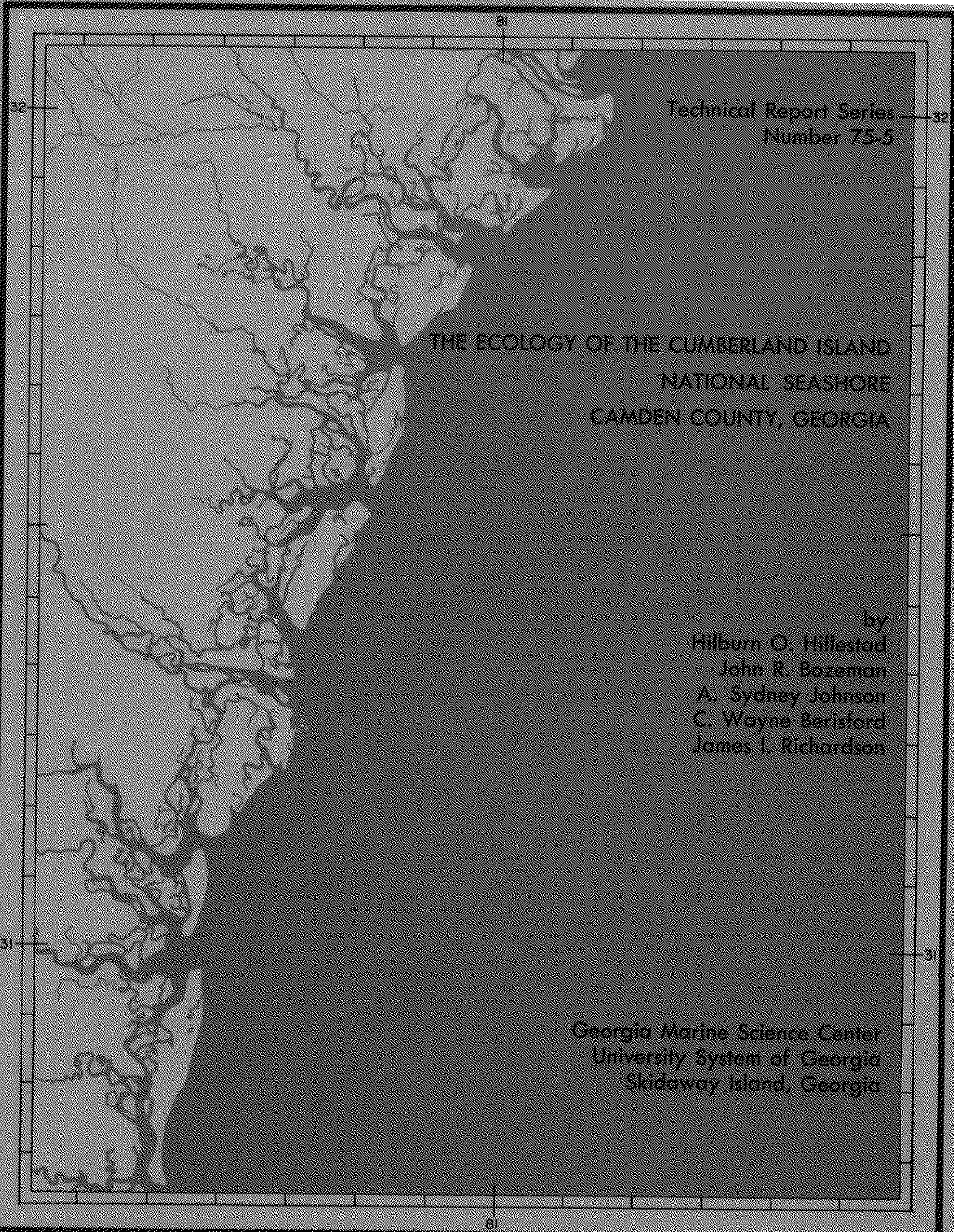

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THE ECOLOGY OF THE CUMBERLAND ISLAND NATIONAL SEASHORE CAMDEN COUNTY, GEORGIA

by
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Georgia Marine Science Center
University System of Georgia
Skidaway Island, Georgia

By

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May 1975

Report to National Park Service under contract number 1910P21157 to the Institute of Natural Resources. The U. S. Government is authorized to produce and distribute reprints for governmental purposes not withstanding any copyright notation that may appear hereon.

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PREFACE

A study of this scope must draw upon a variety of disciplines and requires the cooperation of numerous agencies and their personnel. We gratefully acknowledge the organizations which provided equipment and services and those persons who generously contributed in various ways to this report.

The National Park Service initiated the study with a grant (Contract Number 1910P21157) to the Institute of Natural Resources, University of Georgia. This grant supported much of the field work. Primary financial support was provided by the Institute of Natural Resources.

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S. P. Weems, R. Herman and J. W. Larson of the National Park Service assisted in the administrative coordination of the project. Special appreciation is extended to Park Ranger E. Phillips, who arranged transportation to and from Cumberland and housing on the island for members of the research team. He and Rangers W. Riggins and J. Hudick provided services at critical times, greatly facilitating the field work.

The Game and Fish Division, Georgia Department of Natural Resources, provided transportation to the island on occasions and the use of their vehicle on the island during emergencies. We acknowledge the assistance of conservation officers J. L. Steptoe and W. B. Vaughn.

The Department of Archaeology and Anthropology, University of Georgia, provided a vehicle for use on Cumberland Island during 1973.

R. L. Davis provided dock facilities, assisted with logistic support, and shared his observations on the island.

Thanks are due E. H. Lebetkin, J. W. Compton, J. L. Landers, and G. G. Hammes, University of Georgia, for assistance in collection and compilation of data. T. D. Atkeson, University of Georgia, deserves special acknowledgement for assistance in the collection of vegetation and entomological data.

E. P. Cheatum, Southern Methodist University, and R. W. Fullington, Dallas Museum of Natural History, identified the gastropods. R. J. Beshear and J. O. Howell, Georgia Agricultural Experiment Station, identified certain groups of arthropods and provided species lists. T. C. Barr, University of Kentucky, identified all carabids; R. E. Woodruff, Florida Department of Agriculture and Consumer Services, identified members of the Scarabaeidae; and L. L. Pechuman, Cornell University, identified the Tabanidae. E. L. Cheatum, University of Georgia, reviewed the manuscript, conducted gastropod collections and provided assistance during many phases of the study. R. M. North, University of Georgia, provided assistance in designing the study.

C. Hart and M. Rozier, Georgia Department of Archives and History, J. E. Godley, Woodbine, Georgia; R. V. Wood, Belmont, Massachusetts; and relatives of M. R. Bullard cooperated in many ways to enhance the compilation of historical records.

The Soil Conservation Service, USDA, conducted for this study a survey of the soils of Little Cumberland and Cumberland islands. The soils information contained in this report is adapted from a report by T. A.

Rigdon. Soil survey field work was conducted by T. A. Rigdon, M. M. Blevins and R. L. Wilkes. J. M. Flanders assembled the survey team and arranged for W. C. Young to visit Cumberland in 1973.

C. Ruckdeschel, Cumberland Island, contributed observations on many species and results of her sea turtle tagging studies for 1974. H. B. Jordan, National Park Service Collaborator, provided a list of reptiles and amphibians based on her collections on Cumberland, and assisted with various phases of the project.

J. P. Kilgo and R. L. Carlton, University of Georgia, contributed editorial suggestions on sections of the manuscript. Special acknowledgement is made of the thorough editing of the manuscript by R. Rivers. Sincere thanks are due S. Vinson and C. Hess for their preparation of the numerous drafts and typing of the final manuscript.

The authors and their areas of responsibility are as follows.

M. R. Bullard prepared the historical summary. The historical records on the past occupants of Cumberland and their use of its resources are commendably condensed in Chapter II.

The geological history and interpretation of dune erosion (Chapter III) was prepared by V. J. Henry, R. T. Giles, J. R. Woolsey, and G. Nash and was adapted from their report to the National Park Service, Contract CX001-3-0052. The geology map was also adapted from their report.

H. N. Neuhauser and W. W. Baker compiled the mammal list and contributed other observations on species occurring within the Seashore.

J. R. Bozeman conducted the vegetation survey and analysis, wrote Chapter VI and prepared the vegetation map.

C. W. Berisford directed the entomological investigations and wrote those sections dealing with this subject and contributed in numerous other ways.

J. I. Richardson conducted the aquatic surveys and contributed the surface water material in Chapter V, original data on sea turtle populations and other information.

H. O. Hillestad and A. S. Johnson wrote all other sections, coordinated and supervised the study, and organized and edited the report.

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I. INTRODUCTION

In 1972 Cumberland Island was designated a National Seashore and became a part of the National Park System. Accordingly, the National Park Service began to recruit resource data on the island to aid in preparation of a management plan for the Seashore.

Previous reports (e.g. Clement 1971, Johnson et al. 1975) described the structure and function of the coastal ecosystem and generalized management recommendations. However, these reports did not provide specific data on Cumberland Island other than a list of vertebrates. Several other publications reported on certain faunal components of Cumberland (Bangs 1898, Sprunt 1936, Pearson 1922, Jones 1967, Beshear 1971, Tippins and Beshear 1970a), but the overall structure of Cumberland has not been adequately described.

This study was initiated in 1973 to contribute to the understanding of the ecology of the island. The objectives were to inventory and describe the natural resources within the boundaries of the Cumberland Island National Seashore and to generally describe their functions and relationships. The study area was defined to exclude mainland properties of the National Park Service; it was bounded by the Intracoastal Waterway on the west, the St. Marys River on the south, St. Andrews Sound on the north, and the Atlantic Ocean on the east. Emphasis was on the terrestrial communities of Cumberland (primarily) and Little Cumberland Islands. The offshore and inshore waters were excluded; their structure and function have been summarized previously (Johnson et al. 1975).

The approach included detailed sampling, analysis and mapping of vegetation, and extensive surveying of the general fauna with intensive sampling of certain groups. The U. S. Soil Conservation Service cooperated by conducting a soil survey, and other cooperators contributed results of their studies on history, geology and small mammals. Details of procedure are discussed where appropriate throughout the report. Unquestionably, more information is needed to fully define the functional relationships of the various components of the islands' systems.

II. HISTORICAL OCCUPATION[1]

Cumberland Island is not a virgin wilderness; it has a long history of human occupation and intensive use. It exists today in a semi-wild state but greatly modified by the land uses and management practices of earlier inhabitants. This short history may provide the reader with the perspective for better evaluating the descriptions and discussions of Cumberland's natural resources that follow.

Cumberland Island has served as a hunting area since aboriginal times and as an intermittent source of timber. Its militarily strategic location was recognized during the Spanish occupation, and forts were erected by several armies over a period of 180 years. Cumberland produced the high quality sea island cotton during the plantation era and has been the site of various attempts at animal husbandry. Feral swine and other residual livestock still roam the island.

Aboriginal Occupation (2000 B.C. - 1562 A.D.)

Archaeological excavations show that pottery-making aboriginal populations inhabited the coastal islands as early as the second millenium B.C. Timucuans, part of the Muskhogean linguistic group, occupied inland and coastal areas north of the St. Johns River and the southern part of Georgia; they were the tribe observed by earliest Spanish and French explorers. Mouths of the great rivers in this area were densely settled.

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[1]This section written and contributed by Mrs. Mary R. Bullard, Cumberland Island, Georgia.

Timucuans, living near the Satilla, the St. Marys, and the St. Johns rivers, were probably the first settlers of Cumberland Island.

Cumberland Island, like other sea islands, provided resources important to the Timucuans. Shells were valuable items. Hammers, picks, chisels, and pounders were made from conchs (Strombidae) or other large marine shells. Hammers, picks or hoes (implying agriculture) were formed from conchs in which the end of the columella had been rounded and the body of the shell broken and perforated for hafting. Larger beads, ear pendants, breast ornaments, and net sinkers came from the conchs. From margin (Marginellidae) and olive shells (Olividae) came ornamental beads; from heavier bivalves came knives suitable for scraping out canoe interiors or scraping a bow into shape, or scrapers and smoothers for shaping up pottery interiors. An Indian canoe, hollowed by fire and finished by scraping, was excavated from a tidal flat of Cumberland Island in 1932.

Excavations by the Florida State Museum (Hemmings and Deagan 1973) on Amelia Island, immediately south of Cumberland Island, included careful examination of Timucuan refuse middens to identify food remains. On Amelia Island refuse middens produced stout razor clams (*Tagelus plebeius*), oysters (*Crassostrea virginica*), hard shell clams (*Mercenaria mercenaria*), ribbed mussels (*Modiolus demissus*), blood ark (*Anadara ovalis*), coquina (*Donax variabilis*), and knobbed whelk (*Busycon carica*) shells--some burned by charcoal and wood ash.

Fishing was a major activity among the Timucuans. Archaeological evidence for fishing gear is lacking, but Hemmings and Deagan (1973) point out that the remains of the species they found represent fish that school in large numbers in estuaries. Gafftopsail (*Bagre marinus*), sea catfish (*Arius felis*), sheepshead (*Archosargus* sp.), black drum

(Pogonias cromis), and mullet (Mugil spp.) were identified. Fish were 2 to 3 feet in length and could have been taken by simple fishing gear such as traps, hook and line, nets, and tidal weirs. A single ear bone was identified as from the Atlantic bottle-nose dolphin[2] which comes into marsh tributaries at flood-tide and may have been taken with weirs.

Other remains from refuse middens include bones of opossum, raccoon, mink, white-tailed deer, black bear, gray squirrel, rice rat, and marsh rabbit. Two bones of the West Indian seal (Monachus tropicalis) were identified from excavations at Table Point[3] (Milanich 1973). The West Indian seal was known to be present along the southeastern coast of North America until late in the 19th Century.

Hemmings and Deagan (1973) found on Amelia Island remains of a large freshwater turtle and diamondback terrapin, and Milanich (1973) found remains of the box turtle (Terrapene carolina), chicken turtle (Deirochelys reticularia), gopher tortoise, and sea turtle at Table Point.

There is no evidence of the use of hogs, horses and cattle by Timucuans on Cumberland Island before the advent of Spanish missions there. No pig or chicken remains that can be dated definitely to the pre-Spanish (before 1565) period were found in the Amelia Island excavations (Hemmings and Deagan 1973). Hernando de Soto took large herds of swine in his march through Florida and westward. Pedro Menendez de Avila, in his colonizing effort at St. Augustine (August-September, 1565), brought several hundred

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[2]Scientific names are given in the text only for those species not included in the species lists for Cumberland and Little Cumberland Islands. For scientific names not given in the text, consult these lists: Table 10 (fish); Appendices I (plants), III (mammals), IV (birds), and V (reptiles and amphibians).

[3]See map of place names in pocket inside back cover.

cattle, horses, hogs, and sheep. The southeastern Indians living on river estuaries and on islands travelled mostly by canoe and did not find horses particularly useful.

European Arrivals (1562-1733)

English ships sailed by Cumberland Island investigating the Spanish settlement of St. Augustine and more northerly Spanish settlements. Jean Ribault and Rene Goulaine de Laudoniere, French colonizers, may have landed on Cumberland Island in 1562. Pedro Menendez de Avila's 1565 expedition to found a settlement in Florida consisted of nine vessels with about 1500 persons and stock. A few days after his landfall near Cape Canaveral, Menendez sailed northward and put in at what is now St. Sugustine.

As early as 1569, a Captain Antonio de Prado made recommendations to the Spanish Crown with regard to strengthening four forts, one of which had already been erected on Cumberland Island:

> In the fort of San Pedro, which is on the island of Tacatacoru...there must be one hundred more soldiers; and there cannot be less, although now there are more, because this island is six leagues long, and (is) where the French...planned to return to build a fort...the Indians are great enemies of ours and friends of the French (Connor 1925, 1:291-93).

The Timucuans on Cumberland Island were the Tacatacoru tribe, and their main village took the name of the tribe. The Tacatacoru had been friendly with the French before the establishment of St. Augustine and had shown themselves to be distinctly unfriendly toward the missionary efforts of Jesuits led by Father Pedro Martinez. They killed him, three other Jesuits and 11 Spanish soldiers on Cumberland Island in September, 1566.

Between 1566 and 1576 there was a gradual slowing of Menendez's plans for colonization, especially in agriculture and cattle raising.

His death left the Spanish sovereign, Philip II, unable to generate interest in the colony by Menendez's heirs. Despite intense ministerial opposition, Philip II was determined to maintain Florida as a Spanish colony. In executing his policy, the Crown assumed increasing control of minor as well as major facets of colonial life. By Crown decree, the Jesuits were replaced in 1574 by the Franciscans. Franciscan responsibility for reviving languishing mission work was to be paid for by the Crown.

Despite a 1582 Indian rebellion in Guale (the name used by Indian and Spaniards to denote both an area in southern Georgia north of Cumberland Island, including the sea islands, and a series of tribes linguistically and culturally distinct from the Timucuans), Franciscan mission work commenced in the mid-1580's. In 1587 the Franciscan Father Baltasar Lopez landed on San Pedro de Mocama (Cumberland Island) to establish a mission for the Tacatacoru. ("Mocama" was a Timucuan word meaning "on the sea.")

The excavations by Milanich (1972) produced evidence to suggest location of the village of Tacatacoru, probably also the site of the mission. Milanich's excavations exposed a 1-mile-long shell midden running along the inland waterway or marsh side of the island. Its southern end lies at Dungeness and the major occupied portion, just north of Dungeness Big Dock. Milanich says the piles appear to be of uniform thickness and suggest a village laid out on an elongated, rectangular grid plan.

> The erosion along this sector has exposed in profile in the bank a line of nine or ten individual shell piles, each twenty to thirty feet in diameter and appearing from the surface to have been circular. These piles, thought to be adjacent to individual house sites, are evenly spaced about every 100 feet along the bank. Back roughly 100 feet from the bank is another line of four individual piles, discernible from the surface as low humps (Milanich 1972).

After quelling Indian uprisings in 1597, Governor Canzo encouraged rebuilding of the church at San Pedro. Although masons and carpenters were sent from St. Augustine, much of the work on the new church was done by Indian converts from the island. The new church, completed and dedicated in 1603, was said to be as large as the church at St. Augustine. When Father Lopez left in 1603, there remained a mission church, possibly an outlying chapel, and the friendship and loyalty to the Spanish of the local Timucuan Indians.

Franciscan influence reached its height in 1650. Two reasons for its subsequent decline were preeminent: coastal Indians sickened and died by the thousands from the "pestilence;" and Yamassee Indians, displaced by English settlers to the north, pushed the less aggressive and weakened Timucuans further south and inland.

Yamassee occupation of the site of San Pedro de Mocama is demonstrated archaeologically by Milanich (1972). Later mission lists indicate San Pedro de Mocama to be the same as San Pedro Athluteca, possibly indicating that the mission persisted into Yamassee times. But Jonathan Dickenson, shipwrecked traveler (1699) escorted up the southeastern coast by Indians, gives no description of San Pedro Athluteca, although he describes ruins of Guale missions.

Spanish use of natural resources on Cumberland Island must surely have included the oak mast for hogs. Father Baltasar Lopez mentions specifically that the Indians of Mission San Pedro contributed corn to the garrison of San Augustine in many years of need, and also that the garrision of San Augustine one year furnished corn to the San Pedro Indians.

English Occupation (1733-1763)

Spanish and English colonial aspirations came into conflict in this portion of the Spanish Floridas and Georgia border. Cumberland Island was an important element in the "debatable land" formed by this uncertain and dangerous frontier.

As early as 1733 Colonel James Edward Oglethorpe had made friends with Tomochichi, a local Yamacraw chief in Georgia. In 1734 Tomochichi and his 13-year-old heir, Toonahowie, were taken to London to meet the Trustees of Georgia and to be presented to members of the Royal Family. Later (1736), back in Georgia, while Frederica and its fort were nearing completion, Oglethorpe set off to see "where His Majesty's Dominions and the Spaniards join." Tomochichi, Toonahowie and 40 Indian warriors accompanied him. The Indians took them to the island of Wissoe or Missoe (the Creek or Yamassee name for the island of San Pedro), to a high point of land which, they said, marked the beginning of the Spanish dominion. Young Toonahowie, asked by the English if he would like to name the island afresh, declared he would name the island after his friend, William Augustus, Duke of Cumberland. Captain High Mackay and his men marked out a fort to be named for the patron saint of Scotland, St. Andrew. Oglethorpe left, although later he returned to check the progress of the fort. The Indians remained to fish and hunt for their friends.

Fort St. Andrew may have gone through two periods of construction: an early one, built by frontiersmen working in haste; and a later one, by detachments of regulars sent from Gibraltar. In its early stage Fort St. Andrew may have been made of alternate layers of felled trees and earth. The trees prevented sand from falling, and sand protected wood from fire.

A map from the British Museum, prepared by the French (no date given), shows a substantial small fort, enclosing a tiny 4-pointed star which is described as the contour of the old fort. The new fort is, according to the legend on the French plan, "capable of holding stores and barracks for 200 soldiers, and about 20 rooms extra for some other residents... 3 double rows of Barracks...Bakery...Forge...Latrines...Parade ground... redoubts to keep the attackers far off and to prevent them from camping in the gully...." Trenches are shown which communite between the redoubts and the fort.[4]

An often quoted sentence of Frederick Ober's writing in 1880 speaks of Oglethorpe's hunting lodge "Dungeness" on the southern end of Cumberland Island. Dungeness was named after an estate belonging to the Royal Family on the Cape of Dungeness, Kent. Fort Prince William was built on South Point, high land forming part of Cumberland but separated by a large marsh and Beach Creek. Its exposed position on a relatively small point of land, connected to Cumberland by either marsh or a circuitous walk via the beach, raises speculation that the Indians left behind to hunt for the Highlanders and English may have cached their game for the guard from Fort Prince William at the head of Beach Creek, hence Oglethorpe's "hunting lodge" at the site of the present Dungeness. The Highlanders might even have found it amusing to dignify an Indian cache with the name of a Hanoverian hunting lodge.

Fort Prince William, on South Point, was manned by 60 men, and it controlled the entrance to the harbor of Amelia Island (Fernandina). In 1739, hostilities between Spain and England resumed (War of Jenkins' Ear).

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[4]Map, British Museum, photostat in Plum Orchard House.

Fort Prince William was bombarded by Spanish ships making their way up the coast for the long-expected attack on the English at St. Simons Island. Immediately after the little fort drove off the Spanish ships, word was sent to Frederica of the imminent arrival of the Spanish fleet. Oglethorpe went to Cumberland Island on receipt of the news from Fort Prince William, taking men with him from his own regiment, rangers from Fort St. Andrew and a few Highlanders from an outpost on Amelia Island. The Spanish proceeded up the coast, attacked Frederica, were repulsed at the Battle of Bloody Marsh, and retreated, all within the space of a few short weeks in June and July, 1742.

Since such retreats by no means guaranteed the end of the war, Highlanders and English regulars sent from Gibraltar continued to occupy Fort St. Andrew. The village of Barriemackie sprang up as a consequence of these soldiers' families joining them. Barriemackie was the next settled community on Cumberland Island. By 1740 there were 24 families (Candler and Evans 1906). Lots were assigned which settlers cultivated and improved. Jones (1878) quotes from a 1755 French description of the colonies in which "Barimake" is one of the only three municipalities in Southern Georgia. Barriemackie's location on the island is not definitely known.

About the decade Barriemackie is said to have disappeared (1756-1766), a new group moved in, sometimes referred to as "Gray's Gang." Edmond Gray headed the group of lawless backwoodsmen who established a community called New Hanover of some 70 to 80 persons 30 miles up the Great Satilla River and became a thorn in the flesh of both English and Spanish authorities. The trading post established by his friend, Ephraim Alexander, threatened the peaceable relations between the Spanish, the

English, and the Creek Nation. About 1761, Governor Ellis of Georgia visited New Hanover himself. He urged Gray and Alexander to remove to Cumberland Island. Alexander was given a permit to establish a trading post on the St. Marys opposite Fort Prince William. Gray's community included some Spanish families. Of the other members, De Brahm said: "All persons incapable or unwilling to satisfy their creditors, as also Men guilty of criminal actions would resort both from the English and the Spaniards."

Slow Settlement on Cumberland Island (1763-1786)

With the cession of Florida by Spain to England in 1763, the English Board of Trade began to pass on applications made to it by English courtiers, investors and speculators for grants in Georgia and Florida. Denys Rolles and a group of associates attempted to acquire all that part of Georgia south of the Altamaha River, with an extension into Florida; their purposes "to develop great plantations of silk, indigo and cotton, to exploit the timber resources, and to seize the Indian trade." Their petition was refused. Rolles then petitioned more specifically for Cumberland Island, where he envisaged another Garden of Eden. This petition was also refused. Between 1765 and 1768 nearly all of Cumberland Island was granted to some nine individuals. Cumberland Island apparently remained relatively unsettled. William Bartram, well-known American botanist (1739-1823), made a very brief stop on the island but made the following observant remarks about Jekyll and Cumberland (1774):

> It may be a subject of some inquiry, why those fine islands, on the coast of Georgia, are so thinly inhabited; though perhaps Amelia may in some degree plead an exemption, as it is a very fertile island on the north border of East Florida and at

> the Capes of St.Mary, the finest harbor in this new colony. If I should give my opinions, the following seem to be the most probable reasons: the greatest part of these are as yet the property of a few wealthy planters, who having their residence on the continent, where lands on the large rivers, as Savannah, Ogeechee, Altamaha, St. Illa and others, are of a nature and quality adapted to the growth of rice, which the planters chiefly rely upon for obtaining ready cash, and purchasing family articles; they settle a few poor families on their insular estates, who rear stocks of horned cattle, horses, swine and poultry, and protect the game for their proprietors. The inhabitants of these islands also lay open to the invasion and ravages of pirates, and in case of a war, to incursions from their enemies armed vessels, in which case they must either remove with their families and effects to the main, or be stripped of all their movables, and their houses laid in ruins (Bartram 1791).

Bartram mentions "deer, bears, and other game" on Cumberland and Jekyll. Although ample proof exists to show that Bartram was correct in his speculation about population on Cumberland Island, much evidence exists to show that inhabitants from the mainland fled to Cumberland Island to escape the "depredations and ravages of the savages." Deeds, petitions, proclamations, and appointments of attorneys-in-fact, dating from this period (Camden County Court House) show absentee owners of property on Cumberland vainly trying to prevent hunting of "their" game on the island, or forbidding lumbering of "their" timber. The parishes that became Camden County were thinly populated because of the uncertainty up to 1783 as to the limits of Spanish-English jurisdiction, the ability of British troops in British East Florida to obtain cooperation from Indian allies (1775-1783) in harassing American rebels in coastal southeast Georgia, and lack of interest in agriculture on the part of the earliest poor settlers when cattle-raising was so easy. Cumberland Island reflected these facts. The great cotton, indigo and rice plantations envisaged by its owners in Charleston or in Savannah required slave labor. Slave labor in Camden County, in its relatively lawless state up to 1788, would have required a degree of supervision on Cumberland Island which its various owners apparently were not ready to provide.

Plantation Era (1786-1880)

The first commercial ventures in this period depended upon exploitation of lumber, growth and sale of long staple cotton, and growing enough food products locally to feed slaves and reduce cash outlay. A possibility exists that a non-agricultural commercial venture--that of brick-making--may have prospered.

Title descriptions up to 1860 depended upon a survey completed in 1802 to settle litigation between the heirs of General Nathanael Greene and the heirs of Thomas Lynch. The 1802 map[5] divides all the island into a series of parallel strips, running east-west and numbered from Tract No. 1 (South Point) to Tract 12 (Little Cumberland). Earlier grants, whose titles apparently were undisputed lying within these 12 parallel strips, remain undisturbed; but, generally speaking, all of Cumberland Island belonged in 1802 to either the Estate of Greene or the Estate of Lynch. Cumberland Island, at the beginning of its plantation period, was divided into land units reflecting a legal, not agricultural principle. The following plantations were in operation in the 1860's.

Dungeness, administered by a grandson of General Greene, Phineas Miller Nightingale, heir to Dungeness through his aunt, Louisa Catharine (Greene) Shaw, consisted of 4,000 acres. Mr. Nightingale resided on Cumberland and in Brunswick, Georgia.

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[5]Photostats of the 1802 map of Cumberland Island are in the author's possession.

Stafford Plantation, an 8,000-acre plantation administered by Robert Stafford, whose father and uncle were among St. Marys' earliest settlers but whose residence on Cumberland is contemporaneous with the Greenes' arrival at Dungeness. The younger Robert Stafford and his mother, Lucy (Stafford) Spalding, bought much of the Greene properties, including Ray Field, a separate plantation belonging to Nathanael Ray Greene.

Oakland Plantation, administered by James Shaw, apparently was comprised of Jim Pease's Point, south of Plum Orchard, and perhaps the two northerly fields of the Benne-Banks and Baltimore Fields area.

Plum Orchard Plantation, purchased by Peter Bernardy in 1823, consisted of 500 acres near the present Plum Orchard mansion and land on the Table of Pines (Table Point). Total properties eventually equalled 1240 acres. Part of his holdings went to his daughter, Margaret Bernardy. Robert Stafford later acquired some of Plum Orchard.

The Downs Properties were described in 1869 as consisting of the Longwood, Fairmont, and High Point Plantation, 3,000 acres in all, and including Brick Kiln River and Brick Kiln Bluff (deep water landing).

A primary resource of Cumberland was live oak. By 1800 "live-oaking" had become a sea island industry. Teams of highly skilled lumbermen came for the winter from New England to find and to cut live oak branches best suited for specialized parts of ships. Phineas Miller, second husband of Mrs. Nathanael Greene, had contracts with the United States government to furnish live oak for the budding American navy. Dr. William Baldwin, an enthusiastic amateur naturalist practicing medicine in St. Marys and friend of the Greenes and Millers at Dungeness, in 1816 wrote (Darlington 1843):

> Live Oak, fit for ship building, considerable. It is abundant in the Province; but that only which is in the immediate vicinity of salt water, is considered prime for ship building. That kind of land which is here called Hammock, is generally covered with Live Oak. It is a little elevated, calcareous, still abounding all along the coast with undecomposed oyster shells, etc.

Of forest products other than live oak, White (1849) mentions only cedar and "a few pine."

A second resource was derived from the shell middens of the Timucuan occupation. The middens provided level platforms on which a house could be built, a solid base for the main road system running from Dungeness to High Point (Ober 1880), and "tabby" for house and wall construction (the four-storied house of Dungeness built by the Greenes is thought perhaps to have been the tallest of tabby houses).

Plantations produced hogs, cattle and horses. High marsh, then as now, provided forage for stock. Oak forests provided mast for hogs. Robert Stafford permitted others to catch the small wild ponies called "marsh-tackies" which he sold for $5 each. The 1802 map shows a dike corresponding exactly to what is now known as "Kings Bottom" road or area. Perhaps the dike represented an early effort to increase bottomland or to increase the amount of salt marsh hay.

One plantation produced citrus and other fruit. Ample testimony exists for the fine oranges, lemons, pomegranates, and figs grown at Dungeness (Darlington 1843, White 1849, Ober 1880, Nightingale 1938). Dungeness orange groves were "destroyed" by a frost in 1835. They had previously been subject to some depredation by the British in the War of 1812. The early Greene-Miller-Shaw owners established an olive grove at Dungeness which existed until 1881.

Corn and sweet potatoes led the list of edible field crops according to White who said corn averaged 12 bushels per acre and sweet potatoes, 70 bushels per acre. In the 1850 U. S. Agricultural Census, Robert Stafford reported 1000 lbs. of cane sugar and 600 gallons of mollasses. Four of his island neighbors reported cane sugar in considerably lesser amounts. Finally we come to the most important crop--sea island cotton. In 1850 Robert Stafford reported 175 bales of cotton, each bale being figured at 400 pounds. Stafford reported 12 times as many bales of cotton as any one of his island neighbors. By 1860 Stafford owned not quite one third of Cumberland Island.

A by-product of Cumberland Island plantations might be said to have been slaves. White (1849) mentions particularly the healthy conditions of Cumberland Island and the longevity of the slaves. Leasing of slaves for construction or lumbering became more and more profitable in the 1840's and 1850's when plantations seemed unable to provide sufficient year-round work for them.

Establishment of Private Estates (1880-1916)

When the Civil War ended, Cumberland Island's plantation economy was in a shambles. White (1849) speaks of the fine house at Dungeness going to ruin, so a partial abandonment of Dungeness may have taken place before the war, but it was certainly uninhabited and vandalized afterwards. Stafford, reportedly embittered by the refusal of his slaves to work once the word of the Emancipation Proclamation was brought to them, is said to have burned their cottages and shanties and driven them away. Oral tradition on the island today says most of them emigrated to Brunswick, many of their descendants returning to fish or to hunt on Cumberland. The First African Baptist church (built in 1893) now existing at High Point possibly derives from the efforts of ex-Stafford slaves who reportedly had had a church built for them by Stafford before the Civil War.

The Nightingales sold the last of the Greene holdings, Dungeness Plantation, to Eliza H. Molyneux, descendant of a well-established Georgia family married to an Englishman who had been for a long time the Cousul in Savannah and subsequently resided in Liverpool. The Downes properties were sold to two men who apparently were speculators from the north--Joseph Shepard and Silas Fordham. The Stafford properties, abandoned by Robert Stafford, were inherited by two nephews, John Tomkins and Thomas D. Hawkins, and were clearly unfarmed. Dungeness House had become a tourist attraction for the hotels in Fernandina, which took their guests on boating excursions to nearby Cumberland Island to show them the still-beautiful gardens of Dungeness's "Garden Point" and the romantic but ruined beauty of the four-storied house.

In 1881 Thomas M. Carnegie acquired Dungeness and presented it to his wife. Almost immediately afterward (1882, 1883), Carnegie and Leander Morris bought all the Stafford holdings. Several recreational facilities were constructed on the island for the family's use. One old field (Old House Field) became a skeet field and Stafford House Field became a golf links. New roads were cut to facilitate duck-shooting or deer-hunting (Duck House Road, Roller Coaster Road, Yankee Paradise) or for pleasure riding (Andrews System, Pratts Road). Several presently prominent features of the island bear names given by the Carnegie family. Lake Retta was named after one of Mrs. Carnegie's daughters. Lake Whitney was probably named by Mrs. Carnegie after Harry Whitney, close friend of her sons and noted big-game hunter and involuntary participant in the Dr. Frederick Cook-Robert Peary controversy over discovery of the North Pole. Coleman Avenue was named for one of her sons.

The manager's papers of the Carnegie estate show the planting of corn, Irish and sweet potatoes, and many garden vegetables. Some evidence at the beginning shows it was Mrs. Carnegie's intention to obtain some relatively small income for Stafford Plantation from the sale of Stafford's free-ranging hogs and horses. Sales of hogs, cattle and horses were made throughout the period of the Carnegie family.

Before her death in 1916, Mrs. Carnegie established a trust to maintain her 16,000 acres on Cumberland Island as a home for her children. By that date her property extended up to what is referred to as the Carnegie-Candler fence.

About the turn of the century the northern part of the island was a popular resort. It later became the private estate of the Candler family of Atlanta.

Private and Public Ownership (1916-present)

The synergistic effects of the Great Depression, the emigration of the labor force to industries developing in Florida, and a cumbersome trust arrangement induced severe problems in the management of Cumberland by the Carnegie heirs. The owners began to seek a product for Cumberland which could possibly make the island financially self-sufficient. T. Morrison Carnegie, recognizing that rubber and rubber products would be increasingly in demand, experimented with growing tung trees. Tung nuts would produce tung oil for waterproof paints, varnishes and cloth compounds for insulating motor dynamos and cables, and serve as other substitutes for rubber. The tung nuts were processed near Gainesville, Florida. Remnants of the tung orchards can still be found on the southern portion of the island.

The last venture would have been the most ambitious. Between 1955 and 1957 various mining companies became interested in strip and hydraulic mining for titanium and ilmenite, found in the sands of the sea islands. The extraction of this natural resource would have ensured retention of the land by the Carnegie heirs but would also have changed radically the topography, floral and faunal habitats, and future suitability of Cumberland as a private retreat.

According to a map prepared by the American Smelting and Refining Co., the ore body has as a southern limit an east-west meridian running through or slightly to the north of Old House Creek and a northern limit at the Carnegie-Candler fence line. Within this 7000 acres, however, a much smaller area was described as "assured ore". This smaller area had a long tapering shape at its southern end, about 200 yards north of the ruins of Stafford's slave chimneys. Running south to north, assured ore would have been found in New Swamp Field, Old Swamp Field, Yankee Paradise, "a pine hill section," Oyster Pond and Oyster Pond Field, Ray Field, "Kill Man" Field, and the area tapered out once again slightly to the west of Lake Whitney. Both the "assured ore" and the "probable and low grade ore" bodies would have been utilized by the successful bidder. The high bidder was Glidden Company of Cleveland, who planned to spend 9 million dollars on its installation. The Company planned to employ 100 persons, build a 150-acre village in Brick Kiln Bluff area, erect 70 residences, fence the area to keep employees from trespassing on the estate, and maintain a system of guards.

Records from the Glidden Company[6] describe the contents of the ore body:

> The Company intends to mine and concentrate ilmenite, luecoxene, rutile, zirconium, and rare earth minerals, and remove such minerals from the property to the extent it is economical to do so....

Expected production: (annually)	Ilmenite and luecozene concentrates	100,000 tons
	Rutile	10,000 tons
	Zirconium	15,000 tons

Glidden Company promised 2.25 million dollars minimum royalties. Experts retained by the Trust officer promised that in actuality the Carnegie owners would get about 4.25 million dollars. Glidden Company offered to re-contour and reforest land which had been mined, up to a cost of $50 per acre. The offer to lease was refused, as the result of litigation brought by one Carnegie heir. The most important single reason for the Superior Court decision against acceptance of the lease was that the Trustee had no right to enter into an agreement of such a long period of time. The Trust declared that Cumberland Island was to be maintained as a home for Mrs. Carnegie's children until the last of her children died. In 1957 the "last surviving child" was then an elderly lady. But the mining lease was to extend for 20 years. The Superior Court declared that a 20-year lease would extend beyond the life of the Trust and was therefore invalid.

From this court decision came certain private decisions for the Carnegie owners, one of which was to be prepared for the Trust to terminate, and another of which was to be ready to divide the land among the heirs,

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[6] From the bid presented to the First National Bank of Brunswick, Ga., Trustee of the Estate of Lucy C. Carnegie.

land higherto owned in common. The Cumberland Island Company was set up in 1959, the officers members of the Carnegie family. When the trust came to an end in 1962, the Cumberland Island Company was able to handle the transition from administration by a bank to ownership by individual owners, and it was also able to represent those heirs who were beginning to consider sale of land on the island to the National Park Foundation. Eventually Foundation acquisitions amounted to slightly more than 70 percent of the so-called Carnegie land. In 1972 Cumberland Island National Seashore became an official part of the Nation Parks system of the U. S. Department of the Interior.

III. GEOLOGY[7]

Geological History of Cumberland Island

Cumberland Island is one of the southernmost major islands in the chain of sea islands extending from Cape Hatteras, North Carolina, to Talbot Island, Florida. It is classified as a barrier island and is genetically related to others in the group. These barriers are relatively short and broad, usually less than 18 by 4 miles respectively, and are separated from the mainland by 4 to 6 miles of salt marsh. Cumberland Island, one of the largest of the group, is about 17.5 miles long by 3 miles wide, narrowing to .5 mile in the south. The islands are generally of low relief (15-25 feet above mean sea level) except in dune areas which may reach elevations of 50 feet. The islands of this barrier chain are separated by estuaries of sounds typically several miles wide.

Tides of the area are semi-diurnal with ranges of 6+ to 8+ feet during neap and spring tides, respectively. Strong tidal currents are generated during the flood and ebb, being especially strong during the latter. Resulting currents of several knots are common in the estuary mouths, particularly where restricted by extending barrier tips. In these areas currents have scoured channels 40 to 80 feet deep. Such channels maintain themselves for several miles offshore and are flanked by marginal

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[7] This section written and contributed by V. J. Henry, R. T. Giles, J. R. Woolsey, and G. Nash. University of Georgia Marine Institute, and Skidaway Institute of Oceanography, Skidaway Island, Georgia.

bars. They shoal rapidly with attenuation of the ebb tide current, however, and are fronted by a sill or bar having as little as one fathom of water at low tide. Beyond this point, there is little evidence of channel influence on bottom topography.

The ocean floor off Cumberland is of low relief and slopes seaward at approximately 4 feet per mile. Farther seaward, the slope flattens to less than 2 feet per mile before reaching the edge of the continental shelf.

Cumberland is fronted by two systems of shoals extending as much as 5 miles offshore. The shoals vary in mean tide depth from 6 to 12 feet and are generally composed of minerals of relatively low specific gravity (less than 3.0) of very fine sand size and of broken shell material. The lighter mineral composition is conducive to continual shifting with respect to sea level, but the areal extent is generally maintained within the shallow zone of the island front between bounding estuary inlets.

Geologically, Cumberland Island is a compound barrier island, which developed largely during two distinct periods of time and in response to two major fluctuations of sea level caused by the growth and decay of continental ice sheets that covered much of the Northern Hemisphere during the Wisconsin stage of the Pleistocene Epoch. Modification of the basic island morphology has continued to the present.

Geological features of Cumberland Island are shown on the geologic map (in pocket inside back cover). The core, comprising more than 90 percent of the island, is constructed of Pleistocene sediments. These consist of fine-grained sands having a litoral and shallow marine origin, lying unconformably on a subaerially weathered surface developed on Pliocene marl. The average thickness of the Pleistocene sediments is approximately 50 feet.

All but the lower levels are typically devoid of beach shell because of solution of the calcium carbonate by slightly acidic surface water percolating through the upper deposits. Humate soil horizons are common. The surface is characterized by a topography of generally subdued relief ranging in elevation from 10 to 20 feet above mean sea level in the narrow, southern half of the island to 30 and 40 feet in the northern half. Drainage is generally poor in the lower areas where ponds and swampy terrain are common.

The Pleistocene portion of the island is the remnant of a pre-existing barrier island dating between 25,000 and 50,000 years b. p. (before present). It was developed along a shoreline extending from Cape Cod to southern Florida during the mid-Wisconsin high stand of the sea associated with glacial retreat. This remnant shoreline is referred to as the Silver Bluff and is about 5 feet higher than present mean sea level.

The processes responsible for the modification of Silver Bluff Cumberland Island through weathering and erosion and the eventual addition of the Holocene portion were set in motion approximately 25,000 years b. p. when the growth of the late Pleistocene continental glaciers resulted in the world-wide lowering of sea level, reaching approximately -350 feet by 18,000 years b. p. With subsequent retreat of the ice sheets, the sea again began its transgression of the land, marking the advent of the Holocene Epoch. Throughout the span of the low-stand of sea, the agents of weathering and erosion modified the parent island. Rivers and streams draining the interior and crossing the former shelf periodically incised their valleys or were filled with sediment as was determined by climatic factors. As sea level rose attendant to glacial retreat, a barrier island system sustained by littoral processes advanced landward correspondingly; approximately 6000 years b. p. the rate of sea level rise slowed as it approached the present level, attaining a near-present stand about 3,500 b. p. During this period the Holocene barrier system abutted the remnant Silver Bluff barrier forming the composite Cumberland Island.

Meanderings and channel erosion of the St. Andrews and St. Marys estuaries have reworked the northern and southern extremities of the island into a series of seaward sand spits. On the northern end Holocene beach and dune sediments making up Little Cumberland Island are separated from the Pleistocene interior by a Holocene salt marsh nourished by Christmas Creek. The southern extension of this intermediate marsh has been overridden by the modern beach/dune sequence with slow but continued sea level rise and presently abuts the lower two-thirds of the Pleistocene island core.

Although the Holocene beach and dune sands are similar in size and mineralogy to that of the Silver Bluff, these younger deposits can be easily distinguished by the presence of shell material in the upper zone, absence of humate horizons and a well defined surface relief of both dune ridge and swale systems and composite dunes.

The modern salt marshes bordering the western side of Cumberland Island have reoccupied and thinly overlie older salt marshes that developed in association with the Pleistocene portion of the island. (For a general review of the geological formation of the barrier islands and interacting systems, see Johnson et al. 1975.)

Beach and Dune Erosion

The problem of beach erosion at Cumberland Island is essentially common to the entire shoreline of the southeast Atlantic coast. It is principally a natural phenomenon considered the result of (1) a slight, but persistent rise in sea level (approximately 6 inches per century) following the marked slowing of sea level rise between 6,000 and 4,000 b. p. and (2) a paucity of river-borne sand available for natural beach maintenance. The rate of this general erosion is slow compared to the more spectacular erosional events typically associated with storms, both the common winter northeaster and the more rare hurricane. Periodic variation in frontal shoal depths opens corridors for storm wave attack on the beach. In this way,one or more stretches of beach front may be exposed to greater than normal erosion during a given period. The net erosion to the beach as a whole, however, is typically low,due mainly to the immediate redeposition of sand down-drift from the sector of severe erosion as well as the trapping effect of the inlet shoals,which may serve as a reservoir of sand for subsequent resupply to the beach.

A factor possibly influencing the variable advance of erosion along the beach is the presence or absence of foredunes. Along the southern sector of the Cumberland beach, where erosion in the past has been most severe, foredunes are essentially absent (Figure 1, top). To the north however, foredunes are present in varying degrees of stability and apparently have offered some resistance to storm surf attack (Figure 1, bottom).

The condition of the dunes on Cumberland is itself an interesting problem. A very prominent dune ridge 20 to 40 feet in height extends

Figure 1. Top. Along the southern beach, where erosion in the past has been most severe, foredunes are essentially absent. Bottom. Further north foredunes are present in varying degrees of stability.

continuously for the greater length of the island (see Geologic Map). The dune ridge exists in various states of stability. In the south there is a marked absence of stabilizing dune vegetation, and the dune is actively advancing landward (Figure 2). Forests offer some impedance; however, grassy fields such as are found in the vicinity of Dungeness are easily transgressed. Rates of advance in that area may be as much as several feet per year. In the vicinity of Willow Pond (central sector) a portion of this same high dune system was observed to have transgressed a normal system of dunes and swales apparently of early Holocene age.

Extending from the high dune ridge to the water's edge is an extensive zone of deflation evidenced by a lag concentrate of shell. No typical dune system exists in this zone other than hummocky remnants. A scarcity of vegetation is immediately apparent. Sea oats are completely absent in the southern sector. It is suggested that the removal of dune vegetation is the prime factor in the exposure of a pre-existing, natural dune system to deflation with the subsequent entrapment of the mobilized sand along the forest front where it has grown to its present height. In certain more open areas in the northern half of the island, series of lower discontinuous dunes dominate the topography, lacking the common line of concentration determined by a forest edge.

It is further suggested that the hogs, cows and horses of Cumberland that preferentially graze the dune grasses are the primary cause of devegetation (Figure 1; Figure 2). This process may have begun in colonial times when livestock were introduced to the island. This period may have marked the initial development of the high dune ridge. Following the Civil

Figure 2. Large migrating dune that has transgressed forest and is encroaching upon pasture near Dungeness.

War, livestock for the most part were removed and not reintroduced until the 1900's, allowing an interval of stabilization. In support of this theory is the fact that a dune of such height and extent must have a considerable source area of unvegetated sand. Considering the natural case of a series of dune seldom greater than 12 feet in height, some unnatural means of denudation must occur before widespread deflation and transport can take place. In the case of the composite high dunes commonly found on the north and more rarely on the south ends of the barrier islands, inlet shoals have been observed to grow to the point of instability in the wave zone and migrate ashore as bars. In this manner large volumes of nonstabilized sand are made available periodically for dune nourishment. Such a mechanism could not, however, explain the formation of essentially a single high dune extending almost the entire length of the island. These features are common to several other barrier islands with a history of livestock grazing.

IV. SOILS AND PLANT NUTRIENTS

Nutrient Cycling and General Characteristics of Island Soils

The soils of the barrier islands were derived primarily from quartz sands, which are highly resistant to decomposition by chemical and physical weathering processes. They have resisted environmental degradation for 35-50,000 years and still closely resemble their parent materials. The coarse-to-fine sandy soils of the islands are commonly placed in the Regosol soil group (i.e. soils with a poorly differentiated profile).

Atmospheric fallout (Art et al. 1974), high tidewaters and terrestrial birds and mammals that feed on marine organisms bring nutrients to the islands from the sea. These same agents also return nutrients to the sea, and the net gain, if any, is small. Nutrients are at a premium on the islands.

The dominant feature of island soils is their high permeability, which results in low water-holding capacity and rapid leaching. The lack of cation (Na, K, Ca, etc.) adsorption sites on the quartz crystals produces soils with a low cation exchange capacity (C.E.C.) and, consequently, an inability to retain essential plant nutrients. Nutrients, therefore, are vigorously recycled, and at any given time most cations will be complexed in plants or organic humus. Microbial decomposition of organic matter releases the nutrients and they again are quickly tied up by vegetation.

In this system, where competition for nutrients is intense, natural selection has favored the development of communities with efficient mechanisms for nutrient conservation and recycling.

Most of the dominant and climax vegetation on both wet and dry sites are evergreen species, which lose their leaves and release nutrients gradually throughout the year. The litter produced is moderately to strongly resistant to decomposition, which further enhances a gradual release of nutrients for uptake by vegetation as they become available (Monk 1966). Other adaptive mechanisms for nutrient conservation involve the distribution of root systems of the various dominants and codominants. Certain species such as live oak have a shallow, spreading root system with a diameter about equal to that of the crown. Such a root system is thus always in close proximity to the nutrient source. Other evergreen species, such as pines, have a different but effective nutrient gathering root system. Pines (especially longleaf which grows on very poor sites) have a small, shallow lateral root system combined with a deeply penetrating tap root system. The latter extends through a large portion of the soil profile which permits a larger effective "uptake time" of nutrients percolating through the soil. Both systems effectively reduce the net loss of nutrients to the community.

Most island soils are acidic, the exception being those soils near the beach (Fripp and Duckston sands). In most instances the acid soils are composed of coarse sand and have moderate relief. Acidity on well drained soils develops when the exchangeable bases are leached and replaced with hydrogen ions. On poorly drained sites acidity is enhanced by the dissociation of adsorbed hydrogen into the soil solution and the production of inorganic (e.g. sulfuric and nitric) acids (Richardson and Worthington 1975).

Natural plant communities have adapted to high acidity levels, but introduced domestic crops are productive only if the native soils are intensively managed. Antebellum planters reduced the acidity of the soils by applying large quantities of shell materials, and they increased the C.E.C. and fertility by importing marsh mud and applying it to the fields (Johnson 1930). Apparently these practices were responsible for the highly productive island agriculture before the advent of commercially available inorgnaic fertilizers.

Soils of Cumberland and Little Cumberland Islands

U. S. Soil Conservation Service personnel, cooperating in this study, conducted a soil survey of Cumberland and Little Cumberland islands. Standard survey methods were employed (e.g. Byrd et al. 1961; Wilkes et al. 1974). The following soil descriptions are excerpted from the survey report.[8] A soils map showing the distribution of the various series on the two islands can be found in the pocket in the back of this report. Acreages occupied by each soil are presented in Table 1, and results of chemical analyses of selected soils are presented in Table 2.

The soils of the two islands are divided into three categories for purposes of this discussion. There are (1) upland soils that range from excessively to moderately well drained sands, (2) sandy to loamy

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[8]Rigdon, A., M. Blevins and R. Wilkes. 1973. Soils report and interpretations for Cumberland Island, Georgia. USDA, Soil Conservation Service. Typewritten.

Table 1. Summary of soil types by acreage and percent of area on Cumberland and Little Cumberland Islands, Camden County, Georgia.

Soil Type	Cumberland Island		Little Cumberland Island		Islands Combined	
	Acreage	Percent	Acreage	Percent	Acreage	Percent
Lakeland Sand	2,322.4	10.0	-	-	2,322.4	9.1
Chipley Sand	2,126.6	9.2	-	-	2,126.6	8.3
Olustee Sand	95.1	0.4	-	-	95.1	0.4
Fripp-Leon Sand Complex	890.4	3.8	812.5	33.4	1,702.9	6.6
Leon Fine Sand	5,174.4	22.3	61.3	2.5	5,235.7	20.4
Johnston Loam	1,231.9	5.3	-	-	1,231.9	4.8
Duckston Sand	513.9	2.2	115.6	4.7	629.5	2.5
Capers Soil	8,051.3	34.7	1,024.4	42.1	9,075.7	35.4
Coastal Beach	1,145.1	4.9	294.4	12.1	1,439.5	5.6
Unstabilized Dunes	1,675.5	7.2	126.3	5.2	1,801.8	7.0
Totals	23,226.6	100.0	2,434.5	100.0	25,661.1	100.1

Table 2. Chemical analyses of selected soils on Cumberland Island, January 1973

Sample	Horizon	Depth (inches)	pH (wet)	Mineral Nutrients (pounds/acre) P	K	Ca	Mg	Al	Na	Percent Organic Carbon	Soluble Salts mho's x 10-5	Percent Organic Matter
	A1	0-8	3.8	< 7	68	202	307	-	-	-	-	5.96
	A2	8-27	4.4	53	<47	173	<39	-	-	-	-	0.34
Leon fine sand	Bh21	27-31	6.1	484	<47	1201+	91	-	-	-	-	3.40
	Bh22	31-36	3.9	372	<47	965	74	-	-	-	-	4.20
	B3	36-44	4.5	11	<47	<119	<39	-	-	-	-	2.50
	A'2	44-56	4.5	21	<47	<119	<39	-	-	-	-	0.74
	B'h	56-65	4.9	29	<47	<119	<39	-	-	-	-	1.07
	A1	0-6	4.1	< 7	<47	229	78	120	-	2.17	-	2.50
	A21	6-12	4.0	8	<47	<119	61	120	-	0.98	-	1.90
Leon fine sand	A22	12-24	4.5	< 7	<47	<119	<39	80	-	0.21	-	0.27
	Bh	24-28	4.0	78	<47	208	65	3048	-	1.68	-	1.50
	B3	28-35	4.5	8	<47	<119	<39	1888	-	0.21	-	0.94
	A'21	35-50	4.6	10	<47	<119	<39	256	-	0.36	-	0.27
	A'22	50-65	5.2	11	<47	<119	<39	392	-	0.06	-	0.27
	B'h	65-70	5.4	83	<47	<119	<39	880	-	0.12	-	0.40
	A1	0-3	5.0	356	<47	1116	44	-	76	-	Trace	1.20
	C1	3-9	4.3	21	<47	<160	<39	-	20	-	3	0.07
Duckston sand	C2	9-24	5.6	484	<47	1201+	120	-	132	-	3	0.02
	C3	24-45	5.8	487	<47	1201+	264	-	157	-	4	0.27
	C4	45-53	5.6	487	<47	1201+	115	-	100	-	3	0.34
	A11	0-12	5.0	12	<47	694	100	-	-	-	-	2.80
Lakeland fine sand	A12	12-24	5.6	27	<47	254	<39	-	-	-	-	1.50
	C1	24-34	5.1	44	<47	<119	<39	-	-	-	-	0.07

soils on broad flats, depressions, and drainageways in the island interior that are poorly to very poorly drained, and (3) near neutral to alkaline soils that range from poorly drained to very wet conditions.

Drained Upland Soils

The upland soils reported for Cumberland are mostly porous sands derived from late Pleistocene or recent Holocene sediments. Some of these sediments have been reworked by aeolian action (Fripp series). The representative series occurring in upland situations are Lakeland, Chipley and Olustee (similar to Chipley), all of Pleistocene origin, and Fripp soils which are of Holocene origin. The Fripp soils are a newly described series that includes unstabilized dunes or duneland. The major part of the upland soils of the Lakeland, Chipley and Olustee series were under cultivation during the latter part of the 19th century and the first quarter of this century. Since the early 1920's most of these cultivated lands have been abandoned and subsequently have overgrown with forested vegetation.

> Lakeland Sands. These are deep, excessively drained, strongly acid sandy soils. Typically, the surface layer is very dark grayish-brown or dark gray sand. Beneath this layer is a yellowish brown sand that extends to depths of 80 or more inches. Silt plus clay content in the 10- to 40-inch layer is 5 to 10 percent. Slopes range from about 0 to 8 percent. (See Table 2 for chemical analysis of typical profile of this series.)

Vegetational cover of Lakeland sand varies from pine-oak to oak-pine dominated forests. The most abundant species are live oak, laurel oak, loblolly pine, longleaf pine, slash pine, red bay, and American holly. These forests most often have an open understory with scattered shrubs of bayberry, sparkleberry, and saw palmetto. Numerous vines also occur in these forests. Ground cover is sparse in most areas, but several species of grasses and forbs are common throughout.

These soils occur on smooth to strongly dissected landscapes from Greyfield north to the Cumberland Wharf. Because of rapid permeability, these soils have severe limitations for use as pond reservoirs, pond embankments, excavated ponds, and sewage lagoons. Because of the coarse sandy texture, they have severe limitations for use as camp areas, picnic areas, playgrounds, paths, and trails.

Chipley Sand. This series consists of moderately well drained, rapidly permeable, strongly acid, sandy soils that occur in nearly level to sloping landscapes. These soils have a very dark gray A horizon about 6 inches thick. Beneath the A horizon is a light yellowish brown or brownish yellow C horizon. At depths of 32 inches the soil is mottled in shades of gray, yellow or brown and changes to light gray colors with increasing depths. Slopes are dominatly 0 to 5 percent. This soil had 5 to 10 percent silt plus clay between the depths of 10-40 inches.

Vegetational cover of Chipley sand varies from oak-pine dominated forests to mixed oak-hardwood forests. The most abundant species are live oak, laurel oak, American holly, magnolia, staggerbush, red bay, longleaf pine, and loblolly pine. This forest generally has an open understory similar to that found on Lakeland sand.

Chipley sands occur in small scattered units from Dungeness to High Point. Some areas in the interior have never been cultivated. These soils have severe limitations for pond reservoirs and sewage lagoons, and moderate limitations for pond embankments, excavated ponds, septic tank filter fields, camp areas, picnic areas, playgrounds, paths and trails, and low-cost roads.

Olustee Sand. This series occurs in small acreages on Cumberland Island and is similar to Chipley sand. The land use interpretations for the Chipley Series can be used for the Olustee Series. Olustee soils generally occur on slopes of 0 to 2 percent.

Fripp Series. This series consists of fine sands in dunes along the coast. Typically, these soils are thick beds of light gray to white sands with slopes commonly ranging from 2 to 15 percent and

> occasionally, up to 30 percent. This soil occurs in a complex with Leon soils.

This series includes all unstabilized dune areas on the eastern side of Cumberland Island. From the Willow Ponds area north to Lake Whitney, the Fripp Series forms a complex of parallel dunes with the poorly drained Leon soils.

Dune sands contain a high percentage of very fine sands (Graetz 1973). These very fine sands contain relatively high salt concentrations and after drying inhibit the vertical percolation of rainfall through the dune. After drying, the upper sands appear to form a "cap" over the dune. Consequently, the interior portion of the dunes remains dry even after moderately heavy rains (ibid.). The exact mechanism for this phenomenon is not understood but apparently the salt concentrations and the very fine sand particles retard water percolation in the dune. The capping effect results in a lateral drainage of rainfall along the sides of the dune with increasing vertical penetration occurring near the base of the dune.

Dune sands are composed almost exclusively of quartz particles. The dunes are very low in nutrients, containing very little organic matter and small amounts of calcium. The presence of calcium and the inhibition of leaching by rainfall induces a basic pH to the dune sands. Below the base of the dunes and between the dunes a slight buildup of organic matter is susceptible to increased leaching and a slightly acid pH may develop.

Vegetational cover of the Fripp Series, where it occurs, is predominantly oak-buckthorn scrub. The most abundant species are live oak, buckthorn, slash pine, loblolly pine (interior low dunes), staggerbush, red bay, and saw palmetto. In areas where the rear dunes are mobile, the upper stems of live oak and red bay persist as the forest becomes inundated by sand. Other plants commonly found on unstable dunes are bayberry, Spanish bayonet, and sea-oats.

The Fripp soils have severe limitations for sewage lagoons, sanitary landfills, shallow excavations, dwellings, pond reservoirs, embankments, and excavated ponds. Because of severe blowing of loose sand, the soil has moderate limitations for camp areas, picnic areas, playgrounds, paths and trails. A soil binder would be necessary for road use.

Poorly Drained Upland Soils

The second group of soils to be discussed is composed of sandy to loamy soils that are poorly to very poorly drained. These soils occur in broad flats, depressions and drainageways of the island interior. Only small areas of these soils have ever been cultivated. All of the forested areas on these soils have been logged extensively since European man came to the island. The series included in this group include Leon fine sand and Johnston loam. Leon soils are much more abundant than the Johnston (Pleistocene origin) and are probably the most abundant soil type on Cumberland and Little Cumberland islands.

> Leon Fine Sand. This series is composed of poorly drained, sandy soils with a weakly cemented, organic stained layer within 30 inches of the surface. The series has a thin sand surface layer and a light gray sandy subsurface layer. The weakly cemented, organic stained layer is black, dark reddish brown, or dark brown sand. Below the cemented layer to 80 inches in depth is loose sand. This soil formed in acid sandy marine sediments. This is the only soil on the island to have a zone of accumulation (see Table 2 for chemical analysis with depth).

The Leon soil is nearly level to gently sloping and occurs in broad flats and slight depressions. Leon soil is the principal type on the north end of Cumberland, covering an extensive area south of High Point and west of Lake Whitney, to a point that it grades into Lakeland sand. On the south end of Cumberland, Leon fine sand is the dominant soil between Greyfield and Dungeness. In other areas of the island this soil commonly occurs between drainageways and depressions and upland sands.

Vegetational cover of Leon fine sand varies from pine-oak scrub, oak scrub to oak-palmetto. In extensive wet areas the dominant plant species are scrubby live oak, pond pine, slash pine, staggerbush, and red bay, with a dense understory of saw palmetto, staggerbush and an assortment of other shrubs. Sites with better drainage on the north end are covered with predominantly an oak-scrub forest composed of live oak, slash pine, myrtle oak, American olive, and Chapman's oak. Saw palmetto, bayberry, and staggerbush form a dense thicket in the understory. In more mature forest stands, live oak, red bay and staggerbush form a dense low canopy from 25 to 35 feet in height. Saw palmetto and staggerbush form a dense ground cover under these forests. Herbs and grasses are found predominantly in disturbed sites, such as roadsides and ditches, in old burn sites, or open marshes scattered in the forest. Leon soils throughout the island are probably best characterized by a dense growth of saw palmetto.

This soil has severe limitations for use in the construction of pond reservoirs, pond embankments, septic tank filter fields, sewage lagoons, dwellings, local roads and streets and for use as camp areas, picnic areas, playgrounds, paths and trails due primarily to the high water table.

> Johnston Loam. This soil consists of nearly level, very poorly drained soils that are subject to flooding. Typically, the surface horizons are composed of thick, black loam and subsurface horizons contain gray, stratifield sands. Slopes are less than 2 percent.

The Johnston series is similar to the Rutledge series found in drainageways and depressions (bays) on the mainland. The greater part of the interior wetlands is composed of this soil type. Examples are Swamp Field and the Willow Ponds areas.

Vegetational cover of the Johnston soil varies from grass-sedge marshes around the border of freshwater ponds to shrub marshes and lowland mixed hardwood forests. Only the forested areas will be described here. Live oak and loblolly pine grow in areas with infrequent flooding. Other species commonly found on this soil include swamp red bay, bayberry, loblolly bay, sweet bay, water oak, red maple, blackgum, and sweet-gum. In the transition from shrub marsh to forest, willow is a dominant species. Pond cypress occurs in several localities on the island, but only one specimen was observed outside of ponds located near residences.

This soil has severe limitations for use as pond reservoirs, pond embankments, dwelling sites, septic tank filter fields, sewage lagoons, sanitary landfills, roadbeds, camp and picnic areas, playgrounds, paths and trails.

Near Neutral Poorly Drained Soils

The third group of soils to be discussed are near neutral to alkaline soils that range from poorly drained to very wet conditions. The series included are the Duckston, Capers, and Coastal Beach soils (all Holocene soils). The Duckston series is the only soil of this group that supports a forest cover, and only then in areas that are protected from flooding by storm or high spring tides.

Duckston Sand. The Duckston series is a tentative soil type proposed to include poorly drained, neutral through moderately alkaline and very rapidly permeable sands. The soils occur along the coast parallel to dune ridges, and generally at elevations of 5 feet or less above the mean sea level. The surface layer is grayish brown to dark grayish brown sand overlying gray sand to a depth of 60 inches. These soils have been reworked by wave and wind action. Slopes are 2 percent or less. Alternating bands of heavy and light minerals form plane to concave streaks. This series was originally mapped as Plummer Sand. (See Table 2 for chemical analysis of soil profile for this series.)

The Duckston Sand series occurs in interdune areas where it may become moderately alkaline. These sites form meadows that vary considerably in plant cover. Other more protected sites behind rear dunes or between high dune ridges may support a shrub thicket or pine-mixed hardwood forest. This soil has severe limitations for use as septic tank absorption fields, sewage lagoons, sanitary landfills, pond reservoirs, dwelling sites, road-beds, camp and picnic areas, and playgrounds. The Duckston series has moderate limitations for paths and trails.

Capers Soils. The Capers series consist of very poorly drained soils of the high salt marshes that are frequently flooded by saline water. These soils have a very dark gray clay loam surface layer. The subsoil is dark gray or greenish gray clay. Slopes are 0 to 2 percent. The soil mineral characteristics, combined with periodic flooding by saline water and high evaporation, all contribute to the formation of the "salt pan" typical of this series.

Capers soils occur on the mainland sides of Cumberland and Little Cumberland islands and between these islands adjacent to their respective borders. The soils are delimited by the short-grass marsh and the shrub zone adjacent to high land.

The Capers soils may be sparsely to densely covered with grasses and forbs, or completely unvegetated. The most common species are glasswort, saltwort, and saltgrass.

These soils have severe to very severe limitations for use as pond embankments, excavated ponds, septic tank filter fields, sewage lagoons, roadbeds, dwelling sites, camp and picnic areas, playgrounds, paths and trails.

<u>Coastal Beach</u>. Coastal beach soils consist of very wet, coarse beach sands with a high salt content. They occur in bands between the ocean and coastal dunes. These sands have a gradual slope toward the ocean with the portion adjacent to the ocean being flooded twice daily by tidal action.

The coastal beach represents the ecotone occurring between the land and the sea and is unvegetated.

V. WATER RESOURCES

Groundwater

The Coastal Plain of the southeastern United States consists of an accumulation of sediments deposited by ancient seas. These sedimentary strata slope gently toward the Atlantic Ocean. Strata exposed at the surface are younger toward the present coastline, and the oldest strata are exposed near the fall line. These sedimentary strata extend under the present coastal islands and the continental shelf beyond.

Most of the groundwater supply for Cumberland Island and vicinity is obtained from two series of water-bearing strata or aquifers. The most important of these is a deep-lying limestone aquifer, known as the principal artesian aquifer or Coastal Plain aquifer. This artesian aquifer is an important source of water throughout much of the Coastal Plain. Younger, overlying sediments consisting primarily of clay, sand and gravel comprise a shallow, water table aquifer with a local recharge area. This aquifer produces no artesian flow but is a source of free groundwater (i.e. pumping is required). Figure 3 is a diagrammatic cross section of these aquifers.

For most of the Coastal Plain region of Georgia the principal source of groundwater is the Coastal Plain aquifer (Warren 1944, Carver 1968). The aquifer is a system of Eocene and Miocene limestone sediments covered by an impervious layer of Miocene clays (ibid.). The primary recharge areas for the aquifer lie immediately below the Valdosta area, and just west of the Okefenokee Swamp (Callahan 1964). The primary source of recharge water is rainfall.

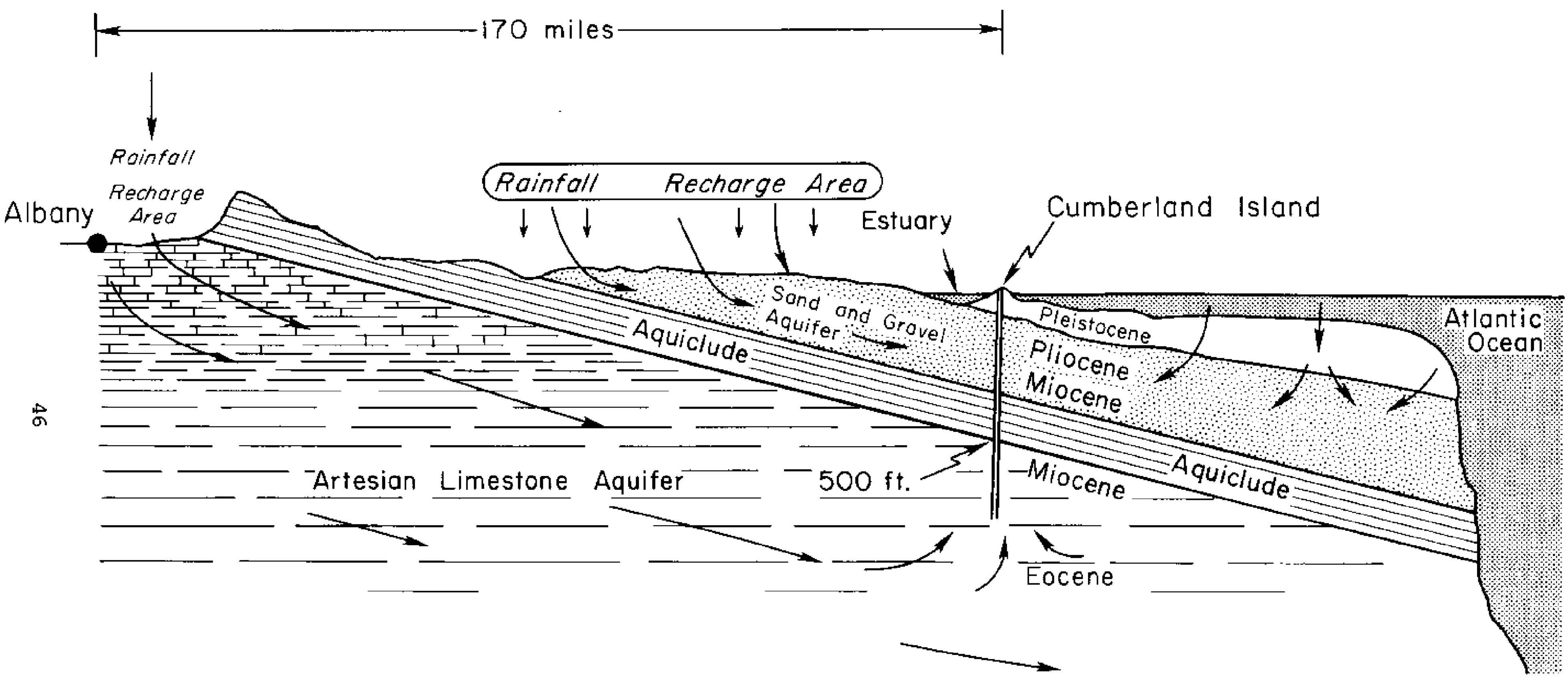

Figure 3. Diagrammatic cross-section of the Coastal Plain showing major aquifers.

The aquifer passes deep (approximately 500 feet) underneath Cumberland Island (Krause and Gregg 1972) and surfaces as submarine springs on the continental shelf offshore (McCallie 1898, Warren 1944). The cities of St. Marys and Brunswick, Georgia, and Fernandina, Florida, obtain their municipal water supplies from this aquifer. Industries (especially paper mills) located in these cities also place heavy demands upon the aquifer, and cones of depression in artesian pressure have developed about these cities since the 1930's. Artesian flow from small private wells in the area has generally ceased. Salt water encroachment into the aquifer has occurred in the Brunswick area as a result of intensive pumping. Apparently this is caused by the upward movement of connate salt water from underlying limestone in response to the relief in artesian pressure caused by pumping from the strata above (Stewart and Croft 1960). This is in contrast to the situation at Savannah where lateral encroachment of sea water has occurred as a result of excessive withdrawal of fresh water.

Prior to about 1880, the artesian pressure caused water to rise to an elevation of about 65 feet above sea level in wells tapping the aquifer in the Cumberland Island area (Warren 1944). Cumberland is presently within the cone of depression associated with Fernandina, Florida. The elevation of the piezometric surface ranges from 20 feet on the southern portion of the island to 40 feet on the northern portion. That is, artesian pressure reaches 20 feet above sea level on the southern end of the island and 40 feet on the northern end.

Apparently, the first deep artesian well on Cumberland which penetrated the Coastal Plain aquifer was bored in 1887. The well was located near the beach at Dungeness and was known as "Mrs. Lucy Carnegie's well"

(McCallie 1898). The 6-inch-diameter well was bored to a depth of 680 feet from an elevation of 16 feet and had an artesian flow 51 feet above the surface. Daily flow of the well was about 800,000 gallons. Two other wells were bored on the north end of Cumberland to depths of 600 and 485 feet in 1889 and 1890. These wells had an artesian flow 12 feet above the surface (McCallie 1898).

Presently, there are approximately 15 artesian wells on Cumberland Island, the deepest being about 850 feet. Many of these wells are being used by island residents for personal use or livestock watering purposes. The artesian head of these wells reaches the surface on the southern end of the island and approximately 5 feet above the surface in the Plum Orchard area.

There is every reason to believe that the decline in artesian pressure of the Coastal Plain aquifer will continue for at least the near future. This will necessitate pumping of groundwater on the island. Because of the great depth of the aquifer in the Cumberland area and the cap of impervious material overlying it, contamination of the aquifer from local surface sources is unlikely.

Water withdrawn from the aquifer contains in solution numerous chemicals and minerals. Perhaps the most obvious of these is hydrogen sulfide, which imparts a detectable taste to the water immediately after withdrawal from the ground. The water usually contains small amounts of ammonia, carbon dioxide, silica, alumina, and iron (McCallie 1898, Thomson et al. 1956). The amount of carbonates commonly is high in aquifer water and is related to the distance the water has moved from the recharge area. Tapping the aquifer in the coastal area maximizes this distance (Figure 3), permitting increasing amounts of carbonates to enter solution from the limestone aquifer. Along the coast carbonate concentrations ("hardness") approach 300 ppm (Thomson et al. 1956). Sodium, calcium, sulfate, and chloride are also usually present but in concentrations within tolerance limits for human consumption. The hydrogen sulfide in the water is offensive to many people. Most personal wells in the coastal area are connected to an oxidation vat which permits the dissipation of this compound.

The shallow, water table aquifer, which lies above the Coastal Plain aquifer in the late Miocene and Pliocene clays, provides much of the water for the numerous shallow wells in the coastal area. On Cumberland these wells range in depth from 65 to 265 feet and are locally known as "rock wells." Yields average about 2,000 gallons per hour for a 2-inch well (R. L. Davis, pers. comm.). There is no artesian pressure associated with these wells, and water must be pumped to the surface.

Many island residents who do not require large volumes of water prefer these wells to those of the Coastal Plain aquifer. Water from them usually contains small amounts of carbonates because of its short residence time within the limestone-clay matrix (Thomson et al. 1956). Thus, this water is usually "soft". It also contains very low levels of hydrogen sulfide and has reduced tendencies to corrode metal pipes and fixtures.

Warren (1944) and Callahan (1964) present an idealized cross-section of an island's groundwater system. The percolation of rainfall into the porous, sandy strata and the resistence of the sand to lateral flow causes a water table (head) to build up above sea level on the island. The fresh water recharging the aquifer from rainfall on the island is lighter than the salt water recharging it from the sea. Therefore, this cone- or lens-shaped body of fresh water floats on the sea water, displacing it approximately

40 feet below sea level for every one foot of fresh water above sea level. For every foot the water table is lowered by pumping, salt water will rise 40 feet below the cone (Callahan 1959), inducing a cone of depression centering near the well.

Surface Water

In contrast to the ground water systems, surface water systems on the barrier islands are very sensitive to human-induced alterations of the surrounding environment. Because of the shallow water table and the sandy soils, surface waters are very vulnerable to lateral movement of pollutants from septic tank fields or other sources. Alteration of surface drainage patterns with resultant changes in salinity, depth and fluctuation regimes can drastically affect plants and animals associated with the aquatic systems.

The aquatic systems of Cumberland Island exhibit pulse stability (Odum 1971). More or less regular but acute perturbations imposed from without maintain and perpetuate such systems. Without perturbations, shallow open-water systems rapidly fill with organic matter, and succession proceeds toward a shrub or swamp forest. Cumberland has perhaps a thousand acres containing shallow standing water for at least six months of the year. Another thousand acres might be expected to flood after heavy rains sufficiently to provide temporary breeding habitat for amphibians, insects and the ubiquitous mosquitofish.

On Cumberland Island, the principal perturbing factor is water level fluctuation. Since all aquatic systems on Cumberland have relatively level bottoms and shallow depths, a change in water level of only a foot or two is a significant perturbation to the system. Rainfall is the only source of water for most of the ponds and sloughs. When rainfall is adequate, water levels are high, and emergent vegetation tends to be killed by inundation. During dry periods, floating vegetation is stranded and killed by exposure. As shallow bottoms are exposed, there is an acceleration in the aerobic decomposition of organic matter, releasing nutrients which will later support wet season productivity. The spatial and temporal distribution of rainfall on the islands is not uniform and local rainfall conditions can greatly influence biological conditions and events (such as breeding of amphibians) in the aquatic systems.

Fire is a second and more violent perturbation which has occurred on Cumberland Island. Prolonged drought exposes and dessicates peat and root mats of pond bottoms, making them susceptible to burning. Fire at such times may kill much of the pond vegetation and drastically increase pond depths by burning the peat. A fire that occurred in the vicinity of Johnson's Pond some 10 years ago may account for the extensive open water and the presence of charred, submerged logs in that pond.

Change in salinity is another perturbing factor. Unusually high tides periodically inundate some areas. A sudden increase in salinity kills certain forms of invading vegetation such as the common cattail. Lake Retta and the South End ponds are closely associated with the ocean, contain euryhaline fish species, and probably owe their extensive areas of open water to occasional tidal flooding.

The complicated perturbations that regulate the aquatic systems are essential to the community network of predator-prey relationships. For example, high water levels favor prey species (frogs, insects, moquitofish);

food and breeding areas for such species are in abundance, and predation presures are low. Low water levels favor the predators (herons, alligators, snakes, etc.). When water levels are down, prey are concentrated and relatively easy to catch. It has been shown (Kahl 1964) that the wood stork will only breed when falling water levels concentrate prey. Prey species are again favored when water levels fall below the bottom of the ponds. Predators are reduced or, in the case of predaceous fish, frequently eliminated while the prey species survive in refugia such as alligator holes, crayfish (Cambarus spp.) burrows and damp vegetation. When water levels return to normal, conditions are again optimum for prey to breed.

No two ponds or sloughs on Cumberland Island are exactly alike and some systems are quite different from others. Most of these differences are related to the successional stage of a particular pond at a given time. Perturbations maintain each system at some point in the successional continuum. For the following discussion, a series of descriptive categories has been used to group similar systems. Acreages of aquatic systems are given in Table 3. Water depths mentioned in the descriptions were observed during September 1973 and probably represent average conditions. Depths might be expected to vary during the year within 3 feet of the average. Additional discussion of plants and animals associated with the aquatic systems is presented in Chapters VI and VII. Generalized management suggestions are presented for some systems, but the reader is referred to Chapter VIII for additional discussions of management systems deemed compatible with maintaining the natural integrity of the aquatic systems occurring on Cumberland.

Table 3. Surface water systems occurring on Cumberland Island, Georgia.[a]

Name of System	Total acreage	Open water acreage	Type of System
Lake Whitney	83	40	Permanent lake (fresh)
Roller Coaster Ponds	14	4	Permanent ponds (fresh)
Ashley Pond	15	-	Permanent pond (fresh)
Willow Pond	70	13	Permanent pond (fresh)
Lake Retta	34	15	Permanent (saline)
South End Ponds	24	4.5	Permanent (saline)
Heron Pond	5.5	1	Permanent pond (fresh)
Sweetwater Lake	300	-	Temporary lake (fresh)
South Whitney Pond	16	-	Temporary pond (fresh)
Killman Field Pond	4	-	Temporary pond (fresh)
Oyster Pond	21	-	Temporary pond (fresh)
Lost Road Ponds	-	-	Temporary ponds (fresh)
Johnson's Pond	11	-	Temporary pond (fresh)
Pine Pond	16	-	Temporary pond (fresh)
Stafford Ponds	3	-	Temporary ponds (fresh)
Hickory Hill Pond	5	-	Temporary pond (fresh)
South End Flats	100	-	Temporary ponds (brackish and saline)
Serendipity Farm Pond	1	1	Artificial pond (fresh)
Plum Orchard Pond	1	1	Artificial pond (fresh)
High Point Farm Pond	.5	.5	Artificial pond (fresh)
Whitney Outflow	-	-	Natural drainage
McIntosh Bridge Outflow	-	-	Natural drainage
Red Bridge Outflow	-	-	Natural drainage
Lake Retta Outflow	-	-	Natural drainage
Swamp Field Drainage	-	-	Artificial drainage
Totals	724.0	80.0	

[a]Aquatic system names adapted from Cumberland Island Plat prepared in 1946 for the Lucy C. Carnegie Estate (revised 1965) or local usage. Location of surface water systems are shown on the place names map of Cumberland Island, Georgia.

Permanent Ponds

Natural.--Lake Whitney is the dominant freshwater natural lake on Cumberland Island. There are less than a half dozen ponds which approach Lake Whitney in persistence of standing water throughout most of the year, although almost any aquatic system on Cumberland may dry up during extreme droughts.

In addition to Lake Whitney, the permanent ponds on Cumberland include Roller Coaster Ponds, Ashley Pond, Willow Pond, and Heron Pond which has had a common egret rookery in the past. Except for Lake Whitney, all of the ponds are characterized by fresh water, an average depth of 3 feet, moderate numbers of mosquitofish, 25 percent or less open water, and a vigorous growth of floating and emergent vegetation. Permanent ponds are classic examples of systems that are maintained in their open state by fluctuating water levels.

The Lake Whitney system encompasses approximately 83 acres with 40 acres of open water. Lake Whitney is the largest permanent natural freshwater lake on the barrier islands. The system is discussed separately as it is the only one on the island with an average depth greater than 3 feet, although its depth does not exceed 6 feet. Drifting sand is filling the lake on its northeast shore at a point which also represents the maximum depth of the lake. Vegetation is intruding from the south and west shores. Colonization of Lake Whitney by plants is proceeding in a series of stages characteristic of most Cumberland ponds not affected by salt water. Rooted floating plants (water-lily, floating hearts) give way to floating mats (bladderwort, frog's-bit), then to deep water emergents (duck-potato, pickerelweed), and finally to stabilizing emergents (saw-grass, sand cordgrass, water willow, marsh mallow and other woody shrubs) and scattered trees (red maple, willow, blackgum, dahoon).

Bluegill, warmouth, and largemouth bass occur in Lake Whitney and provide sport fishing during the warmer months. These species may have been introduced for sport fishing many years ago. Long-time residents of the island state that Lake Whitney has been a popular fishing lake for perhaps 100 years. Mosquitofish are maintained at low densities by predaceous fish in open water areas. Because of the suppressive effect of these predators on mosquitofish, concentrations of the prey species during periods of low water would not be expected to occur, and large numbers of heron, egrets and ibis are not attracted to this area as they are to other areas of Cumberland Island. Scaup, ringneck, mallards, and other ducks use the open water and marsh areas. Other species of sport fish and such scenic attractions as American lotus make Lake Whitney a recreationally attractive lake, but it is of less importance as a source of food and breeding habitat for island wildlife. Thus, Lake Whitney could support considerable non-polluting boat traffic and other recreational uses without endangering sensitive island wildlife. Since Lake Whitney is unique on Cumberland because of its depth of standing water, drifting sand filling the deepest part of the lake should be stopped as soon as possible.

Willow Pond is the second largest of the freshwater permanent ponds occurring on Cumberland. Warmouth are present and almost certainly were introduced. Most of the 57 acres of vegetated area is colonized by sand cordgrass and scattered red maple. Sand cordgrass is rather resistant to fluctuating water levels but vulnerable to fire. A necessary perturbation to increase open water in Willow Pond might be the occasional application of fire during periods of low water.

At the southern end of Willow Pond is a true floating bog, about 1/4 acre in extent and the only example of its kind on the island.

The 13 acres of open water in Willow Pond probably could be connected by a series of short channels to provide an attractive area for canoeing.

East of the dunes separating Sweetwater from the ocean is a more recently formed system known as Lake Retta. This system is about 34 acres in extent, with approximately half of the area in open water. Like the Sweetwater system, Lake Retta exists because of the accumulation of dunes to the seaward side of the area. Unlike Sweetwater, Lake Retta is closely coupled to the marine environment by an outflow that allows regular access to the area by such euryhaline species as the sheepshead minnow, sailfin molly, striped mullet, mosquitofish, and the predaceous American eel. The three former species frequently breed in enormous numbers under such conditions, feeding on an abundance of rich organic detritus on the pond bottom.

Lake Retta has extensive areas of open water even though it averages only about 2 feet in depth. Open water is probably maintained by the occasional inundation of salt water which would kill emergent and floating vegetation. Salinity was too low to measure ($<1\,^0/_{00}$) in September 1973, and patches of cattail occurred along the edges of the pond.

Lake Retta is a nutrient-rich, eutrophic system supporting a large standing crop of food fish for island predators. As might be suspected, this lake attracts the greatest densities of herons, ibis, egrets, wood storks, alligators, turtles, ducks, and anhingas. As long as access to the ocean is maintained in its present state, Lake Retta should continue to produce the food that supports so much wildlife. Closing the outlet to the ocean or stabilizing the water level would destroy the productivity of this system. Boats or canoes would be disruptive to Lake Retta, unlike Lake Whitney. The lake would provide an excellent location for an interpretive boardwalk.

Artificial ponds.--There are several examples of artificial freshwater ponds on Cumberland Island, but all of them are small (< 1 acre). Ponds at Serendipity and High Point support domestic waterfowl. The Plum Orchard pond was constructed for ornamental reasons and now serves as a roosting area for several hundred white ibis, night herons, common and snowy egrets, and Louisiana and little blue heron. The pond supports catchable-size largemouth bass and bluegills. Alligators also frequent the pond. The Serendipity and Plum Orchard ponds are eutrophic as a result of the deposition of bird guano.

Temporary Ponds

Temporary ponds are regularly without standing water for part of each year and range from fresh to saline. Included in this category are Sweetwater Lake, South Whitney Pond, Killman Field Pond, Oyster Pond, Lost Road Ponds, Johnson's Pond, Pine Pond, Stafford Ponds, South End Ponds, South End Flats, and Hickory Hill Pond. There are, in addition, numerous other small ponds belonging to this category, unnamed and scattered throughout the island.

Temporary freshwater ponds differ from permanent freshwater ponds by supporting primarily grass (sand cordgrass and saw-grass) and scattered trees (blackgum, red maple, dahoon). Brackish or saline ponds are dominated by salt meadow cordgrass. When water levels are high, temporary ponds provide breeding habitat for insects, crayfish and frogs. These habitats are protected from fish predation because they frequently dry up. Except for mosquitofish in the two systems near Lake Whitney and in Sweetwater Lake, no fish were observed in any of the freshwater ponds. When water levels are low, temporary freshwater ponds function as bogs, exhibiting a water-saturated floor of sphagnum moss, yellow-eyed grass and associated species. Frogs, particularly southern leopard and southern cricket frogs, are abundant in the bog areas.

The grassy nature of freshwater ponds is indicative of a system occasionally stabilized by fire. The possible role of fire in determining the characteristics of Johnson's Pond has already been discussed.

Temporary ponds would seem to provide little of interest for the Cumberland visitor except in the case of Sweetwater Lake and the saline South End Ponds and South End Flats. When standing water is present in the fall, ducks use the freshwater ponds for nesting and feeding and would be available for hunting and bird watching. At least one of these ponds could be made available as an interpretive area. Johnson's Pond lies within a mile of Plum Orchard headquarters and would be convenient for comparison to Ashley Pond, a permanent pond.

Sweetwater Lake is a comprehensive name for an area of some 300 acres included in a narrow, 4-mile strip running south along the eastern side of the island from the vicinity of Lake Whitney to Old Duck House Road. As the island built eastward, a series of parallel dune ridges were formed, trapping rain water in the narrow areas between the ridges. These narrow impoundments constitute Sweetwater Lake. Drainage is to the north, by an outlet known as Whitney Outflow. In actuality, most of the water flowing from this outlet to the ocean comes from the Sweetwater complex and not from Lake Whitney. Perhaps half of the 300-acre area consists of forested ridges. The remainder consists of narrow, vegetation-filled sloughs and channels averaging slightly less than 3 feet in depth. Open water is scarce. Most of the sloughs are filled with floating mats or emergent vegetation. Sweetwater Lake is an area of hidden waterways buried in vegetation and of old dune ridges covered with impenetrable saw palmetto and giant oaks with limbs supporting ferns and orchids.

Wildlife is present in the Sweetwater area but is hard to observe. Most of the herons and egrets are absent because of a lack of shallow pools and open water. Mink, otter and alligators are present in observable numbers. Mosquitofish occur throughout the area. Sailfin mollies, warmouth, bluegills, and largemouth bass were collected from the drainage system of this area. These fish undoubtedly have access to the entire area and may occur in small numbers where there is sufficient water to temporarily support them. The predaceous game fish probably gain periodic access to Sweetwater when Lake Whitney overflows during periods of intensive rainfall.

Boat travel and fishing would be all but impossible due to the lack of open water and inaccessibility of the area. Sweetwater is, however, a beautiful, jungle-like area offering opportunity for developing hiking trails along the ridges. The intricacies of the vegetation-choked waterways and dense forest trees produce a subtropical atmosphere unlike any other area on the island.

South End Ponds comprise a 24-acre system of ponds and ridges at the southern end of Cumberland similar in many respects to the Lake Retta system. At least 4 acres of open water are closely linked with Beach Creek and the adjoining marine environment, providing access for sailfin mollies, sheepshead minnows and mosquitofish and allowing occasional inundation by salt water. The density of fish in the South End Ponds is very high. While turtles and alligators were not observed in these shallow ponds (<2 feet), wood storks, ibis, egrets, and herons occurred in abundance.

South End Flats occur at the southern end of Cumberland Island and are growing rapidly as a result of sedimentation induced by a long offshore jetty. Since the resulting topography is flat and near sea level, 4 to 8 inches of water regularly collect on an area of about 100 acres. Salt meadow cordgrass, the principal ground cover, is a favorite forage for the horses and cattle in the area, and grazing maintains the area as a marshy, short grass (3-8 inches) habitat. The area provides perhaps the finest habitat of this type on the Georgia coast and attracts rare and unusual species of shore birds and open country passerines. Buff-breasted sandpiper, stilt sandpiper, upland plover, and golden plover are examples of unusual species which were observed in the habitat during the fall of 1973. Peregrine falcons frequent this area during their September-October migrations.

Drainage Systems

Natural.--There are four principal natural drainage systems on Cumberland.

Whitney Outflow drains the entire 300-acre Sweetwater Lake System and occasional overflow from Lake Whitney. Because of the natural ability of Sweetwater to hold water and regulate flow, discharge through Whitney Outflow is probably moderate (10-100 gal/min) and continuous throughout most of the year. There are sufficient holes and pools along the channel to support a breeding stock of sailfin molly, mosquitofish, warmouth, bluegill, and largemouth bass. Cottonmouths and banded water snakes are common.

A difference of perhaps 6 feet of elevation exists between the Sweetwater system and the mouth of the outflow, with several small waterfalls serving as effective barriers against salt water intrusion. Thus, mullet, mojarra and mosquitofish were found in the lower, marine-influenced portion of the outflow while warmouth, bluegill and largemouth bass were collected from the upper portion influenced by rainwater discharge. The sailfin molly, a euryhaline species gaining access from the ocean, was found breeding in considerable numbers in eutrophic pools of open water beneath oak trees but not in the vegetated pools of Sweetwater above the outflow area.

Lake Retta Outflow is a channel discharging to the ocean at the eastern end of Old Duck House Road. Compared to Whitney Outflow, the drop in elevation and length of channel in the Retta Outflow is relatively small. Furthermore, the flow is not unidirectional but probably oscillatory, flowing in on flood tides and out on ebb tides and after excessive rainfall. The entire length of the outflow is influenced by the marine environment. The nature of the linkage between Lake Retta and the ocean is critical to the maintenance of Lake Retta as one of the most productive wildlife areas on the island. The characteristics of the outflow must be carefully preserved to insure the continued productivity of Lake Retta.

Similar to Retta Outflow are a series of smaller outflows linking South End Ponds to Beach Creek. The ecology and management of these outflows would be similar to the Retta Outflow.

Red Bridge Outflow drains an area of undertermined acreage through a channel on the west side of the island. This drainage serves temporary ponds and an extensive area of impenetrable fetter-bush bottomland. The outflow is tidal to a point about 100 yards above Red Bridge, at which point a water fall 3 feet in height separates the marine portion from the freshwater portion above. Mosquitofish occur throughout the drainage while mummichogs, marsh killifish and grass shrimp (*Palamonetes pugio*) were collected from pools below the falls.

McIntosh Bridge Outflow on the west side of the island is tidal for several hundred yards above the bridge. Above this point, the outflow drains an undetermined acreage of forested lowlands on the northern end of the island. Tidal areas of the outflow are similar to Red Bridge Outflow and support similar fish. Above tidal influence, the main channel of this drainage passes for approximately 1 mile through perhaps the finest example of mature lowland mixed hardwood forest on the island. A sweetbay found in the area measured 42 inches in diameter at a height 8 feet above the ground.

Artificial.--About 2.5 miles of canals have been excavated to drain an agricultural area known as Old Swamp Field and New Swamp Field. The canal system is continuous, grading from marine at the northern point of entry into the salt marshes to fresh at the southern boundary of New Swamp Field. The canal is less than 3 feet in depth and 3 to 10 feet in width. Mosquitofish and sailfish mollies are abundant throughout. Breeding populations of warmouth and hellow bullhead at the upper end of the system have probably been introduced. Watersnakes are common along the canal. Crayfish and frogs breed in the fresh portions, and grass shrimp appear in more saline sections.

VI. VEGETATION

This section concerns the functional relationships of the natural vegetation of Cumberland Island. A literature survey conducted by Johnson et al. (1975) revealed little information on the forest vegetation of the coastal islands other than species lists. Bozeman (1971) made a comparative analysis of dune forests on selected barrier islands and inland sites having deep sandy soils, but Cumberland Island was not included.

Notable investigations of the inland vegetation of the Atlantic Coastal Plain are a study of the Okefenokee Swamp by Wright and Wright (1932) and a study of the southern mixed hardwood forest by Quarterman and Keever (1962). Although certain species common to the Okefenokee Swamp also occupy similar habitats on Cumberland Island, the two environments are for the most part quite dissimilar. Quarterman and Keever's study dealt with the moist phases of the southern mixed hardwood forest and excluded those found on sandy soils, such as the coastal island forests.

Despite the usefulness of these investigations and others of ecologically comparable areas along the South Atlantic Coastal Plain to interpretation of the vegetation on Cumberland Island, they have limited value for detailed land use planning for Cumberland Island. Therefore, a vegetation survey was conducted in 1973. The objectives were to

(1) qualitatively and quantitatively analyze and describe the major plant communities;

(2) construct a vegetation map showing the approximate areal coverage of each community type (including Little Cumberland Island);

(3) graphically illustrate the habitats and major communities, and their successional relationships; and

(4) compile a list of the native and naturalized vascular plant species on the island.

This investigation was limited in scope to observations, measurements and analyses of the plant communities during one growing season. An extension of the study over several growing seasons would have been most desirable. Direct measurements of environmental parameters did not fit into the time and budgetary framework of the study. Such measurements would have substantially increased the validity and acceptability of our interpretations. Additional time would have allowed the extension of the dune transects across the entire island and, consequently, a more rigorous analysis of the interior aquatic communities.

Methods of Vegetation Analysis

This survey was initiated in November 1972 and continued through the growing season of 1973 to September. Preliminary studies involved reconnaissance surveys, consultation with area soil scientists and examination of aerial photographs, topographic maps and old land use maps. These preliminary studies provided a good understanding of the plant-soil interrelationships, effects of land use practices on vegetation, and the physical features of the island. Quantitative measurements of vegetation and collection of voucher specimens for the compilation of the plant catalog were conducted primarily during the summer months of June, July and August, when the investigators were in residence on the island.

Quantitative measurements of the interior vegetation of the island were made using a variation of the quarter-point or point-quarter method established by Cottam and Curtis (1956). Sample points were located along all accessible roads at pre-determined 0.2-mile intervals. At each interval, a point was alternately selected for each side of the road at a distance of 100 feet as measured by pacing at right angles from the center of the road. By this procedure, 249 points were sampled for trees equal to or greater than 4 inches in diameter at breast height. At each point, the closest tree to the point in each of four quarters was chosen. The species, stem diameter and distance to the point were recorded for the sample tree in each quarter. The presence of woody understory species, including saplings and seedlings of tree species less than 4 inches in diameter, was recorded for 250 6.6- X 6.6-foot quadrats centered on each point. Similarly, the presence of herbaceous ground cover species was recorded for 248 3.3- X 3.3-foot quadrats located in the right front quadrat of each point. A continuous log of variations in topography, drainage features and plant community composition was maintained between each sample point. By these procedures, qualitative descriptions and quantitative measurements were obtained for approximately 50 linear miles of the vegetation on the island interior.

Qualitative measurements of the beach, dune and interdune vegetation were made along 10 transect lines that traversed these habitats perpendicular to the shoreline. The transect sites were selected by first dividing the 16-mile long shoreline into 2-mile intervals, second, by dividing each 2-mile interval into tenths and, third, by choosing a tenth-interval from zero to 20 from a random numbers table. In this manner, one transect was randomly selected from each 2-mile interval. Two additional transects were randomly selected by choosing a tenth-interval from one to 160 from a random numbers table. The jetty on the south end of the island was used as a reference point for the location of transects. Beginning with zero miles at the jetty (a permanent structure), all transect locations were measured by odometer and marked by metal stakes and tags for future reference. Each transect was started at a point corresponding to the high tide drift line.

The presence of herbaceous and woody species and of bare and disturbed areas was recorded for 3.3- X 3.3-foot quadrats located at 30-foot intervals along these transect lines. A total of 151 quadrats were analyzed in this manner. Notes on changes in elevation, slope, exposure, and moisture conditions were compiled for each transect for future reference.

Synthesis of the quadrat data of the dune and interdune habitats was begun by subdividing these areas into several categories based on exposure, slope and wetness. The data were tabulated accordingly, then consolidated into the following habitat-communities: foredunes, interdune high meadow, interdune low meadow (wet), interdune shrub thicket, rear dune, and unstable dune. By vertical movement and manipulation of species in the table according to frequency and distribution, it was possible to demonstrate the composition of communities occupying these habitats along a complex environmental gradient from foredune to rear dune (see Table 16, Appendix II).

A map depicting the distribution of the major plant community types on Cumberland and Little Cumberland islands was prepared by the following procedures:

(1) stereoscopic photointerpretation of black-and-white and color infrared aerial photographs;

(2) correlation of photointerpretations with topographic maps, soil maps, and ground verification, as determined by sample data and continuous log;

(3) assortment of sample point data into groups of points as determined by location, soil type and similarity in species composition;

(4) synthesis and mathematical calculation of importance values for the tree species by group, and calculation of frequency values for woody understory and herbaceous species as determined by their presence in quadrats by group;

(5) establishment of mapping units based upon dominant species, and realignment of boundaries of mapping units on black-and-white aerial photographs; and

(6) transposition of mapping units to a topographic baseline map of approximately the same scale--1:16,000.

By the above procedures, the major forest types were quantitatively defined and delimited. Those communities not analyzed by quantitative measurement were described and mapped from field observations, photointerpretations and published accounts of similar vegetation.

The black-and-white aerial photographs utilized in this study were made by contract for the USDA, Soil Conservation Service, in 1953. The infrared aerial photographs were made in 1971 and were obtained from the National Oceanic and Atmospheric Administration. From these aerial photographs, which covered an 18-year time span, it was possible to analyze changing land use patterns, ecological succession and other changes in the physical features of the island. The color infrared photographs were immensely valuable to the interpretation and mapping of aquatic communities--lakes, sloughs and marshes. In addition, two aerial flights were conducted for reconnaissance and photography during the summer of 1973.

Plant Communities

The physical and chemical environment of the biota of Cumberland Island has been determined by the inherent nature of the parental substrate and by the continuous interaction of geologic, climatic, edaphic, and biotic processes. The actions of these processes on plant and animal life account for the distribution of biotic communities along a complex of environmental gradients from purely aquatic to very dry terrestrial habitats, and from freshwater aquatic to saline aquatic habitats. Discussions of the most important features of each of these environmental factors and of the influence of each on the plant-animal communities are treated in separate sections of the report under their respective headings.

Habitat-Community Profiles

Cumberland Island has the greatest diversity of habitats and consequently, the greatest diversity of biotic communities of any of Georgia's coastal islands. This diversity is illustrated in Figures 4-6 by idealized habitat-plant community profiles, starting with the beach and dune system on the east and continuing across the island to the salt marsh habitat. Geologic age, size of area exposed above high tides, diversity of substrates, topographic gradients, and climatic conditions all have influenced either directly or indirectly the invasion of the island by plants and animals and their establishment and perpetuation.

Natural plant-animal communities tend toward stability because of the functioning of feedback systems. In island habitats vegetation or plant cover assists in the land building process. Physical disruptions, overgrazing or competition from newly introduced species often interfere with natural checks and balances and cause or bring about severe changes in a habitat.

Plant cover on the dune-interdune habitats consists of grass-forb communities on the foredunes, grass-forb-sedge or grass-sedge communities (meadows) on interdune areas, and grass-forb or shrub thicket communities on rear dunes (Figure 4). Considerable variation exists in the species composing these communities throughout the island dune-interdune system. Plant cover is an extremely important factor in the stabilization and maintenance of the substrate of these systems.

Rear dunes protected from salt spray, and back slopes of rear dunes in the shear-zone generally develop a scrub forest type of plant cover. Broad flats and interdune depressions towards the rear of the dune system may form lakes, ponds and sloughs where submerged, floating and emergent vegetation persists for long periods of time. Generally, these are fresh-water or only slightly brackish habitats and are bordered by shrub marsh or forest or both.

Broad flats and ridges on the island interior support a variety of forest types depending upon soil type and histories of land use and fire (Figure 5). High, narrow ridges to the interior differ in species composition from those in the frontal dune system.

Drainageways in the interior that are seldom, if ever, flooded by high storm tides are covered by broad-leaved evergreen bay type forests or a mixture of bay type and deciduous lowland hardwood species. Pines may occur as co-dominants in localized areas.

The high land bordering the salt marsh on the mainland side of the island is often covered by an oak-juniper-palm forest. Considerable

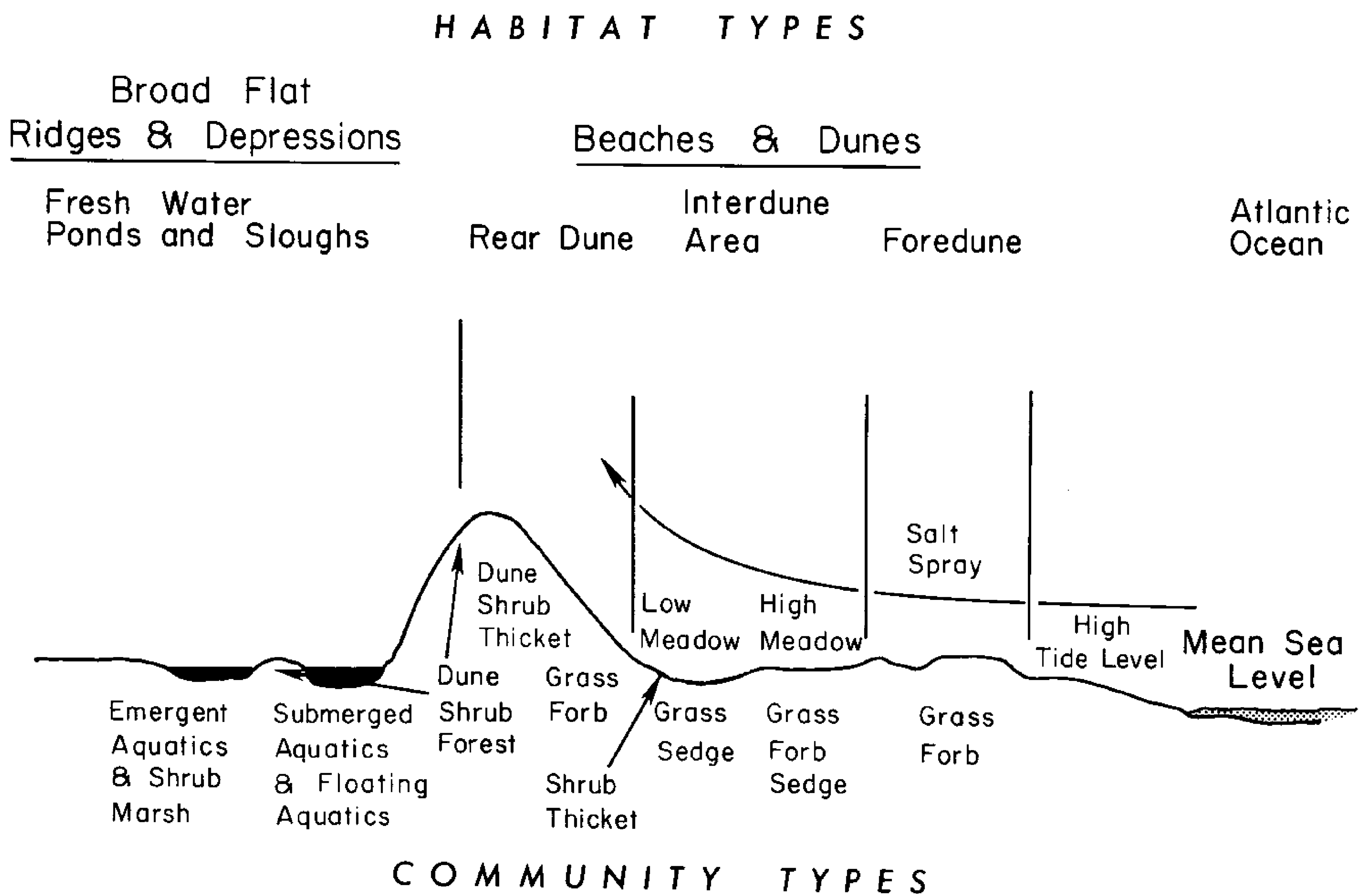

Figure 4. An idealized habitat-plant community profile of Cumberland Island: eastern side.

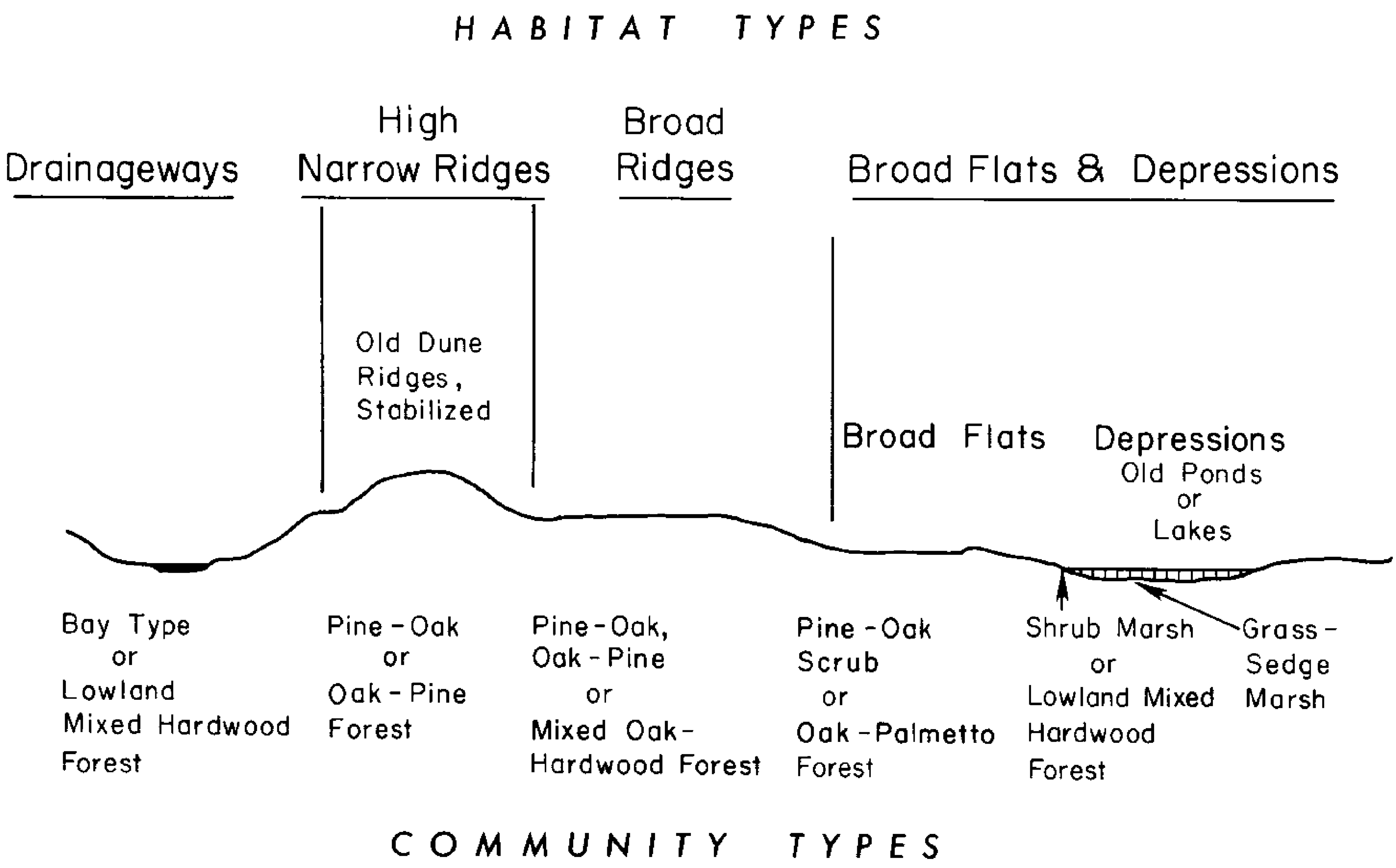

Figure 5. An idealized habitat-plant community profile of Cumberland Island: interior.

variation exists, however, especially where erosion has brought about the formation of bluffs. In these areas the upland forests form an abrupt transition to the high salt marsh vegetation.

The interpretations of the salt marsh communities on the mainland side of the island follow Teal (1958) and Johnson et al. (1975), with slight modification (Figure 6). Topographic and salinity gradients form distinct zones of vegetation through this tidal salt marsh habitat.

Description of Plant Communities

The vegetation, or plant cover, of an area is composed of both natural and man-influenced communities. From the discussion of soils and hydrology, it should be apparent that a great variety of plant species are distributed along gradients as determined by each species' adaptation to one or more forms of environmental stress such as mineral shortages, mineral toxicity, flooding, drought, and physical damage. Plant cover, particularly combinations of species, is one of the best measurements of the total environment of any particular area, both past and present. The vegetation reflects local variations in environmental conditions, which determine the characteristics of the habitat upon which one or more plant species may develop. Habitat or site conditions may be such that no anchored plants may be able to grow and reproduce, or site conditions may be adequate for the development of grassland, shrub, or forest communities. Forests are generally stratified communities with trees (overstory), shrubs and vines (understory), and herbs (ground layer), and therefore may include all of these physiognomic categories.

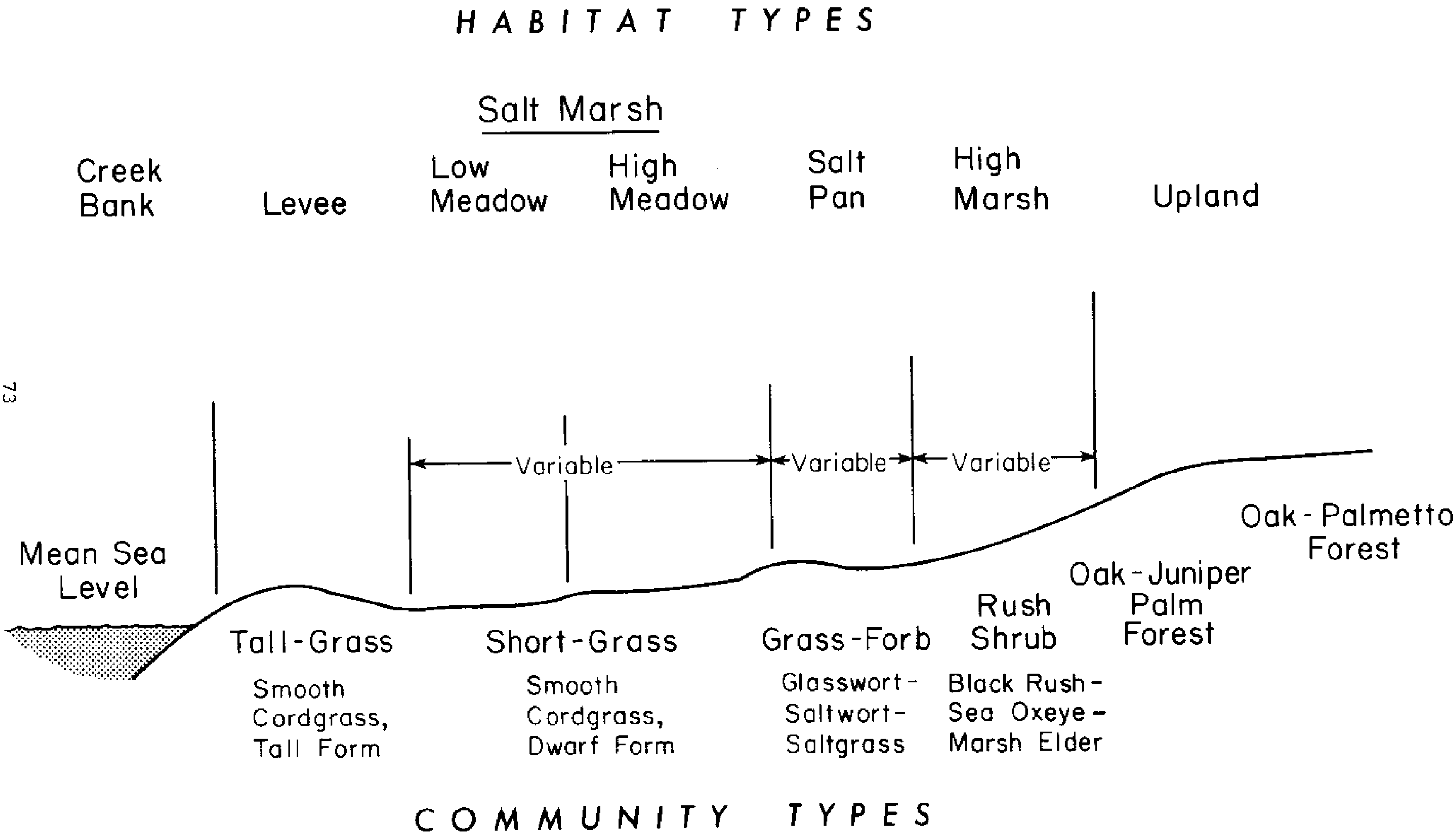

Figure 6. An idealized habitat-plant community profile of Cumberland Island: western side.

Plant communities, because of inherent variation in physiognomic features and species composition, may be organized or arranged in a variety of ways. Unfortunately, there seems to be no single system of community classification that satisfies all needs. Generally, the need determines the means or scale by which communities are grouped or classified.

Within the confines of Cumberland Island, 22 plant community or vegetation types were recognized and mapped. (See vegetation map in pocket in the back of this report and see Table 4 for acreage and percent coverage of each type.) These vegetation types are not associations in the strictest sense (i.e., the conceptual "association" as used by some schools). This scheme or classification system was devised to show the diversity of habitats, the composition of the vegetation in these habitats and the areal extent or coverage of each recognizable unit on the island. The system reflects natural units as nearly as possible, and it is extensive enough to include the principal variations in plant cover. Those qualities considered to be most important in synthesizing this scheme were the structural features of the community (grassland, shrubland, forest), species composition and presumed successional relationships between the communities (see Küchler 1973). All communities overlap by nature through shared species, transition zones between habitats and geological time dimensions. Therefore, boundaries between communities or mapping units cannot be considered as abrupt changes from one type to another but must be considered as transition zones where these communities overlap. The scale or dimension of the map itself imposes certain limitations on the recognition of small variations in the landscape. Areas below a certain size cannot be represented simply because of technical difficulty. For example, interdune sloughs may be 100

Table 4. Summary of principal vegetation types by acreage and percent of area on Cumberland and Little Cumberland islands, Camden County, Georgia

Community Type	Cumberland Island		Little Cumberland Island		Areas Combined	
	Acreage	Percent	Acreage	Percent	Acreage	Percent
Dunes						
Grass-Forb	540.9	2.4	101.9	4.3	662.8	2.6
Dune-Shrub-Thicket	978.2	4.2	72.6	3.0	1,050.8	4.1
Oak-Buckthorn-Scrub Forest	221.6	1.0	53.4	2.2	275.0	1.1
Sand Beach	231.7	1.0	162.6	6.8	394.3	1.5
Interdune Flats						
Grass-Sedge	361.7	1.6	22.7	1.0	384.4	1.5
Interdune Shrub Thicket	444.4	1.9	15.2	0.6	459.6	1.8
Pine-Mixed Hardwood	647.1	2.8	0	0	647.1	2.5
Salt Marsh						
Grass (Spartina)	7,941.3	34.1	864.9	36.3	8,806.2	34.3
Grass-Forb-Rush Marsh	425.8	1.8	109.2	4.6	535.0	2.1
Shrub Border	30.0	0.1	0	0	30.0	0.1
Oak-Juniper-Palm Forest	152.5	0.7	172.4	7.2	324.9	1.3
Fresh Water						
Pond-Slough	42.7	0.2	0	0	42.7	0.2
Grass-Sedge	575.1	2.5	14.5	0.6	589.6	2.3
Shrub Marsh	231.1	1.0	0	0	231.1	0.9
Lowland Mixed Hardwood Forest	884.2	3.8	0	0	884.2	3.4
Upland Forests						
Mixed Oak-Hardwood	1,165.7	5.0	0	0	1,165.7	4.5
Oak-Pine	3,699.8	15.9	0	0	3,699.8	14.4
Oak-Palmetto	3,017.1	13.0	704.2	29.5	3,721.3	14.5
Oak-Scrub	588.1	2.5	90.3	3.8	678.4	2.6
Pine-Oak Scrub	655.9	2.8	0	0	655.9	2.6
Other Miscellaneous Communities						
Pasture and Lawns	286.6	1.2	0	0	286.6	1.1
Cultivated Fields	70.7	.3	0	0	70.7	0.3
Pine Plantation	55.6	.2	0	0	55.6	0.2
Totals	23,267.8	100.0	2,383.9	99.9	25,651.7	99.9

feet wide or less, but several hundred feet in length, yet it is impossible to show these on a map at a scale of 1:16,000.

The classification scheme compiled in the course of this study is new for the Georgia coast, as well as for the South Atlantic barrier islands. The maritime live oak forest was first described by Wells in 1939 as a new forest climax: "The salt spray climax of Smith Island, North Carolina." Subsequent research weighed very heavily on the dynamics and distribution of the duneland live oak forest along the Atlantic Coastline (Oosting and Billings 1942, Boyce 1954, Oosting 1954, Bourdeau and Oosting 1959, and Bozeman 1971). Other research on sandy soils in the Coastal Plain interior of north Florida (Laessle and Monk 1961, Monk 1965, 1968) and southeastern Georgia (Bozeman 1971) illustrated the dominance or co-dominance of live oak on sites where salt spray is non-existent. While these studies conclusively show that live oak is better adapted than some competing species to the salt-spray zone and that live oak on the interior is dominant on dry sterile sites in general and more specifically on such sites that are protected from frequent fires, they do not provide a comprehensive scheme for classifying and mapping the vegetation units in which live oak occurs on Cumberland. Duncan (1955) reported thirteen vegetation types for Sapelo Island, but as yet this scheme has not been amplified and published. Worthington (1972) recognized nine community types in describing and mapping the vegetation of Little Cumberland Island. Due to differences in substrates, age, and land use patterns between the two islands, Worthington's scheme does not adequately describe the vegetation on Cumberland Island proper. The composition of the salt marsh vegetation is well known. Consequently, the interpretations and descriptions of these communities follow Teal (1958) and Johnson et al. (1975) with slight modification.

The community descriptions are grouped into assemblages that contain related but distinct units as follows: dune, interdune, salt marsh, fresh water, upland forests, and other (man-dominated) communities. The descriptions, which appear in the above order within the text, include brief comments on habitat conditions, distribution, general features of the community, and a listing of the important or characteristic species of trees, shrubs and herbs. Importance values (sum of relative frequency, relative density and relative dominance for a total of 300) for tree species and frequency values for shrubs, vines and herbs are included in Tables 16-33 (Appendix II) and are not repeated in the community descriptions. Where quantitative data on abundance or dominance are available, the order of species listed in the description corresponds to that found in the tables. Common and scientific names of all trees, shrubs and vines, and herbaceous plants found on Cumberland Island are provided in Tables 13, 14 and 15 (Appendix II), respectively.

Dune Community Types

Dune Grass-Forb Community.--This community occurs on foredunes and low interdunes (Figures 7-11). The community is characterized by grasses and forbs (herbs) tolerant of salt-spray, wind, burial by blowing sand, drought, occasional flooding, and grazing (see Table 16 for additional species present).

Canopy--Absent

Shrubs & vines--woody shrubs and vines mostly absent, exceptions are eroded sites where rear dunes are exposed to tidal action.

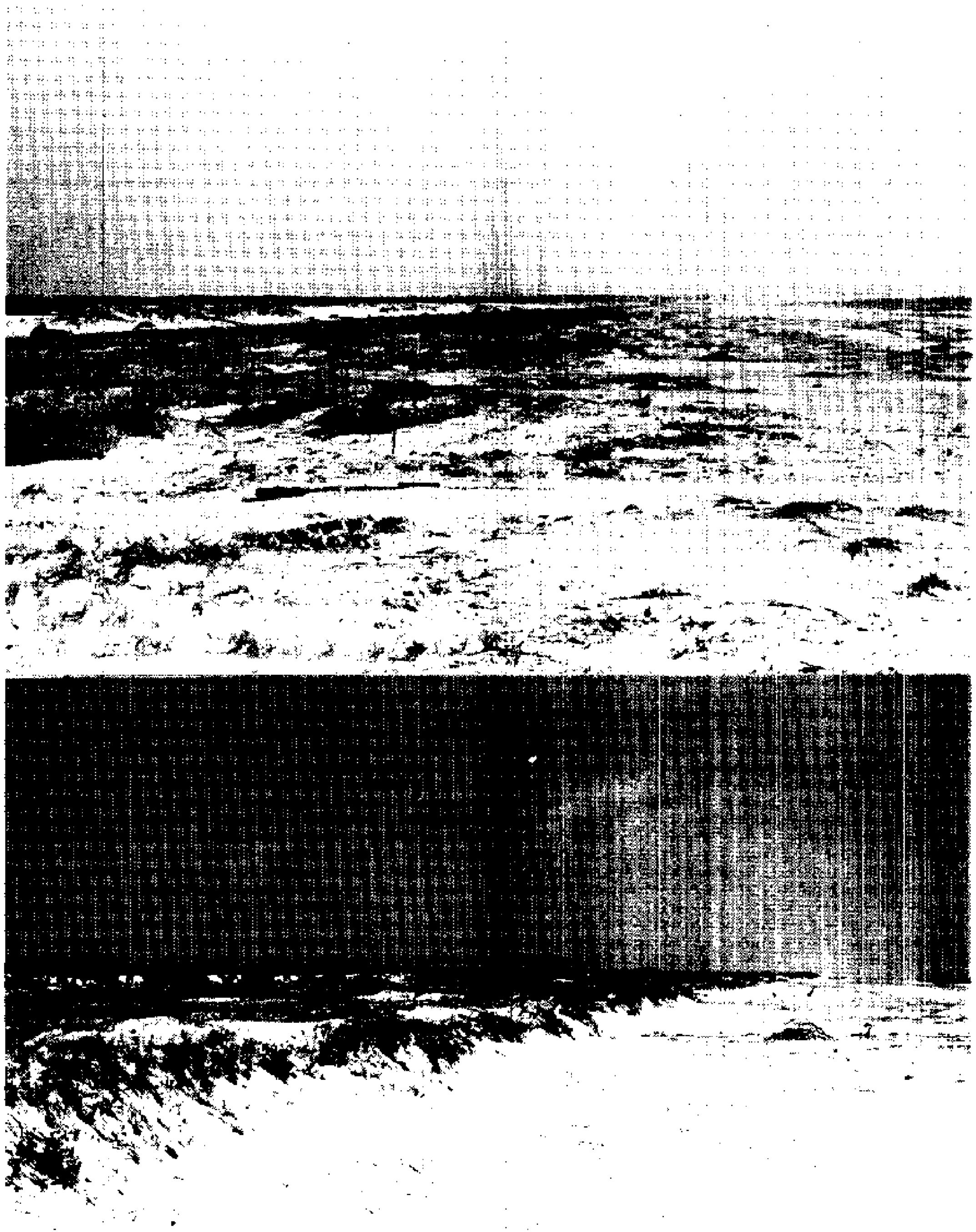

Figure 7. Top. Wide flat beach on south end of Cumberland Island. Dominants are seashore paspalum, beach hogwort, beach pennywort. Bottom. Ledge type beach on middle section of island. In addition to the above species, seashore dropseed is common.

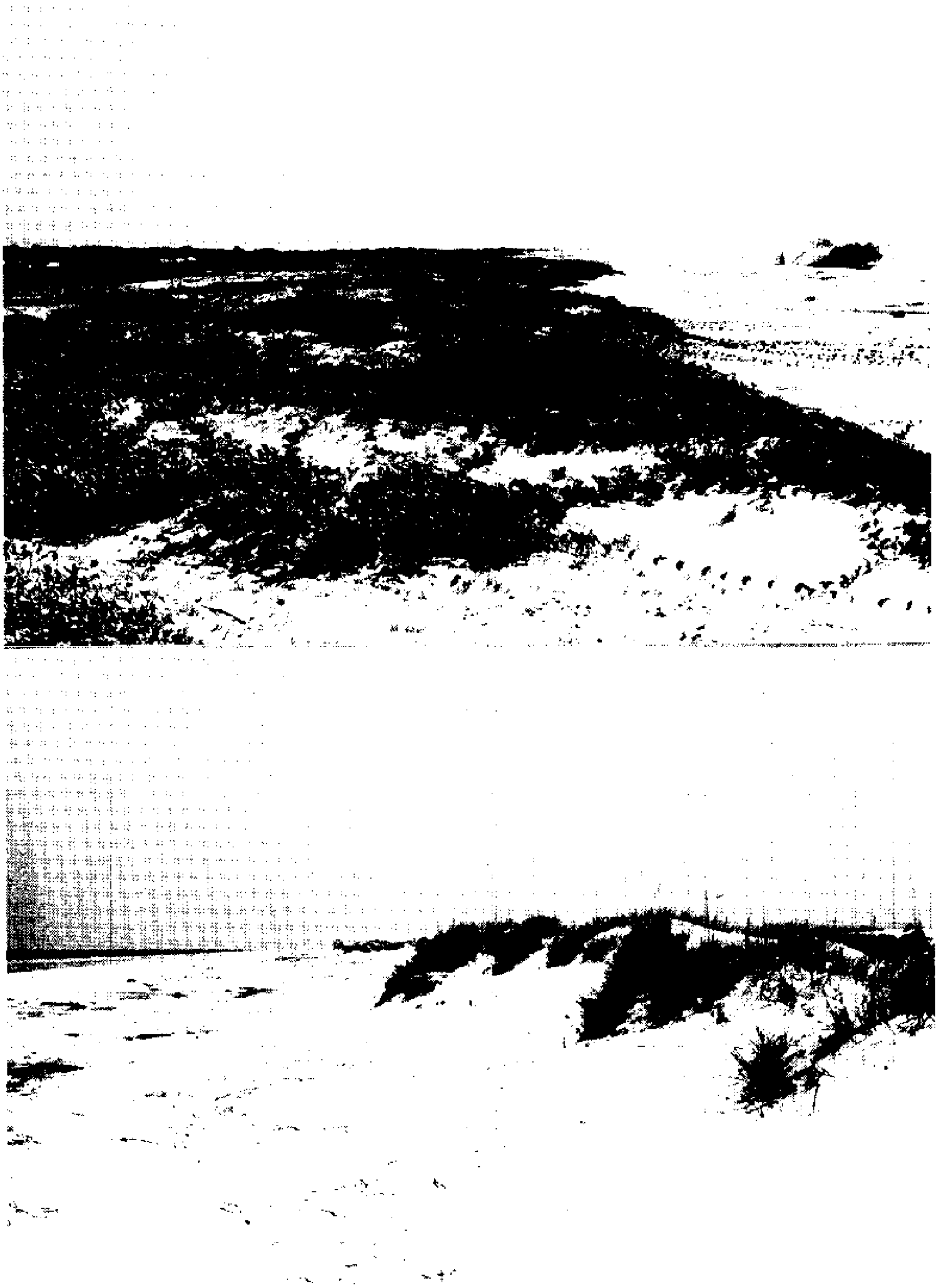

Figure 8. Top. Wide sloping beach without foredunes in middle section of island. Dominants are railroad vine and seashore paspalum. Bottom. Wide sloping beach on north end with foredunes dominated by sea-oats. The dunes are being eroded by wind in this area.

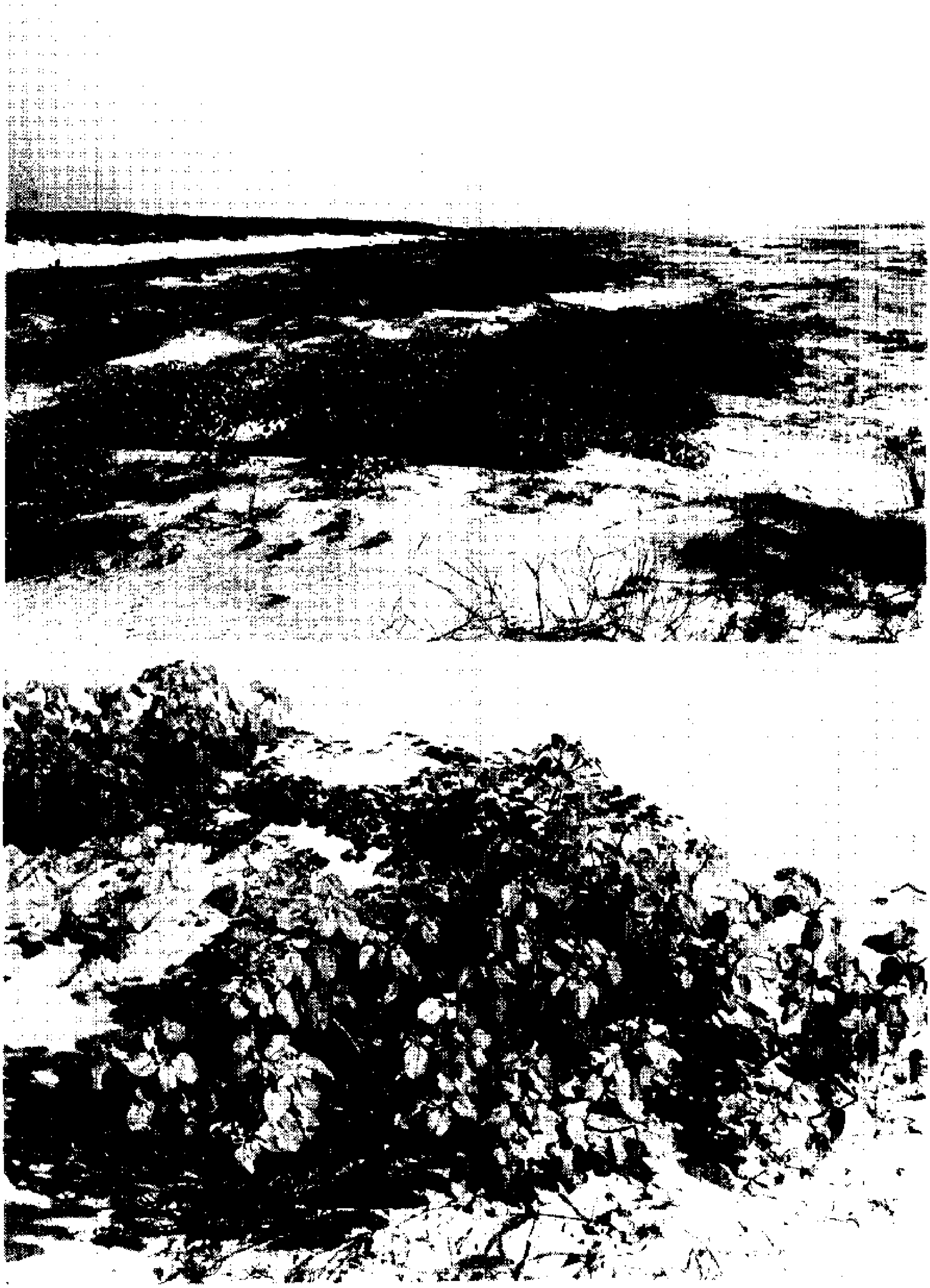

Figure 9. Top. Wide sloping beach in middle south section of island with wide flat meadow in interdune area. Rear dune unstable. Bottom. Beach hogwort, beach pennywort and seashore paspalum are principal dominants as seen in top view.

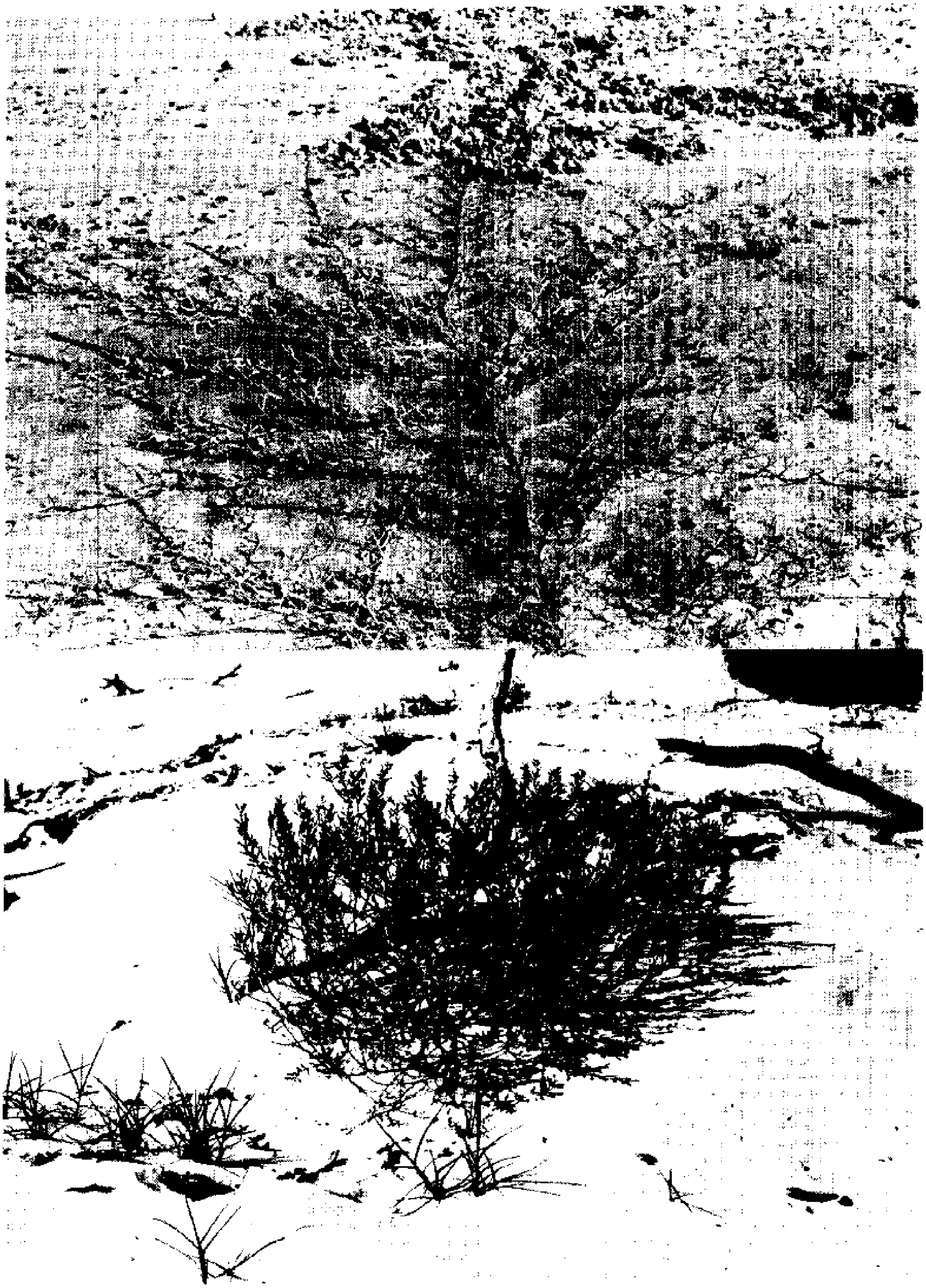

Figure 10. Top. Interdune meadow illustrating stoloniferous nature of seashore paspalum. Rooting of beach pennywort stolons by pigs (in background) is extensive in interdune meadows. Bottom. Beach elder with seashore dropseed on unstable reardune.

Figure 11. Top. Reardune moving across the salt marsh south of Dungeness. The tracks were made by cattle. Bottom. Extensive area of unstable duneland on north end of island.

Herbs--Seashore paspalum, beach pennywort, beach hogwort, cape-weed, seaside spurge, sandspur, seashore dropseed, Russian thistle, railroad vine, and sea-oats. Sea-oats is the dominant dune-binding grass on most of the barrier islands in Georgia. However, due to extensive grazing on Cumberland the species is limited to certain locales.

Dune Shrub Thicket Community.--This community ordinarily occupies the upper-half of the foreslope of rear dunes. On Cumberland this area, for the most part, is unstable and highly mobile. Consequently, this mapping unit is composed predominantly of unstable rear dunes (Figure 12). Stabilization of these areas should lead to the establishment of a shrub-shear zone on the rear dunes.

Canopy--Essentially absent.

Shrubs, vines and juvenile trees--bayberry, saw palmetto, spanish bayonet, tough buckthorn, yaupon, bamboo-brier, pepper-vine, cross vine, red bay, and live oak. Drummond prickly-pear occurs in marginal areas.

Dune Oak-Buckthorn Scrub Forest Community.--This community would normally occupy the tops and rear slopes of rear dunes. The area included in this mapping unit is relatively small, and represents predominantly stable dune forests of recent origin on the seaward side of the island. Many sites show evidence of severe browsing, with little vegetative growth below the browse line (Figure 12). See Tables 17-21 for quantitative data.

Canopy--live oak, tough buckthorn, red bay, slash pine, and loblolly pine. Loblolly pine is more commonly found on lower slopes of less exposed sites.

Shrubs, vines and juvenile trees--saw palmetto, tough buckthorn, Hercules-club, bayberry, yaupon, rusty lyonia, muscadine grape, bamboo-brier, pepper-vine, and live oak.

Herbs--herbs are uncommon, but the following species may be encountered: bedstraw, nut-rush, panic-grass, and nut-grass. In open areas sandspur, poor-Joe and broom-sedge may be found.

Figure 12. Top. Heavily grazed interdune meadow that is contributing sand to a previously stable reardune. Bottom. Regressing oak-buckthorn forest on reardune. Live oak and tough buckthorn are dominants in many areas such as this.

Interdune Community Types

Interdune Grass-Sedge Meadow Community.--The grass-sedge meadow community can be divided into two phases on the basis of topography and fluctuations in the water table (Figure 4). These phases are high meadow and low meadow, the latter characterized by species tolerant to standing water for infrequent periods. Many species are found in both phases (Table 16). Soil pH ranges from near neutral to moderately alkaline.

Canopy--Absent.

Shrubs and vines--seaside evening-primrose, beach elder, moundlily yucca, and bayberry.

High meadow herbs--cape-weed, beach pennywort, seashore paspalum, horseweed, centipede grass, ground cherry, and muhly grass.

Low meadow herbs--beach pennywort, cape-weed, seashore paspalum, salt-marsh fimbristylis, nut-grass, toad rush, marsh-gentian, coastal love grass, and star-rush.

Interdune Shrub Thicket Community.--The habitat for this community includes interdune meadows somewhat protected from salt-spray and marginal areas of intermittent ponds and sloughs between dunes (Figure 15). Typically, the community consists of a dense growth of shrubs and often juvenile trees that are overtopped and intertwined with vines.

Canopy--essentially absent.

Shrubs and vines and juvenile trees--bayberry, cabbage palm, live oak, hackberry, slash pine, dahoon, willow, southern elderberry, Hercules'-club, saw palmetto, pepper-vine, muscadine grape, Virginia creeper, and bamboo-brier.

Herbs--Nut-grass, dog-fennel, cape-weed, salt-meadow cordgrass, marsh-fleabane, marsh pennywort, climbing hempweed, salt-marsh fimbristylis, fringe-leaved paspalum, rush, star-rush, broom-sedge, and false nettle.

Interdune Pine-Mixed Hardwood Forest Community.--This community occurs on broad interdune flats and depressions. Essentially, the community is an advanced successional stage of the interdune shrub thicket community but is located in more protected areas.

Canopy--slash pine, loblolly pine, cabbage palm, hackberry, live oak, southern red-cedar, sweet bay, blackgum.

Shrubs and vines--bayberry, saw palmetto, button-bush on wet sites, muscadine grape, laurel greenbrier, pepper-vine.

Herbs--false nettle, spike grass, lizard's-tail, beak-rush, water pimpernel, chinaman's shield.

Salt Marsh Community Types

Salt Marsh Grass Community.--This community occurs throughout the tidal land on the mainland side of Cumberland between the island proper (high ground) and the tidal creeks, rivers and sounds. The community is essentially monospecific, dominated almost entirely by smooth cordgrass. The mapping unit includes the marsh zones characterized by the tall and short ecotypes of smooth cordgrass and much of the narrow high marsh zones recognized by Teal (1958) and Johnson et al. (1975) (Figure 6). The upper margin of this community grades into the salt pan or the grass-forb community.

Canopy--absent.

Shrubs and vines--absent.

Herbs--smooth cordgrass, tall and short ecotypes. Upper margin intermixed with salt grass (Figure 13).

Salt Marsh Grass-Forb-Rush Community.--This community or mapping unit includes the salt pan and high marsh zones that are frequently to infrequently flooded by saline water (Figures 13,14). Also included in this unit is the marginal and predominantly unvegetated zone around spoil banks. These spoil

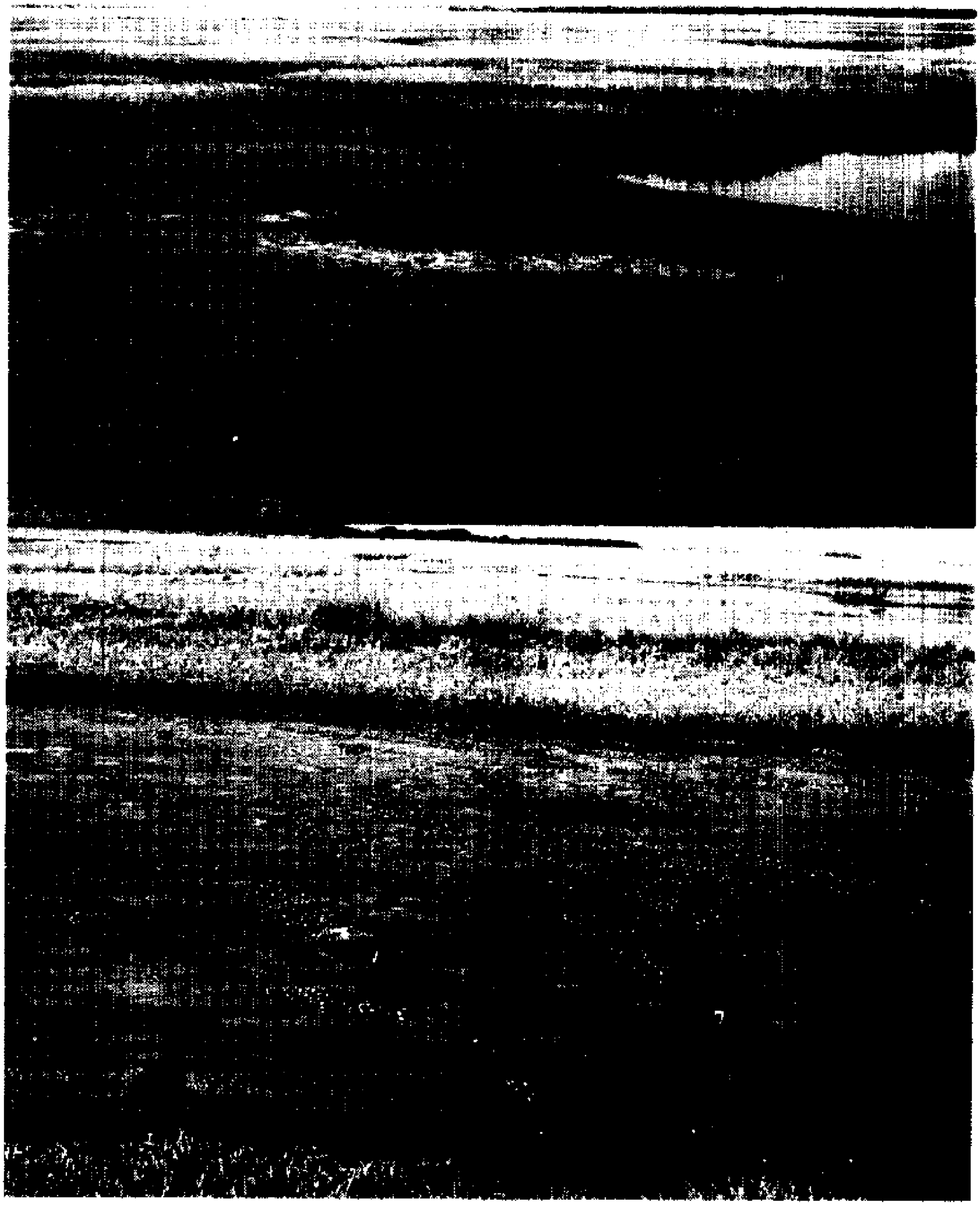

Figure 13. Top. Smooth cordgrass salt marsh typical of regularly flooded marsh. Bottom. Salt pan (Capers Soils) with glasswort and saltwort dominant. Fiddler crabs (*Uca* spp.) forage heavily in this habitat.

Figure 14. Top. Zonation of high marsh and shrub border: saltwort-glasswort zone, followed by black rush-sea ox-eye zone and shrub border. Bottom. Oak-southern red-cedar-cabbage palm forest on peninsula of high ground in salt marsh.

areas are located south of Dungeness in the salt marsh proper and on Drum Point Island.

Canopy--absent.

Shrubs--glasswort, saltwort, sea ox-eye (glasswort and saltwort are shrubby-herbs).

Herbs--Bigelow glasswort, slender glasswort, salt grass, salt-marsh bullrush, nut-grass, black rush, salt-meadow cordgrass, and sea lavender.

Salt Marsh Shrub Border Community.--The high marsh border that is infrequently or rarely flooded is dominated by shrubs (Figure 14). Included in this mapping unit are shrub communities on spoil banks or man-made land in the salt marshes. The shrub border community is generally too narrow to be represented on the map. Consequently, most of the mapping unit includes spoil areas south of Dungeness and on Drum Point Island.

Canopy-absent.

Shrubs, vines and juvenile trees--marsh elder, sea ox-eye, groundsel-tree, Florida privet, bayberry, yaupon, southern red-cedar, and live oak.

Herbs--rush, black rush, salt-meadow cordgrass, sand cordgrass in limited areas, milk-vine, sea lavender, American three-square bullrush.

Oak-Juniper-Palm Forest Community.--Essentially this community is a forest border or zone between the salt marsh shrub community and the oak-palmetto or upland forest. The community is best developed on peninsulas of high ground (approximately 5 feet in elevation) in the salt marsh (Figure 14).

Canopy--live oak, southern red-cedar, and cabbage palm are the most common tree species.

Shrubs and vines--bayberry, yaupon, Florida privet, and saw palmetto.

Herbs--not studied in detail.

Fresh Water Community Types

These communities include lakes, ponds and sloughs (slow-moving water in basins between old dunes) and drainageways fed by rainwater and seepage from upland habitats. The water is darkly stained and predominantly acid to neutral. Most lakes and sloughs are shallow, some drying completely during part of the year. Nearly all of these aquatic habitats are undergoing ecological succession. Lake succession on Cumberland follows the general pattern found elsewhere: from open water with submerged aquatics, to floating or floating-leaved aquatics, to emerged aquatics, to shrubs, and, with the eventual filling of the lake basin, to a lowland mixed hardwood forest (Figures 15-18).

Typical submerged aquatics--water milfoil, pondweed, spike-rush and bladderwort.

Typical floating or floating-leaved aquatics--waterlily, cowlily, floating-hearts, water-shield, pondweed, big duckweed, frog's bit, mosquito fern, and American lotus.

Emergent aquatics--frog's-bit, slender arrow-head, duck-potato, pickerel weed, common cat-tail, narrow-leaved cat-tail, lizard's tail, knotweed, and water-purslane. Emergent grasses, sedges and rushes include the following dominants: maiden cane, floating paspalum, sand cordgrass, saw-grass, nut-grass, umbrella-grass, bullrushes, spikerushes, beak-rushes, sedges, and common rush.

Shrubs or juvenile trees--water willow, marsh mallow, button-bush, persimmon, dahoon, bayberry, willow, blackgum, sweet bay, and swamp red bay.

The filling of a lake or pond basin by organic sedimantation is an extremely slow process. The zonation of vegetation types around the perimeter of these aquatic habitats generally typifies the stage to which a lake or pond has progressed from an emergent grass-sedge marsh ⟶ shrub marsh ⟶ forest (Figure 17).

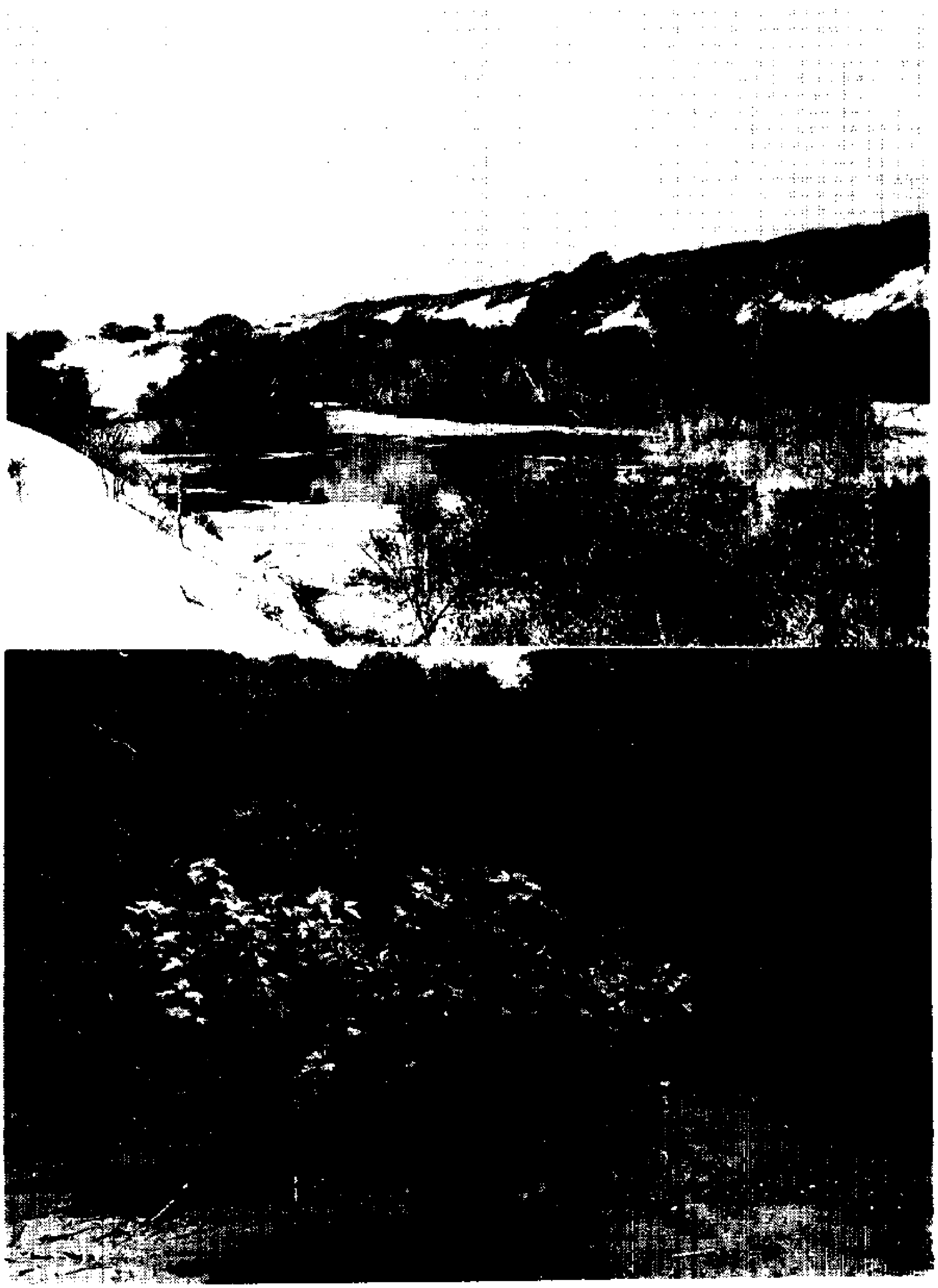

Figure 15. Top. Interdune slough being filled by migrating dune. Bottom. Interdune slough illustrating grass-sedge and shrub-succession (marsh mallow and willow).

Figure 16. Top. Interdune slough, Duckhouse area. Floating aquatics - duckweed and frog's-bit; emergent aquatics - pickerelweed, duck-potato, sand cordgrass. Bottom. Shaded slough with duckweed and a shrub border of water willow.

Figure 17. Top. A mass of floating and emergent aquatics in Lake Whitney illustrate lake or pond succession on Cumberland Island. Frog's-bit (foreground) and common cat-tail (left center) are prominent emergents on the eastern shore. Bottom. Shrub zone and dead snags of flooded trees on northwestern border of Lake Whitney.

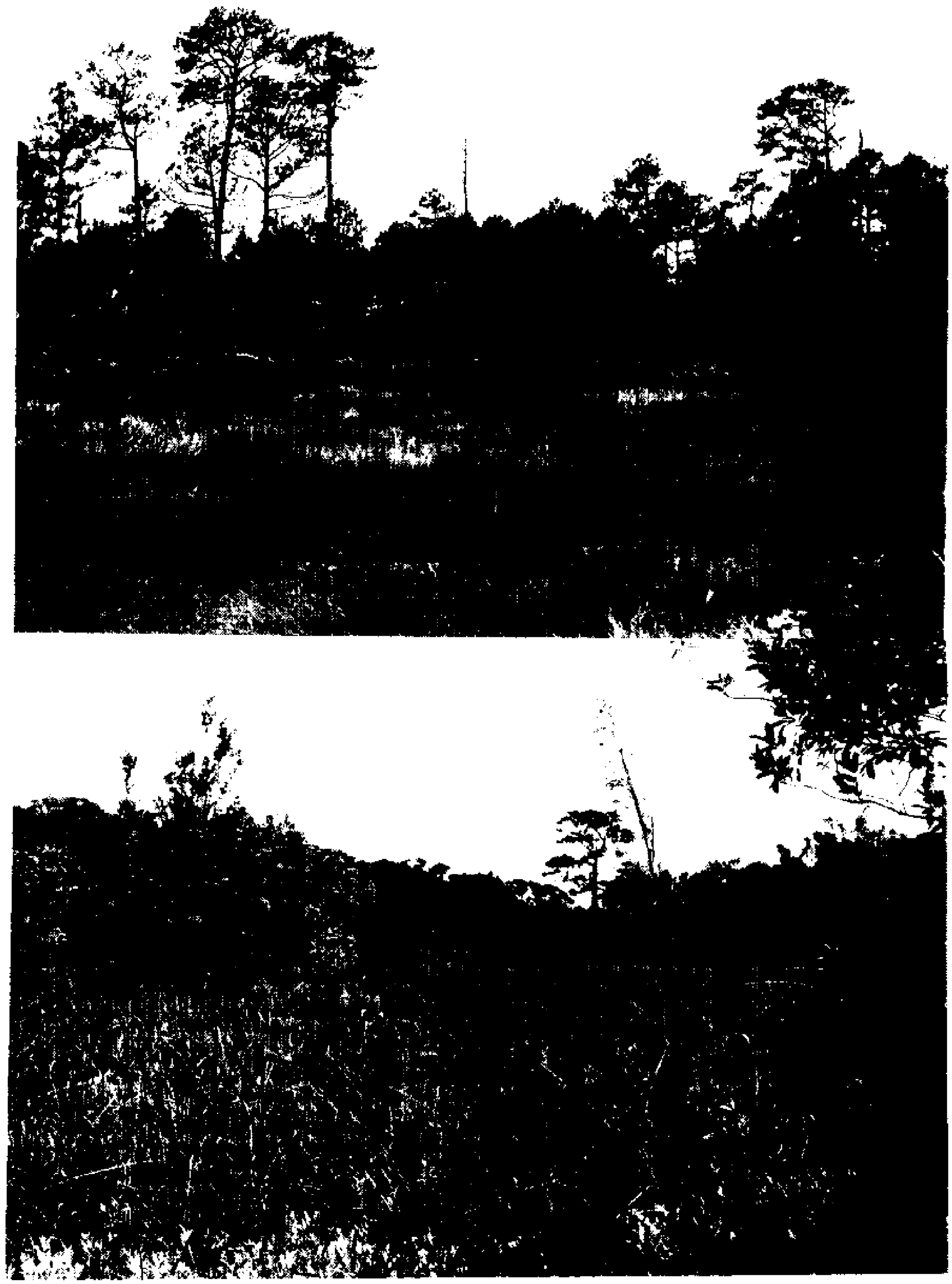

Figure 18. Top. Sand cordgrass marsh in wet spot of pine-oak-scrub forest on northern end of island. Bottom. Saw-grass marsh on Duckhouse Road. Common trees are dahoon, blackgum and willow.

The freshwater pond-slough mapping unit includes all major open water areas and, in the case of small lakes or sloughs, also may include some floating and emergent vegetation.

On the marginal areas of large lakes and ponds, such as Lake Whitney, the grass-sedge mapping unit includes all emergent herbaceous vegetation.

The fresh water shrub marsh is limited to advanced stages of lake-pond succession where shrubs dominate the emergent vegetation.

Lowland Mixed Hardwood Forest Community.--This community,which occupies drainageways and depressions, represents the most advanced successional stage on freshwater aquatic sites. Composition varies from predominately broadleaf evergreen species to a mixture of evergreen and deciduous species. Bays or bayheads, as recognized by Monk (1968), are not clearly differentiated from mixed hardwood swamps. This lack of development of purely evergreen versus predominately deciduous forest types is probably best explained by the dissimilarity in the minerals of drainageways on the coastal islands as compared to the alluvial flood-plains of streams on the mainland, particularly large riverswamps. Consequently, most of the mature forests on lowland sites tend to be dominated by evergreens, but also contain some deciduous species (see Tables 17-19, 22,23).

Canopy--swamp red bay, loblolly bay, sweet bay, water oak, red maple, loblolly pine, live oak, laurel oak, hackberry, blackgum, caggabe palm and American elm.

Shrubs and vines--fetterbush, bayberry, muscadine grape, saw palmetto, pepper-vine, switch-cane, button-bush and laurel greenbrier.

Herbs--lizard's-tail, beak-rush, cinnamon fern, royal fern, water pimpernel, and chain fern.

Upland Forest Community Types

The upland or predominantly upland forests of Cumberland Island are divisable into six types based upon age or structural stratification of the forests, species composition and site characteristics. Additional types possibly could be recognized in the early successional stages of old fields and pastures where different species of pine are dominant. However, mapping these as separate units from the oak-pine forest did not seem practical for the purposes of this study, as will be explained further in the section on ecological succession.

A summary of the quantitative analysis of the major forest types is provided in Tables 17-19. Complete details on the structural and compositional characteristics of each forest type are provided in Tables 24-33. Tables 17 and 18 were compiled from Tables 24-33 by synthetic phytosociological procedures. These procedures have been found advantageous for their expediency in demonstrating relationships among vegetation units, for typifying communities and for the synthesis and construction of vegetational maps (Poore 1955a-c, Becking 1957, Lieth 1968). Phytosociological methods provide a means of grouping and synthesizing different sets of measurements, in this case data obtained by quarter-point analysis, to determine species of greatest value in community classification.

Pine-Oak Scrub Forest Community.--This community occurs on the moderate to poorly drained Leon soils on the north end of the island. Previous land uses probably have been limited to timber production and pasture. Some sites were burned in the past 10 years, but most of the mapping unit was last burned approximately 20-25 years ago. Pond pine and slash pine form a scattered overstory above a dense shrubby growth of oaks, saw palmetto, and heath species (Figures 18-20).

Canopy--pond pine, slash pine, and live oak.

Shrubs, vines and juvenile trees--live oak, rusty lyonia, red bay, saw palmetto, huckleberry, dwarf blueberry, fetterbush, gallberry, and tar-flower. Saplings of pond pine were found in a few recently burned sites.

Herbs--milk-pea (G. elliottii), bracken fern, beak-rush, and broom-sedge. Many additional grass, sedge and forb species occur in disturbed areas, such as ditches, roadsides and cleared land.

Oak Scrub Forest Community.--This community occurs on moderately drained Leon soils historically utilized for timber production and pasture. It was last burned probably between 25 and 35 years ago and is now characterized by a dense, scrubby growth of broad-leaved evergreens and scattered pines. This community and the previous one are successional stages to the oak-palmetto forest type. Tables 16 and 17 illustrate the woody species shared, as well as those that distinguish each community type (see also Tables 24-27).

Canopy--live oak, slash pine, myrtle oak, American olive, Chapman's oak, red bay, and, less commonly, pond pine and longleaf pine.

Shrubs, vines and juvenile trees--saw palmetto, bayberry, rusty lyonia, myrtle oak, gallberry, huckleberry, and drawf blueberry.

Herbs--milk-pea and bracken fern. Many grass, sedge and forb species occur in distrubed areas.

Oak-Palmetto Forest Community.--This community dominates most of the Leon soils on Cumberland and Little Cumberland Islands. On an old land use map of the Lucy C. Carnegie estate (prepared by E. A. Meader and W. E. Page 1898-1905, scale: 1" = 3000'), this community was indicated as "oak-hammock lands." Although the pine timber has been logged, very little of

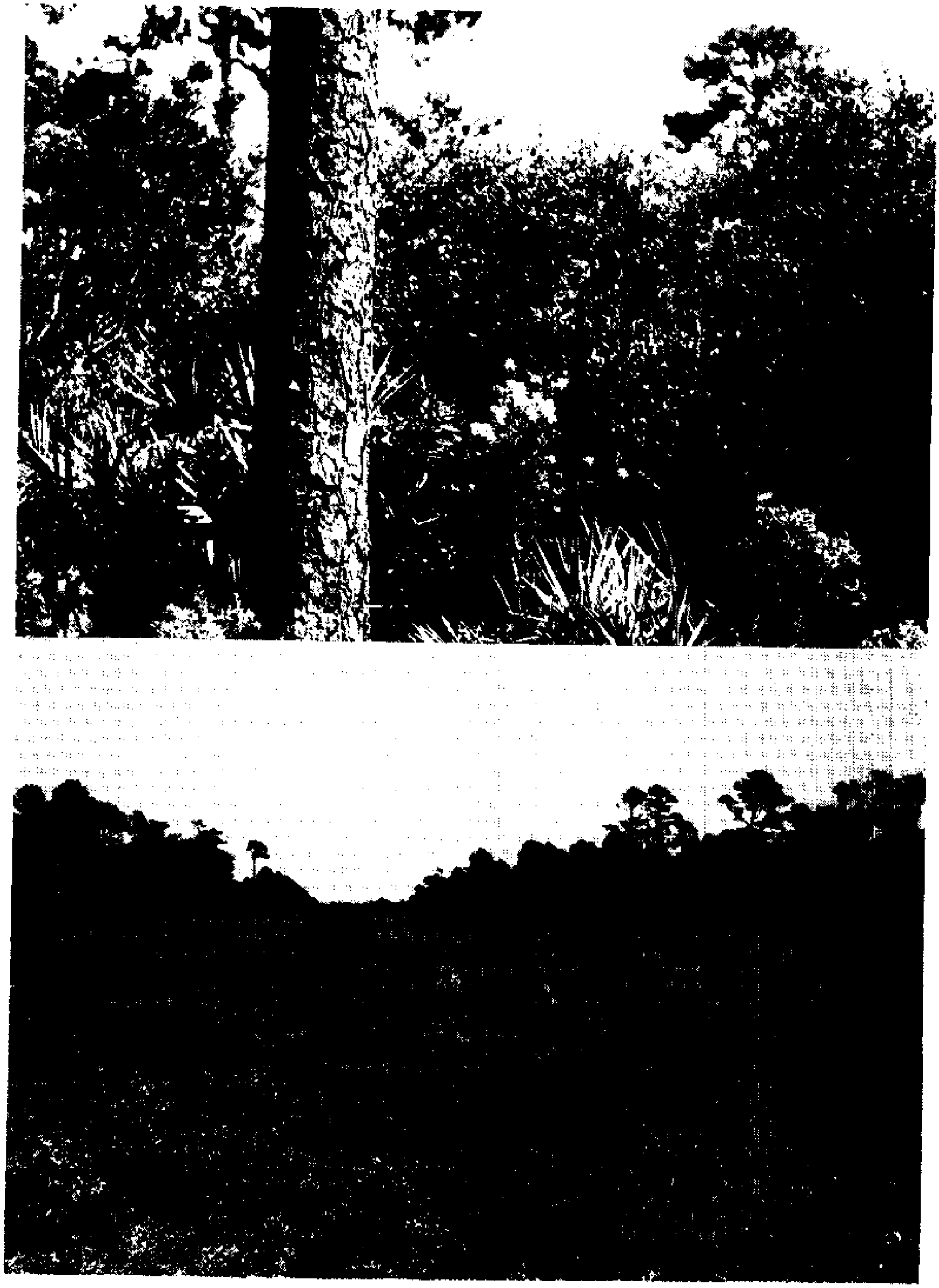

Figure 19. Top. Pine-oak-scrub forest on northern end of Cumberland. Dominants shown are pond pine, tar flower, and myrtle oak. Bottom. Secondary succession of rusty lyonia, bayberry, grasses and forbs on abandoned airstrip on northern end of Cumberland. Note scattered overstory of pines in the background.

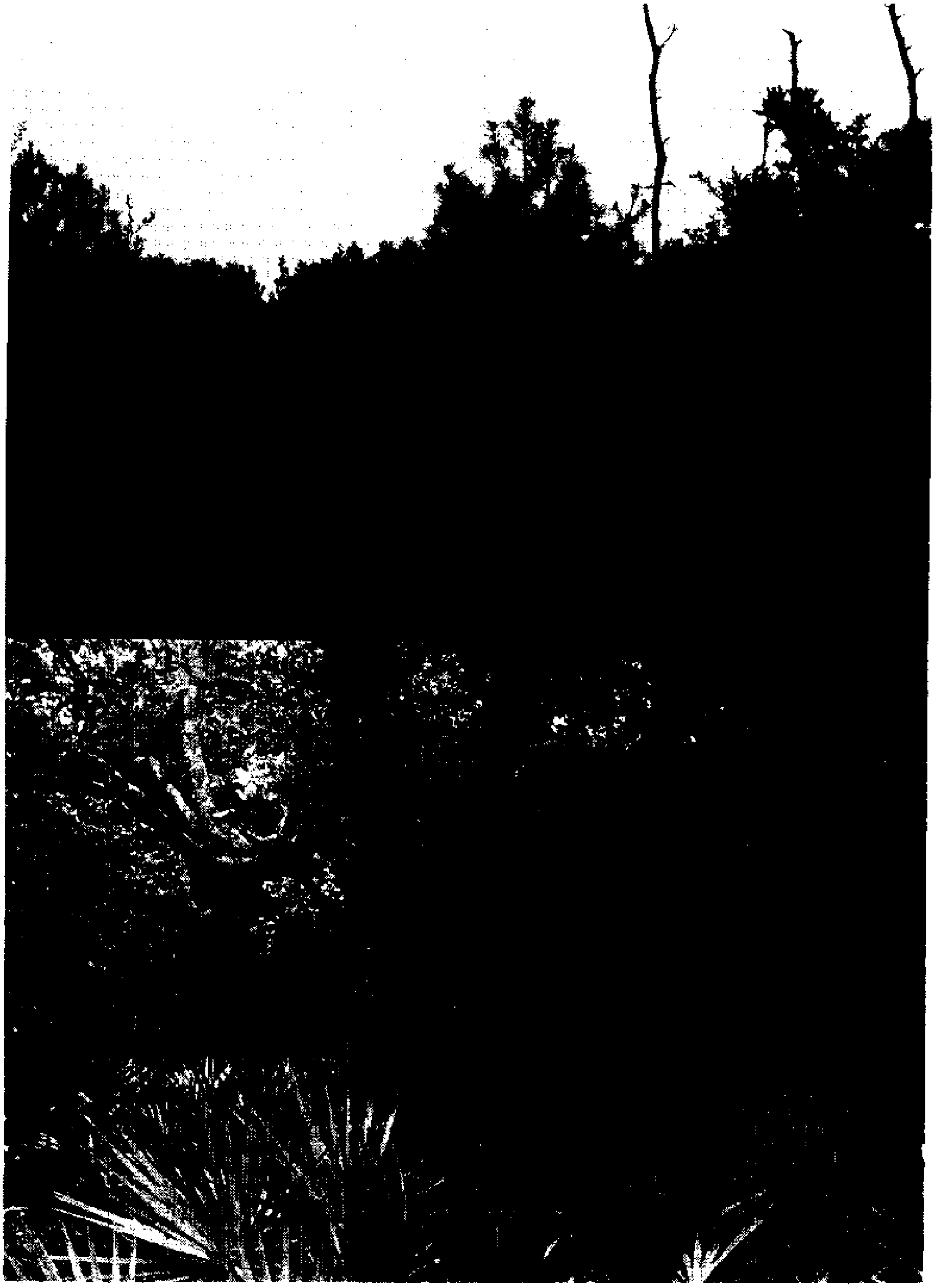

Figure 20. Top. Secondary growth of pond pine in pine-oak-scrub forest following fire. Note snags in background. Bottom. Mature oak-palmetto forest on south end of island. Dominants shown are live oak and saw palmetto.

the total area has ever been under cultivation. The community, except for small acreages, has not experienced intensive fire for 75-100 years or more (Figure 20--bottom).

Canopy--live oak dominant, red bay and rusty lyonia. Less common species are: American holly, American olive, swamp red bay, myrtle oak, loblolly pine, water oak, laurel oak, tough buckthorn, and slash pine.

Shrubs, vines and juvenile trees--saw palmetto dominant, rusty lyonia, muscadine grape, saw-brier, bamboo-brier, bayberry, fetter-bush (on wetter sites), sparkleberry, live oak, red bay, and American olive (Tables 28, 29).

Herbs--panic grass, spike grass, nut-rush and resurrection fern. Herbs rarely occur in this community, consequently those species listed above are more common to other communities.

<u>Oak-Pine Forest Community.</u>--This community occurs on upland soils of predominantly the Lakeland type, and to a lesser extent of the Chipley type. Most of the acreage was under cultivation at some time prior to 1920. The community represents secondary forest growth on old fields and pastures that have been logged extensively of the first generation of pine. Loblolly and slash pines are most common from Plum Orchard south to Greyfield, whereas, longleaf pine is common on the northern fields, particularly the Terrapin Point Field. Of course, some areas have all three species present (Figure 21).

Canopy--live oak, laurel oak, loblolly pine, longleaf pine, slash pine, red bay, American holly, southern red-cedar, pignut hickory, myrtle oak, and, less commonly, southern magnolia and blue-jack oak.

Shrubs, vines and juvenile tree species--common species: bamboo-brier, muscadine grape, bayberry, sparkleberry, scattered clumps of saw palmetto, and rusty lyonia (Tables 30, 31).

Indicative species: summer grape, Virginia creeper, pawpaw, and squaw-huckleberry (Table 18).

Juvenile species: live oak, American holly, laurel oak, red bay, myrtle oak, longleaf pine, and loblolly pine.

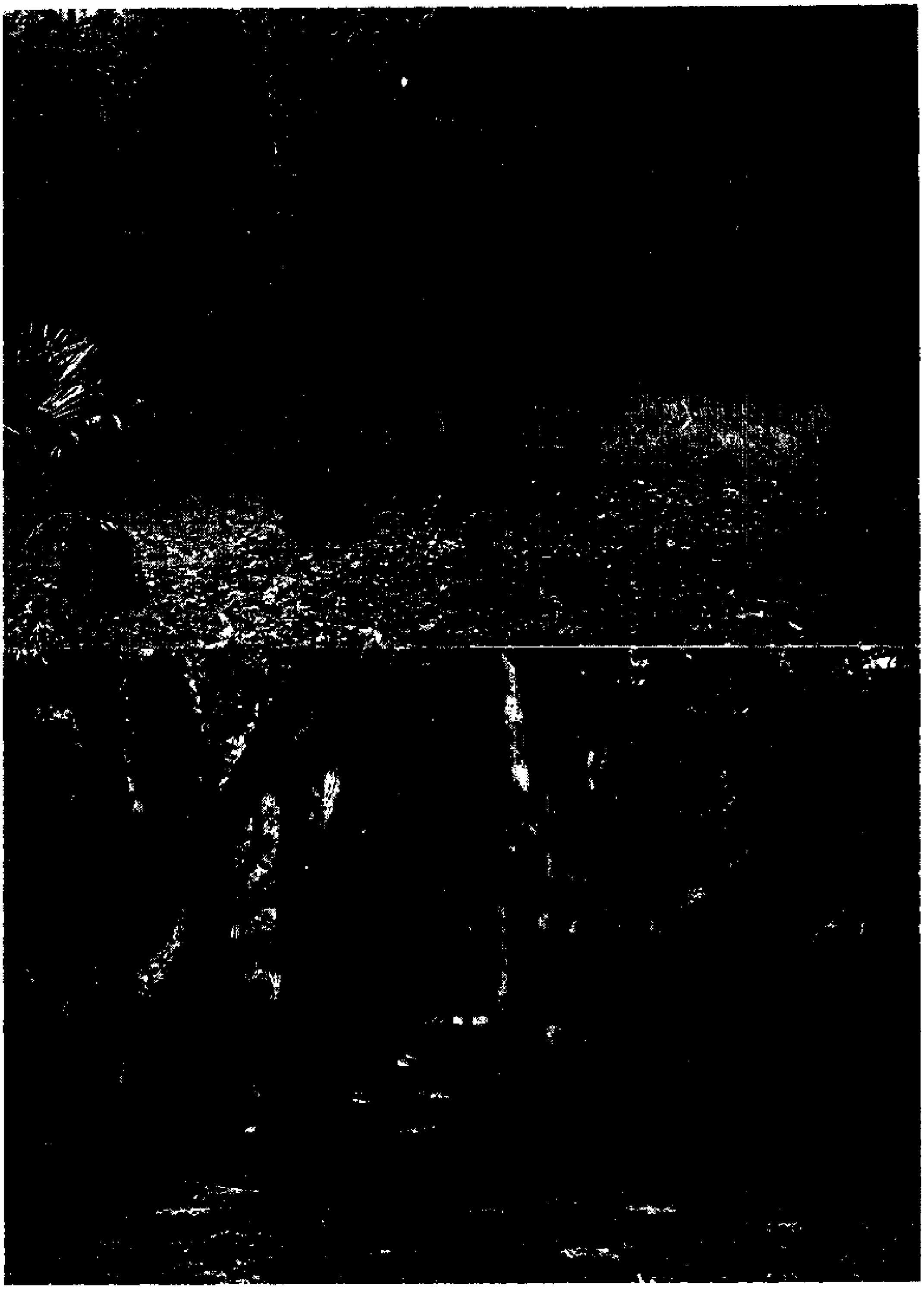

Figure 21. Top. Secondary growth of oak-pine or pine-dominated forest on upland site. Species shown are loblolly pine and live oak, with scattered growth of bluestem in open areas. Bottom. Dense growth of live oak and scattered clumps of saw palmetto in a live oak-dominated forest.

Herbs--panic grass, spike grass, thoroughwort, nut-grass, frostweed (H. *corymbosum*), broom-sedge, nut-rush, centipede grass, and stinging nettle.

Mixed Oak-Hardwood Forest Community.--The mixed oak-hardwood forest represents the most advanced successional stage of forest on the upland soils. This community is much less extensive than the previous one, and, by comparison, it occurs predominately on Chipley soils. Most of the species composing this community are shared with the oak-pine community (Figure 22, Tables 17-19).

Canopy--live oak, laurel oak, American holly, southern magnolia, red bay, rusty lyonia, southern red-cedar, longleaf pine, loblolly pine, myrtle oak, slash pine, water oak, pignut hickory, cabbage palm, and American olive.

Shrubs, vines and juveniles--There are no woody understory species limited to this community. As with most of the tree species, woody understory species found here are also common to the oak-pine community. Seedlings and saplings of the following species were found to be common: American holly, laurel oak, red bay, and live oak.

Herbs--Fewer herb species occur in this community than in the oak-pine community. None were found to be exclusive to the mixed oak-hardwood forest. Those species found to be most common are: panic grass, spike grass, broom-sedge, nut-grass, thoroughwort, nut-rush, and black oat grass.

As can readily be observed from Tables 17-19 and from the preceeding community descriptions, there is considerable overlap in species composition between communities occurring on similar soil types. Also, a single species, live oak, is not only common to all communities, but practically dominates every forested community on the island. A few local areas have a dominant pine overstory which tends to obscure the presence of live oak. Additional quantitative data is needed on the more moist habitats, but the present study should be adequate to illustrate the principal forest types, their relationships as determined by species composition in both the canopy and understory, and their distribution as shown on the vegetation map.

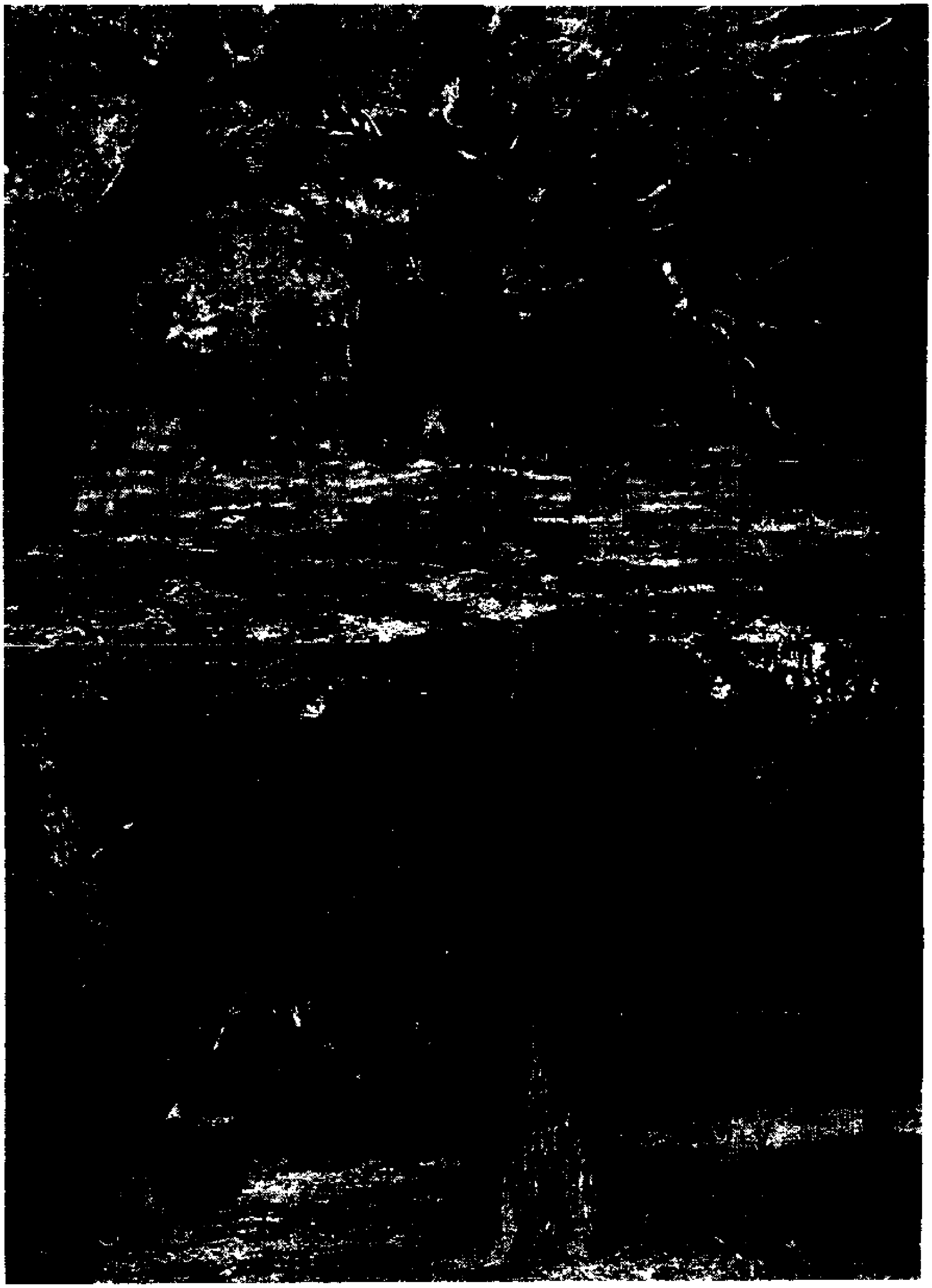

Figure 22. Top. Park-like forest of large scattered live oak. Grazing and browsing of seedlings is extensive in this habitat. Bottom. Mixed oak-hardwood forest with good reproduction of woody understory shrubs and tree saplings.

Other Community Types

The other communities shown on the vegetation map are man-dominated communities that are maintained directly by man's activities or indirectly by feral animals. Open pastures are dominated by centipede, Bermuda and St. Augustine grasses, among others. Large lawns around old homesites are also included in this mapping unit. Corn and sorghum were the dominant cultivated crops on the island in 1973 with only small acreages being utilized for crop production. One loblolly pine plantation occupies small acreage on the east end of Long Field (Stafford Place). Live oak was the most common hardwood occurring in this plantation. The remainder of Long Field also has scattered plantings of loblolly pine, but the field appears to have been undergoing secondary succession at the time of planting.

Ecological Succession

At this point, a discussion of ecological succession is pertinent to an understanding of the interrelationships of the plant communities on Cumberland Island. Ecological succession is generally accepted as an orderly, progressive and sequential change in plant communities on a site or habitat. Succession is characterized by changes in species composition, species diversity, levels of productivity, and rate of mineral cycling. Biotic processes affect or alter the habitat conditions through competition for light, water, nutrients, and space, among other things. Each successive community alters the habitat conditions to the maximum extent possible. In the earlier stages of community succession, this alteration of the environment is such that the species inhabiting the site may no longer be able to reproduce or compete with newly established forms;

consequently, gradual changes in species composition occur, often accompanied by structural changes in the nature of the community.

Succession may be defined in two ways depending upon the nature or cause of habitat modification. When succession occurs in a habitat as a result of alterations caused by the community, it is known as biotic succession (Oosting 1956) or autogenic succession (Hanson and Churchill 1961). Autogenic succession generally culminates in a diverse, complex community that is in a steady-state with the prevailing environmental conditions. The populations composing the community under such conditions are self-maintaining and relatively permanent. Any further changes in species composition within the community are dependent upon alterations of environmental conditions by external processes. Such alterations are allogenic or physiographic in nature and are independent of the plant community.

Succession may also be defined according to the nature of the substrate at the time of the initial establishment or reestablishment of plant cover. If the substrate has never been colonized or modified by plant cover (i.e. newly formed land, bare rock, or a shallow lake, pond or stream), the initial colonization and establishment of plant cover is known as primary succession. Consequently, once vegetation has been established and then disturbed to the extent of partial or total destruction by man, animal or natural causes, revegetation is by secondary succession. In either case, the process of succession is similar, beginning with pioneer or invading species and continuing to the maximum development of community structure that is allowable under the prevailing environmental conditions. In some instances, certain environmental stresses may slow or inhibit the succession of plant communities to the point that a pioneer stage or secondary stage persists for an indefinite time. This self-perpetuating community may be viewed as a "climax" or terminal stage.

The concept of succession has been applied to many successional sequences throughout the vegetation types of North America (Oosting 1956) and particularly to the forest types in the Southeast (Quarterman and Keever 1962, Monk 1965, 1968). The application of successional sequences to the zonation of vegetation on the maritime strand has not met with the same success. In discussing the herbaceous, shrubby and arborescent zones on Island Beach, New Jersey, Martin (1959) stated that these "zones do not necessarily represent seral stages in biotic (autogenic) succession," but "...perhaps on barrier beaches in general (plant succession) is largely an interzonal phenomenon. Within the environmentally less severe shrubby and arborescent zones, several sere--xerosere, hydrosere, and halosere--are recognizable, and the structure of terminal stages is determined by environmental limitations--especially salt spray intensity." A sere is defined as a traditional series of communities which terminate in a climax community.

There are numerous disruptions, perturbations or environmental stresses that change community structure and composition or generally inhibit succession with regularity. In addition to salt spray, disruptive factors such as overgrazing, wind, tidal flooding, drought, and fire severely limit the development and continuation of vegetation. Pine-dominated forests in the Southeast are maintained by certain intensities and frequencies of fire (Komarek 1968). Komarek (1962, 1964) views these pine-dominated forests and their associated herbaceous flora as successional ecosystems maintained through long periods of time by lightning-caused fires. When certain of these forests are released (protected) from periodic burning, hardwood forests develop as a climax on the site (Harper 1911, 1962, and Monk 1968). Harper applied this concept to the development of evergreen hammock vegetation on islands and peninsulas in 1911. Monk (1968) expanded the concept to include the development of the xeric phase of the southern-mixed hardwood forest in North Central Florida.

The following discussion of ecological succession and community relationships on Cumberland Island is based upon a study of old land use maps, inferences drawn from community composition, direct observations, and a survey of the pertinent literature relating to the forest communities. A summary of these findings is illustrated in Figure 23. An attempt has been made to illustrate the probable primary and secondary successional trends on the island. Many factors interact to limit the further development of certain communities, such as the duneland and salt marsh types, and it is assumed that succession proceeds only after these limiting factors are removed. The ultimate development of a subtropical broad-leaved mixed hardwood forest is not viewed as a probability for the entire island at any particular point in time, because all communities continually undergo change, if not in species composition, at least in the replacement of individuals.

Dunes undergo primary succession, and the nature of the species invading the dunes determines to a large extent the rate by which the dune continues to develop and become stabilized. Succession beyond the grass-forb stage on foredunes and the dune shrub thicket stage on rear dunes is assumed to occur only as a result of the growth of the island seaward, thereby reducing the effect of salt spray. Factors which disrupt

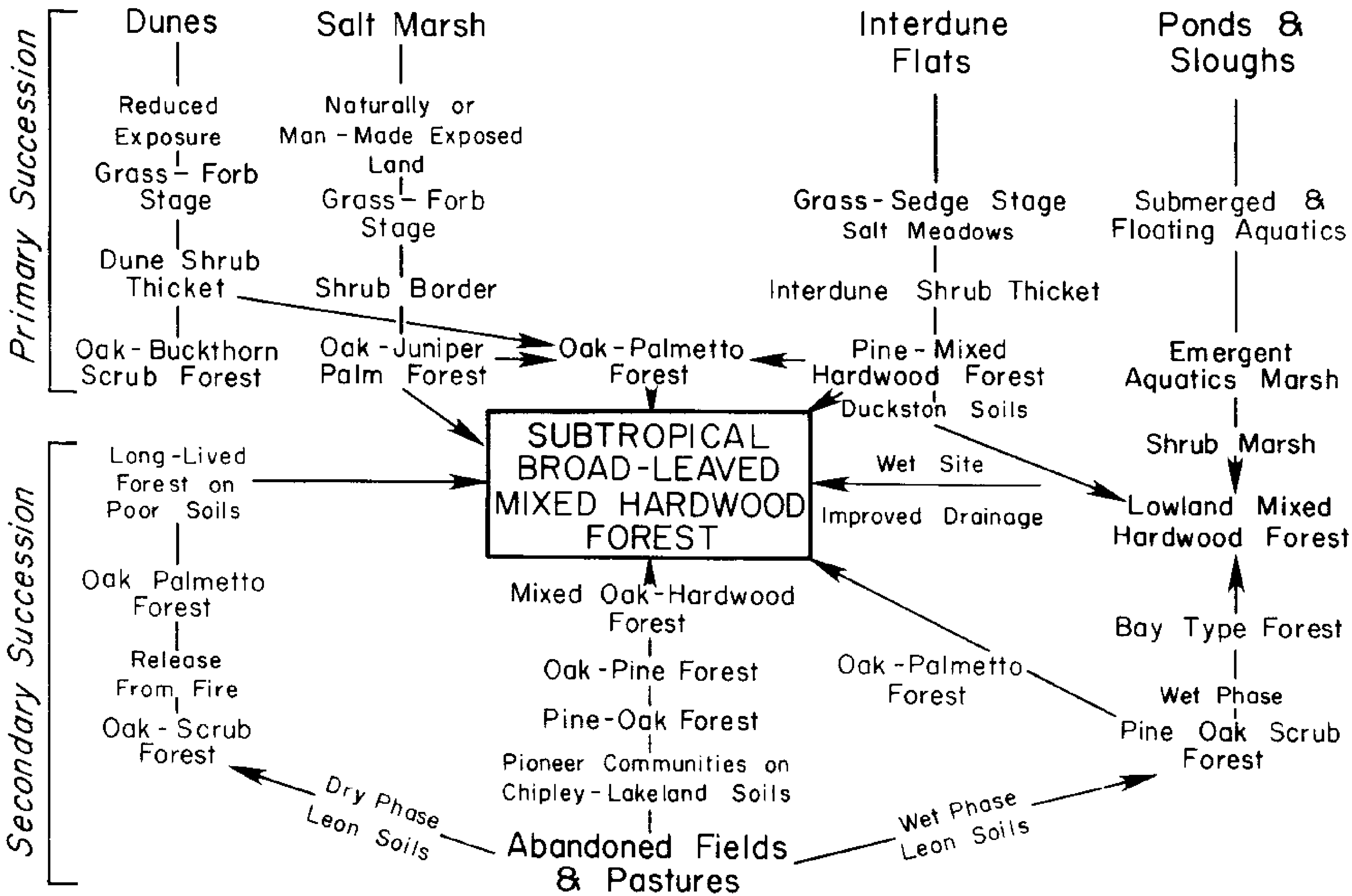

Figure 23. Successional relationships of plant communities on Cumberland Island, Georgia.

and often reverse the successional process on dunes are drought, erosion, fire, windfall, overgrazing, recreational use, and the trailing of livestock (Daubenmire 1968).

The invasion of the grass-sedge stage in interdune meadows by shrubs and seedlings naturally occurs at a faster rate than the establishment of the dune shrub thicket on rear dunes. On Wassaw and Blackbeard Islands, where grazing and other perturbations have been kept to a minimum, one is best able to visualize the orderly development and stabilization of dune and interdune communities as the land builds seaward.

Succession of aquatic communities is associated with accumulation of organic matter and, consequently, development from a hydric to a mesic habitat. But in the salt marsh along the Atlantic coast the accumulation of organic matter is offset by a slowly rising sea level. Redfield (1972) described the development of a salt marsh in New Englend with the initial establishment of smooth cordgrass on mud flats, followed by the accumulation of sediments to form a high marsh dominated by the dwarf form of smooth cordgrass plus salt-meadow cordgrass and salt grass. He determined that in 3-4000 years, the marsh did not advance beyond the high marsh stage except in local areas. Except where man has interfered with hydrologic patterns and except for spoil areas, the salt marsh around Cumberland Island exists in a steady state, eroding in some areas, but building in others. Succession occurs only where the marsh emerges above mean high tide, primarily as a result of human action. The shrub and forest border communities are naturally limited to narrow zones and may actually represent a reversal succession as high ground is gradually inundated.

Primary succession in ponds and sloughs has been roughly outlined in the description of these freshwater habitats. The primary factors which affect the rate of eutrophication or aging of these habitats are the rates of mineral enrichment, sedimentation, and leaching of alkaline substrates in certain areas. Every conceivable stage of lake and slough succession occurs on the island. Some of the best examples of lake succession occur in Johnson's Pond and in Lake Whitney. The Sweetwater Lake complex contains representative examples of succession in sloughs.

On upland sites abandoned fields and pastures have followed typical patterns of secondary succession. Local variations in soil characteristics, seed availability, subsequent lumbering operations, grazing, and fire have led to the development of a variety of forest types. Table 17 illustrates the dominance of live oak throughout many if not most of these forests. Except for pines, which are transitional and generally short-lived plants (100-200 yrs) compared to live oak (400-600 yrs), the majority of the co-dominant trees are broad-leaved evergreen plants. It is not improbable that the forests will become even more similar than they presently are with time.

Secondary succession on upland abandoned fields is well demonstrated by the forest development on the west end of Long Field (Stafford Place). Loblolly pine is common throughout this area of the island; consequently, this species was one of the first tree species to invade the field (by wind-blown seed). Other tree species occurring in the field are live oak, laurel oak, cabbage palm and southern red-cedar. Common shrub, vine and juvenile plants are red bay, frost-weed, bamboo-brier, muscadine grape, laurel cherry, black cherry, bayberry, saw palmetto, pawpaw, and saplings of loblolly pine in open areas. Common herbs include broom-sedge, nut-grass, spike grass, stinging nettle, carpet grass, centipede grass, beggarweed, lespedeza, and

and thoroughwort. The composition of this forest is similar to the oak-pine forest community in canopy, understory and herb species present. Until such time that long-term studies of old field succession are completed on the island, we may assume that succession following abandonment proceeds from perennial grasses and forbs to a pine or pine-dominated forest to a pine-oak, or oak-pine forest and eventually to a mixed-oak hardwood forest. The selective removal or harvest of the pine timber on some upland sites has probably increased the rate at which succession has occurred.

The pine-oak scrub and oak scrub forests are considered here as sequential stages in the development of the oak-palmetto forest on Leon soils. These forests types are related through similarity in species composition and site characteristics to the Atlantic Coast Flatwoods and to the sand pine-scrub forests of the Florida Central Highlands. The wetter sites of Leon soils (pine-oak scrub) are very similar to the flatwoods of East-Central Florida in species composition. Monk's (1968) research on the flatwoods complex suggested that three phases of pine flatwood communities exist, each dominated by longleaf pine, slash pine or pond pine. The longleaf pine-dominated community occupies the drier sites between deep upland sands and broad flats, and Monk believed that the community may represent a broad transitional zone. Slash pine was found by Monk to dominate the wetter sites with a pH reaction greater than 4.5. Pond pine was found to dominate the very acid and poorly drained sites. Upon release from fire (periodic burning), these communities change in species composition. The drier phases develop toward a mixed hardwood forest dominated by several sclerophyllous evergreen species, and more often by live oak. The pond pine phase on wet-acid sites develops toward the evergreen-dominated bayhead type forest. The interpretations of forest succession on Leon soils presented in Figure 24 do not differ greatly from those suggested by Monk (1968) for these soil types on the mainland. However, because of the lower frequency of naturally occurring lightning fires on islands in general, as compared to the mainland, the stages in succession between a pine-dominated forest and the live oak-dominated forest may be shortened. Except for the lack of sand pine (Pinus clausa), the oak-scrub forest on the north end of Cumberland resembles the sand pine-scrub forest of north Florida. Slash pine is the second most dominant tree in this forest on Cumberland, followed by myrtle oak (Table 17). We generally agree with Monk's interpretation that this scrubby sclerophyllous forest develops toward the "xeric portion of the climax southern mixed hardwoods." On Cumberland Island, slash pine has been removed almost entirely from the mature oak-palmetto forest by timber harvest. The species is still quite common on many areas of Little Cumberland Island, and on Wassaw Island where little timbering has occurred, slash pine is a long-time co-dominant with live oak (Bozeman 1971).

Monk (1965, 1968) suggested that evergreens (broad-leaf) dominate the climax forest on dry-sterile sites (sands) in the southeastern coastal plain. Monk, however, did not interpret this forest as being floristically different from the southern mixed hardwood forest. In regard to the nature of the forest, Monk asked "if the upland mixed hardwoods of north-central Florida are not a part of the Eastern Deciduous Forest as Braun (1950) suggests, then in what formation should they be placed?" He previously stated that "the alternative would be to consider them transitional to the Deciduous Forest and a Subtropical Forest." This author (Bozeman) has chosen the alternative as a treatment for the prominent southeastern broad-leaved evergreen (laurel) forest. Both dry and wet phases fit into this interpretation.

Those species found by Monk to be the most important members of the xeric or dry phase are: laurel oak, southern magnolia, American holly, red bay, and at least two species of hickory. All of these species are found on Cumberland Island in the more mature forests (see Table 17). Monk found the following evergreens to be dominant in the wet acid phase (bayhead forest): sweet bay, swamp red bay, and loblolly bay. These species were found to be prominent members of the lowland mixed hardwood communities on Cumberland (importance values of 14.7, 65.6, and 21.7, respectively). It seems reasonable to interpret the more mature forests of Cumberland as subtropical in nature since these forests are dominated by broad-leaved evergreens, show floristic affinities with tropical forests, and occur in a moderate oceanic climate. These island forests, because of the dominance or co-dominance of oaks and pine in many phases, also might be considered as sub-tropical variations of the oak-pine forests of North and Central America. With the exclusion of fire over many decades, the forests change gradually in composition to predominantly oaks and other hardwoods.

Influence of Land Use

It will be evident from previous and following sections of this report that the island vegetation has been greatly modified by man's use and management. Much of the island forest was cleared for agriculture at one time. The exact acreage under cultivation at the peak of Cumberland's agricultural productivity is unknown to us. But, from early land use maps, we assume that the major part of the upland soils was under cultivation.

The amount of land currently in cultivation and improved pasture is relatively small.

Secondary succession has proceeded on the abandoned agricultural lands, and many of these habitats have reverted to a semi-natural condition. They have, however, been subjected to grazing and selective harvest of pine timber for many years. In the last 10 to 20 years small areas have been used for spoil disposal and for pine plantations. Some habitat alterations such as drainage canals, dikes and spoil deposition have produced essentially permanent habitat changes.

The probable sequence of vegetation changes resulting from man's activities are shown in Figure 24.

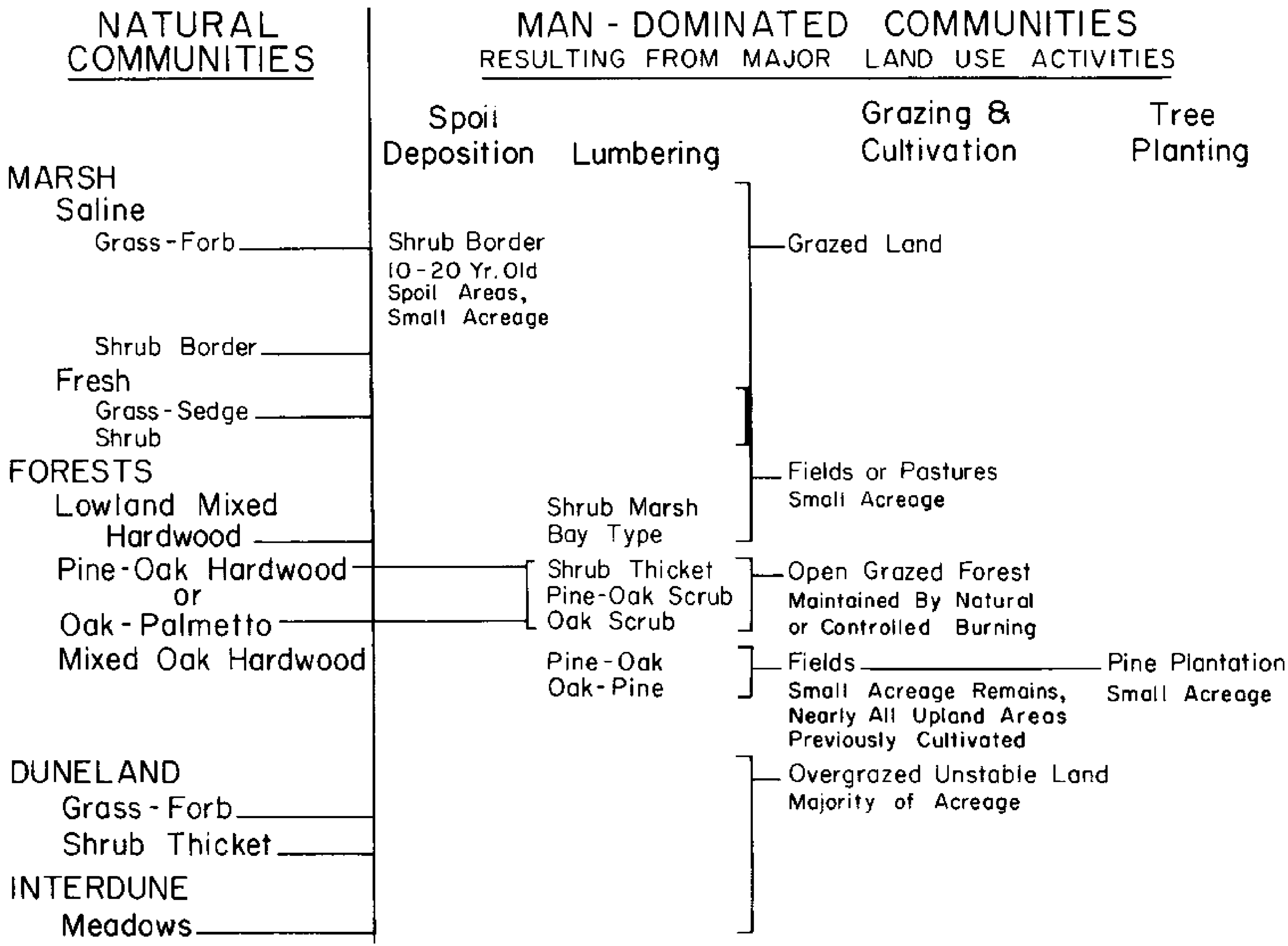

Figure 24. Relationship of the natural plant communities and man's past land use practices on Cumberland Island.

VII. FAUNA

Cumberland has perhaps the greatest faunal diversity of Georgia's barrier islands. Because of its large size and considerable habitat diversity, the island supports large resident populations of white-tailed deer, raccoons and feral animals and seasonally attracts large numbers of shore birds, herons, egrets, and sea turtles. The island provides essential breeding and overwintering habitat for many species. No comparative information on invertebrate fauna exists.

During this study, an effort was made to survey the vertebrate and invertebrate fauna of Cumberland and to define, whenever possible, interactions with habitats. Most terrestrial vertebrates and freshwater fishes were systematically surveyed, but only certain groups of invertebrates were sampled. Survey procedures are discussed where appropriate in the following pages.

Mammals

Museum records and published accounts reveal that 26 species of wild terrestrial or arboreal mammals once inhabited Cumberland Island (Tables 5, 6). Seven species of marine and estuarine mammals have been recorded in the area (see Appendix III for complete listing). Records for Little Cumberland Island (Tables 5, 6) include 13 species, exclusive of marine forms, one of which has been extirpated. The opossum, gray fox, black bear, and bobcat were apparently extirpated from Cumberland within the last 100

Table 5. Summary of terrestrial and arboreal wild mammal records for Little Cumberland and Cumberland islands, Georgia.[a]

Common Name	Little Cumberland Island	Cumberland Island
Virginia opossum	L*	L*
Short-tailed shrew		S
Least shrew		S
Eastern mole	O	S
Eastern pipistrelle	O	S
Big brown bat	O	S
Seminole bat		S
Northern yellow bat		S
Nine-banded armadillo	O	O
Marsh rabbit	S	S
Gray squirrel		S
Fox squirrel		S
Cumberland Island pocket gopher		S*
Marsh rice rat	O	S
Eastern harvest mouse		S
Oldfield mouse		L*
Cotton mouse	S	S
Hispid cotton rat	O	S
Black rat		S
Gray fox		L*
Black bear		L*
Raccoon	S	S
Mink	O	S
River otter	S	L
Bobcat		L
White-tailed deer	L	S

[a]Explanation of Symbols:
- *Species no longer exists on Island. Documentation in Appendix II.
- S - Record documented by specimen;
- L - Record documented by literature citation;
- O - Record documented by sight observation.

Table 6. Wild, terrestrial mammal groups presently occurring on Little Cumberland and Cumberland islands and the adjacent mainland.

Group	Number of Species		
	Little Cumberland	Cumberland	Mainland
Small mammals	4	8	18
Intermediate mammals	5	8	15
Large mammals	1	1	3
Total	10	17	36

years. The opossum was present on the island in the late 1800's (Ober 1880), the gray fox about 1930 (Bent 1940), and the bobcat about 1900 (Harper 1927). The latter species was reintroduced onto Cumberland in 1972 and 1973. One species, the Cumberland Island pocket gopher, apparently became extinct within the last three years. This was the only known insular species of mammal from Georgia (Johnson et al. 1975). Only one species for which there are no previous records has become established within historic times (armadillo).

The small terrestrial mammal fauna includes moles, cotton rats, rice rats and other similar small mammals. Absence of certain habitats found on the mainland, relatively recent geologic development, and isolation of the islands have resulted in a relatively impoverished small mammal fauna. Cumberland is older, larger and more diverse than Little Cumberland Island, and there are records of eight species of small mammals from Cumberland as compared to four species for Little Cumberland. Because of its proximity, Cumberland undoubtedly provided the ancestral stock of small mammals occurring on Little Cumberland; all the small mammal species found on Little Cumberland also occur on Cumberland. Cumberland presently supports 44 percent of the small mammals occurring on the adjacent mainland. (See Tables 5 and 6 and Appendix III for listing of species.)

The Cumberland Island pocket gopher was described by Bangs in 1898. He reported that "...the hills [gopher mounds] straggled off through the pine woods for miles" near Stafford Place. Gophers were also common on the north end of the island. The last recorded presence of this species on Cumberland was March 1970 when six mounds were observed at Stafford

Place (Johnson et al. 1975). Intensive field surveys during 1973 failed to reveal its existence, and the species should now be considered extinct. Causes of its extinction are unknown.

Bangs (1898) described Peromyscus insulanus as a new species of mouse from Cumberland. Osgood (1909) revised the genus and made P. insulanus a junior synonum of P. gossypinus anastasae (Anastasia Island cotton mouse). The subspecies has been collected on Little Cumberland and Cumberland islands and Anastasia Island, Florida. It has been extirpated from the latter (Pournelle and Barrington 1953) but still occurs on Little Cumberland and Cumberland Islands. This subspecies has been proposed for addition to the federal list of threatened species.

The cotton rat is the most common small mammal on the two islands. It occurs in practically all upland habitats, being absent from only the most xeric and hydric habitats. It is a common prey species for hawks, owls, and rattlesnakes.

Moles are the second most common small mammal and are abundant on all well-drained habitats, but especially the interdune habitat. They are common prey for barn owls on the islands.

The oldfield mouse was reported by Wright (1926) to occur on Cumberland but several recent attempts to record the species there have been fruitless. The species should be considered extirpated from Cumberland. It is common on the mainland.

The rice rat is the most common mammal in the salt marshes and is one of the few mammals to inhabit this environment. Its ecology and energetics have been reported on by Sharp (1962, 1967). Rice rats also occur in the fresh water marshes on the islands and are occasionally encountered in terrestrial habitats.

The short-tailed shrew, least shrew and eastern harvest mouse probably occur in moderate numbers on Cumberland, but no data were collected on them. The introduced black rat occurs near buildings. During the survey of Cumberland, very few of these pests were observed, probably because of minimal agriculture and animal husbandry, which normally provide these rodents with food and cover.

Small mammals (especially rodents) on small islands tend to be somewhat larger than their counterparts on the mainland, while the reverse is true of lagomorphs, carnivores and artiodactyls (Foster 1964, Corbet 1966). Bangs (1898) reported that pocket gophers, gray squirrels and moles on Cumberland Island and rice rats on Ossabaw Island were larger than their mainland counterparts. However, he reported that Peromyscus insulanus was slightly smaller on Cumberland than Peromyscus on the mainland, and he did not quantify morphometric differences for the series of mammals he collected. The exact reasons for the apparently larger size of small mammals on islands are unknown, but they probably are related to reduced levels of competition and predation on islands (Foster 1964, Corbet 1966).

Four species of bats have been collected in the Cumberland-Little Cumberland Island vicinity (see Appendix III for species listing). A northern yellow bat collected on Cumberland Island constitutes one of the very few records for this species in the Coastal Plain of Georgia. The Seminole bat is not an uncommon species on Cumberland Island from late fall to spring. It commonly roosts in Spanish moss in portions of its range in southwestern Georgia (Golley 1962). A small nursery colony of big brown bats occurs in the Dungeness carriage house and stables.

Mammals of intermediate size include the gray squirrel, marsh rabbit, mink, otter, raccoon, and armadillo. Gray squirrels are common on Cumberland although they do not occur in large numbers. They are apparently native to Cumberland (Bangs 1898, Harper 1927) but do not occur on Little Cumberland Island (Tomkins 1965). Fox squirrels are reported to occur on Cumberland Island (see Appendix III), but they were not observed during this survey and must occur in small numbers, if at all.

Marsh rabbits are most commonly found in semiaquatic areas between older dune systems on the eastern side of the islands. They are frequently observed in large numbers in late afternoon on the roads through these habitats.

Otter are common near the freshwater habitats on Cumberland and also frequent the small salt marsh creeks. Mink are very common in the salt marshes around Cumberland. They are less common than otter in the interior freshwater habitats of the island. Both species feed on small fish and various crustaceans.

The raccoon is ubiquitous, occurring in all island habitats and in the adjacent salt marshes. It is by far the most common mammal of its size class on Cumberland and is one of the most ecologically important species. It is a significant predator of sea turtle eggs on some islands and is a common predator of turtle nests on Cumberland. Undoubtedly the large distance between the nesting beach and the adjacent forests reduces the number of raccoons foraging on Cumberland's beaches during the turtle nesting season. Thus, depredation of turtle nests by raccoons is lower on Cumberland than on many other islands. Raccoons adapt quickly to the presence of people and frequently become pests near recreation centers. These problems are discussed further in a subsequent chapter (Management Options).

The armadillo was first noted on Cumberland in 1973 and on Little Cumberland in 1974. It is not known whether its introduction was deliberate or by natural means. Regardless, its presence on Cumberland was to be expected because it has been expanding its range throughout the southeast in recent years and is an excellent swimmer. In 1962 it was reported only in Bibb, Decatur and Grady counties (Golley 1962), but today it is very common in the southeast corner of the state (Cleveland 1970). The high reproductive potential and longevity of the species insures its continued existence, and there is every reason to suspect that it will become a very common animal on Cumberland in the near future.

Armadillos are primarily insectivorous and are not a significant predator on the eggs of ground nesting birds (Kalmbach 1944, Kennamer and Lunceford 1973). They should not be considered a threat to wild turkeys on Cumberland. Also, they prefer wooded areas and should not present a threat to tern colonies on the beaches.

The only large native mammal presently found on the islands is the white-tailed deer. It is generally well distributed over both islands. Highest numbers occur in the Greyfield-Dungeness and Plum Orchard-Duck House areas which contain a diversity of habitats including semi-maintained fields and pastures. Also, these areas have not received substantial hunting pressure in recent years. On the northern portion of the island, annual hunting combined with less productive habitat probably depress deer numbers. No harvest data exist, but based on conversations with landowners, the estimated harvest is no more than 50 deer per year. No hunting is permitted on Little Cumberland Island.

Bangs (1898) reported a "tremendous" herd on Cumberland, "...about all the island can support...", but the island presently supports a relatively low deer density--much less than other islands such as Ossabaw and Blackbeard.

Estimated density is one deer per 30 acres or a total population of about 500 for the upland portion of the island. The population is depressed by the presence of livestock.

Population densities are usually much greater on the islands than on the adjacent mainland. Differences in hunting pressures may account for some of the differences but not all. For example, the Blackbeard Island population is hunted by archers, and an estimated 25 percent of the herd is harvested annually. Yet, the island sustains a prehunting season population of approximately one deer per 7 acres (S. Osborne, per. comm.).

Cumberland and Little Cumberland islands lie within the region of integradation between the Blackbeard Island white-tailed deer (*Odocoileus virginianus nigribarbis*) and the Florida white-tailed deer (*O. v. seminolus*) (Taylor 1956). However, due to the isolation of Cumberland and the similarities of the island's habitats to those on Blackbeard Island, the Cumberland population is probably more closely related genetically to the Blackbeard population. Long-term residents of Cumberland state that deer from the mainland have been introduced on Cumberland but give no details as to when this occurred, how many deer were involved or from where they came. Therefore, the impact of the introductions on the native herd is not known. However, the deer appear to be of the same size range as deer on other barrier islands; they are notably smaller than deer on the adjacent mainland.

The reasons for the significant difference in body size between island deer and mainland deer has been the subject of conjecture by wildlife biologists for many years. Qualitative and quantitative deficiencies in diet are an obvious factor, but the small size of island deer seems to be at least in part genetically based. The general trend for island deer to be smaller than their mainland counterparts is found throughout the white-tailed deer complex, and in North America the smallest form is the Key West white-tail (O. v. calvium) of southern Florida (Taylor 1956). Foster (1964) surveyed the artiodactyla on 11 marine islands off western North America and Europe and reported that island forms were smaller than their mainland counterparts on nine islands and the same size on two islands.

On most islands in the Southeast, deer populations are limited by parasites and diseases interacting with poor nutrition. Because island deer populations are limited in immigration possibilities and large predators are absent, selection pressures for optimum size would favor smaller animals better able to maintain a population size large enough to insure survival of the herd in a habitat with food resources greatly limited in quantity and quality. Subtropical temperatures may also be a factor.

Livestock (horses, cattle and pigs) are abundant on Cumberland Island. Little Cumberland Island has a small number of pigs only. All three species are well distributed over Cumberland Island. Cattle and horses tend to be concentrated in pastures and marshes. Horses seem to graze more frequently in the high phase salt marsh than do cattle. An accurate estimate of the population of cattle and horses was not obtained, but 60 horses and 300 cattle were counted during the survey. No accurate estimate of the ubiquitous pig population was obtained, but there are several hundred animals on the island. On Cumberland all livestock are reduced periodically by trapping (pigs) or corralling (cattle and horses).

Deer and livestock are discussed further in the chapter on management options.

Birds

The avifauna of Cumberland Island has not been systematically or thoroughly studied. Helme (1904) reported several unusual occurrences on Cumberland (Kirtlands warbler, Ipswich sparrow and Sprague's pipit).

Pearson (1922) listed 97 species of birds he encountered on a visit to the island May 2-6, 1921. Sprunt (1936) visited Cumberland for a week in April 1932 and a week in April 1933. He presented a list of 149 species observed during these two weeks.

There have been several recent reports dealing with certain colonial nesters, such as glossy ibis (Jones 1967), black skimmers (Dopson and Richardson 1968), terns (Dopson and Richardson 1968, Downing 1973) and herons and egrets (Johnson et al. 1975).

During the summer and fall of 1973, we made general observations of bird life on Cumberland but did not conduct a systematic study of the avifauna of the island.

The list of birds expected to occur on the island during the year includes 323 species (Appendix IV). The estuarine and marine environments surrounding Cumberland and Little Cumberland islands combine with 22 terrestrial communities to provide a diversity of habitats unequaled anywhere on the Georgia coast. About 101 species nest within the area which exceeds any other region of the state. Nesting habitats of resident species are presented in Table 7. There are 18 species of colonial nesters.

Cumberland provides resting and feeding areas for about 222 species which do not nest on the island but occur there during migration. The maritime live oak forest provides essential feeding habitat for many passerine migrants. Thus island stands of live oak are becoming increasingly important for many songbird species as live oaks on the mainland are replaced by pine plantations. In general the island forest is in an advanced stage of succession and supports the bulk of the nonmarine birds, which are primarily insectivores (111 species). There are about 67 species of granivorous birds on the island, but they are less abundant because of the limited amount of habitat producing the small seeds preferred by these species. Most of the feeding habitat suitable for granivores occurs in the small fields, pastures, and lawns and in the interdune areas of the island. Generalized food habits of birds expected to occur on the islands are presented in Table 8. For additional information on occurrence and habitat requirements of birds visiting or residing on Cumberland, see Appendix IV.

Various native and exotic game birds have been released periodically on most of the privately owned coastal islands. Cumberland Island has received stockings of wild turkeys, bobwhite quail and coturnix quail (*Coturnix coturnix*), an old world species. The bobwhite quail releases apparently have not resulted in a self-sustaining population, probably because of habitat deficiencies. Likewise released coturnix quail failed to become established.

Table 7. Birds expected to nest on Cumberland and Little Cumberland Islands according to habitat.

Nesting habitat	Number of species
Ground	32
Tree (above 3 feet)	47
Cavities	22
Total	101

Table 8. Generalized food habits of birds expected to occur on Cumberland and Little Cumberland Islands

Type of feeder	Number of species
Herbivore-granivores	67
Insectivore	111
Carnivore (marine)	120
Carnivore (non-marine)	25
Total	323

Wild turkeys were formerly native to Cumberland Island. Sprunt (1936) reported them to be unusually abundant there, but it is not known whether his observations were of native or introduced stock. Pen-reared, semi-tame turkeys are released periodically by island residents, and the turkeys presently on Cumberland Island are of pen-reared origin. About 75 turkeys were counted during a two-day survey in the summer of 1973. About 60 of these were in the Stafford-Greyfield area, and the remainder were observed at Plum Orchard and near Brickhill Bluff.

Cumberland Island provides habitat for a fairly large number of wintering waterfowl. Dabbling ducks such as mallards, black ducks, pintails, baldpates, and wood ducks comprise the bulk of the overwintering waterfowl. All except the wood duck are most commonly observed in Lake Retta, Willow Pond and Lake Whitney. The wood duck is most common in small sloughs and ponds. Although wood duck numbers increase during the fall with the arrival of migrants, a fairly large number nest on the island.

Five species of birds classified as threatened or endangered may be encountered on Cumberland Island, but none are permanent residents. Brown pelicans are common on the beaches, offshore and in the sounds near Cumberland but they are not known to nest in Georgia. Birds observed in the vicinity of Cumberland Island are non-nesting adults or young produced at colonies near Georgetown, South Carolina, and St. Augustine, Florida. Nesting success of these colonies has increased in recent years, and the number of birds seen on Cumberland should increase.

The southern bald eagle is occasionally seen on Cumberland but has not nested there for many years. The last documented nesting of bald eagles on the Georgia coast was on St. Catherines Island in 1970. Adequate nesting habitat exists on Cumberland, and eagles may nest there again in the future.

Peregrine falcons are rare transients, seen on the beaches during their southward migration in September, October and November. J. Hudick (pers. comm.) observed 14 from 27 September to 14 October, 1974. Most observations of peregrines are on the south beach where shorebirds, which comprise much of the diet of these predators, are numerous.

Kirtland's warbler was recorded on Cumberland Island in 1902 (Helme 1904). There are no recent records from Cumberland. This warbler nests in North Central Michigan and winters in the Bahamas (Burleigh 1958). It is rare throughout its range.

The red-cockaded woodpecker is a rare transient on the island. There are no records of the species ever having nested there, although adequate nesting habitat seems to exist especially on the northern portion of the island. The red-cockaded woodpecker nests primarily in mature pines infected with red-heart disease (*Fomes pini*).

Shore birds nesting on Cumberland include gull-billed terns, least terns, Wilson's plover, willets, oystercatchers, black skimmers. Nesting occurs from May to August.

Least terns are the most common nesting shore birds on Cumberland. They commonly nest in sandy expanses above the high tide line on the front beach. The nesting areas are subject to wind and water erosion, and the locations of nesting colonies change from year to year.

In 1973 four colonies of least terns nested on Cumberland. The largest colony of about 100 pairs nested on the south end between the jetty and Dungeness Beach Road (Downing 1973). This site has been used every year since 1970 or before. A small colony of approximately 25 pairs nested near the beach exit of Dungeness Beach Road. Another small colony of 15-20 pairs nested east of the Sweetwater complex in a large area of sand accretion. From 1970 to 1973 terns nested on Long Point on the northern end of Cumberland. The size of this and other colonies fluctuates from year to year. In 1973 approximately 50-75 pairs nested on Long Point.

Gull-billed terns commonly nest among least terns. During the nesting season of 1973, they nested in low numbers at Long Point and South End. Approximately 25 pairs were observed in both colonies. In contrast to the least tern, which makes a simple excavation in the sand for a nest, the gull-billed tern usually accumulates a moderate amount of wrack debris around its nest.

Black Skimmers prefer isolated sand bars that rise only a few feet above high tide. This type of habitat occurs in the mouth of Christmas Creek where approximately 200 pairs nested in 1973. Dopson and Richardson (1968) reported 15 downy young among 400 adult and immature skimmers on a small sand bar island in St. Andrews Sound.

Wilson's plover, oystercatchers, and willets nest in small numbers throughout the interdune-front beach habitat on Cumberland. Willets nest most commonly in short vegetation, chiefly salt-meadow cordgrass. Several nests of this species were found near the South End Flats. Oystercatchers and Wilson's plover nest above high tide in the wrack zone. All of these species are solitary nesters, although willets may nest in close proximity.

All of the shore birds are highly susceptible to human disturbance during the nesting season. The reader is referred to chapter VIII for management recommendations relating to these and other birds.

Wading birds (herons, egrets and ibises) nest in emergent vegetation in and around the numerous sloughs and ponds on Cumberland and Little Cumberland Islands. The location and species composition of these rookeries varies each year. Apparently, water levels in the sloughs and ponds determine to a great degree the selection of rookery sites. In 1970 common and snowy egrets nested in the Sweetwater-Lake Retta complex and great blue herons and cattle egrets nested in Ashley's and Johnsons ponds (Johnson et al. 1975). In mid-May 1973, 20 or 30 pairs of common egrets nested in Heron Pond, and an undetermined number of common and snowy egrets nested in the Sweetwater complex. Approximately 20 pairs of great blue herons nest on Little Cumberland Island each year.

Reptiles and Amphibians

Cumberland Island supports 34 species of reptiles and Little Cumberland supports 23 species. Eighteen species of amphibians occur on Cumberland compared to eight species on Little Cumberland. All species of reptiles and amphibians found on Little Cumberland also occur on Cumberland, which probably has served as the source of Little Cumberland's herpetofauna. The herpetofauna of Cumberland Island includes 51 percent of those species occurring on the nearby mainland (Table 9). Little Cumberland Island, smaller and younger than Cumberland, supports 31 species of reptiles and amphibians, or 51 percent of Cumberland Island's herpetofauna and only 29 percent of the mainland herpetofauna. For a listing of species, see Appendix V.

The loggerhead sea turtle, although seasonal, is the only insular species of reptile or amphibian, and no insular races of reptiles or amphibians have been discovered on the islands. However, there have been no detailed taxonomic studies of the reptiles or amphibians occurring there.

Frogs and toads have been rather successful in colonizing the islands, whereas salamanders have been the least successful group (Table 9). Four species of salamanders occur on Cumberland Island; only one species occurs on Little Cumberland. Christmas Creek and the adjacent salt marsh apparently are effective barriers to movement of salamanders between the islands.

Fifteen species of snakes have been collected on Cumberland Island, including three species of poisonous snakes. The cottonmouth moccasin is perhaps the most common poisonous species. It is very common in the aquatic and semiaquatic habitats. It is often confused with the harmless banded water snake which occurs in the same habitat but is much more aggressive. The diamondback rattlesnake is the largest common poisonous snake on the island. Specimens up to six feet in length were encountered during this survey. The diamondback occurs in all habitats but is more

Table 9. Summary of reptile and amphibian groups occurring on Cumberland and Little Cumberland islands and the adjacent mainland.[a]

Group	Species on Little Cumberland	Species on Cumberland	Species on Mainland	Percent of Cumberland species on Little Cumberland	Percent of Mainland species on Little Cumberland	Percent of Mainland species on Cumberland
Frogs & Toads	7	14	21	50	33	67
Salamanders	1	4	14	25	8	29
Snakes	12	15	38	80	32	39
Turtles	4	9	17	44	24	53
Alligator	1	1	1	100	100	100
Lizards	6	9	11	67	55	82
Total	31	52	102	59	30	51

[a]See Appendix V for listing of species occurring on Cumberland and Little Cumberland Islands.

frequently encountered near old fields in grassy areas in the swales of the old dunes, and in upland habitats having a dense understory of saw palmetto.

Only one specimen of the canebrake rattlesnake has been collected from Cumberland and it may represent a recent introduction.

There are no records of the copperhead or the coral snake having been collected from Cumberland. The nonpoisonous scarlet king snake closely resembles the coral snake, and it is present.

Of the reptile groups, lizards have been most successful in colonizing the habitats of the two islands. Nine species occur on Cumberland and six on Little Cumberland, compared to the mainland's compliment of 11 species. Apparently, most habitats supporting mainland species of lizards occur on Cumberland. One species, the fence lizard, occurs only on the northern 4/5 of Cumberland. It apparently does not occur south of the Greyfield area although adequate habitat exists there.

The American alligator is well distributed throughout the aquatic habitats of the island. A complete census of the population was not conducted because of the inaccessibility of certain areas. Five night counts were conducted during the summer of 1973 and yielded a high count of 45 alligators. The total population was estimated at approximately 100 alligators. The largest alligators (and greatest numbers) occur in Lake Whitney. One count in June revealed 16 alligators in the 3- to 9-foot size range in Lake Whitney. No very large alligators were observed anywhere on the island.

There is much seasonal movement of alligators from one habitat to another on the island and infrequent movement between Cumberland and Little Cumberland and between Cumberland and the mainland. During breeding season, females move out of the deep water areas into the shallow marshes and sloughs to nest, and in periods of drought alligators are concentrated near the deeper ponds and potholes. During the wet season they are well distributed throughout the island's aquatic habitats.

Females (approximately 7 feet and larger) nest throughout the shallow marshy habitats on the island. Several nests observed were constructed of sand cordgrass on the margins of fresh water sloughs and ponds. After hatching, the young remain in the shallow marshes for several years. They move into the deep water areas only after they attain a length of 2 to 3 feet. Alligators of this size and larger feed extensively in the tidal creeks on the western side of and between the two islands.

Five species of freshwater or terrestrial turtles occur on Cumberland (see Appendix V). Only one, the mud turtle, occurs on Little Cumberland. One species, the gopher tortoise, apparently was recently introduced on Cumberland. It occurs in greatest numbers near Hickory Hill although individuals have been sighted on both the northern and southern portions of the island. This species probably will thrive on Cumberland.

The Atlantic loggerhead sea turtle is the most conspicuous component of the island's herpetofauna. Nesting females begin to arrive on the beaches in mid-May, and the last hatchlings usually have departed by November. Thus, the loggerhead utilizes Cumberland's beaches for almost 6 months of the year.

Many aspects of this marine reptile's life history have been studied and reported (Caldwell et al. 1959, Caldwell 1962, Daniel and Smith 1947) and will not be repeated in detail here. A general summary of its distribution and nesting habitat needs in Georgia is provided by Johnson et al. (1975).

Loggerheads arrive in the Cumberland-Little Cumberland area in early spring. Both sexes and all size classes occur in the sounds and estuaries during this time. Females begin nesting in mid-May and continue until mid-August. Males of breeding size apparently move out of the area following breeding and are seldom encountered during the egg-laying period of the females. It is well known that nesting females select certain types of beaches for nesting (Caldwell et al. 1959). These preferred nesting beaches can be identified by easily recognized characteristics. (See Caldwell et al. 1959, Johnson et al. 1975, for detailed description of beach types.) In general nesting females require a sloping beach backed by a stable dune system. The dune system enhances the orientation of females returning to the sea after laying and of the hatchlings moving to the sea. These types of systems usually have an adequate area for egg deposition above mean high tide at the base of the dunes.

Desirable and consequently well used nesting habitat occurs on the northern end of Cumberland Island. The Candler Beach Road generally demarks the southern end of this good beach, which extends about 4.5 miles. Only sporatic nesting occurs along the beach to the south of this point. The beach system in this region is generally of the wide sloping type with no foredunes and rear dunes as much as 100-300 yards inland of the beach. Including Little Cumberland Island, there are about 8 miles of suitable nesting beach.

A sea turtle research and conservation program, sponsored by the Little Cumberland Island Association, has been operating on Little Cumberland Island since 1964 (unpublished report, 1973, The Little Cumberland Island Association). The program has consisted of tagging females on the beach, relocating eggs to an artificial hatchery, and releasing hatchlings into the sea. From 1964 to 1973, 634 turtles were tagged and over 60,000 hatchlings released into the sea. From the tagging data (1964-1971) it was estimated that 500-600 nesting females used the Little Cumberland Island beach. From 1964 to 1971, the number of nesting females using Little Cumberland was relatively constant. However, the years 1972-1974 produced a significant increase in the number of untagged turtles nesting on the island. This increase may have resulted from the return of turtles hatched and released on Little Cumberland during the early years of the project, but this is not definitely known. Turtles hatched in 1964-1966 would have reached size classes required for laying about that time. The influx of new turtles also could be due to shifting of a nesting population from elsewhere to Little Cumberland, but this is doubtful. In any case, the additional turtles have boosted the nesting population on Little Cumberland to more than the original estimate of 600, but additional data must be obtained before a new estimate can be made. Based on the tagging data from Little Cumberland, limited tagging data from Cumberland, and the number of nests recorded on Cumberland for the last three year, the estimated nesting population of Cumberland is approximately 300. The combined nesting population for the two islands probably approaches 1,000 individuals.

The loggerheads nesting in the Cumberland-Little Cumberland area show a high degree of overlap of nest site selection between the two islands, perhaps indicative of a single breeding population for this area. At least 50 percent of the turtles nesting on Cumberland-Little Cumberland switch beaches between nestings. This percentage may prove to be higher if a tagging project is conducted throughout the nesting season for at least a three year period. During 1972 and 1973 a limited amount of tagging was conducted on Cumberland and a significant amount of overlap of nesting was detected. However, during the summer of 1974, Ms. Carol Ruckdeschel conducted the first systematic tagging project on Cumberland to last throughout the nesting season. She documented 364 crawls and encountered females on 208 occasions. Of the 364 attempts, 138 resulted in complete nests. Seventy-six different females were encountered of which 50 had been tagged previously, most of them on Little Cumberland Island. These data strongly suggest that the two islands constitute one rookery.

The average number of nests per female during a breeding season is two, but an individual turtle may nest from one to six times in a summer. An average clutch is approximately 120 eggs. Turtles return to the nesting beach on a 2- to 3-year cycle. Thus, the number of nesting loggerheads on Little Cumberland and other islands in any given year varies considerably.

Fresh and Brackish Water Fish

During the summer and fall of 1973, 14 aquatic systems on Cumberland were sampled to determine the species composition and distribution of fish on the island. Both fresh and brackish water systems were sampled by seining or by sport fishing methods.

The survey revealed 12 species (Table 10); their distribution by systems, previously discussed in Chapter V, is summarized in Table 11.

Table 10. Common and scientific names of fish collected on Cumberland Island, September 1973.

Common Name	Scientific Name
Mosquitofish	*Gambusia affinis*
Sailfin molly	*Poecilia latipinna*
Sheepshead minnow	*Cyprinodon variegatus*
Marsh Killifish	*Fundulus confluentus*
Mummichog	*Fundulus heteroclitus*
American eel	*Anguilla rostrata*
Yellow bullhead	*Ictalurus natalis*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Largemouth bass	*Micropterus salmoides*
Mojarra	*Eucinostomus* sp.
Striped mullet	*Mugil cephalus*

Table 11. Distribution by aquatic systems of fish species collected by seining and by hook and line, September 1973.

Aquatic System[a]	*Gambusia affinis*	*Fundulus heteroclitus*	*Fundulus confluentus*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Mugil cephalus*	*Eucinostomus* sp.	*Anguilla rostrata*	*Ictalurus natalis*	*Micropterus salmoides*	*Lepomis gulosus*	*Lepomis macrochirus*
Whitney Lake	x					x			x	x	x	x
Sweetwater Lake	x			x		x				x	x	x
Whitney Outflow	x			x		x	x			x	x	x
Killman Field Pond	x											
Red Bridge Outflow	x	x	x									
Ashley Pond	x											
Swamp Field Drainage	x			x					x		x	
Willow Pond	x										x	
Lake Retta	x			x	x	x		x				
South End Ponds	x			x	x							
Heron Pond	x											
Plum Orchard Pond	x									x	x	x

[a]See place names map for location of aquatic systems.

Most of the species collected are euryhaline and occurred in the almost fresh to strongly brackish water. Four species, largemouth bass, bluegill, warmouth, and yellow bullhead, occurred in Lake Whitney, Willow Pond, Whitney Outflow, and Plum Orchard Pond. These are permanent fresh water systems except for the lower portion of Whitney Outflow, which is brackish.

Only the largemouth bass, bluegill, warmouth, and yellow bullhead obtain sport fishing size. Other species, too small for sport fishing, frequently occur in large numbers in the shallow systems and serve as important prey species for numerous wading birds and a few species of waterfowl (e.g. mergansers). Harvestable stocks of desirable sport fish occur primarily in Whitney Lake, Willow Pond and Plum Orchard Pond. Other small artificial ponds such as High Point may support catchable quantities of these fish.

Invertebrates

Terrestrial arthropods -- Very little is known about most arthropods on the barrier islands. Most of the arthropod research conducted in the coastal area has been directed at effecting controls for noxious arthropods (Bidlingmayer and Schoof 1957, Snoddy 1970, others). No island has been systematically surveyed or studied in relation to its arthropod fauna. Tippins and Beshear (1969, 1970a, 1970b, 1971) studied the Homoptera of Cumberland Island, and Beshear (1969, 1970a, 1970b, 1971, 1973) published on the Thysanoptera and other groups. They reported several new species and new records.

Within budgetary and time limitations, a study was conducted on Cumberland during June-August, 1973, to:

a) survey some of the arthropod fauna of the island to provide baseline data on arthropod fauna for evaluating future habitat changes,

b) ascertain the status of certain noxious species and groups, and

c) survey timber stands for present or potential insect damage.

Pitfall traps were used to trap the common beetles in the groups Scarabaeidae and Carabidae. These groups are composed of numerous species, some of which may be habitat-specific. Pitfall traps yield numerous other groups as well and can be monitored with a minimum of personnel.

Arthropod ground fauna associated with eight vegetation types were collected in pitfall traps from 1 June through 30 August, 1973. Ten traps consisting of 1-quart freezer containers were buried to ground level in each vegetation type. Each trap had a cover that allowed arthropods to enter but prevented debris and rain from falling into the trap. Ethylene glycol was placed 2 inches deep in the traps to kill and preserve arthropods until they were collected. The traps were checked at weekly intervals, and all arthropods, other invertebrates and vertebrates trapped were removed and preserved in 70 percent alcohol or formalin for counting and identification.

Vegetation types in which the traps were placed are described in detail in Chapter VI; they are (I) Interdune flats, grass-sedge (wet site), (II) Interdune flats, grass-sedge (dry site), (III) Upland-forests, oak-palmetto forest, (IV) Upland-forests, mixed oak-hardwood forests, (V) Loblolly pine plantation, (VI) Fresh water, shrub marsh, (VII) Upland-forests, pine-oak scrub forest, and (VIII) Upland forests, oak-pine forest.

An extensive survey of forest stands was conducted to identify any present or potential forest insect damage problems. Surveys were made by systematically traversing all roads and beaches on the island during August and November 1973. Additionally, residents and other researchers on the island were asked to report any recently dead or dying trees or other evidence of insect damage.

Also, general insect collecting was done by hand, and with insect nets, beating sheets, and sticky boards.

Numbers of insects in different orders and families collected at weekly intervals from pitfall traps in vegetation types I-VIII are shown in Tables 34-41, Appendix VI. Table 42 shows total numbers of orders and families for the entire trapping period.

The most prominent insects both in numbers and biomass were beetles of the family Scarabaeidae. Twenty-three species of scarabs were collected. Identifications are incomplete at this time, but species of scarabs identified to date are given in Table 43. Apparent associations of certain species with particular vegetation types may be artifactual as a large number of the species are coprophagous (dung-feeders), and their abundance and distribution may be affected to some degree by the distribution of large grazing and browsing animals such as deer, cattle, horses, and swine.

Twenty species of Carabidae (ground beetles) were collected during the survey period (Table 44). The largest numbers of carabids were collected from sites I and II (beach sites), and one species, *Omophron labiatus*, dominated the carabid fauna. Site VI had the highest number of carabid species, but numbers of individual species were low. One very large ground beetle, *Pasimachus strenuus*, occurred almost exclusively in vegetation type VIII which contained many large longleaf pines and a heavy layer of pine needles. Ground beetles are mostly predaceous on other small arthropods, but some species feed on seed and *P. strenuus* may feed on the pine seeds in the heavy pine needle ground cover.

Distribution and numbers of insects by families and vegetation types are given in Table 42(Appendix VI). Types I and II had the largest numbers of families although the plant diversity is not high on these sites. Types III, V and VI also had large numbers of families, but this was not unexpected since these sites have a rather large number of plant species (see Chapter VI). Types IV and VIII had the lowest numbers of families. Type IV was dominated by live oak and had virtually no understory and a very thin litter layer which provides little cover for insects. Type VIII contained large longleaf pines and had a heavy but homogeneous ground cover of pine needles, thus providing a ground habitat of limited diversity.

Identifications of spiders collected from the pitfall traps are incomplete, and species associations with vegetations types have not yet been established. A list of spiders identified to date is given in Table 45. Species poisonous to humans were not collected, although more intensive collecting may reveal their presence.

Results of arthropod (Thysanoptera, Diptera, Homoptera) collection by methods other than pitfall traps are given in Tables 46, 47 and 48.

Some new collection records have been established on Cumberland Island. Beshear (1970a, 1970b) reported the deer fly Stenotabanus psammophila and the thrips, Sporothrips amplus and Atractorthrips bradley, as new state records. Tippins and Beshear (1970a) listed 41 species of scale insects in an annotated list of armored scale insects from Cumberland Island, including four undescribed species and one new North American record. Two species of armored scales from laurel oak and saw-grass were subsequently described (Tippins and Beshear 1970b, 1971).

Forest insects (those attacking trees) and noxious (blood-feeding) arthropods are discussed in a later section.

Gastropods -- No systematic studies of the gastropod fauna of the barrier islands of Georgia have been conducted. Pilsbury (1948) collected *Succinea campestris* on Sea Island and St. Simons Island and *Euglandina rosea* from Hutchinson's Island (Chatham County) and St. Simons Island. Hubricht (1964) reported on the land snails of Georgia based on non-systematic collecting in the state. Records reported in his paper are incomplete, especially for the coastal area. He reported only two species, *Polygyra volvoxis* and *Zonitoides arboreus*, from the mainland portion of Camden County.

A survey of the gastropod fauna of Cumberland Island was initiated in 1973. Only limited systematic collections were made. Gastropods were collected primarily during the gathering of other field data.

Ten species of gastropods, all of which occur on the mainland, were collected on Cumberland Island (Table 12). One species, *Triodopsis hopentonensis*, has not been reported from any of the barrier islands before. *Euglandina rosea* is a widely distributed predator of other land snails and usually occurs with other species. Collections made during the survey were insufficient to adequately describe the species composition of gastropod populations occurring with this predator.

Zonitoides arboreus is the only species presently known to occur both on Cumberland and in adjacent Camden County. *Lymnaea humilis* is a common pulmmate and probably occurs in most freshwater habitats on Cumberland. It has not been reported from the adjacent mainland although it probably occurs there.

Table 12. Gastropods collected from Cumberland Island, Georgia, 1973

Habitat	Species
Ground litter under Cycad fern	Polygyra pustula
	Zonitoides arboreus
	Helicina orbiculata
	Hawaiia minuscula
	Pupoides modicus
Terrestrial; low, moist interdune flats	Succinea campestris
Freshwater aquatic; low interdune flats	Lymnaea humilis
Well drained pastures and lawns covered with centipede grass	Euglandina rosea
	Succinea campestris
	Tridopsis hopetonensis
Freshwater basins, centipede pasture	Lymnaea humilis
Slash pine plantation	Polygyra septemvolva
	Succinea campestris

Future systematic studies will undoubtedly yield numerous additions to the list presented here. A study of the gastropod fauna of Cumberland in its present condition would provide valuable reference data for studies that may be conducted following the initiation of management. For example, ground cover, which strongly influences the presence and distribution of gastropods, will change upon the reduction of feral animal populations.

VIII. MANAGEMENT ISSUES AND CONSIDERATIONS

Options for the management of resources in specific situations usually exist along a spectrum from total protection of natural systems and processes at one end to intensive modification of these systems and processes at the other. In evaluating management options and offering recommendations, we have considered many alternatives deemed consistent with National Park Service objectives for the Seashore, which we assume to be perpetuating, featuring and interpreting for the public the diverse natural features and processes within the Seashore boundaries. Therefore, the reader will note in this chapter that intensive management of some habitats is recommended initially to return the habitats to more natural conditions, whereas total protection is suggested for other habitats.

In this chapter, management issues are discussed briefly which sometimes repeats information presented previously. It is our consensus that this will enable the reader to better focus on the management options at hand rather than retrieving the supporting information from previous chapters. Thus, this chapter can be read separately from the main text. For those desiring detailed information on the systems and habitats discussed here, reference is given to the appropriate chapter or section of the text.

Island Habitats

Beach and Dunes

Erosion control.--Severe dune erosion is occurring throughout the length of Cumberland Island (see Chapter III, Geologic map), and large dunes have transgressed adjacent forests in some areas. The most severe encroachment upon inland habitats is occurring near Lake Whitney, in the central portion of the island along Sweetwater Lake, and in the southern portion near the Beach Field at Dungeness.

Although dune erosion is a natural process on similar beaches along the southern Atlantic seaboard, the extensive and massive unstable dune system on Cumberland is primarily man-induced. The long-term access of free-ranging livestock to the dunes and associated systems has resulted in the near extirpation of dune-stabilizing plants and creation of a large deflation area. Sand movement from this area onto previously stable rear dunes has increased their size and initiated their movement inland.

The loggerhead sea turtle especially has been adversely affected by the loss of the frontal dune system. Loggerheads require beach types backed by a stable dune system (see Johnson et al. 1975 for a review of preferred types of nesting beaches and Chapter VII here).

Also, unstable dunes filling Lake Whitney and Sweetwater Lake are depleting important habitats for alligators, wood ducks, otters, amphibians, wading birds, raccoons, and other animals.

Unrestricted dune encroachment upon Cumberland may eventually cause problems in the protection of certain historical sites such as Dungeness. Also, siting of seashore recreation facilities near the beaches will be more hazardous in areas near unstable dunes.

The severe dune erosion on Cumberland should be controlled as quickly as possible by the following measures:

1. Immediate removal of feral animals from problem areas.
2. Reintroduction of stabilizing plants onto frontal dune sites.
3. Erection of physical barriers in the most severely eroded areas.

4. Prohibition of traffic across dunes.

The removal of feral animals is absolutely essential before the reintroduction of stabilizing plants. Unfortunately, many desirable plants are also desirable forage species for livestock. A more complete description of feral animal problems is presented later in this chapter.

Native plants such as sea-oats and sea beach panic grass should be planted in the frontal dune areas. Saltmeadow cordgrass could be planted in moist interdune areas. All plantings should be made in the fall, and plants should be closely spaced. Nutrients, especially nitrogen, are limiting factors in the dune habitats; thus, the plantings should be fertilized with nitrogen to enhance initial survival and growth.

Where sand is rapidly filling Lake Whitney, physical impediment of sand movement with "snow-fencing" may be necessary in conjunction with plantings. Once sand movement is reduced by vegetation, the fencing could be removed. With continued management, plants established will eventually produce and maintain a stable sand system.

Interpretive areas.--The following sites would be suitable for demonstration and interpretation of geological and biological features and processes.

South End Flats: This 100-acre area (see place names map) is important habitat for shorebirds. It has very little relief and is frequently inundated by salt water. Saltmeadow cordgrass, the dominant plant, is heavily grazed by cattle and horses. During fall migrations the area attracts rare and unusual species such as buff-breasted sandpipers, golden plovers, upland plovers, and stilt sandpipers. Willets nest in abundance here during the summer. The endangered peregrine falcon frequents this habitat during late September and October.

Visitors should be permitted to use the South End Flats during fall and winter but prohibited during the spring and summer. This natural area could easily be visited without any developments. Visitors could observe birdlife and plant communities from the beach.

Lake Whitney: The large unstable dune system encroaching upon Lake Whitney provides an excellent opportunity to observe and study the geological processes of beach and dune formation and the effects of man-induced removal of dune-stabilizing vegetation. This area could be developed as a geological interpretive area adjacent to the Lake Whitney vegetation and wildlife interpretive area.

Boardwalks should be employed to permit visitor access in the dune areas.

Dungeness: A geological interpretive site could be located near Dungeness Beach Road and extend from the beach to the unstable dune systems encroaching upon Beach Field (see Figure 2). Interpretive opportunities and visitor facilities would be similar to those recommended for Lake Whitney.

<u>Salt Marsh</u>

To the casual visitor approaching Cumberland from the mainland, the extensive salt marsh may appear monotonous. The dominant species, smooth cordgrass, extends over thousands of acres with no marked change in profile. However, the salt marsh is very complex and highly productive and provides essential nutrients which support numerous estuarine and marine organisms. The processes and functions of this important community have been described in numerous publications, summarized by Johnson et al. 1975. Chapter VI contains a discussion of this habitat within the Seashore boundaries.

The salt marsh environment is not suitable for any kind of development. This productive and essential system should remain unexploited by activities that would permanently alter its basic nature.

We recommend that several interpretive areas be located in the salt marsh. Most should be located adjacent to the mainland to provide the casual and short-term visitor with the opportunity to observe and study the relationships among components of the salt marsh ecosystem. Perhaps as few as two sites should be established on Cumberland to provide the same opportunity. Sites on Cumberland could be established most easily by adapting existing piers and docks.

Upland Forests

The vegetation of Cumberland is the result of long-term natural and artificial physical, chemical, and biological selection forces (Chapter VI). Many of these forces should be allowed to continue to interact naturally with the communities, while the effect of others should be reduced.

Fire management.--Historically, fire has played an important role in modifying terrestrial ecosystems and determining present vegetation features. No historical records exist for the frequency, location and characteristics of fires on Cumberland. Interpretation of field sign and literature reviews provide a basis for generalizations about the past and future role of fire on Cumberland.

Live oaks occur in all communities on Cumberland and dominate most. Young live oaks are very sensitive to fire and are killed by severe fires. However, older trees with thick bark are somewhat fire-resistant, and stands of live oaks have characteristics that reduce the incidence of fires within them. Live oaks are seldom killed by lightning. The leaf-fall is also practically incombustible, and therefore lightning seldom initiates fire within a live-oak dominated stand. Fires do occur, however, in live oak stands having a palmetto understory; infrequent fires in this habitat may be severe. Fires occurring in live oak forests with palmetto understories should be controlled (with existing roads acting as fire lanes) to protect historical sites and other developments.

Fires on the island most often originate and burn best in pine-dominated stands. Such fires usually are naturally extinguished upon reaching a pure live oak stand.

Fire is a dominant feature of the scrub forest (Figure 19). Periodic, severe fires arrest succession and thus maintain this community. Fires sufficient to maintain the scrub forest are lightning-caused and occur on a 30-50 year frequency (Fugure 20). Permanent visitor facilities should not be constructed within this community because of the inherent fire hazard.

Since the scrub forest is fire-maintained and the community is a conspicuous natural component of Cumberland, natural fires should be allowed to burn within the area. Fire-breaks or other fire control methods should not be established within the community. Adequate containment fire-breaks presently exist in the form of roads.

Prescribed fires could be used to maintain pastures and fields in their present state. These areas provide important feeding sites for deer, turkeys and numerous ground dwelling passerines. Also, these areas partially reflect the past agricultural history of Cumberland. Burns in these habitats should be conducted in late winter.

Fire may be used to remove the dense understory in habitats such as the live-oak-palmetto forests. An open understory reduces visitor encounters with ticks. Such fires would probably have limited applicability on Cumberland but should be reserved as a management option.

Grazing.--Like fire, grazing has played an important role in modifying the vegetation of Cumberland Island. Limited grazing of certain habitats should be considered as an optional method of controlling understory vegetation in local situations. The management implications of feral animals are discussed elsewhere in this chapter.

Interpretive areas.--The following upland areas are suggested as natural interpretive areas.

Terrapin Point: This area has both historical and natural history significance. Fort Andrew is thought to have been located on the high bluffs at Terrapin Point. Very large southern red-cedars are planted along the perimeter road passing by the site. The bluffs provide a striking vista of the saltmarshes and estuaries bordering Cumberland on the western side.

The forest around Terrapin Point and south is dominated by large live oaks adjacent to the marshes and very large loblolly and slash pines inland. Several rare or unusual trees and shrubs occur here and include redbud, buckthorn, and Sageretia. The site provides an excellent opportunity to observe numerous species of songbirds (primarily warblers) in the overstory of large pines and live oak, and estuarine species such as gulls, terns, longbilled marsh wrens, and clapper rails in the marshes nearby.

Terrapin Point and adjacent forests are adequately accessible by the present road system, and visitor usage should be restricted primarily to the existing road system.

Red Bridge: This area occurs upstream from Red Bridge and is composed of mesic bottomland hardwoods. The dominant feature of the site is a large stand of old-growth swamp tupelo. The area contains the only known Georgia colony of shoestring fern (Vittaria lineata). This species occurs primarily in peninsular Florida. Specimens were observed growing in the crevices of a very large sweet bay. An elevated boardwalk would provide visitor access to this area. Visitor use and movements would have to be restricted to prevent damage to the shoestring fern colony.

Scrub forest: This area is not shown as such on the place names map but occurs in the vicinity of a large airstrip on the northern end of the island and west of Lake Whitney (Figure 19). The area is dominated by several species of scrub oaks and pond pine. This habitat closely resembles the scrub forest of peninsular Florida and is found only on Cumberland and Sapelo Islands on the Georgia coast. Characteristic species of the community include myrtle oak, Chapman's oak, wicky laurel, American olive, and tar flower. The latter species approaches the northern limits of its range on Cumberland. The dense scrub forest can conveniently be observed from existing roads through the area and from the abandoned airstrip. The area has a high water table, and some portions are frequently flooded. Visitor use will be reduced following substantial rainfall.

Kings Bottom: This area is a mature lowland hardwood forest containing large specimens of southern magnolia, loblolly bay and several deciduous species. A foot-trail would provide adequate visitor access to this area. The area could withstand fairly heavy visitor use due to the relatively open understory and large overstory species present.

Lowland hardwood swamp: This area is located immediately north of New Swamp Field and is transected by Duck House Road. It is a large, mature forest composed of exceptionally large loblolly bay, red maple, sweet bay, and other species. Seasonally, the area contains large numbers of migrating songbirds, especially warblers. Large breeding choruses of frogs, including the barking tree frog, are common during the spring. Adequate visitor access to this area could be provided by an elevated boardwalk from Duck House Road.

Aquatic Resources

Ground water.--Ground water resources on Cumberland Island are sufficient to sustain the demands of Seashore recreationists for the immediate future. Future industrial and commerical development on the adjacent Florida and Georgia mainland will certainly increase ground water demands, however, and may decrease ground water availability on Cumberland. Substantial mainland demands on both the Coastal Plain aquifer and the shallow, local aquifer may induce salt water encroachment into wells on Cumberland. Wells on Cumberland should be monitored to detect salt water encroachment.

Because of the availability of widely dispersed sites suitable for percolation dispersal of wastes, disposal of small amounts of liquid wastes will not constitute a pollution problem on Cumberland. However, if visitor usage develops to even the most conservatively estimated level, liquid waste disposal may become a significant problem within a few years. The factors limiting the release of substantial amounts of liquid waste are the high water table and high permability of the sandy island soils. Without stringent controls on effluent releases, lateral percolation of sewage will pollute inland sloughs and lakes and adjacent marshes and estuaries, and vertical percolation may contaminate the shallow, local aquifer.

Dispersal systems utilizing extensive percolation fields are probably more feasible on Cumberland than sewage oxidation impoundments commonly used on the mainland, at least for moderate numbers of recreationists. Secondary sewage treatment facilities probably will be required to accommodate large numbers of recreationists during peak usage of the island.

Surface water.--The surface water systems on Cumberland are primarily responsible for the plant and wildlife diversity occurring on the island. (See Chapter V for further discussion.) It is imperative that these systems occupy a prominent position in the management scheme for Cumberland.

Stabilization of water levels in the aquatic system on Cumberland allows succession to proceed toward a swamp forest. Periodic perturbations, primarily fluctuations in water levels, salt water intrusion, and occasional fires maintain the systems in their present state. Fire could be a useful management tool for maintaining a desirable stage of succession to provide nesting and feeding habitat for alligators, water birds, otters and mink.

Natural drainages should not be blocked by road fill or other construction. Drainages such as that connecting Lake Retta to the sea are essential for maintaining the productiveness of such systems. Further, the recreational use of surface systems should be tailored to the ecological characteristics of the system.

Interpretive areas.--The following areas are recommended as natural interpretive areas as they are well distributed over the island and illustrate the various successional stages of ponds or sloughs. Some contain unusual species.

Lake Whitney: This large pond (40 acres) and marsh (43 acres) complex offers the visitor the best opportunity to observe and study pond succession on Cumberland (see Figure 17). The vegetation varies along a continuum of mixed hardwood lowland forest on the southeastern side of the lake to open water having a depth of 3-5 feet on the northeastern side.

Spectacular floral displays by water spider orchid, spoonflower, and American lotus occur during the summer months in Lake Whitney and enhance the esthetic qualities of a visit to the area.

A visitor to Lake Whitney is afforded the opportunity to observe large numbers of alligators (especially during the warmer months) and ospreys. Ospreys are almost continuously present around Lake Whitney during the summer and frequently rest in the numerous live oak snags surrounding the lake. Large numbers (25-40) of black vultures roost in the snags on the western side of the lake during the summer.

Lake Whitney also provides an opportunity for sport fishing of largemouth bass, warmouth and bluegill. A survey of the lake's standing crop of fish should be conducted to provide guidelines for fishing regulations, however,

Observations on vegetation and successional processes could best be made from a boardwalk and, possibly, observation platforms erected on the southeastern shore of Lake Whitney. Regulated non-motorized boating would provide the visitor with additional opportunities to observe successional relationships and to observe wildlife in the area.

Lake Retta: This lake is connected to the sea by a small tidal canal and is saline near the beach and brackish in its upper reaches. The entire complex contains 34 acres, approximately half of which is permanent open water.

Lake Retta provides the best opportunity for observing the influence of saline perturbation in an island slough complex. Succession typical of numerous other sloughs on Cumberland is arrested in Lake Retta by periodic inundations of salt water. Should the connection of Lake Retta to the ocean be severed, the lake would become a freshwater lake, and succession would eventually produce a lowland mixed hardwood swamp if other perturbations were minimal.

Seasonally, Lake Retta attracts large concentrations of herons, ibis, egrets, wood storks, ducks, and anhingas. All species except ducks are most abundant during the spring and summer, when visitor usage of the island will probably peak. Ducks are most common during the fall and winter. Alligators are also common in Lake Retta.

The small size and shallow depths of Lake Retta prohibit boat traffic. Elevated boardwalks transecting the habitats could provide the visitor with an opportunity to observe wildlife and successional relationships in a saline-dominated environment. Successional relationships could be observed and compared with a freshwater slough system such as Sweetwater Lake.

Sweetwater Lake: This 300-acre system consists of a four-mile-long series of freshwater sloughs with a southern terminus immediately north of Lake Retta. Sweetwater does not contain any substantial open-water areas. Small, open-water areas occur adjacent to Duck House Road. The slough system is filled with dense emergent and floating vegetation throughout its lenth (Figure 16).

The lack of open water and prey species reduces the occurrence of egrets, herons and related birds in Sweetwater Lake during the spring and summer. During the winter, emergent plants are reduced, leaving small areas of open water that are attractive to waterfowl, especially wood ducks and mallards.

The marsh complex of Sweetwater Lake provides extensive breeding habitat for all types of amphibians occurring on Cumberland. Very large breeding choruses of frogs and toads occur following moderate to heavy rainfall in spring and summer. Breeding choruses of barking tree frogs, other tree frogs, and toads may occasionally become so intense during spring nights that normal conversation cannot be conducted.

Boat travel would not be possible on Sweetwater Lake because of the lack of open water. As with Lake Retta, boardwalks should be employed to enhance visitor observations within the complex.

Duck House Road transects the complex on its southern end and could serve as a departure site for a boardwalk into the system. Roller Coaster Road borders Sweetwater Lake on the west-central side. This road would provide an excellent site for departure of a boardwalk, which could transect the lake and the large dune system encroaching from the beach. The dune ridges of Roller Coaster Road in this vicinity would also provide excellent opportunities for hiking and nature study in the live oak stand.

Johnson's and Ashley Ponds: Although quite different ecologically, these two ponds are considered together since they offer an unusual opportunity for the visitor to examine plant succession in two contrasting systems. Ashley Pond is a 15-acre permanent, freshwater pond, and Johnson's Pond is an 11-acre, temporary freshwater pond.

Johnson's Pond presently contains a moderate amount of shallow, open water. Dominant emergent plants are various grasses and sedges. Its present open water features are apparently the result of a fire that burned the pond approximately 10 years ago and removed the encroaching forest and reduced the occurrence of certain emergent plants. Ashley Pond is deeper than Johnson's Pond and is therefore less susceptible to fire during droughts.

No evidence of fire in Ashley Pond was observed during the study. Emergent vegetation is very dense and is composed of various shrubs and small trees. Succession in Ashley Pond will eventually produce a mixed bottomland hardwood forest.

Both ponds should be visited only from elevated boardwalks originating from Ray Field Road, which separates the two ponds. Such facilties would provide the visitor the opportunity to observe plant communities and wildlife occurring in the ponds.

Island Wildlife

Protection of Vulnerable Wildlife

Most forms of wildlife will require no specific protective measures beyond those automatically provided in a national seashore (i.e. protection against exploitation and habitat destruction). However, some species, because of breeding habits or low numbers, may require specific protective measures.

Birds.--Certain shore birds may be adversely affected by recreationists on the beaches during the nesting season (summer). Vehicles and beach-combers frighten adults from the nests, exposing the eggs and young to the intense insolation and heat on the beach. Young chicks may die within minutes if not shielded from the sun by the adults. Gull-billed and least terns have had little reproductive success in recent years on Cumberland because of uncontrolled recreational traffic through the nesting colonies. Wilson's plovers, willets and oystercatchers have been less affected by this disturbance than the colony nesters but will probably incur nesting losses if large numbers of recreationists have unrestricted access to their nesting habitat. Black-skimmers have suffered less from molesters because of their propensity to nest on offshore bars. Terns have suffered additional nesting losses to depredations by raccoons and feral pigs and disruptions of nesting sites by foraging cattle.

Because the location of tern colonies changes from year to year according to changes in the nesting habitat, an annual survey for the rookeries should be made. Recreational use of these areas should be minimized during the nesting season.

Wading bird rookeries may be utilized as a recreational resource if visitation is properly managed. Wading birds are easily frightened at the approach of people, thus infrequent visits to the rookeries always disturb the nesting birds. However, they adapt quickly and will tolerate visitation by people during the nesting season if it is a common event. Therefore, after the rookeries are located each year, they should receive a moderate amount of human contact or no visits at all.

Suitable nesting habitat for the bald eagle presently exists on Cumberland. This endangered species may nest on Cumberland in the future.

There are no nesting records for the threatened red-cockaded woodpecker and the species is infrequently observed on the island. Suitable nesting habitat exists on Cumberland, especially on the northwestern end of the island, and the species may nest there someday. Nesting, should it occur on Cumberland, should be the result of a natural extension of the species' breeding range to Cumberland. Management for the species should consist only of maintaining stands of large mature pines at least on the northern end of the island. The species should not be introduced on Cumberland.

Sea turtles.--The loggerhead sea turtle has been proposed for addition to the Endangered Species List by the Department of the Interior. Most authorities consider its perpetuation threatened by loss of nesting habitat and over-exploitation. The proper stewardship of the remaining beaches in Georgia is very important to the continued existence of the loggerhead.

Little Cumberland Island and the northern end of Cumberland Island provide loggerhead sea turtles with approximately eight miles of desirable nesting beach. The most suitable nesting area on Cumberland Island at present is the northern 4.5 miles of beach. This area should be given special protection, and we recommend that it be established as a sea turtle nesting sanctuary with only limited, supervised use by people during the turtle nesting season. It should be recognized, however, that the beaches and nesting areas change, and management policies must be sufficiently flexible to meet changing conditions.

On Cumberland Island nests are exposed to all the natural forces of destruction, such as predation by raccoons and ghost crabs and inundation and erosion by the sea. These natural forces of nest destruction have selected for the production of large numbers of eggs by loggerheads. But the natural system has been altered on other islands by man's development of beaches and the consequent reduction in nesting habitat, which has probably brought about a proportional decrease in net annual production of young. Consequently, production should be increased by protective measures on the remaining nesting beaches. The feral pig, for example, is not a native predator of the loggerhead and should be eliminated from the beach during the nesting season. Raccoon depredation could be reduced by trapping and removing raccoons from the beach during the turtle nesting season. This practice is common on certain wildlife refuges in the southeastern states and its appropriateness in a national seashore should be considered.

On Little Cumberland Island eggs are removed from the natural nests and deposited in an artificial hatchery where they are protected from depredation by raccoons and pigs. No such hatchery exists on Cumberland, and we do not recommend establishing one.

Sea turtles nest in the summer months when visitor use of the beach is at a peak. Although they nest at night when normal recreational use of the beach will be reduced, the nesting turtles probably will attract those curious and interested turtle watchers who may be present. Night use of the northern beach during turtle nesting season should be prohibited or closely supervised.

Small numbers of people using the nesting beaches during the day may cause little destruction, but large numbers of recreationists in the nesting area will certainly cause nest destruction through trampling and compaction and the deliberate excavation of nests by persons attracted to the nest site by the conspicuous tracks and mounded sand left by nesting females.

Alligators.--The American alligator is presently on the Department of the Interior's endangered species list and is thus a federally protected species. It has recovered significantly in recent years, but has not attained its former numbers or distribution in Georgia. Cumberland Island serves as an important refuge for alligators in coastal Georgia. Alligators are still occasionally poached on Cumberland. This probably represents a significant loss and may account for the lack of large individuals. They should receive strict protection there against poaching, and their habitats should not be detrimentally modified.

There is every reason to believe that the number of alligators on Cumberland will increase in the next few years with additional protection. They should pose no significant management problems.

Control of Problem Animals

Livestock.--Livestock have had a great impact on Cumberland Island and their numbers should be reduced. The grazing and browsing by cattle and deer have produced a pronounced "browse line" on the woody vegetation and have greatly altered species composition. Plants having desirable forage quality have been reduced in occurrence or perhaps even extirpated.

In severely overgrazed or overbrowsed habitats, plants present are usually of low palatability (beach hogwort, dog-fennel) or have protective characteristics limiting intensive grazing or browsing without depleting carbohydrate reserves (e.g. underground storage of carbohydrates in pasture grasses). Pigs commonly feed on underground tubers and rhizomes causing the loss or displacement of some of these (e.g. beach pennywort) plant species.

The disruption of dune plants (especially sea oats) by the feeding of pigs and cattle has prevented the stabilization of dunes on Cumberland Island. The removal of pigs and cattle from the beach and dune areas should allow re-establishment of many dune-building plants, which would help to stabilize inland dunes.

In the island forest, cattle and pigs prevent regeneration of certain woody plants by grazing, rooting and trampling. Cattle compete to some extent with deer for browse and forage and serve as a reservoir for certain parasites of deer. Pigs compete with deer, raccoons, squirrels, and various birds for acorns and fruits of saw palmetto, cabbage palmetto, sweetbay, magnolia and others.

Pigs should be eliminated, and cattle and horses should be reduced in numbers and excluded from the beach and dunes. It may be desirable to maintain small numbers of cattle and horses in portions of the island interior for vegetation control, that is, the maintenance of openings and the park-like aspect in certain habitats. Horses and cattle could maintain the short grass characteristics of the South End Flats. However, they should be excluded from the adjacent beach and dunes. Containment of the animals in the flats would necessitate fencing the area.

White-tailed deer.--The reduction of livestock numbers will result in improved habitat conditions and reduced competition for food resources of deer. These improved food conditions can be expected to result in a substantial increase in deer numbers followed by deterioration of animal health and habitat quality. Increasing food availability by planting or other habitat manipulation would alleviate these conditions only temporarily and bring about further increase in deer numbers.

A deer management policy (control of numbers) should be developed and implemented before intensive public use of the Seashore develops. The alternatives are to (1) allow natural factors now in action to control deer numbers, (2) introduce additional natural controls (i.e predators), and (3) remove surplus animals by trapping or shooting. (The use of chemical reproductive inhibitors is not feasible at this time.)

The first alternative would produce undesirable conditions. Population density would be regulated primarily by an interaction of parasitism and disease with malnutrition. These controls would be undesirable from a biological point of view as the quality of the animals and the habitat would suffer. Furthermore, one of the critical periods for island deer occurs in late summer when heat and drought, declining browse and forage quality, and ticks, mites and insects exert additional stress on an already stressed population, and large numbers of visitors would be on the island during this time to encounter emaciated, sick, and dead deer.

The second alternative, introduction of predators such as bobcats or pumas, would probably be only partially effective. The latter species could also cause people-management problems to develop. Removal of surplus animals by trapping or by shooting appears most desirable and feasible. Animals could be removed by trapping, by sport-hunting, or by professional animal control agents.

The only trapping method likely to be efficient enough to effect herd control would be corral trapping, in which deer conditioned to use baited areas are herded into a corral trap. The trapping technique is described by Williams (1965) and Stafford et al. (1966).

If a decision is made to remove deer by shooting, we recommend this be accomplished by sport hunters rather than by professional shooters. Control of excess animals by sport hunting would provide recreation and use of the resource and probably would be more economical. Archery hunting probably would be more compatible with the management of the Seashore than would hunting with firearms. Annual archery hunts on Blackbeard Island National Wildlife Refuge have been effective in keeping the deer herd at the desired level on that island since 1948.

Sport hunting on Cumberland Island would occur during fall and winter when other visitor use of the island would be reduced. The island could easily be compartmentalized with hunting rotated between units to maintain desirable population levels within compartments. Population levels within management units should be periodically monitored. This would permit segregation of hunters from other recreationists for safety reasons.

Some public opposition to sport hunting on the island can be expected. Initiation of hunting probably would be less difficult if introduced at the outset.

Raccoons.--Island-wide reduction of raccoons probably is neither feasible nor necessary. Most problems caused by raccoons are localized, and local reduction should be accomplished by trapping with box traps to avoid public reaction.

In parks and similar areas where raccoons are offered protection, they become quite fearless and wander boldly into campgrounds and picnic areas where they come into close contact with humans. They are a source of amusement and entertainment for many recreationists who encourage the animals with food. But large numbers of raccoons may become a nuisance or pose a human health problem.

Encounters between visitors and raccoons could be reduced by trapping the problem animals from picnic and camping areas and releasing them elsewhere. Because of the large number of animals on the island, this would have to be an almost continuous operation.

Local reduction in raccoon numbers may be desirable on beaches used intensively by nesting loggerhead sea turtles. Damage to turtle nests can be reduced by trapping raccoons from important nesting areas during the peak of nesting and releasing them on the western (marsh) side of the island. The northern portion of the beach is relatively isolated from the forests and marshes and presently constitutes the best turtle nesting beach and experiences relatively low depredation by raccoons. However, should a depredation problem develop, a trapping program probably would significantly reduce the problem since recruitment into vacated feeding territories by inland raccoons is slow. Should the quality of nesting beaches improve south of Candler Road, raccoon depredation could be expected to become significant due to the proximity of nearby cover.

Alligators.--Alligators can be expected to become more abundant on Cumberland Island, but they would not pose a threat to the safety of visitors, and control will not be necessary. Large individuals that become a nuisance may be trapped and relocated. However, visitor facilities in areas having high alligator populations should be designed to prevent confrontations between recreationists and alligators thus reducing the need to remove and relocate substantial numbers of alligators.

Poisonous snakes.--Cottonmouths and diamondback rattlesnakes should be regarded as a distinct danger to island visitors. Nevertheless, these species are significant elements of the island fauna and control should be considered only in picnic areas or other very localized situations. Boardwalks or other visitor activities located in or near sloughs and ponds should be designed to reduce visitor encounters with cottonmouths, the most common poisonous snakes.

Blood-feeding arthropods.--Cumberland Island has a large number of blood-feeding insects and ticks which will annoy visitors. Deer flies (Tabanids) are common in all of the vegetated areas of the island. Tabanids breed primarily in the salt-marsh-island ecotone (Hansens and Robinson 1973) and perhaps in the infrequently flooded mud flats of the island's fresh water and brackish marshes. After emergence, they begin to move inland to seek a blood meal. Tabanids generally have painful bites and may be a serious problem during spring and early summer. Personal repellents generally only temporarily repel these pests. Light-colored garments usually reduce attacks. Heavily wooded areas should be avoided when Tabanids are most common.

Mosquitoes are common over the entire island. The most serious pests are the salt marsh mosquitoes _Aedes solicitans_, _A. taeniorhynchus_ and _Anopheles crucians_. They have a painful bite and may travel considerable distances to secure a blood meal. The breeding biology and ecology of these species were discussed by Johnson et al. (1975).

Sand flies of the genus _Culicoides_ are a severe annoyance throughout most of the year, especially in areas on the western side of the island. Sand flies periodically occur in such numbers as to create extreme physical discomfort and, perhaps as importantly, a severe psychological annoyance. Recreationists may employ repellents or conduct their activities when numbers are lowest.

All of these blood-feeding Dipterans, which are problems over most of the island, cause less discomfort on the beach due to the strong winds which reduces their presence there.

Mosquitoes and sand flies breed in salt marshes and freshwater sloughs on the island. Chemical control would be very expensive and of doubtful benefit; therefore, control by chemicals is generally not warranted. With the exception of deer flies, the discomfort caused by most of the human-biters can be reduced by using commercially available insect repellents when visiting the inland areas of the island.

Ticks and mites are numerous on the island, probably due in part to the presence of high numbers of large mammals. Tick populations will be reduced following the reduction or extirpation of feral animals from the island. Tick attacks on humans may be reduced by cutting low vegetation away from foot trails, by prescribed burning in certain habitats and by local application of insecticides in heavy use areas. (Regulations governing the use of pesticides are under almost constant review and revision by the Environmental Protection Agency; therefore, current EPA regulations should be confirmed before any chemical control is attempted.)

The imported fire ant (*Solenopsis* spp.) occurs on Cumberland in fairly low numbers, presently occurring in the heavier soils on dikes and roads near Old Swamp Field and along the road system in the marsh areas near Duck House. Although annoying, the fire ant has not been shown to be a significant human health hazard, and it does not seriously depress wildlife populations. Therefore, control is unwarranted and unnecessary.

Destructive forest insects.--A survey of forest insect damage was conducted in the summer and fall of 1973. The survey revealed a group of slash pines attacked and killed by the coarse writing engraver, *Ips calligraphus*, approximately one mile south of the Stafford Beach House immediately inland from the dunes. The focal point of the attack was a lightning strike in a young stand with several trees attacked after the initial beetle attacks on the lightning-struck tree. The beetles killed 55 trees with d.b.h. of 3-10 inches. A recheck of this site in November 1973 revealed no additional tree mortality.

Infestations of *Ips* spp. beetles are likely to occur on and around pines damaged by lightning. If control is desired, lightning-struck trees may be either felled and removed from the area before beetle broods emerge, or felled and thoroughly sprayed with 0.5 percent benzene hexachloride. Quick action, i.e. within 3 days after the strike occurs, may prevent beetle brood development in the trees initially attacked.

Young loblolly pines on the island are lightly attacked by the Nantucket pine tip moth, Rhyacionia frustrana, but tree mortality is rare and damage is not conspicuous.

Many of the large red-cedars on the island have been windthrown, and most have been attacked by the eastern juniper bark beetle, Phloeosinus dentatus. Although juniper beetles generally are not considered to be sufficiently aggressive to kill large numbers of trees, a few standing red-cedars had apparently been killed by the beetles.

Juniper beetles may be controlled during the summer by exposing all sides of cut red-cedar logs to full sunlight. The heat should be sufficient to kill beetle broods developing in the logs. Also, broken limbs on red-cedars near dwellings or proposed high-use areas should be removed to prevent juniper beetle attacks.

The hardwoods on the island appeared to be generally free from serious insect infestations. Occasionally, minor defoliation of oaks by insects, primarily caterpillars of the family Megalopygidae, was observed, but no defoliation sufficient to merit control attempts was seen. The insect infestations on most of the island vegetation are normal and control attempts are unnecessary.

Construction, particularly in areas with extensive pine stands, may damage roots and trunks and may predispose trees to attack by insects. Care should be exercised to minimize tree damage in construction areas.

Since insect damage is a constantly occurring natural phenomenon, control of infestations should be considered only in extreme cases. Insect invasion of a stand is usually the result of naturally induced habitat changes within the stand (lightning strikes, wind damage). In most instances the resulting insect invasion changes the stand composition only on a minor scale. However, the change, although small, may provide new feeding or reproduction areas for various species of wildlife. Woodpeckers especially are attracted to bark beetle-infested timber stands and feed actively in these areas following an attack. The lightning-induced removal of part of the overstory permits light penetration into the stand, resulting in greater production of groundstory plants. These sites provide additional browsing habitat for deer.

Reintroduction of Extirpated Species

A number of species have been extirpated from Cumberland Island in historic times. Only the Cumberland Island pocket gopher was unique, so the opportunity exists to re-introduce most extirpated species from the mainland. Three bobcats (one male and two females) were released on Cumberland in 1972 and 1973. Whether this low number will be sufficient to produce a breeding population remains to be seen. If it is deemed desirable to re-establish the species, it would be advisable to augment its numbers with additional individuals obtained from the nearby mainland. Bobcats on the island can be expected to feed primarily on marsh rabbits and small mammals, but they would also prey to some extent on white-tailed deer, primarily on fawns and unhealthy adults. The effect on the deer population, if any, would be beneficial.

Other extirpated mammals include the opossum, the oldfield mouse, the gray fox, and the black bear. An effort should be made to determine if the oldfield mouse type specimen is still available for study. The identification of this mouse should be checked carefully, as it has not been reported before or after Wright's 1926 report. This mouse should not be reintroduced until the type specimen is examined. If the record is valid for the species, then its re-introduction would not be expected to cause ecological problems with other species.

The opossum is native to Cumberland and could be re-introduced from adjacent mainland sources. This species has not caused any special management problems on Sapelo, St. Simons and Jekyll islands, where it is common. Although it adapts quickly to human habitation, it does not become a pest as raccoons often do. Additionally, the opossum is apparently quite resistant to rabies and does not pose a health hazard. The gray fox is a shy, retiring animal which occurs on the adjacent mainland. It creates no management problems there and should not be expected to create any problems on Cumberland should it be reintroduced.

The black bear is native to Cumberland (probably transient animals) but its reintroduction could pose special management problems. In other parks black bears have become nuisance animals and pose safety problems for recreationists. Cumberland Island contains no extensive habitats which could serve the "wilderness" needs of black bears. It would be undesirable to establish a wild population of black bears on the island because of the lack of suitable habitat and the forced association with people.

Wildlife Diseases and Parasites

Wildlife diseases and parasites on the barrier islands pose potentially serious management problems having implications for human health as well as for wildlife.

Residents of Cumberland and Little Cumberland islands have reported periodic island-wide mortality of deer and raccoons and occasionally feral pigs. During March, 1973, extensive mortality of deer and raccoons occurred on Cumberland. From 12-14 March, 14 raccoons, 7 deer and 3 pigs were observed in various stages of decomposition. Island residents reported that a few raccoons exhibiting abnormal behavior were encountered approximately two weeks prior to the die-off. Inhibition of fear, diurnal activity and reduced locomotor coordination were common symptoms.

On 2 August 1973, an emaciated 4-year-old doe deer was found near Stafford alive, but unable to evade capture. The doe died enroute to Athens, Georgia, where a clinical necropsy was performed. The deer was heavily parasitized by both internal and external parasites. Approximately 1700 large stomach worms (*Haemonchus contortus*) were recovered from the abomasum. Sixteen lungworms (*Dictyocaulus viviparus*) were present in the lungs. Death was caused by extreme malnutrition complicated by chronic parasitism.

Prestwood et al. (in press) investigated helminth parasites among deer and free-ranging cattle and swine on Ossabaw Island. Eight of 19 (42 percent) species of helminths infecting deer also infected cattle. Cattle are the main hosts of *Haemonchus contortus* and perhaps serve as reservoirs of this parasite for infecting deer. They may function in a similar capacity for other helminths.

Deer are infected by both *Haemonchus contortus* and *Dictyocaulus viviparus* via a direct life cycle. The pathogenic consequences of these parasites for deer has been reported by Prestwood and Kellogg (1971), Prestwood et al. (1971), and Prestwood et al. (1973). Cattle also harbor *Dictyocaulus viviparus*.

The abnormal behavioral pattern exhibited by raccoons on Cumberland has been frequently observed elsewhere. Johnson (1970) reported that six such animals examined in Alabama suffered from variously diagnosed infections including canine distemper, pneumonia associated with distemper, chronic pleurisy of unknown origin, and verminous pneumonia in conjunction with debilitation by internal parasites. The causative agents of raccoon disease have not been clearly defined, but they probably have a significant role in controlling raccoon populations.

In some situations raccoons become not only a nuisance, but they offer a potential hazard to human health as they are known to carry a number of diseases transmissible to man, including rabies, leptospirosis, tularemia, and others.

Rabies has not been reported in raccoons from the barrier islands of Georgia, but the mainland nearby has possibly the highest incidence of rabies in raccoons of any area in the United States, and should the disease reach the dense population of raccoons in close contact with recreationists on the island, it could create a dangerous situation such as that described by Kappus et al. (1970) on Long Boat Key in Florida.

The role of parasites and diseases in regulating island wildlife populations is poorly understood. In general, most parasites and diseases exert their greatest influence on high density populations during periods of food stress. These may be circumstances under which periodic island-wide wildlife die-offs occur. A reduction of the competition for the limited food resource on the island by removing feral ungulates will initially lessen parasite and disease impacts upon wild populations. However, without controls, deer populations, for example, may exceed the "new" carrying capacity of the island, and parasites and diseases can be expected to again interact with food stress to induce die-offs in deer populations. Similar die-offs in raccoon may occur.

Continuous surveillance of the disease and parasite burdens of profile species such as raccoons and deer should be conducted. If indications of impending problems develop, decisions must be made to initiate population reductions or allow nature to take its course. These aspects of management are further discussed elsewhere in this chapter (Control of Problem Animals).

Monitoring and Research

Throughout the report we have cited the lack of interpretive information for precisely defining abiotic and biotic relationships among plant and animal communities and their environments on Cumberland. Substantial interpretive data were generated during this study; however, in our opinion, the management of the natural resources of the Cumberland Island National Seashore will be considerably enhanced by data from long-term research and monitoring programs conducted on the island. We therefore submit the following recommendations which, if implemented, will increase the objectivity of management decisions regarding the natural resources of Cumberland.

We strongly recommend that permanent exclosures of 1/5- to 1-acre be erected throughout the island in the major habitat types. These exclosures should be livestock- and deer-proof but should not inhibit the movement of small mammals and birds. Annual studies of plant and animal communities contained within these exclosures should be conducted. Minimal vegetation studies should determine species composition, relative frequency, density, and cover. Temporal and spacial distribution patterns of animal species, especially selected invertebrate groups, should be monitored.

Data obtained from these exclosures will yield important management information within 5 years as impacts of livestock on community types will become evident. General successional relationships among components of the communities will also be more easily defined within this time.

Permanently marked transects should be established in the major communities and should be monitored annually. These studies would provide important data on successional trends on the island, especially in beach and dune habitats. Animal components of the habitats, including invertebrates, should be sampled along the transects too. Transects should be established on beach and dune areas where stabilization efforts are being made and in representative beach and dune environmenets. Data from transects will be valuable in evaluating stabilization results.

The size and distribution of the exclosures and transects should be determined by statistically sound experimental design.

Permanent camera points should be established at exclosures and transect locations. Periodic photographs will provide useful graphic illustrations of habitat changes.

The relationship of fire and plant and animal communities should be closely studied. The effects of natural fires on plant succession (changes in species composition and distribution, soil nutrients, etc.) should be studied at every opportunity. Data from such studies are essential for predicting the impact of prescribed, controlled fires on island communities.

We recommend that study areas be established that transect visitor use areas, especially within the recommended natural areas. Studies of the vegetation should be conducted annually within these areas to quantify the impacts of visitor usage on the species present. Information would permit a visitor-use model to be developed for the various habitats. Such data would provide sound base for regulating visitor areas or siting new areas to accommodate future recreational demands.

We strongly recommend that intensive hydrologic studies be initiated to determine:

1. Present water quality and withdrawal rates in ground water systems serving the island.
2. Natural water quality parameters in interior surface water systems and adjacent marshes and estuaries.

Seasonal monitoring programs should be initiated to provide future management data on the above parameters.

Animal die-offs will continue to occur on Cumberland, especially during periods of food stress. These die-offs should be investigated promptly after detection. Periodic monitoring of disease and parasite burdens of large mammals on Cumberland will yield information for evaluating the effects of these groups on island mammals. These data will be important in developing long-term management programs for the larger mammals on Cumberland.

The loggerhead sea turtle research project should be expanded and continued for three more years. Complete, systematic tagging studies over a three-year period would quantify important population dynamics parameters such as total nesting population, distribution of size classes, recruitment and losses and inter-island movements. The latter is made possible by studies being conducted on Little Cumberland, Jekyll, Ossabaw and Wassaw islands in Georgia. These data would greatly expedite the drafting of a valid long-term management plan for this reptile on Cumberland Island.

IX. SUMMARY

Cumberland Island National Seashore, Camden County, Georgia, became a part of the National Park System in 1972. The portion of the Seashore studied and reported on here is bounded by St. Andrews Sound, the Intracoastal Waterway, St. Marys Entrance, and the Atlantic Ocean. The study was directed at surveying the natural resources of Cumberland and Little Cumberland islands and defining processes and functional relationships. Primary emphasis was on Cumberland Island, which will support all visitor usage of the terrestrial portion of the Seashore. Little Cumberland, although encompassed by the Seashore, will not be used by Seashore recreationists.

Cumberland Island is not a virgin wilderness. Portions of the island presently exist in a semiwild state and some habitats constitute significant natural areas which exhibit certain characteristics of virgin habitats.

Historical evidence indicates aboriginal peoples inhabited Cumberland by at least 2,000 B.C. These occupants hunted and fished on Cumberland and probably changed the overall features of the island very little. The first substantial change in the island's communities began in the mid-1500's when Europeans arrived on Cumberland and began erecting forts and military camps.

The maximum development and utilization of Cumberland Island occurred during the Plantation Era (1786-1880). During this period, owners of at least five large plantations cleared vast acreages for the production of sea island cotton, corn, potatoes, sugar cane, pigs, cattle, and horses. On some plantations various citrus fruits, figs, pomegranates, and other fruits are grown. Some of these species still persist on Cumberland.

At various times after the decline of the plantations (from 1880), portions of the island were purchased by wealthy individuals who used the island as their private retreat, a use that has extended to the present.

Cumberland is a compound barrier island composed of both Pleistocene and Holocene deposits. Little Cumberland Island is composed entirely of Holocene deposits. The islands were formed during two distinct periods of time and in response to two major fluctuations of sea level caused by the advance and retreat of continental ice sheets that covered much of the northern hemisphere during the Wisconsin stage of the Pleistocene epoch. Over 90 percent of Cumberland is composed of fine-grained sands of littoral and shallow marine origin. Pleistocene sediments average 50 feet in thickness. The Pleistocene portion of the island is the remnant of a pre-existing barrier island dating 25,000-50,000 years B. P.

The Holocene portions of Cumberland and Little Cumberland islands are composed of beach and dune sands similar in size and mineralogy to those of Pleistocene deposits. These younger deposits lack shell material in the upper zone and a humate horizon. They have a well defined surface relief of both dune ridge and swale systems on composite dunes.

Dune erosion constitutes a serious management problem on Cumberland. Dune encroachment is destroying critical beach and inland aquatic habitats. To restabilize the dune system, it is recommended that (1) feral animals be removed from problem areas, (2) stabilizing plants be reintroduced onto frontal dunes, (3) physical barriers be erected to retard sand movement in severely eroded areas, and (4) traffic be prohibited across dunes.

The salt marshes on the western side of Cumberland thinly overlie older salt marsh deposits developed in association with the Pleistocene portion of the island. The salt marsh is a productive and essential component of the estuarine system and should not be permanently altered. It is unsuitable for any kind of development.

The soils of Cumberland and Little Cumberland are derived from marine quartz deposits which are highly resistant to weathering. The eight soil series occurring on the islands are characterized by high permeability, low cation exchange capacity and low nutrient levels. Natural nutrient input is received from salt spray-borne deposits and organic matter deposited on the island by high tides and by birds and mammals tapping marine food chains. Nutrients are in short supply and are vigorously recycled by island vegetation. Long-term selection pressures for nutrient conservation have favored a forest composed of evergreen broadleaf species and conifers.

Ground water supplies for Cumberland are obtained from the deep-lying Coastal Plain artesian aquifer and the local, shallow, non-artesian aquifer. Artesian flow still occurs from wells on Cumberland, but it is much reduced from the past. Although both aquifers should sustain future needs of seashore recreationists, withdrawal rates should be monitored to detect possible salt water encroachment.

The surface aquatic systems of Cumberland and Little Cumberland islands are fluctuating water systems which exhibit pulse-stability. Permanent ponds on Cumberland Island comprise approximately 80 acres, about 20 acres of which are saline. The island has a total of approximately 724 acres of surface aquatic systems including open water and adjacent marshes (excluding salt marshes). Water quality ranges from fresh to strongly saline. The systems are in various stages of ecological succession ranging from open water permanent lakes to dense bottomland swamps.

The aquatic systems of Cumberland are more extensive and diverse than those of other barrier islands in Georgia. They provide nesting, feeding, and roosting areas for large numbers of wading birds and shore birds, and essential habitats for otters and numerous amphibians and reptiles, including alligators. Alteration of these habitats should be avoided, but limited public usage of certain systems is compatible with wildlife protection.

Because of the high permeability of the soils and the relatively high water table, contamination of surface water systems by sewage and other effluents via lateral percolation is a potential major problem in the development of the Seashore. Estuarine waters adjacent to the island are easily polluted by the lateral release of contaminants from island sources. The siting of waste treatment and disposal facilities should be carefully evaluated on the basis of proximity to surrounding natural aquatic systems and the percolation characteristics of surrounding soils. After treatment centers are sited, water quality of nearby freshwater and estuarine areas should be monitored for the prompt detection of possible pollutants.

Physical, chemical and biological processes have interacted during the geological history of Cumberland to produce a diverse and dynamic biological system. Physical and chemical stresses such as drought, inundation, salt spray, acidity, alkalinity, mineral availability or toxicity, erosion and accretion, and periodic fire or release from fire have selected for the many plant communities occurring on Cumberland. Superimposed upon these natural physical and chemical factors are those modifying biological forces such as grazing, browsing, parasitism, competition, and man's exploitation and modification of the island resources.

Twenty-two plant communities were described, classified and mapped within the Cumberland-Little Cumberland island complex. General vegetation classification (grassland, forest, etc.), species composition and presumed successional relationships are presented for each community (lists of vascular species collected on Cumberland and Little Cumberland islands are presented in Appendix I; summary tables of the vegetation analysis are presented in Appendix II). The mature forests of Cumberland and Little Cumberland islands are dominated by broadleaf evergreen tree species. These forests are classified as subtropical forests because they show strong floristic affinities with tropical forests and occur in a moderate oceanic climate. No endangered plants were found on the island; one species, shoe-string fern, is considered rare.

Fire and grazing have been important in determining the present composition of the flora of Cumberland. Natural fires should be allowed to occur in certain habitats such as the scrub forest on the northern end but should be contained in other habitats such as live-oak forests having a dense understory of saw-palmetto. Prescribed fires could be used to maintain an open understory in some forest habitats and to maintain fields and pastures.

Cumberland Island supports more species of large vertebrates than any of Georgia's barrier islands. It supports large resident populations of white-tailed deer, raccoons, and feral animals, and seasonally it attracts large numbers of shore birds, herons, egrets, and sea turtles. The island provides essential breeding and rearing habitat for many species.

Approximately 323 species of birds have been recorded within the Seashore area (a species list is presented in Appendix IV). At least 101 species are known to nest within the area--probably more than any other area of comparable size in Georgia. Cumberland provides critical nesting habitat for 18 species of colonial nesters such as least and gull-billed terns, herons and egrets. The mature forest, dominated by live oak, provides nesting habitat for 77 species of tree nesters and feeding habitat for over 100 species of insectivores.

Certain species, such as shore birds and wading birds, may be adversely affected by unrestricted access to nesting areas by summer recreationists. An annual survey should be made to locate nesting colonies of shore birds and wading birds. Recreational use of the nesting areas should be limited according to the tolerance limits of the species involved.

The saltwater environment surrounding Cumberland and Little Cumberland islands has inhibited their colonization by reptiles and amphibians. Reptiles dominate the herpetofauna of both Cumberland and Little Cumberland. Cumberland supports 34 species of reptiles and 18 species of amphibians, compared to 23 and 8 species, respectively, on Little Cumberland (a species list is presented in Appendix V).

The loggerhead sea turtle is the only insular species of reptile occurring on Cumberland and Little Cumberland islands. It has been proposed for addition to the Department of the Interior's Endangered Species List. There are no insular, endangered or threatened amphibians on Cumberland or Little Cumberland islands. The northern end of Cumberland should be established as a sea turtle nesting sanctuary. The area should receive only limited supervised public usage during the nesting season.

The American alligator occurs commonly throughout the aquatic habitats of Cumberland. Additional protection afforded by the Seashore should result in an increase in numbers, but the species should not pose any significant management problems. Occasional nuisance individuals may be trapped and released into remote habitats.

Historical records indicate 26 species of wild terrestrial or aboreal mammals once inhabited Cumberland (species known to occur within the Seashore are presented in Appendix III). Seven species of marine mammals have been recorded in waters within the Seashore boundaries. Cumberland

and Little Cumberland presently support 17 and 10 species, respectively, of wild terrestrial mammals. Five species of mammals have been extirpated from Cumberland within the last 100 years. The Cumberland Island pocket gopher, the only insular species of mammal in Georgia, became extinct within the last three years.

The reduction or extirpation of feral animals from Cumberland will improve habitat conditions for white-tailed deer. An increase in the deer population should be expected. A control-oriented deer management policy should consider the following alternatives: (1) allow natural factors to control deer numbers, (2) introduce additional natural controls (predators), (3) remove surplus by trapping or sport hunting. Hunting with primitive weapons would be most feasible.

Certain species such as raccoons may post special management problems in some areas. Raccoon numbers may increase greatly near camping areas and could pose human health problems. Reduction of campground-conditioned raccoons might be accomplished by live trapping and removal to other areas of the island.

In general, the reintroduction of extirpated species would be compatible with the resources and recreational use of the Seashore. The black bear is an exception.

Extensive surveys for certain groups of arthropods were conducted. Data are summarized in Appendix VI. The surveys were conducted to provide a baseline for analysis of habitat changes, which will certainly occur following initiation of Seashore management.

Large-scale control of noxious arthropods is not recommended. Repellents should be used by island visitors. Recreational facilities should be sited in areas having low concentrations of noxious arthropods.

Thirteen natural areas illustrating the physical, chemical, and biological features and processes of Cumberland are described. The areas recommended are distributed throughout the various community types.

It is strongly recommended that continuing monitoring and research programs be initiated before substantial habitat modification occurs. Data from such programs will be invaluable in devising long-term management programs. It is recommended that deer and livestock exclosures and camera points be located in representative habitats throughout the island. Permanent plots or transects should be established in these habitats and sampled for vegetation and selected animal species. Appropriate data reflecting habitat changes should be obtained on an annual basis. A procedure should be established for continuous surveillance of wildlife diseases. Animal die-offs will undoubtedly occur in the future on Cumberland, and they should be promptly investigated. The loggerhead sea turtle project should be expanded and continued for three years. Systematic tagging over this period will yield management data on total nesting population, recruitment and losses, and inter-island movements.

LITERATURE CITED

Art, H. W., F. H. Bormann, G. K. Voight, and G. M. Woodwell. 1974. Barrier island forest ecosystem: role of meteorologic nutrient inputs. Science 184(4132):60-62.

Bangs, O. 1898. The land mammals of peninsular Florida and the coast region of Georgia. Proc. Boston Soc. Nat. Hist. 28(7):157-235.

Bartram, W. 1791. Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee country, the extensive territories of the Muscogulges or Creek confederacy, and the country of the Chactaws. James and Johnson, Philadelphia. 522 pp.

Becking, R. W. 1957. The Zürich-Montpellier School of Phytosociology. Bot. Rev. 23(7):411-488.

Bent, A. C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies. 1964 Republication, Dover Publ. Inc., New York. 2 pts. 506 pp. plus 73 pl.

Beshear, R. J. 1969. Observations on the life history of *Hemisphaerota cyanea* in Georgia (Coleoptera: Chrysomelidae). J. Georgia Entomol. Soc. 4(4):168-170.

______________. 1970a. A new record of *Stenotabanus* (*Aegialomyia*) *psammophila* in Georgia (Diptera: Tabanidae). J. Georgia Entomol. Soc. 5(3):183.

______________. 1970b. New collection records for *Sporothrips amplus* and *Atractothrips bradleyi* (Thysanoptera: Phlaeothripidae). Entomol. News 81:220.

______________. 1971. Thrips collected on *Spartina* spp. from Cumberland Island, Georgia. J. Georgia Entomol. Soc. 6(4):243-246.

______________. 1973. The thrips of Georgia, suborder Terebrantia. Georgia Agric. Exp. Stn. Res. Bull. 122. 26 pp.

Bidlingmayer, W. L., and H. F. Schoof. 1957. The dispersal characteristics of the salt-marsh mosquito, *Aedes taeniorhynchus* (Wiedemann), near Savannah, Georgia. Mosquito News 17(3):202-212.

Bourdeau, P. F., and H. J. Oosting. 1959. The maritime live oak forest in North Carolina. Ecology 40(1):148-152.

Boyce, S. G. 1954. The salt spray community. Ecol. Monogr. 24(1):29-67.

Bozeman, J. R. 1971. A sociologic and geographic study of the sand ridge vegetation in the Coastal Plain of Georgia. Ph.D. dissertation. Univ. North Carolina, Chapel Hill. 243 pp.

Braun, E. L. 1950. Deciduous forest of Eastern North America. Blakiston Co., Philadelphia. 596 pp.

Burleigh, T. D. 1958. Georgia birds. Univ. Oklahoma Press, Norman. 746 pp.

Byrd, H. J., D. G. Aydelott, D. D. Bacon, and E. M. Stone. 1961. Soil Survey of McIntosh County, Georgia. U. S. Dept. Agric., Soil Conserv. Serv., 62 pp. + maps.

Caldwell, D. K. 1962. Comments on the nesting behavior of Atlantic loggerhead sea turtles, based primarily on tagging returns. Q. J. Florida Acad. Sci. 25(4):287-302.

_______________, A. Carr, and L. H. Ogren. 1959. Nesting and migration of the Atlantic loggerhead. Bull. Florida State Mus. 4(10):295-308.

Callahan, J. T. 1959. Jekyll Island--its geology and water resources. Georgia Mineral Newsl. 12(1):23-39.

_______________. 1964. The yield of sedimentary aquifers of the Coastal Plain Southeast River Basins. U. S. Geol. Surv., Water Supply Pap. 1669-W. 56 pp.

Candler, A. D., and C. A. Evans, eds. 1906. Cyclopedia of Georgia. State Hist. Assoc., Atlanta. (Reprinted in 1972 by the Reprint Co., Spartanburg, S. C.) 1:132.

Carver, R. E. 1968. The piezometric surface of the Coastal Plain aquifer in Georgia, estimates of original elevation and long-term decline. Southeast. Geol. 9(1):87-99.

Clement, C. D. 1971. The Georgia coast: issues and options for recreation. Coll. Business Admin., Univ. Georgia, Athens. 167 pp.

Cleveland, A. G. 1970. The current geographic distribution of the armadillo in the United States. Texas J. Sci. 22(1):90-92.

Connor, J. T., ed. and transl. 1925. Colonial records of Spanish Florida. Florida State Hist. Soc., Deland. 1:291-293.

Corbet, G. B. 1966. Small mammals on small islands. Animals 8(11):289-291.

Cottam, G., and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37(3):451-460.

Daniel, R. S., and K. U. Smith. 1947. The migration of newly hatched loggerhead turtles toward the sea. Science 106(2756):398-399.

Darlington, W. 1843. Reliquiae Baldwinianae: selections from the correspondence of the late William Baldwin, M. D. Kimber and Sharpless, Philadelphia.

Daubenmire, R. F. 1968. Plant communities--a textbook of plant synecology. Harper and Row, New York. 300 pp.

Dopson, C. W., Jr., and J. I. Richardson. 1968. Late summer and fall observations from the Georgia coast. Oriole 33(4):41-43.

Downing, R. L. 1973. Preliminary nesting survey of least terns and black skimmers in the East. Am. Birds 27(6):946-949.

Duncan, W. H. 1955. Woody vegetation of Sapelo Island, Georgia. (Abstract) ASB Bulletin 2(1):5.

Foster, J. B. 1964. Evolution of mammals on islands. Nature 202(4929): 234-235.

Golley, F. B. 1962. Mammals of Georgia. Univ. Georgia Press, Athens. 218 pp.

Graetz, K. E. 1973. Seacoast plants of the Carolinas for conservation and beautification. Univ. North Carolina, Sea Grant Program, School of Public Health, Chapel Hill. 206 pp.

Hansens, E. J., and J. W. Robinson. 1973. Emergence and movement of the saltmarsh deer flies Chrysops fuliginosus and Chrysops altanticus. Ann. Entomol. Soc. Am. 66(6):1215-1218.

Hanson, H. C., and E. D. Churchill. 1961. The plant community. Reinhold Publ. Corp., New York. 218 pp.

Harper, F. 1927. The mammals of the Okefinokee (sic) Swamp region of Georgia. Proc. Boston Soc. Nat. Hist. 38:191-196.

Harper, R. M. 1911. The relation of climax vegetation to islands and peninsulas. Bull. Torrey Bot. Club 38(11):515-525.

_______________. 1962. Historical notes on the relation of fires to forests. Proc. Tall Timbers Fire Ecol. Conf. 1:11-29.

Helme, A. H. 1904. The Ipswich sparrow, Kirtland's warbler, and Sprague's pipit in Georgia. Auk 21(2):291.

Hemmings, E. T., and K. A. Deagan. 1973. Excavations on Amelia Island in Northeast Florida. Contr. Florida State Mus., Anthropol. and Hist., No. 18, Gainesville. 87 pp.

Hubricht, L. 1964. The land snails of Georgia. Sterkiana, No. 16, pp. 5-10.

Ivers, L. E. 1974. British drums on the southern frontier: the military colonization of Georgia, 1733-1749. Univ. North Carolina Press, Chapel Hill. 274 pp.

Johnson, A. S. 1970. Biology of the raccoon (Procyon lotor varius) Nelson and Goldman in Alabama. Bulletin 402. Agric. Exp. Stn., Auburn Univ., Auburn. 148 pp.

______________, H. O. Hillestad, S. Shanholtzer, and G. F. Shanholtzer. 1975. The ecology of the Georgia coast. Natl. Park Serv., Sci. Monogr. No. 3, 211 pp. + maps.

Johnson, G. G. 1930. A social history of the sea islands. Univ. North Carolina Press, Chapel Hill. 245 pp.

Jones, A. W. 1967. Glossy ibis and black-necked stilt on Cumberland Island, Georgia. Oriole 32(2):25.

Jones, C. C., Jr. 1878. The dead towns of Georgia. Morning News Steam Printing House, Savannah. 263 pp.

Kahl, M. P. 1964. Food ecology of the wood stork (Mycteria americana) in Florida. Ecol. Monogr. 34(2):97-117.

Kalmbach, E. R. 1944. The armadillo: its relation to agriculture and game. Texas Game, Fish and Oyster Comm., Austin. 60 pp.

Kappus, K. D., W. J. Bigler, R. G. McLean, and H. A. Trevino. 1970. The raccoon an emerging rabies host. J. Wildl. Dis. 6(4):507-509.

Kennamer, J. E., and W. H. Lunceford, Jr. 1973. Armadillos tested as potential egg predators of wild turkeys in the Mississippi delta. Pages 175-177 in Glen C. Sanderson and Helen C. Schultz, eds. Wild turkey management: current problems and programs. Univ. Missouri Press, Columbia. 355 pp.

Komarek, E. V., Sr. 1962. Fire ecology. Proc. Tall Timbers Fire Ecol. Conf. 1:95-107.

_______________. 1964. The natural history of lightning. Proc. Tall Timbers Fire Ecol. Conf. 3:139-183.

_______________. 1968. Lightning and lightning fires as ecological forces. Proc. Tall Timbers Fire Ecol. Conf. 8:196-197.

Krause, R. E., and D. O. Gregg. 1972. Water from the principal artesian aquifer in coastal Georgia. Georgia Dept. Nat. Resour., Earth and Water Div., Hydrol. Atlas 1.

Küchler, A. W. 1973. Problems in classifying and mapping vegetation for ecological regionalization. Ecology 54(3):512-523.

Laessle, A. M., and C. D. Monk. 1961. Some live oak forests of northeastern Florida. Q. J. Florida Acad. Sci. 24(1):39-55.

Lieth, H. 1968. Continuity and discontinuity in ecological gradients and plant communities. Bot. Rev. 34(3):291-302.

McCallie, S. W. 1898. A preliminary report on the artesian-well systems of Georgia. Geol. Surv. Georgia Bull. 7. 214 pp.

Martin, W. E. 1959. The vegetation of Island Beach State Park, New Jersey. Ecol. Monogr. 29(1):1-46.

Milanich, J. T. 1972. Tacatacuru and the San Pedro de Mocama Mission. Florida Hist. Q. 50(3):283-291.

_______________. 1973. A Deptford phase house structure, Cumberland Island, Georgia. Florida Anthropol. 26(3):105-118.

Monk, C. D. 1965. Southern mixed hardwood forest of Northcentral Florida. Ecol. Monogr. 35(4):335-354.

_______________. 1966. An ecological significance of evergreenness. Ecology 47(3):504-505.

_______________. 1968. Successional and environmental relationships of the forest vegetation of North Central Florida. Am. Midl. Nat. 79(2):441-457.

Nightingale, B. N. 1938. Dungeness. Georgia Hist. Q. 22(4):369-383.

Ober, F. A. 1880. Dungeness, General Greene's Sea-Island Plantation. J. B. Lippincott Co., Philadelphia. 32 pp.

Odum, E. P. 1971. Fundamentals of Ecology. 3rd ed. W. B. Saunders Co., Philadelphia. 546 pp.

Oosting, H. J. 1954. Ecological processes and vegetation of the maritime strand in the southeastern United States. Bot. Rev. 20(4):226-262.

_______________. 1956. The study of plant communities. 2nd ed. W. H. Freeman and Co., San Francisco. 440 pp.

_______________, and W. D. Billings. 1942. Factors effecting vegetational zonation on coastal dunes. Ecology 23(2):131-142.

Osgood, W. H. 1909. Revision of the mice of the American genus Peromyscus. North Am. Fauna No. 28. U. S. Fish and Wildl. Serv., Washington. 285 pp.

Pearson, T. G. 1922. Notes on the birds of Cumberland Island, Georgia. Wilson Bull. 34(2):84-90.

Pilsbury, H. A. 1948. Land mollusca of North America (North of Mexico). Acad. Nat. Sci. Philadelphia Monogr. No. 3, vol. II, Part 2. pp. 521-1113.

Poore, M. E. D. 1955a. The use of phytosociological methods in ecological investigations. I. The Braun-Blanquet System. J. Ecol. 43: 226-244.

______________. 1955b. The use of phytosociological methods in ecological investigations. II. Practical issues involved in an attempt to apply the Braun-Blanquet System. J. Ecol. 43:245-269.

______________. 1955c. The use of phytosociological methods in ecological investigations. III. Practical application. J. Ecol. 43: 606-651.

Pournelle, G. H., and B. A. Barrington. 1953. Notes on mammals of Anastasia Island, St. Johns County, Florida. J. Mammal. 34(1):133-135.

Prestwood, A. K., and F. E. Kellogg. 1971. Naturally occurring haemonchosis in a white-tailed deer. J. Wildl. Dis. 7(2):133-134.

______________, J. F. Smith, and J. Brown. 1971. Lungworms in white-tailed deer of the southeastern United States. J. Wildl. Dis. 7(3):149-154.

______________, F. A. Hayes, J. H. Eve, and J. F. Smith. 1973. Abomasal helminths of white-tailed deer in southeastern United States, Texas and the Virgin Islands. J. Am. Vet. Med. Assoc. 163(6):556-561.

______________, F. E. Kellogg, S. E. Pursglove, and F. A. Hayes. 1975. Helminth parasitism among intermingling insular populations of white-tailed deer, feral cattle, and feral swine. J. Wildl. Manage. (In press)

Quarterman, E., and C. Keever. 1962. Southern mixed hardwood forest: climax in the southeastern Coastal Plain, U. S. A. Ecol. Monogr. 32(2):167-185.

Redfield, A. C. 1972. Development of a New England salt marsh. Ecol. Monogr. 42(2):201-237.

Richardson, J. I., and J. Worthington. 1975. Value and vulnerability of Georgia's coastal island system. Pages 37-109 in The value and vulnerability of coastal resources--background papers for review and discussion. Georgia Dept. Nat. Resour., Planning Sect., Atlanta. 291 pp.

Sciple, G. W., Jr. 1950. A second Georgia specimen of Cabot's tern. Oriole 15(1):8.

Sharp, H. F., Jr. 1962. Trophic relationships of the rice rat, *Oryzomys palustris palustris* (Harlan), living in a Georgia salt marsh. M. S. Thesis, Univ. Georgia, Athens. 53 pp.

______________. 1967. Food ecology of the rice rat, *Oryzomys palustris* (Harlan), in a Georgia salt marsh. J. Mammal. 48(4):557-563.

Snoddy, E. L. 1970. Trapping deerflies with colored weather balloons (Diptera: Tabanidae). J. Georgia Entomol. Soc. 5(4):207-209.

Sprunt, A., Jr. 1936. Some observations on the bird life on Cumberland Island, Georgia. Oriole 1(1):1-6.

Stafford, S., C. T. Lee, and L. E. Williams, Jr. 1966. Drive-trapping white-tailed deer. Proc. Southeastern Game and Fish Commissioners 20:63-69.

Stewart, J. W., and M. G. Croft. 1960. Ground-water withdrawals and decline of artesian pressures in the coastal counties of Georgia. Georgia Mineral Newsl. 13(2):84-93.

Taylor, W. P. (ed.). 1956. The deer of North America. Stackpole Co., Harrisburg. 668 pp.

Teal, J. M. 1958. Distribution of fiddler crabs in Georgia salt marshes. Ecology 39(2):185-193.

Thomson, M. T., S. M. Herrick, E. Brown. 1956. The availability and use of water in Georgia. Georgia Dept. Mines, Mining, Geol. Bull. 65. 329 pp.

Tippins, H. H., and R. J. Beshear. 1969. New collection records for *Niveaspis ilicis* (Hoke), (Homoptera: Diaspididae). Entomol. News 80(11):304.

——————, and ——————. 1970a. The armoed scale insects (Homoptera: Diaspididae) of Cumberland Island, Georgia. J. Georgia Entomol. Soc. 5(11):7-12.

——————, and ——————. 1970b. A new species of *Quernaspis* (Homoptera: Diaspididae). Ann. Entomol. Soc. Am. 63(3):808-809.

——————, and ——————. 1971. *Aspidiotus* n. sp. (Homoptera: Diaspididae) from saw grass, *Mariscus jamaicensis*. J. Georgia Entomol. Soc. 6(2):85-86.

Warren, M. A. 1944. Artesian water in southeastern Georgia. Georgia Dept. Mines, Mining, Geol. Bull. 49. 140 pp.

Wells, B. W. 1939. A new forest climax: the salt spray climax of Smith Island, North Carolina. Bull. Torrey Bot. Club 66(9):629-634.

White, G. 1849. Statistics of the State of Georgia. W. T. Williams, Savannah. 701 pp.

Wilkes, R. L., J. H. Johnson, H. T. Stoner, and D. D. Bacon. 1974. Soil survey of Bryan and Chatham counties, Georgia. U. S. Dept. Agric., Soil Conserv. Serv. 71 pp. + maps.

Williams, L. E., Jr. 1965. Capture methods. Pages 177-185 in R. F. Harlow and F. K. Jones. The white-tailed deer in Florida. Florida Game and Freshwater Fish Comm. Tech. Bull. No. 9. 240 pp.

Worthington, J. S. 1972. An evaluation of environmental impact Little Cumberland Island, Georgia. M. S. Thesis, Univ. Massachusetts, Amherst. 161 pp.

Wright, A. H. 1926. The vertebrate life of Okefinokee (sic) Swamp in relation to the Atlantic Coastal Plain. Ecology 7(1):77-95.

__________, and A. A. Wright. 1932. The habitats and composition of the vegetation of Okefinokee (sic) Swamp, Georgia. Ecol. Monogr. 2(2):109-232.

APPENDIX I

Vascular Plants of Cumberland and Little Cumberland Islands, Camden County, Georgia

The following tentative species lists were compiled for native or naturalized trees (Table 13), shrubs and vines (Table 14), and herbaceous plants (Table 15) found on Cumberland and Little Cumberland islands during the vegetation survey in 1973. The plants are arranged alphabetically by common name so that plants mentioned by common name in the text can be quickly and accurately identified with the appropriate scientific name. Scientific names generally follow Radford et al. (1968) or Small (1933).

Literature Cited

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. 1183 pp.

Small, J. K. 1933. Manual of the southeastern flora. Univ. North Carolina Press, Chapel Hill. 1554 pp.

Table 13. Tentative list of native or naturalized tree species occurring on Cumberland Island, Georgia, arranged alphabetically by common name.

Common Name	Species
American elm	*Ulmus americana*
American holly	*Ilex opaca*
American olive	*Osmanthus americanus*
Bayberry	*Myrica cerifera*
Black cherry	*Prunus serotina*
Blackgum	*Nyssa sylvatica* var. *biflora*
Bluejack oak	*Quercus incana*
Buckthorn	*Rhamus caroliniana*
Cabbage palm	*Sabal palmetto*
Chapman's oak	*Quercus chapmanii*
China-berry	*Melia azedarach*
Dahoon	*Ilex cassine*
Grapefruit	*Citrus paradisi* (escaped from cultivation)
Hackberry	*Celtis laevigata*
Hercules-club	*Zanthoxylum clava-herculis*
Horse-sugar	*Symplocos tinctoria*
Laurel cherry	*Prunus caroliniana*
Laurel oak	*Quercus laurifolia*
Live oak	*Quercus virginiana* (incl. *Q. maritima*, *Q. geminata*)
Loblolly bay	*Gordonia lasianthus*
Loblolly pine	*Pinus taeda*
Longleaf pine	*Pinus palustris*
Myrtle oak	*Quercus myrtifolia*
Olive	*Olea europaea* (persisting from early plantations)
Pecan	*Carya illinoiensis*
Persimmon	*Diospyros virginiana*
Pignut hickory	*Carya glabra*
Pond cypress	*Taxodium ascendens*
Pond pine	*Pinus serotina*

Table 13. (continued)

Common Name	Species
Red bay	*Persea borbonia*
Redbud	*Cercis canadensis*
Red maple	*Acer rubrum*
Red mulberry	*Morus rubra*
Rusty lyonia	*Lyonia ferruginea*
Sassafras	*Sassafras albidum*
Saw palmetto	*Serenoa repens* (arborescent forms)
Seville orange	*Citrus aurantium* (escaped from cultivation)
Slash pine	*Pinus elliottii*
Southern elderberry	*Sambucus simpsonii*
Southern magnolia	*Magnolia grandiflora*
Southern red-cedar	*Juniperus silicicola*
Southern red oak	*Quercus falcata*
Sparkleberry	*Vaccinium arboreum*
Spruce pine	*Pinus glabra*
Stiff-cornel dogwood	*Cornus stricta*
Swamp red bay	*Persea palustris*
Sweet bay	*Magnolia virginiana*
Sweet-gum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Tamarisk	*Tamarix gallica*
Tough buckthorn	*Bumelia tenax*
Tree of Heaven	*Ailanthus altissima*
Tung oil tree	*Aleurites fordii*
Turkey oak	*Quercus laevis*
Water oak	*Quercus nigra*
Willow	*Salix caroliniana*
Yaupon	*Ilex vomitoria*

Table 14. Tentative list of native or naturalized shrubs and vines occurring on Cumberland Island, Georgia arranged alphabetically by common name.

Common Name	Species
American holly	*Ilex opaca*
American olive	*Osmanthus americanus*
Bamboo-brier	*Smilax auriculata*
Bayberry	*Myrica cerifera* (incl. *Myrica pusilla* Raf.)
Beach elder	*Iva imbricata*
Beach hogwort	*Croton punctatus*
Bear-grass	*Yucca filamentosa*
Blackberry	*Rubus cuneifolius*
Black highbush blueberry	*Vaccinium atrococcum*
Buckeye	*Aesculus pavia*
Buckthorn	*Rhamnus caroliniana*
Button-bush	*Cephalanthus occidentalis*
Carolina holly	*Ilex ambigua*
Cassia	*Cassia* sp. (escaped from cultivation)
Castor-bean	*Ricinus communis* (perennial forms)
Chapman's oak	*Quercus chapmanii*
Chickasaw plum	*Prunus angustifolia*
China-berry	*Melia azedarach*
China brier	*Smilax bona-nox*
Chinquapin	*Castanea pumila*
Coral bean	*Erythrina herbacea*
Coral honeysuckle	*Lonicera sempervirens*
Creeping fig	*Ficus pumila* (persistent around old buildings)
Cross vine	*Anisostichus capreolata*
Dahoon	*Ilex cassine*
Daubentonia	*Daubentonia punicea*
Devil's walking stick	*Aralia spinosa*
Dewberry	*Rubus trivialis*
Downy grape	*Vitis cinerea*

Table 14. (continued)

Common Name	Species
Drummond prickly-pear	*Opuntia drummondii*
Dwarf blueberry	*Vaccinium myrsinites*
Dwarf pawpaw	*Asimina parviflora*
Eastern prickly-pear	*Opuntia compressa*
Elderberry	*Sambucus canadensis*
False indigo	*Amorpha fruiticosa*
False willow	*Baccharis angustifolia*
Fetter-bush	*Lyonia lucida*
Florida privet	*Forestiera porulosa*
French mulberry	*Callicarpa americana*
Fringe-tree	*Chionanthus virginicus*
Frostweed	*Helianthemum corymbosum*
Gallberry	*Ilex glabra*
Glasswort	*Salicornia virginica*
Grapefruit	*Citrus paradisi* (escaped from cultivation)
Groundsel-tree	*Baccharis halimifolia*
Hercules-club	*Zanthoxylum clava-herculis*
Hog plum	*Prunus umbellata*
Horse-sugar	*Symplocos tinctoria*
Huckleberry	*Gaylussacia frondosa* var. *tomentosa*
Japanese honeysuckle	*Lonicera japonica*
Laurel cherry	*Prunus caroliniana*
Laurel greenbrier	*Smilax laurifolia*
Marsh elder	*Iva frutescens*
Marsh mallow	*Hibicus grandiflorus*
Mistletoe	*Phoradendron serotinum*
Moundlily yucca	*Yucca gloriosa*
Muscadine grape	*Vitis rotundifolia*
Myrtle-leaf St. John's wort	*Hypericum myrtifolium*
Myrtle oak	*Quercus myrtifolia*
Oleander	*Nerium oleander* (escaped from cultivation)

Table 14. (continued)

Common Name	Species
Pawpaw	*Asimina incana*
Pawpaw	*Asimina pygmaea*
Pepper-vine	*Ampelopsis arborea*
Persimmon	*Diospyros virginiana*
Pin-weed	*Lechea villosa*
Poison-ivy	*Rhus radicans*
Railroad vine	*Ipomoea pes-caprae*
Ratton-vine	*Berchemia scandens*
Red bay	*Persea borbonia*
Red chokeberry	*Sorbus arbutifolia*
Round-podded St. John's wort	*Hypericum cistifolium*
Rusty lyonia	*Lyonia ferruginea*
Sageretia	*Sageretia minutiflora*
Sago palm	*Cycas revoluta* (escaped from cultivation)
Saltmarsh mallow	*Kosteletzkya virginica*
Saltwort	*Batis maritima*
Sandweed	*Hypericum fasciculatum*
Saw-brier	*Smilax glauca*
Saw palmetto	*Serenoa repens*
Sea ox-eye	*Borrichia frutescens*
Seaside evening-primrose	*Oenothera humifusa*
Seville orange	*Citrus aurantium* (escaped from cultivation)
Southern elderberry	*Sambucus simpsonii*
Spanish-bayonet	*Yucca aloifolia*
Sparkleberry	*Vaccinium arboreum*
Squaw huckleberry	*Vaccinium stamineum*
Stagger-bush	*Lyonia mariana*
St. Andrew's cross	*Hypericum hypericoides*
St. Peter's wort	*Hypericum stans*
Stiff-cornel dogwood	*Cornus stricta*
Summer grape	*Vitis aestivalis*
Swamp rose-mallow	*Hibiscus moscheutos*

Table 14. (continued)

Common Name	Species
Switch-cane	*Arundinaria tecta*
Tar-flower	*Befaria racemosa*
Tough buckthorn	*Bumelia tenax*
Tree of Heaven	*Ailanthus altissima*
Trumpet vine	*Campsis radicans*
Tung-oil tree	*Aleurites fordii*
Virginia creeper	*Parthenocissus quinquefolia*
Water willow	*Decodon verticillatus*
Wicky laurel	*Kalmia hirsuta*
Winged sumac	*Rhus copallina*
Witch-hazel	*Hamamelis virginica*
Wooly greenbrier	*Smilax pumila*
Yaupon	*Ilex vomitoria*
Yellow jessamine	*Gelsemium sempervirens*

Table 15. Tentative list of native or naturalized herbaceous plant species occurring on Cumberland Island, Georgia, arranged alphabetically by common name.

Common Name	Species
Amaryllis	*Amaryllis* sp.
American lotus	*Nelumbo lutea*
American three-square bulrush	*Scirpus americanus*
Angle-pods	*Matelea gonocarpa*
Baggy-knees	*Sacciolepis striata*
Bahia grass	*Paspalum notatum*
Beach elder	*Iva imbricata*
Beach hogwort	*Croton punctatus*
Beach morning-glory	*Ipomoea stolonifera*
Beach pennywort	*Hydrocotyle bonariensis*
Beak-rush	*Rhynchospora* spp.
Beak-rush	*Rhynchospora decurrens*
Beak-rush	*Rhynchospora inexpansa*
Beak-rush	*Rhynchospora microcephala*
Beak-rush	*Rhynchospora wrightiana*
Bedstraw	*Galium hispidulum*
Bedstraw	*Galium pilosum*
Beggar-weed	*Desmodium* spp.
Beggar-weed	*Desmodium lineatum*
Bermuda grass	*Cynodon dactylon*
Big carpet grass	*Axonopus furcatus*
Big duckweed	*Spirodela* sp.
Bigelow glasswort	*Salicornia bigelovii*
Bitter-weed	*Helenium amarum*
Black oat-grass	*Stipa avenacea*
Black-root	*Pterocaulon pycnostachyum*
Black rush	*Juncus roemerianus*
Bladderwort	*Utricularia* spp.
Blue-eyed grass	*Sisyrinchium resulatum*
Bluestem	*Andropogon* sp.

Table 15. (continued)

Common Name	Species
Bracken-fern	Pteridium aquilinum
Bristly panic grass	Panicum aciculare (P. aciculare complex)
Bristly paspalum	Paspalum setaceum
Broom-sedge	Andropogon virginicus
Brome grass	Bromus catharticus
Bulrush	Scirpus spp.
Burmannia	Burmannia biflora
Butterfly pea	Clitoria mariana
Camphor-weed	Heterotheca graminifolia
Camphor-weed	Heterotheca subaxillaris
Cancer-weed	Salvia lyrata
Cape-weed	Lippia nodiflora
Carpet-weed	Mollugo verticillata
Centipede grass	Eremochloa ophiuroides
Chain fern	Woodwardia virginica
Chinaman's shield	Centella asiatica
Cinnamon fern	Osmunda cinnamomea
Climbing hempweed	Mikania scandens
Coastal love grass	Eragrostis refracta
Common carpet grass	Axonopus affinis
Common cat-tail	Typha latifolia
Common rush	Juncus effusus
Conespur bladderwort	Utricularia gibba
Coontail	Ceratophyllum echinatum
Coral bean	Erythrina herbacea
Cotton-weed	Frolichia floridana
Cow-lily	Nuphar luteum
Crab grass	Digitaria sanguinalis
Crane-fly orchid	Tipularia discolor
Creeping rush	Juncus repens
Cutleaf evening-primrose	Oenothera laciniata

Table 15. (continued)

Common Name	Species
Dayflower	*Commelina erecta*
Deer's-tongue	*Trilisa odoratissima*
Diamond-flower	*Houstonia procumbens*
Dock	*Rumex hastatulus*
Dodder	*Cuscuta* sp.
Dog-fennel	*Eupatorium capillifolium*
Dotted smartweed	*Polygonum punctatum*
Dropseed grass	*Sporobolus* spp.
Dropseed grass	*Sporobolus teretifolia*
Duck-potato	*Sagittaria latifolia*
Dune thistle	*Carduus smallii*
Dutchman's pipe	*Aristolochia* sp.
Dwarf plantain	*Plantago virginica*
Dyschoriste	*Dyschoriste oblongifolia*
Eastern bladderwort	*Utricularia biflora*
Eastern gamma grass	*Tripsacum dactyloides*
Ebony spleenwort	*Asplenium platyneuron*
Elephant-foot	*Elephantopus nudatus*
False dandelion	*Krigia virginica*
False dandelion	*Pyrrhopappus carolinianus*
False nettle	*Boehmeria cylindrica*
Fanwort	*Cabomba caroliniana*
Finger grass	*Chloris petraea*
Flat sedge	*Cyperus* sp.
Flax	*Linum virginianum*
Fleabane	*Erigeron quercifolius*
Fleabane	*Erigeron vernus*
Floating bladderwort	*Utricularia inflata*
Floating-hearts	*Nymphoides aquatica*
Floating paspalum	*Paspalum fluitans*
Florida pussley	*Richardia scabra*
Foxtail grass	*Setaria geniculata*

Table 15. (continued)

Common Name	Species
Fragrant goldenrod	*Solidago odora*
Fringe-leaved paspalum	*Paspalum ciliatifolium*
Frog's-bit	*Limnobium spongia*
Frost-weed	*Helianthemum carolinianum*
Frost-weed	*Helianthemum corymbosum*
Gaura	*Gaura angustifolia*
Giant plume grass	*Erianthus giganteus*
Glasswort	*Salicornia* spp.
Goose grass	*Eleusine indica*
Green-fly orchid	*Epidendrum conopseum*
Ground-cherry	*Physalis viscosa* ssp. *maritima*
Hair-sedge	*Bulbostylis ciliatifolia*
Hares-foot fern	*Polypodium aureum*
Hawkweed	*Hieracium* sp.
Hedgehog grass	*Cenchrus echinatus*
Horned beak-rush	*Rhynchospora corniculata*
Horseweed	*Erigeron canadensis*
Indian grass	*Sorghastrum secundum*
Indigo-bush	*Amorpha fruticosa*
Indigo	*Indigofera caroliniana*
Knawel	*Scleranthus annuus*
Knotweed	*Polygonum* spp.
Ladies' tresses	*Spiranthes praecox*
Lamb's-quarters	*Chenopodium album*
Leather-flower	*Clematis reticulata*
Lespedeza	*Lespedeza* sp.
Little duckweed	*Lemna minor*
Little duckweed	*Lemna valdiviana*
Lizard's-tail	*Saururus cernuus*
Low hop-clover	*Trifolium dubium*
Maiden-cane	*Panicum hemitomon*
Marsh fleabane	*Pluchea* spp.

Table 15. (continued)

Common Name	Species
Marsh fleabane	Pluchea rosea
Marsh-gentian	Sabatia stellaris
Marsh pennywort	Hydrocotyle umbellata
Marsh-purslane	Ludwigia palustris
Meadow-beauty	Rhexia mariana
Mermaid-weed	Proserpinaca pectinata
Mexican-tea	Chenopodium ambrosioides
Milk-pea	Galactia elliottii
Milk-pea	Galactia regularis
Milk-vine	Cynanchum palustre
Milk-vine	Cynanchum scoparium
Milkwort	Polygala grandiflora
Miterwort	Cynoctonum mitreola
Mock-bishop weed	Ptilimnium capillaceum
Morning glory	Ipomoea sagittata
Mosquito fern	Azolla caroliniana
Muhly grass	Muhlenbergia capillaris
Narrow-leaved cat-tail	Typha angustifolia
Needlepod rush	Juncus scirpoides
Noseburn	Tragia urens
Nut-grass	Cyperus esculentus
Nut-grass	Cyperus globulosus
Nut-rush	Scleria triglomerata
Panic grass	Panicum spp.
Partridge pea	Cassia fasciculata
Pearlwort	Sagina decumbens
Pellitory	Parietaria floridana
Pencil-flower	Stylosanthes biflora
Pickerelweed	Pontederia cordata
Pickerelweed	Pontederia lanceolata
Pineweed	Hypericum gentianoides
Pinweed	Lechea villosa

Table 15. (continued)

Common Name	Species
Plume grass	*Erianthus* sp.
Pokeweed	*Phytolacca americana*
Polycarpon	*Polycarpon tetraphyllum*
Polypremum	*Polypremum procumbens*
Pondweed	*Potamogeton* sp.
Pony-foot	*Dichondra carolinensis*
Poor-joe	*Diodia teres*
Poor-man's pepper	*Lepidium virginicum*
Prickly-poppy	*Argemone albiflora*
Purple bladderwort	*Utricularia purpurea*
Purple love grass	*Eragrostis spectabilis*
Purple sand grass	*Triplasis purpurea*
Purslane	*Portulaca oleracea*
Quaking grass	*Briza minor*
Queen's delight	*Stillingia sylvatica*
Rabbit tobacco	*Gnaphalium obtusifolium*
Rabbit tobacco	*Gnaphalium purpureum*
Ragweed	*Ambrosia artemisiifolia*
Railroad vine	*Ipomoea pes-caprae*
Rattlebox	*Crotalaria purshii*
Red-flowered sage	*Salvia coccinea*
Resurrection fern	*Polypodium polypodioides*
Royal fern	*Osmunda regalis* var. *spectabilis*
Rush	*Juncus* spp.
Rushfoils	*Crotonopsis* sp.
Russian thistle	*Salsola kali*
Rye grass	*Lolium multiflorum*
Saint Augustine grass	*Stenotaphrum secundatum*
Salt grass	*Distichlis spicata*
Salt marsh aster	*Aster tenuifolius*
Salt-marsh bulrush	*Scirpus robustus*

Table 15. (continued)

Common Name	Species
Salt-marsh fimbristylis	Fimbristylis spadicea
Saltmarsh pluchea	Pluchea purpurascens
Salt-meadow cordgrass	Spartina patens
Saltwort	Batis maritima
Sand cordgrass	Spartina bakeri
Sandspur	Cenchrus tribuloides
Sand spurrey	Spergularia marina
Sandwort	Arenaria serpyllifolia
Saw-grass	Cladium jamaicense
Seabeach knotweed	Polygonum glaucum
Sea beach panic grass	Panicum amarum
Sea-blite	Suaeda linearis
Sea lavender	Limonium carolinianum
Sea-oats	Uniola paniculata
Sea purslane	Sesuvium maritimum
Sea purslane	Sesuvium portulacastrum
Sea-rocket	Cakile harperi
Seashore dropseed	Sporobolus virginicus
Seashore paspalum	Paspalum vaginatum
Seaside evening-primrose	Oenothera humifusa
Seaside goldenrod	Solidago sempervirens
Seaside heliotrope	Heliotropium curassavicum
Seaside spurge	Euphorbia polygonifolia
Secula	Secula viscidula
Sedge	Carex spp.
Seedbox	Ludwigia alternifolia
Sensitive-brier	Schrankia microphylla
Sicklepod	Cassia obtusifolia
Sixweeks fescue	Festuca octoflora
Sleepy-catchfly	Silene antirrhina
Slender arrowhead	Sagittaria graminea

Table 15. (continued)

Common Name	Species
Slender glasswort	*Salicornia europaea*
Slender goldenrod	*Solidago tenuifolia*
Slender marsh-purslane	*Ludwigia linearis*
Smooth cordgrass	*Spartina alterniflora*
Snakeroot	*Aristolochia hastata*
Snakeroot	*Sanicula canadensis*
Spanish-moss	*Tillandsia usneoides*
Spiderwort	*Tradescantia ohiensis*
Spike grass	*Uniola sessiliflora*
Spike-rush	*Eleocharis* spp.
Spike-rush	*Eleocharis vivipara*
Spoonflower	*Peltandra sagittaefolia*
Spring cress	*Cardamine pensylvanica*
Spurge	*Euphorbia* sp.
Star-rush	*Dichromena colorata*
Stinking fleabane	*Pluchea foetida*
Stinging nettle	*Cnidoscolus stimulosus*
Swamp smartweed	*Polygonum hydropiperoides*
Switchgrass	*Panicum virgatum*
Thoroughwort	*Eupatorium aromaticum*
Three awn grass	*Aristida* sp.
Three awn grass	*Aristida lanosa*
Three-way sedge	*Dulichium arundinaceum*
Toad-flax	*Linaria canadensis*
Toad rush	*Juncus bufonius*
Tobacco-weed	*Elephantopus tomentosus*
Tropical carpet grass	*Axonopus compressus*
Umbrella-grass	*Fuirena squarrosa*
Vasey grass	*Paspalum urvillei*
Venus looking-glass	*Specularia perfoliata*
Verbena	*Verbena tenuisecta*

Table 15. (continued)

Common Name	Species
Vetch	*Vicia* sp.
Water-grass	*Bulbostylis barbata*
Water-hyssop	*Bacopa caroliniana*
Water-hyssop	*Bacopa monnieri*
Water-lily	*Nymphaea odorata*
Water meal	*Wolfiella floridana*
Water milfoil	*Myriophyllum* sp.
Water pimpernel	*Samolus parviflorus*
Water purslane	*Ludwigia* spp.
Water-shield	*Brasenia schreberi*
Water spider orchid	*Habenaria repens*
Wild sensitive plant	*Cassia nictitans*
Wood-grass	*Oplismenus setarius*
Woody glasswort	*Salicornia virginica*
Woolgrass	*Scirpus cyperinus*
Wooly panic grass	*Panicum lanuginosum*
Wooly mullein	*Verbascum thapsus*
Wright's panic grass	*Panicum wrightianum*
Yankeeweed	*Eupatorium compositifolium*
Yellow-eyed grass	*Xyris* sp.
Yellow passion-flower	*Passiflora lutea*
Yellow thistle	*Carduus spinosissimus*
Zornia	*Zornia bracteata*

APPENDIX II

Summary Tables, Vegetation Analysis

Cumberland Island, Camden County, Georgia

The following tables (Tables 16-33) summarize the data from the vegetation studies conducted on Cumberland Island during 1973. The reader is referred to Chapter VI for a detailed description of the methods used in the collection of field data and procedures for analysis of the data.

These summary tables will provide the reader with the quantitative data on habitat-community structure. They will be valuable to future researchers evaluating habitat changes following development of the Seashore and for studying long-term successional relationships on Cumberland or other similar maritime ecosystems.

Table 16. Summary of importance values for dominant and co-dominant tree species (> 4"dbh) composing the major forest types on Cumberland Island, Georgia. Data based on 249 sample points, as determined by the point-quarter sampling method. Importance values of less than 10 are excluded.

Species	Community Type						
	Pine-Oak Scrub (18)[a]	Oak Scrub (6)	Oak-Buckthorn Scrub (6)	Oak-Palmetto (59)	Oak-Pine (122)	Mixed Oak-Hardwood (28)	Lowland Mixed Hardwood (10)
Pinus serotina	77.0						
Pinus elliottii	64.4	46.4	15.7		24.6		
Quercus myrtifolia		29.4					
Osmanthus americanus		14.9					
Quercus chapmanii		14.5					
Bumelia tenax			48.4				
Lyonia ferruginea	31.8		12.3	21.9		15.3	
Persea borbonia	28.8			31.3	15.5	14.9	
Quercus virginiana	79.9	194.7	197.9	192.8	118.1	118.4	77.3
Quercus laurifolia					36.7	47.7	
Pinus taeda			13.6		28.2		41.4
Pinus palustris					27.8	10.8	
Ilex opaca					12.9	21.8	
Juniperus silicicola					11.6	10.9	
Magnolia grandiflora						19.0	
Myrica cerifera			12.1				29.4
Persea palustris							65.6
Gordonia lasianthus							21.7
Magnolia virginiana							14.7
Quercus nigra							12.2
Acer rubrum							11.6

[a]Numbers in parentheses indicate number of sample points in each community type.

Table 17. Summary of woody understory species (> 4"dbh) present in the major forest types on Cumberland Island, Georgia. Data based on occurrence in two hundred fifty 6.6 X 6.6 ft. quadrats. Only dominant species or those with indicative value are included.[a]

Species	Community Type						
	Pine-Oak Scrub (18)[b]	Oak Scrub (6)	Oak-Buckthorn Scrub (6)	Oak-Palmetto (60)	Oak-Pine (122)	Mixed Oak-Hardwood (28)	Lowland Mixed Hardwood (10)
Serenoa repens	17	6	3	53	15	6	3
Vitis rotundifolia	3		3	26	36	11	4
Smilax auriculata	3		3	18	43	2	1
Lyonia ferruginea	13	4		33	11	5	3
Myrica cerifera	2	5	2	11	30	2	4
Smilax glauca	2			22	5		2
Vaccinium arboreum				7	16	2	
Lyonia lucida	4	1		9	1		4
Gaylussacia frondosa var. tomentosa	5	2		1			
Vaccinium myrsinites	5	2		2	5		
Ilex glabra	4	3		4			1
Befaria racemosa	3	1					
Diospyros virginiana	1						
Rhus copallina	1						
Sorbus arbutfolia	1						
Bumelia tenax			3		4		
Zanthoxylum clava-herculis			2				
Ampelopsis arborea			1	2	1		1
Ilex vomitoria			1	1	1		
Opuntia drummondii			1				
Vaccinium atrococcum				2			
Vitis aestivalis					11	1	
Parthenocissus quinquefolia					6		

Table 17 (Continued)

Species	Pine-Oak Scrub (18)	Oak Scrub (6)	Oak-Buckthorn Scrub (6)	Oak-Palmetto (60)	Oak-Pine (122)	Mixed Oak-Hardwood (28)	Lowland Mixed Hardwood (10)
	Community Type						
Asimina pygmaea					4	1	
Asimina parviflora					4		
Vaccinium stamineum					2		
Cephalanthus occidentalis							1
Smilax laurifolia							1
<u>Seedlings & Saplings</u>:							
Quercus virginiana	4	1	1	15	16	1	
Pinus serotina	3						
Quercus myrtifolia	1	4		3	7		
Osmanthus americanus		1		5			
Persea borbonia				7	9	1	
Quercus laurifolia				1	11	2	
Ilex opaca					16	6	1
Pinus palustris					2		
Pinus taeda					2		
Juniperus silicicola					1		
Pinus elliottii					1		
Sabal palmetto					1		
Persea palustris							2
Gordonia lasianthus							1

[a]Species enclosed by vertical lines are indicator species for community.

[b]Numbers in parentheses indicate number of quadrats in each community.

Table 18 Summary of herbaceous species present in the major forest types on Cumberland Island, Georgia. Data based on occurrence in two hundred forty eight 3.3 X 3.3 ft. quadrats.[a]

Species	Community Type						
	Pine-Oak Scrub (18)[b]	Oak Scrub (6)	Oak-Buckthorn Scrub (5)	Oak Palmetto (59)	Oak-Pine (122)	Mixed Oak-Hardwood (28)	Lowland Mixed Hardwood (10)
Panicum aciculare	1		2	6	53	12	
Uniola sessiliflora				4	40	7	
Eupatorium aromaticum				1	28	5	
Cyperus spp.			1	1	24	5	
Helianthemum corymbosum				1	14	1	
Andropogon virginicus	1			1	11	6	1
Scleria triglomerata				3	11	4	
Eremochloa ophiuroides			1		10	1	
Oplismenus setarius					7	1	
Stenotaphrum secundatum					7		
Galactia elliottii	5	2		2	5		
Pteridium aquilinum	2	1					
Rhynchospora wrightiana	1						
Cenchrus tribuloides			1				
Galium hispidulum			1		3		
Oenothera humifusa			1				
Cnidosculos stimulosus					5		
Paspalum ciliatifolium				1	5	2	
Eupatorium compositifolium					4		
Stipa avenacea					4	2	
Carex sp.					3		
Cyperus retrorsus					3		
Galactia regularis					3		
Lespedeza sp.					3		
Aristolochia hastata					2		
Heterotheca graminifolia					2	1	

Table 18. (Continued)

Species	Community Type						
	Pine-Oak Scrub (18)[b]	Oak Scrub (6)	Oak-Buckthorn Scrub (5)	Oak-Palmetto (59)	Oak-Pine (122)	Mixed Oak-Hardwood (28)	Lowland Mixed Hardwood (10)
Houstonia procumbens					2	1	
Stillingia sylvatica					2		
Rhynchospora decurrens							1
Saururus cernuus							1
Epiphytes:							
Tillandsia usneoides	X[c]	X		X	X	X	X
Polypodium polypodioides	X	X		X	X	X	X
Epidendrum conopseum				X	X	X	X
Uncommon Species:							
Burmannia biflora	1 (wet)						X
Houstonia procumbens				1			
Dyschoriste oblongifolia					2		
Aristida lanosa					1		
Commelina erecta					1		
Cynanchum scoparium					1		
Matalea gonocarpa					1		
Schrankia microphylla					1		
Stylosanthes biflora					1		
Tragia urens					1		
Sorghastrum secundum					X	1	

[a]Species enclosed by vertical lines are indicator species for community, or related communities.
[b]Numbers in parentheses indicate number of sample quadrats in each community type.
[c]X's indicate plants occurring in community but not in quadrats.

Table 19. Summary of plant species present in the major communities of the beach and dune habitats. Data based on occurrence in one hundred fifty one 3.3 X 3.3 ft. quadrats located at 30-foot-intervals along 10 transect lines.

Species	Plant Habit[a]	Foredune	Interdune Area: High Meadow	Interdune Area: Low Meadow	Interdune Area: Shrub Thicket	Rear Dune	Unstable Dune[b]
Paspalum vaginatum	h	30	20	15		8	2
Hydrocotyle bonariensis	h	22	21	25		12	3
Lippia nodiflora	h	10	24	21	2	10	
Croton punctatus	s-h	19	7	1		8	2
Euphorbia polygonifolia	h	8				1	1
Cenchrus tribuloides	h	7		1		5	
Sporobolus virginicus	h	4	2				1
Spartina patens	h	4	1		1		1
Salsola kali	h	3					
Ipomoea pes-caprae	v	2					1
Polygonum glaucum	h	1		1			1
Oenothera humifusa	s-h	6	16	5		7	
Erigeron canadensis	h	5	13	2		5	
Eremochloa ophiuroides	h		9	4			
Scleranthus annus	h	1	7	5	1	3	
Physalis viscosa	h		6	1		3	1
Paspalum ciliatifolium	h		5	1		4	
Plantago virginica	h		5				
Chenopodium ambrosioides	h	2	4	2		4	
Cynodon dactylon	h	2	2	2			1
Iva imbricata	s-h		2	1			
Yucca gloriosa	s		1			1	1
Setaria sp.	h		1				
Fimbristylis spadicea	h		9	15		3	
Cyperus spp.	h	1	8	13	2	4	
Juncus bufonius	h	1	12	12		1	
Sabatia stellaris	h	1	12	12		1	

Table 19. (Continued)

Species	Plant Habit[a]	Foredune	Interdune Area: High Meadow	Interdune Area: Low Meadow	Interdune Area: Shrub Thicket	Rear Dune	Unstable Dune[b]
Eragrostis refracta	h	2	10	11			
Chloris petraea	h		1	5		2	
Eupatorium capillifolium	h		2	4	2	1	
Pluchea sp.	h			4	1	1	
Eupatorium compositifolium	h	1	1	3		2	
Bulbostylis barbata	h		1	2		1	
Dichromena colorata	h			2			
Eleocharis sp.	h			2			
Juncus sp.	h			2			
Portulaca oleracea	h			1			
Scirpus americanus	h			1			
Typha sp.	h			1			
Myrica cerifera	s		2	4	3	1	3
Hydrocotyle umbellata	h				1		
Mollugo verticillata	h				1		
Mikania scandens	v				1		
Sabal palmetto	t				1		
Diodia teres	h	1		1		6	
Uniola paniculata	h	2				3	4
Muhlenbergia capillaris	h					3	
Andropogon sp.	h					1	
Houstonia procumbens	h					1	
Pinus elliottii	t					1	
Yucca aloifolia	s						2
Bumelia tenax	s-t						1

[a]Plant Habit: h=herb, s-shrub, t=tree, v=vine.

[b]A total of <u>44</u> quadrats out of 151 are included here as unstable dune, mostly bare sand.

Table 20. Importance values for tree species composing the pine-oak scrub forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 18 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	13	18.1	3045.0	39.6	8	22.2	79.9
Pinus serotina	24	33.3	1646.7	21.4	8	22.2	77.0
Pinus elliottii	16	22.2	1961.9	25.5	6	16.7	64.4
Lyonia ferruginea	9	12.5	203.8	2.7	6	16.7	31.8
Persea borbonia (incl. P. palustris)	7	9.7	398.2	5.2	5	13.9	28.8
Quercus laurifolia	1	1.4	363.1	4.7	1	2.8	8.9
Ilex opaca	1	1.4	56.8	.7	1	2.8	4.9
Quercus myrtifolia	1	1.4	12.6	.2	1	2.8	4.3

Additional Tree Species Present:

Magnolia virginiana
Osmanthus americanus
Quercus chapmanii

Table 21. Woody understory species present in pine-oak scrub forest. Data based on occurrence in eighteen 6.6 x 6.6 ft. quadrats.

Species	Frequency
Serenoa repens	17
Lyonia ferruginea	13
Gaylussacia frondosa var. tomentosa	5
Vaccinium myrsinites	5
Ilex glabra	4
Lyonia lucida	4
Befaria racemosa	3
Smilax auriculata	3
Vitis rotundifolia	3
Myrica cerifera	2
Smilax glauca	2
Diospyros virginiana	1
Rhus copallina	1
Sorbus arbutifolia	1
Seedlings & Saplings	
Quercus virginiana	4
Pinus serotina	3
Quercus myrtifolia	1

Table 22. Importance values for tree species composing the oak scrub forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 6 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	17	70.8	521.4	69.3	6	54.6	194.7
Pinus elliottii	3	12.5	186.5	24.8	1	9.1	46.4
Quercus myrtifolia	2	8.3	22.2	3.0	2	18.2	29.4
Osmanthus americanus	1	4.2	12.6	1.7	1	9.1	14.9
Quercus chapmanii	1	4.2	9.6	1.3	1	9.1	14.5

Additional Tree Species Present:

Persea borbonia

Pinus serotina

Table 23. Woody understory species present in the oak scrub forest. Data based on occurrence in six 6.6 x 6.6 ft. quadrats.

Species	Frequency
Serenoa repens	6
Myrica cerifera	5
Lyonia ferruginea	4
Ilex glabra	3
Gaylussacia frondosa var. tomentosa	2
Vaccinium myrsinites	2
Befaria racemosa	1
Lyonia lucida	1
Smilax pumila	1
Symplocos tinctoria	1
Seedlings & Saplings	
Quercus myrtifolia	4
Osmanthus americanus	1
Quercus virginiana	1

Table 24. Importance values for tree species composing the oak-buckthorn scrub forest (duneland) on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 6 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	15	62.50	4925.6	89.22	6	46.15	197.9
Bumelia tenax	5	20.83	250.1	4.53	3	23.08	48.4
Pinus elliottii	1	4.17	213.8	3.87	1	7.69	15.7
Pinus taeda	1	4.17	95.0	1.72	1	7.69	13.6
Lyonia ferruginea	1	4.17	23.8	.43	1	7.69	12.3
Myrica cerifera	1	4.17	12.6	.23	1	7.69	12.1

Additional Tree Species Present:

Persea borbonia
Juniperus silicicola
Prunus serotina
Sabal palmetto
Zanthoxylum clava-herculis

Table 25. Woody understory species present in the oak-buckthorn scrub forest (duneland). Data based on occurrence in six sample sites.

Species	Frequency
Bumelia tenax	3
Smilax auriculata	3
Serenoa repens	3
Vitis rotundifolia	3
Myrica cerifera	2
Zanthoxylum clava-herculis	2
Ampelopsis arborea	1
Ilex vomitoria	1
Opuntia drummondii	1
Seedlings & Saplings	
Quercus virginiana	1

Table 26. Importance values for tree species composing the oak-palmetto forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 59 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	144	61.0	36,903.5	88.1	55	43.7	192.8
Persea borbonia	26	11.0	1,172.2	2.8	22	17.5	31.3
Lyonia ferruginea	21	8.9	439.0	1.1	15	11.9	21.9
Ilex opaca	8	3.4	338.8	.8	6	4.8	9.0
Osmanthus americanus	7	3.0	99.6	.2	6	4.8	8.0
Persea palustris	7	3.0	630.4	1.5	3	2.4	6.9
Quercus myrtifolia	5	2.1	103.5	.3	5	4.0	6.3
Pinus taeda	6	2.5	373.7	.9	3	2.4	5.8
Quercus nigra	3	1.3	623.6	1.5	2	1.6	4.4
Quercus laurifolia	2	.9	240.5	.6	2	1.6	3.0
Bumelia tenax	2	.9	91.1	.2	2	1.6	2.7
Pinus elliottii	1	.4	471.4	1.1	1	.8	2.3
Magnolia grandiflora	1	.4	240.5	.6	1	.8	1.8
Pinus serotina	1	.4	132.7	.3	1	.8	1.5
Symplocos tinctoria	1	.4	15.9	.1	1	.8	1.3
Myrica cerifera	1	.4	19.6	.1	1	.8	1.3

Additional Tree Species Present:

Carya glabra
Juniperus silicicola
Liquidambar styraciflua
Prunus serotina
Sabal palmetto

Table 27. Woody understory species present in the oak-palmetto forest. Data based on occurrence in sixty 6.6 x 6.6 ft. quadrats.

Species	Frequency
Serenoa repens	53
Lyonia ferruginea	33
Vitis rotundifolia	26
Smilax glauca	22
Smilax auriculata	18
Myrica cerifera	11
Lyonia lucida	9
Vaccinium arboreum	7
Ilex glabra	4
Smilax bona-nox	4
Ampelopsis arborea	2
Parthenocissus quinquefolia	2
Vaccinium atrococcum	2
Vaccinium myrsinites	2
Arundinaria tecta	1
Gaylussacia frondosa var. tomentosa	1
Gelsemium sempervirens	1
Ilex vomitoria	1
Smilax pumila	1
Symplocos tinctoria	1
Seedlings & Saplings	
Quercus virginiana	15
Persea borbonia	7
Osmanthus americanus	5
Quercus myrtifolia	3
Quercus laurifolia	1

Table 28. Importance values for tree species composing the oak-pine forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 122 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	161	33.0	69,223.5	57.9	80	28.2	118.1
Quercus laurifolia	63	12.9	12,920.2	10.8	38	12.9	36.7
Pinus taeda	61	12.5	6,949.4	5.8	29	9.9	28.2
Pinus palustris	49	10.0	10,305.5	8.6	27	9.2	27.8
Pinus elliottii	43	8.8	7,910.6	6.6	27	9.2	24.6
Persea borbonia	30	6.2	1,868.0	1.6	23	7.8	15.5
Ilex opaca	24	4.9	1,303.1	1.1	20	6.8	12.9
Juniperus silicicola	18	3.7	4,137.6	3.5	13	4.4	11.6
Carya glabra	4	.8	2,525.5	2.1	4	1.4	4.3
Quercus myrtifolia	7	1.4	228.8	.2	7	2.4	4.0
Lyonia ferruginea	5	1.0	83.6	.1	5	1.7	2.8
Magnolia grandiflora	2	.4	853.4	.7	2	.7	1.8
Quercus incana	3	.6	139.7	.12	3	1.0	1.8
Bumelia tenax	3	.6	109.4	.1	3	1.0	1.7
Quercus nigra	2	.4	210.7	.2	2	.7	1.3
Vaccinium arboreum	2	.4	28.5	.02	2	.7	1.1
Nyssa biflora	1	.2	298.7	.3	1	.3	.8
Myrica cerifera	2	.4	32.2	.03	1	.3	.8
Morus rubra	2	.4	64.4	.1	1	.3	.8
Pinus serotina	1	.2	78.5	.1	1	.3	.6
Osmanthus americanus	1	.2	28.8	.02	1	.3	.6
Liquidambar styraciflua	1	.2	44.2	.1	1	.3	.6
Prunus serotina	1	.2	95.0	.1	1	.3	.6
Persea palustris	1	.2	95.0	.1	1	.3	.6
Cercis canadensis	1	.2	15.9	.01	1	.3	.6

Additional Tree Species Present:

Celtis laevigata, Quercus laevis, and Sabal palmetto

Table 29. Woody understory species present in the oak-pine forest. Data based on occurrence in one hundred twenty-two 6.6 x 6.6 ft. quadrats.

Species	Frequency
Smilax auriculata	43
Vitis rotundifolia	36
Myrica cerifera	30
Vaccinium arboreum	16
Serenoa repens	15
Lyonia ferruginea	11
Vitis aestivalis	11
Parthenocissus quinquefolia	6
Smilax glauca	5
Vaccinium myrsinites	5
Asimina pygmaea	4
Asimina parviflora	4
Bumelia tenax	4
Rubus sp.	4
Smilax bona-nox	4
Gelsemium sempervirens	2
Vaccinium stamineum	2
Ampelopsis arborea	1
Anisostichus capreolata	1
Arundinaria tecta	1
Berchemia scandens	1
Hamamelis virginiana	1
Ilex ambiqua	1
Ilex vomitoria	1
Lyonia lucida	1
Seedlings & Saplings	
Ilex opaca	16
Quercus virginiana	16
Quercus laurifolia	11
Persea borbonia	9
Quercus myrtifolia	7
Pinus palustris	2
Pinus taeda	2
Juniperus silicicola	1
Pinus elliottii	1
Sabal palmetto	1

Table 30. Importance values for tree species composing the mixed oak-hardwood forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 28 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	39	34.8	15,507.3	57.5	18	26.1	118.4
Quercus laurifolia	17	15.2	4,867.2	18.1	10	14.5	47.7
Ilex opaca	11	9.8	493.6	1.8	7	10.1	21.8
Magnolia grandiflora	5	4.5	2,742.7	10.2	3	4.4	19.0
Lyonia ferruginea	7	6.3	106.0	.4	6	8.7	15.3
Persea borbonia	7	6.3	388.1	1.4	5	7.3	14.9
Juniperus silicicola	3	2.7	1,030.1	3.8	3	4.4	10.9
Pinus palustris	5	4.5	935.8	3.5	2	2.9	10.8
Pinus taeda	5	4.5	218.5	.8	3	4.4	9.6
Quercus myrtifolia	4	3.6	170.4	.6	3	4.4	8.6
Pinus elliottii	2	1.8	32.2	.1	2	2.9	4.8
Quercus nigra	1	.9	201.1	.8	1	1.5	3.1
Carya glabra	1	.9	86.6	.3	1	1.5	2.7
Sabal palmetto	1	.9	70.9	.3	1	1.5	2.6
Osmanthus americanus	1	.9	44.2	.2	1	1.5	2.5
Celtis laevigata	1	.9	33.2	.1	1	1.5	2.5
Vaccinium arboreum	1	.9	12.6	.1	1	1.5	2.4
Vitis aestivalis	1	.9	12.6	.1	1	1.5	2.4

Additional Tree Species Present:

Liquidambar styraciflua
Prunus serotina

Table 31. Woody understory species present in the mixed oak-hardwood forest. Data based on occurrence in twenty-eight 6.6 x 6.6 ft. quadrats.

Species	Frequency
Vitis rotundifolia	11
Serenoa repens	6
Lyonia ferruginea	5
Smilax bona-nox	3
Myrica cerifera	2
Smilax auriculata	2
Vaccinium arboreum	2
Asimina pygmaea	1
Gelsemium sempervirens	1
Vitis aestivalis	1
Ailanthus altissima (naturalized)	1
Aleurites fordii (naturalized)	1
Seedlings & Saplings	
Ilex opaca	6
Quercus laurifolia	2
Persea borbonia	1
Quercus virginiana	1

Table 32. Importance values for tree species composing the lowland mixed hardwood forest on Cumberland Island, Georgia, as determined by the point-quarter sampling method. Data based on 10 sample points.

Species	Density	Relative Density	Dominance (Basal Area)	Relative Dominance	Frequency	Relative Frequency	Importance Value
Quercus virginiana	4	10.00	3,429.0	54.81	3	12.50	77.3
Persea palustris	11	27.50	561.0	8.97	7	29.17	65.6
Pinus taeda	8	20.00	554.0	8.86	3	12.50	41.4
Myrica cerifera	6	15.00	116.1	1.86	3	12.50	29.4
Gordonia lasianthus	3	7.50	363.8	5.82	2	8.33	21.7
Magnolia virginiana	1	2.50	502.8	8.04	1	4.17	14.7
Quercus nigra	1	2.50	346.4	5.54	1	4.17	12.2
Acer rubrum	2	5.00	150.2	2.40	1	4.17	11.6
Lyonia ferruginea	2	5.00	28.5	.46	1	4.17	9.6
Quercus laurifolia	1	2.50	153.9	2.46	1	4.17	9.1
Ilex opaca	1	2.50	50.3	.80	1	4.17	7.5

Additional Tree Species Present:

Celtis laevigata
Ilex cassine
Magnolia grandiflora
Nyssa biflora
Morus rubra
Pinus elliottii
Sabal palmetto
Salix caroliniana (early stages)
Ulmus americana

Table 33. Woody understory species present in lowland mixed hardwood forest. Data based on occurrence in ten 6.6 x 6.6 ft. quadrats.

Species	Frequency
Lyonia lucida	4
Myrica cerifera	4
Vitis rotundifolia	4
Lyonia ferruginea	3
Serenoa repens	3
Smilax glauca	2
Ampelopsis arborea	1
Arundinaria tecta	1
Cephalanthus occidentalis	1
Ilex glabra	1
Smilax auriculata	1
Smilax laurifolia	1
Seedlings & Saplings	
Persea palustris	2
Gordonia lasianthus	1
Ilex opaca	1

APPENDIX III

Mammals of Cumberland and Little Cumberland Islands, Camden County, Georgia

Introduction

This compilation of distribution records for mammals that occur or have been known to occur within the boundaries of the Cumberland Island National Seashore includes 34 species (native and introduced). Domestic, feral, and captive wild mammals are not included. Names of mammals which have been extirpated from Little Cumberland or Cumberland Islands are preceded by an asterisk (*) in the text. Scientific and vernacular names are from Jones et al. (1973).

Sources of information include museum specimens and records, collections of private individuals, field work, a literature review, and personal inquiry. In the text, distribution records for both Little Cumberland and Cumberland Islands are subdivided into three categories in decreasing order of reliability: those based on specimens, literature citations and sight observations.

Specimens and their accompanying data were examined by the senior author (or indications or specimens' existence were conveyed to us) in the following museums and personal collections:

AMNH	American Museum of Natural History, New York, N. Y.
Carn	Carnegie Museum, Pittsburgh, Pa.
CM	Charleston Museum, Charleston, S. C.
CR	Private collection of Ms. Carol Ruckdeschel, Cumberland Island, Ga.
GSU	Georgia State University, Atlanta, Ga.
HNN	Private collection of Hans N. Neuhauser, Savannah, Ga.
MCZ	Museum of Comparative Zoology, Cambridge, Mass.

UF	Univeristy of Florida State Museum, Gainesville, Fla.
UG-Z	University of Georgia Museum of Zoology, Athens, Ga.
USNM	U. S. National Museum of Natural History, Washington, D. C.
MWD	Private collection of Michael W. Dix, University of Guatamala.
WWB	Private collection of W. Wilson Baker, Tallahassee, Fla.

Supplemental mammal surveys were made on both Cumberland and Little Cumberland Islands, with concentrated collecting efforts made on Cumberland in the spring of 1970 by W. W. Baker, C. W. Dopson, J. I. Richardson and M. Hopkins. Field observations were made on the mammalian fauna during 1973 by H. O. Hillestad and J. I. Richardson; additional collections were made by Carol Ruckdeschel in 1974. Most of the specimens collected by the authors and others assisting in these surveys are housed in either the University of Georgia Museum of Zoology (Athens, Georgia) or the Tall Timbers Research Station (Tallahassee, Florida).

Literature records of distribution are given when published by professional biologists; records by others are accepted only for the following easily identifiable species: opossum, bear, raccoon, wild boar, and white-tailed deer. While some effort was made to survey the non-technical literature, there was ubdoubtedly records contained in it that have been overlooked. Much of the information in this compilation was included in an earlier annotated list of mammals of the Georgia Coast (Neuhauser and Baker 1975). This represents an updating and extension of the material on Cumberland and Little Cumberland islands. References to the previous report are generally omitted in the literature records.

Sight observations represent field observations by the authors or by biologists who have communicated their observations to the authors. Sight observations are included only when no more reliable records are available.

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CLASS MAMMALIA

ORDER MARSUPIALIA

Family Didelphidae

*Didelphis virginiana — Virginia opossum

Literature - *Little Cumberland (Lee et al. 1963)
*Cumberland (White 1849, Ober 1880, Lee et al. 1963)

Remarks: The Virginia opossum was abundant on Cumberland (White 1849, Ober 1880) but has since been eliminated there and on Little Cumberland (Lee et al. 1963).

ORDER INSECTIVORA

Family Soricidae

Blarina brevicauda — short-tailed shrew

Specimens - Cumberland (WWB, CR)

Cryptotis parva — least shrew

Specimens - Cumberland (WWB)

Remarks: The specimens were found in owl pellets, probably barn owl.

Family Talpidae

Scalopus aquaticus — eastern mole

Specimens - Cumberland (MCZ, WWB, CR)

Literature - Cumberland (Bangs 1898, Jackson 1915, Harper 1927)

Sight observations - Little Cumberland

ORDER CHIROPTERA

Family Vespertilionidae

Pipistrellus subflavus — eastern pipistrelle

Specimens - Cumberland (WWB)

Sight observations - Little Cumberland

<u>Eptesicus fuscus</u> big brown bat

Specimens - Cumberland (WWB)

<u>Lasiurus seminolus</u> seminole bat

Specimens - Cumberland (MCZ, WWB)

<u>Lasiurus intermedius</u> Northern yellow bat

Specimen - Cumberland (WWB)

Remarks: The Cumberland specimen is one of the few records of this species from Georgia's Coastal Plain.

ORDER EDENTATA

Family Dasypodidae

<u>Dasypus novemcinctus</u> nine-banded armadillo

Specimen - Little Cumberland (HNN)

Sight observations - Little Cumberland, Cumberland

Remarks: The Little Cumberland specimen, consisting of skeleton and armor, was found among the beach drift above the high tide line at the north end of the island in 1971. It is presumed that the animal died before reaching the island. An armadillo was observed feeding on the river beach of Little Cumberland near midnight between 14-17 July 1974 by H. Bruch and H. Meigs.

One burrow was found near Hickory Hill on Cumberland in July 1973. Two sight observations of the species were made in March 1974 near Hickory Hill and Plum Orchard. Carol Ruckdeschel observed an armadillo just west of the sand dunes of the High Point Road 19 May 1974.

ORDER LAGOMORPHA

Family Leporidae

<u>Sylvilagus palustris</u> marsh rabbit

Specimens - Little Cumberland (HNN), Cumberland (MCZ, CM, WWB, GSU)

Literature - Cumberland (Bangs 1898, Nelson 1909, Harper 1927)

ORDER RODENTIA

Family Sciuridae

Sciurus carolinensis gray squirrel

Specimens - Cumberland (MCZ, CM, WWB, CR, GSU)

Literature - Cumberland (Bangs 1898, Harper 1927)

Remarks: Tomkins (1965) wrote that "the gray squirrel is not native on...Little Cumberland."

Sciurus niger fox squirrel

Specimens - Cumberland (Carn)

Remarks: Bangs (1898) and Harper (1927) did not report the presence of fox squirrels on Cumberland; thus they apparently were introduced between 1927 and 1957 when Dr. Doutt collected them on the island. Mrs. Lucy Ferguson speaks of squirrels being introduced on Cumberland, but details are lacking. No fox squirrels were seen during intensive field studies conducted in 1970 and 1973.

Family Geomyidae

*Geomys cumberlandius Cumberland Island pocket gopher

Specimens - *Cumberland (MCZ, AMNH, USNM, CM, UG-Z)

Literature - *Cumberland (Bangs 1898, Harper 1927, Johnson et al. 1975, Neuhauser and Baker 1975, others as secondary sources.)

Remarks: This species was endemic to Cumberland Island; the type locality is Stafford Place (Bangs 1898). The type specimen is number B5016 in the Museum of Comparative Zoology, Harvard (Neuhauser and Baker 1975).

The species should be regarded as extinct. On 18 March 1970, C. W. Dobson, Jr., M. Hopkins and W. W. Baker observed fairly recent but not active sign in a small planted field at Stafford Place. This was the only evidence found on "pretty thorough examination" of the island between 16 and 22 March. On 18 April 1970, Dobson and Hopkins flew over the island. The field where they has seen Geomys sign in March had been recently plowed. They saw no fresh sign there or anywhere else on the island. (C. W. Dobson, pers. comm., and W. W. Baker, field notes).

The sign observed on 18 March 1970 by Dobson, Hopkins and Baker represents the most recent evidence of the species. Intensive investigation since then has failed to reveal additional sign. The reasons for the extinction of the species is unknown.

Family Cricetidae

Oryzomys palustris — marsh rice rat

Specimens - Cumberland (MCZ, AMNH, WWB, CR)

Literature - Cumberland (Bangs 1898, Goldman 1918)

Sight observations - Little Cumberland

Reithrodontomys humulis — eastern harvest mouse

Specimen - Cumberland (WWB)

Remarks: The single specimen was taken from an owl pellet. It is possible that the owl captured the mouse on the adjacent mainland where the species is known to occur (Golley 1962).

**Peromyscus polionotus* — oldfield mouse

Literature - *Cumberland (Wright 1926)

Remarks: No specimens of the oldfield mouse have been found to verify Wright's citation. The species, if it ever existed on the island, is presumed extirpated.

Peromyscus gossypinus — cotton mouse

Specimens - Little Cumberland (UG-Z, HNN), Cumberland (MCZ, AMNH, CM, GSU, WWB, CR)

Literature - Little Cumberland (Frankenberg et al. 1971, Neuhauser in press), Cumberland (Bangs 1898, Osgood 1909, Harper 1927, Golley 1962, Neuhauser in press, others as secondary sources).

Remarks: Bangs (1898) described a new species of mouse, *Peromyscus insulanus*, from the north end of Cumberland Island. Osgood (1909), revising the genus, made *P. insulanus* a junior synonym of *P. gossypinus anastasae* Bangs. This subspecies has been collected on Little Cumberland, Cumberland, and Anastasia (Florida) islands. Cotton mice found on other nearby islands have not been identified to subspecies yet. The mainland subspecies is *P. g. gossypinus*, according to Bangs (1898).

Pournelle and Barrington (1953) trapped extensively for *P. g. anastasae* on Anastasia Island, Florida, but found none. They stated that no cotton mice had been taken on the island since Surber's collection, reported in Elliot (1901). Thus the present known distribution of the subspecies is restricted to Little Cumberland and Cumberland Islands. Dr. M. H. Smith (pers. comm.) has recently trapped some cotton mice on Anastasia Island, but the specimens have not been identified to subspecies yet.

Sigmodon hispidus — hispid cotton rat

Specimens - Cumberland (MCZ, AMNH, CM, WWB)

Literature - Cumberland (Bangs 1898, Harper 1927)

Sight observations - Little Cumberland

Rattus rattus — black rat

Specimens - Cumberland (MCZ, CM)

ORDER CETACEA

Family Ziphiidae

Ziphius cavirostris — goose-beaked whale

Specimens - Little Cumberland (UG-Z), Cumberland (UF)

Literature - Little Cumberland (Caldwell et al. 1971)

Family Kogiidae

Kogia breviceps — pygmy sperm whale

Specimens - Little Cumberland (UG-Z), Cumberland (UG-Z, CR)

Literature - Little Cumberland (Zam et al. 1971, Caldwell et al. 1971)

Kogis simus — dwarf sperm whale

Specimen - Cumberland (UG-Z)

Family Delphinidae

Steno bredanensis — rough-toothed porpoise

Specimens - Little Cumberland (UG-Z)

Literature - Little Cumberland (Richardson 1973)

Tursiops truncatus bottle-nosed dolphin

Specimens - Little Cumberland (HNN, MWD), Cumberland (HNN, CR)

Globicephala macrorhyncha short-finned pilot whale

Specimens - Little Cumberland (UG-Z, HNN)

Literature - Little Cumberland (Caldwell, et al. 1971)

ORDER CARNIVORA

Family Canidae

**Urocyon cinereoargenteus* gray fox

Literature - *Cumberland (Bent 1940)

Remarks: Bent's observation was made some years before 1940. As no further sightings have been reported, the species is presumed extirpated.

Family Ursidae

**Ursus americanus* black bear

Literature - *Cumberland (Ober 1880, Bangs 1898, Harper 1927, Sprunt 1936)

Remarks: Sprunt (1936) said that the bear was still present on Cumberland in small numbers, and that unmistakable sign was noted. A few island residents are certain that black bears occurred on Cumberland approximately 15 years ago.

Family Procyonidae

Procyon lotor raccoon

Specimens - Little Cumberland (HNN, CR), Cumberland (MCZ, WWB, CR)

Literature - Cumberland (White 1849, Ober 1880, Sprunt 1936, Bent 1940)

Family Mustelidae

Mustela vison mink

Specimens - Cumberland (UG-Z)

Sight observations - Little Cumberland

<u>Lontra canadensis</u> river otter

Specimens - Little Cumberland (UG-Z)

Literature - Little Cumberland (Jenkins 1953), Cumberland (Jenkins 1953)

Family Felidae

<u>Lynx rufus</u> bobcat

Literature - Cumberland (Harper 1927)

Remarks: Harper wrote that "Isaac F. Arnow stated that the species was common on Cumberland Island up to about 1907, when some disease exterminated it there."

One male (from Coweta County) and two female (Talbot County) bobcats were released on Cumberland in 1972 and 1973. Their present status on the island is unknown.

ORDER SIRENIA

Family Trichechidae

<u>Trichechus manatus</u> manatee

Literature - Cumberland (Tomkins 1956, Golley 1962, Caldwell and Golley 1965)

ORDER ARTIODACTYLA

Family Suidae

*<u>Sus scrofa</u> wild pig

Sight observation - *Little Cumberland, *Cumberland

Remarks: Hanson and Karstad (1959) said that European wild boar were introduced into feral herds of swine to increase the sporting value of the resident populations. Probably no true wild pig exist on the coastal islands today. Domestic and feral pigs are common.

Family Cervidae

<u>Odocoileus virginianus</u> white-tailed deer

Specimens - Cumberland (MCZ, USNM)

Literature - Little Cumberland (Jenkins 1953), Cumberland (White 1849, Ober 1880, Bangs 1898, Barbour and Allen 1922, Harper 1927, Sprunt 1936, Bent 1940, Jenkins 1953, Bartram *in* Harper 1958, Hall and Kelson 1959)

Literature Cited

Bangs, O. 1898. The land mammals of peninsular Florida and the coast region of Georgia. Proc. Boston Soc. Nat. Hist. 28(7):157-235.

Barbour, T., and G. M. Allen. 1922. The white-tailed deer of eastern United States. J. Mammal. 3:65-78.

Bent, A. C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies. 1964 Republication, Dover Publ. Inc., New York. 2 pts. 506 pp.plus 73 pl.

Caldwell, D. K., and F. B. Golley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. J. Elisha Mitchell Sci. Soc. 81(1): 24-32.

_______________, H. N. Neuhauser, M. C. Caldwell, and H. W. Coolidge. 1971. Recent records of marine mammals from the coasts of Georgia and South Carolina. Cetology 5:1-12.

Elliot, D. G. 1901. A list of mammals obtained by Thaddeus Surber, in North and South Carolina, Georgia and Florida. Field Colombian Mus. Publ. 58, Zool. Ser. 3:31-57.

Frankenberg, D., L. R. Pomeroy, L. Bahr, and J. I. Richardson. 1971. Coastal ecology and recreational development. 49 p. In: C. D. Clement, The Georgia Coast: Issues and Options for Recreation. Univ. of Georgia, Athens.

Goldman, E. A. 1918. The rice rats of North America (genus Oryzomys). North Am. Fauna No. 43. U. S. Fish and Wildl. Serv., Washington. 100 pp.

Golley, F. B. 1962. Mammals of Georgia. Univ. of Georgia Press, Athens. 218 pp.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Co., New York. 2 vols. 1083 pp.

Hanson, R. P., and L. Karstad. 1959. Feral swine in the southeastern United States. J. Wildl. Manage. 23:64-74.

Harper, F. 1927. The mammals of the Okefinokee (sic) Swamp region of Georgia. Proc. Boston Soc. Nat. Hist. 38:191-396.

Harper, F. 1958. The travels of William Bartram. Yale Univ. Press, New Haven, Conn. 727 pp.

Jackson, H. H. T. 1915. A review of the American moles. North Am. Fauna No. 38. U. S. Fish and Wildl. Serv., Washington. 100 pp.

Jenkins, J. H. 1953. The game resources of Georgia. Georgia Game and Fish Comm., Atlanta. 114 pp.

Johnson, A. S., H. O. Hillestad, S. F. Shanholtzer, and G. F. Shanholtzer. 1975. The ecology of the Georgia Coast. Natl. Park Serv. Sci. Monogr. No. 3. 211 pp.plus maps (in press).

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1973. Checklist of North American mammals north of Mexico. Occas. Pap., The Museum, Texas Tech. Univ. 12:1-14.

Lee, C., I. R. Tomkins, E. O. Mellinger, and Mrs. E. O. Mellinger. 1963. Plant list of Little Cumberland Island, Camden County, Georgia. Unpubl.

Nelson, E. W. 1909. The rabbits of North America. North Am. Fauna No. 29. U. S. Fish and Wildl. Serv., Washington. 314 pp.

Neuhauser, H. N., and W. W. Baker. 1975. Annotated list of mammals of the coastal islands of Georgia. Appendix 5 in A. S. Johnson, H. O. Hillestad, S. F. Shanholtzer, and G. F. Shanholtzer. The ecology of the Georgia coast. Natl. Park Serv. Sci. Monogr. No. 3. 211 pp. plus maps.

Ober, F. A. 1880. Dungeness, General Greene's Sea-Island Plantation. J. B. Lippincott Co., New York. 32 pp.

Osgood, W. H. 1909. Revision of the mice of the American genus Peromyscus. North Am. Fauna No. 28. U. S. Fish and Wildl. Serv., Washington. 285 pp.

Pournelle, G. H., and B. A. Barrington. 1953. Notes on mammals of Anastasia Island, St. Johns County, Florida. J. Mammal. 34:133-135.

Richardson, J. I. 1973. A confined occurrence of the rough-toothed dolphin (Steno bredanensis) on the Atlantic coast of the United States. J. Mammal. 54:275.

Sprunt, A., Jr. 1936. Some observations on the bird life of Cumberland Island, Georgia. Oriole 1:1-6.

Tomkins, I. R. 1956. The manatee along the Georgia coast. J. Mammal. 37:288-289.

______________. 1965. Absence of the blue jay on some of Georgia's coastal islands. Oriole 30:77-79.

White, G. 1849. Statistics of the State of Georgia. W. T. Williams, Savannah. 624 p. plus 77 pp.

Wright, A. H. 1926. The vertebrate life of Okefinokee (sic) Swamp in relation to the Atlantic Coastal Plain. Ecology 7:77-95.

Zam, S. G., D. K. Caldwell, and M. C. Caldwell. 1971. Some endoparasites from small odontocete cetaceans collected in Florida and Georgia. Cetology 2:1-11.

APPENDIX IV

Checklist of Birds known or expected to occur
in the Cumberland Island National Seashore,
Camden County, Georgia

The following checklist of birds known or expected to occur in the vicinity of Cumberland Island National Seashore was compiled from reliable sight observations and from published accounts. Much of the list has been adapted from Shanholtzer (1975). Nomenclature has been modified according to the Thirty-second Supplement to the A.O.U. checklist of North American Birds (American Ornithologists' Union 1973).

Generalized categories of status, seasonal occurrence, and preferred habitat are included. Seasonal occurrence and preferred habitat categories are self-explanatory. A key to abbreviations used in the status category follows:

C - common, encountered nearly every time one visits preferred habitat.

FC - fairly common, encountered approximately 30-70 percent of the time one visits preferred habitat

UN - uncommon, encountered less than 30 percent of the time one visits preferred habitat

R - rare, encountered infrequently in preferred habitat

AC - accidental, very few records of occurrence, generally of extralimital occurrence

* - known to nest

LO - locally (used in combination with other status category)

IR - irregular

Literature Cited

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union checklist of North American Birds. Auk 90(2):411-419.

Shanholtzer, G. F. 1975. Checklist of birds occurring in the Coastal Region of Georgia: species, abundance and habitat. Appendix 3 in Johnson, A. S., H. O. Hillestad, S. F. Shanholtzer, and G. F. Shanholtzer, 1975. The Ecology of the Georgia Coast. Natl. Park Serv. Sci. Monogr. No. 3, 211 p. plus maps (in press).

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
GAVIIFORMES													
Gaviidae													
<u>Gavia</u> <u>immer</u>	FC			●	●		●						●
Common Loon													
<u>G.</u> <u>stellata</u>	UN			●			●						●
Red-throated Loon													
PODICIPEDIFORMES													
Podicipedidae													
<u>Podiceps</u> <u>grisegena</u>	UN			●									●
Red-necked Grebe													
<u>P.</u> <u>auritus</u>	FC			●			●						●
Horned Grebe													
*<u>Podilymbus</u> <u>podiceps</u>	C			●	●						●		●
Pied-billed Grebe	UN		●										
PROCELLARIIFORMES													
Procellariidae													
<u>Puffinus</u> <u>diomedea</u>	AC				●		●						
Cory's Shearwater													
<u>P.</u> <u>gravis</u>	AC						●						
Greater Shearwater													
<u>P.</u> <u>griseus</u>	AC						●						
Sooty Shearwater													
<u>P.</u> <u>lherminieri</u>	AC						●						
Audubon's Shearwater													
Hydrobatidae													
<u>Oceanites</u> <u>oceanicus</u>	AC						●						
Wilson's Petrel													
PELECANIFORMES													
Pelecanidae													
<u>Pelecanus</u> <u>erythrorhynchos</u>	R				●		●						●
White Pelican													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
P. occidentalis	FC	●						●					●
Brown Pelican													
Sulidae													
Morus bassanus	FC			●			●						
Gannet													
Phalacrocoracidae													
Phalacrocorax carbo	R			●				●					●
Great Cormorant													
P. auritus	C			●	●			●					●
Double-crested Cormorant	FC		●										
Anhingidae													
*Anhinga anhinga	FC		●								●		
Anhinga	UN			●									
Fregatidae													
Fregata magnificens	AC				●		●						●
Magnificent Frigate-bird													
CICONIIFORMES													
Ardeidae													
Ardea herodias													
occidentalis	AC					●		●					
Great White Heron													
*A. herodias	C	●						●				●	
Great Blue Heron													
*Butorides virescens	FC		●								●	●	
Green Heron	UN			●									
*Florida caerulea	FC	●									●		
Little Blue Heron													
*Bubulcus ibis	C		●							●			
Cattle Egret	R			●									
Dichromanassa rufescens	AC							●					
Reddish Egret													
*Casmerodius albus	C	●						●			●	●	
Great Egret													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
*Egretta thula	C	●						●			●	●	
Snowy Egret													
*Hydranassa tricolor	C		●					●			●	●	
Louisiana Heron	FC			●									
*Nycticorax nycticorax	FC		●								●	●	
Black-crowned Night	UN			●									
Heron													
*Nyctanassa violacea	FC		●								●	●	
Yellow-crowned Night													
Heron	R			●									
*Ixobrychus exilis	FC		●								●		
Least Bittern													
Botaurus lentiginosus	FC				●						●		
American Bittern	UN			●									
Ciconiidae													
Mycteria americana	FC		●							●	●		
Wood Stork	UN			●									
Threskiornithidae													
*Plegadis falcinellus	FC		●							●	●	●	
Glossy Ibis	R			●									
*Eudocimus albus	C		●							●	●	●	
White Ibis	UN			●									
Ajaia ajaja	AC					●		●					
Roseate Spoonbill													
ANSERIFORMES													
Anatidae													
Olor columbianus	R			●	●								●
Whistling Swan													
Branta canadensis	FC			●	●					●	●		
Canada Goose													
B. bernicla	R			●									●
Brant													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Chen caerulescens Snow Goose	R				●						●		●
C. caerulescens Blue Goose	R			●	●			●					
Dendrocygna bicolor Fulvous Tree Duck	R			●				●					
Anas platyrhynchos Mallard	FC			●	●						●		●
A. rubripes	FC			●	●						●		●
Black Duck	R		●										
A. fulvigula Mottled Duck	AC									●	●		
A. strepera Gadwall	C			●							●		●
A. acuta Pintail	FC			●	●						●		
A. crecca carolinensis American Green-winged Teal	C			●	●						●		●
A. discors	FC				●						●		●
Blue-winged Teal	UN			●									
A. penelope European Wigeon	R			●	●						●		
A. americana American Wigeon	FC			●							●		
A. clypeata Northern Shoveler	FC			●	●						●		
**Aix sponsa* Wood Duck	C	●									●		
Aythya americana Redhead	UN			●	●								●
A. collaris	FC				●						●		●
Ring-necked Duck	C			●									

ORDER FAMILY SPECIES COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
A. valisineria Canvasback	FC			●	●								●
A. marila Greater Scaup	R LO			●									●
A. affinis Lesser Scaup	C			●	●						●		●
Bucephala clangula Common Goldeneye	UN			●									●
B. albeola Bufflehead	C			●	●								●
Clangula hyemalis Oldsquaw	UN			●									●
Somateria spectabilis King Eider	R			●									●
Melanitta deglandi White-winged Scoter	R			●			●						●
M. perspicillata Surf Scoter	UN			●			●						●
M. nigra Black Scoter	C LO			●			●						●
Oxyura jamaicensis Ruddy Duck	FC			●							●		●
Lophodytes cucullatus Hooded Merganser	R C		●	● ●	● ●								●
Mergus merganser Common Merganser	UN			●							●		●
M. serrator Red-breasted Merganser	C			●	●						●		●
FALCONIFORMES													
Cathartidae													
Cathartes aura Turkey Vulture	C	●						●	●	●			

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
*Coragyps atratus	C	●						●	●	●			
Black Vulture													
Accipitridae													
Elanoides forficatus	R		●		●				●	●			
Swallow-tailed Kite													
Ictinia misisippiensis	UN		●							●			
Mississippi Kite													
Accipiter striatus	UN			●					●				
Sharp-shinned Hawk													
*A. cooperii	FC	●							●				
Cooper's Hawk													
*Buteo jamaicensis	FC	●								●			
Red-tailed Hawk													
*B. lineatus	FC	●							●	●			
Red-shouldered Hawk													
B. platypterus	FC				●				●				
Broad-winged Hawk	R			●									
B. lagopus	?					●				●			
Rough-legged Hawk													
Aquila chrysaetos	?					●				●			
Golden Eagle													
*Haliaeetus leucocephalus	UN	●							●	●			●
Bald Eagle													
Circus cyaneus	C			●	●				●	●	●		
Marsh Hawk													
Pandionidae													
*Pandion haliaetus	FC		●								●		●
Osprey	UN			●									
Falconidae													
Falco peregrinus	R			●				●		●			
Peregrine Falcon	FC				●			●					
F. columbarius	UN			●	●			●		●			
Merlin													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
*F. sparverius	C			●						●			
American Kestrel	UN		●										
GALLIFORMES													
Phasianidae													
*Colinus virginianus	R	●							●	●			
Bobwhite													
Meleagrididae													
*Meleagris gallopavo	FC	●							●	●			
Turkey	LO												
GRUIFORMES													
Gruidae													
Grus canadensis	AC				●			●		●			
Sandhill Crane													
Aramidae													
Aramus guarauna	R					●					●		
Limpkin													
Rallidae													
*Rallus elegans	UN			●							●		
King Rail	C		●										
*R. longirostris	C	●										●	
Clapper Rail													
R. limicola	FC			●	●						●	●	
Virginia Rail													
Porzana carolina	FC			●	●						●	●	
Sora													
Coturnicops noveboracensis	R			●	●					●	●	●	
Yellow Rail													
Laterallus jamaicensis	R			●	●							●	
Black Rail													
*Porphrula martinica	FC		●								●		
Purple Gallinule	LO												

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
*Gallinula chloropus	FC	●									●		
Common Gallinule													
*Fulica americana	C			●	●						●		●
American Coot	UN		●										
CHARADRIIFORMES													
Haematopodidae													
*Haematopus palliatus	C	●						●					
American Oystercatcher													
Charadriidae													
Charadrius semipalmatus	C			●	●			●					
Semipalmated Plover	FC		●										
C. melodus	C			●	●			●					
Piping Plover													
*C. wilsonia	C		●					●					
Wilson's Plover													
C. vociferus	C			●				●		●			
Killdeer	UN		●										
C. montana	AC							●					
Mountain Plover													
Pluvialis dominica	R				●			●					
American Golden Plover													
P. squatarola	C			●	●			●					
Black-bellied Plover	UN		●										
Arenaria interpres	C				●			●					
Ruddy Turnstone	UN		●										
Scolopacidae													
Philohela minor	UN	●							●	●			
American Woodcock													
Capella gallinago	C				●						●		●
Common Snipe	FC			●									
Numenius americanus	R			●	●			●					
Long-billed Curlew													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
N. phaeopus	C				●			●				●	
Whimbrel	UN		●										
Bartramia longicauda Upland Plover	R				●			●		●			
Actitis macularia	C				●			●			●	●	
Spotted Sandpiper	UN			●									
Tringa solitaria Solitary Sandpiper	FC				●						●		
T. melanoleucus	C				●								
Greater Yellowlegs	FC			●				●			●		●
	UN		●										
T. flavipes	C				●						●		●
Lesser Yellowlegs	UN		●	●									
*Catoptrophorus semipalmatus Willet	C	●						●				●	
Calidris canutus	C				●								
Red Knot	FC			●				●					
	UN		●										
C. maritima Purple Sandpiper	R			●									
C. melanotos Pectoral Sandpiper	FC				●			●		●	●		
C. fuscicollis	FC				●			●					
White-rumped Sandpiper	LO												
C. minutilla	C			●	●			●					
Least Sandpiper	UN		●										
C. alpina Dunlin	C			●	●			●					
C. pusillus					●			●					
Semipalmated Sandpiper	UN		●	●									

ORDER FAMILY SPECIES COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
C. mauri	C			●	●			●					
Western Sandpiper	UN		●										
C. alba	C			●	●			●					
Sanderling	UN		●										
Limnodromus griseus	C				●			●					
Short-billed Dowitcher	UN			●									
L. scolopaceus	?							●			●		
Long-billed Dowitcher													
Micropalama himantopus	UN				●			●			●		
Stilt Sandpiper													
Tryngites subruficollis	FC				●			●		●			
Buff-breasted Sandpiper													
Limosa fedoa	FC			●	●			●					
Marbled Godwit													
Recurvirostridae													
Recurvirostra americana	R				●			●			●		
American Avocet													
Himantopus mexicanus	R				●			●			●		
Black-necked Stilt													
Phalaropodidae													
Phalaropus fulicarius	C				●		●						
Red Phalarope	LO												
Steganopus tricolor	R					●	●				●		
Wilson's Phalarope													
Lobipes lobatus	R					●	●						
Northern Phalarope													
Stercorariidae													
Stercorarius parasiticus	R			●			●						
Parasitic Jaeger													
S. pomarinus	AC					●	●						●
Pomarine Jaeger													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Laridae													
<u>Larus hyperboreus</u> Glaucous Gull	R			●			●						
<u>L. glaucoides</u> Iceland Gull	AC												●
<u>L. marinus</u> Great Black-backed Gull	UN			●				●					●
<u>L. argentatus</u> Herring Gull	C			●	●			●				●	●
	UN		●										
<u>L. delawarensis</u> Ring-billed Gull	C			●	●							●	●
	UN		●										
<u>L. atricilla</u> Laughing Gull	C				●								
	FC		●	●				●				●	●
<u>L. philadelphia</u> Bonaparte's Gull	C			●	●			●					●
<u>Xema sabini</u> Sabine's Gull	AC												●
*<u>Gelochelidon nilotica</u> Gull-billed Tern	FC				●			●					●
	LO												
	UN		●										
<u>Sterna forsteri</u> Forster's Tern	C			●	●			●					
<u>S. hirundo</u> Common Tern	FC				●			●					●
<u>S. fuscata</u> Sooty Tern	AC						●						
<u>S. anaethetus</u> Bridled Tern	AC						●						
*<u>S. albifrons</u> Least Tern	FC		●					●					●
<u>Thalasseus maximus</u> Royal Tern	C	●						●					●
<u>T. sandvicensis</u> Sandwich Tern	UN				●			●					●

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Hydroprogne caspia	FC			●	●			●					●
Caspian Tern	UN		●										
Anous stolidus	AC						●						
Noddy Tern													
Rynochopidae													
**Rhynchops nigra*	C	●						●					●
Black Skimmer													
Alcidae													
Alca torda	AC						●						
Razorbill													
Plautus alle	AC						●						
Dovekie													
COLUMBIFORMES													
Columbidae													
Columba livia	C	●								●			
Rock Dove													
Zenaida asiatica	AC									●			
White-winged Dove													
**Zenaida macroura*	C	●								●			
Mourning Dove													
**Columbina passerina*	C	●								●			
Ground Dove													
CUCULIFORMES													
Cuculidae													
* *Coccyzus americanus*	C		●		●				●				
Yellow-billed Cuckoo													
C. erythropthalmus	UN				●				●				
Black-billed Cuckoo													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
STRIGIFORMES													
Tytonidae													
*Tyto alba	FC	●								●		●	
Barn Owl													
Strigidae													
*Otus asio	FC	●							●	●			
Screech Owl													
*Bubo virginianus	FC	●							●				
Great Horned Owl													
Nyctea scandiaca	AC									●			
Snowy Owl													
Speotyto cunicularia	AC									●			
Burrowing Owl													
*Strix varia	UN	●							●				
Barred Owl													
Asio otus	UN			●					●				
Long-eared Owl													
A. flammeus	FC			●	●			●		●	●		
Short-eared Owl	LO												
Aegolius acadicus	R								●				
Saw-whet Owl													
CAPRIMULGIFORMES													
Caprimulgidae													
*Caprimulgus carolinensis	C		●						●	●			
Chuck-will's-widow													
C. vociferus	UN			●	●				●				
Whip-poor-will													
*Chordeiles minor	C		●					●	●	●	●	●	
Common Nighthawk													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE					PREFERRED HABITAT						
		PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
APODIFORMES													
Apodidae													
*Chaetura pelagica	C		●						●				
Chimney Swift													
Trochilidae													
*Archilochus colubris	FC		●						●				
Ruby-throated Hummingbird													
CORACIIFORMES													
Alcedinidae													
Megaceryle alcyon	FC	●									●		●
Belted Kingfisher													
PICIFORMES													
Picidae													
*Colaptes auratus	C			●	●				●				
Common Flicker	UN		●										
*Drocopus pileatus	C	●							●				
Pileated Woodpecker													
*Centurus carolinus	C	●							●				
Red-bellied Woodpecker													
*Melanerpes erythrocephalus	FC	●							●				
Red-headed Woodpecker	LO												
Sphyrapicus varius	FC			●					●				
Yellow-bellied Sapsucker													
*Dendrocopos villosus	FC	●							●				
Hairy Woodpecker													
*D. pubescens	C	●							●				
Downy Woodpecker													
D. borealis	R				●				●				
Red-cockaded Woodpecker													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
PASSERIFORMES													
Tyrannidae													
*Tyrannus tyrannus Eastern Kingbird	C		●							●		●	
*T. dominicensis Gray Kingbird	R		●		●					●		●	
T. verticalis Western Kingbird	AC			●						●			
*Myiarchus crinitus Great Crested Flycatcher	C		●						●				
Sayornis phoebe Eastern Phoebe	C			●	●				●				
Empidonax flaviventris Yellow-bellied Flycatcher	R				●				●				
*E. virescens Acadian Flycatcher	FC		●						●				
E. traillii Traill's Flycatcher	UN				●				●				
E. minimus Least Flycatcher	UN				●				●				
*Contopus virens Eastern Wood Peewee	FC		●						●				
Pyrocephalus rubinus Vermilion Flycatcher	AC									●	●		
Hirundinidae													
Iridoprocne bicolor Tree Swallow	C			●	●			●		●	●	●	
Riparia riparia Bank Swallow	UN				●			●		●	●	●	
*Stelgidopteryx ruficollis Rough-winged Swallow	C		●		●						●	●	

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
*Hirundo rustica Barn Swallow	C UN		●		●			●		●	●	●	
Petrochelidon pyrrhonota Cliff Swallow	R				●						●	●	
*Progne subis Purple Martin	C		●		●				●		●	●	
Corvidae													
*Cyanocitta cristata Blue Jay	FC LO	●							●				
*Corvus brachyrhynchos Common Crow	FC	●							●	●			
*C. ossifragus Fish Crow	C	●						●	●	●	●	●	
Paridae													
*Parus carolinensis Carolina Chickadee	C	●							●				
P. bicolor Tufted Titmouse	R					●			●				
Sittidae													
Sitta carolinensis White-breasted Nuthatch	UN			●	●				●				
S. canadensis Red-breasted Nuthatch	UN			●	●				●				
*S. pusilla Brown-headed Nuthatch	C	●							●				
Certhiidae													
Certhia familiaris Brown Creeper	UN			●	●				●				
Troglodytidae													
Troglodytes aedon House Wren	FC			●	●				●				
T. troglodytes Winter Wren	FC			●					●				

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Thryomanes bewickii	UN			●						●			
Bewick's Wren													
*Thryothorus ludovicianus	C	●							●				
Carolina Wren													
*Telmatodytes palustris	C	●									●	●	
Long-billed Marsh Wren													
Cistothorus platensis	FC			●	●					●		●	
Short-billed Marsh Wren	LO												
Mimidae													
*Mimus polyglottos	C	●							●	●			
Mockingbird													
*Dumetella carolinensis	C			●					●				
Gray Catbird	UN		●										
*Toxostoma rufum	C	●							●				
Brown Thrasher													
Turdidae													
*Turdus migratorius	C			●	●				●	●			
American Robin	R		●										
Catharus guttata	C			●					●				
Hermit Thrush													
C. ustulata	C				●				●				
Swainson's Thrush													
C. minima	UN				●				●				
Grey-cheeked Thrush													
C. fuscescens	UN				●				●				
Veery													
*Hylocichla mustelina	FC	●							●				
Wood Thrush													
*Sialia sialis	C	●							●	●			
Eastern Bluebird													
Sylviidae													
*Polioptila caerulea	C		●					●	●	●			
Blue-gray Gnatcatcher	UN			●									

ORDER FAMILY SPECIES COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Regulus satrapa	FC			●					●				
Golden-crowned Kinglet													
R. calendula	C			●					●				
Ruby-crowned Kinglet													
Motacillidae													
Anthus spinoletta	FC			●						●			
Water Pipit													
A. spragueii	AC									●			
Sprague's Pipit													
Bombycillidae													
Bombycilla cedrorum	C			●					●				
Cedar Waxwing	LO												
Laniidae													
*Lanius ludovicianus	C	●								●			
Loggerhead Shrike													
Sturnidae													
*Sturnus vulgaris	C	●								●			
Starling													
Vireonidae													
*Vireo griseus	FC		●						●				
White-eyed Vireo	R			●									
*V. flavifrons	UN		●	●	●				●				
Yellow-throated Vireo													
V. solitarius	FC				●				●				
Solitary Vireo	UN			●									
*V. olivaceus	C		●		●				●				
Red-eyed Vireo													
V. philadelphicus	R								●				
Philadelphia Vireo													
Parulidae													
Mniotilta varia	C				●				●				
Black-and-white Warbler	UN			●									
*Protonotaria citrea	FC		●		●				●		●		
Prothonotary Warbler													

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Limnothlypis swainsonii	UN		●						●		●		
Swainson's Warbler													
Helmitheros vermivorus	UN				●				●				
Worm-eating Warbler													
Vermivora chrysoptera	R				●				●				
Golden-winged Warbler													
V. pinus	UN				●				●	●			
Blue-winged Warbler													
V. bachmanii	AC								●		●		
Bachman's Warbler													
V. peregrina	UN				●				●				
Tennessee Warbler													
V. celata	FC			●	●				●				
Orange-crowned Warbler													
*_Parula americana_	C		●		●				●				
Northern Parula	AC			●									
Dendroica petechia	C				●				●		●		
Yellow Warbler													
D. magnolia	UN				●				●				
Magnolia Warbler													
D. tigrina	FC				●				●				
Cape May Warbler													
D. caerulescens	FC				●				●				
Black-throated Blue Warbler													
D. coronata	C			●	●				●				
Yellow-rumped Warbler													
D. virens	UN				●				●				
Black-throated Green Warbler													
D. fusca	UN				●				●				
Blackburnian Warbler													
*_D. dominica_	C		●		●				●				
Yellow-throated Warbler	FC			●									

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
D. pensylvanica Chestnut-sided Warbler	UN				●				●				
D. striata Blackpoll Warbler	C				●				●				
*D. pinus Pine Warbler	C	●							●				
D. kirtlandii Kirtland's Warbler	R				●				●				
D. discolor Prairie Warbler	FC		●		●				●				
D. palmarum Palm Warbler	C				●								
	FC			●					●	●			
Seiurus aurocapillus Ovenbird	C				●				●				
S. noveboracensis Northern Waterthrush	UN				●				●				
S. motacilla Louisiana Waterthrush	FC				●				●				
Oporornis formosus Kentucky Warbler	UN				●				●				
O. agilis Connecticut Warbler	UN				●				●				
*Geothlypis trichas Common Yellowthroat	C	●							●		●		
*Icteria virens Yellow-breasted Chat	UN		●						●	●			
	R			●									
*Wilsonia citrina Hooded Warbler	FC				●				●				
	UN		●										
W. pusilla Wilson's Warbler	UN				●				●				
W. canadensis Canada Warbler	R				●				●				
Setophaga ruticilla American Redstart	FC				●				●				

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Ploceidae													
*Passer domesticus House Sparrow	FC LO	●								●			
Icteridae													
Dolichonyx oryzivorus Bobolink	FC				●			●		●		●	
*Sturnella magna Eastern Meadowlark	FC	●								●			
S. neglecta Western Meadowlark	AC									●			
Xanthocephalus xanthocephalus Yellow-headed Blackbird	AC				●			●		●			
*Agelaius phoeniceus Redwinged Blackbird	C	●						●		●	●	●	
*Icterus spurius Orchard Oriole	FC		●						●				
I. galbula Northern Oriole	UN			●	●				●				
Euphagus carolinus Rusty Blackbird	FC				●				●		●		
*Cassidix major Boat-tailed Grackle	C	●						●	●	●		●	
*Quiscalus quiscula Common Grackle	C	●							●	●	●		
Molothrus ater Brown-headed Cowbird	FC LO	●								●			
Thraupidae													
Piranga olivacea Scarlet Tanager	UN				●				●				
*P. rubra Summer Tanager	C		●						●				

ORDER / FAMILY / SPECIES / COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
Fringillidae													
*Cardinalis cardinalis	C	●							●		●		
Cardinal													
*Guiraca caerulea	FC		●						●	●			
Blue Grosbeak													
*Passerina cyanea	FC		●						●	●			
Indigo Bunting													
*P. ciris	C		●						●	●			
Painted Bunting													
Hesperiphona vespertina	UN			●					●				
Evening Grosbeak													
Carpodacus purpureus	UN			●					●	●			
Purple Finch													
Spinus pinus	IR			●					●				
Pine Siskin													
S. tristis	C			●					●	●			
American Goldfinch	R		●										
Loxia curvirostra	AC			●					●				
Red Crossbill													
*Pipilo erythrophthalmus	C	●							●				
Rufous-sided Towhee													
Calamospiza melanocorys	AC				●			●		●			
Lark Bunting													
Passerculus sandwichensis princeps	R			●				●					
Ipswich Sparrow													
P. s. sandwichensis	C			●				●		●			
Savannah Sparrow													
Ammodramus savannarum	R			●	●					●			
Grasshopper Sparrow													
A. henslowii	R			●						●			
Henslow's Sparrow													
Ammospiza caudacuta	C			●								●	
Sharp-tailed Sparrow													

ORDER FAMILY SPECIES COMMON NAME	STATUS	SEASONAL OCCURRENCE: PERMANENT RESIDENT	SUMMER RESIDENT	WINTER RESIDENT	TRANSIENT	UNCERTAIN	PREFERRED HABITAT: OFFSHORE	BEACHES, DUNES, MUD FLATS	FORESTS	FIELDS, PASTURES	FRESHWATER MARSHES, PONDS	SALT MARSHES	ESTUARIES, SOUNDS
A. caudacutus Le Conte's Sparrow	AC									●			
A. maritima Seaside Sparrow	C	●										●	
Pooecetes gramineus Vesper Sparrow	FC			●						●			
Chondestes grammacus Lark Sparrow	UN			●				●		●			
*Aimophila aestivalis Bachman's Sparrow	UN	●							●				
Junco hyemalis Dark-eyed Junco	C			●					●	●			
Spizella passerina Chipping Sparrow	C			●						●			
*S. pusilla Field Sparrow	FC	●								●			
Zonotrichia leucophrys White-crowned Sparrow	AC								●	●			
Z. albicollis White-throated Sparrow	C			●					●	●			
Passerella iliaca Fox Sparrow	FC			●					●				
Melospiza lincolnii Lincoln's Sparrow	R			●	●						●		
M. georgiana Swamp Sparrow	C			●							●		
M. melodia Song Sparrow	C			●					●	●	●		
Calcarius lapponicus Lapland Longspur	AC			●				●		●			
Plectrophenax nivalis Snow Bunting	AC			●				●		●			

APPENDIX V

Amphibians and Reptiles of Cumberland and Little Cumberland Islands, Camden County, Georgia

Introduction

The following list is a summary of records of amphibians and reptiles known to occur on Cumberland and Little Cumberland Islands. The list was compiled from specimens in museum and private collections, reliable sight observations and specimen records obtained during the survey.

The names of museum and private collections have been abbreviated in the list under the category "Specimens." The names of museum collections are as follows: Georgia State University (GSU), Tall Timbers Research Station (TTRS), Charleston Museum (CM), University of Georgia-Zoology (UG-Z).

Private collections cited are: Carol Ruckdeschel (CR), John E. Cagle (JEC), Helen Jordan (HJ), James I. Richardson (JIR), H. O. Hillestad (HOH), C. W. Dopson (CDW).

Scientific names are from Blair et al. 1968.

CLASS AMPHIBIA

ORDER CAUDATA

Family Ambystomidae

Ambystoma talpoideum mole salamander

Specimens - Cumberland (CR)

Family Salamandridae

Notophthalmus viridescens newt

Specimens - Cumberland (CR)

Family Plethodontidae

Desmognathus fuscus dusky salamander

Specimens - Cumberland (GSU)

Manculus quadridigitatus dwarf salamander

Specimens - Cumberland (JEC, CR)

ORDER ANURA

Family Pelobatidae

Scaphiopus holbrooki eastern spadefoot toad

Specimens - Cumberland (TTRS, CM, GSU, HJ)

Sight observations - Little Cumberland

Family Ranidae

Rana grylio pig frog

Specimens - Cumberland (GSU)

Rana sphenocephala southern leopard frog

Specimens - Little Cumberland (JIR), Cumberland (CM, GSU)

Family Microhylidae

Gastrophryne carolinensis eastern narrow-mouthed toad

Specimens - Cumberland (GSU, HJ)

Sight observations - Little Cumberland

Family Bufonidae

Bufo quercicus oak toad

Specimens - Cumberland (HOH)

Bufo terrestris southern toad

Specimens - Cumberland (TTRS, CM, GSU, HJ)

Sight observations - Little Cumberland (JEC)

Family Hylidae

Acris gryllus southern cricket frog

Sight observations - Cumberland (JEC)

Hyla cinerea green tree frog

Specimens - Little Cumberland (UG-Z), Cumberland (CM, GSU, HJ)

Hyla femoralis pine woods tree frog

Specimens - Cumberland (GSU)

Hyla gratiosa barking tree frog

Specimens - Cumberland (HOH, HJ)

Sight observations - Little Cumberland (JEC)

Hyla squirella squirrel tree frog

Specimens - Cumberland (CM, GSU, HJ)

Sight observations - Little Cumberland (JEC)

Hyla versicolor gray tree frog

Specimens - Cumberland (HOH, HJ)

Limnaoedus ocularis little grass frog

Specimens - Cumberland (HOH)

<u>Pseudacris nigrita</u> southern chorus frog

Specimens - Cumberland (HOH)

CLASS REPTILIA

ORDER TESTUDINATA

Family Chelydridae

<u>Chelydra serpentina</u> snapping turtle

Specimens - Cumberland (CM)

<u>Kinosternon subrubrum</u> mud turtle

Specimens - Cumberland (CR), Little Cumberland (HOH)

<u>Kinosternon bauri</u> striped mud turtle

Specimens - Cumberland (CR)

Family Emyidae

<u>Malaclemys terrapin</u> diamondback terrapin

Sight observations - Little Cumberland (JEC), Cumberland (HOH)

Remarks: The diamondback terrapin is common throughout the salt marsh estuary of Georgia and occasionally appears on the ocean beach.

<u>Pseudemys scripta</u> yellow-bellied turtle

Specimens - Cumberland (CM, GSU)

Family Testudinidae

<u>Gopherus polyphemus</u> gopher tortoise

Sight observations - Cumberland (CR, HOH)

Remarks: The gopher tortoise was introduced on Cumberland Island in recent years. A small population presently exists on the upland soils near Hickory Hill.

Family Chelonidae

Caretta caretta loggerhead sea turtle

Specimens (skulls) - Little Cumberland (JIR), Cumberland (CWD, HOH, CR)

Literature - Little Cumberland (Caldwell et al. 1959a. and 1959b, Carr 1967), Cumberland (Caldwell et al. 1959b).

Lepidochelys kempi Ridley turtle

Specimens (skulls) - Cumberland (JIR, CR), Little Cumberland (JR)

Remarks: The Ridley is infrequently observed on the Georgia coast and has not been reported to nest on the coast. Several dead specimens are usually reported from the Georgia islands during the summer.

Family Trionychidae

Trionyx ferox Florida softshell

Sight observations - Cumberland (HOH, CR)

ORDER CROCODILIA

Family Crocodylidae

Alligator mississippiensis American alligator

Sight observations - Little Cumberland (JEC, HOH), Cumberland (HOH, CR)

ORDER SQUAMATA

Family Iguanidae

Anolis carolinensis green anole

Specimens - Cumberland (TTRS, GSU, HJ)

Sight observations - Little Cumberland (JEC)

Remarks: This species and *Sceloporus undulatus* have been the subject of intensive blood parasite studies in recent years (see Jordan and Friend, 1971).

Sceloporus undulatus fence lizard

Specimens - Cumberland (TTRS, GSU, HJ)

Family Scincidae

Lygosoma laterale ground skink

Specimens - Cumberland (GSU, HJ)

Sight observations - Little Cumberland (JEC)

Eumeces fasciatus five-lined skink

Specimens - Cumberland (HJ)

Eumeces laticeps broad-headed skink

Specimens - Cumberland (GSU, HJ)

Sight observations - Little Cumberland (JEC)

Eumeces inexpectatus southeastern five-lined skink

Specimens - Cumberland (GSU)

Family Teiidae

Cnemidophorus sexlineatus six-lined racerunner

Specimens - Cumberland (GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Family Anguidae

Ophisaurus ventralis eastern glass lizard

Specimens - Cumberland (HJ)

Sight observations - Little Cumberland (JEC)

Ophisaurus compressus island glass lizard

Specimens - Cumberland (CR)

Sight observations - Little Cumberland (JEC)

Family Colubridae

Natrix fasciata banded water snake

Specimens - Cumberland (GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Thamnophis sirtalis garter snake

Specimens - Cumberland (TTRS, CM, GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Thamnophis sauritus ribbon snake

Specimens - Little Cumberland (JIR), Cumberland (CM, GSU, HJ)

Coluber constrictor black racer

Specimens - Cumberland (TTRS, GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Masticophis flagellum coachwhip

Specimens - Cumberland (GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Opheodrys aestivus rough green snake

Specimens - Cumberland (GSU, HJ)

Sight observations - Little Cumberland (JEC)

Elaphe obsoleta quadrivittata greenish rat snake

Specimens - Cumberland (TTRS, GSU, HJ)

Sight observations - Little Cumberland (JEC)

Remarks: The form occurring on the islands is the "greenish rat snake." Conant (1958) states that it is an intergrade between the yellow rat snake (*E. o. quadrivittata*) and the black rat (*E. o. obsoleta*)

Elaphe guttata corn snake

Specimens - Cumberland (HJ, GSU, CR)

Sight observations - Little Cumberland (JEC)

Cemophora coccinea scarlet snake

Specimens - Cumberland (GSU, CR)

Sight observations - Little Cumberland (JEC)

Pituophis melanoleucus mugitus Florida pine snake

Specimens - Cumberland (GSU)

Lampropeltis getulus Eastern kingsnake

Specimens - Cumberland (TTRS, GSU, HJ, CR)

Sight observations - Little Cumberland (JEC)

Lampropeltis doliata doliata scarlet kingsnake

Specimens - Cumberland (HJ, GSU)

Family Viperidae

Agkistrodon piscivorus cottonmouth

Specimens - Little Cumberland (UG-Z), Cumberland (GSU, HJ)

Crotalus adamanteus Eastern diamondback rattlesnake

Specimens - Little Cumberland (UG-Z), Cumberland (GSU, HJ)

Crotalus horridus atricaudatus canebrake rattlesnake

Specimens - Cumberland (HJ)

Literature Cited

Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cagle, and G. A. Moore. 1968. Vertebrates of the United States. 2nd ed. McGraw-Hill Book Co., New York. 616 pp.

Caldwell, D. K., A. Carr, and L. H. Ogren. 1959a. Nesting and migration of the Atlantic loggerhead. Bull. Florida State Mus. Bio. Sci. 4(10):295-308.

Caldwell, D. K., F. H. Berry, A. Carr, and R. A. Ragotzkie. 1959b. Multiple and group nesting by the Atlantic loggerhead turtle. Bull. Florida State Mus. Bio. Sci. 4(10):309-318.

Carr, A. 1967. So excellent a fishe. The Natural History Press. Garden City, N.Y. 248 pp.

Conant, R. 1958. A field guide to reptiles and amphibians of the United States and Canada east of the 100th meridian. Houghton Mifflin Co., Boston. 366 pp.

Jordan, H. B., and M. B. Friend. 1971. The occurrence of *Schellackia* and *Plasmodium* in two Georgia lizards. J. Protozool. 18(3):485-487.

Moore, R. W. 1934. The golden isles of Guale. Natl. Geogr. Mag. 65(2):235-264.

APPENDIX VI

Summary of Insect and Spider Collections on Cumberland Island, Camden County, Georgia

APPENDIX VI

Summary of Insect and Spider Collections on Cumberland Island, Camden County, Georgia

The following tables (Tables 34-48) summarize the results of the arthropod collections by the study team on Cumberland Island in 1973 and of Thysanoptera and Homoptera from Cumberland collections by R. Beshear. Complete descriptions of collection methods and collection sites are given in Chapter VII for Tables 34-44.

These baseline data should be of value in future studies quantifying changes in biotic communities with succession and management. The species composition and distribution of arthropod groups is, at least in part, a function of habitat conditions, and certain species or groups respond to even subtle habitat changes.

Table 34. Orders and families of insects collected* in pitfall traps in vegetation type I, interdune flats, grass-sedge, (wet site)

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Acrididae	2	-	-	2	1	-	-	-	-	5	1	11
Gryllidae	41	5	-	21	18	53	81	271	135	418	259	1302
Gryllicrididae	2	-	-	8	9	4	4	5	6	5	4	47
Tridactylidae	-	-	-	9	15	-	-	-	-	-	-	24
Tettigoniidae	-	-	-	-	1	-	1	-	-	-	-	2
HEMIPTERA & HOMOPTERA												
Gelastocoridae	-	-	-	-	8	-	1	2	2	-	-	13
Reduviidae	-	-	-	-	-	-	-	-	1	-	-	1
Miridae	14	2	1	3	-	-	-	-	-	-	-	20
Belostomatidae	-	-	1	1	-	-	-	-	-	-	-	2
Lygaeidae	-	-	1	-	-	-	-	-	-	2	-	3
Cicadellidae	2	-	-	-	-	-	-	-	-	-	-	2
DERMAPTERA												
Labiduridae	23	2	20	16	22	67	75	158	206	125	125	839
COLEOPTERA												
Carabidae	57	-	7	13	9	7	12	32	16	12	8	173
Cicindelidae	1	-	1	-	-	1	1	-	1	-	-	5
Clatuidae	28	-	-	11	6	11	29	50	13	57	30	240
Scarabaeidae	1	-	-	-	-	2	1	-	6	4	8	22
Tenebrionidae	-	-	1	-	1	1	1	-	-	-	-	4
Staphylinidae	-	-	1	-	-	-	-	-	-	-	-	1
Hydrophilidae	-	-	1	1	-	-	-	-	-	-	-	2
Curculionidae	-	-	-	1	-	-	-	-	-	-	-	1
Alleculidae	-	-	-	-	-	-	-	2	1	-	-	3
Histeridae	-	-	-	-	-	-	-	-	-	1	-	1
HYMENOPTERA												
Pompillidae	4	-	-	2	-	5	4	4	1	6	-	26
Formicidae	10	1	-	-	21	20	36	50	-	50	-	188
DIPTERA	52	-	2	28	76	72	146	91	96	79	75	717
TOTAL	237	10	36	116	187	243	392	665	489	764	510	3649

*see text for description of collection sites

Table 35. Orders and families of insects collected in pitfall traps in vegetation type II, interdune flats, grass-sedge*, (dry site)

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Acrididae	1	-	-	-	-	-	-	-	2	-	-	3
Gryllidae	-	-	-	1	-	4	7	4	15	418	18	467
Gryllicrididae	5	-	4	3	1	5	-	3	4	-	-	25
Tridactylidae	-	-	-	2	1	1	-	-	-	-	-	4
Tettigoniidae	-	-	-	-	-	-	-	1	-	1	-	2
HEMIPTERA & HOMOPTERA												
Lygaeidae	-	-	-	-	-	1	-	-	-	-	-	1
Reduviidae	-	-	-	-	-	-	-	1	-	-	-	1
Cicadellidae	-	-	-	-	-	-	1	-	-	-	-	1
DERMAPTERA												
Labiduridae	1	-	1	1	3	17	3	2	5	2	2	37
COLEOPTERA												
Elateridae	17	70	8	35	33	58	25	46	-	42	17	351
Carabidae	1	-	-	-	-	-	-	-	-	1	-	2
Tenebrionidae	6	5	-	7	-	3	2	-	2	1	-	26
Scarabaeidae	1	2	1	-	-	-	-	-	-	-	-	4
Cantharidae	-	1	-	-	-	-	-	-	-	-	-	1
Staphylinidae	-	1	-	-	-	-	-	-	-	-	-	1
Mordellidae	-	9	1	-	-	-	-	-	-	-	-	10
Nitidulidae	-	1	-	-	-	-	-	-	-	-	-	1
Histeridae	-	-	2	-	-	1	1	-	-	1	-	5
Curculionidae	-	-	1	-	-	-	-	-	-	-	-	1
Pedilidae	-	2	8	2	-	7	-	-	-	-	-	19
HYMENOPTERA												
Pompillidae	-	7	2	5	4	3	4	5	5	8	1	44
Formicidae	53	13	25	39	75	13	10	20	17	20	15	300
DIPTERA	26	48	5	4	15	26	22	14	36	38	17	251
TOTAL	111	159	58	99	132	139	75	96	86	532	70	1557

*See text for description of collection sites

Table 36. Orders and families of insects collected in pitfall traps in vegetation type III, upland-forests, oak-palmetto forest*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Acrididae	1	2	-	-	-	-	-	-	-	-	-	3
Gryllidae	-	1	5	2	5	4	5	3	4	6	-	35
Gryllicrididae	2	-	-	-	2	-	-	-	-	-	-	4
Tettigoniidae	3	2	-	2	-	2	-	-	2	-	-	11
Blattidae	35	7	23	21	34	3	4	4	2	-	5	138
COLEOPTERA												
Tenebrionidae	-	-	-	-	-	-	-	-	1	-	-	1
Histeridae	-	-	-	-	-	-	1	-	-	-	-	1
Silphidae	6	3	1	4	4	-	-	-	1	-	-	19
Scarabaeidae	156	64	48	144	141	56	125	46	17	11	4	812
Curculionidae	3	-	2	-	-	-	-	-	3	-	-	8
Lycidae	2	-	-	-	-	-	-	-	-	-	-	2
Elateridae	1	-	1	2	-	1	-	-	-	-	-	5
Staphylinidae	278	120	45	81	63	15	6	13	3	2	-	626
Carabidae	-	1	1	3	-	-	-	-	-	-	-	5
Alleculidae	-	-	-	-	-	1	-	-	-	-	-	1
HYMENOPTERA												
Pompillidae	-	-	-	1	-	-	-	-	-	-	-	1
Mutillidae	1	-	-	-	-	-	-	-	-	-	-	1
Braconidae	1	-	-	-	-	-	-	-	-	-	-	1
Formicidae	42	21	15	25	46	34	19	14	21	13	10	260
DIPTERA	75	14	34	37	25	23	16	7	10	12	100	353
TOTAL	606	235	175	322	320	139	176	87	64	44	199	2287

*See text for description of collection sites

Table 37. Orders and families of insects collected in pitfall traps in vegetation type IV, upland forests, mixed oak-hardwood forests*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Gryllidae	-	5	5	5	12	6	7	6	12	-	5	63
Tettigoniidae	-	-	-	1	-	-	1	-	-	-	-	2
Blattidae	3	11	23	7	56	18	11	2	4	-	2	137
COLEOPTERA												
Tenebrionidae	-	1	-	-	-	-	-	-	-	-	-	1
Histeridae	-	6	-	16	-	15	-	6	-	-	-	43
Silphidae	-	-	1	4	5	22	12	9	1	-	-	54
Scarabaeidae	-	67	48	519	654	1387	1418	510	252	198	211	5264
Curculionidae	-	2	2	1	-	-	-	-	1	-	-	6
Alleculidae	-	1	-	1	-	-	-	-	-	-	-	2
Carabidae	1	2	1	7	3	9	8	1	4	1	3	40
Elateridae	-	-	1	-	-	-	-	-	-	-	-	1
Staphylinidae	-	22	45	44	53	44	23	6	4	1	4	246
HYMENOPTERA												
Formicidae	25	17	15	3	15	5	9	6	5	2	11	113
Pompillidae	-	-	-	-	-	-	-	-	-	1	-	1
DIPTERA	2	6	34	3	-	9	13	1	5	1	-	74
TOTAL	31	140	175	611	798	1515	1502	547	288	204	236	6047

*see text for description of collection sites

Table 38. Orders and families of insects collected in pitfall traps in vegetation type V, loblolly pine plantation*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Gryllidae	3	2	19	5	9	8	5	2	3	8	-	64
Tettigoniidae	4	-	-	1	-	-	-	-	-	-	-	5
Blattidae	12	2	0	-	17	16	4	2	4	-	3	69
HOMOPTERA												
Cixiidae	1	-	-	-	-	-	-	-	-	-	-	1
Fulgoridae	1	-	-	-	-	-	-	-	-	-	-	1
COLEOPTERA												
Scarabaeidae	287	197	378	115	207	59	76	28	16	10	30	1403
Histeridae	54	16	14	8	15	-	-	5	-	-	-	112
Elateridae	2	-	1	-	1	-	-	-	-	-	-	4
Silphidae	2	2	2	-	-	-	-	-	-	-	-	6
Curculionidae	2	-	5	1	-	-	-	-	-	-	-	8
Staphylinidae	32	6	38	4	4	1	1	3	2	-	1	92
Pedilidae	-	2	-	-	-	-	-	-	-	-	-	2
Carabidae	-	-	6	1	1	-	-	-	3	-	-	11
Alleculidae	-	-	2	1	-	-	-	-	-	-	-	3
Tenebrionidae	-	-	1	-	1	-	-	-	-	-	-	2
DIPTERA	12	17	7	7	9	-	3	2	-	3	1	61
HYMENOPTERA												
Sphecidae	-	-	-	2	-	-	-	-	-	-	2	4
Pompillidae	-	7	1	-	2	2	-	-	-	-	-	12
Tiphiidae	-	-	-	-	-	-	1	-	-	-	-	1
Formicidae	21	19	5	7	12	53	12	8	15	10	5	167
Total	433	270	488	152	278	139	102	50	43	31	42	2028

*see text for description of collection sites

Table 39. Orders and families of insects collected in pitfall traps in vegetation type VI, fresh water, shrub marsh*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Acrididae	-	1	-	2	-	-	5	-	7	-	-	15
Gryllidae	7	2	25	18	30	17	15	18	-	18	13	163
Tettigoniidae	1	-	-	-	-	-	-	-	-	-	-	1
Blattidae	-	-	-	-	-	2	-	-	-	-	1	3
HEMIPTERA & HOMOPTERA												
Cicadellidae	1	-	-	-	-	-	-	-	-	-	-	1
Reduviidae	-	-	-	-	-	-	-	1	-	-	-	1
Cercopidae	-	-	-	1	1	2	-	1	-	2	-	7
Gelastocoridae	-	1	-	-	2	1	-	1	-	-	-	5
COLEOPTERA												
Histeridae	4	-	-	-	-	-	-	1	1	-	-	6
Carabidae	18	4	9	13	12	11	13	4	8	1	3	96
Curculionidae	4	-	-	1	1	-	1	2	2	-	-	11
Elateridae	2	-	-	2	2	3	2	1	-	-	-	12
Scarabaeidae	-	-	1	1	1	2	3	1	2	2	-	13
Staphylinidae	-	1	1	-	-	-	-	1	1	1	-	5
Hydrophilidae	-	-	-	1	-	-	-	-	-	-	-	1
Tenebrionidae	-	-	-	-	-	-	-	2	-	-	-	2
Cicindellidae	-	-	-	-	-	-	-	1	-	-	-	1
DIPTERA	1	-	8	5	-	4	3	2	6	-	5	34
HYMENOPTERA												
Formicidae	1	-	5	7	7	15	12	6	12	14	8	87
Pompillidae	-	1	-	-	-	1	-	1	-	-	-	3
Total	39	10	49	51	56	58	54	43	39	38	30	467

*see text for description of collection sites

Table 40. Orders and families of insects collected in pitfall traps in vegetation type VII, upland forests, pine-oak-palmetto scrub forests*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Gryllidae	9	7	5	3	3	4	2	6	6	3	-	48
Tettigoniidae	-	1	-	-	2	2	-	1	-	-	-	6
Blattidae	5	3	3	1	3	-	1	-	1	-	-	17
COLEOPTERA												
Scarabaeidae	14	3	6	103	349	127	194	100	44	14	7	961
Carabidae	1	1	-	-	-	3	2	4	2	1	-	14
Curculionidae	2	-	-	-	-	-	-	-	-	-	-	2
Histeridae	1	-	1	1	-	-	-	-	-	-	-	3
Staphylinidae	1	2	2	-	-	1	-	-	2	1	-	9
Alleculidae	-	-	2	-	-	-	-	1	-	-	-	3
Chrysomelidae	-	-	-	-	-	1	-	-	-	-	-	1
Silphidae	-	-	-	-	1	-	-	-	-	-	-	1
DIPTERA	9	3	4	7	5	1	6	3	4	5	1	48
HYMENOPTERA												
Tiphiidae	-	-	-	1	-	-	-	-	-	-	-	1
Formicidae	70	10	73	12	-	10	18	15	14	25	4	251
Vespidae	-	-	-	-	-	-	-	-	-	-	1	1
TOTAL	112	30	96	128	363	149	223	130	73	49	13	1366

*see text for description of collection sites

Table 41. Orders and families of insects collected in pitfall traps in vegetation type VIII, upland forests, oak-pine forests*

	Collection Date (1973)											
	June 14	June 26	July 3	July 10	July 17	July 24	July 31	Aug. 7	Aug. 14	Aug. 22	Aug. 27	Total
ORTHOPTERA												
Gryllidae	4	1	7	4	23	13	12	14	6	21	6	111
Tettigoniidae	-	1	-	1	-	-	-	-	-	-	-	2
Blattidae	7	2	5	4	4	8	6	2	2	6	-	46
HEMIPTERA												
Aradidae	-	-	-	-	-	1	-	-	-	-	-	1
COLEOPTERA												
Scarabaeidae	515	126	484	487	1645	2592	2151	1812	1233	632	89	11,766
Histeridae	12	-	34	7	22	25	22	15	4	6	-	147
Elateridae	2	1	-	-	-	1	-	-	-	-	-	4
Staphylinidae	6	-	-	-	-	4	3	7	1	4	-	25
Silphidae	1	-	-	-	-	-	-	1	-	1	-	3
Carabidae	3	1	7	3	3	1	1	2	5	2	-	28
DIPTERA	9	10	3	4	5	5	1	1	4	8	-	50
HYMENOPTERA												
Formicidae	4	5	25	8	18	20	15	30	53	35	10	223
TOTAL	563	147	565	518	1720	2670	2211	1887	1308	715	105	12,409

*See text for description of collection sites.

Table 42. Total numbers of insects trapped per site, June-August 1973

	Collection Sites* I	II	III	IV	V	VI	VII	VIII	TOTAL
ORTHOPTERA									
Tridactylidae	24	4	0	0	0	0	0	0	28
Acrididae	11	3	3	0	0	15	0	0	32
Tettigoniidae	2	2	11	2	5	1	6	2	31
Gryllicrididae	47	25	4	0	0	0	0	0	76
Gryllidae	1302	481	35	70	64	163	48	111	2,274
Blattidae	0	0	140	137	68	2	17	46	411
HEMIPTERA									
Belostomatidae	2	0	0	0	0	0	0	0	2
Gelastocoridae	13	0	0	0	0	5	0	0	18
Miridae	20	0	0	0	0	0	0	0	20
Reduviidae	1	1	0	0	0	1	0	0	3
Lygaeidae	3	1	0	0	0	0	0	0	4
Aradidae	0	0	0	0	0	0	0	1	1
HOMOPTERA									
Cercopidae	0	0	0	0	0	7	0	0	7
Cicadellidae	1	1	0	0	0	1	0	0	3
Fulgoridae	0	0	0	0	1	0	0	0	1
Cixidae	0	0	0	0	1	0	0	0	1
DERMAPTERA									
Labiduridae	839	37	0	0	0	0	0	0	876
COLEOPTERA									
Carabidae	173	2	5	40	11	95	14	28	368
Cicindellidae	5	0	0	0	0	1	0	0	6
Histeridae	1	5	1	43	112	6	3	147	318
Hydrophilidae	2	0	0	0	0	1	0	0	3
Silphidae	0	0	20	54	6	0	1	3	84
Staphylinidae	1	1	626	240	92	5	9	25	999
Cantharidae	0	1	0	0	0	0	0	0	1
Lycidae	0	0	2	0	0	0	0	0	2
Elateridae	240	351	5	1	4	12	0	4	617
Nitidulidae	0	1	0	0	0	0	0	0	1
Pedilidae	0	19	0	0	2	0	0	0	21
Mordellidae	0	10	0	0	0	0	0	0	10
Tenebrionidae	4	26	1	1	2	2	0	0	36
Alleculidae	3	0	1	2	3	0	3	0	12
Scarabaeidae	22	4	812	5265	1413	13	961	11,789	20,279
Chrysomelidae	0	0	0	0	0	0	1	0	1
Curculionidae	1	1	8	6	8	11	2	0	37

Table 42. (continued)

	Collection Sites*								
	I	II	III	IV	V	VI	VII	VIII	TOTAL
DIPTERA	720	251	353	74	61	34	48	50	1,591
HYMENOPTERA									
Braconidae	0	0	1	0	0	0	0	0	[illegible]
Tiphiidae	0	0	0	0	1	0	1	0	2
Mutillidae	0	0	1	0	0	0	0	0	1
Formicidae	188	186	260	113	167	87	151	252	1,404
Vespidae	0	0	0	0	0	0	1	0	[illegible]
Sphecidae	–	–	–	–	4	–	–	–	4
Pompillidae	26	44	1	1	12	3	0	0	87
TOTAL	3651	1457	2290	6049	2037	466	1266	12,458	29,674

*See text for description of collection sites.

Table 43. Species of Scarabaeidae collected on Cumberland Island, June-August, 1973

SPECIES	Collection Site* I	II	III	IV	V	VI	VII	VIII
Aphodius campestris				x	x			
Aphonus variolosus						x		x
Ateuchus lecontei			x		x			
Bothynus morio		x						
Canthon chalcites			x					
Copris minutus			x	x				x
Deltochilum gibbosum			x					
Diplotaxis subcostata					x			
Dyscinetus morator						x		
Euphoria limbalis			x					
Geotrupes egeriei			x					
Melanocanthon bispinatus				x	x			x
Onthophagus hecate			x				x	x
Onthophagus striatulus					x			
Onthophagus tuberculifrons					x			x
Phanaeus igneus igneus				x				
Phyllophaga aemula								x
Phyllophaga glaberrima	x							
Plectris aliena		x						
Serica sp.			x					
Strategus antaeus			x					
Trox monachus				x				
Trox terrestris					x		x	x

*See text for description of collection sites.

Table 44. The numerical distribution of Carabid species by habitats, Cumberland Island, June-August, 1973.

Species	Collection Site*								
	I	II	III	IV	V	VI	VII	VIII	TOTAL
Agonum extensicolle	3								3
Apenes sinuata					2				2
Ardistomis puncticollis						29			29
Ardistomis viridis						26			26
Aspidoglossa subangulata						8			8
Brachinus alternans						14			14
Brachinus medius						3			3
Chlaenius floridanus	31	2							33
Chlaenius nemoralis	11								11
Dicaelus elongatus			3						3
Ega sallei						7			7
Evarthrus levifaber			1	1			4		6
Evarthrus morio			2						2
Helluomorphoides clairvillei					2				2
Loxandrus sp.							1		1
Omophron labiatus	128								128
Pasimachus strenuus							4	22	26
Pasimachus subsulcatus			1	39	7		5	6	58
Scarites subterraneus						7			7
Stenocrepis striatus						2			2
Total	173	2	7	40	11	96	14	28	371

*See text for description of collection sites

Table 45. Spiders collected on Cumberland Island, June-August 1973

FAMILY SPECIES
AMAUROBIIDAE
Titanoeca brunnea
GNAPHOSIDAE
Callilepis imbecilla
Cesonia bilineata
Herpyllus sp.
Zelotes duplex
Sergiolus sp.
LYCOSIDAE
Arctosa sp.
Lycosa carolinensis
L. helluo
L. hentzi
L. punctulata
L. rabida
L. wallacei
Pardosa floridana
P. georgiae
P. saxatilis
Pirata spp.
Schizocosa ocreata
Schizocosa spp.
SALTICIDAE
Metaphidippus sp.
Phidippus sp.
THOMISIDAE
Xysticus spp.
ULOBORIDAE
Uloborus glomosus

Table 46. Thrips collected from Cumberland Island, Georgia

ORDER Suborder Species	Host(s)
THYSANOPTERA	
Terebrantia	
Aeolothrips bicolor	*Panicum* sp.
Anaphothrips nanus	*Panicum* sp.
Bregmatothrips venustus	*Andropogon* sp.
Chirothrips praeocularis	*Spartina* sp.
Frankliniella bispinosa	*Magnolia* sp.
Frankliniella fusca	an unidentified rush
Frankliniella tritici	dead *Ilex cassine*
Heterothrips aesculi	*Aesculus* sp.
Heterothrips quercicola	*Spartina patens*, *Symplocos* sp.
Merothrips morgani	dead *Ilex cassine*
Pseudothrips inequalis	*Spartina* sp.
Scirtothrips sp.	*Quercus* sp.
Scirtothrips niveus	*Salicornia* sp.
Scirtothrips near *ruthveni*	*Vaccinium* sp.
Sericothrips desmodianus	*Spartina* sp.
Thrips spinosus	*Magnolia* sp.
Tubulifera	
Adraneothrips bellus	*Spartina* sp.
Adraneothrips near *decorus*	*Vitis* sp.
Adraneothrips exiguus	unident. lichen
Aleurodothrips fasciapennis	*Cycas revoluta* *Spartina* sp.
Amphibolothrips watsoni	unidentified lichen
Amphibolothrips corticinus	*Salix* sp.
Atractothrips bradleyi	*Mariscus* sp.
Bagnalliella yuccae	*Yucca* sp.
Diceratothrips harti	dead *Acacia* limbs

Table 46. (continued)

ORDER Suborder Species	Host(s)
THYSANOPTERA	
Tubulifera	
Elaprothrips coniferarum	dead *Juniperus*
Elaphrothrips parallelus	*Spartina* sp.
Eurythrips ampliventralis	*Eremochloa ophiuroides*
Eurythrips dissimilis	*Cenchrus* sp.
Haplothrips graminis	*Spartina* sp.
Haplothrips flavipes	unidentified bamboo
Haplothrips harti	*Spartina* sp.
Haplothrips mali	*Spartina* sp.
Haplothrips melaleucus	*Spartina* sp.
Hoplandrothrips sp.	*Mariscus* sp.
Hoplothrips angusticeps	dead *Ilex cassine*
Hoplothrips near *bruneri*	no record
Hoplothrips ? *leibyi*	dead *Ilex cassine*
Hoplothrips tejas	dead *Acacia*
Illinothrips rossi	*Cenchrus* sp.
Liothrips umbripennis	*Panicum* sp.
Lissothrips muscorum	unidentified moss
Macrophthalmothrips sp.	dead *Eriobotrya japonica* *Mariscus* sp.
Neothrips corticis	unidentified bamboo
Nesothrips near *bicolor*	*Spartina* sp.
Neurothrips magnafemoralis	dead *Eriobotrya japonica*
Oedaleothrips hookeri	*Spartina* sp.
Polyphemothrips near *tibialis*	dead *Acacia*
Sporothrips amplus	dead *Sabal palmetto*
Williamsiella bicoloripes	dead *Ilex cassine*

Table 47. Noxious insects of humans on feral and wildlife populations on Cumberland Island, Georgia

ORDER Family Species
DIPTERA
Tabanidae
Tabanus atratus
Tabanus sparus milleri
Tabanus sparus
Tabanus nigrovittatus
Stenotabanus psammophila
Diachlorous ferrugatus
Chrysops vittatus floridanus
Chrysops montanus perplexus
Chrysops reicherti
Chrysops atlanticus
Chrysops fuliginosus
Chrysops dimmocki
Simuliidae
Simulium congareenarum

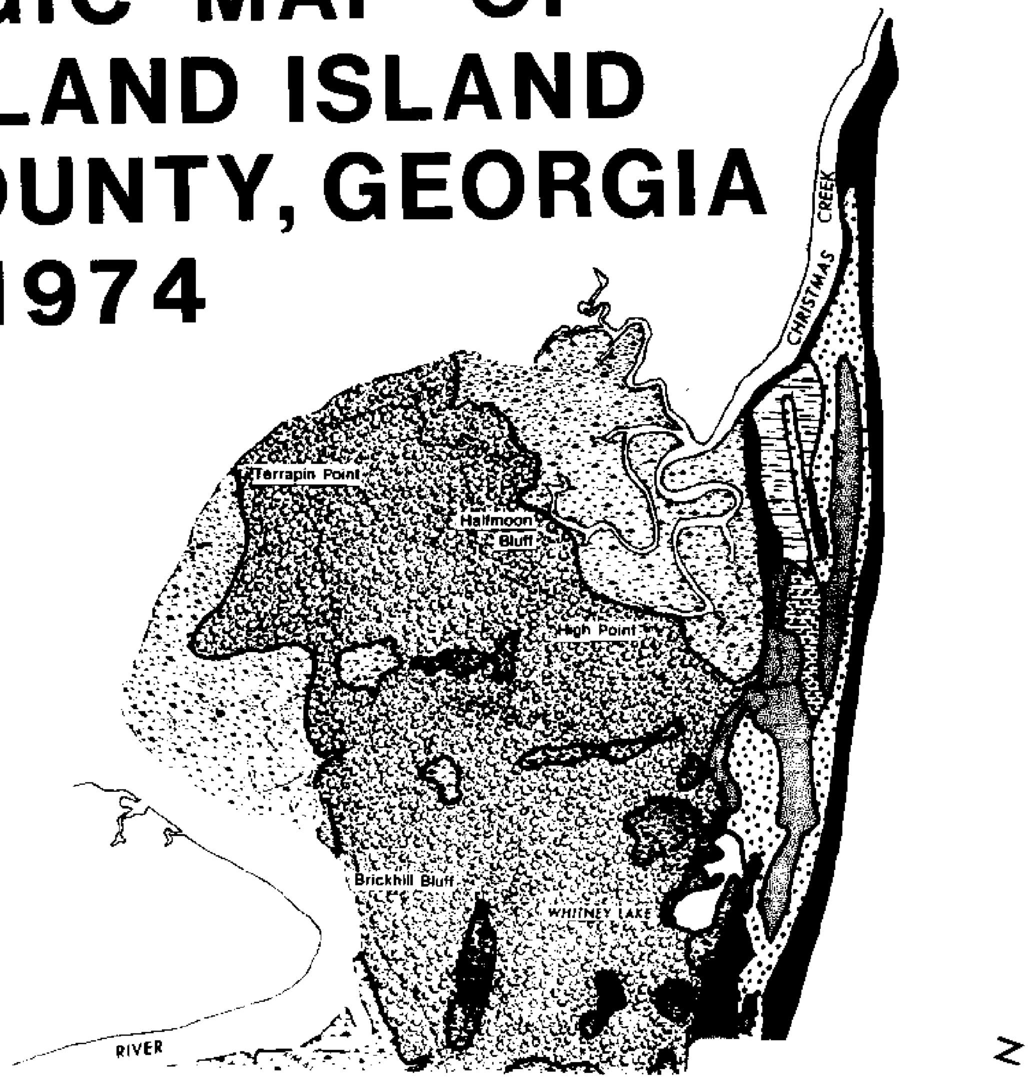
Table 48. Species of Homoptera collected from Cumberland Island, Georgia

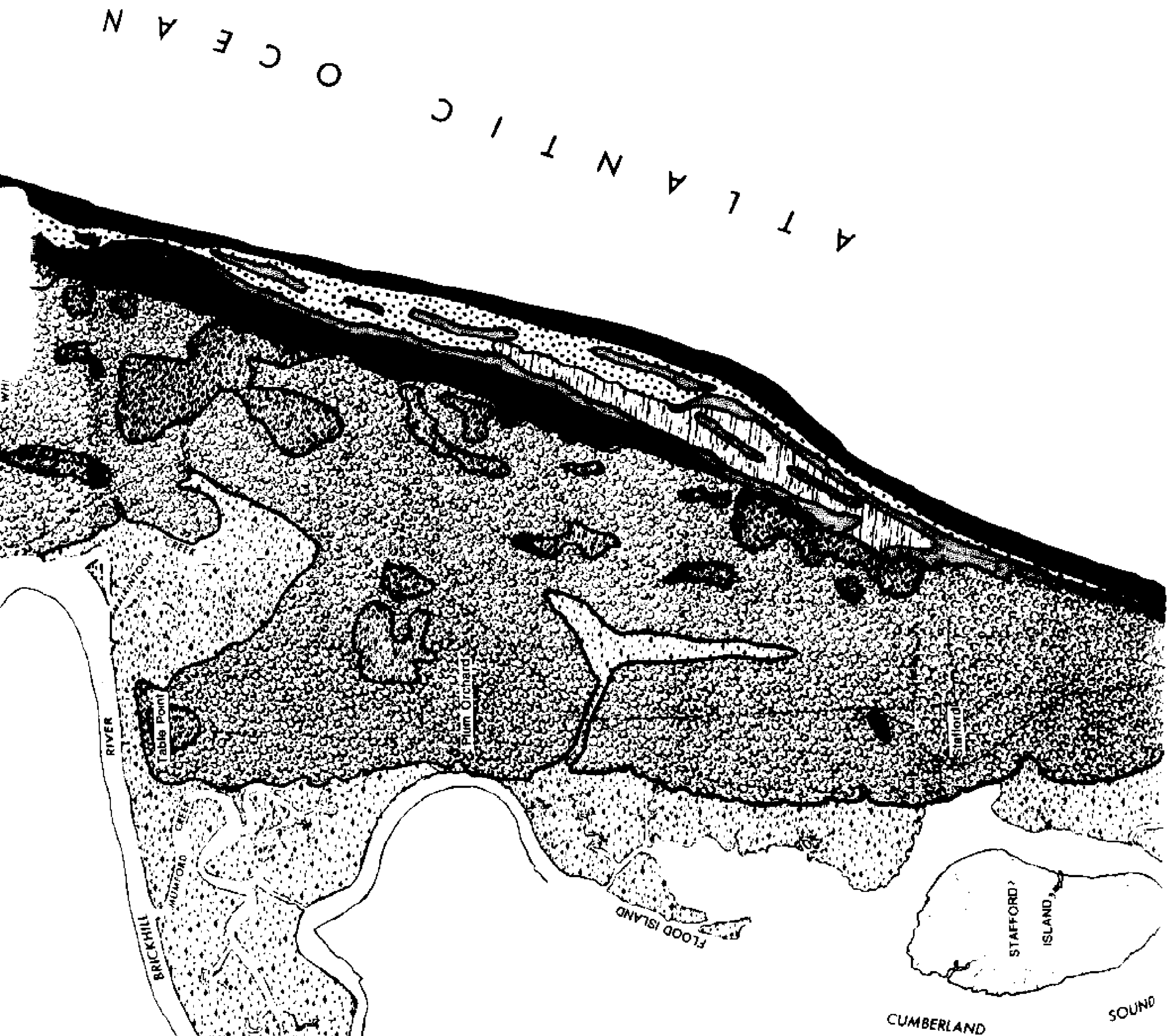
ORDER Family Species
HOMOPTERA
Diaspididae
Abgrallaspis townsendi
Acutaspis morrisonorum
Acutaspis perseae
Aonidia atlantica
Aonidomytilus solidaginis
Aspidiotus hederae
Aspidiotus mariscus
Aspidiotus spinosus
Chionaspis heterophyllae
Chionaspis nyssae
Circulaspis fistulella
Comstockiella sabalis
Diaspidiotus ancylus
Diaspidiotus coniferarum
Diaspidiotus hunteri
Diaspidiotus liquidambaris
Diaspidiotus mecombi
Diaspidiotus osborni
Diaspidiotus uvae
Fiorinia fioriniae
Fiorinia pinicola
Haliaspis spartinae
Haliaspis uniolae
Hemiberlesia cyanophylli
Hemiberlesia diffinis
Hemiberlesia lataniae
Hemiberlesia rapax

Table 48 (continued)

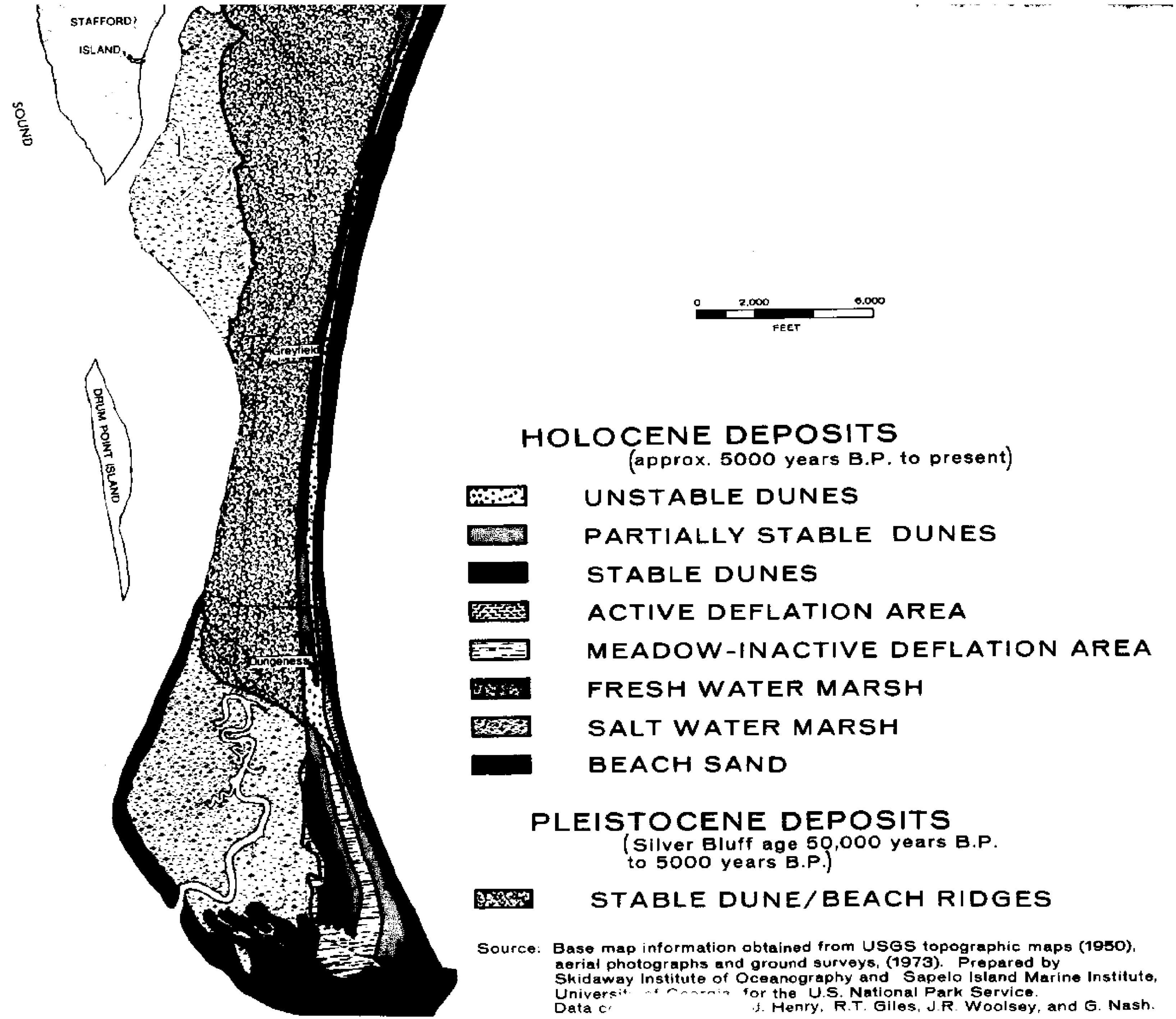
ORDER Family Species
<u>HOMOPTERA</u>
Diaspididae
Kuwanaspis howardi
Kuwanaspis pseudoleucaspis
Lepidosaphes camelliae
Melanaspis obscurus
Melanaspis smilacis
Melanaspis tenebricosus
Neopinnaspis harperi
Niveaspis ilicis
Nuculaspis californica
Odonaspis penicillata
Odonaspis ruthae
Pinnaspis strachani
Pseudaonidia paeoniae
Pseudaulacaspis pentagona
Pseudoparlatoria parlatorioides
Quadraspidiotus forbesi
Quadraspidiotus perniciosus
Quadraspidiotus taxodii
Quernaspis quercus
Quernaspis quercicola
Unaspis euonymi
Velataspis dentata
Asterolecaniidae
Asterolecanium bambusae
Asterolecanium bambusicola
Pseudococcidae
Antonina pretiosa
Pseudoantonina giganticoxa
Syrmococcus spirapuncta

GEOLOGIC MAP OF CUMBERLAND ISLAND CAMDEN COUNTY, GEORGIA 1974

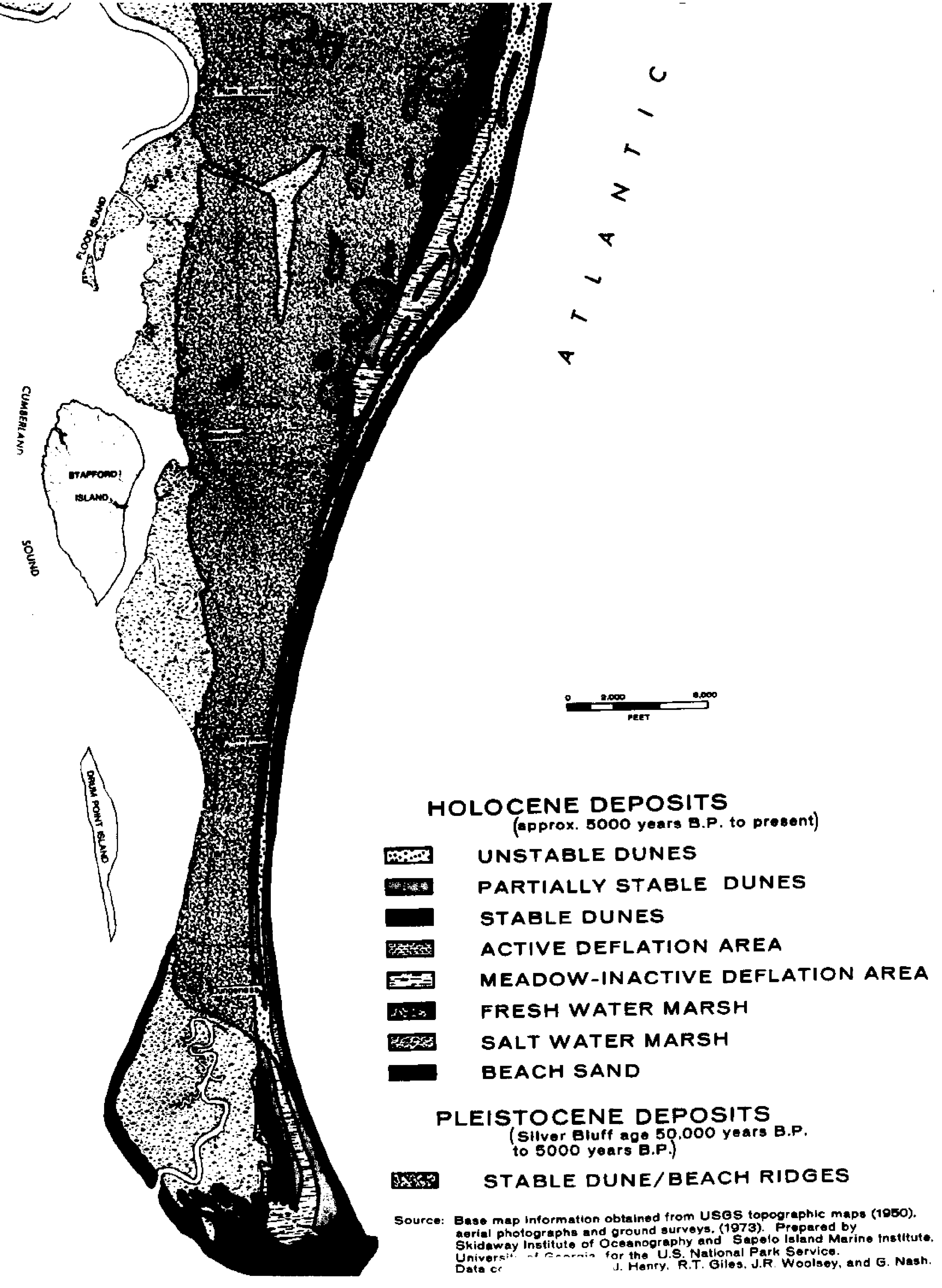




ATLANTIC OCEAN
Table Point
RIVER
BRICKHILL
MUMFORD
CREEK
Plum Orchard
Stafford
FLOOD ISLAND
STAFFORD ISLAND
CUMBERLAND
SOUND


STAFFORD
ISLAND
SOUND
DRUM POINT ISLAND
Greyfield
Dungeness
0 2,000 6,000
FEET
HOLOCENE DEPOSITS
(approx. 5000 years B.P. to present)
UNSTABLE DUNES
PARTIALLY STABLE DUNES
STABLE DUNES
ACTIVE DEFLATION AREA
MEADOW-INACTIVE DEFLATION AREA
FRESH WATER MARSH
SALT WATER MARSH
BEACH SAND
PLEISTOCENE DEPOSITS
(Silver Bluff age 50,000 years B.P. to 5000 years B.P.)
STABLE DUNE/BEACH RIDGES
Source: Base map information obtained from USGS topographic maps (1950), aerial photographs and ground surveys, (1973). Prepared by Skidaway Institute of Oceanography and Sapelo Island Marine Institute,
for the U.S. National Park Service.
J. Henry, R.T. Giles, J.R. Woolsey, and G. Nash.

GEOLOGIC MAP OF CUMBERLAND ISLAND CAMDEN COUNTY, GEORGIA 1974


ATLANTIC
FLOOD ISLAND
CUMBERLAND
SOUND
STAFFORD ISLAND
DRUM POINT ISLAND
0 2,000 6,000
FEET
HOLOCENE DEPOSITS
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UNSTABLE DUNES
PARTIALLY STABLE DUNES
STABLE DUNES
ACTIVE DEFLATION AREA
MEADOW-INACTIVE DEFLATION AREA
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(Silver Bluff age 50,000 years B.P. to 5000 years B.P.)
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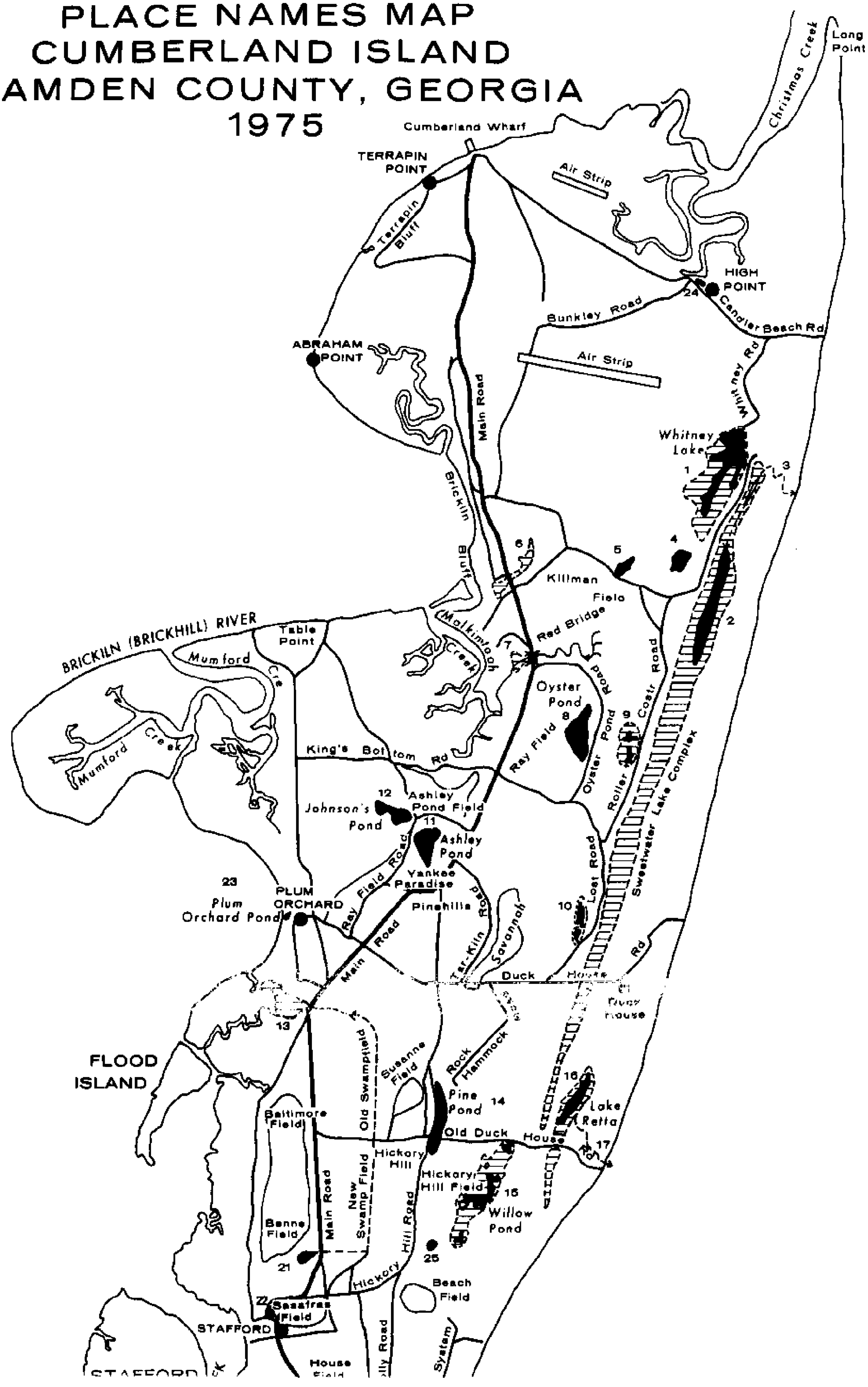
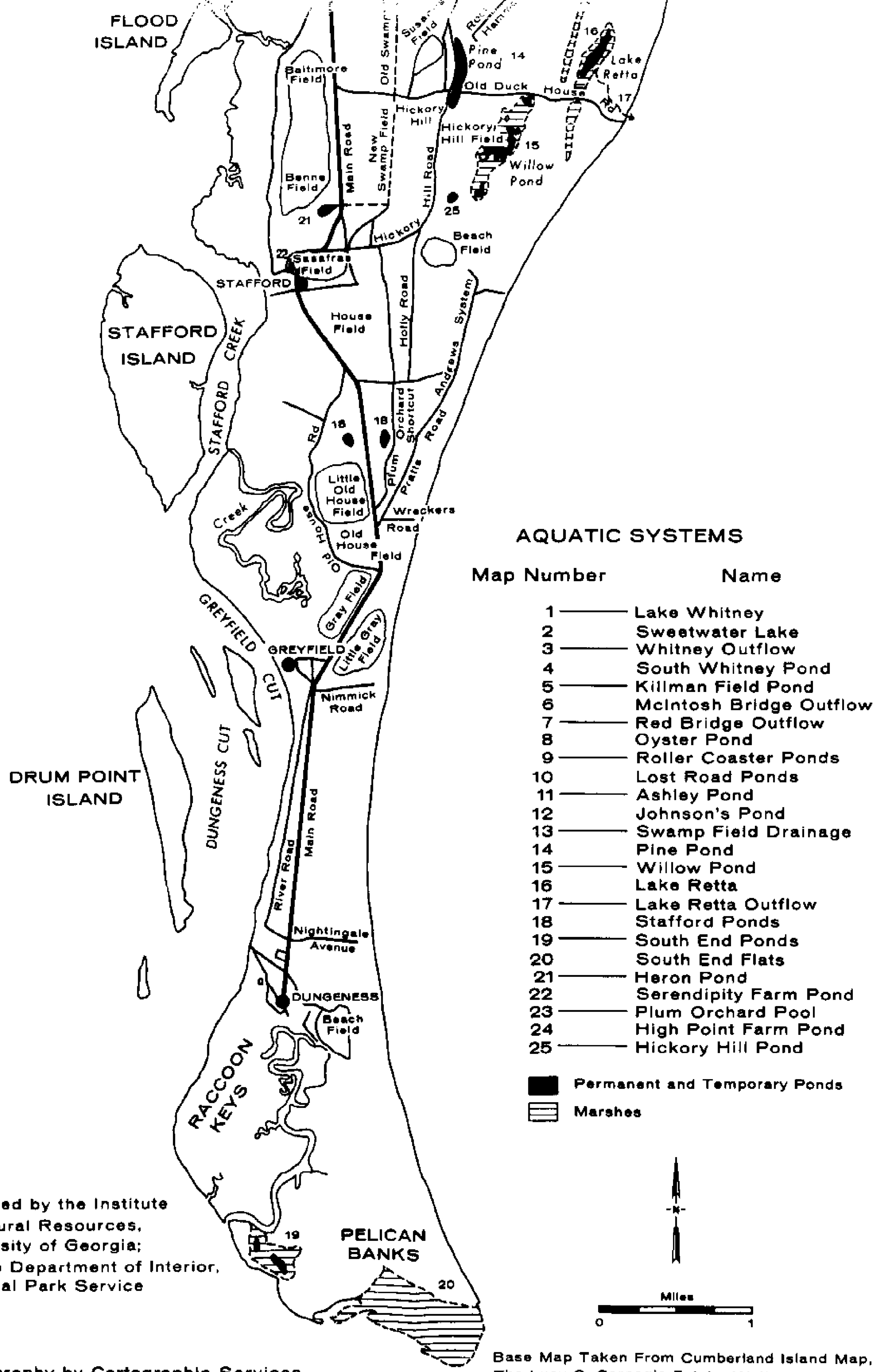
Data c... J. Henry, R.T. Giles, J.R. Woolsey, and G. Nash.

PLACE NAMES MAP
CUMBERLAND ISLAND
CAMDEN COUNTY, GEORGIA
1975





Prepared by the Institute of Natural Resources, University of Georgia; For the Department of Interior, National Park Service

Base Map Taken From Cumberland Island Map, The Lucy C. Carnegie Estate, Watts Engineering Company, Waycross, Georgia, January, 1965

Cartography by Cartographic Services, University of Georgia, Athens, Georgia

SOILS MAP OF CUMBERLAND AND LITTLE CUMBERLAND ISLANDS CAMDEN COUNTY, GEORGIA 1974

SOIL TYPES

- Ca CAPERS SOIL (851A1)
- Cs2 CAPERS SOIL (852A1)
- Ch CHIPLEY SAND (35A1) 0-5

Source: Uncontrolled mosaic of soil survey field sheets mapped on 1953 photography. Adapted by Institute of Natural Resources, University of Georgia from soils map prepared by Soil Conservation Service, U.S. Dept. of Agriculture, Athens, Ga. for the U.S. National Park Service. Names may be changed and areas combined pending correlation of field survey data.