Department of Administration or the appropriate federal agencies. (3) requires removal of such structures by the owner within 30 days of abandonment.

G.S. 87-81 regulates construction, operation, and maintenance of wells. It also requires prior permission for construction of any well with a capacity of 100,000 gallons a day or greater, or any well in a hydrologically sensitive area (G.S. 87-88). It requires all wells to meet certain construction standards set out in regulations adopted by EMC.

It requires testing and chlorination of water-supply wells and prohibits the contamination of any water supply.

Artesian wells must be equipped with valves so that they can be shut off when not in use.

G.S. 104B-3(1) provides for counties to adopt ordinances to enforce provisions of Act, otherwise the Act is enforced by DNER. (2) requires permit for alteration, destruction, development, and construction of sand dunes, seaward of shore protection line without permit from DNER or local government. (3) prohibits construction of groins, jetties, piers, etc., without a permit from DNER.

G.S. 113-24 prohibits sale or transportation of any aquatic plant foods or other waterfowl food growing in public waters.

G.S. 113-229 requires issuance of a permit before any excavation or filling can begin in estuaries, etc.

G.S. 113-230 to protect the coastal wetlands, the Secretary of DNER is empowered to adopt, repeal, or modify any orders regulating dredge, fill, and removal operations.

G.S. 113-378 is intended to protect water, air, and soil from damage from drilling operations, and to prevent the waste of oil and gas resources.

In planning for drilling or oil exploration, the parties are required to drill in the most efficient manner possible (largely by tapping the center of the well), and to designate shares in wells where more than one owner is involved (G.S. 113-391, 392, 393).

G.S. 113A-30 provides for the classification of "natural and scenic" rivers that meet certain criteria, and protects the environmental quality of rivers so designated. More specifically, the Act is applicable to the southern section of the Outer Banks where rivers and streams empty directly into the ocean.

G.S. 130-169.01 gives power to the Department of Human Resources to regulate the sanitary aspect of harvesting, handling, and processing shellfish, scallops, and shrimp.

G.S. 143-214.2 prohibits discharge of wastes, including thermal discharges, in the Atlantic Ocean.

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GLOSSARY

1. Berm - The slightly higher portion of the beach that is not covered by normal tidal action.

2. Biotic Community - Relates to animal, plant, and living organisms.

3. Deposition - Material left in a new position by some natural transporting agent such as water, wind, or gravity.

4. Foredune Soils - Are soils that are located on the foredunes, which lie adjacent to the beach.

5. Hardpan - A hardened soil layer caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides or calcium carbonate. The hardness does not change appreciably with changes in the moisture content, and pieces of the hard layer do not slake in water.

6. Hummocky - Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

7. Leaching - A process by which soluble material has been removed from the entire soil profile or has been removed from one part of the profile and accumulated in another part.

8. Migration - Movement and shifting of soil by natural elements.

9. Morphology, Soil - The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

10. Overflow - Refers to land that is covered periodically with water.

11. Overwash flats - Are nearly level, low-lying areas that receive periodic overwash water from above normal tides.

12. Pedogenic horizons - Are soil layers formed by the interactions of the soil-forming factors.

13. Perched water - The upper surface of a body of free ground water that is separated from an underlying body of ground water by unsaturated material.

14. Profile Development - Refers to the various soil layers, and changes that form in the soil as the result of soil forming process.

15. Profile, soil - A vertical section of the soil through all the horizons described.

16. Relief - The elevations or inequalities of a land surface, considered collectively.

17. Root mat - A layer containing large amounts of live roots.

18. Salinity - Relative amounts of salts in solution compared to the salt content of seawater (35 parts per thousand).

19. Surface ponding - Refers to standing water on the soil surface.

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