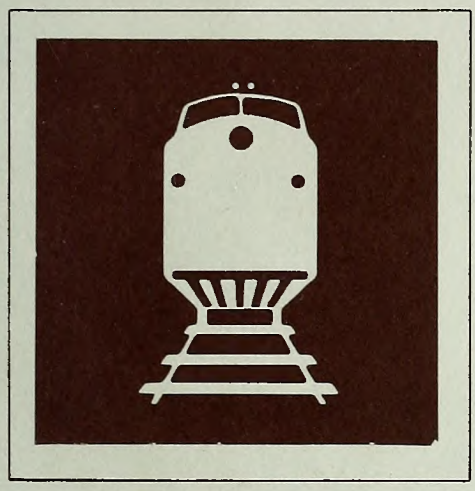

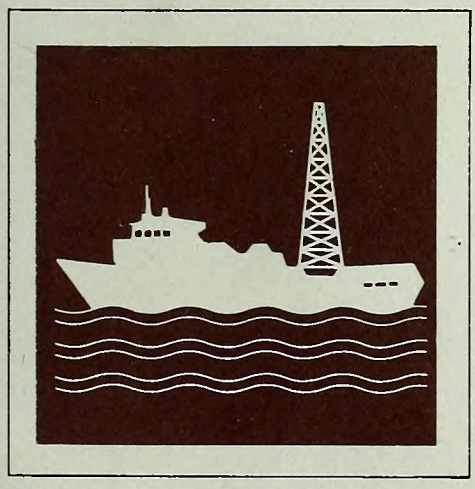

Natural Areas Inventory of Gates County, North Carolina

Cecil C. Frost
Department of Botany
University of North Carolina
Chapel Hill, NC

APRIL 1982

North Carolina
Coastal Energy Impact Program
Office of Coastal Management
North Carolina Department of Natural Resources
and Community Development

CEIP REPORT NO. 16

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NATURAL AREAS INVENTORY

GATES COUNTY, NORTH CAROLINA

BY

Cecil C. Frost

Department of Botany
University of North Carolina[1]

The preparation of this report was financed through a Coastal Energy Impact Program grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration. This CEIP grant was part of NOAA grant.

This natural areas inventory was prepared for and supervised by the North Carolina Natural Heritage Program (Division of Parks and Recreation, N. C. Department of Natural Resources and Community Development).

April 1982

CEIP Report No. 16

[1]Chapel Hill, NC 27514

PREFACE

The North Carolina Office of Coastal Management and the North Carolina Natural Heritage Program, both units of the Department of Natural Resources and Community Development, have commissioned a series of natural areas inventories for ten counties in the coastal zone of this state. The Gates County inventory was conducted in 1981 and was financed by a Coastal Energy Impact Program (CEIP) grant. CEIP funded the Gates County survey because of the potential environmental impacts of energy-related development.

The recommendations made in this report are by Cecil C. Frost. His inventory and recommendations are designed to help state and federal agencies, county officials, resource managers, landowners and developers work out effective land management and preservation mechanisms to protect the seven outstanding or exemplary natural areas described in this report. Agencies such as the N. C. Division of Environmental Management, Division of Land Resources, Division of Marine Fisheries Service, Wildlife Resources Commission, the U. S. Fish and Wildlife Service, and Environmental Protection Agency should find this report useful, as may university researchers, private consultants, and private conservation groups. The Office of Coastal Management will use the report in assessing permit applications and for federal and state consistency reviews.

Cecil Frost is an experienced field biologist, with initmate familiarity with Gates County. The former ranger-naturalist for Merchants Millpond State Park is a candidate for a doctorate in botany from the University of North Carolina at Chapel Hill. The investigator was exceptionally well qualified to identify, describe, and evaluate the most outstanding natural areas of Gates County.

The project investigator was instructed to identify those natural areas that contain highly unique, endangered, or rare natural features, or highest quality representations of relatively undisturbed natural habitats. The investigator was instructed to include the portion of the Dismal Swamp National Wildlife Refuge in Gates County in his survey report because the state's scientific community is generally unfamiliar with the ecological resources of the refuge.

The Natural Heritage Program is most pleased to have had this opportunity to conduct this project for the Office of Coastal Management. The inventory has documented a number of high-quality natural areas that possess natural elements of statewide priority and are important parts of North Carolina's natural diversity. The Natural Heritage Program hopes that these areas will be protected for the benefit of present and future generations of North Carolinians and for the preservation of the state's truly exceptional natural heritage.

Charles E. Roe, Coordinator
N. C. Natural Heritage Program
November 16, 1982

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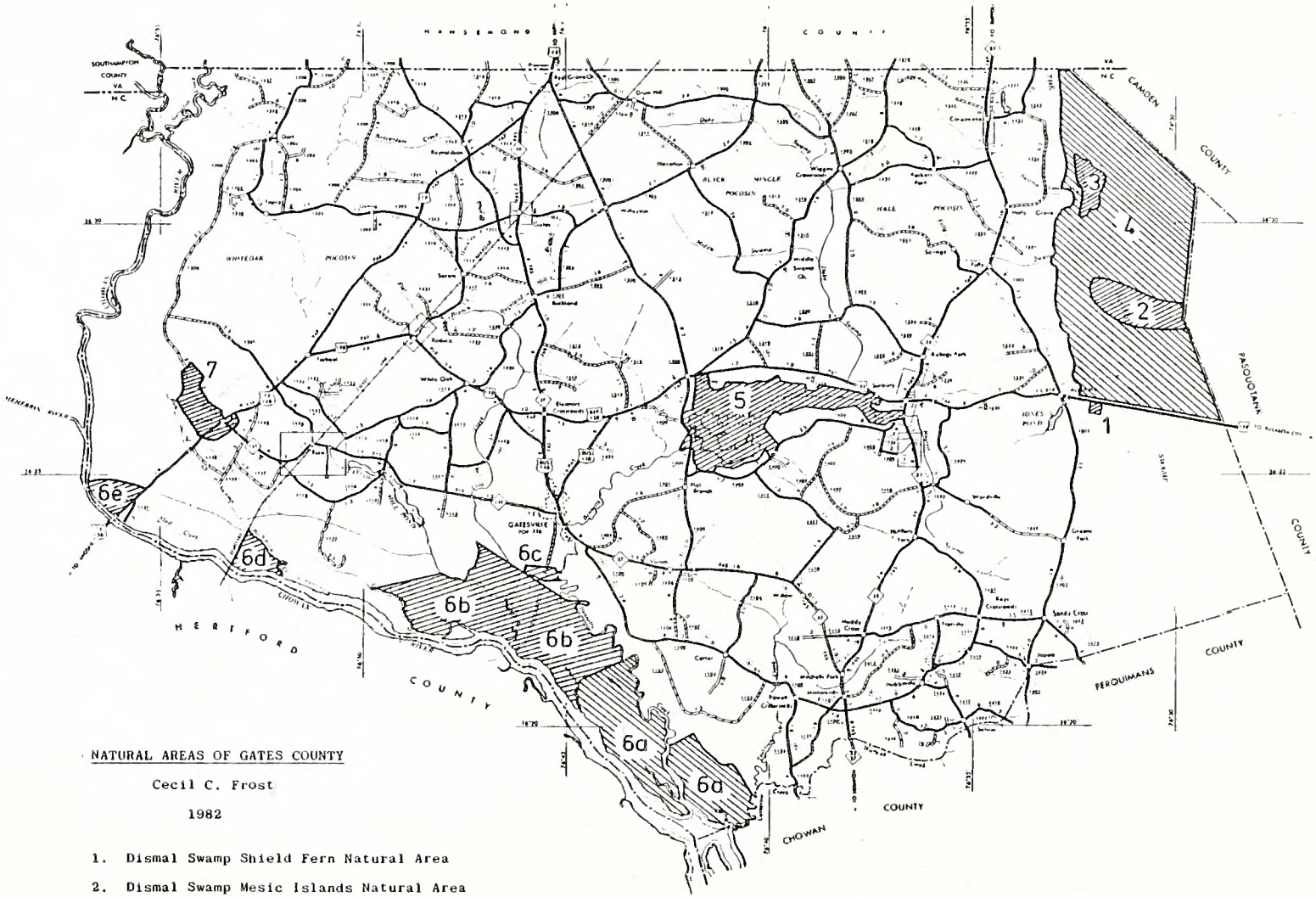
1. Pat Gammon, U. S. Geological Survey and M. K. Garrett, Dismal Swamp National Wildlife Refuge for color infrared aerial photographs, free advice, and access to the Dismal Swamp.

2. Dr. Lytton J. Musselman, Biological Sciences Dept, Old Dominion University, for aerial photos, expert identification of ferns in the field, access to materials collected by students on projects in Gates County, and companionship in field explorations.

3. Leo Snead, who prepared the map of vegetation of Chowan Swamp under supervision of, and with minor assistance from the author.

4. Chuck Roe, Julie Moore, Merrill Lynch and Lance Peacock of the North Carolina Natural Heritage Program, for preparation of a workable set of inventory specifications, advice and guidance during the project.



NATURAL AREAS OF GATES COUNTY

Cecil C. Frost

1982

1. Dismal Swamp Shield Fern Natural Area
2. Dismal Swamp Mesic Islands Natural Area
3. Corapeake Marsh Natural Area
4. Great Dismal Swamp National Wildlife Refuge Natural Area
5. Merchants Mill Pond State Park Natural Area

6a. Chowan Swamp Natural Area – Forestry Foundation Property

6b. Chowan Swamp Natural Area – State Parks Property (Sarem Creek Tract)

6c. Chowan Swamp Natural Area – State Parks Property (Capt. Jim Felton's Island)

6d. Chowan Swamp Natural Area – State Parks Property (Barne's Creek Tract)

6e. Chowan Swamp Natural Area – Wildlife Resources Commission Property

7. Sand Banks Natural Area

INTRODUCTION

Gates County, North Carolina is located in the northeastern region of the state, adjacent to the Virginia state line. The Chowan River forms its western and southern borders. while the eastern boundary runs approximately down the center of Dismal Swamp. Most income of this rural county comes directly from the land, with the majority of the population of about 8,000 employed in agriculture, logging or related occupations. Principal agricultural products are soybeans, corn, peanuts and hogs, the latter becoming a major source of income subsequent to development of numerous small hog farming operations in the past 20 years.

The principal forest products are pulpwood and sawtimber, primarily derived from loblolly pine (*Pinus taeda*). Most farms have some portion in woodlands, which produce a crop of pine that is currently being harvested at about 35 to 75 years of age. Several timber companies have large tracts of woodlands in the county, chief of these being Union Camp Corporation. The company has extensive holdings in the western third of the county, most of which are intensively managed as loblolly pine plantations. These woodlands supply pulpwood to the paper mill at Franklin, Virginia.

The county has been isolated historically from major arteries of trade, and consequently has experienced little industrialization or urbanization. The population has changed little since the first US census in 1790, suggesting that it is in balance with the natural resources the land has to offer.

Few in the county would lament this condition. The quality of life is high in terms of clean air, access to outdoor recreation, such as fishing, boating and hunting, unspoiled natural beauty and open space. A major shopping area is 35-40 minutes away in Elizabeth City, and cultural events are available in Norfolk, little more than an hour's drive. While per capita income is lower than some other areas of the state, relative isolation has meant that the county has escaped the pollution, crime, overpopulation and high taxes of more urbanized, industrialized areas. The pace of life appears to be much more relaxed than in the cities.

GEOLOGY, TOPOGRAPHY AND PHYSIOGRAPHY

Gates County spans three terraces in the Embayed Section of the Coastal Plain Province of the Atlantic Plain. Its flat to gently rolling topography has largely been determined by marine and fluvial events within the past 80,000 years (Fig. 1). No detailed geologic survey of the county has been done. The geologic information presented here, and in the following individual sections on each of the natural areas

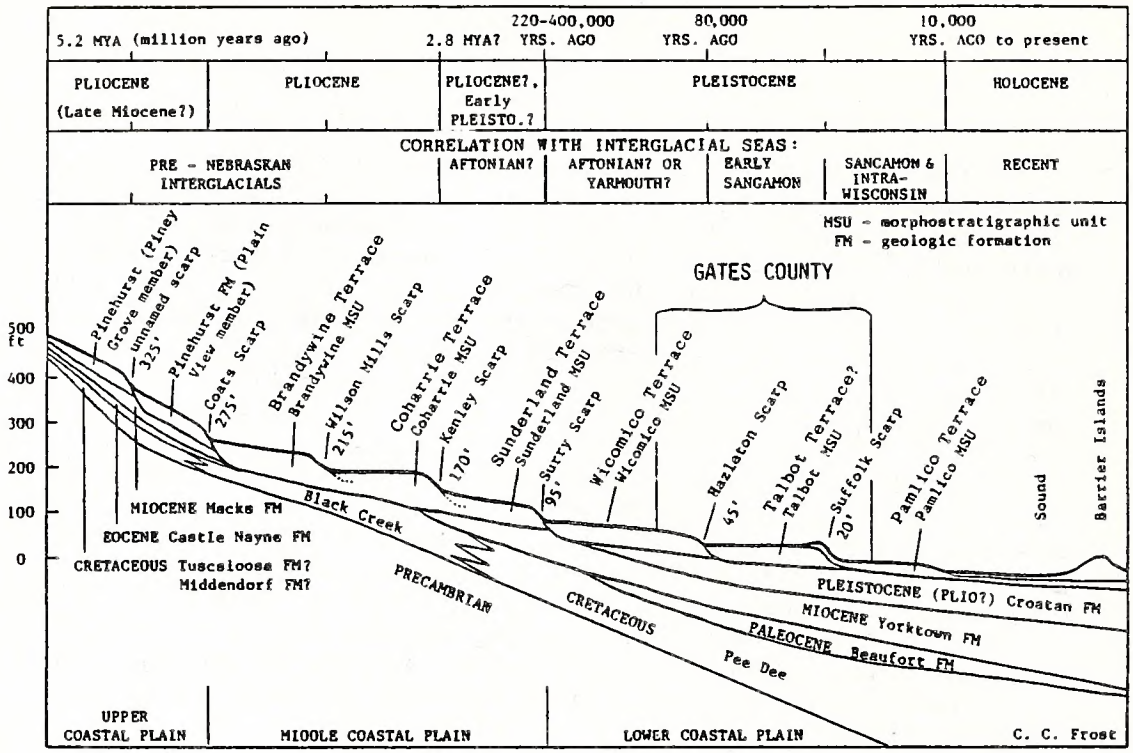


Fig. 1. Geology of Gates County in relation to the rest of the Coastal Plain: simplified surficial stratigraphy and geomorphology from high-elevation remnants in western Wake County to the coast. Elevations are for toes of scarps. Vertical exaggeration 600X (subsurface formations and lateral distances variable in scale). Compiled from Oaks and Coch (1963), Oaks and DuBar (1974), Oaks and Whithead (1979), Daniels et al. (1966, 1971, 1972, 1978). Bellis et al. (1975), Vail and Hardenbol (1979) and Parker (1979). The Hazelton Scarp is a local feature, perhaps analogous to the Walterboro Scarp elsewhere, and identified at present only in Suffolk, Virginia and Gates County.

surveyed for this report, is a tentative interpretation based upon the references given in figure 1, field work for this study, the 1929 soil map for Gates County, and the work of Whitehead (1972). This interpretation relies most heavily upon the detailed work of Oaks and DuBar (1974) in adjacent Virginia and the northeastern corner of Gates County. A conclusive understanding of the geology of the area will have to await further comprehensive field studies at some future date.

The county is quite young geologically. The oldest part is represented by the high, rolling land from Gates and Willeyton north to the Virginia line. This area comprises a semicircular plateau above the Hazelton Scarp. Even so, this portion of the Wicomico Terrace has only been exposed since sometime in the mid to late Pleistocene, about

220,000 to 400,000 years ago. The rest of the county is much younger.

The Suffolk Scarp and the older parts of the Talbot Terrace, which includes most of the upland areas and farmland of the county, are probably no more than 80,000 years old. The next younger surface includes the sandy lands around 20 feet elevation in the southern part of the county near Carter and the sub-peat formations beneath Dismal Swamp, perhaps 40,000 to 60,000 years in age. The Dismal Swamp peat only began forming around 8,900 years ago (Oaks and Whitehead 1979). In Chowan Swamp, peat probably only began forming around 5,000 years ago (see discussion of geology in section on Chowan Swamp). Sea level appears to be rising worldwide (Milliman and Emery 1968, Bloom 1978), and the rate of rise in the Albemarle area suggests that the region of which Gates County is a part is presently subsiding. Consequently, Chowan Swamp, which lies approximately at sea level in the southern part of the county, is undergoing geologic aggradation through deposition of river sediment and accumulation of peat. This would make it the youngest surface in the area.

STUDY SITES

The present study was undertaken to inventory the remaining natural areas, vegetation and wildlife of the county for the use of county officials, state and federal government, and the public. The study was carried out from May 1981 to April 1982 and utilized other data collected by the author during residence in the county from February 1976 to May 1981 as the first ranger at Merchants Mill Pond State Park.

Study sites were selected by travelling all of the roads in the county and by examination of a complete set of black and white orthophotoquad aerial photographs and color imagery from the Landsat satellite. Detailed study was carried out with NASA color infrared aerial photography of Dismal Swamp, Chowan Swamp and Merchants Mill Pond. Low altitude 35mm color infrared photography by Pat Gammon of the USGS was also used for Merchants Mill Pond.

Study sites were analyzed according to the specification guidelines of the North Carolina Natural Heritage Program, based in part on the method of Ecosystematics devised by A. E. Radford of the University of North Carolina. This involves study of each site in terms of seven major components: Biology, Climatology, Geology, Soils, Hydrology, Topography and Physiography.

An attempt was made to accumulate all scientific literature in which work was carried out in Gates County, or was directly related to the area. The majority of the material found involved work only within the past 10 years. These materials are presented in the section on References Cited.

With the exception of a small area in the Sand Banks, and the uplands around Merchants Mill Pond, all of Gates County's significant remaining natural areas are wetlands. Final areas selected for detailed study were:

1. A small tract of rare ferns in Dismal Swamp south of US 158.

2. The sandy "islands" north of US 158 in the Dismal Swamp National Wildlife Refuge.

3. The remnant marsh at the mouth of Corapeake Swamp in the Dismal.

4. The rest of the Gates County portion of the Dismal Swamp National Wildlife Refuge.

5. Merchants Mill Pond State Park.

6. The publicly owned lands in Chowan Swamp.

7. The small remnant areas of longleaf pine and turkey oak in the Sand Banks.

These areas are summarized in detail in the following report.

VEGETATION AND LAND-USE TYPES IN GATES COUNTY

1. UPLAND OAK FORESTS: originally a major type, rare now, with only scattered small remnants.

2. LONGLEAF PINE (*Pinus palustris*) and Longleaf pine/turkey oak/heath: originally the dominant upland communities of the county, on well-drained loams as well as deep sand soils. Now gone except for small remnants in the Sand Banks owned by the Story and Vaughan families.

3. BEECH SLOPES: once bordered all of the streams wherever high, steep slopes occurred. Many small remnants, the principal one at Merchants Mill Pond.

4. UPLAND POCOSINS OR CAROLINA BAYS: (Whiteoak, Black Mingle, Hall Pocosins) now mostly drained and converted to loblolly pine plantations.

5. SWAMP FORESTS:
   A. ATLANTIC WHITE CEDAR: Once occurred in pure stands in Dismal and Chowan Swamps. All gone now except for scattered trees and a small stand of about 5 acres owned by Weyerhauser Corporation south of US 158. This portion of the Dismal has recently been extensively ditched and drained, so, once removed by logging or fire, this stand will not reproduce itself.

   B. BALDCYPRESS/BLACK GUM: This was the dominant swamp forest, with the following major variations: cypress (*Taxodium distichum*) over tupelo (*Nyssa aquatica*) in areas with permanently standing water, and cypress over black gum (*Nyssa sylvatica biflora*) in the larger, less wet areas. This community has reproduced itself well in Chowan Swamp and along stream swamps, but it will take several centuries to regain its full stature because of the long

time required for cypress to reach its full height and mature form.

C. RED MAPLE and various mixtures of red maple, loblolly pine and black gum: This is a disturbance community resulting from wetland drainage attempts. Now the dominant forest type of the Dismal.

6. FRESHWATER MARSH: A naturally rare community, found only at the mouths of Sarem and Bennett's Creeks and at the mouth of Corapeake Swamp.

7. LOBLOLLY PINE - either in plantations or as unmanaged old-field and post-logging seral stands: This is now the dominant forest type of the county, having replaced several different presettlement forest communities.

8. MIXED PINE (LOBLOLLY) - HARDWOODS: Earlier in this century this was the prevailing type, occurring in unmanaged stands following 19th century and early 20th century logging. The present area of this type is about 15% of the uplands, and declining as more intensive forestry is practiced.

9. AGRICULTURE: Cleared agricultural lands, mostly in row crops, now comprise the largest single vegetation-land use category in the county.

10. URBAN - towns, trailer parks, houses, paved roads: Only about 1 to 2% of the county land area.

Pine timber presently being cut still comes chiefly from unmanaged woodlands. Loblolly pine (Pinus taeda) is the principle old-field pine of the county, springing up wherever a small patch of cultivated land or pasture is unused.

The original upland vegetation of sandy loam and clay soils was probably a complicated mosaic of longleaf pine with some shortleaf and loblolly; pocosin vegetation, and patches of oak forest. The drier uplands were cleared and farmed first, eliminating longleaf from all but the sandiest lands. As various small tracts were cleared and then abandoned, old-field loblolly pine stands became established, initiating the trend which resulted in dominance of this species by the early to mid 19th century. These were the stands reported by W. W. Ashe (1894) in the first survey of timber of the Coastal Plain by a trained forester.

Actual logging for sawtimber was apparently a minor practice, and mostly for local consumption until the mid 1800's. The invention of steam power in the early 19th century, and subsequent development of logging technology using steam equipment, led to the first large-scale removal of timber. A postal survey of individuals knowledgable about local forests, conducted by P. M. Hale, showed that by 1882 whole counties in northeastern North Carolina had been almost completely timbered.

Timber removed from central Gates County probably went from the old landings on Bennett's Creek by the Albemarle Sound and the Dismal Swamp Canal to Norfolk for export to New England, which had already decimated most of its large timber. The resulting cut-over woodlands, whatever the original forest types, formed the basis of the second major source of loblolly pine stands. Whereas abandoned agricultural tracts produced uniform stands of old-field pine, the ragged woodlands, completely unmanaged, developed a second growth of mixed pine and hardwoods. As these matured, they began to be logged in piecemeal fashion in the early 20th century. Removal of the second growth pine and some of the hardwood accellerated and became a major business for small, locally-owned logging companies. Essentially all of this wave of pine regeneration was removed by mid-century. Most of the present pine supply comes from unmanaged old-field and cutover woodland stands dating from the depression era.

Intensive forestry and conversion of woodlands to pine monoculture only began to be practiced in this area about 30 years ago. This process is intensifying, with most corporate and private lands now receiving site preparation by heavy equipment, followed by pine seeding or planting after logging. Nearly all of the extensive Union Camp holdings have already been so treated.

The county is therefore in a major period of transition in terms of its forests. The original types are being permanently converted to loblolly pine plantations. In addition, a great deal of land has been cleared for agriculture after logging, in the past 20 years. Examination of color infrared aerial photographs shows that, of the uplands, about 80% are now either cleared or in essentially pure pine stands. About 1 to 2% is urban or paved road. About 15% is in mixed pine-hardwood stands, most of which will be logged and converted to pine within the next 20 years. Therefore, only about 1 to 2% of the original upland oak and upland longleaf pine forest remains.

The only sizable remnants occur around Merchants Mill Pond and in the Sand Banks. Many farms have small tracts of oak forest, but most of these will be consumed for firewood within the next few years or otherwise converted to pine, agriculture or house lots. The outlook is bleak, then, for the county to retain examples of its native upland forests. Merchants Mill Pond will have a remnant of the white oak and red oak types. The only hope for future generations to see the native longleaf pine and turkey oak forests will be if the Story and Vaughan families see fit to preserve some small areas of these unusual types in the Sand Banks.

THREATS TO NATURAL AREAS, REMNANTS OF ORIGINAL VEGETATION AND WILDLIFE HABITAT IN GATES COUNTY

1. LAND CONVERSION FROM WOODLAND AND WETLAND TO OTHER USES. As discussed in several places in the following report, the original forests of the county have been entirely removed except for a few small remnants. Large areas have been cleared for agriculture. It is predicted that millions of

acres of new land will be cleared in the US in the next 20 years, to keep pace with rising world demand for grain. It is conceivable that most of the upland forests of the county will eventually be removed for agriculture. This may be carried out by the next generation, after the present pine plantations are harvested.

About half the county's portion of Dismal Swamp is being converted to agriculture and tree farming operations. Through continuing drainage efforts, the Dismal Swamp National Wildlife Refuge will eventually be the only significant remnant of this wetland.

Future demand for forest products after upland forests are all converted to agriculture and other uses, plus new technology will probably lead to some sort of tree farming in even the wettest swamps, with native communities being replaced with some fast growing species.

2. PEAT MINING: There may be enough peat in the Dismal and Chowan Swamps to fuel a power plant or some other facility for 20 to 30 years. Should this occur, Dismal Swamp might cease to exist as a wetland. Should Chowan Swamp be mined for peat, only open water would remain and the county would actually lose about 30,000 acres of land area. This would be an extremely short-sighted action, since the peat, once used, would be gone, but left in place would provide a permanent base for forest and wildlife habitat. Should the Miocene formation underlying the swamp ever be mined for phosphate, the same result would ensue. The county commissioners would do well to prepare ordinances in advance to prevent such a loss.

At present, the only significant natural areas in the county that are reasonably protected for access by future generations are Merchants Mill Pond and the portion of Dismal Swamp included in the Refuge. Should owners of the lands in the Sand Banks decide to log the small tracts of longleaf pine and turkey oak, these remnants of the original forests would be gone forever. In Chowan Swamp, the mineral rights to the public lands are privately owned, so this extensive natural area is, in reality, unprotected, and could be destroyed at some future date.

SPECIES EXTIRPATION FROM GATES COUNTY

Removal of the remaining upland forests and peat mining or tree farming of wetlands would drastically reduce the diversity of wildlife and plant species in the county. A number of native species have already been lost. The county was within the original range of both the Carolina Paroquet and the Passenger Pigeon before their extinction. It is unknown whether the Ivory-billed Woodpecker ever occurred this far north. At least two large mammals, the eastern panther and red wolf were eliminated long ago, probably during the 18th century.

The shortnose sturgeon and an unknown number of other aquatic species have been extirpated. Most of the other anadromous fishes of the Chowan River are on the decline because of pollution. An unknown number

of bird species, reptiles, amphibians and small mammals have been eliminated. Half the nest trees of the endangered red-cockaded woodpecker in the county have been cut in the past five years. Only about eight known nesting cavity trees remain. If the remaining longleaf pine - turkey oak areas in the Sand Banks are cut over, this species will also pass from the county fauna.

Among plants, it is likely that a large number of sandhills species has been lost, especially as land was converted to loblolly pine plantation in the sandy areas. Longleaf pine and turkey oak are reduced to only a few mature trees. During the course of this study, a search was made for the attractive, small creeping blueberry, which once occurred in the northern part of the Sand Banks. Examination of its last two known northern locations in Gates and Hertford Counties, revealed that both sites had been destroyed, one for a pulpwood plantation and the other cleared for agriculture. It can be concluded that this species has now been eliminated from the northern part of the state.

The future looks bleak in the county for fox squirrel, wild turkey, bobcat, river otter, mink, weasel, the red-shouldered hawk, eastern bluebird, red-cockaded woodpecker, the major food fishes of the Chowan River, longleaf pine, turkey oak, white cedar and a great number of less conspicuous species of birds, animals, shrubs and herbs, unless there is an active concern and effort by county residents to protect the critical habitats necessary.

Hopeful signs that this can be done have been efforts in recent years by area wildlife clubs to restore black bear and wild turkey; the decision by farm landowners not to channelize Duke Swamp and its tributaries; and efforts by the county commissioners to find a solution to the problem of pollution of the Chowan River. Sufficient natural areas barely remain to guarantee habitat for survival for most of the animal and plant species of Gates County. The quality of life of future generations will depend upon the decisions and efforts of the present inhabitants. This will eventually boil down to hard choices between natural values and the dollar.

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: DISMAL SWAMP SHIELD FERN NATURAL AREA

2. County:

Gates, NC

3. Location:

Along south side of US 158, just below toe of Suffolk Scarp.
About 0.6 mi east of Acorn Hill in east-central Gates County.
Fern area occurs for 300 m parallel to hwy. and extends 300 m into swamp.

4. Topographic quadrangle(s):

Beckford, 1929(1942) 15 min (1:62,500).
Beckford NE, 1981 advance print. 7½ min (1:24,000)

5. Size:

40 acres (16 ha)

6. Elevation: 20 feet (6 meters)

7. Access:

Park along shoulder of US 158. Walk in along boundary line path between M. R. White and J. B. Briggs. Boundary perpendicular to road, poorly marked with faded red blazes.

8. Names of investigators:

Cecil C. Frost, Botany Dept., UNC

9. Date(s) of investigation:

8-12-1981, 1-4-1982 and several other visits from 1977 to 1981.

10. Priority rating:

High

11A. Prose Description of Site.

This 40 acre area is remarkable for containing eight taxa (four species and four hybrids)of rare shield ferns (Dryopteris spp.). It was discovered in 1974 during the compilation of a preliminary flora of Dismal Swamp (Musselman et al. 1977), and has been the subject of two journal articles (Nickrent et al. 1978, McGraw et al. 1979) and a book chapter (Wagner and Musselman 1978). It is sometimes referred to enthusiastically by Dr. Musselman and his students as the Dismal Swamp "fern supersite".

The area occurs at the toe of the Suffolk Scarp, a relict wave-cut shoreline which forms the western boundary of the Dismal. At this point, US 158 decends about 25 ft. from the farmland along the top of the scarp to the old sea floor now occupied by swamp forest. This marine feature probably dates to the height of the Sangamon Interglacial around 90,000 years ago. Sea level at that time is believed to have been around 25 ft. higher than at present, which would correspond with the elevation at the bottom of the escarpment.

Much of Dismal Swamp is underlain by peat, up to 12 feet thick, over a sandy basal deposit of marine origin. In most of the swamp the age of this sand should correspond the beginning of recession of the sea around the end of the Sangamon, perhaps 70,000 to 80,000 years ago. Shallow drainage patterns bably formed on this exposed surface during the early Wisconsin ice age. The peat deposits are much younger, having been formed beginning around 11,000 to 12,000 years ago at the end of the Wisconsin.

As the scarp is approached on the west, organics are shallower and peat grades into a mineral soil with high organic content, which then feathers out onto the toe of the scarp. Underlying the fern site are fine-textured soils, probably derived from colluvial downwash from the scarp, continually mixed over a long period of time with organic material formed on the site. The soil

Organic soils are formed when the water table is high enough to prevent complete decomposition of plant litter. Under the previous hydrologic regime and in the absence of a sediment source from the nearby scarp, this site would have developed a thin layer of peat, which would have increased in thickness eastward into the swamp. The mineral content, however, probably precludes it being classified as a histosol.

Color infrared photography shows that the hydrology of the site was considerably interrupted by construction of US 158. In the undisturbed swamp, water was collected by the small swamp which crosses US 158 at Acorn Hill and flows downhill through a stream cut in the scarp just north of the highway. From there it moved south along a low area near the toe of the scarp into the headwaters of the Perquimans River.

US 158 has acted as a dam, preventing southward flow and causing the

swamp to become relatively wetter on the north side and drier on the south. Water entering the swamp from the Acorn Hill drainage is now diverted into the canal on the north side of the highway, where it flows easterly across the swamp.

A second important aspect of the hydrology of Dismal Swamp may be the supply of water from aquifers below the surface with origins somewhere above the Suffolk Scarp (Gammon & Garrett , pers. comm.). Clearing of much of the watershed for agriculture on the high lands above the swamp means that rainfall may now run off rapidly through drainage ditches rather than percolating slowly through forest litter into the ground to recharge these aquifers.

A third hydrologic factor for consideration is the general lowering of the water table in the Dismal which was begun with ditch construction by George Washington in the 18th century and has continued to the present day. The combined effects of these changes have undoubtedly caused the fern site to be considerably drier than in the original, undisturbed swamp.

These water table changes may not necessarily have seriously affected the rare Dryopteris populations however. The ferns occupy a topographic position that is better drained than the wetter lands to the east. It is quite possible that they existed in the virgin forest of the area on the toe of the scarp and simply adjusted to their moisture needs by migrating slowly downslope over the 200 years that the water table has been declining in response to drainage.

The complexity of the fern community and the general northern affinities of most of the genus suggest that they are relicts from cooler times at the end of the Wisconsin, protected here by the cool, moist conditions at the foot of the Suffolk Scarp.

11B. Prose Description of Site Significance.

This site contains a remarkable assemblage of ferns of the genus Dryopteris. This grouping has already been the subject of several scientific investigations. Of these, three species, plus an orchid, Listera australis are listed as threatened in North Carolina. The other 5 taxa of ferns are a group of disjunct and hybrid species, the nature of which is still not understood.

The swamp forest on this site is one of the more unusual in the Dismal, being a mature stand, of a type on more mesic sites than the generally hydric swamp forest which dominates the area. The difference is due to its presence on the lowest portion of the toe of the Suffolk Scarp, giving it a slightly better drainage situation.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Special concern species	A	Dryopteris celsa. Rare in North Carolina (Log fern)	Perhaps largest known population of this species. Over 1,000 individuals reported by Lytton Musselman
Endangered or threatened species	A	Dryopteris cristata (Crested shield fern). Threatened in North Carolina.	One of only two populations known on the Coastal Plain of North Carolina.
Endangered or threatened species	A	Dryopteris spinulosa (Spinulose wood fern). Threatened in North Carolina	Only two other populations (2 plants and four plants) known on the North Carolina Coastal Plain.
Disjunct plant population	A	Dryopteris intermedia (Fancy fern)	Only known population on the Coastal Plain of North Carolina.
Special concern plant hybrid	A	Dryopteris x australis (Southern wood fern hybrid)	Only population in North Carolina.
Special concern plant hybrid	A	Dryopteris x triploidea (Glandular spinulose fern hybrid).	Only population in North Carolina.
Special concern plant hybrid	A	Dryopteris x separabilis (Glandular log fern hybrid)	One other site in N.C. (Perquimans Co., 2 plants)

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Special concern plant hybrid	A	*Dryopteris celsa* x *cristata* (Log fern-crested shield fern hybrid)	Known from only three other locations in the United States.
High quality wetland plant community	A	*Acer rubrum*/*Ilex opaca*/ mixed *Dryopteris* taxa	Mature 2nd growth (70-90 years old). May be useful in determining the outcome of *Acer rubrum* succession in other Acer-dominated parts of the swamp.
Endangered or threatened species	A	*Listera australis* (Southern twayblade)	Endangered peripheral in NC (Cooper et al. 1977) Reported by Lytton Musselman. Being a spring ephemeral, this species was not seen during this site investigation.

Fig. 2. Access information:
DISMAL SWAMP SHIELD FERN NATURAL AREA

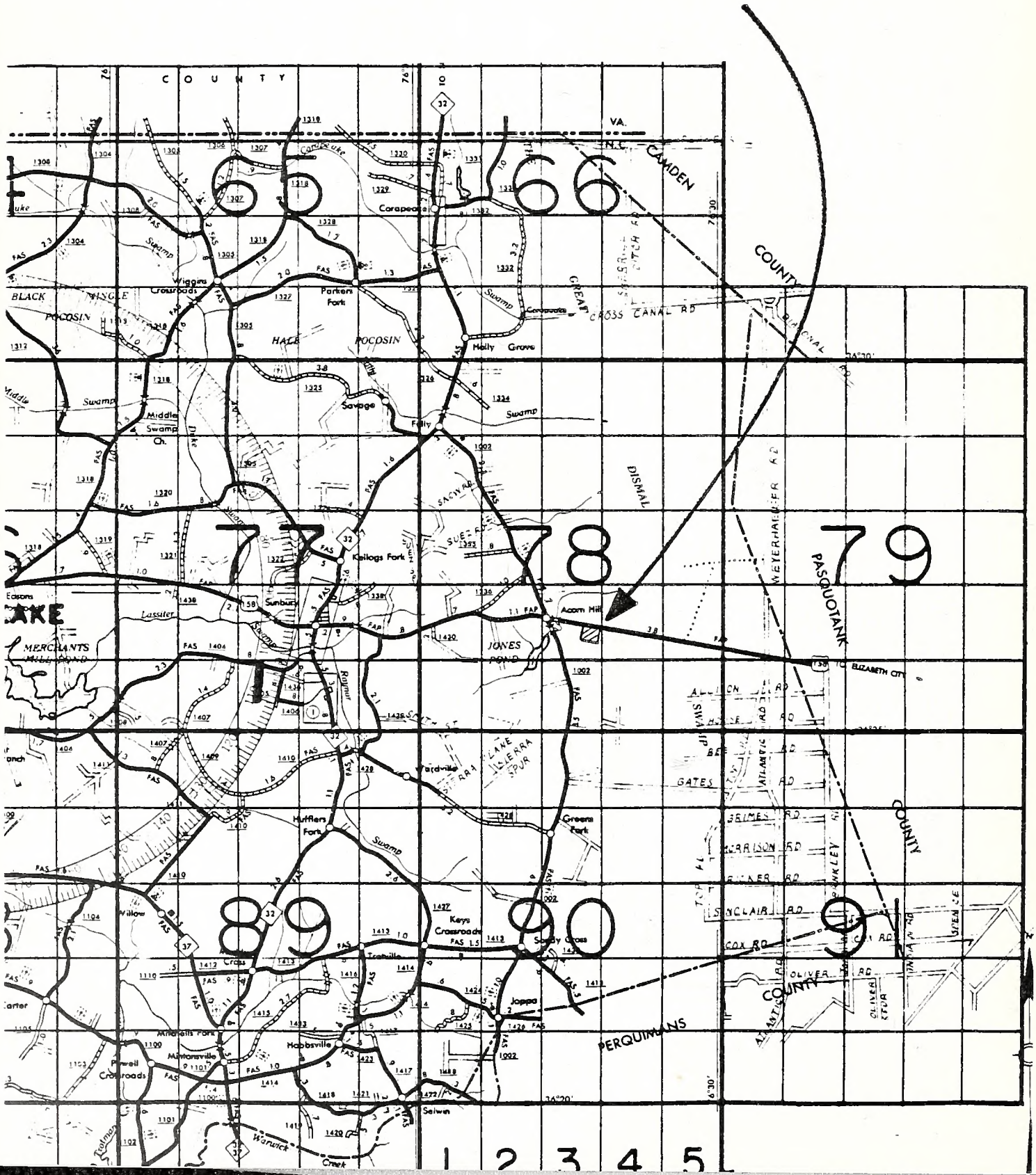
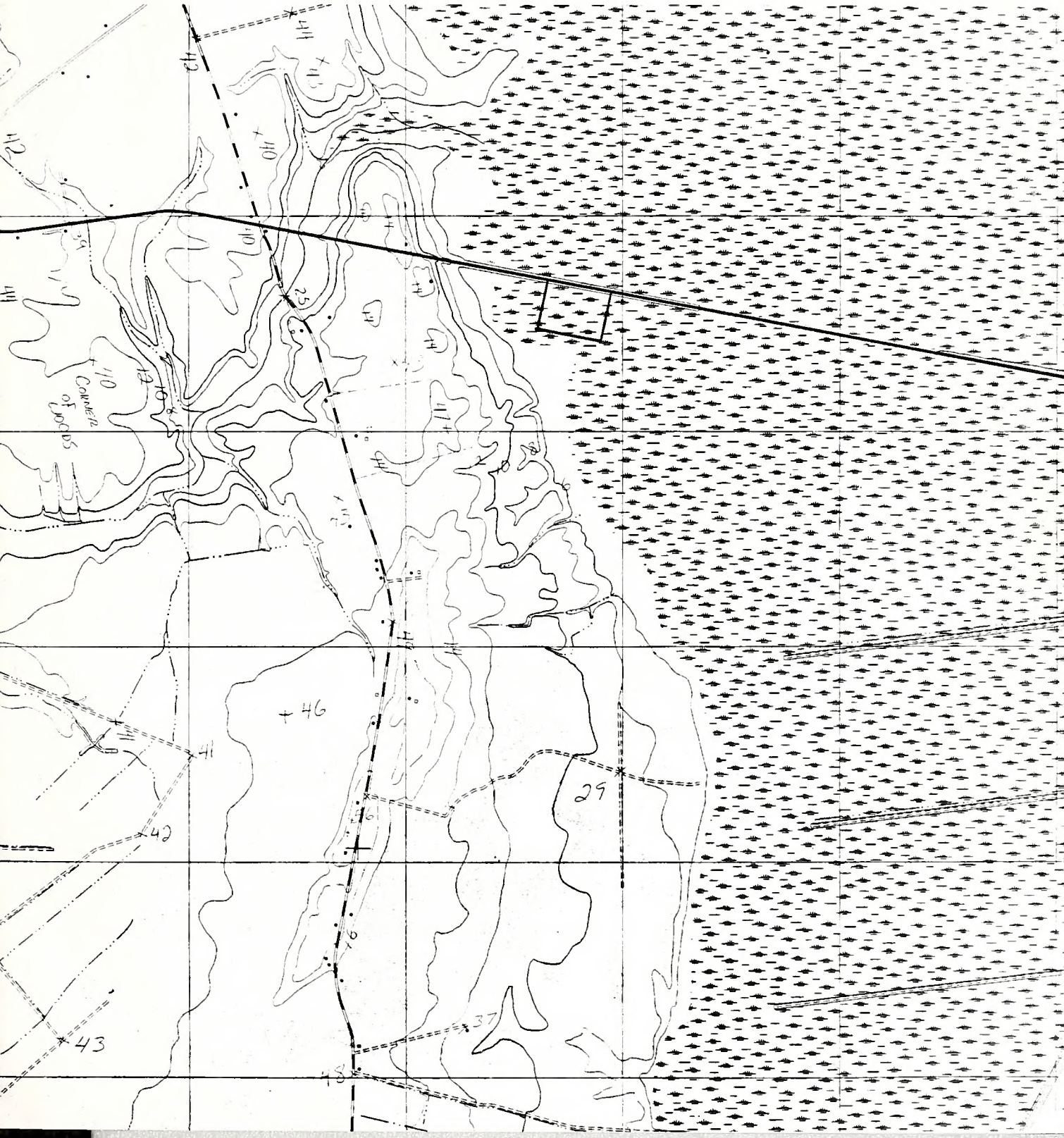


Fig. 3. Boundary, Dismal Swamp Shield Fern Natural Area.



Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	100 %
Public	%
Unknown	%

14. Number of owners: 2

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

Moses R. White Rt. 3 Elizabeth City, NC 27909 919-771-2423	M. R. White Lumber Co. Rt. 5 Elizabeth City 27909 919-771-5140	East half of natural area (20 a)
Joseph B. Briggs Rt. 1, Box 151 Sunbury, NC 27979		West half of natural area (20 a)

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

1. Dr. Lytton J. Musselman. Biological Sciences. Old Dominion Univ.
~~P. O. Box 6173. Norfolk, VA 23508~~
804-440-3610 Office
804-489-8614 Home
Discovered site, has published several journal articles on fern studies there.

2. Pat Gammon, Botanist, US Geological Survey
Dismal Swamp National Wildlife Refuge
P. O. Box 349
~~Suffolk, VA 23434~~
804-539-7479 Office
804-539-5335 Home
Has published several studies on the flora of Dismal Swamp using remote sensing.

17. Attitude of owner toward preservation (contacted?):

Mr. White has registered his 20 a half (part of a wooded tract of ~~452 acres) as a North Carolina Natural Heritage Area.~~

Mr. Briggs has not been contacted. His attitude is unknown.

18. Uses of natural area:

Site has been used by Dr. Musselman and several of his graduate students for species biology studies of the rare fern assemblage. No other uses known.

19. Uses of surrounding land:

a. Wildland 100 %

b. Agricultural _____ %

c. High-intensity forestry _____ %

d. Developed _____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
4	50%	White tract registered natural heritage area
6	50%	Briggs tract - unprotected

21. Regulatory protections in force:

Unknown

22. Threats:

Anything that would disrupt present light and moisture regimes. Logging is the most likely threat. Clearcutting would destroy the fern community by elimination of the shady, moist habitat and by allowing a takeover by weedy species.

It is likely that at some time in the future US 158 will be widened. Ditching on the south side of the highway could destroy the fern site by lowering the water table.

23. Management and preservation recommendations:

Preserve the site from any type of logging. Explore the possibility of Natural Heritage Registry with Mr. Briggs. Consider the possiblity of acquisition. See if Mr. White might consider willing his 20 a portion to the Nature Conservancy. The land on the opposite side of US 158 is owned by the Dismal Swamp National Wildlife Refuge, which might be able to manage the area.

The District Engineer of the Dept. of Transportation in Ahoskie and the Division Engineer in Elizabeth City should be notified of the sensitivity of the site to highway construction, and requested to keep this information on file for such time as the highway is to be widened.

Widening of the highway per se will not harm the site. However, care must be taken to preserve existing hydrology. This means that there should be no ditching on the south side of the highway and no new culverts connecting the north and south sides. Existing culverts far down the road should be replaced at exactly the same elevation after any new construction and any redredging or relocation of the existing ditch on the north side should be done in such a way as to maintain existing water levels.

The vegetation consists entirely of native species, with the exception of Japanese honeysuckle which has invaded and is locally dominant in the herb and shrub layers. At some point it might be necessary to (manually?) remove this species if it appears to be overrunning the more important fern assemblages.

24a. Vegetation - Biotic Community Summary

Community type:

Acer rubrum/*Ilex opaca*/mixed *Dryopteris* taxa

Community cover type:

Acer rubrum

General habitat feature:

Pocosin-relict marine scarp ecotone

Average canopy height:

82-92 feet

Estimated age of canopy trees:

Around 80 yrs.

Canopy cover:

Closed.

Estimated size of community:

40 acres.

Successional stage: Subclimax. Eventual climax unknown. The area is in transition because of disturbances in hydrology within the swamp and above the Suffolk Scarp.

Sere type: Originally a psammosere (beginning of Wisconsin period) but present vegetation developed on a soil derived from fine-textured colluvial material from the Suffolk Scarp, intermingled with organic material formed in situ. There is no suitable term for this seral situation.

Common canopy species in community cover or community type (but not dominant): *Nyssa sylvatica biflora*, *Taxodium distichum*.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Pawpaw (*Asimina triloba*)

Common herb stratum species in community cover or community type (but not dominant):

Cane (*Arundinaria gigantea*), Japanese honeysuckle (*Lonicera japonica*)

24b. Soil Summary (by community type)

Soil series: Bladen loam. (1929 classification - probably incorrect).

Soil classification: n.d. (Humaquept?)

Soil association: Coxville-Myatt-Rains (1972 tentative general soil map). Mapped Ponzer-Pamlico-Dorovan on general soil map of North Carolina.

pH class: n.d.

Source of information: Davis, W. A. and R. E. Devereux. 1929. Soil survey of Gates County, North Carolina. USDA Bureau of Chemistry and Soils.

Other notes:
No survey has been done in the county using modern nomenclature.

24c. Hydrology Summary (by community type)

Hydrologic system: Palustrine (bordering on terrestrial)

Hydrologic subsystem: Interaqueous

Water chemistry: Fresh

Water regime: Intermittently flooded

Drainage class: Somewhat poorly drained

Drainage basin: Perquimans River

Hydrology characterization: A somewhat poorly drained, intermittently flooded, interaqueous palustrine system, wetted by fresh rains and a seasonally high water table.

24d. Topography Summary

Landform: Transition zone between relict marine scarp and peat-filled pocosin. Located on lower toe slope of scarp.

Shelter: Partly sheltered by scarp on west.

Aspect: n.a.

Slope angle: Nearly level (0-2°)

Profile: Flat

Surface patterns: Generally smooth surface with minor undulations.

Position: n.a.

25. Physiographic characterization of natural area:

Subclimax community on mixed organic and fine-textured colluvial deposit at toe of the Suffolk Scarp, on the western boundary of the Great Dismal Swamp, in the Embayed section of the Coastal Plain Province of the Atlantic Plain.

Geological formation:

Holocene organics and colluvium overlying the Pleistocene Pamlico Formation. In recent work a few miles to the north of this locality, the Pamlico has been found to be a complex group of five geologic formations. Exact data is not available for the natural area however.

Geological formation age:

About 80,000 years (Pamlico Formation).

References cited:

Daniels, R. E., E. E. Gamble and W. H. Wheeler. 1978. Age of soil landscapes in the Coastal Plain of North Carolinal Soil Sci. Soc. Am. J. 42:98-105.

Oaks, R. Q., Jr. and D. R. Whitehead. 1979. Geologic setting and origin of the Dismal Swamp, southeastern Virginia and northeastern North Carolina. In: P. W. Kirk, Jr., ed. The Great Dismal Swamp. Charlottesville: Univ. of Virginia Press. 427 p.

26. Summary - endangered and threatened species

Name of species: Dryopteris celsa (Log fern)

Species legal status and authority: Threatened in North Carolina.Cooper et al., 1977.

Number of populations on site: One large, irregularly distributed population.

Number of individuals per population: Over 1,000 plants reported by Lytton J. Musselman.

Size or maturity of individuals: Large, reproducing plants.

Phenology of population:

Eg: vegetative % Most individuals producing abundant sori.

flowering %

fruiting %

General vigor of population: Robust

Disturbance or threats to population:
Potential logging, likely widening of US 158 at some future date.

Habitat characteristics

Plant community: CT-A

Topography: Swampy toe of relict marine scarp

Soil series: Bladen loam (1929 classification)

Microclimate: Cooler and wetter than natural area climate.

Drainage basin: Perquimans River

Other plants and animal species present:

Red maple, american holly, seven other Dryopteris taxa.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Dryopteris cristata (Crested shield fern)

Species legal status and authority: Threatened in North Carolina. Cooper et al. 1977.

Number of populations on site: Unknown. Not abundant.

Number of individuals per population: Unknown (few).

Size or maturity of individuals: Healthy, reproducing plants.

Phenology of population:

Eg: vegetative % Most individuals producing sori.

flowering %

fruiting %

General vigor of population: Small, fragile population.

Disturbance or threats to population: Logging, lowering of water table by ditching or change in hydrology during widening of US 158 at sometime in future, or overrunning of site by japanese honeysuckle could eliminate this species.

Habitat characteristics

Plant community: CT-A

Topography: Flat lower toe of Suffolk Scarp.

Soil series: Shown Bladen loam on 1929 soil map.

Microclimate: Cooler and moister than natural area climate.

Drainage basin: Perquimans River.

Other plants and animal species present: Red maple, american holly, seven other Dryopteris taxa.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Dryopteris spinulosa (Spinulose wood fern)

Species legal status and authority: Threatened in North Carolina. Cooper et al. 1977.

Number of populations on site: Unknown.

Number of individuals per population: Unknown (Abundant).

Size or maturity of individuals: Large plants.

Phenology of population:

Eg: vegetative %

flowering %

fruiting % Most individuals producing abundant sori.

General vigor of population: Robust.

Disturbance or threats to population: Potential logging, likely widening of US 158 at some future date.

Habitat characteristics

Plant community: CT-A

Topography: Flat lower toe of Suffolk Scarp.

Soil series: Bladen loam (1929 classification)

Microclimate: Cooler than natural area climate.

Drainage basin: Perquimans River.

Other plants and animal species present: Red maple, american holly, seven other Dryopteris taxa.

Aerial or detailed maps with populations clearly marked:

27. Master species list.

CANOPY:

Acer rubrum
Liquidambar styraciflua
Liriodendron tulipifera
Nyssa aquatica
Nyssa sylvatica
Pinus taeda
Taxodium distichum
Ulmus americana

SUBCANOPY:

Aralia spinosa
Asimina triloba
Ilex opaca
Magnolia virginica
Prunus serotina
Symplocus tinctoria

SHRUBS:

Arundinaria gigantea
Callicarpa americana
Clethra alnifolia
Euonymus americana
Leucothoe axillaris
Rubus sp.

HERBS:

Asplenium platyneuron
Athyrium asplenioides
Carex sp. (3 species)
Commelina sp.
Dryopteris x australis
Dryopteris celsa
Dryopteris celsa x cristata
Dryopteris cristata
Dryopteris intermedia
Dryopteris x separabilis
Dryopteris spinulosa
Dryopteris x triploidea
Panicum sp.
Phytolacca americana
Sambucus canadensis
Woodwardia (Lorinseria) areolata

VINES:

Anisostichus capreolata
Campsis radicans
Decumaria barbara
Lonicera japonica
Parthenocissus cinquefolia
Rhus radicans
Smilax rotundifolia
Smilax glauca
Vitis rotundifolia

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: DISMAL SWAMP MESIC ISLANDS

2. County: Gates

3. Location: On refuge road 2.4 miles north of US 158 near Gates County line. About 1/4 mile due west of road.

4. Topographic quadrangle(s):
Beckford 1929(1942) 15 min (1:62,500).
South Mills 1940 15 min (1:62,500).
The islands extend across both of these topos but, unfortunately, are not shown on either.

5. Size:
600 acres (242 ha)

6. Elevation: From about 20 to 30 ft.

7. Access: East on US 158 from Acorn Hill, 2.7 mi. Turn north on refuge road across ditch. North 2.4 miles to a large steel pipe (about 4 ft in diameter) lying in canal parallel to road. Cross canal and steer due west through swamp ¼ mi to first island.

8. Names of investigators:

Cecil C. Frost, Botany Dept., UNC-Chapel Hill.

9. Date(s) of investigation: 9 August 1981.

10. Priority rating: High.

11A. Prose Description of Site:

The mesic islands are a series of sand ridges in the Dismal Swamp, the most conspicuous of which occur in small groups along an east-west axis in Gates and Pasquotank Counties. They rise several feet above the general peat landscape and support a mesophytic plant community that is of very limited extent in the Dismal. The flora is similar in composition to the mesic islands in Chowan Swamp which have, however, a different geologic origin. The elevated portions of the islands are dominated by a mature (75-100 yr) beech forest.

The modern history of the Dismal Swamp has been one of artificially lowered water tables, leading to peat removal by wildfire, and subsequent replacement of the native white cedar by less specialized mesophytes — red maple in particular. Much of the black gum (Nyssa sylvatica) and loblolly pine in the southern part of the refuge also represents disturbance vegetation. The proper habitat of these species in the original forest is discussed in the section of the Introduction on presettlement forests of Gates County.

There is no reason to assume that this portion of the swamp has escaped the type conversion which has occurred over other areas of deep peat. Therefore, the original forest vegetation surrounding the mesic islands was probably Atlantic white cedar (Chamaecyparis thyoides). There was probably a higher water table and a more constant moisture regime before european settlement.

The role of fire in regulating beech communities on the Coastal Plain may be the prevention of their spread onto drier uplands (Ware 1978) and, therefore, confinement to moist slopes and other fire-protected sites. It is unlikely that fire played a major role in the vegetation of these isolated islands. While the original vegetation of the dry top of the Suffolk Scarp, and of the drier sandy uplands in other parts of Gates County to the west, was a longleaf pine pyroclimax, the surrounding swamp probably protected the mesic islands from all but the infrequent surface peat burns characteristic of white cedar habitat. This phenomenon may have been enhanced by the fire barrier created by a wet depression along the toe of the scarp to the west.

It is presumed that the Indians living along the scarp probably fired the woods, for hunting purposes and for ease of travel, as often as litter accumulation would support a fire — perhaps every 2 or 3 years. Within the central swamp, a likely fire frequency might be only 3 or 4 per century. Judging from the age of existing white cedar stands, fires hot enough to kill established stands of cedar occurred only once or twice per century. Large stumps preserved in older levels of peat suggest that the frequency may have been even less in the past.

In the summer of 1982, after 2 yrs of severe drouth, there was no appreciable litter buildup on the islands, and scarcely enough material to support a light surface fire. This apparently is a characteristic of mature beech forest. Little litter is produced by the trees themselves. On the shady, moist sites preferred by beech, litter decomposes rapidly. The closed canopy prevents growth of shrub and herb vegetation which could support fire when dry. Therefore, it seems unlikely that fire could substantially affect these sites.

It might be questioned with some justification, whether the mesic islands might have originally supported mesophytic oak species in addition to beech. It is possible that white oak and other species were dominant or co-dominant with beech before the surrounding swamp land was logged. Oak could have been removed for timber, or consumed for fuel by logging or hunting camps (a small cedar cabin remains standing on one of the largest islands). If so, the present beech stand could represent a residual species which has simply closed the canopy after removal of its associates. The long-term successional role of beech beyond 75 to 100 yrs in southern Coastal Plain forests is unknown.

Soils of the mesic islands are sands and sandy loams. These have not been mapped on existing soil maps and their further classification is unknown. The islands derive most of their moisture from rainfall and the high water table in the surrounding swamp. Root systems of most of the trees should be able to reach the water table or benefit from capillary action in the soil above it.

POSSIBLE ORIGINS

Two hypotheses are proposed to account for the geologic origin of these unusual features. Their presence in the otherwise unbroken swamp is striking in that they appear to be unrelated to the rest of the landscape. This is a consequence of post-Wisconsin mantling of the area with peat, obscuring the basal topography of which they are a part. Mapping of this sub-peat horizon is incomplete in the southern portion of the Dismal, and a satisfactory account of their origin may not be obtained until this is done.

Their remarkable orientation, perpendicular to the Sangamon shoreline, and their lenticular shapes, suggest formation by fluvial or eolian processes. They could date from the end of the Sangamon interglacial period, some 80,000 years ago, or may have been deposited later during the Wisconsin glacial.

1. Sangamon Origin: Dunes along shoreline of the Pasquotank basin.

Perhaps the most plausible explanation might be that they formed as a series of dunes along the south shore of a lagoonal area during recession of the Sangamon sea. As discussed in the formation of the marsh at 'Washington's Rice Farm', creation of the Pasquotank drainage may have begun with the cutting of Corapeake and Moss Swamps through the Suffolk Scarp during the Illinoian glacial period. As these flowed together across the flat plain of the Dismal, they would have formed a shallow stream valley which may have been the precursor for the present sub-peat drainage pattern partially mapped by Oaks and Whitehead (1979).

With the rise of sea levels during the Sangamon, this area was flooded as far west as the Suffolk Scarp, and some filling of the shallow valley occurred. Deposition of the Norfolk and Sand Bridge Formations would have softened the contours of the previous drainage, leaving only a shallow estuarine basin. The mesic islands could have formed in a lagoonal situation, along the southern rim of this Pasquotank basin, as the Sangamon shoreline receded to the east.

Details of these sandy ridges are readily distinguishable on color infrared aerial photography. Eolian origin is suggested by their lenticular shapes and the repetitive pattern observable in some groups. The islands are elongated from west to east, but show a stacking pattern from north to south. In one remarkable group, just east of the Gates/Pasquotank County line, a series of five parallel ridges can be discerned. Similarly, a repeating pattern of ridges within an island group can be found along the Pasquotank River farther east, and, less distinctly, within the clusters in Gates County.

If this hypothesis is correct, these ridges were probably formed at the close of the last high stand of the Sangamon sea and have been covered with vegetation since that time. Unfortunately, since sea levels are presently rising (Bellis et al. 1975), contemporary examples of coastal morphology resulting from receding seas are not available for comparison in this part of the Atlantic Coastal Plain.

2. Wisconsin Origin: Fluvial sand deposits and associated dunes.

The distribution of these ridges along the apparent former course of the Pasquotank River suggests the possibility of fluvial origin. Whether or not the Pasquotank drainage, with its headwaters in Corapeake and Moss swamps, began to form in the Illinoian, it is certain that it operated during the Wisconsin since it can be seen directly beneath the post-Wisconsin peat.

Formation of the Dismal Swamp peat did not begin until around 11,000 to 12,000 years ago. During the Wisconsin, this abandoned sea floor was a flat, sandy plain, vegetated by spruce, northern pines of sandy soils (Pinus banksiana and Pinus resinosa) and northern herbaceous species characteristic of open areas (Whitehead 1972). The mesic islands could have originated as dune sands accumulated by dry winds sweeping across the sandy plain.

A more likely hypothesis, however, might involve both fluvial and eolian processes. Fluvial origin is suggested by the fact that the entire series of ridges parallels the apparent sub-peat course of the Pasquotank River. Sand, from the Sangamon beach deposits atop the Suffolk Scarp, could have been carried down onto the plain.

Because of the elevational differences between the Talbot and Pamlico terraces, the floor of the plain underlying the Dismal served as base level for streams arising above the scarp. The stream gradient was much lower to the east. As gradient decreased abruptly, the sand portion of the bed load would have been deposited as sand bars on the lower terrace. This alone, however, would not be adequate to explain the present sand ridges, which rise 6 to 8 feet above the peat beds.

Significant sand movement through the stream system, across the nearly level plain, probably occurred only during times of high water. During dry periods the low sand bars would have been exposed to drying and subsequent wind action. Wind-borne sands could have been swept from the shallow stream bars and accumulated in the adjacent woods to their present height. The parallel ridges could represent sequences of accumulation during channel migration.

11B. Prose description of site significance:

The mesic islands are covered with mature beech stands (75 to 100 yrs: one specimen 60 cm [24 in] dbh), which also contain a few oaks (Quercus alba, Q. nigra, Q. falcata, Q. michauxii). This may have been the major presettlement community type on mesic slopes and other fire-protected sites with similar drainage on the Coastal Plain. The role and composition of this type have been investigated (Nesom and Treiber 1977, Ware 1978) but is still poorly understood. Few quality sites remain. These islands will be valuable study sites for determination of the long-term successional fate of beech and its oak associates.

Similarly, the islands are ringed by large loblolly pine (Pinus taeda: one specimen 59 cm [23 in] dbh). As a consequence of disturbance through logging, agriculture and fire suppression, this weedy, old-field species is now the dominant tree in Gates County. Its primary original habitat may have been a zonal situation along a moisture gradient, such as that in which it occurs on this site. Here, pines form a ring around each island in the transition area between mesic upland and hydric swamp.

Loblolly occupies the zone which is slightly wetter than beech and oak, but drier than baldcypress and black gum (Nyssa sylvatica). Its preferred habitat is very close to that of red maple. Most studies of loblolly pine have treated its characteristics as a sylvicultural specimen grown for pulpwood and timber, taking advantage of its role as an early successional species on upland sites. Little has been done to study it in its primary wetland habitat. Because of its commercial value, few remnant old-growth stands remain; consequently, the mesic islands will be valuable study sites for this species also.

The "islands" constitute a significant geomorphic feature, being the only specimens of this type in the region (along with the two or three small groups to the east in Pasquotank County). No comparable features elsewhere are known to this author. Two possible origins are suggested: peripheral lagoonal dunes deposited by a retreating Sangamon sea, or fluvial and eolian dunes formed during the Wisconsin.

The islands contain Stewartia malacodendron (silky camellia) and Listera australis (southern twayblade), an endangered peripheral species in North Carolina. Mesic sites are rare in the Dismal and were even more so in the original swamp. As such they are of critical importance as wildlife habitat. They are used heavily by black bear, a species plagued on the Coastal Plain by shrinking habitat. Further investigation is needed to determine use by other swamp species such as bobcat and possibly panther, an endangered species of which several sightings were made a few miles to the north in 1979 and 1980.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
High quality terrestrial plant community	A	*Fagus grandifolia*/*Ilex opaca*/ *Fagus* transgressives	Mature beech forest (75-100 yrs) on mesic sand ridges surrounded by swamp. Absence of any non-native species.
High quality wetland plant community.	B	*Pinus taeda*/mixed evergreen shrubs	Large second-growth loblolly pine in one of its native presettlement habitats.
Geologic/geomorphic feature	C	Relict Sangamon lagoonal dunes (or Wisconsin fluvial-eolian dunes)	Unusual landform in this area. Extent elsewhere unknown.
Endangered or threatened species	D	*Listera australis* (Southern twayblade)	Endangered peripheral in North Carolina (Cooper et al. 1977).

Fig. 4. Access information:
DISMAL SWAMP MESIC ISLANDS

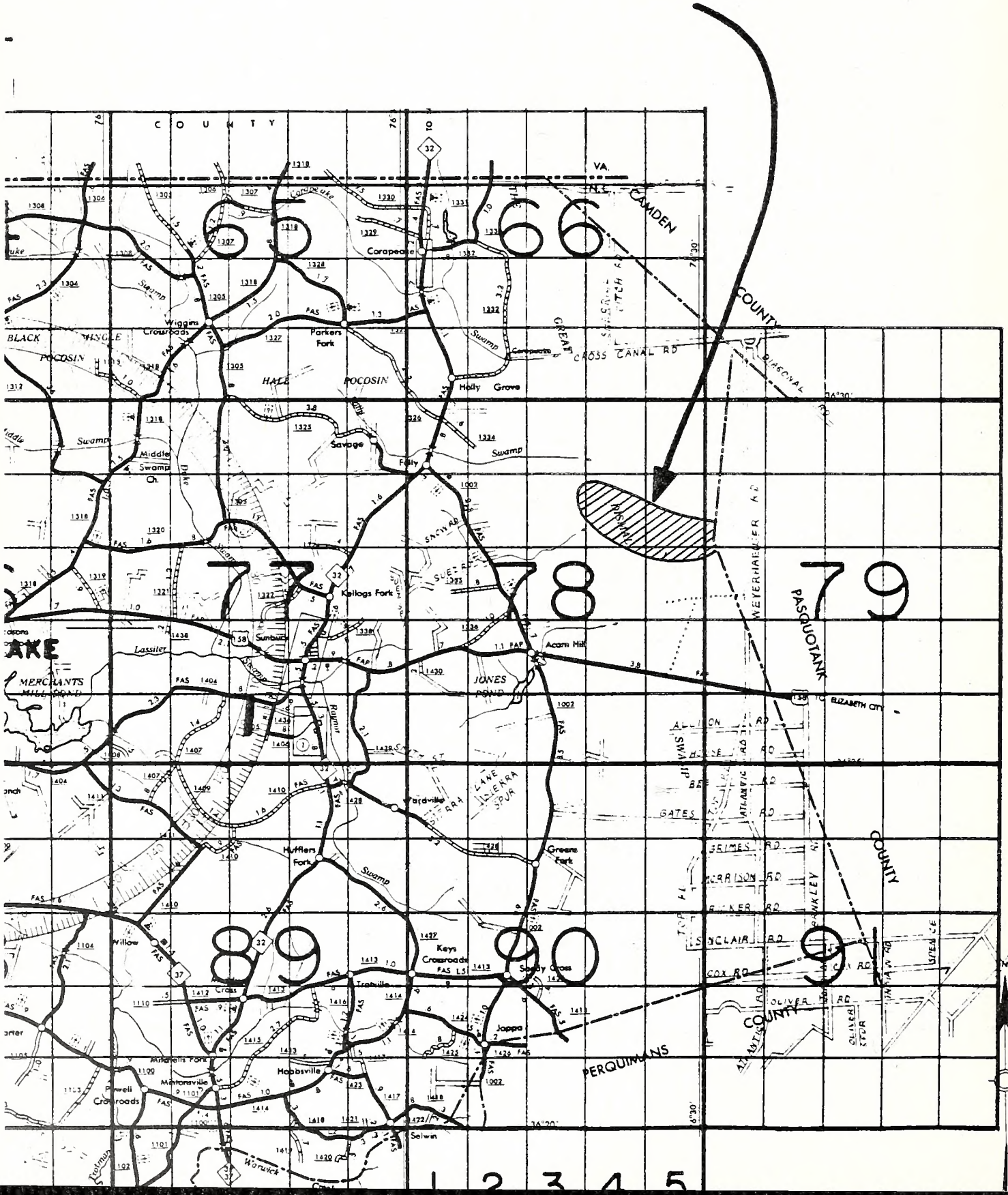


Fig. 5. Boundary and Significant Natural Features, Dismal Swamp Mesic Islands Natural Area. I = Mesic Islands.

Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	%
Public	100 %
Unknown	%

14. Number of owners: 1

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434 (804) 539-7479

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

Pat Gammon, Botanist, US Geological Survey
Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434
(804) 539-7479 Office
(804) 539-5335 Home Has published several studies on the flora of Dismal Swamp, using remote sensing techniques.

17. Attitude of owner toward preservation (contacted?):

Contacted June, 1981. Refuge managers consider this an important natural area because of presence of *Stewartia*, the large, mature hardwood forest and the importance as habitat for black bear and other wildlife species.

18. Uses of natural area: Present use is as wildlife habitat for black bear and other species, and as a natural area for preservation of high quality plant community containing Stewartia malacodendron, Listera australis, and mature beech forest.

A tiny cabin on the island closest to the road may have been used as a hunting camp in the past. The islands were undoubtedly used as temporary bases during past logging operations.

19. Uses of surrounding land:

a. Wildland 100 %

b. Agricultural _____ %

c. High-intensity forestry _____ %

d. Developed _____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
1	100%	National Wildlife Refuge. Area
		registered as a North Carolina Natural Heritage Area.

21. Regulatory protections in force:

Area is subject to all the rules and regulations of the Dismal Swamp National Wildlife Refuge.

22. Threats: None known if Refuge continues to protect the area.

23. Management and preservation recommendations: Maintain the site as a study area for observation of the long-term successional role of beech, for other vegetation studies, and for wildlife habitat. Leave the mesic islands undisturbed. Do not practice fire suppression or prescribed burning.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary

Community type: *Fagus grandifolia/Ilex opaca/Fagus transgressives*.

Community cover type: *Fagus grandifolia*.

General habitat feature: Possible late Sangamon relict dunes, occurring as 'islands' in a sea of peat.

Average canopy height: 24 meters.

Estimated age of canopy trees: 100 years.

Canopy cover: Closed.

Estimated size of community: Perhaps 100 acres total, scattered over several islands.

Successional stage: Climax.

Sere type: Psammosere.

Common canopy species in community cover or community type (but not dominant): Mixed oaks.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant): *Vaccinium corymbosum*, *Gaylussacia frondosa*.

Common herb stratum species in community cover or community type (but not dominant): None.

24b. Soil Summary (by community type)

Soil series: Unknown. Unmapped on any existing soil maps for the area.

Soil classification: Unknown.

Soil association: Unknown.

pH class: Unknown.

Source of information: Davis et al. 1929. USDA SCS 1972. USDA SCS 1974.

Other notes: Surface soils are sands and sandy loams.

24c. Hydrology Summary (by community type)

Hydrologic system: Terrestrial

Hydrologic subsystem: Dry-mesic.

Water chemistry: Fresh.

Water regime: Permanently exposed.

Drainage class: Well-drained.

Drainage basin: Located in the swamp near the divides between the Pasquotank, Little and Perquimans Rivers. Presettlement drainage for those mesic islands in Gates County may have been to the Perquimans River. Mapping of subsurface drainage patterns, formed before the post-Wisconsin accumulation of peat, is incomplete for the southern half of the swamp (Oaks and Whitehead 1979).

Hydrology characterization: A well-drained, permanently exposed, dry-mesic terrestrial system, wetted by fresh rains (and at its lower level, by a seasonally high water table in the surrounding swamp.)

24d. Topography Summary

Landform: Possible relict estuarine dune system.

Shelter: Open.

Aspect: N/A.

Slope angle: From flat top to 10% around periphery of islands.

Profile: Convex.

Surface patterns: Smooth to gently undulating.

Position: From mid-slope on one side of island, across gently rounded crest, to mid-slope on other side.

25. Physiographic characterization of natural area:
Climax beech community on mesic islands in the southern half of the Great Dismal Swamp, in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation: Unnamed local formation, of limited extent, on Pleistocene deposits of unknown stratigraphy, over the Yorktown Formation.

Geological formation age: Late Sangamon or Wisconsin (see prose description of site for discussion).

References cited:

Oaks, R. Q., and D. R. Whitehead. 1979. Geologic setting and origin of the Dismal Swamp, southeastern Virginia and northeastern North Carolina. In: P. W. Kirk, Jr., ed. The Great Dismal Swamp. Charlottesville: Univ. of Virginia Press. 427 p.

Oaks, R. Q., JR. and N. K. Coch. 1963. Pleistocene sea levels, southeastern Virginia. Science 140:979-983.

Daniels, R. B., E. E. Gamble and W. H. Wheeler. 1978. Age of soil landscapes in the Coastal Plain of North Carolina. Soil Sci. Soc. Am. J. 42:98-105.

26. Summary - endangered and threatened species

Name of species: Listera australis (Southern twayblade).

Species legal status and authority: Endangered peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: One reported by Pat Gammon, Dismal Swamp National Wilflife Refuge.

Number of individuals per population: Unknown.

Size or maturity of individuals: Unknown.

Phenology of population: Unknown. Highly ephemeral species. not easily recognizable at the time of year during which this survey was conducted.

Eg: vegetative %

flowering %

fruiting %

General vigor of population: Unknown.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community: CT-A. Fagus grandifolia

Topography: Gently rolling eolian ridges of low relief.

Soil series: Unknown.

Microclimate: Warmer and drier than local climate.

Drainage basin: On ill-defined divide between Pasquotank, Little and Perquimans Rivers.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists:

CANOPY:
- Acer rubrum
- Fagus grandifolia
- Liquidambar styraciflua
- Liriodendron tulipifera
- Pinus taeda
- Quercus alba
- Quercus falcata
- Quercus michauxii
- Quercus nigra

SUBCANOPY:
- Ilex opaca
- Magnolia virginiana
- Oxydendron arboreum

SHRUBS:
- Aralia spinosa
- Asimina triloba
- Euonymus americana
- Gaylussacia frondosa
- Hamamelis virginiana
- Lyonia lucida
- Persea borbonia
- Rhododendron viscosum
- Sassafras albidum
- Stewartia malacodendron
- Symplocus tinctoria
- Vaccinium corymbosum
- Vaccinium stamineum

HERBS:
- Arundinaria gigantea
- Carex sp.
- Carex sp.
- Chimaphila maculata
- Conopholis americana
- Goodyera pubescens
- Medeola virginiana
- Mitchella repens
- Osmunda cinnamomea
- Osmunda regalis
- Rubus sp.
- Thelypteris noveboracensis
- Tipularia discolor
- Woodwardia virginica
- Woodwardia areolata

VINES:
- Anisostichus capreolata
- Gelsemium sempervirens
- Parthenocissus quinquefolia
- Rhus radicans
- Smilax rotundifolia
- Vitis rotundifolia

BIRDS:
- Carolina wren
- Chickadee
- Pileated woodpecker
- Prothonotary warbler
- Red-bellied woodpecker
- Red-eyed vireo
- Wood thrush

MAMMALS:
- Black bear (Tracks, droppings, diggings on island & gnawings on cabin)
- Raccoon
- White-tailed deer

Listera australis, a species listed as an endangered peripheral in North Carolina (Cooper et al. 1977), occurs on the site (Pat Gammon, pers. comm.) but, being a spring ephemeral, was not recorded during this survey.

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: CORAPEAKE MARSH (WASHINGTON'S RICE FARM)

2. County: Gates.

3. Location: Dismal Swamp National Wildlife Refuge. Just east of mouth of Corapeake Swamp.

4. Topographic quadrangle(s): Corapeake, VA - NC, 1977. 7½ min (1:24,000) topographic orthophotomap.

5. Size: Originally described as 2,000 to 3,000 acres by George Washington in 1763. Visible boundaries indicate an area of about 300 acres overgrown in recent times. Actual remnant marsh about 30 acres. Nominal natural area size, 300 acres (121 ha).

6. Elevation: 24 feet.

7. Access: East on SR 1332 from Holly Grove, about 1 mile to southern edge of Corapeake Swamp. Turn right onto dirt farm road about 1.1 miles east into Refuge along south side of Cross Canal. Cross Cross Canal on foot by rotting bridge into remnant marsh.

8. Names of investigators:
   Cecil C. Frost
   Botany Department
   University of North Carolina

9. Date(s) of investigation: 17 June 1981.

10. Priority rating: Medium (demonstration that this is truly a remnant of a natural marsh would require upgrading the priority rating of this area).

11A. Prose description of site.

In the Dismal Swamp, just east of the mouth of Corapeake Swamp, lies a 30 acre freshwater marsh. It is unique within the geographic region and its origin is an enigma.

The vegetation is a mixture of hydrophytic grasses and other wetland herbs. From the comments of early travelers, seeking a night's pasture for horses, any type of grassland may have been rare in the original forests of this area. The existing marsh is a small remnant of a much larger wetland, rapidly being invaded by red maple, which, if unmanaged, will convert the community to a swamp forest within a few more years.

The marsh lies at an elevation of about 20 feet in the Dismal Swamp proper. It may be significant, however, that it occurs at the mouth of Corapeake Swamp, just east of the point at which it enters the Dismal. This small swamp originates in Virginia, about 8 miles to the northwest. Beginning at some time in the past, it has downcut through the Suffolk Scarp, perhaps to a level slightly below that of the swamp floor today. This cutting may have begun in the early Illinoian glacial period after recession of the Yarmouth sea. The land has been exposed to erosion since that time, between 145,000 and 400,000 years ago (Daniels et al. 1978).

The greatest depth of channel cutting should have occurred by the late Wisconsin. However, topographic contours at the base of the Dismal Swamp peat indicate that Corapeake Swamp cut no deeper than to an elevation of about 16 to 20 feet above sea level. This is not unexpected, since the flat, sandy plain forming the basal surface of the Dismal would have acted as base level for the small streams to the west. The flat bottom of Corapeake Swamp suggests that downcutting largely ceased after base level was reached, and subsequent erosion was limited to lateral expansion of the small floodplain.

While sub-peat contours of much of the floor of the Dismal have been mapped, 200 years of drainage, and consequent deep peat burns, may have disrupted presettlement drainage patterns within the peat formation beyond the possibility of reconstruction. The pre-peat drainage from Corapeake Swamp appears to have been to the Pasquotank River. However, the mouth is near the center of the Dismal and is remote from any well-established drainage system. Topographic variation in the area is so subtle today that a slight accumulation of peat in the middle of the swamp might have been sufficient to divert flow to the north toward Lake Drummond or south to the Perquimans River. The characteristic of pocosins to accumulate peat in their centers makes this supposition a reasonable possibility. Examination of color infrared aerial photography suggests that the most likely drainage, after peat buildup in the Holocene, would have been

along a wet topographic low at the foot of the Suffolk Scarp, south into the Perquimans River. The disturbance history of the area, however, prevents the advancement of this hypothesis with any degree of certainty.

Mantling of the Dismal with peat, during the period 8,900 to 6,000 years BP, would have slightly raised the base level of Corapeake Swamp, terminating further valley carving. This probably initiated a period of slight aggradation, bringing the swamp bottomland to its present elevation of just under 25 feet MSL near the mouth.

The rate of post-Wisconsin erosion from the surrounding uplands should be considered minimal. However, it is likely that small quantities of fine sediment and organic matter would be transported during times of heavy rainfall and deposited in the Dismal. This may have resulted in a soil with a mineral fraction intermixed with alluvial organics and those formed in situ. Fanlike deposition in a deltaic area at the mouth of Corapeake Swamp may have created the basis for a marsh.

The exact nature of the original hydrology is unknown. Water was received from rainfall and from Corapeake Swamp. It is also possible that ground water may have been obtained from beneath the Suffolk Scarp. The porous Norfolk sand underlies the site but stops at the scarp, its western depositional boundary (Oaks and Coch 1973). An older aquifer beneath the scarp could deliver water to the Norfolk sand from a recharge area to the west. The current potentiometric studies of Gammon and Garrett may shed light on this possibility.

It is also plausible that the marsh may have received water from elsewhere in the swamp. If there were peat accumulation toward the center of the Dismal (now reduced by post-drainage fires), water from rainfall could have flowed west to the toe of the scarp and then north or south to an outlet. However, neither this effect nor an artesian source of ground water would necessarily be required to explain the existence of a marsh.

The present woody invasion of the last marsh remnant represents the current stage of succession after nearly 40 years of fire suppression. Fire protection has been particularly effective for the past 15 years. Any wildfire in the Dismal Swamp is considered to have "project fire potential" by the NC Division of Forest Resources and is promptly dealt with. The 30 acre remnant marsh is surrounded by a disturbed area of about 300 acres, clearly visible on aerial photography. There is historical evidence of a much larger size in the past.

ORIGIN OF THE MARSH — NATURAL OR MAN-MADE?

Possible natural origin

Whether the original marsh was of human or natural origin may never be known unless historical research uncovers some account from the early period of settlement. It is clear, however, that a much larger grassy wetland once existed.

In 1762 a land company of which George Washington became a member purchased 40,000 acres in the Dismal, and the following year he explored the area on horseback. Washington made the notes below on October 15, 1763:

> *"From Mossey Swamp to a branch, and a large one it is, of Oropeake (not less than 80 yards over) is reckoned 4 miles; two miles short of which is a large plantation belonging to one Brindle, near to which (on the south side) passes the Carolina line.*
>
> *The Main Swamp of Oropeake is about ½ a mile onwards from this, where stands the Widow Norflets, Mi & Luke Sumner's plantations. This swamp cannot be less than 200 yards across, but does not nevertheless discharge as much water as Cypress Swamp.*
>
> *At the mouth of this swamp is a very large meadow of 2 or 3000 acres, held by Sumner, Widow Norflet, Marmaduke Norflet, Powel and others, and valuable ground it is.*
>
> *From Oropeake Swamp to loosing swamp is about 2 miles, and this 70 yards across."*

In several other letters Washington mentions his private land purchases in the Dismal, in addition to his 10% holdings in the Company (Washington 1784). He refers to a purchase from Marmaduke Norfleet, presumably the same person he listed as one of the owners of the large marsh (Washington 1794), and elsewhere mentions sharing a half interest in land with a Mr. Norfleet's father (Washington 1784). It is not clear from his letters what use Washington made of the property.

McClenny (1933) says that George and John Washington owned a plantation in Gates County and that "there had been a large field cleared in the swamp and that rice was attempted to be grown on a commercial scale."

It would have been not at all uncharacteristic of an enterprising planter like Washington to experiment with a rice plantation in the marsh that he found in Dismal Swamp in 1763.

The early planters in Virginia eagerly tested any crop which might be planted for profit, including such ill-fated tropicals as oranges, lemons, almonds and tea. Rice culture had been introduced 116 years earlier and was first grown in this country in Virginia.

Debow (1853) reported the history of rice and a number of other crop species in America. "This grain was first introduced into Virginia by Sir William Berkeley, in 1647, who received half a bushel of seed, from which he raised sixteen bushels of excellent rice, most or all of which was sown the following year." Rice was introduced into Charleston, SC in 1694 and 60 tons were exported to England only 4 years later. By 1754 the export of rice from South Carolina was up to 104,682 barrels, while Virginia's economy was still almost entirely dependent on tobacco. The success of rice in South Carolina was viewed enviously by planters like Washington, who saw this as a way to produce income from wetlands which previously had been used only for pasturage. The Dismal Swamp Land Company actually operated a plantation on the western edge of the swamp for a few years. Rice and corn were produced, with rice crops up to 10,000 pounds annually (Stewart 1979).

In 1729, thirty-four years before Washington's description of the great marsh at Corapeake Swamp, William Byrd surveyed the boundary between Virginia and North Carolina. He waited at a plantation on the Suffolk Scarp for his men to traverse the Dismal, occupying the time by making notes on the surrounding land, including a striking feature of the swamp:

> *"There is one remarkable part of the Dismal, lying to the south of the Line, that has few or no Trees growing on it, but contains a large Tract of tall Reeds. These being green all the Year round, and waveing with every Wind, have procur'd it the Name of the Green Sea."*

There appear to be two candidates for the location of the "Green Sea" in the historical literature. It may have been the same large marsh that Washington observed in 1763, or it may have been another feature described by him to the south. It is not clear whether Byrd or his men actually saw this feature. If the marsh were present at the time of Byrd's survey, it would have been remarkable for them to have missed it during the several goings and comings between the survey line and the plantation at which Byrd was a guest, 6 miles south of Corapeake Swamp.

Washington explored south along the western periphery of the Dismal in 1763, crossing the Perquimans River in northern Perquimans County, and then travelling north through the swamp to the neck of higher land where US 158 emerges on the east side today. He described the traverse through this southeastern arm

of the swamp, which overflowed into the Little River.

> *"The arm of Dismal, which we passed through to get to this new land (as it is called) is 3½ miles measured; little or no timber in it, but very full of reeds and excessive rich."*

It is possible that Byrd received descriptions of this large, reedy marsh from his host, Thomas Speight, the Carolina Commissioners or the local residents who came to visit during his two-week stay in Gates County.

In the Dismal, at the mouth of Corapeake Swamp there is visible on color infrared photography, a series of three concentric areas of disturbance (Fig. 6). The 30 acre remnant marsh is represented by a whitish area. The next larger zone, of darker appearance than the surrounding swamp, about 300 acres in size, indicates the former marsh area of recent times, perhaps the remaining size before the era of modern fire suppression. A larger, fine-textured, light blue area of over 1,000 acres may represent the limits of the large marsh described by Washington.

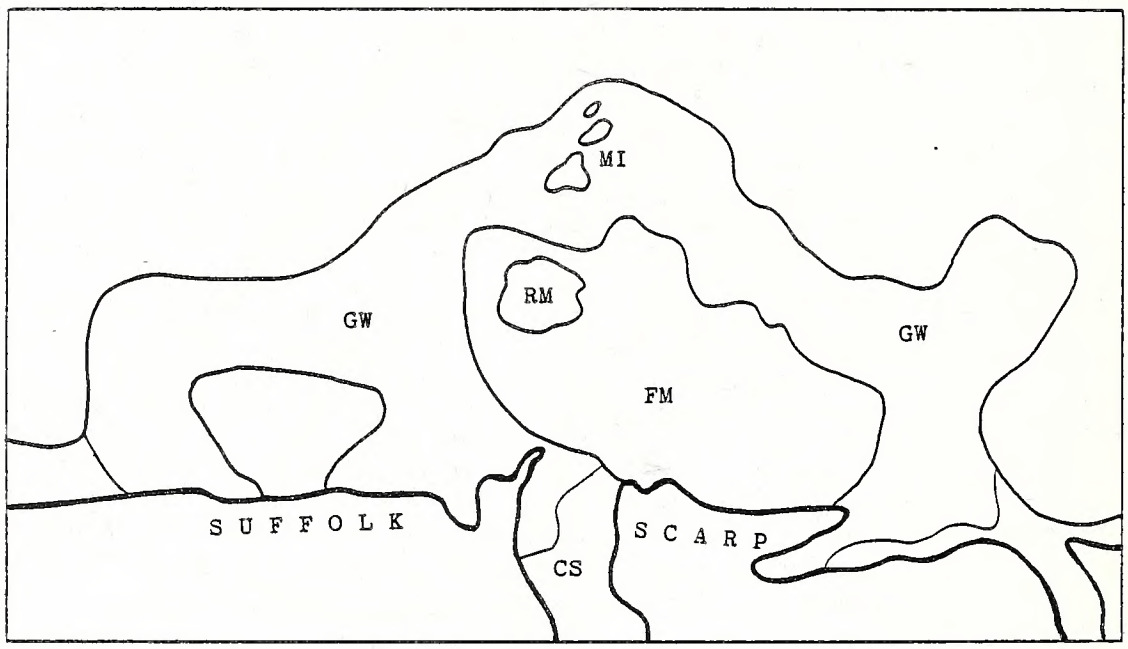


Fig. 6. Corapeake Marsh (Washington's Rice Farm). CS - Corapeake Swamp, MI - mesic islands. RM - remnant marsh, FM - former marsh, invaded by forest in recent years, GW - possible outline of original marsh described by George Washington in 1763.

Why should there be a large marsh along a portion of the toe of the scarp and not in the rest of the swamp? Hydrology, fire and nutrients may all have played a part. Fire, either lightning-started or set by Indians (Corapeake was originally Orapeake, an Indian village), could have removed (or prevented) forest vegetation, allowing new herbaceaous growth when the water table returned to the surface. In nutrient-poor wetland areas where fire-hydroperiod regimes prevent reforestation, pocosin shrub vegetation predominates. Marshes (grassy wetlands) may require more nutrients than shrublands. In this respect, it may be significant that the marsh lies at the mouth of Corapeake Swamp, which could be expected to have delivered a fresh supply of nutrients and bases after each rainfall.

In the wet interval after fire, and in the presence of surviving subsurface rhizomes and higher nutrient levels, reeds and grasses (Arundinaria gigantea, Calamogrostis cinnoides etc.) might be competent to rapidly revegetate the area, assuming dominance before establishment of woody species.

This hypothesis requires four interacting factors: a water table higher than that presently found on the site; seasonal drought (or at least every few years) sufficient to support fire hot enough to kill woody species; fires, probably set by Indians, (and later by settlers to maintain pasturage), and a supply of nutrients and bases higher than those found in the deep peat areas of the swamp.

It should be possible to sample soils to determine whether there is a nutrient or pH gradient from the the mouth of Corapeake Swamp into the Dismal. However, it would be expected that there would have been little new nutrient input since construction of Cross Canal. This drainage effectively bypasses any distribution of water or nutrients over the marsh, carrying all nutrient runoff through the site into other areas (originally directly across the swamp into the Dismal Swamp Canal).

Finally, it cannot be ruled out that the marsh may have been simply the result of deliberate land clearing by early settlers. Edmund Ruffin (1861) described the practice of clearing swamp lands for agriculture, a few miles to the south in Perquimans County in the 1830's:

> *"On the farms of Messrs. Francis Nixon and J. T. Granberry, I saw the manner in which these swamp lands are brought under cultivation. The large trees, not needed for timber or fuel are belted and so killed. The heavy forest growth is mostly of gum, poplar, oak and large swamp pine, used for naval timber, some of the latter of great size. The smaller growth is cut down more than once, and mostly dies. The land is used for grazing, until the roots are enough rotted to permit ditching*

and ploughing. This will be in about five years after the belting of the trees."

It could be that the Corapeake marsh was so created, in the late 17th or early 18th century. An equally reasonable possibility is that the settlers found a small marshy area which they subsequently enlarged for pasture.

11B. Prose description of site significance:

Whether of natural or man-made origin, a large fresh marsh has existed for over two hundred years at the mouth of Corapeake Swamp. It is the only vegetation community of its type in Gates County or the Dismal Swamp, and may not be known elsewhere. Historically, it may have been the only place in the county where rice culture was practiced.

This grassy wetland, especially if restored to its former extent, could be one of the most striking features of the Dismal. Its possible original significance to resident wildlife and wintering waterfowl are unknown.

Riverbank sandreed (Calamovilfa brevipilis), a species listed as threatened (Cooper et al. 1977) and as a protected species in North Carolina (Sutter 1980) was listed for this site, but was later found to be Calamogrostis cinnoides (L. J. Musselman 1980, pers. comm.), and should be removed from any lists of records for Gates County.

No other endangered or threatened species are currently known. However, no avian or other faunal survey was made at the site. Also, the field work was done in the later stages of a two-year drought. Most of the grasses present were not flowering or fruiting at the time and remain to be identified. Other surviving herbs were obviously drought-stressed.

The presence of hydrophytes such as golden club (Orontium aquaticum), lizard's tail (Saururus cernuus) and wild iris (Iris virginica) indicate that the water table must ordinarily occur at or above the surface for at least part of the year. Many more species of hydrophytic herbs are to be expected in a year with normal rainfall. Consequently, the area should be resurveyed during a season of typical precipitation.

If the original 2-3,000 acre marsh were indeed a natural feature, it may have been a community type found nowhere else. It presently has considerable value for vegetation study and for examining the effects on a marsh, of two centuries of varying agricultural uses. Documentation of efforts to reestablish the marsh will be of value to other land managers involved in rehabilitation of damaged natural areas, a relatively new science.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Unique wetland community	B	Mixed hydrophytic grasses and other hydrophytic herbs.	Only marsh community of this type in Gates County or the
			Dismal Swamp. Only community of this type known to this
			surveyor.
Endangered or threatened species	B	Southern bog lemming	Reported by Pat Gammon. No further information.

Fig. 7. Access information: CORAPEAKE MARSH NATURAL AREA.

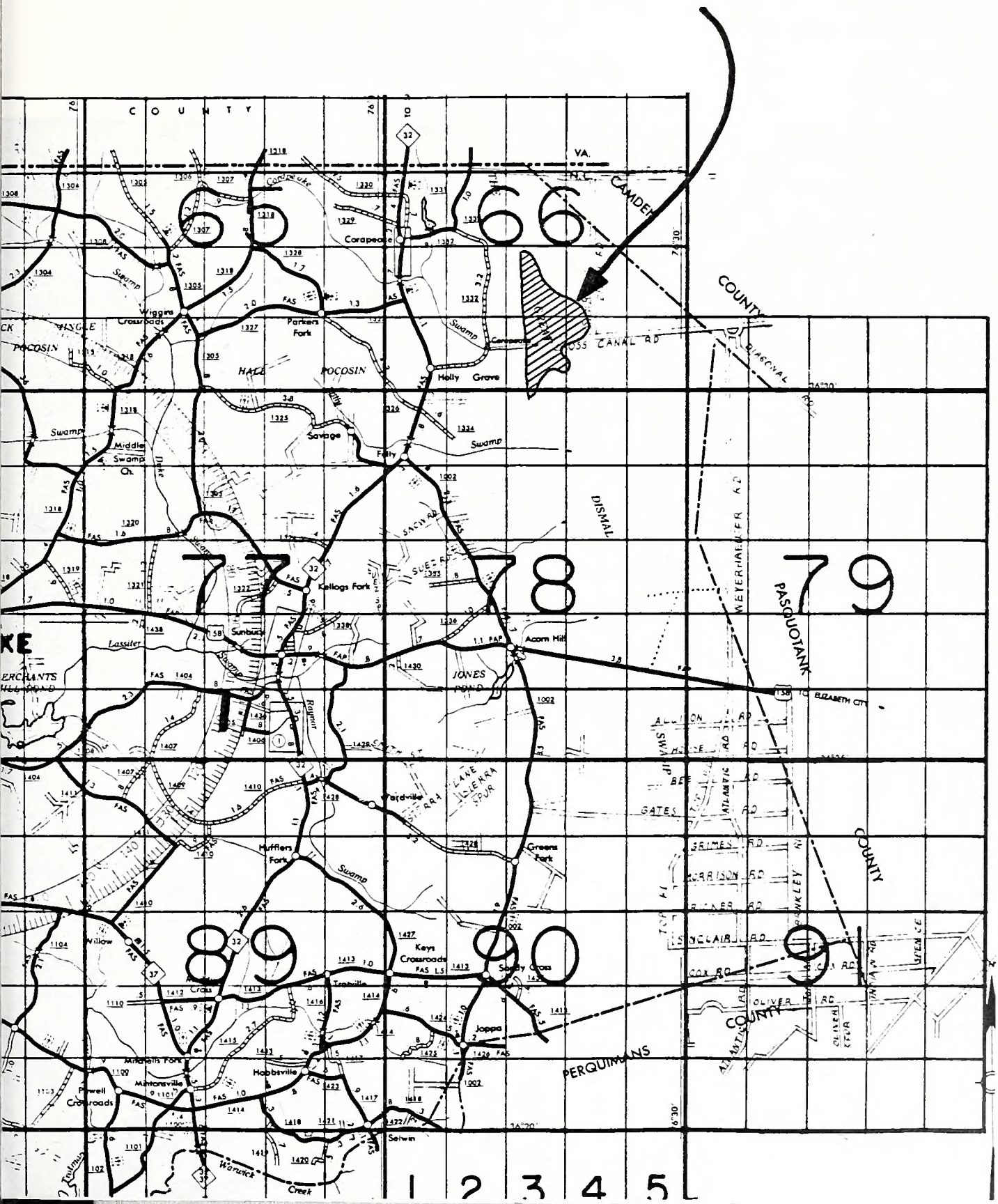


Fig. 8. Boundary, Corapeake Marsh Natural Area.
For more detailed map of natural features see Fig. 6.

Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	%
Public	100 %
Unknown	%

14. Number of owners: 1

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434 (804) 539-7479

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

Pat Gammon, Botanist, US Geological Survey
Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434
(804) 539-7479 Office
(804) 539-5335 Home Has published several studies on the flora of Dismal Swamp, using remote sensing techniques.

17. Attitude of owner toward preservation (contacted?):

Contacted 17 June 1981. Refuge managers plan to try to maintain existing remnant marsh by the use of controlled burning to prevent encroachment of forest species.

18. Uses of natural area: Present use as wildlife habitat in a National Wildlife Refuge. Formerly used as pasture land for grazing, and possibly as a rice plantation in the late 1700's or early 1800's.

19. Uses of surrounding land:

a. Wildland 100 %

b. Agricultural _____ %

c. High-intensity forestry _____ %

d. Developed _____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
1	100%	National Wildlife Refuge. Area registered as a North Carolina Natural Heritage Area.

21. Regulatory protections in force:
Area subject to all the rules and regulations of the Dismal Swamp National Wildlife Refuge.

22. Threats: The site, at present, is conspicuously threatened with invasion by woody species, especially red maple (Acer rubrum). In June, 1981 the 30 acre remnant was occupied by small patches of open marsh with scattered clumps of maple. These were present in numbers sufficient to have divided the marsh into a mosaic of small openings of perhaps 0.1 hectare in size. As maple continues to close the canopy, marsh grasses and other hydrophytic herbs will be unable to tolerate the increasing shade and will disappear. Unless management steps are quickly taken to restore previous environmental conditions, the site will succeed to red maple, the ubiquitous disturbance vegetation of the Dismal.

23. Management and preservation recommendations: Regardless of the historical origin of the marsh, the only reasonable management alternative for the site is maintenance of this community, for vegetation study and for the habitat diversity that it lends to the otherwise forested swamp. While other portions of the refuge might be managed for conservation of disturbance forest types, there is no compelling reason why the goal for this area should not be restoration of the 18th century marsh.

The immediate aim should be stabilization of the 30 acre remnant, with the long range goal of slowly expanding the marsh to at least 300 acres, the minimal area that can be historically documented. Any decision on further expansion, to the size suggested by George Washington, could be based on the relative success of initial efforts.

Cross Canal should be closed at some point east of the marsh with a variable water control structure. The best approximation to original conditions would be to raise the water in the canal to a level which causes the water table of the surrounding land to be at or above the surface during the wetter seasons of the year. The height should be sufficient to cause the outflow from Corapeake Swamp to spread over the marsh as it would have done during wet seasons before artificial drainage. This would restore periodic nutrient and base input to the marsh.

Increasing hydroperiod and height of the water table will probably not eliminate established red maple, since it is highly tolerant of fluctuating moisture regimes. It will be necessary to burn periodically as proposed by Gammon and Garrett (1981) to eliminate this species. Once fire has eliminated the maple, it should be possible to prevent encroachment by woody

species by firing the marsh during natural dry periods at the rate of every two or three years. Actual fire frequency necessary to maintain or expand the marsh should be readily discernable after a few years.

The specific nature of the original grassy vegetation is not clear. Washington describes it as a large meadow, which would suggest grasses of medium height, such as those now investing the site. Byrd called the "Green Sea" a tract of tall reeds, a term he usually applied to Arundinaria gigantea. Decisions on management practices that may lead to a specific type of marsh vegetation will have to be made by refuge botanists once conditions approximating those of the undisturbed marsh community have been reestablished.

The hydrologic studies and preliminary burning experiments begun by Gammon and Garrett should provide valuable scientific background for future evaluation. Hydrologic and vegetation changes should be studied quantitatively and significant results published for the benefit of those attempting to manage similar areas elsewhere.

Further historical investigation should be pursued. The journals of Washington and others may have additional information. The records of the Register of Deeds for Gates County are complete to the earliest times, never having been destroyed by fire. A thorough title search of the adjacent upland properties (Washington mentioned the names of four landowners whose properties included portions of the marsh in 1763) might reveal clues as to the nature and management of this area over the past 200 years.

24a. Vegetation - Biotic Community Summary

Community type: Mixed fresh hydrophytic grasses (Trending toward red maple/mixed mesophytic grasses)

Community cover type: Mixed fresh hydrophytic grasses.

General habitat feature: Remnant of a large freshwater marsh in a deltaic area where a small swampy stream empties into the Dismal Swamp.

Average canopy height: About ½ meter for grasses, up to 5 m for invading red maple.

Estimated age of canopy trees: Maples about 4 to 6 years.

Canopy cover: Closed (grasses)

Estimated size of community: 30 acres.

Successional stage: Originally pyroclimax. Now, subsequent to fire suppression, the community is moving into a sere that will lead to a swamp forest in which red maple will be the early dominant.

Sere type: psammosere.

Common canopy species in community cover or community type (but not dominant):

Acer rubrum

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

None.

Common herb stratum species in community cover or community type (but not dominant):

None.

24b. Soil Summary (by community type)

Soil series: Unknown. Simply listed as 'peat' on 1929 soil map. May be Pamlico.

Soil classification: Terric medisaprist?

Soil association: Mapped Ponzer-Dorovan-Dare on tentative general soil map of Gates County; Ponzer-Pamlico-Dorovan on general soil map of North Carolina.

pH class:

Source of information: Davis et al. 1929. USDA SCS 1972. USDA SCS 1974.

Other notes: Soil formed in a deltaic area where the mouth of Corapeake Swamp delivered water and small amounts of sediment into the Dismal. A textural gradient of the mineral fraction from the mouth into the larger swamp would be expected. This would be an interesting area for pedogenic and other studies.

24c. Hydrology Summary (by community type)

Hydrologic system: Palustrine.

Hydrologic subsystem: Interaqueous.

Water chemistry: Fresh.

Water regime: Intermittently flooded. (Was probably seasonally flooded before construction of Cross Canal).

Drainage class: Somewhat poorly drained (Was probably poorly drained before canal construction).

Drainage basin: Pasquotank River.

Hydrology characterization: A somewhat poorly drained, intermittently flooded, interaqueous palustrine system, wetted by fresh rains, a tributary swamp and a seasonally high water table.

24d. Topography Summary

Landform: Deltaic area at mouth of small swamp.

Shelter: Open. Perhaps a minimum of shelter provided by Suffolk Scarp to west of site.

Aspect: Flat.

Slope angle: Nearly level (0-2%).

Profile: Flat.

Surface patterns: Smooth.

Position: N/A

25. Physiographic characterization of natural area:

Pyroclimax marsh grass community on mixed organic-alluvial deposit below mouth of Corapeake Swamp, on the western boundary of the Great Dismal Swamp, in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation: Holocene organics and alluvium over the Sand Bridge and Norfolk Formations.

Geological formation age:

Mixed organics and alluvium:	Holocene (11,000 yrs. ago to present)
Sand Bridge and Norfolk Formations	: 35,000 to 115,000 yrs ago.

References cited: Oaks, R. Q., Jr. and D. G. Whitehead. 1979. Geologic setting and origin of the Dismal Swamp, southeastern Virginia and northeastern North Carolina. In: P. W. Kirk, Jr., ed. The Great Dismal Swamp. Charlottesville: Univ. of Virginia Press. 427 p.

Oaks, R. Q., Jr. and N. K. Coch. 1963. Pleistocene sea levels, southeastern Virginia. Science 140: 979-983.

Daniels, R. B., E. E. Gamble and W. H. Wheeler. 1978. Age of soil landscapes in the Coastal Plain of North Carolina. Soil Sci. Soc. Am. J. 42:98-105.

26. Summary - endangered and threatened species

Name of species: None known at present.

Species legal status and authority:

Number of populations on site:

Number of individuals per population:

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %
flowering %
fruiting %

General vigor of population:

Disturbance or threats to population:

Habitat characteristics

Plant community:
Topography:
Soil series:
Microclimate:
Drainage basin:
Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists:

CANOPY:

- Acer rubrum
- Nyssa sylvatica

SHRUBS:

- Salix caroliniana

HERBS:

- Calamogrostis cinnoides
- Carex sp.
- Dulichium arundinaceum
- Eupatorium capillifolium
- Iris virginica
- Orontium aquaticum
- Osmunda cinnamomea
- Osmunda regalis
- Peltandra virginica
- Sagittaria sp.
- Saururus cernuus
- Typha angustifolia
- Woodwardia virginica

VINES:

- Clematis crispa
- Rhus radicans

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: DISMAL SWAMP NATIONAL WILDLIFE REFUGE (portion not included in Washington's Rice Farm and the Dismal Swamp mesic islands).

2. County: Gates.

3. Location: Entire tract of land bounded on the south by US 158; on the north by the NC/VA state line; on the east by the Gates County line, and on the west by the Suffolk Scarp.

4. Topographic quadrangle(s): Beckford 1929(1942) 15 min (1:62,000) South Mills 1940 15 min (1:62,000); Corapeake VA-NC 1977 7½ min (1:24,000); Beckford NE, 1981 advance print 7½ min (1:24,000).

5. Size: 13,500 acres (5,464 ha) not including 600 acres in the mesic island portion and 300 acres in Washington's Rice Farm.

6. Elevation: 20-30 ft MSL.

7. Access: By Refuge roads from US 158, Corapeake and Holly Grove. All Refuge roads are gated and permission to enter must be obtained.

8. Names of investigators: Cecil C. Frost, Dept. of Botany, UNC Chapel Hill.

9. Date(s) of investigation: 12 August 1981, 15 August 1981 and numerous other visits from 1976 to 1981.

10. Priority rating: High.

11A. Prose Description of Site.

This section treats the remaining portion of the Dismal Swamp north of US 158, not discussed in Washington's Rice Farm (Corapeake Marsh) or the Dismal Swamp Mesic Islands. This large tract (about 13,500 acres) of swamp forest lies between US 158 and the NC/VA state line. It is bounded on the west by the Suffolk Scarp and on the east by the Gates/Pasquotank County line.

The area lies nearly level, at an elevation of about 20 ft, and forms the headwaters of the Pasquotank, Little and Perquimans Rivers, and perhaps a portion of that for the Northwest River. It is underlain by the Dismal Swamp peat, up to 3 meters in depth. The peat overlies the Norfolk sand and the Sandbridge Formation of late Sangamon age (Fig. 9).

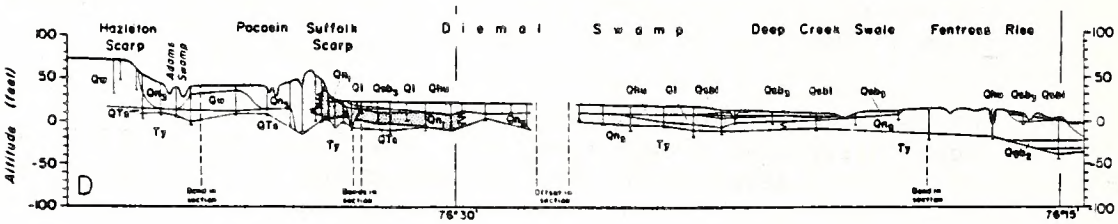


Fig. 9. Geologic section through Dismal Swamp from a point in Virginia, across the state line into North Carolina. Then parallel to the state line, across the Suffolk Scarp north of Corapeake, into the Dismal.

Qhu = Dismal Swamp Peat; Qsb_1 = Sand Bridge Formation (Fm), upper member, clayey-sand facies; Qsb_3 = silty-clay facies; *Qsbl* = lower member; *Ql* = Londonbridge Fm.; Qn_1 = Norfolk Fm., coarse-sand facies; Qn_3 = silty-clay facies; Qn_5 = medium-sand facies; Qn_6 = fine-sand facies; Qgb_2 = Great Bridge Fm., silty-clay facies; *Qw* = Windsor Fm.; *QTs* = Sedley Fm.; *Ty* = Yorktown Fm. From Oaks and Coch 1973 (plate 2), courtesy Virginia Division of Mineral Resources.

This tract is large enough to contain valuable habitat for wide-ranging species such as black bear and bobcat, and there were several panther sightings just to the north of the area in 1979 and 1980. Most of the following endemic, threatened or special concern species listed in Cooper et al. (1977) probably occur on the site:

Threatened Species:

Buteo lineatus (Red-shouldered hawk

Special Concern Species:

Dendroica virens (Black-throated green warbler
Helmitheros (=Limnothlypis) swainsonii (Swainson's warbler)
Protonotaria citrea (Prothonotary warbler)
Ursus americanus (Black bear)

Endemic races of unknown status:

Blarina brevicauda telmalestes (Dismal Swamp Short-tailed shrew). Endemic race; considered a species until recently.
Microtus pennsylvanicus nigrans (Dismal Swamp meadow vole) Endemic race.
Sorex longirostris fisheri (Dismal Swamp southeastern shrew). Endemic race.
Synaptomys cooperi helaletes (Dismal Swamp southern bog lemming). Disjunct endemic race, known from only one site in North Carolina.

Rare species of unknown status:

Plecotus rafinesquii macrotis (Rafinesque's big-eared bat)

POSSIBLE ENDEMISM OF SMALL MAMMALS IN THE DISMAL SWAMP

A great deal of research remains to be done on the wildlife of the Dismal, especially the endemic small mammals. Apparent endemism may be simply the result of taxonomic splitting, based on regional variation in species characters. However, the possibility exists that these species may have been isolated since the Wisconsin.

The species in question could have migrated northward and inland with warming postglacial climate and rising sea level. Toward the end of this process the Dismal Swamp area became a peninsula, isolated by the James River estuary, Chesapeake Bay, Atlantic Ocean, and Currituck and Albemarle Sounds. The Suffolk Scarp could have served as a partial migratory barrier for small wetland mammals. Possible escape routes around the northern and southern ends of the scarp may have been blocked by salt marsh vegetation, a different habitat (Albemarle Sound was brackish before closure of the last inlet in the early nineteenth century). Thus, a measure of isolation sufficient to permit development of local races might have been achieved.

The effects on wildlife habitat of drainage and disturbance, have probably been to open up the central swamp to medium and large mammals, which would have found little habitat there when it was a white cedar bog. Wetland habitat for small endemic mammals may have been diminished.

VEGETATION, HYDROLOGY AND HUMAN DISTURBANCE

The area remains a high-quality wetland, despite the history of vegetation change in the Dismal. The present forest canopy ranges from about 50 to 75 yrs in age, with scattered remnant individuals and clusters of much older cypress and black gum. This vegetation has been mapped using color infrared aerial photography by Gammon and Carter (1979). The canopy is composed almost entirely of Nyssa sylvatica biflora and red maple in most areas, with either species being locally dominant. Cypress or loblolly pine are important in a few small areas. Sweet gum can be found occasionally in the canopy, but is not abundant.

Locally, red maple, sweet bay (Magnolia virginiana)or holly (Ilex opaca) form a thin subcanopy. Clethra alnifolia and Smilax are the most common species in the shrub stratum, occasionally forming a nearly closed layer. Because of deep shade and low nutrient availability, the herb flora is depauperate, comprising only a handful of species, and these very thinly distributed in most areas.

As discussed in the introduction to this report, the Dismal has undergone nearly two centuries of human disturbance, beginning with construction of the Dismal Swamp Canal. Understanding present vegetation will require a variety of scientific studies, investigation of vegetation along moisture, edaphic and topographic gradients in the region, as well as recorded historical events and descriptions of early travelers.

Examination of color infrared aerial photography (NASA UAg 1045 153.22, 2 December 1972) shows little observable change from vegetation along ditches to that of areas remote from drainage. The absence of a visible gradient from mesic species near ditches to more hydric species farther from drainage is remarkable in view of the fact that these ditches are cut to a depth of several feet below the land surface. During wet periods they can be seen carrying away surplus water at a rate which must be several times faster than that which occurred in the original situation. The lack of a vegetation gradient suggests that the peat is relatively impermeable to lateral movement of water and that water visible in ditches and canals in wet seasons is primarily due to shallow surface runoff.

This function of ditches was partially simulated in nature by a dendritic drainage pattern, remnants of which can be seen in the headwaters of the major streams draining the Dismal. That the streams sometimes carried a flow surprisingly rapid for a swampy area is documented by Kearney (1901) and Ruffin (1861).

A pertinent question for water management in the Dismal would be the degree to which modern ditches simulate natural drainage. It is unknown to what extent the original dendritic stream pattern penetrated the interior of the white cedar bog which comprised the largest community in the swamp. Similar areas for comparison, which have been undisturbed by artificial drainage, are virtually nonexistent.

Even if a complete drainage network existed, its tributaries would have shallowed progressively toward the interior. This is in striking contrast with the grid of 20th century ditches and canals up to 10 ft deep, which dissect the heart of the swamp. The net hydrologic effect must be a much more rapid removal of water after rainfall than in the undisturbed swamp.

The consequence of this effect for vegetation would be a decrease in the time during which the water content of peat soils exceeds saturation, and an increase in the length of time that soils are aerated. In white cedar areas the equilibrium between peat formation and decomposition clearly has been shifted toward the latter process, with much of the upper surface exposed to drying and subaerial oxidation.

It appears that the center of the swamp has been most affected, with white cedar undergoing rapid replacement by more mesophytic community types. However, the periphery of the swamp is also undergoing type conversion in many areas. Huge stumps along the toe of the Suffolk Scarp demonstrate the presence of a community type in which baldcypress was a canopy or emergent species. The zone is now dominated by the slightly more mesophytic black gum (Nyssa sylvatica biflora) and red maple, suggesting that the slow feed of moisture from the swamp interior and from uplands to the west originally maintained a higher water table and/or longer hydroperiod than at present.

To what extent roads in the Dismal Swamp act as dams is unknown. Since the sands which were dredged from beneath the peat horizon as roadfill are probably more permeable than the original peat, it seems likely that the effect of their presence is negligible in comparison with effects of the adjacent ditches. The roads may not act as moisture barriers at all, unless in areas where clay fill was trucked in. Resolution of this question would necessitate understanding the composition of the road fill along the different sections, and the original variation in rate of water movement through peat at different depths.

Restoration of original hydrology might seem a quixotic endeavor in view of the extent to which it has been disturbed. South of US 158, drainage and partitioning of the swamp into small blocks for tree farming, agriculture and eventually peat

mining, will remove all the organic horizon and the resulting land surface will be lowered from several feet to several meters below the original. To the north, in the Dismal Swamp National Wildlife Refuge, it is possible to use water control structures to permanently maintain the hydrology of the swamp. This will eventually by the only significant remnant of the Dismal in Gates County.

Since it is possible to restore normal water levels to some areas in the southern half of the Refuge, it might be desirable to attempt reversal of drainage efforts on selected sites. Insofar as vehicular access would not be needed or appropriate in areas with higher water tables, managed as natural communities, it would be desirable to actually remove existing roads. It would be prohibitively expensive to do this on a large scale, since a great quantity of road fill was trucked in to build up roadbeds. However, on an experimental basis, it might be feasible to slowly mine fill from one or two roads over a period of years, using the material elsewhere as needed. The adjacent ditches could be permanently closed and allowed to fill with organic matter, reestablishing the original continuity.

11B. Prose description of site significance:

Much old-growth forest remains in patches or as scattered individuals of cypress and black gum. One Taxodium measured 98 ft (30 m) high and 5 ft (151 cm) in diameter. These large individuals are several hundred years old and therefore represent remnants of the original forest.

The endemic small mammals discussed earlier may represent a unique example of species isolation on the Coastal Plain, and deserve further study. A detailed survey of the fauna of this tract has not been conducted. Further work, especially with warblers and other birds, will undoubtedly show that the area supports additional rare or threatened species.

Any remaining large tract of wildland is of significance simply because of its size, in view of the rapid conversion of land from natural communities to agriculture and intensive forestry during the past twenty years. Such areas offer the only hope for permanent survival of many native wildlife species, especially those such as black bear, bobcat, panther and wild turkey which require roadless areas ar large tracts in which to range.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
High quality wetland plant community		Extensive wetland dominated by black gum (*Nyssa sylvatica biflora*) and red maple (*Acer rubrum*).	Largest single-owner tract of wildland remaining in county.
			Scattered stands of original old-growth baldcypress and black gum.
Rare mammalian fauna		Dismal Swamp short-tailed shrew (*Blarina brevicauda telmalestes*), Dismal Swamp	Unusual (and unexplained) group of small mammals with races endemic to the Dismal
		meadow vole (*Microtus pennsl-vanicus nigrans*), Dismal Swamp southeastern shrew (Sorex	Swamp area.
		longirostris fisheri), Dismal Swamp southern bog lemming (Synaptomys cooperi helaletes).	
Special concern species		Red-shouldered hawk	Threatened in North Carolina (Cooper et al. 1977). Occasional in this tract.
			Nesting status unknown.
High quality wildlife habitat		Black bear	Size of the area important in sustaining a permanent population of this large
			mammal on the Coastal Plain.

Fig. 10. Access information:
DISMAL SWAMP NATIONAL WILDLIFE REFUGE NATURAL AREA

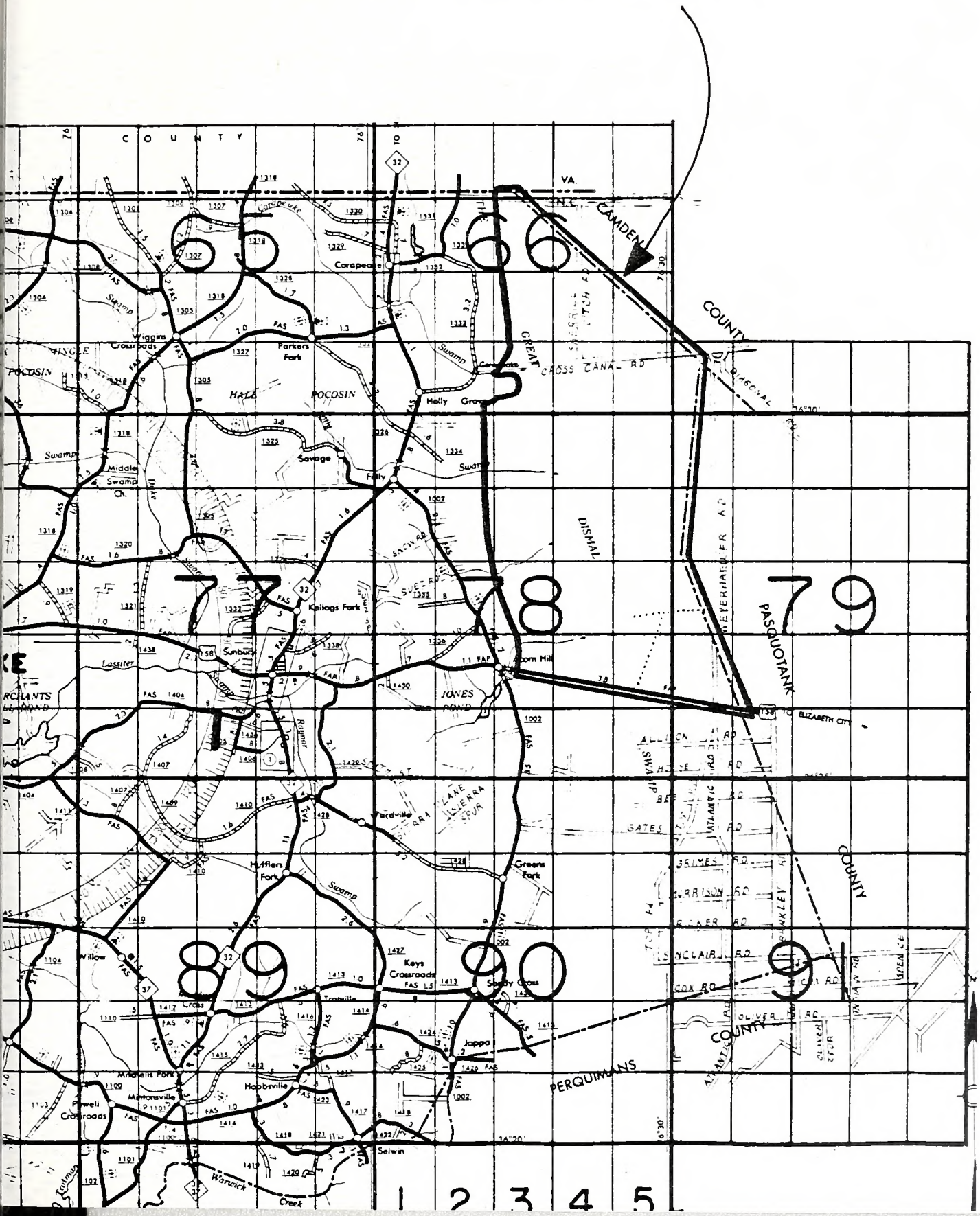
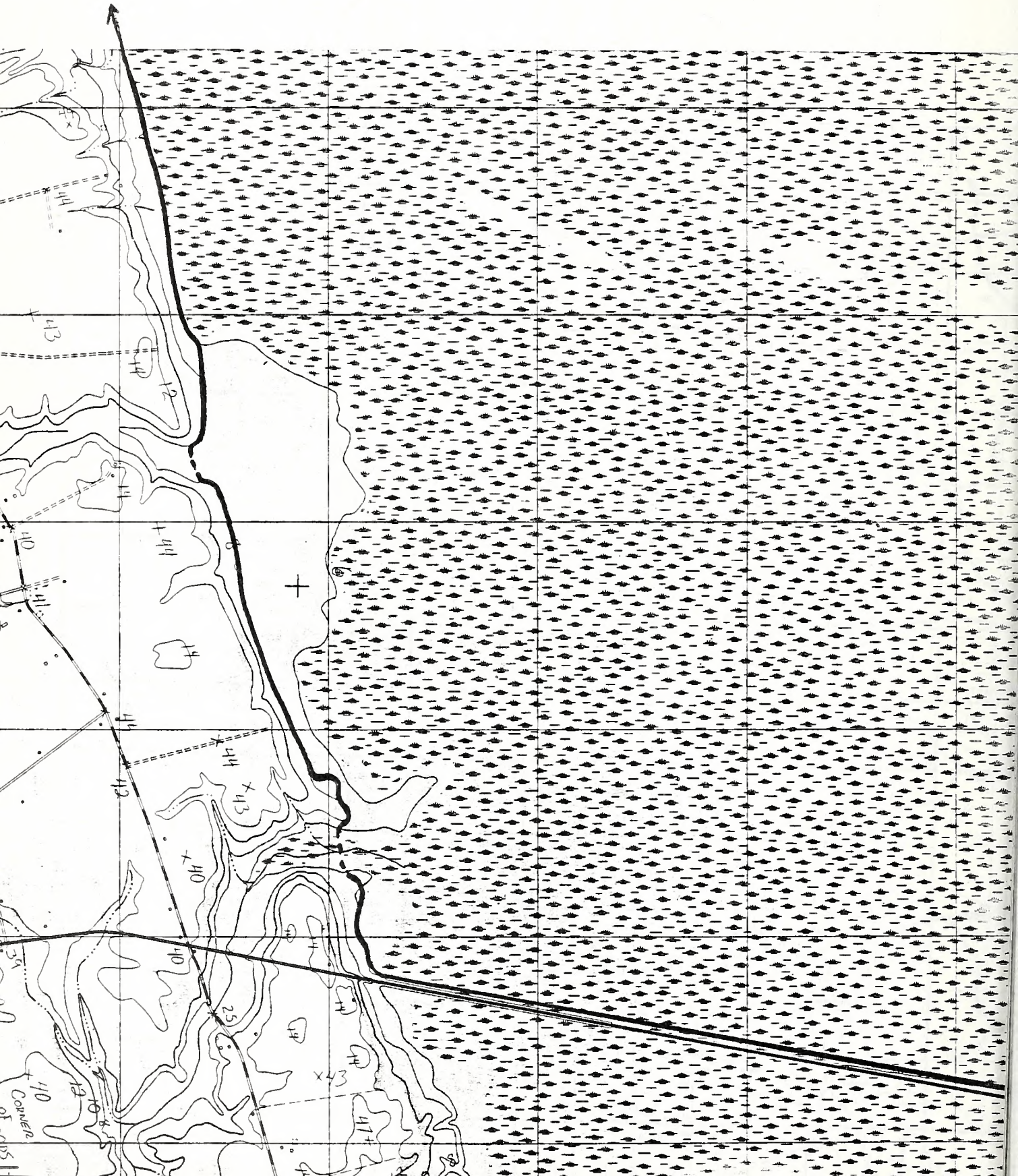


Fig. 11. Southern Boundary,
Great Dismal Swamp National Wildlife Refuge Natural Area.



Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	%
Public	100 %
Unknown	%

14. Number of owners: 1

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434 (804) 539-7479

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

Pat Gammon, Botanist, US Geological Survey
Dismal Swamp National Wildlife Refuge
P. O. Box 349
Suffolk, VA 23434
(804) 539-7479 Office
Has published several studies on the flora of Dismal Swamp.
(804) 539-5335 Home

17. Attitude of owner toward preservation (contacted?):

Contacted June, 1981. Management plans for this tract depend upon continuing studies by Gammaon, Garrett and others.

18. Uses of natural area: Presently contained entirely within the Dismal Swamp National Wildlife Refuge. Past uses were logging, hunting, some hiking. Primary use now is for preservation of wildlife habitat (black bear, bobcat, many other species). Also used for hunting white-tailed deer, educational and research purposes. It is unknown whether the Refuge will practice timber cutting on this tract in the future.

19. Uses of surrounding land:

a. Wildland 50 %

b. Agricultural 40 %

c. High-intensity forestry 10 %

d. Developed ____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
1	100%	National Wildlife Refuge. Area registered as a North Carolina Natural Heritage
		Area.

21. Regulatory protections in force:

Area is subject to all the rules and regulations of the Dismal Swamp National Wildlife Refuge.

22. Threats:

1. Continued loss of peat through fire and oxidation (perhaps the principal process of peat wastage since establishment of effective fire suppression).

2. Continued type conversion of forest communities: Conversion of white cedar to maple and gum is already complete in the Gates County tract. The type probably occurred at least in the northeast corner and along the eastern third of the property.

   Along the western half of the tract, hydrologic conditions are among the least altered in the swamp. Even here, however, the slight change in soil drainage class from very poorly drained to poorly drained, has apparently caused a shift to the next more mesophytic forest type. The moist area at the toe of the scarp probably originally contained tupelo (Nyssa aquatica). An example of a second-growth stand of this type can be seen in a similar topographic position south of US 158. Stumps of large baldcypress, and the existing vegetation gradients in other parts of the region suggest that the original series of communities, from the toe of the scarp east into the swamp was as follows:
   Taxodium distichum/Nyssa aquatica → Taxodium distichum Nyssa sylvatica biflora → Chamaecyparis thyoides.
   Red maple would have occurred as a common, small understory species.

   Logging and slight alteration of hydrology have produced a community composed almost entirely of black gum and red maple, with one or the other being dominant in selected areas. Should the existing canopy be disturbed, it is likely that the subsequent community would be dominated by red maple and loblolly pine, the next more mesophytic type in the hydrologic series.

   Invasion by loblolly pine in many areas of the swamp where it did not originally occur, represents a subtle threat in itself, in that its commercial value leads to political and administrative pressures for its management and perpetuation, to the detriment of natural communities.

23. Management and preservation recommendations:

1. Establish water control structures on all ditches and canals.

2. Raise water table in as much of the swamp as practicable.

3. Begin to eliminate roads where practicable.

These suggestions are intended for the swamp as a whole, but especially for the portion south of Lake Drummond, including the North Carolina State Park lands. The Gates County tract has been less affected than these sections to the north and northeast, but here too, water level should be raised enough to stop type conversion and to initiate return to the original communities.

If management objectives are to preserve existing remnants of the original vegetation of the Dismal, the best alternative would be to close all the ditches and raise the water table until water is ponded in the topographic lows. Ponding would serve as an indicator of the proper level at which to set spillways.

The result, of course, would not be an entirely natural situation, since the aquatic community was probably rare in the undisturbed swamp. It would, however, be a first step in healing the past century's scars by reinitiating peat formation in the ponded areas and protecting the remaining peat highs from further oxidation and deep peat burns.

This would be the most ethical course of action and would acknowledge the disturbance nature of much of the present vegetation and topography. Reflooding the burned-out lows would create excellent waterfowl habitat for a century of two while these areas undergo peat filling and succession from aquatics to white cedar. The healing process could be a central interpretive theme for the Refuge and a subject for research.

Without some such management, prospects for the Dismal are more burns, continued loss of peat by oxidation and continued conversion to loblolly pine and red maple. Because of the depth of the ditches, and of organic matter, these processes could continue for centuries, until exhaustion of the peat.

Since pine and maple would not be expected to survive in the wetter areas if the water table were raised, it might not be objectionable to harvest these in some areas. Some tracts should be left for study.

Should survival of the National Wildlife Refuge system become contingent upon production of income at some time in the future, it might be desirable to maintain a portion of the swamp in loblolly pine. However, for esthetic, scientific and educational purposes, some large portion of the swamp should be managed in the manner suggested.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary

Community type: Nyssa sylvatica/Acer rubrum/mixed deciduous and evergreen shrubs. (Maple dominant in many areas).

Community cover type: Nyssa sylvatica

General habitat feature: Pocosin (swamp).

Average canopy height: 70 ft (individual relict cypress and black gum [Nyssa sylvatica biflora] to 100 ft).

Estimated age of canopy trees: 75 yrs where dominated by Nyssa.

Canopy cover: Closed.

Estimated size of community: 12,000 acres.

Successional stage: Seral. Unknown whether this community will eventually be dominated by Nyssa, red maple or some other species.

Sere type: Psammosere.

Common canopy species in community cover or community type (but not dominant):

Acer rubrum (red maple)
Pinus taeda (loblolly pine) in a few small areas.
Taxodium distichum (baldcypress) in a few areas.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Ilex opaca (holly)
Clethra alnifolia (sweet pepperbush)
Magnolia virginiana (sweet bay)

Common herb stratum species in community cover or community type (but not dominant):

Woodwardia areolata (netted chainfern)

24b. Soil Summary (by community type)

Soil series: Unknown. Simply listed as 'peat' on 1929 soil map.

Soil classification: Histosol. Saprist.

Soil association: Mapped Ponzer-Dorovan-Dare on tentative general soil map of Gates County; Ponzer-Pamlico-Dorovan on general soil map of North Carolina.

pH class: Undetermined. Probably strongly acidic.

Source of information: Davis et al. 1929; USDA SCS 1972: USDA SCS 1974.

Other notes: At least two soil series must be included since the site ranges from deep peat to shallow peat over mineral substrate.

24c. Hydrology Summary (by community type)

Hydrologic system: Palustrine.

Hydrologic subsystem: Interaqueous.

Water chemistry: Fresh

Water regime: Saturated. Much of site was probably seasonally flooded in presettlement moisture regime.

Drainage class: Poorly drained. Was probably very poorly drained before ditch and canal construction.

Drainage basin: Drainage obscure. Located near the divide between the Pasquotank, Little and Perquimans Rivers. Portions of this site may have drained into all of these.

Hydrology characterization:
A poorly-drained, saturated, interaqueous palustrine system, wetted by fresh rains, downslope drainage and a high water table.

24d. Topography Summary

Landform: Pocosin (swamp).

Shelter: Open.

Aspect: Flat.

Slope angle: Nearly flat (0-2%).

Profile: Flat

Surface patterns: Irregular.

Position: N/A

25. Physiographic characterization of natural area:

Seral gum-maple community in the northern half of the Gates County portion of the Great Dismal Swamp, in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation: The Dismal Swamp Peat, over the Norfolk and Sandbridge Formations.

Geological formation age:

Dismal Swamp Peat: 11,000 - 12,000 yrs ago to early 19th century. Norfolk and Sandbridge Formations: Sangamon Interglacial, 80,000 to 100,000 yrs BP.

References cited:

Oaks, R. Q., and D. R. Whitehead. 1979. Geologic setting and origin of the Dismal Swamp, southeastern Virginia and northeastern North Carolina. In: P. W. Kirk, Jr., ed. The Great Dismal Swamp. Charlottesville: Univ. of Virginia Press. 427 p.

Oaks, R. Q., Jr. amd J. R. Dubar. 1974. Post-Miocene stratigraphy, central and southern Atlantic Coastal Plain. Logan: Utah State Univ. Press. 275 p.

26. Summary - endangered and threatened species

Name of species: Red-shouldered hawk (Buteo lineatus).

Species legal status and authority: Threatened in North Carolina (Cooper et al. 1977).

Number of populations on site: Unknown.

Number of individuals per population: Unknown.

Size or maturity of individuals: Adults.

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population: Uncommon in the central Dismal Swamp. Better habitat exists in the swamps along the rivers draining the Dismal.

Disturbance or threats to population: Continued drainage of wetlands. Continued conversion of upland woods to agriculture, with consequent increase of pesticide runoff into wetland food chains.

Habitat characteristics

Plant community: Taxodium distichum/Nyssa aquatica; Taxodium distichum/Nyssa sylvatica.

Topography:

Soil series:

Microclimate:

Drainage basin:

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists:

CANOPY:

Acer rubrum
Liquidambar styraciflua
Nyssa sylvatica biflora
Taxodium distichum
Pinus taeda

SUBCANOPY:

Acer rubrum
Ilex opaca
Magnolia virginiana

SHRUBS:

Callicarpa americana
Clethra alnifolia
Leucothoe axillaris
Symplocos tinctoria
Vaccinium corymbosum
Vaccinium stamineum

HERBS:

Arisaema triphyllum
Arundinaria gigantea
Carex sp.
Hypericum virginicum
Mitchella repens
Osmunda regalis
Saururus cernuus
Woodwardia areolata
Woodwardia virginica

VINES:

Berchemia scandens
Decumaria barbara
Parthenocisus quinquefolia
Rhus radicans
Smilax rotundifolia

DISMAL SWAMP MAMMALS

Virginia Opossum *(Didelphis virginiana)*
Eastern Cottontail *(Sylvilagus floridanus)*
Marsh Rabbit *(Sylvilagus palustris)*
Eastern Chipmunk *(Tamias striatus)*
Gray Squirrel *(Scirus carolinensis)*
Southern Flying Squirrel *(Glaucomys volans)*
Muskrat *(Ondatra zibethicus)*
Black Bear *(Ursus americana)*
Raccoon *(Procyon lotor)*
Long-Tailed Weasel *(Mustela frenata)*
Mink *(Mustela vison)*
River Otter *(Lutra canadensis)*
Bobcat *(Felis rufus)*
White-Tailed Deer *(Odocoileus virginianus)*

DISMAL SWAMP TURTLES

Snapping Turtle *(Chelydra serpentina s.)*
Stinkpot *(Sternothaerus odoratus)*
Eastern Mud Turtle *(Kinosternon subrubrum s.)*
Spotted Turtle *(Clemmys guttata)*
Eastern Box Turtle *(Terrepene carolina c.)*
Eastern Painted Turtle *(Chrysemys pictap.)*
Yellow-Bellied Turtle *(Chysemys concinna c.)*
River Cooter *(Crysemys concivia c.)*
Red-Bellied Turtle *(Crysemys rubriventris r.)*

LIZARDS

Green Anole *(Anolis carolinensis c.)*
Northern Fence Lizard *(Sceloporus undulatus hyacinthinus)*

SKINKS

Ground Skink *(Lygosoma laterale)*
Five-Lined Skink *(Eumeces fasciatus)*
Brown-Headed Skink *(Eumeces laticaps)*
Southeastern Five-Lined Skink *(Eumeces inexpectatus)*

DISMAL SWAMP SNAKES

Non-Poisonous

Brown Water Snake *(Natrix taxispilata)*
Red-Bellied Water Snake *(Natrix erythrogaster e.)*
Northern Water Snake *(Natrix sipedon s.)*
Northern Brown Snake *(Storeria dekayi d.)*
Northern Red-Bellied Snake *(Storeria occipitomaculata o.)*
Eastern Ribbon Snake *(Thamophis sauritus s.)*
Eastern Garter Snake *(Thamophis sirtalis s.)*
Eastern Earth Snake *(Virginia valeriae v.)*
Eastern Hognose Snake *(Heterodon platyrkinas p.)*
Southern Ringneck Snake *(Diadophis punctatus p.)*
Eastern Worm Snake *(Carphophis amoenus a.)*
Eastern Mud Snake *(Faroncia abacura a.)*
Northern Black Racer *(Colibur constrictor c.)*
Rough Green Snake *(Opheodrys aestivus)*
Black Rat Snake *(Elaphe obsoleta o.)*
Eastern Kingsnake *(Lampropeltis getulus g.)*
Scarlet Kingsnake *(Lampropeltis triangulum elapsoides)*

Poisonous

Southern Copperhead *(Agkistrodon contoritrix c.)*
Eastern Cottonmouth *(Agkistrodon piscivorous p.)*
Canebrake Rattlesnake *(Crotalus horridus atricaudatus)*

DISMAL SWAMP SALAMANDERS

Greater Siren *(Siren lacertina)*
Two-Toed Amphiuma *(Amphiuma means means)*
Marbled Salamander *(Ambystoma opacum)*
Southern Disky Salamander *(Desmognathus fascus auriculatus)*
Red-Backed Salamander *(Plethodon cinereus cinsreus)*
Many-Lined Salamander *(Stereochilus marginatus)*
Southern Two-Lined Salamander *(Eurycea bislineata cirrigera)*

DISMAL SWAMP TOADS AND FROGS

Toads

American Toad *(Bufo americanus a.)*
Southern Toad *(Bufo terrestris)*
Fowler's Toad *(Bufo woodhousei fowleri)*
Oak Toad *(Bufo quercicus)*

Frogs

Green Treefrog *(Hyla cinera cinera)*
Pine Woods Treefrog *(Hyla femoralis)*
Squirrel Treefrog *(Hyla squirella)*
Gray Treefrog *(Hyla versicolor v.)*
Little Grass Frog *(Limaeoedus ocularis)*
Upland Chorus Frog *(Pseudacris triseriata feriarm)*
Brimsley's Chorus Frog *(Pseudaris brimleyi)*
Southern Cricket Frog *(Acris gryllus gryllus)*
Bull Frog *(Rana catesbeiana)*
Carpenter Frog *(Rana vigatipes)*
Green Frog *(Rana clamitans melanota)*
Southern Leopard Frog *(Rana utricularis)*
Eastern Narrow-Mouthed Frog *(Gastrophyrne carolinensis)*

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: MERCHANTS MILL POND STATE PARK

2. County: Gates.

3. Location: SR 1400, 1.4 mi south of Eason's Crossroads on US 158.

4. Topographic quadrangle(s): Beckford 1929 15 min (1:62,500).

5. Size: 3,300 a (1,335 ha).

6. Elevation: 6 ft to 38 ft (2 m to 11 m).

7. Access: Park entrance on SR 1400. Best access to beech slopes, pond and swamp is by canoe. Access to beech slopes, upland beech-white oak and pine successional areas by 7 mi loop trail on north side of pond.

8. Names of investigators: Cecil C. Frost, Dept. of Botany, UNC Chapel Hill.

9. Date(s) of investigation: 3 June 1981, 7 June 1981, 10 June 1981 plus data gathered during five years residence on site as naturalist and Ranger in charge.

10. Priority rating: High.

11A. Prose Description of Site.

Merchants Mill Pond is located in central Gates County, on SR 1400 about 1.4 miles south of US 158 at Eason's Crossroads. The park presently consists of about 2,500 acres, with eventual proposed size of about 3,300 acres upon completion of the park master plan (Fig. 13).

The history of the area, discussed in the master plan (1978), revolves around the mill pond, constructed in 1811, and once a center of commercial activity. The pond was constructed to operate a series of mills, with the most important in existence around the end of the 19th century, supporting a number of small businesses and a post office.

The pond fortunately survived the period when milling businesses turned to other sources of power and most of the old mill ponds were abandoned and eventually drained. The property was donated to the State in 1973 by the A. B. Coleman family of Moyock, NC and dedicated as a State Park. In 1980 a large tract was registered as a North Carolina Natural Heritage Area, designating it for the permanent protection of high quality wildlife habitat; habitat for a number of rare, endangered or threatened plant species, and as examples of the original forest types of the area.

With the exception of the pond itself, all of the plant communities of the park are representative natural communities of the region. Despite its man-made origin, the pond is also an outstanding natural community. It has existed for about 170 years and has acquired one of the most diverse collections of aquatic and wetland plants in the mid-Atlantic area — over 165 species. Only three of these, *Myriophyllum brasiliense* (Parrot's feather), *Spirodela oligorrhiza* and *Aneilema kaizak*, are not native plants.

Furthermore, there is evidence that this flora, with communities too numerous to analyze separately in a study of this scope, is entirely natural for the geographic region, having originally occurred in beaver ponds (Frost, unpublished study). Beaver, originally common in this area, carved out numerous ponds in the virgin swamp forests. These natural impoundments would have been the major habitat for many of the species of aquatics now found in the remaining mill ponds.

Beaver were completely extirpated from the Atlantic Coastal Plain by trapping, by the early part of this century (the last one was trapped in North Carolina around 1915). As beaver disappeared in the 18th and 19th centuries, and their ponds were absorbed into new swamp forest, numerous mill ponds were being constructed for water power. So, by happy circumstance,

these aquatic communities were preserved, albeit on a larger scale. The mill ponds may have even served to prevent extinction or extirpation of a few rare aquatics such as Hottonia inflata and Potamogeton confervoides.

Now, as the old mill ponds are drained one by one, the return of beaver offers hope of reestablishing these communities in their natural setting, at least in areas where trapping is not permitted and the ponds can be maintained on a semipermanent basis (it takes 20-50 yrs or more for this type community to reach its full development). The early steps of this process can be observed in Lassiter Swamp where the rare Hottonia can be seen invading new beaver ponds as they are extended upstream.

The water supply for the pond comes almost entirely through Lassiter Swamp, originating in upland forest and agricultural lands. The system is presently just able to handle existing amounts of sediment input and agricultural runoff. Some additional water comes from small direct tributaries to the pond, from rainfall, the water table, and downslope drainage from adjacent slopes.

The park is found within the Embayed Section of the Atlantic Coastal Plain, in the Chowan River basin. It is tributary to the Albemarle estuary, the headwaters of which extend some distance up the Chowan River and Bennett's Creek. The exact point at which this stream reaches base level is unknown, but apparently occurs within a mile or two below the Merchants Mill Pond spillway. The mouth of the creek is embayed and lies approximately at sea level. Wind tides from the Albemarle Sound and Chowan River frequently cause reversal of flow in Bennett's Creek, extending nearly to the park boundary.

The mill pond is impounded in a flat, alluvial swamp bottomland which is only 2 to 4 ft above sea level. The pond surface is 6½ ft MSL. Communities in Lassiter Swamp represent the type of swamp forest that would have occurred in the pond area before impoundment. The flat-bottomed swamp averages about ½ mi wide and is bounded on both sides by steep valley walls, which rise to an elevation of about 30 ft MSL. Above these are flat to very gently rolling upland divides which reach a maximum elevation in the natural area of 39 ft.

These flat uplands are remnants of the Talbot Terrace, which in this area may have been formed by fluvial or estuarine wave action during the Sangamon. The last stand of the sea high enough to have covered central Gates County occurred at the time of deposition of the Norfolk Formation on the eastern edge of the County. Sea level at that time (about 80,000 - 90,000 yrs ago) reached 45 to 50 ft higher than the present in this area

(Oaks and DuBar 1974). This would have inundated all of the county with the exception of the plateau of high land above the Hazleton Scarp in north-central Gates County adjacent to the NC/VA state line.

Some or all of the carving of the scarp could have occurred during that period, which may have lasted several thousand years. The coastline apparently lay along the Suffolk Scarp. Sand deposits there may have comprised something resembling modern barrier islands, at least during the later stage of this time. The interior of the county may have been a sound or bay where the Chowan emptied into the sea. Water may have flowed through inlets in the barrier or directly from the mouth of the river, perhaps in the same manner in which the James River becomes embayed at its mouth before emptying into the Chesapeake.

The Hazleton Scarp would have been formed primarily by wave action from the Chowan embayment. As its wave-cut face receded northward, the present 35-40 ft terrace forming the uplands surrounding Merchants Mill Pond would have been created and mantled with estuarine sediments which later developed into the modern soils of the area. Recession of the Sangamon sea left the new terrace exposed from that time until the present day.

While the precursor of the drainage pattern that was to become Bennett's Creek may have been incised during the earlier Illinoian glacial exposure, most of the existing modern topography visible along its course was shaped in the Wisconsin. The dendritic pattern of streams that were to become Duke, Harrell, Raynor and Lassiter Swamps was extended and deepened during this erosional period.

Daniels et al. (1971) have shown that the flat terraces between stream drainage systems are extremely stable on the Coastal Plain, with little erosion having occurred over a period of several million years on the higher terraces. Since the Talbot Terrace is only about 80,000 to 90,000 yrs old, its present surface is probably little changed from the time of its deposition, with the exception of portions dissected by streams.

The most prominent of these stream valleys is that of Bennett's Creek which, although flat-bottomed, is walled by steep, rolling valley sides and has topography which is locally quite rugged for the Coastal Plain (see ravines around Merchants Mill Pond and Lassiter SWamp). Most of this relief was created in the period from late Sangamon (around 70,000 - 80,000 yrs ago) to the end of the Wisconsin (around 15,000 yrs ago).

During this 60,000 yr period, world sea level fell to as much as 350 ft lower than the present. This meant that most of the continental shelf to the east of the present Outer Banks

was exposed as dry land, and that Gates County stood about 400 ft above sea level, nearly the elevation of the present lower Piedmont in the vicinity of Raleigh and Durham.

With greatly lowered base level, the Chowan River and Bennett's Creek were narrow, Piedmont-like streams, downcutting and becoming entrenched in their floodplains. Stream valleys would have been much more V-shaped than at present. The depth to which these valleys were cut is unknown, although this may someday be determined from well borings. It is certain that the level was considerably below that of the present. Deep holes in the stream channels of Lassiter Swamp and Bennett's Creek, both in its upper section and near its mouth, are remnants of the Wisconsin stream valley. Since the present surface of Bennett's Creek is at sea level, the holes 20 ft or more deep reported from its lower section could not have been eroded by the present slow-flowing stream, but are remnants of a much deeper valley that only began to fill around 5,000 yrs ago (see discussion of geology of Chowan Swamp).

The rolling land and slopes forming the valley sides of Bennett's Creek were probably formed by a series of processes. One such event may have been wave action during recession of water from the Chowan embayment. The major erosional period, however, probably occurred during the Wisconsin while streams were deepening their valleys.

With respect to the relative ages of these three major topographic surfaces exposed within the natural area, the flat, stable uplands are the oldest, dating from the end of the Sangamon. The valley slopes are younger, having undergone extensive erosion and lateral recession during the Wisconsin. This process has continued, although at a very reduced rate, in post-Wisconsin time to the present day. Youngest of all are the swamp bottomlands, which are presently aggrading year by year.

Obviously, very different time intervals have been available for the formation of soils. From the overview above it would be expected that the bottomlands would contain Entisols in the swampy areas and Inceptisols on the drier flats. The valley walls may be Inceptisols, and the upland divides should have had time to develop Ultisols. A detailed soil survey of part of the natural area has been begun by the local office of the Soil Conservation Service. Identification of the various soils to series has not yet been completed.

These swamp bottoms, tributary to the Chowan River, are the filled floodplains of deeper stream valleys carved during the late Sangamon and Wisconsin. Filling must have been rapid in the past few thousand years. About 2,000 years ago sea level had

recovered to its present height in this region, and actually rose to about 4 ft above modern levels during a period from about 1900 to 1200 yrs BP (Oaks and DuBar 1974). This would have embayed water in all of these low-lying stream valleys, allowing deposition of sediment and organic matter in the upper stretches of the impounded portions, and initiating new peat deposition in the lower segments. Sea level later fell about 10 ft and has risen to its present level over the past 725 yrs. This recent rise has elevated stream base levels and initiated more valley filling. Lassiter Swamp is typical of these swampy streams in that it is presently aggrading. Each spring flood brings sediment from the uplands which is spread over the swamp floor, incorporating leaf litter and other organic matter and adding slightly to its elevation. This process will continue for as long as sea level remains at its present elevation or continues to rise.

The role of beaver in the geology of these valleys is unknown, but must have been a factor. If present during the Wisconsin, their impoundments would have created a terracing effect, slowing the rate of stream downcutting. Historical records show that they were present in the post-Wisconsin period, when their dams may have contributed to the rapid filling of swamp bottomlands. It is possible, for instance, that in the absence of beaver, delayed filling of upper Bennett's Creek might have caused the stream to remain navigable as far as Sunbury. That this filling is very recent is indicated by the remaining holes in the channels of Lassiter and Duke Swamps. The activities of recently returned beaver, which have constructed dams in excess of 2,000 ft across the swamp, give some indication of their potential for affecting local geology.

PRESENT PLANT DIVERSITY AND ORIGINAL FLORA

There are six major forest community types within the natural area (see analysis of communities CT-A through CT-F), not including the disturbed pine successional areas found over much of the uplands. In addition, there are numerous minor community types which were not analyzed. These include some distinct forest types of very limited extent, and a number of aquatic communities that are either seasonal or ephemeral.

CT-A. CYPRESS-TUPELO SWAMP FOREST (*Taxodium distichum*(emergent)/*Nyssa aquatica*/*Acer rubrum*-*Fraxinus caroliniana*/*Saururus cernuus*.

This community appears to be climax for the wettest portion of low lying fluvial swamps in the county. Because of proximity to sea level, it occurs where the water table is never more than a few inches below the surface, even in the most severe droughts. A few acres of this type in Lassiter Swamp may represent a remnant of the virgin forest of the area. The state record tupelo (*Nyssa aquatica*) is found in this stand. A larger area has been

logged, but a number of the larger virgin cypress were left standing. One of these measured over 100 ft tall and 7.2 ft dbh. This is the best remaining example of what was once a major forest type in the county.

CT-B. TUPELO FOREST (Nyssa aquatica/rare aquatic herbs.

The tupelo stand occurs in the headwaters of Merchants Mill Pond, in the transition area between the pond and Lassiter Swamp. As such, it is apparently the result of the man-made impoundment. Similar stands can be seen in the headwaters of other mill ponds in nearby counties.

However, it may to some extent duplicate conditions occurring in the headwaters of relatively permanent beaver ponds before extirpation of this mammal in historical times. The natural relationships of the community will have to await long-term successional studies on some tract where beaver are protected and allowed to maintain ponds on a continuous basis. The natural area would be an ideal site for this study, but unfortunately, incomplete park boundaries in Lassiter Swamp prevent protection of the present beaver population from trapping.

This community provides habitat for several endangered or threatened species of plants. Most prominent of these are Hottonia inflata (Featherfoil), Ranunculus flabellaris (Yellow water crowfoot) and Glyceria pallida (Pale mannagrass). This is one of the two best locations in the US for Hottonia (the other is in Nags Head Woods). The largest recorded bloom of this species occurred at Merchants Mill Pond in 1979.

There is only one other location known in North Carolina for water crowfoot, and the natural area is the only presently known location for pale mannagrass. In addition, the uncommon form of hornwort (Ceratophyllum echinatum) is found on this tract. Red-shouldered hawks with young are seen here in spring, but it is unknown whether they are nesting in Lassiter Swamp. On 13 May 1980 a pair of anhingas were observed in this area and another was sighted here 11 April 1981 — very rare sightings this far north. The least bittern has also occurred here.

CT-C. OLD MILL POND WITH DIVERSE AQUATIC AND WETLAND PLANTS.

This 170 yr old, 600 acre pond (Merchants Mill Pond) has one of the most diverse assemblages of aquatic and wetland plants in the geographic region. Rare aquatics include Hottonia , Carex lupuliformis (not seen in this study, but reported from the north shore by Gammon 1976), Potomogeton confervoides, Potomogeton foliosus and Wolffia papulifera. Potomogeton confervoides (Conferva pondweed) is recorded from only three

other counties in North Carolina, as is Potomogeton foliosus (Leafy pondweed). Both these are found here around submerged tree stumps in the lower pond. As species they seem to require very clean, unpolluted water, which may explain their confinement to the area of the pond closest to the spillway.

Sediments and pollutants entering the pond appear to be strained out and deposited in the upper reaches. Originating as agricultural runoff, these materials pass through Lassiter Swamp and enter the upper pond, where still water and a thick growth of aquatic plants remove them from suspension and solution. A series of conductivity readings taken in fall, 1976 showed that the total amount of dissolved material decreased regularly from the upper pond to the lower end near the spillway.

Neither species is common here, and their limitation to the cleanest waters of the pond indicate that their presence is endangered at this site. Additional runoff of sediment and nutrients from fertilizer and livestock wastes would probably eliminate these species from the county flora.

Wolffia papulifera (Pappilose water meal) occurs in the pond but is rare in some years. Wolffia columbiana was listed for the site in the park master plan but only the above species has been seen during the past six years. An unidentified species of Ludwigia, which could be a state record, also occurs at the pond.

CT-D. BLACK GUM SWAMP (Nyssa sylvatica biflora/Acer rubrum-Liriodendron tulipifera-Liquidambar styraciflua/mixed mesophytic herbs).

This community type is best seen on the recently purchased Cathleen Edwards tract along a small swamp tributary leading from SR 1404 into the southeastern headwaters of the mill pond. This is the type, within the natural area, which most closely resembles the dominant community of the Dismal Swamp. The presence of yellow poplar and sweet gum is probably due to the presence of colluvium along the valley borders and could likely be segregated as a distinct community type.

This community type contains two rare herb species plus a third, Listera australis (Southern twayblade) on the adjacent uplands. The four other sites for this orchid species in the county are on low moist sands around the periphery of sand ridges in swamps. Here it occurs at an elevation of 35 ft in a pine successional area. Its presence on this atypical site may be due to a local seepage area.

Yellow water crowfoot (Ranunculus flabellaris) is found at the lowest elevation on this site, along the tributary swamp and is actually confluent with the larger population of this species described under CT-B (Tupelo Swamp). Along the eastern

edge of this community, in a colluvial area, is found a tract of about two acres in which logfern (Dryopteris celsa) is abundant. Some of these, growing in a small opening, form robust masses four feet high. A visit to the site with Dr. Lytton J. Musselman, world's leading authority on this species, revealed that it was the only member of its genus present.

CT-E. BEECH SLOPES (Fagus grandifolia)

This type is the dominant community on the valley wall slopes which represent the transitional topography between flat uplands and swamp bottom. As such, it occurs in narrow strips several miles long on both sides of the natural area. Mature stands of this type 70-90 years in age occur in several places, most strikingly in a large tract on the north side of the mill pond in the vicinity of the long, north-trending ravine, and along the pond to the east of this area.

Slightly different beech communities are found on several flats in Lassiter Swamp and on some of the flat uplands to the south of the pond. Stewartia malacodendron (Silky camelia) occurs beneath the beech at the canoe camp on the north shore. On some narrow upland ridges in this vicinity, beech is found with white oak in what might be segregated as a distinct community.

CT-F. MIXED MESOPHYTIC OAKS

This designation includes upland communities dominated primarily by white oak (Quercus alba), black oak (Quercus velutina), southern red oak (Quercus falcata) and water oak (Quercus nigra). This is the least understood of the major forest types of the natural area since it occurs on the uplands which have been almost universally disturbed by logging or agriculture. This is true of nearly the whole Coastal Plain.

No sizable tract of upland hardwoods remains in the county. Enough small patches of mature and seral stage oaks exist to indicate some type of oak or oak-beech forest to be one of the climax types of the uplands. There is evidence in places to suggest that there may have been a beech-white oak type on some of the moister uplands, and a mixed oak type in the drier places.

Fire undoubtedly played an important role, and there was probably some longleaf pine (Pinus palustris) along the well-drained ridge crests at the top of the steep valley slopes. Just north of the state line, above Corapeake, the last natural stand of longleaf pine in Virginia was cut in 1978. This had been a Pinus palustris/Quercus alba community on a sandy loam soil. The same was true of several other former longleaf sites in Virginia. Apparently, deep sand was not a requirement for

longleaf in this area. The pines at the last site in Virginia were somewhat older than the oaks (up to 100 yrs) and the presence of oak was probably due to fire suppression. Before this practice became universal in the 20th century, fire was an important factor in determining upland forest types of this region.

William Byrd in 1729 described longleaf pine as the dominant type along the Suffolk Scarp near Sunbury. An ad in the Virginia Gazette in 1772 described a large tract of land on the headwaters of Bennett's Creek (possibly the present site of Sunbury) on which there was available a large quantity of "lightwood". This term was usually applied to dead and fallen longleaf pine, and when present, was sometimes mentioned in land descriptions because of its commercial value for tar and pitch making.

Modern remnants of the longleaf pine forests of Gates County occur now only on a few small tracts in the Sand Banks area. This species was probably an important forest type on the uplands of the rest of the county as well. It would have been found as a fire climax on sandy loam soils on low ridges above streams or wherever the land was rolling enough to allow good drainage. Virtually all of these sites are now in agriculture.

ANIMAL DIVERSITY

Because of the diversity of wetland and upland habitats within the natural area, Merchants Mill Pond has the highest species diversity of the remaining natural areas in the county. Species lists, while still incomplete, have been kept for plants, birds, mammals, reptiles and amphibians. In a published study (Tarplee 1979) 26 species of fish were identified from the watershed above the mill pond. Virtually no work has been done on bryophytes, fungi, lichens, algae, insects or other invertebrates. The rich invertebrate fauna of the pond should be especially rewarding. Much work remains to be done before it will be possible to complete a catalog of species and evaluate the habitat and protection status of each. This should be a long-term goal of park naturalists.

The park bird list includes about 160 species, of which 11 are listed as endangered or threatened in North Carolina (see Significance Summary Table). About an equal number are listed as of special concern. No information is available on the possible breeding status of the first 11 species mentioned. All except several hawks are presumed to be visitors. The red-shouldered hawk, in particular, is present year round and nests somewhere in the vicinity. Their presence, with young in Lassiter Swamp during spring and summer months suggests nesting there, but no actual sites have been discovered.

WINTER WATERFOWL

During the winter of 1976, the first year of protection from waterfowl hunting, only about 75 ducks were to be seen at one time on the upper mill pond. This is a large, open area where summer and fall seed production by a variety of wetland plants creates an abundance of food for winter waterfowl.

During the winter of 1977 about 300 ducks were seen, mostly mallards and black ducks. In 1978 this increased to about 1,000 birds, and in 1979 and 1980 from 1,000 to 2,000 could be seen on some dates, with up to 14 species of ducks present (see site bird list). Canada geese have been known to occasionally visit the pond in large flocks. Snow geese and whistling swans sometimes overfly the area. Whether or not they use the pond for feeding is unknown.

Osprey visit the area in spring and fall, and have been observed fishing successfully on the upper pond. Wild turkey were once numerous on the site, according to several older residents who used to hunt them on the property, sometimes killing several in one day. They were nearly extirpated from the county, but now under full protection, seem to be making a comeback. A small flock of about three birds was reported south of the park in 1980. If protection is continued, they should eventually find their way into the park and become a permanent part of its bird fauna. As pine successional areas are replaced by mature, mast-producing hardwoods, the park should contain excellent wild turkey habitat.

There have been occasional rare sightings of such species as anhinga, purple gallinule, glossy and white ibis and red-cockaded woodpecker.

Other species lists include 11 turtles, 6 lizards, 16 snakes, 2 salamanders and 11 frogs and toads. There are undoubtedly more species, especially of the amphibians to be collected.

Twenty six mammals have been found. No detailed small mammal study has been conducted, and it is certain that a few species have escaped notice. The natural area constitutes excellent habitat for wetland mammals. The park serves as a refuge for these species, which are maintained everywhere by trapping, at levels far below those at which they would have a natural interaction with the environment. The park boundary upstream and downstream is lined with traps each winter.

River otter occur on the park, probably denning in abandoned or active beaver lodges. There have been only three sightings of bobcat within the park since its inception, plus one sighting several years earlier. Mink den on the park, and have been seen with young in the mill pond. All three of these

species are threatened in the area and should receive full protection.

Raccoon are abundant and are occasionally seen in the daytime. Gray fox, opossum, white-tailed deer and two species of rabbits also occur. A considerable number of deer, perhaps 50 to 100, may be found on the park at any one time. No damage of any kind attributable to deer has been noted. In late winter browsed stems of cane (Arundinaria gigantea), cat brier (Smilax rotundifolia and other species, and Japanese honeysuckle (Lonicera japonica) can be seen. At other times there is little evidence of their presence.

Bear were numerous in this area in the past. About 1978, a bear that had been transplanted to the Dismal Swamp passed through the park and was killed later in a county to the south. With this exception, the last bear reported was seen around 1966, uprooting and eating water lily rhizomes in the upper section of the mill pond. The only way that this species could ever be a part of this system again, however, would be if a fairly wide wildlife corridor could be maintained between Chowan Swamp, through this area to Dismal Swamp. This appears to be a very unlikely possibility.

11B. Prose description of site significance:

Merchants Mill Pond State Park contains six major examples of climax forest types native to Gates County. Several of these have been nearly eliminated from the area. As the remaining wooded areas mature, the quality of these forests will continue to increase. This large natural area will eventually be the only place in the county to see these examples of the primeval forests of the area. There are a diversity of lesser (but valuable) forest and herbaceous community types, too numerous to be surveyed in this study.

Nine endangered or threatened plant species occur on the park. For two of these, *Glyceria pallida* and *Ranunculus flabellaris*, this is the only protected site in the state. For a third, *Hottonia inflata*, this is one of the two best sites known for the species.

The area when completed will be large enough, and contain an adequate diversity of habitats, to support permanent populations of most of the mammals and many of the birds present in the area.

The mill pond is the most significant waterfowl site in the county, and serves a valuable function in the support of winter ducks and other waterfowl. The provision of this winter feeding and resting area guarantees the return of many of these birds to summer breeding grounds.

A total of 22 birds listed as endangered, threatened or of special concern occur within the park. The status of many of these on the park is incompletely understood. Whether nesting or not, the site is important in the support of these and the 140 other species which occur here.

As wildlife habitat continues to disappear in the face of growing population, and as more land is converted to agriculture and intensive forestry, the value of these few reserved areas, in guaranteeing survival of native plants, animals and forest types, will be inestimable. Many forest researchers indicate that adequate study sites for many forest types can no longer be found. The value of this natural area for scientific study alone would be enough to justify its preservation.

For the people of the county, the area will be of increasing value as a permanent place to see and experience the beauty and diversity that is part of the natural heritage of the area.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
High quality wetland plant community	CT-A	Taxodium distichum/Nyssa aquatica/Acer rubrum-Fraxinus caroliniana/Saururus cernuus	Climax (possibly virgin) cypress-tupelo stand. State Record tupelo.
High quality wetland plant community	CT-B	Nyssa aquatica/mixed aquatic herbs.	Almost pure stand of tupelo. Rare aquatic herbs: Ranunculus flabellaris(EP)
			Hottonia inflata(TP) Glyceria pallida(TP)
High quality wetland plant community	CT-C	Old mill pond with aquatic and wetland plants.	One of most diverse assemblages of aquatic and wetland plants on the mid-Atlantic
			Coastal Plain. Rare aquatic herbs: Carex lupuliformis(TP)
			Hottonia inflata(TP) Potomogeton confervoides(TP) Potomogeton foliosus(TP)
			Wolffia papulifera(EP)
High quality wetland plant community	CT-D	Nyssa sylvatica biflora/ Acer rubrum-Liriodendron tulipifera-Liquidambar	Late successional(40-70yrs) black gum stand. Rare herbs: Dryopteris celsa(TP)
		styraciflua/mixed mesophytic herbs.	Listera australis(EP)(on adjacent uplands) Ranunculus flabellaris(EP)
High quality terrestrial plant community	CT-E	Fagus grandifolia	Climax Coastal Plain beech community(75-90 yrs) on moderately steep slopes.
High quality terrestrial plant community	CT-F	Mixed mesophytic oaks.	Mature(75-90 yrs) oaks in mixed stands in scattered small remnants on uplands

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Endangered or threatened species		*Ranunculus flabellaris* (Yellow water crowfoot)	Endangered peripheral in North Carolina (Cooper et al. 1977).
			Known only from one other site in NC.
Endangered or threatened species		*Listera australis* (Southern twayblade)	Endangered peripheral in North Carolina (Cooper et al. 1977). Known from 7 sites in NC (5
			from Gates County).
Endangered or threatened species		*Hottonia inflata* (Featherfoil)	Threatened peripheral in North Carolina (Cooper et al. 1977). This location and Nags Head
			Woods are the two best sites for this species in the US. The largest known bloom of *Hottonia*
			occurred here in 1979.
Endangered or threatened species.		*Glyceria pallida* (Pale mannagrass)	Threatened peripheral in North Carolina (Cooper et al. 1977). Only location in NC where this
			species still known to exist.

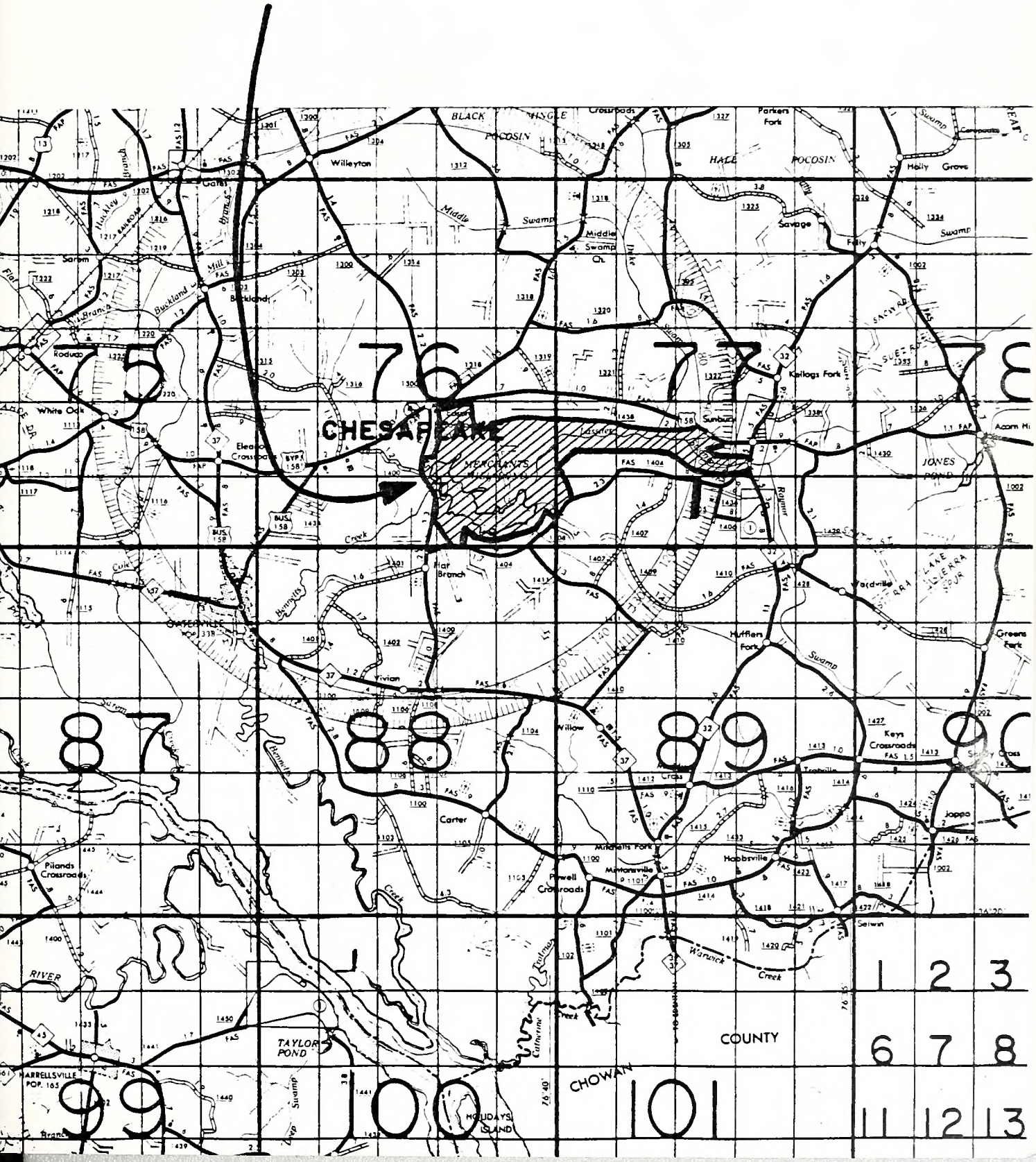
12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Endangered or threatened species		Potamogeton confervoides (Conferva pondweed)	Threatened peripheral in North Carolina (Cooper et al. 1977). Known in NC only from three other counties.
Endangered or threatened species		Potomogeton foliosus (Leafy pondweed)	Threatened peripheral in North Carolina (Cooper et al. 1977). Known in NC only from three other counties.
Endangered or threatened species		Carex lupuliformis (Hoplike sedge)	Threatened peripheral in North Carolina (Cooper et al. 1977). Known in NC only from three other counties.
Endangered or threatened species		Dryopteris celsa (Log fern)	Threatened peripheral in North Carolina (Cooper et al. 1977).
Endangered or threatened species		Red-shouldered hawk	Threatened in North Carolina (Cooper et al. 1977). Resident, possibly nesting.
Endangered or threatened species		Cooper's Hawk	Threatened in North Carolina (Cooper et al. 1977). Occasional visitor.
Endangered or threatened species		Sharp-shinned hawk	Threatened in North Carolina (Cooper et al. 1977). Uncommon visitor.
Endangered or threatened species		Turkey vulture	Threatened in North Carolina (Cooper et al. 1977). Common in this area.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Endangered or threatened species		Black vulture	Threatened in North Carolina (Cooper et al. 1977). Common in this area.
Endangered or threatened species		Sparrow hawk (American Kestrel)	Threatened in North Carolina (Cooper et al. 1977). Winter resident.
Endangered or threatened species		Brown creeper	Threatened in North Carolina (Cooper et al. 1977). Rare visitor.
Endangered or threatened species		Least bittern	Threatened in North Carolina (Cooper et al. 1977). Rare visitor.
Endangered or threatened species		Anhinga	Threatened in North Carolina (Cooper et al. 1977). Rare visitor.
Endangered or threatened species		Least bittern	Threatened in North Carolina (Cooper et al. 1977). Rare visitor.
Endangered or threatened species		Red-cockaded woodpecker	Endangered (Endangered Species Scientific Authority). Rare visitor.
Endangered or threatened species		*Trillium pusillum* (Carolina trillium	Threatened throughout (Cooper et al. 1977). Large flowering population.

Fig. 12. Access information:
MERCHANTS MILL POND STATE PARK



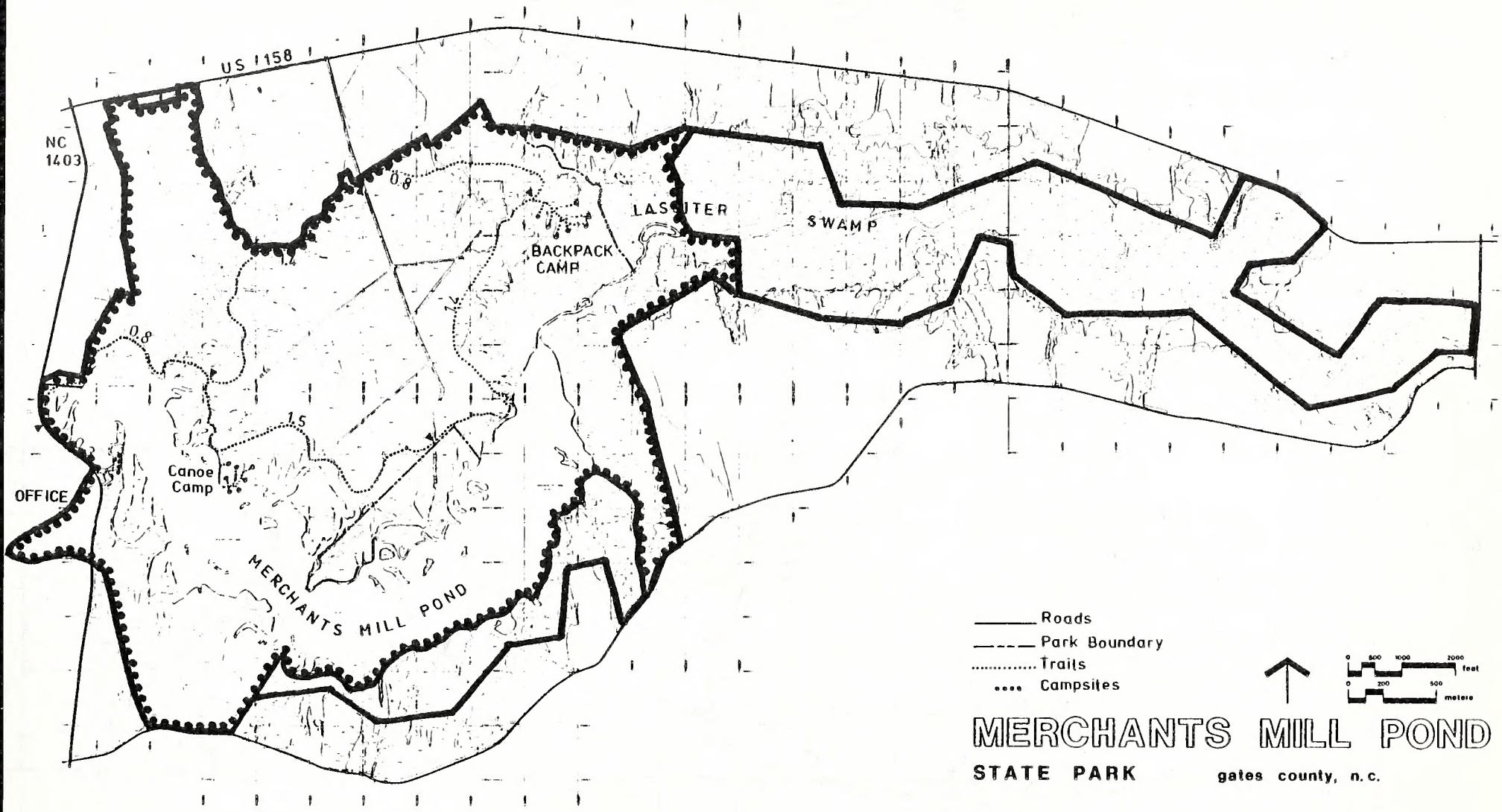


Fig. 13. Property boundaries of Merchants Mill Pond State Park:

Existing boundaries as of 1981

Proposed final boundary.

Legal Status, Use and Management

13. Ownership type by percent area:

Type	
Private	23 %
Public	77 %
Unknown	%

14. Number of owners: 1

15. Names of owners and/or custodians (with addresses, phone numbers, other pertinent information).

Numbers correspond with ownership map of Merchants Mill Pond - Lassiter Swamp vicinity. (Map in NC State Parks planning section files).

6. John Moody
   Sunbury, NC 27979

8. C. C. Edwards estate. Hunter Morgan, trustee
   Kellogg-Morgan Insurance Co.
   Sunbury, NC 27979

11. Same as 8.

29. Same as 8.

30. Mrs. Frank Nixon
    Sunbury, NC 27979

24. Same as 30.

28. Johnny C. Lassiter
    Sunbury, NC 27979

26. William H. Lassiter
    Sunbury, NC 27979

14. S. E. Nixon
    Sunbury, NC 27979

15. D. W. Wiggins
    Sunbury, NC 27979

16. R. L. Corbett Est.
    Rt. 4, Box 299
    Oxford, NC 27565

17. Cathleen Edwards
    Sunbury, NC 27979

18. O. G. Williams
Sunbury, NC 27979

25. Earlie B. Brinkley
Sunbury, NC 27979

19. Verna Bond
Sunbury, NC 27979

20. Pierce, Stephan & Ange
Sunbury, NC 27979

23. G. L. and J. W. Nixon
Sunbury, NC 27979

21. I. F. Outland
Sunbury, NC 27979

22. Rosie Tucker Cross
Sunbury, NC 27979

7. J. W. Busbee
Sunbury, NC 27979

18. North Carolina Department of
Natural Resources and Community Development
P. O. Box 27687
Raleigh, NC 27611

16. Names of knowlegeable persons (with addresses, phone numbers, other pertinent information).

Hon. Phillip Godwin
Godwin & Godwin
Gatesville, NC 27938

17. Attitude of owner(s) toward preservation (contacted?):

All of landowners contacted by Div. of State Parks when Merchants Mill Pond State Park established. Attitudes vary widely.

18. Uses of natural area:

State Park property used for canoeing, camping, fishing, hiking. A large portion of the property designated a natural area for preservation of rare plant species, habitat for endangered and threatened species.

Portion in private ownership consists of wooded slopes and swamp. Used for hunting, occasional timber harvesting.

19. Uses of surrounding land:

a. Wildland 25 %

b. Agricultural 70 %

c. High-intensity forestry _____ %

d. Developed 5 %

20. Preservation status:

Cat.	*%	*Description of Preservation status
1	52%	Registered Natural Heritage Area.
2.	25%	State Park public use area.
6.	23%	Private land. No protection provisions.

21. Regulatory protections in force:

Merchants Mill Pond State Park covered by park rules and regulations.

22. Threats:

1. Channelization of Duke, Harrell and Raynor Swamps in the watershed above the park.

2. Logging in Lassiter Swamp.

3. Logging of hardwood forest remnants on adjacent slopes and uplands.

4. Further clearing of woodlands for agriculture leading to additional disruption of natural hydrology.

5. Pollution in the form of nutrient runoff from hog farming operations and agricultural fields.

6. Pollution in the form of pesticides used in agriculture.

7. Sedimentation from all sources

Of the various threats listed above, potentially the most damaging would be channelization in any part of the watershed above Merchants Mill Pond and Lassiter Swamp. This region, which already contains the largest area of cleared agricultural land in the county, supplies the mill pond with as much sediment and agricultural chemicals as the system can handle.

Some 20 yrs ago the Soil Conservation Service and US Army Corps of Engineers proposed to channelize the entire watershed, including all of Duke Swamp and part of Lassiter Swamp. A variety of prechannelization studies studies were done (Pardue et al. 1975). In 1979 a meeting was held in the county to present plans and options to all County, State and Federal officials who might be involved. After two days of plan review, on-site inspections and meetings, the concensus was that the damage to water quality, fishing, and wildlife habitat would far outweigh the slight agricultural advantage to be gained.

Soon after, at a meeting of the landowners involved, it was voted to scrap the project in view of the potentially harmful effects. Officials involved were informed by the Raleigh office of the Soil Conservation Service that they had agreed to drop the project and that a notice to that effect would soon be mailed. A telephone call some months later brought only the information that this was still the intention of the federal agencies. Some two years later, however, no such notice has been received. It may be that the Corps and the SCS are still planning to carry out this destructive project.

[NOTE: in a follow-up visit to the Raleigh office of the SCS after completion of this study, it was found that this project was indeed closed out on September 30, 1981].

In Pitt County, North Carolina, sediment traps constructed as part of the channelization of Chicod Creek were filled the first year. No effective method for dealing with this problem has yet been devised. Merchants Mill Pond acts as a 600 acre sediment trap for upper Bennett's Creek. As such, it is undergoing slow filling and eventual conversion to a bog. Already fishing and boating have been affected, with the shallower water and high levels of nutrients from agricultural runoff and livestock operations causing a lush growth of aquatic plants.

Should the park ever be able to acquire a portion of land around the whole mill pond, it will be possible to raise the water level, effectively deepening the pond and reducing the present problems. However, there is a limit to which the water can be raised without affecting some of the important wetland forest communities. Park trails and some facilities would have to be relocated. This course of action might be effective for the next 50 to 100 yrs with the present rate of sediment input. Evidence from Chicod Creek suggests that the huge input of sediment from channelization would defeat these efforts, and destroy much of the natural qualities of Merchants Mill Pond.

23. Management and preservation recommendations:

1. ACQUISITION AND DEVELOPMENT

___Update the park master plan to limit park development to the northwestern corner, from the mill pond to US 158, and along SR 1403-1400 near the spillway. Development in the center of the park as proposed in the original master plan would be enormously detrimental to park wildlife, mill pond plant communities and esthetic values.

___Because of future funding uncertainties, care should be taken not to develop facilities beyond the ability of one or two rangers to maintain. Examples abound in other state park systems, where excess commitment to user facilities was followed by loss of staff positions, with the consequence that present facilities are shabby and run down, and with inadequate staff to prevent damage to natural values caused by excessive public access and use.

___The planned park boundary should be completed. Future conversion of land use to other types will necessitate that all state parks should be, as far as possible, complete and self-sufficient ecosystems.

2. PERSONNEL

___The park should always have a resident naturalist, or the park superintendent or a ranger should be a competent naturalist with a degree in Biology, Botany, Ecology or Forestry. One of the naturalist's responsibilities should be to make recommendations and be involved in any aspect of park operations, construction and development that might affect the natural systems involved.

3. FIRE MANAGEMENT

___A fire plan should be developed for the park, in conjunction with county forestry personnel. It should be made clear that in no circumstance should fire plows be used within park boundaries. The use of fire plows to fight fires in any state park should be eliminated. Preservation of soil structure and topography will one day be recognized as as important role of these areas.

___Any fire should be controlled with hand tools only. Areas around buildings or equipment should have vegetation thinned, mowed or otherwise planned so that fire will not be a threat. Forestry may consider it necessary to prevent a fire originating on, or passing through the park from continuing onto adjacent private property. In this case,

any plowed fire lines should be established outside park boundaries.

___Wildfire was a frequent natural occurrence in this area before settlement. The only real danger from fire in this area is damage to loblolly pine plantations. Mature hardwood forest is essentially immune from damage by fire, unless it recurs frequently. There is little litter accumulation under the several climax forest types present on the park, and any fire would only burn lightly across the surface in these areas. It is questionable whether it is even desirable to try to suppress fire on these sites. The only communities on the park capable of supporting a hot fire are weedy and loblolly pine successional areas. When fire occurs in such an area the usual practice is to use fire plows. This is neither necessary nor desirable, since state parks are not in the business of raising pine for sale. Such fires should only be controlled at park roads or boundaries.

___No harm will be done by destruction of young pine stands. Fire was a natural determiner of forest types on the uplands in this area, and may serve to redirect the course of succession toward fire-tolerant community types if it occurs. Plant succession following fire can be interpreted by the park to the public.

___The only exception to the use of fire plows on state parks should be in areas such as Weymouth Woods where the dominant forest type was a pyroclimax or in experimental areas where fire may have been a lesser factor. This differs greatly from fighting wildfires, in that park personnel can carefully plan permanent boundaries of areas to be fire-managed, so as to minimize damage to natural values.

___It would be desirable to do this on some small upland tract at Merchants Mill Pond since some of the upland communities were probably fire-selected. Much of the present upland vegetation may represent an unnatural grouping resulting from 20th century fire-suppression. None of the slope or swamp communities develop flammable litter, nor would they have been dependent upon fire for their original composition.

4. MANAGEMENT OF FOREST TYPES

___No management is needed for any of the slope or swamp community types in the park. These are natural climax communities.

___Since there is historical evidence for the presence of longleaf pine (*Pinus palustris*) on some of the upland sites,

it would be desirable at some time in the future to treat one or two small tracts by burning and seeding with native longleaf pine (from local sources) and study the results. Little harm to park values would be done since much of the uplands have been heavily disturbed by past logging and agriculture.

___Beyond the attempt to restore a sample of the original upland types, no other attempts at management on the uplands is necessary. Most of these areas are dominated by loblolly pine in successional stands of various ages. In the natural process of succession, these will begin to thin gradually and eventually will be replaced by hardwoods — one of the native climax types. The exact composition of the original upland hardwood forests is unknown.

___Under no circumstances should pines be harvested from these areas. Neither should any attempt be made to spray or otherwise control beetle infestations or diseases should they occur. The replacement of pines on these sites is a natural process, and care should be taken not to interfere with the natural succession. The resulting climax forest will be invaluable for scientific purposes, since it will be the only site within the geographic region where climax upland hardwood forest can be studied on a long-term basis.

5. FIREWOOD FOR PARK USE

___State parks should develop a policy regarding use of firewood as fuel for heating park buildings. At some time in the future, economic pressures might make it necessary for parks to be more self-sufficient. Ideally these needs should be met by having all park structures designed for passive solar heating. However, should it be necessary to use firewood, it might not be objectionable to designate a small tract of 5 or 10 acres specifically for the purpose. It should be carefully chosen, and be within the developed portion of the park or in a non-sensitive area along a state road. Once so designated, it should be carefully managed to provide a perpetual supply of firewood. No change of site should be permitted, and no harvesting of living, dead or fallen trees should be allowed within parks, with the exception of any that happen to fall across a road.

6. MILL POND MANAGEMENT

___Sedimentation may be the greatest long-term problem. suspended material from agricultural fields has accumulated over the 170 year existence of the pond, but has been greatly aggravated by additional land clearing and ditching in the past 20 years. During this time the upper pond has

accumulated sediment, and shallowed to the point that it supports a dense, impenetrable mat of vegetation in the summer.

___This process will continue, eventually converting the upper mile of pond to a bog, a natural stage in the filling of any lake. It will be necessary, especially under pressure from the public for improvement of fishing and boating access, to resist the temptation to tamper with the system in a destructive manner. Under no circumstances should herbicides be used. Since the problem is due to simple shallowing of the pond by sediment fill, the only workable solution will be to raise pond level.

___Increasing the height of the spillway by about a foot might alleviate the problem for another century. If this were done slowly, perhaps 6 inches the first year, and 6 inches two years later, the rare aquatic plants in Lassiter Swamp should be able to adapt by moving upstream. This should probably only be done once, to avoid repeated disruption of the major wetland forest communities, decreasing their value for scientific study.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-A

Community type: *Taxodium distichum* (emergent)/*Nyssa aquatica* *Acer rubrum*-*Fraxinus caroliniana*/*Acer* & *Fraxinus* transgressives/ *Saururus cernuus*

Community cover type: *Taxodium distichum*

General habitat feature: Fluvial swamp.

Average canopy height: Emergent cypress: 120 ft +
Nyssa aquatica: 80-90 ft

Estimated age of canopy trees: Emergent cypress: 300-500 yrs
Nyssa aquatica: 80-120 yrs

Canopy cover: Closed.

Estimated size of community: 60 a.

Successional stage: Climax.

Sere type: Pelosere.

Common canopy species in community cover or community type (but not dominant): None.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):
Itea virginica.

Common herb stratum species in community cover or community type (but not dominant):

Unidentified aquatic moss in stream channel.

24b. Soil Summary (by community type) CT-A

Soil series: Johnston?

Soil classification: Coarse-loamy, silceous, acid, thermic, cumulic Humaquept.

Soil association: Johnston-Bibb.

pH class: Strongly acid.

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map for Gates County.

Other notes:
A small portion of the park has been surveyed recently (around 1979).

24c. Hydrology Summary (by community type)

Hydrologic system: Riverine.

Hydrologic subsystem: Lower perennial.

Water chemistry: Fresh. Following determined 10 June 1981: pH 5.0, Cl^- 23 mg/L, Conductivity 220 micromhos/cm, Turbidity 15 JTU (Jackson Turbidity Units).
Water regime: Seasonally flooded.

Drainage class: Very poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A very poorly drained, seasonally flooded, lower perennial riverine system.

24d. Topography Summary CT-A

Landform: Aggrading alluvial floodplain.

Shelter: Open to partly sheltered.

Aspect: N/A.

Slope angle: 0-2%.

Profile: N/A (flat bottom).

Surface patterns: Dissected by shallow, water or muck-filled, intermittent swamp stream channels.

Position: Nearly flat swamp bottom between toe of slope at well-defined valley side, and stream channel.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-B.

Community type: Nyssa aquatica/Sparganium americanum (pond ecotone) Nyssa aquatica/Hottonia inflata (vernal), Nyssa/Polygonum punctatum (autumnal).

Community cover type: Nyssa aquatica.

General habitat feature: Broad ecotone between large, old mill pond and alluvial bottomland swamp.

Average canopy height: 70 ft.

Estimated age of canopy trees: 75 yrs.

Canopy cover: Closed to open.

Estimated size of community: 100 a (40 ha).

Successional stage: Climax? Presence of Taxodium suggests one more stage in succession: the establishment of cypress as an emergent.

Sere type: Pelosere.

Common canopy species in community cover or community type (but not dominant):
Taxodium distichum.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):
Cephalanthus occidentalis
Decumaria barbara
Rosa palustris
Fraxinus caroliniana

Common herb stratum species in community cover or community type (but not dominant):

Ranunculus flabellaris (dominant in one area)
Potomogeton pulcher
Limnobium spongia
Callitriche heterophylla (vernal)
Saururus cernuus
Nuphar luteum
Glyceria pallida (vernal)
Ceratophyllum echinatum
Lemna sp.
Spirodela polyrrhiza
Pontederia cordata

24b. Soil Summary (by community type) CT-B

Soil series: Johnston?

Soil classification: Coarse-loamy, siliceous, acid, thermic cumulic Humaquept (before alteration by impoundment of Merchants Mill Pond.

Soil association: Johnston-Bibb.

pH class: Strongly acid.

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map for Gates County.

Other notes: Impoundment of Merchants Mill Pond about 170 yrs ago has initiated deposition of sediment in this area, probably changing the soil classification to an Entisol.

24c. Hydrology Summary (by community type)

Hydrologic system: Riverine.

Hydrologic subsystem: Lower perennial.

Water chemistry: Fresh. Following data collected 10 June 1981: pH 5.0 (unusually acid following prolonged drought), Cl^- 23 mg/L, Conductivity 140 micromhos/cm, Turbidity 15 JTU.

Water regime: Semipermanently flooded.

Drainage class: Very poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A very poorly drained, semipermanently flooded, lower perennial riverine system.

24d. Topography Summary CT-B.

Landform: Transition area between aggrading alluvial floodplain and man-made impoundment (170 yr old mill pond).

Shelter: Open.

Aspect: N/A. (flat).

Slope angle: 0-2%.

Profile: N/A (flat bottomland).

Surface patterns: Dissected by shallow, water or muck-filled intermittent stream channels and pools.

Position: Nearly flat swamp bottom, contained between steep valley walls.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-C.

Community type: *Taxodium distichum-Nyssa aquatica*/mixed wetland shrubs/mixed aquatic herbs.

Community cover type: *Taxodium distichum-Nyssa aquatica*.

General habitat feature: 170 yr old, man-made mill pond.

Average canopy height: 40-60 ft.

Estimated age of canopy trees: 75 yrs.

Canopy cover: Sparse.

Estimated size of community: 600 acres (243 ha).

Successional stage: Unknown.

Sere type: Hydrosere.

Common canopy species in community cover or community type (but not dominant):

None.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Acer rubrum	*Myrica cerifera*	*Cephalanthus occidentalis*
Rosa palustris	*Itea virginica*	*Vaccinium* sp.
Decodon verticillata	*Leucothoe racemosa*	*Rhus radicans*

Common herb stratum species in community cover or community type (but not dominant):

Nuphar luteum	*Potomogeton pusillus*
Nymphaea odorata	*Brasenia shreberi*
Egeria densa	*Myriophyllum brasiliense*
Ceratophyllum demersum	*Spirodela oligorrhiza*
Riccia fluitans	*Wollfiella floridana*

24b. Soil Summary (by community type) CT-C.

Soil series: Johnston? (before impoundment).

Soil classification: Unknown.

Soil association: Unknown.

pH class: Medium to slightly acid.

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map for Gates County.

Other notes: Impoundment of Merchants Mill Pond about 170 years ago has initiated deposition of sediment in this area, probably changing the soil type.

24c. Hydrology Summary (by community type)

Hydrologic system: Lacustrine.

Hydrologic subsystem: Littoral.

Water chemistry: Fresh. pH varies from about 5.5 to circumneutral during the year, depending on rainfall and agricultural runoff.
Water regime: Permanently flooded (to intermittently exposed around pond periphery.

Drainage class: N/A (flooded).

Drainage basin: Chowan River.

Hydrology characterization: A littoral lacustrine system in the Chowan River drainage basin.

24d. Topography Summary CT-C.

Landform: A man-made impoundment (170 yr old mill pond) in an aggrading alluvial floodplain.

Shelter: Open.

Aspect: N/A (flat).

Slope angle: 0%.

Profile: N/A.

Surface patterns: Water.

Position: Impoundment in nearly flat swamp bottom, contained between steep valley walls.

24a. Vegetation - Biotic Community Summary CT-D.

Community type: Nyssa sylvatica biflora/Acer rubrum-Liriodendron tulipifera-Liquidambar styraciflua/Ilex opaca-Carpinus caroliniana/ mixed mesophytic herbs.
Community cover type: Nyssa sylvatica biflora.

General habitat feature: Colluvial-alluvial floodplain of a small, intermittent swamp stream.

Average canopy height: 70 ft.

Estimated age of canopy trees: 40-70 yrs.

Canopy cover: Closed.

Estimated size of community: 80 acres.

Successional stage: Seral. Perhaps undergoing change from Nyssa and Taxodium to Liriodendron and Liquidambar because of lowering of pond level 30-40 yrs ago.

Sere type:

Pelosere.

Common canopy species in community cover or community type (but not dominant):
Ulmus americana
Fagus grandifolia (slightly drier microsites).

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):
Morus rubra

Common herb stratum species in community cover or community type (but not dominant):

Woodwardia areolata
Dryopteris celsa (locally dominant).
Arisaema triphyllum
Thelypteris noveboracensis
Athyrium asplenioides
Glecoma hederacea
Saururus cernuus
Impatiens capensis

24b. Soil Summary (by community type) CT-D.

Soil series: Johnston or Bibb?

Soil classification: Unknown.

Soil association: Johnston-Bibb?

pH class: medium to slightly acid.

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map for Gates County.

Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Terrestrial.

Hydrologic subsystem: Wet.

Water chemistry: Fresh.

Water regime: Semipermanently saturated.

Drainage class: Somewhat poorly drained to poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A somewhat poorly drained, semipermanently saturated, wet terrestrial system in the Chowan River drainage basin.

24d. Topography Summary CT-D.

Landform: A colluvial-alluvial floodplain of a small tributary swamp.

Shelter: Open to partly sheltered.

Aspect: N/A (flat)

Slope angle: 0-2%.

Profile: N/A (flat). (Slightly concave in colluvial areas near edge of stream valley)

Surface patterns: Dissected by shallow, water or muck filled intermittent swamp stream channels.

Position: Nearly flat swamp bottom bounded by gently to strongly sloping valley walls.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-E.

Community type: *Fagus grandifolia*.

Community cover type: *Fagus grandifolia*.

General habitat feature: Beech slope.

Average canopy height: 70-80 ft.

Estimated age of canopy trees: 70-90 yrs.

Canopy cover: Closed.

Estimated size of community: 500 a total as long, narrow strips several miles long, on slopes bordering north and south sides of Merchants Mill Pond and Lassiter Swamp.

Successional stage: Topoedaphic climax.

Sere type: Pelopsammosere.

Common canopy species in community cover or community type (but not dominant):
Quercus alba
Pinus taeda

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):
Oxydendron arboreum
Ilex opaca
Symplocos tinctoria

Common herb stratum species in community cover or community type (but not dominant):
Hexastylis virginica
Euonymus americana
Mitchella repens
Tipularia discolor
Epifagus virginiana

24b. Soil Summary (by community type) CT-E.

Soil series: Unknown. Mapped Craven on 1929 soil map for Gates County. A detailed soil survey of the park has been initiated through the local office of the Soil Conservation Service.
Soil classification: Clayey, mixed, thermic Aquic Hapludult. (if Craven).

Soil association: Lenoir-Craven-Dunbar

pH class: Medium acid to very strongly acid.

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map for Gates County. Davis and Devereux. 1929. Soil survey of Gates County. USDA Bur. of Chemistry and Soils.
Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Terrestrial.

Hydrologic subsystem: Mesic.

Water chemistry: Fresh.

Water regime: Permanently exposed.

Drainage class: Well-drained.

Drainage basin: Chowan River.

Hydrology characterization: A well-drained, permanently exposed, mesic terrestrial system in the Chowan River drainage basin.

24d. Topography Summary CT-E.

Landform: Valley wall slopes transitional from flat upland divides of the Talbot Terrace, to low alluvial floodplain swamp and mill pond.

Shelter: Open to sheltered.

Aspect: All aspects are represented.

Slope angle: Nearly level (0-2°) to moderately steep (15-25°).

Profile: Constant.

Surface patterns: Nearly smooth.

Position: Entire slope and on upland divides in topographically fire-protected areas.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-F.

Community type: Mixed oaks. (The nature of this community is unclear because it occurs on the upland divides — the most disturbed areas. Two or more communities could probably be segregated)

Community cover type:

Mixed oaks.

General habitat feature: Hardwoods on ridges and flat upland divides of the Talbot Terrace.

Average canopy height: 70-80 ft.

Estimated age of canopy trees: 70-90 yrs.

Canopy cover: Closed.

Estimated size of community: 500 acres (including all post-pine successional areas and areas with a variety of disturbance).

Successional stage: Seral and climax.

Sere type: Pelopsammosere.

Common canopy species in community cover or community type (but not dominant):

Quercus alba	*Quercus falcata*
Quercus nigra	*Fagus grandifolia*
Quercus velutina	*Pinus taeda*

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Ilex opaca

Common herb stratum species in community cover or community type (but not dominant):

None.

24b. Soil Summary (by community type) CT-F.

Soil series: Mapped Lenoir on 1929 soil map of Gates County.

Soil classification: Clayey, mixed, thermic Aeric Paleaquult.

Soil association: Lenoir-Craven-Dunbar.

pH class: Strongly to very strongly acid (pH 4.5-5.5).

Source of information: USDA Soil Conservation Service. 1972. Tentative general soil map of Gates County. Davis and Devereux. 1929. Soil survey of Gates County. USDA Bur. Chemistry and Soils.

Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Terrestrial.

Hydrologic subsystem: Mesic.

Water chemistry: Fresh.

Water regime: Permanently exposed.

Drainage class: Moderately well-drained.

Drainage basin: Chowan River.

Hydrology characterization: A moderately well-drained, permanently exposed, mesic terrestrial system, wetted by fresh rains and a high water table, in the Chowan River drainage basin.

24d. Topography Summary CT-F.

Landform: Upland ridges and divides.

Shelter: Open.

Aspect: N/A (tops of divides)

Slope angle: 0-10%.

Profile: Flat to gently rolling.

Surface patterns: Generally smooth, with scattered pits and mounds from the root systems of wind-thrown trees. Furrows from past agriculture visible in some small areas. Large upland area cut over about 8 yrs ago deeply rutted by heavy logging equipment.

Position: Flat interstream divides.

25. Physiographic characterization of natural area:

Climax communities on fluvial bottomland swamp, steep valley slopes and upland divides surrounding Merchants Mill Pond and in Lassiter Swamp, in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation: Shallow surface formation on upland divides probably an estuarine deposit corresponding in age to the Norfolk Formation (early Sangamon?); over unnamed Pleistocene deposit corresponding in age to the Windsor Formation; over unnamed Pleistocene deposit corresponding in age to the "Moorings Unit" of the Bacon's Castle Formation; over unnamed Pleistocene (Pliocene?) deposit corresponding in age to the Sedley Formation, over the Miocene Yorktown Formation.

Geological formation age: Surface formation may correspond to the height of the Sangamon Interglacial, about 80,000 to 90,000 yrs ago. Steep slopes are erosional surfaces active from the late Sangamon (perhaps 60,000 to 80,000 yrs ago) to the present. Islands in the mill pond, and slightly elevated flats around the pond and in Lassiter Swamp may contain deposits corresponding to one of the higher stands of the sea between 40,000 and 60,000 yrs ago described by Oaks and Dubar (1974). The swamp bottom is an alluvial deposit which is presently aggrading.

References cited:

Oaks, R. Q., Jr. and J. R. Dubar. 1974. Post-Miocene stratigraphy: central and southern Atlantic Coastal Plain. Logan, Utah: Utah State University Press. 275 p.

26. Summary - endangered and threatened species

Name of species: Ranunculus flabellaris (Yellow water-crowfoot).

Species legal status and authority: Endangered peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: One large tract with numerous small patches.

Number of individuals per population: 20-100.

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population: Various annually with water volume and chemistry.

Disturbance or threats to population: Possible pollution with agricultural pesticides. No others known.

Habitat characteristics

Plant community: Nyssa aquatica/Ranunculus flabellaris.

Topography: Water.

Soil series: Unknown.

Microclimate: Cooler and with less insolation than natural area climate.

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Listera australis (southern twayblade)

Species legal status and authority: Endangered peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: One.

Number of individuals per population: Only about 8.

Size or maturity of individuals:

Phenology of population:

Eg: vegetative % 50%

flowering % 50%

fruiting %

General vigor of population: Very tenuous population.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community: Pinus taeda/? Sucessional area.

Topography: Flat ridge top.

Soil series: Unknown.

Microclimate:

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: *Wolffia papulifera* (Papillose water-meal).

Species legal status and authority: Endangered peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: Unknown.

Number of individuals per population: Individuals widely dispersed over 600 acre mill pond.

Size or maturity of individuals: Mature.

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population: Rarely abundant. Nearly impossible to find in some years.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community: Mill pond aquatic community. Mixed Lemnaceous aquatics.

Topography: Water.

Soil series: Undetermined.

Microclimate:

Drainage basin: Chowan River.

Other plants and animal species present: About 165 species of aquatic and wetland plants.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Hottonia inflata (Featherfoil).

Species legal status and authority: Threatened peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: Numerous, scattered through transition area between mill pond headwaters and Lassiter Swamp.

Number of individuals per population: Several hundred in good years.

Size or maturity of individuals: Usually fairly large and robust when flowering and fruiting from April 1 through June 7.

Phenology of population:

Eg: vegetative %

flowering % 100%

fruiting % 100%

General vigor of population: Varies highly with water volume, quality and chemistry from year to year. Adversely affected by both flooding and drought.

Disturbance or threats to population: Disturbed water regime of excessively fast runoff alternating with dry spells affects site quality. Beaver trapping on park boundary eliminates some habitat.

Habitat characteristics

Plant community: Nyssa aquatica/Hottonia inflata.

Topography: Water.

Soil series: Undetermined.

Microclimate: Cooler, and with less insolation than natural area.

Drainage basin: Chowan River.

Other plants and animal species present: Glyceria pallida, Callitriche heterophylla, Sparganium americanum, Ceratophyllum echinatum. Beaver, wood ducks.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Glyceria pallida (pale mannagrass).

Species legal status and authority: Threatened peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: Several.

Number of individuals per population: Varies greatly from year to year. From 2 or 3 to several hundred individuals in good years.

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %

flowering % 100%

fruiting % 100%

General vigor of population: Varies highly from year to year.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community: Nyssa aquatica/mixed emergent aquatic herbs.

Topography:

Soil series: Undetermined.

Microclimate: Cooler and with less insolation than natural area climate.

Drainage basin: Chowan River.

Other plants and animal species present:
Hottonia inflata, Callitriche heterophylla, Ceratophyllum echinatum, beaver, wood ducks.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Potomogeton confervoides (Conferva pondweed).

Species legal status and authority: Threatened peripheral in North Carolina (ooper et al. 1977).

Number of populations on site: A few.

Number of individuals per population: Few.

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %
flowering % 50%
fruiting % 50%

General vigor of population: Rather tenuous population.

Disturbance or threats to population: Sedimentation, excess dissolved material in water.

Habitat characteristics

Plant community: Mill pond aquatic community.

Topography: Water.

Soil series: N/A.

Microclimate: Same as natural area climate.

Drainage basin: Chowan River.

Other plants and animal species present: About 165 species of aquatic and wetland plants.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Potomogeton foliosus (Leafy pondweed).

Species legal status and authority: Threatened peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: Only one seen.

Number of individuals per population: Only a few.

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %

flowering %

fruiting % 50%

General vigor of population: Very tenuous population.

Disturbance or threats to population: Sedimentation.

Habitat characteristics

Plant community: Mill pond community. Plants grow attached to submersed tree stumps a few inches below the surface.

Topography: Water.

Soil series: Arboraquent.

Microclimate:

Drainage basin: Chowan River.

Other plants and animal species present: Around 165 species of aquatic and wetland plants.

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Carex lupuliformis (Hoplike sedge). Not seen during this study but reported by Gammon 1976.

Species legal status and authority: Threatened peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site:

Number of individuals per population:

Size or maturity of individuals:

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population:

Disturbance or threats to population:

Habitat characteristics

Plant community:

Topography:

Soil series:

Microclimate:

Drainage basin:

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Dryopteris celsa (Logfern).

Species legal status and authority: Threatened peripheral in North Carolina (Cooper et al. 1977).

Number of populations on site: One.

Number of individuals per population: Several hundred.

Size or maturity of individuals: Some unusually large (to 4 ft high).

Phenology of population:

Eg: vegetative %

flowering %

fruiting % 100%

General vigor of population: Robust.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community: Nyssa sylvatica biflora/Acer rubrum-Liriodendron tulipifera-Liquidambar styraciflua/mixed mesophytic herbs.

Topography: Colluvial/alluvial area at toe of slope.

Soil series:

Microclimate: Same as natural area climate.

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

26. Summary - endangered and threatened species

Name of species: Trillium pusillum (Carolina trillium). (Reported after completion of field work for this study, by Floyd Williams, park naturalist, Merchants Mill Pond State Park).
Species legal status and authority: Threatened throughout (Cooper et al. 1977).

Number of populations on site: One.

Number of individuals per population: Several hundred.

Size or maturity of individuals: Flowering.

Phenology of population:

Eg: vegetative %
flowering %
fruiting %

General vigor of population: Good.

Disturbance or threats to population: None known.

Habitat characteristics

Plant community:

Topography:

Soil series: Undetermined.

Microclimate: Cooler and wetter than natural area climate.

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists:

CANOPY

Populus heterophylla
Juglans nigra
Carya tomentosa
Fagus grandifolia
Quercus alba
Quercus stellata
Quercus lyrata
Quercus michauxii
Quercus shumardii?
Quercus velutina
Quercus falcata
Quercus falcata var. pagodaefolia
Quercus nigra
Quercus phellos
Quercus laurifolia
Ulmus americana
Liriodendron tulipifera
Platanus occidentalis (introduced)
Acer rubrum
Paulownia tomentosa
Pinus taeda
Pinus echinata
Pinus palustris (extirpated)
Taxodium distichum
Nyssa aquatica, Nyssa sylvatica biflora

SUBCANOPY

Juniperus virginiana
Carpinus caroliniana
Morus rubra
Magnolia viriginana
Asimina triloba
Sassafras albidum
Prunus persica (persistent)
Ilex opaca
Cornus florida
Oxydenrum aboreum
Diospyros virginiana
Fraxinus carolinana
Prunus serotina

SHRUBS

Salix sp.
Myrica cerifera
Alnus serrulata
Castanea pumila
Ulmus rubra
Lindera benzoin
Itea virginica
Rosa palustris
Sorbus arbutifolia
Crataegus uniflora

SHRUBS (cont.

Amelanchier sp.
Amelanchier sp.
Cyrilla racemiflora
Ilex verticillata
Ilex glabra
Euonymus americanus
Stewartia malacodendron
Hypericum hypericoides
Aralia spinosa
Clethra alnifolia
Rhododendron viscosum
Rhododendron atlanticum
Leucothoe racemosa
Epigaea repens
Gaylussacia frondosa
Vaccinium stamineum
Vaccinium tenellum
Vaccinium vacilans
Vaccinium corymbosum
Symplocos tinctoria
Ligustrum sinense
Cephalanthus occidentalis
Sambucus canadensis
Decodon verticillatus
Callicarpa americana

HERBS

Lycopodium obscurum
Lycopodium flabelliforme
Selaginella apoda
Botrychium dissectum
Botrychium biternatum
Osmunda cinnamomea
Osmunda regalis
Athyerium asplenioides
Dryopteris celsa
Polystichum acrosticoides
Thelypteris hexagonoptera
Thelypteris noveboracensis
Woodwardia areolata
Woodwardia virginica
Asplenium platyneuron
Polypodium polypodioides
Azolla caroliniana
Typha latifolia
Sparganium americanum
Potomogeton diversifolius
Potomogeton confervoides
Potomogeton berchtoldii
Potomogeton foliosus
Potomogeton pulcher

HERBS (cont.)

Egeria densa
Elodea canadensis
Limnobium spongia
Arundinaria gigantea
Uniola laxa
Glyceria pallida
Leersia lenticularis
Leersia oryzoides
Paspalum laeve
Panicum scoparium
Cyperus odoratus
Cyperus erythrorhizos
Cyperus strigosus
Dulichium arundinaceum
Eleocharis obtusa
Scirpus cyperinus
Rhyncospora corniculata
Carex annectens
Carex seorsa
Carex alata
Carex nigromarginata
Carex debilis
Carex glaucescens
Carex crinita
Carex comosa
Carex lupulina
Carex gigantea
Carex lupuliformis
Peltandra virginica
Arisaema triphyllum
Spirodela polyrrhiza
Spirodela oligorrhiza
Lemna valdiviana
Wolffia papulifera
Wolffiella floridana
Tillandsia usneoides
Commelina communis
Commelina virginica
Aneilema keisak
Pontederia cordata
Juncus effusus
Juncus coriaceus
Juncus tenuis
Juncus repens
Luzula bulbosa
Luzula echinata
Smilax rotundifolia
Smilax sp.
Trillium pusillum
Medeola virginiana
Smilacina racemosa
Polygonatum biflorum
Yucca filamentosa
Amianthium muscaetoxicum
Hemerocallis fulva
Lilium michauxii
Allium vineale
Hypoxis hirsuta
Iris virginica
Iris verna
Cypripedium acaule
Listera australis
Spiranthes cernua
Spiranthes praecox
Tipularia discolor
Goodyera pubescens
Saururus cernuus
Boehmeria cylindrica
Pilea fontana
Phoradendron serotinum
Hexastylis virginica
Rumex conglomeratus
Tovara virginica
Polygonum densiflorum
Polygonum pensylvanicum
Polygonum cespitosum
var. longisetum
Polygonum punctatum
Polygonum hydropiperoides
Polygonum hydropiperoides
var. opelousanum
Polygonum sagittatum
Chenopodium ambrosioides
Chenopodium album
Phytolacca americana
Mollugo verticillata
Stellaria sp.
Cerastium glomeratum
Saponaria officinalis
Ceratophyllum demersum
Ceratophyllum echinatum
Nuphar luteum
Nymphaea odorata
Brasenia schreberi
Clematis crispa
Ranunculus flabellaris
Podophyllum peltatum
Sanguinaria canadensis
Draba verna
Lepidium virginicum

HERBS (cont.)
Arabidopsis thaliana
Cardamine hirsuta
Penthorum sedoides
Potentilla canadensis
Rubus sp.
Cassia fasciculata
Cassia nictitans
Trifolium arvense
Trifolium pratense
Trifolium repens
Trifolium dubium
Melilotus alba
Desmodium paniculatum
Lespedeza striata
Vicia angustifolia
Apios americana
Polygala mariana
Polygala lutea
Croton glandulosus var. septentrionalis
Acalypha virginica
Acalypha gracilens
Tragia urens
Euphorbia supina
Euphorbia maculata
Callitriche heterophylla
Impatiens capensis
Sida rhombifolia
Hibiscus mosheutos
Hypericum walteri
Hypericum mutilum
Viola papilionacea
Viola primulifolia
Passiflora incarnata
Passiflora lutea
Rhexia marianna var. purpurea
Ludwigia decurrens
Ludwigia palustris
Ludwigia sp.
Oenothera laciniata
Circaea lutetiana ssp. canadensis
Myriophyllum brasiliense
Myriophyllum heterophyllum
Hydrocotyle sp.
Sanicula canadensis
Daucus carota
Ptilimnium capillaceum
Chimophila maculata
Monotropa hypopithys

HERBS (cont.)
Galax aphylla
Hottonia inflata
Polypremum procumbens
Bartonia paniculata
Asclepias tuberosa
Cuscuta compacta
Hydrolea quadrivalvis
Verbena urticifolia
Glecoma hederacea
Lamium amplexicaule
Lamium purpureum
Salvia lyrata
Pycnanthemum setosum
Lycopus rubellus
Perilla frutescens
Physalis sp.
Solanum americanum
Solanum carolinense
Datura stramonium
Gratiola virginiana
Lindernia dubia
Mimulus alatus
Verbascum thapsus
Linaria canadensis
Veronica peregrina
Aureolaria virginica
Agalinis purpurea
Epifagus virginiana
Utricularia inflata
Utricularia purpurea
Utricularia biflora
Utricularia vulgaris
Ruellia caroliniensis
Plantago lanceolata
Plantago aristata
Plantago virginica
Mitchella repens
Houstonia caerulea
Galium circaezans
Galium triflorum
Galium obtusum
Valerianella radiata
Specularia perfoliata
Lobelia cardinalis
Lobelia puberula
Ambrosia artemisiifolia
Hieracium X marianum
Krigia virginica
Pyrrhopappus carolinianus
Senecio tomentosus
Elephantopus tomentosus

HERBS (cont.)
Elephantopus carolinianus
Eupatorium capillifolium
Eupatorium coelestinum
Gnaphalium obtusifolium
Erigeron annuus
Erigeron canadensis
Aster pilosus var.
demotus
Aster laterifolius
Solidago rugosa var.
celtidifolia
Solidago altissima
Eclipta alba
Rudbeckia hirta
Bidens laevis
Bidens discoidea
Bidens bipinnata
Helenium autumnale
Helenium amarum

MOSSES (Data supplied by Dr. Lewis E. Anderson, Duke University)

Mnium cuspidatum
Atrichum crispum
Hypnum lindbergii var. americanum
Thuidium allenii
Amblystegium sypho
Amblystegium riparium
Fissidens fontanus
Leskea gracilescens
Brotherella tenuirostris
Climacium americanum

FISHES OF MERCHANTS MILL POND STATE PARK
(From Tarplee 1979; most species verified during this study)

1.	BOWFIN	*Amia calva*
2.	AMERICAN EEL	*Aguilla rostrata*
3.	EASTERN MUDMINNOW	*Umbra pygmaea*
4.	REDFIN PICKEREL	*Esox americanus americanus*
5.	CHAIN PICKERAL	*Esox niger*
6.	GOLDEN SHINER	*Notemigonus crysoleucas*
7.	Unidentified shiner	*Notropis* sp.
8.	CREEK CHUBSUCKER	*Erimyzon oblongus*
9.	YELLOW BULLHEAD	*Ictalurus natalis*
10.	BROWN BULLHEAD	*Ictalurus nebulosus*
11.	TADPOLE MADTOM	*Noturus gyrinus*
12.	SWAMPFISH	*Chologaster cornuta*
13.	PIRATE PERCH	*Aphredoderus sayanus*
14.	LINED TOPMINNOW	*Fundulus lineolatus*
15.	MOSQUITOFISH	*Gambusia affinis*
16.	MUD SUNFISH	*Acantharchus pomotis*
17.	FLIER	*Centrarchus macropterus*
18.	BLACK BANDED SUNFISH	*Enneacanthus chaetodon*
19.	BLUESPOTTED SUNFISH	*Enneacanthus gloriosus*
20.	BANDED SUNFISH	*Enneacanthus obesus*
21.	PUMPKINSEED	*Lepomis gibbosus*
22.	WARMOUTH	*Lepomis gulosus*

FISHES (cont.)

23.	BLUEGILL	*Lepomis macrochirus*
24.	LARGEMOUTH BASS	*Micropterus salmoides*
25.	BLACK CRAPPIE	*Pomoxis nigromaculatus*
26.	SWAMP DARTER	*Etheostoma fusiforme*

The following faunistic list for Merchants Mill Pond was compiled over several years of observations and includes common species and very rare or uncommon visitors.

BIRDS

Pied-billed grebe
Red-necked grebe
Whistling Swan
Canada goose
Snow goose
Mallard
Black duck
Pintail
American widgeon
Blue-winged teal
Green-winged teal
Wood duck
Redhead
Canvasback
Ring-necked duck
Lesser scaup
Bufflehead
Common goldeneye
Hooded merganser
Turkey vulture
Black vulture
Cooper's hawk
Sharp-shinned hawk
Marsh hawk
Rough-legged hawk
Red-tailed hawk
Red-shouldered hawk
Broad-winged hawk
Osprey
Sparrow hawk
Bobwhite
Great egret
Snowy egret
Cattle egret
Great Blue heron
Green heron
Yellow-crowned night heron
Black-crowned night heron
American bittern
Least bittern
Glossy ibis
White ibis
Purple gallinule
American coot
Killdeer
Spotted sandpiper
American woodcock
Common snipe
Herring gull
Ring-bill gull

Rock dove
Mourning dove
Yellow-billed cuckoo
Screech owl
Great horned owl
Barred owl
Chuck-willis widow
Whip-poor will
common Nighthawk
Chimney swift
Ruby-throated hummingbird
Belted Kingfisher
Common flicker
Pileated woodpecker
Red-billed woodpecker
Red-cockaded woodpecker
Red-headed woodpecker
Yellow-belted sapsucker
Hairy woodpecker
Downy woodpecker
Eastern kingbird
Great crested flycatcher
Eastern phoebe
Acadian flycatcher
Eastern wood pewee
Barn swallow
Tree swallow
Righ-winged swallow
Bank swallow
Purple martin
Blue jay
Common crow
Fish crow
Carolina chickadee
Tufted titmouse
White-breasted nuthatch
Red-breasted nuthatch
Brown-headed nuthatch
Brown creeper
Winter wren
Carolina wren
Mockingbird
Catbird
Brown thrasher
Robin
Wood thrush
Hermit thrush
Swainson's thrush
Eastern Bluebird
Blue-gray gnatcatcher

BIRDS (continued)

Golden-crowned kinglet
Ruby crowned kinglet
Cedar waxwing
Loggerhead shrike
Starling
White-eyed vireo
Yellow-throated vireo
Red-eyed vireo
Black and white warbler
Prothonatary warbler
Swainson's warbler
Magnolia warbler
Yellow-rumped warbler
Black-throated green warbler
Black-throated blue warbler
Yellow-throated warbler
Chestnut-sided Warbler
Pine warbler
Prairie warbler
Ovenbird
Louisiana waterthrush
Yellowthroat
Hooded warbler
American redstart
Kentucky warbler
House sparrow
Bobolink
Eastern meadowlark
Red-winged blackbird
Rusty blackbird
Common grackle
Brown-headed cowbird
Northern oriole
Orchard oriole
Scarlet tanager
Summer tanager
Cardinal
Evening grosbeak
Blue grosbeak
Indigo bunting
Purple finch
American goldfinch
Rufous-sided junco
Chipping sparrow
Field sparrow
White-throated sparrow
Fox sparrow
Swamp Sparrow
Song sparrow

MAMMALS

Opossum
Shorttail shrew
Eastern mole
Pine vole
Hoary bat
Black bear
Raccoon
Mink
River otter
Longtail weasel
Red fox
Bobcat
Gray fox
Eastern chipmunk
Eastern Gray squirrel
Southern flying squirrel
Beaver
House mouse
White footed mouse
Hispid cotton rat
Norway rat
Muskrat
Eastern cottontail
Marsh rabbit
Whitetail deer

TURTLES

Snapping turtle
Stink pot
Eastern mud turtle
Spotted turtle
Eastern box turtle
Eastern painted turtle
Yellow-bellied turtle
River cooter
Slider
Florida cooter
Red-bellied turtle

LIZARDS

Northern fence lizard
Six-linned racerunner
Ground skink
Southeastern five-lined skink
Broad-headed skink
Slender glass lizard

SNAKES

Brown water snake
Red-bellied water snake
Northern water snake
Banded water snake
Eastern garter snake
Eastern hognose snake
Southern ringneck snake
Eastern worm snake
Rainbow snake
Northern Black racer
Rough green snake
Black rat snake
Greenish rat snake
Eastern king snake
Southern copperhead
Eastern cottonmouth

AMPHIBIANS

Red-backed salamander
American toad
Fowler's toad
Southern toad
Pine woods treefrog
Green treefrog
Spring peeper
Pickerel frog
Southern leopard frog
Green frog
Bullfrot
Carpenter frog
Cricket frog
Gray treefrog

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: CHOWAN SWAMP NATURAL AREA.

2. County: Gates.

3. Location: Forming the southern border of the county along the Chowan River from the Meherrin River to the Chowan County line at Catherine's Creek.

4. Topographic quadrangle(s): Winton 1906 15 min (1:62, 00). Beckford 1929 15 min (1:62, 00).

5. Size: About 11,000 acres in 6 tracts.

6. Elevation: Sea level to 6 ft.

7. Access: By canoe from ferry landing near mouth of Meherrin River in Hertford County. From US 158 at Chowan River bridge. From new landing at end of SR 1111 from Gatesville. By canoe from landing near the Gatesville bridge on Bennett's Creek. By canoe from SR 1102 at Catherine's Creek. From wildlife access area in Chowan County.

8. Names of investigators:

Cecil C. Frost, Department of Botany. University of North Carolina. Chapel Hill, NC 27514.

9. Date(s) of investigation:

26 April 1980, 3 May 1980, 4 May 1980, 8 October 1980, 27 October 1980, 31 October 1980, 6 May 1980, 9 November 1980, 31 May 1981, 14 July 1981, 17 August 1981, 12 July 1981, 21 July 1981.

10. Priority rating:

High.

(Pages 156-162 intentionally deleted.)

11 A. Prose description of site:

Chowan Swamp is a continous wetland forest, overlying a peat deposit along the southern boundary of Gates County. It extends from the point at which the Chowan River bends eastward around the southwestern corner of the county, to the Chowan County line. The average width is about 3 miles.

All of the natural area studied lies within boundaries of several tracts of land which have just come into public ownership within the past 10 years. These are the Forestry Foundation property, consisting of 3,800 acres on both sides of the mouth of Bennett's Creek; 6,500 acres (in 3 tracts) purchased with funds for Merchants Mill Pond State Park, and the land donated to the Wildlife Resources Commission just west of US 13, consisting of about 900 acres. Collectively, this 11,000 acres comprises over 12 miles of shoreline along the Chowan River.

The natural area can be divided into four broad ecosystem categories: swamp forest, which includes over 90% of the site; the mesic islands described later; the two freshwater marshes at the mouth of Bennett's and Sarem Creeks, and the mesic slopes of the escarpment forming the transition between swamp and adjacent sandy uplands. The marshes have the greatest species diversity to be found in the swamp, and include such unusual wetland species as *Zizaniopsis miliacea* (southern wild rice) and *Spartina pectinata* (freshwater cordgrass).

A variety of studies of the area have been carried out by several agencies. Deyle and Smith (1976) explored the State Park properties for two days and prepared a report for the Department of Natural and Economic Resources. Wilkinson (1978) submitted a site report on a portion of the same properties to NC Natural Heritage Program staff. Pitchford and Stuart (1978) inventoried aquatic and wetland plant species of Sarem and Bennett's Creek marshes, and submitted a report to Lytton J. Musselman in fulfillment of class requirements for Biology 418 at Old Dominion University in Norfolk. Mead and Gammon (1981) mapped the regional vegetation of the area including Chowan Swamp, on a scale of 1:24,000, using color infrared aerial photography. A report has been prepared by a study group at NC State University (Kaplan et al. 1978) on the potential for development of an environmental education and study center adjacent to the 3,800 acre Forestry Foundation property. The most detailed vegetation study to date was carried out in 1980 and 1981 by Snead and Frost (results reported in the present study (Fig. 16).

GEOLOGY, HYDROLOGY AND PEAT FORMATION IN CHOWAN SWAMP

Kaplan et al. (1978) discuss geology of the area based on Richards (1950). The following interpretation is based on the more recent work of Oaks and DuBar (1974).

Geology of the upland portion of the Sand Banks area, forming the escarpment bordering Chowan Swamp, is described in the discussion of the Chowan Sand Ridge natural area later in this report. Most of the adjacent topographic features of the natural area were formed during the Sangamon. Similarly, the floor of the basin which contains Chowan Swamp probably corresponds to a late Sangamon floodplain of the Chowan River. This was the period in which the river carved the two large meander bends which can be seen south of Eure and Gatesville. The mesic islands in Chowan Swamp are probably fluvial/estuarine sands deposited earlier in the Sangamon and reworked during late Sangamon high stands of the sea.

The history of the peat deposits supporting swamp vegetation along the Chowan River has not been investigated. Peat formation in the Dismal Swamp began about 8,900 years ago, some time after the end ofthe Wisconsin (Oaks and Whitehead 1979). The Chowan Swamp peats may be much more recent.

During the Wisconsin, the Chowan and its local tributaries carved channels to an unknown depth below the present surface, as indicated by holes in their channels 10 to 20 feet or more below present sea level. Not until 5,000 years ago did post-Wisconsin sea levels reach -20 feet MSL in this area (Oaks and DuBar 1974), perhaps initiating peat formation and sedimentation in the lower levels of the river valley.

Peats investigated in the present study range from very shallow, where they feather out onto the fluvial sand ridges composing the mesic islands and upland borders, to at least 10 feet below sea level at the mouth of Bennett's Creek. The total extent and greatest depth in the area are unknown. As sea level continued to rise, peat deposits apparently kept pace, spreading over the inundated floodplain. Not until about 3,200 years ago, did sea level reach -13 feet, enough to initiate peat formation at the lowest levels. Therefore, it is presumed that most of the modern peat deposit underlying Chowan Swamp is no more than about 3,000 years old.

Sea level rise continued until about 1185 years ago, at which time it was 4 feet above the present level. This was followed by recession of relative sea level to about -6 feet 725 years ago. Sea level has risen since that time to its present elevation.

World sea level is estimated to be rising at more than 10 cm per century (about 4 inches) (Milliman and Emery 1968, Bloom 1978). Relative sea level rise in the Albemarle region has been estimated at 6 to 18 inches per century (Bellis et al. 1975), implying regional subsidence of the land. Data from Oaks and DuBar (1974) give an average relative rise of 10 inches per century over the past 725 years.

These recent fluctuations, 10 feet in all, have left visible reminders, and may be important in interpreting recent vegetation changes. During the +4 feet high stand of the sea 1185 years ago, a considerable additional depth of peat must have been deposited. Now, however, the peat surface is approximately at sea level, with small hummocks of vegetation raised a few inches above the surface, interspersed with the general low flats, which are constantly moist and flooded almost daily by wind tides.

This illustrates well the dynamic nature of peat formation and destruction at the interface between water and air. Apparently all of the peat formed during the high stand of the sea was oxidized during the following 500 years of sea level recession. In the intervening 725 years between that time and the present, peat formation has kept pace with sea level rise, creating an average of 10 inches new peat per century.

Evidence of recent sea level rise abounds along the shoreline of Chowan Swamp. Numerous cypress and tupelo are found growing in permanent standing water two feet deep, a situation in which they could never have germinated today. Both species require at least temporarily exposed soil on which to become established. Neither could they have germinated in time of drought, since the area is at sea level today. In the summers of 1980 and 1981, after a severe drought, there was no readily observable change in water level in the area being discussed. The only observed consequence of the drought was the unusual sighting of blue crabs following intrusion of brackish water, because of the lack of fresh water flow from upstream. This influx caused dieback of a previously lush growth of freshwater plants along the shores of the Perquimans River near its mouth on the Albemarle Sound (observed fall, 1981). In a year of normal rainfall, chloride content of water in the Chowan River at the landing near the mouth of Sarem Creek was 11mg/L, less than that of drinking water from wells in the area (31 September 1979). Conductivity, also tested at that time was only 70 micromhos/cm; pH was 6.7.

VEGETATION DYNAMICS

As water level rises, the swamp as a whole is moving upslope over higher ground. This means that some low-lying areas such as the pastureland along the upland swamp boundary near Gatesville will become increasingly hydric. Juncus and other hydrophytes are common there now. Along the Chowan the swamp forest appears to be

receding slowly. This contradicts Kaplan et al. (1978) who claim that the swamp is building to the south. Evidence for recession can be seen in the unvegetated peat beneath the surface of the river along the swamp border. In the vicinity of Bennett's Creek, a thick peat, composed of only slightly decomposed rhizomes and and roots, lies at a depth of six feet below the surface. Tussocks of Carex stricta, the common grassy sedge of the swamp, stand on submersed columns of interlaced rhizomes. These underwater pillars, as much as 2 or 3 feet tall and each supporting a single clump of sedge, have kept pace with sea level rise and could be a century or two in age.

Within the swamp, replacement of one of the major original forest types, Atlantic white cedar, by other types after logging, may be due to sea level rise. Earlier in this century, existing stands were logged by Richmond Cedar Works and later by other companies. These have been replaced largely by black gum (Nyssa sylvatica biflora) and loblolly pine. Only single trees and very small clusters of white cedar remain. Kaplan et al. (1978) found that the cedar occurred on shallow peat over the tops of submerged sand ridges (Fig.14). It could be that these moist sand ridges were occasionally dry enough in the past to support the fire required for establishment of white cedar stands. Examination of the swamp during the recent drought leads to the impression that it is now impossible for these wet sites to ever burn under the present moisture regime. It may be that a few inches of sea level rise during the 60 or 70 years since the last stands were established could be enough to convert the area to more hydrophytic, non fire-dependent species. An interesting series of vegetation changes must occur with the submergence of sand flats and islands under peat. The range of forest types present in the area suggest that the sequence may be as follows:

1. High, well-drained mesic (beech-oak) or xeric (oak-longleaf pine) sand ridges, with Pinus taeda around the moist periphery.

2. Less well-drained mesic (beech-oak) islands ringed with Pinus taeda.

3. Low, wet, peat-mantled sand ridges with the peripheral Pinus taeda closing in over the top of the ridge as sea level rises: stands of white cedar arising after drought-induced fires.

4. Site mantled with peat, with sea level too high to permit fire. Vegetated with Pinus taeda, Nyssa sylvatica biflora, red maple.

5. Hydric site, permanently saturated, with sand ridge too far beneath water table and peat to have any significant

HABITAT	OPEN WATER CHANNEL AND MARGINS			SEASONALLY FLOODED BOTTOMLANDS			WELL DRAINED UPLANDS
	AQUATIC	FRESH WATER MARSH	GUM - CYPRESS	HARDWOOD SWAMP	ATLANTIC WHITE CEDAR	BAY FOREST	PINE-MIXED HARDWOODS
HABITAT DESCRIPTION	Tha river and creek channals are typically wida, shallow with sandy bottoms, tha watar is slow moving, high organic content, and ralatively low pH.	Land-water interface with tldal fluctuations up to two feet.	Characterizad by long hydro periods, flooded up to 2 feet, a muck substrstum with vegetation as trees.	Long hydroperiods; thick canopy with eparse shrub and herb layar, The most extensive habitat in the Union Camp Land.	Long hydroperiods, medium depth peat undarlain by eandy subaurfaca, in thia casa possibly a relic sand bar.	Characterized by long hydroparioda but only temporary surfeca water. Logging end fire hava had considerable influence on tha structure and composition of this plent community	Well drained sandy to fine loamy uplands. Separated from bottomlands by a ralic river bank and a three to five foot elevational difference.
MICROCLIMATE	High humidity; open light			High humidity; low light			
GEOLOGY	Pamlico deposits: unconsolidated aands and clays of Quaternary Aga, Yorktown Formation: aands, clay, shell beds of late Miocana Aga						
SUBSURFACE HYDRGLOGY	Floodad year-round			Saasonelly high water table at surfsce			Well drained, no standing water
SOILS			Dorovan Serias: Black, highly decomposad organic soil, greater than 51 inchas; poorly drainad	Dara Sariea: Dark organics, up to 51" deap. Fina aandy subsoil, poorly drained.	Ponzer Seriea: Organic material 16 to 40 inchea thick with loamy minaral subaoil; poor drainaga		Norfolk Series: Fine loamy mineral soils, well drained
VEGETATION							
Canopy			Black Gum Bald Cypresa, Rad Ash, Water Gum	Black Gum, Red Mapla, Sweat Gum, Beech, Yellow Poplar, Swamp Cheatnut Oak, Loblolly Pine	Atlantic White Cadar, Loblolly Pine, Rad Maple, Black Gum, Red Bay	Red Bay, Black Gum, Red Mapla, Loblolly Pine	Loblolly Pine, Sweet Gum, Red Maple, White Oak, Southern Red Oak Mockernut Hickory, Pignut Hickory, Water Oak, American Holly, Swamp Chestnut Oak, Tulip Poplar
Subcanopy		Red Maple, Sweet Bay	Red Maple, Laatherwood, Water Ash, Sweet Bay, Tag Aldar, Buttonbush, Dogwood, Wax Myrtle	Doghobble, Wax Myrtle, Red Bay, Sweet Pepperbush, Gallberry	Sweat Bay, Leatharwood, Sweat Pepperbush, Gallberry, Latterbush	Virginia Willow, Wax Myrtle, Swamp Roae, Horse Sugar, Sweat Bay Leatherwood, Sweet Pepperbush, Fatterbush, Gallberry	Wax Myrtle, American Holly, Sourwood Dogwood, Ironwood, Doghobbla, Vaccinimum sp.
Underatory		Southern Wild Rica, Rica Ruah, Bulrush, Sedge	Cana, Royal Fern Carex sp. Poison Ivy, Southarn Wild Rica, Spatterdock, Lizard's Tail, Resurraction Fern, Spaniah Moss, Virginia Creeper, Catbriar	Sphagnum, Cane Royal Fern, Virginia Creeper, Poison Ivy, Spaniah Moss, Resurrection Farn, Catbriar	Catbriar, Sphagnum	Cane, Royal Fern, Cinnamon Fern Rattan, Catbriar, Sphagnum	Catbriar, Wild Grape, Honeysuckle, Trumpet Vine, Cane Panicum sp. Rattlesnaka Plaintain, Netted Chain Fern, Rattlesnake Fern
WILDLIFE	Yellow Perch, Black Crappia, Bluegill, Sunfish, Flier, Golden Shiner, White Perch, Whita Catfiah, Alewive, Blueback Herring, Stripped Bass, American Shad	Cottonmouth, Watarsnaka, Red-bellied Snaka, Eastarn Box Turtla, Bull Frog, Spring Peeper, Ottar, Mink, Wood Duck, Moodad Margannar, Prothonotory Warbler, Parula Warblar, Grean Heron, Graat Blue Heron Ospray		Black Bear, Whita Tailed Deer, Bobcat, Fox, Raccoon, Oppoasum, Swamp Rabbit, Grey Squirral, Cottonmouth, Cane Brake Rattlar, Copperhead, Redtailad Mawk, Rad-ahoulderad Hawk, Broad-winged Hawk, Pilaated Woodpecker, Red-Bellied Woodpecker, Radhaadad Woodpecker, Red Cockadad Woodpecker			

Fig. 14. Ecological Habitats of Chowan Swamp. (From Kaplan et al. 1978).

effect on surface vegetation. Typical swamp forest of Nyssa sylvatica biflora with emergent Taxodium distichum.

PLANT COMMUNITIES

The vegetation of Chowan Swamp can be seen to be a complex mosaic of community types (Fig. 16), resulting from environmental gradients, disturbance by logging and possibly by rising sea level. Since most of these areas are only seral stages after disturbance, with different combinations of the same species, natural characteristics summaries are limited to four major community types:

CT-A Beech-mixed mesophytic oaks/mixed ericads on mesic islands.

CT-B Nyssa sylvatica biflora/Acer rubrum/Woodwardia virginica, the dominant community type of the swamp.

CT-C Mixed hydrophytic grasses and shrubs: the freshwater marsh community.

CT-D Taxodium distichum/Nyssa aquatica/ mixed wetland herbs. As a narrow strip along the Chowan River.

Of the community types listed above, all are believed to be representative of the original vegetation of the respective sites with the exception of CT-B. This type may have originally had an open or sparse canopy of Taxodium distichum emergent above the closed Nyssa layer.

The following field notes were made summer of 1980 by Leo Snead, with additions by Cecil Frost during the present study:

CATHERINE CREEK, TROTMAN CREEK

At the mouth of Trotman Creek the canopy is Nyssa sylvatica biflora, N. aquatica, Fraxinus caroliniana and Taxodium distichum. Nyssa sylvatica biflora and N. aquatica are the major species. Taxodium distichum tends to form a very sparse fringe along streams. Fraxinus caroliniana is scattered throughout. The shrubs are Alnus serrulata, Lyonia ligustrina, Cyrilla racemiflora and Myrica cerifera. Rosa palustris is an occasional species.

Farther down Catherine Creek (the first 180° turn past Trotman Creek) there are some Acer rubrum and Pinus taeda included in the canopy. The frequency of these two species seems to increase downstream. At bends the canopy is mostly Taxodium distichum.

The fifth 180° turn past Trotman Creek is a shrub-marsh area with a scattered, open canopy of Acer rubrum (very young). There is little marsh — this area is very similar to the shrub zone on the south side of Sarem Creek. Just before reaching this point, there is a cluster of Fraxinus on the west side of of the

fourth 180° turn. There is a very small marsh on the east side of the point consisting of Hibiscus mosheutos, Cicuta maculata, Typha latifolia, Polygonum arifolium, Pontederia cordata, Asclepias lanceolata, Ludwigia alternifolia, Thelypteris palustris, young red maple and Vernonia noveboracensis.

Farther down the creek, near the mouth, was found a species of Sagittaria not in fruit. This plant was growing on the water's edge along with Polygonum arifolium, Thelypteris palustris, another species of Sagittaria, Rosa palustris and Osmunda regalis. This is a very marshy area that is fairly narrow. The shrub and tree zones are no more than 50 feet away.

At the junction of Chowan River, Catherine Creek and a small unnamed tributary of Catherine Creek (Snake Creek?), is a narrow marsh whose predominant cover is Polygonum arifolium. Typha latifolia, Sagittaria sp., Pontederia cordata, Cicuta maculata. and Rosa palustris occur along the shoreline. Scattered shrubs and trees (Acer rubrum, Nyssa sylvatica biflora, Alnus serrulata, Myrica cerifera) are found inland. The west side of this marsh is bordered by shrubs and trees, mostly Acer rubrum.

Near the mouth of the unnamed tributary there is a large cypress fringe along the shore. The major tree species behind this fringe are Nyssa sylvatica biflora and N. aquatica. Viburnum dentatum, Myrica cerifera and Alnus serrulata appear to be the dominants in the subcanopy, along with a few Magnolia virginiana. There is no Fraxinus and very little red maple. There is a shrub area along the west side.

Between this small tributary and Bennett's Creek there are a number of pines behind Nyssa sylvatica biflora and N. aquatica. The only cypress here occur as a fringe along the water's edge.

BENNETT'S CREEK

On the Chowan River side of the marshy point along the west side of Bennett's Creek at its mouth, the vegetation is mainly Acer rubrum forest with Salix as an infrequent associate. There are some shrubby areas consisting of red maple and Arundinaria gigantea that approach the shoreline.

On the southwest side of Bennett's Creek at its mouth, there is a marsh that is predominantly Spartina pectinata. Behind the marsh is a shrub zone that is contiguous with the Acer-Salix forest. The marsh itself is well above water level — quite a bit of leaf litter covering the ground (mostly from Spartina pectinata) — one of the only areas in the swamp that might become dry enough to support a fire. There are a few small Acer rubrum and Nyssa sylvatica biflora. In the shrub zone and beneath the trees there is a stand of Arundinaria.

The greatest diversity occurs near the water, with almost all of the species, with the exception of Arundinaria and Asclepias, being found here. Osmunda regalis occurs between hummocks of Spartina pectinata in lower areas.

On the east side of Bennett's Creek the canopy is mostly Taxodium distichum and Nyssa sylvatica. There are a few large pines behind the cypress and gum. Some large Acer rubrum occur occasionally. The understory is largely Cyrilla racemiflora, Alnus serrulata, Viburnum nudum, Myrica cerifera, Fraxinus caroliniana and red maple. There is also a narrow fringe of Typha latifolia around part of the area. Just a little farther downstream there are approximately 20 cypress that reach inland. Still farther east, there are more Acer and Salix.

LANDING RIDGE

This is a large island in the swamp to the north of Sarem Creek. Along the creek in several places there are a large number of Fraxinus caroliniana intermixed with gum, cypress and large maples. In places Fraxinus is the dominant tree. Little or no difference could be determined for these areas on color infrared aerial photography.

Landing Ridge island has many hardwoods: Quercus falcata, Q. nigra, Q. velutina, Q. stellata, Q. laevis, Acer rubrum. Other species include Pinus taeda, P. echinata, Chamaecyparis thyoides, Magnolia virginiana, Persea borbonia, Vaccinium spp., Lyonia lucida, Smilax rotundifolia, S. glabra, Ilex glabra, I. opaca and Clethra alnifolia. There are a number of large pines on the island (up to 30" dbh). Myrica cerifera occurs in clumps that are in some cases up to 50 feet from the ditch leading to the island, in dry, sandy soil similar to that found in the Sand Banks. Hexastylis virginica is found throughout. Gaultheria procumbens grows beneath Quercus nigra on a ridge ten feet from the ditch. This entire area is very dry — mostly pines and oaks. There are occasional Fagus grandifolia. Vaccinium spp., Gaylusaccia spp., Pteridium aquilinium, Smilax rotundifolia, Vitis rotundifolia, Lyonia lucida and Acer rubrum are ever-present. Oxydendrum arboreum is sparsely scattered through the understory.

CAPT. JIM FELTON'S ISLAND (called Hermit island on brochure for the Chowan Swamp Trail)

This is the first island on the south side of Cole's Creek upstream from its mouth on Bennett's Creek. The island is raised two to six feet above water level and is crossed by two trenches, probably remnants from past logging activities, that appear to intersect in the swamp away from the island. The southeast end (that nearest the channel) is predominantly Pinus taeda on the former site of a cabin. There is a clearing west of this, and on

the western side there are four large beech trees along with two or three large oaks (Quercus falcata, Q. velutina and Q. nigra). Approximately 100 feet south of this there are more oaks (Q. stellata, Q. falcata and Q. nigra). Lyonia lucida forms a shrub layer beneath this canopy near the edge of the island. with Vaccinium spp. and Gaylusaccia spp. in the drier areas. The west side of the island has a fringe of Gaylussacia with scattered Asimina parviflora and Hamamelis virginiana. The northeast end of the island has two large beech.

BUCKHORN CREEK

The lower part of Buckhorn Creek is a young cypress-gum forest. This area has been logged in recent years. Most cypress are less than 8 inches dbh, with a few large specimens standing as lone sentinels. Nyssa sylvatica biflora is by far the dominant tree. Fraxinus caroliniana is scattered throughout. None of the Fraxinus are large trees, nor do they make up a very large portio- of the canopy or subcanopy. Several areas along the creek have Zizania aquatica and Nuphar luteum in shallow water.

At the power line crossing are several pines and maples (with increasing frequency over that near the mouth of the creek). The northeastern side of the creek has more cypress and fewer Nyssa sylvatica biflora. There are also more cypress here than near the creek mouth.

The south side of the creek was investigated by foot downstream (near the first large bend from the power line crossing). Again, by far, the most abundant tree was Nyssa sylvatica biflora. Pines and large cypress were scattered throughout. The understory was predominantly Arundinaria gigantea, with Smilax, small trees and Vaccinium on mossy hummocks in the dense understory. There are many fallen trees in some sections. There were also young red maple and a few Magnolia virginica in the understory.

FLUVIAL/ESTUARINE ESCARPMENT along upland boundary of Forestry Foundation property (3,800 acre tract).

At the escarpment adjacent to the Union Camp Corparation property on the uplands, there is a decrease in elevation of approximately 15 feet. On the slope there is a localized population of Liriodendron tulipifera surrounded by Pinus taeda. Northwest of this site at lower elevation is a population of Acer rubrum. This area is wet and has a low ground cover of Leucothoe axillaris, Woodwardia and sphagnum along with a sparse shrub layer represented by Clethra alnifolia, Persea borbonia and Magnolia virginiana. This area differs from the area described below in that vegetation beneath the canopy is less than three feet tall and is mostly ground cover, whereas the following site is mostly a very dense layer of shrubs, mostly Ilex glabra.

The second community in this site has a canopy of Pinus taeda and Chamaecyparis thyoides which is open enough to allow the dense growth of shrubs below. This site at the toe of the slope is considerably drier than that previously described.

West of the escarpment the slopes level off abruptly into the Ilex thicket. The canopy becomes more sparse to the west and pine is replaced by Nyssa sylvatica biflora/Acer rubrum/Woodwardia areolata. Close to the slope there is no ground cover — just a shrub layer within the gradient from pine to gum.

CANAL ISLAND

Canal Island is so named because it is bisected by an old, partially filled, canal or ditch which runs down to a small tributary of Sarem Creek. It rises only about two feet above the surrounding swamp. It is covered primarily with beech, with a few Liriodendron tulipifera, Oxydendron, Quercus nigra and Ilex opaca. Around the border of the island is a zone of Arundinaria and Smilax that is dense in places. This island is ringed by scattered large Pinus taeda (around 2 feet dbh) along its moist perimeter. About 50 feet south and 200 feet from the canal Habenaria clavellata grows on low, moist hummocks above a dark, mucky swamp soil. This small swamp forest orchid is widespread throughout the swamp in similar situations.

SAREM CREEK

The majority of the marsh species at the mouth of Sarem Creek occur on low hummocks, mostly Carex stricta and Carex alata derived. Large populations of Peltandra virginica occur between the hummocks. Apios americana and Lathyrus palustris serve effectively to bind the vegetation together. The marsh itself, consisting of the hummocks and the surrounding muck of the Dorovan Series, extends 50 to 150 feet inland to a shrubby area consisting of a young Acer rubrum canopy with Myrica cerifera and Alnus serrulata as codominants in the understory. As the inland swamp forest is approached, the frequency of Arundinaria gigantea increases. Some Typha latifolia and Rubus argutus, as well as Fraxinus caroliniana, are found sporadically (all trees were less than 4 inches dbh). Several species of herbs (Ludwigia palustris, Carex stricta, Apios americana, Mikania scandens, Peltandra virginica, Hibiscus mosheutos, Polygonum arifolium and P. punctatum) are characteristic of the flora beneath the canopy. All of the trees are growing on the hummocks, which may extend up to 18 inches above the mucky peat.

There is a shrub zone surrounding a small area of larger trees. This consists of Acer rubrum up to 6 inches dbh (8 inches near the pines) with an extensive subcanopy of Myrica cerifera and Alnus serrulata. Major species below this are: Peltandra virginica, Polygonum punctatum, Osmunda regalis (all three very abundant)

with some Arundinaria occurring in scatterred areas, but by no means a large part of the cover.

There is also a pine zone (Pinus taeda) farther inland. Within this area there is a small clearing of about ¼ acre almost completely filled with Osmunda regalis and fringed with Arundinaria gigantea. Apparently this area is slightly raised and not quite as wet as the adjacent marsh. Within the interior of the point of land between Sarem Creek and the Chowan River, pine is common, suggesting dry land from aerial photographs. Examination of this site, however, proved it all to be swamp, with the pines growing on individual hummocks, only 1 or 2 square meters in size, and about 6 to 12 inches above the saturated, mucky swamp soil. Within the pine site, the understory is reduced to Smilax laurifolia, scattered Rosa palustris, Arundinaria gigantea and Osmunda regalis. There are a few Alnus and Myrica. Approximate maximum sizes of the three tree species present are as follows:

Pinus taeda: 6-20 inches dbh and 60-65 feet tall.
Nyssa sylvatica biflora: 12-20 inches dbh and 50-60 feet.
Taxodium distichum: 12-15 inches dbh and 50-60 feet tall.

ANIMAL DIVERSITY

The swamp supports a population of black bear and is the only site remaining in the county, besides the Dismal, with the proper vegetation to provide permanent habitat for this species. All of the wetland mammals found at Merchants Mill Pond, including beaver, river otter, muskrat and mink, also occur here. Bobcat have been observed swimming creeks in the swamp, and there was an unverified panther sighting around 1979.

The swamp harbors a large number of bird species. The threatened red-shouldered hawk can always be found, and the area, if protected, may be one of the best permanent nesting sites for this species. Osprey feed here and nest along the ends of Holiday Island just offshore from the mouth of Bennett's Creek. A pair of anhinga were sighted in Sarem Creek on 4 May 1980.

In summary, the natural area is a complex wetland with high quality wildlife habitat for a diversity of species. The area has suffered only moderate human disturbance, primarily from past logging, and if protected, has a high potential for returning to an exemplary mature freshwater swamp forest of the type originally occurring on the site. Such a site would preserve high wildlife, scientific, recreational and aesthetic values.

11B. Prose description of site significance:

1. UNIQUE WETLAND COMMUNITY. The most significant feature of this extensive tract of wetland is the high diversity fresh marsh community, dominated by *Spartina pectinata* and *Zizaniopsis miliacea* (Southern wild rice), a type not known to be represented elsewhere in public ownership, and perhaps unique in the state. This association is represented primarily by marshes at the mouths of Sarem and Bennett's Creeks and to a lesser extent at Catherine Creek. Small patches of tall Zizaniopsis occur at intervals along most of the streams within the natural area.

   The hydrologic situation which supports these communities is unique in the state in that it is the headwaters of an embayed area which, although at sea level, is maintained in fresh water because of the lack of a direct outlet to the sea. Similar areas farther east and to the south are occupied by marsh species adapted to brackish water.

2. HIGH QUALITY WILDLIFE HABITAT. This is the most important site in the county for wetland mammals. The sheer size of the wetland area (around 11,000 acres) plus mesic islands and an equally large area of surrounding wetland in private ownership contributes to its value for wildlife species. If native mammals, such as black bear, river otter, beaver, mink, muskrat and bobcat are to remain a permanent part of the natural heritage of the county, it will be essential to leave as much of this large wetland as possible in an undisturbed condition.

3. SCIENTIFIC VALUE AS A STUDY SITE FOR FOREST SUCCESSION. In contrast to most other areas of the Coastal Plain, the hydrology of this site, which lies nearly at sea level, has been essentially undisturbed by ditching and draining. Disturbance history is largely limited to logging, and dates primarily only to the late 19th century. Consequently, natural processes of succession should return the vegetation to the original forest types of the area. These would include those of the mesic islands, with a gradient from upland types in the centers, to mesic and hydric types around the moist peripheries; slope community types transitional to the adjacent uplands; the primary cypress-gum forest of most of the swamp; the special communities along the edges of the interior streams and the Chowan River, and the marsh communities.

   Little is known of the processes or end results of forest succession in wetland areas. No long-term studies have been carried out, and suitable sites protected from logging are few. Chowan Swamp is a valuable site for long-term study of wetland forest succession.

4. HABITAT FOR ENDANGERED AND THREATENED SPECIES. The red-shouldered hawk is a threatened species, limited to swamp forests, and has suffered from destruction of habitat and probably from pesticides such as DDT. A decline of populations by as much as 75% over a few years was noted in the 1970's. The species is conspicuous here throughout the year (being an especially noisy denison of the swamp). The size and quality of this large feeding and nesting habitat makes it the best in the county. Protection from logging will make it the focal point of the region for this species.

Many other birds and mammals listed as of special concern or of undetermined status (Cooper et al. 1977) occur here. Yellow-crowned and black-crowned night herons probably nest on the site and numerous bird species use the swamp as a feeding and resting area seasonally and during migration.

Dryopteris celsa (logfern), a threatened peripheral in North Carolina, has been reported from an area north of Barne's Creek and along the canal bank adjacent to SR 1111 (Wilkinson 1978). Construction related to extension of this road to the Chowan River in 1979 may have eliminated the second site. The presence of this species in these two areas was not investigated during this study.

Listera australis (Southern twayblade) is a small orchid of moist, sandy woodlands, known only from two other counties in North Carolina (Dare and Brunswick). In Chowan Swamp a small population occurs on Hermit Island. Similar habitat was examined for this species on several other islands with no success.

5. VALUE AS A SITE FOR STUDY OF PEAT FORMATION. In contrast with Dismal Swamp, which is losing peat through oxidation, there is evidence that Chowan Swamp is in a state of active peat formation. The presence of an organic horizon approximately coincident with the water table indicates that peat formation has kept pace with recent sea level rise. This should be an excellent site for geological studies of peat deposition under freshwater conditions.

6. Such a large, high quality wetland also offers unlimited opportunities for studies of any of its individual species of trees, other plants and wildlife species. The site also acts as a buffer for the Chowan River which contains a number of species considered rare or otherwise in need of protection. The list and their status is from Cooper et al. (1977):

Extirpated? *Acipenser brevirostrum* (Shortnose sturgeon). Anadromous. Tidal portions of basin.

Special concern. *Lampsilis ochracea* (Tidewater mucket). Tidal portions.
Oronectes virginiensis (Chowan River crayfish). Tributaries.

Depleted. *Alosa aestivalis* (Blueback herring).
Alosa pseudoharengus (Alewife).
Alosa sapidissima (American shad).

All three are anadromous fishes which migrate throughout the Chowan River and tributaries.

Acipenser oxyrhynchus (Atlantic sturgeon). Anadromous. Tidal portions of the basin.

Undetermined. *Ligumia nasuta* (Eastern pondmussel). Tidal portions. Only known site of occurrence in North Carolina.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
High quality wetland plant community	CT-A	*Nyssa sylvatica biflora/Acer rubrum/Woodwardia areolata*	Extensive swamp forest.
High quality wetland plant community	CT-B	Mixed hydrophytic marsh grasses and herbs	High species diversity fresh marshes at mouths of Bennett's and Sarem Creeks. *Spartina pectinata* and *Zizaniopsis miliacea*.
High quality wetland plant community	CT-C	*Taxodium distichum/Nyssa aquatica*	Very large cypress (to 80 ft and 5 ft dbh) left along Shoreline of Chowan River and especially along parts of Bennett's and Sarem Creeks
High quality terrestrial plant community	CT-D	*Fagus grandifolia*-mixed oaks	Mature hardwood forest (75 yrs) on mesic islands in swamp. *Listera australis*, *Stewartia malacodendron*.
Endangered or threatened species		*Listera australis* (Southern twayblade	On Hermit Island. Endangered Peripheral in North Carolina (Cooper et al. 1977).
Special concern species		Red-shouldered hawk	Threatened in North Carolina (Cooper et al. 1977). Nesting on site.
High quality wildlife habitat		Black bear, osprey, beaver, mink, waterfowl, bobcat.	Area is large enough to provide permanent habitat for these species.
Special concern species		*Dryopteris celsa* (Logfern) Threatened peripheral in North Carolina (Cooper 1977).	Reported from swamp north of Barnes creek (Wilkinson 1978) and canal bank along SR 1111.

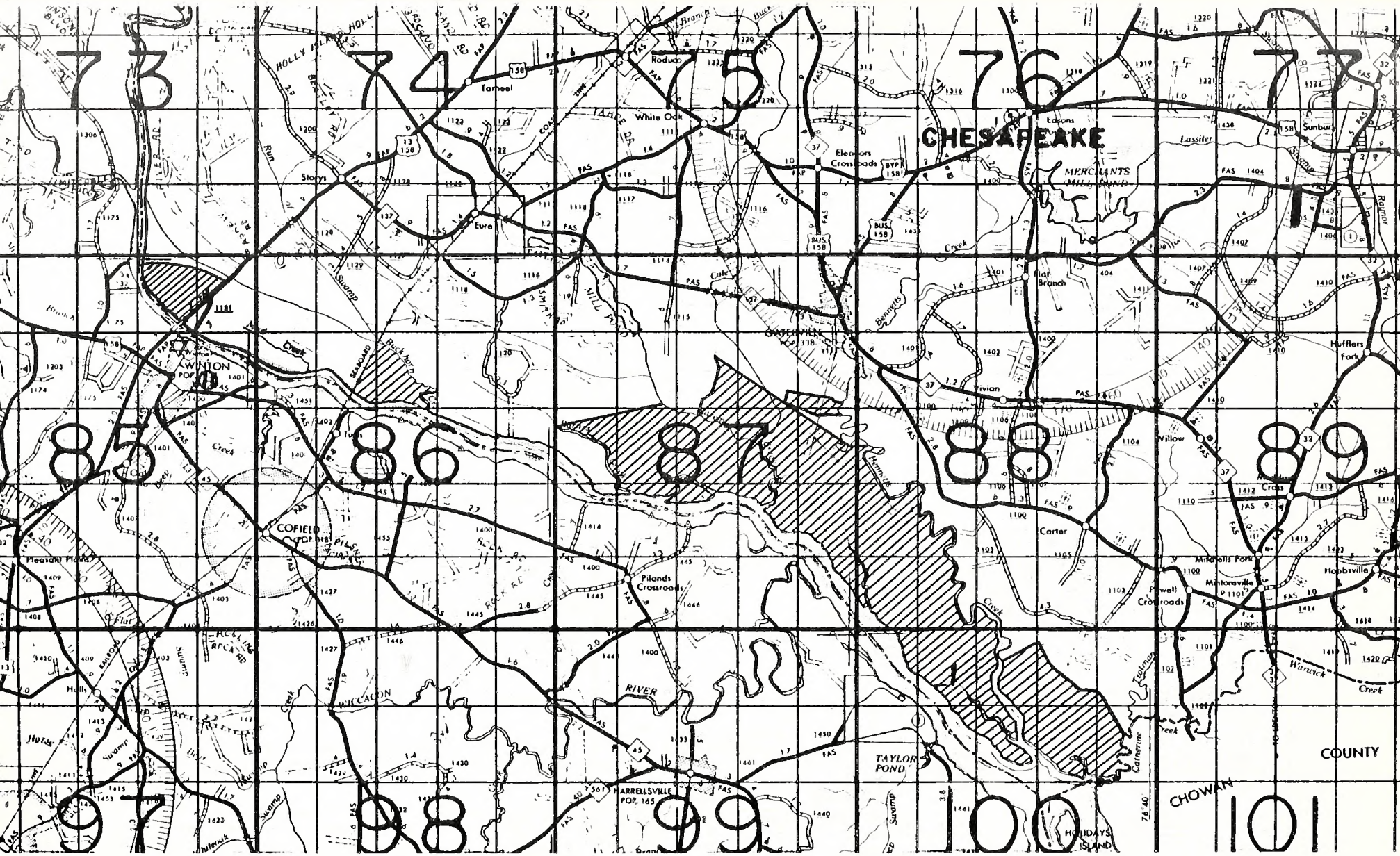


Fig. 15. Access Information:
CHOWAN SWAMP

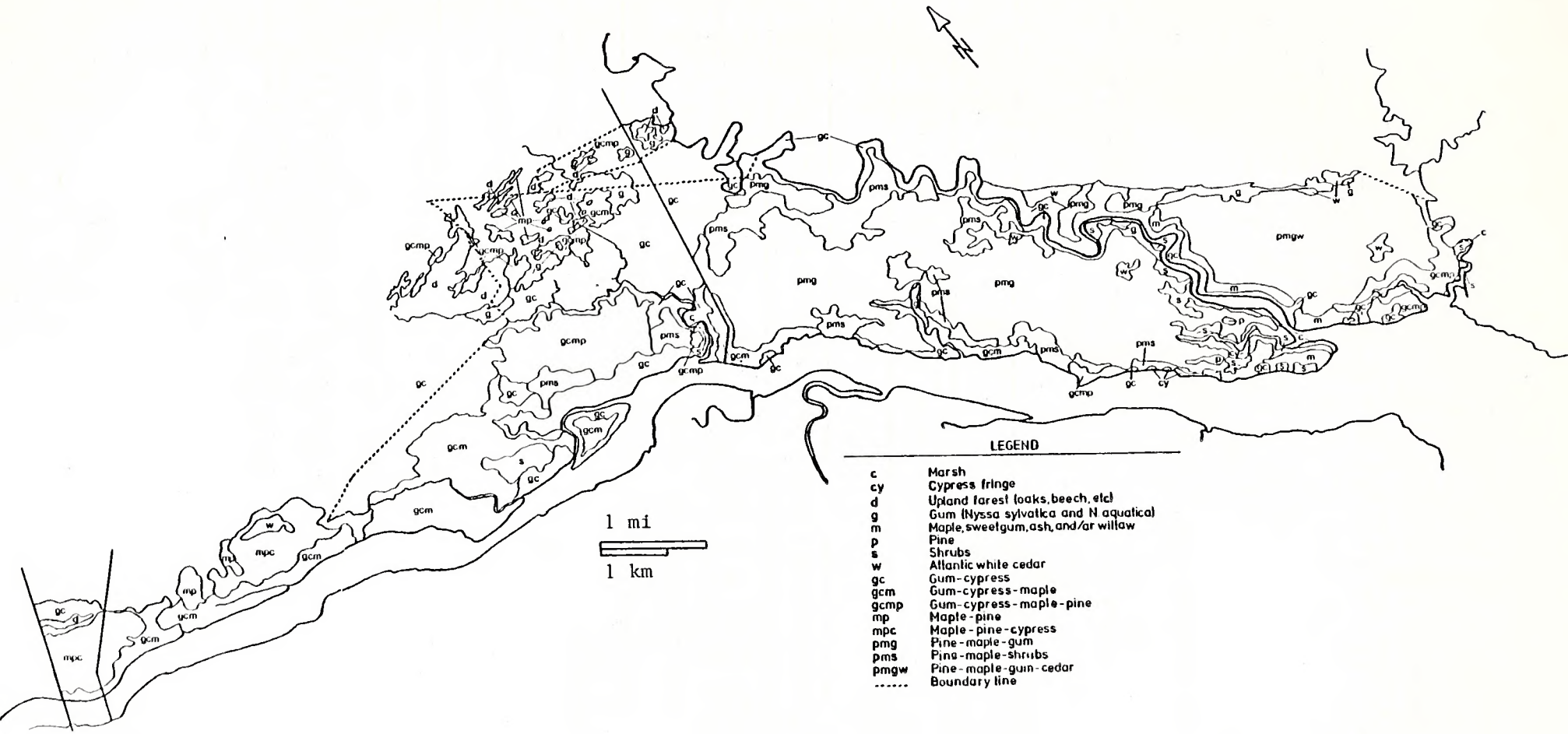


Fig. 16. Vegetation cover map prepared in 1980 by Leo Snead, from ground work and color infrared aerial photography (NASA photos, JSC 356, April 12, 1977, numbers 241, 242, 243). Area mapped extends 14 mi, from the abandoned railroad right-of-way above Barnes Creek to the Chowan County line at Catherine Creek.

Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	%
Public	100 %
Unknown	%

14. Number of owners: 3

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

North Carolina Forestry Foundation
NCSU School of Forestry
North Carolina State University
Raleigh, NC

North Carolina Department of Natural Resources and Community Dev.
P. O. Box 27687
Raleigh, NC 27611

North Carolina Wildlife Resources Commission
P. O. Box
Raleigh, NC 27611

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

Richard R. Wilkinson (Forestry Foundation tract)
School of Design
North Carolina State University
Raleigh, NC

17. Attitude of owner toward preservation (contacted?):

All state agencies involved concerned about preservation. Future of Forestry Foundation Tract still under study.

18. Uses of natural area:
Used as a canoe trail with wilderness campsites (Chowan Swamp Canoe Trail), Fishing, Hunting. Past use was primarily logging of white cedar and other timber types.

19. Uses of surrounding land:

a. Wildland 100 %
b. Agricultural _____ %
c. High-intensity forestry _____ %
d. Developed _____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
2.	100	Lands recently acquired by three NC state agencies. All should be registered as North Carolina Natural Heritage Areas.

21. Regulatory protections in force:

Land owned by NC Wildlife Resources Commission, west of US 158 at Chowan River Bridge covered by their regulations. State Park lands in large tract and several small tracts presently being used as game lands and administered under the same regulations.

22. Threats:

PEAT MINING, PHOSPHATE MINING.

While the property is now in public ownership, the mineral rights to the 6,500 acres owned by the Department of Natural Resources and Community Development were retained by a previous owner. The status of these rights as pertain to the other tracts in Chowan Swamp is unknown.

Perhaps the most destructive threat facing this large natural area would be the possibility of future surface mining. Energy demand in the future could make it economically profitable to sell or mine the peat underlying the swamp. Similarly, if the phosphate-bearing portion of the Miocene Yorktown Formation is present beneath the swamp, it could someday become economically significant enough to mine.

Since the site lies at sea level, either event would destroy the natural area. Any removal of material leading to lowering of the surface would simply eliminate the swamp, leaving only the river and irregular islands of whatever waste remained.

TRAPPING, LOSS OF VALUE AS STUDY SITE FOR WETLAND MAMMALS.

The site contains habitat for black bear, bobcat, and most of the wetland mammals native to the area, including beaver, river otter, muskrat and mink. These species are heavily trapped within the surrounding region. All of these, while once abundant, are now maintained at levels far below that at which they could have a significant interaction with the environment. At present, few significant mammal study sites exist where trapping is prevented.

A great deal remains unknown about the life histories and ecology of these species in the south. This site, for instance, would have previously been considered an unlikely site for beaver. However, the species returned to the area about 10 years ago and now build lodges and low dams in the small tributaries of the swamp. Their ultimate effect in determining the composition of the native swamp forest is completely unknown. Trapping prevents their numbers from reaching a saturation level, at which reasonably scientific studies could be carried out, or from even maintaining existing lodges. Numerous other examples could be cited of the value of this area as a study site if maintained as a sanctuary for wetland mammals.

LOGGING, DAMAGE TO WILDLIFE HABITAT AND LOSS OF VALUE AS A STUDY SITE FOR SWAMP FOREST SUCCESSION AND AS EXAMPLES OF NATIVE SWAMP FOREST TYPES.

As discussed elsewhere in this report, the natural area has excellent potential as a site for long-term forest successional

studies. These processes are poorly understood. One such study was carried out at a site in Hertford County several miles upstream (Allen 1958). This present site has a considerably different moisture regime and the successional processes are unstudied. As more land is converted to other uses, it is increasingly important to set aside examples of each of the several hundred plant community types in the state to serve as scientific reference, as a basis for management decisions elsewhere, and to guarantee the right of North Carolinians to see unspoiled examples of their natural heritage. Logging in Chowan Swamp would diminish this important social and scientific resource.

23. Management and preservation recommendations:

Because of the hydrologic stability of the site little management is needed. Fire offers no hazard and there is little accessible dry land that might be abused by overuse by the public.

1. All mineral rights should be acquired for the several tracts in public ownership to prevent possible future destruction through mining of peat, phosphate or other minerals.

2. A cooperative agreement should be worked out between the Wildlife Resources Commission, the Division of State Parks, and the Forestry Foundation that would:

   A. Protect from logging so that the area can return to mature forest for study and as examples of the original climax forest types.

   B. Protect from trapping, and designate the area as a study site and sanctuary for wetland mammals.

   C. Retain the use of Hermit Island and Landing Ridge for camping.

   D. Allow hunting on the rest of the property under rules and regulations of the NC Wildlife Resources Commission.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-A.

Community type: Nyssa sylvatica biflora/Acer rubrum/Woodwardia areolata.

Community cover type: Nyssa sylvatica biflora

General habitat feature: Freshwater peat swamp.

Average canopy height: 50 ft. Highly variable from place to place depending upon logging history.

Estimated age of canopy trees: Mostly less than 50 years. A few remnant cypress along streams may be 200-300 yrs.

Canopy cover: Closed.

Estimated size of community: 8,000 acres.

Successional stage: Seral, all stages.

Sere type: Hydrosere.

Common canopy species in community cover or community type (but not dominant):

Taxodium distichum
Pinus taeda
Nyssa aquatica

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Fraxinus caroliniana
Vaccinium corymbosum

Common herb stratum species in community cover or community type (but not dominant):

Osmunda regalis
Arundinaria gigantea

24b. Soil Summary (by community type) CT-A

Soil series: Ponzer, Dorovan and Dare Series.

Soil classification: Ponzer: Terric Medisaprist
Dorovan: Typic Medisaprist
Dare: Typic Medisaprist

Soil association:
Ponzer-Dorovan-Dare

pH class: Very strongly acid to slightly acid.

Source of information: Soil Conservation Service (1972) Tentative General Soil Map of Gates County. Kaplan et al.(1978)

Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Riverine.

Hydrologic subsystem: Tidal.

Water chemistry: Acid within the interior of the swamp to circumneutral in the Chowan River. Following values obtained 31 August 1979: pH 6.7, Chloride 11 mg/L, Conductivity 70 micromhos/cm.

Water regime: Semipermanently flooded. Hard to apply any of the standard modifiers on this case where wind tides flood the area at highly irregular intervals, sometimes twice a day or twice a week.

Drainage class: Very poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A very poorly drained, semi-permanently flooded tidal riverine system, wetted by fresh rains. tributary streams and wind tides.

24d. Topography Summary CT-A.

Landform: Fluvial/estuarine peat swamp.

Shelter: Open.

Aspect: N/A.

Slope angle: N/A (flat).

Profile: Flat.

Surface patterns: Flat-topped hummocks which rise 12 in above the permanently saturated, mucky swamp floor.

Position: N/A

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-B.

Community type: Mixed hydrophytic marsh grasses and herbs.

Community cover type: Mixed hydrophytic marsh grasses and herbs.

General habitat feature: Fluvial/estuarine freshwater marsh over peat.

Average canopy height: 3 ft.

Estimated age of canopy trees: N/A.

Canopy cover: Closed.

Estimated size of community: Perhaps 50 acres total, including Bennett's and Sarem Creeks.

Successional stage: Unknown.

Sere type: Hydrosere.

Common canopy species in community cover or community type (but not dominant):

Spartina pectinata
Carex alata
Carex stricta
Zizaniopsis mileacea

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Common herb stratum species in community cover or community type (but not dominant):

24b. Soil Summary (by community type) CT-B.

Soil series: Dorovan.

Soil classification: Typic medisaprist.

Soil association: Ponzer-Dorovan-Dare.

pH class: Slightly acid.

Source of information: Soil Conservation Service (1972) Tentative General Soil Map of Gates County. Kaplan et al.(1978).

Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Riverine.

Hydrologic subsystem: Tidal.

Water chemistry: Circumneutral.

Water regime: Semipermanently flooded. (Very erratically flooded by wind tides. Flooding may occur at intervals from twice daily to twice a week or less.)

Drainage class: Very poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A very poorly drained, semipermanently flooded tidal riverine system, wetted by fresh rains and wind tides.

24d. Topography Summary CT-B

Landform: Fluvial/estuarine peat swamp.

Shelter: Open.

Aspect: N/A.

Slope angle: N/A. (flat)

Profile: N/A (flat).

Surface patterns: Sedge hummocks which rise 12 in above the permanently saturated, level, muck surface.

Position: N/A.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-C.

Community type: *Taxodium distichum/Nyssa aquatica*.

Community cover type: *Taxodium distichum*.

General habitat feature: Fluvial/estuarine freshwater peat swamp.

Average canopy height: 80 ft.

Estimated age of canopy trees: 200-300 yrs old.

Canopy cover: Sparse.

Estimated size of community: Perhaps 500 acres in widely scattered remnant strips and patches.

Successional stage: Climax.

Sere type: Hydrosere.

Common canopy species in community cover or community type (but not dominant):

Pinus taeda
Nyssa sylvatica biflora

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Fraxinus caroliniana	Alnus serrulata	Hypericum walteri
Acer rubrum	Rosa palustris	
Cyrilla racemiflora	Myrica cerifera	

Common herb stratum species in community cover or community type (but not dominant):

Nuphar luteum	Osmunda regalis
Carex stricta	
Zizaniopsis miliacea	

24b. Soil Summary (by community type) CT-C.

Soil series: Dorovan.

Soil classification: Typic medisaprist.

Soil association: Ponzer-Dorovan-Dare.

pH class: Circumneutral to slightly acid.

Source of information: Field observations, Soil Conservation Service Tentative General Soil Map for Gates County (1972). Kaplan et al. (1978).

Other notes:

24c. Hydrology Summary (by community type) CT-C.

Hydrologic system: Riverine.

Hydrologic subsystem: Tidal.

Water chemistry: Circumneutral. Values obtained 31 August 1979: pH 6.7, chloride 11 mg/L, conductivity 70 micromhos/cm. (All values subject to considerable fluctuation in this system, esp. chloride).

Water regime:
Permanently flooded.

Drainage class: Very poorly drained.

Drainage basin: Chowan River.

Hydrology characterization: A very poorly drained, permanently flooded tidal riverine system, wetted by fresh rains, tributary streams and wind tides.

24d. Topography Summary CT-C.

Landform: Fluvial/estuarine peat swamp.

Shelter: Open.

Aspect: N/A. (Flat)

Slope angle: N/A (flat).

Profile: N/A (flat).

Surface patterns: Water.

Position: N/A.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-D.

Community type: *Fagus grandifolia*-mixed oaks/mixed ericads.

Community cover type: *Fagus grandifolia*-mixed oaks.

General habitat feature: Relict estuarine shoreline dunes.

Average canopy height: 60 ft.

Estimated age of canopy trees: 75-85 yrs.

Canopy cover: Closed.

Estimated size of community: Around 10 acres in several islands.

Successional stage: Climax. Beech may be the eventual climax in the absence of fire on the smaller islands. Larger islands may have burned occasionally.

Sere type: Psammosere.

Common canopy species in community cover or community type (but not dominant):

Pinus taeda (successional except around wet periphery)
Quercus falcata
Liquidambar styraciflua
Quercus alba
Quercus nigra
Oxydendrum arboreum

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Vaccinium stamineum
Gaylussacia frondosa

Common herb stratum species in community cover or community type (but not dominant):

24b. Soil Summary (by community type) CT-D.

Soil series: Undetermined.

Soil classification: Psamment? Possible Spodosol.

Soil association: Lakeland-Chipley-Pactolus.

pH class: Undetermined.

Source of information: Soil Conservation Service Tentative General Soil Map of Gates County (1972).

Other notes:

24c. Hydrology Summary (by community type) CT-D.

Hydrologic system: Terrestrial.

Hydrologic subsystem: Dry-mesic to mesic.

Water chemistry: Fresh.

Water regime: Permanently exposed.

Drainage class: Well-drained.

Drainage basin: Chowan River.

Hydrology characterization: A well-drained, permanently exposed, mesic terrestrial system wetted by fresh rains and a permanently high water table in the surrounding swamp.

24d. Topography Summary CT-D.

Landform: Relict estuarine shoreline dunes. Now islands surrounded by peat swamp.

Shelter: Open.

Aspect: N/A. (nearly flat).

Slope angle: N/A (nearly flat).

Profile: Slightly convex.

Surface patterns: Smooth.

Position: All parts of these low, gently rolling islands which are sufficiently raised above the water table. A separate community, not analyzed in this report forms a distinct ring around the island peripheries, This CT would be Pinus taeda/Lyonia lucida and other variants.

25. Physiographic characterization of natural area:

Complex mosaic of seral and mature plant communities on islands, and in marshes and swamp forests on the Chowan Swamp Peat, within the Chowan Embayment in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation:
Recent peat (5,000 years BP to present) over late Sangamon fluvial and estuarine deposits. Unnamed formations, corresponding at least in part to the ages of the Norfolk, Sand Bridge and Londonbridge Formations to the east of the Suffolk Scarp.

Geological formation age: See above.

References cited:

Kaplan, C. J. et al. 1978. The Chowan Swamp Environmental Center. A development feasibility study. Raleigh: NC State University Schools of Forest Resources and Design. 197 p.

Oaks, R. Q., Jr. and J. R. DuBar. 1974. Post-Miocene shorelines and sea levels, southeastern Virginia. In: R. Q. Oaks, Jr. and J. R. DuBar, eds. Post-Miocene stratigraphy, central and southern Atlantic Coastal Plain. Utah State University Press. 275 p.

26. Summary - endangered and threatened species

Name of species: Red-shouldered hawk (Buteo lineatus).

Species legal status and authority:

Threatened in North Carolina (Cooper et al. 1977).

Number of populations on site: Unknown. Probably 10 or more nesting pairs.

Number of individuals per population: Two.

Size or maturity of individuals: Adults and immatures.

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population:

Disturbance or threats to population: Possible accumulation of pesticides in the food chain from runoff of agricultural pesticides into the Chowan River and its tributaries. Future logging or peat mining could destroy this habitat.

Habitat characteristics

Plant community: Taxodium distichum/Nyssa aquatica.
Taxodium distichum/Nyssa sylvatica.

Topography:

Soil series:

Microclimate:

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists: CT-D only

CANOPY

Fagus grandifolia
Quercus falcata
Quercus alba
Quercus velutina
Quercus nigra
Quercus laurifolia
Pinus taeda
Pinus echinata
Pinus palustris (formerly — on larger islands)
Liquidambar styraciflua
Quercus laurifolia
Quercus michauxii
Oxydendron arboreum

SUBCANOPY

Ilex opaca
Acer rubrum .
Fagus transgressives
Sassafras albidum
Cornus florida
Quercus laevis

SHRUBS

Rhododendron nudiflorum
Vaccinium stamineum
Vaccinium atrococcum
Vaccinium corymbosum
Gaylussacia frondosa
Gaylussacia baccata
Stewartia malacodendron
Persea borbonia
Lyonia lucida
Hamamelis virginiana
Ligustrum sp.
Magnolia virginiana
Clethra alnifolia
Rhododendron viscosum
Myrica cerifera
Castanea pumilla
Kalmia angustifolia
Asimina parviflora
Sorbus arbutifolia
Vaccinium vacilans
Rhus sp.
Ilex glabra
Symplocos tinctoria

HERB LAYER

Listera australis
Woodwardia areolata
Woodwardia virginica
Osmunda cinnamomea
Osmunda regalis
Mitchella repens
Hexastilis virginica
Chimaphila maculata
Tipularia discolor
Medeola virginiana
Pteridium aquilinum
Aureolaria
Gaultheria procumbens
Mitchella repens
Cypripedium acaule
Euphorbia ipecacuanhae

VINES

Rhus radicans
Parthenocissus quinquefolia
Smilax sp.
Smilax sp.
Vitis rotundifolia
Smilax laurifolia

27. Master species lists: Wetland areas.

CANOPY:
Taxodium distichum
Nyssa sylvatica biflora
Nyssa aquatica
Fraxinus tomentosa
Pinus taeda
Chamaecyparis thyoides
Liquidambar styraciflua
Liriodendron tulipifera

SUBCANOPY:
Fraxinus carolinana
Acer rubrum
Magnolia virginiana
Salix caroliniana

SHRUBS:
Alnus serrulata
Cephalanthus occidentalis
Clethra alnifolia
Cyrilla racemiflora
Itea virginica
Lyonia ligustrina
Lyonia lucida
Persea borbonia
Myrica cerifera
Rosa palustris
Rhododendron viscosum
Ilex glabra
Sambucus canadensis
Vaccinium corymbosum
Viburnum nudum
Viburnum dentatum var lucidulum
Ilex verticillata
Leucothoe axillaris
Leucothoe racemosa
Ilex coriacea

HERBS:
Iris virginica
Justicia americana
Muphar luteum
Osmunda cinnamomea
Osmunda regalis
Ludwigia palustris
Pontederia cordata
Saururus cernuus

HERBS (cont.)
Zizaniopsis miliacea
Zizania aquatica
Arundinaria gigantea
Carex stricta
Carex alata
Thelypteris palustris
Woodwardia areolata
Woodwardia virginica
Polypodium polypodioides
Phoradendron serotinum
Tillandsia usneoides
Impatiens capensis
Convolvulus arvensis
Asclepias lanceolata
Boehmeria cylindrica
Dracocephalum purpureum
Hypericum virginicum
Hypericum walteri
Lycopus rubellus
Echinochloa walteri
Peltandra virginica
Cuscuta sp.
Polygonum sp.
Arisaema triphyllum
Galium obtusum
Habenaria clavellata
Juncus effusus
Cladium jamaicense
Typha latifolia
Sphagnum sp.
Sagittaria falcata
Sagittaria latifolia
Agrostis perennans
Spartina cynosuroides
Spartina pectinata
Leersia oryzoides
Echinochloa crusgalli
Panicum virgatum
Panicum dichotomum
Calamogrostis cinnoides
Sacciolepis striata
Cyperus erythrorhizos
Cyparis strigosus
Eleocharis quadrangulata
Scirpus validus
Rhynchospora macrostachya
Acorus calamus
Spirodela polyrrhiza
Chelone glabra

HERBS (Cont.)
Lobelia elongata
Gentiana catesbaei
Proserpinaca palustris
Riccia fluitans
Commelina virginica
Aneilema kaisak
Pilea fontana
Polygonum punctatum
Polygonum hydropiperoides
Lathyrus palustris
Polyginum sagittatum
Polyganum arifolium
Clematis crispa
Apios americana
Kosteletskya virginica
Hibiscus mosheutos
Viola sp.
Rhexia virginica
Cicuta maculata
Ptilimnium capillaceum
Oxypolis rigidior
Asclepias incarnata
Asclepias tuberosa
Cuscuta compacta
Lycopus virginicus
Agalinis purpurea
Lobelia glandulosa
Lobelia puberula
Lobelia cardinalis
Vernonia noveboracensis
Eupatorium capillifolium
Aster puniceus
Aster novi-belgii
Eclipta alba
Helianthus giganteus
Bidens mitis
Helenium autumnale

Herbs in part from Pitchford & Stuart (1978).

BIRDS

Wood duck
Black duck
Chickadee
Chimney swift
Fish crow
Great blue heron
Green heron
Kingfisher
Pileated woodpecker
Robin
Red-eyed vireo
Red-shouldered hawk
Downy woodpecker
Wood thrush
Yellow-bellied cuckoo
Yellow-throated warbler
Prothonotary warbler
Cormorant
Anhinga (yes)
Ring-billed gull
Laughing gull
Osprey
Black vulture
Turkey vulture
Red-bellied woodpecker
Yellow-crowned night heron
Black-crowned night heron

MAMMALS

Bobcat
Black bear
Panther (one sighting)
Mink
Beaver
Gray squirrel
Raccoon
River otter
Swamp rabbit
White-tailed deer

REPTILES AND AMPHIBIANS

Yellow-bellied turtle
Stinkpot
Brown water snake
Cottonmouth

NATURAL AREA INVENTORY FORM

Basic Information Summary Sheet

1. Natural area name: SAND BANKS NATURAL AREA (CHOWAN RIDGE)

2. County: Gates

3. Location: Along SR 1200 on both sides of road from Storys at junction of SR 1200 and US 13/158 in southwestern Gates County.

4. Topographic quadrangle(s): Winton 1906 15 min (1:62,500)

5. Size: About 800 acres.

6. Elevation: Near sea level to 47 ft.

7. Access: SR 1200 runs through the natural area from US 13 and 158, west about two miles.

8. Names of investigators: Cecil Frost, Department of Botany, University of North Carolina, Chapel Hill, NC 27514.

9. Date(s) of investigation: 17 September 1981, 26 November 1980, Numerous other visits between February 1976 and September 1981.

10. Priority rating: High (Highest priority in County, since this is the only significant natural area which does not receive at least partial protection, remaining in Gates County).

11A. Prose Description of Site.

The Gates County Sand Banks is a portion of a series of fluvial and estuarine sand deposits of Sangamon age, which border the western and southern boundaries of the county along the Chowan River. The "Sand Banks" is a local name, of some antiquity, applied to a section of these sand ridges running from US 13 near Storys, paralleling the Chowan River to the Virginia state line. It is proposed that the entire geomorphic feature, from Edenton to the Virginia line, be called the Chowan Sand Ridge, and that the natural area be named for the local feature, the Sand Banks, in which it occurs.

The natural area comprises about 840 acres of forested sand ridges on SR 1200 just west of US 13 and 158. Elevation within the study area ranges from near sea level to 47 ft. This is the last remnant in the county, and the northern half of the state, of a once extensive longleaf pine - turkey oak forest, which, before settlement, reached uninterrupted from Edenton, nearly to the James River in Virginia.

The area was probably first seen by upriver explorations from Sir Walter Raleigh's early settlement on Roanoke Island in the 1580's, but the first description dates from 1609. In that year Capt. John Smith sent a search party from Jamestown overland through this area to the Indian town of Chowanoc in what is now Chowan County to search for survivors of Raleigh's ill-fated colony:

> *"Master Sicklemore well returned from Chawwonoke, but found little hope and less certaintie of them were left by Sir Walter Raleigh. The river, he saw was not great, the people few, the countrey most over growne with pynes,..."*

William Byrd, in his journal of the VA/NC boundary line survey of 1728 - 1729, also described the area as a pine barrens. The xerophytic longleaf pine forests were later described with more certainty by Hale (1883), Ashe (1884) and Fernald (1939).

Drainage is rapid from the elevated sand ridges into several small swamp runs, which flow slowly into Chowan Swamp to the south. Soils in the area have been described by Risk (1981), who observed the following catena:

> Lakeland Series, Thermic, coated, Typic Quartzipsamment, on xeric upland sand ridges formerly dominated by longleaf pine.
>
> Sandy mixed, thermic, Typic Haplaquept, beneath loblolly pine and tulip poplar on mesic lower slopes adjacent to wet bottomlands.

Otte (1978) determined the following soil in the interspersed bottomlands dominated by loblolly pine:

Mixed, thermic, Typic Hydraquent.

PREVIOUS STUDIES IN THE SAND BANKS

The site has been visited for years by Ecosystematics class field trips taught by Dr. A. E. Radford of the Dept. of Botany, University of North Carolina, Chapel Hill. Two detailed reports have resulted — the first by Otte (1978) and a second, more detailed study by Pat Risk (1981). A third report was prepared by Lynch (1980). Consequently, less field time was spent on this site for the present study. Much of the data presented here is summarized from the above studies, especially that of Pat Risk, which contains quantitative field data on vegetation and soils and should be consulted for a detailed understanding of these factors.

The above studies discussed geology in terms of the very general work of Richards (1950) and others. A different interpretation is presented in this report, based on the more recent work of Oaks and DuBar (1974). This excellent study was carried out only 20 miles from this site and is therefore the most relevant source. Their data are adequate to permit a tentative geologic interpretation based on simple, well-known processes.

GEOLOGY — CHOWAN SAND RIDGE

The time of initial establishment of the modern Chowan River channel is unknown, but probably dates to the Illinoian glacial or earlier. Most of the modern geomorphology can be interpreted in terms of events during and following the Sangamon Interglacial beginning some 80,000 to 90,000 years ago.

At the height of the Sangamon, relative sea level in this area was 45 to 50 feet higher than at present (Oaks and DuBar 1974). Consequently, all of Gates County was submerged, with the exception of the high land from Gates and Willeyton north, behind the Hazleton Scarp, and the sand ridge along the top of the Suffolk Scarp, perhaps acting as a barrier island. There may have been an inlet in the area between Corapeake and US 158, where these higher sediments are lacking, and another inlet just south of Edenton, where the Chowan now enters the Albemarle Sound.

Otherwise, all of central Gates County lay under a small sound or bay, with the coastline along the Suffolk Scarp in the eastern part of the county. The water would have been saline or brackish, and no more than 10 feet deep, except where previous land exposure during the Illnoian may have established the initial

valleys of the Chowan River and possibly, of Bennett's, Cole's, Trotman, Catherine and Somerton Creeks, and the small swamps draining into the Dismal.

The Chowan Sand Ridge is not a part of the Suffolk Scarp. It, however, joins the scarp at Edenton, and is a fluvial counterpart in which several of the higher features correspond with the high stands of the sea which formed the scarp. Some of the steepest portions of the Chowan River Scarp may have been formed by fluvial action some time after the sea receded from the Suffolk Scarp.

The deposits of the Chowan Sand Ridge are a complex feature, ranging in elevation from near sea level to 47 ft., and in time from recent to 80,000 years ago, and cannot be explained by a single geologic event. Sands of the highest ridge are located in the Gates County Sand Banks, and support the last small stands of longleaf pine and turkey oak in the county. The earliest plausible date for these ridges would be early Sangamon, perhaps 80,000 years ago. At this time the area was inundated by the high stand of the sea which deposited the Norfolk Formation to the east of the Suffolk Scarp, and its estuarine counterpart in central Gates County.

This hypothesis presupposes that the modern course of the Chowan River had already been established during an earlier glacial period, and that these highest deposits were formed perhaps as sand bars and low dunes along the northern edge of the inundated valley. Much of the deposition of sands which were to become the Sand Banks probably occurred during this time.

Since the highest sands are only about 5 to 15 feet above the interior plateau (Talbot Terrace), their present configuration could represent estuarine dunes from the mid Sangamon, when sea level had fallen slightly to the upper level of the modern Chowan River Valley. The rest of the lower ridges and flats of the Chowan Sand Ridge are younger features, dating from a series of events in the mid to late Sangamon (perhaps 40,000 to 50,000 years ago.

After the initial retreat of the sea from its high level in the early Sangamon, there were two separate stillstands in the mid Sangamon, reaching +22 and +26 feet above present sea level respectively (Oaks and DuBar 1974). These corresponded with deposition of the Kempsville and Londonbridge Formations to the east of the Suffolk Scarp.

The lands on the southern border of the county, between Carter, Trotman and Bennett's Creeks, lie at an elevation of 15 to 20 ft. These flats, which were inundated twice during this time, were mantled by sands, either newly deposited or reworked

from the earlier period of deposition. Similarly, the next lower series of ridges in the Sand Banks and in the area south of Eure were deposited or reworked during this period. These areas may have been vegetated with salt marsh during this time, since the coastline was nearer than at present, and the area would have likely been a brackish estuary similar to that of the present James River. Comparable modern sand deposits can be seen there, and around the shoreline of the Chesapeake Bay, the embayed river valley of the ancestral Susquehannah River.

This period was followed by a series of four stillstands of the sea before the close of the Sangamon around 40,000 years BP. Relative elevations of sea level during these stages were +17, +15, +6 and +2 ft above present sea level. The lower ridges of sand in the Sand Banks area and the various islands in Chowan Swamp were probably deposited or reworked to their modern positions during this time.

There are two prominent meander bends of the Chowan River along the southern margin of the county. One of these, south of Eure, inundated Fort Island and carved the channel separating it from the uplands to the north. The other, more striking bend, reached as far as Gatesville, inundating Landing Ridge and carving the shoreline nearly to NC 137 just west of Gatesville. SR 1111 from Gatesville to the new landing on the Chowan, traverses this old river meander, now filled with swamp forest. Dating of these features is difficult, but the manner in which they truncate some of the sand deposits suggests that they occurred in the late Sangamon, around 40,000 years ago (although there is a chance that this may have taken place much more recently, in the past 3,000 years).

There appears to have been little change in the general geomorphology of the Chowan Sand Ridge since that time. During the Wisconsin, the Chowan River became entrenched in its present valley, and the dendritic drainage patterns of the smaller streams in the county were extended to their present development.

11B. Prose description of site significance:

This is the only significant natural area left in the county which is not protected in some manner. It consists of a complex series of sand ridges of various elevations and geologic ages, interspersed with moist depressions. The site is the last remnant in the county of xerophytic, pyroclimax longleaf pine - turkey oak forest, which was once a major dominant in the area.

Significant remnants occur only on the Story and Vaughan tracts. Many sandhills - type plant species probably reached their northern limits in the vicinity, but have now been extirpated from the northern part of their range. One documented example is Vaccinium crassifolium (creeping blueberry). With the exception of this site, longleaf pine as a forest type has been extirpated from the northern 300 km of its original northern range (Frost, unpublished study).

The following list of significant features is from Lynch (1980), with a few additions.

1. Presence of the most extensive stand (at least 400 acres) of mature, old-growth loblolly pine (Pinus taeda) forest in the state; trees up to 120 ft tall, 3 ft in diameter and 250 yrs old (Radford 1980, Heritage files, this study).

2. Northernmost natural old-growth stand of longleaf pines (Pinus palustris) on the Atlantic Coastal Plain (Frost, unpublished study).

3. Presence of exemplary plant communities: Pinus taeda/Quercus laevis-Q. falcata/Gaylussacia frondosa-Vaccinium vacillans; Pinus taeda-Pinus palustris/Quercus laevis/Gaylussacia frondosa-Vaccinium vacillans. These communities are significant because of the mature canopy cover, the excellent zonation of the tree-subcanopy-shrub strata, and the high diversity of ericaceous shrubs present (Otte 1978).

4. Presence of plant community (Pinus taeda/Quercus laevis/ mixed ericaceous shrubs) with unique species composition: 9 species of ericaceous shrubs present (Otte 1978).

5. Example of possible vegetational determination of soil type (spodosol under the ericaceous shrubs, entisol under areas without ericaceous shrubs (Otte 1978, Risk 1981).

6. Excellent examples of relict beach ridges along the Chowan River embayment. Geomorphic landform feature formed by receding sea level during periods of previous Pleistocene glacial maxima (Richards 1950, Oaks and DuBar 1974).

7. Presence of state "champion" & co-champion longleaf pines. Largest 95 ft tall, 39.9 in dbh (diameter breast height) and an estimated 350-400 years old (NC list of state champion trees 1980).

8. Presence of at least three active breeding colonies of red-cockaded woodpeckers (Picoides borealis), an endangered species; northernmost colonies in North Carolina (Lynch 1980).

9. High diversity of breeding birds, including many associated with extensive tracts of mixed pine-hardwoods systems; 62 species have been recorded, including 7 species of woodpeckers, 3 species of owls and 11 species of wood warblers (Lynch 1980).

10. Presence of black bear (Ursus americanus), nominated for state endangered status (Coastal Plain population). Area is an important adjunct to bear habitat in Chowan Swamp where they forage throughout the wetland and especially on the numerous mesic islands (Frost 1981).

11. Presence of a population of longleaf pine that may be varietally distinct. Mature individuals here and in Virginia appear to have smaller cones and shorter needles than in the rest of the range further south. Only about 25 mature individuals remain in the state of Virginia, and perhaps an equal number here. If this observation is correct, this genotype is in danger of extinction.

12. Most extensive stand of large turkey oaks (Quercus laevis) known (Radford 1981).

13. A few virgin loblolly pine (trees to 250 yrs old) in moist depressions, perhaps their optimum habitat in the original forest.

12. Significance Summary Table (categories represented and descriptions)-by site

a. Feature	Map legend	b. Description of significant feature	c. Comparative assessment
Endangered or threatened species		Red-cockaded woodpecker (*Picoides borealis*)	3 nest colonies.
High quality terrestrial plant community	Shaded	*Pinus taeda*-*Pinus palustris*/ *Quercus laevis*/mixed ericads	Two small remnants of the native forest of the area (northern ecotype of longleaf pine?).
High quality terrestrial plant community	Shaded	*Pinus taeda*/*Quercus laevis*/ mixed ericads	Largest known stand of old-growth turkey oak. Unusual assemblage of 9 species of ericaceous shrubs.
High quality wetland plant community	Shaded	*Pinus taeda*	A few large loblolly pines, some in excess of 200 years old, in a small bottomland.
High quality wildlife habitat	Whole site	62 species of breeding birds, black bear, wild turkey.	Excellent mast-producing habitat. One of two areas left in county for black bear.
Exemplary geomorphic feature	Whole site	Relict Sangamon estuarine shoreline dunes.	Well-developed feature along many miles of Chowan River. This is the oldest and best-developed portion.

Fig. 17. Access information: SAND BANKS NATURAL AREA.

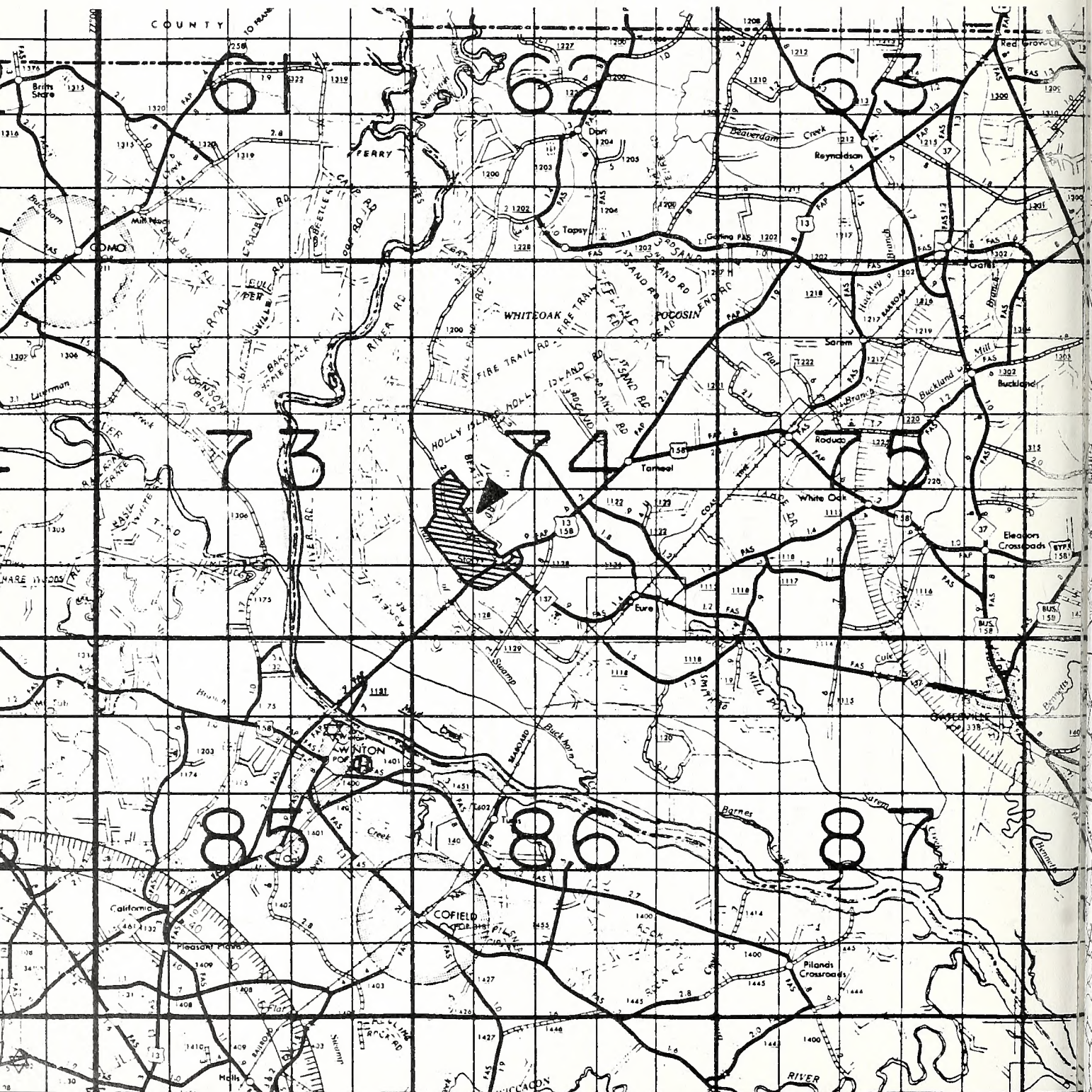


Fig. 18. Boundary and Significant Natural Features:
SAND BANKS NATURAL AREA

Shaded areas are have concentrations of natural features described in text.

Legal status, Use, and Management

13. Ownership type by percent area:

Type	
Private	100 %
Public	%
Unknown	%

14. Number of owners: 2 primary owners. 9 owners of total natural area.

15. Name(s) of owner(s) and/or custodian(s) (with addresses, phone numbers, other pertinent information).

See next page.

16. Name(s) of knowledgeable person(s) (with addresses, phone numbers, other pertinent information).

Dr. A. E. Radford, Department ot Botany, Univ. of North Carolina, Chapel Hill, NC 27514

Dr. Lytton. J. Musselman, Biological Sciences, Old Dominion University, Norfolk, VA

Pat Risk, Department of Botany, Univ. of North Carolina, Chapel Hill, NC 27514

J. Merrill Lynch, North Carolina Natural Heritage Program, N.C. Department of Natural Resources & Community Development, Box 27687, Raleigh, NC 27611.

17. Attitude of owner toward preservation (contacted?):

Contacted for permission to study area. Attitude toward preservation unknown.

15. Names of Owners. See also Lynch 1981.

LANDOWNERS - CHOWAN SAND RIDGE, GATES COUNTY

Gates Co. tax map 236

1. A. T. Byrum & Son, Inc. (lumber company)

1A. Lonnie & Ina Kay Powell

2. Mrs. Sue Felton Recently inherited - Helen Felton Vaughan (Mrs. T. C. Vaughan, Sr.)
Rt. 1, Box 7
Eure, NC 27935 86 acres

3. J. B. Futhrell
Winton, NC 27986 50 acres

4. E. R. Evans, Jr.
P. O. Box 621
Ahoskie, NC 27910 30 acres

20. Edward P. Story, Sr.
Rt. 1, Box 37
Eure, NC 27935 413 acres

528. Union Camp Corporation
Franklin, VA

Gates Co. tax map 255

6. Curtis A. Crawford

7. Frances Story Lawrence & Dorothy L. Bauerle
Rt. 1, Box 38
Eure, NC 27935 150 acres

8. Devilla Story Kennedy

8A. H. S. Hofler & Sons Lumber Co., Inc.
Sunbury, NC 27979 171.9 acres

532. Union Camp Corporation

Gates County tax map 234

C. Mrs. Devilla Story Kennedy
Rt. 1, Box 138
Eure, NC 27935 8.68 acres

D. Frances Story Lawrence
Rt. 1, Box 138
Eure, NC 27935 11.6 acres

18. Uses of natural area:

Hunting deer, squirrel, quail. Selective logging. Botanical study.

19. Uses of surrounding land:

a. Wildland 65 %

b. Agricultural 10 %

c. High-intensity forestry 25 %

d. Developed ____ %

20. Preservation status:

Cat.	*%	*Description of Preservation status
6	100	Private land. Unprotected.

21. Regulatory protections in force:

None known.

22. Threats: While there is the possibility of activities such as residential homesite development, sand mining, and damage from road widening at some future date, logging is the only likely short-term activity which could harm some of the unusual plant communities. This, however, is a serious and immediate threat.

If logged, the area will undoubtedly be converted to plantations of loblolly or longleaf pine. This would have the following sad effects on the flora of the county:

1. Loss of these last remnants of the original forests — an important part of the natural heritage of Gates County.

2. Loss of the entire population of the northern race of longleaf pine in North Carolina.

3. Loss of the largest known stand of large turkey oak.

4. Loss of the small bottomland tract of virgin loblolly pines.

5. Elimination of the great scientific research value of the area as a study site for forest ecology.

23. Management and preservation recommendations:

The choicest areas of high quality natural communities occupy only a small percentage of the total natural area. These are:

1. The stand of large turkey oaks on the Vaughan tract, which also contain a colony of red-cockaded woodpeckers and the unusual assemblage of ericad shrubs described by Otte (1978) and Risk (1981): about 40 acres of very important communities.

2. The adjoining east-facing slope on the Story property with the second largest longleaf pine in the state, other very old longleaf specimens, large turkey oak and diverse ericads: perhaps 20 acres.

3. The moist bottomland at the foot of the above site, containing a few very large, very old loblolly pines and some large beech: about 5 acres.

4. The site shown the author and the staff of the NC Natural Heritage Program by Mr. Story in 1981, containing a very xerophytic stand of large longleaf pines with an understory of small turkey oak & ericads: about 35 acres.

This is a total of only about 100 acres, on which is represented nearly the whole remaining portions of these types of

forest communities in the county, and in the northern half of North Carolina.

With this in mind, it might be possible to approach the Story and Vaughan families to see if they would consider marking off these tracts to be left undisturbed as natural areas. If this would impose too great a financial hardship, perhaps they would be willing to enter into some sort of easement to preserve these tracts and give them some financial benefit.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary

Community type: CT-A. Pinus taeda-Pinus palustris/Quercus laevis/ mixed ericads.

Community cover type: Loblolly pine-longleaf pine.

General habitat feature: Relict sand ridge.

Average canopy height: 60-70 ft.

Estimated age of canopy trees: Annual rings were counted on the stumps of three old longleaf pines cut August 1981:

DBH	AGE
23 in	308 yr
25 in	177 yr
27 in	167 yr

Canopy cover: open.

Estimated size of community: About 55 acres of prime CT, in 2 separate places.

Successional stage: Pyroclimax, succeeding to Loblolly pine and hardwoods because of fire suppression.

Sere type: Psammosere.

Common canopy species in community cover or community type (but not dominant): Quercus falcata. Pinus echinata.

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Oxydendrum arboreum
Gaylussacia baccata
Gaylussacia dumosa
Vaccinium stamineum
Vaccinium atrococcum
Vaccinium tenellum

Common herb stratum species in community cover or community type (but not dominant):

Gaultheria procumbens
Cladonia sp. (perhaps should be named as a layer)

24b. Soil Summary (by community type) CT-A

Soil series: Lakeland (Risk 1981).

Soil classification: Thermic, coated, Typic Quartzipsamment.

Soil association: Shown Lakeland-Chipley-Pactolus on tentative general soil map of Gates County.

pH class: Strongly acid.

Source of information: Risk (1981).

Other notes:

24c. Hydrology Summary (by community type)

Hydrologic system: Terrestrial.

Hydrologic subsystem: Very dry-xeric.

Water chemistry: N/A

Water regime: Permanently exposed.

Drainage class: Excessively drained.

Drainage basin: Chowan River.

Hydrology characterization: A permanently exposed, very dry-xeric terrestrial system wetted by fresh rains.

24d. Topography Summary CT-A.

Landform: Relict Sangamon estuarine shoreline dunes.

Shelter: Open.

Aspect: East-facing.

Slope angle: 2-10%.

Profile: Convex.

Surface patterns: Smooth to gently undulating.

Position: Upper slope.

Natural Characteristics Summary

24a. Vegetation - Biotic Community Summary CT-B

Community type: Pinus taeda/Quercus laevis/Gaylussacia frondosa-mixed ericads.

Community cover type: Pinus taeda.

General habitat feature: Relict Sangamon estuarine shoreline dunes, highest ridge tops with thin, xerophytic pine forest.

Average canopy height: 60 feet.

Estimated age of canopy trees: 100 yrs.

Canopy cover: Open.

Estimated size of community: 40 acres.

Successional stage: Seral: in transition from longleaf pine pyroclimax to Pinus taeda following fire suppression.

Sere type: Psammosere.

Common canopy species in community cover or community type (but not dominant):

Pinus echinata

Common sub-canopy or shrub stratum species in community cover or community type (but not dominant):

Carya tomentosa	Gaylussacia dumosa
Pinus transgressives (taeda)	Vaccimium atrococcum
Oxydendrum arboreum	Vaccinium vacillans
Gaylussacia baccata	Vaccinium tenellum

Common herb stratum species in community cover or community type (but not dominant):

Cladonia sp.

24b. Soil Summary (by community type) CT-B.

Soil series: Lakeland (Risk 1981).

Soil classification: Thermic, coated, Typic Quartzipsamment.

Soil association: Lakeland-Chipley-Pactolus.

pH class: Strongly acid.

Source of information: Risk (1981), Soil Conservation Service Tentative General Soil Map ofGates County (1972).

Other notes: See Risk (1981) for excellent analysis of this site.

24c. Hydrology Summary (by community type) CT-B.

Hydrologic system: Terrestrial.

Hydrologic subsystem: Very dry-xeric.

Water chemistry: N/A.

Water regime: Permanently exposed.

Drainage class: Excessively drained.

Drainage basin: Chowan River.

Hydrology characterization: A permanently exposed, very dry-xeric terrestrial system wetted by fresh rains.

24d. Topography Summary CT-B.

Landform: Relict Sangamon estuarine shoreline dunes.

Shelter: Open.

Aspect: N/A (Ridge crest).

Slope angle: 0-6%.

Profile: Convex.

Surface patterns: Smooth to gently undulating.

Position: Ridge crest

25. Physiographic characterization of natural area:

Relict xerophytic forest communities on highest ridge of the Gates County Sand Banks, a part of the Chowan Sand Ridge, in the Chowan Embayment in the Embayed Section of the Coastal Plain Province of the Atlantic Plain.

Geological formation: Unnamed estuarine/fluvial sand deposits.

Geological formation age: Early Sangamon — highest ridges; mid to late Sangamon for progressively lower ridges.

References cited: Oaks, R. Q., Jr. and J. R. DuBar. 1974. Post-Miocene shorelines and sea levels, southeastern Virginia. In: R. Q. Oaks, Jr. and J. R. DuBar, eds. Post-Miocene stratigraphy, central and southern Atlantic Coastal Plain. Logan, Utah: Utah State University Press. 275 p.

26. Summary - endangered and threatened species

Name of species: Red-cockaded woodpecker (Picoides borealis).

Species legal status and authority: Federally listed Endangered Species.

Number of populations on site: 3 colonies (Lynch 1981).

Number of individuals per population: Unknown.

Size or maturity of individuals: Adults and immatures.

Phenology of population:

Eg: vegetative %

flowering %

fruiting %

General vigor of population: May be declining due to logging of cavity trees within last five years.

Disturbance or threats to population: Logging threatens to destroy remaining populations.

Habitat characteristics

Plant community: Pinus taeda/Quercus laevis/mixed ericads.

Topography: Ridge tops.

Soil series: Lakeland.

Microclimate: Xeric.

Drainage basin: Chowan River.

Other plants and animal species present:

Aerial or detailed maps with populations clearly marked:

27. Master species lists: See Otte 1978 for additional species.

CANOPY
Pinus palustris
Pinus taeda
Pinus echinata
Quercus falcata

SUBCANOPY
Quercus laevis
Oxydendrum arboreum
Pinus transgressives
Fagus grandifolia
Juniperus virginia
Carya tomentosa
Carya sp.
Quercus margaretta
Sassafras albidum
Magnolia virginiana
Quercus velutina
Ilex opaca

SHRUBS
Gaylussacia frondosa
Gaylussacia baccata
Gaylussacia dumosa
Vaccinium stamineum
Vaccinium atrococcum
Vaccinium tenellum
Vaccinium vacillans
Castanea pumila
Acer rubrum
Symplocos tinctoria
Kalmia angustifolia
Pteridium aquilinium
Gaultheria procumbens

VINES
Vitis rotundifolia
Smilax glauca
Smilax rotundifolia
Clitoria mariana

HERBS
Cladonia sp.
Euphorbia ipecacuanhae
Heterotheca (Chrysopsis) nervosa
Diodia teres
Chimaphila maculata
Cypripedium acaule
Cyperus sp.
Panicum sp.
Cassia nictitans

See NC Natural Heritage Program files for list of 62 bird species reported by J. M. Lynch (1981). No survey of mammals of other groups was conducted on this site.

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GLOSSARY

ABBREVIATIONS (units)

in - inches
ft - feet
mi - miles
cm - centimeters
m - meters
km - kilometers
mg/L - milligrams per liter

ABBREVIATIONS AND DEFINITIONS (terms)

dbh - diameter at breast height (standard measurement of tree diameter at 4½ ft above the ground).

hydric - a wet plant habitat (adjective).
mesic - a plant habitat of moderate moisture levels.
xeric - a very dry plant habitat, often on sandy soils.

hydrophyte - a plant of aquatic or wetland habitats.
mesophyte - a plant of sites with moderate moisture conditions.
xerophyte - a plant of very dry habitats.

sere, seral stage - referring to a sequence of vegetation changes after disturbance. In this area, for instance, there is often a loblolly pine seral stage a few years after logging.

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