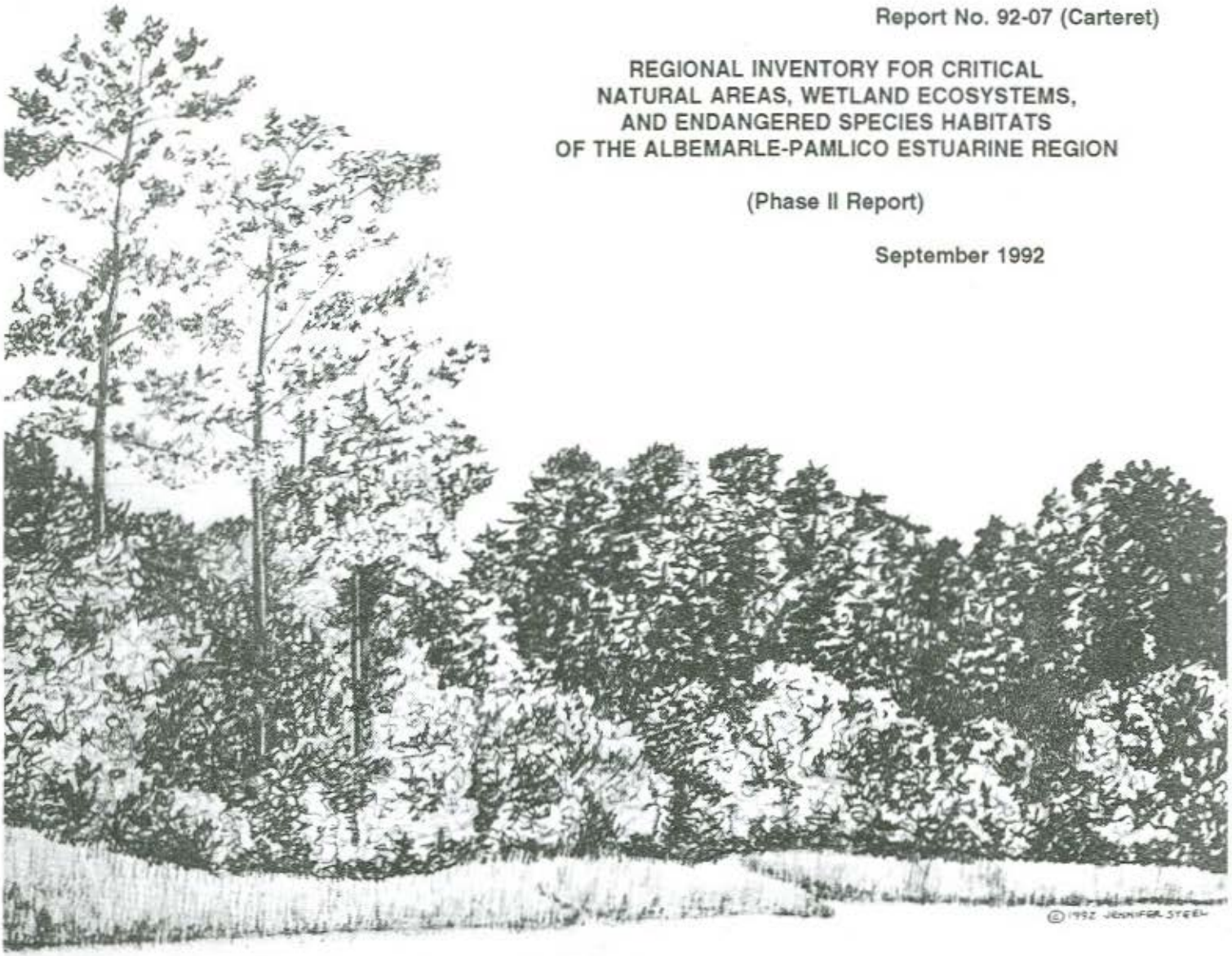
Report No. 92-07 (Carteret)

REGIONAL INVENTORY FOR CRITICAL NATURAL AREAS, WETLAND ECOSYSTEMS, AND ENDANGERED SPECIES HABITATS OF THE ALBEMARLE-PAMLICO ESTUARINE REGION

(Phase II Report)

September 1992



ALBEMARLE-PAMLICO ESTUARINE STUDY

NC Department of Environment, Health, and Natural Resources

Environmental Protection Agency National Estuary Program

REGIONAL INVENTORY FOR

CRITICAL NATURAL AREAS, WETLAND ECOSYSTEMS,

AND ENDANGERED SPECIES HABITATS

OF THE ALBEMARLE-PAMLICO ESTUARINE REGION: PHASE 2

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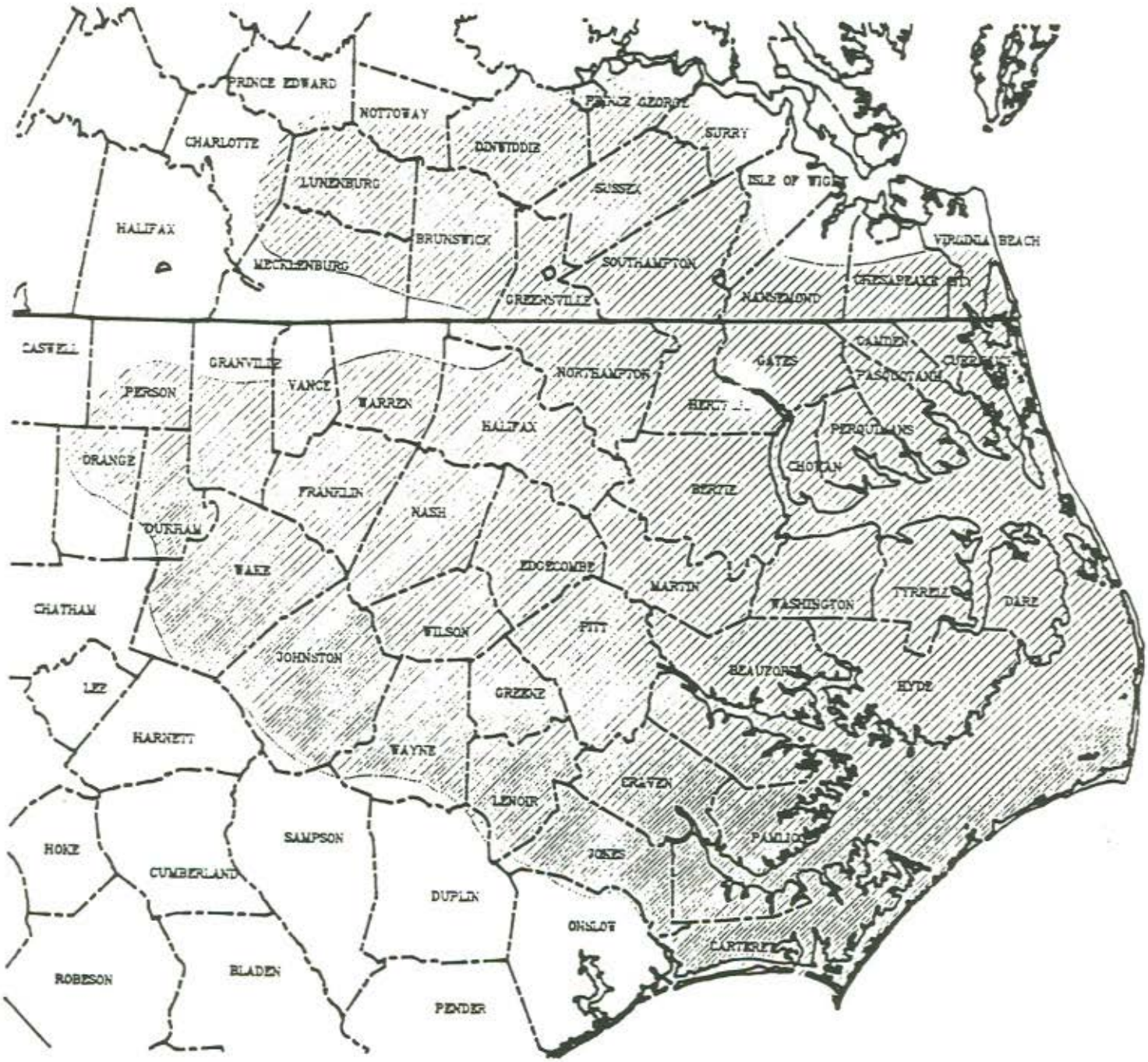
A/P Study Project No. 92-07 (Carteret)
September, 1992

NOTE TO READERS

This report contains the introductory material for the entire Phase 2 report, plus the site reports for one county. To obtain further information about the entire Phase 2 report, or other A/P Study reports, please contact the Albemarle-Pamlico Estuarine Study, 225 N. McDowell Street, Raleigh, NC 27603; phone (919) 733-0314.

ALBEMARLE - PAMLICO ESTUARINE STUDY AREA



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Several people assisted with field work, particularly Milo Pyne in Beaufort and Pamlico counties and Richard LeBlond in Pamlico County. LeBlond and John Fussell (one of the authors) simultaneously conducted rare plant surveys on Croatan National Forest while the A/P Study was in progress, and this Croatan survey provided much data for this report. Others who have conducted previous field work on several sites each, and whose published and unpublished reports were quite valuable to this report, are Merrill Lynch, Lance Peacock, Jeannie Wilson Kraus, Mike Schafale, Rick Schneider, Charles McDonald, Andrew Ash, and Charlotte Jones-Roe. Previously published county inventories for Carteret, Craven, Hyde, and Pamlico counties, funded by Coastal Energy Impact Program grants from the National Oceanic and Atmospheric Administration, were extremely helpful in the preparation of this report.

The authors also acknowledge the many landowners who gave permission to have survey work conducted on their property. These landowners were also helpful in providing information about the history of the property, as well as providing comments about potential and real threats to the property. Without such permission, this report would have been difficult to compile and would have been very incomplete.

ABSTRACT

The rapid development of North Carolina's coastal and tidewater regions has caused an urgent need to protect significant natural resources in this part of the state. However, before protection of natural resources and natural areas can be accomplished, it is important to have background information about these resources, such as locations of endangered and rare species and delineation and description of critical natural areas. The North Carolina Nature Preserves Act delegates responsibilities to the N.C. Natural Heritage Program for maintaining the statewide inventory of important natural areas and rare species habitats.

Funding from the Albemarle-Pamlico Estuarine Study has allowed a reconnaissance inventory to identify, describe, map, prioritize, and make protection recommendations for special natural areas, exceptional wetland ecosystems, and endangered and rare species habitats in 7 counties -- Beaufort, Carteret, Craven, Hyde, Jones, Pamlico, and Pitt -- adjacent to Pamlico Sound. Biologists contracted by the N.C. Natural Heritage Program have consulted other biologists familiar with these counties, in addition to reviewing soil maps, topographic maps, aerial photos, and other sources to determine sites for survey work for sites that appear to contain significant or critical natural resources.

Over 200 sites were identified from these various sources during the preliminary screening. After a visitation to a majority of these sites, a total of 106 have been identified as containing biological or physiographical significance at the national, state, or regional level.

This report is a compilation of critical natural areas, both those already under protection and those lacking protection, in addition to a discussion of endangered and rare species, wetland ecosystems and other natural communities, and the geomorphology of the 7-county region. Data from the project will be recorded in the Natural Heritage Program's central inventory management system, which is used by many other agencies for environmental impact assessment, land use planning, resource management decisions, and conservation planning. It is hoped that this report will lead to increased protection of the natural heritage of the Pamlico Sound region.

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INTRODUCTION

This report is the second of three regional inventories for critical natural areas, wetland ecosystems, and endangered species habitats in the Albemarle-Pamlico region of North Carolina. Contained in this report are natural area descriptions of 7 counties surrounding or adjacent to Pamlico Sound (hereinafter, A/P II Study): Beaufort, Carteret, Craven, Hyde, Jones, Pamlico, and Pitt. The first regional inventory, published in 1990 (Frost et al. 1990), describes natural areas and resources in 10 counties surrounding or adjacent to Albemarle Sound: Bertie, Camden, Chowan, Currituck, Gates, Hertford, Martin, Pasquotank, Perquimans, and Washington. Two counties within the A/P Study area -- Dare and Tyrrell -- were not surveyed, nor included, in any inventory because these counties had been well surveyed earlier (McDonald and Ash 1981, Peacock and Lynch 1982b). The third regional inventory will be conducted in 1991-92 for the remaining 17 North Carolina counties in the Albemarle-Pamlico Estuarine Study area. The N.C. Natural Heritage Program is administering each of these inventories with funds provided by the U.S. Environmental Protection Agency and the N.C. Department of Environment, Health, and Natural Resources.

This inventory describes the general physiographic and biological features of the 7-county area, the natural communities and rare plants and animals of the area, and (most importantly) the significant natural areas. The inventory also discusses the current protection status for the natural areas. For many of the sites, the threats to them are not known. This report is thus intended to present the biology and geomorphology of the 7-county A/P II Study area and its natural areas, and the significance of these areas, especially in relation to the State of North Carolina as a whole.

The A/P II Study area in the vicinity of Pamlico Sound lies in the Coastal Plain physiographic province and is relatively young in origin. Despite the relatively flat topography, the region contains many natural features, such as extensive pocosins, limesink ponds, and marl outcrops, that are rare on a national scale. Habitat destruction and fire suppression in the area has led to near extirpation of some original natural forest types such as Atlantic white cedar forests and oak flats, and habitat for many wildlife species has been reduced nearly to the minimum required for survival. Though urban development is not as severe a problem in this region as in other parts of the state, land clearing for agriculture and silviculture is extreme, especially in nonriverine areas such as pocosins and nonriverine hardwood flats. Current protection of significant natural areas in the 7-county region is not adequate. However, some strides appear to have been made in protection of wetland areas during in the late 1980's and early 1990's in the region. The creation of the Pocosin Lakes National Wildlife Refuge by the acquisition of over 100,000 acres of land in Hyde, Tyrrell, and Washington counties by The Conservation Fund has given protection to wetlands in the northeastern part of the A/P II Study area. Congressionally-designated Wilderness Areas and natural area registry agreements in Croatan National Forest have given protection to tens of thousands of acres of wetlands in the southern portion of the A/P II Study area. However, a considerable percentage of the natural

areas identified in this inventory are unprotected, particularly in Beaufort, Pamlico, and Pitt counties. Sites featuring nonriverine hardwoods, marl outcrops, and brownwater river forests are especially under-protected.

This inventory should be of considerable use to town and county planning agencies, State and Federal agencies, and private conservation groups in the protection of the natural areas described. It is hoped that many of these sites that are currently unprotected will be afforded protection by acquisition or other means within the coming years. Also, it is hoped that future development can be steered away from significant natural areas, even if these areas are not afforded protection.

Readers should be aware that this is, by no means, a complete inventory. Coverage of such a large area in a single calendar year (1990) is extremely difficult, especially when many sites cannot be surveyed by foot but must instead be visited by boat or plane. The authors believe that the majority of the truly significant sites, at the national and state level, are incorporated in this report, but additional field work will certainly uncover other significant areas and rare and endangered species. Additional field work in the known sites may identify new features that will change our understanding of their significance.

METHODS

A. DATA SOURCES

The authors held meetings with the staff of the N.C. Natural Heritage Program to begin the inventory of natural areas. The authors, along with sub-contractees Milo Pyne and Richard LeBlond, received guidelines from the staff on conducting field work and preparing site reports; the Heritage Program also provided the authors with site report forms for completion, so that all reports would be presented in the same format. The authors and Heritage Program staff, especially Alan Weakley, reviewed the Program's database on rare and endangered plants and animals, natural communities, and identified natural areas for sites to be included in the survey. Topographic maps, soil maps, and orthophoto maps were also reviewed for potential sites for survey work.

The authors and the sub-contractees also contacted numerous local citizens, foresters, and other biologists familiar with the 7-county area. These sources suggested additional sites that would be suitable for exploration as possible significant natural areas.

B. FIELD WORK AND COMPILATION OF NATURAL AREAS

The authors each compiled a list of sites for potential survey work during the calendar year 1990; these sites were arranged by topographic quad map. Over 200 sites were identified in the 7-county area. Because county-wide inventories of Carteret (Fussell and Wilson 1983), Craven (McDonald et al. 1981), Hyde (Lynch and Peacock 1982), and Pamlico (Peacock and Lynch 1982a) counties had previously been compiled, intensive survey work was not conducted on sites listed in these inventories. Rather, work consisted mainly of brief surveys of already identified sites in the 7 counties to determine if the sites were still significant natural areas, plus "new" field work on previously undescribed or poorly described sites. Field work began in February 1990 and continued into early 1991. The 5 surveyors completed Site Survey Report forms (designed by the N.C. Natural Heritage Program) for all sites newly identified as being significant natural areas. Obviously, not all sites checked in the field were considered to be significant; some sites identified from maps had been cut-over, some were not in a mature forest condition, and others were in a natural condition but judged not to have features of significance.

Summary information about each site was included in this report. The sites are described in the Inventory of Sites section.

C. SITE SELECTION AND RANKING OF SIGNIFICANCE

A total of 106 natural areas are described in this report. These areas were chosen because of their ecological significance, in terms of quality and integrity of the natural communities, the population size and condition of rare plants or animals, or the uniqueness or importance of the geomorphic features. For each site selected for inclusion in this report, a level of significance is designated, using National, State, and Regional (denoted A, B, and C, respectively). This designation of significance follows that of the N.C. Natural Heritage Program.

The following are descriptions of the significance categories utilized in this inventory.

A. NATIONAL significance. The natural area is considered to be of national importance. The site is one of the premier (perhaps in the top 5 or 6) natural areas of its kind in the country featuring an exemplary natural community, rare or endangered species population, or outstanding geomorphic feature. Usually such a site is in relatively undisturbed condition and is often extensive in size, or the population sizes of the significant plants and animals are large and healthy. Such a natural area is given an extremely high priority for protection.

B. STATE significance. The natural area is considered to be of statewide importance. The site contains one the best 5 or 6 examples of a given natural community, rare or endangered species population, or outstanding geomorphic feature in the state. However, there are other natural areas with similar ecological features that are more significant elsewhere in the state or in other states (i.e., of National significance). Usually the community is relatively undisturbed and the populations of the rare species are fairly large. Such a natural area is given a very high priority for protection.

C. REGIONAL significance. The natural area is considered to be of regional importance; that is, it is one of the most significant sites in that portion of the physiographic province in the state. For this report, it is one of the most significant sites in the east-central portion of the Coastal Plain. However, there are other natural areas with similar ecological features that are more significant elsewhere in the Coastal Plain of North Carolina (or elsewhere within the same region if they are of National or State significance). Such a natural area is given a high priority for protection.

It should be emphasized that the priority rankings of the natural areas in this inventory are based solely on their biological and geomorphic significance. The rankings are not based on the degree of threat or on the amount of protection afforded them.

Many of the sites are contiguous with others, and the contiguous sites taken collectively as a larger natural area would likely have a higher significance level than those of the individual sites. For example, several of the State-significant sites in northeastern Pamlico and adjacent Beaufort counties are collectively of National Significance. For further information on such "complexes" of sites, see the Discussion section.

GENERAL FEATURES

A. SURVEY AREA

This report covers a 7-county region centered on Pamlico Sound in eastern North Carolina. The 7 counties are Beaufort, Carteret, Craven, Hyde, Jones, Pamlico, and Pitt (Figure 1). The region lies in the Coastal Plain physiographic province. The survey area includes all portions of these counties with the exception of the barrier islands along the immediate coast (Ocracoke Island, Portsmouth Island, Core Banks, Shackleford Banks, and Bogue Banks). Pamlico Sound, proper, is also excluded from the survey.

These 7 counties show a wide range in population (see Table 1). Three counties contain fewer than 12,000 people each, according to the 1990 census, whereas 2 contain over 80,000 people each. The major population centers, and areas of most rapid development, are in the Morehead City - Beaufort area of Carteret County, New Bern and Havelock areas of Craven County, and Greenville area of Pitt County.

B. TOPOGRAPHY AND PHYSIOGRAPHY

The 7-county area lies on the lower terraces of the Coastal Plain, and the topography of the landscape is very subdued, particularly those portions lying near tidal waters. Elevations range from sea level (in most of the counties) to approximately 120 feet in western Jones County. Over 90% of the region can be considered flat; however, there are several areas with steep slopes. Elevation differences of more than 50 feet are found on north-facing slopes along the southern edge of the Tar River floodplain in Pitt County, and more than 30 feet along the southern edge of the Neuse River floodplain in Craven County. Highly significant topographic features include a series of north-south trending scarps that were former shorelines when the Atlantic Ocean was higher and extended much farther inland than at present. Most such scarps show only a 10- to 15-foot drop in elevation from the higher terrace on the west to the lower terrace on the east. The best-developed remnant shoreline is the Suffolk Scarp, which extends from southeastern Virginia south through eastern Gates County, western Washington County, central Beaufort County, and central Pamlico County, before becoming an insignificant landscape feature in western Carteret County. Elevation changes from west to east at the scarp show a drop from approximately 40 to 50 feet above sea level to about 15 to 20 feet above sea level.

Between the scarps, there are approximately 7 terraces in the North Carolina Coastal Plain (Stuckey 1965). Of these 7 terraces, only the lower 4 (Wicomico, Penholoway, Talbot, and Pamlico) are present in the A/P II Study area. By far the most significant is the Pamlico, which lies east of the Suffolk Scarp and ranges in elevation from sea level to approximately 25 feet; the eastern 45% of the A/P II Study area consists of the Pamlico Terrace. The Talbot Terrace lies west of the Suffolk Scarp and ranges upward to about 42 feet in elevation (Stuckey 1965). Each terrace was formed in shallow seas when the scarp to the west was the shoreline at that time. With the lowering of sea level, the terraces became exposed.

The major topographic feature of the A/P II Study area is Pamlico Sound, which is a body of brackish water ranging from Roanoke Island on the north

Figure 1. Counties and major towns in the 7-county Albemarle-Pamlico Estuarine Study region.

Table 1. Counties, county seats, area, and population of the 7-county Albemarle-Pamlico Estuarine Study region.

County	County Seat	Area [1]	Population [2]
Beaufort	Washington	826	42,283
Carteret	Beaufort	526	52,556
Craven	New Bern	701	81,613
Hyde	Swan Quarter	624	5,411
Jones	Trenton	470	9,414
Pamlico	Bayboro	341	11,372
Pitt	Greenville	657	107,924
	Total	4,145	310,573

[1] square miles

[2] 1990 census

to Cedar Island on the south, separating the mainland from the Outer Banks. It extends roughly 75 miles in length from north to south and averages 22 to 25 miles in width, with average depths only 12 to 15 feet (see Figure 2). This is an embayed area, being the drowned lower portion of the Pamlico and Neuse rivers, in part. Many of the tributary streams have also been flooded by the Holocene rise in sea level, so that much of the rivers such as Bay River and Pungo River, in addition to Pamlico River and Neuse River, are extensions of the sound rather than free-flowing rivers. Most of the tides on the sound and rivers are less than a foot; wind-driven tides are more significant than lunar ones. This tidal amplitude is in stark contrast to sounds and bays elsewhere on the Atlantic Coast, such as Chesapeake Bay, where lunar tidal amplitudes are several feet each day.

There are relatively few rivers in the A/P II Study area that are greater than 30 miles in length. Flowing rivers are confined to the western part of the study area; in the eastern part, many streams are drowned by rising seawater. There are only 2 rivers that reach into the Piedmont province -- the Tar and the Neuse. These brownwater rivers carry a high sediment load and contain rather rich mineral soils in the floodplains. The floodplains of these rivers are not as wide as that of the Roanoke to the north or the Cape Fear to the south, with the Neuse's floodplain averaging about 1.5 miles wide just above New Bern and the Tar's floodplain averaging nearly 2 miles wide just above Washington. One other river deserving mention is the Trent, which is a tributary of the Neuse; it originates just outside the A/P II Study area in southern Lenoir County and flows eastward to empty into the Neuse at New Bern. Its significance is that it flows through a region of marl (limestone) sediments, as does the Neuse in Craven County. At certain points along the banks of these 2 rivers, the marl is exposed as vertical rock formations.

Natural lakes are present in 2 cluster areas in the region. A group of 5 lakes -- Great, Catfish, Long, Little, and Ellis Simon -- is present in southern Craven, eastern Jones, and western Carteret counties, within Croatan National Forest. Three other natural lakes -- Mattamuskeet, New (also known as Alligator), and Pungo -- are present in Hyde County, in the northeastern portion of the area. These lakes are all believed to have been formed by fires that burned deeply into the peat layer. The depressions caused by the fires eventually became water-filled by rainfall and by the high water table present throughout nearly all of the study area. Two other natural lakes in Hyde County -- Swan Creek and Lost -- have a distinct drainage to the embayed Alligator River and might have been formed by peat burns or might be embayed portions of the creeks along which they lie. Most of the peat-burn lakes have no outlet flow, or very diffuse outlet flow, except through man-made canals. Inlet streams are also poorly developed or nonexistent; therefore, the lakes are largely fed by rainfall.

In addition to natural lakes, the A/P II Study area contains a number of natural limesink ponds and Carolina bays. The limesink ponds are clustered in the western part of Carteret County, within Croatan National Forest. Although there is some question as to whether Patsy Pond is a limesink pond or is a pond created by blockage of flow of a stream, there is little question that there are several dozen small (mostly less than an acre each) ponds in the southern portion of Croatan that were formed by a sinking of the surface sediments caused by solution of underlying marl. None of the Carolina bays are water-filled, unlike those in the vicinity of Bladen County. However, there are numerous Carolina bays scattered in the A/P II Study area, some of

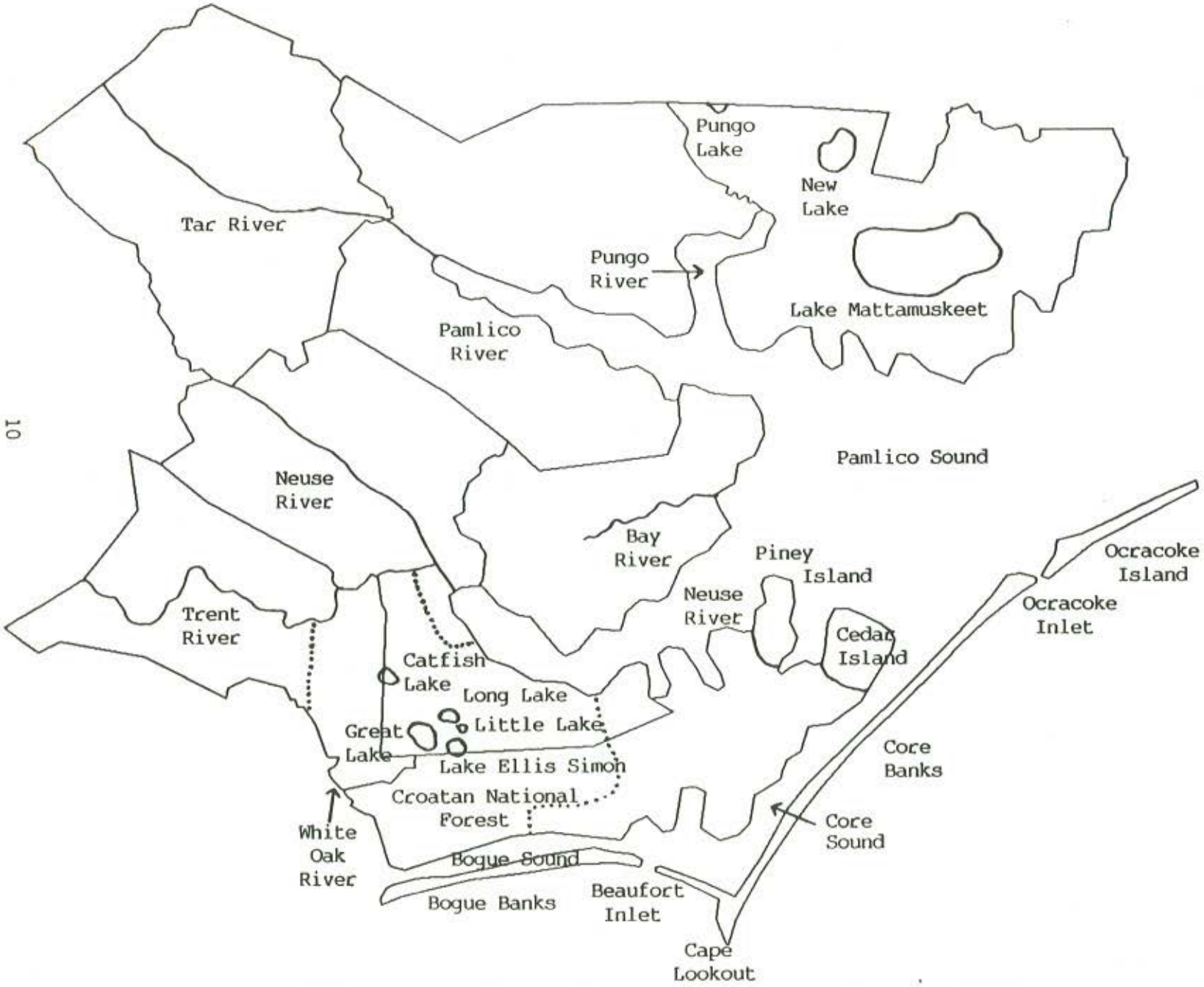


Figure 2. Major physiographic features in the 7-county Albemarle-Pamlico Estuarine Study region.

which are over 1/2-mile in length. There is a cluster of bays in extreme eastern Carteret County (sites CA22 and CA24), a cluster in western Carteret County (Site CA7), a cluster in northwestern Craven County (Site CR1), and a cluster in northwestern Pitt County (Site PI2), in addition to scattered bays elsewhere. As with all bays, they are oriented in a northwest-southeast manner and have an elliptical shape, frequently with a sand rim on the southeastern edge of the bay. Bays in the study area are filled with peat or mucky mineral soils and contain either pocosin or swamp vegetation.

Though not natural, old millponds may often function as natural ecosystems, with the same communities, plants, and animals as beaver ponds. There are relatively few millponds in the study area, and only one -- Walkers Millpond (Site CA16) -- is considered highly significant on a biological basis.

Another topographic feature of significance is the extensive flat and poorly-drained basins present in the region, particularly on the Pamlico Terrace east of the Suffolk Scarp. These basins contain (or contained) pocosins, nonriverine swamps, and nonriverine wet hardwoods; these basins include Light Ground Pocosin, Open Ground Pocosin, and Gum Swamp, among others. Many lie just east of scarps and receive moisture by seepage of ground water flow from the higher ground on the west of the scarp. The natural lakes mentioned above all lie in such extensive basins, which were once flat areas of former sea floors. Many basins are peat domes that are slightly raised in the center.

C. GEOLOGY

The geology of the A/P II Study area is rather complex. However, all of the surficial materials in the region are sediments deposited in shallow waters of the Atlantic Ocean when the area was submerged, or are recently deposited riverine sediments in floodplains. The oldest sediments at the surface are of the Cretaceous Period age, from the late Mesozoic Era, and are over 63 million years in age. These sediments are exposed along the Tar River in Pitt County, in southern Pitt County, and in western Jones County (Figure 3). Farther eastward, the surficial sediments are of younger age, with the Suffolk Scarp separating the Tertiary Period (of the Cenozoic Era) deposits from the even younger Quaternary Period deposits east of the scarp. The oldest of the Cenozoic formations -- the Beaufort Formation -- occurs in an extremely limited area in northwestern Craven County and is not portrayed in Figure 3. The Castle Hayne Formation is slightly younger than the Beaufort Formation, being of Eocene Epoch time -- 57 to 36 million years ago (Carter et al. 1988). This is a significant formation because of its limestone/marl character; exposures of marl occur where streams have eroded into the beds of the formation. The younger River Bend and Belgrade formations also contain considerable marl content with numerous fossils where the formations appear at the immediate surface. All 3 of these formations are essentially limited in the A/P II Study area to Craven and Jones counties, which corresponds to the region where marl outcrops are found along bluffs of the Neuse and Trent rivers and several of their tributaries. The Yorktown and Duplin formations were formed during the Pliocene Epoch, from 5.3 to 1.8 million years ago, and they contain some marl, as well as limesink ponds. However, no significant marl outcrops are known in association with these formations. East of the

Figure 3. Generalized view of the geologic formations and significant geologic features in the 7-county Albemarle-Pamlico Estuarine Study region. The asterisks are locations of significant marl outcrops. The dashed lines separate formations of different geologic periods, whereas the dotted lines separate formations within the same geologic period. All descriptions below are from the N.C. Geological Survey (1985).

Cretaceous Period (Mesozoic Era)

Cape Fear Formation (C-CF). Sandstone and sandy mudstone, yellowish gray to bluish gray, mottled red to yellowish orange, indurated, graded and laterally continuous bedding, blocky clay, faint cross-bedding, feldspar and mica common.

Black Creek Formation (C-BC). Clay, gray to black, lignitic; contains thin beds and laminae of fine-grained micaceous sand and thick lenses of cross-bedded sand. Glauconitic, fossiliferous clayey sand lenses in upper part.

Peedee Formation (C-P). Sand, clayey sand, and clay, greenish gray to olive black, massive, glauconitic, fossiliferous and calcareous. Patches of sandy molluscan-mold limestone in upper part.

Tertiary Period (Cenozoic Era)

Castle Hayne Formation (T-CH).
Spring Garden Member: Molluscan-mold limestone, indurated, very sandy. Grades downward into a calcareous sand and laterally into Comfort Member.
Comfort Member: Bryozoan-echinoid skeletal limestone, locally dolomitized, solution cavities common.
New Hanover Member: Phosphate-pebble conglomerate, micritic, thin; restricted to basal part of Castle Hayne Formation in southeastern counties.

River Bend Formation (T-RB). Limestone, calcarenite overlain by and intercalated with indurated, sandy, molluscan-mold limestone.

Belgrade Formation, Undivided (T-B).
Pollocksville Member: Oyster-shell mounds in tan to orange sand matrix, indurated locally.
Haywood Landing Member: Fossiliferous clayey sand, gray to brown.
Members grade into each other laterally.

Figure 3. (continued)

Yorktown Formation and Duplin Formation, Undivided (T-YD and T).
Yorktown Formation: Fossiliferous clay with varying amounts of fine-grained sand, bluish gray, shell material commonly concentrated in lenses; mainly in area north of Neuse River.
Duplin Formation: Shelly, medium- to coarse-grained sand, sandy marl, and limestone, bluish gray; mainly in area south of Neuse River.

Quaternary Period (Cenozoic Era)

Surficial Deposits, Undivided (Q). Sand, clay, gravel, and peat deposited in marine, fluvial, eolian, and lacustrine environments.

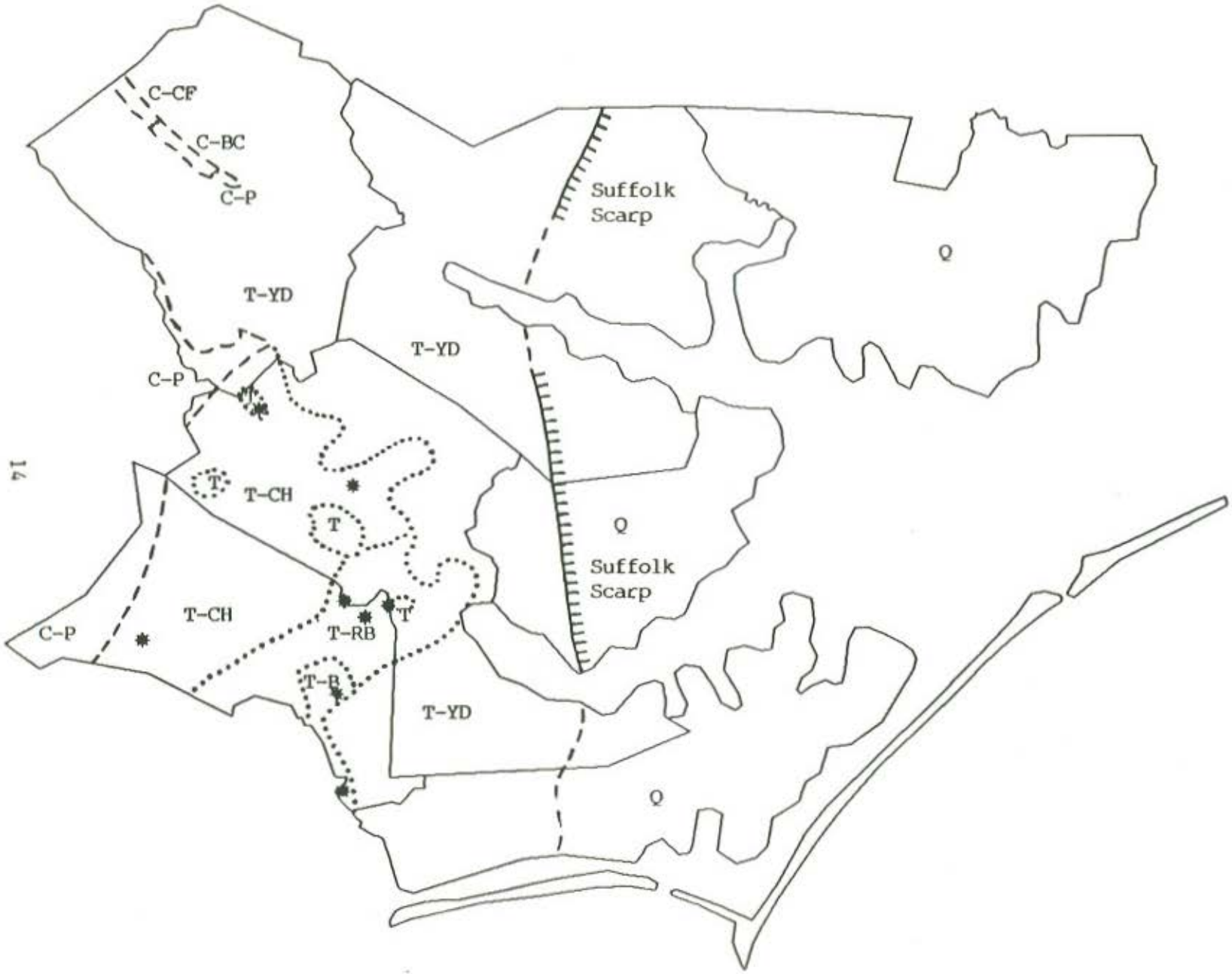


Figure 3. Generalized view of the geologic formations and significant geologic features in the 7-county Albemarle-Pamlico Estuarine Study region.

Suffolk Scarp, the surficial deposits are undivided and are only about 40,000 years old (Oaks and DuBar 1974).

There are several sites in the region where marl outcrops are easily seen at the surface. These are essentially limited to vertical banks of rivers and creeks that have eroded downward into the marl deposits. The Trent River in Jones and Craven counties, and the Neuse River in Craven County, contain several marl outcrops, primarily on the south banks. Fossils are often found at these marl outcrops, but of more significance to this inventory is the presence of rare plants and rare natural communities at the marl outcrops. Carter et al. (1988) give information about locations and descriptions of fossil-bearing sites.

Pamlico Sound, the dominant physical feature of the A/P II Study area, was formed more recently than the terraces and represents the embayed portion of the Pamlico/Tar River and Neuse River floodplains that were flooded when the seas began to rise after the close of the Wisconsin glacial period (Ice Age). The Atlantic Ocean and Pamlico Sound are rising; in 1,000 years much of land east of the Suffolk Scarp, particularly much of Hyde County, will be flooded.

A scattering of Carolina bays are located in the A/P II Study area, with the heaviest concentrations in Carteret and Craven counties. However, this number of bays is miniscule compared to the many thousands present in the southern half of the state's Coastal Plain. The origin of these geomorphic features has long been controversial, and no conclusive explanations have been presented. Probably the most widely "accepted" theory is that the bays, which are elliptical in shape and oriented generally in a northwest-southeast direction, were formed when the receding seas left behind shallow pools of water, which were shaped into elliptical bodies by wind action on the water.

D. LAND USE

The 7-county A/P II Study area contains somewhat equal amounts of wooded and non-wooded land. Major blocks of forested land occur in Croatan National Forest in western Carteret, southern Craven, and eastern Jones counties. Other heavily forested areas in natural vegetation include much of mainland Hyde County, part of Pamlico County, and scattered areas elsewhere.

Forestry is a major land use in the region. Many of the former nonriverine hardwood forests and pocosins have been drained, cleared, and planted in loblolly pines (Pinus taeda) for future timber harvest. Riverine forests, for the most part, have been selectively cut for valuable timber species such as bald cypress (Taxodium distichum); large-scale clearcutting has not occurred in most floodplains. Most of the forested lands in Pitt, Beaufort, and the western halves of Craven and Jones counties either exist in pine plantations or in successional stages of natural vegetation. Because the great preponderance of the forested land in the study area exists as successional stages or in pine plantations, generalizations about percentage of forest land is difficult and can be misleading. It certainly is not safe to say that because a county is primarily forested it contains an abundance of natural areas or high-quality natural communities.

Probably 40-50% of the land area has been cleared for agriculture and development. Crops such as soybeans, corn, and wheat are commonly grown. On the other hand, livestock farming is not prevalent and is a declining industry

in the region. However, there is a major "superfarm" of approximately 60 square miles in Carteret County that contains a high percentage of pastures for cattle. Several other "superfarms" of considerably more than 10,000 acres are present in the northern half of Hyde County and in Beaufort County.

Peat mining has occurred in former pocosin land in northern Hyde County and in northeastern Beaufort County, but such mining has come under heavy environmental pressures in recent years, and the activity is on the wane. Phosphate mining in Beaufort County has caused environmental problems in the Pamlico River, as well as eliminating thousands of acres of wetlands and uplands onshore.

The A/P II Study area is a mix of many remote, sparsely populated areas and rapidly growing areas. Greenville is the only town with a population over 25,000, but the areas around Washington, New Bern, Havelock, and the Morehead City - Beaufort vicinity contain over 10,000 people each. On the other hand, 3 of the 7 counties contain no towns of over 1,000 people -- Hyde, Jones, and Pamlico, and most of the eastern half of Beaufort County is decidedly rural. However, rapid development is not limited to the major towns. New housing developments are springing up along essentially all upland shorelines of estuaries, especially along Bogue Sound of southern Carteret County, along the Neuse River in southeastern Craven and Pamlico counties, and along the Pamlico River in Beaufort County.

Tourism is a fairly important industry in the region, especially in Carteret County, which lies along the coast. Much recreation occurs in Croatan National Forest, and boating and sailing are popular on the Pamlico and Neuse rivers, among other areas. Lake Mattamuskeet is a popular tourist attraction for wildlife enthusiasts.

Hunting and fishing are major pastimes. Hyde County is nationally known for waterfowl hunting at Lake Mattamuskeet and at private preserves. A number of waterfowl impoundments, both private and public, attract hunters to coastal areas of Pamlico and Carteret counties. Hunting is also popular in Croatan National Forest and at other forested sites throughout the region. Both recreational and commercial fishing are important activities, and Pamlico Sound and other estuaries are critical sites for commercial fishing.

E. NATURAL COMMUNITIES

E. 1. General Comments

A general summary of the natural communities found in the 7-county A/P Study area is presented in Table 2. The names of the communities on the table, as well as in the text, are taken from Classification of the Natural Communities of North Carolina, Third Approximation (Schafale and Weakley 1990), with a few exceptions. For the purpose of this study, some of the community types were further divided into subtypes or variants not recognized by Schafale and Weakley (1985).

Determination of natural communities is often a difficult task. Some sites of natural vegetation appear to represent mosaics of two or more communities, as with most of the marshes in the study area and with many sites featuring a mix of bay, pocosin, and swamp vegetation. In other cases, sites are easily determined to be a given natural community, but the margins usually grade into other communities in an indistinct manner. Perhaps

Table 2. Remnant natural communities, their abundance, and their locations, in the 7-county Albemarle-Pamlico Estuarine Study region. Names of the communities are from Schafale and Weakley (1990), with the following exception: * = community that is described in this A/P Study report.

Community, Abundance, Condition, and General Location	Exemplary Sites
TERRESTRIAL COMMUNITIES	
Mesic Mixed Hardwood Forest, Bluff/Slope variant Uncommon, over the inland three-fourths of the A/P Study area, mainly in ravines and floodplain slopes; many sites in good to excellent condition	BE1,BE12,BE14,CR2, CR10,CR15,JO3,JO8, JO9,PA11,PI3,PI4, PI5,PI6
Mesic Mixed Hardwood Forest, Upland Flats variant Apparently very rare in the A/P Study area; on flat terraces, where soil moist but not wet, perhaps mainly in the northern part of the area	
Mesic Mixed Hardwood Forest, Swamp Island variant Extremely rare if not absent; on slightly raised ground within extensive floodplains or swamps	
Basic Mesic Forest, Coastal Plain subtype Rare; restricted to ravines and slopes over marl, in Craven and Jones counties	CR3,CR8,JO3,JO4, JO8
Dry-Mesic Oak-Hickory Forest Uncommon to fairly common in western half of the A/P Study area, but scarce in the eastern portion; likely abundant in pre-civilization times; on clayey or sandy-clay uplands, now mainly near bluffs and dissected areas	BE12,BE13,CR17,JO9, PI3,PI5
Dry Oak-Hickory Forest Rare to uncommon, mainly in western portion of the A/P Study area; mostly in xeric, clayey uplands, such as ridges or tops of bluffs	BE12,PI3,PI5
Piedmont/Coastal Plain Heath Bluff Very rare in the A/P Study area; primarily limited to extreme western Pitt County, on bluffs and ravines	

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Coastal Plain Marl Outcrop Rare and exceedingly limited in acreage; on vertical exposures of marl along rivers and creeks in Craven and Jones counties only	CR3,CR4,CR8,JO1, JO2,JO3,JO4
Mesic Pine Flatwoods Uncommon in Croatan National Forest, but rare elsewhere; probably once abundant in the study area; on somewhat moist clayey to loamy soil; often difficult to distinguish from Wet Pine Flatwoods	BE16,CA3,CA4,CA6, CR9,CR14,PA3
Pine/Scrub Oak Sandhill Fairly common, but mostly in the southern half of the A/P Study area, particularly in Croatan National Forest; on mesic to dry soils such as old beach ridges and Carolina bay rims	BE11,BE15,CA4,CA7, CA12,CR6,PA2,PA3, PI9
Xeric Sandhill Scrub Uncommon to fairly common; in similar sites as the former community, but on even drier, more sterile soils, particularly on bay rims	CA7,CA9,CA12,CR1, CR5
Oak-Hickory Sandhill (*) A fire-suppression community, thus not completely natural; rare and poorly known; on sandy soils; no obvious examples reported in the A/P Study area	
Coastal Fringe Sandhill Rather rare, on very sandy soils near sounds and estuaries; mainly in extreme southern Croatan National Forest and on Cedar Island	CA9,CA20,CA24,CA25, CR5
Coastal Fringe Evergreen Forest Uncommon and badly disturbed along Bogue Sound of mainland Carteret County; rare and isolated elsewhere along estuary/sound shorelines on sandy soils	BE4,CA2,CA20,CA22, CR17,HY15,PA9,PA14
Dune Grass Though common on barrier islands in A/P Study counties, very rare in the study area, on estuarine islands in Carteret County only	CA18,CA25

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Maritime Dry Grassland Status the same as Dune Grass community, being limited to a few estuarine islands in Carteret County	CA18,CA25
Maritime Shrub Essentially limited to estuarine islands and mainland of Carteret County, in the A/P Study area, where it is uncommon on moist sandy soils	CA18,CA25
Maritime Evergreen Forest Essentially absent, by definition, in the A/P Study area, as the community is limited to barrier or estuarine islands; a very small and poor example at Rachel Carson Reserve	CA18
PALUSTRINE COMMUNITIES	
Coastal Plain Levee Forest, Brownwater subtype Limited essentially to the Tar and Neuse river floodplains, where it is uncommon and not nearly as well developed as along the Roanoke River (A/P I Study area)	CR2,PI4
Coastal Plain Bottomland Forest, Brownwater subtype Only along the Tar and Neuse river floodplains, where it is quite limited; on old levees and ridges within the floodplain; very few good examples in the A/P Study area	PI9
Cypress-Gum Swamp, Brownwater subtype Only along the Tar and Neuse river floodplains (Pitt, Beaufort, and Craven counties); however, it is the dominant community in these floodplains	CR2,PI7,PI9
Coastal Plain Levee Forest, Blackwater subtype Rare to practically absent; blackwater streams in this part of the North Carolina Coastal Plain have poor or no development of levees	

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Coastal Plain Bottomland Forest, Blackwater subtype Rare to very rare; most blackwater rivers contain only swamp forests with no levees or bottomlands; no identified examples in the A/P Study area	
Cypress-Gum Swamp, Blackwater subtype Fairly common, but very few of high quality or protection priority; cypress-gum swamps are common in the A/P Study area, but most are tidal or are Small Stream Swamps	HY4
Coastal Plain Small Stream Swamp, Blackwater subtype Very common, scattered throughout the A/P Study area; many in good condition; in floodplains of small streams	BE1,BE12,CA2,CA3, CA10,CA16,CR15,JO8, PI6
Oxbow Lake Very rare to absent; present in North Carolina along highly meandering rivers; examples known along the Roanoke, Neuse, Waccamaw, and other rivers, outside of the A/P II Study area	
Coastal Plain Semipermanent Impoundment Uncommon to fairly common, generally beaver ponds and old millponds; however, very few are of high biological significance	CA16
Low Elevation Seep Rare; present in a linear zone along the base of bluffs or slopes; limited mainly to the Tar River in western Pitt County	PI4
Nonriverine Wet Hardwood Forest Common to abundant in pre-settlement times, but mostly destroyed today; a handful of good examples still remain; in poorly drained flats over most of the area	BE5,BE6,CR13,HY3, HY13,PA10,PA11,PA13, PI1,PI2
Nonriverine Swamp Forest Formerly very common, and still fairly common on poorly drained flats and basins; however, relatively few in old-growth, pristine condition	BE3,BE5,BE17,CR1, CR11,CR12,HY7,HY12, HY13,PA4,PA5,PA12, PA13,PI2

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Low Pocosin Generally uncommon; in the center of extensive pocosins, over deep peat deposits; most remaining examples in Croatan National Forest and Hyde County	CA5,CA8,CA14,CA15, CR1,CR10,CR11,HY13, HY15,PA4
High Pocosin Formerly common; still fairly common over much of the southeastern two-thirds of the A/P Study area; on peat deposits in poorly drained flats and basins	CA5,CA15,CR1,CR10, CR11,HY1,HY4,HY13, HY16,PA1,PA12,PA13
Pond Pine Woodland Though considerable acreage destroyed, still a common community in the A/P Study area (except in the northwestern one-third of the region); however, mainly limited today to public lands, such as Croatan National Forest and national wildlife refuges	BE3,BE9,BE16,CA5, CA6,CA7,CA15,CA24, CR1,CR10,HY6,HY7, HY11,HY13,HY15,JO7, PA1,PA4,PA5,PA12, PA13
Bay Forest Although somewhat widespread in pocosins, extensive, well-defined examples are apparently rare; best examples may be in Carolina bays	CA24,PA1
Streamhead Pocosin Very rare; this and the Sandhill Seep community are found mainly in the Sandhills region of the state; limited to the Suffolk Scarp and portions of Croatan National Forest, where streams dissect rolling topography	BE16,CA11
Peatland Atlantic White Cedar Forest Surprisingly rare over the A/P Study area, except in northeastern Hyde County; few good examples known, mainly near Alligator River and Catfish Lake, in peaty soils; historical extent not well understood	HY6,HY7,JO7
Small Depression Pocosin Rare and very limited in size; generally in shallow limesinks that are peat-filled rather than water-filled; limited mainly to Croatan National Forest in the study area	CA9,CA12

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Small Depression Pond Rare and very limited in size; nearly all are limesinks that are deep enough to reach the water table; limited mainly to Croatan National Forest	CA3,CA9,CA13
Vernal Pool Rare and poorly known; variable in origin; most in the study area are limesinks that are shallow, with water standing for only part of the year (by definition)	CA9
Natural Lake Shoreline Rather rare, being limited to the shorelines of natural lakes in Croatan National Forest and in Hyde County; mainly consisting of herbaceous and shrub zones around the lakes	CR12,HY7,HY8
Wet Pine Flatwoods Formerly fairly common to common, particularly in the southern half of the A/P Study area; good examples are now uncommon, owing to habitat loss and fire suppression; best examples are in Croatan National Forest	BE11,BE15,CA4,CA6, CA7,CA8,CA11,CA12, CA13,CA22,CA24,CR6, CR9,JO6,JO7,PA2, PA3
Pine Savanna Formerly rare or uncommon, but now quite rare; limited to areas south of the Pamlico River, with the best examples being in Croatan National Forest	BE16,CA3,CA4,CA8, CR14
Sandhill Seep Very rare in the A/P Study area, restricted mainly to the Suffolk Scarp and a portion of Croatan National Forest; sides of slopes in sandy soil where seepage occurs	BE16,CA11
Tidal Freshwater Marsh Rather rare, being limited mainly to the Trent River, Tar River, and upper Alligator River; generally contains numerous "broad-leaf" herbaceous species; most "freshwater" marshes fall into the Oligohaline Marsh community	CR2,CR7,HY6,PI7

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Oligohaline Marsh (*) Slightly brackish marshes with characteristics of both brackish marshes and tidal freshwater marshes; rather common along the Pamlico River and its tributaries, and also found in upper reaches of tidal creeks elsewhere	BE4,BE6,BE7,BE10, BE14,HY2,HY5,HY6
Tidal Cypress-Gum Swamp Common in the A/P Study area, but less numerous than in the A/P I Study area; present along many shorelines of tidal creeks, but most shorelines contain marshes and not swamps	BE4,BE10,BE11,BE14, CR5,HY5,HY6,HY11, JO8,PA11
Estuarine Fringe Loblolly Pine Forest Common near much of the shorelines, especially adjacent to the brackish marshes that fringe Pamlico Sound	BE4,BE7,BE8,HY2, HY10,HY11,HY12,HY14, HY15,PA6,PA8,PA9, PA11,PA14
Maritime Wet Grassland Limited to a few maritime islands in the A/P Study area, apparently only in Carteret County; merges frequently with Maritime Dry Grassland and Brackish Marsh communities	CA18,CA25
ESTUARINE/MARINE COMMUNITIES	
Brackish Marsh Very common, particularly along the shoreline of Pamlico Sound and tributaries; sites of hundreds of acres of this community are present in Carteret, Pamlico, and Hyde counties; grades into Salt Marsh at one salinity extreme and Oligohaline Marsh at the other	BE8,BE10,BE11,BE15, CA1,CA2,CA19,CA21, CA22,CA23,CR15,HY2, HY3,HY10,HY11,HY12, HY13,HY14,HY15,PA5, PA6,PA7,PA8,PA9, PA10,PA11,PA14
Salt Marsh Fairly common to common on the mainland of Carteret County, but scarce in other counties, being replaced by Brackish Marsh on most shorelines elsewhere in the A/P Study area	CA1,CA2,CA10,CA18, CA20,CA23,PA7
Salt Flat Rather limited to scattered sites, often only a few square yards each, within salt marshes and (less frequently) brackish marshes	CA2,CA18,CA19

Table 2. (continued)

Community, Abundance, Condition, and General Location	Exemplary Sites
Salt Shrub Apparently not common in the study area, though common on barrier islands; occurs adjacent to Salt Marsh and Brackish Marsh communities; frequently called "maritime shrub" in the literature	
Upper Beach Very rare in the A/P Study area, though common along most ocean beaches; limited to a few sites in Carteret County, particularly at Cedar Island	CA18,CA25

most difficult in the determination of communities is the effect of human modification of the environment that shapes the community, particularly fire frequency and water levels. With modification of these factors, natural succession can lead to very different vegetation than was natural on a given site.

Some of the natural communities extend over several thousand acres, whereas others occur as small pockets of just a few acres. Generally speaking, most of the swamp, pocosin, and estuarine communities can occur in extensive stands of over 1000 acres. Upland (terrestrial) communities in good condition are much more limited in the study area, because most of the upland forests were long ago converted to cultivated fields, commercial development, or pine plantations. The upland communities that are reasonably intact tend to occur along slopes, bluffs, or other sites that are inaccessible or unsuitable for agriculture.

E. 2. Terrestrial Communities

E. 2. a. Mesic Mixed Hardwood Forest, Bluff/Slope variant. The Mesic Mixed Hardwood Forest, Coastal Plain Subtype natural community is subdivided into three variants -- a Bluff/Slope variant, an Upland Flats variant, and a Swamp Island variant. The Bluff/Slope variant occurs primarily on the bluffs and dissected land above the floodplains of rivers, both brownwater rivers such as the Tar and the Neuse, and smaller blackwater rivers and creeks. Such sites are limited in terms of acreage but generally are in good to excellent condition because the slopes have hindered clearing of the land. American beech (Fagus grandifolia) is the most characteristic canopy tree, but tuliptree (Liriodendron tulipifera), white oak (Quercus alba), northern red oak (Q. rubra), water oak (Q. nigra), and bitternut hickory (Carya cordiformis) are also found in many such communities. The understory or shrub layer is composed of species such as flowering dogwood (Cornus florida), painted buckeye (Aesculus sylvatica), red maple (Acer rubrum), and American holly (Ilex opaca). On slopes along brownwater rivers, in the western portion of the study area, the herb layer may be rich and tends to be somewhat Piedmont-like in character. Slopes in the eastern portion of the study area, especially those along blackwater rivers, are usually much less diverse.

E. 2. b. Mesic Mixed Hardwood Forest, Upland Flats variant. The Upland Flats variant occurs on terraces and other undissected but fairly well drained upland sites. (The drier terraces and flats contain mainly Dry-Mesic Oak-Hickory Forests, whereas the wetter ones contain mostly Nonriverine Wet Hardwood Forest [discussed later]). This variant features a great range of vegetation, including a few xeric species and a few hydric species growing essentially together with the mesic species. This community is poorly known and is apparently quite rare at present over most of the A/P II Study area; many of the agricultural lands were probably once this variant before clearing. The most typical trees include American beech, swamp chestnut oak (Quercus michauxii), cherrybark oak (Q. pagoda), southern red oak (Q. falcata), and white oak. Mesic species such as flowering dogwood are frequently present with the more hydric American hornbeam (Carpinus caroliniana) and giant cane (Arundinaria gigantea).

E. 2. c. Mesic Mixed Hardwood Forest, Swamp Island variant. The Mesic Mixed Hardwood Forest, Swamp Island variant occurs on slight ridges within floodplains, swamps, or pocosins and which are elevated above flood levels and are moderately well drained. Although this community is not rare in the A/P I Study area to the north, it appears to be very rare in the A/P II Study region. The mesic forests on these islands tend to have American beech as the characteristic canopy tree, as do the mesic forests on slopes. Tuliptree and several oak species are also often present. An uncommon shrub in the state -- silky camellia (Stewartia malacodendron) -- is a characteristic species of such mesic islands, and the rare southern twayblade (Listera australis) may often be found on these islands. However, the herbaceous flora is only moderately well developed and has a decidedly Coastal Plain-like affinity, with very few species typical of Piedmont slopes.

E. 2. d. Basic Mesic Forest, Coastal Plain subtype. The Basic Mesic Forest occurs on sites similar to those of the Mesic Mixed Hardwood Forest, Bluff/Slope variant, on slopes where limestone (marl) is near the surface. The limestone makes the soil less acidic and more fertile than is typical for North Carolina soils. Such conditions exist in parts of Craven and Jones counties but are essentially absent elsewhere in the study area. The canopy has trees typical of Mesic Mixed Hardwoods, with the addition of base-loving species, such as southern sugar maple (Acer barbatum) and black walnut (Juglans nigra). Species that normally occur in bottomlands, such as cherrybark oak, Shumard oak (Quercus shumardii), and American elm (Ulmus americana) often are present in these communities on the slopes above the bottomlands. The understory and shrub layers include a similar mix of mesic species, such as flowering dogwood and painted buckeye; base-loving species, such as hop hornbeam (Ostrya virginiana) and umbrella magnolia (Magnolia tripetala); and bottomland species, such as spicebush (Lindera benzoin) and tall pawpaw (Asimina triloba). The herb layer is often lush, with a diverse mix of mesic and base-loving species.

E. 2. e. Dry-Mesic Oak-Hickory Forest. Better drained upland sites that are naturally sheltered from fire, such as steep bluffs or dissected terrain, have Dry-Mesic Oak-Hickory Forest. The community occurs primarily in the western half of the A/P II Study area. Such sites tend to be small in the study area, where they are largely confined to the upper halves of the slopes above creeks and rivers, with Mesic Mixed Hardwood Forest typically occupying the lower slopes. In the canopy of mature forests, white oak is generally most abundant, with southern red oak and black oak (Q. velutina) also usually present, among a variety of other tree species. The understory layer is moderate in density, with flowering dogwood, red maple, and sourwood (Oxydendrum arboreum) often numerous. The shrub and herb layers are usually sparse.

E. 2. f. Dry Oak-Hickory Forest. On slightly drier sites, such as on ridge tops, the crest of bluffs, and on sandy soils that are naturally sheltered from fire, a Dry Oak-Hickory Forest natural community may be present. This is a relatively rare community in the study area, with most of the drier forests being "sandhills" communities listed below. As with the Dry-Mesic Oak-Hickory Forest, most of these sites are small in acreage. Typical canopy species include southern red oak, white oak, and post oak

(Quercus stellata), along with various hickories. Blackjack oak (Q. marilandica) or pines (Pinus taeda, P. palustris) are sometimes present. This community type usually features a shrub layer dominated by ericaceous plants, particularly blueberries (Vaccinium spp.).

E. 2. g. Piedmont/Coastal Plain Heath Bluff. The most extreme development of bluffs in the 7-county study area is the Piedmont/Coastal Plain Heath Bluff community type. This community occurs on steep, acidic slopes and bluffs, often where the slope is greater than 45 degrees. Such conditions, however, are very rare in the study area and are limited mainly to extreme western Pitt County along the Tar River and possibly along the Neuse River in Craven County. The most prominent feature of the vegetation is a dense stand of mountain laurel (Kalmia latifolia), which is more typical of the Piedmont and mountains. Beech and other mesic hardwoods are usually present in a sparse to open canopy. An herb frequently found on such bluffs is galax (Galax aphylla), a typical piedmontane/montane species. This community type is often found in good to excellent condition, because the steep topography limits timber cutting and other human disturbances.

E. 2. h. Coastal Plain Marl Outcrop. Although limestone underlies large parts of Craven and Jones counties, and a smaller portion of other counties in the study area, outcrops are very rare. Where significant amounts of rock are exposed, a Coastal Plain Marl Outcrop community occurs. The outcrops generally occur on steep bluffs along creeks, particularly along the Trent River. All of the plants characteristic of the Basic Mesic Forest may occur, rooting in soil pockets and crevices in the rock, or hanging over from adjacent edges. The bare rock supports several characteristic limestone-loving herbs and mosses such as eastern columbine (Aquilegia canadensis), including the rare ferns Carolina spleenwort (Asplenium heteroresiliens) and Tennessee bladder-fern (Cystopteris tennesseensis).

E. 2. i. Mesic Pine Flatwoods. Most of the flat uplands in the study area were subject to frequent fires under natural conditions. On moist, clayey to loamy soils in frequently burned areas, Mesic Pine Flatwoods are the natural community type. These communities are among the most endangered in the state. Most of these sites are now agricultural fields, old field pine stands, or pine plantations. Examples that are not directly destroyed tend to deteriorate rapidly in the absence of fire. Where examples remain, mostly restricted to Croatan National Forest in the study area, they have an open canopy of longleaf pine (Pinus palustris), sometimes mixed with loblolly pine (P. taeda). A hardwood understory of sweetgum (Liquidambar styraciflua), red maple, and oaks (Quercus marilandica, Q. nigra) may be present if fire has been infrequent. The ground cover is a dense mixture of low shrubs and herbs. Wiregrass (Aristida stricta) is the dominant herb in frequently burned examples, but a tremendous diversity of other herbs in the grass, composite, and legume families, for example, are often present. Species of both drier and wetter habitats are frequently present in small irregularities of the ground surface. With less frequent fire, low shrubs, especially blueberries, huckleberries (Gaylussacia spp.), and inkberry (Ilex glabra), become the dominant ground cover.

E. 2. j. Pine/Scrub Oak Sandhill. These communities occur on frequently burned, well-drained flats or slopes, on clayey to loamy soils, or sandy soils with underlying clay. The community is fairly common in parts of Croatan National Forest, but it is uncommon elsewhere; most examples at present occur in the southern half of the A/P II Study area. The canopy is dominated by longleaf pine and is open to sparse. An understory of scrub oaks, such as turkey oak (Quercus laevis), blackjack oak, bluejack oak (Q. incana), and scrub post oak (Q. margaretta) is present. Its height and density depend on the past frequency and season of fire. The ground cover is a mixture of low shrubs and herbs, dominated by wiregrass. There are fewer species than in the Mesic Pine Flatwoods, but diversity may still be high if fire has been frequent. In the absence of fire, the scrub oaks become dense and suppress the ground cover.

E. 2. k. Xeric Sandhill Scrub. Coarse, excessively drained sands support Xeric Sandhill Scrub communities, the driest of the longleaf pine communities. They are most common in the study area on relict dune and beach ridge deposits in southern Carteret County, and on scattered Carolina bay rims. The canopy is generally exclusively longleaf pine, and is usually open. A scrub oak understory is present, but turkey oak is the only common species. A few bluejack oaks or scrub post oaks may be present. The wiregrass-dominated ground cover is sparser and lower in diversity than in the other longleaf pine community types, with a number of species specially adapted for the dry, infertile conditions of the coarse sands. Lichens (Cladonia spp.) are often an important component, and there may be much unvegetated bare sand. These communities depend on fire, but are slower to deteriorate in its absence than the moister longleaf pine communities. They are, however, very slow to recover from cutting and soil disturbance.

E. 2. l. Oak-Hickory Sandhill. Oak-Hickory Sandhill is not believed to be a truly natural community type, and it is not included in the Classification of Natural Communities of North Carolina (Schafale and Weakley 1990). It appears to be a semi-natural response to long suppression of fire in former Pine/Scrub Oak Sandhill and Mesic Pine Flatwoods communities. As scrub hardwoods and shrubs become denser, and leaf litter accumulates in the absence of fire, longleaf pines are no longer able to reproduce. The site is gradually invaded by species such as southern red oak, post oak, black oak, and hickories; some resemblance to Dry-Mesic Oak-Hickory Forest or especially Dry Oak-Hickory Forest becomes evident. Wiregrass and other species of open vegetation are suppressed and disappear, or remain only in small openings. The old longleaf pine trees can persist for a very long time in the canopy, producing a community of mixed character; eventually they will die, leaving the site to the hardwoods. This "community" is now common in the Sandhills region of the state but is poorly known from the A/P II Study area.

E. 2. m. Coastal Fringe Sandhill. Frequently burned sandy areas within a few miles of the mainland coast in the southern part of North Carolina have natural communities that are somewhat different from typical Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill. The most prominent difference is the importance of evergreen scrub oaks -- dwarf live oak (Quercus geminata) and sand laurel oak (Q. hemispherica) -- in the understory. The study area is at the extreme northern end of the range of this community

type, and examples are rare. Coastal Fringe Sandhill, somewhat surprisingly, does occur on Cedar Island in eastern Carteret County, as well as a few places in the extreme southern edge of Croatan National Forest.

E. 2. n. Coastal Fringe Evergreen Forest. These communities occur on more moist, infrequently burned areas within a few miles of the coast. They can be colloquially considered a "mainland maritime forest", containing species such as live oak (Q. virginiana), sand laurel oak, wild olive (Osmanthus americana), and yaupon (Ilex vomitoria), which are otherwise characteristic of the maritime forests on the barrier islands. Unlike the true maritime forests, they are not pruned by salt spray and are less subject to disturbance by coastal storms. Like the Coastal Fringe Sandhill, Coastal Fringe Evergreen Forest is more abundant in the southern part of the state and is very limited in the study area. A well-developed example occurs at Cedar Point in southwestern Carteret County, and disturbed examples occur in eastern Carteret County. A few isolated examples occur well "inland" at Goose Creek State Park and along the shores of Pamlico County and mainland Hyde County.

E. 2. o. Dune Grass. The barrier islands, and occasional estuarine islands, along the coast present a very different environment for plants and animals than the mainland areas. Salt spray from the surf, especially during storms, is a major stress on plants and prevents most species from occurring in the maritime areas. Storm winds and waves are also important. Soils are young, very sandy, generally low in organic matter, but probably higher in some nutrients, such as calcium. The Dune Grass community occurs on the active dunes, usually just behind the beach, and is subject to the additional stress of shifting sand, which can bury plants or expose their roots. The dominant and most characteristic plant is sea oats (Uniola paniculata). Other major plants include marsh-pennywort (Hydrocotyle bonariensis), bitter panic grass (Panicum amarum), and sand pea (Strophostyles helvola). Plant diversity tends to be low because of the stressful environment. Beach grass (Ammophila breviligulata) is often planted to artificially stabilize dunes, but it is not native this far south in the state. The primary location of the community in the study area is along that portion of Cedar Island that fronts Pamlico Sound.

E. 2. p. Maritime Dry Grassland. On more stable sands, either old dunes or flats, occur Maritime Dry Grassland communities. On the lower sites, overwash of sea water during storms is an important natural stress. These communities are dominated by salt-meadow cordgrass (Spartina patens). Scattered shrubs such as waxmyrtle (Myrica cerifera) and yaupon may occur. Plant diversity is somewhat higher than in Dune Grass communities but is still fairly low. This community is very limited in the study area, primarily found at Cedar Island and Rachel Carson sanctuary; it is common on barrier islands just outside the study area.

E. 2. q. Maritime Shrub. On barrier island sites that are protected from overwash, shrubs are able to dominate the vegetation. The vegetation is a dense thicket dominated by waxmyrtle, yaupon, southern red-cedar (Juniperus silicicola), and stunted live oaks. A few vines, especially poison ivy (Rhus radicans) and greenbriers (Smilax spp.), are often present, but herbs are almost absent beneath the dense shrubs. Salt spray limits the size

of the plants, often pruning the canopy into streamlined shapes. This is a terrestrial community on sandy but often moist soils; its wetland counterpart is the Salt Shrub community. As with other maritime communities described in this section, most are highly limited in the A/P II Study area, as barrier islands are excluded from this region.

E. 2. r. Maritime Evergreen Forest. Barrier island sites, or rarely estuarine island sites, that are protected from overwash and have somewhat less salt spray are able to support forest vegetation. The composition and stature of the forest are still limited by salt spray; the canopy is usually pruned by the salt-laden wind into streamlined shapes, often grading down to Maritime Shrub in the front. The dominant trees are live oak, sand laurel oak, and loblolly pine. The primary understory trees are redbay (Persea borbonia), American hornbeam, southern red-cedar, flowering dogwood, wild olive, American holly, and Carolina laurel-cherry (Prunus caroliniana). Yaupon dominates the shrub layer, and vines, particularly muscadine grape (Vitis rotundifolia), poison ivy, and greenbriers, are often abundant. Many of these species -- the live oak, sand laurel oak, redbay, wild olive, Carolina laurel-cherry, and yaupon -- are largely limited in North Carolina to the barrier islands and mainland coastal fringe, though some are more abundant farther south. This community is practically absent in the study area; there is a marginal example at the Rachel Carson reserve.

E. 3. Palustrine (Wetland) Communities

E. 3. a. Overview of Wetland Communities. Wetland natural communities are abundant in the A/P II Study area, and they dominate in the areas east of the Suffolk Scarp. Some of the eastern counties consisted primarily of wetlands, before canals and drainage ditches dried out the land. Approximately 30 palustrine (freshwater) natural communities are present in the study area, based on the classification of communities in Schafale and Weakley (1990). An additional 5 wetland communities are considered as Estuarine or Marine and are described in Section E.4.

Many of the palustrine communities are separated by their occurrence in brownwater river systems, blackwater river systems, or on poorly drained flats (nonriverine systems). Brownwater rivers originate in the Piedmont and carry much mineral sediments; they are often muddy and reddish in color, especially after heavy rains. The high sediment load is deposited on the banks or in backwaters, and natural levees are well developed. Blackwater rivers originate within the Coastal Plain and are generally much shorter than brownwater streams. The sediments are mainly organic in nature, and the waters are typically dark brown to blackish in color but less turbid. Natural levees are rare or are poorly developed. Nonriverine areas are poorly drained basins or flats with no major stream outlets; they were once shallow areas flooded by seawater during higher stages of the ocean. Many have accumulations of organic matter on the surface, sometimes deep peat.

E. 3. b. Coastal Plain Levee Forest, Brownwater subtype. The Coastal Plain Levee Forest, Brownwater subtype, occurs along the banks of the Neuse and Tar rivers in the study area, except for the lowest few miles, where there is a tidal influence. The levees receive the heaviest deposition of

sediment, with its accompanying nutrients, but are higher and flooded for shorter periods than areas farther from the river. The levees contain tree species that are not found elsewhere in the floodplain forests. These trees are capable of establishing themselves on sand bars and grow well in sunlight or partial shade. Characteristic canopy species of the levees include sugarberry (Celtis laevigata), American sycamore (Platanus occidentalis), green ash (Fraxinus pennsylvanica), sweetgum, and American elm. The understory is also rich, with boxelder (Acer negundo) being characteristic. The shrub and herb layers are also rich, and feature species typically found on circumneutral to basic soils. Common shrubs are painted buckeye, tall pawpaw, spicebush, and giant cane.

E. 3. c. Coastal Plain Bottomland Forest, Brownwater subtype. As a river channel migrates, some levees are eroded away, whereas those on the opposite bank become farther removed from the channel and receive less sediment during flooding. The levees also take on a different set of canopy trees. The Coastal Plain Bottomland Forest, Brownwater subtype, occurs on such former levees, now being considered floodplain ridges. Bottomland forests also occur on terraces at the edges of the floodplains. These forests, if not heavily disturbed in the past, characteristically have oaks in the canopy, featuring species such as cherrybark oak, swamp chestnut oak, willow oak (Q. phellos), and overcup oak (Q. lyrata), the last species being found in the wetter sites. Sweetgum and several hickory species (Carya spp.) also occur frequently. If there has been heavy logging, loblolly pine is often a major component, especially on the higher sites. The understory layer is fairly well developed, and American hornbeam is often present. The shrub and herb layers are rather sparse, giving most mature bottomlands a rather park-like appearance. Despite the large acreage of the Tar and Neuse river floodplains in the study area, relatively little acreage is vegetated in bottomland forest; most forests in the floodplain are swamps (of the following community).

E. 3. d. Cypress-Gum Swamp, Brownwater subtype. The Cypress-Gum Swamp, Brownwater subtype, is common along the Neuse and Tar rivers; some stands cover hundreds of acres. These swamps may occur as backswamps (extensive flat basins behind the natural levees that are covered in floodwater for much of the year), or in the old river channels (sloughs), which are narrow and lie between ridges in the floodplain. These swamps have a relatively low plant species diversity and are dominated in the canopy by bald cypress (Taxodium distichum) and either water tupelo (Nyssa aquatica) or swamp tupelo (N. biflora). The former tupelo dominates where the water flow is greater, such as nearer the river channel; the latter prefers more stagnant or acidic waters. Most swamps contain no other canopy species. A common understory tree is water ash (Fraxinus caroliniana); swamp cottonwood (Populus heterophylla) also is commonly present in the understory or canopy. These swamps contain water for such long periods through the year that shrubs and herbs tend to be scarce, except where bare ground is exposed.

E. 3. e. Coastal Plain Levee Forest, Blackwater subtype. The levee forest, bottomland forest, and cypress-gum swamp have counterparts found on the larger blackwater rivers, but in the A/P II Study area most of the blackwater streams are small and have almost no levees or bottomlands. No

good examples of Coastal Plain Levee Forest, Blackwater subtype, have been reported during the study; notable examples occur along the Waccamaw, Northeast Cape Fear, and Lumber rivers in the southern part of the state's Coastal Plain.

E. 3. f. Coastal Plain Bottomland Forest, Blackwater subtype. The Coastal Plain Bottomland Forest, Blackwater subtype, is rare in the A/P II Study area, and no outstanding examples have been found. Based on work done along the Waccamaw River floodplain (Schafale et al. 1986), plus results from a few sites in the A/P I and II Study areas, typical canopy species include laurel oak (Quercus laurifolia), water oak, loblolly pine, red maple, and sweetgum. Atlantic white cedar (Chamaecyparis thyoides), characteristic of blackwater and nonriverine swamps, may also be present. The understory and shrub layers generally feature a somewhat more evergreen or "bay" composition than found in brownwater floodplains, with redbay, titi (Cyrilla racemiflora), and sweet pepperbush (Clethra alnifolia) often present.

E. 3. g. Cypress-Gum Swamp, Blackwater subtype. The Cypress-Gum Swamp, Blackwater subtype, is fairly common in the A/P II Study area, yet there are rather few sites in excellent, mature condition. Bald cypress and swamp tupelo generally form the canopy. Pumpkin ash (Fraxinus tomentosa) is often present in the canopy, but seldom in large numbers. The understory is dominated by water ash or red maple in most cases. The shrub and herb layers are usually sparse and may be absent in constantly flooded sites, except for floating aquatic herbs. However, aquatic herbs may be numerous in this community and in other types of cypress-gum swamps.

E. 3. h. Coastal Plain Small Stream Swamp, Blackwater subtype. Similar to the last-named community is the Coastal Plain Small Stream Swamp, Blackwater subtype. These communities are quite common in the Coastal Plain of North Carolina, including the study area. They occur in narrow floodplains of streams with so little sediment flow that the characteristic natural levees, floodplain ridges, and sloughs are not formed, or are too small to produce vegetation patterns. Such floodplains are seldom more than 100 or 200 yards wide on either side of the stream. The same canopy and understory species are present as in the above blackwater communities, often mixed together in combinations not seen on the larger rivers. Generally speaking, the main differences are geomorphic and hydrologic (more irregular flooding), and differences in scale of patterns, rather than floristic. However, these small swamps often have a greater abundance and diversity of herbs and shrubs than are found in the larger swamps.

E. 3. i. Oxbow Lake. Another community that is primarily geomorphic in significance is the Oxbow Lake. This type of lake is rare to absent in the A/P Study area, and community descriptions have gone unrecorded. Because the water in such a lake is standing rather than flowing, there is the potential for the community to contain floating aquatic herbs that are absent in most floodplain communities. The canopy in and along the margins of the lake contain cypress and the two tupelo species.

E. 3. j. Coastal Plain Semipermanent Impoundment. These communities develop from swamp or bottomland communities by impoundment of water. The

most common impounding agent is beavers, but occasionally natural sediment deposition can have the same effect. Old man-made millponds that mimic the aquatic community of beaver ponds are also included in this category, although their origin is not strictly natural. These impoundments, no matter the origin, feature much open water with a widely scattered canopy of bald cypress, often with swamp tupelo, water tupelo, red maple, or other remnant trees also present. Typically, there is little understory or shrub vegetation, but floating aquatic plants (including duckweeds [Lemna spp.] and water-lily [Nymphaea odorata]) are common. This community is not common in the A/P II Study area, but an excellent example is Walkers Millpond in Carteret County.

E. 3. k. Low Elevation Seep. Low Elevation Seeps occur in small areas at the bases of bluffs and in small ravines, where seepage water keeps the soil perennially saturated. This is primarily a Piedmont community type, but a few examples occur in the study area, particularly along the base of the slopes along the Tar River in western Pitt County. Seeps can be recognized by dense stands of ferns of several species, such as cinnamon fern (Osmunda cinnamomea) and royal fern (O. regalis), as well as other wetland herbs su lizard's-tail (Saururus cernuus) and jewelweed (Impatiens capensis). Shrubs of wetlands, such as southern wild-raisin (Viburnum nudum) and highbush blueberry (Vaccinium corymbosum), are also characteristic of this community type.

E. 3. l. Nonriverine Wet Hardwood Forest. One of the most endangered natural communities in North Carolina is the Nonriverine Wet Hardwood Forest. Such forests apparently covered many thousands of acres in pre-settlement times, especially in the northern two-thirds of the study area. They most typically occur on wet mineral soils on the edges of the large peatlands, such as at the edges of Light Ground Pocosin in Pamlico County. The great majority have been cleared for agriculture, as the sites are easy to drain and have fertile soils. Timber harvest and conversion to pine plantations has also been a major factor in the destruction of this community. Few good examples remain. Examples at the drier end of the spectrum often merge into Mesic Mixed Hardwood Forest, Upland Flats variant natural community, whereas examples at the wetter end of the spectrum merge with the Nonriverine Swamp Forest type. The Nonriverine Wet Hardwood Forest community occurs on flats with poor drainage and seasonally high water table, but where water stands for only brief periods. The mature canopy is rather similar to that of the Bottomland Hardwood Forest on brownwater rivers in that various oaks predominate. Such forests usually contain cherrybark oak and swamp chestnut oak as dominants in the canopy, with willow oak, laurel oak, tuliptree, sweetgum, loblolly pine, and a variety of other species also in the canopy. Loblolly pine may be abundant if there has been heavy cutting in the past. Nonriverine forests tend to contain more elements of swamp or bay forests and feature swamp tupelo, red maple, and pocosin shrubs more frequently than a site in a brownwater floodplain. They lack the species associated with more circumneutral conditions, such as sugarberry, sycamore, buckeye, and a variety of maple species. Also, there are differences in hydrology and nutrient dynamics between these communities, as the Nonriverine Wet Hardwood Forests receive no nutrient-laden flood-carried sediments.

E. 3. m. Nonriverine Swamp Forest. Nonriverine Swamp Forests were also common in the study area, but much acreage has been drained and timbered. Bald cypress and swamp tupelo are the dominant canopy trees of some Nonriverine Swamps, but the cutting and draining of the swamp forests has led to a red maple and swamp tupelo canopy. Nonriverine Swamps tend to be less deeply flooded than riverine ones, but are saturated for longer periods in most years. They generally feature more diverse understory, shrub, and herb layers. Pocosin and bay species such as sweetbay (Magnolia virginiana), titi, sweet pepperbush, and inkberry are often common in Nonriverine Swamp Forests.

E. 3. n. Low Pocosin. Various types of pocosins occur on extensive poorly drained flats and basins over most of the A/P Study area. The deep peats of the pocosin centers have hindered the destruction of the pocosins until relatively recent times, but many have now been drained and cleared for pine plantations or large-scale agriculture. Several pocosins are protected in Croatan National Forest, and several others remain at least partially intact. The pocosins have been divided into several natural community types, which tend to occur in characteristic zoned patterns in the peatlands. Low Pocosin communities occur in the centers of the large peatlands, where the peat is the deepest, generally greater than 3 feet deep. The Low Pocosins are on the highest part of the local landscape, so they receive water and nutrient input only from rainfall. The peat is extremely poor in nutrients, and no plant roots can reach through it to the mineral soil below. The peat is normally very wet, holding water like a sponge and raising the water table, but in drought periods it may dry out. At these times the pocosins are subject to catastrophic wildfires which may consume all of the above-ground vegetation and often some of the peat. The plants are well adapted to fire and quickly recover by resprouting. The vegetation of Low Pocosins is a dense thicket of stunted shrubs, less than 4 feet tall. The only trees are scattered, stunted pond pines (Pinus serotina) and loblolly-bays (Gordonia lasianthus). The dominant shrubs are fetterbush (Lyonia lucida), inkberry, titi, honey-cup (Zenobia pulverulenta), and sweet pepperbush. Tangles of laurel-leaf greenbrier (Smilax laurifolia) are often common. Low Pocosins generally feature open pools or other openings where sphagnum and other non-woody vegetation grows.

E. 3. o. High Pocosin. The High Pocosin natural community type occurs on somewhat shallower peat deposits, in a ring around the Low Pocosins, or in the centers of smaller peatlands. High Pocosins feature a dense shrub or small tree zone, usually not more than 10 to 15 feet tall. In addition to the shrubs found in the Low Pocosin, small trees such as sweetbay, redbay, and loblolly-bay also are characteristic. The smallest shrubs, such as honey-cup, are uncommon except immediately after fires. Scattered pond pines are almost invariably present, but as with the Low Pocosin, the pines are generally small and stunted (25 feet or less tall). High Pocosins usually are devoid of openings where herbs dominate, except when they are recovering from fire. This community is more common than Low Pocosin, and there are still a number of good examples, particularly in the southeastern two-thirds of the study area.

E. 3. p. Pond Pine Woodland. The Pond Pine Woodland natural community type occurs on the outer margins of large peatlands, and in shallow wet swales, flats, and basins. It features a well-developed canopy of pond pines, generally 25 or more feet tall. This pocosin type, as with the above two, occurs on broad flats and poorly drained basins and in Carolina bays. Fires are generally catastrophic, but in the past may have been more frequent and less intense. Much of this community type in the A/P II Study area has been converted to intensive silviculture or agriculture, though a number of extensive examples remain, particularly in Croatan National Forest and in several national wildlife refuges. In addition to the various pocosin/bay species of trees and shrubs, red maple and Atlantic white cedar can often be present. In some situations, Pond Pine Woodlands are apparently successional to Nonriverine Swamp Forest or Bay Forest in the absence of fire. However, in other situations, even in the long absence of fire, this community apparently maintains itself. Where Pond Pine Woodlands adjoin Pine Savanna or Wet Pine Flatwoods communities, a diverse transition zone, or ecotone, is often present. The frequent fires of the longleaf pine communities burn into the edge of the Pond Pine Woodland, creating open wet conditions where a mixture of shrubs and herbs can occur. This narrow zone often has a tremendous diversity of plant species and a number of rare plants.

E. 3. q. Bay Forest. The Bay Forest consists of peatland communities dominated by bay species -- redbay, sweetbay, or loblolly-bay (Schafale and Weakley 1990). The name is sometimes used more broadly to include communities that are considered here as Pond Pine Woodland or Nonriverine Swamp Forest. Bay Forests are uncommon, and their ecology is poorly known; few well-known examples occur in the A/P II Study area. They appear to be associated with the heads of developing streams near the edges of peatlands. It has been suggested that they may develop from Pond Pine Woodland or Peatland Atlantic White Cedar Forest in the long absence of fire. Broadleaf evergreen trees such as redbay, sweetbay, and loblolly-bay dominate the canopy, but species as varied as red maple, pond pine, bald cypress, swamp tupelo, or Atlantic white cedar may occur in the canopy or in the understory. Invariably, Bay Forests have a dense shrub layer of pocosin species such as fetterbush, inkberry, sweet gallberry (Ilex coriacea), sweet pepperbush, and others.

E. 3. r. Streamhead Pocosin. Streamhead Pocosins are a common community type in the Sandhills region of the state, but they are rare on the outer Coastal Plain. Marginally developed examples occur at Nine Foot Road/Broad Creek Pinewoods in Croatan National Forest and along the Suffolk Scarp in Beaufort County. Streamhead Pocosins typically occur along small ravines in sloping topography. The soils are mucky and are apparently kept saturated by seepage from adjacent sandy uplands. Because they tend to be long and narrow, effects of fire in adjacent uplands can be important. They usually have an open canopy of pond pine, sometimes with swamp tupelo, tuliptree, or red maple. As in other pocosin types, the shrub layer is very dense. Important species include fetterbush, titi, inkberry, sweet pepperbush, and poison sumac (Rhus vernix). Streamhead Pocosin ecotones with adjacent communities, typically longleaf pine communities, can be rich in herbaceous species.

E. 3. s. Peatland Atlantic White Cedar Forest. Atlantic white cedar stands historically were less common in the 7-county study area than in the 10-county A/P Study area farther north, and those that were present have been largely removed by logging. They occur on shallow organic deposits on nonriverine flats; most in the study area are located in northeastern Hyde County. They feature a nearly solid canopy of white cedar, though other wetland species such as bald cypress, loblolly pine, swamp tupelo, and red maple are often present. Though the interior of such a forest is usually dark, a variety of pocosin shrubs are usually present. White cedar generally depends on severe fires to regenerate. Fire suppression has played a major role in the decline of white cedar. In the absence of fire, this community type is succeeded by bay forest or maple-gum swamp forest. This process of succession was greatly accelerated by typical white cedar logging methods, which removed cedar but left understory shrubs and canopy trees such as swamp tupelo and bay species largely intact.

E. 3. t. Small Depression Pocosin. Most Small Depression Pocosins are found in limesinks that were created in sandy surface sediments with underlying limestone. In a few places, groundwater dissolves small patches of limestone, causing the surface sand to collapse. Shallower small depressions that are filled with organic matter and do not hold open water are Small Depression Pocosin communities. The vegetation resembles the outer shrub zone of the Small Depression Pond communities, with an open pond pine canopy, and a dense layer of shrubs such as fetterbush, inkberry, sweet pepperbush, dangleberry (Gaylussacia frondosa), and titi. There are generally very few herbs, although a diverse ecotone may occur adjacent to longleaf pine communities.

E. 3. u. Small Depression Pond. If the water table is near the surface of limesinks or other depressions, such depressions will hold water, at least during wet seasons. Small depressions tend to occur in clusters. The only well-developed cluster in the study area is the Patsy Pond complex in Croatan National Forest, but 2 other clusters are also present in the southern portion of Croatan National Forest. Small Depression Pond communities occur in the deepest depressions, those that hold water through all but the driest years. The vegetation is usually strongly zoned. An outer zone of shrubs such as titi, fetterbush, inkberry, and sweet pepperbush, along with pond pine, pond cypress (Taxodium ascendens), or swamp tupelo, is often present. The rare pondspice (Litsea aestivalis) occurs in this zone. Inside of the rim are one or more zones of herbs which occur on the part of the pond bottom that is exposed as the water level drops during normal summers. These zones are dominated by sedges, grasses, and a variety of other herbaceous plants. Plants such as meadow-beauties (Rhexia spp.) can produce spectacular floral displays. In wetter areas, maiden-cane (Panicum hemitomon) often dominates. In the center of the pond is a zone of open water, sometimes with aquatic plants such as water-lilies.

E. 3. v. Vernal Pool. Shallow depressions that are not filled with peat and which hold water only during the winter in most years are Vernal Pool communities. Because they are dry for much of the growing season, they can support some upland as well as wetland flora. They are also subject to fire spreading from adjacent uplands during the dry season. Little bluestem

(Andropogon scoparium), switch-grass (Panicum virgatum), and spadeleaf (Centella asiatica) are commonly dominant. Aquatic species such as bladderworts (Utricularia spp.) may be present in the spring. A few swamp tupelo or other wetland tree species are sometimes present. This community is poorly known in the study area, presumably occurring mainly in the limesink pond belt in the southern Croatan National Forest.

E. 3. w. Natural Lake Shoreline. Several natural lakes occur in the study area in Croatan National Forest and in Hyde County. The deep water portion of the lakes are aquatic communities, which are not yet covered in the community classification. The palustrine shoreline zone of a lake, extending from the inland limit of influence of the lake's hydrology to the limit of emergent vegetation, is considered the Natural Lake Shoreline natural community. Two distinctive kinds of vegetation occur in the study area. Marsh vegetation, usually dominated by maiden-cane, with scattered bald cypress trees, occurs along the sandy shores of many lakes, such as Lake Mattamuskeet and Lake Ellis Simon. In a few places, such as the south shore of Great Lake, a more extensive lakeshore swamp forest occurs. The canopy is dominated by sweetgum, with relatively little undergrowth. Other portions of lakeshores are dense bands of overhanging pocosin shrubs which seem to be no different than the adjacent pocosins.

E. 3. x. Wet Pine Flatwoods. Low, wet, sandy soils generally support Wet Pine Flatwoods communities. The canopy is open and is dominated by longleaf pine, sometimes in combination with pond pine. There is essentially no understory, other than scattered or patchy young pines. The dense ground cover is dominated by wiregrass and low shrubs. Sometimes bracken fern (Pteridium aquilinum) and creeping blueberry (Vaccinium crassifolium) co-dominate. Important shrubs are dangleberry, inkberry, and sheep-kill (Kalmia angustifolia). Like the Mesic Pine Flatwoods, these communities are dependent on frequent fire to maintain their structure. In the absence of fire, the shrubs become dense and the wiregrass is suppressed. Pine regeneration is also suppressed, but hardwood invasion is generally very slow. This was formerly a common natural community, at least in the southern half of the study area, but the majority of the good examples remaining are located in Croatan National Forest.

E. 3. y. Pine Savanna. Very wet, sandy or clayey soils in areas with frequent fire sometimes contain Pine Savanna communities. They are generally on the wettest sites that support longleaf pine vegetation. They grade to Wet Pine Flatwoods on sandy soils, but often grade directly to Mesic Pine Flatwoods on finer-textured soils. The canopy is open to sparse, consisting of longleaf pine, sometimes with pond pine. The ground cover is dominated by herbs, with a very high diversity of species. Pine Savannas are among the most species-rich communities known in the world at small scales. As many as 52 plant species have been found in a single square meter in a Pine Savanna site outside of the A/P II Study area. The most plentiful species in the ground cover may be wiregrass, toothache grass (Ctenium aromaticum), or wireleaf dropseed (Sporobolus sp. 1). A large number of sedges (especially Rhynchospora spp.) are often present. Insectivorous plants, including pitcherplants (Sarracenia spp.), sundews (Drosera spp.), and Venus' flytraps (Dionaea muscipula) are often abundant, along with a number of showy

wildflowers. Shrubs such as dangleberry, inkberry, sheep-kill, and giant cane are present in low numbers. Pine Savannas are extremely dependent on frequent fire. With fire suppression, they quickly deteriorate, with the shrubs becoming dense and the herbs being suppressed. With long absence of fire, they may come to resemble Pond Pine Woodland. Because of fire suppression and habitat destruction, this community is quite rare now in the A/P II Study area, with nearly all examples being in Croatan National Forest, where such sites are burned regularly by Forest Service personnel.

E. 3. z. Sandhill Seep. Sandhill Seeps occur primarily in the Sandhills region of the state and are very rare in the outer Coastal Plain. Marginally developed examples occur at Nine Foot Road/Broad Creek Pinewoods in Croatan National Forest and along the Suffolk Scarp in Beaufort County. Sandhill Seeps generally occur on sloping land where water seeps out, creating wetland conditions. The vegetation is generally a mixture of shrubs and herbs. Many species are shared with the Pine Savanna community type, but the vegetation is more patchy. Additional species, such as dwarf witch-alder (Fothergilla gardenii) and poison sumac, are sometimes present. Like Pine Savannas, they are dependent on frequent fire and quickly become shrubby in its absence. However, unlike savannas, seeps are linear in configuration and seldom exceed an acre or two in size; they are certainly one of the rarest communities in North Carolina in terms of total acreage.

E. 3. aa. Tidal Freshwater Marsh. Schafale and Weakley (1990) recognize two variants of the Tidal Freshwater Marsh community type -- freshwater marsh proper and oligohaline. These variants are distinctive enough that they are treated as separate for the purposes of this report. Salt content of estuaries becomes progressively more dilute with distance from sea water inlets. In lower river reaches, beyond the limit of any salt penetration, water levels may still rise and fall with the tides. The tides are a result of rising water downstream effectively damming the river, and of wind pushing water up the river. The Tidal Freshwater Marsh community occurs on muddy or mucky flats flooded by the tidally fluctuating waters. They tend to have abundant broad-leaved forbs, with lesser amounts of grasses, sedges, and rushes than found in brackish/oligohaline marshes. Typical species are southern wild rice (Zizaniopsis miliacea), several sedges (Carex spp.), arrow arum (Peltandra virginica), a few species of arrowheads (Sagittaria spp.), and a great variety of other species. Tidal fluctuation in the marshes is very slight and barely noticeable, but the structure and composition of the marshes appear to correlate well with tidal freshwater marshes elsewhere in the mid-Atlantic states, where tidal amplitude is much greater (Odum et al. 1984). This is a rare natural community in North Carolina; good examples are found along the Trent River near New Bern and along the Tar River near the Pitt-Beaufort county line.

E. 3. bb. Oligohaline Marsh. Both Tidal Freshwater Marsh proper and Oligohaline Marsh fall within the definition of fresh water (Cowardin et al. 1979), but the Oligohaline Marsh has enough salt to influence the vegetational composition, while the freshwater marsh proper has no trace of salt influence. The Oligohaline Marsh communities are most common north of the study area in North Carolina, but examples in the A/P II Study area are present along the Pamlico River, the Pungo River, and the embayed portion of

the Neuse River. The marshes tend to be dominated by sawgrass (Cladium jamaicense), several species of cattails (Typha spp.), big cordgrass (Spartina cynosuroides), and common reed (Phragmites communis). A very high diversity of plant species, both herbs and shrubs, is often present, especially where the marshes are burned at frequent intervals.

E. 3. cc. Tidal Cypress-Gum Swamp. Associated with the marshes are the Tidal Cypress-Gum Swamps, common along the shores of drowned river and stream valleys. The predominant feature is the canopy of bald cypress, water tupelo, and swamp tupelo. Lower vegetation is relatively sparse, though a shrubby border of waxmyrtle, swamp rose (Rosa palustris), and titi is often present. The margins of most of the sounds and embayed rivers in the study area contain Brackish Marshes rather than this community; yet Tidal Cypress-Gum Swamps are common along many of the tributaries of the embayed rivers.

E. 3. dd. Estuarine Fringe Loblolly Pine Forest. This poorly understood natural community type occurs along the margins of estuaries, Tidal Freshwater Marshes, Oligohaline Marshes, and Brackish Marshes. It seldom if ever abuts tidal water directly, but it generally forms a zone between the marshes and other forested communities farther inland. It is a common community near the shores of Pamlico Sound, with many good examples in Hyde and Pamlico counties. The canopy, sometimes stunted and open, is dominated by loblolly pine. Some red maple, sweetgum, and swamp tupelo may be present in the canopy. Red maple and redbay are common in the understory, and waxmyrtle is the characteristic shrub. Greenbriers (Smilax spp.) are found in most stands. The most common herbs are royal fern, netted chain fern (Woodwardia areolata), and occasional patches of sphagnum. Marsh vegetation is often present in openings of this forest. Groundsel-tree (Baccharis halimifolia) often occurs along the pine/marsh boundaries.

E. 3. ee. Maritime Wet Grassland. Maritime Wet Grasslands occur on barrier islands, and rarely on estuarine islands, in dune swales and on low sand flats where the water table is at, or seasonally above, the ground surface. Like the Maritime Dry Grassland, they are subject to salt spray and may be subject to sea water overwash during severe storms. The vegetation is generally dominated by salt-meadow cordgrass, hair-awn muhly (Muhlenbergia capillaris), or fimbries (Fimbristylis spp.), and is often very diverse.

E. 4. Estuarine and Marine Communities

E. 4. a. Brackish Marsh. Estuarine shorelines somewhat more remote from sea water, flooded with brackish water, support Brackish Marsh communities. Black needlerush (Juncus roemerianus) or salt-meadow cordgrass strongly dominate the vegetation; salt grass (Distichlis spicata) is also frequently common in this community. A number of species may occur in the narrow upland transition zone, but only a few can tolerate the salt and the dense cover of the dominants in most of the marsh. Brackish Marshes cover vast areas along the shoreline of Pamlico Sound.

E. 4. b. Salt Marsh. Estuarine shorelines relatively near inlets are influenced by sea water with little dilution. The vegetated intertidal areas support Salt Marsh communities. Although these communities are highly productive, the high salt concentration severely limits the vascular plants that can occur. The marsh is strongly dominated by saltmarsh cordgrass (Spartina alterniflora). Only a few other species are usually present. This is a common and easily identified community on the barrier islands, but in the A/P II Study area is limited mainly to mainland Carteret County, which is relatively close to the salty water entering Beaufort and Drum inlets.

E. 4. c. Salt Flat. Shallow depressions in the upper zones of Salt Marshes may hold salt water that is only intermittently replenished by unusually high tides. As water evaporates, the salt becomes concentrated above the levels in sea water, forming a very harsh environment for higher plants. The surface is often encrusted with salt. In these communities the vegetation consists of sparse individuals of salt grass and glassworts (Salicornia spp.). The centers of the Salt Flats are often completely barren. These communities are generally small, often just a few square yards in size; all known sites in the study area are in Carteret County.

E. 4. d. Salt Shrub. Above the Salt Marshes and Brackish Marshes, on barrier island or mainland shorelines, frequently occurs a shrubby zone that is occasionally flooded by high tides. A handful of salt-tolerant shrubs make up the vegetation. The dominant species generally are sea oxeye (Borrichia frutescens), broadleaf marsh-elder (Iva frutescens), waxmyrtle, groundsel-tree, and southern red-cedar. This community is usually described as "maritime shrub" community in most natural area descriptions, though Maritime Shrub as used in this inventory is a terrestrial, non-wetland community. Because of the confusion about the Salt Shrub community, which is actually reasonably distinctive, its abundance in the study area is poorly known. Though common on the barrier islands, it is probably uncommon in the A/P II Study area, though it likely occurs not only in Carteret County but perhaps near shores of Pamlico Sound on mainland Hyde County.

E. 4. e. Upper Beach. This community type occurs in front of the foredunes, above the level of normal high tide. It is an extremely dynamic and stressful setting, periodically reworked by storm waves, and always subject to heavy salt spray. It is now also often subject to vehicle traffic on accessible barrier islands. Vegetation is sparse and composed of a number of herbaceous plants that are specialized for this environment. They include sea rocket (Cakile edentula), sandmats (Euphorbia spp.), and the rare plants seabeach buckwheat (Polygonum glaucum) and seabeach amaranth (Amaranthus pumilus).

F. PLANT LIFE

F. 1. Rare and Endangered Plant Species

The 10-county A/P I Study area (Frost et al. 1990) is relatively depauperate in rare plant species. On the other hand, the 7-county A/P II Study area (this inventory) contains dozens of rare plant species at well over 100 sites within the region. A total of 83 rare vascular plant species, and 5 rare species of mosses and liverworts, have been reported from the region (see Table 3), with the heaviest concentration (by far) being in the Croatan National Forest.

Despite the large number of rare plants, only the rough-leaf loosestrife (Lysimachia asperulifolia) and the sensitive joint-vetch (Aeschynomene virginica) are Federally listed, as Endangered and Threatened, respectively. The loosestrife is an attractive herb with a raceme of large yellow flowers; it grows primarily along the ecotone between savannas and pocosins. With the exception of a single currently-known site in Pamlico County, all other currently-known populations of the loosestrife in the A/P II Study area are in Croatan National Forest in Carteret County. The loosestrife occurs at a few dozen sites in North Carolina, but elsewhere is present at just a few places in adjacent South Carolina. The joint-vetch, on the other hand, is primarily a mid-Atlantic species of tidal freshwater marshes, ranging from New Jersey to North Carolina. Sites in North Carolina, however, are in canals, ditches, and other man-altered sites, and it has not yet been found in tidal marshes.

One species -- the seabeach amaranth (Amaranthus pumilus) -- has been proposed as a Federally Threatened species. This plant occurs on beaches and sand flats, primarily on barrier islands outside the A/P II Study area, but a few plants do occur in the study area.

A total of 12 plant species are Federal candidates (category C2) for listing. Several of these plants grow in savannas -- savanna cowbane (Oxypolis ternata), Carolina goldenrod (Solidago pulchra), wireleaf dropseed (Sporobolus sp. 1), Carolina asphodel (Tofieldia glabra), and savanna campylopus (Campylopus carolinae). Limesink ponds and their margins provide habitat for the shrub pondspice (Litsea aestivalis), and such ponds and natural lakes provide habitat for loose watermilfoil (Myriophyllum laxum). The remaining Federal candidate species occur in widely divergent habitats. The Carolina spleenwort (Asplenium heteroresiliens) grows only on vertical exposures of marl outcrops, with at least 7 sites in the study area. Although Godfrey's sandwort (Minuartia godfreyi) has been reported in the state from a marl site (Site JO3), its only known occurrence in the state at present is in openings and banks of tidal freshwater marshes, perhaps over marl (Site CR7). Chapman's sedge (Carex chapmanii) occurs in swampy or wet woods. Carolina bogmint (Macbridea caroliniana) is found primarily in ditches, while the spring-flowering goldenrod (Solidago verna) is found mainly along wooded road margins, often in disturbed soil.

Several rare plants are considered State Endangered or State Threatened, but yet have no Federal designation. State Endangered species include the pinebarrens sandreed (Calamovilfa brevipilis), a grass of savannas, and the Tennessee bladder-fern (Cystopteris tennesseensis), a fern of marl outcrops. State Threatened species without a Federal designation include saltmarsh spikerush (Eleocharis halophila), which occurs in brackish marshes; Carolina

Table 3. Endangered, threatened, and rare plant species in the 7-county Albemarle-Pamlico Estuarine Study region. Where a species occurs in an identified natural area, the Site Number is given; otherwise, the county of occurrence is listed.

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
VASCULAR PLANTS						
Aeschynomene virginica sensitive joint-vetch	E	LT	S1	G2	ditches, wet fields, marshes	HY9; Beaufort, Craven
Agalinis aphylla scale-leaf gerardia	C		S2	G3G4	savannas	CA4,CR9; Jones
Agalinis linifolia flaxleaf gerardia	SR		S2	G3G4	savannas, ditches	CR14
Agalinis virgata branched gerardia	C		S2	G3G4	savannas, ditches	CA4,CA6, CA8,CA9, CA11,CA12, CA22,CR9
Amaranthus pumilus seabeach amaranth	T	PT	S2	G2	ocean beaches, sand flats	CA18,CA22
Amphicarpum purshii pinebarrens goober grass	SR		S3	G3?	savannas, pocosin ecotones	CA3,CA7, CA8,CA9, CA12,CR14; Pitt
Aristida palustris longleaf three-awn	SR		S2	G4	margins of limesinks, wet savannas	CA7,CA9
Asclepias pedicellata savanna milkweed	C		S1	G3G4	dry savannas, flatwoods	CA7,CA8, CA9,CA12, CA13
Asplenium heteroresiliens Carolina spleenwort	E	C2	S1	G2	marl outcrops	CR3,CR4, CR8,JO1, JO2,JO3, JO4
Bidens coronata crowned beggarticks	SR		S1	G5	fresh to brackish marshes	CR7; Beaufort

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Calamovilfa brevipilis pinebarrens sandreed	E	3C	S2	G3	savannas	CA3,CA6, CA7,CA8, CA11,CA12; Pitt
Cardamine longii Long's bittercress	SR	3C	S1	G3G4	tidal creeks and marshes	Jones
Carex chapmanii Chapman's sedge	T	C2	S2	G2G3	moist woods	JO8; Carteret, Craven
Carex crus-corvi crowfoot sedge	SR		S1	G5	swamp forests	Pitt
Cladium mariscoides twig-rush	SR		S2	G5	savannas	Carteret, Craven
Cystopteris tennesseensis Tennessee bladder-fern	E-SC		S1	G5	marl outcrops	CR3,JO3
Dionaea muscipula Venus' flytrap	C-SC		S3	G3	savannas, pocosins, ditches	BE16,CA4, CA7,CA8, CA10,CA11, CA12,PA2; Craven, Jones
Eleocharis equisetoides horsetail spikerush	SR		S2	G4	limesink ponds, natural lakes	CA3,CA9, CR12
Eleocharis halophila saltmarsh spikerush	T		S1	G4	brackish or fresh marshes	HY8
Eleocharis robbinsii Robbins' spikerush	C		S1	G4G5	limesink ponds, natural lakes	CA9,CR12
Eleocharis rostellata beaked spikerush	SR		S1	G5	brackish marshes	HY14; Beaufort
Eriocaulon aquaticum (= E. septangulare) seven-angled pipewort	SR		S2	G5	lakes, ponds, sluggish streams	CR12

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Eriocaulon parkeri estuary pipewort	C	3C	S1	G3	natural lakes	HY8
Halodule beaudettei Beaudette's shoalweed	SR		S2	G5	sounds, estuaries	CA25
Helenium brevifolium littleleaf sneezeweed	C		S1	G3	bogs, seeps, open wet areas	Carteret
Helianthemum corymbosum pinebarren sunrose	SR		S1	G4G5	maritime forests	Carteret
Helianthemum georgianum Georgia sunrose	C		S1	G4	maritime forests	Carteret
Hexalectris spicata crested coralroot	SR		S2	G3G4	upland woods over basic soil	Jones
Hibiscus aculeatus comfortroot	SR		S1	G4G5	savannas	Carteret
Isoetes riparia riverbank quillwort	SR		S1	G4	shallow water	CR7; Pitt
Lachnocaulon beyrichianum southern bogbutton	C	3C	S1	G2G3	pocosin ecotones	CA11
Lilaeopsis carolinensis Carolina grasswort	T	3C	S2	G3	fresh to slightly brackish marshes	HY5
Listera australis southern twayblade	SR		S2	G4	mesic woods, bottomlands	CR11,HY3, HY13,JO8
Litsea aestivalis pondspice	C	C2	S2	G4G5	margins of wooded ponds	CA9,CA13
Ludwigia linifolia flaxleaf seedbox	SR		S1	G4	limesink ponds	CA9

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Lysimachia asperulifolia rough-leaf loosestrife	E	LE	S2	G2	pocosin/ savanna ecotones	CA7,CA11, CA12,PA3; Beaufort
Macbridea caroliniana Carolina bogmint	C	C2	S1	G2G3	savanna/ pocosin ecotones, ditches	Jones
Malaxis spicata Florida adder's mouth	SR		S1	G3G4	moist woods over marl	JO3
Minuartia godfreyi Godfrey's sandwort	E	C2	S1	G1	fresh marshes (over marl?)	CR7,JO3
Myriophyllum laxum loose watermilfoil	T	C2	S1	G2G3	limesink ponds, natural lakes	CA9,CR12
Orbexilum lupinellum (= Psoralea lupinellus) lupine scurfpea	SR		S2	G3G4	sandhills	CR1
Oxypolis ternata savanna cowbane	C	C2	S2	G3?	savannas, seeps	CA3,CA4, CA7,CA8, CA11,CA12, CR14
Panicum tenerum southeastern panic grass	SR		S2	G4	wet savannas, limesink ponds	CA9
Peltandra sagittifolia spoonflower	SR		S2	G3G4	marshes, ditches, "bogs"	CR11,CR12; Carteret, Jones
Pinguicula pumila small butterwort	C		S1	G4	savannas	CA6,CA7, CA11
Platanthera integra yellow fringeless orchid	T	3C	S1	G5	savannas	CA8,CA11, CR9; Pamlico
Platanthera nivea snowy orchid	C		S1	G5	wet savannas	CR14; Beaufort

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Polygala hookeri Hooker's milkwort	C		S1?	G3	savannas	CA4
Polygonum glaucum seabeach buckwheat	C		S1	G3	ocean beaches, sand flats	CA18
Polygonum hirsutum hairy smartweed	SR		S1	G4G5	limesink ponds	CA9
Ponthieva racemosa shadow-witch	SR		S2	G4G5	damp woods over marl	CR12,JO3, JO8; Beaufort
Prenanthes sp. 1 (= P. alba subsp. pallida) pale rattlesnakeroot	SR		S2?	G2?	flatwoods, swamp margins	JO8
Quercus austrina bluff oak	SR		S1?	G5	bluffs and slopes over basic soil	CR2,JO2
Rhexia cubensis West Indies meadow-beauty	SR		S1	G?	limesink ponds, millponds	CA9,CA13, CA16
Rhynchospora alba northern white beakrush	C		S2	G5	pond margins, "bogs"	CR6,CR12
Rhynchospora breviseta shortbristled beakrush	SR		S1	G3G4	savannas	CA8,CA11; Craven
Rhynchospora harperi Harper's beakrush	C		S1	G3	limesink ponds	CA9
Rhynchospora oligantha feather-bristle beakrush	C		S1	G5	savannas, seepage bogs	CA4,CA7
Rhynchospora pallida pale beakrush	SR		S2S3	G2G3	savannas	CA7,CA8, CA11,JO6; Beaufort
Rhynchospora pleiantha coastal beakrush	C		S1	G3	limesink ponds	CA9
Rhynchospora scirpoides long-beak bald-sedge	SR		S1	G4	wet savannas	CA9

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Rhynchospora stenophylla littleleaf beakrush	C		S1	G2	savannas, seepage bogs	CA11
Sageretia minutiflora small-flowered buckthorn	C	3C	S1	G4	shell middens	Carteret
Sagittaria graminea var. chapmanii Chapman's arrowhead	C		S1	G?T?	limesink ponds	CA9
Sagittaria stagnorum water arrowhead	SR		S1	G4G5	marshes	CR7
Scirpus acutus hardstem bulrush	SR		SH	G5	natural lakes	CR12,HY8; Carteret
Scirpus etuberculatus Canby's bulrush	SR		S1S2	G3G4	blackwater creeks	Craven
Scirpus lineatus drooping bulrush	C		S1	G4	low woods over marl	Jones
Scleria baldwinii Baldwin's nutrush	C		S1	G3G4	wet savannas	CA7
Scleria georgiana Georgia nutrush	C		S2	G4	savannas	CA4,CR14
Scleria minor slender nutrush	SR		S2	G3	savannas, seeps	CA4,CR14; Pitt
Scleria verticillata savanna nutrush	C		S1	G5	savannas	Carteret
Solidago pulchra Carolina goldenrod	C	C2	S2	G2	savannas	CA3,CA4, CA6,CA7, CA8,CA11, CA12,CR14
Solidago verna spring-flowering goldenrod	E	C2	S2	G3	woodland borders	CR7,CR14, CR16,JO5; Pamlico
Spiranthes laciniata lace-lip ladies'-tresses	C		S1	G4G5	moist, wet habitats	Beaufort

Table 3. (continued)

Scientific and Common Names	Status 1 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Spiranthes longilabris giant spiral orchid	C		S1	G3	savannas	CA4
Sporobolus sp. 1 wireleaf dropseed	T	C2	S1	G2?	wet savannas	Jones
Syngonanthus flavidulus yellow hatpins	SR		S2	G5	ditches	Craven
Tofieldia glabra Carolina asphodel	C	C2	S2S3	G2G3	savannas, pocosin ecotones	CA7,CA8, CA11,CA12; Beaufort, Craven
Utricularia geminiscapa two-flowered bladderwort	C		SH	G4G5	seepage area	Beaufort
Utricularia olivacea dwarf bladderwort	T		S2	G4	limesink ponds, natural lakes	CA9,CR12
Xyris flabelliformis savanna yellow-eyed grass	C		S1	G4	savannas	CA11,CA13
Yucca gloriosa moundlily yucca	SR		S2?	G?	dunes	CA18
MOSSES AND LIVERWORTS						
Campylopus carolinae savanna campylopus	C	C2	S1	G1	savannas, open pine woods	CA24
Cheilolejeunea rigidula a liverwort	SR		S2	G5	swamps?	Hyde
Fissidens hallii Hall's pocket moss	C		S1	G2	on bark in cypress-gum swamps	JO3
Lejeunea bermudiana a liverwort	SR		S1	G3G4	swamps, at base of trees	Carteret
Sphagnum fitzgeraldii Fitzgerald's peatmoss	C		S2	G2	pocosins, savannas	CA5; Craven

1 From Sutter, R.D., L. Mansberg, and J.H. Moore. 1983. Endangered, threatened, and rare plant species of North Carolina: a revised list. ASB Bulletin 30:153-163, and updated lists of the N.C. Natural Heritage Program and the N.C. Plant Conservation Program.

E = Endangered
T = Threatened
SC = Special Concern
C = Candidate
SR = Significantly Rare

E, T, and SC species are protected by state law (the Plant Protection and Conservation Act, 1979); the other two categories indicate rarity and the need for population monitoring, as determined by the Plant Conservation and Natural Heritage Programs.

2 From Federal Register, December 15, 1980, Part IV; Federal Register, July 27, 1983; Federal Register, November 28, 1983, Part II. Department of Interior. Established by the Endangered Species Act of 1973, as amended.

LE = Taxon currently listed as Endangered
LT = Taxon currently listed as Threatened
PE = Taxon currently proposed for listing as Endangered
PT = Taxon currently proposed for listing as Threatened
T(S/A) = Threatened due to similarity of appearance
C1 = Taxon with sufficient information to support listing
C2 = Taxon without sufficient information to support listing
3C = Taxon that has proven to be more abundant or widespread than previously believed and/or that is not subject to any identifiable threat

3 From the Nature Conservancy, 1985. Global element rank: world-wide status. Unpublished listing.

G1 = Critically imperiled globally because of extreme rarity or otherwise very vulnerable to exinction throughout its range.
G2 = Imperiled globally because of rarity or otherwise vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range, or found locally in a restricted area.
G4 = Apparently secure globally, though it may be quite rare in parts of its range (especially at the periphery).
G5 = Demonstrably secure globally, though it may be quite rare in parts of its range (especially at the periphery).
GU = Possibly in peril but status uncertain; need more information.
GH = Of historical occurrence, perhaps not having been verified in the past 20 years, and suspected to still be extant.
GX = Believed to be extinct throughout range.
Q = a suffix attached to the Global Rank indicating questionable taxonomic status.
T_ = an additional status for the subspecies or variety; the G rank then refers only to the species as a whole.

4 Taken from Cooper, J.E., S.S. Robinson, and J.B. Funderburg (Eds.). 1977. Endangered and threatened plants and animals of North Carolina. N.C. Museum of Natural History, Raleigh, NC. 444 pages + i-xvi, and updated lists of the Natural Heritage Program.

E = Endangered
T = Threatened
SC = Special Concern
SR = Significantly Rare
UNK = Undetermined, Unknown

5 From the Nature Conservancy, 1985. Definitions of state ranks are the same as for those of the global ranks, except insert the word "in state" for "globally". Additional state ranks used in this report are:

S_B = State rank of the breeding population (SAB = accidental breeding)
S_N = State rank of the non-breeding population(s)
SZ_ = Of no (zero) conservation concern during the season

grasswort (Lilaeopsis carolinensis), which occurs in fresh to slightly brackish marshes and pond margins; yellow fringeless orchid (Platanthera integra), which occurs in savannas; and dwarf bladderwort (Utricularia olivacea), a tiny floating plant found on limesink ponds and natural lakes.

Several additional rare plants occurring the the A/P II Study area deserve mention. The venus' flytrap (Dionaea muscipula) is endemic to the Carolinas, and it ranges northward at present only to extreme southern Beaufort County, with many locales in the Carteret County portion of Croatan National Forest. Despite its limited range, it may be locally common if savannas and flatwoods are properly maintained by burning. In addition to the flytrap and the dwarf bladderwort, 2 other "insectivorous" or "carnivorous" plants considered rare in the region are small butterwort (Pinguicula pumila) and two-flowered bladderwort (Utricularia geminiscapa); the latter, however, has no currently known sites remaining in the state. In addition to the yellow fringeless orchid, other rare orchids in the A/P II Study area are southern twayblade (Listera australis), Florida adder's mouth (Malaxis spicata), crested coralroot (Hexalectris spicata), snowy orchid (Platanthera nivea), shadow-witch (Ponthieva racemosa), lace-lip ladies'-tresses (Spiranthes laciniata), and giant spiral orchid (Spiranthes longilabris).

F. 2. Significant Botanical Habitats

Habitats where rare plant species or high diversities of plant species occur are important to identify and protect. The majority of the significant botanical habitats in the A/P II Study area are various wetland communities.

By far the most significant habitat is pine savanna. Approximately 34 of the rare plant species occur in savannas, though not all grow in the middle of savannas. Many, such as the rough-leaf loosestrife, grow primarily along the edges of savannas where pocosins border the savannas. Some grow only in the wettest spots within a savanna, whereas a few, such as the savanna milkweed (Asclepias pedicellata), prefer the drier sites and the pine flatwoods. Of course, not only are savannas important to rare species, but they are extremely rich in overall plant diversity and are important habitats for showy wildflowers such as pitcherplants, orchids, lilies, meadow-beauties, and others. Millis Road Savanna (Site CA8) is the premier savanna in the study area, but a number of other smaller savannas are present in Croatan National Forest. Pine flatwoods, which occur at slightly drier sites than savannas, also contain a moderate number of rare plants, especially where the forests are burned regularly such that shrub invasion does not shade out herbaceous plants.

Limesink ponds and their margins provide habitat for a handful of rare species. Patsy Pond and adjacent limesink ponds (Site CA9) are considered Nationally significant because of the abundance of rare species. Some of the rare species found at limesink ponds also occur along the shores or in the shallow water of natural lakes, another important habitat. Although most natural lakes in North Carolina contain very acidic waters and are rather sterile, a few such as Lake Ellis Simon and Lake Mattamuskeet are rich in plant species.

The presence of marl at or near the land surface is an important factor in the presence of rare plant species and rare botanical habitats. In addition to the limesink ponds, a "marl" geomorphic feature, marl outcrops

provide habitat for 2 very rare ferns. Forests over marl contain high pH soils and are usually rich in plant species. Several rare plants, including a few rare orchids, occur in the A/P II Study area only in wet or moist woods over marl. The Island Creek Natural Area (Site JO3) is, by far, the most significant marl-dominated natural area in the study area.

Tidal freshwater marshes provide habitat for several rare plants, including the extremely rare Godfrey's sandwort; some such marshes, such as along the Tar River (Site PI7), have a high diversity of plant species. Marshes along the Trent River (Site CR7) contain at least 5 species of rare plants.

Although maritime forests are rather limited in the study area, with most having been destroyed or damaged by development, a handful of rare plants occur in mainland maritime forests (the Coastal Fringe Evergreen Forest natural community) in Carteret County. Shell middens along the shoreline of estuaries in Carteret County, though extremely limited in size, contain rare plants, particularly the rare shrub small-flowered buckthorn (Sageretia minutiflora).

Estuarine/marine habitats in the study area contain relatively few rare plants and, in general, are not rich in plant species diversity. Several rare plants in the region do occur in brackish marshes, and several others, including the Federal Candidate seabeach amaranth, are found on sand flats and beaches. The Rachel Carson Reserve (Site CA18) contains a wide variety of such estuarine and marine habitats and, thus, has a good variety of plant species.

Pocosins cover many thousands of acres of the A/P II Study area. Although pocosins provide habitat for many animal species, including large mammals such as black bear (Ursus americanus) and bobcat (Felis rufus), these habitats, consisting of several natural communities, are depauperate in rare plants. However, pocosin ecotones, especially where pocosins border savannas, are important habitats for many herbaceous plant species.

Swamps, bottomland hardwood forests, and other wet forested habitats are likewise not critical rare plant habitats in the study area. However, such habitats, particularly brownwater floodplain forests, may contain a vast array of plant species. Brownwater levees, for example, are quite rich in herbaceous species, and such forests may contain several dozen species of canopy trees.

Sandhills-type pine forests, dominated by longleaf pine and with various scrub species of oaks, provide habitat for dozens of rare plants in the Sandhills region of North Carolina. On the other hand, such dry and sandy forests in the A/P Study area contain very few rare plants. Nonetheless, because of the relative rarity of these communities in this part of North Carolina, being limited mainly to narrow Carolina bay rims and former beach ridges, they are important to protect and may contain plant species not found in other habitats in the A/P II Study area.

A number of rare plants take advantage of disturbances by man to find suitable habitat. Some of the highest diversity of plant species in the A/P II Study area is present in man-altered sites. Powerline clearings through pocosins or pine flatwoods, despite being unsightly and creating fragmented forests, may provide habitat for dozens of herbaceous plants. The powerline clearings in Sites CR9 and CR14 contain many dozens of showy herbs, with several being rare. The Federal Candidate spring-flowering goldenrod occurs mostly along damp woodland borders, especially where frequently mowed.

Roadside ditches provide important habitats for wetland plants; a few rare species, such as the sensitive joint-vetch, are present in these linear habitats. Another man-made habitat of significance is "scrapes" or borrow areas in flatwoods or savannas. A borrow area that is only one or two feet deeper than the adjacent terrain might lie at the water table and form a "mini-savanna". Such borrow areas or scrapes at sites CA4 and CA11 in Croatan National Forest provide habitat for dozens of plants, many of which probably do not occur in the adjacent flatwoods. Although the authors do not advocate the creation of such man-made habitats, powerline clearings, ditches, road margins, and borrow areas that are kept free of woody vegetation by mowing or burning do provide suitable habitat for wetland plants that otherwise might be very rare in the A/P II Study area.

G. ANIMAL LIFE

G. 1. Rare and Endangered Animal Species

As with plants, the A/P II Study area contains many more rare and endangered animal species than are present in the A/P I Study area (Frost et al. 1990). A total of 44 vertebrate species, and 23 invertebrate species, are considered rare by the N.C. Natural Heritage Program. Five such species are mammals, 24 are birds, 9 are reptiles, 2 are amphibians, and 4 are fishes. For invertebrates, the listing is rather incomplete, but there are at least 5 rare mollusks, 16 rare butterflies and moths, and 2 rare crustaceans. There are certainly many other rare invertebrates, such as moths, beetles, and crustaceans, that are neither being tracked by the Natural Heritage Program nor are listed as candidates for listing by the U.S. Fish and Wildlife Service.

Of the 6 Federally Endangered animals in the study area, only the peregrine falcon (Falco peregrinus), the bald eagle (Haliaeetus leucocephalus), the red-cockaded woodpecker (Picoides borealis), and the roseate tern (Sterna dougallii) are known to occur at present in the 7-county region. The panther (Felis concolor couguar) might have formerly occured in the region, and the Tar River spiny mussel (Elliptio steinstansana) has been reported from the Tar River in Pitt County but is presumed extirpated there. The peregrine falcon is a regular fall migrant down the Atlantic Coast, stopping over at impoundments and sandflats where large numbers of waterbirds, their prey, are feeding. One or two may overwinter in the study area, such as at the Rachel Carson Reserve (Site CA18); the species does not, however, breed in the Coastal Plain of the state. The bald eagle nests at several sites in the A/P II Study area, but these are not identified in this inventory for security purposes. Nesting habitat includes a tall, living pine (usually) for a nest site, generally within a swamp or otherwise extensive forest, yet near to marshes and shallow estuary waters, such as the Pamlico and lower Neuse rivers. Eagles spend much of the year at Lake Mattamuskeet (Site HY8), and they formerly nested at the lake, but this lake and refuge has surprisingly not had nesting eagles for over 20 years. Eagles visit many wetland sites in the study area during the year, including habitats as diverse as catfish ponds, natural lakes, impoundments, and tidal waters. The red-cockaded woodpecker formerly nested throughout most of the North Carolina Coastal Plain, but clearing of longleaf pine forests, fire suppression, and other

Table 4. Endangered, threatened, and rare animal species in the 7-county Albemarle-Pamlico Estuarine Study region. Where a species occurs in an identified natural area, the Site Number is given; otherwise, the county of occurrence is listed.

Scientific and Common Names	Status 4 NC	2 US	5 state rank	3 global rank	Habitat	Locations
MAMMALS						
Condylura cristata star-nosed mole [Coastal Plain pop. is SC]	SC	3C	S4	G5	wetlands, mainly wooded	Pitt
Felis concolor couguar panther	E	LE	SH	G4	remote forests	Carteret
Neotoma floridana floridana eastern woodrat	T		S1	G5T?	unknown	Carteret
Plecotus rafinesquii Rafinesque's big-eared bat	SC	C2	S3	G4	bottomland woods, swamps	Beaufort
Ursus americanus black bear	SR		S3	G5	extensive moist woods, pocosins	found in all counties; many sites
BIRDS						
Aimophila aestivalis Bachman's sparrow	SC	C2	S3B,S2N	G3	open pine woods, savannas	CA3,CA4, CA6,CA7, CA8,CA9, CA11,CA12, CR9
Ammodramus henslowii Henslow's sparrow	SR	C2	S2B,S1N	G4	damp bushy fields, open savannas	BE2,CA6, CA8,PI8
Anhinga anhinga anhinga	SR		S2B,SZN	G5	open swamps, lake shores	CA16,CR12, HY7
Aquila chrysaetos golden eagle	SR		SXB?,S1N	G5	extensive open country	HY1

Table 4. (continued)

Scientific and Common Names	Status 4 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Botaurus lentiginosus American bittern	SR		S1B,S3N	G4	fresh or brackish marshes	CA23,HY8, PA7; Beaufort
Charadrius melodus piping plover	T	LT	S2B,S2N	G2	ocean beaches, sand flats	CA18
Circus cyaneus northern harrier	SR		S1B,S4N	G5	extensive brackish marshes	CA21,CA23
Coragyps atratus black vulture	SC		S3	G5	rural country	found in all counties
Coturnicops noveboracensis yellow rail	UNK		S2N	G4	marshes, wet fields	Carteret, Hyde
Egretta cerulea little blue heron	SC		S3B,S3N	G5	wooded estuarine islands (nesting)	CA17
Egretta thula snowy egret	SC		S3B,S3N	G5	wooded estuarine islands (nesting)	CA17
Egretta tricolor tricolored heron	SC		S3B,S3N	G5	wooded estuarine islands (nesting)	CA17
Falco peregrinus tundrius Arctic peregrine falcon	E	LT	S1B,S2N	G3	lakes, ponds, mudflats	CA18; Hyde
Haliaeetus leucocephalus bald eagle	E	LE	S1B,S2N	G3	remote swamps (nest site), open water (foraging)	HY8,HY11; Beaufort; visits most counties
Himantopus mexicanus black-necked stilt	SR		S2B	G5	fresh or brackish pools	CA19,CA21, PA7; Beaufort
Lanius ludovicianus loggerhead shrike	SC	C2	S2B,S3N	G4	fields and pastures	Pitt

Table 4. (continued)

Scientific and Common Names	Status 4 NC	2 US	5 state rank	3 global rank	Habitat	Locations
Laterallus jamaicensis black rail	SR	C2	S3B,S2N	G4?	brackish marshes	CA19,CA21, CA23,HY14; Craven, Pamlico
Pelecanus occidentalis brown pelican	SC		S3B,S4N	G5	estuarine islands (nesting)	Carteret
Phalacrocorax auritus double-crested cormorant	SR		S1B,S5N	G5	natural lakes (nesting)	CR12
Picoides borealis red-cockaded woodpecker	E	LE	S2	G2	open pine woods	BE4,BE15, CA3,CA6, CA8,CA9, CA11,CA12, CA13,CR9, CR14,PA2; Jones
Plegadis falcinellus glossy ibis	SC		S2B,S1N	G5	wooded estuarine islands (nesting)	CA17
Rynchops niger black skimmer	SC		S3B,S3N	G5	sand flats (nesting)	Carteret
Sterna dougallii dougallii roseate tern	E	LE	SAB,S1N	G3	sand flats (nesting)	Carteret
Sterna nilotica gull-billed tern	T		S3B,SZN	G5	sand flats (nesting)	Carteret
REPTILES						
Alligator mississippiensis American alligator	T	T(S/A)	S3	G5	fresh to slightly brackish waters	CA1,CA3, CA22,CR10, CR11,CR12, HY6,HY7, HY11,HY12; Beaufort, Jones, Pamlico

Table 4. (continued)

Scientific and Common Names	Status NC[4]	US[2]	state rank[5]	global rank[3]	Habitat	Locations
Caretta caretta loggerhead (turtle)	T	LT	S2B,S2N	G3	beaches (nesting)	CA18
Chelonia mydas green turtle	T	LT	S1B,SZN	G3	beaches (nesting)	Carteret
Crotalus adamanteus eastern diamondback rattlesnake	SR		S1	G5	flatwoods, pine/oak sandhills	CA4,CA13; Craven
Heterodon simus southern hognose snake	SR	C2	S3	G4G5	flatwoods, pine/oak sandhills	not determined
Malaclemys terrapin diamondback terrapin	SC	C2	S3	G5	salt/brackish marshes	CA18,CA19, CA23,CA25
Nerodia sipedon williamengelsi Carolina water snake	SC		S2	G5T2	tidal creeks	CA23,CA25; Hyde, Pamlico
Ophisaurus mimicus mimic glass lizard	SC		S2	G3	flatwoods, pine/oak sandhills	CA13
Sistrurus miliarius pigmy rattlesnake	SR		S3	G5	flatwoods, pine/oak sandhills	CA3,CA4, CA9
AMPHIBIANS						
Necturus lewisi Neuse River waterdog	SC	3C	S3	G3	rivers and streams -- Neuse and Tar drainages	CR2; Beaufort, Jones, Pitt
Rana capito capito Carolina gopher frog	SC	C2	S2	G4T?	sandy woods; breeds in pools and ponds	CA3,CA4, CA9; Beaufort, Jones

Table 4. (continued)

Scientific and Common Names	Status 4 NC	2 US	5 state rank	3 global rank	Habitat	Locations
FISHES						
Ambloplites cavifrons Roanoke bass	SR		S3	G3	Neuse and Tar drainages	Pitt
Lampetra aepyptera least brook lamprey	SC		S2	G5	rivers and streams	Jones, Pitt
Notropis bifrenatus bridle shiner	SC		SH	G5	stream in Neuse drainage	Craven
Noturus furiosus Carolina madtom	SC	3C	S3	G3	Neuse and Tar drainages	CR2; Jones, Pitt
MOLLUSKS						
Elliptio steinstansana Tar River spiny mussel	E	LE	S1	G1	Tar River drainage	Pitt
Fusconaia masoni Atlantic pigtoe	T	C2	S1	G3	rivers and streams	Pitt
Lampsilis cariosa yellow lampmussel	T	C2	S1	G4	rivers	Pitt
Lampsilis ochracea tidewater mucket	SC		S2	G4	rivers	Pitt
Ligumia nasuta eastern pondmussel	SC		S2	G4	rivers	Pitt
BUTTERFLIES AND MOTHS						
Amblyscirtes alternata least Florida skipper	SR		S2?	G3G4	open pine woods	Jones
Atrytone arogos arogos eastern beard-grass skipper	SR	C2	S1	G4T3	savannas	CA8

Table 4. (continued)

Scientific and Common Names	Status NC[4]	US[2]	state rank[5]	global rank[3]	Habitat	Locations
Atrytonopsis loammi southern dusted skipper	SR		S1?	GUQ	grassy areas	Carteret
Autochton cellus gold-banded skipper	SR		S2?	G4	damp woods, pond margins	Pitt
Erynnis martialis mottled dusky wing	UNK		S3?	G4	dry woods, brushy fields	Craven
Euphyes berryi Berry's skipper	SR		S1	G3G4	savannas, marshes	CA8
Euphyes bimacula two-spotted skipper	SR		S2?	G4	marshes near swamps	CA8; Jones
Euphyes dukesi Duke's skipper	SR		S1?	G3G4	marshes, swamps	Craven
Fixsenia ontario northern hairstreak	UNK		S3?	G4	dry to mesic oak/pine woods	Carteret, Hyde
Hesperia attalus dotted skipper	SR		S1S3	G4	savannas, open pine woods	Craven
Lithophane lemmeri Lemmer's noctuid moth	SR	3C	S1S3	G3G4	swamps with cedars	Craven
Megathymus yuccae giant yucca skipper	UNK		S3?	G4	open oak or pine woods	Carteret, Craven
Oligoria maculata twin spot skipper	UNK		SU	G5	marshes, grassy areas	Carteret, Craven
Phyciodes phaon phaon crescent	UNK		S2?	G5	moist open areas	Carteret
Problema byssus byssus skipper	UNK		S1?	G3G4	brackish or salt marshes	Craven
Satyrium kingi King's hairstreak	SR		S3?	G3G4	hardwood forests	Carteret, Craven

Table 4. (continued)

Scientific and Common Names	Status 4 NC	2 US	5 state rank	3 global rank	Habitat	Locations
CRUSTACEANS						
Procambarus medialis Albemarle crayfish	SR	C2	S?	G2	pools, creeks	Pitt
Procambarus plumimanus Croatan crayfish	SR	C2	S?	G2	ditches	Carteret, Craven, Jones

1 From Sutter, R.D., L. Mansberg, and J.H. Moore. 1983. Endangered, threatened, and rare plant species of North Carolina: a revised list. ASB Bulletin 30:153-163, and updated lists of the N.C. Natural Heritage Program and the N.C. Plant Conservation Program.

E = Endangered
T = Threatened
SC = Special Concern
C = Candidate
SR = Significantly Rare

E, T, and SC species are protected by state law (the Plant Protection and Conservation Act, 1979); the other two categories indicate rarity and the need for population monitoring, as determined by the Plant Conservation and Natural Heritage Programs.

2 From Federal Register, December 15, 1980, Part IV; Federal Register, July 27, 1983; Federal Register, November 28, 1983, Part II. Department of Interior. Established by the Endangered Species Act of 1973, as amended.

LE = Taxon currently listed as Endangered
LT = Taxon currently listed as Threatened
PE = Taxon currently proposed for listing as Endangered
PT = Taxon currently proposed for listing as Threatened
T(S/A) = Threatened due to similarity of appearance
C1 = Taxon with sufficient information to support listing
C2 = Taxon without sufficient information to support listing
3C = Taxon that has proven to be more abundant or widespread than previously believed and/or that is not subject to any identifiable threat

3 From the Nature Conservancy, 1985. Global element rank: world-wide status. Unpublished listing.

G1 = Critically imperiled globally because of extreme rarity or otherwise very vulnerable to exinction throughout its range.
G2 = Imperiled globally because of rarity or otherwise vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range, or found locally in a restricted area.
G4 = Apparently secure globally, though it may be quite rare in parts of its range (especially at the periphery).
G5 = Demonstrably secure globally, though it may be quite rare in parts of its range (especially at the periphery).
GU = Possibly in peril but status uncertain; need more information.
GH = Of historical occurrence, perhaps not having been verified in the past 20 years, and suspected to still be extant.
GX = Believed to be extinct throughout range.
Q = a suffix attached to the Global Rank indicating questionable taxonomic status.
T_ = an additional status for the subspecies or variety; the G rank then refers only to the species as a whole.

4 Taken from Cooper, J.E., S.S. Robinson, and J.B. Funderburg (Eds.). 1977. Endangered and threatened plants and animals of North Carolina. N.C. Museum of Natural History, Raleigh, NC. 444 pages + i-xvi, and updated lists of the Natural Heritage Program.

E = Endangered
T = Threatened
SC = Special Concern
SR = Significantly Rare
UNK = Undetermined, Unknown

5 From the Nature Conservancy, 1985. Definitions of state ranks are the same as for those of the global ranks, except insert the word "in state" for "globally". Additional state ranks used in this report are:

S_B = State rank of the breeding population (SAB = accidental breeding)
S_N = State rank of the non-breeding population(s)
SZ_ = Of no (zero) conservation concern during the season

factors have left the species restricted to very small and fragmented populations. Close to 50 pairs of the woodpeckers occur at Croatan National Forest at the present time, but away from that area only a few pairs still remain. The roseate tern nested on one occasion near Cape Lookout and occurs sporadically along the coast of Carteret and Hyde counties.

The piping plover (Charadrius melodus) is Federally Threatened. It breeds on barrier islands just outside the A/P II Study area; however, it does winter regularly at Bird Shoal, part of the Rachel Carson Reserve (Site CA18). Despite no obvious change in wintering habitat, the plovers have declined from 70+ birds each winter about 20 years ago to just 4-8 birds in the past few years, implying that the decline is traceable to nesting season failures. Two sea turtles -- the loggerhead (Caretta caretta) and the green turtle (Chelonia mydas) -- nest on the North Carolina coast, though the latter is quite rare. These species, along with occasional Atlantic ridleys (Lepidochelys kempii) and leatherbacks (Dermochelys coriacea), each of which is Federally Endangered, appear occasionally in estuarine waters in the region.

Twelve animal species in the A/P II Study area are Federal candidates for listing (C2 category). The only candidate mammal is Rafinesque's big-eared bat (Plecotus rafinesquii), which occurs in swamps or moist woods. Though recorded only from Beaufort County in the study area so far, it is presumed to be present in a number of other counties, as suitable forested wetland habitat appears to be present. The Bachman's sparrow (Aimophila aestivalis) breeds in open longleaf pine forests, primarily savannas; almost the entire breeding population in the A/P II Study area is restricted to Croatan National Forest. The Henslow's sparrow (Ammodramus henslowii) winters with the Bachman's sparrow in wiregrass and other herbaceous vegetation in the savannas. It nests mainly in recently cut-over and burned pocosins where a thick grass cover and very small saplings are present, such as at the Voice of America sites (Site BE2 and PI8). The sparrow has been found in the nesting season at several other recent clearcuts, but vegetative succession, particularly the rapid growth of pine seedlings, has caused the birds to abandon such sites after just a few years. The loggerhead shrike (Lanius ludovicianus) is a sharply declining bird of pastures and other open, rural country. It presently nests and winters in Pitt County in the study area, but it formerly occurred in most of the 7 counties. The black rail (Laterallus jamaicensis) is a secretive and mostly nocturnal-calling bird of the brackish marshes. Large populations are present at Cedar Island (Site CA23) and Piney Island (Site CA21), and it has been heard calling at other brackish marshes surrounding Pamlico Sound. North Carolina may well have the largest breeding populations of black rails in the country.

The diamondback terrapin (Malaclemys terrapin) is a Federal candidate; it inhabits salt and brackish marshes and estuaries. This turtle is reasonably common in coastal North Carolina, but it has been exploited by man for culinary purposes and its populations have been nationally depleted. The southern hognose snake (Heterodon simus) is a secretive animal that occurs in dry and sandy pinewoods, presumably in Croatan National Forest and elsewhere in the study area. The Carolina gopher frog (Rana capito capito) is a secretive frog of dry pinewoods and sandy places, yet it lays eggs in fish-free ponds. Such a rare combination of habitat requirements implies that the species probably was never common in North Carolina, and it is limited in the study area mainly to limesink ponds and adjacent pinewoods in Croatan National Forest.

Two mollusks found in the Tar River in Pitt County are also Federal candidates for listing. The Atlantic pigtoe (Fusconaia masoni) and the yellow lampmussel (Lampsilis cariosa) occur in large streams and rivers, generally in the lower Piedmont and upper Coastal Plain in the Atlantic states. The only butterfly or moth found in the A/P II Study area that is a Federal candidate is the eastern beard-grass skipper (Atrytone arogos arogos). This subspecies occurs in relatively pristine grassy areas and has been recently observed at Millis Road Savanna (Site CA8). Two crayfishes -- the Croatan crayfish (Procambarus plumimanus) and the Albemarle crayfish (Procambarus medialis) -- are endemic to eastern North Carolina and are found in the study area.

Although there are no animal species considered State Endangered that are not also Federally listed, a few State Threatened (but not Federally listed) animals occur in the A/P II Study area. The eastern woodrat (Neotoma floridana floridana) has been reported historically in Carteret County, and it has recently been found in nearby Onslow County. It might be expected to occur at present in western Carteret County, possibly nesting in old barns or abandoned buildings near woods. The gull-billed tern (Sterna nilotica) breeds on barrier islands and on other estuarine islands; however, it forages in estuaries and other coastal habitats in Carteret County, and occasionally in other tidewater counties, in the study area. The American alligator (Alligator mississippiensis) was formerly considered a Federal Threatened species, but it has since been demoted to "Threatened due to similarity of appearance" in order to protect the similar-appearing American crocodile (Crocodylus acutus), which is a Federally protected species of southern Florida. Alligators occur in all A/P II Study counties except Pitt, with the largest populations probably at Lake Ellis Simon (Site CR12).

Other species of rare animals worthy of mention are several wading birds considered State Special Concern. The little blue heron (Egretta cerulea), the snowy egret (Egretta thula), the tricolored heron (Egretta tricolor), and the glossy ibis (Plegadis falcinellus) breed in colonies (heronries) at selected coastal sites, most notably in the study area at Phillips Island (Site CA17). Several other colonial waterbirds that nest on sandy islands, and that are also Special Concern, are the brown pelican (Pelecanus occidentalis) and the black skimmer (Rynchops niger). Three species of poisonous snakes -- the eastern coral snake (Micrurus fulvius), the eastern diamondback rattlesnake (Crotalus adamanteus), and the pigmy rattlesnake (Sistrurus miliarius) -- were proposed for State listing by the Scientific Council on Reptiles and Amphibians, but the proposal was rejected by the N.C. Wildlife Resources Commission. The latter 2 species occur in the A/P II Study area, mainly in longleaf pine forests; however, the diamondback rattlesnake appears to be on the verge of extirpation from North Carolina.

G. 2. Significant Wildlife Habitats

The most significant habitats for wildlife in the A/P II Study area are those with open water and shorelines. Of course, this description covers many widely differing habitats. There are many estuarine shoreline habitats. The extensive sand and mud flats and tidal marshes at the Rachel Carson Reserve (Site CA18) provides foraging and nesting habitat for hundreds of species of animals. Estuarine islands, such as Phillips Island (Site CA17), contain a shrub/tree thicket with hundreds of nesting herons, egrets, and ibises.

Brackish marshes, shorelines, and shallow waters of sounds are important habitats for wintering waterfowl, marshbirds, estuarine/marine fishes, and countless invertebrates. Marshy shorelines and open water of natural, fresh water lakes are important habitats for alligators, birds, frogs, and other species. Lake Ellis Simon (Site CR12) provides habitat for nesting anhingas (Anhinga anhinga), double-crested cormorants (Phalacrocorax auritus), and ospreys (Pandion haliaetus); Lake Mattamuskeet (Site HY8) has a large nesting population of ospreys, foraging habitat for bald eagles, and foraging habitat for as many as 100,000 swans, geese, and ducks.

Not only are natural lakes important wildlife habitats, but smaller bodies of water are also critical to animals. Fresh water impoundments have been constructed in recent decades, mostly within brackish marshes, to attract waterfowl, mostly for hunting purposes. Impoundments and ponds also provide foraging habitats for shorebirds and other wildlife. Small ponds, such as limesink ponds, are important breeding sites for amphibians. Frogs, toads, and salamanders must lay eggs in fish-free pools and ponds so that the eggs are not devoured; the Patsy Pond complex (Site CA9) and other limesink complexes in Croatan National Forest (Sites CA3 and CA13) are extremely important sites for amphibians.

Swamp forests and bottomland forests contain relatively few rare animals. However, these habitats frequently are rich in wildlife species. Bottomland hardwoods, in particular those dominated by oaks, contain some of the densest breeding bird populations of any habitats in North Carolina. Swamp forests are important waterfowl and amphibian habitats. Because of their frequently extensive size, some covering 10,000 or more acres, swamps and bottomlands provide habitat for large mammals such as the black bear and bobcat. Likewise, pocosins provide habitat for larger mammals because they also frequently occur as extensive tracts numbering thousands of acres. Low pocosins are not rich in wildlife species, but the taller pocosins provide a heavy berry crop in fall and winter for migratory birds and other wildlife species.

The A/P II Study area contains several thousand acres of longleaf pine habitats, though there are few high-quality stands remaining outside of Croatan National Forest. Savannas are not nearly as critical to wildlife populations as they are to plant populations; however, the red-cockaded woodpecker and many other animal species reach peak abundance in savannas and flatwoods. Sandy longleaf pine forests, such as flatwoods and pine/scrub oak communities, are important habitats for many reptiles such as snakes and glass lizards. Animals such as the Carolina gopher frog and other frogs and salamanders spend most of their life cycles in burrows in such sandhill sites, even though they lay eggs in temporary or other small ponds and pools.

Other upland forests are also important wildlife habitats. Mature hardwood forests in uplands are rare in the study area, with the majority on ravine slopes. These forests may closely resemble forests in the Piedmont and provide habitat for animals typical of that province. Very few mainland maritime forests remain in the A/P II Study area; the animal life of such forests is poorly known, but they are known to be important foraging habitats for migratory landbirds, especially during fall migration.

Aquatic habitats were not a focus of the inventory. However, in addition to lakes and other open bodies of water mentioned above, free-flowing rivers and large streams are important habitats. Two endemic vertebrates in North Carolina -- the Neuse River waterdog (Necturus lewisi) and the Carolina madtom

(Noturus furiosus) -- are present in rivers and large streams in the Neuse and Tar drainages in the western part of the study area (Craven, Jones, and Pitt counties). The Tar River and tributaries in Pitt County provide habitat for 5 rare mollusk species and 2 additional rare fishes.

Wildlife habitats consist of more categories than simply the mature natural communities listed above. Habitats also include edges of 2 communities and various seral stages within a single community, such as croplands, weedy fields, and pine thickets. The younger stages of communities, such as fields and shrub thickets, often are valuable to wildlife. As such fields and shrub/sapling thickets mature into pine forests, generally dominated by loblolly pine, the animal diversity generally declines. However, this diversity generally begins to increase as the pines mature past the 15- to 25-year cycle of field abandonment, when deciduous saplings begin to appear beneath the pines. Pine forests over most of the A/P II Study area eventually succeed to hardwood forests, except where fires maintain habitat in pine. Diversity and wildlife values usually continue to increase with an increasing amount of hardwood cover and fruit production, such as acorns and berries.

H. WETLAND ECOSYSTEMS

A considerable proportion of the A/P II Study area consists of wetlands. Cowardin et al. (1979) devised a classification system for wetlands that is used by the U.S. Fish and Wildlife Service in mapping wetlands (National Wetlands Inventory). Cowardin et al. (1979) state that:

> "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."

The N.C. Natural Heritage Program has divided its classification of natural communities into four groupings: Terrestrial, Palustrine, Estuarine, and Aquatic. The Palustrine and Estuarine communities are wetlands. Wetland ecosystems include not only the plants and animals but also non-living components such as soil and water. A number of major wetland ecosystems, or perhaps better called "wetland complexes", are present in the A/P II Study area. These complexes are larger in areal extent than are the individually described natural areas in this report. For the most part, this inventory considers all natural areas along a river system, for example, as belonging to a single wetland complex. This section describes some of the most significant wetland complexes in the region (see Figure 4). These complexes are, in roughly descending order of significance:

1. Southern Croatan savannas, flatwoods, bays, and limesinks -- This complex of many wetland types lies almost wholly within Croatan National

Figure 4. Significant wetland complexes in the 7-county Albemarle-Pamlico Estuarine Study region. The wetlands are numbered in descending order of significance. The site numbers of each natural area within the complex are listed in parentheses.

1. Southern Croatan savannas, flatwoods, bays, and limesinks (CA3,CA4,CA6,CA7,CA8,CA9,CA10,CA11,CA12,CA13)
2. Croatan pocosins and natural lakes (CA5,CA14,CA15,CR10,CR11,CR12,JO7)
3. Hyde County nonriverine forests (HY3,HY4,HY5,HY6,HY7)
4. Hyde County/Pamlico Sound marshes and forests (HY10,HY11,HY12,HY13,HY14,HY15)
5. Cedar Island/Piney Island marshes and forests (CA21,CA22,CA23,CA24,CA25)
6. Lake Mattamuskeet wetlands (HY8,HY9)
7. Goose Creek/Pamlico Point marshes and forests (BE15,PA5,PA6,PA7,PA8,PA9)
8. Southern Pamlico nonriverine forests (PA10,PA11,PA12,PA13)
9. Carteret County estuarine islands (CA17,CA18,CA20)
10. Northern Pamlico/southern Beaufort nonriverine forests (BE16,BE17,PA1,PA4)
11. Grindle Pocosin remnants (PI1,PI2)
12. Neuse River wetlands (CR2,CR5,CR6,PI9)
13. Tar River wetlands (PI6,PI7)
14. Pungo River wetlands (BE9,BE10,BE11,HY2)

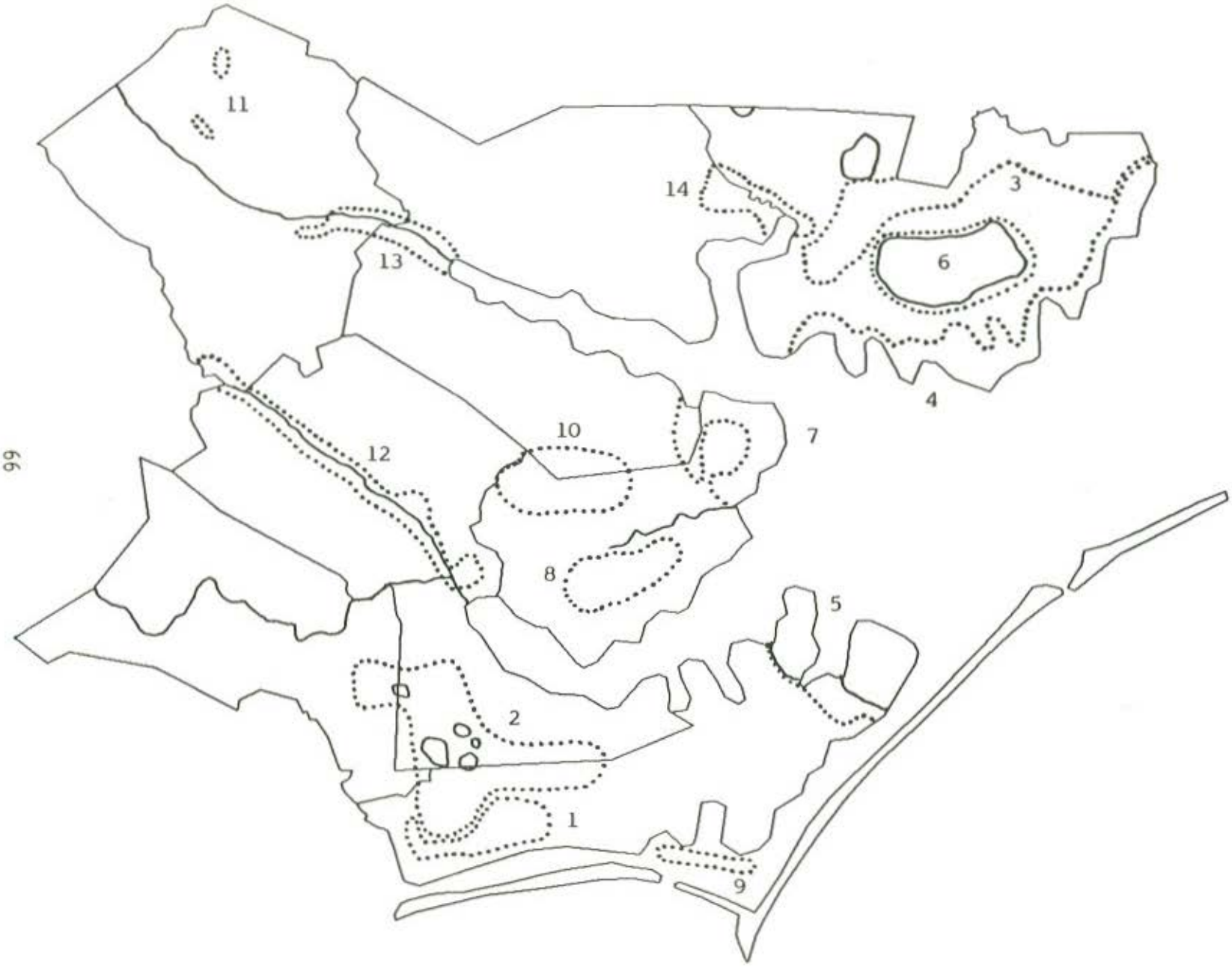


Figure 4. Significant wetland complexes in the 7-county Albemarle-Pamlico Estuarine Study region.

Forest in western Carteret County. The complex features a number of Carolina bays containing pocosin vegetation, many limesink ponds with rare plants, remnant beach ridges and swales, seepages on slopes, and pocosins, savannas, and flatwoods on interstream flats. The complex contains dozens of rare plants and animals, especially at the savannas and pocosin-savanna ecotones.

2. Croatan pocosins and natural lakes -- The central portion of Croatan National Forest is an extensive basin covered by thousands of acres of pocosins, perhaps the largest remaining extent of the vegetation type anywhere. Scattered among the pocosins are 5 large natural lakes believed to have been formed by fire burning deep into the peat layer. Though most of the lakes are rather sterile, Lake Ellis Simon contains many rare plants and animals and features much marsh vegetation.

3. Hyde County nonriverine forests -- Nearly all of Hyde County is a vast wetland, and many thousands of acres in the northern half of the county still retain their natural forested vegetation. Most of these forests are nonriverine, with those in the northeastern corner of the county being primarily pocosin and swamp, whereas those west of Lake Mattamuskeet are primarily wet hardwood forest. This last type is one of the most endangered natural communities in North Carolina.

4. Hyde County/Pamlico Sound marshes and forests -- The northern shoreline of Pamlico Sound contains a nearly unbroken extent of brackish marshes stretching for perhaps 30 linear miles along the shore. Behind the marshes are various pocosin, nonriverine swamp, and estuarine fringe pine forests. The marshes, and the shallow water of Pamlico Sound and associated bays, provide a wintering haven for thousands of waterfowl, especially diving ducks.

5. Cedar Island/Piney Island marshes and forests -- This complex contains among the most extensive brackish marshes in the country; they are rich in animal life, with notable breeding bird species. In addition, Carolina bays occur on both Cedar Island and the adjacent mainland. The complex also features pocosins and pine flatwoods on the mainland, longleaf pine communities on Cedar Island, and an estuarine barrier island system along the shoreline of Pamlico Sound.

6. Lake Mattamuskeet wetlands -- This lake is the largest natural lake in the state, and its shallow waters are wintering grounds for tens of thousands of swans, geese, and ducks. Marshes and impoundments along the shoreline provide additional habitat for wildlife. The cypresses and pines along the shore provide nesting habitat for bald eagles and ospreys. Canals and drainage ditches near the lake are habitat to the endangered sensitive joint-vetch.

7. Goose Creek/Pamlico Point marshes and forests -- The northeastern corner of Pamlico County and extreme southeastern Beaufort County contain thousands of acres of brackish marshes, some of which have been impounded for waterfowl habitat. The impoundments, marshes, and inshore waters of Pamlico Sound provide valuable habitat for waterbirds. Forests in the complex feature a virgin stand of cypress, longleaf pine communities, swamps and pocosins, and estuarine pine forests.

8. Southern Pamlico nonriverine forests -- The southern half of Pamlico County still contains remnant forest vegetation on nonriverine flats. Much still remains in Light Ground Pocosin and in the basin east of Merritt. These forests are a mosaic of nonriverine wet hardwoods, swamps, and pocosin

vegetation types. Nonriverine wet hardwoods are among the most endangered communities in North Carolina.

9. Carteret County estuarine islands -- This county contains a handful of small islands between the mainland and the barrier islands that contain natural vegetation, ranging from salt marshes and salt flats to restricted examples of maritime forest. The islands are important nesting and foraging habitat for a large variety of estuarine animals, such as wading birds and shorebirds.

10. Northern Pamlico/southern Beaufort nonriverine forests -- Portions of the once extensive forests in Bay City Pocosin and Northwest Pocosin still remain near the boundary of Pamlico and Beaufort counties. The Suffolk Scarp separates these two pocosins, and alongside the scarp, especially along the toe of the scarp, are a number of significant wetland longleaf pine communities. Pocosins and nonriverine swamps cover most of the wetland complex.

11. Grindle Pocosin remnants -- The majority of Grindle Pocosin, one of the more inland nonriverine basins in the state, has now been converted to pine plantations. However, remnant nonriverine wet hardwood forests remain, especially in the northeastern corner. Several Carolina bays, with swamp vegetation, are located along the southern fringe of Grindle Pocosin.

12. Neuse River wetlands -- The floodplain of the Neuse River, from southern Pitt County downstream to the New Bern vicinity, contains a csiderable amount of swamp forest in its rather narrow floodplain. This is one of only two major brownwater rivers in the A/P II Study area. Several marshy islands lie in the river near New Bern, and an extensive swamp/pocosin/pine flatwoods complex lies just east of this town.

13. Tar River wetlands -- The Tar River is the other brownwater river in the study area, and its floodplain (somewhat wider than that of the Neuse) contains extensive swamp forests, with some small portions of levee and bottomland forests. Near the mouth of the river, where it becomes embayed, are several tidal freshwater marshes, a rather rare natural community in the state.

14. Pungo River wetlands -- This wetland complex contains both brackish marshes and forests. Remnant longleaf pine flatwoods occur amid the marshes, and pocosins and swamps are present in fairly extensive stands.

DISCUSSION

A. THREATS TO NATURAL RESOURCES

As with all parts of North Carolina, a severe strain is being placed on the natural resources of the 7-county A/P II Study area. Nearly all of the threats are human-induced. The A/P II Study area is considerably more heavily populated than the 10-county A/P I Study area, and threats to natural resources are consequently greater. Table 5 presents the estimated degree of threats to the individual natural communities in the 7-county region, based on the authors' field observations.

The most severe threats are occurring in coastal regions, where uplands abut sounds and other bodies of water. The mainland maritime forests along the Bogue Sound portion of Carteret County are almost completely destroyed by shoreline development. Within the past 10 to 20 years there has been a push toward development of land along the shores of the Pamlico River in Beaufort County and along the shores of the embayed portion of the Neuse River in Craven and Pamlico counties. Much of this development is recreation oriented, with many landowners owning motorboats or sailboats. The second major development pressure on resources is from "urban sprawl". Though there are no major cities (50,000 or greater population), there is a continued development pressure on upland habitats in the vicinity of towns such as Greenville, Washington, New Bern, Havelock, Morehead City, and Beaufort.

Construction of new highways poses a major threat in some portions of the region. New by-passes are being constructed around the west side of Greenville and the northwest side of New Bern. In each case, major fragmentation of the Tar River floodplain and the Neuse River floodplain, respectively, will be done, with new bridges also being built across the rivers. A controversial project -- the Havelock by-pass -- proposes to construct a new highway around the west side of the town, with at least half of the highway impacting Croatan National Forest, much of which is wetlands. Widenings of existing highways, such as NC 24 along the south side of Croatan National Forest and the entire length of US 264 in Beaufort and Hyde counties, will certainly impact wetlands and endangered species habitats.

Threats from timber harvest and creation of pine plantations continue to exist. Such threats have occurred in all 7 counties, with Beaufort, Pitt, Pamlico, and the western halves of Craven and Jones all being heavily impacted by logging and the establishment of pine plantations. Such plantations exist as artificial "monocultures", generally of loblolly pines planted in rows. Much of the damage comes from the ditching and site preparation that precedes the actual seeding of the pines, but the use of herbicides and the dense shade of the planted pines also do much to eliminate native plant species. Before the original vegetation -- generally nonriverine wet hardwoods, nonriverine swamps, and pocosins -- has been cleared, ditches are constructed into the vegetation to lower the water table to make it easier for heavy equipment to operate. After harvest of the trees and subsequent clearing, the land is frequently site-prepped into furrows so that the pine seedlings can be planted on the ridges.

In addition to such large-scale pine plantation operations, considerable land is simply timbered each year by private landowners wishing to provide income. Usually, such tracts are left alone and natural revegetation occurs. Some natural communities can recover to their previous composition fairly well after cutting. Others, such as Atlantic white cedar forests and longleaf pine forests, need a special combination of fire or other environmental factors to

Table 5. Threats (in unprotected areas) to remaining natural communities in the 7-county Albemarle-Pamlico Estuarine Study region.

Community	Degree of Threat	Major Threats
TERRESTRIAL COMMUNITIES		
Mesic Mixed Hardwood Forest, Bluff/Slope variant	Moderate	timber harvest, development
Mesic Mixed Hardwood Forest, Upland Flats variant	Very high	timber harvest, development, agriculture
Mesic Mixed Hardwood Forest, Swamp Island variant	Moderate	timber harvest
Basic Mesic Forest, Coastal Plain subtype	Moderate	timber harvest
Dry-Mesic Oak-Hickory Forest	Very high	timber harvest, development, agriculture
Dry Oak-Hickory Forest	High	timber harvest, development
Piedmont/Coastal Plain Heath Bluff	Low	timber harvest
Coastal Plain Marl Outcrop	Low to Moderate	timber harvest (above the outcrop), fossil collecting, erosion
Mesic Pine Flatwoods	Very high	timber harvest and conversion to pine plantations, fire suppression, development
Pine/Scrub Oak Sandhill	High	timber harvest, fire suppression, development
Xeric Sandhill Scrub	Moderate	timber harvest, fire suppression, development
Oak-Hickory Sandhill	High	timber harvest

Table 5. (continued)

Community	Degree of Threat	Major Threats
Coastal Fringe Sandhill	Very high	development, fire suppression
Coastal Fringe Evergreen Forest	Very high	development
Dune Grass	Moderate	development
Maritime Dry Grassland	Very high	development
Maritime Shrub	Very high	development
Maritime Evergreen Forest	Very high	development
PALUSTRINE COMMUNITIES		
Coastal Plain Levee Forest, Brownwater subtype	Moderate to High	timber harvest
Coastal Plain Bottomland Forest, Brownwater subtype	Moderate to High	timber harvest
Cypress-Gum Swamp, Brownwater subtype	Moderate	timber harvest
Coastal Plain Levee Forest, Blackwater subtype	Moderate	timber harvest
Coastal Plain Bottomland Forest, Blackwater subtype	Moderate	timber harvest
Cypress-Gum Swamp, Blackwater subtype	Low to Moderate	timber harvest
Coastal Plain Small Stream Swamp, Blackwater subtype	Moderate	timber harvest
Oxbow Lake	Low	timber harvest
Coastal Plain Semipermanent Impoundment	Low to Moderate	sedimentation filling in impoundment, eutrophication
Low Elevation Seep	Moderate	timber harvest

Table 5. (continued)

Community	Degree of Threat	Major Threats
Nonriverine Wet Hardwood Forest	Very high	timber harvest and conversion to pine plantations, agriculture, development
Nonriverine Swamp Forest	Very high	timber harvest and conversion to pine plantations
Low Pocosin	High	draining and clearing for pine plantations, agriculture, peat mining
High Pocosin	High	draining and clearing for pine plantations, agriculture, peat mining
Pond Pine Woodland	High	draining and clearing for pine plantations, agriculture, peat mining
Bay Forest	High	draining and clearing for pine plantations, agriculture
Streamhead Pocosin	Moderate	timber harvest and conversion to pine plantations
Peatland Atlantic White Cedar Forest	Very high	timber harvest
Small Depression Pocosin	Moderate	timber harvest, draining for agriculture
Small Depression Pond	High	timber harvest (on adjacent land), off-road vehicles and other human recreation, lowered water table
Vernal Pool	High	timber harvest (on adjacent land), off-road vehicles, lowered water table
Natural Lake Shoreline	Moderate	development
Wet Pine Flatwoods	Very high	timber harvest and conversion to pine plantations, fire suppression

Table 5. (continued)

Community	Degree of Threat	Major Threats
Pine Savanna	Very high	timber harvest and conversion to pine plantations, fire suppression
Sandhill Seep	High	timber harvest and conversion to pine plantations, fire suppression
Tidal Freshwater Marsh	Low to Moderate	succession to shrub thicket and swamp forest (along drier margins) in the absence of fire
Oligohaline Marsh	Low to Moderate	ditching for boat canals or mosquito control, filling for development, diking for impoundments, Phragmites invasion
Tidal Cypress-Gum Swamp	Moderate	timber harvest
Estuarine Fringe Loblolly Pine Forest	Low	clearing for development
Maritime Wet Grassland	Low to Moderate	succession to Salt Shrub in absence of fire or overwash
ESTUARINE/MARINE COMMUNITIES		
Brackish Marsh	Low to Moderate	ditching for boat canals or mosquito control, diking for impoundments or spoil deposition, Phragmites invasion
Salt Marsh	Low	filling for road construction
Salt Flat	Low	succession to Salt Marsh
Salt Shrub	Low to Moderate	development
Upper Beach	Moderate	trampling by humans, dredge spoil deposition

allow recovery. While good examples that have recovered from cutting are known, many examples have been lost after cutting. Lands that have been ditched and timbered, whether planted in pines or left fallow, seldom return to their natural state.

Agriculture has long ago removed millions of acres of former natural vegetation. Clearing of forests for farmland is not widespread at present, but several large "superfarms" have, within the past 20 years, cleared hundreds of thousands of acres of pocosin and hardwood forest land. Such superfarms exist in northeastern and northwestern Hyde County, northern Beaufort County, and eastern Carteret County, with the one in Carteret being roughly 60 square miles (approximately 38,400 acres)! Of course, many smaller farmlands are present throughout the region. Clearing of land for peat mining is also a concern, particularly in Beaufort and Hyde counties. Though this threat has lessened in the past few years, much land suitable for peat harvest is present in parts of the 7-county area. Run-off from croplands and other cleared lands is another concern, especially to the well-being of the rivers and sounds. Run-off of fertilizers, pesticides, animal wastes, and various chemicals from such lands lead to algal blooms, fish kills, and other environmental crises in the state's waterways.

Although the mining industry is limited in the eastern part of North Carolina, environmental concerns from mining have been present in the A/P II Study area. A major phosphate mining operation along the Pamlico River has created problems in the river, in addition to destroying large acres of wetlands and other natural habitats onshore.

Exclusion of fire, in both marshes and in certain forested areas, can be considered a type of threat. Some of the pine forests, pocosins, and marshes need occasional or frequent fires to maintain their integrity; lack of fire leads, in these cases, to a conversion of the natural community into a "fire-suppression" community that is not completely natural, with the loss of many of their component species. Infrequent fire in longleaf pine (Pinus palustris) habitats leads to a more mesic community of loblolly pines (P. taeda), oaks, and hickories. Infrequent fire in marshes, especially fresh or slightly brackish (oligohaline) ones, leads eventually to a dominance of the marshes by only one to several species of grasses, sedges, or rushes. Some freshwater marshes succeed to swamp forests of red maple (Acer rubrum), bald cypress (Taxodium distichum), loblolly pine, or swamp tupelo (Nyssa biflora) in the long absence of fire. The fire needs of pocosins are not well known, but these systems did burn in nature, and fire is probably important in the long term.

Marshes face numerous threats, in addition to those relating to fire exclusion. Where disturbance occurs in fresh to brackish marshes, the apparently exotic common reed (Phragmites communis) frequently forms solid stands, to the exclusion of all other plants. Ditching of marshes is a major threat, at least formerly. Ditches are cut through marshes for mosquito control, for canals for boat passage, and for other reasons. Marshes are occasionally filled in for construction, whereas others are diked for waterfowl impoundments. These latter activities have been reduced in recent years by a tightening of government regulations and a more "hard-line" stance from permitting agencies.

B. SIGNIFICANCE OF THE NATURAL AREAS

The 7-county A/P II Study area contains a number of significant natural areas. The following factors are used in the rating of the significance of natural areas, but the factors and ratings are qualitative and necessarily subjective; no quantitative rating scale is used.

1. Rarity of a natural community, species, or geomorphic feature --
   National: one of the 5 or 6 best examples or largest populations in the nation
   State: one of the best examples or largest populations in the state (North Carolina)
   Regional: one of the best examples or largest populations in the region (east-central Coastal Plain of North Carolina)

2. Maturity of the natural area and natural communities --
   National: usually mature or old-growth communities
   State: may be mature or old-growth
   Regional: perhaps middle-aged (seral), but may be mature or old-growth

3. Size (areal extent) of the natural area --
   National: may be extensive, often 1,000 acres or more
   State: variable, but may be extensive
   Regional: variable

4. Disturbances to the natural area --
   National: usually little evidence of disturbances, such as recent logging, ditching, or presence of exotic species
   State: may show some evidence of disturbances
   Regional: variable, but often show some evidence of disturbances

Many sites in the A/P II Study area would likely get unanimous support for being of National significance. There is often some hesitation to rate a given site of National significance, because it is necessary to know if the features of the natural area are among the best 5 or 6 of their kind in the nation. Thus, there is the need to know the rarity of natural communities, or population sizes of rare species, for example, in neighboring states. Therefore, the significance of some sites may be underestimated. In addition, the significance of sites may increase as other, better examples are destroyed or degraded.

A feature that has a great bearing on the significance of a site is its size. Small sites (under 100 acres) have less likelihood of being significant at the national level than larger ones, because the more extensive the natural communities are, the more significant they become. One problem that manifests itself in this inventory is that individual "small" sites might be hereby considered to be of Statewide or Regional significance, yet when taken collectively with adjacent sites, the collection of sites might be of National significance.

Generally speaking, large sites that were poorly surveyed, perhaps because of difficulty of access by land, were left as one large natural area. Large tracts that were reasonably well surveyed were often divided into individual sites to better describe the vegetation and other features. Such is the case for many of the tracts in the southern portion of Croatan National

Forest in Carteret County, where, even though frequently contiguous with adjacent sites, enough data were collected on specific sites to warrant descriptions of each. This is opposed to the very large Neuse River floodplain site (Site CR2), which was not thoroughly surveyed enough to warrant splitting it into individual sites.

Unlike the A/P I Study area centered around Albemarle Sound, the A/P II Study area abounds in sites considered to be of National significance. In Carteret County alone, the authors consider 6 sites to be of National significance, with 5 of these occurring almost solely in Croatan National Forest, and the other -- Cedar Island marshes -- occurring in the extreme eastern part of the county. Two Nationally significant sites are identified in Craven County, 4 in Hyde County, and 2 in Jones County. Of these last 8 sites, the 2 in Jones are located in Croatan National Forest, and the 2 in Craven are within the Forest boundary but are privately owned. Three of the 4 sites in Hyde are essentially protected as national wildlife refuges, with the other being in private ownership. No specific sites are identified in this inventory as being of National significance in Beaufort, Pamlico, or Pitt counties, though one site in Pitt (Site PI1) was considered Nationally significant until late 1991, when logging of a portion of it reduced the significance.

There are several clusters of natural areas that should be considered of National significance, even if no single site in the cluster rates National significance. These clusters are the Goose Creek/Pamlico Point Marshes and Forests in northeastern Pamlico County and adjacent southeastern Beaufort County and the Southern Pamlico Nonriverine Forests in the southern half of Pamlico County.

C. SELECTION OF THE NATURAL AREAS FOR THE INVENTORY

The selection of which sites are to be presented in a natural areas inventory report is always a difficult decision. Certainly, sites considered to be of National or Statewide significance were included. The biggest difficulty concerns the abundance versus rarity of natural communities, and the condition of these communities. For example, there is a general abundance of riverine and estuarine swamp forest communities and brackish marshes in the A/P II Study area, and many of these forests and marshes are in mature condition. The more common the community, even if sites are pristine, the less significant each site becomes, on a National or Statewide scale. On the other hand, certain communities, such as basic mesic forests and limesink ponds, are rather rare, and few of those sites are in excellent condition. Thus, a mediocre quality basic mesic forest site, of a rather small acreage, might be included in the inventory over a much larger swamp forest or brackish marsh that is nearly pristine.

The areal extent of the various natural communities is also important. Some swamp forests and pocosins may occur over several thousand acres, of a single natural community type. Other communities are quite limited in extent, such as a small depression pond (limesink) or a marl outcrop. Swamps or pocosins of very small acreage (i.e., less than 100 acres) are not likely to make an inventory list, whereas a 1-acre marl outcrop or depression pond would be sufficient in size to be included, assuming that the site has a moderate to high integrity.

The researchers did not include in the inventory representatives of all of the natural communities present in the A/P Study area. A few natural

communities known or presumed to be present are not represented in this inventory, such as Oxbow Lake and perhaps Coastal Plain Levee Forest, Blackwater subtype. Nor did the researchers make an attempt to survey for the best quality sites of rare and endangered species. In fact, the researchers attempted to survey sites based on the extent and condition of the natural communities, looking for coherent, defensible natural areas as well as rare communities. Little effort was made to survey for previously-known locations of rare species. In the majority of these instances, with the exception of the Croatan National Forest, the existing location records of such plants and animals were vague, making the finding of a previously reported site difficult.

D. AREAS FOR FURTHER SURVEY WORK

As with most types of inventory and survey work, there is never enough time and money available to do a complete and thorough survey. A thorough survey of the 7-county A/P II Study area would likely require many thousands of hours. In fact, most previous county-wide inventories of natural areas have focused on just one county per year. Obviously, many portions of the 7-county region need better coverage.

Coupled with the previous coverage of the interior portions of Hyde County (Lynch and Peacock 1982), the coverage of the marshes along Pamlico Sound during the present survey and additional survey work away from the marshes yielded a reasonably complete survey, at least from a "broad-brush" standpoint, of the non-coastal portion of the county. There was no previous county-wide survey done for Beaufort County, and considerable effort was spent to survey the county. A number of sites were surveyed and described for this inventory that were not considered significant enough for inclusion in this report. Pitt County, likewise, had no previous systematic natural heritage inventory, though a number of sites had been surveyed in the county and described individually, mostly for course work or research work at East Carolina University. A moderate amount of time was spent on A/P II Study inventory in Pitt County, though the coverage can only be considered adequate at best.

Pamlico County coverage was somewhat like that of Hyde County. A previous county-wide survey has been published (Peacock and Lynch 1982a), but the survey did not include coverage of the marshes along the fringes of the county. The A/P Study was able to adequately cover these brackish marshes, plus survey many of the previously described sites. Thus, overall coverage of Pamlico County is considered as moderately thorough. Craven County, other than the southern portion in Croatan National Forest, did not receive adequate survey work in the A/P II Study, in part because a previous survey of the county (McDonald et al. 1981) has already been published. Nonetheless, there is a need for additional survey work in the northern half of the county. Because of the richness of Croatan National Forest for rare and endangered species and significant natural areas, additional work in that forest is warranted. Most of the A/P II Study work in Jones County centered on Croatan National Forest, because of the high potential for significant natural areas and rare species. Except for some survey work in search of marl outcrops along the Trent River and tributaries, the majority of the western two-thirds of Jones County was under-surveyed.

Carteret County has had a previous county-wide survey published (Fussell and Wilson 1983). However, this county has such a high potential for

significant natural areas and rare species and, therefore, many days of field work were concentrated in the county, especially in the Croatan National Forest portion. The A/P II Study also concentrated on tidal marshes in the eastern portion of the county. Thus, coverage of Carteret County was reasonably thorough.

Most of the survey work was botanically oriented. Little work was conducted on animal populations, and most animals were recorded in passing during the survey of the vegetation on the sites. Certainly, aquatic surveys in the streams, lakes, and sounds could be done at a later date by other researchers. Surveys for small mammals, amphibians, and reptiles in terrestrial and wetland habitats is also needed. Field work on birds is also needed, though both LeGrand and Fussell made lists of birds seen on surveys of sites that they conducted. There was no intent in this inventory to describe critical "wildlife habitats" or "wildlife corridors". Such habitats and corridors generally are based on areal extent of forested areas, often without concern as to whether or not the forests are mature or cut-over. In some cases, the best wildlife habitats are actually overgrown fields and brushy areas with an abundance of cover, such as hedgerows and brushpiles. The intent of this inventory was to include only those areas of high quality, reasonably mature forests or reasonably intact marshes, rare or uncommon natural communities, or sites of endangered or rare species.

E. RECOMMENDATIONS FOR PROTECTION

E. 1. Agencies and Organizations Involved in Protection

Local land conservancy groups are not known for the 7-county A/P II Study area, which could purchase or otherwise protect significant natural areas. The major land conservancy group in the state is the N.C. Nature Conservancy, a statewide chapter of The Nature Conservancy, which protects land throughout North and South America. The Nature Conservancy has been involved in the protection of a number of natural areas in the study area, especially in Hyde County. This group will undoubtedly play a key role in the protection of other sites in the region in upcoming years. The Conservation Fund is another private land conservancy that played a major part in protecting over 100,000 acres of land in the vicinity of the A/P I and A/P II Study areas.

Several State government agencies are also involved in land protection and will have a role in protection of significant natural areas in the region. The Division of Parks and Recreation has several roles in protection. The N.C. Natural Heritage Program is a State agency located within Parks and Recreation. This program maintains and administers the N.C. Registry of Natural Heritage Areas. These are areas, both in public and in private ownership, that contain significant biological and ecological features which the owners have signed a non-binding agreement to protect. There are approximately 300 such registered areas in the state, including 23 sites in the A/P II Study area. In addition, this program administers the Dedicated State Nature Preserve system, whereby non-Federally owned land is protected in perpetuity by the granting of a conservation easement to the State of North Carolina by the owner. There are presently 11 Dedicated Nature Preserves in North Carolina, only one of which (Rachel Carson Estuarine Research Reserve) is located in the A/P II Study area. The Division of Parks and Recreation also maintains and operates State Parks, State Natural Areas, State Recreation Areas, and State Lakes, Rivers, and Trails. Such facilities in the 7-county

region are Goose Creek State Park, and Fort Macon State Park and Theodore Roosevelt State Natural Area on Bogue Banks.

The N.C. Wildlife Resources Commission owns considerable land in the region as Game Lands, especially in southern Hyde County and northeastern Pamlico and adjacent Beaufort counties. Commission-owned lands in the 7-county region are: Gull Rock Game Land (Hyde County); Goose Creek Game Land (Beaufort and Pamlico counties); and Neuse River Game Land (Craven County).

The Division of Coastal Management's Coastal Reserve system currently has one site in the region -- the Rachel Carson Estuarine Research Reserve in coastal Carteret County. The authors hope that their system of reserves will eventually include sites on the mainland in the A/P II Study area. The Division of Forest Resources owns no properties in the study area, but a few tracts are owned by colleges and universities, or forestry foundations, at the State level. In addition, a few un-allocated State-owned tracts are present in the region; these are under the jurisdiction of the N.C. Department of Administration. It is hoped that such un-allocated tracts can be allocated to conservation-minded State agencies for administration and management.

There are 3 major Federal agencies that are concerned with land acquisition and protection in the eastern United States. The National Park Service owns land in the 7-county area (Cape Lookout National Seashore on Core Banks and Shackleford Banks), but not in the study area proper. On the other hand, the U.S. Forest Service owns and administers Croatan National Forest, in Craven, Jones, and Carteret County. The U.S. Fish and Wildlife Service has a major presence in the A/P II Study area. It owns and administers 5 national wildlife refuges in the area -- Alligator River (Hyde County, extending into Dare and Tyrrell counties), Pocosin Lakes (Hyde County, extending into Tyrrell and Washington counties), Mattamuskeet (Hyde County), Swanquarter (Hyde County), and Cedar Island (Carteret County).

A few other Federal government lands are worthy of mention. Considerable land is owned by the U.S. Government and operated as military installations; Piney Island and Atlantic Field (Carteret County) and Cherry Point (Craven County) are installations of considerable acreage in the A/P II Study area. Three Voice of America installations are present in Beaufort and Pitt counties; they are operated by the U.S. Information Agency and contain significant biological features, despite the cleared nature of the landscape.

E. 2. Protection Priorities

The authors hope that all of the sites described in this inventory will be afforded some measure of protection in future years. They also hope that future field work will reveal other significant natural areas in the 7-county area which will also be provided protection.

Recommendations for protection are determined by several factors. First, the more significant the natural area, the higher should the priority be for protection. Second, the size of a site is important, so that it is better to preserve large tracts of a given natural community than smaller ones. Third, the contiguity of a site with other sites is important. Sites that are isolated from others are likely to be less important in conserving biological diversity in future years than adjacent sites that are protected as a unit (complex). Fourth, protection should focus on natural communities or rare species that are essentially unprotected, or rather poorly protected, in the A/P Study area, or in the state or nation. There is a more pressing need to

preserve a community such as a Nonriverine Wet Hardwood Forest, which presently is nearly unprotected in the 7-county region, than there is to protect a Cypress-Gum Swamp, even if both sites are given the same significance rating.

Protection priorities also need to take into account, to some extent, the degree of threat to a given site. Sites that appear to be, or are known to be, in immediate threat of destruction might well take priority over sites that have apparently little threat to them. However, in most cases, threats are poorly known, or can only be speculated. Thus, the biological significance of the site is the primary factor involved in the priority of protection.

Included below is the suggested priority of protection list, which groups sites that are adjacent to each other as a "complex", in hopes that protection can be achieved for the entire complex rather than the specific site. The suggested priority of protection (in descending order) for these complexes is listed in Table 6; the locations of the complexes are portrayed on Figure 5. The first 8 complexes are considered of National significance, and the remainder of State significance. This list is by no means a complete list of complexes or sites of State significance. The reader should refer to the Inventory of Sites and Table 7 for the listing of significances of each individual natural area.

1. Southern Croatan savannas, flatwoods, bays, and limesinks -- This is considered to be the single-most significant natural area "complex" in the A/P II Study area because of the extremely diverse geomorphology and the very high concentrations of rare species located there. Over 95% of the complex lies within Croatan National Forest and is thus protected from development. However, there is no assurance of protection of all sites; some portions are expected to be logged, at least by thinning. Even more serious is the occasional locating of public facilities, such as landfills, trash receptacles, and monitoring wells, on the Federally-owned property. Additional sites within this complex should be added to the N.C. Registry of Natural Heritage Areas, and additional private properties, such as those containing limesink ponds and longleaf pine forests, should be acquired by the U.S. Forest Service as additions to Croatan National Forest. Further administrative protection in the form of Research Natural Area designation would also be appropriate for much of this complex.
2. Croatan pocosins and natural lakes -- This natural area lies in the central portion of Croatan National Forest. The 5 natural lakes lie in the midst of extensive pocosins. Four of these pocosins are Congressionally-designated Wilderness Areas and are thus protected, and additional other pocosins that are also on U.S. Forest Service land can also be considered protected from logging. However, of the 5 lakes, only 2 of them -- Great and Catfish -- are essentially protected by Forest Service ownership. A third lake -- Lake Ellis Simon -- is privately owned by a hunt club but is protected, at least in the short term, by a registry agreement. The Forest Service has recently acquired, or is in the process of acquiring, lands in the vicinity of the other lakes -- Long and Little.

Table 6. Overview of the most significant natural area "complexes" in the 7-county Albemarle-Pamlico Estuarine Study region. Complexes are listed in descending order of significance. N.W.R. = National Wildlife Refuge; N.F. = National Forest

Natural area "complex"	Site numbers	Degree of protection
NATIONAL significance		
1. Southern Croatan savannas, flatwoods, bays, and limesinks	CA3,CA4,CA6,CA7,CA8, CA9,CA10,CA11,CA12, CA13	Nearly all within Croatan N.F. and thus has moderate protection; a few sites registered
2. Croatan pocosins and natural lakes	CA5,CA14,CA15,CR10, CR11,CR12,JO7	Mostly protected on N.F. lands; some pocosins protected by Wilderness designation, plus Site CR12 registered
3. Trent River/Neuse River marl outcrops	CR3,CR4,CR8,JO1,JO2, JO3,JO4	Only 2 of 7 sites protected; only half of JO3 protected
protected		
4. Hyde County nonriverine forests	HY3,HY4,HY5,HY6,HY7	About 40% protected in N.W.R.'s; remainder unprotected
5. Hyde County/Pamlico Sound marshes and forests	HY10,HY11,HY12,HY13, HY14,HY15	About 75% protected, in N.W.R.'s and state game land
6. Cedar Island/Piney Island marshes and forests	CA21,CA22,CA23,CA24, CA25	About 50% protected in Cedar Island N.W.R.; the 45% in U.S. military ownership considered unprotected
7. Lake Mattamuskeet wetlands	HY8,HY9	Essentially all protected in N.W.R. (Site HY8); Site HY9 unprotected

Table 6. (continued)

Natural area "complex"	Site numbers	Degree of protection
8. Goose Creek/Pamlico Point marshes and forests	BE15,PA5,PA6,PA7, PA8,PA9	About 45% protected in Goose Creek Game Land; remainder unprotected
9. Southern Pamlico nonriverine forests	PA3,PA10,PA11,PA12, PA13	No protection
STATE significance		
10. Carteret County estuarine islands	CA17,CA18,CA20	Site CA18 protected, with some protection for CA17
11. Northern Pamlico/southern Beaufort nonriverine forests	BE16,BE17,PA1,PA2, PA4	No protection
12. Grindle Pocosin remnants	PI1,PI2	No protection
13. White Oak River forests	CA1,CA2,JO8,JO9	Mostly protected in N.F. or private registry
14. Neuse River wetlands	CR2,CR5,CR6,PI9	No protection, except for small tracts owned by N.C. Wildlife Resources Commission
15. Tar River wetlands	PI6,PI7	No protection
16. Pungo River wetlands	BE9,BE10,BE11,HY2	No protection

Figure 5. The most significant natural area complexes in the 7-county Albemarle-Pamlico Estuarine Study region. The complexes are numbered in descending order of significance. The site numbers of each natural area within the complex are listed in parentheses.

1. Southern Croatan savannas, flatwoods, bays, and limesinks
   (CA3,CA4,CA6,CA7,CA8,CA9,CA10,CA11,CA12,CA13)
2. Croatan pocosins and natural lakes
   (CA5,CA14,CA15,CR10,CR11,CR12,JO7)
3. Trent River/Neuse River marl outcrops
   (CR3,CR4,CR8,JO1,JO2,JO3,JO4)
4. Hyde County nonriverine forests
   (HY3,HY4,HY5,HY6,HY7)
5. Hyde County/Pamlico Sound marshes and forests
   (HY10,HY11,HY12,HY13,HY14,HY15)
6. Cedar Island/Piney Island marshes and forests
   (CA21,CA22,CA23,CA24,CA25)
7. Lake Mattamuskeet wetlands
   (HY8,HY9)
8. Goose Creek/Pamlico Point marshes and forests
   (BE15,PA5,PA6,PA7,PA8,PA9)
9. Southern Pamlico nonriverine forests
   (PA3,PA10,PA11,PA12,PA13)
10. Carteret County estuarine islands
    (CA17,CA18,CA20)
11. Northern Pamlico/southern Beaufort nonriverine forests
    (BE16,BE17,PA1,PA2,PA4)
12. Grindle Pocosin remnants
    (PI1,PI2)
13. White Oak River forests
    (CA1,CA2,JO8,JO9)
14. Neuse River wetlands
    (CR2,CR5,CR6,PI9)
15. Tar River wetlands
    (PI6,PI7)
16. Pungo River wetlands
    (BE9,BE10,BE11,HY2)

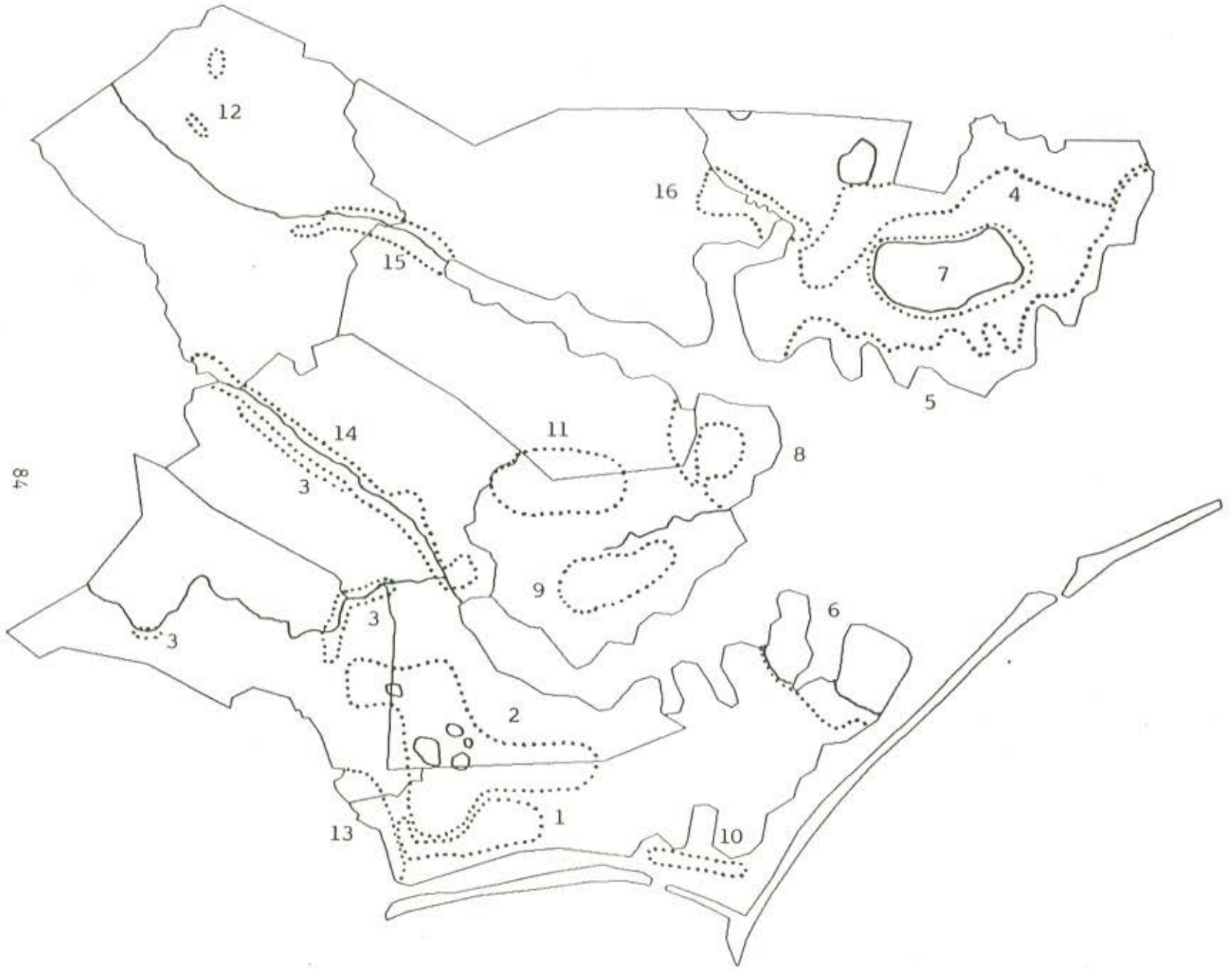


Figure 5. The most significant natural area complexes in the 7-county Albemarle-Pamlico Estuarine Study region.

3. Trent River/Neuse River marl outcrops -- This complex is not a contiguous one but consists mainly of scattered marl outcrops, with most located on banks of the Neuse or Trent rivers. This is the northernmost extent of marl outcrops on the Atlantic coast, at least as vertical bank exposures. The most significant site -- Island Creek -- is protected on the west bank by the U.S. Forest Service, but the eastern bank is in private ownership and is a very high priority for protection. Of the remaining 6 sites considered in the A/P Study, only 2 are protected (by registry); registry or acquisition is needed for these sites. Other small outcroppings of marl are present but are not considered to be of at least Regional significance. It is expected, however, that a few other significant marl outcrops remain to be "discovered" in the A/P Study area.
4. Hyde County nonriverine forests -- This complex includes much of the undisturbed forests remaining in the northern half of Hyde County. Somewhat less than half of the complex is protected, this being included within the boundaries of Alligator River and Pocosin Lakes national wildlife refuges. Additional key natural areas, such as Roper Island, are encouraged to be acquired by the U.S. Fish and Wildlife Service as additions to the refuges. A highly significant nonriverine wet hardwood forest in the western portion of the complex needs protection by registry or conservation or management agreement.
5. Hyde County/Pamlico Sound marshes and forests -- This complex forms a nearly continuous band across the southern and eastern fringes of Hyde County. Perhaps half of this land is brackish marsh, with the remainder being pocosins and other forest types. Fortunately, about 75% of the complex lies within the boundaries of Swanquarter and Alligator River national wildlife refuges and Gull Rock Game Land. However, there is a need to acquire additional lands, with the acquisition of nonriverine hardwood forests and swamps being a very high priority.
6. Cedar Island/Piney Island marshes and forests -- This is a very diverse complex of extensive marshes, Carolina bays, flatwoods, pocosins, and even a barrier island system along Pamlico Sound. Approximately half of the complex is protected within Cedar Island National Wildlife Refuge. Additional private lands on the mainland are worthy of acquisition by the Fish and Wildlife Service, as are barrier island lands along Pamlico Sound. Piney Island, comprising about 45% of the complex, is in U.S. military ownership and cannot be considered protected, though much of the buffer lands around the military facilities and target zones perhaps can be registered.
7. Lake Mattamuskeet wetlands -- This complex consists almost wholly of Mattamuskeet National Wildlife Refuge, of which Lake Mattamuskeet is the main component. The refuge is protected, but there is little available adjacent property to add to the refuge. Several small sites along US 264 containing the Federally-proposed sensitive joint-vetch might be protected through registry, but there is a need to find populations of this plant either on the refuge or at sites more easily protectable than roadside ditches.
8. Goose Creek/Pamlico Point marshes and forests -- This complex contains thousands of acres of brackish marshes, along with

swamps, pine forests, and waterfowl impoundments. Goose Creek Game Land, owned by the N.C. Wildlife Resources Commission, protects about 45% of the complex; most of this Game Land is worthy of registry, or dedication as a State Nature Preserve. However, thousands of acres of extensive marshes remain unprotected along the shore of Pamlico Sound; these might be potential additions to the Game Land, as are lands along Oyster Creek along Pamlico River and in eastern Gum Swamp.

9. Southern Pamlico nonriverine forests -- The southern half of Pamlico County still contains thousands of acres of natural forested vegetation, particularly pocosins and nonriverine hardwood forests. Unfortunately, there is no protection for any of the lands. In fact, a tract of approximately 1000 acres of un-allocated State property has been turned downed by several State agencies for re-allocation because of the requirement that fair market value must be paid to the State Literary Fund for the property. Because perhaps 25% or more of the complex consists of the highly endangered Nonriverine Wet Hardwood Forest community, protection efforts at this complex are of the utmost need.

10. Carteret County estuarine islands -- This is a small complex of several natural islands in estuaries in Carteret County, highlighted by the fully protected Rachel Carson Estuarine Research Reserve. Browns Island is unprotected, but it might be acquired as an addition or satellite to the Rachel Carson reserve. The National Audubon Society has been working to acquire or arrange management agreements for the heronry islands.

11. Northern Pamlico/southern Beaufort nonriverine forests -- This is another complex of nonriverine forests, along with Complex 9, that is completely unprotected. It should be obvious that one of the most pressing needs for protection in North Carolina is acquisition of tracts of nonriverine wet hardwoods and nonriverine swamps, especially the former type. Portions of this complex along the Minnesott Sand Ridge (sites BE16 and PA2) contain an unusual mix of seeps and other longleaf pine communities that are also worthy of protection.

12. Grindle Pocosin remnants -- Grindle Pocosin is an extensive nonriverine basin in northern Pitt County that formerly contained thousands of acres of hardwood forests, but probably not pocosin vegetation. Unfortunately, nearly all of the pocosin has been converted to pine plantations; perhaps only 1-2 thousand acres of remnant vegetation remains. None of the complex is protected, but the hardwood forests in the northeastern corner (Site PI1) are very significant and should be acquired, perhaps by a State agency for protection.

13. White Oak River forests -- This complex is a rather disjunct series of mature forests, mostly hardwoods, on the eastern side of the river. Within the complex are a mainland maritime forest, rich forests underlain by marl, and forests on rolling topography reminiscent of the Piedmont. Three of the 4 sites included in this complex lie within Croatan National Forest and are given protection, though one of the 3 (Site JO8) needs to be added to the N.C. Registry of Natural Heritage Areas. (Two other sites have already been registered by the U.S. Forest Service, and the private site is partially registered).

14. Neuse River wetlands -- The Neuse River floodplain is one of just 2 areas of "brownwater forests" in the A/P II Study area, the other being the Tar River floodplain. Despite its considerable length in the region, extending from southern Pitt County to the New Bern area, relatively little detailed biological survey work has been conducted, and the complex is essentially unprotected. The N.C. Wildlife Resources Commission owns 120 acres in the floodplain just north of New Bern. Because of that agency's "foothold", the Commission might take the lead in protection of additional floodplain sites. One landowner is in the process of registering property in the floodplain with the N.C. Natural Heritage Program, but even so, the floodplain forests are woefully unprotected. At least one formerly significant site in the floodplain has been clearcut in recent years, and the fate of nearly all of the forests is uncertain without protection.

15. Tar River wetlands -- This brownwater river system is, like the Neuse River complex, virtually unprotected. This floodplain is somewhat wider than that of the Neuse, at least within the A/P Study area. While not as urgent for protection as the nonriverine wet hardwoods and other nonriverine communities, these riverine habitats (except for the Roanoke River system) are woefully underprotected.

16. Pungo River wetlands -- Unlike the previous 2 complexes, this is a complex of blackwater river communities, with some brackish marshes along with swamps and pocosins. All sites are in private ownership, and there is no protection for any of the complex.

It can be seen from the above listing that the majority of the most significant complexes are wetlands. This is not surprising, as most of the upland habitats have been destroyed or altered. On the other hand, the most pressing protection needs are the preservation of upland and nonriverine forests, since these communities are under the heaviest threats. Upland habitats such as longleaf pine forests and hardwood forests over marl (Basic Mesic Forest natural community) are in critical need of protection, though fortunately many of the longleaf pine forests are protected in Croatan National Forest. However, the most critical protection needs are to save the Nonriverine Wet Hardwood Forests, as nearly all have been cleared for agriculture or pine plantations. There is practically none of this community, which has high wildlife values, in protected status in North Carolina.

The authors hope that agencies and groups involved in protection of natural resources take an active role. Protection involves more than just acquisition of natural areas. Strict enforcement of regulations in regard to the ditching and filling of wetlands is important in protection of North Carolina's resources. Protection of the waters of Albemarle and Pamlico sounds includes prevention or reduction of runoff from agricultural fields into streams that eventually reach these sounds. Protection of upland forests is also important in this regard, as clearcut sites are poor at controlling erosion. Protection of the sounds and their waters must first center on the wetlands immediately adjacent to the sounds, such as the tidal marshes and tidal swamps, but the wetland sites farther up the rivers and streams, the nonriverine sites, and the upland sites are also very important to North Carolina's natural heritage.

REFERENCES

(NHP = North Carolina Natural Heritage Program, Division of Parks and Recreation, Department of Environment, Health, and Natural Resources, Raleigh.)

Bellis, V., and G. Laroussini. 1977. Natural landmark survey of the Goose Creek State Park Natural Area. Bio. Impact Studies No. 14, Environ. Assessment Lab.

Bellis, V., and M. Schafale. 1986. Otter Creek Natural Area. Site description. NHP.

Carter, J.G., P.E. Gallagher, R.E. Valone, and T.J. Rossbach. 1988. Fossil collecting in North Carolina. Bulletin 89. Geological Survey Section, Division of Land Resources, Dept. of Natural Resources and Community Development.

Clayton, J.H. 1974. Seasonal dispersion patterns of the dusky salamander Desmognathus fuscus, in the Coastal Plain. M.S. thesis, East Carolina University.

Corda, S. 1980. Goose Creek State Park Natural Area. Report for University of North Carolina botany class.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Washington: U.S. Fish and Wildlife Service.

Frost, C. 1990a. Eastern Gum Swamp. Site survey report. NHP.

--------. 1990b. Oyster Creek Pine Hammocks. Site survey report. NHP.

--------. 1990c. Nevil Creek Natural Area. Site survey report. NHP.

--------. 1990d. Sophie Island Natural Area. Site survey report. NHP.

--------. 1990e. Live Oak Bay. Site survey report. NHP.

--------. 1990f. Suffolk Scarp Bogs. Site survey report. NHP.

--------. 1990g. Back Landing Bay. Site survey report. NHP.

--------. 1990h. (Eastern Half) Light Ground Pocosin. Site survey report. NHP.

--------. 1990i. Jones Island. Site survey report. NHP.

--------. 1990j. Upper Pungo River Wetlands. Site survey report. NHP.

--------. 1990k. Hobucken Marshes. Site survey report. NHP.

--------. 1990l. Mouse Harbor Marshes. Site survey report. NHP.

--------. 1990m. Swanquarter National Wildlife Refuge -- West. Site survey report. NHP.

--------. 1990n. Caffey Bay Wetlands. Site survey report. NHP.

--------. 1990o. Rose Bay Marshes. Site survey report. NHP.

--------. 1990p. Long Point. Site survey report. NHP.

--------. 1990q. Wysocking Bay Marshes. Site survey report. NHP.

--------. 1990r. Long Shoal River Marshes & Pocosins N.A. Site survey report. NHP.

--------. 1990s. Gibbs Point Marsh. Site survey report. NHP.

--------. 1990t. Bay City Low Pocosin. Site survey report. NHP.

--------. 1990u. Merritt Hardwoods. Site survey report. NHP.

--------. 1990v. South Prong N.A. (includes Stonewall Oak Flats). Site survey report. NHP.

--------. 1990w. Pocosin Lakes NWR/Mattamuskeet NWR Connector. Site survey report. NHP.

Frost, C., and K. Davis. 1990. Swanquarter National Wildlife Refuge -- East. Site survey report. NHP.

Frost, C., and R. LeBlond. 1990. Goose Creek Game Lands. Site survey report. NHP.

Frost, C.C., H.E. LeGrand, Jr., and R.E. Schneider. 1990. Regional inventory for critical natural areas, wetland ecosystems, and endangered species habitats of the Albemarle-Pamlico Estuarine Region: phase 1. Albemarle-Pamlico Estuarine Study, Project No. 90-01.

Fuller, M.K. 1980. Lake Ellis-Simon Natural Area. Report for Univ. of North Carolina.

Fussell, J. 1990. Piney Island (Bombing Range). Site survey report. NHP.

--------. 1991a. Carrot Island -- Horse Island -- Bird Shoal Complex. Site survey report. NHP.

--------. 1991b. FSR 177 Pinewoods. Site survey report. NHP.

--------. 1991c. Bayland Property, Summary. Unpublished report.

--------. 1991d. Pettiford Creek Open Flatwoods. Site survey report. NHP.

--------. 1991e. Hibbs Road Pine Ridges. Site survey report. NHP.

--------. 1991f. Southwest Prong Flatwoods. Site survey report. NHP.

--------. 1991g. Hadnot Creek Sinks. Site survey report. NHP.

--------. 1991h. Catfish Lake Impoundment Bay Rims. Site survey report. NHP.

--------. 1992a. Pringle Road Bay Rims. Site description. NHP.

--------. 1992b. Hancock Creek Forest. Site description. NHP.

--------. 1992c. Mill Creek Outcrops. Site description. NHP.

Fussell, J., and H. LeGrand. 1991. Nine Foot Road/Roberts Road Limesink Complex. Site survey report. NHP.

Fussell, J., H. LeGrand, and J. Kraus. 1990. Cedar Island: North Bay Barrier Strand. Site survey report. NHP.

Fussell, J., and J. Wilson. 1983. Natural areas inventory of Carteret County, North Carolina. CEIP Report No. 9. N.C. Coastal Energy Impact Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

Holmes, R.P., III. 1965. Observations at an impounded salt marsh area. Chat 29:105-106.

Jones-Roe, C.A. 1982. The status of two endangered ferns, Asplenium heteroresiliens Wagner and Cystopteris tennesseensis Shaver, in North Carolina. Report to Plant Conservation Board, N.C. Dept. of Agriculture.

Kraus, J.W. No date. Species along Nine Foot Road, .5 mile north of Hwy 24. Report to NHP.

LeBlond, R. 1990a. South Minnesott Sand Ridge. Site survey report. NHP.

--------. 1990b. North Minnesott Sand Ridge. Site survey report. NHP.

--------. 1991. Croatan National Forest endangered and rare species survey, Compartments 25-32 and 39-40. Report to U.S. Forest Service and N.C. Natural Heritage Program.

LeGrand, H.E., Jr. 1985a. Little Road Longleaf Pine Woodlands and Savannas. Site description. NHP.

--------. 1985b. Gum Swamp Bottomland Hardwood Forest. Site description. NHP.

--------. 1990a. Chicod Creek Slopes. Site survey report. NHP.

--------. 1990b. Jolly Old Field Natural Area. Site survey report. NHP.

--------. 1990c. Bethel/Grindle Hardwood Flats. Site survey report. NHP.

--------. 1990d. Belvoir Hardwood Flats. Site survey report. NHP.

--------. 1990e. Harris Mill Run Slopes. Site survey report. NHP.

--------. 1990f. Tar River Slopes near Bruce. Site survey report. NHP.

--------. 1990g. Blue Banks Farm Natural Area. Site survey report. NHP.

--------. 1990h. Belvoir Carolina Bays. Site survey report. NHP.

LeGrand, H., and C. Frost. 1990. Lower Tar River Marshes and Swamp. Site survey report. NHP.

LeGrand, H., J. Wright, and R. Tyndall. 1990. Chicod Creek Swamp Forest. Site survey report. NHP.

Lewis, D. 1970. Summer birds at a coastal marsh impoundment in North Carolina. Chat 34:87-92.

Lynch, J.M. 1985. Roper Island. General site summary. The Nature Conservancy.

Lynch, J.M., and S.L. Peacock. 1982. Natural areas inventory of Hyde County, North Carolina. CEIP Report No. 28. N.C. Coastal Energy Impact Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

Mansberg, L. 1985. Cedar Point - White Oak River Marshes Natural Area. Site description. NHP.

McCrimmon, D.H. 1978. Nest site characteristics among five species of herons on the North Carolina coast. Auk 95:267-280.

McDonald, C.B., and A.N. Ash. 1981. Natural areas inventory of Tyrrell County, North Carolina. CEIP Report No. 8. N.C. Coastal Energy Impact Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

McDonald, C.B., A.N. Ash, and J.O. Fussell. 1981. Natural areas inventory of Craven County, North Carolina. CEIP Report No. 15. N.C. Coastal Energy Impact Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

N.C. Department of Natural and Economic Resources. 1976. Goose Creek State Park Master Plan. Division of Parks and Recreation.

N.C. Department of Natural Resources and Community Development. 1988. Benthic Macroinvertebrate Ambient Network (BMAN) Water Quality Review 1983-1986. Report No. 88-03.

N.C. Geological Survey. 1985. Geologic map of North Carolina. Raleigh: N.C. Department of Natural Resources and Community Development.

N.C. Natural Heritage Program. 1979. Wildberry Woods Natural Area. Site description.

--------. 1985a. Millis Road Longleaf Pine Savanna and Pocosin. Site description.

--------. 1985b. Patsy Pond Natural Area. Site description.

--------. 1985c. Croatan Pocosins Natural Area. Site description.

--------. 1985d. Great Lake Sweetgum Forest. Site description.

--------. No date. Pungo National Wildlife Refuge. Site report. NHP.

N.C. Wildlife Resources Commission. 1981. Forest Management Plan for Goose Creek Game Land.

Oaks, R.Q., Jr., and J.R. DuBar. 1974. Post-Miocene shorelines and sea levels, southeastern Virginia. In Post-Miocene stratigraphy, central and southern Atlantic Coastal Plain, edited by R.Q. Oaks, Jr., and J.R. DuBar. Logan: Utah State University Press.

Odum, W.E., T.J. Smith III, J.K. Hoover, and C.C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States East Coast: a community profile. FWS/OBS-83/17. Washington: U.S. Fish and Wildlife Service.

Otte, D.K.S., and R.D. Whetstone. 1979. Patsy Pond Natural Area. Ecosystematics report prepared for Botany 235, University of North Carolina, Chapel Hill, N.C.

Otte, L.J. 1981. Origin, development, and maintenance of the pocosin wetlands of North Carolina. N.C. Natural Heritage Program, N.C. Department of Natural Resources and Community Development.

Parnell, J.F., D.M. DuMond, and D.A. McCrimmon. 1986. Colonial waterbird habitats and nesting populations in North Carolina estuaries: 1983 Survey. Technical Report D-86-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Parnell, J.F., and R.F. Soots, Jr. 1979. Atlas of colonial waterbirds of North Carolina estuaries. UNC Sea Grant Publication, UNC-SG-78-10.

Peacock, S.L., and J.M. Lynch. 1982a. Natural areas inventory of Pamlico County, North Carolina. CEIP Report No. 29. N.C. Coastal Energy Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

--------. 1982b. Natural areas inventory of mainland Dare County, North Carolina. CEIP Report No. 27. N.C. Coastal Energy Program, Office of Coastal Management, N.C. Department of Natural Resources and Community Development.

Pyne, M. 1990a. Broad Creek. Site survey report. NHP.

--------. 1990b. Pantego Swamp and Pocosins. Site survey report. NHP.

--------. 1990c. Jackson Swamp Remnants. Site survey report. NHP.

--------. 1990d. St. Clair Creek. Site survey report. NHP.

--------. 1990e. Hills Creek/Camp Hardee Woods. Site survey report. NHP.

--------. 1990f. VOA Site A. Site survey report. NHP.

--------. 1990g. Haw Creek Meanders (Sand Pit). Site survey report. NHP.

--------. 1990h. Upper Pungo River Swamp. Site survey report. NHP.

--------. 1990i. Little Creek. Site survey report. NHP.

--------. 1990j. Western Light Ground Pocosin. Site survey report. NHP.

--------. 1990k. Cherry Run Headwater Flats. Site survey report. NHP.

--------. 1990l. Goose Creek State Park Additions. Site survey report. NHP.

Pyne, M., and C. Frost. 1990. Pantego Wetlands. Site survey report. NHP.

Pyne, M., and A. McKerrow. 1990. W. Gum Swamp. Site survey report. NHP.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Chapel Hill: Univ. of North Carolina Press.

Roe, C., and C. Jones-Roe. 1985. Island Creek. Site description. NHP.

Schafale, M. 1987. Wildberry Woods RHA. Preliminary site reconnaissance survey. NHP.

--------. 1988. Cedar Island National Wildlife Refuge -- SE End Upland. Preliminary site reconnaissance survey. NHP.

--------. 1989. Croatan Pocosins Natural Area (Catfish Lake South Wilderness). Site survey report. NHP.

--------. 1990. Hadnot Creek Ponds. Site survey report. NHP.

Schafale, M., and C. Durost. 1988. Holston Creek Swamp Forest. Preliminary site reconnaissance survey. NHP.

Schafale, M.P., H.E. LeGrand, Jr., and R.S. Marty. 1986. Reconnaissance survey of natural areas along the Waccamaw River, North Carolina. NHP.

Schafale, M., and J. Moore. 1991. Cool Springs. Site survey report. NHP.

Schafale, M., and C. Schafale. 1990. Campbell Creek - Goose Creek Game Land. Site survey report. NHP.

--------. 1991. Goose Creek Game Land - Lower Spring Creek. Site survey report. NHP.

Schafale, M.P., and A.S. Weakley. 1985. Classification of the natural communities of North Carolina. Second approximation. NHP.

--------. 1990. Classification of the natural communities of North Carolina. Third approximation. NHP.

Schneider, R. 1989a. Yucca Sand Ridge (Long Arm Sand Ridge). Site survey report. NHP.

--------. 1989b. Devil's Garden Flatwoods. Site survey report. NHP.

Sears, M.N. 1966. A floristic study of the limestone along Island Creek in Jones County, North Carolina. M.S. thesis. University of North Carolina.

Snyder, J.R. 1977. Report on the vegetation and site factors of the Pond Pine-Pocosin Research Natural Area, Croatan National Forest. Report to the Southeastern Forest Experiment Station, Asheville, N.C.

--------. 1978. Analysis of Coastal Plain vegetation, Croatan National Forest, North Carolina. Veroff. Geobot. Inst. ETH Stiftung Rubel, Zurich 69. Heft. 40-113.

Stuckey, J.L. 1965. North Carolina: Its geology and mineral resources. Raleigh: Dept. of Conservation and Development.

Taggart, J., and K. Henderson. 1988. Exploring the North Carolina National Estuarine Research Reserve. Division of Coastal Management, N.C. Department of Natural Resources and Community Development.

Terwilliger, K., coordinator. 1991. Virginia's endangered species. Proceedings of a symposium. McDonald and Woodward Publishing Co., Blacksburg, Va.

U.S. Department of Commerce. 1990. North Carolina National Estuarine Research Reserve -- Final Management Plan. Prepared by the U.S. Department of Commerce and the State of North Carolina Division of Coastal Management.

U.S. Fish and Wildlife Service. 1968. Pungo National Wildlife Refuge (pamphlet). U.S. Department of the Interior.

--------. 1978a. Swanquarter National Wildlife Refuge. Master Plan.

--------. 1978b. Mattamuskeet National Wildlife Refuge. Master Plan.

Venters, V. 1991. A look at our newest refuge. Wildlife in North Carolina 55:9-13.

Weakley, A.S., R. Marty, and L. Mansberg. 1985. Hunter's Creek Upland Forest Natural Area. Site description. NHP.

Wilson, J. 1978a. Croatan National Forest. [Report on area west of SR 1124, just north of East Prong of Broad Creek.] Report to NHP.

--------. 1978b. Holston Creek on the White Oak River. Report to NHP.

--------. 1983. Botanical survey of the proposed Carteret County landfill site. Report to NHP.

--------. No date. Nine Foot Road Ponds in the Croatan National Forest. Report to NHP.

INVENTORY OF SITES

The major feature of this report is the description of the natural areas and their significance. Table 7 summarizes the sites and briefly gives their significance. Each natural area is given a Site Name and Site Number. The letters in the site numbers are the first 2 digits of the county name. The various sites within each county are generally arranged from west to east or north to south. Thus, the site numbers are not based on significance, but rather on geography. The geographical size (in acres) of the natural area is given; this is not intended to include "buffer" land around the site for additional protection. For many of the sites, the size is poorly known, as it is very difficult to survey the boundaries of wetlands, especially swamps, by boat or by land.

The site significance is given both a letter code (A, B, or C) and a descriptive term. The 7.5 minute U.S. Geological Survey topographic quad maps for each site are listed. Several key significant features of the site are presented. The majority of the information for the site is the description of the biology and geomorphology, including the type of vegetation or natural communities and noteworthy plants and animals. Ownership information, whether public or private, is given, but names of private owners are not listed. The protection status of the natural area, such as whether it is a State Park or a Wildlife Resources Commission Game Land, is presented. Also given is information about how the site should or could be managed to promote or perpetuate the significant features, plus comments on what means of protection appear to be available. Additional comments about the site are also given, such as degree of threat (if known) or completeness of survey. References are also given for each site, though many such references are simply Site Survey Reports completed by the researchers for this project. The N.C. Natural Heritage Program has copies of all Site Survey Reports.

The inventory also provides a map of each natural area, showing approximate boundaries of the site. The maps are to the 1:24,000 scale (7.5 minute U.S. Geological Survey quad maps) unless otherwise indicated; on these 7.5 minute maps, 1 inch equals 2000 feet. A number of sites are so large that they cannot be presented on an 8 1/2" x 11" page without reduction. In such cases, 1:100,000 scale maps are used; on such maps, 1 inch equals 1.6 miles (or 1 centimeter equals 1 kilometer). None of the topographic maps in this inventory are reduced; they are either of the two scales listed above.

Table 7. List of natural areas, and their significance, in the 7-county Albemarle-Pamlico Estuarine Study region. Sites are listed by county and are arranged in a north to south, or west to east, order within each county. Significance levels: A = National; B = State; C = Regional (east-central portion of the Coastal Plain of North Carolina).

County and Site Name	Site No.	Significance Level	Features
BEAUFORT			
Haw Creek Meanders	BE1	C	Unusual geomorphic (fluvial) features; varied communities
Voice of America Site A	BE2	B	Henslow's sparrow population; habitat for "savanna" plants
Cherry Run Headwater Flats	BE3	C	Nonriverine swamp forest and pocosin vegetation
Goose Creek State Park	BE4	C	Remnant live oak and red-cockaded woodpecker populations; tidal marshes
Jackson Swamp Remnants	BE5	B	Good quality Nonriverine Wet Hardwood Forest community
St. Clair Creek Natural Area	BE6	C	Variety of natural communities, including upland hardwoods
Broad Creek Marshes and Forests	BE7	C	Extensive oligohaline marshes; swamp forests
Pantego Wetlands	BE8	C	Extensive brackish marshes and swamp forests
Pantego Swamp and Pocosins	BE9	C	Extensive pocosins and swamps; remnant longleaf pine stand
Upper Pungo River Wetlands	BE10	C	Very diverse wetland communities, especially the marshes
Sophie Island Natural Area	BE11	C	Longleaf pine "islands" amid brackish marshes and swamps
Hills Creek/Camp Hardee Woods	BE12	C	Good quality upland hardwood forests
Little Creek Upland Forests	BE13	C	Mature hardwood forests with a rolling topography

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Nevil Creek Natural Area	BE14	C	Excellent array of communities, both uplands and wetlands
Goose Creek Game Land (Beaufort)	BE15	B	Pine flatwoods near northern limit of range; brackish marshes
Suffolk Scarp Bogs	BE16	B	Pine savanna and seepage "bogs" along Suffolk Scarp; rare plants
Western Gum Swamp	BE17	C	Extensive Nonriverine Swamp Forest natural community
Eastern Gum Swamp	PA5	B	Remnant virgin cypress swamp; brackish marshes; pine "savanna"
Lower Tar River Marshes and Swamp	PI7	C	Tidal freshwater marshes; extensive brownwater swamp forest
CARTERET			
Hadnot Creek Natural Area	CA1	C	Upland forests along ravine slopes; brackish and salt marshes
Cedar Point -- White Oak River Marshes	CA2	C	Mainland maritime forest; brackish marshes
Hadnot Creek Ponds and Longleaf Pine Woods	CA3	C	Several limesink ponds; pine flatwoods and savannas; rare plants and animals
Pettiford Creek Open Flatwoods	CA4	B	Numerous pine flatwoods and savannas; rare plants and animals
Pocosin Wilderness	CA5	A	One of the largest pocosin tracts in the country
Millis Swamp Road Pinewoods	CA6	C	Pine flatwoods; many rare plants and animals
Pringle Road Bay Rims	CA7	A	Carolina bays, with bay rims containing longleaf pine; at least 15 rare species
Millis Road Savannas and Pocosins	CA8	A	Extensive savannas and pocosins; numerous rare plants and animals

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Patsy Pond Limesink Complex	CA9	A	Highly significant cluster of natural ponds, mostly limesinks; numerous rare plants and animals
Wildberry Woods	CA10	C	Diversity of communities in a small area; carnivorous plants
Nine Foot Road/Broad Creek Pinewoods	CA11	B	Flatwoods, "savannas", seeps, and pocosin ecotones; many rare plants
Hibbs Road Pine Ridges	CA12	A	Relict beach ridges and swales; over 10 rare plants and animals
Nine Foot Road/Roberts Road Limesink Ponds	CA13	B	Limesink ponds and longleaf pine forests; rare species
Masontown Pocosin	CA14	B	Extensive pocosins, particularly the Low Pocosin community
Union Point Pocosin	CA15	C	Extensive pocosins; Low Pocosin community
Walkers Millpond and Black Creek	CA16	B	Millpond and swamp with rare plants and colonial waterbirds
Phillips and Annex Islands	CA17	B	Heronry present on islands for many decades
Rachel Carson Estuarine Research Reserve	CA18	B	Waterbird foraging area at extensive intertidal flats; many coastal natural communities
North River Marshes	CA19	C	Brackish marshes; marsh birds and shorebirds
Browns Island	CA20	B	Varied communities on natural island; Coastal Fringe Sandhill community
Piney Island	CA21	B	Very extensive brackish marshes; black rails and other rare birds
Atlantic Natural Area	CA22	B	Carolina bays; relict beach ridges; pine flatwoods, pocosins

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Cedar Island Marshes	CA23	A	Very extensive brackish marshes; large marsh bird populations, especially black rails
Cedar Island Flatwoods and Bays	CA24	C	Carolina bays; pocosins and longleaf pine communities
Cedar Island/North Bay Barrier Strand	CA25	B	Rare example of estuarine barrier island system; Coastal Fringe Sandhill
Great Lake/Pond Pine Wilderness Natural Area	CR11	B	Largest natural lake in the region; nonriverine swamp forest; rare plants and animals
Lake Ellis Simon	CR12	A	Natural lake; excellent wildlife habitat; at least 12 rare plants and animals
CRAVEN			
Dover Bay Pocosin	CR1	B	Two large Carolina bays; longleaf pine communities on bay rims
Neuse River Floodplain and Bluffs	CR2	C	Extensive swamp forest; rare animals in river
Fort Barnwell Bluffs	CR3	B	Marl outcrops with rare ferns; Basic Mesic Forest on slopes
Shell Landing	CR4	B	Marl outcrop with large Carolina spleenwort population
Cool Springs Sand Ridge and Swamp	CR5	C	Sand ridges and swales; longleaf pine and swamp communities
Duck Creek Natural Area	CR6	C	Extensive mixture of pocosins and longleaf pine forests
Trent River -- Brice Creek Marshes	CR7	B	Tidal Freshwater Marsh communities; rare plants
Reedy Branch	CR8	A	Marl outcrops with large population of Carolina spleenwort

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Little Road Longleaf Pine Savannas	CR9	B	Pine flatwoods and powerline "savannas"; rare species
Little Lake, Long Lake, and Sheep Ridge Wilderness	CR10	B	Natural lakes; very extensive pocosins
Great Lake/Pond Pine Wilderness Natural Area	CR11	B	Largest natural lake in the region; nonriverine swamp forest; rare plants and animals
Lake Ellis Simon	CR12	A	Natural lake; excellent wildlife habitat; at least 12 rare plants and animals
Gum Swamp Bottomland Hardwood Forest	CR13	C	Good example of Nonriverine Wet Hardwood Forest community
Southwest Prong Flatwoods	CR14	C	Extensive pine flatwoods; rare plants in powerline "savannas"
Flanner Beach Natural Area	CR15	C	Rolling topography with Piedmont-like vegetation
Riverdale Goldenrod Roadsides	CR16	B	Extremely large population of spring-flowering goldenrod
Hancock Creek Forest	CR17	C	Mixture of mainland maritime and upland hardwood forests
Masontown Pocosin	CA14	B	Extensive pocosins, particularly the Low Pocosin community
Union Point Pocosin	CA15	C	Extensive pocosins; Low Pocosin community
Deep Gully	JO2	C	Marl outcrops and Basic Mesic Forest; rare plants
Catfish Lake/Catfish Lake South Wilderness	JO7	A	Natural lake; Atlantic white cedar stand; extensive pocosins

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
HYDE			
Pungo Refuge Natural Areas	HY1	C	Large natural lake; waterfowl refuge; swamps and pocosins
Back Landing Bay	HY2	C	Brackish marshes; variety of forests, including flatwoods
Scranton Hardwood Forest	HY3	A	Very extensive Nonriverine Wet Hardwood Forest; high wildlife populations
New Lake Fork Pocosin	HY4	C	Extensive pocosins, especially High Pocosin natural community
Upper Alligator River Marshes and Forests	HY5	C	Extensive oligohaline marshes; tidal cypress-gum swamps
Roper Island	HY6	C	Extensive oligohaline marshes and pocosins; Atlantic white cedar
Alligator River -- Swan Creek Lake Swamp Forest	HY7	A	Very extensive swamps and pocosins; natural lakes; stands of Atlantic white cedar
Mattamuskeet National Wildlife Refuge	HY8	A	Largest natural lake in the state; very large wintering waterfowl populations; rare species
Lake Landing Joint-vetch Sites	HY9	B	Largest state populations of sensitive joint-vetch
Rose Bay Marshes	HY10	B	Extensive brackish marshes and wetlands; waterfowl habitat
Swanquarter National Wildlife Refuge	HY11	A	Vast expanses of brackish marshes; swamps, pocosins, and other wetlands; wildlife habitat
Caffey Bay Wetlands	HY12	B	Brackish marshes and wetland forests; rare animals
Gull Rock Game Land	HY13	B	Marshes, swamps, pocosins, and hardwood flats; excellent wildlife habitat

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Long Point and Wysocking Bay Marshes	HY14	B	Extensive brackish marshes; fire-maintained wet "savanna"
Long Shoal River/Gibbs Point Marshes and Pocosins	HY15	B	Extensive brackish marshes and pocosins, including Low Pocosin
Pantego Swamp and Pocosins	BE9	C	Extensive pocosins and swamps; remnant longleaf pine stand
Upper Pungo River Wetlands	BE10	C	Very diverse wetland communities, especially the marshes
JONES			
Sally Simmons Limestone Ledge	JO1	B	Marl outcrop with Carolina spleenwort
Deep Gully	JO2	C	Marl outcrops and Basic Mesic Forest; rare plants
Island Creek Natural Area	JO3	A	Extensive marl outcrops; rich hardwood forests with many rare plants
Mill Creek Outcrops	JO4	C	Marl outcrops; Basic Mesic Forest natural community
Maysville Goldenrod Roadsides	JO5	B	Extremely large population of spring-flowering goldenrod
Catfish Lake Impoundment Bay Rims	JO6	C	Pine flatwoods on bay rims; old-growth longleaf pines
Catfish Lake/Catfish Lake South Wilderness	JO7	A	Natural lake; Atlantic white cedar stand; extensive pocosins
Holston Creek/Haywood Landing Forests	JO8	B	Swamp forests; Basic Mesic Forest communities; rare plants
Hunters Creek Upland Forest	JO9	B	Good examples of upland hardwood forest communities
Reedy Branch	CR8	A	Marl outcrops with large population of Carolina spleenwort

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Great Lake/Pond Pine Wilderness Natural Area	CR11	B	Largest natural lake in the region; nonriverine swamp forest; rare plants and animals
PAMLICO			
Northwest Pocosin	PA1	C	Extensive pocosins and other wetland forests
North Minnesott Sand Ridge	PA2	C	Remnant pine flatwoods and "sandhills"; Suffolk Scarp
South Minnesott Sand Ridge	PA3	C	Remnant "sandhills" vegetation; Suffolk Scarp
Bay City Low Pocosin	PA4	C	Extensive pocosins, especially the Low Pocosin community
Eastern Gum Swamp	PA5	B	Remnant virgin cypress swamp; brackish marshes; pine "savanna"
Oyster Creek Pine Hammocks	PA6	B	Brackish marshes; Estuarine Fringe Loblolly Pine Forest community
Pamlico Point Marshes and Impoundments	PA7	B	Impoundments with excellent waterbird habitats; extensive brackish marshes
Hobucken Marshes	PA8	C	Brackish marshes and Estuarine Fringe Loblolly Pine Forests
Jones Island	PA9	B	Extensive brackish marshes and Estuarine Fringe Loblolly Pine Forests
Merritt Hardwoods	PA10	B	Good quality Nonriverine Wet Hardwood Forest; diverse forest communities
South Prong Natural Area	PA11	C	Variety of wetland natural communities
Light Ground Pocosin -- Central	PA12	C	Extensive pocosins and swamp forests

Table 7. (continued)

County and Site Name	Site No.	Significance Level	Features
Light Ground Pocosin -- Southeast	PA13	B	Extensive Nonriverine Wet Hardwood Forest; swamp forests; high wildlife values
Live Oak Bay	PA14	C	High variety of communities, from marshes to mainland maritime forest
Western Gum Swamp	BE17	C	Extensive Nonriverine Swamp Forest natural community
PITT			
Bethel/Grindle Hardwood Flats	PI1	B	Extensive and high-quality Nonriverine Wet Hardwood Forest
Belvoir Carolina Bays and Flats	PI2	C	Hardwood flats; Carolina bays with intact swamp vegetation
Otter Creek Natural Area	PI3	C	High diversity of natural communities; mature upland forests
Tar River/Blue Banks Farm Slopes	PI4	C	Extensive wooded seeps; rich wooded slopes; natural levees
Harris Mill Run Slopes	PI5	C	Diverse upland communities, including Dry Oak-Hickory Forest
Chicod Creek Swamp and Slopes	PI6	C	Rich hardwood slopes; old-growth cypresses
Lower Tar River Marshes and Swamp	PI7	C	Tidal freshwater marshes; extensive brownwater swamp forest
Voice of America Site B	PI8	B	Henslow's sparrow population; habitat for "savanna" plants
Jolly Old Field Natural Area	PI9	C	Ridge and swale fluvial landforms; variety of natural communities
Haw Creek Meanders	BE1	C	Unusual geomorphic (fluvial) features; varied communities

Figure 6. General locations of the significant natural areas in the 7-county Albemarle-Pamlico Estuarine Study region. Site numbers are listed on the individual county maps (Figures 7 through 13).

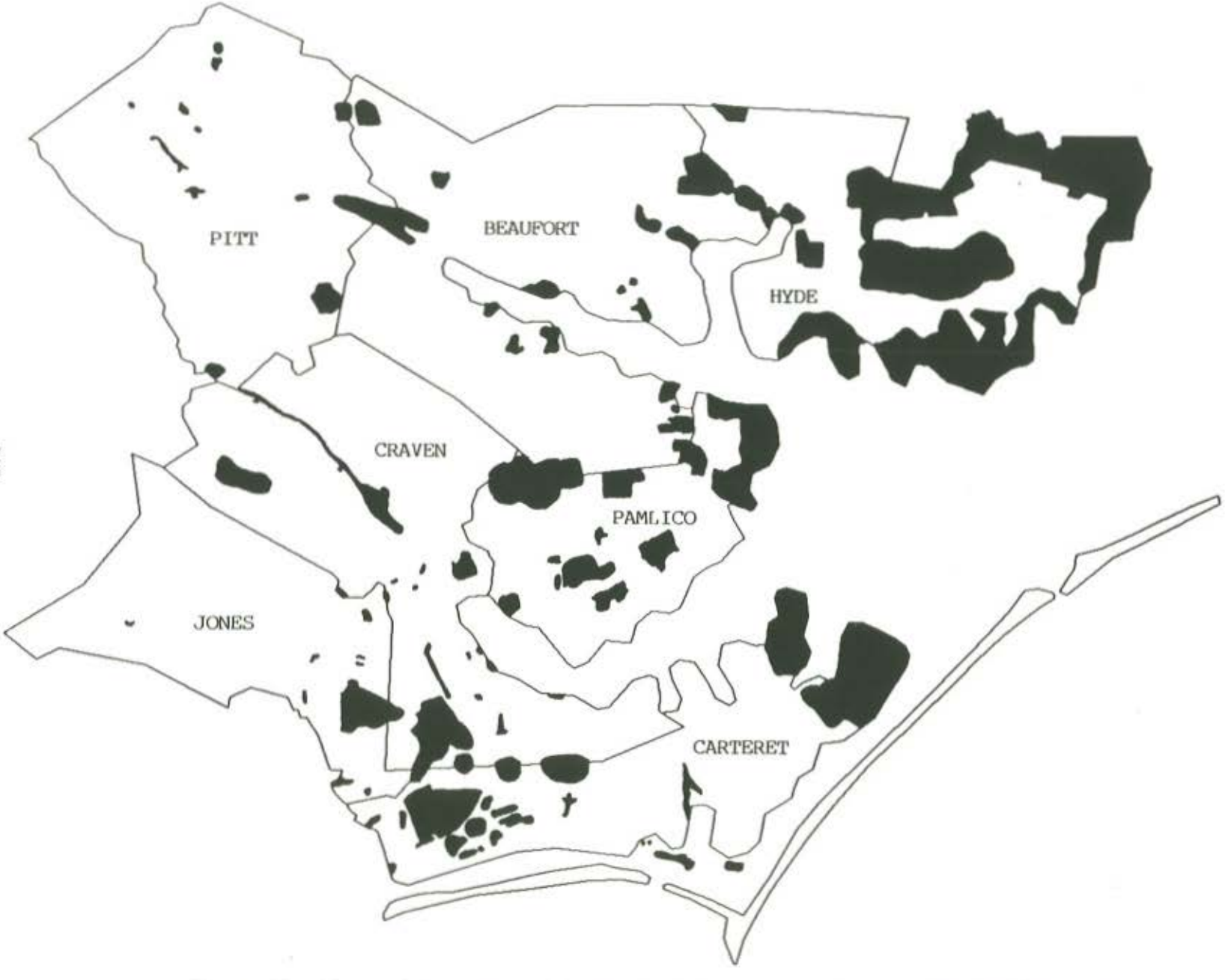


Figure 6. General locations of the significant natural areas in the 7-county Albemarle-Pamlico Estuarine Study region.

Figure 8. Significant natural areas in Carteret County. The areas are numbered generally in a north to south, or west to east, manner; see Table 7 and the Inventory of Sites section for further information.

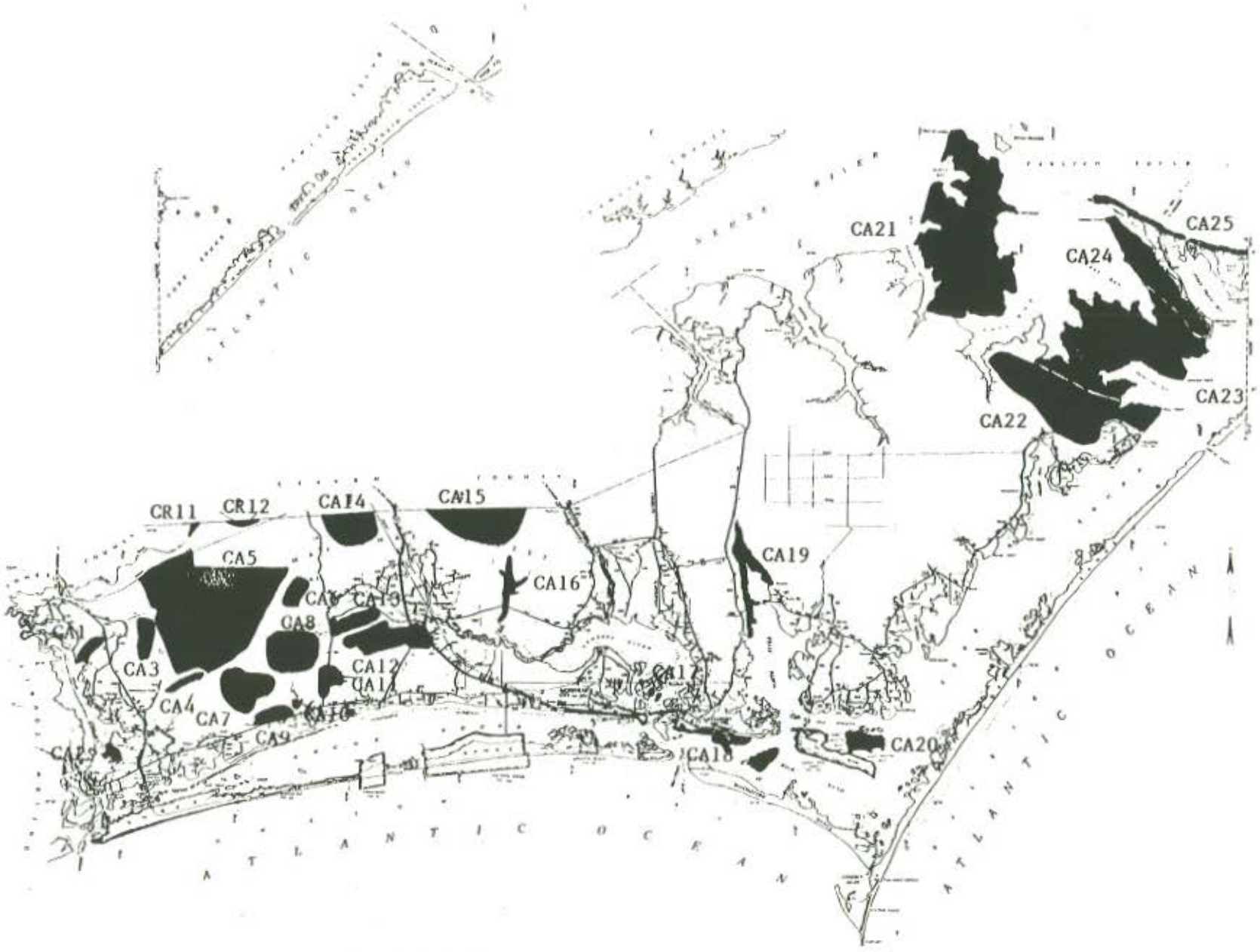


Figure 8. Significant natural areas in Carteret County.

SITE NAME: Hadnot Creek Natural Area

SITE NUMBER: CA1 SIZE: about 550 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: Extreme northwestern portion of Carteret County; lying between SR 1104 on the east and White Oak River on the west, with Hadnot Creek forming the northern boundary and Caleb Branch the southern boundary.

QUAD MAP: Hadnot Creek

SIGNIFICANT FEATURES:

1. The natural area features a pristine creek with salt marshes near the mouth and brackish marshes farther upstream. Upland forested communities are also present.

GENERAL DESCRIPTION:

The Hadnot Creek area of Carteret County is still a reasonably pristine setting, with almost no development visible from Hadnot Creek. This brackish creek contains salt marshes near its confluence with White Oak River. Smooth cordgrass (Spartina alterniflora) is dominant near the mouth, but the marshes become brackish farther upstream. In such places, common three-square (Scirpus americanus), sawgrass (Cladium jamaicense), and big cordgrass (Spartina cynosuroides) become abundant. A small island (Pork Chop Island) of brackish marsh is significant because it contains an abundant mat of the very uncommon eastern grasswort (Lilaeopsis chinensis).

Cedar "hummocks" are present along the creek. These shrubby clumps feature southern red cedar (Juniperus salicicola), yaupon (Ilex vomitoria), and other shrubs, along with the relatively uncommon dwarf palmetto (Sabal minor). The forests along the creek are mainly upland communities along ravines and gentle bluffs; some marl is present at the bluffs. American beech (Fagus grandifolia) occurs in the area but is infrequent. Of interest is the relatively uncommon silky camellia (Stewartia malacodendron), and the more widespread hop hornbeam (Ostrya virginiana), both indicators of fairly rich soil.

The animal life of the area has apparently not been studied in detail. However, the State Threatened American alligator (Alligator mississippiensis) occurs in Hadnot Creek. Other animals of note in the natural area are bobcat (Felis rufus) and prothonotary warbler (Protonotaria citrea).

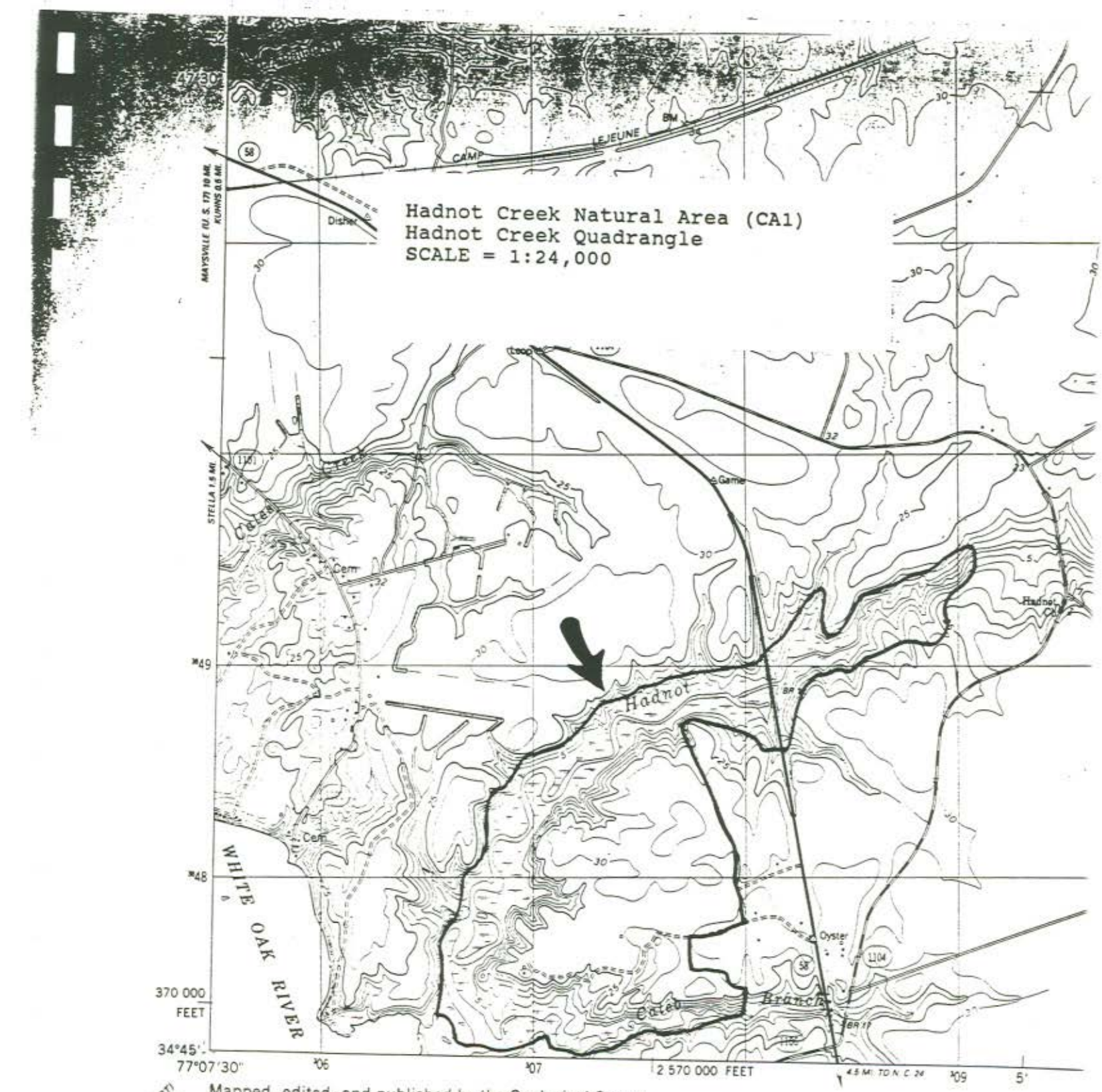
OWNERSHIP: Multiple public and private. A portion of the natural area, generally the north side of Hadnot Creek, is owned by the U.S. Forest Service -- Croatan National Forest.

PROTECTION STATUS: Approximately 100 acres of land owned by a private individual has been protected by adding it to the N.C. Registry of Natural Heritage Areas. The owner has constructed nature trails, with signs that identify a number of plant species; many groups visit this "nature preserve". The Croatan National Forest land is protected from development according to U.S. Forest Service regulations, though there is no guarantee of protection from logging.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The private "nature preserve" should continue to be managed as a preserve and educational facility for school groups and other groups of individuals wishing to learn about natural history. The portion of Croatan National Forest within the natural area should be registered with the Natural Heritage Program as a Registered Natural Heritage Area. No cutting of timber should take place in the natural area, either on private property or public lands.

COMMENTS: The Natural Heritage Program is working with additional private landowners for registry of their property in the natural area.

REFERENCES: Fussell and Wilson (1983)



Mapped, edited, and published by the Geological Survey

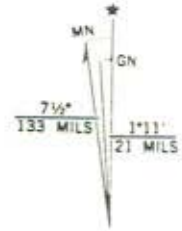
Control by USGS, NOS/NOAA, and North Carolina Geodetic Survey

Topography by photogrammetric methods from aerial photographs taken 1977. Field checked 1979. Map edited 1984

Projection and 10,000-foot grid ticks: North Carolina coordinate system (Lambert conformal conic)
1000-meter Universal Transverse Mercator grid, zone 18
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 13 meters south and 27 meters west as shown by dashed corner ticks

Short dashed blue lines indicate elliptical bay ou visible on aerial photographs.

There may be private inholdings within the bounc the National or State reservations shown on this



UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SITE NAME: Cedar Point -- White Oak River Marshes

SITE NUMBER: CA2 SIZE: about 260 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The extreme western portion of Carteret County; located along the eastern shore of White Oak River, south to Boathouse Creek, north nearly to Pettiford Creek Bay, and east to SR 1114.

QUAD MAP: Swansboro

SIGNIFICANT FEATURES:

1. The natural area consists of a variety of natural communities representative of coastal estuarine systems. The variety includes tidal marshes and several woodland communities, in particular a protected example of Coastal Fringe Evergreen Forest (mainland maritime forest).

GENERAL DESCRIPTION:

The White Oak River is a scenic blackwater river that flows southward along the western boundary of Croatan National Forest and empties into Bogue Sound. That portion along the shore of Carteret County contains brackish water and is an embayed river mouth; it is over a mile wide in the vicinity of Cedar Point.

This natural area lies on the eastern shore of the White Oak River, just north of the town of Cape Carteret. The U.S. Forest Service (Croatan National Forest) maintains the site as a recreation area with an interpretive nature trail. The Cedar Point Tideland Trail passes through examples of the several natural communities. Much of the upland portion of the natural area is a Coastal Fringe Evergreen Forest natural community. The canopy is not old-growth, as live oak (Quercus virginiana), a characteristic canopy species in mature stands, is common in the understory but not the canopy. The canopy is dominated by loblolly pine (Pinus taeda), pond pine (P. serotina), black gum (Nyssa sylvatica), and red maple (Acer rubrum), with some southern red cedar (Juniperus silicicola). Joining live oak in the understory are water oak (Q. nigra), red maple, and redbay (Persea borbonia). Other maritime elements (in addition to live oak) occur in the shrub layer: yaupon (Ilex vomitoria), wild olive (Osmanthus americana), and beauty-berry (Callicarpa americana).

Another wooded community present, though covering only a small percentage of the site, is the Coastal Plain Small Stream Swamp, Blackwater subtype. Sweetgum (Liquidambar styraciflua), red maple, and black gum are important canopy trees. Shrubs include dwarf azalea (Rhododendron atlanticum), sweet pepperbush (Clethra alnifolia), and fetterbush (Lyonia lucida); several ferns are also common.

The Tideland Trail extends into salt to brackish marshes, with boardwalks allowing visitors to observe the marshes without getting their feet wet. This marsh is a mixture of 2 communities -- Salt Marsh and Brackish Marsh. Smooth cordgrass (Spartina alterniflora), the dominant plant of the Salt Marsh, grows closest to the open water of the river. Black needlerush (Juncus roemerianus), the most characteristic species of the Brackish Marsh, grows in the next higher zone, out of the reach of tides. Shallow flats (salt pans) in the marsh are occupied by salt-tolerant species such as glasswort (Salicornia sp.), halberd-leaf orache (Atriplex patula), and salt grass (Distichlis spicata). Typical species along the marsh fringe include groundsel-tree

(Baccharis halimifolia), broadleaf marsh-elder (Iva frutescens), sea oxeye (Borrichia frutescens), waxmyrtle (Myrica cerifera), and seaside goldenrod (Solidago sempervirens).

The marshes provide habitat for many animals. Herons and egrets feed in the marshes and on the tidal flats. Ospreys (Pandion haliaetus) forage in the area and nest nearby.

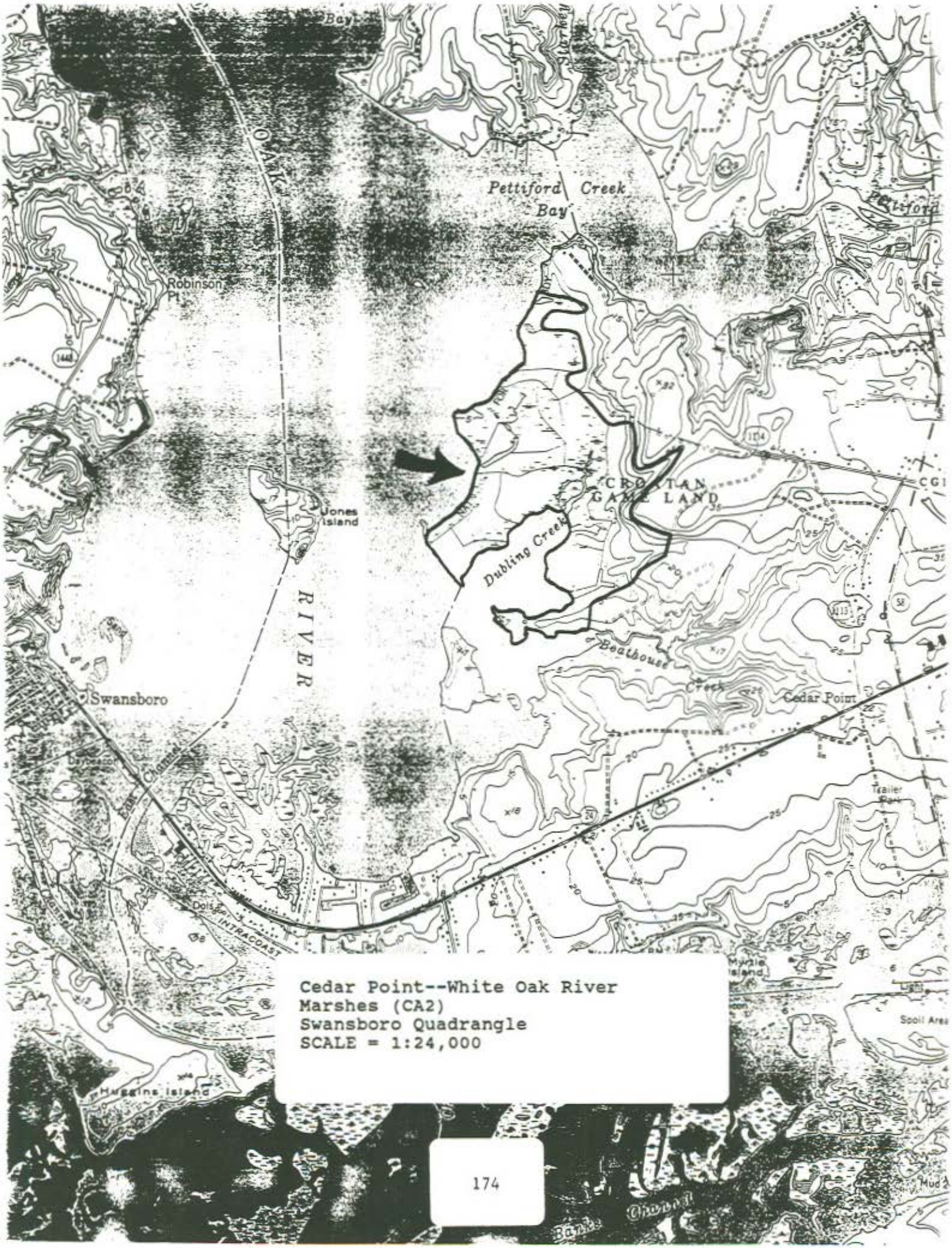
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: The natural area is protected according to U.S. Forest Service regulations. In addition, Cedar Point Tideland Trail is a National Recreation Trail, and Cedar Point is a recreation area with camping and other facilities (located outside the 260-acre natural area). The natural area as described here is a N.C. Registered Natural Heritage Area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: This natural area needs relatively little management, other than making sure that the visitors are keeping to the trails. Construction of additional trails might be detrimental to the natural area, and discussions with the N.C. Natural Heritage Program about any additional trails or facilities is strongly recommended.

COMMENTS: Cedar Point is a rather isolated tract surrounded by a rapidly developing portion of Carteret County. Additional acquisitions to enlarge the Forest Service landholdings at Cedar Point appear to be limited.

REFERENCES: Mansberg (1985)



Cedar Point--White Oak River Marshes (CA2)
Swansboro Quadrangle
SCALE = 1:24,000

SITE NAME: Hadnot Creek Ponds and Longleaf Pine Woods

SITE NUMBER: CA3 SIZE: about 550 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The extreme western portion of Carteret County; lying both east and west of Forest Service Road 3014, extending from FSR 166 on the south and nearly to FSR 127 on the north.

QUAD MAP: Hadnot Creek

SIGNIFICANT FEATURES:

1. The natural area contains a handful of natural limesink ponds, which are rare features in North Carolina and are located mostly on private property.
2. The area features a number of pine flatwoods and one or two pine savannas.
3. At least 5 rare plant species are present in the natural area. However, more significant is the fact that 6 rare animal species are present in the natural area.

GENERAL DESCRIPTION:

The natural area is a mostly flat and poorly drained area over loamy to clayey mineral soils just to the west of a large pocosin. Slight variations in elevation cause the natural communities to grade from Mesic Pine Flatwoods to Pine Savannas to Coastal Plain Small Stream Swamp. Of even more interest is a series of small natural ponds, believed to be limesink ponds, that are scattered over the natural area.

The higher parts of the natural area feature the Mesic Pine Flatwoods community. Longleaf pine (Pinus palustris) is practically the only canopy tree. There is no understory in most of the flatwoods, though some blackjack oak (Quercus marilandica) and scrub post oak (Q. margaretta) are present. The ground cover is dominated by wiregrass (Aristida stricta) and numerous other herbs, along with a good amount of small shrubs such as inkberry (Ilex glabra) and dangleberry (Gaylussacia frondosa). Many species of composites, such as asters and goldenrods, are present in the flatwoods. A few stands of Wet Pine Flatwoods are present; they are less diverse than the Mesic Pine Flatwoods and are strongly dominated by wiregrass, creeping blueberry (Vaccinium crassifolium), and bracken fern (Pteridium aquilinum).

The Pine Savanna community is rather limited and occurs in a mosaic within the flatwoods. This community is slightly lower than the others listed above. Longleaf pine dominates the canopy, and there is little understory, though sweetgum (Liquidambar styraciflua) sprouts are present. The herb layer is dominated by wiregrass and little bluestem (Andropogon scoparium). Among the vast array of herb species in the savannas are several rare ones -- the State Endangered pinebarrens sandreed (Calamovilfa brevipilis), the State Candidate savanna cowbane (Oxypolis ternata), the State Candidate Carolina goldenrod (Solidago pulchra), and the "significantly rare" pinebarrens goober grass (Amphicarpum purshii).

The Small Depression Pond community dominates the limesink ponds. The open water centers are dominated by white water-lily (Nymphaea odorata) and maiden-cane (Panicum hemitomon); a few swamp tupelos (Nyssa biflora) and pond pines (Pinus serotina) occur in the pond interiors. A dense population of

pinebarrens goober grass is present along the shore of one of the ponds. The "significantly rare" horsetail spikerush (Eleocharis equisetoides) grows in several of the ponds.

A number of rare animals are known from the natural area. The Carolina gopher frog (Rana capito capito), State Special Concern, has been found breeding in 2 small ponds. American alligator (Alligator mississippiensis), a State Threatened species, has been seen along a small stream. The longleaf pine woods are home to the Federally Endangered red-cockaded woodpecker (Picoides borealis), the State Special Concern Bachman's sparrow (Aimophila aestivalis), and the "significantly rare" pigmy rattlesnake (Sistrurus miliarius). Black bear (Ursus americanus) signs have been seen in the natural area, though the animals certainly do not spend much time at the site.

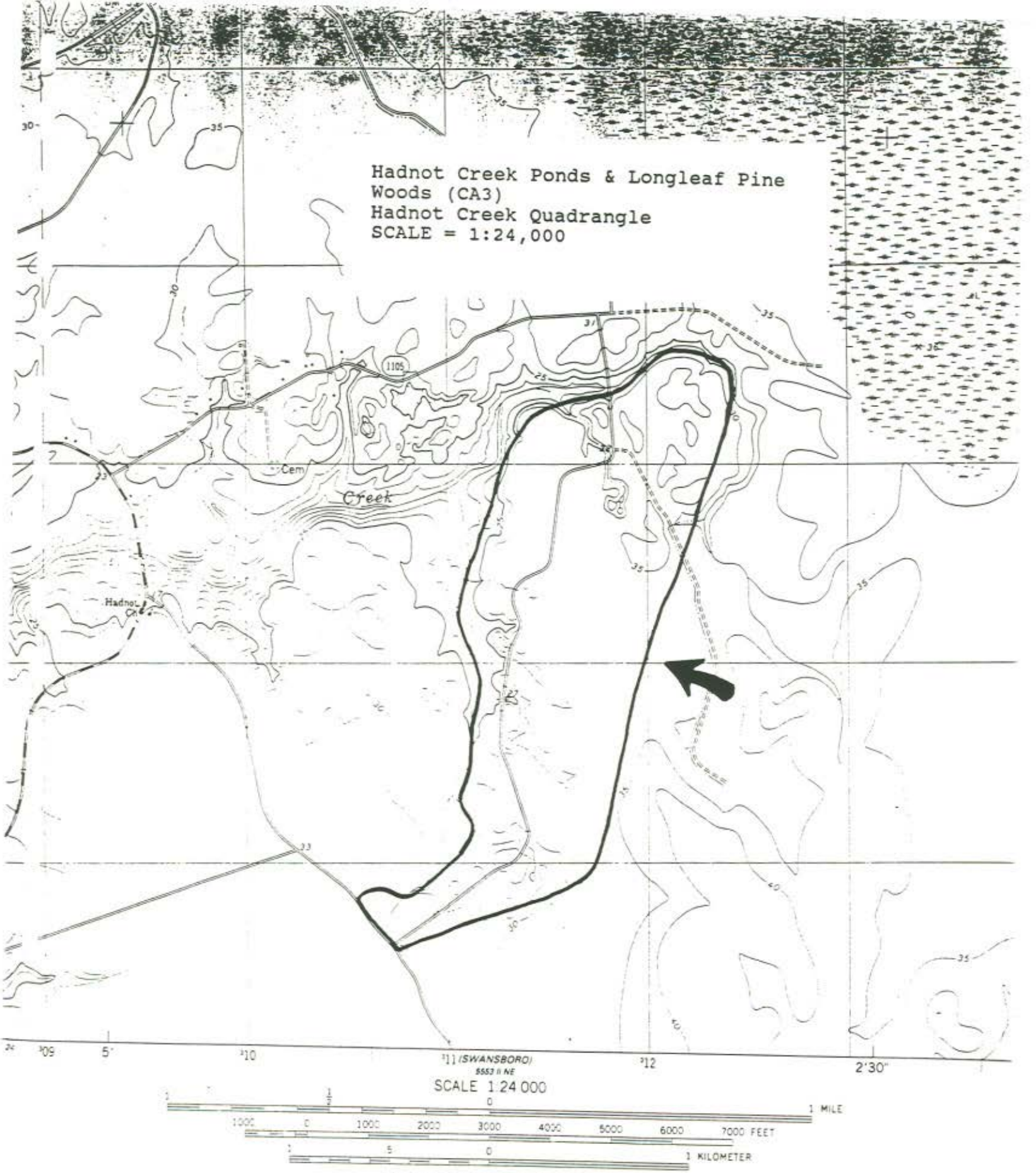
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: The property is protected according to that agency's regulations. However, there is no formal protected designation for the area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: Scattered through the natural area are several recent clearcuts, some of which might have been cuts of longleaf pine forests. The existing longleaf pine forests should not be cut, other than by selective cutting, and should not be clearcut under any circumstances. Several of the clearcuts were made right up to the margins of the ponds, a most unfortunate circumstance, as this allows more sediment to reach the ponds and perhaps also allows weedy species to grow around the pond margins. Proper management of the natural area would be to burn the longleaf pine woods on a several-year cycle to maintain the character of the pine forest. Little or no management of the ponds is needed. At present there is little or no impact to the ponds by vehicular traffic as there has been at some other ponds in Croatan. Much of the area qualifies for the N.C. Registry of Natural Heritage Areas, and the Natural Heritage Program should pursue this protection.

COMMENTS: There is considerable concern about the fate of much of the natural area, despite its "protection" as national forest land. The number of recent clearcuts cause this concern, and there are questions whether some of the longleaf pine areas at the site are planned for clearcutting.

REFERENCES: Schafale (1990), Fussell (1991g)



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QUADRANG

SITE NAME: Pettiford Creek Open Flatwoods

SITE NUMBER: CA4 SIZE: about 110 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The western portion of Carteret County; lying along Forest Service Roads (FSR) 128 (Millis Road), 201, and 617. The area lies west of FSR 123 (Pringle Road) and east of FSR 166.

QUAD MAPS: Hadnot Creek, Swansboro

SIGNIFICANT FEATURES:

1. The natural area features some of the best examples of pine flatwoods in the state, with some merging into examples of savannas.
2. A very high diversity of plant and animal species is present, including 10 species of rare plants and 5 species of rare animals.

GENERAL DESCRIPTION:

The Pettiford Creek natural area lies on upland flats and gently rolling uplands that are dissected by small tributaries of Pettiford Creek, in the southwestern part of Croatan National Forest. The area consists primarily of Mesic Pine Flatwoods, though there are small amounts of Wet Pine Flatwoods, Pine Savanna, and Pine/Scrub Oak Sandhill natural communities. The driest places feature the last-named community, characterized by longleaf pine (Pinus palustris) over an understory of oaks, dominated by bluejack oak (Quercus incana). The typical ground layer is dominated by wiregrass (Aristida stricta), dwarf huckleberry (Gaylussacia dumosa), and lowbush blueberry (Vaccinium tenellum).

The Mesic Pine Flatwoods also feature a canopy of longleaf pine, with some sweetgum (Liquidambar styraciflua) generally in the understory. The shrub and ground layers feature a high diversity of species. Common are wiregrass, inkberry (Ilex glabra), dangleberry (Gaylussacia frondosa), creeping blueberry (Vaccinium crassifolium), and bracken fern (Pteridium aquilinum). A rare plant found in this community is the State Candidate scale-leaf gerardia (Agalinis aphylla), along with the uncommon LeConte's thistle (Cirsium lecontei), savanna sunflower (Helianthus heterophyllus), and Loomis' loosestrife (Lysimachia loomisii). The State Special Concern Bachman's sparrow (Aimophila aestivalis) breeds in this community, and cavity trees of the Federally Endangered red-cockaded woodpecker (Picoides borealis) are present.

The Wet Pine Flatwoods and Pine Savanna are mostly ecotonal between the Mesic Pine Flatwoods and the drains, which are largely vegetated in pocosins. Ground cover in these communities tends to be higher than in the mesic woods, and a few species locally rare are found in the ecotone, including Catesby's gentian (Gentiana catesbaei), New York aster (Aster novi-belgii), and Elliott's goldenrod (Solidago elliottii). In addition to scale-leaf gerardia, other rare plants are: State Candidate -- Venus' flytrap (Dionaea muscipula), savanna cowbane (Oxypolis ternata), Hooker's milkwort (Polygala hookeri), Carolina goldenrod (Solidago pulchra), branched gerardia (Agalinis virgata), feather-bristle beakrush (Rhynchospora oligantha), Georgia nutrush (Scleria georgiana), and giant spiral orchid (Spiranthes longilabris); and State "significantly rare" -- slender nutrush (Scleria minor).

In addition to the birds listed above, there are several rare reptiles and amphibians that are believed to occur in the natural area. The State Special Concern gopher frog (Rana capito capito) has been found as a road kill at the natural area, as has been the eastern diamondback rattlesnake (Crotalus adamanteus), unofficially considered "endangered" in the state but with no formal protection. The unofficially "special concern" pigmy rattlesnake (Sistrurus miliarius) also occurs in the natural area. Other rare species that might occur are the mimic glass lizard (Ophisaurus mimicus) and the fox squirrel (Sciurus niger).

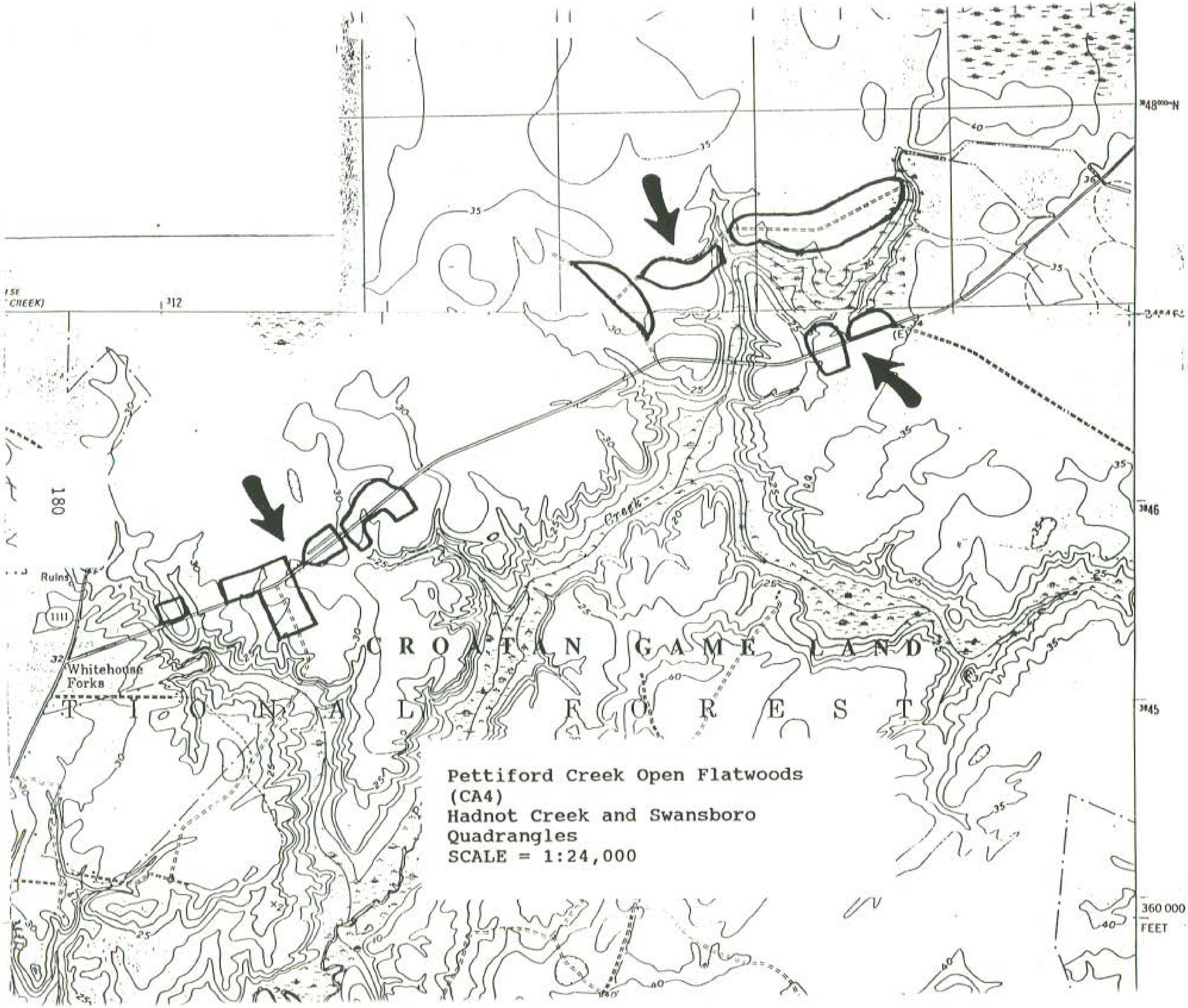
OWNERSHIP: The entire natural area is owned by the U.S. Forest Service -- Croatan National Forest.

PROTECTION STATUS: The land is administered and managed under Forest Service regulations; however, the area has no official protection status.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The natural area should be burned more frequently than at present, and the prescribed burns should be conducted during the growing season. No timber cutting, or only selective cutting, should be done, as the area is dominated by longleaf pine and is foraging habitat for the red-cockaded woodpecker. The natural area should be proposed for addition to the N.C. Registry of Natural Heritage Areas.

COMMENTS: The natural area needs additional zoological survey work, especially for reptiles and amphibians. It should be noted that a number of the rare plants at the site are growing in an old borrow pit, whose bottom lies closer to the water table than does the surrounding land. Thus, it has a wetter soil and a different set of plants than occur elsewhere in the natural area. The borrow pit should not be filled in, as it represents a "wetland" with a savanna-like flora that is rarely found elsewhere in the Croatan National Forest.

REFERENCES: Fussell (1991d)



Pettiford Creek Open Flatwoods
(CA4)
Hadnot Creek and Swansboro
Quadrangles
SCALE = 1:24,000

SITE NAME: Pocosin Wilderness

SITE NUMBER: CA5 SIZE: about 11,000 acres

SITE SIGNIFICANCE: A (National)

LOCATION: The western portion of Carteret County. The area lies between NC 58 on the west and SR 1125 (Carteret) on the east, with Lake Ellis Simon to the northeast; the wilderness lies wholly within Croatan National Forest.

QUAD MAPS: Hadnot Creek, Masontown

SIGNIFICANT FEATURES:

1. This natural area is a Federally designated Wilderness Area. It is one of the most extensive, pristine tracts of pocosin vegetation in the country.

GENERAL DESCRIPTION:

Much of western Carteret County, as well as neighboring portions of Craven and Jones counties, are very flat and poorly drained areas of the Talbot Terrace. These flats apparently began developing from 10,000 to 12,000 years ago (Otte 1981). The flats are underlain by peat deposits and are covered by pocosin vegetation so dense that it is very difficult to traverse. Unlike most other peatlands in North Carolina, the Croatan pocosins have a much smaller amount of wood in the peat deposits; apparently Atlantic white cedar (Chamaecyparis thyoides) and cypress (Taxodium spp.) have always been uncommon in these pocosins. Drainage of the pocosins is very poorly developed; generally, the drainage is radial in all directions away from them.

Pond pine (Pinus serotina) is the dominant tree species, and it is often the only tree species over many areas. Common shrubs include fetterbush (Lyonia lucida), inkberry (Ilex glabra), titi (Cyrilla racemiflora), honey-cup (Zenobia pulverulenta), loblolly-bay (Gordonia lasianthus), and redbay (Persea borbonia). Virginia chain fern (Woodwardia virginica) is common in the herb layer. Other important woody species include sweetbay (Magnolia virginiana), sheep-kill (Kalmia angustifolia), leatherleaf (Cassandra calyculata), red chokeberry (Sorbus arbutifolia), and various blueberries (Vaccinium spp.). Some insectivorous species are present in the more open spots, such as yellow pitcherplant (Sarracenia flava), purple pitcherplant (S. purpurea), and sundews (Drosera spp.). The state Candidate species Fitzgerald's peatmoss (Sphagnum fitzgeraldii) occurs in some of the pocosins in Croatan National Forest and is presumed to occur in Pocosin Wilderness natural area.

The natural area consists of 3 natural communities. The central area, where the peat is deeper, contains mostly Low Pocosin community. The vegetation height ranges only from 2 to 4 feet in the Low Pocosin, and pines are absent or widely spaced. Where the peat is slightly shallower (less than 4 feet deep), a High Pocosin community is present. The vegetation commonly reaches 4 to 10 feet high, and pond pines are more closely spaced but do not form a canopy. Where the peat is even shallower, generally along the fringes of the pocosin, the pond pine is taller and forms a canopy; this is the Pond Pine Woodland natural community. Because of the absense of roads and other ditches and trails in this area, the Low Pocosin (and also the High Pocosin) is seen primarily from the air.

The pocosins have only a moderate wildlife value. They are important habitats for the black bear (Ursus americanus). The great amount of berries

produced by pocosin plants in the fall and winter, in addition to the extensive evergreen cover, is responsible for large wintering populations of songbirds.

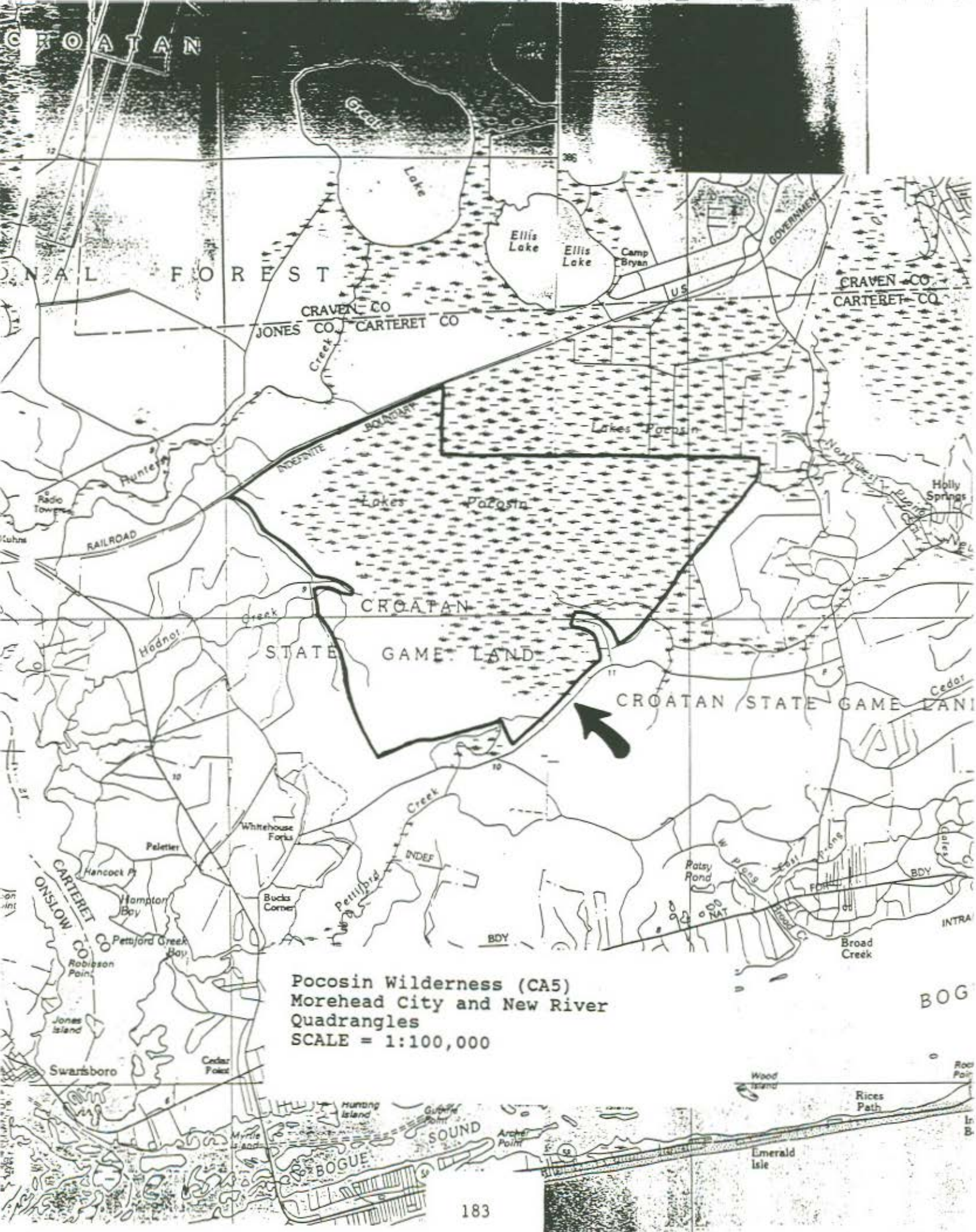
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: This natural area is a Federally-designated Wilderness Area. No roads are to be constructed within the boundaries of the area. It is also a N.C. Registered Natural Heritage Area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: Though the natural area is protected by being designated a Wilderness Area, there is concern about the potential damage to the area that would be done if a fire breaks out. The current U.S. Forest Service policy for this area is that no management will be done, indicating that no prescribed burns will be undertaken. However, if a fire breaks out, the Service plans to suppress it, even in a Wilderness Area. Lightning-generated fires are a part of the natural system, and pocosins depend on fire to maintain their plant composition. It is most unfortunate that such a policy of complete fire suppression, even in a Wilderness Area, is presently established, as heavy equipment used in fire control has been known to do considerable damage in pocosins. The natural area should be considered off-limits for any activities such as peat mining or off-road vehicle usage. Construction of hiking trails would be a suitable use.

COMMENTS: Additional studies on fire management and vegetation succession in relation to fire are needed. There have been conflicting ideas on what is the successional scheme of vegetation types and whether pocosins are self-perpetuating in the long absence of fire. Are Low Pocosins self-perpetuating, or do all succeed to High Pocosin or Pond Pine Woodland? As vegetation dies and forms additional peat deposits, is it possible that vegetation height actually regresses? It has been speculated that, at least in some soil conditions, High Pocosin may succeed to Low Pocosin, because the latter is generally found on the deepest peat deposits (Otte 1981). Some pocosins in the long absence of fire succeed to bay forests or maple-gum forests (broadleaf deciduous forests), but it may be that such vegetation changes are brought upon by a lowering of the water table by ditches or other means.

REFERENCES: Otte (1981), Fussell and Wilson (1983), N.C. Natural Heritage Program database



Pocosin Wilderness (CA5)
Morehead City and New River
Quadrangles
SCALE = 1:100,000

SITE NAME: Millis Swamp Road Pinewoods

SITE NUMBER: CA6 SIZE: about 250 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: Western portion of Carteret County, within Croatan National Forest; located along Forest Service Road 177 about 1.5 miles west of the intersection of SR 1124 and SR 1125.

QUAD MAP: Masontown

SIGNIFICANT FEATURES:

1. The natural area contains a large tract of pine flatwoods; many flatwoods in Croatan National Forest are in narrow swales or ridges rather than a broad area such as this site.
2. In addition to the black bear (Ursus americanus), the natural area contains 3 known rare species of birds: red-cockaded woodpecker (Picoides borealis), Bachman's sparrow (Aimophila aestivalis), and Henslow's sparrow (Ammodramus henslowii). Four rare plant species are present in the natural area.

GENERAL DESCRIPTION:

This natural area lies on a broad and flat "upland" just to the east of the extensive pocosins associated with the natural lakes in Croatan National Forest. There are no well-defined sand ridges in the natural area. Because the woods have been burned frequently by Croatan foresters, the area has an open aspect of scattered pines.

Three natural communities are present. Approximately 80-90% of the site is Wet Pine Flatwoods. Longleaf pine (Pinus palustris) is the dominant and often only tree over much of the area. Some areas have few if any shrubs, but for the most part inkberry (Ilex glabra) is common in the shrub layer. Wiregrass (Aristida stricta) is very common nearly everwhere as a ground cover, but bracken fern (Pteridium aquilinum) is common in some areas.

Mesic Pine Flatwoods occur in small areas on drier sites. These are similar to the above but inkberry is not common, whereas creeping blueberry (Vaccinium crassifolium) is an important component. Dwarf waxmyrtle (Myrica cerifera var. pumila) and bracken fern also become important on these slightly drier sites.

Scattered over the natural area, on Murville soils, is the Pond Pine Woodland natural community. Pond pine (Pinus serotina) is the only canopy tree; various evergreen hardwoods are in the understory, such as redbay (Persea borbonia), loblolly-bay (Gordonia lasianthus), fetterbush (Lyonia lucida), sweetbay (Magnolia virginiana), and sweet gallberry (Ilex coriacea). Because the area has burned frequently, the evergreen vegetation is mainly 10 to 15 feet high.

The herbaceous flora of the natural area is not nearly as rich as that of savannas, but several dozen wildflower species are present. The frequent burning of the site presumably promotes such species; flatwoods unburned for a decade or more often contain few herbs other than wiregrass. Among notable herbs are: the State Endangered pinebarren sandreed (Calamovilfa brevipilis); and the State Candidate small butterwort (Pinguicula pumila), branched gerardia (Agalinis virgata), and Carolina goldenrod (Solidago pulchra). Also

of interest are the yellow pitcherplant (Sarracenia flava) and pine barren gentian (Gentiana autumnalis).

The Federally Endangered red-cockaded woodpecker (Picoides borealis) nests in the natural area, as does the State Special Concern Bachman's sparrow (Aimophila aestivalis). The "significantly rare" Henslow's sparrow (Ammodramus henslowii) is known to winter in dense wiregrass stands. Black bears (Ursus americanus) occasionally occur in the area when they move from pocosin to pocosin.

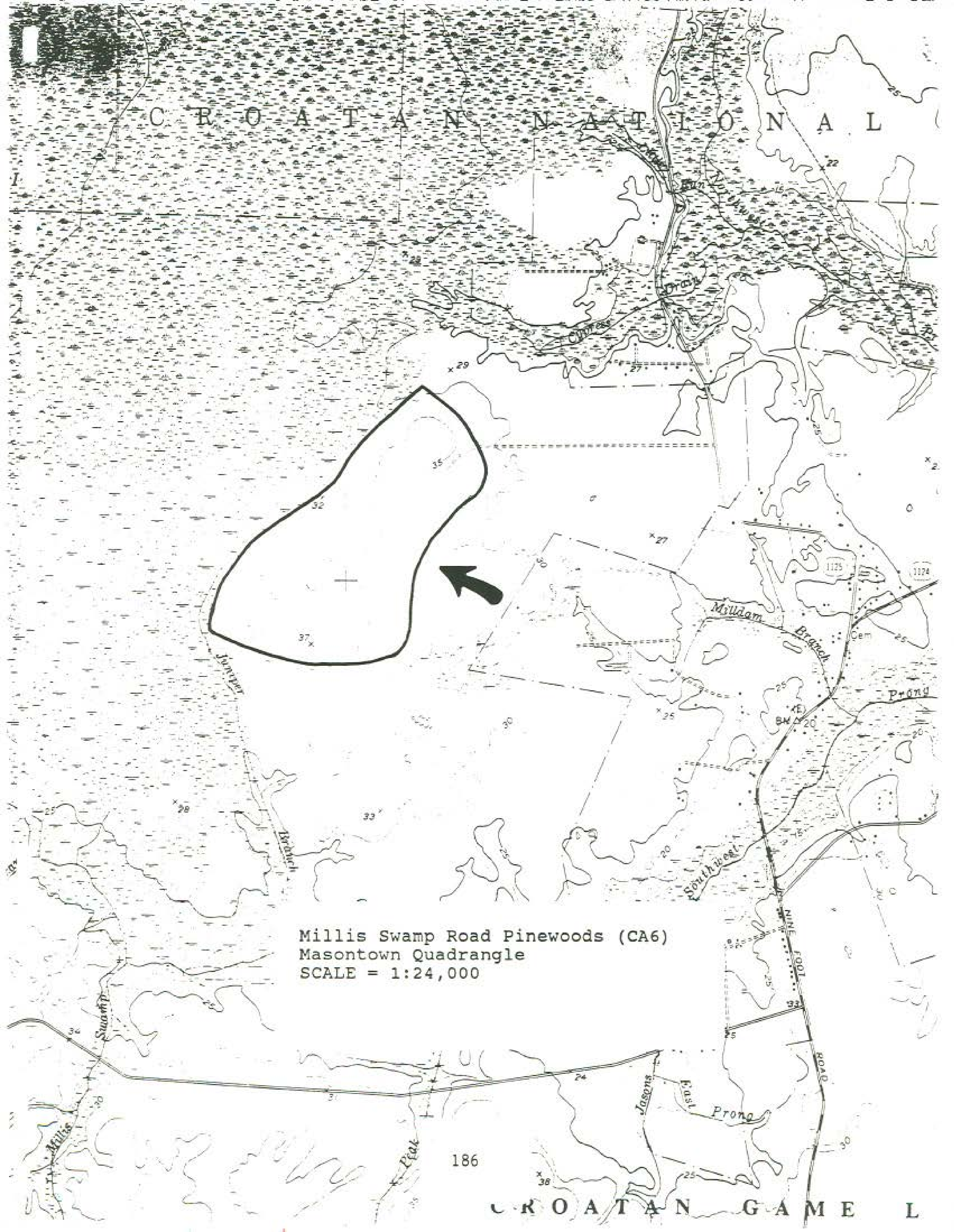
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: No official protection status; protected and managed under U.S. Forest Service regulations. Because of the presence of the red-cockaded woodpecker, the site is managed as nesting and foraging habitat for the species.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The natural area needs continued burning every several years to maintain the open understory required by the woodpecker. Frequent burning also helps provide a diverse herbaceous flora. A portion of the natural area had been leased for pine straw raking a few years ago. This activity, which damages the ground cover, has apparently been terminated, at least for the time being, in the natural area. The area is suitable for addition to the Registry of Natural Heritage Areas and might be nominated for such designation within the next few years.

COMMENTS: This natural area probably contains more rare plant species than those mentioned above. Much of the area received a burn in early summer of 1990, and because of drought conditions, herbaceous vegetation did not return to any significant extent until autumn of that year.

REFERENCES: Fussell (1991b)



Millis Swamp Road Pinewoods (CA6)
Masontown Quadrangle
SCALE = 1:24,000

SITE NAME: Pringle Road Bay Rims

SITE NUMBER: CA7 SIZE: about 1800 acres

SITE SIGNIFICANCE: A (National)

LOCATION: The southwest portion of Carteret County, within Croatan National Forest; located both east and west of Pringle Road (Forest Service Road 123), about 3 miles northeast of Ocean community.

QUAD MAPS: Maysville, Masontown, Salter Path, Swansboro

SIGNIFICANT FEATURES:

1. The site contains well-defined Carolina bay rims, many of which are undisturbed. Thus, the area has considerable geological merit.
2. The natural area contains an abundance of pocosins both within the bays and outside of them, as well as longleaf pine (Pinus palustris) communities on the bay rims.
3. The area contains at least 13 species of rare plants, in addition to 2 rare bird species.

GENERAL DESCRIPTION:

This natural area contains an unusual number of Carolina bays for the lower Coastal Plain of North Carolina. Unlike in the Bladen Lakes area, where the bays and rims are quite distinct and are present in a "matrix" of uplands, these bays are surrounded by pocosins and merge into the pocosins except where the bay rims "emerge" from that vegetation. The rims are generally only one to two feet higher than the surrounding topography, even though they stand out sharply on aerial photographs. Of interest are the variety of bays and their rims; present are complete rims, incomplete rims (with just the rim on the southeastern side of the bay showing), and even double rims with overlapping bays.

The rims of the bays are mainly Wet Pine Flatwoods natural community. Longleaf pine (Pinus palustris) is the dominant canopy species, but there is little understory vegetation on most of the areas. The ground flora is dominated by wiregrass (Aristida stricta), inkberry (Ilex glabra), creeping blueberry (Vaccinium crassifolium), and other species. A few of the highest and driest rims feature Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill vegetation. These sites have open understories of turkey oak (Quercus laevis), bluejack oak (Q. incana), and blackjack oak (Q. marilandica). Many of the bay rims feature only small-stature pines, owing to intense wildfires killing the trees; an intense fire in the spring of 1985 is an example of this phenomenon.

The borders of the rims -- the ecotone between flatwoods and pocosins -- contain the richest diversity of plant species, and the majority of the rare plants are found in these ecotones. The rare plants are: Federally Endangered rough-leaf loosestrife (Lysimachia asperulifolia); the State Endangered pinebarrens sandreed (Calamovilfa brevipilis); the State Candidate Venus' flytrap (Dionaea muscipula), savanna cowbane (Oxypolis ternata), small butterwort (Pinguicula pumila), feather-bristle beakrush (Rhynchospora oligantha), Baldwin's nutrush (Scleria baldwinii), savanna milkweed (Asclepias pedicellata), Carolina goldenrod (Solidago pulchra), and Carolina asphodel (Tofieldia glabra); and the "significantly rare" pinebarrens goober grass (Amphicarpum purshii), longleaf three-awn (Aristida palustris), and pale

beakrush (Rhynchospora pallida). Rare animal species on the sand rims are the Federally Endangered red-cockaded woodpecker (Picoides borealis) and the State Special Concern and Federal candidate Bachman's sparrow (Aimophila aestivalis).

The non-rim portions of the natural area are vegetated in pocosins, all or mostly all in Pond Pine Woodland natural community. The pond pines (Pinus serotina) of the canopy are of tree size, and loblolly-bay (Gordonia lasianthus) and other broadleaf evergreens form a subcanopy. In the northeastern third of the area, the pocosin is very low in stature, much of it being only 2 to 3 feet high. Although this might be Low Pocosin, Fussell (1992a) believes that it is best considered a Pond Pine Woodland that has been severely burned. The uncommon sweet pitcherplant (Sarracenia rubra) is frequent amid this low pocosin vegetation.

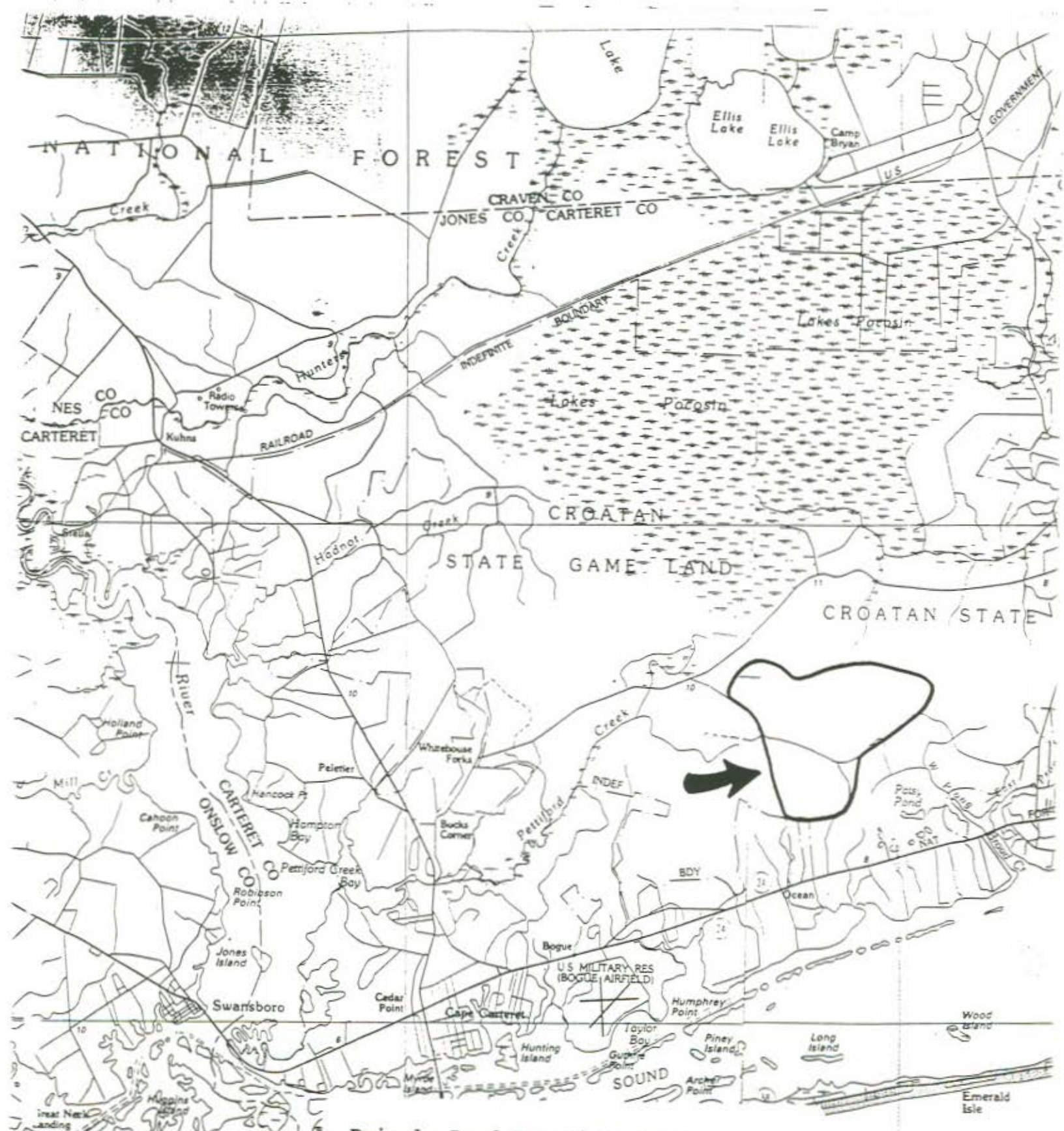
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: The natural area is protected under regulations of that agency; however, there is no formal protection, such as a registry agreement.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The ridges need more frequent prescribed burns. Wildfires in the past have been very damaging (often killing the longleaf pines) because of the infrequency of prescribed burns. There is a great need to do some growing season burning. A detrimental handful of construction projects have taken place along and adjacent to Pringle Road in recent years, such as construction of monitoring wells and a trash disposal area. The natural area, because of its National significance, is strongly worthy of being added to the N.C. Registry of Natural Heritage Areas.

COMMENTS: Despite the high amount of recent botanical field work, as part of both the A/P Study and a U.S. Forest Service contract for a rare plant survey, the area is so extensive, with miles of ecotones, that there is still potential for other rare plants to be discovered. Animal survey work, other than for birds, has also been limited.

REFERENCES: Snyder (1978), LeBlond (1991), Fussell (1992a)



Pringle Road Bay Rims (CA7)
Morehead City and New River Quadrangle
SCALE = 1:100,000

SITE NAME: Millis Road Savannas and Pocosins

SITE NUMBER: CA8 SIZE: about 1475 acres

SITE SIGNIFICANCE: A (National)

LOCATION: The western portion of Carteret County; located south of Forest Service Road 128 (Millis Road) and SR 1112, and north of Forest Service Road 154, in the southern part of Croatan National Forest.

QUAD MAP: Masontown

SIGNIFICANT FEATURES:

1. The savannas are among the most extensive in North Carolina and contain a very diverse flora, including at least 11 species rare in the state.
2. The savannas are home to several rare bird species -- the Federally Endangered red-cockaded woodpecker (Picoides borealis), Bachman's sparrow (Aimophila aestivalis), and Henslow's sparrow (Ammodramus henslowii).
3. The natural area includes extensive pocosins. Narrow pocosin streamheads are present, as well as pocosins in extensive and poorly drained basins.

GENERAL DESCRIPTION:

The Millis Road Savannas and Pocosins natural area lies in the southern portion of Croatan National Forest. The savannas lie on rather broad north-south sand ridges that are separated by north-south fingers of pocosin vegetation along small drains. To the south of these savannas and drains, which flow to the north, there is an extensive flat of poorly drained soil that is covered with extensive pocosin vegetation.

The savannas vary somewhat in elevation, such that the higher areas are actually Wet Pine Flatwoods natural community. This community features a moderate to dense shrub layer under the canopy of longleaf pines (Pinus palustris). Staggerbush (Lyonia mariana), inkberry (Ilex glabra), dwarf waxmyrtle (Myrica cerifera var. pumila), and lowbush blueberry (Vaccinium tenellum) are typical shrubs. Wiregrass (Aristida stricta) is found both in the flatwoods and the savannas. The latter community is very rich in herb species, particularly in the wetter areas near the pocosins. Three species of pitcherplants are present in the savannas, along with the State Candidate Venus' flytrap (Dionaea muscipula). Other noteworthy herbaceous plants include a State Endangered species -- pinebarrens sandreed (Calamovilfa brevipilis); a State Threatened species -- yellow fringeless orchid (Platanthera integra); 5 State Candidate species -- branched gerardia (Agalinis virgata), stalked milkweed (Asclepias pedicellata), savanna cowbane (Oxypolis ternata), Carolina goldenrod (Solidago pulchra), and Carolina asphodel (Tofieldia glabra); and 3 "significantly rare" species -- shortbristled beakrush (Rhynchospora breviseta), pale beakrush (R. pallida), and pinebarrens goober grass (Amphicarpum purshii).

The savannas are not only well-known to botanists, but birdwatchers often visit them to search for 3 rare species. There are several colonies of the Federally Endangered red-cockaded woodpecker (Picoides borealis), impressive numbers of the State Special Concern Bachman's sparrow (Aimophila aestivalis), and a few "significantly rare" Henslow's sparrows (Ammodramus henslowii) in winter. Both sparrow species forage in the dense grass and herb cover; the Bachman's sparrows build their nests on the ground.

The pocosins along the narrow drains contain pond pine (Pinus serotina) in the canopy; dense evergreen shrubs and small trees include sweet gallberry (Ilex coriacea), fetterbush (Lyonia lucida), and redbay (Persea borbonia). After a hot fire, honey-cup (Zenobia pulverulenta) may become important in the pocosins. The extensive pocosins in the southern portion of the natural area have been poorly studied. Some of this area contains Low Pocosin natural community, which is uncommon in the state.

OWNERSHIP: Entirely within Croatan National Forest (U.S. Forest Service ownership and administration)

PROTECTION STATUS: The property is protected according to U.S. Forest Service regulations. In addition, approximately 300 acres, mainly the savannas along Millis Road, are a N.C. Registered Natural Heritage Area, being designated in 1986.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: There has been considerable discussion in the past year or two about the possible leasing of land in the savannas for pine straw harvest by outside companies. Such raking would almost certainly damage the natural area, even if done in the winter months. A study is being conducted on several acres of the savannas to determine the effects of pine straw raking. Until proven otherwise, it is recommended that commercial pine straw harvesting should be prohibited from this natural area, as it is one of the best known savannas in the Southeast and is visited and studied frequently by scientists. It is a very important educational area because of easy access and diversity of habitats. The natural area should continue to receive controlled burns at irregular intervals every 1 to 3 years, particularly in the growing season. Because of the presence of the woodpeckers, any timber removal should be minimal, with great care taken not to disturb the birds' activities and nesting and foraging habitat. Little additional protection is needed, though it might be suitable to place additional portions of the natural area on the N.C. Registry of Natural Heritage Areas.

COMMENTS: Additional animal field work is needed. For example, there are records of eastern diamondback rattlesnake (Crotalus adamanteus) and mimic glass lizard (Ophisaurus mimicus) from the general area of Millis Road. These reptiles inhabit pine flatwoods and might occur in this natural area. The pocosins south of the savannas seem to have been poorly studied, presumably because the dense vegetation makes access difficult.

REFERENCES: Fussell and Wilson (1983), N.C. Natural Heritage Program (1985a)

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SITE NAME: Patsy Pond Limesink Complex

SITE NUMBER: CA9 SIZE: about 650 acres

SITE SIGNIFICANCE: A (National)

LOCATION: The southwestern portion of mainland Carteret County; located just north of NC 24, with Forest Service Road 3126 (Pringle Road) running through the area near the western edge, and with West Prong of Broad Creek lying just east of the area. NC 24 forms the southern boundary, with the natural area extending northward for approximately 2/3 mile.

QUAD MAP: Salter Path

SIGNIFICANT FEATURES:

1. The complex of ponds in the natural area is one of the more significant clusters of limesinks known in the Southeast. Though most of the ponds appear to be sinkhole ponds, some appear to be natural impoundments of old streams.
2. The natural area features several distinct natural communities, such as Small Depression Pond, Xeric Sandhill Scrub, and Coastal Fringe Sandhill.
3. The ponds support many rare plants, including the shrub pondspice (Litsea aestivalis) and numerous herbs, such as the State Threatened loose watermilfoil (Myriophyllum laxum).
4. Rare animals at the natural area include the Federally Endangered red-cockaded woodpecker (Picoides borealis), the State-listed Bachman's sparrow (Aimophila aestivalis) and Carolina gopher frog (Rana capito capito), and the "significantly rare" pigmy rattlesnake (Sistrurus miliarius).

GENERAL DESCRIPTION:

The Patsy Pond region of southwestern Carteret County lies in the southern section of Croatan National Forest. The entire area lies on an old sand ridge system of Pleistocene age (Otte and Whetstone 1979). The area is dominated by various forests of longleaf pine (Pinus palustris) and mixed oaks. Embedded within the sand ridge are numerous (approximately 24) small to medium-sized natural ponds. Some of them are likely to be naturally-impounded sections of old streams, whereas others seem to be limesink ponds caused by slumping of underlying formations. Most of these contain water all year or at least the majority of the year.

The uplands dominate the site in terms of acreage. Portions are Coastal Fringe Sandhill community. In this community the longleaf pine (Pinus palustris) shares dominance with maritime elements such as live oak (Quercus virginiana) and laurel oak (Q. laurifolia). Uplands that feature turkey oak (Q. laevis) as the dominant hardwood are the Xeric Sandhill Scrub community, which is characteristic of the Sandhills region of North Carolina. These uplands contain essentially no known rare plants, but Coastal Fringe Sandhill is uncommon in the state, with very few protected examples. On the other hand, the Federally Endangered red-cockaded woodpecker (Picoides borealis) resides in the pine forests, as does the State Special Concern Bachman's sparrow (Aimophila aestivalis). The State Special Concern Carolina gopher frog (Rana capito capito) has been reported from the natural area; it breeds in the ponds, but resides in the sandy woods at other times of the year. The "significantly rare" pigmy rattlesnake (Sistrurus miliarius) occurs in the uplands at this site.

The two-dozen ponds in the natural area vary considerably in size, shape, and vegetative characteristics. Patsy Pond, about 11-12 acres in size, is the largest, having a narrow east-west shape. Those that have open water zones are Small Depression Pond natural communities. Some ponds contain much floating vegetation, whereas others contain emergent vegetation, particularly maiden-cane (Panicum hemitomon). Most have zones of herbaceous vegetation along the rims, with zones of dense shrubs slightly higher on the rim. The known rare plant species of the ponds are the State Threatened loose watermilfoil (Myriophyllum laxum) and dwarf bladderwort (Utricularia olivacea); the State Candidate pondspice (Litsea aestivalis), coastal beakrush (Rhynchospora pleiantha), Harper's beakrush (R. harperi), branched gerardia (Agalinis virgata), Robbins' spikerush (Eleocharis robbinsii), and Chapman's arrowhead (Sagittaria graminea var. chapmanii); and "significantly rare" flaxleaf seedbox (Ludwigia linifolia), West Indies meadow-beauty (Rhexia cubensis), horsetail spikerush (Eleocharis equisetoides), southeastern panic grass (Panicum tenerum), and longleaf three-awn (Aristida palustris). Rare plants in the flatwoods not far from the ponds are savanna milkweed (Asclepias pedicellata), pinebarrens goober grass (Amphicarpum purshii), and long-beak bald-sedge (Rhynchospora scirpoides).

The shrub zone around the ponds is often dense and pocosin-like. A few of the smaller ponds contain pocosin vegetation and are a Small Depression Pocosin natural community. Typical shrubs of these pond rims and pocosins are titi (Cyrilla racemiflora), myrtle-leaved holly (Ilex myrtifolia), fetterbush (Lyonia lucida), and highbush blueberry (Vaccinium atrococcum).

OWNERSHIP: About 95% of the area is owned by the U.S. Forest Service -- Croatan National Forest. There is a small area of private property along NC 24 that juts northward and includes a part of one of the larger ponds.

PROTECTION STATUS: The Forest Service property is protected according to regulations of that agency. Approximately 420 acres of the natural area were added to the N.C. Registry of Natural Heritage Areas in 1986. This includes essentially the eastern 2/3rds of the Croatan National Forest property, but it does not extend west to Pringle Road.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: This natural area has numerous threats and management problems. The area is constantly being damaged by off-road vehicles that traverse the jeep trails and often drive into the ponds, especially damaging the fragile herbaceous vegetation along the pond rims. The larger ponds, particularly Patsy Pond itself, are especially susceptible to damage. The N.C. Natural Heritage Program has been working with staff of Croatan National Forest to close off jeep trails from NC 24 and to provide public foot access off Pringle Road in the form of an interpretive facility with foot trails, such as is currently done at Island Creek and Cedar Point (in this national forest). It is imperative that all efforts be made to keep off-road vehicles out of this natural area.

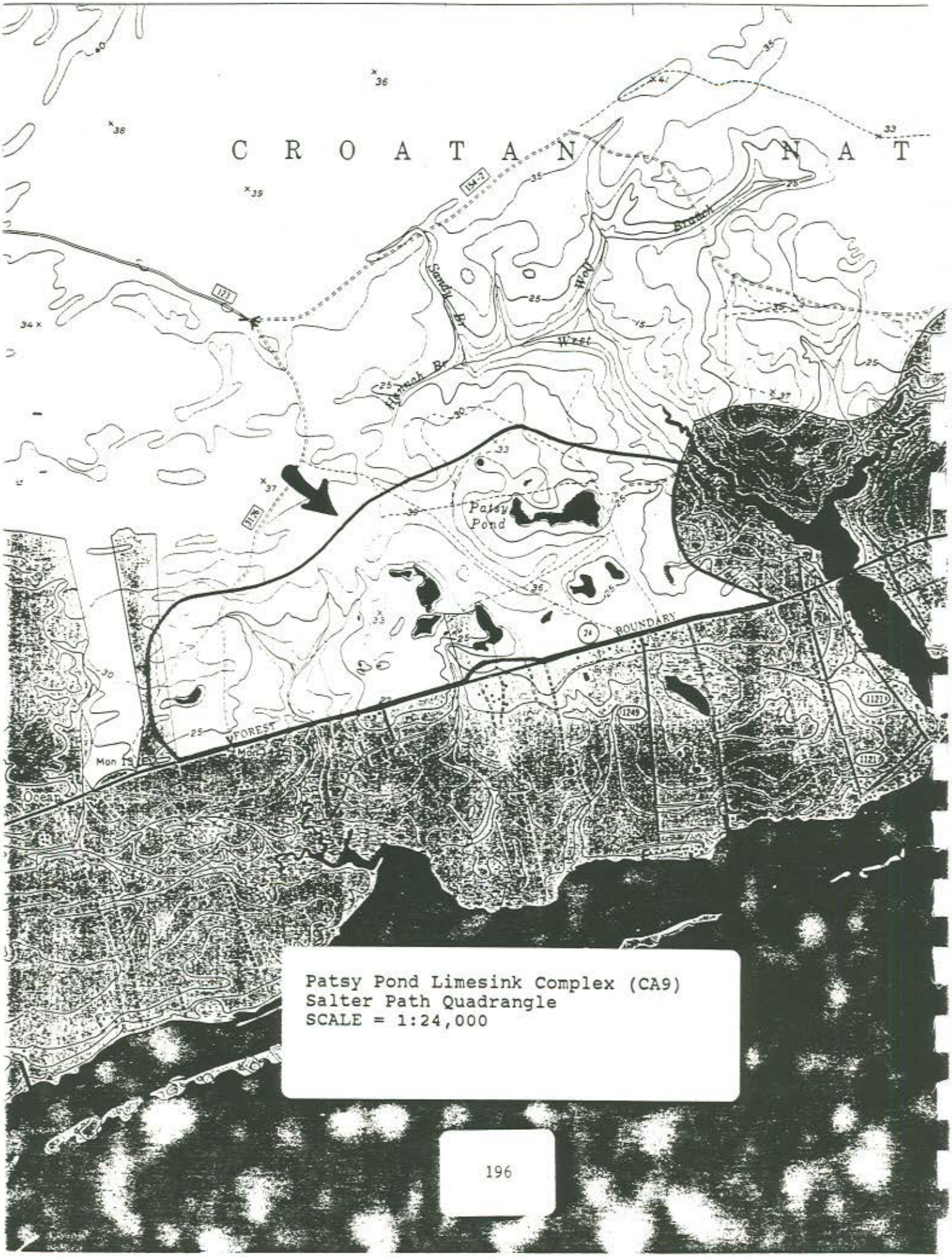
The longleaf pine forest is managed for the red-cockaded woodpecker, and prescribed burning should continue on a cycle of every several years. Any timber harvest should be minimal, with selective cutting only. A garbage disposal facility has been constructed along the east side of Pringle Road in the past few years. Some construction of utility facilities has occurred along this road in recent years, as well.

If at all possible, some of the private "inholding" should be acquired. A home is located in the inholding along NC 24, but the northern portion of the

tract(s) should be acquired so that the large pond bisected by the property line can be managed by the Forest Service.

COMMENTS: The natural area has been studied in great detail over the past few decades by biologists and geologists, and the flora is well known, though new plant discoveries are continually being made. It is hoped that the Patsy Pond area can become a Forest Service interpretive facility so that it can be enjoyed by biologists and others wishing to study and observe the ponds and upland forests in a peaceful, non-motorized setting.

REFERENCES: Otte and Whetstone (1979), Fussell and Wilson (1983), N.C. Natural Heritage Program (1985b), LeBlond (1991)



Patsy Pond Limesink Complex (CA9)
Salter Path Quadrangle
SCALE = 1:24,000

SITE NAME: Wildberry Woods

SITE NUMBER: CA10 SIZE: about 38 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The southwestern portion of Carteret County; located north of NC 24, just west of West Prong of Broad Creek and east of Patsy Pond and Croatan National Forest.

QUAD MAP: Salter Path

SIGNIFICANT FEATURES:

1. The natural area, though small, features a good diversity of habitats, ranging from salt marsh, to sandy woodlands, to seeps, to small stream swamps.
2. The area contains the State Candidate Venus' flytrap (Dionaea muscipula), as well as other carnivorous plants.

GENERAL DESCRIPTION:

Wildberry Woods is located on the mainland just east of a limesink complex known as the Patsy Pond natural area (Site CA9). Both areas lie on an old sand ridge; Wildberry Woods is bisected by a small east-flowing stream (Huckleberry Branch). The area slopes eastward toward West Prong of Broad Creek; some slopes also occur along Huckleberry Branch.

A fringe of salt marsh occurs along Broad Creek. Black needlerush (Juncus roemerianus) dominates the marsh, but smooth cordgrass (Spartina alterniflora) is invading the marsh, perhaps in response to the very slight rise in sea level. Above the marsh is a loblolly pine (Pinus taeda) dominated woodland of uncertain natural community classification. Besides the pine in the canopy, also present are southern red oak (Quercus falcata), water oak (Q. nigra), and laurel oak (Q. laurifolia). The dense understory contains a number of evergreen species such as American holly (Ilex opaca) and yaupon (Ilex vomitoria) plus deciduous species that include Alleghany chinquapin (Castanea pumila). There is a Small Stream Swamp, Blackwater subtype community along Huckleberry Branch. The canopy is dominated by swamp tupelo (Nyssa biflora), with frequent sweetgum (Liquidambar styraciflua) and red maple (Acer rubrum).

Of more significance are the seeps and sandy woods. A tiny seep occurs in the loblolly pine forest. Growing in the seepage is Venus' flytrap (Dionaea muscipula), a State Candidate species. Yellow and purple pitcherplants (Sarracenia flava, S. purpurea) are also present, along with several species of ferns. The sandy woods contain an open canopy of longleaf pine (Pinus palustris). The open understory is dominated by turkey oak (Quercus laevis), with a few live oak (Q. virginiana), laurel oak, and bluejack oak (Q. incana) trees present. Some patches of dangleberry (Gaylussacia frondosa) occur, but most of the ground cover is wiregrass (Aristida stricta).

OWNERSHIP: A single private ownership

PROTECTION STATUS: A total of 38 acres of the tract has been designated a N.C. Registered Natural Heritage Area, having been added to the Registry in 1979. The owners live at the site.

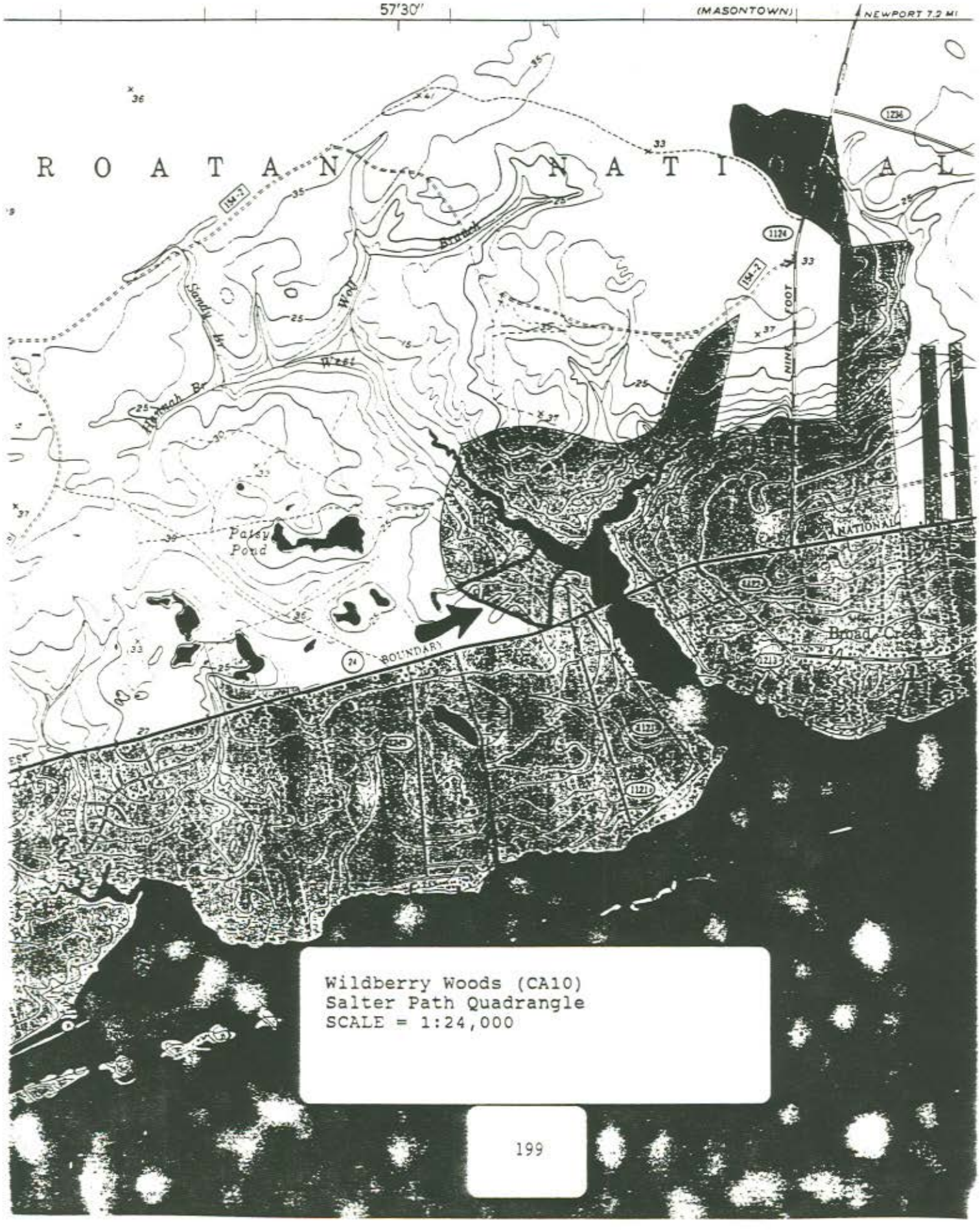
RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The upland areas, particularly the longleaf pine portion, have long been fire-suppressed. Burning is

desperately needed. Because of the heavy leaf litter and understory levels, winter burns are needed at first, followed by growing season burns later on, once the fuel loads have been lowered by the winter burns. The land has been willed to The Nature Conservancy, to be protected as a natural area receiving limited visitation. At the present time, the University of North Carolina has been involved with some management of the land, with considerable field work being conducted by university personnel and biologists from other universities. This university is slated to maintain the natural area as a possible field station.

COMMENTS: The proposed widening of NC 24 from the present 2 lanes to a 4- or 5-lane highway may impact the natural area. It is expected that most of the widening of the highway will be on the north side, as there are fewer homes on this side of the present road. Efforts should be made to minimize any damage to the natural area.

REFERENCES: N.C. Natural Heritage Program (1979), Schafale (1987)

CROATAN NATIONAL FOREST



Wildberry Woods (CA10)
Salter Path Quadrangle
SCALE = 1:24,000

SITE NAME: Nine Foot Road/Broad Creek Pinewoods

SITE NUMBER: CA11 SIZE: about 690 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The west-central portion of Carteret County; located just north of NC 24, along the southern 1.5 miles of SR 1124 (Nine Foot Road), with the majority of the natural area to the east of the road.

QUAD MAP: Salter Path

SIGNIFICANT FEATURES:

1. The natural area features a very high diversity of savanna and wetland plant species, including an impressive array of carnivorous plants.
2. The area features examples of Wet Pine Flatwoods natural community as well as pocosin-like streamheads, which are uncommon in the lower Coastal Plain.
3. There are 14 rare species of plants and 2 rare species of animals known for the natural area, a very impressive number for such an area.

GENERAL DESCRIPTION:

The southern portion of Croatan National Forest contains considerably more sand ridges and topographic changes than the remainder of the forest. These sandy areas are former beach ridges. As a result, this portion of the forest contains an extensive amount of longleaf pine (Pinus palustris) habitats, ranging from savannas to flatwoods to xeric "sandhills". Some of the streams cutting into the sand ridges exhibit a somewhat "sandhills-like" streamhead pocosin vegetation similar to streams in the Sandhills region of the inner Coastal Plain of North Carolina. A Carolina bay is present in the eastern portion of the natural area.

This natural area cannot be considered pristine. Most of that portion west of SR 1124 (Nine Foot Road) was clearcut around 1975, then site prepared and planted in pines. This portion of the area slopes moderately to the south, from a high point of 37 feet above sea level down to practically sea level at East Prong Broad Creek. Perhaps because of such a drop, there are some seepages along the slopes, such that wetland plants are present in the otherwise upland. Carnivorous plants such as Venus' flytrap (Dionaea muscipula), a State Candidate species, and sweet pitcherplant (Sarracenia rubra) are found. Kraus (no date) recorded several hundred plant species from this area west of the road a few years after the clearcut, while the area resembled a "savanna". Other notable plants in this area include dwarf witch-alder (Fothergilla gardenii), 4 species of gerardia (Agalinis spp.), twining screwstem (Bartonia paniculata), white screwstem (B. verna), all 3 grass pink orchids (Calopogon spp.), 3 species of fringed orchids (Platanthera spp.), 3 species of pitcherplants (Sarracenia spp.), and 3 species of bladderworts (Utricularia spp.). The uncommon Florida bluehearts (Buchnera floridana) grows on the roadside.

To the east of the road, there is a telephone clearing paralleling the road, with a slightly "dug out" area just north of the creek that contains a "savanna-like" flora. Rare species at this area include Venus' flytrap, Carolina asphodel (Tofieldia glabra), branched gerardia (Agalinis virgata), pale beakrush (Rhynchospora pallida), savanna yellow-eyed grass (Xyris flabelliformis), savanna cowbane (Oxypolis ternata), small butterwort

(Pinguicula pumila), Carolina goldenrod (Solidago pulchra), yellow fringeless orchid (Platanthera integra), and pinebarrens sandreed (Calamovilfa brevipilis). Hundreds of blue butterworts (Pinguicula caerulea) occur in this area. The Federally Endangered rough-leaf loosestrife (Lysimachia asperulifolia) occurs in large numbers in the eastern portion of the natural area. Other rare plants in the natural area are shortbristed beakrush (Rhynchospora breviseta), littleleaf beakrush (R. stenophylla), and southern bogbutton (Lachnocaulon beyrichianum).

Despite the large number of rare species, much of the eastern portion of the natural area has been poorly surveyed. The pine flatwoods and Carolina bay, as well as other pocosin wetlands, remain to be surveyed in a detailed manner.

Noteworthy animals at the natural area are red-cockaded woodpecker (Picoides borealis), which is Federally Endangered, and the State Special Concern Bachman's sparrow (Aimophila aestivalis).

OWNERSHIP: More than half of the natural area is owned by the U.S. Forest Service -- Croatan National Forest. The remainder is privately owned.

PROTECTION STATUS: The Forest Service property is protected according to the regulations of that agency. The area, however, has no official protection status.

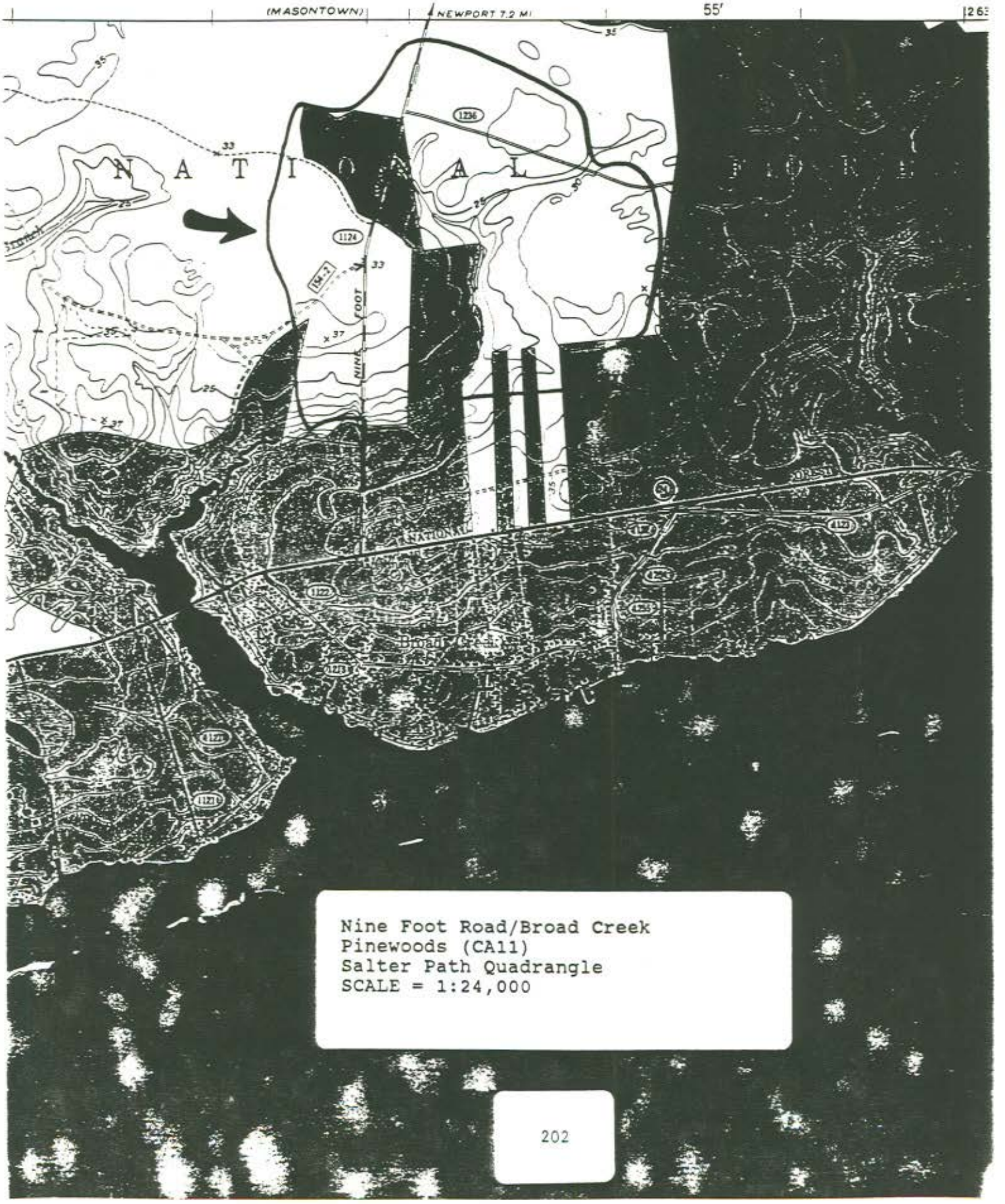
RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The clearcut on the west side of the road is now growing up in pine saplings. The area needs burning, because the saplings are presumed to have already shaded out some of the rare plants in that area. That clearcut, and perhaps other parts of the natural area, have suffered from poaching of flytraps and pitcherplants. Such poaching should be stopped by whatever means possible. No further clearcutting should be done in the area, especially in longleaf pine stands. The pines are foraging habitat for the red-cockaded woodpecker, and further loss of mature pines is to be discouraged.

The Forest Service should attempt to acquire tracts east of the road that remain in reasonably intact condition, in order to add habitat for the woodpecker and to add habitats such as flatwoods and pocosins to their landholdings. Development is encroaching on the area at the east end; trailer courts are sprouting up in the longleaf pine stands. Much of the area is suitable for addition to the N.C. Registry of Natural Heritage Areas.

COMMENTS: There is considerable need for biological survey work in the eastern portion of the natural area. The Carolina bay and some of the pine forests in the vicinity appear to have been poorly studied. Survey is also needed to document the loss of plant species from the pine plantation, losses resulting from shading, lack of fire, and poaching.

REFERENCES: Kraus (no date), Wilson (1978a), LeBlond (1991), N.C. Natural Heritage Program files

CROATAN NATIONAL FOREST



Nine Foot Road/Broad Creek
Pinewoods (CA11)
Salter Path Quadrangle
SCALE = 1:24,000

SITE NAME: Hibbs Road Pine Ridges

SITE NUMBER: CA12 SIZE: about 2200 acres

SITE SIGNIFICANCE: A (National)

LOCATION: West-central portion of Carteret County, in the extreme southern portion of Croatan National Forest; located west of Hibbs Road (SR 1141) and east of Nine Foot Road (SR 1124), both north and south of Forest Service Road 154.

QUAD MAPS: Masontown, Newport

SIGNIFICANT FEATURES:

1. The natural area features an excellent example of a linear series of relict beach ridges and swales.
2. The natural area features a high diversity of plants, with 9 rare species, several of which are Federal candidate species and one of which -- rough-leaf loosestrife (Lysimachia asperulifolia) -- is a Federally Endangered species.
3. Two rare bird species -- red-cockaded woodpecker (Picoides borealis) and Bachman's sparrow (Aimophila aestivalis) -- are present in the natural area.

GENERAL DESCRIPTION:

The natural area consists of a parallel series of well-defined relict beach ridges of Pleistocene age. The ridges and the associated swales are aligned in a west-southwest - east-northeast fashion. Most of the ridges are narrow, with some being only 100 feet across; most are just 1 - 2 feet higher than the interlying swales. Some of the ridges are as much as 5 feet above the adjacent swales. The ridges comprise about 40% of the area and the swales the remaining 60%.

Most of the ridges contain a Wet Pine Flatwoods natural community, but the highest sections contain both Pine/Scrub Oak Sandhill and Xeric Sandhill Scrub communities. In all cases, the canopy trees are rather young, being no more than 30 - 40 feet high and 6 - 8 inches in trunk diameter, probably owing to catastropic fires that killed canopy trees a few decades ago.

The flatwoods feature longleaf pine (Pinus palustris) as the canopy tree. The shrub layer contains inkberry (Ilex glabra) and creeping blueberry (Vaccinium crassifolium) as common components, with wiregrass (Aristida stricta) typically the dominant herb. Of greatest significance are the ecotones between the flatwoods and the pocosins, which vegetate the swales. The vegetation is much more diverse in these ecotones, and most of the rare plants are found in the extensive, linear ecotones. The scrub oak communities contain a mix of turkey oak (Quercus laevis) and some bluejack oak (Q. incana) with the longleaf pine. The pocosins in the swales contain pond pine (P. serotina) as the main canopy tree. The understory features loblolly-bay (Gordonia lasianthus), fetterbush (Lyonia lucida), sweet gallberry (Ilex coriacea), and titi (Cyrilla racemiflora) as common species. Species such as sheep-kill (Kalmia angustifolia), honey-cup (Zenobia pulverulenta), leatherleaf (Cassandra calyculata), and yellow pitcherplant (Sarracenia flava) occur in lower and more open sites in the swales.

The natural area, though not significant in terms of natural communities or maturity of the communities, contains a remarkable array of herbaceous plants,

including 9 rare species. One of the largest known populations of the Federally Endangered rough-leaf loosestrife (Lysimachia asperulifolia) occurs in the ecotones. Over 1000 individuals of the Federal Candidate Carolina asphodel (Tofieldia glabra) were found in a 1991 survey, perhaps the largest known population of the species anywhere. Other rare plants are the State Endangered pinebarrens sandreed (Calamovilfa brevipilis); 5 State Candidate plants -- branched gerardia (Agalinis virgata), savanna milkweed (Asclepias pedicellata), Venus' flytrap (Dionaea muscipula), savanna cowbane (Oxypolis ternata), and Carolina goldenrod (Solidago pulchra); and the "significantly rare" pinebarrens goober grass (Amphicarpum purshii). Other scarce herbs include pine barren gentian (Gentiana autumnalis) and Loomis' loosestrife (Lysimachia loomisii).

A colony of the Endangered red-cockaded woodpecker (Picoides borealis) occurs adjacent to Hibbs Road, and the Special Concern Bachman's sparrow (Aimophila aestivalis) also occurs near this road. There is the potential for other rare animals, including the eastern diamondback rattlesnake (Crotalus adamanteus), one of which was killed in the fall of 1991 near Newport.

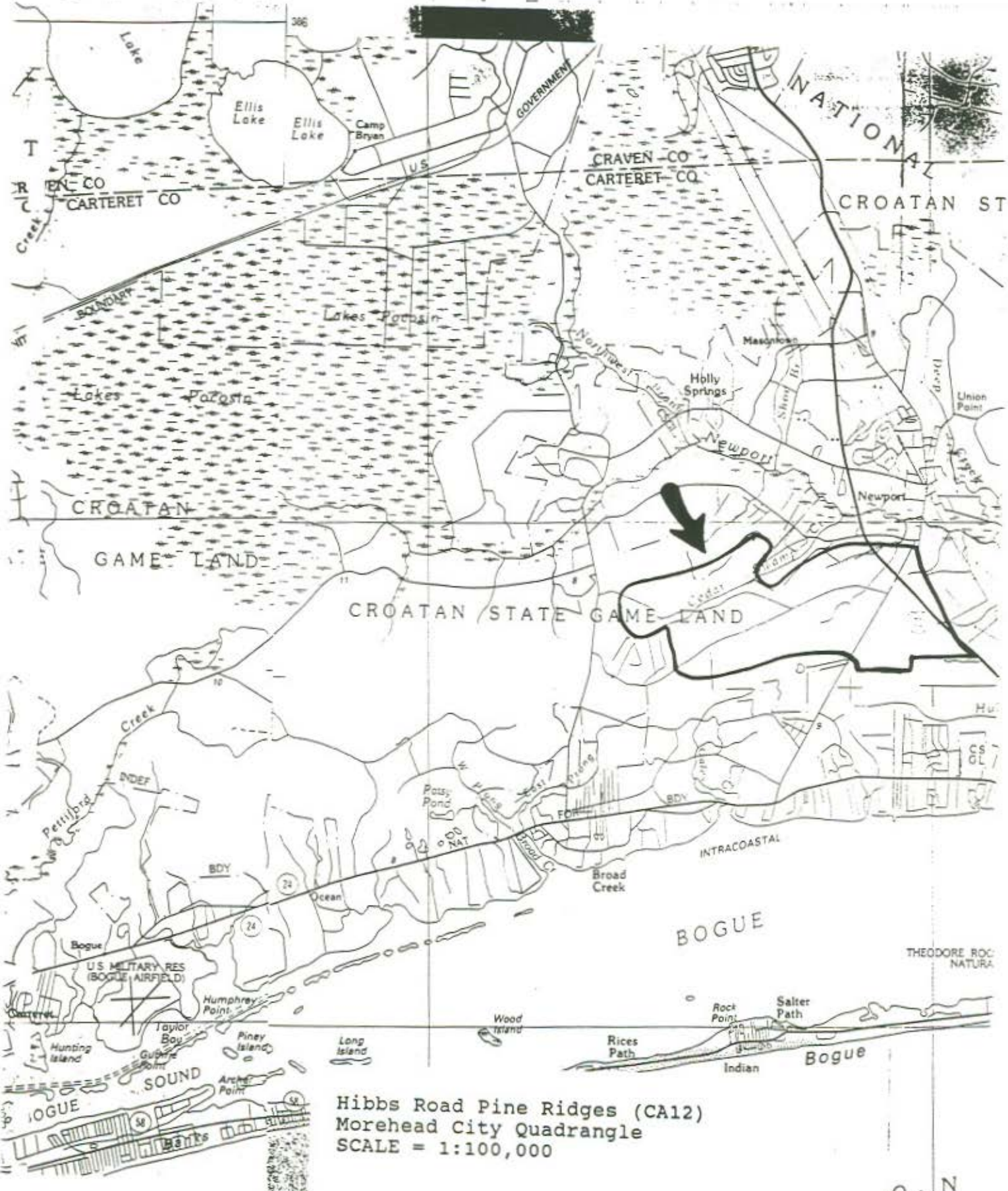
OWNERSHIP: Approximately 90% of the natural area is owned by the U.S. Forest Service -- Croatan National Forest. The remainder is in private ownership.

PROTECTION STATUS: The Forest Service property is protected according to that agency's regulations. However, there is no formal protection, such as a registry agreement, for any of the natural area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The primary management recommendation is for more frequent burning of the site by the Forest Service. At present, the area appears to have gone many years without a fire. Fire is needed to maintain the high diversity of herbaceous species, to reduce the fuel load of hardwood species, and maintain habitat for the red-cockaded woodpecker. Most of the area is suitable for registry as a N.C. Natural Heritage Area, and the Natural Heritage Program should work with the Forest Service to ensure protection. The Forest Service should consider acquisition of portions of private property, particularly the wedge of land that extends in a westerly direction along the northern boundary of the natural area.

COMMENTS: A section in the center of the natural area, just south of FSR 154, has been excluded from the site because it is currently a landfill. Also, a former landfill is located along the southern boundary. The present landfill is expected to close soon, perhaps in 1992. John Fussell (pers. comm., 1991) believes that the current landfill may have destroyed as many as 1000 individuals of rough-leaf loosestrife, based on his finding of considerable numbers in habitats similar to those destroyed by the landfill. It is clear from the references listed below that the 2 landfills eliminated much habitat for rare plants, and that perhaps better locations could have been found for siting the landfills. It is expected that other rare animals, such as mimic glass lizard (Ophisaurus mimicus), are present in the natural area. Though considerable time has been spent surveying the area, many miles of ecotones are present, and much more field work is needed.

REFERENCES: Wilson (1983), Fussell (1991e)



Hibbs Road Pine Ridges (CA12)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: Nine Foot Road/Roberts Road Limesink Ponds

SITE NUMBER: CA13 SIZE: about 780 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The central portion of Carteret County; located mostly in Croatan National Forest, south of Roberts Road (SR 1140) and east of the intersection of Nine Foot Road (SR 1124) and Millis Road (SR 1112).

QUAD MAP: Masontown

SIGNIFICANT FEATURES:

1. The natural area contains several clusters of limesink ponds, which are geologic features scattered in the lower Coastal Plain of the state. These clusters are at the northeastern edge of the "range" for the limesinks. Several rare plant species are found in the ponds and in the pine flatwoods nearby.
2. The Federally Endangered red-cockaded woodpecker (Picoides borealis) has been found in the natural area, as have 2 rare reptiles.

GENERAL DESCRIPTION:

The natural area occurs on a fairly flat relict dune ridge as a part of the Flanner Beach Formation (Wilson, no date). Scattered over the natural area, although clustered mainly at the western and eastern ends, are a series of small limesink ponds, most considerably smaller than an acre in size. Most of the remainder of the area is vegetated in a Wet Pine Flatwoods natural community. The ponds represent the Small Depression Pond natural community. Some patches of pocosin vegetation are also present.

The majority of the natural area is a longleaf pine (Pinus palustris) dominated site with a modest understory. The few understory trees are generally sweetbay (Magnolia virginiana) and turkey oak (Quercus laevis). Low shrubs such as inkberry (Ilex glabra), waxmyrtle (Myrica cerifera), and huckleberries (Gaylussacia spp.) are common. Two notable herbs of the forest, both State Candidates, are savanna milkweed (Asclepias pedicellata) and savanna yellow-eyed grass (Xyris flabelliformis). The shallowest limesinks have no water and generally have a thick pocosin cover.

The primary feature of the area is the limesink ponds and their associated vegetation. A number of the ponds contain water for most of the year. Plants found in the water include Baldwin's spike-rush (Eleocharis baldwinii), spatterdock (Nuphar luteum), beak rushes (Rhynchospora spp.), and maiden-cane (Panicum hemitomon). Much sphagnum moss is often present. Most have a dense shrub rim of titi (Cyrilla racemiflora) and highbush blueberries (Vaccinium spp.). Present in this zone at many of the ponds is the State Candidate pondspice (Litsea aestivalis). The uncommon myrtle-leaved holly (Ilex myrtifolia) is also present. A few notable herbs grow in the "drawdown" zones at the edge of the water. The "significantly rare" West Indies meadow-beauty (Rhexia cubensis) is present at one of the eastern ponds, and the uncommon northern bluethreads (Burmannia biflora) grows at one of the ponds in the northeastern portion of the natural area.

The animal life of the area has apparently been poorly studied. The red-cockaded woodpecker (Picoides borealis) resides in the area, at least formerly. The State "significantly rare" eastern diamondback rattlesnake (Crotalus adamanteus) was found here (dead on a road) in 1991. The mimic

glass lizard (Ophisaurus mimicus), State Special Concern, has been recorded from this area, as well. It is believed that the ponds are host to amphibians in the breeding season.

OWNERSHIP: About 60% is owned by the U.S. Forest Service -- Croatan National Forest. The remainder is privately owned.

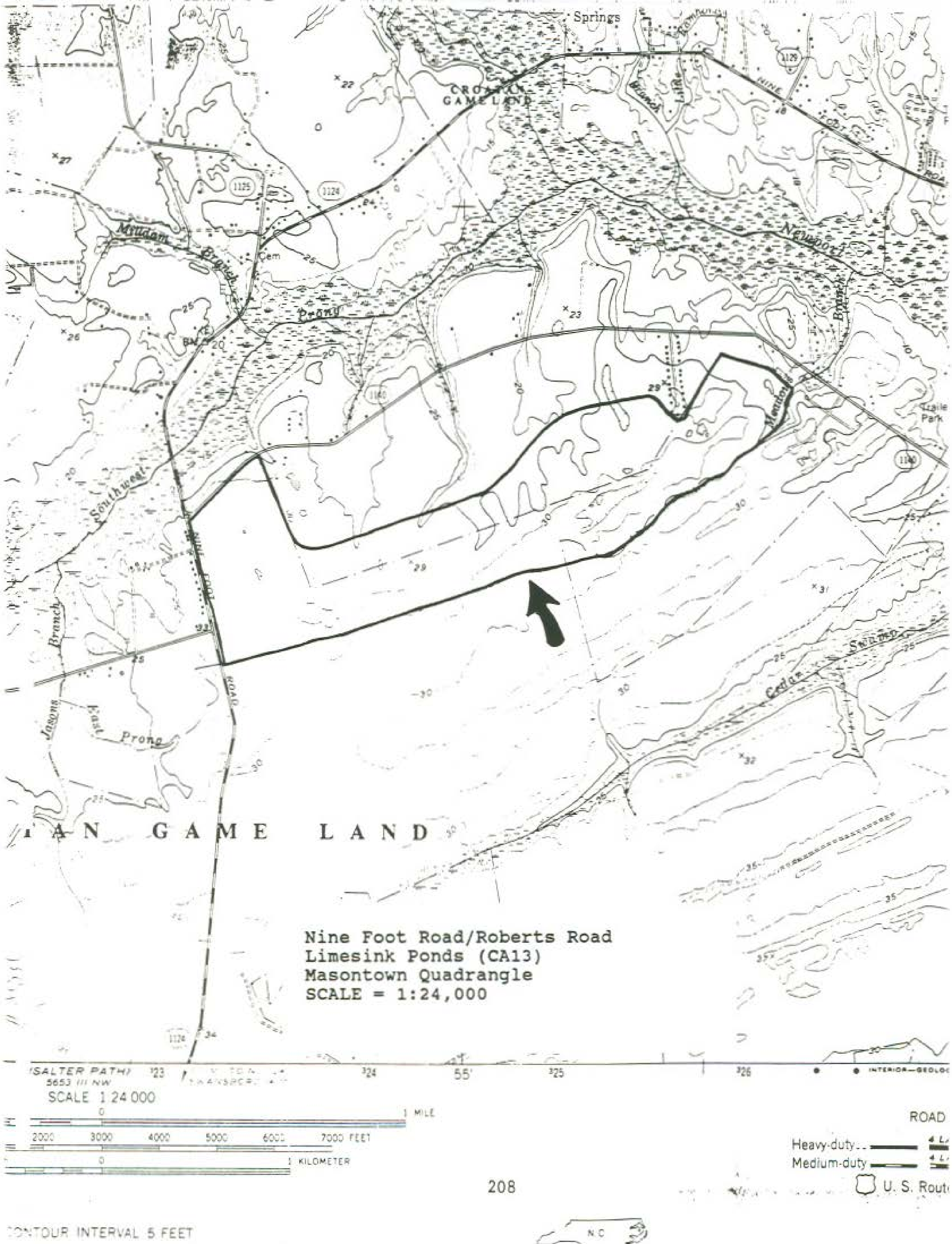
PROTECTION STATUS: The Forest Service property is protected according to regulations of that agency. The area, however, has no official protection status.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The ponds, so far, have generally been free of off-road vehicle traffic and other disturbances. It is important for the Forest Service to continue to keep roads and jeep trails in the natural area blocked to all vehicles except their own in order to keep the ponds from being damaged. The forest should continue to be burned every several years to maintain the natural fire regime, to provide habitat for herbaceous plants, and to provide suitable nesting and foraging habitat for the red-cockaded woodpecker. Only some selective cutting of the longleaf pines should be done; no clear-cutting should take place. Pine straw raking should be prohibited.

There are a few crucial pieces of private property in the natural area that should be acquired by the U.S. Forest Service for addition to Croatan National Forest. Several of the ponds, plus longleaf pine habitat for the woodpeckers, are on private property in the northeastern corner of the area. The Service is looking to acquire lands that contain woodpecker habitat, and such property exists here; in addition, a few limesink ponds could be acquired at the same time. The entire area is suitable for registry as a Natural Heritage Area, and it is hoped that the N.C. Natural Heritage Program will propose this natural area for such a designation in the near future.

COMMENTS: Additional field work is needed, particularly study of amphibian use of the ponds. The Special Concern Carolina gopher frog (Rana capito capito) is possible as a resident in the area.

REFERENCES: Wilson (no date), Fussell and LeGrand (1991)



Nine Foot Road/Roberts Road
Limesink Ponds (CA13)
Masontown Quadrangle
SCALE = 1:24,000

SITE NAME: Masontown Pocosin

SITE NUMBER: CA14 SIZE: about 2950 acres

SITE SIGNIFICANCE: B (State)

LOCATION: Extreme northern portion of Carteret County and southern Craven County; lying west of US 70 and east of SR 1125 (Carteret), just northwest of the community of Masontown.

QUAD MAP: Masontown

SIGNIFICANT FEATURES:

1. The natural area contains approximately 4 square miles of relatively undisturbed pocosin. Of major importance is an extensive area, perhaps close to 1000 acres, of Low Pocosin natural community. This is one of the larger extents of this community known anywhere.

GENERAL DESCRIPTION:

Masontown Pocosin is one of a handful of pocosins in Croatan National Forest. It lies along the Carteret - Craven county line and is one of the easternmost pocosins in the national forest. The natural area is a flat basin at least 4 square miles in size; the northern portion drains into Slocum Creek, and the southern portion drains into Newport River.

The outer portion of the pocosin has apparently not been well surveyed. However, the inner portion -- the Low Pocosin -- was surveyed with some intensity in October 1980 (Fussell and Wilson 1983). The majority of the vegetation is less than 2 feet high. A few pond pines (Pinus serotina) about 15 feet tall are scattered over the pocosin, as are clumps of broadleaf evergreen "trees" such as loblolly-bay (Gordonia lasianthus) and redbay (Persea borbonia). The bulk of the vegetation consists of dense stands of fetterbush (Lyonia lucida) and honey-cup (Zenobia pulverulenta). Other common shrubs include inkberry (Ilex glabra), titi (Cyrilla racemiflora), and leatherleaf (Cassandra calyculata). Laurel-leaf greenbrier (Smilax laurifolia) is a common vine. Tawny cotton-grass (Eriophorum virginicum), an uncommon sedge in North Carolina, is fairly common where the mass of vegetation is less than a foot high.

The animal life in the natural area is poorly known but is not expected to be of high diversity. Pocosins are important habitat for black bears (Ursus americanus), which may well occur here, and for wintering birds. Pocosins typically feature trees and shrubs that produce large quantities of berries, such as holly species, redbay, and others, and these berries are staples for songbirds and other species of wildlife.

OWNERSHIP: U.S. Forest Service -- Croatan National Forest

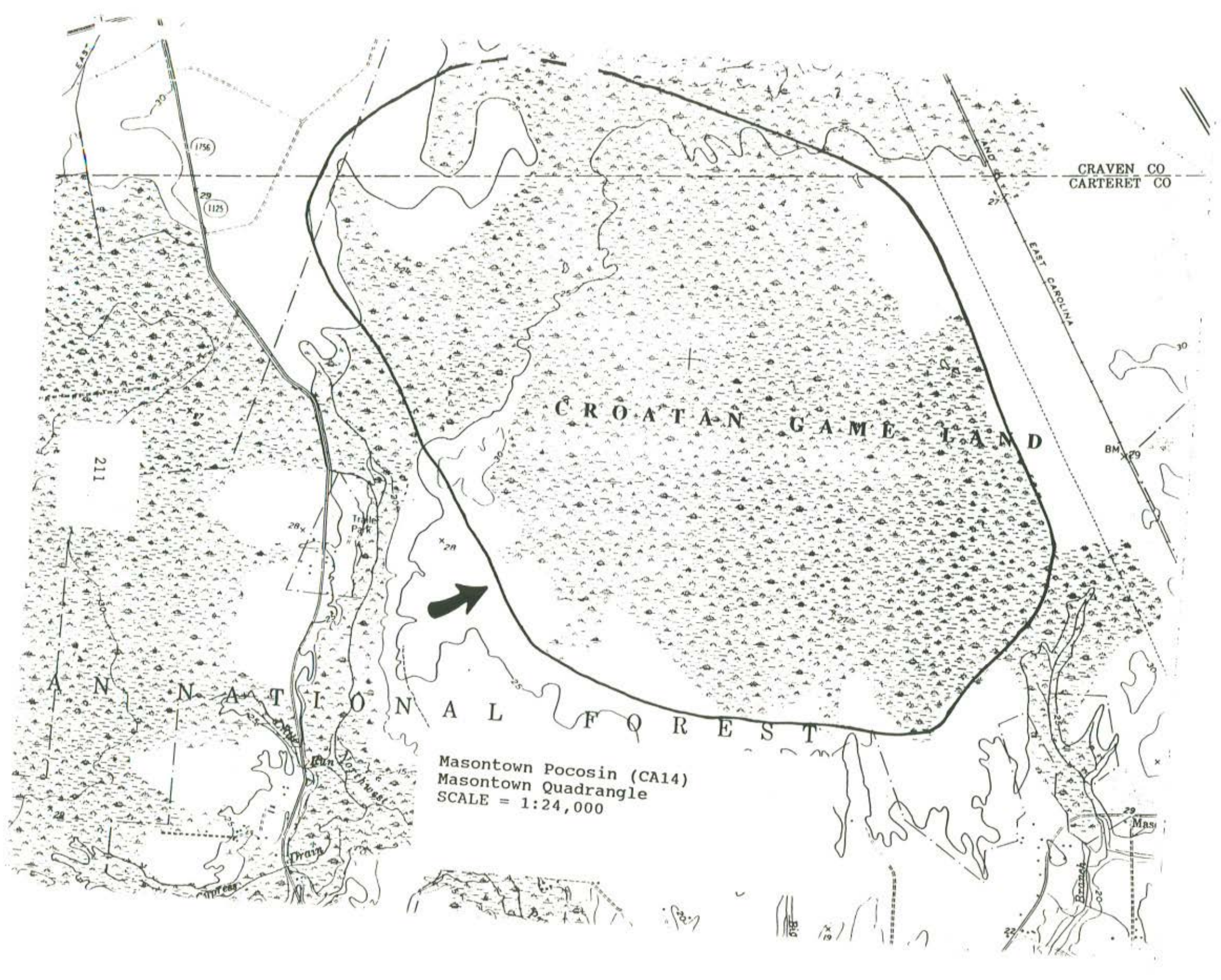
PROTECTION STATUS: The Forest Service property is protected according to that agency's regulations. There is no formal protection, however; it is not one of the pocosins in the forest that have been designated as a Wilderness Area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The pocosins in Croatan National Forest generally have a "hands-off" management. That is, there will be no management of them, such as timber removal, nor will they be burned to reduce fuel load or to improve habitat for wildlife. Pocosins are frequently

a fire-maintained ecosystem. Some pocosins seem to be self-perpetuating in the long absence of fire, particularly those over deep peat soils, such as low pocosins. However, pocosins on soils with less peat but more minerals may succeed to a bay forest or possibly to a swamp forest if fire is suppressed for many decades. The natural area is worthy of protection; it should be a possible candidate for inclusion on the N.C. Natural Heritage Program's Registry of Natural Heritage Areas.

COMMENTS: Further descriptions of the vegetation along the outer portions of the natural area are needed. This vegetation may well be similar to that at other pocosins, with tree-sized pond pines dominating, along with considerable redbay, loblolly-bay, and sweetbay (Magnolia virginiana) mixed with the pines.

REFERENCES: Fussell and Wilson (1983)


CRAVEN CO
CARTERET CO
CROATAN GAME LAND
EAST CAROLINA
211
ANNATIONAL FOREST
Masontown Pocosin (CA14)
Masontown Quadrangle
SCALE = 1:24,000

SITE NAME: Union Point Pocosin

SITE NUMBER: CA15 SIZE: about 6000 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The northern portion of Carteret County and extreme southern Craven County, with the majority lying in Carteret. The area is located east of US 70, south and west of NC 101, and north of SR 1154 (Carteret).

QUAD MAP: Newport

SIGNIFICANT FEATURES:

1. The natural area is one of the more extensive pocosins in the Croatan National Forest area. Though not designated a wilderness area, it is entirely roadless and devoid of man-made disturbances.
2. The natural area contains examples of pocosin natural communities, including the uncommon Low Pocosin.

GENERAL DESCRIPTION:

Extensive (over 500 acres) pocosins in North Carolina are now relatively uncommon. Most have been cleared for pine plantations or large-scale agriculture. Fortunately, a handful of such pocosins still remain in Croatan National Forest. This pocosin lies along the Carteret - Craven county line north of the town of Newport.

The natural area is essentially flat, lying approximately 24 feet above sea level. It is featureless, with no streams, though along the periphery the elevation drops slightly below 20 feet. Water drains outward in all directions in an inperceptible manner. Most of the area contains Pond Pine Woodland and High Pocosin vegetation, with the height of the vegetation decreasing toward the center, which is primarily Low Pocosin. Pond pine (Pinus serotina) dominates the natural area. Also abundant are loblolly-bay (Gordonia lasianthus), titi (Cyrilla racemiflora), fetterbush (Lyonia lucida), and sweet gallberry (Ilex coriacea).

One area of Low Pocosin contains a sparse amount of pond pine, with a dense 4-foot tall layer of fetterbush and titi. Laurel-leaf greenbrier (Smilax laurifolia) is common. Another portion of the natural area features an abundance of giant cane (Arundinaria gigantea) beneath a canopy of pond pine. Such canebrake variants of Pond Pine Woodland are uncommon in Carteret County. Because of the dense woody vegetation, herbaceous species are scarce. Sphagnum moss (Sphagnum spp.) is present, and the uncommon tawny cotton-grass (Eriophorum virginicum) is present.

There is some marginal habitat present for the Endangered red-cockaded woodpecker (Picoides borealis), though the species is not yet known from the site. The black bear (Ursus americanus), a species of concern in the state, occurs at the natural area.

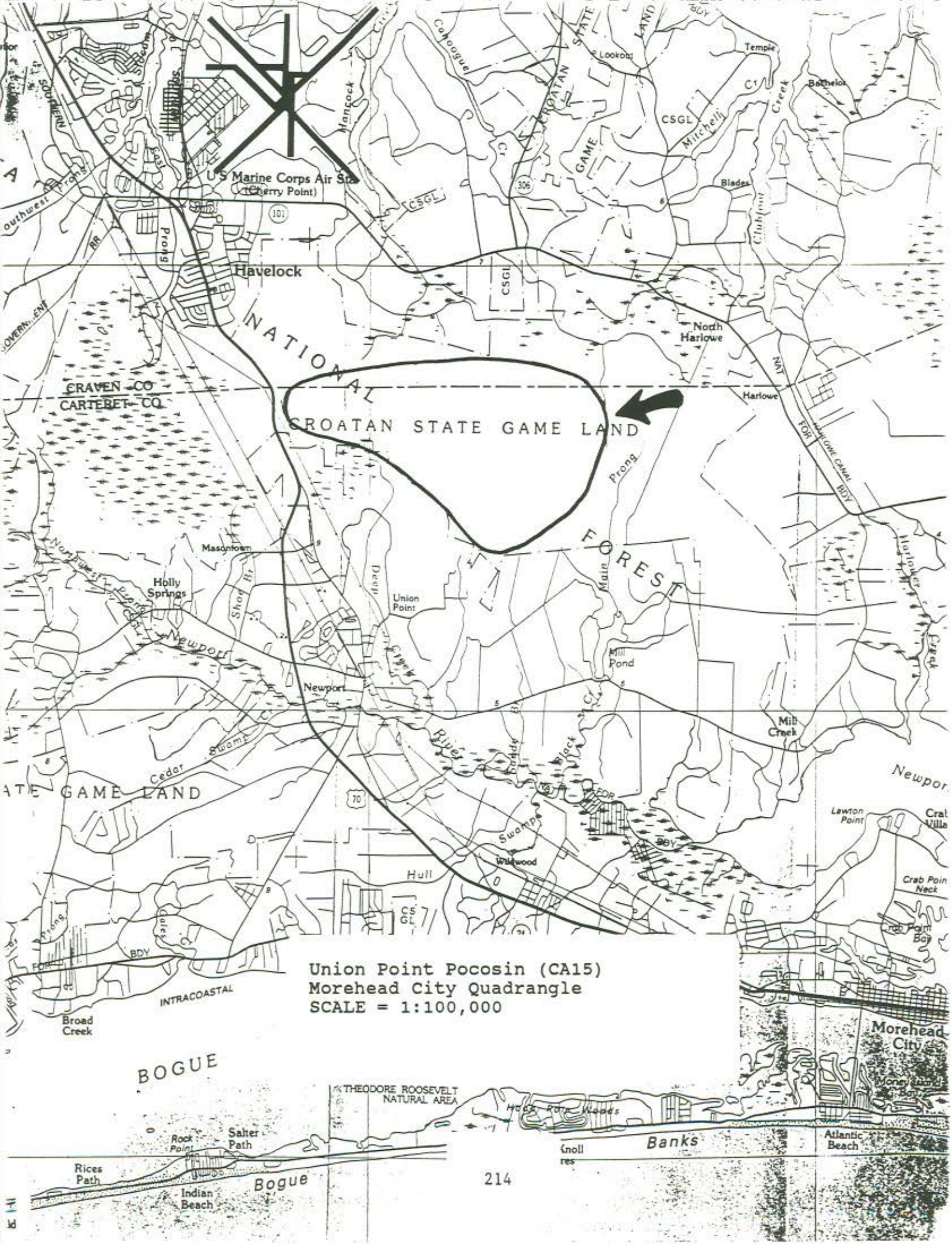
OWNERSHIP: U.S. Forest Service -- Croatan National Forest

PROTECTION STATUS: No official protection status; protected under U.S. Forest Service regulations. Their regulations indicate a "no management" status for pocosins. As with all Forest Service lands at Croatan, hunting is allowed.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The area is worthy of being added to the Registry of Natural Heritage Areas, and probably should be nominated for the Registry in the future. Whether or not the pocosin should be burned to restore it to its natural fire regime is a moot point, because the Forest Service plans to leave the pocosins alone, witn no burning of them. The best management is that, when a natural or man-made fire breaks out in such a pocosin, the fire be allowed to run its course and burn out in the pocosin. All too often, fire plow lines are constructed into a pocosin to block and contain the fire, when it is highly likely that the fire will burn itself out in the pocosin. Such lines can forever damage a pocosin by altering the hydrology of it, as few such fire lines are ever graded and filled in.

COMMENTS: Additional survey work in the Low Pocosin community would be helpful; however, access to such habitats is usually very difficult because of dense vegetation. Further animal survey work is also needed.

REFERENCES: Fussell and Wilson (1983)



Union Point Pocosin (CA15)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: Walkers Millpond and Black Creek

SITE NUMBER: CA16 SIZE: about 500 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The central portion of Carteret County; lying both north and south of SR 1154, approximately 3 miles east of Newport. Walkers Millpond lies just north of the road.

QUAD MAP: Newport

SIGNIFICANT FEATURES:

1. Walkers Millpond is one of the more significant millponds in North Carolina, from a rare species standpoint. Noteworthy plants include West Indies meadow-beauty (Rhexia cubensis), water-spider orchid (Habenaria repens), and pale-green orchid (Platanthera flava).
2. The natural area contains breeding habitat for noteworthy birds, such as anhinga (Anhinga anhinga) and several species of warblers.
3. Several high quality natural communities are present, including swamp forests and mesic hardwood forests.

GENERAL DESCRIPTION:

Walkers Millpond is a man-made impoundment constructed on Black Creek in Carteret County. The dam was built shortly after 1900 (Fussell and Wilson 1983). The millpond is a narrow north-south body of water covering about 125 acres. The pond itself is apparently rather sterile; however, the margins of the pond contain several rare plants, and anhingas (Anhinga anhinga), considered "significantly rare" in the state, are believed to nest in trees at the upper end of the millpond, as do great blue herons (Ardea herodias). Scattered bald cypresses (Taxodium distichum) dot the pond. One portion of the margin of the pond features a population of West Indies meadow-beauty (Rhexia cubensis), considered "significantly rare" in North Carolina. The water-spider orchid (Habenaria repens), uncommon in the state, is common at the upper reaches of the pond, whereas pale-green orchid (Platanthera flava) is locally common in floodplain forests.

Swamp forests composed almost entirely of bald cypress are present along the lower reaches of the streams emptying into the millpond. Spanish moss (Tillandsia usneoides) is common on the trees. White water-lily (Nymphaea odorata) abounds on the water surface in this area. Most of the floodplains of the creeks in the natural area, including Black Creek below the pond, are vegetated in Coastal Plain Small Stream Swamp natural community. Ash (Fraxinus tomentosa?), swamp tupelo (Nyssa biflora), and sweetgum (Liquidambar styraciflua) are common, with the tupelo most common downstream and the sweetgum most numerous upstream. Between the swamps and the uplands (mostly pine plantations) there are narrow mesic forests on the slightly sloping ground. In some places, this mesic hardwood forest is dominated by pignut hickory (Carya glabra) and water oak (Quercus nigra); some areas feature swamp chestnut oak (Q. michauxii) as a dominant. Flowering dogwood (Cornus florida) is the dominant understory tree. Some shrubs of this community include dwarf palmetto (Sabal minor), coastal doghobble (Leucothoe axillaris), and fetterbush (Lyonia lucida).

The area abounds in wildlife. Though waterfowl are rarely found on the pond, because of the sterile conditions, many birds are present. Red-

shouldered hawk (Buteo lineatus), black vulture (Coragyps atratus), Swainson's warbler (Limnothlypis swainsonii), black-throated green warbler (Dendroica virens), and Kentucky warbler (Oporornis formosus) are uncommon birds in the state that breed in the natural area. Black bears (Ursus americanus) occur in the natural area, as well.

OWNERSHIP: The extreme northern portion of Main Prong lies in Croatan National Forest, under U.S. Forest Service ownership. However, the remainder is in multiple private ownership, including both individuals and a timber company.

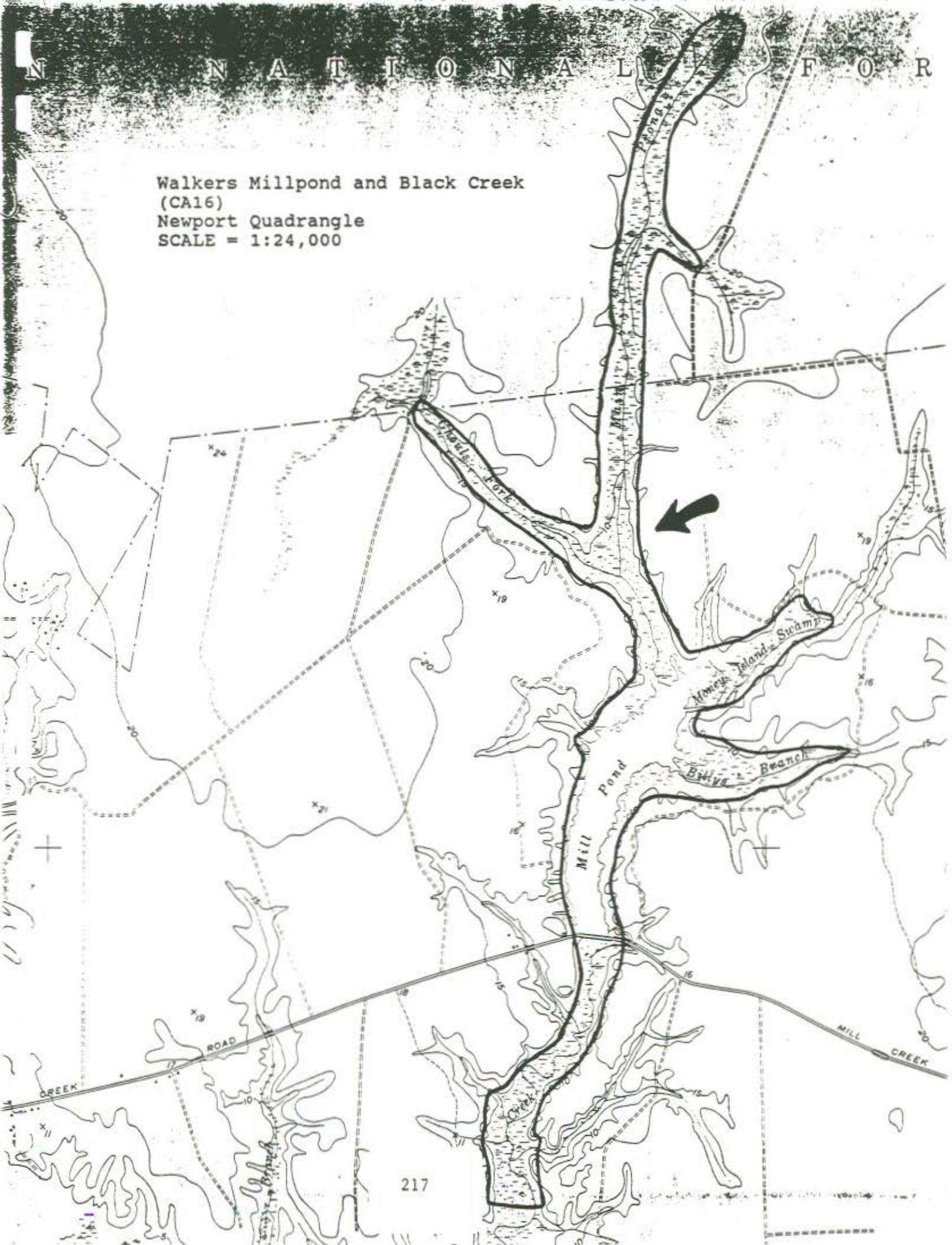
PROTECTION STATUS: The only portions of the natural area in protected status are 3 tracts totalling 32 acres along Black Creek south of the pond that have been added to the Registry of Natural Heritage Areas. These 3 owners have voluntarily agreed to protect and manage their lands, having registered them with the N.C. Natural Heritage Program. The pond is owned by a group of private citizens who use it for fishing and hunting.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: No timber cutting should be allowed in the natural area. There is the potential for cutting of timber around the periphery of the pond. Much cutting has occurred in the zone behind the periphery, but the timber immediately along the pond has been intact for many decades. Sale of the pond to a timber company would be detrimental. The best protection for the area would be acquisition of the pond and surrounding lands by the U.S. Forest Service for inclusion within Croatan National Forest. Such acquisition might be detrimental in that, if the pond came into public ownership, overuse by boaters and pond-bank fishermen could impact the wildlife and plants. Nonetheless, the best protection, in the long run, would be ownership by a public agency.

COMMENTS: Though the millpond is not a natural feature of the landscape, it is certainly one of the more biologically significant ponds in the state, at least at the upper reaches and shoreline. It does not contain the significant aquatic fauna of Orton Pond or the abundant aquatic flora of Merchants Millpond, but it is significant for other merits, as discussed above.

REFERENCES: Fussell and Wilson (1983)

Walkers Millpond and Black Creek
(CA16)
Newport Quadrangle
SCALE = 1:24,000



SITE NAME: Phillips and Annex Islands

SITE NUMBER: CA17 SIZE: about 46 acres
Phillips Island -- about 23 acres
Annex Island -- about 23 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The central portion of Carteret County; lying near the mouth of the Newport River between Morehead City and Beaufort, north of US 70.

QUAD MAP: Beaufort

SIGNIFICANT FEATURES:

1. These islands have hosted one of the largest heronries in North Carolina for several decades.

GENERAL DESCRIPTION:

Phillips Island and neighboring Annex Island (on the west) lie in Newport River north of the US 70 bridge and causeway. The origin of Phillips Island is uncertain; it might be a natural island within the river, but dredged materials have been deposited on the island. Annex Island is believed to be a dredged material island; it has been partly diked (Parnell and Soots 1979).

Phillips Island contains remains of human habitation, and a chimney is a distinctive visual feature of the island. The island contains a dense maritime shrub/wooded thicket but is not a maritime forest. Dominant species include two introduced trees -- paper mulberry (Broussonetia papyrifera) and white mulberry (Morus alba) --along with the native eastern red cedar (Juniperus virginiana), yaupon (Ilex vomitoria), and broadleaf marsh-elder (Iva frutescens) (McCrimmon 1978).

Annex Island was partly diked in 1974; the dike included much of the central portion of the island. The perimeter of the island is heavily vegetated in shrubs and small trees, where wading birds nest. These thickets are dominated by waxmyrtle (Myrica cerifera), groundsel-tree (Baccharis halimifolia), yaupon, marsh-elder, eastern red cedar, and loblolly pine (Pinus taeda).

Over the past few decades, since at least the 1960's, the islands have been home to a large heronry. In any given year, generally 6 to 8 species of waders nest, with total nests running into many hundreds. The species that typically breed each year are great egret (Chasmerodius albus), snowy egret (Egretta thula), cattle egret (Bubulcus ibis), tricolored heron (E. tricolor), little blue heron (E. cerulea), black-crowned night-heron (Nyctanassa nycticorax), white ibis (Eudocimus albus), and glossy ibis (Plegadis falcinellus). Four of these species -- the snowy egret, tricolored heron, little blue heron, and glossy ibis -- are considered Special Concern in North Carolina. In recent years, nearly all of the nesting has taken place on Phillips Island; however, in some years most of the birds have nested on Annex Island.

OWNERSHIP: Private

PROTECTION STATUS: The National Audubon Society has arranged a lease agreement with the owner of Phillips Island to manage for the colonial waterbirds. Some erosion is occurring on the island, and the Audubon Society

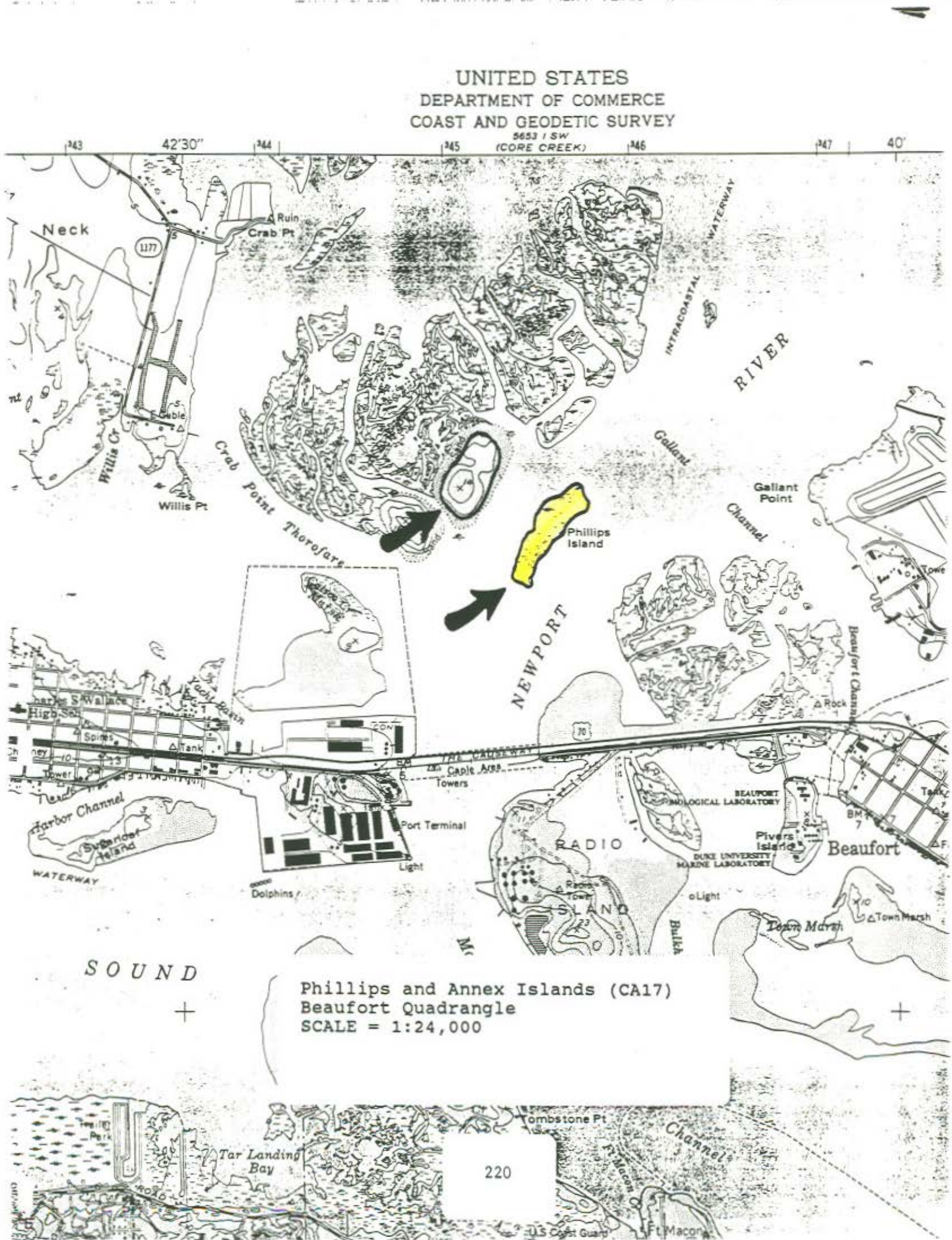
hopes to halt the erosion and initiate other management practices, if necessary. Annex Island has no known protection.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The most urgent management need is to halt the erosion that is occurring on the northeastern end of Phillips Island, which is losing shrubs and trees that the wading birds have used for nesting. It is also important for the National Audubon Society or the N.C. Wildlife Resources Commission to continue to monitor human visitation of the islands; in the nesting season, such visitations should be prohibited, unless persons have permission to be on the island to study the birds. Predation of eggs and young, by crows, raccoons, and other animals is almost always a problem in heronries. It may be necessary to remove or otherwise scare off such predators to allow the waders to nest successfully. No dredge material should be placed on the islands during the nesting season, nor should this material be placed in areas that presently contain trees or dense shrubs, as those sites can be suitable for future nesting by wading birds.

Although a lease agreement at Phillips Island should be a benefit to the wading birds, ultimate protection will necessitate the acquisition of Phillips and Annex islands, especially the former. The National Audubon Society, the N.C. Division of Coastal Management, and perhaps the Wildlife Resources Commission are agencies and organizations that would be suitable owners and administrators of these islands.

COMMENTS: The bird nesting populations on these islands and other coastal islands in North Carolina have been censused every several years by James F. Parnell and other biologists at the University of North Carolina - Wilmington.

REFERENCES: McCrimmon (1978), Parnell and Soots (1979), Parnell et al. (1986)



Phillips and Annex Islands (CA17)
Beaufort Quadrangle
SCALE = 1:24,000

SITE NAME: Rachel Carson Estuarine Research Reserve

SITE NUMBER: CA18 SIZE: 2625 acres

SITE SIGNIFICANCE: B (State)

LOCATION: Southern portion of Carteret County; located immediately south of Beaufort, bounded on the north by Taylor Creek, on the west by Bulkhead Channel, on the south by Beaufort Inlet and Shackleford Slue, and on the east by Back Sound. Components of the natural area include Carrot Island, Horse Island, Bird Shoal, Town Marsh, and Middle Marshes. The area can be accessed only by boat.

QUAD MAPS: Beaufort, Harkers Island

SIGNIFICANT FEATURES:

1. The Rachel Carson Reserve contains extensive intertidal mudflats and sandflats that provide foraging habitat for thousands of waterbirds throughout the year.
2. The intertidal flats contain a wide array of plant and animal species, particularly invertebrates. A number of rare species are present, including the state's largest wintering population of the Federally Threatened piping plover (Charadrius melodus).
3. The reserve, though partly consisting of dredge spoil depositions, contains a large array of plant communities, including a very small example of Maritime Evergreen Forest. Approximately 10 natural communities are represented.
4. The natural area is heavily used for research by universities and other groups.

GENERAL DESCRIPTION:

The Rachel Carson Estuarine Research Reserve is one of 4 North Carolina units of the National Estuarine Research Reserve system. The reserve is located inside Beaufort Inlet and thus is an intertidal area containing extensive sand and mud flats. Carrot Island forms most of the northern portion of the reserve. This natural island has had repeated deposition of dredge spoil from channel clearing operations in Taylor Creek. In addition, a band of wild horses roams the island, further adding to the unnatural disturbances at the reserve. On the other hand, the majority of the reserve is free from such impacts, including the extensive Middle Marshes at the eastern end of the reserve and Bird Shoal along the southern boundary.

The southern portion of the reserve consists of a rather narrow east-west trending sand spit that lies above the high tide zone. This spit is dominated by the Upper Beach community. Dominant species include sea rocket (Cakile edentula), saltwort (Salsola kali), salt-meadow cordgrass (Spartina patens), among other species. Also dominant are several rare species -- the State Candidate seabeach buckwheat (Polygonum glaucum) and the State "watch list" shoreline sea-purslane (Sesuvium portulacastrum). A small population of the Federal candidate (and State Threatened) plant seabeach amaranth (Amaranthus pumilus) is present on the spit.

The extensive intertidal flats are perhaps the most significant feature of the reserve. In addition to providing habitat for a wide array of invertebrates, it is a well known foraging area for thousand of waterbirds, especially shorebirds. For many years, the flats were one of the nation's

principal wintering habitats for the Federally Threatened piping plover (Charadrius melodus); however, the wintering population has declined precipitously in the last decade as a result of poor breeding success of the birds on the nesting grounds in Canada and the northern United States. Other notable bird species that forage on the flats are marbled godwits (Limosa fedoa) and an occasional long-billed curlew (Numenius americanus).

The reserve has relatively few nesting waterbirds, in part because of the high predator population, mainly foxes. Wilson's plovers (Charadrius wilsonia) breed there, and sporadically colonies of terns or skimmers will attempt to breed as well.

Other natural communities present include Salt Marsh, which comprises about 400 acres, Salt Flat, Maritime Wet Grassland, Maritime Dry Grassland, Dune Grass, Maritime Shrub, and Maritime Evergreen Forest. Most of these are limited in acreage and are better represented and more extensive on the barrier islands. The maritime forest is very restricted, and it occurs on dredged material east of Deep Creek. Live oak (Quercus virginiana), southern red cedar (Juniperus silicicola), and loblolly pine (Pinus taeda) are the dominants. The uncommon buckthorn bumelia (Bumelia lycioides) is present in this habitat. Other rare or uncommon plants of note at the reserve are moundlily yucca (Yucca gloriosa), aloe yucca (Yucca aloifolia), hammock swallow-wort (Cynanchum palustre), and Florida pellitory (Parietaria floridana).

Rare animal species present, in addition to those listed above, include several that are Federally listed. The peregrine falcon (Falco peregrinus) occurs in migration and winter; at least one bird spends the winter at the site. A loggerhead turtle (Caretta caretta) nested in 1990; this might be a fluke event, but the species is probably somewhat regular in the estuaries in the warmer months. Diamondback terrapins (Malaclemys terrapin), a Federal candidate, occurs in the area.

OWNERSHIP: State of North Carolina, with the management lead being the Division of Coastal Management of the Department of Environment, Health, and Natural Resources.

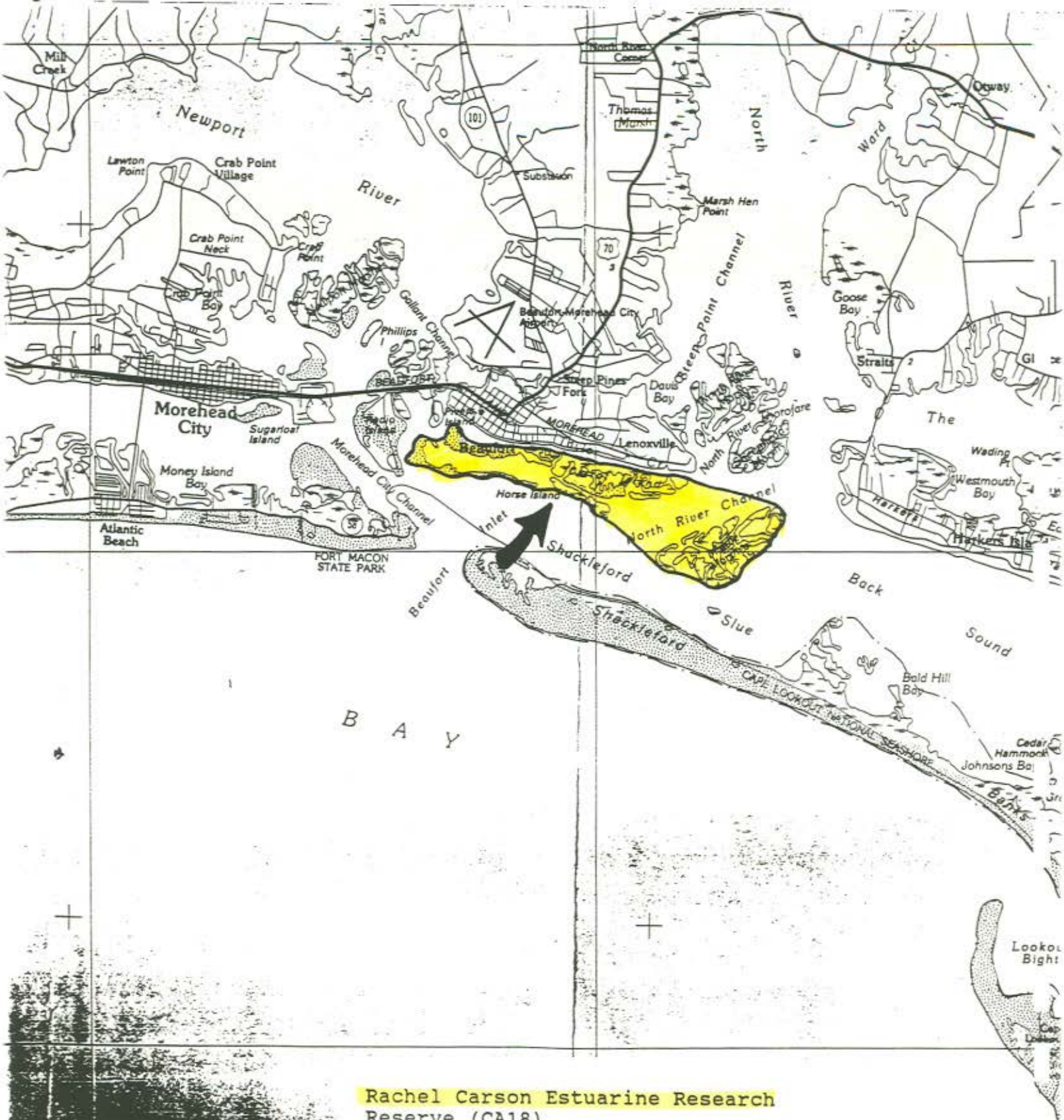
PROTECTION STATUS: The natural area is protected under regulations of the Federal Coastal Zone Management Act of 1972 as part of the National Estuarine Research Reserve system. In addition, the reserve is a Dedicated State Nature Preserve. Management of the reserve is provided by the N.C. Division of Coastal Management, with Duke University also having management responsibility.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: Though the reserve is fully protected, in terms of acquisition, there are many management needs. As mentioned above, the reserve is not entirely undisturbed. Much deposition of dredge material has occurred in recent decades. Fussell (1991a) indicates that predator control may be necessary on the reserve. If foxes and raccoons could be removed, Wilson's plovers, terns, skimmers, and other birds would likely have a much higher nesting success. Further disposal of dredged material, in the winter months, might be desirable to provide nesting substrate for such birds in the short term, but this increase in upland habitat might lead to an increase in mammalian predators in the long term. Fussell (1991a) believes that no further spoil deposition should take place on the southwestern corner of the reserve. This material has been eroded and transported eastward to the intertidal flats, elevating them above the normal

tidal range. Nests of plovers, terns, skimmers, and other ground nesting birds should be staked off to prevent human disturbance; this is particularly the case on the barrier spit. The impact of the feral horses has been a constant concern to biologists. The animals overgraze the marsh and grassland vegetation, and perhaps trample nests of birds. Public sentiment, for the most part, favors keeping some horses on the reserve, but from a biological standpoint all of the horses should be removed.

COMMENTS: There is a great need to understand the impacts of both the horses and dredge material disposal on the reserve. There is the concern that the flats could be impaired by the addition of dredge material nearby, because the material can be washed onto the flats and cause them to be elevated above the normal tidal range.

REFERENCES: Fussell and Wilson (1983), Taggart and Henderson (1988), U.S. Department of Commerce (1990), Fussell (1991a)



Rachel Carson Estuarine Research
Reserve (CA18)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: North River Marshes

SITE NUMBER: CA19 SIZE: about 1900 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The central portion of Carteret County; located on both the eastern and western shores of North River, from the vicinity of SR 1163 and SR 1300 on the north and extending southward to US 70 on the eastern shore and southward several miles past US 70 to Marsh Hen Point on the western shore.

QUAD MAPS: Core Creek, Williston

SIGNIFICANT FEATURES:

1. The natural area consists of extensive brackish and salt marshes and provides important nesting habitat for many marsh birds, including the rare black rail (Laterallus jamaicensis). The mudflats and estuaries are important nursery areas for shellfish and other aquatic organisms.
2. Portions of grazed areas contain pools of fresh to brackish water that are inhabited by shorebirds during migration and winter.

GENERAL DESCRIPTION:

The North River marshes consist of a number of microhabitats caused by small topographic variation. Along the margins of the river, smooth cordgrass (Spartina alterniflora) is the dominant species; however, as there is little flooding of these marshes by tidal water, the cordgrass is of small stature. Black needlerush (Juncus roemerianus) is the dominant species over most of the marshes. Shallow pools are scattered throughout the marshes. Salt pans, which are slightly elevated areas in the marshes, contain woody saltwort (Salicornia virginica) and other herbs. The margins of some drainage ditches in the marshes contain shrubs such as sea oxeye (Borrichia frutescens), waxmyrtle (Myrica cerifera), and groundsel-tree (Baccharis halimifolia).

North River Marshes is well known to birdwatchers, as there is a wide diversity of waterbirds at all seasons. Breeding species include the "significantly rare" black rail (Laterallus jamaicensis), the "significantly rare" black-necked stilt (Himantopus mexicanus), American black duck (Anas rubripes), least bittern (Ixobrychus exilis), and seaside sparrow (Ammodramus maritimus). Other notable birds that forage in the marshes and ponds include barn owl (Tyto alba), glossy ibis (Plegadis falcinellus), northern harrier (Circus cyaneus), and a wide array of herons and egrets. In migration and winter, a number of shorebirds that forage primarily in freshwater pools are found here that are rare elsewhere in Carteret County; these include long-billed dowitcher (Limnodromus scolopaceus) and stilt sandpiper (Tringa himantopus).

The Special Concern diamondback terrapin (Malaclemys terrapin) occurs in the natural area. The American alligator (Alligator mississippiensis) possibly occurs in the area but has not yet been reported.

OWNERSHIP: Various private ownership. A tract of about 40 acres is owned by a local wildlife club.

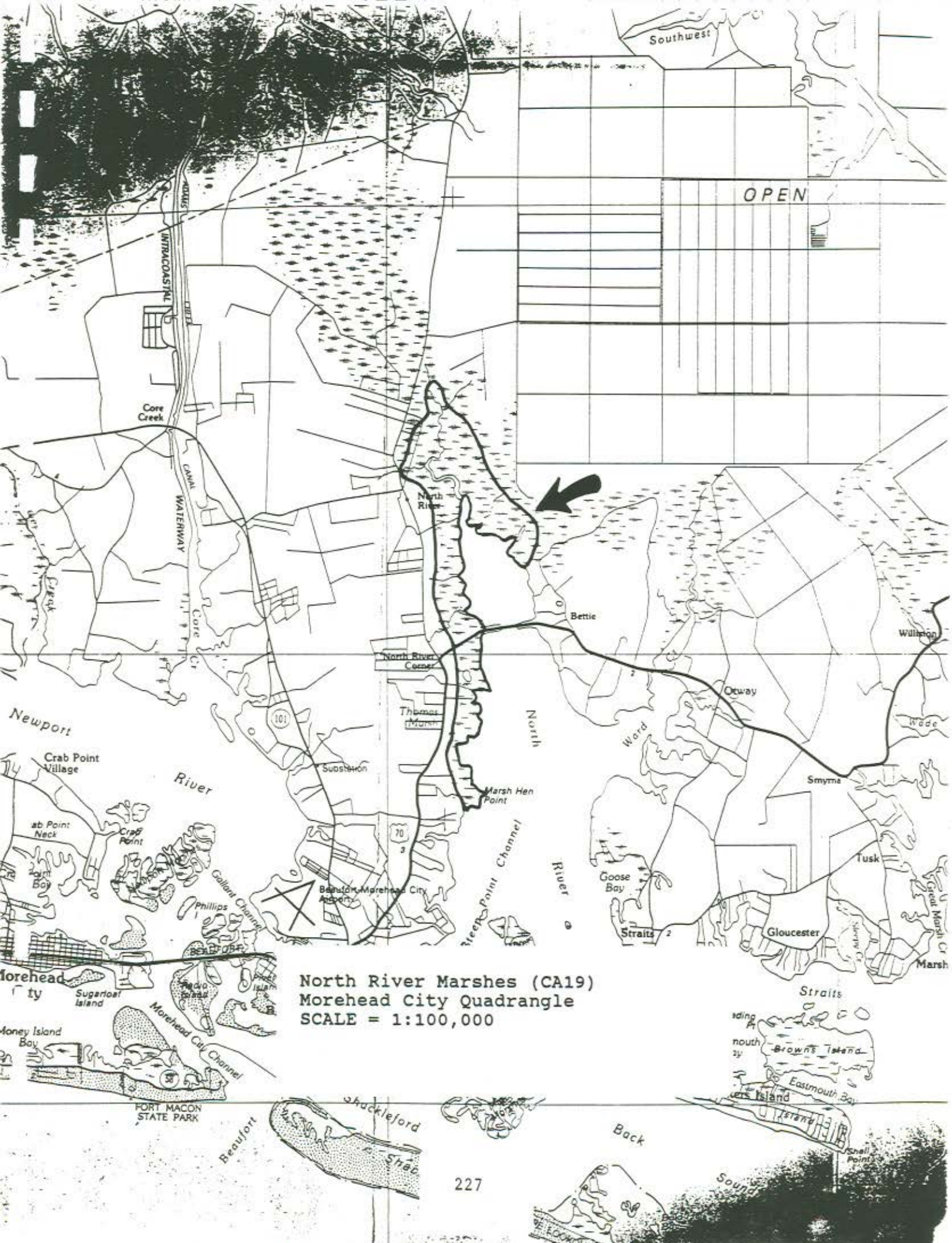
PROTECTION STATUS: Approximately 30 acres of the above 40-acre tract has been protected by the owners (Carteret County Wildife Club) by adding it to

the N.C. Registry of Natural Heritage Areas. The remainder of the marshes have no formal protection.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: There are a number of threats to the natural area. There has been some pollution of the river and estuary from the North River community just upstream along SR 1300. There are many mosquito control ditches that have been constructed through the natural area, and these have decreased the moisture of the marshes. Portions of the marshes south of US 70 are grazed by cattle. Actually, this grazing has been a benefit by creating a short-grass habitat for shorebirds that forage at the shallow pools among the grazed area. The natural area needs protection, as a number of birdwatching groups and other biologists have visited the area to study the animal and plant life of these marshes. Additional registry of properties with the N.C. Natural Heritage Program is one protection option. Some acquisition, such as by the N.C. Division of Coastal Management, may be necessary to provide long-term protection of the marshes.

COMMENTS: The birdlife of the marshes has been well studied by John Fussell for over 20 years. This is one of the more accessible places for visiting birdwatchers to see and hear the elusive black rail. This might be one of the few marshes in the state where grazing might be beneficial, as there are several bird species that forage in the grazed area that are rarely found elsewhere in the county on a regular basis. Fortunately, the grazing is limited to a portion of the marshes, south of the US 70 causeway.

REFERENCES: Fussell and Wilson (1983)



North River Marshes (CA19)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: Browns Island

SITE NUMBER: CA20 SIZE: about 690 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The southeastern portion of Carteret County; located just north of the eastern end of Harkers Island, with Core Sound on the east and The Straits on the north and west.

QUAD MAP: Harkers Island

SIGNIFICANT FEATURES:

1. The island contains one of the relatively few stands of Coastal Fringe Sandhill natural communities in the state in a relatively undisturbed situation. Such a community on an estuarine island is quite unusual.
2. The island contains salt marshes, pocosins, and a remnant maritime live oak forest.

GENERAL DESCRIPTION:

Browns Island is a fairly large estuarine island located near Cape Lookout; it consists of a series of beach ridges, separated by swales that are now marshes. The island apparently contained a moderate amount of live oak (Quercus virginiana) hammocks (Coastal Fringe Evergreen Forest natural community) at one time, based on the numerous stumps present. However, much of the island appears to be succeeding to a marsh, in part because of the slight rise in sea level.

The south side of Browns Island, and the swales between the ridges, consist of salt marshes. Black needlerush (Juncus roemerianus) and smooth cordgrass (Spartina alterniflora) dominate the marshes. A live oak hammock is present on a ridge surrounded by marsh; this tree is the only canopy species. The northern part of the island contains considerable uplands, most of which are dominated by live oak and longleaf pine (Pinus palustris). The southernmost dune ridge supports a rare combination of longleaf pine, live oak, and wiregrass (Aristida stricta). Another ridge to the north has more loblolly pine (P. taeda) than longleaf pine. This ridge also contains more laurel oak (Q. laurifolia) than live oak. A swale area to the southeast of this latter ridge is a low wooded area with elements of both maritime forest and pocosin. Typical species are loblolly-bay (Gordonia lasianthus), sweetbay (Magnolia virginiana), American holly (Ilex opaca), wild olive (Osmanthus americana), and other typical pocosin shrubs. Saline pools are present in low areas on the island, with the dominant aquatic herb being widgeon grass (Ruppia maritima).

Two homesites are present on the island, located in the maritime forest on the northwestern portion of the island. Interestingly, an uncommon plant species -- Florida pellitory (Parietaria floridana) -- grows on old brick chimney bases at the house. The island has had much disturbance in the past, some from selective timber cutting. There are still a number of domestic animals on the island, and grazing is a management concern.

In addition to the pellitory, a handful of other rare or uncommon species are present. Salt marsh gerardia (Agalinis maritima) and creeping marsh purslane (Ludwigia repens) grow in wetlands. Many Special Concern bird species forage in the marshes and nearby waters, such as brown pelican (Pelecanus occidentalis), glossy ibis (Plegadis falcinellus), and black

skimmer (Rynchops niger); however, the island is not known to contain breeding sites for these birds.

OWNERSHIP: The island is owned by a single family, and it is divided into a number of parcels with separate ownerships within this family.

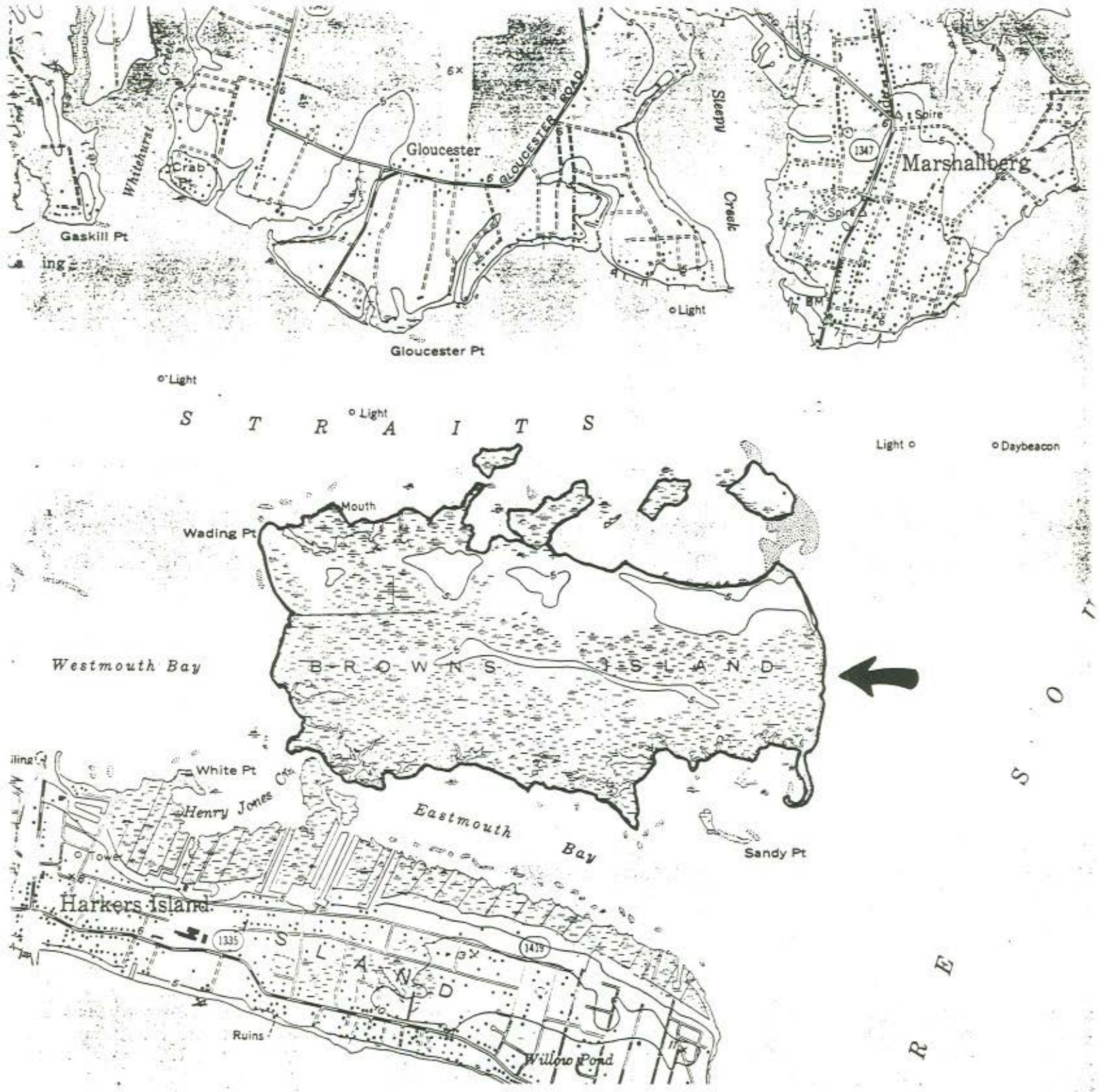
PROTECTION STATUS: None

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: Much of the island is proposed for development, with lots being available for sale. At present, there appears to be no development except for the several homesites located at one corner of the island. Of course, any further development of the island would damage the natural character of it. The biggest present management concern is the potential damage done to the vegetation by the horses, sheep, and hogs that are grazing on the island. These animals should be removed from the island so that the island can recover its natural vegetation. Loss of the maritime forests to rising sea level and storm overwash is a natural process that will continue.

The best protection would be acquisition for a nature preserve or research study area. The island would be a suitable estuarine research reserve acquisition project for the N.C. Division of Coastal Management.

COMMENTS: The island has had some poaching of animals in recent history, particularly of deer that were released on the island. Even cattle had been poached. It is rather surprising that, in this day and age, the island is still relatively free of development, but it should be considered a critical area for protection with high threats.

REFERENCES: Fussell and Wilson (1983), N.C. Natural Heritage Program database



Browns Island (CA20)
Harkers Island Quadrangle
SCALE = 1:24,000

SITE NAME: Piney Island

SITE NUMBER: CA21 SIZE: about 12,500 acres

SITE SIGNIFICANCE: B (State)

LOCATION: Northeastern portion of Carteret County; located at the southwestern end of Pamlico Sound, with the mouth of the Neuse River on the north. A canal at Stump Bay forms the southern boundary of Piney Island.

QUAD MAPS: Point of Marsh, Long Bay

SIGNIFICANT FEATURES:

1. The natural area contains extensive brackish marshes, which burn frequently as a result of flares accidently set off by military manouvers. These fires simulate the natural fires started by lightning strikes and help to keep the plant and animal diversity quite high.
2. The marshes have one of the largest breeding populations of black rails (Laterallus jamaicensis) in both North Carolina and the United States. This species is considered "significantly rare" in the state. Also occurring in the marshes and considered "significantly rare" in North Carolina are northern harrier (Circus cyaneus) and black-necked stilt (Himantopus mexicanus).

GENERAL DESCRIPTION:

Piney Island is a large peninsula of over 12,000 acres in northeastern Carteret County. It contains mostly a Brackish Marsh natural community, dominated by black needlerush (Juncus roemerianus) and salt-meadow cordgrass (Spartina patens). Sawgrass (Cladium jamaicense) and switch grass (Panicum virgatum) are also locally common in the marsh. The U.S. Navy owns the land and uses the island as a bombing range. Canals, dikes, roads, and target areas are scattered over the central portions of the island, and numerous bomb craters and vehicle tracks are scattered through the marsh. The bomb craters and the frequent fire in the marsh resulting from flares tend to benefit the marsh and its inhabitants. The craters open up "potholes" in the marsh; these open water areas are likely used by waterfowl for foraging. The frequent fires tend to keep invading shrubs to a minimum and keep a higher diversity of plants present than would normally occur in a marsh unburned for decades. Portions of the natural area are dominated by shrubs -- primarily waxmyrtle (Myrica cerifera) and groundsel-tree (Baccharis halimifolia); this is either a Salt Shrub natural community or a successional stage of Estuarine Fringe Loblolly Pine Forest natural community. There is a small remnant of pocosin in the southern part of the natural area, with pond pine (Pinus serotina) dominant, along with a mix of various shrubs.

The marshes are very significant for their breeding bird populations. Approximately 7 black rails (Laterallus jamaicensis) were heard calling on the survey during June 1990, and it is believed that the nesting population of the rails is as high as, or higher than, the well known population at nearby Cedar Island (Site CA23). Most of the island contains suitable habitat for this poorly known and highly secretive bird, but the survey was done only from a road in the central portion of the natural area. Also noted on the survey were at least 4 northern harriers (Circus cyaneus), one of which was an adult male. This hawk probably nests in the marshes. Two black-necked stilts (Himantopus mexicanus) were seen at a pool in the marsh and were probably

nesting. These 3 species are considered "significantly rare" in the state. A flock of 50 glossy ibises (Plegadis falcinellus) was noted in the marsh; this State Special Concern bird nests on small islands near Cedar Island, but it forages at Piney Island. Large populations of Virginia rails (Rallus limicola) and seaside sparrows (Ammospiza maritima) also nest in the marshes. Although not noted on the survey, the Carolina salt marsh snake (Nerodia sipedon williamengelsi) and the American bittern (Botaurus lentiginosus) are expected to breed at Piney Island. The former is Special Concern in the state; the latter is considered "significantly rare".

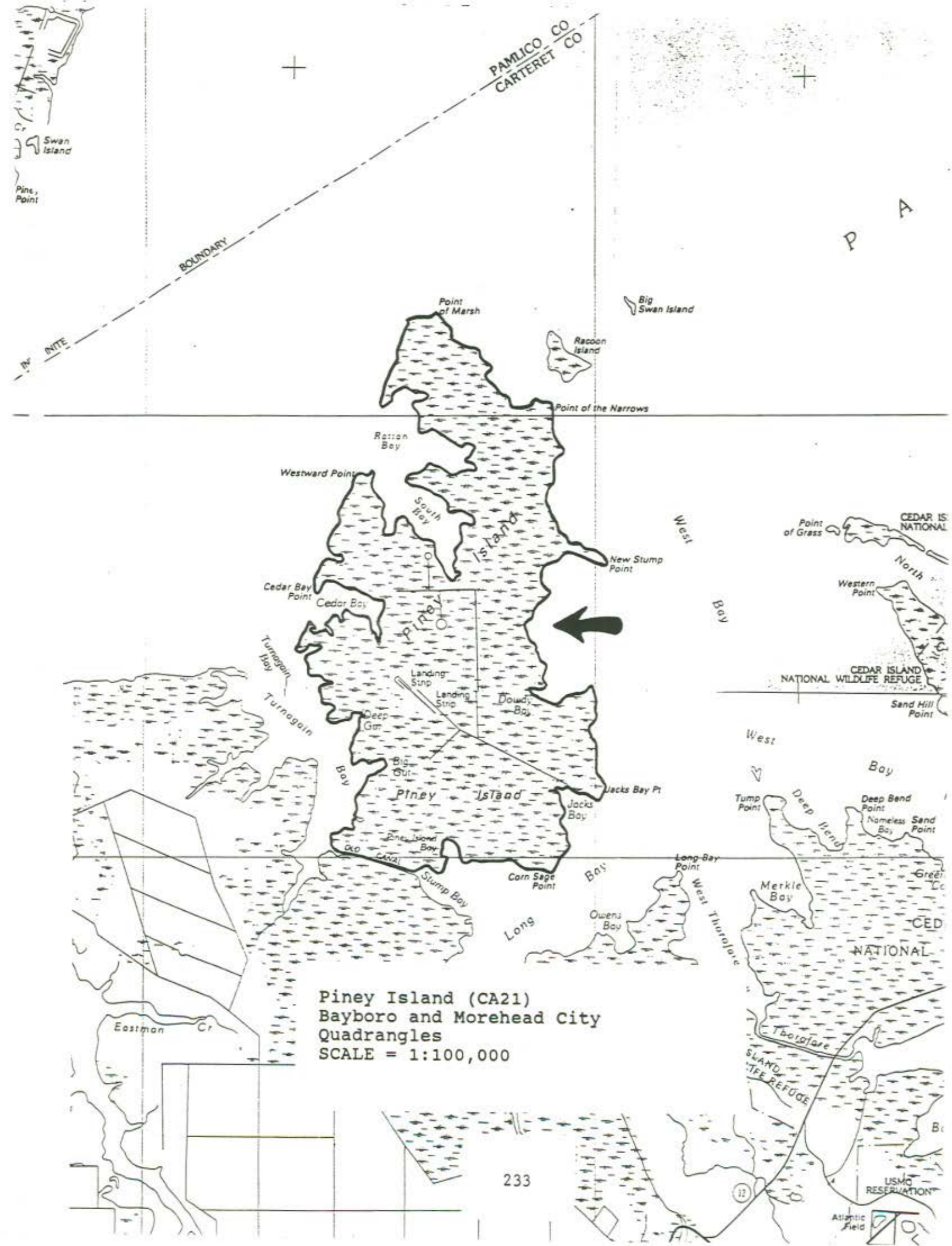
OWNERSHIP: U.S. Navy. The site is used as a bombing range.

PROTECTION STATUS: None

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: Protection for the natural area is best done as a registry through the N.C. Natural Heritage Program. The fires and crater potholes perhaps benefit wildlife. However, there should be a minimum of vehicular traffic in the marshes, as such traffic is presumably detrimental to the plant and animal populations. Any additional facilities added to the bombing range, such as roads, canals, and targets, would also be detrimental.

COMMENTS: Additional survey work at this site is certainly warranted. The marshes appear to be a highly significant site for breeding by marshbirds in North Carolina, with one of the densest populations of black rails known from anywhere in the species' range. The marshes and pools are likely to be used heavily by waterfowl during the winter and by black ducks (Anas rubripes) for breeding.

REFERENCES: Fussell (1990a)



Piney Island (CA21)
Bayboro and Morehead City
Quadrangles
SCALE = 1:100,000

SITE NAME: Atlantic Natural Area

SITE NUMBER: CA22 SIZE: about 6700 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The extreme eastern portion of Carteret County; located both north and south of NC 12, extending from The Thorofare (Cedar Island) on the north nearly to US 70 and Nelson Bay on the south. The area extends east to Core Sound and west of NC 12 for over a mile.

QUAD MAPS: Atlantic, Long Bay

SIGNIFICANT FEATURES:

1. This extensive natural area contains many pristine Carolina bays. In addition, relict beach ridge systems are present in linear northeast-southwest bands.
2. The natural communities are varied, ranging from pocosins in the Carolina bays, to longleaf pine (Pinus palustris) communities on the sand ridges, to brackish marshes along the outer margins.
3. The natural area contains several populations of sand-myrtle (Leiophyllum buxifolium); this evergreen heath species is disjunct from elsewhere in the state, where it ranges east to the Wilmington area.

GENERAL DESCRIPTION:

The landscape in eastern Carteret County northwest of the town of Atlantic consists of a scattering of Carolina bays and old former beach ridges, in addition to marshes fringing the coastline. The bays extend in a northwest-southeast band, bisected by the highway; each bay is aligned in a northwest-southeast manner. The beach ridges are very low and barely discernable on the ground. Longleaf pine (Pinus palustris) is the primary canopy tree on the ridges. The understory is sparse, but shrubs are common, mostly ericaceous species such as dangleberry (Gaylussacia frondosa). Some of these areas dominated by longleaf pine -- the Wet Pine Flatwoods natural community -- feature a diverse ground cover of herbs. Wiregrass (Aristida stricta) is locally common.

The Carolina bays contain pocosin vegetation, with pond pine (P. serotina) the dominant tree. The marshes are dominated by black needlerush (Juncus roemerianus) for the most part. The saltier areas toward Core Sound are dominated by smooth cordgrass (Spartina alterniflora), whereas the fresher areas along the inland borders of the marshes are dominated by sawgrass (Cladium jamaicense) and broadleaf cattail (Typha latifolia). One unusual area near Hall Point, called The Hammock, contains longleaf pine surrounded by salt marsh. The eastern tip of The Hammock contains a small mainland maritime forest -- a Coastal Fringe Evergreen Forest natural community. Live oak (Quercus virginiana) dominates the canopy of this forest.

The natural area has a wide array of rare or uncommon plants and animals. Though not State listed, sand-myrtle (Leiophyllum buxifolium) is disjunct from the rest of its range in the Coastal Plain, being found no farther east than the Wilmington area, except in this natural area. Other notable shrubs are dwarf witch-alder (Fothergilla gardenii) and leatherleaf (Cassandra calyculata). Notable herbs include the "significantly rare" branched gerardia (Agalinis virgata), as well as the pine barren gentian (Gentiana autumnalis), blue butterwort (Pinguicula caerulea), 2 species of pitcherplants (Sarracenia

spp.), and bearded grass-pink (Calopogon barbatus). A very small population of seabeach amaranth (Amaranthus pumilus), a Federal candidate beach plant, occurs in this area.

A large variety of animal species is present. Rare ones include American alligator (Alligator mississippiensis), black bear (Ursus americanus), and presumably black rail (Laterallus jamaicensis). There are former records of red-cockaded woodpecker (Picoides borealis) and Bachman's sparrow (Aimophila aestivalis) in nearby pinewoods, but they have yet to be found on the natural area.

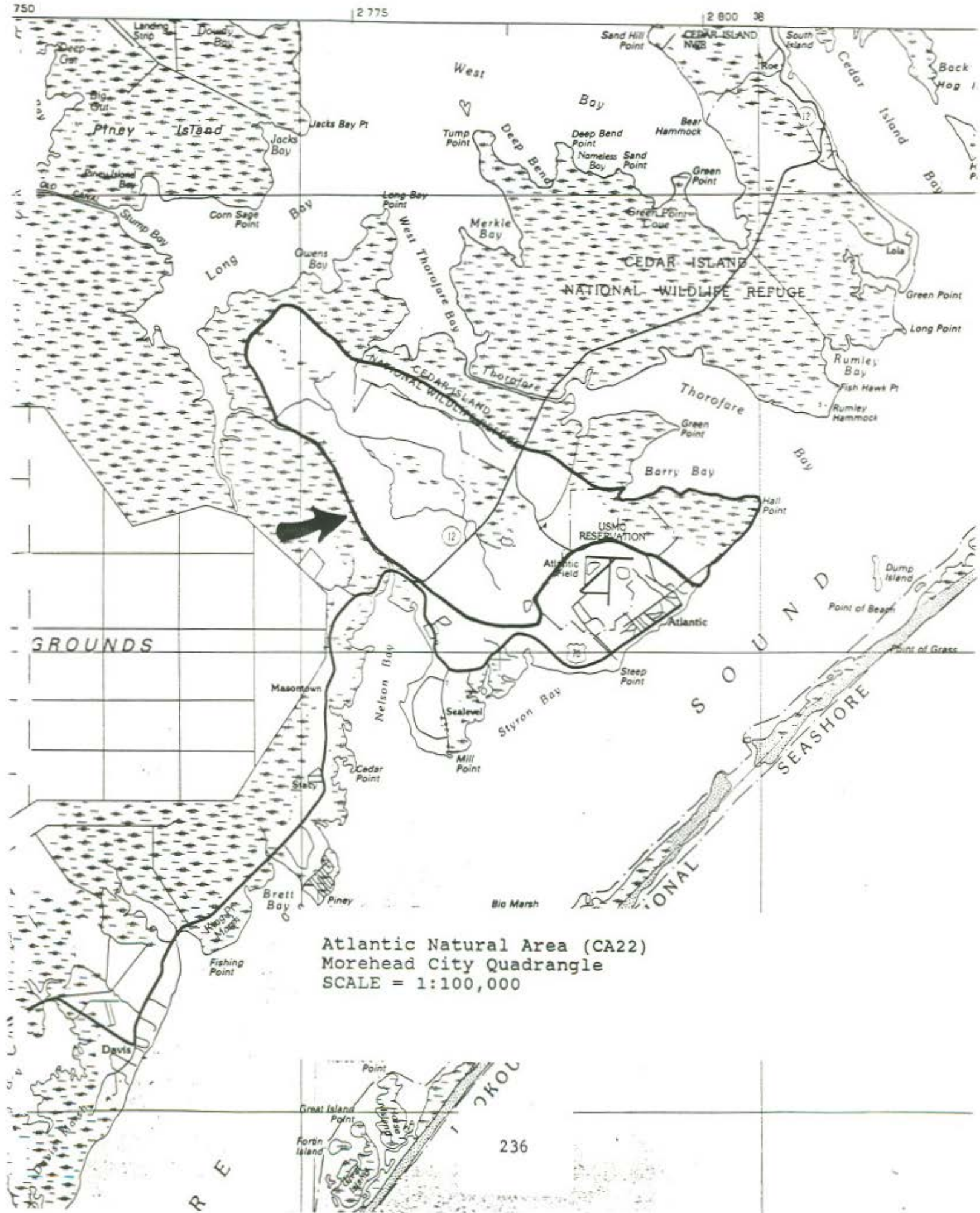
OWNERSHIP: About half of the natural area is owned by the U.S. Fish and Wildlife Service -- Cedar Island National Wildlife Refuge. Other portions are owned by the U.S. Marine Corps (Atlantic Field), Duke University, and perhaps one or two other owners. The refuge property incorporates the majority of the northern half of the area.

PROTECTION STATUS: The Cedar Island National Wildlife Refuge is protected according to U.S. Fish and Wildlife Service regulations. None of this portion of the refuge is a Registered Natural Heritage Area. A total of 2061 acres, all east of NC 12, was transferred to the refuge in 1991 as a gift of the Bayland Corporation. The Atlantic Field and private tracts are not protected.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The longleaf pine portions of the natural area definitely need prescribed burns every few years to restore the natural fire regime. Fire keeps the shrubs from encroaching and promotes a higher diversity of herbs. It is not certain how fire would affect the sand-myrtle, as it is a shrub. However, because it is a rather low-growing species, reaching about 3 feet tall, the long absence of fire would lead to its elimination by shading from taller species. Fire in the marshes and Carolina bays are also recommended, at least once every 10 years. Additional acquisition is needed by the U.S. Fish and Wildlife Service, to add more lands to the west and south. Unless additional properties are acquired, development along NC 12 and SR 1387 will make it more difficult to control burning of the refuge. The Marine Corps owns over 600 acres of relatively undisturbed land on the north side of SR 1387. It is important that this property not be developed, but whether this land can be traded or sold by the Marine Corps to the U.S. Fish and Wildlife Service is not known. This property separates refuge property on the west from an isolated tract (containing The Hammock) on the east; both of these tracts were recently acquired from the Bayland Corporation.

COMMENTS: It is gratifying to see this refuge expanding onto the mainland, to incorporate and protect additional longleaf pine lands. The Nature Conservancy assisted in this transfer of the 2061 acres to the refuge. It is hoped that continued acquisitions on the mainland can be obtained.

REFERENCES: Fussell and Wilson (1983), Fussell (1991c)



Atlantic Natural Area (CA22)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: Cedar Island Marshes

SITE NUMBER: CA23 SIZE: about 7000 acres

SITE SIGNIFICANCE: A (National)

LOCATION: Extreme eastern portion of Carteret County; located on, and occupying nearly all of, Cedar Island. The marshes occur both southeast and northwest of NC 12.

QUAD MAPS: Atlantic, Long Bay

SIGNIFICANT FEATURES:

1. This extremely large extent of essentially unaltered marsh, except for NC 12 running down the middle, is one of the most significant brackish/irregularly flooded salt marshes along the Atlantic coast.
2. The marshes contain perhaps the largest known population of the secretive black rail (Laterallus jamaicensis) in the world. Many other rare or uncommon animals are present, including the northern harrier (Circus cyaneus), American bittern (Botaurus lentiginosus), and Carolina water snake (Nerodia sipedon williamengelsi).

GENERAL DESCRIPTION:

The northeastern portion of Carteret County contains thousands of acres of salt and brackish marshes. Cedar Island itself is composed primarily of marshes. These marshes extend onto the mainland, especially along the northern margin of the county bordering the lower Neuse River. Except for the fact that NC 12 and adjacent canals bisect the marshes at Cedar Island, the marshes on that island are essentially unaltered by mosquito ditches and other canals. The marshes contain scattered small ponds; some are presumably natural, whereas others have been blasted by stray bombs from military maneuvers.

The dominant plants in the marshes, which are essentially treeless, are black needlerush (Juncus roemerianus) and salt-meadow cordgrass (Spartina patens), but smooth cordgrass (S. alterniflora), big cordgrass (S. cynosuroides), and switch grass (Panicum virgatum) are common in certain parts of the marshes. The marshes southeast of NC 12 are more brackish than the relative "fresh" marshes northwest of the highway. Small ponds are common in this southeastern area, with widgeon grass (Ruppia maritima) being common in the ponds. Farther northwestward, toward NC 12, smooth cordgrass, which is present mainly southeast of the highway, grades into black needlerush and salt-meadow cordgrass. These latter 2 species continue to dominate the marsh past NC 12 to the northwest, though big cordgrass may be locally dominant. In the center of the marsh northwest of the road, some shrubs are present, presumably on slightly higher or drier ground; these are mainly big-leaf marsh-elder (Iva frutescens) and groundsel-tree (Baccharis halimifolia). Pure stands of black needlerush occur toward the mainland near The Thorofare and near John Day Ditch in the northeastern portion of the marsh.

Cedar Island marshes are one of the premier nesting habitats for marshbirds along the Atlantic coast. The black rail (Laterallus jamaicensis), a Federal candidate bird that is considered "significantly rare" in the state, is abundant in the marshes. Counts of over 80 calling birds have been made in the summer, just from NC 12, indicating that these marshes, along with the Elliott Island marshes in Maryland, support what are probably the largest

breeding populations of this rail in the world. The northern harrier (Circus cyaneus), also "significantly rare" in the state as a breeder, is present in summer and presumably nests; the secretive American bittern (Botaurus lentiginosus), another "significantly rare" bird species, is also presumed to nest. The marshes are home to large breeding populations of other rails, including Virginia (Rallus limicola), clapper (R. longirostris), and king (R. elegans). Other breeding birds include American black duck (Anas rubripes), marsh wren (Cistothorus palustris), and seaside sparrow (Ammodramus maritimus). Many waterfowl species, herons and egrets, and other birds forage in the marshes and ponds during the year.

Two species of reptiles that occur in the marshes are considered of Special Concern -- the Carolina water snake (Nerodia sipedon williamengelsi) and the diamondback terrapin (Malaclemys terrapin). Also, a number of frog species are present in the marshes.

OWNERSHIP: The entire area is owned by the U.S. Fish and Wildlife Service -- Cedar Island National Wildlife Refuge.

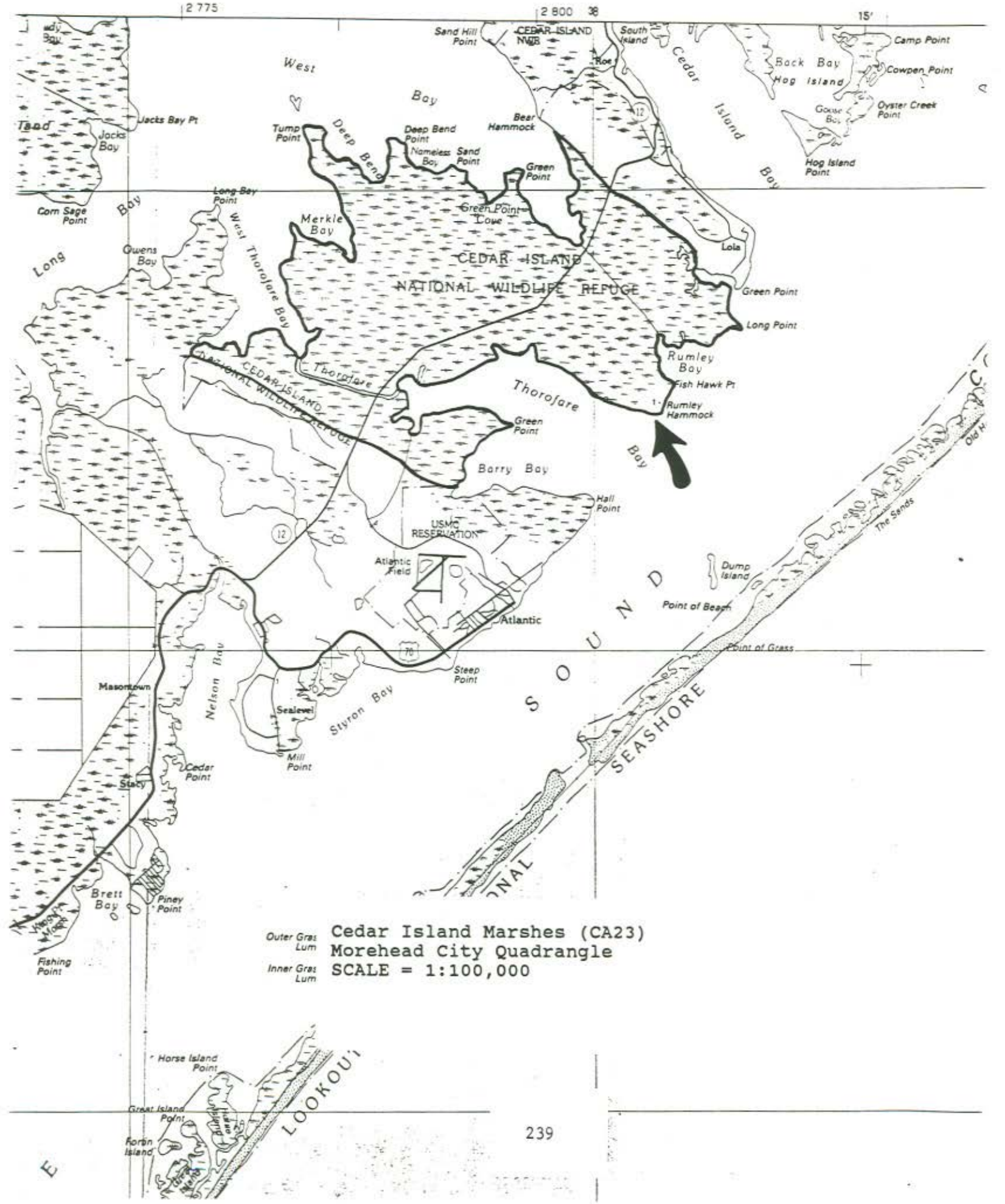
PROTECTION STATUS: The refuge is protected under regulations of the U.S. Fish and Wildlife Service. About 40% of the natural area, generally southeast of NC 12, has additional protection by being on the Registry of Natural Heritage Areas, by a signed agreement with the N.C. Natural Heritage Program.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: One management and protection concern for over a decade has been a proposal by the Service to construct one to several large waterfowl impoundments on the northwest side of NC 12, which would destroy a few thousand acres of marshes. At present, such plans have been put on hold, and it is probably unlikely that the impoundments will be built. However, the refuge staff is planning to construct a handful of small "potholes" in the marshes to provide more foraging habitat for waterfowl.

The marshes should be burned every few years, though only portions at a time should be burned as opposed to burning the entire marsh at once. This will keep a higher plant diversity present and will keep black needlerush from dominating. Monitoring should be done to see if common reed (Phragmites communis) has invaded the marshes; this noxious weed is nearly impossible to eradicate once it takes a foothold in marshes.

COMMENTS: There has been considerable study of the birdlife of the marshes. Additional field work is needed along the fringes of the marshes, as most work has been along NC 12.

REFERENCES: Fussell and Wilson (1983)



Cedar Island Marshes (CA23)
Morehead City Quadrangle
SCALE = 1:100,000

SITE NAME: Cedar Island Flatwoods and Bays

SITE NUMBER: CA24 SIZE: about 2900 acres

SITE SIGNIFICANCE: C (Regional)

LOCATION: The extreme eastern portion of Carteret County, on Cedar Island; located along the northeastern portion of the island, with North Bay and Cedar Island Bay forming the northern boundary, and West Bay and extensive marshes forming the southern boundary.

QUAD MAPS: Atlantic, North Bay

SIGNIFICANT FEATURES:

1. The natural area features a number of Carolina bays in a relatively undisturbed condition.
2. The area contains good examples of maritime-influenced longleaf pine (Pinus palustris) natural communities, including both flatwoods and sandy uplands.

GENERAL DESCRIPTION:

The eastern portion of Carteret County contains a surprising number of Carolina bays. Such geomorphic features are rather infrequent near the coastline of North Carolina. The landscape in which these bays are located on Cedar Island is, for the most part, sandy, and it features the Coastal Fringe Sandhill natural community, which is relatively uncommon and has been severely impacted elsewhere in North Carolina.

The series of Carolina bays extends in a northwest to southeast fashion from the vicinity of Western Point to the community of Lola. The bays contain fairly typical pocosin vegetation, consisting mainly of the Pond Pine Woodland natural community, though grading to Bay Forest community in places. Pond pine (Pinus serotina) is common in the canopy; loblolly-bay (Gordonia lasianthus) and red maple (Acer rubrum) are also numerous. In the shrub and understory layers are redbay (Persea borbonia), fetterbush (Lyonia lucida), and sweet gallberry (Ilex coriacea), among other species. Of more interest to ecologists are the communities away from the bays. The drier areas are Coastal Fringe Sandhills. Longleaf pine (P. palustris) is common, though the ubiquitous loblolly pine (P. taeda) is also found. The understory is dominated by laurel oak (Quercus laurifolia), which is generally stunted here. Live oak (Q. virginiana) is often present as well, and bluejack oak (Q. incana) occurs in the driest places. Shrubs include wild olive (Osmanthus americanus), waxmyrtle (Myrica cerifera), and dangleberry (Gaylussacia frondosa). Yaupon (Ilex vomitoria), typically a maritime species, is present also. Wiregrass (Aristida stricta) is present in the herb layer.

Some of the "uplands" are actually flatwoods, generally representing the Wet Pine Flatwoods natural community. Pond pine or loblolly pine dominate the canopy. The understory includes some redbay and red maple, but the shrub layer is dense. Fetterbush dominates the shrub layer; creeping blueberry (Vaccinium crassifolium) is also present. A few individuals of Carolina laurel-cherry (Prunus caroliniana), near the northern end of the range, are present in this community.

The animal life of this area is apparently not well known. The uncommon Swainson's warbler (Limnothlypis swainsonii) breeds in the Carolina bays, and

the black-throated green warbler (Dendroica virens) breeds in the area, as well.

OWNERSHIP: Almost entirely within Cedar Island National Wildlife Refuge, which is administered by the U.S. Fish and Wildlife Service.

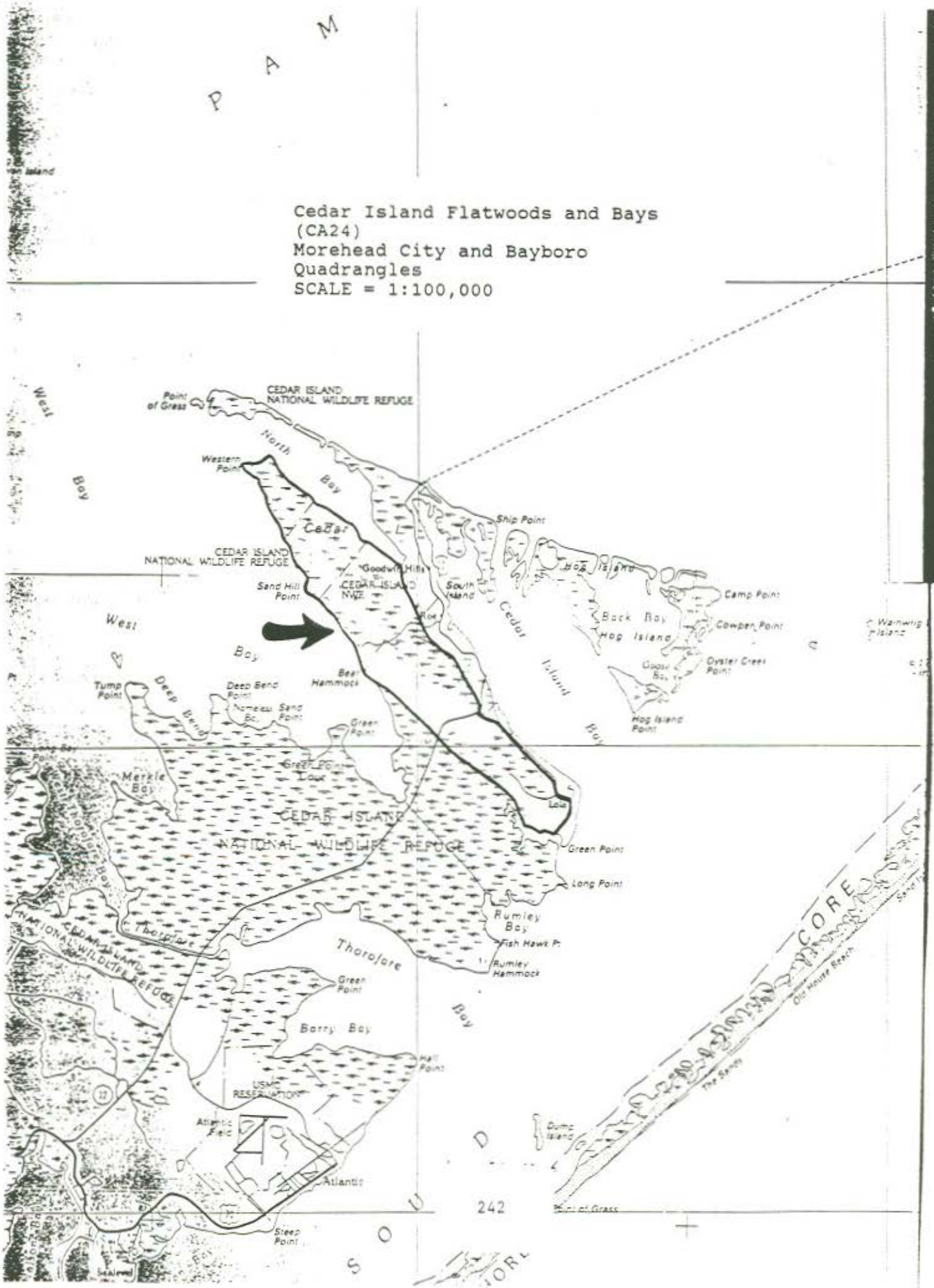
PROTECTION STATUS: The refuge is protected under regulations of the U.S. Fish and Wildlife Service. In addition, the natural area has been added to the N.C. Registry of Natural Heritage Areas (in 1980).

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The natural area is already protected, and relatively little management is needed. It is recommended that the area be burned periodically, perhaps every 5 to 10 years, so that vegetation in the upland pine forests does not become too thick. Natural lightning-strike fires during pre-settlement days presumably burned areas such as this, and prescribed burns are suggested to restore such conditions.

COMMENTS: There appear to be no known endangered or threatened species in the area. However, it is likely like detailed botanical field work has not been done, particularly along the ecotone between the bays and the uplands, where such rare species would be most likely to occur.

REFERENCES: Schafale (1988), N.C. Natural Heritage Program database

Cedar Island Flatwoods and Bays
(CA24)
Morehead City and Bayboro
Quadrangles
SCALE = 1:100,000



SITE NAME: Cedar Island/North Bay Barrier Strand

SITE NUMBER: CA25 SIZE: about 425 acres

SITE SIGNIFICANCE: B (State)

LOCATION: Extreme northeastern portion of Carteret County; located at the northern end of Cedar Island, bounded on the north by Pamlico Sound and on the south by marshes and several small bays, including North Bay.

QUAD MAPS: North Bay, Wainwright Island

SIGNIFICANT FEATURES:

1. The natural area features the best (and practically only) example of an estuarine barrier island system in North Carolina. It contains essentially the same geomorphic and vegetative features that are found on the marine barrier islands that form the coastline of the state.
2. The natural area supports a large number of bird species during the year. A number of rare animal species occur on the barrier strand, though most are occasional visitors.

GENERAL DESCRIPTION:

This natural area features a very low and narrow barrier island system, but instead of fronting the Atlantic Ocean, it fronts Pamlico Sound. The strand features a low dune system that is about 7 miles long and 300 feet wide. Several inlets break the strand. The dunes are low (mostly less than 10 feet high), with varying amounts of vegetation cover. Pockets of shrub thickets are present, but there is no Maritime Forest community.

Of considerable interest is the presence of several acres of Coastal Fringe Sandhill community, just northwest of the Cedar Island ferry terminal. Longleaf pine (Pinus palustris) and live oak (Quercus virginiana) are common in the canopy. On the back side of the strand are patches of Maritime Shrub. The vegetation is similar to those thickets on ocean barrier islands, plus the shrubs also show the wind and salt-spray sheared growth form visible on those present on ocean beaches. Live oak, yaupon (Ilex vomitoria), and waxmyrtle (Myrica cerifera) are the dominant species on the strand. Other natural communities present are Upper Beach, Dune Grass, Maritime Dry Grassland, and Maritime Wet Grassland. Brackish Marsh and Salt Marsh are found immediately behind the barrier island. Some of the more notable plants on this estuarine strand include slender sea-purslane (Sesuvium maritimum), saltmarsh sandspurry (Spergularia marina), pineland scaly-pink (Stipulicida setacea), and Beaudette's shoalweed (Halodule beaudettei). The last plant, a submerged aquatic species, is "significantly rare" in North Carolina, whereas the other three grow on the sand or tidal flats.

A number of rare animal species are present at the natural area. Both the loggerhead turtle (Caretta caretta) and the green turtle (Chelonia mydas) -- both Federally Threatened -- occur in Pamlico Sound and have been found dead on the beach, but no nesting has yet been reported. The State Special Concern diamondback terrapin (Malaclemys terrapin) and Carolina water snake (Nerodia sipedon williamengelsi) occur in the estuaries. In the nonbreeding season, both the bald eagle (Haliaeetus leucocephalus) and the peregrine falcon (Falco peregrinus) -- each Federally Endangered -- occur at the natural area. Some uncommon bird species sporadically nest on the beaches and dunes, including

gull-billed tern (Sterna nilotica), least tern (Sterna albifrons), black skimmer (Rynchops niger), and Wilson's plover (Charadrius wilsonia).

OWNERSHIP: The western 1.5 to 2 miles is owned by the U.S. Fish and Wildlife Service as part of the Cedar Island National Wildlife Refuge. The State of North Carolina owns some land near the ferry terminal, but the majority of the natural area is believed to be in private ownership.

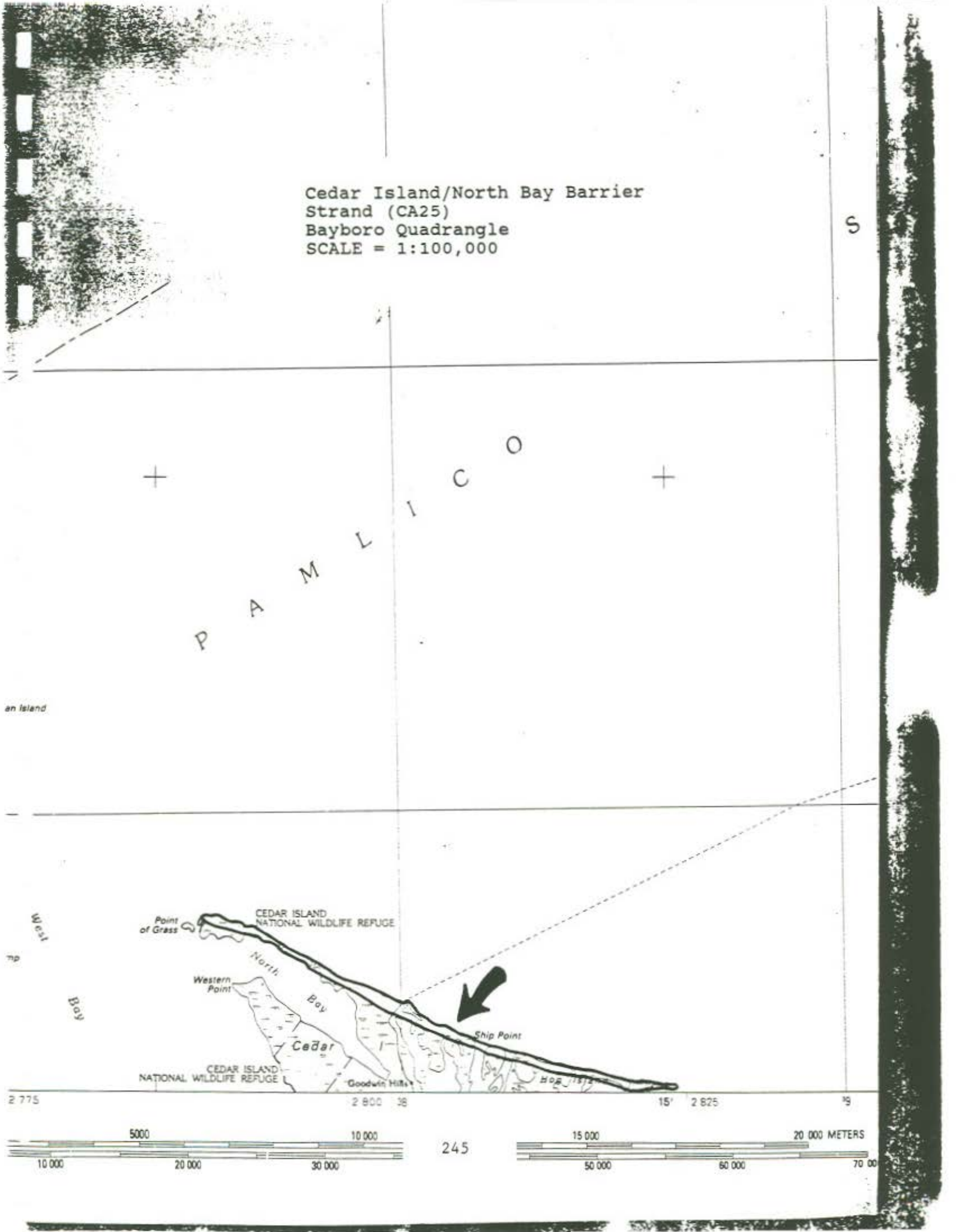
PROTECTION STATUS: That portion of the natural area under U.S. Government ownership, from Sandy Landing westward, is protected according to U.S. Fish and Wildlife Service regulations. This same portion of the natural area is a Registered Natural Heritage Area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The biggest threat to the natural area is the continued construction of cottages on the strand northwest of the ferry terminal. It would be desirable for the U.S. Fish and Wildlife Service to acquire the undeveloped land between their current boundary and the last cottage, which is approximately a 1/2-mile stretch of barrier island. This agency should also investigate the possible acquisition of the barrier strand, and the associated marshes behind it, that lies to the east of the ferry terminal.

COMMENTS: This natural area, though not containing a spectacular series of dunes, and not a key habitat for any single rare species, is nonetheless a unique site in the state. It replicates the beach processes that occur along the ocean front, even in the movement of inlets, at a smaller scale; however, it is essentially the only such system in the state in an estuarine situation.

REFERENCES: Fussell et al. (1990)

Cedar Island/North Bay Barrier
Strand (CA25)
Bayboro Quadrangle
SCALE = 1:100,000



SITE NAME: Great Lake/Pond Pine Wilderness Natural Area

SITE NUMBER: CR11 SIZE: about 5100 acres

SITE SIGNIFICANCE: B (State)

LOCATION: The extreme southern portion of Craven County and adjacent Jones and Carteret counties. The site includes Great Lake, a swamp forest on the southern shore of the lake, and the Pond Pine Wilderness, located along the eastern edge of Forest Service Road 126, in Croatan National Forest.

QUAD MAPS: Hadnot Creek, Catfish Lake

SIGNIFICANT FEATURES:

1. The natural area contains one of the more mature stands of nonriverine swamp forest in the state; it is dominated by sweetgum (Liquidambar styraciflua).
2. Great Lake is the largest natural lake in the Croatan region and is surrounded by extensive and essentially undisturbed forests.
3. The lake and surrounding forests provide habitat for a number of rare plants and animals, including the American alligator (Alligator mississippiensis), black bear (Ursus americanus), spoonflower (Peltandra sagittifolia), and southern twayblade (Listera australis).

GENERAL DESCRIPTION:

Great Lake is the largest of the 5 natural lakes in the Croatan region of the North Carolina Coastal Plain. All of these lakes are believed to have formed from the burning of peat and subsequent filling by precipitation and ground water. Great Lake, with a surface area of approximately 2600 acres, drains pocosins and swamps to the north, with the water in the lake flowing southward through a swamp and into Hunters Creek, which flows into the White Oak River. The lake itself is rather sterile of plant or animal life, with the predominant plant at the lake being a narrow band of maiden-cane (Panicum hemitomon) bordering the shoreline.

The southern (and eastern) shores of Great Lake support a Nonriverine Swamp Forest natural community. Near the shore there is a narrow natural levee, and beyond it a broad and low terrace. The forest is dominated by sweetgum (Liquidambar styraciflua) in the canopy, with redbay (Persea borbonia) the dominant understory tree and giant cane (Arundinaria gigantea) the most numerous "shrub". Bald cypress (Taxodium distichum) is relatively uncommon, and swamp tupelo (Nyssa biflora), often common in such nonriverine swamps, is present mainly in the southern portion of the natural area. Other common understory trees in the area are sweetleaf (Symplocos tinctoria) and loblolly-bay (Gordonia lasianthus).

The Pond Pine Wilderness contains various pocosin communities. A study by Snyder (1977) found that the "short pocosin" is dominated by honey-cup (Zenobia pulverulenta), titi (Cyrilla racemiflora), inkberry (Ilex glabra), and fetterbush (Lyonia lucida). The "tall pocosin" is dominated by fetterbush, redbay, titi, inkberry, and sweet gallberry (Ilex coriacea). Pond pine (Pinus serotina) is present as a canopy tree throughout the area, but the "short pocosin" has a lower height of the evergreen understory than does the "tall pocosin". In the more open areas, leatherleaf (Cassandra calyculata) is common but inconspicuous, and pitcherplants (Sarracenia flava and S. purpurea) are also found.

Several rare plants are present. Spoonflower (Peltandra sagittifolia) occurs in the wilderness area and has been reported from the rim of the lake. The rare orchid southern twayblade (Listera australis) occurs in the sweetgum swamp forest. Great Lake is home to a small population of the State Threatened American alligator (Alligator mississippiensis), and black bears (Ursus americanus) occur in the extensive swamps and pocosins. The forests contain numerous breeding warblers, particularly notable being the black-throated green warbler (Dendroica virens).

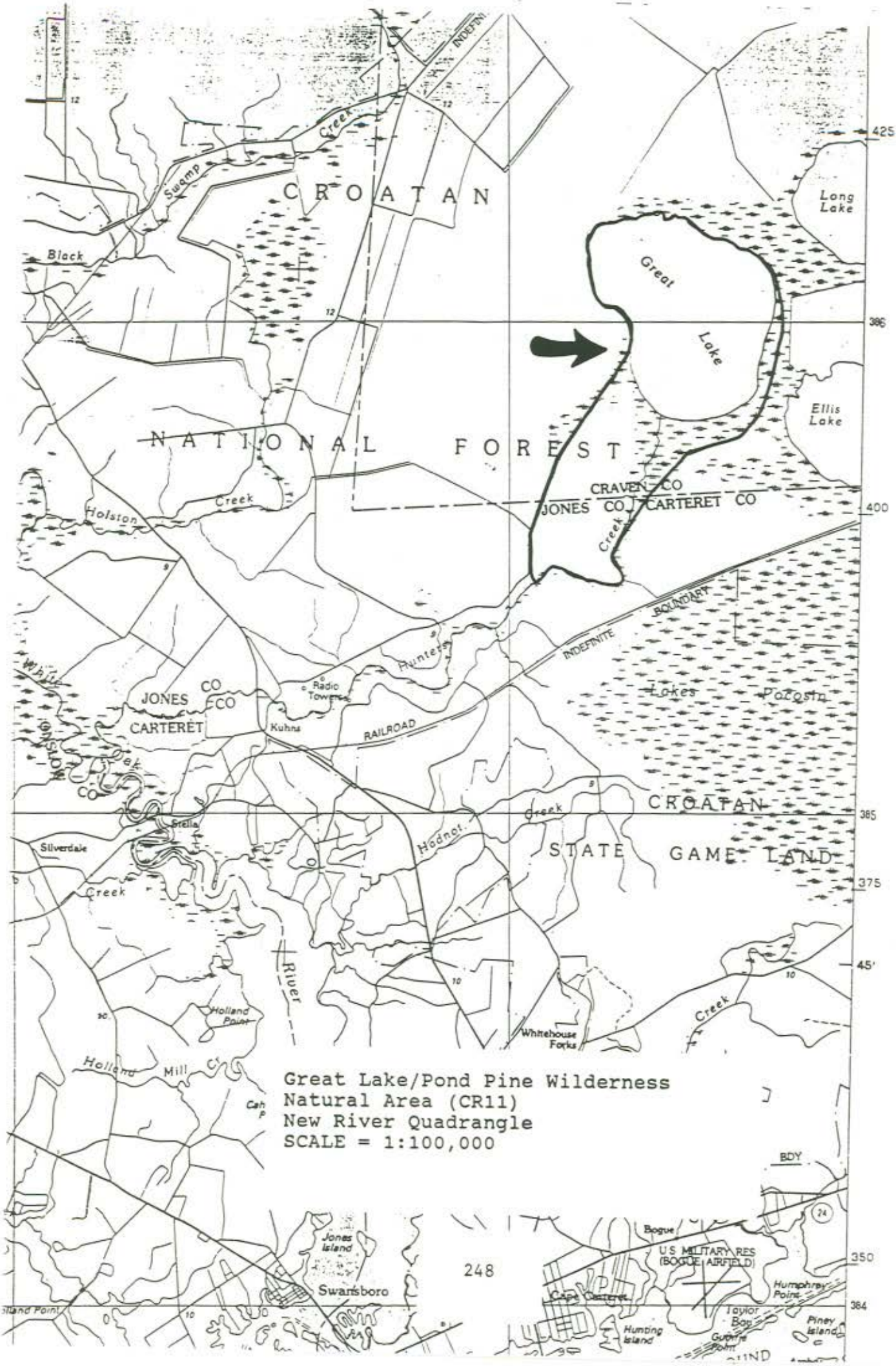
OWNERSHIP: The natural area is believed to be entirely in public ownership (U.S. Forest Service -- Croatan National Forest). Much of the sweetgum forest was in private ownership until several years ago, when it was added to the National Forest.

PROTECTION STATUS: The lands are protected according to Forest Service regulations. In addition, the Pond Pine Wilderness is a Congressionally-designated Wilderness Area. The Wilderness, along with the non-wilderness portion of the natural area owned by the Forest Service in 1986, is a N.C. Registered Natural Heritage Area. The portions that were privately owned, as of 1986, had been registered by the owner. However, now that the privately owned land has been acquired by the Forest Service, the registry is no longer valid, and a new registry must be made with the Forest Service for those lands. At any rate, the entire natural area can be considered as protected.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The natural area needs little if any management. No timber cutting should be allowed, nor should any new roads be constructed. It might be prudent to construct or revamp hiking trails so that visitors can enjoy the area for educational purposes.

COMMENTS: There is a small boat ramp at the end of FSR 126 at Great Lake for the boating public. This road can be difficult at times to traverse in a 2-wheel drive vehicle. Otherwise, access to the lake is very difficult.

REFERENCES: Snyder (1977), N.C. Natural Heritage Program (1985d)



Great Lake/Pond Pine Wilderness
Natural Area (CR11)
New River Quadrangle
SCALE = 1:100,000

SITE NAME: Lake Ellis Simon

SITE NUMBER: CR12 SIZE: about 2000 acres

SITE SIGNIFICANCE: A (National)

LOCATION: The extreme southern portion of Craven County and adjacent Carteret County; located about 6 miles west-southwest of the center of Havelock. The natural area includes Lake Ellis Simon (1452 acres) and lands surrounding the lake.

QUAD MAPS: Hadnot Creek, Masontown

SIGNIFICANT FEATURES:

1. The natural lake is one of the most important wildlife habitats in North Carolina and probably one of the richest natural lakes in the Southeast for plant and animal diversity.
2. The lake provides habitat for one of the largest populations of American alligators (Alligator mississippiensis) in the state, and the largest of 2 nesting colonies of double-crested cormorants (Phalacrocorax auritus) in the state.
3. At least 9 rare species of plants are found at the lake or near the shoreline. This number is in stark contrast to the near void of rare plants found at most of the other natural lakes in North Carolina.

GENERAL DESCRIPTION:

Lake Ellis Simon is one of the 5 large natural lakes in the Croatan region of southeastern North Carolina. Unlike the other four lakes, which are essentially sterile in animal and plant species, Lake Ellis Simon is unusually diverse, and the diversity is somewhat of a mystery. Lake Waccamaw, in Columbus County, is a very diverse lake because of outcroppings of marl, which give the water a somewhat neutral pH, as opposed to the very acidic waters of other bay lakes. Lake Ellis Simon, probably formed by peat fires, is not known to have marl deposits in its vicinity, though this possibility needs to be investigated. Rather, the high productivity of the lake might be due to its shallow nature, especially as numerous canals have been dug into the lake that have probably lowered the water level from that of former times. The majority of the canal system was dug in 1964; older canals have mostly filled in (McDonald et al. 1981).

The lake lies near other natural lakes such as Great Lake and Little Lake, in an extensive basin. The soils nearby are peaty, but sands and clays are present as well. The lake is poorly drained, with no obvious inflow or outflow, though canals now carry the flow from the lake eastward to the Neuse River. The lake is surrounded by extensive pocosins and swamp forests. Of local interest is a sand ridge about a mile southeast of the lake that is dominated by oaks such as live oak (Quercus virginiana), water oak (Q. nigra), and laurel oak (Q. laurifolia). A mature sweetgum (Liquidambar styraciflua) dominated forest, covering about 320 acres, also lies about a mile southeast of the lake. Redbay (Persea borbonia) is a common understory tree in this sweetgum forest (Nonriverine Swamp Forest natural community).

The lake itself has a number of plant communities, most of which can be grouped under the Natural Lake Shoreline natural community. An emergent aquatic plant zone is dominated by horsetail spikerush (Eleocharis equisetoides), a "significantly rare" species, along with white water-lily

(Nymphaea odorata), maiden-cane (Panicum hemitomon), and sphagnum moss (Sphagnum spp.). Bog moss (Mayaca aubletii) is a common submerged plant. Boggy areas near the northern shore of the lake feature leatherleaf (Cassandra calyculata), sphagnums, northern white beakrush (Rhynchospora alba), and spoonflower (Peltandra sagittifolia); the beakrush is a State Candidate species, whereas the spoonflower is "significantly rare". Freshwater marsh habitat at the lake is common; typical species include broadleaf cattail (Typha latifolia), lamp rush (Juncus effusus), cottongrass bulrush (Scirpus cyperinus), sphagnums, and a variety of other species. Pocosins habitats around the margin contain dense stands of fetterbush (Lyonia lucida), waxmyrtle (Myrica cerifera), and catbriers (Smilax spp.). The western portion of the lake is dominated by a swamp forest featuring red maple (Acer rubrum), sweetgum, loblolly pine (Pinus taeda), and bald cypress (Taxodium distichum). Scattered in the lake, and along the shores, are considerable amounts of bald cypress and pond cypress (T. ascendens).

In addition to the spoonflower, beakrush, and spikerush listed above, other rare plants are loose watermilfoil (Myriophyllum laxum) [State Threatened], dwarf bladderwort (Utricularia olivacea) [State Threatened], Robbins' spikerush (Eleocharis robbinsii) [state Candidate], hardstem bulrush (Scirpus acutus) ["significantly rare"], seven-angled pipewort (Eriocaulon aquaticum) ["significantly rare"], and shadow-witch (Pontheiva racemosa) ["significantly rare"].

Lake Ellis Simon contains one of the largest populations of American alligators (Alligator mississippiensis) in the state. The largest of 2 active breeding colonies of double-crested cormorants (Phalacrocorax auritus) in the state is at the lake, where the birds nest in the scattered cypresses in the middle of the lake. Nesting with the cormorants are anhingas (Anhinga anhinga), which along with the former species is considered "significantly rare". Bald eagles (Haliaeetus leucocephalus) occasionally visit the lake, and ospreys (Pandion haliaetus) nest commonly. Black bears (Ursus americanus) are present in the woods surrounding the lake. The Carolina gopher frog (Rana capito capito) has been reported from the lake.

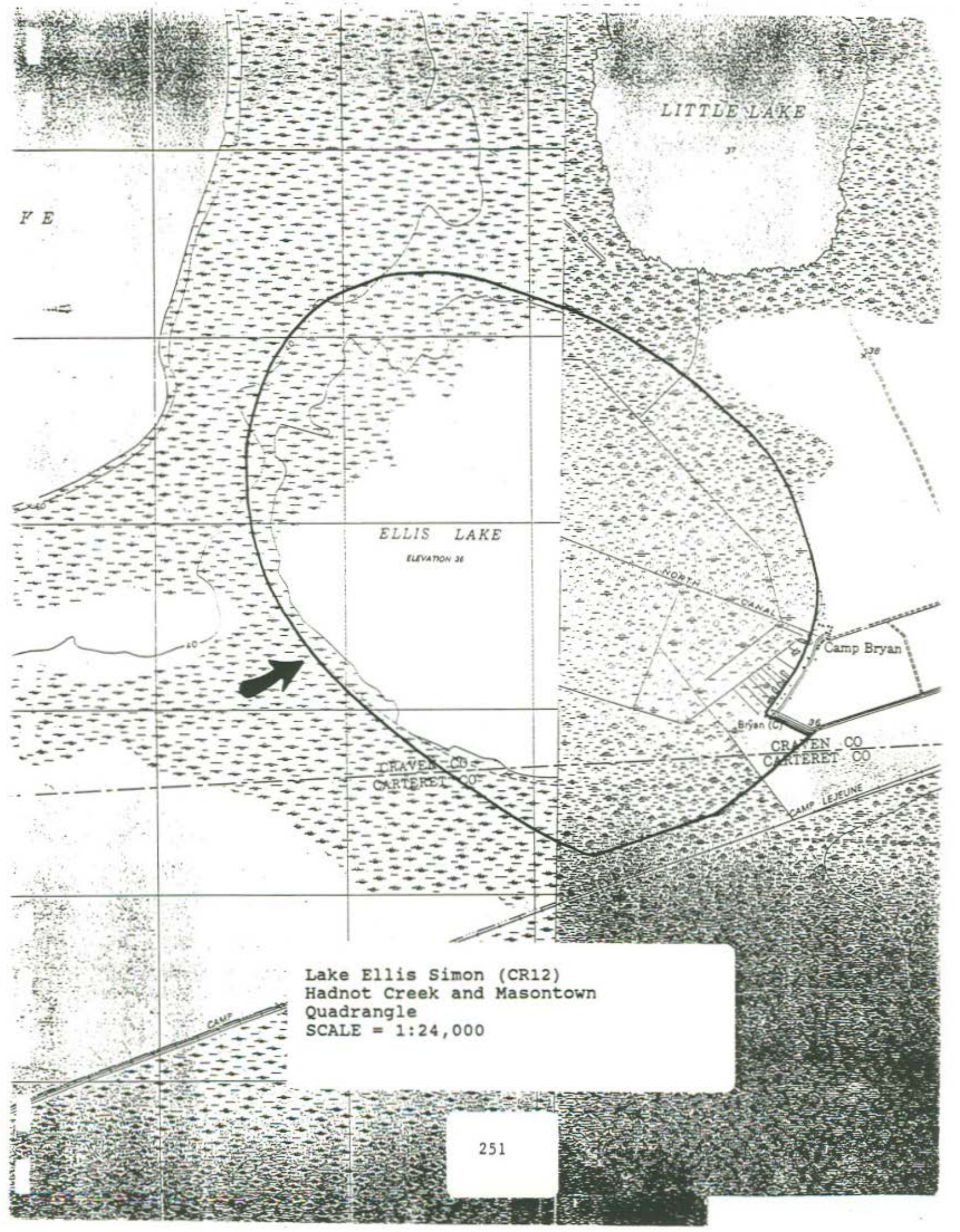
OWNERSHIP: The natural area is owned by the Camp Bryan Rod and Gun Club.

PROTECTION STATUS: The owner registered the site as a N.C. Natural Heritage Area in 1981. This registry, a non-binding agreement, indicates that the owner will protect the natural area.

RECOMMENDATIONS FOR MANAGEMENT OR PROTECTION: The hunt club manages the property primarily for hunting and fishing. Canals are maintained by the club, and cabins are present along the eastern shore of the lake. The area is used as a site for field trip studies by various groups; however, visitation of the area is by permission or invitation only. The natural area should be maintained in its present condition, with no timber cutting. Because the site is somewhat of an inholding within Croatan National Forest, if the property should ever be sold, the U.S. Forest Service should make every attempt to acquire the natural area as an addition to Croatan National Forest.

COMMENTS: Most of the inventory work on Lake Ellis Simon was conducted at least 10 years ago. Follow-up surveys, such as for rare plants as well as for animals, is probably needed.

REFERENCES: Fuller (1980), McDonald et al. (1981)



Lake Ellis Simon (CR12)
Hadnot Creek and Masontown
Quadrangle
SCALE = 1:24,000

Appendix A. Site Survey Report Form (Blank)

SITE SURVEY REPORT
-- N C. Natural Heritage Program
P.O. Box 27687 / Raleigh NC 27611

Date: _____
Quad Name: _____
County: _____

Name of Site: _____
Surveyors: _____
Location & Directions: _____

Size: _____ Province: _____ Watershed: _____
Owners and address: _____

Owner contacted & attitude: _____

General Landscape Description:

Physical Description:

Aspect:	Slope:	Topog. Position:	Hydrology:	Moisture:
___ N	___flat	___crest	___terrestrial	___inundated
___ E	___0-5	___upper slope	___palustrine	___freq. flooded
___ S	___5-10	___mid slope	___estuarine	___saturated
___ W	___10-35	___lower slope	___riverine	___seasonally wet
___ flat	___35 +	___upland flat	___lacustrine	___moist (mesic)
___ all	___vertical	___alluvial flat	___subterranean	___dry (xeric)

Elevation: _____
Geology:

Soils (series if known, correlated with Natural Communities, p.2, if possible):

Comments on Physical Description:

Biological Description:

Natural Communities. List communities and for each describe:

A) vegetation structure,
B) dominants & important spp. by strata,
C) position in landscape & relation to other communities,
D) quality & condition,
E) size

Special Status Species present (attach forms):

Potential for other Special Status Species:

Other noteworthy species or features present:

Site Integrity: ___high ___good ___fair ___poor

Average DBH of canopy trees:

Maximum DBH of canopy trees:

Fire regime (natural, suppression, date of most recent, etc.):

___logged (when, describe):

___even-aged canopy (successional stand from pasture or clearcut)
___non-native or weedy spp. present (list and describe):

___ditched/drained (describe):

___stream channelized
___dredging/filling
___understory cleared
___grazing
___ORV damage (describe):
___other (describe):

Adjacent land use (describe):

Significance of site: (high quality and/or rare communities, rare spp., etc.):

Discussion:

___national
___state
___regional
___county

Protection Considerations and Management Needs: (discuss recommended protection for natural area, and management needed to maintain or improve quality of site, such as fire, ORV exclusion, fencing, blocking drainage, etc.)

Documentation

Survey boundaries (describe why your survey stopped where it did):

Priority for further survey (why, for what, at what season):

Specimens collected (plants, animals, soil, rock - of what and state repository):

Photographs (of what):

Others knowledgeable about site:

___TOPO MAP ATTACHED
___Sketch of site or part of site attached (as needed or appropriate, to show access, rare spp., relative positions of communities, etc., particularly if cannot be well-portrayed on attached topo map).

PLANT SPECIES LIST

Code species by community in which they occur.
How thorough is this list? ___nearly complete ___medium ___casual

CANOPY:

SUBCANOPY:

SHRUBS:

VINES:

488

PLANT SPECIES LIST (page 2)

HERBS:

HERBS:

NONVASCULARS:

NOTES ON ANIMAL SPECIES PRESENT

List animals present, evidence (sighting or other), breeding?, etc. (attach separate list if needed):

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Appendix B. Site Survey Report Form (Completed)

SITE SURVEY REPORT
-- N.C. Natural Heritage Program
P.O. Box 27687 / Raleigh NC 27611

Date: 4-28-1990, 5-12-90
Quad Name: BAYBORO, VANDEMERE
County: PAMLICO

Name of Site: BAY CITY LOW POCOSIN
Surveyors: CECIL FROST
Location & Directions: NORTH CENTRAL PAMLICO COUNTY ON EAST SIDE OF SR 1002 FROM BEAUFORT COUNTY LINE SOUTH FOR 2 MILES TOWARD BAY CITY.

(BAY CITY NO LONGER EXISTS — AT PRESENT THERE IS NOT A SINGLE STRUCTURE AT THE LOCATION MARKED ON THE ATTACHED TOPO MAP.)
Size: 3200 acres Province: COASTAL PLAIN Watershed: BAY R. → PAMLICO SOUND
Owners and address: SEE ATTACHED OWNERSHIP MAP AND LIST OF OWNERS

Owner contacted & attitude: WEYERHAEUSER GAVE PERMISSION TO WORK AT THEIR LANDS - BEYOND THE OUTLINED AREA.

General Landscape Description: A VERY FLAT, PEATY LANDSCAPE; A 5 SQUARE-MILE REMNANT OF THE VAST 50 OR 60 SQUARE MILE MOSAIC OF WHITE CEDAR, CANEBRAKE, POCOSIN AND SWAMP FOREST ORIGINALLY CALLED GUM SWAMP. THIS LARGE WETLAND EXTENDED ABOUT 2 MILES NORTH AND 4 MILES SOUTH ALONG THE BEAUFORT/PAMLICO LINE, FROM THE SUFFOLK SCARP EAST TO NEAR THE PAMLICO SOUND.

Physical Description:

Aspect:	Slope:	Topog. Position:	Hydrology:	Moisture:
___ N	✓ flat	___ crest	___ terrestrial	___ inundated
___ E	___ 0-5	___ upper slope	✓ palustrine	___ freq. flooded
___ S	___ 5-10	___ mid slope	___ estuarine	✓ saturated
___ W	___ 10-35	✓ lower slope	___ riverine	✓ seasonally wet
✓ flat	___ 35 +	✓ upland flat	___ lacustrine	✓ moist (mesic)
___ all	___ vertical	___ alluvial flat	___ subterranean	___ dry (xeric)
			___ marine	

Elevation: 15 TO 16 FT, MSL
Geology: HOLOCENE AND RECENT WHITE CEDAR PEAT UNDERLAIN BY FILE-TEXTURED ESTUARINE AND MARINE SEDIMENTS OF LATE SANGAMON AGE (~ 40,000 - 50,000 YBP) DEPOSITED BEFORE AND DURING THE RETREAT OF THE SANGAMON SEA FROM THE SUFFOLK SCARP.
Soils (series if known, correlated with Natural Communities, p.2, if possible):
CT-1, 3, 5 BELHAVEN - TERRIC MEDISAPRIST
CT-2 BELHAVEN AND DARE - TYPIC MEDISAPRIST (PATCHES TOO SMALL TO MAP)
CT-4 WAZDA - HISTIC HUMAQUEPT

Comments on Physical Description:

THIS SITE APPEARS TO BE NEAR THE CENTER OF THE ORIGINAL PEAT DOME OF CENTRAL PAMLICO COUNTY, WITH REMNANT EVIDENCE OF RADIAL DRAINAGE FROM THIS CENTER, TO THE NORTH, EAST AND SOUTH.

Biological Description:

Natural Communities. List communities and for each describe:
A) vegetation structure,
B) dominants & important spp. by strata,
C) position in landscape & relation to other communities,
D) quality & condition,
E) size

CT-1 SPARSE POCOSIN TREES / LOW POCOSIN SHRUBS (LIGHT AREA ON PHOTO)

LOW POCOSIN (SCHAFALE AND WEAKLEY)

THIS COMMUNITY IS AN UNUSUAL VARIANT OF LOW POCOSIN, OF GREAT EXTENT, IN WHICH ONE CAN WALK EASILY FOR MILES. MOST OF THE COMMON POCOSIN SPECIES ARE PRESENT, WITH THE SURPRISING ABSENCE OF SMILAX LAURIFOLIA. FIRE EXCLUSION APPEARS TO HAVE BEEN COMPLETE SINCE ESTABLISHMENT OF THE PRESENT STAND OF TREES AROUND 25 YRS AGO. TREE COVER RANGES FROM NONE TO SINGLE SPECIMENS OR SMALL CLUMPS OF POND PINE, LOBLOLLY PINE AND RED MAPLE. LOBLOLLY IS PROBABLY ADVENTIVE, IN THE LONG ABSENCE OF FIRE.

THE SHRUB COMMUNITY IS BILAYERED, WITH PATCHES OF TALL SHRUBS, DOMINATED BY VACCINIUM CORYMBOSUM, ILEX GLABRA OR CLETHRA RACEMIFLORA, WITH DOMINANCE VARYING FROM PLACE TO PLACE. THE TALL SHRUBS OCCUR IN PATCHES IN A MORE GENERAL MATRIX OF KNEE-HIGH VEGETATION DOMINATED BY LYONIA LUCIDA OF UNUSUALLY LOW STATURE AND WOODWARDIA VIRGINICA. IN MANY AREAS PTERIDIUM AQUILINUM IS COMMON AND THERE IS A SUBSTANTIAL GROUND COVER OF CLADONIA LICHENS (ON AN ORGANIC SOIL!).

THE UNDERLYING BELHAVEN AND SOME WASDA SOILS ARE RELATIVELY NONACID, IN CONTRAST TO THE SUBSTRATE USUALLY UNDERLYING MORE TYPICAL EXAMPLES OF LOW POCOSIN, AND HAVE A MUCH HIGHER MINERAL COMPONENT (PEDOGENIC SOURCE UNKNOWN). GREATER FERTILITY, COMBINED WITH INDUCED DRYNESS, MAY EXPLAIN THE ODD SPECIES ASSEMBLAGE.

PROBING REVEALED FAIRLY UNIFORM PEAT DEPTHS OF 1.2 TO 1.4 M IN THIS CT WITH AN ABUNDANCE OF WHITE CEDAR LOGS BURIED OR EXPOSED IN DITCH CUTS. THE BELHAVEN SOIL WAS ONE OF THE PRINCIPAL WHITE CEDAR SERIES BEFORE ELIMINATION OF THE SPECIES BY LOGGING AND DRAINAGE.

CT-2 _ POND PINE FOREST

_ PINUS SEROTINA / CYRILLA RACEMIFLORA - MEDIUM POCOSIN SHRUBS

_ POND PINE WOODLAND (SCHAFFALE & WEAKLEY)

THIS COMMUNITY IS READILY DISTINGUISHED AS LARGE DARK PATCHES ON THE ATTACHED AERIAL PHOTOS. IT IS CHARACTERIZED BY A SOMEWHAT OPEN (WOODLAND) TO FULLY CLOSED (FOREST) CANOPY OF POND PINE, WITH ESSENTIALLY NO OTHER CANOPY SPECIES. THE ONE SITE EXAMINED ON FOOT OCCURRED ON THE DEEPEST SOIL MEASURED IN THE NATURAL AREA, ABOUT 1.5 TO 2 M DEEP.

THERE WAS A SPARSE SUBCANOPY OF PERSEA AND RED MAPLE OVER A TYPICAL DENSE POCOSIN SHRUB LAYER AVERAGING ABOUT 2 M IN HEIGHT. SHRUBS WERE DOMINATED BY CYRILLA. THERE WAS SOME SMILAX LAURIFOLIA BUT AT LESS THAN USUAL DENSITY FOR POCOSINS. HERBS WERE NEARLY LACKING. THERE WERE NUMEROUS BURIED WHITE CEDAR LOGS. THE PRESENT STAND MAY BE A FIRE-SUPPRESSED FEATURE, SUCCESSIONAL FROM MORE TYPICAL LOW POCOSIN WITH SCATTERED POND PINE UNDER THE ORIGINAL FIRE REGIME. IT IS UNKNOWN WHETHER THE WHITE CEDAR WAS REPLACED BY POCOSIN IN PRESETTLEMENT OR HISTORIC TIMES.

CT-3 _ POND PINE / CANEBRAKE

_ PINUS SEROTINA / ARUNDINARIA GIGANTEA

_ POND PINE WOODLAND (SCHAFFALE & WEAKLEY)

REMNANTS OF THIS COMMUNITY ARE FOUND ON SHALLOWER REGIONS OF BELHAVEN MUCK AND ESPECIALLY ON THE THINNER, MORE FERTILE WESDA SOILS TRANSITIONAL BETWEEN MUCKS OF THE INTERIOR AND MINERAL SOILS OF THE SURROUNDING LANDS. AVERAGE DEPTH TO FIRM SUBSTRATE WAS 1 METER.

A TYPICAL STAND HAD A CLOSED CANOPY OF POND PINE WITH SOME LOBLOLLY OVER A SHADE-THINNED STAND OF ARUNDINARIA 2 TO 2.5 M TALL. THE CANE BECAME DENSE IN THE SUNNIER TRANSITION AREA BETWEEN POND PINE FOREST AND OPEN LOW POCOSIN. WESDA IS ONE OF THE CLASSIC CANEBRAKE SOILS AND UNDER THE ORIGINAL FIRE REGIME (@ EVERY 5 YRS) THIS COMMUNITY WAS PROBABLY DENSE CANEBRAKE WITH ONLY AN OCCASIONAL STEM OR PATCH OF POND PINE.

CT-4 _ Loblolly pine - Red maple forest

_ Pinus taeda - Acer rubrum / Acer rubrum / Smilax wet-mesophytic shrubs & vines

_ Nouriverine Swamp Forest (Schafale and Weakley)

Original type unknown but this stand is in a region transitional to a wetter area of Eastern Gum Swamp, dominated by Liquidambar styraciflua, which may have given the region its name. This area has not been burned in many years. In regions where fire has been more frequent, fertile soils like the Wasda sometimes have canebrake with an overstory of sweetgum in areas transitional to mineral soil, and patches of white cedar, sometimes directly abutting canebrake on the slightly deeper pitases. The present stand may be successional from such a mosaic.

_ Gum Swamp

CT-5 _ Nyssa biflora - Mixed Nouriverine Swamp Trees / Liquidambar styraciflua / Mixed Coastal Plain Nouriverine Swamp Shrubs.

_ Nouriverine Swamp Forest (Schafale & Weakley).

This appears to be a natural forest type of wet depressions and drainage ways of large peatlands with relatively shallow organic accumulations. Soil here is mapped Belhaven (Terric Medisaprist). Note also the elevation difference; 5-10 ft vs. up to 16 ft for the low pocosin (CT-1). Such areas seemed to escape most of the fires that swept canebrake, pocosin, and upland flatwoods of the region. The lower topographic situation may have provided for accumulation of nutrients to support swamp forest cover, which in turn may have provided enough shade to preclude formation of a dense, flammable shrub layer.

Regardless of the mechanism, there is evidence from a number of sites in the region (including Eastern Gum Swamp, Jackson Hardwoods, and Federal Paper Hardwoods) that fires that made a clean sweep of adjacent pocosins usually burned themselves out on the fringes of these wetter sites. Those fires that did penetrate the interiors were usually non-catastrophic.

Special Status Species present (attach forms):

BLACK BEAR

Potential for other Special Status Species:

BOBCAT, SWAINSON'S WARBLER

Other noteworthy species or features present:

Site Integrity: ___high ✓good ___fair ___poor

Average DBH of canopy trees: 10-12 INCHES - POND PINE, LOBLOLLY PINE

Maximum DBH of canopy trees: 14 INCHES - LOBLOLLY PINE

Fire regime (natural, suppression, date of most recent, etc.):

UPLAND SURROUNDING GUM SWAMP - ORIGINALLY EVERY 1-3 YRS IN SAVANNAS & WOODLAND.
CANEBRAKES & POCOSINS - ORIGINALLY N EVERY 3-5 YRS (10 YRS).
WETTER INTERIOR PARTS OF WHITE CEDAR 20-70 YRS.

___logged (when, describe): MAY HAVE HAD SOME POND PINE AND WHITE CEDAR CUT IN PAST, NATURAL AREA OUTLINED MAY NEVER HAVE HAD ANY COMMERCIAL TIMBER EXCEPT
___even-aged canopy (successional stand from pasture or clearcut): IN A FEW PATCHES.
___non-native or weedy spp. present (list and describe):
MICROSTEGIUM VIMINEUM NEAR ROAD IN CT-5

✓ditched/drained (describe): DEEP DITCHES 6 TO 8 FEET BELOW LAND SURFACE SURROUND THE SQUARE-MILE BLOCKS.

___stream channelized:
___dredging/filling:
___understory cleared:
___grazing:
___ORV damage (describe):
___other (describe):

Adjacent land use (describe):

ALL ADJACENT LANDS EITHER WOODED OR RECENTLY CLEARED FOR LARGE-SCALE ROW-CROP AGRICULTURE. MUCH OF THE CLEARED LAND IS JUST IN ITS FIRST CROP OR NOT YET IN CULTIVATION.

Significance of site: (high quality and/or rare communities, rare spp., etc.):

Discussion: THIS IS A LARGE NATURAL AREA CONTAINING A UNIQUE VARIANT OF LOW POCOSIN VEGETATION AND CONSIDERABLE HABITAT FOR BEAR AND DEER. NATURAL HYDROLOGY COULD BE RESTORED BY INSTALLATION OF WATER CONTROL DEVICES ON DITCHES DRAINING ITS CENTER. THE AREA WOULD BE OF GREAT SIGNIFICANCE FOR PERPETUATION OF WILDLIFE IN THE REGION IF IT COULD BE INCORPORATED INTO A REGIONAL LANDSCAPE PLAN TO MAINTAIN WILDLIFE CORRIDORS. THIS WOULD ENTAIL MAINTAINING A PORTION OF THE NATURAL WOODED CORRIDOR EXTENDING THROUGH EASTERN GUM SWAMP TO THE GOOSE CREEK GAME LANDS, AND WEST THROUGH WESTERN GUM SWAMP TO THE PRESCOTT RIDGE LONGLEAF PINE SAVANNA ON THE SUFFOLK SCARP, AND BEYOND TO NORTHWEST POCOSIN. THIS CORRIDOR STILL EXISTS BUT SEEMS DESTINED TO BE FRAGMENTED UNLESS SOME ACTION IS TAKEN.

___national
___state
_✓_regional
___county
___local

Protection Considerations and Management Needs: (discuss recommended protection for natural area, and management needed to maintain or improve quality of site, such as fire, ORV exclusion, fencing, blocking drainage, etc.)

LEE OTTE (SEE INGRAM & OTTE - PEAT STUDIES) HAS SHOWN THAT DITCHING SUBSTANTIALLY LOWERS THE WATER TABLE IN PEATLANDS FOR UP TO 1/4 MILE ON EITHER SIDE OF THE DITCH. WHEN THE NATURAL AREA WAS VISITED IN APRIL AND MAY THE PEAT SEEMED UNNATURALLY DESSICATED IN THE UPPER 1/2 TO 1 METER.

RESTORATION OF THE NATURAL COULD BE ACCOMPLISHED BY RETURNING THE WATER TABLE AND THEN BURNING EACH BLOCK - PERHAPS ON DIFFERENT FREQUENCIES. ACQUISITION OF 1 SQUARE MILE BLOCK WOULD BE OF LITTLE VALUE UNLESS ADJACENT LANDOWNERS AGREED TO PERMIT BLOCKING OF THE SURROUNDING DITCHES. IF THE CENTRAL 4 SQUARE-MILE BLOCK COULD BE OBTAINED, HOWEVER, THE INTERNAL DITCHES COULD BE DAMMED, RESTORING AT LEAST THE CENTER TO A HIGHER WATER TABLE.

Documentation

Survey boundaries (describe why your survey stopped where it did):

SAW MOST OF THE VARIATION.

Priority for further survey (why, for what, at what season):

MIGHT EXPECT TO FIND MORE BOG GARLIC IN THE HERB LAYER IN A WETTER SUMMER.

Specimens collected (plants, animals, soil, rock - of what and state repository):

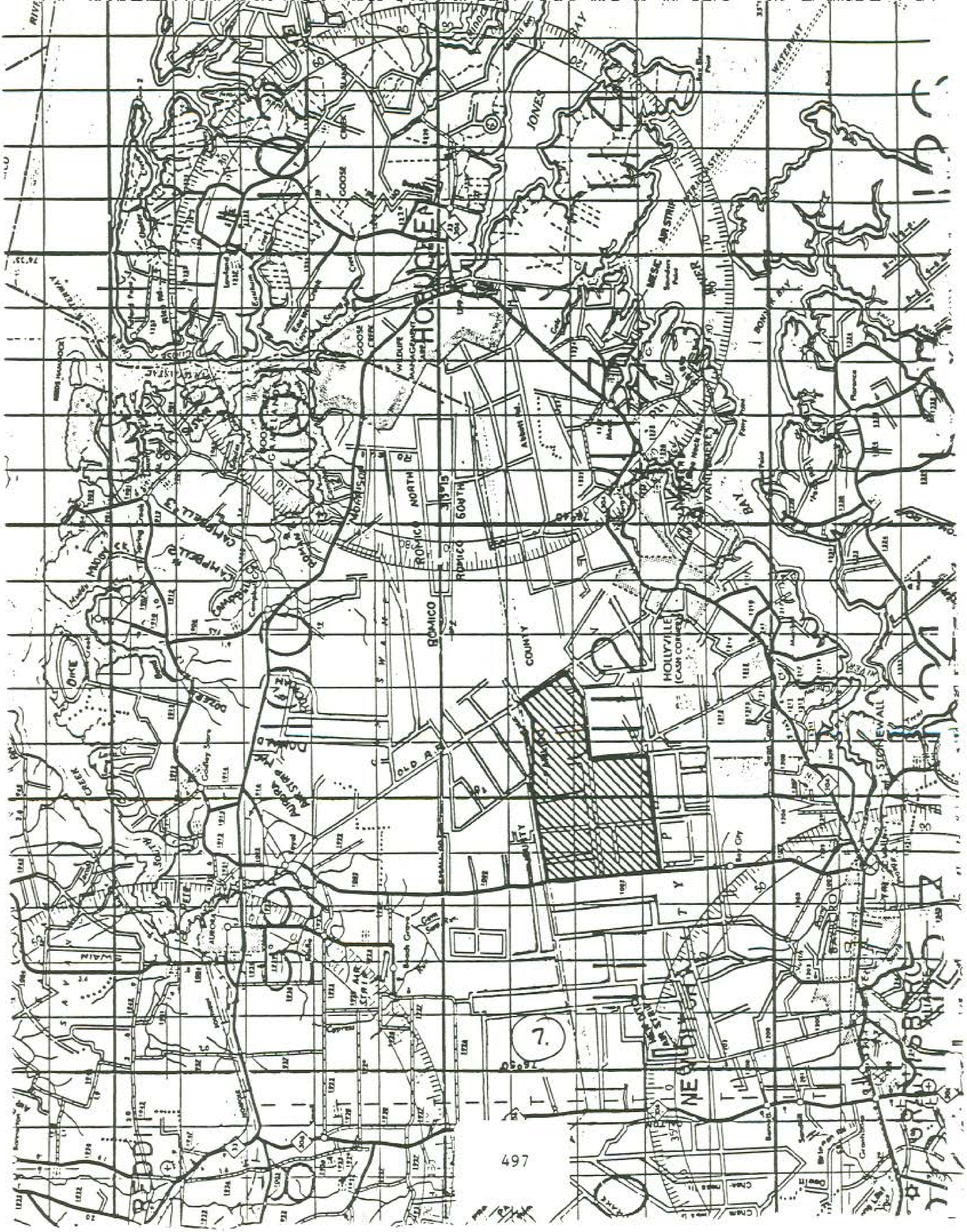
Photographs (of what):

CT-1, CT-2, CT-3

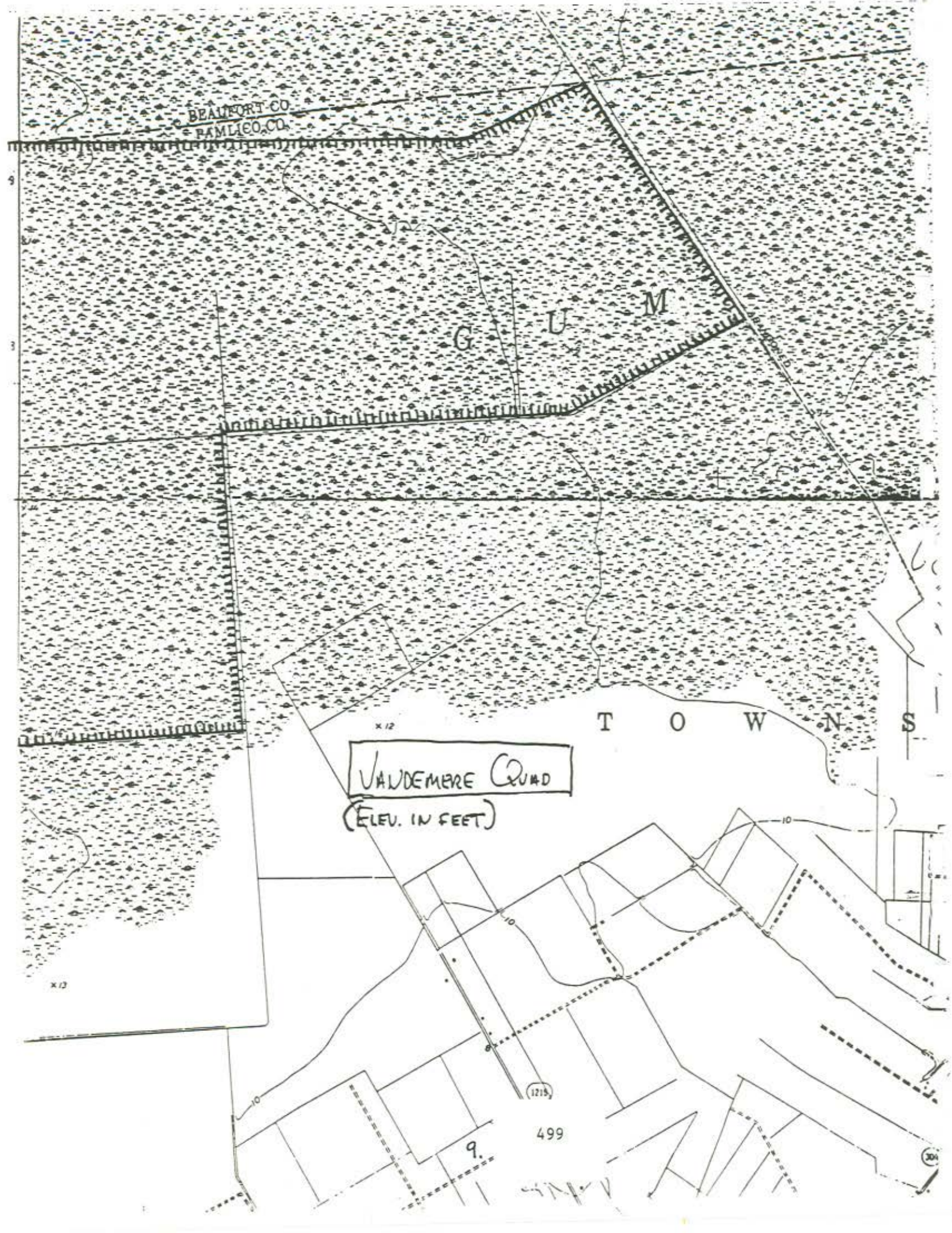
Others knowledgeable about site:

✓ TOPO MAP ATTACHED

✓ Sketch of site or part of site attached (as needed or appropriate, to show access, rare spp., relative positions of communities, etc., particularly if cannot be well-portrayed on attached topo map).

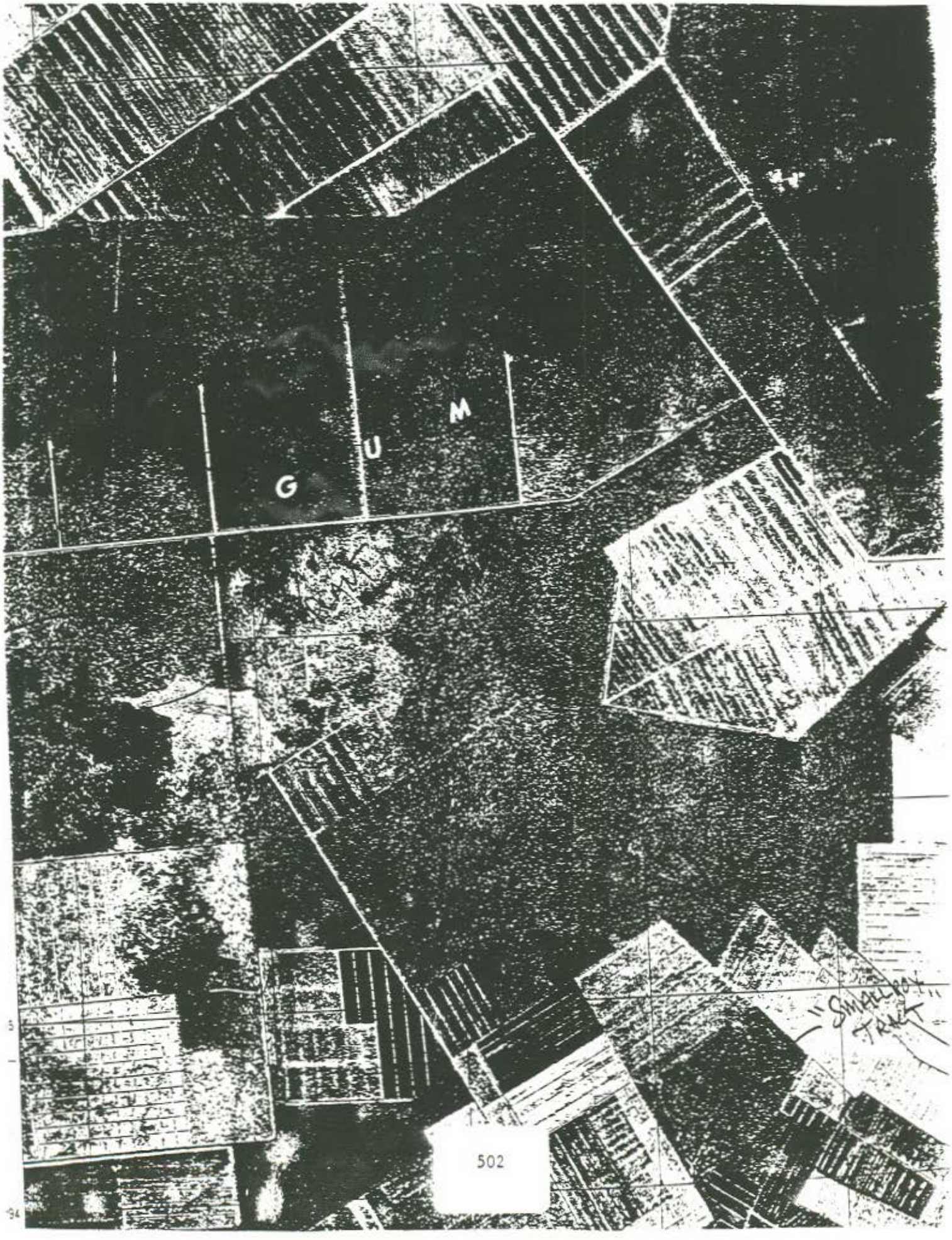

HOLLYVILLE
(CASH CORNER)
STONEWALL
JONES
BAY
GOOSE CREEK
ROMICO
COUNTY
AIR STRIP
AURORA
SWAN
7.


ISAYBOAC QUAD
ELEV. IN FEET
BEAUFORT CO
PAMLICO CO
12'30"
CANAL
CANAL
CANAL
KEYS
IVANDEMERE
3954 II NW
Whitehurst
Bay City
498
3899
3898
3897
3896
3894


BEAUFORT CO.
PAMLICO CO.
G U M
T O W N S
VANDEMERE QUAD
(ELEV. IN FEET)
499
9.


PLANT COMMUNITIES & SOILS
1
2
1
1
1
1
3
BH
BH
BH
500


4
1
BH
BH
501
13


G
U
M
"SMELLPOT"
TRUCK
502

PLANT SPECIES LIST

Code species by community in which they occur.
How thorough is this list? ___nearly complete ✓medium ___casual

D = Stratal dominant
* = Special status species

CANOPY:	CT-	1 – Low Pocosin	2 – Pond Pine Woodland	3 – Pond Pine Forest	4 – Mixed Pine/Hardwood	5 – Hardwood Swamp
PINUS SEROTINA		✓	D	D		
PINUS TAEDA		✓		✓	D	✓
ACER RUBRUM		✓			D	✓
LIQUIDAMBAR STYRACIFLUA		✓		✓		✓
PRUNUS SEROTINA		✓				
NYSSA SYLVATICA VAR. BIFLORA						D
CHAMAECYPARIS THYOIDES (AS BURIED LOGS ONLY)		✓	✓	✓		

SUBCANOPY:	CT-	1	2	3	4	5
ACER RUBRUM			✓		D	
PERSEA BORBONIA			✓	✓	✓	✓
ILEX OPACA				✓		
CYRILLA RACEMIFLORA (B16)					✓	
LIQUIDAMBAR STYRACIFLUA						D

PLANT SPECIES LIST (page 2)

SHRUBS:

D = Stratal Dominant
* = Special Status Species

–Low Pocosin –Pond Pine Forest –Pond Pine/Cane –PITA-ACRU Forest –Swamp Forest

CT-	1	2	3	4	5		
Cyrilla racimiflora	D	D	✓				
Vaccinium corymbosum	D		✓	✓			
Vaccinium atrococcum	✓						
Ilex glabra	D		✓				
Clethra alnifolia	✓			✓	✓		
Rhus copalina	✓		✓				
Persea borbonia	✓	✓	✓		✓		
Myrica cerifera	✓	✓	✓	✓			
Lyonia lucida	D	✓			✓		
Lyonia ligustrina	✓						
Kalmia angustifolia	✓						
Sorbus arbutifolia		✓					
Arundinaria gigantea			D				
Liquidambar styraciflua				✓			
Magnolia virginiana					✓		

VINES:

CT-	1	2	3	4	5		
Vitis rotundifolia	✓			✓	✓		
Smilax bona-nox	✓						
Smilax rotundifolia							
Smilax laurifolia		✓		✓			
Smilax glauca				✓	✓		
Rhus radicans			✓		✓		
Gelsemium sempervirens			✓		✓		
Berchemia scandens			✓				
Parthenocissus quinquefolia				✓			

EPIPHYTES:

PLANT SPECIES LIST (page 3)

HERBS:

D = Stratal Dominant
* = Special Status Species

- Low Pocosin
- Pond Pine
- Pond Pine/Cane
- Loblolly-Hardwood Forest
- Swamp Forest

	CT-	1	2	3	4	5			CT-	1
Woodwardia virginica		D	✓	✓	D	✓				
Woodwardia (Lorinseria) areolata						✓				
Osmunda cinnamomea						✓				
Pteridium aquilinum		D	✓	✓						
Andropogon glomeratus		✓								
Eupatorium sp.		✓								
Phytolacca americana						✓				
Mikrostegium vimineum						✓				
NONVASCULAR:										
Cladonia (dominant in some patches)										✓

NOTES ON ANIMAL SPECIES PRESENT

List animals present, evidence (sighting or other), breeding?, etc.

* BLACK BEAR (SCAT)
DEER
COPPERHEAD
COOPERS (OR SHARP-SHINNED) HAWK
YELLOW-BREASTED CHAT
EASTERN WOOD PEEWEE
BANK SWALLOW
LAUGHING GULL
TURKEY VULTURE
BOB-WHITE QUAIL
WOOD THRUSH
CARDINAL
CHICKADEE
GREAT-CRESTED FLYCATCHER
FISH CROW
CATBIRD
PINE WARBLER
PRAIRIE WARBLER