# AN ECOSYSTEMATIC ANALYSIS OF CAROLINA BAYS IN THE COASTAL PLAIN OF THE CAROLINAS

by

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ABSTRACT

TIMOTHY DAVID NIFONG: An Ecosystematic Analysis of Carolina Bays in the Coastal Plain of the Carolinas
(Under the direction of Albert E. Radford and Robert K. Peet)

Carolina bays are elliptic, directionally aligned depressions occurring on the Atlantic Coastal Plain from New Jersey to northeast Florida. Eighty percent of those depressions are estimated to occur on the coastal plain of the Carolinas. Once only the subject of scientific study and debate in relation to their geologic origin, Carolina bays have increasingly drawn attention because of the exceptional biotic diversity of the lentic ecosystems they contain. This study sought to document the vegetational diversity that occurs within this seemingly uniform depressional environment, and to determine the environmental factors responsible for that variation.

Detailed examinations of community vegetational composition and environmental relationships in 482 intensively sampled, permanent plots located in 57 Carolina bay depressions are presented in this study. Cluster analysis of vegetation data grouped stands into 9 vegetation classes and 63 community types. Vegetation classes and subclasses represent a broad spectrum of southeastern coastal plain wetlands types, including, brackish marsh, freshwater pond, freshwater marsh, freshwater prairie, pocosin, bay forest, bog, swamp forest, depression meadow, cypress savanna, and longleaf pine savanna communities. Detailed, structured descriptions of the characteristics of each identified vegetation group type are presented and discussed in relation to the existing literature.

Nonmetric multidimensional scaling was used to examine community compositional gradients in relation to 69 environmental variables. Overall, vegetation was consistently correlated with "landscape hydrology", soil type and percent soil organic matter, and site disturbance regime. Specific vegetation groups exhibited distinctive, within group variation in response to soil nutrient and texture status, hydrologic regime, and site disturbance history.

Vegetation--environment relationships were also examined over five landscape

surfaces representing different regimes of regional hydrology, geology, and soils. Environmental gradients within landscapes were generally consistent with overall study area gradients. Additionally, the distribution of major vegetation groups was examined in relation to site hydrologic regime, fire frequency, soil type, and characteristic plant life forms and growth forms.

Carolina bay depressions, once thought to number in the hundreds of thousands, are substantially rarer than previously believed. I estimate that fewer than 900 bay depressions with relatively unaltered site hydrologies remain within the study area. Those that do remain continue to disappear at an alarming rate. North and South Carolina bay depressions are important refugia for wildlife and for plant populations, including more than 65 "special status" plant species. Field observations and pertinent literature indicate that bay vegetation at relatively intact sites is highly dynamic, and that depression vegetation responds dramatically to differences in site disturbance regimes. Development of surrounding upland areas has resulted in increased isolation of Carolina bay depressions from the once pervasive role of fire as a landscape disturbance factor, and in the lowering of regional water tables. Consequently, bay vegetation has undergone an apparent "homogenization", with concomitant decreases in species richness and community diversity. If Carolina bay biodiversity is to be conserved and protected, increased and immediate attention must be given to prioritization, acquisition, and restoration of bay systems.

## ACKNOWLEDGMENTS

When a five to seven year project unexpectedly stretches into two decades, the thanks that are warranted seem to multiply exponentially. To add to the dilemma, memories fade with time, and seemingly "minor" assistance along the way may have been forgotten. But it is often those little things that, even if forgotten, smooth the road to the final destination. So I thank in advance the many who, though not mentioned by name, helped with the "little things" that do not now jump to mind.

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doubts.

To all I give my heartfelt thanks.

FRONTISPIECE: Pumpkinseed Bay in Hoke County North Carolina.

In loving memory of my Daddy, Julius L. "Bill" Nifong,

1923-1967,

who always thought it would be good to have a "Doctor" in the family.

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# CHAPTER I.

# INTRODUCTION

"Carolina bays" are unique elliptic, directionally aligned, geomorphic depressions that dot the southeastern Atlantic coastal plain. That physiographic region, and more specifically, the coastal plain within the confines of North and South Carolina, is largely known for its sandy soils, its hot and humid summers, and its broad expanses of flat, comparatively monotonous terrain. Perhaps that explains the surprise registered by Henry Savage (1982) in his description of Carolina bay depressions:

> It is surprising to discover on the gentle terrain of the Atlantic Coastal Plain, with no concealing cover or topography, one of the earth's most immense, spectacular, and intriguing topographical phenomena. Seen from the air Carolina bays are an astounding, unforgettable revelation. But though hundreds of thousands lie clearly visible, scattered across the Atlantic Coastal Plain from Maryland to northern Florida, they are often all but unrecognizable to the uninitiated eyes of groundlings.

Although Savage's count of Carolina bay numbers is, unfortunately, appears greatly inflated (as discussed in Chapter VI, below), his sense of human regard for those unique depressions is highly accurate. As eighteenth-century scientific explorers in the Carolinas and bona fide "groundlings", John Lawson (1709) and John Bartram (1765) encountered and described the unmistakable vegetation of Carolina bay depressions. However, each traveler mentions bay vegetation only in passing, while describing their respective journeys through the Carolinas.

It was not until man took wings in the early twentieth century that scientists discovered the true nature of the "revelation" known as Carolina bays. First, by studying aerial photographs, scientists learned about the sheer numbers of Carolina bay depressions (*see, e.g.*, Melton and Schriever, 1933; Prouty, 1952). Confronted with the uniqueness and abundance of this rather spectacular, "new" geomorphic landform, geologists and other natural scientists clamored to explain the origin of these depressions with convincing finality. Along the way, numerous botanists described the general vegetation of selected bay depressions (*e.g.*, Buell, 1939, 1946a; Wells, 1943, 1946; Kelley and Batson, 1955; Porcher, 1966). And eventually, it was recognized that Carolina bay depressions are the most abundant natural lentic system found on the Carolina coastal plain (Frey, 1950; Schalles *et al.*, 1989).

However, it was not until relatively recent decades -- given increasing governmental interest in wetlands protection and the rise of conservation biology with its emphasis biodiversity preservation -- that field surveys revealed the true scope of environmental and vegetational variation occurring within Carolina bay depressions. That range embraces in some form virtually every non-marine wetlands system found on the southeastern coastal plain, including brackish marsh, freshwater pond, freshwater marsh, freshwater prairie, pocosin, bay forest, bog, swamp forest, depression meadow, cypress savanna, and longleaf pine savanna communities, among others.

This study was conceived and undertaken to document and systematically describe the remarkable vegetational diversity that occurs within Carolina bay depressions in the Carolinas and to relate that diversity to abiotic parameters. It grew out of the tried and tested "ecosystematic" approach to understanding species distributions that was developed by Dr. Albert E. Radford at the University of North Carolina at Chapel Hill in the decades preceding and immediately following publication of the *Manual of the Vascular Flora of the Carolinas* (Radford *et al.*, 1968). While using the ecosystematic approach to understanding vegetation, this study attempts to improve upon the concept by incorporating the more modern elements of community plant ecology, such as vegetation clustering techniques and community gradient analysis.

At the same time, unlike community plant ecology, the ecosystematic approach to understanding natural community diversity implies more than simply data analysis. It has always been a basic tenet of ecosystematics that a primary purpose of increasing our knowledge of natural systems and systematically documenting those findings is to foster effective conservation and management of the biodiversity described. Consequently, from the very beginning, this study was implemented with the hope that the final product would contribute to the understanding of these unique wetlands systems, and facilitate public and private efforts to prioritize, conserve, and protect this critical component of our natural heritage.

## 1.1 Study Objectives

As noted, this study of Carolina bay depressional wetlands in North and South Carolina was aimed from the beginning at the identification, description and classification of the vegetational diversity found within those depressions, and the subsequent relation of that diversity to site environmental parameters. Over time, those initial, broad goals evolved into the following specific objectives for this study:

(1) Documentation of the vegetational and edaphic diversity occurring within Carolina bay depressional wetlands in the Carolinas;

(2) Classification of Carolina bays within the study region by type, either floristically and/or environmentally, in a manner that accounts for known variation and anticipates potential additional wetlands communities;

(3) Understanding the relationship between vegetation group and/or species distributions and site or landscape abiotic parameters;

(4) Comparison of study findings concerning vegetation and vegetation--environment relationships to the findings of other studies of depressional wetland communities described in the literature; and

(5) Recommendations for the conservation, protection, and future management of Carolina bay biodiversity.

# CHAPTER II.

# PUTTING THE PROBLEM IN CONTEXT: BACKGROUND INFORMATION

## 2.1 Review of Literature Pertaining to Carolina bays

The unique geomorphology of Carolina bay depressions has been recognized for more than a century. Toumey (1848), in his *Report on the Geology of South Carolina*, described shallow, circular depressions, both water-filled and dry, in the middle and upper South Carolina coastal plain, "reminding one of a circular race-course." It was not however, until aerial photographs became widely available in the 1920s with the advent of the use of military reconnaissance aircraft that Carolina bay depressions were given their appropriate due. Based upon a review of southeastern United States coastal plain aerial photography, Melton and Schriever in 1933 published a provocative geologic paper querying whether the numerous, elliptic, northwest-southeast trending depressions occurring in that region were craters resulting from the impact of a swarm of meteors coming from out of the northwestern sky.

The response to that initial article was immediate and voluminous. Both in the scientific literature and in the popular press, theories on the origin of the Carolina bays became a "hot" topic of the day, in a debate that raged for over three decades. During the debate, two major competing theories of bay origin were advanced, each with its own advocates: (1) the aforementioned meteorite theory (Melton and Schriever, 1933; Prouty, 1934, 1938, 1952; MacCarthy, 1936, 1937; MacCampbell, 1944, 1945); and (2) the "solution/aeolian" hypothesis, which proposed that Carolina bays are solution depressions that have been subsequently shaped by wave action created by directionally aligned winds (Cooke, 1933, 1934, 1940; Johnson, 1934, 1936,1942; Odum, 1952; LeGrand, 1951). However, Carolina bay origin theories forwarded over the years are as diverse and exotic as suggestions that bay formation resulted from the tail-fanning action of spawning, giant fish (Grant, 1945), or from the impact of ice fragments spewed forth from collision of a huge comet with the earth in the Hudson Bay region of Canada (Davis, 1971).

Bay origin still remains controversial to some degree. Both the "extraterrestrial" hypothesis and the "uniformitarianism" hypothesis, as Colquhoun (1982) labels them, have undergone refinement since they were initially advanced, and each still has its advocates. Kaczorowski (1977) concluded from field research and reconstructive laboratory experiments that bays originated as wind-deflation features that were subsequently shaped by the action of strong, unidirectional winds on water ponded in the surface depressions. Some variant of this theory of bay origin is now widely accepted by the scientific community as best conforming to the existing body of knowledge on bay depressions (*see, e.g.*, Stager and Cahoon, 1987; Carver and Brook, 1989). Given that Carolina bay depressions occur on land surfaces having a wide variety of ages that cover a range of tens of thousands of years (Gamble *et al.*, 1977), it is probably more reasonable to conclude that bay formation resulted from ongoing terrestrial processes rather than from a single cataclysmic event (Soller, 1991). Nevertheless, some investigators remain unconvinced, and still adhere to the "pressure-cone/shock wave" theory -- the most recent version of the meteorite impact theory (*see* Savage, 1982). Bay formation theories have been thoroughly reviewed by Kaczorowski (1977), Sharitz and Gibbons (1982), Savage (1982), and Ross (1987).

The "physical environment" (geology, geomorphology, soils, hydrology) of Carolina bay depressions continues to be an area of scientific interest to the present day. Ross (1987) has produced a bibliography of Carolina bay literature that lists publications dealing with those topics, *inter alia*. In addition, the existing literature on Carolina bay soils is summarized below in Chapter 6. However, despite the large body of geologic literature concerned with Carolina bay formation and geology that developed some half-century ago and that is still ongoing, there has been a relative dearth of specifically biological information concerning bays until relatively recent years. Wells (1942, 1943, 1944, 1946), Wells and Boyce (1953), and others (*e.g.*, Straley, 1951) briefly noted the vegetation of certain Carolina bay depressions in consideration of other ecological and geological problems. Moreover, there is a long line of paleo-ecologic papers dealing chiefly with the analysis and interpretation of micro fossils (pollen profiles) found in the sediments of peat-filled Carolina bays, that often contain useful information concerning present-day bay vegetation (Buell, 1939, 1945, 1946a, 1946b; Frey, 1950, 1951a, 1951b, 1953, 1954a, 1955; Whitehead, 1963, 1964a, 1964b; Whitehead and Tan, 1969).

Nevertheless, prior to the 1980s, only a handful of scientific papers dealt with the biology of Carolina bays. Initially, that literature consisted of a series of zoological papers published concerning the distribution and life histories of endemic "bay lake" fishes (Hueske, 1948; Frey, 1951b; Louder, 1962). Similarly, only a few papers dealing specifically with Carolina bay depression floristics are known from that period: Eyles (1941) performed an early phytosociological analysis of Georgia coastal plain "boggy pond" vegetation communities (although Eyles did not recognize those ponds as Carolina bays at the time). Kelley and Batson (1955) described vegetation zonation in Craig's Pond, a bay depression located in the southwestern coastal plain of South Carolina. Porcher (1966) analyzed the floristics and associated habitats of selected Carolina bays in Berkeley County, South Carolina. And Wharton (1978), in considering the "natural habitats" of Georgia, described Carolina bay vegetation communities in that State.

However, with the comparatively recent, increased governmental interest in (and funding for) projects dealing with both the nature and status of wetlands, and biodiversity protection, a more extensive body of Carolina bay biological literature has developed. That literature may generally be divided into three components: (1) "natural heritage" inventories or floristic surveys of Carolina bays within a specific region; (2) zoological studies of, or within, Carolina bays (which may peripherally describe depression vegetation); and (3) vegetation/ecological studies of, or within, Carolina bays.

Inventories or floristic surveys of Carolina bays and the respective regions of coverage include Ashton and Ashton (1979) -- Bladen Lakes State Forest, North Carolina; Carter (1979) -- Hoke, Richmond, Robeson, and Scotland Counties, North Carolina; Nifong (1982) -- North Carolina Middle Coastal Plain area; Weakley and Scott (1982) -- Bladen and Cumberland Counties, North Carolina; Schalles *et al.* (1989) -- Department of Energy

Savannah River Plant, Aiken County, South Carolina; and Bennett and Nelson (1991) -- South Carolina coastal plain. Zoological studies pertaining to Carolina bays include Gibbons (1970) (turtles); Gibbons *et al.* (1977) (snakes); Gibbons and Semlitsch (1982) (snakes); Clark *et al.* (1985) (mammals); Semlitsch (1986) (mole crickets); Taylor *et al.* (1987) (salamanders); Semlitsch *et al.* (1988) (salamanders); Mahoney *et al.* (1990) (zooplankton); Taylor and Mahoney (1990) (zooplankton); Burke *et al.* (1994) (turtles); Plummer and Congdon (1994) (reptiles); Burke and Gibbons (1995) (turtles); and Seigel *et al.* (1995) (reptiles).

In addition to these biological treatments pertaining to Carolina bay depressions, there continue to be some studies dealing primarily with the physical and chemical properties of Carolina bays in the region. Those studies include Kormondy (1968) (limnological processes); Newman and Schalles (1990) (water chemistry); and Leff *et al.* (1991) (biochemical processes).

More specifically germane to this study are the recent vegetation community analyses and other ecological treatments of Carolina bays that have been published in the last fifteen years. That literature begins, more or less, with Sharitz and Gibbons (1982), who have to date provided the most comprehensive treatise on Carolina bay wetlands by thoroughly reviewing the then pre-existing literature on all aspects of Carolina bay ecology in light of additional, original data. Many of the more recent references are specifically discussed in relation to study area Carolina bay vegetation communities in Chapter 4 of this document. However, that body of literature is generally described below.

Carolina bays are the most abundant natural, lentic system found on the southeastern United States coastal plain (Sharitz and Gibbons, 1982). They vary significantly in terms of size, depth, and degree of slope, and occur on land surfaces with widely divergent ages (Gamble *et al.*, 1977). Additionally, bay depressions vary greatly in site hydrologic regime, ranging from almost never flooded, to seasonally flooded, to continuously flooded, except during severe drought periods (Kirkman, 1992; Nifong, personal observation). Toumey (1848) originally noted the marked variation in water level found in Carolina bays, where historically ponded bays were suddenly found to be without surface water. However, most bay depressions are at least temporarily flooded following periods of locally heavy precipitation, and site hydrologic regime has generally been recognized as the primary controlling factor in site vegetation in Carolina bay depressions (Schalles and Shure, 1989; Bennett and Nelson, 1991; Kirkman and Sharitz, 1994).

Carolina bays often have a perched water table due to subsurface clay layers, especially in the more inland portions of the coastal plain (Schalles, 1979; Sharitz and Gibbons, 1982; Kirkman, 1992). As such, they are precipitation dominated systems, but significant groundwater exchange also occurs within most such bay depressions (Schalles and Shure, 1989). Groundwater may be the primary source of site water in the majority of Carolina bays located on lower, less well-drained coastal plain surfaces (Daniels, 1995). Groundwater exchange is apparently lateral, rather than vertical, in those Carolina bay systems where subsurface features act as an aquiclude (Schalles and Shure, 1989). Lateral exchange between surface waters and groundwater has been found to be important in a variety of similar wetland systems, including prairie potholes (Sloan, 1972), Florida cypress domes (Heimberg, 1984) and northern peatlands (Kadlec, 1977).

Typically, Carolina bay wetland systems are "self-contained", *i.e.*, they have neither stream inflows nor outfalls. In such systems, the primary mechanism for water loss is through surface evapotranspiration, but basin seepage may be significant at some sites, especially those where bay floor sediments exhibit no evidence of a perching mechanism during periods of low groundwater (*see*, Winter, 1981). Groundwater levels are generally highest in the winter and early spring, when the difference between precipitation and evapotranspirational losses are the greatest.

Whatever the source of their surface waters, bay depressions are almost always dystrotrophic systems in having shallow, low nutrient waters with dilute water chemistry (Schalles and Shure, 1989). While there are apparently no consistent, dominant factors controlling bay water chemistry as a whole, water chemistry is similar between bays having similar vegetation types (Newman and Schalles, 1990). Like other wetlands, Carolina bay depressions typically present an anaerobic environment that significantly restricts potential site species composition. Bay depressions exhibit persistent oxygen deficits in surface waters and soils, resulting from a combination of factors that include respiration of benthic detritus produced by aerial foliage, foliage induced restricted surface diffusion and wind mixing, shading of submergent plants by emergents and emergents by surrounding forests, nutrient accumulation by woody species on the wetland site perimeter, and abiotic photochemical reactions between site iron and humic matter (Schalles and Shure, 1989). Given their anaerobic condition and low nutrient status, primary biological production within bays is generally low to moderate (Tilly, 1973; Sharitz and Gibbons, 1982; Schalles and Shure, 1989).

Soils found within Carolina bays are closely related to site sediments, hydrologic regime and vegetation, but almost always are comparatively nutrient poor. Bay soils are typically sandy loams in bays located on upland surfaces (Frey, 1950; Bryant, 1964; Bryant and McCracken, 1964; Daniels *et al.*, 1984). However, as a result of site paludification, they may be dominated by organic soils on the less well-drained surfaces typical of the lower coastal plain (Frey, 1950; Daniels, 1995). The lack of significant peat deposits in upper coastal plain Carolina bays is apparently the result of regular, periodic drawdown of ponded water, and resultant oxidation of the exposed substrates (Schalles and Shure, 1989).

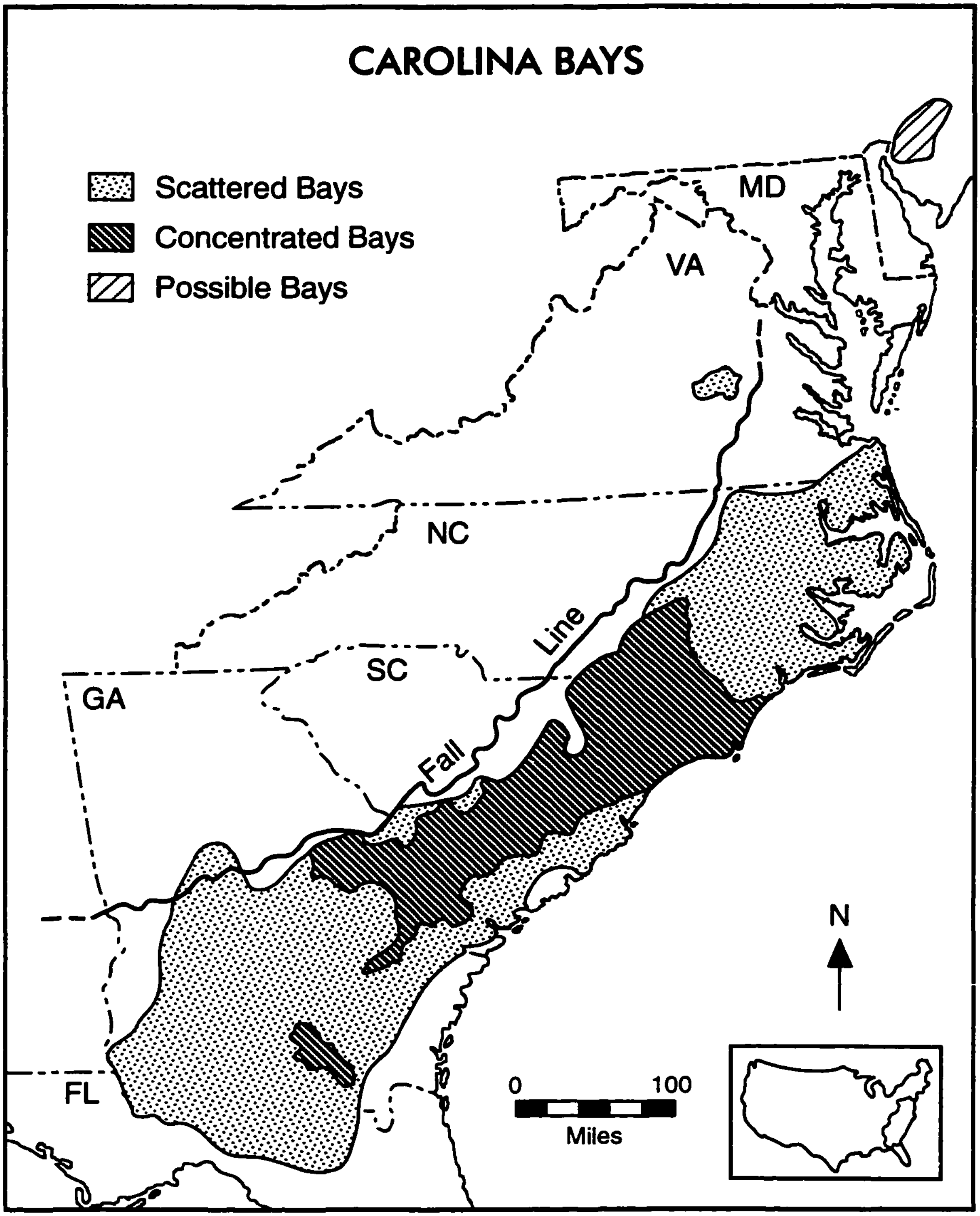
Carolina bay vegetation varies greatly, ranging from the dense, evergreen shrub-bog ("bay") communities that gave the depressions their common name to the herb-dominated communities that have commonly been referred to as "depression meadows" (*see* Sharitz and Gibbons, 1982; Schafale and Weakley, 1990, Bennett and Nelson, 1991; Kirkman, 1992). Bay vegetational communities are generally described in terms of physiognomy of community dominants and species composition. Within herb-dominated vegetational communities, forbs and graminoids are typically distributed in irregular patches that appear to be dominated by a single species. This seeming single-species dominance is often due to the overwhelming effect upon human visual perception caused by the physiognomy or growth form of the apparent dominant species, and may or may not prove to be real under quantitative floristic analysis. Vegetation communities found within bays also include cypress savannas, cypress swamps, hardwood swamps, pine woodlands, freshwater ponds, freshwater marshes, and brackish marshes (Wharton, 1978; Sharitz and Gibbons, 1992;

Newman and Schalles, 1990; Bennett and Nelson, 1991; Nifong, personal observation). The great variance found within bay vegetation is not surprising, given the great variation in site abiotic parameters (primarily soils and hydrology) that exists within Carolina bay depressions and the fact that they occur over a wide geographic area -- from New Jersey to Florida (Prouty, 1952; Eyton and Parkhurst, 1975) (*see* Figure 2.1).

Fire, drainage, grazing, timbering and other natural and human disturbance factors are also significant in shaping Carolina bay vegetation communities, but the respective roles of such forces are not presently well understood within Carolina bay communities (Kirkman, 1992; Nifong, personal observation). Nevertheless, fire is known to be a particularly significant shaping force in a number of the vegetational communities found within Carolina bays (Garren, 1943; Christensen, 1988), and evidence of fire can be found in virtually every Carolina bay found within the study area (*e.g., see* Plate 17, following Chapter 7 below.). The role of fire in Carolina bay communities is discussed in more detail in relation to specific vegetation groups in Chapter 4, below. In addition, Kirkman & Sharitz (1994) found that at least in the short-term, significant changes in species diversity, evenness, and richness resulted from site disturbance in drawn down bay depressions under artificially manipulated pyric and pedologic disturbance regimes.

Bay depressions are not necessarily dominated by a single vegetation type, but may contain a number of different vegetational communities distributed along hydrologic or other intra-bay environmental gradients. However, bay depressions vegetated by communities having woody species dominants are more likely to be dominated by a single vegetation type than are depressions vegetated by herb-dominated communities (Nifong, personal observation). Zonal vegetation patterns have been described for herb-dominated Carolina bays by a number of researchers, including Eyles (1941); Kelley and Batson (1955); Wharton (1978); Schalles and Shure (1989); Schalles *et al.* (1989); Tyndall *et al.* (1990); Bennett and Nelson (1991); and Kirkman and Sharitz (1994). Kelley and Batson (1955) described vegetational zonation within a herb-dominated Carolina bay in terms of traditional Clementsian succession. More recent research within bay depressions suggests that the vegetation dynamics in herb-dominated Carolina bay wetlands represents cyclical succession

Figure 2.1. The distribution of Carolina bay depressions in the southeastern coastal plain of the United States (adapted from Eyton and Parkhurst, 1975).




(Adapted from Eyton & Parkhurst, 1975).

primarily related to water level dynamics (Schalles, 1979; Schalles and Shure, 1989; Kirkman, 1992), similar to the Gleasonian wetlands succession model proposed by van der Valk (1981) for prairie pothole vegetation communities. Subsequent seedbank studies within Carolina bays appear to corroborate the view of cyclical vegetation dynamics in many Carolina bay depressions (Keough *et al.*, 1990; Kirkman and Sharitz, 1994; Poiani and Dixon, 1995).

## 2.2 Description of the Study Area

### 2.2.1 Introduction

A basic understanding of the regional topography, physiography, geology, pedology, and hydrology is essential for any problem entailing vegetation distribution across landscapes. Those topics are particularly germane to a discussion of Carolina bays, since they comprise a unique, significant geomorphic feature throughout much of the southeastern United States coastal plain. Topography and physiography are closely related in the Carolina coastal plain and are discussed together below. Similarly, because pedologic development in the study area is closely tied to regional water table levels, soils and hydrology are also discussed together.

### 2.2.2 Topography/Physiography

Both terrestrial and marine geomorphic processes have been responsible for the development of coastal plain land surfaces in the Carolinas. Though not well understood at present, regional tectonic activity in the form of a general uplift of the emerged coastal plain has also likely contributed significantly to coastal plain geomorphology, as evidenced by the comparatively high topographic position of the older transgressive--regressive coastal plain surfaces discussed below (Soller and Mills, 1991). Because of this topographic difference in different-aged land surfaces, the coastal plains of North and South Carolina may be divided geomorphically into two broad regions: (1) the "inner coastal plain", an area of erosional topography generally extending eastward from the Fall Zone (demarcating the limits between the Coastal Plain and Piedmont Provinces) to the "Orangeburg Scarp"(or "Coats Scarp" north of the Cape Fear River; *see* Daniels *et al.*, 1966; 1978); and (2) the "outer coastal plain", the area seaward of the Orangeburg Scarp, dominated by constructional topography indicative of marine transgressive--regressive cycles (Soller and Mills, 1991). The inner coastal plain region includes the "Sandhills" area, where a thick mantle of aeolian sands overlies the surficial sediments that characterize the remainder of the inner Coastal Plain. Because the Sandhills region has a pedologic, and thus vegetative, regime that is different from the remainder of the inner Coastal Plain, it is often separated out as a distinct subunit within that division.

"Scarps" -- erosional, presumably wave-cut ridges paralleling the coastline and often sharply evident on an otherwise nearly level surface -- are regarded as important geomorphic features and have been used by many researchers to further divide the outer coastal plain into subregions: (1) the "middle coastal plain", extending seaward from the Orangeburg Scarp to the Surry Scarp; and (2) the "lower coastal plain", extending from the Surry Scarp to the Atlantic Ocean (Colquhoun, 1969; Daniels *et al.*, 1984). North of Cape Lookout, North Carolina, the lower coastal plain may be further subdivided into two east--west subregions separated by the Suffolk Scarp.

The scarp-delimited, elevationally similar regions ("terraces") of the outer coastal plain have typically been presumed to represent distinct marine terraces deposited during a discrete, identifiable sea highstand in the geologic past (*see, e.g.*, Cooke, 1936; Colquhoun, 1969; Daniels *et al.*, 1966; 1978). However, Soller and Mills (1991) point out that while the mapping of these terraces was the logical outgrowth of their original identification, subtleties in depositional history and stratigraphy in the outer coastal plain are more complex than initially believed. It is now fairly settled that each terrace does not necessarily correspond to a single transgressive--regressive sequence, and that there is no direct correlation between topographic elevation and underlying sediment age.

The Carolina coastal plain is also sometimes divided into north--south regions as well as east--west zones. Fenneman (1938) noted that the area of erosional topography on the coastal plain (*i.e.*, the inner coastal plain) is very narrow south of a line drawn from the Cape Fear River--Neuse River divide in central North Carolina seaward to Cape Lookout. Fenneman denoted the area north of this line, where the coastal estuaries extend westward virtually to the Fall Zone and the coastline is rugged with an extensively developed barrier island system, as his "Embayed section". By contrast, Fenneman's "Sea Islands section", found south of the line, exhibits a much broader area of constructional topography, and is characterized by small estuaries, a relatively smooth coastline, and a less extensive barrier island system.

### 2.2.3 Geology

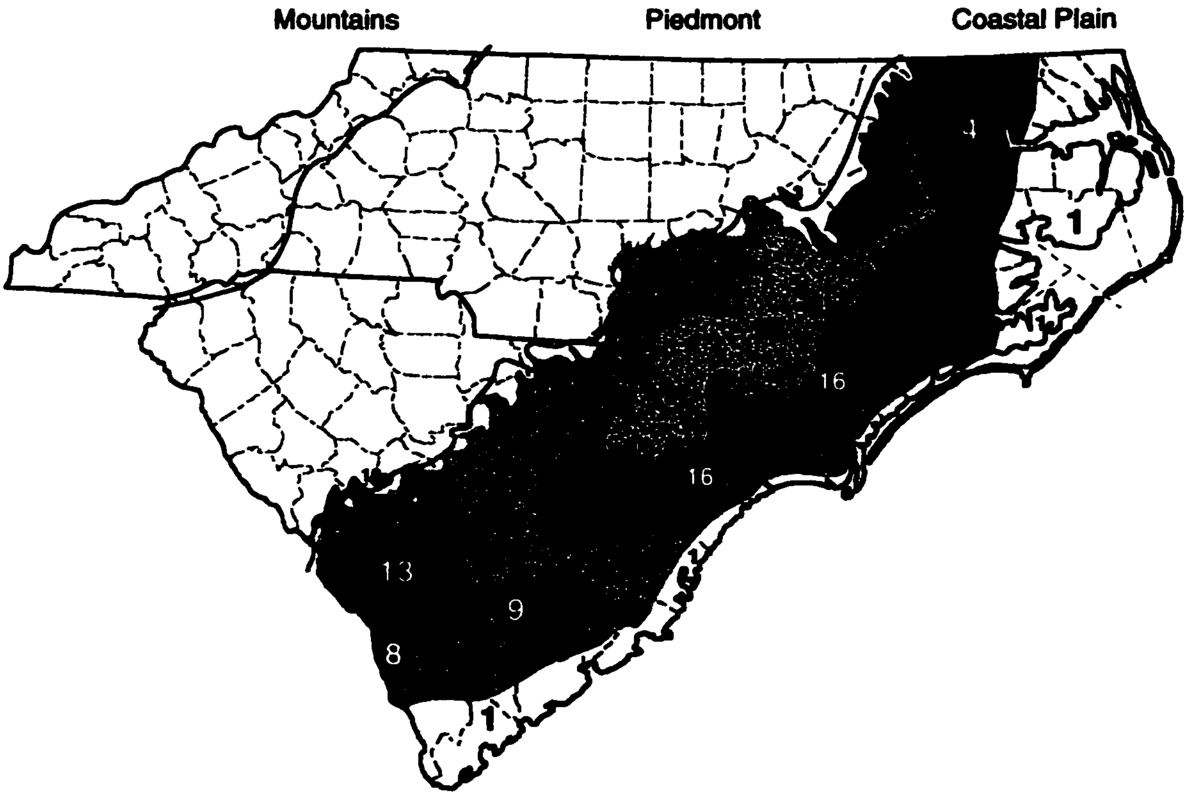
The geologic description of the study area presented herein is largely synthesized from Cooke (1936), Stuckey (1958), Colquhoun (1969), and Soller and Mills (1991), unless noted by citation otherwise. Based on those sources, a summary diagram of the Cretaceous and Tertiary geologic formations underlying the study area is presented in Figure 2.2.

On coastal plain land surfaces within the study area, younger fluvial and marine sediments overlie geomorphic formations that slope gently seaward. The total thickness of those various sediments ranges from a few meters at the Piedmont--Coastal Plain interface to hundreds of meters at the coast. The major near-surface geologic formations found in the inner coastal plain include the Cape Fear formation, found in the central North Carolina Coastal Plain; the Middendorf formation, found throughout the inner coastal plain (both included within the "Tuscaloosa formation" in Figure 2.2); and the Tar Heel (Pee Dee) formation, extending from central North Carolina coastal plain south to the Pee Dee River. Each of these formations is of Upper Cretaceous age and is comprised primarily of interbedded clays and clayey sands. In addition, the Black Mingo and Huber (Barnwell in Figure 2.2) formations, made up of sands of upper Paleocene to Middle Eocene age, are found in the extreme southwest South Carolina Coastal Plain.

These inner coastal plain formations are overlain by younger alluvial, colluvial and residual deposits in various portions of their ranges. The most significant of those overlying deposits include the post-Eocene to early Pleistocene Hawthorne and Citronelle (Raysor (?)) formations, located in the central portion of the South Carolina inner coastal plain and comprised generally of sandy fluvial sediments, and the Pinehurst (Middendorf) formation, encompassing the southwestern North Carolina and northwestern South Carolina coastal plains (*i.e.*, the Sandhills area), and characterized by thick aeolian surficial sands. Carolina bays are rare in the Sandhills area of the inner coastal plain, but are moderately abundant in the upper coastal plain in South Carolina west of the Congaree River (Nystrom *et al.*, 1991). In that area, the vast majority of Carolina bays occur on the most upland, highest portions of the stream interfluves, *i.e.*, on the oldest topographic surfaces. Accordingly, some researchers conclude that these bays

Figure 2.2. Cretaceous and Tertiary geologic formations underlying the coastal plain of North Carolina and South Carolina.

# CRETACEOUS & TERTIARY GEOLOGIC FORMATIONS OCCURRING ON THE COASTAL PLAIN OF THE CAROLINAS




RECENT
↑
PLEISTOCENE — 1 Undifferentiated coastal deposits

PLIOCENE — Waccamaw formation

MIOCENE
- Duplin marl (includes some undifferentiated Yorktown formation; Croatan formation in NC)
- Yorktown formation (includes some Duplin marl; St. Mary's & Murfreesboro formations in NC)
- Raysor marl
- Hawthorn formation
- Belgrade formation (includes Trent marl)

OLIGOCENE — Flint River formation

UPPER EOCENE / LOWER EOCENE
- Cooper marl
- Riverbend formation
- Santee limestone
- Castle Hayne limestone
- Barnwell sand
- McBean formation
- Black Mingo formation

UPPER CRETACEOUS
- Peedee formation (includes Burches Ferry & Ripley formations in SC)
- Black Creek formation (includes Bladen formation in NC)
- Tuscaloosa formation (includes Middendorf, Cape Fear, Patuxent,& Tuscaloosa formations)

are of at least Miocene age, and accordingly, have been exposed to terrestrial land-shaping processes for a much greater period of time than have Carolina bays on younger surfaces in the middle and lower coastal plain areas (Nystrom *et al.*, 1991). Otherwise, bay depressions are largely absent from the inner coastal plain within the study area.

The surficial geology of the outer coastal plain in the Carolinas is dominated by sandy, exposed (regressive) barrier island systems that are Pliocene to Pleistocene in age. No fewer than seven transgressive--regressive cycles are preserved by the geomorphology of the outer coastal plain and have been delineated by researchers below the Orangeburg Scarp. The oldest transgressive--regressive sequence is evidenced by the lower-Pliocene Duplin formation found in the Middle Coastal Plain from southern North Carolina to central South Carolina, comprised of weathered sands and clays. Where this surface is sandy, Carolina bays are numerous, distinguishing this surface from older surficial units to the west (*i.e.*, the inner coastal plain, which generally lack bays (Soller, 1988). Carolina bays are also common over the Bear Bluff formation (included within the Duplin and Waccamaw marls in Figure 2.2), comprised mostly of interbedded clayey and sandy silts of late Pliocene age, which generally extends seaward of the Duplin formation from the Cape Fear River in North Carolina to the Pee Dee River in South Carolina.

Within the younger, less dissected lower Coastal Plain, surficial geologic units (not mapped in Figure 2.2) are dominated by sandy barrier systems of Quaternary age. Carolina bays are generally prominent features of these surfaces, at least in the Sea Island section of the region. The oldest of these surficial units is the Waccamaw formation (early Pleistocene in age), located primarily in southeastern North Carolina and northeastern South Carolina. Moving from west to east in this area, the subsequent sequence of delineated surface marine terraces include the Penholoway (early Pleistocene), the Canepatch (middle Pleistocene), the Socastee, and the Wando (both late Pleistocene) formations.

Carolina bays are numerous on the Socastee unit surface but are absent from the Wando formation, though both geomorphic surfaces are stratigraphically similar. This has led some investigators to conclude that Carolina bay depressions are pre-middle Pleistocene in age (Thom, 1970; Soller, 1988). However, if one accepts the theory that Carolina bays did not result from a single cataclysmic event, but are the product of ongoing terrestrial processes, it is likely that bays found on surficial units of differing ages also differ in age of origin (Nystrom *et al.*, 1991). As noted elsewhere, it is now generally accepted that Carolina bays originated as wind-deflation or surface solution features that later filled with water and were subsequently rounded to their current forms by unidirectional wind and wave action (Kaczorowski, 1977; Stager and Cahoon, 1987; Carver and Brooke, 1989).

The ages of surficial sediments in the Embayed section of the lower coastal plain are comparatively poorly known, but probably represent deposits resulting from Pliocene or Pleistocene sea level transgressions. A surficial unit chronological, transgressive--regressive sequence for that area, analogous to the sequence denoted for the lower Coastal Plain along the North Carolina/South Carolina border area, has been mapped as follows: the Wicomico "formation" abuts the Talbot "formation" between the Surry and Suffolk Scarps, and the Pamlico plain lies east of the Suffolk Scarp (Daniels *et al.*, 1984). Carolina bays appear to be uncommon in the Embayed section of the lower coastal plain of the Carolinas. However, given that large portions of that region are dominated by organic soils and that Carolina bay depressions are locally abundant over sandy surfaces on the most seaward mainland surfaces within the area, it is possible that such depressions are simply obscured from identification by the thick "peat" mantle characteristic of the Embayed section.

Fluvial surfaces also contribute significantly to the geology of the coastal plain of the Carolinas. Piedmont draining rivers such as the Roanoke, Cape Fear, Pee Dee, and Santee dominate coastal plain drainage patterns, and their valleys contain extensive fluvial (terrace) deposits. The most intensely studied of these river valleys from a geomorphic perspective is the Cape Fear River basin in North Carolina. This area comprises the, the so-called "Bladen Lakes" area, and is noteworthy as the region of the highest concentration of large Carolina bays in the United States (Prouty, 1952; Eyton and Parkhurst, 1975) (*see* Plate 1). River terraces in the Cape Fear River valley can generally be correlated in age with barrier systems found outside the river valley. Study has indicated that the oldest Cape Fear River terrace is of Bear Bluff age, followed sequentially by the surfaces of the much younger Waccamaw, Penholoway, Socastee and Wando terraces.

Carolina bays are absent from the Wando terrace, just as they are absent from marine terraces of the same age, but are common on the other Cape Fear River valley surfaces. By contrast, in the Pee Dee River valley in South Carolina, Carolina bays are absent from fluvial terraces of Wando, Socastee, Penholoway and Waccamaw ages. The difference between the two systems in terms of bay development has been attributed by Soller (1988) to regional tectonics and differing lithologies in the two systems. The Cape Fear River valley is located in the area of maximal uplift within the Carolina coastal plain, and the presence of abundant medium to coarse sands and relatively well-drained landscapes in the valley has provided a source of sand and conditions conducive to the development of Carolina bays. By contrast, the Pee Dee River valley is removed from the area of maximum uplift, and exhibits poorer drainage and finer sediments than those characteristic of the Cape Fear River valley, dominated largely by very fine sand, silt and clay. These differing characteristics are postulated to have largely precluded Carolina bay development in this region (Thom, 1967; Soller and Mills, 1991).

#### 2.2.4 Soils/Hydrology

Soils are extremely significant in terms of the distribution of vegetation groups in study area Carolina bays, as discussed in Chapter 4 in relation to individual vegetation groups. Appendix II contains relatively complete, representative soil profile descriptions for sampling site pedons. For those reasons, study area soils and soil formation factors are discussed below in some detail. Because relative landscape "wetness" is a dominant factor in soil development in the Carolina coastal plain, coastal plain hydrology is discussed here, in conjunction with soils. Much of the discussion is distilled from Daniels *et al.* (1984), as supplemented by personal observations and other cited references.

Coastal plain soil systems largely coincide with the geomorphic units over which the soils have developed. This is hardly surprising, given that pedogenic development is dependent on site geology, parent material, hydrology, topography, climate and vegetation (Soil Survey Staff, 1975; Buol *et al.*, 1980). Of those factors, landscape hydrology, *i.e.*, the position and duration of free water within a soil solum, is perhaps the most important factor controlling soil development within the Carolina coastal plain. Sediment hydrologic properties (*e.g.*, soil permeability), soil landscape position, amount and depth of stream dissection, surface runoff rates, and evapotranspiration largely determine site hydrology (Daniels *et al.*, 1984). Consequently, medium to coarse textured soils located near the edge of an upland flat are generally the most well drained, while fine textured soils located far from a dissecting stream are typically less well drained.

These changes in site hydrologic regimes result in discrete concomitant changes in pedon morphology for mineral soils. For example, relatively well drained, loamy subsoils are typically brownish to yellowish-red in coloration because they seldom are saturated for long time periods, and therefore contain relatively oxidized sediments. By contrast, in less well drained, loamy soils, where the seasonal high water table is near the surface for significant periods, "gleying" (*i.e.*, the presence of bluish-gray mottles having a chroma of 2 or less on a Munsell soil color chart) within a more brightly colored solum is seen in moderately well drained soils, and the subsoils at poorly drained sites are typically gray colored (Soil Survey Staff, 1975; Buol *et al.*, 1980). In addition to changes in coloration, the prevalence of exchangeable aluminum increases as a percentage of the cation exchange capacity ("CEC") moving from well drained to wetter soils.

Similarly, in sandy substrates, distinct morphological changes occur across a soil drainage sequence. Well drained sites have thick sandy surface horizons and may or may not have an underlying weak spodic horizon (*i.e.*, a subsurface layer of accumulation of downwardly translocated organic materials, also known as the "Bh" horizon). By contrast, spodic horizons are much more prominent and nearer the surface in sandy soils where the depth to the water table decreases (*see, e.g.*, Daniels *et al.*, 1976). As the height and duration of the water table increases, the A horizon becomes progressively thicker and darker due to the accumulation of unoxidized organic matter. At the wettest (most poorly drained) sites, where soils are saturated to or above the surface for most of the year, true organic soils -- peats (less decomposed) and mucks (more decomposed) -- predominate, overlying and obscuring the properties of subsurface mineral strata.

Carolina bay soils are "unified", almost without exception, by the fact that they share an aquic moisture regime because of their landscape position in geomorphic depressions. An "aquic moisture regime" implies the presence of reducing soil conditions virtually free of dissolved oxygen, due to soil saturation by ground or capillary water (Soil Survey Staff, 1975). However, given the fact that Carolina bays are distributed over a wide variety of coastal plain geomorphic surfaces, their pedologic similarity largely ends at a shared soil moisture regime. Pedologic complexity is enhanced by the fact that Carolina bay depressions have historically served as fluvial and aeolian "catch basins", so that depression mineral sediments include not only sediments equal in age to that of bay formation, but also those that have blown or washed in more recently (Nystrom *et al.*, 1991). Bay soils range across at least six of the seven soil "Orders" (*see* Soil Survey Staff, 1975) occurring in the Carolinas, including Alfisols, Entisols, Histosols, Inceptisols, Spodosols, and Ultisols. Bay depressions having soils within four of those soil orders -- Entisols, Histosols, Spodosols, and Ultisols -- were sampled in this study.

North Carolina coastal plain soils are fairly well studied as a regional unit, while South Carolina's coastal plain soils are less well represented in the pertinent literature. However, the U.S. Department of Agriculture's Soils Conservation Service ("SCS") has completed and published soil surveys for the large majority of North and South Carolina coastal counties, which contain excellent descriptions of individual coastal plain soil types (series).

2.2.4.1 Study Area Soil Systems

The discussion of study area coastal plain "soil systems" set out below is largely derived from Daniels *et al.* (1984) and their description of North Carolina coastal plain soil systems, as extrapolated to include the southern portion of the study area in light of Cooke (1936) and Colquhoun (1969). Daniels *et al.* divide the North Carolina coastal plain into nine "landscape surface" soil systems that largely correspond to the geomorphic land surfaces occurring on the coastal plain, as previously discussed. Soil systems are defined by the regional pedologic similarities that result from similarities in soil formation factors found on those different geomorphic surfaces.

Given this "natural" grouping of coastal plain soils, the close connection between Carolina bay vegetation and soils, and the fact that bay depressions occur on virtually every coastal plain geomorphic surface, the "physiographic" systems of Daniels *et al.* (1984) and Colquhoun (1969) were adapted for use with Carolina bay data as a potential means to examine depressional differences over different landscape surfaces within the study area (*see* Chapter 5). The study area was divided into five geomorphic surfaces, or "landscape positions": (1) the

Upper Coastal Plain, including the "Sandhills", (2) the Middle Coastal Plain, (3) the Inner Lower Coastal Plain, (4) the Outer Lower Coastal Plain, and (5) Major River Valleys and Floodplains (Figure 2.3). With the relative geomorphic and geologic similarities between the Sea Island section of the North and South Carolina coastal plains, the adapted soil systems approach appears to be reasonably applicable to the entire study area. The pedologic regime found within each landscape position is discussed briefly below.

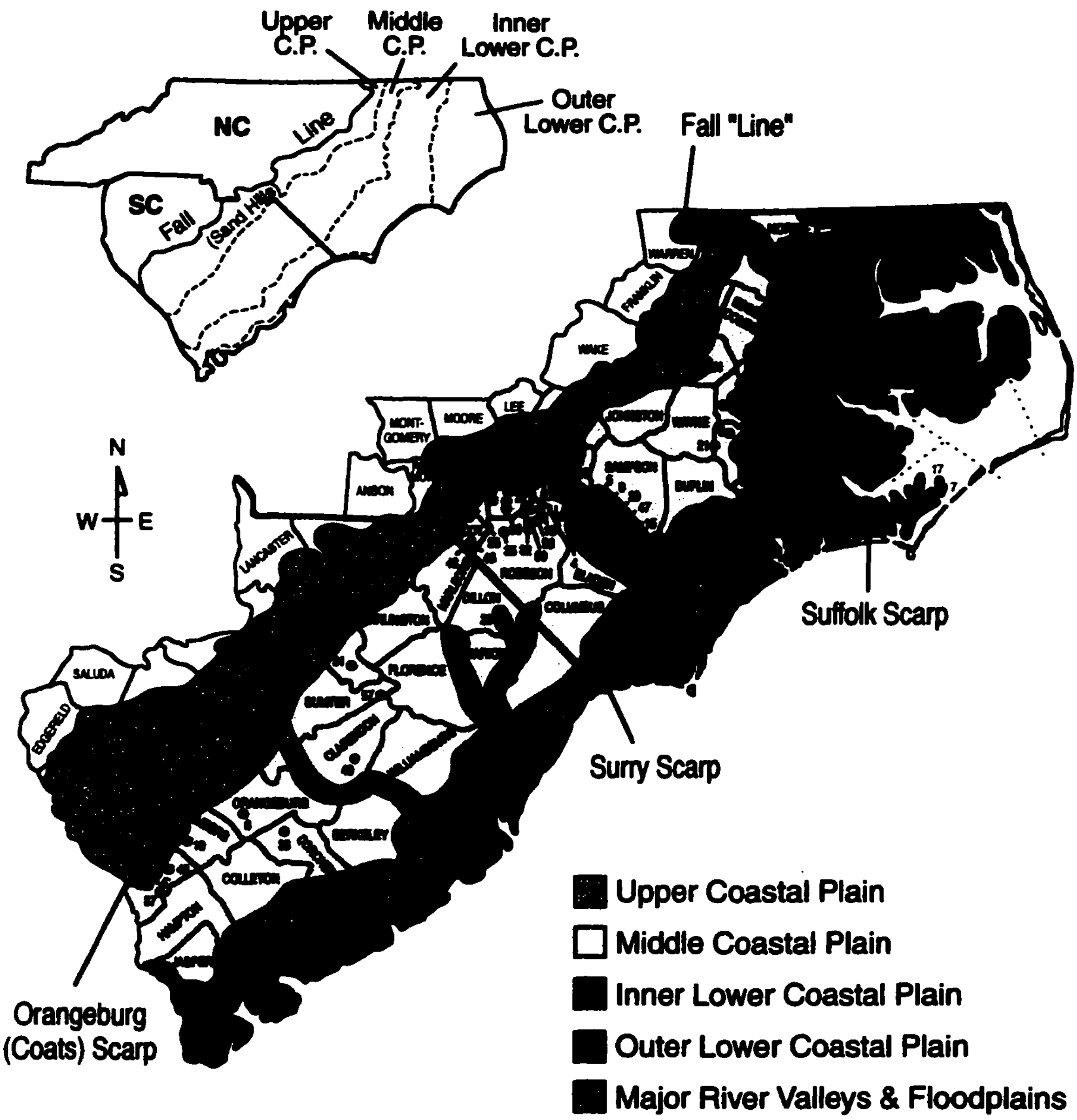
The Middle Coastal Plain is the largest and generally most diverse of the five coastal plain surfaces, and contains the largest number of Carolina bays found within the study area. For that reason, it is discussed first.

The Middle Coastal Plain consists of gently undulating, seaward sloping lands that are moderately dissected by stream erosion that is deep enough to affect water tables in the area of erosion, but that are nevertheless characterized by broad poorly drained interstream divides. Accordingly, a zone of well drained, brightly colored subsoils fringes the dissected edges of the uplands within this unit, sometimes known as the "dry edge effect". Moving from these well drained "edges" to the interstream divides, the water table moves closer to the surface and subsoils may be saturated seasonally for protracted periods of time. As a consequence, within the interstream flats local differences in micro relief as small as 15 to 20 cm may become very important for plant growth (*see, e.g.*, Ehrenfeld, 1995).

Moreover, some Middle Coastal Plain soils may have impeding subsurface layers that act as an aquiclude, resulting in temporarily perched water tables. One such layer occurs in loamy soils and is known as a "fragipan". Fragipan formation apparently results from breakdown of the structure of silicate clays from repeated wetting and drying, resulting in a brittle, somewhat indurated, relatively impermeable layer within the subsoil (Soil Survey Staff, 1975; Buol *et al.*, 1980). Fragipans are common, and to some extent characteristic, of Carolina bay soils found within the Middle Coastal Plain of the study area. Indeed, the "type locality" for the SCS's "McColl" soil series -- a fine-loamy, siliceous, thermic Typic Fragiaquult -- is a Middle Coastal Plain Carolina bay depression located near the town of McColl, in Marlboro County, South Carolina.

Other subsurface, relatively impermeable clay layers that are not true fragipans --

Figure 2.3. Major physiographic divisions of the North and South Carolina coastal plain (based on Daniels *et al.*, 1984; Colquhoun, 1969; and Cooke, 1936). The red circles represent the locations of study area sampling sites. Those sites are identified in Figure 3.1.



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall Line
(Sand Hills)
Fall "Line"
N
W
E
S
Suffolk Scarp
Surry Scarp
Orangeburg (Coats) Scarp
WARREN
FRANKLIN
WAKE
LEE
MOORE
MONT-GOMERY
ANSON
JOHNSTON
WAYNE
SAMPSON
DUPLIN
ROBESON
COLUMBUS
LANCASTER
SALUDA
EDGEFIELD
FLORENCE
SUMTER
CLARENDON
ORANGEBURG
BERKELEY
COLLETON
HAMPTON
Upper Coastal Plain
Middle Coastal Plain
Inner Lower Coastal Plain
Outer Lower Coastal Plain
Major River Valleys & Floodplains

commonly referred to as a "clay lens" -- also occur in Middle Coastal Plain bay depressions (Schalles, 1979; Sharitz and Gibbons, 1982; Schalles and Shure, 1989). Additionally, where soils are generally sandy, subsurface spodic horizons are frequent in Middle Coastal Plain bays, as they are in bay depressions occurring in other landscape positions. As noted, spodic horizons represent zones of eluviated organic matter within the soil profile, and if indurated may serve as a barrier to downward water movement. Finally, organic soils occurring in Middle Coastal Plain or other depressions may act as a dam to groundwater movement (Daniel, 1981), and slowly permeable , underlying mineral soil layers may impede the downward movement of water in shallow organic soils.

Carolina bays are abundant in the Middle Coastal Plain, particularly in the area of the North Carolina/South Carolina border. Most depressions within the region are small, but moderate to large sized bays are not uncommon.

The Upper Coastal Plain abuts the Middle Coastal Plain on the west, and for the most part, soils on that surface are similar to those occurring in the Middle Coastal Plain. Typic Paleaquults dominate Carolina bay soils in most of the Upper Coastal Plain. This area also includes the Sandhills region, which is dominated by sandy sediments derived from fluvial, marine, and aeolian sediments. The Sandhills is an area of rolling hills, substantial relief and occasional dune fields. Soils on the interstream divides are generally well drained, and Typic Paleaquults (in loamy sediments) to Aquic Quartzipsamments (in sandy sediments) are characteristic of Carolina bay soils in the Sandhills.

Carolina bays are generally infrequent in the Upper Coastal Plain in North Carolina, and are comparatively rare in the Sandhills. However, they are more plentiful in the southwestern Coastal Plain of South Carolina within the region of so-called "Peach Belt" soils (Bennett, 1994). In all Upper Coastal Plain areas, Carolina bay depressions tend to be small, sometimes exhibiting irregular, "sink-like" features and atypical directional orientation.

The Inner Lower Coastal Plain essentially occupies that portion of the Sea Islands section of the Carolina coastal plain seaward of the Surry Scarp, and the portion of the Embayed section of the Carolina coastal plain between the Surry Scarp and the Suffolk Scarp. As compared to the coastal plain regions lying to the west, the upland surfaces of the Inner Lower Coastal Plain have less local relief, wider interfluves (less stream dissection), and a change in clay mineralogy from kalonitic to a mixed mineralogy. Large areas of poorly to very poorly drained soils exist in the Inner Lower Coastal Plain, given the lack of local relief, broad relatively flat interstream divides, and slowly permeable strata near the surface that characterize this region. Nevertheless, aside from a greater proportion of wet soils exhibiting surficial gleyed sediments and soils exhibiting a high organic matter content in the A horizon, soils in the Inner Lower Coastal Plain are essentially the same as those found in the Middle Coastal Plain. Characteristic bay depression soils range from Typic Paleaquults (loamy sediments) to Typic Haplaquods (sandy sediments) to Terric Medisaprists (shallow organic soils that develop in the wettest areas, with either loamy or sandy underlying sediments).

Carolina bays are common in the Inner Lower Coastal Plain and are especially abundant in the southeastern most counties of North Carolina and the adjoining northeastern most counties of South Carolina.

The Outer Lower Coastal Plain is located primarily within the Embayed section of the Carolina Coastal Plain east of the Suffolk Scarp (now generally termed the "Albemarle Embayment" (*see* Horton and Zullo, 1991)), and thus occurs primarily in the extreme northeastern portion of the study area. It also includes, with a much smaller area, a narrow wedge of undifferentiated coastal deposits southward, within the Sea Islands section of the Carolina coastal plain (*see* Figure 2.3). Daniels *et al.* (1984) describe the "Pamlico Plain as "low, flat, and wet." The area is characterized by low elevation, virtually no relief, and broad flat interfluves, leading to widespread paludification (Daniel, 1981). The mineral soils that do occur in the region have formed in marine sediments deposited during the late Pleistocene (Mixon *et al.*, 1976). Dark A-horizons and histic epipedons, indicating organic matter accumulation, are common. Gley and gray colors dominate mineral soils at or near the surface, indicating that little water movement occurs within the soil solum (thus, no mottling) and that excess water (above evapotranspiration) is removed by surface runoff. Carolina bay soils found on this geomorphic surface are characteristically Typic Haplaquods in the more "upland" areas, and Terric to Typic Medisaprists in the lower, wetter areas.

Discernable Carolina bays are rare over broad areas within the Outer Lower Coastal

Plain, particularly where organic soils predominate, but appear to be more frequent immediately adjacent to the coast and near other drainages. As noted above, this may in part simply be a reflection of the fact that underlying geomorphology is obscured by a thick mantle of organic matter in many areas of the lower Coastal Plain.

Soils genesis in the Major River Valleys and Floodplain landscape position is separated from other geomorphic surfaces found in the Carolina coastal plain because the sedimentary history of these areas is generally quite different than that of the surfaces that surround the river valley. Stream valley sediments are a composite of sediments translocated from upstream, and those exposed and reworked by the down-cutting action of the stream itself or aeolian forces. Consequently, sediments along large Carolina rivers are a combination of Piedmont and coastal plain sediments. Sediments are typically acid and siliceous if derived primarily from reworked coastal plain sediments, and nonacid with mixed mineralogy if derived primarily from Piedmont sediments. Sediments are deposited in a series of step-like terraces along the stream, representing ancient river floodplains. Terrace soils are typically loamy and range from well drained to very poorly drained depending on the nature of the sediment and the landscape position. Floodplain soils are usually poorly drained and may be either organic or mineral. Typical Carolina bay soils in this landscape position are Terric Medisaprists and Typic Haplaquods (Leab, 1990).

As previously discussed in the section on "Geology" above, two of the Carolina major river valleys are of especial interest concerning Carolina bays: the Cape Fear and Pee Dee River valleys. The Santee River valley in South Carolina also contains significant numbers of Carolina bay depressions, but most of those have been inundated by the extensive impoundment of waters in that system (*see* Savage, 1982). As noted there, Carolina bays are rare in the Pee Dee River valley, but exceptionally large and abundant on terraces within the Cape Fear River valley.

### 2.2.5 Climate

The climate of the study area is warm temperate mesothermal (Trewartha, 1954), *i.e.*, it has hot, humid summers and moderately cold, but short winters. The proximity of the of the study area to the Atlantic Ocean exerts a strong maritime influence on much of the area. For that reason, the average freeze-free period within the study area ranges from 237 days near the coast to 205 days in the Sandhills in the central part of the study area (Hudson, 1984; Barnhill, 1986). Similarly, the freeze-free period ranges from north to south, from 192 days in the northeastern part of the study area to 227 days in the southwest portion of the study area (Rogers, 1985; Tant, 1988).

In winter, the average daily temperature and the average daily minimum temperature range from 6.7° C and 0° C, respectively, in the northeastern portion of the study area, to 8.9° C and 2.8° C, respectively, in the southwestern portion of the study area (Rogers, 1985; Tant, 1988). The average daily summer temperature and average daily summer maximum temperatures range from 25.0° C to 31.1° C, respectively, in the northeastern portion of the study area to 26.1° C and 32.2° C, respectively, in the southwest Carolina coastal plain (Rogers, 1985; Tant, 1988). Mean annual temperature data for 8 representative locations in the study area -- set out in Figure 2.4 -- are summarized in Figure 2.5 (North Carolina stations) and Figure 2.6 (South Carolina stations). Those figures indicate that there is a general trend of warmer mean annual temperature from north to south, and cooler mean annual temperatures from east to west.

The representative site climatological data summary graphs also indicate that study area annual average precipitation generally ranges between 122 cm and 137 cm, being highest near the coast. Most of that precipitation is in the form of rainfall, but most areas of the study area also average one to three snows per year (Kopec and Clay, 1975). That snowfall is highly variable from year to year, ranging, on average, from 10 cm in the northern part of the study area to 5 cm or less in the southern part of the study area (Rogers, 1985; Tant, 1988). Precipitation is comparatively evenly distributed throughout the year -- of the total annual precipitation on the Carolina coastal plain, 55% to 60% generally falls in the period from April through September (Rogers, 1985; Tant, 1988). While rainfall is highest in the summer, that is also the period of highest temperatures and highest evapotranspiration. Consequently, short-term moisture deficits are common within the study area during the summer months, but droughts are usually minor (Kopec and Clay, 1975). It is during those drought periods that many normally ponded Carolina bays are observed in a "drawdown" condition, *i.e.*, without standing surface water.

The area is also subject to three types of convective or cyclonic storms: tornadoes, tropical storms (including hurricanes), and thunderstorms. Tornadoes are relatively rare within

Figure 2.4. Locations of 8 representative study area sites (blue circles) for which summary climatological data are presented in relation to sampling site distribution (red circles). Selected sites include 4 North Carolina coastal plain sites -- Elizabeth City (Pasquotank Co.), Elizabethtown (Bladen Co.), Laurinburg (Scotland Co.), and New Bern (Craven Co.); and 4 South Carolina coastal plain sites -- Charleston (Charleston Co.), Conway (Horry Co.), Orangeburg (Orangeburg Co.), and Saluda (Saluda Co.).

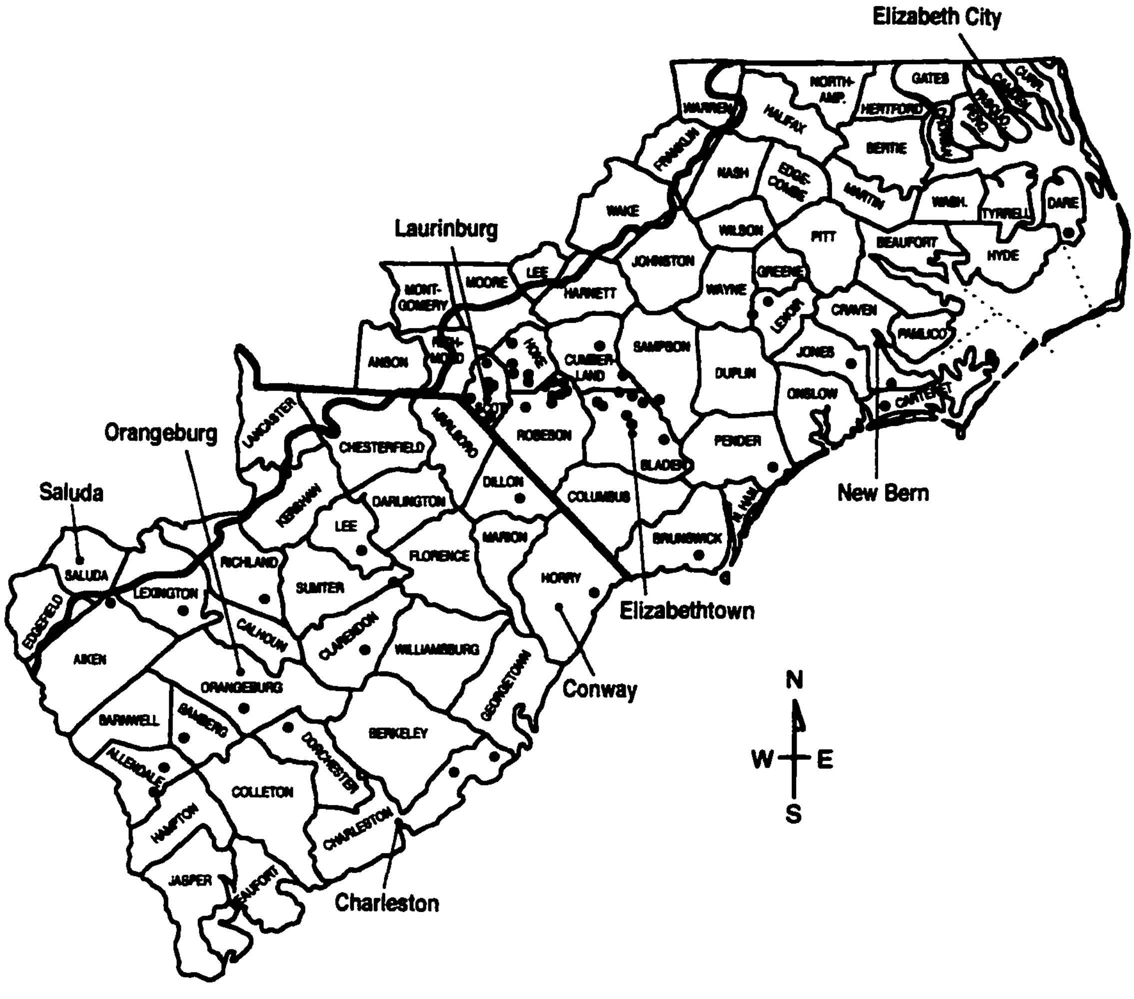
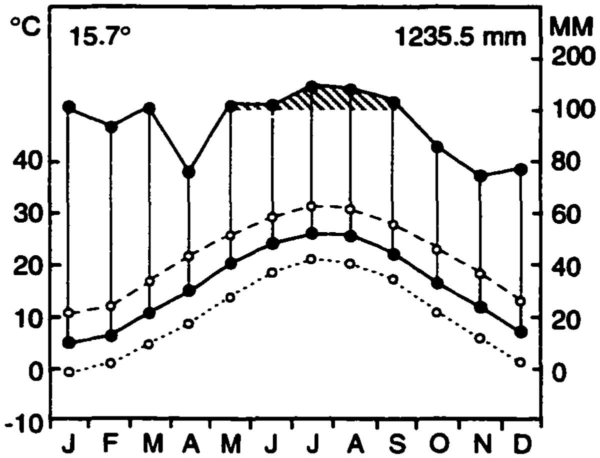
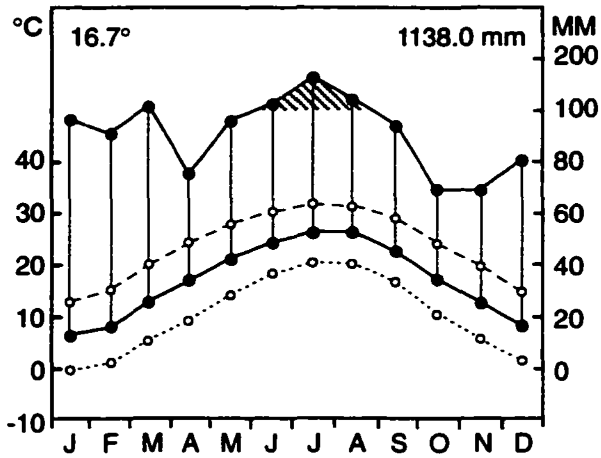

Elizabeth City
Laurinburg
Orangeburg
Saluda
New Bern
Elizabethtown
Conway
Charleston
WARREN
NORTH-AMP.
GATES
HERTFORD
HALIFAX
BERTIE
FRANKLIN
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
GREENE
MONT-GOMERY
MOORE
LEE
HARNETT
WAYNE
LENOIR
CRAVEN
PAMLICO
ANSON
CUMBER-LAND
SAMPSON
DUPLIN
JONES
ONSLOW
CARTERET
LANCASTER
CHESTERFIELD
ROBESON
PENDER
BLADEN
DILLON
COLUMBUS
KERSHAW
DARLINGTON
LEE
MARION
BRUNSWICK
SALUDA
RICHLAND
SUMTER
FLORENCE
HORRY
EDGEFIELD
LEXINGTON
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
DORCHESTER
BERKELEY
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

Figure 2.5. Study area climate diagrams for North Carolina coastal plain stations. Data are from the Southeastern Regional Climate Center (SERCC, 1997). The lower, solid line on the individual climate diagrams represents the mean monthly temperature. The dashed line just above the mean monthly temperature line represents the monthly average maximum temperature, while the dotted line just below the mean monthly temperature line represents the monthly average minimum temperature (all temperatures given in C°). The upper, solid line on the individual climate diagrams represents the mean monthly precipitation (in mm) for that station. Within the patterned area of the diagram, the scale is reduced 1/10.

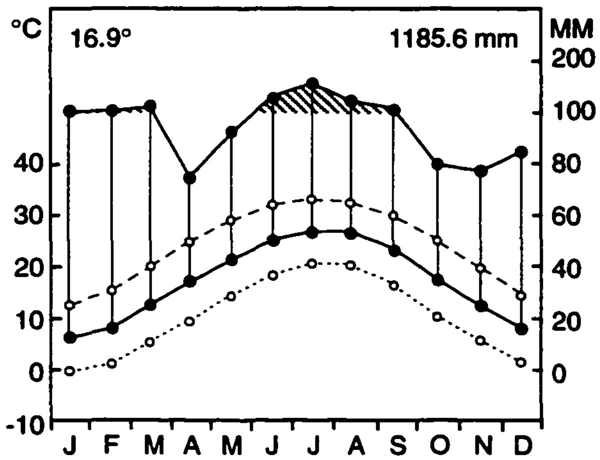
**Elizabeth City, N.C. (1961-90)**




**Elizabethtown, N.C. (1961-90)**




**Laurinburg, N.C. (1961-90)**




**New Bern, N.C. (1961-90)**

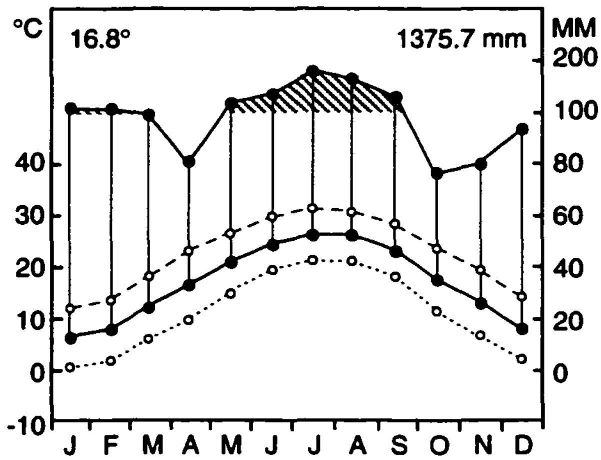
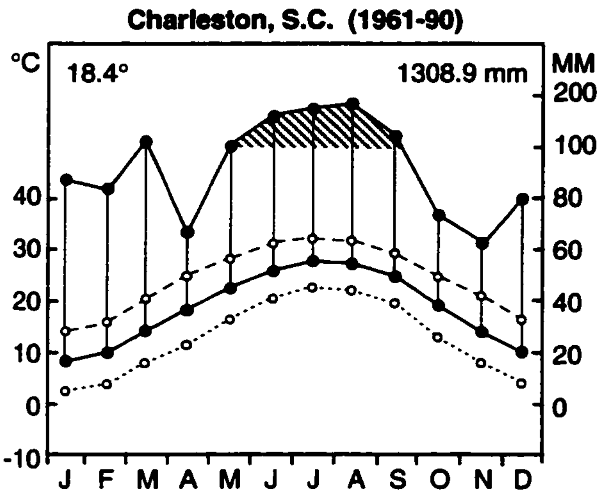
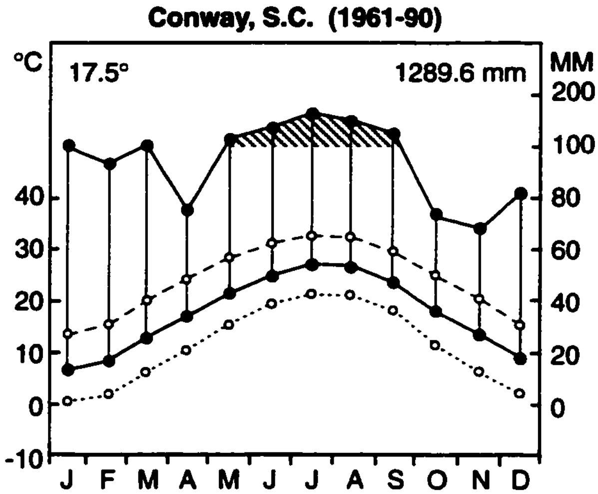
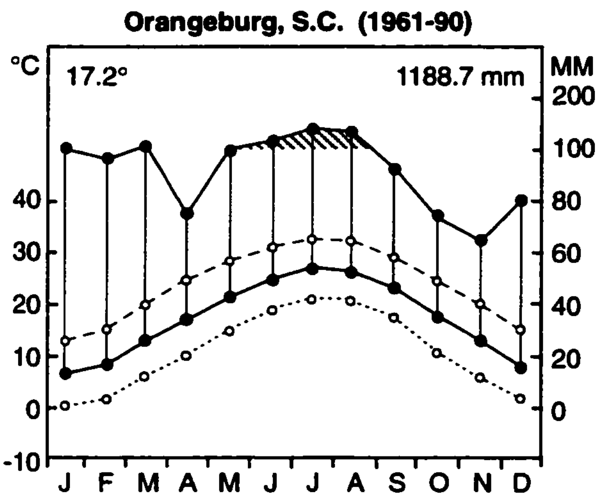
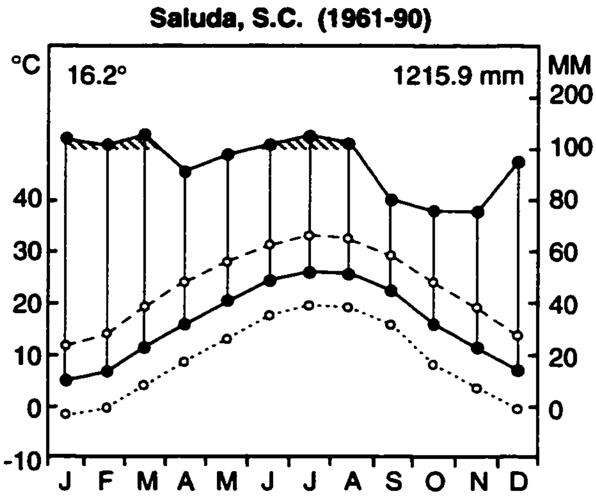


Figure 2.6. Study area climate diagrams for South Carolina coastal plain stations. Data are from the Southeastern Regional Climate Center (SERCC, 1997). The lower, solid line on the individual climate diagrams represents the mean monthly temperature. The dashed line just above the mean monthly temperature line represents the monthly average maximum temperature, while the dotted line just below the mean monthly temperature line represents the monthly average minimum temperature (all temperatures given in C°). The upper, solid line on the individual climate diagrams represents the mean monthly precipitation (in mm) for that station. Within the patterned area of the diagram, the scale is reduced 1/10.


Charleston, S.C. (1961-90)
°C
18.4°
1308.9 mm
MM
200
100
80
60
40
20
0
40
30
20
10
0
-10
J F M A M J J A S O N D


Conway, S.C. (1961-90)
°C
17.5°
1289.6 mm
MM
200
100
80
60
40
20
0
40
30
20
10
0
-10
J F M A M J J A S O N D


Orangeburg, S.C. (1961-90)
°C
17.2°
1188.7 mm
MM
200
100
80
60
40
20
0
40
30
20
10
0
-10
J F M A M J J A S O N D


Saluda, S.C. (1961-90)
°C
16.2°
1215.9 mm
MM
200
100
80
60
40
20
0
40
30
20
10
0
-10
J F M A M J J A S O N D

the study area, but thunderstorms occur with an annual frequency of 45 to 55 days per year (Trewartha *et al*., 1967; Kopec and Clay, 1975; Rogers, 1985; Tant, 1988). Hurricanes occur with intermediate frequency within the study area and are much more likely to affect the coastal portions of the study area than the inland portions of the coastal plain. When they do occur, they may dump large amounts of rainfall within a short period, and may greatly affect the short-term hydrology of precipitation dominated depressional systems like Carolina bays.

Prevailing winds are typically from the southwest in inland portions of the study area, but are more southerly near the coast (Kopec and Clay, 1975). North and northeast winds are common in the coastal plain during the late fall and winter months. Wind speed is typically between 16 and 19 km/hr. on average, and tends to be strongest in the later winter and early spring months (Rogers, 1985; Tant, 1988).

# CHAPTER III.

# STUDY METHODOLOGY

## 3.1 Site Selection

Because a primary objective of this study was to document and sample the floristic diversity occurring within Carolina bays in North and South Carolina, site selection began with the examination of aerial photographs for each coastal plain county in those two states. Aerial photographs were scrutinized for comparatively undisturbed depression sites that appeared to exhibit a variety of vegetation communities as determined principally by photograph texture, color, and pattern. Available SCS county soil survey reports and other data available from governmental agencies and many individuals were used to supplement the examination of study area photographs. From that supplemented examination, a list of potential Carolina bay sites was compiled to be visited during field reconnaissance.

Field reconnaissance was extremely time-consuming, and consisted of visiting hundreds of potential sampling sites. Because of fiscal and logistic constraints, the survey of potential sites was eventually restricted to North Carolina, and initial sampling sites were selected from that area. As the availability of relatively detailed information on Carolina bay depressions in South Carolina increased (particularly, the botanical survey of South Carolina bays performed by Bennett and Nelson, 1991), site reconnaissance was extended southward, and depression sites were selected from the southern portion of the study area.

Following extensive field reconnaissance over a period of years, plots were chosen to represent as completely as practicable the observed range of vegetational and environmental diversity occurring within study area Carolina bays. Ultimately, 269 permanent plots were located in 57 Carolina bay depressions, ranging in location from Dare County, North Carolina to Aiken County, South Carolina, and representing the full range of bay depression vegetational variation found within the coastal plain of the Carolinas (Figure 3.1).

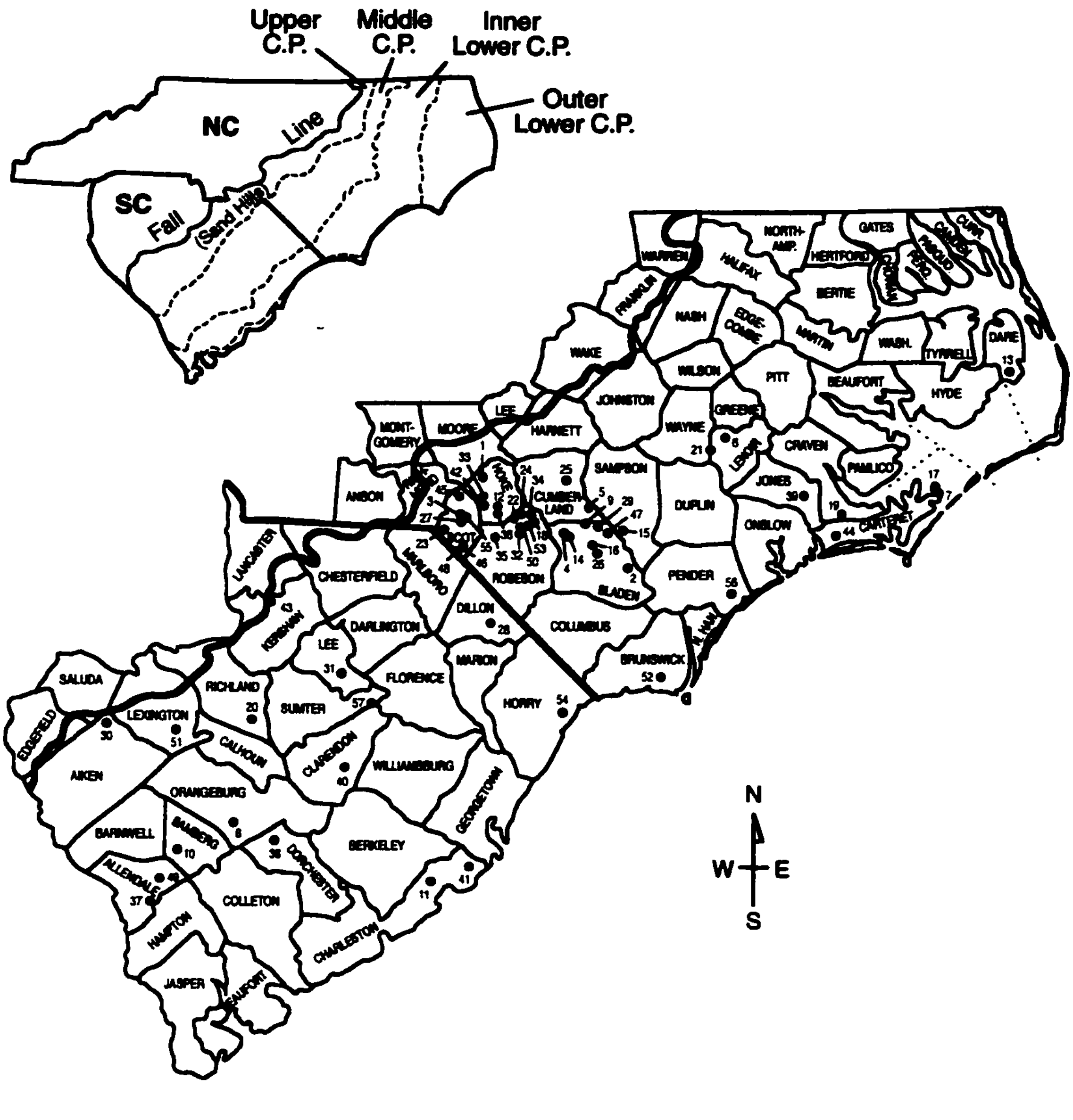
### 3.2 Field Sampling

Vegetation was sampled for this study during three time periods over a span of 15 years. Consequently, sampling methodology evolved during that period. Sampled plots are divided into three groups according to the relative time of sampling: (1) 1981-1984 plots, (2) 1988 plots, and (3) 1994-1995 plots. Sampling methodologies are summarized in Figure 3.2, below.

During 1981-1984, vegetation was sampled using 0.01 ha square (10m x 10m) plots placed in representative, comparatively homogeneous vegetation using a stratified random sampling methodology. Each plots was marked with 5 stakes made from approximately 0.5 m lengths of half-inch, PVC conduit, one placed at each plot corner, with the last stake placed in the center of the plot as determined by stretching a cord from the diagonal corners to form an 'x". Within each plot, all trees greater than 2 m in height were identified and measured for diameter at breast height ("DBH"). The aerial cover of all shrubs occurring within the plot was estimated as a percent of total cover to the nearest 5 percent. The herb stratum within each plot was sampled with a series of 19 1 m x 1 m quadrats arranged in two intersecting rows forming a cross centered on the plot's center stake (*see* Figure 3.2a). The presence and cover to the nearest 5 percent of herbs occurring within each quadrat, as well as woody species shading each quadrat, were recorded. Herb species located within the 0.01 ha plot, but not within one of the 1 $m^2$ subplots were noted.

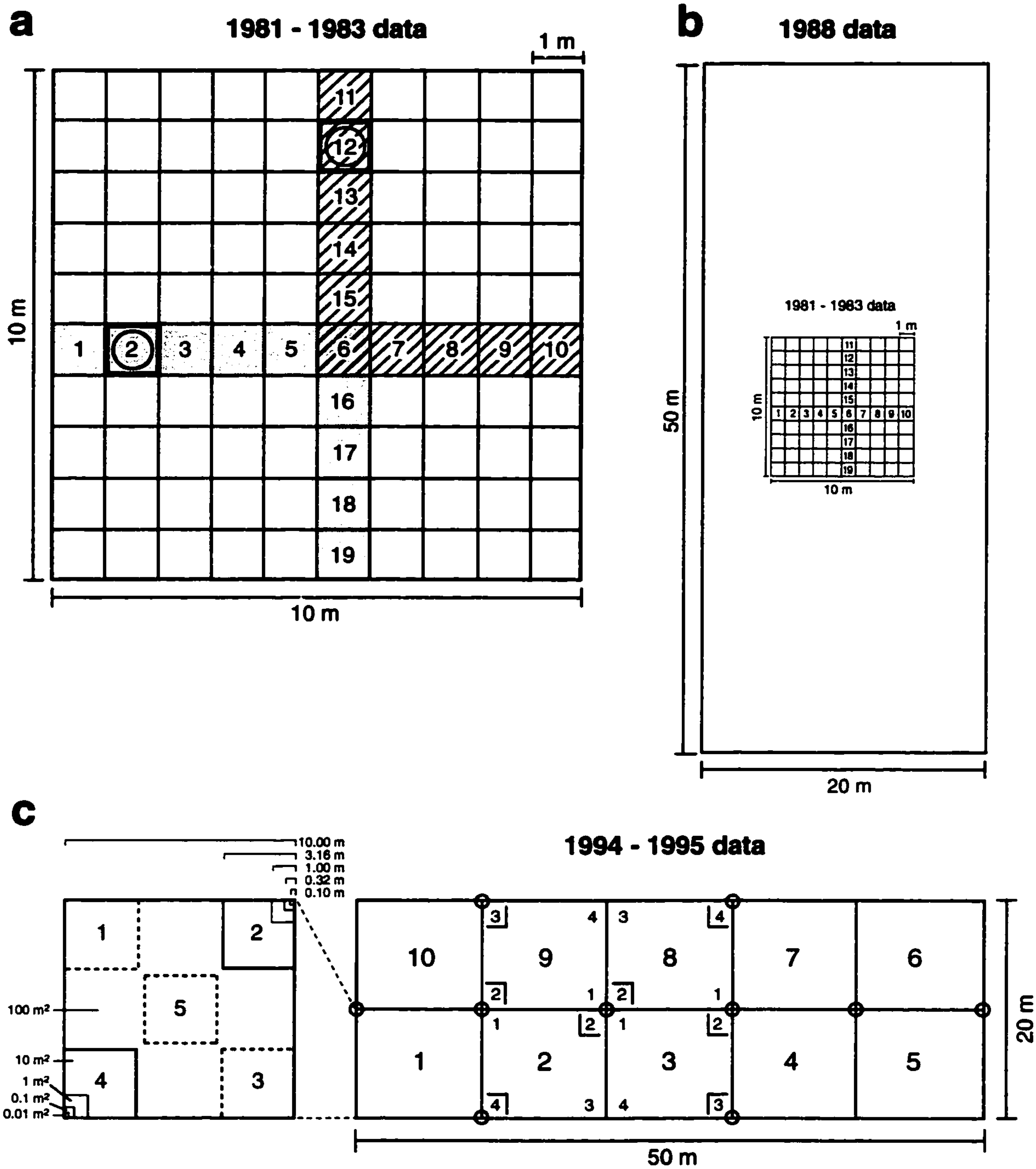
Vegetation was sampled during 1988 in a manner similar to that used in the prior period. A 0.1 ha plot measuring 20 m x 50 m was located in representative, comparatively homogeneous vegetation, and each plot was marked with 5 PVC stakes in the manner previously described. Within each plot, all trees greater than 2 m in height were identified and measured for diameter at breast height ("DBH"). The aerial cover of all shrubs occurring within the plot was estimated as a percent of total cover to the nearest 5 percent. The herb stratum within each plot was again sampled with a series of 19 1 m x 1 m quadrats arranged in two intersecting rows forming a cross centered on the plot's center stake (*see* Figure 3.2b). The presence and cover to the nearest 5 percent of herbs occurring within each quadrat, as

Figure 3.1. Map of the study area, including locations of sampled Carolina bay depressions. Those depressions are, as follows: (1) Ashmont Bay; (2) Bear Run Bay; (3) Big Cypress Meadow; (4) Big Gallberry Bay; (5) Big Pond Bay; (6) Black Pond; (7) Bog Hole Bay; (8) Branchville Bay; (9) Bushy Lake; (10) Cathedral Bay; (11) Cooter Creek Bay; (12) Cowlick Bay; (13) Cranberry Bay; (14) Cypress Pond; (15) Dew-Thread Bay; (16) Dowd's Bay; (17) Drowned Bay; (18) Duck Potato Bay; (19) Ellis Lake; (20) Gadsden Bay; (21) Garris Chapel Bay; (22) Goose Pond; (23) Green Pond Bay; (24) Gum Pond Bay; (25) Huckleberry Pond; (26) Jones Lake; (27) Laurinburg Road Bay; (28) Little Pee Dee Bay; (29) Mill Bay; (30) Monetta Sink; (31) Mount Pleasant Church Bay; (32) Oak Savanna Bay; (33) Panic Bay; (34) Pistol Pond; (35) Prickly-Ash Bay; (36) Pumpkinseed Bay; (37) Queen's Delights Bay; (38) Reevesville Bay; (39) Round Ridge Bay; (40) Sandhill Bay; (41) Santee Reserve Bay; (42) Sarvis Bay; (43) Savage Bay; (44) Sawgrass Bay; (45) Seventeen Frog Pond; (46) Sink Pond Bay; (47) Smith Mill Pond; (48) State-line Prairie; (49) Stony Lake Bay; (50) Strandy Road Bay; (51) Swansea Bay; (52) Target Bay; (53) Titi Bay; (54) Trumpet Bay; (55) Tunstall's Bay; (56) Well's Bay; and (57) Woods Bay. The insert at the upper left corner of the figure sets out the physiographic subdivisions of the Carolina coastal plain as pertains to this study (figure adapted from Taggart, 1990; used by permission).



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall Line
(Sand Hills)
WARREN
HALIFAX
NORTH-AMP.
HERTFORD
GATES
BERTIE
FRANKLIN
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
GREENE
LEE
HARNETT
WAYNE
LENOIR
CRAVEN
PAMLICO
MONT-GOMERY
MOORE
SAMPSON
JONES
ANSON
HOKE
CUMBER-LAND
DUPLIN
ONSLOW
CARTERET
ROBESON
BLADEN
PENDER
LANCASTER
CHESTERFIELD
MARLBORO
KERSHAW
DARLINGTON
DILLON
COLUMBUS
LEE
MARION
BRUNSWICK
SALUDA
RICHLAND
FLORENCE
HORRY
LEXINGTON
SUMTER
EDGEFIELD
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
BERKELEY
DORCHESTER
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

Figure 3.2. Field vegetation sampling methodologies employed in this study. See the accompanying text for the description of techniques and explanation of the figures (a) through (c).



a
1981 - 1983 data
1 m
10 m
10 m
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19
b
1988 data
1981 - 1983 data
50 m
20 m
c
10.00 m
3.16 m
1.00 m
0.32 m
0.10 m
100 m²
10 m²
1 m²
0.1 m²
0.01 m²
1994 - 1995 data
50 m
20 m

well as woody species shading each quadrat, were recorded. As before, herb species located within the 0.01 ha plot, but not within one of the 1 $m^2$ subplots were noted.

In the 1994-1995 sampling period, vegetation was sampled using methodology developed for the North Carolina Vegetation Survey ("NCVS"), commonly known as "GOS" plots by Peet *et al.* (1996). Plots were placed in depression areas exhibiting representative and relatively homogeneous vegetation. The standard sample was a series of 0.01 ha (10 m x 10 m) plots aggregated into two row of five plots to form a standard 0.1 ha sampling plot measuring 20 m by 50 m (*see* Figure 3.2c). The number of 10 x 10 modules was reduced at those locations where the spatial extent of the representative vegetation was too small to accommodate the standard 0.1 ha sampling unit. In some cases, the aggregate plot was reduced to a 20 m x 20 m square consisting of 4 10 m x 10 m modules. In a few instances, the sampling plot consisted of a single 10 m x 10 m module. Half-inch, thin-wall steel conduit stakes were used to permanently mark the plot center line and module corners, as indicated in Figure 3.2c.

Within each standard aggregate plot, four modules were intensively sampled (*see* Figure 3.2c). Presence and cover of all species and tree stem DBHs were initially recorded in each intensively sampled 10 m x 10 m module. In addition, the module was divided into two series of nested quadrats wherein sub-modules were named by "nesting class": '5' = 10 cm x 10 cm sub-module, '4' = 31 cm x 31 cm sub-module, '3' = 1 m x 1 m sub-module, '2' = 3.1 m x 3.1 m sub-module, and '1'= the entire 10 m x 10 m module. Species were assigned a value corresponding to the lowest level (*i.e.*, the highest number) sub-module in which the species was found to be rooted. Species cover was estimated as a vertical projection onto the module and assigned a value according to the following 10-class system: '1' = trace, '2' = 0-1% cover, '3' = 1-2% cover, '4' = 2-5% cover, '5' = 5-10% cover, '6' = 10-25% cover, '7' = 25-50% cover, '8' = 50-75% cover, '9' = 75-95% cover, and '10' = 95-100% cover. In addition, diameters of all woody stems taller than 1.4 m in height were measured at 1.4 m (*i.e.*, at breast height) and recorded according to the specified diameter classes: (1) 0-1 cm, (2) 1-2.5 cm, (3) 2.5-5 cm, (4) 5-10 cm, (5) 10-15 cm, (6) 15-20 cm, (7) 20-25 cm, (8) 25-30 cm, (9) 30-35 cm, (10) 35-40 cm, and (11) stems >40 cm. Stems falling into the latter category were noted separately and recorded to the nearest centimeter. If the aggregate plot contained 4 or fewer 10 m x 10 m modules, then all modules were intensively sampled.

Presence and cover were estimated for any additional species rooted in the residual modules (usually 6 in number). Woody stems greater than 1.4 m in height were tallied collectively, by species and DBH, for the residual modules. Where stem density was too great to make the measurement of each individual species impractical (*e.g.*, in Evergreen Shrub-bog communities), woody stem subsamples (usually 20% ) were used.

Botanical nomenclature follows Kartesz (1994). Radford *et al.* (1968), supplemented by Godfrey and Wooten (1981), was used to identify most species occurring within Carolina bay depressions, except that Campbell (1985) was used to identify species of the genus *Andropogon*, and Gould and Clark (1978) was used to identify species in the genus *Dichanthelium* (*Poaceae*). One additional taxonomic species was collected, but not yet positively identified -- *Rhynchopsora* species #1, which is similar to, but morphologically distinct from, *Rhynchospora inundata* and was growing with the latter species at the site at which it was recorded.

### 3.3 Site Environmental Characterization

A total of 67 environmental variables divided into four suites of parameters -- (1) site soil factors, (2) site hydrologic factors, (3) site geomorphologic factors, and (4) site disturbance factors -- were measured or determined for each sampled plot. These environmental parameters and their respective abbreviation codes (used in the biplot figures presented in the community gradient analyses in Chapters 4 and 5) are set out in Table 3.1. Each suite of environmental parameters is described in turn, below.

#### 3.3.1 Site soil factors

Forty-eight soils parameters (*i.e.*, 16 soils variables at each of 3 sampling depths) were measured at for each intensively sampled 0.01 ha permanent plot established. Within each plot, two sets of soil samples were taken from depths of 10 cm, 25 cm, and 50 cm, using a standard bucket augur. The samples from each depth were composited and submitted to the North Carolina Department of Agriculture's Soils Analysis Laboratory for determination of humic matter content, weight per unit volume (bulk density), cation exchange capacity,

Table 3.1. List identifying the 69 environmental parameters measured for individual study plots, giving abbreviation codes used in biplot figures (for definitions of individual factors, see text).

| ENVIRONMENTAL PARAMETER | ABBREVIATION CODE |
|---|---|
| **Site Soil Factors:** | |
| Humic Matter Content @ 10 cm | HUM10 |
| Weight/Volume @ 10 cm | WTVOL10 |
| CEC @ 10 cm | CEC10 |
| % Base Saturation @ 10 cm | BSAT10 |
| % Acidity @ 10 cm | ACID10 |
| pH @ 10 cm | pH10 |
| Phosphorus @ 10 cm | P10 |
| Potassium @ 10 cm | K10 |
| Calcium @ 10 cm | CA10 |
| Magnesium @ 10 cm | MG10 |
| Manganese @ 10 cm | MN10 |
| Zinc @ 10 cm | ZN10 |
| Copper @ 10 cm | CU10 |
| % Sand @ 10 cm | SAND10 |
| % Silt @ 10 cm | SILT10 |
| % Clay @ 10 cm | CLAY10 |
| Humic Matter Content @ 25 cm | HUM25 |
| Weight/Volume @ 25 cm | WTVOL25 |
| CEC @ 25 cm | CEC25 |
| % Base Saturation @ 25 cm | BSAT25 |
| % Acidity @ 25 cm | ACID25 |
| pH @ 25 cm | pH25 |
| Phosphorus @ 25 cm | P25 |
| Potassium @ 25 cm | K25 |
| Calcium @ 25 cm | CA25 |
| Magnesium @ 25 cm | MG25 |
| Manganese @ 25 cm | MN25 |
| Zinc @ 25 cm | ZN25 |
| Copper @ 25 cm | CU25 |
| % Sand @ 25 cm | SAND25 |
| % Silt @ 25 cm | SILT25 |
| % Clay @ 25 cm | CLAY25 |
| Humic Matter Content @ 50 cm | HUM50 |
| Weight/Volume @ 50 cm | WTVOL50 |
| CEC @ 50 cm | CEC50 |
| % Base Saturation @ 50 cm | BSAT50 |

| ENVIRONMENTAL PARAMETER | ABBREVIATION CODE |
|---|---|
| % Acidity @ 50 cm | ACID50 |
| pH @ 50 cm | pH50 |
| Phosphorus @ 50 cm | P50 |
| Potassium @ 50 cm | K50 |
| Calcium @ 50 cm | CA50 |
| Magnesium @ 50 cm | MG50 |
| Manganese @ 50 cm | MN50 |
| Zinc @ 50 cm | ZN50 |
| Copper @ 50 cm | CU50 |
| % Sand @ 50 cm | SAND50 |
| % Silt @ 50 cm | SILT50 |
| % Clay @ 50 cm | CLAY50 |
| **Site Hydrologic Factors:** | |
| Water Depth Index | WATDEPTH |
| Hydroperiod Class | HYDROPRD |
| Water Constancy Index | CONSTCY |
| Organic Layer Depth | ORGDEPTH |
| Soil Drainage Class | DRAINAGE |
| Soil Permeability Class | PERMBLTY |
| Soil Available Water Capacity Class | WATERCAP |
| **Site Geomorphologic Factors:** | |
| Site Elevation | ELEV |
| Site Latitude | RLAT |
| Site Longitude | RLONG |
| Elevational Drop in 1 Km (m) | RDROP |
| Distance to 10 m Elevational Drop (m) | NDROP |
| Depression Area (ha) | AREA |
| Depression Length/Width Ratio | LWRATIO |
| Depression Long Axis Orientation | ORIENT |
| **Site Disturbance Factors:** | |
| Fire Frequency Class | FIREFRQ |
| Cultivation Index | CULTIV |
| Grazing Index | GRAZING |
| Timbering Index | TIMBER |
| Drainage Index | DITCHING |
| Landscape Disturbance Class | LANDDIST |
| | |

percent base saturation, percent acidity, pH, and extractable phosphorus, potassium, calcium, magnesium, manganese, zinc, and copper. In addition, sub-samples of mineral soils collected from each depth were submitted to Brookside Laboratories, Inc., in New Knoxville, Ohio for determination of sample particle size distribution (texture). In order to effect cost savings, and given the difficulties associated with texturing soils dominated by organic material, organic soil samples were not submitted for particle size determination. Soils data were collected and analyzed as described for all plots sampled during 1994 and 1995, but only for some of the plots sampled in prior sampling years.

At each sampled site a representative site soil profile at least 1.5 m deep was excavated using a standard soil augur, laid out to scale, photographed, and described by color, texture and other relevant soil properties. Soil families for the described soil profiles were determined by comparison with pertinent county soil surveys from the study area, and by consultation with state Soil Conservation Service personnel and faculty from the Soils Science Department at North Carolina State University. Those soil family identifications were subsequently used, as discussed below, to determine specific site hydrologic factors for each sampling site.

### 3.3.2 Site hydrologic factors

As noted in the review of Carolina bay literature, previous studies of bay depressions have indicated that site hydrology is the single most important factor in determining site vegetation (Schalles, 1979; Schalles *et al.*, 1989; Kirkman, 1992). For that reason a number of direct and surrogate measures of site hydrology were recorded for all sites sampled.

First, the ambient site water level was determined for all intensively sampled plots by direct measurement of surface water depth in centimeters. In the case where sites were not inundated, several holes were bored within the plot with a standard bucket augur, and the mean depth to water within those holes was measured after allowing a period of from 6 to 24 hours for the in-hole water level to stabilize. From that information, a relative site water index was constructed where a value of 150 represented water at the surface (*i.e.*, a measured depth of 0 cm). The site hydrologic index value was determined by adding or subtracting from 150 a number equal to the measured depth of water above or below the site surface.

Both a hydroperiod class and a water constancy index were determined for each sampled site, based on interviews with landowners and local residents, and through years of field observation. Assigned hydroperiod classes are set out in Table 3.2. Similarly, each site was assigned an ambient site water constancy class depending upon the relative stability of site hydrologic conditions in a year of average rainfall. Those classes are displayed and defined in Table 3.3, below.

As noted, at each sampled site, a soil profile was described. Using a combination of field texturing and soil color, the depth of the organically dominated portion of the soil solum, *i.e.*, the "organic layer depth", was measured for each site. Generally, the deeper the organic layer, the wetter the site, since constant inundation prevents oxidation of organic litter and allows peat build-up.

In addition to organic layer depth, three other wetness surrogate measures related to soils data were determined for each site. Relevant SCS reports (county soil surveys) from the study area were used to determine the soil drainage class, soil permeability class, and available water capacity for the soil families identified at each site. Soil drainage class is defined as the frequency and duration of periods of soil saturation or partial saturation within a soil solum. Three classes of drainage are found within the soils of study area Carolina bays: (1) moderately well-drained to somewhat poorly drained soils, (2) poorly drained soils, and (3) very poorly drained soils.

Soil permeability refers to the quality of the soil that enables water to move downward through the profile. It is measured as the number of centimeters of water that percolates downward through saturated soil in one hour. The permeability of study area depression site soils falls within the range of five permeability classes, as set out in Table 3.4, below.

Available water (moisture) capacity is the capacity of soils to hold water available for use by most plants, *i.e.*, the difference between the amount of soil water at field capacity and the amount at the wilting point. It is typically expressed as centimeters of water per 150 cm profile of a soil, as displayed in Table 3.5.

Table 3.2. Hydroperiod classes assigned to sampled Carolina bay sites.

| HYDROPERIOD CLASS | RELATIVE SITE WETNESS |
|---|---|
| 1 | Site almost always dry (surface inundated < 10% of the time) |
| 2 | Site usually dry (surface inundated ≥ 10% < 50% of the time) |
| 3 | Site flooded ~ as often as dry (surface inundated ~50% of the time) |
| 4 | Site usually flooded (surface inundated > 50% < 90% of the time) |
| 5 | Site almost always flooded (surface inundated ≥ 90% of the time) |

Table 3.3. Water constancy classes assigned to sampled Carolina bay sites.

| WATER CONSTANCY CLASS | SITE AMBIENT WATER LEVEL |
|---|---|
| 1 | Highly variable |
| 2 | Moderately variable/stable |
| 3 | Highly stable |

Table 3.4. Soil permeability classes applicable to soils occurring in sampled Carolina bay sites.

| SOIL PERMEABILITY CLASS | DESCRIPTION | RANGE (cm/hr) |
|---|---|---|
| 2 | Slow | 0.1 to 0.5 |
| 3 | Moderately Slow | 0.5 to 1.5 |
| 4 | Moderate | 1.5 to 5.0 |
| 5 | Moderately Rapid | 5.0 to 15.0 |
| 6 | Rapid | 15.0 to 50.0 |

Table 3.5. Available water capacity classes applicable to soils occurring in sampled Carolina bay sites.

| AWC CLASS | AVAILABLE WATER CAPACITY | RANGE (cm/hr) |
|---|---|---|
| 1 | Very Low | 0 to 7.5 |
| 2 | Low | 7.5 to 15.0 |
| 3 | Moderate | 15.0 to 22.5 |
| 4 | High | 22.5 to 30.0 |
| 5 | Very High | >30.0 |

Table 3.6. Fire frequency classes assigned to sampled Carolina bay sites.

| FIRE FREQUENCY CLASS | DESCRIPTION | FIRE FREQUENCY |
|---|---|---|
| 1 | Very Frequent Fires | $\leq$ 5 years |
| 2 | Frequent Fires | > 5 $\leq$ 10 years |
| 3 | Occasional Fires | >10 $\leq$ 25 years |
| 4 | Infrequent Fires | > 25 years |

Table 3.7. Site disturbance indices assigned to sampled Carolina bay sites for intra-bay human disturbance activities.

| SITE DISTURBANCE INDEX (Cultivation, Grazing, Timbering, or Drainage) | DESCRIPTION |
|---|---|
| 1 | No evidence of human activity |
| 2 | Evidence of human activity in distant past (> 25 yrs. BP) |
| 3 | Evidence of human activity in recent past (< 25 yrs. BP) |
| 4 | Current human activity at site |

Table 3.8. Relative landscape disturbance classes assigned to sampled Carolina bay sites.

| LANDSCAPE DISTURBANCE CLASS | DEFINITION |
|---|---|
| 1 | $\leq$ 25% of surrounding landscape intensively disturbed |
| 2 | > 25 % $\leq$ 50% of surrounding landscape intensively disturbed |
| 3 | > 50% $\leq$ 75% of surrounding landscape intensively disturbed |
| 4 | > 75% of surrounding landscape intensively disturbed |

### 3.3.3 Site geomorphologic factors

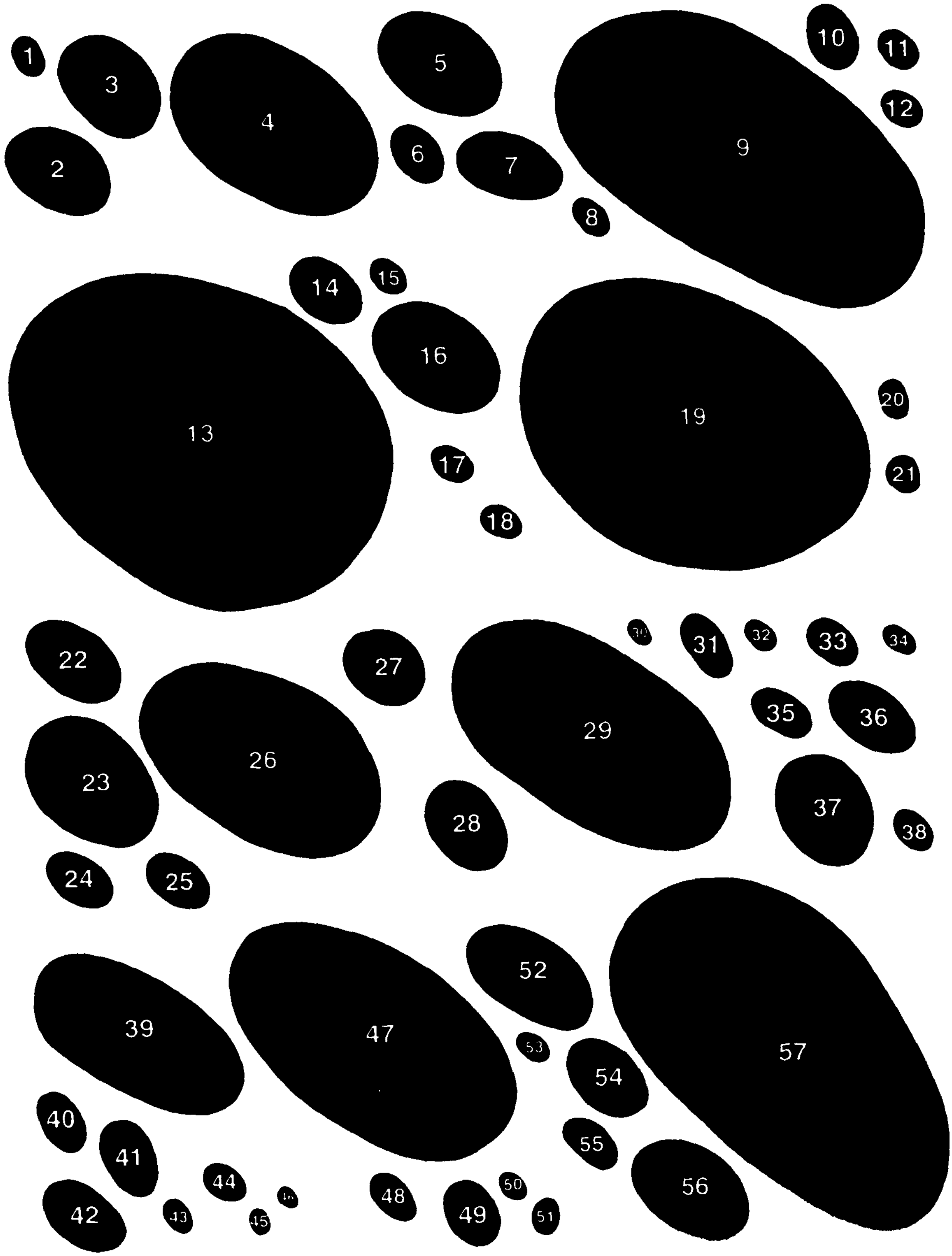
Six site geomorphologic factors were recorded for each sampled site: (1) site elevation, (2) the elevational drop in 1 km, (3) distance to the nearest 10 m elevational drop, (4) the depression area, (5) the depression length to width ratio, and (6) the depression long axis orientation. Each parameter was determined using relevant U.S. Geological Survey ("USGS") topographic quadrangle maps. Site elevation is the elevation, in meters, of the outer edge of the bay (just below the rim) in which the plot is located. Elevational drop per kilometer and distance to the nearest 10 meter elevational drop are measures of the relative local relief of the land surfaces on which the sampled depression is located. The former measure is the maximum drop in elevation, measured in meters, in a distance of 1 kilometer from the below-rim, edge elevation of the depression in which the site is located. The latter measure is the distance, to the nearest 25 m, from the below-rim elevation of the depression in which the site is located to a point on the surrounding landscape 10 m lower in elevation. Depression area is the area, expressed in hectares, of the depression site in which a sampled plot is located.

Investigators have long commented on the change in both Carolina bay depression shape and depression orientation from north to south within the Atlantic coastal plain (Johnson, 1942; Prouty, 1952; Savage, 1982). Consequently, these two parameters were measured to determine whether any correlation exists between that observed variation and depression vegetational composition. Depression length to width ratio is a measure of the relative "ellipticity" of the bay depression in which a sampled plot is located. Depression long axis orientation is a measure of the variance, in degrees, from true northwest--southeast, of the long axis of the bay depression in which a sampled plot is located. Figure 3.3 presents a relative comparison of the sizes, shapes, and directional orientations of the 57 Carolina bay depressions sampled within this study.

### 3.3.4 Site disturbance factors

The quantification of site disturbance factors represents an attempt to account for disturbance agents observed or believed to be important to the development of site vegetation. Those factors include the frequency of fire; human usage of depression sites for

Figure 3.3. Diagram showing the relative size, shape, and directional orientation of 57 sampled Carolina bays in North and South Carolina. Individual sampling sites are identified by number, as follows: (1) Ashmont Bay; (2) Bear Run Bay; (3) Big Cypress Meadow; (4) Big Gallberry Bay; (5) Big Pond Bay; (6) Black Pond; (7) Bog Hole Bay; (8) Branchville Bay; (9) Bushy Lake; (10) Cathedral Bay; (11) Cooter Creek Bay; (12) Cowlick Bay; (13) Cranberry Bay; (14) Cypress Pond; (15) Dew-Thread Bay; (16) Dowd's Bay; (17) Drowned Bay; (18) Duck Potato Bay; (19) Ellis Lake; (20) Gadsden Bay; (21) Garris Chapel Bay; (22) Goose Pond; (23) Green Pond Bay; (24) Gum Pond Bay; (25) Huckleberry Pond; (26) Jones Lake; (27) Laurinburg Road Bay; (28) Little Pee Dee Bay; (29) Mill Bay; (30) Monetta Sink; (31) Mount Pleasant Church Bay; (32) Oak Savanna Bay; (33) Panic Bay; (34) Pistol Pond; (35) Prickly-Ash Bay; (36) Pumpkinseed Bay; (37) Queen's Delights Bay; (38) Reevesville Bay; (39) Round Ridge Bay; (40) Sandhill Bay; (41) Santee Reserve Bay; (42) Sarvis Bay; (43) Savage Bay; (44) Sawgrass Bay; (45) Seventeen Frog Pond; (46) Sink Pond Bay; (47) Smith Mill Pond; (48) State-line Prairie; (49) Stony Lake Bay; (50) Strandy Road Bay; (51) Swansea Bay; (52) Target Bay; (53) Titi Bay; (54) Trumpet Bay; (55) Tunstall's Bay; (56) Well's Bay; and (57) Woods Bay.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cultivation, livestock grazing and as a source of timber; the construction of drainage outlets into, or out of, a given depression site; and the extent of land disturbing activities occurring in the landscape surrounding the depression in which a sampled plot is located.

Fire frequency was determined from interviews with landowners and local residents, and from observation of fire scars on woody vegetation and charcoal in site soils. Depressions sites were assigned to one of four fire frequency classes, as set out in Table 3.6.

Human disturbance activities within sampled bay sites that were "quantified" include (1) prior cultivation of a depression site to grow agricultural products, (2) use of a bay depression for livestock grazing, (3) cutting of canopy trees from a depression site, and (4) construction of drainage ditches leading into or out of a depression. Each such disturbance activity was categorized by an assigned index value indicating the relative recency of the disturbance, as indicated in Table 3.7.

Anecdotal evidence suggests that the human usage of landscapes surrounding some Carolina bay depressions for land disturbing activities may significantly affect site vegetation in a variety of ways, including (1) lowering of the local water table, (2) decreasing site fire frequency, and (3) allowing the non-point source discharge of agricultural wastes into the depression. For that reason, each depression site containing sampled plots was assigned to a landscape disturbance class, which simply represents the relative proportion of the landscape surrounding a given depression site that is currently under intensive human usage. Landscape disturbance classes are defined in Table 3.8.

### 3.4 Community Classification

A community classification was generated for study area Carolina bay plots using techniques that cluster the sample plots into groups containing compositionally similar vegetation. Preliminary analyses were undertaken using three different distance-based, agglomerative clustering programs: (1) Unweighted Pair-Group Method using arithmetic Averages method (UPGMA; Sneath and Sokal, 1973); (2) Ward's minimum variance method (Ward, 1963); and (3) Lance-Williams flexible beta averaging method (Lance and Williams, 1966). All agglomerative methods are widely used clustering algorithms (Sneath and Sokal, 1973; Orloci, 1975; Feoli and Gerdol, 1982; Pielou, 1984; Belbin and McDonald, 1993).

Although it has been one of the most widely used clustering methods in the recent past, TWINSPAN was rejected as a potential classification technique for this study because of relatively recently identified problems with that method (Gauch, 1982; Belbin and McDonald, 1993).

Classification techniques were implemented in SAS (SAS Institute, Inc., 1996) using PROC CLUSTER. Because of comparability problems between data collected using different sampling methods in different years, each clustering technique was initially used with each of three different data sets: (1) all data for all sampling years, which used a mix of sampling methodologies; (2) the 1994-1995 data, which used standardized NCVS plots for sampling, only; and (3) data from all intensively sampled 10 m x 10 m modules, which included the data for all sampling years. The latter data set, which consisted of 482 intensively sampled modules from the study area, was chosen as producing the most interpretable results.

Each clustering technique was then implemented using the selected data sets, including all 482 intensively sampled modules. Subsequently, the TRIM function in PROC CLUSTER was used to remove outliers from cluster analyses at three specified levels (2.5%, 5%, and 10% of total plots), but was ultimately rejected for use with the Carolina bays data set. However, 4 modules -- from the Brackish Marsh vegetation group described in Chapter IV -- were eventually discarded from the data set because they were so different from other vegetation stands that they tended to substantially skew the results of the clustering program. Species cover, using the coefficient of community value (Bray and Curtis, 1957) with average cover per 0.01 ha plot, was used to calculate a dissimilarity matrix to determine distances between stands.

No method produced a classification that lacked significant interpretability problems. However, the Ward's and Lance-Williams methods were both found to be superior to UPGMA for classification of Carolina bay vegetation, producing similar results. Classification results for the Ward's and Lance-Williams classifications were evaluated by examining the distribution of classified stands along ordination axes using the ordination method Detrended Correspondence Analysis ("DCA"; Hill, 1979). The Lance-Williams flexible beta clustering method was chosen for the final classification because overall, within "problem" groups of plots, it produced more interpretable compositional separation of vegetation stands.

### 3.5 Multivariate methods

Ordination is used in modern vegetation analysis to find dominant gradients in complex, multidimensional data. Indirect ordination methods allow the arrangement of vegetation stands along axes (which represent dimensions) on the basis of species composition (ter Braak, 1995). Thus, ordination was used both to aid in the delineation of the vegetation groups identified via hierarchical classification techniques previously described and to facilitate an understanding of how those vegetation groups are distributed in relation to study area environmental conditions.

Nonmetric multidimensional scaling ("NMDS"; Kruskal, 1964) was chosen to identify major compositional gradients within the collected Carolina bays data set. NMDS extracts compositional gradients independently of site environmental variables, allowing compositional axes to be analyzed in light of site variables through correlation and/or regression analysis (ter Braak, 1986). NMDS has been shown to be superior to DCA as an ordination method in more accurately reflecting species distributions along environmental gradients (Faith *et al.*, 1987; Minchin, 1987). NMDS ranks plots in order of dissimilarity with each other (Minchin, 1987). Plot dissimilarities for NMDS were calculated using the Bray-Curtis dissimilarity coefficient. NMDS was performed using the program DECODA (Minchin, 1994).

### 3.6 Life Form and Growth Form Spectra

Vegetation structure, morphology, and physiognomy are generally presumed to closely reflect the physical environment characterizing the community under consideration (*see, e.g.,* Raunkaier, 1937). Consequently, physiognomic methods of vegetation description based on life form or growth form spectra have been used successfully to illustrate differences between plant communities occurring in different environments (Kent and Coker, 1992). This vegetation description methodology has also been used to elucidate ecological relationships between "Raunkaier" life form spectra and environmental gradients (Danin and

Orshan, 1990).

As noted, study area Carolina bay depressions exhibit remarkable floristic diversity for a uniform geomorphic landform type. Based on filed observation, that vegetational diversity was intuitively believed to be related to major environmental gradients such as site hydrology, soil texture, and soil organic matter content. A primary objective of this study was to make sense of and understand observed vegetational diversity. For those reasons, species occurring in each identified vegetation class and subclass for the study area were graphed according to both life form spectra -- based on Raunkaier (1937) as presented in Mueller-Dombois and Ellenberg (1974) -- and growth form categories -- based on Whittaker and Niering (1968). Tables 3.9 and 3.10 respectively summarize the life form and growth form categories employed in this analysis. They also set out the abbreviation codes used for those categories in the life form and growht form figures provided for each vegetation class and subclass in Chapter 4. In each of those figures, life form and growth form values were assigned to a species as a proportion of the total number of species occurring within the vegetation group being considered.

| ABBREVIATION CODE | MEANING |
|---|---|
| PHAN | Phanerophytes: trees and shrubs over 0.5 m tall |
| MEGAPHAN | Megaphanerophytes: trees over 5 m tall |
| EVERGR MEGAPHAN | Evergreen megaphanerophytes: deciduous trees over 5 m tall |
| DECID MEGAPHAN | Deciduous megaphanerophytes: evergreen trees over 5 m tall |
| MICROPHAN | Microphanerophytes: smaller trees and arborescent shrubs, 0.5 to 5 m tall |
| EVERGR MICROPHAN | Evergreen microphanerophytes: evergreen, small trees or shrubs, 0.5 to 5 m tall |
| DECID MICROPHAN | Deciduous microphanerophytes: deciduous, small trees or shrubs, 0.5 to 5 m tall |
| CHAMAEPHYTES | Chamaephytes: shrubs typically less than 0.5 m tall |
| LIANAS | Lianas: woody vines that root in the ground, but support themselves by growing on other plants |
| HEMICRYPTOPHYTES | Hemicryptophytes: surface-deciduous and evergreen perennial herbs, with buds at soil level, protected by vegetative tuft, hardened base or crown, or similar structure |
| CRYPTO GEOPHYTES | Cryptophytic geophytes: species transitional between hemicrypto-phytes and geophytes, having both ground-level and subterranean perennating structures |
| GEOPHYTES | Geophytes: herbs with overwintering, subterranean meristems, including rhizomes, bulbs, corms, tubers, and taproots |
| AQUATIC GEOPHYTES | Aquatic geophytes: geophytes typically growing in water |
| THEROPHYTES | Therophytes: annual herbs, passing the unfavorable season as seeds |
| EPIPHYTES | Epiphytes: plants that germinate and root on other plants |
| THALLO-CHAM | Thallo-chamaephytes: perennial, non-vascular cryptogams, cushion or hummock-forming mosses, and fruticose lichens |
| ERR VASC HYDRO | Errant vascular hydrophytes: floating, aquatic herbs that are free-moving in the water, and not attached or rooted in the ground |

Table 3.9. Life-form categories. The system used is adapted from that of Raunkaier (1937), as presented by Mueller-Dombois and Ellenberg (1974).

| ABBREVIATION CODE | MEANING |
| --- | --- |
| **TREE** | Trees |
| TREE BROADLF DECID | Broadleaf deciduous tree |
| TREE BROADLF EVERG | Broadleaf evergreen tree |
| TREE PINNATE LEGUME | Pinnate leguminous tree |
| TREE NEEDLELF DECID | Needleleaf evergreen tree |
| TREE NEEDLELF EVERG | Needleleaf deciduous tree |
| **SHRUB** | Shrubs |
| SHRUB BROADLF DECID | Broadleaf deciduous shrub |
| SHRUB BROADLF EVERG | Broadleaf evergreen shrub |
| SHRUB SUFFRUTESCENT | Suffrutescent shrub, with upper parts of stems dying back in unfavorable seasons |
| SHRUB WOODY VINE | Woody vine |
| SHRUB PARASITIC | Parasitic shrub |
| **HERB** | |
| HERB FERN DECID | Deciduous fern |
| HERB GRAMIN PERENN | Perennial graminoid (grass, sedge, rush) |
| HERB GRAM S-ANN | Summer-annual graminoid |
| HERB PERENN DECID | Deciduous perennial forb (herb other than fern or graminoid) |
| HERB PERENN EVERG | Evergreen perennial forb |
| HERB W-ANN | Winter-annual forb |
| HERB S-ANN | Summer-annual forb |
| **OTHER** | Plant not classified within one of the preceding categories |

Table 3.10. Growth-form categories. The system used is adapted from that presented by Whittaker and Niering (1968).

## CHAPTER IV.

## THE VEGETATION OF STUDY AREA CAROLINA BAYS

### 4.1 Introduction

The overriding objective of this study was to describe and document the diversity of vegetation communities occurring in Carolina bay depressions in North and South Carolina, and then to relate that diversity to measured and observed variation in environmental parameters within the study area. In this Chapter, sampled Carolina bay communities are described in detail, and relationships between community types are discussed. Relationships between larger vegetation groups are the focus of Chapters 5 and 6.

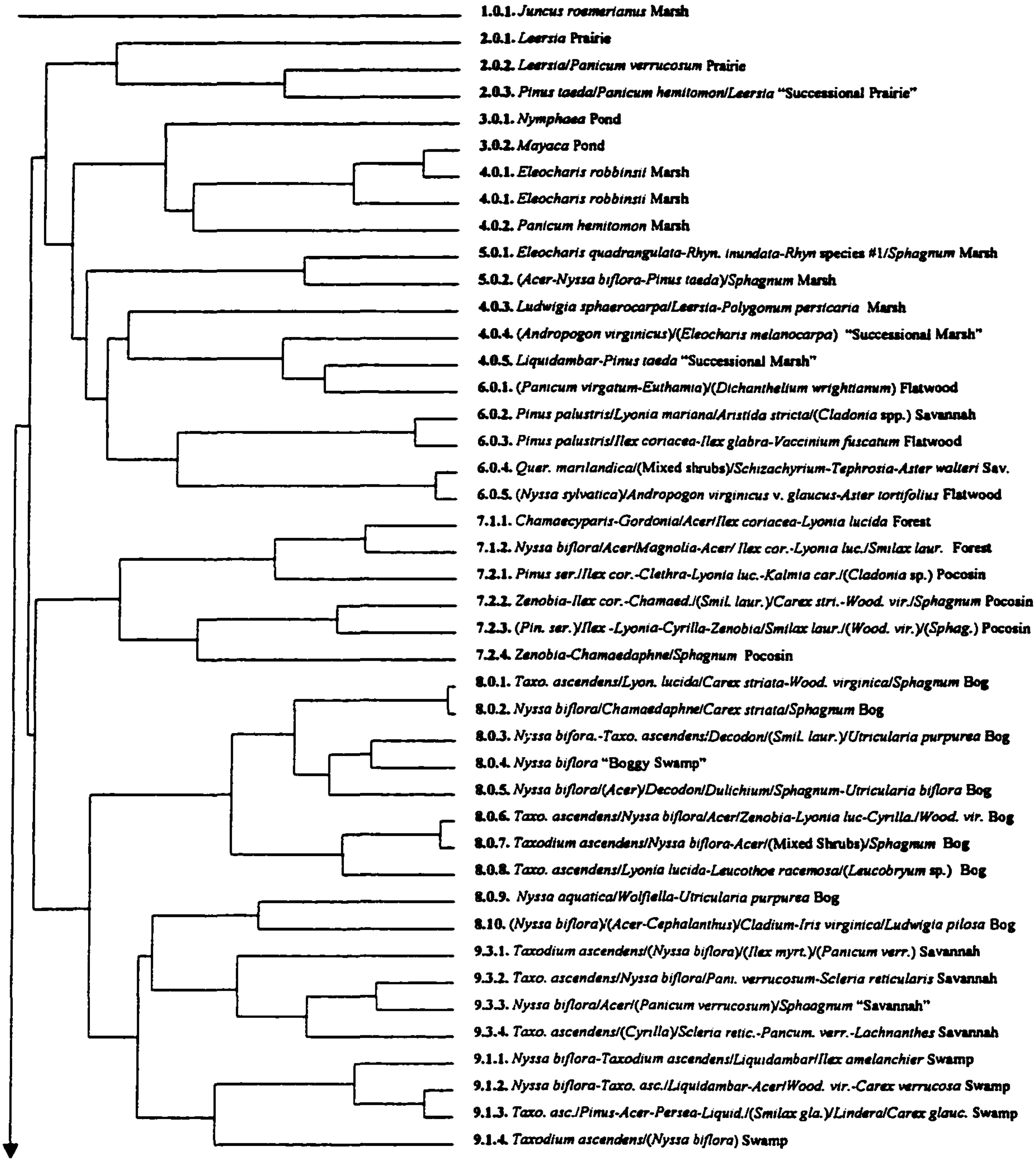
However, before vegetation units could be discussed meaningfully, it was necessary to define both those units and their relationship to each other. That task was accomplished using polythetic, hierarchical clustering techniques to identify stands with similar vegetational compositions, as described in Chapter 3 and discussed below.

### 4.2 Vegetation Community Classification

Carolina bays are a unique geomorphic landform that occur over a wide geographic area and across a broad range of landscapes. Consequently, bay depressions encompass a diverse array of southeastern United States wetland ecosystems and vegetation types. A classification of sampled vegetation was created using the Lance-Williams flexible-beta clustering method described in Chapter 3 (Figure 4.1; Table 4.1). Four-hundred seventy-eight of 482 intensively sampled plots and all 371 species encountered in the study were used in the classification. That analysis yielded a three-tier hierarchical classification scheme that recognizes some 9 vegetation classes, 6 vegetation subclasses, and 63 Carolina bay community types. At the broadest level, vegetation is grouped into nine vegetation classes that embrace a broad range of southeastern wetland vegetation systems. Where intuitively or

Figure 4.1. Dendogram showing divisions and final vegetation groupings identified for study area Carolina bay plots, using the Bray-Curtis dissimilarity measure in the Lance-Williams clustering technique. 478 of 482 intensively sampled plots were used, excluding 4 "Brackish Marsh" stands. Consequently, the Brackish Marsh vegetation class is shown on the diagram as not being connected to the main dendogram.

# CAROLINA BAY VEGETATION COMMUNITY TYPES



## CAROLINA BAY VEGETATION COMMUNITY TYPES (CONTINUED)

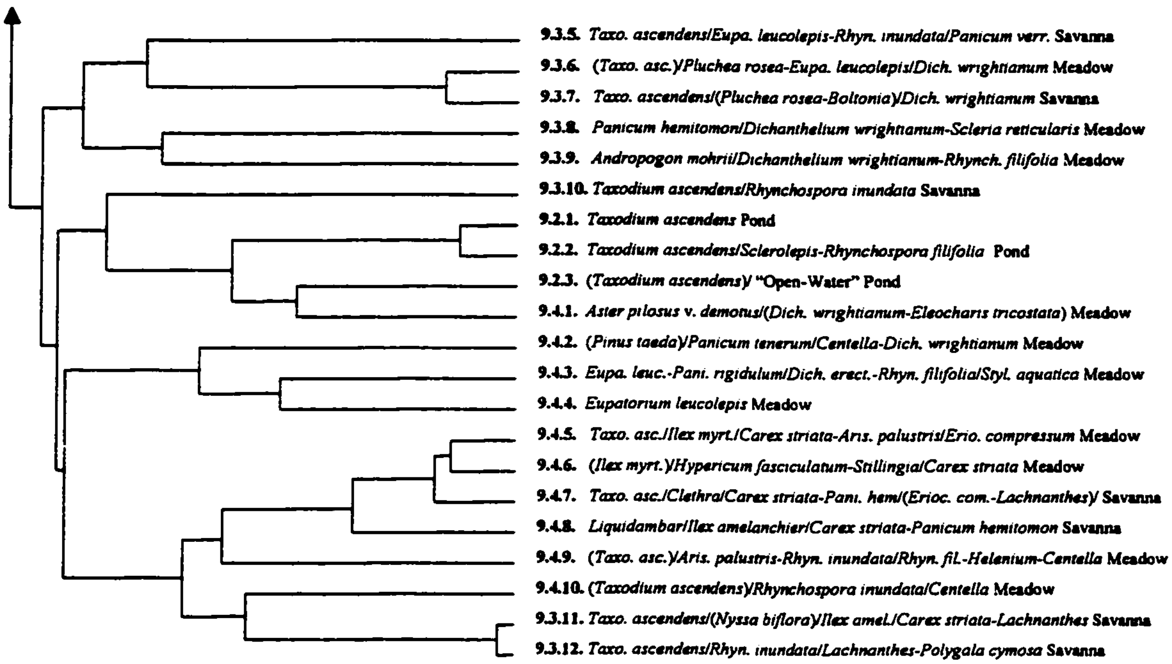


Table 4.1. Vegetation classes, subclasses and community types assigned in the final classification for sampled Carolina bay vegetational communities.

1. **BRACKISH MARSH**

1.0.1 *Juncus roemerianus* Marsh

2. **INTERMITTENTLY FLOODED DEPRESSION PRAIRIE**

2.0.1 *Leersia* Prairie
2.0.2 *Leersia/Panicum verrucosum* Prairie
2.0.3 *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie"

3. **FRESHWATER POND**

3.0.1 *Nymphaea* Pond
3.0.2 *Mayaca* Pond

4. **FRESHWATER MARSH**

4.0.1 *Eleocharis robbinsii* Marsh
4.0.2 *Panicum hemitomon* Marsh
4.0.3 *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh
4.0.4 (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marsh"
4.0.5 *Liquidambar-Pinus taeda* "Successional Marsh"

5. **BOGGY MARSH**

5.0.1 *Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marsh
5.0.2 (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh

6. **LONGLEAF PINE WOODLAND**

6.0.1 (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood
6.0.2 *Pinus palustris/Lyonia mariana/Aristida stricta*/(*Cladonia* spp.) Savanna
6.0.3 *Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwood
6.0.4 *Quercus marilandica*/(*Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa*)/ *Schizachyrium-Tephrosia-Aster walteri* Savanna
6.0.5 (*Nyssa sylvatica*)/*Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwood

7. **EVERGREEN SHRUB-BOG**

7.1. **BAY FOREST**

7.1.1. *Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest
7.1.2. *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/Smilax laurifolia* Forest

Table 4.1 (cont.). Vegetation classes, subclasses and community types assigned in the final classification for sampled Carolina bay vegetational communities.

7.2. **POCOSIN**

- 7.2.1. *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/(Cladonia* spp.) Pocosin
- 7.2.2. *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin
- 7.2.3. *(Pinus serotina)/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosin
- 7.2.4. *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin

**8. CYPRESS/GUM BOG**

- 8.0.1 *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog
- 8.0.2 *Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog
- 8.0.3 *Nyssa biflora-Taxodium ascendens/Decodon/(Smilax laurifolia)/Utricularia purpurea* Bog
- 8.0.4 *Nyssa biflora* "Boggy Swamp"
- 8.0.5 *Nyssa biflora/(Acer)/Decodon/Dulichium/Sphagnum* spp.-*Utricularia biflora* Bog
- 8.0.6 *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog
- 8.0.7 *Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.-*Zenobia)/ Sphagnum* spp. Bog
- 8.0.8 *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/(Leucobryum* spp.) Bog
- 8.0.9 *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog
- 8.0.10 *(Nyssa biflora)/(Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Bog

**9. INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION**

9.1. **CYPRESS/GUM SWAMP**

- 9.1.1 *Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp
- 9.1.2 *Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/Woodwardia virginica-Carex verrucosa* Swamp
- 9.1.3 *Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/Lindera/Smilax glauca/Carex glaucescens* Swamp
- 9.1.4 *Taxodium ascendens/(Nyssa biflora)* Swamp

9.2. **CYPRESS/GUM POND**

- 9.2.1 *Taxodium ascendens* Pond
- 9.2.2 *Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond
- 9.2.3 *(Taxodium ascendens)*/"Open-Water" Pond

9.3. **DRAWDOWN SAVANNA/MEADOW**

- 9.3.1 *Taxodium ascendens/(Nyssa biflora)/(Ilex myrtifolia)/(Panicum verrucosum)* Savanna
- 9.3.2 *Taxodium ascendens/Nyssa biflora/Panicum verrucosum-Scleria reticularis* Savanna
- 9.3.3 *Nyssa biflora/Acer/(Panicum verrucosum)/Sphagnum* spp. "Savanna"
- 9.3.4 *Taxodium ascendens/(Cyrilla)/Scleria reticularis-Panicum verrucosum-Lachnanthes* Savanna

**Table 4.1 (cont.). Vegetation classes, subclasses and community types assigned in the final classification for sampled Carolina bay vegetational communities.**

9.3.5 *Taxodium ascendens/Eupatorium leucolepis-Rhynchospora inundata/Panicum verrucosum* Savanna
9.3.6 (*Taxodium ascendens*)/*Pluchea rosea-Eupatorium leucolepis/Dichanthelium wrightianum* Meadow
9.3.7 *Taxodium ascendens/*(*Pluchea rosea-Boltonia*)/*Dichanthelium wrightianum* Savanna
9.3.8 *Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow
9.3.9 *Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow
9.3.10 *Taxodium ascendens/Rhynchospora inundata* Savanna
9.3.11 *Taxodium ascendens/*(*Nyssa biflora*)/*Ilex amelanchier/Carex striata-Lachnanthes* Savanna
9.3.12 *Taxodium ascendens/Rhynchospora inundata/Lachnanthes-Polygala cymosa* Savanna

9.4. **WET SAVANNA/MEADOW**

9.4.1 *Aster pilosus* var. *demotus/*(*Dichanthelium wrightianum-Eleocharis tricostata*) Meadow
9.4.2 (*Pinus taeda*)/*Panicum tenerum/Centella-Dichanthelium wrightianum* Meadow
9.4.3 *Eupatorium leucolepis-Panicum rigidulum* var. *combsii/Dichanthelium erectifolium-Rhynchospora filifolia/Stylisma aquatica* Meadow
9.4.4 *Eupatorium leucolepis* Meadow
9.4.5 *Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum* Meadow
9.4.6 (*Ilex myrtifolia*)/*Hypericum fasciculatum-Stillingia/Carex striata* Meadow
9.4.7 *Taxodium ascendens/Clethra/Carex striata-Panicum hemitomon/*(*Eriocaulon compressum-Lachnanthes*) Savanna
9.4.8 *Liquidambar/Ilex amelanchier/Carex striata-Panicum hemitomon* Savanna
9.4.9 (*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata/Rhynchospora filifolia-Helenium-Centella* Meadow
9.4.10 (*Taxodium ascendens*)/*Rhynchospora inundata/Centella* Meadow

logically helpful, vegetation classes are further subdivided into vegetation subclasses. Vegetation classes (or subclasses) contain one or more of the 63 community types identified by the classification analysis.

Each vegetation class (Figure 4.1, Table 4.1) is a broad grouping that embodies a range of community types that have general structural, floristic, and habitat similarities. Vegetation subclasses, where used, divide the vegetation class into groups of communities that while similar to other community types in the class when compared to Carolina bay vegetation as a whole, are distinct enough in character to merit subdivision treatment. Community types, the lowest level of the hierarchy, are the basic vegetation unit described. They are discrete, mappable units that are recognizable in the field in one to many Carolina bay depressions scattered across the landscape within the study area. Community type grouping within a vegetation class is based on membership in broader subdivisions of the Lance-Williams classification.

A standard strategy was used for naming community types derived from the classification. Only dominant species in each vegetation stratum of the community were used to name the community types. A "dominant species", in this context, is a species with both high constancy (≥75%) and consistently high cover (≥6). Where a layer exists wherein no species meets the threshold constancy and cover levels, but where one or more species has a constancy of ≥60% and cover of ≥5, the species name is enclosed in parentheses (). In the name of the community type, a '-' separates species present in the same vertical stratum, while a '/' separates species in different strata. There may be any number of strata, or layers, for both woody and herbaceous species in a community type name. Unless otherwise stated, species are listed in descending order of abundance, and strata by descending structural position, *i.e.*, canopy species always occur at the beginning of the name, and ground cover herb species at the end of the name. Scientific names are used, and are referred to by genus only unless more than one species in the genus was present within the study area.

### 4.3 Ecosystematic Description of Study Area Carolina Bay Vegetation

The concept of comparable descriptions of plant communities and their habitats is basic to the ecosystematic analysis of vegetation across landscapes (Radford *et al.*, 1981).

Consequently, in the section that follows a standard description scheme was employed to facilitate interpretation and comparison between vegetation group characteristics. The format is based on that used by Newell and Peet (1995), which they cite as being developed from Curtis (1959) and Rodwell (1991). Vegetation group descriptions are divided hierarchically by vegetation class, vegetation subclass (where present), and community type. After a brief introduction of the vegetation class (and vegetation subclass, where relevant), each community type is described in detail in the following sequence: (1) the community type is introduced by a unique name and identifying code; (2) synonymous names for the community type are listed within the "Synonymy" category, followed by *p.p* (*pro parte*) where the described group has only partial overlap with the synonymous descriptor; (3) constant species -- those with ≥ 75% frequency at the 0.1 ha level -- are set out; (4) nationally and regionally listed plant species -- *i.e.*, those species meriting special "protective" status according to Amoroso (1997) that occur within the community type -- are listed; (5) a detailed description of community dominants and physiognomy is provided, including plot species richness data [summarized for all vegetation groups in Table 4.2]; (6) features that distinguish the community type from other recognized vegetation groups are noted; (7) typical community habitat conditions and specific site factors are summarized; (8) the soils underlying the community types are described in detail; (9) disturbance, successional status, and probable future successional development are briefly described based on measured and anecdotal evidence; (10) the characteristic landscape position of the community type and its soils within the study area are identified [Tables 4.3 and 4.4, respectively; *see also*, Figure 2.3, above, regarding study area landscape surfaces]; (11) the spatial distribution and abundance of recognized community types are described [Table 4.5 summarizes each vegetation group recognized in terms of the number of sites (bays) in which it was found to occur, as well as the number of intensively sampled plots that comprise that group]; and (12) the conservation status of the community type is noted.

The "Analysis" section at the end of the description of community types within each vegetation class contrasts the community types identified within the class and compares them with similar vegetation groups in other Carolina bay or southeastern United States wetland studies. Included as a separate section in that analysis is a discussion of the environmental gradients prevalent within that vegetation class, and the relationship of community types to those gradients. For each vegetation class or subclass, that discussion includes a community gradient analysis based upon biplot vector diagrams produced for that vegetation class. The methodologies used to construct those diagrams is discussed in detail in Chapter 5, below. At the end of each vegetation group section, tables are provided that summarize community type floristic, structural, and environmental features for each vegetation class (and subclass, where applicable).

Table 4.2. Mean species richness per vegetation group at the 0.1 ha level. Species values are provided for each vegetation class, vegetation subclass, and community type sampled. Each vegetation group is represented by its abbreviation code (see text for explanation).

| OBS. # | VEGETATION GROUP | MEAN SPECIES RICHNESS |
|---|---|---|
| 1 | 1.0.1 | 1.0000 |
| 2 | 2. | 6.4388 |
| 3 | 2.0.1 | 2.6863 |
| 4 | 2.0.2 | 7.2326 |
| 5 | 2.0.3 | 8.5254 |
| 6 | 3. | 7.0789 |
| 7 | 3.0.1 | 7.1754 |
| 8 | 3.0.2 | 6.7895 |
| 9 | 4.0. | 7.1551 |
| 10 | 4.0.1 | 7.1429 |
| 11 | 4.0.2 | 3.1333 |
| 12 | 4.0.3 | 7.9153 |
| 13 | 4.0.4 | 6.9111 |
| 14 | 4.0.5 | 8.7455 |
| 15 | 5. | 14.9320 |
| 16 | 5.0.1 | 14.7391 |
| 17 | 5.0.2 | 15.0877 |
| 18 | 6.0. | 31.1572 |
| 19 | 6.0.1 | 22.9048 |
| 20 | 6.0.2 | 11.5217 |
| 21 | 6.0.3 | 17.0597 |
| 22 | 6.0.4 | 46.4820 |
| 23 | 6.0.5 | 36.6997 |
| 24 | 7. | 15.9236 |
| 25 | 7.1. | 14.2824 |
| 26 | 7.1.1 | 14.8475 |
| 27 | 7.1.2 | 13.0000 |
| 28 | 7.2 | 16.3496 |
| 29 | 7.2.1 | 21.4762 |
| 30 | 7.2.2 | 14.7803 |
| 31 | 7.2.3 | 15.7967 |
| 32 | 7.2.4 | 9.6765 |
| 33 | 8. | 18.5631 |
| 34 | 8.0.1 | 26.6038 |
| 35 | 8.0.2 | 16.5455 |
| 36 | 8.0.3 | 22.8462 |
| 37 | 8.0.4 | 8.6364 |
| 38 | 8.0.5 | 11.9778 |
| 39 | 8.0.6 | 19.6410 |
| 40 | 8.0.7 | 20.3595 |
| 41 | 8.0.8 | 7.7742 |
| 42 | 8.0.9 | 10.4634 |
| 43 | 8.0.10 | 15.6557 |

Table 4.2 (cont.). Mean species richness per vegetation group at the 0.1 ha level. Species values are provided for each vegetation class, vegetation subclass, and community type sampled. Each vegetation group is represented by its abbreviation code (see text for explanation).

| OBS. # | VEGETATION GROUP | MEAN SPECIES RICHNESS |
|---|---|---|
| 44 | 9. | 17.4066 |
| 45 | 9.1. | 16.4924 |
| 46 | 9.1.1 | 22.2558 |
| 47 | 9.1.2 | 8.8286 |
| 48 | 9.1.3 | 13.8519 |
| 49 | 9.1.4 | 16.1050 |
| 50 | 9.2. | 9.1698 |
| 51 | 9.2.1 | 2.5000 |
| 52 | 9.2.2 | 11.0323 |
| 53 | 9.2.3 | 8.0625 |
| 54 | 9.3. | 13.7959 |
| 55 | 9.3.1 | 9.5135 |
| 56 | 9.3.2 | 14.8305 |
| 57 | 9.3.3 | 9.5946 |
| 58 | 9.3.4 | 13.2353 |
| 59 | 9.3.5 | 19.2456 |
| 60 | 9.3.6 | 12.1277 |
| 61 | 9.3.7 | 15.2583 |
| 62 | 9.3.8 | 10.3168 |
| 63 | 9.3.9 | 15.4643 |
| 64 | 9.3.10 | 8.4109 |
| 65 | 9.3.11 | 15.0000 |
| 66 | 9.3.12 | 14.5854 |
| 67 | 9.4. | 22.2652 |
| 68 | 9.4.1 | 12.3889 |
| 69 | 9.4.2 | 16.0744 |
| 70 | 9.4.3 | 19.3947 |
| 71 | 9.4.4 | 15.1013 |
| 72 | 9.4.5 | 31.0968 |
| 73 | 9.4.6 | 33.5672 |
| 74 | 9.4.7 | 24.2500 |
| 75 | 9.4.8 | 19.9620 |
| 76 | 9.4.9 | 27.6912 |
| 77 | 9.4.10 | 18.3706 |

Table 4.3. SUMMARY OF CAROLINA BAY VEGETATION GROUPS BY LANDSCAPE POSITION.

| | LANDSCAPE POSITION | | | | |
|---|---|---|---|---|---|
| | Inner Lower Coastal Plain | Major River Valleys & Floodplains | Middle Coastal Plain | Outer Lower Coastal Plain | Upper Coastal Plain |
| | % | % | % | % | % |
| VEGETATION GROUP: | | | | | |
| 1. BRACKISH MARSH | . | . | . | 100 | . |
| 1.0.1 *Juncus roemerianus* Marsh | . | . | . | 100 | . |
| 2. INTERMITTENTLY FLOODED DEPRESSION PRAIRIE | . | . | 91 | . | 9 |
| 2.0.1 *Leersia* Prairie | . | . | 81 | . | 19 |
| 2.0.2 *Leersia/Panicum verrucosum* Prairie | . | . | 100 | . | . |
| 2.0.3 *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie" | . | . | 100 | . | . |
| 3. FRESHWATER POND | 27 | . | 73 | . | . |
| 3.0.1 *Nymphaea* Pond | . | . | 100 | . | . |
| 3.0.2 *Mayaca* Pond | 100 | . | . | . | . |
| 4. FRESHWATER MARSH | . | . | 70 | . | 30 |
| 4.0.1 *Eleocharis robbinsii* Marsh | . | . | 100 | . | . |
| 4.0.2 *Panicum hemitomon* Marsh | . | . | 100 | . | . |
| 4.0.3 *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh | . | . | . | . | 100 |
| 4.0.4 (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*)"Successional Marsh" | . | . | 29 | . | 71 |
| 4.0.5 *Liquidambar-Pinus taeda* "Successional Marsh" | . | . | 100 | . | . |
| 5. BOGGY MARSH | 11 | . | 17 | 72 | . |
| 5.0.1 *Eleocharis quadranagulata-Rhynchospora inundata*-Rhynchospora sp. #1/*Sphagnum* spp. Marsh | . | . | . | 100 | . |
| 5.0.2 (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh | 20 | . | 30 | 50 | . |
| 6. LONGLEAF PINE WOODLAND | . | . | 57 | . | 43 |
| 6.0.1 (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrigtianum*) Flatwood | . | . | 55 | . | 45 |
| 6.0.2 *Pinus palustris/Lyonia mariana/Aristida stricta*/(*Cladonia* sp.) Savannah | . | . | . | . | 100 |

| | | | | | |
|---|---|---|---|---|---|
| 6.0.3 *Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwood | . | . | . | . | 100 |
| 6.0.4 *Quercus marilandica*/(Mixed Shrubs)/*Schizachyrium-Tephrosia* Savannah | . | . | 100 | . | . |
| 6.0.5 (*Nyssa sylvatica*)/*Andropogon virginicus-Aster tortifolius* Flatwood | . | . | 100 | . | . |
| 7. EVERGREEN SHRUB-BOG | 29 | 57 | . | 14 | . |
| 7.1. *BAY FOREST* | . | 100 | . | . | . |
| 7.1.1 *Chamaecyparis-Gordonia*/(*Acer*)/*Ilex coriacea-Lyonia lucida* Forest | . | 100 | . | . | . |
| 7.1.2 *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia ludica/Smilax laurifolia* Forest | . | 100 | . | . | . |
| 7.2. *POCOSIN* | 36 | 45 | . | 18 | . |
| 7.2.1 *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina*/(*Cladonia* sp.) Pocosin | . | 100 | . | . | . |
| 7.2.2 *Zenobia-Ilex coriacea-Chamaedaphne*/(*Smilax laurifolia*)/*Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin | 33 | 33 | . | 33 | . |
| 7.2.3 (*Pinus serotina*)/*Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia*/(*Woodwardia virginica*)/(*Sphagnum*) Pocosin | 75 | . | . | 25 | . |
| 7.2.4 *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin | . | 100 | . | . | . |
| 8. CYPRESS/GUM BOG | 27 | 9 | 55 | 9 | . |
| 8.0.1 *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog | . | . | . | 100 | . |
| 8.0.2 *Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog | . | . | 100 | . | . |
| 8.0.3 *Nyssa biflora-Taxodium ascendens/Decodon*/(*Smilax laurif.*)/*Utricularia purpurea* Bog | . | . | 100 | . | . |
| 8.0.4 *Nyssa biflora* "Boggy Swamp" | . | . | 100 | . | . |
| 8.0.5 *Nyssa biflora*/(*Acer*)/*Decodon/Dulichium/Sphagnum-Utricularia biflora* Bog | 100 | . | . | . | . |
| 8.0.6 *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog | . | . | 100 | . | . |
| 8.0.7 *Taxodium ascendens/Nyssa biflora-Acer*/(Mixed Shrubs)/*Sphagnum* spp. Bog | 50 | . | 50 | . | . |
| 8.0.8 *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa*/(*Leucobryum* sp.) Bog | . | 100 | . | . | . |
| 8.0.9 *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog | . | . | 100 | . | . |
| 8.10 (*Nyssa biflora*)/(*Acer-Cephalanthus*)/*Cladium-Iris virginica/Ludwigia pilosa* Bog | 100 | . | . | . | . |

| | | | | | |
|---|---|---|---|---|---|
| 9. INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION | . | . | 96 | 2 | 2 |
| 9.1. *CYPRESS/GUM SWAMP* | . | . | 96 | . | 4 |
| 9.1.1 *Nyssa biflora-Taxodium ascendens/ Liquidambar/Ilex amelanchier* Swamp | . | . | 100 | . | . |
| 9.1.2 *Nyssa biflora-Taxodium ascendens/ Liquidambar-Acer/Woodwardia virginica- Carex verrucosa* Swamp | . | . | 100 | . | . |
| 9.1.3 *Taxodium ascendens/Pinus taeda-Acer- Persea-Liquidambar/Lindera/Smilax glauca/ Carex glaucescens* Swamp | . | . | 100 | . | . |
| 9.1.4 *Taxodium ascendens/(Nyssa biflora)* Swamp | . | . | 94 | . | 6 |
| 9.2. *CYPRESS/GUM POND* | . | . | 100 | . | . |
| 9.2.1 *Taxodium ascendens* Pond | . | . | 100 | . | . |
| 9.2.2 *Taxodium ascendens/Sclerolepis- Rhynchospora filifolia* Pond | . | . | 100 | . | . |
| 9.2.3 (*Taxodium ascendens*)/"Open-Water" Pond | . | . | 100 | . | . |
| 9.3. *DRAWDOWN SAVANNAH/MEADOW* | . | . | 97 | . | 3 |
| 9.3.1 *Taxodium ascendens/(Nyssa biflora)/(Ilex myrtifolia)/(Panicum verrucosum)* Savanna | . | . | 100 | . | . |
| 9.3.2 *Taxodium ascendens/Nyssa biflora/Panicum verrucosum-Scleria reticularis* Savanna | . | . | 100 | . | . |
| 9.3.3 *Nyssa biflora/Acer/(Panicum verrucosum) Sphagnum* spp. "Savanna" | . | . | 100 | . | . |
| 9.3.4 *Taxodium ascendens/(Cyrilla)/Scleria reticularis-Panicum verrucosum- Lachnanthes* Savanna | . | . | . | . | 100 |
| 9.3.5 *Taxodium ascendens/Eupatorium leucolepis- Rhynchospora inundata/Panicum verrucosum* Savanna | . | . | 100 | . | . |
| 9.3.6 (*Taxodium ascendens*)/*Pluchea rosea- Eupatorium leucolepis/Dichanthelium wrightianum* Meadow | . | . | 100 | . | . |
| 9.3.7 *Taxodium ascendens/(Pluchea roaea-Boltonia) Dichanthelium wrightianum* Savanna | . | . | 100 | . | . |
| 9.3.8 *Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow | . | . | 100 | . | . |
| 9.3.9 *Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow | . | . | 100 | . | . |
| 9.3.10 *Taxodium ascendens/Rhynchospora inundata* Savanna | . | . | 100 | . | . |
| 9.3.11 *Taxodium ascendens/(Nyssa biflora)/Ilex amelanchier/Carex striata-Lachnanthes* Savanna | . | . | 100 | . | . |
| 9.3.12 *Taxodium ascendens/Rhynchospora inundata/ Lachnanthes-Polygala cymosa* Savannah | . | . | 100 | . | . |

| | | | | | |
|---|---|---|---|---|---|
| 9.4. *WET SAVANNAH/MEADOW* | . | . | 94 | 6 | . |
| 9.4.1 *Aster pilosus* var. *demotus*/(*Dichanthelium wrightianum-Eleocharis tricostata*) Meadow | . | . | 100 | . | . |
| 9.4.2 (*Pinus taeda*)/*Panicum tenerum/Centella-Dichanthelium srightianum* Meadow | . | . | 100 | . | . |
| 9.4.3 *Eupatorium leucolepis-Panicum rigidulum* var. *combsii/Dichanthelium erectifolium-Rhynchospora filifolia/Stylisma aquatica* Meadow | . | . | 100 | . | . |
| 9.4.4 *Eupatorium leucolepis* Meadow | . | . | 100 | . | . |
| 9.4.5 *Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum* Meadow | . | . | 100 | . | . |
| 9.4.6 (*Ilex myrtifolia*)*Hypericum fasciculatum-Stillingia/Carex striata* Meadow | . | . | 100 | . | . |
| 9.4.7 *Taxodium ascendens/Clethra/Carex striata-Panicum hemitomon*/(*Eriocaulon compressum-Lachnanthes*) Savannah | . | . | . | 100 | . |
| 9.4.8 *Liquidambar/Ilex amelanchier/Carex striata-Panicum hemitomon* Savannah | . | . | 100 | . | . |
| 9.4.9 (*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata/Rhynchospora filifolia-Helenium-Centella* Meadow | . | . | 100 | . | . |
| 9.4.10 (*Taxodium ascendens*)/*Rhynchospora inundata/Centella* Meadow | . | . | 100 | . | . |

Table 4.4. SUMMARY OF CAROLINA BAY SOILS FAMILY FREQUENCIES BY LANDSCAPE POSITION.

| | LANDSCAPE POSITION | | | | |
|---|---|---|---|---|---|
| | Inner Lower Coastal Plain | Major River Valleys & Floodplains | Middle Coastal Plain | Outer Lower Coastal Plain | Upper Coastal Plain |
| | % | % | % | % | % |
| SOIL FAMILY: | | | | | |
| Sandy, siliceous, thermic Typic Haplaquods, "argillic" variant | . | . | 80 | . | 20 |
| Fine-loamy, siliceous, thermic Typic Paleaquults | . | . | 88 | . | 12 |
| Clayey, kaolonitic, thermic Typic Paleaquults | . | . | 100 | . | . |
| Loamy, siliceous, thermic Arenic Paleaquults | . | . | 100 | . | . |
| Fine-loamy, siliceous, thermic Umbric Paleaquults | . | . | 100 | . | . |
| Fine-loamy, siliceous, thermic Typic Ochraquults | . | . | . | . | 100 |
| Fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquults | . | . | 100 | . | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | . | . | 100 | . | . |
| Fine-loamy, siliceous, thermic Aquic Paleudults | . | . | 100 | . | . |
| Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemists | 33 | . | 67 | . | . |
| Dysic, thermic Typic Medisaprists | . | 50 | . | 50 | . |
| Fine-loamy, siliceous, thermic Umbric Paleaquults, "mucky" variant | . | . | 100 | . | . |
| Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists | 22 | 56 | 22 | . | . |
| Loamy, siliceous, dysic, thermic Terric Medisaprists | 100 | . | . | . | . |
| Loamy, mixed, dysic, thermic Terric Medisaprists | . | 100 | . | . | . |
| Sandy, mixed, euic, thermic Terric Medisaprists | 100 | . | . | . | . |
| Mixed, thermic Typic Psammaquents | 43 | . | . | 57 | . |
| Siliceous, thermic, Typic Psammaquents/Loamy, siliceous, thermic Grossarenic Paleaquults | . | . | . | . | 100 |
| Sandy, siliceous, thermic Typic Haplaquods | 8 | 16 | 26 | 50 | . |
| Sandy, siliceous, thermic Aeric Haplaquods | . | . | . | . | 100 |

Table 4.5. Number of sites and intensively sampled plots for each identified study area Carolina bay vegetation group.

| VEGETATION GROUP | NUMBER SITES | NUMBER PLOTS |
|---|---|---|
| **1. BRACKISH MARSH** | **1** | **4** |
| 1.0.1 *Juncus roemerianus* Marsh | 1 | 4 |
| **2. INTERMITTENTLY FLOODED DEPRESSION PRAIRIE** | **4** | **43** |
| 2.0.1 *Leersia* Prairie | 3 | 21 |
| 2.0.2 *Leersia/Panicum verrucosum* Prairie | 2 | 14 |
| 2.0.3 *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie" | 1 | 8 |
| **3. FRESHWATER POND** | **2** | **11** |
| 3.0.1 *Nymphaea* Pond | 1 | 8 |
| 3.0.2 *Mayaca* Pond | 1 | 3 |
| **4. FRESHWATER MARSH** | **9** | **43** |
| 4.0.1 *Eleocharis robbinsii* Marsh | 2 | 9 |
| 4.0.2 *Panicum hemitomon* Marsh | 5 | 11 |
| 4.0.3 *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh | 1 | 8 |
| 4.0.4 (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marsh" | 2 | 7 |
| 4.0.5 *Liquidambar styraciflua-Pinus taeda* "Successional Marsh" | 3 | 8 |
| **5. BOGGY MARSH** | **2** | **18** |
| 5.0.1 *Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* sp./*Sphagnum* spp. Marsh | 1 | 8 |
| 5.0.2 (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh | 2 | 10 |
| **6. LONGLEAF PINE WOODLAND** | **4** | **30** |
| 6.0.1 (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood | 3 | 11 |
| 6.0.2 *Pinus palustris/Lyonia mariana/Aristida stricta*/(*Cladonia* spp.) Savanna | 1 | 4 |
| 6.0.3 *Pinus palustris/Ilex coriacea-Ilex glabra* Flatwood | 1 | 4 |
| 6.0.4 *Quercus marilandica*/(*Rhododendron atlanticum-Vaccinium* sp.-*Gaylusaccia dumosa*)/ *Schizachyrium-Tephrosia-Aster walteri* Savanna | 1 | 3 |
| 6.0.5 (*Nyssa sylvatica*)/*Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwood | 1 | 8 |
| **7. EVERGREEN SHRUB-BOG** | **14** | **56** |
| **7.1. BAY FOREST** | **3** | **12** |
| 7.1.1 *Chamaecyparis-Gordonia*/(*Acer*)/*Ilex coriacea-Lyonia lucida* Forest | 2 | 8 |
| 7.1.2 *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida*/(*Smilax laurifolia*) Forest | 1 | 4 |

| VEGETATION GROUP | NUMBER SITES | NUMBER PLOTS |
|---|---|---|
| 7.2. POCOSIN | **11** | **44** |
| 7.2.1 *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/*(*Cladonia* spp.) Pocosin | 2 | 8 |
| 7.2.2 *Zenobia-Ilex coriacea-Chamaedaphne/*(*Smilax laurifolia*)*/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin | 3 | 12 |
| 7.2.3 (*Pinus serotina*)*/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/*(*Smilax laurifolia*)/ (*Woodwardia virginica*)/(*Sphagnum* spp.) Pocosin | 4 | 16 |
| 7.2.4 *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin | 2 | 8 |
| 8. CYPRESS/GUM BOG | **11** | **44** |
| 8.0.1 *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog | 1 | 4 |
| 8.0.2 *Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog | 1 | 4 |
| 8.0.3 *Nyssa biflora-Taxodium ascendens/Decodon/*(*Smilax laurifolia*)*/Utricularia purpurea* Bog | 1 | 4 |
| 8.0.4 *Nyssa biflora* "Boggy Swamp" | 1 | 4 |
| 8.0.5 *Nyssa biflora/*(*Acer*)*/Decodon/Dulichium/Sphagnum* spp.-*Utricularia biflora* Bog | 1 | 4 |
| 8.0.6 *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog | 1 | 4 |
| 8.0.7 *Taxodium ascendens/Nyssa biflora-Acer/*(*Leucothoe racemosa-Vaccinium* spp.-*Zenobia*)*/Sphagnum* spp. Bog | 2 | 8 |
| 8.0.8 *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/*(*Leucobryum* spp.) Bog | 1 | 4 |
| 8.0.9 *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog | 1 | 4 |
| 8.0.10 (*Nyssa biflora*)/(*Acer-Cephalanthus*)*/Cladium-Iris virginica/Ludwigia pilosa* Bog | 1 | 4 |
| 9. INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION | **25** | **231** |
| 9.1. CYPRESS/GUM SWAMP | **14** | **28** |
| 9.1.1 *Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp | 1 | 4 |
| 9.1.2 Nyssa *biflora-Taxodium ascendens/Liquidambar-Acer/Woodwardia virginica-Carex verrucosa* Swamp | 1 | 4 |
| 9.1.3 *Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/Lindera/*(*Smilax glauca*)/ (*Carex glaucescens*) Swamp | 1 | 4 |
| 9.1.4 *Taxodium ascendens/*(*Nyssa biflora*) Swamp | 11 | 16 |
| 9.2. CYPRESS/GUM POND | **2** | **15** |
| 9.2.1 *Taxodium ascendens* Pond | 1 | 5 |
| 9.2.2 *Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond | 1 | 6 |
| 9.2.3 (*Taxodium ascendens*)/"Open-Water" Pond | 1 | 4 |

| VEGETATION GROUP | NUMBER SITES | NUMBER PLOTS |
|---|---|---|
| **9.3. DRAWDOWN SAVANNA/MEADOW** | **8** | **118** |
| 9.3.1 *Taxodium ascendens*/(*Nyssa biflora*)/(*Ilex myrtifolia*)/(*Panicum verrucosum*) Savanna | 1 | 8 |
| 9.3.2 *Taxodium ascendens*/*Nyssa biflora*/*Panicum verrucosum-Scleria reticularis* Savanna | 1 | 4 |
| 9.3.3 *Nyssa biflora*/*Acer*/(*Panicum verrucosum*)/*Sphagnum* spp. "Savanna" | 1 | 4 |
| 9.3.4 *Taxodium ascendens*/(*Cyrilla*)/*Scleria reticularis-Panicum verrucosum-Lachnanthes* Savanna | 1 | 4 |
| 9.3.5 *Taxodium ascendens*/*Eupatorium leucolepis-Rhynchospora inundata*/*Panicum verrucosum* Savanna | 1 | 12 |
| 9.3.6 (*Taxodium ascendens*)/*Pluchea rosea-Eupatorium leucolepis*/*Dichanthelium wrightianum* Meadow | 1 | 16 |
| 9.3.7 *Taxodium ascendens*/(*Pluchea rosea-Boltonia*)/*Dichanthelium wrightianum* Savanna | 1 | 16 |
| 9.3.8 *Panicum hemitomon*/*Dichanthelium wrightianum-Scleria reticularis* Meadow | 1 | 16 |
| 9.3.9 *Andropogon mohrii*/*Dichanthelium wrightianum-Rhynchospora filifolia* Meadow | 1 | 11 |
| 9.3.10 *Taxodium ascendens*/*Rhynchospora inundata* Savanna | 1 | 19 |
| 9.3.11 *Taxodium ascendens*/(*Nyssa biflora*)/*Ilex amelanchier*/*Carex striata-Lachnanthes* Savanna | 1 | 4 |
| 9.3.12 *Taxodium ascendens*/*Rhynchospora inundata*/*Lachnanthes-Polygala cymosa* Savanna | 1 | 4 |
| **9.4. WET SAVANNA/MEADOW** | **9** | **70** |
| 9.4.1 *Aster pilosus* var. *demotus*/(*Dichanthelium wrightianum-Eleocharis tricostata*) Meadow | 1 | 7 |
| 9.4.2 (*Pinus taeda*)/*Panicum tenerum*/*Centella-Dichanthelium wrightianum* Meadow | 1 | 8 |
| 9.4.3 *Eupatorium leucolepis-Panicum rigidulum* var. *combsii*/*Dichanthelium erectifolium-Rhynchospora filifolia*/*Stylisma* Meadow | 1 | 8 |
| 9.4.4 *Eupatorium leucolepis* Meadow | 1 | 12 |
| 9.4.5 *Taxodium ascendens*/*Ilex myrtifolia*/*Carex striata-Aristida palustris*/*Eriocaulon* compressum Meadow | 1 | 4 |
| 9.4.6 (*Ilex myrtifolia*)/*Hypericum fasciculatum-Stillingia*/*Carex striata* Meadow | 1 | 4 |
| 9.4.7 *Taxodium ascendens*/*Clethra*/*Carex striata-Panicum hemitomon*/(*Eriocaulon compressum-Lachnanthes*) Savanna | 1 | 4 |
| 9.4.8 *Liquidambar*/*Ilex amelanchier*/*Carex striata-Panicum hemitomon* Savanna | 1 | 4 |
| 9.4.9 (*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata*/*Rhynchospora filifolia-Helenium-Centella* Meadow | 1 | 8 |
| 9.4.10 (*Taxodium ascendens*)/*Rhynchospora inundata*/*Centella* Meadow | 1 | 11 |

### 4.3.1 VEGETATION CLASS: **Brackish Marsh (1.)**

The Brackish Marsh vegetation class is common in near coast and estuarine areas throughout the study area. Brackish marshes generally inhabit the slightly raised flats and depressions immediately adjacent to brackish coastal waters. Such marshes are generally dominated by dense, often pure stands of Black Needlerush, *Juncus roemerianus*, though other community types may be present. *Juncus roemerianus* marsh was the only Brackish Marsh community type encountered within sampled Carolina bays. While subject to frequent inundation by wind and storm tides, brackish marshes are not subject to the diurnal flooding characteristic of the elevationally lower coastal salt marshes dominated by *Spartina alterniflora*. Photographs of this vegetation class appear in Plate 2, following Chapter 7 below.

#### 4.3.1.1 COMMUNITY TYPE: ***Juncus roemerianus* Marsh (1.0.1)**

(1) Synonymy

Brackish Marsh *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.6)

*Juncus roemerianus.*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type comprises a homogenous, single layer herbaceous community devoid of overlying woody strata. A dense, essentially pure stand of *Juncus roemerianus* predominates and the mineral substrate is only rarely exposed, generally being covered by a thick detrital mat composed of dead *Juncus* stems and leaves. Other species occurring within the brackish marsh adjacent to, but not in the sampled plot, included *Distichlis spicata, Kolsteletskya virginica, Ipomea sagittata, Lythrum lineare, Solidago sempervirens,* and *Fimbristylis castanea.*

This community type had the lowest mean species richness sampled at the 0.1 ha level, at 1.00 species (Table 4.2).

(5) Distinguishing Features

This community type inhabits both the lowest elevational position and location most proximate to the Atlantic Ocean among Carolina bay vegetation types. While one of several graminoid-dominated, herbaceous community types found within Carolina bays, it is the only of those communities dominated by either a single graminoid species or a halophytic species.

(6) Habitat

This community type inhabits regularly flooded flats and relatively small (*ca.* 8.43 ha) depressions immediately adjacent to salty or brackish coastal waters (Table 4.7). Elevation is 0.5 m or less, and water generally stands at or above the surface year-round (water stood to 8 cm in depth at time of sampling of this community type). The frequency of flooding is variable, occurring both as the result of storm and wind tides, but normally, not as the result of lunar tides.

(7) Soils

This community type is found over very poorly drained, mixed, thermic Typic Psammaquent soils within the study area (Table A-II-1). Psammaquents are wet, sandy-textured, recently formed soils that have little or no evidence of development of pedogenic horizons (Soil Survey Staff, 1975). A brief description of this soil, as sampled within this community type, is provided in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Soil pH for this community type is very strongly acid (4.55) surficially, ranging to only slightly acid (6.18) at 50 cm. This range likely reflects the effects of organic matter build-up and decomposition at the surface, given the mixed mineralogy of local sediments from the input of calcic shell materials. The CEC is relatively high throughout the soil profile, and its base saturation was the highest encountered in sampled communities, indicating a relative abundance of soil nutrients within this community type. Soil "humic matter"content is the percentage of the organic matter component of the soil that has decomposed to form chemically active compounds known as humic and fulvic acids (NCDA, 1995). Within the soil underlying this community type, humic matter content increases substantially with depth. Soil bulk density (weight per unit volume) is moderate in the surface layers, where organic matter content is relatively high, and increases with depth. Silt-sized particles predominate at the surface, but sand-sized particles dominate the mineral fraction of the soil below. While not measured in this study, salt concentrations in these soils typically range from 15 to 30 parts per thousand (Goodwin, 1986).

Soils in the area of this community were erroneously mapped by the United States Department of Agriculture's Soil Conservation Service as organic mucks, specifically, as euic, thermic Typic Medisaprists. The error was apparently based on the logistic difficulty of sampling relatively remote wetlands soils and upon reliance on predominant surface vegetation as an indicator of underlying soil properties, given that the mapped soil type is generally characterized by the presence of *Juncus roemerianus* marsh (Goodwin, 1986).

(8) Succession & Disturbance

This community is located in an area of relatively abundant Carolina bays dominated by "pocosin" type vegetation occurring over Spodosols (*see* discussion of soils for vegetation groups "Boggy Marsh" and "Pocosin", below) that developed in wet, sandy sediments. Moreover, estuarine beaches in the area are commonly dotted with exposed *Pinus* spp. "stumps", indicating the former presence of forest communities in areas now covered with water. An examination of the soil profile information for this community type indicates that this brackish marsh occurs over shallow, sandy surficial sediments that may have been deposited over a pre-existing Spodosol. Taken together, these factors suggest that this community type has resulted from an historic, long-term encroachment of coastal waters over the peninsula where the community type is located.

This community type is subject to disturbance by wind and wave action resulting from hurricanes and other large storms in a manner not relevant to other Carolina bay communities. Fire has also been an historically important factor in maintaining *Juncus roemerianus* Marshes in North Carolina, and they are believed to have burned on a regular cycle under natural conditions (DEHNR, 1996). While no evidence of recent fires was observed within this community, evidence of recent fires is abundant within the pine-dominated communities immediately adjacent to this community type. Brackish marshes are occasionally used as pasture for livestock, and evidence of such use was observed in the area of the depression containing this community.

(9) Landscape Position

This community type is found only immediately adjacent to brackish, coastal estuarine waters, and is thus limited to Carolina bays located in the extreme Outer Lower Coastal Plain (Table 4.3). *Juncus roemerianus* Marshes make up 12 percent of sampled Carolina bay vegetation found within the Outer Lower Coastal Plain, and mixed, thermic Typic Psammaquents comprise 1 of 3 soil families found within sampled Carolina bays located on that surface (Table 4.4).

(10) Distribution & Abundance

Both this community type and its vegetation class are generally limited in distribution in the Carolinas, occurring only immediately adjacent to coastal estuarine waters (Table 4.5). It is even more limited within the context of Carolina bay wetlands. Only one Carolina bay exhibiting a brackish marsh community -- located in the northeastern portion of the study area -- is known from the Carolinas. Consequently, only 4 of 482 intensively sampled plots (0.8%) fall within this community type. While the study area did not include Virginia, Carolina bays vegetated by brackish marshes apparently are present to a limited extent on the southeastern-most barrier islands in that State (Bliley and Petrie, 1979).

(11) Conservation Status

An example of this community type and vegetation class within a Carolina Bay is not known to be currently protected either within the study area or throughout the range of Carolina bays.

4.3.1.2 ANALYSIS

The Brackish Marsh vegetation class is widespread along the eastern seaboard, and is very common in coastal North Carolina (DEHNR, 1996). It was, however, unknown in Carolina bays prior to this study (*see* Figure 4.2).

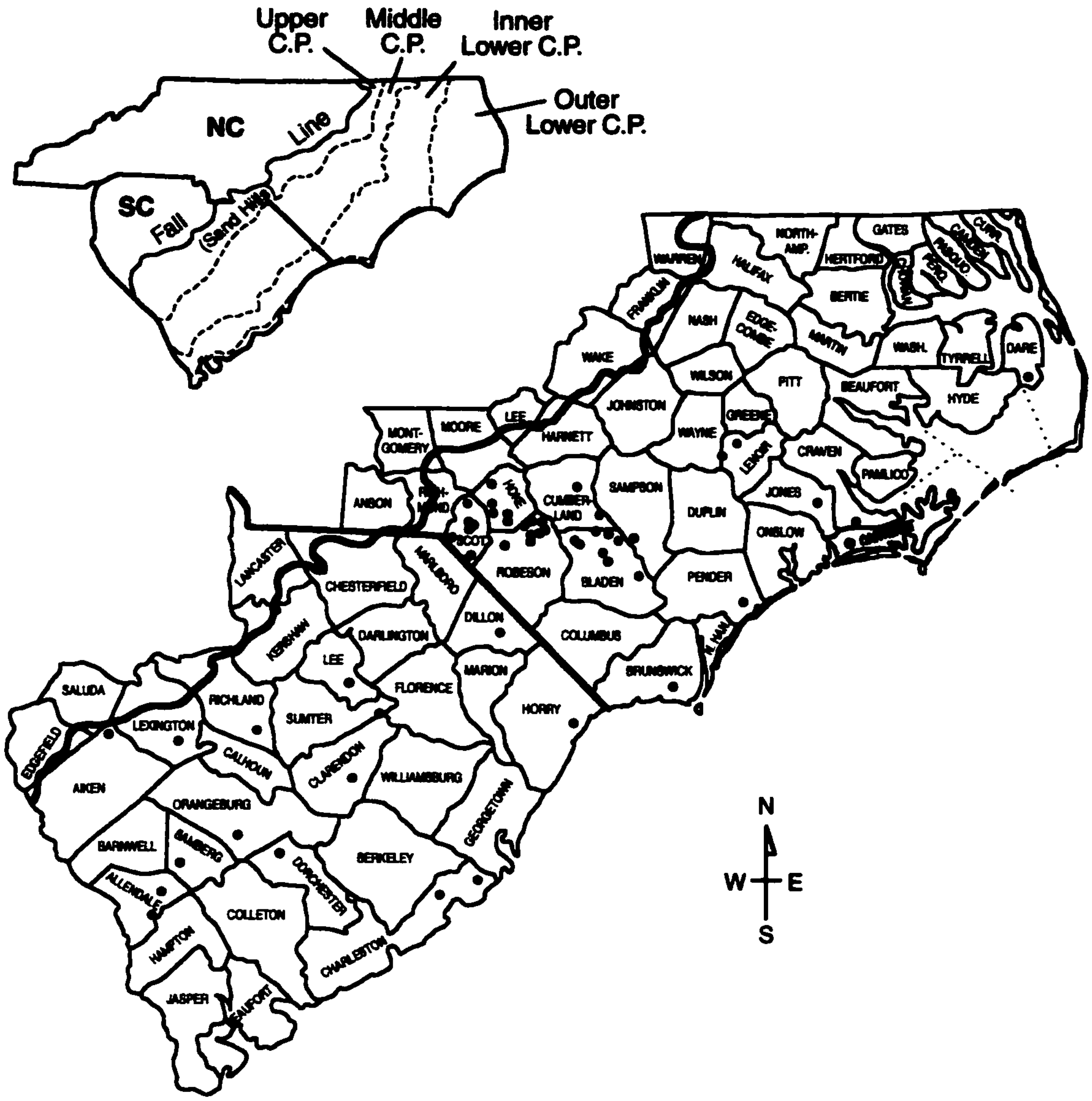
Brackish marshes are considered among the most productive of United States wetland systems as a result of community subsidies in the form of external nutrient inputs and abundant water (Mitsch and Gosselink, 1993). This vegetation class exhibits both the highest soil pH and the most nutrient rich soils encountered within study area Carolina bays (although individual community types in other classes had higher pH and specific nutrient values) (Tables A-II-2 to A-II-4). It seems rather anomalous that a vegetation type that is among the most productive known should be characterized by the lowest species richness recorded for any study vegetation class, consisting of a single species . However, numerous wetlands studies have indicated that while increased site productivity (biomass) is directly correlated with increased site nutrient availability, those factors are inversely correlated with site species richness in productive wetlands systems (*see, e.g.*, Vermeer and Berendse, 1983). The floristics and ecology of North Carolina brackish marshes have been widely documented in the literature (Cooper, 1974; Broome *et al.*, 1975a, 1975b).

Given natural processes occurring in brackish marshes and the potential frequency and magnitude of natural disturbances to which they are subject, the long-term stability of this vegetation class within Carolina bays is uncertain. Absent catastrophic disturbance, stability in tidal marshes is determined by the relative rates of two dominating processes: sediment accretion, including the production and deposition of peat by growing plants; and coastal submergence caused by rising sea level and/or marsh subsidence (Mitsch and Gosselink, 1993). As previously noted, the occurrence of this vegetation class within a Carolina bay depression is believed to be a result of the latter process.

However, that subsidence must be relatively recent, given the lack of peat accumulation at this site. Surface accretion through *in situ* peat accumulation is characteristic of North Carolina *Juncus roemerianus* marshes, which most typically occur over shallow to deep organic soils (*i.e.*, Terric or Typic Medisaprists) (Goodwin, 1986; DEHNR, 1996). The lack of such accretion within this community type suggests that the frequency and duration of site flooding is minimal, yielding surface conditions that are periodically conducive to the oxidation of accumulated plant remains.

Life form and growth form spectra diagrams are not provided for this vegetation class since it consists of a single, perennial graminoid (chamaephytic geophyte) species. Similarly, with respect to environmental gradient analysis for this vegetation class, neither NMDS ordinations nor vector biplot diagrams were used with this community type because of its relative"non-applicability", in that the vegetation class consists of a single community type dominated by a single species.

Figure 4.2. Distribution of study area Carolina bay sites containing Brackish Marsh vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Brackish Marsh community types. Locations of individual, sampled Carolina bay sites are indicated by red circles.



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
NORTH-AMP.
GATES
WARREN
HALIFAX
HERTFORD
FRANKLIN
BERTIE
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
GREENE
MONT-GOMERY
MOORE
LEE
HARNETT
WAYNE
LENOIR
CRAVEN
PAMLICO
ANSON
RICH-MOND
HOKE
CUMBER-LAND
SAMPSON
DUPLIN
JONES
ONSLOW
LANCASTER
MARLBORO
ROBESON
BLADEN
PENDER
CHESTERFIELD
DILLON
COLUMBUS
KERSHAW
DARLINGTON
LEE
MARION
BRUNSWICK
SALUDA
RICHLAND
FLORENCE
HORRY
LEXINGTON
SUMTER
EDGEFIELD
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
DORCHESTER
BERKELEY
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

Table 4.6. Average cover class and constancy of species present in the Brackish Marsh vegetation class. Values are given for the vegetation class, which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | |
|---|---|---|
| | 1.0.1 | |
| | Cov/ | Con |
| Species | | |
| JUNCUS ROEMERIANUS | 10 | 100 |

Table 4.7. Average site information for the Brackish Marsh vegetation class. The vegetation class is represented by its "Group" abbreviation code (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group |
|---|---|
| | 1.0.1 |
| Site Hydrology | |
| Water Depth Index | 154.5 |
| Hydroperiod Class | 5.0 |
| Water Constancy Index | 2.0 |
| Organic Layer Depth | 22.0 |
| Soil Drainage Class | 3.0 |
| Soil Permeability Class | 6.0 |
| Soil Available Water Capacity Class | 1.5 |
| | |
| Site Geomorphology | |
| Site Elevation (m) | 0.6 |
| Elevational Drop in 1 Km (m) | 0.6 |
| Distance to 10 m Elevational Drop (m) | — |
| Depression Area (ha) | 8.4 |
| Depression Length/Width Ratio | 1.6 |
| Depression Long Axis Orientation | +2.0 |
| | |
| Site Disturbance | |
| Fire Frequency Class | 4.0 |
| Cultivation Index | 1.0 |
| Grazing Index | 2.0 |
| Timbering Index | 1.0 |
| Drainage Index | 1.0 |
| Landscape Disturbance Class | 2.0 |

4.3.2. VEGETATION CLASS: **Intermittently Flooded Depression Prairie (2.)**

The term "prairie" has typically been used in the literature in application to wetlands to refer to graminoid dominated communities in the Okefenokee Swamp and the Everglades (*see*, *e.g.*, Auble *et al.*, 1982; Cohen *et al.*, 1984; Gerritsen and Greening, 1989). However, the term as defined by Mitsch and Gosselink (1993) -- an herb dominated wetland intermediate in wetness between a marsh (wetter) and a wet meadow (drier) -- is equally applicable to study area Carolina bay communities. Intermittently Flooded Depression Prairies exhibit this intermediate wetness condition, and are found over loamy soils in shallow, relatively flat Carolina bay depressions. As a result of those factors, they are characterized by vegetational communities that occur in response to low amplitude, periodically fluctuating ambient site water levels. Photographs of this vegetation class appear in Plate 3, following Chapter 7 below.

4.3.2.1 COMMUNITY TYPE: ***Leersia* Prairie (2.0.1)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.8)

*Leersia hexandra*

(3) Special Status Species

*Eleocharis melanocarpa, E. robbinsii, Nymphoides cordata*

(4) Vegetation & Physiognomy

This community type is characterized by a single, herbaceous stratum comprised of typically decumbent *Leersia hexandra* that is usually dominant, and often occurs in pure stand. Depending on the wetness of the site and upon recent site hydrology, *Eleocharis* spp. or *Panicum hemitomon* may be site co-dominants. The site lacks any woody strata, although saplings of a number of trees, including *Nyssa biflora, Acer rubrum,* and *Pinus taeda*, may occur occasionally within the community type.

This community type exhibited very low mean species richness at the 0.1 ha level, at

2.69 species (Table 4.2).

(5) Distinguishing Features

This community type represents the "flooded phase" for this vegetation class. It is distinctive both by sight -- *Leersia hexandra* has a distinctive color both vegetatively and when in bloom -- and by "feel" -- the species is very aptly named "Cut-grass".

(6) Habitat

This community type occurs in relatively small depressions at the wettest, highest elevation sites within this vegetation class (Table 4.9). On average, water stood on the surface of the poorly drained, mineral soils (described below) at *ca.* 60 cm at the time of sampling, and the organic-dominated surface layer was some 20 cm thick. Depression basins are some 5.3 ha in size, located at an elevation of *ca.* 52.8 m, and on land surfaces having moderate relief.

(7) Soils

The soils underlying this community type are typically fine-loamy, siliceous, thermic Typic Paleaquult soils, although clayey, kaolonitic, thermic Typic Fragiaquult soils are encountered at a small percentage of sites exhibiting this community type (Table A-II-1). Both soils are poorly drained (McCachren, 1978). Paleaquults are the wet, gray, clay rich but relatively nutrient poor, mineral soils developed on old land surfaces where groundwater is at or near the surface (Soil Survey Staff, 1975). A typical pedon of this soil type is described for this community type in Appendix II, while a Typic Fragiaquult soil is discussed and described later in this chapter.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for this community type is extremely acid and fairly constant throughout the soil solum. The CEC is very low throughout the soil solum, and the vast bulk of that CEC is occupied by "acidity factors", *e.g.*, hydrogen and aluminum ions, indicating a relatively nutrient depauperate soil. Copper is relatively abundant in the soils characterizing this community type. Soil bulk density is moderate, and increases slightly with depth as the percentage of silt decreases and the percentage of sand increases.

(8) Succession & Disturbance

Being the "flooded phase" of the Intermittently Flooded Depression Prairie, it is not surprising that the vigor and spread of this community type largely ebbs and flows with the hydroperiod of the site in which it occurs. In periods where annual precipitation is normal or above normal, this community type may cover the entire flooded portion of the depression in which it is found. However, during drawdown (dry down) periods, the *Leersia* Prairie tends to decline (Kirkman, 1992), and *Panicum hemitomon* Marsh may began to replace the *Leersia* community type. During extended drought periods, the site may be invaded by *Pinus taeda* seedlings, giving way -- at least temporarily -- to the *Pinus taeda/Panicum hemitomon/ Leersia* "Successional Prairie" discussed below.

As indicated by Table 4.9, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively frequent in this community type, occurring at intervals of every 10 to 25 years, presumably during extended drought periods. Charcoal is identifiable in the soils of the community type, and rim area tree bases are generally fire-scarred. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

This community type is found in upland depressions of the Middle Coastal Plain, and to a lesser extent, in the Upper Coastal Plain (Table 4.3). *Leersia* Prairies make up 5 percent of sampled Carolina bay vegetation found within the Middle Coastal Plain and 11 percent of sampled vegetation in the Upper Coastal Plain. The community type is found over two soil types -- fine-loamy, siliceous, thermic Typic Paleaquults (90%), and clayey, kaolonitic, thermic Typic Fragiaquults (10%). Each soil type is 1 of 12 soil families found within sampled Middle Coastal Plain Carolina bays. Ultisols comprise 7 of the 12 sampled soil types located on that surface (Table 4.4).

(10) Distribution & Abundance

Twenty-one of 482 intensively sampled plots (4.4%), occurring in Carolina bays located in the central portion of the study area, fall within this classification (Table 4.5; Figure 4.3). This community type comprises 49 percent of the sampled community types that make up the vegetation class. While this is the most common of the Intermittently Flooded Depression Prairie community types, the occurrence of this vegetation class within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

This community type is currently protected to a limited extent on State-owned lands in North Carolina. However, the best of the known examples of this community type remain privately-owned and unprotected.

4.3.2.2 COMMUNITY TYPE: ***Leersia/Panicum verrucosum* Prairie (2.0.2)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.8)

*Leersia, hexandra, Panicum verrucosum, Scleria reticularis*

(3) Special Status Species

*Andropogon mohrii, Eleocharis melanocarpa, Iva microcephala, Nymphoides cordata, Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type, like others within this vegetation class, lacks any woody strata. Instead, it is characterized by "dual" graminoid layers within the herbaceous stratum, with *Leersia hexandra* to 0.5 m in height providing moderate to sparse cover above, and the annual *Panicum verrucosum* covering the surface of the ground below. *Scleria reticularis* is sometimes found as a co-dominant with *Panicum verrucosum* in the lower herbaceous layer.

This community type exhibited low mean species richness at the 0.1 ha level, at 7.23 species (Table 4.2).

(5) Distinguishing Features

This community type represents the "post-flooded phase" or immediate "drawdown phase" for this vegetation class. As in the previous community type, its *Leersia* component is distinctive by sight and by feel, but occurs over moist soil rather than over water. The annuals *Panicum verrucosum* and *Scleria reticularis* are exceedingly abundant in the seedbank for Intermittently Flooded Depression Prairies, and form a thick ground cover where individual plants may number in the hundreds of thousands.

(6) Habitat

This community type also occurs in relatively small depressions, but in the driest sites within this vegetation class (Table 4.9; Figure 4.5). On average, the water table stood some 72 cm below the surface of the poorly drained, mineral soils (described below) at the time of sampling, but the organic-dominated surface layer was similar to that of the preceding community type. Depression basins are the largest within the group at 8.9 ha in size and are located on land surfaces having somewhat less relief than other community types within this vegetation class.

(7) Soils

Approximately two-thirds of the soils characteristic of this community type are fine-loamy, siliceous, thermic Typic Paleaquults, while one-third are clayey, kaolonitic, thermic Typic Fragiaquults (Table A-II-1). As previously noted, both soils are poorly drained. The profile for a Typic Paleaquult soil that typifies this community type is described in Appendix II for CT 2.0.1. The soil profile for a Typic Fragiaquult soil similar to that found beneath this community type is described in Appendix II for CT 9.3.1, discussed below.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for this community type is extremely acid near the surface to very strongly acid at a depth of 50 cm. The CEC is very low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum, particularly at the surface, indicating relatively nutrient depauperate soils. Copper is relatively abundant in these soils. Soil bulk density is moderate, and increases slightly with depth as the percentage of silt decreases and the percentage of sand increases.

(8) Succession & Disturbance

As noted, the vigor and spread of the *Leersia* Prairie depends on the phase of this vegetation class relative to surface water inundation, and this community type occupies the site immediate upon that surface water "drawing down". If the site re-floods, the *Leersia* Prairie will eventually return as the dominant community type, though this community type may persist indefinitely if the flooding is shallow. As additionally noted, during extended drawdown periods the *Leersia* dominated community types may begin to give way to the *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie" discussed below.

As indicated by Table 4.9, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively frequent in this community type, occurring at intervals of every 10 to 25 years, presumably during extended drought periods. Charcoal is identifiable in the soils of the community type, and rim area tree bases are generally fire-scarred. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

The community type "*Leersia/Panicum verrucosum* Prairie" makes up 4 percent of sampled Carolina bay vegetation found within the Middle Coastal Plain (Table 4.3). The community type is found over two soil types -- fine-loamy, siliceous, thermic Typic Paleaquults (64%), and clayey, kaolonitic, thermic Typic Fragiaquults (36%). Each soil type makes up 1 of the 12 soil families found within sampled Middle Coastal Plain Carolina bays. Ultisols are the most common Middle Coastal Plain bay soils, comprising 7 of the 12 sampled soil types located on that surface (Table 4.4).

(10) Distribution & Abundance

Fourteen of 482 intensively sampled plots (2.9%), occurring in Carolina bays located in the central portion of the study area, fall within this classification (Table 4.5; Figure 4.3). This community type comprises 33 percent of the sampled community types that make up the vegetation class. As previously noted, the occurrence of Intermittently Flooded Depression Prairie community types within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected either within the study area, or elsewhere within the range of Carolina bays.

4.3.2.3 COMMUNITY TYPE: ***Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie" (2.0.3)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.8)

*Acer rubrum, Leersia hexandra, Nyssa biflora, Panicum hemitomon, Pinus taeda*

(3) Special Status Species

*Eleocharis robbinsii, Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type is characterized by scattered saplings and small (to 3 m tall) *Pinus taeda* trees, emergent over a thick herbaceous cover of *ca.* 1-m tall *Panicum hemitomon* overtopping a layer consisting of decumbent, scattered patches of *Leersia hexandra*. As in the other community types comprising Intermittently Flooded Depression Prairies, *Eleocharis* spp. may assume some importance in the herbaceous layer. In addition, *Pinus serotina, Liquidambar styraciflua, Acer rubrum*, and particularly, *Nyssa biflora*, may constitute a significant portion of the sapling layer component of the vegetation found within this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.53 species (Table 4.2).

(5) Distinguishing Features

This community type represents the "drought phase" for this vegetation class, and is generally distinguished by a large number of even-aged, *Pinus taeda* seedlings and saplings overtopping *Leersia* Prairies that have been invaded to some degree by the vigorous vegetative growth of *Panicum hemitomon*.

(6) Habitat

This community type, like others within this vegetation class, occurs in relatively small depressions having poorly drained, mineral soils having a moderately thick organic-dominated surface layer, and located on land surfaces with moderate relief (Table 4.9; Figure 4.5). On average, the ambient site water level ("water table") stood just below the surface of this community type at the time of sampling.

(7) Soils

This community type is found only over poorly drained, fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). A representative profile of a Typic Paleaquult soil is described in Appendix II for CT 2.0.1, discussed above.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is somewhat less acid than the pH for other community types within this vegetation class, being very strongly acid throughout the soil solum (Figure 4.4). However, as is characteristic of the other community types in this vegetation class, the CEC is very low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum, indicating relatively nutrient depauperate soils. Nevertheless, the percentage of the CEC occupied by calcium and magnesium is much higher for soils underlying this community type than for those found beneath other community types within this vegetation class, and there is little copper in this soil. Soil bulk density is moderately high throughout the soils found in this community type, indicating the relatively greater proportion of sand characteristic of its soils.

(8) Succession & Disturbance

Being the "drought phase" of the Intermittently Flooded Depression Prairie, this community type is typically observed in periods characterized by successive years of below normal rainfall. In addition, it requires successful seed production by surrounding *Pinus taeda* trees in a given period, as *Pinus* seedlings are not persistent in the seedbanks of Carolina bay sites (Kirkman, 1992). This "Successional Prairie" community type may flourish under continued periods of below normal rainfall. However, thousands of dead *Pinus taeda* seedlings and saplings 2 to 3 m in height have been observed within this community type following two or more seasons of post-drought depression re-flooding, indicating that this community type generally does not persist when normal precipitation recurs and the site re-floods for an extended period.

As indicated in Table 4.9, the sites inhabited by this community type, like the other communities within this vegetation class, show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively frequent in this community type, occurring at intervals of every 10 to 25 years, presumably during extended drought periods. Charcoal is identifiable in the soils of this community type, and rim area tree bases are generally fire-scarred. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land-altering activities.

(9) Landscape Position

The community type "*Pinus taeda/Panicum hemitomon/Leersia* 'Successional Prairie'" occurs in Carolina bays in the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which makes up 1 of 7 Ultisols found within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in Carolina bays located in the central portion of the study area, fall within this classification (Table 4.5; Figure 4.3). This community type comprises 18 percent of the sampled community types that make up the vegetation class. This is the least common of the Intermittently Flooded Depression Prairie community types sampled, and the occurrence of this vegetation class within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected either within the study area, or elsewhere within the range of Carolina bays.

4.3.2.4 ANALYSIS

Vegetation Class Environmental Gradients

Intermittently Flooded Depression Prairie plots within the study area are distributed along both a complex water depth/soil pH--acidity-nutrient-density gradient and an orthogonally oriented "hydrologic"/disturbance gradient (Figs. 4.4 and 4.5). Stands are located on the first gradient principally by their relative values for ambient site water depth, soil pH, soil acidity (here, the portion of the soil cation exchange capacity that is occupied by hydrogen and aluminum ions), soil exchangeable calcium, and soil bulk density. Those factors are most strongly associated with the second compositional axis. Plots are distributed along the second gradient by their comparative scores for site elevation, rotated site longitude (which is more or less the equivalent of elevation), organic-dominated layer depth, soil permeability, and history of grazing disturbance. The factors comprising the latter gradient are associated with both compositional axes.

*Leersia* Prairie plots are found along these gradients at low elevation sites showing little ditching disturbance and characteristically having the highest site ambient water levels. They are located on low ph, acidic soils having high organic matter, comparatively low bulk density, and low calcium levels. *Leersia/Panicum verrucosum* Prairies are found at higher elevation sites at sites that show little recent grazing disturbance. Their soils are moderately acidic, and have a comparatively shallow organic-dominated layer. *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie" stands are found at disturbed sites -- showing evidence of ditching and recent grazing -- with the comparatively lowest ambient water level. They occur on sandy loam soils having relatively high pH levels, nutrient levels and permeabilities, and the lowest soil bulk densities.

Discussion

As noted above, Intermittently Flooded Depression Prairie community types are temporal in nature and essentially represent different points along the periodic, fluctuating hydrologic gradient that is the namesake of this vegetation class. When sites are flooded, *Leersia* Prairie predominates, often in monotypic stand. During drawdown periods, when the soil surface is moist but not flooded, the annuals *Panicum verrucosum* and *Scleria reticularis* germinate from the site seedbank by the tens of thousands (yielding the second community type within this vegetation class), quickly maturing, fruiting, and replenishing seedbank propagules of those species. During drawdown periods, the dominance of comparatively more drought-tolerant depression species, such as *Panicum hemitomon*, tends to increase (Kirkman, 1992). If the site burns during the drawdown period, the dominance of *Leersia*, which is relatively fire intolerant, is diminished even further, while that of *Panicum verrucosum* may increase dramatically (Kirkman and Sharitz, 1994). With extended droughts, invasion of woody species having windblown seeds, particularly *Pinus taeda*, *Acer rubrum*, and *Andropogon virginicus*, occurs rapidly, leading to the establishment of the "Successional" Depression Prairie community type.

When sites are reinundated, the dominance of *Leersia* increases (unless it has been killed by fire), that of *Panicum hemitomon* may decrease, and the therophyte ground cover disappears as plants fruit and die (*see* Figures 4.6 and 4.7). Seedlings of woody species are usually killed by protracted inundation, but sapling may persist except under the most extended flooding regimes. These observations are consistent with the results discussed by Kirkman (1992) in examining "depression meadow" communities in the southernmost portion of the study area.

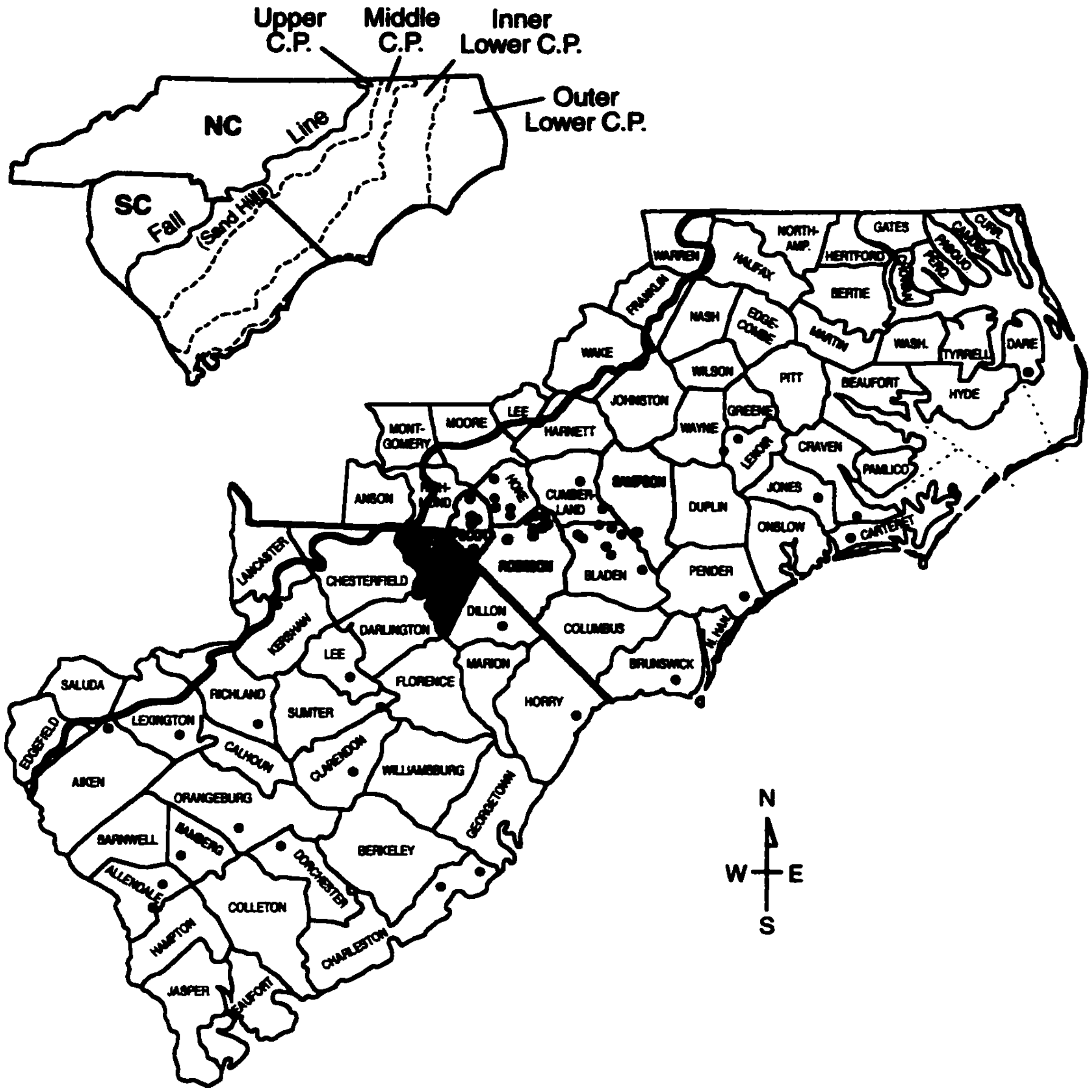
Observations of this community type over a period of years and a number of varying hydrologic conditions indicates that species richness of Depression Prairies is low regardless of the hydrologic phase represented or the season. This suggests that the seedbank diversity is lower than that observed in most other freshwater, herb-dominated community types.

Plant life form and growth form dominance in Depression Prairies reflect the temporal nature of the community types. Therophytes are absent from the *Leersia* Prairie, but are a significant component of the taxa found in the remaining two community types, while Megaphanerophytes show increased representation in those latter two community types (Figure 4.6). Similarly for growth forms, perennial herbs dominate the taxa found in *Leersia* Prairies, while annual herbs have increased representation in the other community type within this vegetation class (Figure 4.7).

Intermittently Flooded Depression Prairies are one of three graminoid-dominated Carolina bay vegetation groups discussed in this study -- along with Freshwater Marsh and Wet Meadow communities -- that have often been referred to collectively as "depression meadows" (*see*, *e.g.*, Schafale and Weakley, 1990; Bennett and Nelson, 1991; Kirkman, 1992). Substantial consideration was given to including the Intermittently Flooded Depression Prairie vegetation class as a Freshwater Marsh vegetation subclass, based on the NMDS ordination diagram for the study area herb-dominated plots (*see* Chapter 5). However, while similar in appearance and floristics, the three "depression meadow" groups are relatively distinct in terms of hydroperiod.

Depression Prairies, while regularly flooded, typically exhibit shallower surface waters and a shorter hydroperiod than those characteristic of Freshwater Marshes. At the same time, Depression Prairies are not so dry as the Wet Meadow vegetation group described below, which are graminoid dominated systems characterized by often waterlogged soils, but lacking standing water for most of the year. In addition, while the overall pattern of growth form dominance is similar in Depression Prairies and Freshwater Marshes, the plots falling into the latter vegetation group exhibit a significantly increased proportion of woody species than is characteristic of Depression Prairies (Figures 4.7 and 4.17, respectively). This phenomenon may result from the comparatively greater exposure of Depression Prairie communities to fire during more frequent drawdown periods than occurs in Freshwater Marshes.

Figure 4.3. Distribution of study area Carolina bay sites containing Intermittently Flooded Depression Prairie vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Intermittently Flooded Depression Prairie community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Intermittently Flooded Depression Prairie community types were observed during field reconnaissance for this study. Locations of individual, sampled Carolina bay sites are indicated by red circles.



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
WARREN
NORTH-AMP.
GATES
HERTFORD
HALIFAX
BERTIE
FRANKLIN
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
GREENE
MOORE
LEE
MONT-GOMERY
HARNETT
WAYNE
LENOIR
CRAVEN
PAMLICO
ANSON
HOKE
CUMBER-LAND
SAMPSON
DUPLIN
JONES
ONSLOW
CARTERET
LANCASTER
CHESTERFIELD
ROBESON
BLADEN
PENDER
DILLON
COLUMBUS
KERSHAW
DARLINGTON
LEE
MARION
BRUNSWICK
SALUDA
RICHLAND
FLORENCE
SUMTER
HORRY
EDGEFIELD
LEXINGTON
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
BERKELEY
DORCHESTER
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

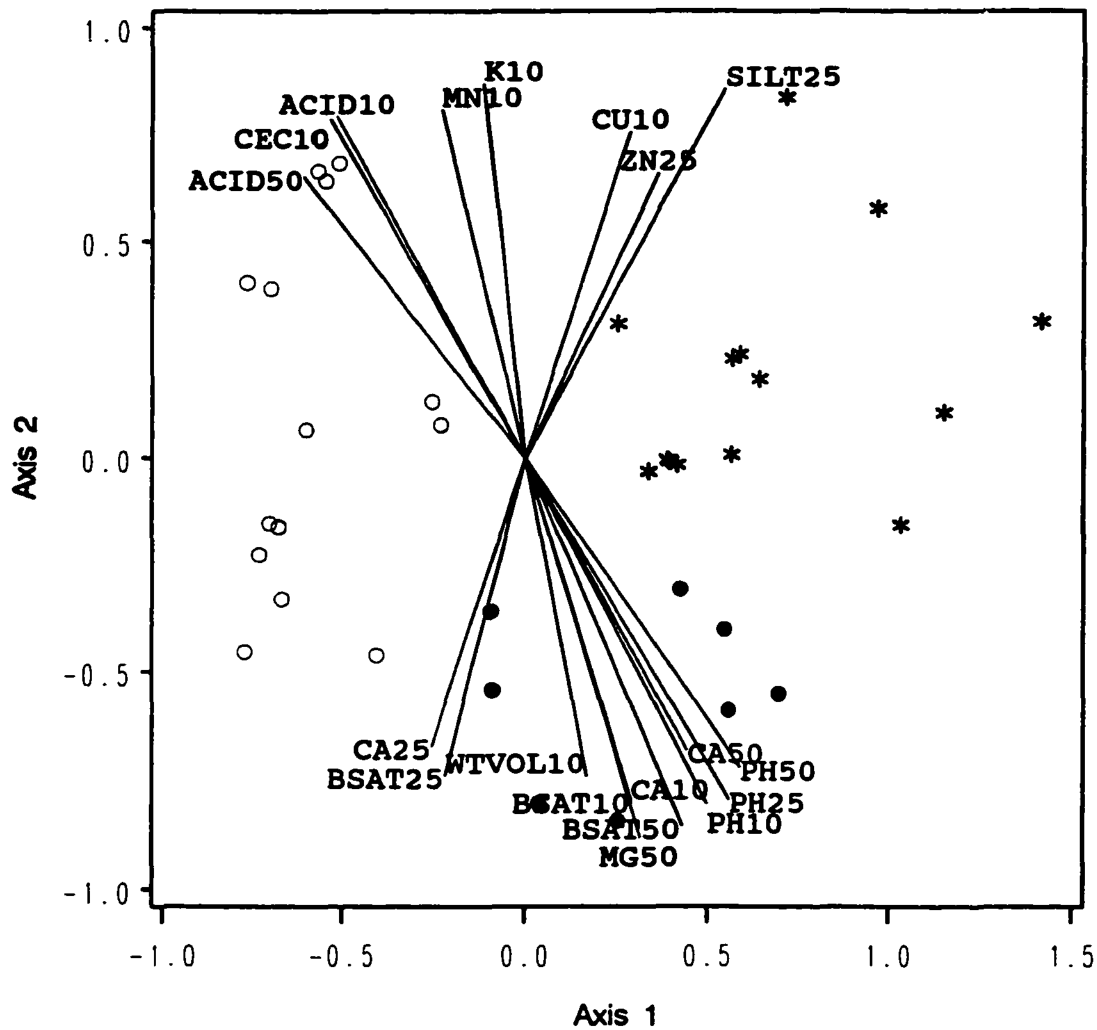
Table 4.8. Average cover class and constancy of species present in the Intermittently Flooded Depression Prairie vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2. | | 2.0.1 | | 2.0.2 | | 2.0.3 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | | | |
| ACER RUBRUM | 3 | 37 | | | 2 | 57 | 4 | 100 |
| ANDROPOGON MOHRII* | 3 | 2 | | | 3 | + | | |
| ASTER PILOSUS VAR. DEMOTUS | 3 | 5 | 3 | + | | | | |
| CYPERUS SP. | 2 | 2 | | | 2 | + | | |
| DICHANTHELIUM WRIGHTIANUM | 4 | 12 | | | 4 | + | | |
| DIOSPYROS VIRGINIANA | 3 | 2 | | | 3 | + | | |
| ELEOCHARIS MELANOCARPA** | 3 | 5 | 2 | + | 4 | + | | |
| ELEOCHARIS MICROCARPA | 2 | 2 | | | 2 | + | | |
| ELEOCHARIS ROBBINSII* # | 6 | 30 | 7 | + | | | 4 | 50 |
| ERIOCAULON COMPRESSUM | 3 | 9 | 3 | + | | | | |
| EUPATORIUM LEUCOLEPIS | 1 | 12 | | | 1 | + | 2 | 50 |
| IVA MICROCEPHALA* | 8 | 2 | | | 8 | + | | |
| LACHNANTHES CAROLINIANA | 3 | 7 | | | 3 | + | | |
| LEERSIA HEXANDRA | 7 | 98 | 7 | 100 | 6 | 93 | 6 | 100 |
| LIQUIDAMBAR STYRACIFLUA | 3 | 2 | | | 3 | + | | |
| LUDWIGIA LINEARIS | 2 | 2 | | | 2 | + | | |
| NYMPHOIDES CORDATA** | 5 | 12 | 5 | + | 3 | + | | |
| NYSSA BIFLORA | 5 | 16 | | | 3 | + | 5 | 75 |
| PANICUM HEMITOMON | 7 | 19 | 4 | 5 | 9 | 7 | 7 | 75 |
| PANICUM VERRUCOSUM | 7 | 40 | | | 8 | 93 | 5 | + |
| PASPALUM LAEVE | 4 | 2 | | | 4 | + | | |
| PINUS TAEDA | 5 | 47 | 5 | + | 4 | 50 | 7 | 100 |
| PLUCHEA ROSEA | 2 | 5 | | | | | 2 | + |
| RHEXIA ARISTOSA* # | 3 | 7 | | | 4 | + | 2 | + |
| RHYNCHOSPORA DEBILIS | 2 | 2 | | | | | 2 | 13 |
| RHYNCHOSPORA FILIFOLIA | 3 | 16 | | | 3 | + | 2 | + |
| RHYNCHOSPORA PERPLEXA VAR. PERPLEXA | 4 | 5 | | | 4 | + | | |
| SCLERIA RETICULARIS* | 5 | 40 | | | 5 | 93 | 5 | + |
| UTRICULARIA BIFLORA | 4 | 5 | 4 | + | | | | |
| UTRICULARIA RADIATA | 6 | 5 | 6 | + | | | | |
| VIOLA LANCEOLATA | 2 | 5 | | | 2 | + | | |
| XYRIS AMBIGUA | 1 | 2 | | | 1 | + | | |

Table 4.9. Average site information for the Intermittently Flooded Depression Prairie vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | |
|---|---|---|---|---|
| | 2. | 2.0.1 | 2.0.2 | 2.0.3 |
| Site Hydrology | | | | |
| Water Depth Index | 142.0 | 205.6 | 78.1 | 142.3 |
| Hydroperiod Class | 4.0 | 4.0 | 3.9 | 4.0 |
| Water Constancy Index | 1.0 | 1.0 | 1.0 | 1.0 |
| Organic Layer Depth | 19.4 | [20.0] | 18.3 | 20.0 |
| Soil Drainage Class | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Permeability Class | 3.7 | 3.8 | 3.3 | 4.0 |
| Soil Available Water Capacity Class | 2.9 | 3.0 | 2.8 | 3.0 |
| | | | | |
| Site Geomorphology | | | | |
| Site Elevation (m) | 41.8 | 52.8 | 37.6 | 35.1 |
| Elevational Drop in 1 Km (m) | 12.9 | 14.0 | 11.0 | 13.7 |
| Distance to 10 m Elevational Drop (m) | 1025 | 800 | 1550 | 750 |
| Depression Area (ha) | 6.8 | 5.3 | 8.9 | 6.1 |
| Depression Length/Width Ratio | 1.5 | 1.4 | 1.6 | 1.4 |
| Depression Long Axis Orientation | -7.2 | -6.4 | -6.1 | -9.0 |
| | | | | |
| Site Disturbance | | | | |
| Fire Frequency Class | 3.0 | 3.0 | 3.0 | 3.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.8 | 1.7 | 1.6 | 2.0 |
| Timbering Index | 1.0 | 1.0 | 1.0 | 1.0 |
| Drainage Index | 1.9 | 1.7 | 2.0 | 2.0 |
| Landscape Disturbance Class | 3.6 | 3.4 | 3.3 | 4.0 |

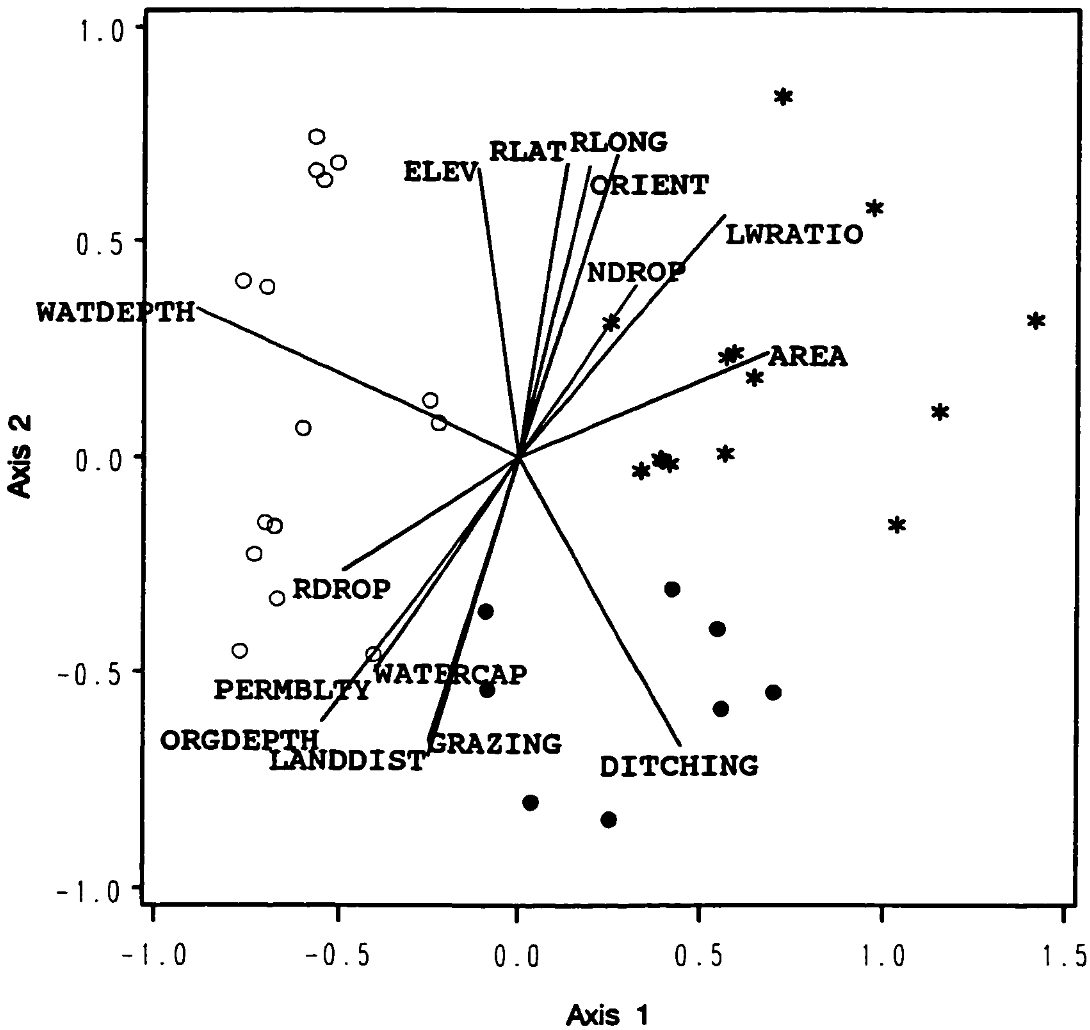
Figure 4.4. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Intermittently Flooded Depression Prairie stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY FLOODED DEPRESSION PRAIRIE — Community Types:**

○ Leersia Prairie
✱ Leersia/Panicum verrucosum Prairie
● Pinus taeda/Panicum hemitomon/Leersia "Successional Prairie"

Figure 4.5. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Intermittently Flooded Depression Prairie stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY FLOODED DEPRESSION PRAIRIE — Community Types:**

○ Leersia Prairie

✱ Leersia/Panicum verrucosum Prairie

● Pinus taeda/Panicum hemitomon/Leersia "Successional Prairie"

Figure 4.6. Plant Life Forms for Intermittently Flooded Depression Prairie vegetation groups found within North and South Carolina Carolina bay depressions.

PLANT LIFE FORMS OCCURRING IN INTERMITTENTLY FLOODED DEPRESSION PRAIRIE VEGETATION GROUPS

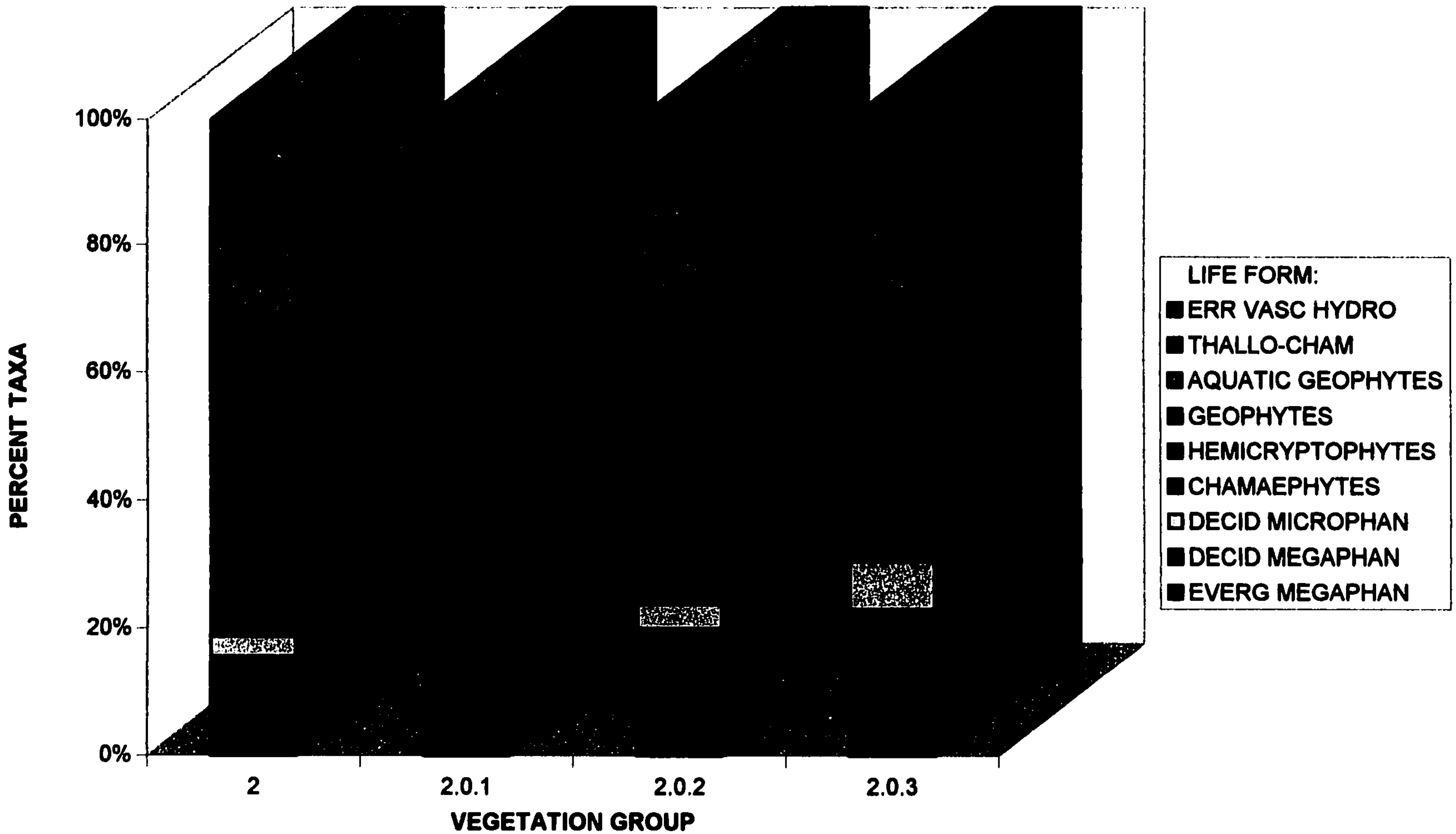
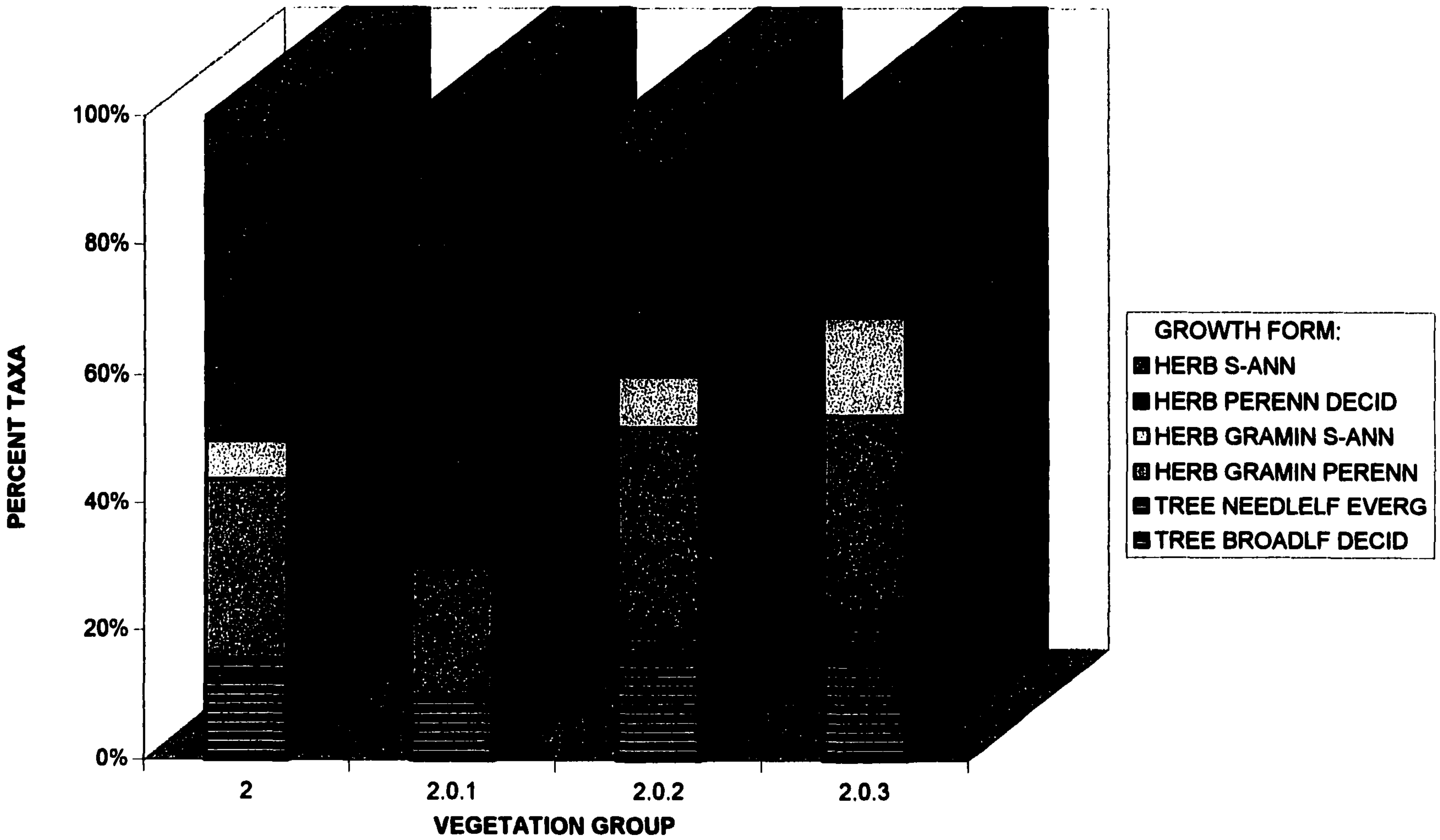


Figure 4.7. Plant Growth Forms for Intermittently Flooded Depression Prairie vegetation groups found within North and South Carolina Carolina bay depressions.

**PLANT GROWTH FORMS OCCURRING IN INTERMITTENTLY FLOODED DEPRESSION PRAIRIE VEGETATION GROUPS**



4.3.3 VEGETATION CLASS: **Freshwater Pond (3.)**

Freshwater Pond vegetation communities occur primarily in Carolina bays having mineral soils and long hydroperiods. That water permanence is typically the result of either a relatively impervious subsurface layer underlying the depression, or the occurrence of springs as a water source within the depression. Such sites are characteristically dominated by floating-leaved macrophytes, with or without emergent perennial species. Photographs of this vegetation class appear in Plate 4, following Chapter 7 below.

4.3.3.1 COMMUNITY TYPE: ***Nymphaea* Pond (3.0.1)**

(1) Synonymy

Open Water Pond *p.p.* (Bennett and Nelson, 1991); Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.10)

*Leersia hexandra, Nymphaea odorata, Panicum hemitomon, Utricularia fibrosa, Utricularia purpurea*

(3) Special Status Species

*Nymphoides cordata, Polygonum hirsutum*

(4) Vegetation & Physiognomy

This community type, found in Carolina bays that are flooded for extended periods of time, is characterized by a complete absence of woody vegetation, and only emergent, floating aquatics in the herbaceous stratum. *Nymphaea odorata* is a typically found throughout such a Freshwater Pond, except where water depths exceed 2 m. *Nymphoides* spp. may be co-dominant with *Nymphaea* in intermediate water depths, while *Brasenia schreberi* may have significant cover in shallower pond waters. A discontinuous surficial "mat" of either *Utricularia fibrosa* (shallow waters) or *Utricularia purpurea* (deeper waters) is also typical of this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 7.18 species (Table 4.2).

(5) Distinguishing Features

This is only one of two community types sampled dominated by true aquatic species. It is easily distinguished both visually and by component species as a characteristic "lily pond", dominated by *Nymphaea odorata, Nymphoides* spp., *Nuphar* spp. (which occurred within this community type, although not within the actual sampled plots), and other floating-leaved aquatics.

(6) Habitat

This community type occurs over poorly drained soils (described below), in relatively small, generally flooded depressions located on land surfaces of moderate elevation and with moderate relief (Table 4.11; Figure 4.10). On average, the water table stood some 32 cm above the surface at the time of sampling, but the water depth for this community type within Carolina bays was observed to vary from just a few centimeters to 2 meters. A thin, "peaty" surface layer usually occurs, and the soils of this community type, although mineral in nature overall, are sometimes referred to as "boggy soils" (*see* Eyles, 1941). Depression basins exhibiting this community are generally small (20.7 ha as sampled), and therefore tend to be relatively "steep-walled" in comparison to the slope found in larger depressions. They have moderately stable water level constancy, and typically draw down only during periods of prolonged drought.

(7) Soils

This community type occurs over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). A representative pedon for this soil family was previously described for an Intermittently Flooded Depression Prairie community. However, another sampled pedon is described for this CT in Appendix II, because this vegetation type characteristically occurs at sites that are "semi-permanently" flooded, which apparently allows the development of a "peaty" surface layer from decayed herbaceous material. As previously noted, these soils are poorly drained and typically form in upland depressions.

The very bright yellow and red colors found in the soil some 1 to 1.5 m below the bottom of the pond are striking. As previously noted, the bright colored subsurface mottles indicate subsurface oxidizing conditions during a significant portion of the year (Buol *et al.* 1980).

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is very strongly acid to strongly acid, increasing slightly with depth. The CEC is very low throughout the soil solum, and while the bulk of that CEC is occupied by hydrogen and aluminum at the surface, acidic ions occupy less than half of the CEC at 50 cm. The percentage base saturation in the soils underlying this community type is, on average, twice that found in Intermittently Flooded Depression Prairie communities, which occur over similar soils. Copper and zinc are relatively abundant in the surface layers of the soils characterizing this community type, but decrease markedly with depth. Soil bulk density is moderate, and silt-sized particles dominate the soil beneath this community type at all measured depths (*see* Figure 4.9).

(8) Succession & Disturbance

As noted, this community type is generally found in small depressions that consequently have a relatively steep depression bottom to rim gradient. Where this community type occurs, the inner portions of these depressions typically remain flooded for extended periods of time. The surrounding vegetation is a series of concentric zones of herbaceous vegetation characterized by differing dominant species, reflecting the different hydrologic regimes in moving away from the flooded inner zone. *Panicum hemitomon* Marsh typically occupies the shallow water zone adjacent to this community type. Both this community type and the surrounding zones of herbaceous vegetation tend to expand and contract as the depression water level rises and falls. As noted, the height of the water measured within the *Nymphaea* zone ranged from *ca.* 20 cm to 175 cm.

Although fire is common within the landscape surrounding this community type, fire is infrequent within the community itself. *Nymphaea* Ponds are commonly stocked with game fish and used as fishing ponds, and the sites may be used for grazing, livestock watering or other agricultural activities. The owner of a site exhibiting this community type noted that during an extended drawdown period some 40 years previously, much of the site was plowed, and corn was planted to attract waterfowl to the pond. According to the owner, when the site re-flooded, the native vegetation returned to its approximate "pre-cultivation" condition within a matter of a few years. As with most other small depressions, the sites wherein this community type is found tend to occur in landscapes highly altered by human disturbance activities.

(9) Landscape Position

The community type "*Nymphaea* Pond" is found in Carolina bays in the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation within that landscape class. As previously discussed, the community type is found on fine-loamy, siliceous, thermic Typic Paleaquult soils, which comprises 1 of the 12 soil families found within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in Carolina bays located in the southern portion of the study area, fall within this classification (Table 4.5; Figure 4.8). This community type comprises 73 percent of the sampled community types that make up the vegetation class. This community type is the commonest of the Carolina bay Freshwater Pond vegetation types, and is also fairly common in other "pond-like" habitats within the study area. While Carolina bays exhibiting Freshwater Pond communities are relatively uncommon in most of the study area, extensive field reconnaissance and reference to published studies indicates that their frequency substantially increases in the southern portion of the study area (*see, e.g.*, Schalles *et al.*, 1989) (*see* Figure 4.8). Eyles (1941) also reported on freshwater pond communities in northern Georgia that would appear to fit this classification.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected either within the study area, or elsewhere within the range of Carolina bay depressions.

4.3.3.2 COMMUNITY TYPE: ***Mayaca* Pond (3.0.2)**

(1) Synonymy

Open Water Pond *p.p.* (Bennett and Nelson, 1991).

(2) Constant Species (*see* Table 4.10)

*Eriocaulon parkeri, Mayaca fluviatilis, Panicum hemitomon*

(3) Special Status Species

*Eleocharis equisetoides, E. robbinsii, Eriocaulon parkeri, Potamogeton confervoides*

(4) Vegetation & Physiognomy

This community type, found only at permanently flooded sites, is characterized by a mosaic of floating "mats" of *Mayaca fluviatilis*, either alone or in conjunction with such species as *Potamogeton confervoides* and *Eriocaulon parkeri*. Breaks in the surface mat of vegetation reveal patches of the *Eriocaulon* growing on the pond bottom -- up to 1.5 m below the water surface -- in some areas, and stands of *Eleocharis* spp. with *Brasenia schreberi*, in other areas.

This community type exhibited low mean species richness at the 0.1 ha level, at 6.79 species (Table 4.2).

(5) Distinguishing Features

This is the other of the two sampled Carolina bay communities dominated by aquatic species. It is distinguished by the relative lack of floating leaved macrophytes such as *Nymphaea*, and by the stark clarity of its waters, which allows development and maintenance of the "bi-layered" (surface and bottom) aquatic community described above.

(6) Habitat

This community type is known to inhabit only large (*ca.* 629 ha), shallow (mostly $\leq$1 m), permanently flooded Carolina bay depressions located on broad, flat interfluves (Table 4.11). The water characterizing this community type is remarkably clear, allowing both a floating, surface vegetative layer and a "benthic" vegetation layer 1 m or more below the surface. As described below and in Appendix II, the very poorly drained soils are mucky and low nutrient at the surface, but are sandy with a higher nutrient status below that surface layer.

(7) Soils

This community type occurs over mixed, thermic Typic Psammaquent soils (Table A-II-1). The general characteristics of Psammaquents are discussed for CT 1.1, above. A general description of the soil found beneath this wet community type is set out in Appendix II.

The mucky surface layer of this soil is similar to the Histosols (discussed elsewhere in this chapter) occurring in most Carolina bays located in the region where this community type occurs, but far too shallow to render this an organic soil. This soil type may represent a case where, as discussed under "Soils" below, an organic soil has failed to develop over the sandy to loamy sediments that underlie the organic horizons in most of the Carolina bays in the area.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is very strongly acid throughout. The CEC is also very low throughout the soil solum, and while the bulk of that CEC is occupied by hydrogen and aluminum at the surface, acidic ions occupy less than half of the CEC at 50 cm, where the percentage base saturation is the highest (50% v. 21% at 10 cm). As a consequence, soil nutrients appear to be relatively abundant beneath the mucky surface layer. Soil copper and zinc levels are moderately high in the soils characterizing this community type, increasing with depth. As would be expected given the soil profile, soil humic matter content decreases markedly with depth. Soil bulk density is moderately high, and sand-sized particles dominate the soil in this community type at all measured depths.

(8) Succession & Disturbance

In contrast to this community type, the vast majority of water-filled Carolina bays located in the areas where this community type is found contain organic soils characterized by "pocosin" vegetation (see vegetation class 7.2, below). While the periphery of the basin where this community type predominates exhibits Pocosin vegetation, that vegetation type is not found in the central portion of the large depression where this community type is best developed. In this mid-depression location, the entire water column is subject to disturbance from wind-induced wave action. Presumably, it is the ongoing, mixing effect of this wind and wave action, coupled with the nature of the plant material growing in this community, that in large part are responsible for the lack of development of an organic soil in the depressions containing this community type (Wells, 1928, 1946).

Fire is essentially not a factor in this permanently flooded community. While water levels in the depression characterized by this community type would normally be subject to seasonal and periodic fluctuation, the water levels at this site -- and in most "lake-like" Carolina bays -- are controlled by sluice gates or dams to maintain relative hydrologic stability.

(9) Landscape Position

The community type "*Mayaca* Pond" is found only in the Inner Lower Coastal Plain (Table 4.3), and makes up 9 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over mixed, thermic Typic Psammaquent soils, which represents 1 of the 6 soil families found within sampled Inner Lower Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Three of 482 intensively sampled plots (0.6%), occurring in Carolina bays located in the northeastern portion of the study area, fall within this classification (Table 4.5; Figure 4.8). This community type comprises 27 percent of the sampled community types that make up the vegetation class. As noted, Carolina bays exhibiting Freshwater Pond vegetation are uncommon in the study area. Within the range of Freshwater Pond vegetation, this community type is rare. It is known to occur in only one Carolina bay, although it previously occurred in at least one other Carolina bay site within the study area (Radford, 1996).

(11) Conservation Status

This community type is currently known only from Ellis Lake, a privately owned Carolina bay. Although public access to the site is extremely limited, the depression communities have no legal protections other than those accorded to wetlands in general.

4.3.3.3 ANALYSIS

Vegetation Class Environmental Gradients

Freshwater Pond stands within the study area are distributed along a complex soil texture-nutrient/locational-hydrologic gradient (Figs. 4.9 and 4.10). Plots are located on the gradient principally by their relative values for site elevation and rotated longitude, soil drainage class, depth of organic-dominated layer, texture, and extractable phosphorus and manganese. Those factors are most strongly associated with the second compostional axis of the ordination diagram for this vegetation class.

*Nymphaea* Pond stands are found farther inland and south within study area Carolina bays, over better drained soils having a shallow organic-dominated layer, a silty particle texture, comparatively low phosphorus levels, but higher near-surface manganese levels. *Mayaca* Ponds, on the other hand, are located at near-coast, low elevations northern study area sites. Their soils have a deeper organic-dominated layer, but are sandy textured beneath that layer. Those soils show low levels of manganese, but comparatively high levels of surficial phosphorus.

Discussion

The Freshwater Pond vegetation class consists of two very different community types occurring in markedly different depression habitats. The *Nymphaea* Pond community type is relatively common and has been widely reported from Carolina bays and other southeastern depression types (*see*, *e.g.*, Gano, 1917; Eyles, 1941; Schalles *et al.*, 1989; Tyndall *et al.*, 1990; LaClaire, 1995). It is dominated primarily by aquatic geophyte and errant vascular cryptophyte plant life forms (Figure 4.11), and generally occurs over mineral soils having a shallow, peaty surface layer (Eyles, 1941; Nifong, personal observation). By contrast, the *Mayaca* Pond community type is rare within Carolina bays or other southeastern depressions. It occurs over sandy soils and is dominated by plant taxa that represent a much broader range of life forms (Figure 4.11).

As noted, both community types occur at sites characterized by extended hydroperiods, *i.e.*, that are semi-permanently flooded and draw down only rarely under natural conditions. However, *Nymphaea* Ponds typically occur in "ombrotrophic" (as used here, precipitation dominated) systems, and waters are generally dark and relatively turbid. *Mayaca* Ponds, on the other hand, appear to occur only within minerotrophic (spring-fed by water passing through mineral soil) water bodies, where the waters are crystal clear. While no measures of water chemistry were made during this study, the observed difference in water color and clarity between the two community types were marked. As previously noted, a community type similar to the *Mayaca* Pond has historically been reported from White Lake, located in the north central portion of the study area. White Lake has long been noted for its water clarity, which was observed to be the typical condition for the *Mayaca* Pond community type. Weiss and Kuenzler (1976) measured a Secchi depth -- *i.e.*, the maximum depth at which a white disc of specific size is visible from the surface of a water body -- of >3 m in White Lake, as compared to Secchi depths of 0.6 m or less in all dark-water Carolina bay lakes sampled. As noted previously, that water clarity allows the development of both surface and benthic aquatic zones within the *Mayaca* Pond community type.

Figure 4.8. Distribution of study area Carolina bay sites containing Freshwater Pond vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Freshwater Pond community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Freshwater Pond community types were observed during field reconnaissance for this study. Locations of individual, sampled Carolina bay sites are indicated by red circles.

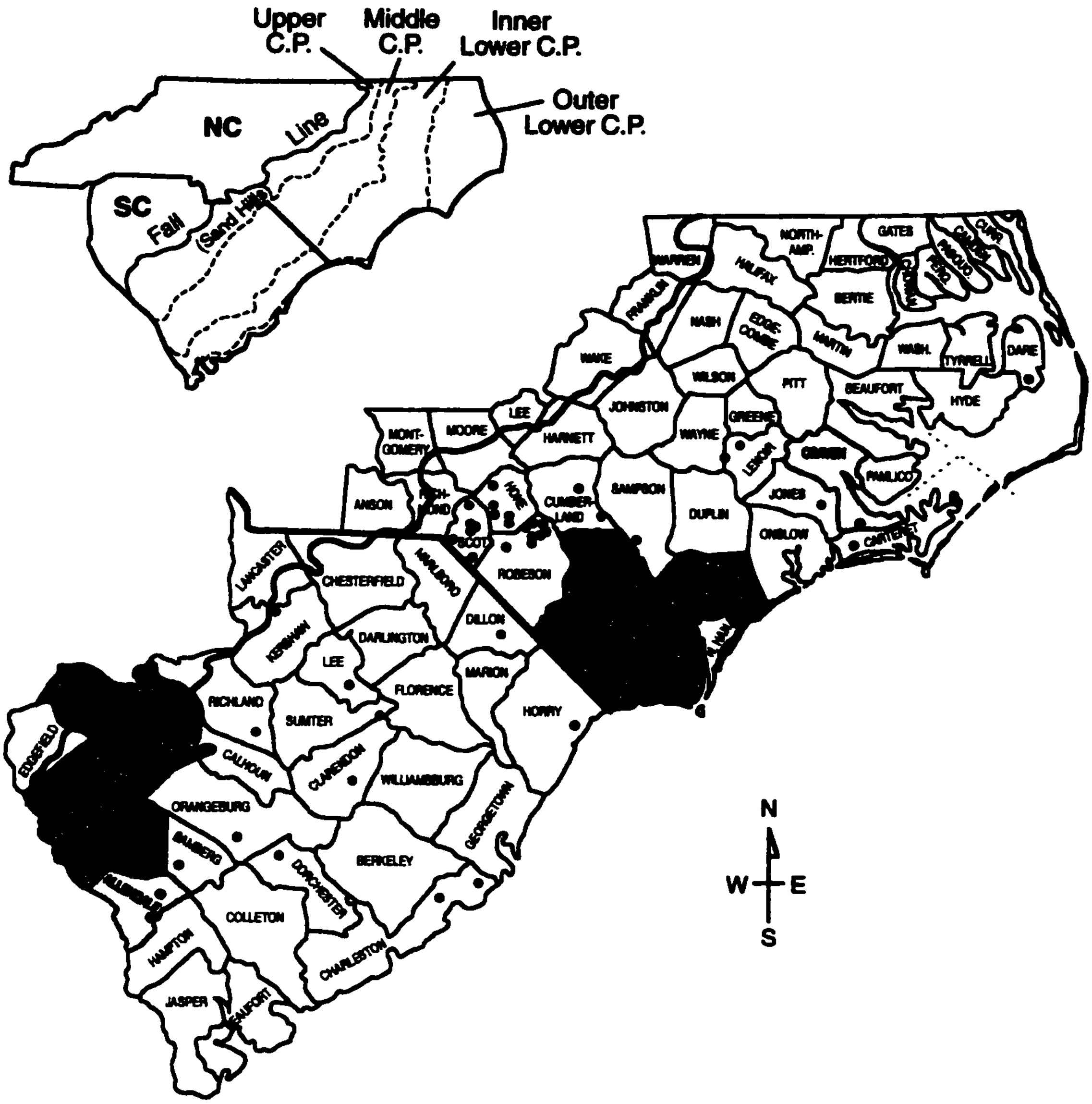

Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
Line
SC
Fall
(Sand Hills)
WARREN
NORTH-AMP.
GATES
HERTFORD
HALIFAX
BERTIE
FRANKLIN
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
LEE
MOORE
MONT-GOMERY
HARNETT
WAYNE
GREENE
LENOIR
CRAVEN
PAMLICO
SAMPSON
CUMBER-LAND
DUPLIN
JONES
ANSON
RICH-MOND
HOKE
SCOT
ONSLOW
CARTERET
ROBESON
LANCASTER
CHESTERFIELD
MARLBORO
DILLON
KERSHAW
DARLINGTON
LEE
MARION
RICHLAND
FLORENCE
SUMTER
HORRY
EDGEFIELD
CALHOUN
CLARENDON
WILLIAMSBURG
ORANGEBURG
GEORGETOWN
BAMBERG
BERKELEY
DORCHESTER
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

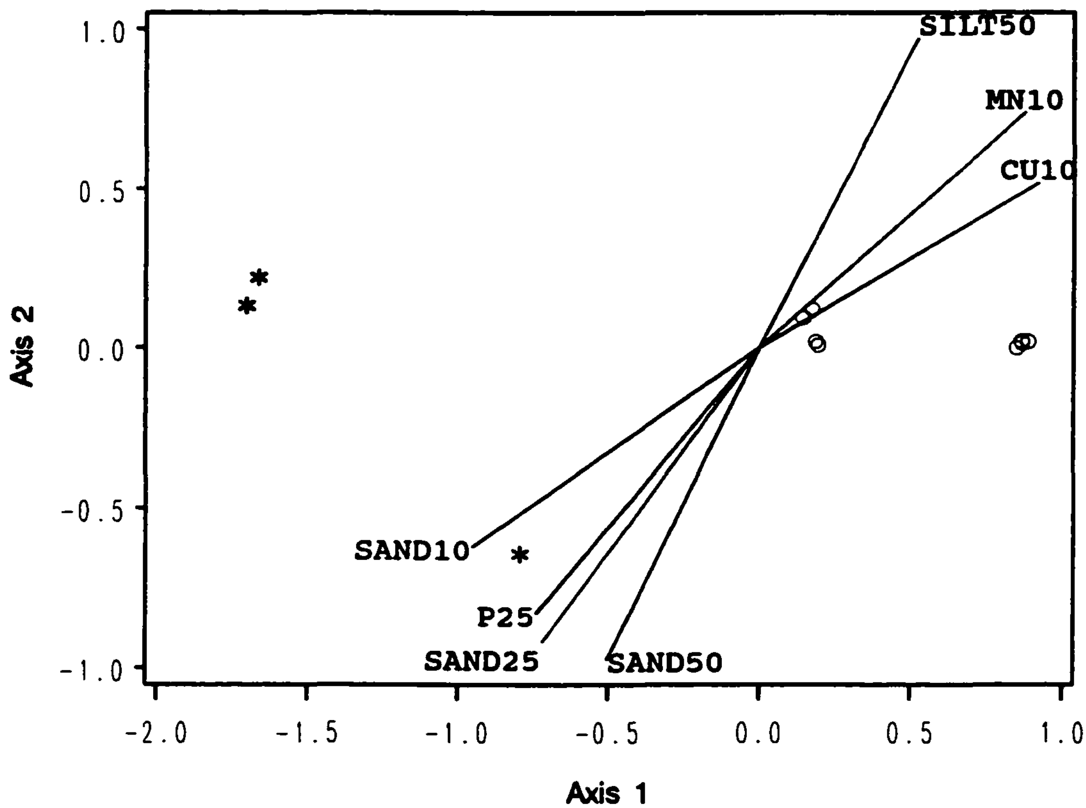
Table 4.10. Average cover class and constancy of species present in the Freshwater Pond vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | |
|---|---|---|---|---|---|---|
| | 3. | | 3.0.1 | | 3.0.2 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | |
| BRASENIA SCHREBERI | 6 | 55 | 7 | + | 5 | 67 |
| ELEOCHARIS EQUISETOIDES** | 8 | 9 | | | 8 | + |
| ELEOCHARIS ROBBINSII* # | 8 | 9 | | | 8 | 33 |
| ERIOCAULON PARKERI* | 4 | 27 | | | 4 | 100 |
| LEERSIA HEXANDRA | 3 | 73 | 3 | 100 | | |
| MAYACA FLUVIATILIS | 7 | 27 | | | 7 | 100 |
| NYMPHOIDES AQUATICA | 3 | 45 | 3 | + | | |
| NYMPHOIDES CORDATA** | 5 | 36 | 5 | + | | |
| NYMPHAEA ODORATA | 6 | 91 | 7 | 100 | 3 | 67 |
| PANICUM HEMITOMON | 4 | 82 | 4 | 75 | 4 | 100 |
| POLYGONUM HIRSUTUM* | 3 | 27 | 3 | 38 | | |
| PONTEDERIA CORDATA | 5 | 9 | | | 5 | + |
| POTAMOGETON CONFERVOIDES* | 5 | 18 | | | 5 | + |
| POTAMOGETON DIVERSIFOLIUS | 2 | 45 | 2 | + | | |
| UTRICULARIA FIBROSA | 5 | 55 | 5 | 75 | | |
| UTRICULARIA PURPUREA | 5 | 73 | 5 | 100 | | |
| XYRIS AMBIGUA | 3 | 9 | | | 3 | + |

Table 4.11. Average site information for the Freshwater Pond vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | |
|---|---|---|---|
| | 3. | 3.0.1 | 3.0.2 |
| Site Hydrology | | | |
| Water Depth Index | 206.4 | 182.4 | 230.3 |
| Hydroperiod Class | 5.0 | 5.0 | 5.0 |
| Water Constancy Index | 2.5 | 2.0 | 3.0 |
| Organic Layer Depth | 12.0 | 12.0 | 12.0 |
| Soil Drainage Class | 2.5 | 2.0 | 3.0 |
| Soil Permeability Class | 5.0 | 4.0 | 6.0 |
| Soil Available Water Capacity Class | 2.3 | 3.0 | 1.5 |
| | | | |
| Site Geomorphology | | | |
| Site Elevation (m) | 67.1 | 54.9 | 12.2 |
| Elevational Drop in 1 Km (m) | 6.6 | 12.2 | 1.5 |
| Distance to 10 m Elevational Drop (m) | 3175 | 900 | 5425 |
| Depression Area (ha) | 324.9 | 20.7 | 629.1 |
| Depression Length/Width Ratio | 1.4 | 1.4 | 1.4 |
| Depression Long Axis Orientation | +6.5 | +23.0 | -10.0 |
| | | | |
| Site Disturbance | | | |
| Fire Frequency Class | 4.0 | 4.0 | 4.0 |
| Cultivation Index | 1.5 | 2.0 | 1.0 |
| Grazing Index | 1.0 | 1.0 | 1.0 |
| Timbering Index | 1.0 | 1.0 | 1.0 |
| Drainage Index | 3.0 | 2.0 | 4.0 |
| Landscape Disturbance Class | 3.0 | 4.0 | 2.0 |

Figure 4.9. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Freshwater Pond stands as distributed by community type on the two major compositional gradients.

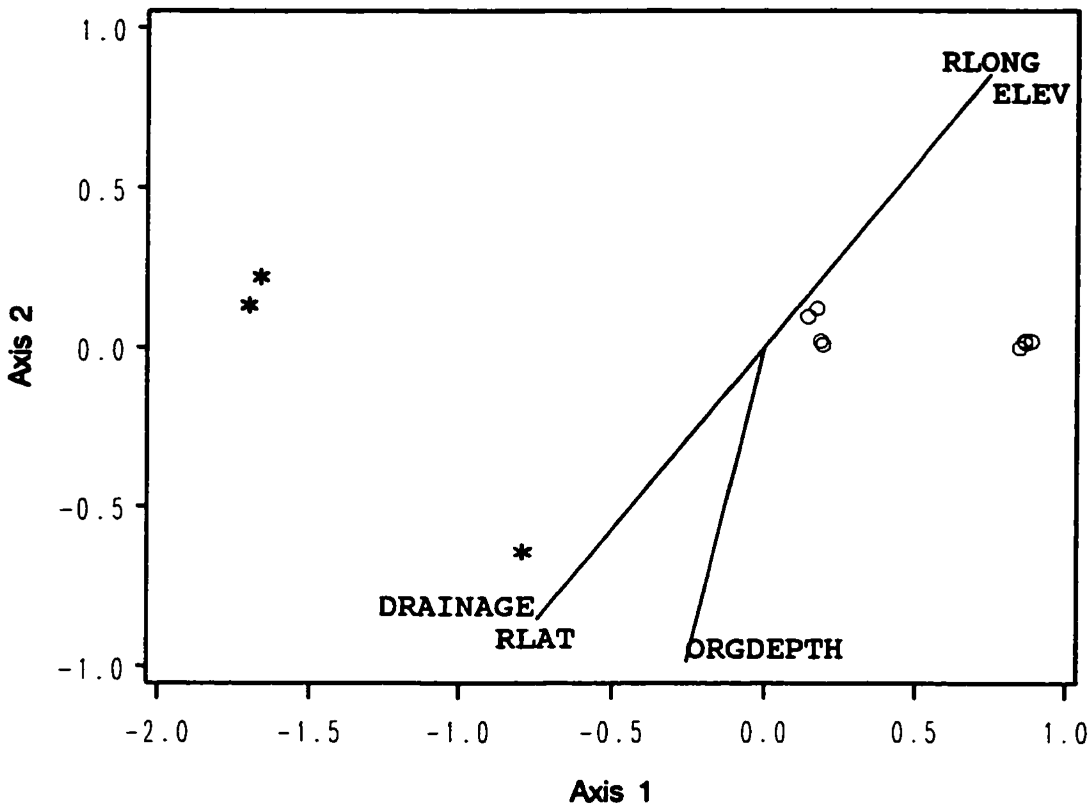



**FRESHWATER POND — Community Types:**

O Nymphaea Pond

* Mayaca Pond

Figure 4.10. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Freshwater Pond stands as distributed by community type on the two major compositional gradients.




**FRESHWATER POND — Community Types:**

O Nymphaea Pond
* Mayaca Pond

Figure 4.11. Plant Life Forms for Freshwater Pond vegetation groups found within North and South Carolina Carolina bay depressions.

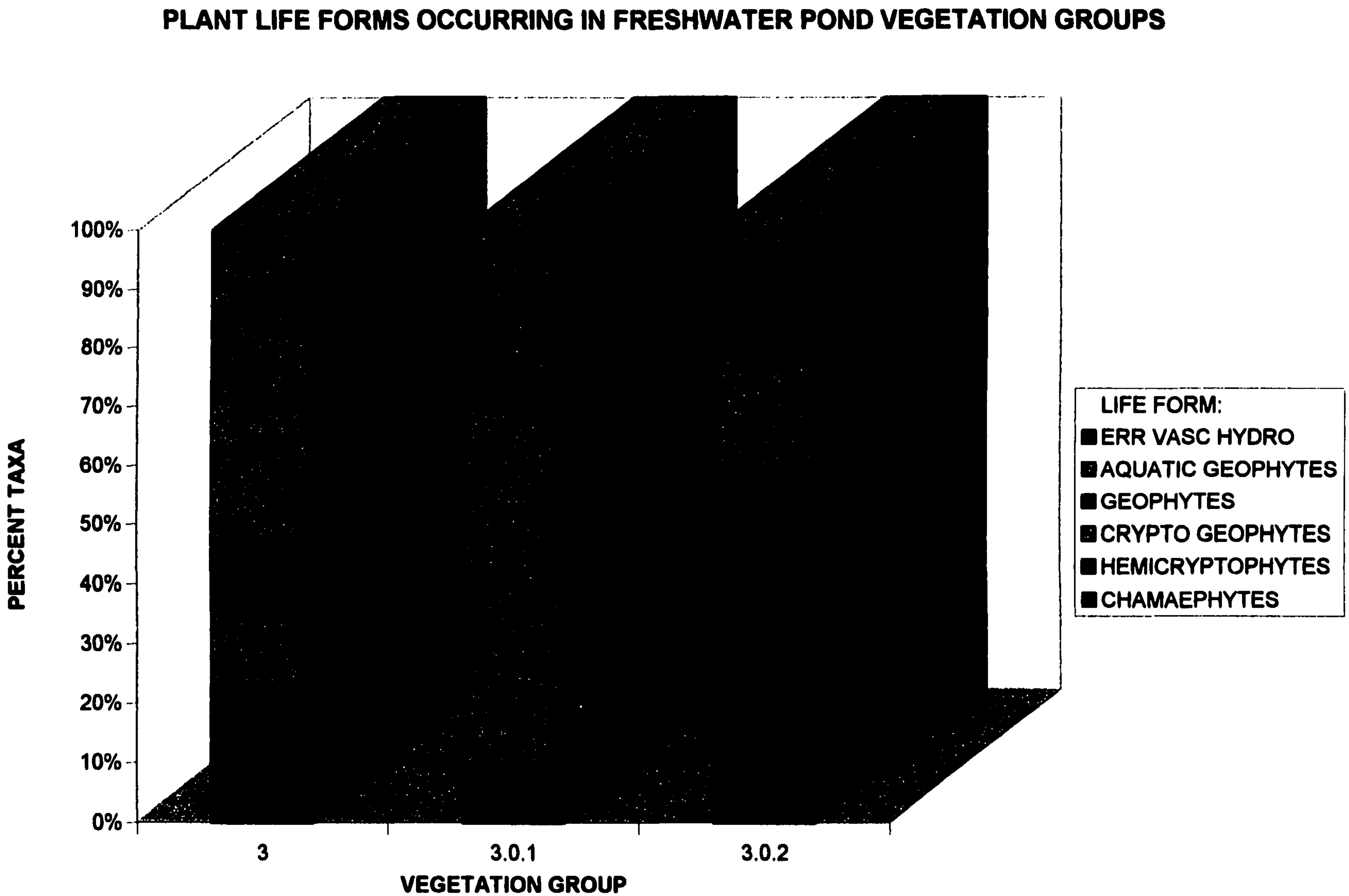
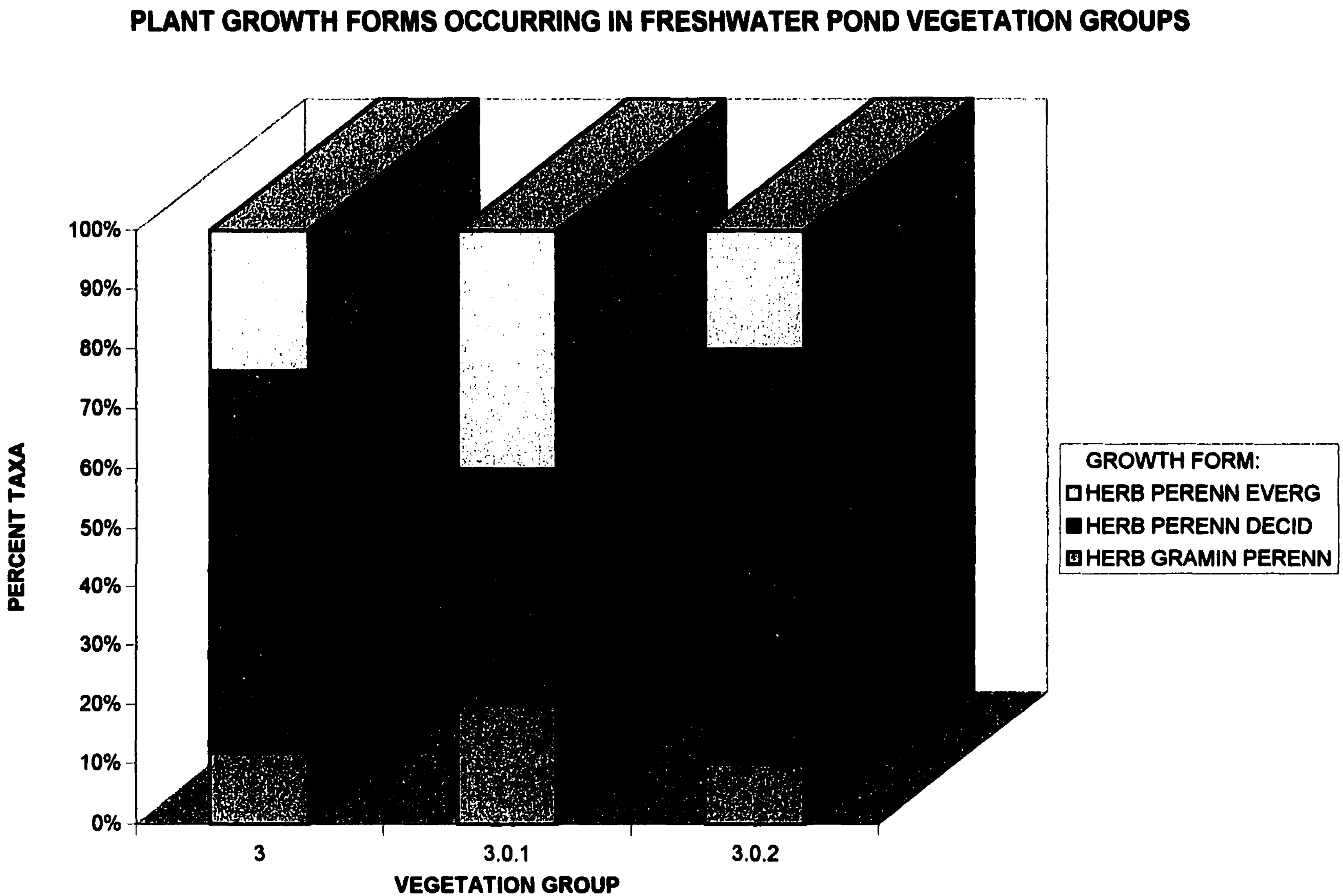

PLANT LIFE FORMS OCCURRING IN FRESHWATER POND VEGETATION GROUPS
PERCENT TAXA
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
3
3.0.1
3.0.2
VEGETATION GROUP
LIFE FORM:
ERR VASC HYDRO
AQUATIC GEOPHYTES
GEOPHYTES
CRYPTO GEOPHYTES
HEMICRYPTOPHYTES
CHAMAEPHYTES

Figure 4.12. Plant Growth Forms for Freshwater Pond vegetation groups found within North and South Carolina Carolina bay depressions.


PLANT GROWTH FORMS OCCURRING IN FRESHWATER POND VEGETATION GROUPS
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT TAXA
3
3.0.1
3.0.2
VEGETATION GROUP
GROWTH FORM:
HERB PERENN EVERG
HERB PERENN DECID
HERB GRAMIN PERENN

### 4.3.4 VEGETATION CLASS: **Freshwater Marsh (4.)**

Freshwater Marsh community types generally share a stable, moderately long hydroperiod, with water standing at or above the surface. As previously discussed, community types found within this vegetation class, along with Depression Prairies and Wet Meadows, have often been referred to as "depression meadows", but are significantly different from both of those vegetation groups. In part, they are characterized by higher species richness than that found in Depression Prairies, but lower species richness than that typifying Wet Meadow communities. Photographs of this vegetation class appear in Plate 5, following Chapter 7 below.

#### 4.3.4.1 COMMUNITY TYPE: ***Eleocharis robbinsii* Marsh (4.0.1)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Small Depression Pond, *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.12)

*Eleocharis robbinsii, Leersia hexandra*

(3) Special Status Species

*Andropogon gyrans* var. *stenophyllus, Bacopa caroliniana, Dichanthelium erectifolium, Eleocharis robbinsii, Hypericum fasciculatum, Rhynchospora inundata, Sagittaria isoetiformis, Xyris smalliana*

(4) Vegetation & Physiognomy

This community type is characterized by a single herbaceous layer wherein *Eleocharis robbinsii* is the dominant. *Leersia hexandra* and, where there is significant standing water, *Utricularia biflora* are typically also common vegetative components of this community type. A woody stratum is generally absent, although scattered, small specimens of *Nyssa biflora* or *Cephalanthus occidentalis* occur occasionally.

This community type exhibited low mean species richness at the 0.1 ha level, at 7.14 species (Table 4.2).

(5) Distinguishing Features

The Freshwater Marsh communities typically are wetter (*i.e.*, water characteristically stands at or above the surface continuously for longer periods of time) than Intermittently Flooded Depression Prairie community types. Community types within this vegetation class are generally distinguished by their dominants, usually a single herbaceous species with the ability to rapidly spread throughout the depression basin by way of vigorous vegetative growth. *Eleocharis robbinsii* was observed in the field to spread rapidly both by subsurface rhizomes and by "tip rooting" of decumbent, vegetative stems.

<u>(6) Habitat</u>

This community type generally occurs in small, "inland" depressions having poorly drained, mineral soils (described below) with a thick organic-dominated surface layer *ca.* 25 cm (Table 4.13; Figure 4.15). The community type site is characterized by a fluctuating water table and is typically located on land surfaces with moderate relief. On average, water stood some 28 cm above the surface of this community type at the time of sampling.

<u>(7) Soils</u>

This community type occurs both over a fine-loamy, siliceous, thermic Typic Paleaquult soil, and over an "argillic variant" (*see*, Lawrence, 1976) of a sandy, siliceous, thermic Typic Haplaquod soil (Table A-II-1). A representative general profile for the Typic Paleaquult portion of the soil characterizing this community type is described in Appendix II for CT 2.0.1, discussed above. As to Typic Haplaquods, they are the mid-latitude, wet Spodosols occurring where there is a shallow, fluctuating water table (Soil Survey Staff, 1975). The "spodic" horizon characteristic of these soils is a subsurface, eluvial zone where amorphous mixtures of organic matter and aluminum (without iron in southeastern United States soils) has accumulated (Buol *et al,* 1980). Spodic horizons indicate a fluctuating water tables, as they do not seem to develop in a soil that is permanently saturated with water (Soil Survey Staff, 1975). The "argillic" variant of a Typic Haplaquod soil that was found to underlie this community type is described in Appendix II.

This latter pedon represents a taxonomically problematical soil that needs additional investigation. It appears to have a subsoil, clayey layer that qualifies as an argillic horizon, that itself overlies a spodic horizon. Current soil classification terms a spodic horizon overlying an argillic horizon an "Ultic Spodosol", but makes no provision for the reverse situation, as appears to occur in this case.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is very strongly acid, increasing slightly with depth. The CEC is low to very low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum. Major cations (plant nutrients) comprise only a very small portion of the CEC. Copper and zinc are relatively abundant in the soils characterizing this community type, though zinc levels decrease with depth. Soil bulk density is low at the surface, nearly tripling to moderately high at 50 cm. Silt-sized particles dominate the upper portions of the soil solum but sand-sized particles predominate at 50 cm.

(8) Succession & Disturbance

Freshwater Marshes within Carolina bays tend to show little or none of the "invasion" by *Pinus* spp. seedlings characteristic of Intermittently Flooded Depression Prairies, or the invasion by *Pinus taeda* and *Liquidambar styraciflua* seedlings typical of Intermittently Ponded Cypress/Gum Depressions (discussed later in this chapter). This presumably occurs because sites characterized by Freshwater Marshes exhibit fewer, and less prolonged drawdown periods than do depressions characterized by Prairie and Cypress/Gum communities. Kirkman (1992) found that the seeds of *Pinus* spp. do not persist in the seedbanks typical of small Carolina bay wetlands. As noted, small, scattered specimens of *Nyssa biflora*, and less frequently, *Cephalanthus occidentalis*, are the only woody species characteristic of these marsh sites.

As indicated in Table 4.13, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively infrequent in this community type, occurring at intervals of every 10 to 25 years, presumably during prolonged drought periods. However, charcoal is less often identifiable in the soils of this community type and rim area tree bases are less often fire-scarred than is true for the Intermittently Flooded Depression Prairie communities previously discussed. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

*Eleocharis robbinsii* Marshes are found in Carolina bays in the Middle Coastal Plain (Table 4.3), and make up less than 3 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, these marshes are found over two soil types -- fine-loamy, siliceous, thermic Typic Paleaquults (56%), and sandy, siliceous, thermic Typic Haplaquods (44%). Each soil represents 1 of 12 soil families found within sampled Middle Coastal Plain Carolina bays, though Ultisols are far more common than Spodosols on that landform surface (Table 4.4).

(10) Distribution & Abundance

Nine of 482 intensively sampled plots (1.9%), occurring in Carolina bays scattered within the central portion of the study area, fall within this classification (Table 4.5; Figure 4.13). This community type comprises 21 percent of the sampled community types that make up the vegetation class. Like Intermittently Flooded Depression Prairie community types, the occurrence of this vegetation class within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays.

4.3.4.2 COMMUNITY TYPE: ***Panicum hemitomon* Marsh** (4.0.2)

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Cypress Savanna, Depression Meadow Variant, *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.12)

*Panicum hemitomon*

(3) Special Status Species

*Eleocharis robbinsii, Lobelia boykinii, Ludwigia suffruticosa, Polygonum hirsutum, Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is characterized by a single, approximately 1.0 m tall herbaceous stratum dominated by dense, monospecific stands of *Panicum hemitomon*, *i.e.*, typically to the exclusion of other herbaceous species. Woody strata are completely absent from this community type.

This community type exhibited very low mean species richness at the 0.1 ha level, at 3.13 species (Table 4.2).

(5) Distinguishing Features

As previously noted, the Freshwater Marsh communities typically are wetter (*i.e.*, water characteristically stands at or above the surface continuously for longer periods of time) than Intermittently Flooded Depression Prairie community types. Community types within the vegetation class are generally distinguished by their dominants, usually a single herbaceous species with the ability to rapidly spread throughout the depression basin by way of vigorous vegetative growth. *Panicum hemitomon* is especially characterized by rapid, robust vegetative growth under favorable hydroperiod conditions in wetlands characterized by a fluctuating water table (Kirkman, 1992).

(6) Habitat

This community type generally occurs in small, depressions having poorly drained, mineral soils (described below) with a relatively thin organic-dominated surface layer (*ca.* 8 cm) (Table 4.13). The community type site is characterized by a fluctuating water table and is typically located on land surfaces with moderate relief. On average, water stood some 21 cm above the surface of this community type at the time of sampling, but varied from 3 cm to >40 cm in depth.

(7) Soils

Two types of soils were encountered underlying this community type within sampled depressions: poorly drained, fine-loamy, siliceous, thermic Typic Paleaquults; and clayey, kaolonitic, thermic Typic Fragiaquults (Table A-II-1). Typic Fragiaquults are wet, clayey, low nutrient soils similar to Paleaquults, but are distinct in having a subsurface "fragipan" layer. A fragipan is a mottled, brittle, loamy subsurface horizon that has a very low organic matter content, has high soil bulk density relative to overlying horizons, and is seemingly cemented when dry (Soil Survey Staff, 1975). It is known to impede both the movement of water and the growth of plant roots. A general description of a Typic Paleaquult soil similar to that found beneath this community type is provided in Appendix II for CT 2.1, discussed above. Similarly, a general description of the Typic Fragiaquult found beneath this community type is also found in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is very strongly acid to strongly acid, increasing slightly with depth. The CEC is very low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum. Soil bulk density is moderately high, and silt-sized particles dominate the soil in this community type at all depths.

(8) Succession & Disturbance

Once established, this community type tends to persist for long periods of time, although its areal extent within a given depression characteristically expands or contracts with the site's fluctuating water table. Kirkman (1992) found that the dominance of this community type tends to decline within Carolina bays where the winter water level is higher than the stems of the preceding year's growth, presumably indicating some role by those stems in overwintering of the species.

As discussed above, Freshwater Marshes within Carolina bays tend to show little or none of the "invasion" by *Pinus* spp. seedlings characteristic of Intermittently Flooded Depression Prairies, or the invasion by *Pinus taeda* and *Liquidambar styraciflua* seedlings typical of Intermittently Ponded Cypress/Gum Depressions (discussed later in this chapter). Also as previously noted and as indicated by Table 4.13, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively infrequent in this community type, occurring at intervals of every 10 to 25 years, presumably during prolonged drought periods. However, as in *Eleocharis robbinsii* Marshes, charcoal is less often identifiable in the soils of this community type, and rim area tree bases are less often fire-scarred than is true for most of the Intermittently Flooded Depression Prairie communities. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

*Panicum hemitomon* Marshes are found within study area Carolina bays located in the Middle Coastal Plain (Table 4.3), and make up 3 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, these marshes are found over two soil types -- fine-loamy, siliceous, thermic Typic Paleaquults (64%), and clayey, kaolonitic, thermic Typic Fragiaquults (36%). Both soil types are common within sampled Middle Coastal Plain Carolina bay depressions, and represent 2 of the 12 soil families observed in bay depressions located on that surface (Table 4.4).

(10) Distribution & Abundance

Eleven of 482 intensively sampled plots (2.3%), occurring in 5 Carolina bays located in both North and South Carolina, fall within this classification (Table 4.5; Figure 4.13). This community type comprises 25 percent of the sampled community types that make up the vegetation class. It is likely the most common of the Freshwater Marsh community types in Carolina bays. *Panicum hemitomon* Marsh has been noted in Carolina bays as far north as the Eastern Shore of Maryland (Tyndall *et al*., 1986). It is also common in Carolina bays in the southwestern coastal plain of South Carolina (Kirkman, 1992), and occurs in similar depression habitats in the Florida Panhandle (LaClaire, 1995). Nonetheless, as previously noted, Freshwater Marsh communities are not widespread in Carolina bays as a whole.

(11) Conservation Status

Examples of this community type are currently protected within study area Carolina bays, both in North and South Carolina.

4.3.4.3 COMMUNITY TYPE: ***Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh (4.0.3)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Small Depression Pond, *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.12)

*Eleocharis melanocarpa, Leersia hexandra, Ludwigia sphaerocarpa, Polygonum persicaria*

(3) Special Status Species

*Bacopa caroliniana, Eleocharis melanocarpa, Ludwigia sphaerocarpa, Luziola fluitans, Nymphoides cordata*

(4) Vegetation & Physiognomy

This community type is dominated by a "bi-layered" herbaceous stratum, with *Ludwigia sphaerocarpa* to 1 m tall overtopping decumbent *Leersia hexandra*. *Polygonum persicaria* is sometimes a co-dominant in the lower herbaceous layer, and *Proserpinaca pectinata* may be a significant component of that layer. Woody strata are absent, though occasional small specimens of *Nyssa biflora* occur within this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 14.74 species (Table 4.2).

(5) Distinguishing Features

This community type was the only one sampled exhibiting a soil having an ochric epipedon, and therefore less of a surface organic layer than is usual Carolina bay depressions having mineral soils. As noted previously, Freshwater Marsh communities typically are wetter (*i.e.*, water characteristically stands at or above the surface continuously for longer periods of time) than Intermittently Flooded Depression Prairie community types, and community types within the vegetation class are generally distinguished by their dominants. Like its immediate predecessor, dominants here are those herbaceous species with the ability to spread throughout the depression basin by way of rapid vegetative growth. Within this community type, *Ludwigia sphaerocarpa* was observed to spread by vigorous stoloniferous growth, and *Polygonum persicaria* was observed to "root as it goes" from leaf nodes along decumbent stems.

(6) Habitat

This community type inhabits small, upland (elevation = *ca.* 192 m) depressions having poorly drained but highly permeable, mineral soils (described below) with a thin organic-dominated surface layer (Table 4.13; Figure 4.15). The community type site is characterized by a moderately fluctuating water table and is found on land surfaces with substantial relief. On average, water stood some 20 cm above the surface of this community type at the time of sampling.

(7) Soils

The soils encountered within this community type are fine-loamy, siliceous, thermic Typic Ochraquult soils (Table A-II-1). Typic Ochraquults are poorly-drained, wet soils similar in may ways to Paleaquults and Fragiaquults, but distinct from them in lacking a fragipan and an abrupt textural change at the top of the argillic horizon, and having an "ochric" epipedon, *i.e.*, a relatively thin, light-colored, surface horizon with a low organic matter content. The Typic Ochraquult soil underlying this community type is described in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is very strongly acid throughout. The CEC is very low throughout the soil solum, and while the vast bulk of that CEC is occupied by hydrogen and aluminum at the surface, acidic ions occupy less than half of the CEC at 50 cm. The percentage base saturation in this community type is, on average, twice that found in Intermittently Flooded Depression Prairie communities. Copper levels are extremely high near the surface of the soil characterizing this community type, and manganese levels at all soil depths are the highest of any recorded during this study. Soil bulk density within the soils underlying this community type is moderately high. Silt-sized particles dominate the soil solum, although the relative proportion of sand increases with increasing soil depth.

(8) Succession & Disturbance

As discussed above, Freshwater Marshes within Carolina bays tend to show little or none of the "invasion" by *Pinus* spp. seedlings characteristic of Intermittently Flooded Depression Prairies, or the invasion by *Pinus taeda* and *Liquidambar styraciflua* seedlings typical of Intermittently Ponded Cypress/Gum Depressions (discussed later in this Chapter). This lack of woody species may be the result of a relatively stable site ambient water level that provides few opportunities for woody species invasion. As indicated by Table 4.13, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common. This community type had relatively recently been exposed to livestock (cattle) grazing. As with other communities within this vegetation class, fire is relatively infrequent in this community type, presumably occurring only during prolonged drought periods. This community type occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

*Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marshes occur in Carolina bays in the Upper Coastal Plain (Table 4.3), and make up 23 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, these marshes are found over fine-loamy, siliceous, thermic Typic Ochraquults, which comprise 1 of 5 soil families found within sampled Upper Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in the southwestern portion of the study area, fall within this classification (Table 4.5; Figure 4.13). This community type comprises 19 percent of the sampled community types that make up the vegetation class. This community type is not known from other Carolina bays within the study area, although the dominant species occur in ditches or other wet habitats within the region. As noted, the occurrence of Freshwater Marshes within Carolina bays is infrequent at best, and *Panicum hemitomon* Marsh predominates.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays.

4.3.4.4 COMMUNITY TYPE: ***(Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marsh"** (4.0.4)

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.12)

*Andropogon virginicus* var. *glaucus, Eleocharis melanocarpa, Leersia hexandra*

(3) Special Status Species

*Eleocharis melanocarpa, Ludwigia suffruticosa, Nymphoides cordata, Xyris smalliana*

(4) Vegetation & Physiognomy

This community type is typified by a sparse, "bi-layered" herbaceous stratum dominated by a very open, *ca.* 1 m tall mixture of *Andropogon virginicus* var. *glaucus* and *Euthamia tenuifolia*, overtopping *ca.* 0.25 m tall, scattered, but dense patches of *Eleocharis melanocarpa*. Strata of woody species are generally absent within this community type, although saplings of *Pinus palustris* may periodically assume some importance.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.09 species (Table 4.2).

(5) Distinguishing Features

As noted, Freshwater Marsh communities typically are wetter than Intermittently Flooded Depression Prairie community types, community types are distinguished by their dominants, and the dominants are usually one or more herbaceous species with the ability to rapidly spread throughout the depression basin by way of vigorous vegetative growth. This general characterization of the vegetation class is perhaps somewhat less true of this community type -- *Eleocharis melanocarpa* (very much on the increase within these sites) spreads rapidly by rhizomes and "tip rooting", but *Andropogon virginicus* var. *glaucus* (very much on the decline within these sites at the time of sampling, with most stems dead) appears to have derived from seedlings that invaded the sites during unusual periods of prolonged drawdown.

(6) Habitat

This community type generally occurs in small, "inland" depressions having poorly drained, mineral soils (Table 4.13, Figure 4.15). The community type site is characterized by a fluctuating water table and is typically located on upland (elevation = *ca.* 100.6 m) land surfaces with moderate relief. On average, water stood some 34 cm above the surface of this community type at the time of sampling.

(7) Soils

This community type was found to occur primarily over poorly drained, fine-loamy, siliceous, thermic Typic Paleaquult soils, but clayey, kaolonitic, thermic Typic Fragiaquult soils also comprise a significant portion of the soils found underlying this community type (Table A-II-1). A general description of the former soil family is found in Appendix II for CT 2.0.1, discussed above, and a general description of the latter soil family is found in Appendix II for CT 4.0.2, also discussed above.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for Community Types 2.1 and 4.2, above (*see* Tables A-II-2 to A-II-7).

(8) Succession & Disturbance

As discussed previously, Freshwater Marshes within Carolina bays tend to show little or none of the "invasion" by *Pinus* spp. seedlings characteristic of Intermittently Flooded Depression Prairies, or the invasion by *Pinus taeda* and *Liquidambar styraciflua* seedlings typical of Intermittently Ponded Cypress/Gum Depressions (discussed later in this chapter). However, as noted above, this community type appears to be transitional in nature. The now largely dead *Andropogon* component likely occupied the site as the result of "old field" type succession during a period of prolonged drawdown. By contrast, *Eleocharis melanocarpa* is the true "marsh" component of the dominant vegetation. *Pinus* seedlings may also periodically occur in these sites, apparently also entering during periods of prolonged drought, but tend to be eliminated following rehydration and several successive seasons of site flooding.

As indicated by Table 4.13, the sites inhabited by this community type show little or no evidence of past cultivation, grazing, timbering, or drainage Fire is relatively more frequent in this community type than others within this vegetation class, probably due to its characteristic location with landscapes dominated by Longleaf Pine communities. Fires presumably occur during prolonged drought periods. This community type occurs in small depressions, and the surrounding landscape is generally less highly disturbed by human land altering activities than other community types within this vegetation class.

(9) Landscape Position

This community type is found primarily among sampled Carolina bays of the Upper Coastal Plain (71%), and to a lesser extent, in the Middle Coastal Plain (21%) (Table 4.3). (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marshes" make up 14 percent of sampled Carolina bay vegetation found within the Upper Coastal Plain, but less than 1 percent of sampled vegetation in the Middle Coastal Plain. The community type is found over two soil types -- fine-loamy, siliceous, thermic Typic Paleaquults (71%), and clayey, kaolonitic, thermic Typic Fragiaquults (29%). Ultisols are the most common soil type found within both sampled Middle Coastal Plain and sampled Upper Coastal Plain Carolina bays. They represent 7 of 12 soil families observed in the Middle Coastal Plain, and 3 of 5 soil types sampled in Upper Coastal Plain bays (Table 4.4).

(10) Distribution & Abundance

Seven of 482 intensively sampled plots (1.5%), occurring in Carolina bays located in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.13). This community type comprises 16 percent of the sampled community types that make up the vegetation class. This is an uncommon Freshwater Marsh community type, particularly since it appears to be "transitional" in nature towards other community types. As noted, the occurrence of Freshwater Marshes within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

An example of this community type occurs within a State-owned Carolina bay within the study area, in an area managed as a "Game Land".

4.3.4.5 COMMUNITY TYPE: ***Liquidambar-Pinus taeda*** **"Successional Marsh"** (4.0.5)

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.12)

*Liquidambar styraciflua, Pinus taeda*

(3) Special Status Species

*Echinodorus parvulus, Eleocharis melanocarpa*

(4) Vegetation & Physiognomy

This community type is characteristically dominated by a cover of *Liquidambar styraciflua* and *Pinus taeda* saplings and small trees that ranges from fairly open to dense, sometimes to the complete exclusion of herbaceous species. Those saplings and small trees are generally less than 5 m in height. No shrub or herbaceous strata are normally present within this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 7.92 species (Table 4.2).

(5) Distinguishing Features

As previously discussed, sampled Freshwater Marsh communities are typically wetter than Intermittently Flooded Depression Prairie community types. However, this is the "driest" of the community types within this vegetation class, tending to become established and persist only during and immediately following periods of prolonged drought. This community is "successional" in nature, as its name indicates, and is the only woody community type within the vegetation class.

(6) Habitat

This community type generally occurs in small, depressions characterized by a fluctuating water table, located on land surfaces with moderate relief, and having poorly drained, mineral soils (described below) (Table 4.13; Figure 4.15). On average, water stood only some 5 cm above the surface of this community type at the time of sampling.

(7) Soils

This community type usually occurs over poorly drained, clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). A general description of that soil family is found in Appendix II under CT 4.0.2. In addition, fine-loamy, siliceous, thermic Typic Paleaquults; clayey, kaolonitic, thermic Typic Paleaquults; and sandy, siliceous, thermic Typic Haplaquods are each found to underlie plots comprising this community type. A general description of each of those soils can also be found in Appendix II.

Although soil cores were extracted and the resulting profile described at this site, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type can reasonably be presumed to be very similar to those described previously for similar soil types.

(8) Succession & Disturbance

As discussed previously, Freshwater Marshes within Carolina bays tend to show little or none of the "invasion" by woody species seen in Depression Prairies, principally because those Marshes are characterized by standing water at most times. However, like its immediate predecessor, this community type appears to be transitional in nature between the marsh communities found throughout much of the depression basin and the surrounding upland communities. It typically occupies the periphery of the depression sites at which it occurs, and the seedlings of constituent species become established in very concentrated zones during periods of prolonged drawdown. The densely populated zones apparently occur as the result of large numbers of "wind-rowed", floating seeds being deposited at the water/soil interface as drawdown occurs. *Pinus taeda* tends to be rather quickly eliminated from the community following rehydration and several successive seasons of site flooding, but *Liquidambar* may persist at the site for more extended periods of time.

Similar to most other plant communities within this vegetation class and as indicated by Table 4.13, the sites inhabited by this community type show little or no evidence of past cultivation or timbering, though shallow drainage ditches are common, and many areas show old fence lines or other evidence of past usage for grazing. Fire is relatively infrequent in this community type, occurring at intervals of every 10 to 25 years, presumably during prolonged drought periods. This community type also occurs in small depressions, and the surrounding landscape is generally highly disturbed by human land altering activities.

(9) Landscape Position

The community type "*Liquidambar-Pinus taeda* 'Successional Marshes'" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and make up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over a variety of soil types -- clayey, kaolonitic, thermic Typic Fragiaquults (63%); fine-loamy, siliceous, thermic Typic Paleaquults (13%); clayey, kaolonitic, thermic Typic Paleaquults (13%); and sandy, siliceous, thermic Typic Haplaquods (13%). Ultisols were the most common soil type found in sampled Middle Coastal Plain Carolina bays, while Spodosols were relatively rare on that surface (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in Carolina bays located in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.13). This community type comprises 19 percent of the sampled community types that make up the vegetation class. Like its immediate predecessor within this vegetation class, this is an uncommon Freshwater Marsh community type, particularly since it appears to be "transitional" in nature towards other community types. As noted, the occurrence of Freshwater Marshes within Carolina bays and similar depressional communities is infrequent at best.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays.

4.3.4.6 ANALYSIS

Vegetation Class Environmental Gradients

Study area Freshwater Marsh stands are distributed along both an elevational/surface nutrient gradient and an orthogonal hydrologic gradient (Figs. 4.14 and 4.15). Plots are located on the first gradient principally by their relative values for site elevation and longitude, degree of local relief, and surficial sol levels of magnesium. Those factors are correlated with both compositional axes on the ordination diagram for Freshwater Marsh plots. Stands are distributed along the second gradient by their comparative scores for depth of organic-dominated layer and site ambient water level. The factors comprising the latter gradient are also associated with both compositional axes.

Within study area Freshwater Marsh community types, *Eleocharis robbinsii* Marshes are found at relatively low elevation, eastern sites on soils with the deepest organic-dominated layer. *Panicum hemitomon* Marshes are typified by a substantial organic-dominated layer, but on sites with relatively low magnesium levels and high subsurface phosphorous levels. *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh plots are found at relatively high elevation, inland sites having significant local relief, over soils with comparatively high surface magnesium levels. (*Andropogon virginicus* var. *glaucus*)/ (*Eleocharis melanocarpa*) "Successional Marsh" stands tend to be similarly situated to *Ludwigia* Marshes along the environmental gradients that characterize this vegetation class. *Liquidambar--Pinus taeda* "Successional Marsh" plots are found most frequently at intermediate elevation sites on soils having comparatively negligible organic-dominated layers. However, as might be expected of a successional community, they occur over a comparatively broad portion of the environmental gradient spectrum within the vegetation class.

Discussion

It should be noted at the outset that Freshwater Marsh community types are most frequently encountered in relatively steep-walled bay depressions having a fluctuating, perched ambient site water table. In addition to the "inter-plot" environmental gradients discussed above, these sites exhibit a natural moisture (hydrologic) gradient, moving from the center of the depression to its outer edges. Freshwater Marsh communities typically occur as concentric bands of vegetation around the central pool of water (or moist soil).

In the manner of the Depression Prairie community types discussed previously, the first three community types described for the Freshwater Marsh vegetation class are "typic" community types for the class, while the latter two community types may represent "successional" communities that occur when wetland sites are invaded by plant propagules from surrounding upland species during periods of prolonged drought. All three "typic" community types exhibit species dominants that are "opportunists", *i.e.*, species capable, under favorable hydrologic conditions, of spreading rapidly via vegetative growth to occupy the full extent of the areas exhibiting those conditions. *Panicum hemitomon* marsh is the most widespread and dominant of the Freshwater Marsh community types found within study area Carolina bays. It occurs in bay depressions characterized by a fluctuating water table from the Eastern Shore of Maryland (*see* Tyndall *et al*., 1990) to the Florida Panhandle (LaClaire, 1995). *Panicum hemitomon* exhibits rapid rhizomatous growth under favorable conditions, and is often observed in the field to displace virtually every species in its path. In addition, *Panicum hemitomon* is relatively drought and fire tolerant, and shows the ability, through stem elongation, to survive in a wide variety of water depths (Kirkman, 1992; Kirkman and Sharitz, 1994). The significance of this species' ability to persist under a variety of less favorable environmental conditions, but to rapidly colonize a site vegetatively once conditions improve, is enhanced in view of the finding that it produces few progeny by seed (Kirkman and Sharitz, 1994; Radford, 1995).

By contrast, *Eleocharis robbinsii* Marsh appears to be a post-drawdown community type, becoming best developed at sites that have become reinundated following a period of extensive drought, and exhibit a shallow, relatively constant surface water level. The dominant species has been observed to have a remarkable capacity to cover a site, spreading rapidly through a combination of stoloniferous growth and "tip rooting" of decumbent stems. *Sagittaria isoetiformis* was frequently encountered as an associate species at *Eleocharis robbinsii* dominated depression sites. Kirkman and Sharitz (1994) determined during seedbank studies of Carolina bay Freshwater Marsh sites in the southern portion of the study area that unflooded seeds of *Sagittaria isoetiformis*, *Echinodorus parvulus*, *Eleocharis tricostata*, *Potamogeton diversifolius* and *Xyris* spp. will not germinate. In light of the seasonal and annual variability in site hydrologic regimes, that finding helps to explain why many Freshwater Marsh species and other wetland species associated with Carolina bay depressions may be found abundantly at a site in a given point in time, "disappear" from the site flora for a period of years, and then "reappear"in abundances similar to those observed initially.

*Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marshes are rare in study area Carolina bays and observations are consequently limited. However, Tyndall *et al.* (1986) found *Ludwigia sphaerocarpa* to be a subdominant species in the most hydric zone of a Carolina bay freshwater marsh in Maryland. As a Freshwater Marsh community dominant, *Ludwigia* appears to occupy a similar niche to that of *Eleocharis robbinsii*, being best developed in reinundated, post-drought sites. *Ludwigia sphaerocarpa* also spreads rapidly by the prolific production of basal offshoots.

As discussed for the "successional" Depression Prairie community types, the two "Successional Marsh" community types in this vegetation class appear to originate during extended drought periods that afford less moisture tolerant species from surrounding uplands the opportunity type invade the exposed depression floor. If the drought is prolonged prior to significant reinundation, the invading species may become established, and may persist once reflooding does occur. Within study area Carolina bays, *Andropogon virginicus* var. *glaucus* commonly invades Freshwater Marshes during drawdowns, but is "pushed outwards" or killed outright, dependent on the amplitude of flooding, when a site is reinundated.

The various community types comprising this vegetation class also show significant differences in terms of component taxa. The *Liquidambar-Pinus taeda* "Successional Marsh" community type exhibits a much higher proportion of phanerophyte taxa than other community types, which tend to be dominated by geophyte taxa (Figure 4.16). Among these four community types, therophyte and hemicryptophyte species are most numerous in the *Ludwigia* dominated marsh, while chamaephytic geophytes are more important in the remaining three vegetation groups. In all Freshwater Marsh community types other than the

*Liquidambar-Pinus taeda* "Successional Marsh", which is characterized by a prevalence of woody growth form dominants, plant growth forms are primarily perennial forbs and graminoids (Table 4.17).

Figure 4.13. Distribution of study area Carolina bay sites containing Freshwater Marsh vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Freshwater Marsh community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Freshwater Marsh community types were observed during field reconnaissance for this study. Locations of individual, sampled Carolina bay sites are indicated by red circles.

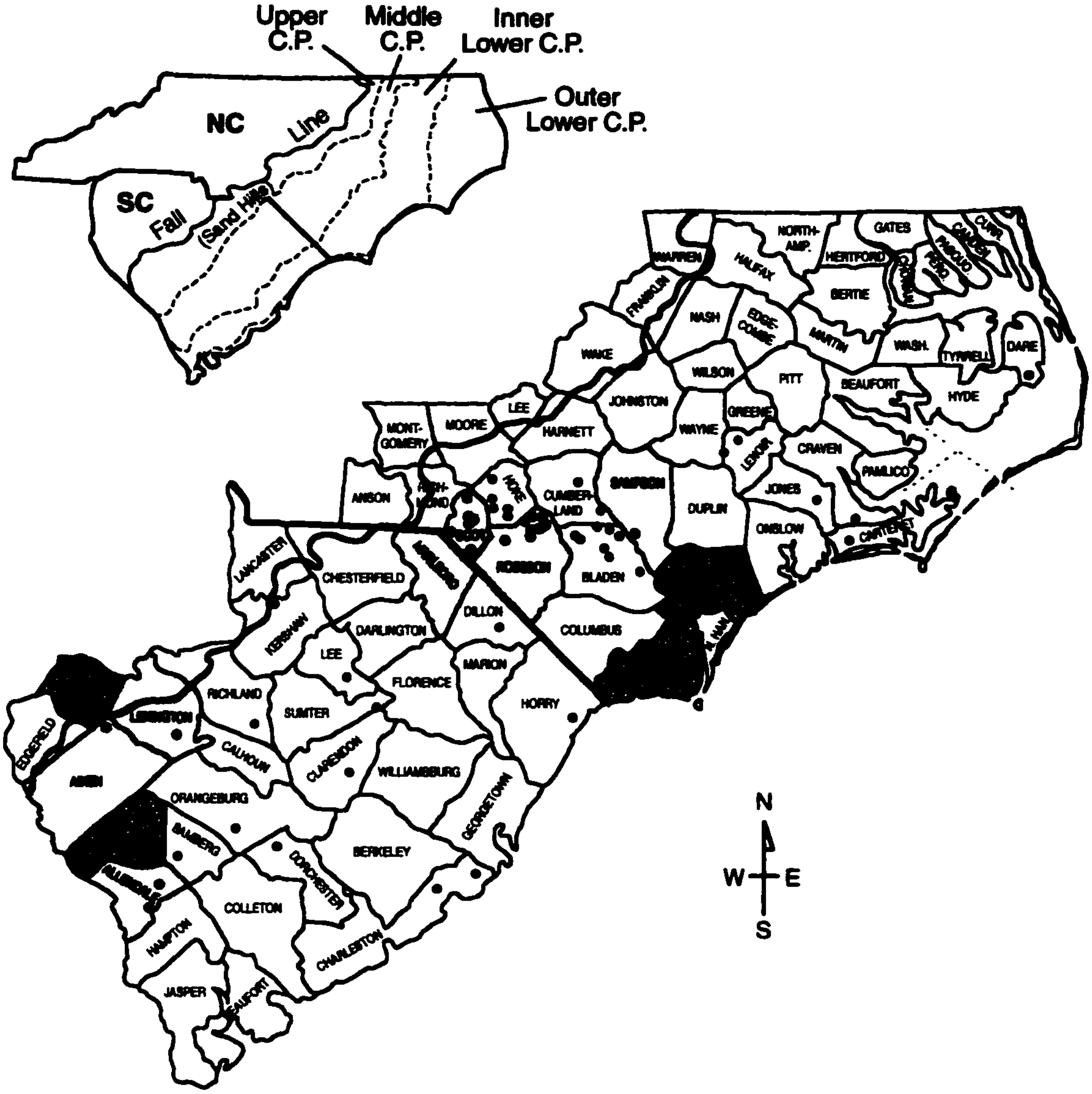

Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
WARREN
HALIFAX
NORTH-AMP.
HERTFORD
GATES
CAMDEN
CURR.
PASQUO.
PERQ.
CHOWAN
BERTIE
FRANKLIN
NASH
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
LEE
MONT-GOMERY
MOORE
HARNETT
WAYNE
GREENE
LENOIR
CRAVEN
PAMLICO
ANSON
RICH-MOND
HOKE
CUMBER-LAND
SAMPSON
DUPLIN
JONES
ONSLOW
CARTERET
LANCASTER
CHESTERFIELD
ROBESON
BLADEN
DILLON
COLUMBUS
KERSHAW
DARLINGTON
LEE
MARION
FLORENCE
RICHLAND
SUMTER
HORRY
EDGEFIELD
LEXINGTON
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BAMBERG
BERKELEY
DORCHESTER
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

Table 4.12. Average cover class and constancy of species present in the Freshwater Marsh vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4. | | 4.0.1 | | 4.0.2 | | 4.0.3 | | 4.0.4 | | 4.0.5 | |
| Species | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| ACER RUBRUM | 6 | 7 | | | | | | | | | 6 | 38 |
| ANDROPOGON GYRANS VAR. STENOPHYLLUS** | 2 | 2 | 2 | + | | | | | | | | |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 5 | 21 | | | | | | | 5 | 86 | 5 | 38 |
| BACOPA CAROLINIANA* | 4 | 9 | 3 | + | | | 4 | + | | | | |
| BIDENS FRONDOSA | 4 | 7 | | | | | 4 | + | | | | |
| BRASENIA SCHREBERI | 5 | 5 | | | | | 5 | + | | | | |
| BULBOSTYLIS CILIATIFOLIA | 2 | 2 | | | | | | | | | 2 | + |
| CENTELLA ASIATICA | 5 | 5 | 7 | 11 | | | | | 2 | + | | |
| CYRILLA RACEMIFLORA | 8 | 2 | | | | | | | | | 8 | 13 |
| DICHANTHELIUM ERECTIFOLIUM** | 5 | 2 | 5 | + | | | | | | | | |
| DIODIA VIRGINIANA | 4 | 2 | | | | | | | | | 4 | + |
| DIOSPYROS VIRGINIANA | 4 | 7 | | | | | | | | | 4 | 38 |
| ECHINODORUS PARVULUS* # | 5 | 5 | | | | | | | | | 5 | + |
| ELEOCHARIS BALDWINII | 5 | 7 | | | | | 5 | + | | | | |
| ELEOCHARIS MELANOCARPA** | 5 | 35 | | | | | 4 | 75 | 5 | 100 | 6 | + |
| ELEOCHARIS MICROCARPA | 4 | 2 | | | | | | | | | 4 | + |
| ELEOCHARIS ROBBINSII* # | 7 | 23 | 8 | 100 | 5 | 9 | | | | | | |
| ERIOCAULON COMPRESSUM | 2 | 2 | | | | | | | 2 | + | | |
| EUPATORIUM LEUCOLEPIS | 6 | 5 | 4 | + | | | | | 7 | + | | |
| EUTHAMIA TENUIFOLIA | 4 | 12 | | | 2 | + | | | 5 | 57 | | |
| HYDROCOTYLE VERTICILLATA | 4 | 2 | | | | | 4 | + | | | | |
| HYPERICUM FASCICULATUM** | 2 | 2 | 2 | + | | | | | | | | |
| ILEX GLABRA | 4 | 2 | | | | | | | | | 4 | + |
| ILEX OPACA | 5 | 2 | | | | | | | | | 5 | + |
| JUNCUS ABORTIVUS | 2 | 5 | 2 | + | | | | | | | | |
| LACHNANTHES CAROLIANA | 1 | 2 | | | | | | | | | 1 | + |
| LEERSIA HEXANDRA | 5 | 56 | 3 | 78 | 4 | + | 7 | 88 | 4 | 100 | | |
| LIQUIDAMBAR STYRACIFLUA | 6 | 19 | | | | | | | | | 6 | 100 |
| LOBELIA BOYKINII* # | 2 | 2 | | | 2 | + | | | | | | |
| LUDWIGIA ALTERNIFOLIA | 2 | 2 | | | | | | | | | 2 | + |
| LUDWIGIA PILOSA | 2 | 2 | | | | | | | | | 2 | + |
| LUDWIGIA SPHAEROCARPA** | 8 | 19 | | | | | 8 | 100 | | | | |
| LUDWIGIA SUFFRUTICOSA* | 3 | 14 | | | 4 | + | | | 3 | 71 | | |
| LUZIOLA FLUITANS* | 4 | 7 | | | | | 4 | + | | | | |
| LYONIA LUCIDA | 4 | 2 | | | | | | | | | 4 | + |
| MAGNOLIA VIRGINIANA | 4 | 5 | | | | | | | | | 4 | + |
| NYMPHOIDES CORDATA** | 3 | 12 | | | | | 3 | + | 4 | + | | |
| NYMPHAEA ODORATA | 4 | 9 | 4 | + | 4 | + | | | | | | |
| NYSSA BIFLORA | 5 | 9 | 5 | + | | | | | | | 5 | + |
| PANICUM HEMITOMON | 6 | 47 | 3 | 56 | 9 | 100 | | | 1 | + | 3 | 38 |
| PANICUM RIGIDULUM VAR. PUBESCENS | 3 | 2 | | | | | | | 3 | + | | |
| PANICUM VERRUCOSUM | 4 | 5 | 4 | + | | | 4 | 13 | | | | |
| PANICUM VIRGATUM | 3 | 2 | | | | | | | 3 | + | | |
| PERSEA PALUSTRIS | 3 | 2 | | | | | | | | | 3 | + |
| PINUS PALUSTRIS | 2 | 2 | | | | | | | 2 | + | | |
| PINUS TAEDA | 6 | 14 | | | | | | | | | 6 | 75 |
| PLUCHEA ROSEA | 6 | 2 | 6 | + | | | | | | | | |
| POLYGONUM HIRSUTUM* | 4 | 9 | | | 4 | + | | | | | | |
| POLYGONUM PERSICARIA | 6 | 19 | | | | | 6 | 100 | | | | |
| PROSERPINACA PECTINATA | 5 | 9 | | | | | 5 | 50 | | | | |
| QUERCUS NIGRA | 4 | 9 | | | | | | | | | 4 | 50 |
| RHEXIA VIRGINICA | 3 | 2 | 3 | + | | | | | | | | |

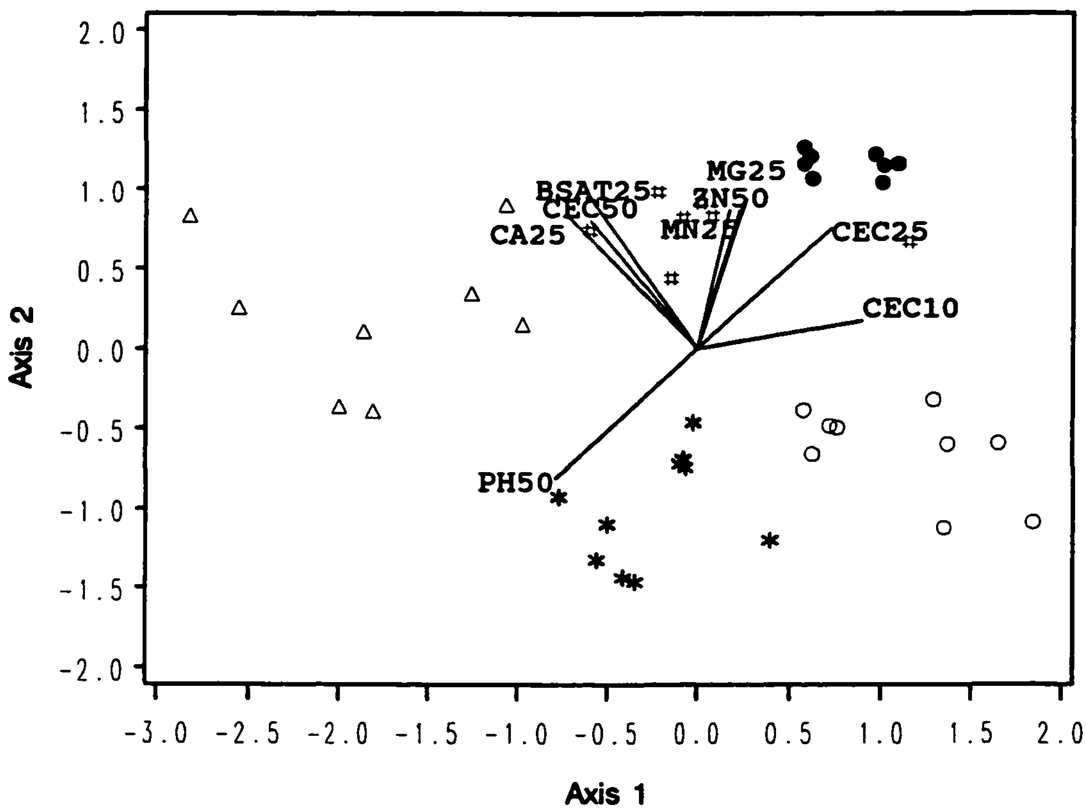
Table 4.12 (cont.). Average cover class and constancy of species present in the Freshwater Marsh vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RHYNCHOSPORA FILIFOLIA | 3 | 5 | 2 | + | 3 | + | | | | | | |
| RHYNCHOSPORA INUNDATA**# | 4 | 9 | 4 | 44 | | | | | | | | |
| RUBUS ARGUTUS | 3 | 9 | | | 2 | + | | | 2 | + | 4 | + |
| SAGITTARIA ISOETIFORMIS* # | 5 | 9 | 5 | + | | | | | | | | |
| SASSAFRAS ALBIDUM | 3 | 2 | | | | | | | | | 3 | + |
| SCIRPUS CYPERINUS | 5 | 9 | | | | | 5 | + | | | | |
| SCLEROLEPIS UNIFLORA** | 4 | 2 | | | 4 | + | | | | | | |
| UTRICULARIA BIFLORA | 4 | 16 | 5 | 56 | 2 | + | | | | | | |
| UTRICULARIA FIBROSA | 4 | 12 | | | | | 4 | 50 | 2 | + | | |
| UTRICULARIA PURPUREA | 2 | 5 | 2 | + | | | | | | | | |
| UTRICULARIA RADIATA | 7 | 12 | | | 5 | + | | | 8 | 14 | 8 | + |
| VACCINIUM FUSCATUM | 4 | 2 | | | | | | | | | 4 | + |
| XYRIS SMALLIANA** | 2 | 14 | 3 | + | | | | | 2 | + | | |

Table 4.13. Average site information for the Freshwater Marsh vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | |
|---|---|---|---|---|---|---|
| | 4. | 4.0.1 | 4.0.2 | 4.0.3 | 4.0.4 | 4.0.5 |
| Site Hydrology | | | | | | |
| Water Depth Index | 173.7 | 188.0 | 171.4 | 169.8 | 184.1 | 155.3 |
| Hydroperiod Class | 4.3 | 4.0 | 4.3 | 5.0 | 4.3 | 3.8 |
| Water Constancy Index | 1.4 | 1.0 | 1.7 | 2.0 | 1.0 | 1.0 |
| Organic Layer Depth | 14.7 | 25.0 | 8.0 | 11.0 | — | — |
| Soil Drainage Class | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Permeability Class | 3.4 | 4.4 | 3.3 | 4.0 | 3.4 | 2.0 |
| Soil Available Water Capacity Class | 2.7 | 2.1 | 2.8 | 3.0 | 2.9 | 2.6 |
| | | | | | | |
| Site Geomorphology | | | | | | |
| Site Elevation (m) | 94.9 | 83.9 | 50.6 | 192.0 | 100.6 | 47.4 |
| Elevational Drop in 1 Km (m) | 15.1 | 13.0 | 10.4 | 27.4 | 15.2 | 9.3 |
| Distance to 10 m Elevational Drop (m) | 1500 | 800 | 1900 | 625 | 1375 | 2800 |
| Depression Area (ha) | 7.0 | 5.8 | 11.8 | 3.1 | 3.3 | 11.2 |
| Depression Length/Width Ratio | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.5 |
| Depression Long Axis Orientation | +4.8 | +11.0 | +7.6 | +7.0 | -0.1 | -1.4 |
| | | | | | | |
| Site Disturbance | | | | | | |
| Fire Frequency Class | 2.9 | 3.0 | 3.0 | 3.0 | 2.7 | 2.9 |
| Cultivation Index | 1.1 | 1.0 | 1.4 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.6 | 1.5 | 1.3 | 3.0 | 1.0 | 1.4 |
| Timbering Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 |
| Drainage Index | 1.5 | 1.5 | 1.7 | 2.0 | 1.0 | 1.4 |
| Landscape Disturbance Class | 3.5 | 4.0 | 3.8 | 4.0 | 1.9 | 3.9 |

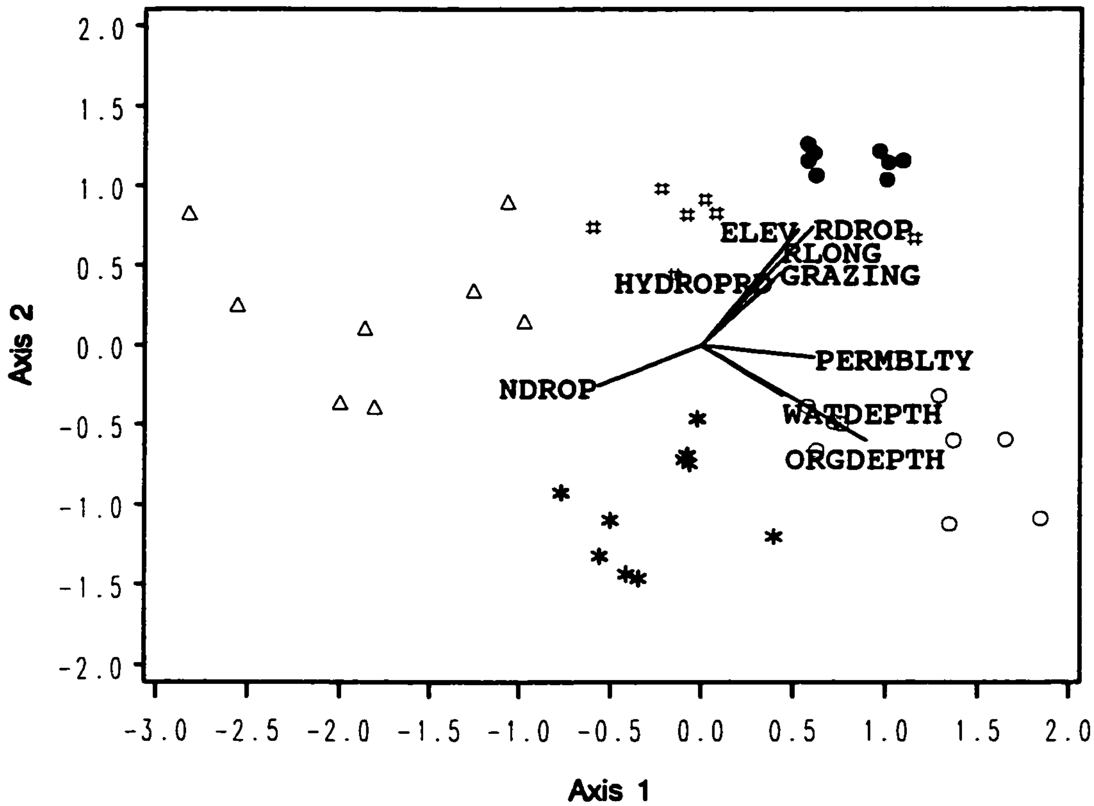
Figure 4.14. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Freshwater Marsh stands as distributed by community type on the two major compositional gradients.




**FRESHWATER MARSH — Community Types:**

○ Eleocharis robbinsii Marsh
✱ Panicum hemitomon Marsh
● Ludwigia sphaerocarpa–Leersia–Polygonum persicaria Marsh
♯ (Andropogon virginicus var. glaucus)/(Eleocharis melanocarpa) "Successional Marsh"
△ Liquidambar–Pinus taeda "Successional Marsh"

Figure 4.15. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Freshwater Marsh stands as distributed by community type on the two major compositional gradients.




**FRESHWATER MARSH — Community Types:**

○ Eleocharis robbinsii Marsh
✱ Panicum hemitomon Marsh
● Ludwigia sphaerocarpa—Leersia—Polygonum persicaria Marsh
# (Andropogon virginicus var. glaucus)/(Eleocharis melanocarpa) "Successional Marsh"
△ Liquidambar—Pinus taeda "Successional Marsh"

Figure 4.16. Plant Life Forms for Freshwater Marsh vegetation groups found within North and South Carolina Carolina bay depressions.

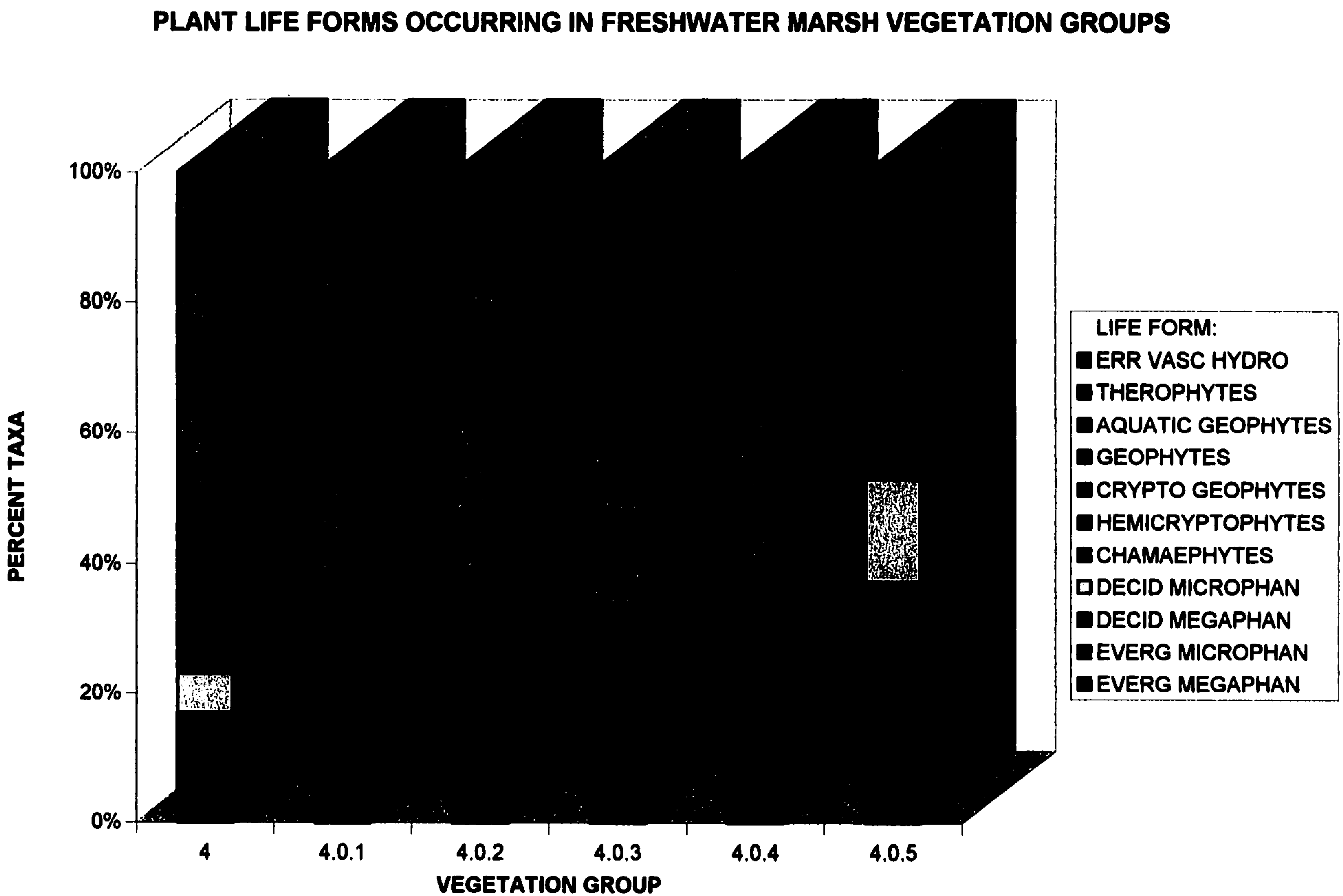
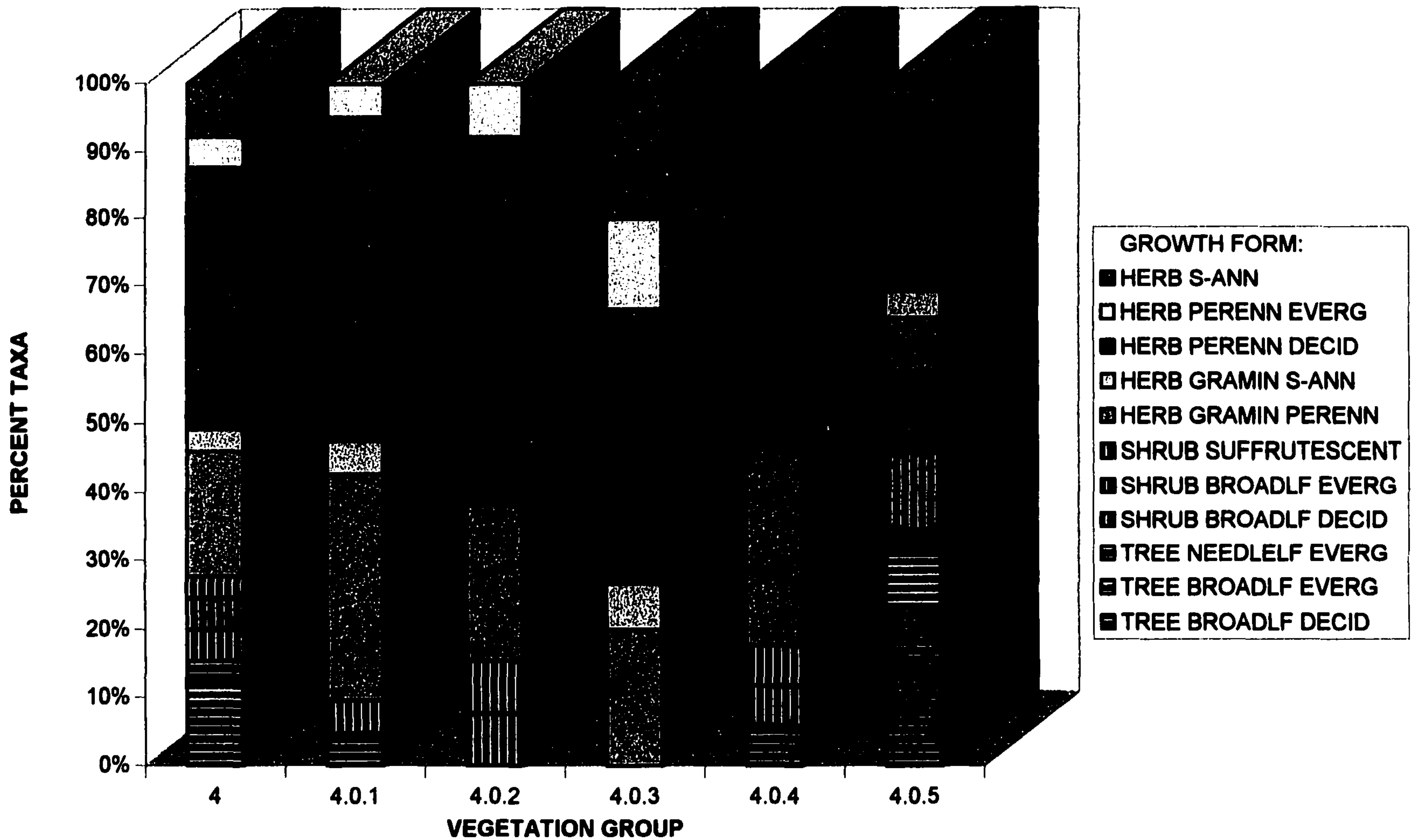

PLANT LIFE FORMS OCCURRING IN FRESHWATER MARSH VEGETATION GROUPS
100%
80%
60%
40%
20%
0%
PERCENT TAXA
4
4.0.1
4.0.2
4.0.3
4.0.4
4.0.5
VEGETATION GROUP
LIFE FORM:
ERR VASC HYDRO
THEROPHYTES
AQUATIC GEOPHYTES
GEOPHYTES
CRYPTO GEOPHYTES
HEMICRYPTOPHYTES
CHAMAEPHYTES
DECID MICROPHAN
DECID MEGAPHAN
EVERG MICROPHAN
EVERG MEGAPHAN

Figure 4.17. Plant Growth Forms for Freshwater Marsh vegetation groups found within North and South Carolina Carolina bay depressions.

# PLANT GROWTH FORMS OCCURRING IN FRESHWATER MARSH VEGETATION GROUPS



### 4.3.5 VEGETATION CLASS: **Boggy Marsh (5.)**

Boggy Marsh vegetational communities are dominated by perennial forbs and graminoids (Figures 4.21 and 4.22). To some extent, they have the physiognomic aspect of the other Carolina bay vegetational communities that have commonly been lumped together as "depression meadows", as previously discussed. However, instead of being found on loamy soils like most other herb-dominated Carolina bay vegetation, these communities occur in bay depressions only in the "sand-organic" systems more closely associated with pocosin type vegetation. To that end, the vegetation class is also similar to the grass-sedge dominated "bog" communities that occur in peatlands as a result of severe fires (Kologiski, 1977; Christensen, 1979, 1988). However, the term "grass-sedge bog" has historically been applied to wet savanna, clay-soil communities within the study area (Wells and Shunk, 1928), rather than to marsh-like communities, and that terminology is not used here.

The "boggy" nature of this vegetation class comes from the characteristic presence of a peat mantle overlying the sandy substrates found in the area of this vegetation class. Standing surface water is typically present in Boggy Marshes for much of the year, although drawdowns during periods of drought are not infrequent. Photographs of this vegetation class appear in Plate 6, following Chapter 7 below.

#### 4.3.5.1 COMMUNITY TYPE: ***Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marsh (5.0.1)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.14)

*Eleocharis quadrangulata, Juncus abortivus, Nymphaea odorata, Rhynchospora inundata, Rhynchospora* sp. #1, *Sphagnum* spp., *Xyris fimbriata*

(3) Special Status Species

*Eleocharis equisetoides, Eupatorium recurvans, Rhynchospora inundata*

(4) Vegetation & Physiognomy

This "marsh-like" community type characteristically consists of a single, 0.25 to 0.5 m tall herbaceous layer dominated by a mixture of *Rhynchospora inundata, Rhynchospora* spp., and *Eleocharis quadrangulata*. *Carex striata, Eleocharis equisetoides, Eupatorium recurvans,* and *Juncus abortivus* may be locally abundant within this community type. Depending upon recent site hydrology, *Nymphaea odorata* may also be a significant component of the herbaceous stratum. A thick (6 to 18 cm), broken mat of *Sphagnum* spp. is characteristically present as a ground cover within this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 6.91 species (Table 4.2).

(5) Distinguishing Features

This community type represents one of only a handful of marsh-like (*i.e.*, herb dominated) vegetational communities having a ground cover of *Sphagnum* spp. and occurring over an extremely acid substrate. Overtopping the *Sphagnum*, it is characterized by dense, clonal patches of its graminoid dominants.

(6) Habitat

This community type occurs within moderately small depressions located on near-coast, broad, flat interfluves, having highly permeable, poorly to very poorly drained soils and a fluctuating water table (Table 4.15). Typically, the community type is found in a patchwork mosaic in conjunction with "pocosin" type vegetation, as that term is discussed for vegetation subclass 7b., below. Water typically stands at or above the surface for most of the year, except during periods of drought. Sampling took place during such a drought year, when the site water table stood, on average, at almost 60 cm below the surface.

(7) Soils

Within the study area, this community type is found exclusively on sandy, siliceous, thermic Typic Haplaquod soils (Table A-II-1). Such a soil is characterized by a series of alternating albic and spodic subsurface horizons, indicative of an historic fluctuating, highly variable water table (Soil Survey Staff, 1975; Buol *et. al*, 1980). The general characteristics of Haplaquods have previously been described for CT 4.0.1, but the soil underlying this community type is much closer to a "typic" Haplaquod pedon than to the "argillic variant"

Haplaquod soil described there. A typical soil profile from this community type is provided in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is extremely acid throughout. The CEC is also relatively low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum. Soil humic matter content is very high near the surface, and moderately high at measured subsurface depths. Soil bulk density within this community type is low at the surface to moderate at 50 cm. Silt-sized particles dominate the soil solum at 10 and 25 cm depths for this community type, but sand-sized particles predominate at a soil depth of 50 cm.

(8) Succession & Disturbance

As noted, this community type occurs within a matrix of pocosin-like vegetational communities. Frequent fire is characteristic of southeastern pocosin communities (Christensen, 1981), and fires reportedly occur within this community type every 5 to 10 years on average (Table 4.15). The open, marsh-like nature of this community type is apparently fire maintained, and in the absence of frequent fires, the surrounding pocosin shrubs quickly encroach upon this community. This community type occurs within relatively undisturbed landscapes, and disturbance other than fire is generally lacking.

(9) Landscape Position

*Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marshes are found within study area Carolina bays in the Outer Lower Coastal Plain (Table 4.3), and make up 24 percent of sampled Carolina bay vegetation found within that landscape class. The community type is found over sandy, siliceous, thermic Typic Haplaquod soils. They comprise 1 of the 3 soil families found observed in Outer Lower Coastal Plain Carolina bays, where sandy and organic soils predominate (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in Carolina bays located in the northeastern portion of the study area, fall within this classification (Table 4.5; Figure

4.18). This community type comprises 44 percent of the sampled community types that make up the vegetation class. One or more of the species that are dominant within this community type are found as dominants in other uncommon depressional habitats in the Lower Coastal Plain. Nevertheless, while there appear to be a number of Carolina bays that would provide suitable habitat for this community type, its occurrence is rare within the study area.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

### 4.3.5.2 COMMUNITY TYPE: ***(Acer-Nyssa biflora-Pinus taeda)/Sphagnum* spp. Marsh (5.0.2)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Vernal Pool *p.p.*, Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.14)

*Acer rubrum, Sphagnum* spp.

(3) Special Status Species

*Chamaedaphne calyculata, Eleocharis equisetoides, Eleocharis robbinsii, Eriophorum virginicum, Peltandra sagittifolia, Rhynchospora alba, Rhynchospora inundata*

(4) Vegetation & Physiognomy

This community type is characterized by widely scattered, small (<5 m in height) *Nyssa biflora* trees over a usually thick surface "mat" of *Sphagnum* spp. *Acer rubrum* and *Pinus taeda* saplings are frequent in the *Nyssa biflora* "layer". A sparse cover of *Carex striata* is often present, either alone or in conjunction with other herbs characteristic of "boggy" soils, including *Woodwardia virginica, Xyris fimbriata,* and *Rhynchospora* spp. In some locations, shrubs characteristic of the "Pocosin" vegetation subclass discussed later in this chapter assume some importance within this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.75 species (Table 4.2).

(5) Distinguishing Features

This community type represents the second of only a handful of marsh-like (*i.e.*, herb dominated) vegetational communities having a ground cover of *Sphagnum* spp. and occurring over an extremely acid substrate. Woody species are a more significant component of this community type than its immediate predecessor, and this community is characterized by a more open, mixed herbaceous vegetation component.

(6) Habitat

This community type occurs within moderately small to large depressions located on near-coast, broad, flat interfluves, having highly permeable, poorly to very poorly drained soils and a moderately fluctuating water table (Table 4.15; Figure 4.20). Like its predecessor, this community type is typically found in a patchwork mosaic of "Boggy Marsh" and "Pocosin". Water typically stands at or above the surface for most of the year, except during periods of drought.

(7) Soils

This community type is found over two soil families. Most of the time, it is encountered on sandy, siliceous, thermic Typic Haplaquod soils, while it is occasionally also found on sandy-skeletal, siliceous, dysic, thermic Terric Medihemists (Table A-II-1). Hemists are very poorly drained, mid-latitude organic soils consisting of plant remains that have decomposed enough that the botanic origin of up to two-thirds of the materials cannot be readily determined, where ground water is within a few cm of the surface nearly all the time (Soil Survey Staff, 1975). This soil is apparently not mapped by the soil surveyors for the study area (*i.e.*, the Carolina coastal plain). However, according to the Soil Survey Staff (1975), Hemists occur "from the Equator to the tundra regions in closed depressions and in broad, very poorly drained flat areas such as coastal plains", and is thus not unexpected in the study area. A Typic Haplaquod soil profile similar to the one found beneath this community type is described in Appendix II for CT 5.0.1, discussed immediately above. A Terric Medihemist soil characteristic of this community type is also described in Appendix II. In some instances within this community type, the "soil solum" may simply be a thick (1.5 to 2 m), "mat" of semi-decomposed organic material floating in water 0.5 m or more above sandy residuum.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is extremely acid throughout. The CEC is also relatively low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum. Soil humic matter content is relatively high at all measured soil depths. Soil bulk density within this community type is very low at the surface to moderate at 50 cm. Silt-sized particles dominate the soil solum at 10 and 25 cm depths for this community type, but sand-sized particles predominate below the mucky surface layers at a soil depth of 50 cm.

(8) Succession & Disturbance

As noted, this community type occurs within a matrix of pocosin-like vegetational communities, and frequent fire is characteristic of southeastern pocosin communities. Fires are somewhat less frequent in this community type than its immediate predecessor, occurring every 10 to 25 years on average (Table 4.15). This may account for the relatively increased significance of the woody component of this community type. In the absence of fires, the woody component of the community would be expected to increase its dominance, eventually displacing the herbaceous stratum that currently dominates the vegetation type. This community type occurs within relatively undisturbed landscapes, and disturbance other than fire is generally lacking.

(9) Landscape Position

This community type was found within study area Carolina bays in the Outer Lower Coastal Plain (50%), in the Middle Coastal Plain (30%), and in the Inner Lower Coastal Plain (20%) (Table 4.3). *Acer-Nyssa biflora-Pinus taeda/Sphagnum* spp. Marshes make up 15 percent of sampled Carolina bay vegetation found within the Outer Lower Coastal Plain, less than 1 percent of sampled Carolina bay vegetation in the Middle Coastal Plain, and 6 percent of the sampled vegetation in the Inner Lower Coastal Plain. As noted above, this community type is found over two soils types -- sandy, siliceous, thermic Typic Haplaquod soils (80%), and sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemist soils (20%). The former soil type is one of the more common soil families found within Outer Lower Coastal Plain Carolina bays, was found occasionally in bays in the Inner Lower Coastal Plain, and is relatively rare within bay depressions in the Middle Coastal Plain (Table 4.4). Medihemist soils are uncommon on all land surfaces within the study area, and as noted, are apparently not recognized within the Carolina coastal plain in existing county soil surveys. They would be expected to be most common on poorly drained, Lower Coastal Plain surfaces.

(10) Distribution & Abundance

Ten of 482 intensively sampled plots (2.1%), occurring in Carolina bays located in the northeastern portion of the study area, fall within this classification (Table 4.5; Figure 4.18). This community type comprises 56 percent of the sampled community types that make up the vegetation class. As for the previous Boggy Marsh community type, while there appear to be a number of Carolina bays that would provide suitable habitat for this vegetation type, it is uncommon in bays other than the sampled sites. One or more of the species that are dominant within this community type are found as dominants in other "boggy" depressional habitats in the Lower Coastal Plain.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.5.3 ANALYSIS

Vegetation Class Environmental Gradients

Study area Boggy Marsh stands are distributed along both a subsoils ph-nutrient/ water level/disturbance gradient and an orthogonal complex elevation--relief/disturbance/ surface soil nutrient gradient (Figs. 4.19 and 4.20). Plots are located on the first gradient principally by their relative values for site water constancy, subsoil pH, and fire frequency. Those factors are correlated with both compositional axes on the ordination diagram for

Boggy Marsh plots. Stands are distributed along the second gradient by their comparative scores for site elevation, local relief, rotated latitude, soil surface nutrient level, recent grazing history, and degree of disturbance in the surrounding landscape. Those factors are also associated with both compositional axes.

*Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marsh plots are located at sites with a fluctuating water table and comparatively frequent fires, over soils with relatively high pH and nutrient levels, except for low surface potassium levels. By contrast, the (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh stands occur at sites having a comparatively stable water table, infrequent fires, and lower pH soils with a relatively high surface potassium level.

Discussion

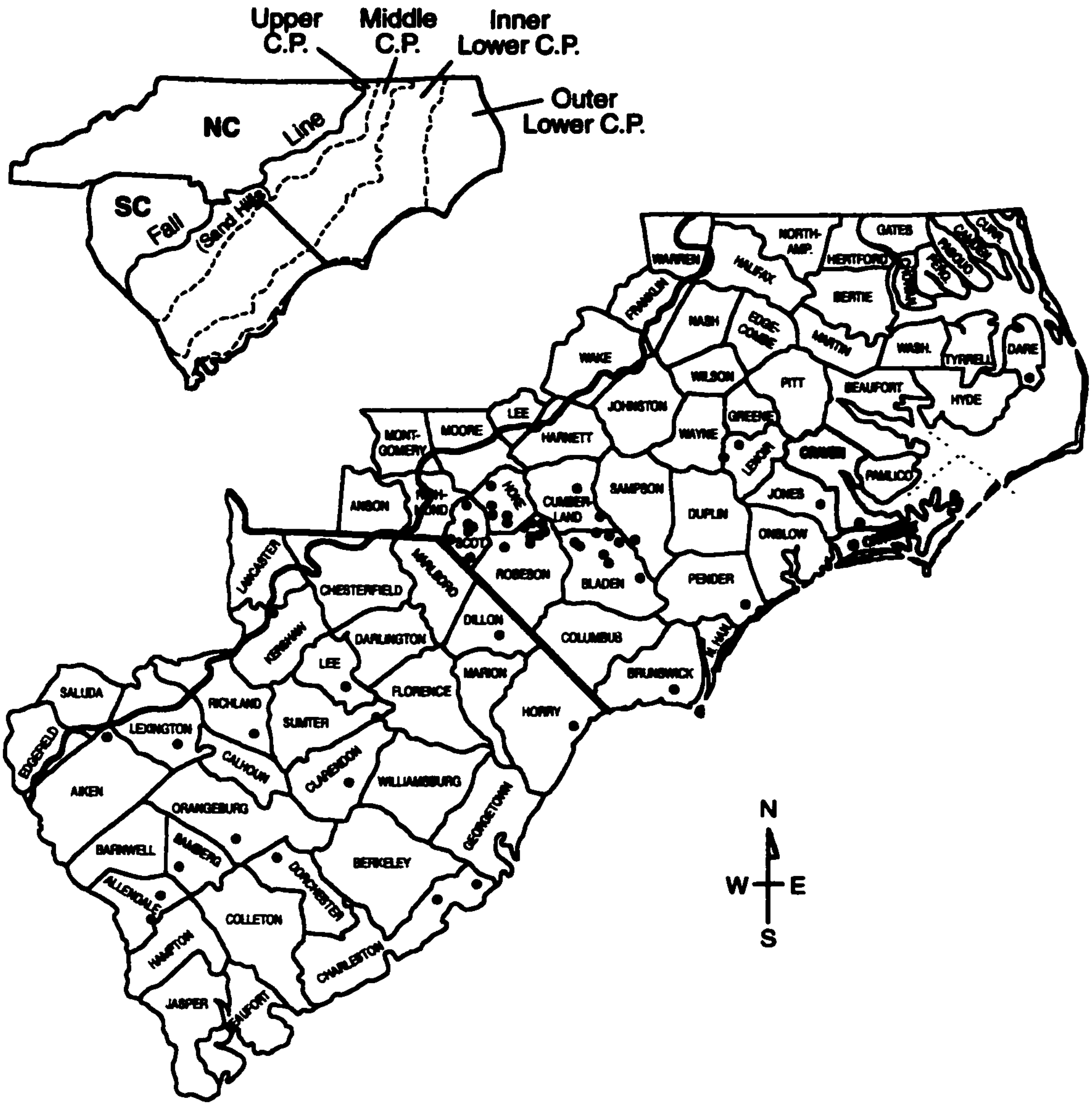
Boggy Marsh vegetation is unusual in Carolina bays, and its constituent community types appear to be transitional in terms of floristics and soils between Freshwater Pond--Freshwater Marsh and Evergreen Shrub-Bog--Cypress/Gum Bog Carolina bay communities. Boggy Marsh community types are restricted to the northeastern portion of the study area, and show clear floristic affinities with northern wetlands and depression communities (*see*, *e.g*., Sipple and Klockner, 1984 [Maryland, Eastern Shore "potholes"]; Olsson, 1979 [New Jersey Pine barrens "Marsh-Sod Vegetation Type"], 1979).

The *Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species # 1/*Sphagnum* spp. Marsh community type is dominated by hemicryptophyte and cryptophytic geophyte taxa, while phanerophyte life forms are not well represented (Figure 4.21). It is currently known to occur within Carolina bays only in treeless "pools" located in interior areas of depressions exhibiting pocosin vegetation and surrounded by well-developed, sandy bay rim communities. The depressions are characterized by Typic Haplaquod soils, both in the case of their Boggy Marsh communities and their pocosin vegetation. As previously noted, Typic Haplaquod soils are indicative of an historical fluctuating, highly variable ground water table. Vegetational communities may contain a thick surface cover of *Sphagnum* spp., but essentially no peat build-up is seen.

Given the long-term role of fire as a predominant factor in shaping and maintaining pocosin vegetation, this scenario suggests that the pools wherein this community type occurs are the peat "burn-out" areas discussed by other investigators, that result from severe fires in organic soils (Kologiski, 1977; Christensen, 1988). However, soils in depressions containing this community type are mineral, rather than organic, in nature, and site vegetation is more diverse than the *Carex striata-Woodwardia virginica* community typical of burn-out pools. For those reasons, it is proposed that the pools wherein Boggy Marsh community types occur are deflation phenomena resulting from aeolian forces operating on a barren, sandy depression floor, following severe, drought period fires that destroyed all pre-existing, woody vegetation at the site.

By contrast, while also found within pocosin dominated bay depressions, the (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh community type is more akin to a true coastal bog, generally occurring over a wet, peaty surface layer (whether the underlying soils are mineral or organic), and containing more typical "bog" herbs, such as *Eriophorum virginicum*. In addition, a higher proportion of woody phanerophyte species characterizes this community type, and herbaceous taxa tend to be geophytes (Figure 4.21).

Figure 4.18. Distribution of study area Carolina bay sites containing Boggy Marsh vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Boggy Marsh community types. Locations of individual, sampled Carolina bay sites are indicated by red circles.



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
N
W
E
S

Table 4.14. Average cover class and constancy of species present in the Boggy Marsh vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | |
|---|---|---|---|---|---|---|
| | 5. | | 5.0.1 | | 5.0.2 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | |
| ACER RUBRUM | 4 | 56 | 3 | 13 | 5 | 90 |
| ANDROPOGON GLOMERATUS VAR. GLOMERATUS | 3 | 22 | 3 | + | 3 | + |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 2 | 6 | | | 2 | + |
| BARTONIA VIRGINICA | 1 | 6 | | | 1 | + |
| CALOPOGON TUBEROSUS | 5 | 6 | | | 5 | + |
| CAREX STRIATA VAR. STRIATA | 5 | 50 | 5 | 50 | 6 | 50 |
| CENTELLA ASIATICA | 2 | 6 | | | 2 | + |
| CHAMAEDAPHNE CALYCULATA# | 7 | 17 | | | 7 | + |
| CYRILLA RACEMIFLORA | 5 | 11 | 1 | + | 8 | + |
| DECODON VERTICILLATUS | 5 | 6 | | | 5 | + |
| DROSERA FILIFORMIS | 3 | 6 | | | 3 | + |
| DROSERA INTERMEDIA | 2 | 17 | | | 2 | 30 |
| DULICHIUM ARUNDINACEUM | 4 | 6 | | | 4 | + |
| ELEOCHARIS EQUISETOIDES** | 5 | 28 | 5 | 50 | 3 | + |
| ELEOCHARIS QUADRANGULATA | 6 | 50 | 6 | 100 | 3 | + |
| ELEOCHARIS ROBBINSII* # | 3 | 6 | | | 3 | + |
| ELEUSINE INDICA | 2 | 11 | 2 | 25 | | |
| ERIOCAULON DECANGULARE | 5 | 11 | 5 | + | | |
| ERIOPHORUM VIRGINICUM** | 4 | 6 | | | 4 | + |
| EUPATORIUM RECURVANS** | 6 | 22 | 6 | 50 | | |
| EUTHAMIA TENUIFOLIA | 6 | 11 | 6 | + | | |
| ILEX CORIACEA | 4 | 6 | | | 4 | + |
| ILEX GLABRA | 4 | 6 | | | 4 | + |
| JUNCUS ABORTIVUS | 4 | 56 | 5 | 88 | 3 | 30 |
| KALMIA CAROLINA | 2 | 6 | | | 2 | + |
| LEUCOTHOE RACEMOSA | 4 | 6 | | | 4 | + |
| LIQUIDAMBAR STYRACIFLUA | 6 | 6 | | | 6 | + |
| LUDWIGIA PILOSA | 5 | 11 | 5 | + | | |
| LYONIA LUCIDA | 4 | 28 | 1 | + | 4 | 40 |
| MAGNOLIA VIRGINIANA | 3 | 28 | 3 | + | 4 | 30 |
| MYRICA CERIFERA VAR. CERIFERA | 5 | 17 | | | 5 | + |
| MYRICA HETEROPHYLLA | 4 | 6 | | | 4 | + |
| NYMPHAEA ODORATA | 4 | 39 | 3 | 75 | 5 | + |

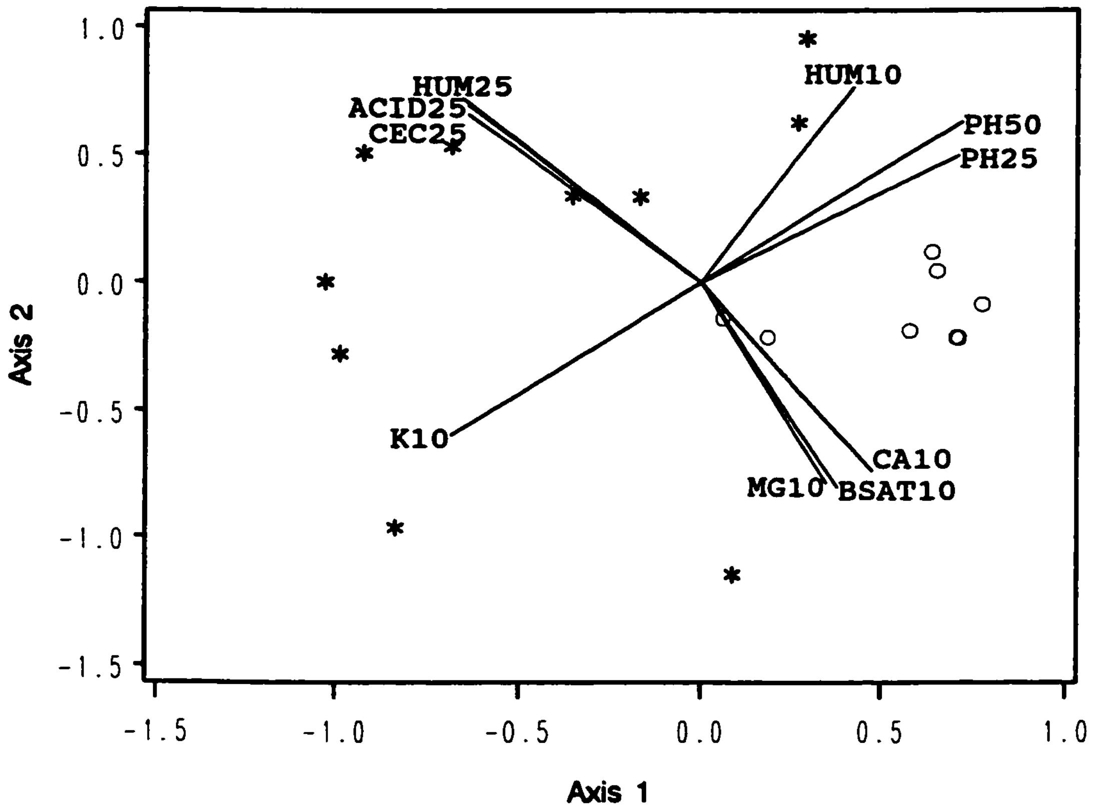
Table 4.14 (cont.). Average cover class and constancy of species present in the Boggy Marsh vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | |
|---|---|---|---|---|---|---|
| NYSSA BIFLORA | 6 | 44 | 6 | + | 6 | 60 |
| PANICUM HEMITOMON | 4 | 11 | | | 4 | + |
| PELTANDRA SAGITTIFOLIA* # | 5 | 11 | | | 5 | + |
| PERSEA PALUSTRIS | 3 | 28 | 1 | + | 4 | 40 |
| PINUS SEROTINA | 4 | 17 | | | 4 | 30 |
| PINUS SP. | 3 | 6 | | | 3 | + |
| PINUS TAEDA | 5 | 50 | 5 | 38 | 5 | 60 |
| POLYGONUM HYDROPIPEROIDES | 2 | 6 | 2 | + | | |
| PROSERPINACA PECTINATA | 2 | 11 | 2 | + | 1 | + |
| RHYNCHOSPORA SP. #1 | 6 | 50 | 6 | 100 | 2 | + |
| RHYNCHOSPORA ALBA* | 8 | 6 | | | 8 | + |
| RHYNCHOSPORA CEPHALANTHA VAR. CEPHALANTHA | 1 | 6 | | | 1 | + |
| RHYNCHOSPORA CHALAROCEPHALA | 6 | 6 | | | 6 | + |
| RHYNCHOSPORA INUNDATA**# | 5 | 61 | 6 | 100 | 3 | 30 |
| SACCHARUM GIGANTEUM | 4 | 17 | 5 | + | 3 | + |
| SARRACENIA FLAVA | 4 | 11 | | | 4 | + |
| SMILAX LAURIFOLIA | 4 | 6 | | | 4 | + |
| SMILAX WALTERI | 2 | 6 | 2 | + | | |
| SPHAGNUM SP. | 9 | 100 | 9 | 100 | 8 | 100 |
| TRIADENUM VIRGINICUM | 2 | 33 | 2 | 25 | 3 | 40 |
| UTRICULARIA BIFLORA | 6 | 17 | | | 6 | + |
| UTRICULARIA SUBULATA | 2 | 6 | | | 2 | + |
| VACCINIUM FUSCATUM | 5 | 11 | | | 5 | + |
| WOODWARDIA VIRGINICA | 6 | 22 | 2 | + | 8 | + |
| XYRIS FIMBRIATA | 6 | 39 | 5 | 75 | 9 | 10 |

Table 4.15. Average site information for the Boggy Marsh vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | |
|---|---|---|---|
| | 5. | 5.0.1 | 5.0.2 |
| Site Hydrology | | | |
| Water Depth Index | 111.8 | 91.0 | 132.5 |
| Hydroperiod Class | 4.1 | 4.0 | 4.1 |
| Water Constancy Index | 1.3 | 1.0 | 1.5 |
| Organic Layer Depth | 24.2 | 19.0 | 29.3 |
| Soil Drainage Class | 2.5 | 2.5 | 2.5 |
| Soil Permeability Class | 4.4 | 4.5 | 4.3 |
| Soil Available Water Capacity Class | 2.8 | 2.5 | 3.0 |
| | | | |
| Site Geomorphology | | | |
| Site Elevation (m) | 9.9 | 4.6 | 15.3 |
| Elevational Drop in 1 Km (m) | 3.8 | 2.1 | 5.5 |
| Distance to 10 m Elevational Drop (m) | 2075 | 1900 | 2250 |
| Depression Area (ha) | 96.5 | 43.7 | 149.4 |
| Depression Length/Width Ratio | 1.5 | 1.6 | 1.5 |
| Depression Long Axis Orientation | -15.1 | -17.0 | -13.2 |
| | | | |
| Site Disturbance | | | |
| Fire Frequency Class | 2.4 | 2.0 | 2.7 |
| Cultivation Index | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.2 | 1.0 | 1.3 |
| Timbering Index | 1.0 | 1.0 | 1.0 |
| Drainage Index | 1.5 | 1.0 | 1.9 |
| Landscape Disturbance Class | 1.5 | 1.0 | 2.1 |

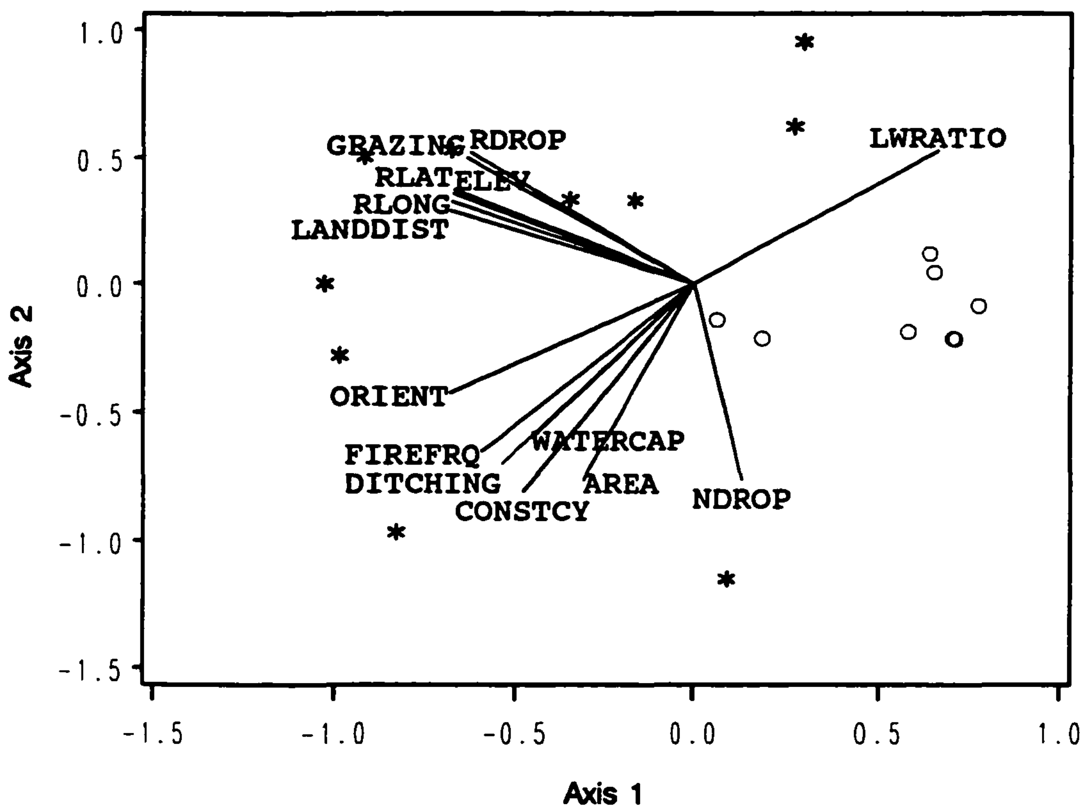
Figure 4.19. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Boggy Marsh stands as distributed by community type on the two major compositional gradients.




**BOGGY MARSH – Community Types:**

O *Eleocharis quadrangulata*–*Rhynchospora inundata*–*Rhynchospora* species #1/*Sphagnum* spp. Marsh
✱ *Acer*–*Nyssa biflora*–*Pinus taeda*/*Sphagnum* spp. "Marsh"

Figure 4.20. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Boggy Marsh stands as distributed by community type on the two major compositional gradients.




**BOGGY MARSH — Community Types:**

○ Eleocharis quadrangulata—Rhynchospora inundata—Rhynchospora species #1/Sphagnum spp. Marsh

✱ Acer—Nyssa biflora—Pinus taeda/Sphagnum spp. "Marsh"

Figure 4.21. Plant Life Forms for Boggy Marsh vegetation groups found within North and South Carolina Carolina bay depressions.

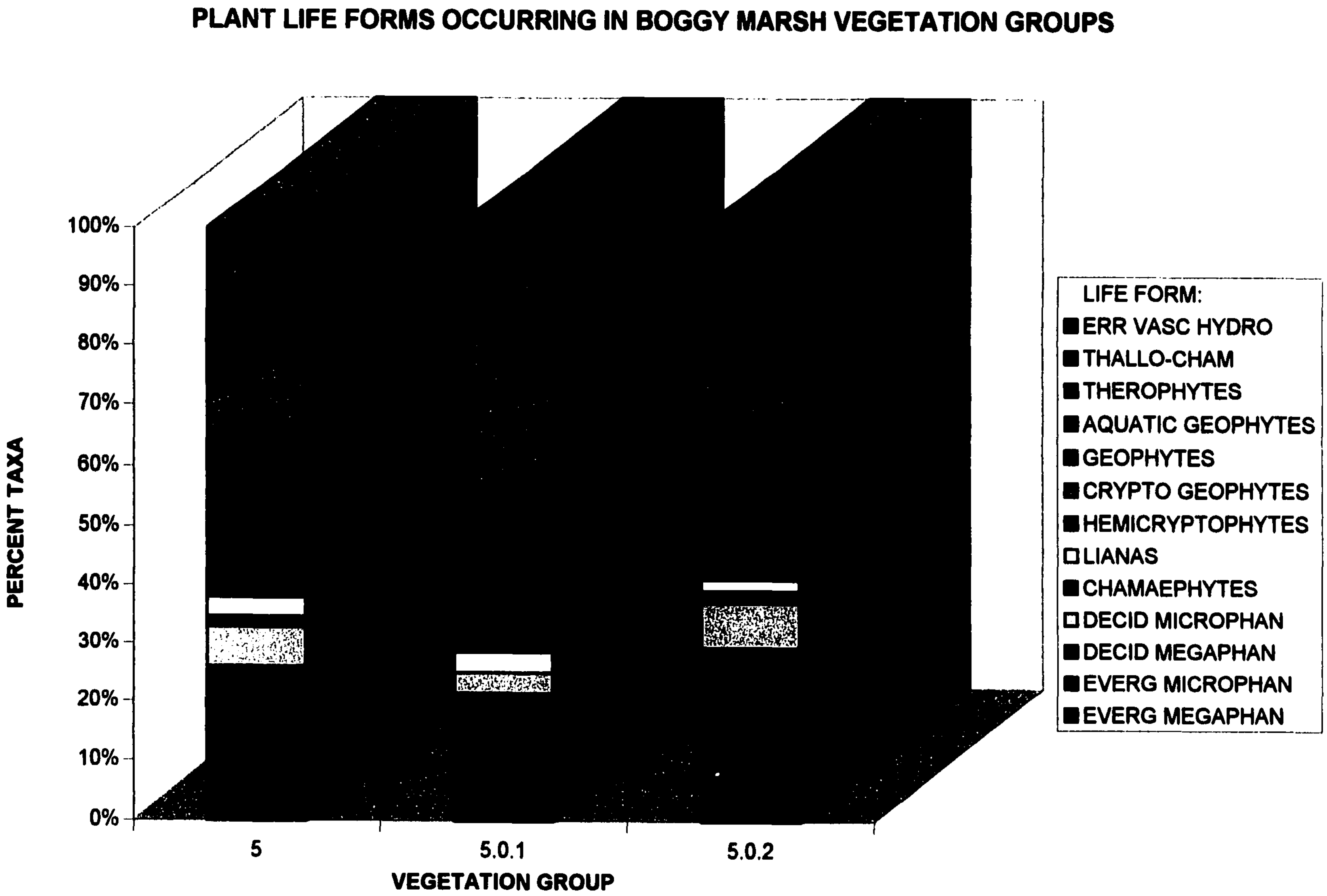
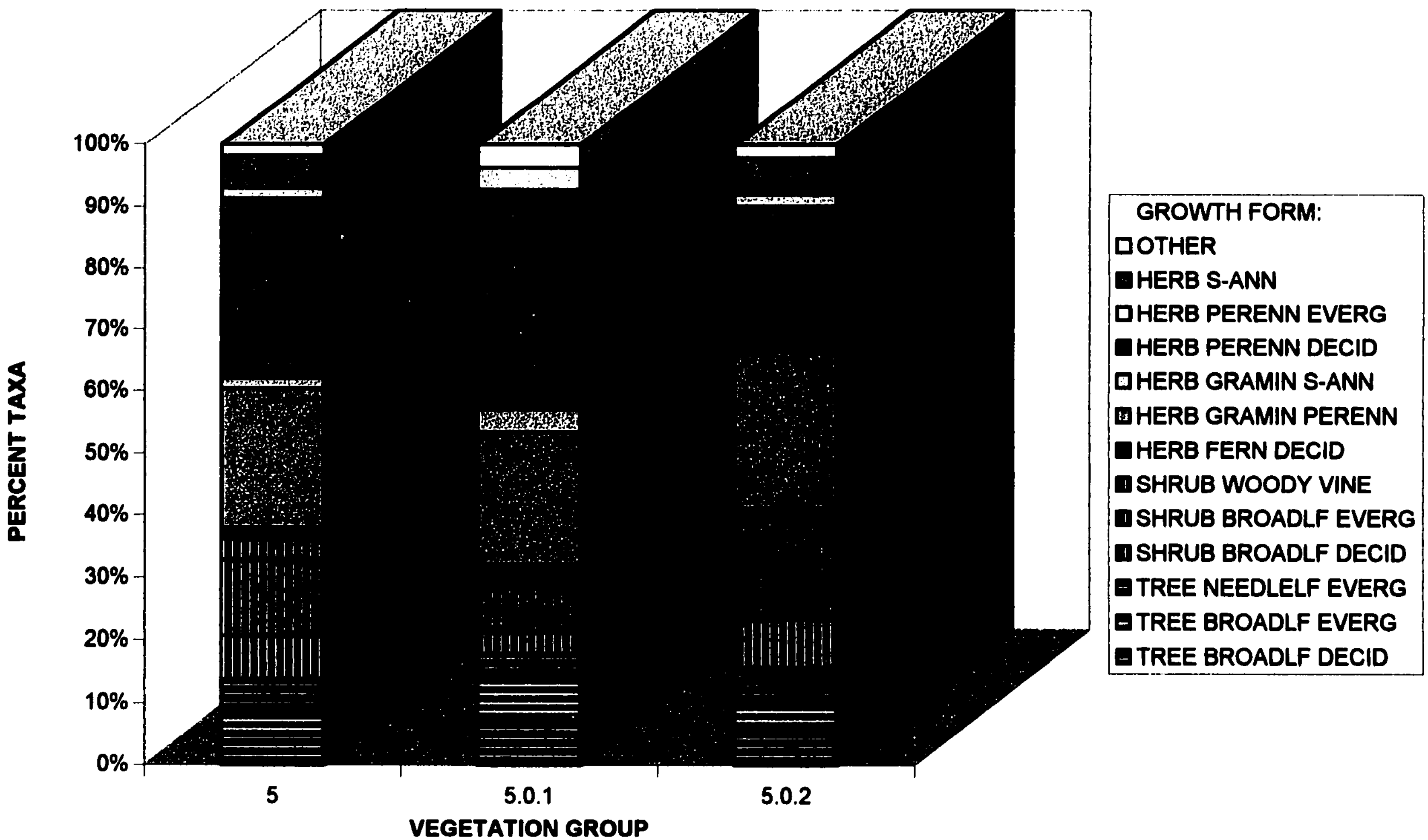

PLANT LIFE FORMS OCCURRING IN BOGGY MARSH VEGETATION GROUPS
PERCENT TAXA
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
5
5.0.1
5.0.2
VEGETATION GROUP
LIFE FORM:
ERR VASC HYDRO
THALLO-CHAM
THEROPHYTES
AQUATIC GEOPHYTES
GEOPHYTES
CRYPTO GEOPHYTES
HEMICRYPTOPHYTES
LIANAS
CHAMAEPHYTES
DECID MICROPHAN
DECID MEGAPHAN
EVERG MICROPHAN
EVERG MEGAPHAN

Figure 4.22. Plant Growth Forms for Boggy Marsh vegetation groups found within North and South Carolina Carolina bay depressions.

## PLANT GROWTH FORMS OCCURRING IN BOGGY MARSH VEGETATION GROUPS



4.3.6 VEGETATION CLASS: **Longleaf Pine Woodland (6.)**

Longleaf Pine Woodlands -- including "sandhills", savanna, and flatwoods communities -- are a common vegetation type of the southeastern United States coastal plain (Christensen, 1988). However, the occurrence of Longleaf Pine Woodland communities within Carolina bay depressions was unknown (or at least unreported) prior to the reconnaissance that begin this study. Since that time, at least two longleaf pine savanna communities located within Carolina bay depressions have been investigated as the part of a larger vegetation study (Taggart, 1990).

The vegetation class falls within the "Mesic Pine Communities" ("Flatwoods" and "Savannas") of Christensen (1988), and include portions of Schafale and Weakley's (1990) "Wet "Pine Flatwoods", "Pine Savanna", and "Mesic Pine Flatwoods". In addition, the community types described within the vegetation class are encompassed, in part, by Taggart's (1990) "Dry Spodosol Savanna" and "Dry Ultisol Savanna" vegetation groups.

Longleaf Pine Woodland community types either contain *Pinus palustris* as a significant component of their vegetation as sampled, or were judged to potentially include *Pinus palustris* as a significant community component. In the latter case, the sampled community types occur within a region dominated by Longleaf Pine, and sites show evidence that the species has been removed by past timber harvest or other disturbance. Photographs of this vegetation class appear in Plate 7, following Chapter 7 below.

4.3.6.1 COMMUNITY TYPE: ***(Panicum virgatum-Euthamia)/(Dichanthelium wrightianum)* Flatwood (6.0.1)**

(1) Synonymy

Wet Pine Flatwoods *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.16)

None.

(3) Special Status Species

*Agalinis linifolia, Andropogon gyrans* var. *stenophyllus, Dichanthelium erectifolium, Eleocharis melanocarpa, Eleocharis tricostata, Eupatorium leptophyllum, Eupatorium* *recurvans, Ludwigia suffruticosa, Lycopus angustifolius, Oldenlandia boscii, Parietaria pensylvanica, Pityopsis graminifolia, Rhexia aristosa, Scleria reticularis, Sclerolepis uniflora, Stylisma aquatica.*

(4) Vegetation & Physiognomy

This community type typically occurs in the mosaic of longleaf pine upland communities that historically characterized much of the Carolina coastal plain. It typically lacks a true woody stratum. Instead, it exhibits scattered *Liquidambar styraciflua* saplings 2 m or less in height, with occasional co-dominance by *Pinus palustris*, over scattered stands of *Panicum virgatum* to 1.5 m tall, as the dominant in upper part of the herbaceous stratum. A mixture of forbs and graminoids 1 m or less tall forms the open to sparse ground cover "layer" of the herbaceous stratum. Significant species in the lower herbaceous layer include *Andropogon virginicus var. glaucus, Euthamia tenuifolia* and *Dichanthelium wrightianum*.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 22.90 species (Table 4.2).

(5) Distinguishing Features

The community types included within this vegetation class are the "driest" found within sampled Carolina bay wetlands, often being dominated by species not necessarily associated with wetland communities. This is the only sampled Carolina bay community type in which *Panicum virgatum* is a dominant.

(6) Habitat

This community type occurs in small depressions located on highly dissected land surfaces and exhibiting poorly drained, moderately permeable soils (Table 4.17, Figure 4.25). The soil water table is relatively stable, and water stands at or above the surface for short to moderately long periods under normal precipitation conditions. At the time of sampling, the water table was found within this community type at some 22 cm below the soil surface.

(7) Soils

This community type was encountered over three soil families -- fine-loamy, siliceous, thermic Typic Paleaquults (18%); clayey, kaolonitic, thermic Typic Fragiaquults (45%); and siliceous, thermic Typic Psammaquents/loamy, siliceous, thermic Grossarenic

Paleaquults (36%) (Table A-II-1). A pedon from the first soil family is described for CT 2.0.1 and for the second listed soil family a pedon description is set out for CT 4.0.2, in Appendix II. The general characteristics of those soils as well as Psammaquents and Paleaquults, have also previously been discussed. However, the dominating characteristic of the third listed soil family (Typic Psammaquents/Grossarenic Paleaquults) is the presence of sandy surface layers in a poorly drained soil solum. Indeed, it is the varying depth of these surface sands that often makes the two soil groups difficult to tell from one another in the field, and causes two taxonomically distinct soils to be lumped into a single class by field mappers (*see, e.g.*, McCachren, 1978). However, the physical and chemical properties of a sandy surface layer, whatever its ultimate taxonomic designation, are relatively constant. A profile for a Typic Psammaquent/Grossarenic Paleaquult soil characteristic of this community type is described in Appendix II.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for previously described, similar soils.

<u>(8) Succession & Disturbance</u>

Fire is a major factor is longleaf pine communities, and fires have been relatively frequent within this community type, as evidenced by the charred outer bark of community trees, the clumped nature of community shrubs, and abundant charcoal in surficial soil layers. As indicated by Table 4.17, most of the communities within this vegetation class show recent or historic evidence of timbering, usually the cutting of *Pinus* spp. Evidence of past cultivation, grazing or drainage is characteristically minimal, though this community type did show signs of both past grazing and attempts to improve depression drainage. Surrounding landscapes have only been moderately altered by human land disturbance activities.

It is apparently the combination of frequent fires and frequent, if relatively brief, flooding that maintain this community type in an open condition without well-developed woody strata. Similar, non-Carolina bay, wet flats and depressions in the surrounding landscape usually exhibit either wet Longleaf Pine savanna or pocosin-like vegetation.

(9) Landscape Position

This community type was found in sampled Carolina bay depressions of both the Middle Coastal Plain (55%) and the Upper Coastal Plain (45%) (Table 4.3). (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwoods make up some 2 percent of sampled Carolina bay vegetation found within the Middle Coastal Plain and 17 percent of sampled vegetation in the Upper Coastal Plain. As previously discussed, the community type is found over three soil types -- clayey, kaolonitic, thermic Typic Fragiaquults (45%); siliceous, thermic, Typic Psammaquents/loamy, siliceous, thermic Grossarenic Paleaquults (36%); and fine-loamy, siliceous, thermic Typic Paleaquults (18%). Typic Fragiaquults are among the most common soils found in Middle Coastal Plain Carolina bays in the central portion of the study area, and represent the "typic" soil for bay depressions located in that region. Fragiaquults are not known to occur in Upper Coastal Plain Carolina bays, but other Ultisols are common in bay depressions located on that surface (Table 4.4). Typic Psammaquents/Grossarenic Paleaquult soils are a special case, and appear to represent instances where sandy rim or adjacent upland sediments have blown into bay depressions in the past, covering the pre-existing clayey soils with a sandy veneer. The latter soil group was found in this study to occur only in bay depressions located on the Upper Coastal Plain surface (Table 4.4).

(10) Distribution & Abundance

Eleven of 482 intensively sampled plots (2.3%), occurring in 3 Carolina bays located in North Carolina, fall within this classification (Table 4.5). This community type comprises 37 percent of the sampled community types that make up the vegetation class. *Panicum virgatum* Flatwoods are generally limited in occurrence to shallow Carolina bay basins located in upland areas and having sandy rims that in large part exhibit *Pinus palustris* dominated vegetational communities. This community type, like the vegetation class in general, while most common in the central part of the study area, is infrequent within the Carolinas (Figure 4.23).

(11) Conservation Status

Examples of this community type currently exist within Carolina bays on both publicly held lands and privately owned lands held for conservation purposes.

4.3.6.2 COMMUNITY TYPE: ***Pinus palustris/Lyonia mariana/Aristida stricta/ (Cladonia* sp.) Savanna (6.0.2)**

(1) Synonymy

Pine Savanna *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.16)

*Andropogon virginicus* var. *virginicus, Aristida stricta, Cladonia* spp., *Diospyros virginiana, Gaylussacia dumosa, Lyonia mariana, Pinus palustris, Xyris caroliniana*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community is "savanna-like" in nature, characterized by an open *Pinus palustris* canopy over a sparse shrub "layer" of scattered *Lyonia mariana*, and an herbaceous layer dominated by *Aristida stricta* in a layer characterized by moderately dense, patchy stands of *Aristida* interspersed with clumps of *Xyris caroliniana,* cover by the lichen, *Cladonia* sp., or bare ground *Gaylussacia dumosa* is often significant in the shrub "layer". The community type represents a form the familiar "Longleaf Pine/Wiregrass" Savanna typical of much of the southeastern coastal plain.

This community type exhibited low mean species richness at the 0.1 ha level, at 11.52 species (Table 4.2).

(5) Distinguishing Features

As noted, the community types included within this vegetation class are the "driest" found within sampled Carolina bay wetlands, often being dominated by species not necessarily associated with wetland communities, especially *Pinus palustris*. This is one of the driest of those dry community types, wherein some areas of the ground consist of unvegetated, white sand. It is also the only sampled Carolina bay community type in which *Aristida stricta* is a dominant.

(6) Habitat

This community type occurs in medium-sized depressions located on moderately dissected land surfaces and exhibiting poorly drained, moderately rapidly permeable soils (Table 4.17, Figure 4.25). The soil water table is relatively stable, and water stands at or above the surface, if at all, only during brief periods immediately following a significant local rainfall event. At the time of sampling, the water table was found within this community type at some 35 cm below the soil surface.

This community type is found near the periphery of Carolina bay depressions having well-developed "classic" longleaf pine rim communities (*see, e.g.*, Wells 1928, 1946). It appears that the community exists within the bays as a result of historic, significant, aeolian deposit of rim (or surrounding uplands) sands within the depression proper. This has, with time, allowed the migration of a more typically "upland" community into the depression basin.

(7) Soils

This community type is found over sandy, siliceous, thermic Aeric Haplaquod soils (Table A-II-1). As previously noted, Haplaquods are the mid-latitude wet Spodosols characteristic of areas wherein there is a fluctuating water table. "Aeric" Haplaquods are those Haplaquods that have an ochric epipedon and are not quite so wet as the Typic subgroup, though they are still poorly drained soils (Soil Survey Staff, 1975). A representative Aeric Haplaquod soil underlying this community type is described for this community type in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is extremely acid to very strongly acid, increasing slightly with depth. The CEC is also very low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. Major cation concentrations are very low to negligible, indicating that this is a very nutrient poor soil . Soil bulk density within this community type is high throughout the soil solum and increases slightly with depth. This is reflected in the fact that sand-sized particles completely dominate the soil solum at all depths within this community type.

(8) Succession & Disturbance

Fire is a major factor is longleaf pine communities, and fires have been relatively frequent within this community type, as evidenced by the charred outer bark of community trees, the clumped nature of community shrubs and subcanopy trees, and abundant charcoal in surficial soil layers. As indicated by Table 4.17, most of the communities within this vegetation class show recent or historic evidence of timbering, usually the cutting of *Pinus* spp., which was true for this community type. Evidence of past cultivation, grazing or drainage was minimal. Surrounding landscapes have only been moderately altered by human land disturbance activities.

It is apparent that frequent fires are in large part responsible for maintaining this community type in an open condition without a well-developed shrub stratum. In the absence of such fires, the cover of woody species found within the community type, such as *Gaylussacia dumosa, Lyonia mariana, Vaccinium tenellum,* and *Quercus* spp. would be expected to increase rather dramatically, ultimately displacing much of the herbaceous layer within the community.

(9) Landscape Position

The community type "*Pinus palustris/Lyonia mariana/Aristida stricta/(Cladonia* spp.) Savanna" is found in sampled Carolina bay depressions of the Upper Coastal Plain (Table 4.3), and make up some 11 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, that community type is found over sandy, siliceous, thermic, Typic Haplaquods. Typic Haplaquods soils comprise 1 of the 5 soil families found within sampled Upper Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in Carolina bays located in the western, central portion of the study area, fall within this classification (Table 4.5). This community type comprises 13 percent of the sampled community types that make up the vegetation class. This community type is relatively common in the upland and "flatwoods" areas of coastal North Carolina. Because such communities are generally found to be "dry" in nature, this vegetation type would not typically be regarded as a viable depression community type. As previously discussed, it appears to occur in areas where surrounding bay rim vegetation "grades into" the wetter vegetation characteristic of Carolina bay interiors. *Pinus palustris* dominated communities, while common on bay rims, are rare within Carolina bays, and are presently known from only a few localities in North Carolina (*see* Figure 4.23).

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.6.3 COMMUNITY TYPE: ***Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwood (6.0.3)**

(1) Synonymy

Wet Pine Flatwoods - Spodic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.16)

*Acer rubrum, Andropogon virginicus* var. *virginicus, Aronia arbutifolia, Gaylussacia dumosa, Ilex coriacea, Ilex glabra, Lyonia mariana, Nyssa sylvatica, Panicum virgatum, Pinus palustris, Pinus serotina, Rhexia alifanus, Smilax glauca, Vaccinium fuscatum*

(3) Special Status Species

*Asclepias longifolia*

(4) Vegetation & Physiognomy

This community type is characterized by a generally closed canopy of *Pinus palustris*, often mixed with *Pinus serotina*, over a relatively thick shrub layer made up of *Ilex coriacea, Ilex glabra*, *Vaccinium* spp., and *Lyonia mariana*. Herbaceous cover is typically sparse within this community type, and a continuous mat of pine needles often covers the ground beneath the community.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 17.06 species (Table 4.2).

(5) Distinguishing Features

The community types included within this vegetation class are the "driest" found within sampled Carolina bay wetlands, often being dominated by species not necessarily associated with wetland communities, especially *Pinus palustris*. This community type is the wettest of these dry communities, and is distinguished by a well-developed shrub layer under a *Pinus palustris* canopy.

(6) Habitat

This community type occurs in medium-sized depressions located on moderately dissected land surfaces and exhibiting poorly drained, rapidly permeable soils (Table 4.17, Figure 4.25). The soil water table is relatively stable, and water stands at or above the surface only for brief to moderate periods following a significant local rainfall event. At the time of sampling, the water table was found within this community type at some 13 cm below the soil surface.

(7) Soils

This community type is found over a siliceous, thermic, Typic Psammaquents/loamy, siliceous, thermic Grossarenic Paleaquults soil type (Table A-II-1). As previously noted, this soil is poorly drained and dominated by sand throughout the soil solum. A sampled soil profile from this community type is described in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. The CEC is also extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. Major cation concentrations are very low to negligible, indicating that this is a very nutrient poor soil. Soil bulk density within this community type is high throughout the soil solum. While sand predominates at the surface of this soil, both sand- and silt-sized particles share dominance in the subsurface soil layers within this community type.

(8) Succession & Disturbance

Fire is a major factor is longleaf pine communities, and fires have been relatively frequent within this community type over time, as evidenced by the charred outer bark of community trees, the clumped nature of community shrubs, and abundant charcoal in surficial soil layers. As indicated by Table 4.17, most of the communities within this vegetation class show recent or historic evidence of timbering, usually the cutting of *Pinus* spp., as was true for this community type. Evidence of past cultivation, grazing or drainage is characteristically minimal. Surrounding landscapes have only been moderately altered by human land disturbance activities.

It is apparently the combination of periodic fires and frequent, if relatively brief, flooding that maintain this community type in its present condition with scattered herbs and a low shrub layer. However, the quantity of litter on the ground within this community indicates that no recent fires have occurred. Walker and Peet (1983) found that wet savannas are quickly invaded by pocosin shrubs if not frequently burned. In the absence of fire, the shrubs that characterize this community type would be expected to increase their dominance, with the community eventually taking on a pocosin-like aspect (Kologiski, 1977).

<u>(9) Landscape Position</u>

*Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwoods are found in Carolina bay depressions of the Upper Coastal Plain (Table 4.3), and make up some 11 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, that community type is found over siliceous, thermic Typic Psammaquents/loamy, siliceous, thermic Grossarenic Paleaquults. This soil comprises 1 of 5 soil types found within sampled Upper Coastal Plain Carolina bays, and is restricted to that surface (Table 4.4).

<u>(10) Distribution & Abundance</u>

Four of 482 intensively sampled plots (0.8%), occurring in Carolina bay located in the western central portion of the study area, fall within this classification (Table 4.5). This community type comprises 13 percent of the sampled community types that make up the vegetation class. This community type, like its predecessor in this vegetation class, is relatively common in the upland and "flatwoods" areas of coastal North Carolina. *Pinus palustris* dominated communities, while common on bay rims, are rare within Carolina bays, and are presently known from only a few localities in North Carolina (*see* Figure 4.23).

<u>(11) Conservation Status</u>

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

#### 4.3.6.4 COMMUNITY TYPE: ***Quercus marilandica/(Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa)/ Schizachyrium-Tephrosia-Aster walteri* Savanna (6.0.4)**

(1) Synonymy

Wet Pine Flatwoods - Lumbee Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.16)

*Aster concolor, Aster linariifolius, Aster paludosus, Aster spectabilis, Aster tortifolius, Aster walteri, Ceanothus americanus, Dichanthelium longiligulatum, Euphorbia corollata, Hypericum hypericoides, Lechea pulchella* var. *pulchella, Myrica heterophylla, Orbexilum pedunculatum* var. *psoralioides, Pityopsis adenolepis, Potentilla canadensis, Quercus marilandica, Rhododendron atlanticum, Schizachyrium scoparium, Scleria ciliata, Solidago patula* var. *strictula, Stylosanthes biflora, Tephrosia virginiana, Vaccinium fuscatum, Vernonia angustifolia* var. *angustifolia*

(3) Special Status Species

*Aster spectabilis, Solidago patula* var. *strictula*

(4) Vegetation & Physiognomy

This community type is typified by an open canopy of small- to medium-sized *Quercus marilandica* and other species of oak, with occasional *Pinus palustris* emergent above the canopy layer. A shrub layer is either made up of scattered, low (to .5 m in height) *Gaylusaccia dumosa*, *Rhododendron atlanticum*, and *Vaccinium* spp., or absent when burning of the community has not been suppressed for a number of years. The woody strata overlie a diverse herbaceous layer dominated by such species as *Schyzachyrium scoparium* and *Tephrosia virginiana*. *Pteridium aquilinum* is sometimes an important component of the herbaceous layer.

This community type exhibited the highest mean species richness found within a study area Carolina bay, at the 0.1 ha level, at 46.48 species (Table 4.2).

(5) Distinguishing Features

The community types included within this vegetation class are the "driest" found within sampled Carolina bay wetlands, often being dominated by species not necessarily associated with wetland communities, especially *Pinus palustris*. This is among the driest of the community types sampled within study area Carolina bays. Most of the *Pinus palustris* canopy trees have been removed from this community type, and it is the only sampled Carolina bay community dominated by *Quercus* spp. The community type is also distinctive for its herbaceous species richness.

(6) Habitat

This community type occurs in small depressions located on moderately dissected land surfaces and exhibiting moderately well drained, moderately rapidly permeable soils (Table 4.17, Figure 4.25). The soil water table is relatively stable, and is never found at or above the soil surface. At the time of sampling, the water table was found within this community type at some 150 cm below the soil surface.

(7) Soils

This community type is found on fine-loamy, siliceous, thermic Aquic Paleudult soils within the study area (Table A-II-1). Paleudults are the more or less freely drained, organic matter poor Ultisols of very old, stable land surfaces, with a thick argillic horizon. The Aquic subgroup designation indicates that soil surface ground water stands within 75 cm of the soil surface for part of the year, as indicated by low-chroma mottles within the soil profile, rendering this a moderately well drained soil (Soil Survey Staff, 1975). The Aquic Paleudult soil found beneath this community type is described in Appendix II.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for previously described Typic Paleaquult soils.

(8) Succession & Disturbance

Fire is a major factor is longleaf pine communities, and fires have been very frequent within this community type, as evidenced by the charred outer bark of community trees, the clumped nature of community shrubs and subcanopy trees, and abundant charcoal in surficial soil layers. As indicated by Table 4.17, most of the communities within this vegetation class show recent or historic evidence of timbering, usually the cutting of *Pinus* spp., as was true of this community type. Evidence of past cultivation, grazing or drainage were minimal. Surrounding landscapes have been significantly altered by human land disturbance activities in the area of this community type.

It is clearly the occurrence of frequent fires that has maintained this community type in its open condition, with dominance by a diverse herbaceous layer. Shrubs and other woody species are extremely numerous within the community, though they exist in a physiognomically low, suppressed state. In the absence of frequent fires, those woody components of the vegetation can be expected to very quickly assume dominance, changing the community's savanna-like aspect to a "thicket" vegetation type.

(9) Landscape Position

The community type "*Quercus marilandica*/(*Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa*)/*Schizachyrium-Tephrosia-Aster walteri* Savanna" is found in Carolina bay depressions of the Middle Coastal Plain (Table 4.3), and make up less than 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, that community type is found over fine-loamy, siliceous, thermic Aquic Paleudult soils. This soil family is rare in Carolina bay depressions, and is known only from sampled sites located on the Middle Coastal Plain landform surface (Table 4.4).

(10) Distribution & Abundance

Three of 482 intensively sampled plots (0.6%), occurring in the central portion of the study area, fall within this classification (Table 4.5). This community type comprises 10 percent of the sampled community types that make up the vegetation class. This community type, like its predecessors in this vegetation class, is relatively common in the upland and "flatwoods" areas of coastal North Carolina. Because this community is generally found to be somewhat "dry" in nature, this vegetation type would not typically be regarded as a viable depression community type. As previously noted for other community types within this vegetation class, it appears to occur in areas where surrounding bay rim vegetation "grades into" the wetter vegetation characteristic of Carolina bay interiors. *Pinus palustris* dominated communities (including this *Quercus marilandica* variant), while common on bay rims, are rare within Carolina bays, and are presently known from only a few localities in North Carolina (*see* Figure 4.23).

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

4.3.6.5 COMMUNITY TYPE: ***(Nyssa sylvatica)/Andropogon virginicus*** **var.** ***glaucus-Aster tortifolius*** **Flatwood (6.0.5)**

(1) Synonymy

Wet Pine Flatwoods - Lumbee Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.16)

*Aletris farinosa, Andropogon virginicus* var. *glaucus, Aronia arbutifolia, Aster tortifolius, Aster walteri, Eryngium yuccifolium* var. *yuccifolium, Eupatorium leucolepis, Eupatorium rotundifolium* var. *rotundifolium, Ilex glabra, Lechea minor, Lespedeza angustifolia, Lespedeza capitata, Liquidambar styraciflua, Ludwigia suffruticosa, Myrica heterophylla, Nyssa sylvatica, Pteridium aquilinum, Rhexia alifanus, Vaccinium fuscatum*

(3) Special Status Species

*Aristida palustris, Aster spectabilis, Ludwigia suffruticosa*

(4) Vegetation & Physiognomy

This community type typically lacks a developed canopy or shrub layer, although scattered small- to medium-sized *Nyssa sylvatica* trees, and to a lesser extent, *Pinus* spp. and *Quercus* spp. trees, and a diverse array of woody shrubs are present. The community type instead is dominated by a relatively diverse, graminoid- and composite-rich herbaceous layer consisting of such dominants as *Andropogon virginicus* var. *glaucus* and *Aster tortifolius.*

This community type exhibited comparatively high mean species richness at the 0.1 ha level, at 36.70 species (Table 4.2).

(5) Distinguishing Features

The community types included within this vegetation class are the "driest" found within sampled Carolina bay wetlands, often being dominated by species not necessarily associated with wetland communities, especially *Pinus palustris*. This is the one of the drier community types sampled within study area Carolina bays. Like its immediate predecessor, most of the *Pinus palustris* canopy trees have been removed from this community. The community is also similar to its immediate predecessor in having a rich herbaceous flora. It is the only sampled Carolina bay community dominated by *Nyssa sylvatica*, rather than *Nyssa biflora*, which is a characteristic dominant of many Carolina bay community types.

(6) Habitat

This community type occurs in small depressions located on moderately dissected land surfaces and exhibiting moderately well drained, moderately permeable soils (Table 4.17, Figure 4.25). The soil water table is relatively stable, and is never found at or above the soil surface. At the time of sampling, the water table was found within this community type at some 93 cm below the soil surface.

(7) Soils

The major portion of plots falling into this community type occur over clayey, kaolonitic, thermic Typic Fragiaquult soils, but a significant portion of the community occurred was found on fine-loamy, siliceous, thermic Aquic Paleudult soils. A pedon for the former soil family is described in Appendix II for CT 4.0.2, discussed previously. A pedon for the latter soil family is described in Appendix II for CT 6.0.4, discussed immediately above.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for previously described, similar soils, *i.e.*, the soils here are very strongly acid, nutrient poor and relatively fine-textured.

(8) Succession & Disturbance

Fire is a major factor is longleaf pine communities, and fires have been very frequent within this community type, as evidenced by the charred outer bark of community trees, the clumped nature of community shrubs and subcanopy trees, and abundant charcoal in surficial soil layers. As indicated by Table 4.17, most of the communities within this vegetation class show recent or historic evidence of timbering, usually the cutting of *Pinus* spp., as was true of this community type Evidence of past cultivation, grazing or drainage were minimal. Surrounding landscapes have been significantly altered by human land disturbance activities in the area of this community type.

Similarly to the immediately preceding community type, it is clearly the occurrence of frequent fires that has maintained this community in its relatively open condition, with dominance by a diverse herbaceous layer. Shrubs and other woody species are numerous within the community, though they exist in a physiognomically low, suppressed state. In the absence of frequent fires, those woody components of the vegetation can be expected to rather quickly assume dominance, changing the community's open aspect to a closed, "thicket-like" vegetation type.

(9) Landscape Position

*(Nyssa sylvatica)/Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwoods are found in Carolina bay depressions of the Middle Coastal Plain (Table 4.3), and make up only some 2 percent of sampled Carolina bay vegetation found within that landscape position. As previously discussed, that community type is found over two soil types -- clayey, kaolonitic, thermic Typic Fragiaquults (62%), and fine-loamy, siliceous, thermic Aquic Paleudults (38%). Ultisols are the most common soil type found in on this surface; these soil families represent 2 of the 7 Ultisols found within Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in the central portion of the study area, fall within this classification (Table 4.5). This community type comprises 27 percent of the sampled community types that make up the vegetation class. This community type, like its predecessors in this vegetation class, is more common in the upland and "flatwoods" areas of the study area. As previously discussed, this community type also appears to occur in areas where surrounding bay rim vegetation "grades into" the wetter vegetation characteristic of Carolina bay interiors. *Pinus palustris* dominated communities and their "flatwoods variants", while common on bay rims and surrounding upland areas, are rare within Carolina bays, and are presently known from only a few localities in North Carolina (*see* Figure 4.23).

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

4.3.6.6 ANALYSIS

Vegetation Class Environmental Gradients

Study area Longleaf Pine Woodland plots are distributed along both a hydrologic gradient and an orthogonal elevation-relief/soil density--nutrient gradient (Figs. 4.24 and 4.25). Plots are located on the first gradient principally by their by their comparative scores for depth of organic-dominated layer and soil permeability. Those factors are correlated with both compositional axes on the ordination diagram for Longleaf Pine Woodland plots. Stands are distributed along the second gradient according to their relative values for site elevation, local relief, fire frequency, soil drainage class, and soil calcium levels. The factors comprising the latter gradient are also associated with both compositional axes.

With respect to Longleaf Pine Woodland community type distribution along those gradients, (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood plots occur on less permeable, less sandy soils with a comparatively deep organic-dominated layer, at inland sites characterized by relatively infrequent fire disturbance. *Pinus palustris*/*Lyonia mariana*/*Aristida stricta* Savanna stands and *Pinus palustris*/*Ilex coriacea-Ilex glabra-Vaccinium fuscatum*/(*Cladonia* sp.) Flatwood plots occur in similar locations along the major gradients. Both community types occur at mid-elevation sites exhibiting a moderate fire frequency. They have sandy and highly permeable, but poorly drained soils, with a negligible organic-dominated layer. *Quercus marilandica*/(*Rhododendron atlanticum-Vaccinium fuscatum-Gaylussacia dumosa*)/*Schizachyrium scoparium-Tephrosia-Aster walteri* plots occur on still sandier soils (with the highest weight/volume) that are comparatively well drained and have a shallow organic-dominated layer. This community type is subject to the most frequent fires found within Carolina bay Longleaf Pine Woodland communities. (*Nyssa sylvatica*)/*Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwood stands are found at conditions similar to those characterizing the *Quercus marilandica* community type.

Discussion

Vegetational communities dominated by *Pinus palustris* are exceptionally common the sandy rims that surround many Carolina bay depressions. In addition, bays are plentiful within study area landscapes dominated by Longleaf Pine flatwoods. However, vegetational communities dominated by *Pinus palustris* rarely occur within bay depressions proper under natural conditions, apparently because the depressions are characterized by hydroperiods beyond the tolerance of that species. However, though rare, Longleaf Pine community types were observed to occur within Carolina bay depressions in two situations. The first instance occurs where substantial quantities of sand from outside the basin (apparently from a well-developed rim in most cases) are wind-transported and deposited within the depressions itself. Significant aeolian transport appears to be limited to the area immediately adjacent to the rim, significantly lessening slope of the depression walls. In such a case, longleaf pine communities may generally be observed both on the rim, in the transition area between the rim and the depression basin, and to an extent within the basin itself.

The second observed instance of longleaf pine communities entering bays occurs in the case of very shallow Carolina bay depressions located on broad flats where longleaf pine flatwoods are a significant portion of the dominant vegetation. In such areas, bay rims tend to be low or absent, the slope from rim to the basin center very gradual, and hydroperiods relatively short. As a consequence, the same flatwoods communities found on low flats surrounding bays are occasionally also found within the confines of a bay depression.

In both cases, the long hydroperiod/prolonged wet conditions associated with most bay depressions in their natural states has been somewhat ameliorated, and the depression soils range from poorly drained to moderately well drained. The (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood community type is an example of the second situation described, while the remaining four community types within this vegetation class occupy different points along the natural "hydrologic gradient" from rim to bay interior existing in the wind-modified basins described in the first instance.

Of these latter four community types, the *Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwood is the wettest (*i.e.*, the most interior) along the hydrologic gradient, occurring just adjacent to an interior bay community dominated by typical pocosin vegetation. This is not surprising, as it has long been reported that longleaf pine savanna vegetation is often encountered in the field as being transitional between more xeric pine communities and evergreen shrub-bog communities (Wells, 1928, 1946; Wells and Shunk, 1928; Woodwell, 1956; Walker and Peet, 1983). This community type occurs over a poorly drained, Typic Psammaquent soil, shows low species richness, and is dominated by the lowest proportion of herbaceous species and the highest proportion of woody taxa seen in the vegetation class (Table 4.2; Figures 4.26 and 4.27).

By contrast, the *Quercus marilandica/(Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa)/Schizachyrium-Tephrosia-Aster walteri* Savanna is the "driest" community type in the vegetation class (*i.e.*, closest to the bay rim). It occurs over a moderately well drained Aquic Paleudult soil, exhibits the highest species richness found in Carolina bay depressions, and is dominated by herbaceous species having underground perennating structures (Table 4.2; Figures 4.26 and 4.27). The other two community types found in this basin-rim transition area fall between these two extremes in terms of site wetness, species richness, and plant life and growth forms.

These observed vegetational differences no doubt reflect the different environmental conditions presented by poorly drained, nutrient-poor, excessively acid sandy soils where anoxic conditions are often present on the one hand, and moist but better-drained and less acidic clay soils on the other. However, they also likely reflect burning frequency. The relatively species rich community type was reportedly burned annually or very other year by local residents for decades prior to sampling for this study, while the species poor community type has reportedly burned only infrequently (Tables 4.2 and 4.17). Walker and Peet (1983) found that frequently burned Longleaf Pine savannas had consistently higher species richness than savannas where fire is infrequent.

Figure 4.23. Distribution of study area Carolina bay sites containing Longleaf Pine Woodland vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Longleaf Pine Woodland community types. Locations of individual, sampled Carolina bay sites are indicated by red circles.

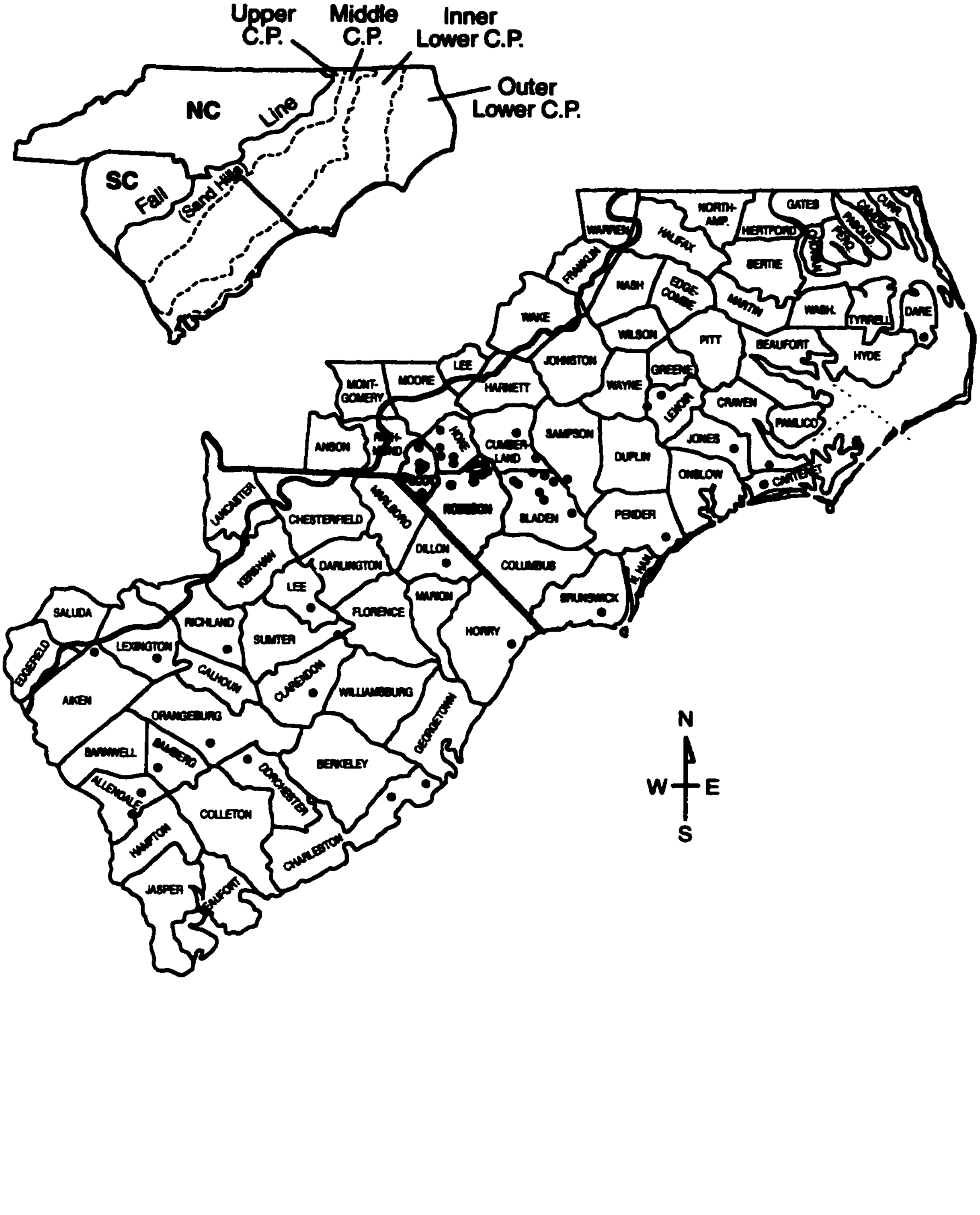

Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall Line
(Sand Hills)
WARREN
HALIFAX
NORTH-AMP.
HERTFORD
GATES
FRANKLIN
NASH
EDGE-COMBE
BERTIE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
GREENE
LEE
MONT-GOMERY
MOORE
HARNETT
WAYNE
LENOIR
CRAVEN
PAMLICO
ANSON
RICH-MOND
HOKE
CUMBER-LAND
SAMPSON
DUPLIN
JONES
ONSLOW
CARTERET
ROBESON
BLADEN
PENDER
COLUMBUS
BRUNSWICK
LANCASTER
CHESTERFIELD
MARLBORO
DILLON
KERSHAW
DARLINGTON
MARION
LEE
FLORENCE
HORRY
SALUDA
RICHLAND
SUMTER
EDGEFIELD
LEXINGTON
CALHOUN
CLARENDON
WILLIAMSBURG
GEORGETOWN
AIKEN
ORANGEBURG
BARNWELL
BAMBERG
DORCHESTER
BERKELEY
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT
N
W
E
S

Table 4.16. Average cover class and constancy of species present in the Longleaf Pine Woodland vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6. | | 6.0.1 | | 6.0.2 | | 6.0.3 | | 6.0.4 | | 6.0.5 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | | | | | | | |
| ACER RUBRUM | 4 | 27 | 3 | + | | | 4 | 100 | | | 4 | + |
| AGALINIS LINIFOLIA* | 4 | 3 | 4 | + | | | | | | | | |
| ALBIZIA JULIBRISSIN | 4 | 3 | 4 | + | | | | | | | | |
| ALETRIS FARINOSA | 3 | 30 | | | | | | | 2 | + | 3 | 100 |
| ANDROPOGON GERARDII | 4 | 3 | | | | | | | | | 4 | + |
| ANDROPOGON GLOMERATUS VAR. GLOMERATUS | 3 | 7 | 2 | + | | | 3 | + | | | | |
| ANDROPOGON GLOMERATUS VAR. GLAUCOPSIS | 4 | 23 | 7 | + | | | | | | | 3 | 63 |
| ANDROPOGON GYRANS VAR. GYRANS | 6 | 13 | 3 | + | | | | | | | 7 | + |
| ANDROPOGON GYRANS VAR. STENOPHYLLUS** | 7 | 3 | 7 | + | | | | | | | | |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 6 | 43 | 5 | 55 | | | | | | | 7 | 88 |
| ANDROPOGON VIRGINICUS VAR. VIRGINICUS | 3 | 23 | | | 4 | 100 | 3 | 75 | | | | |
| ANGELICA VENOSA | 2 | 7 | | | | | | | 2 | 67 | | |
| APOCYNUM CANNABINUM | 3 | 3 | 3 | + | | | | | | | | |
| ARISTIDA PALUSTRIS** | 5 | 3 | | | | | | | | | 5 | + |
| ARISTIDA STRICTA | 7 | 20 | | | 8 | 100 | 4 | + | | | 7 | + |
| ARONIA ARBUTIFOLIA | 4 | 43 | 5 | + | | | 3 | 75 | | | 4 | 100 |
| ASCLEPIAS LONGIFOLIA** | 2 | 3 | | | | | 2 | + | | | | |
| ASTER CONCOLOR | 3 | 13 | | | | | | | 3 | 100 | 2 | + |
| ASTER LINARIIFOLIUS | 2 | 10 | | | | | | | 2 | 100 | | |
| ASTER PALUDOSUS | 4 | 10 | | | | | | | 4 | 100 | | |
| ASTER PILOSUS VAR. DEMOTUS | 7 | 7 | 7 | + | | | | | | | | |
| ASTER PATERNUS | 2 | 7 | | | | | | | 2 | 67 | | |
| ASTER SPECTABILIS** | 2 | 17 | | | | | | | 2 | 100 | 2 | + |
| ASTER TORTIFOLIUS | 5 | 37 | | | | | | | 3 | 100 | 6 | 100 |
| ASTER WALTERI | 4 | 30 | | | | | | | 6 | 100 | 3 | 75 |
| AXONOPUS FURCATUS | 7 | 7 | 7 | + | | | | | | | | |
| BALDUINA UNIFLORA | 2 | 13 | | | | | | | 2 | + | 2 | + |
| BIGELOWIA NUDATA | 3 | 7 | | | | | | | | | 3 | + |
| BULBOSTYLIS CAPILLARIS | 2 | 7 | 2 | + | | | | | | | 1 | + |
| BULBOSTYLIS CILIATIFOLIA | 4 | 3 | 4 | + | | | | | | | | |
| CARPHEPHORUS BELLIDIFOLIUS | 5 | 10 | | | | | | | 6 | 67 | 2 | + |
| CARYA TOMENTOSA | 3 | 7 | | | | | | | 3 | 67 | | |
| CEANOTHUS AMERICANUS | 3 | 10 | | | | | | | 3 | 100 | | |
| CENTELLA ASIATICA | 3 | 10 | 3 | + | | | | | | | | |
| CHAMAECRISTA FASCICULATA | 2 | 10 | 2 | 27 | | | | | | | | |
| CHAPTALIA TOMENTOSA | 4 | 3 | | | | | | | | | 4 | + |
| CIRSIUM LECONTEI | 3 | 3 | | | | | | | 3 | + | | |
| CLADONIA SP. | 5 | 17 | | | 5 | 100 | 3 | + | | | | |
| CLETHRA ALNIFOLIA | 3 | 20 | | | 4 | + | | | | | 2 | 63 |
| CLITORIA MARIANA | 2 | 3 | | | | | | | 2 | + | | |
| COMMELINA VIRGINICA | 4 | 3 | 4 | + | | | | | | | | |
| COREOPSIS MAJOR | 2 | 3 | | | | | | | | | 2 | + |
| COREOPSIS VERTICILLATA | 2 | 3 | | | | | | | 2 | + | | |
| CTENIUM AROMATICUM | 8 | 7 | | | | | | | | | 8 | + |
| DICHANTHELIUM ACUMINATUM VAR. ACUMINATUM | 3 | 23 | | | | | | | 2 | 67 | 3 | 63 |
| DICHANTHELIUM CHAMAELONCHE | 5 | 13 | | | 3 | + | | | | | 5 | + |
| DICHANTHELIUM ERECTIFOLIUM** | 3 | 7 | 3 | + | | | | | | | | |
| DICHANTHELIUM LEUCOTHRIX | 4 | 7 | 4 | + | | | | | | | | |
| DICHANTHELIUM LONGILIGULATUM | 3 | 17 | | | | | | | 3 | 100 | 2 | + |

Table 4.16 (cont.). Average cover class and constancy of species present in the Longleaf Pine Woodland vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DICHANTHELIUM SCOPARIUM | 2 | 3 | 2 | + | | | | | | | | |
| DICHANTHELIUM WRIGHTIANUM | 5 | 37 | 5 | 73 | | | | | | | 3 | + |
| DIODIA VIRGINIANA | 5 | 13 | 5 | 36 | | | | | | | | |
| DIOSPYROS VIRGINIANA | 4 | 37 | 4 | 55 | 4 | 75 | | | 2 | + | 3 | + |
| DROSERA CAPILLARIS | 3 | 7 | 3 | + | | | | | | | | |
| ELEOCHARIS MELANOCARPA** | 5 | 10 | 5 | + | | | | | | | | |
| ELEOCHARIS TRICOSTATA** | 1 | 3 | 1 | + | | | | | | | | |
| ERAGROSTIS PILOSA | 6 | 3 | 6 | + | | | | | | | | |
| ERIGERON VERNUS | 4 | 17 | 6 | + | | | | | 4 | 67 | 4 | + |
| ERYNGIUM YUCCIFOLIUM VAR. YUCCIFOLIUM | 2 | 27 | 2 | + | | | | | | | 2 | 88 |
| EUPATORIUM ALBUM | 3 | 3 | | | | | | | 3 | + | | |
| EUPATORIUM ALTISSIMUM | 4 | 3 | | | | | | | 4 | + | | |
| EUPATORIUM CAPILLIFOLIUM | 2 | 3 | 2 | + | | | | | | | | |
| EUPATORIUM COMPOSITIFOLIUM | 2 | 3 | 2 | + | | | | | | | | |
| EUPATORIUM DUBIUM | 2 | 3 | | | | | | | | | 2 | + |
| EUPATORIUM LEPTOPHYLLUM* | 5 | 3 | 5 | + | | | | | | | | |
| EUPATORIUM LEUCOLEPIS | 4 | 43 | 4 | 36 | 3 | + | | | | | 4 | 100 |
| EUPATORIUM PERFOLIATUM | 4 | 3 | 4 | + | | | | | | | | |
| EUPATORIUM PILOSUM | 2 | 3 | | | | | 2 | + | | | | |
| EUPATORIUM RECURVANS** | 2 | 3 | 2 | + | | | | | | | | |
| EUPATORIUM ROTUNDIFOLIUM VAR. ROTUNDIFOLIUM | 2 | 47 | 2 | + | 3 | 50 | | | 2 | 67 | 3 | 100 |
| EUPHORBIA COROLLATA | 2 | 13 | 2 | + | | | | | 2 | 100 | | |
| EUTHAMIA TENUIFOLIA | 4 | 33 | 5 | 73 | | | | | | | 2 | + |
| FIMBRISTYLIS CASTANEA | 5 | 7 | 5 | + | | | | | | | | |
| GALACTIA ERECTA | 4 | 7 | | | 4 | 50 | | | | | | |
| GALIUM PILOSUM | 2 | 3 | | | | | | | 2 | + | | |
| GAYLUSSACIA DUMOSA | 4 | 43 | 2 | + | 5 | 100 | 4 | 100 | 6 | 67 | 3 | + |
| GAYLUSSACIA FRONDOSA VAR. FRONDOSA | 3 | 17 | | | | | | | 4 | 67 | 3 | + |
| GRATIOLA RAMOSA | 2 | 13 | 2 | 36 | | | | | | | | |
| HELIANTHUS ATRORUBENS | 4 | 7 | | | | | | | 6 | + | 2 | + |
| HIERACIUM GRONOVII | 2 | 7 | | | | | | | 2 | 67 | | |
| HYPERICUM CISTIFOLIUM | 3 | 17 | 3 | 27 | | | | | | | 2 | + |
| HYPERICUM HYPERICOIDES | 2 | 10 | | | | | | | 2 | 100 | | |
| ILEX CORIACEA | 7 | 20 | | | 5 | + | 7 | 100 | | | | |
| ILEX GLABRA | 4 | 43 | 3 | + | | | 6 | 100 | 3 | + | 3 | 75 |
| IPOMOEA PANDURATA | 4 | 3 | | | | | | | 4 | + | | |
| IRIS VERNA VAR VERNA | 2 | 13 | | | | | | | 2 | 67 | 3 | + |
| JUNCUS DICHOTOMUS | 5 | 3 | 5 | + | | | | | | | | |
| JUNCUS MARGINATUS | 2 | 3 | 2 | + | | | | | | | | |
| JUNCUS REPENS | 6 | 3 | 6 | + | | | | | | | | |
| JUNCUS SP. | 4 | 3 | 4 | + | | | | | | | | |
| LACHNOCAULON MINUS | 2 | 13 | | | 3 | + | | | | | 1 | 38 |
| LECHEA MINOR | 2 | 30 | | | | | | | 2 | 67 | 2 | 88 |
| LECHEA PULCHELLA VAR. PULCHELLA | 2 | 20 | | | | | | | 3 | 100 | 1 | 38 |
| LEERSIA HEXANDRA | 5 | 7 | 5 | + | | | | | | | | |
| LESPEDEZA ANGUSTIFOLIA | 3 | 37 | 2 | + | | | | | 4 | + | 3 | 100 |
| LESPEDEZA CAPITATA | 4 | 33 | 4 | + | | | | | 2 | + | 4 | 88 |
| LESPEDEZA CUNEATA | 4 | 13 | 5 | + | | | | | 2 | + | | |
| LESPEDEZA INTERMEDIA | 2 | 10 | | | | | | | 2 | + | 2 | + |
| LESPEDEZA REPENS | 2 | 3 | 2 | + | | | | | | | | |
| LESPEDEZA VIOLACEA | 2 | 7 | | | | | | | 2 | 67 | | |
| LIATRIS MICROCEPHALA | 1 | 10 | | | | | | | 1 | 67 | 2 | + |
| LINDERNIA DUBIA VAR. ANAGALLIDEA | 2 | 3 | 2 | + | | | | | | | | |
| LIQUIDAMBAR STYRACIFLUA | 4 | 50 | 5 | 55 | | | | | 3 | + | 4 | 100 |
| LOBELIA NUTTALLII | 2 | 10 | 2 | 27 | | | | | | | | |
| LUDWIGIA SP. #1 | 4 | 3 | 4 | + | | | | | | | | |
| LUDWIGIA ALTERNIFOLIA | 3 | 7 | 3 | + | | | | | | | | |

Table 4.16 (cont.). Average cover class and constancy of species present in the Longleaf Pine Woodland vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LUDWIGIA SUFFRUTICOSA* | 3 | 37 | 4 | 36 | | | | | | | 2 | 88 |
| LYCOPODIELLA ALOPECUROIDES | 2 | 3 | | | | | | | | | 2 | + |
| LYCOPUS ANGUSTIFOLIUS** | 4 | 3 | 4 | + | | | | | | | | |
| LYONIA LIGUSTRINA | 3 | 13 | | | | | | | 4 | + | 3 | + |
| LYONIA MARIANA | 4 | 57 | 4 | 36 | 6 | 100 | 5 | 100 | 2 | + | 3 | 50 |
| MAGNOLIA VIRGINIANA | 4 | 3 | | | | | 4 | + | | | | |
| MYRICA HETEROPHYLLA | 3 | 33 | | | | | | | 3 | 100 | 3 | 88 |
| NUTTALANTHUS CANADENSIS | 1 | 17 | | | | | | | 1 | 33 | 1 | 50 |
| NYSSA BIFLORA | 3 | 13 | 3 | 36 | | | | | | | | |
| NYSSA SYLVATICA | 4 | 43 | 2 | + | | | 4 | 100 | | | 5 | 100 |
| OLDENLANDIA BOSCII* | 3 | 7 | 3 | + | | | | | | | | |
| ORBEXILUM PEDUNCULATUM VAR. PSORALIOIDES | 2 | 17 | | | | | | | 2 | 100 | 2 | + |
| PANICUM HEMITOMON | 5 | 3 | 5 | + | | | | | | | | |
| PANICUM VIRGATUM | 5 | 50 | 7 | 64 | | | 3 | 100 | | | 2 | 50 |
| PARIETARIA PENSYLVANICA** | 2 | 3 | 2 | + | | | | | | | | |
| PASPALUM LAEVE | 2 | 3 | 2 | + | | | | | | | | |
| PENSTEMON AUSTRALIS | 2 | 3 | 2 | + | | | | | | | | |
| PERSEA PALUSTRIS | 5 | 3 | | | | | 5 | + | | | | |
| PINUS PALUSTRIS | 7 | 40 | 7 | + | 6 | 100 | 8 | 100 | 6 | 33 | | |
| PINUS SEROTINA | 4 | 27 | 2 | + | | | 5 | 100 | | | 4 | + |
| PINUS TAEDA | 4 | 10 | 5 | + | 3 | + | | | | | | |
| PITYOPSIS ADENOLEPIS | 3 | 27 | | | | | | | 4 | 100 | 2 | 63 |
| PITYOPSIS GRAMINIFOLIA* | 8 | 3 | 8 | 9 | | | | | | | | |
| PLUCHEA ROSEA | 4 | 7 | 4 | + | | | | | | | | |
| POLYGALA CRUCIATA | 1 | 10 | 2 | + | | | | | | | 1 | + |
| POLYGALA CURTISSII | 2 | 17 | | | | | | | 1 | + | 2 | 50 |
| POLYGALA RAMOSA | 4 | 7 | 4 | + | | | | | | | | |
| POTENTILLA CANADENSIS | 2 | 20 | | | | | | | 2 | 100 | 2 | 38 |
| PROSERPINACA PECTINATA | 2 | 3 | 2 | + | | | | | | | | |
| PTERIDIUM AQUILINUM | 5 | 27 | | | | | | | 5 | 67 | 5 | 75 |
| PYCNANTHEMUM FLEXUOSUM | 3 | 10 | 3 | + | | | | | | | | |
| QUERCUS FALCATA | 4 | 13 | 6 | + | | | | | 4 | 67 | 3 | + |
| QUERCUS INCANA | 4 | 7 | 3 | + | 4 | 25 | | | | | | |
| QUERCUS LAEVIS | 4 | 7 | | | 4 | + | | | | | | |
| QUERCUS MARGARETTIAE | 5 | 3 | 5 | + | | | | | | | | |
| QUERCUS MARILANDICA | 4 | 27 | | | | | | | 6 | 100 | 3 | 63 |
| QUERCUS NIGRA | 4 | 27 | 4 | + | | | 5 | 25 | 2 | + | 3 | + |
| QUERCUS STELLATA | 5 | 10 | | | | | | | 5 | + | 5 | + |
| RHEXIA ALIFANUS | 4 | 40 | | | | | 4 | 100 | | | 4 | 100 |
| RHEXIA ARISTOSA* # | 3 | 7 | 3 | + | | | | | | | | |
| RHEXIA MARIANA | 4 | 13 | 4 | 36 | | | | | | | | |
| RHEXIA MARIANA VAR. EXALBIDA | 1 | 3 | 1 | + | | | | | | | | |
| RHODODENDRON ATLANTICUM | 4 | 20 | 3 | + | | | | | 5 | 100 | 4 | + |
| RHUS COPALLINA | 2 | 30 | 3 | + | | | | | 2 | 67 | 2 | 50 |
| RHYNCHOSPORA FILIFOLIA | 4 | 13 | 4 | + | | | | | | | 4 | + |
| RHYNCHOSPORA PERPLEXA VAR. PERPLEXA | 3 | 27 | 3 | 36 | | | | | | | 3 | 50 |
| ROTALA RAMOSIOR | 4 | 3 | 4 | + | | | | | | | | |
| RUBUS ARGUTUS | 3 | 23 | 3 | 55 | | | | | | | 2 | + |
| SABATIA BRACHIATA | 4 | 10 | 5 | + | | | | | | | 1 | + |
| SABATIA DIFFORMIS | 3 | 3 | 3 | + | | | | | | | | |
| SACCHARUM ALOPECUROIDES | 3 | 10 | | | | | | | 4 | + | 2 | + |
| SACCHARUM GIGANTEUM | 3 | 20 | 4 | + | | | | | | | 2 | + |
| SALIX NIGRA | 2 | 3 | 2 | + | | | | | | | | |
| SCHIZACHYRIUM SCOPARIUM | 7 | 13 | | | | | | | 7 | 100 | 7 | 13 |
| SCLERIA CILIATA | 4 | 10 | | | | | | | 4 | 100 | | |
| SCLERIA RETICULARIS* | 2 | 7 | 2 | + | | | | | | | 1 | + |
| SCLEROLEPIS UNIFLORA** | 4 | 3 | 4 | + | | | | | | | | |
| SMILAX GLAUCA | 3 | 50 | 3 | 45 | | | 4 | 100 | 2 | + | 3 | 63 |
| SMILAX LAURIFOLIA | 3 | 3 | | | | | 3 | + | | | | |
| SMILAX ROTUNDIFOLIA | 4 | 10 | 7 | + | | | | | 2 | + | 2 | + |

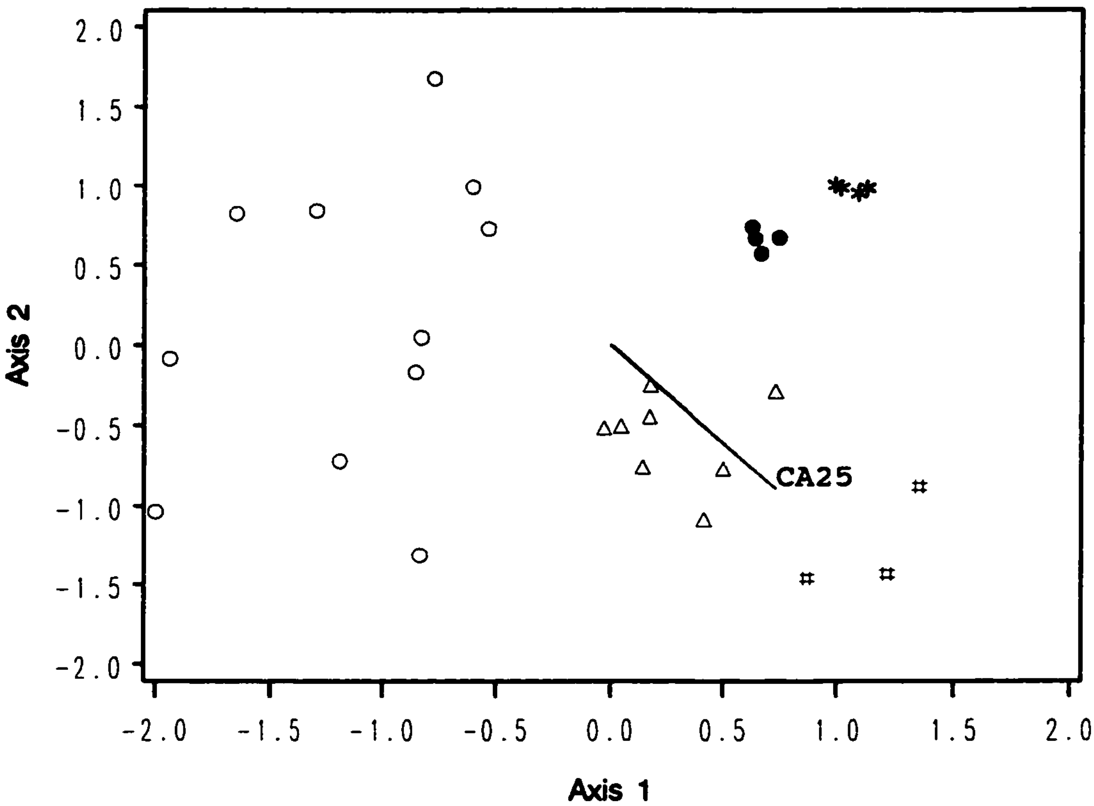
Table 4.16 (cont.). Average cover class and constancy of species present in the Longleaf Pine Woodland vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOLIDAGO ODORA | 3 | 13 | 3 | + | | | | | 3 | 67 | 2 | + |
| SOLIDAGO PATULA VAR. STRICTULA** | 3 | 17 | | | | | | | 4 | 100 | 3 | + |
| SOLIDAGO STRICTA | 3 | 3 | | | | | | | | | 3 | + |
| STYLISMA AQUATICA* | 2 | 3 | 2 | + | | | | | | | | |
| STYLOSANTHES BIFLORA | 3 | 23 | 2 | + | | | | | 3 | 100 | 3 | + |
| STYLISMA PICKERINGII | 2 | 3 | | | | | | | 2 | + | | |
| TAXODIUM ASCENDENS | 4 | 3 | 4 | + | | | | | | | | |
| TEPHROSIA VIRGINIANA | 7 | 10 | | | | | | | 7 | 100 | | |
| TOXICODENDRON TOXICARIUM | 3 | 7 | | | | | | | 3 | 67 | | |
| VACCINIUM CORYMBOSUM | 2 | 17 | 2 | 27 | | | 3 | 50 | | | | |
| VACCINIUM FUSCATUM | 5 | 53 | 5 | + | | | 6 | 100 | 5 | 100 | 3 | 100 |
| VACCINIUM TENELLUM | 4 | 7 | | | 3 | + | 4 | + | | | | |
| VERNONIA ANGUSTIFOLIA VAR. ANGUSTIFOLIA | 3 | 10 | | | | | | | 3 | 100 | | |
| VERNONIA X GEORGIANA | 2 | 7 | | | | | | | 2 | + | 2 | + |
| VIOLA LANCEOLATA | 2 | 13 | 2 | 36 | | | | | | | | |
| VITIS ROTUNDIFOLIA | 4 | 7 | 2 | + | | | | | | | 5 | + |
| WOODWARDIA VIRGINICA | 2 | 3 | 2 | + | | | | | | | | |
| XYRIS AMBIGUA | 2 | 3 | 2 | + | | | | | | | | |
| XYRIS CAROLINIANA | 3 | 30 | | | 5 | 100 | 4 | + | | | 2 | 50 |
| XYRIS JUPICAI | 2 | 7 | 2 | + | | | | | | | | |
| XYRIS SP. | 1 | 3 | 1 | + | | | | | | | | |

Table 4.17. Average site information for the Longleaf Pine Woodland vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | |
|---|---|---|---|---|---|---|
| | 6. | 6.0.1 | 6.0.2 | 6.0.3 | 6.0.4 | 6.0.5 |
| Site Hydrology | | | | | | |
| Water Depth Index | 87.3 | 127.6 | 115.0 | 137.0 | 0.0 | 56.9 |
| Hydroperiod Class | 1.6 | 2.7 | 1.0 | 2.0 | 1.0 | 1.0 |
| Water Constancy Index | 2.4 | 1.8 | 2.0 | 2.0 | 3.0 | 3.0 |
| Organic Layer Depth | 5.0 | 12.0 | 0.0 | 3.0 | — | — |
| Soil Drainage Class | 1.6 | 2.0 | 2.0 | 2.0 | 1.0 | 1.2 |
| Soil Permeability Class | 4.2 | 3.8 | 4.5 | 6.0 | 4.0 | 2.8 |
| Soil Available Water Capacity Class | 2.4 | 2.4 | 2.0 | 2.0 | 3.0 | 2.7 |
| | | | | | | |
| Site Geomorphology | | | | | | |
| Site Elevation (m) | 71.9 | 88.2 | 79.2 | 79.2 | 56.4 | 56.4 |
| Elevational Drop in 1 Km (m) | 8.6 | 12.6 | 9.1 | 9.1 | 6.1 | 6.1 |
| Distance to 10 m Elevational Drop (m) | 2025 | 1625 | 1175 | 1175 | 3050 | 3050 |
| Depression Area (ha) | 41.4 | 4.7 | 96.6 | 96.6 | 4.6 | 4.6 |
| Depression Length/Width Ratio | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Depression Long Axis Orientation | +4.7 | +1.6 | +6.0 | +6.0 | +5.0 | +5.0 |
| | | | | | | |
| Site Disturbance | | | | | | |
| Fire Frequency Class | 1.6 | 2.1 | 2.0 | 2.0 | 1.0 | 1.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.1 | 1.4 | 1.0 | 1.0 | 1.0 | 1.0 |
| Timbering Index | 2.3 | 1.4 | 3.0 | 3.0 | 2.0 | 2.0 |
| Drainage Index | 1.5 | 1.4 | 1.0 | 1.0 | 2.0 | 2.0 |
| Landscape Disturbance Class | 2.5 | 2.4 | 2.0 | 2.0 | 3.0 | 3.0 |

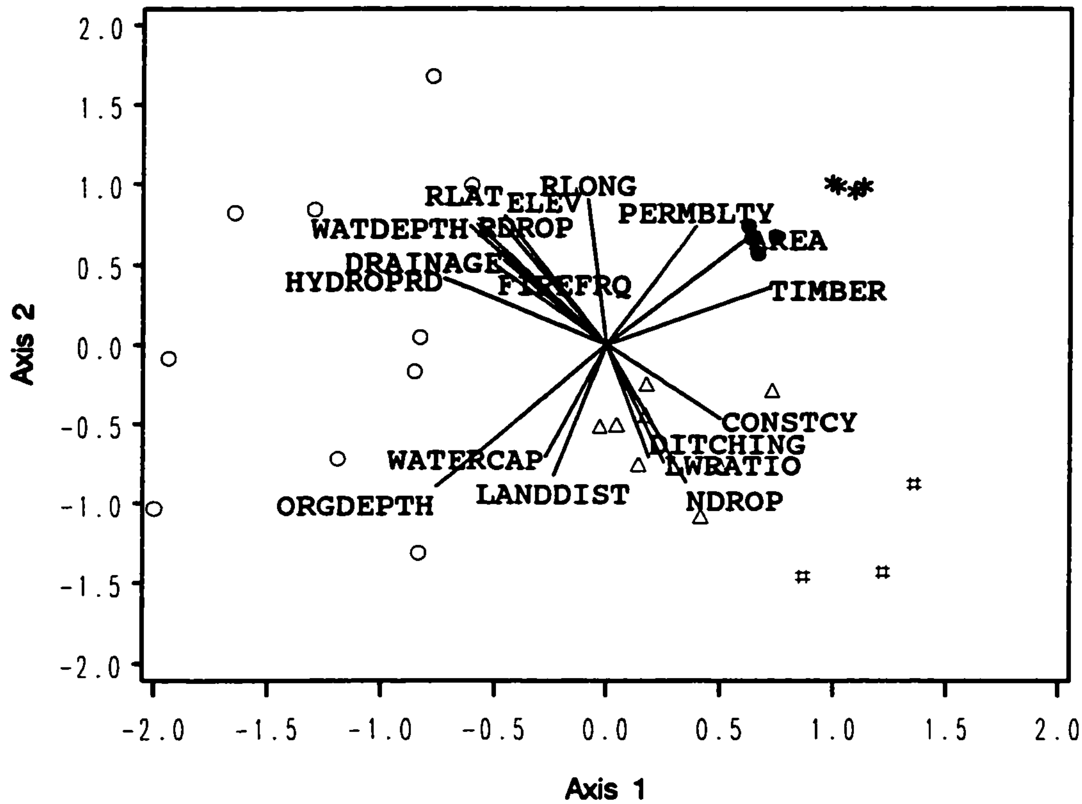
Figure 4.24. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Longleaf Pine Woodland stands as distributed by community type on the two major compositional gradients.




**LONGLEAF PINE WOODLAND – Community Types:**

○ Panicum virgatum–Euthamia/Dichanthelium wrightianum Flatwood
✱ Pinus palustris/Lyonia mariana/Aristida stricta/Cladonia spp. Savanna
● Pinus palustris/Ilex coriacea–I. glabra Flatwood
⌗ Quercus marilandica/Mixed shrubs/Schizachyrium–Tephrosia–Aster walteri Savanna
△ Nyssa sylvatica/Andropogon virginicus var. glaucus–Aster tortifolius Flatwood

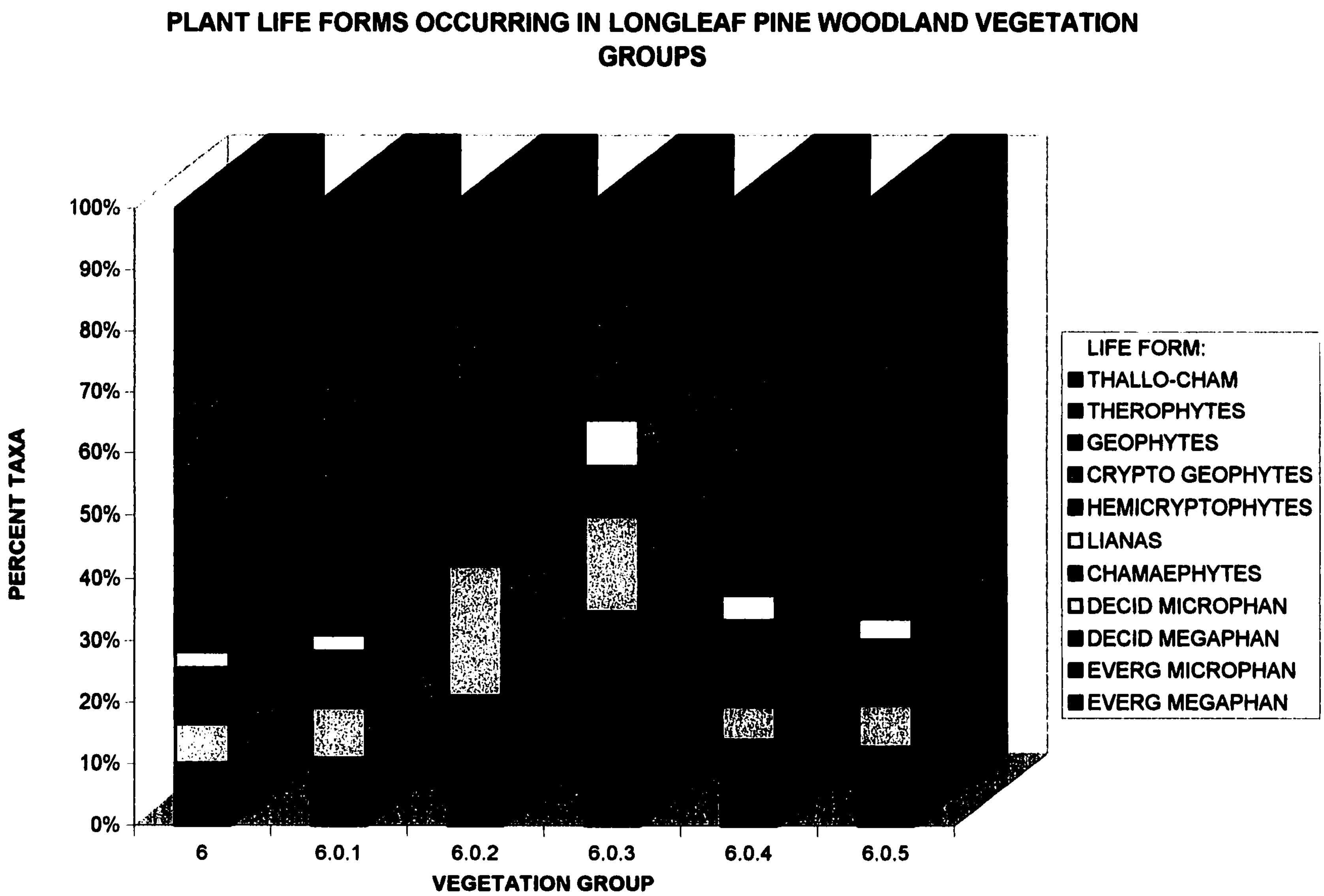
Figure 4.25. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soils-related, and Longleaf Pine Woodland stands as distributed by community type on the two major compositional gradients.




**LONGLEAF PINE WOODLAND – Community Types:**

○ Panicum virgatum–Euthamia/Dichanthelium wrightianum Flatwood
✱ Pinus palustris/Lyonia mariana/Aristida stricta/Cladonia spp. Savanna
● Pinus palustris/Ilex coriacea–I. glabra Flatwood
# Quercus marilandica/Mixed shrubs/Schizachyrium–Tephrosia–Aster walteri Savanna
△ Nyssa sylvatica/Andropogon virginicus var. glaucus–Aster tortifolius Flatwood

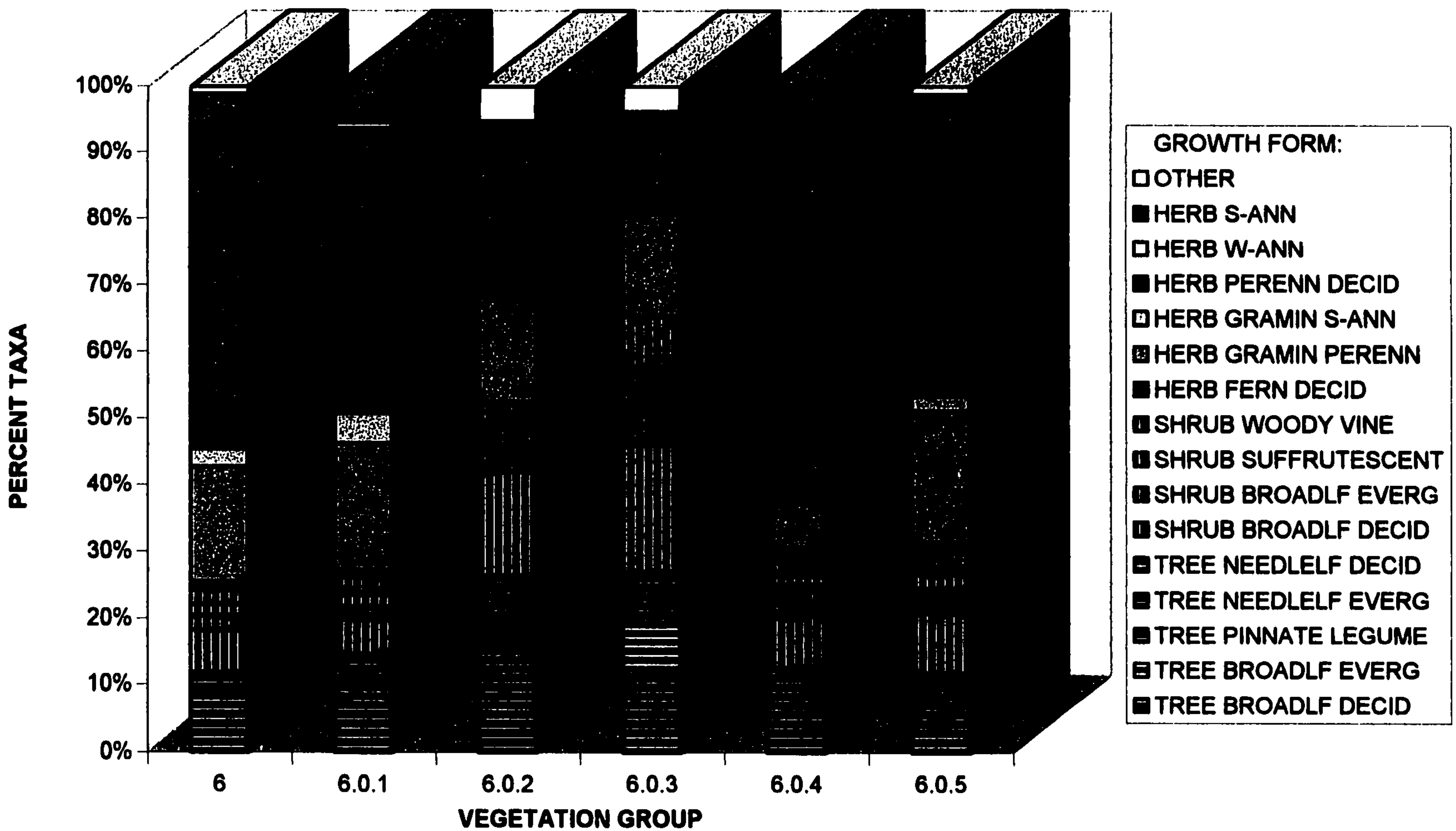
Figure 4.26. Plant Life Forms for Longleaf Pine Woodland vegetation groups found within North and South Carolina Carolina bay depressions.



PLANT LIFE FORMS OCCURRING IN LONGLEAF PINE WOODLAND VEGETATION GROUPS
PERCENT TAXA
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
6
6.0.1
6.0.2
6.0.3
6.0.4
6.0.5
VEGETATION GROUP
LIFE FORM:
THALLO-CHAM
THEROPHYTES
GEOPHYTES
CRYPTO GEOPHYTES
HEMICRYPTOPHYTES
LIANAS
CHAMAEPHYTES
DECID MICROPHAN
DECID MEGAPHAN
EVERG MICROPHAN
EVERG MEGAPHAN

Figure 4.27. Plant Growth Forms for Longleaf Pine Woodland vegetation groups found within North and South Carolina Carolina bay depressions.

## PLANT GROWTH FORMS OCCURRING IN LONGLEAF PINE WOODLAND VEGETATION GROUPS



4.3.7 VEGETATION CLASS: **Evergreen Shrub-bog (7.)**

The Evergreen Shrub-bog vegetation class comprises the "classic" Carolina bay vegetation type. Indeed, this kind of vegetation, with its characteristic broadleaf, evergreen "bay" species -- Loblolly Bay (*Gordonia lasianthus*), Sweet Bay (*Magnolia virginiana*), and Red Bay (*Persea palustris*) -- was so closely identified with these depressions early on, that the depression designation as "bays" was derived. (Savage, 1982).

Evergreen Shrub-bogs are the "thickety", shrub dominated wetlands associated with the southeastern United States coastal plain. They are characterized by dense, nearly impenetrable cover of evergreen and deciduous shrubs that range in height from less than a meter to 10 meters or more. The shrub cover is usually "tied together" by the invasive stems of *Smilax laurifolia*, and scattered, emergent trees may be present. Evergreen Shrub-bog soils are dominated by nutrient-poor, sandy and organic materials.

Various "forms" or "types" of this wetland community have been recognized. Most such classifications are based on either floristic affinities (*see*, *e.g.*, Woodwell, 1956; Kologiski, 1977) or physiognomy (*see*, *e.g.*, Wells, 1946, Christensen, 1988; Schafale and Weakley, 1990; Weakley and Schafale, 1991). In this study, Evergreen Shrub-bogs have been divided into two vegetation subclasses -- Bay Forest and Pocosin -- based on floristic and environmental similarities, as discussed below. Despite their differences in terms of constituent species, physiognomy and other factors, the vegetation of both subclasses consists predominantly of evergreen, and to a lesser extent, deciduous, shrubs.

4.3.7.1 VEGETATION SUBCLASS: **Bay Forest (7.1.)**

The Bay Forest vegetation subclass as described here occurs within Carolina bay depressions on sandy or shallow organic soils, but not on deep peats. Fire is comparatively infrequent in sites exhibiting Bay Forest community types, and individual woody plants tend to be much larger than individuals occurring in Pocosin community types. *Gordonia lasianthus* and *Magnolia virginiana* are characteristic of Bay Forest communities, but with the absence of fire, fire-intolerant hardwoods such as *Acer rubrum*, *Nyssa biflora*, and even *Liriodendron tulipifera* may occur as common canopy species. Carolina bays containing significant dominance by *Chamaecyparis thyoides* also fall within this vegetation subclass. Photographs of this vegetation subclass class appear in Plate 8, following Chapter 7 below.

4.3.7.1.1 COMMUNITY TYPE: ***Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest (7.1.1)**

(1) Synonymy

Pocosin *p.p.*, Bay Forest *p.p.* (Bennett and Nelson, 1991); Tall Pocosin *p.p.*, Bay Forest *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.18)

*Acer rubrum, Chamaecyparis thyoides, Clethra alnifolia, Gordonia lasianthus, Ilex coriacea, Ilex laevigata, Lyonia lucida, Magnolia virginiana, Persea palustris, Smilax laurifolia, Vaccinium corymbosum*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type is typified by a tall, very dense layer of evergreen species, including hollies (*Ilex coriacea* and *Ilex laevigata*), "ericaceous" shrubs -- (particularly *Lyonia lucida,* with *Gaylusaccia frondosa, Vaccinium* spp., and *Leucothoe* spp.), and small trees (*Acer rubrum, Magnolia virginiana, Persea palustris*). *Smilax laurifolia* vines are also frequent within this community type. *Chamaecyparis thyoides* and *Gordonia lasianthus*, sometimes mixed with *Pinus serotina* and/or *Pinus taeda*, either tower above the shrub layer as a canopy, or exist as scattered emergents rising through the dense shrub layer. Except for occasional ferns -- typically *Osmunda cinnamomea* or *Woodwardia virginica* -- herbs are generally absent from this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 14.85 species (Table 4.2).

(5) Distinguishing Features

Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents one of the "forest" communities within the vegetation class, and is the only sampled Carolina bay community dominated by *Chamaecyparis thyoides*.

(6) Habitat

This wet community type occurs in large depressions located on relatively flat, undissected land surfaces and is characterized by very poorly drained, moderately permeable, organic soils (described below) (Table 4.19, Figure 4.30). The soil water table is relatively stable, and generally is found at, or just below, the soil surface for most of the year. At the time of sampling, the water table was found within this community type at the soil surface.

(7) Soils

This community type was encountered in the study area with equal frequency over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists and sandy, siliceous, thermic Typic Haplaquods (Table A-II-1). Typic Medisaprists are the very poorly drained, mid-latitude, organic soils consisting of almost completely decomposed plant remains. They occur where the groundwater table, while often at or near the surface, tends to fluctuate periodically, allowing aerobic decomposition of soil organic matter. Terric Medisaprists are the shallow organic soils (Saprists) that overlie near-surface mineral sediments (Soil Survey Staff, 1975). A soil profile for the Typic Medisaprist soil that underlies this community type is described in Appendix II.

As previously discussed, Typic Haplaquod soils are poorly drained soils that develop over sand sediments having a fluctuating ground water table. A pedon of the Typic Haplaquod soil found beneath this community type is also described for this community type in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The humic matter content in this soil is relatively high at all measured soil depths, and generally increase with increasing soil depth. The soil bulk density values for this community type found within Tables A-II-2 to A-II-4 represent an average value for a "composite" of samples from both Histosol and Spodosol soils. Nevertheless, bulk density values are relatively low throughout the soil profile. Because sand, which has a relatively high bulk density, predominates throughout the soil solum within the Typic Haplaquod soils underlying this community type (organic soils were not "textured"), the extremely low bulk density values for the Terric Medisaprist soil found underlying this community type is apparent.

(8) Succession & Disturbance

As previously noted, fire is also a major factor in evergreen shrub bog communities. There is no evidence of recent fires within this community type however, and canopy trees generally lack fire scars that would indicate frequent burning of the community. Nevertheless, the historic significance of fires within this community type is evidenced by the extremely clumped nature of community woody species and the characteristic presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows no overt evidence of human disturbance. Surrounding landscapes have not been significantly altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

The community type "*Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest" is found in depressions within the Major River Valleys and Floodplains of the Coastal Plain (Table 4.3), and makes up some 22 percent of sampled Carolina bay vegetation found within that landscape position. As previously discussed, this community type is found over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (50%); and sandy, siliceous, thermic Typic Haplaquods (50%). Each soil type represents 1 of 4 soil families found within sampled Carolina bays located in Major River Valleys and Floodplains of the Coastal Plain. As Table 4.4 indicates, sandy and organic soils predominate on that landscape surface.

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in Carolina bays in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.28). This community type comprises 14 percent of the sampled community types that make up the vegetation class. Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North Carolina and northeastern South Carolina. However, enormous tracts of this once common vegetation type have been converted to silvicultural and agricultural use, and extant Carolina bays have become increasingly important as "refugia" for these community types. Bennett and Nelson (1991) state that "Pocosins" (Evergreen Shrub-bogs) are relatively rare in South Carolina as compared to other Carolina bay vegetation types.

(11) Conservation Status

Examples of this community type exist within State-owned North Carolina bay depressions managed as State park and State forest lands.

4.3.7.1.2 COMMUNITY TYPE: ***Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/ Smilax laurifolia* Forest (7.1.2)**

(1) Synonymy

Bay Forest *p.p.* (Bennett and Nelson, 1991); Nonriverine Swamp Forest *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.18)

*Acer rubrum, Aronia arbutifolia, Clethra alnifolia, Gelsimium sempervirens, Ilex coriacea, Lyonia lucida, Magnolia virginiana, Nyssa biflora, Persea palustris, Smilax laurifolia, Vitis rotundifolia*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type, like its predecessor, is characterized by a tall (4 to 6 m in height), very dense layer of evergreen shrubs -- especially *Ilex coriacea* and *Lyonia lucida* -- and small trees -- *Acer rubrum,* and particularly, *Magnolia virginiana* and *Persea palustris*. This evergreen community is usually "tied" together by the twining stems of *Smilax laurifolia*. However, unlike the preceding Bay Forest community type, the shrub layer in this community is overtopped by a moderately closed canopy consisting primarily of large specimens of *Nyssa biflora* and *Acer rubrum*. *Liriodendron tulipifera* and *Pinus taeda* comprise a significant portion of the canopy layer in some areas, and *Magnolia virginiana* and *Acer rubrum* form a subcanopy layer. *Gelsimium sempervirens* joins *Smilax* in twining over the shrub layer. An herbaceous layer is absent from this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 13.00 species (Table 4.2).

(5) Distinguishing Features

As noted above, Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents the second of the "forest" communities within the vegetation class, and is the only sampled Carolina bay community wherein *Acer rubrum* is a canopy dominant, and where *Liriodendron tulipifera* is a significant component of the vegetation.

(6) Habitat

This wet community type occurs in medium-sized depressions located on flat, undissected land surfaces and is characterized by very poorly drained, moderately permeable, moderately deep organic soils (described below) (Table 4.19, Figure 4.30). The soil water table is relatively stable, and generally is found at, or just below, the soil surface for most of the year. At the time of sampling, the water table was found within this community type just above the soil surface.

(7) Soils

As indicated by Table A-II-1, loamy, mixed, dysic, thermic Typic Medisaprist soils underlie this community type within the study area. A description of that very poorly drained, "muck" soil is set out for this community type in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type, while extremely acid at all measured soil depths, is notably higher than the pH levels encountered in other community types within this vegetation class. The CEC in the upper 30 cm of the soil from this community type was the highest measured, and its percent base saturation is markedly higher (39 to 52%) than other community types within this vegetation class. Moreover, unlike other community types within this vegetation class, the bulk of that CEC is not occupied by hydrogen and aluminum ions. Major cation concentrations are unusually high for an acid, organic soil, indicating that this is a relatively nutrient rich soil . Soil bulk density within this community type is very low throughout the measured portion of the soil solum, reflecting the organic soil.

(8) Succession & Disturbance

As previously noted, fire is generally a major factor in Evergreen Shrub-bog communities. Like the other Carolina bay "Bay Forest" community, there is no evidence of recent fires within this community type however, and canopy trees lack fire scars that would indicate frequent burning of the community. The presence of *Liriodendron tulipifera* as a canopy species and the large size of *Acer rubrum* trees, both relatively fire-intolerant species, would also appear to indicate lack of fire for a substantial period of time. Nevertheless, the historic significance of fires within this community type would appear to be evidenced by the extremely clumped nature of community shrubs deriving from large, woody rootstocks, and the occasional presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows no overt evidence of human disturbance. Surrounding landscapes have not been significantly altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

The community type "*Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/Smilax laurifolia* Forest", like its immediate predecessor community type, is found in Carolina bays within the Major River Valleys and Floodplains of the Coastal Plain (Table 4.3), and makes up some 11 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over loamy, siliceous, dysic, thermic Terric Medisaprist soils, which comprise 1 of the 4 soil families found within sampled Carolina bays located in Major River Valleys and Floodplains of the Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the south central portion of the study area, fall within this classification (Table 4.5; Figure 4.28). This community type comprises 7 percent of the sampled community types that make up the vegetation class. In general, Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North Carolina and northeastern South Carolina. However, enormous portions of this once common vegetation type have been converted to silvicultural and agricultural use, and extant Carolina bays have become increasingly important as "refugia" for these community types. Moreover, this specific community type is known from a single Carolina bay in South Carolina. Bennett and Nelson (1991) state that Evergreen Shrub-bogs ("Pocosins") are relatively rare in South Carolina as compared to other Carolina bay vegetation types.

(11) Conservation Status

An example of this community type currently exists within a South Carolina bay depression located on State-owned lands held for the purpose of biodiversity protection.

4.3.7.2 VEGETATION SUBCLASS: **Pocosin (7.2.)**

Carolina bays dominated by Pocosin vegetation have received considerable attention over the last half century. Buell (1939, 1945, 1946a, & 1946b), Wells (1943, 1946), Wells and Boyce (1953), Frey (1951a, 1953, & 1955), Whitehead (1963, 1964a, & 1964b), Whitehead and Tan (1969) and others studied the pollen record preserved in the organic soils of pocosin-dominated Carolina bay depressions in an effort to understand the age and origin of the elliptic depressions. And in more recent years, Sharitz and Gibbons (1982) thoroughly examined the ecology of Carolina bay Shrub-bogs.

The Pocosin vegetation class occurring within Carolina bays is dominated by a mixture of evergreen and deciduous shrubs that range in height from less than 1 meter to 5 meters or more tall. Pond Pine (*Pinus serotina*) is a characteristic emergent within the vegetation subclass, but the age, size and cover of that species, where present at all, vary greatly with site nutrient relations and fire history. Pocosin vegetation occurs both over sandy, mineral soils, and over shallow to deep peats. Photographs of this vegetation class appear in Plate 9, following Chapter 7 below.

4.3.7.2.1 COMMUNITY TYPE: ***Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/(Cladonia* sp.) Pocosin (7.2.1)**

(1) Synonymy

Pocosin *p.p.*, Pond Pine Woodlands *p.p.* (Bennett and Nelson, 1991); Low Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.18)

*Amelanchier canadensis, Aronia arbutifolia, Cladonia* spp., *Clethra alnifolia, Gaylussacia frondosa* var. *frondosa, Ilex coriacea, Kalmia carolina, Lyonia lucida, Magnolia virginiana, Pinus serotina, Pinus taeda, Smilax laurifolia, Sphagnum* spp., *Vaccinium corymbosum*

(3) Special Status Species

*Chamaedaphne calyculata, Gaylusaccia dumosa* var. *bigeloviana, Kalmia cuneata, Rhynchospora plieantha*

(4) Vegetation & Physiognomy

This community type is typified by an open canopy of *Pinus serotina* generally 12 m or less in height, overlying an open to dense shrub layer 1.5 m or less tall, made up of a diverse array of species. Shrub distribution tends to be "clumped", with multi-stemmed patches of the principal dominants being *Ilex coriacea, Lyonia lucida, Clethra alnifolia* and *Kalmia carolina*. However, other shrub or small tree species that may locally assume some significance include *Kalmia cuneata, Ilex laevigata, Fothergilla gardenii, Magnolia virginiana, Rhododendron viscosum, Rhododendron atlanticum, Gaylusaccia frondosa, Cyrilla racemiflora, Vaccinium corymbosum, Vaccinium fuscatum, Zenobia pulverulenta,* and *Chamaedaphne calyculata*. Scattered herbs occur where there are openings in the shrub layer, and include primarily graminoid species (*e.g.*, *Carex striata*) and *Sarracenia* spp. in "peaty" depressions.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 21.48 species (Table 4.2).

(5) Distinguishing Features

As noted, Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents one of the pocosin communities within the vegetation class, and is distinctive for its scattered *Pinus serotina* "canopy" and shrub diversity, having the highest species richness of any community type within the vegetation class.

(6) Habitat

This wet community type occurs in large depressions located on relatively flat, undissected land surfaces and is characterized by very poorly drained, moderately rapidly permeable, shallow (*ca.* 25 cm) organic soils (described below) (Table 4.19, Figure 4.34). The soil water table is relatively stable, and generally is found at, or just below, the soil surface for most of the year. At the time of sampling, the water table was found within this community type some 20 cm below the soil surface.

(7) Soils

This community type was encountered in the study area with equal frequency over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists and sandy, siliceous, thermic Typic Haplaquods (Table A-II-1). As previously discussed, the former soil type is a very poorly drained soil that developed in place over mineral sediments from highly decomposed organic materials. A representative profile of this soil group is set out in Appendix II for CT 7.1.1, discussed above. The Typic Haplaquod soil found beneath this community type is a poorly drained soil that developed in sandy sediments, exhibiting the alternating "albic/spodic" horizons indicative of varying zones of illuviation (leaching of organic materials) and eluviation (deposition of organic materials) characteristic of these soils within the study area. The soil profile description for this component of the soils underlying this community type is similar to the pedon description for CT 5.0.1, set out in Appendix II and discussed above.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. As would be expected, the soil humic matter content is high at all measured depths. The soil bulk density values for this community type found within Tables A-II-2 to A-II-4 represent an average value for a "composite" of samples from both Histosol and Spodosol soils. Nevertheless, bulk density values are relatively low in the upper portion of the soil profile. As noted for the immediately preceding community type, this indicates that bulk density values for the Terric Medisaprist soil found underlying this community type are extremely low.

(8) Succession & Disturbance

As previously noted, fire is also a major factor in evergreen shrub bog communities. There is no evidence of recent fires within this community type however, and canopy trees generally lack fire scars that would indicate frequent burning of the community. Nevertheless, the historic significance of fires within this community type is evidenced by the extremely clumped nature of community woody species and the characteristic presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows no overt evidence of human disturbance. Surrounding landscapes have not been significantly altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

The community type "*Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/(Cladonia* sp.) Pocosin" is found in Carolina bays within the Major River Valleys and Floodplains of the Coastal Plain (Table 4.3), and makes up some 22 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (50%), and sandy, siliceous, thermic Typic Haplaquods (50%). As noted, each soil type comprises 1 of the 4 sandy and/or organic soil families found within sampled Carolina bay depressions located in Major River Valleys and Floodplains of the Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in northern study area Carolina bays, fall within this classification (Table 4.5; Figure 4.28). This community type comprises 14 percent of the sampled community types that make up the vegetation class. Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North Carolina and northeastern South Carolina. However, large areas of Pocosin have been destroyed by human activities. As noted, Pocosins are relatively rare in South Carolina as compared to other Carolina bay vegetation types.

(11) Conservation Status

This community type is largely unprotected within Carolina bays within the study area, and likely does not exist within bays outside the Carolinas. Sampled Carolina bays for this vegetation group are privately owned, although similar communities may be present in

North Carolina in Bladen Lakes State Forest, Holly Shelter Game Land, or other publicly held lands.

4.3.7.2.2 COMMUNITY TYPE: ***Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin (7.2.2)**

(1) Synonymy

Pocosin *p.p.* (Bennett and Nelson, 1991); Low Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.19)

*Carex striata* var. *striata, Chamaedaphne calyculata, Ilex coriacea, Sarracenia flava, Smilax laurifolia, Sphagnum* spp., *Woodwardia virginica, Zenobia pulverulenta*

(3) Special Status Species

*Chamaedaphne calyculata, Eriophorum virginicum, Kalmia cuneata, Peltandra sagittifolia, Polygala brevifolia* (NOTE: *Vaccinium macrocarpon* was also collected from a Carolina bay falling within this community type, but was not found in the actual sampled plots at that site)

(4) Vegetation & Physiognomy

This community type is characterized by an open, low (to 3 m tall) evergreen shrub layer consisting of scattered clumps of, primarily, *Zenobia pulverulenta* and *Ilex coriacea*. Other shrub or small tree species, particularly *Chamaedaphne calyculata*, *Lyonia lucida, Myrica cerifera* and *Persea palustris*, may exhibit local dominance in some areas. The shrubs are found in large, multi-stemmed clumps generally "tied together" by the twining stems of *Smilax laurifolia. Pinus serotina* trees are occasional small "emergents" over the shrub layer. Water usually stands in "pools" in the openings between shrub clumps, with the pools most typically vegetated by dense stands of *Carex striata* and *Woodwardia virginica*, but giving way to rather spectacular stands of *Sarracenia flava* in some areas. *Sphagnum* spp. generally carpets the ground throughout this community type. Small (generally 5 m or less in height), widely scattered specimens of *Pinus serotina* stand above the "low pocosin" as emergents.

This community type exhibited low mean species richness at the 0.1 ha level, at 14.78 species (Table 4.2).

(5) Distinguishing Features

As noted, Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents one of the pocosin communities within the vegetation class, and is physiognomically distinctive for its "low" pocosin with no canopy layer, and relative lack of species richness.

(6) Habitat

This wet community type occurs in large depressions located on flat, relatively undissected land surfaces and is characterized by very poorly drained, moderately permeable, deep organic soils (described below) (Table 4.19, Figure 4.34). The soil water table is relatively stable, and generally is found at, or just below, the soil surface for most of the year. At the time of sampling, the water table was found within this community type at the soil surface. The surface within this community type has a "hummocky" appearance and exhibits significant site micro relief, resulting from the interspersion of low mounded areas where *Pinus* stumps are now covered with vegetation, with "inter-hummock" pools that apparently resulted from removal of surface peat layers by severe fires during periods of prolonged drought (Kologiski, 1977).

(7) Soils

This community type was encountered in the study area over two Histosols -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists; and dysic, thermic Typic Medisaprists (Table A-II-1). Both soils are very poorly drained soils and develop in place from decomposed organic materials. A Typic Medisaprist is essentially just a Terric Medisaprist with a significantly deeper organic horizon. A representative profile of a sampled Terric Medisaprist soil is set out in Appendix II for CT 7.1.1, discussed above. Appendix II also contains a profile description of the Typic Medisaprist soil underlying this community type. It should be noted from that plant rooting depth within this soil (and vegetation community) is similar to that described by Christensen *et al.* (1981) for a similar soil underlying a Croatan National Forest pocosin in eastern North Carolina. In that pocosin, they found that virtually all below-ground biomass, including live roots and lignotubers, occurred in the upper 30 cm of the organic soil.

A summary of soil chemical properties for this community type is set out in Tables A-II-2 to A-II-4. Textures for organic soils were not determined during this study. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. As would be expected, the soil humic matter content is high at all measured depths. The soil bulk density values for this community type are among the lowest encountered throughout the measured soil solum.

(8) Succession & Disturbance

As previously noted, fire is generally a major factor in evergreen shrub bog communities, and appears to be frequent within this community type. There is abundant evidence of recent fires, including charring on the lower boles of *Pinus serotina* trees, the extremely clumped nature of shrubs and other woody species, and the characteristic presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows little overt evidence of recent human disturbance, although low *Pinus* stumps now covered with vegetation may indicate past timbering. Surrounding landscapes have not been significantly altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

This community type is fairly ubiquitous, and is found in depressions within the Inner Lower Coastal Plain (33%), the Outer Lower Coastal Plain, and in the Major River Valleys and Floodplains of the Coastal Plain (Table 4.3). *Zenobia-Ilex coriacea-Chamaedaphne/ (Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosins make up some 12 percent of sampled Carolina bay vegetation found within the Inner Lower Coastal Plain, 12 percent of the sampled vegetation in the Outer Lower Coastal Plain, and 11 percent of the sampled vegetation in the Major River Valleys and Floodplains of the Coastal Plain. As previously discussed, the community type is found over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (67%), and dysic, thermic Typic Medisaprists (33%). Sandy and/or organic soil families predominate in Carolina bay depressions within each of the landscape positions wherein this community type is found -- the Inner Lower Coastal Plain, the Outer Lower Coastal Plain, and in Major River Valleys and Floodplains of the Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Twelve of 482 intensively sampled plots (2.5%), occurring in the east central portion of the study area, fall within this classification (Table 4.5; Figure 4.28). This community type comprises 21 percent of the sampled community types that make up the vegetation class. As noted, Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North Carolina and northeastern South Carolina. Moreover, this is one of the most common of the Evergreen Shrub-bog community types sampled.

(11) Conservation Status

Example of this community type currently exist within study area Carolina bays on both state and federally owned lands, thereby having some degree of future protection.

4.3.7.2.3 COMMUNITY TYPE: ***(Pinus serotina)/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosin** (7.2.3)

(1) Synonymy

Pocosin *p.p.* (Bennett and Nelson, 1991); Low Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.18)

*Aronia arbutifolia, Cyrilla racemiflora, Ilex coriacea, Lyonia lucida, Persea* *palustris, Smilax laurifolia, Sphagnum* spp., *Woodwardia virginica, Zenobia pulverulenta*

(3) Special Status Species

*Chamaedaphne calyculata, Gaylusaccia dumosa* var. *bigeloviana*

(4) Vegetation & Physiognomy

This community type is characterized by a relatively low (1.5 to 4 m) stratum of evergreen shrubs growing in multi-stemmed clumps, dominated by *Ilex coriacea, Lyonia lucida* and *Cyrilla racemiflora*. Other "pocosin" shrubs and small trees, including *Gaylusaccia dumosa* var. *bigeloviana, Myrica cerifera, Persea palustris* and *Zenobia pulverulenta* are locally significant within this community type, and the shrub layer, like that of other "pocosin-like" community types, tends to be "tied together" by *Smilax laurifolia*. Apparently largely dependent on site fire history, *Pinus serotina* and *Gordonia lasianthus* may either by completely absent, or may comprise a significant part of the woody vegetation as either emergents or forming a scattered canopy layer. The ground of this community type typically contains frequent patches of *Sphagnum* spp. Except for the scattered *Sarracenia* spp., *Rhynchospora* spp. or *Woodwardia virginica*, herbs are typically absent from this community type.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.80 species (Table 4.2).

(5) Distinguishing Features

As noted, Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents one of the pocosin communities within the vegetation class, and is distinguished by its "low" to "medium" pocosin under scattered *Pinus serotina* canopy trees.

(6) Habitat

This wet community type occurs in medium sized to large depressions located on relatively flat, undissected land surfaces and is characterized by very poorly drained, moderately rapidly permeable, organic soils (described below) (Table 4.19, Figure 4.34). The soil water table is relatively stable, and generally is found at, or just below, the soil surface for most of the year. However, at the time of sampling, the water table was found within this community type some 77 cm below the soil surface.

(7) Soils

This community type was encountered in the study area over three soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists; loamy, siliceous, dysic, thermic Terric Medisaprists; and sandy, siliceous, thermic Typic Haplaquods (Table A-II-1). As previously noted, Terric Medisaprist soils are very poorly drained soils that developed in place from decomposed organic materials, while Typic Haplaquod soils are poorly drained soils that developed in a sandy substrate. All three soil families are characteristic of an area with a fluctuating groundwater table. The two Terric Medisaprists differ only in terms of the particle size class characteristics , *i.e.*, in the physical nature of the underlying mineral soil. Representative soil profiles of a sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist and a Typic Haplaquod from the study area are described in Appendix II for previously discussed community types. A description of the loamy, siliceous, dysic, thermic Terric Medisaprist soil found underlying this community type is also described in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. As would be expected, the soil humic matter content is high at all measured depths. The soil bulk density values for this community type are low in the upper portions of the measure soil solum, where silt-sized particles predominate, and higher in the lower portion of the soil solum, where sand predominates.

(8) Succession & Disturbance

As previously noted, fire is a major factor in evergreen shrub bog communities, and appears to be frequent within this community type. There is abundant evidence of recent fires, including charring on the lower boles of *Pinus serotina* trees, the extremely clumped nature of shrubs and other woody species, and the characteristic presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows little overt evidence of recent human disturbance, although low *Pinus* stumps now covered with vegetation may indicate past timbering. Surrounding landscapes have not been significantly altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

This community type is found in depressions located in both the Inner Lower Coastal Plain and the Other Lower Coastal Plain (Table 4.3). *(Pinus serotina)/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosins make up some 36 percent of sampled Carolina bay vegetation found within the Inner Lower Coastal Plain and 12 percent of the vegetation sampled in the Outer Lower Coastal Plain. As previously discussed, the community type is found over three soil types -- sandy, siliceous, thermic Typic Haplaquods (50%), sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (25%), and loamy, siliceous, dysic thermic Terric Medisaprists (25%). Both soil types comprise 1 of 6 soil families sampled within Carolina bays located in the Inner Lower Coastal Plain, and 1 of 3 soil types observed in bay depressions in the Outer Lower Coastal Plain (Table 4.4). As previously discussed, sandy-textured and organic soils predominate on the flat, poorly drained surfaces of the Lower Coastal Plain, and on the relatively poorly drained soils occurring on major river terraces within the study area.

(10) Distribution & Abundance

Sixteen of 482 intensively sampled plots (3.3%), occurring in the northeastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 29 percent of the sampled community types that make up the vegetation class. As noted, Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North

Carolina and northeastern South Carolina (Figure 4.28). Moreover, this is the most common of the Evergreen Shrub-bog community types sampled. However, because large portions of this once common vegetation type have been converted to silvicultural and agricultural use, extant Carolina bays have become increasingly important as "refugia" for these community types.

(11) Conservation Status

Examples of this community type currently exist within study area Carolina bays on government lands wherein private development activities are prohibited.

4.3.7.2.4 COMMUNITY TYPE: ***Zenobia pulverulenta-Chamaedaphne/Sphagnum* spp. (7.2.4)**

(1) Synonymy

Pocosin *p.p.* (Bennett and Nelson, 1991); Low Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.18)

*Carex striata* var. *striata, Chamaedaphne calyculata, Sphagnum* spp., *Zenobia pulverulenta*

(3) Special Status Species

*Chamaedaphne calyculata, Kalmia cuneata*

(4) Vegetation & Physiognomy

This community type is typified by an open, low (generally 2 m or less in height) woody stratum consisting of multi-stemmed clumps of evergreen shrubs. The shrub layer is characteristically dominated by *Zenobia pulverulenta* and *Chamaedaphne calyculata*, but other "pocosin" shrubs, including *Ilex coriacea, Ilex laevigata, Kalmia cuneata, Leucothoe ligustrina*, and especially, *Lyonia lucida*, may be locally abundant. While there is generally no significant component of emergent tree stems within this community type, *Nyssa biflora, Acer rubrum* and *Pinus serotina* trees may occur as small, isolated specimens within the community. As in the other Pocosin communities described from the study area, *Smilax laurifolia* tends to also be abundant as a sprawling component of this community type. The very irregular ground surface of this community is covered by a thick mat of *Sphagnum* spp. Herbaceous species other than an occasional *Carex striata, Woodwardia virginica* or *Sarracenia* spp. are virtually absent from this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 9.68 species (Table 4.2).

(5) Distinguishing Features

Evergreen Shrub-bog community types are distinctive from most other Carolina bay vegetation communities in being dominated exclusively by woody species, especially evergreen shrubs. The community types within the vegetation class are distinguished from each other principally by their species composition and their physiognomy. This community type represents one of the pocosin communities within the vegetation class, and is distinguished by its generally abundant surface water, low pocosin composed primarily of *Chamaedaphne calyculata* and *Zenobia pulverulenta*, and lack of canopy trees.

(6) Habitat

This wet community type occurs in large depressions located on relatively flat, undissected land surfaces and are characterized by very poorly drained, deep, moderately permeable, organic soils (Table 4.19, Figure 4.34). The soil water table is relatively stable, and generally is found at, or more typically above, the soil surface for most of the year. At the time of sampling, the water table was found within this community type at some 16 cm above the soil surface.

(7) Soils

This community type was encountered in the study area with equal frequency over two soil types -- dysic, thermic, Typic Medisaprists and sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (Table A-II-1). As noted, a Typic Medisaprist is essentially just a Terric Medisaprist with a significantly deeper organic horizon. A description of a representative profile from a sampled Terric Medisaprist soil is set out in Appendix II for CT 7.1.1, discussed above. A representative description of a sampled Typic Medisaprist soil is found in Appendix II under CT 7.2.2, also discussed previously.

A summary of soil chemical properties for this community type is set out in Tables A-

II-2 to A-II-4. Textures for organic soils were not determined during this study. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The humic matter content in the surface portion of soils of this community type is significantly lower that the content of humic matter found in the soils underlying other community types within this vegetation class, but is substantial at 50 cm in depth. The soil bulk density values throughout the measured soil solum for this community type are among the very lowest encountered in Carolina bays.

(8) Succession & Disturbance

As previously noted, fire is generally a major factor in Evergreen Shrub-bog communities, and appears to be fairly frequent within this community type. Evidence of recent fires consists primarily of the extremely clumped nature of shrubs and other woody species and the characteristic presence of charcoal in the peaty soils. As indicated by Table 4.19, this community type shows little overt evidence of recent human disturbance, although low *Pinus* stumps now covered with vegetation may indicate past timbering. In addition, water tables within this community type are sometimes altered by drainage outlets controlled by sluice-gates, usually managed to keep water at or above the surface level. Surrounding landscapes have been moderately altered by human land disturbance activities in the area of this community type.

(9) Landscape Position

The community type "*Zenobia pulverulenta-Chamaedaphne calyculata/Sphagnum* spp. Pocosin" is found in depressions located in the Major River Valleys and Floodplains of the Coastal Plain (Table 4.3), and makes up some 22 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over two soil types -- sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists (50%), and dysic, thermic Typic Medisaprists (50%). As noted, each soil type represents 1 of the 4 soil families observed within sampled Carolina bay depressions located in Major River Valleys and Floodplains of the Coastal Plain (Table 4.4), where sandy and organic soils predominate.

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in the north central and eastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 14 percent of the sampled community types that make up the vegetation class. Evergreen Shrub-bog community types are relatively common in Carolina bays and similar depressions located in the Major River Valley and Floodplain landform surface of the study area Coastal Plain (primarily, the Cape Fear River and Pee Dee River Valleys), and in depressions and on broad, flat interfluves in the Lower Coastal Plain of eastern North Carolina and northeastern South Carolina (*see* Figure 4.28).

(11) Conservation Status

This community type was sampled only within privately owned Carolina bays having only the protective status of other wetland communities. However, examples of the community type may currently exist within state or federally owned forest or game lands.

4.3.7.2.5 ANALYSIS

Vegetation Class Environmental Gradients

Bay Forest plots within study area Carolina bays are distributed along both a soil density--acidity--nutrient/hydrologic gradient and an orthogonal elevation-locational/soil pH gradient (Figures 4.29 and 4.30). Stands are located on the first gradient primarily by their comparative scores for soil acidity, density, permeability, and surface phosphorus and potassium levels, as well as depth of organic-dominate layer, site hydroperiod, and site ambient water depth. Those factors are correlated with both compositional axes on the ordination diagram for Bay Forest plots, but are most strong associated with the first compositional axis. Stands are distributed along the second gradient according to their relative values for site elevation, rotated latitude, and soil pH. The factors comprising the latter gradient are associated with both compositional axes.

With respect to Bay Forest community type distribution along those gradients, *Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest stands are found at more inland, northern study area sites exhibiting a comparatively short hydroperiod. They occur over shallow organic soils having permeable (sandier) underlying soils. *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/Smilax laurifolia* Forest plots, on the other hand, tend to occur over deeper organic soils at sites with longer hydroperiods, generally standing surface water, and comparatively higher levels of surface potassium and phosphorus.

Similarly, Carolina bay Pocosin stands within the study area are distributed along dual, complex gradients -- a soil density/"site" hydrologic gradient and an orthogonal elevation/ soil nutrient/"landscape" hydrologic gradient (Figs. 4.33 and 4.34). Plots are located on the first gradient principally by their by their comparative scores for soil density and drainage class, site hydroperiod, and relative site fire frequency. Those factors are most strongly correlated with the first compositional axis on the ordination diagram for Pocosin stands. Plots are distributed along the second gradient according to their relative values for site elevation and longitude, site ambient water level, and soil manganese and zinc levels. The factors comprising the latter gradient are associated with both scatterplot compositional axes.

With respect to the distribution of Pocosin community types along those gradients, *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/(Cladonia* sp.) Pocosin plots occur at the sites with the shortest hydroperiod and best drained soils, resulting in the highest frequency of fire, over relatively dense soils. Both *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin stands and *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin plots are found at poorly drained sites with comparatively long hydroperiods, and thus have the lowest frequency of fires among Pocosin communities within sampled Carolina bay depressions. (*Pinus serotina)/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosin stands occur at comparatively eastern study area sites that exhibit a moderate fire frequency. These plots have little standing surface water, and comparatively high soils levels of manganese and zinc.

<u>Discussion</u>

Christensen *et al.* (1981) point out that the term "Evergreen Shrub-bog" can be misleading, because over one-half of pocosin shrub species are actually deciduous in nature. However, as previously noted, Carolina bay Evergreen Shrub-bog community types are universally dominated by broadleaf evergreen shrubs. While a diversity of deciduous shrubs was encountered within Carolina bay depressions, two broadleaf evergreen species -- *Lyonia lucida* and *Ilex coriacea* -- were the ubiquitous dominants in study area Carolina bays exhibiting Evergreen Shrub-bog vegetation. Christensen *et al.* (1981) also noted based on the literature on southeastern pocosins, that *Cyrilla racemiflora, Lyonia lucida, Ilex glabra,* and *Zenobia pulverulenta* are the most abundant pocosin shrubs. While *Lyonia lucida* and *Zenobia pulverulenta* were plentiful within bay depression sites, both *Cyrilla* and *Ilex glabra* were found to be comparatively infrequent in study area Carolina bays.

For a variety of reasons, the line between vegetational communities characterized, respectively, as Bay Fores" and Pocosin is never as clear in the field as it appears to be in the literature. First, site hydroperiod, soil type, fire history, nutrient status, and other significant site environmental parameters occur across a continuum that is reflected in the vegetational diversity found within Evergreen Shrub-bogs in terms of floristics, physiognomy, and patterning. Second, major environmental factors that shape Shrub-Bog vegetation may interact in complex ways that are not readily discernible or easily measured. Third, the use of pertinent terminology is not always consistent. In this instance, the term "Pocosin" is commonly used in the literature to refer both to a wetland type -- the true raised, ombrotrophic bog, or "swamp-on-a-hill" (*see*, *e.g.*, Richardson, 1981) -- and to a vegetation type (*see*, *e.g.*, Wells, 1928; Christensen, 1988). It is used only in the latter sense in this study. And finally, the issue is further complicated by the fact that this study did not purposefully look at any vegetation class across its entire range of variability within the study area, where examples of most vegetation classes also occur in non-Carolina bay wetland sites in the form of community types that either never were, or are no longer, represented within bay depressions.

As described in this study, the Pocosin vegetation subclass is essentially Kologiski's (1977) "Pine-ericalean Pocosin" class, while the Bay Forest vegetation subclass includes parts of both his "Bay Forest" and his "Conifer-hardwood Pocosin" class. As previously noted, the two vegetation subclasses are distinguishable in Carolina bays primarily in terms of species dominants, site fire frequency, and to a lesser degree, soils. For example, within Carolina bay Evergreen Shrub-bogs: (1) *Pinus serotina* is rarely found in Bay Forest community types, but is abundant in many Pocosin communities; (2) fire is comparatively rare in Bay Forest communities, but is a frequent occurrence in Pocosins; and (3) only Pocosin community types are found on deep organic soils.

The distinctness of the two vegetation subclasses is also reflected in the comparative dominant plant life forms found within each vegetation group. Bay Forests are dominated by woody phanerophytes, and on average, taxa with subterranean perennating structures comprise less than 10% of species present in that vegetation subclass. Moreover, while evergreen and deciduous shrubs predominate in Bay Forests as a whole, deciduous megaphanerophytes make up nearly 20% of the taxa present (Figures 4.31 and 4.32). By contrast, species having subterranean perennating structures make up over 40% of the taxa found in Pocosins, and deciduous megaphanerophytes make up only ~5% of the taxa present in that vegetation subclass. As to dominant plant growth forms in Evergreen Shrub-bogs, broadleaf deciduous and evergreen trees comprise over 30% of Bay Forest taxa, while they make up less than one-half that amount in Pocosin community types (Figures 4.35 and 4.36).

Atlantic White Cedar Forest (*Chamaecyparis thyoides*) vegetation occurs in the types of coastal plain environs characteristic of Evergreen Shrub-bogs, and has been ascribed to Carolina bay sites by Schafale and Weakley (1990). However, while that species is striking in apparent dominance in a number of bays -- in part because its almost black color and conic form stand in such contrast to the comparatively light colors and rounded form of shrub dominants -- closer investigation generally shows that species to, at best, share dominance with a number of other species, particularly *Gordonia lasianthus* and *Pinus taeda*, in communities with clear floristic similarities to other Bay Forest types. For that reason, Carolina bay communities exhibiting dominance by *Chamaecyparis thyoides* were subsumed into the Bay Forest subclass in this study.

The various Evergreen Shrub-bog community types identified within Carolina bays likely reflect vegetational responses to a variety of direct and subtle effects of site wetness (hydroperiod), pedology, including nutrient status -- which is closely related to site hydroperiod, and fire history. As noted in the Introduction to this vegetation class, Evergreen Shrub-bog vegetation is typically classified by site physiognomy, using terms that designate the general height of the vegetation, *e.g.*, "High Pocosin", "Medium Pocosin", and "Low Pocosin" (*see*, *e.g.*, Schafale and Weakley, 1990; Weakley and Schafale, 1991). Evergreen Shrub-bog community types sampled included all physiognomic groups, from "Bay Forest" to "Low Pocosin".

Walbridge (1991) found that the natural gradient from Short Pocosin to Bay Forest represents a gradient of increasing soil phosphorus availability. The tallest vegetation occurring within Evergreen Shrub-bogs was found in the *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/Smilax laurifolia* Forest community type (CT 7.1.2). Tables A-II-2 to A-II 4 summarize the chemical properties of Carolina bay soils. As those tables indicate, soils pH is indeed highest among Evergreen Shrub-bog vegetation groups for community type 7.1.2. However, for other Evergreen Shrub-bog communities the soils data for this study indicate no clear relationship between vegetation height and soil phosphorus levels. This suggests that vegetation height variability within sampled Carolina bay communities has resulted from differences in recent site fire history, rather than reflecting the "natural nutrient gradient" observed by Walbridge.

Fire is the principal natural disturbance factor in Evergreen Shrub-bog communities, even though it does not generally occur as frequently as in more upland, pine-dominated southeastern coastal plain vegetational communities such as savannas (Christensen, 1988). Even so, the life histories of most pocosin species center on fire (Christensen, 1979; Christensen *et al.*, 1981). The effect of fires on Shrub-bog vegetation is highly variable, depending upon such factors as its seasonality, intensity, the length of time since the previous fire, and the relative saturation of the soil at the time of the fire (Wells, 1928, 1946; Garren, 1943; Kologiski, 1977). Canopy trees, where they are present, may come through a fire unscathed, or may be killed outright. In general, fires remove the aerial stems of component shrub species, which then re-sprout from woody rootstocks, quickly giving the community a semblance of its former vegetational structure and species composition. Where fires burn the peat layers of the soil, their effects on community vegetational dynamics may be drastic, changing the community from a shrub-dominated bog to a graminoid-dominated one (Kologiski 1977). In the absence of fire, Evergreen Shrub-bogs tend to persist in a given condition for long periods of time, gradually changing physiognomically as dominant shrub individuals increase in size and height.

Wells (1946) and Woodwell (1956) noted that *Zenobia pulverulenta* and its associates -- *Clethra alnifolia, Kalmia caroliniana, Ilex glabra,* and *Chamaedaphne calyculata* -- are site disturbance indicators, being most common in recently burned areas, and eventually being overtopped by other pocosin shrubs. Accordingly, the *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia caroliniana/(Cladonia* spp.) Pocosin community type identified in this study would be expected to occur at sites that have burned more recently than those occupied by other Shrub-Bog community types. That expectation appears to comport with field observations of fire history in Pocosin vegetation groups (Table 4.19).

Fire frequency and intensity may also be linked to vegetation dynamics in more subtle ways. For example, both shrub species richness and fire frequency was found to vary significantly within Carolina bay Pocosins (Tables 4.2 and 4.19), ranging from 8 to 20 shrub species per 0.01 ha study plot, and from ~5 to >25 years, respectively. The *Pinus serotina/ Ilex coriacea-Clethra-Lyonia lucida-Kalmia caroliniana/(Cladonia* spp.) Pocosin community type discussed above, apparently the most recent of the Shrub-bogs sampled to undergo fire, also exhibited the highest species richness of the Pocosin community types encountered (Table 4.2). Christensen *et al.* (1981) proposed that variation in shrub-bog species richness reflects differential species response to the nutrient gradient resulting from uneven combustion in fires occurring in this vegetation type. This may be particularly important in Evergreen Shrub-bog communities, which are nutrient limited, particularly with respect to phosphorus and nitrogen (Woodwell, 1958; Christensen, 1979, 1988).

Kologiski (1977) found that *Zenobia pulverulenta* tended to occur on the deeper, wetter peat soils in Green Swamp Pocosins in North Carolina, and was often associated with *Woodwardia virginica* and *Carex striata*, two herbaceous "opportunists" that spread rapidly following severe fires. This finding also appears to be supported by this study. *Zenobia* was a dominant species in three of the four Pocosin community types sampled, occurring over the deepest peats encountered within Carolina bays, and generally at the wettest sites (Table 4.19). It is associated with *Woodwardia* as a layer dominant in two of those community types, and with *Carex striata* in one of the community types.

Similarly, site hydrology is linked to vegetation dynamics in a number of direct and indirect ways. Carolina bay depressions with long and stable hydroperiods, where anaerobic conditions typically prevail year-round, tend to accumulate the most peat and typically (but not always) contain Evergreen Shrub-bog vegetation. Daniel (1981) found that elevated peatlands have a slightly shorter hydroperiod than otherwise similar, but elevationally lower bogs, and that as a result of that different wetness factor, support different species than the moister bog sites. He also noted other indirect effects of site hydrology. Daniel determined that in depressional bogs, ground water tends to enter the organic soil at the uphill edge because peat acts as a dam to area ground water flow. Dissolved minerals in the groundwater are depleted by cation exchange and plant consumption as water moves inward within the depression. As a result, a nutrient gradient is created within the depression, with "minerotrophic", comparatively nutrient-rich conditions occurring towards the depression edge, and "ombrotrophic", comparatively nutrient-poor conditions occurring towards the middle of the basin. Daniel concluded that bog vegetation communities tend to be distributed along this gradient.

The results of this study would appear to support that conclusion. The "(*Pinus serotina*)/*Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia*/(*Smilax laurifolia*)/(*Woodwardia virginica*)/(*Sphagnum* spp.) Pocosin" community type was the only Evergreen Shrub-bog vegetation group identified wherein all sampled plots were located in the "middle" area of a large Carolina bay depression having an organic soil. The soil nutrient values for that community type are either the lowest, or among the lowest, for the vegetation subclass for all soil nutrients measured (Tables A-II-2 to A-II-4).

Hummocks occurring in bays and other micro relief features create wetness gradients, and thereby may be expected to comparatively increase species richness at any given site (*see, e.g.*, Ehrenfeld, 1995). However, no correlation was found in this study between Evergreen Shrub-bog species richness and site micro relief.

From a hydrologic standpoint, southeastern Evergreen Shrub-bogs, and especially the Pocosin subclass, are commonly referred to as ombrotrophic peatlands (*see, e.g.*, Wilbur and Christensen, 1983), indicating nutrient poor bogs that are hydrologically isolated from surface and groundwater flow, and therefore almost entirely dependent on precipitation for water and nutrient inputs. Minerotrophic peatlands are, by contrast, generally defined as comparatively nutrient-rich bogs (or "fens") that receive water that has passed through mineral soil (Mitsch and Gosselink, 1993). However, given the hydrology of most Carolina bay depressions, neither term is particularly suitable, since even "Pocosin" bays characteristically receive water and nutrients from a combination of sources -- precipitation, ground water, and overland flow (Daniel, 1981).

Relative hydrologic isolation and depression water source may be particularly instructive in understanding the *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/Smilax laurifolia* Forest community type found within the Bay Forest vegetation subclass. As compared to the soils found beneath other Evergreen Shrub-bog communities, the soils underlying the specified community type show high levels of major cations, particularly manganese, and high site pH at all soil depths (Tables A-II-2 to A-II-4). Those nutrient differences may be the result of lack of the hydrologic isolation that occurs in true ombrotrophic bogs. The site where that community occurs is located on the floodplain of a major river in an area with very little relief, and undoubtedly receives periodic water and nutrient input from the adjacent stream during major flooding events. It is the only Carolina bay site sampled that is subject to overland, fluvial input.

Figure 4.28. Distribution of study area Carolina bay sites containing Evergreen Shrub-bog vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Evergreen Shrub-bog community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Evergreen Shrub-bog community types were observed during field reconnaissance for this study. In each instance, counties having bay sites exhibiting Bay Forest community types are indicated by vertical stripes superimposed on the county of occurrence for that vegetation subclass, while counties having bay sites exhibiting Pocosin community types are indicated by horizontal stripes superimposed on the county of occurrence for that vegetation subclass. Locations of individual, sampled Carolina bay sites are indicated by red circles.

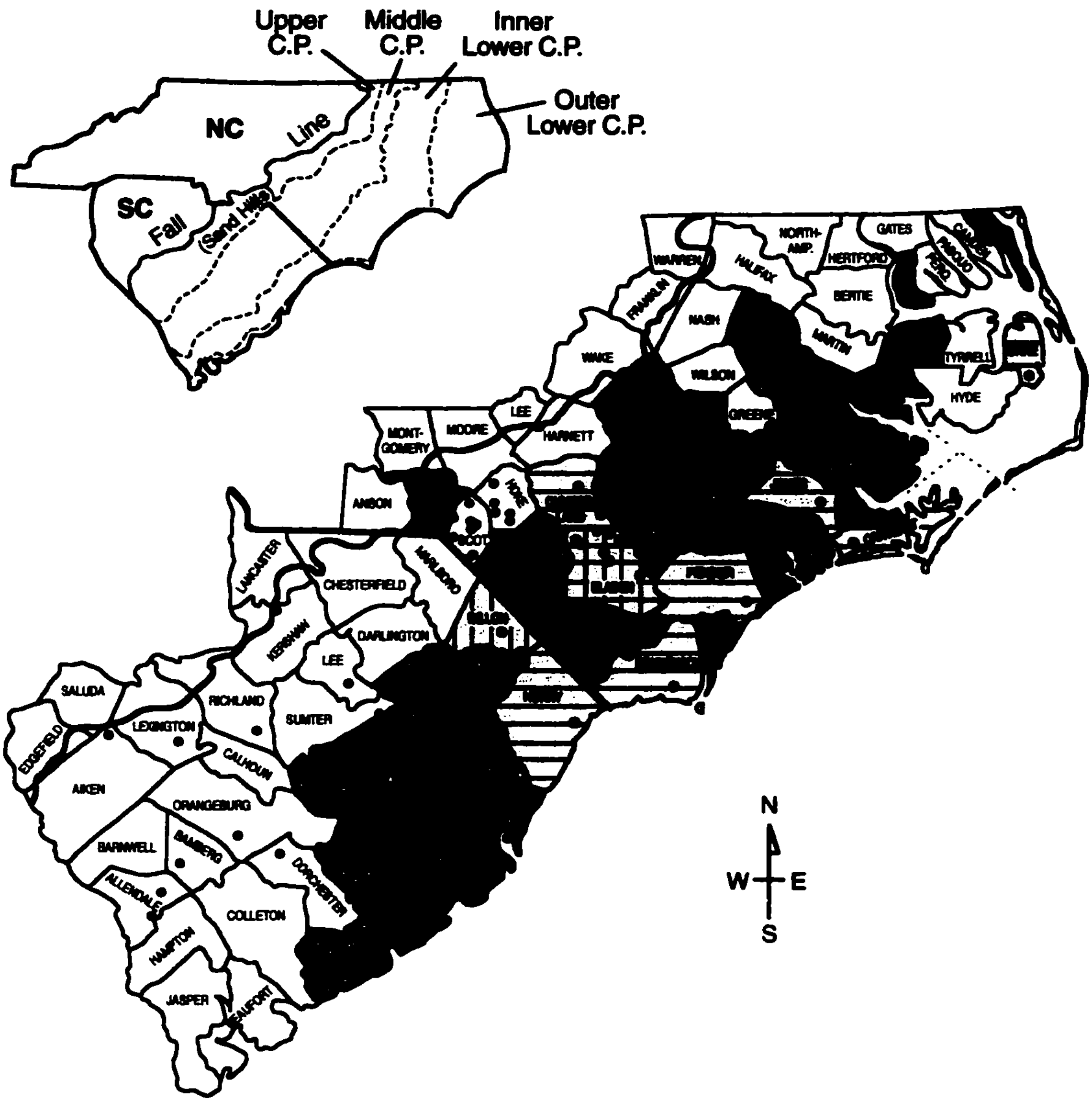

Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
WARREN
NORTH-AMP.
GATES
HALIFAX
HERTFORD
BERTIE
FRANKLIN
NASH
MARTIN
TYRRELL
WAKE
WILSON
HYDE
GREENE
LEE
MONT-GOMERY
MOORE
HARNETT
ANSON
LANCASTER
CHESTERFIELD
MARLBORO
KERSHAW
DARLINGTON
LEE
SALUDA
RICHLAND
SUMTER
EDGEFIELD
LEXINGTON
CALHOUN
AIKEN
ORANGEBURG
BARNWELL
BAMBERG
DORCHESTER
ALLENDALE
COLLETON
HAMPTON
JASPER
BEAUFORT
N
W
E
S

Table 4.18. Average cover class and constancy of species present in the Evergreen Shrub-bog vegetation class. Values are given for the vegetation class and its constituent vegetation subclasses and community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7. | | 7.1 | | 7.1.1 | | 7.1.2 | | 7.2 | | 7.2.1 | | 7.2.2 | | 7.2.3 | | 7.2.4 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | | | | | | | | | | | | | |
| ACER RUBRUM | 5 | 48 | 6 | 100 | 6 | 100 | 7 | 100 | 4 | 34 | 4 | 63 | 4 | 42 | 3 | + | 2 | + |
| AMELANCHIER CANADENSIS | 3 | 14 | 4 | 17 | 4 | + | 4 | + | 3 | 14 | 3 | 75 | | | | | | |
| ANDROPOGON GLOMERATUS VAR. GLOMERATUS | 2 | 9 | | | | | | | 2 | 11 | | | 3 | + | 2 | + | | |
| ARONIA ARBUTIFOLIA | 4 | 50 | 2 | 50 | 1 | + | 3 | 100 | 4 | 50 | 3 | 88 | 3 | + | 4 | 75 | | |
| ARUNDINARIA GIGANTEA VAR. TECTA | 2 | 5 | | | | | | | 2 | 7 | 2 | + | | | | | | |
| BARTONIA VIRGINICA | 1 | 2 | | | | | | | 1 | 2 | | | 1 | + | | | | |
| CAREX STRIATA VAR. STRIATA | 5 | 48 | | | | | | | 5 | 61 | | | 7 | 100 | 3 | + | 4 | 100 |
| CHAMAEDAPHNE CALYCULATA# | 6 | 54 | | | | | | | 6 | 68 | 4 | 63 | 6 | 75 | 5 | + | 8 | 100 |
| CHAMAECYPARIS THYOIDES | 7 | 14 | 7 | 67 | 7 | 100 | | | | | | | | | | | | |
| CLADONIA SP. | 4 | 32 | | | | | | | 4 | 41 | 5 | 75 | | | 4 | 50 | 5 | 50 |
| CLETHRA ALNIFOLIA | 5 | 36 | 4 | 92 | 4 | 100 | 4 | 75 | 6 | 20 | 7 | 100 | | | 4 | + | | |
| CYRILLA RACEMIFLORA | 6 | 43 | | | | | | | 6 | 55 | 3 | 50 | 6 | + | 7 | 100 | | |
| DICHANTHELIUM DICHOTOMUM | 2 | 4 | | | | | | | 2 | 5 | | | | | 2 | + | | |
| DICHANTHELIUM CF. SABULORUM VAR. PATULUM | 1 | 2 | | | | | | | 1 | 2 | 1 | + | | | | | | |
| DROSERA INTERMEDIA | 2 | 4 | | | | | | | 2 | 5 | | | 2 | + | | | | |
| ERIOPHORUM VIRGINICUM** | 4 | 4 | | | | | | | 4 | 5 | | | 4 | + | | | | |
| FOTHERGILLA GARDENII | 4 | 5 | | | | | | | 4 | 7 | 4 | + | | | | | | |
| GAYLUSACCIA DUMOSA VAR. BIGELOVIANA** | 5 | 21 | | | | | | | 5 | 27 | 2 | + | | | 6 | 69 | | |
| GAYLUSSACIA FRONDOSA VAR. FRONDOSA | 5 | 25 | 4 | 42 | 4 | 63 | | | 6 | 20 | 6 | 100 | | | 3 | + | | |
| GELSEMIUM SEMPERVIRENS | 4 | 7 | 4 | 33 | | | 4 | 100 | | | | | | | | | | |
| GORDONIA LASIANTHUS | 6 | 38 | 7 | 67 | 7 | 100 | | | 5 | 30 | 6 | 13 | 4 | + | 6 | 56 | | |
| ILEX CORIACEA | 7 | 86 | 8 | 100 | 8 | 100 | 9 | 100 | 7 | 82 | 8 | 100 | 6 | 100 | 8 | 100 | | |
| ILEX GLABRA | 5 | 4 | | | | | | | 5 | 5 | 5 | + | | | | | | |
| ILEX LAEVIGATA | 4 | 21 | 4 | 58 | 4 | 88 | | | 4 | 11 | | | 6 | + | | | 3 | + |
| ILEX MYRTIFOLIA | 5 | 7 | | | | | | | 5 | 9 | | | | | 5 | + | | |
| ILEX OPACA | 4 | 2 | | | | | | | 4 | 2 | | | 4 | + | | | | |
| ITEA VIRGINICA | 3 | 7 | 2 | 25 | 2 | + | | | 4 | 2 | | | | | 4 | + | | |
| KALMIA CAROLINA | 5 | 30 | | | | | | | 5 | 39 | 7 | 88 | 5 | 33 | 5 | + | 4 | + |
| KALMIA CUNEATA* | 5 | 23 | | | | | | | 5 | 30 | 4 | 63 | 5 | + | | | 6 | + |
| LEUCOTHOE AXILLARIS | 6 | 4 | 6 | 17 | 6 | + | | | | | | | | | | | | |
| LEUCOTHOE RACEMOSA | 4 | 14 | | | | | | | 4 | 18 | 4 | + | 5 | + | | | | |
| LIQUIDAMBAR STYRACIFLUA | 5 | 2 | 5 | 8 | | | 5 | + | | | | | | | | | | |

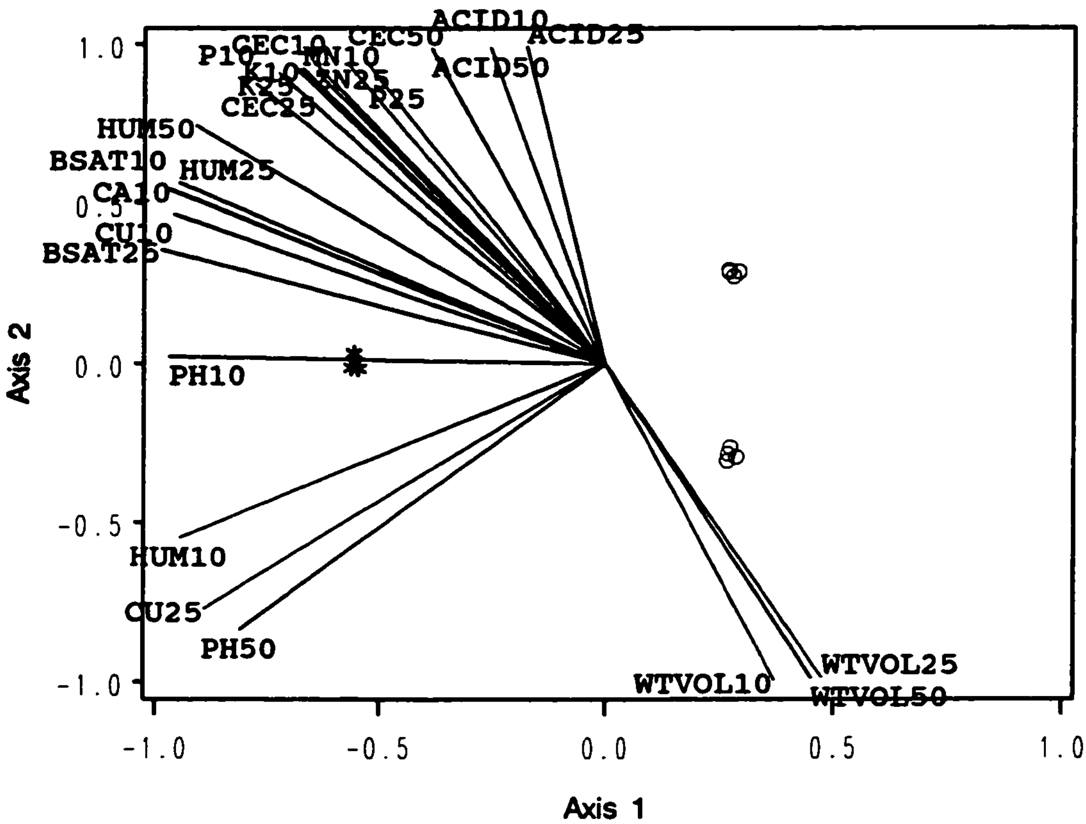
Table 4.18 (cont.). Average cover class and constancy of species present in the Evergreen Shrub-bog vegetation class. Values are given for the vegetation class and its constituent vegetation subclasses and community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sities in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LIRIODENDRON TULIPIFERA | 6 | 5 | 6 | 25 | | | 6 | + | | | | | | | | | | |
| LYONIA LIGUSTRINA | 3 | 11 | 3 | 17 | 3 | + | | | 3 | 9 | 2 | + | 4 | + | | | 3 | + |
| LYONIA LUCIDA | 7 | 86 | 6 | 100 | 6 | 100 | 7 | 100 | 7 | 82 | 7 | 100 | 6 | 67 | 8 | 100 | 5 | 50 |
| LYONIA MARIANA | 3 | 4 | | | | | | | 3 | 5 | 3 | + | | | | | | |
| MAGNOLIA VIRGINIANA | 5 | 50 | 5 | 83 | 5 | 88 | 6 | 75 | 5 | 41 | 5 | 100 | 4 | + | 5 | + | 4 | + |
| MYRICA CERIFERA VAR. CERIFERA | 5 | 13 | | | | | | | 5 | 16 | 6 | + | 5 | 8 | 2 | + | 4 | 13 |
| MYRICA HETEROPHYLLA | 5 | 23 | | | | | | | 5 | 30 | | | 6 | + | 5 | 56 | | |
| NYSSA BIFLORA | 5 | 23 | 7 | 33 | | | 7 | 100 | 5 | 20 | 2 | + | 5 | + | 6 | + | 6 | + |
| NYSSA SYLVATICA | 5 | 5 | | | | | | | 5 | 7 | 5 | + | | | | | | |
| OSMUNDA CINNAMOMEA | 3 | 11 | 3 | 50 | 3 | 50 | 4 | + | | | | | | | | | | |
| PELTANDRA SAGITTIFOLIA* # | 3 | 4 | | | | | | | 3 | 5 | | | 3 | + | | | | |
| PERSEA PALUSTRIS | 4 | 73 | 5 | 100 | 4 | 100 | 5 | 100 | 4 | 66 | 4 | 75 | 5 | 67 | 5 | 94 | | |
| PINUS SEROTINA | 6 | 52 | 6 | 25 | 6 | + | | | 6 | 59 | 6 | 100 | 5 | 58 | 6 | 69 | | |
| PINUS TAEDA | 7 | 7 | 7 | 33 | 6 | 13 | 7 | + | | | | | | | | | | |
| POLYGALA BREVIFOLIA** | 2 | 4 | | | | | | | 2 | 5 | | | 2 | + | | | | |
| PTERIDIUM AQUILINUM | 3 | 5 | | | | | | | 3 | 7 | 3 | + | | | 4 | + | | |
| QUERCUS NIGRA | 6 | 2 | 6 | 8 | | | 6 | 25 | | | | | | | | | | |
| RHODODENDRON ATLANTICUM | 4 | 9 | | | | | | | 4 | 11 | 5 | + | | | 4 | + | | |
| RHODODENDRON VISCOSUM | 5 | 14 | 4 | 25 | 4 | + | | | 5 | 11 | 5 | + | | | 4 | 6 | | |
| RHYNCHOSPORA FASCICULARIS | 2 | 2 | | | | | | | 2 | 2 | | | | | 2 | + | | |
| RHYNCHOSPORA PLEIANTHA* | 1 | 2 | | | | | | | 1 | 2 | 1 | + | | | | | | |
| SARRACENIA FLAVA | 4 | 32 | | | | | | | 4 | 41 | | | 4 | 100 | 3 | + | 2 | 50 |
| SARRACENIA PURPUREA | 4 | 11 | | | | | | | 4 | 14 | | | | | 4 | + | | |
| SASSAFRAS ALBIDUM | 3 | 2 | | | | | | | 3 | 2 | 3 | + | | | | | | |
| SMILAX GLAUCA | 3 | 2 | | | | | | | 3 | 2 | | | | | 3 | + | | |
| SMILAX LAURIFOLIA | 5 | 91 | 4 | 100 | 4 | 100 | 6 | 100 | 5 | 89 | 4 | 88 | 5 | 100 | 6 | 100 | 4 | 50 |
| SPHAGNUM SP. | 5 | 73 | 2 | 25 | 2 | + | | | 6 | 86 | 3 | 75 | 7 | 100 | 5 | 75 | 7 | 100 |
| UTRICULARIA FIBROSA | 1 | 4 | | | | | | | 1 | 5 | | | | | | | 1 | + |
| VACCINIUM CORYMBOSUM | 4 | 27 | 4 | 67 | 4 | 100 | | | 4 | 16 | 4 | 75 | | | 2 | + | | |
| VACCINIUM FUSCATUM | 4 | 13 | 2 | 8 | 2 | + | | | 4 | 14 | 5 | + | | | 4 | + | | |
| VACCINIUM TENELLUM | 3 | 2 | | | | | | | 3 | 2 | 3 | + | | | | | | |
| VITIS ROTUNDIFOLIA | 3 | 7 | 3 | 33 | 1 | + | 4 | 75 | | | | | | | | | | |
| WOODWARDIA VIRGINICA | 6 | 55 | | | | | | | 6 | 70 | 4 | + | 7 | 100 | 5 | 100 | | |
| XYRIS SP. | 2 | 5 | | | | | | | 2 | 7 | 2 | + | | | 2 | + | | |
| XYRIS FIMBRIATA | 2 | 5 | | | | | | | 2 | 7 | | | 2 | + | | | | |
| ZENOBIA PULVERULENTA | 7 | 75 | 4 | 8 | 4 | + | | | 7 | 93 | 6 | 63 | 7 | 100 | 6 | 100 | 9 | 100 |
| ZIGADENUS GLABERRIMUS | 3 | 2 | | | | | | | 3 | 2 | | | | | 3 | + | | |

Table 4.19. Average site information for the Evergreen Shrub-bog vegetation class. The vegetation class and its constituent vegetation subclasses and community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7. | 7.1. | 7.1.1 | 7.1.2 | 7.2. | 7.2.1 | 7.2.2 | 7.2.3 | 7.2.4 |
| Site Hydrology | | | | | | | | | |
| Water Depth Index | 137.2 | 151.1 | 149.6 | 152.5 | 130.3 | 131.0 | 150.7 | 73.1 | 166.3 |
| Hydroperiod Class | 4.3 | 4.5 | 4.5 | 4.5 | 4.3 | 3.5 | 5.0 | 3.5 | 5.0 |
| Water Constancy Index | 2.1 | 2.0 | 2.0 | 2.0 | 2.2 | 2.0 | 2.3 | 2.0 | 2.5 |
| Organic Layer Depth | 80.1 | 71.5 | 58.0 | 85.0 | 88.7 | 25.0 | 109.3 | 70.5 | 150.0 |
| Soil Drainage Class | 2.9 | 3.0 | 3.0 | 3.0 | 2.8 | 2.5 | 3.0 | 2.8 | 3.0 |
| Soil Permeability Class | 3.5 | 3.3 | 4.5 | 2.0 | 3.7 | 4.3 | 3.3 | 4.3 | 3.0 |
| Soil Available Water Capacity Class | 3.5 | 3.3 | 3.5 | 3.0 | 3.7 | 3.0 | 4.2 | 3.4 | 4.3 |
| | | | | | | | | | |
| Site Geomorphology | | | | | | | | | |
| Site Elevation (m) | 22.6 | 24.8 | 28.2 | 21.3 | 20.4 | 31.3 | 13.0 | 11.4 | 25.9 |
| Elevational Drop in 1 Km (m) | 4.0 | 4.2 | 8.4 | 0.0 | 3.8 | 4.6 | 1.5 | 2.8 | 6.5 |
| Distance to 10 m Elevational Drop (m) | 9425 | 15,900 | 2175 | 29,625 | 2950 | 3800 | 2875 | 3925 | 1200 |
| Depression Area (ha) | 191.6 | 140.6 | 239.1 | 42.2 | 242.6 | 206.9 | 464.9 | 89.9 | 208.8 |
| Depression Length/Width Ratio | 1.6 | 1.5 | 1.6 | 1.4 | 1.7 | 1.7 | 1.6 | 1.8 | 1.6 |
| Depression Long Axis Orientation | -1.8 | +2.7 | -9.7 | +15.0 | -6.4 | -6.5 | -1.7 | -10.8 | -6.5 |
| | | | | | | | | | |
| Site Disturbance | | | | | | | | | |
| Fire Frequency Class | 2.9 | 4.0 | 4.0 | 4.0 | 2.4 | 2.0 | 2.7 | 2.0 | 3.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Timbering Index | 1.3 | 1.0 | 1.0 | 1.0 | 1.6 | 2.0 | 1.3 | 1.5 | 1.5 |
| Drainage Index | 1.4 | 1.0 | 1.0 | 1.0 | 1.8 | 1.5 | 1.3 | 1.8 | 2.5 |
| Landscape Disturbance Class | 1.4 | 1.3 | 1.5 | 1.0 | 1.5 | 1.5 | 1.0 | 1.5 | 2.0 |

Figure 4.29. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Evergreen Shrub-bog "Bay Forest" stands as distributed by community type on the two major compositional gradients.

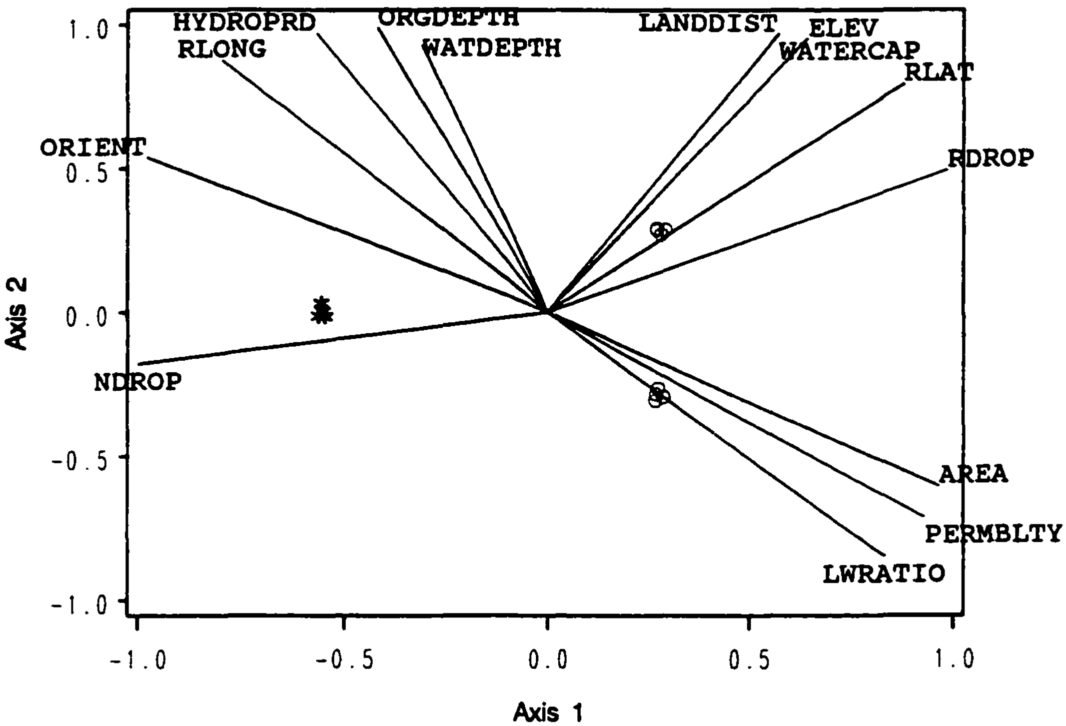



**EVERGREEN SHRUB–BOG, Bay Forest –**
**Community Types:**

O Chamaecyparis–Gordonia/Acer/Ilex coriacea–Lyonia lucida Forest

✱ Nyssa biflora–Acer/Magnolia–Acer/Ilex coriacea–Lyonia lucida/Smilax laurifolia Forest

Figure 4.30. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Evergreen Shrub-bog "Bay Forest" stands as distributed by community type on the two major compositional gradients.




**EVERGREEN SHRUB—BOG, Bay Forest —**
**Community Types:**

○ Chamaecyparis—Gordonia/Acer/Ilex coriacea—Lyonia lucida Forest

✱ Nyssa biflora—Acer/Magnolia—Acer/Ilex coriacea—Lyonia lucida/Smilax laurifolia Forest

Figure 4.31. Plant Life Forms for Evergreen Shrub-bog "Bay Forest" vegetation groups found within North and South Carolina Carolina bay depressions.

**PLANT LIFE FORMS OCCURRING IN EVERGREEN SHRUB-BOG 'Bay Forest' VEGETATION GROUPS**

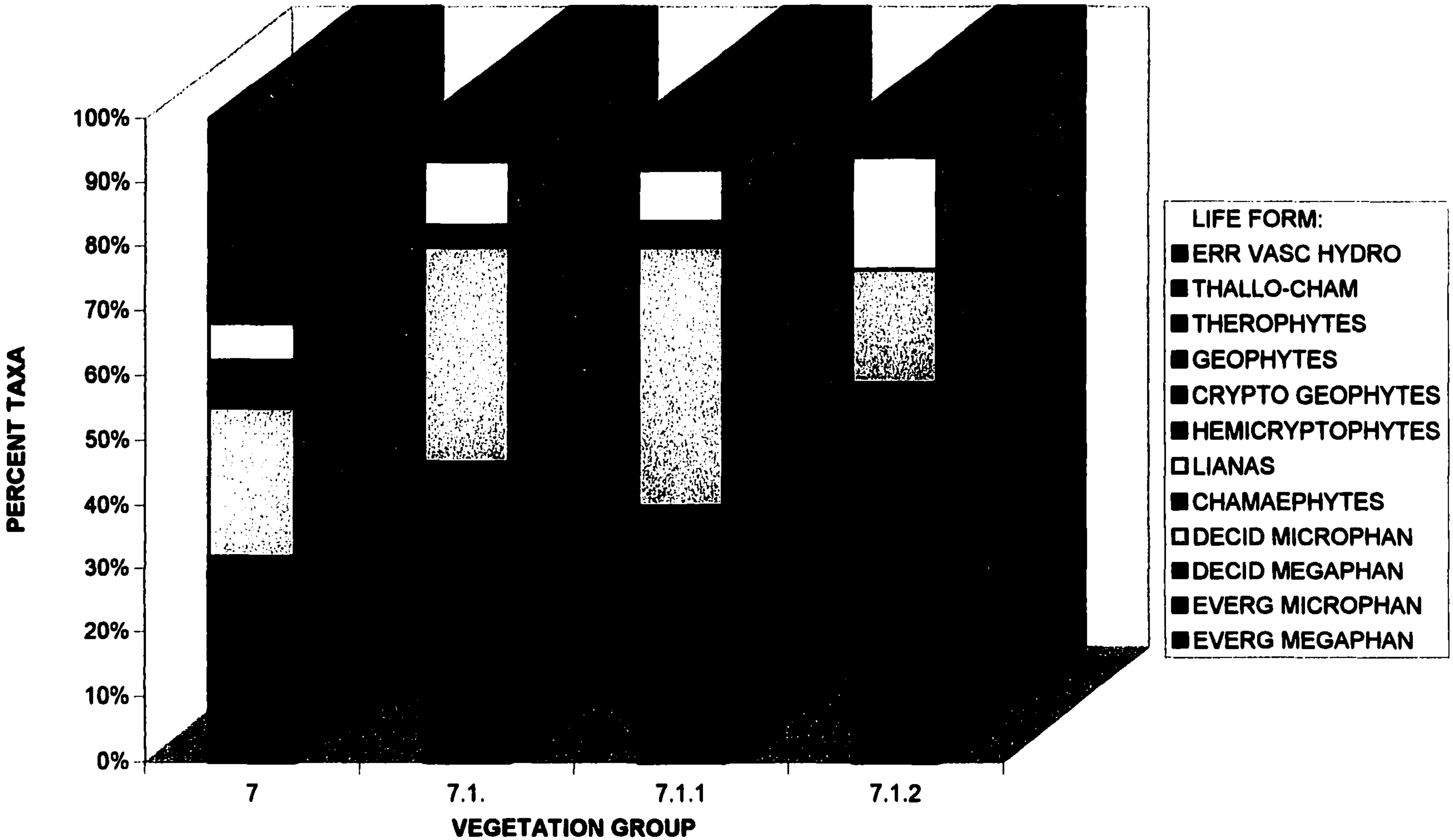


Figure 4.32. Plant Growth Forms for Evergreen Shrub-bog "Bay Forest" vegetation groups found within North and South Carolina Carolina bay depressions.

## PLANT GROWTH FORMS OCCURRING IN EVERGREEN SHRUB-BOG 'Bay Forest' VEGETATION GROUPS

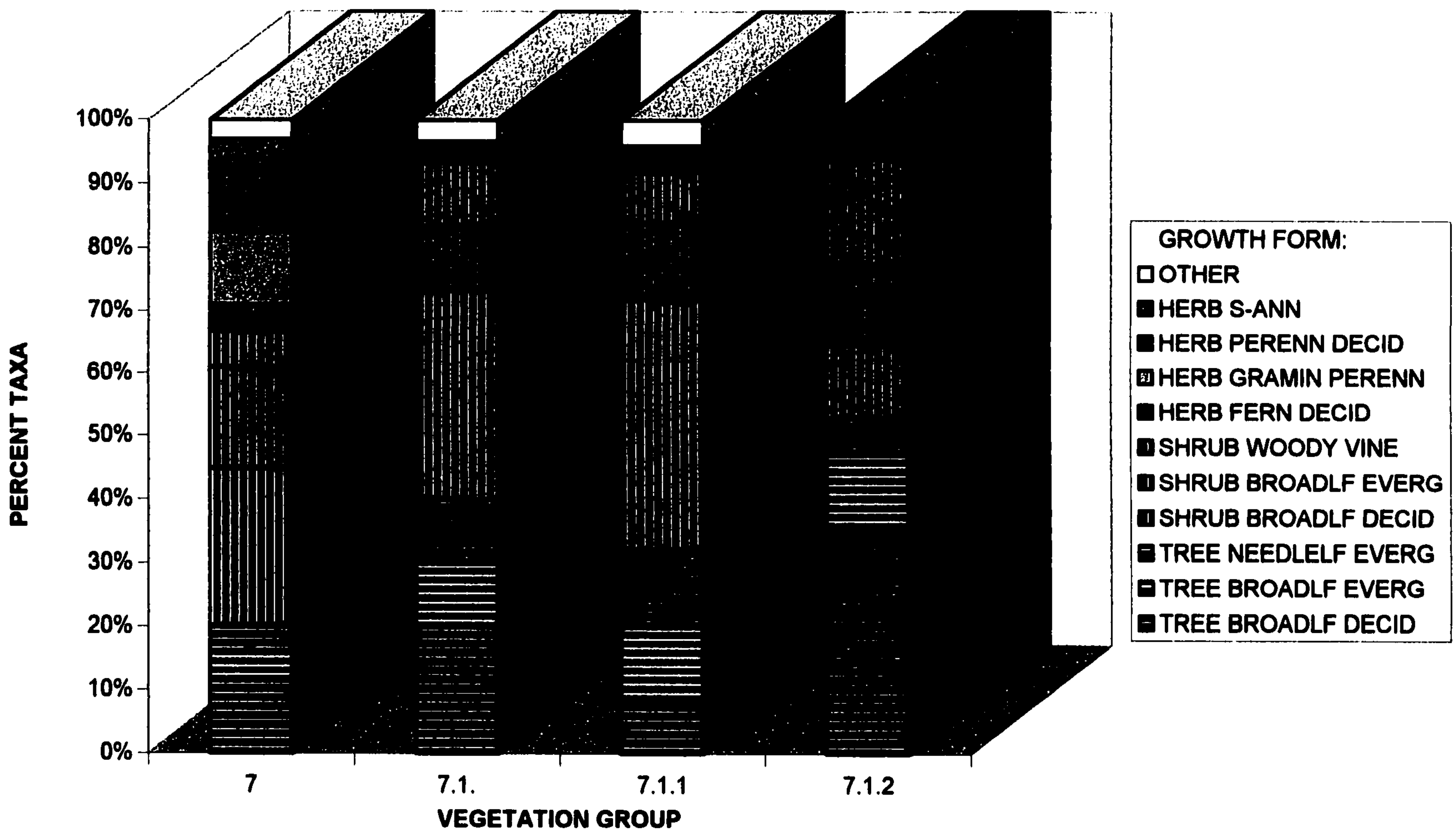
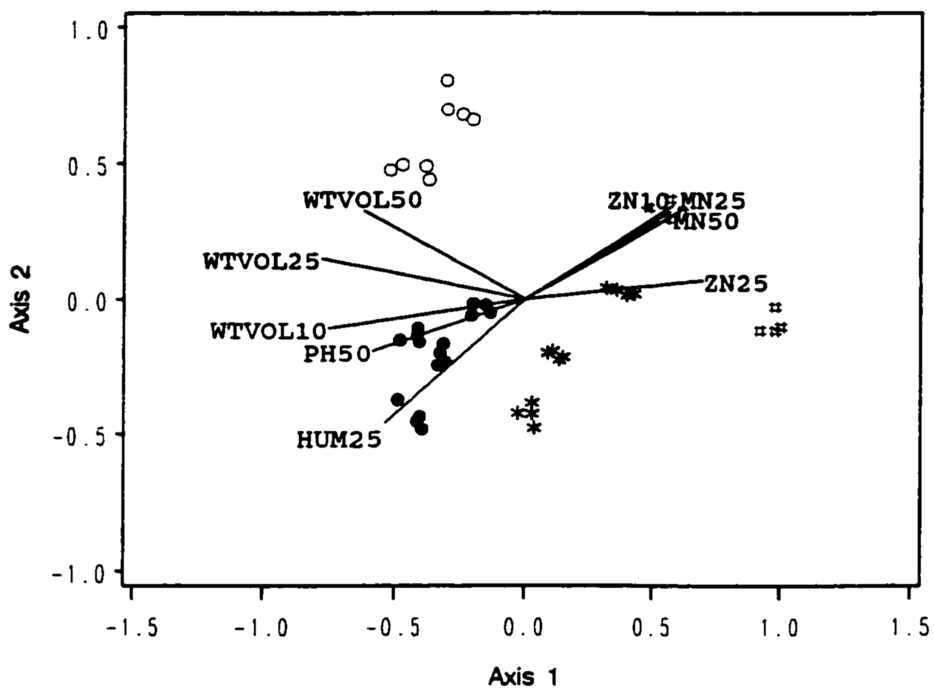


Figure 4.33. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Evergreen Shrub-bog “Pocosin” stands as distributed by community type on the two major compositional gradients.




**EVERGREEN SHRUB-BOG, Pocosin -**
**Community Types:**

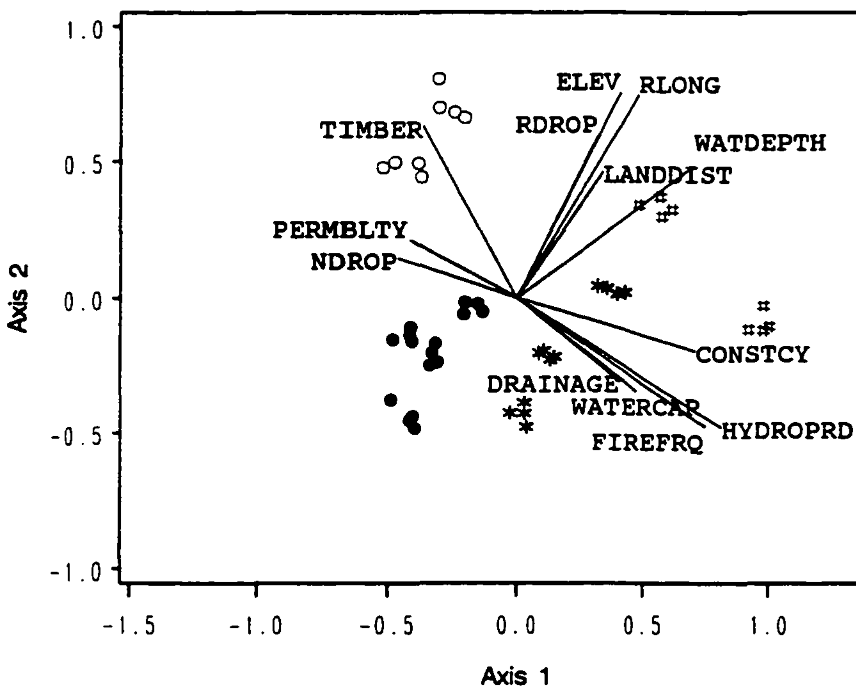
○ Pinus serotina/Ilex coriacea–Clethra–Lyonia lucida–Kalmia carolina/Cladonia spp. Pocosin

✱ Zenobia–Ilex coriacea–Chamaedaphne/Smilax laur./Carex striata–Woodw. virginica/Sphagnum spp. Pocosi

● Pinus serotina/Ilex coriacea–Lyonia lucida–Cyrilla–Zenobia/Smilax laur./Woodw. virginica/Sphagnum spp. P

# Zenobia/Chamaedaphne/Sphagnum spp. Pocosin

Figure 4.34. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Evergreen Shrub-bog "Pocosin" stands as distributed by community type on the two major compositional gradients.




**EVERGREEN SHRUB–BOG, Pocosin – Community Types:**

○ Pinus serotina/Ilex coriacea–Clethra–Lyonia lucida–Kalmia carolina/Cladonia spp. Pocosin

✱ Zenobia–Ilex coriacea–Chamaedaphne/Smilax laur./Carex striata–Woodw. virginica/Sphagnum spp. Pocosir

● Pinus serotina/Ilex coriacea–Lyonia lucida–Cyrilla–Zenobia/Smilax laur./Woodw. virginica/Sphagnum spp. P

# Zenobia/Chamaedaphne/Sphagnum spp. Pocosin

Figure 4.35. Plant Life Forms for Evergreen Shrub-bog "Pocosin" vegetation groups found within North and South Carolina Carolina bay depressions.

PLANT LIFE FORMS OCCURRING IN EVERGREEN SHRUB-BOG 'Pocosin' VEGETATION GROUPS

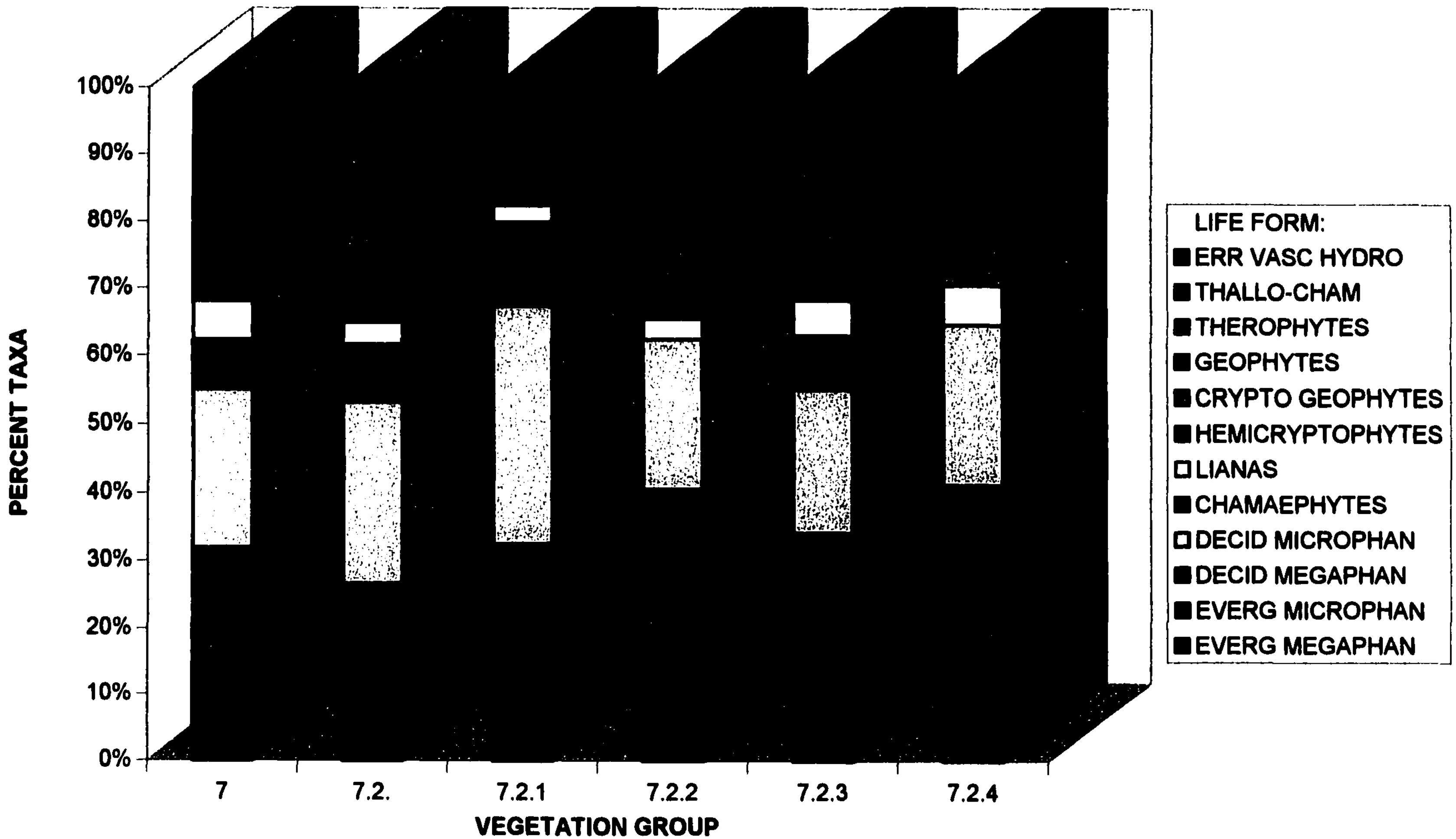
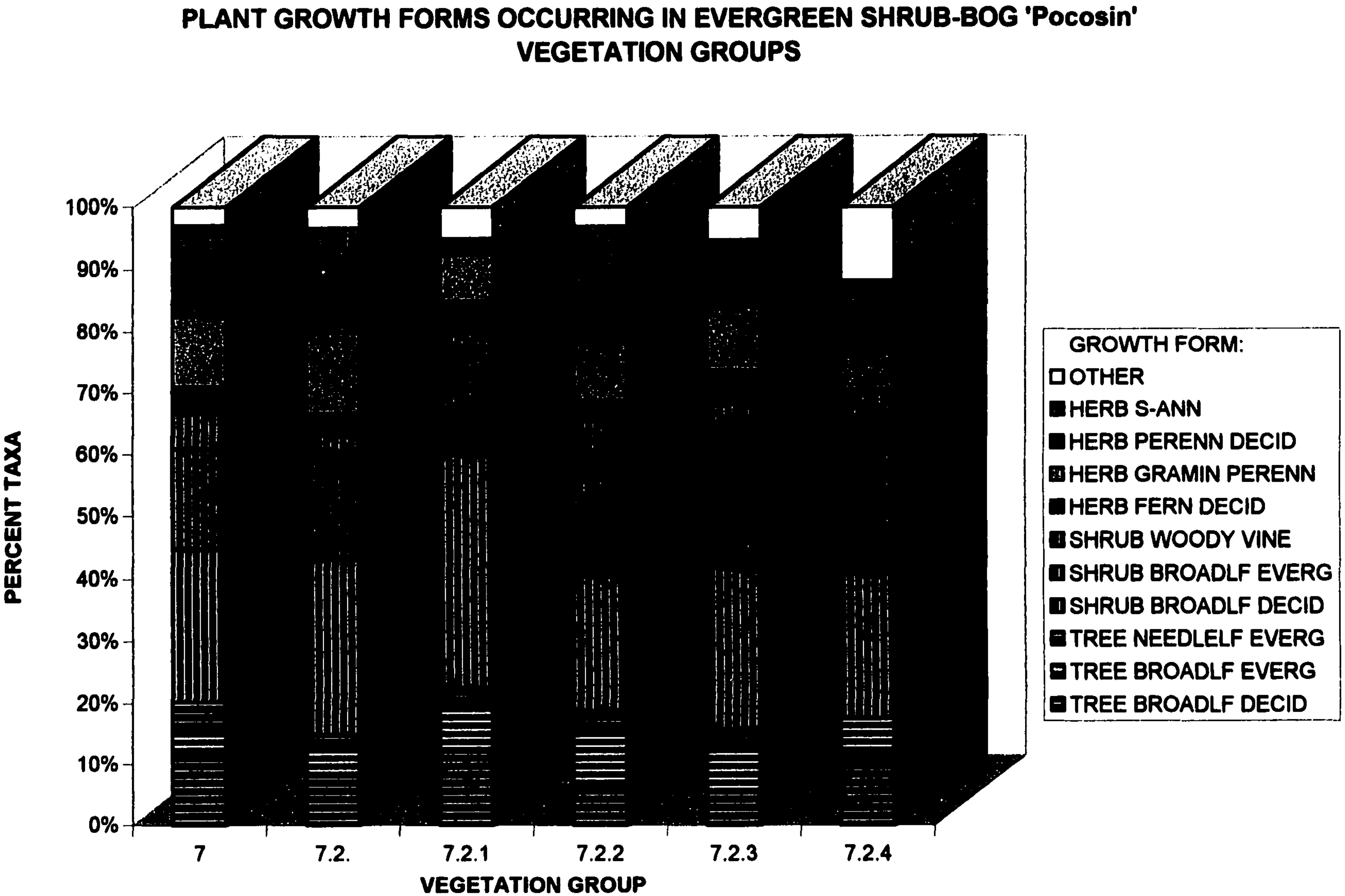


Figure 4.36. Plant Growth Forms for Evergreen Shrub-bog "Pocosin" vegetation groups found within North and South Carolina Carolina bay depressions.


PLANT GROWTH FORMS OCCURRING IN EVERGREEN SHRUB-BOG 'Pocosin' VEGETATION GROUPS
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT TAXA
7
7.2.
7.2.1
7.2.2
7.2.3
7.2.4
VEGETATION GROUP
GROWTH FORM:
OTHER
HERB S-ANN
HERB PERENN DECID
HERB GRAMIN PERENN
HERB FERN DECID
SHRUB WOODY VINE
SHRUB BROADLF EVERG
SHRUB BROADLF DECID
TREE NEEDLELF EVERG
TREE BROADLF EVERG
TREE BROADLF DECID

### 4.3.8 VEGETATION CLASS: **Cypress/Gum Bog (8.)**

Cypress/Gum Bog community types are for the most part distinct from other Carolina bay vegetational communities in having a canopy of cypress (*Taxodium* spp.) and/or "gum" (*Nyssa biflora*, and to a very limited extent, *Nyssa aquatica*) over an organic dominated, or "bog" soil. As a consequence, these communities in many respects appear to be "hybrids" between Intermittently Ponded Cypress/Gum Depressions and Evergreen Shrub-bogs, having canopy dominants similar to the former vegetation class, soils similar to the latter vegetation class, and subcanopy vegetation (shrub and herbaceous strata) intermediate between the two. As such, Cypress/Gum Bogs are one of the most unique and interesting of the vegetation types encountered within Carolina bay depressions. Photographs of this vegetation class appear in Plate 10, following Chapter 7 below.

#### 4.3.8.1 COMMUNITY TYPE: ***Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog (8.0.1)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Andropogon glomeratus* var. *glaucopsis, Aronia arbutifolia, Carex striata* var. *striata, Clethra alnifolia, Drosera intermedia, Ilex glabra, Lyonia lucida, Magnolia virginiana, Myrica cerifera* var. *cerifera, Nyssa biflora, Persea palustris, Pinus serotina, Rhexia mariana* var. *ventricosa, Rhynchospora cephalantha* var. *microcephala, Rhynchospora fascicularis, Sarracenia flava, Smilax laurifolia, Smilax walteri, Sphagnum* spp., *Taxodium ascendens, Triadenum virginicum, Woodwardia virginica, Xyris fimbriata, Zenobia pulverulenta*

(3) Special Status Species

*Ilex cassine, Rhynchospora inundata*

(4) Vegetation & Physiognomy

This community type consists of an open canopy of *Taxodium ascendens* over well developed shrub and herb strata. *Pinus serotina* and *Nyssa biflora* occasionally assume co-dominance with *Taxodium ascendens* in the canopy or form a shorter "subcanopy" layer. The open shrub layer is comprised of numerous, multi-stemmed clumps of, principally, *Lyonia lucida*, but *Myrica cerifera, Ilex glabra,* and *Zenobia pulverulenta* may also provide significant shrub cover within this community type. An herbaceous layer occupies the interstices within the community between shrub clumps. *Carex striata* and *Woodwardia virginica* are the dominants in the herb stratum, but *Rhexia mariana* var. *ventricosa, Rhynchospora fascicularis, Rhynchospora cephalantha* var. *microcephala* and *Sarracenia flava* are also significant components of the herbaceous layer. The surface is irregular, and shallow pools filled with a mat of *Sphagnum* spp. and various herbs are interspersed with dense clumps of multi-stemmed shrubs, usually clustered near the bases of canopy trees.

This community type exhibited high mean species richness at the 0.1 ha level, at 26.60 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" trees over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinctive in the presence of *Pinus serotina* as a canopy and subcanopy species, by the presence of *Ilex cassine* in the shrub layer, and by the presence of *Rhexia mariana* var. *ventricosa* as a constant species in the herbaceous stratum.

(6) Habitat

This wet community type occurs in small depressions located on relatively flat, undissected land surfaces in longleaf pine flatwoods. It is characterized by very poorly drained, rapidly permeable, soils having a high organic matter content in the surface horizons (Table 4.21, Figure 4.39). The soil water table is relatively stable, and generally is found at, or more typically above, the soil surface for most of the year. At the time of sampling, during a dry year, the water table was found within this community type at some 7 cm above the soil surface.

(7) Soils

This community type occurred within the study area over sandy, siliceous, thermic Typic Haplaquod soils (Table A-II-1). A representative soil profile of a Typic Haplaquod from the study area similar to the soil underlying this community type is described in Appendix II for CT 5.0.1, discussed above.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. These soils, like other organic soils encountered in this study, were not analyzed as to particle texture (*i.e.*, "textured"). Soil humic matter content is high at all measured depths.

<u>(8) Succession & Disturbance</u>

This community type is found within a landscape dominated by longleaf pine savanna, pine flatwoods, and Evergreen Shrub-bogs, all of which tend to be fire-maintained ecosystems. Consequently, fire has been a major and frequent factor within this community type, as evidenced by fire scars on the trunks of all canopy and subcanopy trees, the extremely clumped nature of shrubs, and the occasional presence of charcoal in the community soils. As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance. Surrounding landscapes have undergone relatively little alteration by human land disturbance activities in the area of this community type.

<u>(9) Landscape Position</u>

*Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginiana/ Sphagnum* spp. Bogs are found in Carolina bays in the Outer Lower Coastal Plain (Table 4.3), and make up some 12 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy, siliceous, thermic Typic Haplaquod soils. That soil family comprises 1 of 3 soil types observed within sampled Outer Lower Coastal Plain Carolina bays (Table 4.4).

<u>(10) Distribution & Abundance</u>

Four of 482 intensively sampled plots (0.8%), occurring in the southeastern, coastal portion of the study area, fall within this classification. This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are common in Carolina bays, and most are currently known from only a single depression site (*see* Table 4.5). However, many Cypress/Gum Bog community types, as this one, contain vegetation types that are more common in non-Carolina bay wetlands in the region. Community types falling into this vegetation class tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

This community type is found in a Carolina bay depression in Francis Marion National Forest in South Carolina, which affords it a relative degree of protection.

#### 4.3.8.2 COMMUNITY TYPE: ***Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog (8.0.2)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Carex striata* var. *striata, Chamaedaphne calyculata, Gordonia lasianthus, Lyonia ligustrina, Lyonia lucida, Nymphaea odorata, Nyssa biflora, Peltandra sagittifolia, Smilax walteri, Sphagnum* spp., *Taxodium ascendens, Utricularia purpurea, Zenobia pulverulenta*

(3) Special Status Species

*Chamaedaphne calyculata, Peltandra sagittifolia*

(4) Vegetation & Physiognomy

This community type is characterized by an open to very open canopy, approximately 5-8 m in height, of *Nyssa biflora*, with *Taxodium ascendens* sometimes assuming canopy co-dominance. The tree canopy overlies an open shrub layer comprise primarily of scattered, but large, patches of *Chamaedaphne calyculata* approximately 0.75 m in height, with taller (to 4 m) *Lyonia lucida* and *Zenobia pulverulenta* common, but having lesser importance within the community type. The relatively dense herbaceous layer consists almost exclusively of *Carex striata*, with *Nymphaea odorata* scattered throughout. The community type is also typified by large floating mats of *Sphagnum* spp., on which grow a number of other herbaceous species. Like many of the "bog" communities, the "sub-canopy" strata are patchy in distribution, where multi-stemmed shrub clumps are interspersed with dense stands of graminoids.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 16.55 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" trees over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinctive among these bogs in being savanna-like in nature, with an open canopy of *Nyssa biflora* and *Taxodium ascendens*, an abundance of *Carex striata* as the herbaceous dominant, constant standing water, and a relatively undecomposed, organic soil.

(6) Habitat

This very wet community type occurs in large depressions located on relatively flat, undissected land surfaces, and is characterized by very poorly drained, rapidly permeable, organic soils (Table 4.21, Figure 4.39). The soil water table is relatively constant and the depression surface is characteristically inundated year-round. At the time of sampling, the water table was found within this community type at some 25 cm above the soil surface (1 m above the underlying mineral, "parent" material).

(7) Soils

This community type occurred within the study area over sandy or sandy-skeletal, siliceous, thermic Terric Medihemist soils. A representative soil profile of a Terric Medihemist soil from the study area and similar to the one found beneath this community type is described in Appendix II for CT 5.0.2, discussed above. As previously noted, these soils appear to not be mapped by the SCS within the Carolina Coastal Plain.

A summary of soil chemical properties for this community type is set out in Tables A-II-1. Textures for organic soils were not determined during this study. Those data indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. While these are relatively nutrient depauperate soils, the manganese levels at 25 and 50 cm is unusually high for this community type as compared to other community types within this vegetation class. The soil bulk density values for this community type are also among the very lowest encountered in Carolina bays. Extremely low bulk densities are characteristic of Hemist, as compared to Saprist, soils (Soil Survey Staff, 1975).

(8) Succession & Disturbance

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance, but site hydrology is controlled to the extent of preventing outflow from the Carolina bay depression. Nevertheless, the site does periodically drawdown, or dry out within the area of this community type. Consequently, fire has been a significant factor within this community type, primarily as evidenced by fire scars on the trunks and boles of canopy species, and the extremely clumped nature of shrubs. Vegetational dynamics appear to be similar to those described previously for pocosin vegetational communities. Surrounding landscapes have undergone fairly extensive alteration by human land disturbance activities in the area of this community type.

(9) Landscape Position

*Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* Bogs are found in Carolina bays in the Middle Coastal Plain (Table 4.3), and make up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemist soils. That soil family is rare in study area bay depressions, and is 1 of 12 soil types observed within Middle Coastal Plain Carolina bays, where Ultisols predominate (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the south central portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are common in Carolina bays, but many, as this one, contain vegetation types that may occur in non-Carolina bay depressions and "swamps". Community types falling into this vegetation grouping tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

This community type occurs in a protected, State Park site in South Carolina.

4.3.8.3 COMMUNITY TYPE: ***Nyssa biflora-Taxodium ascendens/Decodon/(Smilax laurifolia)/Utricularia purpurea*** **Bog** (8.0.3)

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Clethra alnifolia, Decodon verticillatus, Dulichium arundinaceum, Itea virginica, Leucothoe racemosa, Lycopus virginicus, Lyonia ligustrina, Lyonia lucida, Nymphaea odorata, Nyssa biflora, Smilax laurifolia, Smilax walteri, Taxodium ascendens, Tillandsia usneoides, Toxicodendron radicans* var. *radicans, Triadenum virginicum, Utricularia purpurea, Vaccinium corymbosum, Woodwardia areolata*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

A dense canopy of relatively tall (16 to 18 m) *Nyssa biflora*, sometimes with similar sized *Taxodium ascendens* as a co-dominant, is characteristic of this wet community type. The canopy layer overtops scattered clumps of *Lyonia lucida, Leucothoe racemosa, Itea virginica* and *Clethra alnifolia*, which grow principally around the bases of canopy trees.

The water surface in the permanently flooded community type is largely covered by a dense, 1 m tall stand of *Decodon verticillatus*, with *Nymphaea odorata* and *Dulichium arundinaceum* occurring in the widely scattered pools where *Decodon* is absent. Large "mats" of *Utricularia purpurea* are common among the *Decodon* stands, but are best developed in the inter-stand pools. The surface of this community is very irregular, and on the small "islands" at the base of canopy trees, *Smilax laurifolia* and *Woodwardia areolata* are very common.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 22.85 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" trees over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinctive among these bogs in being similar in appearance to the riverine, "blackwater" swamps located in the coastal area of the study area savanna-like in nature, with a dense canopy of *Nyssa biflora* and *Taxodium ascendens*, and relatively deep standing water. It is one of two Cypress/Gum Bog communities characterized by *Decodon verticillatus* in dense stand, but is distinguished from that second site by its canopy and the presence of a relatively undecomposed, organic soil.

(6) Habitat

This very wet, more or less permanently flooded, community type occurs in large depressions located on relatively flat, undissected land surfaces, and is characterized by very poorly drained, rapidly permeable, organic soils (Table 4.21, Figure 4.39). This community type occurs at a site that is reportedly spring-fed. Consequently, the soil water table is relatively constant and the depression surface is characteristically inundated year-round. At the time of sampling, the water table was found within this community type at some 69 cm above the soil surface (120 cm above the underlying mineral, "parent" material).

(7) Soils

This community type occurred within the study area over sandy or sandy-skeletal, siliceous, thermic Terric Medihemist soils. A representative soil profile of a Terric Medihemist soil from the study area similar to that encountered within this community type is described in Appendix II for CT 5.0.2, discussed above.

A summary of soil chemical properties for this community type is set out in Tables A-II-2 to A-II-4. Textures for organic soils were not determined during this study. Those tables indicate that the pH for the soils found beneath this community type is among the lowest encountered within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The overall soil bulk density values for this community type are the lowest encountered in Carolina bays.

(8) Succession & Disturbance

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance, but site hydrology is controlled to the extent of preventing outflow from the Carolina bay depression. As noted, the site of this community type is reportedly spring-fed and is known to dry out only very rarely. Consequently, fire has not been a significant factor within this community type. Canopy trees appear to be relatively even-aged, pointing to a common date of origin, which probably stemmed from exposure of the soil surface during a severe, prolonged drought, and perhaps following a fire that removed existing canopy trees. Surrounding landscapes have undergone fairly extensive alteration by human land disturbance activities in the area of this community type.

(9) Landscape Position

The community type "*Nyssa biflora-Taxodium ascendens/Decodon/(Smilax laurifolia)/Utricularia purpurea* Bog" is found in Carolina bays in the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemist soils. As noted for the preceding community type, this soil family is rare both in Middle Coastal Plain Carolina bays, and within the study area (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the south central portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. As noted, none of the Cypress/Gum Bog community types are common in Carolina bays, but many, as this one, contain vegetation types that may occur in non-Carolina bay depressions and surrounding "swamps". Community types falling into this vegetation grouping tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

This community type occurs in a protected, State Park site in South Carolina.

4.3.8.4 COMMUNITY TYPE: ***Nyssa biflora* "Boggy Swamp" (8.0.4)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Boehmeria cylindrica, Liquidambar styraciflua, Lyonia lucida, Nyssa biflora, Taxodium ascendens.*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type is marked by an extremely dense stand of tall (*ca.* 18 to 20 m in height), apparently even-aged *Nyssa biflora*. *Taxodium ascendens* is also a significant, though greatly lesser, component of the canopy in this community type. This community type and its immediate predecessor (CT 8.0.3) had by far the best developed stands of *Nyssa biflora* sampled in Carolina bays within the study area. The few shrubs within the community, primarily *Lyonia lucida* and *Leucothoe racemosa*, grow rooted in crevices in the bark of canopy trees. The forest floor is typified by a thick litter layer, and is virtually devoid of herbaceous species.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.64 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinguished by its dense canopy of *Nyssa biflora* in almost pure stand, and lack of shrub and herbaceous strata.

(6) Habitat

This community type occurs in small depressions located on relatively flat, undissected land surfaces, and is characterized by very poorly drained, moderately rapidly permeable soils having a high organic matter content in the surface horizon (described below) (Table 4.21, Figure 4.39). The soil water table fluctuates seasonally, but surface water is present at least in the winter during periods of normal rainfall. At the time of sampling, during a dry year, the water table was found within this community type at some 105 cm below the soil surface. However, "water marks" on canopy trees indicate that the water stands seasonally at 20 to 30 cm above the soil surface. The denseness of canopy trees within this community type greatly reduces light penetration to the forest floor during the growing season.

(7) Soils

This community type occurs within study area Carolina bays over a "mucky variant" of a fine-loamy, siliceous, thermic Umbric Paleaquult soils (Table A-II-1). Umbric Paleaquults are very poorly drained, and are similar to Typic Paleaquults, except they have an "umbric" epipedon, *i.e.*, a dark surface layer having low base saturation and a high organic matter content. The mucky, Umbric Paleaquult found beneath this community type is described in Appendix II.

The mucky surface layer described for this pedon is not typical of Umbric Paleaquult soils, which generally have a loamy surface layer, but is occasionally encountered within this soil family (Leab, 1990). However, it clearly distinguishes the soil underlying this community type from those Umbric Paleaquult soils more typically found in Carolina bays, which are discussed later in this chapter. It is, presumably, largely the influence of the mucky, umbric epipedon found in this soil that is responsible for the occurrence of this particular community type within a Carolina bay, and that directly relates it to the other community types falling into this vegetation class, most of which are found over organic soils.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicates that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The soil bulk density values for this community type are low at 10 cm, but greatly increase by 50 cm, reflecting the fact that while silt-sized particles predominate within the soil solum near the surface (93%), its dominance lessens with depth, and the clay and sand soil particle fractions are more important at lower levels of the profile.

(8) Succession & Disturbance

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance. Surrounding landscapes have undergone fairly extensive alteration by human agricultural usage in the area of this community type, and it is occurs primarily in isolated "pockets". It is perhaps at least in part for that reason that fire appears not to have been a significant, recent factor within this community. Canopy trees appear to be relatively even-aged, pointing to a common date of origin. At the time of sampling, thousands of dead *Nyssa biflora* seedlings were observed within this community type, apparently dying as a result of either drought or inability to compete in the dense shade of canopy trees.

(9) Landscape Position

The community type "*Nyssa biflora* 'Boggy Swamp'" is found in Carolina bays in the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over the "mucky variant" of fine-loamy, siliceous, thermic Umbric Paleaquult soils. That soil family comprises 1 of 12 soil types sampled within Middle Coastal Plain Carolina bays, but is comparatively rare among the Ultisols observed in depressions located on that landform surface (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the southeastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are common in Carolina bays, but many, as this one, contain vegetation types that may occur in non-Carolina bay depressions and surrounding "swamps". Community types falling into this vegetation grouping tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.8.5 COMMUNITY TYPE: ***Nyssa biflora*/(*Acer*)/*Decodon*/*Dulichium*/*Sphagnum* spp.-*Utricularia biflora* Bog (8.5)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Cyrilla racemiflora, Decodon verticillatus, Dulichium arundinaceum, Liquidambar styraciflua, Nyssa biflora, Smilax laurifolia, Sphagnum* spp., *Utricularia biflora*

(3) Special Status Species

*Litsea aestivalis*

(4) Vegetation & Physiognomy

This community type is characterized by an open to moderately open canopy of, principally, *Nyssa biflora* approximately 6-8 m in height. *Acer rubrum* also assumes some importance in the canopy of this community type. Many of the canopy trees within this community type are dead or appear to be dying. The shrub layer is dominated by a dense but somewhat patchy, *ca.* 1 m tall stand of *Decodon verticillatus* to the exclusion of most other species, though *Clethra alnifolia* is sometimes abundant around the bases of canopy trees. The community is typified by a multi-layered herbaceous stratum that occurs between *Decodon* patches, with *Dulichium arundinaceum* growing over a dense carpet of *Sphagnum* spp. and *Utricularia biflora*.

This community type exhibited low mean species richness at the 0.1 ha level, at 11.98 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. The dominant species within this community type are similar to those of CT 8.0.3, above, but this community is distinguished from that one in having much smaller canopy trees, lacking *Taxodium ascendens*, by the presence of *Litsea aestivalis* in the shrub layer and *Utricularia biflora* in the herbaceous layer, and by occurring over a highly decomposed, organic soil.

(6) Habitat

This wet community type occurs in small depressions located on moderately flat and dissected land surfaces, and is characterized by very poorly drained, rapidly permeable, shallow organic soils (Table 4.21, Figure 4.39). The soil water table is relatively stable, and the surface of this community type is generally inundated for most of the year. At the time of sampling, the water table was found within this community type at an average of 19 cm above the soil surface. As noted, many of the canopy trees within this community type are dead or dying, and the presence of abundant logs and other woody debris underwater and within the soil profile indicates that this phenomenon has been ongoing for some time.

(7) Soils

This community type occurs within study area Carolina bays over loamy, siliceous, dysic, thermic Terric Medisaprist soils (Table A-II-1), a very poorly drained soil (Leab, 1990). A representative, sampled pedon of this soil type is described in Appendix II for CT 7.2.3, discussed above.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicates that the pH for the soils found beneath this community type is among the lowest sampled within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The soil bulk density values for this community type is low throughout the measured soil solum, and silt-sized particles predominate throughout the soil.

(8) Succession & Disturbance

According to the present owner of the site exhibiting this community type, the depression was artificially drained in the past, and at such time was dominated by a canopy of *Pinus serotina* and thick shrubs. Subsequently, the pines were cut and the remaining vegetation caught fire, resulting in the smoldering of the underlying peat for a number of years. Eventually, the original site hydrology was restored by the plugging of existing outlet, drainage ditches. When the site "refilled" with water, the bay was used as a fish pond for a period, until encroaching vegetation brought it to its present state.

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance, although the site was historically drained and timbered. Surrounding landscapes have undergone extensive alteration for agricultural use. There is little evidence that fire has been a frequent factor within this community type, and the site has reportedly not burned in some 50 years.

(9) Landscape Position

*Nyssa biflora/(Acer)/Decodon/Dulichium/Sphagnum* spp.-*Utricularia biflora* Bogs are found in Carolina bays in the Inner Lower Coastal Plain (Table 4.3), and make up some 12 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over loamy, siliceous, dysic, thermic Terric Medisaprist soils. That soil family comprises 1 of the 6 soil types sampled within Inner Lower Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the northeastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are common in Carolina bays, but many, as this one, contain vegetation types that may occur in non-Carolina bay depressions and surrounding "swamps". Community types falling into this vegetation grouping tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.8.6 COMMUNITY TYPE: ***Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog (8.0.6)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Clethra alnifolia, Cyrilla racemiflora, Dulichium arundinaceum, Leucothoe racemosa, Liquidambar styraciflua, Lyonia ligustrina, Lyonia lucida, Myrica cerifera* var. *cerifera, Nyssa biflora, Scirpus cyperinus, Smilax laurifolia, Taxodium ascendens, Utricularia purpurea, Vaccinium fuscatum, Woodwardia virginica, Zenobia pulverulenta*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type is characterized by an open to very open stand of *Taxodium* *ascendens* 9 to 12 m in height, overtopping a well developed subcanopy of *Nyssa biflora*, *Acer rubrum*, and sometimes, *Liquidambar styraciflua* 5 to 7 m tall. The shrub layer consists of scattered, large, dense, multi-stemmed clumps of *Clethra alnifolia, Cyrilla racemiflora, Lyonia lucida* and (to a lesser extent) *Zenobia pulverulenta*. The *Cyrilla* is especially striking when in bloom or fruit. Herbs are absent under the shade of the densely clumped shrubs, but *Woodwardia virginica* colonies are abundant in the gaps between the shrub clumps. Also significant within the herbaceous layer are *Scirpus cyperinus*, which is widely scattered in the openings between shrub clumps, and *Utricularia purpurea*, characteristically occurring as "mats" in pools within those openings.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 19.64 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinctive in the presence of a *Taxodium ascendens* canopy over scattered patches of "pocosin" shrubs, wherein *Cyrilla racemiflora* is a co-dominant.

(6) Habitat

This wet community type occurs in small depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately rapidly permeable soils (described below) (Table 4.21, Figure 4.39). The soil water table is highly variable both seasonally and from year to year. At the time of sampling, the water table was found within this community type at some 38 cm above the soil surface.

(7) Soils

Unlike other soils within this vegetation class, this community type occurs within study area Carolina bays over sandy, mineral -- rather than organic -- soils. Specifically, it occurs over loamy, siliceous, thermic Arenic Paleaquult soils (Table A-II-1). This poorly drained soil was mapped by the SCS as a Grossarenic Paleaquult, which is characterized by having a sandy A-horizon to a depth of 145 cm in a typical pedon, overlying a buried argillic horizon. (McCachren, 1978). While the soil underlying this community type falls short of the requirements for a grossarenic epipedon (*i.e.*, a sandy surface layer 1 to 2 m thick), it does have a sandy surface layer that is between 50 cm and 1 m thick, thereby qualifying as having an arenic epipedon instead. For that reason, it is designated as named. A typical pedon of the soil underlying this community type is described in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicates that the pH for the soils found beneath this community type is very strongly acid in the upper part of the measured soil solum, to extremely acid at 50 cm. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The soil bulk density values for this community type are relatively low at the surface, but increase significantly with depth.

(8) Succession & Disturbance

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance, and surrounding landscapes have undergone extensive alteration by human land disturbance activities in the area of this community type. Nevertheless, fire scarring on the trunks of all canopy trees, the extremely clumped nature of shrubs, and the occasional presence of charcoal in the community soils indicate that fire has been a major and frequent factor within this community type. In its absence, the subcanopy/transgressive layer would be expected to displace *Taxodium*, which was not observed to be reproducing within the community. In addition, the shrub layer would be expected to assume increased dominance by "filling in the gaps" between existing shrub clumps, at the ultimate expense of the herbaceous stratum.

(9) Landscape Position

*Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bogs are found in Carolina bays in the Middle Coastal Plain (Table 4.3), and make up some 12 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over loamy, siliceous, thermic Arenic

Paleaquult soils. That soil family is comparatively rare among sampled Carolina bays located in the Middle Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the central portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. Cypress/Gum Bog community types are uncommon in Carolina bays, but many, as this one, contain vegetation types that may occur in non-Carolina bay depressions and surrounding "swamps". Community types falling into this vegetation grouping tend to be widely distributed, but are most numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.8.7 COMMUNITY TYPE: ***Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.*-Zenobia)/Sphagnum* spp. Bog** (8.0.7)

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Gelsimium sempervirens, Leucothoe racemosa, Liquidambar styraciflua, Nyssa biflora, Sphagnum* spp., *Taxodium ascendens, Vaccinium corymbosum, Vaccinium fuscatum, Zenobia pulverulenta*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type is typified by a relatively dense canopy of medium to tall (13 to

18 m in height) *Taxodium ascendens* exhibiting widely buttressed bases, overtopping a scattered subcanopy of *Nyssa biflora* and *Acer rubrum*. *Ilex opaca* may be locally abundant in the subcanopy layer. While there is no true shrub stratum, various "ericaceous" shrubs (primarily *Vaccinium* spp., *Leucothoe racemosa* and *Zenobia pulverulenta*) are rooted in and grow almost exclusively from vertical crevices in the bark of canopy trees. The community type lacks an herbaceous layer, but the ground is virtually "carpeted" with a thick mat of *Sphagnum* spp., sometimes in conjunction with *Lachnanthes caroliniana*.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 20.36 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Bog vegetation is generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is distinctive in the presence of a *Taxodium ascendens* canopy overtopping a pocosin-like shrub layer where virtually all shrubs are rooted in the bark crevices of canopy trees, and *Sphagnum* spp. comprises the bulk of the herbaceous layer.

(6) Habitat

This wet community type occurs in small to medium-sized depressions located on moderately flat and dissected land surfaces, and is characterized by poorly to very poorly drained, moderately rapidly permeable, organic-dominated soils (Table 4.21, Figure 4.39). The soil water table fluctuates seasonally and from year to year depending on local rainfall, and drawdown conditions are relatively common. At the time of sampling, the water table was found within this community type at some 126 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays over both loamy, siliceous, dysic, thermic Terric Medisaprists; and sandy, siliceous, thermic Typic Haplaquods (Table A-II-1). These soils are very poorly drained and poorly drained, respectively. (Leab, 1990) A representative sampled pedon of a Terric Medisaprist soil similar to the one underlying this community type is described for CT 7.2.3, while a representative sampled pedon of a Typic Haplaquod soil similar to the one found beneath this community type is described for CT 5.0.1, both in Appendix II.

A summary of soil chemical properties and soil textures for this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those tables indicate that the pH for the soils found beneath this community type is among the lowest sampled within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The percent base saturation of the CEC is extremely low within this community type. The soil bulk density values for this community type is low at the surface, but increases to moderately high with increasing soil depth.

(8) Succession & Disturbance

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance, although fence lines indicate past usage for livestock grazing. Surrounding landscapes have undergone extensive alteration by human land disturbance activities in the area of this community type. Fire scarring on the trunks of canopy trees indicates that fire has been a significant, if not recent, factor within this community type. In the absence of fire, the subcanopy/ transgressive layer would be expected to displace *Taxodium*, which was not observed to be reproducing within the community. Because the shrub layer is largely limited to the boles of canopy trees, it is unclear whether new individuals would be recruited into the shrub layer, or whether shrub dominance would simply increase through the increasing size of existing shrub clumps.

(9) Landscape Position

*Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.-*Zenobia)/Sphagnum* spp. Bogs are found in Carolina bays in both the Inner Lower Coastal Plain and the Middle Coastal Plain (Table 4.3). This community type makes up some 12 percent of sampled Carolina bay vegetation found within the Inner Lower Coastal Plain, and some 1 percent of sampled vegetation in the Middle Coastal Plain. As previously discussed, the community type is found over two soil types -- loamy, siliceous, dysic, thermic Terric Medisaprist soils (50%), and sandy, siliceous, thermic Typic Haplaquod soils (50%). Both soils are relatively common on the Lower Coastal Plain land surfaces within the study area, where sandy and organic soil families predominate. They are comparatively uncommon in Carolina bay depressions located in the Middle Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in the northeastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 18 percent of the community types that make up the vegetation class. Cypress/Gum Bog community types are uncommon in study area Carolina bays, but many, as this one, contain vegetation types that occur in non-Carolina bay wetlands. Community types falling into this vegetation grouping tend to be widely distributed, but are more numerous in the southern portion of the study area (*see* Figure 4.37).

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.8.8 COMMUNITY TYPE: ***Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/ (Leucobryum* sp.) Bog (8.0.8)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Leucobryum* spp., *Leucothoe racemosa, Lyonia ligustrina, Lyonia lucida, Taxodium ascendens*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

A moderately open canopy of medium-sized (12 to 14 m), "flat-topped" *Taxodium* *ascendens* characterizes this community type. A subcanopy layer is lacking. The canopy overtops a dense shrub layer composed of multi-stemmed clumps of *Lyonia lucida, Leucothoe racemosa* and *Lyonia ligustrina* 4 to 5 m in height. An herbaceous layer is absent in this community type. *Sphagnum* spp. appears to be completely absent from this "boggy" community type. Instead, *Leucobryum* spp. occurs as a "ground cover" in scattered patches.

This community type exhibited low mean species richness at the 0.1 ha level, at 7.78 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is particularly distinctive in the occurrence of a pure *Taxodium ascendens* canopy over an organic soil, and by the apparent complete lack of *Sphagnum* spp. from the community and instead, the presence of *Leucobryum* sp. as the ground cover moss.

(6) Habitat

This wet community type is known to occur in small depressions located on moderately flat, relatively undissected land surfaces, and is characterized by very poorly drained, moderately rapidly permeable, organic soils (Table 4.21, Figure 4.39). The soil water table is relatively stable, and while the site surface is typically inundated year round, infrequent, periodic drawdowns are known to occur. At the time of sampling, the water table was found within this community type at some 8 cm above the soil surface. The surface within this community type is extremely uneven, with the shrub clumps tending to occur on closely spaced "hummocks", with standing water (or more rarely, bare soil) between the hummocks. An elevational difference of up to 75 cm was recorded between the site surface and the top of site shrub hummocks.

(7) Soils

This community type occurs within study area Carolina bays over sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist soils (Table A-II-1). A representative, sampled pedon of a Terric Medisaprist soil from the study area similar to the one underlying this community type is described in Appendix II for CT 7.1.1, discussed above.

A summary of soil chemical properties for this community type is set out in Tables A-II-2 to A-II-4. Textural values for organic soils were not determined in this study. Those data indicate that the pH for the soils found beneath this community type is among the lowest sampled within Carolina bays, and is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. The soil bulk density values for this community type is among the lowest encountered within Carolina bays throughout the measured soil solum.

(8) Succession & Disturbance

This community type is found within a landscape dominated by Longleaf Pine savanna, pine flatwoods, and Evergreen Shrub-bogs, all of which tend to be fire-maintained ecosystems. Consequently, fire has been a major and continuous factor within this community type, as evidenced by fire scars on the trunks of all canopy trees, the extremely clumped nature of shrubs, and the presence of charcoal in the community soils. Fires likely simply remove the aerial portions of site shrubs, which then re-sprout from woody rootstocks. However, a "hot" fire occurring during a period of prolonged drought would likely oxidize a portion of the surface peat at the site, partially or entirely removing the shrub layer, and yielding either a "Cypress Pond" or herbaceous bog community at the site.

As indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance. Surrounding landscapes have undergone moderate alteration by human land disturbance activities in the immediate area of this community type.

(9) Landscape Position

This community type "*Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/* (*Leucobryum* sp.) Bog" is found in a Carolina bay located in a coastal plain Major River Valley (Table 4.3), and makes up some 11 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist soils. That soil family comprises 1 of 4 soil types found within sampledCarolina bays located in the Major River

Valleys and Floodplains of the Coastal Plain (Table 4.4), where organic soils are common.

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the north central portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are especially common in Carolina bays. This community type does occur, however, both in surrounding "swamps" and as small patches in other area Carolina bays. Nevertheless, this community type, at least in significant areal extent, is very rare within study area Carolina bays.

(11) Conservation Status

No adequate example of this community type within a Carolina bay is known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast, although small patches of this community type have been observed in some Bladen Lakes State Forest bays having organic soils.

4.3.8.9 COMMUNITY TYPE: ***Nyssa aquatica*/*Wolfiella-Utricularia purpurea* Bog (8.0.9)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Boehmeria cylindrica, Lemna gibba, Lycopus rubellus, Nyssa aquatica, Triadenum walteri, Utricularia purpurea, Wolfiella gladiata*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This most unusual Carolina bay community type is characterized by a canopy of large to very large (to 111 cm DBH and 25 m tall) *Nyssa aquatica*. *Taxodium distichum* is also a minor component of the canopy. The more common Carolina bay species, *Nyssa biflora* and

*Taxodium ascendens* are completely lacking from this community. While there is no true subcanopy layer, transgressive *Nyssa aquatica* and *Fraxinus caroliniana* are common in the community type. The surface of the water beneath the overtopping trees is virtually covered by *Wolfiella gladiata*, with *Lemna gibba* assuming herbaceous layer significance in some areas, mixed with thick surface/ subsurface mats of *Utricularia purpurea*.

This community type exhibited low mean species richness at the 0.1 ha level, at 10.46 species (Table 4.2).

<u>(5) Distinguishing Features</u>

Cypress/Gum Bog communities are distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is unique among study area Carolina bay communities in the presence *Nyssa aquatica* as the canopy dominant, with *Taxodium distichum* also occurring as a canopy tree. Both species are unknown elsewhere within study area Carolina bays.

<u>(6) Habitat</u>

This wet community type occurs in small depressions located on relatively flat, undissected land surfaces, and is characterized by very poorly drained, moderately permeable, moderately deep organic soils (Table 4.21, Figure 4.39). The soil water table is relatively stable, and the site surface is typically inundated year round, although drawdowns are known to occur. At the time of sampling, the water table within this community type was found, on average, at some 89 cm above the soil surface, but ranged from 57 to 115 cm in depth.

<u>(7) Soils</u>

This community type occurs within study area Carolina bays over sandy, mixed, dysic, thermic Terric Medisaprist soils (Table A-II-1). Representative, sampled pedons of other Terric Medisaprist soils similar to the one found beneath this community type are described in Appendix II for CT 7.2.3, discussed previously. The peat making up the soil at the site is highly decomposed even at the surface, and is readily compressed as compared to the surficial peats at most other sampled sites having organic soils. This community type is located in a landscape characterized by a mosaic of Aeric Haplaquod, Typic Haplaquod and Typic Quartzipsamment soils.

A summary of soil chemical properties for this community type is set out in Tables A-II-2 to A-II-4. Textural values for organic soils were not determined in this study. Those tables indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. The CEC is low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions. Nevertheless, the percentage of the CEC occupied by bases is moderately high, as are the levels of major cations within the soil, relative to most other "boggy" communities sampled. The soil bulk density values for this community type is among the lowest encountered within Carolina bays throughout the measured soil solum.

(8) Succession & Disturbance

There is little evidence that fire has been a frequent factor within this community type. And, as indicated by Table 4.21, this community type shows little overt evidence of recent human disturbance. Surrounding landscapes have undergone fairly extensive alteration by human agricultural usage in the area of this community type, and Carolina bays are highly insular wetland sites in the region. While some canopy trees are quite large, and presumably, relatively old, canopy trees occur in a number of size classes, indicating that canopy regeneration does occur within this community.

(9) Landscape Position

The "*Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog" community type is known only from a Middle Coastal Plain Carolina bay (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist soils. That soil family comprises 1 of 12 soil types found within sampled Middle Coastal Plain Carolina bays, and is comparatively uncommon at that landscape position (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the southern portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. None of the Cypress/Gum Bog community types are common in Carolina bays, but this community type is not uncommon in adjacent riverine swamps. Nevertheless, this community type is very rare within study area bays, and is highly unusual for a closed, depressional community.

(11) Conservation Status

The only known example of this community type occurs within a Carolina bay that is privately held by the South Carolina Nature Conservancy for the express purpose of biodiversity conservation.

### 4.3.8.10 COMMUNITY TYPE: *(Nyssa biflora)/(Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Bog (8.0.10)

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pocosin *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.20)

*Acer rubrum, Cephalanthus occidentalis, Cladium mariscus* var. *jamaicense, Eriocaulon decangulare, Iris virginica, Ludwigia pilosa, Lycopus rubellus, Nyssa biflora, Pluchea foetida, Proserpinaca pectinata, Smilax walteri, Triadenum virginicum*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type (NOTE: While not within a sampled plot exhibiting this community type, *Eriocaulon parkeri* was collected within the bay depression immediately adjacent to this community).

(4) Vegetation & Physiognomy

This community type is also quite unusual among Carolina bay vegetation types within the study area. It is characterized by scattered, raised, sandy "islands" of woody vegetation amongst a dense, multi-layered, "marsh-like" herbaceous stratum dominated by *Cladium mariscus* var. *jamaicense* and *Iris virginica*, overtopping *Ludwigia pilosa*. The islands are typically vegetated by *Nyssa biflora* and *Acer rubrum* trees to 6 m in height, associated in particular with *Myrica cerifera* and dense thickets of *Smilax walteri*. In addition to the woody species found on community "islands", small (2 to 3 m in height) specimens of *Acer rubrum* and *Cephalanthus occidentalis*, are scattered throughout the *Cladium* bog.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.66 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Bog community types are generally distinct in having a canopy of "cypress" and/or "gum" over an organic-dominated soil, and the various community types are distinguished primarily by the species composition of their shrub and herbaceous strata. This community type is unique among study area Carolina bay communities in the presence *Cladium mariscus* var. *jamaicense*, which is the principal dominant in the herbaceous layer.

(6) Habitat

This wet community type is known within Carolina bays only from a small depression located on a flat, undissected, near-coast land surface, and is characterized by very poorly drained, moderately permeable, shallow organic soils (Table 4.21, Figure 4.39). The soil water table is highly variable, although water stands on the surface at least seasonally in most years. At the time of sampling, the water table was found within this community type at some 13 cm above the soil surface.

(7) Soils

This community type occurs within a study area Carolina bay over a sandy, mixed, euic, thermic Terric Medisaprist soil (Table A-II-1). This very poorly drained soil is "structurally" similar to the previously discussed Terric Medisaprist soils common in Carolina bays, but is distinguished from those soils by having an euic, rather than a dysic, family reaction class. That simply means that the pH of an undried soil sample is $\geq 4.5$ in some part of the organic materials in the "control section" of the soil solum (Soil Survey Staff, 1975). Field testing of the peat extracted from the soil profile for this community type indicated the pH to be in excess of 5.0. This soil is not mapped by the SCS in inland (nonestuarine) wetlands areas within the study area. A profile for this soil is generally described in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. This is chemically a most unusual soil within the context of Carolina bay communities. The pH for this Cypress/Gum Bog community type is not extremely acid at all measured soil depths, like other "bog" communities, but is instead only strongly acid (pH=5.23) at the surface, to slightly acid (pH=6.40) at 50 cm. Moreover, the CEC is relatively high throughout the soil solum, and the bulk of that CEC is occupied by cations, particularly calcium, with very low saturation by hydrogen and aluminum ions. The soil bulk density values for this community type are relatively low at the surface, but relatively high at 50 cm. This in part reflects the predominance of silt-sized particles near the surface of the soil, with a substantial increase of sand at the lower levels of the measured soil solum.

(8) Succession & Disturbance

Like the "Boggy Marsh" community types discussed previously within this Chapter, this community type occurs within a matrix of pocosin-like vegetational depression communities, where frequent fire is characteristic. Within this community type, fires reportedly occur within this community type every 5 to 10 years on average (Table 4.21). The open, marsh-like nature of this community type is apparently fire maintained, and in the absence of frequent fires, the surrounding pocosin shrubs quickly encroach upon this community. This community type occurs within relatively undisturbed landscapes, and disturbance other than fire is generally lacking.

(9) Landscape Position

The "(*Nyssa biflora*)/(*Acer-Cephalanthus*)/*Cladium-Iris virginica*/*Ludwigia pilosa* Bog" community type is found in a Carolina bay located in the Inner Lower Coastal Plain (Table 4.3), and makes up some 12 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy, mixed, euic, thermic Terric Medisaprist soils. That soil family is rare in Carolina bays within the study area. It represents 1 of the 6 soil types observed within sampled Inner Lower

Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the northeastern portion of the study area, fall within this classification (Table 4.5). This community type comprises 9 percent of the community types that make up the vegetation class. While Cypress/Gum Bog community types are uncommon in Carolina bays, many contain vegetation types more common elsewhere within the study area. Indeed, this community type would not be unusual for an estuarine marsh area in the vicinity of its occurrence. Nevertheless, this community type is very rare within Carolina bay depressions, known only from a single site.

(11) Conservation Status

The only known example of this community type within a study area Carolina bay is located within a bay depression located in Croatan National Forest, thereby having a relative degree of protection from human disturbance.

4.3.8.11 ANALYSIS

Vegetation Class Environmental Gradients

Cypress Gum/Bog plots within study area Carolina bays are distributed along a soil pH--nutrient/"locational" gradient and an orthogonal fire/site wetness gradient (Figures 4.38 and 4.39). Stands are located on the first gradient primarily by their comparative scores for soil pH, and calcium and subsoil manganese levels, as well as site elevation/longitude, and local relief. Those factors are correlated with both compositional axes on the ordination diagram for Cypress/Gum Bog stands, but are most strongly associated with the first compositional axis. Stands are distributed along the second gradient according to their relative values for organic-dominated layer depth, soil permeability, and site fire frequency. The factors comprising the latter gradient are associated primarily with the first compositional axis.

With respect to Cypress/Gum Bog community type distribution along those gradients, *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog stands occur at sites with comparatively high fire frequency, over fairly impermeable, low phosphorus soils that have a comparatively shallow organic-dominated layer. *Nyssa biflora/ Chamaedaphne/Carex striata/Sphagnum* spp. Bog plots are found at wet sites where fires are infrequent, over a relatively deep organic soil. *Nyssa biflora-Taxodium ascendens/Decodon/ (Smilax laurifolia)/Utricularia purpurea* Bog stands occur in conditions that are intermediate in all respects, *i.e.*, in the "middle" of both gradients. *Nyssa biflora* "Boggy Swamp" stands occur at moderately wet sites characterized by a very low fire frequency. The soils at those sites have a moderately shallow organic-dominated layer comparatively high soil phosphorus, and a clayey, relatively impermeable subsoil. *Nyssa biflora/(Acer)/Decodon/ Dulichium/Sphagnum* spp.-*Utricularia biflora* Bog stands at wet sites located at low elevations, and are subject to an intermediate frequency of fires. Soils in this community type have a moderately shallow organic-dominated layer, as well as moderate pH and nutrient levels, except that soil surface phosphorus is comparatively low. Both *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog plots and *Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.-*Zenobia)/Sphagnum* spp. Bog stands occur at sites similar to those occupied by *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/Sphagnum* spp. Bog stands (CT 8.0.1), except that depressions where the two community types are found tend to be on landscapes exhibiting more local relief than that characterizing the former community type. *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/(Leucobryum* sp.) Bog plots are found on moderately deep organic, very low pH soils having comparatively high manganese level in subsurface mineral sediments. Fire frequency in these plots is moderate. *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog plots are found at the wettest sites, with the deepest organic-dominated layer. Soil permeability is low and soil phosphorus levels are comparatively high. Fires are rare in this community type. *(Nyssa biflora)/(Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa/* Bog stands are exhibit the highest pH soils and highest calcium levels found in this vegetation class, and are found at low elevation (near-coast) sites.

Discussion

As noted in the introduction to this vegetation class, Cypress/Gum Bogs in many ways form a bridge between Intermittently Ponded Cypress/Gum Depression and Evergreen Shrub-bog communities occurring within Carolina bays. Like Evergreen Shrub-bog vegetation, these communities are underlain by "sandy-organic system"soils, particularly Terric Medisaprists (63%) and Typic Haplaquods (18%) (Table A-II-1). The other soils found beneath Cypress/Gum Bog communities are wet, clayey Paleaquult soils, which are typical of Intermittently Ponded Cypress/Gum Depression communities. However, the Cypress/Gum Bog Paleaquult soils represent variants of the central group whose "typic" properties are substantially modified by sandy or peaty layers within the upper soil profile, and that difference is reflected in the vegetational dominants of the overlying communities. Like Evergreen Shrub-bogs, most Cypress/Gum Bog community types exhibit (1) a shrub stratum dominated by typical "pocosin" species -- including *Lyonia lucida, Chamaedaphne calyculata, Zenobia pulverulenta, Cyrilla racemiflora,* and *Leucothoe racemosa*; (2) an herbaceous layer that, like Evergreen Shrub-bog communities, is dominated by *Woodwardia virginica* and *Carex striata*; and (3) a ground cover of *Sphagnum* spp. However, unlike Evergreen Shrub-bogs, Cypress/Gum Bog communities have the well-developed canopy layer of *Taxodium ascendens* and/or *Nyssa* spp. that is characteristic of Intermittently Ponded Cypress/Gum Depression vegetation communities, discussed later in this chapter.

To illustrate this point, it is useful to compare the plant life form and plant growth form community type summaries for these related vegetation classes (*see* "List of Figures"). A high percentage of taxa with mega- and micro-phanaerophytic life forms occur in Evergreen Shrub-bog communities (55%), they comprise a moderate proportion of the taxa found within Cypress/Gum Bog communities (37%), and they are a substantially lesser component of the taxa found in Intermittently Ponded Cypress/Gum Depressions (23%). Similarly, species having subterranean and ground level perennating buds (primarily herbs) make up a moderate portion of the taxa found within Evergreen Shrub-bogs (40%), more than half the taxa found within Cypress/Gum Bogs (53%), and the bulk of the taxa found in Intermittently Ponded Cypress/Gum Depressions (70%).

In like manner, taxa with shrubby growth forms comprise 41% of Evergreen Shrub-bog species, 21 % of those species found in Cypress/Gum Bogs, but only 13% of species occurring in Intermittently Ponded Cypress/Gum Depressions. By contrast, perennial herbs account for 22% of Evergreen Shrub-bog taxa, 38% of taxa found in Cypress/Gum Bogs, and 54% of taxa found to occur in Intermittently Ponded Cypress/Gum Depressions.

Like both the Evergreen Shrub-bog and Intermittently Ponded Cypress/Gum Depression vegetation classes, fire is the most important disturbance phenomenon acting on Cypress/Gum Bog vegetation, although it occurs less often in Cypress/Gum Bog communities than in Cypress/Gum Depression communities, with a fire frequency on par with that characterizing Evergreen Shrub-bogs (Tables 4.19 and 4.21). This presumably occurs because both Cypress/Gum Bogs and Evergreen Shrub-bogs have longer, more stable hydroperiods than those typifying Intermittently Ponded Cypress/Gum Depressions. Indeed, it is the presence of near-continuous anoxic conditions at these sites that allows the peat accumulation that characterize soils found within these vegetation classes to occur.

Species with woody growth forms -- broadleaf and deciduous trees and shrubs -- predominate in most Cypress/Gum Bogs, although two community types -- the *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog and the *(Acer-Nyssa biflora-Cephalanthus)/ Cladium-Iris virginica/Ludwigia pilosa* Bog -- show substantial dominance of herbaceous perennial taxa (Figure 4.41). Similarly, evergreen and deciduous microphanerophyte taxa predominate as to plant life forms within the individual communities comprising this vegetation class, except in the two previously listed community types (Figure 4.40). While deciduous microphanerophyte taxa remain important in each of those two community types, species with ground level and subterranean vegetative buds predominate as a whole. This difference is explained at least in part by the notably higher cation levels for major soil nutrients that occur in these two community types as compared to other Cypress/Gum Bog communities (*see* Tables A-II-2 to A-II-4).

Several of the unique Cypress/Gum Bog community types found in study area Carolina bays merit specific discussion. First, the *Nyssa aquatica/Wolfiella-Utricularia purpurea* community type reflects the only know occurrence of water tupelo within a Carolina bay depression. Southeastern United States wetlands communities dominated by *Nyssa aquatica* are typically alluvial, occurring over silty or sandy soils in riverine swamp sites characterized by deep water and long hydroperiods (Christensen, 1988). The occurrence of this species over an organic soil at a non-alluvial site is not readily explained, although the mean ambient site water level is comparatively deep and site hydroperiod is long within the depression supporting this community type.

An examination of the soils underlying this community type provides some apparent insight into the occurrence of a *Nyssa aquatica* dominated community at this site. Throughout the soil profile, the peat encountered there had a very low bulk density -- representing the most highly decomposed peat encountered in this study in soil surface layers, seen in Evergreen Shrub-bogs only at depths well below the shallow rooting depth characteristic of Shrub-bog sites -- and comparatively high levels of extractable phosphorus (Tables A-II-2 to A-II-4). As compared to Evergreen Shrub-bogs, relatively high nutrient levels are characteristic of the "brown-water" swamps where *Nyssa aquatica* is normally found (Christensen, 1988). Elevated soil phosphorus levels at this site may alone give *Nyssa aquatica* and its community associates a competitive edge lacking in Evergreen Shrub-bog sites exhibiting deep water and long hydroperiods. Moreover, the relevant soils data suggest that the organic soils underlying this community type has not developed from species with sclerophyllous leaves, as is characteristic of study area Evergreen Shrub-bog communities (*see*, Walbridge, 1991). The comparatively high level of plant matter decomposition in the organic soil at this site may also be significant. Daniel (1981) found that Evergreen Shrub-bog vegetational communities vary according to the "type" of peat on which they are growing. He attributed this difference to the fact that organic soils vary greatly in their relative hydraulic conductivities, with that property being inversely proportional to the degree of organic matter decomposition.

The *(Acer-Nyssa biflora-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Marsh community type identified within this vegetation class is also unique within study area Carolina bays both in terms of its vegetational dominants and soil nutrient status. It is the only Cypress/Gum Bog dominated by herbaceous species, and is similar in many ways to the graminoid-dominated wetland "bog" communities described by Penfound (1952). The principal community dominant, *Cladium mariscus* var. *jamaicense* is not a typical depressional wetland species, but is a characteristic dominant of alkaline peats found in mixohaline, estuarine marshes within the study area (Goodwin, 1986; Schafale and Weakley, 1990). Edaphic factors are likely the key to the occurrence of this community type within a Carolina bay depression. The soil at the site supporting the *Cladium* Marsh is a shallow peat, but is not extremely acidic, like most depression organic soils. Instead, it has an euic (*i.e.*, comparatively high pH) soil family reaction class. As a result, at all measured depths this soil exhibited the highest soil pH and calcium levels encountered within any Carolina bay depression (Tables A-II-2 to A-II-4).

The *Cladium* Marsh community type occurs at a site surrounded by a relatively undisturbed landscape, ensuring that the site's elevated nutrient status is "natural". Observation of road cuts in the area of the site indicates that unconsolidated marl is often found within a meter of the surface in the region. Moreover, the *Cladium* Marsh is located in an area of the depression with a noticeably lower elevation than most of the basin, which may be the result of a post-fire deflation event, as discussed in reference to Boggy Marsh communities, above. That "lower" setting would presumably bring the level of the depression surface in closer proximity to any underlying marl layers, although no surficial marl layers were located by soil probing at the site. Nevertheless, taken together, these factors suggest that the flow of near-surface, minerotrophic waters across a shallow, buried marl layer and into the depression is responsible for the site's enhanced pH and nutrient status. This explanation seems plausible given that, while unknown elsewhere within the study area, inland freshwater, minerotrophic *Cladium*-dominated marshes occurring on an organic soil overlying limestone are common elsewhere, *e.g.*, the Florida Everglades (*see* Kushlan, 1990)

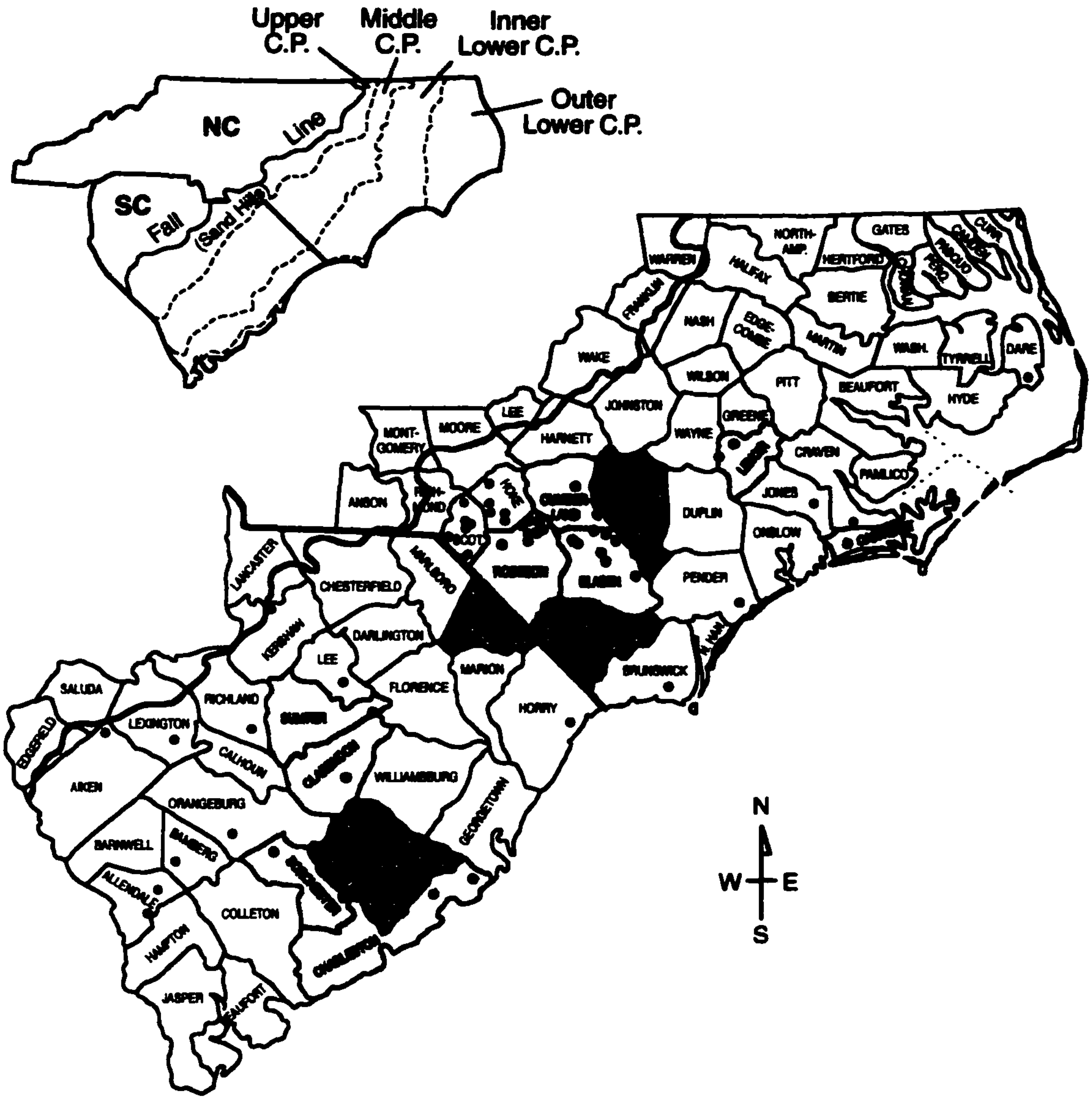
Interestingly, as noted in the description of this community type, the peaty soil layer on which it occurs overlies a spodic horizon. In fact, the majority of the depressions in which this community type is located is dominated by typical pocosin vegetation. Soil augur borings in those communities indicate that the soil is a Typic Haplaquod for most of the depression basin, lacking the surface organic layer found in the *Cladium* Marsh. A possible explanation for this occurrence is that localized, long-term nutrient enhancement in an otherwise nutrient depauperate system greatly accelerated the rate of local paludification, fostering the accumulation of peat in that area only.

Finally, the occurrence of the *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/(Leucobryum* sp.) Bog community is also notable within Carolina bay depressions. This community type is also rare, and represents the only real vegetational community (as opposed to small inclusions of this vegetation within other depressional community types) encountered in study area depressions where *Taxodium ascendens* is the sole dominant over an organic soil. Within the realm of study area wetlands, that species is the characteristic canopy dominant in mineral soil Intermittently Ponded Cypress/Gum Depressions. *Taxodium ascendens* also occasionally exhibits some significance in wet pocosin depressional communities occurring over shallow peats (Kologiski, 1977), but is almost never the principal woody dominant in Evergreen Shrub-bogs.

Like the *Cladium* Marsh discussed above, this community type is more common to the south of the study area, and is possibly a northern variant of the nutrient-limited "cypress dome" communities described for poorly drained depressions in Georgia and Florida (Kurz and Wagner, 1953; Monk and Brown, 1965; Schlesinger, 1978; Wharton, 1978). Like those communities, this Carolina bay community type exhibits a thick layer dominated by a mixture of sclerophyllous shrubs typical of Evergreen Shrub-bogs beneath the dense *Taxodium* canopy. It is noteworthy that the bryophyte ground cover species in every other study area bog (*i.e.*, depression sites exhibiting an organic soil) encountered was one or more species of the genus *Sphagnum*. By contrast, the ground cover bryophyte within this community type is clearly not *Sphagnum*, and has tentatively been identified as *Leucobryum* sp. Should that identification bear out, it would appear to give this community type some affinity with more northern peatlands. For example, *Leucobryum* spp. is a common ground cover dominant in "shrub-thicket" bog communities in the New Jersey pine barrens (Olsson, 1979).

Christensen (1988) states that the successional fate of cypress domes appears to depend on site hydrology, with *Taxodium* forming stable, dominant populations in areas that remain permanently inundated. Given the stature and obvious, comparatively old age of the *Taxodium ascendens* trees occurring within this community type, its reported long-term stability, and observed site surface water levels at various seasons over a 15-year period, it is likely that this community type represents such a stable, dominant population.

Figure 4.37. Distribution of study area Carolina bay sites containing Cypress/Gum Bog vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Cypress/Gum Bog community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Cypress/Gum Bog community types were observed during field reconnaissance for this study. Locations of individual, sampled Carolina bay sites are indicated by red circles.



Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall
Line
(Sand Hills)
WARREN
NORTH-AMP.
GATES
HALIFAX
HERTFORD
FRANKLIN
NASH
BERTIE
EDGE-COMBE
MARTIN
WASH.
TYRRELL
DARE
WAKE
WILSON
PITT
BEAUFORT
HYDE
JOHNSTON
LEE
MONT-GOMERY
MOORE
HARNETT
GREENE
WAYNE
CRAVEN
PAMLICO
ANSON
RICH-MOND
HOKE
DUPLIN
JONES
ONSLOW
PENDER
BRUNSWICK
LANCASTER
CHESTERFIELD
MARLBORO
DARLINGTON
KERSHAW
LEE
SALUDA
RICHLAND
FLORENCE
MARION
HORRY
EDGEFIELD
LEXINGTON
CALHOUN
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
ALLENDALE
COLLETON
HAMPTON
JASPER
BEAUFORT
N
W
E
S

Table 4.20. Average cover class and constancy of species present in the Cypress/Gum Bog vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8. | | 8.0.1 | | 8.0.2 | | 8.0.3 | | 8.0.4 | | 8.0.5 | | 8.0.6 | | 8.0.7 | | 8.0.8 | | 8.0.9 | | 8.0.10 | |
| Species | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| ACER RUBRUM | 4 | 80 | 2 | 50 | 4 | 100 | 2 | 50 | 3 | 50 | 5 | 100 | 7 | 100 | 6 | 100 | 3 | 100 | 4 | + | 5 | 100 |
| ANDROPOGON GLOMERATUS VAR. GLAUCOPSIS | 3 | 9 | 3 | 100 | | | | | | | | | | | | | | | | | | |
| ARONIA ARBUTIFOLIA | 3 | 18 | 3 | 75 | | | 3 | + | | | | | | | 3 | 50 | | | | | | |
| ASCLEPIAS LANCEOLATA | 2 | 5 | | | | | | | | | | | | | | | | | | | 2 | 50 |
| BIDENS SP. #1 | 3 | 2 | | | | | 3 | + | | | | | | | | | | | | | | |
| BOEHMERIA CYLINDRICA | 3 | 16 | | | | | | | 2 | 75 | | | | | | | | | 4 | 100 | | |
| CAREX SP. | 5 | 5 | | | | | | | | | 5 | + | | | | | | | | | | |
| CAREX STRIATA VAR. STRIATA | 8 | 18 | 7 | 100 | 8 | 100 | | | | | | | | | | | | | | | | |
| CAREX VERRUCOSA | 3 | 7 | | | | | | | | | | | | | 3 | + | | | | | | |
| CEPHALANTHUS OCCIDENTALIS | 5 | 9 | | | | | | | 3 | + | | | | | | | | | | | 5 | 75 |
| CHAMAEDAPHNE CALYCULATA# | 6 | 9 | | | 6 | 100 | | | | | | | | | | | | | | | | |
| CLADIUM MARISCUS VAR. JAMAICENSE | 9 | 9 | | | | | | | | | | | | | | | | | | | 9 | 100 |
| CLETHRA ALNIFOLIA | 4 | 30 | 3 | 75 | | | 5 | 100 | 3 | + | | | 5 | 75 | 3 | + | | | | | 4 | + |
| CYRILLA RACEMIFLORA | 5 | 18 | | | | | | | | | 5 | 75 | 6 | 75 | 4 | + | | | | | | |
| DECODON VERTICILLATUS | 8 | 20 | | | 4 | + | 8 | 10C | | | 9 | 100 | | | | | | | | | | |
| DICHANTHELIUM DICHOTOMUM | 2 | 2 | 2 | + | | | | | | | | | | | | | | | | | | |
| DROSERA INTERMEDIA | 2 | 9 | 2 | 100 | | | | | | | | | | | | | | | | | | |
| DULICHIUM ARUNDINACEUM | 4 | 36 | 4 | + | 3 | + | 4 | 100 | | | 7 | 100 | 4 | 100 | | | | | 3 | 50 | | |
| ERECHTITES HIERACIIFOLIA | 1 | 7 | | | | | | | | | | | | | 1 | + | | | | | | |
| ERIOCAULON COMPRESSUM | 5 | 7 | | | | | | | | | | | | | 5 | + | | | | | | |
| ERIOCAULON DECANGULARE | 3 | 7 | | | | | | | | | | | | | | | | | | | 3 | 75 |
| EUPATORIUM COMPOSITIFOLIUM | 1 | 2 | | | | | | | | | | | | | 1 | + | | | | | | |
| FRAXINUS CAROLINIANA | 5 | 5 | | | | | | | | | | | | | | | | | 5 | + | | |
| GELSEMIUM SEMPERVIRENS | 3 | 14 | | | | | | | | | | | | | 3 | 75 | | | | | | |
| GORDONIA LASIANTHUS | 4 | 7 | | | 4 | 75 | | | | | | | | | | | | | | | | |
| HYDROCOTYLE RANUNCULOIDES | 2 | 2 | | | | | | | | | | | | | | | | | 2 | + | | |
| ILEX CASSINE** | 2 | 2 | 2 | + | | | | | | | | | | | | | | | | | | |
| ILEX GLABRA | 5 | 9 | 5 | 75 | | | | | | | | | | | 5 | 13 | | | | | | |
| ILEX LAEVIGATA | 4 | 7 | | | | | | | | | | | | | 4 | + | | | | | | |
| ILEX MYRTIFOLIA | 3 | 5 | | | 3 | + | | | | | | | | | | | | | | | 2 | + |
| ILEX OPACA | 5 | 9 | | | | | | | | | | | | | 5 | 50 | | | | | | |
| IRIS VIRGINICA | 5 | 14 | | | | | 3 | 50 | | | | | | | | | | | | | 6 | 100 |
| ITEA VIRGINICA | 4 | 39 | | | 4 | + | 5 | 100 | 4 | + | 5 | + | 4 | + | 4 | 50 | | | 3 | + | | |
| LACHNANTHES CAROLINIANA | 6 | 11 | 2 | + | | | | | | | | | | | 7 | + | | | | | | |
| LEUCOBRYUM SP. | 5 | 9 | | | | | | | | | | | | | | | 5 | 100 | | | | |
| LEMNA GIBBA | 5 | 9 | | | | | | | | | | | | | | | | | 5 | 100 | | |
| LEUCOTHOE RACEMOSA | 5 | 50 | 4 | 25 | | | 5 | 100 | 4 | 25 | 5 | 25 | 4 | 75 | 5 | 100 | 6 | 100 | | | | |
| LIQUIDAMBAR STYRACIFLUA | 4 | 45 | | | | | | | 3 | 100 | 4 | 75 | 5 | 100 | 4 | 100 | | | 5 | + | | |
| LITSEA AESTIVALIS* # | 6 | 5 | | | | | | | | | 6 | + | | | | | | | | | | |
| LUDWIGIA PILOSA | 7 | 9 | | | | | | | | | | | | | | | | | | | 7 | 100 |

Table 4.20 (cont.). Average cover class and constancy of species present in the Cypress/Gum Bog vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LYCOPUS RUBELLUS | 3 16 | | | | | | | | | 3 100 | 3 75 |
| LYCOPUS VIRGINICUS | 3 11 | | | 3 100 | 3 + | | | | | | |
| LYONIA LIGUSTRINA | 4 41 | | 4 100 | 4 100 | | | 4 100 | 3 + | 5 100 | | |
| LYONIA LIGUSTRINA VAR. FOLIOSIFLORA | 5 5 | | | | | | | 5 + | | | |
| LYONIA LUCIDA | 6 61 | 6 100 | 5 100 | 5 100 | 4 75 | | 6 100 | 6 + | 7 100 | | |
| MAGNOLIA VIRGINIANA | 4 23 | 4 75 | | 3 + | 2 + | 6 + | | 4 + | | | |
| MITREOLA PETIOLATA | 3 5 | | | | | | | | | | 3 + |
| MYRICA CERIFERA VAR. CERIFERA | 5 25 | 5 100 | 5 25 | | 3 + | | 5 100 | | | | 5 25 |
| NYMPHAEA ODORATA | 5 20 | 3 + | 5 100 | 5 100 | | | | | | | |
| NYSSA AQUATICA | 8 9 | | | | | | | | | 8 100 | |
| NYSSA BIFLORA | 6 84 | 5 100 | 6 100 | 7 100 | 9 100 | 7 75 | 7 100 | 6 100 | 4 + | 5 + | 5 100 |
| OSMUNDA REGALIS | 3 2 | | | | | | | | | | 3 + |
| PANICUM VERRUCOSUM | 3 9 | | | | | | | 3 50 | | | |
| PELTANDRA SAGITTIFOLIA* # | 4 7 | | 4 75 | | | | | | | | |
| PERSEA PALUSTRIS | 4 41 | 4 100 | | 4 + | 3 50 | 4 + | 4 + | 5 63 | 3 + | | 2 + |
| PHORADENDRON SEROTINUM | 3 7 | | | 3 25 | | | 3 50 | | | | |
| PHYTOLACCA AMERICANA | 2 2 | | | | | | | 2 + | | | |
| PINUS SEROTINA | 5 9 | 5 100 | | | | | | | | | |
| PINUS TAEDA | 4 16 | | | | | | 4 + | 4 63 | | | |
| PLUCHEA FOETIDA | 4 9 | | | | | | | | | | 4 100 |
| POLYGONUM PERSICARIA | 2 2 | | | | | | | | | 2 + | |
| POLYPODIUM POLYPODIOIDES | 2 2 | | | 2 + | | | | | | | |
| PROSERPINACA PALUSTRIS | 2 2 | | | | | | | | | | 2 + |
| PROSERPINACA PECTINATA | 4 9 | | | | | | | | | | 4 100 |
| PRUNUS CAROLINIANA | 3 2 | | | | | | 3 + | | | | |
| QUERCUS NIGRA | 2 2 | | | | | | | 2 + | | | |
| RHEXIA MARIANA VAR. VENTRICOSA | 5 9 | 5 100 | | | | | | | | | |
| RHEXIA VIRGINICA | 3 2 | | | | | | | 3 + | | | |
| RHYNCHOSPORA CEPHALANTHA VAR. MICROCEPHALA | 5 9 | 5 100 | | | | | | | | | |
| RHYNCHOSPORA CHALAROCEPHALA | 3 2 | | | | | | | 3 + | | | |
| RHYNCHOSPORA FASCICULARIS | 5 9 | 5 100 | | | | | | | | | |
| RHYNCHOSPORA FILIFOLIA | 2 5 | | | | | | | | | | 2 50 |
| RHYNCHOSPORA INUNDATA**# | 3 5 | 3 + | | | | | | | | | |
| SACCHARUM GIGANTEUM | 3 5 | | | | | | 3 + | | | | |
| SALIX CAROLINIANA | 5 5 | | | | | | | | | | 5 + |
| SALIX NIGRA | 2 2 | | | | | | | | | 2 + | |
| SARRACENIA FLAVA | 5 9 | 5 100 | | | | | | | | | |
| SASSAFRAS ALBIDUM | 3 2 | | | | | | | 3 + | | | |
| SAURURUS CERNUUS | 4 5 | | | 4 + | | | | | | | |
| SCIRPUS CYPERINUS | 5 9 | | | | | | 5 100 | | | | |
| SMILAX BONA-NOX | 4 2 | | | | | | | 4 + | | | |
| SMILAX GLAUCA | 2 11 | | | | | | | 2 63 | | | |
| SMILAX LAURIFOLIA | 4 43 | 4 100 | | 5 100 | | 3 100 | 4 75 | 3 50 | | | |
| SMILAX ROTUNDIFOLIA | 3 5 | | | | | | | 3 + | | | |
| SMILAX WALTERI | 4 39 | 3 100 | 4 100 | 4 100 | 3 + | | | | | | 4 100 |
| SPHAGNUM SP. | 8 52 | 8 100 | 7 100 | 5 + | | 9 100 | 5 25 | 9 100 | | | |
| TAXODIUM ASCENDENS | 6 70 | 6 100 | 5 100 | 6 100 | 5 75 | | 6 100 | 8 100 | 7 100 | | |
| TAXODIUM DISTICHUM | 5 2 | | | | | | | | | 5 25 | |

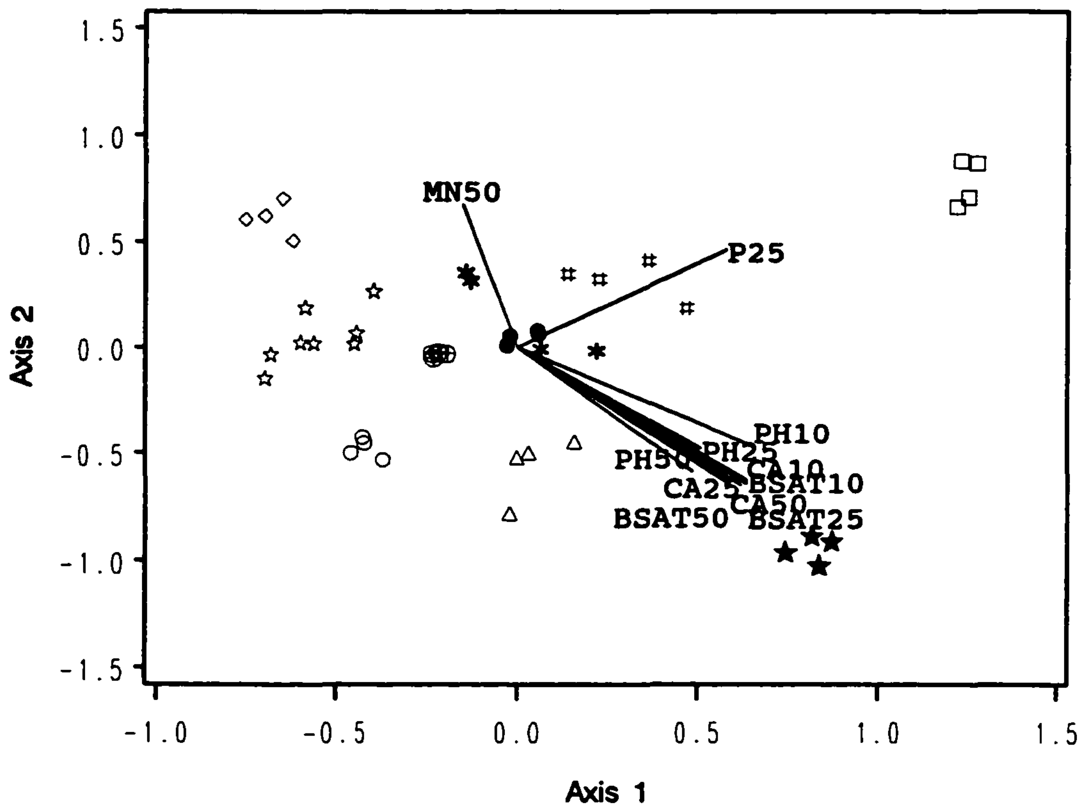
Table 4.20 (cont.). Average cover class and constancy of species present in the Cypress/Gum Bog vegetation class. Values are given for the vegetation class and its constituent community types, each of which is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TILLANDSIA USNEOIDES | 3 25 | 2 * | 3 50 | 4 100 | 3 * | | | | | 3 * | |
| TOXICODENDRON RADICANS VAR. RADICANS | 3 20 | 2 * | | 4 100 | 1 * | | | 4 * | | | |
| TRIADENUM VIRGINICUM | 4 25 | 4 75 | 3 * | 4 100 | | | | | | | 4 75 |
| TRIADENUM WALTERI | 3 7 | | | | | | | | | 3 75 | |
| UTRICULARIA BIFLORA | 7 9 | | | | | 7 100 | | | | | |
| UTRICULARIA PURPUREA | 5 36 | | 4 100 | 6 100 | | | 5 100 | | | 7 100 | |
| VACCINIUM CORYMBOSUM | 4 41 | 3 * | 4 * | 4 100 | | | 4 * | 5 100 | 5 25 | | |
| VACCINIUM FUSCATUM | 4 25 | | | | | | 4 100 | 5 75 | | | 3 * |
| VIBURNUM NUDUM | 4 5 | | | | | 4 50 | | | | | |
| VITIS ROTUNDIFOLIA | 2 2 | | | | | | | 2 * | | | |
| WOLFFIELLA GLADIATA | 9 9 | | | | | | | | | 9 100 | |
| WOODWARDIA AREOLATA | 4 14 | 2 * | | 5 100 | | | | | | | |
| WOODWARDIA VIRGINICA | 6 25 | 6 100 | | | | 4 * | 7 100 | | | | 5 * |
| XYRIS FIMBRIATA | 4 11 | 4 100 | 4 * | | | | | | | | |
| ZENOBIA PULVERULENTA | 6 48 | 5 75 | 5 100 | | | | 7 100 | 5 75 | 8 * | | |

Table 4.21. Average site information for the Cypress/Gum Bog vegetation class. The vegetation class and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8. | 8.0.1 | 8.0.2 | 8.0.3 | 8.0.4 | 8.0.5 | 8.0.6 | 8.0.7 | 8.0.8 | 8.0.9 | 8.0.10 |
| Site Hydrology | | | | | | | | | | | |
| Water Depth Index | 153.5 | 157.0 | 175.0 | 219.0 | 45.0 | 169.0 | 187.5 | 23.5 | 157.5 | 238.8 | 163.0 |
| Hydroperiod Class | 4.4 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Water Constancy Index | 2.0 | 2.0 | 3.0 | 3.0 | 1.0 | 3.0 | 1.0 | 2.0 | 2.0 | 2.0 | 1.0 |
| Organic Layer Depth | 54.1 | 57.0 | 75.0 | 56.0 | 27.0 | 43.0 | 10.0 | 49.0 | 79.0 | 100.0 | 45.0 |
| Soil Drainage Class | 2.9 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.0 | 2.5 | 3.0 | 3.0 | 3.0 |
| Soil Permeability Class | 3.9 | 5.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.0 | 3.0 |
| Soil Available Water Capacity Class | 3.7 | 3.0 | 4.0 | 4.0 | 3.0 | 4.5 | 2.5 | 3.3 | 4.0 | 4.0 | 4.5 |
| | | | | | | | | | | | |
| Site Geomorphology | | | | | | | | | | | |
| Site Elevation (m) | 30.8 | 10.7 | 36.6 | 36.6 | 33.0 | 30.0 | 47.2 | 35.8 | 32.0 | 35.1 | 10.7 |
| Elevational Drop in 1 Km (m) | 5.2 | 3.0 | 3.0 | 3.0 | 3.0 | 8.0 | 7.6 | 9.1 | 7.6 | 4.6 | 3.0 |
| Distance to 10 m Elevational Drop (m) | 3475 | 5800 | 4375 | 4375 | 6525 | 1600 | 1700 | 2075 | 2250 | 1625 | 4425 |
| Depression Area (ha) | 134.6 | 8.4 | 623.0 | 623.0 | 8.4 | 16.1 | 5.4 | 13.3 | 24.5 | 14.6 | 9.2 |
| Depression Length/Width Ratio | 1.6 | 1.4 | 1.8 | 1.8 | 1.6 | 1.5 | 1.5 | 1.4 | 1.6 | 1.7 | 1.7 |
| Depression Long Axis Orientation | +6.3 | +5.0 | +12.0 | +12.0 | +13.0 | +4.0 | -1.0 | +1.5 | -3.0 | +18.0 | +1.0 |
| | | | | | | | | | | | |
| Site Disturbance | | | | | | | | | | | |
| Fire Frequency Class | 3.2 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 | 4.0 | 2.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 | 1.0 | 1.0 | 1.0 |
| Timbering Index | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Drainage Index | 2.0 | 2.0 | 4.0 | 4.0 | 1.0 | 2.0 | 2.0 | 1.5 | 1.0 | 1.0 | 1.0 |
| Landscape Disturbance Class | 2.7 | 1.0 | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 1.0 |

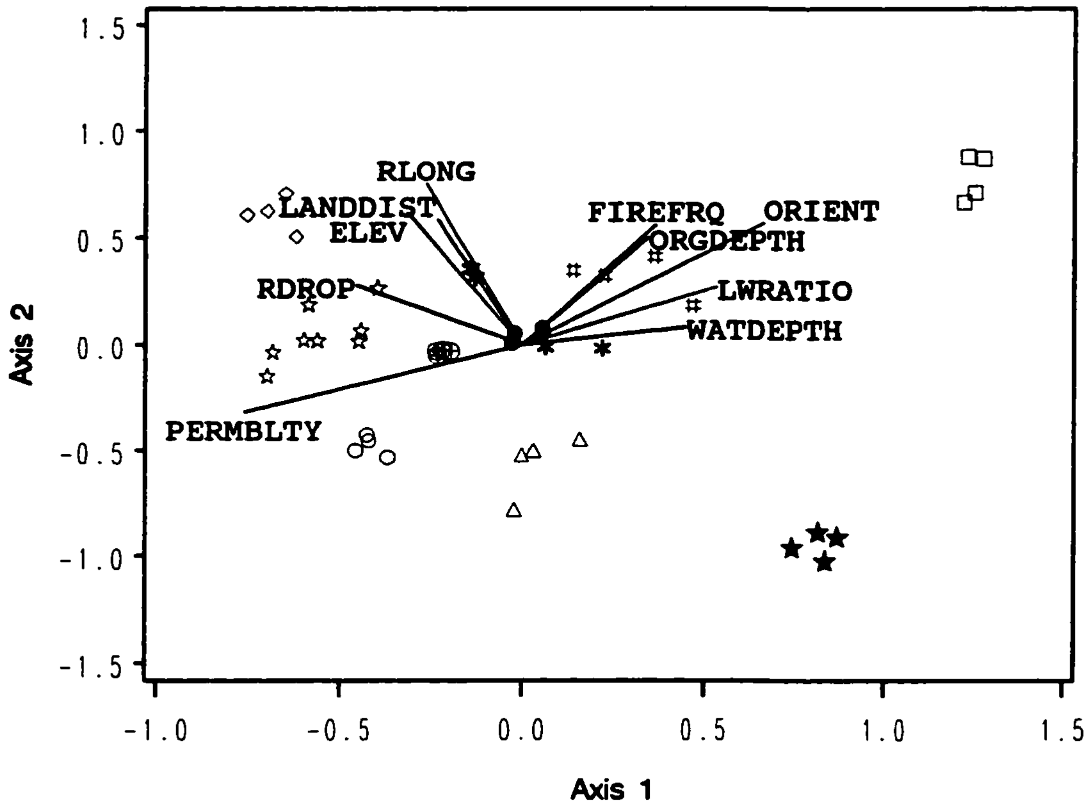
Figure 4.38. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Cypress/Gum Bog stands as distributed by community type on the two major compositional gradients.




**CYPRESS/GUM BOG — Community Types:**

○ Taxodium ascendens/Lyonia lucida/Carex striata—Woodwardia virginica/Sphagnum spp. Bog
✱ Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum spp. Bog
● Nyssa biflora—Taxodium ascendens/Decodon/Smilax laurifolia/Utricularia purpurea Bog
# Nyssa biflora "Boggy Swamp"
△ Nyssa biflora/Decodon/Dulichium/Sphagnum spp.—Utricularia biflora Bog
⊕ Taxodium ascendens/Nyssa biflora—Acer/Zenobia—Lyonia lucida—Cyrilla/Woodwardia virginica Bog
☆ Taxodium ascendens/Nyssa biflora—Acer/Mixed Ericaceous Shrubs/Sphagnum spp. Bog
◇ Taxodium ascendens/Lyonia lucida—Leucothoe racemosa/Leucobryum spp. Bog
□ Nyssa aquatica/Wolfiella gladiata—Utricularia purpurea Bog
★ Nyssa biflora/Acer—Cephalanthus/Cladium—Iris virginica/Ludwigia pilosa Bog

Figure 4.39. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Cypress/Gum Bog stands as distributed by community type on the two major compositional gradients.




**CYPRESS/GUM BOG — Community Types:**

○ Taxodium ascendens/Lyonia lucida/Carex striata—Woodwardia virginica/Sphagnum spp. Bog
✱ Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum spp. Bog
● Nyssa biflora—Taxodium ascendens/Decodon/Smilax laurifolia/Utricularia purpurea Bog
♯ Nyssa biflora "Boggy Swamp"
△ Nyssa biflora/Decodon/Dulichium/Sphagnum spp.—Utricularia biflora Bog
⊕ Taxodium ascendens/Nyssa biflora—Acer/Zenobia—Lyonia lucida—Cyrilla/Woodwardia virginica Bog
☆ Taxodium ascendens/Nyssa biflora—Acer/Mixed Ericaceous Shrubs/Sphagnum spp. Bog
◇ Taxodium ascendens/Lyonia lucida—Leucothoe racemosa/Leucobryum spp. Bog
□ Nyssa aquatica/Wolfiella gladiata—Utricularia purpurea Bog
★ Nyssa biflora/Acer—Cephalanthus/Cladium—Iris virginica/Ludwigia pilosa Bog

Figure 4.40. Plant Life Forms for Cypress/Gum Bog vegetation groups found within North and South Carolina Carolina bay depressions.

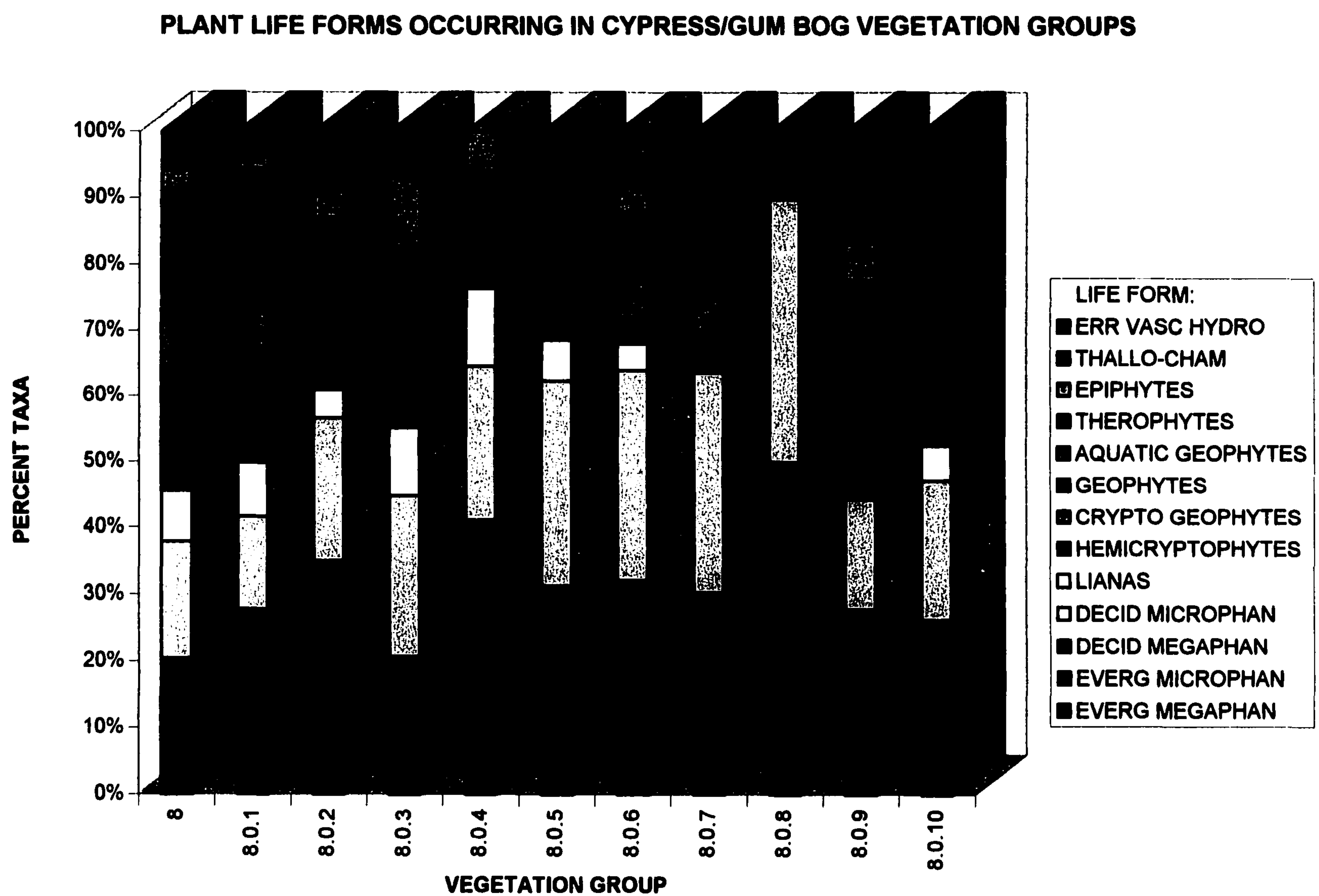
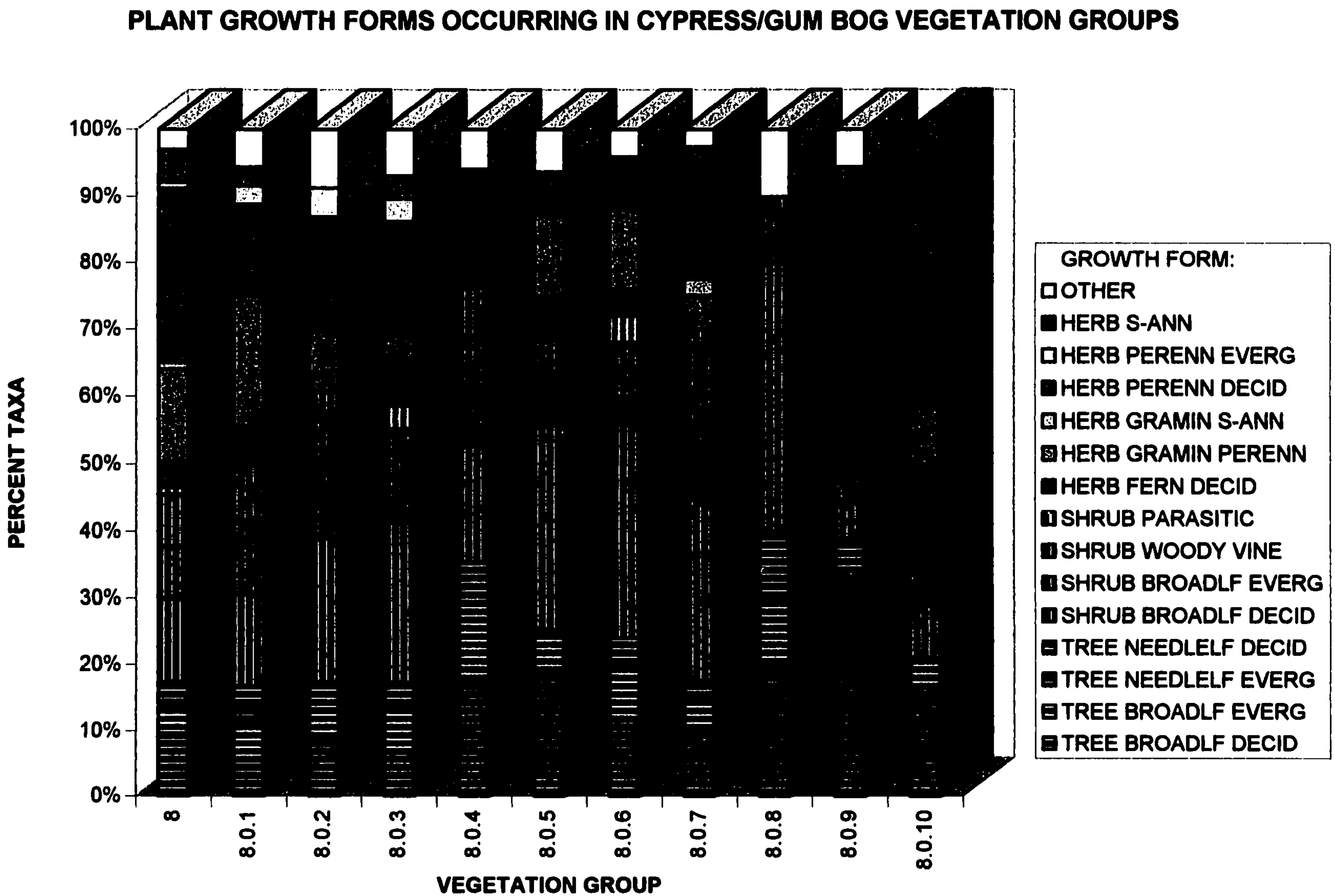

PLANT LIFE FORMS OCCURRING IN CYPRESS/GUM BOG VEGETATION GROUPS
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT TAXA
8
8.0.1
8.0.2
8.0.3
8.0.4
8.0.5
8.0.6
8.0.7
8.0.8
8.0.9
8.0.10
VEGETATION GROUP
LIFE FORM:
ERR VASC HYDRO
THALLO-CHAM
EPIPHYTES
THEROPHYTES
AQUATIC GEOPHYTES
GEOPHYTES
CRYPTO GEOPHYTES
HEMICRYPTOPHYTES
LIANAS
DECID MICROPHAN
DECID MEGAPHAN
EVERG MICROPHAN
EVERG MEGAPHAN

Figure 4.41. Plant Growth Forms for Cypress/Gum Bog vegetation groups found within North and South Carolina Carolina bay depressions.


PLANT GROWTH FORMS OCCURRING IN CYPRESS/GUM BOG VEGETATION GROUPS
PERCENT TAXA
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
8
8.0.1
8.0.2
8.0.3
8.0.4
8.0.5
8.0.6
8.0.7
8.0.8
8.0.9
8.0.10
VEGETATION GROUP
GROWTH FORM:
OTHER
HERB S-ANN
HERB PERENN EVERG
HERB PERENN DECID
HERB GRAMIN S-ANN
HERB GRAMIN PERENN
HERB FERN DECID
SHRUB PARASITIC
SHRUB WOODY VINE
SHRUB BROADLF EVERG
SHRUB BROADLF DECID
TREE NEEDLELF DECID
TREE NEEDLELF EVERG
TREE BROADLF EVERG
TREE BROADLF DECID

4.3.9 VEGETATION CLASS: **Intermittently Ponded Cypress/Gum Depression (9.)**

Intermittently Ponded Cypress/Gum Depressions are the primarily mid-study area, small to medium sized, mineral soil Carolina bay depressions typically dominated by perennial herbs, with a sparse to moderately closed canopy of *Taxodium ascendens*, or less frequently, *Nyssa biflora*. As the name of the vegetation class implies, the ambient site water level within this vegetation class is moderately to highly variable, both seasonally and from year to year. Consequently, sites exhibiting this type of vegetation are in a state of nearly constant "hydrologic flux", being periodically inundated for significant periods, but dry at the surface at other times.

4.3.9.1 VEGETATION SUBCLASS: **Cypress/Gum Swamp (9.1.)**

"Cypress/Gum Swamps" are generally characterized by woody species dominants growing over a mineral soil. Typically there is a dense canopy wherein *Taxodium ascendens* and/or *Nyssa biflora* are the principal dominants and a subcanopy of *Acer rubrum, Liquidambar styraciflua* and/or *Pinus taeda*. A dense shrub stratum composed of species dominants other than typical "pocosin shrubs is often present as well. A well developed herbaceous stratum is generally lacking, herb diversity is low, and herbaceous species are distributed in "patches" within the larger community. Because of the denseness of the woody strata, relatively little light reaches the site floor. The site water table is usually highly variable, and to a large degree, depends both seasonally and from year to year on local precipitation budgets. Mean species richness within this vegetation subclass at the 0.1 ha level is low to moderate, ranging from *ca*. 9 to 22 species (Table 4.2). Photographs of this vegetation class appear in Plate 11, following Chapter 7 below.

4.3.9.1.1 COMMUNITY TYPE: ***Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp (9.1.1)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Acer rubrum, Carex glaucescens, Diospyros virginiana, Hypericum gymnanthum, Ilex amelanchier, Iris prismatica, Leucothoe racemosa, Liquidambar styraciflua, Lyonia lucida, Nyssa biflora, Pinus taeda, Rhynchospora filifolia, Saccharum giganteum, Smilax glauca, Smilax laurifolia, Smilax rotundifolia, Taxodium ascendens, Vaccinium fuscatum*

(3) Special Status Species

*Ilex amelanchier, Iris prismatica*

(4) Vegetation & Physiognomy

This community type is characterized by a moderately open canopy composed primarily of large (*ca.* 19 to 20 m in height) *Nyssa biflora* and *Taxodium ascendens. Liquidambar styraciflua* also occurs occasionally as a canopy tree, and is the principal component of the subcanopy layer within this community type. *Pinus taeda* is sometimes a co-dominant subcanopy species. The shrub layer in this community type is composed principally of large, dense, multi-stemmed clumps of *Ilex amelanchier*, although pocosin-type shrubs -- *Cyrilla racemiflora, Leucothoe racemosa, Lyonia lucida,* and *Vaccinium* spp. -- are also common. *Ilex* grows exclusively rooted in the mineral soil of the site floor, while the pocosin-type shrubs were observed to grow only from rotting "nursery" stumps and logs, or from accumulations of organic matter in the bark crevices of canopy trees. While there is no distinctive herbaceous layer within this community type, a number of graminoids and forbs are locally dominant in the gaps between clumps of *Ilex*.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 22.26 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Swamps are generally characterized by: (1) relatively low species richness, (2) dominance by woody species, (3) a patchy or absent herbaceous layer, (4) a mineral soil, and (5) a highly variable water table. Community types are distinguished by their woody species dominants. This community type is distinctive for its *Liquidambar styraciflua* subcanopy and its dense shrub layer of *Ilex amelanchier*.

(6) Habitat

This community type occurs in small to medium-sized depressions located on moderately flat and dissected land surfaces, and is characterized by very poorly drained, rapidly moderately permeable, mineral soils having a high surface organic matter content (described below) (Table 4.23, Figure 4.45). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods in most years. At the time of sampling, the water table was found within this community type at some 136 cm below the soil surface, but "water marks" on site woody species indicated that the water stands seasonally at *ca.* 13 to 19 cm, but surface water to 75 cm was recorded in the late fall season.

(7) Soils

This community type occurs within study area Carolina bays over fine-loamy, siliceous, thermic Umbric Paleaquult soils (Table A-II-1). A representative, sampled pedon of an Umbric Paleaquult soil having a mucky surface layer is described in Appendix II for CT 8.0.4, discussed previously. However, this community type occurred over a more "typical" Umbric Paleaquult soil, for which a pedon is described separately in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Table _ indicates that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is very low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with very low base saturation. The soil bulk density values for this community type is relatively high (>1.0) throughout the measured soil solum, and the soil profile is dominated by silt-sized particles, presumably reflecting the umbric epipedon characteristic of the soil found beneath this community type.

(8) Succession & Disturbance

This community type shows evidence of past fire effects, including charred stumps, fire scars on the trunks of canopy trees, the extremely clumped nature of shrubs, and the presence of charcoal in the community soils. Personal field observation indicates that *Ilex amelanchier* is relatively fire intolerant. Consequently, even ground fires tend to kill the aerial stems of that species, but new shoots quickly re-sprout from woody rootstocks. Under a regime of frequent fires, the site vegetation could be expected to eventually be replaced by a "Wet Savanna" community type.

The current vegetation and structure of this community type suggest that fire has been excluded for some time. In its continued absence, the dominance of the subcanopy species (*Liquidambar* and *Pinus taeda*) would be expected to increase, and the shrub layer would likely eventually replace the herb-dominated patches that currently exist at within the community.

As indicated by Table 4.23, this community type shows significant evidence of past human disturbance, including some cutting of trees, ditching, and use for livestock grazing. The latter activity would suggest that the site was once in a more open condition than that in which it presently exists, perhaps as the result of fire. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Umbric Paleaquult soils, which comprise 1 of 7 "clayey" soil families observed within Middle Coastal Plain Carolina bays, where Ultisols predominate (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Extensive field reconnaissance within the study area indicated that Cypress/Gum Swamps are relatively common in the Middle Coastal Plain of the study area. However, no sampled community type within this vegetation subclass is frequent, and most Carolina bays containing such vegetation types have undergone severe disturbance or extensive alteration, primarily through timbering and/or draining.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.1.2 COMMUNITY TYPE: ***Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/ Woodwardia virginica-Carex verrucosa*** **Swamp (9.1.2)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Liquidambar styraciflua, Nyssa biflora, Taxodium ascendens, Woodwardia virginica*

(3) Special Status Species

No plant species listed as meriting special status were encountered during sampling of this community type.

(4) Vegetation & Physiognomy

This community type consists of a mixture of approximately one-third relatively large (to 42 cm DBH and 15 to 17 m tall) *Taxodium ascendens* and two-thirds equally large *Nyssa biflora*, which form a dense canopy in this community type. A relatively well developed subcanopy of *Liquidambar styraciflua* is present within the community, with *Acer rubrum* being a significant, but lesser important component of the subcanopy layer. The herbaceous layer consists of a "patchwork quilt" of *Carex verrucosa* -- where a moderate amount of light filters through the canopy to the forest floor, *Woodwardia virginica* -- where relatively little light filters down from above, and open ground largely devoid of herbs -- where very little light reaches the forest floor.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.83 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Swamps are generally characterized by: (1) relatively low species richness, (2) dominance by woody species, (3) a patchy or absent herbaceous layer, (4) a mineral soil, and (5) a highly variable water table. Community types are distinguished by their woody species dominants. This community type is distinctive for its dense subcanopy/transgressive layer composed of *Liquidambar styraciflua* and *Acer rubrum*, and its virtual lack of a shrub.

(6) Habitat

This community type occurs in small depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately rapidly permeable, mineral soils having a high surface organic matter content (Table 4.23, Figure 4.45). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods in most years. At the time of sampling, the water table was found within this community type at some 31 cm below the soil surface, but water marks on site trees indicate that water stands seasonally at *ca.* 25 cm.

(7) Soils

This community type occurs within study area Carolina bays over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). As previously discussed, Typic Paleaquults are deep, poorly drained, clay soils that are characteristic of shallow depressions (Leab, 1990), including Carolina bays. They are colorful soils, characterized by one or more shallow, dark, loamy surface layers having a high organic matter content, overlying a grayish, loamy subsoil that is mottled with bands of lighter and darker colors, including grays, yellows, browns and reds. A representative, sampled pedon of a Typic Paleaquult soil similar to the one found beneath this community type is described in Appendix II for CT 2.0.1 and CT 3.0.1, each discussed previously.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is very low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with very low base saturation. The soil profile is dominated by sand- and silt-sized particles, and soil bulk density values for this community type are relatively high throughout the measured soil solum.

(8) Succession & Disturbance

This community type shows abundant evidence of the effect of relatively frequent past fires, including charred stumps, fire scars ranging to 3.5 m in height on the trunks of canopy trees, and the presence of charcoal in the community soils. The most recent fire evidence suggested that a surface fire burned through this community type, with little effect on canopy or subcanopy trees. Under a regime of frequent fires, the site vegetation could be expected to eventually be replaced by a Cypress Pond community type, unless fires were severe enough to lessen the cover of canopy and subcanopy trees. In the absence of fire, the subcanopy species would be expected to assume increased site dominance, and the much of the herbaceous "layer" would likely disappear with time.

As indicated by Table 4.23, this community type shows relatively little evidence of past human disturbance, but has been used for livestock grazing in the past. The latter activity would suggest that the site once had a more open canopy. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type. When depressions exhibiting Intermittently Ponded Cypress/Gum Depression communities under natural conditions are ditched or are subject to other activities that fundamentally alter their hydrologies, *Pinus taeda* and *Liquidambar styraciflua* have been observed to become the "dual dominants" at these sites, ultimately supplanting *Taxodium*. Although *Liquidambar* is a significant component of the vegetation within this community type, few *Pinus taeda* trees are present. That would appear to suggest that *Liquidambar* is a "natural" component of the vegetation at this site, *i.e.*, it does not occur because of an altered site hydrology.

(9) Landscape Position

The community type "*Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/ Woodwardia virginica-Carex verrucosa* Swamp" is found in a Carolina bay located in the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which comprise 1 of the 7 wet Ultisols found within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, Cypress/Gum Swamps are relatively common in the Middle Coastal Plain of the study area, but no sampled community type within this vegetation subclass is frequent. In addition, most Carolina bays containing such vegetation types have undergone severe disturbance or extensive alteration, primarily through timbering and/or draining.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.1.3 COMMUNITY TYPE: ***Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/Lindera/Smilax glauca/Carex glaucescens* Swamp (9.1.3)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Ilex opaca, Lindera melissifolia, Liquidambar styraciflua, Nyssa biflora, Persea palustris, Pinus taeda, Smilax glauca, Taxodium ascendens, Vaccinium fuscatum*

(3) Special Status Species

*Lindera melissifolia, Litsea aestivalis*

(4) Vegetation & Physiognomy

This community type is "thickety" in nature, consisting of a mixed, somewhat closed canopy of moderately tall (to 15 m) *Taxodium ascendens* and *Pinus taeda* -- and to a lesser extent, *Liquidambar styraciflua* and *Nyssa biflora* -- overtopping a 6 to 10 m tall subcanopy composed primarily of *Acer rubrum* and *Persea palustris*. Scattered transgressives of the above listed species and others are scattered throughout the community beneath the subcanopy, over dense colonies of *Lindera melissifolia ca.* 1 m tall. *Ilex* glabra is locally abundant around the bases of canopy trees. *Smilax glauca* twines over the taller woody species within the community in dense thickets. The herbaceous stratum is patchy, with *Carex glaucescens* forming scattered, but dense patches in the gaps between the *Lindera* colonies.

This community type exhibited low mean species richness at the 0.1 ha level, at 13.85 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Swamps are generally characterized by: (1) relatively low species richness, (2) dominance by woody species, (3) a patchy or absent herbaceous layer, (4) a mineral soil, and (5) a highly variable water table. Community types are distinguished by their woody species dominants. The community type represents the only one sampled wherein *Lindera melissifolia* and *Smilax glauca* are vegetational stratum dominants.

(6) Habitat

This community type occurs in medium-sized depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils having a high surface organic matter content (Table 4.23, Figure 4.45). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods in most years. At the time of sampling, the water table was found standing above the soil surface at some 45 cm.

(7) Soils

This community type occurs within study area Carolina bays over sandy, siliceous, thermic Typic Haplaquod soils (Table A-II-1). As previously noted, Typic Haplaquods are poorly drained soils that developed in sandy sediments and are common in low flats and depressions, including Carolina bays. They are characterized by dark, loamy to sandy surface layers having a relatively high organic matter content, overlying a sandy subsoil that grades from a loose, dark gray sandy layer to a hard, indurated, dark brown or black sandy, spodic horizon. A representative, sampled pedon of a Typic Haplaquod is described in Appendix II for both CT 5.0.1 and CT 7.1.1, each discussed previously.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is very low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with very low base saturation. The soil profile is dominated by sand-sized particles throughout, and bulk density values for this community type are relatively high (>1.0) throughout the measured soil solum.

(8) Succession & Disturbance

This community type shows evidence of past fire effects, including charred stumps, fire scars on the trunks of canopy trees, and the extremely clumped nature of shrubs that are present. The current vegetation and structure of this community type suggest that fire has been excluded for a significant period of time. Under a regime of frequent fires, the site vegetation could be expected to eventually be replaced by a Wet Savanna community type (that vegetation group is discussed later in this chapter). In the continued absence of fire, the dominance of the woody, lower strata species would be expected to increase, eventually replacing the herb-dominated patches that currently exist at within the community. *Lindera melissifolia*, which is currently the shrub layer dominant, was observed to grow only in the more open areas, *i.e.*, those with less canopy and subcanopy cover, within the community type. Consequently, that species could also be expected to be replaced by other, more shade tolerant woody species if fire continues to be suppressed. Field observation indicates that *Lindera melissifolia* is extensively rhizomatous, and that many above-ground stems die when the species is subjected to long hydroperiods.

As indicated by Table 4.23, this community type shows less evidence of past human disturbance than most communities within this vegetation subclass, but there has been some past cutting of trees and ditching within the community. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/*

*Lindera/Smilax glauca/Carex glaucescens* Swamp" is known only from Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy, siliceous, thermic Typic Haplaquod soils, which are comparatively uncommon in Middle Coastal Plain bay depressions, but nevertheless frequent in the regions where it abuts the Inner Lower Coastal Plain (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Carolina bay community types wherein *Lindera melissifolia* is a dominant are extremely rare. As noted, Carolina bay communities within this vegetation class have rapidly disappeared as depression sites have undergone extensive human alteration.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.1.4 COMMUNITY TYPE: ***Taxodium ascendens/(Nyssa biflora)* Swamp (9.1.4)**

(1) Synonymy

Pond Cypress Pond *p.p.*, Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Nyssa biflora, Taxodium ascendens*

(3) Special Status Species

*Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is much more of a generalized, "composite" community type in terms of included species and species importance values than most other vegetation groups found within the accepted classification scheme. As such, it contains a number of different individual plots that do not intuitively belong within the same class. Because of its seemingly arbitrary, somewhat artificial nature, it is somewhat more difficult to describe adequately. By the same token, these qualities probably make a very detailed community type description unnecessary. Nevertheless, in general, this community type is characterized by an open canopy of *Taxodium ascendens* over a sparse subcanopy layer composed principally of *Nyssa biflora* and, often, *Pinus taeda*. While no continuous shrub layer exists within this community type, scattered, dense, multi-stemmed clumps of a number of "pocosin" shrubs may be present, including *Cyrilla racemiflora, Ilex amelanchier, Symplocos tinctoria, Zenobia pulverulenta*, and especially, *Lyonia lucida*. As is true of the shrub layer, no continuous herbaceous stratum is present, but *Carex glaucescens* or *Dichanthelium* spp. are locally abundant, and the ground in the more open areas is commonly covered with mats of *Sphagnum* spp.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 16.11 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Swamps are generally characterized by: (1) relatively low species richness, (2) dominance by woody species, (3) a patchy or absent herbaceous layer, (4) a mineral soil, and (5) a highly variable water table, and community types are distinguished by their woody species dominants. This community type is distinguished by the prominence of *Pinus taeda* in the subcanopy, and the patchy nature of the shrub and herbaceous strata.

(6) Habitat

This community type occurs in small depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately permeable, mineral soils having a high surface organic matter content (Table 4.23; Figure 4.45). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods in most years. At the time of sampling, the water table was found within this community type at some 31 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays over a wide variety of soil families, primarily: clayey, kaolonitic, thermic Typic Fragiaquults; and clayey, kaolonitic, thermic Typic Paleaquults; but also including sandy, siliceous, thermic Typic Haplaquods (both the regular type and the "argillic" variant); fine-loamy, siliceous, thermic Typic Paleaquults; and fine-loamy, siliceous, thermic Umbric Paleaquults (Table A-II-1). This is reflective of its probable artificiality, expressed in terms of its diversity of included vegetation. Each of those soils is poorly drained (Leab, 1990; McCachren, 1978). A representative, sampled pedon of each of those soil families has previously been described in Appendix II and discussed elsewhere in this chapter.

Soil chemical and textural data for this community type are incomplete, and are not reported here. However, the soils over which this community type occurs are essentially identical to the extremely acid, sandy, low nutrient soils previously discussed for other community types, and can reasonably be presumed to be similar in terms of chemical and textural soil properties.

(8) Succession & Disturbance

This community type shows evidence of past fire effects, including charred stumps, fire scars on the trunks of canopy trees, and the extremely clumped nature of shrubs that are present. The current vegetation and structure of this community type suggest that fire has been excluded for a significant period of time. Under a regime of frequent fires, the site vegetation could be expected to eventually be replaced by a Wet Savanna community type. In the continued absence of fire, the dominance of the woody, lower strata species would be expected to increase, eventually replacing the herb-dominated patches that currently exist at within the community.

As indicated by Table 4.23, this community type shows significant evidence of past human disturbance, including cutting of trees, ditching, and past use for livestock grazing. The latter activity would suggest that the site vegetation was once in a more open condition than that in which it presently exists, perhaps as the result of fire. Surrounding landscapes have generally undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens*/(*Nyssa biflora*)Swamp" is found primarily (94%) in Carolina bays of the Middle Coastal Plain, and to a much lesser extent (6%), bays in the Upper Coastal Plain (Table 4.3). As such, this community type makes up some 4 percent of sampled Carolina bay vegetation found within the Middle Coastal Plain, and 3 percent of sampled Carolina bay vegetation found within the Upper Coastal Plain. As previously discussed, this community type is found over a wide range of soil types, but principally over clayey, kaolonitic, thermic Typic Fragiaquults (56%), and clayey, kaolonitic, thermic Typic Paleaquults (19%). The former soil family is "typic" of central Middle Coastal Plain Carolina bays, but is not known to occur in Upper Coastal Plain bays. The latter soil type is common in depressions located at both landscape positions (Table 4.4).

(10) Distribution & Abundance

Sixteen of 482 intensively sampled plots (3.3%), located primarily in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 48 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As previously noted, while Cypress/Gum Swamps are relatively common in the Middle Coastal Plain of the study area, no sampled community type within this vegetation subclass is frequent, and most Carolina bays containing such vegetation types have undergone extensive human alteration.

(11) Conservation Status

Examples of this community type within Carolina bays are found on both publicly held lands and privately owned lands held for the express purpose of biodiversity conservation.

4.3.9.2 VEGETATION SUBCLASS: **Cypress/Gum Pond (9.2.)**

This vegetation subclass is very similar to the subclass that follows, "Drawdown Savannas/Meadows" in terms of community types, soils, habitat and landscape position. The primary difference between the two subclasses is found in the occurrence of substantial amounts of standing water in the former, but not the latter, subclass. While this subclass represents a distinct vegetation grouping because of its relative lack of shrub or herb strata, it is best considered a temporal subclass, rather than a spatial one like the other vegetation subclasses that comprise Intermittently Ponded Cypress/Gum Depressions. In that respect, it is most closely associated with Drawdown Savannas/Meadows, which are also characterized by periodic, comparatively deep surface inundation that may displace all herbaceous vegetation at the site. Cypress/Gum Swamps and Wet Savannas/Meadows rarely have deep standing surface water. Consequently, Cypress/Gum Ponds are perhaps in actuality best considered to represent the "flooded variant" of the Drawdown Savanna/Meadow vegetation subclass discussed later in this chapter. Photographs of this vegetation class appear in Plate 12, following Chapter 7 below.

4.3.9.2.1 COMMUNITY TYPE: ***Taxodium ascendens* Pond (9.2.1)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Taxodium ascendens*

(3) Special Status Species

*Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type consists of a moderately open to open canopy of medium-sized to large *Taxodium ascendens*, typically with significantly buttressed bases, overtopping shallow, open water. Aquatic species such as *Sclerolepis uniflora, Utricularia* spp. or *Potamogeton diversifolius* may be present within the subtending waters. In addition, the tops of "flooded", persistent, terrestrial species that may have colonized the depression during previous, prolonged drought periods are occasionally found within this community type.

This community type exhibited very low mean species richness at the 0.1 ha level, at 2.50 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Ponds are generally characterized by: (1) very low to low species richness; (2) no shrub layer; (3) either no herbaceous layer, or a sparse herbaceous layer dominated by "aquatic species", with or without an open canopy layer of cypress or gum; (4) a Fragiaquult soil; and (5) standing surface water. Community types are distinguished primarily by the presence/absence of a canopy layer and herbaceous stratum species dominants. This community type is distinctive for its well-developed canopy layer of medium to large *Taxodium ascendens* and a lack of herbaceous species.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.24). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 17 cm above the soil surface. This community type is likely the flooded counterpart of a "Drawdown Savanna" community type, as discussed below.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). Typic Fragiaquults are poorly drained soils that developed in mineral sediments in upland depressions having no natural drainage outlets, particularly Carolina bays (McCachren, 1978). They are characterized by a dark colored, loamy surface layer having a relatively high organic matter content, overlying a highly colored, mottled, sandy clay subsoil that features a "fragipan", *i.e.*, a mottled, loamy, brittle, seemingly cemented, subsurface horizon that is very low in organic matter content and clay, rich in silt or very fine sand, and when dry has a high bulk density in comparison to overlying layers (Soil Survey Staff, 1975). A representative, sampled pedon of the Typic Fragiaquult soil underlying this community type is described in Appendix II.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type can reasonably be presumed to be similar to those of the soils described for community types 9.2.3, 9.3.2, 9.3.5, 9.3.9, 9.3.11, and 9.3.12, each discussed below.

(8) Succession & Disturbance

Like Cypress/Gum Swamps, most Cypress/Gum Pond sites show evidence of the past effects of fire on site vegetation. Within this community type, the primary evidence of fires occurs in the form of burned out stumps the project above the water surface and fire scars to 3 m in height occurring on the bases of *Taxodium ascendens* trunks. Reportedly, fires have occurred in sites exhibiting this community type during drawdown periods with a frequency of approximately every 10 to 20 years (Table 4.24). The results of lightning strikes have been observed within this community type, and are presumably an agent of such fires.

Under the continued regime of general ponding of water in most years and occasional fires in drought years that characterizes this community type, site vegetation can be expected to remain in its current open condition. Herbaceous species dominants will vary with the amount of time that the depression surface has been flooded, water depth, and site seedbank species composition and abundance (Kirkman, 1992; van der Valk, 1981). Given periodic stability of the water table, aquatic species such as *Sclerolepis uniflora, Utricularia* spp., *Potamogeton* spp. and *Isoetes* spp. may flourish at the site. However, if site ponding is short-lived or intermittent in nature, herbaceous layer diversity will remain very low, as it is within this community type.

As indicated by Table 4.24, this community type shows moderate evidence of recent human disturbance. Sites exhibiting this community type are commonly used to water livestock, and canopy cypress trees were observed that had been cut and used for poles for livestock fencing. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens* Pond" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Five of 482 intensively sampled plots (1.0%), occurring at sites located in the north central portion of the study area, fall within this classification (Table 4.5). This community type comprises 33 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. The distribution of sites exhibiting Cypress/Gum Pond communities is set out in Figure 4.42. Extensive field reconnaissance within the study area indicated that undisturbed Cypress/Gum Ponds are relatively uncommon in the Middle Coastal Plain of the study area. As noted, most Carolina bays containing such vegetation types have undergone severe disturbance or extensive alteration, primarily through timbering and/or draining.

(11) Conservation Status

An example of this community type currently exists within a Carolina bay that is privately held for the express purpose of biodiversity conservation.

4.3.9.2.2 COMMUNITY TYPE: ***Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond (9.2.2)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Rhynchospora filifolia, Sclerolepis uniflora, Taxodium ascendens*

(3) Special Status Species

*Eleocharis tricostata, Lycopus angustifolius, Rhynchospora inundata, Scleria reticularis, Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is similar to the immediately preceding community type, consisting of an open canopy of *Taxodium ascendens* over open, shallow water. However, in contrast to that community type, an "aquatic" herbaceous stratum is characteristic of this vegetation type, dominated by scattered "rafts" of *Sclerolepis uniflora* in the deeper water areas, and *Rhynchospora filifolia* and *Juncus repens* in the shallowest waters and on exposed flats.

This community type exhibited low mean species richness at the 0.1 ha level, at 11.03 species (Table 4.2).

(5) Distinguishing Features

Cypress/Gum Ponds are generally characterized by: (1) very low to low species richness; (2) no shrub layer; (3) either no herbaceous layer, or a sparse herbaceous layer dominated by "aquatic species", with or without an open canopy layer of cypress or gum; (4) a Fragiaquult soil; and (5) standing surface water. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinctive for its well-developed canopy layer of medium to large *Taxodium ascendens* overtopping extensive stands of *Sclerolepis uniflora*.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.24). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood just at the surface in most places and on average, but varied from 21 cm below the soil surface to 45 cm above the soil surface.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed for the preceding community type, and a representative sampled pedon of a Typic Fragiaquult similar to the one found beneath this community type is described in Appendix II for CT 9.2.1.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for community types 9.2.3, 9.3.2, and 9.3.5, discussed below.

(8) Succession & Disturbance

As noted, most Cypress/Gum Pond sites show evidence of the past effects of fire on site vegetation. Within this community type, the primary evidence of fires occurs in the form of burned out stumps the project above the water surface and fire scars occurring on the bases of *Taxodium ascendens* trunks. Reportedly, fires have occurred in sites exhibiting this community type during drawdown periods with a frequency of approximately every 10 to 20 years (Table 4.24). The results of lightning strikes have been observed within this community type, and are presumed to be the agent of most such fires.

Under the continued regime of general ponding of water in most years and occasional fires in drought years that characterizes this community type, site vegetation can be expected to remain in its current open condition. As noted, herbaceous species dominants will vary with the amount of time that the depression surface has been flooded, water depth, and site seedbank species composition and abundance. With even short-term periodic stability of the water table, aquatic species such as *Sclerolepis uniflora, Potamogeton* spp. and *Isoetes* spp. flourish at the sites comprising this community type. However, if site ponding is short lived or intermittent in nature, herbaceous layer diversity will likely decrease, as the sites become too dry to sustain current herbaceous dominants.

As indicated by Table 4.24, this community type shows moderate evidence of recent human disturbance. Sites exhibiting this community type are commonly used to water livestock, and canopy cypress trees were observed that had been cut and used for poles for livestock fencing. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, this community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South

Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Six of 482 intensively sampled plots (1.2%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 40 percent of the sampled community types that make up the vegetation subclass, and _ percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, undisturbed Cypress/Gum Ponds are relatively uncommon in the study area, and most Carolina bays containing such vegetation types have been extensively altered.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.2.3 COMMUNITY TYPE: ***(Taxodium ascendens)*/"Open-Water"Pond (9.2.3)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.22)

*Aster pilosus* var. *demotus, Euthamia tenuifolia, Panicum hemitomon, Pluchea rosea, Rhynchospora perplexa* var. *perplexa, Utricularia purpurea*

(3) Special Status Species

*Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is similar to the other community types within this vegetation subclass, being characterized by "open water". While there is no true canopy or subcanopy layer in this community type, scattered, generally small specimens of *Taxodium ascendens* occur throughout the community. Shrubs are almost completely absent from the community type, and there is no definable herbaceous layer. Typically, where present within this community type, aquatic species such as *Utricularia* spp. are relatively insignificant.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.06 species (Table 4.2).

(5) Distinguishing Features

As noted, Cypress/Gum Ponds are generally characterized by: (1) very low to low species richness; (2) no shrub layer; (3) either no herbaceous layer, or a sparse herbaceous layer dominated by "aquatic species", with or without an open canopy layer of cypress or gum; (4) a Fragiaquult soil; and (5) standing surface water. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinctive for its well-developed canopy layer of medium to large *Taxodium ascendens* and a lack of herbaceous species.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.24). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 65 cm above the soil surface. This community type is probably the flooded counterpart of a "Drawdown Meadow" community type, discussed below.

(7) Soils

This community type occurs within study area Carolina bays over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed, and a representative, sampled pedon of a Typic Fragiaquult similar to the one encountered beneath this community type is described in Appendix II for CT 9.2.1, discussed previously.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is very strongly acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. As would be expected, the soil profile is characterized by virtually no humic matter at 25 or 50 cm (*i.e.*, within the fragipan horizon), and has a relatively high bulk density at those depths.

(8) Succession & Disturbance

Cypress/Gum Pond sites show evidence of the past effects of fire on site vegetation. Within this community type, the primary evidence of fires occurs in the form of fire scars to 7 m in height occurring on the bases of *Taxodium ascendens* trunks located within the depressions that exhibiting this community type, but outside the actual sampled plots that characterize this vegetation type. Reportedly, fires have occurred in sites exhibiting this community type during drawdown periods with a frequency of approximately every 5 to 10 years (Table 4.24).

Under the continued regime of general ponding of water in most years and occasional fires in drought years that characterizes this community type, site vegetation can be expected to remain in its current open condition. Herbaceous species dominants here will vary with the amount of time that the depression surface has been flooded, water depth, and site seedbank species composition and abundance (Kirkman, 1992; van der Valk, 1981). Given periodic stability of the water table, the relative importance of aquatic species such as *Sclerolepis uniflora* and *Utricularia* spp. may be expected to increase within this community type. However, observation indicates that water of substantial depth in Cypress/Gum Ponds is relatively short-lived.

As indicated by Table 4.24, this community type shows little evidence of recent human disturbance, although ditches draining into sites exhibiting this community type have been observed. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "(*Taxodium ascendens*)/'Open-Water' Pond" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (1.0%), occurring in sites located in the north central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 27 percent of the sampled community types that make up the vegetation subclass, and 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, Cypress/Gum Ponds are relatively uncommon in the study area, and Carolina bays containing such vegetation types have typically undergone severe disturbance or extensive alteration.

(11) Conservation Status

An example of this community type currently exists within a Carolina bay that is privately held for the express purpose of biodiversity conservation.

4.3.9.3 VEGETATION SUBCLASS: **Drawdown Savanna/Meadow (9.3.)**

Drawdown Savannas/Meadows are among the most distinctive of Carolina bay wetland communities, and are the "type" concept of those vegetation groupings usually referred to as "Cypress Savanna" (*see*, *e.g.*, Schafale and Weakley, 1990; Bennett and Nelson, 1991). Depression sites exhibiting this sort of vegetation have highly variable, "feast or famine" hydroperiods, *i.e.*, these sites have historically been subject to frequent alternating periods of drought and flooding that are unpredictable as to both frequency and duration.

The various community types found within this vegetation subclass are relatively rare. They exhibit a high degree of soil family affinity, being found almost exclusively over Typic Fragiaquults soils. Typic Fragiaquult soils typically have a brittle, weakly cemented subsurface layer called a fragipan, which serves as a barrier to the downward movement of water within the depression basin (Soil Survey Staff, 1975). By that characteristic, the fragipan is thought to "perch" the water table, leading to basin inundation following significant rainfall events. Despite this frequent flooding, Fragiaquult soils are typified by brightly colored subsurface mottling, indicating historical oxidizing, subsurface conditions for significant periods of time. The genesis of fragipans within soils, discussed earlier in this chapter, is not well understood and is the subject of some debate. However, fragipans are characteristically associated with fluctuating water levels within the soil profile (Soil Survey Staff, 1975; Buol *et al.*, 1980).

Most sites exhibiting communities falling within this vegetation subclass are savanna-like and have an open canopy of *Taxodium ascendens* over a mixture of characteristic annual and perennial forbs and graminoids. Some sites lack a canopy layer and display a decidedly meadow-like physiognomy. Typically, however, they are floristically very similar to the savanna community types found within this vegetation subclass, exhibiting the same herb layer dominants. The lack of a canopy layer at these sites was termed "natural" by Schafale and Weakley (1990), but based on extended field observation is believed to be the product of severe fires and/or timbering that obliterated canopy trees, followed by ineffective dispersal of canopy species propagules to increasingly insular wetland sites. Photographs of this vegetation class appear in Plate 13, following Chapter 7 below.

4.3.9.3.1 COMMUNITY TYPE: ***Taxodium ascendens/(Nyssa biflora)/(Ilex myrtifolia)/ (Panicum verrucosum)* Savanna (9.3.1)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Ilex myrtifolia, Nyssa biflora, Panicum verrucosum, Scleria reticularis, Taxodium ascendens, Tillandsia usneoides*

(3) Special Status Species

*Lycopus angustifolius, Rhynchospora inundata, Scleria reticularis, Triadenum tubulosum*

(4) Vegetation & Physiognomy

This community type is typified by a moderately open canopy of generally large (16 to 18 m in height; to 91 cm DBH) *Taxodium ascendens*, usually having significantly buttressed bases. *Taxodium* transgressives are generally absent. The community type characteristically has no subcanopy layer, but small specimens of *Nyssa biflora* are typically scattered throughout the community. While there is also no true shrub layer, *Ilex myrtifolia* or *Cephalanthus occidentalis* may exhibit local importance as tall shrubs or small trees. An herbaceous layer is also typically absent in this community type, and instead, the ground is typically bare. However, *Panicum verrucosum* may be locally abundant in large patches.

This community type exhibited low mean species richness at the 0.1 ha level, at 9.51 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are generally characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. The community type discussed here is distinctive for its well-developed canopy layer of large *Taxodium ascendens*, the presence of scattered clumps of large *Ilex myrtifolia*, and an herbaceous "layer" dominated by moist, bare ground with scattered, dense patches of *Panicum verrucosum*.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 50 cm below the soil surface, although the same sites have been previously observed with an average water depth of some 60 cm above the surface and a maximum measured water depth of 125 cm. Water marks on site canopy trees indicate that water stands seasonally at 127 cm.

(7) Soils

This community type occurs within study area Carolina bays over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). Like other wet clay soils occurring in areas where the ground water table fluctuates significantly, these soils exhibit the gray to brightly colored mottling pattern characteristic of soils having highly variable, "feast or famine" hydroperiods, *i.e.*, that are subject to frequent, relatively short-term, alternating periods of drought and flooding. A representative, sampled pedon of the soil underlying this community type is described in Appendix II.

Typic Fragiaquult soils are generally not mapped by the Soil Conservation Service in the southern portion of the study area to which this community type extends. However, field sampling of soils indicates that depression soils containing fragipans are present far south of the area to which they are generally restricted on county soil maps.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with low base saturation. However, the relative level of manganese is unusually high in the soils underlying this community type. This is a relatively "heavy" soil in terms of bulk density. Silt-sized particles predominate in the upper part of the profile, but sand, silt and clay occur in relatively equal proportions in the lower part of the measured soil solum. As would be expected, the soil profile is characterized by virtually no humic matter at 50 cm (*i.e.*, within the apparent fragipan horizon), and has a high bulk density at that depth.

(8) Succession & Disturbance

As noted, Drawdown Savanna/Meadow sites typically show evidence of the past effects of fire on site vegetation. Within this community type, fire scars to 2.5 m in height occur on the bases of *Taxodium ascendens* trunks, and every *Ilex myrtifolia* individual occurs as a multi-stemmed clump. Reportedly, fires have occurred in sites exhibiting this community type with a frequency of approximately every 10 to 25 years (Table 4.26), apparently during the drawdown periods during which this community type is present. The results of lightning strikes have been observed within this community type, and are presumably an agent of such fires.

Under the continued regime of general ponding of water in wet years and occasional fires in drought years that characterizes this community type, site vegetation can be expected to remain in an open, "savanna-like" condition during drawdowns. Herbaceous species dominants will vary, according primarily to variations in site surface water depth and periodicity, as well as site seedbank species composition and abundance (Kirkman 1992; van der Valk 1981). In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure. For example, *Liquidambar styraciflua* seedlings were present by the thousands within this community type at the time of sampling, but not one sapling or mature tree of that species was observed.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens*/(*Nyssa biflora*)/(*Ilex myrtifolia*)/(*Panicum verrucosum*) Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in south central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 7 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Extensive field reconnaissance within the study area indicated that undisturbed Drawdown Savannas/Meadows, like other vegetation subclasses within this group, are relatively rare within the study area, and that no sampled community type within this vegetation subclass is frequent.

(11) Conservation Status

An example of this community type is located within a South Carolina bay depression that is publicly held for the express purpose of biodiversity/habitat conservation.

#### 4.3.9.3.2 COMMUNITY TYPE: ***Taxodium ascendens/Nyssa biflora/Panicum verrucosum-Scleria reticularis* Savanna (9.3.2)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Dichanthelium wrightianum, Diodia virginiana, Liquidambar styraciflua, Lycopus angustifolia, Nyssa biflora, Panicum verrucosum, Rhexia aristosa, Rhynchospora perplexa* var. *perplexa, Scleria reticularis, Smilax rotundifolia, Taxodium ascendens, Toxicodendron radicans* var. *radicans*

(3) Special Status Species

*Coelorachis rugosa, Lycopus angustifolius, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type has an open canopy of medium to large *Taxodium ascendens*, overtopping a moderately closed "subcanopy" of mostly transgressive, small to medium sized (4 to 6 m in height) *Nyssa biflora* trees. *Nyssa* generally does not occur as a canopy tree, and *Taxodium* recruits are rare. The community type lacks a shrub stratum. The herbaceous layer consists primarily of the annual graminoids *Panicum verrucosum* and *Scleria reticularis* in dense stand, sometimes joined by *Dichanthelium wrightianum* as a co-dominant.

This community type exhibited low mean species richness at the 0.1 ha level, at 14.83 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its relatively dense subcanopy of *Nyssa biflora*, an herbaceous layer dominated by the annuals, *Panicum verrucosum* and *Scleria reticularis*, and little or no standing surface water.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26, Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 53 cm below the soil surface. Water marks on community trees indicate that water stands seasonally at sites exhibiting this community type at 63 cm.

(7) Soils

This community type occurs within study area Carolina bays over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults have been previously discussed, and a representative sampled pedon of a Typic Fragiaquult similar to the one underlying this community type is described in Appendix II for community types 9.2.1 and 9.3.1.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. As would be expected, the soil profile is characterized by virtually no humic matter in the middle portions of the subsoil (*i.e.*, within the apparent fragipan horizon), and has a relatively high bulk density at those depths.

(8) Succession & Disturbance

As noted, Drawdown Savanna/Meadow sites show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are occasional and charcoal fragments can be found in surface soil layers, but fire scars on the trunks of canopy trees are infrequent, and usually absent. This may have resulted from relatively infrequent, "hot" fires, rather than frequent "ground fires" at the site. Reportedly, fires have occurred within this community type during drawdown periods, with a frequency of approximately every 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type, and shallow drainage ditches are sometimes observed. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Nyssa biflora/Panicum verrucosum-*

*Scleria reticularis* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the central portion of the study area, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 3 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted undisturbed Drawdown Savannas/Meadows are relatively rare within the study area.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.3.3 COMMUNITY TYPE: ***Nyssa biflora/Acer/(Panicum verrucosum)/Sphagnum* spp. "Savanna" (9.3.3)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Small Depression Pond *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Acer rubrum, Liquidambar styraciflua, Nyssa biflora, Panicum verrucosum, Scleria reticularis, Smilax rotundifolia, Sphagnum* spp.

(3) Special Status Species

*Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type is dominated by a moderately dense layer of *Nyssa biflora* and *Acer rubrum* consisting of many size and age classes and ranging in height from 6 to 15 m, which is overtopped by relatively large *Pinus taeda* trees. The *Pinus* could appropriately be considered either the canopy over a subcanopy of *Acer* and *Nyssa*, or as emergents through the *Acer-Nyssa* canopy. Stems of *Smilax* spp. are a characteristic component of the woody strata, sprawling over many of the tree species present. Shrub and herbaceous strata are usually absent in this community type. The ground beneath the woody species is typically either bare or covered by large patches of either *Panicum verrucosum* or *Sphagnum* spp.

This community type exhibited low mean species richness at the 0.1 ha level, at 9.59 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are generally characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its lack of *Taxodium ascendens* -- with the occurrence instead of a dense canopy layer dominated by *Nyssa biflora, Acer rubrum* and *Pinus taeda*, a very sparse herbaceous layer of *Panicum verrucosum*, and the presence of little or no standing surface water.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately rapidly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 83 cm below the soil surface, but water marks on community trees indicate that water stands seasonally at 45 cm. Light penetration to the forest floor is greatly reduced within this community type, due to the denseness of the canopy layer. Within this community type, the site floor is distinctly higher around the bases of canopy *Pinus taeda* trees, which by observation appears to be true in nearly all wetland vegetational communities wherein that species occurs as a canopy tree.

(7) Soils

This community type occurs within study area Carolina bays over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of Typic Paleaquult soils have been discussed previously, and a representative sampled pedon of a Typic Paleaquult soil similar to the one occurring beneath this community type is described in Appendix II for CT 2.0.1.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with low base saturation. This is a relatively "heavy" soil, with moderate bulk soil density throughout. Silt-sized particles predominate near the surface, while sand-sized particles are dominant at lower depths in the measured soil solum.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, canopy *Pinus taeda* trees show some fire scars, and charred stumps of *Acer rubrum* are observed. Reportedly, fires have occurred within this community type during drawdown periods with a frequency of approximately every 15 to 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that appears to characterize this community type, site vegetation can be expected to remain in a relatively open, state, lacking a community shrub stratum. However, in the long-term absence of fire, the shrub component of this community type would be expected to increase dramatically, as the community contains more woody species than other community types within this vegetation subclass.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type, and shallow drainage ditches are sometimes observed. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Nyssa biflora/Acer/(Panicum verrucosum)/Sphagnum* spp. 'Savanna'" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent (8/345) of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which comprise are common within Middle Coastal Plain Carolina bays, and comprise 1 of 7 "clayey" depression soils found on this landscape surface (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in northeastern study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 3 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.3.4 COMMUNITY TYPE: ***Taxodium ascendens/(Cyrilla)/Scleria reticularis-Panicum verrucosum-Lachnanthes*** **Savanna (9.3.4)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Cyrilla racemiflora, Lachnanthes caroliniana, Litsea aestivalis, Nyssa biflora, Panicum verrucosum, Rhynchospora filifolia, Scleria reticularis, Sphagnum* spp., *Taxodium ascendens, Utricularia purpurea*

(3) Special Status Species

*Litsea aestivalis, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type is characterized by an open canopy of relatively large (16 to 18 m in height), flat-topped *Taxodium ascendens* exhibiting significantly buttressed bases. Subcanopy and shrub strata are absent, but *Cyrilla racemiflora* is common, growing exclusively from the stumps of old pond cypress trees. *Litsea aestivalis*, while not prevalent, is scattered throughout the community, growing immediately adjacent to the boles of large pond cypresses. While *Taxodium* seedlings and small saplings (<2 m in height) are abundant, larger transgressive *Taxodium* are largely absent from this community type. A mixture of *Lachnanthes caroliniana, Panicum verrucosum* and *Scleria reticularis* comprises the herb stratum in this community type, largely carpeting the ground where the water is shallow. "Mats" of *Sphagnum* spp. are a locally significant component of the community type vegetation.

This community type exhibited low mean species richness at the 0.1 ha level, at 13.24 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its open canopy layer of *Taxodium ascendens*, the scattered occurrence of *Litsea aestivalis* and *Cyrilla racemiflora*, and the presence of shallow surface water.

(6) Habitat

This community type occurs in small, relatively steep-walled, upland depressions located on relatively undulating and dissected land surfaces, and is characterized by poorly drained, moderately rapidly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 24 cm above the soil surface, but water marks on canopy *Taxodium ascendens* trees indicate that water stands seasonally at 83 cm on average. The floor of the depression within this community type is generally irregular, and "holes" up to 50 cm deeper than the surrounding depression floor are frequent.

(7) Soils

This community type occurs within study area Carolina bays over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of Typic Paleaquults were discussed for CT 2.0.1, above. A representative sampled pedon of a Typic

Paleaquult soil similar to the one encountered beneath this community type is described in Appendix II for CT 2.0.1.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with low base saturation. Organic matter content is high for a mineral soil at 10 and 25 cm depths, but drops markedly at 50 cm. This is a relatively "heavy" soil, with increasing bulk soil density as depth increases. Silt-sized particles predominate near the surface, while sand-sized particles are increasingly dominant at lower depths in the measured soil solum.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are common, fire scars occur on the trunks of canopy trees, and charcoal fragments can be found in surface soil layers. This community type is located within depressions that occur in a longleaf pine dominated landscape, and reportedly, fires have occurred during drawdown periods with a frequency of approximately every 5 to 10 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, current site vegetation can be expected to persist indefinitely. As previously noted, herbaceous species dominants will likely vary from year to year according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and some canopy *Taxodium* trees have been cut and removed. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens*/(*Cyrilla racemiflora*)/*Scleria reticularis*-*Panicum verrucosum*-*Lachnanthes* Savanna" is found in Carolina bays of the Upper Coastal Plain (Table 4.3), and makes up some 11 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which are common at this landscape position, and comprise 1 of the 5 soil families observed within Upper Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in central southwestern study area Carolina bays, fall within this classification (Table 4.5). This community type comprises 3 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Extensive field reconnaissance within the study area indicated that undisturbed Drawdown Savannas/Meadows are relatively rare within the study area, and are especially rare in the Upper Coastal Plain, where this community type occurs (*see* Figure 4.42).

(11) Conservation Status

An example of this community type currently exists within a Carolina bay that is publicly held for the express purpose of biodiversity conservation.

4.3.9.3.5 COMMUNITY TYPE: ***Taxodium ascendens*/*Eupatorium leucolepis*-**

***Rhynchospora inundata/Panicum verrucosum*** **Savanna (9.3.5)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Boltonia asteroides, Eriocaulon compressum, Eupatorium leucolepis, Lobelia boykinii, Panicum verrucosum, Pluchea rosea, Polygala cymosa, Rhexia aristosa, Rhynchospora filifolia, Rhynchospora inundata, Rhynchospora perplexa* var. *perplexa, Scleria reticularis, Taxodium ascendens, Xyris ambigua*

(3) Special Status Species

*Boltonia asteroides, Coelorachis rugosa, Dichanthelium erectifolium, Eleocharis tricostata, Lobelia boykinii, Lycopus angustifolius, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type is characterized by an open canopy of small to medium height (8 to 12 m), small-boled, flat-topped *Taxodium ascendens* having widely flared bases. Subcanopy and shrub strata are completely lacking, although transgressive *Taxodium* of all size classes occur throughout the community. The herb stratum ranges from moderately sparse to moderately dense, and is dominated by an approximately 1 m tall stand of *Eupatorium leucolepis*, often mixed with *Pluchea rosea, Rhynchospora inundata* and/or *Rhynchospora perplexa*, overtopping a lower herbaceous layer composed primarily of *Panicum verrucosum*, with or without *Scleria reticularis*.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 19.25 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its open canopy layer of small *Taxodium ascendens*, its bi-layered herbaceous stratum with *Eupatorium leucolepis* and *Rhynchospora inundata* overtopping *Panicum verrucosum*, and the presence of moist soil with no standing surface water.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 32 cm below the soil surface, but has commonly been observed in this community type standing above the surface at 18 to 25 cm.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquult soils are discussed for community types 9.2.1 and 9.3.1, above. A representative sampled pedon of a Typic Fragiaquult similar to the one underlying this community type is described in Appendix II for each of the listed community types.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid near the surface to very strongly acid in the subsoil. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. As would be expected, the soil profile is characterized by virtually no humic matter at 25 or 50 cm depths (*i.e.*, within the fragipan horizon), and has a relatively high bulk density at those depths. Silt-sized mineral particles predominate within the soil underlying this community type at all measured soil depths.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are common, and fire scars are generally present on the trunks of canopy trees. Reportedly, fires have occurred within this community type during drawdowns with a frequency of approximately every 10 to 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. Herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Eupatorium leucolepis-Rhynchospora inundata/Panicum verrucosum* Savanna" is found in Carolina bays of the Middle Coastal

Plain (Table 4.3), and makes up some 3 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bays occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Twelve of 482 intensively sampled plots (2.5%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 10 percent of the sampled community types that make up the vegetation subclass, and 5 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

### 4.3.9.3.6 COMMUNITY TYPE: ***(Taxodium ascendens)/Pluchea rosea-Eupatorium leucolepis/Dichanthelium wrightianum*** Meadow (9.3.6)

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Boltonia asteroides, Dichanthelium wrightianum, Eleocharis tricostata, Eupatorium leucolepis, Pluchea rosea, Rhexia aristosa, Scleria reticularis, Taxodium ascendens*

(3) Special Status Species

*Boltonia asteroides, Eleocharis tricostata, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis, Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is dominated by a dense, "bi-layered" herbaceous stratum composed primarily of a mixture of *Pluchea rosea* and *Eupatorium leucolepis*, overtopping a ground cover of *Dichanthelium wrightianum*. While dominant woody strata are absent, a widely scattered, sparse to very sparse layer of small to medium-sized, small-boled *Taxodium ascendens* with widely flared bases is generally present in this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 12.13 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its lack of a canopy layer, its bi-layered herbaceous stratum with *Pluchea rosea* and *Eupatorium leucolepis* overtopping *Dichanthelium wrightianum*, and the presence of moist soil with no standing surface water.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 26 cm below the soil surface, but has commonly been observed within this community type standing above the surface on other occasions.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquult soils are discussed for community types 9.2.1 and CT 9.3.1, above. A representative sampled pedon of a Typic Fragiaquult soil similar to the one found beneath this community type is described in Appendix II for each of the listed community types.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type can reasonably be presumed to be very similar to those described for community types 9.2.3, 9.3.2, and 9.3.5-9.3.12, discussed elsewhere in this chapter.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are very common, and fire scars are generally present on the trunks of the scattered cypress trees. It is likely that canopy trees were removed from this community type by fire given the relatively large number of burned out stumps observed and the lack of evidence of any timbering. Reportedly, fires have occurred within this community type during drawdowns with a frequency of approximately every 10 to 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "(*Taxodium ascendens*)/*Pluchea rosea-Eupatorium leucolepis*/ *Dichanthelium wrightianum* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 5 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Sixteen of 482 intensively sampled plots (3.3%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and 7 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

4.3.9.3.7 COMMUNITY TYPE: ***Taxodium ascendens*/(*Pluchea rosea-Boltonia*)/ *Dichanthelium wrightianum* Savanna (9.3.7)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Boltonia asteroides, Dichanthelium wrightianum, Eupatorium leucolepis, Panicum verrucosum, Pluchea rosea, Rhexia aristosa, Scleria reticularis, Taxodium ascendens*

(3) Special Status Species

*Boltonia asteroides, Coelorachis rugosa, Dichanthelium erectifolium, Eleocharis tricostata, Ilex amelanchier, Lycopus angustifolius, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis, Sclerolepis uniflora*

(4) Vegetation & Physiognomy

This community type is also characterized by an open canopy of small to medium height (8 to 12 m), small-boled, flat-topped *Taxodium ascendens* having widely flared bases. Subcanopy and shrub strata are completely lacking, although transgressive *Taxodium* of all size classes occur throughout the community. The herb stratum is composed of a dense cover of *Dichanthelium wrightianum*, often to the exclusion of other species. However, *Pluchea rosea* and *Boltonia asteroides*, while not community type dominants, are also important constituent species in the overtopping "layer" of the herb stratum.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.26 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its open canopy layer of small *Taxodium ascendens*, its abundance of *Dichanthelium wrightianum* as a ground cover, the constant presence of *Boltonia asteroides* in the herbaceous layer, and the presence of little or no standing surface water.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 22 cm below the soil surface, but has commonly been observed within this community type standing above the surface.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed above for community types 9.2.1 and 9.3.1. A representative sampled pedon of a Typic Fragiaquult soil similar to the one underlying this community type is described in Appendix II for the two listed community types.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for community types 9.2.3, 9.3.2, and 9.3.5-9.3.12, discussed elsewhere in this chapter.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are common, and fire scars are generally present on the trunks of canopy trees. Reportedly, fires have occurred within this community type during drawdowns with a frequency of approximately every 10 to 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens*/(*Pluchea rosea-Boltonia*)/ *Dichanthelium wrightianum* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 5 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Sixteen of 482 intensively sampled plots (3.3%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and 7 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

At least one example of this community type is found within a privately owned North Carolina bay depression expressly held for the purpose of biodiversity conservation.

4.3.9.3.8 COMMUNITY TYPE: ***Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow (9.3.8)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Andropogon virginicus* var. *glaucus, Dichanthelium wrightianum, Panicum hemitomon, Panicum verrucosum, Pluchea rosea, Rhexia aristosa, Scleria reticularis, Taxodium ascendens*

(3) Special Status Species

*Coelorachis rugosa, Dichanthelium erectifolium, Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

Woody strata are essentially absent in this community type, although scattered, small trees of *Taxodium ascendens* are common throughout. Instead, the community type is dominated by a "bi-layered" herbaceous stratum composed of an open layer of 1-m tall *Panicum hemitomon*, which overtops a "carpet" of *Dichanthelium wrightianum* and, to a lesser extent, *Scleria reticularis*. A shrub layer is completely lacking in this community type.

This community type exhibited low mean species richness at the 0.1 ha level, at 10.32 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its lack of a canopy layer, *Panicum hemitomon* as the "upper" herbaceous layer dominant, and water just below the surface.

(6) Habitat

This community type occurs in small, relatively steep-walled depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 20 cm below the soil surface, but water has been recorded within the sites exhibiting this community type at 68 cm.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquult soils are discussed for community types 9.2.1 and 9.3.1, above. A representative sampled pedon of a Typic Fragiaquult soil similar to the one found beneath this community type is described in Appendix II for each above-listed community type.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type can reasonably be presumed to be similar to those described for community types 9.2.3, 9.3.2, and 9.3.5-9.3.12, discussed elsewhere in this chapter.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, fire scars are present on the trunks of all *Taxodium ascendens* trees. Reportedly, fires have occurred during drawdown periods with a frequency of approximately every 10 to 15 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and fires in some drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "meadow-like" condition indefinitely. However, as previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In that regard, the dominance of *Panicum hemitomon* as the overtopping layer in the herbaceous stratum is likely to continue only so long as its shoots are not inundated over the winter months (Kirkman, 1992). In the absence of fire, *Taxodium ascendens* would be expected to increase its dominance within this depression meadow, eventually changing it to a cypress savanna community.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although ditches draining into the small, relatively steep walled Carolina bays exhibiting Fragiaquults soils are not uncommon, and occur at sites containing this community type. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 5 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Sixteen of 482 intensively sampled plots (3.3%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 13 percent of the sampled community types that make up the vegetation subclass, and 7 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists within a Carolina bay that is privately held for the express purpose of biodiversity conservation.

4.3.9.3.9 COMMUNITY TYPE: ***Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow (9.3.9)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Andropogon mohrii, Dichanthelium wrightianum, Eleocharis melanocarpa, Lachnanthes caroliniana, Panicum verrucosum, Rhexia aristosa, Rhynchospora filifolia, Rhynchospora perplexa* var. *perplexa, Scleria reticularis*

(3) Special Status Species

*Andropogon gyrans* var. *stenophyllus, A. mohrii, Eleocharis melanocarpa, Iva microcephala, Rhexia aristosa, Rhynchospora inundata, R. tracyi, Scleria reticularis*

(4) Vegetation & Physiognomy

This community type is entirely lacking of woody strata. Rather, it is characterized by an herbaceous layer composed of a moderately dense stand of *ca.* 0.75 m tall *Andropogon mohrii* overtopping a dense, 0.25 cm tall carpet of *Dichanthelium wrightianum* and *Rhynchospora filifolia*. At times, the dominants of either layer in the herbaceous stratum may displace the other layer in large patches. *Eleocharis melanocarpa, Lachnanthes caroliniana, Panicum verrucosum* and *Rhynchospora perplexa* are significant components of this community type, and may occasionally be locally dominant.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.46 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its lack of a canopy layer, the occurrence of *Andropogon mohrii* as an herbaceous layer dominant, and the presence of little or no surface water.

(6) Habitat

This community type occurs in small, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 64 cm below the soil surface, but surface water has been measured at up to 48 cm seasonally in sites exhibiting this community type.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed for community types 4.0.2, 9.2.1, and 9.3.1. A representative sampled pedon of a Typic Fragiaquult soil similar to the one underlying this community type is described in Appendix II for CT 4.0.2.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is very strongly acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. The soil for this community type exhibits a high humic acid content in surface layers, but as would be expected, the soil profile is characterized by virtually no humic matter at 50 cm (*i.e.*, within the fragipan horizon), and has a relatively high bulk density within the subsoil. Silt-sized particles predominate near the surface, but particle size distribution is relatively evenly distributed among the size classes within the subsoil.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. However, such evidence is generally lacking within this community type given its lack of woody species, although fires are common in the rim area vegetational communities that surround depressions exhibiting this community type, and presumably burn across such depressions on occasion during drought years. Reportedly, fires have occurred in recent history in depressions exhibiting this community type with a frequency of approximately every 20 years (Table 4.26).

Under the continued, typical disturbance regime -- ponding of water in most years and occasional fires in drought years -- that appears to also characterize this community type, site vegetation can be expected to remain in its current open, "meadow-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the absence of fire, *Nyssa biflora*, and perhaps, *Taxodium ascendens*, would be expected to increase in dominance within sites exhibiting this community type, eventually changing it from a meadow-like community to a savanna-like community.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although ditches draining into the small, relatively steep walled Carolina bays exhibiting Fragiaquults soils are not uncommon, and occur at sites containing this community type. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 3 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Eleven of 482 intensively sampled plots (2.3%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 9 percent of the sampled community types that make up the vegetation subclass, and less than 5 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.3.10 COMMUNITY TYPE: ***Taxodium ascendens/Rhynchospora inundata* Savanna**

(9.3.10)

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Nyssa biflora, Rhynchospora inundata, Taxodium ascendens*

(3) Special Status Species

*Ilex amelanchier, Lycopus angustifolius, Rhexia aristosa, Rhynchospora inundata*

(4) Vegetation & Physiognomy

This community type is characterized by a moderately open canopy of relatively tall (17 to 20 m), medium-boled, often flat-topped *Taxodium ascendens* having widely flared bases. A continuous shrub stratum is absent, but widely scattered, multi-stemmed clumps of *Ilex amelanchier* to 3 m in height are common within the community type. A *ca.* 1-m tall, moderately open to moderately dense stand of *Rhynchospora inundata* characterizes the herbaceous stratum within this savanna community.

This community type exhibited low mean species richness at the 0.1 ha level, at 8.41 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its well-developed canopy layer of *Taxodium ascendens*, the occurrence of *Rhynchospora inundata* as the herbaceous layer dominant, and the usual presence of shallow surface water.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 26 cm above the soil surface, although the sites exhibiting this community type have been observed seasonally with no standing surface water.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed for community types 9.2.1 and 9.3.1, above. A representative sampled pedon of a Typic Fragiaquult soil similar to the one underlying this community type is described in Appendix II for the two listed community types.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for community types 9.2.3, 9.3.2, and 9.3.5-9.312, discussed elsewhere in this chapter.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are common, fire scars to 3 m in height occur on the trunks of virtually every canopy trees, and charcoal fragments can be found in surface soil layers. Reportedly, fires have occurred in sites exhibiting this community type with a frequency of approximately every 10 years (Table 4.26), during drawdown periods. Lightning strikes have been observed within this community type, and are presumably the chief agent of such fires.

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. *Rhynchospora inundata*, a dominant species within this community type, requires flooded conditions to germinate (Gerritson and Greening, 1989). While that species is rhizomatous, it has been observed to be relatively short-lived, and its clumps typically lose vigor and decline rapidly after just a few years.

In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure. However, the woody, "sub-canopy" components of this community type would be expected to eventually increase significantly in dominance.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Rhynchospora inundata* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 6 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Nineteen of 482 intensively sampled plots (3.9%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 16 percent of the sampled community types that make up the vegetation subclass, and 8 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

4.3.9.3.11 COMMUNITY TYPE: ***Taxodium ascendens/(Nyssa biflora)/Ilex amelanchier/ Carex striata-Lachnanthes* Savanna (9.3.11)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Carex striata* var. *striata, Dichanthelium longiligulatum, Dichanthelium wrightianum, Diodea virginiana, Ilex amelanchier, Lachnanthes caroliniana, Liquidambar styraciflua, Lycopus angustifolius, Nyssa biflora, Polygala cymosa, Saccharum giganteum, Taxodium ascendens*

(3) Special Status Species

*Coelorachis rugosa, Ilex amelanchier, Lycopus angustifolius, Rhexia aristosa*

(4) Vegetation & Physiognomy

Like its predecessor within this vegetation subclass, this community type is characterized by a moderately open canopy of relatively tall (17 to 20 m), medium-boled, often flat-topped *Taxodium ascendens* having widely flared bases. While no subcanopy layer is present, small to medium-sized specimens of *Nyssa biflora* are a common, if scattered, component of the vegetation within this community type. Large, multi-stemmed clumps of *Ilex amelanchier* form a patchy mosaic within this community type, being interspersed with smaller openings wherein *Carex striata* and *Lachnanthes caroliniana* exist in dense stand, carpeting the floor of the bay. In addition, *Polygala cymosa* is a locally abundant component of the community type herbaceous stratum.

This community type exhibited low mean species richness at the 0.1 ha level, at 15.00 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its well-developed canopy layer of *Taxodium ascendens*, the occurrence of a shrub layer (dominated by *Ilex amelanchier*), and site water at or just below the surface.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 5 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquults are discussed, and representative, sampled pedons of a Typic Fragiaquult soil similar to the one found beneath this community type are described in Appendix II for community types 9.2.1 and 9.3.1.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. As would be expected, the soil profile is characterized by low humic matter content at lower soil depths (*i.e.*, within the fragipan horizon), and has a relatively high bulk density at those depths. Sand-sized particles predominate throughout the soils underlying this community type, at all measured soil depths.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are occasional, fire scars to 3 m in height occur on the trunks of canopy trees, the dominant shrub -- *Ilex amelanchier* -- occurs only in multi-stemmed clumps from large rootstocks, and charcoal fragments can be found in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 10 years (Table 4.26) during drawdown periods. The evidence of lightning strikes have been observed within this community type, and are presumably an agent of such fires.

As is true of other community types within this vegetation subclass, under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. Herbaceous species dominants will vary according to differences in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, the dominance of both *Ilex amelanchier* and "sub-canopy" sized species -- primarily *Liquidambar styraciflua* and *Nyssa biflora* -- would be expected to increase significantly, although the rapidity with which this physiognomic change might come about would depend on the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/(Nyssa biflora)/Ilex amelanchier/Carex striata-Lachnanthes* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 3 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists in North Carolina within a Carolina bay that is privately held for the express purpose of biodiversity conservation.

4.3.9.3.12 COMMUNITY TYPE: ***Taxodium ascendens/Rhynchospora inundata/ Lachnanthes-Polygala cymosa* Savanna (9.3.12)**

(1) Synonymy

Pond Cypress Pond *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.25)

*Dichanthelium longiligulatum, Eriocaulon compressum, Lachnanthes caroliniana, Nyssa biflora, Polygala cymosa, Rhynchospora filifolia, Rhynchospora inundata, Rhynchospora perplexa* var. *perplexa, Taxodium ascendens*

(3) Special Status Species

*Coelorachis rugosa, Ilex amelanchier, Lycopus angustifolius, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis, Sclerolepis uniflora*

(4) Vegetation & Physiognomy

Again, this community type is similar to others within this vegetation subclass, being characterized by a moderately open to moderately dense canopy of relatively tall (17 to 10 m), medium-boled, often flat-topped *Taxodium ascendens* having widely flared bases. A shrub stratum is absent. The herbaceous stratum within this savanna community typically contains an open stand of *ca.* 1 m tall *Rhynchospora inundata*, overtopping a ground cover of *Polygala cymosa* and *Lachnanthes caroliniana*. The *Polygala* is extremely striking when in flower. In addition, *Eriocaulon compressum* is locally abundant, and may be a local herbaceous stratum co-dominant.

This community type exhibited low mean species richness at the 0.1 ha level, at 14.59 species (Table 4.2).

(5) Distinguishing Features

Drawdown Savannas/Meadows are characterized by: (1) low species richness; (2) an open aspect, with dominance by annual or short-lived perennial, herbaceous species, with or without an open canopy layer of cypress or gum; (3) a Fragiaquult soil; and (4) an annually and seasonally variable water table. Community types are distinguished primarily by their presence/absence of a canopy, herbaceous layer species dominants, and site water level. This community type is distinctive for its well-developed canopy layer of *Taxodium ascendens*, the occurrence of *Polygala cymosa* as an herbaceous layer dominant, and the presence of shallow surface water.

(6) Habitat

This community type occurs in medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.26; Figure 4.50). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated most of the time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 3 cm above the soil surface, although the depressions exhibiting this community type have been observed both without standing surface water, and with surface water to 30 cm in height.

(7) Soils

This community type occurs within study area Carolina bays only over clayey, kaolonitic, thermic Typic Fragiaquult soils (Table A-II-1). The general characteristics of Typic Fragiaquult soils have been previously discussed for community types 9.2.1 and 9.3.1. A representative sampled pedon of a Typic Fragiaquult soil similar to the one underlying this community type is described in Appendix II for each of the two listed community types.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is very strongly acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Moreover, the relative level of zinc in the soil is notably high at all measured depths in the soil underlying this community type. As would be expected, the soil profile is characterized by virtually no humic matter at 25 or 50 cm (*i.e.*, within the fragipan horizon), and has a relatively high bulk density at those depths. Silt-sized particles account for the highest percentage dominance within this soil, but particle size distribution is relatively evenly distributed between the size classes throughout the measured soil solum.

(8) Succession & Disturbance

Drawdown Savanna/Meadow sites characteristically show evidence of the past effects of fire on site vegetation. Within this community type, charred *Taxodium ascendens* stumps are common, fire scars to 6 m in height occur on the trunks of canopy trees, and charcoal fragments can be found in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 10 years (Table 4.26) during drawdown periods. Lightning strikes have been observed within this community type, and are presumably the chief agent of such fires.

Under the continued, typical disturbance regime -- ponding of water in most years and fires in drought years -- that characterizes this community type, site vegetation can be expected to remain in its current open, "savanna-like" condition indefinitely. As previously noted, herbaceous species dominants will likely vary according to variations in site surface water depth, periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, relatively little short-term physiognomic change would be expected within this community type, given the frequency and duration of site flooding, and the consequent extended periods of anaerobic conditions that site vegetation must endure.

As indicated by Table 4.26, this community type shows little evidence of recent human disturbance, although past site use for livestock grazing has occurred within this community type and is common in this vegetation subclass. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Rhynchospora inundata/Lachnanthes-Polygala cymosa* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Fragiaquult soils, which are characteristic of Middle Coastal Plain bays near the North Carolina/South Carolina border, but represent only 1 of 12 soil families found within bay depressions occurring at that landscape position (Table 4.4).

(10) Distribution & Abundance

Six of 482 intensively sampled plots (1.2%), occurring in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 5 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. As noted, because of extensive human disturbance activities, undisturbed Drawdown Savanna/Meadow sites are relatively rare within the study area.

(11) Conservation Status

An example of this community type currently exists in North Carolina within a Carolina bay that is privately held for the express purpose of biodiversity conservation.

4.3.9.4 VEGETATION SUBCLASS: **Wet Savanna/Meadow (9.4.)**

Like its immediate predecessor, this vegetation subclass contains both savanna-like and meadow-like (treeless) communities. However, it is distinct from Drawdown Savannas/ Meadows in a number of ways, as discussed below in detail. In general, ponded surface water -- where it occurs at all -- is almost always shallow, and the ambient site water table is significantly more stable than that found in sites characterized by Drawdown vegetation. Wet Savanna/Meadow depressions are typically flooded in the winter, but in many years have water standing on the surface during the growing season only immediately after a significant, local rainfall event. Wet Savannas/Meadow are floristically diverse as compared to other Intermittently Ponded Cypress/Gum Depression vegetation subclasses, and tend to be dominated by long-lived, rhizomatous perennial species capable of aggressive vegetative reproduction. Photographs of this vegetation class appear in Plate 14, following Chapter 7 below.

#### 4.3.9.4.1 COMMUNITY TYPE: ***Aster pilosus* var. *demotus*/(*Dichanthelium wrightianum-Eleocharis tricostata*) Meadow (9.4.1)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Aster pilosus* var. *demotus, Gratiola ramosa,*

(3) Special Status Species

*Eleocharis tricostata, Eupatorium leptophyllum, Eupatorium recurvans, Sagittaria isoetiformis, Scleria georgiana*

(4) Vegetation & Physiognomy

Woody strata are absent in this community type, although sapling *Nyssa biflora* and *Pinus taeda* occur as scattered individuals within the community. The herbaceous stratum is "bi-layered", consisting of a moderately dense layer of *ca.* 1.5-m tall *Aster pilosus* var. *demotus*, overtopping a *ca.* 0.25-m tall layer of *Eleocharis tricostata* and *Dichanthelium wrightianum*, which carpet the ground within the community. *Pluchea rosea* and *Leersia hexandra* are also locally significant vegetation components, respectively, of the upper and lower layers of the herbaceous stratum.

This community type exhibited low mean species richness at the 0.1 ha level, at 12.39 species (Table 4.2).

(5) Distinguishing Features

Wet Savannas/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by having no woody strata, with herbaceous layer dominance by *Aster pilosus* var. *demotus*.

(6) Habitat

This community type occurs in small, relatively steep-sided depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface appears to be inundated for significant periods of time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 6 cm above the soil surface.

(7) Soils

This community type occurs within study area Carolina bays only over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of this soil family are discussed below for CT 9.4.3. A representative sampled pedon of a fine-loamy, siliceous, thermic Typic Paleaquult soil similar to the one encountered beneath this community type is described in Appendix II for CT 9.4.3.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type are likely very similar to those described for community types 9.4.2, 9.4.3, and 9.4.4, discussed below.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows extensive evidence of past fire effects. Within this community type, those evidences include fire scars on the trunks of rim trees and the occasional presence of charcoal fragments in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 10 to 25 years (Table 4.28). Under this regime of frequent fires, the site vegetation would be expected to remain in its open, "meadow-like" condition. Herbaceous species dominants will vary, according primarily to variations in site surface water depth and periodicity, and site seedbank species composition and abundance (Kirkman 1992; van der Valk 1981). In the long-term absence of fire, the *Pinus taeda* and *Liquidambar styraciflua* saplings common around the periphery of sites exhibiting this community type would be expected to increase in dominance, although site hydrologic regimes ultimately determine whether such woody species colonizers become successfully established (*see* text discussion for CT 2.0.3, above).

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although some sites with this community type have reportedly been used as "fish ponds" (*i.e.*, stocked with edible game fishes) during extended wet periods, and shallow "excavation pits" occur at some sites. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Aster pilosus* var. *demotus*/(*Dichanthelium wrightianum*-*Eleocharis tricostata*) Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled

Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Seven of 482 intensively sampled plots (1.5%), occurring in central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 10 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Extensive field reconnaissance within the study area indicated that undisturbed Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and no sampled community type within this vegetation subclass is frequent. In addition, most Carolina bays containing such vegetation types have undergone severe disturbance or extensive alteration, primarily through timbering and/or draining.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.4.2 COMMUNITY TYPE: ***(Pinus taeda)/Panicum tenerum/Centella-Dichanthelium wrightianum*** **Meadow (9.4.2)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Andropogon gyrans* var. *stenophyllus, Andropogon virginicus* var. *glaucus, Centella asiatica, Dichanthelium wrightianum, Eleocharis robbinsii, Eupatorium leucolepis, Panicum tenerum, Pinus taeda*

(3) Special Status Species

*Andropogon gyrans* var. *stenophyllus, Aristida palustris, Coelorachis rugosa,* *Dichanthelium erectifolium, Drosera filiformis, Eleocharis robbinsii, Panicum tenerum, Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

This is another of the herb-dominated, treeless or "wet meadow" community types found within Carolina bays, and is characterized by a multi-layered herbaceous stratum where an open stand of *ca.* 0.75-m tall *Panicum tenerum* overtops a patchy, *ca.* 0.25-m tall layer of *Dichanthelium wrightianum*, or in some years, *Dichanthelium erectifolium*. *Andropogon gyrans* var. *stenophyllus* is also common within this community type, and may share co-dominance in the upper herbaceous layer. "Beneath" (or amongst) the *Dichanthelium*, *Centella asiatica* carpets the ground. While true woody strata are absent, both live and dead stems of *Pinus taeda* saplings are commonly scattered throughout this community.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 16.07 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished primarily by its "bi-layered" herbaceous stratum structure with upper and lower layer graminoid dominants, *Panicum tenerum* and *Dichanthelium* spp., respectively.

(6) Habitat

This community type inhabits small, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is apparently inundated for significant periods of time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 25 cm below the soil surface, although surface water has been measured on the surface of this community type at sustained, higher levels (to *ca.* 30 cm) following episodic rainfall events.

(7) Soils

This community type occurs within study area Carolina bays only over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The soil underlying this community type appears to represent a "sandy variant" of this soil family, where sand of apparently eolian origin (presumably from the surrounding rim area) has been deposited over the generally loamy sediments of the site to a depth and quantity sufficient to influence site vegetation, but insufficient to relegate the soil to another soil group. The general characteristics of fine-loamy, siliceous, thermic Typic Paleaquults are discussed for community types 2.0.1 and 9.4.3. A representative sampled pedon of a Typic Paleaquult soil similar to the one underlying this community type is described in Appendix II for the two listed community types.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is very strongly acid to strongly acid. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Humic matter is negligible within this soil throughout the profile. Soil bulk density for this community type is among the highest encountered within study area Carolina bays. Sand-sized particles totally dominate the soil solum for this community type at all measured soil depths.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including fire scars on the trunks of rim trees, the extremely clumped nature of shrubs that commonly occur on the rims of sites exhibiting this community type, and the occasional presence of charcoal fragments in surface soil layers within the community itself. Reportedly, fires have occurred in recent history with a frequency of approximately every 10 to 25 years (Table 4.28). Under this fire regime, the site vegetation would be expected to remain in its open, "meadow-like" condition. Herbaceous species dominants may vary, according primarily to variations in site surface water depth and periodicity, and site seedbank species composition and abundance (Kirkman, 1992; van der Valk, 1981). However, under relatively stable hydrologic conditions, this community type is persistent. In the long-term absence of fire, the *Pinus taeda* saplings and seedlings occurring within this community type would be expected to increase in dominance. However, as noted for the immediately preceding community type, the historic hydrologic regime at these Wet Savanna/Meadow sites ultimately determines whether such woody species colonizers become successfully established.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although some sites exhibiting this community type have been used for livestock grazing, and many contain shallow drainage ditches. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*(Pinus taeda)/Panicum tenerum/Centella-Dichanthelium wrightianum* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring primarily in north central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 11 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

### 4.3.9.4.3 COMMUNITY TYPE: ***Eupatorium leucolepis-Panicum rigidulum* var. *combsii*/*Dichanthelium erectifolium-Rhynchospora filifolia*/*Stylisma aquatica* Meadow (9.4.3)**

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Andropogon virginicus* var. *glaucus, Dichanthelium erectifolium, Drosera capillaris, Eupatorium leucolepis, Euthamia tenuifolia, Hypericum cistifolium, Panicum hemitomon, Panicum rigidulum* var. *combsii, Panicum tenerum, Pinus taeda, Pluchea rosea, Rhynchospora filifolia, Rhynchospora perplexa* var. *perplexa, Scleria georgiana, Stylisma aquatica*

(3) Special Status Species

*Agalinis linifolia, Andropogon gyrans* var. *stenophyllus, Aristida palustris, Coelorachis rugosa, Dichanthelium erectifolium, Ludwigia suffruticosa, Panicum tenerum, Rhexia aristosa, Scleria georgiana, Scleria reticularis, Stylisma aquatica*

(4) Vegetation & Physiognomy

Like several other community types within this vegetation subclass, this wet meadow community type is characterized by a multi-layered herbaceous stratum. That stratum consists of a moderately dense, overtopping layer of *Eupatorium leucolepis* and *Panicum rigidulum* var. *combsii* that stands *ca.* 1 m tall; another moderately dense, intermediate herbaceous layer comprised by *Dichanthelium erectifolium* and *Rhynchospora filifolia* and standing *ca.* 0.25 m tall; and a ground-hugging carpet of *Stylisma aquatica* beneath the other herb layers. Other significant, and locally abundant, components of the herbaceous stratum include *Andropogon virginicus var. glaucus, Euthamia tenuifolia, Rhynchospora perplexa, R. rariflora* and *Scleria georgiana.* Woody strata are typically absent from this community type, although *Pinus taeda* saplings are a common component of the vegetation in this community type.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 19.39 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by characteristically having no woody strata, with an herbaceous layer dominated by the relatively tall, fine-leaved graminoids *Aristida palustris* and *Panicum rigidulum* var. *combsii*, and the vining ground cover of *Stylisma aquatica.*

(6) Habitat

This community type occurs in small, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is variable both seasonally and from year to year. This community type occurs at sites that appear to be drier at the surface than most sites vegetated by community types falling within this vegetation subclass, and the site surfaces are usually inundated only as the aftermath of significant local rainfall events. At the time of sampling, the water table within this community type stood an average of 120 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays only over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of this poorly drained soil family are discussed for CT 2.0.1, above. A representative, sampled pedon of the soil underlying this community type is described in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid to very strongly acid. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Humic matter decreases to negligible quantities by 50 cm in depth. Soil bulk density for this community type is moderate throughout the profile. Particle size distribution is relatively constant throughout the measured soil solum, with silt-sized particles comprising *ca.* 50 percent of the mineral fraction and sand and silt making up *ca.* 25 percent each of the mineral soil fraction.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including fire scars on the trunks of rim trees, the extremely clumped nature of shrubs that commonly occur on the rims of sites exhibiting this community type, and the occasional presence of charcoal fragments in surface soil layers within the community itself. Reportedly, fires have occurred in recent history with a frequency of approximately every 10 to 25 years (Table 4.28). Under this fire regime, the site vegetation would be expected to remain in its open, "meadow-like" condition, and the relatively long-lived, perennial graminoid dominants typical of this community type are likely to persist indefinitely.

Fire is likely a more important factor in maintaining this community type than is true of most community types within this vegetation subclass because the sites on which it occurs appear to be significantly drier than those of other communities within this vegetation subclass. Given the less frequent anaerobic conditions that occur with site surface inundation, the *Pinus taeda* saplings and seedlings occurring within the community may be expected to overtop and "shade out" the herbaceous species that characterize this Wet Meadow community type in the absence of frequent fires.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although some sites containing this community type have been used for livestock grazing, and may contain shallow drainage ditches. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Eupatorium leucolepis-Panicum rigidulum* var. *combsii/ Dichanthelium erectifolium-Rhynchospora filifolia/Stylisma aquatica* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 11 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

An example of this community type is apparently protected within a study area Carolina bay privately held for the express purpose of biodiversity conservation.

4.3.9.4.4 COMMUNITY TYPE: ***Eupatorium leucolepis*** **Meadow** (9.4.4)

(1) Synonymy

Depression Meadow *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Depression Meadow Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Eupatorium leucolepis, Rhexia aristosa, Sclerolepis uniflora*

(3) Special Status Species

*Aristida palustris, Coelorachis rugosa, Dichanthelium erectifolium, Eleocharis tricostata, Eupatorium recurvans, Lobelia boykinii, Ludwigia suffruticosa, Rhexia aristosa, Scleria georgiana, Scleria reticularis, Sclerolepis uniflora, Stylisma aquatica, Xyris smalliana*

(4) Vegetation & Physiognomy

Woody strata are lacking in this wet meadow community type. The herbaceous stratum is dominated by a single-layer, dense stand of *ca.* 1-m tall *Eupatorium leucolepis*, sometimes to the exclusion of other herbs. Occasionally, *Rhynchospora perplexa* is co-dominant with *Eupatorium* in the herbaceous layer, particularly in unusually wet years.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 15.10 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is similar in aspect to other "mono-specific" Carolina bay community types discussed previously, distinctive in having no woody strata and an herbaceous layer dominated by a single species, *Eupatorium leucolepis* in this instance.

(6) Habitat

This community type occurs in small, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table within this community type is usually variable both seasonally and from year to year. The site surface may be rarely or frequently inundated. At the time of sampling, the water table within this community type stood just at the surface, on average.

(7) Soils

This community type occurs within study area Carolina bays only over fine-loamy, siliceous, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of this soil family are discussed for CT 9.4.3, immediately above. A representative, sampled pedon of a fine-loamy, siliceous, thermic Typic Paleaquult soil similar to the one found beneath this community type is described for CT 9.4.3 in Appendix II.

Although soil cores were extracted and the resulting profile described, individual soil samples were not collected and analyzed for this community type. However, the physical and chemical properties of the soils characterizing this community type can reasonably be presumed to be very similar to those described for community types 9.4.2 and 9.4.3, discussed above.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including fire scars on the trunks of rim trees, the extremely clumped nature of shrubs that commonly occur on the rims of sites exhibiting this community type, and the occasional presence of charcoal fragments in surface soil layers within the community itself. Reportedly, fires have occurred in this vegetation in recent history with a frequency of approximately every 10 to 25 years (Table 4.28). Under this fire regime, the site vegetation would be expected to remain in its open, "meadow-like" condition, and the relatively long-lived, rhizomatous, perennial dominants typical of this community type are likely to persist indefinitely. In the absence of frequent fire and under prolonged drought conditions, the *Pinus taeda* saplings and seedlings occurring in and on the fringe of this community would be expected to increase significantly in dominance.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although some sites containing this community type have been used for livestock grazing, and may contain shallow drainage ditches. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Eupatorium leucolepis* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Twelve of 482 intensively sampled plots (2.5%), occurring in central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 17 percent of the sampled community types that make up the vegetation subclass, and 5 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

An example of this community type is apparently protected within a study area Carolina bay privately held for the express purpose of biodiversity conservation.

4.3.9.4.5 COMMUNITY TYPE: ***Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum*** **Meadow (9.4.5)**

(1) Synonymy

Pond Cypress Savanna *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Aristida palustris, Burmannia biflora, Carex striata* var. *striata, Dichanthelium sphaerocarpon* var. *sphaerocarpon, Eriocaulon compressum, Gratiola ramosa, Helenium pinnatifidum, Hypericum cistifolium, Hypericum fasciculatum, Ilex myrtifolia, Lachnanthes caroliniana, Ludwigia linifolia, Mitreola sessilifolia, Nyssa biflora, Oxypolis canbyi, Panicum rigidulum* var. *combsii, Pluchea foetida, Polygala cymosa, Rhexia aristosa, Rhynchospora cephalantha* var. *cephalantha, Rhynchospora filifolia, Saccharum giganteum, Scleria reticularis, Taxodium ascendens, Tillandsia usneoides, Xyris difformis* var. *floridana*

(3) Special Status Species

*Agalinis linifolia, Andropogon gyrans* var. *stenophyllus, Aristida palustris, Burmannia biflora, Helenium pinnatifidum, Hypericum fasciculatum, Ludwigia linifolia, Lycopus angustifolius, Oxypolis canbyi, Rhexia aristosa, Scleria baldwinii, Scleria reticularis, Xyris difformis* var. *floridana*

(4) Vegetation & Physiognomy

This "savanna-like" community type is characterized by an open canopy of medium sized (8 to 12 m tall), medium-boled, often flat-topped *Taxodium ascendens* having widely flared bases. While a true subcanopy layer is absent, a tall (4-5 m in height), open to sparse shrub stratum comprised by *Ilex myrtifolia* is characteristic of the community, and gives the appearance of a subcanopy layer. The herbaceous stratum within the community is "bi-layered" and relatively diverse, consisting of a moderately dense layer of *Carex striata* and *Aristida palustris*, overtopping an open layer of *Eriocaulon compressum* and other herbs. Within the overtopping layer, *Hypericum cistifolium, Hypericum fasciculatum* and *Rhynchospora filifolia* are significant components of the herbaceous stratum, while *Helenium pinnatifidum, Lachnanthes caroliniana* and *Polygala cymosa* are significant constituent species of the ground layer of the herbaceous stratum.

This community type exhibited comparatively high mean species richness at the 0.1 ha level, at 31.10 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by its *Taxodium ascendens* canopy with *Carex striata* and *Aristida palustris* as the herbaceous layer co-dominants, and by a high herbaceous species richness.

(6) Habitat

This community type occurs in small, fairly steep-sided depressions located on relatively flat and undissected land surfaces for this vegetation subclass, and is characterized by very poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods of time in most years. At the time of sampling, the water table within this community type stood an average of some 51 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays over a "typical", fine-loamy, siliceous, thermic Umbric Paleaquult soil (Table A-II-1). The general characteristics of Umbric Paleaquults are discussed for CT 9.1.1, above. A representative sampled pedon of an Umbric Paleaquult soil similar to the one found beneath this community type is described for CT 9.1.1 in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soil underlying this community type is extremely acid to very strongly acid. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Percent humic matter is low and decreases with depth. Soil bulk density is very high throughout the profile. Silt- and sand-sized particles share dominance near the surface, but sand-sized particles dominate the soil mineral fraction at lower levels within the measured soil solum.

(8) Succession & Disturbance

This community type shows substantial evidence of past fire effects, including charred (burned out) stumps, fire scars occurring well up the trunks of canopy trees, the very clumped nature of the *Ilex myrtifolia* present, and the occasional presence of charcoal fragments in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 5 to 10 years (Table 4.28). Under this regime of frequent fires, the site vegetation would be expected to remain in its current, "savanna-like" condition. As previously noted for several community types within this vegetation class, herbaceous species dominants will likely vary, according primarily to variations in site surface water depth and periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, the dominance of woody species, such as the *Ilex myrtifolia* common in the community type and the *Clethra alnifolia* common in the surrounding landscape, would be expected to increase significantly.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although most sites containing this community have been used in the past for livestock grazing, as indicated by the vestiges of barbed-wire fence lines common at these sites. Surrounding landscapes have undergone moderately extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Umbric Paleaquult soils, which represent 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays, but are much less common than Paleaquults and Fragiaquults at that landscape position (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in south central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 6 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the

Southeast.

4.3.9.4.6 COMMUNITY TYPE: ***(Ilex myrtifolia)/Hypericum fasciculatum-Stillingia/ Carex striata*** **Meadow (9.4.6)**

(1) Synonymy

Pond Cypress Savanna *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Andropogon virginicus* var. *glaucus, Bartonia virginica, Carex striata* var. *striata, Clethra alnifolia, Dichanthelium longiligulatum Eleocharis microcarpa, Eriocaulon compressum, Eriocaulon decangulare, Eupatorium leucolepis, Fuirena squarrosa, Hypericum cistifolium, Hypericum fasciculatum, Ilex myrtifolia, Lycopus angustifolius, Myrica cerifera* var. *cerifera, Nyssa biflora, Panicum rigidulum* var. *combsii, Pinus elliottii, Pluchea foetida, Proserpinaca pectinata, Rhexia virginica, Rhynchospora filifolia, Rhynchospora inundata, Saccharum giganteum, Scleria reticularis, Stillingia aquatica, Taxodium ascendens, Tillandsia usneoides, Xyris fimbriata*

(3) Special Status Species

*Andropogon gyrans* var. *stenophyllus, Hypericum fasciculatum, Lycopus angustifolius, Oxypolis canbyi, Rhynchospora inundata, Scleria georgiana, Scleria reticularis, Stillingia aquatica*

(4) Vegetation & Physiognomy

Woody strata are essentially absent from this wet meadow community type, but scattered specimens of *Taxodium ascendens* and *Pinus elliottii* comprising a variety of size classes are scattered throughout the herbaceous vegetation. The largely "bi-layered" herbaceous stratum dominates, and consists of a moderately open, overtopping layer of *Hypericum fasciculatum*, and to a somewhat lesser extent, *Stillingia aquatica*, to *ca.* 1.5 m in height. These species are underlain by a moderately open layer of *Carex striata ca.* 0.5 m in height. Typically, *Eupatorium capillifolium, Panicum rigidulum* var. *combsii, Rhynchospora inundata* and *Saccharum giganteum* are significant components of the overtopping herbaceous layer, while *Eriocaulon compressum, Eriocaulon decangulare* and *Rhynchospora filifolia* are important constituent species in the lower herbaceous layer within this community type.

This community type exhibited the highest mean species richness at the 0.1 ha level seen within this vegetation subclass, at 33.57 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type lacks a true canopy layer, but is distinguished primarily by its herbaceous co-dominants, *Hypericum fasciculatum* and *Stillingia aquatica.*

(6) Habitat

This community type occurs in small to medium-sized, fairly steep-sided depressions located on relatively flat and undissected land surfaces for this vegetation subclass, and is characterized by very poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is characteristically inundated except in the driest seasons or during drought periods. At the time of sampling, the water table within this community type stood an average of 4 cm above the very irregular soil surface. Much of the surface irregularity at sites exhibiting this community type is caused by the wallowing activity of American alligators (*Alligator mississippiensis*), which use bay depressions for nesting and feeding habitat in many parts of the study area. The higher species richness at sites exhibiting this community type is caused at least in part by this alligator activity, which results in a high degree of micro-relief and the consequent relative increase of typically noninundated habitat located within such depressions. "Windthrow", *i.e.*, the downing or tipping of canopy trees, was also observed to be a common occurrence within sites exhibiting this community type.

(7) Soils

Like the immediately preceding community type, this wet meadow community occurs within study area Carolina bays over fine-loamy, siliceous, thermic Umbric Paleaquult soils (Table A-II-1). The general characteristics of that soil family are discussed for CT 9.1.1, above. A representative, sampled pedon of a fine-loamy, siliceous, thermic Umbric Paleaquult soil similar to the one found to underlie this community type is described in Appendix II for CT 9.1.1.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is very strongly acid in surface layers, decreasing to extremely acid at 50 cm in depth. This community type occurs on relatively nutrient poor soils. The CEC is low throughout the soil solum, but particularly near the surface, a lower than usual percentage of that CEC is occupied by hydrogen and aluminum ions. Base saturation of the CEC is relatively high, as are the relative levels of major cations available for this soil family, particularly calcium and manganese. Humic matter content is moderate at the surface, but decreases markedly with increasing depth. The bulk density of this soil is low at the surface, and moderate at increasing depths within the measured soil solum. Silt-sized particles account for about one-half of the mineral fraction at the surface, but shares dominance with sand-sized particles at increased depths within the measured soil solum.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including fire scars on the trunks of canopy trees, the clumped nature of shrubs that are present, and the occasional presence of charcoal fragments in surface soil layers. Reportedly, fires have occurred within this community type with a frequency of approximately every 10 to 25 years (Table 4.28). Under this fire regime and given its characteristic wetness, the site vegetation would be expected to remain in its open, "meadow-like" condition. As previously noted for several community types within this vegetation class, herbaceous species dominants will likely vary, primarily according to variations in site surface water depth and periodicity, and site seedbank species composition and abundance. In the long-term absence of fire, the dominance of *Pinus elliottii* would be expected to increase, although the long-term hydrologic regime of this community type will determine whether woody species colonizers become successfully established.

As indicated by Table 4.28, this community type shows evidence of recent timbering in some areas, in addition to the animal activity previously described. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "(*Ilex myrtifolia*)/*Hypericum fasciculatum-Stillingia*/*Carex striata* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Umbric Paleaquult soils, which comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays, but are much less common than Paleaquults and Fragiaquults on that landscape surface (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in the southernmost study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 6 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown

Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.8.4.7 COMMUNITY TYPE: ***Taxodium ascendens/Clethra/Carex striata-Panicum hemitomon/(Eriocaulon compressum-Lachnanthes)* Savanna (9.4.7)**

(1) Synonymy

Pond Cypress Savanna *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Andropogon glomeratus* var. *glaucopsis, Andropogon virginicus* var. *glaucus, Andropogon virginicus* var. *virginicus, Aristida palustris, Burmannia biflora, Carex striata* var. *striata, Clethra alnifolia, Eriocaulon compressum, Eupatorium leucolepis, Lachnanthes caroliniana, Panicum hemitomon, Panicum rigidulum* var. *combsii, Panicum verrucosum, Persea palustris, Rhexia mariana, Saccharum giganteum, Scleria reticularis, Taxodium ascendens, Woodwardia virginica, Xyris fimbriata*

(3) Special Status Species

*Aristida palustris, Burmannia biflora, Lycopus angustifolius, Rhynchospora inundata, Scleria reticularis*

(4) Vegetation & Physiognomy

This wet savanna community type is characterized by a moderately open canopy of relatively short (8 to 10 m in height), medium to large-boled, very flat-topped *Taxodium ascendens* having widely flared bases, and a "stocky" appearance. The canopy *Taxodium* appear to be relatively even-aged, and while there is no subcanopy stratum, transgressive

*Taxodium* saplings of all size classes are common within the community type. The shrub layer is dominated by a tall (*ca.* 4 m in height), open "layer" of multi-stemmed *Clethra alnifolia* growing around the boles of canopy cypress trees and primarily rooted in bark crevices of cypress boles. *Persea palustris* is an additional, significant component of the shrub stratum. The herbaceous layer is formed by a dense mixture of primarily three species -- *Carex striata, Panicum hemitomon,* and *Woodwardia virginica. Lachnanthes caroliniana* and *Eriocaulon compressum* are locally significant constituents of the herbaceous stratum within this community type.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 24.25 species (Table 4.2).

<u>(5) Distinguishing Features</u>

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished especially by its underlying Spodosol, but also by its canopy of *Taxodium ascendens*, the abundance of *Clethra alnifolia* around canopy trees, and the herbaceous layer co-dominance of *Carex striata* and *Panicum hemitomon*.

<u>(6) Habitat</u>

This community type occurs in small, shallow depressions located on nearly level, relatively undissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods of time in years having average precipitation. At the time of sampling, the water table within this community type stood an average of 38 cm below the soil surface, but water marks on the trees indicate that water stands seasonally at some 12 to 15 cm.

(7) Soils

This community type occurs within study area Carolina bays over sandy, siliceous, thermic Typic Haplaquod soils (Table _), a significant departure from the soil families found to underlie other Wet Savanna/Meadow community types. The general characteristics of that soil family are discussed for community types 5.0.1 and 7.2.1, above. Representative sampled pedons of a sandy, siliceous, thermic Typic Haplaquod soil similar to that occurring beneath this community type are described in Appendix II for community types 5.0.1 and 7.2.1. Nevertheless, because this is the only "specific" community type within the study area, either sampled or generally observed, falling into the "Intermittently Ponded Cypress/ Gum Depression" vegetation class that occurs over a soil other than an Ultisol, a description of a sampled pedon underlying this community type is also set out in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths, registering the lowest recorded for soils underlying community types within this vegetation subclass. This community type occurs on nutrient poor soils. The CEC is extremely low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Soil humic matter content is much higher for this community type than for other community types within this vegetation class especially near the surface, although humic matter content decreases substantially with increasing depth. Bulk density for the soil underlying this community type is low at the surface, but high at 50 cm, presumably due to the relatively high organic matter content of the soil near the surface. Silt-sized particles account for the highest percentage dominance within this soil at the surface, with sand predominating as depth increases. Clay-sized particles comprise an insignificant portion of the mineral fraction of the soil characterizing this community type.

(8) Succession & Disturbance

This community type occurs within a landscape dominated by Longleaf Pine Woodlands, which is typically a fire-maintained ecosystem, and evidence of frequent fire is abundant. Within this community type, relatively "hot" fires appear to have been common, and those evidences include charred stumps, fire scars on the trunks of canopy trees to 8 m in height, the extremely clumped nature of *Clethra alnifolia* and *Persea palustris*, and the common presence of charcoal fragments in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 5 to 10 years (Table 4.28). Under this regime of frequent fires, the site vegetation would be expected to remain in its open, "meadow-like" condition. As previously noted for several community types within this vegetation class, herbaceous species dominants will likely vary, primarily according to variations in site surface water depth and periodicity, and site seedbank species composition and abundance. Observation of similar depression communities in the region indicates that in the long-term absence of fire the dominance of *Clethra alnifolia* will increase greatly, at the expense of the herbaceous stratum, and that *Nyssa biflora* could be expected to form a dense subcanopy layer and ultimately become a canopy dominant.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance. Surrounding landscapes have undergone relatively little alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Taxodium ascendens/Clethra alnifolia/Carex striata-Panicum hemitomon/(Eriocaulon compressum-Lachnanthes)* Savanna" is found in Carolina bays of the Outer Lower Coastal Plain (Table 4.3), and makes up some 12 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over sandy, siliceous, thermic Typic Haplaquod soils, which represent 1 of 3 soil families observed within sampled Outer Lower Coastal Plain Carolina bays, and are relatively common in depressions located on that surface (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in southeastern study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 6 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities. Pond Cypress Savannas occurring over Spodosols are virtually unknown in other Carolina bays within the study area.

(11) Conservation Status

A South Carolina example of this community type within a Carolina bay occurs on State-owned lands used in part as a nature preserve.

### 4.3.9.4.8 COMMUNITY TYPE: ***Liquidambar styraciflua/Ilex amelanchier/Carex striata-Panicum hemitomon* Savanna (9.4.8)**

(1) Synonymy

Non-alluvial Swamp *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Acer rubrum, Carex striata* var. *striata, Dichanthelium wrightianum, Diospyros virginiana, Eupatorium leucolepis, Hypericum fasciculatum, Ilex amelanchier, Liquidambar styraciflua, Myrica cerifera* var. *cerifera, Panicum hemitomon, Panicum rigidulum* var. *combsii, Panicum verrucosum, Persea palustris, Rhexia aristosa, Rhynchospora filifolia, Saccharum giganteum*

(3) Special Status Species

*Hypericum fasciculatum, Ilex amelanchier, Ludwigia sphaerocarpa, Rhexia aristosa, Scleria reticularis*

(4) Vegetation & Physiognomy

The moderately dense canopy of this wet savanna community type is dominated by a mixture of relatively small (5 to 7 m in height) *Nyssa biflora, Pinus taeda* and particularly, *Liquidambar styraciflua*. While no subcanopy layer is present, transgressives of the canopy and other woody species of varying size classes are common within this community type, giving it a somewhat less open appearance than many of the other "savanna-like" vegetational communities within this vegetation class. The sparse shrub layer consists of scattered, multi-stemmed clumps of *Ilex amelanchier*. A dense cover of *Carex striata* and *Panicum hemitomon* dominate the herbaceous stratum within the community. *Hypericum fasciculatum* and *Proserpinaca pectinata* are other significant components of the community type herbaceous stratum. This community type includes the southernmost known location of *Ilex amelanchier* within a Carolina bay depression.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 19.96 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by its primarily *Liquidambar styraciflua* canopy overtopping *Carex striata* and *Panicum hemitomon* as herbaceous layer dominants, and by the presence of *Ilex amelanchier* in a Carolina bay not dominated by *Taxodium ascendens*.

(6) Habitat

This community type occurs in small, shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, moderately slowly permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table appears to be variable both seasonally and from year to year, and is at least periodically inundated for significant periods of time. At the time of sampling, the water table within this community type stood an average of 12 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays over clayey, kaolonitic, thermic Typic Paleaquult soils (Table A-II-1). As previously noted, Paleaquults are poorly drained soils characteristic of many small, shallow upland depressions of the Middle Coastal Plain (Leab, 1990). However, the soil family found beneath this community type differs from those Typic Paleaquults already discussed in terms of mineralogy, the soil here being dominated by finer mineral particles and "2-to-1" clays. Like the Typic Fragiaquult soils found in many Carolina bays within the study area, which share the same mineralogy, these soils exhibit the gray to brightly colored mottling pattern characteristic of soils developed in an upland area with a fluctuating ground water, but lack a fragipan horizon. The general characteristics of Typic Fragiaquult soils have been previously discussed for community types 9.2.1 and 9.3.1, and a representative sampled pedon of a fine-loamy, siliceous, thermic Typic Fragiaquult is described in Appendix II for each of those community types. A pedon of the soil observed underlying this community type is also described in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid at all measured soil depths. This community type occurs on relatively nutrient poor soils. The CEC is extremely low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. The soil profile is characterized by moderate levels of humic matter at the surface, but decreasing levels with increasing depth. Soil bulk density is moderate throughout the profile. Sand- and silt-sized particles share dominance near the surface, with sand-sized particles increasing dominance with depth within the measured soil solum.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including fire scars on the trunks of rim and some canopy trees, the extremely clumped nature of *Ilex amelanchier* and *Nyssa biflora*, and some surface charcoal fragments. Reportedly, fires have occurred in recent history with a frequency of approximately every 20 years (Table 4.28). Under this fire regime, the site vegetation would be expected to remain in an open, "savanna-like" condition. Typically, Carolina bay depressions that contain a relatively high proportion of *Liquidambar styraciflua*, as is found in this community type, also contain a similarly high proportion of *Pinus taeda*. However, *Pinus* seedlings and saplings are relatively few within this community type. Woody species common to the community type, especially *Liquidambar, Ilex amelanchier* and *Diospyros virginiana*, would be expected to increase their dominance both during the interval between fires, and with long-term fire exclusion from the community.

As indicated by Table 4.28, this community type shows evidence of some cutting of canopy trees in the past, but little other disturbance. Surrounding landscapes have undergone moderate alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "*Liquidambar styraciflua/Ilex amelanchier/Carex striata-Panicum hemitomon* Savanna" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 1 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Four of 482 intensively sampled plots (0.8%), occurring in south central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 6 percent of the sampled community types that make up the vegetation subclass, and less than 2 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

### 4.3.9.4.9 COMMUNITY TYPE: *(Taxodium ascendens)/Aristida palustris-Rhynchospora inundata/Rhynchospora filifolia-Helenium-Centella* Meadow (9.4.9)

(1) Synonymy

Pond Cypress Savanna *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Agalinis linifolia, Andropogon virginicus* var. *glaucus, Aristida palustris, Centella asiatica, Dichanthelium wrightianum, Drosera capillaris, Eupatorium leucolepis, Euthamia tenuifolia, Helenium pinnatifidum, Hypericum cistifolium, Ilex myrtifolia, Nyssa biflora, Pinus serotina, Rhexia aristosa, Rhynchospora filifolia, Rhynchospora inundata, Sabatia difformis, Saccharum giganteum, Taxodium ascendens*

(3) Special Status Species

*Agalinis linifolia, Andropogon gyrans* var. *stenophyllus, Aristida palustris, Boltonia asteroides, Coelorachis rugosa, Dichanthelium erectifolium, Helenium pinnatifidum, Lycopus angustifolius, Oxypolis canbyi, Panicum tenerum, Rhexia aristosa, Rhynchospora inundata, Scleria reticularis*

(4) Vegetation & Physiognomy

This wet meadow community type is characterized by very sparse woody "strata" of relatively small (5 to 8 m in height) *Taxodium ascendens* overtopping widely scattered *Ilex myrtifolia*, giving the community a decided "savanna-like" appearance, but exhibiting insufficient importance values to justify including those layers in the community type name. The herbaceous stratum in the community type is "bi-layered" and relatively diverse, consisting primarily of *Aristida palustris* and *Rhynchospora inundata*, overtopping *Rhynchospora filifolia* and *Helenium pinnatifidum* in the ground cover layer. Other significant components of the overtopping and ground cover herbaceous layers, respectively, include *Andropogon virginicus* var. *glaucus, Eupatorium leucolepis, Euthamia tenuifolia* and *Saccharum giganteum*, and *Dichanthelium wrightianum* and *Rhexia aristosa*.

This community type exhibited a comparatively high mean species richness at the 0.1 ha level, at 27.69 species (Table 4.2).

(5) Distinguishing Features

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by its relatively high herbaceous species richness, its sparse *Taxodium ascendens* canopy, and *Aristida palustris* and *Helenium pinnatifidum* as herb dominants.

(6) Habitat

This community type occurs in small, relatively steep-sided depressions located on nearly level, relatively undissected land surfaces, and is characterized by very poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is reportedly inundated for significant periods of time in most years. At the time of sampling, the water table within this community type stood an average of 6 cm below the soil surface.

(7) Soils

This community type occurs within study area Carolina bays on fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquult soils (Table A-II-1). Umbraquults are very wet, dark-colored Aquults (*i.e.*, wet clay soils), so-named for their "umbric epipedon" -- a dark, organic material dominated surface horizon having a low base saturation (Soil Survey Staff, 1975). A pedon description of the Typic Umbraquult soil found beneath this community type is described in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid throughout the measured soil solum. This community type occurs on relatively nutrient poor soils. The CEC is low throughout the soil solum, and the vast bulk of that CEC is occupied by hydrogen and aluminum ions. Base saturation of the CEC is. Humic matter content is moderate at the surface and decreases with increasing depth. The bulk density of this soil is moderate at all depths within the measured soil solum. Sand- and silt-sized particles share dominance near the surface, with sand an increasingly large component of the soil mineral fraction with increasing soil depth within the measured soil solum.

(8) Succession & Disturbance

Like virtually all Wet Savanna/Meadow sites, this community type shows evidence of past fire effects, including charred stumps, fire scars on the trunks of canopy trees, fire scars on the trunks of rim trees, the extremely clumped nature of shrubs that are present, and the occasional presence of charcoal fragments in surface soil layers. Reportedly, fires have occurred in recent history with a frequency of approximately every 5 to 10 to 25 (Table 4.28). Under this regime of frequent fires, the site vegetation would be expected to remain in its open, "savanna-like" condition. As previously noted for several community types within this vegetation class, herbaceous species dominants will likely vary according to variations in site surface water depth and periodicity, as well as site seedbank species composition and abundance. Observation of similar depression vegetational communities in the region indicates that in the long-term absence of fire, the dominance of the woody components of this community type -- especially *Nyssa biflora, Liquidambar styraciflua, Clethra alnifolia, Persea palustris, Zenobia pulverulenta* and *Vaccinium* spp. -- will increase dramatically, at the expense of the diverse herbaceous stratum.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although some sites containing this community type have been used for livestock grazing or have some canopy trees removed by cutting. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "(*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata*/ *Rhynchospora filifolia-Helenium-Centella* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 2 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over fine-loamy, siliceous, thermic Umbric Paleaquult soils, which comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays, but are much less common than Paleaquults and Fragiaquults at this landscape position (Table 4.4).

(10) Distribution & Abundance

Eight of 482 intensively sampled plots (1.7%), occurring in south central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 11 percent of the sampled community types that make up the vegetation subclass, and 3 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Extensive field reconnaissance within the study area indicated that undisturbed Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare, and no sampled community type within this vegetation subclass is frequent. Moreover, this community type is rare, and most potential similar sites have been severely degraded by human activities.

(11) Conservation Status

No examples of this community type within a Carolina bay are known to be currently protected within the study area, or elsewhere within the range of Carolina bays in the Southeast.

4.3.9.4.10 COMMUNITY TYPE: ***(Taxodium ascendens)/Rhynchospora inundata/ Centella* Meadow (9.4.10)**

(1) Synonymy

Pond Cypress Savanna *p.p.* (Bennett and Nelson, 1991); Cypress Savanna, Typic Variant *p.p.* (Schafale and Weakley, 1990).

(2) Constant Species (*see* Table 4.27)

*Centella asiatica, Euthamia tenuifolia, Lachnanthes caroliniana, Lycopus angustifolius, Panicum hemitomon, Panicum verrucosum, Rhynchospora inundata, Saccharum giganteum, Taxodium ascendens, Utricularia juncea*

(3) Special Status Species

*Agalinis linifolia, Andropogon gyrans* var. *stenophyllus, Aristida palustris, Coelorachis rugosa, Eupatorium recurvans, Ludwigia suffruticosa, Lycopus angustifolius, Oxypolis canbyi, Rhynchospora inundata, Rhynchospora tracyi, Scleria reticularis*

(4) Vegetation & Physiognomy

This wet meadow community type typically consists of widely scattered, small (to 5 m in height) specimens of *Taxodium ascendens*, giving the community a "savanna-like" appearance. However, true woody strata are absent from the community type, and it is characterized by a "bi-layered", relatively dense herbaceous cover. The "upper" herbaceous stratum dominant is *Rhynchospora inundata*, overtopping a ground cover of *Centella asiatica* and *Utricularia juncea*. Other characteristic species include *Saccharum giganteum*, which appears more or less as a scattered, "emergent" species within the herbaceous stratum. *Andropogon gyrans* var. *stenophyllus* is a locally abundant and significant vegetative constituent of this community type. Its dead stems and leaves often carpet the ground in thick mats. In addition, *Lachnanthes caroliniana* also occurs in large, dense patches in the lower herbaceous layer.

This community type exhibited moderate mean species richness at the 0.1 ha level, at 18.37 species (Table 4.2).

<u>(5) Distinguishing Features</u>

Wet Savanna/Meadows are generally characterized by: (1) moderate species richness, (2) an open aspect, with dominance by herbaceous species with or without an open canopy layer of cypress or gum (3) a mineral soil, and (4) a variable water table. Community types are distinguished primarily by their presence/absence of a canopy and herbaceous layer species dominants. This community type is distinguished by a very sparse layer of small *Taxodium ascendens*, a graminoid layer dominated by *Rhynchospora inundata*, and a ground cover of *Centella asiatica*.

<u>(6) Habitat</u>

This community type occurs in small to medium-sized, relatively shallow depressions located on moderately flat and dissected land surfaces, and is characterized by poorly drained, rapidly moderately permeable, mineral soils (Table 4.28; Figure 4.54). The site soil water table is highly variable both seasonally and from year to year, although the site surface is inundated for significant periods of time in most years. At the time of sampling, the water table within this community type stood an average of 65 cm below the soil surface, but water marks on site trees indicates seasonal inundation to 25 cm.

<u>(7) Soils</u>

This community type occurs within study area Carolina bays over clayey, kaolonitic, thermic Typic Paleaquult soils (Table A-II-1). The general characteristics of that soil family are discussed for CT 9.4.8, above. Similarly, a representative sampled pedon description similar to the one found beneath this community type is described for CT 9.4.8 in Appendix II.

A summary of soil chemical and textural properties for the soils underlying this community type is set out in Tables A-II-2 to A-II-4, and A-II-5 to A-II-7, respectively. Those data indicate that the pH for the soils found beneath this community type is extremely acid in surface layers and very strongly acid at a depth of 50 cm. This community type occurs on relatively nutrient poor soils. The CEC is very low throughout the soil solum, and the bulk of that CEC is occupied by hydrogen and aluminum ions, with only moderate base saturation. Percent humic matter is significant only at the surface, and decreases markedly with increasing depth. Soil bulk density is moderate throughout the profile. Silt-sized particles predominate at all depths within the measured soil solum, while sand comprises a relatively minor portion of the mineral soil fraction for the soil family underlying this community type.

(8) Succession & Disturbance

As with other "Wet Savanna/Meadow" sites, this community type shows evidence of past fire effects, particularly charred stumps, fire scars on the trunks of site trees, and the multi-stemmed, or clumped, nature of most woody species present. Reportedly, fires have occurred in recent history with an average frequency of approximately every 5 to 10 years (Table 4.28). Under this regime of frequent fires, the site vegetation would be expected to remain in its open, "meadow-like" condition. As previously noted for several community types within this vegetation class, herbaceous species dominants will likely vary, primarily according to variations in site surface water depth and periodicity, as well as site seedbank species composition and abundance. In the long-term absence of fire, the *Pinus taeda* seedlings and saplings common within this community and around the periphery of sites exhibiting this community type would be expected to increase greatly in dominance.

As indicated by Table 4.28, this community type shows relatively little evidence of recent human disturbance, although in the past, *Pinus taeda* and *Taxodium ascendens* trees have been removed from some parts of the community, and shallow drainage ditches are a common occurrence. Surrounding landscapes have undergone extensive alteration for human agricultural activities in the immediate area of this community type.

(9) Landscape Position

The community type "(*Taxodium ascendens*)/*Rhynchospora inundata*/*Centella* Meadow" is found in Carolina bays of the Middle Coastal Plain (Table 4.3), and makes up some 3 percent of sampled Carolina bay vegetation found within that landscape class. As previously discussed, the community type is found over clayey, kaolonitic, thermic Typic Paleaquult soils, which are common in Middle Coastal Plain bay depressions, and comprise 1 of the 7 Aquult soil families that predominate within sampled Middle Coastal Plain Carolina bays (Table 4.4).

(10) Distribution & Abundance

Eleven of 482 intensively sampled plots (2.3%), occurring in central study area Carolina bays, fall within this classification (Table 4.5; Figure 4.42). This community type comprises 16 percent of the sampled community types that make up the vegetation subclass, and 5 percent of the sampled community types that comprise Intermittently Ponded Cypress/Gum Depressions. Wet Savannas/Meadows, like Drawdown Savannas/Meadows, are relatively rare within the study area, and most potential sites for this vegetation type have been fundamentally altered by human activities.

(11) Conservation Status

An example of this community type currently exists within a North Carolina bay depression that is privately held for the express purpose of biodiversity conservation.

4.3.9.5 ANALYSIS

Vegetation Class/Subclass Environmental Gradients

Intermittently Ponded Cypress/Gum Depression plots as a vegetation class within study area Carolina bays are distributed along a soils pH--acidity--texture gradient and a complex orthogonally related hydrologic/disturbance/soils density--nutrient gradient (Figs. 4.57 and 4.58). Stands comprising vegetation subclasses are located on the first gradient primarily by their comparative scores for soil pH, acidity, texture, humic matter (organic acids) content, and CEC. Those factors are strongly correlated with both compositional axes on the ordination diagram for Intermittently Ponded Cypress/Gum Depression stands identified by vegetation subclass, but are most strongly associated with the first compositional axis. Stands are distributed along the second, complex gradient according to their relative values for site ambient water level, organic-dominated layer depth, soil density, soil levels of manganese, zinc, and copper, and site fire frequency. The factors comprising the latter gradient are associated with both axes of the vegetation subclass scatterplot.

With respect to Intermittently Ponded Cypress/Gum Depression vegetation subclass distribution along those gradients, Cypress/Gum Swamp stands are found on the most organic-dominated soils (*i.e.*, those with the deepest organic-dominated layer, low pH, high acidity, and high humic matter content). Those characteristics would appear to be associated with long periods in which the rhizosphere is subject to anaerobic conditions, which would retard the oxidation of organic surface material and allow the build-up of site organic matter. Despite the apparent wetness, Cypress/Gum Swamps still draw down relatively frequently, and occur at sites with moderate fire frequency.

Cypress/Gum Pond plots are found at flooded sites over relatively high pH, clayey soils (*see* Figures 4.57 and 4.58). The comparatively high content of clay is indicative of the fragipan soils that underlie these communities, as previously noted, which is in turn indicative of the long-term, highly variable water tables that characterize sites exhibiting this vegetation subclass. The soils are comparatively low in organic matter and phosphorus.

Drawdown Savanna/Meadow plots occur at similar sites to those typical of Cypress/Gum Ponds, but over a broader total range of conditions. That they occur over similar conditions as Cypress/Gum Ponds is not surprising, as discussed previously, and Cypress/Gum Pond communities might be considered the "flooded phase" of Drawdown

Savanna/Meadow vegetation. Soils for this vegetation group are also clayey, and are moderate in terms of pH, acidity, humic matter and phosphorus contents, and depth of organic-dominated layer. As indicated by the vector diagram, Drawdown Savanna/Meadow plots generally occur in highly disturbed landscapes, and a history of intra-bay livestock grazing is common (Figures 4.57 and 4.58; Table 4.26).

Stands falling within the final vegetation subclass, Wet Savanna/Meadows, occur at comparatively drier sites with sandier soils (the highest bulk densities), moderate pH and acidity levels, and low manganese, copper, zinc, and organic matter dominance (Figures 4.57 and 4.58). Despite the fact that they occur at drier sites, fire frequency appears to be lower in plots comprising this vegetation subclass. Relative site dryness (these are still wetlands soils) makes these sites more stable in terms of hydrologic conditions, which likely explains, at least in part, the fact that these sites tend to be occupied by communities dominated by long-lived perennial herbs.

In addition to the environmental gradients that govern the vegetation class as a whole, vegetation--environment relationships for each of the four vegetation subclasses that make up the group may also be examined. The environmental gradients that define each vegetation subclass of Intermittently Ponded Cypress/Gum Depressions are discussed below, in turn.

Cypress/Gum Swamp plots within study area Carolina bays are distributed along a soil permeability--surface nutrient gradient and an orthogonally related "locational"/subsoil nutrient gradient (Figures 4.43 and 4.44). Stands are located on the first gradient primarily by their comparative scores for soil permeability, and surficial phosphorus and potassium levels. Stands are also defined on the gradient by the relative degree of landscape disturbance surrounding the depression at which the sampled plot occurs. Those factors are correlated with both compositional axes on the ordination diagram for Cypress/Gum Swamp stands. Stands are distributed along the second gradient for this vegetation subclass according to their relative values for site longitude and subsoil levels of copper. These latter factors are associated with both compositional axes on the scatterplot for the vegetation subclass, but are more strongly correlated with the second compositional axis.

With respect to Cypress/Gum Swamp community type distribution along those gradients, *Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp plots are located in the central portion of each gradient. This location indicates the community's characteristic occurrence at Middle Coastal Plain sites over moderately permeable soils having moderate soil nutrient levels, at sites with moderately disturbed surrounding landscapes. *Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/Woodwardia virginica-Carex verrucosa* Swamp stands occur at relatively more eastern sites, over comparatively permeable soils with low subsoil copper and surface phosphorus and potassium levels. *Taxodium ascendens/Pinus taeda-Acer-Persea/Liquidambar/Lindera/Smilax glauca/Carex glaucescens* Swamp plots are also found at comparatively "eastern" coastal plain sites, but occur over sandier (more permeable) soils having relatively higher levels of surface potassium and phosphorus. Lastly, *Taxodium ascendens/(Nyssa biflora)* Swamp stands were found in relatively western study area sites surrounded by highly disturbed landscapes. They occur over relatively impermeable soils having comparatively high subsoil copper levels .

Both because of the small sample size and incomplete soils data for the "Cypress/Gum Pond" vegetation group, regression based vegetation--environment relationship analysis was not performed for study area stands falling in that group.

Drawdown Savanna/Meadow plots within study area Carolina bays are distributed along a hydrologic/soils density--nutrient/disturbance gradient and an orthogonally related soil texture--acidity gradient (Figures 4.49 and 4.50). Stands are located on the first gradient primarily by their comparative scores for site hydroperiod, ambient site water level, soil density and phosphorus content, and to a lesser extent, by their relative degree of site disturbance in terms of both fire frequency and grazing history. Those factors are strongly correlated with both compositional axes on the ordination diagram for Drawdown Savanna/Meadow stands. Stands are distributed along the second gradient according to their relative values for pH, soil acidity, and soil texture. The factors comprising the latter gradient are also strongly associated with both compositional axes.

With respect to Drawdown Savanna/Meadow community type distribution along those gradients, *Taxodium ascendens/(Nyssa biflora)/(Ilex myrtifolia)/(Panicum verrucosum)* Savanna plots occur at sites with low pH, acid, sandy soils also having moderately high copper levels. Plots of the *Taxodium ascendens/Nyssa biflora/Panicum verrucosum-Scleria reticularis* Savanna community type are found at sites with moderately long hydroperiods, infrequent fires, and moderate soil acidity, pH, and nutrient levels. *Nyssa biflora/Acer/(Panicum verrucosum)/Sphagnum* spp. "Savanna" stands and *Taxodium ascendens/(Cyrilla)/Scleria reticularis-Panicum verrucosum-Lachnanthes* Savanna stands are found in similar conditions. Both community types occur at sites with little history of recent disturbance, including fire, over comparatively sandy soils having moderate pH and soil nutrient levels. *Taxodium ascendens/Eupatorium leucolepis-Rhynchospora inundata/Panicum verrucosum* Savanna plots also occur in the middle portion of the relevant environmental gradients, being defined by moderate levels of the applicable environmental factors.

*(Taxodium ascendens)/Pluchea rosea-Eupatorium leucolepis/Dichanthelium wrightianum* Meadow stands, *Taxodium ascendens/(Pluchea rosea-Boltonia)/Dichanthelium wrightianum* Savanna plots, and *Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow plots occur under similar conditions, being found at sites with the comparatively least acid, highest pH soils. The soils for these community types are also silty, rather than sandy, and low in copper. Moreover, plots falling within these community types tend to occur at sites surrounded by highly disturbed landscapes.

By contrast, *Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow stands occur over comparatively sandy soils, as evidenced by their comparatively high bulk densities and high permeabilities. The community type occurs at relatively dry sites that are nevertheless characterized by low fire frequency. *Taxodium ascendens/Rhynchospora inundata* Savanna stands are found over soils with low bulk density and comparatively high phosphorus levels, at sites exhibiting relatively high levels of disturbance by fire and past grazing activities. Plots of the *Taxodium ascendens/(Nyssa biflora)/Ilex amelanchier/Carex striata-Lachnanthes* Savanna and *Taxodium ascendens/Rhynchospora inundata/Lachnanthes-Polygala cymosa* Savanna community types occur at comparatively wet sites, over sandy soils evidencing relatively low pH levels and high copper levels, and where the CEC is largely occupied by hydrogen and aluminum ions.

Wet Savanna/Meadow plots within study area Carolina bays are also distributed along a hydrologic/soils factors/disturbance gradient as well as an orthogonally related fire frequency gradient (Figures 4.53 and 4.54). Stands are located on the first gradient primarily by their comparative scores for a suite of hydrologic factors -- site hydroperiod, depth of the organic-dominated soil layer, and soil drainage class -- as well as soil pH, acidity and surface bulk density. Those factors are strongly correlated with both compositional axes on the ordination diagram for Wet Savanna/Meadow stands. Stands are distributed along the second gradient according to the relative fire frequency at the sites in which they occur. That factor is associated primarily with the first scatterplot compositional axis.

With respect to Wet Savanna/Meadow community type distribution along those gradients, *(Pinus taeda)/Panicum tenerum/Centella-Dichanthelium wrightianum* Meadow plots occur on the sandiest soils, which have relatively high pH and low acidity. The community type is also found at sites having comparatively good drainage and short hydroperiods, and that are subject to grazing. *Eupatorium leucolepis-Panicum rigidulum* var. *combsii/Dichanthelium erectifolium-Rhynchospora filifolia/Stylisma aquatica* Meadow stands and *Eupatorium leucolepis* Meadow plots occur under similar conditions, at sites with a low fire frequency, although they have relatively short hydroperiods, and some grazing history. Those communities occur over soils with moderate pH and acidity levels. Stands making up the next four community types -- *Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum* Meadows, *(Ilex myrtifolia)/Hypericum fasciculatum-Stillingia/Carex striata* Meadows, *Taxodium ascendens/Clethra/Carex striata-Panicum hemitomon/(Eriocaulon compressum-Lachnanthes)* Savannas, and *Liquidambar/*

*Ilex amelanchier*/*Carex striata-Panicum hemitomon* Savannas -- are found at sites having comparatively longer hydroperiods, with more poorly drained soils. They are characterized by relatively low soil pH, and by a comparatively high CEC. The CEC is dominated by "acidity factors", presumably a refection of increased organic matter within the soils of these community types. Plots for the last two community types in the vegetation subclass -- (*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata*/*Rhynchospora filifolia-Helenium-Centella* Meadow stands and *Rhynchospora inundata*/*Centella asiatica-Utricularia juncea* Meadow plots -- are found at sites characterized by intermediate hydroperiod lengths, but frequent fires, and comparatively moderate soil conditions in terms of pH, acidity, drainage, and organic matter dominance.

Discussion

The vegetation dynamics of Intermittently Ponded Cypress/Gum Depressions are primarily the product of individual species and plant community responses to existing hydrologic conditions, as secondarily influenced by historic and ongoing site disturbance factors -- chiefly fire, livestock grazing, and timbering. Intermittently Ponded Cypress/Gum Depressions are generally small in size, and intra-site vegetation is often distributed along a natural hydrologic gradient from the central, "deepest" portions of the depression to the upland bay rim (Tyndall *et al.*, 1990; Schalles and Shure, 1989).

At the same time, because the hydrology of sites occupied by this vegetation class is highly dynamic, vegetation undergoes what is termed here "cyclic vegetation patterning". That is, species and communities characteristic of Intermittently Ponded Cypress/Gum Depressions respond to site hydrologic conditions not only in space, but over time. As a consequence, it is possible to find, at a given location and at given point in time, a certain community type one year, and a different community type within that same vegetation class in a subsequent year. Moreover, it is also possible to find, at a given location, a community type falling into one subgroup of this vegetation class in a given year, and a community type falling into another of the vegetation subclasses in a subsequent year (*see* Keough *et al.*, 1990; Kirkman and Sharitz, 1994). Thus in many ways, this vegetation class is as much a habitat site descriptor as it is a vegetation label.

As previously noted, the Drawdown Savanna/Meadow vegetation subclass is, at least potentially, the low-water "alter ego" of the Cypress/Gum Pond vegetation subclass. Drawdown Savanna/Meadow communities occur at those sites where flooding by shallow waters, and therefore anoxic conditions, may last for long periods of time (years), but flooding predictability is low, and drawdown occurs with "irregular certainty". Although the idea of cyclic vegetation patterning potentially applies to all Intermittently Ponded Cypress/Gum Depressions, that concept is particularly apt in describing Drawdown Savanna/Meadow community types, since they occur at sites characterized by hydrologic extremes.

The idea of combined spatial and temporal wetlands vegetation variability is not new, essentially being the basis of van der Valk's (1981) Gleasonian model of community vegetational dynamics (spatial) and plant succession (temporal) in Midwestern prairie pothole wetlands. Based on van der Valk, Kirkman (1992) developed a conceptual model of vegetational patterning and succession for southern study area Freshwater Marsh depressional communities. In both models, herbaceous wetlands species tend to occupy roughly concentric zones moving from the center of the depression to its edge, that represent different points along a natural hydrologic gradient. In reference to Drawdown Savannas/Meadows, these spatial zonation patterns sometimes appear to be simple --aquatic macrophytes occur in the flooded, interior areas of the depression; emergent wetland obligates are found adjacent to the flooded, interior zone; facultative wetland species occur above the obligates; and terrestrial species are found near the depression edge. More often, however, hydrologic relationships are much more complex, depending on a host of factors -- site micro relief features, hydroperiod, variation in water depth, seasonality of water depth, temperature, current and past site vegetation, plant propagule dispersal mechanisms, long-term seed viability, seed germination requirements, site fire and disturbance history, and chance, among others.

As noted, in addition to this annual spatial variance, a continuum of vegetational zones can occur at a single position within a depression over a period of years (Kirkman and Sharitz, 1994; Poiani and Dixon, 1995). This occurs both because different site flooding regimes (1) favor or disfavor existing site perennial species, and (2) result in differential patterns of seedling recruitment from the site seedbank.

Intermittently Ponded Cypress/Gum Depressions typically exhibit low to moderate species richness. However, that impression can also be misleading. As with most wetlands sites, Carolina bay seedbanks do not generally resemble the existing site plant communities (Poiani and Dixon, 1995). Keough *et al.* (1990) studied southern study area Carolina bay depressions and found that (1) on average, less than half the species occurring in the vegetation of the depression at the time of seedbank sampling, including many common species, were represented in the site seedbank, and (2) seedbank species richness always exceeded the species richness of site vegetation. For example, Kirkman and Sharitz (1994) found from 79 to 108 species, occurring in extraordinarily high densities, in the seedbank flora of sampled Carolina bay depressions, but less than half that number of species in the site vegetation.

Each of those investigators worked in Carolina bay depressions exhibiting wholly herbaceous vegetation (Intermittently Flooded Depression Prairies and Freshwater Marshes in this study). While their findings are clearly applicable to Drawdown Savannas/ Meadows and are plausible for other Intermittently Ponded Cypress/Gum Depression communities in terms of data collected and information observed during this study, it will take additional seedbank studies to confirm whether those findings are applicable to any or all vegetation groups within this class.

In light of the above discussion, it becomes apparent that despite low to moderate "spatial" species richness, site "temporal" species richness may be extraordinarily high. Because comparatively small groups of those latent seedbank species have similar life history requirements, the point-in-time, spatial expression of site temporal species richness will always be comparatively low. Nevertheless, Carolina bay seedbanks are exceedingly important as a recruitment reservoir both for "new" site species and individuals of many existing site species. While dominant site perennials may persist vegetatively for indefinite periods during cycles of hydroperiod fluctuation, other species not possessing such competitive tenacity persist in the seedbank.

Vegetational differences between Intermittently Ponded Cypress/Gum Depression subclasses can be discerned from an examination of the species growth forms and life forms that predominated within each vegetation subclass (Figures 4.45 and 4.46 [Cypress/Gum Swamps]; 4.47 and 4.48 [Cypress/Gum Ponds]; 4.51 and 4.52 [Drawdown Savannas/ Meadows]; and 4.55 and 4.56 [Wet Savannas/Meadows]). Woody plant growth forms (trees, shrubs, and vines) predominate in Cypress/Gum Swamp communities (45% of taxa), but are proportionately much less significant in other vegetation subclasses (from 8 to 26% of taxa). By contrast, perennial forbs and graminoids predominate in Cypress/Gum Pond (67% of taxa), Wet Savanna/Meadow (61% of taxa), and Drawdown Savanna/Meadow (60% of taxa) communities. Annual herbs and graminoids are a substantial component of the taxa only in Cypress/Gum Ponds.

Proportionately predominant life forms in Cypress/Gum Swamp community types are evenly split between species having aerial buds (47% of taxa) and those with ground-level or subterranean perennating structures (47% of taxa), while therophytes comprise a minor component of taxa in that group (6%). In Cypress/Gum Ponds, species having ground-level or subterranean perennating structures predominate (68%), while therophytes constitute a major part of the flora (25% of taxa), and species with aerial buds are a comparatively minor proportion of the taxa present (7%). Drawdown Savanna/Meadow community types show a prevalence of species having ground-level or subterranean perennating structures (65% of taxa), species with aerial buds are of intermediate importance (27% of taxa), and therophytes comprise a fairly minor component of taxa in that group (8%). Similarly, Wet Savanna/

Meadow community types also show a prevalence of species having ground-level or subterranean perennating structures (70% of taxa), species with aerial buds are of intermediate importance (22% of taxa), and therophytes comprise a fairly minor component of taxa in that group (8%).

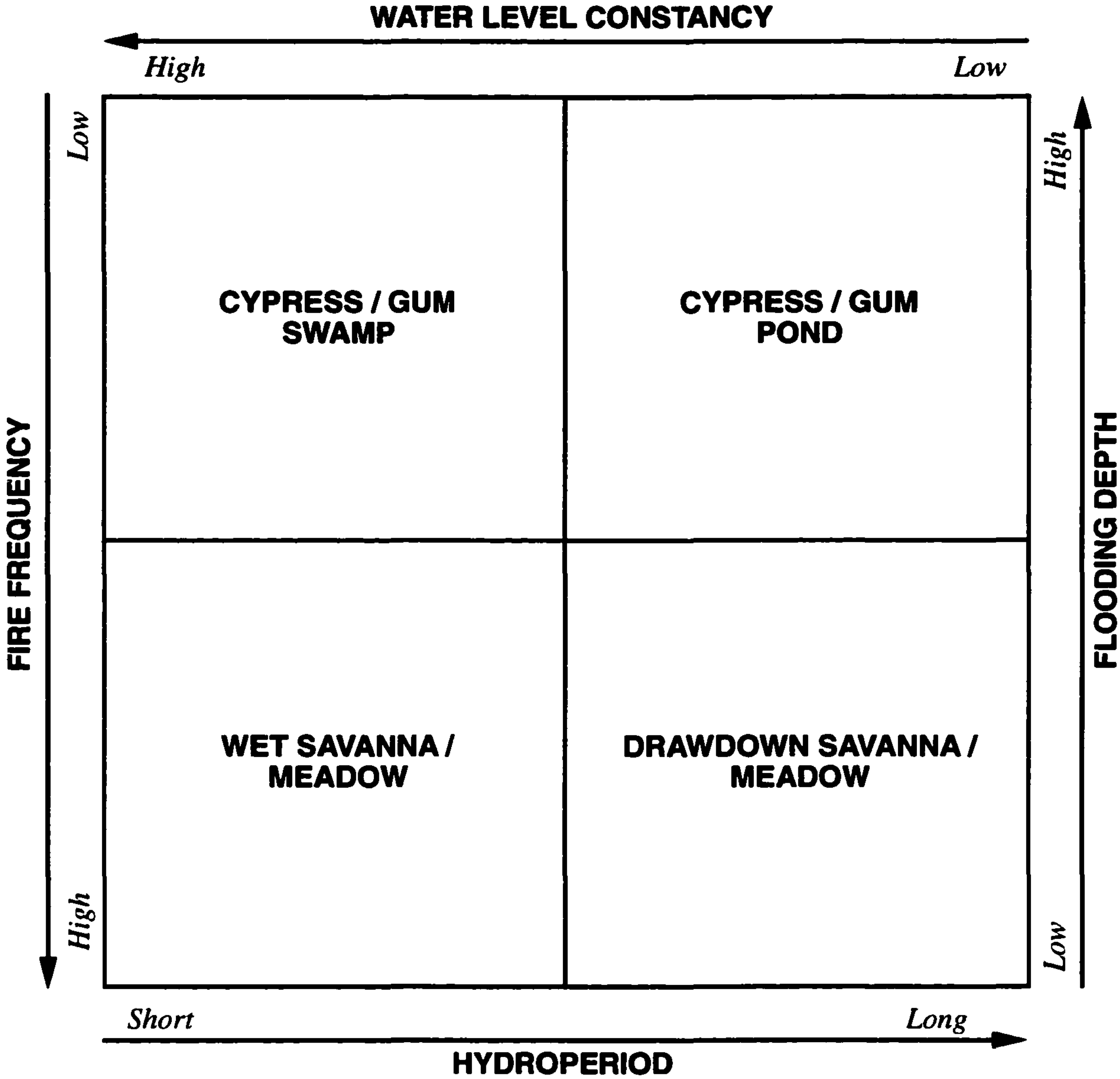
The fact that therophytes -- annual plants overwintering as seeds, as that term is traditionally defined -- are a relatively minor component of Intermittently Ponded Cypress/ Gum Depression vegetation is misleading. Field observation indicates that many perennial species characteristic of Carolina bay wetlands, while properly classified by life form as geophytes or similar designation by virtue of underground perennating structures, are therophytes in effect. For example, *Rhexia aristosa*, sometimes characterized as a Carolina bay "endemic", persists vegetatively through short-term unfavorable site conditions by the production of underground, cormous rootstocks. *Rhexia* is extremely prolific, and under favorable growing conditions a single *Rhexia aristosa* plant typically produces hundreds, or even thousands, of seeds. Through such life history strategies, *Rhexia* thus has "the best of both worlds". Under favorable hydrologic conditions -- usually, shallow inundation or moist soil -- when the temperature warms at the beginning of the growing season, *Rhexia* is able to quickly sprout from its subterranean rootstock, "keeping up" with other site perennials, and gaining a competitive edge for limited nutrients over the seedlings of annual species. However, when long-term site hydrologic conditions occur that are so extreme that all *Rhexia* individuals at the site are killed (*e.g.*, during prolonged periods of drought or deep surface inundation), with abundant seeds in the seedbank, *Rhexia* persists like an annual, and quickly sprouts as soon as favorable site conditions return.

Because, like the Cypress/Gum Bog vegetation class, Intermittently Ponded Cypress/ Gum Depressions are restricted in distribution -- central North Carolina to northern Florida, at best -- and comparatively rare throughout their range, relatively little is known about these ecosystems. Schafale and Weakley (1990) surmised that Carolina bay "Cypress Savannas" depend on a combination of flooding and fire to maintain their physiognomy, but cite Peroni

(1988) as having determined that such communities have retained their savanna-like vegetative character for half a century without fire and despite human disturbance. Following their survey of South Carolina Carolina bays, Bennett and Nelson (1991) divided depressions included in this study within the Intermittently Ponded Cypress/Gum Depression vegetation class into three groups -- Pond Cypress Pond, Non-alluvial Swamp, and Pond Cypress Savanna. According to their observations: (1) Pond Cypress Ponds have the longest hydroperiod of the three groups, being nearly permanently flooded, limiting the frequency and effect of fires; (2) Non-alluvial Swamps have moderate flooding regimes, usually being only seasonally flooded, which allows for a comparatively more diverse flora and increased canopy dominance by broad leaved species; and (3) Pond Cypress Savannas have a comparatively short hydroperiod, burn frequently, are sedge-dominated, and are the most floristically diverse of South Carolina bay community types.

The general relationship between the four vegetation subclasses found within the grouping "Intermittently Ponded Cypress/Gum Depressions" is proposed in Figure 4.59, which is based on site habitat summaries, biplot vector diagrams, literature review, and anecdotal evidence collected over a period of years. The terms used in the figure are defined in Chapter 3, above. According to Figure 4.59, in depressions characterized by comparatively long hydroperiods but low water constancy, Cypress/Gum Pond communities predominate during periods of relatively high ambient site water levels. Under those same conditions of potential hydroperiod and water constancy, but during drier periods when the site surface water level is comparatively low or the site is moist but without standing water, Drawdown Savanna/Meadow vegetational communities are to be expected. Drawdown communities are subject to relatively frequent fires, whose intensity largely varies as a consequence of the length of time since the site last burned, and hence, the site fuel load. In sites with a short hydroperiod, relatively stable surface water levels, comparatively high flooding depth, and infrequent fires, Cypress/Gum Swamp community types are favored. In depressions having similar hydroperiod and water constancy conditions, but subject to

Figure 4.42. Proposed relationships between vegetation subclasses in the Carolina bay vegetation class "Intermittently Ponded Cypress/Gum Depressions".


WATER LEVEL CONSTANCY
High
Low
FIRE FREQUENCY
Low
High
FLOODING DEPTH
High
Low
CYPRESS / GUM SWAMP
CYPRESS / GUM POND
WET SAVANNA / MEADOW
DRAWDOWN SAVANNA / MEADOW
Short
Long
HYDROPERIOD

conditions of infrequent, shallow flooding with a consequent increased exposure to fire risk, Wet Savanna/Meadow community types tend to occur.

Of course, Figure 4.59 is by necessity idealized to some extent. In the field, hydrologic regimes, fire frequencies, and other environmental facts that shape vegetation occur across a continuum, and species respond accordingly. Under intermediate conditions of site hydrologic regime or fire history, the various vegetation subclasses intergrade and plant communities become more and more difficult to "buttonhole" to a specific vegetation subclass. Bennett and Nelson (1991) expressed a somewhat different view of proposed community dynamics for Intermittently Ponded Cypress/Gum Depressions, as previously discussed. However, those conclusions appear to be based solely on short-term, qualitative observations of a comparatively limited subset of Carolina bay depressions.

Figure 4.43. Distribution of study area Carolina bay sites containing Intermittently Ponded Cypress/Gum Depression vegetation communities, by county. The yellow counties contain sampled sites exhibiting examples of Intermittently Ponded Cypress/Gum Depression community types. The blue counties, while not containing sampled examples of this vegetation group, contain bay sites wherein Intermittently Ponded Cypress/Gum Depression community types were observed during field reconnaissance for this study. In each instance, counties having bay sites exhibiting Cypress/Gum Swamp community types are indicated by vertical stripes superimposed on the county of occurrence for that vegetation subclass; counties with bay sites exhibiting Cypress/Gum Pond community types are indicated by horizontal stripes superimposed on the county of occurrence for that vegetation subclass; counties with bay sites exhibiting Drawdown Savanna/Meadow community types are indicated by SW-NE diagonal stripes superimposed on the county of occurrence for that vegetation subclass; and counties with bay sites exhibiting Wet Savanna/Meadow community types are indicated by NW-SE diagonal stripes superimposed on the county of occurrence for that vegetation subclass. Locations of individual, sampled Carolina bay sites are indicated by red circles.

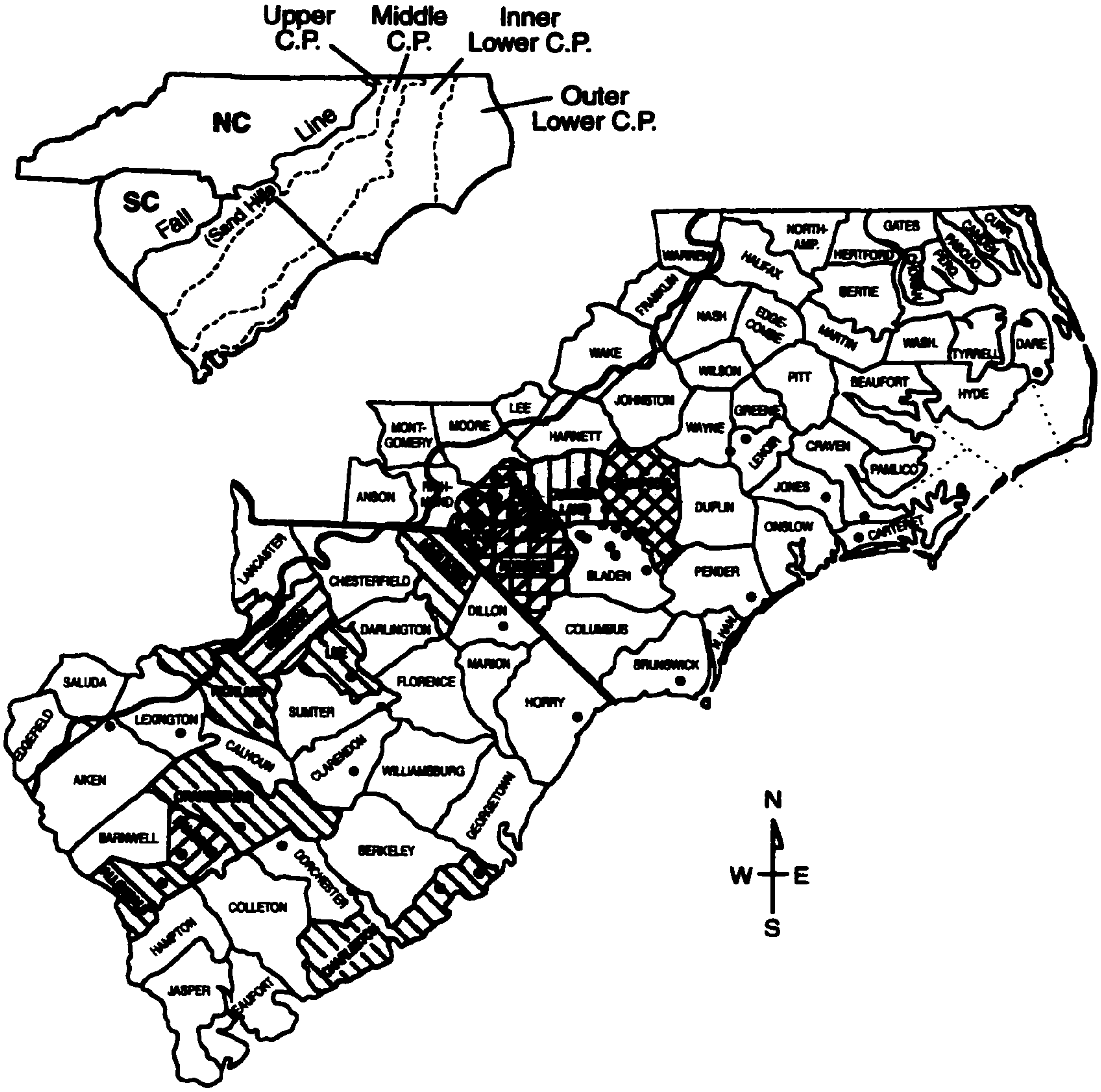

Upper C.P.
Middle C.P.
Inner Lower C.P.
Outer Lower C.P.
NC
SC
Fall Line
(Sand Hills)
N
W
E
S

Table 4.22. Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Swamp (9.1.) & Cypress/Gum Pond (9.2.) vegetation subclasses. Values are given for the vegetation class, the two subclasses, and the respective constituent community types of each subclass. Each vegetation group is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | | 9.1 | | 9.1.1 | | 9.1.2 | | 9.1.3 | | 9.1.4 | | 9.2 | | 9.2.1 | | 9.2.2 | | 9.2.3 | |
| | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| Species | | | | | | | | | | | | | | | | | | | | |
| ACER RUBRUM | 4 | 20 | 5 | 68 | 2 | 100 | 6 | 100 | 7 | 100 | 3 | 44 | | | | | | | | |
| AGALINIS LINIFOLIA* | 3 | 5 | | | | | | | | | | | | | | | | | | |
| ANDROPOGON GLOMERATUS VAR. GLAUCOPSIS | 4 | 2 | | | | | | | | | | | | | | | | | | |
| ANDROPOGON GYRANS VAR. STENOPHYLLUS** | 4 | 10 | | | | | | | | | | | | | | | | | | |
| ANDROPOGON MOHRII* | 6 | 4 | | | | | | | | | | | | | | | | | | |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 4 | 25 | 3 | 11 | | | | | | | 3 | + | | | | | | | | |
| ANDROPOGON VIRGINICUS VAR. VIRGINICUS | 3 | 1 | | | | | | | | | | | | | | | | | | |
| ARISTIDA PALUSTRIS** | 6 | 12 | | | | | | | | | | | | | | | | | | |
| ARONIA ARBUTIFOLIA | 4 | 1 | 4 | 7 | | | | | | | 4 | + | | | | | | | | |
| ASTER PILOSUS VAR. DEMOTUS | 4 | 12 | 3 | 7 | | | | | | | 3 | + | 2 | 27 | | | | | 2 | 100 |
| AXONOPUS FURCATUS | 4 | 2 | | | | | | | | | | | | | | | | | | |
| BARTONIA VIRGINICA | 2 | 6 | 2 | 7 | | | | | | | 2 | + | | | | | | | | |
| BOEHMERIA CYLINDRICA | 3 | 1 | | | | | | | | | | | | | | | | | | |
| BOLTONIA ASTEROIDES** | 4 | 18 | | | | | | | | | | | | | | | | | | |
| BURMANNIA BIFLORA** | 2 | 3 | | | | | | | | | | | | | | | | | | |
| BURMANNIA CAPITATA | 1 | + | | | | | | | | | | | | | | | | | | |
| CAREX SP.#1 | 2 | 2 | 2 | 14 | 2 | 100 | | | | | | | | | | | | | | |
| CAREX GLAUCESCENS | 4 | 6 | 5 | 39 | 4 | 100 | | | 6 | 100 | 7 | + | | | | | | | | |
| CAREX STRIATA VAR. STRIATA | 8 | 9 | 5 | 4 | | | | | | | 5 | + | | | | | | | | |
| CAREX VERRUCOSA | 4 | 3 | 5 | 18 | | | 6 | 100 | | | 1 | + | | | | | | | | |
| CENTELLA ASIATICA | 6 | 12 | 1 | 4 | | | | | | | 1 | + | | | | | | | | |
| CEPHALANTHUS OCCIDENTALIS | 3 | 4 | | | | | | | | | | | | | | | | | | |
| CHAMAEDAPHNE CALYCULATA# | 2 | + | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| CLETHRA ALNIFOLIA | 4 | 6 | 4 | 11 | | | | | | | 4 | + | | | | | | | | |
| COELORACHIS RUGOSA** | 3 | 10 | | | | | | | | | | | | | | | | | | |
| CUSCUTA COMPACTA | 2 | + | 2 | 4 | | | | | 2 | + | | | | | | | | | | |
| CYRILLA RACEMIFLORA | 5 | 4 | 6 | 21 | 3 | + | | | | | 6 | + | | | | | | | | |
| DICHANTHELIUM ERECTIFOLIUM** | 5 | 18 | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| DICHANTHELIUM LONGILIGULATUM | 4 | 9 | 3 | 14 | 1 | 50 | | | | | 4 | + | | | | | | | | |
| DICHANTHELIUM SPHAEROCARPON VAR. SPHAEROCARPON | 4 | 1 | | | | | | | | | | | | | | | | | | |

Table 4.22 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Swamp (9.1.) & Cypress/Gum Pond (9.2.) vegetation subclasses. Values are given for the vegetation class, the two subclasses, and the respective constituent community types of each subclass. Each vegetation group is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and '*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DICHANTHELIUM WRIGHTIANUM | 5 55 | 4 29 | | | | 4 50 | 6 13 | 6 + | |
| DIGITARIA SANGUINALIS | 2 + | | | | | | | | |
| DIODIA VIRGINIANA | 3 12 | 1 4 | 1 + | | | | 4 20 | 4 + | |
| DIOSPYROS VIRGINIANA | 3 6 | 3 25 | 3 100 | | | 3 + | | | |
| DROSERA CAPILLARIS | 3 9 | | | | | | | | |
| DROSERA FILIFORMIS | 3 2 | | | | | | | | |
| DROSERA INTERMEDIA | 1 1 | | | | | | | | |
| DULICHIUM ARUNDINACEUM | 4 + | | | | | | | | |
| ELEOCHARIS SP. | 7 4 | | | | | | | | |
| ELEOCHARIS MELANOCARPA** | 5 5 | | | | | | | | |
| ELEOCHARIS MICROCARPA | 4 3 | 2 4 | | | | 2 + | 4 7 | 4 + | |
| ELEOCHARIS ROBBINSII* # | 3 3 | 5 4 | | | | 5 + | | | |
| ELEOCHARIS TRICOSTATA** | 4 18 | 3 4 | | | | 3 + | 5 27 | 5 67 | |
| ELEUSINE INDICA | 2 + | | | | | | 2 7 | 2 + | |
| ERAGROSTIS PILOSA | 3 4 | 4 4 | | | | 4 + | | | |
| ERAGROSTIS REFRACTA | 4 1 | | | | | | | | |
| ERIOCAULON COMPRESSUM | 4 21 | 3 7 | | | | 3 + | | | |
| ERIOCAULON DECANGULARE | 4 2 | | | | | | | | |
| EUPATORIUM CAPILLIFOLIUM | 2 3 | 2 7 | | | | 2 + | | | |
| EUPATORIUM LEPTOPHYLLUM* | 4 2 | | | | | | | | |
| EUPATORIUM LEUCOLEPIS | 5 43 | 2 7 | | | | 2 + | 3 7 | | 3 25 |
| EUPATORIUM RECURVANS** | 4 2 | | | | | | | | |
| EUTHAMIA TENUIFOLIA | 4 20 | 3 4 | | | | 3 + | 3 27 | | 3 100 |
| FIMBRISTYLIS AUTUMNALIS | 1 + | | | | | | | | |
| FUIRENA SQUARROSA | 3 3 | 2 4 | | | | 2 + | | | |
| GELSEMIUM SEMPERVIRENS | 2 + | 2 4 | | | | 2 + | | | |
| GRATIOLA RAMOSA | 3 9 | | | | | | 3 20 | 3 + | |
| HELENIUM PINNATIFIDUM* # | 5 5 | | | | | | | | |
| HYPERICUM CANADENSE | 3 1 | 1 4 | 1 + | | | | | | |
| HYPERICUM CISTIFOLIUM | 3 23 | 1 7 | 1 + | | | 1 + | | | |
| HYPERICUM FASCICULATUM** | 6 5 | | | | | | | | |
| HYPERICUM GYMNANTHUM | 1 1 | 1 11 | 1 75 | | | | | | |
| ILEX AMELANCHIER* # | 6 12 | 7 25 | 8 100 | | | 6 + | | | |
| ILEX CORIACEA | 4 1 | 3 4 | | | | 3 + | | | |
| ILEX GLABRA | 4 2 | 5 14 | | | 5 + | 5 + | | | |
| ILEX LAEVIGATA | 2 + | 2 4 | | | | 2 + | | | |
| ILEX MYRTIFOLIA | 5 9 | | | | | | | | |
| ILEX OPACA | 3 2 | 3 14 | | | 3 75 | 3 + | | | |
| IRIS PRISMATICA** | 3 2 | 3 14 | 2 75 | | | 4 + | | | |
| ITEA VIRGINICA | 3 3 | 3 14 | | 3 + | 3 + | 3 + | | | |
| IVA MICROCEPHALA* | 2 + | | | | | | | | |
| JUNCUS DIFFUSISSIMUS | 4 3 | | | | | | | | |
| JUNCUS POLYCEPHALUS | 2 + | | | | | | | | |

Table 4.22 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Swamp (9.1.) & Cypress/Gum Pond (9.2.) vegetation subclasses. Values are given for the vegetation class, the two subclasses, and the respective constituent community types of each subclass. Each vegetation group is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and '*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JUNCUS REPENS | 5 | 3 | | | | | | | | | | | 4 | 40 | 3 | 40 | 5 | 67 | | |
| JUNCUS SP. | 3 | 1 | | | | | | | | | | | | | | | | | | |
| LACHNANTHES CAROLINIANA | 5 | 22 | 4 | 14 | | | | | | | 4 | + | | | | | | | | |
| LEERSIA HEXANDRA | 4 | 9 | 2 | 7 | | | | | | | 2 | + | | | | | | | | |
| LEUCOTHOE RACEMOSA | 3 | 3 | 3 | 18 | 4 | 100 | | | | | 3 | + | | | | | | | | |
| LINDERA MELISSIFOLIA* | 8 | 2 | 8 | 14 | | | | | 8 | 100 | | | | | | | | | | |
| LIQUIDAMBAR STYRACIFLUA | 4 | 24 | 6 | 64 | 6 | 100 | 8 | 100 | 6 | 75 | 5 | 44 | | | | | | | | |
| LITSEA AESTIVALIS* # | 3 | 2 | 5 | 7 | | | | | 5 | + | | | | | | | | | | |
| LOBELIA BOYKINII* # | 2 | 6 | | | | | | | | | | | | | | | | | | |
| LOBELIA CANBYI | 2 | 3 | | | | | | | | | | | | | | | | | | |
| LOBELIA NUTTALLII | 2 | 7 | | | | | | | | | | | | | | | | | | |
| LUDWIGIA SP. #1 | 3 | 3 | | | | | | | | | | | 2 | 20 | | | 2 | 50 | | |
| LUDWIGIA ALTERNIFOLIA | 2 | 3 | | | | | | | | | | | | | | | | | | |
| LUDWIGIA LINIFOLIA* | 4 | 2 | | | | | | | | | | | | | | | | | | |
| LUDWIGIA LINEARIS | 4 | 2 | | | | | | | | | | | | | | | | | | |
| LUDWIGIA PILOSA | 4 | 1 | | | | | | | | | | | | | | | | | | |
| LUDWIGIA SPHAEROCARPA** | 4 | + | | | | | | | | | | | | | | | | | | |
| LUDWIGIA SUFFRUTICOSA* | 3 | 5 | | | | | | | | | | | | | | | | | | |
| LYCOPODIELLA ALOPECUROIDES | 4 | 1 | 3 | 4 | | | | | | | 3 | + | | | | | | | | |
| LYCOPUS ANGUSTIFOLIUS** | 3 | 21 | 3 | 11 | | | | | | | 3 | + | 2 | 20 | | | 2 | 50 | | |
| LYCOPUS RUBELLUS | 2 | + | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| LYONIA LIGUSTRINA | 7 | 1 | 7 | 7 | | | | | | | 7 | + | | | | | | | | |
| LYONIA LUCIDA | 5 | 4 | 5 | 32 | 4 | 100 | | | | | 6 | 31 | | | | | | | | |
| LYONIA MARIANA | 2 | + | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| MAGNOLIA VIRGINIANA | 3 | 5 | 4 | 32 | 2 | + | 3 | 25 | 5 | + | 3 | 31 | | | | | | | | |
| MITREOLA SESSILIFOLIA | 3 | 2 | | | | | | | | | | | | | | | | | | |
| MYRICA CERIFERA VAR. CERIFERA | 4 | 5 | 5 | 11 | | | | | 5 | 25 | 5 | + | | | | | | | | |
| NYSSA BIFLORA | 4 | 52 | 6 | 86 | 6 | 100 | 7 | 100 | 5 | 75 | 5 | 81 | 6 | 13 | | | 6 | + | | |
| OSMUNDA REGALIS | 2 | + | 2 | 4 | | | 2 | + | | | | | | | | | | | | |
| OXYPOLIS CANBYI* # | 3 | 5 | | | | | | | | | | | | | | | | | | |
| PANICUM HEMITOMON | 4 | 30 | 4 | 25 | 1 | + | | | | | 5 | 38 | 4 | 27 | | | | | 4 | 100 |
| PANICUM RIGIDULUM VAR. COMBSII | 4 | 13 | | | | | | | | | | | | | | | | | | |
| PANICUM TENERUM* | 5 | 8 | | | | | | | | | | | | | | | | | | |
| PANICUM VERRUCOSUM | 5 | 48 | 5 | 36 | 2 | + | | | | | 5 | 50 | 4 | 13 | | | 4 | + | | |
| PASPALUM LAEVE | 5 | 3 | | | | | | | | | | | | | | | | | | |
| PERSEA PALUSTRIS | 5 | 4 | 5 | 18 | | | | | 6 | 100 | 5 | + | | | | | | | | |
| PHORADENDRON SEROTINUM | 2 | + | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| PINUS ELLIOTTII | 4 | 1 | | | | | | | | | | | | | | | | | | |
| PINUS PALUSTRIS | 6 | + | | | | | | | | | | | | | | | | | | |
| PINUS SEROTINA | 4 | 4 | 3 | 11 | | | | | | | 3 | + | | | | | | | | |
| PINUS TAEDA | 4 | 30 | 5 | 61 | 5 | 100 | | | 6 | 100 | 5 | 56 | | | | | | | | |
| PLATANUS OCCIDENTALIS | 1 | + | | | | | | | | | | | | | | | | | | |
| PLUCHEA FOETIDA | 4 | 3 | | | | | | | | | | | | | | | | | | |

Table 4.22 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Swamp (9.1.) & Cypress/Gum Pond (9.2.) vegetation subclasses. Values are given for the vegetation class, the two subclasses, and the respective constituent community types of each subclass. Each vegetation group is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLUCHEA ROSEA | 5 | 38 | | | | | | | | | | | 3 | 27 | | | | | 3 | 100 |
| POLYGALA CYMOSA | 3 | 30 | 1 | 11 | 1 | + | | | | | 1 | + | 4 | 20 | | | 4 | + | | |
| POLYPODIUM POLYPODIOIDES | 2 | + | 2 | 4 | | | 2 | + | | | | | | | | | | | | |
| PROSERPINACA PECTINATA | 3 | 10 | 4 | 4 | | | | | | | 4 | + | | | | | | | | |
| PRUNUS CAROLINIANA | 3 | 1 | | | | | | | | | | | | | | | | | | |
| PRUNUS SEROTINA | 1 | + | | | | | | | | | | | | | | | | | | |
| PSILOCARYA NITENS | 1 | + | | | | | | | | | | | | | | | | | | |
| QUERCUS LYRATA | 4 | 1 | 4 | 7 | | | | | 4 | + | | | | | | | | | | |
| QUERCUS NIGRA | 2 | 3 | 2 | 21 | 1 | + | 2 | + | | | 3 | + | | | | | | | | |
| QUERCUS PHELLOS | 4 | 3 | 3 | 4 | | | | | | | 3 | + | | | | | | | | |
| RHEXIA ARISTOSA* # | 3 | 52 | 2 | 11 | | | | | | | 2 | + | | | | | | | | |
| RHEXIA MARIANA | 3 | 4 | 1 | 4 | | | | | | | 1 | + | 3 | 20 | | | 3 | 50 | | |
| RHEXIA VIRGINICA | 3 | 3 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA CEPHALANTHA VAR. CEPHALANTHA | 4 | 3 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA CHALAROCEPHALA | 3 | 2 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA FILIFOLIA | 4 | 45 | 1 | 11 | 1 | 75 | | | | | | | 6 | 33 | | | 6 | 83 | | |
| RHYNCHOSPORA GRACILENTA | 3 | 1 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA INTERMIXTA | 4 | 3 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA INUNDATA**# | 5 | 32 | 3 | 7 | | | | | | | 3 | + | 2 | 13 | | | 2 | + | | |
| RHYNCHOSPORA PERPLEXA VAR. PERPLEXA | 4 | 30 | 3 | 11 | | | | | | | 3 | + | 2 | 27 | | | | | 2 | 100 |
| RHYNCHOSPORA RARIFLORA | 5 | 2 | | | | | | | | | | | | | | | | | | |
| RHYNCHOSPORA TRACYI* # | 6 | 3 | | | | | | | | | | | | | | | | | | |
| RUBUS ARGUTUS | 4 | 1 | | | | | | | | | | | | | | | | | | |
| SABATIA BRACHIATA | 2 | 2 | | | | | | | | | | | 2 | 7 | | | 2 | + | | |
| SABATIA DIFFORMIS | 2 | 8 | 2 | 7 | 2 | + | | | | | | | | | | | | | | |
| SACCHARUM GIGANTEUM | 4 | 21 | 3 | 21 | 3 | 75 | | | | | 3 | + | | | | | | | | |
| SAGITTARIA ISOETIFORMIS* # | 2 | + | | | | | | | | | | | | | | | | | | |
| SARRACENIA FLAVA | 3 | + | | | | | | | | | | | | | | | | | | |
| SASSAFRAS ALBIDUM | 2 | + | 2 | 4 | | | | | | | 2 | + | | | | | | | | |
| SCLERIA BALDWINII* # | 2 | + | | | | | | | | | | | | | | | | | | |
| SCLERIA GEORGIANA* | 4 | 5 | | | | | | | | | | | | | | | | | | |
| SCLERIA RETICULARIS* | 4 | 52 | 4 | 7 | | | | | | | 4 | + | 4 | 27 | | | 4 | 67 | | |
| SCLEROLEPIS UNIFLORA** | 4 | 15 | | | | | | | | | | | 6 | 93 | 7 | + | 6 | 100 | 2 | + |
| SMILAX GLAUCA | 3 | 7 | 3 | 50 | 1 | 100 | | | 6 | 100 | 2 | 38 | | | | | | | | |
| SMILAX LAURIFOLIA | 2 | 5 | 2 | 21 | 1 | 75 | | | | | 3 | + | | | | | | | | |
| SMILAX ROTUNDIFOLIA | 2 | 8 | 2 | 32 | 1 | 75 | 2 | 50 | | | 4 | + | | | | | | | | |
| SMILAX WALTERI | 4 | + | | | | | | | | | | | | | | | | | | |
| SPHAGNUM SP. | 5 | 11 | 6 | 18 | | | | | | | 6 | 31 | | | | | | | | |
| STILLINGIA AQUATICA# | 6 | 2 | | | | | | | | | | | | | | | | | | |
| STYLISMA AQUATICA* | 5 | 6 | | | | | | | | | | | | | | | | | | |
| SYMPLOCOS TINCTORIA | 5 | + | 5 | 4 | | | | | | | 5 | 6 | | | | | | | | |

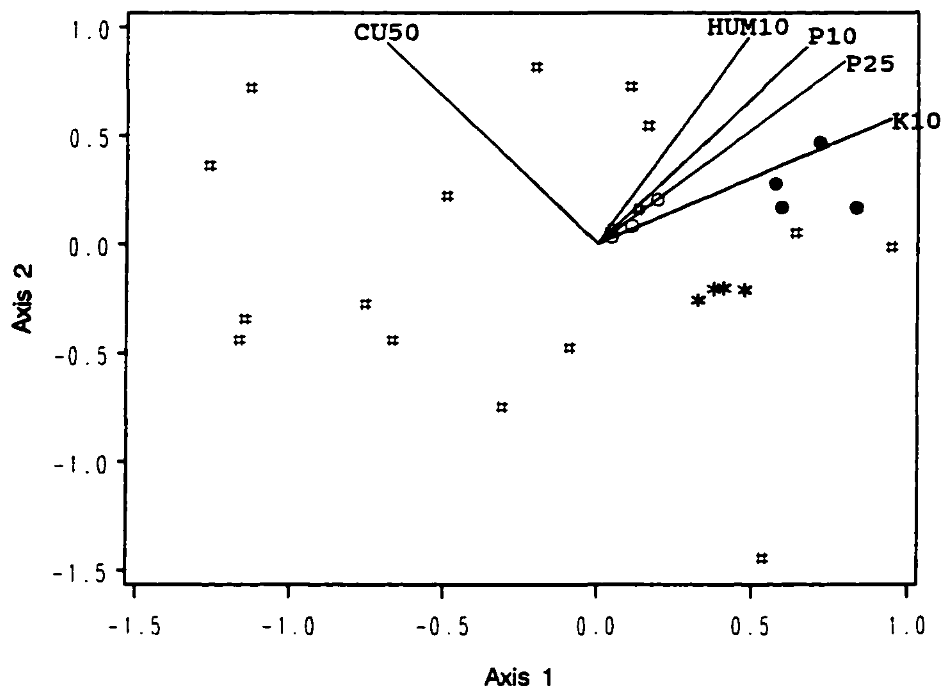
Table 4.22 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Swamp (9.1.) & Cypress/Gum Pond (9.2.) vegetation subclasses. Values are given for the vegetation class, the two subclasses, and the respective constituent community types of each subclass. Each vegetation group is represented by its abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXODIUM ASCENDENS | 6 | 76 | 6 | 89 | 6 | 100 | 6 | 100 | 6 | 75 | 7 | 88 | 6 | 100 | 7 | 100 | 6 | 100 | 6 | + |
| TILLANDSIA USNEOIDES | 3 | 6 | | | | | | | | | | | | | | | | | | |
| TOXICODENDRON RADICANS VAR. RADICANS | 3 | 9 | 3 | 21 | 1 | + | 2 | + | 4 | + | 4 | + | | | | | | | | |
| TRIADENUM TUBULOSUM** | 3 | 1 | | | | | | | | | | | | | | | | | | |
| TRIADENUM VIRGINICUM | 3 | 2 | | | | | | | | | | | | | | | | | | |
| UTRICULARIA BIFLORA | 6 | 2 | | | | | | | | | | | | | | | | | | |
| UTRICULARIA FIBROSA | 3 | 4 | | | | | | | | | | | | | | | | | | |
| UTRICULARIA JUNCEA | 7 | 3 | | | | | | | | | | | | | | | | | | |
| UTRICULARIA PURPUREA | 3 | 3 | | | | | | | | | | | 2 | 27 | | | | | 2 | 100 |
| UTRICULARIA RADIATA | 6 | + | | | | | | | | | | | 6 | 7 | | | 6 | 17 | | |
| VACCINIUM CORYMBOSUM | 3 | 1 | | | | | | | | | | | | | | | | | | |
| VACCINIUM FUSCATUM | 4 | 12 | 4 | 54 | 3 | 75 | 5 | + | 4 | 100 | 4 | 38 | | | | | | | | |
| VIOLA LANCEOLATA | 3 | 12 | 4 | 7 | | | | | | | 4 | + | | | | | | | | |
| VITIS ROTUNDIFOLIA | 3 | 4 | 2 | 7 | 1 | + | | | | | 3 | + | | | | | | | | |
| WOODWARDIA AREOLATA | 3 | 1 | | | | | | | | | | | | | | | | | | |
| WOODWARDIA VIRGINICA | 5 | 8 | 5 | 39 | 4 | 25 | 7 | 75 | 4 | 50 | 4 | 31 | | | | | | | | |
| XYRIS AMBIGUA | 2 | 11 | | | | | | | | | | | 3 | 20 | | | 3 | + | | |
| XYRIS DIFFORMIS VAR. FLORIDANA* | 3 | 1 | | | | | | | | | | | | | | | | | | |
| XYRIS FIMBRIATA | 3 | 5 | | | | | | | | | | | | | | | | | | |
| XYRIS JUPICAI | 3 | 2 | | | | | | | | | | | | | | | | | | |
| XYRIS SMALLIANA** | 3 | 3 | | | | | | | | | | | | | | | | | | |
| ZENOBIA PULVERULENTA | 5 | 2 | 5 | 11 | | | | | | | 5 | + | | | | | | | | |

Table 4.23. Average site information for the Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp" vegetation subclass. The vegetation subclass and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | | Group | | | | |
|---|---|---|---|---|---|---|
| | 9.0. | 9.1. | 9.1.1 | 9.1.2 | 9.1.3 | 9.1.4 |
| Site Hydrology | | | | | | |
| Water Depth Index | 126.7 | 114.0 | 14.0 | 119.0 | 195.0 | 127.9 |
| Hydroperiod Class | 3.5 | 3.1 | 3.0 | 3.0 | 3.0 | 3.4 |
| Water Constancy Index | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.3 |
| Organic Layer Depth | 12.5 | 13.0 | 6.0 | 8.0 | 21.0 | [17.1] |
| Soil Drainage Class | 2.1 | 2.3 | 3.0 | 2.0 | 2.0 | 2.1 |
| Soil Permeability Class | 3.0 | 3.6 | 4.0 | 4.0 | 4.0 | 2.6 |
| Soil Available Water Capacity Class | 2.7 | 2.8 | 3.5 | 3.0 | 2.0 | 2.7 |
| | | | | | | |
| Site Geomorphology | | | | | | |
| Site Elevation (m) | 55.5 | 58.1 | 76.2 | 57.9 | 36.6 | 61.6 |
| Elevational Drop in 1 Km (m) | 8.0 | 6.9 | 3.0 | 7.6 | 9.1 | 7.9 |
| Distance to 10 m Elevational Drop (m) | 2425 | 3100 | 3975 | 2825 | 2850 | 2700 |
| Depression Area (ha) | 22.6 | 31.1 | 32.2 | 3.8 | 65.1 | 23.2 |
| Depression Length/Width Ratio | 1.6 | 1.6 | 1.6 | 1.5 | 1.6 | 1.5 |
| Depression Long Axis Orientation | +3.4 | +0.2 | +2.0 | +5.0 | -4.0 | -2.1 |
| | | | | | | |
| Site Disturbance | | | | | | |
| Fire Frequency Class | 2.6 | 2.8 | 3.0 | 3.0 | 3.0 | 2.2 |
| Cultivation Index | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.8 | 1.6 | 2.0 | 2.0 | 1.0 | 1.4 |
| Timbering Index | 1.3 | 1.4 | 1.0 | 1.0 | 2.0 | 1.4 |
| Drainage Index | 1.5 | 1.8 | 2.0 | 1.0 | 2.0 | 2.0 |
| Landscape Disturbance Class | 3.4 | 3.6 | 4.0 | 4.0 | 3.0 | 3.4 |

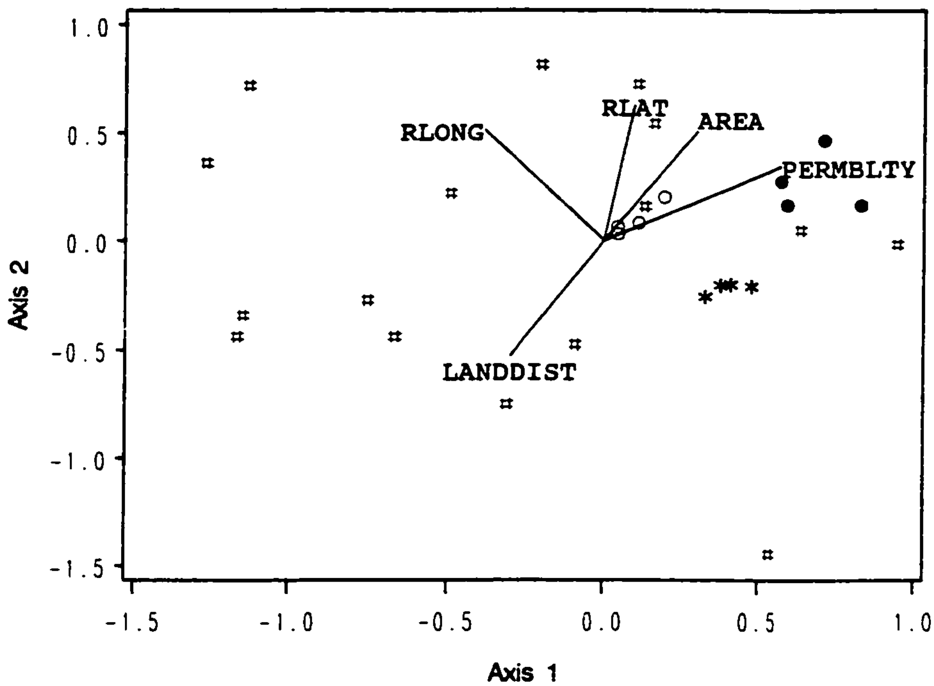
Figure 4.44. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION,**
**Cypress/Gum Swamp — Community Types:**

○ Nyssa biflora—Taxodium ascendens/Liquidambar/Ilex amelanchier Swamp
✱ Nyssa biflora—Taxodium ascendens/Liquidambar—Acer/Woodwardia virginica—Carex verrucosa Swamp
● Taxodium ascendens/Pinus taeda—Acer—Persea/Liquidambar/Lindera/Smilax glauca/Carex glaucescens Sw
# Taxodium ascendens/Nyssa biflora Swamp

Figure 4.45. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION,**
**Cypress/Gum Swamp — Community Types:**

○ Nyssa biflora—Taxodium ascendens/Liquidambar/Ilex amelanchier Swamp

✱ Nyssa biflora—Taxodium ascendens/Liquidambar—Acer/Woodwardia virginica—Carex verrucosa Swamp

● Taxodium ascendens/Pinus taeda—Acer—Persea/Liquidambar/Lindera/Smilax glauca/Carex glaucescens Sw

⌗ Taxodium ascendens/Nyssa biflora Swamp

Figure 4.46. Plant Life Forms for Intermittently Ponded Cypress/Gum Depression "Cypress/ Gum Swamp" vegetation groups found within North and South Carolina Carolina bay depressions.

PLANT LIFE FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Cypress/Gum Swamp' VEGETATION GROUPS

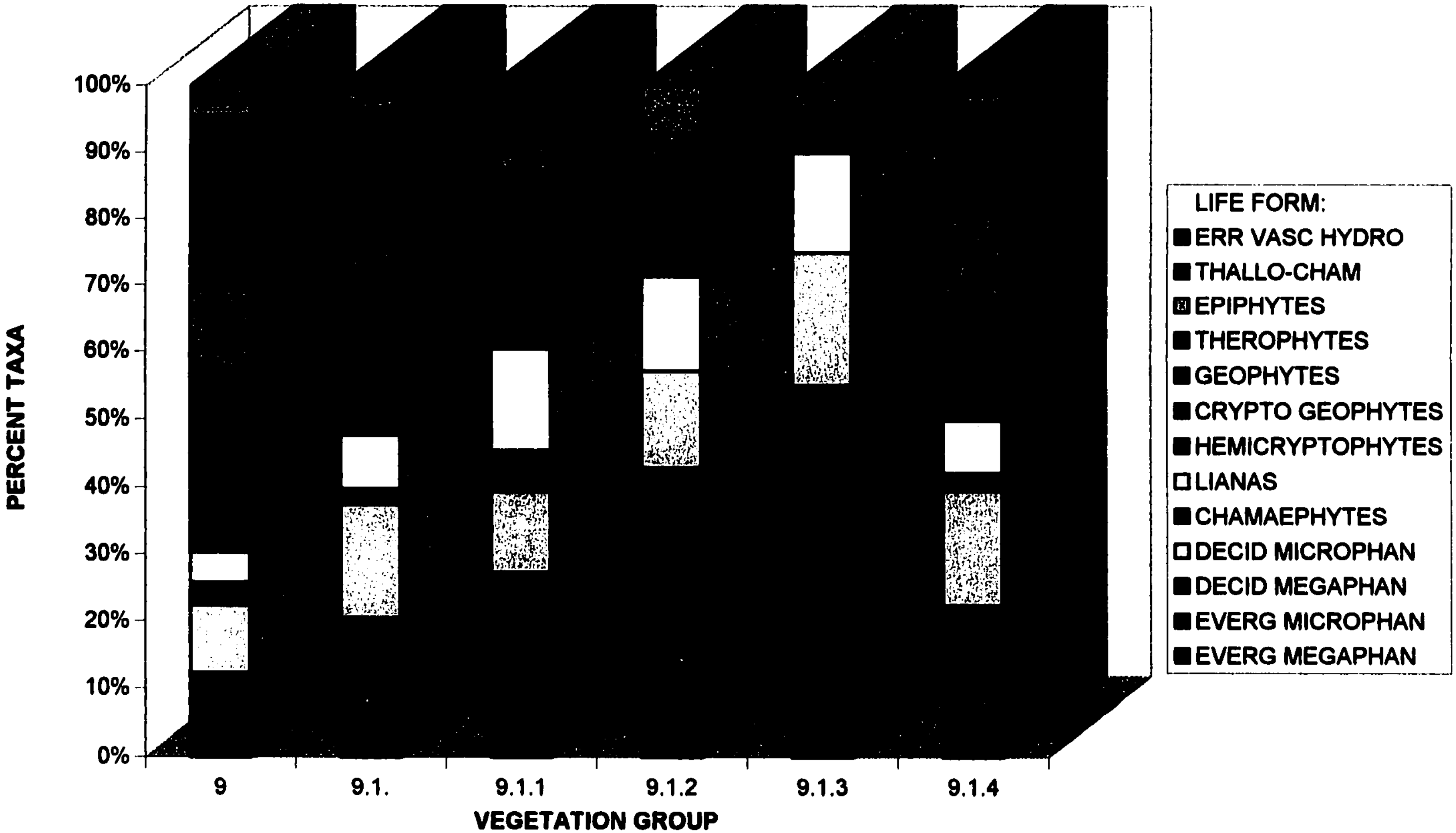


Figure 4.47. Plant Growth Forms for Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp" vegetation groups found within North and South Carolina Carolina bay depressions.

**PLANT GROWTH FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Cypress/Gum Swamp' VEGETATION GROUPS**

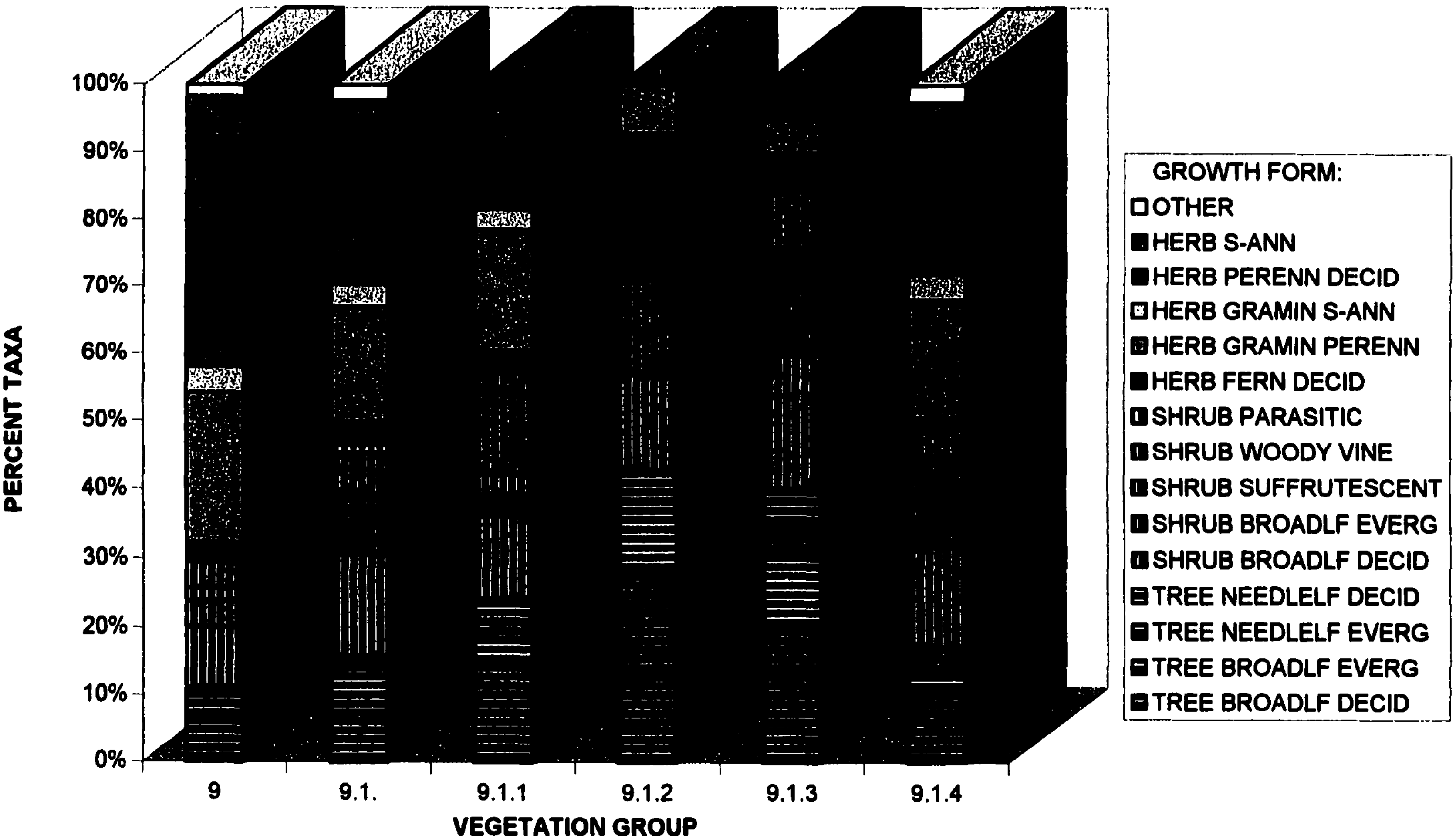


Table 4.24. Average site information for the Intermittently Ponded Cypress/Gum Depression, Cypress/Gum Pond vegetation subclass. The vegetation subclass and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | |
|---|---|---|---|---|
| | 9.2. | 9.2.1 | 9.2.2 | 9.2.3 |
| Site Hydrology | | | | |
| Water Depth Index | 176.7 | 167.4 | 147.7 | 215.0 |
| Hydroperiod Class | 4.0 | 4.0 | 4.0 | 4.0 |
| Water Constancy Index | 1.0 | 1.0 | 1.0 | 1.0 |
| Organic Layer Depth | [15.0] | — | — | 15.0 |
| Soil Drainage Class | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Permeability Class | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Available Water Capacity Class | 2.5 | 2.5 | 2.5 | 2.5 |
| | | | | |
| Site Geomorphology | | | | |
| Site Elevation (m) | 59.4 | 65.5 | 65.5 | 47.2 |
| Elevational Drop in 1 Km (m) | 7.6 | 7.6 | 7.6 | 7.6 |
| Distance to 10 m Elevational Drop (m) | 2500 | 2425 | 2425 | 2650 |
| Depression Area (ha) | 8.4 | 9.2 | 9.2 | 6.9 |
| Depression Length/Width Ratio | 1.5 | 1.5 | 1.5 | 1.4 |
| Depression Long Axis Orientation | -6.0 | -2.0 | -2.0 | -14.0 |
| | | | | |
| Site Disturbance | | | | |
| Fire Frequency Class | 2.7 | 3.0 | 3.0 | 2.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 3.0 | 4.0 | 4.0 | 1.0 |
| Timbering Index | 1.7 | 2.0 | 2.0 | 1.0 |
| Drainage Index | 1.3 | 1.0 | 1.0 | 2.0 |
| Landscape Disturbance Class | 4.0 | 4.0 | 4.0 | 4.0 |

Figure 4.48. Plant Life Forms for Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Pond" vegetation groups found within North and South Carolina Carolina bay depressions.

## PLANT LIFE FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Cypress/Gum Pond' VEGETATION GROUPS

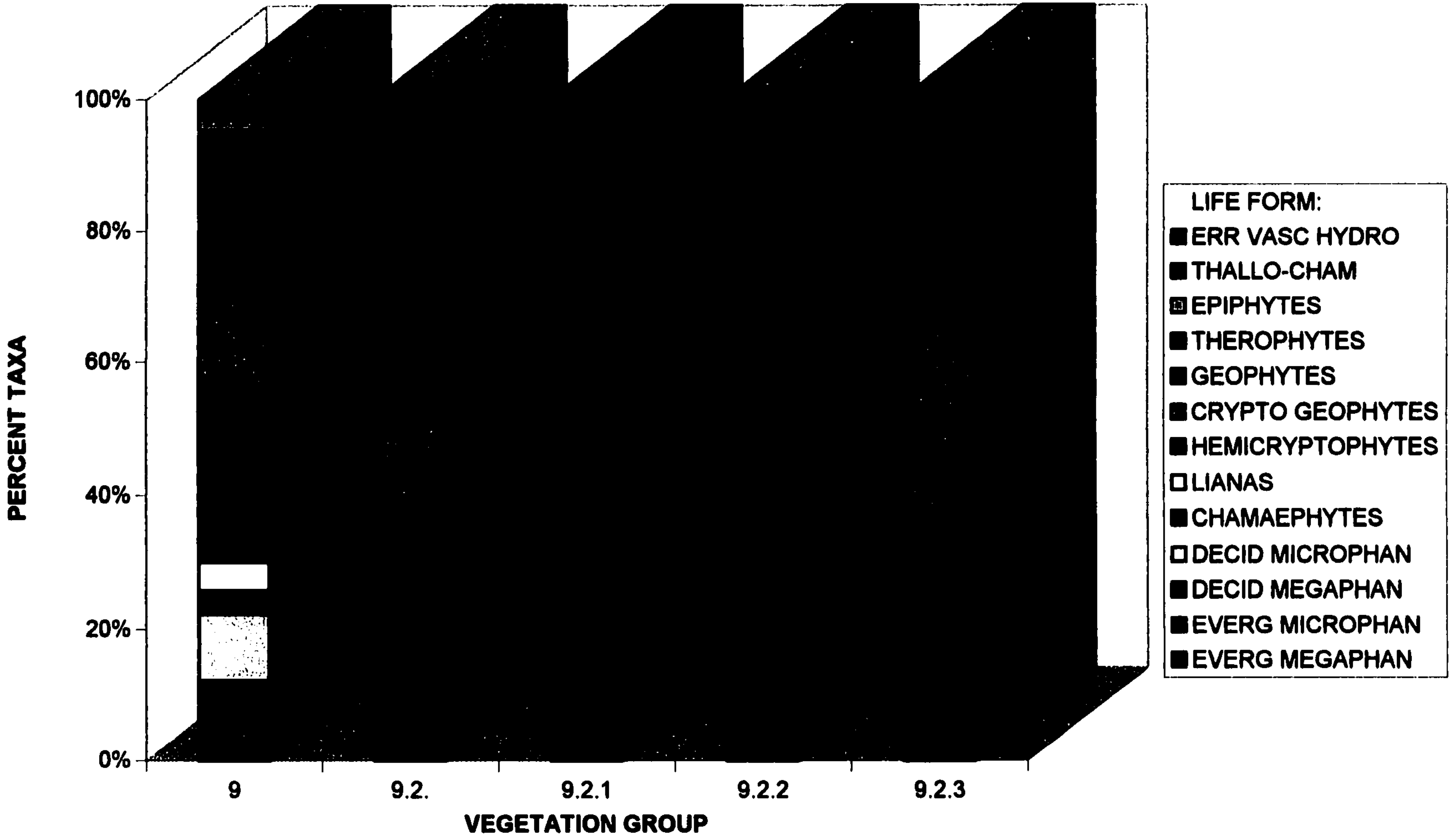


Figure 4.49. Plant Growth Forms for Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Pond" vegetation groups found within North and South Carolina Carolina bay depressions.

# PLANT GROWTH FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Cypress/Gum Pond' VEGETATION GROUPS

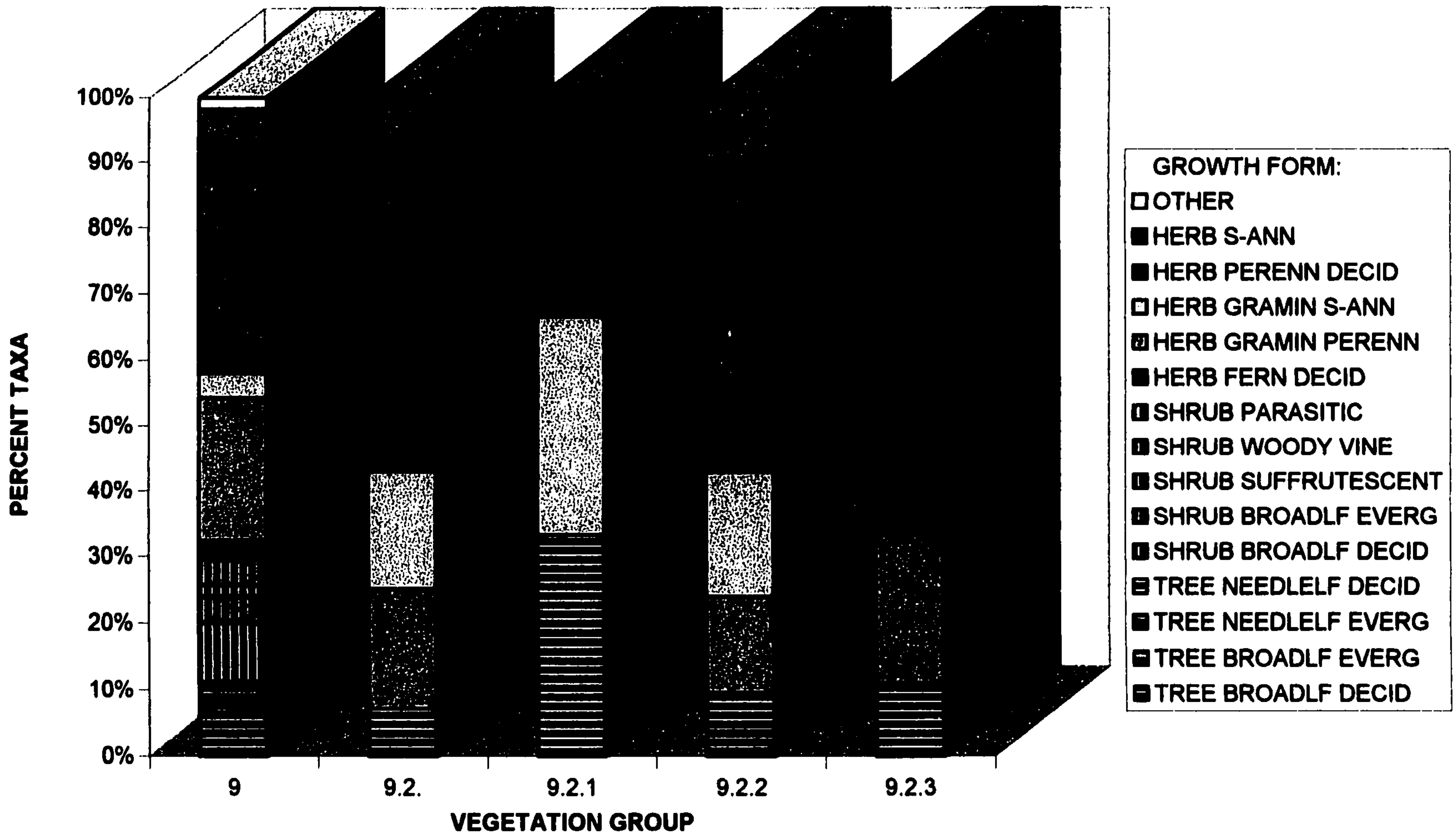


Table 4.25. Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow (9.3.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | 9.3. | 9.3.1 | 9.3.2 | 9.3.3 | 9.3.4 | 9.3.5 | 9.3.6 | 9.3.7 | 9.3.8 | 9.3.9 | 9.3.10 | 9.3.11 | 9.3.12 |
| Species | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con | Cov/ Con |
| ACER RUBRUM | 4 20 | 5 12 | | 3 + | 8 100 | | 5 + | | | | 3 64 | | | 4 + |
| AGALINIS LINIFOLIA* | 3 5 | | | | | | | | | | | | | |
| ANDROPOGON GLOMERATUS VAR. GLAUCOPSIS | 4 2 | | | | | | | | | | | | | |
| ANDROPOGON GYRANS VAR. STENOPHYLLUS** | 4 10 | 3 3 | | | | | | | | | 3 + | | | |
| ANDROPOGON MOHRII* | 6 4 | 6 8 | | | | | | | | | 6 91 | | | |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 4 25 | 3 19 | | 2 + | | | 3 + | | 5 + | 3 88 | 3 + | | | 2 + |
| ANDROPOGON VIRGINICUS VAR. VIRGINICUS | 3 1 | | | | | | | | | | | | | |
| ARISTIDA PALUSTRIS** | 6 12 | | | | | | | | | | | | | |
| ARONIA ARBUTIFOLIA | 4 1 | | | | | | | | | | | | | |
| ASTER PILOSUS VAR. DEMOTUS | 4 12 | 3 8 | | | | | 5 8 | | 3 + | 3 + | | | | |
| AXONOPUS FURCATUS | 4 2 | 4 4 | | | | | | | | | 4 + | | | |
| BARTONIA VIRGINICA | 2 6 | | | | | | | | | | | | | |
| BOEHMERIA CYLINDRICA | 3 1 | 3 3 | 3 + | | | 3 + | | | | | | | | |
| BOLTONIA ASTEROIDES** | 4 18 | 4 33 | | | | | 4 100 | 3 100 | 5 75 | | | | | |
| BURMANNIA BIFLORA** | 2 3 | | | | | | | | | | | | | |
| BURMANNIA CAPITATA | 1 + | | | | | | | | | | | | | |
| CAREX SP.#1 | 2 2 | | | | | | | | | | | | | |
| CAREX GLAUCESCENS | 4 6 | 3 3 | | | | | | | | | | 3 + | | 2 + |
| CAREX STRIATA VAR. STRIATA | 8 9 | 8 4 | | | | | | | | | | 8 5 | 8 100 | |
| CAREX VERRUCOSA | 4 3 | 3 2 | | 3 50 | | | | | | | | | | |
| CENTELLA ASIATICA | 6 12 | | | | | | | | | | | | | |
| CEPHALANTHUS OCCIDENTALIS | 3 4 | 3 8 | 4 50 | | | | | | | | | 2 + | 3 + | |
| CHAMAEDAPHNE CALYCULATA# | 2 + | | | | | | | | | | | | | |
| CLETHRA ALNIFOLIA | 4 6 | 4 1 | | | | | | | | | | | | 4 + |
| COELORACHIS RUGOSA** | 3 10 | 3 11 | | 3 + | | | 2 50 | | 5 + | 2 + | | | 2 50 | 3 + |
| CUSCUTA COMPACTA | 2 + | | | | | | | | | | | | | |
| CYRILLA RACEMIFLORA | 5 4 | 5 3 | | | | 5 75 | | | | | | | | |
| DICHANTHELIUM ERECTIFOLIUM** | 5 18 | 4 17 | | | | | 4 + | | 5 + | 4 + | | | | |
| DICHANTHELIUM LONGILIGULATUM | 4 9 | 4 11 | | | | | 5 + | | | | | | 3 75 | 4 100 |
| DICHANTHELIUM SPHAEROCARPON VAR. SPHAEROCARPON | 4 1 | | | | | | | | | | | | | |
| DICHANTHELIUM WRIGHTIANUM | 5 55 | 6 64 | | 5 100 | | | 5 + | 6 100 | 7 100 | 8 100 | 7 100 | 3 + | 2 75 | 6 + |
| DIGITARIA SANGUINALIS | 2 + | | | | | | | | | | | | | |
| DIODIA VIRGINIANA | 3 12 | 3 17 | | 4 100 | | | 3 + | 2 + | 2 + | 2 + | | | 3 100 | 2 + |
| DIOSPYROS VIRGINIANA | 3 6 | | | | | | | | | | | | | |
| DROSERA CAPILLARIS | 3 9 | 1 2 | 1 + | | | | | | | | | | | 1 + |
| DROSERA FILIFORMIS | 3 2 | | | | | | | | | | | | | |
| DROSERA INTERMEDIA | 1 1 | | | | | | | | | | | | | |
| DULICHIUM ARUNDINACEUM | 4 + | 4 1 | | | | 4 + | | | | | | | | |
| ELEOCHARIS SP. | 7 4 | 2 1 | | | 2 + | | | | | | | | | |
| ELEOCHARIS MELANOCARPA** | 5 5 | 5 9 | | | | | | | | | 5 100 | | | |
| ELEOCHARIS MICROCARPA | 4 3 | 5 1 | | | | | | | | 5 6 | | | | |
| ELEOCHARIS ROBBINSII* # | 3 3 | | | | | | | | | | | | | |
| ELEOCHARIS TRICOSTATA** | 4 18 | 4 23 | | | | | 2 + | 4 75 | 4 63 | | | | | |
| ELEUSINE INDICA | 2 + | | | | | | | | | | | | | |
| ERAGROSTIS PILOSA | 3 4 | 3 3 | | | | | | | 4 + | 1 + | | | | |
| ERAGROSTIS REFRACTA | 4 1 | | | | | | | | | | | | | |
| ERIOCAULON COMPRESSUM | 4 21 | 4 17 | | | | | 4 92 | | 2 + | | | | | 5 83 |
| ERIOCAULON DECANGULARE | 4 2 | | | | | | | | | | | | | |

Table 4.25 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow (9.3.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EUPATORIUM CAPILLIFOLIUM | 2 3 | 2 5 | 2 • | | | | | | 3 • | | | 2 • | | |
| EUPATORIUM LEPTOPHYLLUM• | 4 2 | | | | | | | | | | | | | |
| EUPATORIUM LEUCOLEPIS | 5 43 | 5 39 | | 3 • | | | 7 100 | 6 100 | 4 100 | 2 • | | | | |
| EUPATORIUM RECURVANS•• | 4 2 | | | | | | | | | | | | | |
| EUTHAMIA TENUIFOLIA | 4 20 | 3 8 | | | | | | | 2 • | 4 • | 3 • | 1 • | | |
| FIMBRISTYLIS AUTUMNALIS | 1 • | 1 1 | | | | | | | | | 1 • | | | |
| FUIRENA SQUARROSA | 3 3 | 4 1 | | | | | | | | | 4 • | | | |
| GELSEMIUM SEMPERVIRENS | 2 • | | | | | | | | | | | | | |
| GRATIOLA RAMOSA | 3 9 | 2 3 | | | | | 2 • | | | | | | | |
| HELENIUM PINNATIFIDUM• # | 5 5 | | | | | | | | | | | | | |
| HYPERICUM CANADENSE | 3 1 | 4 1 | | | | | | | | | 4 • | | | |
| HYPERICUM CISTIFOLIUM | 3 23 | 2 18 | | | | | 3 58 | 1 • | 2 56 | | 4 • | | | |
| HYPERICUM FASCICULATUM•• | 6 5 | | | | | | | | | | | | | |
| HYPERICUM GYMNANTHUM | 1 1 | | | | | | | | | | | | | |
| ILEX AMELANCHIER• # | 6 12 | 6 14 | | | | | | | 5 • | | | 6 47 | 8 100 | 6 • |
| ILEX CORIACEA | 4 1 | | | | | | | | | | | | | |
| ILEX GLABRA | 4 2 | 2 1 | | | | | | | | | | 2 • | | |
| ILEX LAEVIGATA | 2 • | | | | | | | | | | | | | |
| ILEX MYRTIFOLIA | 5 9 | 5 6 | 5 88 | | | | | | | | | | | |
| ILEX OPACA | 3 2 | | | | | | | | | | | | | |
| IRIS PRISMATICA•• | 3 2 | | | | | | | | | | | | | |
| ITEA VIRGINICA | 3 3 | 3 3 | | | | 4 • | | | | | | 2 • | | |
| IVA MICROCEPHALA• | 2 • | 2 1 | | | | | | | | | 2 • | | | |
| JUNCUS DIFFUSISSIMUS | 4 3 | 4 2 | | | | | | | | | 4 • | | | |
| JUNCUS POLYCEPHALUS | 2 • | | | | | | | | | | | | | |
| JUNCUS REPENS | 5 3 | | | | | | | | | | | | | |
| JUNCUS SP. | 3 1 | | | | | | | | | | | | | |
| LACHNANTHES CAROLINIANA | 5 22 | 6 23 | 4 • | | | 7 100 | | | 8 6 | | 5 100 | | 6 100 | 6 100 |
| LEERSIA HEXANDRA | 4 9 | 5 4 | | | | | | | | | 5 • | | | |
| LEUCOTHOE RACEMOSA | 3 3 | 1 1 | | | | | | | | | | | 1 • | |
| LINDERA MELISSIFOLIA• | 8 2 | | | | | | | | | | | | | |
| LIQUIDAMBAR STYRACIFLUA | 4 24 | 4 18 | 2 50 | 4 100 | 4 100 | | | | 6 • | | 3 • | 2 • | 4 100 | |
| LITSEA AESTIVALIS• # | 3 2 | 3 3 | | | | 3 75 | | | | | | | | |
| LOBELIA BOYKINII• # | 2 6 | 2 8 | | | | | 2 83 | | | | | | | |
| LOBELIA CANBYI | 2 3 | | | | | | | | | | | | | |
| LOBELIA NUTTALLII | 2 7 | 2 13 | | | | | | 2 69 | 2 • | | | | | |
| LUDWIGIA SP. #1 | 3 3 | 3 1 | | | | | | | 3 • | | | | | |
| LUDWIGIA ALTERNIFOLIA | 2 3 | 2 5 | | | | | | | 2 • | 2 • | | 2 • | | |
| LUDWIGIA LINIFOLIA• | 4 2 | | | | | | | | | | | | | |
| LUDWIGIA LINEARIS | 4 2 | 4 4 | | | | | | 1 • | 5 • | | 2 • | | | |
| LUDWIGIA PILOSA | 4 1 | | | | | | | | | | | | | |
| LUDWIGIA SPHAEROCARPA•• | 4 • | | | | | | | | | | | | | |
| LUDWIGIA SUFFRUTICOSA• | 3 5 | | | | | | | | | | | | | |
| LYCOPODIELLA ALOPECUROIDES | 4 1 | | | | | | | | | | | | | |
| LYCOPUS ANGUSTIFOLIUS•• | 3 21 | 3 18 | 2 • | 4 100 | | | 3 • | | 3 • | | | 2 • | 3 75 | 2 50 |
| LYCOPUS RUBELLUS | 2 • | | | | | | | | | | | | | |
| LYONIA LIGUSTRINA | 7 1 | | | | | | | | | | | | | |
| LYONIA LUCIDA | 5 4 | 4 1 | | | | 4 • | | | | | | | | |
| LYONIA MARIANA | 2 • | | | | | | | | | | | | | |
| MAGNOLIA VIRGINIANA | 3 5 | 3 2 | | | | | | | 2 • | | | | | 4 • |
| MITREOLA SESSILIFOLIA | 3 2 | | | | | | | | | | | | | |
| MYRICA CERIFERA VAR. CERIFERA | 4 5 | 4 2 | | | | 4 • | 4 • | | | | | | | |
| NYSSA BIFLORA | 4 52 | 4 60 | 5 100 | 8 100 | 6 100 | 3 75 | 3 50 | 2 • | 2 56 | 2 • | 2 55 | 4 84 | 5 100 | 4 100 |
| OSMUNDA REGALIS | 2 • | | | | | | | | | | | | | |
| OXYPOLIS CANBYI• # | 3 5 | | | | | | | | | | | | | |
| PANICUM HEMITOMON | 4 30 | 5 18 | 5 13 | | | | | | 1 • | 6 88 | 4 55 | | | |
| PANICUM RIGIDULUM VAR. COMBSII | 4 13 | | | | | | | | | | | | | |
| PANICUM TENERUM• | 5 8 | | | | | | | | | | | | | |
| PANICUM VERRUCOSUM | 5 48 | 5 68 | 5 100 | 7 100 | 5 100 | 7 100 | 7 100 | 3 • | 4 88 | 4 94 | 5 82 | 1 • | | |
| PASPALUM LAEVE | 5 3 | 6 4 | | | | | | | | 5 • | 7 • | | | |
| PERSEA PALUSTRIS | 5 4 | | | | | | | | | | | | | |

Table 4.25 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow (9.3.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHORADENDRON SEROTINUM | 2 • | | | | | | | | | | | | | |
| PINUS ELLIOTTII | 4 1 | | | | | | | | | | | | | |
| PINUS PALUSTRIS | 6 • | | | | | | | | | | | | | |
| PINUS SEROTINA | 4 4 | | | | | | | | | | | | | |
| PINUS TAEDA | 4 30 | 3 17 | | 1 • | 5 100 | | | 2 • | 3 • | | 3 • | 1 • | | 4 • |
| PLATANUS OCCIDENTALIS | 1 • | 1 1 | | | | | | | | | | 1 • | | |
| PLUCHEA FOETIDA | 4 3 | | | | | | | | | | | | | |
| PLUCHEA ROSEA | 5 38 | 5 48 | | | | | 5 100 | 7 100 | 5 100 | 3 75 | | | | 3 • |
| POLYGALA CYMOSA | 3 30 | 3 38 | | | | | 3 100 | 2 • | 3 44 | | | 3 58 | 5 100 | 6 83 |
| POLYPODIUM POLYPODIOIDES | 2 • | | | | | | | | | | | | | |
| PROSERPINACA PECTINATA | 3 10 | 3 8 | | | | | 3 • | | | | | 3 • | | |
| PRUNUS CAROLINIANA | 3 1 | 3 1 | | | | | | | | | | | | 3 • |
| PRUNUS SEROTINA | 1 • | 1 1 | | | | | | | | 1 • | | | | |
| PSILOCARYA NITENS | 1 • | 1 1 | | | | | | | | | 1 • | | | |
| QUERCUS LYRATA | 4 1 | | | | | | | | | | | | | |
| QUERCUS NIGRA | 2 3 | | | | | | | | | | | | | |
| QUERCUS PHELLOS | 4 3 | | | | | | | | | | | | | |
| RHEXIA ARISTOSA* # | 3 52 | 4 71 | | 4 100 | 1 • | | 3 92 | 4 100 | 4 100 | 4 94 | 4 82 | 3 47 | 2 • | 2 33 |
| RHEXIA MARIANA | 3 4 | 4 1 | | | | | | | 4 • | | | | | |
| RHEXIA VIRGINICA | 3 3 | 2 2 | | | | 2 50 | | | | | | | | |
| RHYNCHOSPORA CEPHALANTHA VAR. CEPHALANTHA | 4 3 | | | | | | | | | | | | | |
| RHYNCHOSPORA CHALAROCEPHALA | 3 2 | 1 1 | | | | | 1 • | | | | | | | |
| RHYNCHOSPORA FILIFOLIA | 4 45 | 5 44 | | | 4 • | 4 75 | 5 100 | 2 69 | 5 • | 4 • | 7 100 | | | 4 100 |
| RHYNCHOSPORA GRACILENTA | 3 1 | | | | | | | | | | | | | |
| RHYNCHOSPORA INTERMIXTA | 4 3 | 2 1 | | | 2 • | | | | | | | | | |
| RHYNCHOSPORA INUNDATA**# | 5 32 | 5 39 | 2 • | 3 25 | | | 6 100 | 3 • | 5 • | | 3 • | 6 84 | | 6 100 |
| RHYNCHOSPORA PERPLEXA VAR. PERPLEXA | 4 30 | 4 37 | | 3 100 | | | 5 75 | 3 • | 4 • | 3 • | 5 82 | 2 • | | 3 83 |
| RHYNCHOSPORA RARIFLORA | 5 2 | | | | | | | | | | | | | |
| RHYNCHOSPORA TRACYI* # | 6 3 | 5 1 | | | | | | | | | 5 9 | | | |
| RUBUS ARGUTUS | 4 1 | | | | | | | | | | | | | |
| SABATIA BRACHIATA | 2 2 | | | | | | | | | | | | | |
| SABATIA DIFFORMIS | 2 8 | 2 8 | | | | | 2 • | 2 • | 1 • | | | | | 2 • |
| SACCHARUM GIGANTEUM | 4 21 | 4 8 | | | | | 4 • | | 2 • | | 4 • | 4 • | 4 100 | |
| SAGITTARIA ISOETIFORMIS* # | 2 • | | | | | | | | | | | | | |
| SARRACENIA FLAVA | 3 • | | | | | | | | | | | | | |
| SASSAFRAS ALBIDUM | 2 • | | | | | | | | | | | | | |
| SCLERIA BALDWINII* # | 2 • | | | | | | | | | | | | | |
| SCLERIA GEORGIANA* | 4 5 | | | | | | | | | | | | | |
| SCLERIA RETICULARIS* | 4 52 | 4 74 | 3 100 | 6 100 | 3 75 | 8 100 | 4 83 | 4 100 | 4 88 | 6 100 | 4 91 | | | 2 67 |
| SCLEROLEPIS UNIFLORA** | 4 15 | 3 6 | | | | | | 4 • | 4 • | | | | | 2 • |
| SMILAX GLAUCA | 3 7 | 3 3 | | 3 • | | | | | | | | | | 4 17 |
| SMILAX LAURIFOLIA | 2 5 | 2 2 | | 1 • | 2 25 | | | | | | | | | |
| SMILAX ROTUNDIFOLIA | 2 8 | 2 8 | 2 • | 2 100 | 3 100 | | | | | | | | 1 • | |
| SMILAX WALTERI | 4 • | | | | | | | | | | | | | |
| SPHAGNUM SP. | 5 11 | 5 8 | | | 6 75 | 5 75 | | | | | 6 • | | | |
| STILLINGIA AQUATICA# | 6 2 | | | | | | | | | | | | | |
| STYLISMA AQUATICA* | 5 6 | | | | | | | | | | | | | |
| SYMPLOCOS TINCTORIA | 5 • | | | | | | | | | | | | | |
| TAXODIUM ASCENDENS | 6 76 | 6 88 | 7 100 | 8 100 | | 6 100 | 7 100 | 5 100 | 6 100 | 4 100 | | 6 100 | 7 100 | 8 100 |
| TILLANDSIA USNEOIDES | 3 6 | 4 7 | 4 100 | | | | | | | | | | | |
| TOXICODENDRON RADICANS VAR. RADICANS | 3 9 | 3 6 | 1 • | 3 75 | | 4 • | | | | | | | | |
| TRIADENUM TUBULOSUM** | 3 1 | 3 3 | 3 • | | | | | | | | | | | |
| TRIADENUM VIRGINICUM | 3 2 | 3 3 | 2 • | | | 4 • | | | | | | | | |
| UTRICULARIA BIFLORA | 6 2 | 4 1 | | | | 4 • | | | | | | | | |
| UTRICULARIA FIBROSA | 3 4 | 2 6 | | | | | | | | | | 2 • | | |
| UTRICULARIA JUNCEA | 7 3 | | | | | | | | | | | | | |
| UTRICULARIA PURPUREA | 3 3 | 4 3 | | | | 4 75 | | | | | | | | |
| UTRICULARIA RADIATA | 6 • | | | | | | | | | | | | | |

Table 4.25 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow (9.3.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VACCINIUM CORYMBOSUM | 3 1 | | | | | | | | | | | | | |
| VACCINIUM FUSCATUM | 4 12 | 4 8 | | | | 4 25 | 4 • | 3 6 | 2 • | | | | 4 • | |
| VIOLA LANCEOLATA | 3 12 | 3 18 | | | | | | 2 • | 3 44 | 3 • | 4 64 | | | |
| VITIS ROTUNDIFOLIA | 3 4 | 3 6 | | | 1 • | | 3 • | | | | | | 4 25 | |
| WOODWARDIA AREOLATA | 3 1 | 3 1 | | | | 3 • | | | | | | | | |
| WOODWARDIA VIRGINICA | 5 8 | 2 1 | | | | | | | | | | | 2 • | |
| XYRIS AMBIGUA | 2 11 | 2 18 | | | | 2 • | 3 75 | | | | 2 • | 1 • | 2 • | 2 67 |
| XYRIS DIFFORMIS VAR. FLORIDANA* | 3 1 | | | | | | | | | | | | | |
| XYRIS FIMBRIATA | 3 5 | | | | | | | | | | | | | |
| XYRIS JUPICAI | 3 2 | | | | | | | | | | | | | |
| XYRIS SMALLIANA** | 3 3 | | | | | | | | | | | | | |
| ZENOBIA PULVERULENTA | 5 2 | | | | | | | | | | | | | |

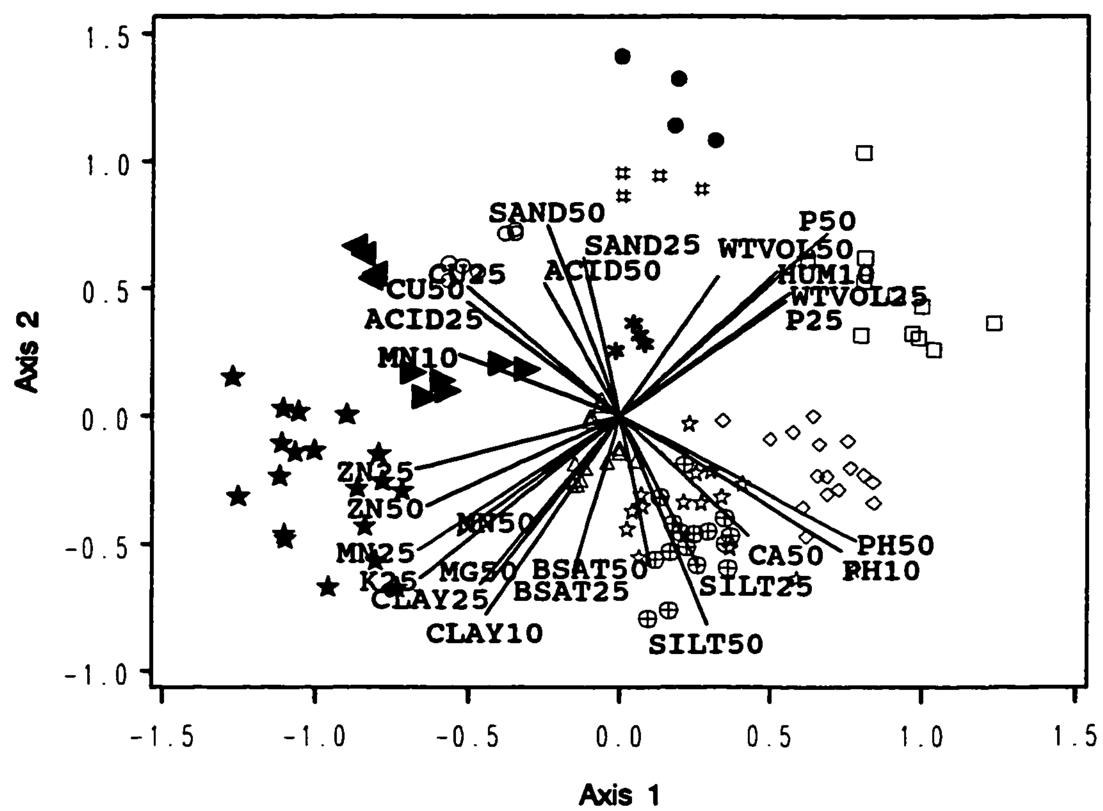
Table 4.26. Average site information for the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow vegetation subclass. The vegetation subclass and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into 3 categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9.3. | 9.3.1 | 9.3.2 | 9.3.3 | 9.3.4 | 9.3.5 | 9.3.6 | 9.3.7 | 9.3.8 | 9.3.9 | 9.3.10 | 9.3.11 | 9.3.12 |
| Site Hydrology | | | | | | | | | | | | | |
| Water Depth Index | 124.8 | 99.8 | 97.0 | 67.0 | 174.0 | 117.7 | 124.3 | 127.6 | 130.0 | 86.4 | 175.7 | 145.0 | 153.0 |
| Hydroperiod Class | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.4 | 4.0 | 4.0 | 4.0 |
| Water Constancy Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Organic Layer Depth | 13.7 | 9.0 | 14.0 | 13.0 | 14.0 | 12.0 | [8.7] | 13.0 | --- | 15.7 | --- | 15.0 | 23.0 |
| Soil Drainage Class | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Permeability Class | 2.3 | 2.0 | 2.0 | 4.0 | 4.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Soil Available Water Capacity Class | 2.6 | 2.5 | 2.5 | 3.0 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| | | | | | | | | | | | | | |
| Site Geomorphology | | | | | | | | | | | | | |
| Site Elevation (m) | 62.0 | 54.0 | 56.4 | 35.1 | 103.6 | 65.5 | 65.5 | 63.2 | 47.2 | 70.1 | 61.0 | 61.0 | 61.0 |
| Elevational Drop ini 1 Km (m) | 8.5 | 12.0 | 6.1 | 13.7 | 27.4 | 7.6 | 7.6 | 7.6 | 7.6 | 6.1 | 4.6 | 4.6 | 4.6 |
| Distance to 10 m Elevational Drop (m) | 2525 | 850 | 3950 | 750 | 475 | 2175 | 2175 | 2225 | 2650 | 3000 | 4000 | 4000 | 4000 |
| Depression Area (ha) | 24.9 | 19.9 | 19.9 | 6.1 | 5.4 | 33.0 | 33.0 | 29.7 | 6.9 | 13.8 | 43.7 | 43.7 | 43.7 |
| Depression Length/Width Ratio | 1.6 | 1.6 | 1.6 | 1.4 | 2.0 | 1.7 | 1.7 | 1.6 | 1.4 | 1.9 | 1.6 | 1.6 | 1.6 |
| Depression Long Axis orientation | +0.5 | +22.0 | 0.0 | -9.0 | +18.0 | -3.0 | -3.0 | -4.4 | -14.0 | -1.0 | 0.0 | 0.0 | 0.0 |

Table 4.26 (cont.). Average site information for the Intermittently Ponded Cypress/Gum Depression, Drawdown Savanna/Meadow vegetation subclass. The vegetation subclass and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into 3 categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Disturbance | | | | | | | | | | | | | |
| Fire Frequency | 2.5 | 3.0 | 3.0 | 3.0 | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 3.0 | 2.0 | 2.0 | 2.0 |
| Cultivation Index | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.8 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 | 1.0 | 1.0 | 2.0 | 2.0 | 3.0 |
| Timbering Index | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Drainage Index | 1.4 | 1.0 | 3.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.1 | 2.0 | 2.0 | 1.0 | 1.0 | 1.0 |
| Landscape Disturbance Class | 3.4 | 4.0 | 4.0 | 4.0 | 2.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 3.0 | 3.0 | 3.0 |

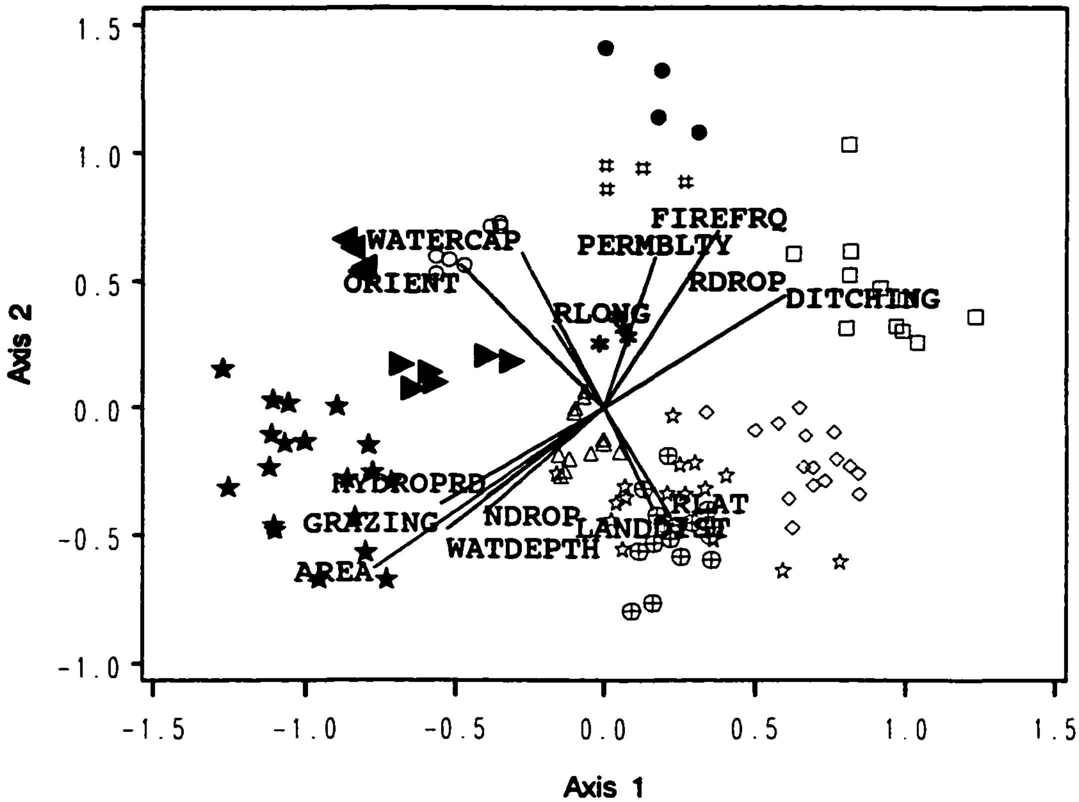
Figure 4.50. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION,**
**Drawdown/Savanna Meadow — Community Types:**

○ Taxodium ascendens "Savanna"
✱ Taxodium ascendens—Nyssa biflora/Panicum verrucosum—Scleria reticularis Savanna
● Nyssa biflora/Acer/Panicum verrucosum/Sphagnum spp. "Savanna"
# Taxodium ascendens/Cyrilla/Scleria reticularis—Panicum verrucosum—Lachnanthes Savanna
△ Taxodium ascendens/Eupatorium leucolepis—Rhynchospora inundata/Panicum verrucosum Savanna
⊕ Taxodium ascendens/Pluchea rosea—Eupatorium leucolepis/Dichanthelium wrightianum Meadow
☆ Taxodium ascendens/Pluchea rosea—Boltonia/Dichanthelium wrightianum Savanna
◇ Panicum hemitomon/Dichanthelium wrightianum—Scleria reticularis Meadow
□ Andropogon mohrii/Dichanthelium wrightianum—Rhynchospora filifolia Meadow
★ Taxodium ascendens/Rhynchospora inundata Savanna
◀ Taxodium ascendens/Nyssa biflora/Ilex amelanchier/Carex striata—Lachnanthes Savanna
▶ Taxodium ascendens/Rhynchospora inundata/Lachnanthes—Polygala cymosa Savanna

Figure 4.51. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soil-related, and Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION, Drawdown Savanna/Meadow — Community Types:**

○ Taxodium ascendens "Savanna"
✱ Taxodium ascendens–Nyssa biflora/Panicum verrucosum–Scleria reticularis Savanna
● Nyssa biflora/Acer/Panicum verrucosum/Sphagnum spp. "Savanna"
# Taxodium ascendens/Cyrilla/Scleria reticularis–Panicum verrucosum–Lachnanthes Savanna
△ Taxodium ascendens/Eupatorium leucolepis–Rhynchospora inundata/Panicum verrucosum Savanna
⊕ Taxodium ascendens/Pluchea rosea–Eupatorium leucolepis/Dichanthelium wrightianum Meadow
☆ Taxodium ascendens/Pluchea rosea–Boltonia/Dichanthelium wrightianum Savanna
◇ Panicum hemitomon/Dichanthelium wrightianum–Scleria reticularis Meadow
□ Andropogon mohrii/Dichanthelium wrightianum–Rhynchospora filifolia Meadow
★ Taxodium ascendens/Rhynchospora inundata Savanna
◀ Taxodium ascendens/Nyssa biflora/Ilex amelanchier/Carex striata–Lachnanthes Savanna
▶ Taxodium ascendens/Rhynchospora inundata/Lachnanthes–Polygala cymosa Savanna

Figure 4.52. Plant Life Forms for Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow" vegetation groups found within North and South Carolina Carolina bay depressions.

PLANT LIFE FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Drawdown Savanna/Meadow' VEGETATION GROUPS

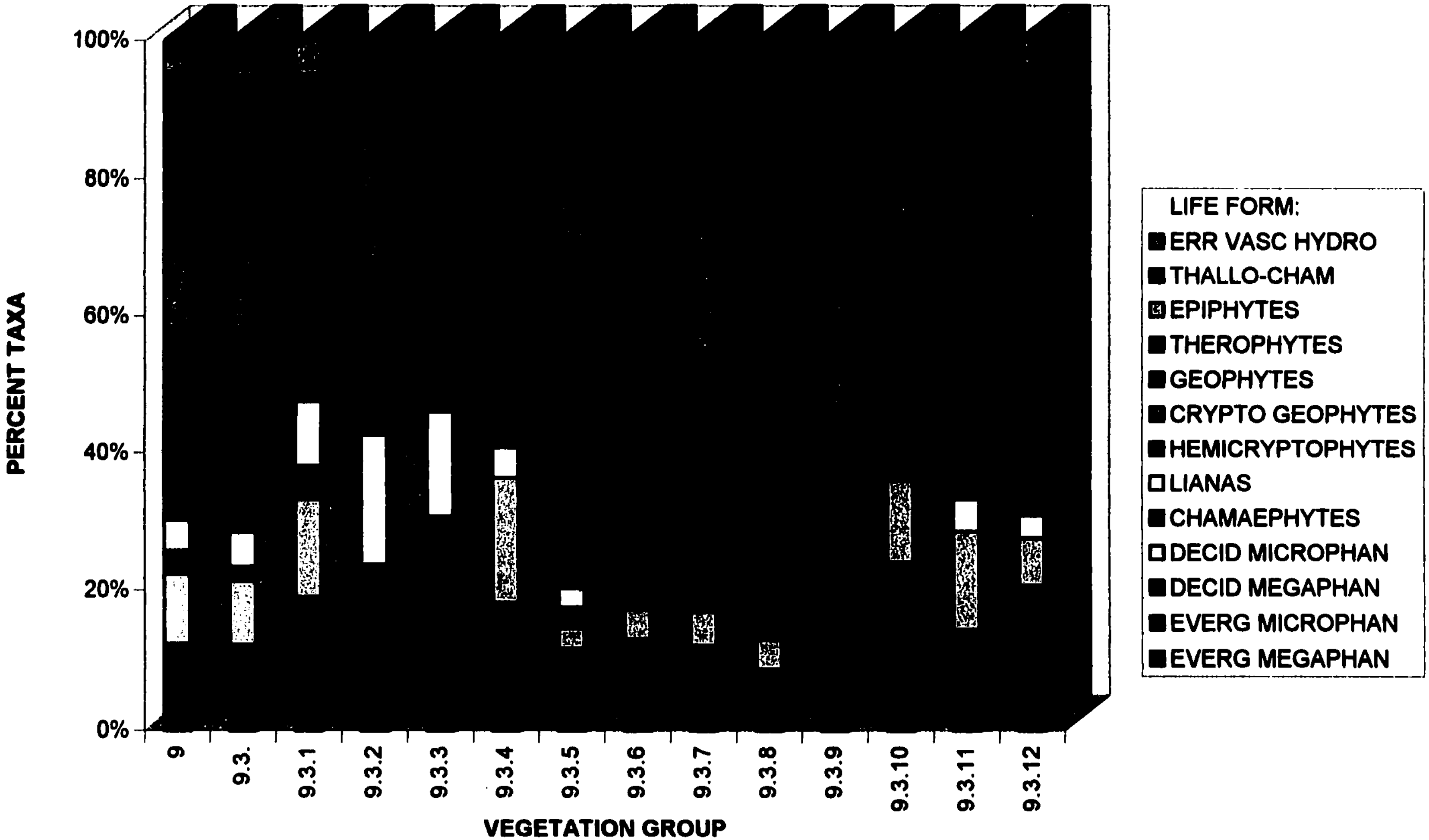
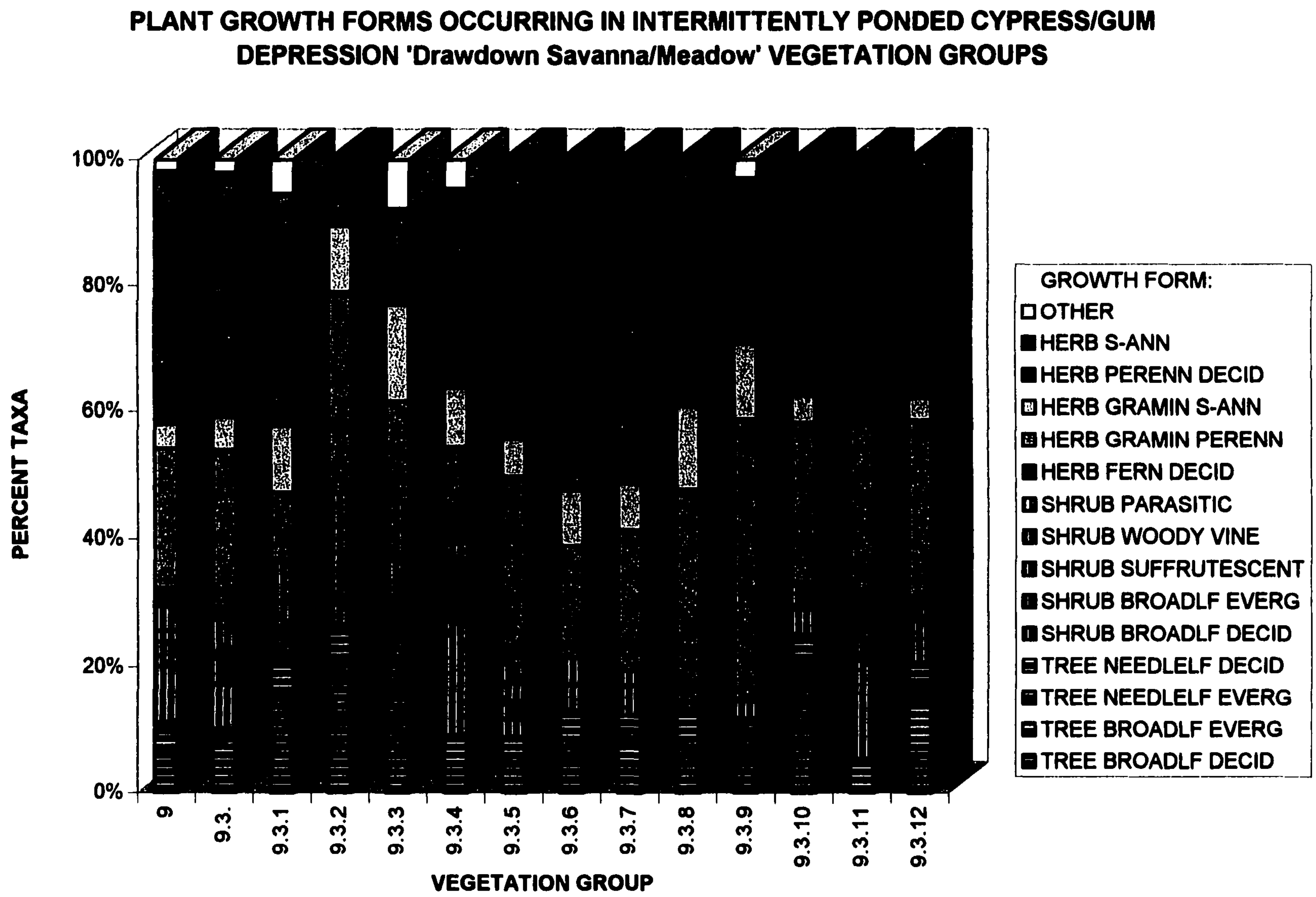


Figure 4.53. Plant Growth Forms for Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow" vegetation groups found within North and South Carolina Carolina bay depressions.



PLANT GROWTH FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Drawdown Savanna/Meadow' VEGETATION GROUPS
PERCENT TAXA
100%
80%
60%
40%
20%
0%
9
9.3.
9.3.1
9.3.2
9.3.3
9.3.4
9.3.5
9.3.6
9.3.7
9.3.8
9.3.9
9.3.10
9.3.11
9.3.12
VEGETATION GROUP
GROWTH FORM:
OTHER
HERB S-ANN
HERB PERENN DECID
HERB GRAMIN S-ANN
HERB GRAMIN PERENN
HERB FERN DECID
SHRUB PARASITIC
SHRUB WOODY VINE
SHRUB SUFFRUTESCENT
SHRUB BROADLF EVERG
SHRUB BROADLF DECID
TREE NEEDLELF DECID
TREE NEEDLELF EVERG
TREE BROADLF EVERG
TREE BROADLF DECID

Table 4.27. Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Wet Savanna/Meadow (9.4.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | VegGroup | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | | 9.4 | | 9.4.1 | | 9.4.2 | | 9.4.3 | | 9.4.4 | | 9.4.5 | | 9.4.6 | | 9.4.7 | | 9.4.8 | | 9.4.9 | | 9.4.10 | |
| Species | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con | Cov/ | Con |
| ACER RUBRUM | 4 | 20 | 3 | 20 | | | 3 | 50 | | | | | | | 3 | 50 | 3 | 50 | 4 | 100 | | | 3 | + |
| AGALINIS LINIFOLIA* | 3 | 5 | 3 | 17 | | | | | 2 | + | | | 4 | + | | | | | | | 4 | 100 | 4 | + |
| ANDROPOGON GLOMERATUS VAR. GLAUCOPSIS | 4 | 2 | 4 | 7 | | | | | | | | | | | 4 | + | 4 | 75 | | | | | | |
| ANDROPOGON GYRANS VAR. STENOPHYLLUS** | 4 | 10 | 5 | 30 | | | 4 | 88 | 3 | + | | | 3 | + | 4 | + | | | | | 6 | + | 5 | 55 |
| ANDROPOGON MOHRII* | 6 | 4 | | | | | | | | | | | | | | | | | | | | | | |
| ANDROPOGON VIRGINICUS VAR. GLAUCUS | 4 | 25 | 4 | 47 | | | 4 | 88 | 5 | 100 | 3 | + | | | 4 | 100 | 3 | 100 | | | 5 | 100 | | |
| ANDROPOGON VIRGINICUS VAR. VIRGINICUS | 3 | 1 | 3 | 4 | | | | | | | | | | | | | 3 | 75 | | | | | | |
| ARISTIDA PALUSTRIS** | 6 | 12 | 6 | 39 | | | 4 | + | 8 | + | 7 | + | 6 | 100 | | | 4 | 75 | | | 8 | 100 | 5 | 9 |
| ARONIA ARBUTIFOLIA | 4 | 1 | 4 | 1 | | | | | | | | | | | | | | | | | 4 | + | | |
| ASTER PILOSUS VAR DEMOTUS | 4 | 12 | 5 | 19 | 7 | 100 | | | 3 | + | 4 | + | | | | | | | | | | | | |
| AXONOPUS FURCATUS | 4 | 2 | | | | | | | | | | | | | | | | | | | | | | |
| BARTONIA VIRGINICA | 2 | 6 | 2 | 17 | | | 1 | + | | | | | 2 | + | 2 | 75 | 2 | 50 | 1 | + | | | 2 | + |
| BOEHMERIA CYLINDRICA | 3 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| BOLTONIA ASTEROIDES** | 4 | 18 | 5 | 3 | | | | | | | | | | | | | | | | | 5 | + | | |
| BURMANNIA BIFLORA** | 2 | 3 | 2 | 10 | | | | | | | | | 2 | 100 | | | 2 | 75 | | | | | | |
| BURMANNIA CAPITATA | 1 | + | 1 | 1 | | | | | 1 | + | | | | | | | | | | | | | | |
| CAREX SP.#1 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | |
| CAREX GLAUCESCENS | 4 | 6 | 1 | 1 | | | | | | | | | | | | | | | | | | | 1 | + |
| CAREX STRIATA VAR. STRIATA | 8 | 9 | 8 | 23 | | | | | | | | | 8 | 100 | 6 | 100 | 8 | 100 | 9 | 100 | | | | |
| CAREX VERRUCOSA | 4 | 3 | | | | | | | | | | | | | | | | | | | | | | |
| CENTELLA ASIATICA | 6 | 12 | 6 | 39 | | | 7 | 100 | | | 3 | + | | | | | | | | | 6 | 75 | 6 | 82 |
| CEPHALANTHUS OCCIDENTALIS | 3 | 4 | | | | | | | | | | | | | | | | | | | | | | |
| CHAMAEDAPHNE CALYCULATA# | 2 | + | | | | | | | | | | | | | | | | | | | | | | |
| CLETHRA ALNIFOLIA | 4 | 6 | 4 | 14 | | | | | | | | | 3 | + | 3 | 75 | 6 | 100 | | | 1 | + | | |
| COELORACHIS RUGOSA** | 3 | 10 | 3 | 14 | | | 4 | + | 2 | + | 2 | + | | | | | | | | | 4 | 50 | 3 | + |
| CUSCUTA COMPACTA | 2 | + | | | | | | | | | | | | | | | | | | | | | | |
| CYRILLA RACEMIFLORA | 5 | 4 | | | | | | | | | | | | | | | | | | | | | | |
| DICHANTHELIUM ERECTIFOLIUM** | 5 | 18 | 6 | 30 | | | 6 | + | 7 | 100 | 4 | 50 | | | | | | | | | 5 | + | | |
| DICHANTHELIUM LONGILIGULATUM | 4 | 9 | 4 | 6 | | | | | | | | | | | 4 | 100 | | | | | | | | |
| DICHANTHELIUM SPHAEROCARPON VAR. SPHAEROCARPON | 4 | 1 | 4 | 4 | | | | | | | | | 4 | 75 | | | | | | | | | | |
| DICHANTHELIUM WRIGHTIANUM | 5 | 55 | 4 | 57 | 6 | 71 | 6 | 100 | 3 | + | 5 | + | | | | | | | 3 | 75 | 5 | 100 | 2 | 64 |
| DIGITARIA SANGUINALIS | 2 | + | 2 | 1 | 2 | + | | | | | | | | | | | | | | | | | | |
| DIODIA VIRGINIANA | 3 | 12 | 2 | 4 | 2 | + | | | | | 2 | + | | | | | | | | | | | | |
| DIOSPYROS VIRGINIANA | 3 | 6 | 4 | 10 | | | | | | | | | | | | | | | 5 | 75 | 4 | + | 3 | + |
| DROSERA CAPILLARIS | 3 | 9 | 3 | 29 | | | 3 | 50 | 3 | 75 | 3 | + | 4 | + | | | | | | | 4 | 75 | | |
| DROSERA FILIFORMIS* | 3 | 2 | 3 | 6 | | | 3 | + | | | | | | | | | | | | | | | | |
| DROSERA INTERMEDIA | 1 | 1 | 1 | 3 | | | | | | | | | | | 1 | 50 | | | | | | | | |

Table 4.27 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Wet Savanna/Meadow (9.4.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DULICHIUM ARUNDINACEUM | 4 + | | | | | | | | | | | |
| ELEOCHARIS SP. | 7 4 | 7 11 | 11 14 | 2 50 | | | | | | | | |
| ELEOCHARIS MELANOCARPA** | 5 5 | | | | | | | | | | | |
| ELEOCHARIS MICROCARPA | 4 3 | 4 6 | | | | | | 4 100 | | | | |
| ELEOCHARIS ROBBINSII* # | 3 3 | 3 9 | | 3 75 | | | | | | | | |
| ELEOCHARIS TRICOSTATA** | 4 18 | 5 13 | 6 71 | | | 5 + | | | | | | |
| ELEUSINE INDICA | 2 + | | | | | | | | | | | |
| ERAGROSTIS PILOSA | 3 4 | 2 7 | | | 2 + | | | | | | 2 + | |
| ERAGROSTIS REFRACTA | 4 1 | 4 3 | | | | | | | | | 4 + | |
| ERIOCAULON COMPRESSUM | 4 21 | 5 37 | 2 + | 4 + | | | 7 100 | 5 75 | 5 100 | 5 25 | 5 + | 4 64 |
| ERIOCAULON DECANGULARE | 4 2 | 4 7 | | | | | | 5 100 | 1 + | | | |
| EUPATORIUM CAPILLIFOLIUM | 2 3 | | | | | | | | | | | |
| EUPATORIUM LEPTOPHYLLUM* | 4 2 | 4 6 | 4 57 | | | | | | | | | |
| EUPATORIUM LEUCOLEPIS | 5 43 | 5 71 | 3 + | 3 88 | 7 100 | 7 100 | 3 + | 3 75 | 3 75 | 3 75 | 5 100 | 2 + |
| EUPATORIUM RECURVANS** | 4 2 | 4 6 | 2 + | | | 6 + | | | | | | 3 + |
| EUTHAMIA TENUIFOLIA | 4 20 | 4 46 | 2 + | | 5 100 | 4 58 | | | | 2 + | 5 75 | 3 82 |
| FIMBRISTYLIS AUTUMNALIS | 1 + | | | | | | | | | | | |
| FUIRENA SQUARROSA | 3 3 | 3 6 | | | | | | 3 100 | | | | |
| GELSEMIUM SEMPERVIRENS | 2 + | | | | | | | | | | | |
| GRATIOLA RAMOSA | 3 9 | 3 21 | 2 86 | | | 4 + | 4 100 | | | 3 50 | 3 + | |
| HELENIUM PINNATIFIDUM* # | 5 5 | 5 17 | | | | | 5 100 | | | | 6 100 | |
| HYPERICUM CANADENSE | 3 1 | | | | | | | | | | | |
| HYPERICUM CISTIFOLIUM | 3 23 | 3 43 | | 2 + | 3 100 | 3 + | 5 100 | 3 100 | | | 4 100 | |
| HYPERICUM FASCICULATUM** | 6 5 | 6 17 | | | | | 5 100 | 8 100 | | 5 100 | | |
| HYPERICUM GYMNANTHUM | 1 1 | | | | | | | | | | | |
| ILEX AMELANCHIER* # | 6 12 | 6 4 | | | | | | | | 6 75 | | |
| ILEX CORIACEA | 4 1 | 5 1 | | | | | | | 5 + | | | |
| ILEX GLABRA | 4 2 | | | | | | | | | | | |
| ILEX LAEVIGATA | 2 + | | | | | | | | | | | |
| ILEX MYRTIFOLIA | 5 9 | 5 21 | | | | | 7 100 | 5 100 | | | 5 88 | |
| ILEX OPACA | 3 2 | | | | | | | | | | | |
| IRIS PRISMATICA** | 3 2 | | | | | | | | | | | |
| ITEA VIRGINICA | 3 3 | | | | | | | | | | | |
| IVA MICROCEPHALA* | 2 + | | | | | | | | | | | |
| JUNCUS DIFFUSISSIMUS | 4 3 | 4 6 | | 4 + | | | | | | | | |
| JUNCUS POLYCEPHALUS | 2 + | 2 1 | | | | | | 2 + | | | | |
| JUNCUS REPENS | 5 3 | 8 3 | 8 + | | | | | | | | | |
| JUNCUS SP. | 3 1 | 3 3 | 3 + | | | | | | | | | |
| LACHNANTHES CAROLINIANA | 5 22 | 5 29 | | | | | 5 100 | | 5 100 | 2 + | | 5 100 |
| LEERSIA HEXANDRA | 4 9 | 4 20 | 5 71 | 4 13 | | 5 + | | | | | | 4 + |
| LEUCOTHOE RACEMOSA | 3 3 | 4 1 | | | | | | | | 4 + | | |
| LINDERA MELISSIFOLIA* | 8 2 | | | | | | | | | | | |
| LIQUIDAMBAR STYRACIFLUA | 4 24 | 4 23 | | | 5 13 | 2 + | 2 50 | | | 7 100 | 4 + | 2 + |
| LITSEA AESTIVALIS* # | 3 2 | | | | | | | | | | | |
| LOBELIA BOYKINII* # | 2 6 | 2 7 | | | | 2 + | | | | | | |
| LOBELIA CANBYI | 2 3 | 2 10 | | | | | 2 50 | | 1 + | | 2 50 | |
| LOBELIA NUTTALLII | 2 7 | | | | | | | | | | | |
| LUDWIGIA SP. #1 | 3 3 | 4 6 | | | | | | 4 100 | | | | |
| LUDWIGIA ALTERNIFOLIA | 2 3 | 2 1 | 2 + | | | | | | | | | |
| LUDWIGIA LINIFOLIA* | 4 2 | 4 6 | | | | | 4 100 | | | | | |

Table 4.27 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Wet Savanna/Meadow (9.4.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and'*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LUDWIGIA LINEARIS | 4 2 | | | | | | | | | | | |
| LUDWIGIA PILOSA | 4 1 | 4 3 | | | | | | | | | 4 + | |
| LUDWIGIA SPHAEROCARPA** | 4 + | 4 1 | | | | | | | | 4 + | | |
| LUDWIGIA SUFFRUTICOSA* | 3 5 | 3 16 | | | 4 + | 3 58 | | | | | | 4 + |
| LYCOPODIELLA ALOPECUROIDES | 4 1 | 5 1 | | | | 5 8 | | | | | | |
| LYCOPUS ANGUSTIFOLIUS** | 3 21 | 3 31 | | | | | 3 25 | 4 100 | 3 + | | 4 + | 3 100 |
| LYCOPUS RUBELLUS | 2 + | | | | | | | | | | | |
| LYONIA LIGUSTRINA | 7 1 | | | | | | | | | | | |
| LYONIA LUCIDA | 5 4 | | | | | | | | | | | |
| LYONIA MARIANA | 2 + | | | | | | | | | | | |
| MAGNOLIA VIRGINIANA | 3 5 | 3 1 | | | | | | | | | 3 + | |
| MITREOLA SESSILIFOLIA | 3 2 | 3 6 | | | | | 3 100 | | | | | |
| MYRICA CERIFERA VAR. CERIFERA | 4 5 | 4 9 | | | | | 2 + | 4 100 | | | 5 + | |
| NYSSA BIFLORA | 4 52 | 4 34 | | | | | 4 100 | 4 100 | 3 + | 5 100 | 4 75 | 4 + |
| OSMUNDA REGALIS | 2 + | | | | | | | | | | | |
| OXYPOLIS CANBYI* # | 3 5 | 3 16 | | | | | 4 100 | 2 + | | | 3 + | 3 45 |
| PANICUM HEMITOMON | 4 30 | 4 51 | | | 3 88 | 3 50 | 2 + | | 6 100 | 7 100 | 3 50 | 3 82 |
| PANICUM RIGIDULUM VAR. COMBSII | 4 13 | 4 44 | | | 6 100 | 4 67 | 4 100 | 5 100 | 4 75 | | | 4 + |
| PANICUM TENERUM* | 5 8 | 5 26 | | 6 100 | 4 75 | | | | | | 6 + | |
| PANICUM VERRUCOSUM | 5 48 | 4 29 | | 3 + | | 4 + | | 3 + | 4 100 | 4 + | | 4 91 |
| PASPALUM LAEVE | 5 3 | 2 1 | 2 + | | | | | | | | | |
| PERSEA PALUSTRIS | 5 4 | 5 7 | | | | | | | 5 100 | | 5 + | |
| PHORADENDRON SEROTINUM | 2 + | | | | | | | | | | | |
| PINUS ELLIOTTII | 4 1 | 4 4 | | | | | | 4 75 | | | | |
| PINUS PALUSTRIS | 6 + | 6 1 | | | | | | | | | 6 13 | |
| PINUS SEROTINA | 4 4 | 4 9 | | | | | | | | | 4 75 | |
| PINUS TAEDA | 4 30 | 4 49 | 3 + | 5 100 | 4 100 | 5 + | 1 50 | | 3 + | 5 100 | | 4 55 |
| PLATANUS OCCIDENTALIS | 1 + | | | | | | | | | | | |
| PLUCHEA FOETIDA | 4 3 | 4 10 | | | | | 4 100 | 4 75 | | | | |
| PLUCHEA ROSEA | 5 38 | 4 40 | 5 71 | 3 63 | 3 88 | 4 67 | | | | 4 75 | | |
| POLYGALA CYMOSA | 3 30 | 3 24 | | | | | 5 100 | | 3 + | 4 + | 3 50 | 2 45 |
| POLYPODIUM POLYPODIOIDES | 2 + | | | | | | | | | | | |
| PROSERPINACA PECTINATA | 3 10 | 3 19 | 2 43 | | | | 3 + | 2 75 | | 5 100 | 2 + | |
| PRUNUS CAROLINIANA | 3 1 | 2 1 | | | | | | | | | 2 + | |
| PRUNUS SEROTINA | 1 + | | | | | | | | | | | |
| PSILOCARYA NITENS | 1 + | | | | | | | | | | | |
| QUERCUS LYRATA | 4 1 | | | | | | | | | | | |
| QUERCUS NIGRA | 2 3 | | | | | | | | | | | |
| QUERCUS PHELLOS | 4 3 | 4 7 | | | | | | | | 4 100 | 3 + | |
| RHEXIA ARISTOSA* # | 3 52 | 3 47 | | 3 63 | 3 63 | 3 75 | 3 100 | | | 3 100 | 5 75 | |
| RHEXIA MARIANA | 3 4 | 3 7 | | | | | | | 4 100 | | 2 + | |
| RHEXIA VIRGINICA | 3 3 | 4 6 | | | | | | 4 100 | | | | |
| RHYNCHOSPORA CEPHALANTHA VAR. CEPHALANTHA | 4 3 | 4 11 | | | | | 4 75 | | 3 + | | 4 50 | |
| RHYNCHOSPORA CHALAROCEPHALA | 3 2 | 4 6 | | | | | | | | 4 + | 4 + | |
| RHYNCHOSPORA FILIFOLIA | 4 45 | 4 61 | | 2 50 | 6 100 | 3 58 | 5 100 | 5 100 | 3 + | 3 75 | 7 100 | 3 + |
| RHYNCHOSPORA GRACILENTA | 3 1 | 3 3 | | | | | | | | | 3 + | |
| RHYNCHOSPORA INTERMIXTA | 4 3 | 4 10 | | 3 + | | 5 + | | | | | | |
| RHYNCHOSPORA INUNDATA**# | 5 32 | 6 34 | | | | | | 5 100 | 3 + | | 6 100 | 6 100 |

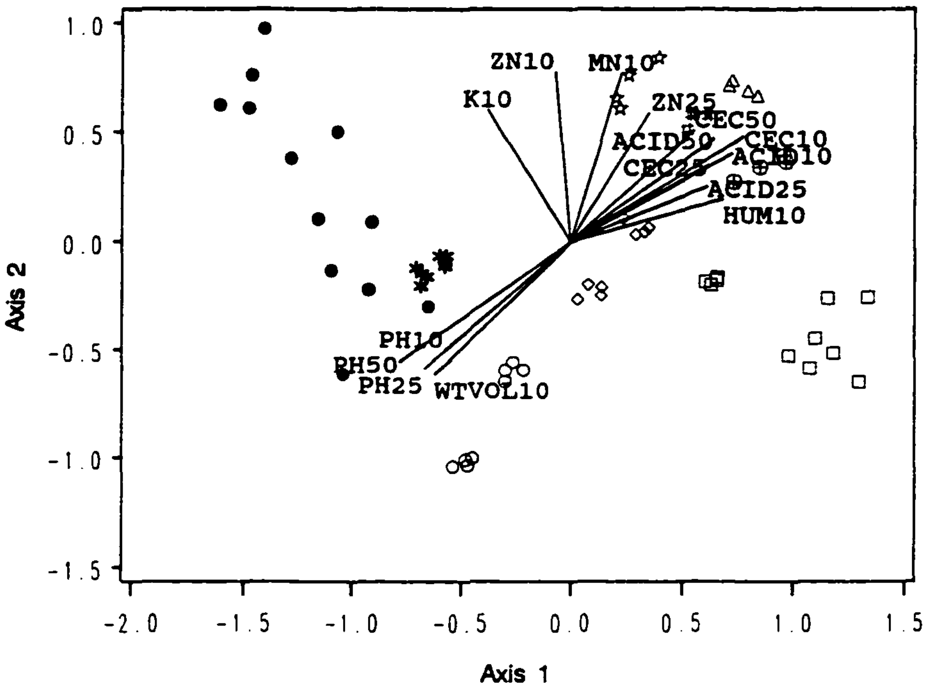
Table 4.27 (cont.). Average cover class and constancy of species present in the Intermittently Ponded Cypress/Gum Depression, Wet Savanna/Meadow (9.4.) vegetation subclass. Values are given for the vegetation class, the vegetation subclass, and the constituent community types of the subclass. Each vegetation group is represented by its respective abbreviation code (see text). 'Cov' is the mean cover class for a species for the sites in which it is present, 'Con' is the constancy of a species, and '*', '**', and '#' indicates a regionally or nationally rare, listed species (see text for respective designations).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RHYNCHOSPORA PERPLEXA VAR. PERPLEXA | 4 30 | 4 27 | 3 43 | | 5 88 | 5 50 | | 4 + | | | 1 + | |
| RHYNCHOSPORA RARIFLORA | 5 2 | 5 7 | | | 5 63 | | | | | | | |
| RHYNCHOSPORA TRACYI* # | 6 3 | 6 7 | | | | | | | | | | 6 + |
| RUBUS ARGUTUS | 4 1 | 4 3 | | | 3 + | | | 4 + | | | | |
| SABATIA BRACHIATA | 2 2 | 2 4 | | | 1 + | 2 + | | | | | | |
| SABATIA DIFFORMIS | 2 8 | 3 9 | | | | | | | | | 3 75 | |
| SACCHARUM GIGANTEUM | 4 21 | 5 46 | | | | | 4 100 | 5 100 | 4 100 | 4 100 | 5 75 | 5 91 |
| SAGITTARIA ISOETIFORMIS* # | 2 + | 2 1 | 2 + | | | | | | | | | |
| SARRACENIA FLAVA | 3 + | 3 1 | | | | | | | 3 + | | | |
| SASSAFRAS ALBIDUM | 2 + | | | | | | | | | | | |
| SCLERIA BALDWINII* # | 2 + | 2 1 | | | | | 2 + | | | | | |
| SCLERIA GEORGIANA* | 4 5 | 4 16 | 3 + | | 5 88 | 2 + | | 3 + | | | | |
| SCLERIA RETICULARIS* | 4 52 | 3 37 | | 7 + | 2 + | 3 + | 3 75 | 2 100 | 4 100 | 2 + | 3 + | 2 + |
| SCLEROLEPIS UNIFLORA** | 4 15 | 4 20 | 4 57 | | | 4 83 | | | | | | |
| SMILAX GLAUCA | 3 7 | | | | | | | | | | | |
| SMILAX LAURIFOLIA | 2 5 | 2 6 | | | | | 2 + | 3 + | 1 + | | | |
| SMILAX ROTUNDIFOLIA | 2 8 | | | | | | | | | | | |
| SMILAX WALTERI | 4 + | 4 1 | | | | | | 4 25 | | | | |
| SPHAGNUM SP. | 5 11 | 4 14 | | | | | | | 5 25 | | 4 50 | 5 + |
| STILLINGIA AQUATICA# | 6 2 | 6 6 | | | | | | 6 100 | | | | |
| STYLISMA AQUATICA* | 5 6 | 5 20 | | | 6 100 | 4 50 | | | | | | |
| SYMPLOCOS TINCTORIA | 5 + | | | | | | | | | | | |
| TAXODIUM ASCENDENS | 6 76 | 5 44 | | | | | 6 100 | 4 100 | 7 100 | | 5 100 | 5 100 |
| TILLANDSIA USNEOIDES | 3 6 | 3 10 | | | | | 3 100 | 3 75 | | | | |
| TOXICODENDRON RADICANS VAR. RADICANS | 3 9 | 3 11 | | | | | | 3 + | | 3 + | 4 + | 3 + |
| TRIADENUM TUBULOSUM** | 3 1 | | | | | | | | | | | |
| TRIADENUM VIRGINICUM | 3 2 | 3 1 | | | | | | | 3 + | | | |
| UTRICULARIA BIFLORA | 6 2 | 6 6 | | 6 + | | | | | | | | |
| UTRICULARIA FIBROSA | 3 4 | 6 3 | 6 + | | | | | | | | | |
| UTRICULARIA JUNCEA | 7 3 | 7 10 | | | | | | | | | | 7 64 |
| UTRICULARIA PURPUREA | 3 3 | | | | | | | | | | | |
| UTRICULARIA RADIATA | 6 + | | | | | | | | | | | |
| VACCINIUM CORYMBOSUM | 3 1 | 3 3 | | | | | | | | 4 + | | 1 + |
| VACCINIUM FUSCATUM | 4 12 | 3 4 | | | | | | | 3 + | | 5 + | 2 + |
| VIOLA LANCEOLATA | 3 12 | 1 6 | | | | 2 + | | | | | | 1 + |
| VITIS ROTUNDIFOLIA | 3 4 | | | | | | | | | | | |
| WOODWARDIA AREOLATA | 3 1 | 3 3 | | | | | | 3 + | | | 3 + | |
| WOODWARDIA VIRGINICA | 5 8 | 5 9 | | | | | | 4 + | 6 100 | | | |
| XYRIS AMBIGUA | 2 11 | | | | | | | | | | | |
| XYRIS DIFFORMIS VAR FLORIDANA* | 3 1 | 3 4 | | | | | 3 75 | | | | | |
| XYRIS FIMBRIATA | 3 5 | 3 17 | | | | | | 2 75 | 4 100 | | 3 63 | |
| XYRIS JUPICAI | 3 2 | 3 6 | | | | 3 + | | | | | | |
| XYRIS SMALLIANA** | 3 3 | 3 10 | | | | 3 58 | | | | | | |
| ZENOBIA PULVERULENTA | 5 2 | 3 1 | | | | | | | | | 3 + | |

Table 4.28. Average site information for the Intermittently Ponded Cypress/Gum Depression, Wet Savanna/Meadow vegetation subclass. The vegetation subclass and its constituent community types are represented by their respective "Group" abbreviation codes (see text). For convenience, site information is divided into three categories: (1) Site Hydrological factors, (2) Site Geomorphologic factors, and (3) Site Disturbance factors (see text for definitions of parameters listed for each category).

| | Group | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9.4. | 9.4.1 | 9.4.2 | 9.4.3 | 9.4.4 | 9.4.5 | 9.4.6 | 9.4.7 | 9.4.8 | 9.4.9 | 9.4.10 |
| Site Hydrology | | | | | | | | | | | |
| Water Depth Index | 119.1 | 155.6 | 125.0 | 30.0 | 149.1 | 99.0 | 153.3 | 112.0 | 138.0 | 144.4 | 84.7 |
| Hydroperiod Class | 3.0 | 4.0 | 3.0 | 2.0 | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 2.2 |
| Water Constancy Index | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 1.0 |
| Organic Layer Depth | 10.5 | — | 0.0 | 12.0 | — | 13.0 | 7.0 | 16.0 | 11.0 | 13.0 | 12.0 |
| Soil Drainage Class | 2.3 | 2.0 | 2.0 | 2.0 | 2.0 | 3.0 | 3.0 | 2.0 | 2.0 | 3.0 | 2.0 |
| Soil Permeability Class | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 4.0 | 4.0 |
| Soil Available Water Capacity Class | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.0 | 3.5 | 3.0 | 3.0 |
| | | | | | | | | | | | |
| Site Geomorphology | | | | | | | | | | | |
| Site Elevation (m) | 46.4 | 59.4 | 35.1 | 54.9 | 54.9 | 45.0 | 36.6 | 6.1 | 50.3 | 48.8 | 73.2 |
| Elevational Drop in 1 Km (m) | 7.3 | 13.7 | 13.7 | 9.1 | 9.1 | 3.0 | 3.0 | 3.0 | 7.6 | 1.5 | 9.1 |
| Distance to 10 m Elevational Drop (m) | 2050 | 625 | 750 | 800 | 800 | 3125 | 3300 | 3575 | 1500 | 4900 | 1025 |
| Depression Area (ha) | 20.8 | 1.5 | 6.1 | 10.0 | 10.0 | 6.9 | 66.7 | 26.1 | 5.4 | 16.9 | 58.2 |
| Depression Length/Width Ratio | 1.6 | 1.6 | 1.4 | 1.5 | 1.5 | 1.5 | 1.3 | 1.7 | 1.5 | 2.0 | 1.5 |
| Depression Long Axis Orientation | +10.4 | +12.0 | -9.0 | +5.0 | +5.0 | +9.0 | +21.0 | +23.0 | +34.0 | +12.0 | -3.0 |
| | | | | | | | | | | | |
| Site Disturbance | | | | | | | | | | | |
| Fire Frequency Class | 2.6 | 3.0 | 3.0 | 3.0 | 3.0 | 2.0 | 3.0 | 2.0 | 3.0 | 2.0 | 2.0 |
| Cultivation Index | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Grazing Index | 1.6 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.0 |
| Timbering Index | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.0 | 1.0 | 2.0 | 2.0 | 2.0 |
| Drainage Index | 1.6 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 2.0 |
| Landscape Disturbance Class | 3.1 | 4.0 | 4.0 | 4.0 | 4.0 | 3.0 | 3.0 | 1.0 | 2.0 | 3.0 | 3.0 |

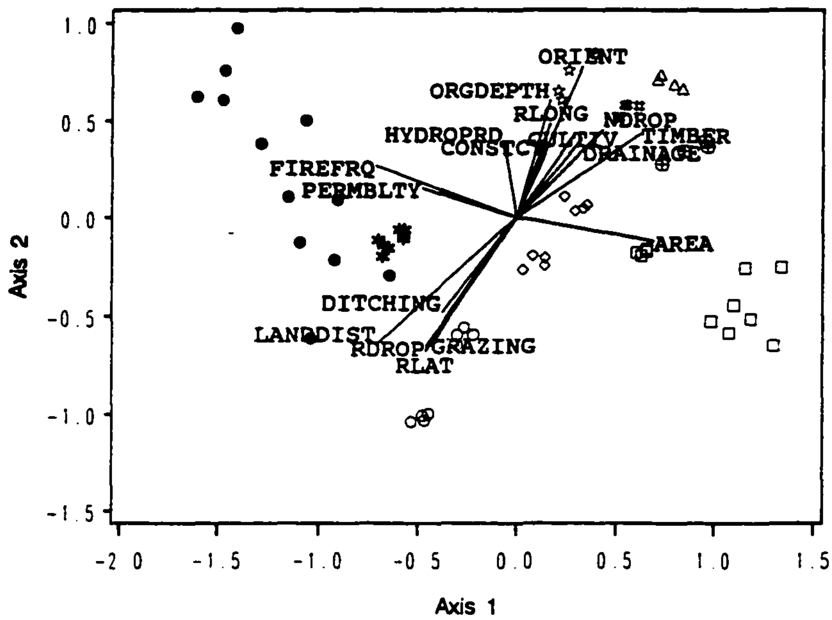
Figure 4.54. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major soil-related environmental gradients and Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION,**
**Wet Savanna/Meadow — Community Types:**

○ Pinus taeda/Panicum tenerum/Centella—Dichanthelium wrightianum Meadow
✱ Eupatorium leucolepis—Panicum rigidulum v. combsii/Dichanthelium erectifolium—Rhynchospora filifolia/Stylisma aquatica Meadow
● Eupatorium leucolepis Meadow
# Taxodium ascendens/Ilex myrtifolia/Carex striata—Aristida palustris/Eriocaulon compressum Savanna
△ Ilex myrtifolia/Hypericum fasciculatum—Stillingia/Carex striata Meadow
⊕ Taxodium ascendens/Clethra/Carex striata—Panicum hemitomon/Eriocaulon compressum—Lachnanthes Savanna
☆ Liquidambar/Ilex amelanchier/Carex striata—Panicum hemitomon Savanna
◇ Taxodium ascendens/Aristida palustris—Rhynchospora inundata/Rhynchospora filifolia—Helenium—Centella Savanna
□ Rhynchospora inundata/Centella—Utricularia juncea Meadow

Figure 4.55. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of North and South Carolina Carolina bay depression plots showing associations between major environmental gradients that are not directly soils-related and Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow" stands as distributed by community type on the two major compositional gradients.




**INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION,**
**Wet Savanna/Meadow — Community Types:**

○ Pinus taeda/Panicum tenerum/Centella–Dichanthelium wrightianum Meadow

✱ Eupatorium leucolepis–Panicum rigidulum v. combsii/Dichanthelium erectifolium–Rhynchospora filifolia/Stylisma aquatica Meadow

● Eupatorium leucolepis Meadow

⌗ Taxodium ascendens/Ilex myrtifolia/Carex striata–Aristida palustris/Eriocaulon compressum Savanna

△ Ilex myrtifolia/Hypericum fasciculatum–Stillingia/Carex striata Meadow

⊕ Taxodium ascendens/Clethra/Carex striata–Panicum hemitomon/Eriocaulon compressum–Lachnanthes Savanna

☆ Liquidambar/Ilex amelanchier/Carex striata–Panicum hemitomon Savanna

◇ Taxodium ascendens/Aristida palustris–Rhynchospora inundata/Rhynchospora filifolia–Helenium–Centella Savanna

□ Rhynchospora inundata/Centella–Utricularia juncea Meadow

Figure 4.56. Plant Life Forms for Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow" vegetation groups found within North and South Carolina Carolina bay depressions.

**PLANT LIFE FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Wet Savanna/Meadow' VEGETATION GROUPS**

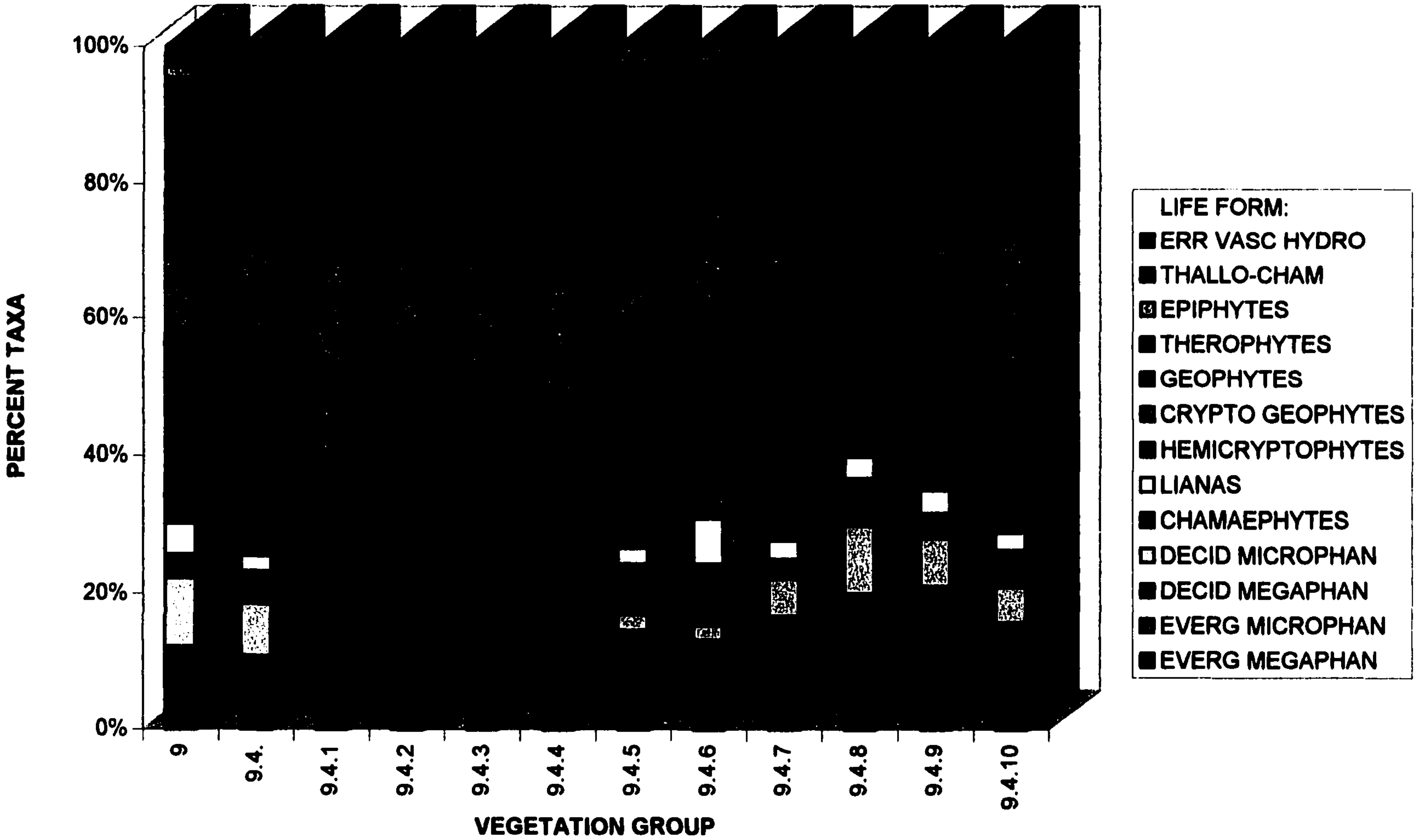
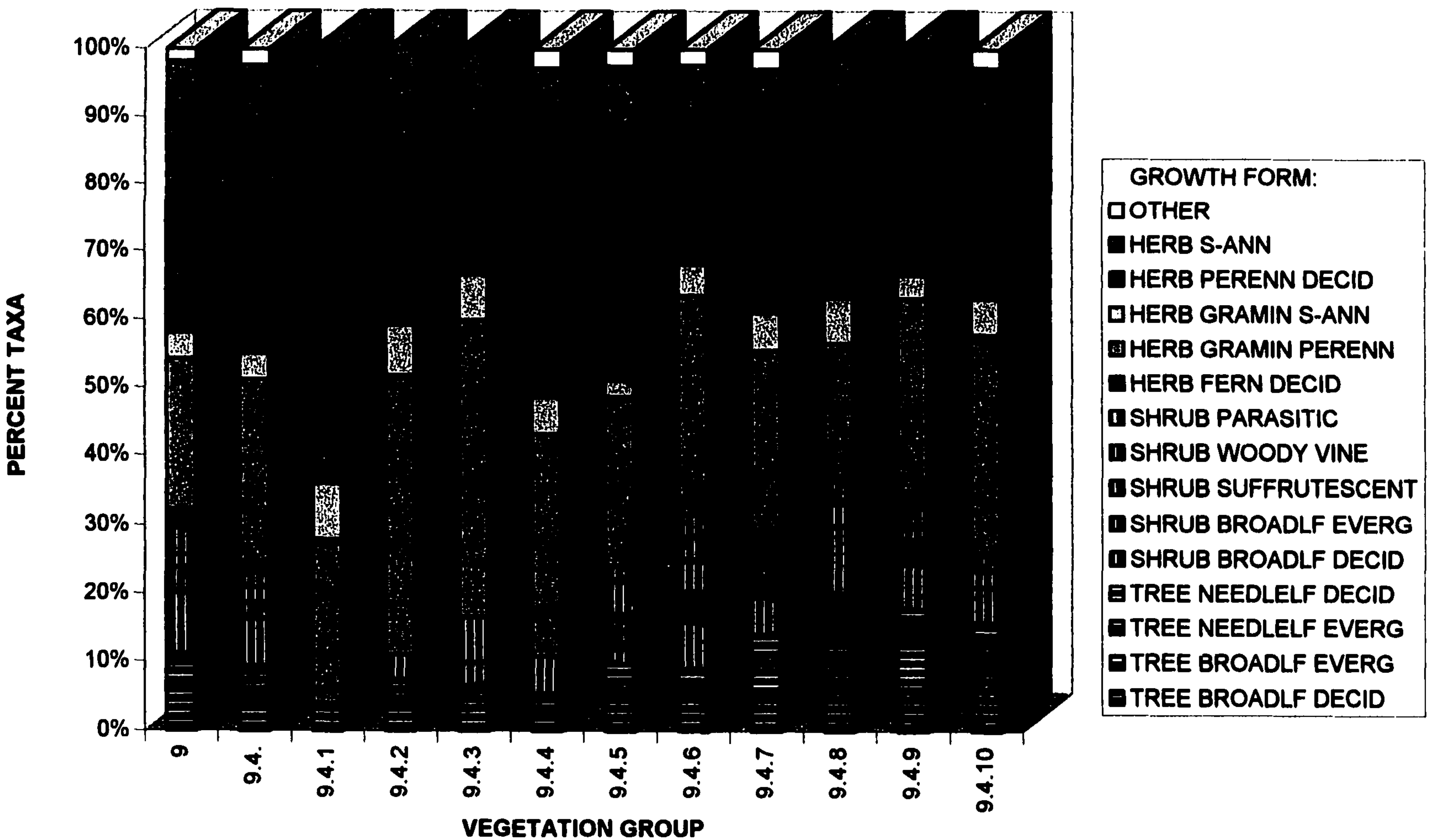


Figure 4.57. Plant Growth Forms for Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow" vegetation groups found within North and South Carolina Carolina bay depressions.

**PLANT GROWTH FORMS OCCURRING IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION 'Wet Savanna/Meadow' VEGETATION GROUPS**



# CHAPTER V.

# COMMUNITY GRADIENT ANALYSIS OF STUDY AREA CAROLINA BAYS

## 5.1 Introduction

As previously discussed, Carolina bays constitute a unique, widespread, remarkably uniform geomorphic depression type. Nevertheless, Carolina bay vegetation within the selected study area is highly diverse, running the gamut from Freshwater Pond to Brackish Marsh to Pocosin to Cypress Swamp to Longleaf Pine Savanna, *inter alia*. Consequently, bay depressions provide the setting for a comparatively unique wetlands ecological problem. One of the primary objectives of this study was to illuminate understanding of this remarkable biodiversity in the midst of seeming uniformity.

Vegetation--environment relationships within study area Carolina bays were examined using NMDS ordination (described in detail in Chapters 3 and 4, above). A Principal Components Analysis (PCA) of sampling site latitude and longitude was used to determine relative stand position along the major southwest--northeast axis of the Atlantic coastal plain and the orthogonal northwest--southeast slope (axis) of coastal plain land surfaces that are largely the basis of the land surface (physiographic) divisions set out in Figure 2.3. The PCA factors were orthogonally rotated using VARIMAX, to determine the percent of the variation in the latitude and longitude gradients explained by each respective rotated factor.

A correlation analysis of all measured environmental factors (including both "rotated" and "non-rotated" latitude and longitude values ) was performed to determine relationships between variables and to determine whether highly correlated variable should be eliminated from the regression analysis. Ultimately, only non-rotated latitude and non-rotated longitude were rejected as being very highly correlated, respectively, with rotated latitude and rotated longitude. A total of 69 site environmental factors (21 "non-soil" related factors and 16 soil parameters from each of three depths levels) were used in the regression analysis (*see* Table 3.1).

NMDS ordinations were computed in DECODA (Minchin, 1995) using 50 random starting configurations. Ordinations were computed for each data set (*i.e.*, groupings of total sampled study area plots, as described below). The scatter plots produced represent solutions with one to four dimensions for the study area analysis. The starting configuration with the lowest minimum stress level was used for each ordination. Stand scores from ordination solutions with increasing dimensionality were not fitted to each other with procrustes rotation. The two dimensional solution was chosen in all analyses to explain vegetation--environment relationships.

Regressions of individual environmental factors and stand scores on the first two NMDS axes (*i.e.*, 'Axis 1' x 'Axis 2') were used to identify environmental variables significantly associated with the two ordination compositional axes. Identified relationships were plotted on a series of biplot vector diagrams, where the angle of the vector is determined by the ratios of the fitted regression coefficients and vector length is determined by the strength of the correlation.

In the following analysis, a scatterplot (ordination diagram) is initially presented showing the primary and secondary compositional gradients (Axis 1 and Axis 2) identified using NMDS. Stands are plotted by their scores on Axis 1 and Axis 2 (*see, e.g.*, Figure 5.1) and are identified by their vegetation group (vegetation class or subclass) as assigned by the previously discussed hierarchical clustering analysis used to classify study area Carolina bay vegetation. Biplots show the relationship between vegetation composition and individual environmental variables. Because of the large number of environmental variables used (69 total), four separate biplot vector diagrams were produced for each ordination diagram to facilitate biplot "readability": (1) a biplot for environmental variables not directly related to plot soil properties, (2) a biplot for plot soil properties measured at a depth of 10 cm, (3) a biplot for plot soil properties measured at a depth of 25 cm, and (4) a biplot for plot soil properties measured at a depth of 50 cm.

This chapter principally examines the relationships between environmental factors and vegetation classes. Significant environmental gradients found within those vegetation groups are discussed in Chapter 4 following the detailed ecosystematic descriptions of each vegetation group.

## 5.2 Community Gradient Analysis

### 5.2.1 Environmental gradients in intensively sampled plots as a whole

According to the vector biplot diagrams for all sampled study area Carolina bay plots (excluding Brackish Marsh plots), vegetation stands are distributed, overall, along a complex hydrologic/soil acidity--density gradient (Figures 5.1 to 5.5). The hydrologic portion of the overall distributional gradient consists of relative "wetness" factors at several levels: (1) individual plot (soil drainage class, depth of organic-dominated layer); (2) depressional (elevation;, and (3) landscape (rotated longitude, which in essence represents distance from the coast, and may be thought of as a surrogate for elevation). Stands fall along the soil acidity--texture portion of the overall controlling gradient according to relative plot soil pH, "acidity" (*i.e.*, percentage dominance of the CEC by hydrogen and aluminum ions), CEC, percent humic matter, and bulk density. The latter soil property connects the soil and "non-soil" portions of the complex gradient in that bulk density decreases with increasing proportion of organic matter, and the depth of the organic-dominated soil layer generally increases with increasing site "wetness". Both portions of the complex gradient are strongly associated with both scatterplot compositional axes, although the soil acidity--density portion of the gradient is more strongly correlated with the first compositional axis (*i.e.*, Axis 1). Figure 5.5 also depicts a gradient in terms of relative site landscape disturbance, which is defined in Chapter 3. That comparative value is probably better considered as a site descriptor, rather than a true environmental variable.

Along the hydrologic portion of the gradient, Evergreen Shrub-bog plots (found in the lower left portion of the ordination diagram presented in Figure 5.1) generally possess the most poorly drained, organic dominated soils, and tend to be located at lower elevations and at the lowest longitudes (*i.e.*, the farthest east). In terms of the soil acidity--density portion of the overall environmental gradient, Evergreen Shrub-bogs occur over the most acidic soils (both in terms of low pH and CEC dominance by hydrogen and aluminum ions), and those having the highest CEC, the highest concentrations of humic matter, and the lowest bulk densities. Each of those characteristics is a reflection of high soil organic matter content. Evergreen Shrub-bogs are generally found within the study area in relatively undisturbed landscapes.

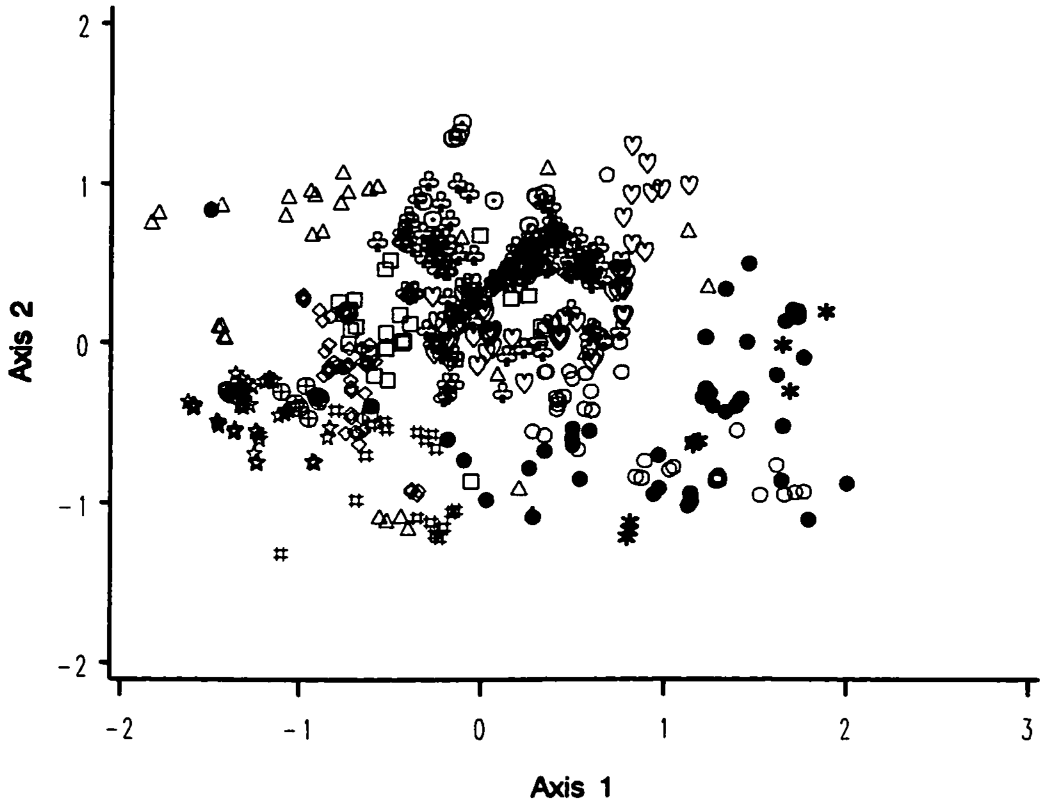
By contrast, at the other end of the spectrum, Drawdown and Wet Savanna/Meadow plots (found in the upper right portion of the ordination diagram) tend to occur over relatively better drained, less acid, mineral soils, and tend to be located at higher elevations and farther from the coast. Depressions exhibiting stands classified within either of these vegetation subclasses tend to be insular natural systems within a landscape whose vegetation and physical environment have been fundamentally altered by human activities.

Other study area Carolina bay vegetation groups occur along the dominant environmental gradient between these two extremes. Generally, sampling plots falling within vegetation classes characterized by organic soils and found at wetter sites are located on the bottom portion of the scatter plot diagram, while plots assigned to vegetation classes characterized by mineral soils and found at relatively "drier" wetlands sites are located in the upper portion of the ordination diagram.

Also significant to overall stand distribution within the study area is a weaker local relief/hydroperiod/disturbance/soil nutrient gradient running orthogonally to the primary study area environmental gradient. The secondary gradient reflects relative site relief, the relative level of available calcium (and to a lesser extent, manganese) in plot soils, hydroperiod length, and comparative site disturbance levels, chiefly fire frequency. Plots in the lower right portion of the ordination diagram -- representing stands falling within Freshwater Pond, Freshwater Marsh, and Intermittently Flooded Depression Prairie vegetation groups -- tend to be found at sites located on relatively dissected landscapes and having more available calcium, but at the same time having a comparatively long hydroperiod, and consequently being only infrequently subject to fire disturbance. Plots in the upper left portion of the diagram -- principally plots assigned to Longleaf Pine Woodland and Intermittently Ponded Cypress/Gum Depression vegetation groups -- tend comparatively to be located on less dissected landscapes, have less available soil calcium, have shorter hydroperiods, and be subject to more frequent disturbance by fires.

Reference to the ordination diagram presented in Figure 5.1 indicates that plots falling into those vegetation classes dominated primarily by herbaceous species -- Intermittently Flooded Depression Prairies, Freshwater Ponds, Freshwater Marshes, and Boggy Marshes -- are located in the lower right portion of the scatter diagram, while plots assigned to vegetation classes dominated by woody species -- Longleaf Pine Woodlands, Evergreen Shrub-bogs, Cypress/Gum Bogs, and Intermittently Ponded Cypress/Gum Depressions -- are found in the upper left portion of the ordination scatterplot. The latter group of plots, which are more numerous in number than the herb-dominated stands, are compressed into a relatively small portion of the ordination diagram as a result of their shared comparative dissimilarity with the herb-dominated plots. In an attempt to reveal detail in stand arrangement in relation to site environmental conditions, a second ordination was run and vector biplot diagrams produced for study area plots after dividing them into two groups: (1) plots dominated by herbaceous species, and (2) plots dominated by woody species. The results of that second-level gradient analysis follow, first for herb-dominated plots, and then for plots dominated by woody species.

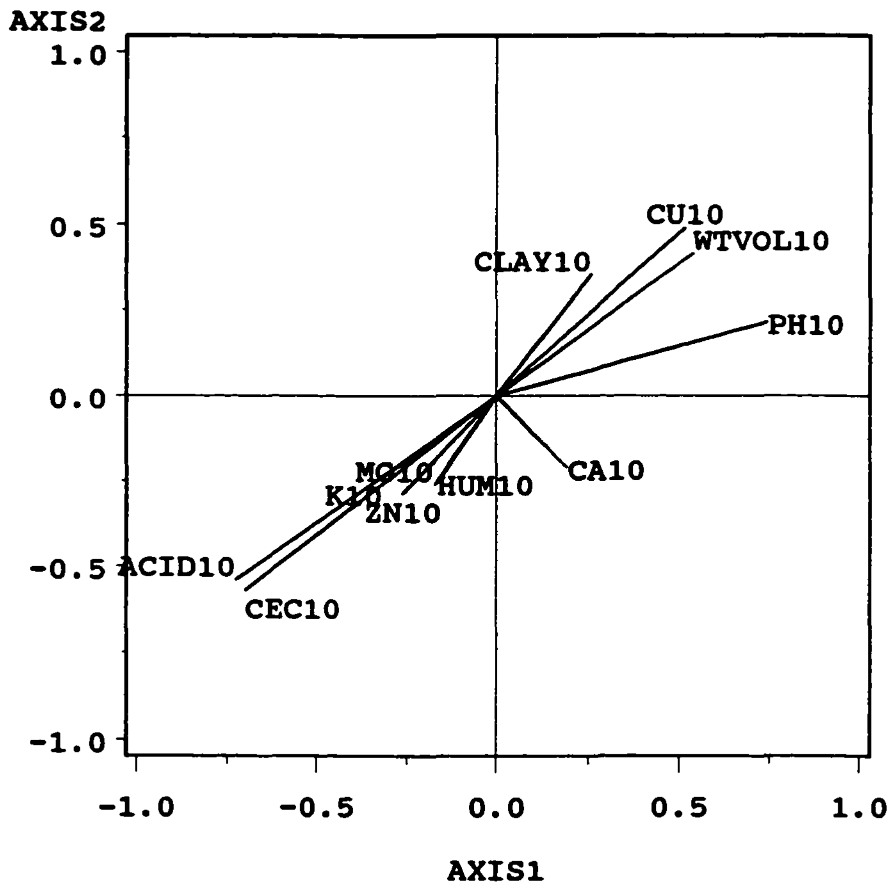
Figure 5.1. Diagram for NMDS ordination of all study area Carolina bay plots (except Brackish Marsh plots) showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**Vegetation Class:**

○ 2. Intermittently Flooded Depression Prairie
✱ 3. Freshwater Pond
● 4. Freshwater Marsh
♯ 5. Boggy Marsh
△ 6. Longleaf Pine Woodland
⊕ 7a. Evergreen Shrub—Bog "Bay Forest"
☆ 7b. Evergreen Shrub—Bog "Pocosin"
◇ 8. Cypress/Gum Bog
□ 9a. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp"
⊙ 9b. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Pond"
♧ 9c. Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow"
♡ 9d. Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow"

Figure 5.2. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.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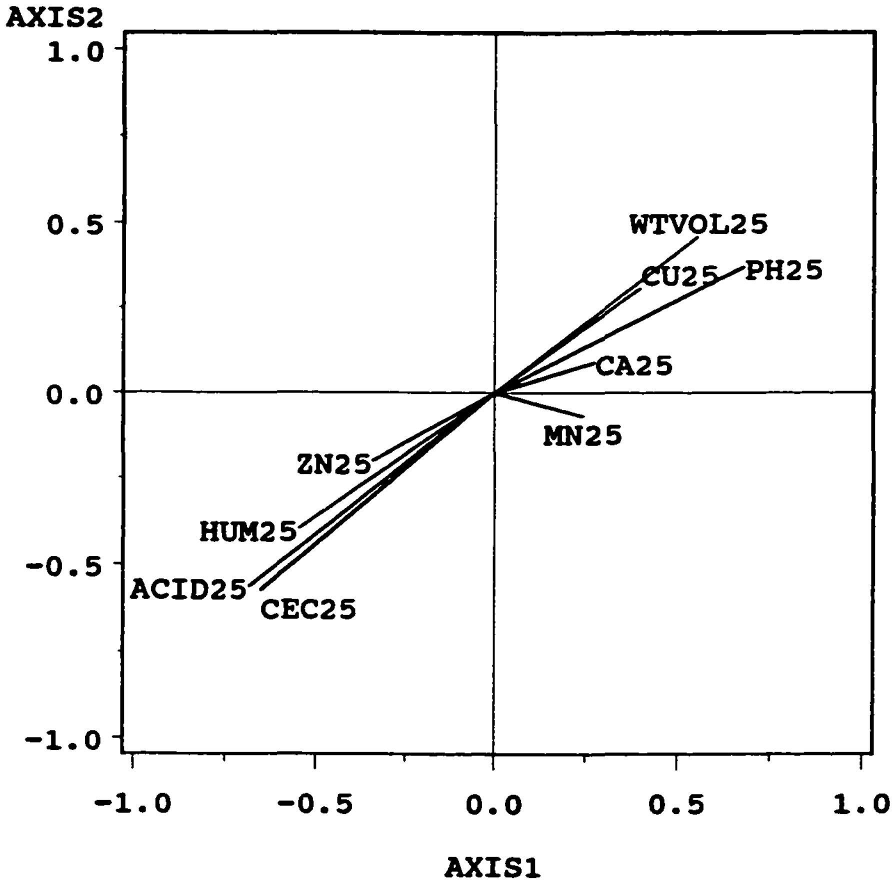
0.0
-0.5
-1.0
CU10
WTVOL10
CLAY10
PH10
CA10
MG10
HUM10
K10
ZN10
ACID10
CEC10
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.3. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.



AXIS2
1.0
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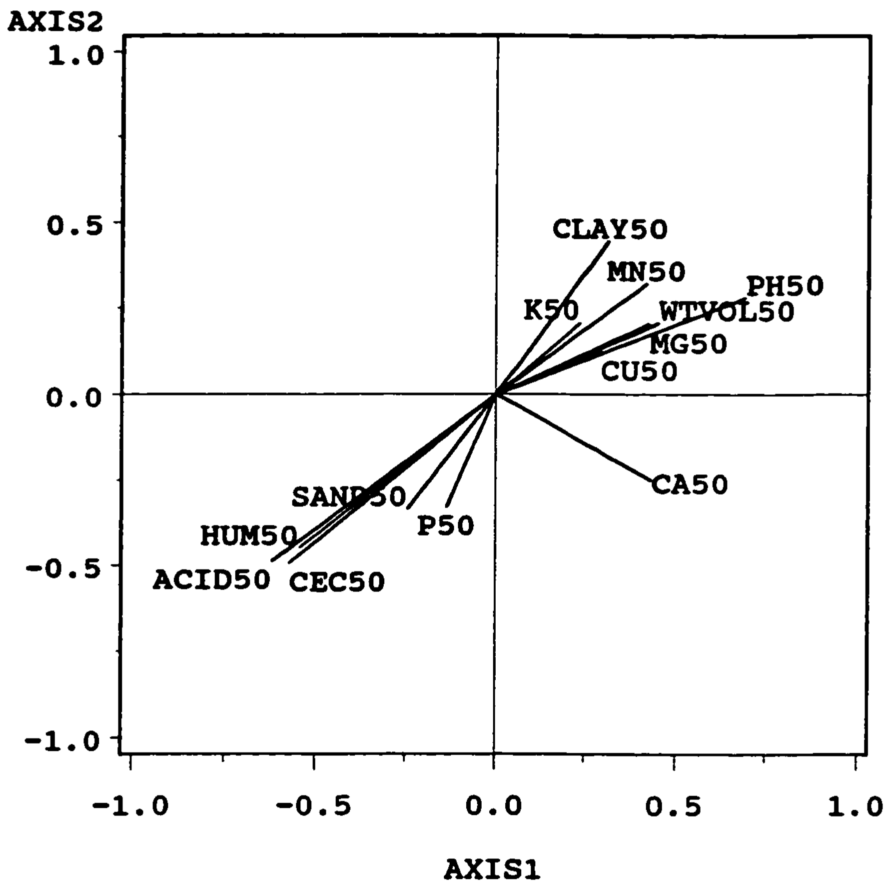
-0.5
-1.0
WTVOL25
CU25
PH25
CA25
MN25
ZN25
HUM25
ACID25
CEC25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.4. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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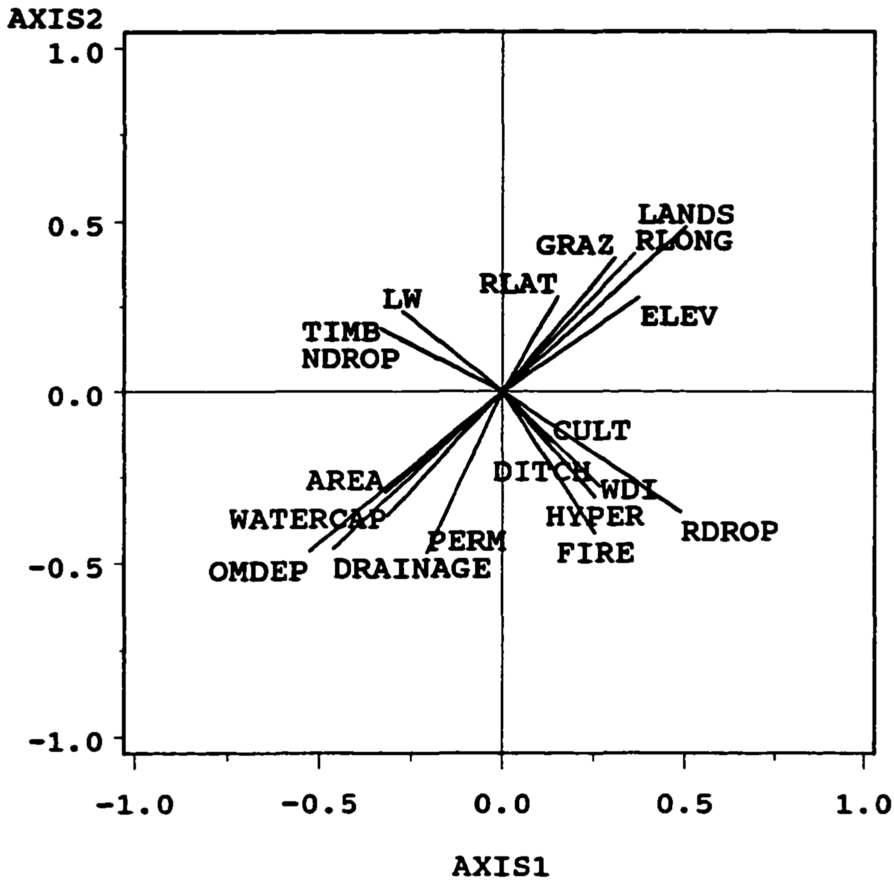
-1.0
CLAY50
MN50
PH50
K50
WTVOL50
MG50
CU50
CA50
SAND50
P50
HUM50
ACID50
CEC50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.5. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.


AXIS2
1.0
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-0.5
-1.0
LANDS
RLONG
GRAZ
RLAT
ELEV
LW
TIMB
NDROP
CULT
DITCH
WDI
AREA
WATERCAP
HYPER
RDROP
PERM
FIRE
OMDEP
DRAINAGE
-1.0
-0.5
0.0
0.5
1.0
AXIS1

### 5.2.2 Environmental gradients in plots dominated by herbaceous species

In relation to all other study area stands, herb-dominated plots are located at sites with poorly drained soils and relatively long hydroperiods, making fires infrequent. Herb-dominated communities span a wide range of soil properties, as discussed in Chapter 4. Relative to each other, herb-dominated study area plots are distributed along two complex gradients: a major locational/soil "acidity" gradient, and an orthogonal elevational/site relief/soil textural gradient (Figures 5.6 to 5.10). Along the locational/soil "acidity" gradient, stands are distributed according to their comparative soil pH, acidity, CEC, and humic matter content, as well as their longitudinal location (essentially, distance from the coast). On the elevational/site relief/soil textural gradient, plots are located by their relative clay content at the soil surface, and by the elevation and relief of the depressions in which they occur. The primary environmental gradient is strongly correlated with the first compositional axis found on the ordination diagram for herb-dominated plots, while the secondary gradient is more closely associated with both compositional axes.

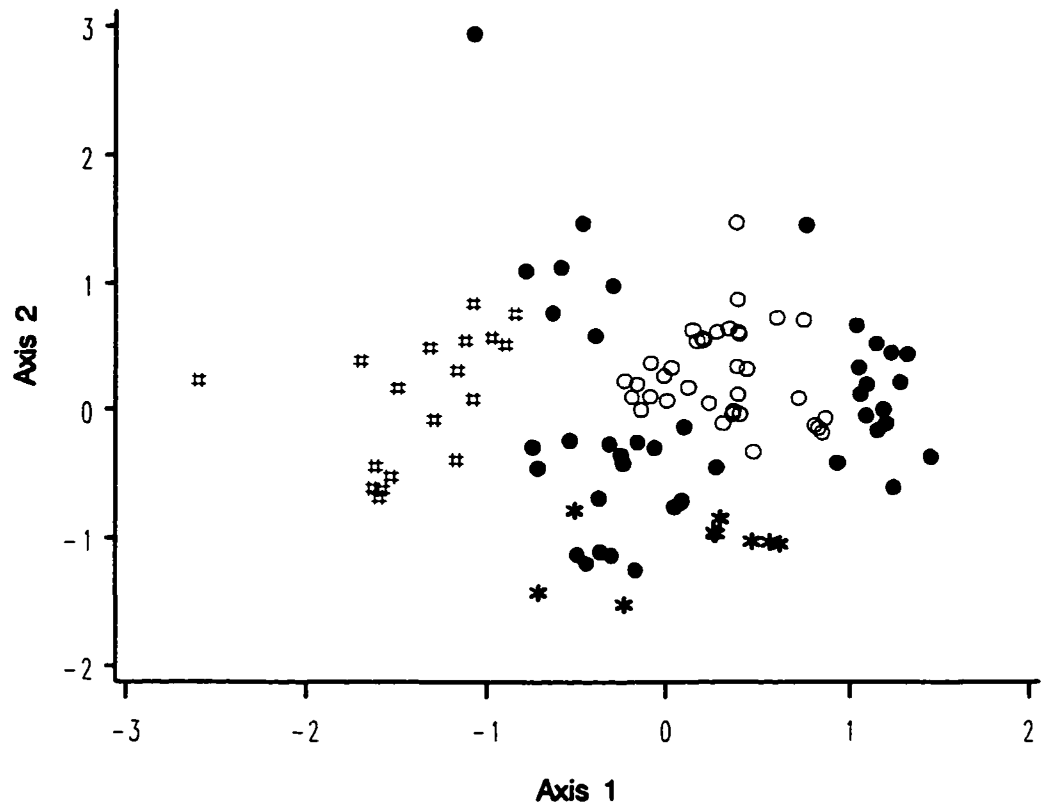
As the biplots for study area herb-dominated plots (Figures 5.7 to 5.10) indicate, study area Boggy Marsh plots are found at the easternmost (lowest longitude), elevationally lowest depressions located on flat land surfaces, over low pH, strongly acidic, poorly drained soils dominated by surficial humic matter and zinc. Intermittently Flooded Depression Prairie plots are found at elevationally higher sites, having moderate relief and located away from the immediate coast, on acid soils where clay is significant near the surface. Freshwater Pond plots are found in lower elevation depressions over poorly drained, moderately acid soils tending to be low in organic matter. Freshwater Marsh plots occur over a wide variety of environmental conditions within the study area, but are generally found over comparatively less acid, mineral soils.

### 5.2.3 Environmental gradients in plots dominated by woody species

In relation to herb-dominated study area stands, woody species-dominated plots are located at sites having comparatively shorter hydroperiods, with a history of more frequent fires, but less ditching and cultivation disturbance. "Woody" plots are found over soils that include virtually the entire gamut of soil properties encountered in Carolina bay wetlands, but tend to be less calcium rich than those found in herb-dominated plots. Relative to each other, study area plots dominated by woody species are distributed along the same complex hydrologic/soil acidity--density gradient common to all plots, as well as an orthogonally related disturbance/hydroperiod/soil textural gradient (Figures 5.11 to 5.15). Along the primary gradient, stands are distributed according to their comparative soil pH, acidity, CEC, organic layer depth, humic matter content, weight/volume, and drainage class, as well as relative site elevation. On the disturbance/hydroperiod/soil textural gradient, plots are located by their relative soil textures and permeabilities, hydroperiod lengths, and degree of human disturbance. The primary environmental gradient is significantly correlated with both compositional axes found on the ordination diagram, although it is more strongly correlated with the first compositional axis. The secondary gradient is strongly associated with both compositional axes.

As the biplots for study area woody species-dominated plots indicate, within Carolina bay depressions, Longleaf Pine Woodland plots -- which are found on the lower portion of the ordination diagram -- generally occur at the highest elevation sites, over the sandiest (therefore more permeable and with high bulk density), least acidic soils. Evergreen Shrub-bogs occur at the lowest elevation, most poorly drained sites, over organic, extremely acidic soils having comparatively high CECs. That CEC is occupied primarily by hydrogen, aluminum, and zinc ions. Intermittently Ponded Cypress/Gum Depressions are found at moderate elevations (*i.e.*, the Middle Coastal Plain, as discussed in Chapter 4), at sites tending to have longer hydroperiods -- probably associated with relatively impermeable, subsurface clay layers -- with acid, clayey mineral soils having shallow organic-dominated layers. Cypress/Gum Bogs are found on sites with environmental conditions mid-way between those found for Evergreen Shrub-bogs and those characterizing Intermittently Ponded Cypress/Gum Depressions, *i.e.*, at moderate elevation sites with intermediate hydroperiods, over moderately deep organic, strongly acidic soils.

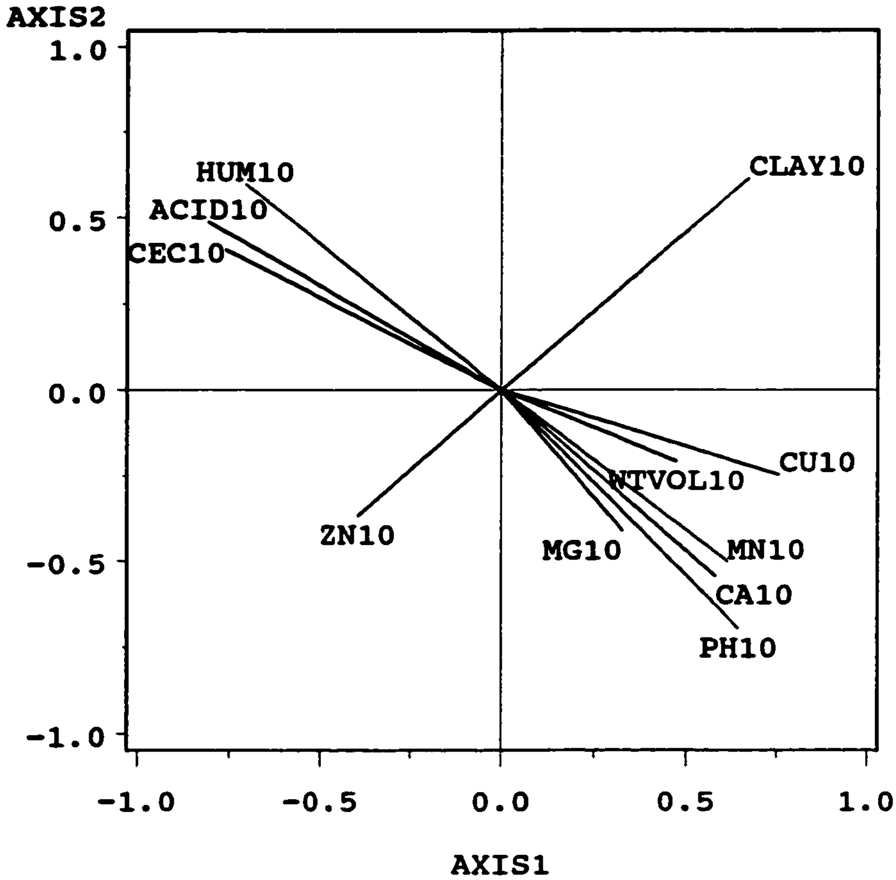
Figure 5.6. Diagram for NMDS ordination of all herb-dominated study area Carolina bay plots (except Brackish Marsh plots) showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**Vegetation Class:**

○ 2. Intermittently Flooded Depression Prairie
✱ 3. Freshwater Pond
● 4. Freshwater Marsh
♯ 5. Boggy Marsh

Figure 5.7. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all herb-dominated study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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-0.5
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HUM10
ACID10
CEC10
CLAY10
CU10
WTVOL10
ZN10
MG10
MN10
CA10
PH10
-1.0
-0.5
0.0
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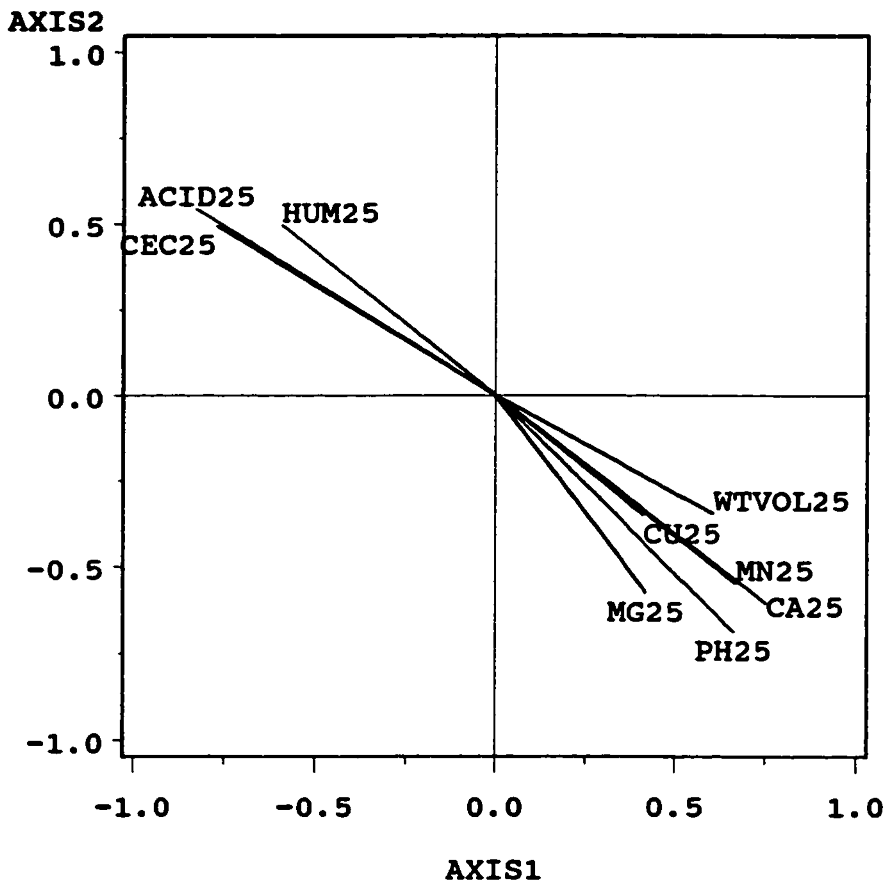
1.0
AXIS1

Figure 5.8. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all herb-dominated study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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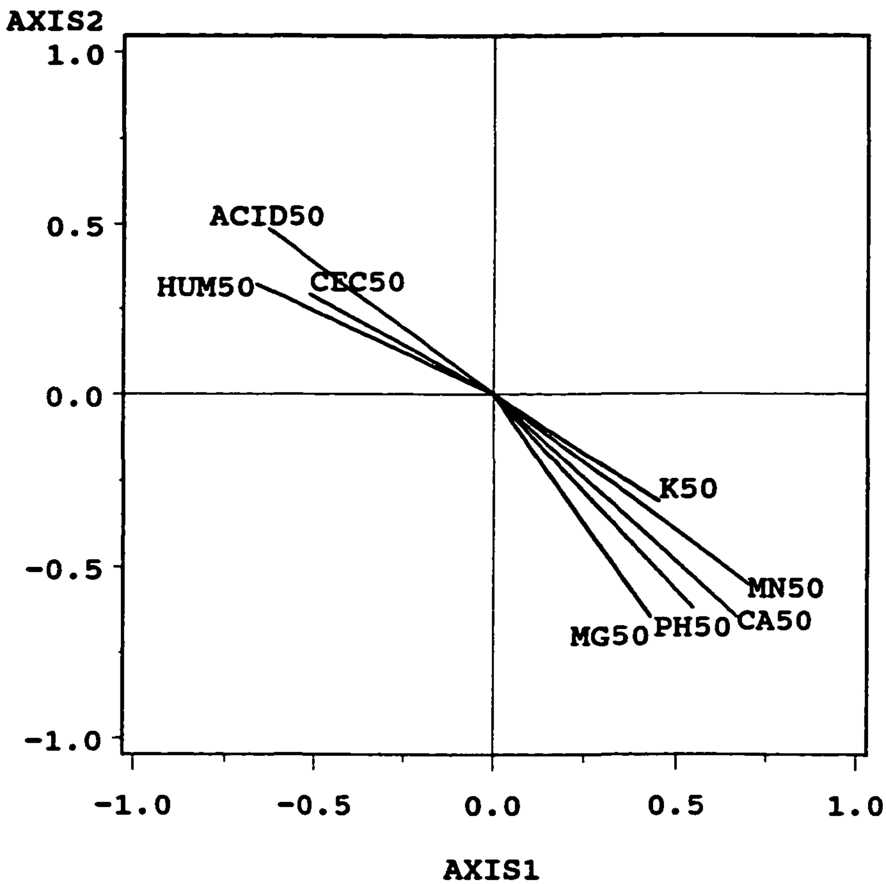
ACID25
HUM25
CEC25
WTVOL25
CU25
MN25
CA25
MG25
PH25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.9. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all herb-dominated study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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-0.5
-1.0
ACID50
HUM50
CEC50
K50
MN50
CA50
PH50
MG50
-1.0
-0.5
0.0
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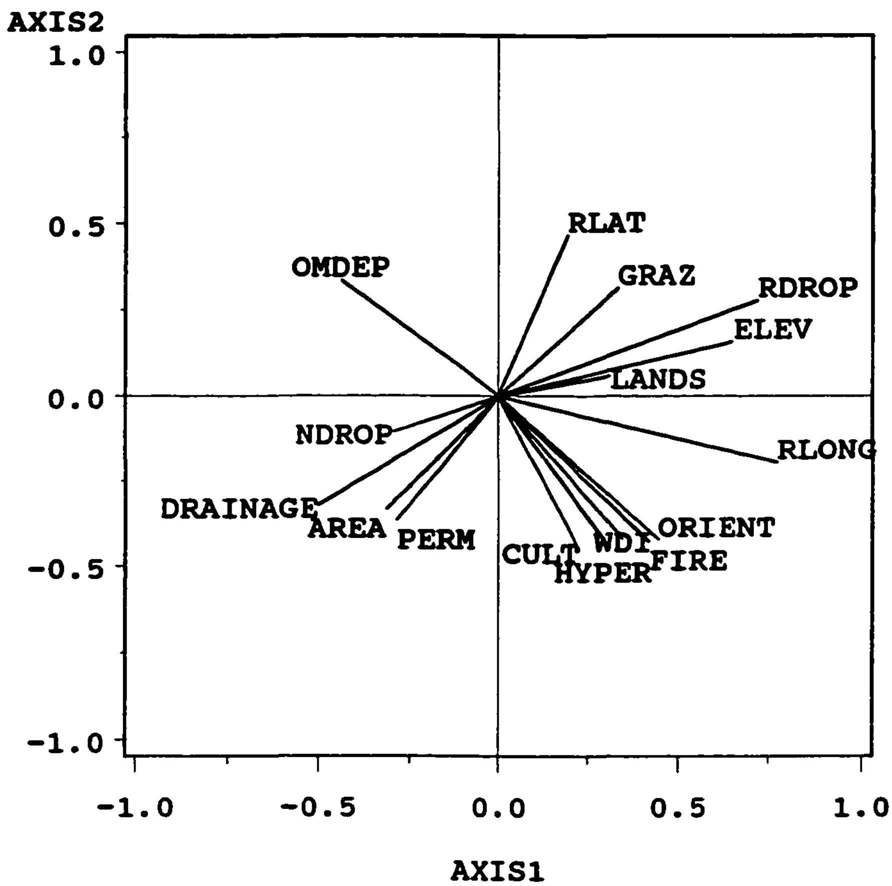
AXIS1

Figure 5.10. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of all herb-dominated study area Carolina bay plots (except Brackish Marsh plots) showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.


AXIS2
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RLAT
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RDROP
ELEV
LANDS
NDROP
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ORIENT
FIRE
HYPER
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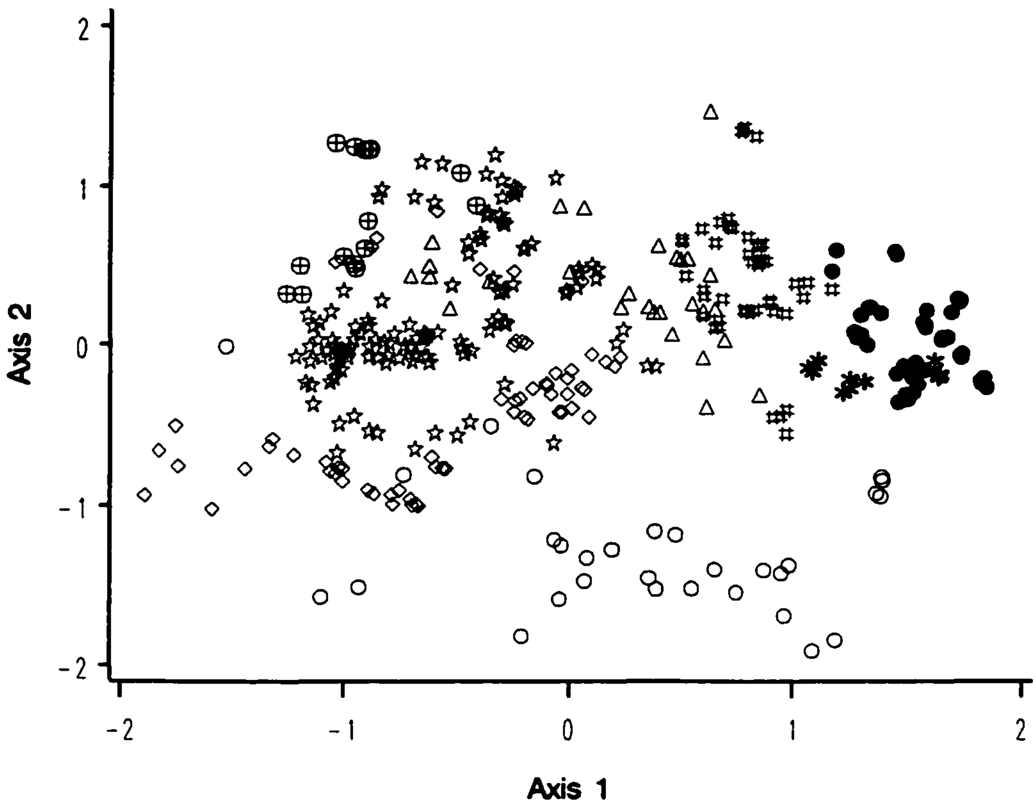
AXIS1

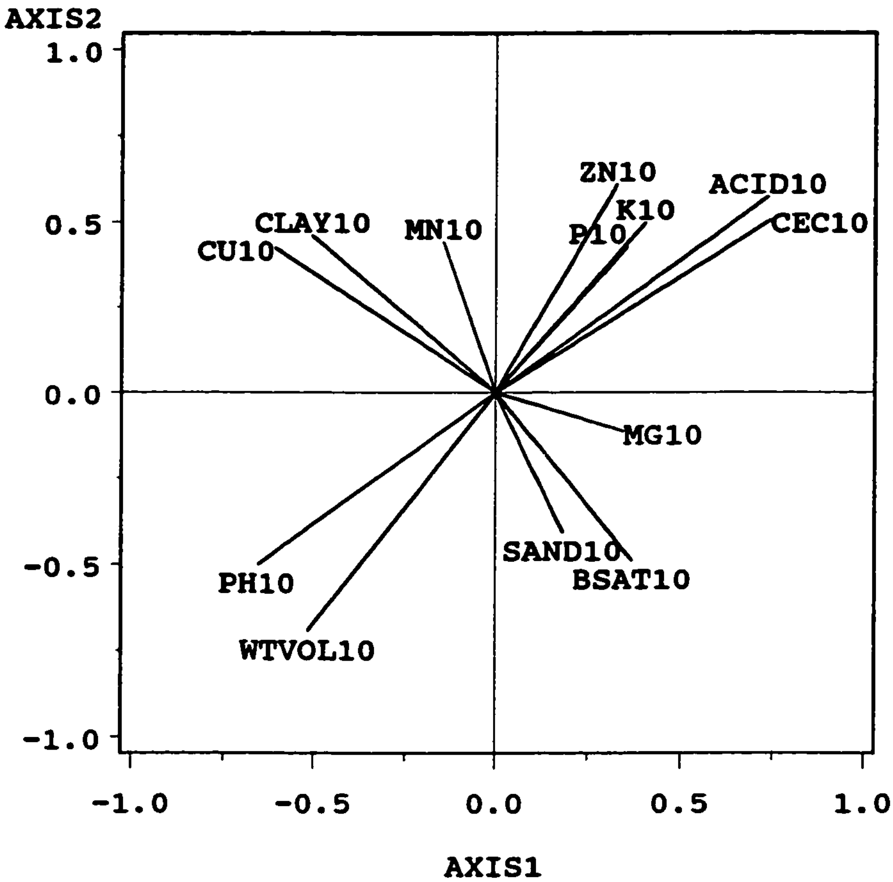
Figure 5.11. Diagram for NMDS ordination of all study area Carolina bay plots having woody dominants showing the distribution of stands classified by vegetation classes and subclasses on the two major compositional gradients.




**Vegetation Class:**

○ 6. Longleaf Pine Woodland
✱ 7a. Evergreen Shrub–bog "Bay Forest"
● 7b. Evergreen Shrub–bog "Pocosin"
# 8. Cypress/Gum Bog
△ 9a. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp"
⊕ 9b. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Pond"
☆ 9c. Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow"
◇ 9d. Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow"

Figure 5.12. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots having woody dominants showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.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ZN10
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MN10
CU10
MG10
SAND10
BSAT10
PH10
WTVOL10
-1.0
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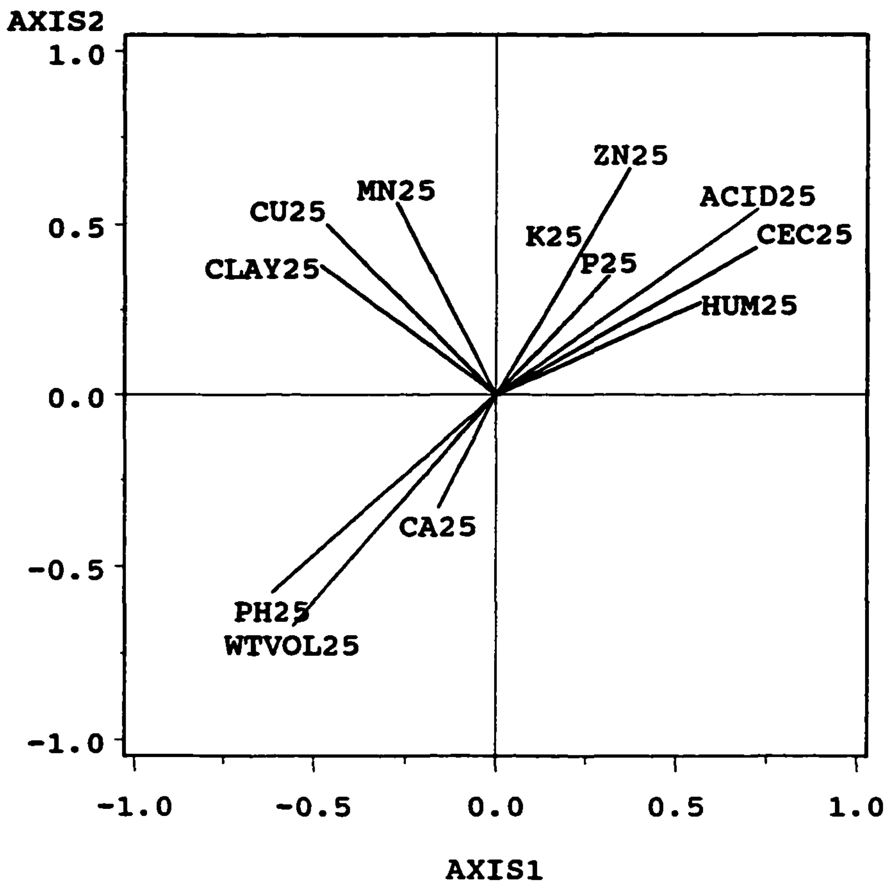
AXIS1

Figure 5.13. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots having woody dominants showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.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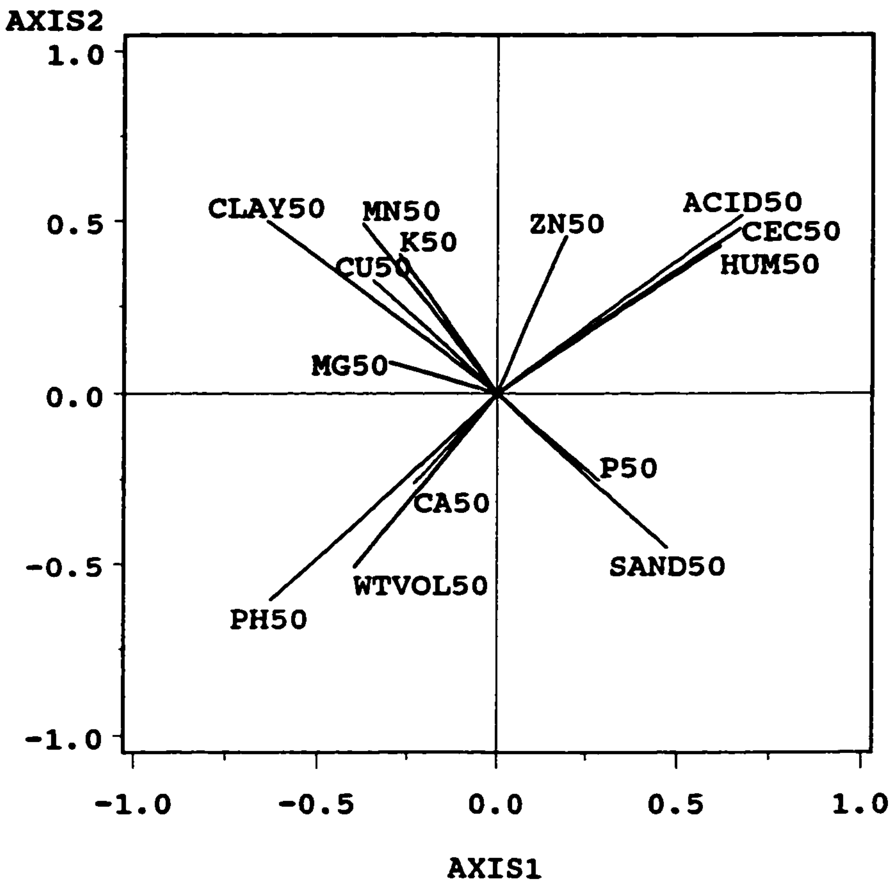
AXIS1
ZN25
ACID25
MN25
CU25
K25
CEC25
P25
CLAY25
HUM25
CA25
PH25
WTVOL25

Figure 5.14. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots having woody dominants showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.



AXIS2
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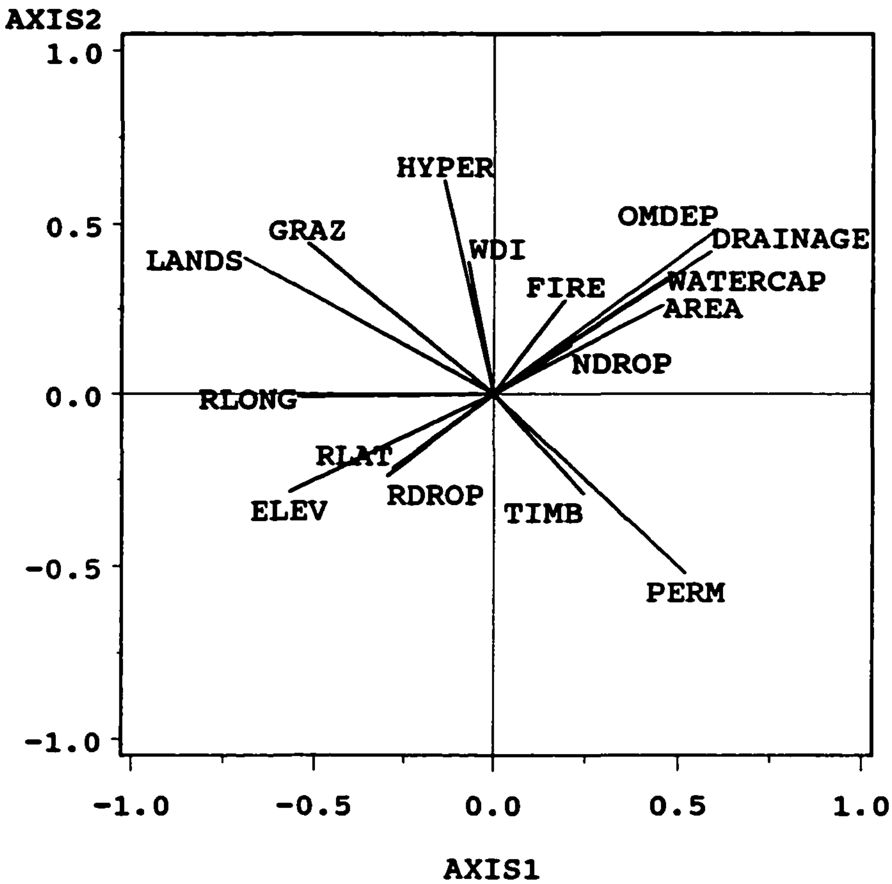
0.5
1.0
AXIS1
CLAY50
MN50
K50
CU50
ZN50
ACID50
CEC50
HUM50
MG50
P50
CA50
SAND50
WTVOL50
PH50

Figure 5.15. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots having woody dominants showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.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HYPER
GRAZ
LANDS
WDI
OMDEP
DRAINAGE
FIRE
WATERCAP
AREA
NDROP
RLONG
RLAT
ELEV
RDROP
TIMB
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1.0
AXIS1

### 5.2.4 Landscape surface vegetation--environment relationships

As discussed above, Carolina bay plots within the study area are generally distributed along a complex hydrologic/soil acidity--texture gradient related to site elevation and landscape position, among other factors. As noted in the description of the study area in Chapter 2, the Carolina coastal plain may be divided into five geomorphic surfaces, or landscape positions, that reflect gross differences in drainage, geology, and soils (*see* Figure 2.3). Four of those geomorphic surfaces may be thought of as representing roughly equidistant points along the primary stand distribution gradient for Carolina bay plots: the Upper, Middle, Inner Lower, and Outer Lower Coastal Plain. The fifth land surface pertains to major coastal plain river systems, and may create a differing perpendicular surface over the divisions through which it cuts. Consequently, study plots were divided into five groups -- Upper Coastal Plain plots, Middle Coastal Plain plots, Inner Lower Coastal Plain plots, Outer Lower Coastal Plain plots, and plots found in Major River Valleys and Floodplains. At each of those landscape "points", grouped plots were examined using NMDS in order to illuminate vegetation--environment relationships that may be obscured by distributional gradients for all stands. Environmental gradients within plots located on each of those landform surfaces are discussed below in turn.

#### 5.2.4.1 Upper Coastal Plain plots

Upper Coastal Plain Carolina bay vegetation stands are distributed along both a complex site wetness/disturbance/soil surface texture gradient and an orthogonal soil acidity--nutrient/depression orientation gradient (Figures 5.16 to 5.20). Plots are located on the first gradient by their relative scores in terms of site "wetness" factors (hydroperiod, organic matter depth, elevation, available water capacity, soil permeability), disturbance factors (fire and timbering frequencies), and soil surface texture (percent sand and silt). Those factors are associated with both compositional axes represented on the ordination diagram for this landscape position, but are most strongly correlated with the second compositional axis. Stands are arranged along the orthogonal gradient according to the comparative pH, acidity, nutrient (calcium and magnesium) content, and humic matter content of their soils, as well as the orientation (direction of depression long axis) and shape (bay length to width ratio) of the depression in which the stand occurs. Environmental factors comprising this secondary gradient are associated strongly with both compositional axes found on the ordination diagram for Upper Coastal Plain plots.

The vector biplot diagrams for this landscape position indicate that Intermittently Flooded Depression Prairie plots occurring in the Upper Coastal Plain are found on moderately fertile and permeable, less acid, surficially sandy soils, at sites having moderate hydroperiods and tending to be elliptic and strongly aligned in a northwest--southeast direction. Upper Coastal Plain Freshwater Marsh stands are found at sites having comparatively longer hydroperiods and consequently few fires, over relatively less acidic, more fertile, mineral soils having significant surface organic layers. Longleaf Pine Woodlands in the Upper Coastal Plain occur over highly permeable, relatively infertile, sandy soils, at sites that are relatively well drained and have short hydroperiods, making them subject to an increased fire frequency. They are also subject to higher levels of timbering, presumably because of the market value of their community dominant species, *Pinus palustris*. Cypress/Gum Swamps are rare in the Upper Coastal Plain, but where present occur at relatively poorly drained sites subject to infrequent fires, over strongly acid, comparatively infertile soils having a significant organic component. Drawdown Savanna/Meadow plots are also relatively rare in the Upper Coastal Plain, but where present appear to occur at sites having similar conditions to those found for Cypress/Gum Swamps. Plots falling within the latter two vegetation groups tend to be located in more oval, southerly oriented depressions in the Upper Coastal Plain.

5.2.4.2 <u>Middle Coastal Plain plots</u>

Vegetation stands found within the Middle Coastal Plain portion of the study area are distributed along two complex gradients: a soil density-acidity/local relief gradient, and an orthogonal fire frequency/soil phosphorus gradient (Figures 5.21 to 5.25). Plots are located along the first gradient according to their relative soil pH, acidity, zinc levels, organic matter content -- and consequent bulk density, CEC, and humic matter content -- as well as relative site relief (elevational drop in 1 km). Those factors are relatively strongly correlated with both compositional axes found on the ordination diagram for Middle Coastal Plain plots.

Stands are arranged along the weaker, orthogonal gradient according to the comparative frequency of fire in the sampled plot and stand soil phosphorus levels. Environmental factors comprising this second gradient are also associated with both compositional axes found on the ordination diagram for Middle Coastal Plain plots.

The biplots for Middle Coastal Plain plots indicate that stands exhibiting herb-dominated vegetation groups -- Intermittently Flooded Depression Prairies, Freshwater Ponds, and Freshwater Marshes -- occur at sites with moderate local relief that are subject to comparatively infrequent fires, have shallow organic-dominated soil layers, comparatively high soil phosphorus levels, and moderate soil pH. Middle Coastal Plain Longleaf Pine Woodland plots occur over mineral (relatively high bulk density), low phosphorus soils and are subject to frequent disturbance by fires. Cypress/Gum Bogs within the Middle Coastal Plain occur in depressions located in areas with less local relief, are subject to fires on a moderately frequent basis, and are characterized by organic soils exhibiting low bulk density, low pH, high acidity, and high subsurface zinc levels. Intermittently Ponded Cypress/Gum Depression plots in the Middle Coastal Plain tend to occur at sites with "intermediate" conditions as compared to other vegetation groups found in that landscape position. Among the vegetation subclasses found within that group, Cypress/Gum Swamps burn fairly infrequently and occur on more acid, lower pH, more organic-dominated soils. By contrast, Wet Savanna/Meadow plots occur at sites that burn with relative frequency, and have mineral, higher pH soils exhibiting none of the factors associated with organic dominated soils -- low bulk density, high CEC, high humic matter content, and high zinc levels. Not surprisingly, Drawdown Savanna/Meadow and Cypress/Gum Pond plots are characterized by similar site and soil conditions. Those conditions tend to be intermediate between those typical of the other two Intermittently Ponded Cypress/Gum Depression vegetation types, Cypress/Gum Swamp and Wet Savanna/Meadow plots.

5.2.4.3 Inner Lower Coastal Plain plots

Vegetation stands found within the Inner Lower Coastal Plain portion of the study area are distributed along both a complex hydroperiod/fire/soil texture-nutrient gradient and an orthogonal soil permeability/surface texture-nutrient gradient (Figures 5.26 to 5.30). Plots are located on the first gradient in terms of their relative scores in terms of site hydroperiod and fire frequency, and according to comparative soil texture and nutrient content (principally, phosphorus and copper). Those factors are associated with both compositional axes, but the wetness measures are most strongly correlated with the second compositional axis found on the ordination diagram for Inner Lower Coastal Plain plots, while soil texture is more strongly correlated with the first compositional axis. Stands are arranged along the orthogonal gradient according to the relative permeability, surface texture, and available magnesium content of plot soils. Environmental factors comprising this second gradient are associated strongly with both compositional axes found on the ordination diagram for Inner Lower Coastal Plain plots.

The biplots for this landscape position indicate that Freshwater Pond plots found on the Inner Lower Coastal Plain occur in depressions with the longest hydroperiods, and consequently, with the most infrequent fires. Freshwater Pond soils are sandy mineral soils exhibiting comparatively moderate phosphorus and copper abundances. Inner Lower Coastal Plain Pocosin plots occur at lower elevation sites with comparatively shorter hydroperiods and more frequent fires, over soils that tend to have a silty surface layer and high CEC -- presumably reflecting an increased organic component of the soil. Cypress/Gum Bogs within the Inner Lower Coastal Plain are found at sites with comparatively greater elevation and moderate hydroperiods and fire frequencies, over clayey, relatively impermeable, moderately fertile soils. Boggy Marsh plots are rare in the Inner Lower Coastal Plain, and occur under intermediate conditions of hydroperiod, fire, soil texture and soil nutrients as compared to other vegetation groups found in this landscape position within the study area.

5.2.4.4 Outer Lower Coastal Plain Plots

Outer Lower Coastal Plain Carolina bay vegetation stands within the study area are distributed along both a soils acidity--nutrient gradient and an orthogonal locational/ geomorphic gradient (Figures 5.31 to 5.35). Plots are located on the first gradient by their relative scores in terms of soils acidity factors (pH and acidity) and soil nutrients (primarily, potassium and phosphorus). Those factors are associated with both compositional axes, but are most strongly correlated with the first compositional axis found on the ordination diagram for Outer Lower Coastal Plain plots. Stands are arranged along the orthogonal gradient according to the relative geographic locations (latitude and longitude) and directional orientation of the depression in which the plot occurs. To a lesser degree, they are also ordered by the copper and zinc contents of plot soils. Environmental factors comprising this second gradient are associated strongly with the vertical compositional axis found on the ordination diagram for Outer Lower Coastal Plain plots.

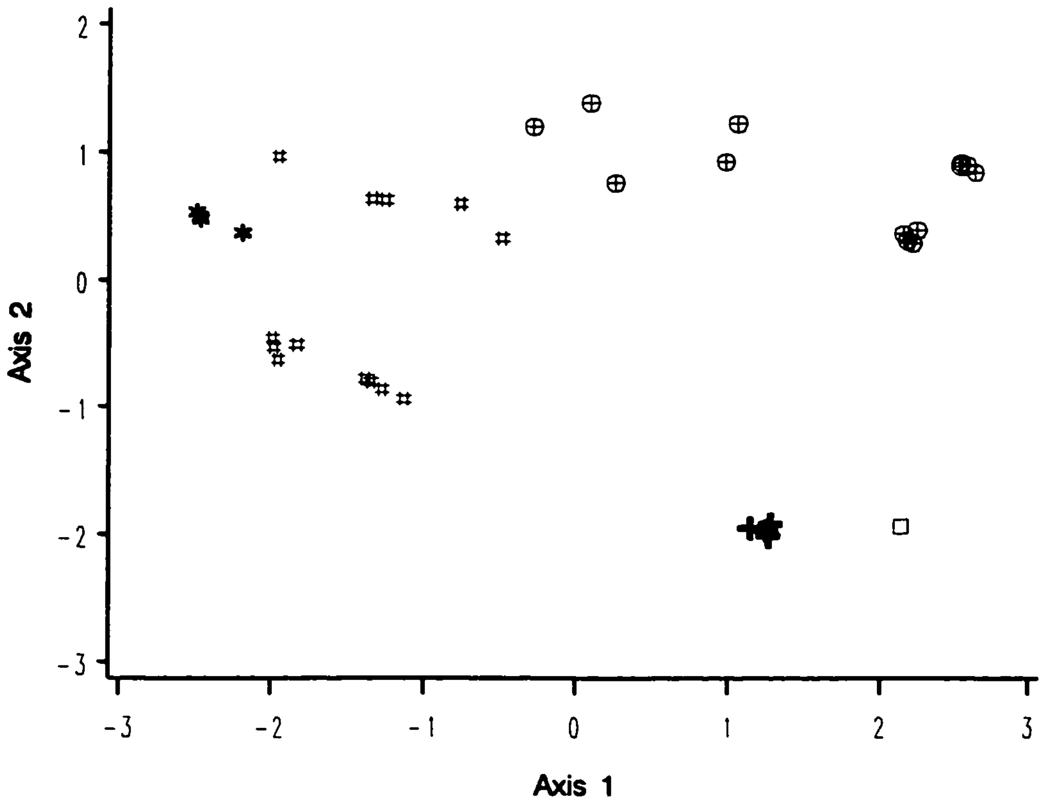
The vector diagrams for this landscape position indicate that Boggy Marsh plots found on the Outer Lower Coastal Plain occur in depressions restricted to the northeastern portion of the Outer Lower Coastal Plain, over low pH soils that are strongly influenced by organic acids (humic matter) and that contain comparatively high levels of zinc and copper. Outer Lower Coastal Plain Pocosin plots occur at the lowest elevation sites that tend to also be located toward the north and east portion of that landscape position. They are found on the most acidic, lowest pH soils. Pocosin soils have a comparatively high CEC, presumably reflecting a relatively high organic matter content, and contain relatively high concentrations of phosphorus and potassium. Wet Savanna/Meadow plots are rare in the Outer Lower Coastal Plain. Where found, they occur in the most westerly and southerly portions of that landscape position in areas of comparatively moderate relief, over more fertile soils than other plots in this group. Cypress/Gum Bogs occur in the Outer Lower Coastal Plain under conditions intermediate in all respects between those characterizing the other vegetation groups found within the study area in that landscape position.

5.2.4.5 Major River Valleys and Floodplain Plots

Study area vegetation stands found in Major River Valleys and Floodplains are distributed along a primarily locational/disturbance gradient and an orthogonal soil density gradient (Figures 5.36 to 5.40). Plots are located on the first gradient by their relative distance from the coast (longitudinal location) and degree of depression disturbance by fire, timbering, or ditching. Each of those factors tends to be associated with both compositional axes on the ordination diagram for Major River Valley and Floodplain plots, but overall correlation of environmental parameters with ordination stand arrangement is comparatively weak. Plots are arranged along the orthogonal gradient according to soil bulk density, the relative disturbance of the landscape surrounding the depression in which the plot is located, and to a lesser extent, site hydroperiod. Environmental factors comprising this second gradient are associated strongly with both compositional axes found on the ordination diagram for Major River Valley and Floodplain plots.

The vector biplot diagrams for this landscape position indicate that sampled Bay Forest plots found in Major River Valleys and Floodplain surfaces tend to occur in more westerly depressions on that surface in relatively undisturbed landscapes, over soils with comparatively high bulk densities and high manganese levels. Intra-depression disturbance, such as fire or timbering, is relatively infrequent in Bay Forest plots. Sampled Major River Valley and Floodplain Pocosin plots occur in the more easterly portions of this landscape position, over sites having somewhat lower bulk densities, and are "disturbance dominated", having a relatively high frequency of fire and timbering. Cypress/Gum Bogs are rare on the terraces of major rivers within the study area, but occur in the eastern portion of that landscape position over extremely light weight (low bulk density), organic soils.

Figure 5.16. Diagram for NMDS ordination of all study area Carolina bay plots found in the Upper Coastal Plain showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**VEGETATION CLASSES AND SUBCLASSES FOUND IN SAMPLED CAROLINA BAYS IN THE UPPER COASTAL PLAIN:**

✱ VEGETATION CLASS 2. Intermittently Flooded Depression Prairie

♯ VEGETATION CLASS 4. Freshwater Marsh

⊕ VEGETATION CLASS 6. Longleaf Pine Woodland

□ VEGETATION SUBCLASS 9a. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp"

✚ VEGETATION SUBCLASS 9c. Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow"

Figure 5.17. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Upper Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.

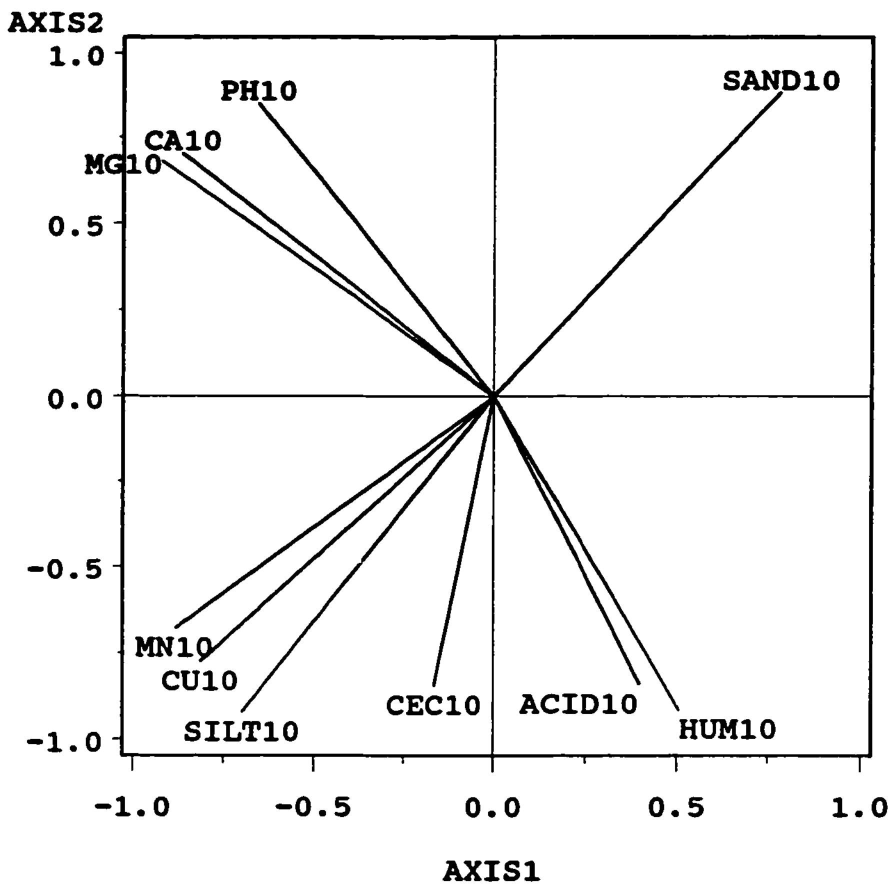
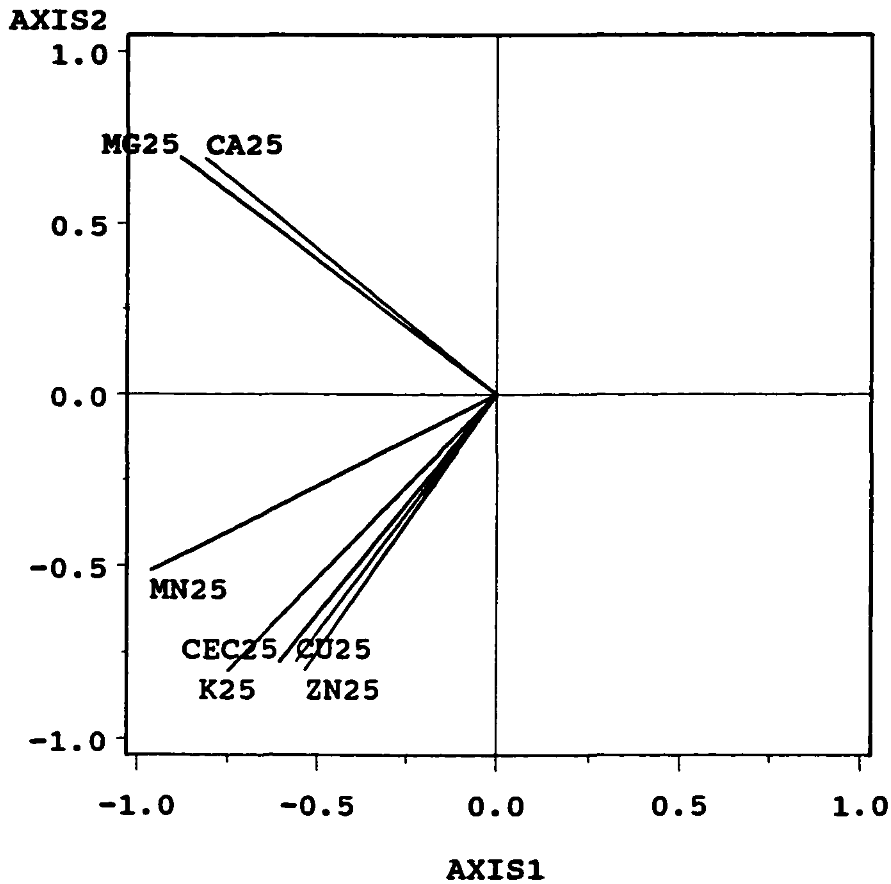

AXIS2
1.0
0.5
0.0
-0.5
-1.0
-1.0
-0.5
0.0
0.5
1.0
AXIS1
PH10
CA10
MG10
SAND10
MN10
CU10
SILT10
CEC10
ACID10
HUM10

Figure 5.18. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Upper Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.



AXIS2
1.0
0.5
0.0
-0.5
-1.0
MG25
CA25
MN25
CEC25
CU25
K25
ZN25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.19. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Upper Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.

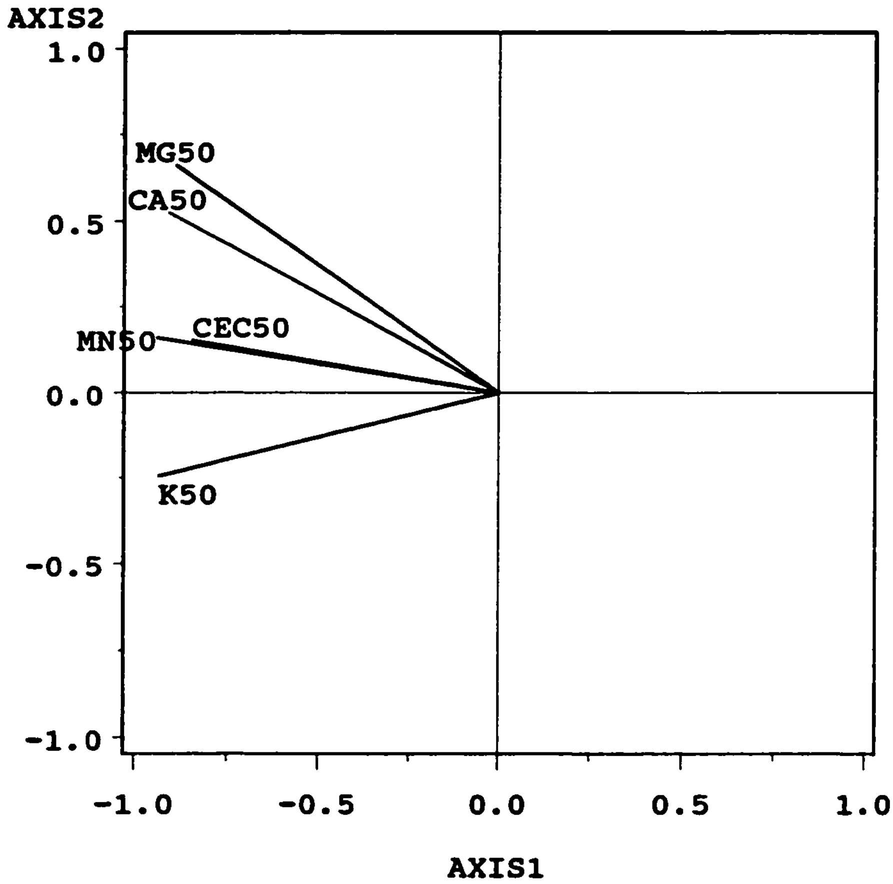

AXIS2
1.0
0.5
0.0
-0.5
-1.0
MG50
CA50
CEC50
MN50
K50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.20. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Upper Coastal Plain showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.

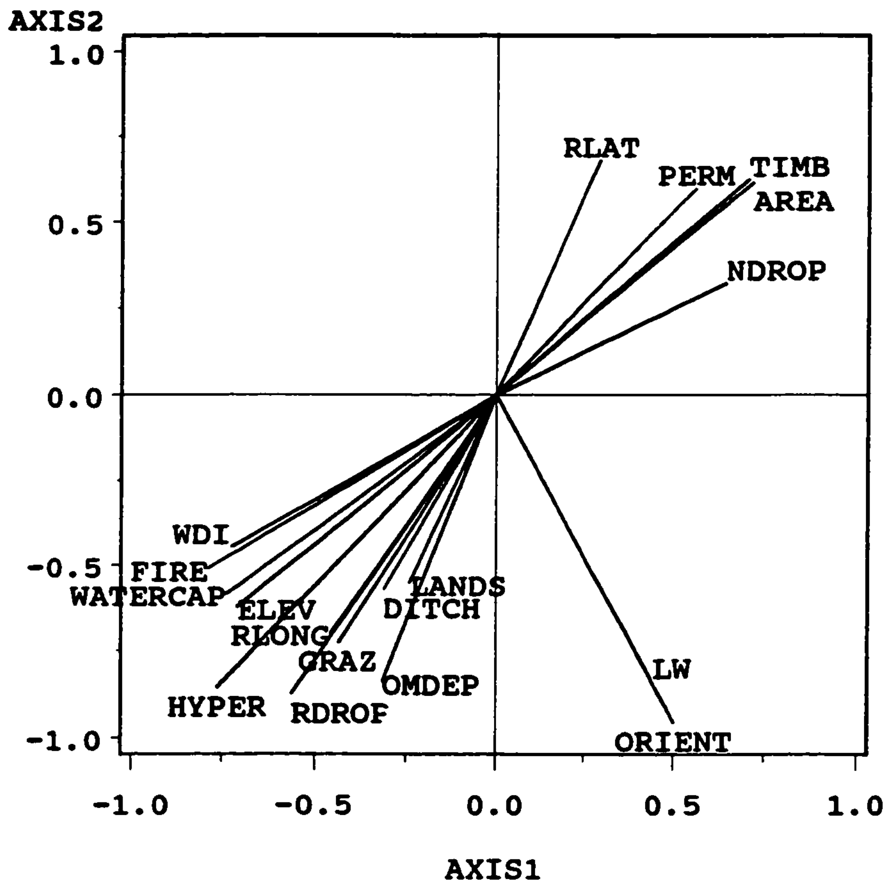
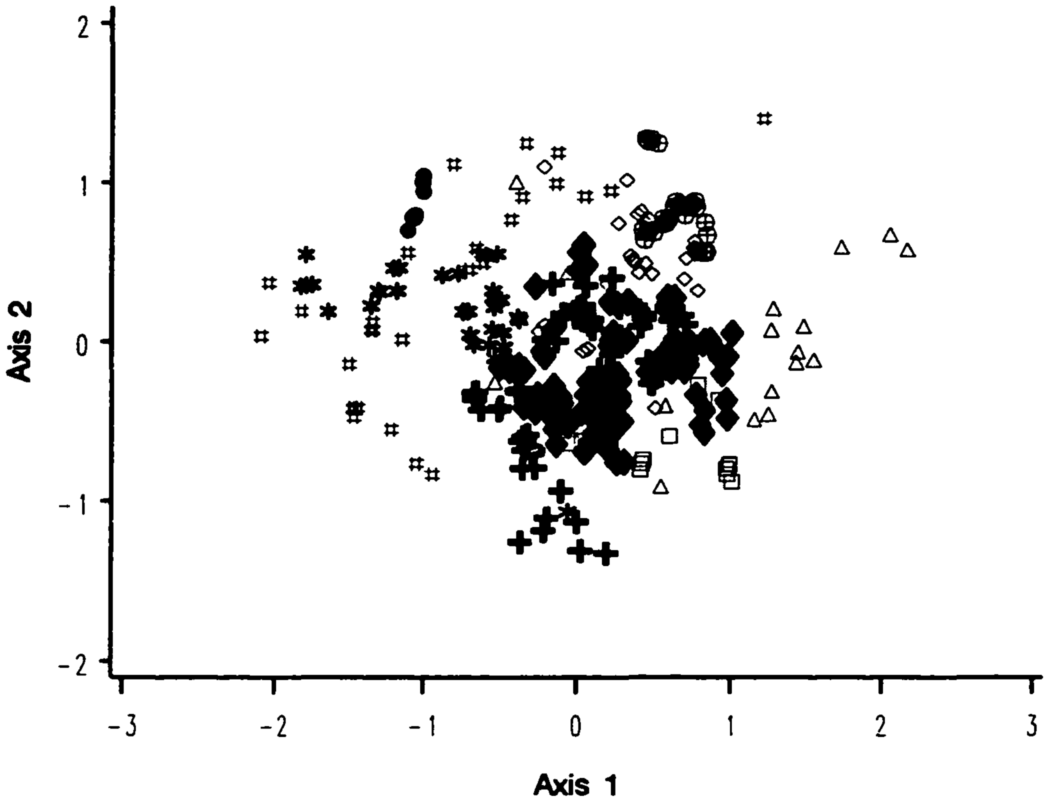

AXIS2
1.0
0.5
0.0
-0.5
-1.0
RLAT
PERM
TIMB
AREA
NDROP
WDI
FIRE
WATERCAP
ELEV
RLONG
GRAZ
HYPER
RDROF
LANDS
DITCH
OMDEP
LW
ORIENT
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.21. Diagram for NMDS ordination of all study area Carolina bay plots found in the Middle Coastal Plain showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**VEGETATION CLASSES AND SUBCLASSES FOUND IN SAMPLED CAROLINA BAYS IN THE MIDDLE COASTAL PLAIN:**

✱ VEGETATION CLASS 2. Intermittently Flooded Depression Prairie
● VEGETATION CLASS 3. Freshwater Pond
# VEGETATION CLASS 4. Freshwater Marsh
△ VEGETATION CLASS 6. Longleaf Pine Woodland
⊕ VEGETATION CLASS 8. Cypress/Gum Bog
◇ VEGETATION SUBCLASS 9a. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Swamp"
□ VEGETATION SUBCLASS 9b. Intermittently Ponded Cypress/Gum Depression "Cypress/Gum Pond"
◆ VEGETATION SUBCLASS 9c. Intermittently Ponded Cypress/Gum Depression "Drawdown Savanna/Meadow"
✚ VEGETATION SUBCLASS 9d. Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow"

Figure 5.22. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Middle Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.

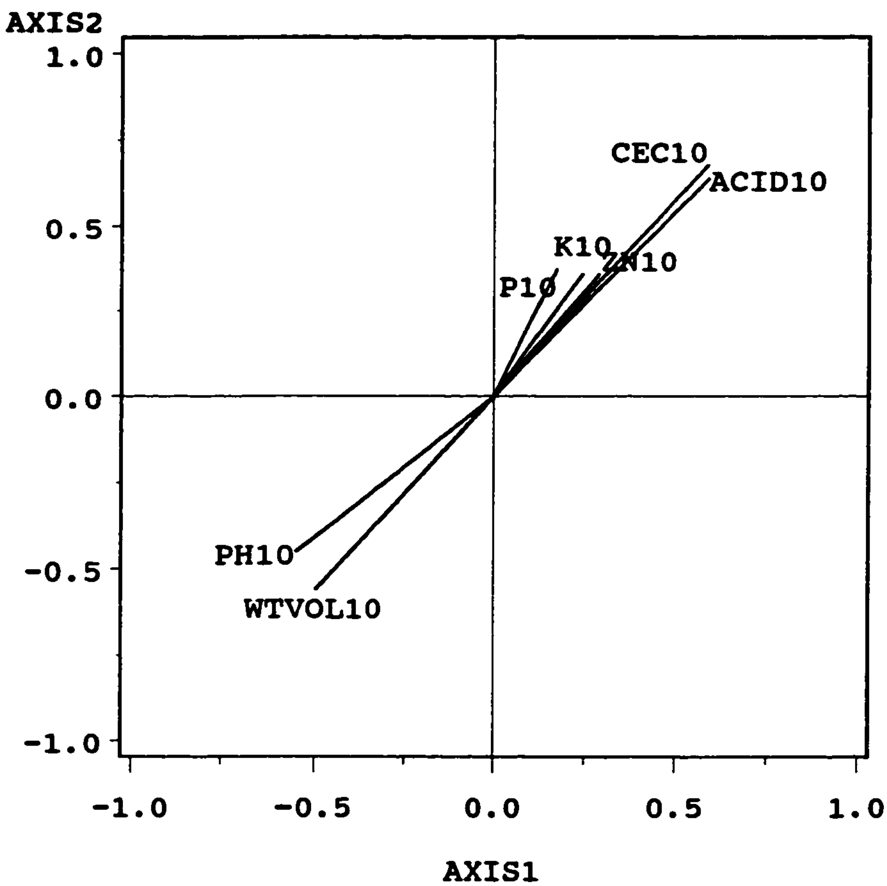

AXIS2
1.0
0.5
0.0
-0.5
-1.0
CEC10
ACID10
K10
ZN10
P10
PH10
WTVOL10
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.23. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Middle Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.

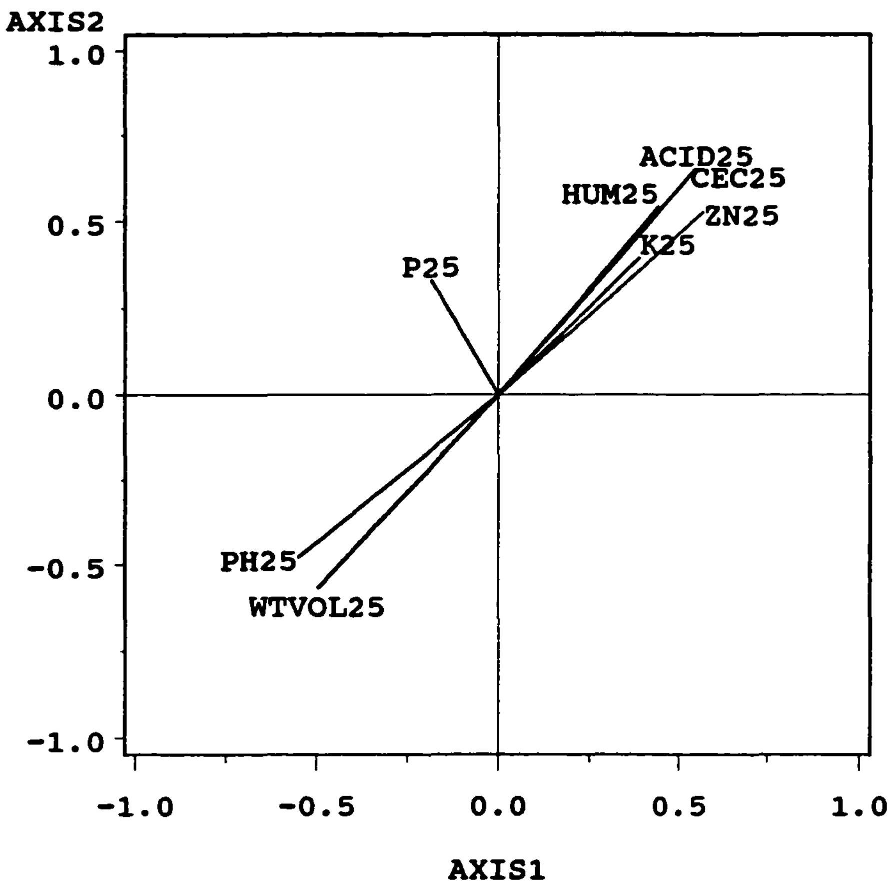

AXIS2
1.0
0.5
0.0
-0.5
-1.0
ACID25
CEC25
HUM25
ZN25
K25
P25
PH25
WTVOL25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.24. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Middle Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.

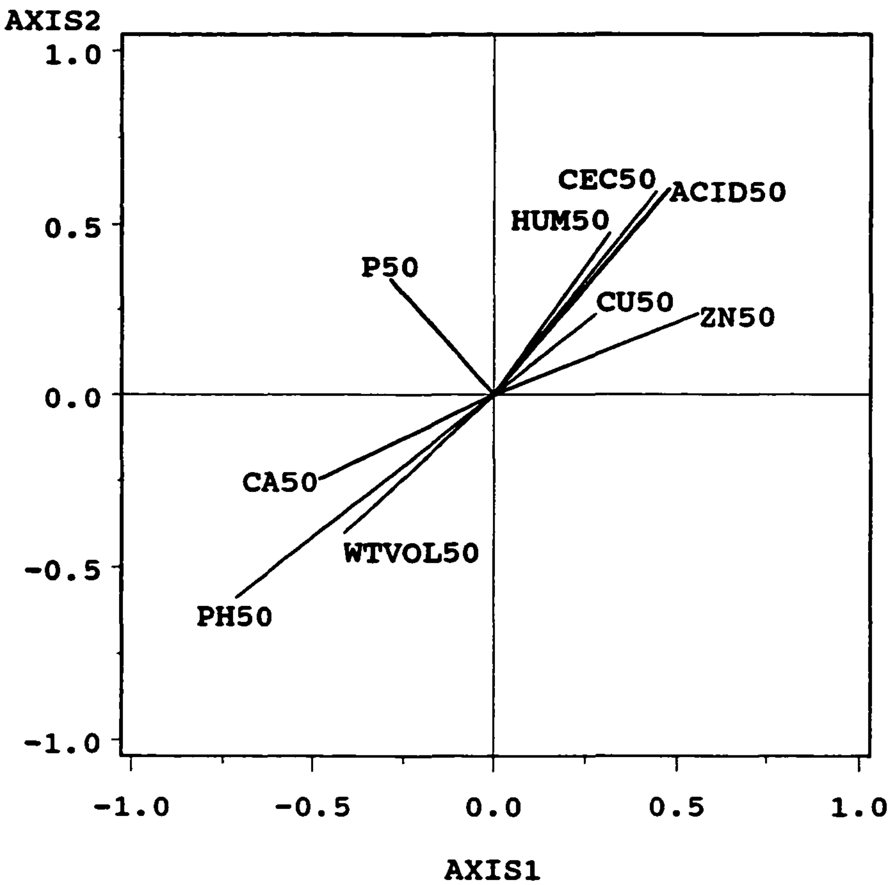
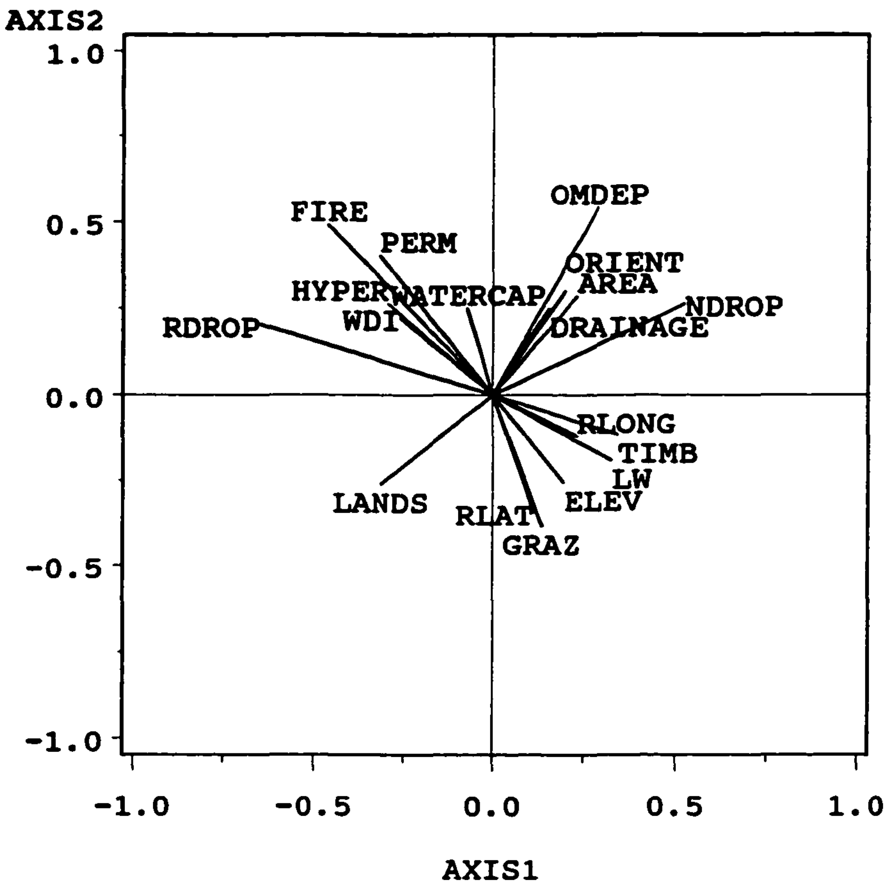
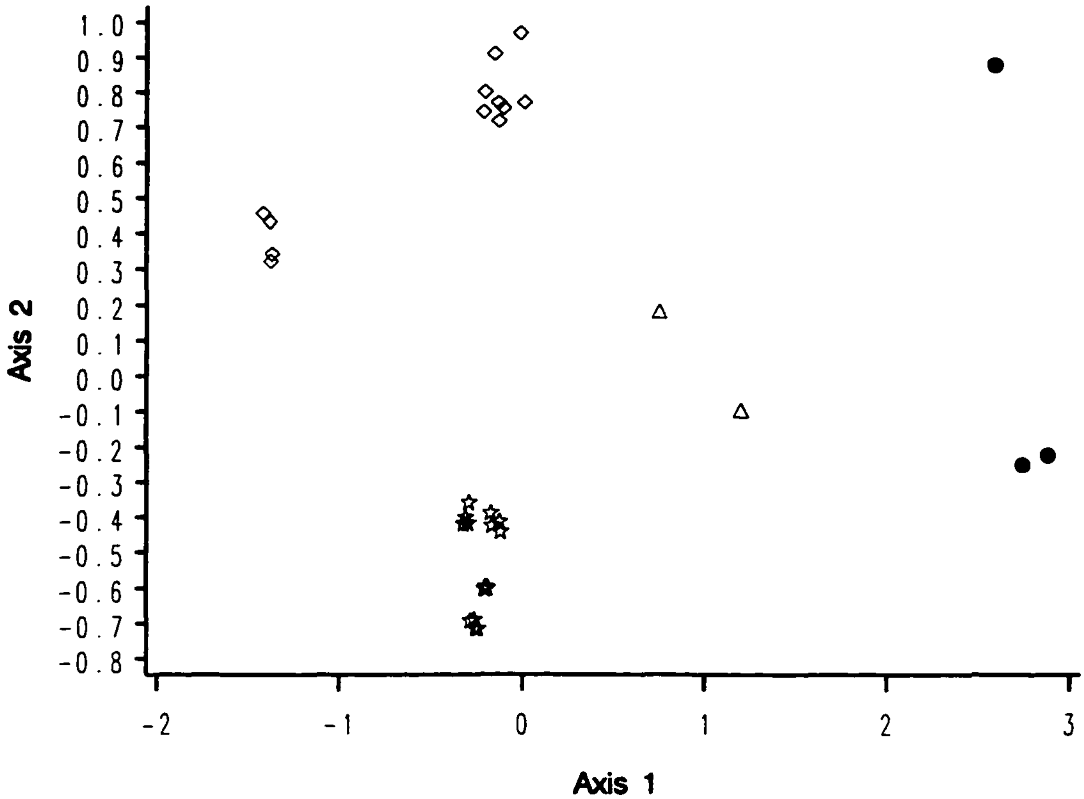

AXIS2
1.0
0.5
0.0
-0.5
-1.0
CEC50
ACID50
HUM50
P50
CU50
ZN50
CA50
WTVOL50
PH50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.25. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Middle Coastal Plain showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.



AXIS2
1.0
0.5
0.0
-0.5
-1.0
-1.0
-0.5
0.0
0.5
1.0
AXIS1
FIRE
PERM
HYPER
WATERCAP
WDI
RDROP
OMDEP
ORIENT
AREA
NDROP
DRAINAGE
RLONG
TIMB
LW
ELEV
LANDS
RLAT
GRAZ

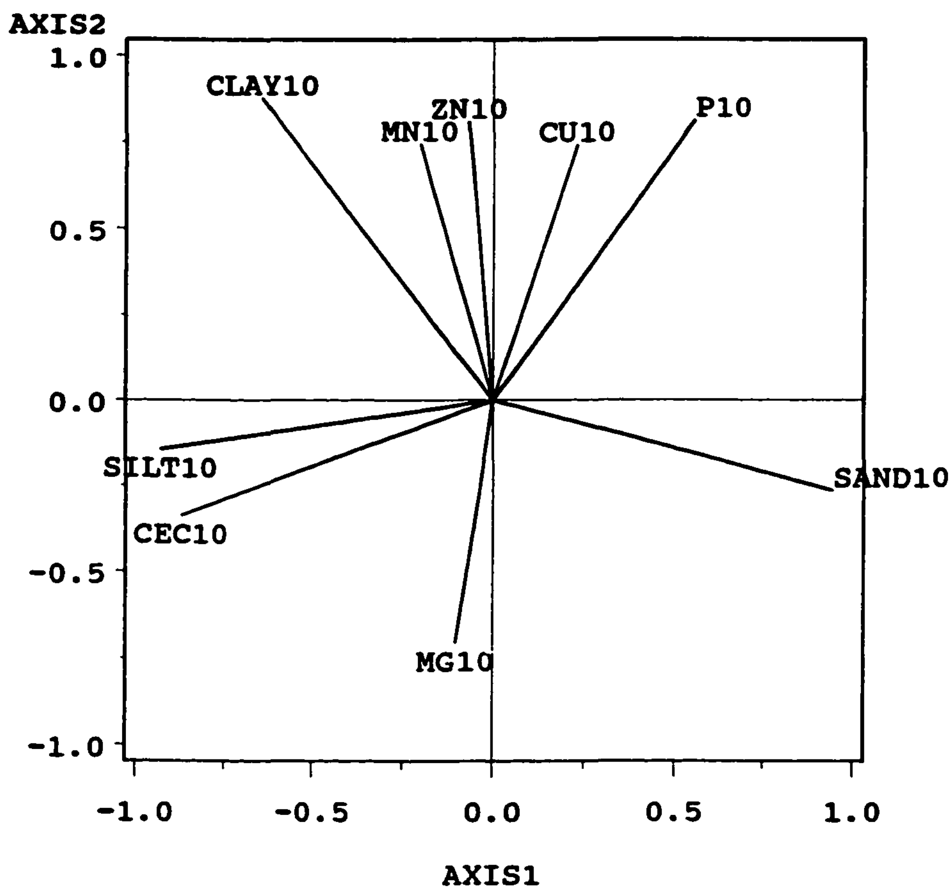
Figure 5.26. Diagram for NMDS ordination of all study area Carolina bay plots found in the Inner Lower Coastal Plain showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**VEGETATION CLASSES AND SUBCLASSES FOUND IN SAMPLED CAROLINA BAYS IN THE INNER LOWER COASTAL PLAIN:**

● VEGETATION CLASS 3. Freshwater Pond
△ VEGETATION CLASS 5. Boggy Marsh
☆ VEGETATION SUBCLASS 7b. Evergreen Shrub–Bog "Pocosin"
◇ VEGETATION CLASS 8. Cypress/Gum Bog

Figure 5.27. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Inner Lower Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.



AXIS2
1.0
0.5
0.0
-0.5
-1.0
CLAY10
ZN10
MN10
CU10
P10
SILT10
CEC10
SAND10
MG10
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.28. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Inner Lower Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.

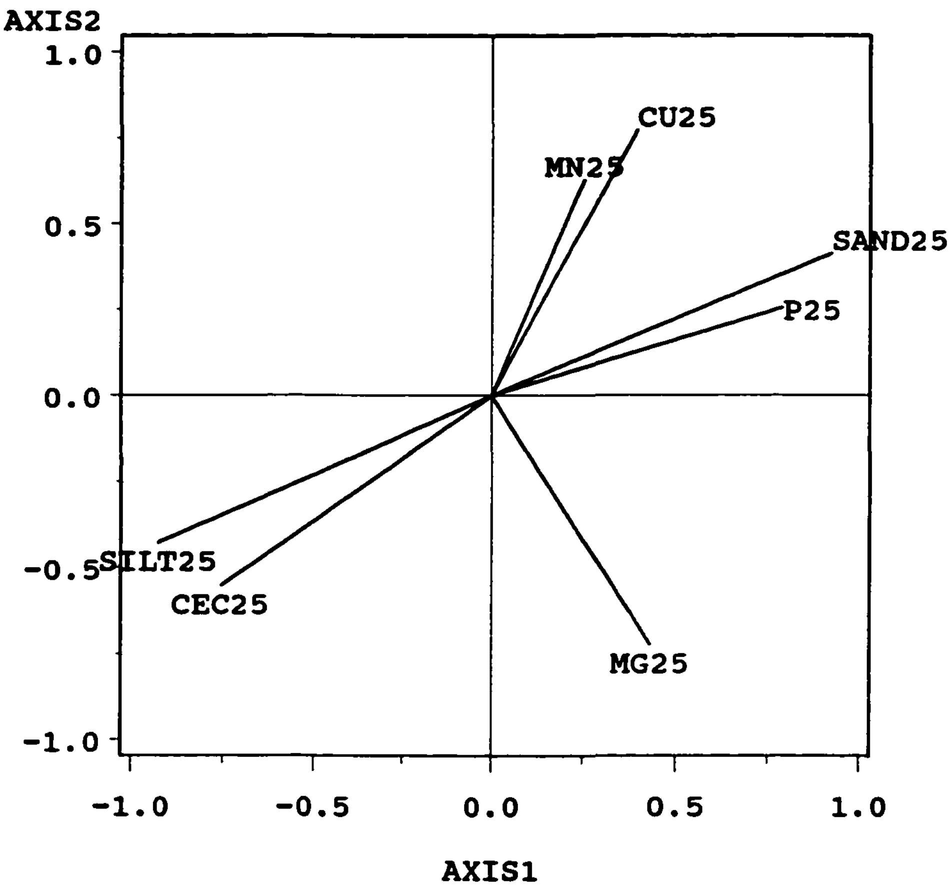

AXIS2
1.0
0.5
0.0
-0.5
-1.0
CU25
MN25
SAND25
P25
SILT25
CEC25
MG25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.29. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Inner Lower Coastal Plain showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.

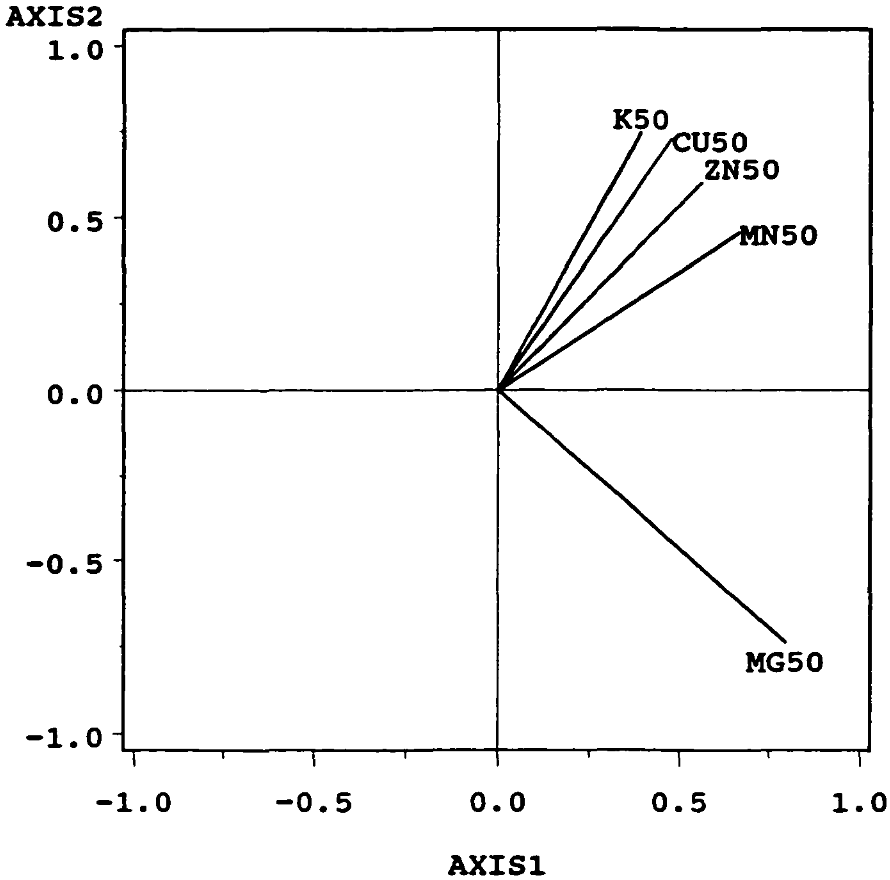

AXIS2
1.0
0.5
0.0
-0.5
-1.0
K50
CU50
ZN50
MN50
MG50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.30. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Inner Lower Coastal Plain showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.

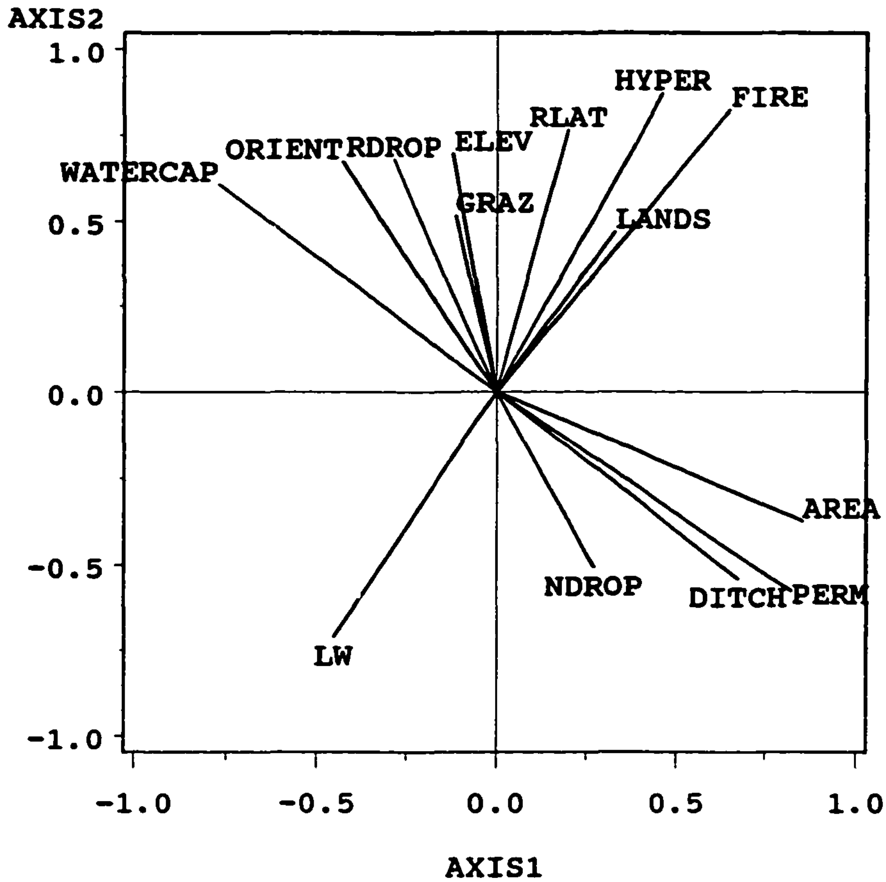
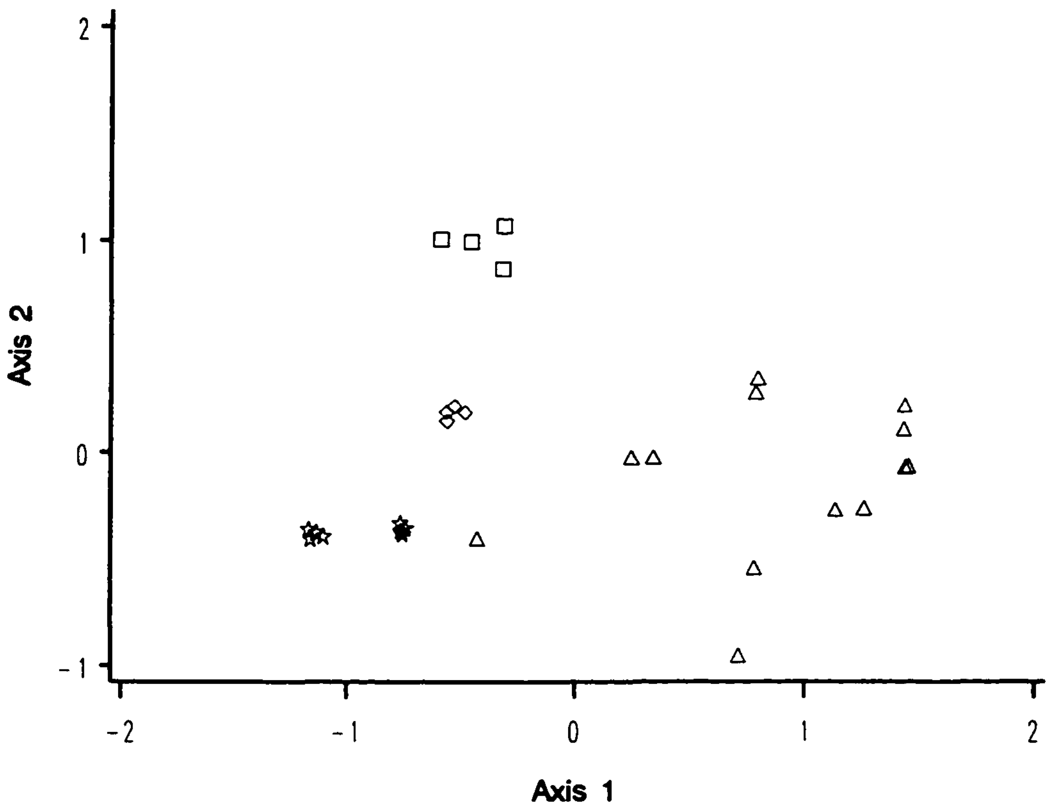

AXIS2
1.0
0.5
0.0
-0.5
-1.0
WATERCAP
ORIENT
RDROP
ELEV
GRAZ
RLAT
HYPER
FIRE
LANDS
AREA
NDROP
DITCH
PERM
LW
-1.0
-0.5
0.0
0.5
1.0
AXIS1

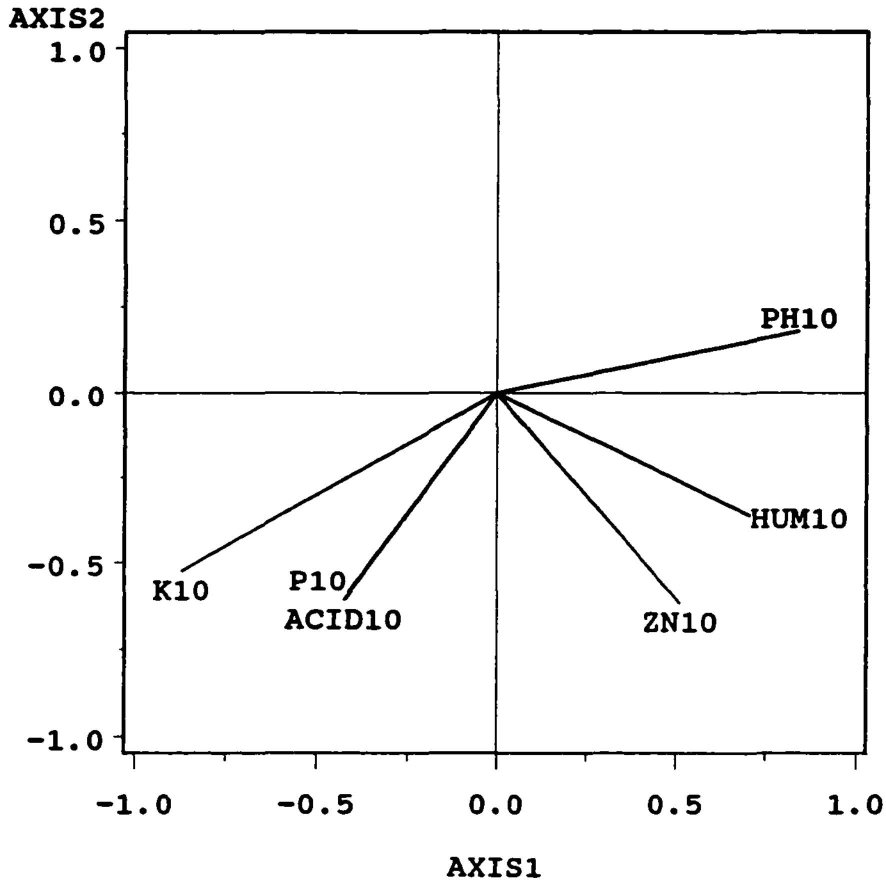
Figure 5.31. Diagram for NMDS ordination of all study area Carolina bay plots found in the Outer Lower Coastal Plain (except Brackish Marsh plots) showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**VEGETATION CLASSES AND SUBCLASSES FOUND IN SAMPLED CAROLINA BAYS IN THE OUTER LOWER COASTAL PLAIN:**

△ VEGETATION CLASS 5. Boggy Marsh
☆ VEGETATION SUBCLASS 7. Evergreen Shrub—Bog "Pocosin"
◇ VEGETATION CLASS 8. Cypress/Gum Bog
□ VEGETATION SUBCLASS 9d. Intermittently Ponded Cypress/Gum Depression "Wet Savanna/Meadow"

Figure 5.32. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Outer Lower Coastal Plain (except Brackish Marsh stands) showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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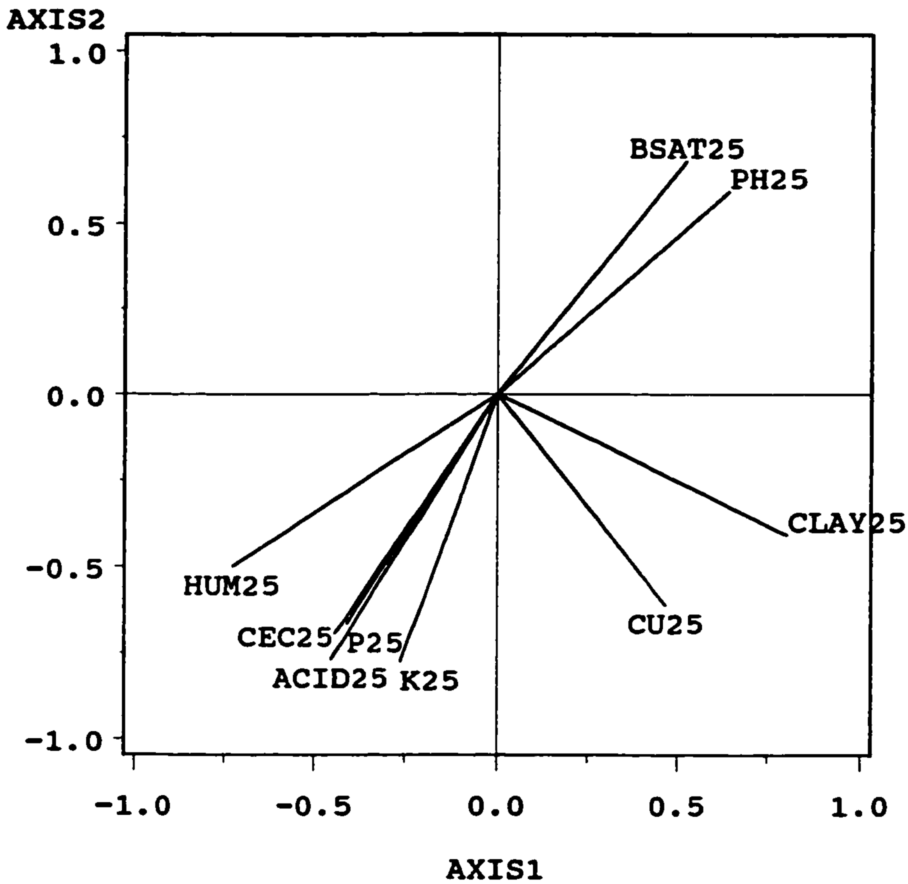
0.5
0.0
-0.5
-1.0
PH10
HUM10
ZN10
K10
P10
ACID10
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.33. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Outer Lower Coastal Plain (except Brackish Marsh stands) showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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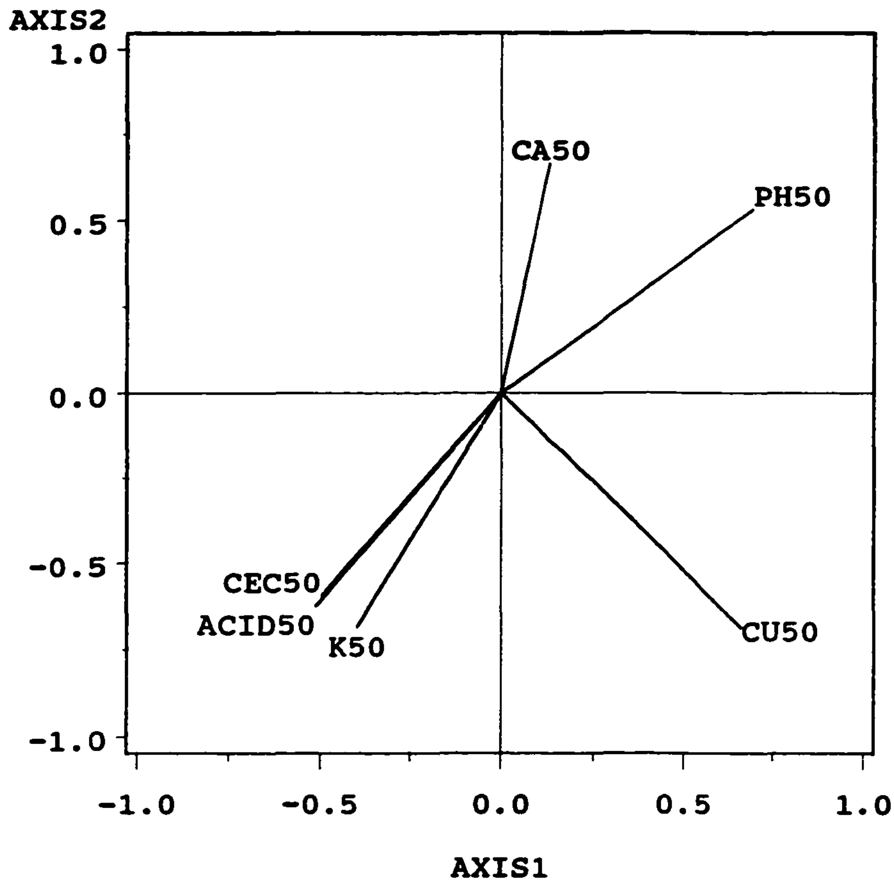
0.0
-0.5
-1.0
BSAT25
PH25
CLAY25
CU25
HUM25
CEC25
P25
ACID25
K25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.34. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Outer Lower Coastal Plain (except Brackish Marsh stands) showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.


AXIS2
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0.5
0.0
-0.5
-1.0
CA50
PH50
CEC50
ACID50
K50
CU50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.35. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in the Outer Lower Coastal Plain (except Brackish Marsh stands) showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.

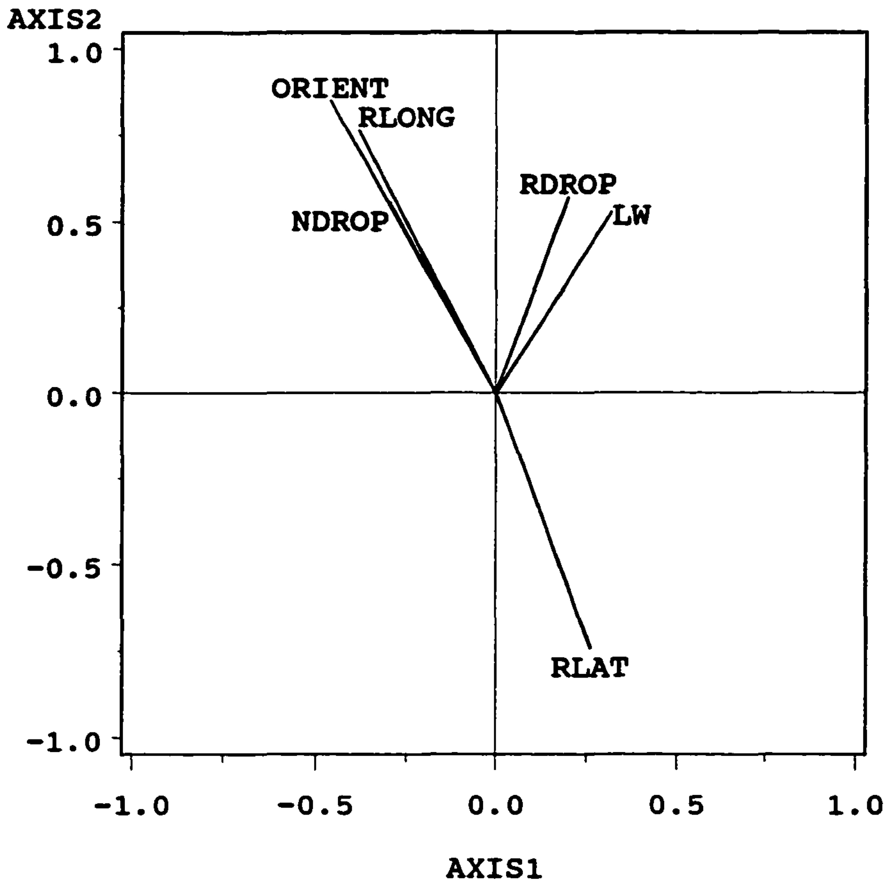
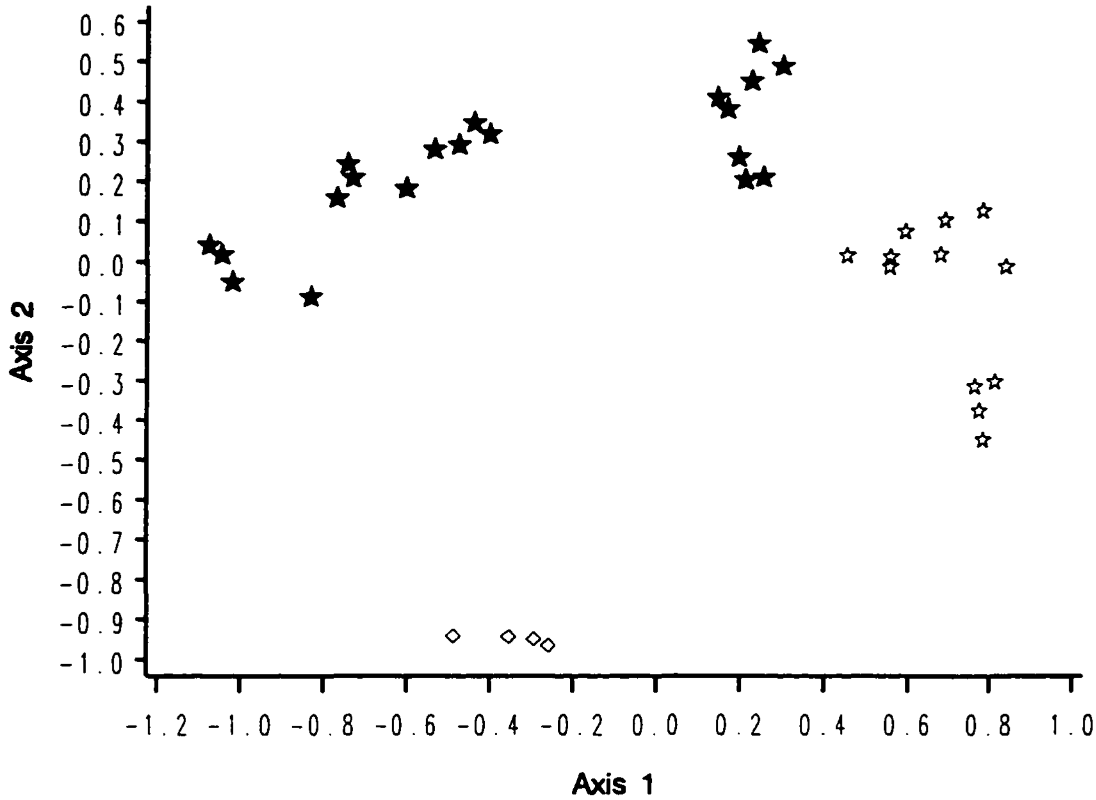

AXIS2
1.0
0.5
0.0
-0.5
-1.0
ORIENT
RLONG
NDROP
RDROP
LW
RLAT
-1.0
-0.5
0.0
0.5
1.0
AXIS1

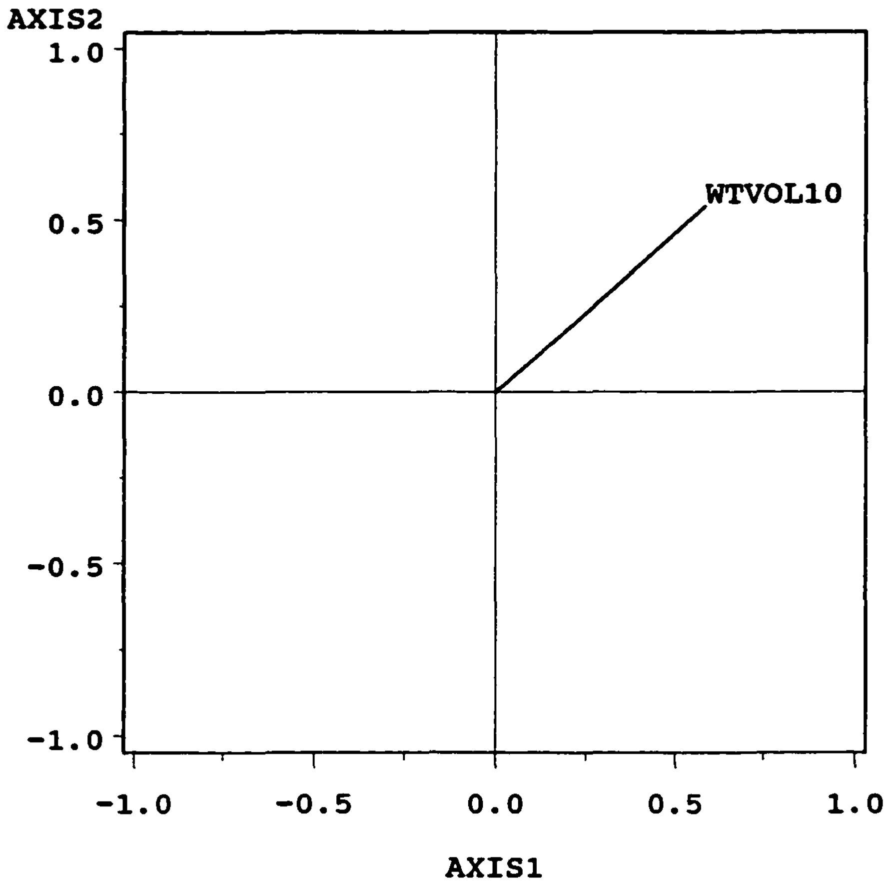
Figure 5.36. Diagram for NMDS ordination of study area Carolina bay plots located in Major River Valleys and Floodplains showing the distribution of stands classified by vegetation classes on the two major compositional gradients.




**VEGETATION CLASSES AND SUBCLASSES FOUND IN SAMPLED CAROLINA BAYS IN MAJOR COASTAL PLAIN RIVER VALLEYS & FLOODPLAINS:**

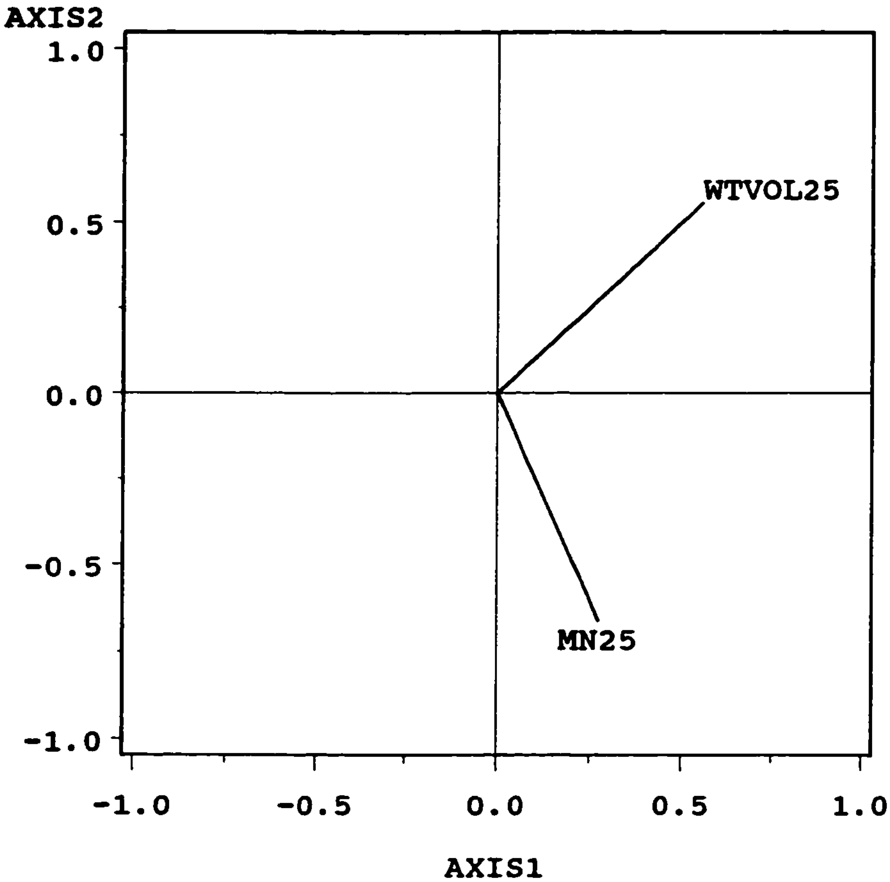
☆ **VEGETATION SUBCLASS 7a. Evergreen Shrub—Bog "Bay Forest"**
★ **VEGETATION SUBCLASS 7b. Evergreen Shrub—Bog "Pocosin"**
◇ **VEGETATION CLASS 8. Cypress/Gum Bog**

Figure 5.37. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in Major River Valleys and Floodplains showing associations between those stands and major soil-related environmental gradients at a depth of 10 cm, as distributed by community type on the two major compositional gradients.



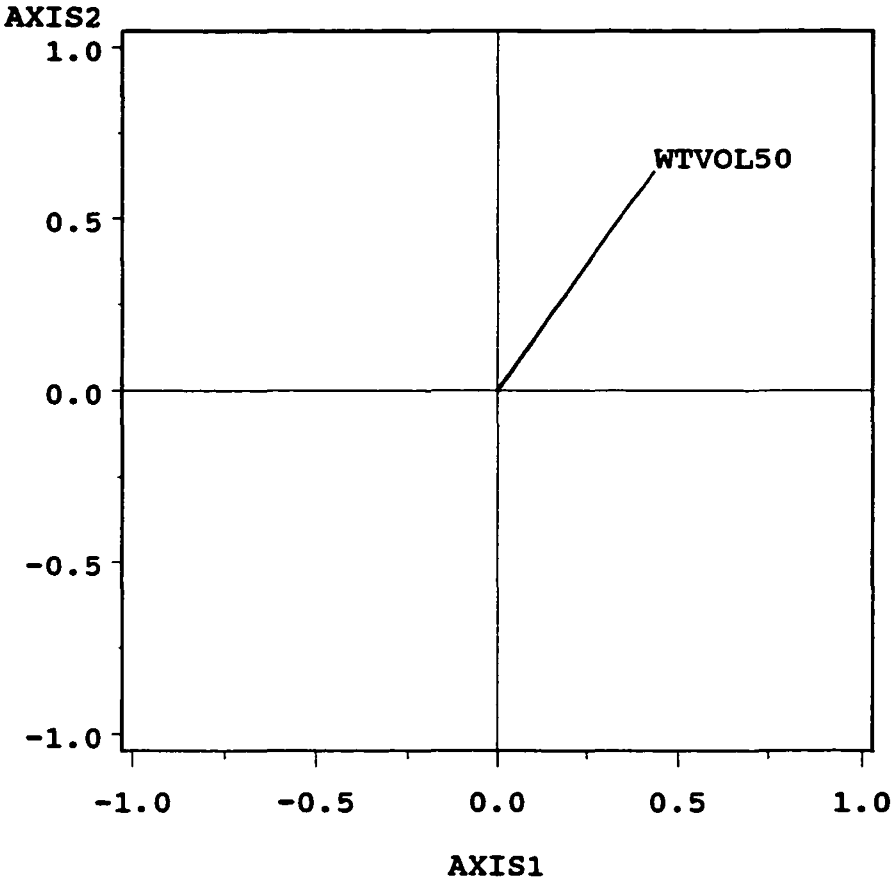
AXIS2
1.0
0.5
0.0
-0.5
-1.0
WTVOL10
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.38. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in Major River Valleys and Floodplains showing associations between those stands and major soil-related environmental gradients at a depth of 25 cm, as distributed by community type on the two major compositional gradients.



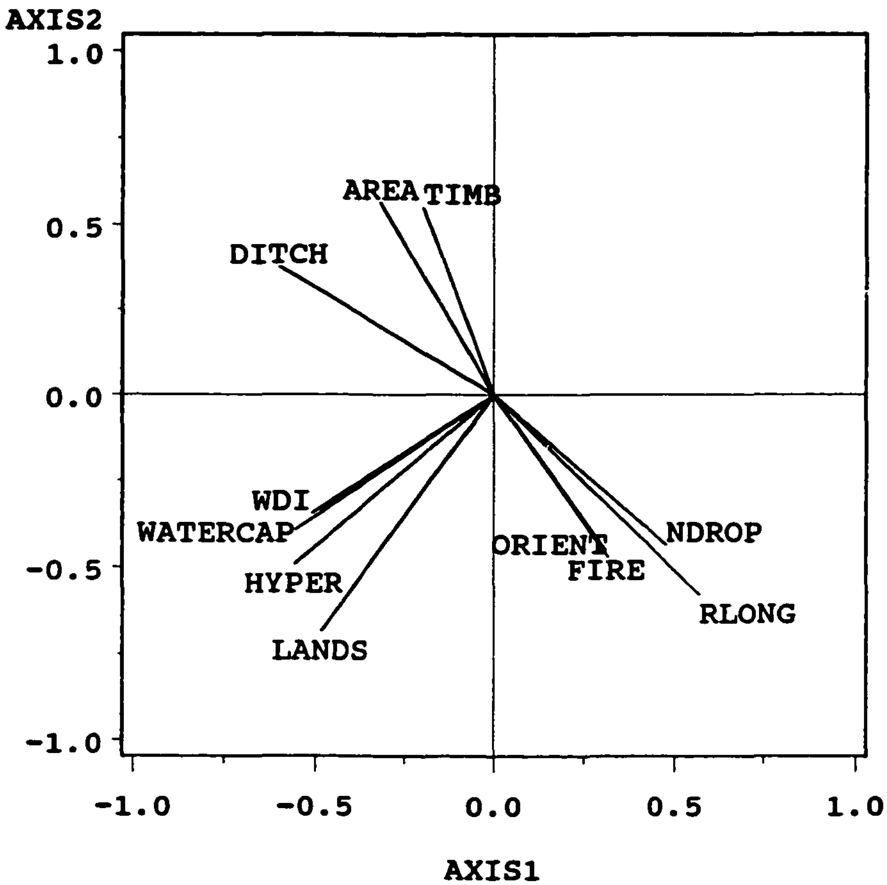
AXIS2
1.0
0.5
0.0
-0.5
-1.0
WTVOL25
MN25
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.39. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in Major River Valleys and Floodplains showing associations between those stands and major soil-related environmental gradients at a depth of 50 cm, as distributed by community type on the two major compositional gradients.



AXIS2
1.0
0.5
0.0
-0.5
-1.0
WTVOL50
-1.0
-0.5
0.0
0.5
1.0
AXIS1

Figure 5.40. Vector diagram for Axis 1 and Axis 2 of the NMDS ordination of study area Carolina bay plots located in Major River Valleys and Floodplains showing associations between those stands and major environmental gradients that are not directly soil-related, as distributed by community type on the two major compositional gradients.


AXIS2
1.0
0.5
0.0
-0.5
-1.0
AREA
TIMB
DITCH
WDI
WATERCAP
HYPER
LANDS
ORIENT
FIRE
NDROP
RLONG
-1.0
-0.5
0.0
0.5
1.0
AXIS1

## 5.3 Discussion of Vegetation--Environment Relationships

### 5.3.1 Community Gradient Analysis

Analysis of study area Carolina bay plots indicates that stands are primarily arranged along a complex hydrologic/soil acidity--density gradient. The soil component of that gradient is in essence a reflection of site hydrologic differences, since low pH, acidic, low bulk density organic soils tend to accumulate at the lowest elevation, wettest sites (Daniels, 1995). This hydrologic gradient approximates the east to west "topographic" gradient found in moving from comparatively young, low elevation land surfaces having broad, flat, relatively undissected interfluves to the more highly dissected, upland surfaces characteristic of the western coastal plain. At less wet sites, where oxidizing conditions within the rhizosphere are at least recurrent on a regular enough basis that peat does not accumulate and mineral soils prevail, soil nutrients and other properties not directly related to site wetness influence depression vegetation. Consequently, Carolina bay vegetation, at least in the first order analysis, is a reflection of site soils, which are in turn a product primarily of site wetness and mineral parent materials.

Similarly, other investigations of the relationship of Carolina bay vegetation to site environmental parameters have concluded that site "hydrologic regime" is the single most important factor in determining site vegetation type (Schalles and Shure; 1989; Tyndall *et al.*, 1990; Kirkman, 1992). However, unlike the present study, investigations of Carolina bay communities have heretofore been largely limited to consideration of vegetation community types (rather than broader vegetation groups) in only herb-dominated bay depressions. Moreover, "hydrologic gradient" has previously referred only to relative site water level, rather than to a complex of site wetness related factors.

At the same time, analysis of plots on land surfaces that are relatively uniform in terms of elevation, relief and other factors related to soil water table depth ("regional wetness") indicates that a wetness-related gradient is not necessarily the primary factor controlling stand arrangement at each landscape position considered in isolation. For example, Inner Lower Coastal Plain plots represent a poorly drained landscape class in a regional sense. Nevertheless, soil texture and nutrient status, as well as fire frequency, overshadow site wetness factors in determining stand distribution along the compositional axes for Inner Lower Coastal Plain plots.

The community gradient analysis confirms the significance of fire and other disturbance in shaping Carolina bay site vegetation. Fire has long been recognized as a major controlling factor for Longleaf Pine Woodlands and Evergreen Shrub-bogs (Christensen, 1988), and has been speculated to also be significant in determining vegetation in other Carolina bay vegetation types (Porcher, 1966; Sharitz and Gibbons, 1982; Schafale and Weakley, 1990; Bennett and Nelson, 1991). As discussed in Chapter 4, evidences of relatively frequent past fires abound in the vast majority of Carolina bay vegetation groups. The fact that both herb-dominated Carolina bay plots and bay plots dominated by woody species occur across a wide spectrum of similar soil types within the study area suggests the critical historic, if presently masked, role that site disturbance has played in determining current depressional vegetation.

# CHAPTER VI.

# OTHER VEGETATION--ENVIRONMENT RELATIONSHIPS IN STUDY AREA CAROLINA BAYS

## 6.1 Introduction

As previously noted, the analyses of individual vegetation groups and overall bay depression floristics are complicated by the fact that Carolina bay depressions contain selected elements of diverse southeastern coastal plain wetland vegetation types, but seldom contain the full range of plant communities that characterize any single vegetation type. In addition, because Carolina bay depressions occur from Maryland to Florida, the most "northern" and "southern" floristic elements of bay vegetation are likely less well represented in study area depressions. As a result, a full understanding of Carolina bay vegetation is likely obscured by a lack of information on vegetation types having little representation in study area Carolina bays.

On the other hand, except for climate, the full breadth of environmental parameters and landscape dynamics occurring within the range of Carolina bay depressions appears well represented within study area depressions. For that reason, the analysis of vegetation groups that do occur within the study area is potentially more meaningful. The most significant vegetation--environment relationships identified by the community gradient analysis in Chapter 5 are examined below. They include the relationships of vegetation to site hydrology, site soil factors, and landscape position. In addition, "vegetation trends" identified for Carolina bay vegetation communities in Chapter 4 are discussed in this chapter.

## 6.2 Hydrology

In addition to the community gradient analysis of Chapter 5, both field experience and reliance on the research of others indicate that hydrologic regime -- the depth, amplitude, and duration of inundation -- within bay depressions is the single most important environmental control for Carolina bay vegetation (Eyles, 1941; Schalles, 1979; Sharitz and

Gibbons, 1986; Tyndall *et al.*, 1986; Schalles *et al.*, 1989; Kirkman, 1992). Though all Carolina bays are wetlands in their natural condition, they vary widely in terms of hydrologic regime, ranging by degree from sites that are permanently inundated to those that are permanently exposed. The effects of hydrologic regime are both direct, *e.g.*, submersion of a plant growing on the bay floor, and indirect, *e.g.*, maintenance of a hydrologic regime that promotes paludification at the site.

Stahle *et al.* (1988) analyzed annual growth rings in southeastern North Carolina trees in order to reconstruct the historic climate of the region. From that analysis, they determined that cyclic periods of predominantly wet or predominantly dry years have occurred in approximately 30-year intervals over the last 1500 years. Consequently, it is likely that study area bays have been subjected to alternating periods of flood and drought for at least hundreds of years, resulting in long-term variability in the annual hydrologic regime of any given depression site.

Understanding the effects of site hydrology is further complicated by the fact that the relative dominance of site wetness may vary not only from site to site, but also, within a specific site over time. One such difficulty is the proverbial "chicken or egg" problem with respect to site hydrologic controls. For example, as discussed in Chapter 4, subsurface fragipans, spodic horizons, or peat accumulation may act as an aquiclude to impede the movement of water in a soil. Yet, each of those pedologic impediments to water movement may have resulted from the long-term pedogenic effects of fluctuating site water table levels.

Depression water level is generally a function of local precipitation, differences in groundwater behavior (*e.g.*, levels of site water--ground water exchange), variability in the permeability of underlying site strata, depression slope, depression surface area and consequent evapotranspiration rates, and seasonality in evapotranspiration rates (Wells and Boyce, 1953; Schalles, 1979; Schalles *et al.*, 1989; Lide *et al.*, 1995; Nifong, personal observation). Middle and Upper Coastal Plain Carolina bay depressions with loamy soils are generally presumed to have an impervious "clay lens" (not a fragipan) that perches the water table at the site (Sharitz and Gibbons, 1982; Schalles *et al.*, 1989; Kirkman, 1992). In addition, relatively impermeable, subsurface diagnostic soil horizons (fragipan and spodic layers) may also result in a perched water table (Soil Survey Staff, 1975; Buol *et al.*, 1980)

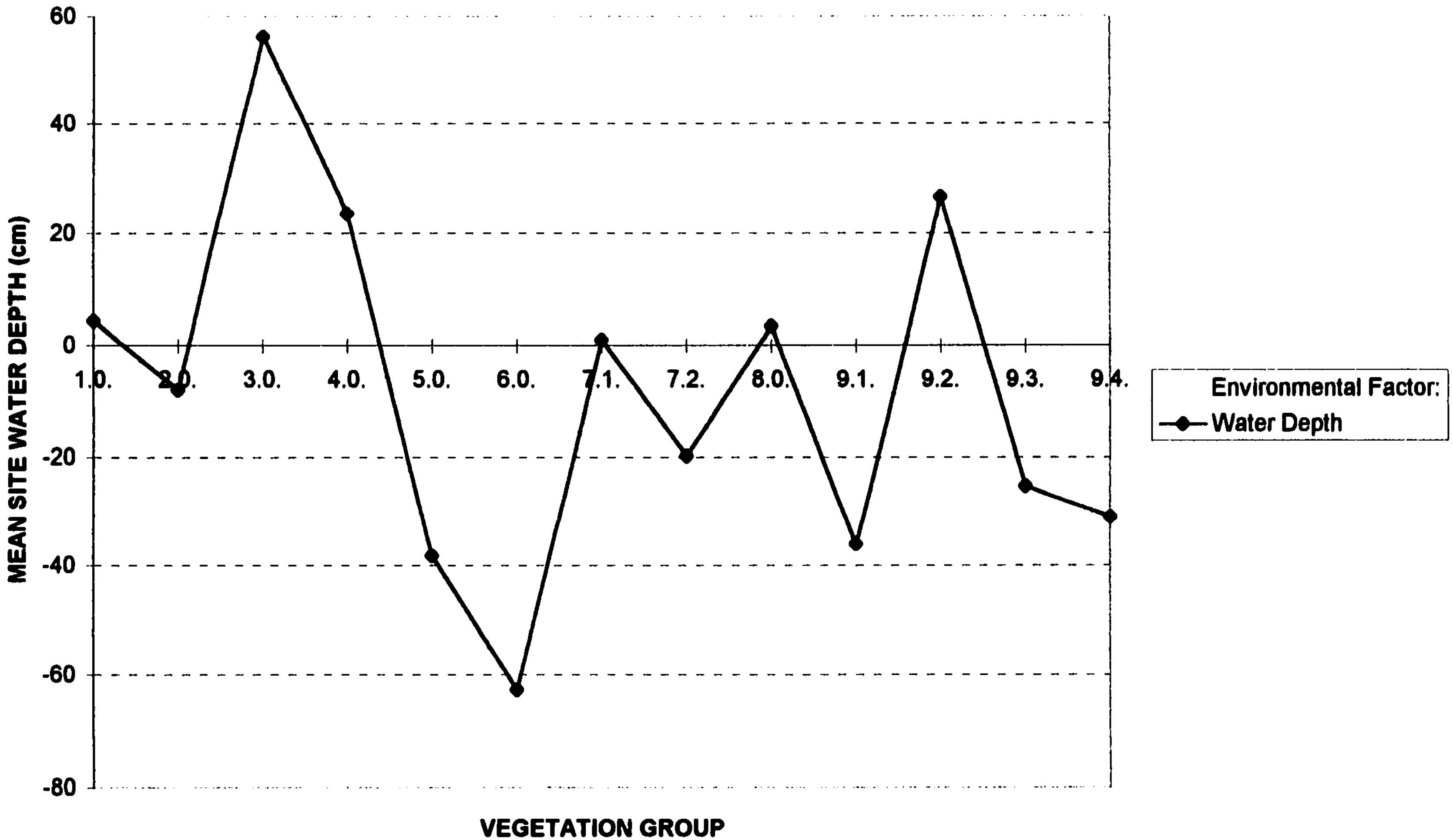
The relative importance of local precipitation patterns to site hydrology has been given different weights by different investigators. Sharitz and Gibbons (1982), Kirkman (1992), and others have attributed point-in-time site water level almost entirely to local rainfall, while Lide *et al.* (1995) found site water--ground water exchange to be extremely significant in both short and long-term site water level. Personal observation of bay sites over a period of two decades has led to the conclusion that while water table interactions are very significant in some bays, especially at the lower elevation landscape positions, site hydrology in upland bays is chiefly precipitation-driven. Similarly vegetated, Middle Coastal Plain sites located only a few kilometers apart typically show a wide and inconsistent (*i.e.*, one is not always wetter or drier than the other) variance in water depth in a given year or season.

Data collected during this study reflect the variance in the ambient water level of Carolina bay depressions. Figure 6.1 indicates the wide range of variability in the ambient site water level at time of sampling observed between study area sites exhibiting different vegetation groups. Ambient water levels vary from sites where surface water stood in excess of 80 cm, to sites where the ambient water level was measured at 150 cm below the surface of the depression floor at the time of sampling. Those findings are not surprising given the differences between sampling sites in terms of basin area and slope, depression soils, landscape relief in the area of the depression location, the inevitable variability in local rainfall events across the study area, and the seasonal range of sampling (from June through November).

Similarly, the year-to-year variation in ambient site water levels occurring within a given "type" of Carolina bay, or within any specific bay site, may be substantial. As noted in the preceding descriptions of Carolina bay vegetation groups, year-to-year site water level fluctuation is characteristic of most vegetation types, but appears to be most pronounced in

Figure 6.1. Mean ambient site water depth at the time of sampling encountered in Carolina bay depressions, by vegetation class and subclass. Water depth is in centimeters.

MEAN SITE WATER DEPTH AT TIME OF SAMPLING OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP



two vegetation classes -- Intermittently Flooded Depression Prairies, and Intermittently Ponded Cypress/Gum Depressions. Table 6.1 displays the temporal water level variation measured in the late summer in an Intermittently Flooded Depression Prairie site during four different years. For those years, the ambient site water level varied from a maximum of 50 cm above the depression floor to a minimum of 61 cm below the surface, with the water level varying between those two extremes in the other two years. Table 6.2 reflects the yearly water level variation measured for the mid-summer period during two (and in one case, three) sampling years in sites exhibiting vegetation representative of each of the four Intermittently Ponded Cypress/Gum Depression vegetation subclasses. Again, that table indicates that seasonal water levels vary substantially at any given Carolina bay site from year to year.

Taken together, these findings are indicative of the wide range of ambient site water levels present in precipitation dominated, temperate climate, lentic systems. They are consistent with seasonal and yearly variations in depression site water levels measured in other investigations of study area Carolina bays that examined site hydrology. Hodge (1985) noted a range of 25-63 cm in the water levels of eight bays located in the southern portion of the study area over a one-year period. Similarly, Tyndall *et al.* (1990) reported site water fluctuations between years in six Maryland Carolina bays of from <1 to 22 cm. Schalles *et al.* (1989) found that site water levels fluctuated between 35 and 83 cm over an annual cycle in six Carolina bays located in the southwestern portion of the study area.

As indicated by Figure 6.1, the mean ambient site water level at the time of sampling was generally highest in the Freshwater Pond vegetation subclass, closely followed by the Cypress/Gum Pond vegetation subclass and the Freshwater Marsh vegetation class. Site water level at the time of sampling was lowest in the Longleaf Pine Woodland vegetation class. Site water level was slightly above or very near the soil surface in the Brackish Marsh, Intermittently Flooded Depression Prairie, Evergreen Shrub-bog, and Cypress/Gum Bog vegetation classes. The Boggy Marsh, Cypress/Gum Swamp, Drawdown Savanna/ Meadow, and Wet Savanna/Meadow vegetation types all exhibited mean site water levels substantially below the depression surface at the time of sampling.

Table 6.1. Annual site ambient water level variation in a Carolina bay Intermittently Flooded Depression Prairie vegetation community.

| VEGCLASS 2: INTERMITTENTLY FLOODED DEPRESSION PRAIRIE | | | | |
|---|---|---|---|---|
| | YEAR 1 | YEAR 6 | YEAR 12 | YEAR 13 |
| Water Depth (cm) | +50 | -25 | -61 | +48 |
| Number of Species Present | 3 | 5 | 5 | 5 |

Table 6.2. Annual site ambient water level variation in 4 Intermittently Ponded Cypress/Gum Depression vegetation communities representing each vegetation subclass within that vegetation group.

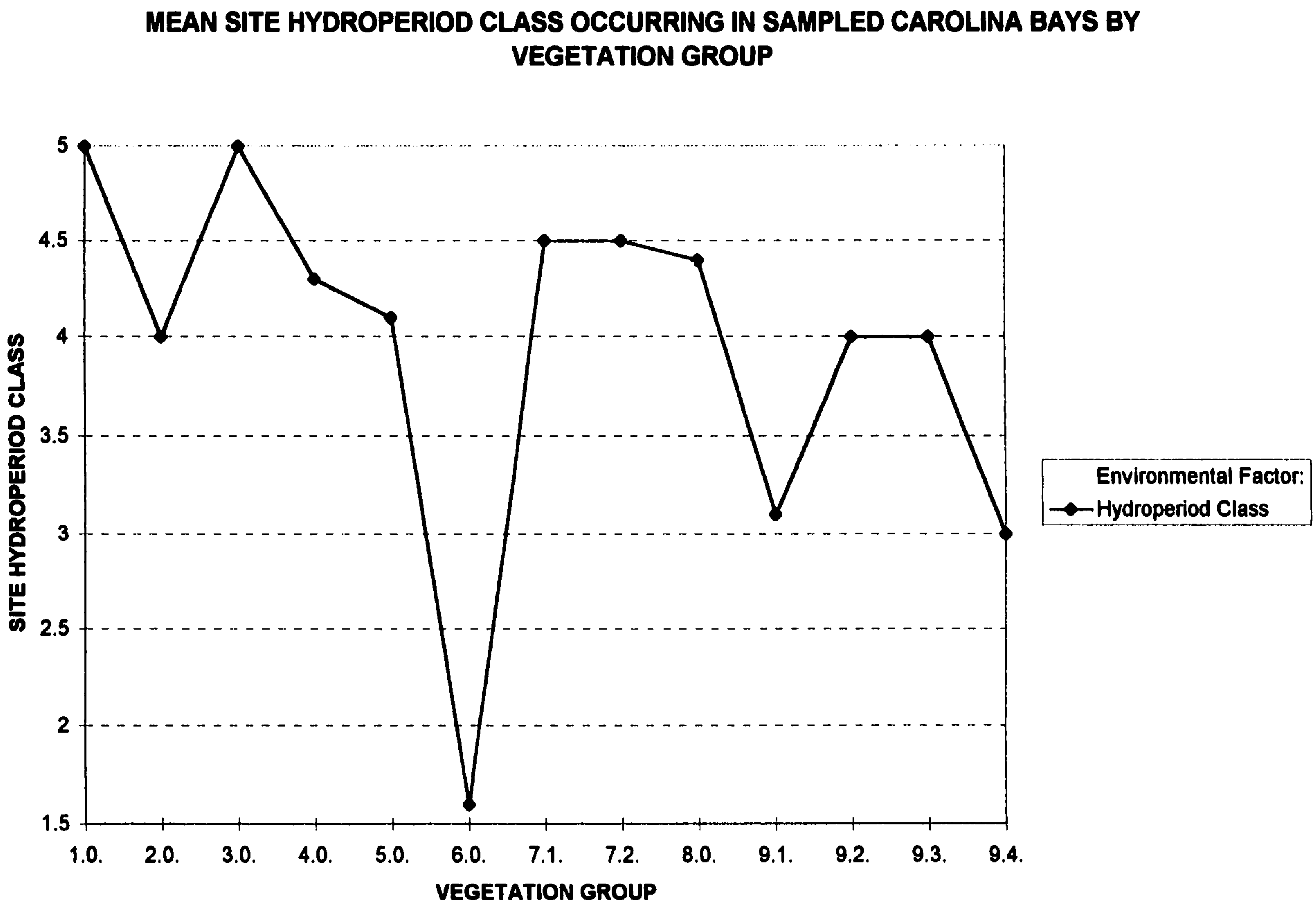
| VEGCLASS 9: INTERMITTENTLY PONDED DEPRESSION PRAIRIE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 9.1. Cypress/Gum Swamp | | 9.2. Cypress/Gum Pond | | 9.3. Drawdown Savanna/ Meadow | | | 9.4. Wet Savanna/ Meadow | |
| | YEAR 1 | YEAR 7 | YEAR 1 | YEAR 13 | YEAR 1 | YEAR 6 | YEAR 12 | YEAR 1 | YEAR 11 |
| Water Depth (cm) | -38.0 | -135.0 | -20.0 | +64.0 | +28.0 | -25.0 | +2.0 | 0 | -35.0 |
| Number of Species Present | 22 | 22 | 11 | 8 | 7 | 13 | 15 | 11 | 17 |

Given the significance of site hydrologic regime in determining vegetation, the ambient site water depth at the time of sampling for each vegetation group was plotted as an overlay to the plant life form and plant growth form summary figures. However, those figures indicated no discernible relationship between prevalent life forms/growth forms and the depth of water at the time of sampling. That is not surprising, since sampled water depth represents a "snapshot" measure of site hydrology, while site plant communities are the expression of long-term vegetation response to the influences of site hydrologic regime, among other factors. However, given the potential variability in point-in-time site water depth, it is apparent that ambient site water depth is not an accurate predictor of long-term site hydrologic regime.

A better measure of the long-term hydrologic regime that characterizes a vegetation class is the mean hydroperiod class found in depressions exhibiting that vegetation type. Mean hydroperiod class, as explained in Chapter 3, is based on the relative percentage of time that a depression may be observed to have standing surface water in an average year. Figure 6.2 plots mean site hydroperiod class by Carolina bay vegetation group. According to that measure, the "driest" vegetation type, *i.e.*, that group of vegetational communities occurring in depressions that lack standing surface water for the longest period of time, is the Longleaf Pine Woodland, while the "wettest" vegetation types are the Freshwater Pond and Brackish Marsh communities. Overall, the vegetation groups are arranged by mean hydroperiod class, from wettest to driest, as follows: (1) Brackish Marsh, (2) Freshwater Pond, (3) Bay Forest, (4) Pocosin, (5) Cypress/Gum Bog, (6) Freshwater Marsh, (7) Boggy Marsh, (8) Intermittently Flooded Depression Prairie, (9) Cypress/Gum Pond, (10) Drawdown Savanna/Meadow, (11) Cypress/Gum Swamp, (12) Wet Savanna/Meadow, and (13) Longleaf Pine Woodland.

The Carolina bay vegetation classification scheme that serves as the linchpin of this study sets out groups have plots that have been sorted and arranged according to overall, inter-plot floristic similarity. As a consequence, the arrangement of stands is "value neutral" in terms of underlying environmental gradients that shape the vegetation and are the source of the species compositional variability that serves as the basis for classification. Given the

Figure 6.2. Mean site hydroperiod class found in study area Carolina bays by vegetation class and subclass. Site hydroperiod class is determined by a vegetation group's mean site index value. Hydrologic "site index value" is defined in Chapter 3 of the text.


MEAN SITE HYDROPERIOD CLASS OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP
SITE HYDROPERIOD CLASS
5
4.5
4
3.5
3
2.5
2
1.5
1.0.
2.0.
3.0.
4.0.
5.0.
6.0.
7.1.
7.2.
8.0.
9.1.
9.2.
9.3.
9.4.
VEGETATION GROUP
Environmental Factor:
Hydroperiod Class

apparent preeminence of hydrologic regime in determining Carolina bay vegetation, it is suggested that the designated classification groups occur on the landscape as points along a relative site wetness, or hydrologic, gradient. The sequential arrangement of the major vegetation groups found within study area Carolina bays according to mean group hydroperiod class set out above gives an approximation of that "natural" arrangement.

### 6.3 Soils

Carolina bay soils as a whole are poorly understood, although they have been the subject of a number of studies over the years. Early on, in conducting palynological studies in an attempt to understand bay age and origin, Buell (1939, 1945, 1946a, 1946b), Wells (1943, 1946), Frey (1951a, 1953, 1955), and other scientists described organic soils from a number of eastern North Carolina bays. In addition, Frey (1950) described soil properties of a number of Carolina bays characterized by both organic and mineral soils. Bryant (1964), and Bryant and McCracken (1964) reported on soils properties of North Carolina Middle Coastal Plain loamy bay soils. Thom (1967, 1970) generally described organic-sand system "humate" soils (Spodosols) from northeastern South Carolina in detailing the geomorphology of that region. Daniels *et al.* (1984), discussed Carolina bay soils as a whole in the context of soil formation factors and regional soil development on the North Carolina coastal plain. Schalles *et al.* (1989), relying primarily on work by Hodge (1985), detailed soils properties for a series of mostly Freshwater Marsh Carolina bays in the southwestern South Carolina coastal plain. Outside of the study area, Bliley and Pettrey (1979) described Carolina bay soils from the Virginia Eastern Shore, and Stolt and Rabenhorst (1987) discussed soil properties and taxonomy for Carolina bays located on the Eastern Shore of Maryland.

Each cited soil study was relatively localized in terms of geographic extent, and no study attempted, nor was intended, to relate Carolina bay soils to site vegetation. By contrast, one of the objectives of this study was to generally describe and document study area Carolina bay soils and their relationships to bay vegetation. Carolina bay soils sampled and identified in this study fall into one of four soils orders -- Entisols, Histosols, Spodosols, and Ultisols. In addition, Alfisols and Inceptisols are attributed to Carolina bay depressions within the study area (Long, 1980; Leab, 1990), but were not encountered within sampled depressions. The four soil Orders found within sampled Carolina bays further represent thirteen taxonomic soils Subgroups (*see* Soil Survey Staff, 1975), as listed in Figure 6.3.

The figure graphically displays the soil family frequency information summarized in Table 4.3. The results for sampled, study area Carolina bays may be summarized as follows: (1) Brackish Marshes are restricted to Typic Psammaquent soils; (2) Intermittently Flooded Depression Prairie and Freshwater Pond communities occur predominantly over Typic Paleaquult soils; (3) Freshwater Marshes are found over a variety of wet, loamy soils, including, Typic Paleaquults, Typic Fragiaquults, and Typic Ochraquults; (4) Boggy Marsh communities occur predominantly over Typic Haplaquods soils; (5) Longleaf Pine communities occur over a wide variety of different soil types, including Typic Fragiaquults, Typic Psammaquents, Aquic Paleudults, and Aeric Haplaquods; (6) Evergreen Shrub-bog and Cypress/Gum Bog communities are found primarily on Terric Medisaprist and Typic Haplaquod soils; (7) Cypress/Gum Swamps occur over a wide variety of sandy to loamy mineral soils; (8) Cypress/Gum Ponds and Drawdown Savanna/Meadows occur almost exclusively on Typic Fragiaquult soils; and (9) Wet Savanna/Meadow communities are found principally over Typic Paleaquult soils. Descriptions and distributions of bay soils in relation to specific vegetation groups have previously been discussed.

Site soils, like vegetation, can also be viewed as representing an expression of long-term response to site hydrological conditions. Under the anoxic conditions that occur at the wettest sites, organic matter tends to accumulate, eventually forming peat, but organic matter is oxidized at relatively drier sites or during drawdown periods at wetter sites, when surface layers are not saturated (Daniels, 1995). Schalles and Shure (1989) suggested that drawdown oxidation of surficial organics is responsible for the general absence of peat in upper coastal plain bays in South Carolina. Consequently, the depth of the surface organic-dominated layer of the soil profile is potentially an indication of long-term site hydrologic conditions.

For those reasons, site organic matter depth was examined as a possible surrogate for long-term site hydrologic regime. Figure 6.4 shows the relative mean depths of the organic layer for each major Carolina bay vegetation group. However, that graph shows little relation to Figure 6.2, which plots hydroperiod class by vegetation group. That would appear to

Figure 6.3. Soil Subgroups occurring in study area Carolina bay depressions, by vegetation class and subclass. Site soils are discussed in detail in Chapter 4 and Appendix II.

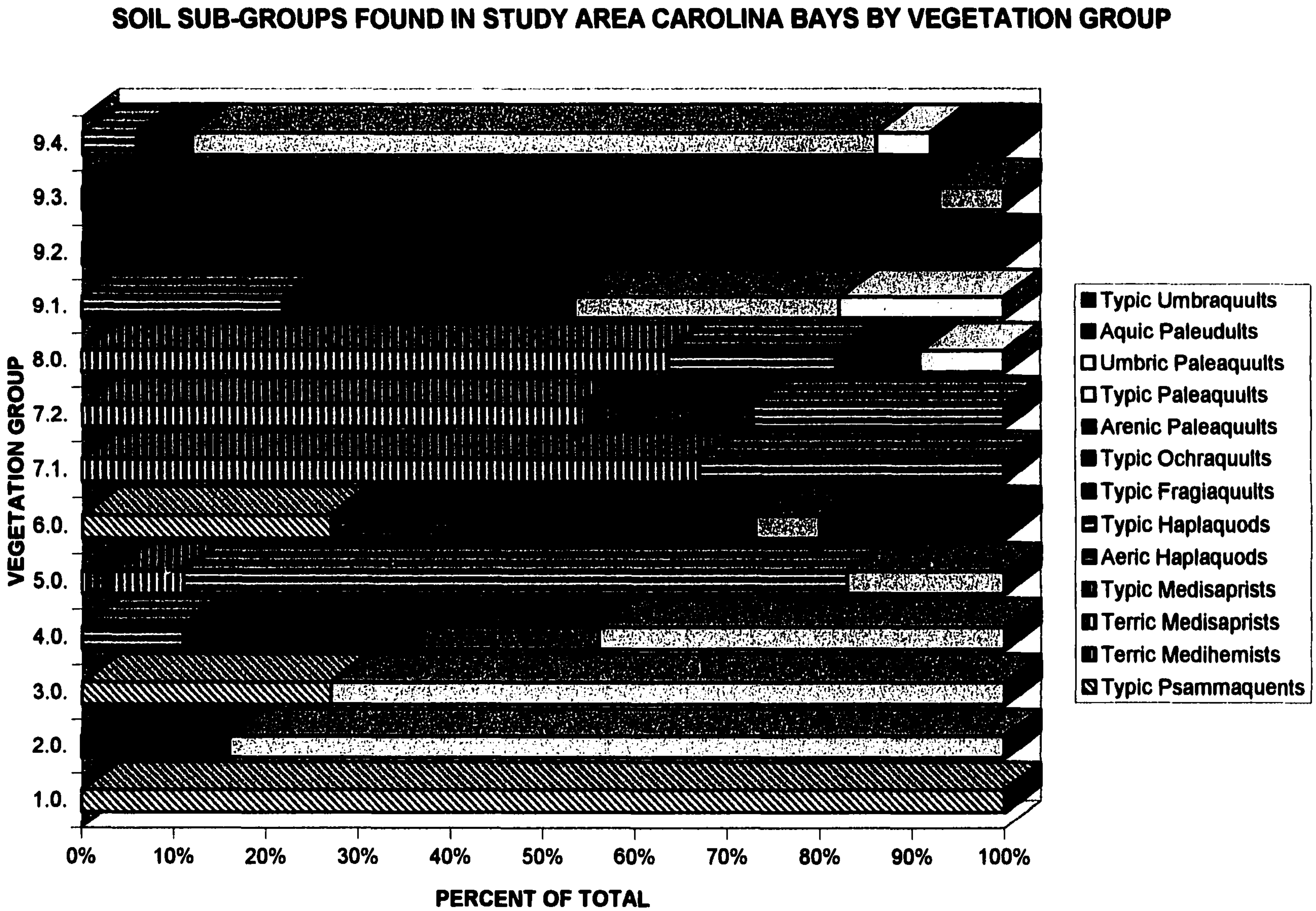
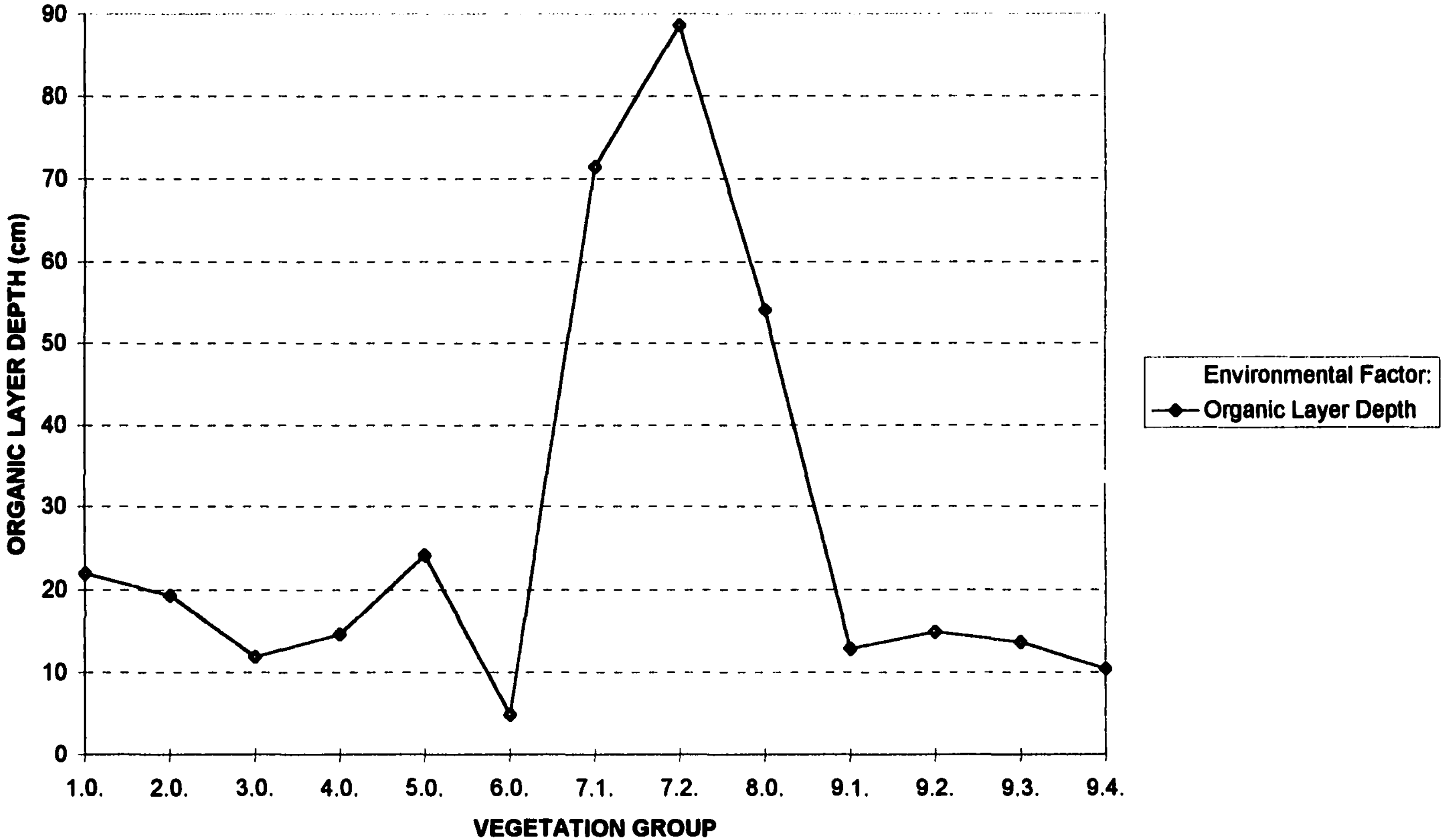

SOIL SUB-GROUPS FOUND IN STUDY AREA CAROLINA BAYS BY VEGETATION GROUP
9.4.
9.3.
9.2.
9.1.
8.0.
7.2.
7.1.
6.0.
5.0.
4.0.
3.0.
2.0.
1.0.
VEGETATION GROUP
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
PERCENT OF TOTAL
Typic Umbraquults
Aquic Paleudults
Umbric Paleaquults
Typic Paleaquults
Arenic Paleaquults
Typic Ochraquults
Typic Fragiaquults
Typic Haplaquods
Aeric Haplaquods
Typic Medisaprists
Terric Medisaprists
Terric Medihemists
Typic Psammaquents

Figure 6.4. Mean site organic layer depth occurring in study area Carolina bays, by vegetation group. "Organic layer depth" refers to that portion of the soil solum in which organic matter predominates, as determined by soil color and texture.

## MEAN SITE "ORGANIC LAYER" DEPTH OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP

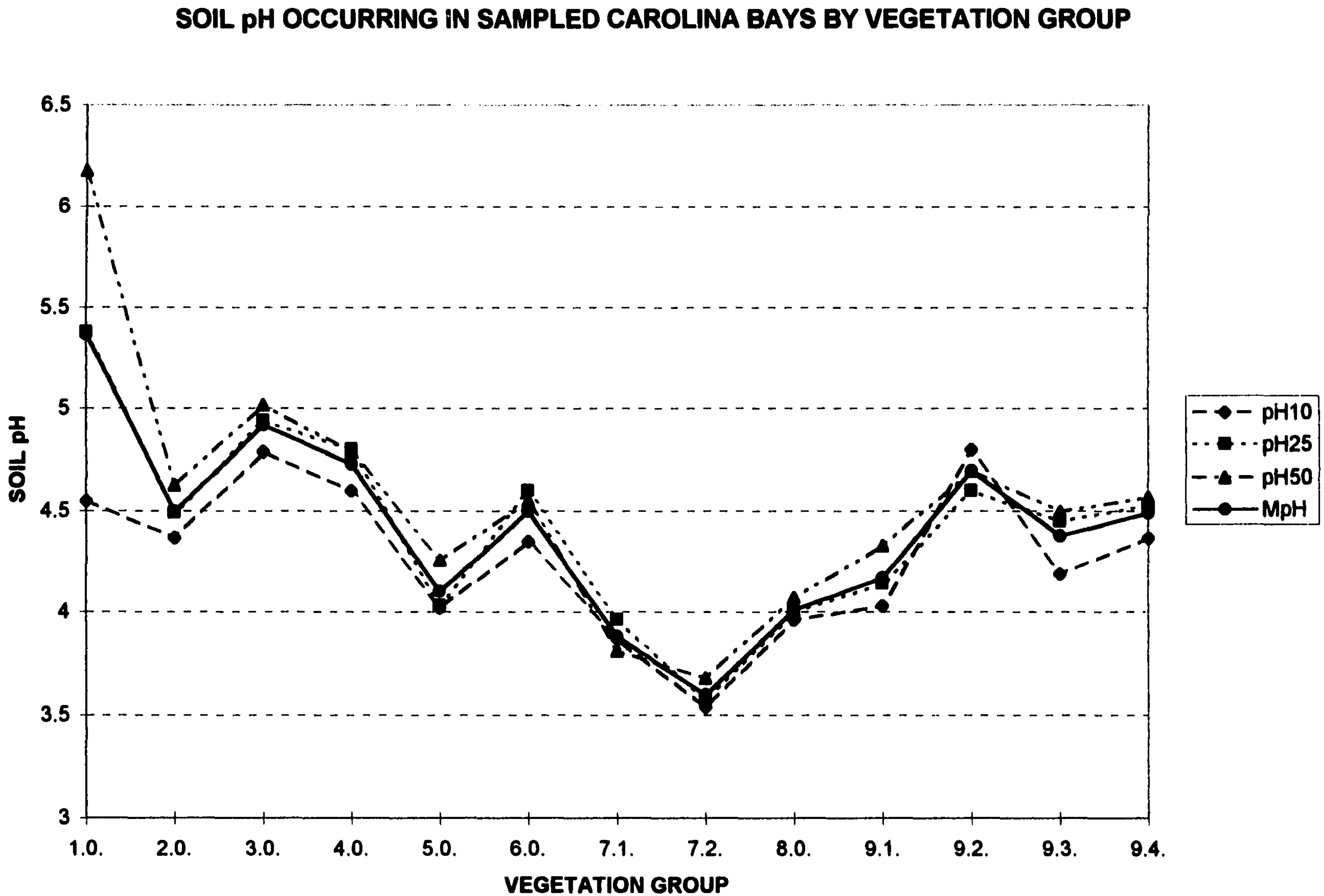


suggest that rather than being controlled primarily by site wetness, site organic matter depth is controlled by the complex interaction of a number of factors. It is likely that those factors include, at a minimum, site hydroperiod, site fire frequency and intensity, site age, site pH and nutrient status, makeup of the species that contribute organic litter to the site, and makeup of the underlying sediments contributing species.

The chemical and physical properties of sampled Carolina bay soils are presented in Tables A-II--2 to A-II-7. Soil reaction (pH) is typically considered a reliable indicator of certain vegetation types (Radford *et al.*, 1981). Based on values appearing in Tables A-II-2 to A-II-4 values, Figure 6.5 graphically displays the range of soil reaction (pH) across major sampled vegetation groups in terms of pH at depths of 10 (pH10), 25 (pH25), and 50 cm (pH50), as well as mean soil pH (MpH). That figure indicates that the pH found in all Carolina bay soils is relatively low, being in the extremely acid (pH<4.5) to slightly acid (6.1<pH<6.5) range.

Specific differences in soil pH values occurring between vegetation groups are readily apparent. The lowest soil pH values are found for those vegetation classes and subclasses occurring primarily on Histosols and Spodosols. Consequently, the lowest soil reaction values are found within the "bog" communities described from the study area. Pocosin vegetation occurs over the most acidic soils, closely followed by Bay Forest, Cypress/Gum Bog, and Boggy Marsh communities. By contrast, Brackish Marshes, with periodic inputs of sea water and marine sediments containing calcic shell fragments, occur over the least acidic soils. All other vegetation groups occur, as a whole, over very strongly acid soils (but note specific exceptions set out in the soils discussions for individual community types, *e.g.*, the "*(Nyssa biflora-Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Bog" community type found within the Cypress/Gum Bog vegetation class, as discussed in Chapter 4). Soil reaction in typically flooded communities -- Freshwater Ponds, Freshwater Marshes, and Cypress/Gum Ponds -- is somewhat higher than those found in sites that are frequently "drawn down" -- Intermittently Flooded Depression Prairies, Cypress/Gum Swamps, Drawdown Savannas/Meadows, and Wet Savannas/Meadows. Within each vegetation group, soil pH generally increases with depth, reflecting the influence of organic

Figure 6.5. Soil reactions (pH) occurring in study area Carolina bays, by vegetation class and subclass. Symbols used are as follows: pH10 = the mean pH measured for the vegetation group at a depth 10 cm below the soil surface; pH25 = the mean pH measured for the vegetation group at a depth 25 cm below the soil surface; pH50 = the mean pH measured for the vegetation group at a depth 50 cm below the soil surface; and MpH = the mean pH measured for the vegetation group as a whole.



SOIL pH OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP
SOIL pH
6.5
6
5.5
5
4.5
4
3.5
3
1.0.
2.0.
3.0.
4.0.
5.0.
6.0.
7.1.
7.2.
8.0.
9.1.
9.2.
9.3.
9.4.
VEGETATION GROUP
pH10
pH25
pH50
MpH

acids that result from the decay of plant material in the upper portion of the soil pedons.

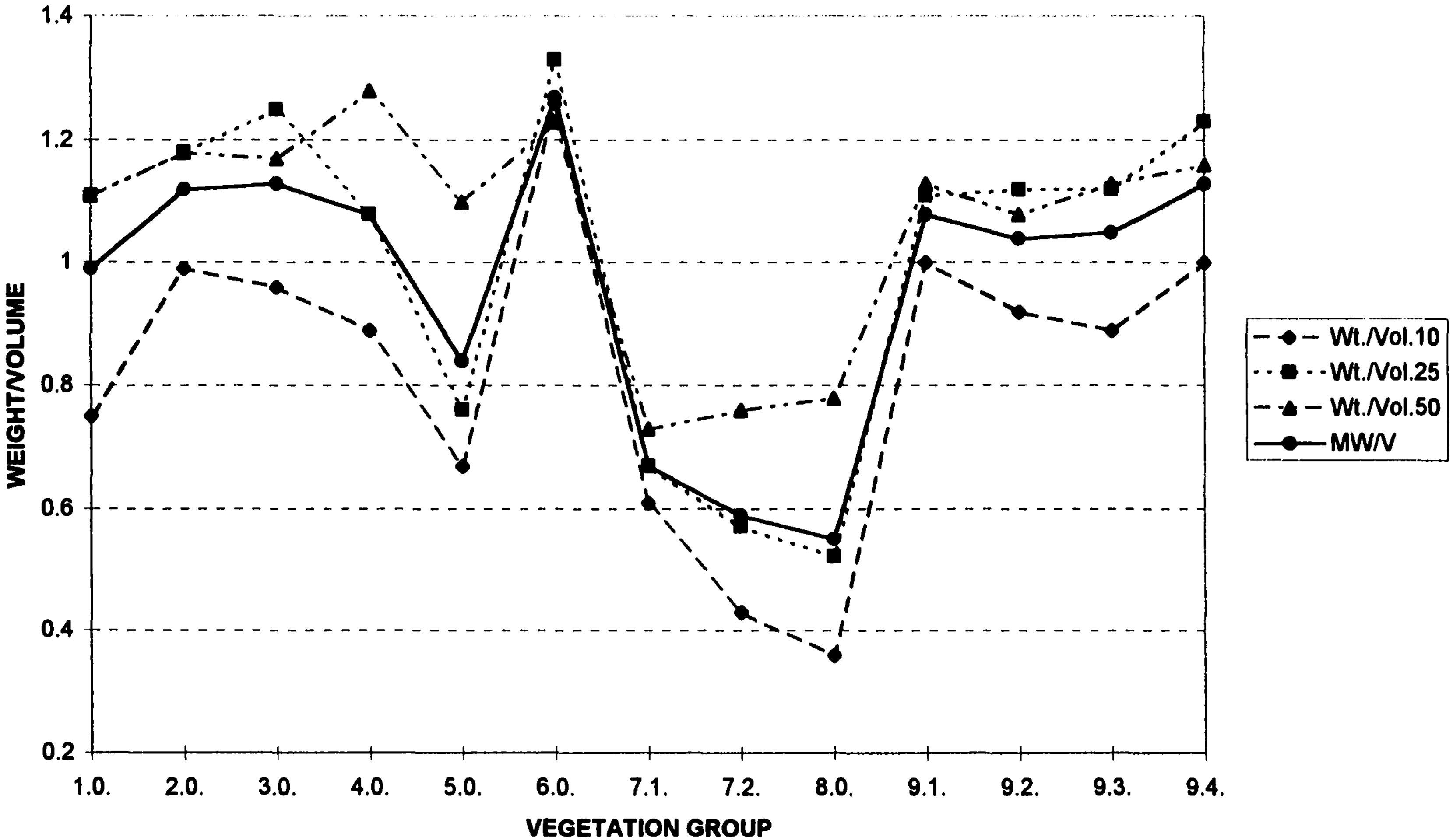
Soil texture is another soil property generally considered significant to plant growth. A summary of soil textures by vegetation group is contained in Tables A-II-5 to A-II-7. As previously noted, textural analysis was not performed for organic soils within this study. For that reason, and because soil bulk density (*i.e.*, weight/volume) is a good indicator of soil texture (NCDA, 1996), bulk density was used as a surrogate for soil texture. Sandy, mineral soils have the highest bulk densities, while organics have the lowest bulk densities, because of their higher porosities (percent pore space). Bulk densities of mineral soils typically range between 1.0 g/cm$^3$ and 2.0 g/cm$^3$, with sandy soils in the upper part of that range and clay loams usually weighing near 1.0 g/cm$^3$ (Mitsch and Gosselink, 1993; Soil Test Report, 1995). Organic soils developed from *Sphagnum* spp. may weigh as little as 0.04 g/cm$^3$ (Mitsch and Gosselink, 1993), though organic soil bulk densities typically range between 0.2 and 0.3 g/cm$^3$ (Brady, 1974). Soil samples from study area Carolina bays were found to have bulk densities ranging from 0.09 g/cm$^3$ (in a Cypress/Gum Bog plot) to 1.55 g/cm$^3$ (in a Wet Savanna/Meadow plot).

Figure 6.6 presents graphically the range of soil bulk density across sampled vegetation groups in terms of soil weight/volume at depths of 10 (Wt./Vol.10), 25 (Wt./Vol.25), and 50 cm (Wt./Vol.50), and mean soil bulk density (MW/V). Again, the gross relationships between this soil parameter and vegetation groupings are relatively self-evident and largely as would be predicted. Longleaf Pine Woodlands are found on the sandiest soils, *i.e.*, those with the generally highest bulk density, approaching 1.4 g/cm$^3$. Cypress/Gum Bog and Evergreen Shrub-bog communities occur over organic soils, which have the lowest bulk densities among those sampled (<0.7 g/cm$^3$ on average). The bulk densities of Boggy Marsh soils are also comparatively low. Soils underlying other Carolina bay vegetation groups are somewhere between those two extremes, in the 0.8 to 1.2 g/cm$^3$ range, generally representing loamy soils with a mixture of soil particle sizes. Soil bulk density generally increases with depth for soils underlying all vegetation groups, again reflecting the influence on soil properties of decomposed plant material in the upper parts of a soil solum.

As an aside, it is noted that the advent of the modern county soils survey published by

Figure 6.6. Mean soil bulk densities occurring in study area Carolina bays, by vegetation class and subclass. Symbols used are as follows: Wt./Vol.10 = the mean soil bulk density measured for the vegetation group at a depth 10 cm below the soil surface; Wt./Vol.25 = the mean soil bulk density measured for the vegetation group at a depth 25 cm below the soil surface; Wt./Vol.50 = the mean soil bulk density measured for the vegetation group at a depth 50 cm below the soil surface; and MW/V = the mean soil bulk density measured for the vegetation group as a whole.

MEAN SOIL BULK DENSITIES OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP



the U.S. Department of Agriculture's Soil Conservation Service has been both a boon and a curse to the understanding of Carolina bay soils. Given their unique geomorphology, bay depression soils are easily mapped as discrete units, and the sites are readily picked out by soil survey users. Relevant published soil surveys generally provide an excellent guide to the range of depression or wetlands soils in a given area, and provide good descriptions of the general and diagnostic characteristics of those soils. At the same time, the accuracy of these soils designations has often been accepted and perpetuated by public and private resource agencies, with little or no attempt at field verification of the information. The soil surveys themselves alert the user to the scale problems inherent in soils mapping, the general nature of the information presented, and the small number of actual field samples that serve as the basis for the maps presented. In this study, mapped soil unit designations for sampled Carolina bays were found to be accurate slightly less than half the time, although the actual soil units could nearly always be found for other depressions in the area of the sampling site.

### 6.4 Landscape Position

The study area includes a broad range of landscapes from north (the North Carolina/ Virginia line) to south (the South Carolina/Georgia line), and moving east to west from the Atlantic Ocean to the Piedmont Plateau. As noted in the introductory description of the study area, those landscapes vary from the near-coast, broad, flat, relatively undissected interfluves of the northeast portion of the study area to the excessively drained, undulating topography of the Sandhills in the westernmost portions of the study area. In between, the land surfaces represent a series of northeast-southwest trending, ancient marine and fluvial terraces that roughly parallel the present day coast, and are separated by a series of low ridges, or scarps, that represent ancient shorelines. Those surfaces increase in age, and therefore, in relative degree of dissection, in moving from east to west. To add to the mix, extensive terrace systems abut major rivers that cut across these land surfaces perpendicularly in flowing southeastwards to the sea. Carolina bay depressions are located on all such land surfaces within the study area, but are generally more plentiful in the middle portions of the coastal plain than in its eastern or western fringes.

As previously discussed, for purposes of this analysis study area land surfaces were divided into five surface types, or "landscape positions" (adapted from Daniels *et al.*, 1984; and Colquhoun, 1969), having relatively similar characteristics in terms of topography, geology, hydrology, and soils, the: (1) Upper Coastal Plain (including Sandhills), (2) Middle Coastal Plain, (3) Inner Lower Coastal Plain, (4) Outer Lower Coastal Plain, and (5) Major River Valleys and Floodplains (*see* Figure 2.3).

Table 4.3 summarizes sampled Carolina bay vegetation groups across each designated, study area landscape position. It shows that sampled (1) Brackish Marsh communities are located entirely within the Outer Lower Coastal Plain; (2) Intermittently Flooded Depression Prairies are almost totally restricted to the Middle Coastal Plain; (3) Freshwater Pond communities are largely located in the Middle Coastal Plain, but are also found in the Inner Lower Coastal Plain; (4) Freshwater Marsh communities are found primarily in the Middle Coastal Plain, but are significantly represented in the Upper Coastal Plain; (5) Boggy Marsh communities are largely restricted to the Outer Coastal Plain; (6) Longleaf Pine Woodlands occur with almost equal frequencies on Middle and Upper Coastal Plain land surfaces; (7) Evergreen Shrub-bogs -- both Bay Forest and Pocosins -- are most numerous on Major River Valley and Floodplain surfaces, but also occur significantly on Lower Coastal Plain surfaces; (8) Cypress/Gum Bog communities, while most numerous in the Middle Coastal Plain, occur over the broadest range of study area land surfaces, including all landscape positions except the Upper Coastal Plain; and (9) Intermittently Ponded Cypress/Gum Depressions, including all four vegetation subclasses, are virtually restricted to the Middle Coastal Plain within the study area.

It is extremely important to note that field reconnaissance indicated that the sampled study area depression sites, while selected to be representative of proportionate occurrence of different vegetation types on different land surfaces as a whole, do not include each vegetation class at each landscape position on which it occurs. Consequently, only general conclusions may be drawn as to the distributions of Carolina bay vegetation types by landscape position.

The distribution of Carolina bay communities among study area landscape positions holds no real surprises, and in large part simply reflects the relative abundance of Carolina bay depressions within the study area. Aerial photographs of the study region indicate that individual Carolina bay depressions are more numerous, by far, in the Middle Coastal Plain (including the Middle Coastal Plain "portion" of the Major River Valleys and Floodplains surface that bisects the other landscape positions) than in any other landscape position. It is therefore not surprising that all but one Carolina bay vegetation class (Brackish Marsh) is found in the Middle Coastal Plain. By contrast, Carolina bays are relatively rare in both the outer Lower Coastal Plain and the Upper Coastal Plain, explaining at least in part the relatively limited number of vegetation types occurring at those landscape positions. An intermediate number of bay depressions is found in the Inner Lower Coastal Plain.

Table 4.4 summarizes the frequency of Carolina bay soil families found within sampled depressions according to landscape positions. While the distribution of those soil groups by landscape position is largely self-explanatory, it is instructive to note that like the vegetation class distribution, the great majority of soil families can be found in Middle Coastal Plain Carolina bays -- only three of twenty soil families found in sampled bay depressions were not represented at that landscape position.

Viewing Tables 4.3 and 4.4 in conjunction, it is clear that the distribution of Carolina bay soils and vegetation types are significantly correlated. For example, Pocosins within sampled Carolina bays occur only over Typic Medisaprist, Terric Medisaprist, and Typic Haplaquod soils, and are restricted to Major River Valley and Floodplain and Lower Coastal Plain landscape positions. Table 4.4 indicates that these soils groups are almost entirely restricted to sites located in the Lower Coastal Plain and Major River Valley and Floodplain landscape positions. That is not surprising, given that Pocosin communities occur only over sandy, spodic and organic soils, and are thus limited to landscape positions conducive to the development of such soils. The floodplains of major coastal plain rivers are often the sites of large deposits of sandy sediments, while near-coast landscapes often contain relict dune fields and other sources of surface sands. Both landscape positions are comparatively flat, undissected, and poorly drained, with near surface water tables, also making them typical sites for peat development.

As noted early on, depression sites were selected in part to ensure reasonable representation of Carolina bay vegetation types across the landscape, and throughout the study area, as a whole. Consequently, the data results allow rational predictions of the distributions and abundances of individual Carolina bay vegetation types. However, with one exception, the data do not show an absolute correlation between a given landscape position and any single vegetation type. The single exception is the Brackish Marsh vegetation class, which by its nature is limited to near-shore landscape positions that abut estuarine waters.

## 6.5 Vegetation Trends

Floristic similarities between species groups is the basis of the Carolina bay vegetation classification that is one of the primary foci of this study. Consequently, the vegetation of each plant community type sampled and of the larger vegetation group to which it belongs has previously been described in detail. This section briefly discusses general trends in the vegetation data.

### 6.5.1 Plant Life Forms/Growth Forms

Carolina bay wetlands systems as a whole are dominated by perennial herbs (Figures 6.7 and 6.8). Figure 6.7 summarizes the life form information for each Carolina bay vegetation class or subclass contained in Chapter 4. The figure indicates that as a proportion of the taxa present in a given vegetation group, plants having buds at the ground surface (cryptophytes), below the ground surface (geophytes), or both (geophytic cryptophytes) dominate either wholly or in substantial part in every vegetation group but Evergreen Shrub-bog communities, which are dominated by deciduous and evergreen phanerophtye taxa.

Similarly, Figure 6.8 summarizes the previously discussed plant growth form information for vegetation groups. It indicates that as a percentage of total species present: (1) perennial graminoid taxa predominate in Brackish Marsh communities; (2) perennial forbs predominate in Freshwater Pond, Freshwater Marsh, Longleaf Pine Woodland, and Cypress/Gum Pond communities; (3) perennial graminoids and perennial forbs are co-dominants in Intermittently Flooded Depression Prairie, Boggy Marsh, Drawdown Savanna/Meadow, and Wet Savanna/Meadow communities; (4) perennial herbs share dominance with trees and shrubs in Cypress/Gum Bogs and Cypress/Gum Swamps; (5) herbs

Figure 6.7. Summary plant life form information for study area Carolina bay vegetation groups.

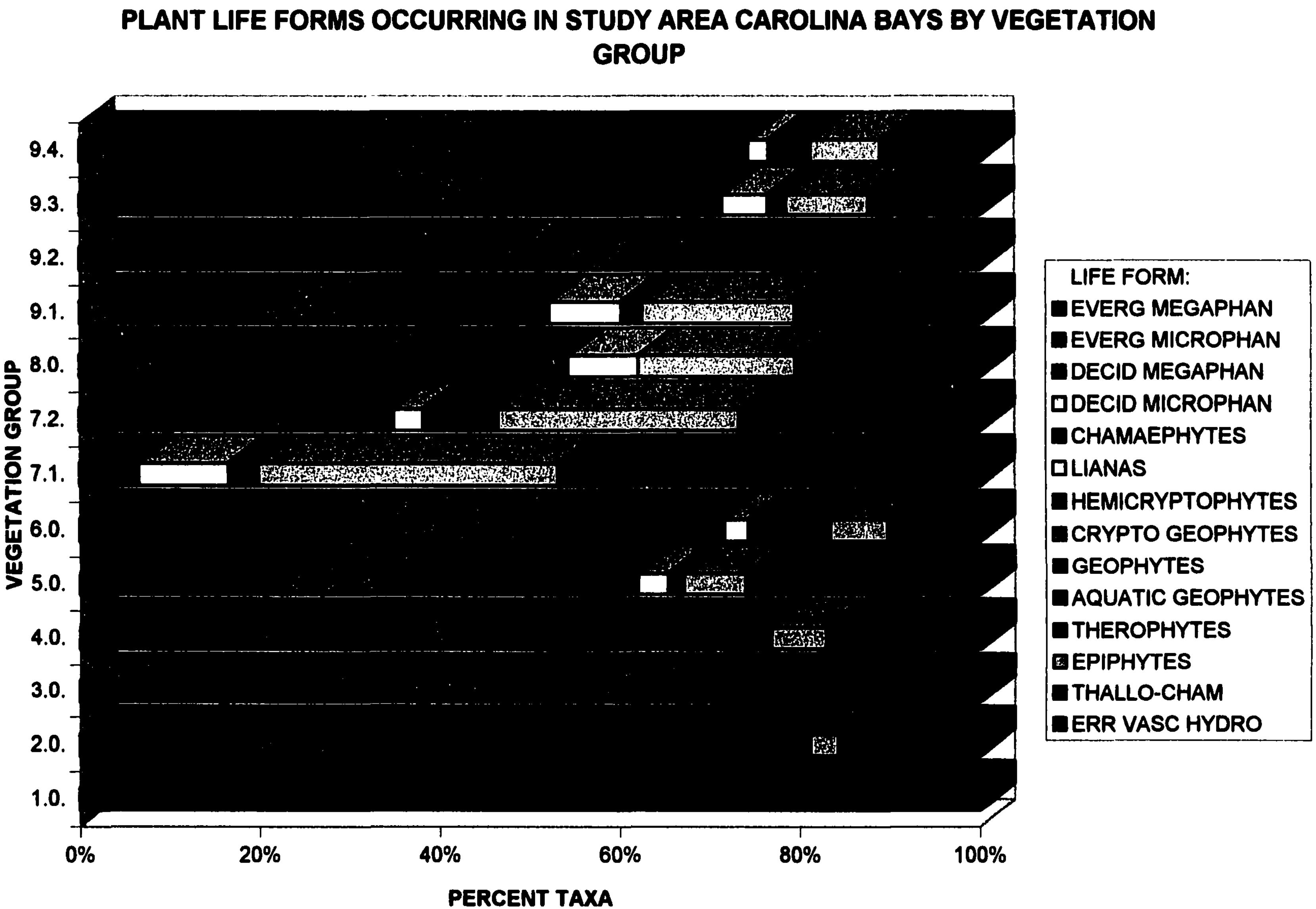
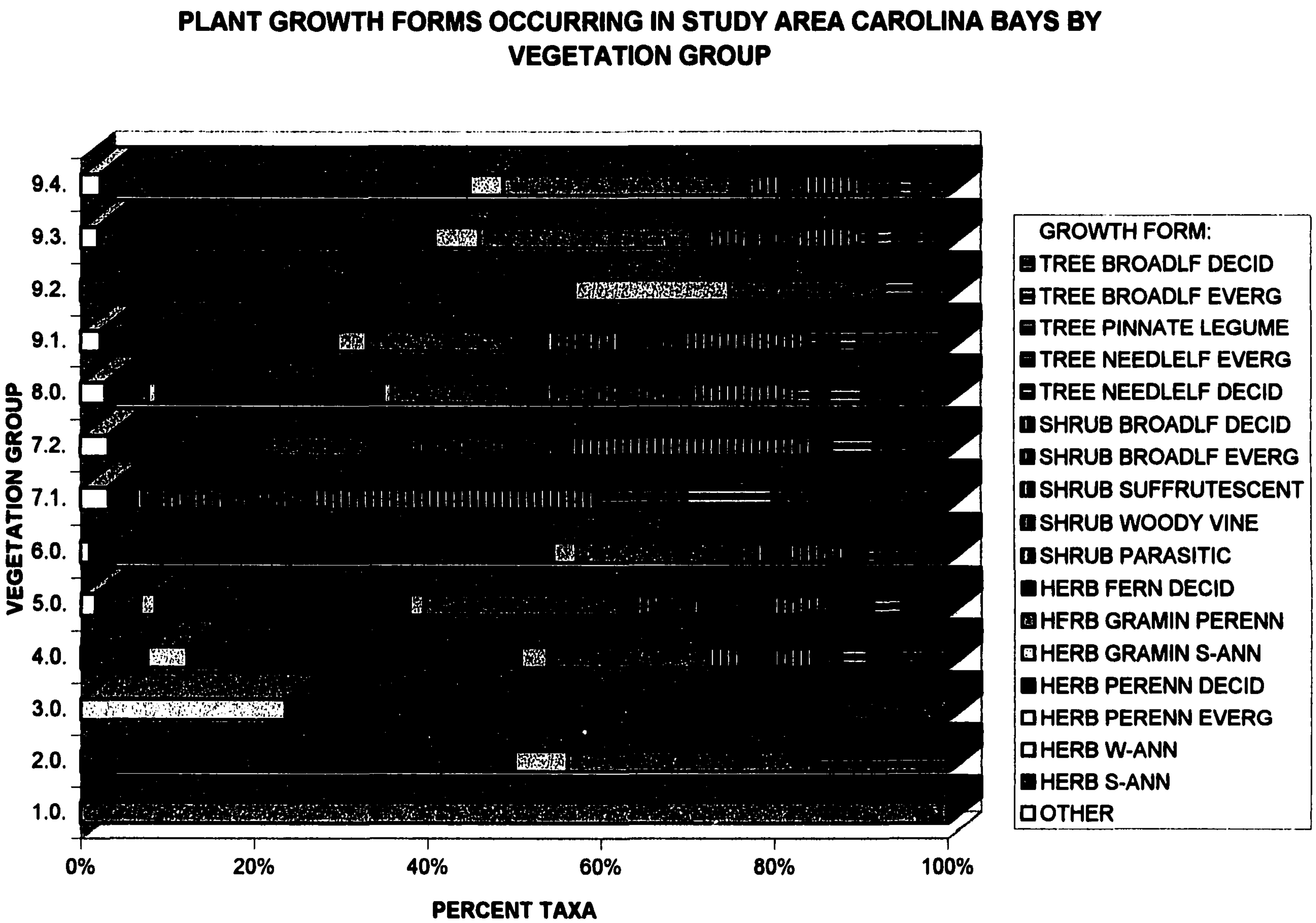

PLANT LIFE FORMS OCCURRING IN STUDY AREA CAROLINA BAYS BY VEGETATION GROUP
VEGETATION GROUP
9.4.
9.3.
9.2.
9.1.
8.0.
7.2.
7.1.
6.0.
5.0.
4.0.
3.0.
2.0.
1.0.
0%
20%
40%
60%
80%
100%
PERCENT TAXA
LIFE FORM:
EVERG MEGAPHAN
EVERG MICROPHAN
DECID MEGAPHAN
DECID MICROPHAN
CHAMAEPHYTES
LIANAS
HEMICRYPTOPHYTES
CRYPTO GEOPHYTES
GEOPHYTES
AQUATIC GEOPHYTES
THEROPHYTES
EPIPHYTES
THALLO-CHAM
ERR VASC HYDRO

Figure 6.8. Summary plant growth form information for study area Carolina bay vegetation groups.



PLANT GROWTH FORMS OCCURRING IN STUDY AREA CAROLINA BAYS BY VEGETATION GROUP
VEGETATION GROUP
9.4.
9.3.
9.2.
9.1.
8.0.
7.2.
7.1.
6.0.
5.0.
4.0.
3.0.
2.0.
1.0.
0%
20%
40%
60%
80%
100%
PERCENT TAXA
GROWTH FORM:
TREE BROADLF DECID
TREE BROADLF EVERG
TREE PINNATE LEGUME
TREE NEEDLELF EVERG
TREE NEEDLELF DECID
SHRUB BROADLF DECID
SHRUB BROADLF EVERG
SHRUB SUFFRUTESCENT
SHRUB WOODY VINE
SHRUB PARASITIC
HERB FERN DECID
HERB GRAMIN PERENN
HERB GRAMIN S-ANN
HERB PERENN DECID
HERB PERENN EVERG
HERB W-ANN
HERB S-ANN
OTHER

are essentially lacking in Evergreen Shrub-bog communities; (6) trees and shrubs predominate in Bay Forest communities; and (7) shrubs are the dominant taxa in Pocosin community types.

The distribution of plant life forms and growth forms within the various Carolina bay vegetation groups was examined in relation to various soil (pH, bulk density, organic layer depth, soil nutrients) and hydrologic (water depth at time of sampling, hydroperiod class, water level constancy). Those analyses emphasized the obvious, *e.g.*, that plots dominated by woody taxa tend to occur over acid, organic soils, but otherwise provided little illumination of the data.

The above generalizations as to plant life forms and growth forms represent the long-term expression by depression vegetation groups of the environmental forces that shape them. As noted in the preceding discussion on Carolina bay hydrology, short-term variance of environmental parameters, and particularly, site water level, also have significant effects on community type expression within vegetation groups.

Figure 6.9 shows dominant plant life form taxa as a function of fluctuating water depth over time at an Intermittently Flooded Depression Prairie site. From that figure it may be seen that in the initial wet year, when the site was flooded, hemicryptophyte, geophytic cryptophyte, and errant vascular hydrophyte taxa share site dominance. In a subsequent "moist" drawdown year, while the geophytic cryptophytes remain, the cespitose hemicryptophytes and errant vascular hydrophytes have disappeared and have been replaced by hemicryptophytes and therophytes. In a second, subsequent "deep" drought year, the therophyte taxa have assumed dominance with the geophytic cryptophytes. Finally, in a subsequent wet year, the hemicryptophyte taxa have returned to the site and the therophytes have again disappeared. During the sampling period, both the total number of species present and the presence of geophytic cryptophyte taxa has remained relatively constant.

Similarly, Figure 6.10 shows annual variation in plant life forms with fluctuating water depth in Intermittently Ponded Cypress/Gum Depression vegetation subclasses. In the Cypress/Gum Swamp, the percent taxa of various life forms and the number of species change very little between a "moist" dry year and a very dry year. In the Cypress/Gum Pond

Figure 6.9. Annual variation in plant life forms occurring with different site water depths over a period of years at an Intermittently Flooded Depression Prairie site.

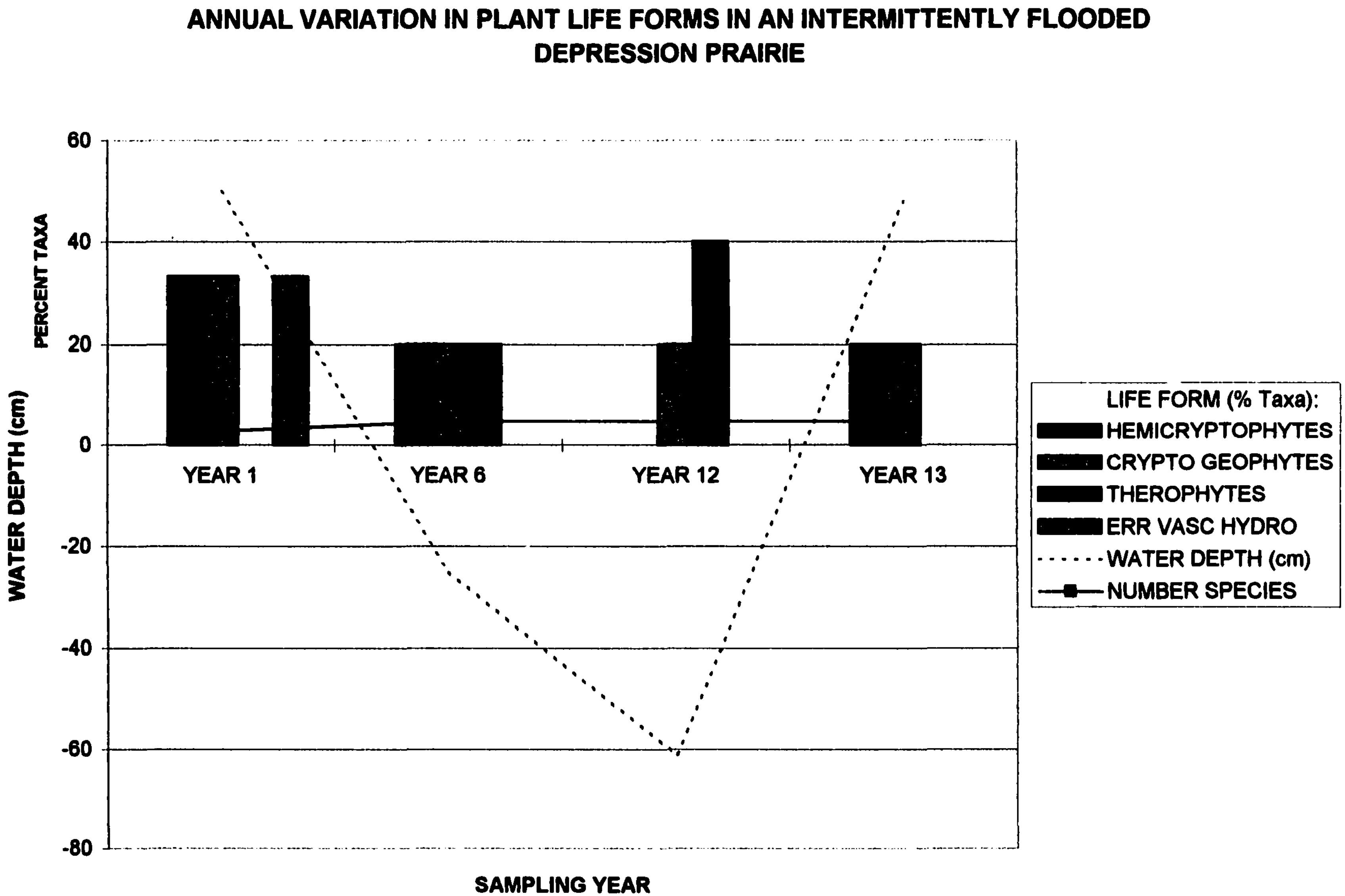
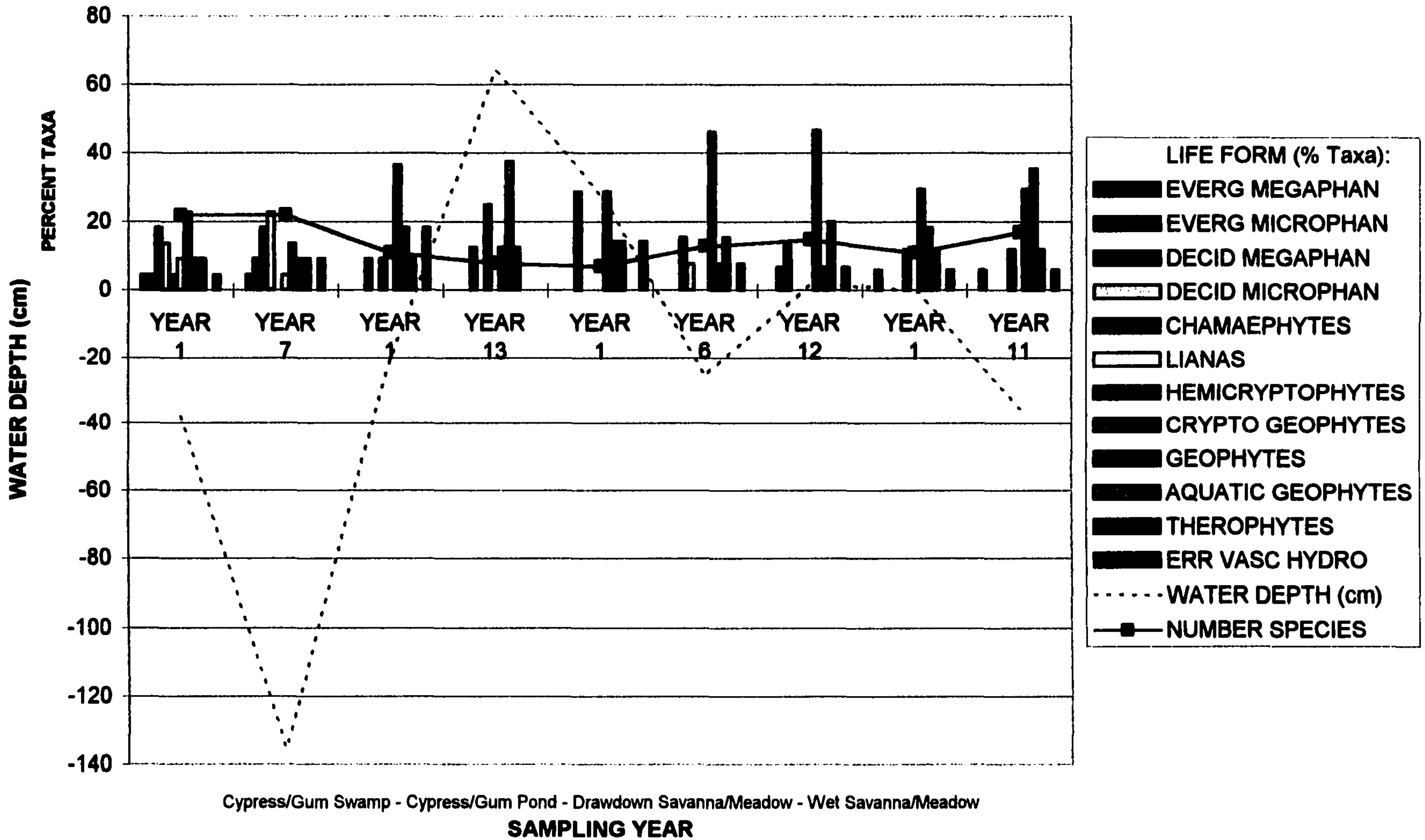

ANNUAL VARIATION IN PLANT LIFE FORMS IN AN INTERMITTENTLY FLOODED DEPRESSION PRAIRIE
60
40
20
0
-20
-40
-60
-80
PERCENT TAXA
WATER DEPTH (cm)
YEAR 1
YEAR 6
YEAR 12
YEAR 13
SAMPLING YEAR
LIFE FORM (% Taxa):
HEMICRYPTOPHYTES
CRYPTO GEOPHYTES
THEROPHYTES
ERR VASC HYDRO
WATER DEPTH (cm)
NUMBER SPECIES

Figure 6.10. Annual variation in plant life forms occurring with different site water depths over a period of years at sites exhibiting Intermittently Ponded Cypress/Gum Depression subclass vegetation units.

ANNUAL VARIATION IN PLANT LIFE FORMS IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION VEGETATION GROUPS



plot, a variety of life forms is represented in an initial "moist soil" drawdown year, but in a subsequent "ponded" year, the diversity of life forms (and species) decreases, and geophytic cryptophytes and chamaephytes increase proportionately in dominance. The Drawdown Savanna/Meadow plot represented in the figure is shallowly inundated in the initial year, and is dominated by numerous life forms, including errant vascular hydrophyte taxa. In subsequent drier years, both the number of life forms represented in the taxa and the number of species increase, errant vascular hydrophytes disappear, and herbaceous species with ground level and underground perennating structures dominate the taxa. Finally, in a Wet Savanna/Meadow plot with water at the surface in the initial year, a range of herbaceous cryptophyte and geophyte taxa predominate. In a subsequent drier year, while the number of life forms represented among the taxa remains about the same, the number of species present has risen slightly, and geophytic cryptophytes have proportionately tripled in number.

Figures 6.11 and 6.12 show similar variations in percent dominance of growth forms in the same plots for the same period. As a whole, both figures emphasize the concept of cyclic vegetation patterning, *i.e.*, the changing nature of these depression environments as reflected by temporal changes in site vegetation patterning as it occurs in Carolina bay communities.

5.4.2 Species Richness

Mean species richness at the 0.1 ha level in sampled Carolina bay community types ranged from 1 species in the *Juncus roemerianus* Marsh community type occurring in the Brackish Marsh vegetation class, to 46 species in the *Quercus marilandica/(Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa)/Schizachyrium-Tephrosia-Aster walteri* Savanna community type found in the Longleaf Pine Woodland vegetation class (Table 4.2). Maximum species richness at the 0.01 ha level was 44 species, and within individual 1 $m^2$ sampling quadrats, 25 species was the highest number of taxa encountered within a study area Carolina bay plot.

Within the recorded species richness range there is substantial variance between vegetation groups. Figure 6.13 shows relative mean species richness for each Carolina bay vegetation group. It indicates that, on average, species richness is highest in Longleaf Pine

Figure 6.11. Annual variation in plant growth forms occurring with different site water depths over a period of years at an Intermittently Flooded Depression Prairie site.

ANNUAL VARIATION IN PLANT GROWTH FORMS IN AN INTERMITTENTLY FLOODED DEPRESSION PRAIRIE

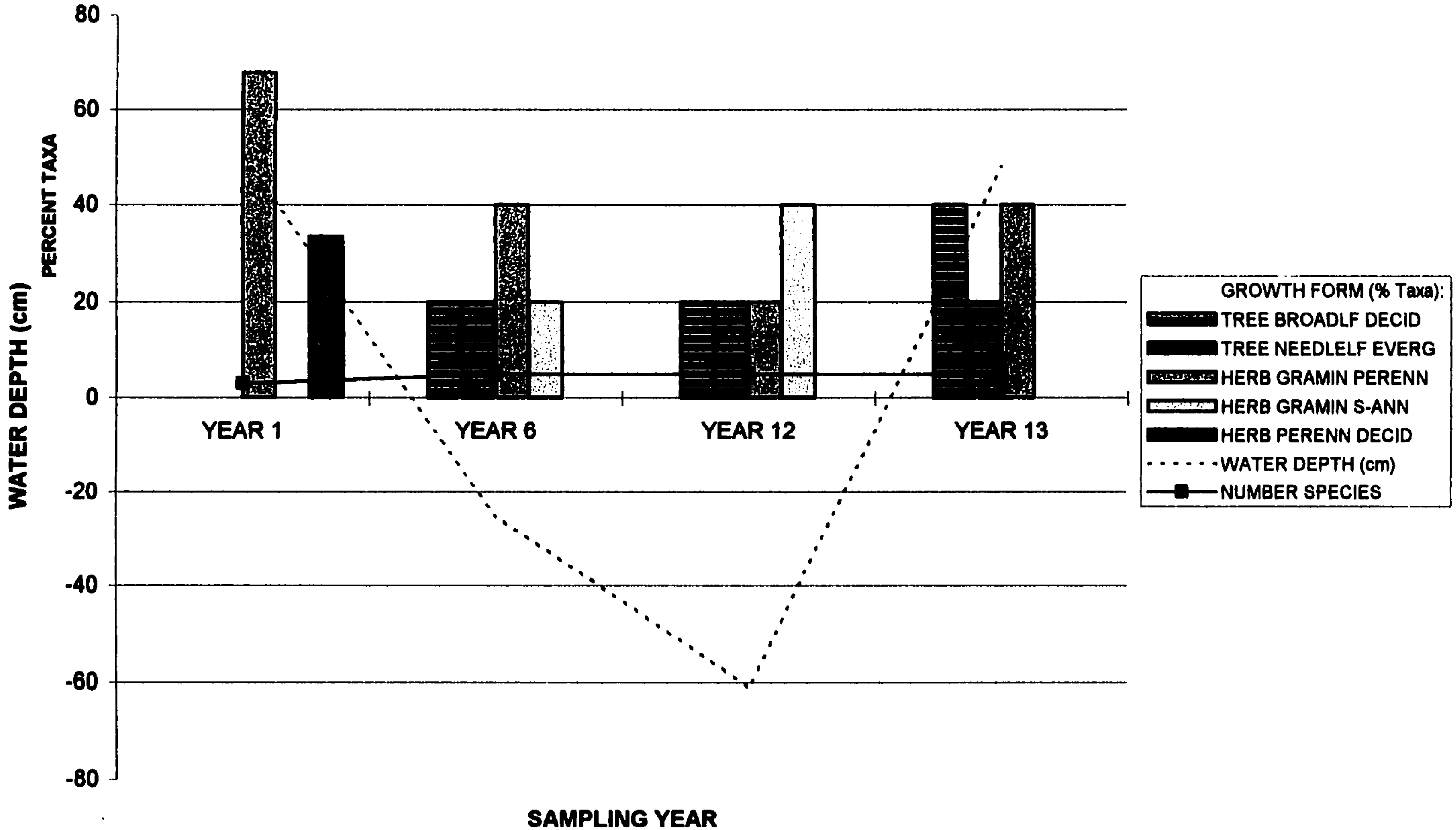


Figure 6.12. Annual variation in plant growth forms occurring with different site water depths over a period of years at sites exhibiting Intermittently Ponded Cypress/Gum Depression subclass vegetation units.

## ANNUAL VARIATION IN PLANT GROWTH FORMS IN INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION VEGETATION GROUPS

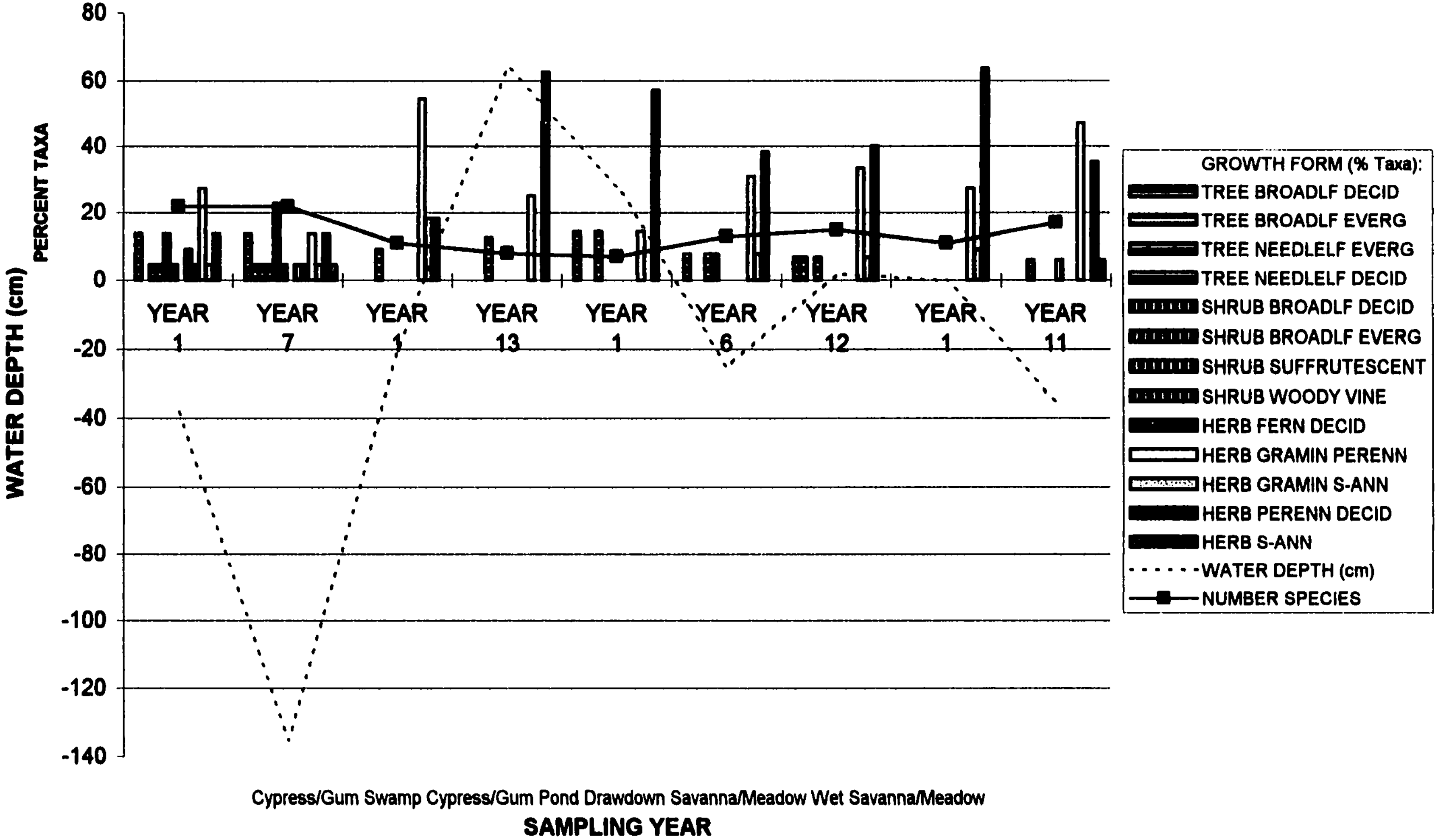
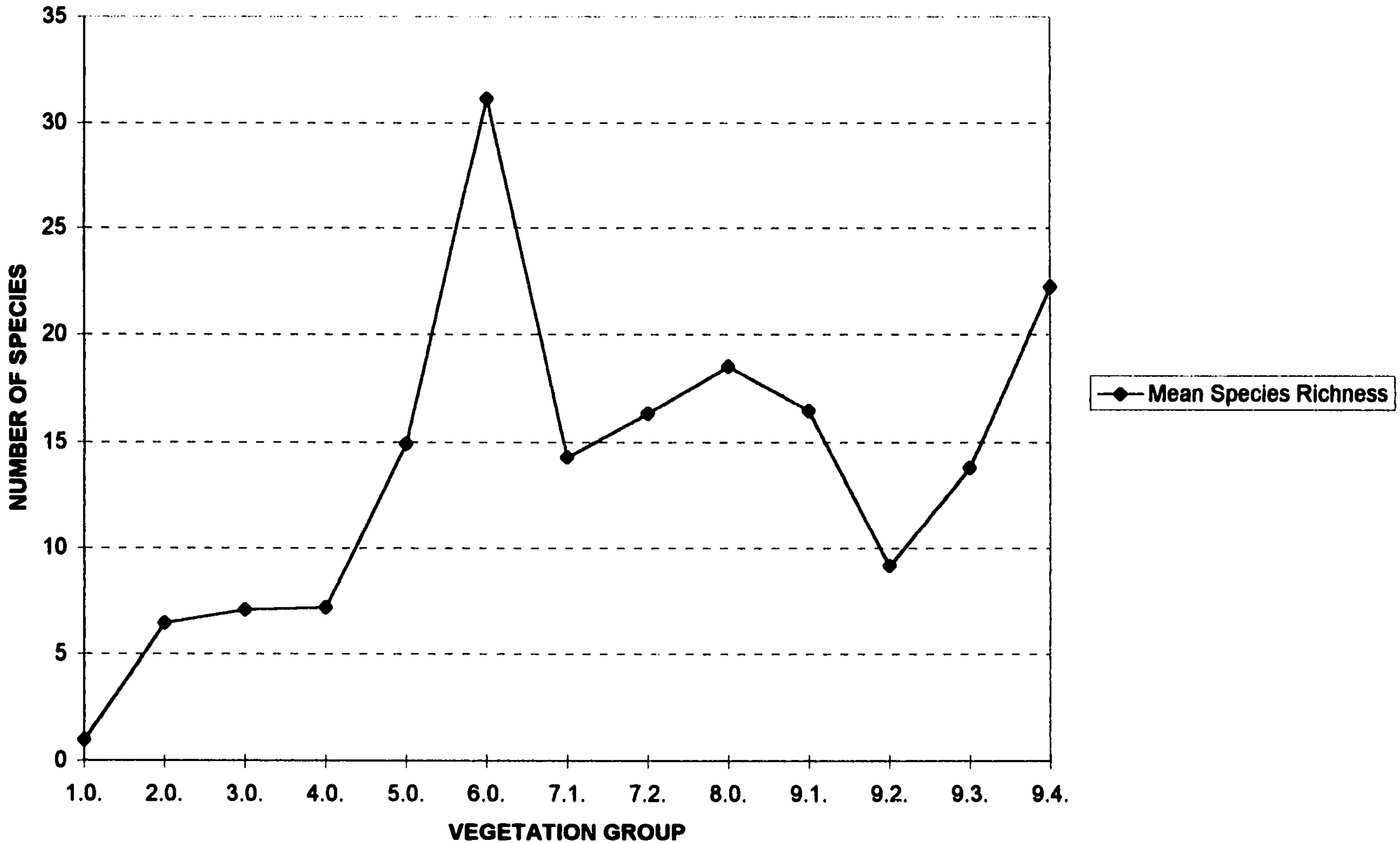


Figure 6.13. Mean species richness occurring in study area Carolina bay vegetation groups.

**MEAN SPECIES RICHNESS OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP**



Woodland and Wet Savanna/Meadow communities, and lowest in Brackish Marsh, Intermittently Flooded Depression Prairie, Freshwater Pond, Freshwater Marsh, and Cypress/ Gum Pond communities. Other vegetation classes and subclasses fall somewhere in between those extremes. Figure 6.2 displays reported mean site hydroperiod class by major vegetation group. Comparison of that figure with Figure 6.13 indicates that the highest mean species richness occurs at the "driest" sites, while lowest mean species richness is found at the wettest sites, with the exception of Evergreen Shrub-bog and Cypress-Gum Bog communities, which though relatively wet, display moderate species richness. Both of those vegetation classes occur over predominantly organic soils. Their comparatively higher species richness may be explained, at least at some sites, by increased nutrients made available by the organic fraction of a soil, where nutrients are not otherwise limiting (Brady, 1974) (*see* Tables A-II-2 to A-II-4).

Eyles (1941), Tyndall *et al.* (1990), Kirkman (1992), and Poiani and Dixon (1995) all reported that specific wet, typically flooded Carolina bay communities (Freshwater Ponds and Freshwater Marshes in this study) were comparatively species poor. It is likely that low species richness in certain vegetation groups is a result of the relatively inhospitable conditions to plant growth that exist at the wettest sites -- high water, low pH, and an anaerobic rhizosphere -- with which comparatively few species can cope. Competition probably also plays a significant role in limiting species diversity. As previously discussed, species capable of aggressive vegetative growth under favorable conditions, *e.g.*, *Panicum hemitomon* or *Eleocharis robbinsii*, are typical dominants at flooded Carolina bay sites. When hydrologic conditions suit the species' needs, it begins a rapid advance, and few less-prolific species survive the competitive onslaught to "fight another day", often yielding near monotypic stands (*see*, *e.g.*, Kirkman, 1992).

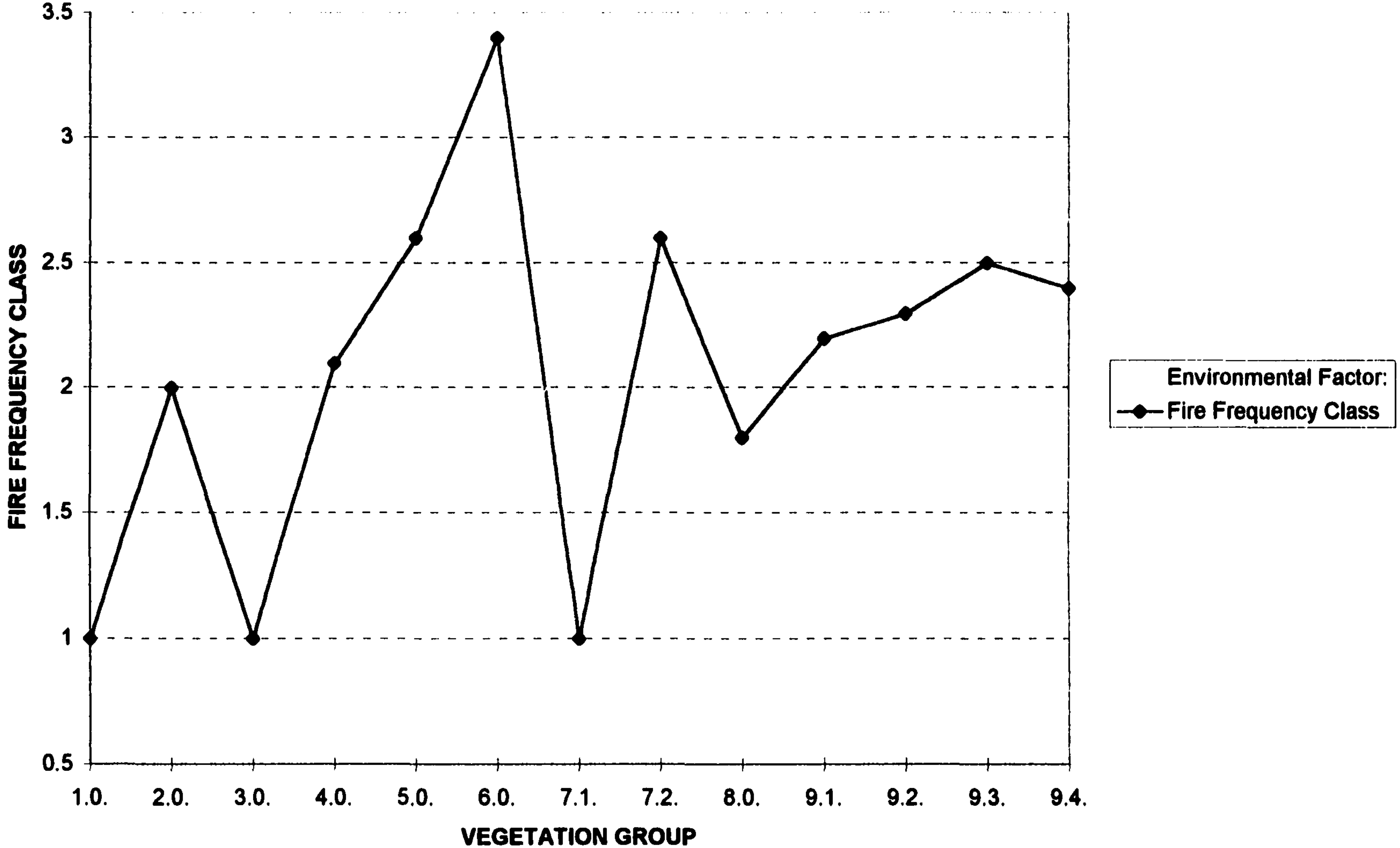
On the other hand, the highest mean species richness values reported for Longleaf Pine Woodland communities are on par with species richness values reported for other mesic pine savanna communities (Taggart, 1990). The reasons for the highest species richness in the Carolina bay vegetation groups with the "driest" hydrologic regime are likely several. First and foremost, these sites are typically not flooded for long periods of time during the growing season. As a result, the rhizosphere is not anoxic for extended periods, allowing a much wider variety of plants to become established at the site, as when typical upland, "old field" invaders, such as *Andropogon virginicus*, move into bay depressions during drought periods. Second, while these richer communities occur at comparatively drier sites, they are still wetland sites, as evidenced by their mottled and gley-colored soils, indicating that abundant soil moisture is available to plants at virtually all times. Finally, fire is likely a significant factor in increasing species diversity at these drier sites, given that they are in an unflooded, "combustible" condition for significantly longer periods of time than wetter vegetation types.

As previously noted, Walker and Peet (1983) found that species richness is always higher in burned, as compared to unburned, longleaf pine savanna communities. Other investigators have also found that fires also increase diversity in organic soil wetlands systems (Wells, 1946; Woodwell, 1956). Based on their survey of South Carolina bays, Bennett and Nelson (1991) attributed the comparatively high species richness found in "Cypress Savanna" communities (Wet Savanna/Meadows in this study) to moisture and fire regimes that "approximate those of pine savannas." Figure 6.14 shows mean fire frequency, by designated frequency class, for the major Carolina bay vegetation groups. A comparison of that figure with Figure 6.13, which plots species richness by vegetation group, indicates that the two graphs are very similar, indicating the probable importance of fire as a factor in maintaining species diversity in Carolina bays.

Some investigators have also attributed species richness in Carolina bays to additional causes other than fire. Kirkman and Sharitz (1994) found floristic richness in Freshwater Marsh sites to be closely linked with site disturbance (fire and physical soil disturbance in their study) regime and seed bank composition. Poiani and Dixon (1995) reported that the use of landscapes adjacent to Carolina bay depressions is potentially significant to species richness. Bay depressions located adjacent to clear-cuts were found to have a significantly greater number of weedy species in their seedbank flora than those located in comparatively undisturbed landscapes.

Figure 6.14. Mean fire frequency reported in study area Carolina bays by vegetation classes and subclasses. Fire frequency increases with increasing height on the ordinate scale according to the following mean fire frequency classes: (1) infrequent [$\geq$ 25 yrs.]; (2) occasional [$\geq$10 <25 yrs.]; (3) frequent [$\geq$5 <10 yrs.]; and (4) very frequent [<5 yrs.].

# MEAN FIRE FREQUENCY OCCURRING IN SAMPLED CAROLINA BAYS BY VEGETATION GROUP



# CHAPTER VII.

# THE FUTURE OF STUDY AREA CAROLINA BAYS

## 7.1 Significance of Carolina bay Wetland Communities

Carolina bay wetlands are extremely significant to the natural heritage of the southeastern United States, and particularly North and South Carolina, for a number of reasons. First, those depressions are the location of a large number of special status plant taxa are found in Carolina bays. Photographs of a few of those notable species appear in Plates 15 and 16, immediately following this chapter. Table 7.1 lists the "special status" species documented in this study, and the primary vegetation group in which each was observed. That list is not "all-inclusive" for the study area, since many rare species appear in a depression site flora only infrequently, during periods of favorable site hydrologic conditions. Carolina bay depressions are the primary coastal plain habitat for a large number of the species listed in Table 7.1. In addition, Carolina bay depressions serve as significant genetic reservoirs by harboring enormous existing or latent (seedbank) populations of both rare (*e.g.*, *Rhexia aristosa, Sagittaria isoetiformis, Iva microcephala, Lindera melissifolia, Ilex amelanchier)* and comparatively common (*e.g.*, *Polygala cymosa, Pluchea rosea*) wetland species.

Carolina bay depressions also serve as breeding habitat for a number special status animal species, and as general feeding habitat for a wide variety of wildlife (Clark *et al.*, 1985). Historically, study area Carolina bays provided important coastal plain heronries (*e.g.*, Lennons' Marsh in Robeson County, North Carolina). Middle Coastal Plain Carolina bay depressions that are either spring-fed or seasonally contain standing water remain important feeding habitats for juveniles of a number of special status North Carolina birds, such as the White Ibis (*Eudocimus albus*), during their summer, post-breeding dispersal period (Parnell, 1980; Nifong, personal observation). Anhingas (*Anhinga anhinga*) have also been observed nesting within a study area Carolina bay depression. Many of the same bay depressions, as semi-permanent or ephemeral ponds, also serve as the primary breeding habitat for a wide variety of amphibians (Sharitz and Gibbons, 1982).

Moreover, Carolina bay depressions are spectacular, unique geomorphic landscape features. While they are similar in some respects to the "clamshell" ponds of the Alaskan coastal plain (Kelly, 1951; Price, 1951, 1963; Livingston, 1954; Carson and Hussey, 1962), the southern Chilean potholes (Kaczorowski, 1977), South African salt pans (Shand, 1946), and west Texas playa lakes (Kaczorowski, 1977), they are clearly unparalleled by any depressional system worldwide in terms of number, size, and uniformity.

## 7.2 The Number of Carolina bay Depressions

Melton and Schriever, in their provocative and controversial 1933 paper proposing the meteorite formation theory for Carolina bays, estimated that there were approximately 1,500 Carolina bay depressions on the Atlantic Coastal Plain, largely confined to the Carolinas. Some twenty years later, Prouty (1952), a geologist at the University of North Carolina in Chapel Hill during the 1940s and 1950s, and a vocal and widely published advocate of the meteorite theory of bay formation, set the number of depressions as being much higher. Using a North Carolina subsample, Prouty estimated that there were 140,000 bay depressions with long axes greater than 500 feet in length, and 500,000 Carolina bay depressions overall, located on the Atlantic Coastal Plain from New Jersey to northeastern Florida. Prouty further estimated that 80% of those bays were found in the Carolina coastal plain, *i.e.*, within the study area for this investigation. Since that time, Prouty's estimate of bay numbers has been widely cited, with little questioning of the accuracy of his figures. Indeed, as late as 1982, one author continued to insist that bays number "at least 500,000" (Savage, 1982).

However, Bennett and Nelson, in their 1991 survey of South Carolina Carolina bay depressions, challenge Prouty's numbers. From aerial photographs of the entire coastal plain of that State, they identified 2,651 Carolina bays $\geq$ 0.8 ha (2 acres) in size. Based on the density of bays < 0.8 ha in size in a representative sample of known area, they estimated the total number of "small" bays in South Carolina and arrived at a final estimate of between

4,000 and 5,000 bays of all sizes located on the coastal plain of the State. Of the 2,651 bays identified, 613 were judged "relatively intact" and scheduled for site visits. Field reconnaissance showed that 64% of the bays judged intact from aerial photographs were actually "regrowth" communities with fundamentally altered site hydrologies (*i.e.*, the sites had lost most or all of their original wetland functions). From those numbers, Bennett and Nelson estimated the total number of functioning, relatively intact Carolina bays in South Carolina at 400 to 500. Additionally, they estimated from field reconnaissance that intact bays were being functionally altered at the approximate rate of 6% per year.

Nifong, using 1988 aerial photographs for the North Carolina coastal plain, counted 8,057 Carolina bay depressions in 43 coastal counties, ranging in number from 0 bays in several coastal plain counties to 1,437 bay depressions in Robeson County, North Carolina (Table 7.1). Of those identifiable bay depressions, 6,331 (79%) were found to be cleared of >50% of their vegetation, while 1,726 (21%) were found to retain vegetative cover. Applying Bennett and Nelson's numbers -- (1) 64% of depressions identified as intact from aerial photographs are actually fundamentally altered; and (2) remaining intact bays are disappearing at an approximate rate of 6% per year -- to those totals yields estimates that: (1) some 620 Carolina bays, or 8% of the total number of remaining, identifiable depressions, are likely functionally intact; and (2) remaining intact North Carolina bays are potentially being converted to non-wetland uses at a rate of some three dozen per year. Extensive field reconnaissance in the North Carolina coastal plain over a period of two decades supports those estimates as being reasonable.

Combining the numbers of Bennett and Nelson (1991) and Nifong indicates that there are fewer than 13,000 identifiable Carolina bay depressions in the study area, in contrast to the 400,000 bays estimated by Prouty to occur within the two states (Figure 7.1). Reference to historic aerial photographs of the Carolina coastal plain (*e.g.*, those appearing in Johnson, 1942) indicates that identifiable, small bay depressions were once much more numerous within the study area than they are at present. Nevertheless, it appears that Prouty's 1952 estimate of bay numbers is simply not supported by the evidence. Bennett and Nelson (1991) opine that Prouty's overestimate of bay number has devalued Carolina bays as a preservation priority by giving conservationists a longstanding "false sense of abundance" concerning depression numbers. Whatever the reason for this historic lack of preservation/protection priority for Carolina bays, it is clear that their numbers have dwindled to the point that attempts to preserve them as either functional ecosystems or biodiversity reserves must occur quickly, before the opportunity is entirely lost.

### 7.3 The Role of Disturbance in Carolina bay Preservation

From a conservation standpoint, the "bad news" is that Carolina bay depressions are not nearly so common as once believed, and that those that remain tend to have been greatly affected by human disturbance activities. The "good news", on the other hand, is that Carolina bay vegetational communities are exceptionally dynamic, having evolved in response to ongoing, and often severe, disturbance. As such, Carolina bay vegetational communities that have been highly disturbed by human activities appear to have significant potential "regenerative" capabilities.

The vegetation descriptions and community gradient analyses contained in Chapters 4 and 5 above indicate the historic importance of disturbance, particularly fire, in shaping the vegetation of Carolina bay depressions. Evidences of past fires can be found in virtually every Carolina bay community, even those that appear to be permanently ponded, indicating the cyclic nature of long-term hydrologic regimes within these depressions, which makes them susceptible to burning during periodic droughts. The intensity of those fires ranges from relatively minor "ground fires" that simply remove herbaceous and low-growing shrub vegetation, to catastrophic fires that remove all above-ground vegetation. In the case of sites growing on organic soils, both above and below ground vegetation may be removed (*see*, Kologiski, 1977; Christensen, 1979, 1988). The ultimate effects of fire on site vegetation depend on the season of occurrence, the existing site hydrologic regime, the length of time since a previous fire, and similar factors. As previously noted, fire frequency is directly related to species richness in southeastern pine savannas, pocosins, and similar fire-dominated communities (Wells, 1942; Garren, 1943; Woodwell, 1956; Walker and Peet, 1983; Christensen, 1988), and has significant effects upon herbaceous dominants in freshwater marsh sites (Kirkman, 1992).

Fire is not, however, the only "natural" disturbance significant in shaping Carolina bay vegetation. The intermittent wetting and drying of sites with fluctuations in site ambient water levels also greatly affects site vegetation by subjecting plants to hugely different oxidative regimes in the soil rhizosphere. That mechanism is likely key to the ability of some herbaceous species to dominate vegetation communities, as discussed in Chapter 6, and has been proposed as critical to the episodic replenishment of seedbank propagules for a number of rare or uncommon species (Gerritsen and Greening, 1989; Tyndall *et al.*, 1990).

When small "family farms" dominated the landscape in the early and middle portions of this century, savanna and meadow-like bay depressions were commonly used for livestock grazing or watering holes. In addition, according to the accounts of local residents, depression pocosin communities were sometimes purposefully burned to yield grasslands that could be used to support cattle and swine.

In addition, mechanical soil disturbance has been shown to have dramatic effects on site vegetation within Carolina bay depressions (Kirkman, 1992). Anecdotal evidence supplied by local residents has indicated that many hydrologically intact bays, including one Freshwater Pond site in this study, have been cultivated, planted, and harvested in extended drought periods in the past, but that the original, or similar, vegetation returned relatively quickly when the drought subsided and "normal" water levels returned. Similarly, drained, timbered, and cultivated Carolina bay depressions in southwestern South Carolina have largely returned to their natural states some fifty years after the cessation of human disturbance activities (Sharitz and Gibbons, 1982; Schalles *et al.*, 1989). During field reconnaissance, one Robeson County, North Carolina site discovered was characterized by large populations of *Rhexia aristosa, Stylisma aquatica,* and *Sclerolepis uniflora*, growing in plow furrows following abandonment of recent cultivation. Field observation of sites has also indicated that mechanical removal of above ground vegetation in both herb-dominated and shrub-dominated bay communities (by mowing or "bush-hogging", a relatively common activity undertaken by deer hunting clubs) results in greatly increased species richness in the years immediately following that disturbance.

Despite this history of disturbance, as Carolina bay depressions have become increasingly insular -- islands of vegetation in a sea of man-altered landscapes -- the overall frequency of disturbance has greatly diminished. In addition, depression sites not having subsurface, relatively impermeable soil layers, but which are dependent on groundwater exchange from regionally high water tables, have undergone fundamental change as agricultural and industrial consumption of staggering quantities of groundwater have proliferated in the Carolina coastal plain. The net effect has been that Carolina bay vegetation has, as a whole, undergone an apparent "homogenization" over recent decades, with concomitant decreases in species richness and community diversity. While recent studies indicate that the seeds of many characteristic Carolina bay wetland species appear to remain viable in site seedbanks for a significant length of time (Kirkman and Sharitz, 1994; Poiani and Dixon, 1995), it is not clear how long a site may be shielded from disturbance and still retain a reasonable probability that species can regenerate themselves if more favorable growing conditions return.

## 7.4 Carolina bay Preservation and Management Recommendations

In their 1982 summary of Carolina bay vegetation in the southeastern United States, Sharitz and Gibbons made four general recommendations for the conservation, protection, and management of Carolina bays: (1) expansion of wide-ranging ecological research about Carolina bays, particularly concerning their use by wildlife and their natural history; (2) development of a focused critical habitat protection program including public acquisition and tax incentives for private preservation; (3) development of comprehensive regional planing strategies to minimize unintended deleterious effects on these systems; and (4) development of education programs to increase public awareness of the value of these unique systems.

Those general recommendations retain continued viability, although it is clear that with the continued conversion of coastal plain wetlands, including Carolina bays, to large-scale agricultural and silvicultural uses with minimal governmental intervention, time is increasingly of the essence. In addition, those recommendations merit revision to reflect advances in our knowledge of these systems over the past 15 years. First, because Carolina bays are much rarer and even more significant from a natural heritage standpoint than was apparent in 1982, it is clear that the first priority must be the development and implementation of an aggressive, comprehensive, (*i.e.*, involving a wide variety of public and private resource agencies) acquisition/protection program for Carolina bay depressions. The program must involve a coordinated effort in many arenas, including (1) governmental use of its regulatory powers to protect privately owned Carolina bay wetlands, (2) governmental use of its policy-making authorities to protect those Carolina bays already existing in public ownership, (3) the acquisition and expenditure of public and private funds to acquire critical bay habitats, and (4) better management of existing, "protected" Carolina bay depressions.

In light of the difficulties encountered in this study in reasonably defining Carolina bay vegetation "community types" given the remarkably dynamic nature of bay depression vegetation, it is unreasonable to believe that every bay community type can be, or should be, preserved. Instead, Carolina bay prioritization and acquisition must focus on preserving representative examples of the major vegetation classes and subclasses occurring in bays, and within those groups, community uniqueness, rare species occurrences, large species populations, wildlife value, and similar factors. It is also increasingly evident that Carolina bay depressions merit protection for their intrinsic value as a unique geomorphic landform, regardless of their estimated biological worth.

The first "revised" recommendation for Carolina bay protection leads logically to the second: Carolina bay research efforts should target two critical areas, wetland site restoration and site disturbance management. Wetland site restoration anticipates a general understanding of site hydrology, of which the body of knowledge is growing, but still fairly rudimentary. Nevertheless, because Carolina bays are largely "self-contained" (*i.e.*, no evident inflowing or outflowing water sources), precipitation-dominated systems (Schalles *et al.*, 1989), the probability of success at protecting the water regimes of intact systems and restoring site hydrologies in altered systems is greatly enhanced. That may be even more likely at depression sites that have a truly "perched" water table.

As discussed above, Carolina bay depressions have historically been subject to continuing, intermittent disturbance from a variety of sources. From the standpoint of species and community diversity, site vegetation appears to have thrived on that disturbance. Consequently, the natural heritage value of a site may be greatly diminished or potentially lost through a failure to implement ongoing disturbance regimens for those depressions. Unlike many other natural communities, in the case of Carolina bay wetlands, "gated" sites are not necessarily protected sites. For those reasons, it is critical that future research give priority to studies on the use of fire and mechanical removal of aerial portions of woody species as potential site management tools for protected Carolina bays.

It is also essential that the fragmentation of thinking about appropriate management that exists between different governmental agencies and between public and private resource agencies must be resolved, so that Carolina bay depressions can be managed as a part of the larger system they comprise instead of as individual, isolated units. This could be achieved in large part by the creation, though memoranda of understanding or similar agreements, of a cooperative, networked entity (*e.g.*, a "Carolina Bay Wetlands Resource Research Center") designed to function as a clearinghouse for information on bays throughout the southeast, to focus on gathering and disseminating critical management information to resource agencies or private citizens owning Carolina bays, and to direct future research projects pertaining to Carolina bay wetlands.

Given their relative "self-containment" in terms of site hydrology and the highly dynamic nature of site vegetation in response to disturbance, there is little current reason to believe that "regrowth" Carolina bay communities at sites that are relatively intact hydrologically or that can be returned to the status of functioning wetlands cannot be restored vegetationally to some reasonable semblance of their former states with long-term disturbance management. Should that prove to be the case, it will allow resource agencies desiring to preserve Carolina bay diversity much wider latitude in prioritizing and acquiring representative depression sites.

While much remains to be accomplished in terms of site acquisition to protect the biodiversity existing in study area Carolina bays, that does not diminish the significance of the variety of sites that are already protected in public and private resource agency ownership. However, many of those protected resources are severely underutilized. If public education concerning the considerable virtues of Carolina bay wetlands is to succeed at increasing public demand for protection of these unique depressions, opportunities for direct public exposure to and interaction with a wide variety of Carolina bay systems must be significantly expanded. Recommendations aimed at achieving that goal include the following:

(1) Interstate coordination of currently fragmented public offerings at protected Carolina bays sites. Achievement of this recommendation will require an ongoing effort to expand and coordinate programs and activities at publicly and privately owned Carolina bay sites *throughout* the southeast;

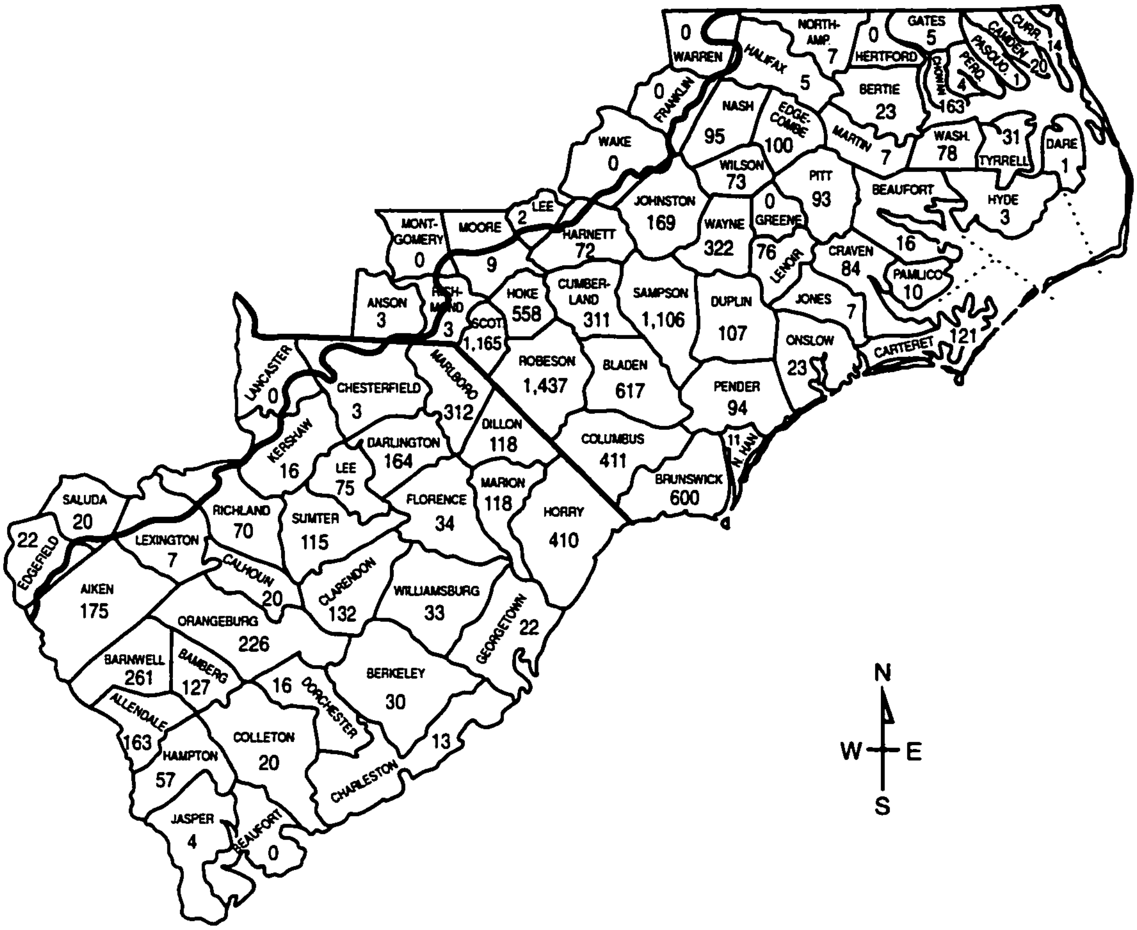
(2) Development and implementation of a wetlands curriculum, including a Carolina bay component, with state and local education agencies; and

(3) Development and implementation of programs designed to increase public awareness of and familiarity with Carolina bay depressions. A bay-centered volunteer involvement program could be modeled after the highly successful "Stream Watch" ("Baywatch") or "Adopt-a-highway" ("Adopt-a bay") programs currently administered by North Carolina government agencies in other areas.

Table 7.1. Summary of the status of North Carolina Carolina bay depressions, by county, based on 1988 SCS aerial photographs. "Cleared" bays are those with greater than 50% of their vegetation removed.

| COUNTY | TOTAL NUMBER OF BAYS | NUMBER OF VEGETATED BAYS | NUMBER OF CLEARED BAYS |
|---|---|---|---|
| Anson | 3 | 3 | 0 |
| Beaufort | 16 | 6 | 10 |
| Bertie | 23 | 15 | 8 |
| Bladen | 617 | 325 | 292 |
| Brunswick | 600 | 422 | 178 |
| Camden | 20 | 0 | 20 |
| Carteret | 121 | 118 | 3 |
| Chowan | 163 | 7 | 156 |
| Columbus | 411 | 118 | 293 |
| Craven | 84 | 40 | 44 |
| Cumberland | 311 | 79 | 232 |
| Currituck | 14 | 2 | 12 |
| Dare | 1 | 1 | 0 |
| Duplin | 107 | 11 | 96 |
| Edgecombe | 100 | 6 | 94 |
| Gates | 5 | 1 | 4 |
| Greene | 0 | 0 | 0 |
| Halifax | 5 | 1 | 4 |
| Harnett | 72 | 4 | 68 |
| Hertford | 0 | 0 | 0 |
| Hoke | 558 | 43 | 515 |
| Hyde | 3 | 0 | 3 |
| Johnston | 169 | 29 | 140 |
| Jones | 7 | 5 | 2 |
| Lee | 2 | 2 | 0 |
| Lenoir | 76 | 11 | 65 |
| Martin | 7 | 2 | 5 |
| Montgomery | 0 | 0 | 0 |
| Moore | 9 | 4 | 5 |
| Nash | 95 | 17 | 78 |
| New Hanover | 11 | 7 | 4 |
| Northampton | 7 | 4 | 3 |
| Onslow | 23 | 17 | 6 |
| Pamlico | 10 | 7 | 3 |
| Pasquotank | 1 | 0 | 1 |
| Pender | 94 | 76 | 18 |
| Perquimmans | 4 | 2 | 2 |
| Pitt | 93 | 5 | 88 |
| Richmond | 3 | 2 | 1 |
| Robeson | 1,437 | 133 | 1,304 |
| Sampson | 1,106 | 96 | 1,010 |
| Scotland | 1,165 | 78 | 1,087 |
| Tyrrell | 31 | 1 | 30 |
| Washington | 78 | 5 | 73 |
| Wayne | 322 | 14 | 308 |
| Wilson | 73 | 7 | 66 |
| **TOTALS:** | 8,057 | 1,726 | 6,331 |

Figure 7.1. Number of identifiable Carolina bay depressions currently existing within the study area, by county [Source: (1) North Carolina -- Review of 1988 North Carolina county aerial photographs, U.S. Dept. of Agriculture, Soil Conservation Service, Raleigh, North Carolina; (2) South Carolina -- Bennett and Nelson (1991)].



WARREN 0
NORTH-AMP. 7
HALIFAX 5
HERTFORD 0
GATES 5
CAMDEN 20
CURR. 14
PASQUO. 1
PERQ. 4
CHOWAN 163
FRANKLIN 0
NASH 95
EDGE-COMBE 100
BERTIE 23
MARTIN 7
WASH. 78
TYRRELL 31
DARE 1
WAKE 0
WILSON 73
PITT 93
BEAUFORT 16
HYDE 3
LEE 2
JOHNSTON 169
GREENE 0
WAYNE 322
MONT-GOMERY 0
MOORE 9
HARNETT 72
LENOIR 76
CRAVEN 84
PAMLICO 10
ANSON 3
RICH-MOND 3
HOKE 558
SCOT 1,165
CUMBER-LAND 311
SAMPSON 1,106
DUPLIN 107
JONES 7
ONSLOW 23
CARTERET 121
ROBESON 1,437
BLADEN 617
PENDER 94
LANCASTER 0
CHESTERFIELD 3
MARLBORO 312
DILLON 118
COLUMBUS 411
N. HAN 11
BRUNSWICK 600
KERSHAW 16
DARLINGTON 164
LEE 75
MARION 118
SALUDA 20
RICHLAND 70
SUMTER 115
FLORENCE 34
HORRY 410
EDGEFIELD 22
LEXINGTON 7
CALHOUN 20
CLARENDON 132
WILLIAMSBURG 33
AIKEN 175
ORANGEBURG 226
GEORGETOWN 22
BARNWELL 261
BAMBERG 127
DORCHESTER 16
BERKELEY 30
ALLENDALE 163
HAMPTON 57
COLLETON 20
CHARLESTON 13
JASPER 4
BEAUFORT 0
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W
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S

Table 7.2. "Special Status" taxa occurring in study area Carolina bays. A '*' refers to a taxon (usually, a species) which is on the N.C. Natural Heritage Program's "Rare Plants List", according to Amoroso (1997). Similarly, '**' denotes a taxon that is designated as being on the N.C. Natural Heritage Program's "Plant Watch List". A '#' indicates those species that are designated as "Rare/Threatened/Endangered Plant Taxa" for the State of South Carolina by Bennett and Nelson (1991).

| SPECIES CODE & STATUS SYMBOL | SPECIES NAME | VEGETATION GROUP IN WHICH SPECIES PRIMARILY OCCURS |
|---|---|---|
| AGALLIN * | AGALINIS LINIFOLIA | Wet Savanna/Meadow |
| ANDRGYRS** | ANDROPOGON GYRANS VAR. STENOPHYLLUS | Wet Savanna/Meadow |
| ANDRMOH * | ANDROPOGON MOHRII | Wet Savanna/Meadow |
| ARISPAL ** | ARISTIDA PALUSTRIS | Wet Savanna/Meadow |
| ASCLLON ** | ASCLEPIAS LONGIFOLIA | Cypress/Gum Bog |
| ASTESPE ** | ASTER SPECTABILIS | Longleaf Pine Woodland |
| BACOCAR * | BACOPA CAROLINIANA | Freshwater Marsh |
| BOLTAST ** | BOLTONIA ASTEROIDES | Drawdown Savanna/Meadow |
| BURMBIF ** | BURMANNIA BIFLORA | Wet Savanna/Meadow |
| CHAMCAL # | CHAMAEDAPHNE CALYCULATA | Pocosin |
| COELRUG ** | COELORACHIS RUGOSA | Wet Savanna/Meadow |
| | | Drawdown Savanna/Meadow |
| DICHERE ** | DICHANTHELIUM ERECTIFOLIUM | Drawdown Savanna/Meadow |
| DROSFIL * | DROSERA FILIFORMIS | Wet Savanna Meadow |
| ECHIPAR * # | ECHINODORUS PARVULUS | Drawdown Savanna/Meadow |
| ELEOEQU ** | ELEOCHARIS EQUISETOIDES | Boggy Marsh |
| ELEOMEL ** | ELEOCHARIS MELANOCARPA | Drawdown Savanna/Meadow |
| ELEOROB * # | ELEOCHARIS ROBBINSII | Freshwater Marsh |
| ELEOTRI ** | ELEOCHARIS TRICOSTATA | Drawdown Savanna/Meadow |
| ERIOPAR * | ERIOCAULON PARKERI | Freshwater Pond |
| ERIOVRG ** | ERIOPHORUM VIRGINICUM | Pocosin |
| EUPALEP * | EUPATORIUM LEPTOPHYLLUM | Drawdown Savanna/Meadow |
| EUPAREC ** | EUPATORIUM RECURVANS | Boggy Marsh |
| GAYLDUMB** | GAYLUSACCIA DUMOSA VAR. BIGELOVIANA | Pocosin |
| HABEREP ** | HABENARIA REPENS | Cypress/Gum Bog |
| HELEPIN * # | HELENIUM PINNATIFIDUM | Wet Savanna/Meadow |
| HYPEFAS ** | HYPERICUM FASCICULATUM | Wet Savanna/Meadow |
| ILEXAME * # | ILEX AMELANCHIER | Cypress/Gum Swamp |
| ILEXCAS ** | ILEX CASSINE | Cypress/Gum Bog |
| IRISPRI ** | IRIS PRISMATICA | Cypress/Gum Swamp |
| IVA_MIC * | IVA MICROCEPHALA | Drawdown Savanna/Meadow |
| KALMCUN * | KALMIA CUNEATA | Pocosin |
| LINDMEL * | LINDERA MELISSIFOLIA | Cypress/Gum Swamp |
| LITSAES * # | LITSEA AESTIVALIS | Cypress/Gum Swamp |
| | | Cypress/Gum Bog |
| LOBEBOY * # | LOBELIA BOYKINII | Wet Savanna/Meadow |
| LUDWLNF * | LUDWIGIA LINIFOLIA | Drawdown Savanna/Meadow |
| LUDWSPH ** | LUDWIGIA SPHAEROCARPA | Freshwater Marsh |
| LUDWSUF * | LUDWIGIA SUFFRUTICOSA | Wet Savanna/Meadow |
| LUZIFLU * | LUZIOLA FLUITANS | Freshwater Marsh |
| LYCOANG ** | LYCOPUS ANGUSTIFOLIUS | Drawdown Savanna/Meadow |
| NYMPCOR ** | NYMPHOIDES CORDATA | Freshwater Pond |
| OLDEBOS * | OLDENLANDIA BOSCII | Drawdown Savanna/Meadow |
| OXYPCAN * # | OXYPOLIS CANBYI | Wet Savanna/Meadow |
| PANITEN * | PANICUM TENERUM | Wet Savanna/Meadow |
| PARIPEN ** | PARIETARIA PENSYLVANICA | Drawdown Savanna/Meadow |
| PELTSAG * # | PELTANDRA SAGITTIFOLIA | Cypress/Gum Bog |
| PITYGRA * | PITYOPSIS GRAMINIFOLIA | Longleaf Pine Woodland |
| POLYBRE ** | POLYGALA BREVIFOLIA | Longleaf Pine Woodland |

Table 7.2 (cont.). "Special Status" taxa occurring in study area Carolina bays. A '*' refers to a taxon (usually, a species) which is on the N.C. Natural Heritage Program's "Rare Plants List", according to Amoroso (1997). Similarly, '**' denotes a taxon that is designated as being on the N.C. Natural Heritage Program's "Plant Watch List". A '#' indicates those species that are designated as "Rare/Threatened/Endangered Plant Taxa" for the State of South Carolina by Bennett and Nelson (1991).

| SPECIES CODE & STATUS SYMBOL | SPECIES NAME | VEGETATION GROUP IN WHICH SPECIES PRIMARILY OCCURS |
|---|---|---|
| POLYHIR * | POLYGONUM HIRSUTUM | Freshwater Marsh |
| POTACON * | POTAMOGETON CONFERVOIDES | Freshwater Pond |
| RHEXARI * # | RHEXIA ARISTOSA | Drawdown Savanna/Meadow<br>Wet Savanna/Meadow |
| RHYNALB * | RHYNCHOSPORA ALBA | Boggy Marsh |
| RHYNINU **# | RHYNCHOSPORA INUNDATA | Drawdown Savanna/Meadow |
| RHYNPLE * | RHYNCHOSPORA PLEIANTHA | Pocosin |
| RHYNTRA * # | RHYNCHOSPORA TRACYI | Drawdown Savanna/Meadow |
| SAGIISO * # | SAGITTARIA ISOETIFORMIS | Drawdown Savanna/Meadow<br>Freshwater Marsh |
| SCLEBAL * # | SCLERIA BALDWINII | Wet Savanna/Meadow |
| SCLEGEO * | SCLERIA GEORGIANA | Wet Savanna/Meadow |
| SCLERET * | SCLERIA RETICULARIS | Intermitt. Flooded Depression Prairie<br>Drawdown Savanna/Meadow |
| SCLEUNI ** | SCLEROLEPIS UNIFLORA | Cypress/Gum Pond<br>Drawdown Savanna/Meadow |
| SOLIPATS** | SOLIDAGO PATULA VAR. STRICTULA | Longleaf Pine Woodland |
| SOLIPUB1** | SOLIDAGO PUBERULA VAR. PUBERULA | Longleaf Pine Woodland |
| STILAQU # | STILLINGIA AQUATICA | Wet Savanna/Meadow |
| STYLAQU * | STYLISMA AQUATICA | Wet Savanna/Meadow |
| TRIATUB ** | TRIADENUM TUBULOSUM | Cypress/Gum Bog |
| VACCMAC ** | VACCINIUM MACROCARPON | Pocosin |
| XYRIDIFF* | XYRIS DIFFORMIS VAR. FLORIDANA | Boggy Marsh |
| XYRISMA ** | XYRIS SMALLIANA | Freshwater Marsh |

# COLOR PLATES

PLATE 1. A mosaic photograph of individual aerial photographs for the Bladen County, North Carolina portion of the study area. The photograph shows the striking number, alignment, and uniformity of Carolina bay depressions in the Cape Fear River valley. The Carolina bay in the left center of the photograph is Horseshoe Lake. (Source: U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, 1976)

PLATE 2. [The frames are viewed in order from top to bottom]

FRAME 2(a). A Brackish Marsh vegetation community within a study area Carolina bay. This vegetation type is extremely rare within the study area, but is apparently somewhat more common in "Carolina bays" northward.

FRAME 2(b). Close-up view of the plot center line within a Brackish Marsh study plot, indicating the thickness of its dominant, and often monotypic species, Black Needlerush (*Juncus roemerianus*).

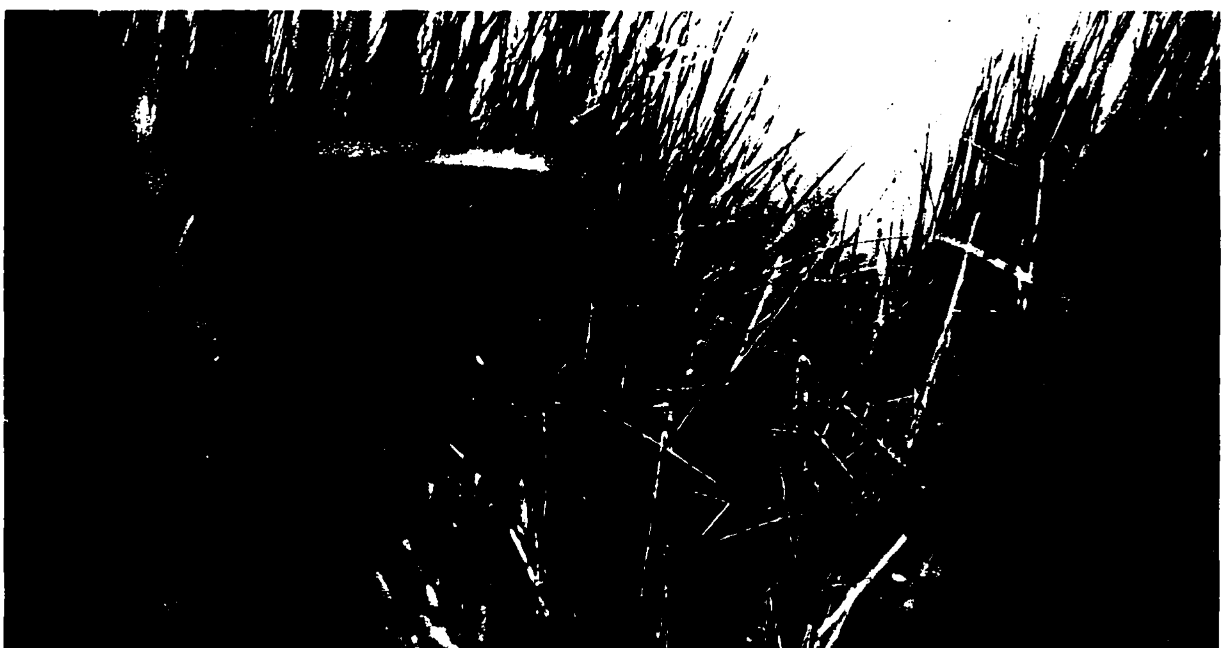


PLATE 3. [The frames are viewed in order from top to bottom]

FRAME 3(a). An Intermittently Flooded Depression Prairie vegetation community within a study area Carolina bay, seen in the "drawdown phase". The view is outwards from the bay interior towards the rim, which is denoted by the large (primarily) Loblolly Pines (*Pinus taeda*). The dominant species in the foreground are Cut-grass (*Leersia hexandra*) and Wart-fruited Panic Grass (*Panicum verrucosum*). Note the abundant young pines near the rim, which have encroached towards the interior of the bay following an extended period of "drought".

FRAME 3(b). An Intermittently Flooded Depression Prairie vegetation group within a study area Carolina bay, photographed in the "flooded phase". The site, moist--dry for most the immediately past growing season, was recently inundated following the passage of a tropical depression. The dominant species at the site is Cut-grass, but the remnants of Broom-sedge (*Andropogon virginicus*) clumps that invaded the outer portions of the site during a period of years with below average rainfall remains clearly visible.

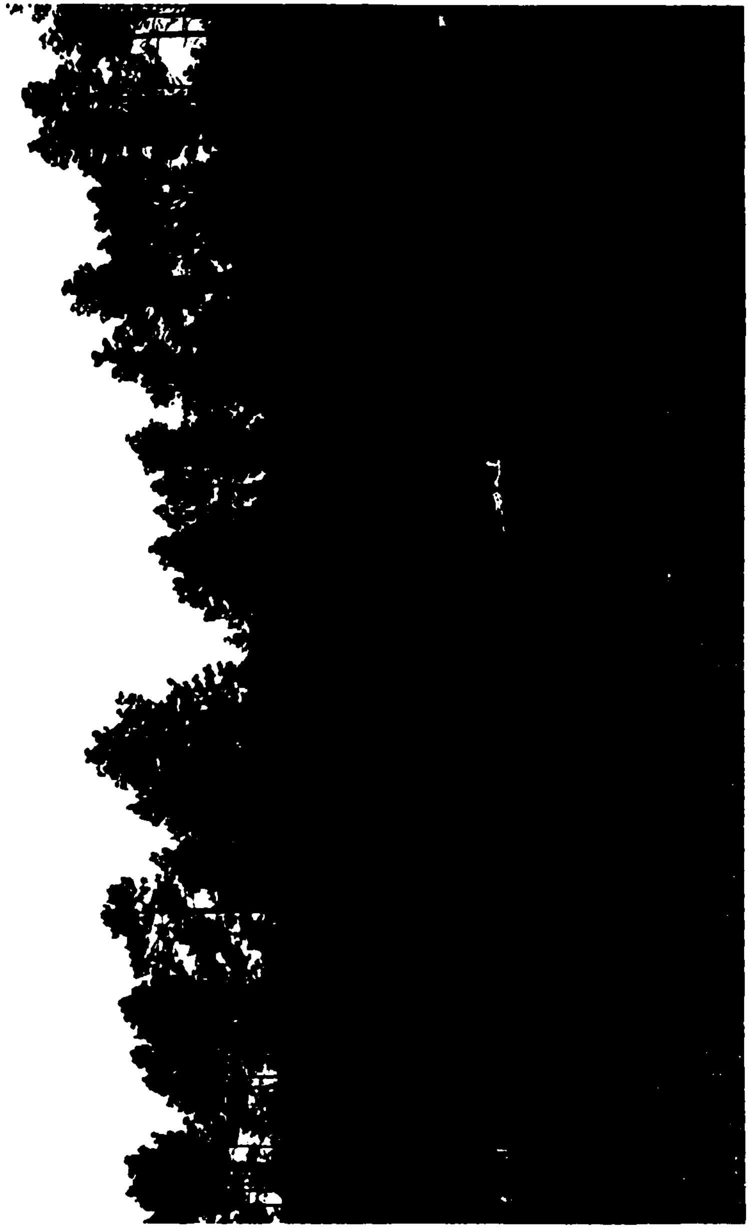
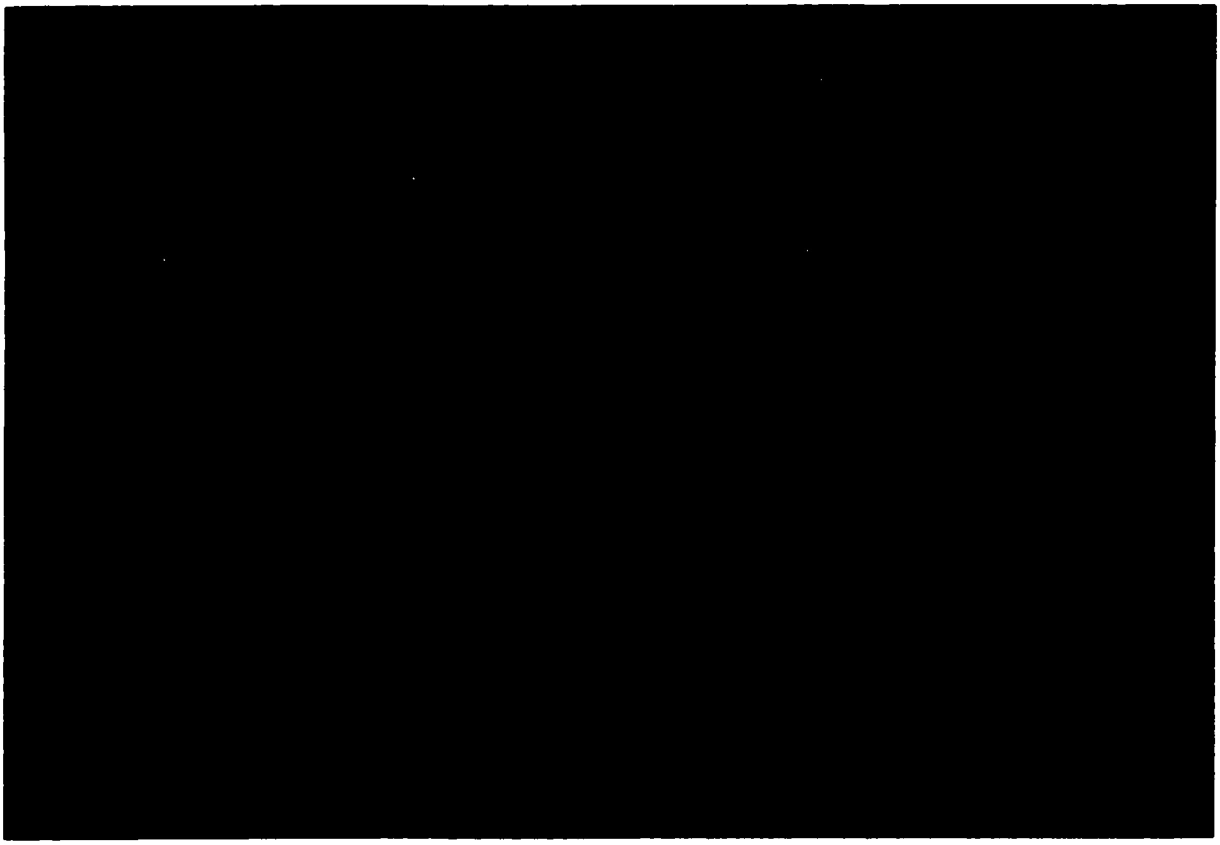


PLATE 4. A Freshwater Pond vegetation community within a study area Carolina bay. The dominant foreground species in this pond community is Water Lily (*Nymphaea odorata*), while Floating Hearts (*Nymphoides aquatica*) and Water Shield (*Brasenia schreberi*) are abundant and become co-dominants in shallower areas of the site. This vegetation type is much more common in the southern portion of the study area. The tree-line in the distance indicates the bay rim, and the light green vegetation band between the bay rim and the Freshwater Pond vegetation is Freshwater Marsh dominated by Maidencane (*Panicum hemitomon*). This latter vegetation community type characteristically occurs in the shallows around the periphery of ponded Carolina bay sites.

PLATE 5. [The frames are viewed in order from top to bottom]

FRAME 5(a). A Freshwater Marsh vegetation community within a study area Carolina bay. The dominant plant in the community is Robbins' Spike-rush (*Eleocharis robbinsii*), a rare species that is "seasonally abundant" in handful of study area Carolina bays. The concept of seasonal abundance is critical to an understanding of Carolina bay vegetational dynamics. Species that are abundant, even dominant, at a site in a given year and under a given site of environmental conditions may thereafter "disappear" from the site flora for a period of years if site hydrology or other environmental conditions change significantly. These species apparently have seeds that are both long-lived and adapted to survival under a broad range of light and hydrologic conditions, germinating only when relatively optimal site conditions return. The dark "lines" in the pictured marsh are White-tailed Deer trails. Permanently wet or seasonally flooded Carolina bays serve as significant feeding and breeding habitats for a broad variety of animal species.

FRAME 5(b). Another Freshwater Marsh vegetation community within a study area Carolina bay, this one dominated by Maidencane in virtually monotypic stand. As noted in the caption for Plate 3, above, this community type characteristically occurs around the periphery of Carolina bay ponds. The outward edge of an interior site pond community may be seen in the upper left portion of the photograph.



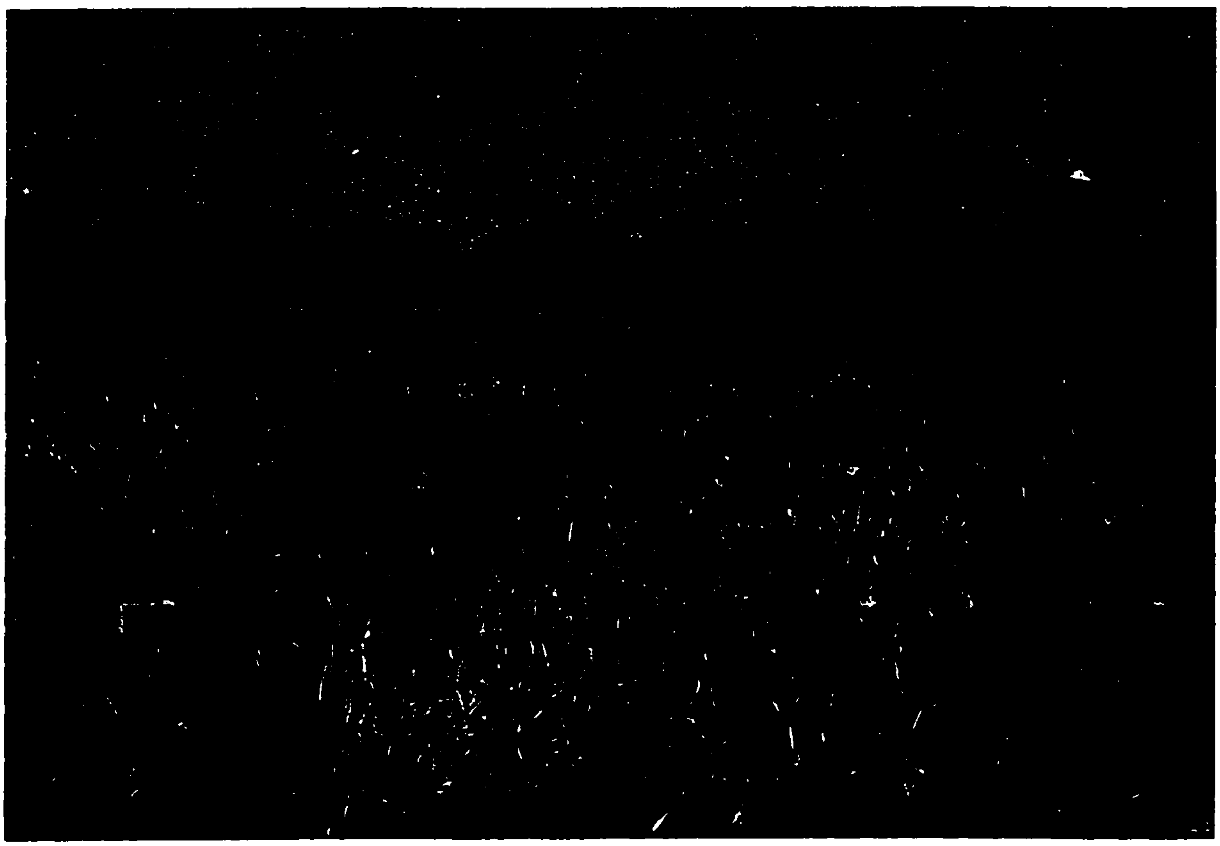


PLATE 6. [The frames are viewed in order from top to bottom]

FRAME 6(a). A Boggy Marsh vegetation community within a study area Carolina bay. The dominant species within this community include Four-side Spike-rush (*Eleocharis quadrangulata*) and Horsetail Spike-rush (*Eleocharis equisetoides*), as well as a Horned Rush (*Rhynchospora inundata*). As noted in the text, this vegetation type typically occurs interspersed within a mosaic of Evergreen Shrub-bog communities, as here. While the dominant tree within the pocosin communities is universally Pond Pine (*Pinus serotina*), Loblolly Pine is the characteristic dominant of the forested "islands" within the relatively more open Boggy Marsh communities. This relatively rare vegetation type appears largely to be limited to the Albemarle Embayment ("Pamlico Plain") within the study area.

FRAME 6(b). Boggy Marsh communities may also occur as "floating peat mats" at perennially inundated Evergreen Shrub-bog sites. The peat mats are apparently comprised largely of partially decomposed *Sphagnum* spp. mosses. As seen here, Walter's sedge (*Carex striata* var. *striata*) and Yellow-eyed Grass (*Xyris fimbriata*) are typical dominants in these extremely acidic vegetational communities. The broad-leaved monocot visible in the picture is Bigroot Peltandra (*Peltandra sagittifolia*), another rare, but locally abundant, species within study area Carolina bays.

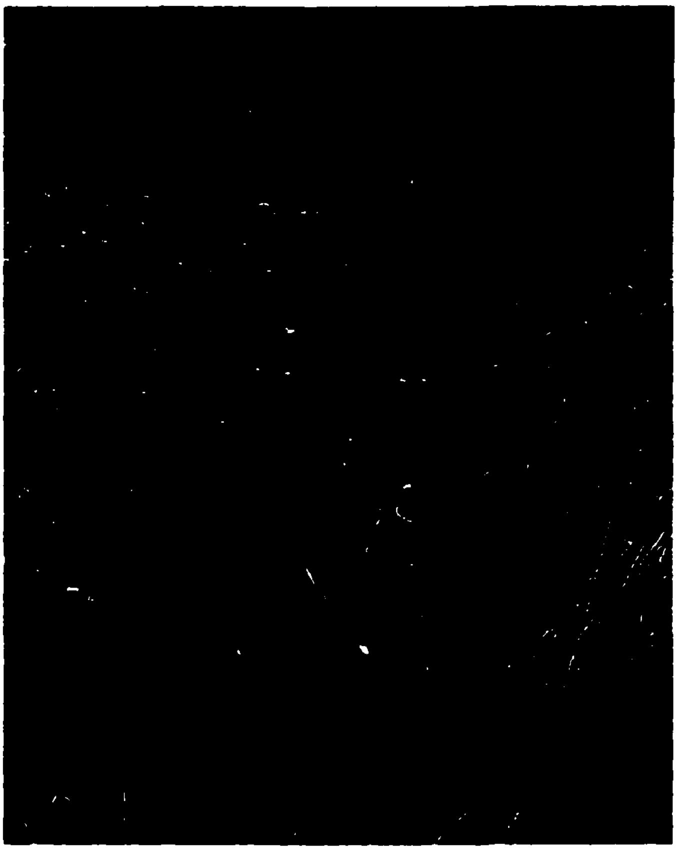


PLATE 7. [The frames are viewed in order from top to bottom]

FRAME 7(a). A Longleaf Pine Woodland vegetation community within a study area Carolina bay. Like other Longleaf Pine (*Pinus palustris*) dominated vegetation types in the region, these Carolina bay communities are highly fire-dependent in terms of maintaining their long-term physiognomic and species integrities. Fire has been suppressed in recent years at this site, and shrubs -- primarily Inkberry (*Ilex glabra*), Sweet Gallbery (*Ilex coriacea*), and Hairy Blueberry (*Vaccinium fuscatum*) -- have invaded the savanna community that typifies this vegetation class within study area Carolina bays.

FRAME 7(b). By contrast, in this Carolina bay Longleaf Pine Woodland vegetation community, fire has recently occurred, and a mesic Pine-Wire-grass (*Aristida stricta*) savanna community is evident. While Longleaf Pine Woodland communities are common within the study area outside of Carolina bays, they are quite rare within bay depressions themselves.

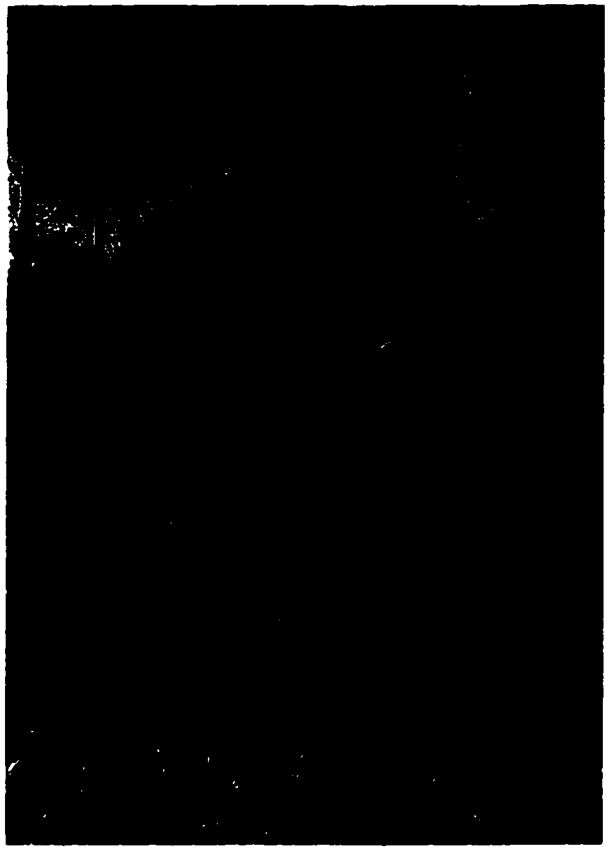
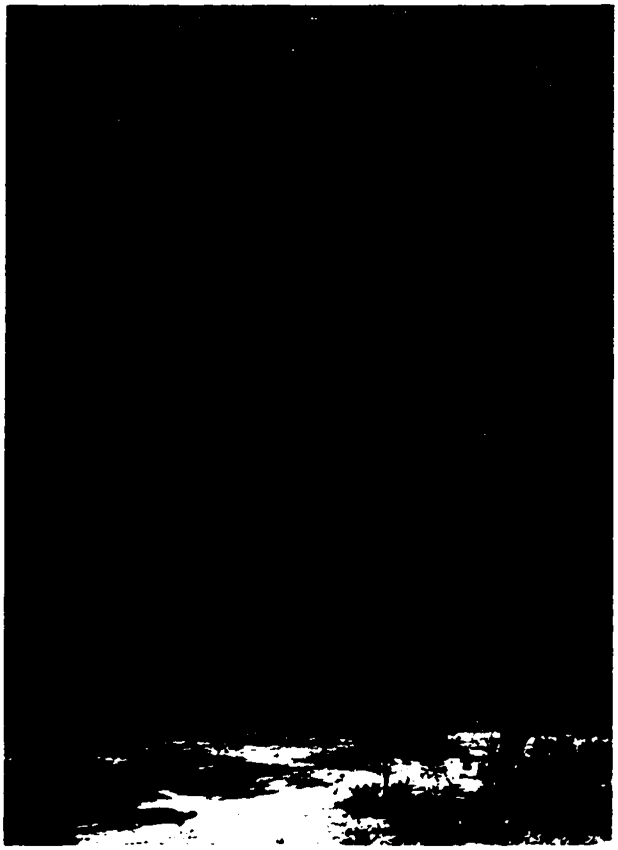


PLATE 8. [The frames are viewed in order from top to bottom]

FRAME 8(a). An Evergreen Shrub-bog: Bay Forest from the outside looking in. The photograph was taken from the southeastern bay rim into the interior of the depression site. The rim dominant, visible in the photograph, is Turkey Oak (*Quercus laevis*), overtopping sparse patches of Wire-grass (*Aristida stricta*) and Sandwort (*Stipulicida setacea*), with abundant white sand. The visible bay dominants include Loblolly Bay (*Gordonia lasianthus*) --which is in bloom in the photograph -- Atlantic White Cedar (*Chamaecyparis thyoides*), Sweet Bay (*Magnolia virginiana*), and Red Maple (*Acer rubrum*), overtopping a myriad of evergreen and deciduous shrubs and canopy species transgressives.

FRAME 8(b). The view down the sampling plot center line within the interior of an Evergreen Shrub-bog: Bay Forest. The photograph hardly does justice to the denseness of the vegetation, where machetes were the order of the day to clear paths both for access to and within the site, and for vegetation sampling. The dominant species visible is Sweet Gallberry, an almost omnipresent species within this vegetation type.



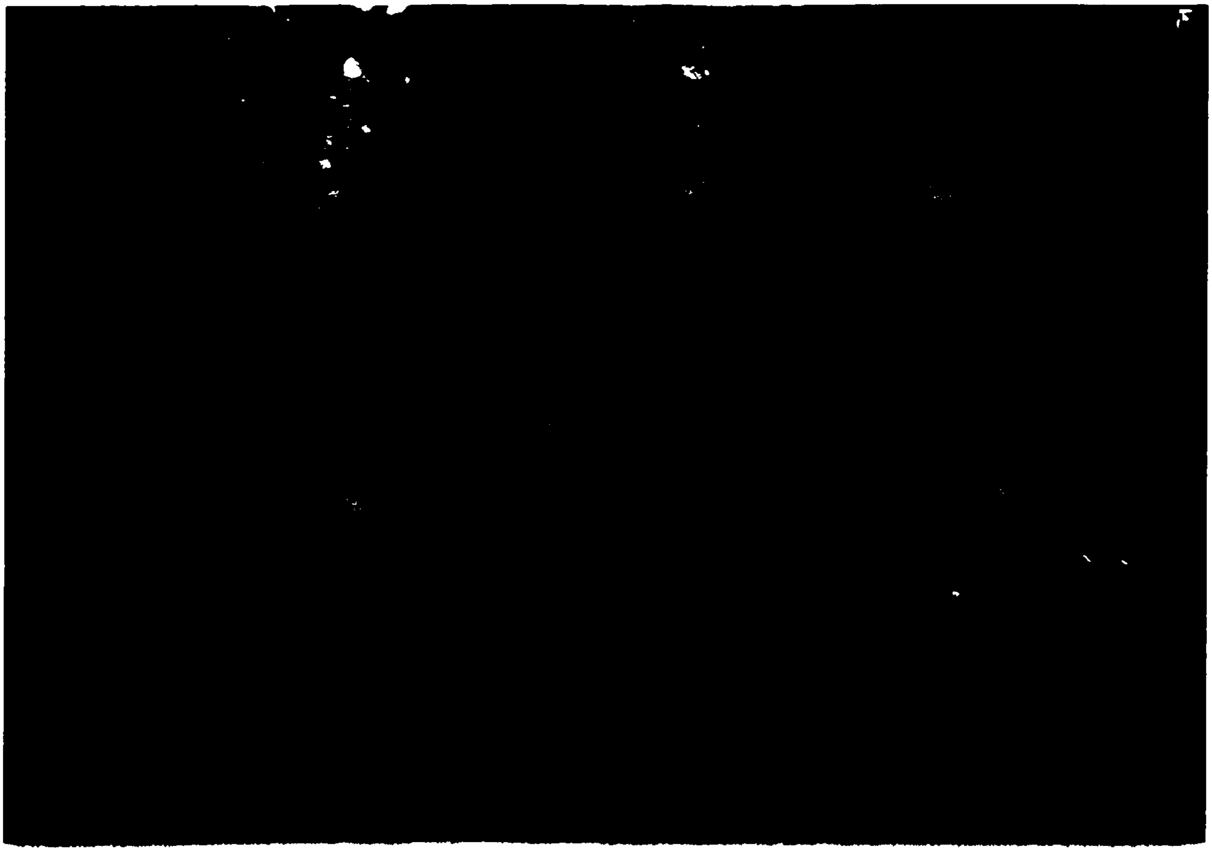


PLATE 9. [The frames are viewed in order from top to bottom]

FRAME 9(a). An Evergreen Shrub-bog: Pocosin vegetation community within a study area Carolina bay. Dwarfed Pond Pines stand as scattered emergents over a sea of evergreen and deciduous shrubs, including Sweet Gallberry, Honey-cup (*Zenobia pulverulenta*), and Leather-leaf (*Chamaedaphne calyculata*). Chain Fern (*Woodwardia virginica*) is the dominant herb, and Bamboo Brier (*Smilax laurifolia*) may be seen sprawling over the entire community. Whether the physiognomically low nature of the vegetation within this community (*ca.* 0.5 m in height) is caused by frequent fire or by nutrient paucity (as is suspected in the case of the pictured vegetation), it is commonly referred to as "Low Pocosin".

FRAME 9(b). View down a study area bay plot center line within a "Medium" or "High Pocosin" Evergreen Shrub-bog: Pocosin. Pond Pine is the typical dominant, although a relatively recent (6 years prior to the photograph), "hot" fire destroyed much of the canopy at this site. Note that despite the recent fire that killed most site shrubs to the ground, upon resprouting they have already attained heights of from 2 to 5 m. This is likely indicative of improved nutrient availability at this site as compared to that for the depression pictured in the preceding photograph. The dominant shrub visible in the picture is Sweet Gallberry.

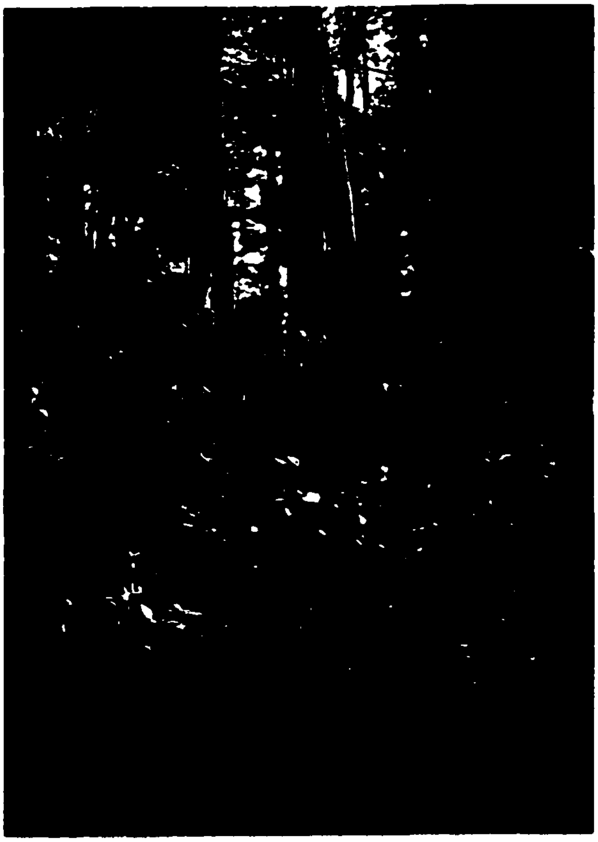
PLATE 10. The Cypress/Gum Bog vegetation class appears to be transitional in nature between the vegetation classes that precede and follow it -- Evergreen Shrub-bogs and Intermittently Ponded Cypress/Gum Depressions, respectively -- in consideration in this study. As the photographs below indicate, this is a diverse group vegetationally, unified by its association with organic-dominated soils (which ties it to the Evergreen Shrub-bogs) and by its canopy dominants -- Cypress (*Taxodium* spp.) or Gum (*Nyssa* spp.) --(which relates it to the Intermittently Ponded Cypress/Gum Depressions). [Frames (a) to (d) are viewed in order moving from the upper left-hand frame to the upper right-hand frame, then from the lower left-hand frame to the lower right-hand frame]

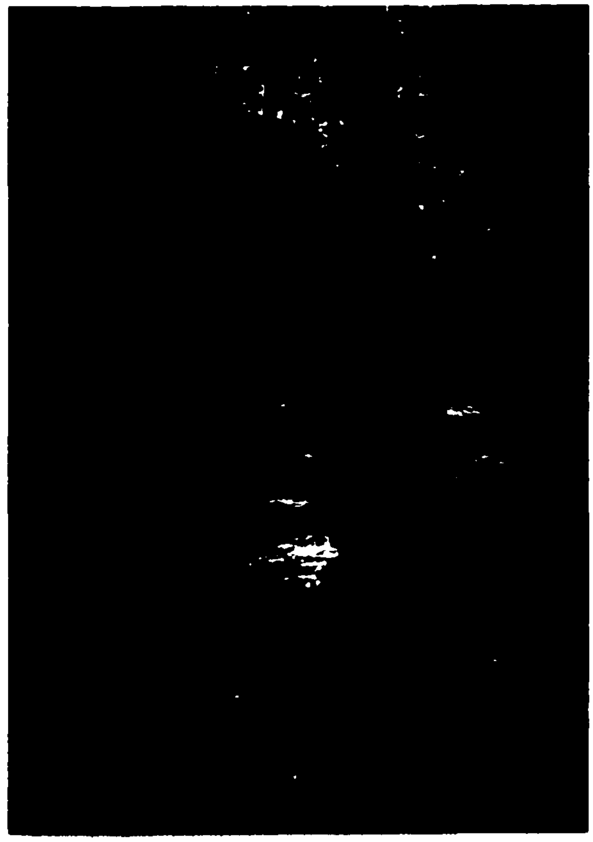
FRAME 10(a). A Cypress/Gum Bog vegetation community within a study area Carolina bay. The canopy dominant is Pond Cypress (*Taxodium ascendens*), with an understory of Black Gum (*Nyssa biflora*), and a typically dense shrub layer consisting of a mix of the evergreen and deciduous shrub species characteristically associated with Evergreen Shrub-bog communities. Fetter-bushes -- *Lyonia lucida* and *Leucothoe racemosa*, Blueberry (*Vaccinium* spp.), and Honey-cup are typical dominants.

FRAME 10(b). This Cypress/Gum Bog community type is dominated by a canopy of large Tupelo Gums (*Nyssa aquatica*), typically over standing water containing abundant Mud-midget (*Wolfiella gladiata*) and Purple Bladderwort (*Utricularia purpurea*). Tupelo swamps are a relatively common wetland vegetation type within the Carolinas. However, this is not a typical depressional community and is known from only one Carolina bay within the study area.

FRAME 10(c). Between "islands" vegetated by Black Gum and Red Maple, this Cypress/Gum Bog is dominated by a mix of Saw-grass (*Cladium mariscus* var. *jamaicense*) and Blue Flag (*Iris virginica*). Like the preceding community type, while such wetland vegetation is not uncommon within the study area outside of bay depressions, it is exceedingly rare within study area Carolina bays.

FRAME 10(d). A Cypress/Gum Bog vegetation community within a study area Carolina bay dominated by Pond Cypress overtopping a dense thicket of Fetter-Bushes. Pond Cypress dominated communities are common over mineral soils within the Intermittently Ponded Cypress/Gum Depression vegetation class. However, Pond Cypress dominated communities over peat are infrequent at best within the study area, and are rare in Carolina bays. This vegetation type appears to have some vegetational and pedologic affinities with the cypress "dome" communities common to southern Georgia and Florida.





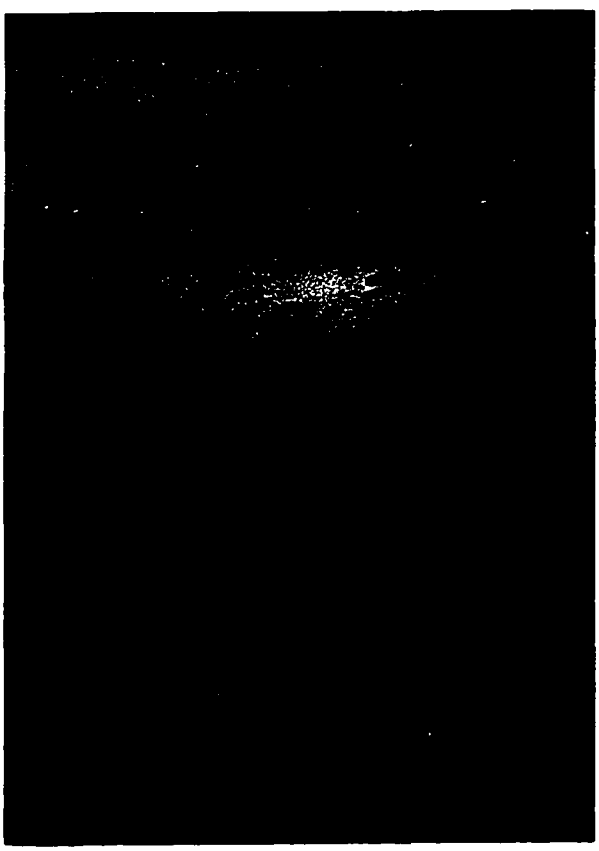


PLATE 11. [The frames are viewed in order from top to bottom]

FRAME 11(a). An Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Swamp vegetation community within a study area Carolina bay. The canopy consists of a dense stand of Pond Cypress and Black Gum overtopping a well-developed subcanopy layer of Sweet-gum (*Liquidambar styraciflua*) and Red Maple, with a ground cover of Virginia Chain-fern and Swamp-sedge (*Carex verrucosa*). Despite the fact that this community is not observed in an open, savanna-like condition, fire scars visible on the boles of canopy trees are indicative of the continued occurrence of fires within this community type, and may account for the absence of a shrub layer here. Though dry at the time of the photograph, water stands seasonally above the surface of this site -- and in most Cypress/Gum Swamps -- in most years.

FRAME 11(b). An Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Swamp vegetation community characteristically associated with the so-called "clay-based" Carolina bays within the study area. The canopy dominant is Pond Cypress overtopping an open to dense shrub layer comprised of Sarvis Holly (*Ilex amelanchier*). The latter species occurs only over clayey soils within Carolina bays, and is much more common in the northern portion of the Middle Coastal Plain within the study area. In the southern part of that physiographic region, Myrtle-leaved Holly (*Ilex myrtifolia*) appears to "replace" Sarvis Holly in many Intermittently Ponded Cypress/Gum Depression vegetation communities.

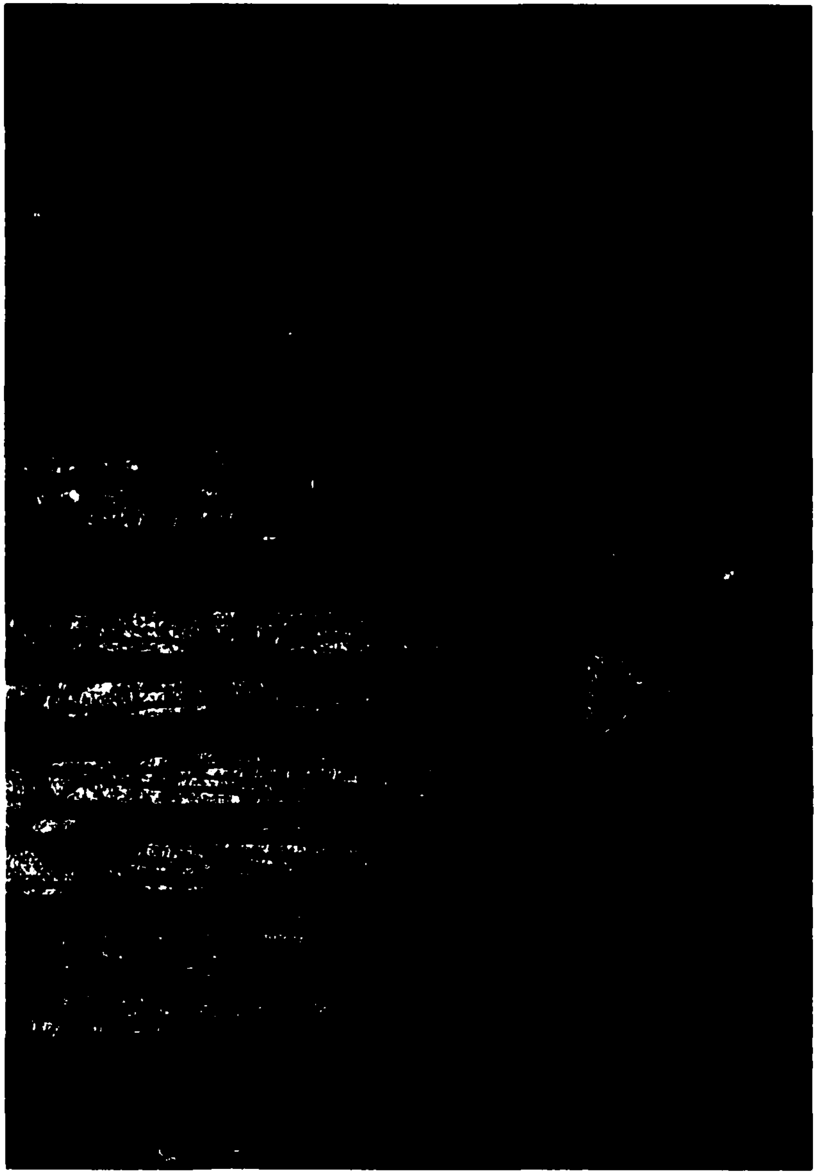


PLATE 12. An Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Pond vegetation community within a study area Carolina bay. The community dominant is Pond Cypress, over open water in most years, although drawdown periods occur infrequently. In many years, Water Aster (*Sclerolepis uniflora*) is a characteristic -- and extremely attractive -- dominant in shallow bay waters within this community. These open, ponded sites are extensively used as both amphibian and avian breeding and feeding habitats.

PLATE 13. [The frames are viewed in order first from right to left, and then from top to bottom]. This vegetation class contains both canopied, savanna-like communities (*i.e.*, communities having a canopy of trees overtopping an herbaceous layer, without a shrub stratum), and treeless, "meadow" communities. Fire, site hydrologies, and past human disturbance are suspected to play a role in determining present site physiognomies.

FRAME 13(a). An Intermittently Ponded Cypress/Gum Depression: Drawdown Savanna vegetation community within a study area Carolina bay. This photograph was taken shortly after dry out occurred at this site following several years of ponding. Pond Cypress is the lone canopy species, and while some perennial herbs have persisted through the wetter conditions that previously typified the site, recruitment of herbaceous seedlings from the site seedbank has largely not yet occurred. Warted Panic-grass and Reticulated Nut-sedge (*Scleria reticularis*), both annuals, are typically the first species to appear in the bays exhibiting this vegetation type, often by the hundreds of thousands. These annual species are typically followed by short-lived perennial species such as those illustrated in the remaining frames of Plate 12. Drawdown cycles are typically precipitation dependent, and are therefore entirely unpredictable. They may occur seasonally (usually during the late summer or fall), irregularly throughout the year, once every several years, or once a decade or longer.

FRAME 13(b). Another Intermittently Ponded Cypress/Gum Depression: Drawdown Savanna vegetation community within a study area Carolina bay. The photograph was taken approximately three years after dry out following an extended period of ponding. The herbaceous layer at this site is dominated by relatively short-lived perennials, including Flattop Polygala (*Polygala cymosa*), Rose Fleabane (*Pluchea rosea*), and Horned Rush. The reddish "flowers" in the lower left hand corner of the photograph are actually the large fruits of the latter species.

FRAME 13(c). An Intermittently Ponded Cypress/Gum Depression: Drawdown Meadow vegetation community within a study area Carolina bay. The herbaceous dominants are typically distributed in a mosaic of roughly concentric zones, presumably indicating past zones of propagule (primarily seed) deposition following previous drawdown events. The dominant, "brownish" species in the foreground and at the far back edge of the site is Wright's Panic-grass (*Dichanthelium wrightianum*). The darker green herb that covers most of the interior of the site is Warted Panic-grass, while the herbaceous patch that appears as a lighter shade of green in the center of the photograph is comprised of Little Marsh-elder (*Iva microcephala*).

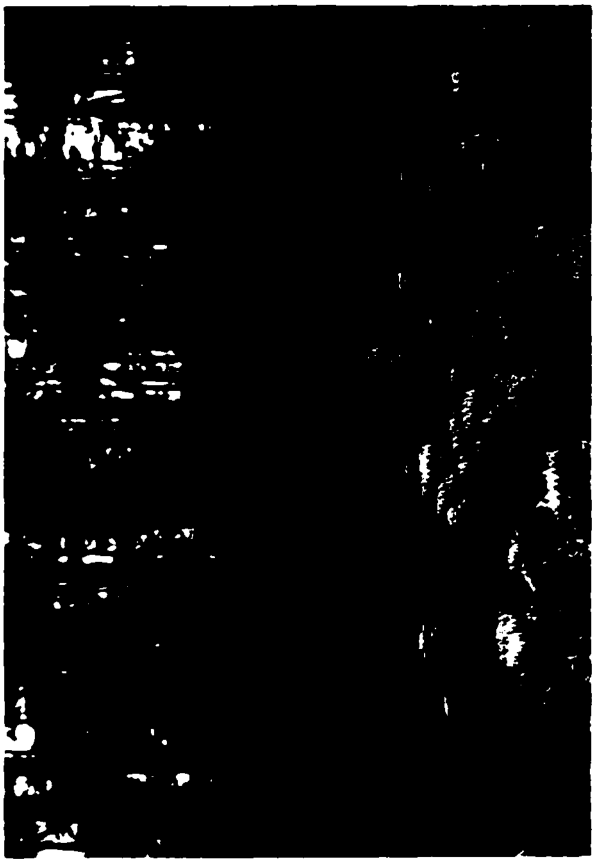
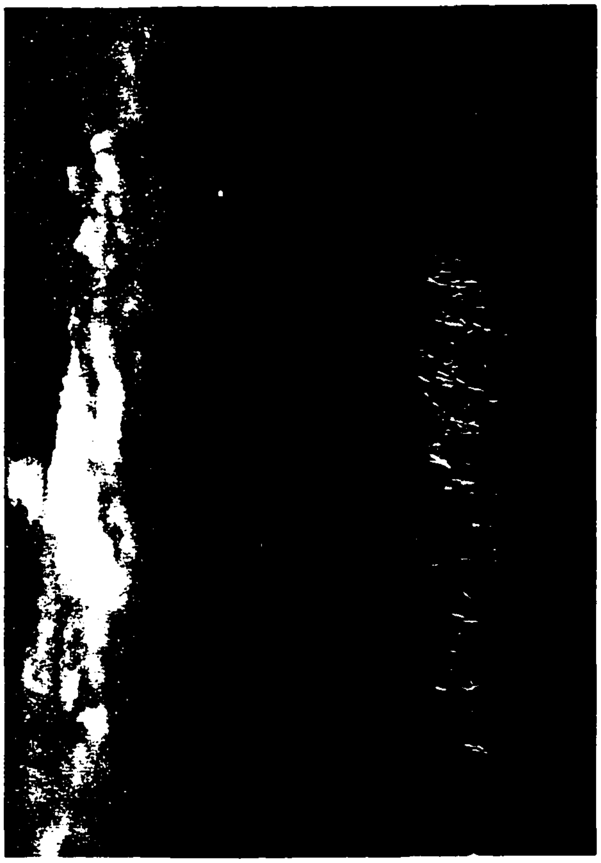




PLATE 14. [The frames are viewed in order from top to bottom]. While Drawdown Savannas/ Meadows are characterized by highly variable hydroperiods and dominated by annual and short-lived perennial herbs, Wet Savannas/Meadows within study area Carolina bays are characterized by more stable hydroperiods, and are typically dominated by relatively long-lived perennials, particularly graminoids. For those reasons, these sites tend to accumulate more litter, and presumably burn more often. That more frequent burning may be largely responsible for maintaining these relatively drier sites in their open condition as opposed to Drawdown Savannas/Meadows, where open site conditions almost certainly result from the harsh uncertainty of wildly fluctuating hydroperiods.

FRAME 14(a). An Intermittently Ponded Cypress/Gum Depression: Wet Savanna vegetation community within a study area Carolina bay. As with the preceding vegetation subclass, the typical canopy dominant is Pond Cypress, here overtopping a mixed graminoid layer dominated by Giant Plume Grass (*Saccharum giganteum*), Horned Rush, and Bay Bluestem (*Andropogon gyrans* var. *stenophyllus*). This community is located in North Carolina.

FRAME 14(b). A similar Intermittently Ponded Cypress/Gum Depression: Wet Savanna vegetation community within a study area Carolina bay located in the southern portion of the study area. Pond Cypress is the canopy dominant, overtopping an open shrub stratum of Myrtle-leaved Holly. The graminoid layer at this site consists chiefly of Walter's Sedge and Marsh Needle-grass (*Aristida palustris*).

FRAME 14(c). An Intermittently Ponded Cypress/Gum Depression: Drawdown Meadow vegetation community within a study area Carolina bay. The grassland illustrated here is dominated principally by Marsh Needle-grass and Comb's Panic-grass (*Panicum rigidulum* var. *combsii*). Following an extended period of drought, the site is being invaded by Loblolly Pine, as is evident in the photograph.

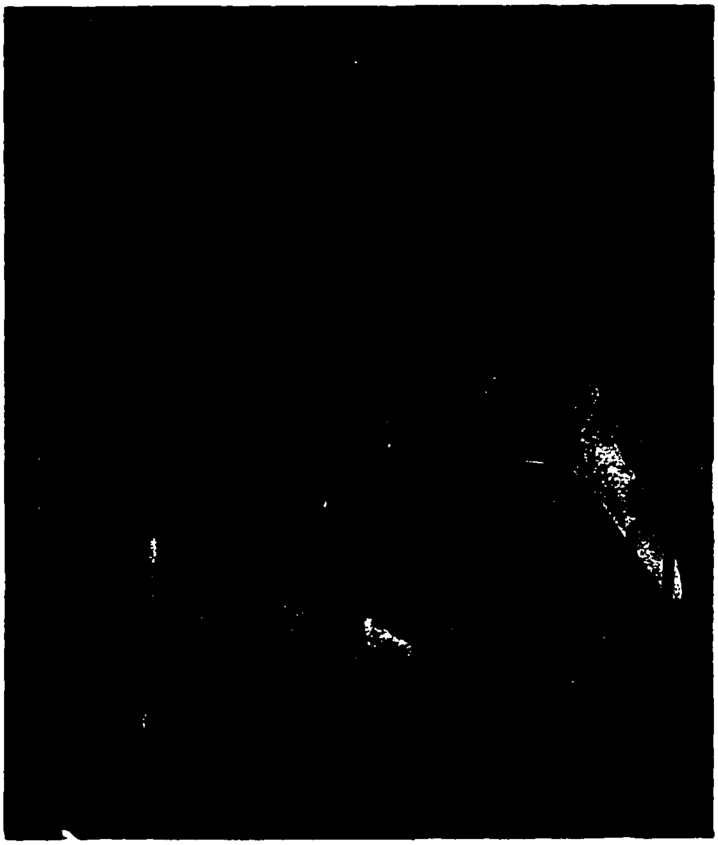
PLATE 15. Rare herbs characteristic of study area Carolina bay depressions. [Frames (a) to (d) are viewed in order moving from the upper left-hand frame to the upper right-hand frame, then from the lower left-hand frame to the lower right-hand frame]

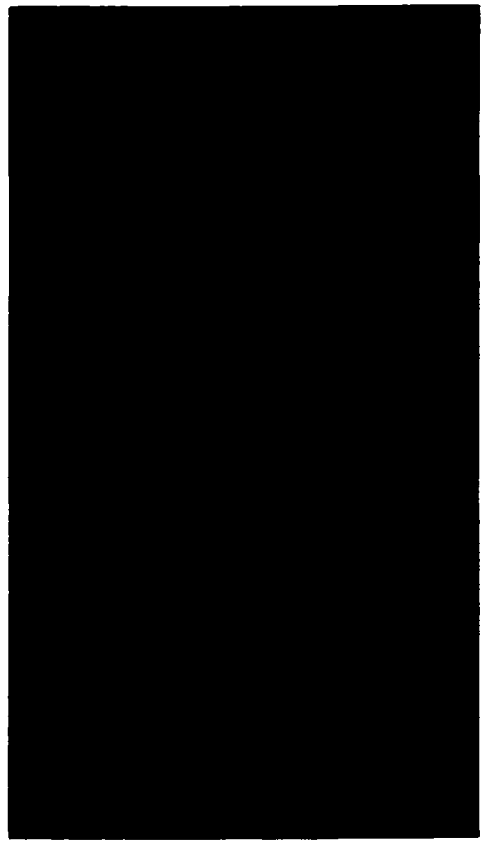
FRAME 15(a). Bigroot Peltandra (*Peltandra sagittifolia*) within a study area Carolina bay Evergreen Shrub-bog Pocosin vegetational community. As seen here, this rare, but locally abundant, species characteristically occurs in peaty *Sphagnum* pools among the fronds of Virginia Chain Fern. As the common name implies, the roots of this species are proportionally very large, and were observed in the field to extend into the peat for depths of a meter or more below the surface at most sites. Presumably, this trait allows the species both to persist during periods of prolonged drought, and to survive the fires that frequently occur within this vegetational community.

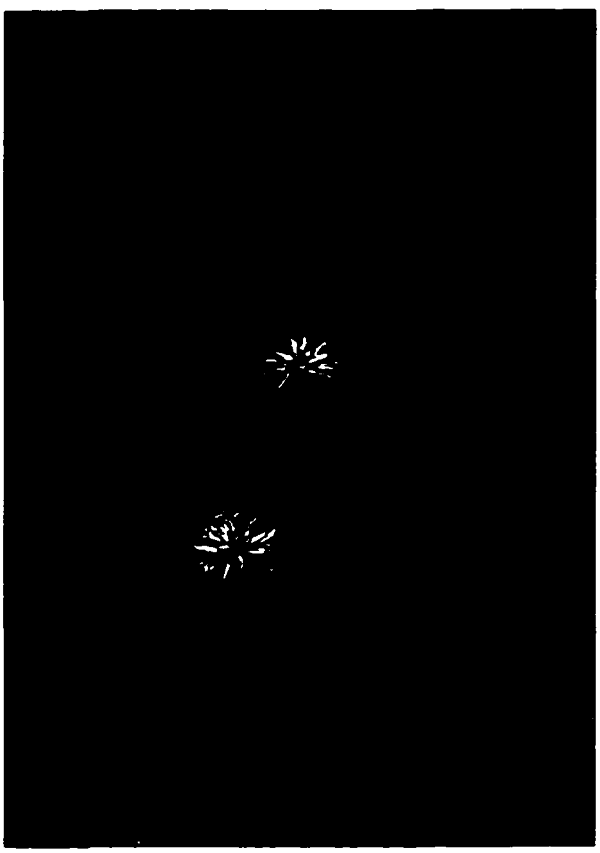
FRAME 15(b). Awned Meadow Beauty (*Rhexia aristosa*) within a study area Carolina bay Intermittently Ponded Cypress Gum/Depression: Drawdown Meadow community. While Awned Meadow Beauty tends to occur annually in some numbers at sites where it is present in the seedbank, this rare species is a clear Carolina bay opportunist. Under favorable conditions -- post-Spring drawdown, moist, but not inundated, soils -- it occurs, with little apparent competition, in spectacularly large populations.

FRAME 15(c). Tracy's Beak-rush (*Rhynchospora tracyi*) within a study area Carolina bay Intermittently Ponded Cypress Gum/Depression: Drawdown Meadow community. This species appears more selective in terms of favorable site conditions than the preceding one. While Awned Meadow Beauty tends to recur annually, Tracy's Beak-rush is typically observed in the flora of a site at which it is known to occur only sporadically over a given period of years.

FRAME 15(d). Quill-leaved Duck Potato (*Sagittaria isoetiformis*) within a study area Carolina bay Freshwater Marsh community. The specimen in the photograph is present within a community dominated by Robbins' Spike-rush, but is also occasionally noted in Intermittently Ponded Cypress/Gum Depression vegetational communities within the study area. While site populations of this species usually number less than 100 plants, Quill-leaved Duck Potato has been observed in spectacular numbers under favorable site conditions. This species is easily overlooked when not in flower or fruit.







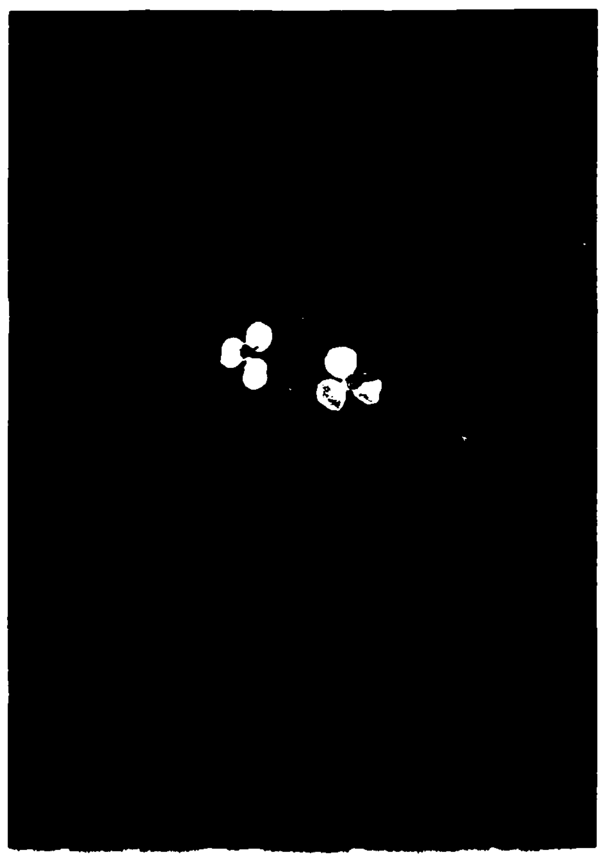


PLATE 16. Rare shrubs characteristic of study area Carolina bay depressions. [Frames (a) to (d) are viewed in order moving from the upper left-hand frame to the upper right-hand frame, then from the lower left-hand frame to the lower right-hand frame].

FRAME 16(a). Sarvis Holly (*Ilex amelanchier*) in fruit within a study area Carolina bay Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Swamp vegetation community. This species, like Awned Meadow Beauty, might be termed a "Carolina bay opportunist", because while it occurs sporadically in wetland communities other than Carolina bays, its largest populations are found within Carolina bay depressions.

FRAME 16(b). White Wicky (*Kalmia cuneata*) in flower within a study area Carolina bay Evergreen Shrub-bog: Pocosin vegetation community. This species is endemic to the pocosins of the Bladen/Cumberland County area of North Carolina. Most of those pocosins occur within Carolina bay depressions. While not widespread within the study area, it is locally abundant, though seldom seen, within the interiors of large, shrub-dominated bay depressions.

FRAME 16(c). A fruiting specimen of Jove's Fruit (*Lindera melissifolia*), one of our rarest shrubs, within a study area Carolina bay Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Swamp vegetation community. This species, while very rare both within and outside of Carolina bays, appears to be aggressively rhizomatous at those sites where it is found. At the same time, it also appears less tolerant of highly fluctuating water tables than most other shrub species observed in Carolina bays, and is therefore subject to rapid decline under unfavorable conditions.

FRAME 16(d). Pond-spice (*Litsea aestivalis*) in fruit within a study area Carolina bay Intermittently Ponded Cypress/Gum Depression vegetation community. Unlike the previous species, Pond-spice is apparently not rhizomatous, but like Jove's Fruit, is sensitive to highly fluctuating water levels. Pond-spice is relatively widespread, but was never observed to be even locally abundant within Carolina bay depressional communities.

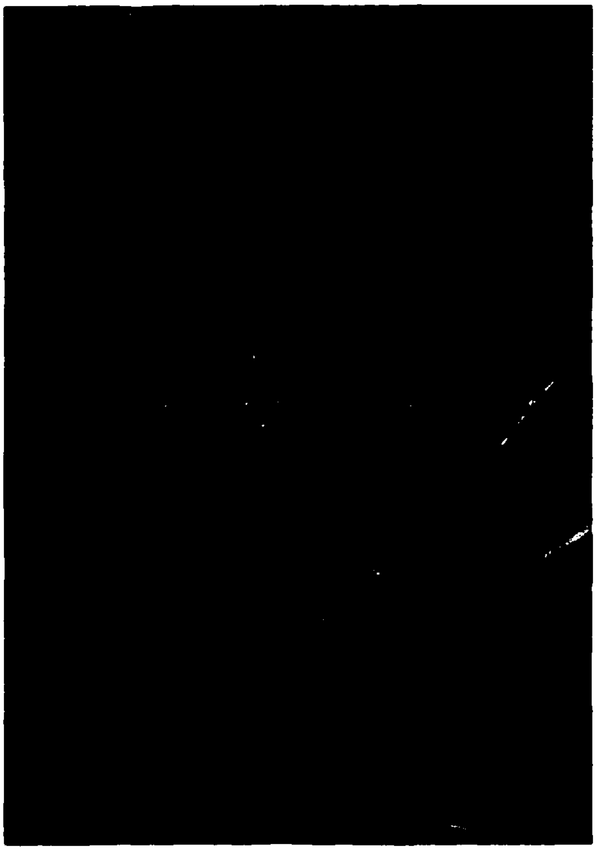
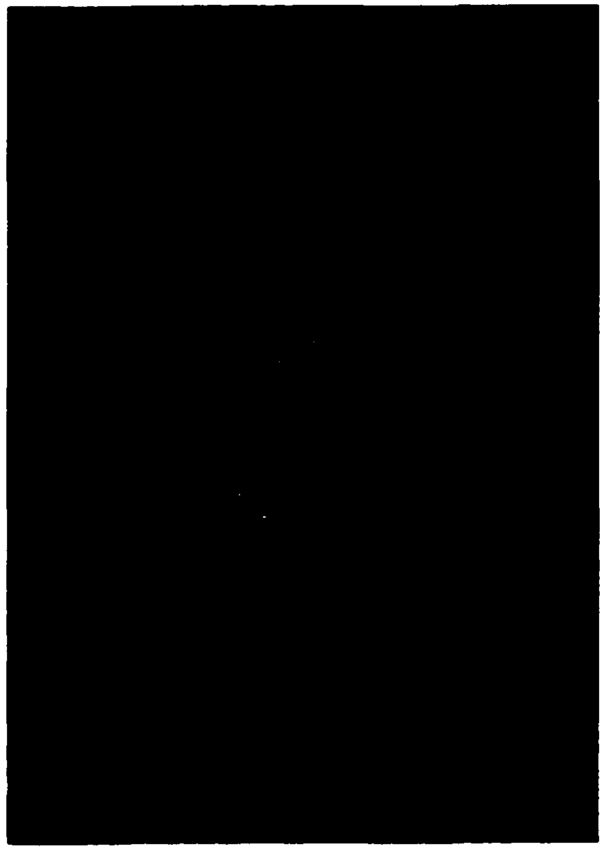
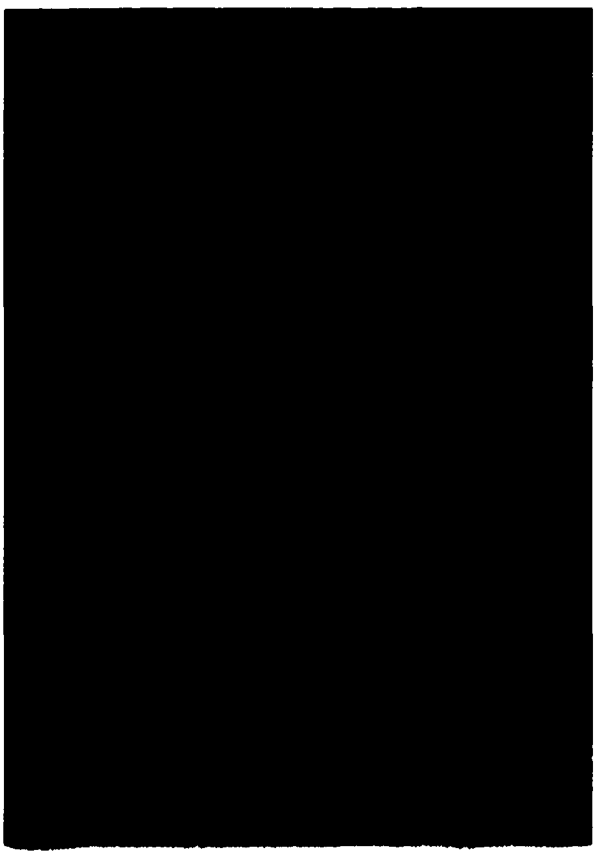
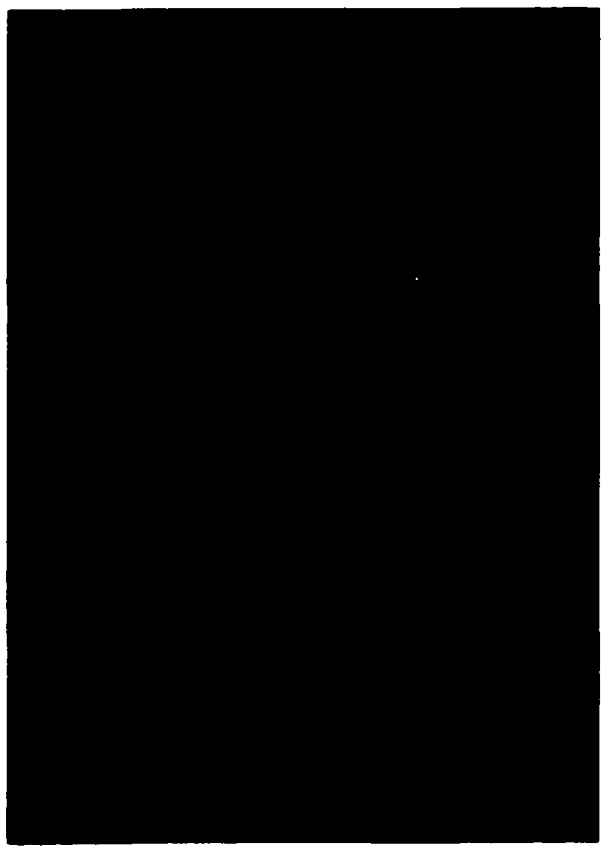





PLATE 17. [The frames are viewed in order from left to right]

FRAME 17(a). The apparent anomaly represented by a Pond Cypress standing in 65 cm deep water, whose bole shows evidence of fire scarring to 5 m in height. While the frequency of fire appears to vary widely within Intermittently Ponded Cypress/Gum Depression vegetation communities, fires are undoubtedly important in maintaining the structural and compositional integrity of virtually all Carolina bay communities, including those falling within this vegetation class. Field observation indicates that most fires within Carolina bays exhibiting Intermittently Ponded Cypress/Gum Depression vegetation are caused by lightning strikes.

FRAME 17(b). The charred stump of a burned out Pond Cypress in an Intermittently Ponded Cypress/Gum Depression vegetational community. The photograph evidences the at least occasional severity of the fires characterizing these depressions. The dominant graminoid in the photograph is Walter's Sedge, while the yellow-flowered herb is Flattop Polygala. The other "flower" is a field assistant, my oldest daughter, Rebecca Lee, then 10 years old.

PLATE 18. Histosols: "Organic" dominated Carolina bay soil profiles. Terric Medisaprists are shallow organic soils that form at very wet sites over sandy or loamy mineral sediments. Within the study area, they are most common in North Carolina, but are also frequent in northeastern South Carolina. Typic Medisaprists are the deep "peaty" mucks. Within the study area, they are generally limited to the largest Carolina bay depressions or those located on the elevationally low, Outer Lower Coastal Plain. [The frames are viewed in order from top to bottom. The top of each soil profile pictured is at the left of its respective frame.]

FRAME 18(a). A loamy, siliceous, dysic, thermic Terric Medisaprist soil pedon extracted from a Carolina bay site characterized by a Cypress/Gum Bog vegetation community type. The organic soil pictured is shallow at this outer bay location, but ranges to at least 65 cm in depth at other locations within the depression. The underlying mineral, "parent material" sediments seen below the shallow organic layer in the photograph comprise a loam to sandy loam. The roots of site herbs, shrubs, and some canopy species are limited to the upper part of the soil profile. Only the roots of larger site trees penetrate into the underlying mineral strata.

FRAME 18(b). A soil profile of a sandy, mixed, euic, thermic Terric Medisaprist soil occurring in a study area Carolina bay exhibiting another Cypress/Gum Bog vegetation community type. Like the soil seen in the immediately preceding frame, this organic soil pedon is relatively shallow, here some 55 cm in depth, and contains virtually all roots of site herbaceous species. The mineral sediments underlying the organic soil are a fine sand. This is a most unusual soil within study area Carolina bays, in that it appears to represent a Histosol formed on top of a preexisting Spodosol. In the photograph, the light grayish, underlying sand layer beginning at *ca.* 60 cm in depth within the profile, is an apparent albic horizon. It, in turn, overlies a very dark brown, "buried" spodic layer starting at *ca.* 1 m in depth. A Typic Haplaquod soil is typical of the Pocosin vegetation that comprises the majority of the depression vegetation in the site at which this soil profile was extracted. Such a soil would likely have formed during a period when the site water table was lower, and water levels fluctuated up and down substantially over an extended time period. The shallow organic soil that now overlies the Spodosol at this site appears indicative of secondary soil formation resulting from an alteration of hydrology at the location of this community, yielding a more stable, higher site water table.

FRAME 18(c). A dysic, thermic Typic Medisaprist soil pedon taken from a Carolina bay site characterized by an Evergreen Shrub bog: Pocosin vegetation community type. Note that the roots of site woody species are largely confined to the upper 50 cm or so of the soil profile. Much of the plant material in the upper portion of the profile is relatively undecomposed, and identifiable by species. While organic matter decomposition increases with increasing depth, the plant detritus is, by comparison with the soil pictured in Frame 18(d), below, still relatively undecomposed and recognizable as decaying plant material.

FRAME 18(d). Another dysic, thermic Typic Medisaprist soil profile from a Carolina bay site exhibiting Evergreen Shrub-bog: Pocosin vegetation. Like the immediately preceding soil pedon pictured in frame 18(c), the roots of predominant site woody and herbaceous species are limited almost entirely within this solum to a "mat" of highly intertwined roots and rhizomes in the upper 50 cm of the soil profile. Below that mat, the organic material is a highly decomposed, very fluid, almost "quicksand-like" muck the color and consistency of partially congealed chocolate pudding. Anecdotal evidence indicates that the muck at this site extends to a depth of > 6 m, making it by far the deepest peat encountered in a study area Carolina bay depression.

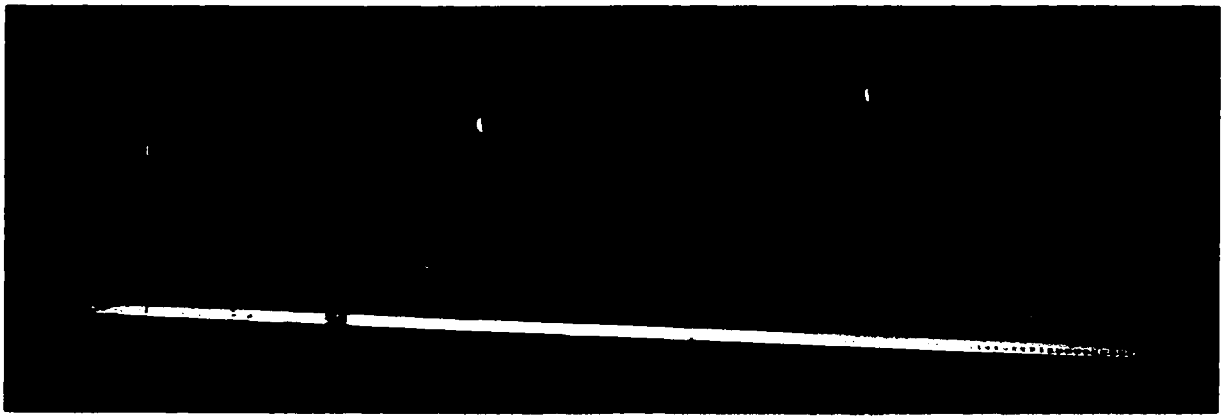
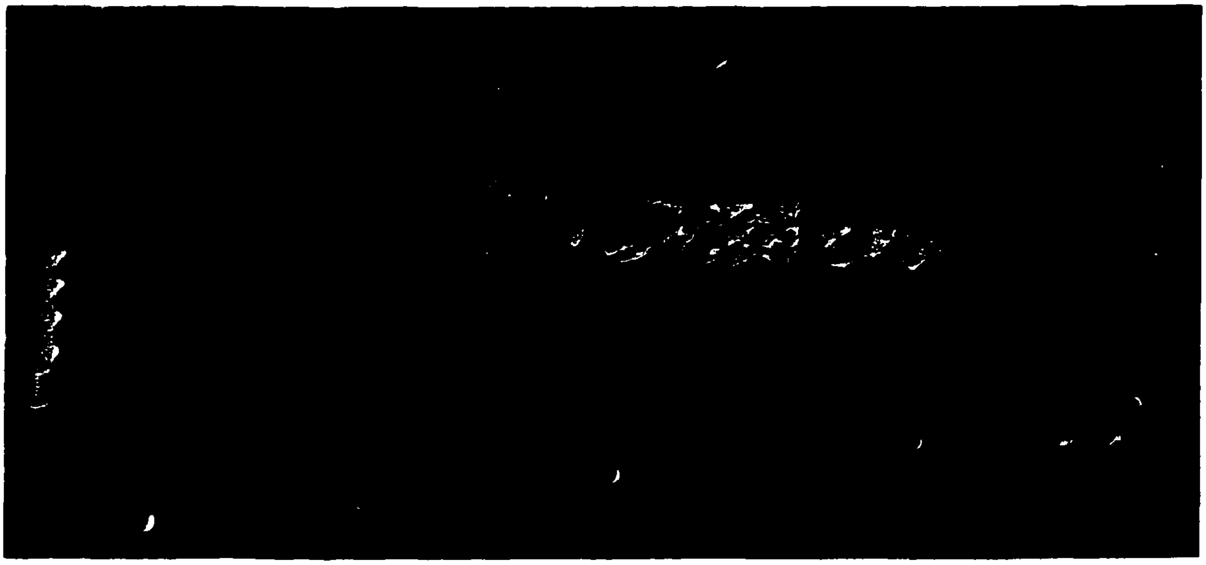


PLATE 19. Spodosols: Spodosols are the sandy Carolina bay depression soils that exhibit zones of illuviation (translocation) -- *i.e.*, an albic horizon -- and zones of eluviation (relocation) -- *i.e.*, a spodic horizon. [The frames are viewed in order from top to bottom. The top of each soil profile is at the left of its respective frame.]

FRAME 19(a). A sandy, siliceous, thermic Typic Haplaquod soil pedon taken from a Carolina bay site characterized by an Intermittently Ponded Cypress/Gum Depression: Wet Savanna vegetation community. Haplaquods form in temperate, sandy soils under acidic vegetation at sites where a high water table has fluctuated up and down within the soil solum over long time periods. While the upper part of the soil profile is a blackish loam with relatively high organic matter content, it is shallowly underlain by a light gray, sandy to loamy albic layer that represent a zone from which surface organic matter -- typically along with amorphous aluminum compounds -- has been leached (illuviated) downwards. The spodic horizon, seen at the bottom of the pedon shown in the photograph, is usually dark brown to dark reddish brown and slightly indurated. The spodic layer is the eluviation zone in which the downwardly translocated organic matter and aluminum compounds accumulate. Roots of woody species typically penetrate into the spodic horizon in Carolina bay depressions. While the pictured Typic Haplaquod soils occurs beneath an Intermittently Ponded Cypress/Gum Depression: Wet Savanna community type, Spodosols are known to occur within study area bays exhibiting this vegetation type only very rarely. The soil is much more characteristic of Evergreen Shrub-bog vegetation communities.

FRAME 19(b). Another sandy, siliceous, thermic Typic Haplaquod soil pedon, in this case extracted from a Carolina bay site exhibiting Evergreen Shrub-bog: Pocosin vegetation, which is typical of this soil family. The profile pictured shows the highly diagnostic albic horizon at *ca.* 27-40 cm, grading downwards to a nearly black, slightly indurated spodic layer at *ca.* 75 to 90 cm, just to the right of the profile center. As seen in the photograph, the spodic horizon is immediately underlain by another lighter colored, albic horizon, which is in turn underlain by a second spodic horizon. Such alternating albic/spodic layers are common in the relatively better drained study area Carolina bay soils developed in sandy sediments. The alternating layers appear to reflect differing site water table regimes at different periods of time in the development of the soil solum.

FRAME 19(c). A close-up view of the illuviation zone (albic layer) overlying the spodic horizon in the soil solum pictured in Frame 19(b), above. Note the highly leached, almost whitish sand within this diagnostic layer, sandwiched between texturally similar sandy layers exhibiting grains that are darkly stained by organic acids, coated with organic materials, or both.



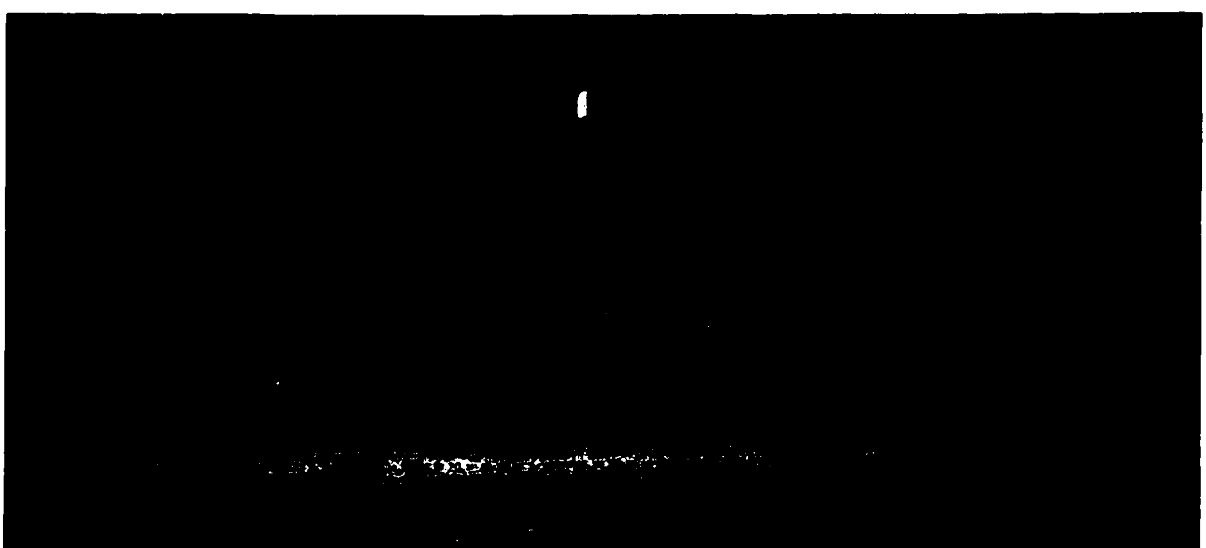
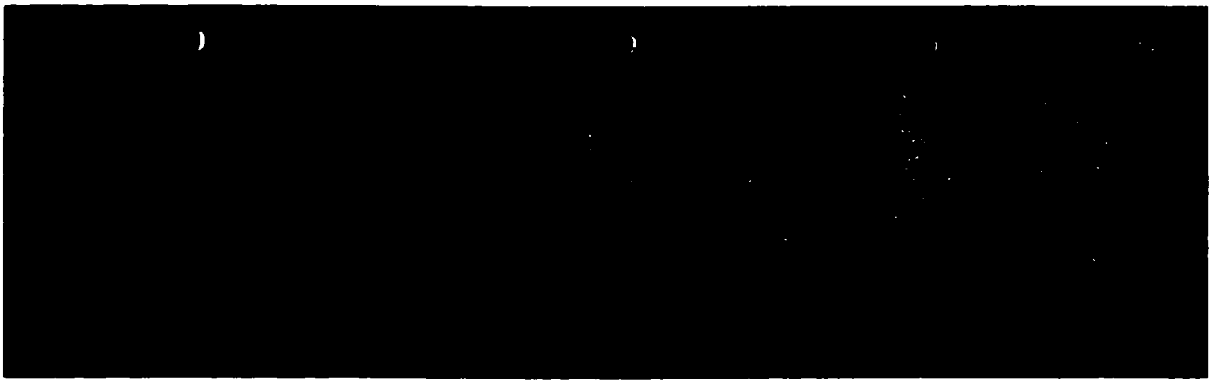


PLATE 20. Ultisols -- Fragiaquults (Plate 1 of 2): Ultisols are the clay-dominated soils found within Carolina bay depressions. Fragiaquults are the very wet Ultisols characterized by a subsurface "fragipan" layer. [The frames are viewed in order from top to bottom]

FRAME 20(a). Soil profile of a clayey, kaolonitic, thermic Typic Fragiaquult pedon taken from a study area bay site exhibiting an Intermittently Ponded Cypress/Gum Depression: Drawdown Meadow vegetation type. As shown here, the upper 15-25 cm of the profile for this soil group is typically a black "organic loam", but the influence of organic materials diminishes rapidly below that depth. The bright orange and reddish-orange colored mottles seen in the solum (indicating areas of subsurface oxidation) interspersed with grayish strata (indicating likely reducing conditions during layer formation) are typical of Fragiaquult soils. They reflect a soil ontogeny characterized by a long-term, fluctuating, highly variable site water table.

FRAME 20(b). A close-up view of the fragipan layer of the soil shown in Frame 19(a), above. Note both the massive, almost structureless sandy clay that comprises this diagnostic layer, and the alternating bright and gleyed soil colors within the horizon. The fragipan is a relatively impermeable layer in terms of water movement and root penetration, and would thus appear to be the current cause of the surface ponding of water at sites typified by this soil. However, because fragipan formation is apparently caused by long-term, periodically fluctuating, highly variable site water levels, it is likely that they formed at a time when the regional water table was higher than at present.

FRAME 20(c). Soil profile of a clayey, kaolonitic, thermic Typic Fragiaquult pedon taken from a study area Carolina bay depression characterized by an Intermittently Ponded Cypress/Gum Depression: Cypress/Gum Pond vegetation. As in the immediately preceding frames, relatively bright subsurface soil solum colors are noteworthy, and are indicative of intra-soil oxidizing conditions over the long term. This occurs within this depression despite the facts that it is inundated a majority of the time, and that the profile was extracted from the depression floor beneath 65 cm of surface water.



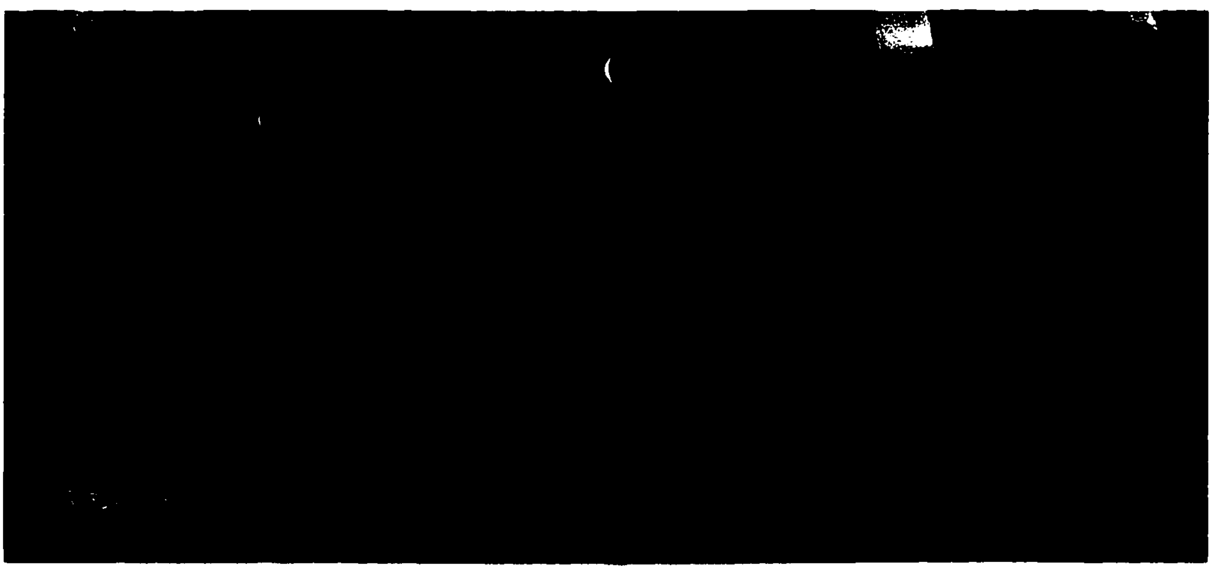


PLATE 21. Ultisols -- Paleaquults, Umbraquults, and Ochraquults (Plate 2 of 2): Clay-dominated soil profiles found in study area Carolina bay depressions other than Fragiaquults. [The frames are viewed in order from top to bottom. Soil profiles are presented so that the top of the soil profile is at the left side of its respective frame.]

FRAME 21(a). Soil profile of a fine-loamy, siliceous, thermic Typic Paleaquult pedon taken from a bay depression site exhibiting Freshwater Pond vegetation. Like the Fragiaquults viewed previously, here: (1) the top portion of the soil solum is dominated by organic materials that diminish rapidly with depth, and (2) the majority of the profile consists of sandy clays and clays exhibiting alternating strata (or mottles) of bright red and gray (or gleyed) colors. These bright colors indicate free oxygen in the soil and long-term oxidizing conditions in that layer, despite the current (and typical) inundated condition of the site. The pedon ends rather abruptly at *ca.* 1.5 m with the encounter of a bright white, loamy sand that represents underlying "parent material".

FRAME 21(b). Soil profile of a fine-loamy, siliceous, thermic Typic Ochraquult pedon extracted from a study area Carolina bay site characterized by Freshwater Marsh vegetation. The profile of this soil type is generally similar to that of a Typic Paleaquult soil in color and texture. However, it lacks the dark, organic-dominated surface layer seen in other Great Groups comprising study area Aquults, having instead a light-colored, "ochric" epipedon. Typic Ochraquult soils are occasional in bay depressions located in the southwestern part of the study area, but are not known to occur in Carolina bays in North Carolina.

FRAME 21(c). Soil profile of a fine-loamy, siliceous, thermic Umbric Paleaquult pedon taken from a study area bay depression site exhibiting Intermittently Ponded Cypress/Gum Depression: Wet Savanna vegetation. This soil is more or less intermediate in appearance and nature between the Typic Paleaquult soil pictured in Frame 21(a), above, and the "mucky variant" Umbric Paleaquult soil pictured in Frame 21(d), below. Like the former soil, it has brighter colored solum mottles, indicating at least occasional subsurface oxidizing conditions, but like the latter soil, shows a significant accumulation of surface organic matter. Within study area Carolina bays, these soils appear to be most characteristic of Intermittently Ponded Cypress/Gum Depression: Wet Savanna vegetation communities. They noticeably lack the very bright colored subsurface mottles that typify depressions with highly variable site water levels -- which have either Typic Fragiaquult or Typic Paleaquult soils, and are characterized by either Intermittently Ponded Cypress/Gum Depression: Drawdown Savanna/Meadow or Intermittently Flooded Depression Meadow vegetation communities-- but as noted retain some bright mottling in the subsurface strata. Such solum characteristics appear to reflect the more stable site water levels at those sites characterized by Wet Savanna/Meadow vegetation communities.

FRAME 21(d). Soil profile of a "mucky variant" of a fine-loamy, siliceous, thermic Umbric Paleaquult soil pedon extracted from a study area Carolina bay site exhibiting Cypress/Gum Bog vegetation. While this soils fits within the parameters for this soil family and is of a clay loam to clay texture in most of the profile, it is unusual in having a shallow muck (rather than loam) "umbric" surface layer. The dark gray solum lacking any bright colors at this site indicates the relative lack of periodic subsurface oxidizing conditions in this depression, which is typically in a ponded condition. It is these near continuous reducing conditions that likely led to the formation of the organic surface layer that sets this site apart from most other study area Carolina bay depression sites having clayey soils.

PLATE 22. Entisols: Very young, relatively undeveloped soil profiles from study area Carolina bay depressions. [The frames are viewed in order from top to bottom]

FRAME 22(a). A siliceous, thermic Typic Psammaquent soil pedon taken from a Carolina bay site characterized by a Longleaf Pine Woodland vegetation community. The profiles consists of medium to fine quartz sand throughout, with little zonal differentiation other than organic staining of the sand particles in the upper portion of the pedon (the bottom of the photograph) and changes in the sandy particle size within the profile. The subsurface grains are a clean, very white sand whose brightness is outshone only by the smile of my field assistant, Rebecca Lee Nifong. As can be seen from the coating of the augur and the soil on the mat, this is a very wet soil, with water typically standing within 30 cm of the soil surface. This soil presumably formed in eolian sands blown into this depression from surrounding sandy uplands, overtopping ultimately clayey depression bottom sediments.

FRAME 22(b). A mixed, thermic Typic Psammaquent soil pedon taken from a Carolina bay site characterized by a Brackish Marsh vegetation community. Depression sediments at this site have resulted from periodic depositions by estuarine tidal waters, giving the site a different mineralogy than that of the immediately preceding soil profile. However, like that profile, there is little apparent zonal differentiation here other than organic staining of the sand particles in the bulk of the upper pedon (the left-hand portion of the photograph) and changes in the sandy particle size within the profile. The browner sediments at the bottom of the profile (right-hand portion of the photograph) are indicative of relatively unstained, *in situ* sediments.

## APPENDIX I. Catalog of Carolina Bay Sites.

The general locations of Carolina bay sites sampled within the study area are shown in Figure 4.1, while summary information pertaining to intensively sampled plots is provided in Table 4.5. Appendix I contains more detailed information with respect to both sampled sites and intensively sampled plots. Sampled Carolina bay sites are listed alphabetically by county and site within each State. Synonymous site names are set out in parentheses immediately after the listed site name. The name of the U.S. Geological Survey topographic quadrangle on which the site is found is provided in brackets following the site name and any synonyms. For each site, a general location is described by reference to county road maps or other references, a listing of vegetation classes (or subclasses) encountered at the site is provided, and coordinates for intensively sampled plots are given.

### NORTH CAROLINA SITES

#### Bladen County

Bear Run Bay [Tomahawk, N.C.]

LOCATION:
This site occurs as one in a northwest--southeast series of Carolina bays east of Black Lake in the northeastern portion of Bladen County; Bear Run Bay is just southeast of Kelso Bay in that series. It is located immediately west of a major northwest--southeast power line right-of-way, some 1.1 miles southeast of the end of S.R. 1553, which is crossed by that power line.

VEGETATION GROUPS:
7.2.4. *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0012. | 343940N | 782122W | 0013. | 343940N | 782122W |
| 0018. | 343940N | 782122W | 0019. | 343940N | 782122W |

Big Gallberry Bay (Jerome Bog) [Jerome, N.C.]

LOCATION:
This site is found near Jerome in the northwestern portion of Bladen County. It is located

0.6 miles east of Hwy. NC 53, north of an unimproved road that intersects that highway just south of the Bladen/Cumberland County line. Alternatively, the site is located 0.4 miles north of the end of S.R. 1345, which intersects Hwy. 53 at Jerome.

VEGETATION GROUPS:
7.1.1. *Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0182. | 345055N | 784331W | 0183. | 345055N | 784331W |
| 0188. | 345055N | 784331W | 0189. | 345055N | 784331W |

Cypress Pond [Jerome, N.C.]

LOCATION:
This site is is also found near Jerome in the northwestern part of Bladen County, a short distance southeast of Big Gallberry Bay. It is located 0.15 mile south of S.R. 1345, 0.4 miles east of its intersection with Hwy. NC 53.

VEGETATION GROUPS:
8.0.8. *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/(Leucobryum* spp.) Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0051. | 345022N | 784433W | 0052. | 345022N | 784433W |
| 0053. | 345022N | 784433W | 0054. | 345022N | 784433W |

Dowd's Bay [Dublin, N.C., Jerome, N.C.]

LOCATION:
This site lies in the north central portion of the county, east of White Oak. It is located immediately west of an unimproved logging road 0.9 miles north of S.R. 1324. The logging road intersects S.R. 1324 1.35 miles east of its junction with S.R. 1332.

VEGETATION GROUPS:
7.2.1. *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/ (Cladonia* sp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0042. | 344456N | 783858W | 0043. | 344456N | 783858W |
| 0048. | 344456N | 783858W | 0049. | 344456N | 783858W |

Jones Lake [Elizabethtown North, N.C.]

LOCATION:
This site is located in Jones Lake State Park, west of Hwy. NC 242, some 3.5 miles north of Elizabethtown. The entrance of the State Park is 0.3 miles south of the intersection of Hwy. NC 242 and S.R. 1511.

VEGETATION GROUPS:
7.1.1. *Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0032. | 344128N | 783556W | 0033. | 344128N | 783556W |
| 0038. | 344128N | 783556W | 0039. | 344128N | 783556W |

Mill Bay [Ammon, N.C.]

LOCATION:
This site is located 60 m north of S.R. 1329 *ca.* 0.8 miles west of its intersection with Hwy. NC 242, just south of the Bladen/Cumberland County line.

VEGETATION GROUPS:
7.2.1. *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/* (*Cladonia* sp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0192. | 345018N | 783421W | 0193. | 345018N | 783421W |
| 0198. | 345018N | 783421W | 0199. | 345018N | 783421W |

Smith Mill Pond (Smith's Pond) [White Lake, N.C.]

LOCATION:
This site is found in the northeastern portion of the county, *ca.* 3.4 miles south of the Bladen/Sampson County line. It is located immediately southeast of the intersection of S.R. 1523 and Hwy. US 701.

VEGETATION GROUPS:
7.2.4. *Zenobia-Chamaedaphne/Sphagnum* spp. Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0732. | 344324N | 782621W | 0733. | 344324N | 782621W |
| 0738. | 344324N | 782621W | 0739. | 344324N | 782621W |

**Brunswick County**

Target Bay [Southport, N.C.]

LOCATION:
This site occurs adjacent to a private firearm firing range in southeastern Brunswick County, some 2.5 miles northwest of Southport. It is located immediately west of a private, marled road 1.1 miles north of its intersection with Hwy. NC 211 at a point 0.1 mile east of Beaverdam Creek.

VEGETATION GROUPS:
7.2.3. *(Pinus serotina )/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0322. | 335822N | 780514W | 0323. | 335822N | 780514W |
| 0328. | 335822N | 780514W | 0329. | 335822N | 780514W |

**Carteret County**

Bog Hole Bay [Atlantic, N.C.; Long Bay, N.C.]

LOCATION:
This site is located immediately east of Hwy. NC 12 1.2 miles north of its intersection with Hwy. US 70, west of Atlantic.

VEGETATION GROUPS:
5.0.1. *Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marsh.
5.0.2. *(Acer-Nyssa biflora-Pinus taeda)/Sphagnum* spp. Marsh.
7.2.3. *(Pinus serotina )/Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia/Smilax laurifolia/(Woodwardia virginica)/(Sphagnum* spp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0241. | 345354N | 762229W | 0251. | 345355N | 762228W |
| 0261. | 345354N | 762226W | 0271. | 345353N | 762226W |
| 0281 | 345352N | 762224W | 0291. | 345354N | 762227W |
| 0301. | 345354N | 762227W | 0312. | 345355N | 762241W |
| 0313. | 345355N | 762241W | 0318. | 345355N | 762241W |
| 0319. | 345355N | 762241W | | | |

Drowned Bay [North Bay, N.C.]

LOCATION:
This site is located 150 m west of a public dump site along Hwy. NC 12, 0.75 miles south of the Cedar Point ferry landing.

VEGETATION GROUPS:
1.0.1. *Juncus roemerianus* Marsh.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0211. | 350031N | 761905W | 0212. | 350031N | 761905W |
| 0213. | 350031N | 761905W | 0214. | 350031N | 761905W |

Sawgrass Bay [Hadnot Creek, N.C.; Masontown, N.C.]

LOCATION:
This site is located in Croatan National Forest some 0.25 miles northeast of Pringle Road (F.R. 123), *ca.* __ miles north of its intersection with Hwy. NC 24 at Ocean.

VEGETATION GROUPS:
8.0.10. *(Nyssa biflora)/(Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0682. | 344500N | 765957W | 0683. | 344500N | 765957W |
| 0688. | 344500N | 765957W | 0689. | 344500N | 765957W |

**Craven County**

Ellis Lake (Lake Ellis Simon) []

LOCATION:
This site is found in southeastern Craven County on the Craven/Carteret County line, some 3.0 miles southwest of Havelock. It is located immediately adjacent to Camp Bryan, a private hunting camp. Public access to the site is restricted by a gated, private road intersecting S.R. 1756 0.65 mile north of the county line.

VEGETATION GROUPS:
3.0.2. *Mayaca* Pond.
5.0.2. *(Acer-Nyssa biflora-Pinus taeda)/Sphagnum* spp. Marsh.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0771. | 345131N | 770021W | 0781. | 345127N | 770011W |

| | | | | | |
|---|---|---|---|---|---|
| 0791. | 345057N | 765924W | 0801. | 345057N | 765921W |
| 0811. | 345101N | 765921W | | | |

**Cumberland County**

Big Pond Bay [Roseboro, N.C.]

LOCATION:
This site lies in the extreme southeastern portion of Cumberland County near the community of Beaverdam. It is located 75 m south of S.R. 2033, 0.5 miles north of its juncture with S.R. 2034.

VEGETATION GROUPS:
9.1.3. *Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/Lindera/Smilax glauca/Carex glaucescens* Swamp.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0742. | 345504N | 783503W | 0743. | 345504N | 783503W |
| 0748. | 345504N | 783503W | 0749. | 345504N | 783503W |

Bushy Lake [Autryville, N.C.; Jerome, N.C.]

LOCATION:
This site comprises a State Park Natural Area located 2 miles east of Hwy. NC 53 in the southernmost portion of Cumberland County. It is accessed by unimproved park roads connecting with S.R. 1002 some 4.2 miles north of the Cumberland/Bladen County line.

VEGETATION GROUPS:
7.2.2. *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0722. | 345231N | 784211W | 0723. | 345231N | 784211W |
| 0728. | 345231N | 784211W | 0729. | 345231N | 784211W |

Huckleberry Pond (Little Duck Pond Swamp) [Vander, N.C.]

LOCATION:
This site lies just east of Hwy. I-95 northeast of Vander. It is located immediately north of S.R. 1864 *ca.* 0.25 miles east of its intersection with S.R. 1887.

VEGETATION GROUPS:

8.0.7. *Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.*-Zenobia)/Sphagnum* spp. Bog.

9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0172. | 350337N | 784720W | 0173. | 350337N | 784720W |
| 0178. | 350337N | 784720W | 0179. | 350337N | 784720W |
| 2751. | 350346N | 784724W | | | |

**Dare County**

Cranberry Bay [Engelhard Northeast, N.C.; Long Shoal, N.C.]

LOCATION:

This site is located 0.65 mile west of Hwy. US 264 *ca.* 6.0 miles southwest of Stumpy Point. It is accessed by a foot trail that intersects Hwy. US 264 some 1.1 miles north of Pain's Creek Canal.

VEGETATION GROUPS:

7.2.2. *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0752. | 353731N | 754753W | 0753. | 353731N | 754753W |
| 0758. | 353731N | 754753W | 0759. | 353731N | 754753W |

**Hoke County**

Ashmont Bay (McCain Bay) [McCain, N.C.]

LOCATION:

This site is located *ca.* 1.5 miles west of Hwy. NC 211 near Ashmont in the northwest portion of Hoke county. It is located 200 m south of S.R. 1225, some 0.25 southeast of its junction with S.R. 1226.

VEGETATION GROUPS:

9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.

PLOT COORDINATES:

| | | |
|---|---|---|
| 2851. | 350053N | 792214W |

Cowlick Bay [Red Springs, N.C.]

LOCATION:
This site is found in the southeastern portion of Hoke County, and is located immediately north of S.R. 1448, 1.2 miles east of its intersection with S.R. 1105.

VEGETATION GROUPS:
9.2.1. *Taxodium ascendens* Pond.
9.2.2. *Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 1961. | 345312N | 791055W | 1971. | 345312N | 791056W |
| 1981. | 345311N | 791056W | 1991. | 345311N | 791055W |
| 2001. | 345311N | 791055W | 2011. | 345309N | 791048W |
| 2021. | 345316N | 791056W | 2031. | 345315N | 791055W |
| 2041. | 345314N | 791047W | 2051. | 345312N | 791052W |
| 2061. | 345315N | 791053W | 2071. | 345311N | 791049W |

Panic Bay [Wagram, N.C.]

LOCATION:
This site lies in the southwestern portion of Hoke County, and is located 150 m southeast of Hwy. US 401, 0.4 miles north of its intersection with S.R. 1200.

VEGETATION GROUPS:

PLOT COORDINATES:
2811. 345448N 791940W

Pumpkinseed Bay (Antioch Bay) [Red Springs, N.C.]

LOCATION:
This site is found in the extreme southeastern portion of Hoke County, near Antioch. It is located must northeast of Hwy. NC 211, *ca.* 0.6 miles south of its junction with S.R. 1447.

VEGETATION GROUPS:
9.3.6. (*Taxodium ascendens*)/*Pluchea rosea-Eupatorium leucolepis*/*Dichanthelium wrightianum* Meadow.
9.3.7. *Taxodium ascendens*/(*Pluchea rosea-Boltonia*)/*Dichanthelium wrightianum* Savanna.

Plot Coordinates:

| | | | | | |
|---|---|---|---|---|---|
| 0062. | 345148N | 791144W | 0063. | 345148N | 791144W |
| 0068. | 345148N | 791144W | 0069. | 345148N | 791144W |
| 0072. | 345149N | 791152W | 0073. | 345149N | 791152W |
| 0078. | 345149N | 791152W | 0079. | 345149N | 791152W |
| 0082. | 345153N | 791142W | 0083. | 345153N | 791142W |
| 0088. | 345153N | 791142W | 0089. | 345153N | 791142W |
| 1001. | 345150N | 791156W | 1011. | 345153N | 791154W |
| 1021. | 345151N | 791152W | 1031. | 345147N | 791139W |
| 1041. | 345149N | 791152W | 1051. | 345148N | 791154W |
| 1061. | 345146N | 791152W | 1071. | 345141N | 791145W |
| 1081. | 345143N | 791142W | 1091. | 345153N | 791145W |
| 1101. | 345150N | 791144W | 1111. | 345152N | 791142W |
| 1121. | 345145N | 791139W | 1131. | 345148N | 791150W |
| 1141. | 345145N | 791149W | 1151. | 345144N | 791146W |
| 1161. | 345146N | 791141W | 1171. | 345148N | 791145W |
| 1181. | 345142N | 791137W | 1191. | 345145N | 791134W |
| 1201. | 345149N | 791139W | 1211. | 345148N | 791136W |
| 1221. | 345158N | 791149W | 1231. | 345155N | 791147W |
| 1241. | 345149N | 791152W | 1251. | 345150N | 791148W |
| 1261. | 345152N | 791149W | 1271. | 345157N | 791153W |
| 2861. | 345150N | 791148W | 2871. | 345152N | 791156W |

Sarvis Bay [Wagram, N.C.]

Location:

This site is found in the southwest portion of Hoke County near Edenburg, *ca.* 1 mile east of Panic Bay. It is located immediately adjacent to the Laurinburg & Southern Railroad, which bisects the extreme southeastern tip of the site, 250 m southwest of the intersection of the railroad and S.R. 1121.

Vegetation Groups:

9.1.1. *Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp.
9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.

Plot Coordinates:

| | | | | | |
|---|---|---|---|---|---|
| 0022. | 345429N | 791827W | 0023. | 345429N | 791827W |
| 0028. | 345429N | 791827W | 0029. | 345429N | 791827W |
| 2821. | 345430N | 791832W | | | |

## Jones County

Round Ridge Bay [Maysville, N.C.; Catfish Lake, N.C.]

LOCATION:
This site lies immediately north of a public waterfowl impoundment located in Croatan National Forest, *ca.* 1 mile north of Catfish Lake Road some 5 miles southeast of Pollocksville.

VEGETATION GROUPS:
7.2.3. (*Pinus serotina* )/*Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia*/*Smilax laurifolia*/(*Woodwardia virginica*)/(*Sphagnum* spp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0222. | 345807N | 770737W | 0223. | 345807N | 770737W |
| 0228. | 345807N | 770737W | 0229. | 345807N | 770737W |

## Lenoir County

Black Pond [LaGrange, N.C.]

LOCATION:
This site is found some 2 miles northwest of LaGrange in extreme northwest Lenoir County. It is located 200 m north of S.R. 1515 at a point 0.3 miles east of its intersection with S.R. 1518.

VEGETATION GROUPS:
8.0.5. *Nyssa biflora*/(*Acer*)/*Decodon*/*Dulichium*/*Sphagnum* spp.-*Utricularia biflora* Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0692. | 351935N | 774521W | 0693. | 351935N | 774521W |
| 0698. | 351935N | 774521W | 0699. | 351935N | 774521W |

## Pender County

Well's Bay [Topsail, N.C.]

LOCATION:
This site lies in the Holly Shelter Game Land in southeastern Pender County. It is located immediately east of Lodge Road 1.5 miles southeast of its intersection with Tram Road. Public access to Lodge Road is controlled by a gate at its intersection with Hwy. US 17 0.5 miles south of S.R. 1563, some 2 miles north of Topsail.

VEGETATION GROUPS:

7.2.3. (*Pinus serotina* )/*Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia*/*Smilax laurifolia*/(*Woodwardia virginica*)/(*Sphagnum* spp.) Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0712. | 342621N | 774438W | 0713. | 342621N | 774438W |
| 0718. | 342621N | 774438W | 0719. | 342621N | 774438W |

**Robeson County**

Duck Potato Bay (Pretty Pond) [St. Pauls, N.C.]

LOCATION:

This site is found in northeastern Robeson County some 2 miles east of St. Pauls. It is located 200 m east of S.R. 1924, 0.2 miles south of its intersection with Hwy. NC 20.

VEGETATION GROUPS:

9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.

9.2.3. (*Taxodium ascendens*)/"Open-Water"Pond.

9.3.8. *Panicum hemitomon*/*Dichanthelium wrightianum-Scleria reticularis* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0672. | 344738N | 785534W | 0672. | 344738N | 785534W |
| 0672. | 344738N | 785534W | 0672. | 344738N | 785534W |
| 1431. | 344738N | 785529W | 1441. | 344737N | 785529W |
| 1451. | 344738N | 785529W | 1461. | 344737N | 785534W |
| 1471. | 344738N | 785532W | 1481. | 344741N | 785533W |
| 1491. | 344742N | 785534W | 1501. | 344740N | 785535W |
| 1511. | 344741N | 785531W | 1521. | 344735N | 785529W |
| 1531. | 344736N | 785530W | 1541. | 344736N | 785532W |
| 1551. | 344740N | 785537W | 1561. | 344737N | 785531W |
| 1571. | 344738N | 785528W | 1581. | 344739N | 785535W |
| 1591. | 344739N | 785535W | 1601. | 344738N | 785526W |
| 1611. | 344736N | 785527W | 1621. | 344742N | 785531W |
| 2791. | 344739N | 785533W | | | |

Goose Pond [Parkton, N.C.]

LOCATION:

This site is located immediately south of S.R. 1704 1.25 miles east of the Robeson/Hoke County line, just south of Lumber Bridge.

VEGETATION GROUPS:

9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.
9.3.5. *Taxodium ascendens*/*Eupatorium leucolepis*-*Rhynchospora inundata*/*Panicum verrucosum* Savanna.
9.3.10. *Taxodium ascendens*/*Rhynchospora inundata* Savanna.
9.3.11. *Taxodium ascendens*/(*Nyssa biflora*)/*Ilex amelanchier*/*Carex striata*-*Lachnanthes* Savanna.
9.3.12. *Taxodium ascendens*/*Rhynchospora inundata*/*Lachnanthes*-*Polygala cymosa* Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0142. | 345245N | 790559W | 0143. | 345245N | 790559W |
| 0148. | 345245N | 790559W | 0149. | 345245N | 790559W |
| 0152. | 345258N | 790601W | 0153. | 345258N | 790601W |
| 0158. | 345258N | 790601W | 0159. | 345258N | 790601W |
| 2431. | 345248N | 790552W | 2441. | 345244N | 790555W |
| 2451. | 345249N | 790559W | 2461. | 345245N | 790601W |
| 2471. | 345249N | 790606W | 2481. | 345251N | 790609W |
| 2491. | 345257N | 790608W | 2501. | 345252N | 790618W |
| 2511. | 345246N | 790608W | 2521. | 345252N | 790605W |
| 2531. | 345252N | 790600W | 2541. | 345253N | 790612W |
| 2551. | 345257N | 790620W | 2561. | 345259N | 790613W |
| 2571. | 345257N | 790602W | 2581. | 345300N | 790607W |
| 2591. | 345259N | 790603W | 2601. | 345255N | 790556W |
| 2611. | 345254N | 790604W | 2621. | 345254N | 790608W |
| 2771. | 345255N | 790557W | 2781. | 345247N | 790558W |

Gum Pond Bay [Parkton, N.C.]

LOCATION:

This site lies in the extreme northern portion of Robeson County, between Lumber Bridge and Parkton. It is located 75 m west of S.R. 1714, 0.9 miles south of its intersection with Hwy. NC 71.

VEGETATION GROUPS:

9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.
9.3.2. *Taxodium ascendens*/*Nyssa biflora*/*Panicum verrucosum*-*Scleria reticularis* Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0162. | 345325N | 790248W | 0163. | 345325N | 790248W |
| 0168. | 345325N | 790248W | 0169. | 345325N | 790248W |
| 2831. | 345325N | 790249W | | | |

Oak Savanna Bay [Rennert, N.C.]

LOCATION:

This site is found in the northern portion of the county *ca.* 0.75 miles southwest of Rennert. It is located 50 m north of S.R. 1811, 0.3 mile west of its intersection with S.R. 1752, immediately east of a northwest--southeast trending power line right-of-way.

VEGETATION GROUPS:

6.0.1. *(Panicum virgatum-Euthamia)/(Dichanthelium wrightianum)* Flatwood.
6.0.4. *Quercus marilandica/(Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa)/Schizachyrium-Tephrosia-Aster walteri* Savanna.
6.0.5. *(Nyssa sylvatica)/Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwood.
9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 1281. | 344830N | 790530W | 1291. | 344824N | 790531W |
| 1301. | 344828N | 790533W | 1311. | 344826N | 790529W |
| 1321. | 344828N | 790532W | 1331. | 344827N | 790531W |
| 1341. | 344830N | 790532W | 1351. | 344825N | 790528W |
| 1361. | 344827N | 790527W | 1371. | 344829N | 790529W |
| 1381. | 344828N | 790528W | 1391. | 344826N | 790529W |
| 1401. | 344825N | 790529W | 1411. | 344823N | 790527W |
| 1421. | 344824N | 790528W | | | |

Pistol Pond [Saint Pauls, N.C.]

LOCATION:

This site lies in northeastern Robeson County, some 5.5 miles northwest of St. Pauls. It is located 75 m north of S.R. 1907, immediately northwest of its intersection with S.R. 1922.

VEGETATION GROUPS:

2.0.1. *Leersia* Prairie.
4.0.4. *(Andropogon virginicus* var. *glaucus)/(Eleocharis melanocarpa)* "Successional Marsh".
4.0.5. *Liquidambar styraciflua-Pinus taeda* "Successional Marsh".
6.0.1. *(Panicum virgatum-Euthamia)/(Dichanthelium wrightianum)* Flatwood.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 1631. | 344939N | 785450W | 1641. | 344938N | 785450W |
| 1651. | 344940N | 785452W | 1661. | 344938N | 785453W |

| | | | | | |
|---|---|---|---|---|---|
| 1671. | 344938N | 785455W | 1681. | 344937N | 785454W |
| 1691. | 344936N | 785452W | 1701. | 344941N | 785453W |
| 1711. | 344941N | 785454W | 1721. | 344936N | 785450W |
| 1731. | 344941N | 785453W | 1741. | 344936N | 785453W |
| 1751. | 344940N | 785451W | | | |

Prickly-Ash Bay (Shorebird Bay) [Wakulla, N.C.]

LOCATION:
This site is found in southeastern Robeson County *ca.* 1.25 miles northeast of Floral College. It is located 50 m south of S.R. 1312, 0.45 miles northeast of its intersection with S.R. 1313.

VEGETATION GROUPS:
9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.

PLOT COORDINATES:
2841. 344738N 791824W

Strandy Road Bay (Chain Pond) [Rennert, N.C.]

LOCATION:
This site lies *ca.* 1.5 miles northwest of Rennert in the northern portion of Robeson County. It is located immediately east of S.R. 1825 (Strandy Road), 0.35 mile from its intersection with S.R. 1821.

VEGETATION GROUPS:
9.1.2. *Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/ Woodwardia virginica-Carex verrucosa* Swamp.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0552. | 345004N | 790445W | 0553. | 345004N | 790445W |
| 0558. | 345004N | 790445W | 0559. | 345004N | 790445W |

Titi Bay [St. Pauls, N.C.]

LOCATION:
This site is found in northeastern Robeson County near St. Pauls, *ca.* 2 miles southeast of Duck Potato Bay. It is located immediately north of S.R. 1006, 0.45 miles west of its intersection with S.R. 1924.

VEGETATION GROUPS:

8.0.6. *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/Woodwardia virginica* Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0702. | 344605N | 785431W | 0703. | 344605N | 785431W |
| 0708. | 344605N | 785431W | 0709. | 344605N | 785431W |

## Sampson County

Dew-Thread Bay (F-10 Bay, Penny Pond) [Garland, N.C.]

LOCATION:

This site lies some 2 miles northwest of Parkersburg near the Sampson/Bladen County line in the southern part of the county. It is located 250 m east of S.R. 1214, 1.25 miles north of the county line (*i.e.*, the South River).

VEGETATION GROUPS:

2.0.1. *Leersia* Prairie.
2.0.2. *Leersia/Panicum verrucosum* Prairie.
2.0.3. *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie".
4.0.1. *Eleocharis robbinsii* Marsh.
4.0.2. *Panicum hemitomon* Marsh.
4.0.5. *Liquidambar styraciflua-Pinus taeda* "Successional Marsh".
5.0.2. (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh.
9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.
9.3.3. *Nyssa biflora/Acer*/(*Panicum verrucosum*)/*Sphagnum* spp. "Savanna".
9.4.2. (*Pinus taeda*)/*Panicum tenerum/Centella-Dichanthelium wrightianum* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0092. | 345107N | 782818W | 0093. | 345107N | 782818W |
| 0098. | 345107N | 782818W | 0099. | 345107N | 782818W |
| 0102. | 345106N | 782818W | 0103. | 345106N | 782818W |
| 0108. | 345106N | 782818W | 0109. | 345106N | 782818W |
| 0111. | 345104N | 782820W | 0112. | 345104N | 782820W |
| 0113. | 345104N | 782820W | 0114. | 345104N | 782820W |
| 0121. | 345103N | 782820W | 0122. | 345103N | 782820W |
| 0123. | 345103N | 782820W | 0124. | 345103N | 782820W |
| 0132. | 345101N | 782821W | 0133. | 345101N | 782821W |
| 0138. | 345101N | 782821W | 0139. | 345101N | 782821W |
| 1761. | 345106N | 782819W | 1771. | 345104N | 782818W |
| 1781. | 345102N | 782818W | 1791. | 345103N | 782821W |

| | | | | | |
|---|---|---|---|---|---|
| 1801. | 345103N | 782820W | 1811. | 345105N | 782820W |
| 1821. | 345102N | 782816W | 1831. | 345101N | 782819W |
| 1841. | 345100N | 782816W | 1851. | 345059N | 782815W |
| 1861. | 345105N | 782822W | 1871. | 345105N | 782819W |
| 1881. | 345104N | 782817W | 1891. | 345103N | 782816W |
| 1901. | 345106N | 782818W | 1911. | 345100N | 782820W |
| 1921. | 345101N | 782817W | 1931. | 345101N | 782821W |
| 1941. | 345101N | 782813W | 1951. | 345103N | 782813W |
| 2741. | 345103N | 782820W | | | |

**Scotland County**

Big Cypress Meadow [Laurinburg, N.C.]

LOCATION:
This site is found in eastern Scotland County some 3.5 miles south of Wagram. It is located immediately west of Hwy. US 401 0.85 miles south of its intersection with S.R. 1416.

VEGETATION GROUPS:
4.0.5. *Liquidambar styraciflua-Pinus taeda* "Successional Marsh".
9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.
9.4.10. (*Taxodium ascendens*)/*Rhynchospora inundata*/*Centella* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0542. | 345051N | 792420W | 0543. | 345051N | 792420W |
| 0548. | 345051N | 792420W | 0549. | 345051N | 792420W |
| 2631. | 345253N | 790607W | 2641. | 345048N | 792413W |
| 2651. | 345038N | 792400W | 2661. | 345052N | 792417W |
| 2671. | 345043N | 792401W | 2681. | 345040N | 792417W |
| 2691. | 345044N | 792409W | 2701. | 345050N | 792409W |
| 2711. | 345047N | 792409W | 2721. | 345050N | 792418W |
| 2731. | 345047N | 792420W | | | |

Green Pond Bay [Ghio, N.C.--S.C.]

LOCATION:
This site lies in the extreme southwest portion of Scotland County near the community of Hunsucker, just north of the South Carolina line. It is located immediately north of S.R. 1152, between its intersection with S.R. 1158 and the C.S.X. Coastline Railroad (which runs south of and parallel to Hwy. NC 381).

VEGETATION GROUPS:

6.0.2. *Pinus palustris*/*Lyonia mariana*/*Aristida stricta*/(*Cladonia* spp.) Savanna.
6.0.3. *Pinus palustris*/*Ilex coriacea-Ilex glabra* Flatwood.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0592. | 344724N | 793754W | 0593. | 344724N | 793754W |
| 0598. | 344724N | 793754W | 0599. | 344724N | 793754W |
| 0602. | 344727N | 793750W | 0603. | 344727N | 793750W |
| 0608. | 344727N | 793750W | 0609. | 344727N | 793750W |

Laurinburg Road Bay (Rabbit Run Bay, 401 Bay) [Laurinburg, N.C.]

LOCATION:

This site lies just south of Big Cypress Meadow, some 4 miles southeast of Wagram. It is located immediately north and south of Hwy. US 401, which bisects the *bay*, *ca.* 0.2 miles north of that highway's juncture with S.R. 1424.

VEGETATION GROUPS:

9.1.4. *Taxodium ascendens*/(*Nyssa biflora*) Swamp.

PLOT COORDINATES:

2761. 345010N 792426W

Seventeen Frog Pond [Marston, N.C.]

LOCATION:

This site is located in the Sandhills Game Land in northern Scotland County. It lies 0.2 mile west of an unimproved Game Land road that runs parallel to S.R. 1328 some 1.5 miles to its east and 2.5 miles south of the Scotland/Richmond County line, just east of Towers Fork Creek.

VEGETATION GROUPS:

2.0.1. *Leersia* Prairie.
4.0.4. (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marsh".
6.0.1. (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 2081. | 345923N | 793042W | 2091. | 345924N | 793041W |
| 2101. | 345925N | 793042W | 2111. | 345922N | 793041W |
| 2121. | 345923N | 793039W | 2131. | 345922N | 793042W |
| 2141. | 345925N | 793040W | 2151. | 345924N | 793038W |
| 2161. | 345925N | 793039W | 2171. | 345926N | 793040W |

| | | | | | |
|---|---|---|---|---|---|
| 2181. | 345923N | 793038W | 2191. | 345921N | 793038W |
| 2201. | 345920N | 793039W | 2211. | 345924N | 793043W |

Sink Pond Bay [Johns, N.C.--S.C.]

LOCATION:
This site lies in extreme southeastern Scotland County south of Hasty. It is located immediately east of S.R. 1622, 0.6 miles north of its intersection with S.R. 1619.

VEGETATION GROUPS:
9.4.1. *Aster pilosus* var. *demotus*/(*Dichanthelium wrightianum-Eleocharis tricostata*) Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 2351. | 344023N | 792918W | 2361. | 344025N | 792916W |
| 2371. | 344024N | 792915W | 2381. | 344021N | 792916W |
| 2391. | 344025N | 792917W | 2401. | 344023N | 792915W |
| 2411. | 344023N | 792918W | 2421. | 344022N | 792915W |

State-line Prairie (located in North Carolina in part) [Johns, N.C.--S.C.]

LOCATION:
This site is bisected by the North Carolina/South Carolina state line south of Hasty. It is located immediately west of S.R. 1622 0.8 miles south of its intersection with S.R. 1619.

VEGETATION GROUPS:
4.0.2. *Panicum hemitomon* Marsh.
9.4.3. *Eupatorium leucolepis-Panicum rigidulum* var. *combsii*/ *Dichanthelium erectifolium-Rhynchospora filifolia*/*Stylisma aquatica* Meadow.
9.4.4. *Eupatorium leucolepis* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0571. | 343919N | 792930W | 0572. | 343919N | 792930W |
| 0573. | 343919N | 792930W | 0574. | 343919N | 792930W |
| 0581. | 343921N | 792934W | 0582. | 343921N | 792934W |
| 0583. | 343921N | 792934W | 0584. | 343921N | 792934W |
| 2221. | 343919N | 792929W | 2231. | 343918N | 792931W |
| 2241. | 343918N | 792935W | 2251. | 343918N | 792929W |
| 2261. | 343918N | 792934W | 2271. | 343921N | 792937W |
| 2281. | 343926N | 792939W | 2291. | 343924N | 792936W |
| 2301. | 343922N | 792934W | 2311. | 343921N | 792934W |
| 2321. | 343923N | 792938W | 2331. | 343926N | 792938W |
| 2341. | 343917N | 792932W | | | |

Tunstall's Bay [Laurinburg, N.C.]

LOCATION:
This site abuts Big Cypress Meadow to the north, and is located immediately west of Hwy. US 401 0.3 miles south of its intersection with S.R. 1416.

VEGETATION GROUPS:
2.0.2. *Leersia/Panicum verrucosum* Prairie.
4.0.2. *Panicum hemitomon* Marsh.
9.3.9. *Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0461. | 345054N | 792356W | 0471. | 345055N | 792356W |
| 0481. | 345057N | 792353W | 0491. | 345057N | 792350W |
| 0501. | 345100N | 792359W | 0511. | 345102N | 792403W |
| 0521. | 345103N | 792404W | 0531. | 345104N | 792404W |
| 2801. | 345056N | 792355W | | | |

**Wayne County**

Garris Chapel Bay [LaGrange, N.C.]

LOCATION:
This site found in eastern Wayne County near the Lenoir county line, some 5 miles southwest of LaGrange. It is located immediately north of S.R. 1733, 0.1 miles east of its intersection with S.R. 1731, just behind Garris Chapel United Methodist Church.

VEGETATION GROUPS:
8.0.7. *Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.-*Zenobia)/Sphagnum* spp. Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0202. | 351713N | 775049W | 0203. | 351713N | 775049W |
| 0208. | 351713N | 775049W | 0209. | 351713N | 775049W |

## SOUTH CAROLINA SITES

### Aiken County

Monetta Sink [Monetta, S.C.]

LOCATION:
This site is found in Aiken County, some 1.3 miles southeast of Monetta. It is located adjacent to a peach orchard immediately west of an unnumbered county road, 0.25 miles north of Hwy. NC 39.

VEGETATION GROUPS:
4.0.3. *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0421. | 335008N | 813527W | 0422. | 335008N | 813527W |
| 0423. | 335008N | 813527W | 0424. | 335008N | 813527W |

### Allendale County

Queen's Delights Bay (Barton Bay) [Barton, S.C.]

LOCATION:
This site lies in southeast Allendale County near the community of Barton, just north of the Allendale/Hampton County line. It is located immediately adjacent to an unumbered county road which bisects the extreme northwest end of the bay, 1.2 miles south of Barton.

VEGETATION GROUPS:
9.4.6. *(Ilex myrtifolia)/Hypericum fasciculatum-Stillingia/Carex striata* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0451. | 325420N | 811741W | 0452. | 325420N | 811741W |
| 0453. | 325420N | 811741W | 0454. | 325420N | 811741W |

Stony Lake Bay [Allendale, S.C.]

LOCATION:
This site is located *ca.* 1.5 miles northeast of Allendale, 120 m south of Hwy. SC 641, some 0.75 miles east of its junction with Hwy. US 301.

VEGETATION GROUPS:
3.0.1. *Nymphaea* Pond.

4.0.2. *Panicum hemitomon* Marsh.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0631. | 330109N | 811627W | 0632. | 330109N | 811627W |
| 0633. | 330109N | 811627W | 0634. | 330109N | 811627W |
| 0641. | 330112N | 811629W | 0642. | 330112N | 811629W |
| 0643. | 330112N | 811629W | 0644. | 330112N | 811629W |
| 0651. | 330111N | 811625W | 0652. | 330111N | 811625W |
| 0653. | 330111N | 811625W | 0654. | 330111N | 811625W |

**Bamberg County**

Cathedral Bay (Chitty Pond) [Olar, S.C.]

LOCATION:
This site lies some 1.5 miles southeast of Olar in Bamberg County. It is located immediately south of Hwy. SC 64, 0.5 miles north of its juncture with Hwy. US 301.

VEGETATION GROUPS:
9.3.1. *Taxodium ascendens*/(*Nyssa biflora*)/(*Ilex myrtifolia*)/(*Panicum verrucosum*) Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0612. | 330941N | 810957W | 0613. | 330941N | 810957W |
| 0618. | 330941N | 810957W | 0619. | 330941N | 810957W |
| 0622. | 330947N | 811002W | 0623. | 330947N | 811002W |
| 0628. | 330947N | 811002W | 0629. | 330947N | 811002W |

**Charleston County**

Cooter Creek Bay [Ocean Bay, S.C.]

LOCATION:
This is found in the Francis Marion National Forest near the Charleston/ Berkeley County line, *ca.* 4 miles northwest of Awendaw. It is located *ca.* 3.5 miles west of Hwy. U.S. 17-701, immediately southwest of a northwest--southeast oriented abandoned railroad grade 0.4 miles south of the intersection of the railroad grade with County Line Road.

VEGETATION GROUPS:
8.0.1. *Taxodium ascendens*/*Lyonia lucida*/*Carex striata*-*Woodwardia virginica*/ *Sphagnum* spp. Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0762. | 330318N | 794117W | 0763. | 330318N | 794117W |
| 0768. | 330318N | 794117W | 0769. | 330318N | 794117W |

Santee Reserve Bay [Santee, S.C.]

LOCATION:
This site lies in the extreme northeastern portion of Charleston County, *ca.* 2 miles south of the Santee River. It is located immediately south of an unimproved access road in the Santee Wildlife Preserve, 0.3 miles south of the Preserve entrance gate at the end of Santee School Road, some 1.6 miles south of its junction with Hwy. US 17-701.

VEGETATION GROUPS:
9.4.7. *Taxodium ascendens/Clethra alnifolia/Carex striata-Panicum hemitomon/* (*Eriocaulon compressum-Lachnanthes*) Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0562. | 330841N | 792433W | 0563. | 330841N | 792433W |
| 0568. | 330841N | 792433W | 0569. | 330841N | 792433W |

**Clarendon County**

Sandhill Bay [Butlers Bay, S.C.]

LOCATION:
This site is found in the southeastern portion of Clarendon County, *ca.* 2.4 miles west-southwest of Foreston. It is located immediately south of a dirt, county road that intersects with Hwy. US 521, where it is paved, at a point 1.35 miles south of the pavement's end.

VEGETATION GROUPS:
8.0.9. *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0342. | 333635N | 800554W | 0343. | 333635N | 800554W |
| 0348. | 333635N | 800554W | 0349. | 333635N | 800554W |

**Dillon County**

Little Pee Dee Bay (Little Pee Dee State Park Bay) [Fork, S.C.]

LOCATION:
This site lies within Little Pee Dee State Park in the southeastern portion of Dillon

County, *ca.* 2.5 miles east of Floydale. It is located immediately west of Little Pee Dee State Park Road, 0.2 miles southeast of the Park's main entrance, and some 0.8 miles north of the Little Pee Dee River bridge.

VEGETATION GROUPS:

7.1.2. *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/ Smilax laurifolia* Forest.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0332. | 341944N | 791720W | 0333. | 341944N | 791720W |
| 0338. | 341944N | 791720W | 0339. | 341944N | 791720W |

**Dorchester County**

Reevesville Bay [St. George, S.C.]

LOCATION:

This site is found about 1.4 miles west of Hwy. I-95 northeast of Reevesville, in western Dorchester County.

VEGETATION GROUPS:

8.0.4. *Nyssa biflora* "Boggy Swamp".

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0402. | 331403N | 803646W | 0403. | 331403N | 803646W |
| 0408. | 331403N | 803646W | 0409. | 331403N | 803646W |

**Horry County**

Trumpet Bay ("Lewis Ocean Bay") [Hand, S.C.]

LOCATION:

This site lies some 1.5 miles northwest of the Atlantic Intracoastal Waterway at Myrtle Beach, in the southeastern part of Horry County, in the Lewis Ocean Bay Preserve owned by the State of South Carolina and adminstered by the Nongame and Heritage Section of the S.C. Wildlife and Marine Resources Department, in Columbia.

VEGETATION GROUPS:

7.2.2. *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0232. | 334655N | 785045W | 0233. | 334655N | 785045W |

| | | | | | |
|---|---|---|---|---|---|
| 0238. | 334655N | 785045W | 0239. | 334655N | 785045W |

**Kershaw County**

Savage Bay [Camden North, S.C.]

LOCATION:
This site is found in east-central Kershaw County, some 2.0 miles northwest of Camden. It is located 200 m south of S.R. 835, 0.6 southeast of its intersection with Hwy. US 1, just northeast of the Shepard community.

VEGETATION GROUPS:
9.3.4. *Taxodium ascendens*/(*Cyrilla*)/*Scleria reticularis-Panicum verrucosum-Lachnanthes* Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0412. | 341930N | 803113W | 0413. | 341930N | 803113W |
| 0418. | 341930N | 803113W | 0419. | 341930N | 803113W |

**Lee County**

Mount Pleasant Church Bay [Elliott, S.C.]

LOCATION:
This site is found some 2.5 miles southeast of Elliott in southeastern Lee County. It is located 90 m north of S.R. S-31-44 (Vista Lane) *ca.* 0.4 miles west of its intersection with S.R. S-31-53 (Tram Road).

VEGETATION GROUPS:
9.4.9. (*Taxodium ascendens*)/*Aristida palustris-Rhynchospora inundata*/*Rhynchospora filifolia-Helenium-Centella* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0352. | 340407N | 800840W | 0353. | 340407N | 800840W |
| 0358. | 340407N | 800840W | 0359. | 340407N | 800840W |
| 0362. | 340408N | 800837W | 0363. | 340408N | 800837W |
| 0368. | 340408N | 800837W | 0369. | 340408N | 800837W |

**Lexington County**

Swansea Bay [Pelion East, S.C.]

LOCATION:
This site lies in southeastern Lexington County, some 6.5 miles northwest of Swansea. It is located 80 m west of Hwy. SC 6 0.1 miles south of its juncture with S.R. 73.

VEGETATION GROUPS:
4.0.1. *Eleocharis robbinsii* Marsh.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0662. | 334755N | 811111W | 0663. | 334755N | 811111W |
| 0668. | 334755N | 811111W | 0669. | 334755N | 811111W |

**Marlboro County**

State-line Prairie (located in South Carolina in part) [Johns, N.C.--S.C.]

LOCATION:
See entry for this site under "North Carolina, Scotland County", above.

VEGETATION GROUPS:
See entry for this site under "North Carolina, Scotland County", above.

PLOT COORDINATES:
See entry for this site under "North Carolina, Scotland County", above.

**Orangeburg County**

Branchville Bay [Branchville North, S.C.]

LOCATION:
This site lies in southeastern Orangeburg County. It is located immediately east of Hwy. US 21 3.8 miles north its intersection with Hwy. SC 210 at Branchville, some 0.8 mile south of the junction of Hwy. US 21 with Mays Chapel Road.

VEGETATION GROUPS:
9.4.5. *Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/ Eriocaulon compressum* Meadow.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0392. | 331824N | 804906W | 0393. | 331824N | 804906W |
| 0398. | 331824N | 804906W | 0399. | 331824N | 804906W |

**Richland County**

Gadsden Bay [Gadsden, S.C.]

LOCATION:
This site is found in central Richland County, 1.6 miles northwest of Gadsden. It is located 40 m north an unnumbered, dirt road that runs parallel to and 0.3 mile north of S.R. 2237, 0.2 miles east of its intersection with S.R. 2206, 1.0 mile south of the intersection of S.R. 2206 with Hwy. SC 769.

VEGETATION GROUPS:
9.4.8. *Liquidambar styraciflua/Ilex amelanchier/Carex striata-Panicum hemitomon* Savanna.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0442. | 335426N | 804649W | 0443. | 335426N | 804649W |
| 0448. | 335426N | 804649W | 0449. | 335426N | 804649W |

**Sumter County**

Woods Bay (primarily in Sumter Co.; partially in Clarendon Co.) [Olanta, S.C.; Turbeville, S.C.]

LOCATION:
This site comprises Woods Bay State Park on the Sumter/Clarendon County line, some 3.0 miles west of Olanta. The park entrance is located on the south side of Hwy. SC 48 (Olanta Road) 2.1 miles northwest of its intersection with Hwy. US 301.

VEGETATION GROUPS:
8.0.2. *Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog.
8.0.3. *Nyssa biflora-Taxodium ascendens/Decodon/(Smilax laurifolia)/Utricularia purpurea* Bog.

PLOT COORDINATES:

| | | | | | |
|---|---|---|---|---|---|
| 0372. | 335645N | 795907W | 0373. | 335645N | 795907W |
| 0378. | 335645N | 795907W | 0379. | 335645N | 795907W |
| 0382. | 335558N | 795843W | 0383. | 335558N | 795843W |
| 0388. | 335558N | 795843W | 0389. | 335558N | 795843W |

## APPENDIX II. Soil Profile Descriptions & Soil Summary Tables

The soil profile descriptions and other study area soils information that follows are arranged by vegetation group, as described in the body of the text. Following the soil profile descriptions, summary tables of the chemical properties and textures for sampling site soil samples are presented, by vegetation group and sample depth.

### 1. BRACKISH MARSH.

**1.0.1. *Juncus roemerianus* Marsh.** This community type is typified within the study area by a mixed, thermic Typic Psammaquent soil, as follows:

> The surface layer (A-horizon) of this soil is a 47 cm thick black (10YR2/1) loam to sandy loam having a significant organic component. The A-horizon directly overlies a hard, somewhat indurated, black (10YR2/1) to very dark brown (10YR2/2) medium sand to fine sand C-horizon that has the appearance of a "spodic" layer. Almost all plant roots were observed within the surface layer of the soil, *i.e.*, above the apparent spodic horizon.

### 2. INTERMITTENTLY FLOODED DEPRESSION PRAIRIE.

**2.0.1. *Leersia* Prairie.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Typic Paleaquult soil, as follows:

> The surface horizon is a black (10YR2/1) loam having a high organic matter content and some 9 cm thick, overlying a subsurface layer of very dark gray (10YR3/1) to very dark grayish-brown (10YR3/2) clay loam to 20 cm deep. Almost all of the plant roots from this community type occur within these surface layers. The upper part of the subsoil is a very dark grayish-brown to dark grayish-brown (10YR4/2) clay loam or sandy clay. In its lower portions (below 55 cm), the subsoil is a brown (10YR5/3) sandy clay to sandy clay loam that has few to common, small to medium red (5YR5/8) mottles. The subsoil often exhibits thin, interbedded layers of brown (10YR5/3) to medium brown (10YR4/3) sand, which appear to be "lithologic discontinuities" within the profile that likely represent eolian, sedimentary deposits within the depression basin. The underlying material (C-horizon) is a sequential series of brown to pale brown (10YR6/3) medium

to coarse sands and loamy sands, that occasionally have white (10YR8/1) sandy clay mottles.

**2.0.2. *Leersia/Panicum verrucosum* Prairie.** The soils found underlying this community type within the study area -- either a fine-loamy, siliceous, thermic Typic Paleaquult; or a clayey, kaolonitic, thermic Typic Fragiaquult -- are similar in appearance and nature to the soil profiles described, respectively, for community types 2.0.1, above, and 9.3.1, below.

**2.0.3. *Pinus taeda/Panicum hemitomon/Leersia* "Successional Prairie".** The soil found underlying this community type within the study area, a fine-loamy, siliceous, thermic Typic Paleaquult, is similar to that described for community type 2.0.1, above.

## 3. FRESHWATER POND.

**3.0.1. *Nymphaea* Pond.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Typic Paleaquult soil, as follows:

> The surface horizon is a very dark gray (10YR3/1) mucky loam some 12 cm deep, having a high organic matter content. A subsurface layer of dark grayish-brown (10YR4/2) to dark gray (10YR4/10) fine sandy loam overlies a multi-layered B-horizon. The subsoil is at least 130 cm deep. The upper part of the subsoil has a "marbled" appearance. It is a light brownish-gray (10YR6/2) to pale brown (10YR6/3) clay loam that is streaked with elongate, yellowish-brown (10YR5/8), light brownish-gray and strong brown (7.5YR5/8) sandy clay loam mottles, with many, small very dark gray (10YR3/1) and few, small yellowish-red (10YR5/8) mottles. The middle part of the subsoil is a light gray (10YR7/2) to strong brown sandy clay loam, with elongate, yellowish-red and dark gray (10YR5/1) mottles, or a very pale brown (10YR7/3) sandy loam with elongate, brownish-yellow (10YR6/2) and yellowish-red mottles. The lower part of the subsoil is a yellowish-brown sandy clay loam with common, small, elongate red (10R4/8) and few, small very pale brown sandy clay mottles. The underlying material (C-horizon) is a fine white (10YR8/2) sand, usually containing some elongate mottles of strong brown sandy clay.

**3.0.2. *Mayaca* Pond.** This community type is typified within the study area by a mixed, thermic Typic Psammaquent soil, as follows:

The surface layer is a black (10YR2/1) muck some 12 cm thick. Virtually all of the *Eriocaulon parkerii* roots observed in this community type were located within this shallow surface layer, but roots of perennial graminoids penetrate the underlying mineral soil. The surface layer overlies a 6 cm thick subsurface layer of dark grayish-brown (10YR4/2) fine sand. The underlying material is composed of interbedded mineral soils, including a gray (10YR5/1) to light gray (10YR7/1) sandy clay loam, and a light gray (10YR7/2) fine sand.

## 4. FRESHWATER MARSH.

**4.0.1. *Eleocharis robbinsii* Marsh.** This community type is typified within the study area by the "argillic" variant of a Typic Haplaquod soil, as follows:

The surface horizon of this soil is a black (2.5Y2/0), 17 cm thick loam having a high organic matter content, overlying a black (10YR2/1) loam, subsurface, "transition" layer to 33 cm deep that is streaked with elongate mottles of very light gray (10YR4/1) clay loam. The multi-layered "B-horizon" contains a pale brown (10YR6/3) loamy sand streaked with elongate, grayish-brown (10YR5/2) loam mottles, overlying a light gray (10YR7/1) sandy clay loam streaked with elongate, gray (10YR6/1) mottles. The next layer is a light gray to gray or white (10YR8/1) medium sand having elongate, mottles of grayish brown (10YR5/2) loam. At a depth of 116 cm, an apparent spodic (Bh) horizon occurs, consisting of a slightly indurated layer of dark brown (10YR3/3) medium sand. The under lying material ("C-horizon") is typically a brown (10YR5/3) medium sand.

**4.0.2. *Panicum hemitomon* Marsh.** This community type is typified within the study area by a clayey, kaolonitic, thermic Typic Fragiaquult soil, as follows:

The soil is characterized by numerous, multi-colored layers. The surface horizon is a black (10YR2/1) loam having a high organic matter content, overlying a subsurface layer of very dark gray (10YR3/1) loam. The subsoil consists of numerous multi-colored, clayey layers exhibiting frequent small to medium, brightly colored mottles in a grayish matrix. The subsoil had no fewer than seven layers in the sampled soil profile. Soil textures throughout the B-horizon are usually a sandy clay loam or sandy clay. Subsoil matrix colors range from light brownish-gray (10YR6/2) to light gray (10YR7/2) to very pale brown (10YR6/3), and the mottles are usually brightly colored, including strong brown (7.5YR5/8), red (2.5YR4/8), bright yellow (10YR6/8), light gray (10YR7/2) and similar hues. As previously noted, the bright colored subsurface mottles indicate subsurface oxidizing conditions during a significant portion of the year (Cite). The brittle fragipan layer occupies the lower B-horizon from 36 to 77 cm, and is similar in color to the other B-horizon layers. The underlying C-horizon is a massive, mottled, sandy clay loam, interbedded with layers of coarse sand.

**4.0.3. *Ludwigia sphaerocarpa/Leersia-Polygonum persicaria* Marsh.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Typic Ochraquult soil, as follows:

> The surface horizon of this soil is a 24 cm thick, very dark grayish-brown (10YR3/2) clay loam having a moderate organic matter content. The subsoil is 62 cm deep, and consists of a light grayish-brown (10YR6/2) clay to sandy clay loam, with frequent, small mottles ranging in color from dark yellowish-brown (10YR4/6) and dark grayish-brown (10YR4/2), to strong brown (7.5YR5/8). The underlying C-horizon is a series of coarse sand to loamy sand layers in yellow, brown and gray hues, including light gray (10YR7/2), bright yellow (10YR5/6), yellowish-brown (10YR5/6), pale brown (10YR6/3), dark brown (10YR3/3) and very dark grayish-brown (10YR3/2).

**4.0.4. (*Andropogon virginicus* var. *glaucus*)/(*Eleocharis melanocarpa*) "Successional Marsh".** The soils found underlying this community type within the study area -- both a fine-loamy, siliceous, thermic Typic Paleaquult; and a clayey, kaolonitic, thermic Typic Fragiaquult -- are similar in nature and appearance to the soil profiles previously described, respectively, for community types 2.0.1 and 4.0.2.

**4.0.5. *Liquidambar-Pinus taeda* "Successional Marsh".** This community type occurs over a variety of soils within the study area. They include: clayey, kaolonitic, thermic Typic Fragiaquults (the primary soil for this vegetation group); fine-loamy, siliceous, thermic Typic Paleaquults; clayey, kaolonitic, thermic Typic Paleaquults; and sandy, siliceous, thermic Typic Haplaquods. A description of a profile for each of those soil types is found elsewhere within this appendix. Specifically, in relation to the order in which the soil types found beneath this community type are listed above, soils profiles similar in appearance and nature are provided for community types 4.0.2, 2.0.1, 9.4.8, and 5.0.1.

## 5. BOGGY MARSH.

**5.0.1. *Eleocharis quadrangulata-Rhynchospora inundata-Rhynchospora* species #1/*Sphagnum* spp. Marsh.** This community type is typified within the study area by a sandy, siliceous, thermic Typic Haplaquod soil, as follows:

> The surface layer of the soil is a black (10YR2/1) to very dark brown (10YR2/2), shallow sandy loam with a high organic matter content, overlying a dark yellowish-brown (10YR3/4), fine-sandy, "albic" layer, which itself overlies a slightly indurated, very dark brown (10YR2/2) loamy sand, spodic layer. Below this spodic layer is a layer of dark grayish-brown (10YR3/2) sand (another albic horizon), which in turn overlies a second, slightly indurated, black (10YR2/1) medium-sand spodic horizon. Such alternating albic and spodic layers typically continue downward below 1.5 m.

**5.0.2. (*Acer-Nyssa biflora-Pinus taeda*)/*Sphagnum* spp. Marsh.** This community type is typified within the study area by a sandy-skeletal, siliceous, dysic, thermic Terric Medihemist soil, as follows:

> The surface layer of this relatively thin soil consists of one or more undecomposed to relatively decomposed, shallow layers of black (10YR2/1) to very dark brown (10YR2/2) sapric material, overlying parent material composed of very dark grayish-brown (10YR3/2) sand.

## 6. LONGLEAF PINE WOODLAND.

**6.0.1. (*Panicum virgatum-Euthamia*)/(*Dichanthelium wrightianum*) Flatwood.** This community type is typified within the study area by a siliceous, thermic Typic Psammaquent/loamy, siliceous, thermic Grossarenic Paleaquult soil, as follows:

> That soil is characterized by a black (10YR2/1) sand to loamy sand surface layer some 13 cm thick, overlying variously hued subsurface strata of sand to loamy sand to a depth of 140 cm. These sandy strata are grayish-brown (10YR5/2), light gray (10YR7/2 to 10YR7/3), white

(10YR8/1), light brownish-gray (10YR6/2), or dark grayish-brown (10YR4/2) in color. The sandy, subsurface layers represent either a C-horizon, in the case of a Typic Psammaquent soil, or a multi-layered A-horizon over a buried B-horizon in the case of a Grossarenic Paleaquult soil. Where it is present beneath this community type, the B-horizon typically consists of a light gray (10YR7/3) sandy loam.

**6.0.2. *Pinus palustris/Lyonia mariana/Aristida stricta/(Cladonia* sp.) Savanna.** This community type is typified within the study area by a sandy, siliceous, thermic Aeric Haplaquod soil, as follows:

> The soil is characterized by a very dark gray (10YR3/1) sand surface layer some 8 cm thick, having a "salt-and-pepper" appearance due to the presence of many clean, quartz sand grains in the dark surface layer. Subsurface layers to a depth of 45 to 55 cm range from grayish-brown (10YR5/2) to white (10YR8/1) sand -- the albic horizon. Beneath that layer, the subsoil spodic layer is a very dark brown (10YR2/2) loamy sand to a black (10YR2/1) sand that is massive, hard and indurated, to a depth of at least 1.5 m.

**6.0.3. *Pinus palustris/Ilex coriacea-Ilex glabra-Vaccinium fuscatum* Flatwood.** This community type is typified within the study area by a siliceous, thermic, Typic Psammaquent/loamy, siliceous, thermic Grossarenic Paleaquult soil, as follows:

> The soil has a surface layer of very dark gray (10YR3/1) fine sand to 11 cm deep. Subsurface layers exhibit a series of variously colored, variously textured sands to 1.5 m deep and beyond, as follows: a 17 cm thick layer of very dark grayish-brown (10YR3/2) loamy fine sand, a 9 cm thick layer of dark grayish-brown (10YR4/2) fine sand, a 9 cm thick layer of grayish-brown (10YR5/2) fine sand, a 23 cm thick layer of light brownish-gray (10YR6/2) fine sand, a 12 cm thick layer of light gray (10YR7/1) loamy fine sand, a 12 cm thick layer of white (10YR8/1) medium to coarse sand, and a 61 cm thick layer of white medium sand.

**6.0.4. *Quercus marilandica/(Rhododendron atlanticum-Vaccinium fuscatum-Gaylusaccia dumosa)/Schizachyrium-Tephrosia-Aster walteri* Savanna.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Aquic Paleudult soil, as follows:

The soil has a grayish-brown (10YR5/2) loamy sand surface layer some 20 cm thick. The subsurface layer of the A-horizon is a yellowish-brown (10YR6/4) loamy sand *ca.* 10 cm in depth. The subsoil ranges from a yellowish-brown (10YR5/4) sandy clay loam in the upper part of the soil solum, to a gray (10YR6/1) sandy clay loam in the lower part of the solum, and extends to 1.5 m deep. It is mottled throughout, but especially in its lower portions, with medium mottles in shades of brownish-gray (10YR6/2), yellowish-red (5YR5/8) and yellowish-brown (10YR5/4).

**6.0.5. *(Nyssa sylvatica)/Andropogon virginicus* var. *glaucus-Aster tortifolius* Flatwood.** The soils found underlying this community type within the study area include both a clayey, kaolonitic, thermic Typic Fragiaquult soil (the principal soil for this vegetation group), and a fine-loamy, siliceous, thermic Aquic Paleudult soil. Those soils are similar in appearance and nature, respectively, to the soil profiles previously described above for community types 4.0.2 and 6.0.4.

## 7. EVERGREEN SHRUB-BOG.

### 7.1. BAY FOREST.

**7.1.1. *Chamaecyparis-Gordonia/Acer/Ilex coriacea-Lyonia lucida* Forest.** This community type is typified within the study area by either a sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists; or a sandy, siliceous, thermic Typic Haplaquod soil. Each of those respective soils is described below, in turn:

The Medisaprist soil typifying this community type has a black (N 2/0), mucky peat surface layer some 8 cm deep, overlying a black (10YR2/1) to very dark gray (10YR3/1) muck to a depth of 109 cm. The underlying material to a depth of 1.5 m was a very dark grayish-brown (10YR3/2) sand to loamy sand. Plant roots are mostly confined to the surface layers of the soil.

The Haplaquod soil found underlying this community type consists of a surface layer of black (10YR2/2), "salt-and-pepper" loam having a high organic matter content and numerous clean sand grains, some 7 cm deep. The surface layer is underlain by subsurface layers of black loamy sand to 23 cm deep, and very dark grayish-brown (10YR4/2) sand to 61 cm. The subsoil to 1.5 m was a black (10YR2/1), somewhat indurated, hard sand. The bulk of plant roots are found in the upper 25 cm of the soil solum, but the rooting zone extended to at least 75 cm in depth.

**7.1.2. *Nyssa biflora-Acer/Magnolia-Acer/Ilex coriacea-Lyonia lucida/ Smilax laurifolia* Forest.** This community type is typified within the study area by a loamy, mixed, dysic, thermic Typic Medisaprist soil, as follows:

> The soil exhibits an organic horizon some 92 cm deep. Within that pedon, a 36 cm surface layer of very dark brown (10YR2/2) muck overlies a black (10YR2/1) to very dark brown (10YR2/2) muck. Most plant roots are confined to the upper 65 cm of the organic layer. The muck overlies a dark brown (10YR3/3) medium sand, which comprises the C-horizon, containing large quantities of "buried" woody, undecomposed plant material.

## 7.2. POCOSIN.

**7.2.1. *Pinus serotina/Ilex coriacea-Clethra-Lyonia lucida-Kalmia carolina/(Cladonia* sp.) Pocosin.** The soils found underlying this community type within the study area include a sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist; and a sandy, siliceous, thermic Typic Haplaquod. Those soils are similar in appearance and character, respectively, to the soil profiles described previously for community types 7.1.1 and 5.0.1.

**7.2.2. *Zenobia-Ilex coriacea-Chamaedaphne/(Smilax laurifolia)/Carex striata-Woodwardia virginica/Sphagnum* spp. Pocosin.** The soil found underlying this community type within the study area is either a sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist, or a dysic , thermic Typic Medisaprist. The former soil is similar in nature and appearance to the soil profile described for community type 7.1.1, above. A profile description of the Typic Medisaprist soil underlying this community type follows:

> The soil has a dark grayish-brown (2.5YR2.5/4), partially decomposed muck surface layer, overlying very dark brown (10YR2/2) to black (10YR2/1) muck organic layers exhibiting various degrees of progressively greater plant material decomposition in moving downward through the profile. The organic layer extends to a depth of 2 m or greater.

Plant roots generally form a dense "mat" in, and are restricted to, the upper 50 cm of the organic layer. Beneath this root mat, the sapric material is very highly decomposed, and mixes with groundwater to form a soil body with the color and consistency of partially congealed "chocolate pudding".

**7.2.3. (*Pinus serotina*)/*Ilex coriacea-Lyonia lucida-Cyrilla-Zenobia*/*Smilax laurifolia*/ (*Woodwardia virginica*)/(*Sphagnum* spp.) Pocosin.** This community is typified by three soil types: a sandy or sandy, skeletal, siliceous, dysic, thermic Terric Medisaprist soil; a loamy, siliceous, dysic, thermic Terric Medisaprist soil; or a sandy, siliceous, thermic Typic Haplaquod soil. Soil profile descriptions similar in appearance and nature to the first and last listed of the soil groups encountered beneath this community type may be found for community types 7.1.1 and 5.0.1, respectively, elsewhere within this appendix. A description of the loamy, siliceous, dysic, thermic Terric Medisaprist soil found beneath this community type follows:

The soil has a 7 cm deep surface layer of black (10YR2/1) mucky loam, overlying a shallow, very dark gray (10YR3/1) mucky loam to 40 cm deep. The organic layer consisted of a black (10YR2/1) sandy muck 30 cm deep. The organic horizon was underlain by alternating layers of mineral sediments to a depth of >1.5 m. Those layers included a very dark gray (10YR3/1) sandy loam, a brown (10YR5/3) fine sand streaked with black (10YR2/1) mucky sand, a medium brown (10YR4/3) fine sand also streaked with black mucky sand, and a very pale brown (10YR7/3) fine sandy clay loam streaked with dark grayish-brown (10YR4/2) sandy loam.

**7.2.4. *Zenobia-Chamaedaphne*/*Sphagnum* spp. Pocosin.** The soils found underlying this community type within the study area -- a dysic, thermic, Typic Medisaprist; and a sandy or sandy-skeletal, siliceous, dysic, thermic Typic Medisaprist -- are similar in appearance and nature, respectively, to the soil profiles described for community types 7.2.2 and 7.1.1, above.

**8. CYPRESS/GUM BOG.**

**8.0.1. *Taxodium ascendens/Lyonia lucida/Carex striata-Woodwardia virginica/ Sphagnum* spp. Bog.** The soil found underlying this community type within the study area -- a sandy, siliceous, thermic Typic Haplaquod soil -- is similar in appearance and nature to the soil profile previously described for community type 5.0.1.

**8.0.2. *Nyssa biflora/Chamaedaphne/Carex striata/Sphagnum* spp. Bog.** The soil found underlying this community type within the study area -- a sandy or sandy-skeletal, siliceous, dysic, thermic Typic Medihemist -- is similar in appearance and nature to the the soil profile previously described for community type 5.0.2.

**8.0.3. *Nyssa biflora-Taxodium ascendens/Decodon/(Smilax laurifolia)/ Utricularia purpurea* Bog.** The soil found underlying this community type within the study area -- a sandy or sandy-skeletal, siliceous, dysic, thermic Typic Medihemist -- is similar in appearance and nature to the the soil profile described for community type 5.0.2, above.

**8.0.4. *Nyssa biflora* "Boggy Swamp".** This community type is typified within the study area by a "mucky variant" of a fine-loamy, siliceous, thermic Umbric Paleaquult soil, as described below:

> The soil has a surface layer of very dark brown (10YR2/2) mucky loam some 9 cm deep. The subsurface layer is a black (10YR2/1) loam 18 cm thick. The subsoil extends below 1.5 m, and is a very dark grayish-brown (10YR3/2) clay loam in the upper part, a very dark gray (10YR3/1) clay in the middle part, and a very dark gray clay with few, small, dark yellowish-brown (10YR3/4) mottles in the lower part.

**8.0.5. *Nyssa biflora/(Acer)/Decodon/Dulichium/Sphagnum* spp.-*Utricularia biflora* Bog.** The soil found underlying this community type within the study area -- a loamy, siliceous, dysic, thermic Terric Medisaprist soil -- is similar in appearance and nature to the the soil profile previously described for community type 7.2.3.

**8.0.6. *Taxodium ascendens/Nyssa biflora-Acer/Zenobia-Lyonia lucida-Cyrilla/ Woodwardia virginica* Bog.** This community type is typified within the study area by a loamy, siliceous, thermic Arenic Paleaquult soil, as described below:

> This soil has a black (10YR2/1) loam surface layer some 5 cm deep, characterized by the abundant occurrence of small to medium sized roots. The subsurface layers, extending to 50 cm deep, include, sequentially, a black fine sand to loamy sand with many small to medium roots, a very dark gray (10YR3/2) medium sand with common small to medium roots, and a layer of pale brown (10YR6/3) sand that is streaked with grayish-brown (10YR5/2) loamy sand "mottles". The multi-layered subsoil extends below 1.6 m. In the upper part, it is a light brownish gray (10YR6/2) sandy loam with frequent large mottles of grayish-brown (10YR5/2) strong brown (7.5YR5/8) and red (2.5YR4/8) sandy clay loam. In the middle part it is a light brownish-gray (10YR6/2) sandy clay loam with either few strong brown (7.5YR5/8) mottles or occasional small strong brown, red and gray (10YR5/1) mottles. In the lower part, the subsoil is a brown (10YR5/3) sandy clay with occasional small yellow-brown (10YR5/8) to strong brown mottles. Buried wood is common throughout the soil profile.

**8.0.7. *Taxodium ascendens/Nyssa biflora-Acer/(Leucothoe racemosa-Vaccinium* spp.-*Zenobia)/Sphagnum* spp. Bog.** The soils found underlying this community type within the study area -- a loamy, siliceous, dysic, thermic Terric Medisaprist soil; and a sandy, siliceous, thermic Typic Haplaquod soil -- are similar in appearance and nature, respectively, to the soil profiles described for community types 7.2.3 and 5.0.1, above.

**8.0.8. *Taxodium ascendens/Lyonia lucida-Leucothoe racemosa/(Leucobryum* sp.) Bog.** The soil found underlying this community type within the study area -- a sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprist -- is similar in appearance and nature to the the soil profile previously described for community type 7.1.1.

**8.0.9. *Nyssa aquatica/Wolfiella-Utricularia purpurea* Bog.** The soil found underlying this community type within the study area -- a sandy, mixed, dysic, thermic Terric Medisaprist -- is similar in appearance and nature to the the soil profile previously described for community type 7.2.3.

**8.0.10. *(Nyssa biflora)/(Acer-Cephalanthus)/Cladium-Iris virginica/Ludwigia pilosa* Bog.** This community type is typified within the study area by a sandy, mixed, euic, thermic Terric Medisaprist soil, as described below:

> The shallow, organic soil underlying this community type has a surface layer of black (10YR2/1) muck consisting of relatively undecomposed to semi-decomposed plant material, to a depth of 35 cm. Most plant roots within this community type occur in this surface muck layer. The subsurface organic layer is a very dark grayish-brown (10YR3/2) muck consisting of highly decomposed plant material, extending to a depth of 55 cm. The organic layer overlies mineral soil consisting of very dark brown (10YR2/2) to black (10YR2/1), slightly to moderately indurated, hard, fine sand that is *ca.* 50 cm thick. This layer probably represents a "buried" spodic horizon, given that most of the surrounding areas at this site are dominated by typical "pocosin" vegetation occurring over a Typic Haplaquod soil. Beneath this "spodic" layer is a deep layer of lighter colored, loose fine sand.

## 9. INTERMITTENTLY PONDED CYPRESS/GUM DEPRESSION.

### 9.1. CYPRESS/GUM SWAMP.

**9.1.1. *Nyssa biflora-Taxodium ascendens/Liquidambar/Ilex amelanchier* Swamp.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Umbric Paleaquult soil, as described below:

> The soil has a surface layer of black (10YR2/1) loam having high organic matter content, to 6 cm deep, overlying a 9 cm thick subsurface layer of very dark gray (10YR3/1) loam. The subsoil is comprised by a series of variously colored, often mottled, loamy to clayey layers to a depth of 1.6 m or more. The upper part of the subsoil is a very dark gray (10YR3/1) to dark gray (10YR4/1) sandy clay loam to sandy clay, containing light brownish-gray (10YR6/2) mottles of sandy clay. The middle portion of the subsoil consists of a gritty, massive, light brownish-gray (10YR6/2) sandy clay layer having numerous small to large mottles of very dark gray (10YR3/1), yellow-brown (10YR5/8), and grayish-brown (10YR5/2). The lower part of the subsoil is a massive, grittier (with very coarse sand to small pebbles common) light brownish-gray (10YR6/2) sandy clay loam, with small mottles of gray (10YR5/1) sandy clay.

**9.1.2. *Nyssa biflora-Taxodium ascendens/Liquidambar-Acer/ Woodwardia virginica-Carex verrucosa* Swamp.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Typic Paleaquult -- is similar in appearance and nature to the soil profiles described previously for community types 2.0.1 and 3.0.1.

**9.1.3. *Taxodium ascendens/Pinus taeda-Acer-Persea-Liquidambar/ Lindera/Smilax glauca/Carex glaucescens* Swamp.** The soil found underlying this community type within the study area -- a sandy, siliceous, thermic Typic Haplaquod soil -- is similar in appearance and nature to each of the soil profiles described previously for community types 5.0.1. and 7.1.1.

**9.1.4. *Taxodium ascendens/(Nyssa biflora)* Swamp.** A wide variety of soils were found to underlie this somewhat "generic" community type within the study area. They include: clayey, kaolonitic, thermic Typic Fragiaquults and clayey, kaolonitic, thermic Typic Paleaquults (the most common soil types for this vegetation group); as well as sandy, siliceous, thermic Typic Haplaquods; fine-loamy, siliceous, thermic Typic Paleaquults; and fine-loamy, siliceous, thermic Umbric Paleaquults. A profile description for each of the listed soil types similar to those encountered beneath this community type may be found, with respect to their order of listing above, for community types 4.0.2, 9.4.8, 5.0.1, 2.0.1, and 9.1.1, elsewhere within this appendix.

**9.2. CYPRESS/GUM POND.**

**9.2.1. *Taxodium ascendens* Pond.** This community type is typified within the study area by a clayey, kaolonitic, thermic Typic Fragiaquult soil, as described below:

> The soil has a very dark brown (10YR2/2) loam surface layer 12 cm thick, overlying a 9 cm thick subsurface layer consisting of a dark gray (10YR6/3) to dark gray brown (10YR4/2) clay loam. The subsoil consists in its upper part of a 13 cm thick, pale brown (10YR6/3) sandy clay layer having a very few small brownish-yellow (10YR6/6) and dark gray (10YR4/1) mottles; and a 26 cm deep brittle, strong brown (7.5YR5/8) sandy clay having many small gray (10YR6/1), light gray (10YR7/1 & 10YR7/2)

and bright yellow (10YR6/8) mottles. The lower portion of the subsoil consists of a brittle, yellowish-brown (10YR5/8) sand clay loam having many distinct, medium gray (10YR5/1) mottles and very few small, red (2.5YR4/8) mottles; a tri-colored sandy clay layer 30 cm deep and consisting of roughly equal portions of large dark gray (10YR4/1), light gray (10YR7/2) and bright yellow (10YR6/8 mottles, with a few very small red (2.5YR4/8) mottles. The underlying material (C-horizon) consists of a mottled dark gray, light gray, bright yellow and very pale brown (10YR7/4) sandy clay, with scattered small, red mottles, to a depth of 1.6 m or greater.

**9.2.2. *Taxodium ascendens/Sclerolepis-Rhynchospora filifolia* Pond.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile described immediately above for community type 9.2.1.

**9.2.3. (*Taxodium ascendens*)/"Open-Water"Pond.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile described above for community type 9.2.1.

## 9.3. DRAWDOWN SAVANNA/MEADOW.

**9.3.1. *Taxodium ascendens*/(*Nyssa biflora*)/(*Ilex myrtifolia*)/(*Panicum verrucosum*) Savanna.** This community type is typified within the study area by a clayey, kaolonitic, thermic Typic Fragiaquult soil as described below:

The soil has a black (5YR2.5/1) loam surface layer 6 cm deep and having a high organic matter content, overlying a 35 cm thick subsurface layer consisting of a very dark grayish-brown (10YR3/2) clay loam, and a "transition layer" consisting that is a grayish-brown (10YR5/2) clay loam. The subsoil consists in its upper part of a 24 cm thick, light brownish gray (10YR6/2) silty clay loam, having distinct, large brownish yellow (10YR6/6) and strong brown (7.5YR4/6) mottles. In the middle part, the subsoil is a gray (10YR5/1 to 10YR6/1) or light brownish gray clay loam, having many small to large strong brown (7.5YR5/8) mottles, few small to many large red (2.5YR4/8) mottles, and few small mottles of other colors, including pale red (10R6/2) and red (10R5/8). The lower part of the subsoil is a highly mottled, 30 cm thick layer of sandy clay appearing to have "bands" of gray, light brownish gray, light yellowish brown (10YR6/4), white (10YR8/2),reddish yellow (7.5YR6/8), and reddish brown (2.5YR5/4). The underlying material is a loamy sand of highly variable colors, with a pale brown (10YR6/3) to brownish yellow (10YR6/8) matrix, containing very small mottles of red (2.5YR5/8), light gray (10YR7/2), and reddish yellow (7.5YR6/6) sandy clay.

**9.3.2. *Taxodium ascendens/Nyssa biflora/Panicum verrucosum-Scleria reticularis* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.3. *Nyssa biflora/Acer/(Panicum verrucosum)/Sphagnum* spp. "Savanna".** The soil found underlying this community type within the study area -- a, a fine-loamy, siliceous, thermic Typic Paleaquult -- is similar in appearance and properties to the soil profile described previously for community type 2.0.1.

**9.3.4. *Taxodium ascendens/(Cyrilla)/Scleria reticularis-Panicum verrucosum-Lachnanthes* Savanna.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Typic Paleaquult -- is similar in appearance and properties to the soil profile described previously for community type 2.0.1.

**9.3.5. *Taxodium ascendens/Eupatorium leucolepis-Rhynchospora inundata/Panicum verrucosum* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.6. *(Taxodium ascendens)/Pluchea rosea-Eupatorium leucolepis/ Dichanthelium wrightianum* Meadow.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.7. *Taxodium ascendens/(Pluchea rosea-Boltonia)/ Dichanthelium wrightianum* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.8. *Panicum hemitomon/Dichanthelium wrightianum-Scleria reticularis* Meadow.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.9. *Andropogon mohrii/Dichanthelium wrightianum-Rhynchospora filifolia* Meadow.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult -- is similar in nature and appearance to the soil profile described previously for community type 4.0.2.

**9.3.10. *Taxodium ascendens/Rhynchospora inundata* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.11. *Taxodium ascendens/(Nyssa biflora)/Ilex amelanchier/Carex striata-Lachnanthes* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

**9.3.12. *Taxodium ascendens/Rhynchospora inundata/Lachnanthes-Polygala cymosa* Savanna.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Fragiaquult soil -- is similar in nature and appearance to the soil profile descriptions previously provided for community types 9.2.1 and 9.3.1.

## 9.4. WET SAVANNA/MEADOW.

**9.4.1. *Aster pilosus* var. *demotus/(Dichanthelium wrightianum-Eleocharis tricostata)* Meadow.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Typic Paleaquult soil -- is similar in nature and appearance to the soil profile described below for community type 9.4.3.

**9.4.2. *(Pinus taeda)/Panicum tenerum/Centella-Dichanthelium wrightianum* Meadow.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Typic Paleaquult soil -- is similar in nature and appearance to the soil profiles described for community types 2.0.1, above, and 9.4.3, immediately below.

**9.4.3. *Eupatorium leucolepis-Panicum rigidulum* var. *combsii/ Dichanthelium erectifolium-Rhynchospora filifolia/Stylisma aquatica* Meadow.** This community type is typified within the study area by a fine-loamy, siliceous, thermic Typic Paleaquult soils, as described below:

The soil has a very dark grayish-brown (10YR3/2) loam surface layer 12 cm deep, overlying a 6 cm thick subsurface layer consisting of a very dark grayish-brown (10YR3/2) loam with abundant grayish-brown (10YR5/2) sandy clay mottles. The subsoil is a mottled clay to sandy clay that extends to a depth of >1.5 m. In its upper part, the subsoil is a light brownish-gray (10YR6/2) sandy clay with infrequent, small yellowish-brown (10YR5/8) and strong brown (7.5YR5/8) and few large, very dark gray (10YR3/1) sandy clay mottles, grading into a strong brown (7.5YR5/8) sandy clay having many small, light gray (10YR7/2) and some small, red (2.5YR4/8) sandy clay mottles. In its middle part, the subsoil is a mottled light gray (10YR7/1) and strong brown (7.5YR5/8) sandy clay, with many small and medium, red (2.5YR4/8) mottles, to a light gray (10YR7/1) clay with many, distinct red and strong brown mottles of sandy clay. The lower part of the subsoil is a mottled sandy clay with abundant, small to large gray (10YR6/1), strong brown, red and dark red (2.5YR3/6) mottles, grading to a light gray sandy clay with many strong brown and gray, and few red, mottles.

**9.4.4. *Eupatorium leucolepis* Meadow.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Typic Paleaquult soil -- is similar in nature and appearance to the soil profile described for community type 9.4.3, immediately above.

**9.4.5. *Taxodium ascendens/Ilex myrtifolia/Carex striata-Aristida palustris/Eriocaulon compressum* Meadow.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Umbric Paleaquult soil -- is similar in appearance and nature to the soil profile previously described for community type 9.1.1.

**9.4.6. *(Ilex myrtifolia)/Hypericum fasciculatum-Stillingia/Carex striata* Meadow.** The soil found underlying this community type within the study area -- a fine-loamy, siliceous, thermic Umbric Paleaquult soil -- is similar in appearance and nature to the soil profile previously described for community type 9.1.1.

**9.4.7. *Taxodium ascendens/Clethra/Carex striata-Panicum hemitomon/(Eriocaulon compressum-Lachnanthes)* Savanna.** This community type is typified within the study area by a sandy, siliceous, thermic Typic Haplaquod soil, as described below:

The soil has a black (10YR2/1) loam surface layer 16 cm deep. The subsurface layer, to a depth of 23 cm is a black loamy fine sand. The subsoil is approximately 45 cm deep. It consists of a black to very dark brown (10YR2/2) fine sand in its upper part, and a slightly indurated, dark yellowish-brown (10YR3/4) to very dark grayish-brown (10YR3/2) loamy sand in its lower portions. The underlying soil (C-horizon) is made up of sequential sandy layers to a depth of >1.6 m, consisting of a dark yellowish-brown (10YR4/4) fine sand, a dark yellowish-brown (10YR3/6) sand, and a pale brown (10YR6/3) fine sand having many coated, black (7.5YR2/0) fine sand grains.

**9.4.8. *Liquidambar/Ilex amelanchier/Carex striata-Panicum hemitomon* Savanna.** This community type is typified within the study area by a clayey, kaolonitic, thermic Typic Paleaquult soil, as described below:

The soil has a black (10YR2/1) loam surface layer 11 cm deep. The subsoil is >1.25 m deep. In its upper part it consists of a brown (10YR5/3) sandy clay loam, grading to a light brownish-gray (10YR6/2) clay loam having few, small dark gray (10YR4/1) mottles. The middle part of the subsoil is a brown (10YR5/3) sandy clay having many distinct, small, light gray (10YR7/1) and red (10R4/8), and few small, strong brown (7.5YR5/8) mottles, with large, uncoated sand grains dispersed throughout, and a grayish-brown (10YR5/2) sandy clay having scattered small, strong brown (7.5YR5/8) mottles. The lower part of the subsoil is a light gray (10YR7/2) sandy clay, streaked with mottles of dark gray (10YR4/1) and very pale brown (10YR7/4).

**9.4.9. *(Taxodium ascendens)/Aristida palustris-Rhynchospora inundata/ Rhynchospora filifolia-Helenium-Centella* Meadow.** This community type is typified within the study area by a on fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquult soil, as described below:

The umbric epipedon is a dark colored, organic-dominated layer some 30 cm in thickness. It contains a black (10YR2/1) loam surface layer 13 cm deep, and a dark grayish-brown (10YR4/2) sandy clay loam subsurface layer some 17 cm thick. The subsoil extends to >1.55 m. In its upper part it consists of a grayish-brown (10YR5/2) coarse sandy loam grading to a light brownish-gray (10YR6/2) sandy clay loam, having few, small very dark gray (10YR3/1) to dark grayish-brown (10YR4/2) mottles. The middle part of the subsoil is a very dark grayish-brown (10YR3/2) to brown (10YR5/3) sandy clay to sandy clay loam, having occasional distinct, small mottles of strong brown (7.5YR5/8), and few, small very pale brown (10YR7/3) mottles. The lower part of the subsoil is a "tri-colored", very dark gray, pale brown (10YR6/3), and strong brown sandy clay in its upper portion, and in its lower part a light gray (10YR7/2) loamy sand, streaked with mottles of dark gray (10YR4/1) and strong brown. Coarse sand and small pebbles are common throughout the middle and lower parts of the subsoil.

**9.4.10. (*Taxodium ascendens*)/*Rhynchospora inundata*/*Centella* Meadow.** The soil found underlying this community type within the study area -- a clayey, kaolonitic, thermic Typic Paleaquult soil -- is similar in appearance and nature to the soil profile described previously for community type 9.4.8.

Table A-II-1. SUMMARY OF CAROLINA BAY SOIL FAMILIES BY VEGETATION CLASS AND SUBCLASS.

VEGCLASS 1: Brackish Marsh

| | VEG GROUP |
|---|---|
| | 1. |
| | % |
| SOIL FAMILY | |
| Mixed, thermic Typic Psammaquents | 100 |

VEGCLASS 2: Intermittently Flooded Depression Prairie

| | VEG GROUP | | | |
|---|---|---|---|---|
| | 2. | 2.1 | 2.2 | 2.3 |
| | % | % | % | % |
| SOIL FAMILY | | | | |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 84 | 90 | 64 | 100 |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 16 | 10 | 36 | . |

VEGCLASS 3: Freshwater Pond

| | VEG GROUP | | |
|---|---|---|---|
| | 3. | 3.1 | 3.2 |
| | % | % | % |
| SOIL FAMILY | | | |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 73 | 100 | . |
| Mixed, thermic Typic Psammaquents | 27 | . | 100 |

VEGCLASS 4: Freshwater Marsh

| | VEG GROUP | | | | | |
|---|---|---|---|---|---|---|
| | 4. | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 |
| | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | |
| Sandy, siliceous, thermic Typic Haplaquods, "argillic" variant | 9 | 44 | . | . | . | . |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 42 | 56 | 64 | . | 71 | 13 |
| Clayey, kaolonitic, thermic Typic Paleaquults | 2 | . | . | . | . | 13 |
| Fine-loamy, siliceous, thermic Typic Ochraquults | 19 | . | . | 100 | . | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 26 | . | 36 | . | 29 | 63 |
| Sandy, siliceous, thermic Typic Haplaquods | 2 | . | . | . | . | 13 |

VEGCLASS 5: Boggy Marsh

| | VEG GROUP | | |
|---|---|---|---|
| | 5. | 5.1 | 5.2 |
| | % | % | % |
| SOIL FAMILY | | | |
| Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemists | 11 | . | 20 |
| Sandy, siliceous, thermic Typic Haplaquods | 89 | 100 | 80 |

VEGCLASS 6: Longleaf Pine Woodlands

| | VEG GROUP | | | | | |
|---|---|---|---|---|---|---|
| | 6. | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 |
| | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 7 | 18 | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 33 | 45 | . | . | . | 63 |
| Fine-loamy, siliceous, thermic Aquic Paleudults | 20 | . | . | . | 100 | 38 |
| Siliceous, thermic, Typic Psammaquents/loamy, siliceous, thermic Grossarenic Paleaquults | 27 | 36 | . | 100 | . | . |
| Sandy, siliceous, thermic Aeric Haplaquods | 13 | . | 100 | . | . | . |

VEGCLASS 7: Evergreen Shrub-Bog
7.1: Bay Forest
7.2: Pocosin

| | VEG GROUP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7. | 7.1. | 7.1.1 | 7.1.2 | 7.2. | 7.2.1 | 7.2.2 | 7.2.3 | 7.2.4 |
| | % | % | % | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | | | | |
| Dysic, thermic Typic Medisaprists | 14 | . | . | . | 18 | . | 33 | . | 50 |
| Sandy or sandy-skeletallk siliceous, dysic thermic Terric Medisaprists | 43 | 33 | 50 | . | 45 | 50 | 67 | 25 | 50 |
| Loamy, siliceous, dysic, thermic Terric Medisaprists | 7 | . | . | . | 9 | . | . | 25 | . |
| Loamy, mixed, dysic, thermic Terric Medisaprists | 7 | 33 | . | 100 | . | . | . | . | . |
| Sandy, siliceous, thermic Typic Haplaquods | 29 | 33 | 50 | . | 27 | 50 | . | 50 | . |

VEGCLASS 8: Cypress/Gum Bog

| | VEG GROUP | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8. | 8.1 | 8.2 | 8.3 | 8.4 | 8.5 | 8.6 | 8.7 | 8.8 | 8.9 | 8.10 |
| | % | % | % | % | % | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | | | | | | |
| Loamy, siliceous, thermic Arenic Paleaquults | 9 | . | . | . | . | . | 100 | . | . | . | . |
| Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medihemists | 9 | . | 100 | . | . | . | . | . | . | . | . |
| Fine-loamy, siliceous, thermic Umbric Paleaquults, "mucky" variant | 9 | . | . | . | 100 | . | . | . | . | . | . |
| Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists | 27 | . | . | 100 | . | . | . | . | 100 | 100 | . |
| Loamy, siliceous, dysic, thermic Terric Medisaprists | 18 | . | . | . | . | 100 | . | 50 | . | . | . |
| Sandy, mixed, euic, thermic Terric Medisaprists | 9 | . | . | . | . | . | . | . | . | . | 100 |
| Sandy, siliceous, thermic Typic Haplaquods | 18 | 100 | . | . | . | . | . | 50 | . | . | . |

VEGCLASS 9: Intermittently Ponded Cypress/Gum Depression
9.1: Cypress/Gum Swamp
9.2: Cypress/Gum Pond

| | VEG GROUP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | 9.1. | 9.1.1 | 9.1.2 | 9.1.3 | 9.1.4 | 9.2. | 9.2.1 | 9.2.2 | 9.2.3 |
| | % | % | % | % | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | | | | | |
| Sandy, siliceous, thermic Typic Haplaquods, "argillic" variant | 0 | 4 | . | . | . | 6 | . | . | . | . |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 21 | 18 | . | 100 | . | 6 | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Paleaquults | 8 | 11 | . | . | . | 19 | . | . | . | . |
| Fine-loamy, siliceous, thermic Umbric Paleaquults | 6 | 18 | 100 | . | . | 6 | . | . | . | . |
| Fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquults | 3 | . | . | . | . | . | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 58 | 32 | . | . | . | 56 | 100 | 100 | 100 | 100 |
| Sandy, siliceous, thermic Typic Haplaquods | 4 | 18 | . | . | 100 | 6 | . | . | . | . |

VEGCLASS 9: Intermittently Ponded Cypress/Gum Depression
9.3. Drawdown Savannah/Meadow

| | VEG GROUP | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | 9.3. | 9.3.1 | 9.3.2 | 9.3.3 | 9.3.4 | 9.3.5 | 9.3.6 | 9.3.7 | 9.3.8 | 9.3.9 | 9.3.10 | 9.3.11 | 9.3.12 |
| | % | % | % | % | % | % | % | % | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | | | | | | | | | |
| Sandy, siliceous, thermic Typic Haplaquods, "argillic" variant | 0 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 21 | 7 | . | . | 100 | 100 | . | . | . | . | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Paleaquults | 8 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Fine-loamy, siliceous, thermic Umbric Paleaquults | 6 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquults | 3 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 58 | 93 | 100 | 100 | . | . | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Sandy, siliceous, thermic Typic Haplaquods | 4 | . | . | . | . | . | . | . | . | . | . | . | . | . |

VEGCLASS 9: Intermittently Ponded Cypress/Gum Depression
9.4. Wet Savannah/Meadow

| | VEG GROUP | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9. | 9.4. | 9.4.1 | 9.4.2 | 9.4.3 | 9.4.4 | 9.4.5 | 9.4.6 | 9.4.7 | 9.4.8 | 9.4.9 | 9.4.10 |
| | % | % | % | % | % | % | % | % | % | % | % | % |
| SOIL FAMILY | | | | | | | | | | | | |
| Sandy, siliceous, thermic Typic Haplaquods, "argillic" variant | 0 | . | . | . | . | . | . | . | . | . | . | . |
| Fine-loamy, siliceous, thermic Typic Paleaquults | 21 | 50 | 100 | 100 | 100 | 100 | . | . | . | . | . | . |
| Clayey, kaolonitic, thermic Typic Paleaquults | 8 | 21 | . | . | . | . | . | . | . | 100 | . | 100 |
| Fine-loamy, siliceous, thermic Umbric Paleaquults | 6 | 11 | . | . | . | . | 100 | 100 | . | . | . | . |
| Fine-loamy over sandy or sandy-skeletal, mixed, thermic Typic Umbraquults | 3 | 11 | . | . | . | . | . | . | . | . | 100 | . |
| Clayey, kaolonitic, thermic Typic Fragiaquults | 58 | . | . | . | . | . | . | . | . | . | . | . |
| Sandy, siliceous, thermic Typic Haplaquods | 4 | 6 | . | . | . | . | . | . | 100 | . | . | . |

Table A-II-2. SUMMARY OF CAROLINA BAY CHEMICAL SOILS DATA FROM THE 10cm SOIL DEPTH.

| VEG GROUP | HumMat-10 | Wt/Vol-10 | CEC10 | BasSat-10 | Acid10 | pH10 | P10 | K10 | Ca10 | Mg10 | Mn10 | Zn10 | Cu10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.65 | 0.75 | 13.10 | 74.75 | 3.40 | 4.55 | 8.75 | 128.00 | 30.95 | 38.83 | 5.50 | 15.75 | . |
| 1.0.1 | 0.65 | 0.75 | 13.10 | 74.75 | 3.40 | 4.55 | 8.75 | 128.00 | 30.95 | 38.83 | 5.50 | 15.75 | 8.00 |
| 2. | 6.00 | 0.99 | 3.36 | 13.32 | 2.91 | 4.37 | 2.93 | 5.64 | 8.37 | 3.95 | 4.64 | 10.75 | . |
| 2.0.1 | 6.14 | 0.97 | 3.91 | 11.38 | 3.45 | 4.26 | 2.63 | 6.00 | 6.78 | 3.53 | 5.00 | 8.88 | 37.25 |
| 2.0.2 | 6.27 | 0.95 | 3.52 | 11.33 | 3.10 | 4.32 | 2.92 | 6.83 | 6.67 | 3.39 | 5.83 | 12.17 | 54.67 |
| 2.0.3 | 5.45 | 1.08 | 2.58 | 18.25 | 2.10 | 4.55 | 3.25 | 3.50 | 12.53 | 5.23 | 2.50 | 10.50 | 7.50 |
| 3. | 1.39 | 0.96 | 3.05 | 25.27 | 2.21 | 4.79 | 10.36 | 14.82 | 13.78 | 8.61 | 40.27 | 53.27 | . |
| 3.0.1 | 1.55 | 0.91 | 3.20 | 26.88 | 2.25 | 4.76 | 7.00 | 18.50 | 14.08 | 10.01 | 53.75 | 63.50 | 70.50 |
| 3.0.2 | 0.97 | 1.09 | 2.67 | 21.00 | 2.10 | 4.87 | 19.33 | 5.00 | 13.00 | 4.87 | 4.33 | 26.00 | 18.67 |
| 4. | 3.95 | 0.89 | 3.81 | 27.53 | 2.73 | 4.60 | 18.65 | 15.29 | 17.69 | 8.02 | 83.18 | 33.47 | . |
| 4.0.1 | 6.80 | 0.56 | 4.20 | 8.50 | 3.80 | 4.55 | 3.00 | 14.00 | 4.85 | 2.43 | 12.50 | 63.25 | 79.00 |
| 4.0.2 | 3.20 | 1.12 | 2.58 | 25.60 | 1.92 | 4.72 | 46.20 | 8.80 | 18.22 | 5.56 | 18.40 | 16.80 | 54.00 |
| 4.0.3 | 3.00 | 0.91 | 4.38 | 38.25 | 2.70 | 4.55 | 9.25 | 20.00 | 23.79 | 12.35 | 159.00 | 29.00 | 110.25 |
| 4.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 4.0.5 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 5. | 13.05 | 0.67 | 8.53 | 12.07 | 7.51 | 4.02 | 7.33 | 9.87 | 5.73 | 5.43 | 4.00 | 35.27 | . |
| 5.0.1 | 15.00 | 0.76 | 8.98 | 11.50 | 7.90 | 4.05 | 3.00 | 3.50 | 5.83 | 5.38 | 3.50 | 33.75 | 7.50 |
| 5.0.2 | 10.81 | 0.56 | 8.01 | 12.71 | 7.07 | 3.99 | 12.29 | 17.14 | 5.61 | 5.49 | 4.57 | 37.00 | 12.29 |
| 6. | 1.79 | 1.26 | 2.03 | 9.88 | 1.85 | 4.35 | 2.38 | 2.75 | 6.36 | 3.14 | 1.63 | 6.63 | . |
| 6.0.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.2 | 2.93 | 1.17 | 2.70 | 7.75 | 2.50 | 4.35 | 3.75 | 5.50 | 3.68 | 3.00 | 1.75 | 8.75 | 11.50 |
| 6.0.3 | 0.65 | 1.36 | 1.35 | 12.00 | 1.20 | 4.35 | 1.00 | 0.00 | 9.05 | 3.28 | 1.50 | 4.50 | 8.00 |
| 6.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.5 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 7. | 5.75 | 0.47 | 11.53 | 15.84 | 9.46 | 3.61 | 6.21 | 39.27 | 4.59 | 9.63 | 15.57 | 28.05 | . |
| 7.1. | 4.22 | 0.61 | 11.16 | 24.25 | 7.60 | 3.87 | 5.58 | 52.00 | 9.12 | 13.10 | 50.08 | 32.58 | 8.17 |
| 7.1.1 | 2.29 | 0.67 | 8.53 | 10.38 | 7.45 | 3.60 | 4.38 | 36.25 | 3.74 | 5.01 | 22.00 | 24.75 | 4.75 |
| 7.1.2 | 8.08 | 0.50 | 16.42 | 52.00 | 7.90 | 4.40 | 8.00 | 83.50 | 19.88 | 29.28 | 106.25 | 48.25 | 15.00 |
| 7.2 | 6.17 | 0.43 | 11.63 | 13.55 | 9.96 | 3.54 | 6.39 | 35.80 | 3.36 | 8.68 | 6.16 | 26.82 | 7.68 |
| 7.2.1 | 8.04 | 0.64 | 10.25 | 12.13 | 8.90 | 3.51 | 5.50 | 66.00 | 1.78 | 7.56 | 7.25 | 28.75 | 8.75 |
| 7.2.2 | 7.95 | 0.26 | 13.78 | 16.50 | 11.31 | 3.56 | 7.67 | 25.75 | 4.62 | 11.03 | 5.17 | 34.67 | 8.92 |
| 7.2.3 | 6.37 | 0.61 | 11.64 | 12.31 | 10.23 | 3.51 | 5.31 | 30.25 | 1.69 | 9.28 | 3.56 | 14.94 | 6.50 |
| 7.2.4 | 1.23 | 0.13 | 9.74 | 13.00 | 8.49 | 3.61 | 7.50 | 31.75 | 6.40 | 5.05 | 11.75 | 36.88 | 7.13 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8. | 5.23 | 0.36 | 9.94 | 19.61 | 7.84 | 3.96 | 8.66 | 25.75 | 13.67 | 4.56 | 13.02 | 38.91 | . |
| 8.0.1 | 5.55 | 0.30 | 12.10 | 18.25 | 9.90 | 3.65 | 6.50 | 36.25 | 9.75 | 7.25 | 15.00 | 23.75 | 13.75 |
| 8.0.2 | 5.05 | 0.21 | 10.80 | 12.50 | 9.50 | 3.53 | 1.75 | 10.00 | 5.73 | 5.78 | 6.75 | 9.25 | 2.00 |
| 8.0.3 | 0.58 | 0.09 | 7.48 | 12.00 | 6.60 | 3.85 | 2.50 | 4.00 | 9.88 | 2.03 | 2.50 | 17.75 | 2.00 |
| 8.0.4 | 3.28 | 0.36 | 8.88 | 14.50 | 7.60 | 4.30 | 13.50 | 33.50 | 9.18 | 3.53 | 11.25 | 58.75 | 39.00 |
| 8.0.5 | 12.75 | 0.49 | 12.60 | 9.50 | 11.40 | 3.43 | 15.00 | 43.50 | 4.38 | 3.48 | 13.50 | 94.50 | 23.00 |
| 8.0.6 | 8.70 | 0.68 | 5.60 | 14.75 | 4.70 | 4.53 | 8.00 | 35.50 | 4.33 | 7.33 | 8.25 | 40.25 | 31.50 |
| 8.0.7 | 6.76 | 0.46 | 9.43 | 7.25 | 8.70 | 3.61 | 7.13 | 24.50 | 2.83 | 3.33 | 26.25 | 31.88 | 13.50 |
| 8.0.8 | 1.38 | 0.14 | 10.55 | 12.75 | 9.20 | 3.53 | 3.25 | 21.00 | 7.15 | 4.45 | 13.00 | 54.50 | 2.50 |
| 8.0.9 | 2.70 | 0.18 | 10.00 | 28.00 | 7.20 | 4.30 | 24.00 | 36.00 | 20.10 | 5.80 | 16.00 | 42.00 | 14.00 |
| 8.0.10 | 4.08 | 0.58 | 12.48 | 79.00 | 2.70 | 5.23 | 6.50 | 14.50 | 74.20 | 3.85 | 4.50 | 23.50 | 22.00 |
| 9. | 5.06 | 0.95 | 4.09 | 13.23 | 3.56 | 4.26 | 4.71 | 8.16 | 7.62 | 4.52 | 11.34 | 18.53 | . |
| 9.1. | 5.95 | 1.00 | 5.40 | 8.17 | 4.93 | 4.03 | 12.75 | 10.00 | 4.31 | 2.93 | 4.00 | 28.08 | 54.92 |
| 9.1.1 | 5.18 | 1.00 | 4.13 | 7.75 | 3.80 | 4.28 | 5.75 | 6.00 | 4.88 | 2.50 | 3.75 | 16.50 | 52.00 |
| 9.1.2 | 4.23 | 0.93 | 4.30 | 7.00 | 4.00 | 4.23 | 5.00 | 8.00 | 2.30 | 3.30 | 5.00 | 20.25 | 39.00 |
| 9.1.3 | 8.45 | 1.07 | 7.78 | 9.75 | 7.00 | 3.60 | 27.50 | 16.00 | 5.75 | 3.00 | 3.25 | 47.50 | 73.75 |
| 9.1.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2. | 4.03 | 0.92 | 2.65 | 33.00 | 1.80 | 4.80 | 2.25 | 12.50 | 21.90 | 8.80 | 31.00 | 20.75 | 91.50 |
| 9.2.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.2 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.3 | 4.03 | 0.92 | 2.65 | 33.00 | 1.80 | 4.80 | 2.25 | 12.50 | 21.90 | 8.80 | 31.00 | 20.75 | 91.50 |
| 9.3 | 5.68 | 0.89 | 4.21 | 11.31 | 3.74 | 4.19 | 4.10 | 10.12 | 5.74 | 4.41 | 11.80 | 20.92 | 62.82 |
| 9.3.1 | 2.71 | 0.86 | 3.96 | 16.13 | 3.30 | 4.20 | 4.25 | 13.00 | 8.26 | 6.40 | 28.38 | 37.50 | 90.25 |
| 9.3.2 | 2.53 | 0.94 | 3.73 | 9.00 | 3.40 | 4.10 | 4.25 | 4.50 | 5.43 | 3.00 | 6.00 | 16.50 | 61.00 |
| 9.3.3 | 6.23 | 0.94 | 4.33 | 7.50 | 4.00 | 3.90 | 8.50 | 6.50 | 3.15 | 3.35 | 5.75 | 12.50 | 59.50 |
| 9.3.4 | 15.00 | 0.82 | 6.45 | 6.75 | 6.00 | 3.88 | 3.75 | 6.50 | 3.80 | 2.43 | 23.25 | 34.75 | 42.00 |
| 9.3.5 | 3.01 | 0.86 | 3.66 | 15.08 | 3.13 | 4.23 | 3.67 | 7.33 | 8.00 | 6.03 | 8.75 | 14.67 | 63.83 |
| 9.3.6 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.7 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.8 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.9 | 9.09 | 0.93 | 3.38 | 8.64 | 3.09 | 4.54 | 2.36 | 7.09 | 5.22 | 2.21 | 5.73 | 12.45 | 51.27 |
| 9.3.10 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.11 | 4.55 | 1.07 | 3.35 | 8.25 | 3.10 | 4.05 | 5.75 | 5.50 | 3.63 | 3.73 | 5.75 | 12.50 | 55.00 |
| 9.3.12 | 4.73 | 0.72 | 7.63 | 11.50 | 6.70 | 3.88 | 4.00 | 38.50 | 2.30 | 6.75 | 11.00 | 37.25 | 70.50 |
| 9.4. | 4.19 | 1.00 | 3.73 | 15.02 | 3.15 | 4.37 | 3.45 | 5.00 | 9.41 | 4.69 | 11.02 | 12.95 | 25.77 |
| 9.4.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.2 | 0.88 | 1.37 | 1.30 | 15.00 | 1.10 | 4.75 | 3.25 | 2.00 | 7.98 | 5.90 | 1.00 | 4.00 | 5.50 |
| 9.4.3 | 2.21 | 1.10 | 2.05 | 12.88 | 1.80 | 4.45 | 2.63 | 7.25 | 7.18 | 3.78 | 3.63 | 10.63 | 46.50 |
| 9.4.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.5 | 2.58 | 1.07 | 3.35 | 17.25 | 2.80 | 4.28 | 5.50 | 4.50 | 8.10 | 8.08 | 18.00 | 7.75 | 11.50 |
| 9.4.6 | 3.35 | 0.66 | 6.08 | 47.00 | 3.20 | 4.80 | 4.50 | 9.50 | 34.75 | 11.55 | 75.00 | 41.25 | 35.50 |
| 9.4.7 | 13.48 | 0.74 | 7.90 | 8.00 | 7.30 | 3.80 | 2.25 | 6.00 | 6.15 | 1.28 | 3.00 | 12.75 | 2.50 |
| 9.4.8 | 4.10 | 1.00 | 4.33 | 11.00 | 3.90 | 4.15 | 4.00 | 3.50 | 7.38 | 3.18 | 3.75 | 14.00 | 25.00 |
| 9.4.9 | 5.36 | 0.91 | 4.35 | 7.50 | 4.00 | 4.23 | 4.00 | 4.50 | 4.71 | 2.45 | 3.63 | 13.50 | 19.25 |
| 9.4.10 | 5.68 | 0.82 | 4.03 | 11.25 | 3.60 | 4.20 | 2.00 | 4.00 | 7.40 | 3.23 | 5.00 | 10.50 | 66.50 |

Table A-II-3. SUMMARY OF CAROLINA BAY CHEMICAL SOILS DATA FROM THE 25cm SOIL DEPTH.

| VEG GROUP | HumMat-25 | Wt/Vol-25 | CEC25 | BasSat-25 | Acid25 | pH25 | P25 | K25 | Ca25 | Mg25 | Mn25 | Zn25 | Cu25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.70 | 1.11 | 11.30 | 86.00 | 1.60 | 5.38 | 3.00 | 53.50 | 41.48 | 42.00 | 1.00 | 4.75 | 7.00 |
| 1.0.1 | 0.70 | 1.11 | 11.30 | 86.00 | 1.60 | 5.38 | 3.00 | 53.50 | 41.48 | 42.00 | 1.00 | 4.75 | 7.00 |
| 2. | 0.61 | 1.18 | 2.33 | 19.14 | 1.89 | 4.49 | 4.04 | 3.50 | 12.43 | 5.82 | 4.29 | 5.89 | 21.21 |
| 2.0.1 | 0.73 | 1.17 | 2.51 | 18.63 | 2.05 | 4.40 | 4.38 | 4.25 | 12.50 | 5.11 | 4.00 | 5.88 | 26.25 |
| 2.0.2 | 0.83 | 1.16 | 2.22 | 16.58 | 1.83 | 4.46 | 5.17 | 4.00 | 11.01 | 4.57 | 4.00 | 6.67 | 30.33 |
| 2.0.3 | 0.18 | 1.23 | 2.33 | 23.50 | 1.80 | 4.63 | 2.00 | 2.00 | 14.48 | 8.40 | 5.00 | 4.75 | 2.50 |
| 3. | 0.52 | 1.25 | 2.05 | 39.45 | 1.23 | 4.94 | 8.45 | 14.09 | 21.95 | 14.55 | 34.00 | 13.91 | 36.55 |
| 3.0.1 | 0.45 | 1.27 | 1.91 | 43.25 | 1.05 | 4.94 | 3.88 | 17.00 | 23.80 | 15.75 | 44.88 | 10.13 | 36.50 |
| 3.0.2 | 0.70 | 1.22 | 2.40 | 29.33 | 1.70 | 4.93 | 20.67 | 6.33 | 17.00 | 11.33 | 5.00 | 24.00 | 36.67 |
| 4. | 1.74 | 1.08 | 3.11 | 32.06 | 1.98 | 4.80 | 4.71 | 16.12 | 20.74 | 9.05 | 78.82 | 10.00 | 47.88 |
| 4.0.1 | 3.00 | 0.75 | 2.40 | 15.50 | 2.00 | 5.00 | 1.00 | 14.50 | 8.45 | 4.00 | 6.75 | 12.50 | 59.50 |
| 4.0.2 | 1.60 | 1.29 | 1.88 | 23.40 | 1.44 | 5.02 | 9.60 | 2.80 | 17.80 | 4.88 | 12.20 | 6.00 | 21.20 |
| 4.0.3 | 1.20 | 1.12 | 4.23 | 45.75 | 2.30 | 4.56 | 3.50 | 25.25 | 28.73 | 14.19 | 156.50 | 11.25 | 58.75 |
| 4.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 4.0.5 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 5. | 6.59 | 0.76 | 8.25 | 11.13 | 7.33 | 4.03 | 3.00 | 5.93 | 4.63 | 6.02 | 3.27 | 13.53 | 10.93 |
| 5.0.1 | 4.68 | 0.89 | 7.33 | 10.50 | 6.60 | 4.10 | 2.25 | 4.00 | 4.15 | 5.93 | 2.50 | 10.50 | 12.00 |
| 5.0.2 | 8.77 | 0.61 | 9.30 | 11.86 | 8.17 | 3.94 | 3.86 | 8.14 | 5.19 | 6.13 | 4.14 | 17.00 | 9.71 |
| 6. | 1.42 | 1.33 | 1.98 | 11.70 | 1.00 | 4.60 | 1.90 | 5.00 | 19.18 | 5.61 | 1.00 | 4.00 | 7.00 |
| 6.0.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.2 | 1.88 | 1.26 | 1.55 | 15.50 | 1.30 | 4.78 | 3.25 | 0.00 | 11.70 | 3.65 | 1.00 | 5.00 | 10.00 |
| 6.0.3 | 0.10 | 1.41 | 0.75 | 8.25 | 0.70 | 4.40 | 1.00 | 0.50 | 4.55 | 3.63 | 1.00 | 3.00 | 4.00 |
| 6.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.5 | 3.15 | . | 5.30 | 11.00 | . | 4.65 | 1.00 | 24.00 | 63.40 | 13.50 | . | . | . |
| 7. | 8.27 | 0.59 | 11.19 | 14.32 | 9.29 | 3.65 | 6.11 | 27.66 | 4.35 | 8.83 | 13.27 | 18.70 | 5.71 |
| 7.1. | 3.40 | 0.67 | 10.73 | 23.25 | 7.37 | 3.96 | 6.25 | 67.33 | 8.18 | 12.51 | 52.25 | 30.58 | 5.83 |
| 7.1.1 | 2.09 | 0.79 | 8.00 | 8.88 | 7.20 | 3.69 | 5.13 | 33.25 | 2.83 | 4.38 | 9.25 | 20.38 | 3.00 |
| 7.1.2 | 6.03 | 0.44 | 16.20 | 52.00 | 7.70 | 4.50 | 8.50 | 135.50 | 18.90 | 28.78 | 138.25 | 51.00 | 11.50 |
| 7.2 | 9.60 | 0.57 | 11.31 | 11.89 | 9.81 | 3.57 | 6.07 | 16.84 | 3.31 | 7.83 | 2.64 | 15.45 | 5.68 |
| 7.2.1 | 9.13 | 0.89 | 8.33 | 8.50 | 7.55 | 3.71 | 5.88 | 26.75 | 1.48 | 5.65 | 2.00 | 11.75 | 5.00 |
| 7.2.2 | 10.46 | 0.30 | 14.28 | 15.58 | 11.78 | 3.53 | 7.25 | 14.75 | 4.03 | 10.99 | 2.58 | 20.08 | 6.83 |
| 7.2.3 | 13.03 | 0.81 | 11.30 | 11.19 | 9.95 | 3.54 | 5.50 | 15.50 | 2.24 | 8.24 | 1.69 | 8.19 | 5.00 |
| 7.2.4 | 1.95 | 0.16 | 9.85 | 11.13 | 8.83 | 3.54 | 5.63 | 12.75 | 6.20 | 4.43 | 5.25 | 26.75 | 6.00 |
| 8. | 6.82 | 0.52 | 8.51 | 18.27 | 6.62 | 4.00 | 6.39 | 15.16 | 13.50 | 3.83 | 10.07 | 22.77 | 17.52 |
| 8.0.1 | 15.00 | 0.50 | 11.20 | 12.50 | 9.73 | 3.53 | 2.50 | 8.25 | 5.75 | 7.50 | 8.75 | 9.00 | 10.25 |
| 8.0.2 | 2.40 | 0.22 | 9.85 | 11.50 | 8.70 | 3.68 | 1.50 | 9.50 | 9.15 | 1.95 | 16.25 | 15.00 | 3.50 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.0.3 | 1.03 | 0.12 | 7.95 | 9.25 | 7.20 | 3.75 | 2.75 | 12.50 | 6.48 | 2.05 | 3.00 | 23.50 | 13.00 |
| 8.0.4 | 3.38 | 0.55 | 2.70 | 18.00 | 2.20 | 4.33 | 4.00 | 11.00 | 9.73 | 6.50 | 3.50 | 14.50 | 35.00 |
| 8.0.5 | 15.00 | 0.47 | 10.25 | 6.50 | 9.60 | 3.33 | 7.25 | 30.50 | 2.68 | 2.05 | 7.00 | 46.50 | 17.50 |
| 8.0.6 | 9.08 | 0.92 | 3.95 | 11.25 | 3.50 | 4.60 | 6.00 | 12.50 | 4.40 | 4.83 | 3.25 | 12.00 | 40.50 |
| 8.0.7 | 8.78 | 0.79 | 6.41 | 5.25 | 6.00 | 3.76 | 3.13 | 11.75 | 2.44 | 2.24 | 15.00 | 16.63 | 16.25 |
| 8.0.8 | 1.65 | 0.20 | 11.05 | 11.25 | 9.80 | 3.60 | 5.00 | 28.00 | 5.43 | 4.23 | 19.50 | 54.75 | 2.50 |
| 8.0.9 | 6.20 | 0.33 | 10.90 | 23.00 | 8.40 | 4.00 | 31.00 | 28.00 | 16.50 | 5.30 | 18.00 | 36.00 | 18.00 |
| 8.0.10 | 3.70 | 0.84 | 12.95 | 87.25 | 1.70 | 5.65 | 4.00 | 3.00 | 83.50 | 3.20 | 1.50 | 6.00 | 20.00 |
| 9. | 1.91 | 1.16 | 2.68 | 17.91 | 2.26 | 4.46 | 4.52 | 4.86 | 10.36 | 6.43 | 7.37 | 9.42 | 29.19 |
| 9.1. | 4.38 | 1.11 | 4.33 | 6.75 | 4.05 | 4.14 | 19.00 | 6.08 | 3.47 | 2.56 | 3.83 | 15.58 | 45.50 |
| 9.1.1 | 4.75 | 1.09 | 3.50 | 5.75 | 3.30 | 4.30 | 3.25 | 4.00 | 2.83 | 2.33 | 3.00 | 11.50 | 57.00 |
| 9.1.2 | 3.38 | 1.06 | 3.50 | 8.25 | 3.20 | 4.33 | 3.25 | 5.50 | 4.08 | 3.60 | 5.50 | 12.75 | 31.50 |
| 9.1.3 | 5.03 | 1.19 | 6.00 | 6.25 | 5.65 | 3.80 | 50.50 | 8.75 | 3.50 | 1.75 | 3.00 | 22.50 | 48.00 |
| 9.1.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2. | 0.50 | 1.12 | 2.43 | 33.00 | 1.60 | 4.60 | 1.25 | 7.00 | 22.73 | 9.10 | 10.50 | 6.25 | 16.50 |
| 9.2.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.2 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.3 | 0.50 | 1.12 | 2.43 | 33.00 | 1.60 | 4.60 | 1.25 | 7.00 | 22.73 | 9.10 | 10.50 | 6.25 | 16.50 |
| 9.3. | 1.56 | 1.12 | 2.53 | 15.29 | 2.16 | 4.45 | 3.80 | 5.80 | 7.73 | 6.34 | 9.06 | 11.37 | 41.41 |
| 9.3.1 | 0.85 | 1.17 | 2.56 | 16.63 | 2.15 | 4.69 | 2.50 | 6.00 | 7.90 | 7.41 | 18.50 | 10.88 | 75.25 |
| 9.3.2 | 1.98 | 1.04 | 2.50 | 8.25 | 2.30 | 4.25 | 3.00 | 4.00 | 3.98 | 3.75 | 4.75 | 8.50 | 21.50 |
| 9.3.3 | 1.45 | 1.04 | 2.63 | 9.00 | 2.40 | 4.20 | 6.50 | 4.00 | 4.70 | 3.78 | 3.75 | 7.75 | 61.00 |
| 9.3.4 | 4.93 | 1.12 | 4.25 | 8.75 | 3.90 | 4.23 | 3.00 | 4.50 | 5.60 | 2.35 | 8.75 | 13.75 | 50.50 |
| 9.3.5 | 0.33 | 1.06 | 2.32 | 23.42 | 1.77 | 4.35 | 2.25 | 7.67 | 10.19 | 11.35 | 12.42 | 7.50 | 16.33 |
| 9.3.6 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.7 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.8 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.9 | 1.54 | 1.25 | 1.93 | 14.09 | 1.64 | 4.68 | 5.64 | 2.73 | 9.69 | 3.64 | 2.91 | 6.00 | 24.91 |
| 9.3.10 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.11 | 3.18 | 1.08 | 2.40 | 9.50 | 2.20 | 4.30 | 3.25 | 4.50 | 4.20 | 4.20 | 4.50 | 23.50 | 48.00 |
| 9.3.12 | 1.50 | 1.09 | 3.13 | 17.25 | 2.60 | 4.53 | 5.50 | 14.50 | 7.08 | 7.88 | 11.50 | 30.75 | 79.00 |
| 9.4. | 1.77 | 1.23 | 2.42 | 22.61 | 1.96 | 4.53 | 1.70 | 3.23 | 14.16 | 7.35 | 6.09 | 5.77 | 11.73 |
| 9.4.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.2 | 0.10 | 1.43 | 0.63 | 33.00 | 0.40 | 5.05 | 1.25 | 2.00 | 20.38 | 10.78 | 1.00 | 3.00 | 4.50 |
| 9.4.3 | 0.06 | 1.26 | 1.80 | 21.63 | 1.40 | 4.60 | 1.38 | 6.00 | 12.20 | 7.51 | 2.75 | 5.00 | 10.25 |
| 9.4.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.5 | 0.10 | 1.55 | 0.70 | 42.00 | 0.40 | 4.63 | 1.75 | 2.00 | 29.00 | 11.60 | 1.75 | 4.25 | 4.00 |
| 9.4.6 | 0.10 | 1.17 | 4.43 | 43.50 | 2.50 | 4.55 | 1.25 | 6.00 | 26.58 | 15.80 | 34.00 | 8.00 | 15.50 |
| 9.4.7 | 11.95 | 0.94 | 4.90 | 6.75 | 4.60 | 4.08 | 1.50 | 0.00 | 5.68 | 1.18 | 1.50 | 5.00 | 2.50 |
| 9.4.8 | 1.38 | 1.21 | 2.33 | 15.25 | 2.00 | 4.35 | 1.75 | 2.00 | 9.20 | 5.63 | 3.25 | 7.00 | 12.50 |
| 9.4.9 | 2.70 | 1.12 | 3.15 | 10.50 | 2.85 | 4.33 | 2.88 | 2.75 | 6.91 | 3.04 | 3.25 | 8.38 | 24.25 |
| 9.4.10 | 0.25 | 0.99 | 3.13 | 11.00 | 2.80 | 4.28 | 1.50 | 4.00 | 6.38 | 3.95 | 12.50 | 6.50 | 16.50 |

Table A-II-4. SUMMARY OF CAROLINA BAY CHEMICAL SOILS DATA FROM THE 50cm SOIL DEPTH.

| VEG GROUP | HumMat-50 | Wt/Vol-50 | CEC50 | BasSat-50 | Acid50 | pH50 | P50 | K50 | Ca50 | Mg50 | Mn50 | Zn50 | Cu50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2.83 | 1.11 | 8.50 | 94.25 | 0.50 | 6.18 | 4.00 | 42.00 | 56.95 | 34.75 | 2.00 | 5.50 | 7.50 |
| 1.0.1 | 2.83 | 1.11 | 8.50 | 94.25 | 0.50 | 6.18 | 4.00 | 42.00 | 56.95 | 34.75 | 2.00 | 5.50 | 7.50 |
| 2. | 0.03 | 1.18 | 2.39 | 23.11 | 1.81 | 4.63 | 4.75 | 4.14 | 13.43 | 8.84 | 5.50 | 5.96 | 9.57 |
| 2.0.1 | 0.04 | 1.19 | 2.46 | 17.88 | 2.00 | 4.48 | 5.38 | 4.00 | 10.71 | 6.38 | 3.50 | 6.75 | 10.25 |
| 2.0.2 | 0.04 | 1.17 | 2.30 | 19.67 | 1.83 | 4.60 | 5.00 | 4.00 | 12.50 | 6.33 | 6.67 | 5.75 | 12.50 |
| 2.0.3 | 0.00 | 1.17 | 2.45 | 33.50 | 1.60 | 4.83 | 3.75 | 4.50 | 17.55 | 15.08 | 5.75 | 5.50 | 4.50 |
| 3. | 0.08 | 1.17 | 2.55 | 51.91 | 1.12 | 5.02 | 2.18 | 16.64 | 28.90 | 20.44 | 36.18 | 12.45 | 38.55 |
| 3.0.1 | 0.09 | 1.13 | 2.15 | 51.75 | 1.00 | 5.05 | 1.63 | 18.00 | 28.74 | 18.98 | 37.00 | 4.38 | 26.75 |
| 3.0.2 | 0.07 | 1.26 | 3.63 | 52.33 | 1.43 | 4.93 | 3.67 | 13.00 | 29.33 | 24.33 | 34.00 | 34.00 | 70.00 |
| 4. | 0.03 | 1.28 | 2.62 | 33.29 | 1.62 | 4.79 | 4.29 | 9.18 | 20.84 | 10.76 | 37.24 | 6.82 | 25.18 |
| 4.0.1 | 0.00 | 1.44 | 1.00 | 20.00 | 0.80 | 4.90 | 10.25 | 4.00 | 10.00 | 8.00 | 4.00 | 3.25 | 21.50 |
| 4.0.2 | 0.00 | 1.30 | 1.84 | 26.40 | 1.36 | 5.06 | 3.00 | 3.60 | 16.64 | 8.86 | 11.00 | 2.80 | 9.60 |
| 4.0.3 | 0.06 | 1.20 | 3.91 | 44.25 | 2.20 | 4.56 | 2.13 | 15.25 | 28.87 | 13.34 | 70.25 | 11.13 | 36.75 |
| 4.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 4.0.5 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 5. | 2.38 | 1.10 | 5.18 | 10.86 | 4.60 | 4.26 | 4.57 | 3.86 | 4.91 | 5.46 | 3.21 | 9.29 | 26.50 |
| 5.0.1 | 2.63 | 1.19 | 4.43 | 10.25 | 4.00 | 4.33 | 5.25 | 3.00 | 4.78 | 5.03 | 1.50 | 5.25 | 28.50 |
| 5.0.2 | 2.05 | 0.98 | 6.18 | 11.67 | 5.40 | 4.18 | 3.67 | 5.00 | 5.10 | 6.03 | 5.50 | 14.67 | 23.83 |
| 6. | 0.69 | 1.23 | 1.44 | 11.13 | 1.30 | 4.55 | 19.38 | 0.00 | 6.59 | 4.23 | 1.38 | 4.13 | 13.00 |
| 6.0.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.2 | 0.08 | 1.31 | 1.10 | 15.75 | 0.90 | 4.65 | 3.00 | 0.00 | 9.65 | 5.83 | 1.75 | 3.50 | 8.00 |
| 6.0.3 | 1.30 | 1.16 | 1.78 | 6.50 | 1.70 | 4.45 | 35.75 | 0.00 | 3.53 | 2.63 | 1.00 | 4.75 | 18.00 |
| 6.0.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 6.0.5 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 7. | 9.23 | 0.75 | 10.30 | 11.54 | 8.86 | 3.70 | 4.95 | 9.70 | 3.63 | 7.55 | 6.13 | 22.04 | 5.66 |
| 7.1. | 7.45 | 0.73 | 10.27 | 18.83 | 7.70 | 3.81 | 5.58 | 30.50 | 6.66 | 10.97 | 15.33 | 23.58 | 6.83 |
| 7.1.1 | 3.68 | 0.84 | 8.11 | 8.88 | 7.20 | 3.59 | 5.88 | 27.00 | 3.24 | 4.33 | 3.88 | 24.38 | 4.00 |
| 7.1.2 | 15.00 | 0.52 | 14.60 | 38.75 | 8.70 | 4.25 | 5.00 | 37.50 | 13.50 | 24.25 | 38.25 | 22.00 | 12.50 |
| 7.2 | 9.72 | 0.76 | 10.31 | 9.55 | 9.17 | 3.68 | 4.77 | 4.02 | 2.81 | 6.62 | 3.61 | 21.61 | 5.34 |
| 7.2.1 | 9.20 | 1.08 | 7.53 | 3.75 | 7.25 | 3.78 | 7.63 | 3.75 | 1.66 | 1.94 | 1.25 | 25.50 | 7.25 |
| 7.2.2 | 11.55 | 0.35 | 13.79 | 13.75 | 11.75 | 3.48 | 5.75 | 6.75 | 3.18 | 10.56 | 3.00 | 45.25 | 7.17 |
| 7.2.3 | 7.47 | 1.01 | 7.84 | 8.88 | 7.05 | 3.86 | 3.06 | 1.50 | 2.44 | 6.24 | 2.06 | 4.56 | 3.00 |
| 7.2.4 | 11.99 | 0.55 | 12.80 | 10.38 | 11.46 | 3.51 | 3.88 | 5.25 | 4.15 | 6.15 | 10.00 | 16.38 | 5.38 |
| 8. | 5.92 | 0.78 | 7.58 | 19.34 | 6.18 | 4.07 | 4.27 | 11.52 | 14.59 | 3.76 | 6.39 | 15.73 | 20.30 |
| 8.0.1 | 7.35 | 0.93 | 7.35 | 7.00 | 6.80 | 3.78 | 2.25 | 6.75 | 2.50 | 3.75 | 1.50 | 5.25 | 7.25 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.0.2 | 1.40 | 0.17 | 9.68 | 13.50 | 8.40 | 3.63 | 5.00 | 28.00 | 9.33 | 2.43 | 15.00 | 15.25 | 4.00 |
| 8.0.3 | 6.65 | 0.63 | 7.53 | 9.50 | 6.80 | 3.65 | 1.75 | 3.50 | 8.30 | 1.23 | 2.50 | 11.75 | 5.00 |
| 8.0.4 | 1.38 | 1.03 | 4.10 | 27.50 | 3.00 | 4.20 | 1.75 | 7.50 | 15.48 | 10.73 | 4.25 | 11.50 | 58.00 |
| 8.0.5 | 11.68 | 0.79 | 10.95 | 6.25 | 10.30 | 3.40 | 3.25 | 29.00 | 2.80 | 1.78 | 2.50 | 49.25 | 9.00 |
| 8.0.6 | 1.85 | 1.18 | 3.45 | 18.00 | 2.80 | 4.40 | 4.00 | 13.50 | 5.10 | 10.70 | 4.50 | 10.00 | 51.50 |
| 8.0.7 | 7.54 | 1.01 | 5.39 | 6.00 | 5.15 | 3.99 | 2.63 | 3.25 | 3.75 | 1.44 | 10.50 | 9.50 | 27.50 |
| 8.0.8 | 3.70 | 0.21 | 10.63 | 9.25 | 9.60 | 3.48 | 4.00 | 18.50 | 5.75 | 2.65 | 8.00 | 30.00 | 5.50 |
| 8.0.9 | 15.00 | 0.54 | 11.30 | 15.00 | 9.60 | 3.90 | 15.00 | 10.00 | 11.50 | 3.00 | 10.00 | 18.00 | 10.00 |
| 8.0.10 | 1.00 | 1.15 | 7.60 | 94.75 | 0.40 | 6.40 | 4.75 | 3.50 | 92.25 | 2.20 | 1.00 | 3.00 | 18.00 |
| 9. | 0.31 | 1.14 | 2.45 | 20.85 | 1.95 | 4.52 | 2.67 | 4.70 | 10.81 | 9.07 | 9.51 | 7.30 | 21.05 |
| 9.1. | 0.98 | 1.13 | 3.18 | 8.67 | 2.88 | 4.33 | 3.92 | 4.17 | 4.90 | 3.38 | 3.25 | 7.33 | 35.92 |
| 9.1.1 | 2.13 | 1.12 | 3.28 | 8.50 | 3.00 | 4.30 | 4.00 | 3.50 | 5.25 | 2.50 | 3.75 | 7.75 | 53.00 |
| 9.1.2 | 0.10 | 1.14 | 2.63 | 10.75 | 2.30 | 4.33 | 1.00 | 2.50 | 4.95 | 5.65 | 4.00 | 8.50 | 10.00 |
| 9.1.3 | 0.70 | 1.14 | 3.63 | 6.75 | 3.35 | 4.38 | 6.75 | 6.50 | 4.50 | 2.00 | 2.00 | 5.75 | 44.75 |
| 9.1.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2. | 0.00 | 1.08 | 2.78 | 34.50 | 1.80 | 4.70 | 1.00 | 6.00 | 21.28 | 12.20 | 12.00 | 23.50 | 4.00 |
| 9.2.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.2 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.2.3 | 0.00 | 1.08 | 2.78 | 34.50 | 1.80 | 4.70 | 1.00 | 6.00 | 21.28 | 12.20 | 12.00 | 23.50 | 4.00 |
| 9.3. | 0.25 | 1.13 | 2.17 | 20.47 | 1.73 | 4.50 | 2.80 | 5.37 | 9.45 | 9.74 | 12.53 | 7.25 | 25.84 |
| 9.3.1 | 0.05 | 1.09 | 2.55 | 22.25 | 2.00 | 4.41 | 1.38 | 4.75 | 6.21 | 15.21 | 38.75 | 6.13 | 34.75 |
| 9.3.2 | 0.10 | 1.06 | 1.95 | 18.25 | 1.60 | 4.40 | 1.75 | 4.00 | 8.85 | 8.38 | 12.00 | 9.25 | 7.50 |
| 9.3.3 | 0.10 | 1.13 | 2.63 | 8.00 | 2.40 | 4.28 | 4.00 | 2.50 | 4.78 | 3.08 | 1.00 | 6.25 | 29.00 |
| 9.3.4 | 0.40 | 1.48 | 1.88 | 13.75 | 1.60 | 4.33 | 7.00 | 0.50 | 9.35 | 4.08 | 4.00 | 7.25 | 14.00 |
| 9.4.5 | 0.15 | 1.05 | 1.97 | 29.58 | 1.40 | 4.56 | 1.08 | 6.50 | 12.43 | 15.43 | 10.58 | 7.17 | 13.17 |
| 9.3.6 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.7 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.8 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.9 | 0.07 | 1.18 | 2.09 | 19.82 | 1.67 | 4.81 | 5.45 | 5.27 | 12.81 | 5.65 | 4.36 | 4.91 | 16.18 |
| 9.3.10 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.3.11 | 1.28 | 1.12 | 2.28 | 10.75 | 2.00 | 4.30 | 1.00 | 6.00 | 4.43 | 5.10 | 4.75 | 9.50 | 58.50 |
| 9.3.12 | 0.50 | 1.07 | 2.18 | 22.50 | 1.70 | 4.38 | 1.00 | 12.00 | 8.10 | 11.35 | 16.75 | 13.00 | 67.00 |
| 9.4. | 0.24 | 1.16 | 2.55 | 23.36 | 1.95 | 4.57 | 2.32 | 3.95 | 13.06 | 9.55 | 7.50 | 5.86 | 13.00 |
| 9.4.1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.2 | 0.00 | 1.24 | 2.10 | 34.00 | 1.40 | 4.83 | 1.25 | 5.00 | 18.30 | 14.28 | 3.25 | 7.50 | 5.00 |
| 9.4.3 | 0.01 | 1.10 | 1.81 | 26.88 | 1.30 | 4.93 | 1.38 | 5.75 | 14.70 | 10.74 | 5.13 | 5.25 | 10.75 |
| 9.4.4 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 9.4.5 | 0.00 | 1.24 | 2.40 | 26.25 | 1.80 | 4.38 | 1.00 | 2.00 | 11.78 | 14.20 | 17.50 | 4.25 | 5.50 |
| 9.4.6 | 0.03 | 1.12 | 4.63 | 32.50 | 3.10 | 4.30 | 1.25 | 6.50 | 16.40 | 15.58 | 26.25 | 7.00 | 29.50 |
| 9.4.7 | 1.55 | 1.11 | 2.55 | 14.50 | 2.20 | 4.35 | 5.50 | 0.00 | 13.30 | 1.60 | 2.50 | 4.75 | 2.00 |
| 9.4.8 | 0.20 | 1.15 | 2.68 | 20.75 | 2.10 | 4.45 | 1.25 | 2.50 | 11.35 | 9.13 | 4.50 | 5.00 | 22.00 |
| 9.4.9 | 0.41 | 1.20 | 2.78 | 10.25 | 2.50 | 4.33 | 4.75 | 3.50 | 6.28 | 3.50 | 3.75 | 6.13 | 20.50 |
| 9.4.10 | 0.00 | 1.06 | 2.38 | 20.75 | 1.90 | 4.63 | 1.75 | 4.00 | 12.30 | 7.55 | 7.50 | 5.75 | 11.50 |

Table A-II-5. SUMMARY OF CAROLINA BAY SOILS TEXTURAL DATA FROM THE 10cm SOIL DEPTH (BY VEGETATION GROUP).

| VEG GROUP | Sand | Silt | Clay |
|---|---|---|---|
| 1. | 8.00 | 25.40 | 67.96 |
| 1.0.1 | 25.40 | 67.96 | 6.64 |
| 2. | 36.21 | 22.62 | 64.88 |
| 2.0.1 | 22.30 | 62.56 | 15.14 |
| 2.0.2 | 14.00 | 72.43 | 13.57 |
| 2.0.3 | 48.80 | 44.56 | 6.64 |
| 3. | 56.36 | 55.47 | 39.10 |
| 3.0.1 | 13.50 | 76.72 | 9.78 |
| 3.0.2 | 83.45 | 14.02 | 2.53 |
| 4. | 86.35 | 13.84 | 74.14 |
| 4.0.1 | 2.60 | 91.12 | 6.28 |
| 4.0.2 | 20.70 | 69.52 | 9.78 |
| 4.0.3 | 12.60 | 70.26 | 17.14 |
| 4.0.4 | . | . | . |
| 4.0.5 | . | . | . |
| 5. | 9.73 | 24.35 | 69.65 |
| 5.0.1 | 27.15 | 67.44 | 5.41 |
| 5.0.2 | 19.88 | 73.19 | 6.93 |
| 6. | 9.75 | 81.50 | 11.36 |
| 6.0.1 | . | . | . |
| 6.0.2 | 84.60 | 9.76 | 5.64 |
| 6.0.3 | 78.40 | 12.96 | 8.64 |
| 6.0.4 | . | . | . |
| 6.0.5 | . | . | . |
| 7. | 7.79 | 39.76 | 56.07 |
| 7.1. | 65.80 | 28.56 | 5.64 |
| 7.1.1 | 65.80 | 28.56 | 5.64 |
| 7.1.2 | . | . | . |
| 7.2. | 33.25 | 62.95 | 3.80 |
| 7.2.1 | 81.80 | 14.56 | 3.64 |
| 7.2.2 | . | . | . |
| 7.2.3 | 17.07 | 79.08 | 3.85 |
| 7.2.4 | . | . | . |
| 8. | 16.07 | 8.24 | 83.86 |
| 8.0.1 | . | . | . |
| 8.0.2 | . | . | . |
| 8.0.3 | . | . | . |
| 8.0.4 | 2.20 | 92.52 | 5.28 |
| 8.0.5 | 1.20 | 91.80 | 7.00 |
| 8.0.6 | 17.80 | 70.92 | 11.28 |
| 8.0.7 | 7.20 | 86.16 | 6.64 |
| 8.0.8 | . | . | . |
| 8.0.9 | . | . | . |
| 8.0.10 | 12.80 | 77.92 | 9.28 |
| 9. | 48.32 | 39.04 | 49.34 |
| 9.1. | 51.77 | 39.45 | 8.77 |
| 9.1.1 | 37.20 | 50.52 | 12.28 |
| 9.1.2 | 43.60 | 45.12 | 11.28 |
| 9.1.3 | 74.50 | 22.71 | 2.74 |
| 9.1.4 | . | . | . |
| 9.2. | 37.20 | 49.16 | 13.64 |
| 9.2.1 | . | . | . |
| 9.2.2 | . | . | . |
| 9.2.3 | 37.20 | 49.16 | 13.64 |

| | | | |
|---|---|---|---|
| 9.3. | 34.51 | 52.98 | 12.51 |
| 9.3.1 | 28.30 | 56.56 | 15.14 |
| 9.3.2 | 54.80 | 33.56 | 11.64 |
| 9.3.3 | 32.20 | 56.52 | 11.28 |
| 9.3.4 | 25.60 | 66.12 | 8.28 |
| 9.3.5 | 30.00 | 50.39 | 19.61 |
| 9.3.6 | . | . | . |
| 9.3.7 | . | . | . |
| 9.3.8 | . | . | . |
| 9.3.9 | 32.87 | 57.03 | 10.10 |
| 9.3.10 | . | . | . |
| 9.3.11 | 72.00 | 17.36 | 10.64 |
| 9.3.12 | 32.00 | 47.36 | 20.64 |
| 9.4. | 44.36 | 45.12 | 10.52 |
| 9.4.1 | . | . | . |
| 9.4.2 | 85.60 | 10.76 | 3.64 |
| 9.4.3 | 29.30 | 54.92 | 15.78 |
| 9.4.4 | . | . | . |
| 9.4.5 | 42.20 | 54.16 | 3.64 |
| 9.4.6 | 34.40 | 49.60 | 16.00 |
| 9.4.7 | 32.40 | 64.32 | 3.28 |
| 9.4.8 | 43.60 | 43.76 | 12.64 |
| 9.4.9 | 48.00 | 43.86 | 8.14 |
| 9.4.10 | 9.60 | 65.40 | 25.00 |

Table A-II-6. SUMMARY OF CAROLINA BAY SOILS TEXTURAL DATA FROM THE 25cm SOIL DEPTH (BY VEGETATION GROUP).

| VEG GROUP | Sand | Silt | Clay |
|---|---|---|---|
| 1. | 56.80 | 38.56 | 4.64 |
| 1.0.1 | 56.80 | 38.56 | 4.64 |
| 2. | 33.36 | 49.22 | 17.42 |
| 2.0.1 | 36.80 | 45.56 | 17.64 |
| 2.0.2 | 25.87 | 56.40 | 17.73 |
| 2.0.3 | 52.40 | 31.32 | 16.28 |
| 3. | 53.90 | 36.88 | 9.22 |
| 3.0.1 | 14.50 | 72.72 | 12.78 |
| 3.0.2 | 80.17 | 12.99 | 6.84 |
| 4. | 22.64 | 60.74 | 16.62 |
| 4.0.1 | 7.00 | 79.72 | 13.28 |
| 4.0.2 | 27.70 | 58.52 | 13.78 |
| 4.0.3 | 25.40 | 53.46 | 21.14 |
| 4.0.4 | . | . | . |
| 4.0.5 | . | . | . |
| 5. | 29.06 | 57.69 | 13.25 |
| 5.0.1 | 31.23 | 53.96 | 14.82 |
| 5.0.2 | 25.60 | 63.67 | 10.73 |
| 6. | 60.05 | 26.49 | 13.82 |
| 6.0.1 | . | . | . |
| 6.0.2 | 97.80 | 0.01 | 3.64 |
| 6.0.3 | 22.40 | 67.96 | 9.64 |
| 6.0.4 | . | . | . |
| 6.0.5 | 60.00 | 19.00 | 21.00 |
| 7. | 57.48 | 37.92 | 4.77 |
| 7.1. | 96.20 | 0.01 | 4.64 |
| 7.1.1 | 96.20 | 0.01 | 4.64 |
| 7.1.2 | . | . | . |
| 7.2. | 47.80 | 47.40 | 4.80 |
| 7.2.1 | 93.80 | 1.56 | 4.64 |
| 7.2.2 | . | . | . |
| 7.2.3 | 32.47 | 62.68 | 4.85 |
| 7.2.4 | . | . | . |
| 8. | 25.60 | 63.30 | 11.10 |
| 8.0.1 | . | . | . |
| 8.0.2 | . | . | . |
| 8.0.3 | . | . | . |
| 8.0.4 | 30.40 | 57.32 | 12.28 |
| 8.0.5 | 1.00 | 89.00 | 10.00 |
| 8.0.6 | 30.40 | 55.32 | 14.28 |
| 8.0.7 | 49.40 | 39.96 | 10.64 |
| 8.0.8 | . | . | . |
| 8.0.9 | . | . | . |
| 8.0.10 | 16.80 | 74.92 | 8.28 |
| 9. | 47.34 | 38.04 | 14.64 |
| 9.1. | 54.05 | 35.24 | 10.71 |
| 9.1.1 | 33.20 | 52.52 | 14.28 |
| 9.1.2 | 52.00 | 35.72 | 12.28 |
| 9.1.3 | 76.95 | 17.47 | 5.58 |
| 9.1.4 | . | . | . |
| 9.2. | 42.00 | 36.36 | 21.64 |
| 9.2.1 | . | . | . |
| 9.2.2 | . | . | . |

| | | | |
|---|---|---|---|
| 9.2.3 | 42.00 | 36.36 | 21.64 |
| 9.3. | 42.62 | 42.06 | 15.32 |
| 9.3.1 | 41.70 | 39.66 | 18.64 |
| 9.3.2 | 46.60 | 39.76 | 13.64 |
| 9.3.3 | 47.00 | 36.72 | 16.28 |
| 9.3.4 | 42.60 | 47.12 | 10.28 |
| 9.3.5 | 25.13 | 52.59 | 22.28 |
| 9.3.6 | . | . | . |
| 9.3.7 | . | . | . |
| 9.3.8 | . | . | . |
| 9.3.9 | 46.02 | 41.34 | 12.64 |
| 9.3.10 | . | . | . |
| 9.3.11 | 64.40 | 22.96 | 12.64 |
| 9.3.12 | 29.40 | 44.96 | 25.64 |
| 9.4. | 55.02 | 31.27 | 13.79 |
| 9.4.1 | . | . | . |
| 9.4.2 | 95.80 | 0.01 | 4.64 |
| 9.4.3 | 27.10 | 52.62 | 20.28 |
| 9.4.4 | . | . | . |
| 9.4.5 | 75.20 | 20.16 | 4.64 |
| 9.4.6 | 48.20 | 35.80 | 16.00 |
| 9.4.7 | 71.80 | 21.92 | 6.28 |
| 9.4.8 | 57.80 | 27.56 | 14.64 |
| 9.4.9 | 47.60 | 40.26 | 12.14 |
| 9.4.10 | 11.20 | 52.80 | 36.00 |

Table A-II-7. SUMMARY OF CAROLINA BAY SOILS TEXTURAL DATA FROM THE 50cm SOIL DEPTH (BY VEGETATION GROUP).

| VEG GROUP | Sand | Silt | Clay |
|---|---|---|---|
| 1. | 66.40 | 26.96 | 6.64 |
| 1.0.1 | 66.40 | 26.96 | 6.64 |
| 2. | 49.92 | 31.46 | 18.62 |
| 2.0.1 | 61.10 | 23.76 | 15.14 |
| 2.0.2 | 42.43 | 37.00 | 20.57 |
| 2.0.3 | 61.20 | 22.52 | 16.28 |
| 3. | 46.63 | 38.03 | 15.34 |
| 3.0.1 | 18.10 | 60.62 | 21.28 |
| 3.0.2 | 65.65 | 22.97 | 11.38 |
| 4. | 37.68 | 47.70 | 14.62 |
| 4.0.1 | 63.60 | 28.12 | 8.28 |
| 4.0.2 | 25.50 | 59.72 | 14.78 |
| 4.0.3 | 36.90 | 45.46 | 17.64 |
| 4.0.4 | . | . | . |
| 4.0.5 | . | . | . |
| 5. | 61.08 | 27.37 | 11.55 |
| 5.0.1 | 67.90 | 21.78 | 10.32 |
| 5.0.2 | 50.16 | 36.31 | 13.53 |
| 6. | 66.50 | 25.36 | 8.14 |
| 6.0.1 | . | . | . |
| 6.0.2 | 88.60 | 5.76 | 5.64 |
| 6.0.3 | 44.40 | 44.96 | 10.64 |
| 6.0.4 | . | . | . |
| 6.0.5 | . | . | . |
| 7. | 71.28 | 23.15 | 5.57 |
| 7.1. | 85.40 | 8.96 | 5.64 |
| 7.1.1 | 85.40 | 8.96 | 5.64 |
| 7.1.2 | . | . | . |
| 7.2. | 67.75 | 26.70 | 5.55 |
| 7.2.1 | 89.60 | 3.76 | 6.64 |
| 7.2.2 | . | . | . |
| 7.2.3 | 60.47 | 34.35 | 5.19 |
| 7.3.4 | . | . | . |
| 8. | 32.60 | 52.90 | 14.50 |
| 8.0.1 | . | . | . |
| 8.0.2 | . | . | . |
| 8.0.3 | . | . | . |
| 8.0.4 | 13.80 | 63.92 | 22.28 |
| 8.0.5 | 27.20 | 62.80 | 10.00 |
| 8.0.6 | 27.20 | 54.52 | 18.28 |
| 8.0.7 | 57.40 | 31.96 | 10.64 |
| 8.0.8 | . | . | . |
| 8.0.9 | . | . | . |
| 8.0.10 | 37.40 | 51.32 | 11.28 |
| 9. | 41.25 | 37.97 | 20.78 |
| 9.1. | 45.95 | 37.06 | 16.99 |
| 9.1.1 | 22.20 | 60.52 | 17.28 |
| 9.1.2 | 43.20 | 39.52 | 17.28 |
| 9.1.3 | 72.45 | 11.13 | 16.42 |
| 9.1.4 | . | . | . |
| 9.2. | 35.60 | 40.76 | 23.64 |
| 9.2.1 | . | . | . |
| 9.2.2 | . | . | . |

| | | | |
|---|---|---|---|
| 9.2.3 | 35.60 | 40.76 | 23.64 |
| 9.3. | 36.17 | 40.94 | 22.89 |
| 9.3.1 | 35.50 | 36.36 | 28.14 |
| 9.3.2 | 39.00 | 37.36 | 23.64 |
| 9.3.3 | 61.20 | 23.52 | 15.28 |
| 9.3.4 | 72.20 | 19.52 | 8.28 |
| 9.3.5 | 19.30 | 56.75 | 23.95 |
| 9.3.6 | . | . | . |
| 9.3.7 | . | . | . |
| 9.3.8 | . | . | . |
| 9.3.9 | 34.64 | 41.81 | 23.55 |
| 9.3.10 | . | . | . |
| 9.3.11 | 58.00 | 24.36 | 17.64 |
| 9.3.12 | 19.20 | 52.16 | 28.64 |
| 9.4. | 50.20 | 32.28 | 17.52 |
| 9.4.1 | . | . | . |
| 9.4.2 | 73.40 | 14.96 | 11.64 |
| 9.4.3 | 20.70 | 56.52 | 22.78 |
| 9.4.4 | . | . | . |
| 9.4.5 | 67.20 | 20.16 | 12.64 |
| 9.4.6 | 43.60 | 33.40 | 23.00 |
| 9.4.7 | 77.80 | 15.92 | 6.28 |
| 9.4.8 | 41.40 | 35.96 | 22.64 |
| 9.4.9 | 59.50 | 29.36 | 11.14 |
| 9.4.10 | 15.00 | 48.00 | 37.00 |

## Appendix III. Catalog of Species

For vascular plant species, the naming and arrangement of taxonomic groups at the family level and above follows Cronquist (1992). Within families, genera and species are listed alphabetically, and taxonomy follows Kartesz (1994). Because Radford *et al.* (1968) endures as the standard flora for the Carolinas, it was used to identify species encountered in this study, supplemented primarily by Godfrey & Wooten (1981) for wetlands species. Consequently, in the list below, where taxonomic treatment of species in Kartesz, and either Radford *et al.* ("RAB")or Godfrey & Wooten ("G&W") differ, equivalent taxa for the plant identification references to those in Kartesz are given in brackets following the full species name.

# NONVASCULAR PLANTS

<u>LICHENS</u>

*Cladonia* sp.

<u>MOSSES</u>

*Leucobryum* sp.
*Sphagnum* spp.

# VASCULAR PLANTS

### DIVISION LYCOPODIOPHYTA (Clubmosses)

LYCOPODIACEAE

*Lycopodiella alopecuroides* (L.) Cranfill
[= *Lycopodium alopecuroides* L., RAB; species not included in G&W]

### DIVISION POLYPODIOPHYTA (Ferns)

OSMUNDACEAE

*Osmunda cinnamomea* L.
*Osmunda regalis* L.

POLYPODIACEAE

*Polypodium polypodioides* (L.) Watt

DENNSTAEDTIACEAE

*Pteridium aquilinum* (L.) Kuhn

BLECHNACEAE

*Woodwardia areolata* (L.) T. Moore
*Woodwardia virginica* (L.) Smith

## DIVISION PINOPHYTA (Gymnosperms)

PINACEAE

*Pinus elliottii* Engelm.
*Pinus palustris* P. Miller
*Pinus serotina* Michaux
*Pinus taeda* L.

TAXODIACEAE

*Taxodium ascendens* Brongn.
*Taxodium distichum* (L.) L.C. Richard

CUPRESSACEAE

*Chamaecyparis thyoides* (L.) B.S.P.

## DIVISION MAGNOLIOPHYTA (Angiosperms)

### CLASS MAGNOLIOPSIDA (Dicotyledons)

MAGNOLIACEAE

*Liriodendron tulipifera* L.
*Magnolia virginiana* L.

LAURACEAE

*Lindera melissifolia* (Walter) Blume
[species name spelled *L. melissaefolium* in RAB; *L. melissaefolia* in G&W]
*Litsea aestivalis* (L.) Fernald
*Persea palustris* (Raf.) Sargent
[= *Persea borbonia* (L.) Sprengel: RAB, in part]
*Sassafras albidum* (Nuttall) Nees

SAURURACEAE
*Saururus cernuus* L.

NYMPHAEACEAE
*Nymphaea odorata* Aiton

CABOMBACEAE
*Brasenia schreberi* J.F. Gmelin

PLATANACEAE
*Platanus occidentalis* L.

HAMMAMELIDACEAE
*Fothergilla gardenii* Murray
*Liquidambar styraciflua* L.

URTICACEAE
*Boehmeria cylindrica* (L.) Swartz
*Parietaria pensylvanica* Muhl. *ex* Willd.

JUGLANDACEAE
*Carya tomentosa* (Poiret) Nuttall

MYRICACEAE
*Myrica cerifera* var. *cerifera* L.
*Myrica heterophylla* Raf.

FAGACEAE
*Quercus falcata* Michaux
*Quercus incana* Bartram
*Quercus laevis* Walter
*Quercus lyrata* Walter
*Quercus margarettiae* Ashe *ex* Small
[species name spelled *Q. margaretta*: RAB; species not included in G&W]
*Quercus marilandica* Meunchh.
*Quercus nigra* L.
*Quercus phellos* L.
*Quercus stellata* Wang.

PHYTOLACCACEAE
*Phytolacca americana* L.

POLYGONACEAE

*Polygonum hydropiperoides* Michaux
*Polygonum hirsutum* Walter
*Polygonum persicaria* L.

THEACEAE

*Gordonia lasianthus* (L.) Ellis

CLUSIACEAE

*Hypericum canadense* L.
*Hypericum cistifolium* Lam.
*Hypericum fasciculatum* Lam.
*Hypericum gymnanthum* Engelm. & Gray
*Hypericum hypericoides* (L.) Crantz
*Triadenum tubulosum* (Walter) Gleason
[= *Hypericum tubulosum* Walter: RAB]
*Triadenum virginicum* (L.) Raf.
[= *Hypericum virginicum* L.: RAB]
*Triadenum walteri* (J.G. Gmelin) Gleason
[= *Hypericum walteri* Gmelin: RAB]

SARRACENIACEAE

*Sarracenia flava* L.
*Sarracenia purpurea* L.

DROSERACEAE

*Drosera capillaris* Poiret
*Drosera filiformis* Raf.
*Drosera intermedia* Hayne

CISTACEAE

*Lechea minor* L.
*Lechea pulchella* var. *pulchella* Raf.
[= *Lechea leggettii* Britton & Hollick: RAB; species not included in G&W]

VIOLACEAE

*Viola lanceolata* L.
*Viola primulifolia* L.

SALICACEAE

*Salix caroliniana* Michaux
*Salix nigra* Marshall

CYRILLACEAE

*Cyrilla racemiflora* L.

CLETHRACEAE

*Clethra alnifolia* L.

ERICACEAE

*Chamaedaphne calyculata* (L.) Moench
[= *Cassandra calyculata* (L.) D. Don: RAB; G&W]
*Gaylusaccia dumosa* (Andrews) Torr. & Gray, var. *bigeloviana* Fernald
[included in *Gaylusaccia dumosa* (Andrews) Torr. & Gray: RAB; G&W]
*Gaylussacia dumosa* var. *dumosa* (Andrews) Torr. & Gray
*Gaylussacia frondosa* var. *frondosa* (L.) Torrey & Gray *ex* Torrey
*Kalmia carolina* Small
[= *Kalmia angustifolia* L. var. *caroliniana* (Small) Fernald: RAB]
*Kalmia cuneata* Michaux
*Leucothoe axillaris* (Lam.) D. Don
*Leucothoe racemosa* (L.) Gray
*Lyonia ligustrina* var. *ligustrina* (L.) DC.
*Lyonia ligustrina* var. *foliosiflora* (Michaux) Fernald
[included in *Lyonia ligustrina* (L.) DC.: RAB]
*Lyonia lucida* (Lam.) K. Koch
*Lyonia mariana* (L.) D. Don
*Rhododendron atlanticum* (Ashe) Rehder
*Rhododendron viscosum* (L.) Torrey
*Vaccinium corymbosum* L.
*Vaccinium fuscatum* Aiton
[= *Vaccinium atrococcum* (Gray) Heller: RAB]
*Vaccinium tenellum* Aiton
*Zenobia pulverulenta* (Bartram *ex* Willd.) Pollard

EBENACEAE

*Diospyros virginiana* L.

SYMPLOCACEAE

*Symplocos tinctoria* (L.) L'Her.

GROSSULARIACEAE

*Itea virginica* L.

ROSACEAE

*Amelanchier canadensis* (L.) Medicus
*Aronia arbutifolia* (L.) Persoon
[= *Sorbus arbutifolia* (L.) Heynhold: RAB]
*Potentilla canadensis* L.
*Prunus caroliniana* (P. Miller) Aiton
*Prunus serotina* Ehrhart
*Rosa palustris* Marshall
*Rubus argutus* Link

MIMOSACEAE

*Albizia julibrissin* Durazzini

FABACEAE

*Chamaecrista fasciculata* (Michaux) Greene
[= *Cassia fasciculata* Michaux: RAB; species not included in G&W]
*Clitoria mariana* L.
*Desmodium tenuifolium* Torr. & Gray
*Galactia erecta* (Walter) Vail
*Lespedeza angustifolia* (Pursh) Ell.
*Lespedeza capitata* Michaux
*Lespedeza cuneata* (Dulmont-Courset) G. Don
*Lespedeza intermedia* (S. Watson) Britton
*Lespedeza repens* (L.) Bartram
*Lespedeza violacea* (L.) Persoon)
*Orbexilum pedunculatum* (P. Miller) Rydberg var. *psoralioides* (Walter) Isely
[= *Psoralea psoralioides* var. *psoralioides* (Walter) Cory: RAB; G&W]
*Stylosanthes biflora* (L.) B.S.P.
*Tephrosia virginiana* (L.) Persoon

HALORAGACEAE

*Proserpinaca palustris* L.
*Proserpinaca pectinata* Lam.

LYTHRACEAE

*Decodon verticillatus* (L.) Ell.
*Rotala ramosior* (L.) Koehne

ONAGRACEAE

*Ludwigia alternifolia* L.
*Ludwigia linifolia* Poiret
*Ludwigia linearis* Walter

*Ludwigia pilosa* Walter
*Ludwigia sphaerocarpa* Ell.
*Ludwigia* suffruticosa Walter

MELASTOMATACEAE
*Rhexia alifanus* Walter
*Rhexia aristosa* Britton
*Rhexia mariana* var. *mariana* L.
[includes the variety *Rhexia mariana* L. var. *exalbida* Michaux found in RAB]
*Rhexia mariana* L. var. *ventricosa* (Fernald & Griscom) Kral
[= *Rhexia ventricosa* Fernald & Griscom: RAB]
*Rhexia nashii* Small
[= *Rhexia mariana* var. *purpurea* Michaux: RAB]
*Rhexia virginica* L.

NYSSACEAE
*Nyssa aquatica* L.
*Nyssa biflora* Walter
[= *Nyssa sylvatica* var. *biflora* (Walter) Sargent: RAB; G&W]
*Nyssa sylvatica* Marshall

VISCACEAE
*Phoradendron serotinum* (Raf.) M.C. Johnston

AQUIFOLIACEAE
*Ilex amelanchier* M.A. Curtis
*Ilex cassine* L.
*Ilex coriacea* (Pursh) Chapman
*Ilex glabra* (L.) Gray
*Ilex laevigata* (Pursh) Gray
*Ilex myrtifolia* Walter
[= *Ilex cassine* L. var. *myrtifolia* (Walter) Sargent: RAB]
*Ilex opaca* Aiton

EUPHORBIACEAE
*Euphorbia corollata* L.
*Stillingia aquatica* Chapman

RHAMNACEAE
*Ceanothus americanus* L.

VITACEAE

*Vitis rotundifolia* Michaux

POLYGALACEAE

*Polygala brevifolia* Nuttall
*Polygala cruciata* L.
*Polygala curtissii* Gray
*Polygala cymosa* Walter
*Polygala ramosa* Ell.

ACERACEAE

*Acer rubrum* L.

ANACARDIACEAE

*Rhus copallina* L.
*Toxicodendron radicans* ssp. *radicans* (L.) Kuntze
[= *Rhus radicans* L.: RAB]
*Toxicodendron pubescens* P. Miller
[= *Rhus toxicodendron* L.: RAB; species not included in G&W]
*Toxicodendron vernix* (L.) Kuntze
[= *Rhus vernix* L.: RAB]

APIACEAE

*Angelica venosa* (Greenway) Fernald
*Centella asiatica* (L.) Urban
*Eryngium yuccifolium* var. *yuccifolium* Michaux
*Hydrocotyle ranunculoides* L.
*Hydrocotyle verticillata* Thunberg
*Oxypolis canbyi* (Coult. & Rose) Fernald
[species not included in RAB or G&W]

LOGANIACEAE

*Gelsemium sempervirens* (L.) St. Hilairo
*Mitreola petiolata* (J.F. Gmelin) Torr. & Gray
[= *Cynoctonum mitreola* (L.) Britton: RAB]
*Mitreola sessilifolia* (J.F. Gmelin) G. Don
[= *Cynoctonum sessilifolium* Walter *ex* J.F. Gmelin: RAB]

GENTIANACEAE

*Bartonia virginica* (L.) B.S.P.
*Sabatia brachiata* Ell.
*Sabatia difformis* (L.) Druce

APOCYNACEAE

*Apocynum cannabinum* L.

ASCLEPIADACEAE

*Asclepias lanceolata* Walter
*Asclepias longifolia* Michaux

CONVOLVULACEAE

*Ipomoea pandurata* (L.) G.F.W. Meyer
*Stylisma aquatica* (Walter) Raf.
[= *Bonamia aquatica* (Walter) Gray: RAB]
*Stylisma pickeringii* (Torrey *ex* M.A. Curtis) Gray
[= *Bonamia pickeringii* (Torrey) Gray: RAB; species not included in G&W]

CUSCUTACEAE

*Cuscuta compacta* Jussieu

MENYANTHACEAE

*Nymphoides aquatica* (Walter) Kuntze
*Nymphoides cordata* (Ell.) Fernald

LAMIACEAE

*Lycopus angustifolius* Ell.
[*Lycopus rubellus* Moench var. *angustifolius* (Ell.) Ahles: RAB: G&W]
*Lycopus rubellus* Moench
*Lycopus virginicus* L.
*Pycnanthemum flexuosum* (Walter) B.S.P.

OLEACEAE

*Fraxinus caroliniana* P. Miller

SCROPHULARIACEAE

*Agalinis linifolia* (Nuttall) Britton
*Bacopa caroliniana* (Walter) B.L. Robinson
*Gratiola ramosa* Walter
*Lindernia dubia* (L.) Pennell var. *anagallidea* (Michaux) Cooperrider
[= *Lindernia anagallidea* (Michaux) Pennell: RAB; G&W]
*Nuttalanthus canadensis* (L.) D.A. Sutton
[= *Linaria canadensis* (L.) Dumont: RAB; species not included in G&W]
*Penstemon australis* Small

BIGNONIACEAE

*Campsis radicans* (L.) Seemann *ex* Bureau

LENTIBULARIACEAE

*Utricularia biflora* Lam.
*Utricularia fibrosa* Walter
*Utricularia juncea* Vahl
*Utricularia purpurea* Walter
*Utricularia radiata* Small
[= *Utricularia inflata* Walter var. *minor* (L.) Chapman: RAB]
*Utricularia subulata* L.

CAMPANULACEAE

*Lobelia boykinii* Torrey & Gray
*Lobelia canbyi* Gray
*Lobelia glandulosa* Walter
*Lobelia nuttallii* Roemer & Schultes

RUBIACEAE

*Cephalanthus occidentalis* L.
*Diodia virginiana* L.
*Galium pilosum* Aiton
*Oldenlandia boscii* (DC.) Chapman

CAPRIFOLIACEAE

*Viburnum nudum* L.

ASTERACEAE

*Aster concolor* L.
*Aster linariifolius* L.
*Aster paludosus* Aiton
*Aster paternus* Cronquist
*Aster pilosus* var. *demotus* Blake
*Aster spectabilis* Aiton
*Aster tortifolius* Michaux
*Aster walteri* Alexander
[= *Aster squarrosus* Walter: RAB; species not included in G&W]
*Balduina uniflora* Nuttall
*Bidens frondosa* L.
*Bigelowia nudata* (Michaux) DC.
[= *Chondrophora nudata* (Michaux) Britton: RAB]
*Boltonia asteroides* (L.) L'Her.

*Carphephorus bellidifolius* (Michaux) Torr. & Gray
*Chaptalia tomentosa* Vent.
*Cirsium lecontei* Torr. & Gray
[= *Carduus lecontei* (Torr. & Gray) Pollard: RAB]
*Coreopsis major* Walter
*Coreopsis verticillata* L.
*Erechtites hieraciifolia* (L.) Raf. *ex* DC.
[species name spelled *Erechtites hieracifolia* in RAB and G&W]
*Erigeron vernus* (L.) Torr. & Gray
*Eupatorium album* L.
*Eupatorium altissimum* L.
*Eupatorium capillifolium* (Lam.) Small
*Eupatorium compositifolium* Walter
*Eupatorium dubium* Willd. *ex* Poiret
*Eupatorium leptophyllum* DC.
[= *Eupatorium capillifolium* (Lam.) Small var. *leptophyllum* (DC.) Ahles: RAB]
*Eupatorium leucolepis* (DC.) Torr. & Gray
*Eupatorium perfoliatum* L.
*Eupatorium pilosum* Walter
*Eupatorium recurvans* Small
*Eupatorium rotundifolium* var. *rotundifolium* L.
*Euthamia tenuifolia* (Pursh) Nuttall
[= *Solidago microcephala* (Greene) Bush: RAB]
*Helenium pinnatifidum* (Nuttall) Rydberg
*Helianthus atrorubens* L.
*Hieracium gronovii* L.
*Iva microcephala* Nuttall
*Liatris microcephala* (Small) K. Schumann
*Pityopsis adenolepis* (Fernald) Semple
[= *Heterotheca adenolepis* (Fernald) Ahles: RAB; species not included in G&W]
*Pityopsis graminifolia* (Michaux) Nuttall
[= *Heterotheca nervosa* var. *nervosa* (Willd.) Shinners: RAB; species not included in G&W]
*Pluchea foetida* (L.) DC.
*Pluchea rosea* Godfrey
*Sclerolepis uniflora* (Walter) B.S.P.
*Solidago odora* Aiton
*Solidago patula* Muhl. *ex* Willd. var. *strictula* Torr. & Gray
*Solidago puberula* var. *puberula* Nuttall
*Solidago stricta* Aiton
*Vernonia angustifolia* ssp. *angustifolia* Michaux

*Vernonia* x *georgiana* Bartlett [*acaulis* x *angustifolia*]

## CLASS LILIOPSIDA (Monocotyledons)

ALISMATACEAE

*Echinodorus parvulus* Engelm.
[species not included in RAB]
*Sagittaria graminea* var. *graminea* Michaux
*Sagittaria isoetiformis* J.G. Smith
[species not included in RAB]

POTAMOGETONACEAE

*Potamogeton confervoides* Reichenbach
*Potamogeton diversifolius* Raf.

ARACEAE

*Peltandra sagittifolia* (Michaux) Morong
*Peltandra virginica* (L.) Schott

LEMNACEAE

*Lemna gibba* L.
*Wolffiella gladiata* (Hegelm.) Hegelm.

XYRIDACEAE

*Xyris ambigua* Beyerich ex Kunth
*Xyris caroliniana* Walter
*Xyris difformis* Chapman var. *floridana* Kral
[included in *Xyris difformis* Chapman: RAB]
*Xyris fimbriata* Ell.
*Xyris jupicai* L.C. Richard
*Xyris smalliana* Nash

MAYACACEAE

*Mayaca fluviatilis* Aublet
[= *Mayaca aubletii* Michaux: RAB]

COMMELINACEAE

*Commelina virginica* L.

ERIOCAULACEAE

*Eriocaulon compressum* Lam.
*Eriocaulon decangulare* L.

*Eriocaulon parkeri* B.L. Robinson
[= (in part) *Eriocaulon pellucidum* Michaux: RAB]
*Lachnocaulon minus* (Chapman) Small

JUNCACEAE
*Juncus abortivus* Chapman
*Juncus dichotomus* Ell.
*Juncus diffusissimus* Buckley
*Juncus marginatus* Rostk.
*Juncus polycephalus* Michaux
*Juncus repens* Michaux
*Juncus roemerianus* Scheele

CYPERACEAE
*Bulbostylis ciliatifolia* (Ell.) Fernald
*Bulbostylis capillaris* (L.) C.B. Clarke
*Carex glaucescens* Ell.
*Carex striata* var. *striata* Michaux
[= *Carex walteriana* Bailey: RAB; G&W]
*Carex verrucosa* Muhl.
*Cladium mariscus* (L.) Pohl ssp. *jamaicense* (Crantz) Kukenthal
[= *Cladium jamaicense* Crantz: RAB; G&W]
*Dulichium arundinaceum* (L.) Britton
*Eleocharis baldwinii* (Torrey) Chapman
*Eleocharis equisetoides* (Ell.) Torrey
*Eleocharis melanocarpa* Torrey
*Eleocharis microcarpa* Torrey
*Eleocharis quadrangulata* (Michaux) Roemer & J.A. Schultes
*Eleocharis robbinsii* Oakes
*Eleocharis tricostata* Torrey
*Eriophorum virginicum* L.
*Fimbristylis autumnalis* (L.) Roemer & J.A. Schultes
*Fimbristylis castanea* (Michaux) Vahl
[= *Fimbristylis spadicea* (L.) Vahl (?): RAB]
*Fuirena squarrosa* Michaux
*Psilocarya nitens* (Vahl) Wood
*Rhynchospora* sp. #1
*Rhynchospora alba* (L.) Vahl
*Rhynchospora cephalantha* var. *cephalantha* Gray
*Rhynchospora cephalantha* Gray var. *microcephala* (Britton) Kukenthal
[= *Rhynchospora microcephala* Britton *ex* Small: RAB; G&W]
*Rhynchospora chalarocephala* Fernald & Gale
*Rhynchospora ciliaris* (Michaux) C. Mohr

*Rhynchospora debilis* Gale
*Rhynchospora fascicularis* (Michaux) Vahl
*Rhynchospora filifolia* Gray
*Rhynchospora gracilenta* Gray
*Rhynchospora inundata* (Oakes) Fernald
*Rhynchospora latifolia* (Baldwin *ex* Ell.) Thomas
[= *Dichromena latifolia* Baldwin: RAB; G&W]
*Rhynchospora macrostachya* Torrey
*Rhynchospora perplexa* var. *perplexa* Britton
*Rhynchospora pleiantha* (Kukenthal) Gale
*Rhynchospora pusilla* Chapman *ex* M.A. Curtis
[= *Rhynchospora intermixta* C. Wright: RAB]
*Rhynchospora rariflora* (Michaux) Ell.
*Rhynchospora tracyi* Britton
*Scirpus cyperinus* (L.) Kunth
*Scleria baldwinii* (Torrey) Steudel
*Scleria ciliata* Michaux
*Scleria georgiana* Core
*Scleria reticularis* Michaux

POACEAE

*Andropogon gerardii* Vitman
*Andropogon glomeratus* var. *glomeratus* (Walter) B.S.P.
[included in *Andropogon virginicus* L.: RAB; G&W (?)]

*Andropogon glomeratus* (Walter) B.S.P. var. *glaucopsis* (Ell.) C. Mohr
[included in *Andropogon virginicus* L.: RAB; = *Andropogon glaucopsis* (Elliott) Nash: G&W]
*Andropogon gyrans* var. *gyrans* Ashe
[= *Andropogon elliottii* Chapman: RAB; species not included in G&W]
*Andropogon gyrans* Ashe var. *stenophyllus* (Hackel) C. Campbell
[included in *Andropogon virginicus* L.: RAB; G&W (?)]
*Andropogon mohrii* (Hackel) Hackel *ex* Vasey
*Andropogon virginicus* L. var. *glaucus* Hackel
[included in *Andropogon virginicus* L.: RAB; = *Andropogon capillipes* Nash: G&W]
*Andropogon virginicus* var. *virginicus* L.
*Aristida palustris* (Chapman) Vasey
[= *Aristida affinis* (Schultes) Kunth: RAB; G&W]
*Aristida stricta* Michaux
*Arundinaria gigantea* (Walter) Muhl. ssp. *tecta* (Walter) McClure
[included in *Arundinaria gigantea* (Walter) Muhl.: RAB]
*Axonopus furcatus* (Flugge) A.S. Hitchcock
*Coelorachis rugosa* (Nuttall) Nash
[= *Manisuris rugosa* (Nuttall) Kuntze: RAB; G&W]
*Ctenium aromaticum* (Walter) Wood
*Dichanthelium acuminatum* var. *acuminatum* (Swartz) Gould & C.A. Clark
[= *Panicum curtifolium* Nash: RAB; species not included in G&W]
*Dichanthelium commutatum* (Schultes) Gould
[= *Panicum commutatum* Schultes: RAB; species not included in G&W]
*Dichanthelium dichotomum* var *dichotomum* (L.) Gould
[= *Panicum dichotomum* L.: RAB; G&W]
*Dichanthelium dichotomum* (L.) Gould var. *ensifolium* (Baldwin *ex* Ell.) Gould & C.A. Clark
[= *Panicum chamaelonche* Trinius: RAB; G&W]
*Dichanthelium erectifolium* (Nash) Gould & Clark
[= *Panicum erectifolium* Nash: RAB; G&W]
*Dichanthelium leucothrix* (Nash) Freckmann
[= *Panicum leucothrix* Nash: RAB; included in *Panicum spretum* Schultes: G&W]
*Dichanthelium longiligulatum* (Nash) Freckmann
[= *Panicum longiligulatum* Nash: RAB; included in *Panicum spretum* Schultes: G&W]
*Dichanthelium sabulorum* var. *patulum* (Scribner & Merrill) Gould & C.A. Clark
[= *Panicum lancearium* Trinius: RAB; species not included in G&W]

*Dichanthelium scoparium* (Lam.) Gould
[= *Panicum scoparium* Lam.: RAB; G&W]
*Dichanthelium sphaerocarpon* var. *sphaerocarpon* (Ell.) Gould
[= *Panicum sphaerocarpon* Ell.: RAB; species not included in G&W]
*Dichanthelium wrightianum* (Scribner) Freckmann
[= *Panicum wrightianum* Scribner: RAB; included in *Panicum spretum* Schultes: G&W]
*Digitaria sanguinalis* (L.) Scopoli
*Eleusine indica* (L.) Gaertner
*Eragrostis pilosa* (L.) Beauvois
*Eragrostis refracta* (Muhl.) Scribner
*Leersia hexandra* Swartz
*Luziola fluitans* (Michaux) Terrell & H. Robinson
[= *Hydrochloa caroliniensis* Beauvois: RAB; G&W]
*Panicum hemitomon* Schultes
*Panicum rigidulum* Bosc *ex* Nees var. *combsii* (Scribner & Ball) Lelong
[= *Panicum longifolium* Torrey var. *combsii* (Scribner & Ball) Fernald: RAB; included in *Panicum longifolium* Torrey in G&W]
*Panicum rigidulum* Bosc *ex* Nees var. *pubescens* (Vasey) Lelong
[= *Panicum longifolium* var. *longifolium* Torrey: RAB; G&W]
*Panicum tenerum* Beyrich *ex* Trinius
*Panicum verrucosum* Muhl.
*Panicum virgatum* L.
*Paspalum laeve* Michaux
*Saccharum alopecuroides* (L.) Nuttall
[= *Erianthus alopecuroides* (L.) Ell.: RAB; G&W]
*Saccharum giganteum* (Walter) Persoon
[= *Erianthus giganteus* (Walter) Muhl.: RAB; G&W]
*Schizachyrium scoparium* (Michaux) Nash
[= *Andropogon scoparius* Michaux: RAB]

BROMELIACEAE
*Tillandsia usneoides* (L.) L.

PONTEDERIACEAE
*Pontederia cordata* L.

HAEMODORACEAE
*Lachnanthes caroliana* (Lam.) Dandy
[species name spelled *L. caroliniana* in RAB and G&W]

LILIACEAE
*Aletris farinosa* L.

*Zigadenus glaberrimus* Michaux

IRIDACEAE

*Iris prismatica* Pursh *ex* Ker-Gawl.
*Iris verna* var. *verna* L.
*Iris virginica* L.

SMILACACEAE

*Smilax bona-nox* L.
*Smilax glauca* Walter
*Smilax laurifolia* L.
*Smilax rotundifolia* L.
*Smilax walteri* Pursh

BURMANNIACEAE

*Burmannia biflora* L.
*Burmannia capitata* (J.F. Gmelin) Martius

ORCHIDACEAE

*Calopogon tuberosus* (L.) B.S.P.
[= *Calopogon pulchellus* (Salisbury) R. Brown: RAB]
*Habenaria repens* Nuttall
*Platanthera blephariglottis* (Willd.) Lindley
[*Habenaria blephariglottis* (Willd.) Hooker: RAB; G&W]

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