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SOIL-VEGETATION CORRELATIONS IN THE POCOSINS OF CROATAN NATIONAL FOREST, NORTH CAROLINA

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SOIL-VEGETATION CORRELATIONS IN THE POCOSINS OF CROATAN NATIONAL FOREST, NORTH CAROLINA

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PREFACE

The National Ecology Research Center of the U.S. Fish and Wildlife Service (FWS) is supporting a series of field research studies to document relationships between hydric soils and wetland vegetation in selected wetlands throughout the United States. This study is one of that series. It is a continuation of the FWS effort, begun by Wentworth and Johnson (1986), to develop a procedure using vegetation to designate wetlands based on the indicator status of wetland vegetation as described by the FWS "National List of Plants that Occur in Wetlands" (Reed 1986). This list classifies all vascular plants of the U.S. into one of five categories according to their natural frequency of occurrence in wetlands. Concurrent with the development of the wetland plant list, the Soil Conservation Service (SCS) developed the "National List of Hydric Soils" (SCS 1985). Studies supported by the National Ecology Research Center quantitatively compare associations of plant species, designated according to their hydric nature using the Wentworth and Johnson (1986) procedure, with the hydric nature of soils according to their designation on the SCS hydric soils list. The studies are being conducted across moisture gradients at a variety of wetland sites throughout the U.S. Several studies have been modified to obtain concommitant information on groundwater hydrology.

These studies were conceived in 1984 and implemented in 1985 in response to internal planning efforts of the FWS. They parallel, to some extent, ongoing efforts by the SCS to delineate wetlands for Section 1221 of the Food Security Act of 1985 (the swampbuster provision). The SCS and FWS provided joint guidance and direction in the development of the Wentworth and Johnson (1986) procedure, and the SCS is currently testing a procedure that combines hydric soils and the Wentworth and Johnson procedure for practical wetland delineation. The efforts of both agencies are complementary and are being conducted in close cooperation.

The primary objectives of these studies are to (1) assemble a quantitative data base of wetland plant community dominance and codominance for determining the relationship between wetland plants and hydric soils; (2) test various delineation algorithms based on the indicator status of plants against independent measures of hydric character, primarily hydric soils; and (3) test, in some instances, the correlation with groundwater hydrology. The results of these studies also can be used, with little or no supplementary hydrologic information, to compare wetland delineation methods of the Corps of Engineers (1987) and the Environmental Protection Agency (Sipple 1987).

Any questions or suggestions regarding these studies should be directed to: Charles Segelquist, 2627 Redwing Road, Creekside One Building, Fort Collins, Colorado, 80526-2899, phone FTS 323-5384 or Commercial (303)226-9384.

SUMMARY

Vegetation data sets representing three spatial scales (the entire southeastern Coastal Plain, Coastal Plain North Carolina and South Carolina, and the Croatan National Forest, North Carolina) were analyzed using weighted averaging (WA) ordination and detrended correspondence analysis (DCA). WA assigns numerical values to stands based on an *a priori* knowledge of species' wetland status (Reed 1986), whereas DCA assigns numerical values to stands based on species' distributions with no *a priori* assumptions regarding species' habitat preferences.

Pocosins had WA scores comparable to those of frequently inundated swamp forests, although they shared few species in common with these forests. Among pocosins, those on deepest peat and of lowest stature had the lowest (wettest) WA scores. At the largest spatial scales, WA scores were not correlated with DCA scores in a simple fashion.

WA scores for samples taken within Croatan National Forest were highly correlated with the first DCA axis. Thus, within this area, species composition was highly correlated with sample wetland status. Although vegetation did vary among soil series, other factors, such as local hydrology and disturbance history, influence species composition. Community wetland status, as indicated by WA scores, varied significantly among soil series.

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ACKNOWLEDGMENTS

We thank Shiree Long, Elisabeth Lusk, and Jean Watts for their assistance under the most adverse field conditions. The personnel of the Soil Conservation Officies in Craven, Carteret, and Jones Counties enthusiastically assisted in all stages of this work. We are especially grateful to Dr. Ray Tucker of the North Carolina Department of Agriculture Soils Testing Laboratory, not only for analyzing our soils, but also for making special adjustments to the normal analysis routine to accommodate the peculiar characteristics of pocosin peats. Helpful comments were made on various iterations of this report by Drs. Stephen J. Brady, Mark M. Brinson, David E. Chalk, and Charles Segelquist. We appreciate the guidance and funding provided for this study by the U.S. Fish and Wildlife Service.

INTRODUCTION

The U.S. Fish and Wildlife Service has accepted responsibility for the development of inventory technologies and methodologies for designation and classification of wetlands. The Service's definition of wetlands follows Cowardin et al. (1979):

> ...transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water... wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.... The upland limit of wetland is designated as: (1) the boundary between land with predominantly mesophytic and xerophytic cover; (2) the boundary between soil that is predominatly hydric and soil that is predominantly nonhydric; or (3) in the case of wetlands without vegetation or soil, the boundary between land that is flooded or saturated at some time each year and land that is not.

Hydric soils are defined by the Soil conservation Service (SCS 1985) as soils that in an undrained condition are saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

Pocosins or shrub bogs are classified by Cowardin et al. (1979) as palustrine systems belonging to the scrub-shrub class. Pocosins generally occur on histosols of varying depth. Shrub and tree stature in these ecosystems varies from <1 m on the deepest peats to >15 m on shallow peats and certain mineral soils.

Until recently, pocosins, were among the most poorly studied and neglected ecosystems in the southeastern United States. On productive sites, cutting, drainage, and frequent burning have greatly altered the pristine structure of these ecosystems; however, many pocosins on deep peat soils have been largely unaltered. Recent interest in forestry, agriculture, and peat mining in these ecosystems has stimulated considerable debate concerning their wetland status. The lack of quantitative data on variations in composition among pocosins and the relationships between such variations and soil characteristics, however, has prevented resolution of these questions.

The goal of this study was to examine variation among pocosin communities with respect to other Coastal Plain ecosystems and in relation to variations in soil-site conditions. Pocosins of the Croatan National Forest were of special interest. Wentworth and Johnson (1986) proposed that wetland designations and comparisons might be best done using a relatively simple weighted-average ordination of communities based on species' wetland indicator values compiled by Reed (1986). We have applied this technique at three spatial scales with data compiled at three levels of detail in order to evaluate the utility of this approach.

DESCRIPTION OF STUDY AREAS

We present the results of analyses of vegetation variation carried out at three geographic scales.

1. Data gathered from both the literature and field over the entire southeastern Coastal Plain were analyzed to provide a regional context for interpretation of geographically and vegetationally more specialized data sets. Data from upland and wetland communities were included.

2. Data gathered from grass-sedge, pocosin, and forest wetlands in North Carolina and South Carolina were analyzed. This analysis provided a more detailed model of wetland gradients and included considerably more specific soil information.

3. Vegetation and soil data were gathered from locations in the Croatan National Forest, with special emphasis placed on sampling of pocosin vegetation.

THE SOUTHEAST COASTAL PLAIN

The southeastern Coastal Plain is a geosynclinal wedge of alluvial and marine sediments that composes much of the landscape from the mid-Atlantic States southward across the Gulf States (Murray 1961). Soils derived from these sediments are often siliceous and quite nutrient poor. Soils derived from carbonaceous sediments also occur and are especially common in peninsular Florida and across the Gulf of Mexico (see Christensen 1988 for a review of Coastal Plain soils and geology). The vegetation of the southeastern Coastal Plain is quite unique compared to that of adjacent physiographic provinces, and the prevalence of wetlands is one of the most striking features of this landscape (Christensen 1988). Virtually all of the wetland types described by Cowardin et al. (1979) are represented on this landscape, including extensive alluvial and paludal ecosystems. The plant communities and environments of forested wetlands of the Southeast are described by Wharton et al. (1982), and the literature on pocosin wetlands was reviewed by Sharitz and Gibbons (1982). Other important treatments of southeastern wetland vegetation include Penfound (1952), Kologiski (1977), Richardson et al. (1981), Whipple et al. (1981), Cohen et al. (1984), Ewel and Odum (1984), and Laderman (1987).

Pocosins are among the most prominent and least studied of all wetland communities in the Southeast. The word "pocosin" is derived from an Algonquin

Indian word meaning "swamp on a hill" (Tooker 1899), and suggests that pocosins are raised bogs. In practice, however, virtually any wet area dominated by shrubs is referred to as a pocosin. Shrub-bog communities occur in a variety of physiographic settings, including "upland" flats, Carolina bays, swales, and local seeps (Woodwell 1956; Christensen et al. 1981; Ash et al. 1983). In many cases such vegetation represents a stable (i.e., nonsuccessional) community; however, shrub bogs may be seral stages in succession following disturbance of a variety of swamp forest ecosystems (Hamilton 1984; Christensen 1988).

Most pocosins occur on Histosols (organic soils), although those that represent seral stages of succession toward other communities may occur on shallow organic or mineral soils (Lilly 1981; Ash et al. 1983; Christensen 1988). Soil catenas associated with peatlands are described by Daniels et al. (1984), and chemical and physical properties of common Coastal Plain peats are documented in Dolman and Buol (1967). The classification of peats at the series level is based largely on peat depth, color, residual wood, and properties of the subpeat basement. Shallow (40-130 cm) organic series include Croatan, Ponzer, Belhaven, and Scuppernong. Common deep (>130 cm) peat series include Dare, Pungo, and Pamlico soils. All of these peat soils are characteristic of paludal wetland systems. Peats belonging to the Dorovan series are characteristic of low-energy alluvial environments and are quite variable in depth. Variations in vegetation stature and production are directly correlated with peat depth (Wendel et al. 1962).

Woodwell (1958) found that most pocosin soils are profoundly phosphorus-limited, a fact later substantiated by Wilbur and Christensen (1983) and Simms (1987). Wilbur (1985) and Wahlbridge (1986) demonstrated that much of this phosphorus limitation is a direct consequence of immobilization of P by microbes.

The hydrologic characteristics of pocosins are reviewed in Daniel (1981). Water moves quite freely through fibrous surface peats, but very slowly through the dense sapric peats characteristic of the lower horizons of many pocosin pedons. Seasonal variation in water levels is considerable. Low evapotranspiration may result in standing water during the winter months; however, evapotranspiration may draw the water table down 0.5-1.0 m below the peat surface during the summer. Daniel reported that drainage ditches, which are now found in many pocosin wetlands, tend to have a much greater effect on the seasonal variance in water table depth than on the mean depth.

In the first quantitative description of pocosin plant community structure, Wells (1946) recognized considerable local variability in relative species abundances, but did not suggest a classification scheme for these variations. He divided these communities into low, medium, and high pocosin based on shrub and tree stature, which ranges from <1 m to shrub canopies >5 m. He recognized that this variation in stature was inversely correlated with peat depth. He also noted that *Zenobia pulverulenta* was most common in areas that had recently burned.

Woodwell (1956) completed the first comparative quantitative study of Coastal Plain wetlands in the Carolinas. He divided pocosins into unions based on whether *Cyrilla racemiflora*, *Lyonia lucida*, or *Zenobia pulverulenta*, was the leading dominant species. Like Wells (1946), he recognized that *Zenobia* was an excellent indicator of recent fire, but posited that *Cyrilla*- and *Lyonia*-dominated communities differed due to geographic distribution. Kologiski's (1977) analysis of the vegetation of the Green Swamp (100 km south of the Croatan National Forest) was the first attempt to apply modern multivariate analytical techniques to describe vegetation gradients in these complex wetlands. Kologiski divided pocosin vegetation into two classes, **Conifer-Hardwood** and **Pine-Ericalean**, the former characteristic of shallow peats and mineral soils (i.e., successional pocosins) and the latter found on deep organic soils. Pine-Ericalean communities include three types.

1. The *Pinus serotina/Cyrilla racemiflora/Zenobia pulverulenta* type was typical of the most nutrient-limited sites on the deepest peats (e.g., bog centers). It is in these areas that *Sphagnum* species may be most important.

2. The *Pinus serotina/Gordonia lasianthus/Lyonia lucida* type is found in elevated areas within the above type 1.

3. The *Pinus serotina/Cyrilla racemiflora/Lyonia lucida* type is more or less synonymous with Wells' high pocosin. This type is found on shallower peats.

Fire has been a recurrent phenomenon in all pocosin peatlands as evidenced by the copious amounts of charcoal throughout peat profiles (Buell 1939, 1946; Watts 1980; Whitehead 1981) and by the numerous fire adaptations possessed by pocosin plants (Christensen 1981, 1985). Wilbur and Christensen (1983) found that fire substantially altered the availability of nutrients (especially P) and suggested that these changes had a considerable impact on patterns of postfire community development. The specific patterns of succession following fire in pocosins appear to depend largely on fire intensity and the extent of peat consumed (Kologiski 1977; Christensen 1988).

THE CROATAN NATIONAL FOREST

The location and many of the pertinent features of the Croatan National Forest are displayed in Figure 1. Parts of the Croatan National Forest fall into Jones, Craven, and Carteret Counties, North Carolina. The climate of this area is typical of the lower Atlantic Coastal Plain, with warm moist summers and cool winters (Walter and Lieth 1967). Most of the forest lies on the Talbot Terrace, the flat basin of an ancient lagoon that slopes gently to the southeast (Ingram and Otte 1981). The hard-packed clay-sand sediments of this surface form the aquaclude for the peatlands. Surface elevations vary between 9 and 13 m above mean sea level (msl), with the highest elevations being in the middle of the so-called Great Lake Pocosin, northwest of Great Lake. Five large lakes are located along the margins of peat deposits. Ellis Lake is a Carolina bay; however, the other four lakes were probably created by major peat burns in the last several millenia. Sand ridges and scattered Carolina bays occur across the study area. Streams flow out of the forest in a radial pattern consistent with the suggestion that the Great Lake Pocosin is indeed a domed bog.

The forest was acquired by the U.S. Forest Service in the early 1950's; it was previously managed by various timber companies. Attempts during the 1940's to drain pocosin areas with a rectangular array of canals were largely unsuccessful; however, these features continue to have affect local hydrology and vegetation and were avoided in this study. The Forest Service has a very active silvicultural management program, particularly on shallow organic and mineral soil areas. Intensively managed areas were not sampled. Wildfires are a frequent occurrence in the peatlands, and fire scars are obvious on aerial photos. Areas that had been burned in the past 4 years were not sampled. Christensen and Wilbur (in preparation) have done an extensive study of pocosin vegetation change during this time period.

Most of the pocosin vegetation of Croatan National Forest occurs on peatlands that have developed during the past 5,000-8,000 years in shallow, extensive drainage basins (Ingram and Otte 1981; Otte 1981; Ash et al. 1983). The patterns of development of these peatlands were described by Otte (1981). In many areas these peatlands can be classified as true bogs or tertiary mires, with deepest peat and highest elevation near their centers (e.g., the Great Lake Pocosin). Water chemistry data indicate that many such areas are indeed ombrotrophic, i.e., with nutrient inputs only from rain (Otte and Loftin 1983) although this is certainly not always the case (e.g., pocosin areas south of Great Lake). Snyder (1980) provided a detailed floristic study of plant communities in Croatan National Forest.

Soils in the Croatan National Forest can be classified into one of five groups, each of which may include several series (SCS 1981). The factors resulting in the differentiation of these soils include hydrology (alluvial vs. nonalluvial), drainage, and parent material. Pocosin vegetation in the Croatan National Forest is confined to the Croatan group, which includes two soil series, Croatan and Dare. Both series are medisaprists and are distinguished from one another based on depth and amount and nature of their mineral component; Croatan peats are shallower with considerably more mineral material (Descriptions of soil series are given in Appendix A). Soils belonging to the Pantego-Torhunta group are very poorly drained, with loamy subsoils, and often support flatwoods that share several important species in common with pocosins. Series in this group frequently border blanket bogs. Soils of the Rains-Goldsboro-Lynchburg group and the Leaf-Lenoir-Craven group vary from poorly drained to moderately well drained and support savannas and flatwoods dominated by loblolly (*Pinus taeda*) and longleaf (*P. palustris*) pines. Most silvicultural activites in the Croatan National Forest have been focused on forests on these soils, and most locations on these soils have been heavily disturbed. Soils belonging to the Muckalee group are characteristic of the floodplains of blackwater streams. This group includes one histic series, Dorovan. Nearly all of the soils in these five groups are classified as hydric (SCS 1985), owing to the shallow water table and subdued topography of this area.

METHODS

SOUTHEAST REGIONAL SURVEY

Data for the regional survey of southeastern Coastal Plain vegetation were gathered from the literature and field sampling by N. L. Christensen and his students over the past 15 years. The specific sources of data for each sample are listed in Appendix B. The goal of this analysis was to provide a general framework for vegetation variation on the Coastal Plain, within which patterns of variation among wetlands could be evaluated. Data from the literature were included in this data set if

1) sampling techniques were judged to be adequate,

2) some measure of relative abundance was given, and

3) data were summarized for a specific geographic location. General descriptions of communities over large geographic areas were not included.

Clearly, such a data set includes information gathered by a variety of techniques, and among these studies species abundance was expressed in a variety of ways. Because the goal of this analysis was to provide a broad general framework, the data were simplified in the following ways. Only the 12 most abundant species were tallied from each sample; this obviated many problems in differences in sampling efficiency among studies. Variations in abundance were simplified to a 3-point scale where 1 = <10%, 2 = 10-25%, and 3 = >25% of the total abundance of all species sampled. The resulting data set included 146 samples and 149 species.

Samples were compared with one another using weighted average ordination (WA, Wentworth and Johnson 1986) and detrended correspondence analysis (DCA, Gauch 1982). In WA ordinations, samples (stands) are scored as the average of numerical species weights derived from some *a priori* known characteristic or feature of the species. In this study, weights for the WA analysis were based on species' wetland designations obtained from the 1986 Wetland Plant List; obligate wetland plants were assigned a score of 1, whereas obligate upland plants received a score of 5 (see Table 1, Reed 1986). Plants not listed in Reed (1986) were assumed to be upland (5), unless information was available to the contrary. Sample WA scores for each sample were calculated both on the basis of species presence-absence (i.e., the simple average of species' wetland designation scores) and species relative abundance (i.e., the average of species' wetland designation scores weighted by relative abundance; see Wentworth and Johnson 1986). Species' wetland designation scores are given in Appendix C.

Table 1. Wetland categories and weights from Reed (1986).

Wetland designation	Acronym	Weight
Obligate	OBL	1
Facultative Wetland	FACW	2
Facultative	FAC	3
Facultative Upland	FACU	4
Upland	UPL	5

DCA differs from WA in that sample scores are derived from patterns of species association or dissociation, independent of any *a priori* assumptions about species' habitat preferences. It is an eigen analysis technique analogous to principal components or factor analysis, but much more suitable to the nonmonotonic relationships among species abundances that are characteristic of vegetation data (Gauch 1982; Peet et al. 1988). This analysis assigns scores to samples (stands) and species based on patterns of species abundance among stands. Thus, stands that are similar to one another in species composition (regardless of species' wetland status) will receive similar DCA scores. We use DCA here to provide a description of major trends (or axes) in variation in species composition, independent of assumptions regarding sample wetland status. By comparing DCA ordinations with WA ordinations we can assess the extent to which the arrangement of samples based on species' wetland designations corresponds to general patterns of vegetation variation.

WETLANDS OF THE CAROLINAS--THE WOODWELL DATA

In pursuit of a master's degree, George Woodwell (now of the Woods Hole Ecosystem Research Center) gathered data on 140 wetland sites in North Carolina and South Carolina in 1955. Sample sites were selected using aerial photographs (the original set is now in Christensen's laboratory) and stratified among forested wetlands, pocosins, and savannas. Sample locations are indicated in Table 3. This study was funded by International Paper, Inc., and the data were turned over to Dr. C. W. Ralston (Duke University) after the study. The results were never published.

This is an important data set for several reasons. First, it represents one of the most extensive wetland vegetation sampling efforts in this region to date; most other studies have focused on a much more confined geographic scale. Second, an effort was made to include the full range of variation characteristic of these wetland types. Third, soil pits were dug at each site, and soil characteristics, topographic features, peat depths, and water-table depths were recorded. Using the photos and recent soil maps, we have been able to determine soil series in many cases (Soil surveys have been completed, but are not published for over half of the counties sampled here; these data should be available within the next 12 months). Fourth, it has been over 30 years since these samples were taken, and many of these wetlands have been drastically altered by human activities. Thus, these data may provide us with the best opportunity to examine vegetation patterns in "natural" wetlands, and it would probably not be possible to duplicate them today.

Woodwell's sampling techniques were similar in some ways to our sampling protocol for Croatan. At each sample site, five independent sample plots were located. At each sample point, cover of herb-layer (<30 cm tall) and shrub-layer (30-450 cm tall) species was estimated in two 2x2 m quadrats. Cover estimates were based on a numerical scale ranging from + = present to 5.5 = 100% cover. All trees (i.e., stems >4.5 m tall) within 25 ft (7.62 m or an area of 182 m^2) were tallied by species. A total of 158 taxa were sampled (Appendix D). The soil profile was descibed from auger borings at each sample point. Most of the sites were carefully marked on low-level aerial photographs. Thus, for sites in those counties with completed SCS soil surveys, we were able to determine the soil series designation.

The resulting data set was enormous, and multivariate techniques and computer facilities suitable to its analysis had yet to be developed at the time of Woodwell's study. We tabulated the data set by species and sample layer. Thus, a species could appear as many as three times in the data for a particular sample, as an herb, a shrub, or a tree. For multivariate analyses such appearances were treated as separate "species." The total number of "species" determined in this way was 238. This may at first seem to be artificially increasing the importance of particular species, but we felt that it would allow us to discriminate between communities that shared many of the same species, but differed considerably in physiognomic structure. For example, *Cyrilla* is found in both bay forests and low pocosins, but is usually a tree in the former communities and a low shrub in the latter. The abundances of each species defined in this way were related to total abundance in that vegetation stratum **over the entire data set**. This put all abundance values in the same currency (percent of total), but preserved the differences in relative abundance among the three strata within each site.

Wetland indicator weights for each species were assigned as indicated above, and a weighted average ordination of the data set was performed. Abundances in each vegetation stratum were summed for each species, and unidentified taxa were excluded prior to calculation of weighted averages. In addition, the data were subjected to DCA ordination (see preceding discussion). DCA and WA ordinations were compared to provide a more general picture of vegetation trends.

THE CROATAN NATIONAL FOREST

The goal of vegetation and soil sampling in the Croatan National Forest was to provide a more precise evaluation of the relationship between variation in soil characteristics and vegetation variation, specifically for pocosin sites. Of particular importance was determination of pocosin status using weighted average ordination based on species indicator values from Reed (1986). We were also interested to determine what relationship, if any, pocosin vegetation variation bears to SCS soil series designations.

Sample sites were selected using detailed soil maps for Jones, Craven, and Carteret Counties (SCS 1981, Craven and Carteret County maps are in press) and low-elevation color infra-red aerial photographs of the Forest. The SCS soil maps were prepared as overlays on aerial photographs, which made location of particular sites and soil types relatively easy. Site locations and soil series are indicated in Table 2 and Figure 1. Pocosins are confined to Croatan and Dare series in this area; therefore these series were sampled most heavily. Four sample areas were also located on Dorovan muck soils; this was the only other common histic series on the forest. Additional samples were located in plant communities that are transitional into pocosins. Areas receiving silvicultural manipulation (e.g., thinning, prescribed burning, planting,) and areas influenced by roads or drainage canals were avoided. Given the extent of such activities on mineral soils in this area, the sites available for sampling were somewhat limited. Note that all of the soil series sampled appear on the list of hydric soils of the State of North Carolina (SCS 1985).

The sample universe comprising each stand was a 1-ha area. In most cases this universe was defined to be 100 x 100 m^2; however, in areas where stand boundaries were irregular (e.g., along streams) plot geometry was adjusted accordingly. Within each such area, five sample points were located using randomly chosen coordinates. The tree, shrub, and herb layers were sampled separately at each sample point. All trees (>1 cm dbh) within 5.64 m (100 m^2) of the sample point were tallied and their dbh recorded. A 1-m^2 quadrat was randomly located in each quadrant of the circle defined above (four quadrats total), and the number of shrub stems (<1 cm dbh, >1 m tall) and herb-layer (<1 tall) cover were tallied by species. Herb-layer cover was estimated using the logarithmic scale proposed by Daubenmire (1968) (1 = 0%-5%, 2 = 5%-25%, 3 = 25%-50%, 4 = 50%-75%, 5 = >75% cover).

As in the Woodwell data set, many species appeared in more than one vegetation stratum. Cover estimates included cryptogams as well as vascular plants. In some cases, particularly with respect to graminoids, only vegetative material was available, and identification to genus or species was not possible. In no case did such plants account for more than 1% of total cover at a site, and cover values for these unknowns were not included in DCA and WA ordinations. In addition, the entire 1-ha sample universe was systematically traversed, and species that were found, but not included in quadrats, were recorded.

Table 2. Vegetation and soil taxonomy for sites sampled in the Croatan National Forest.

Site #	Vegetation type	Soil series	Soil great group
1	Low Pocosin	Dare	Typic Medisaprist
2	Medium Pocosin	Dare	Typic Medisaprist
3	Low Pocosin	Croatan	Terric Medisaprist
4	Gum Swamp	Dare	Typic Medisaprist
5	Gum Swamp	Croatan	Terric Medisaprist
6	Flatwoods	Lenoir	Aeric Paleaquult
7	Medium Pocosin	Dare	Typic Medisaprist
8	Flatwoods	Leaf	Typic Albaquult
9	Medium pocosin	Dare	Typic Medisaprist
10	Bay Forest	Croatan	Terric Medisaprist
11	Flatwoods	Bayboro	Umbric Paleaquult
12	Low Pocosin	Dare	Typic Medisaprist
13	Low Pocosin	Dare	Typic Medisaprist
14	Low Pocosin	Dare	Typic Medisaprist
15	High Pocosin	Croatan	Terric Medisaprist
16	Low Pocosin	Dare	Typic Medisaprist
17	Low Pocosin	Dare	Typic Medisaprist
18	Flatwoods	Pantego	Umbric Paleaquult
19	Gum Swamp	Dorovan	Typic Medisaprist
20	Gum Swamp	Dorovan	Typic Medisaprist
21	Lake-shore Swamp	Dare	Typic Medisaprist
22	Lake-shore Swamp	Dare	Typic Medisaprist
23	Lake-shore Swamp	Croatan	Terric Medisaprist
24	Savannah	Onslow	Spodic Paleudult
25	Gum Swamp	Dorovan	Typic Medisaprist
26	Swamp Forest	Dorovan	Typic Medisaprist

At each herb quadrat a sample of the 0-10 cm of surface soil or peat was collected; these samples were pooled for each sample point, providing five soil samples for each sample area. The depth of the peat and depth to the water table were also measured at each sample point (five points per area) using a PVC rod. In addition, a soil pit was dug in each sample area to describe the soil profile.

Soil samples were sieved to pass a 1.0-cm mesh screen, and samples were sent to the North Carolina State University Agricultural Soil Testing Service for analyses that included available phosphate; exchangeable Ca, Mg, K, Na, Zn, Cu, and Mn, cation exchange capacity; total exchangeable bases; percent exchangeable bases; disturbed bulk density; and pH.

Vegetation data for each site are summarized in Appendix E. Wetland species weights were determined for each species as described above (Appendix F). Species abundances within each stratum were related to total abundance of all species in that stratum. As with the Woodwell data set, species occurring in separate strata were treated as separate species in DCA and WA ordinations. The results of these ordinations were subsequently compared to soil and site variables using correlation analysis.

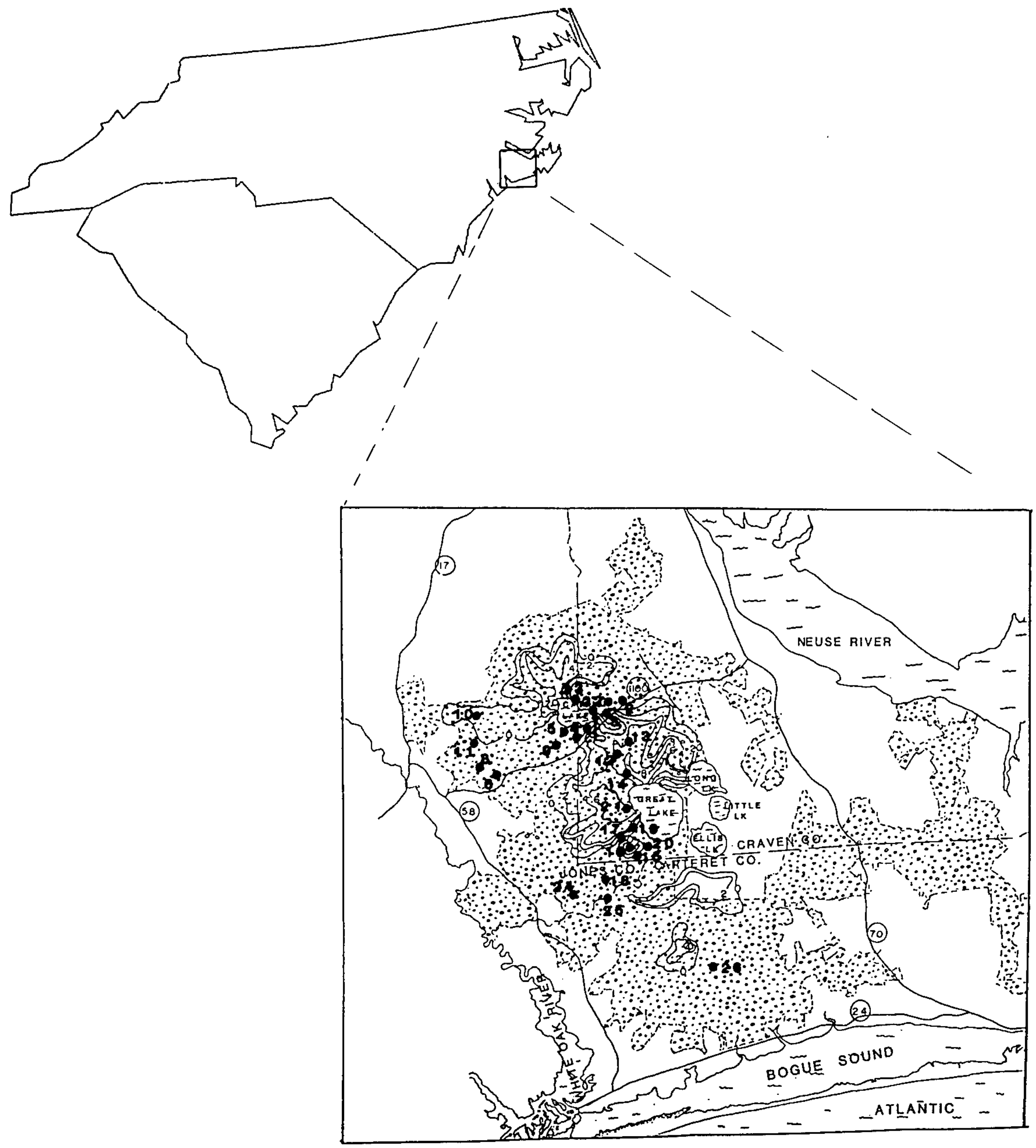

Figure 1. Location of study sites in the Croatan National Forest (stippled area). Peat depth isoclines are indicated in meters. Circled numbers are major highways.

RESULTS AND DISCUSSION

SOUTHEAST REGIONAL SURVEY

DCA and WA scores for each of the "samples" are given in Appendix B, and stand scores for the first two DCA axes are plotted in Figure 2a. Each DCA axis represents an independent trend in species compositional change, with the first axis accounting for the greatest amount of change and each subsequent axis accounting for less change (see Gauch 1982 for a general review and discussion of both DCA and WA). Recall that stand DCA scores are assigned with no *a priori* assumptions about species' wetland status. WA scores varied from a low of 1.53 in samples taken in vegetation in frequently inundated zones along rivers to 4.41 in the xeric sand ridges near Carolina bays. First axis DCA scores had a very weak linear correlation with WA scores ($r = -0.22$, $P < 0.007$), whereas second axis scores were quite clearly correlated with stand weighted averages ($r = 0.84$, $P < 0.0001$). (An analysis of residuals in the comparison of DCA axis one scores and WA scores revealed a clear bimodal relationship.) Note that WA scores reflect variations among stands with respect to the prevalence of plants in various water-tolerance classes, whereas DCA scores reflect relationships among stands with respect to overall trends in variation in species composition.

The relationships among the various samples are more obvious in the 3-dimensional plot of the first and second DCA axes and WA scores in Figure 2b. Note that sites with the lowest weighted averages are clustered near the center of DCA axis one, and that they share low DCA axis two scores. Pocosin wetlands grade toward the right into wet flatwoods on mineral soils (gallberry/saw palm). The former occur on histosols, whereas the latter are characteristic of gleyed, frequently inundated ultisols (Aquults). These flatwoods, in turn, grade into dryer flatwood, savanna, and sandhill forests. To the left on axis one, pocosins grade into a variety of other wetland types. This portion of the ordination is enlarged in Figure 2c. High pocosins, bay forests, and nonalluvial white cedar swamp forests are adjacent to the pocosins with the lowest WA scores. These nonalluvial forested wetlands share many species in common with pocosins and occur on peat of varying depth. These wetlands in turn grade into closed-drainage wetlands such as bayheads and cypress domes. Alluvial swamp forests (equivalent to zone II forests of Wharton et al. 1982) represent a second area of low WA scores in this ordination. These forests grade into zone III and IV bottomland forests and mesic upland deciduous forests, with decreasing first DCA axis and increasing second DCA axis scores; note the rapid increase in WA scores along the gradient from zone II forests to mesic uplands (Figure 2c).

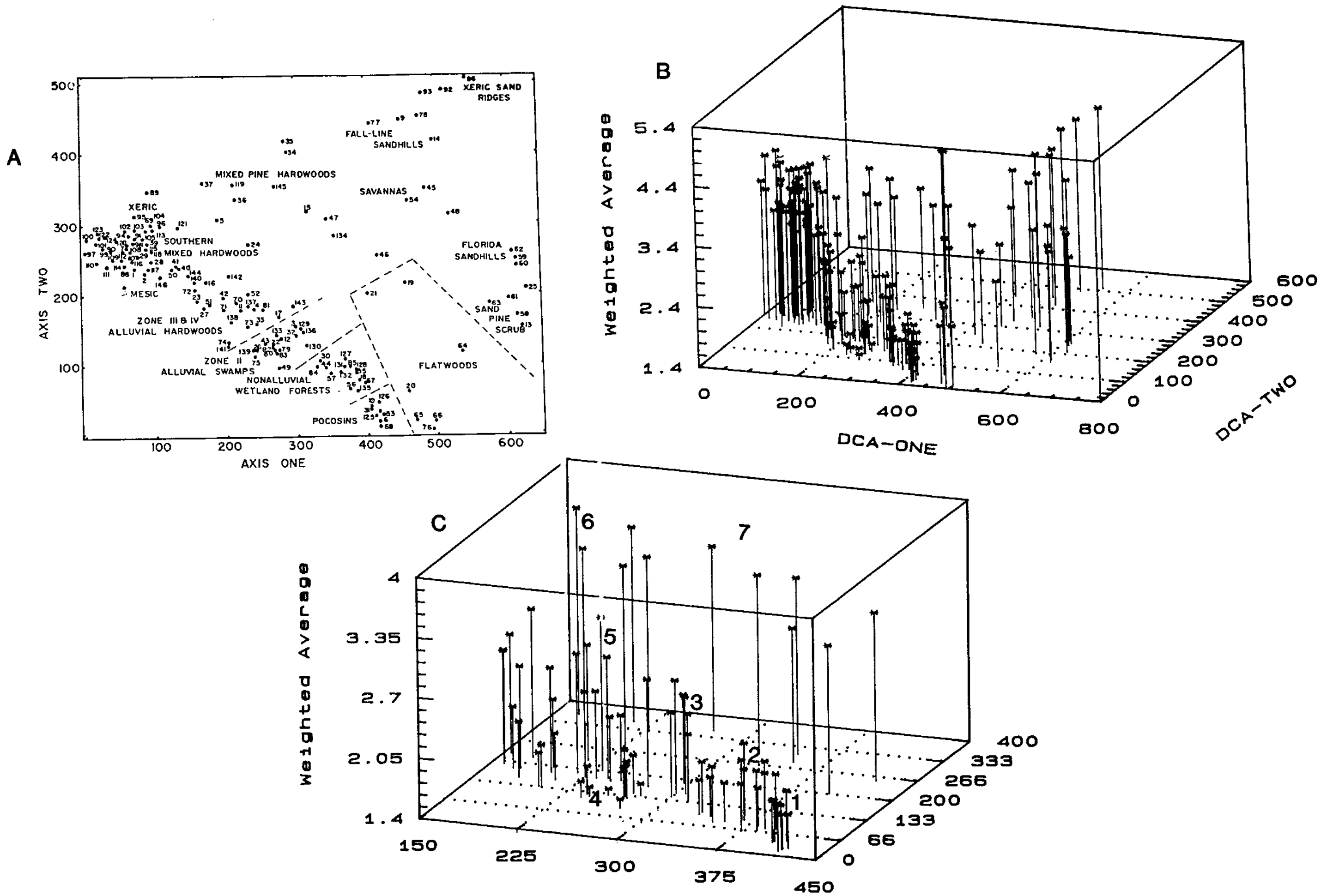

Figure 2. The results of detrended correspondence analysis (DCA) and weighted average (WA) ordination of the southeastern regional data set. A. DCA axis one plotted against DCA axis two. The numbers beside each point indicate sample references (Appendix B). B. DCA axis one and DCA axis two plotted against stand wetland indicator weighted averages. C. Wetland portion of graph B expanded (note change in scale). Numbers indicate locations of pocosins (1), white cedar swamp forests (2), bay forests (3), alluvial swamps (4), bottomland hardwoods (5), transitional hardwoods (6), and savannas (7).

Several conclusions can be drawn from these analyses.

1. Pocosin wetlands have WA scores of roughly the same magnitude (1.5-1.9) as the most frequently inundated swamp forests.

2. Despite this similarity, pocosins share more species in common with other paludal wetland and certain transitional upland communities, which have higher WA scores than alluvial swamp forests.

3. Pocosins grade into bay forests and nonalluvial white cedar swamp forests on shallower peats, which, in turn, grade into closed-drainage, mineral-soil swamp forests (bayheads and cypress domes). Shared species between pocosins and these forest types include various bay species (*Magnolia virginiana*, *Persea borbonia*, and *Gordonia lasianthus*), ti-ti (*Cyrilla racemiflora*), and *Pinus serotina*.

4. With decreasing peat depth and less frequent inundation, pocosins grade into flatwoods typified by frequently saturated mineral soils (often gleyed Aquults). Shared species with such flatwoods include *Ilex glabra*, *Ilex coriacea*, *Vaccinium corymbosum*, *Aronia arbutifolia*, and *Gaylussacia* spp.

WETLANDS OF THE CAROLINAS--THE WOODWELL DATA

The Woodwell data set differs from the Southeast regional data set in that the data are more detailed, and they focus on a specific region (the Carolinas) and on a specific group of communities (wetlands). DCA and WA scores and a summary of site data for each of the sampled stands are given in Table 3. A 3-dimensional plot of DCA axes one and two and WA scores is displayed in Figure 3.

The mean weighted average for all wetlands taken together was 2.13 (SE = 0.049); obviously such a value is greatly influenced by sampling intensity of different areas along wetland gradients. As in the regional analysis, pocosins have intermediate DCA first axis scores and low DCA second axis scores. WA scores showed no significant linear relationship with DCA one and only a weak relationship with DCA two ($r = 0.27$, $P < 0.001$). However, examination of Figure 3 reveals that the distribution of WA stand scores with respect to DCA axis scores is clearly nonrandom. Average WA scores are lowest for samples classified by Woodwell as pocosins (1.88, SE = 0.024), intermediate for swamp forests (2.25, SE = 0.042), and highest for savannas (2.42, SE = 0.092).

Significant correlations between soil-site variables and ordination scores are displayed in Table 4. For all stands taken together, the first DCA axis was strongly negatively correlated with the time elapsed since the last fire. This reflects the fact that fire return intervals are shortest in

Table 3. Locations and site conditions for communities sampled by Woodwell (1956). WA1 refers to weighted average scores calculated on the basis of abundance, whereas WA2 refers to weighted average scores calculated on the basis of presence-absence data.

Stand #	County State	Community type	Soil series	Peat depth (cm)	Water table depth (cm)	Age since burn (yr)	WA1	WA2	DCA1	DCA2
1	Onslow, NC	Pocosin	Unknown	36	2	12	1.94	2.00	316	58
2	Onslow, NC	Pocosin	Unknown	9	6	1	1.96	2.07	327	106
3	Pender, NC	Pocosin	Unknwon	48	0	15	1.67	1.92	287	82
4	Pender, NC	Pocodin	Unknwon	15	0	1	1.90	2.00	308	47
5	Bladen, NC	Pocosin	Unknown	6	8	7	1.88	1.93	317	53
6	Bladen, NC	Pocosin	Unknown	8	0	6	1.99	2.10	301	69
7	Bladen, NC	Pocosin	Unknown	48	100	0	1.85	1.90	273	96
8	Bladen, NC	Pocosin	Unknown	44	0	9	1.76	1.83	316	12
9	Bladen, NC	Pocosin	Unknown	17	0	12	1.98	2.07	318	56
10	Bladen, NC	Pocosin	Unknown	6	100	15	1.92	1.90	327	50
11	Brunswick, NC	Pocosin	Murville	37	100	5	2.05	2.09	292	74
12	Brunswick, NC	Pocosin	Murville	5	60	10	1.79	1.81	328	54
13	Horry, SC	Pocosin	Hobcaw	10	36	9	2.13	2.25	337	58
14	Horry, SC	Pocosin	Johnston	37	1	1	1.71	1.60	318	49
15	Horry, SC	Pocosin	Lynn Haven	25	27	6	1.72	1.75	301	60
16	Horry, SC	Pocosin	Johnston	27	20	6	1.56	1.66	295	45
17	Horry, SC	Pocosin	Johnston	26	8	9	2.09	2.16	287	36
18	Horry, SC	Pocosin	Johnston	28	14	7	1.87	2.00	337	37
19	Horry; SC	Pocosin	Johnston	23	13	3	1.92	0.90	305	55
20	Georgetown, SC	Pocosin	Lynn Haven	10	5	6	1.77	1.83	264	12
21	Georgetown, SC	Pocosin	Lynn Haven	15	100	6	1.74	1.83	262	86
22	Charleston, SC	Pocosin	St.Johns	10	13	5	2.07	2.11	320	21
23	Georgetwon, SC	Pocosin	Hobonny	32	1	1	1.58	1.33	335	41
24	Berkeley, SC	Pocosin	Raines	5	19	19	2.23	2.00	318	88
25	Berkeley, SC	Pocosin	Meggett	8	100	8	1.85	2.07	318	79
26	Berkeley, SC	Pocosin	Raines	13	39	1	1.45	1.31	327	155
27	Berkeley, SC	Pocosin	Raines	2	13	10	1.86	2.00	296	73
28	Berkeley, SC	Pocosin	Leon	15	0	10	2.20	2.00	250	120
29	Berkeley, SC	Pocosin	Leon	21	6	25	1.74	1.75	336	35
30	Berkeley, SC	Pocosin	Pickney	24	8	1	1.86	1.87	320	51
31	Horry, SC	Pocosin	Lynn Haven	20	22	1	2.09	2.23	356	99
32	Brunswick, NC	Pocosin	Croatan	12	6	12	1.70	1.72	306	95
33	Brunswick, NC	Pocosin	Unknown	2	48	8	1.76	1.84	359	62
34	Brunswick, NC	Pocosin	Murville	4	100	10	1.93	1.85	327	21
35	Columbus, NC	Pocosin	Unknown	14	17	4	2.14	2.30	325	66
36	Columbus, NC	Pocosin	Unknown	12	48	10	2.00	2.14	281	113

(Continued)

Table 3. (Continued)

Stand #	County	State	Community type	Soil series	Peat depth (cm)	Water table depth (cm)	Age since burn (yr)	WA1	WA2	DCA1	DCA2
37	Columbus, NC		Pocosin	Unknown	24	0	1	1.79	1.90	293	73
38	Bladen, NC		Pocosin	Unknown	18	1	6	1.64	1.76	323	105
39	Bladen, NC		Pocosin	Unknown	25	12	12	1.69	1.78	318	36
40	Bladen, NC		Pocosin	Unknown	3	6	15	1.76	1.81	340	128
41	Bladen, NC		Pocosin	Unknown	6	2	100	2.36	2.23	259	62
42	Bladen, NC		Pocosin	Unknown	24	4	5	1.78	1.83	328	15
43	Pender, NC		Pocosin	Unknown	48	24	6	1.92	1.85	289	13
44	Pender, NC		Pocosin	Unknown	18	0	2	1.54	1.60	303	30
45	Onslow, NC		Pocosin	Unknown	9	0	15	1.80	1.85	331	49
46	New Hanover, NC		Pocosin	Unknown	24	2	6	1.97	2.00	337	41
47	Carteret, NC		Pocosin	Unknown	18	0	15	1.99	2.08	308	60
48	Carteret, NC		Pocosin	Unknown	18	0	6	1.90	2.10	333	57
49	Pamlico, NC		Pocosin	Unknown	48	0	1	2.27	2.20	329	39
50	Craven, NC		Pocosin	Unknown	60	0	12	1.72	1.72	339	0
51	Marion, SC		Pocosin	Unknown	36	3	1	1.72	1.80	349	11
52	Berkeley, SC		Pocosin	Unknown	4	36	2	2.08	2.22	348	92
53	Horry, SC		Pocosin	Johnston	28	19	1	1.84	1.87	338	88
54	Horry, SC		Pocosin	Unknown	8	14	1	2.00	2.00	502	347
55	Brunswick, NC		Pocosin	Murville	36	100	12	1.95	1.92	336	43
56	Brunswick, NC		Pocosin	Murville	36	100	1	1.91	1.81	357	48
57	Pender, NC		Pocosin	Unknown	18	1	15	1.84	1.82	348	106
58	Brunswick, NC		Pocosin	Murville	12	6	10	2.10	2.27	382	76
59	Onslow, NC		Savanna	Unknown	9	19	3	2.40	2.34	471	188
60	Bladen, NC		Savanna	Unknown	6	0	1	2.33	2.36	421	259
61	Columbus, NC		Savanna	Unknown	3	100	1	2.50	2.31	465	247
62	Onslow, NC		Savanna	Unknown	10	6	100	2.34	2.27	465	220
63	Georgetown,SC		Savanna	Grifton	8	12	5	2.34	2.36	96	446
64	Georgetown, SC		Savanna	Wahee	6	100	6	2.67	2.46	465	162
65	Georgetown, SC		Savanna	Unknown	6	20	5	2.03	2.17	395	381
66	Georgetown, SC		Savanna	Bladen	16	17	3	1.85	2.12	245	298
67	Georgetown, SC		Swamp	Bladen	5	36	1	1.92	1.91	398	141
68	Georgetown, SC		Savanna	Bladen	3	10	1	1.77	2.00	408	208
69	Georgetown, SC		Savanna	Grifton	8	100	6	2.12	2.73	359	358
70	Georgetown, SC		Savanna	Bladen	2	0	5	1.54	2.00	315	335
71	Berkeley, SC		Savanna	Coxville	4	39	10	2.61	2.73	308	264
72	Horry, SC		Savanna	Unknown	3	48	4	3.03	2.54	522	159
73	Horry, SC		Savanna	Unknown	3	100	4	1.36	1.66	393	344
74	Horry, SC		Savanna	Leon	5	24	3	3.15	2.78	519	144
75	Horry, SC		Savanna	Ogeechee	6	4	5	2.40	2.08	513	211
76	Brunswick, NC		Savanna	Leon	3	100	3	3.11	2.76	487	141

(Continued)

Table 3. (Continued)

Stand #	County	State	Community type	Soil series	Peat depth (cm)	Water table depth (cm)	Age since burn (yr)	WA1	WA2	DCA1	DCA2
77	Bladen,	NC	Savanna	Unknown	4	12	10	2.96	2.34	453	154
78	Pender,	NC	Savanna	Unknown	9	0	1	2.15	2.13	460	94
79	Onslow,	NC	Savanna	Unknown	4	7	10	2.91	2.65	491	138
80	Onslow,	NC	Savanna	Unknown	6	8	10	2.84	2.47	459	100
81	Onslow,	NC	Savanna	Unknown	8	5	15	2.24	2.26	448	156
82	Pender,	NC	Savanna	Unknown	5	14	5	2.61	2.35	529	162
83	Craven,	NC	Savanna	Unknown	6	18	2	2.33	2.33	468	170
84	Onslow,	NC	Savanna	Unknown	9	0	3	2.13	2.04	391	66
85	Brunswick,	NC	Savanna	Leon	2	100	2	3.34	2.87	557	155
86	Bladen,	NC	Savanna	Unknown	3	1	5	2.23	2.33	470	279
87	Columbus,	NC	Swamp	Unknown	18	0	100	2.19	2.08	112	170
88	Columbus,	NC	Swamp	Unknown	12	5	100	1.94	1.90	129	185
89	Brunswick,	NC	Swamp	Lynchburg	3	100	20	2.34	2.29	209	179
90	Horry,	SC	Swamp	Hobcaw	2	100	100	2.51	2.55	131	205
91	Horry,	SC	Swamp	Yonges	0	4	100	2.63	2.42	120	159
92	Georgetown,	SC	Swamp	Chipley	8	4	0	2.66	2.60	181	168
93	Georgetown,	SC	Swamp	Cape Fear	9	18	100	2.41	2.32	149	147
94	Georgetown,	SC	Swamp	Cape Fear	4	30	100	2.26	2.21	164	170
95	Georgetown,	SC	Swamp	Unknown	8	19	5	2.00	2.43	148	224
96	Georgetown,	SC	Swamp	Chastain	0	100	100	2.16	1.85	88	188
97	Georgetown,	SC	Swamp	Cape Fear	5	10	100	2.48	2.50	159	196
98	Georgetown,	SC	Swamp	Cape Fear	0	3	100	1.45	1.88	0	207
99	Georgetowm,	SC	Swamp	Cape Fear	0	100	100	1.77	1.90	32	205
100	Georgetown,	SC	Swamp	Unknown	2	42	20	2.50	2.39	175	160
101	Georgetown,	SC	Swamp	Unknown	6	36	100	2.99	2.73	145	193
102	Charleston,	SC	Swamp	Rutlege	4	1	100	1.90	2.15	151	204
104	Charleston,	SC	Swamp	Chastain	0	5	2	2.39	2.16	139	197
105	Williamsbg,	SC	Swamp	Cape Fear	12	1	20	1.93	2.08	120	189
106	Williamsbg,	SC	Swamp	Unknown	6	4	100	2.25	2.25	174	209
107	Williamsbg,	SC	Swamp	Unknown	9	100	100	2.59	2.56	95	178
108	Georgetown,	SC	Swamp	Johnston	7	11	20	2.10	2.30	117	216
109	Berkeley,	SC	Swamp	Meggett	8	100	10	2.89	2.80	106	203
110	Berkeley,	SC	Swamp	Unknown	31	100	10	2.14	2.22	116	190
111	Berkeley,	SC	Swamp	Goldsboro	18	100	5	2.53	2.33	137	187
112	Berkeley,	SC	Swamp	Goldsboro	16	100	1	1.91	1.66	256	94
113	Berkeley,	SC	Swamp	Goldsboro	11	100	25	2.45	2.35	137	163
114	Berkeley,	SC	Swamp	Raines	48	100	25	2.29	1.93	168	193
115	Berkeley,	SC	Swamp	Goldsboro	34	23	6	1.66	1.80	227	172
116	Berkeley,	SC	Swamp	Byars	23	28	10	2.25	2.23	167	106
118	Berkeley,	SC	Swamp	Bayboro	13	9	20	2.00	1.84	181	161

(Continued)

Table 3. (Concluded)

Stand #	County	State	Community type	Soil series	Peat depth (cm)	Water table depth (cm)	Age since burn (yr)	WA1	WA2	DCA1	DCA2
119	Berkeley,	SC	Swamp	Raines	14	13	10	2.28	2.50	190	94
120	Berkeley,	SC	Swamp	Goldsboro	17	20	100	2.35	2.33	184	148
121	Berkeley;	SC	Swamp	Baysboro	8	24	9	1.85	1.77	168	224
122	Berkeley,	SC	Swamp	Chastain	7	10	100	1.99	1.87	74	233
123	Marlboro,	SC	Swamp	Unknown	0	1	100	1.85	2.33	42	210
124	Columbus,	NC	Swamp	Unknown	48	0	100	2.05	2.38	107	181
125	Brunswick,	NC	Swamp	Unknown	19	100	1	1.95	2.16	247	114
126	Columbus,	NC	Swamp	Unknown	20	17	20	2.30	2.30	191	104
127	Columbus,	NC	Swamp	Uknownn	33	10	7	2.16	2.55	242	46
128	Bladen,	NC	Swamp	Unknown	0	14	10	2.59	2.53	139	157
129	Columbus,	NC	Swamp	Unknown	36	0	100	2.21	2.07	192	85
130	Onslow,	NC	Swamp	Unknown	48	0	100	2.33	2.42	176	72
131	Onslow,	NC	Swamp	Unknown	48	0	20	2.44	2.40	167	109
132	Onslow,	NC	Swamp	Unknown	26	5	1	2.45	2.34	225	86
133	Onslow,	NC	Swamp	Unknown	26	0	100	1.74	1.93	209	63
134	Pamlico,	NC	Swamp	Unknown	18	0	10	2.65	2.61	168	151
135	Georgetown,	SC	Swamp	Unknown	26	38	100	2.67	2.63	204	128
136	Berkeley,	SC	Swamp	Unknown	9	24	20	2.04	2.36	273	98
137	Georgetown,	SC	Swamp	Unknown	0	5	0	2.11	2.28	40	223
139	Williamsbg,	SC	Swamp	Unknown	13	8	10	2.40	2.26	148	175
140	Brunswick,	NC	Swamp	Unknown	2	2	15	2.54	2.54	87	149

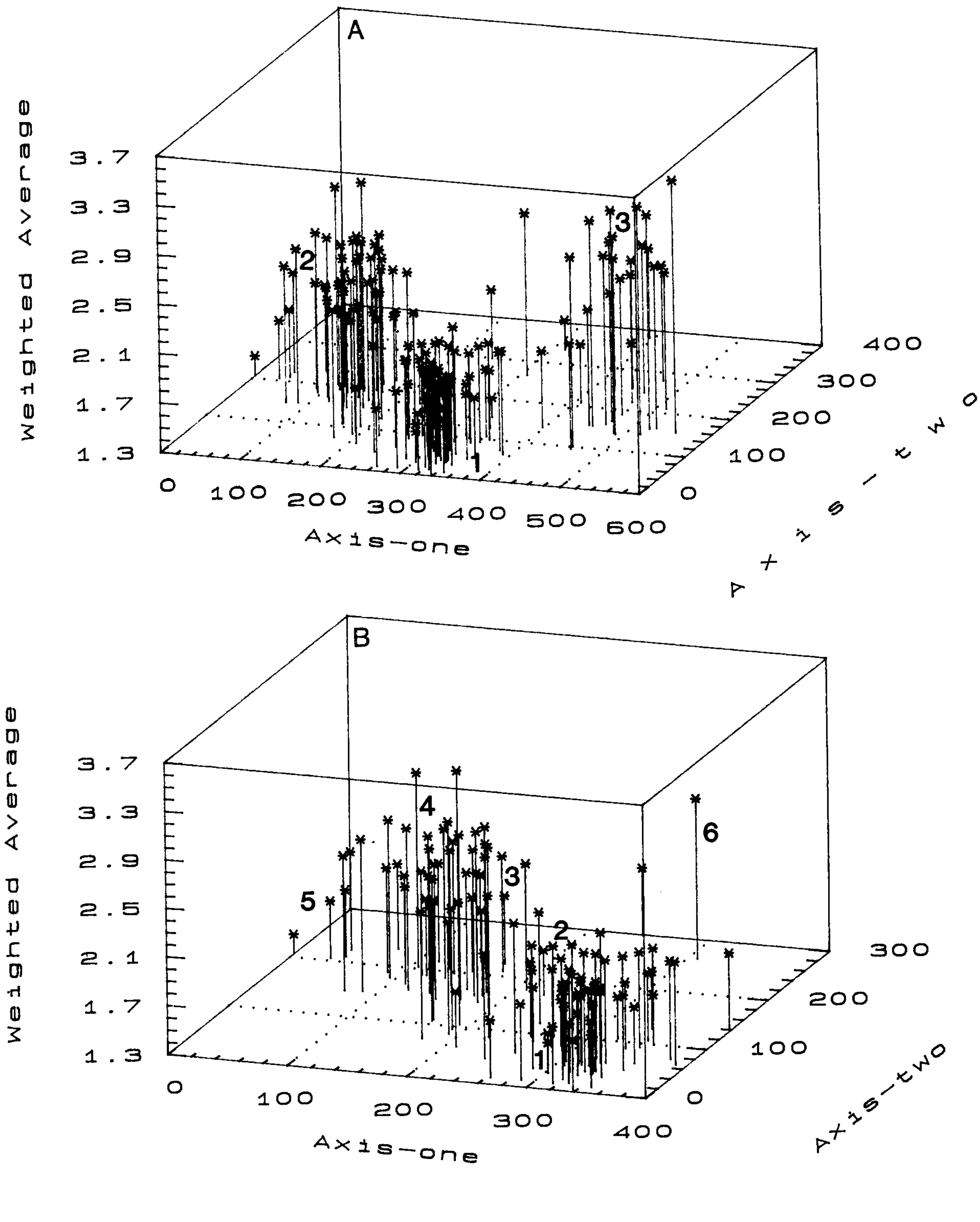

Figure 3. DCA axis one and DCA axis two plotted against the wetland indicator weighted averages for stands sampled by Woodwell (1956). Graph A includes all samples; (1) indicates pocosin samples, (2) swamp forest samples, (3) savanna samples. Graph B is an expanded plot of pocosin and swamp forest samples. Numbers indicate locations of low pocosin (1), high pocosin (2), bay forest (3), gum swamp (4), alluvial cypress swamp (5), and savanna samples (6).

Table 4. Correlations between DCA axis one (DCA1), DCA axis two (DCA2), WA (based on abundances = WA1 and species presence or absence = WA2) scores, and soil-site variables for Woodwell data. Significance levels (p) are indicated by a < 0.05, b < 0.01, and c < 0.001.

Data set	Site variable	DCA1	DCA2	WA1	WA2
All samples (N = 140)	Peat depth	--	-0.46[c]	-0.28[c]	-0.30[c]
	Water table depth	--	--	--	--
	B-horizon depth	--	-0.26[b]	-0.16[a]	-0.21[a]
	Time since burn	-0.54[c]	--	--	--
Pocosins only (N = 58)	Peat depth	--	-0.32[b]	--	--
	Water table depth	--	--	--	--
	B-horizon depth	--	-0.24[a]	--	--
	Time since burn	0.24[a]	--	--	--
Savannas only (N = 28)	Peat depth	--	-0.38[a]	--	--
	Water table depth	--	--	--	--
	B-horizon depth	--	--	--	--
	Time since burn	--	--	--	--
Swamp forests only (N = 54)	Peat depth	0.29[a]	-0.51[c]	--	--
	Water table depth	--	--	--	--
	B-horizon depth	--	--	--	--
	Time since burn	-0.37[b]	--	--	--

savannas (3-10 yr), intermediate in pocosins (20-50 yr), and longest in swamp forests (highly variable, but usually >50 yr). Peat depth and the depth to fine-textured soil horizons were correlated with DCA axis 2 and WA scores for all stands taken together.

In pocosins and swamp forests, DCA axis one was negatively correlated with the time since the last burn (Table 4). In Savannas, DCA axis one was **negatively** correlated with the depth of of peat, whereas in swamp forests DCA axis one was **positively** correlated with peat depth. In other words, peat depth in both of these ecosystem types increases as they become more pocosin-like. In pocosins, DCA axis two was correlated with peat depth. Within each community type, WA scores were not correlated with any soil-site variables; however, the correlation coefficients showed the same trends as observed for DCA axis 2. This may reflect the multiplicity of factors (e.g., natural and man-caused disturbance, soil nutrients, etc.) besides water availability that contribute to vegetation variation **within** a particular community type. Variations in hydrology and water availability obviously play a very important role in the distribution of species **among** these three community types.

The savannas that were most similar to pocosins occurred on gleyed Aquults (clay-rich, frequently inundated), which tend to have a large component of shrub species such as *Ilex glabra*, *Vaccinium* spp., and *Gaylussacia* spp. Woodwell's swamp forest category included vegetation ranging from bay forest to gum swamp to alluvial cypress swamp. An enlargement of that portion of the ordination that includes the swamp forests and pocosins reveals (Figure 3b) that WA increases along the gradient from pocosins to bay forests, then decreases as forests grade into alluvial swamps. Again, although alluvial swamps and pocosins have similar WA scores, they share few species in common. A simple WA ordination may correctly classify an area with regard to wetland status; however, by using a combination of WA and DCA ordinations, specific kinds of wetlands (e.g., paludal vs. alluvial) can be differentiated.

THE CROATAN NATIONAL FOREST

DCA and WA scores for the stands sampled in the Croatan National Forest are displayed in Table 5, and site and soil characteristics are described in Table 6. The results of DCA analysis that included stand # 24 (the only savanna sampled) were confusing, owing to the comparative dissimilarity of this stand to all of the others. Therefore, DCA analysis was done with this sample excluded. First and second DCA axis scores are displayed in relation to stand weighted averages in Figure 4.

Mean weighted average (based on abundance data) for all stands was 2.14 (SE = 0.06); for pocosins only, WA = 1.95 (SE = 0.09). DCA axes 2, 3, and 4 showed no correlation with any environmental factors, nor with WA scores. However, DCA axis one was highly correlated with stand WA ($r = 0.86$, $P < 0.0001$) (Figure 4). Note that true alluvial swamp forests (Zone II alluvial forests, Wharton et al. 1982), such as those with low WA scores in the regional and Woodwell analyses, do not occur in Croatan National Forest and are not included in this data set. Had such stands been included, the relationship with DCA axis one would likely have been more complex.

Table 5. DCA and weighted averages for stands sampled in Croatan National Forest. WA1 refers to weighted averages calculated on the basis of abundance data, and WA2 refers to weighted averages calculated on the basis of presence-absence data.

Stand	Community	Soil series	WA1	WA2	DCA-1	DCA-2	DCA-3	DCA-4
1	Low Pocosin	Dare	1.91	1.80	0	140	70	86
2	Medium Pocosin	Dare	1.94	1.90	76	127	55	75
3	Low Pocosin	Croatan	1.85	1.92	7	157	76	90
4	Gum Swamp	Dare	2.72	2.58	297	140	138	131
5	Gum Swamp	Croatan	2.89	2.77	323	68	116	153
6	Flatwoods	Lenoir	2.29	2.56	288	278	63	0
7	Medium Pocosin	Dare	1.69	1.72	31	138	113	34
8	Flatwoods	Leaf	2.11	2.24	161	130	82	80
9	Medium Pocosin	Dare	1.80	1.84	76	129	131	6
10	Bay Forest	Croatan	2.00	2.00	164	101	0	50
11	Flatwoods	Bayboro	2.06	2.25	185	136	16	45
12	Low Pocosin	Dare	1.94	1.95	3	117	148	22
13	Low Pocosin	Dare	1.94	1.94	6	142	100	63
14	Low Pocosin	Dare	1.95	1.85	147	156	129	42
15	High Pocosin	Croatan	1.88	1.73	1	132	137	35
16	Low Pocosin	Dare	1.98	2.00	35	150	44	108
17	Low Pocosin	Dare	1.90	1.83	11	134	89	72
18	Flatwoods	Pantego	2.58	2.45	247	191	99	78
19	Gum Swamp	Dorovan	2.38	2.69	320	164	88	4
20	Gum Swamp	Dorovan	2.51	2.57	278	98	120	85
21	Lake-shore Swamp	Dare	2.11	2.09	174	77	193	20
22	Lake-shore Swamp	Dare	2.20	2.26	264	49	61	30
23	Lake-shore Swamp	Croatan	2.04	2.08	199	71	65	10
24	Savannah	Onslow	2.82	2.90	***	***	***	***
25	Gum Swamp	Dorovan	2.56	2.51	347	63	125	45
26	Gum Swamp	Dorovan	2.32	2.48	283	0	48	15

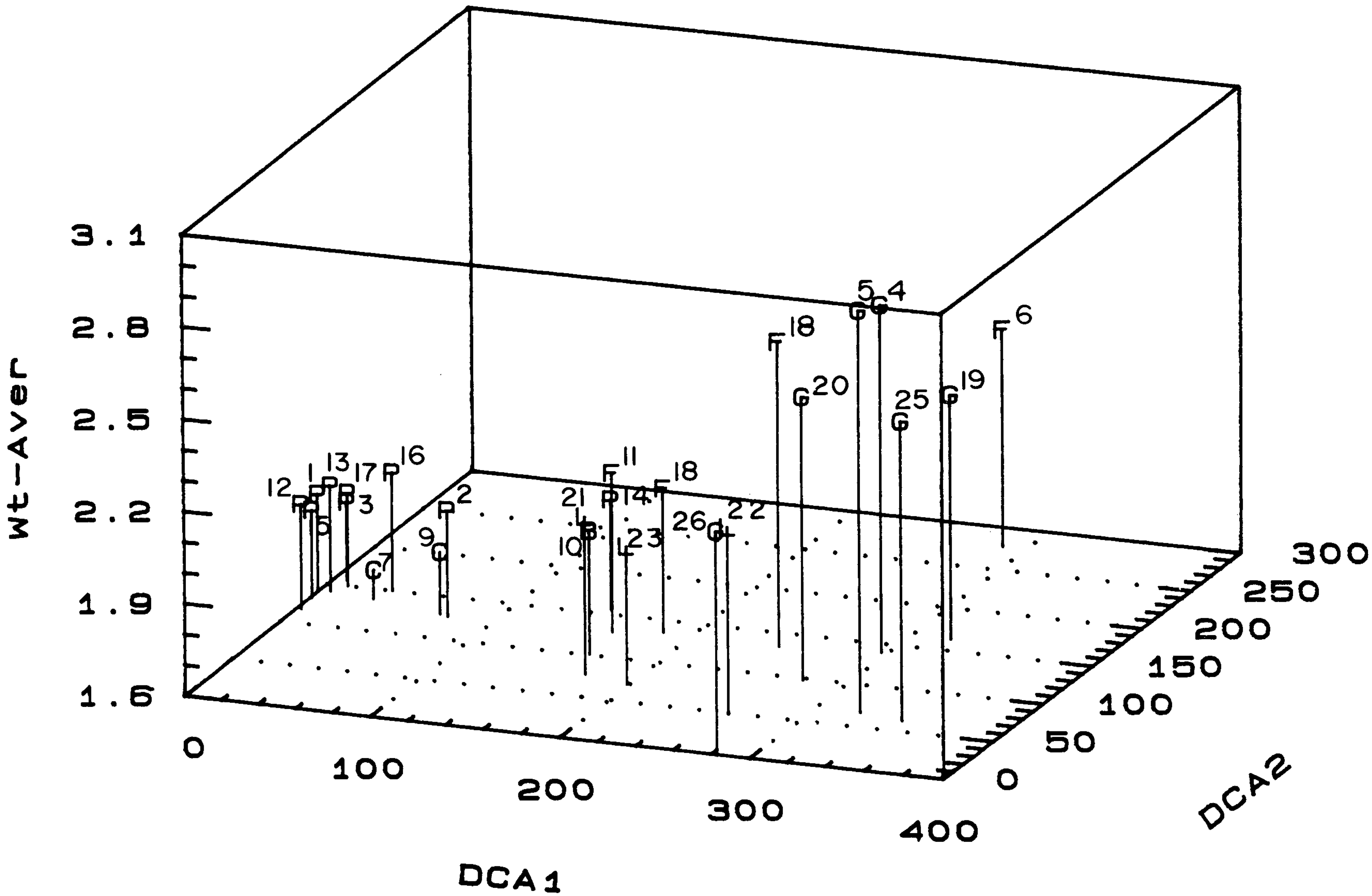

Figure 4. DCA axis one and DCA axis two plotted against the wetland indicator weighted averages (calculated on the basis of abundance data) for stands sampled in Croatan National Forest. Numbers beside each point indicate samples described in Table 2. P refers to pocosin, C refers to pocosin with Atlantic white cedar, B refers to flatwoods, L refers to lakeshore swamp forest, and G refers to gum swamp.

Table 6. Soil-site characteristics for stands sampled in Croatan National Forest

Stand #	Age	Peat Depth (cm)	Depth to Water (cm)	PO4	Ca	Mg	K	CEC	% Bases	pH	Zn	Mn	Cu
1	33	190	35	1.5	1.35	1.12	0.182	12.97	21.93	3.75	2.57	1.80	0.22
2	37	81	36	1.8	0.84	1.35	0.192	13.34	20.26	3.65	2.10	1.52	0.20
3	35	109	49	3.4	0.74	1.48	0.194	13.29	20.48	3.50	2.00	1.44	0.20
4	50	180	10	6.2	0.68	0.79	0.176	11.52	15.84	3.77	4.00	1.96	0.60
5	80	65	28	10.0	0.84	0.68	0.248	12.87	17.54	3.71	4.54	2.08	0.38
6	29	48	25	4.0	0.32	0.24	0.13	8.35	10.52	4.04	0.88	0.76	0.22
7	34	143	24	3.8	0.68	0.94	0.20	13.18	17.52	3.60	4.46	1.20	0.20
8	47	17	>100	4.2	0.86	0.84	0.18	11.18	18.38	3.78	2.14	1.84	0.34
9	37	196	10	3.0	0.70	0.98	0.19	12.24	17.94	3.60	5.62	1.84	0.24
10	63	92	57	3.2	1.10	1.48	0.18	14.01	21.28	3.57	2.16	1.72	0.26
11	47	121	60	6.6	0.76	2.86	0.16	11.92	16.80	3.50	2.80	1.44	0.22
12	15	209	7	2.0	0.50	1.69	0.26	13.60	19.18	3.49	2.50	1.16	6.32
13	33	97	13	2.4	0.82	1.76	0.25	13.71	21.84	3.51	2.54	1.84	1.86
14	25	210	44	5.2	0.56	1.41	0.15	11.33	19.88	3.61	1.40	0.60	0.70
15	25	137	10	2.8	0.38	1.22	0.22	11.27	17.26	3.56	3.34	1.24	8.46
16	24	230	50	2.4	1.28	1.25	0.21	12.86	22.22	3.52	1.56	1.48	0.70
17	24	200	40	1.4	1.46	1.88	0.22	13.56	21.72	3.53	3.58	2.44	2.40
18	50	0	120	3.9	0.66	0.98	0.19	12.77	15.28	3.47	1.80	1.40	0.62
19	80	175	40	19.8	1.06	0.78	0.19	12.96	16.00	3.49	3.02	2.40	1.62
20	80+	114	40	18.8	0.34	0.39	0.24	9.77	7.95	3.64	1.74	2.40	2.98
21	100	115	23	6.4	0.52	0.70	0.14	10.9	13.68	3.55	2.78	0.88	4.22
22	100	161	24	11.6	0.58	0.87	0.17	12.59	14.08	3.48	3.03	0.88	1.08
23	100	176	18	6.3	0.50	0.77	0.15	12.12	12.90	3.37	3.06	0.93	4.43
24	60	0	100	1.6	0.36	0.22	0.06	8.89	8.02	3.74	0.94	0.48	0.86
25	60	0	100	5.2	2.70	0.50	0.14	10.59	32.64	4.23	1.90	1.00	2.60
26	41	116	46	3.4	1.30	0.57	0.14	11.16	18.40	3.75	3.24	1.32	4.02

The distribution of leading dominant species along DCA axis one is shown in Table 7. Species with low first-axis scores are more prevalent in pocosins, whereas those with high scores are most abundant in swamp forests. Recall that taxa that occurred in more than one sampling stratum were treated as different "species" for this analysis. Thus, the species score for a species sampled in the tree stratum might conceivably be different than the score for that species sampled in the shrub or herb stratum. Table 7 indicates that such is indeed the case. Species such as *Gordonia lasianthus*, *Lyonia lucida*, *Cyrilla racemiflora*, and *Myrica cerifera* have intermediate DCA axis one scores in the tree stratum, and decreasing scores in the shrub and herb strata. Thus, while such species may have relatively broad habitat distributions, their relative importance in various vegetation strata reflects narrower ranges of habitat variation. Overall, these data document the clear change in community physiognomy along DCA axis one (and in relation to weighted average scores) from low stature shrub bogs to multilayered swamp forests.

The first DCA axis and WA scores were highly correlated with the a number of soil and site variables (Table 8). Soil bulk density is taken here to be a proxy for organic matter; i.e., low bulk density indicates high organic matter content. Thus, the high positive correlation of bulk density with DCA axis one and WA scores is expected. The high correlation with phosphorus availability is consistent with observations cited earlier that pocosins are severely phosphorus limited. The cation results were interesting in that magnesium was considerably more concentrated relative to calcium in the pocosin areas compared to other ecosystems. This is probably a reflection of the fact that most of the pocosin areas are ombrotrophic, whereas the gum swamp and bay forest areas receive nutrients from runoff and mineral soil weathering. Differences in the ratios of magnesium to calcium among these soils may reflect the differences among sites with respect to nutrient source.

The correlation of DCA and WA scores with age of the oldest trees reflects the fact that fire return intervals are shorter in pocosins (every 30-50 years) than in bay forests and swamp forests (Christensen 1981). This is consistent with the results of the analyses of Woodwell's data.

Perhaps the most striking result of these analyses relative to the original goals of this study was the lack of an especially clear relationship between vegetation type and SCS soil series designations (Figure 4). Put another way, there is considerable variation in species composition and community structure among stands occurring on both Dare and Croatan soils.

The lack of clear relationships between soil series designations and widely differing vegetation types is probably due to the fact that local hydrologic conditions (e.g., proximity to lakes, patterns of groundwater flow,) and disturbance history play a considerable role in determining variation in vegetation composition in these wetlands. Perhaps over a broader range of soil types and ecosystems, clearer relationships would emerge; indeed, on a broad scale, vegetation variation is an essential tool in the mapping of soil types.

Table 7. DCA first axis scores for leading dominants in wetland communities of the Croatan National Forest. Stratum refers to the vegetational layer (T = tree, S = shrub, and H = herb layer) within which a species was sampled (please refer to the methods).

Species	Stratum	DCA score
Carpinus caroliniana	T	100
Quercus michauxii	T	100
Quercus nigra	T	100
Fraxinus pennsylvanica	T	100
Ilex opaca	T	98
Leucothoe axillaris	H	92
Arundinaria gigantea	H	88
Nyssa sylvatica	T	88
Liquidambar styraciflua	T	87
Acer rubrum	S	86
Itea virginica	S	84
Acer rubrum	T	79
Gelsemium sempervirens	H	78
Myrica heterophylla	T	78
Pinus taeda	T	76
Ilex cassine var. *myrtifolia*	H	74
Symplocus tinctora	H	74
Persea borbonia	T	73
Woodwardia areolata	H	72
Persea borbonia	S	71
Magnolia virginiana	T	71
Clethra alnifolia	H	71
Smilax laurifolia	S	70
Myrica heterophylla	S	69
Magnolia virginiana	S	68
Ilex coriacea	S	67
Ilex coriacea	H	66
Cyrilla racemiflora	T	64
Lyonia lucida	T	62
Ilex glabra	S	60
Myrica cerifera	T	57
Gordonia lasianthus	T	55
Lyonia lucida	S	55
Gaylussacia frondosa	S	54
Taxodium ascendens	T S	52

(Continued)

Table 7. (Concluded)

Species	Stratum	DCA score
Symplocus tinctora	T	52
Persea borbonia	H	52
Pinus serotina	T	44
Lyonia lucida	S	39
Myrica cerifera	S	34
Myrica cerifera	H	30
Chamaecyparis thyoides	T	29
Smilax laurifolia	H	29
Gordonia lasianthus	S	27
Cyrilla racimiflora	S	25
Aronia arbutifolia	S	24
Ilex glabra	H	23
Vaccinium crassifolium	H	19
Woodwardia virginica	H	14
Gordonia lasianthus	H	14
Cassandra calyculata	H	14
Cyrilla racemiflora	H	12
Gaylussacia frondosa	H	12
Rhododendron atlanticum	H	11
Zenobia pulverulenta	H	8
Gaylussacia dumosa	H	7
Aronia arbutifolia	H	6
Kalmia carolina	H	4
Carex walteriana	H	2
Pinus serotina	SH	2
Sarracenia purpurea	H	0

Table 8. Soil and site variables having significant linear correlations with the first DCA axis and WA scores.

Variable	Correlation with DCA one		Correlation with WA	
	r	P <	r	P <
Peat depth	-0.43	0.03	-0.44	0.02
Soil bulk density	0.55	0.003	0.46	0.01
Phosphate	0.63	0.0008	0.52	0.008
pH	0.42	0.03	0.40	0.05
Magnesium	-0.53	0.007	-0.48	0.01
Potassium	-0.45	0.02	ns	ns
CEC	-0.51	0.08	-0.36	0.07
Age	0.62	0.0009	0.46	0.02

Irrespective of community type, do communities on these soils vary with respect to wetland indicator status (WA scores) or DCA ordination scores? To answer this question, we divided sample sites into four soil groups, those occurring on Croatan, Dare, Dorovan, or mineral soil. Analysis of variance was used to determine if any significant differences in DCA or WA scores existed among these soil groups. The results of this analysis are displayed in Table 9. WA scores (calculated from both abundance and presence-absence data) were lowest on soils belonging to the Dare series (the deepest peats) and highest on Dorovan mucks (alluvial peat). Multiple range tests revealed considerable overlap. DCA axis one scores for samples taken on mineral soils differed significantly from those of samples taken on organic soil series. There were no significant differences among samples from organic soil series with respect to DCA scores.

Table 9. The results of analysis of variance with WA1 (weighted average scores calculated from abundance data), WA2 (weighted average scores calculated from presence-absence data), and DCA1 (DCA first axis scores) as dependent variables among soil-series groups (class variables). The soil-series groups were Dare (12 sites), Croatan (5 sites), Dorovan (4 sites), and mineral soils (5 sites). Vertical lines indicate statistically homogeneous subgroups based on Duncan's Multiple Range Test.

Soil-series group	Score	Statistics
Class variable = WA1		
Dorovan	2.45 |	$F_{3,22} = 3.17$
Mineral Soils	2.37 | |	$r^2 = 0.30$
Croatan	2.13 | |	$P < 0.05$
Dare	2.01 |	
Class variable = WA2		
Dorovan	2.57 |	$F_{3,22} = 7.17$
Mineral soils	2.48 |	$r^2 = 0.49$
Croatan	2.10 |	$P < 0.001$
Dare	1.98 |	
Class variable = DCA1		
Mineral soils	91.0 |	$F_{3,22} = 7.27$
Dorovan	56.5 |	$r^2 = 0.50$
Croatan	32.4 |	$P < 0.001$
Dare	26.3 |	

CONCLUSIONS

1. Weighted average ordinations of vegetation samples from across the southeastern Coastal Plain, calculated on the basis of species' wetland indicator designations (Reed 1986), indicate that pocosins are comparable to the most frequently inundated alluvial swamp forests with respect to their wetland scores.

2. Pocosins are transitional to wet flatwood communities on poorly drained clay aquults and share such species as *Ilex glabra*, *I. coriacea*, *Aronia arbutifolia*, *Vaccinium* sp., and *Gaylussacia* sp. They are also transitional to other nonalluvial wetlands such as bay forests, white cedar swamps, and cypress domes. *Gordonia lasianthus*, *Cyrilla racemiflora*, *Persea borbonia*, and *Magnolia virginiana* are among the species shared between pocosins and these wetlands.

3. Although pocosins share weighted average scores with alluvial swamp forests that are indicative of frequently inundated wetlands, they share few species in common. WA ordinations may be ideal for simple wetland designations; however, the combination of WA with other indirect ordination techniques (e.g., DCA) is more appropriate for differentiation of wetland types.

4. Patterns of variation in vegetational composition in wetlands sampled on the outer Coastal Plain of the Carolinas (as revealed by DCA and WA ordinations) were similar to patterns observed for the southeastern region taken as a whole.

5. Among Carolina wetlands, pocosins had the lowest (i.e., wettest) wetland weighted averages, followed by swamp forests and savannas. Communities designated as swamp forests included bay forests, poorly drained gum swamps, and alluvial swamp forests. These communities had weighted averages comparable to pocosins; however, they were dissimilar with respect to vegetation composition.

6. Among pocosins, those on deepest peat and of lowest stature had the lowest (wettest) weighted average scores.

7. The diversity (richness) of shrub species is highest in pocosins of low stature and in those most recently burned.

8. Within the Croatan National Forest, pocosins are confined to two soil series, Dare and Croatan. Both are medisaprists that vary between 0.5 and 2 m in depth. Other wetland types present in this area include gum-cypress swamps, white cedar swamps, bay forests, wet flatwoods, and savannas.

9. The primary component of variation in wetland vegetation composition (i.e., the first DCA axis) in Croatan National Forest was highly correlated with stand weighted average scores. Pocosins, particularly those with Atlantic white cedar, had the lowest (wettest) weighted averages.

10. Many species were sampled in the tree, shrub, and herb strata, and DCA scores for each species in each stratum were most often lowest for the herb layer, followed by the shrub and then the tree layers. This pattern reflects a clear physiognomic trend along DCA axis one, with increasing weighted average score from low shrubland to multilayered swamp forest.

11. Soil series information was correlated with vegetation variation only in a very broad way; that is, a great deal of variation in community structure may exist within a particular soil series. For example, pocosins and gum swamps were sampled on both Dare and Croatan soil series. Vegetation variation is clearly influenced by other factors, including local hydrology and past disturbance history.

12. Community wetland status, as measured by WA score, differed significantly among soil types. Communities on Dare soils (the deepest peats) had the lowest WA scores, followed by those on Croatan (shallow peats) and mineral soils. Among the stands sampled in the Croatan National Forest, those on Dorovan soils (alluvial histosols) had the highest WA scores.

13. DCA axis one and WA stand scores were, however, highly correlated with a number of soil characteristics, including peat depth, available P, Mg, K, soil bulk density, pH, and cation exchange capacity.

14. Correlation of DCA and WA scores with age of oldest stems reflects the fact that pocosins have comparatively short fire return intervals (20-50 yr) compared to forested wetlands in this area.

REFERENCES

Ash, A.N., C.B. McDonald, E.S. Kane, and C.A. Pories. 1983. Natural and modified pocosins: literature synthesis and management options. U.S. Fish and Wildlife Service Report FWS/OBS-83/04. 156 pp.

Buell, M.F. 1939. Peat formation in the Carolina Bays. Bull. Torrey Bot. Club 66:483-487.

Buell, M.F. 1946. Jerome Bog, a peat-filled "Carolina Bay." Bulletin of the Torrey Botanical Club 73: 24-33.

Christensen, N.L. 1981. Fire regimes in southeastern ecosystems. Pages 112-136 *in* H.A. Mooney, T.M. Bonnicksen, N.L. Christensen, J.E. Lotan, and W.A. Reiners, eds. Fire regimes and ecosystem properties. USDA Forest Service General Technical Report WO-26.

Christensen, N.L. 1985. Shrubland fire regimes and their evolutionary consequences. Pages 85-100 *in* S.T.A. Pickett and P.S. White, eds. The ecology of natural disturbance and patch dynamics. Academic Press, New York.

Christensen, N.L. 1988. Vegetation of the southeastern Coastal Plain. Pages 317-363 *in* M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation. Cambridge Universtiy Press, New York.

Christensen, N.L., R.B. Burchell, A. Liggett, and E.L. Simms. 1981. The structure and development of pocosin vegetation. Pages 43-61 *in* C.J. Richardson, ed. Pocosin Wetlands. Hutchinson Ross Publishing Co., Stroudsburg, Pennsylvania.

Cohen, A.D., D.J. Casagrande, M.J. Andrejko, and G.R. Best. 1984. The Okefenokee Swamp. Wetland Surveys, Los Alamos, New Mexico.

Cowardin, L.M., V. Carter, F.C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Report FWS/OBS-79/31. 103 pp.

Daniel, C.C., III. 1981. Hydrology, geology and soils of pocosins: a comparison of natural and altered systems. Pages 69-108 *in* C.J. Richardson, ed. Pocosin wOetlands. Hutchinson Ross Publishing Co., Stroudsburg, Pennsylvania.

Daniels, R.B., H.J. Kleiss, S.W. Buol, H.J. Byrd, and J.A. Phillips. 1984. Soil Systems in North Carolina. North Carolina Agric. Res. Ser. Bull. 467. 77 pp.

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

Dolman, J.D., and S.W. Buol. 1967. A study of organic soils (Histosols) in the Tidewater Region of North Carolina. North Carolina Agricultural Experiment Station Bulletin No. 181. 52 pp.

Ewel, K.C. and H.T. Odum. 1984. Cypress Swamps. University of Florida Press, Gainesville, Florida. 472 pp.

Gauch H.G. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, New York.

Hamilton, D.B. 1984. Plant succession and the influence of disturbance in the Okefenokee Swamp. Pages 86-111 *in* A.D. Cohen, D.J. Casagrande, M.J. Andrejko, and G.R. Best eds. The Okefenokee Swamp. Wetland Surveys, Los Alamos, New Mexico.

Ingram R.L., and L.J. Otte. 1981. Peat deposits of Croatan Forest, Craven, Jones, and Carteret counties, North Carolina. Unpublished report to the U.S. Department of Energy. 20 pp.

Kologiski, R. L. 1977. The phytosociology of the Green Swamp, North Carolina. North Carolina Agr. Exper. Sta. Tech. Bull. No. 250. 101 pp.

Laderman A. 1987. Atlantic white cedar wetlands. Westview Press, Boulder Colorado. 400 pp.

Lilly, J.P. 1981. A history of swamp development in North Carolina. Pages 20-39 *in* C.J. Richardson, ed. Pocosin wetlands. Hutchinson Ross, Stroudsburg, Pennsylvania.

Murray, G.E. 1961. Geology of the Atlantic and Gulf Coastal Province of North America. Harper, New York. 692 pp.

Otte, L.J. 1981. Origin, development, and maintenance of the pocosin wetlands of North Carolina. Unpublished report of North Carolina Department of Natural Resources and Community Development Natural Heritage Program, Raleigh, N.C. 50 pp.

Otte, L.J., and L.K. Loftin. 1983. Water Chemistry of the Pocosins of the Croatan National Forest, North Carolina. Upublished Report to the Office of Water Research and Technology, U.S. Department of the Interior. WRRI 84-02-62002.

Peet, R.K., R.G. Knox, J.S. Case, and R.B. Allen. 1988. Putting things in order: the advantages of detrended correspondence analysis. Am. Nat. In press.

Penfound, W.T. 1952. Southern swamps and marshes. Bot. Rev. 18: 413-446.

Reed, P.B., Jr. 1986. Wetland plant list: Southeast Region. U. S Fish and Wildlife Service Publication WELUT-86/W13.02.

Richardson, C.J., R. Evans, and D. Carr. 1981. Pocosins: an ecosystem in transition. Pages 3-19 *in* C.J. Richardson, ed. Pocosin wetlands. Hutchinson Ross, Stroudsburg, Pennsylvania.

Soil Conservation Service. 1981. Soil survey of Jones County, North Carolina. USDA Soil Conservation Service, Washington D.C. 98 pp.

Soil Conservation Service. 1985. Hydric soils of the State of North Carolina 1985. USDA Soil Conservation Service National Technical Committee for Hydric Soils.

Sharitz, R.R., and J.W. Gibbons. 1982. The ecology of southeastern shrub bogs (pocosins) and Carolina Bays: a community profile. U.S. Fish and Wildlife Service Report FWS/OBS-82/04. 93 pp.

Simms, E.L. 1987. The effect of nitrogen and phosphorus addition on the growth, reproduction, and nutrient dynamics of two ericaceous shrubs. Oecologia 71:541-547.

Sipple, W.S. 1987. Wetland identification and delineation manual. Vol. 1: Rationale, wetland parameters, and overview of jurisdictional approach. 28 pp. Vol. 2: Field methodology. 29 pp. U.S. Environ. Protect. Agency, Washington, D.C.

Snyder, J.R. 1980. Analysis of coastal plain vegetation, Croatan National Forest, North Carolina. Veroff. Geobot. Inst. Eidg. Tech. Hochsch. Stift. Rubel Zur. 69:40-113.

Tooker, W.W. 1899. The adapted Algonquin term "Poquosin." American Anthropology Jan.: 162-170.

U.S. Army Corps of Engineers. 1987. Corps of Engineers wetland delineation manual. Tech. Rep. Y-87-1. U.S. Army Corps Engineers, Waterways Exp. Stat., Vicksburg, MS. 100 pp.

Walter, H. and H. Lieth. 1967. Klimmadiagramm-Weltatlas. Gustav Fischer-Verlag, Jena.

Wahlbridge, M.R. 1986. Phosphorus availability in acid organic coastal plain soils. Ph. D. Dissertation. University of North Carolina, Chapel Hill. 117 pp.

Watts, W.A. 1980. The Late Quaternary vegetation history of the southeastern United States. Ann. Rev. Ecol. and Syst. 11:387-409.

Wells, B.W. 1946. Vegetation of Holly Shelter Wildlife Management area. North Carolina Department of Conservation and Development, Division of Game and Inland Fisheries Bulletin No. 2. 40 pp.

Wendel, G.W., T.G. Storey, and G.M. Byram. 1962. Forest fuels on organic and associated soils in the coastal plain of North Carolina. USDA Forest Service, Southeastern Experiment Station Paper No. 144.

Wentworth, T.R., and G.P. Johnson. 1986. Use of vegetation in the designation of wetlands. Final Study Report to the U.S.Fish and Wildlife Service.

Wharton, C.H., W.M. Kitchens, E.C. Pendleton, and T.W. Sipe. 1982. The ecology of bottomland hardwood swamps of the Southeast: a community profile. U.S. Fish and Wildlife Service FWS/OBS 81/37. 133 pp.

Whipple, S.A., L.H. Wellman, and B.J. Good. 1981. A classification of hardwood and swamp forests on the Savannah River Plant, South Carolina. U.S. Department of Energy, Savannah River Plant publication SRO-NERP-6. 36 pp.

Whitehead, D.R. 1981. Late-Pleistocene vegetational changes in northeastern North Carolina. Ecol. Monogr. 51:451-471.

Wilbur, R.B. 1985. Effects of fire on nitrogen and phosphorus availability in a North Carolina coastal plain pocosin. Ph.D. Dissertation. Duke University, Durham, North Carolina. 133 pp.

Wilbur, R.B., and N.L. Christensen. 1983. Effects of fire on nutrient availability in a North Carolina coastal plain pocosin. Am. Midl. Nat. 110:54-61.

Woodwell, G.M. 1956. Phytosociology of coastal plain wetlands in the Carolinas. M.S. Thesis. Duke University. 52 pp.

Woodwell, G.M. 1958. Factors controlling growth of pond pine seedlings in organic soils of the Carolina. Ecol. Monogr. 28:219-236.

APPENDIX A

Soil Series Sampled in The Croatan National Forest
Excerpted from SCS (1981), Soil Survey for Jones County, NC.

Bayboro -- Umbric Paleaquult

This series consists of very poorly drained soils in shallow depressions on uplands. These soils formed from fine-textured sediment. The slope is less than 1 percent. Bayboro soils have a loamy A horizon and a Clayey B horizon more than 152 cm thick over stratified sediment. These soils are very strongly acid.

A11 0-30 cm; black loam; weak medium granular structure; friable; many fine roots; common fine pores; strongly acid.

A12 30-36 cm; very dark gray loam; weak medium granular structure; friable; many fine roots; common fine pores; very strongly acid.

B1g 36-56 cm; dark gray clay loam; few medium faint gray mottles; weak fine angualr blocky structure friable; common fine roots; common fine pores; very strongly acid.

B2tg 56-107 cm; gray clay; few medium distinct yellowish brown mottles; weak fine angular blocky structure; firm, sticky and plastic; thin patchy clay films on faces of peds; very strongly acid.

B3g 107-165 cm; dark gray sandy clay; few medium distinct gray and strong brown mottles; massive; firm, sticky, and plastic; thin clay flims on sides os roots channels; very strongly acid.

Cg 165-200 cm; gray sandy clay loam with lenses of sandy clay; few medium distinct brownish yellow mottles; massive; firm, sticky, and plastic; very strongly acid.

Croatan -- Terric Medisaprist

Very poorly drained organic soils on uplands. Drainage patterns are poorly defined. The slope is < 1 percent. Peat is primarily formed from herbaceous plants. The organic layer is commonly 40-90 cm thick, but may range up to 130 cm. The underlying mineral horizons are extremely acid to slightly acid. Logs, stumps, and fragments of wood compose up to 10 percent of the organic layers. Charcoal particles and pockets of ash occur in some pedons.

Oa1 0-23 cm; black sapric material; moderate fine granular structure; very friable; common fine and medium roots; common grains of clean sand; ~95% organic matter; very strongly acid.

Oa2 23-38 cm; black sapric material; weak medium granular structure; very friable; few fine and medium roots; few grains of clean sand; ~90% organic matter; extremely acid.

Oa3 38-71 cm; black sapric material; massive; very friable; few fine roots; few grains of clean sand; ~75% organic matter; extremely acid.

IIA1g 71-84 cm; Mucky sandy loam; massive; very friable; few fine and medium roots; ~80% mineral material; extremely acid.

IIC1g 84-97 cm; dark brown sandy loam; massive; very friable; few nearly decomposed medium roots; extremely acid.

IIC2g 97-152 cm; grayish brown sandy clay loam; massive; slightly sticky and slightly plastic; few nearly decomposed medium roots; extremely acid.

IIC2g 152-200 cm; mottled grayish brown and dark gray loamy sand; massive; very friable; extremely acid.

Dare -- Typic Medisaprist

This series consists of very poorly drained soils formed in thick beds of organic material. This material sits on uplands and low marine terraces with slopes of less than 1 percent. Dare soils have a highly decomposed organic horizon 130-200 cm thick in most places, but ranging to > 400 cm in local areas. The organic horizon is extremely acid and the subsurface mineral layers are extremely to moderately acid. Buried logs, stumps, and wood fragments account for up to 25% of the volume of the organic horizon.

Oa1 0-30 cm; black muck, about 20% fiber; moderate medium granular structure; very friable, slightly sticky; many fine roots; common medium pieces of charcoal; extremely acid.

Oa2 30-74 cm; black muck; about 15% fiber; massive and very friable; slightly sticky, greasy and paste-like when wet; few fine roots; bommon burried stumps, logs and wood fragments; few medium pieces of charcoal; extremely acid.

Oa3 74-155 cm; dark reddish brown muck; about 20% fiber; massive; very friable, slightly sticky, greasy and paste-like when wet; few fine pieces of charcoal; few bruied stumps, logs, and wood fragments; extremely acid.

2Cg1 155-170 cm; dark reddish brown mucky sand; massive; very friable, extremely acid.

2Cg2 170-200 cm; very dark grayish brown sand, massive, very friable; very strongly acid.

Dorovan -- Typic Medisparist

This series consists of very poorly drained, very slowly permeable, nearly level soils that formed on tidal and stream flood plains and in bays. Slopes are less than 1 %. Many logs, limbs, and other woody fragments are in the middle and lower parts of the organic layer.

Oe 0-10 cm; black muck; massive; about 50% fiber; massive; nonsticky; very strongly acid.

Oa1 10-90 cm; black sapric material; about 25% fiber; massive; nonsticky; few to common roots; partially decomposed limbs and logs; very strongly acid.

Oa2 90-127 cm; very dark gray sapric material; about 25% fiber;massive; few roots; partially decomposed limbs and twigs and occasional logs; very strongly acid.

Oe 140-165 cm; see above.

Leaf -- Typic Albaquult

Poorly drained soils on broad uplands. These soils formed from fine-textured sediment. Slope is less than 1 percent. Leaf soils have a loamy A horizon and a clayey Bt horizon more than 152 cm thick over stratified sediment. These soils are very strongly acid.

Ap 0-20 cm; dark gray silt loam; weak medium granular structure; friable; few fine roots; slightly acid.

A2 20-28 cm; light brownish gray silt loam; few medium distinct brownish yellow mottles; weak medium granular structure; friable; few fine roots; Ap material commonly in old root channels; very strongly acid.

B21tg 28-102 cm; light brownish gray clay; common medium distinct brownish yellow mottles; moderate fine angular blocky structure; firm, sticky and very plastic; thin clay films on faces of peds and in pores; Ap material commonly in old root channels; very strongly acid.

B22tg 102-173 cm; light gray clay; few medium distinct brownish yellow, few fine prominent reddish yellow, and few coarse distinct gray mottles; moderate fine angular blocky structure; firm, sticky and very plastic; thin clay films on faces of peds and in pores; very strongly acid.

B3g 173-203 cm; gray clay loam; few fine distinct brownish yellow and grayish brown mottles; massive; firm, sticky and very plastic; thin clay films on faces of peds; very strongly acid.

Cg 203-230 cm; light gray loam; few fine distinct brownish yellow and grayish brown mottles; massive; friable, slightly sticky and slightly plastic; very strongly acid.

Lenoir -- Aeric paleaquult

Somewhat poorly drained soils on broad smooth uplands. These soils formed from fine-textured marine sediment. Slopes range from 0-2 percent. Lenoir soils have a loamy A horizon and a clayey Bt horizon more than 150 cm thick over stratified sediment. The soils are very strongly to strongly acid.

A1 0-15 cm; dark gray loam; weak medium granular structure; friable; common fine roots; common fine pores; very strongly acid.

A2 15-23 cm; light brownish gray loam; weak medium granular structure; friable; few fine roots; common fine pores; very strongly acid.

B1 23-38 cm; pale brown Og clay loam; few fine faint light brownish gray mottles; moderate fine subangular blocky structure; friable; few fine roots; common fine pores; very strongly acid.

B21tg 38-66 cm; light brownish gray clay; few fine distinct yellowish brown mottles; weak fine angular blocky structure; very firm, sticky, and very plastic; few fine roots; few fine pores; thin clay films on faces of peds and in pores; very strongly acid.

B22tg 66-137 cm; gray clay; few medium distinct brownish yellow and few prominent red mottles. moderate fine angular blocky structure; very firm, sticky and very plastic; thin clay films in pores; very strongly acid.

Cg 137-200 cm; gray clay; few fine distinct brownish yellow and strong brown mottles; massive; firm, sticky, and very plastic; very strongly acid.

Onslow -- Spodic Paleudult

These soils consist of moderately well drained soils on uplands. The soils are formed in moderately fine-textured sediment. The slope is less than 2 percent. Onslow soils have loamy horizons more than 150 cm thick over stratified sediments. They are very strongly to strongly acid.

Ap 0-23 cm; dark gray fine sandy loam; weak medium granular structure; very friable; common fine roots; medium acid.

A2&Bh 23-38 cm; pale brown loamy fine sand; weak fine granular structure; very friable; about 20% is weakly cemented bodies of dark brown loamy fine sand (Bh); medium acid.

B21t 38-61 cm; light olive brown sandy clay loam; few fine distinct yellowish brown mottles; weak fine subangular blocky structure; friable, slightly sticky, and slightly plastic; thin patchy clay films on faces of peds; very strongly acid.

B22t 61-91 cm; pale brown sandy clay loam with pockets of sandy loam; common coarse faint light brownish gray and few medium distinct yellowish brown mottles; weak fine subangular blocky structure; friable, slightly sticky, and slightly plastic; thin patchy clay films on faces of peds; very strongly acid.

B31g 91-132 cm; gray sandy loam and pockets of sandy clay loam; few coarse distinct grayish brown and common fine distinct brownish yellow mottles; weak fine subangular blocky structure; very friable; very strongly acid.

B32g 132-193 cm; light brownish gray sandy loam and thin lenses of loamy sand; few fine distinct gray and yellowish brown mottles; weak medium subangular blocky structure; very friable; common medium bodies of clean sand; very strongly acid

Cg 193-205 cm; light brownish gray sandy clay loam; few medium distinct strong brown mottles; massive; friable, slightly sticky, and plastic; very strongly acid.

Pantego -- Umbric Paleaquult

Very poorly drained soils on broad, smooth flats on uplands. These soils fromed in moderately fine-textured sediment. The slope is less than 2 percent. Pantego soils have loamy horizons more than 150 cm thick over stratified sediment. They are extremely acid.

A11 0-20 cm; black loam; weak medium granular structure; very friable; common fine roots; common fine pores; very strongly acid.

A12 20-38 cm; very dark gray loam; weak medium grandular structure; very friable; common fine roots; strongly acid.

B1g 38-48 cm; grayish brown sandy clay loam; common medium distinct very dark gray mottles; weak fine subangular blocky structure; very friable; common fine roots; extremely acid.

B21tg 48-127 cm; grayish brown sandy clay loam; common medium distinct dark gray mottles; weak fine subangular blocky structure; friable, slightly sticky, and slightly plastic; thin patchy clay films on faces of peds; extremely acid.

B3g 127-173 cm; gray sandy clay loam with pockets of sandy clay; distinct brownish yellow mottles; weak fine subangular blocky structure; friable, slightly sticky, and slightly plastic; common fine pores; extremely acid.

Cg 173-200 cm; greenish gray sandy clay loam with strata of sandy loam; massive; friable; slightly sticky, and slightly plastic; very strongly acid.

APPENDIX B

Community types, locations, references, weighted average, and detrended correspondence scores for the Southeast regional survey. WA1 refers to weighted averages calculated on the basis of abundance data and WA2 refers to weighted averages calculated on the basis of presence-absence data.

Community type	Location	Reference	WA1	WA2	DCA1	DCA2
1 Mesic Hammock	North Florida	Blaisdell et al. 1974	3.048	3.083	73	236
2 Mesic Hammock	North Florida	Blaisdell et al. 1974	2.952	3.000	86	230
3 Swamp Hardwoods	New Jersey	Ehrenfeld and Gulick 1981	2.615	2.615	300	155
4 Stream-bottom Hardwoods	Alabama	Gemborys and Hodgkins 1971	2.706	2.636	242	179
5 Upland-margin Hardwoods	Alabama	Gemborys and Hodgkins 1971	3.391	3.250	188	306
6 Pocosin	North Carolina	Christensen(unpublished)	1.880	1.917	419	18
7 Group I Hardwoods	Southeast	Quarterman and Keever 1962	3.458	3.500	63	267
8 Xeric Flatwoods	North Carolina	Snyder 1980	3.778	3.667	451	446
9 Pine Savanna	North Carolina	Snyder 1980	2.765	2.500	452	299
10 Pocosin	North Carolina	Snyder 1980	1.850	1.833	407	41
11 Bottomland Hardwoods	North Carolina	Snyder 1980	2.316	2.333	226	175
12 River Swamp	North Florida	Laessle 1942	1.533	1.667	279	136
13 Sand Pine Scrub	North Florida	Laessle 1942	3.350	3.250	622	154
14 Sandhill	North Florida	Laessle 1942	4.000	3.750	500	416
15 Xeric Hammock	North Florida	Laessle 1942	3.294	3.167	319	307
16 Mesic Hammock	North Florida	Laessle 1942	3.000	3.083	174	218
17 Hydric Hammock	North Florida	Laessle 1942	2.556	2.455	276	166
18 Bayhead	North Florida	Laessle 1942	2.000	2.000	390	76
19 Longleaf Pine Flatwoods	Central Florida	Edmisten 1963	2.929	2.778	457	215
20 Pond Pine Flatwoods	Central Florida	Edmisten 1963	2.600	2.800	460	60
21 Slash Pine Flatwoods	Central Florida	Edmisten 1963	3.000	2.778	403	200
22 Cypress-tupelo Swamp	South Louisiana	White 1983	1.667	1.727	268	130
23 Bottomland Forest	South Louisiana	White 1983	2.619	2.545	160	190
24 Maritime Forest	North Carolina	Bordeau and Oosting 1959	3.368	3.417	228	273
25 Scrub	Central Florida	Kurz 1942	3.471	3.364	628	207
26 Swamp Forest	South Carolina	Porcher 1981	1.500	1.667	245	120
27 Hardwood Bottom	South Carolina	Porcher 1981	2.063	2.167	170	180
28 Ridge Bottom	South Carolina	Porcher 1981	3.000	3.000	97	247
29 Mixed Mesophytic	South Carolina	Porcher 1981	3.526	3.583	79	254
30 Cypress Dome	North Florida	Monk 1965	1.947	2.000	334	106
31 Pocosin	North Florida	Wells 1946	1.857	1.917	407	36
32 Bayhead	North Florida	Monk 1966b	2.304	2.385	300	143
33 Mixed Hardwood Swamp	North Florida	Mon 1966b	2.091	2.167	246	171
34 Sandhill Pine	East Texas	Marks and Harcombe 1981	3.875	3.750	290	401
35 Upland Pine-Oak	East Texas	Marks and Harcombe 1981	3.800	3.750	285	417
36 Westland Pine Savanna	East Texas	Marks and Harcombe 1981	3.267	3.125	228	335

(Continued)

Community type	Location	Reference	WA1	WA2	DCA1	DCA2
37 Upper slope Oak-pine	East Texas	Marks and Harcombe 1981	3.625	3.667	168	360
38 Mid-slope Oak-pine	East Texas	Marks and Harcombe 1981	3.321	3.250	133	296
39 Lower slope HW-pine	East Texas	Marks and Harcombe 1981	3.286	3.250	80	278
40 Floodplain Hardwoods	East Texas	Marks and Harcombe 1981	2.926	2.917	135	237
41 Flatland Hardwoods	East Texas	Marks and Harcombe 1981	2.481	2.500	132	240
42 Baygall Thicket	East Texas	Marks and Harcombe 1981	2.130	2.167	196	195
43 Cypress-tupelo Swamp	East Texas	Marks and Harcombe 1981	1.471	1.636	257	128
44 Cypress Swamp Forest	Georgia	Schlesinger 1978a	1.826	1.833	343	96
45 Pine Oak Forest	North Florida	Veno 1976	3.652	3.583	487	349
46 Xeric Hammock	North Florida	Veno 1976	3.217	3.250	423	252
47 Mesic Hammock	North Florida	Veno 1976	3.304	3.333	348	308
48 Sandhill	North Florida	Veno 1976	3.952	3.909	522	311
49 Cypress-gum Swamp	Alabama	Hall and Penfound 1943	1.500	1.556	276	92
50 "Dry" Alluvial Swamp	Virginia	Parsons and Ware 1982	3.000	2.917	123	244
51 "Wet" Alluvial Swamp	Virginia	Parsons and Ware 1982	2.500	2.556	175	182
52 Cypress Swamp	Georgia	Schlesinger 1976	3.053	3.111	232	200
53 Pocosin	North Carolina	Kologiski 1977	1.773	1.750	419	21
54 Pine Savanna	North Carolina	Kologiski 1977	3.286	3.000	461	330
55 White Cedar Swamp	North Carolina	Kologiski 1977	1.813	1.909	383	82
56 Evergreen Bay Forest	North Carolina	Kologiski 1977	1.900	2.083	375	65
57 Deciduous Bay Forest	North Carolina	Kologiski 1977	2.000	2.083	349	80
58 Southern Ridge Sandhill	Central Florida	Abrahamson et al. 1984	3.200	3.364	616	169
59 Sand Pine Scrub	North Florida	Coile(unpublished)	2.842	3.750	615	249
60 Southern Ridge Sandhill	Central Florida	Abrahamson et al. 1984	3.263	3.417	615	239
61 Sand Pine Scrub	Central Florida	Abrahamson et al. 1984	3.550	3.583	603	192
62 Sand Pine Scrub	Central Florida	Abrahamson et al. 1984	4.077	3.667	607	261
63 Scrubby Flatwoods	Central Florida	Abrahamson et al. 1984	3.471	3.444	575	188
64 Wiregrass Flatwoods	Central Florida	Abrahamson et al. 1984	2.824	2.818	537	116
65 Palmetto Flatwoods	Central Florida	Abrahamson et al. 1984	2.365	2.417	475	19
66 Gallberry Flatwoods	Central Florida	Abrahamson et al. 1984	2.381	2.600	499	17
67 Bayhead	Central Florida	Abrahamson et al. 1984	2.000	2.000	398	77
68 Pocosin	Central Florida	Wilbur 1985	1.917	1.923	418	13
69 Oak Hickory Forest	South Carolina	Whipple et al. 1981	3.700	3.667	78	294
70 Gum-red bay Forest	South Carolina	Whipple et al. 1981	2.684	2.667	217	186
71 Gum-red Maple Forest	South Carolina	Whipple et al. 1981	2.526	2.417	199	179
72 Black Oak Forest	South Carolina	Whipple et al. 1981	2.571	2.500	156	206
73 Laurel Oak forest	South Carolina	Whipple et al. 1981	2.000	1.917	182	154
74 Gum-ash Forest	South Carolina	Whipple et al. 1981	1.850	1.833	205	133
75 Palmetto Flatwoods	Florida	HIlmon 1968	1.579	1.750	241	112
76 Mesic Sandhill	North Carolina	Weaver 1969	2.750	2.727	494	0
77 Ridge Sandhill	North Carolina	Weaver 1969	3.500	3.583	409	440
78 Swamp Tupelo-Cypress	North Carolina	Allen 1958	3.769	3.625	478	450
79 Water Tupelo-Cypress	North Carolina	Allen 1958	1.750	1.846	271	126

(Continued)

APPENDIX B (Continued)

Community type	Location	Reference	WA1	WA2	DCA1	DCA2
80 Bar Forest	North Carolina	Allen 1958	1.733	2.000	270	123
81 Blackgum Swamp	North Carolina	Applequist 1959	2.105	2.083	253	175
82 Cypress-gum Swamp	North Carolina	Applequist 1959	1.889	1.917	268	133
83 Tupelo-gum Swamp	North Carolina	Applequist 1959	1.800	1.900	272	124
84 Cypress Swamp	Georgia	Cypert 1972	1.778	1.833	334	98
85 Slash Pine Forest	North Florida	Hebb and Clewell 1976	2.050	2.083	367	95
86 Sand ridge	North Carolina	McAlister (unpublished)	4.417	4.125	548	509
87 Hardwoods, Thick Loess	Mississippi	Caplenor 1968	3.476	3.500	59	214
88 Hardwoods, Creek Bottom	Mississippi	Caplenor 1968	3.217	3.250	59	242
89 Hardwoods, Non Loess	Mississippi	Caplenor 1968	3.789	3.667	90	346
90 Hardwoods, Thin Loess	Mississippi	Caplenor 1968	3.667	3.583	40	262
91 Mesophytic Hardwoods	Virginia	Ware 1970	3.560	3.538	72	273
92 Sand Ridge	North Carolina	Christensen(unpublished)	4.267	4.100	513	488
93 Sand Ridge	South Carolina	Christensen (unpublished)	4.100	4.000	485	483
94 Southern Mixed Hradwoods	Georgia	Quarterman and Keever 1962	3.800	3.600	65	285
95 Southern Mixed Hardwoods	Georgia	Quarterman and Keever 1962	3.786	3.556	74	312
96 Southern Mixed Hardwoods	South Carolina	Quarterman and Keever 1962	3.471	3.462	97	294
97 Southern Mixed Hardwoods	Georgia	Quarterman and Keever 1962	3.625	3.667	0	261
98 Southern Mixed Hardwoods	Georgia	Quarterman and Keever 1962	3.684	3.500	73	271
99 Southern Mixed Hardwoods	Mississippi	Quarterman and Keever 1962	3.579	3.429	37	263
100 Southern Mixed Hardwoods	Alabama	Quarterman and Keever 1962	4.000	3.875	2	275
101 Southern Mixed Hardwoods	Alabama	Quarterman and Keever 1962	4.071	4.000	20	283
102 Southern Mixed Hardwoods	Louisiana	Quarterman and Keever 1962	3.600	3.500	60	293
103 Southern Mixed Hardwoods	South Carolina	Quarterman and Keever 1962	3.824	3.667	79	287
104 Southern Mixed Hardwoods	South Carolina	Quarterman and Keever 1962	3.533	3.500	93	298
105 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.500	3.545	79	277
106 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.778	3.714	48	279
107 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.364	3.250	67	254
108 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.835	3.250	62	271
109 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.313	3.364	41	250
110 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.545	3.500	17	246
111 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.231	3.375	35	240
112 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.529	3.455	57	264
113 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.474	3.500	69	274
114 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.278	3.308	55	250
115 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.000	3.222	86	268
116 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.357	3.700	69	245
117 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.250	3.333	92	234
118 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.278	3.417	97	264
119 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.500	3.200	211	354
120 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.632	3.583	68	264
121 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.400	3.455	106	297
122 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.850	3.929	26	272

(Continued)

APPENDIX B (Concluded)

Community type	Location	Reference	WA1	WA2	DCA1	DCA2
123 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.938	3.833	27	287
124 Southern Mixed Hardwoods	Virginia	DeWitt and Ware 1979	3.875	3.833	29	283
125 Pocosin	North Carolina	Laney and Noffsinger 1985	1.765	1.750	422	25
126 Pocosin	North Carolina	Laney and Noffsinger 1985	1.941	1.909	415	46
127 Bay	North Carolina	Laney and Noffsinger 1985	2.182	2.286	365	109
128 Bay	North Carolina	Laney and Noffsinger 1985	2.077	2.111	386	90
129 White Cedar Swamp	North Carolina	Laney and Noffsinger 1985	2.440	2.400	307	156
130 White Cedar Swamp	North Carolina	Laney and Noffsinger 1985	2.333	2.267	315	135
131 White Cedar Swamp	North Carolina	Laney and Noffsinger 1985	1.955	2.077	369	94
132 Alluvial Swamp	Louisiana	Conner and Day 1976	1.824	1.909	357	84
133 Alluvial Swamp	South Carolina	Muzika et al. 1987	1.813	1.818	272	141
134 Savanna	South Carolina	Jones and Gresham 1985	2.846	2.600	352	283
135 Pocosin	South Carolina	Jones and Gresham 1985	2.048	2.083	386	68
136 Bay	South Carolina	Jones and Gresham 1985	2.067	2.083	311	149
137 Sandy Alluvial Swamp	South Carolina	Jones and Gresham 1985	2.333	2.250	234	176
138 Red Water Swamp	South Carolina	Jones and Gresham 1985	1.900	1.917	208	158
139 Alluvial Swamp	South Carolina	Jones and Gresham 1985	1.706	1.909	242	125
140 Floodplain Forest	Texas	Matos and Rudolph 1985	2.684	2.750	156	223
141 Alluvial Swamp	Texas	Matos and Rudolph 1985	1.765	1.833	203	133
142 Baygall	Texas	Matos and Rudolph 1985	2.650	2.750	214	225
143 Baygall	Texas	Matos and Rudolph 1985	2.353	2.333	297	187
144 Wet Transition Forest	Texas	Matos and Rudolph 1985	2.765	2.667	148	230
145 Dry Transition Forest	Texas	Matos and Rudolph 1985	3.389	3.154	272	352
146 Southern Mixed Hardwoods	South Carolina	Golley et al. 1965	2.905	3.000	119	233

APPENDIX B

REFERENCES

Abrahamson, W.G., A.F. Johnson, J.N. Layne, and P.A. Peroni. 1984. Vegetation of the Archbold Biological Station, Florida: an example of the southern Lake Wales Ridge. Fla. Sci. 47:209-250.

Allen, P.H. 1958. A tidewater swamp forest and succession after clearcutting. M.S. Thesis. Duke University, Durham, North Carolina. 48 pp.

Applequist, M.B. 1959. A study of soil and site factors affecting growth and development of swamp blackgum and tupelogum stands in Southeastern Georgia. Ph.D Dissertation. Duke University, Durham, North Carolina. 181 pp.

Au, S. 1974. Vegetation and ecological processes on Shackleford Bank, North Carolina. U.S. Nat. Park Serv. Sci. Monogr. 6:46.

Blaisdell, R.S., J. Wooten, and R.K. Godfrey. 1974. The role of magnolia and beech in forest processes in the Tallahassee, Florida, Thomasville, Georgia area. Proc. Annu. Tall Timbers Fire Ecol. Conf. 13:363-397.

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

Caplenor, D. 1968. Forest composition on loessal and non-loessal soils in west-central Mississippi. Ecology 49:322-331.

Conner, W.H., and J.W. Day, Jr. 1976. Productivity and composition of a baldcypress-water tupelo site and a bottomland hardwood site in a Louisiana swamp. Am. J. Bot. 63:1354-1364.

Croom, J.M. 1978. Sandhills-turkey oak (Quercus laevis) Ecosystem: community analysis and a model of radiocesium cycling. Ph.D. Dissertation, Emory Univ., Atlanta, GA. 75 pp.

Cypert, E. 1972. The origin of houses in the Okefenokee prairies. Am. Midl. Nat. 87:448-458.

Dabel, C.V., and F.P. Day, Jr. 1977. Structural comparisons of four plant communities in the Great Dismal Swamp, Virginia. Bull. Torrey Bot. Club 104:352-360.

Delcourt, H.R., and P.A. Delcourt. 1974. Primeval magnolia-holly-beech climax in Louisiana. Ecology 55:638-644.

DeWitt, R., and S. Ware. 1979. Upland hardwood forests of the central coastal plain of Virginia. Castanea 44:163-174.

Edmisten, J.A. 1963. The ecology of the Florida pine flatwoods. Ph.D. Dissertation. University of Florida, Gainesville, FL. 108 pp.

Ehrenfeld, J.G., and M. Gulick. 1981. Structure and dynamics of hardwood swamps in the New Jersey Pine Barrens: contrasting patterns in trees and shrubs. Am. J. Bot. 68:471-481.

Gemborys, S.R. and E.J. Hodgkins. 1971. Forests of small stream bottoms in the coastal plain of southwestern Alabama. Ecology 52:70-84.

Givens, K.T., J.N. Layne, W.G. Abrahamson, and S.C. White-Schuler. 1984. Structural changes and successional relationshps of five Florida Lake Wales ridge plant communities. Bull. Torrey Bot. Club 111.

Golley, F.B., G.A. Petrides, and J.F. McCormick. 1965. A survey of the vegetation of the Boiling Spring Natural Area, South Carolina. Bull. Torrey Bot. Club 92:355-363.

Hall, T.F., and W.T. Penfound. 1939. A phytosociological study of a cypress-gum swamp in southeastern Louisiana. Am. Midl. Nat. 21:378-395.

Hall, T.F., and W.T. Penfound. 1943. Cypress-gum communities in the Blue Girth Swamp near Selma, Alabama. Ecology 24:208-217.

Hebb, E.A., and A.F. Clewell. 1976. A remnant stand of old-growth slash pine in the Florida panhandle. Bull. Torrey Bot. Club 103:1-9.

Hilmon, J.B. 1968. Autecology of Palmetto (*Serenea repens*(Bartr.) Small). Ph.D. Dissertation. Duke University, Durham, NC.

Hodgkins, E.J. 1958. Effects of fire on undergrowth vegetation in upland southern pine forests. Ecology 58:36-46.

Hull, J.C., and D.F. Whigham. 1985. Atlantic white cedar in the Maryland inner coastal plain and the Delmarva Peninsula. Pages 143-174 <u>in</u> A.D. Laderman, ed. Atlantic white cedar wetlands. Westview Press, Boulder Colorado.

Jones, R.H., and C.A. Gresham. 1985. Analysis of composition, environmental gradients, and structure in the Coastal Plain lowland forests of South Carolina. Castanea 50:207-227.

Kologiski, R.L. 1977. The phytosociology of the Green Swamp, North Carolina. N.C. Agric. Exp. Stn. Tech. Bull. 250:101.

Korstian, C.F., and W.D. Brush. 1931. Southern white cedar. U.S.D.A. Tech. Bull. 251:75.

Kurz, H. 1938. A physiographic study of the tree associations of the Apalachicola River. Proc. Fla. Acad. Sci. 3:78-90.

Kurz, H. 1942. Florida dunes and scrub, vegetation and geology. State Fla. Dep. Conserv., Geol. Bull. 23:154.

Laessle, A.M. 1942. The plant communities of the Welaka area. Univ. Fla. Publ., Biol. Sci. Ser. 4:5-141.

Laessle, A.M. 1965. Spacing and competition in natural stands of sand pine. Ecology 46:65-72.

Laney, R.W., and R.E. Noffsinger. 1985. Vegetative composition of Atlantic white cedar (*Chamaecyparis thyoides* (L.) B.S.P.) swamps in Dare County, North Carolina. pages 175-176 In A.D. Laderman ed., Atlantic white cedar wetlands. Westview Press, Boulder, Colorado.

Marks, P.L., and P.A. Harcombe. 1981. Forest vegetation of the Big Thicket, southeast Texas. Ecol. Monogr. 51:287-305.

Matos, J.A., and D.C. Rudolph. 1985. The vegetation of the Roy E. Larsen Sandylands Sanctuary in the Big Thicket of Texas. Castanea 50:228-249.

Monk, C.D. 1965. Southern mixed hardwood forest of northcentral Florida. Ecol. Monogr. 35:335-354.

Monk, C.D. 1966. An ecological study of hardwood swamps in northcentral Florida. Ecology 47:649-654.

Monk, C.D., and T.W. Brown. 1965. Ecological consideration of cypress heads in northcentral Florida. Am. Midl. Nat. 74:127-140.

Mulvania, M. 1931. Ecological survey of a Florida scrub. Ecology 12:528-540.

Muzika, R.M., J.B. Gladden, and J.D. Haddock. 1987. Structural and functional aspects of recovery in southeastern floodplain forests following a major disturbance. Am. Midl. Nat. In press.

Nesom, G.L., and M. Treiber. 1977. Beech-mixed hardwoods communities: a topo-edaphic climax on the North Carolina Coastal Plain. Castanea 42:119-140.

Parrott, R. T. 1967. A study of wiregrass (Aristida stricta) with particular reference to fire. M.S. Thesis. Duke University, Durham, North Carolina. 130 pp.

Parsons, S.E., and S. Ware. 1982. Edaphic factors and vegetation in Virginia Coastal Plain swamps. Bull. Torrey Bot. Club 109:365-370.

Penfound, W.T., and J.A. Howard. 1940. A phytosociological study of an evergreen oak forest in the vicinity of New Orleans, Louisiana. Am. Midl. Nat. 23:165-174.

Penfound, W.T., and M.E. O'Neill. 1934. The vegetation of Cat Island, Mississippi. Ecology 15:1-16.

Penfound, W.T., and A.G. Watkins. 1937. Phytosociological studies in the pinelands of southeastern Louisiana. Am. Midl. Nat. 18:661-682.

Pessin, L.J. 1933. Forest associations in the uplands of the lower Gulf Coastal Plain. Ecology 14:1-14.

Porcher, R.D. 1981. The vascular flora of the Francis Beidler Forest in Four Holes Swamp, Berkeley and Dorchester Counties, South Carolina. Castanea 46: 248-280.

Quarterman, E., and C. Keever. 1962. Southern mixed hardwood forest: climax in the southeastern coastal plain, U.S.A. Ecol. Monogr. 32:167-185.

Schlesinger, W.H. 1976. Biogeochemical limits on two levels of plant community organization in the cypress forest of Okefenokee Swamp. Ph.D. Dissertation. Cornell University, Ithaca, New York.

Schlesinger, W.H. 1978a. Community structure, dynamics and nutrient cycling in the Okefenokee Cypress swamp-forest. Ecol. Monogr. 48:43-65.

Snyder, J.R. 1980. Analysis of coastal plain vegetation, Croatan National Forest, North Carolina. Veroeff. Geobot. Inst. Eidg. Tech. Hochsch. Stift. Rubel Zurich 69:40-113.

Veno, P.A. 1976. Successional relationships of five Florida plant communities. Ecology 57:498-508.

Walker, J., and R.K. Peet. 1983. Composition and species diversity of pine - wire grass savannas of the Green Swamp, North Carolina. Vegetatio 55:163-179.

Ware, S. 1970. Southern mixed hardwood forest in the Virginia Coastal Plain. Ecology 51:921-924.

Weaver, T.W., III. 1969. Gradients in the Carolina Fall-line Sandhills: environment, vegetation, and comparative ecology of the oaks. Ph.D. Dissertation. Duke University, Durham, North Carolina. 105 pp.

Wells, B.W. 1946. Vegetation of Holly Shelter Wildlife Management area. N.C. Dep. Conserv. Dev., Division of Game and Inland Fish. Bull. 2:40.

Whipple, S.A., L.H. Wellman, and B.J. Good. 1981. A classification of hardwood and swamp forests on the Savannah River Plant, South Carolina. U.S. Dep. Energy, Savannah River Plant Publ. SRO-NERP-6. 36 pp.

White, D.A. 1983. Plant communities of the lower Pearl River basin, Louisiana. Am. Midl. Nat. 110:381-396.

Wilbur, R.B. 1985. Effects of fire on nitrogen and phosphorus availability in a North Carolina Coastal Plain Pocosin. Ph.D. Dissertation, Duke Univ., Durham, North Carolina. 133 pp.

Wilson, J.E. 1978. A floristic study of the "savannahs" on pine plantations in the Croatan National Forest. M.S. Thesis. University of North Carolina, Chapel Hill, NC. 165 pp.

Woodwell, G.M. 1956. Phytosociology of Coastal Plain Wetlands in the Carolinas. M.S. Thesis. Duke University, Durham, NC. 52 pp.

APPENDIX C

Species included in Southeast regional survey. Sp. weight refers to numerical weights assigned to species based on Reed (1986). See Table 1 of this document for details. Asterisks indicate taxa for which weights were unknown. Such taxa were not included in calculation of weighted averages.

Sp. #	Latin name	Sp. weight
1	*Acer rubrum*	3
2	*Acer saccharum* var. *floridanum*	4
3	*Alnus serulata (rugosa)*	2
4	*Schizachrium scoparius*	4
5	*Andropogon virginicus*	3
6	*Aristida stricta*	3
7	*Arundinaria gigantea*	2
8	*Asimina obovata*	5
9	*Befaria racemosa*	2
10	*Betula nigra*	1
11	*Bumelia*	4
12	*Bumelia tenax*	4
13	*Carex spp.*	5
14	*Carpinus carolinaina*	3
15	*Carya aquatica*	1
16	*Carya cordiformis*	3
17	*Carya floridana*	3
18	*Carya glabra*	4
19	*Carya ovalis*	5
20	*Carya spp.*	5
21	*Carya tomentosa*	5
22	*Celtis laevigata*	2
23	*Cephalanthus occidentalis*	1
23	*Ceratiola ericoides*	5
24	*Chamaecyparis thyoides*	1
25	*Chamaedaphne calyculata*	1
26	*Cladonia spp.*	5
27	*Clethra alnifolia*	2
28	*Cornus florida*	4
29	*Cornus foemina*	2
30	*Cyrilla racemiflora*	2
31	*Diospyros virginiana*	3
32	*Fagus grandifolia*	4
33	*Fraxinus americana*	4
34	*Fraxinus caroliniana*	1

(Continued)

Sp. #	Latin name	Sp. weight
35	*Fraxinus pennsylvanica*	2
36	*Garberia heterophylla*	5
37	*Gaylussacia dumosa*	3
38	*Gaylussacia frondosa*	3
39	*Gleditsia aquatica*	1
40	*Gordonia lasianthus*	2
41	*Ilex ambigua*	3
42	*Ilex cassine*	2
43	*Ilex cassine* var. *myrtifolia*	2
44	*Ilex coriacea*	2
45	*Ilex* sp.	*
46	*Ilex decidua*	2
47	*Ilex glabra*	2
48	*Ilex opaca*	4
49	*Ilex vomitoria*	3
50	*Itea virginica*	2
51	*Juglans nigra*	4
52	*Juniperus virginiana*	4
53	*Kalmia hirsuta*	2
54	*Leucothoe racemosa*	2
55	*Licania michauxii*	*
56	*Liquidambar styraciflua*	3
57	*Liriodendron tulipifera*	3
58	*Lyonia ferruginea*	3
59	*Lyonia fruticosa*	*
60	*Lyonia ligustrina*	2
61	*Lyonia lucida*	2
62	*Lyonia mariana*	3
63	*Magnolia grandiflora*	3
64	*Magnolia virginiana*	2
65	*Morus rubra*	3
66	Mosses	*
67	*Myrica cerifera*	3
68	*Myrica heterophylla*	2
69	*Nyssa aquatica*	1
70	*Nyssa ogeeche*	1
71	*Nyssa sylvatica* var. *biflora*	2
72	*Nyssa sylvatica* var. *sylvatica*	3
73	*Osmanthus americana*	3
74	*Osmunda cinnamomea*	2
75	*Ostrya virginiana*	4
76	*Oxydendron arboreum*	5
77	*Panicum abcissum*	2

(Continued)

APPENDIX C (Continued)

Sp. #	Latin name	Sp. weight
78	*Persea borbonia*	2
79	*Persea humilis*	2
80	*Persea* sp.	2
81	*Persea pubescens*	2
82	*Pinus clausa*	5
83	*Pinus echinata*	4
84	*Pinus elliottii*	2
85	*Pinus glabra*	2
86	*Pinus palustris*	4
87	*Pinus rigida*	4
88	*Pinus rigida*	4
89	*Pinus serotina*	2
90	*Pinus taeda*	3
91	*Pinus virginiana*	4
92	*Planera aquatica*	1
93	*Prunus serotina*	4
95	*Prunus angustifolia*	5
96	*Prunus caroliniana*	5
97	*Quercus alba*	4
98	*Quercus chapmanii*	3
99	*Quercus coccinea*	4
100	*Quercus falcata* var. *pagodaefolia*	4
101	*Quercus falcata* var. *falcata*	4
102	*Quercus geminata*	3
103	*Quercus hemispherica*	3
104	*Quercus incana*	5
105	*Quercus inopina*	5
106	*Quercus laevis*	5
107	*Quercus laurifolia*	2
108	*Quercus lyrata*	1
109	*Quercus margaretta*	4
110	*Quercus marilandica*	3
111	*Quercus michauxii*	2
112	*Quercus minima*	3
113	*Quercus myrtifolia*	3
114	*Quercus nigra*	3
115	*Quercus phellos*	2
116	*Quercus prinus*	5
117	*Quercus pumila*	5
118	*Quercus rubra*	4
119	*Quercus shumardii*	2
120	*Quercus stellata*	4
121	*Quercus velutina*	4

(Continued)

APPENDIX C (Concluded)

Sp. #	Latin name	Sp. weight
122	*Quercus virginiana*	4
123	*Rhododendron viscosum*	2
124	*Rhus copalina*	4
125	*Rhus radicans*	3
126	*Sabal etonia*	3
127	*Sabal minor*	2
128	*Sabal palmetto*	3
129	*Sassafrass albidum*	4
130	*Selaginella*	5
131	*Serenoa repens*	3
132	*Smilax laurifolia*	2
133	*Smilax walterinana*	1
134	*Aronia arbutifolia*	2
135	*Styrax americana*	2
136	*Symplocus tinctora*	3
137	*Taxodium distichum*	1
138	*Tilia* sp.	5
139	*Ulmus alata*	4
140	*Ulmus americanum*	2
141	*Ulmus rubra*	3
142	*Vaccinium arboreum*	4
143	*Vaccinium atrococcum*	4
144	*Vaccinium crassifolium*	3
145	*Vaccinium myrsinites*	4
146	*Vaccinium stamineum*	4
147	*Vaccinium corymbosum*	2
147	*Woodwardia virginica*	1
148	*Ximenia americana*	1
149	*Zenobia pulverulenta*	1

APPENDIX D

Species included in Woodwell's (1956) survey. Sp. weight refers to numerical weights assigned to species based on Reed (1986). See Table 1 of this document for details. Asterisks indicate taxa for which weights were unknown. Such taxa were not included in calculation of weighted averages.

Acronym	Latin name	Sp. weight
ACRU	*Acer rubrum*	3
ACSA	*Acer saccharum*	4
AGRO	*Agrostis* spp.	*
AMAR	*Ampelopsis arborea*	3
ANDR	*Andropogon* spp.	3
ANSC	*Andropogon scoparius*	4
ANVI	*Andropogon virginicus*	3
ARGI	*Arundinaria gigantea*	2
ARST	*Aristida stricta*	3
ASCI	*Asclepias* spp.	2
ASTE	*Aster* spp.	*
BAHA	*Baccharis halimifolia*	3
BENI	*Betula nigra*	1
BIDE	*Bidens* spp.	*
BIGE	*Bigelowia* spp.	2
CACA	*Carpinus caroliniana*	3
CAIL	*Carya illinoensis*	3
CALL	*Callicarpa americana*	4
CARD	*Carduus* spp.	4
CARE	*Carex* spp.	*
CARP	*Carphephorus bellidifolius*	2
CARY	*Carya aquatica*	1
CEOC	*Cephalanthus occidentalis*	1
CHRY	*Chrysanthemum* spp.	4
CHTH	*Chamaecyparis thyoides*	1
CLAL	*Clethra alnifolia*	2
CLEM	*Clematis* spp.	*
CLTO	*Clethra tomentosa*	2
COFL	*Cornus florida*	4
CRAT	*Crateagus* spp.	*
CSCA	*Chamadaphnae calyculata*	1
CTEN	*Ctenium aromaticum*	2
CYRA	*Cyrilla racemiflora*	2
DICO	*Dichromena colorata*	2
DIOM	*Dionaea muscipula*	2

(Continued)

APPENDIX D (Continued)

Acronym	Latin name	Sp. weight
DIVI	*Diospyros virginiana*	3
DROP	*Dryopteris ludoviciana*	2
DROS	*Drosera intermedia*	1
ERYU	*Eryngium yuccafolium*	3
EUCU	*Eupatorium cuneifolium*	5
EUPA	*Eupatorium* spp.	*
EURO	*Eupatorium rotundifolium*	3
EURU	*Eupatorium rugosum*	5
FOTH	*Fothergilla gardenii*	2
FRCA	*Fraxinus caroliniana*	1
FRPE	*Fraxinus pennsylvanica*	2
FRTO	*Fraxinus tomentosa*	1
GABA	*Gaylussacia baccata*	4
GAFR	*Gaylussacia frondosa*	3
GALI	*Galium* spp.	*
GAYL	*Gaylussacia* spp.	3
GELS	*Gelsemium sempervirens*	3
GOLA	*Gordonia lasianthus*	2
HELI	*Helianthus* spp.	*
HEPU	*Hedeoma pulegioides*	*
HYPE	*Hypericum* spp.	2
HYQU	*Hydrangea quercifolia*	*
HYST	*Hypericum stans*	2
ILCA	*Ilex cassine*	2
ILCO	*Ilex coriacea*	2
ILEX	*Ilex* spp.	2
ILGL	*Ilex glabra*	2
ILMY	*Ilex cassine* var. *myrtifolia*	2
ILOP	*Ilex opaca*	4
IRIS	*Iris virginica*	1
ITVI	*Itea virginica*	2
JUNC	*Juncus* spp.	1
JURE	*Juncus repens*	1
JUVI	*Juniperus virginiana*	4
KACA	*Kalmia augustifolia* var. *caroliniana*	2
KACU	*Kalmia cuneata*	2
LEIO	*Leiophyllum buxifolium*	5
LEUC	*Leucobryum* spp.	5
LEUT	*Leucothoe* spp.	2
LIGR	*Liatris graminifolia*	5
LILI	*Lilium* spp.	3
LIST	*Liquidambar styraciflua*	3
LITU	*Liriodendron tulipfera*	3

(Continued)

APPENDIX D (Continued)

Acronym	Latin name	Sp. weight
LONI	*Lonicera* spp.	3
LYAM	*Lycopus amplectens*	1
LYCO	*Lycopodium* spp.	1
LYLI	*Lyonia ligustrina*	2
LYLU	*Lyonia lucida*	2
LYMA	*Lyonia mariana*	3
LYON	*Lyonia feruginea*	3
MARS	*Marshallia graminia*	1
MATE	*Matelea suberosa*	2
MAVI	*Magnolia virginiana*	2
MENT	*Mentha* spp.	*
MIRE	*Mitchella repens*	4
MORU	*Morus rubra*	3
MUEX	*Muhlenbergia expansa*	2
MUHL	*Muhlenbergia* spp.	*
MYCE	*Myrica cerifera*	3
MYHE	*Myrica heterophylla*	2
MYPU	*Myrica pumila*	3
NITA	*Nicotiana tabacum*	5
NYAQ	*Nyssa aquatica*	1
NYBI	*Nyssa sylvatica* var. *biflora*	3
ONSE	*Oncolea sensibilis*	2
ORCH	Orchidaceae	*
OSCI	*Osmunda cinnamomea*	2
OSRE	*Osmunda regalis* var. *spectabilis*	1
OXAL	*Oxalis* spp.	*
OXAR	*Oxydendrum arboreum*	5
PAAN	*Panicum anceps*	1
PADI	*Panicum dichotomum*	2
PANI	*Panicum* spp.	*
PAQU	*Parthenocissus quinquefolia*	3
PEBO	*Persea borbonia*	2
PIPA	*Pinus palustris*	4
PISE	*Pinus serotina*	2
PITA	*Pinus taeda*	3
PLAN	*Plantago* spp.	3
PLCA	*Pluchea camphorata*	2
PLEE	*Pleea* spp.	1
PLOC	*Platanus occidentalis*	2
POAS	*Poa* spp.	*
POLU	*Polygala lutea*	2
POLY	*Polystichum acrostichoides*	4
POPU	*Polygonum punctatum*	2

(Continued)

APPENDIX D (Continued)

Acronym	Latin name	Sp. weight
PTAQ	*Pteridium aquilinum*	4
PYBA	*Pyxidanthera barbulata*	3
PYCN	*Pycnanthemum flexuosum*	4
QUBI	*Quercus bicolor*	2
QULA	*Quercus laurifolia*	2
QULY	*Quercus lyrata*	1
QUNI	*Quercus nigra*	3
QUPH	*Quercus phellos*	2
QUPU	*Quercus pumila*	5
QUSH	*Quercus shumardii*	2
QUVE	*Quercus velutina*	5
RHAL	*Rhexia alifanus*	2
RHCO	*Rhus copallina*	5
RHEX	*Rhexia alaphanus*	2
RHLU	*Rhexia lutea*	2
RHPE	*Rhexia petiolata*	2
RHRA	*Rhus radicans*	5
RHTO	*Rhus toxicodendron*	5
RHYN	*Rhynchospora* spp.	2
RHYR	*Rhynchospora rariflora*	1
RUBU	*Rubus* spp.	4
RUME	*Rumex acetosella*	4
SABA	*Sabatia* spp.	*
SAST	*Sabatia stellaris*	*
SACE	*Saururus cernuus*	1
SAFL	*Sarracenia flava*	1
SAMI	*Sarracenia minor*	1
SAPU	*Sarracenia purpurea*	1
SAXI	*Saxifraga* spp.	*
SMLA	*Smilax laurifolia*	2
SMRO	*Smilax rotundifolia*	3
SMTA	*Smilax tamnifolia*	2
SMWA	*Smilax walteri*	1
SOAR	*Sorbus arbutifolia*	2
SOLI	*Solidago* spp.	*
SPHA	*Sphagnum* spp.	1
TAAS	*Taxodium ascendens*	1
TADI	*Taxodium distichum*	1
TECA	*Teucrium canadense*	2
TILI	*Tilia* spp.	*
ULRU	*Ulmus rubra*	3
ULMU	*Ulmus* spp.	3

(Continued)

APPENDIX D (Concluded)

Acronym	Latin name	Sp. weight
VACC	*Vaccinium* spp.	3
VACO	*Vaccinium corymbosum*	2
VACR	*Vaccinium crassifolium*	3
VENO	*Vernonia noveboracensis*	3
VIBU	*Viburnum* spp.	*
VICA	*Viburnum cassinoides*	2
VINU	*Viburnum nudum*	2
VIOL	*Viola* spp.	*
VIRO	*Vitis rotundifolia*	3
WOAR	*Woodwardia areolata*	1
WOVI	*Woodwardia virginica*	1
XYCA	*Xyris caroliniana*	2
XYRI	*Xyris* spp.	2
ZEPU	*Zenobia pulverulenta*	1
ZIGL	*Zigdenus glaberrimus*	2

APPENDIX E

SPECIES COMPOSITION DATA FOR SAMPLE PLOTS
IN THE CROATAN NATIONAL FOREST

Appendix E-1. Species composition data for plot no. 1 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
1 ANSP	Andropogon sp.	1	---	---	0.050	---
1 CHCA	Chamadaphne calyculata	1	---	---	0.100	---
1 CLSP	Cladonia	3	---	---	0.200	---
1 CYRA	Cyrilla racemiflora	5	---	---	2.900	13000
1 GAFR	Gaylussacia frondosa	5	---	---	1.250	---
1 GOLA	Gordonia lasianthus	1	---	---	0.150	1000
1 ILGL	Ilex glabra	5	---	---	1.850	---
1 KAAN	Kalmia carolina	5	---	---	0.850	---
1 LYLU	Lyonia lucida	5	---	---	2.150	500
1 PEBO	Persea borbonia	5	---	---	1.450	500
1 PISE	Pinus serotina	4	25	0.0490	0.450	4000
1 SMLA	Smilax laurifolia	5	---	---	1.850	---
1 SOAR	Aronia arbutifolia	5	---	---	0.850	1000
1 SPBA	Sphagnum bartlettianum	1	---	---	0.150	---
1 SPHA	Sphagnum spp.	1	---	---	0.050	---
1 VACO	Vacinium corymbosum	1	---	---	0.150	---
1 WOVI	Woodwardia virginica	5	---	---	1.200	---
1 ZEPU	Zenobia pulverulenta	5	---	---	2.150	---
	Total		25	0.049	17.800	20000

Appendix E-2. Species composition data for plot no. 2 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
2 CYRA	Cyrilla racemiflora	5	---	---	2.150	6000
2 GOLA	Gordonia lasianthus	5	50	0.1655	1.200	3500
2 ILCO	Ilex coriacea	2	---	---	0.400	---
2 ILGL	Ilex glabra	5	---	---	1.850	---
2 LYLU	Lyonia lucida	5	---	---	3.150	500
2 PEBO	Persea borbonia	5	---	---	1.950	2000
2 PISE	Pinus serotina	5	325	4.6050	---	---
2 RHAT	Rhododendron atlanticum	1	---	---	0.050	1000
2 SMLA	Smilax laurifolia	5	---	---	2.000	4500
2 SOAR	Aronia arbutifolia	2	---	---	0.150	1000
2 SPHA	Sphagnum spp.	2	---	---	0.150	---
2 VACO	Vaccinium corymbosum	2	---	---	0.650	---
2 WOVI	Woodwardia virginica	4	---	---	0.500	---
2 ZEPU	Zenobia pulverulenta	5	---	---	1.500	500
	Total		375	4.770	17.800	19000

Appendix E-3. Species composition data for plot no. 3 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species Name	Freq.	Number of Tree Stems	Basal Area	Herb Cover	Number of Shrub Stems
3 CYRA	Cyrilla racemiflora	5	---	---	2.550	9500
3 GOLA	Gordonia lasianthus	2	---	---	0.650	500
3 ILGL	Ilex glabra	5	---	---	4.000	---
3 KAAN	Kalmia carolina	3	---	---	0.700	---
3 LYLU	Lyonia lucida	5	---	---	2.700	---
3 PEBO	Persea borbonia	5	---	---	1.050	---
3 PISE	Pinus serotina	3	125	1.3950	---	---
3 SMLA	Smilax laurifolia	5	---	---	1.650	---
3 SOAR	Aronia arbutifolia	4	---	---	0.400	---
3 VACR	Vaccinium crassifolium	1	---	---	0.050	---
3 WOVI	Woodwardia virginica	5	---	---	0.800	---
3 ZEPU	Zenobia pulverulenta	5	---	---	3.050	---
	Total		125	1.395	17.600	10000

Appendix E-4. Species composition data for plot no. 4 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species Name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
4 ACRU	Acer rubrum	5	275	10.0067	0.200	---
4 COTY	Unknown	1	---	---	0.050	---
4 ILOP	Ilex opaca	3	125	0.6377	0.100	---
4 ITVI	Itea virginica	1	---	---	0.050	---
4 LIST	Liquidambar styraciflua	5	400	7.9572	0.100	---
4 LYLU	Lyonia lucida	5	---	---	2.700	2000
4 MYHE	Myrica heterophylla	1	25	0.0615	---	---
4 NYSY	Nyssa sylvatica	5	550	6.7017	---	---
4 PEBO	Persea borbonia	3	50	0.3510	0.200	500
4 PISE	Pinus serotina	1	25	3.8882	---	---
4 SMLA	Smilax laurifolia	1	---	---	0.050	---
4 VIRO	Vitis rotundifolia	1	---	---	0.050	---
	Total		1450	29.6040	1.395	2500

Appendix E-5. Species composition data for plot no. 5 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
5 ACRU	Acer rubrum	5	250	12.2482	0.200	500
5 ARSP	Aralia spinosa	1	25	0.1925	---	---
5 ILOP	Ilex opaca	4	650	3.7222	0.300	500
5 LEAX	Leucothoe axillaris	4	---	---	0.900	---
5 LIST	Liquidambar styraciflua	1	50	9.1550	---	---
5 LYLU	Lyonia lucida	4	---	---	0.950	1000
5 NYSY	Nyssa sylvatica	2	50	10.5775	---	---
5 PEBO	Persea borbonia	4	250	7.6175	1.550	1000
5 RHRA	Rhus radicans	1	---	---	0.050	---
5 SMLA	Smilax laurifolia	5	---	---	0.600	---
5 VIRO	Vitis rotundifolia	1	---	---	0.050	---
	Total		1275	43.5129	4.600	3000

Appendix E-6. Species composition data for plot no. 6 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
6 ACRU	Acer rubrum	4	425	2.4302	0.050	---
6 ARSP	Aralia spinosa	1	---	---	0.100	1000
6 ARUN	Arundinarea gigantea	5	---	---	0.850	52000
6 CYRA	Cyrilla racemiflora	2	325	1.5505	0.300	1000
6 ILCO	Ilex coriacea	5	---	---	1.150	1000
6 ITVI	Itea virginica	2	---	---	0.150	1000
6 LIST	Liquidambar styraciflua	3	350	1.9550	---	---
6 MAVI	Magnolia virginia	1	25	0.0510	---	---
6 MYHE	Myrica heterophylla	5	---	---	1.150	---
6 NYSY	Nyssa sylvatica	4	350	2.2607	---	---
6 PISE	Pinus serotina	5	800	37.0377	---	---
6 SMLA	Smilax laurifolia	4	---	---	0.250	1500
6 UNKF	Unknown	4	---	---	0.900	1500
6 WOVI	Woodwardia virginica	1	---	---	0.100	---
	Total		2275	45.2851	5.000	590000

Appendix E-7. Species composition data for plot no. 7 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
7 ACRU	Acer rubrum	2	25	0.0805	0.050	500
7 CAWA	Carex walteriana	1	---	---	0.050	---
7 CHCA	Chamadaphne calyculata	5	---	---	1.150	---
7 CHTH	Chamaecyparis thyoides	3	75	1.1190	0.550	1000
7 CYRA	Cyrilla racemiflora	5	---	---	2.850	11500
7 GOLA	Gordonia lasianthus	1	---	---	0.150	---
7 ILGL	Ilex glabra	3	---	---	1.000	---
7 LYLU	Lyonia lucida	5	---	---	3.650	500
7 PEBO	Persea borbonia	1	---	---	0.100	---
7 PISE	Pinus serotina	4	100	2.6352	---	---
7 SAFL	Sarracenia flava	1	---	---	0.100	---
7 SMLA	Smilax laurifolia	5	---	---	0.900	1000
7 SPHA	Sphagnum spp.	5	---	---	1.950	---
7 WOVI	Woodwardia virginica	5	---	---	2.450	---
7 ZEPU	Zenobia pulverulenta	4	---	---	2.050	---
	Total		200	3.8347	17.000	14500

Appendix E-8. Species composition data for plot no. 8 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
8 ACRU	Acer rubrum	2	50	0.6795	0.150	---
8 CLAL	Clethra alnifolia	2	---	---	0.400	---
8 CRVI	Crataegus viridis	1	---	---	0.050	---
8 CYRA	Cyrilla racemiflora	5	150	0.3640	0.700	10000
8 ILCO	Ilex coriacea	3	---	---	0.300	500
8 ILGL	Ilex glabra	3	---	---	0.600	---
8 ITVI	Itea virginica	1	50	0.1062	0.400	---
8 LYLU	Lyonia lucida	5	---	---	3.250	15000
8 MAVI	Magnolia virginia	1	25	0.0707	---	---
8 NYBI	Nyssa sylvatica var. biflora	2	100	0.2622	0.200	---
8 PEBO	Persea borbonia	5	275	0.8327	0.750	1000
8 PISE	Pinus serotina	5	625	20.7892	---	---
8 POAC	Polystichum acrostichoides	5	---	---	0.600	---
8 SMLA	Smilax laurifolia	3	---	---	0.150	2500
8 VACO	Vaccinium corymbosum	1	---	---	0.350	---
	Total		1275	23.1045	7.900	29000

Appendix E-9. Species composition data for plot no. 9 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
9 ACRU	Acer rubrum	1	25	0.0962	---	---
9 CHCA	Chamadaphne calyculata	3	---	---	0.550	---
9 CHTH	Chamaecyparis thyoides	4	225	7.1917	1.750	1500
9 CYRA	Cyrilla racemiflora	4	25	0.0595	1.600	8500
9 ILGL	Ilex glabra	4	---	---	1.100	1000
9 LYLU	Lyonia lucida	5	---	---	3.700	3000
9 MYCE	Myrica cerifera	3	25	0.0552	0.850	4000
9 PEBO	Persea borbonia	4	25	0.0830	0.450	500
9 PEVI	Peltandra virginica	2	---	---	0.200	---
9 PISE	Pinus serotina	3	100	4.1672	---	---
9 SMLA	Smilax laurifolia	3	---	---	1.050	2000
9 SPHA	Sphagnum spp.	4	---	---	1.850	---
9 WOVI	Woodwardia virginica	5	---	---	2.400	---
9 ZEPU	Zenobia pulverulenta	5	---	---	2.200	---
	Total		425	11.6528	17.700	20500

Appendix E-10. Species composition data for plot no. 10 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
10 CYRA	Cyrilla racemiflora	5	325	0.9497	0.400	10000
10 GOLA	Gordonia lasianthus	4	700	2.9550	0.550	2000
10 ILCO	Ilex coriacea	2	---	---	1.200	6000
10 ILGL	Ilex glabra	1	---	---	0.100	---
10 LYLU	Lyonia lucida	5	---	---	2.400	2500
10 MAVI	Magnolia virginia	2	100	0.2125	---	---
10 PEBO	Persea borbonia	5	400	2.7235	0.700	1500
10 PISE	Pinus serotina	5	400	15.3162	---	---
10 VACO	Vaccinium corymbosum	4	---	---	1.300	1500
	Total		1925	22.1569	6.650	23500

Appendix E-11. Species composition data for plot no. 11 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
11 ACRU	Acer rubrum	1	25	0.1662	---	---
11 CYRA	Cyrilla racemiflora	5	725	1.9105	0.150	3000
11 GOLA	Gordonia lasianthus	5	400	4.9465	---	---
11 ILCO	Ilex coriacea	4	75	0.1780	1.150	2500
11 ILGL	Ilex glabra	1	---	---	0.150	---
11 LYLU	Lyonia lucida	5	---	---	2.550	5000
11 MAVI	Magnolia virginia	1	25	0.0615	---	---
11 NYBI	Nyssa sylvatica var. biflora	1	25	0.1520	---	---
11 PEBO	Persea borbonia	5	175	1.2187	1.100	1000
11 PISE	Pinus serotina	5	1100	23.5770	---	---
11 POAC	Polystichum acrostichoides	1	---	---	0.100	---
11 SMLA	Smilax laurifolia	3	---	---	0.300	1500
11 SOAR	Aronia arbutifolia	2	---	---	0.200	500
11 VACO	Vaccinium corymbosum	3	---	---	0.650	---
11 VAST	Vaccinium stamineum	1	---	---	0.100	---
	Total		2550	32.2104	6.450	13500

Appendix E-12. Species composition data for plot no. 12 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
12 CAWA	Carex walteriana	5	---	---	2.200	---
12 CYRA	Cyrilla racemiflora	5	---	---	2.700	---
12 GAFR	Gaylussacia frondosa	4	---	---	3.000	---
12 GOLA	Gordonia lasianthus	2	---	---	0.350	500
12 ILGL	Ilex glabra	4	---	---	0.600	---
12 KAAN	Kalmia carolina	5	---	---	1.850	---
12 LYLU	Lyonia lucida	5	---	---	3.150	1500
12 PEBO	Persea borbonia	5	---	---	2.300	---
12 PISE	Pinus serotina	5	250	1.3830	0.700	---
12 RHAT	Rhododendron atlanticum	1	---	---	0.100	2500
12 SAFL	Sarracenia flava	2	---	---	0.200	---
12 SMLA	Smilax laurifolia	5	---	---	2.750	1000
12 SOAR	Aronia arbutifolia	6	---	---	2.300	---
12 SPHA	Sphagnum spp.	3	---	---	1.050	---
12 VACR	Vaccinium crassifolium	2	---	---	0.600	---
12 WOVI	Woodwardia virginica	4	---	---	0.900	---
12 XYCA	Xyris caroliniana	1	---	---	0.150	---
12 ZEPU	Zenobia pulverulenta	5	---	---	2.950	---
	Total		250	1.3830	27.850	5500

Appendix E-13. Species composition data for plot no. 13 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
13 CAWA	Carex walteriana	1	---	---	0.150	---
13 CYRA	Cyrilla racemiflora	5	---	---	3.500	3000
13 GAFR	Gaylussacia frondosa	5	---	---	2.250	---
13 GOLA	Gordonia lasianthus	3	---	---	1.000	2000
13 ILGL	Ilex glabra	5	---	---	3.000	---
13 KAAN	Kalmia carolina	4	---	---	1.050	---
13 LYLU	Lyonia lucida	5	---	---	3.400	---
13 PEBO	Persea borbonia	5	---	---	2.250	---
13 PISE	Pinus serotina	5	350	1.9342	0.100	500
13 SMLA	Smilax laurifolia	5	---	---	2.450	---
13 SOAR	Aronia arbutifolia	5	---	---	1.850	---
13 VACR	Vaccinium crassifolium	1	---	---	0.100	---
13 WOVI	Woodwardia virginica	5	---	---	1.300	---
13 ZEPU	Zenobia pulverulenta	5	---	---	2.750	---
	Total		350	1.9342	25.150	5500

Appendix E-14. Species composition data for plot no. 14 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
14 CYRA	Cyrilla racemiflora	2	50	0.2342	---	1500
14 GOLA	Gordonia lasianthus	5	750	4.2400	0.250	1500
14 ILGL	Ilex glabra	4	---	---	0.600	4500
14 LYLU	Lyonia lucida	5	---	---	2.800	18000
14 PEBO	Persea borbonia	3	---	---	0.350	---
14 PISE	Pinus serotina	5	1225	14.2305	---	---
14 SMLA	Smilax laurifolia	3	---	---	0.250	500
14 VACO	Vaccinium corymbosum	5	---	---	2.650	31000
14 VACR	Vaccinium crassifolium	1	---	---	0.350	---
14 WOVI	Woodwardia virginica	3	---	---	0.300	1000
14 ZEPU	Zenobia pulverulenta	2	---	---	0.650	2500
	Total		2025	18.7047	8.200	60500

Appendix E-15. Species composition data for plot no. 15 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
15 ANDR	Andropogon sp.	1	---	---	0.050	---
15 CAWA	Carex walteriana	4	---	---	1.600	---
15 CYRA	Cyrilla racemiflora	5	---	---	3.900	---
15 GAFR	Gaylussacia frondosa	4	---	---	2.050	---
15 GOLA	Gordonia lasianthus	3	---	---	0.500	---
15 ILGL	Ilex glabra	4	---	---	1.850	1000
15 KAAN	Kalmia carolina	5	---	---	0.750	---
15 LYLU	Lyonia lucida	5	---	---	3.750	---
15 PEBO	Persea borbonia	5	---	---	1.650	---
15 PISE	Pinus serotina	3	100	0.3067	0.200	---
15 SAFL	Sarracenia flava	1	---	---	0.050	---
15 SAPU	Sarracenia purpurea	1	---	---	0.050	---
15 SMLA	Smilax laurifolia	5	---	---	2.750	---
15 SOAR	Aronia arbutifolia	4	---	---	1.300	---
15 SPHA	Sphagnum spp.	1	---	---	0.350	---
15 WOVI	Woodwardia virginica	2	---	---	0.300	---
15 ZEPU	Zenobia pulverulenta	4	---	---	2.750	---
	Total		100	0.3067	23.850	1000

Appendix E-16. Species composition data for plot no. 16 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
16 CAWA	Carex walteriana	1	---	---	0.100	---
16 CYRA	Cyrilla racemiflora	5	---	---	1.600	35000
16 GADU	Gaylussacia dumosa	2	---	---	1.100	---
16 GAFR	Gaylussacia frondosa	4	---	---	1.100	---
16 GOLA	Gordonia lasianthus	4	175	0.7555	0.200	1500
16 ILGL	Ilex glabra	5	---	---	0.850	---
16 KAAN	Kalmia carolina	5	---	---	1.850	---
16 LYLU	Lyonia lucida	5	---	---	3.350	2500
16 PEBO	Persea borbonia	5	---	---	2.150	---
16 PISE	Pinus serotina	5	800	9.6862	---	1000
16 SMLA	Smilax laurifolia	5	---	---	1.100	---
16 SOAR	Aronia arbutifolia	5	---	---	0.700	---
16 VACR	Vaccinium crassifolium	2	---	---	0.250	---
16 WOVI	Woodwardia virginica	5	---	---	2.100	---
16 ZEPU	Zenobia pulverulenta	4	---	---	1.050	---
	Total		975	10.4417	17.500	40000

Appendix E-17. Species composition data for plot no. 17 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
17 CLAD	Cladonia	1	---	---	0.100	---
17 CYRA	Cyrilla racemiflora	5	---	---	2.550	8000
17 GADU	Gaylussacia dumosa	3	---	---	1.400	---
17 GAFR	Gaylussacia frondosa	2	---	---	0.500	---
17 GOLA	Gordonia lasianthus	2	---	---	0.300	500
17 ILGL	Ilex glabra	4	---	---	1.700	---
17 KAAN	Kalmia carolina	3	---	---	0.500	---
17 LYLU	Lyonia lucida	5	---	---	3.500	---
17 PEBO	Persea borbonia	5	---	---	0.750	---
17 PISE	Pinus serotina	1	25	0.8660	---	---
17 SMLA	Smilax laurifolia	5	---	---	1.850	1500
17 SOAR	Aronia arbutifolia	5	---	---	1.100	---
17 SPHA	Sphagnum spp.	1	---	---	0.100	---
17 WOVI	Woodwardia virginica	5	---	---	1.900	---
17 ZEPU	Zenobia pulverulenta	5	---	---	2.250	---
	Total		25	0.8660	18.500	10000

Appendix E-18. Species composition data for plot no. 18 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
18 ACRU	Acer rubrum	4	200	6.4082	0.400	---
18 CLAL	Clethra alnifolia	2	---	---	1.400	---
18 CYRA	Cyrilla racemiflora	3	125	0.3922	0.350	4500
18 GESE	Gelsemium sempervirens	3	---	---	0.300	---
18 ILCA	Ilex cassine var. myrtifolia	2	---	---	0.250	---
18 ILCO	Ilex coriacea	3	---	---	0.150	---
18 ILGL	Ilex glabra	5	---	---	1.250	4500
18 ILOP	Ilex opaca	2	---	---	0.250	---
18 LIST	Liquidambar styraciflua	5	125	4.1290	0.250	---
18 LYLU	Lyonia lucida	2	---	---	0.200	---
18 MYCE	Myrica cerifera	1	---	---	0.050	---
18 MYHE	Myrica heterophylla	2	---	---	0.100	---
18 NYSY	Nyssa sylvatica	4	300	0.8532	0.800	2000
18 PEBO	Persea borbonia	5	50	0.1085	0.750	500
18 PITA	Pinus taeda	5	925	35.5865	0.050	---
18 SMLA	Smilax laurifolia	1	---	---	0.100	---
18 SMRO	Smilax rotundifolia	3	---	---	0.050	1500
18 SOAR	Aronia arbutifolia	1	---	---	0.100	---
18 SYTI	Symplocus tinctorum	1	---	---	0.100	---
18 VACO	Vaccinium corymbosum	3	---	---	0.200	1000
18 WOVI	Woodwardia virginica	2	---	---	0.150	---
	Total		1725	47.4776	7.250	14000

Appendix E-19. Species composition data for plot no. 19 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
19 ACRU	Acer rubrum	4	100	19.9715	1.300	---
19 ARUN	Arundinarea gigantea	2	---	---	0.600	14500
19 ERPR	Eryngium prostratum	1	---	---	0.100	---
19 GESE	Gelsemium sempervirens	1	---	---	0.100	---
19 ILOP	Ilex opaca	2	25	0.0510	0.050	---
19 LIST	Liquidambar styraciflua	5	325	28.7775	0.100	---
19 MAVI	Magnolia virginia	1	125	0.8850	---	---
19 NYSY	Nyssa sylvatica	3	50	12.6330	0.400	---
19 PANI	Panicum sp.	1	---	---	0.250	---
19 PEBO	Persea borbonia	5	100	3.1542	2.800	5500
19 RHRA	Rhus radicans	2	---	---	0.150	---
19 RHRU	Unknown	1	---	---	0.200	---
19 SMLA	Smilax laurifolia	5	---	---	0.500	---
19 TIUS	Tillandsia usneoides	1	---	---	0.100	---
19 UNLA	Unknown	3	---	---	1.200	---
19 VIRO	Vitis rotundifolia	1	---	---	0.300	---
19 WOAR	Woodwardia areolata	1	---	---	0.150	---
	Total		725	65.4722	8.300	20000

Appendix E-20. Species composition data for plot no. 20 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
20 ACRU	Acer rubrum	5	300	25.4590	0.750	---
20 ILOP	Ilex opaca	3	50	0.2950	---	500
20 LIST	Liquidambar styraciflua	4	200	27.8562	---	---
20 LYLU	Lyonia lucida	5	---	---	1.900	2500
20 NYSY	Nyssa sylvatica	4	50	8.7735	0.200	---
20 PEBO	Persea borbonia	5	425	8.3462	2.500	3500
20 SMLA	Smilax laurifolia	5	---	---	1.000	---
20 SPHA	Sphagnum spp.	1	---	---	0.300	---
	Total		1025	70.7299	6.650	6500

Appendix E-21. Species composition data for plot no. 21 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
21 ACRU	Acer rubrum	1	---	---	0.100	---
21 ANDR	Unknown	1	---	---	0.050	---
21 CYRA	Cyrilla racemiflora	2	---	---	---	1500
21 DESM	Robinia nana	2	---	---	0.750	---
21 DEVE	Decodon verticillata	3	---	---	1.600	---
21 GAFR	Gaylussacia frondosa	2	---	---	0.300	13500
21 GOLA	Gordonia lasianthus	2	150	1.7825	---	---
21 ILCO	Ilex coriacea	1	25	0.0510	0.450	3000
21 ILGL	Ilex glabra	2	---	---	0.100	1000
21 LYLU	Lyonia lucida	4	---	---	1.900	35000
21 MYCE	Myrica cerifera	1	100	0.3687	---	1500
21 OSRE	Osmunda regalis	1	---	---	0.100	---
21 PEBO	Persea borbonia	4	50	0.1812	0.650	500
21 PISE	Pinus serotina	3	150	5.3582	---	---
21 SMLA	Smilax laurifolia	2	---	---	0.200	---
21 SPHA	Sphagnum spp.	2	---	---	1.750	---
21 SYTI	Symplocus tinctorum	1	25	0.1590	---	---
21 TADI	Taxodium distichum	3	350	6.3907	0.250	500
21 VACO	Vaccinium corymbosum	3	---	---	0.500	8500
21 VACR	Vaccinium crassifolium	1	---	---	0.100	---
21 WOAR	Woodwardia areolata	1	---	---	0.150	---
21 XYCA	Xyris caroliniana	1	---	---	0.100	---
	Total		850	14.2913	9.050	65000

Appendix E-22. Species composition data for plot no. 22 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
22 ACRU	Acer rubrum	2	175	2.2492	---	---
22 CYRA	Cyrilla racemiflora	1	25	0.3577	---	---
22 GOLA	Gordonia lasianthus	4	225	1.6812	---	500
22 ILCO	Ilex coriacea	4	25	0.2002	1.100	1500
22 LIST	Liquidambar styraciflua	3	175	11.0870	---	---
22 LYLU	Lyonia lucida	5	---	---	2.800	5500
22 MAVI	Magnolia virginia	5	450	4.0247	---	1500
22 MYCE	Myrica cerifera	1	25	0.0490	---	---
22 MYHE	Myrica heterophylla	3	225	4.2610	---	500
22 NYSY	Nyssa sylvatica	2	75	2.6107	---	---
22 PEBO	Persea borbonia	5	1550	22.1385	1.550	3500
22 QUNI	Quercus nigra	2	50	7.5482	---	---
22 SMLA	Smilax laurifolia	4	---	---	0.350	5000
22 VIRO	Vitis rotundifolia	1	---	---	0.050	---
	Total		3000	56.2074	5.850	18000

Appendix E-23. Species composition data for plot no. 23 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
23 CHTH	Chamaecyparis thyoides	1	25	0.0805	0.100	---
23 CYRA	Cyrilla racemiflora	3	250	0.7642	---	1000
23 GAFR	Gaylussacia frondosa	3	---	---	1.200	1500
23 GOLA	Gordonia lasianthus	4	250	2.6962	---	---
23 ILCO	Ilex coriacea	5	75	0.2120	1.750	10000
23 LYLU	Lyonia lucida	5	50	0.1417	2.100	18500
23 MAVI	Magnolia virginia	5	300	1.2512	---	2000
23 MYCE	Myrica cerifera	1	25	0.0615	---	---
23 MYHE	Myrica heterophylla	1	---	---	0.050	500
23 PEBO	Persea borbonia	5	375	5.6575	0.550	500
23 PISE	Pinus serotina	5	725	33.5735	---	---
23 RHAT	Rhododendron atlanticum	1	---	---	---	500
23 SMLA	Smilax laurifolia	1	---	---	0.100	500
	Total		2075	44.4383	5.850	35000

Appendix E-24. Species composition data for plot no. 24 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
24 ACRU	Acer rubrum	1	---	---	0.050	---
24 ANDRO1	Unknown	4	---	---	0.550	---
24 ANDR1	Unknown	1	---	---	0.100	---
24 ANVI	Andropogon virgincus	5	---	---	0.900	---
24 ARST	Aristida stricta	5	---	---	2.150	---
24 ARUN	Arundinarea gigantea	4	---	---	1.200	---
24 CLAL	Clethra alnifolia	4	---	---	1.850	---
24 EUHY	Unknown	5	---	---	0.750	---
24 EULE	Eupatorium leucolepis	1	---	---	0.100	---
24 EURO	Eupatorium rotundifolium	4	---	---	0.450	---
24 F2WD	Aster?	3	---	---	0.350	---
24 GADU	Gaylussacia dumosa	5	---	---	1.600	---
24 GAFR	Gaylussacia frondosa	5	---	---	3.700	---
24 GESE	Gelsemium sempervirens	3	---	---	0.750	---
24 ILDE	Ilex decidua	3	---	---	0.900	---
24 ILGL	Ilex glabra	5	---	---	3.550	---
24 LIST	Liquidambar styraciflua	5	---	---	1.150	---
24 MYCE	Myrica cerifera	1	---	---	0.250	---
24 MYHE	Myrica heterophylla	4	---	---	1.400	---
24 NYSY	Nyssa sylvatica	2	50	0.0232	0.100	---
24 OSCI	Osmunda cinnamomea	4	---	---	1.400	---
24 PANI	Panicum sp.---	2	---	---	0.300	---
24 PAN1	Panicum sp. 1	1	---	---	0.150	---
24 PAN2	Panicum sp. 2	1	---	---	0.150	---
24 PEBO	Persea borbonia	3	---	---	0.650	---
24 PIPA	Pinus palustris	5	225	2.3665	---	---
24 POLU	Polygala lutea	2	---	---	0.350	---
24 PTAQ	Pteridium aquilinum	4	---	---	1.850	---
24 QUMG	Quercus margaretta	1	---	---	0.050	---
24 REAL	Unknown	2	---	---	0.200	---
24 RHAL	Rhexia alifanus	5	---	---	1.350	---
24 SAPU	Sarracenia purpurea	1	---	---	0.050	---
24 SG1	Unknown	1	---	---	0.050	---
24 SMGL	Smilax glauca	8	---	---	1.450	---
24 SOAR	Aronia arbutifolia	8	---	---	1.800	---

(Continued)

APPENDIX E-24 (Continued)

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
24 SPHA	Sphagnum spp.	1	---	---	0.100	---
24 SYTI	Symplocus tinctorum	1	---	---	0.200	---
24 UKGRAS	Unknown	4	---	---	0.250	---
24 UKSG	Unknown	1	---	---	0.100	---
24 UKS2	Unknown	5	---	---	0.400	---
24 VACR	Vaccinium crassifolium	4	---	---	0.650	---
24 VATE	Vaccinium tenellum	4	---	---	1.500	---
24 XYCA	Xyris caroliniana	4	---	---	0.200	---
	Total		275	2.3897	35.050	0

Appendix E-25. Species composition data for plot no. 25 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
25 ACRU	Acer rubrum	5	225	2.4587	0.850	2000
25 CACR	Carpinus caroliniana	3	475	0.5615	0.300	500
25 COTY	Unknown	1	---	---	0.050	---
25 CRFB	Unknown	1	---	---	0.100	---
25 EATENH	Unknown	1	---	---	0.100	---
25 ERPR	Eryngium prostratum	1	---	---	0.050	---
25 EUAM	Euonymous americanum	1	---	---	0.050	---
25 FRAX	Fraxinus pennsylvanica	4	575	2.0715	---	3000
25 ILDE	Ilex decidua	1	---	---	0.050	---
25 ILOP	Ilex opaca	2	275	0.2497	---	---
25 LEAX	Leucothoe axillaris	3	---	---	1.950	---
25 LIST	Liquidambar styraciflua	5	225	7.4880	---	---
25 LYLU	Lyonia lucida	2	---	---	0.350	---
25 MYHE	Myrica heterophylla	1	---	---	0.100	---
25 NYSY	Nyssa sylvatica	4	200	9.9605	0.200	---
25 ONSE	Onoclea sensibilis	3	---	---	0.800	---
25 PEBO	Persea borbonia	3	75	0.1162	0.200	---
25 QUMI	Quercus michauxii	1	---	---	0.100	---
25 QUNI	Quercus nigra	1	---	---	0.100	500
25 QUPH	Quercus phellos	2	---	---	0.150	---
25 RUBU	Rubus spp.	1	---	---	0.050	---
25 SACE	Saururus cernuus	1	---	---	0.350	---
25 SMLA	Smilax laurifolia	5	---	---	0.550	9500
25 UKOP	Unknown	1	---	---	0.050	---
	Total		2050	22.9061	6.500	15500

Appendix E-26. Species composition data for plot no. 26 sampled in Croatan National Forest. Acro refers to species acronym used in computer analysis. Frequency is the number of quadrats out of five in which the species appeared, regardless of stratum. Tree and shrub stem numbers are calculated on the basis of a hectare. Basal area is $m^2 \cdot ha^{-1}$, and herb cover is the average herb cover value based on the 1-5 cover scale of Daubenmire (1968).

Acro.	Species name	Freq.	Number of tree stems	Basal area	Herb cover	Number of shrub stems
26 ACRU	Acer rubrum	3	125	0.6042	0.150	---
26 CLAL	Clethra alnifolia	1	---	---	0.050	---
26 GOLA	Gordonia lasianthus	4	125	0.1995	---	---
26 ILCO	Ilex coriacea	3	25	0.0087	1.300	12000
26 ILDE	Ilex decidua	1	---	---	0.100	---
26 ILOP	Ilex opaca	3	25	0.0200	0.050	500
26 LEAX	Leucothoe axillaris	6	---	---	1.750	---
26 LIST	Liquidambar styraciflua	4	150	2.2232	---	---
26 LYLU	Lyonia lucida	2	---	---	0.250	1500
26 MAVI	Magnolia virginia	1	25	0.0165	---	---
26 NYSY	Nyssa sylvatica	1	75	0.0880	---	---
26 PEBO	Persea borbonia	5	575	1.2475	1.250	---
26 PITA	Pinus taeda	2	100	1.9850	---	---
26 QUNI	Quercus nigra	2	225	0.5552	---	---
26 RHRA	Rhus radicans	1	---	---	0.100	---
26 SMGL	Smilax glauca	1	---	---	0.150	---
26 SMLA	Smilax laurifolia	5	---	---	0.450	8000
26 VINU	Viburnum nudum	1	---	---	---	500
26 WOVI	Woodwardia virginica	2	---	---	0.200	---
	Total		1450	6.9478	5.800	22500

APPENDIX F

Species included in data set from Croatan National Forest. ACRO refers to species acronym used in computer analyses. Sp. weight refers to numerical weight assigned each species based on wetland designations from Reed (1986). Asterisks indicate species for which weights were not available. Such species were not included in Weighted Average calculations.

ACRO	Latin name	Sp. weight.
ANVI	*Andropogon virgincus*	3
CARE	*Carex* sp.	*
ARSP	*Aralia spinosa*	3
ARST	*Aristida stricta*	3
ARUN	*Arundinarea gigantea*	2
CACR	*Carpinus caroliniana*	3
CAWA	*Carex walteriana*	1
CHCA	*Chamadaphne calyculata*	1
CHTH	*Chamaecyparis thyoides*	1
CLAD	*Cladonia* sp.	*
CLAL	*Clethra alnifolia*	2
CRFB	*Carex* sp. 2	*
CRVI	*Crataegus viridis*	2
CYRA	*Cyrilla racemiflora*	2
DESM	*Robinia nana*	5
DEVE	*Decodon verticillata*	1
ERPR	*Eryngium prostratum*	2
EUAM	*Euonymous americanus*	3
EUHY	*Eupatorium hyssopifolium*	2
EULE	*Eupatorium leucolepis*	2
EURO	*Eupatorium rotundifolium*	2
F2WD	*Aster* sp.	*
FRAX	*Fraxinus pennsylvanica*	2
GADU	*Gaylussacia dumosa*	3
GAFR	*Gaylussacia frondosa*	3
GESE	*Gelsemium sempervirens*	3
GOLA	*Gordonia lasianthus*	2
ILCA	*Ilex cassine* var. *myrtifolia*	2
ILCO	*Ilex coriacea*	2
ILDE	*Ilex decidua*	2
ILGL	*Ilex glabra*	2
ILOP	*Ilex opaca*	4
ITVI	*Itea virginica*	2

(Continued)

APPENDIX F (CONTINUED)

ACRO	Latin name	Sp. weight.
KAAN	*Kalmia carolina*	2
LEAX	*Leucothoe axillaris*	2
LIST	*Liquidambar styraciflua*	3
LYLU	*Lyonia lucida*	2
MAVI	*Magnolia virginiana*	2
MYCE	*Myrica cerifera*	3
MYHE	*Myrica heterophylla*	2
NYBI	*Nyssa sylvatica* var. *biflora*	3
NYSY	*Nyssa sylvatica*	3
ONSE	*Onoclea sensibilis*	2
OSCI	*Osmunda cinnamomea*	2
OSRE	*Osmunda regalis*	1
PANI	*Panicum* sp.	*
PEBO	*Persea borbonia*	2
PEVI	*Peltandra virginica*	1
PIPA	*Pinus palustris*	4
PISE	*Pinus serontina*	2
PITA	*Pinus taeda*	3
POAC	*Polystichum acrostichoides*	4
POLU	*Polygala lutea*	2
PTAQ	*Pteridium aquilinum*	4
QUMG	*Quercus margaretta*	4
QUMI	*Quercus michauxii*	2
QUNI	*Quercus nigra*	3
QUPH	*Quercus phellos*	2
RHAL	*Rhexia alifanus*	2
RHAT	*Rhododendron atlanticum*	3
RHRA	*Rhus radicans*	3
RUBU	*Rubus* spp.	*
SACE	*Saururus cernuus*	1
SAFL	*Sarracenia flava*	1
SAPU	*Sarracenia purpurea*	1
SG1	Unknown 1	*
SMGL	*Smilax glauca*	3
SMLA	*Smilax laurifolia*	2
SMRO	*Smilax rotundifolia*	3
SOAR	*Aronia arbutifolia*	2
SPBA	*Sphagnum bartlettianum*	1
SPHA	*Sphagnum* spp.	1
SYTI	*Symplocus tinctorum*	3
TADI	*Taxodium distichum*	1
TIUS	*Tillandsia usneoides*	5

(Continued)

APPENDIX F (CONCLUDED)

ACRO	Latin name	Sp. weight.
UKGR	*Carex* sp. 3	*
UKG1	Unknown 2	*
UKG2	Unknown 3	*
MIRE	*Mitchella repens*	4
UKS2	Unknown 4	*
UKSG	Unknown 5	*
UNKF	Unknown 6	*
UNLA	*Chasmanthium laxa*	2
VACO	*Vaccinium corymbosum*	2
VACR	*Vaccinium crassifolium*	3
VAST	*Vaccinium stamineum*	4
VATE	*Vaccinium tenellum*	5
VINU	*Viburnum nudum*	2
VIRO	*Vitis rotundifolia*	3
WOAR	*Woodwardia areolata*	1
WOVI	*Woodwardia virginica*	1
XYCA	*Xyris caroliniana*	2
ZEPU	*Zenobia pulverulenta*	1

APPENDIX G

ADDITIONAL REFERENCES FOR POCOSINS AND RELATED SOUTHEASTERN WETLANDS

Allen, P.H. 1958. A tidewater swamp forest and succession after clearcutting. M.S.Thesis. Duke University, Durham, North Carolina. 48 pp.

Applequist, M.B. 1959. A study of soil and site factors affecting growth and development of swamp blackgum and tupelogum stands in southeastern Georgia. Doctor of Forestry Thesis. Duke University, Durham, North Carolina. 181 pp.

Bartram, W. 1791. Travels through North and South Carolina, Georgia, east and west Florida, the Cherokee country, the extensive territories of the Muscogulges or Creek Confederacy, and the country of the Choctaws: containing an account of the soil and natural productions of those regions, together with observations on the manners of the indians. Philadelphia: James and Johnson.

Beaven, G. F., and H.J. Oosting. 1939. Pocomoke Swamp: a study of a cypress swamp on the eastern shore of Maryland. Bull. Torrey Bot. Club 66:367-389.

Belling, A.J. 1986. Postglacial history of Atlantic white cedar in the northeastern United States. In A. D. Laderman, ed. Atlantic white cedar wetlands. Westview Press, Boulder CO.

Brown, S. 1981. A comparison of the structure, primary productivity, and transpiration of cypress ecosystems in Florida. Ecol. Monogr. 51:403-427.

Brown, S.L., E.W. Flohrschutz, and H.T. Odum. 1984. Structure, productivity, and phosphorus cycling of the scrub cypress ecosystem. Pages 304-317 in K. C. Ewel and H. T. Odum, eds. Cypress Swamps. University of Florida Press, Gainsville.

Buell, M.F. 1946. Jerome Bog, a peat-filled "Carolina Bay." Bull. Torrey Bot. Club 73:24-33.

Buell, M.F., and R.L. Cain. 1943. The successional role of southern white cedar, *Chamaecypris thyoides*, in southeastern North Carolina. Ecology 24: 85-93.

Buol, S.W. 1973. Soils of the southern states and Puerto Rico. Agric. Exp. St. South. States and Puerto Rico Land-Grant Universities, South. Cooperative Ser. Bull. 174:105

Catesby, M. 1654. The Natural History of Carolina, Florida and the Bahama Islands. London: C. March et al. 220 pp.

Christensen, N.L. 1979. Shrublands of the southeastern United States. Pages 441-449 in R. L. Specht, ed. Heathlands and related shrublands of the world, A. Descriptive Studies. Elsevier, Amsterdam.

Clewell, A.F., and D.B. Ward. 1985. White cedar forests in Florida and Alabama. *in* A.D. Laderman, ed., Atlantic white cedar wetlands. Westview Press, Boulder, Colorado.

Cohen, A.D. 1973. Petrology of some Holocene peat sediments from the Okefenokee Swamp - Marsh Complex of southern Georgia. Geol. Soc. Am. Bull. 84:3867-3878.

Cohen, A.D. 1974. Petrography and paleoecology of Holocene peats from the Okefenokee Swamp - Marsh Complex at Georgia. J. Sediment. Petrol. 44: 716-720.

Cohen, A.D., M.J. Andrejko, W. Spackman, and D. Corrinus. 1984. Peat deposits of the Okefenokee Swamp. Pages 493-553 in A.D. Cohen, D.J. Casagrande, M.J. Andrejko, and G.R. Best, eds. The Okefenokee Swamp. Wetland Surveys, Los Alamos, NM.

Colquhoun, D.J. 1969. Geomorphology of the lower coastal plain of South Carolina. State of South Carolina Division of Geology, State Development Board, Ms-15. 36 pp.

Conner, W.H., and J.W. Day, Jr. 1976. Productivity and composition of a baldcypress-water tupelo site and a bottomland hardwood site in a Louisiana swamp. Am. J. Bot. 63:1354-1364.

Cooke, C.W. 1931. Seven coastal terraces in the southeastern states. J. Wash. Acad. Sci. 21:503-513.

Cowdrey, A.E. 1983. This land this south: an environmental history. University Press of Kentucky, Lexington, KY. 236 pp.

Cronin, T.M., B.J. Szabo, T.A. Ager, J.E. Hazel, and J.P. Owens. 1981. Quaternary climates and sea levels of the U.S. Atlantic Coastal Plain. Science 211:233-240.

Cypert, E. 1961. The effects of fires in the Okefenokee Swamp in 1954 and 1955. The Am. Midl. Nat. 66:485-503.

Cypert, E. 1972. The origin of houses in the Okefenokee prairies. The Am. Midl. Nat. 87:448-458.

Cypert, E. 1973. Plant succession on burned areas in Okefenokee Swamp following fires of 1954 and 1955. Proc. of the Annual Tall Timbers Fire Ecology Conf. 12:199-217.

Dabel, C.V., and F.P. Day, Jr. 1977. Structural comparisons of four plant communities in the Great Dismal Swamp, Virginia. Bull. Torrey Bot. Club 104:352-360.

Dachnowski-Stokes, A.P., and B.W. Wells. 1929. The vegetation, stratigraphy, and age of the "Open Land" peat area in Carteret County, North Carolina. J. Washington Acad. Sci. 19:1-11.

Davis, J.H. 1946. The peat deposits of Florida: their occurrence, development, and uses. Fl. Geol. Surv. Bull. No. 30.

Delcourt, P.A. and H.R. Delcourt. 1981. Vegetation maps for eastern North America: 40,000 YR B.P. to the present. Pages 123-165 *in* R. C. Romans, ed. Geobotany II. Plenum, New York.

Dickson, R.E., and T.C. Broyer. 1972. Effects of aeration, water supply, and nitrogen source on growth and development of tupelo gum and bald cypress. Ecology 53:626-634.

Duever, M.J., and L. A. Riopelle. 1983. Successional sequences and rates on tree islands in the Okefenokee Swamp. Am. Midl. Nat. 110:186-193.

Dunn, W.J., L.N. Schwartz, and G.R. Best. 1985. Structure and water relations of the white cedar forests of north central Florida. in A.D. Laderman, ed., Atlantic white cedar wetlands. Westview Press, Boulder, Colorado.

Edmisten, J.A. 1963. The Ecology of the Florida Pine Flatwoods. Ph.D. Dissertation. University of Florida, Gainesville, FL. 108 pp.

Eleuterius, L.N. 1968. Floristics and ecology of coastal bogs in Mississippi M.S. Thesis. University of Southern Mississippi, Hattiesburg.

Eleuterius, L.N., and S.B. Jones, Jr. 1969. A floristic and ecological study of pitcher plant bogs in south Mississippi. Rhodora 71:29-34.

Ewel, K.C. 1984. Effects of fire and wastewater on understory vegetation in cypress domes. Pages 119-126 *in* K.C. Ewel and H.T. Odum, eds. Cypress Swamps. University of Florida Press, Gainesville.

Ewel, K.C., and W.J. Mitsch. 1978. The effects of fire on species composition in cypress dome ecosystems. Fl. Sci. 41:25-31.

Frost, C.C. 1986. Historical overview of Atlantic white cedar in the Carolinas. in A.D. Laderman, ed. Atlantic white cedar wetlands. Westview Press, Boulder, Colorado.

Gano, L. 1917. A study in physiographic ecology in northern Florida. Bot. Gaz. 63:337-372.

Garren, K.H. 1943. Effects of fire on vegetation of the southeastern United States. Bot. Rev. 9:617-654.

Givens, K.T., J.N. Layne, W.G. Abrahamson, and S.C. White-Schuler. 1984. Structural changes and successional relationshps of five Florida Lake Wales ridge plant communities. Bull. Torrey Bot. Club 111.

Gresham, C.A., and D.J. Lipscomb. 1985. Selected ecological characteristics of *Gordonia lasianthus* in coastal South Carolina. Bull. Torrey Bot. Club 112:53-58.

Hall, T.F., and W.T. Penfound. 1939. A phytosociological study of a cypress-gum swamp in southeastern Louisiana. Am. Midl. Nat. 21:378-395.

Hall, T.F., and W.T. Penfound. 1943. Cypress-gum communities in the Blue Girth Swamp near Selma, Alabama. Ecology 24:208-217.

Harper, R.M. 1906. A phytogeographical sketch of the Altamaha Grit Region of the Coastal Plain of Georgia. Ann. N.Y. Acad. Sci. 7:1-415.

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

Harper, R.M. 1914. The "pocosin" of Pike Co., Ala., and its bearing on certain problems of succession. Bull. Torrey Bot. Club 41:209-220.

Harper, R.M. 1914. The geography and vegetation of northern Florida. Fl. Geol. Surv. Annu. Rep. 6:451.

Harper, R.M. 1922. Some pine-barren bogs in central Alabama. Torreya 22: 57-60.

Hull, J.C. and D.F. Whigham. 1985. Atlantic white cedar in the Maryland inner Coastal Plain and the Delmarva Peninsula. in A.D. Laderman, ed. Atlantic white cedar wetlands. Westview Press, Boulder Colorado

Izlar, R.L. 1984. Some comments on fire and climate in the Okefenokee Swamp-Marsh Complex. Pages 70-85 in A.D. Cohen, D.J. Casagrande, M.J. Andrejko, G.R. Best, eds. The Okefenokee Swamp. Wetland Surveys, Los Alamos, NM.

Johnson, W.B., C.E. Sasser, and J.G. Gosselink. 1985. Succession of vegetation in an evolving river delta, Atchafalaya Bay, Louisana. J. Ecol. 73:973-986.

Kearney, T.H. 1901. Report on a botanical survey of the Dismal Swamp Region. U.S. National Herbarium, Contributions 5:321-585.

Korstian, C.F. 1924. Natural regeneration of southern white cedar. Ecology 5:188-191.

Korstian, C.F., and W.D. Brush. 1931. Southern White Cedar. U.S.D.A. Tech. Bull. 251:75.

Kurz, H., and K.A. Wagner. 1953. Factors in cypress dome development. Ecology 34:157-164.

Laessle, A.M. 1942. The plant communities of the Welaka area. Univ. Fl. Publ., Biol. Sci. Ser. 4:5-141.

Laney, R.W., and R.E. Noffsinger. 1985. Vegetative composition of Atlantic white cedar *Chandecyparis thyoides* (L.) B.S.P.) swamps in Dare County, North Carolina. in A.D. Laderman, ed., Atlantic white cedar wetlands. Westview Press, Boulder Colorado.

Leitman, H.M., J.E. Sohm, and M.A. Franklin. 1981. Wetland hydrology and tree distribution of the Apalachicola River flood-plain, Florida. U.S. Geol. Surv. Water Supply Paper No. 2196-A. 204 pp.

Lilly, J.P. 1981. A history of swamp development in North Carolina. Pages 20-39 in C.J. Richardson, ed. Pocosin Wetlands. Hutchinson Ross, Stroudsburg, PA.

Little, S. 1950. Ecology and silviculture in the white cedar and associated hardwoods in southern New Jersey. Yale Univ. Sch. For. Bull. 56:1-103.

McCaffrey, C.A., and D.B. Hamilton. 1984. Vegetation mapping of the Okefenokee Ecosystem. Pages 201-211 *in* A.D. Cohen, D.J. Casagrande, M.J. Andrejko, and G.R. Best, eds. The Okefenokee Swamp. Wetland Surveys, Los Alamos, New Mexico.

Marks, P.L., and P.A. Harcombe. 1981. Forest vegetation of the Big Thicket, southeast Texas. Ecol. Monogr. 51:287-305.

Marois, K.C., and K.C. Ewel. 1983. Natural and management-related variation in Cypress domes. For. Sci. 29:627-640.

Matos, J.A., and D.C. Rudolph. 1985. The vegetation of the Roy E. Larsen Sandylands Sanctuary in the Big Thicket of Texas. Castanea 50:228-249.

Monk, C.D. 1960. A preliminary study on the relationships between the vegetation of a mesic hammock community and a sandhill community. J. Fl. Acad. Sci. 23:1-12.

Monk, C.D. 1965. Southern mixed hardwood forest of northcentral Florida. Ecol. Monogr. 35:335-354.

Monk, C.D. 1966b. An ecological study of hardwood swamps in northcentral Florida. Ecology 47:649-654.

Monk, C.D. 1968. Successional and environmental relationships of the forest vegetation of north central Florida. Am. Midl. Nat. 79:441-457.

Monk, C.D., and T.W. Brown. 1965. Ecological consideration of cypress heads in northcentral Florida. Am. Midl. Nat. 74:127-140.

Moore, J.H. and J.H. Carter, III. 1985. The range and habitats of Atlantic white cedar in North Carolina. In A.D. Laderman, ed. Atlantic white cedar wetlands. Westview Press, Boulder, Colorado.

Neufeld, H.S. 1983. Effects of light on growth, morphology, and photosynthesis in bald cypress *Taxodium distichum* (L.) Rich.) and *pondcypress* (*T. ascendens* Brongn.) seedlings. Bull. Torrey Bot. Club 110:43-54.

Odum, W.E., T.J. Smith, III, J.K. Hoover, and C.C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States east coast: a community profile. U.S. Fish and Wildl. Serv. FWS/OBS 83/17. 177 pp.

Parrish, F.K., and E.J. Rykiel, Jr. 1979. Okefenokee Swamp origin: review and reconsideration. J. Elisha Mitchell Sci. Soc. 95:17-31.

Parsons, S.E., and S. Ware. 1982. Edaphic factors and vegetation in Virginia Coastal Plain swamps. Bull. Torrey Bot. Club 109:365-370.

Penfound, W.T., and E.S. Hathaway. 1938. Plant communities in the marshlands of southeastern Louisiana. Ecol. Monogr. 8:1-56.

Pinchot, G., and W.W. Ashe. 1897. Timber trees and forests North Carolina. N.C. Geol. Surv. Bull. 6:227.

Porcher, R.D. 1981. The vascular flora of the Francis Beidler Forest in Four Holes Swamp, Berkeley and Dorchester Counties, South Carolina. Castanea 46:248-280.

Schlesinger, W.H. 1976. Biogeochemical limits on two levels of plant community organization in the cypress forest of Okefenokee Swamp. Ph.D. Dissertation. Cornell University, Ithaca, NY.

Schlesinger, W.H. 1978. Community structure, dynamics and nutrient cycling in the Okefenokee Cypress swamp-forest. Ecol. Monogr. 48:43-65.

Schlesinger, W.H. 1978. On the relative dominance of shrubs in Okefenokee Swamp. Am. Nat. 112:949-954.

Shaler, N.S. 1885. Seacoast swamps of the eastern United States. U.S. Geol. Surv. Annu. Rep. 6:353-398.

Simms, E.L. 1983. The growth, reproduction, and nutrient dynamics of two pocosin shrubs, the evergreen *Lyonia lucida* and the deciduous *Zenobia pulverulenta* Ph.D. Dissertation. Duke University, Durham, NC. 177 pp.

Turner, R.E., S.W. Forsythe, and N.J. Craig. 1981. Bottomland hardwood forest land resources of the southeastern United States. Pages 13-28 *in* J.R. Clark and J. Benforado, eds. Wetlands of Bottomland Hardwood Forests, Elsevier, Amsterdam.

Veno, P.A. 1976. Successional relationships of five Florida plant communities. Ecology 57:498-508.

Watts, W.A. 1980. Late Quaternary vegetation history of White Pond on the inner Coastal Plain of South Carolina. Quaternary Res. 13:187-199.

Weaver, T.W., III. 1969. Gradients in the Carolina Fall-line Sandhills: environment, vegetation, and comparative ecology of the oaks. Ph.D. Dissertation. Duke University, Durham, NC. 105 pp.

Wells, B.W. 1928. Plant communities of the Coastal Plain of North Carolina and their successional relations. Ecology 9:230-242.

Wells, B.W. 1932. The natural gardens of North Carolina. University of North Carolina Press, Chapel Hill.

Wells, B.W. 1942. Ecological problems of the southeastern United States Coastal Plain. Bot. Rev. 8:533-561.

Wells, B.W., and S.G. Boyce. 1953. Carolina Bays: additional data on their origin, age and history. J. Elisha Mitchell Sci. Soc. 69:119-141.

Wells, B.W., and I.V. Shunk. 1928. A southern upland grass-sedge bog. N.C. State Coll. Agric. Exp. Stn. Tech. Bull. 32:75.

Wells, B.W., and L.A. Whitford. 1976. History of stream-head swamp forests, pocosins, and savannahs in the Southeast. J. Elisha Mitchell Sci. Soc. 92:148-150.

Wharton, C.H. 1978. The natural environments of Georgia. Georgia Dep. of Natural Resources, Atlanta, GA. 227pp.

Whitehead, D.R. 1972. Development and environmental history of the Dismal Swamp. Ecol. Monogr. 42:301-315.

Wilson, J.E. 1978. A floristic study of the "savannahs" on pine plantations in the Croatan National Forest. M.S. Thesis. University of North Carolina, Chapel Hill. 165 pp.

Wright, A.H. and A.A. Wright. 1932. The habitats and composition of the vegetation of Okefinokee Swamp, Georgia. Ecol. Monogr. 2:110-232.

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16. Abstract (Limit: 200 words)

As part of a national study, vegetation associated with known hydric soils was sampled on the Croatan National Forest in North Carolina. In addition, other vegetation data sets from the southeastern Coastal Plain and the Coastal Plains of North Carolina and South Carolina were analyzed using weighted average ordination and detrended correspondence analysis (DCA). Among pocosins, those on deepest peat and of lowest stature had the lowest (wettest) weighted average scores. Weighted average values and DCA were also calculated for 140 vegetation stands in North Carolina and South Carolina and 146 community types in the southeastern Coastal Plain.

17. Document Analysis a. Descriptors

Wetland soils
Wetland plant communities
Wetland vegetation
Wetland ecosystems

b. Identifiers/Open-Ended Terms

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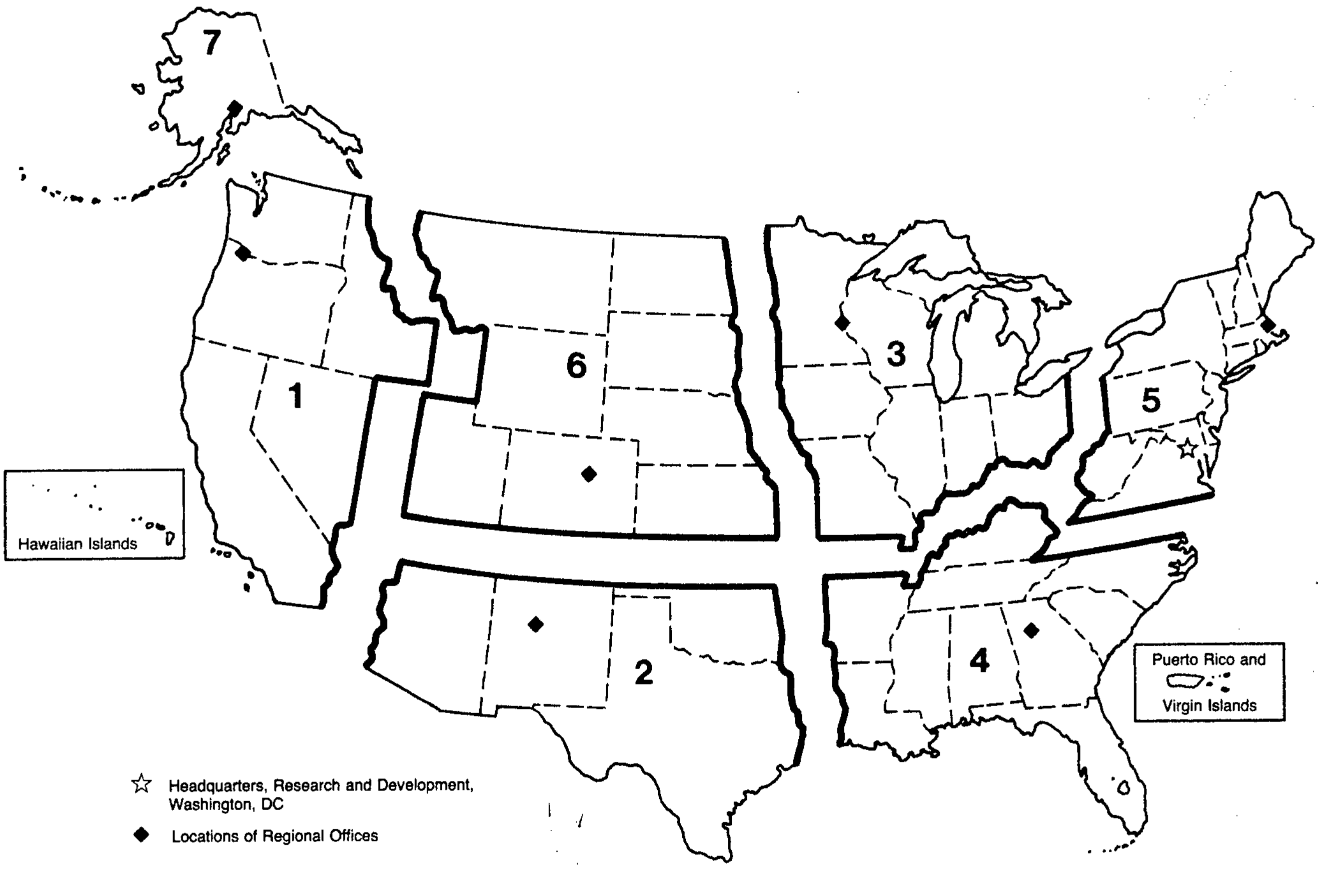

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