SOUTH FLORIDA RESEARCH CENTER

Report T-664

An Inventory of the Plant Communities in the Levee-28 Tieback Area, Big Cypress National Preserve

NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

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An Inventory of the
Plant Communities in the Levee 28 Tieback Area
Big Cypress National Preserve

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Big Cypress Swamp and the Everglades are the two largest physiographic units in south Florida (Davis, 1943; Craighead, 1971). The border between the units is an abrupt transition of plant communities. The forested, cypress-dominated landscape of the swamp is in distinct contrast to the wide open vista of marshes, prairies and hardwood tree islands in the Everglades. The eastern edge of the Big Cypress Swamp is characterized by an extensive forest of dwarfed pondcypress (Taxodium ascendens) with interspersed tropical hardwood hammocks. Davis' (1943) vegetation map of southern Florida depicts cypress heads, domes, and hammock forests in the swamp. Craighead (1971) describes this western bank of the Everglades as a "hammock and cypress ridge." Dominant plant communities in the Everglades area include sloughs, ponds, and lakes, sparse sawgrass marshes and tree islands - bayheads (Davis, 1943, Craighead, 1971).

Different geologic formations are found beneath the Big Cypress and Everglades units. Schroeder and Klein (1954) and Parker et al. (1955) both map the surface (subsoil) geologic structures in the Everglades region as belonging to the Ft. Thompson formation. However, Hoffmeister (1974) only mapped the Ft. Thompson formation in the northern Everglades. He considered that the southern Everglades is underlain by a more recent formation, the Miami limestone. In either case, the recent limestones in the Everglades are newer rock formations than the older Tamiami limestone formation beneath the Big Cypress Swamp.

The surface topography developed on the different bedrock formations, plus subsequent depositions of sand, marl and organic matter results in soil surface elevational differences. The plant species composition can be related to these changes in elevation, as well as the associated soil types and hydrologic regime.

Levee 28

The levee and accompanying canal (referred to as L-28) are part of the water management structures in south Florida managed by the South Florida Water Management District. The canal and levee follow the boundary between the Everglades and Big Cypress physiographic units (Figure 1). Construction of the levee was completed in Spring, 1963 to impound water in Conservation Area 3A of the Everglades, and thereby recharge the underlying Biscayne Aquifer. The levee and canal extend north from U.S. Route 41 approximately 24 km (15 mi). In 1965 a 3.4 km (2.1 mi) westward extension to the levee was completed, and called the L-28 tieback. The extension insures drainage of water from Subunit A of the Big Cypress drainage areas (Klein et al., 1970) into Conservation Area 3A and not into Subunit C of the Big Cypress basin (Figure 1).

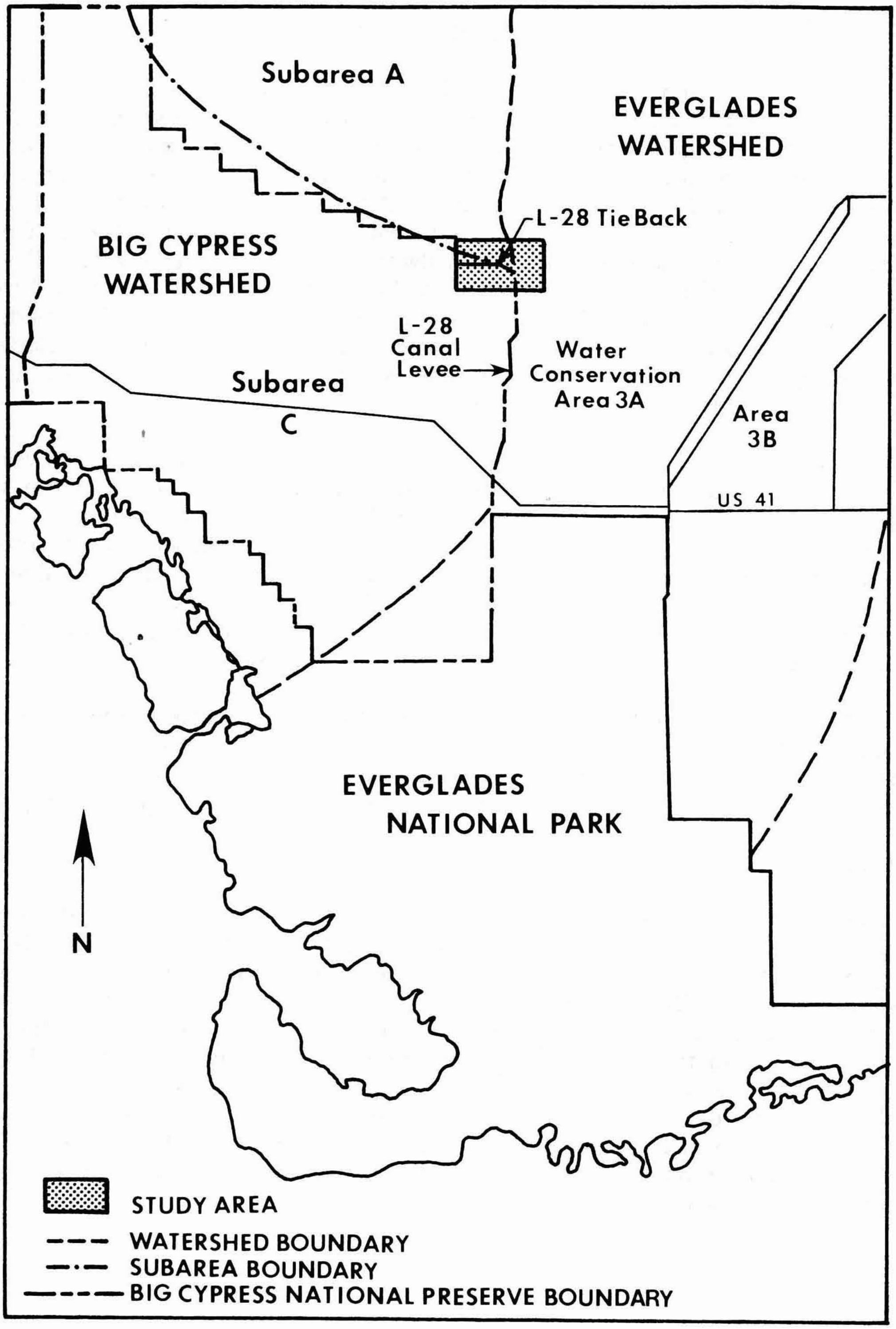

Figure 1. Location of Levee 28 study area within South Florida.

STUDY AREA

The Levee-28 study area is one of five 25-50 km^2 areas in the Big Cypress National Preserve identified for investigation in moderate detail. The study areas were established to provide a baseline inventory of the plant associations of the preserve. This L-28 study area is located at the northern end of the levee and includes the tieback levee (Figure 1). Three major objectives were sought in the study: (1) document current spatial patterns of the plant associations, (2) Quantitatively inventory the unique associations (not found in other study areas), (3) correlate species composition with environmental variables and/or successional patterns. Included in these objectives is the evaluation of impacts of the levee and canal on nearby plant communities.

METHODS

Vegetation Map

The vegetation map was made by first delineating the plant communities on 9 in x 9 in color contact prints (1:8000 taken in 1978). Readily discernible features were also outlined on USGS 7.5 minute orthophoto topographic maps. The features from the orthophoto maps were transferred to a skeleton map using a Map-O-Graph opaque projector. The features on the skeleton map were used as control points to transfer the delineations from the color photographs to the skeleton map. The rough draft was field checked on the ground and by helicopter during December 1980. The map was then drafted, painted and printed. The map was made at a scale of 1:10,000 but was reduced during printing due to limitations on the press size, so that the final copy is approximately 1:14,000.

Vegetation Inventory

The vegetation in a cypress head and a wet prairie was quantitatively inventoried. The locations of the vegetation plots are shown on the vegetation map (enclosed in back of report). The four corners of each tree plot were marked with concrete posts with inset aluminum markers, so that the plots can be relocated.

The vegetation was divided into three categories for quantitative analysis: trees, shrubs, and understory. Trees were defined as any woody stem greater than 5 cm (2 in) in diameter at breast height (1.37 m or 4.5 ft). Shrubs included any plant with a woody stem less than 5 cm dbh and greater than 1 m tall. The understory category encompassed any herbaceous plant, any woody plant less than 1 m tall and any epiphyte with a basal elevation of less than 1 m above ground level.

Trees

The diameters (dbh) of tree-size stems rooted within a 15 x 40 m rectangular plot (Figure 2) were measured to the nearest 0.13 cm (0.05 in). Tree plots were oriented along cardinal bearings, either north to south or east to west, and placed

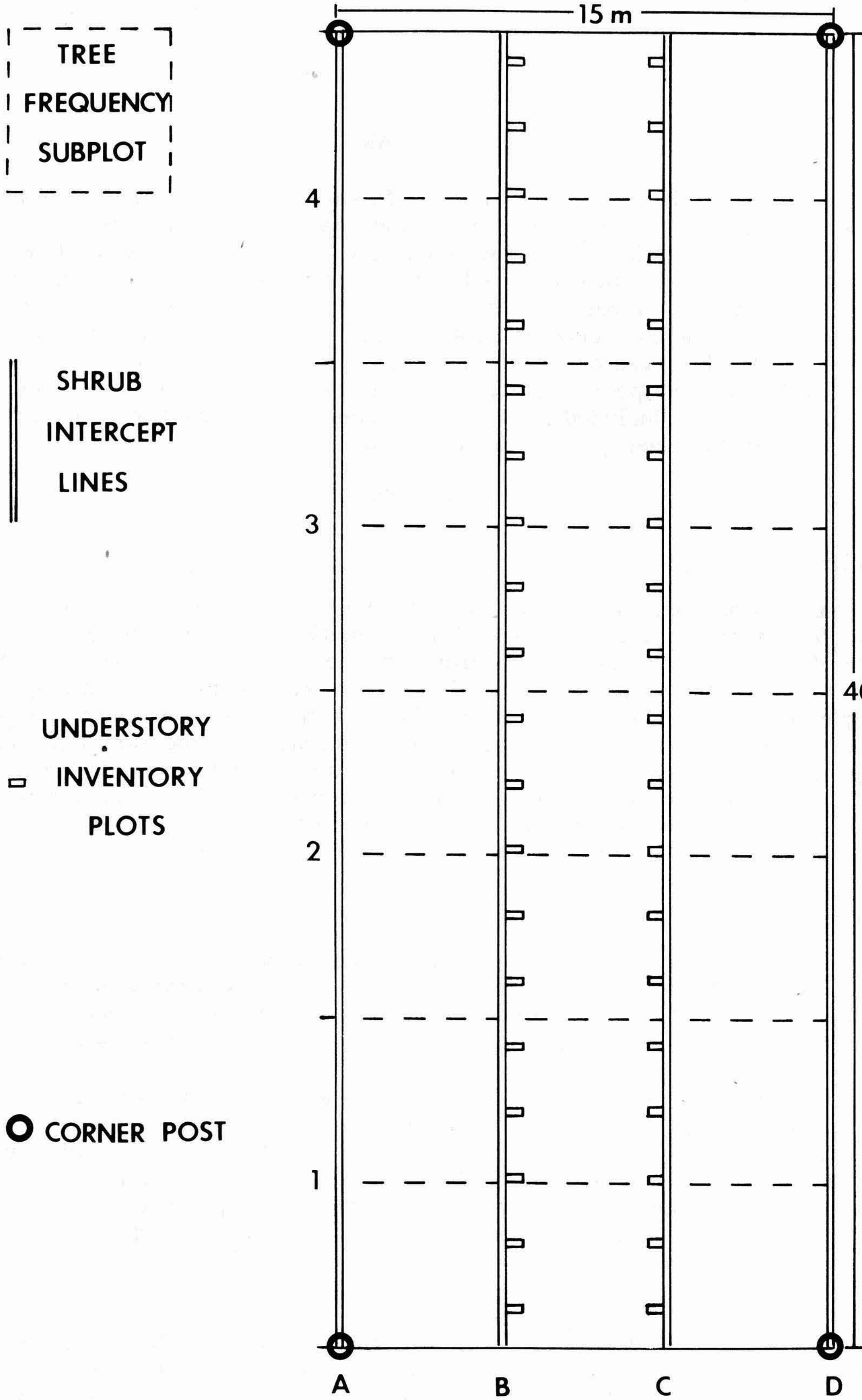

Figure 2. Schematic diagram of vegetation inventory plots.

in homogeneous vegetation types. Basal areas were calculated and used as an expression of dominance of each species. Relative dominance, based on the total area of the plot, was determined for each species. The number of tree stems was tallied within the tree plot to yield stem densities per 600 m^2. Relative density for each species was calculated based on the total stem density in the plot. Occurrence of each species within each of twenty-four 5 x 5 m subplots (Figure 2) was recorded and frequency of occurrence determined for each species. Relative frequency was calculated based on the summation of the frequencies of all species. Relative dominance, relative density and relative frequency were summed for each tree species to yield an importance value index.

Shrubs

Shrub dominance was expressed as the percent cover of each species. Percent cover was determined along four 40 m line segments by the line-intercept method. The intersection of the live leaf cover of each species with the line was measured to the nearest centimeter using a retractable metric tape. Percent cover was calculated by the sum of intersection distances along all four line segments (A, B, C, D, in Figure 2) divided by the total length (160 m). Woody vines were usually inventoried in the shrub class. All intersections were recorded regardless of where the shrub is rooted, inside or outside the tree plot.

Shrub occurrence was noted along each of sixteen 10 m line segments (A1-A4, B1-B4, C1-C4, D1-D4; in Figure 2) and used to calculate frequency and relative frequency of each species. Relative dominance and relative frequency are summed to yield a shrub importance value.

Understory

Understory species were listed within forty 20 x 50 cm (0.1 m^2) plots placed at two meter intervals along the two center lines of the vegetation plot (lines B, C in Figure 2). The plots were placed in the center one-third of the tree plot and always placed on the same side of the two-meter-interval mark. Cover classes were used following Daubenmire's (1959) methods. Numerical values were assigned to each cover class as follows: (1) 0-5%, (2) 5-25%, (3) 25-50%, (4) 50-75%, (5) 75-95%, and (6) 95-100% for ease of recording in the field. The average percent cover of a species was obtained by summing the range midpoints of all recorded cover classes then dividing by the total number of plots (40). For example, suppose that Cladium was encountered six times in 40 plots and cover class values of 1, 2, 3, 4, 5, 6 were recorded. The midpoints of the cover classes (2.5, 15, 37.5, 62.5, 85, 97.5) were summed, yielding 300, and divided by 40 to give an average percent cover of 7.5%. Relative dominance (based on relative cover) was determined by calculating the percent of the total understory cover attributed to each species.

Frequency of occurrence was calculated from the number of times a species was found in the 40 plots. Relative frequency was calculated and added to relative dominance to yield an importance value for each understory species.

Plant Species Identification

Identification references include Long and Lakela, 1971; Lakela and Long, 1976; Hitchcock, 1950; and Ricketts, 1967. Species not previously found in plots were collected and compared with species on file at the herbarium at Everglades National Park Research Center as well as being cross-checked with a species list for the Preserve (Black and Black, 1980). Nomenclature generally follows Black and Black (1980).

Species Composition and Environmental Variables

In order to correlate species composition with environmental variables, a line transect was established (see vegetation map). Sixty-eight benchmarks were established as measurement points at 23 m (75 ft) intervals along the approximately 1600 m long transect. The benchmarks were set by driving .95 cm (3/8 in) diameter steel rod into the bedrock.

Soil surface elevations, soil depth and type were measured at each benchmark. The elevation of the top of the benchmark was surveyed from nearby known elevations. The soil surface elevation was obtained by subtracting the height of the steel rod from the elevation of the top of the rod. Soil depths were determined by inserting a soil probe at three points around the benchmark. A ringing sound indicated that bedrock was reached, then the depth was measured. The three measurements were averaged to yield a mean soil depth. A cut-away soil tube was used to assess each soil type. Major classes of soils were sands, marls, muck and litter.

A second short transect was established to sample communities in the Everglades region. This transect began at the easternmost point on transect one, and headed due east. The majority of the second transect is east of the mapped area, and therefore not shown on the vegetation map. Permanent benchmarks were not established, so no surveying was done. Instead, soil surface elevations were determined by measuring water depths at 50 m intervals along the transect. Soil depths were measured the same way as on transect one.

The plant species were inventoried within a 100 m^2 circular plot which was centered on certain benchmarks on each transect. Ecotonal benchmarks were not inventoried. A list was made of all vascular plant species within the plot.

RESULTS AND DISCUSSION

Cypress Prairies

Cypress prairie is the areally dominant plant community in the L-28 study area. Depicted by yellow on the vegetation map (enclosed in envelope on back cover), this cypress category encompasses all regions of low stature (dwarfed) pondcypress, *Taxodium ascendens*. Tree heights range from 4 to 6 m and diameters (dbh) up to

20 cm are found. The low density scattered pondcypress trees form a very sparse overstory. Other trees, such as strangler fig (Ficus aurea); sweet bay (Magnolia virginiana); wax myrtle (Myrica cerifera); and pondapple (Annona glabra) are infrequently found in the association (Table 1). These other trees also have stunted growth forms.

Half of the 38 species found in the benchmark inventory plots (Table 1) in cypress prairie vegetation were restricted to the understory. Sedges dominated the prairie-like understory, especially Rhynchospora microcarpa, R. tracyi and Cladium jamaicense. Grasses of the genera Andropogon and Panicum were also common understory plants.

Many of the plant species were associated with the cypress trees. Five species of Tillandsia were common epiphytes. The butterfly orchid (Encyclia tampensis) was found on branches less frequently. Ferns of the genera Blechnum and Thelypteris grow in crevices of the Taxodium buttresses. Vines of the genera Aster, Mikania and Ipomoea were also found on the cypress trees.

The environmental parameters measured along the transect suggest the reasons for the observed stunting of cypress. Shallow soil was found beneath the cypress prairies, with an average depth of less than 30 cm, thereby limiting the soil space available to root systems. The surface of the indurated bedrock is virtually impenetrable, thereby limiting root penetration to a few solution holes and fissures. The soil consists of a mixture of sand and marl and, although not measured, is probably nutrient-poor and results in low net productivity (Flohrschutz, 1978).

The soil surface elevation is at an intermediate level among all plant communities (Figures 3, 4), averaging 15 cm above the lowest soil surface measured along the transect (in a willow area) and 35 cm below the average elevation in a bayhead (Figure 5). The mean relative soil surface elevation in the cypress prairie was not found to be statistically different from the elevation in willow, wet prairie, mixed marsh, or cypress head areas.

Cypress Domes, Strands and Heads

Three types of tall pondcypress associations were identified: domes, strands, and heads. The cypress trees in these associations attain heights of approximately 20 m, and are found at greater densities than in the cypress prairie areas. All areas of tall, dense cypress are depicted on the vegetation map by yellow with a stippled pattern.

Cypress domes are characterized by a dome-like, hemispherical profile of the trees. Usually this profile does not reflect age of the trees, but growth conditions, as deeper organic soils, lower bedrock elevations and longer hydroperiods are associated with the larger trees in the center of the dome. Associated species in the domes are Annona glabra, Cephalanthus occidentalis, Myrica cerifera and Salix caroliniana. Various aquatic herbs are common understory plants (Table 1).

Table 1. Species list in each plant community from inventories around benchmarks along transect.

Species	Cypress Prairie	Cypress Dome	Cypress Head	Cladium Marsh	Mixed Marsh	Willow	Wet Prairie
Andropogon virginicus	X		X	X		X	
Annona glabra	X	X			X		
Aster carolinianus						X	
Baccharis glomeruliflora			X				
Bacopa caroliniana	X	X		X	X		
Blechnum serrulatum	X	X	X	X	X	X	
Boehmeria cylindrica	X	X			X		
Cephalanthus occidentalis		X					
Chrysobalanus icaco			X			X	
Cladium jamaicense	X	X		X	X	X	X
Crinum americanum	X					X	X
Cyperus globulosus				X			
Eleocharis cellulosa	X						X
Encyclia tampensis	X						
Erianthus giganteus				X	X		
Eriocaulon compressum	X						
Eupatorium leptophyllum		X			X		
Eupatorium mikanioides		X					
Ficus aurea	X	X	X		X	X	
Fuirena squarrosa	X			X	X		
Ilex cassine							
Ipomea sagittata	X		X				
Juncus polycephalus					X		
Justicia ovata	X				X		
Ludwigia repens	X	X		X	X	X	
Magnolia virginiana	X		X				
Mikania scandens	X	X		X	X	X	
Myrica cerifera	X	X	X	X	X	X	
Nephrolepis exaltata		X	X			X	
Nymphaea odorata	X						
Osmunda regalis			X				
Oxypolis filiformis				X			
Panicum hemitomon	X	X			X		X
Panicum rigidulum	X			X	X		
Panicum virgatum	X				X	X	
Parthenocissus quinquefolia						X	
Peltandra virginica	X	X					
Persea borbonia			X				

Species	Cypress Prairie	Cypress Dome	Cypress Head	Cladium Marsh	Mixed Marsh	Willow	Wet Prairie
Pluchea rosea	X	X		X	X		
Polygonum punctatum				X	X	X	
Pontederia lanceolata	X	X		X	X	X	
Proserpinaca palustris	X	X		X			
Psilotum nudum				X	X	X	
Rhynchospora inundata	X	X		X	X		X
Rhynchospora microcarpa	X	X		X	X		
Rhynchospora tracyi	X				X		X
Sagittaria graminea		X			X	X	
Salix caroliniana		X				X	
Sarcostemma clausa						X	
Smilax auriculata			X				
Taxodium ascendens	X	X	X	X	X	X	
Thalia geniculata		x					
Thelypteris kunthii	X	X	X		X	X	
Tillandsia circinnata	X	X		X			
Tillandsia fasiculata	X		X			X	
Tillandsia recurvata	X	X					
Tillandsia setacea	X						
Tillandsia usneoides	X	X	X			X	
Typha domingensis		X		X	X		
Utricularia foliosa	X	X		X	X	X	X
Utricularia purpurea							X
Xyris elliottii	X	X		X	X		

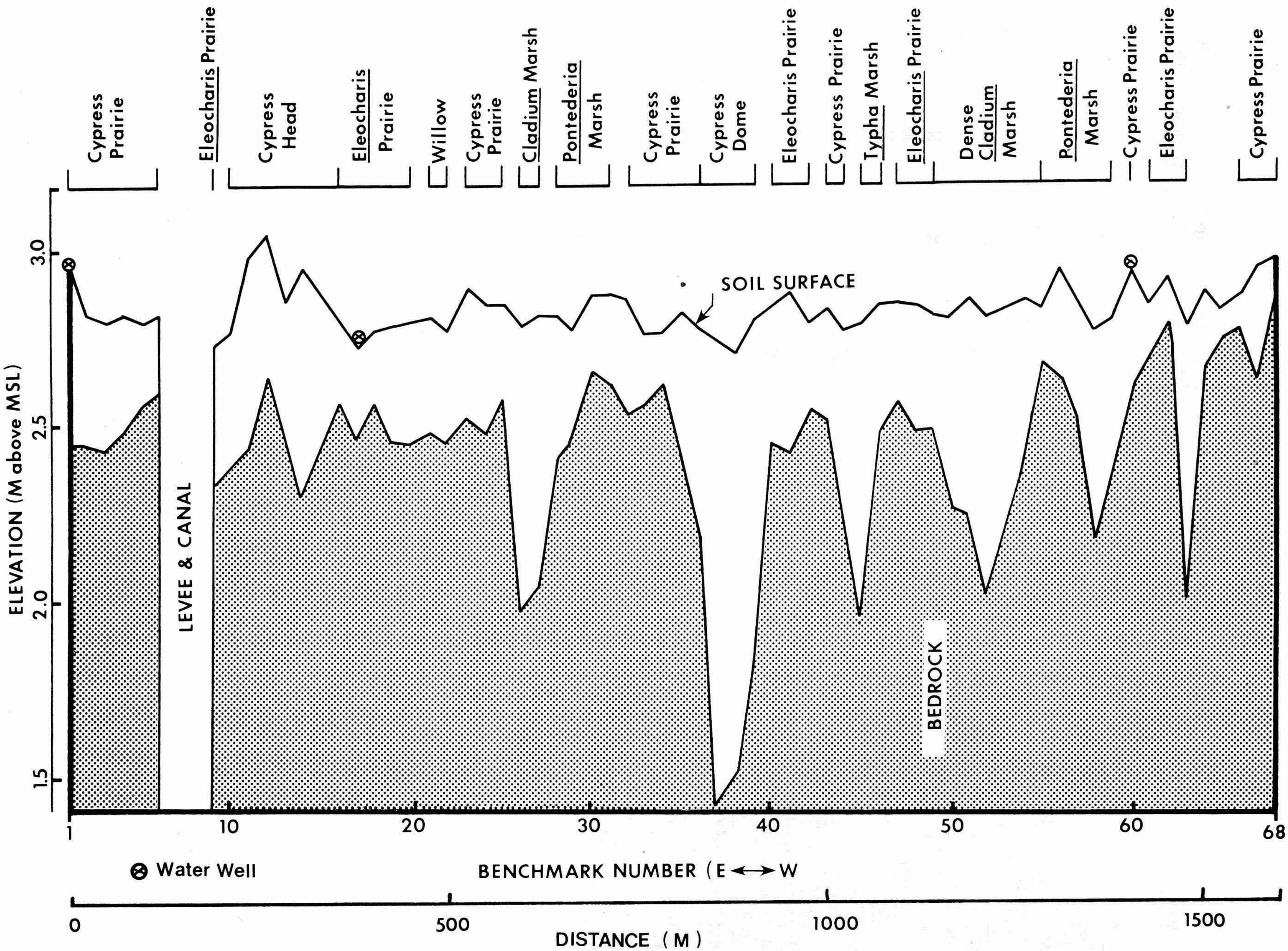

Figure 3. Soil surface and bedrock elevation at each surveyed benchmark along transect one, with associated plant community.

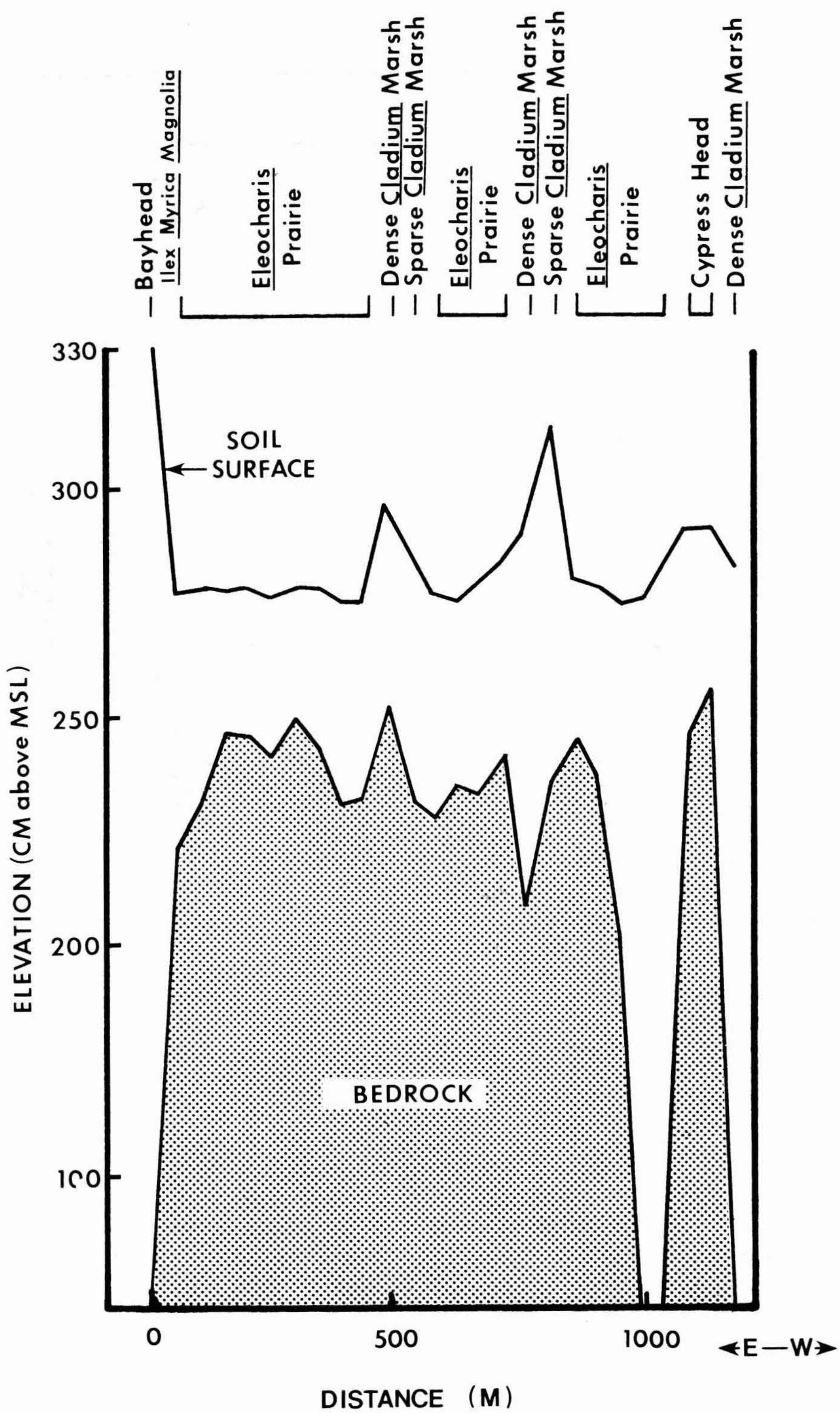

Figure 4. Soil surface and bedrock elevation along transect two, with associated plant community. Elevations determined by water depth at each point. Westernmost measurement point is 50 m east of benchmark one on transect one.

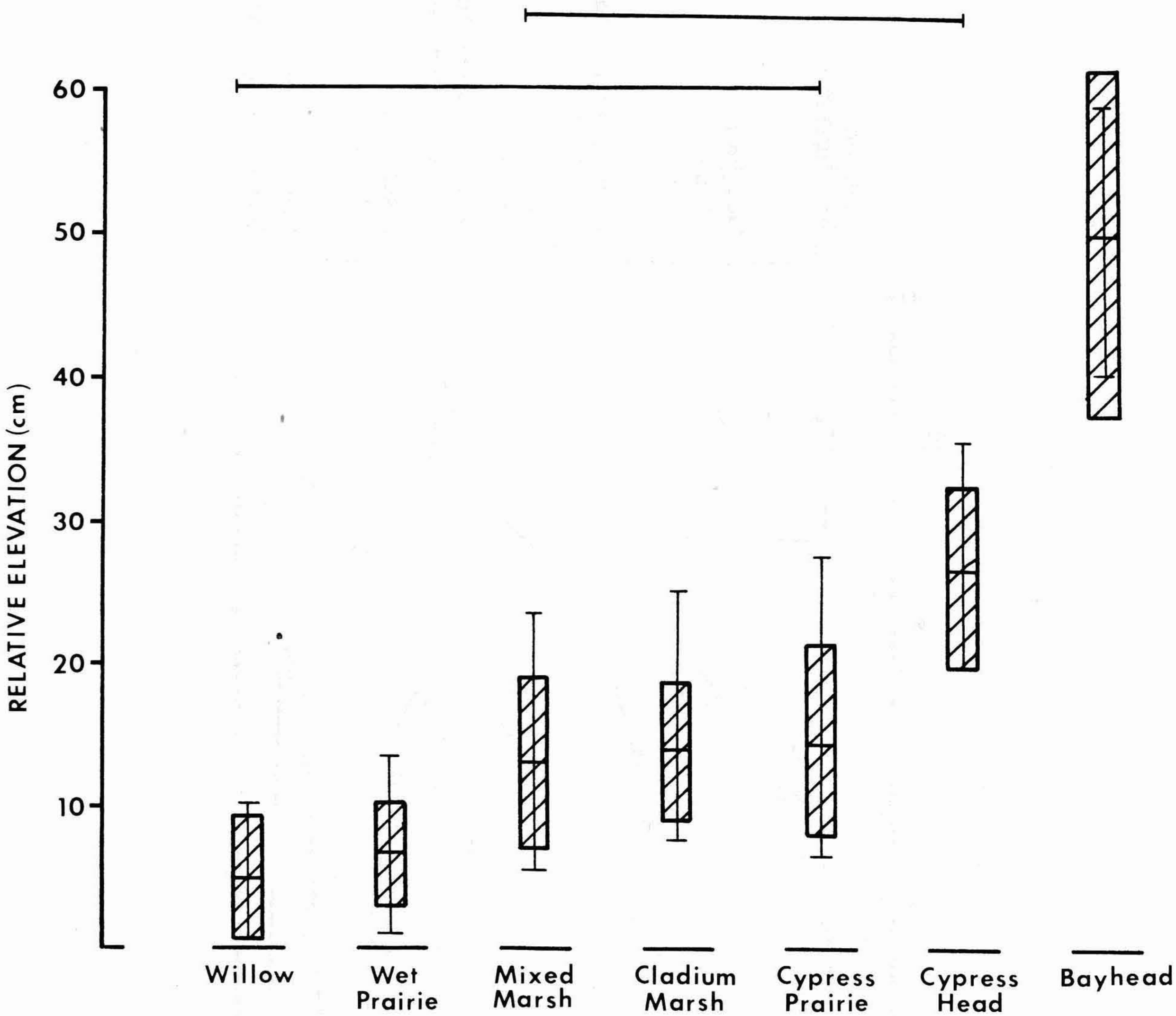

Figure 5. Relative elevations of plant communities along transects. Lowest value (o) equals 270 cm above msl (in willow area). Values are means, ± one STD. DEV. and range of values. Bars at top enclose means not significantly different at p = 0.05.

Cypress strands are similar in species composition and structure to domes. The strands are found in sinuous bedrock depressions, whereas the domes are found in circular depressions. Strands may be considered equivalent to a series of linked domes or one elongated dome.

The overstory cypress in a cypress head is structurally the same as the cypress in a dome. Like a dome, a head has a circular or hemispherical profile. The size and density of the cypress in a head are also similar to the cypress in a dome. The distinction between a dome and a head is the increased abundance of subcanopy swamp hardwoods found in the head.

Some confusion arises over the use of the term head. Davis (1943) used the term to describe a dome attached to a strand near the strand origin or headwaters. Many local observers use the terms dome and head interchangeably to describe any stand of cypress with a hemispherical profile. Olmsted et al. (1980) were the first to use the term "head" to describe a cypress dome with abundant understory hardwoods. The term is useful, as they (Olmsted et al. 1980) point out, because it is a combination of the term "cypress dome" and "bayhead." "Cypress" describes the overstory species, whereas "head" refers to the same hardwood species found in bayhead associations.

The quantitative inventory in the cypress head showed two important tree species: Taxodium ascendens and cocoplum, Chrysobalanus icaco (Table 2). The overstory Taxodium comprised 70% of the basal area (based on dbh), and has an average stem diameter of 27 cm. Cocoplum (a subcanopy tree-sized shrub) had much smaller stem diameters, averaging only 7 cm/stem. Both species had relatively high stem densities and frequency values, resulting in the high importance values for each. Other less important species were bayhead hardwoods such as Persea borbonia, Ficus aurea, Magnolia virginiana, Annona glabra and Ilex cassine (Table 2). Even though these other hardwoods were present, cocoplum was by far the dominant hardwood tree.

Cocoplum was also the dominant shrub species (Table 3). Only three shrub species were within the plot, and all were also present in the tree group. From this observation, it appears that Chrysobalanus, Ficus and Ilex will continue to be conspicuous features in the head. Even though no young cypress were found, Taxodium will apparently retain dominance for some time (barring a catastrophic disturbance) due to its longevity.

Five of the six understory species in the cypress head were epiphytes (Table 4). Of the five species, three were ferns of the genera Blechnum, Nephrolepis and Thelypteris. The epiphytes were found on the basal swells of Taxodium and on felled logs. Cocoplum was the only non-epiphyte found in the understory plots. The presence of cocoplum in all three inventory plots indicates that this species should continue to dominate in the cypress head.

The most noteworthy environmental characteristic of the cypress head is the high soil surface elevation in the central portions of the head (Figure 3). The average

Table 2. Statistics for tree species in cypress head vegetation plot.

Species	Total Basal Area (cm^2/600 m^2)	Stem Density (#/600 m^2)	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Taxodium ascendens	25,197	44	88	71	40	38	149
Chrysobalanus icaco	7,050	50	88	20	45	38	103
Persea borbonia	1,071	6	25	3	5	11	19
Ficus aurea	1,336	6	17	4	5	7	16
Magnolia virginiana	518	2	8	1	2	3	6
Annona glabra	65	1	4	1	1	1	3
Ilex cassine	28	1	4	1	1	1	3

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Ilex cassine	28	1	4	1	1	1	3

soil surface in the head was 25 cm above a nearby willow stand (the lowest point on the transect). The average elevation in the head was also 10 cm above the mean in the cypress prairie, yet still 20 cm below a nearby bayhead (Figure 5). The soil surface "high" appears to be a result of two factors; the initial bedrock elevation and a substantial accumulation of organic matter. The bedrock high in the head is in surprising contrast to the usual bedrock depression associated with domes and strands. An average soil depth of 60 cm was calculated for all benchmarks within the cypress head (Figure 6).

The existence of the cypress-heads seems to be related to a set of unique conditions only found along the border of the Big Cypress and Everglades regions. To the authors' knowledge cypress heads are found only along the eastern edge of the swamp and no similar association is found in the Big Cypress region to the west. The heads are found on the vegetation map of the L-28 area only along the eastern portion of the map at the ecotone between the two major physiographic regions. Cypress domes and heads looked the same on the aerial photographs (taken when the cypress were leafed out) since their canopy profiles are the same. It was impossible to tell the abundance of understory hardwoods. Therefore, both domes and heads were depicted by the yellow-stippled areas on the map. Ground-truthing of the map resulted in identifying that most of these areas on the eastern portion of the map were cypress heads. The heads always seem to be surrounded by wet prairie vegetation, as are the tree islands in the Everglades proper.

The development of the cypress head is somewhat of an enigma, and can only be speculated upon in the absence of conclusive evidence. Three points are clear, however: (1) Cypress trees are present indicating a hydroperiod range for establishment. (2) Hardwood species are present which presumably establish on "drier" sites than cypress. (3) There is a substantial accumulation of peat.

Davis (1943) stated that development of a bayhead initiates with aquatic marsh plants. He related that the aquatic plants die and a subsequently slow decomposition process under flooded, anaerobic conditions results in peat formation. The soil surface elevation gradually rises with this accumulation until conditions are such that establishment of the hardwood species is favored. This process might be assumed to occur in the cypress heads, with cypress as the pioneer species being gradually replaced by hardwoods. Under this scenario, cypress trees establish while the site is reasonably wet, and peat accumulation results from their litter fall. The gradual decrease in the hydroperiod tends to favor hardwood establishment. Even though the process of peat accumulation is slow (Gleason et al., 1974 report an average of 16 cm/century), perhaps only two to four generations of cypress trees (assuming a 100 to 200 year life span) could accrue most of the 60 cm of measured peat. The peat may accumulate quicker than this rate, though Craighead (1971) stated 15 cm of peat was deposited beneath sawgrass and willow in 50 years near the Anhinga Trail in Everglades National Park. The current generation of cypress could have contributed to the bulk of peat accumulation, or at the very least, sufficient organic matter to slightly decrease the hydroperiod to favor hardwood establishment.

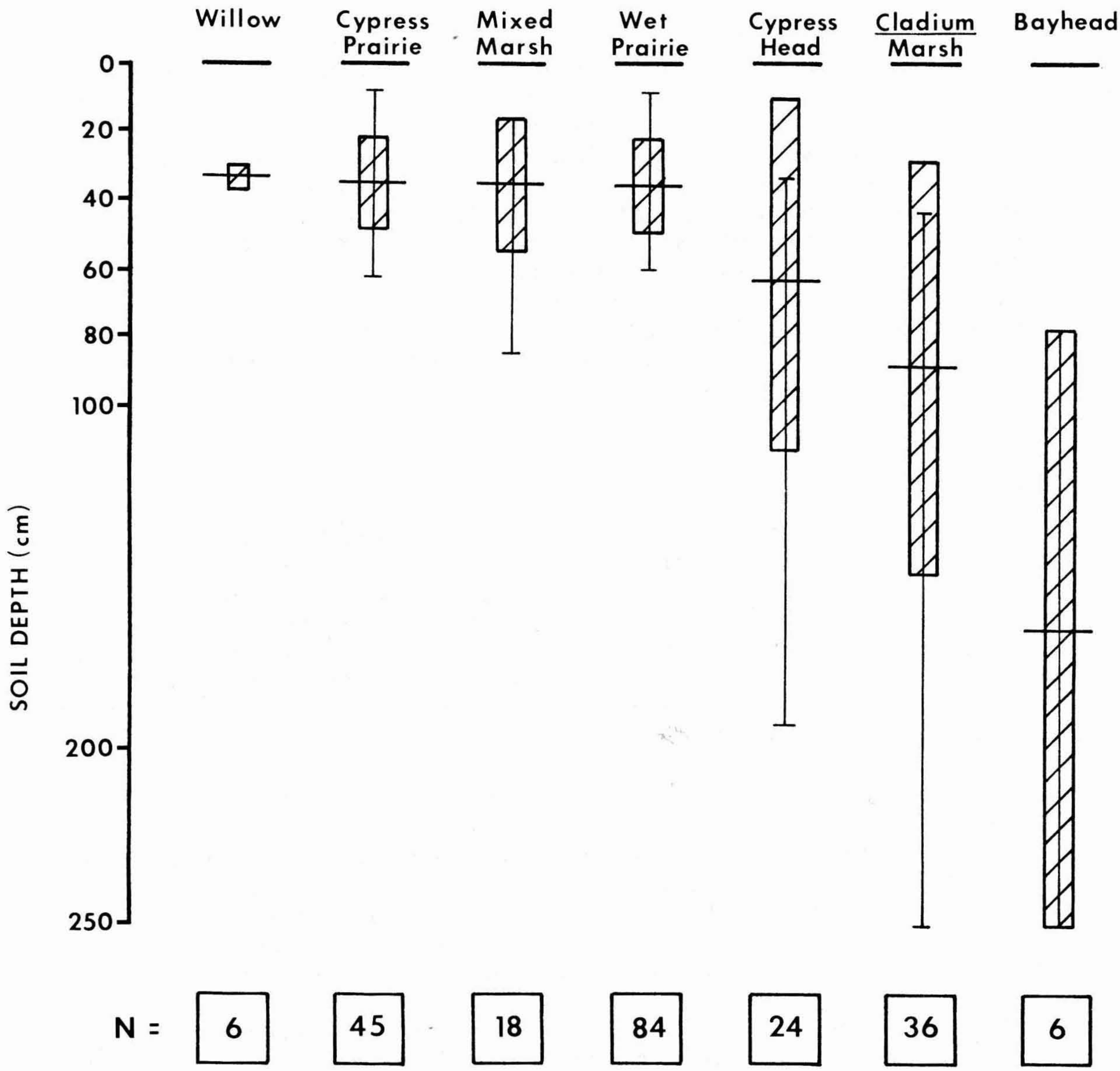

Figure 6. Soil depths beneath plant communities. Values are means, ± one STD. DEV. and range of values. N equals number of samples.

The establishment of the cypress and swamp hardwoods may also be explained in terms of alternating wet and dry years. The wet years favor the cypress establishment, and subsequent drier years (in conjunction with peat accumulation that increases the elevation of a site) would favor the hardwood establishment.

A lack of fire may also account for the abundance of hardwoods. Fire in cypress communities can remove invading hardwoods (Ewel and Mitsch, 1978), leaving cypress as the only remnant tree species. The timing of the fire can affect the fire impact. Fires entering cypress heads during the dry months of severe drought years can consume all vegetation as well as the organic soil. Fires during wetter months of a wet period may enter a head, kill hardwoods, leave the more fire resistant cypress and not remove any soil. Under natural hydrologic conditions however, fires appear to be infrequent in cypress heads. This may be due in part to the low fuel loads and long hydroperiods in the surrounding wet prairie vegetation. The heads may also be somewhat fire-resistant in that soil moisture may stay high (due to the large amount of organic matter and its water retention properties) through the fire-prone dry season. Also, the fuel structure in the heads may act to exclude fire except during dry periods when strong winds may push the fire into the head.

Degraded Cypress Communities

Severe fires during the dry years of 1971 and 1975 entered the tall cypress areas south of the tieback levee. The fires consumed the overstory vegetation in both domes and heads as well as some of the organic soil. Areas with overstory cypress (as shown on 1940 aerial photography) prior to the burns are now colonized by one of three successional plant associations: mixed aquatic marsh, dense Cladium marsh or willow heads. The marshes are represented on the map by light blue; Cladium marshes are plain and the mixed marshes are stippled. Willow areas are depicted by light green on the map.

The mixed aquatics marsh is dominated by emergent species such as Typha domingensis, Pontederia lanceolata and Panicum virgatum. Other species encountered are listed in Table 1. The substrate in the marshes consists of shallow (average 30 cm) mixture of sand and organic matter. Presumably some of the organic matter is a remnant from the pre-burn soil. The average soil surface elevation in the mixed marsh and sawgrass marsh were roughly equal, although soil depths in the marsh were less than depths in the sawgrass areas (Figure 5).

The Cladium marshes were dominated by dense, tall sawgrass (Cladium jamaicense). Some remnant overstory individuals of Taxodium were also present. Other aquatic herbs, such as Pontedaria lanceolata, Proserpinaca palustris, Bacopa caroliniana and Ludwigia repens were common in these areas despite the dominance of Cladium. The mixed marshes and sawgrass marshes were quite similar in terms of overall species composition, but pronounced dominance of certain species was considered to justify establishing different categories.

The average ground surface elevation in sawgrass areas was not statistically different from those in the mixed marshes, willow, or wet prairie (Figure 5), but, soil depths were the greatest in the sawgrass areas among these four types and may account for the sawgrass dominance. The average depth for all sawgrass sites was 66 cm, with a range from 45 to 82 cm (Figure 6). The soils beneath the sawgrass marshes consisted of a dark black peat underlain by marl.

Areas dominated by willow, Salix caroliniana, were found in the deeper areas of burned out cypress. Remnant cypress were usually present in these areas. The overall species composition here is also similar to the other burned out types (mixed marsh and sawgrass - Table 1). As would be expected in the central portions of former cypress domes where organic soil was removed by fire, the ground elevations were the lowest of any measured (Figure 5). The remaining soil, a black muck, was rather shallow with an average depth of 30 cm (Figure 6).

Successional Relationships among Cypress Communities

Severe fires in cypress domes and heads can result in plant associations different from the pre-burn community. The peat-removing fires alter the surface elevations, soil depth and hydrologic pattern. The severity of the fire may be gauged by the amount of peat removed. The resultant spectrum of environmental conditions plus the post-disturbance availability of seed may determine the species dominance in the successional communities. No drastic difference was noticed in total species composition among the three identified associations. Therefore, the changes seem to favor the abundance of certain species especially Typha domingensis, Cladium jamaicense and Salix caroliniana.

The post-fire areas with the lowest soil surface elevations, usually a result of substantial peat removal by the fire, support stands dominated by willow (Figure 7). Little residual soil remains in these areas. Recurring fires can maintain these areas (Robertson, 1953; Loveless, 1959) by removal of invading species, retention of low soil elevations and reinvasion of willow. If the proper fire regime is coupled with an adequate cypress seed source and proper hydrologic conditions, cypress regeneration can occur (Gunderson 1977) which can result in succession towards pre-burn conditions (Figure 7).

The mixed marshes and sawgrass marshes are found at approximately the same post-fire soil surface elevations, but large differences in soil depths were noticed. The larger amount of organic soil and increased organic component probably retain soil moisture and extend the hydroperiods, which may favor the sawgrass dominance.

Frequent fires in the marshes would preclude cypress or hardwood establishment, thereby retaining early successional status. A severe fire in the sawgrass areas may remove additional peat, lower soil elevation and favor establishment of willow (Figure 7). The proper fire regime (low frequency and severity) probably favors cypress regeneration in these areas. Again, only if an adequate cypress seed source and proper hydrologic regime are present, will cypress regeneration occur. No

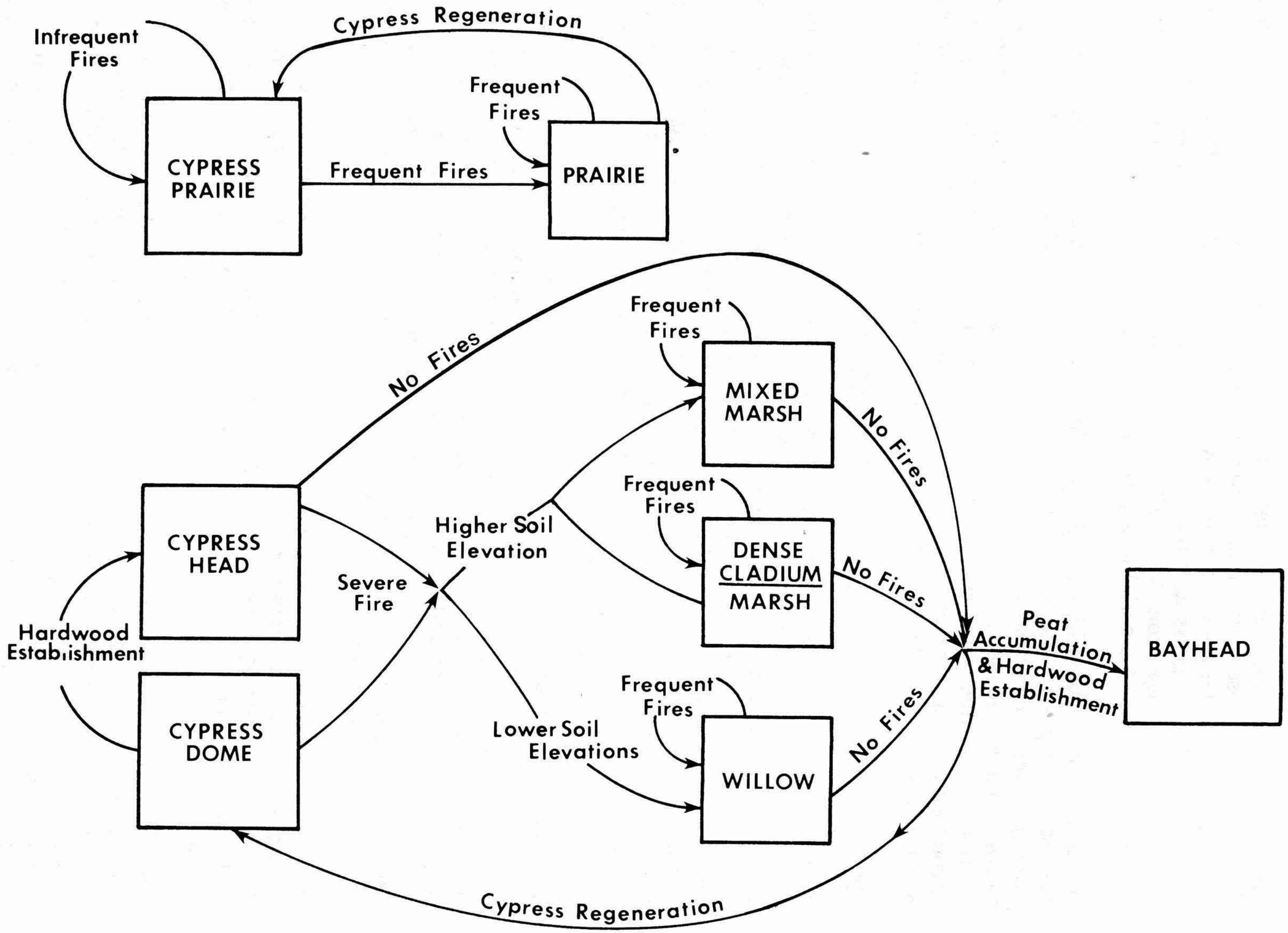

Figure 7. Theorized successional diagram involving cypress communities and fire.

successional relationship is thought probable between the mixed marsh and sawgrass marsh, nor the mixed marsh and willow areas, given that current hydrologic conditions remain stable.

In the absence of fire, all successional communities may converge towards a bayhead type. This succession is probably rare because it can only occur in the absence of fire and after long periods of peat accumulation. In situ peat accumulation proceeds only if hydrologic patterns permit areas of prolonged inundation.

Cypress prairies are usually not severely affected by fires, due to low fuel loads and non-combustible substrates. Frequent fires may remove the cypress by gradually destroying the protective bark, leaving the tree more susceptible to subsequent fires. The removal of the cypress would result in a prairie association (Figure 7) which can also be maintained by frequent fires. A lower fire frequency and cypress seed source would favor cypress regeneration.

Unless a major shift in the hydrologic pattern were to occur, no successional relationship is thought to exist between the cypress prairies and cypress domes or heads. These associations appear to be stable in terms of edaphic and hydrologic parameters. Only if water levels and hydroperiods (and eventually organic soil depths) were increased in cypress prairie would the small cypress be expected to grow as large as those now in domes and strands.

Wet Prairie

The wet prairie vegetation association is widespread throughout the eastern areas of the vegetation map (represented by tan on map). The wet prairie includes areas which may be locally dominated by a Eleocharis-Rhyncospora type, sparse sawgrass or maidencane (Panicum hemitomon). The dominant association, the Eleocharis-Rhynchospora type, was quantitatively inventoried.

Eleocharis cellulosa and Rhynchospora tracyi had the highest importance values in the plot (Table 5). Cover values were low, averaging only 10% for each species. These areas have a low diversity, with only seven species encountered in the plot. In addition to Eleocharis and Rhynchospora, Utricularia purpurea and Panicum paliduvagum were the only species found in any significant abundance.

The elevations in the wet prairie areas were low, averaging only 5 cm above the lowest measured. The soils in these prairies consisted of shallow (average 20 cm) marl and sand over bedrock.

Pine Forests

The pine forests in the Big Cypress Preserve attain their easternmost extension in the L-28 area (depicted by green on vegetation map). The pine forests are found on higher bedrock outcrops of presumably Tamiami limestone. South Florida slash

Table 5. Statistics for understory species in wet prairie inventory plot. No trees or shrubs were in plot.

Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Eleocharis cellulosa	10.4	97	32	33	65
Rhynchospora tracyi	10.9	87	33	29	62
Utricularia purpurea	7.6	50	23	17	40
Panicum paliduvagum	3.2	42	10	14	24
Hymenocallis palmeri	0.3	12	1	4	5
Justicia ovata	0.4	5	1	2	2
Utricularia foliosa	0.1	2	1	1	1

pine, (Pinus elliottii var. densa), cabbage palm, (Sabal palmetto), and saw palmetto (Serenoa repens) are the dominant plants of this association. The palms are interspersed with a graminoid understory dominated by such species as Schizachyrium rhizomatum, Andropogon virginicus and Paspalum monostachyum.

Hardwood Forests

The hardwood assemblages in the L-28 area are divided into three groups: oak-Sabal hammock, tropical hardwood hammock and hardwood scrub. All of the hardwood areas are on higher bedrock outcrops than the pine forests. The hammocks are the northernmost of Craighead's (1971) "hammock cypress ridge," found along the eastern boundry of the Big Cypress Swamp. All the hammocks are brown on the vegetation map; the oak hammocks have no superimposed pattern, the tropical hardwood hammocks are stippled and the scrub areas have horizontal lines. The oak hammocks are uncommon in this area, and are dominated by laurel oak (Quercus laurifolia), with a subcanopy of Sabal palmetto. The tropical hardwood hammocks in the area are comprised of such overstory species as Lysiloma latisiliquum, Bursera simaruba and Quercus virginiana. Common subcanopy species include Coccoloba diversifolia, Bumelia salicifolia and Nectandra coriacea. The hardwood scrub areas are characterized by low stature, successional hardwood species. The scrub areas are usually on the periphery of hammocks, where occasional fires have apparently degraded the hammock vegetation. Common species in scrub are Sabal palmetto, Serenoa repens, Trema micrantha, and Baccharis glomeruliflora.

Exotic Vegetation

The only stand of exotic plants in the study area was a stand of Melaleuca quinquenervia located in the south-central portion of the map. The stand covers approximately 1600 m^2 (.16 ha) and is surrounded by a mixed marsh. The central trees are approximately 20 m tall, and from its structure, the stand appears to be expanding into surrounding areas. The stand does not appear to be a result of intentional planting, but may have originated from seed produced at intentional plantings some 2 to 3 km to the west.

Hydrologic Patterns

Water levels were monitored monthly for one annual cycle at the shallow wells along the vegetation transect (see Figure 3 for location of wells). One well was in a wet prairie east of the levee, one in a cypress prairie west of the levee, and another in a cypress prairie east of the levee. Water levels and stage duration curves are presented for the three stations for the time period September 1979 through August 1980 (Figures 8, 9). Water levels do not appear to be affected by the levee during this year (Sikkema, pers. comm.), as only 0.3 ft (9 cm) separated the values at the 50% mark on the stage duration curve (Figure 9). At all sites, water levels remained above ground for most of the year, indicating a very wet year with no dry period (Figure 8).

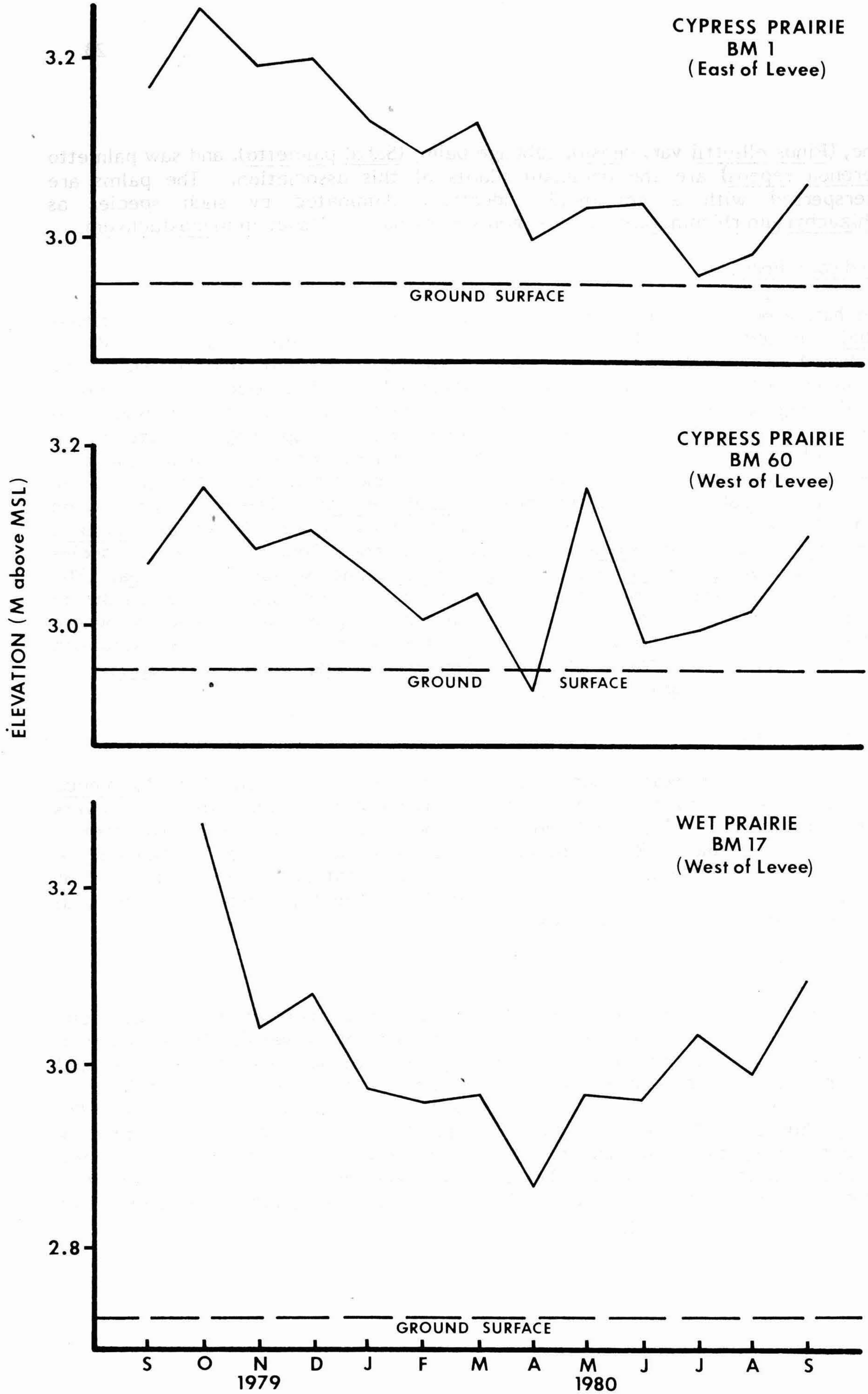

Figure 8. Water levels in sample wells from September 1979 to September 1980.

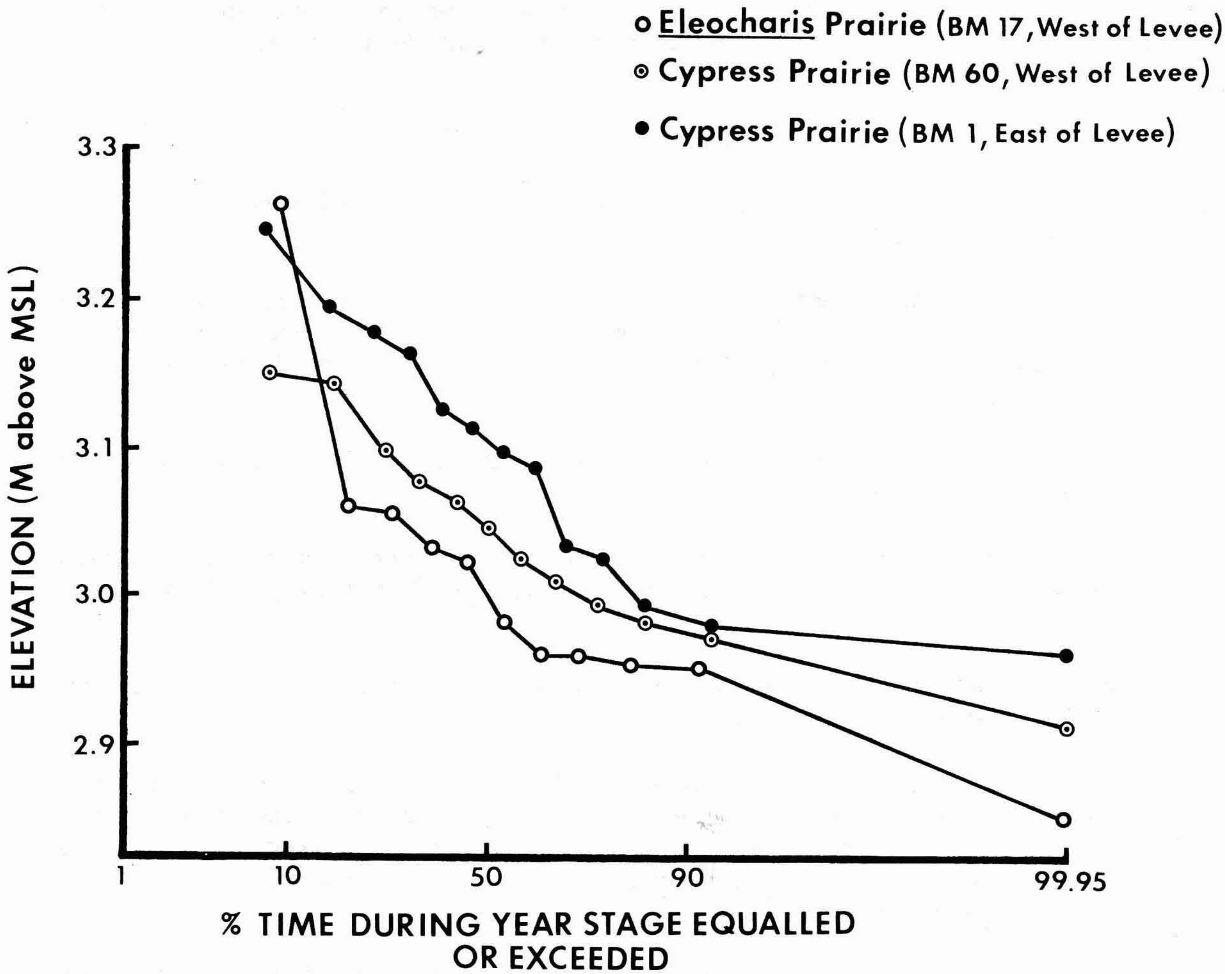

Figure 9. Stage duration curves of water levels from wells, based on one year of data.

The levee and canal may not affect water levels during wet conditions, but may have an impact during dry periods. This was not indicated by the water levels, but from secondary evidence of fire impacts. As shown on the vegetation map, successional post-fire communities are only present west of the levee and south of the tieback. Therefore, severe fire impacts are only seen in areas inside the levee, indicating the dry period may be prolonged and/or made more extreme by the canal.

SUMMARY AND CONCLUSIONS

1. A vegetation map which documents current spatial distribution of the plant associations in the L-28 tieback area is presented.

2. Cypress heads are identified as an unusual cypress association in the Big Cypress Swamp region. They are found mainly along the border between the Big Cypress and Everglades regions, but occur less frequently in Everglades National Park.

3. Quantitative inventories of relocatable plots in a cypress head and wet prairie are reported.

4. Taxodium ascendens was the dominant overstory species in the inventoried cypress head with cocoplum (Chrysobalanus icaco), forming a dense shrub layer.

5. The two dominant species in the herbaceous wet prairie were Eleocharis cellulosa and Rhynchospora tracyi.

6. Severe fires in cypress communities south of the L-28 tieback resulted in colonization by successional species. The successional associations were dominated by Cladium jamaicense, Salix caroliniana, or mixed aquatic plants such as Typha domingensis and Pontedaria cordata. A successional diagram involving fire in these cypress types is presented.

7. Mean relative elevations were lowest in areas dominated by willow, Salix caroliniana, and increased through communities of wet prairie, mixed aquatic marsh, Cladium marsh, cypress prairie, cypress head and bayhead. The range in measured elevations was 60 cm.

8. Mean soil depths were greatest (160 cm) beneath the bayhead, and dense Cladium marsh (100 cm). Shallow soils (less than 30 cm deep) were found beneath the wet prairie (marl type); cypress prairie (sand and marl); mixed marsh (sand and some organic matter) and willow stands (sand and some organic matter).

9. Preliminary hydrologic data show that water levels may not be significantly lowered south and west of the levee during wet years, but the high incidence of severe fire impacts in this area indicates that perhaps some hydrologic alteration has occurred.

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