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SURVEY FOR SPECIAL STATUS PLANTS
WITHIN FORT RALEIGH NATIONAL HISTORIC SITE

Final Report

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for the U.S Park Service
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SUMMARY

From autumn 1996 into early autumn 1997, I surveyed for rare plant species within Fort Raleigh National Historic Site. No Federally listed plant species were found. Two State listed plant species were found, both of these were in the brackish marsh south of US 64/264--twig-rush (*Cladium mariscoides*) and winged seedbox (*Ludwigia alata*). A third State listed species, saltmarsh spikerush (*Eleocharis halophila*) was tentatively identified (no fertile material was available for positive identification) in this brackish marsh, but the plants were found outside of the Park Service boundary on private land. Additionally four State watch list species were found within Fort Raleigh--two in upland forest, one along the beach strand, and one in the brackish marsh.

In this report, locations of rare plants are described. The potential for other rare plants to occur within Fort Raleigh, including areas where they are most likely to be found, is discussed. Threats to known rare plants and to others that may occur are discussed.

INTRODUCTION

In July 1996, I was contracted by the U.S. Park Service to survey Fort Raleigh National Historic Site (hereafter NHS) for special status bird species, for a period of one year, beginning 27 July 1996. "Special status bird species" here refers to bird species that are Federally listed, including Federal Species of Concern, and species that are State listed as Endangered, Threatened, or of Special Concern. (All Federally listed species are also State listed; in this report, for convenience, the term "State listed species" refers to species that are State listed but are not Federally listed.)

Fort Raleigh NHS consists of 355 acres, and lies at the north end of Roanoke Island, in Dare County (see Figures 1 & 2). Most of the tract lies north of US 64/264 but also includes some land south of this highway, in the vicinity of Alder Branch and westward to Croatan Sound. The main purpose of the Historic Site is to preserve the location of the first attempted English settlement in the New World.

A portion of the NHS lying north of US 64/264 has been developed for administrative/interpretive purposes. Here there are various buildings, including an interpretive center and The Lost Colony Theatre, as well as maintained lawns, hiking trails, parking lots, etc. However, the majority of the property is undeveloped. Habitats include upland forests dominated by pines or a mixture of pines and hardwoods, brackish marsh, and swamp forests dominated by hardwoods. (Plant taxonomy within this report follows Radford et al 1968.; common names are based primarily on Schafale and Weakley 1990).

Description of Habitats (excludes developed portions of NHS)

Below are descriptions of the habitats of Fort Raleigh, excluding developed areas. Given first are major upland habitats, followed by major wetland habitats, and then brief descriptions of four minor habitats.

Majority of Upland Forest within Fort Raleigh

Most of the NHS lies on upland soils that vary from well drained to excessively well drained, i.e. Baymeade and Fripp sands. Excluding the developed areas, these upland habitats are, for the most part, forested. In most of this forested area, the canopy is closed or nearly closed, and is almost exclusively loblolly pine (*Pinus taeda*). A very few longleaf pines (*Pinus palustris*) occur within the area, at least along US 64/264. (Adjacent to Roanoke Sound most sites have mixed canopies or are hardwood dominated as discussed later. In general, areas mapped as having Baymeade sand are dominated by loblolly pine.) Most of the canopy pines appear to be of roughly the same age; they undoubtedly came in as agricultural lands were abandoned. In 1997, at a site where pines were cut down for pine beetle control

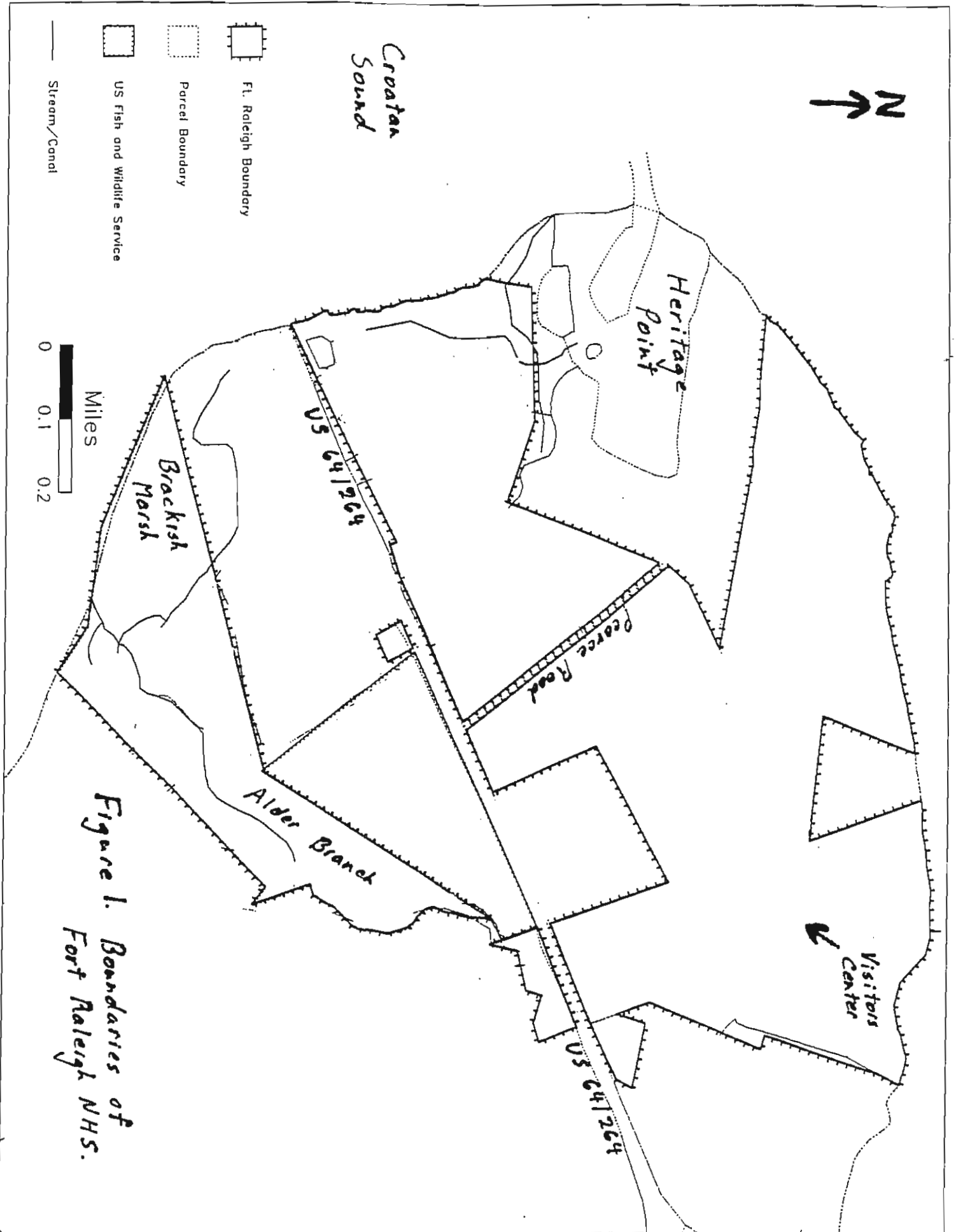


Figure 1. Boundaries of Fort Raleigh NHS.

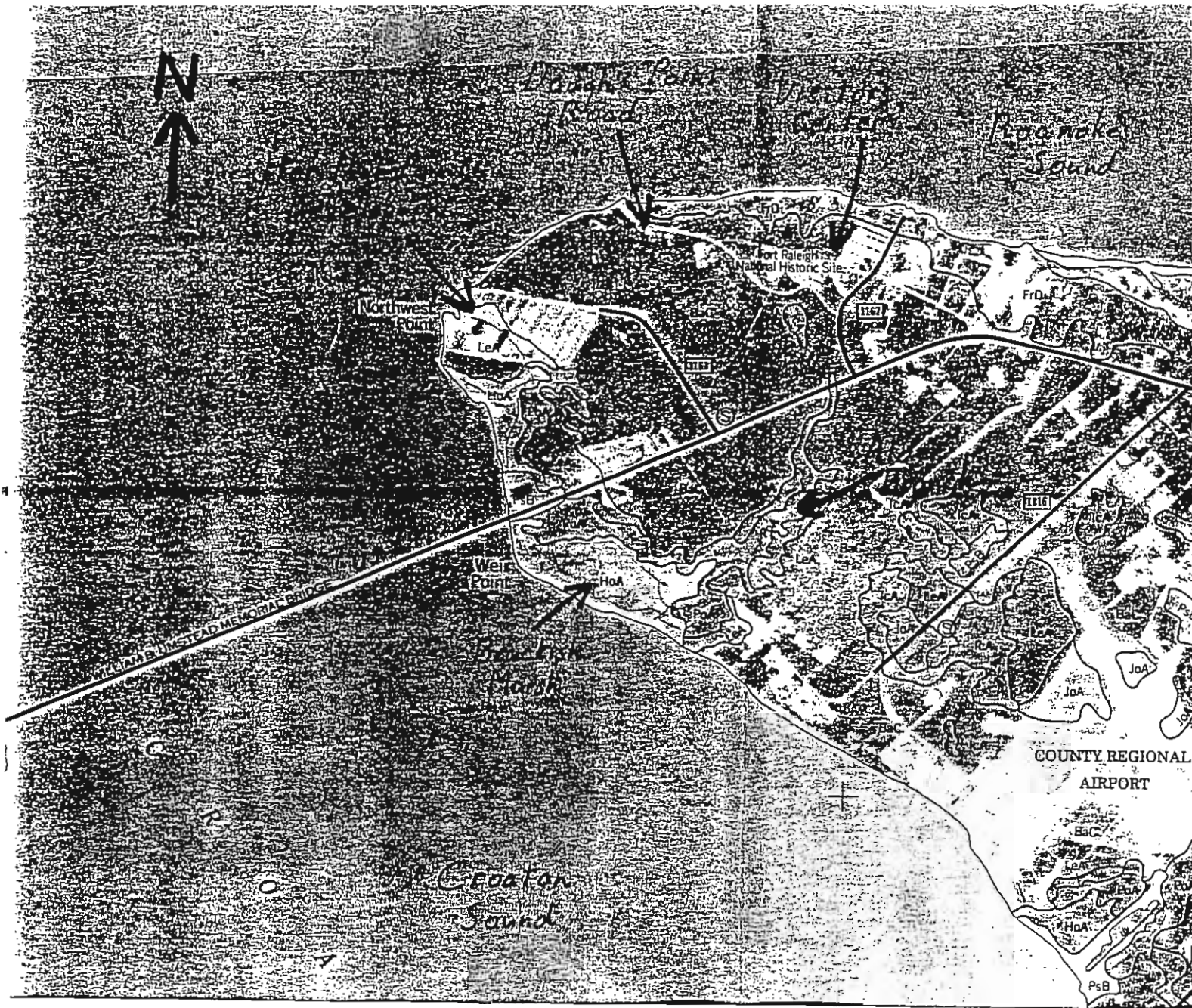


Figure 2. Location map and soils map of Fort Raleigh NHS
 (see Figure 1 for Fort Raleigh boundaries)
 (from County Soils Survey, based on Manteo
 7 1/2' quad sheet, 1"=2000').

soils cited in text: BaC = Baymeade sand
 FrD = Fripp sand
 HoA = Hobonny muck
 LeA = Leon sand
 PoA = Ponzer muck

in 1995, I counted the rings of 10 pine stumps. The trees ranged in age from 43 to 65 years, with an average of 53 years. These figures are probably representative of most pines within the NHS.

Over most of the area, the average **canopy** height is about 60'. Hardwoods that occasionally intrude into the canopy are laurel oak (*Quercus laurifolia*), live oak (*Quercus virginiana*), and southern red oak (*Quercus falcata*). In a few limited areas, laurel oak is codominant with loblolly pine. (Note: it is recognized that many authorities consider the "laurel oaks" of maritime forests and other coastal forests to actually be hybrids of various oak species; whatever they should technically be considered they are a major component of many coastal forests and are obviously different **from the live oak**.)

Within most of the upland forest, the **subcanopy** is poorly developed or absent. Overall, the most frequently observed species within this stratum are laurel oak, red bay (*Persea borbonia*), flowering dogwood (*Cornus florida*), and American holly (*Ilex opaca*). Southward, southern red oak is relatively frequent.

Over much of the area, there is a dense growth of shrubs and young trees, up to about 20' in height. Dominance varies from site to site, but the most typical species overall are laurel oak, flowering dogwood, American holly, red bay, and wild olive (*Osmanthus americana*). The southern magnolia (*Magnolia grandiflora*), which is not native to the area, is prominent in a few areas. In spots, these shrubs and young trees have a dense cover of woody vines; common are wild muscadine (*Vitis rotundifolia*), saw greenbrier (*Smilax bona-nox*), glaucous greenbrier (*Smilax glauca*), and Carolina jessamine (*Gelsemium sempervirens*).

Most areas also have a distinct stratum of low growing shrubs, young trees, and vines that is about one-two feet high. This may be dense or open. Again, dominance varies from site to site, but the most common species overall are young laurel oak, red bay, wild olive, American holly, wax-myrtle (*Myrica cerifera*), blue huckleberry (*Gaylussacia frondosa*), and the vines wild muscadine, Carolina jessamine, and poison ivy (*Rhus radicans*).

Herbaceous cover varies from open to moderately dense. The dominant species by far is partridgeberry (*Mitchella repens*). Also common is bracken (*Pteridium aquilinum*). A very distinctive species that is common in spots is pink ladyslipper (*Cypripedium acaule*). Also frequent is pipsissewa (*Chimaphila maculata*).

About 1995, there were several die-offs of pine trees, typically less than an acre or two, because of pine beetle activity. (At a few of these sites, the pines were cut in an

attempt to suppress beetle activity.) At these die-off sites, because of canopy absence (whether logging occurred or not), understory vegetation has become quite dense. Species that appear to have responded especially favorably to the increased sunlight are laurel oak, wild olive, red bay, and wax-myrtle.

Upland Forest along North Shore of Fort Raleigh

Along a portion of the north shore of Fort Raleigh, the forest is somewhat more maritime in aspect, in that the semievergreen laurel oak (sometimes in combination with the evergreen live oak) makes up a dominant or codominant portion of the canopy. Also, broadleaf evergreen vegetation makes up a larger component of the lower vegetational strata than is the case in the more inland portions of the forest. This type forest occurs north of the developed portion of Fort Raleigh (i.e. administrative offices, visitors center, and associated parking areas) and north of Dough's Point Road). It is roughly correlated with the area mapped as Fripp sand in the County Soil Survey, but extends into adjacent portions of the area mapped as Baymeade sand.

Within most of this forest type, the canopy is closed to somewhat open, with the more open examples typically being closest to the sound shoreline. The canopy height averages about 50-60', but is lower near the sound. At most sites, laurel oak dominates the canopy. However, live oak dominates some sites immediately next to the sound, and farther inland, the canopy at most sites is dominated by a mixture of laurel oak and loblolly pine.

Subcanopy vegetation varies from sparse to moderately well developed. The dominant species in this stratum is laurel oak. Also frequent are American holly, flowering dogwood, and red bay.

At most sites, there is a dense understory, up to about 15' high, of young trees, shrubs, and vines. In general, this stratum has no clear dominants, but consists of a mixture. Common are laurel oak, American holly, yaupon (*Ilex vomitoria*), wild olive, red bay--note that these are all evergreen or semievergreen, and wild muscadine. However, at some sites adjacent to the sound, laurel oak is clearly dominant. Also quite prominent is the exotic southern magnolia. It will be interesting to see if this species, which seems well suited to this environment, becomes increasingly prominent in future years.

A low shrub stratum is most prominent where higher shrubs are most sparse. Common in this low stratum are yaupons, red bays, seedling laurel oaks, and vines, primarily wild muscadine and Carolina jessamine. Blue huckleberry is common at some sites, especially more inland.

Herb vegetation varies from medium to dense. Partridgeberry is by far the dominant species. In spots near the sound, where canopy vegetation has been thinned by salt spray and/or wind damage, the ground is almost covered by partridgeberries. Also common is bracken.

Woody vines are prominent, especially where the canopy is somewhat open. The most common species is wild muscadine. Also common are glaucous greenbrier and Carolina jessamine. At a few sites, trees and shrubs are almost blanketed by the epiphyte Spanish-moss (*Tillandsia usneoides*).

It is difficult to say with certainty what the "original" or "natural" composition of the upland forest would have been. Indeed, even if man were not present today, the natural factors acting on this area would be rather different now from those operant at the time of the first English settlement in the area, when Roanoke Island was almost connected to the mainland by marsh vegetation, and natural fires may have been of somewhat regular occurrence (see Frost, in prep.). At that time, much of what is now Fort Raleigh NHS might have been open canopied longleaf pine, maintained by occasional fire.

At present, if human interference were removed, the composition of most or all of the upland forest would presumably be similar to that described for the Coastal Fringe Evergreen Forest community type (see Schafale and Weakley 1990). Dominant species of this community type are laurel oak, live oak, and loblolly pine. This is considered one of the most endangered community types in the state (see Schafale and Weakley 1990). The forest along the north shore of Fort Raleigh is currently a good example of Coastal Fringe Evergreen Forest. The rest of the upland forest within Fort Raleigh appears to be succeeding toward typical Coastal Fringe Evergreen Forest. It is definitely the case that pine dominance is declining, and based on dominance within the lower vegetational strata, it appears that, barring human interference, laurel oak will become the dominant canopy species within all or most of the upland forest within a few decades. However, it is likely that much of the forest will have a higher percentage of "inland elements", for instance, southern red oak, than the typical Coastal Fringe Evergreen Forest.

Moist/Wet Pine Forest

Within the NHS boundary, there are two areas that are wet to moist and are dominated by loblolly pine. One of these areas is in the western portion of the property, north of US 64/264; the other lies along the border of Alder Branch. The distribution of these areas corresponds closely with the areas mapped as having Leon sand in the County Soil Survey. The two areas are notably different and are discussed separately here.

In the area north of US 64/264, dominance varies somewhat according to degree of wetness, but can generally be described as follows. The canopy is closed to almost closed, about 60' high, and is strongly dominated by loblolly pine at most sites, intermixed with a few red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), and swamp tupelo (*Nyssa sylvatica*). At some sites, especially wetter ones, there have been die-offs of pines. Subcanopy vegetation is of medium density, on average. Common are sweet gum, swamp tupelo, sweetbay, and red bay. Shrub vegetation, often overgrown with woody vines, is generally dense, and about five feet high. The dominant species is fetterbush (*Lyonia lucida*). Other common shrubs are inkberry (*Ilex glabra*), red bay, and wax-myrtle; wax-myrtle is most common in the wetter sites. The most common vines are laurel-leaved greenbrier (*Smilax laurifolia*) and glaucous greenbrier. Herbaceous vegetation is patchy. Virginia chainfern (*Woodwardia virginica*) is overall the dominant species; royal fern (*Osmunda regalis*) generally dominates the wetter sites.

In the area that borders Alder Branch, loblolly pine is also dominant, but there are a few pond pines (*Pinus serotina*). The canopy is somewhat open, and about 75' high. Subcanopy vegetation is of medium density; the major species are red maple, red bay, swamp tupelo, and sweetbay. Shrub vegetation is very dense and up to seven feet high. The dominant species is fetterbush; also common is red bay. The shrubs are overgrown with numerous laurel-leaved greenbrier vines. Herbaceous vegetation is patchy; Virginia chainfern is the major species.

Along at least 150 yards of this area, the pines are notably mature. A couple had DBH's of 24". These mature pines lie next to a strip of mature baldcypresses (*Taxodium distichum*) and swamp tupelos (see below under "Swamp Forest"), making this one of the more noteworthy sites within Fort Raleigh NHS.

Beach Strand

There are distinctive although narrow beach strands along two sections of Fort Raleigh shoreline: along the north shore of the NHS, from the east boundary westward a little past the Elizabethan Gardens (excluding The Lost Colony Theatre area); and along the Croatan Sound shoreline south of US 64/264. These are rather different from each other and are discussed separately below. In the County Soil Survey, these areas are not mapped as being distinct from adjacent areas. Presumably, this is because they are so narrow. It should be stressed that these shorelines are constantly changing; the following descriptions may not be applicable in the future, perhaps maybe not even next year.

The beach strand along the north shore of Fort Raleigh is narrow, typically less than 60' in width, with almost no dune

development. The strand is only one-two feet higher than the adjacent sound.

At the times of my surveys, no vascular plants were seen within about 20' of the water. Typically, the middle 20' or so of the strand has a medium dense growth of herbaceous vegetation. Dominant species within this zone are saltmeadow cordgrass (*Spartina patens*) and bitter panic grass (*Panicum amarum*). Also common are rough buttonweed (*Diodia teres*), cocklebur (*Xanthium strumarium*), and trailing wild bean (*Strophostyles helvola*). Also frequent are sea rocket (*Cakile edentula*), seabeach sandmat (*Euphorbia polygonifolia*), and American beachgrass (*Ammophila breviligulata*). Just inland is another distinctive strip, in that the herbaceous ground cover is a bit sparser, and there are no clear dominants in this zone. Common species within this strip are rough buttonweed, trailing wild bean, saw greenbrier, trumpetvine (*Campsis radicans*), saltmeadow cordgrass, and bitter panic grass. Also frequent is bear-grass (*Yucca filamentosa*). Notably this strand is vegetated by species that are not only typical coastal dune plants, such as the bitter panic grass, saltmeadow cordgrass, trailing wild bean, sea rocket, seabeach sandmat, and American beachgrass, but also by more ubiquitous species, such as rough buttonweed, cocklebur, trumpetvine, etc.

The transition from beach strand to forest may be quite abrupt, but typically there is a zone of 50' or so where vegetation consists primarily of thick young trees, shrubs, and vines, like live oak, sassafras (*Sassafras albidum*), yaupon, wild muscadine, trumpetvine, saw greenbrier, and glaucous greenbrier. Within this shrub zone are frequent small sandy openings that support a variety of herbaceous species. Especially common are rough buttonweed and the composites *Solidago arguta*, *Heterotheca nervosa*, *Heterotheca gossypina*, *Hypochoeris radicata*, and rough buttonweed. Prickly-pears (*Opuntia* sp?) are frequent in these areas. These cacti appear to be intermediate between *Opuntia drummondii* and *Opuntia compressa* (such intermediates are mentioned under the account of *Opuntia drummondii* in Radford et al 1968).

(Westward of this beach strand, to the Fort Raleigh-Heritage Point development boundary, the shore consists of eroding bluffs, up to 15-20' high, with slopes of up to 60°. On the lowest portion of the least steep slopes, there are often numerous young trees, shrubs, and herbaceous vegetation, with a species composition similar to that described in the preceding paragraph).

The beach strand south of US 64/264 tends to be even more narrow, only about 30' wide. It is one-two feet higher than the adjacent sound along most of its length, but near the southern property line is so low that it is frequently overwashed by slightly higher than average water levels. The soundside half of the strand cross-section is barren; the inland half typically has

a dense cover of herbaceous vegetation. Dominant along most of the strand is saltmeadow cordgrass; common reed (*Phragmites communis*) is dominant where the strand is lowest, near the south property line. Common along most of the strand are bitter panic grass, seaside goldenrod (*Solidago sempervirens*), saw greenbrier, and American beachgrass.

Along the inland margin of this barrier strand, lying between it and the adjacent brackish marsh, are intermittent narrow strips, about 5-15' wide, with a sparse growth of mostly dead/dying stunted trees and shrubs over a dense ground cover of herbaceous vegetation. The most common trees/shrubs are loblolly pine and wax-myrtle; also common are red maple, red bay, and live oak. The major herbaceous species are saltmeadow cordgrass, poison ivy, saw greenbrier, rattan vine (*Berchemia scandens*), and peppervine (*Ampelopsis arborea*).

(The section of shoreline lying just north of US 64/264 does not have a distinctive beach strand. For the most part, the shore consists of stumps and eroding peat. Along a section of this shoreline, where this retreating shoreline borders shrub swamp (see below), there is a very narrow strip, a few feet in width, where the dominant vegetation is somewhat different from that of the shrub swamp as a whole. Frequent in this strip are seaside oxeye (*Borrichia frutescens*), marsh elder (*Iva frutescens*), and groundsel-tree (*Baccharis halimifolia*). Along the rest of the shoreline, there is a narrow (about 50' at the widest) tree covered ridge lying between the shore and the shrub swamp. This ridge has an open growth of small trees and shrubs--loblolly pine, live oak, yaupon, southern red cedar (*Juniperus silicicola*), red bay, serviceberry (*Amelanchier canadensis*), and wax-myrtle--over a medium dense herbaceous growth--mostly saltmeadow cordgrass, American beachgrass, and bitter panic grass.

Swamp Forest

Swamp forests are found in two areas of the NHS--in the western section--north of US 64/264, and within the Alder Branch floodplain south of US 64/264. These swamp forests lie within the areas mapped as having Ponzer muck in the County Soil Survey. However, the northern area appears to lie only within the southern and eastern portions of the Ponzer map unit. The two areas are different from each other and are discussed separately below.

The swamp forest lying north of US 64/264 reaches its best development in a relatively small area, only about two acres or so, indicated by the easternmost tip of the area mapped as Ponzer muck. It is assumed that this area has been least affected by occasional flooding from the sound. In this area, the closed canopy is about 70' high. Dominant are swamp tupelo and ash

(*Fraxinus* sp). There are a few sweet gums, and at least one baldcypress. The subcanopy is of medium density. Common species within this stratum are swamp tupelo, red maple, ash, red bay, and sweetbay. Shrub vegetation is patchy, mostly associated with little islands formed by tree bases and stumps. Common shrubs are wax-myrtle, red bay, young red maple, and fetterbush. Herb vegetation is patchy, with royal fern being the most common species. Laurel-leaved greenbrier is thick on the islands. Elsewhere the swamp forest is scruffier, only about 40' high. In these areas, the canopy is dominated by swamp tupelo at some sites, or a combination of swamp tupelo and dying loblolly pines at other sites. Understory vegetation is patchy; common species in this stratum are red maple, wax-myrtle, and red bay. Herb vegetation is also patchy. Royal fern is generally dominant, but dominance shifts toward sawgrass closer to the estuary. Marsh pennywort (*Hydrocotyle umbellata*) is common.

For the most part, the Alder Branch swamp forest is low, with the canopy only 40' high. The canopy is open. In some areas, red maple is dominant; in others, red maple and Carolina willow (*Salix caroliniana*) are codominant. There are a few scattered small baldcypresses. Shrub vegetation is dense, and about 10-15' high. Wax-myrtle is dominant; red maple and red bay are also common. Herbaceous vegetation is dense. Royal fern is dominant. Also common are marsh fern (*Thelypteris palustris*), swamp loosestrife (*Decodon verticillatus*), and whorled pennywort (*Hydrocotyle verticillata*).

Along the north border of the Alder Branch swamp forest, there is a 200-yard strip, about 50-100' wide, dominated by mature baldcypresses and swamp tupelos. This strip is located near the southern tip of the Fish and Wildlife Service property and adjacent to the mature pines cited earlier. The largest tupelo noted had a DBH of 18"; the largest baldcypress had a DBH of 20". This is one of the most notable sites in Fort Raleigh.

Shrub Swamp

Within the western portion of the NHS, north of US 64/264, is a fairly extensive shrub swamp. All of the area mapped as Hobonny is shrub swamp; in addition, some of the adjacent Ponzer map unit is also shrub swamp. In the areas that I walked through, the mass of vegetation is about 10' high or higher, made up of young trees, shrubs, and common reed. The most common species of trees and shrubs appear to be red maple, wax-myrtle, and red bay. Hempvine (*Mikania scandens*) is quite common. There are also frequent openings within the taller vegetation, and these have a medium cover of small herbs, like marsh pennywort, spadeleaf (*Centella asiatica*), and swamp smartweed (*Polygonum hydropiperoides*). Other areas may be somewhat different--some areas may be more strongly dominated by common reed. Based on aerial photography, it is evident that the portion of this

habitat mapped as Hobonny muck was a low, herb-dominated brackish marsh until recent years. It would be interesting to know what factors have led to this marsh becoming a shrub swamp, especially in regard to the brackish marsh south of US 64/264, which has not undergone similar changes.

Brackish Marsh

The brackish marsh south of US 64/264 is about 70 acres in extent, but about one-third of this is on private land. The location of this marsh is indicated by the area mapped as Hobonny muck in the County Soil Survey. This marsh has been ditched in the past, but this ditching has probably had negligible effect on the marsh's hydrology. Typically, the majority of the marsh surface varies from being saturated but not inundated to being inundated with only an inch or two of water. During higher than average water levels in the adjacent Croatan Sound, such as occasionally occur during storms with strong southwest winds, the marsh is inundated with up to two feet of water (sometimes more), which flows into the marsh across the southern end of the beach strand, which is very low, and through a ditch that cuts through the southern end of the beach strand. I observed that the marsh was flooded with two feet or more of water on 24 July 1997, as a result of strong southwest winds associated with the remnants of Hurricane Danny, the center of which passed through the northeastern corner of the state on that afternoon.

Overall, black needlerush (*Juncus roemerianus*) is the dominant plant within the marsh, but dominance varies from site to site. Also very common are sawgrass and common cattail (*Typha latifolia*) (note that many of the cattails within this marsh may actually be hybrids). Most sites are dominated by black needlerush alone or by various combinations of black needlerush, sawgrass, and common cattail. The exotic common reed now dominates some sites, and may become more of a problem in the future. Narrowleaf cattail (*Typha angustifolia*) is another major species, especially near the barrier beach. Other common/frequent species within the marsh are water-parsnip (*Sium suave*), arrowleaf morning-glory (*Ipomoea sagittata*), crimson-eyed hibiscus (*Hibiscus moscheutos*), hempvine, marsh fleabane (*Pluchea foetida* and *P. purpurascens*). The marsh has a nice floral display during the course of the growing season. Other species that contribute to this display, although uncommon in some cases, are seaside goldenrod, seashore mallow (*Kosteletskya virginica*), red milkweed (*Asclepias lanceolata*), large marsh-pink (*Sabatia dodecandra*), Virginia blueflag (*Iris virginica*), and lobelia (*Lobelia elongata*).

Within about 150' of the barrier beach, there is a more even mix of species, and some species are noticeably more common in this area, like narrowleaf cattail and three-square (*Scirpus americanus*). Soil conditions may be somewhat different here

because of the occasional deposition of mineral material washed/blown in from the adjacent beach strand.

Also within the marsh are a few small pools and mostly bare flats, both apparently formed by die-off of marsh species. Patches of little spikerush (*Eleocharis parvula*) are frequent on the flats and around the pool margins. Also seen in these situations were coastal water-hyssop (*Bacopa monnieri*) and toothcup (*Ammannia teres*).

I refer to this marsh as brackish because it obviously has some saline influence. However, the level of salinity is, on average, obviously quite low, and it does not fit the Brackish Marsh community type description in Schafale and Weakley (1990). Based on their classification, it would more properly be considered Tidal Freshwater Marsh, or perhaps intermediate between Tidal Freshwater Marsh and Brackish Marsh.

Minor Habitats

Four habitats, very limited in size and considered to have little potential for rare species, are a small freshwater pond next to the parking lot near the US 64/264 bridge; a nearby isolated (by upland) former brackish marsh that is becoming a shrub swamp; a very small area of old field habitat; and an area of young pine growth adjacent to US 64/264.

The *freshwater pond* is about 300' x 150'. Formerly a boat basin connected to Croatan Sound when the land was privately owned, it became a freshwater pond when the connection filled in, although there may be some slight saline influence. The banks are rather steep, and are covered with a moderate growth of common reed. The margins of the pond have a rather dense growth of the exotic alligator weed (*Alternanthera philoxeroides*), with some coastal water-hyssop.

The *former brackish marsh* is about 400' x 200' in extent; it lies just east of the freshwater pond, although separated from it by a narrow berm. Dominant plants in this marsh are common cattail and sawgrass. Also common and apparently increasing are many shrubs and young trees, as wax-myrtle, red maple, sweet gum, swamp tupelo, and swamp rose (*Rosa palustris*). Other common marsh plants are royal fern, false nettle (*Boehmeria cylindrica*), hempvine, water-hemp (*Amaranthus cannabinus*), spadeleaf, Virginia buttonweed (*Diodia virginiana*), mermaidweed (*Proserpinaca palustris*), giant foxtail grass (*Setaria magna*), and common foxtail grass (*Setaria geniculata*).

The area of *old field* habitat that lies adjacent to US 64/264 is less than an acre in extent. Currently it has a dense, three feet high mixture of many herbaceous species with numerous young loblolly pines. Common herbs are dogfennel

(*Eupatorium capillifolium*), seaside goldenrod and other goldenrods, common broomsedge (*Andropogon virginicus*) and other grasses, common plantain (*Plantago lanceolata*), bitterweed (*Helenium amarum*), ragweed (*Ambrosia artemisiifolia*), numerous asters, lespedeza (*Lespedeza cuneata*), and Virginia creeper (*Parthenocissus quinquefolia*).

The area of young pine growth lies adjacent to US 64/264, and is about 10 acres in extent. It consists of a dense growth of young loblolly pines, about 25' high. Due to shading, understory vegetation is generally sparse. Noted were sweet gum, American holly, sassafras, winged sumac (*Rhus copallina*), wild muscadine, Carolina jessamine, poison ivy, and glaucous greenbrier.

METHODS

After making reconnaissance surveys of Fort Raleigh NHS in late summer 1996, I put together a list of rare plant species that might occur (see Table 1). It was recognized that this was probably an ambitious list, in that it included some species that were slightly out-of-range and that it was based in part on some habitats that might not be present, such as freshwater pools within the upland forest.

I became very familiar with habitats present within Fort Raleigh during the winter of 1996-1997, when I visited all portions of the NHS and made transects across all of the upland forest in a survey for red-cockaded woodpeckers. During these surveys, I found out the following: 1) There are no freshwater pools within the upland forest. 2) Openings within the upland forest large enough to support a variety of herbaceous species are limited to a narrow zone of about 50' in width where the forest borders the beach strand along the northern side of the NHS. 3) There are apparently no sites having a high soil pH (because of the presence of shell material) within the upland forest or along the forest margins. 4) The beach strand is quite narrow (and completely absent along some of the NHS shoreline) with little dune development and a rather low diversity of typical dune species. 5) The brackish marsh south of US 64/264 is of intermediate quality, i.e. has a moderate diversity of species; obviously somewhat brackish, it has little potential for true freshwater species.

Based on the above findings, I decided to focus my searches during the 1997 growing season to 14 species associated with brackish marshes (including ones listed as primarily associated with tidal marshes and salt marshes); seven species associated with dunes, ocean beaches, island-end flats, and barrier island grasslands; three species associated with maritime forests and maritime forest openings; and one species associated with maritime swamp forests.

Thus the areas/habitats I focussed on were 1) two areas of beach strand, to include the narrow zone where the beach strand and forest grade into each other; 2) the brackish marsh south of US 64/264; 3) the two areas of swamp forest. I made numerous surveys of the beach strand and brackish marsh, so that visits were made on the flowering/fruiting dates of all rare species that might occur in those areas. Because of the number of potential species and the relative habitat quality, the area that I devoted most time to was the brackish marsh. The few visits to the swamp forests included visits in early August during the flowering period of the only rare species with reasonable potential to occur in this habitat.

Table 1. Rare species considered as possibly occurring within Fort Raleigh NHS at beginning of this study.

[Given are the species common name and scientific name, Federal status (if any), State status, major habitat, nearest county (to Dare) in which recorded, and flowering-fruiting period. Lists are arranged alphabetically, by scientific name.]

Federally Listed Species

Virginia jointvetch (*Aeschynomene virginica*). Federal: Threatened; State: Endangered. Tidal marshes, wet ditches; Hyde; July-October.

Seabeach amaranth (*Amaranthus pumilus*). Federal: Threatened; State: Threatened. Ocean beaches, island-end flats; Dare; June-frost.

Dune bluecurls (*Trichostema* sp.1). Federal: Special Concern; State: Candidate. Dunes, openings in maritime forests; Dare; August-frost.

State Listed Species (includes species that were once Federally listed but have been demoted to "3C" status)

A water-hyssop (*Bacopa innominata*). State: Candidate. Tidal freshwater marshes; Chowan; June-September.

Crowned beggar ticks (*Bidens coronata*). State: Significantly Rare. Brackish marshes; Tyrrell; August-October.

Long's bittercress (*Cardamine longii*). State: Significantly Rare (Federal: 3C). Tidal marshes; Jones; March-May.

Crowfoot sedge (*Carex crus-corvi*). State: Significantly Rare. Swamp forests; Martin; May-June.

A sedge (*Carex hormathodes*). State: Significantly Rare. Marshes; Currituck; May-June.

Southern hornwort (*Ceratophyllum muricatum* ssp. *australe*). State: Significantly Rare. Pools in maritime forests; Carteret; May-September.

Twig-rush (*Cladium mariscoides*). State: Significantly Rare. Brackish marshes, bogs; Dare; July-September.

Toothed flatsedge (*Cyperus dentatus*). State: Candidate. Marshes; Dare; July-October.

Four-angled flatsedge (*Cyperus tetragonus*). State: Significantly Rare. Maritime forests, barrier island grasslands; Dare; July-September.

Table 1 (continued).

State Listed Species (continued)

Gulfcoast spikerush (*Eleocharis cellulosa*). State: Significantly Rare. Interdune ponds, brackish marshes; Dare; July-September.

Saltmarsh spikerush (*Eleocharis halophila*). State: Threatened. Brackish and freshwater marshes; Dare; July.

Beaked spikerush (*Eleocharis rostellata*). State: Significantly Rare. Brackish marshes; Dare; July-September.

Seven-angled pipewort (*Eriocaulon aquaticum*). State: Significantly Rare. Tidal freshwater marshes; Tyrrell; June-October.

Coralbean (*Erythrina herbacea*). State: Significantly Rare. Maritime forests; Carteret; May-July.

Pinebarren sunrose (*Helianthemum corymbosum*). State: Significantly Rare. Maritime forests; Dare; April-May.

Georgia sunrose (*Helianthemum georgianum*). State: Candidate. Maritime forests; Dare; April-May.

Seaside heliotrope (*Heliotropium curassavicum* var *curassavicum*). State: Candidate. Salt flats, salt marshes; Hyde; June-September.

Water violet (*Hottonia inflata*). State: Candidate. Interdune ponds; Dare; April-May.

Woolly beach heather (*Hudsonia tomentosa*). State: Significantly Rare. Dunes, maritime forest openings; Dare; May-June.

Riverbank quillwort (*Isoetes riparia*). State: Significantly Rare. Tidal freshwater marshes; Currituck, Tyrrell; May-October.

Maritime pinweed (*Lechea maritima* var *virginica*). State: Significantly Rare. Barren dunefields; Dare; June-August.

Long-awned spangletop (*Leptochloa fascicularis* var *maritima*). State: Significantly Rare. Fresh to brackish tidal marshes; Dare; September.

Carolina grasswort (*Lilaeopsis carolinensis*). State: Threatened (Federal: 3C). Freshwater marshes, tidal marshes; Dare; May-June.

Awl-leaf mudwort (*Limosella australis*). State: Candidate. Tidal marshes; Currituck; June.

Table 1 (continued).

State Listed Species (continued)

Small-flowered hemicarpha (*Lipocarpa micrantha*). State: Significantly Rare. Salt marshes; Dare; July.

Winged seedbox (*Ludwigia alata*). State: Significantly Rare. Interdune ponds; Dare; June-September.

Lanceleaf seedbox (*Ludwigia lanceolata*). State: Candidate. Interdune ponds; Dare; August-September.

Florida adder's-mouth (*Malaxis spicata*). State: Significantly Rare. Maritime swamp forests; Dare; July-August.

Seabeach knotweed (*Polygonum glaucum*). State: Candidate. Ocean and sound beaches; Dare; May-October.

Ivy buttercup (*Ranunculus hederaceus*). State: Candidate. Marshes; Currituck; April-June.

Fragrant beaksedge (*Rhynchospora odorata*). State: Significantly Rare. Maritime wet grasslands; Hyde; June-August.

Small-flowered buckthorn (*Sageretia minutiflora*). State: Candidate (Federal:3C). Shell middens; Carteret; September.

Moundlily yucca (*Yucca gloriosa*). State: Significantly Rare. Dunes; Dare; October.

During the surveys for rare plant species, I also looked for State "watch list" species (see Amoroso 1997). These are species "which are rare or otherwise threatened with serious decline, but for which current information does not justify placement on the main list (E, T, C, or SR). Watch list species are additional indicators of significant habitats, and their presence should be considered in planning natural area protection efforts..".

RESULTS AND CONCLUSIONS

Included in this section are brief discussions regarding the rare species that were found (these are summarized in Table 2) and a discussion about the potential for other rare plants to occur.

Federally Listed Species

No Federally listed species were found, and the possibility of any Federally listed species occurring within Fort Raleigh NHS is virtually nil.

I have found seabeach amaranth on a mainland shoreline with habitat as marginal as that at Fort Raleigh NHS (near Atlantic in Carteret County). However, in that case, the mainland shoreline is less than one mile from Core Banks, which has a good population of seabeach amaranth. In contrast, seabeach amaranth is quite rare along the barrier islands of the northeastern part of the state.

During this study, I did find a population of *Trichostema* on the sandy slopes below the Dough's Point cemetery. However, they are the widespread species "common bluecurls" (*Trichostema dichotomum*), and not the dune endemic "dune bluecurls".

State Listed Species

Two State listed species were discovered during this study. Both were found in the brackish marsh south of US 64/264, near the beach strand. Both were found within 100' of each other. These species are:

Twig-rush (*Cladium mariscoides*) (State status: Significantly Rare).

At least 18 individuals were found, on 29 July 1997 plus other dates. The plants were all within 25' of the beach strand, and about 650'-675' northwest (along the beach) from the ditch that drains the marsh into the sound (near south end of property) (see Figure 3 for location). Plants were flowering/fruiting. All plants were within an area of 25' x 10'.

Other individuals of this easily overlooked species may occur elsewhere within the marsh. However, at the least, these plants probably represent a significant concentration.

Potential threats: As these plants are all located within 25' of a barrier beach that is obviously migrating (although slowly) inland, these plants may be threatened with extirpation because of this beach migration. On the other hand, it was observed that there is a greater diversity of species within the vicinity of

Table 2. Rare plant species observed within Fort Raleigh NHS during this study (includes watch list species).

Species	General location
Federally listed species	
None observed	None observed
State listed species	
Twig-rush (<i>Cladium mariscoides</i>) (Significantly Rare)	Brackish marsh
Winged seedbox (<i>Ludwigia alata</i>) (Significantly Rare)	Brackish marsh
Note: saltmarsh spikerush (<i>Eleocharis halophila</i>) (Threatened) tentatively identified in brackish marsh, but plants located outside park boundary	
State watch list species	
Maritime spleenwort (<i>Asplenium platyneuron</i> var. <i>bacculum-rubrum</i>)	Upland forest, northeast of Pearce Road
Coastal virgin's-bower (<i>Clematis catesbyana</i>)	Borders of forest north of developed portion of NHS
Little spikerush (<i>Eleocharis parvula</i>)	Brackish marsh
Maritime pokeweed (<i>Phytolacca rigida</i>)	Widely scattered along beach strands

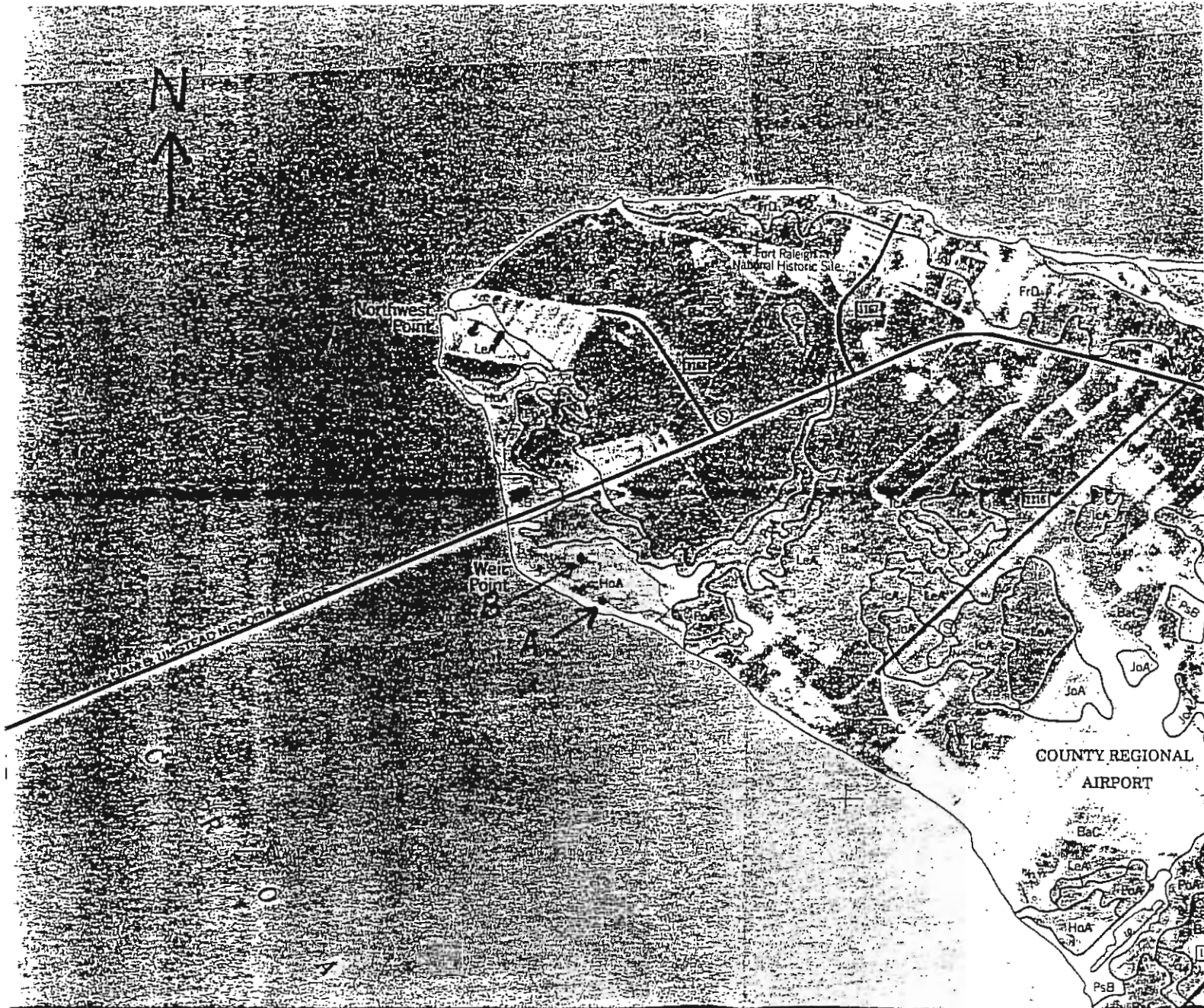


Figure 3. Locations of State listed plants
(from County Soils Survey, based on Manteo
7 1/2' quad sheet, 1"=2000').

- A = location of twig-rush (*Cladium mariscoides*)
and winged seedbox (*Ludwigia alata*)
- B = location of population of spikerush
tentatively identified as saltmarsh spikerush
(*Eleocharis halophila*)

the beach strand, and that some species are definitely more common adjacent to the strand. Perhaps the constant introduction of mineral material (by occasional overwashes and by wind action) is a major reason that these species are more common here. Further, they may be quite able to survive, and may actually benefit from, a very slow deposition of sand. A more important threat may be the proliferation of the exotic common reed throughout the marsh. This species often outcompetes native vegetation and becomes established densely, almost as a monoculture.

Winged seedbox (*Ludwigia alata*) (State status: Significantly Rare).

At least six individuals were found, on 26 September 1997 plus other dates. The plants were about 15' from the mainland border of the beach strand, and about 600' northwest (along the beach) from the ditch that drains the marsh into the sound (near south end of property) (see Figure 3 for location). Plants were fruiting. Plants were in a six feet x three feet area.

Other individuals of this species may occur elsewhere in the marsh.

Potential threats: Potential threats to this population of winged seedbox are the same as for the nearby population of twig-rush. This population is also close to the nearby migrating beach strand, and could be buried. However, this periodic introduction of mineral material may actual be beneficial or essential for the population. A more serious threat may be the spread of common reed within the marsh.

In addition to the two species above, a population of spikerush, tentatively identified as saltmarsh spikerush (*Eleocharis halophila*) (State status: Threatened), was found. However, fruiting material was not available for positive identification. Further, the population, which covers an area of about 30' x 20', lies about 200' outside the Park Service boundary, based on the location of boundary lines given in Figure 1 (see Figure 3 for location). This population would also be threatened by expansion of common reed. Further, because it is on private land, it might be subject to other types of threats, although, being a CAMA "Coastal Wetland", the area could not be filled in or excavated without a permit.

State Watch List Species

Although not a major focus of this survey, I did watch for State watch list species during my field work. Four watch list species were found:

Maritime spleenwort (*Asplenium platyneuron* var *bacculum rubrum*). A population of this variety of ebony spleenwort was found about 600' NE of a point on Pearce Road that is .35 mile from US 64/264. It is common in an area about 300' x 200' in extent. It is likely that scattered individuals occur elsewhere in the upland forest. There are no foreseeable threats to the spleenworts at this time.

Coastal virgin's-bower (*Clematis catesbyana*). This species is frequent within the section of upland forest that lies northward of the developed portions of Fort Raleigh and Dough's Point Road. It may occur elsewhere as well. There are no foreseeable threats to these plants.

Little spikerush (*Eleocharis parvula*). This species is actually fairly common within the brackish marsh, with small populations scattered throughout much of the marsh, although they are most frequently associated with open pools and flats. The major threat to this species is the proliferation of common reed within the marsh.

Maritime pokeweed (*Phytolacca rigida*). This species was found scattered along the beach strand. Its major threat would be the loss of this type of habitat, whether this be through severe erosion to the point that no beach strand survives, or by bulkheading, which would interrupt the natural forces needed to constantly renew this transitory type of habitat.

Potential for Other Rare Species

There is the potential for other State listed species to occur within Fort Raleigh NHS. It should be stressed that herbaceous plants especially are not permanent fixtures--populations become established and extirpated regularly, especially in dynamic habitats such as the beach strand. Below, the potential for other rare species to occur within Fort Raleigh is discussed, by habitat type, for the two habitats where such rarities are most likely to occur.

Beach Strand. As cited, this beach strand has very poor dune development and a low diversity of typical dune species. In general, rare dune species would not be expected here. Periodically, individuals of certain rare dune species may become established here for short periods, perhaps a single growing season, and then be extirpated by erosion. Thus, this area has limited importance to these species. The most likely rare

species to become established here are those species with substantial populations on adjacent sections of the Outer Banks, for instance, woolly beach heather (*Hudsonia tomentosa*) and maritime pinweed (*Lechea maritima* var *virginica*). However, although this beach strand is not of importance to rare species as such, areas such as this (to include the dune/forest borders) may be important to the maintenance of genetic diversity. An example is the distinctive cactus cited earlier. Further, "inland" beach strands are becoming a rare habitat, as bulkheading of shorelines increases.

Brackish Marsh. Although the marsh was covered with transects every 100', there is good potential for one or more additional State listed species to occur here. Rare species that might occur are toothed flatsedge (*Cyperus dentatus*), gulfcoast spikerush (*Eleocharis cellulosa*), and beaked spikerush (*Eleocharis rostellata*). Species not present now may become established adjacent to the beach strand in the near future. Any rare species present within this marsh are potentially at risk from the proliferation of common reed.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

1. No Federally listed plant species were found within Fort Raleigh NHS. Further, habitat suitable for Federally listed plants is not present within Fort Raleigh.
2. Two State listed plant species--twig-rush (*Cladium mariscoides*) and winged seedbox (*Ludwigia alata*) were found within the brackish marsh, and a third may occur (identification tentative because of lack of fruiting material) within this marsh, but a short distance outside the Park Service boundary.
3. Four State watch list species were found--maritime spleenwort in the upland forest, coastal virgin's bower in the section of the upland forest adjacent to Roanoke Sound, little spikerush (which is fairly common in the brackish marsh), and maritime pokeweed (scattered along the beach strand).
4. Other State listed species may sometimes become briefly established along the beach strand, but the beach strand is not of potential importance to rare plant species.
5. The beach strand (to include the strip where it borders the upland forest) may be of some ecological significance in that such mainland beach strands may be important to maintenance of genetic diversity, yet these habitats are becoming increasingly rare.
6. Stabilization of the beach shoreline along the north shore of Fort Raleigh NHS could represent a tradeoff situation--losing the beach strand habitat, while preventing the additional loss of the upland forest, which is a good example of Coastal Fringe Evergreen Forest, a rare community type.
7. Other State listed species may occur within the brackish marsh.
8. The slow migration of barrier beach into the brackish marsh may threaten the rare species that were found, or it may be beneficial to them.
9. It would probably be best to regard the barrier beach migration along the Croatan shoreline of Fort Raleigh as generally desirable, but to monitor the populations of rare plants that were found in the brackish marsh.

10. The spread of common reed definitely represents a potential threat to rare species within the brackish marsh. Occasional flooding from the sound may halt further spread of the reed, but the Park Service should periodically monitor the abundance of the reed. If it continues to expand, steps to halt its expansion need to be taken, but they must be actions that do not in themselves represent a threat to the rare plants.
11. It would be extremely desirable if the Park Service were to acquire the privately owned portion of the brackish marsh. Also desirable would be the acquisition of the portion of the shrub swamp and swamp forest north of US 64/264 that currently lies outside the Park Service boundary.

BIBLIOGRAPHY

- Amoroso, Jame L. 1997. Natural Heritage Program List of the Rare Plant Species of North Carolina. NCDEH&NR, Natural Heritage Program, Raleigh.
- Frost, Cecil C. In prep. Vegetation and Natural History of the Albemarle-Pamlico Region, Virginia and North Carolina. PhD dissertation (draft), Univ. of North Carolina, Chapel Hill.
- Radford, A.E., H.E. Ahles, and C. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.
- Schafale, Michael P. and Alan S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. NCDEH&NR, Natural Heritage Program, Raleigh.
- United States Department of Agriculture, Soil Conservation Service. 1992. Soil Survey of Dare County, North Carolina.

