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The Vegetation History of Canaveral National Seashore, Florida

CPSU Technical Report 22

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The Vegetation History of Canaveral National Seashore, Florida

Kathryn L. Davison and Susan P. Bratton. 1986. NPS-CPSU, Institute of Ecology, University of Georgia, Athens GA 30602. Technical Report No. 22, 75 pp.

Abstract

The disturbance history of Canaveral National Seashore, Florida, is reflected in the vegetation patterns and dynamics of the contemporary landscape. Historic records indicate a landscape dominated by wooded communities before 1766 in both upland and wetland areas. Heavy modification of woodlands, primarily by clearing and drainage, began during the British colonial period (1763-1779) and occurred in five major pulses. Hammocks along Misquito Lagoon's west shores were heavily disturbed by live oak removal for ship timbers between 1822-1835. Laurel oak and cabbage palm replaced live oak as dominants in these hammocks. Cleared, cultivated and abandoned hammock developed into scrub. Cypress swamps were drastically reduced by clearing and drainage and have been nearly completely replaced by willow/maple and switchgrass marshes. Pine flatwoods have occupied much the same areas over the last 400 years, but have been logged completely at least three times during the past century. Drainage of the flatwoods and increased fire frequency have impeded establishment of young pines in the flatwoods and the canopy is declining. Communities along the beach strand appear to have changed little from their historical descriptions.

Fire frequency has increased over time in the Canaveral area, especially during the dry winter season. Most fires occurring within the National Seashore properties during the past 15 years were human-caused and took place during the winter and the early spring. Fires of this nature encourage fire disclimax vegetation.

Table of Contents

Abstract.....	3
Introduction.....	5
Methods.....	6
Results.....	7
Study Area.....	7
Climate and Natural Disturbances.....	10
Landscape Disturbances Caused by Man.....	12
Aboriginal Occupation.....	12
Spanish Colonization.....	16
English Colonization.....	18
English Plantations Abandoned.....	22
Spanish Retrocession.....	22
American Territory.....	24
Florida Statehood.....	28
Civil War.....	30
Post-Civil War Expansion.....	31
Modern Era.....	32
NASA Purchase of Lands.....	36
Discussion.....	38
Summary.....	46
Disturbance History.....	46
Implications for Park Management.....	47
Literature Cited.....	48

The Vegetation History of Canaveral National Seashore

Introduction

Canaveral National Seashore (CANA), located on the central Atlantic coast of Florida, protects many outstanding natural resources. In addition to the beaches enjoyed by millions every year, the Seashore includes acres of hammock, pineland, scrub and wetlands harboring a rich flora and fauna. The wildlands of the Seashore, however, are far from pristine, and have a long history of human caused disturbances. These include logging of live oak, cedar, pine and cypress, ditching and diking of wetlands, plantation farming, livestock grazing, and burning in various rotations. Natural disturbances, such as salt water inundation, high winds, drought, and lightning-ignited fires, have also left their marks on the landscape. The disturbance history of a landscape is reflected in vegetation patterns. These patterns in turn affect the community responses to further disturbance and are therefore important factors in landscape management. The present vegetation of the Canaveral area has been described by Stout (1979) and Ehrhart (1976), but the relationship of historic disturbances to the present vegetation of these lands is not well documented. The objectives of this study were to:

- 1) collect documentation and information concerning major disturbances to the landscape;
- 2) interpret changes in vegetation patterns following disturbance; and
- 3) discuss the impact of historic disturbances on the present dynamics of the landscape, with specific reference to fire management.

Methods

Historic and contemporary scientific literature, historic maps and accounts, diaries, journals, memoirs and newspaper accounts were reviewed for references to :

- 1) the geology and vegetation and natural landscape disturbances of the Canaveral area;
- 2) landscape management practices; and
- 3) changes in the landscape associated with European colonization, settlement and establishment.

Twelve local residents were interviewed about their knowledge of land management and landscape disturbances such as fires and free-ranging livestock. Interviews were conducted from September 1984 to February 1985. Monthly precipitation data from 1887 to the present were obtained from the National Climatic Data Center, Asheville, NC and analyzed for drought and flood patterns. Large wildfire occurrences were related to periods of drought. Black-and-white U.S. Dept. of Agriculture (USDA) aerial photos taken over the last 40 years were reviewed for possible sites of logging and fire. Aerial false color infra-red photos flown by National Aeronautics and Space Administration (NASA) Environmental Studies in 1983 were used with ground truth to determine patterns of contemporary vegetation. Three to nine pines at fourteen sites were sampled by a single increment boring at breast height to determine age stratification of pine in certain hammocks and pine flatwoods. Fire records of Canaveral National Seashore and Merritt Island National Wildlife Refuge were reviewed to determine present wildland fire characteristics.

Botanical nomenclature follows that of Long and Lakela (1971) and or Radford et al. (1964).

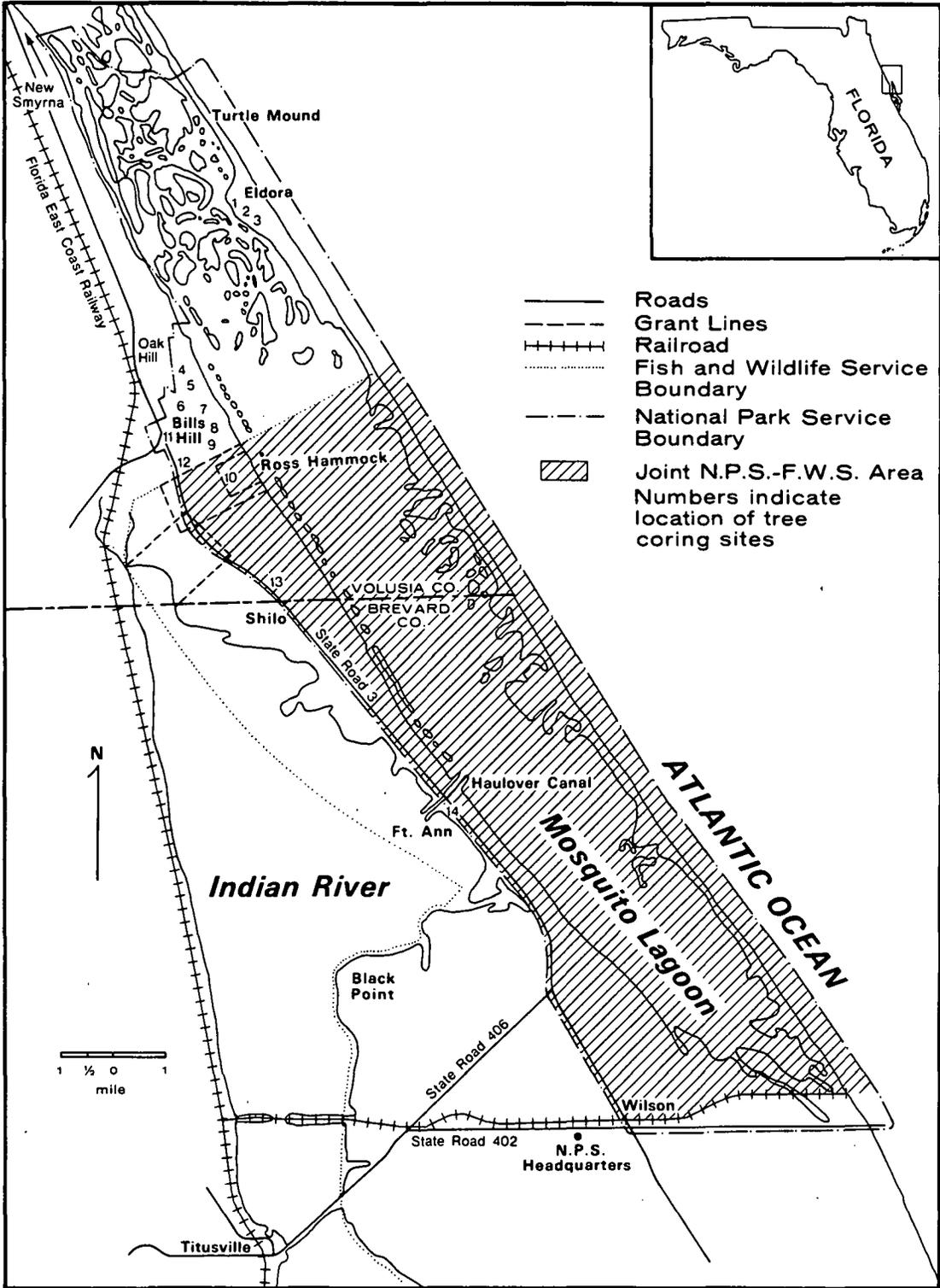
Results

Study Area

Canaveral National Seashore covers 57,627 acres of coastal strand, pine-lands and lagoon east of the head of the Indian River in central Florida. Approximately 70% of these lands remain under NASA jurisdiction and U.S. Fish and Wildlife Service (USFWS) administration. About 30% are administered by the National Park Service. This report concerns mainly the upland acreage surrounding Mosquito Lagoon, approximately 35% of the Seashore's land. The remaining 65% is comprised of the lagoon and lagoon islands (Figure 1).

Since much of Canaveral's disturbance history is related to human settlement, a brief geographic orientation of the associated towns and landscape features may be helpful to the reader. Mosquito Lagoon, around which the Seashore is situated, opens to the Atlantic Ocean at Ponce de Leon (originally Mosquito) Inlet. Halifax River is the branch of the lagoon which flows from the north. During the British and early American periods of settlement in Florida (1763-1830), the widest part of the lagoon immediately south of the inlet through the mangrove islands was known as the Hillsborough River. To the southwest of the lagoon is the head of the Indian River which communicates with the southern end of the lagoon through Haulover Canal. The St. Johns River, a major trade route through the centuries, lies approximately 15-20 miles west of the lagoon. The Seashore lies about 85 miles south of St. Augustine, the primary city during early colonization and settlement of Florida. The oldest city in the Canaveral area is New Smyrna, situated just southwest of Ponce de Leon Inlet, less than 5 miles north of the Seashore. The city of Oak Hill is directly adjacent to the Seashore on the west shore of the lagoon, and Titusville is about 8 miles southwest. Settlements within the Seashore properties include Eldora on the northeast shore of the lagoon, Shiloh to the west of the lagoon, and Wilson to the south. Lands around Ross Hammock on the central west shore of Mosquito Lagoon have the most varied history of settlement, and were the focus of the report (Figure 1).

FIGURE 1. Canaveral National Seashore, Florida, and vicinity (circled numbers refer to tree core sample sites.



The sands and soils of the Canaveral area are geologically young. Lands between Mosquito Lagoon and the Indian River rise 2-15 feet above sea level. Deposits above 5 feet are believed to have been created during the formation of the Silver Bluff terrace of the late Pleistocene, 24,000 and 40,000 years ago (Schnable and Goodell 1968). An analog to present-day Cape Canaveral was located on Merritt Island during this time, west of which the Indian River was a lagoon much like the Mosquito (MacNeil 1949). Mosquito Lagoon and the contemporary beach strand that separates it from the Atlantic Ocean are more recent formations, believed created 6,000-8,000 years ago (Hoyt 1967).

Major vegetation types in the study are: hammock, pine flatwoods, scrub, palmetto prairie, and marsh. Kurz (1942) describes the successional relationship of beach strand vegetation in and around the Canaveral area. Primary succession on the dunes begins with colonization by succulent annuals closely followed by perennial grasses, herbaceous vines and low succulent shrubs. On the leeward face of the dunes, shrubby species such as saw palmetto (Serenoa repens), wax myrtle (Myrica cerifera), varnish-leaf (Dodonaea viscosa), and sand live oak (Quercus geminata) become established among the grasses. The shrubs coalesce into a thicket as the distance from the ocean and protection from salty breezes increases. This low thicket is dominated by saw palmetto on the ocean side, and hardwood shrubs on the soundward side. Thicket intergrades into hammock where the beach strand is wide enough to support it. Hammocks are dominated by live oak (Quercus virginiana), but may contain a variety of subtropical species. The latter are commonly associated with shell mounds built by Indians before European colonization (Norman 1976). Slash pine (Pinus elliottii, var. densa) is also frequently present in the hammocks, especially at disturbed sites. The lagoon's shores are lined in many places with black mangrove (Avicennia germinans), which is always associated with standing water. Lands west of the lagoon are primarily pine flatwoods, with slash pine forming an open canopy over scrubby oak-palmetto thicket. In places, the pine drops out leaving palmetto prairie and scrub. Within these flatwoods are pockets of marsh, swamp, and hammock, some dominated by cabbage palm (Sabal palmetto),

others by laurel oak, and more rarely, live oak. Much of the marsh and swamplands have been drained. This area is also punctuated by active and relict orange groves, often marked by lines of Australian pines (Casurina litorea).

Climate and Natural Disturbances

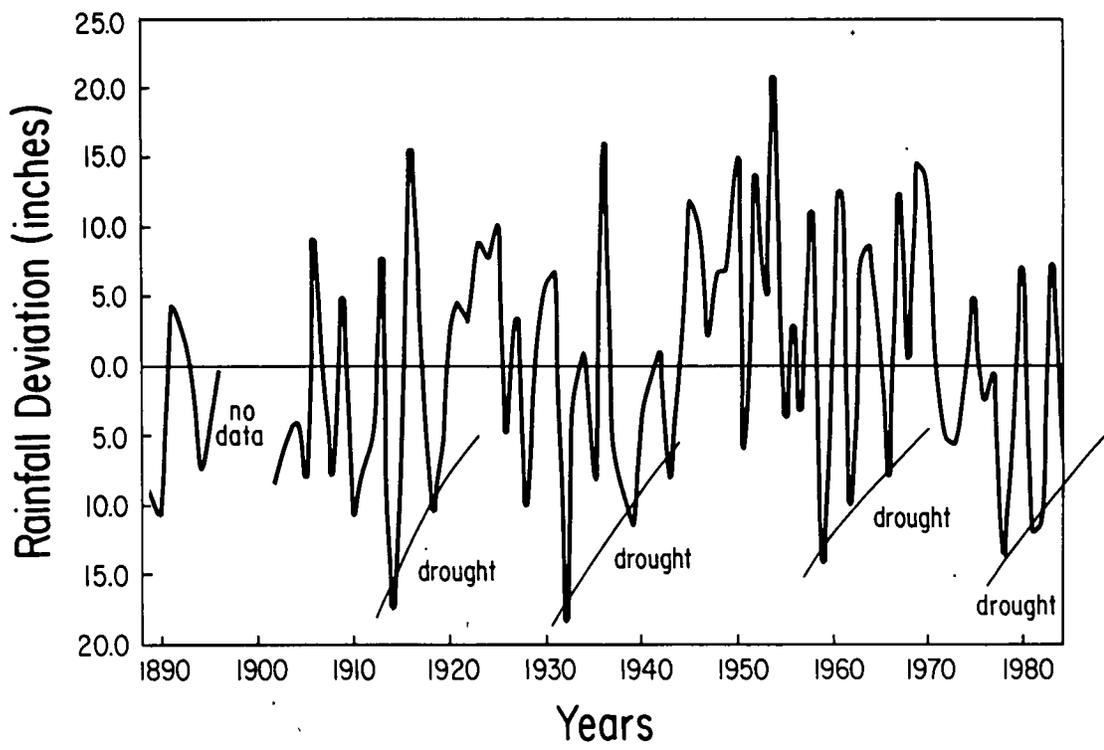
The average annual precipitation, 1888 to date for Titusville, about eight miles east of the southern end of the Seashore, is 54.52 inches. The majority (38.97 inches) occurs between May and October. Winter is typically a dry season, with rainless spells frequently lasting weeks or months.

Lightning is a prominent summer feature. Florida's east coast has one of the highest incidences of lightning in the country: strikes are recorded at least once per day for 60-80 days per year (Komarek 1964). Seventy-five percent of these storms occur from June to September (Wade, et al. 1980). Present-day weather patterns are believed to have originated during the Tertiary, but certainly have been an active source of fire ignitions since the late Pleistocene (Komarek 1974).

Precipitation and temperature fluctuations are major factors in the fire regime. Droughts and freezes stress plants, causing tissues to lose water and making them more flammable. Major droughts during the wet season have occurred on an average of every 23+5 years in the past century (Figure 2). These occurred in 1913, 1931, 1958 and 1981. The years 1931 and 1958 were well documented for wildfires in Florida (Stoddard 1962), and 1981 was a year of devastating fires throughout the southeast.

Severe winter freezes have been more common than droughts, with sixteen in the last 40 years. Lowest temperatures (15-20° F) were recorded in January 1940, December 1957, and January 1981. Although many plants are dormant during the dry season, certain species are susceptible to freeze damage, especially black mangrove and exotic citrus. Dr. Motte, an army surgeon during the 1835 Seminole war noted masses of dead mangroves along Mosquito Lagoon dervied from a freeze the previous December (Motte 1837a). The infant citrus industry suffered staggering freeze damage losses in 1884 and 1895. A Titusville orange

FIGURE 2. Wet season precipitation deviation from average, Canaveral National Seashore.



shipper, Roberts, recalled other freezes affecting the area in 1886, 1899 and 1917 (Star Advocate, 1940).

Storms are also significant sources of landscape disturbance. The hurricane and tropical storm season extends from August through November. A local resident, William Turner, recollected a family story about an 1894 storm tide that created a temporary inlet to Mosquito Lagoon north of Turtle Mound. Storm winds and tides can be very destructive to vegetation, especially to large trees which may be uprooted or snapped off. The contorted form of trees, particularly beach strand-inhabiting oaks, is due partly to wind damage. Storms may bring heavy rains, temporarily flooding low-lying areas. One such hurricane deluged the Canaveral area with 14 inches from 15-19 October 1950 (Day 1953).

Landscape Disturbances Caused by Man

Aboriginal Occupation: The earliest Floridians were subsistence hunters and gatherers. Archaeological evidence of human presence in southern Florida dates back at least 10,000 years (Wade et al. 1980). Bottle gourd and squash cultivation spread from the southwest about 3000 years ago to the eastern Indians. Corn and beans arrived much later, around 800-1000 A.D. (Hudson 1976). There is an interesting homogeneity among the artifacts of the Gulf Coastal Indians, beginning about 500 A.D., with indications of east Florida connections in this trend. This, combined with the presence of stone vessels amongst people who had no local access to stone suggest considerable trade between southeastern tribes (Tebeau 1971). This may have involved an exchange of landscape management practices, as was true later in interactions with Europeans.

The Seashore area may have been visited by aboriginal Indians from the St. John River basin as early as 8000 B.C. They perhaps harvested shellfish, deer and sea turtles, but as nomads probably avoided the coast during mosquito-infested summer months, remaining close to fresh water sources. Semi-permanent settlements increased with agricultural development. Artifacts from the Indian River area dates the first occupation of the central east coast to about 2000

B.C. When Europeans arrived in the early 16th Century, Indians of the Timucuan Tribes had settled along waterways to the north of Cape Canaveral.

Timucuan agriculture was similar to that of other southeastern groups, involving maize, beans, gourds and a variety of minor crops. The journal of Jonathan Dickinson (1696), a Quaker colonist who was shipwrecked south of Cape Canaveral, briefly describes an Indian squash field. The party had traveled through the territory of the nonagriculturalist Ais tribe, encountering plantings only north of the Cape:

"About an hour before sunset we got to an Indian plantation (this was the first place we saw anything planted) being full of pumpkin vines and some small pumpions on them.... some of us got a few as big as one's fist."

Coastal soils of the Southeast are exhausted rapidly and productive husbandry requires regular shifts in cultivation plots. Fields were planted for only a few seasons then abandoned or let fallow. Villages moved with changing agricultural sites because of the scattered nature of fertile soil on the coastal plain (Larson 1980). Agricultural production was insufficient for year-long subsistence. Maize supplies were exhausted by early autumn and were supplemented by acorns or roots. Live oak mast falls before December and must be collected quickly before consumption by insects and animals. Indian villages moved from their fields into the forest during this time (Larson 1980).

Timucuan and Ais Indians relied heavily on game, fish and shellfish for protein. Indian-built shell middens are common features of the east Florida coastal waterways (Rouse 1951). These not only served as refuse dumps, but as landmarks and high ground during storms. Two middens on the east shore of Mosquito Lagoon, known as Turtle Mound and Castle Windy, were occupied between 1000-1600 and 1000-1350 A.D., respectively (Norman 1976).

Mosquito Lagoon's shores were well inhabited by 1605 when Alvaro Mexia led a small Spanish expedition to scout the east coastal waterways from St. Augustine to the Indian River inlet. Mexia noted ten major Indian towns at at least twice that many temporary camps along the Halifax River, Mosquito Lagoon, Banana River and Indian River. Surruqu was a town located near present-day

Table 1. Chronological outline of disturbances and significant events in the Canaveral National Seashore area.

PERIOD	TIME SPAN	DISTURBANCES AND EVENTS
Aboriginal Occupation	8000 BC-1705 AD	Mild disturbances, clearing around settlement sites, primitive agriculture Possible use of fire in wildlands Building of shell middens
Spanish Colonization	1565-1762	Little disturbance in the Canaveral area Advent of free-ranging cattle and beginning of annual burns in the St. Johns River valley Planting of sour orange groves
English Colonization	1763-1779	Plantation agriculture, indigo as cash crop Limited drainage and diking Limited logging of pine and oak
English Plantations Abandoned	1779-1800	Fields abandoned after privateer attacks Florida retroceded to Spain, 1783
Spanish Retrocession	1801-1821	Spanish planters rework British plantations with sugar as cash crop Seminoles move into Florida and take over abandoned Spanish cattle
American Territory	1821-1845	Seminole War, wildland burning Abandonment of plantations Live oak logging begun
Early Florida Statehood	1845-1861	Establishment of towns around citrus industry and intermittent abandonment of settlements Extensive logging of live oak
Civil War	1861-1865	Cattle driven to saltworks for processing Pine logged for saltworks New Smyrna bombed, settlements abandoned
Post Civil War Expansion	1865-1900	Expansion of railroad, logging of virgin pine Towns re-established around citrus industry
Modern	1900-1962	Repeated logging of pine Burning of range for free-ranging cattle Fence Laws, end of free-ranging cattle Drainage and diking of wetlands, mosquito control
NASA purchase of lands	1962-present	FWS administration of Merritt Island NWR NPS administration Canaveral Natl. Seashore Wildland fire suppression and prescribed burning

Ross Hammock, the site of a midden. Mexia also provided a description of the landscape prior to European settlement. He described about ten vegetation types, including a map that depicted waterways, Indian settlements and vegetation (Figure 3). According to this account, beach strand vegetation was comprised of dunes, thorny thickets, gullies, scattered palm groves and low evergreen oaks. Tall pines grew on the seaward edges of Ribault's (Pencn) Inlet, which has since closed. The strand's western side was lined with mangrove. Live oak forest lined the western shore from the northern extension of the Halifax River to the Mangrove island-filled part of Mosquito Lagoon. Here, both shores of the lagoon were lined with mangrove. Near present-day Oak Hill, located further south, live oak forest again lined the lagoon's western shores. West of the live oak forest were expanses of pine flats with scattered woods. The thin neck of land between the lagoon and the Indian River, at present-day Haulover Canal, was vegetated by "live oak savannah." A haulover trail through this vegetation was used by local Indians. No settlements occurred on the Indian River's west shore, since this area was considered too dangerous to be navigated by canoe. Trails through the pine flats provided communication from the villages on the lagoon and river north of this area, to towns along the St. Johns River, "a day's journey" away (Higgs 1951).

The Indian settlements described in Mexia's account were clustered around hammocks. This would be advantageous for several reasons. Hammocks occur on upland terrain, hence less vulnerable to flooding. They are less prone to carry fire and provide more shade and protection from wind and rain than surrounding vegetational types, such as pine, scrub and marsh. Indians probably cleared brush away from settlement areas for easier passage and harvest of acorns. Larson (1980) suggests that the location of oak groves, a significant food source, may have been a major factor in determining territorial tribal boundaries. Impacts on the oak forests would have favored the growth of large trees with very little understory.

Cultivated plots were scattered, and it is unknown what native vegetation types were cleared away for this purpose. Larson (1980) provides some evidence

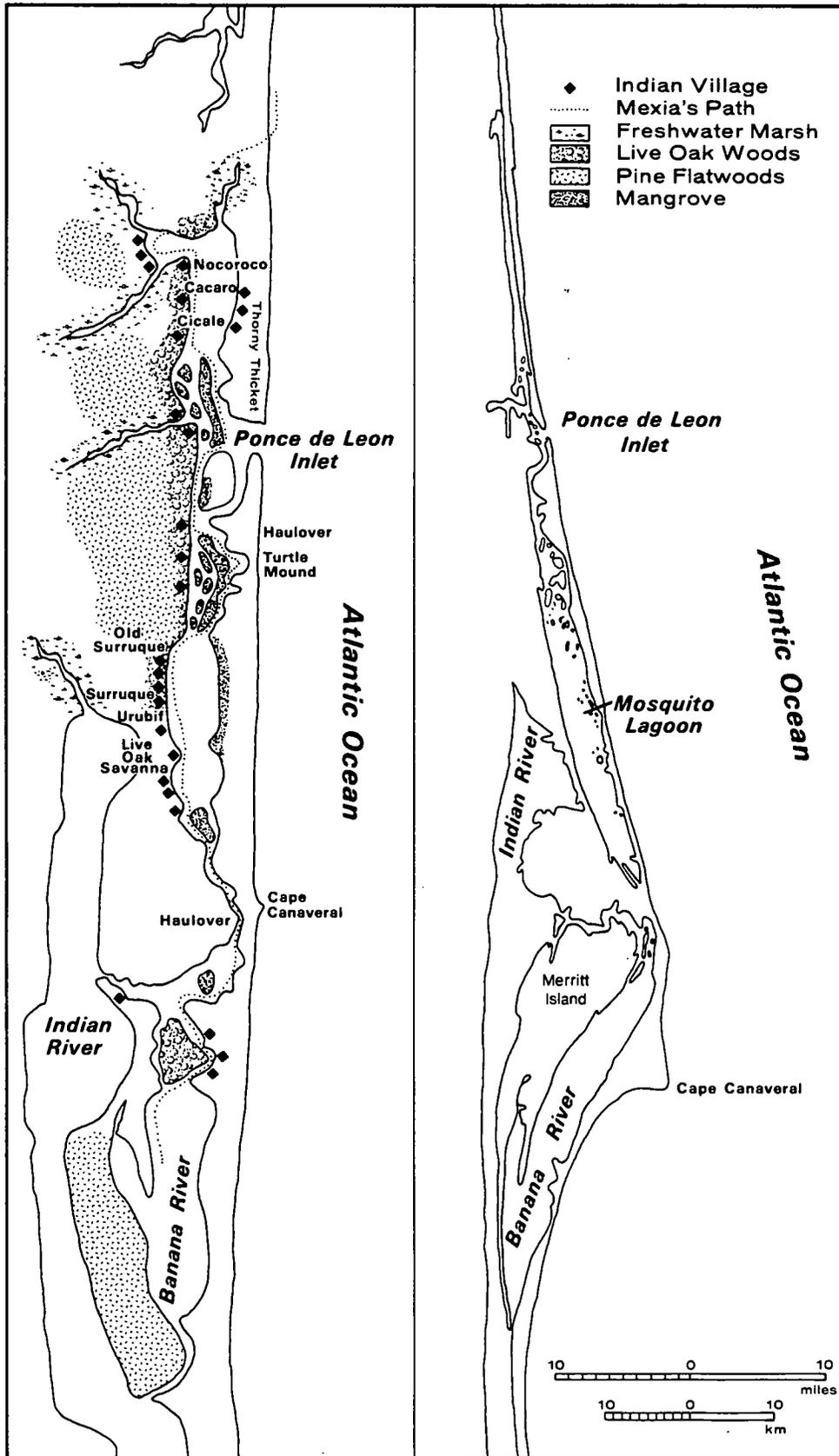
that fallow fields were in "forests of huge pines and barren woods" in coastal Georgia, and recultivated on a rotational basis by the Guale Indians. This practice may have been used by the Timucuan. Since live oaks were of considerable subsistence value, the location of fields was most likely in pine flatlands or in oak scrub.

In addition to moving periodically to more fertile grounds, villages probably moved on a seasonal basis. Larson (1980) states that acorn harvest involved movement of whole villages in Georgia. Mexia's account of the many temporary settlements or camps along Mosquito Lagoon also supports this contention. There is evidence that some coastal fields were planted in spring, abandoned in summer, and revisited for harvest in the autumn after the acorn harvest. Dickinson's party was large enough to attract attention but did not encounter the owners of the Timucuan "pumpkin plantation" when they raided the site in early November, suggesting it was not occupied at that time.

Indians did not have iron tools for clearing fields, and probably used fire to girdle trees and remove stumps and brush, as did the southeastern Indians of the Piedmont and Mountain provinces (Hudson 1976). The major Timucuan planting tool, depicted in an etching by Le Moyne (1565), was a pointed wooden stick used to sow seed. The land in the drawing had already been cleared, and few trees are visible in the field (Hulton 1977). Fire was used by Indians of the Piedmont and Mountain provinces to clear forest understory in the harvest of roasted acorns, hickory nuts and chestnuts (Hudson 1976). However, there is no record that this was practiced among the coastal Indians in the live oak forests, where litter does not burn well and seldom carries fire.

Indians may have occasionally burned parts of the pine flatwoods during late summer or early fall, providing easier passage through the scrubby understory. This would also increase legume, grass and berry yields during the next season, and draw bear, turkeys and small game into the area. If the Indians were managing for deer, however, only sporadic burns spaced at least five years apart, would have been used. Acorns are also the main staple of deer in this area (Larson 1980), and mast is not produced by scrub oaks in any quantity for

FIGURE 3. Alvaro Mexia's map of Canaveral area, 1605. A contemporary map is shown for comparison.



several years following a burn. Annual or biannual burns can affect the removal of hardwood species if continued for more than a decade (Wade et al. 1980, Mobley et al. 1978).

There are no accounts that Timucians used fire in hunting. An impoundment technique used by Virginian Indians was described by Smith in 1624. This employed a circle of fixed fires with hunters interspersed between them to form a barrier. This technique may have been known to the Timucians through trade, but was not recorded as a practice. Instead, the Timucians used a decoy hunter wearing a deer skin with intact head, as depicted by Le Moyne (1565). When deer came into range, it was killed with bow and arrow (Hudson 1976). Although there are several accounts of southeastern Indians using running fire to drive deer, Larson (1980) notes that all these descriptions originate from the 18th Century, when the pressure for deerskins from European trade was intense. The technique may have been taught to Indians by Europeans, and there is no evidence the technique was used before this time.

There are several accounts of ship-bound Europeans seeing Indians on shore lighting fires. Sailing past in 1513, Ponce de Leon described many "lights" on Cape Canaveral's beaches; he did not disembark to investigate. Jacques Le Moyne de Morques, with Laudonniere's French colonial expedition, gave this account (June 1562) when his ship was near the mouth of the St. Johns:

"... The whole coastline was beset by a great assembly of men and women lighting fires, so that we understandably thought we should beware of them. However, we gradually came to realize that they meant us no harm, seeing that they showed many signs of friendship and goodwill."

(Hulton 1977)

These accounts seem to indicate bonfires and torches on the beach, and not a description of deliberate palmetto scrub burning on the dunes.

Spanish Colonization: The first Spanish colonization of Florida began in 1565 and ended in 1768 when Florida was ceded to Great Britain. Spanish settlements were clustered around St. Augustine, along the St. Johns River, and in the

western panhandle of the state. Although the Spanish established forts at inlets north and south of Mosquito Lagoon, they did not settle this area.

Spaniards established missions and cattle ranches across Florida, free-ranging cattle in river valleys and in the pine-wiregrass areas of the east Florida and Pensacola areas. While exploring Florida and building missions they planted sour orange groves, many of which survive today. Although there are no records of a mission being established near Mosquito Lagoon, the area supports many sour orange groves. Groves on lands claimed by the British upon the retrocession of Florida to Spain (described in the following section) may have been planted by Spaniards, or more likely, by Indians within the Spanish sphere of influence.

Livestock introduction from shipwrecks may have been another indirect effect upon the Canaveral landscape. The Spanish maintained a friendly relationship with Indians of the east Florida coast principally for the recovery of shipwrecked persons and property. This apparently occurred commonly, and castaways were often enslaved or killed by natives during the late 1500's, according to Spanish colonial records of 1570-77 (Conner 1925). The coquina shoals off Cape Canaveral were especially treacherous. Warnings of "rocks" as far as two miles offshore were given in Robert's geographical account of Florida (1763). The first introductions of hogs, horses and cattle probably came from shipwrecks. Dickinson (1696) reported the loss of hogs and sheep which he claimed swam ashore from his wrecked ship. However, few accounts between 1760-1820 report hogs as resources of the Canaveral area, even though cattle and horses receive occasional mention. Sheep and goats have never been listed among the area's resources (Harper 1921).

Hostilities between Spanish and English colonies to the north drew in Indians from both localities, and eventually led to the demise of the east Florida aborigines. By 1710 the original Floridian Indians, who had survived European disease epidemics, were completely shattered by intertribal wars. The last aboriginal Floridians left with the Spanish for Cuba when the territory was ceded to England in 1762. East Florida was then largely unoccupied until

Seminole tribes and British colonizers arrived in the 1760's.

English Colonization: British planters began to settle the Mosquito Lagoon area in 1767. The largest and most notable colony, led by Dr. Andrew Turnbull, was founded that year at the mouth of the Halifax and Hillsborough (Mosquito Lagoon) rivers, about 5 miles north of the present-day Seashore. Turnbull's colony eventually became the town of New Smyrna and was key to the prosperity of the Mosquito plantations since it provided a port and safe natural harbor. Since nearly all trade and travel to and from the areas was by boat, New Smyrna served as door to the outside world. William Bartram was present when the area was surveyed, and described the land as it appeared prior to settlement:

"New Smyrna is built on a shelly bluff, on the west bank of the South branch of Musquito river, about ten miles above the capes of that river, which is about thirty miles North of Cape Canaveral, Lat 28. I was there about ten years ago, when the surveyor ran the lines or precincts of the colony, where there was neither habitation nor cleared field. It was then a famous orange grove, the upper or South promontory of a ridge, nearly half a mile wide, and stretching North about forty miles, to the head of the North branch of the Musquito, to where the Tomoko river unites with it, nearly parallel to the sea coast, and not above two miles to the sea beach. All this ridge was then one entire orange grove, with live oaks, magnolias, palms, red bays, and others: I observed then, near where New Smyrna now stands, a spacious Indian mount and avenue, which stood near the banks of the river: the avenue ran on a strait line back, through the groves, across the ridge, and terminated at the verge of natural savannas and ponds."

(Bartram 1792: p. 142)

Grants in east Florida were rapidly obtained by English businessmen seeking fortunes in naval stores and in cash crops such as indigo, cotton, tobacco, hemp, sugar and rice. Subsistence farming of maize and hog, cattle, sheep, chicken and horse husbandry were the backbone activities of the plantation and maintained through slave labor. Four major landowners obtained land within the present-day Seashore boundaries, from Bill's Hill to Haulover: Captain Robert Bisset, William Elliott, Esq., Mr. Clotworthy Upton and Lieutenant Colonel William Faucitt. The memorials of Robert Bisset and the heirs of the Faucitt property were among the claims made against the British crown for compensation of losses suffered during the retrocession of East Florida to Spain. Robert Bisset provided detailed status information on his former holdings and also

references of land management by neighbors William Elliott and Clotworthy Upton (Siebert 1971).

Bisset claimed to have settled nine different land tracts containing 9500 acres, on which he established five settlements. While his tenure on Seashore area lands lasted from 1767-1779, he maintained properties to the north until Spring 1784. The following are excerpts from his claim on these properties:

"No. 1. 300 Acres a tract by grant, called Mount Plenty or Palmerina situated on the south musketo or Hillsborough river bounded Northerly by land of Clotworthy Luptons Esq. all other sides vacant land. This Tract was most pleasantly and advantageously situated, being on Navigation, and only 14 or 15 miles from the Inlet, Having a fine stream of fresh water running thro' the middle of it; having in it's Front (on a branch of the river) a Beautiful Mount of several acres, 60 or 70 feet high which overlooked the whole Country for 20 or 30 miles round, Covered with a very fine Sower orange Grove; It was not above one mile from the great Lagoon [Indian River]...."

"Captain Bisset made this his principal Settlement, having built a good framed dwelling house 30 feet by 20, and a Court of offices Viz. a good Kitchen and Store house with Lofts, a Hen house Stable, and a large barn and corn house Lofted 40 by 20; He Erected 3 Setts Indico vatts with all the implements apparatus, he had 2 large Flats, one Boat, and one canoe and carts and other implements of Husbandry: and built a negro town of good houses for 70 Negroes. This tract had about 160 acres of it rich low Cabbage Cedar and Mulberry Hammock of which he cleared 143 acres, and fenced, ditched and drained, and divided it at a great expence it requiring much draining...."

"No. 2 1000 Acre tract by Grant Situated on the Great Swamp The head of the Indian River, Only 2 miles back from his tract on the river, bounding Northerly on Clotworthy Lupton's land & southerly on Gen. Faucit's land. This swamp was generally esteemed the largest in the Province; the back line of the tract got little more than half thro' it, consequently every acre was swamp; The soil of the best quality for the most part a black or Chocolate coloured Mould and a marle bottom; some of it was low enough for rice, and had plenty good Cypress on it, The greatest part however was high Swamp, very fit for the growth of Sugar, Cotton, Indico, hemp and allsorts of provisions: It had a very large and fine sower Orange grove on it. He made a settlement on this tract 2 Years after his first on the river; he erected several expensive Buildings, Vis. a very large Corn and Indigo house, strongly joisted, lofted and Floored, dimensions 50 F. by 24. A Horse mill and Mill house to grind corn, 2 setts of large Indico vats, with all the necessary apparatus; And 20 good Negro houses; He cleared, ditched, drained, fenced and divided 137 acres of land at a great deal of expence & labor it requiring much draining...."

"No. 3 1000 Acres by Grant Joining the back line of No. 2 & bounded the same as the other tract, the back line of this tract as will appear by the Plat -- got but very little above the swamp consequently there is about 800 Acres of it Swamp, Exactly the same quality of Soil as the other; He made a settlement on this tract the beginning of 1776; and in order to do this was under the Necessity of making a road across the Swamp at a great deal of labour and considerable expence. He built a Corn and Indigo house, a double sett of indigo vats a small overseer's house and 20 Negro houses: He cleared, ditched, fenced and divided about 70 acres of Land...."

"27 March 1787

Capt. Robert Bisset, claimant, Sworn, Says:

That he went to East Florida in the beginning of 1767 and quitted it in 1778, leaving his Son there in possession of his property.

He claims a tract of 300 Acres called Mount Plenty.

He produced a certified copy of a grant dated 2nd Nov. 1768 from General Grant

to the Claimant in fee of 300 acres on the West branch of Northe Hillsborough river -- conditioned for the usual quit rent and peopling --

He settled upon this tract in 1777 and then it was in a state of Nature. It was about 90 Miles South of St. Augustine and fronted upon the river above 1 1/2 Mile -- which was navigable there for flats of 100 barrels tar burthen. In 1779 The Spaniards in a Privateer came into Hillsborough river plundered and broke up this Plantation after which it was never settled.

In 1779 it was used as an Indico and Provision plantation and there was 143 acres cleared an fenced in for planting. A Great part of the tract was swamp with some Hammock...

-- and he left there in 1779 a large flat of from 100 to 15- bar [i.e., barrels] tar burthen worth about 150 and a smaller plat [sic] about 50 barrel worth about 20 or 30L.

This tract consisted of low hammock and indifferent pine barren -- He never was upon this plantation nor any person for him after 1779...."

"He claims a tract of 1000 acres upon the great Swamp on the head of the Indian river about 2 Miles back from the first -- He produced a certified copy of a Grant dated 4th Jan. 1768 from G. Grant to the Claimant in fee of 1000 acres on the West side of the Hillsborough river conditioned as usual. He settled upon this tract about the time of the grant having about 30 negroes which he occasionally employed upon each of these tracts -- This tract lay about 2 Miles east from the first And had no front upon any river or Creek, and was in a state of nature when he settled it and was broke up in 1779 He had upon this tract in 1779... [buildings] ... He cleared and fenced in a field of high swamp of about 137 acres for Indico and Provisions.

The produce of this plantation was to be cared two Miles to a landing upon the 300 Acre tract.

Another tract of 1000 acres adjoining the last -- He produced a certified Copy of a grant dated 18th Oct. 1774 from Gov. Tonyn to the Claimant in fee on the West side of the first 1000 acres conditioned as usual -- It was in a state of nature in the latter end of 1775 or beginning of 1776 when he began to settle it and in 1779 he had a clearing of between 60 and 70 Acres of high swamp higher than the Swamp of the first... These were all left upon the Plantation when he was driven off in 1779 and he never was upon the land afterwards."

(Siebert 1972: pp. 250-257)

Summarized, Bisset claimed a total of 2300 acres situated between the Upton and Faucitt grants and extending from the Mosquito Lagoon to the swamps draining into the Indian River headwaters. He had cleared, ditched, drained and fenced 350 acres, and settled 70 slaves there from 1769-1779. He did not state what his plantation yielded, but only what the newly cleared land was fit to grow. The oldest clearing on the lagoon tract had probably been producing indigo and provisions of maize and beans. The newly cleared land, about 200 acres, may never have been planted since it was abandoned shortly after being cleared. He also claimed the loss of 150-200 barrels of tar or pine pitch, presumably harvested from his flatwoods. Bisset's Mosquito grants were completely abandoned in 1779 after a raid by Spanish privateers, and was not resettled.

Both the Upton and Faucitt grants appear on William DeBrahm's survey map

of 1766 (Fig. 4). There is little indication that these lands were extensively used. The Bisset claim, explaining the reasons for his abandonment of properties, provides information on the "Lupton" properties:

"...the depredations of a Spanish Privateer in 1779. That sent in armed Boars, and first plundered the settlement of Smyrna, and carried off 17 or 18 Negroes afterwards proceeded to Lupton where his negroes were at the time working on naval stores, and plundered the house..."

(Siebert 1972: p. 253)

This indicates that the property was at least settled with slaves, had a main house, and was producing pine tar and turpentine or "naval stores." No other information was found concerning this tract.

The 20,000-acre block on Bisset's southern boundary was granted to Lieutenant Colonel William Faucitt on October 4, 1768 upon the usual preconditions of settling it and paying quit rent. It was conveyed by lease and release dated 29 and 30 April 1771 from the grantee to Richard Oswald. Oswald never settled this tract nor paid quit rent, "and it continued in a perfectly uncleared state to the time of cession." This plantation was known as "Ramsay bay," and was surveyed only once by the Surveyor General, by which is was calculated to contain 4200 acres of swamp and 15,800 acres of pine barren (Siebert 1972).

A fourth grant that may have occurred within present-day Seashore boundaries was that belonging to William Elliott. a map dated ca. 1771 locates this property at the head of the Indian River, but give no boundaries (Cultural Resources Management, Inc. 1978). This land was cleared and supported a sugar plantation according to Bisset (Siebert 1972). From 1773-1776, roads were constructed southward from Matanzas through Timouka River and New Smyrna, through the southern settlements along the Mosquito, terminating at Mr. Elliott's plantation (Mowat 1943).

Elliott sold 20,000 acres to Denys Rolls, and this was said to contain 9000 acres of inland swamp and 11,000 of pineland. The location of this property and date of transaction are not given. Although no other grants to Elliott were found among the records, this transaction may have involved pro-

FIGURE 4. British land grants and vegetation on the Mosquito Lagoon, 1766
(after DeBrahm survey map, 1766, G. Luther, publ.; printed by MIT.

perty outside the Seashore, as most of Rolle's land was on the St. Johns River. No other references to Elliott's grant was found.

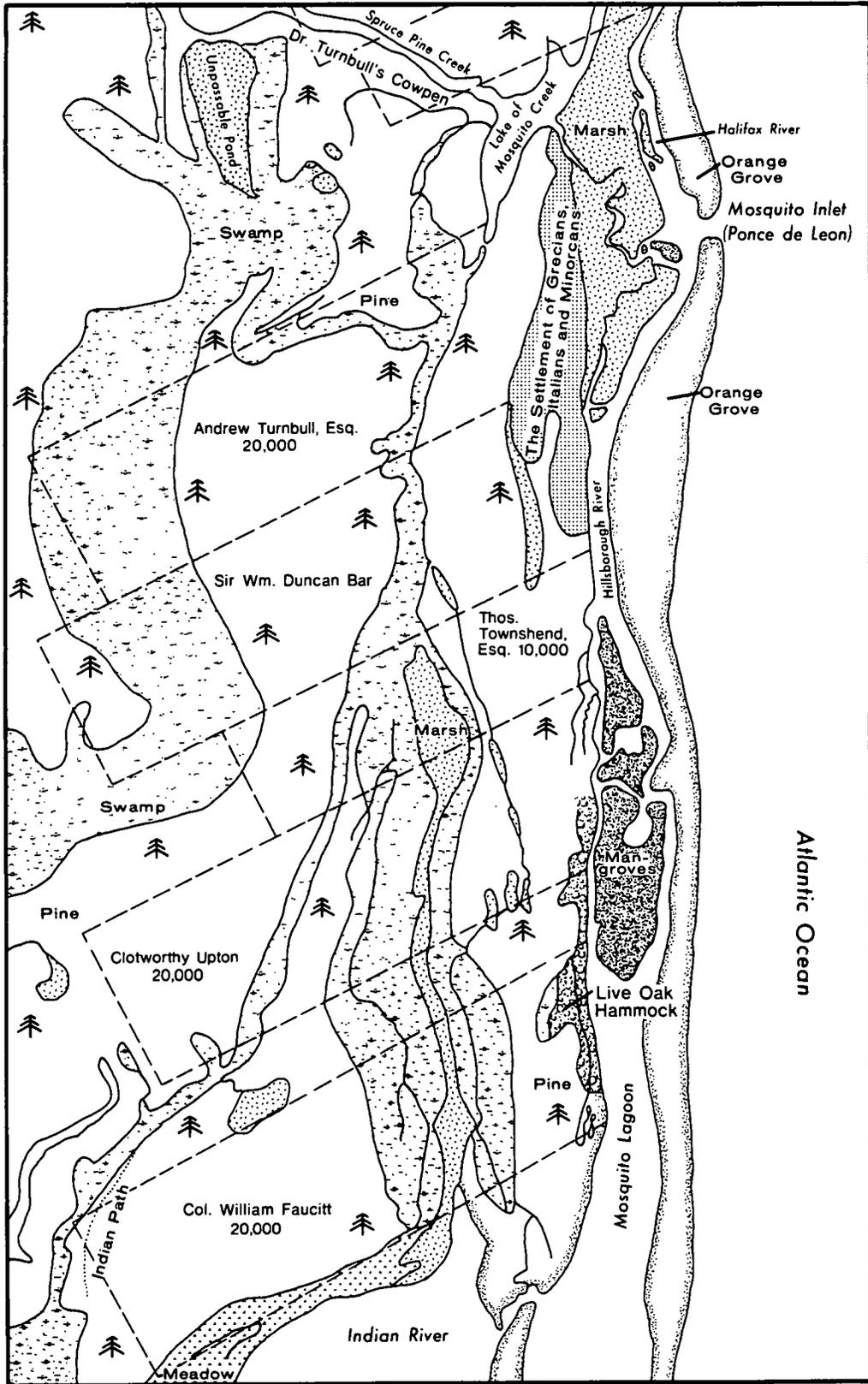
English Plantations Abandoned: The Mosquito Lagoon area was largely unsettled between 1779-1800. Turnbull's colony at New Smyrna moved en masse to St. Augustine in 1777. The southern plantations were attacked by Spanish privateers in 1779 according to the Bisset memorial, and were not resettled. The American Revolutionary War caused great upheaval for the Floridian colonists who remained loyalists. With the war's end in 1783, Florida was exchanged by Great Britain for the Spanish-owned Bahamas. Resettlement of the Mosquito Lagoon grants occurred around 1800.

Spanish Retrocession: The second Spanish colonial period began in 1784. The earliest evidence of resettlement was a grant to Lewis Mattair in 1801 for 300 acres at the English Ross plantation. A plat drawn up by Robert McHardy in 1809 shows cleared land, an orange grove, dock and canal. These appear in the area claimed by Bisset and could have been part of his operation. Mattair raised cotton, corn and other crops, according to McHardy. This property was sold to Antlem Gay in 1822, who "held it until driven out by the resolution" (Cultural Resources Management, Inc. 1978).

Another grant of 1200 acres, centered on the same English plantation, was made to Nicholas Gomex in 1803. The grant was confirmed in 1818 and its owners were said to have resided in St. Augustine after 1821. In seeking title to the lands, the heirs claimed that the property had been in continuous possession and cultivation for ten years, "interrupted, like everyone else, by Indians and rebels, but without relinquishing dominion" (Spanish Land Grants, CANA Historical Files). No other information concerning this second grant was found, although both grants were confirmed and appear on a U.S. Geological Survey topographic map (Oak Hill Quadrangle, 1983).

Still another grant outside the Seashore boundary, but relating to the previous section, was made to Francisco Reyes in 1804. This 100-acre property

FIGURE 4. British land grants and vegetation on the Mosquito Lagoon, 1766
(after DeBrahm survey map, 1766, G. Luther, publ.; printed by MIT.



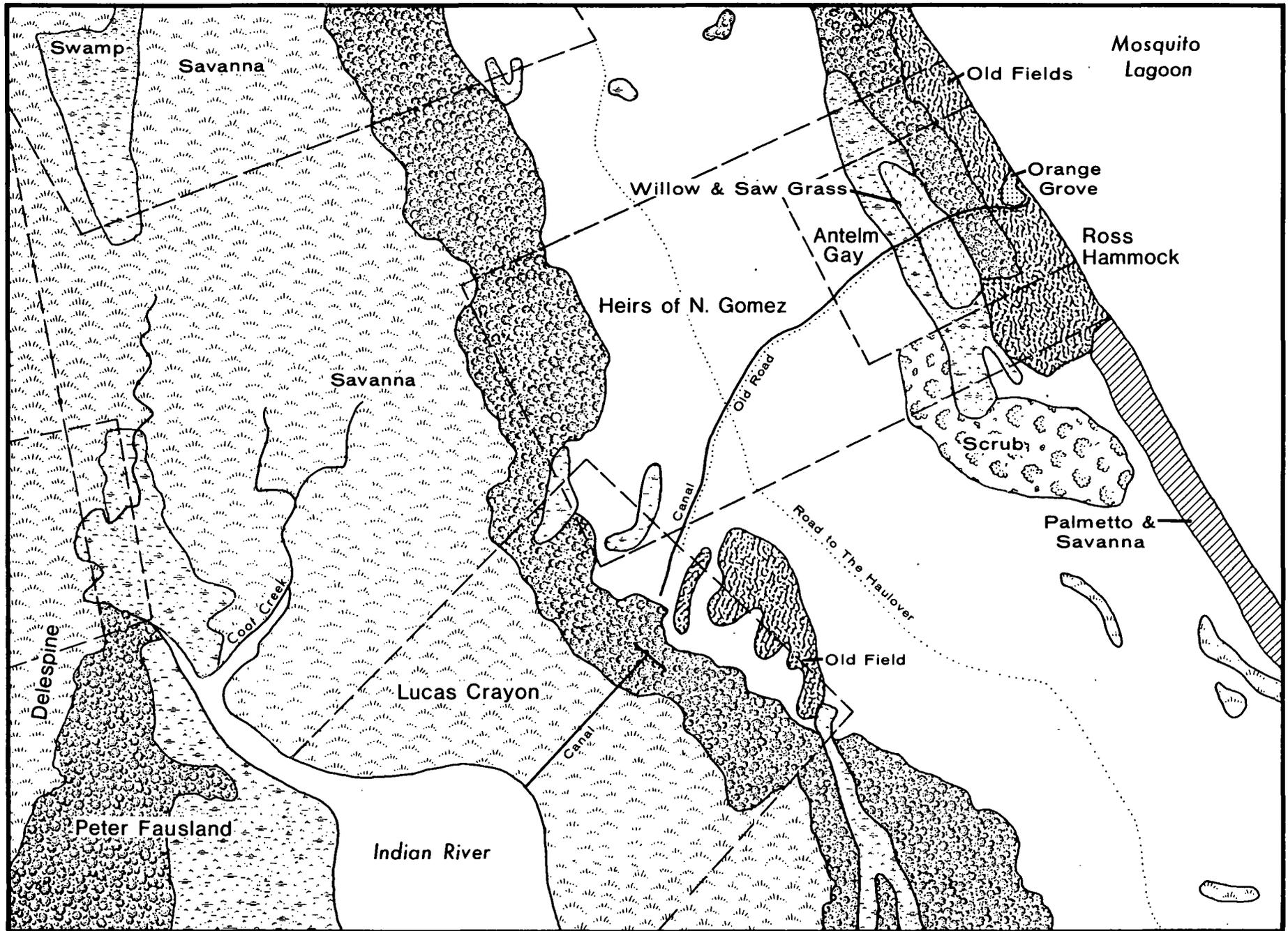
lay at the head of the Indian River, very near the Ellicott plantation area. A plat prepared in 1818 showed cleared land, canal and road, with no indication of how long they had been in existence. Reyes sold this to Lucas Creyon in 1821. Ruins on this property were undoubtedly associated with sugar production (Cultural Resources Management, Inc. 1978). An 1852 plat from General Land Office Plats illustrated all three grants (Figure 5).

From 1811-1813, the East Florida Rebellion caused the plantations to be abandoned. Mattair and his family left their Ross Hammock plantation and Reyes joined the Spanish militia. The property survey maps of 1815 and 1818, however, indicate that Mattair returned. After Florida became a U.S. territory in 1821, Spanish planters may have remained. Yet, neither Mattair nor Reyes appear in the 1830 census and the plantations were certainly abandoned by 1835, when hostile Seminole Indians during the second Seminole War destroyed all the coastal plantations (Cultural Resources Management, Inc. 1978).

Cattle ranching was one of the longest Spanish legacies left to East Florida. These were introduced along the St. Johns River during the first Spanish colonial period, and were common throughout the East Florida wildlands by 1835 (Motte 1835). By 1860 there were 18 ranches along the St. Johns River from Jacksonville to Lake George, and a few in the Brevard County area (Akerman 1976). These ranches maintained cattle on open range, starting a tradition which lasted in Florida for a century. Following their introduction, annual burning of the longleaf pine/wiregrass flatwoods and marshes of the St. Johns River has been associated with free-ranging cattle.

The Mosquito Lagoon was sparsely settled if at all, from 1830 to the 1880's. Several attempts to resettle were made, but were curtailed by wars. Logging, particularly of live oak and pine, was especially important during this period. A shift from the large plantations of the previous century to smaller establishments centered around the production of citrus. Acreage planted to citrus replaced some hammocks, but scrub and high pine flatwoods were usually used for this purpose. Farms and logging operations were abandoned during the Seminole and Civil wars. The major transportation form was by

FIGURE 5. Vegetation of Ross Hammock area, 1852 (after General Land Office Plat of Township 19 South, Range 15 East. Bureau of State Lands, Tallahassee, FL. (Cultural Resources Management, Inc., 1978)



boat until the first railroad reached Daytona in 1883. Settlements on the lagoon were largely isolated, and the lack of rapid transportation or communication made them prime targets during war.

American Territory: After the United States purchased Florida, the government made efforts to survey the land and encourage settlement. Three surveys and descriptions of the peninsula were published shortly after purchase. John Le Conte, a U.S. Army captain, led an expedition down the St. Johns River in 1821 to locate its source. A more accurate and detailed description of the territory was provided by Charles Vignoles. This report describes New Smyrna as abandoned, the lands along the Mosquito Lagoon and Indian rivers as fertile, and relates:

"Nearly all the good lands between this place [the haulover between Mosquito Lagoon and the Indian River] and Spruce creek northwardly have been granted away, but the location of them is not so certain: from the nature of the ground the tracts lie in two parallel lines; the front on the Hillsborough River and Mosquito Lagoon forming one range, and Turnbull's back swamp the other: this latter is situated back a few miles, extending from Spruce creek and gradually shaping its course to the head of the Indian river."

(Vignoles 1823: p. 41)

Only grants made by the U.S. government were recognized in Vignoles' report, and allusions to Spanish grants along the lagoon suggest that they were abandoned yet claimed at this time. Vignoles also noted large quantities of sugar being produced on the old Ross Settlement on Mosquito Lagoon, and stated that New Smyrna was abandoned in 1823.

The third report, published by Dr. William Simmons (1822) draws information from previous reports, adding that:

"the hammocks along the Musquitto, Tomoka, and other rivers and inlets further south, are through by competent judges, to be peculiarly adapted to the cultivation of sugar, and afford also considerable bodies of live oak."

(Simmons 1822)

The most significant events during this period centered around the hostilities of the second Seminole War (1835-1842). After being defeated in north-west Florida during the first of these wars (1818) and following purchase of

the territory by the United States, the Seminoles moved south into less accessible parts of central Florida (Hudson 1976). There, they lived off the land and tended cattle abandoned by the Spanish (Akerman 1976). After being threatened with forced emigration, the Seminoles attacked and killed about but three of a company of 113 soldiers in December 1835. The U.S. government sent troops to Florida, which were unable to remove the Indians. The Seminoles were widely scattered in central Florida at this time, and systematically began destroying all frontier settlements in addition to fighting military forces. New Smyrna and plantations along the Mosquito were attacked and burned in 1835-1836, and not reoccupied until 1842 (Volusia 1888).

A company of troops under Colonel Pierce was sent in December 1837 from St. Augustine to establish a fort at the haulover between Mosquito Lagoon and the Indian River. The company passed along the coast into Mosquito (Ponce de Leon) Inlet, through abandoned New Smyrna, and down the lagoon to the haulover. Dr. Motte, an accompanying army surgeon, kept a journal that described the lagoon's landscape:

"The first half of our way, we had to thread our course through a labyrinth of low mangrove islands, partly inundated, and inaccessible, and packed in closely upon each other, being separated by innumerable narrow and shallow channels, their width barely sufficient in some places for the passage of our boats. The scenery was anything but prepossessing; nothing by the dried and tangled limbs of dead mangrove trees, which had been all killed by a frost during the severe winter of 1835...."

(Motte 1837: p. 156)

Further south, along the lagoon's western shores, he notes:

"The shores lay in all the wildness of nature; in some spots towering forest rose; the perennial palmetto -- the russett-trunked pine -- the silver shafted water oak, and a variety of other trees proudly tossed their high heads in the wind; as if defying the usurpation by us of their dominion, which for ages they had held in undisturbed possession. In other spots,

'Vast plains, spread out on every side,
Stretch to the sloping skies.'

These were covered with a tall rank grass, or prairie reed; presenting a sea of grass in one unbroken expanse.... Nothing obstructed the eye, save here and there a melancholy looking palmetto tree relieved in solitary grandeur against the blue sky on the horizon."

(Motte 1837: p. 15)

His description at the site of the haulover camp:

"The site of our camp was an open prairie, upon a strip of land, which may easily be found by looking on any map of Florida, presenting one unbroken expanse of scrub-saw-palmetto from two to four feet high, an entirely bare of trees, except where here and there a palmetto tree waving high, tossed its umbrella-shaped head in sulky loneliness... its [the Indian River] opposite and distant shore presenting a wilderness of cypress and pine forests, sacred from the invading plough share, or the axe of the woodman."

(Motte 1837: p. 161)

Fort Ann was built that winter to protect the east coast supply route. The posts at Mosquito, Volusia and Fort Mellon were vacated during the summer "on account of their unhealthy positions," a reference to mosquito-transmitted malaria and yellow fever (Motte 1837). Fort Ann was not reoccupied (Cultural Resource Management, Inc. 1978).

In addition to describing the fort's construction, Motte describes a large fire that was set to clear a firing range:

"In order to clear a sufficient space for drilling the Col turned out the whole regiment and had the prairie set on fire on all sides. I never beheld a more magnificent spectacle. The flames appeared to rise to the clouds, and all nature seemed to succumb to the fiery tempest. Not the least sublime or beautiful were the varied hues of the dense columns of smoke that obscured the light of the sun. The most beautiful wreaths of all the varied hues of the rainbow would detach themselves from the dense mass of lurid black vapour, and float into mid-air, undergoing changes that vied with the most beautiful phenomenon. Then as a sudden gust of wind would dispel the smoke, a gorgeous ring of smoke would appear to girt the horizon many miles distant, progressing northwards, sithering every living thing in its path, from the gigantic pine to the smallest shrub."

(Motte 1837: p. 167)

Abandoned New Smyrna was purchased by two officers of the Seminole War, Colonel Andrews and Major Lytle according to John Lee Williams (1837). William's publication was generated to encourage the territory's settlement, and outlined the topography, civil and natural history, climate, Indian tribes and verified claims. Williams described the land between the head of the Indian River and Mosquito Lagoon, as well as several of the larger islands within the lagoon to the south of New Smyrna:

"Bissett's Island is a low narrow island situated in the northwest side of Hillsborough lagoon. It is eight miles long, but contains very little good land. It is surrounded by hundreds of small islands, which fill the Hillsborough, from New Smyrna to Ross's old plantation, a distance of fourteen miles...."

(Williams 1837: p. 43)

"McDougal's swamp commences, where Turnbull's ends, there is only a narrow grass savanna that separates them. This swamp embraces the heads of the Indian River; and it extends in length on the west side, at least thirty miles, on the east side it terminates in a hammock, west of Ross place, about fourteen miles from its commencement."

(Williams 1837: p. 140)

Williams notes the Ross plantation, on the east shore of Coot Creek, as being between this creek (at the head of the Indian River), and wetlands of the Gomez grant. He noted that eastern Florida lands south of Mosquito (Ponce de Leon) Inlet had not been surveyed, but that it was desirable that the abandoned plantations be reoccupied by an industrious and enterprising population. He advised immigrants in the wise choice of lands in the New Smyrna area:

"All the lands for forty miles north and south of Smyrna, lying parallel with, and from two to three miles from the coast, are of an excellent quality. Near the shore they will produce good Cotton and fruits, but are too thin for sugar in their present state. At four and five miles from the coast, the soil becomes poor by constant fires, which destroy all the herbage several times each year....
...In selecting land in Florida, the Islands and sea coast, produce the best sea island or black sea cotton. Hammock and swamp lands produce the best corn and provisions. A clayey or marly soil is best for cane.

Pine lands, on a substratum of clay, are among the most valuable in the Territory. Many of the swamps have the riches and most inexhaustable soils, but the expense of clearing and ditching these is very great. Hammocks usually occupy high and pleasant situations, on the borders of rivers and lakes, delightful sites for country residences. Most of our pine lands change to hammocks when they are preserved from the ravages of fires."

(Williams 1837: pp. 301-304)

Seminole uprisings became less frequent after 1837 and the war was declared over in 1842, although Indian attacks occurred in the area as late as 1856. Attempting to resettle the area, Congress passed the Armed Occupation Act, which offered up to 160 acres of government land in Florida anywhere south of Palatka to any man over 18 who could hold it against Indians for seven years. Many took advantage of this offer, but abandoned their claims with renewed Indian hostilities. The original entries of these claims were lost in the 1850's, when the U.S. land office moved from St. Augustine to Gainesville (Ranson ca. 1900). One of the few known to have settled during this time was Douglas Dummet, who was granted a permit (dated March 16, 1843) to lands near Fort Ann, and was one of the few who probably did not abandon his claim during the Indian disturbances (Cultural Resources Management, Inc. 1978).

Florida Statehood: Florida became a state in 1845, but precarious settlement attempts continued without major success. Boats remained the primary transportation mode, although roads by now connected the Canaveral area to settlements along the St. Johns River. A canal was cut at the haulover between Mosquito Lagoon and the Indian River, allowing intracoastal travel in 1854 for crafts of shallow draft.

Major events affecting the landscape during this period were associated with logging for ship timbers. This activity started during the British period (1763-1783) when men from the Bahamas arrived at Mosquito Inlet to cut live oak, camping near the present-day lighthouse. Charles F. Sibbad obtained a mill grant in 1816 for 4000 acres in Turnbull Hammock, just north of the Seashore boundaries (Hebel 1950). Considerable live oak still occurred in the Mosquito area as documented by Le Conte (1822) and Vignoles (1823); however, oak at the mouth of the St. Johns River had by then been thoroughly cut over.

Swift family men were most actively involved in live oak cutting along Mosquito Lagoon, began plying the trade soon after the War of 1812, and were major suppliers to the rapidly growing U.S. naval fleet. The Swifts also built ships and were heavily involved in whaling. Earliest reference to these Mosquito area live oak operations were given by Audubon in 1831, who sailed past "Live Oak Landing" on the Halifax, north of present-day Ponce Park (Ford 1969).

The Swift holdings on the Halifax and Tomoka rivers were supervised by Elijah Swift and totaled 23,588 acres, most of it fronting the Halifax (Hebel 1950). Brother Reuben was in charge of Hillsborough operations (Hebel 1953). Some shaping of timbers took place at a milling site on Ship Yard Island near Turtle Mound. Boats were built here during the Civil War, possibly using materials left by the Swifts (Hebel 1950). No land grant or logging rights records were found concerning the Swift operations on Mosquito Lagoon, although it is widely known that live oak was removed from the area. Oak Hill, just north of the present-day Seashore boundaries and on the lagoon's west bank, was a major depot for transporting hewn live oak. To access the lagoon, a straight

road was cut to Bill's hill, running due west through Turnbull Hammock to Blue Ridge. A second road running north-south several miles in either direction, bisected the hammock. Logs were hauled to Bill's Hill by oxen, loaded onto barges, and floated down the lagoon by way of Eldora, Raggedy Gap and Turtle Mound, reaching Live Oak Bend at New Smyrna. There, the loads were loaded onto sailing vessels and distributed to U.S. Naval Yards (Galbreath n.d.).

There is some indication the Swifts did not work the area during the Seminole War (1835-1842), but resumed business with the cessation of hostilities (Hebel 1953). Their operations were definitely interrupted by the Civil War, as they barely escaped being lynched when news of the Fort Sumter attack reached the area. In 1862, Confederate sympathizers burned the live oak stores awaiting transport at the Swift docks. Some 40,000 feet of live oak and 2,000 feet of red cedar were reported to have been on the Halifax docks (Strickland 1963). Live oak logging resumed after the war, but only briefly. A tour book of Florida recommends the live oak cutter's camp between Turtle Mound and the Haulover Canal as worth a visit (Rambler 1875). The Swifts returned to their properties in 1868, but left in May 1869 (Hebel 1953), with their operations ceasing around 1875 (Hebel 1950). However, their heirs maintained claim to the live oak lumber on the property as late as 1880 (Strickland 1963). Another suit filed in 1890 in the St. Johns County courts pleaded compensation for large quantities of cedar that were stolen (Hebel 1950).

Live oak poaching was a threat to the nation's store of ship timbers as early as 1826, when U.S. Navy Secretary Samuel L. Southard sent an agent to visit the Atlantic coast. This agent reported that over half the accessible timber (including red cedar) along the coast had disappeared, and that all live oak was stripped for up to fifteen miles inland one mile south of Jacksonville on the St. Johns River and its tributaries. In 1831, Joseph M. White of Florida reported to Naval Secretary Levi Woodbury: "In regard to the detection of trespassers on the public lands, I have first to remark that it is now too late to think of that, as nearly all the timber that was accessible at all, has been cut off." (Strickland 1963).

Civil War: Florida became the third state to join the Confederacy on January 10, 1861 (Ranson 1928), and was an important asset to the Confederate army as a producer of salt, beef, pork and corn. At least three saltworks operated in and around the Seashore. Sand Point, on the Indian River (the present-day town of Titusville) was site of a large saltworks (Ranson ca. 1926). Edward McDonald also made salt at the old Dunlawton plantation north of New Smyrna. Using kettles from the old sugar mill, he boiled salt water from the Halifax River, producing 3000 bushels (Hebel 1955). Ross Hammock was the site of another saltworks, with still another located about two miles north in Oak Hill (Cultural Resources Management, Inc. 1978).

Free-ranging livestock were common in the area during this time, and some local residents made a living catching and taming wild steers for draft labor (Hebel 1955). Livestock were a considerable military resource, more for food than for labor. They were used by Federal and Confederate armies. Confederate armies were supplied with salt, beef and port from the Florida saltworks. Strickland (1963) describes Federal troops collecting free-ranging cattle from the Tomoka area, losing them after they were directed into Turnbull Swamp by a loyal Confederate resident.

During February-March 1862, all principal Florida towns were occupied by Federal troops and the coast blockaded and held until the war's end (Ranson 1928). Although guarded by Union ships at the inlet, New Smyrna continued to be a blockade-run trade point between the Bahamas and central Florida. In March 1862, 43 boat-dispatched troops traveled from New Smyrna south to destroy a saltworks. The details of this exercise are unclear. Some accounts place the saltworks 15-18 miles south of New Smyrna (i.e., Ross Hammock), and relate that after their return from the exercise, the troops were attacked by Confederates (Cultural Resources Management, Inc. 1978). However Hebel (n.d.) places the saltworks only 10 miles south (i.e., closer to Oak Hill) and notes that the Federal troops never reached their destination because water in the lagoon was too low and they were attacked beforehand by Confederates. In July 1863,

several warships entered the lagoon and shelled New Smyrna. Some shells passed over country four miles away (Volusia 1888). Hostilities continued for two days, with 289 shells expended into the woods. Houses were gutted and set afire (Hebel n.d.). This could have been a source of wildfires, although no mention of this was found in any account.

Post-Civil War Expansion: Florida was under military government from 1865 until civil government was restored in 1869. Small communities began with the planting of citrus. The preferred fruit type was sweet and much less frost-tolerant than previously planted sour oranges of the Spanish. Freezes in 1835 and 1884 devastated these plantings, leading to replanting with seed. This devastated many small farmers who could not wait for new plantings to mature.

Douglass Dummett grafted buds from sweet orange onto standing sour orange trees, producing frost-resistant varieties. These survived the 1835 freeze, were used to restock the area, and with wide adoption, this technique formed the basis of the Indian River citrus culture (Strickland n.d.). This advance increased security for small farmers, and many moved into the area after the Civil War. Eldora and Shiloh were among the many small communities founded around the citrus industry during this period.

The citrus industry and dependent population received another boost with development of better transportation. By 1887 the inland waterways of the Floridian east coast were connected by canals and made accessible by steamboat. From 1885-1895, a network of railroads was constructed throughout the state (Ranson 1928), with the most extensive coastal railroad being built by Henry M. Flagler. Using existing lines, Flagler extended the Florida East Coast Railway (FECR) from Jacksonville to the Keys, reaching Daytona in June 1883, and New Smyrna in November 1892 (Harris n.d.); an earlier line had serviced the city (Volusia 1888). The FECR continued south through Oak Hill and was hauling fruit from Cocoa by 1893 (Harris 1964).

The FECR railway lay less than a mile west of Bill's Hill (Figure 6). The area's pine was thoroughly cut over to fuel the locomotives:

"The motive power roster of the FECR started with a group of small wood burning locomotives. The wood was stacked at various points along the track and the engineer left a 'wood ticket' which the supplier of the wood presented to the railroad for payment. In those days, wood could be obtained for as little as \$2.25/cord. Early records show that in 1898 a train on the FECR averaged 56 miles to the cord and that year the road consumed a total of 15,305 cords. Beginning in 1900, when the supply of pine nearby was exhausted, all locomotives were converted to coal."

(McDaniel 1978)

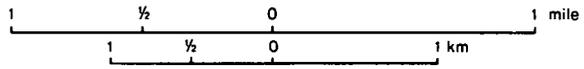
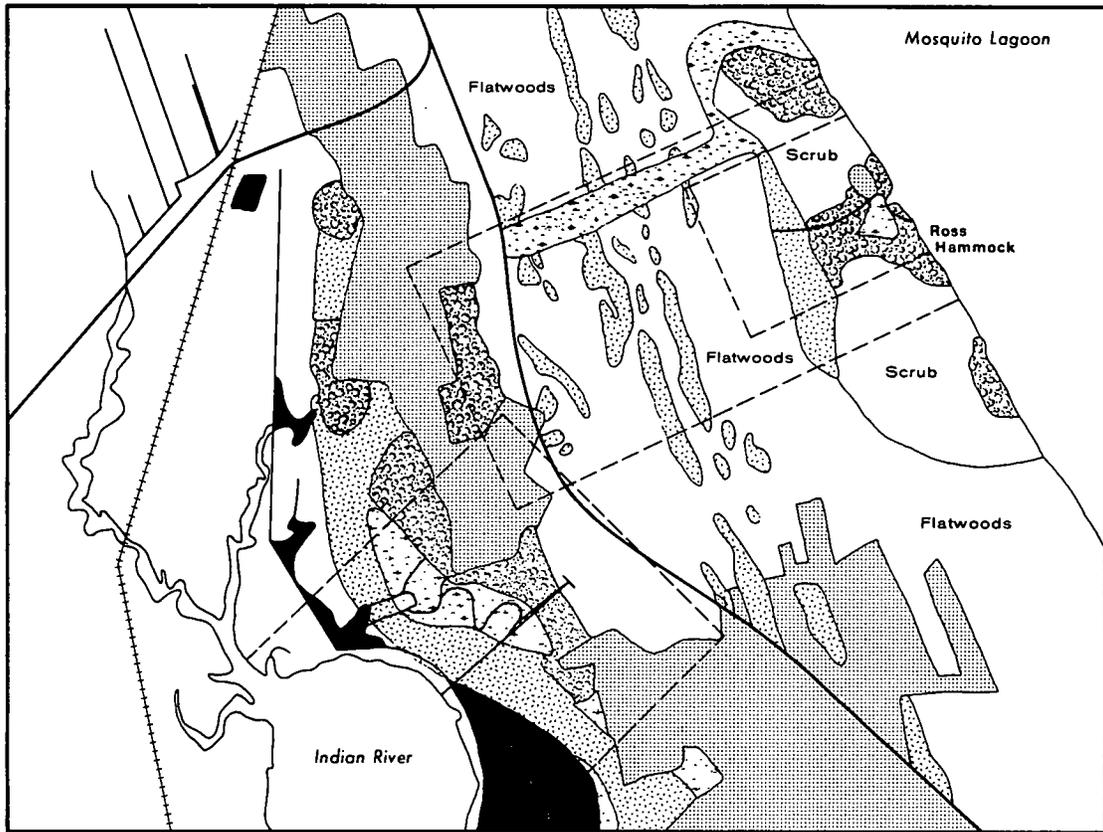
This may have been the first time that pine flatwoods west of the lagoon were cut over, although selective cutting probably occurred earlier.

Modern Era: The Seashore's landscape, especially west of the lagoon, has been heavily modified since 1900. Wetlands were drained, impounded, and sprayed for mosquito control. Flatwoods have been cut over several times, with selective cuts made in some hammocks. Roads built to access timber further drained the area. Much of the upland acreage has been planted to orange groves, vegetable and cut flower crops. Cattle and hogs ranged the area until 1925 and in selected parts until 1947. When NASA purchased properties south of the Seashore at Black Point in 1962, cattle were found. Hogs still range some of the hammocks around Cape Canaveral. The frequency of human-caused fires has varied greatly over the last 80 years with changing use of the landscape.

Pines in the Seashore area have been cut over at least twice since 1900. Cores taken from pines at Bill's Hill and along State Road 3 showed the majority of mature pines to be about 30 years old, with smaller numbers from 40-60 years old (Table 2). Ross Hammock pines (Site 10) were somewhat older, being from 45-70 years old; one large pine was over 115 years old. Very few immature pines occupy stands west of the lagoon. Mature pines in Eldora Hammock were of more varied age, from 25-99 years old. Several stands of immature pines grew in this hammock, seemingly clustered around old home sites. Ring counts and core widths taken from Eldora indicated considerable clearing from 1925-1945.

Ray Goodyear, a local resident, recalled a Mr. Vonidor who thoroughly logged pine from the Bill's hill area south during the 1950's: 1951 NASA photos show pine that does not appear in the 1958 series. USDA photo series

FIGURE 6. Contemporary vegetation of the Ross Hammock area (after Stout 1978).



- | | |
|-------------------|---|
| — Highway |  Hammock |
| — Railroad |  Swamp |
| — Canal & Ditches |  Marsh |
| ■ Impoundment |  Orange Grove |

from 1943-1984 also show few pines in the area around Haulover Canal. Pine was cut from Merritt Island during the early 1940's. A state forestry project was obtained for the north part of Merritt Island and involved a fire protection plan and planting of pine. R. A. Barry, the Island's landowner R. F. Roberts a homesteader near Orsino, and I. Novels and T. I. O'Flannigan, local businessmen, were responsible for obtaining the project. The first fire control measures consisted of using a giant ditching machine to plow wide firebreak ditches around the properties. The ditches were to serve drainage as well as fire protection needs (Star Advocate: 11 April 1941). A local resident claimed that Brevard County Commissioner Barry used the ditching machine for road-building, in order to access pine stands for timber cuts on Merritt Island (Futch interview). Several reports of timber poaching during this time involved pine primarily. The Manning brothers poached timber from Eldora, according to historical research of Ann Towner (CANA research files); Slim Wenzel of Eldora also recalled pine poaching during the 1940's.

In addition to pine logging, some hammocks along the lagoon's west shore were selectively logged during the 1920's for hickory and oak. This was used to manufacture automobile wheel spokes. This need soon ceased with the introduction of metal spokes (Wilkinson interview).

Extensive mosquito control began in Volusia and Brevard counties in 1946. The Star Advocate (Titusville), in a March 18, 1947 article, detailed water control in the Cak Hill area that was implemented by an eight mile ditch draining into the north Indian River. Massive amounts of DDT were used for mosquito control from 1946 into the 1950's. In 1952 238,770 gallons of DDT were sprayed over Brevard County alone (Star Advocate, 20 January 1953).

Orange groves replaced much of the upland scrub and hammock vegetation between the lagoon and the Indian River, from Cak Hill to the Haulover Canal (Figure 6). David Taylor Sr. who came to the area in 1898, was a major planter of groves in Shiloh. Most groves now in the Seashore existed by 1950 (Boyd interview) and many groves appear in the 1943-51 USDA aerial photo series.

Two areas were developed for flower and vegetable crops. The Gilmore

Table 2. Slash pine (*Pinus elliottii*) size (diameter at breast height) and increment bore ring readings for fourteen sites in Canaveral National Seashore. Sites are numbered for reference to the map shown in Figure 1.

ELDCRA AREA			BILLS HILL AREA			STATE RT. 3		
SITE	DBH	RINGS	SITE	DBH	RINGS	SITE	DBH	RINGS
1	71	59 +3	4	39	34	11	28	60
	47	58		34	33		53	51
	41	50 +3		43	30		53	50
	48	47		41	28		36	27
	61	42		33	27			
	45	41	5	44	31	12	59	63
	56	33		38	29		42	50
	19	31		33	29		37	48
	23	25						
2	56	99	6	42	50	13	58	63
	57	75		34	50		49	58
	44	60		31	32		47	48
	43	57	7	49	28	14	54	50
	60	55		32	27		61	37 +3
	43	55		35	23			
	59	51						
	45	48	8	63	53			
45	34	49		33				
		45		28				
3	45	84		33	24			
	37	71	9	37	44			
	36	66		31	39			
	32	33 +3		39	29			
			10	86	118			
				59	70			
		40		65				
		67		61				
			46	46				

Plant and Bulb Company produced paper narcissus, gladiolas, potatoes and cabbage on Merritt Island (Star Advocate, 29 October 1943). George Brockett had over 100 acres in gladiola bulbs and floral fern. The Brockett farm was located northwest of Wilson (Figure 1), just north of the present-day Canaveral Seashore headquarters on State Road 402 (Benecke and Boyd interviews).

Cattle and hogs free-ranged lands west of the lagoon and on Merritt Island until the Brevard County Free Range Law of 1925. This required livestock to be restrained within the owner's property, and many local residents reacted by transferring hogs and cattle to unpatrolled beach strand hammocks (Boyd, Futch, Watton and Wenzell interviews). Hogs in the Eldora woods during the 1940's had distinctly different patterns than those ranging hammocks (and still occurring) around Cape Canaveral. The Eldora hogs were hunted out during a railroad strike when men camped in that area (Wenzell interview). Livestock fencing was not mandated in Volusia County until 1947 (Galbreath and Boyd interviews). Frank Darden maintained cattle at Black Point, running them from State roads 3 and 406 to the edge of the point (Boyd, Futch and Benecke interviews), until his land was purchased by the government in 1963.

Fire frequency has varied during the 20th Century, primarily in response to changing livestock policies. Marsh, pine and scrub were burned over at least annually to provide better livestock range at the turn of the century. Range was burned from November-February after the growing season. March was not considered a good burning month because winds were too high and fires could become intense. Annual range burns ceased in 1925 in Brevard County, and after 1947 within the northern section of the Seashore, except for properties surrounded by water or other wide firebreaks. Frank Darden burned the Black Point marshes at least annually until the property came into federal hands (Benecke, Boyd, Futch, Galbreath and Watton interviews). After deliberate wildland burning was prohibited, brush grew up and fueled intensive drought fires ignited by lightning, arson or accidentally set.

Brush fires, common in the area before the NASA purchase, were particularly severe during droughts. Intense brush fires burned lands south and west of

the lagoon in the early 1920's and in 1944 (Boyd and Watton interviews). Two men were killed fighting a fire south of Shiloh in 1944 when flames jumped State Road 3 (Star Advocate, 24 January 1956).

Controversy between the cattle and timber industries over the use of fire in landscape management became heated during the early 1940's. Lumber companies began purchasing and fencing vast pineland acreage that heretofore had been used for free-range. Annual burning for cattle range was considered a threat to timber resources and was condemned. Fire suppression was proposed by the timber industry (Star Advocate, 7 October 1941). The fire protection program proposed for Merritt Island followed this policy. Intense fires that accompanied droughts during the early 1940's strengthened the anti-burning advocacy. Laws that prohibited deliberate ignition of wildlands (unless the owner wanted to burn off his/her property and kept the fire from spreading to adjacent ones) were passed by the mid-1940's. Embittered cattlemen, prohibited from burning range and faced with fenced off lands that had been open, often resorted to arson. Most cattlemen eventually went out of business because they could not afford to own the large tracts their herds needed for range (Stoddard 1963). None of the persons interviewed during this study recalled any major fires in the Seashore area during the 1950's although the local newspaper termed 1955 as a relatively heavy fire year. This may reflect the diminishing numbers of free-ranging cattlemen, a major source of fire ignitions.

According to interviewees, fires commonly occurred in beach strand scrub and palmetto, but these were ignored since they threatened neither houses nor communities. Many fires were started when the beach strand was used as a bombing target during World War II (Cardwell, pers. commun.). One fire during 1940 or 1941 burned the entire beach strand from near Coronado (near New Smyrna Beach) to the Cape. The Coast Guard maintained telephone poles along the palmetto strand, more than half of which were lost. An underground cable replaced this line after the fire (Boyd and Wenzell interviews).

NASA Purchase of Lands: The contemporary vegetation of a large part of the

Seashore was mapped by Stout (1978), a portion of which appears in Figure 6. Two reference stands in that study measured the canopy species in Ross Hammock and the pine flatwoods around Bill's Hill (Tables 3, 4). Ross Hammock was dominated by laurel oak and cabbage palm. Live oak occurred in low density. The only tree species larger than one inch (2.5 cm) in diameter at breast height in the flatwoods was slash pine and this occurred in low density. The contemporary vegetation map shows scrub north and south of Ross Hammock, corresponding to areas labeled as "old fields" in the 1852 plat (Figure 5). The old orange grove near the lagoon's shore, which appeared in the 1852 map, may have been that claimed by Bisset; it is shown on a 1983 USGS topographic map. This grove and drainage ditches at the head of the Indian River were added to Figure 6, using the USGS map for locations.

The Seashore's fire records for 1970-1984 were collected from Canaveral National Seashore files. These included a summary of NASA Fire Services activities from 1970-1977 and fire reports filed by Merritt Island National Wildlife Refuge (USFWS). Summarized fire record data appear in Table 5.

In the past 15 years, 85 fires have been recorded for the Seashore area. Nine of these were prescribed burns. Sixteen occurred in 1981, eleven between June-August (Figure 7). The fire season shows two peaks, the most pronounced being from January-April, with a second from June-August. About 40% of non-prescribed summer fires occurred during the summer drought of 1981 (Figure 7). Lightning fires were most common in June-July, accounting for 26% of non-prescribed fires. Fires known to be caused by humans or machinery accounted for 38% of non-prescribed fires and occurred all seasons, although most frequently during the dry winter period. Fires of unknown cause also occurred most frequently during the dry season, accounting for 36% of non-prescribed fires. Lightning is uncommon during this time, thus, these fires were probably ignited through human activities (Figure 8). Most fires (83%) in the Seashore have burned less than six acres. Eleven fires have burned more than 20 acres, all of that occurred from June through August took place in 1981. Large fires have also burned in February and March (Figure 9).

Although there were four prescribed burns in the Seashore area before the summer of 1981, prescription burning was not a major component of the fire management plan until after that year. Following a year of devastating wild-fires, the Merritt Island National Wildlife refuge began an intensive program of prescribed burning. Aerial ignition combined with backfires to protect sensitive areas, has reduced fuels throughout the refuge under a rotation of 2-3 years between burns. Since 1981 the entire area west of the lagoon under joint jurisdiction of the U.S. Fish & Wildlife Service and the National Park Service has burned over at least once and at some sites, three times.

Table 3. Density, frequency and basal area of tree species
in Ross Hammock, Summer 1976 (Stout 1979).

SPECIES	No. Per 100 M2	Frequency %	Basal Area cm 2/ 100 m2
<u>Quercus laurifolia</u> var. <u>hemispherica</u>	2.19	76.66	1993.31
<u>Sabal palmetto</u>	2.26	73.33	1314.12
<u>Quercus virginiana</u> var. <u>virginiana</u>	0.38	13.33	718.16
<u>Carya glabra</u>	1.03	50.00	596.63
<u>Magnolia grandiflora</u>	0.97	30.00	95.86
<u>Juniperus silicicola</u>	0.12	6.66	58.81
<u>Osmanthus americanus</u>	0.12	6.66	4.49
<u>Ilex vomitoria</u>	0.58	13.33	4.15
<u>Morus rubra</u>	0.06	3.33	1.21

Table 4. Density, frequency and basal area of tree species in
 Bill's Hill pine flatwoods, Summer, 1977 (Stout 1979).

SPECIES	No. Per 100 M2	Frequency %	Basal Area cm 2/ 100 m2
<u>Pinus</u> <u>elliotti</u> var. <u>densa</u>	0.99	100	576

Table 5. Records of fires occurring within the Seashore 1970-1984.

DATE	LCC CODE	SIZE CODE	CAUSE	SOURCE OF RECORD	
03-15-70	1	1	-	FWS	
04-15-70	2	1	-	FWS	
11-05-70	2	+	-	FWS	Location Codes:
01-20-71	1	-	acc	NASA	1- W of lagoon, N of Haulover
02-10-71	1	-	-	NASA	2- W of lagoon, S of Haulover
03-10-71	1	-	-	FWS	3- E of lagoon, N of Old Coast Guard Sta. & lagoon islands
03-14-71	1	1	310	FWS	4- Playalinda
03-19-71	3	1	-	FWS	
03-20-71	1	+	-	NASA	Fire Size Codes (acres):
03-31-71	2	-	-	NASA	- no record
04-15-71	1	5	-	FWS	1 >0 - 1
04-16-71	2	1	-	FWS	5 >1 - 5
11-10-71	2	5	-	NASA	20 >5 - 20
02-22-72	1	1	-	FWS	+ >20 - 100
08-07-72	2	1	101	FWS	++ >100
08-09-72	2	5	-	FWS	
04-28-74	4	-	-	NASA	
09-02-74	4	1	-	NASA	Fire record sources:
09-29-74	2	-	-	NASA	NASA - NASA Fire Services
10-21-74	1	1	-	NASA	records from CANA
11-29-74	2	1	-	NASA	research files
05-27-75	2	1	-	NASA	
01-17-76	2	1	930	NASA	FWS - Merritt Island Natl.
01-28-76	2	-	-	NASA	Wildlife Refuge fire
01-30-76	2	-	-	NASA	records
02-02-76	2	-	-	NASA	
02-09-76	2	++	310	FWS	NPS - CANA fire records
02-10-76	1	+	310	FWS	
02-10-76	1	++	605	FWS	
02-18-76	1	5	519	NASA	
06-12-76	4	1	-	NASA	
07-23-76	1	-	-	NASA	
03-18-77	4	1	-	NASA	
03-18-77	4	1	430	NPS	
04-08-77	4	1	827	NPS	
07-19-77	4	1	930	NASA	
04-16-77	4	1	930	NPS	
05-27-78	4	1	930	NPS	
06-13-78	1	5	517	NPS	
07-04-78	4	1	101	NPS	
11-21-78	3	1	519	NPS	
02-20-79	1	1	517	NPS	
05-28-79	4	1	101	NPS	
07-12-79	1	20	101	FWS	

Table 5, continued. Records of fires occurring within the Seashore 1970-1984.

DATE	LOC CCDE	SIZE CCDE	CAUSE	SCURCE OF RECORD
02-08-80	3	1	930	NPS
02-09-80	1	1	930	NPS
02-26-80	2	++	017	FWS
03-10-80	3	1	101	NPS
03-28-80	3	1	930	NPS
04-23-80	2	5	5	FWS
06-09-80	4	1	101	NPS
07-29-80	1	5	101	FWS
12-10-80	3	5	101	NPS
01-15-81	3	1	930	NPS
02-10-81	3	1	930	NPS
02-24-81	1	++	517	FWS
06-11-81	1	20	101	FWS
06-13-81	2	5	519	FWS
06-28-81	1	++	101	FWS
07-10-81	2	++	101	NPS
07-11-81	2	1	101	NPS
07-31-81	1	1	101	FWS
07-31-81	1	1	101	FWS
07-31-81	2	+	101	FWS
07-31-81	2	++	101	FWS
08-08-81	3	1	411	NPS
08-17-81	1	+	519	FWS
10-14-81	1	1	524	NPS
12-17-81	2	5	101	NPS
05-13-82	3	+	521	NPS
06-11-82	1	5	101	NPS
08-27-82	1	1	101	NPS
01-16-83	4	1	209	NPS
03-26-83	1	1	930	NPS
03-28-83	1	1	310	NPS
07-17-83	1	1	101	NPS
07-26-83	4	5	101	NPS
09-09-83	3	++	917	NPS
09-10-83	2	+	917	NPS
09-12-83	4	1	310	NPS
11-07-83	2	1	221	NPS
03-18-84	2	1	519	FWS
04-30-84	3	1	411	NPS
07-27-84	4	1	526	NPS
08-29-84	1	5	917	NPS

Figure 7. Seasonal distribution of fires at Canaveral National Seashore, Florida (1970-1984)

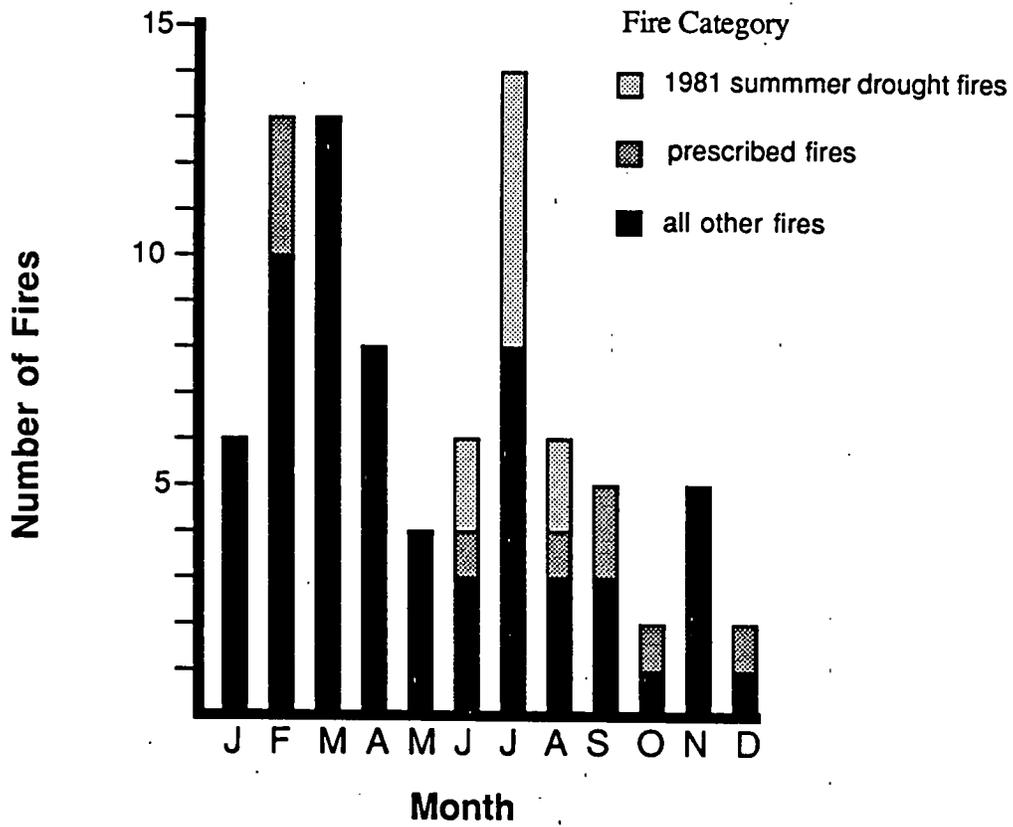
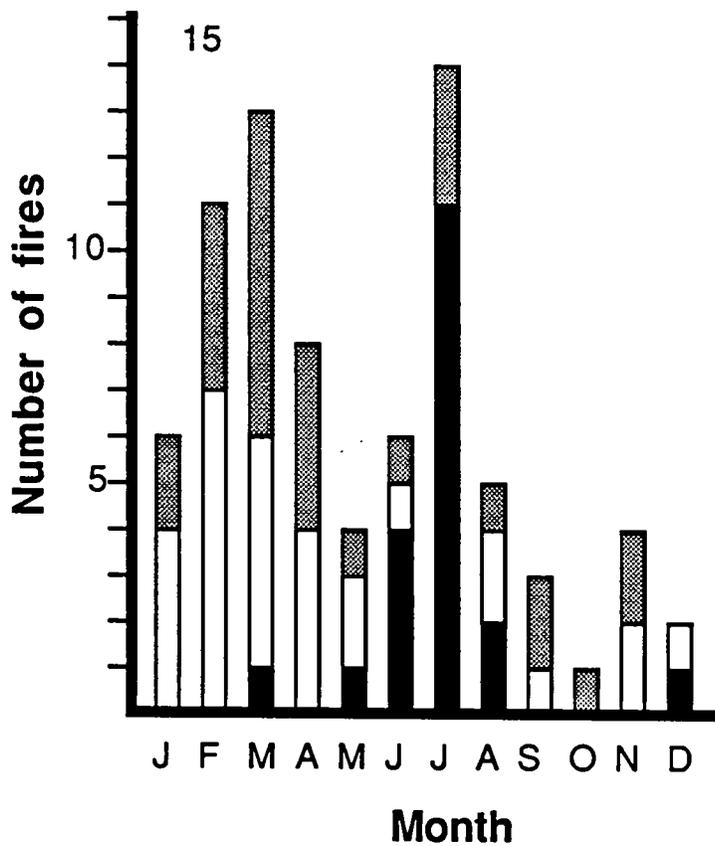


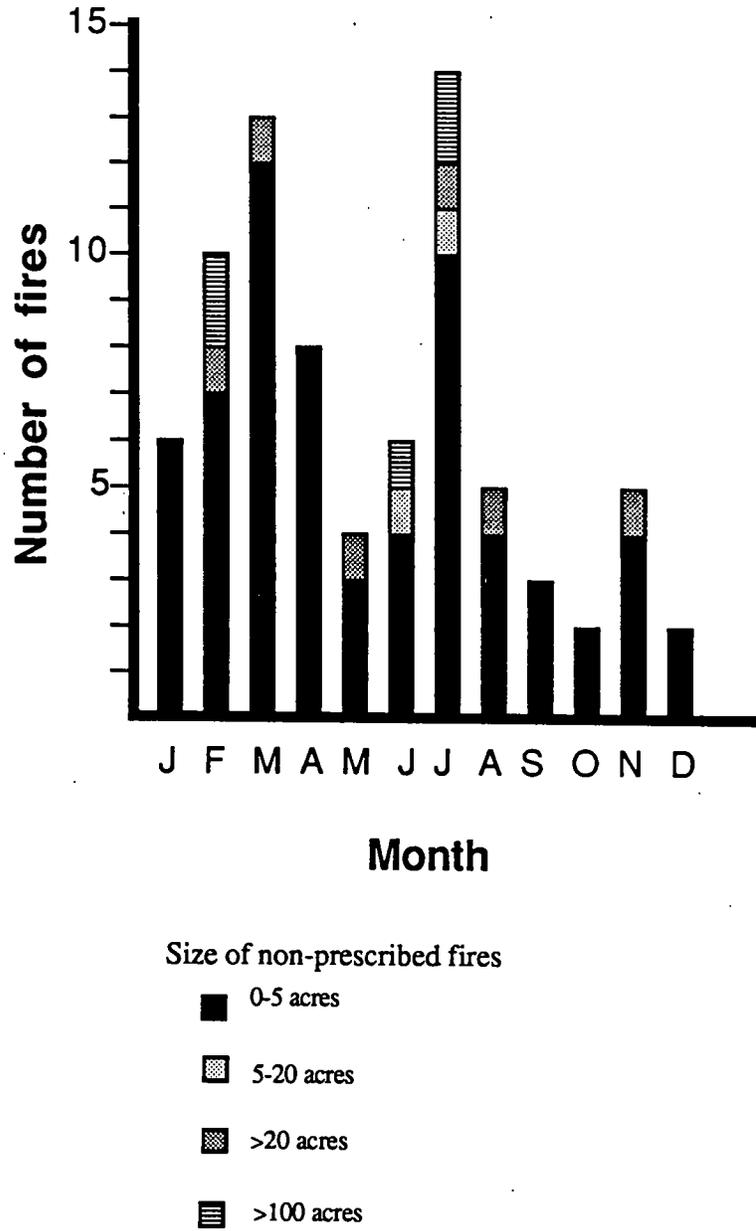
Figure 8. Comparisons of non-prescribed fire causes and seasonal distribution of fires at Canaveral National Seashore, Florida



Cause of non-prescribed fires:

- Lightning
- Human-caused (accidental or arson)
- ▨ Unknown (see Results section)

Figure 9. Comparison of non-prescribed fire size and seasonal distribution of fire at Canaveral National Seashore, Florida



Discussion

The historic record indicates that the Canaveral landscapes, especially lands west of the lagoon, have changed markedly over the last 400 years. Upland and swamp wooded areas dominated landscapes described by Mexia (1605) and DeBrahm (1765). These communities are now much reduced modified in species composition. Conversely, communities of lower profile, such as scrub and marsh, have become more extensive. Major disturbances began during the English colonial period (1763-1779). Woodland clearing (primarily hardwoods) and wetland drainage associated with plantation agriculture occurred in 15-25-year pulses between periods of abandonment of about the same length. Livestock grazing and burning for sugar cane harvest and cattle range improvement further disturbed areas settled by Europeans. As the area became more heavily populated, and with the advent of railways in the late 1860's, pine became more valuable and was repeatedly logged. Removing the pine canopy, with concurrent high frequency of fire, reduced pine dominance in the flatwoods. Extensive drainage efforts and increased frequency of non-natural fire, especially during the dry winter season has, throughout the past 80 years, has continued selective pressure towards disclimax communities of shrubs and grasses.

Canaveral's hammocks have been centers of settlement for every civilization occupying the area. Mexia (1605) noted them as Indian settlement sites. The extent of aboriginal human impact on the hammocks is uncertain, since few direct references occur in historical literature. However, settlement implies some disturbance. Contemporary human impacts on forest ecosystems, noted in several national parks, may provide clues to the extent of this disturbance. For example, at Great Smokey Mountains National Park (North Carolina-Tennessee), human impacts at heavily used campsites included

trampling, inhibition of understory and increases in bare soil (Bratton et al. 1978). High visitation sites experienced soil compaction, reduced levels of soil organic matter, higher tree mortality and canopy opening (Bratton et al. 1982). Heavily visited live oak hammock at Cumberland Island National Seashore (Georgia) developed widening areas of bare soil and inhibition of forest understory, including saw palmetto (CUIS park staff, pers. comm.). Long-term human settlement in Canaveral's hammocks probably had wider ranging impact than observed at national park campsites. Hypothetically, long-term settlement and limited agriculture would affect the development of the hammocks, selecting for widely spaced, large live oaks and a generally clear understory landscape.

Live oak removal greatly affected the hammocks. Mexia's 1605 map (Fig. 3) and the DeBrahm survey map of 1765 (Fig. 4) indicate an unbroken stretch of woods along the west lagoon shore, from the Upton through the Fawcitt grants. This would include Ross Hammock and lagoon hammocks north and south of it. Bisset's property, lying between the two grants, was well-cleared, drained and settled, with a plantation of at least 70 people. The most accessible hammocks along the lagoon were probably logged during the British colonial period. However, before 1822, logging was limited, as Le Conte, Vignoles and Simmons all mention considerable wood resources along Mosquito Lagoon. Yet, when Dr. Motte traveled the lagoon in 1835, instead of live oak, he noted the "silver-shafted water oaks and stately palms." His only mention of live oak was in respect to the New Smyrna ruins. Water oak and live oaks have distinctly dark trunks, so Motte was more likely describing laurel oak with its banded gray trunk and typical inhabitation near water. Although Motte may have been drawn to notice the lighter trunked trees because they were appealing, it is conceivable that laurel oak had replaced live oak in the shoreline hammocks, since these were the first in the area to be logged, possibly as early as 1763. Thus, contemporary landscapes of shoreline hammocks dominated by laurel oak and cabbage palm may have replaced live oak hammock as early as 1835.

Hammocks were further disturbed by domestic stock grazing, especially hogs. Hogs may have become established as early as 1565-1762 due to

shipwrecks, and were certainly present by the end of the British colonial period, being mentioned among the colonists' chattel lost upon retrocession of Florida to Spain. Jonathan Dickinson (1696) stated that while the local Indians looted his wrecked ship, they had no interest in rum, sugar, molasses, beef or pork. When the Indians found and killed a hog, presumably from the recent shipwreck, they offered it to the castaways. There is no record that indicates Indians ate hogs, thus they may have been allowed to roam at will.

Hogs exert selective pressure against live oak, which produces more palatable mast than other oak species common to the area. Since live oak acorns contain considerably less tannin than those of laurel oak, they would be preferentially consumed. After mature live oaks were removed, grazing pressure on live oak acorns may have encouraged establishment of other tree species in the hammocks.

Citrus planting is still another factor causing hammock acreage reduction. Live oak hammocks were the sites of sour orange groves described during the British and second Spanish colonial periods. Groves at New Smyrna described by Bartram (1792) and at Ross Hammock described by Bisset in 1787 (Siebert 1972) were highly prized. During the citrus industry's rapid post-Civil War growth, large areas of hammock were planted to orange. This is especially apparent west of State Road 3 in the Ross Hammock vicinity. The 1852 plat (Figure 5) indicates a band of hardwood forest along marshlands at the head of the Indian River. The contemporary vegetation map (Figure 6) shows most of this now planted to oranges. There are also groves on drained acreage that was marshland on the 1852 plat. Contemporary hammocks west of the lagoon are dominated by sabal palm and laurel oak, although live oak is often present as a subdominant (South 1978).

A similar sequence of laurel oak replacement of live oak following removal of the latter, and subsequent multiple disturbances, has been noted in the landscape histories of Buxton Woods (Cape Hatteras National Seashore, North Carolina) (Bratton and Davison 1985), Fort Frederica National Monument (St. Simons Island, Georgia) (Bratton 1983) and Cumberland Island National Seashore

(Georgia) (Turner, 1984). Laurel oak dominates hammocks where the below-ground biomass was not removed. Although live oak and laurel oaks can reproduce by sprouting, laurel oak appears to have a greater advantage after logging. Hammocks that were cleared, cultivated, then abandoned, developed into scrub.

Other species commonly found in the hammocks are hickory (Carya glabra), southern magnolia (Magnolia grandiflora) and southern red cedar (Juniperus silicicola). Red mulberry (Morus rubra), mentioned by Bisset, occurs in Ross Hammock in low levels (Stout 1978). Slash pine stands were found in Ross and Eldora hammocks and probably became established after some artificial clearing. The oldest trees in the hammocks probably date to the loggings of 1822-1835. The oldest trees dated by this study were pines in Ross and Eldora hammocks, 118 and 99 years old, respectively.

Scrub communities have become more extensive since the arrival of Europeans to the Canaveral area. Mexia (1605) noted two types of scrub in the area: a thorny thicket along the beach strand, and live oak savanna at the narrow isthmus between Mosquito Lagoon and the Indian River at present-day Haulover Canal. Scrub was not shown on DeBrahm's map (1765) nor described in any colonial records since it was of little value to the colonists. As mentioned before, scrub grew up in abandoned fields that had formerly been hammock, as indicated on the 1852 plat map of Ross Hammock. Dr. Motte described the haulover area of 1835 as mainly palmetto prairie. The change from live oak savanna to palmetto prairie indicated some manipulation of the area by that time.

The isthmus was probably the site of frequent fires set to clear the haulover trail between the two waterways, prior to the canal being built. Hardwoods may be removed from scrub and flatwoods by 1-3-year fire rotations if maintained for more than nine years (Wade et al. 1980, Mobley et al. 1978). Short fire rotations select for saw palmetto in upland sites. Saw palmetto reaches highest density in flatwoods and scrub that are burned annually to biannually (Abrahamson 1984). Fire stimulates saw palmetto to sprout from large protected rhizomes and stems; sprouts are the primary method of palmetto

reproduction (Hilmon 1969). Scrub oaks are also maintained by disturbance, especially fire, but need longer rotations.

Fire kills above-ground biomass of most hardwood species. This is normally replaced by sprouts from the rootstock, but fire rotations more frequent than every five years prevent hardwood rootstock restoration, thus depleting their stores and eventually killing the plant. In fire's absence, scrub may mature to hardwood forest or degenerate, depending upon soil fertility (Monk 1967, Monk, pers. comm.). Most scrub occur on infertile soils, where fire acts on the community as a regenerative force, releasing nutrients to the soil that were locked up in dead foliage and litter.,

Scrub dominated by oaks will not normally burn well during the wet summer season when lightning is most common. Webber (1935) described Florida scrub as a fire fighting association, because it did not burn as readily as neighboring longleaf pine/wiregrass flatwoods, although it was ignited as often. Scrub fires are associated with drought, and are usually intense, killing all above-ground vegetation. During summer, however, plants are not usually drought-stressed and since lightning ignitions are normally accompanied by rain, summer fires tend to be small. Summer drought years occur in groups of 3-7 years, roughly every 23 years. Scrub fires during summer drought are exceptionally intense and large, usually burning off all scrub areas. However, the majority of fires within Seashore boundaries (of which most occurred in scrub vegetation) during the past 15 years were human-caused dry winter season blazes. During winter and early spring, scrub is water-stressed and burns readily. But few natural ignition sources are present then, thus winter fires are not natural to native vegetation. When artificially set or promoted, they may affect species proportions and reproductive success unnaturally. For example, most scrub species fruit heavily one year after a summer burn, but irregularly and with little success after a winter fire (Abrahamson 1984). Saw palmetto and switchgrass are among the few species that reproduce well following winter burns; these reproduce by sprouting. Thus, repeated winter burns select against fire-resistant species such as oaks, encouraging fire-

prone species such as palmetto and switchgrass.

Pine flatwoods have occupied much the same areas in all landscape descriptions and maps. Species presence appears to have changed little since 1605, although among canopy species, slash pine has undoubtedly been reduced. Flatwoods were first extensively exploited during the British colonial period harvesting of turpentine and pine tar. Upton grant (Figure 4) and Bisset grant (to the south) flatwoods were turpented from 1767-1779. Flatwoods were also probably logged to some extent, providing lumber for the settlement's buildings. During the second period of plantation agriculture (1800-1820), pine was needed as fuel for boiling sugar syrup and distilling rum. The same equipment and fuel was employed during the Civil War to make salt for meat preservation. Cattle were herded to the saltworks at Ross Hammock to be processed and this may have impacted the hammock and adjacent flatwoods by grazing and trampling. The Civil War's end saw the expansion of railways throughout Florida and from 1870-1900, pine was extensively harvested for this use until depleted. The next two generations of pine were logged for lumber in slightly more selective cuts at Bill's Hill and on Merritt Island. roads were cut through the flatlands and drainage improved. Most pines in present-day flatwoods are 20-30 years old, with a few of 50-60 years that were left due to their imperfect form. All pines found in this study older than 60 years occurred in the hammocks. Very few young slash pines or saplings were observed in the flatwoods, although they were found in the hammocks.

Decline of flatwood pines was in response to multiple disturbances to the community. Turpentine harvest exposed many mature trees to disease and insect infestation. Fires passing through turpented flatwoods killed trees that would have survived but for harvest injuries (Kurz 1941). The flatwoods loggings for fuel were probably non-selective, taking every accessible tree. Pines surrounded by tall hardwoods would have been more difficult to remove than those in more open flatwoods. Later cuts during the 1930's-1950's involved road building and improved drainage of the pinelands. Although these cuts were more selective, leaving gnarled individuals as seed trees, the

drainage created less suitable habitat for pine seedlings. Slash pine reproduces best in wet areas that afford some protection from fire. Slash pine seedlings are fire-intolerant and must be protected until the sapling stage, about five years (Komarek 1974). The only young pines seen during this study were in hammocks. Surrounded by mesic hardwoods, these were relatively protected from fire.

According to British colonial records, wetland swamp forests were much more extensive in that period than today. The British valued these areas as fertile ground suitable for rice and sugar with limited drainage, and for cotton, indigo and maize with extensive drainage. Cypress (Taxodium distichus), which dominated the swamps, was highly prized as a durable, insect- and rot-resistant building material. Early swamp clearing and drainage were probably the greatest impacts to the wetlands. Cypress never reappeared as a dominant, possibly due to the lack of standing water. Where woody succession occurred, willow and maple dominated. These species do not survive inundation as well as cypress, but will outcompete it in drier situations. This pattern was apparent in Ross Hammock between 1765-1852 and from 1852-date. Bisset widened the small stream which ran into the lagoon to a canal that drained the swampy center of Ross Hammock. The canal appears in the 1852 plat as running through an area described as willow and sawgrass, and adjacent to a band of swamp. The contemporary vegetation map indicates marsh and limited swamp along the canal, and a band of swamp about 500 meters north of the canal. The contemporary swamp is dominated by willow and maple, containing no cypress.

Fire may have been a major factor in this successional series as well. The wetlands, drained and planted to sugar cane, were burned annually to facilitate cane harvest. Wetlands have traditionally been used a cattle range and annual burns made the switchgrass more palatable. Today the wetlands are dominated by mangrove, maple and willow in irregularly flooded areas, and by switchgrass in other areas. Cypress occurs in limited areas, usually surrounded by mesic or swamp hardwoods.

The beach strand communities seem to have changed little since 1605.

Descriptions given by Ehrhart (1976) and Kurz (1942) differ little from those of Mexia. The thorny thicket is analagous to backdune scrub, which grades into live oak hammock. In recent history, the backdune scrub has been frequently subjected to fire, which is probably characteristic of the community. Backdune scrub is a primary successional community and is adapted to regular disturbance. Hammocks along the strand are dominated by live oak. Salt stress may inhibit establishment or domination of other tree species in these forests, which also may not have been as heavily logged as the hammocks further inland. Pines existed at the inlet edges in 1605, which Spaniards used as navigational landmarks. Slash pine occurs in Eldora Hammock where the canopy was opened. Although the communities have been impacted by hog grazing, fire and logging, they do not seem markedly changed from their historical counterparts.

Summary

Disturbance History

Historic records of the Canaveral landscapes were compared to contemporary vegetational patterns. Forested communities were reduced over time, while scrub and marsh became more extensive. Hammocks along Mosquito Lagoon's west shore have been heavily modified, primarily through the removal of live oak. Laurel oak and cabbage palm had replaced live oak as a west hammock dominant as early as 1835. Hammock that was cleared, cultivated, then abandoned, developed into scrub. Swamp forest, a major landscape feature in 1766, was drastically reduced by clearing and drainage. The former dominant, cypress, was replaced by willow/maple marsh. Although pine flatwoods have occupied much the same acreage over the last 400 years, slash pine has been reduced from its former dominance. Factors affecting the decline of the flatwood canopy include drainage and frequent fires, which impede establishment of young pines. Communities along the beach strand appear little changed, and today match historical literature descriptions.

Fire frequencies have changed with changing vegetational patterns. Multiple disturbances have selected for disclimax communities presently maintained by fire. Continued short fire rotations will further reduce fire-resistant communities and species diversity within fire-tolerant communities.

Implications for Park Management

Fire has always been an important natural disturbance in the Cape Canaveral region, but anthropogenic burning probably increased fire frequency during the historic period. A complete absence of fire is not natural to the area, but neither is annual burning. The flatwood slash pines are fire-tolerant, as are the strand species. Natural fire rotations will encourage pine recovery, although intense fire should be avoided, especially in areas of

younger trees. Past disturbance has changed the structure of the hammocks, and these should be protected from intense and/or frequent burning. More information on the vegetation at the edges of individual hammocks would help determine if the areas are less extensive than before. Due to the severity of anthropogenic disturbances in hammocks, they should be managed for recovery of native hardwoods. Prescribed fire could be employed in adjoining communities, while avoiding the hammocks themselves. This would reduce the chances of a conflagration that would further retard successional recovery on these sites.

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