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Report T-648
An Inventory of the Plant Communities of the Turner River Area, Big Cypress National Preserve, Florida

NATIONAL PARK SERVICE
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An Inventory of the Plant Communities of the Turner River Area Big Cypress National Preserve, Florida

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INTRODUCTION

Many factors influence the distribution of plant communities in the Big Cypress area of southern Florida. A spectrum of hydrologic conditions is found throughout the communities, ranging from deep water areas with long periods of inundation to "upland" areas with no inundation. The hydrologic regime in each community is a result of topographic and edaphic features combined with the rainfall pattern characterized by a pronounced wet season in May-October.

Other natural influences on the succession within each vegetation type include the effects of hurricanes, fires, frosts, lightning and animals (Craighead, 1971). Man-induced changes on the plant communities are a result of lumbering, canal and road building, excavation, farming, and grazing. Although all of the above mentioned factors are important, this study deals primarily with the relationships between the vegetation and the elevational, soil and hydrologic conditions.

Vegetation and Flora

Davis (1943) made the first detailed classification of the plant communities in southern Florida, which included the area now incorporated in Big Cypress National Preserve (Table 1). He expanded from earlier works dealing with southern Florida by Harshberger (1914) and Harper (1927), neither of whom probably ever entered the Big Cypress region due to limited acess prior to 1928. Craighead (1971) listed the major species of the communities of the Big Cypress region based on field reconnaissance. McPherson (1973) used a classification scheme combining Davis' and Craighead's works to map the Big Cypress region. Duever et al. (1979) used categories similar to McPherson's (Table 1), to describe the plant communities of the Big Cypress National Preserve.

Lakela and Craighead (1965) listed the vascular plant species in Dade, Collier and Monroe Counties, the first such inventory to cover the Big Cypress area. Reference manuals by Small (1933) and Long and Lakela (1971) treat much broader geographical areas, but include many species in the preserve. Black and Black (1980) produced a preliminary checklist of the plants of Big Cypress National Preserve based on field reconnaissance and herbarium specimens filed at Everglades National Park.

The existing vegetation maps of southern Florida are at a scale too small to include details of the plant communities of the Big Cypress and the Turner River areas. Ives (1856), Harshberger (1914), Copeland (1947) and Davis (1943) all generated small scale maps (on the order of 1:500,000) which included major vegetation features, but are not detailed enough to use in interpreting historical changes. McPherson's (1973) map documented the plant communities of the Big Cypress region, but the scale (about 1:120,000) is too small to derive data on detailed vegetation change. Also, the map lacks geographical control; that is close correlation between features on the map and a geographic reference grid such as latitude and longitude, Universal Transverse Mercator or Township, Range and Section.

Table 1. Plant community classifications of the Big Cypress region by various authors

Davis 1943 (a)	Craighead 1971 (b)	McPherson 1973 (b)	Duever, et al. 1979 (c)
PINE HABITATS			
Pine-Wiregrass			
Pine-Palmetto	Pine-Flatwoods		
Pine-Cabbage Palm	Pine-Islands	Pine-Forests	Pine-Palm-Palmetto
	Palmetto Savannah		
Palmetto Prairie			
MIXED HARDWOOD ASSOCIATIONS			
Oak-Hammock		Oak-(Laurel, Live)	Temperate Hammock
Oak-Palm Hammock			
Cabbage-Palm		Cabbage-Palm	
Low Hammock			
Tropical Hammock	Tropical Hardwood Hammock	Tropical Hardwood Hammock	Tropical Hardwood Hammock
FRESHWATER SWAMPS			
Mixed Swamp Forest	Cypress Strand	Mixed Swamp Forest	MixedSwampForest
Cypress Dome	Cypress Dome	Cypress Dome	Cypress Dome
Cypress Slough		Cypress Strand	Cypress Strand
Cypress Scrub	Dwarf Cypress	Cypress Forests	Dwarf Cypress
Custard-Apple	Custard Apple Swamp		Pond Apple Slough
Pop-Ash	Pop-Ash Head		Pop-Ash Head
Willow	Willow		Willow Head
MARSHES AND PRAIRIES			
Marsh	Marsh, Sloughs	Marshes, Sloughs	Marshes
Sawgrass			
Flag			
Aquatic			
Cattail			
Spikerush			
Wet Prairie	Wet Prairie	Wet Prairie	Wet Prairie
Dry Paririe	Dry Prairie	Dry Prairie	Dry Paririe

a) Extrapolated from communities of south Florida
b) Within Big Cypress Region
c) Within Big Cypress National Preserve

Table 1 (continued)

d) Latin binomials of species in list:

Common Name	Latin binomial
Pine	Pinus elliotti var. densa
Palmetto	Serenoa repens
Cabbage palm	Sabal palmetto
Oak	Quercus spp.
Cypress	Taxodium spp.
Custard apple, pond apple	Annona glabra
Popash	Fraxinus caroliniana
Willow	Salix caroliniana
Sawgrass	Cladium jamaicense
Flag	Thalia geniculata
Cattail	Typha spp.
Spikerush	Eleocharis cellulosa

Elevations

The relief of Big Cypress National Preserve is low, with ground elevations ranging from seven meters to slightly above sea level and gradients as low as 20 cm/km (Duever et al., 1979). Elevations in the Turner River area vary from about 10 cm to two meters above sea level. In an area with such low relief, small changes in elevation can result in large differences in the plant communities, mainly due to hydrologic effects. Craighead (1971) recognized that increasing the elevation (road construction) and lowering the elevation (buggy trail) can change the floristic composition from the surrounding areas.

Correlations between ground-surface elevation and plant communities in southern Florida have been made by several previous investigators. Pesnell and Brown (1977) found optimal elevations for six wetland communities at Lake Okeechobee. The lowest ground levels supported vegetation dominated by *Scirpus californicus*. Increasing elevations supported communities dominated by *Eleocharis cellulosa*, *Typha angustifolia*, *Salix caroliniana*, *Rhynchospora tracyi* and *Spartina bakeri*. Klein, et al., (1970) surveyed plant communities in the Big Cypress region and found elevations to vary less than 0.9 m (3 ft.) between the lowest and highest communities, the normal range of water level fluctuations. They found cypress forests on the lowest sites, 0.6 m (2 ft.) less than the elevation of pine areas, and 0.9 m (3 ft.) less than the elevation of hardwood hammocks.

Soils

Davis (1943) first documented the association between soil types and vegetation communities in southern Florida. Leighty et al. (1954) expanded knowledge of soil-plant relationships and mapped the soils of Collier County. Davis (1946) found sandy mucks and muds in cypress swamp areas, peat over marl in sawgrass marshes and sandy muck under rush and flag (*Thalia geniculata*) pond sites. Pinelands in Collier County are found on fine and coarse sands as well as outcrops of limestone bedrock. Prairies of the Ochopee area have a sandy-marl substrate. The mixed hardwood hammocks are found on a mixture of sand and litter (Leighty et al., 1954). Craighead (1971) also describes the soils and corresponding plant associations. Coultas and Duever (1978) reported on parameters of histosols (organic soils) found in cypress swamps.

Hydrologic Influences

Among the hydrologic parameters that influence the vegetation are the length of inundation or hydroperiod, maximum and minimum water levels, and rates of water rise and recession. Major species in the communities are adapted to a certain range of hydroperiods. For example, *Taxodium* seed must soak in water for one to three months prior to germination (Mattoon, 1916). Physiological adaptions such as cypress knees are also a response to a set of long hydroperiods where anaerobic conditions prevail. Short hydroperiods are seen in pine forests, and mixed hardwood hammocks may not be inundated at all. A change in the hydroperiod alone can alter the plant community at a given site. Shorter hydroperiods also increase the frequency of fire, which results in a change in species composition. Tabb et al., (1976) documented changes in the plant communities of the Golden Gates region of the Big Cypress due to shortened hydroperiods, a result of canal construction.

Davis (1943) reported that long hydroperiods were found in swamps, with decreasing periods of inundation through marshes, wet prairies, pine forests and low hammocks. Duever et al. (1978) measured hydroperiods in communities at Corkscrew Swamp in the Big Cypress and found the same relative hydroperiod relationships that Davis reported. Pine forests at Corkscrew were inundated an average of 20 to 60 days at a depth up to 6 inches, low hammocks were shallowly inundated 10 to 45 days, wet prairies were inundated an average of 70 days, marshes averaged 250 days and cypress-mixed swamp forests were under water an average of 290 days. Pondcypress and scrub cypress forests were wet for shorter periods, averaging 250 and 120 days per year, respectively.

The maximum and minimum water levels and rates of water level change can also affect the vegetation composition. Davis (1943) stated that large and rapid water level fluctuations in sandy soils of prairies prevented the establishment of trees. For example, the roots of cypress seedlings must maintain contact with receding water levels for survival (Dickson and Broyer, 1972; Gunderson, 1977). The rapidly receding water levels in the prairies may result in mortality of cypress seedlings, while the longer hydroperiods preclude the establishment of pines.

Study Area

The Turner River study area is located in the southwestern portion of the Big Cypress National Preserve (See Vegetation Map of Turner River area enclosed in back cover). The area is approximately 5 km x 10 km and one of ten such areas located throughout the preserve as intensive study areas. The study area was established to encompass the immediate drainage area surrounding the Turner River. The river was named for Capt. Richard Turner, a scout for the U.S. Army during the Seminole War (Tebeau, 1966). The Turner River is narrow, usually less than 20 m wide, and is an open watercourse for approximately 6 km. Only the headwaters are included in the study area. The rest of the river runs through brackish prairie and mangrove regions into the Chokoloskee Bay area. The Turner River canal was completed in 1962 and built in association with State Route 839. The canal now diverts water from portions of the river. Canal construction and other human activities in the area may have altered the plant communities. This study was carried out to evaluate such impacts, and to gather baseline information on the vegetation and its relationships to elevation, soils and hydrology.

METHODS

Vegetation Analysis

The vegetation of the Turner River area was inventoried in six plots, each representative of a dominant community in the area. Plots were established in communities of Pine-*Sabal*-*Serenoa*, Pine-prairie, Pine-*Serenoa*, Cypress-mixed swamp forest, Cypress-prairie, and *Muhlenbergia* prairie. The locations of the plots are shown on the vegetation map (back cover) and the mercator coordinates of each plot are given in Table 2. The plots are permanently marked with a concrete post and aluminum plate, placed in each corner.

Table 2. Universal Transverse Mercator (Zone 17) coordinates and plot designation of vegetation plots in the Turner River area.

Vegetation Type	UTM Coordinates	Designation on Vegetation Map	Transect Number Associated With Plot
Pine-Sabal-Serenoa	N^{28} 62.74 E^{4} 73.9	1	2
Pine-Prairie	N^{28} 61.96 E^{4} 73.88	2	2
Pine-Serenoa	N^{28} 62.4 E^{4} 73.92	3	2
Cypress-Mixed Swamp	N^{28} 61.88 E^{4} 75.00	4	2
Cypress-Prairie	N^{28} 68.56 E^{4} 74.52	5	5
Muhlenbergia Prairie	N^{28} 67.52 E^{4} 71.71	Not on Map	1

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 inches) 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 which were rooted within a 15 x 40 m rectangular plot (Figure 1) 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 in homogeneous vegetation types. Basal areas were calculated and used as an expression of dominance of each species. Relative dominance, based on the total basal 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 x5 m subplots (Figure 1) was recorded and frequency of occurrence determined for each species. Relative frequency was calculated based on the summation of the frequencies of all species.

No tree heights nor canopy cover were measured. Sabal palmetto with remnant leaf bases (boots) were difficult to measure using a DBH tape, so the diameters were measured using a meter stick held at breast height. Relative dominance, relative density and relative frequency are summed for each 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 1) divided by the total length (160 m). All Sabal palmetto and Serenoa repens that were not trees (no measureable DBH) and not seedlings were measured using this method. Woody vines were usually inventoried in the shrub class. All intersections were recorded regardless of where the shrub was rooted, inside or outside the tree plot.

Shrub occurrence was noted in each of sixteen 10 m line segments (A1-A4, B1-B4, C1-C4, D1-D4 in Figure 1), and used to calculate frequency and relative frequency of each species. Relative dominance and relative frequency are summed to yield the Shrub Importance Value Index.

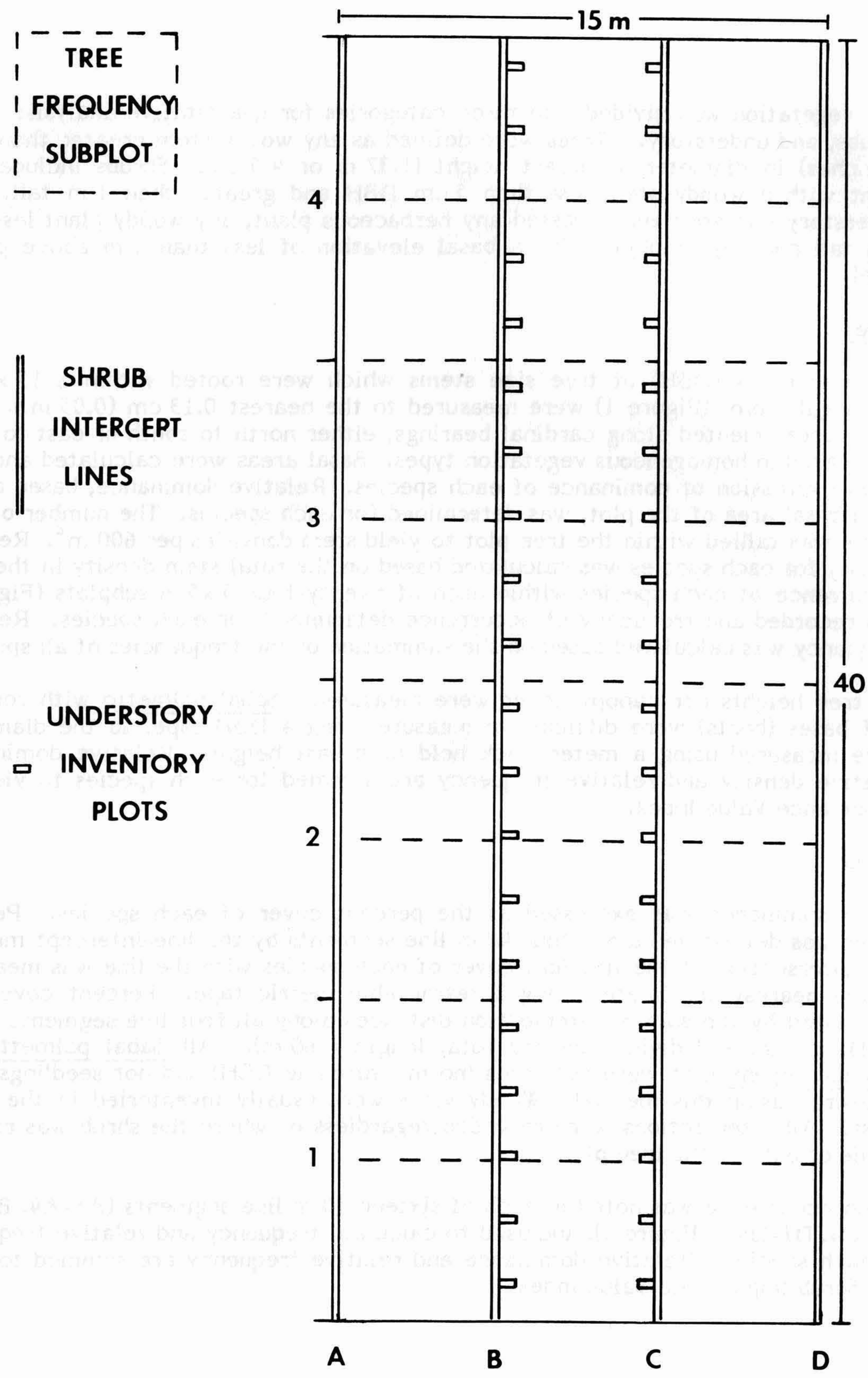


Figure 1. Schematic diagram of vegetation inventory plots.

Understory

Understory species were listed within forty 20 x 50 cm (0.1 m^2) subplots placed at two meter intervals along the two center lines of the vegetation plot (lines B, C in Figure 1). The subplots 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, Cladium was encountered six times in 40 subplots 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 to yield 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.

Identification

Identification references include Long and Lakela, 1971; Lakela and Long, 1976; Hitchcock and Chase, 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).

Vegetation Mapping

The vegetation of the Turner River study area was mapped to document current distributions of plant communities for comparison with future conditions and hence, an evaluation of vegetation change. On the original draft, the scale (1:10,000) was large enough to delineate small areas (100 m^2) of vegetation. Hopefully, delineations at this scale can be used in future comparisons to determine major shifts in the vegetation boundaries. Geographical control was maintained so that vegetation features can be relocated.

The vegetation map was generated by first delineating the plant communities on 9" x 9" color aerial photographs (1:7800, taken in December 1978). Classification of the plant communities was based on field observations and included descriptions of prior workers (Davis, 1943; Craighead, 1971; McPherson, 1973; and Duever et al., 1979). Readily discernable features on the color photographs were also outlined on USGS 7.5' orthophoto maps, then transferred to a skeleton map (scale 1:10,000) using a Map-O-Graph opaque projector. The features on the skeleton map were used as geographical control points in transferring lines from the aerial photographs to the vegetation map (1:10,000). The map was field checked during December 1979 and January 1980, then drafted and colored. The scale was decreased during printing due to limitations on press size, so that the final copy is at a scale of approximately 1:17,000.

Aquatic Vegetation

A detailed mapping project of the aquatic vegetation in the Turner River was done to establish baseline data on the species composition and distribution. This information may be used to compare with data gathered after measures proposed to restore pre-canal hydrologic conditions (Rosendahl and Sikkema, 1981) are enacted. Four 20 meter segments of the river were mapped, each at 100 m intervals north of Bridge 83 on the Tamiami Trail (Figure 2). A grid system, based on 5 x 5 m blocks, was set up across the river using metric tapes. The details within each block were transferred to graph paper using measurements on the tapes. All vegetation between the river banks was mapped. Some species were found intermingled with other species, and these associations were mapped as a single unit.

Environmental Parameters

Transects were established in the Turner River area to determine relationships between the vegetation and topography, soils and hydrology. The locations of the five transects are shown on the vegetation map (enclosed). The transects were oriented generally east to west in order to bisect drainage basins and sample as many plant communities as possible. The transects varied in length from 115-m-to 4000 m. Permanent benchmarks were established along the transects by driving lengths of 9.5 mm (3/8 in.) diameter metal reinforcing rod into the ground until secure. The rods were placed at intervals of 23, 46 or 92 m (75, 150 or 300 ft.) based on visibility between them. At each benchmark, ground and bedrock elevations were determined, and an analysis of the vegetation was made. Soil analysis and water level monitoring were done only at certain benchmarks characteristic of the plant communities.

The vegetation around each benchmark was inventoried in two strata; overstory and understory. The composition and abundance of the overstory species identified the major plant community, whereas the understory species documented the variability within the community. Some benchmarks were in ecotonal areas (transition between two vegetation types) and not included in the elevational analyses of plant communities.

Ground elevations were determined by surveying the top of each rod from established benchmarks of known elevation. The distance from the top of the rods to the soil surface was measured to the nearest 5 millimeters. The distance was subtracted from the benchmark elevation to calculate the soil surface elevation. Soil depth (and bedrock elevation) was measured to the nearest 0.5 cm by inserting a metal rod into the ground until bedrock was reached (indicated by a ringing sound) then measuring to the nearest 0.5 cm. Three probes were made at each benchmark and the mean soil depth calculated.

The nature of soil profiles was determined using either a tube sampler for depths up to 50 cm, or a bucket auger for greater depths. The soils were categorized into one of seven major types: rock, sand, marl, muck, peat, litter and silty-clay. Rock substrates are outcrops of the underlying Tamiami formation.

Water levels were monitored monthly in the vegetation communities for one annual cycle by D. Sikkema (South Florida Research Center Hydrology Program). Shallow ground water wells were established by driving 5 ft. lengths of 2.5 cm (1 in. inside

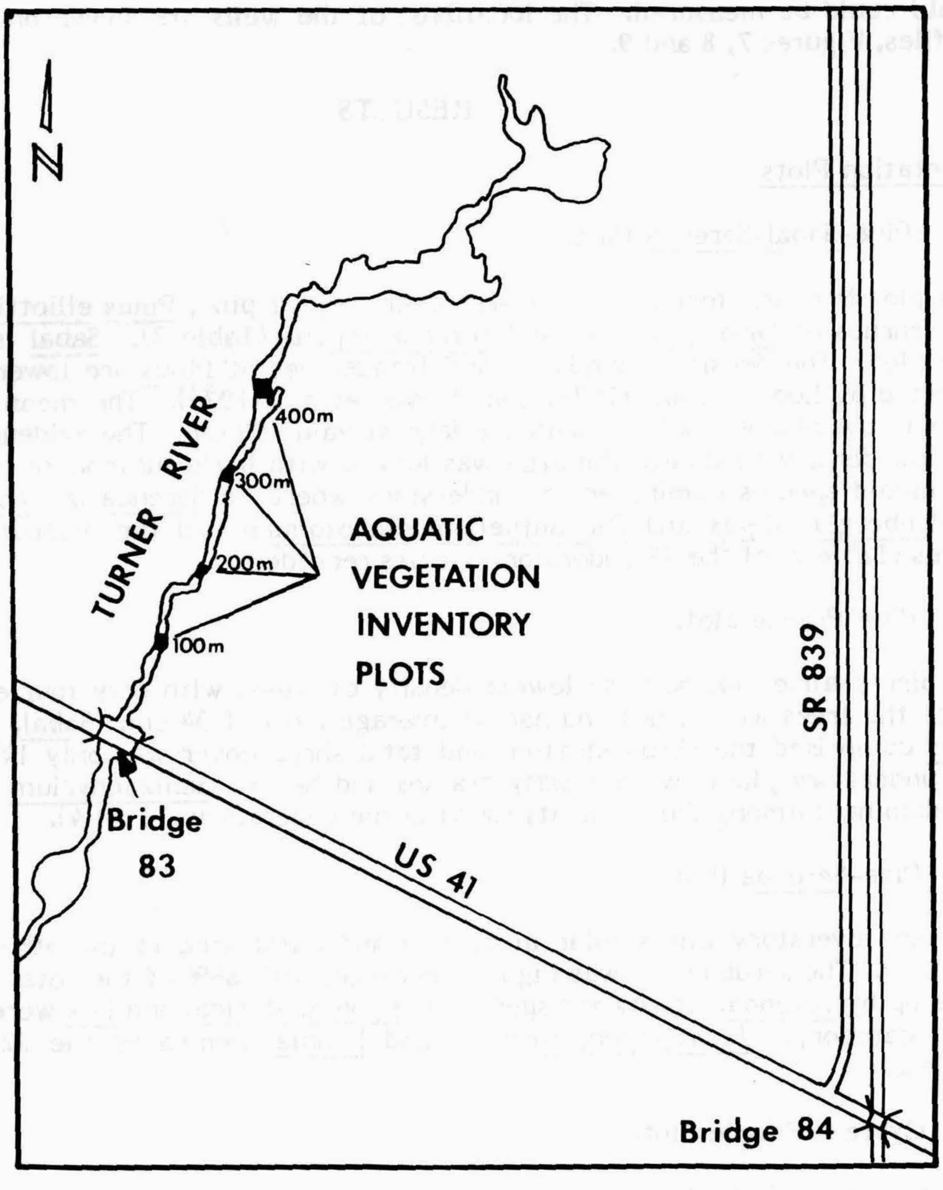


Figure 2. Location of aquatic vegetation inventory plots. See vegetation map (enclosed) for location of the Turner River in South Florida.

diameter) steel pipes into the ground. The pipes were cleared with a pitcher pump to assure good groundwater communication. The elevation of the top of the well (MSL) was determined by surveying to the nearest benchmark, so that water level (MSL) could be measured. The locations of the wells are shown on the transect profiles, Figures 7, 8 and 9.

RESULTS

Vegetation Plots

Pine-Sabal-Serenoa Plot.

This plot is characterized by a sparse overstory of pine, Pinus elliottii var. densa, with shrubs of Sabal palmetto and Serenoa repens (Table 3). Sabal is also in the tree plot. The density, abundance and frequencies of Pinus are lower than values reported by Loope et al., (1979) and Duever et al., (1976). The mean diameter of pines in the plot was 27 cm, with the largest value 38 cm. The evidence of stumps and low densities indicate the area was logged with little subsequent regeneration. Graminoid species dominated the understory where no Serenoa or Sabal occurred. Muhlenbergia filipes and Dichanthelium dichotomum had the highest importance values (Table 3) of the 29 understory species recorded.

Pine-Prairie plot.

The pine-prairie plot had the lowest density of trees, with only four encountered. All of the trees were pines and had an average DBH of 34 cm. Sabal, Serenoa and Pinus comprised the shrub stratum and total shrub cover was only 14% (Table 4). The understory plants were mostly grasses and herbs. Schizachyrium rhizomatum was dominant among the 32 plants found in the understory (Table 4).

Pine-Serenoa Plot.

The pine overstory was similar in density and basal area to the other pine plots (Table 5). The shrub cover was higher, however, with 86% of the total cover (70%) made up by Serenoa. Hardwood species of Lyonia, Myrica, and Ilex were also in the shrub category. Andropogon, Satureja and Lyonia dominated the 22 understory species.

Cypress-Prairie Plot.

The cypress-prairie plot is a monospecific stand of small diameter pondcypress (Taxodium ascendens). Average diameter was 12 cm and maximum heights were 6 m. Stem density and total basal area were much higher than the pine plots, due to the abundance of trees. The only shrubs in the plot were cypress saplings. The understory is mostly graminoid, dominated by Muhlenbergia filipes and Rhynchospora microcarpa. Dominant herbs were Erigeron quercifolius, Xyris jupicai, and Hyptis alata. A total of 26 understory species were recorded (Table 6).

Table 3. Results of vegetation inventory in Pine-Sabal-Serenoa plot. Units for total basal area are $cm^2/600m^2$ and number/$600m^2$ for density. See text for explanation of other terms.

Tree Species	Total Basal Area	Density	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Pinus elliotti var. *densa*	4587	7	29	71	64	64	199
Sabal palmetto	1903	4	17	29	36	36	101

Shrub Species	Measured % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Serenoa repens	32	75	56	40	96
Sabal palmetto	24	100	42	53	95
Myrica cerifera	0	12	0	7	7
Pinus elliotti var. *densa*	1	6	2	1	2

Table 3 (continued).

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Muhlenbergia filipes	5.9	63	28	17	45
Dichanthelium dichotomum	3.8	33	18	13	31
Eupatorium mikanioides	1.2	33	6	13	19
Pinus elliottii var. densa	2.3	15	11	4	15
Schizachryium rhizomatum	1.1	12	5	3	8
Pterocaulon pycnostachyum	0.7	15	3	4	7
Cladium jamaicense	0.5	18	2	5	7
Smilax bona-nox	0.6	10	3	3	6
Myrica cerifera	0.4	15	2	4	6
Aletris lutea	0.6	13	3	3	6
Schinus terebinthifolius	0.3	10	1	3	4
Galactia sp.	0.3	10	1	3	4
Unknown	0.3	10	1	3	4
Cassytha filiformis	0.3	10	1	3	4
Chloris glauca	0.4	5	2	1	3
Rudbeckia hirta var. floridana	0.2	8	1	2	3
Flaveria linearis	0.4	5	2	1	3
Ipomea sagittata	0.2	8	1	2	3
Pluchea rosea	0.4	3	2	1	3
Polygala baldwinii	2.5	3	1	1	2
Sabatia grandiflora	0.1	3	1	1	2
Rhyncospora divergens	0.1	5	1	1	2
Stenandrium dulce var. floridana	0.1	3	1	1	2
Persea borbonia	0.1	3	1	1	2
Andropogon virginicus	0.1	3	1	1	2
Cassia sp.	0.1	5	1	1	2
Ludwigia sp.	0.1	3	1	1	2
Solidago sp.	0.1	3	1	1	2

Table 4. Results of vegetation inventory at Pine-prairie plot. Units for basal area are $cm^2/600\ m^2$ and number/$600m^2$ for density.

Tree Species	Total Basal Area	Density	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Pinus elliottii var. densa	3542	4	29	100	100	100	300

Shrub Species	Measured % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Sabal palmetto	8.8	69	61	46	107
Pinus elliottii var. densa	2.7	56	19	37	56
Serenoa repens	2.9	25	20	17	37

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Schizachyrium rhizomatum	8.9	68	21	11	32
Pinus elliotti var. densa	8.4	40	20	7	27
Rhynchospora divergens	4.3	40	10	7	17
Muhlenbergia filipes	3.4	50	8	8	16
Flaveria linearis	1.3	53	3	9	12
Hypericum brachyphyllum	2.8	28	7	5	12
Centella asiatica	1.2	48	3	8	11
Cladium jamaicense	1.3	25	3	4	7
Ludwigia sp.	0.7	28	2	5	7
Chloris glauca	1.4	10	3	2	5
Samolus ebracteatus	0.8	18	2	3	5
Hyptis alata	0.9	20	2	3	5

Table 4 (continued).

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Pluchea rosea	0.6	23	1	4	5
Linum medium var. texanum	0.4	15	1	3	4
Stenandrium dulce var. floridana	0.4	18	1	3	4
Andropogon sp.	1.1	8	3	1	4
Juncus megacephalus	0.3	13	1	2	3
Myrica cerifera	0.6	13	1	2	3
Heliotropium polyphyllum	0.3	13	1	2	3
Dichromena colorata	0.3	13	1	2	3
Eryngium baldwinii	0.6	10	1	2	3
Proserpinaca palustris var. palustris	0.4	5	1	1	2
Ipomea sagittata	0.1	5	0	1	1
Borreria terminalis	0.1	3	0	1	1
Cassytha filiformis	0.2	8	0	1	1
Aletris lutea	0.2	8	0	1	1
Lobelia glandulosa	0.1	5	0	1	1
Coreopsis laevenworthii	0.1	3	0	1	1
Polygola grandiflora	0.1	5	0	1	1
Xyris sp.	0.1	5	0	1	1
Sabatia grandiflora	0.1	3	0	1	1
Dichanthelium sp.	0.1	5	0	1	1

Table 5. Results of inventory at Pine-Serenoa plot. Units for basal area are $cm^2/600m^2$ and $number/600m^2$ for density

Tree Species	Total Basal Area	Density	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Pinus elliotti var. densa	3330	5	21	63	67	62	192
Sabal palmetto	1956	3	13	37	33	38	108

Shrub Species	Measured % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Serenoa repens	60	100	87	51	138
Myrica cerifera	3	38	4	19	23
Lyonia fruticosa	1	19	1	10	11
Sabal palmetto	2	13	3	7	10
Baccharis glomeruliflora	1	13	1	7	8
Pinus elliottii var. densa	1	6	1	3	4
Ilex cassine	1	6	1	3	4

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Andropogon virginicus	3.4	30	20	13	33
Satureja rigida	3.0	13	18	5	23
Lyonia fruticosa	1.8	23	11	10	21
Pinus elliottii var. densa	1.1	20	6	9	15
Serenoa repens	1.7	8	10	3	13
Toxicodendron radicans	0.8	18	5	8	13
Dichanthelium dichotomum	0.7	15	4	7	11

Table 5 (continued)

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Smilax bona-nox	0.6	8	4	3	7
Dichanthelium sp.	0.3	13	2	5	7
Hyptis alata	0.3	13	2	5	7
Baccharis glomeruliflora	0.3	13	2	5	7
Muhlenbergia filipes	0.4	5	2	2	4
Solidago stricta	0.2	8	1	3	4
Pluchea rosea	0.4	5	2	2	4
Unknown	0.1	3	1	2	3
Crinum americanum	0.4	10	2	1	3
Smilax auriculata	0.1	3	1	2	3
Eupatorium recurvans	0.1	5	1	2	3
Vaccinium myrsinites	0.4	3	2	1	3
Cladium jamaicense	0.1	5	1	2	3
Hypericum cistifolium	0.1	3	1	1	2
Lobelia glandulosa	0.1	3	1	1	2

Table 6. Results of inventory at Cypress-prairie plot. Units for basal area are $cm^2/600m^2$ and $number/600m^2$ for density

Tree Species	Total Basal Area	Density	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Taxodium ascendens	9832	82	100	100	100	100	300

Shrub Species	Measured % Cover	Frequency	Relative Cover	Importance Frequency	Value
Taxodium ascendens	0.01	1	100	100	200

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Muhlenbergia filipes	24.9	100	35	20	55
Erigeron quercifolia	1.9	63	10	13	23
Rhynchospora microcarpa	2.2	50	9	10	19
Xyris jupicai	0.9	38	6	8	14
Hyptis alata	1.4	33	6	7	13
Ludwigia simpsonii	1.1	30	5	6	11
Schizachyrium rhizomatum	2.4	15	6	3	9
Pluchea rosea	0.6	23	1	5	6
Setaria geniculata	0.6	23	1	5	6

Table 6 (continued)

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Rhynchospora divergens	1.3	18	1	4	5
Dichanthelium sp.	0.4	18	1	4	5
Cynoctonum mitreola	0.4	15	1	3	4
Cladium jamaicense	0.4	15	1	3	4
Myrica cerifera	0.3	10	1	2	3
Crinum americanum	0.2	8	1	2	2
Taxodium ascendens	0.2	8	1	2	2
Diodia virginica	0.1	3	1	1	1
Ipomoea sagittata	0.1	5	1	1	1
Heliotropium polyphyllum	0.1	5	1	1	1
Cyperus globulosus	0.1	3	1	1	1
Sabatia grandiflora	0.1	3	1	1	1
Dichromena colorata	0.1	3	1	1	1
Juncus megacephalus	0.1	3	1	1	1
Cyperus sp.	0.1	3	1	1	1
Proserpinaca palustris var. palustris	0.1	3	1	1	1
Persea palustris	0.1	3	1	1	1

Cypress-Mixed Swamp Forest Plot.

The highest tree diversity was found in this plot with nine species. Stem density (131/600 m^2) and total basal areas (3.9 m^2/600 m^2) were greatest of any plot sampled (Table 7). Taxodium distichum comprised over half the total basal area, hence the name cypress-mixed swamp seems appropriate. The other tree species, mostly swamp hardwoods, were found in the shrub plot and as seedlings. These regenerating species included Fraxinus caroliniana, Annona glabra, Sabal palmetto, Myrica cerifera, Acer rubrum, Persea palustris, Myrsine floridana and Schinus terebinthifolius (Table 7). The dominant understory plant was swamp fern, Blechnum serrulatum. Eleven of the fourteen understory species were seedlings of overstory woody plants.

Muhlenbergia Prairie Plot.

This association is strictly a herbaceous community, and is dominated by muhly grass, Muhlenbergia filipes. Twenty-two species were found in this plot (Table 8), and the composition was similar to the understory of the pine-Sabal-Serenoa, pine-prairie and cypress-prairie plots.

Vegetation Mapping

The colors on the map enclosed indicate major vegetation groups and the patterns within the colors indicate variations within the groups. Pondcypress habitats are shown in yellow. Plain yellow color represents cypress areas with a graminoid understory, and a stippled yellow represents larger pondcypress trees with a hardwood shrub understory. The red color indicated potential baldcypress habitats, but the baldcypress may be present (no pattern) or may not (indicated by stipple) depending upon logging history and subsequent regeneration. The distinction between the pondcypress-mixed hardwood and the baldcypress-mixed swamp communities is vague when the two are adjacent, and therefore, the delineation between them is a subjective interpretation based on tree heights. Willow, popash and pondapple areas are considered to be successional cypress communities and included in one group (light green). Pondapple and popash trees can grow as monospecific stands and in association; therefore, all three types were included in one category. Pine habitats are colored green and differentiated by the understory composition. A Sabal-Serenoa understory is represented by areas of solid green, whereas, mixed grass understory is represented by the stippled areas. Sabal-Serenoa areas are included as pine habitats, since a history of logging and inadequate regeneration has eliminated the former pine overstory. Mixed hardwood associations are brown, with the types differentiated by species compositions based on field observations. The marsh communities (light blue) were grouped by substrate similarity, each having organic soils. The Muhlenbergia prairies (orange) are dominated by Muhlenbergia filipes, characterized by a sandy marl substrate and include areas which are locally dominated by short, sparse sawgrass or cordgrass. Open water areas are colored blue and may support submergent vegetation, but not emergent species. Stippled and cross-hatched white areas represent areas of exotic plants and disturbed areas, respectively.

Table 7. Results of inventory at Cypress-mixed swamp forest plot. Units for basal area are $cm^2/600m^2$ and number of stems/$600m^2$ for density.

Tree Species	Total Basal Area	Density	Frequency	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Taxodium distichum	21374	39	84	54	30	26	110
Persea palustris	4581	30	71	12	23	22	57
Fraxinus caroliniana	2143	31	67	5	24	20	49
Sabal palmetto	5896	10	34	15	8	10	33
Acer rubrum	3341	4	17	8	3	5	16
Ficus aurea	688	5	21	2	4	6	12
Ilex cassine	402	5	13	1	4	4	9
Annona glabra	190	4	17	1	3	5	9

Shrub Species	Measured % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Chrysobalanus icaco	5.4	75	22	14	36
Ficus aurea	3.7	75	15	14	29
Sabal palmetto	4.3	50	17	10	27
Fraxinus caroliniana	3.4	50	14	10	24
Persea palustris	1.7	75	7	14	21
Ilex cassine	1.4	75	6	14	20
Toxicodendron radicans	1.7	50	7	10	17
Taxodium distichum	1.6	25	7	5	12
Annona glabra	0.7	25	3	5	8
Psychotria nervosa	0.5	25	2	5	7

Table 7 (continued)

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Blechnum serrulatum	20.9	85	74	47	121
Persea palustris	1.0	28	4	16	20
Sabal palmetto	1.5	10	5	6	11
Polypodium phyllitidis	2.0	5	7	3	10
Toxicodendron radicans	0.3	10	1	6	7
Acer rubrum	0.3	10	1	6	7
Schinus terebinthifolius	0.3	10	1	6	7
Fraxinus caroliniana	0.4	5	1	3	4
Nephrolepis exaltata	0.4	5	1	3	4
Myrsine floridana	0.4	2.5	1	1	2
Chrysobalanus icaco	0.4	2.5	1	1	2
Cephalanthus occidentalis	0.1	3	1	1	1
Annona glabra	0.1	3	1	1	1
Myrica cerifera	0.1	2.5	1	1	1

Table 8. Results of inventory at Muhlenbergia prairie plot.

No trees
No Shrubs

Understory Species	Average % Cover	Frequency	Relative Cover	Relative Frequency	Importance Value
Muhlenbergia filipes	67.5	1.00	74	21	95
Cladium jamaicense	4.3	.45	4	9	13
Centella asiatica	2.6	.55	2	11	13
Rhynchospora microcarpa	4.4	.40	4	8	12
Euphorbia polyphylla	1.7	.43	1	9	10
Crinum americanum	2.1	.33	2	7	9
Cassytha filiformis	0.9	.23	1	5	6
Flaveria linearis	1.1	.18	1	4	5
Hymenocallis palmeri	0.4	.18	1	4	4
Eupatorium mikanioides	0.4	.15	1	3	3
Panicum virgatum var. cubense	0.7	.15	1	3	3
Myrica cerifera	0.4	.15	1	3	3
Rhynchospora inundata	0.9	.10	1	2	3
Dichromena colorata	1.4	.10	1	2	3
Vernonia blodgettii	0.2	.08	1	2	2
Rynchospora divergens	0.2	.08	1	2	2
Schizachyrium rhizomatum	0.5	.08	1	2	2
Lobelia glandulosa	0.3	.10	1	2	2
Elytraria caroliniensis	0.1	.05	1	1	1
Stenandrium dulce var. floridanum	0.1	.03	1	1	1
Pluchea rosea	0.1	.03	1	1	1
Proserpinaca palustris var. palustris	0.1	.03	1	1	1

Logging Histories

Evidence of logging was gathered from the aerial photographs used in mapping the plant communities and ground surveys conducted during field-truthing of the maps. Field observations of stumps and tram roads help to indicate logging histories. Most of the pine areas and large diameter cypress areas have been logged, in both cases prior to 1940 (as seen on aerial photographs taken in 1940). The cypress-mixed swamp forest around the Turner River is devoid of overstory cypress, but regeneration has occurred. Most of the logged pine areas have also returned to pine dominance, but some small stands still show no signs of pine regeneration.

Aquatic Vegetation Maps

The deeper, central areas of the river in all four aquatic vegetation plots (Figures 3-6) were dominated by associations of species of *Najas*, *Ceratophyllum*, *Utricularia* and the exotic *Hydrilla*. Emergent plants of the genera, *Zizaniopsis*, *Crinum*, *Pontedaria*, *Scirpus* and *Panicum* were found in the shallow regions along the banks. Free-floating *Pistia* was found in open areas subjected to full sunlight and out of the main flow.

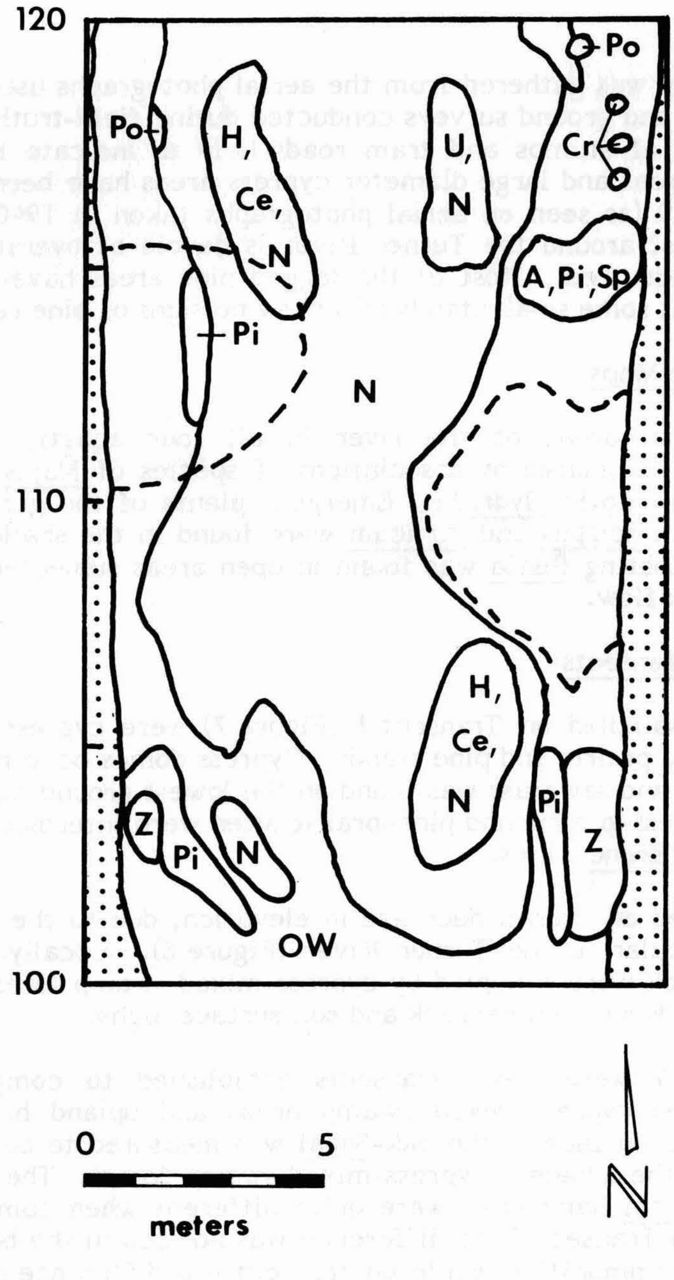
Elevations Along Transects

The communities sampled on Transect 1 (Figure 7) were cypress-prairie, cypress dome, *Muhlenbergia* prairie and pine stands. Cypress domes occurred on the lowest bedrock elevations and sawgrass was found on the lowest ground surface elevations. Muhly prairie, cypress-prairie and pine-prairie sites were intermediate in elevation to the higher pine-*Serenoa* sites.

Transect 2 exhibited an overall decrease in elevation, due to the great length and direction perpendicular to the Turner River (Figure 8). Locally, the lowest soil surfaces and bedrock were occupied by cypress-mixed swamp forest. Pine-*Serenoa* and mixed hardwoods were on bedrock and soil surface highs.

Transects 3 and 4 were short transects established to compare elevational differences between cypress-mixed swamp areas and upland hardwood habitats (Figure 9). The soil surface in the oak-*Sabal* was measured to be 10-15 cm above the soil surface of the adjacent cypress-mixed swamp forest. The bedrock profiles of the two Oak-*Sabal* hammocks were quite different when compared to nearby swamp forests. On Transect 3, no difference was noticed in the bedrock elevation between the two communities, while on transect 4 a difference of over 3 meters was measured. The highest community on transect 4 was an oak-*Serenoa* association, with a soil elevation 1.2 m above the cypress mixed swamp.

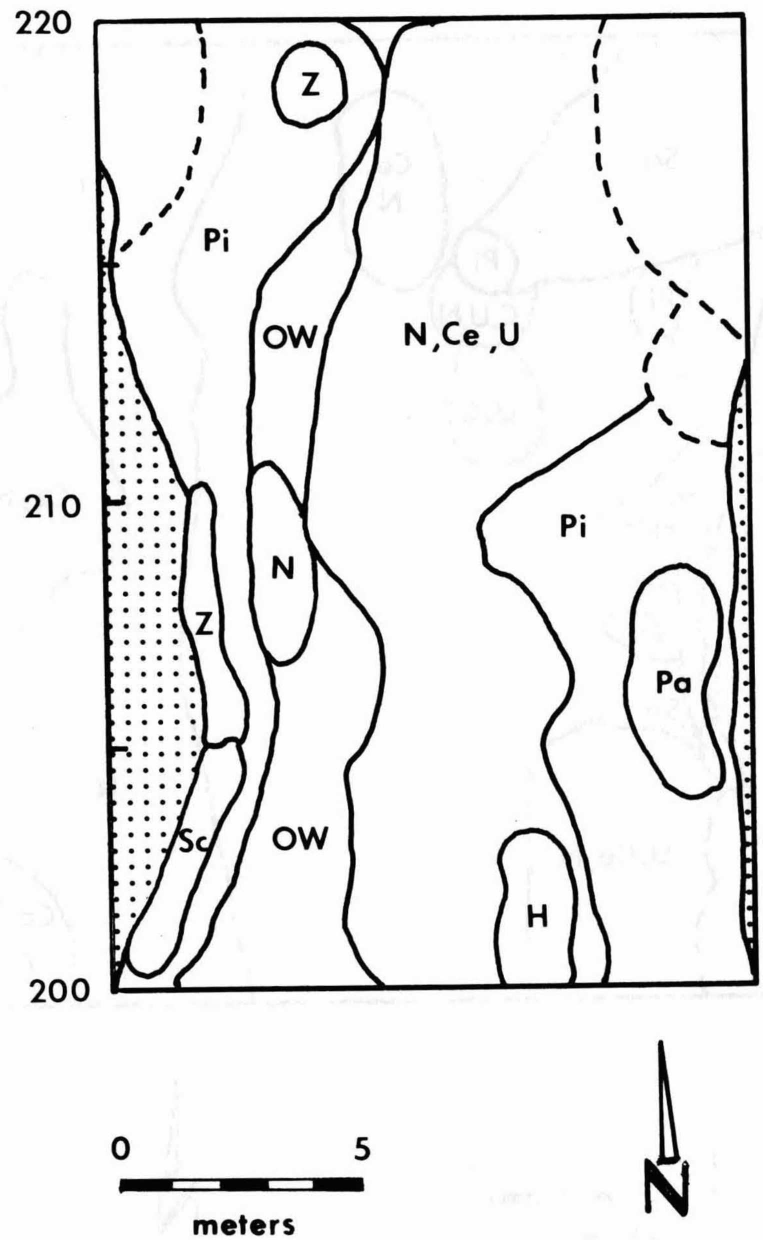
Transect 5 bisected a cypress-mixed swamp forest (Figure 10). Good correlation between ground and bedrock elevations was noticed on this transect, i.e. when the bedrock was lower the soil surface was lower and vice-versa. Cypress domes and popash slough were on the lowest soil elevations. Mixed hardwood species were found on bedrock highs, with pines at slightly lower elevations. Little difference was noted in the ground surface elevations of the cypress-mixed swamp forest and the cypress-prairie.



Symbols on Map

A - Azolla caroliniana
Ce - Ceratophyllum demersum
Cr - Crinum americanum
H - Hydrilla verticillata
N - Najas guadalupensis
Pa - Panicum hemitomon
Pi - Pistia stratiotes
Po - Pontederia lanceolata
Sa - Salix caroliniana
Sc - Scirpus validus
Sp - Spirodela polyrhiza
U - Utricularia inflata
Z - Zizaniopsis miliacea
OW Open Water
--- Overhanging trees
Terrestrial vegetation

Figure 3. Aquatic vegetation for segment of Turner River 100 to 120 meters north of Bridge 83. See Figure 2 for location of plot.



Symbols on Map

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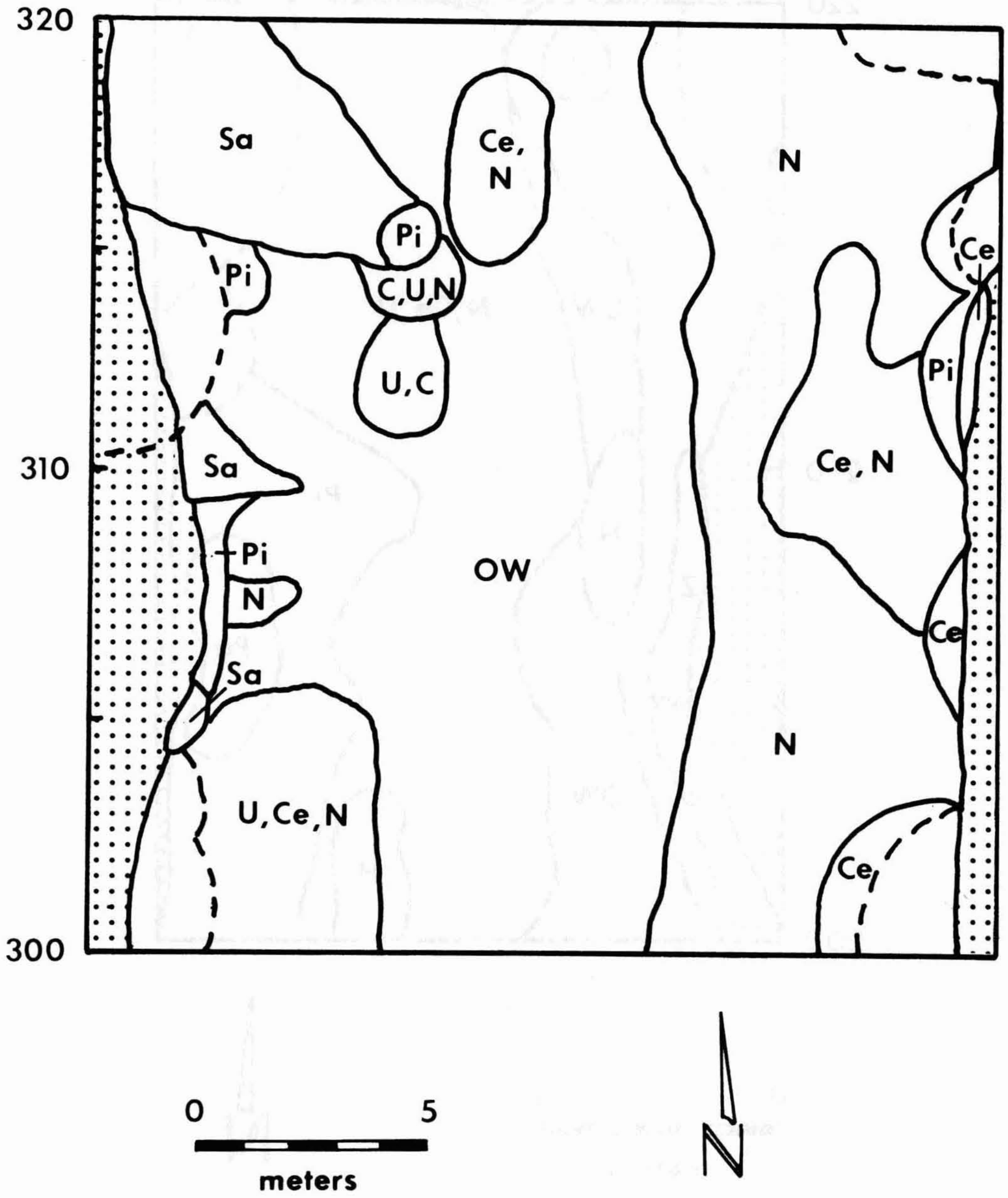
Sa - Salix caroliniana
Sc - Scirpus validus
Sp - Spirodela polyrhiza
U - Utricularia inflata
Z - Zizaniopsis miliacea
OW Open Water
--- Overhanging trees
Terrestrial vegetation

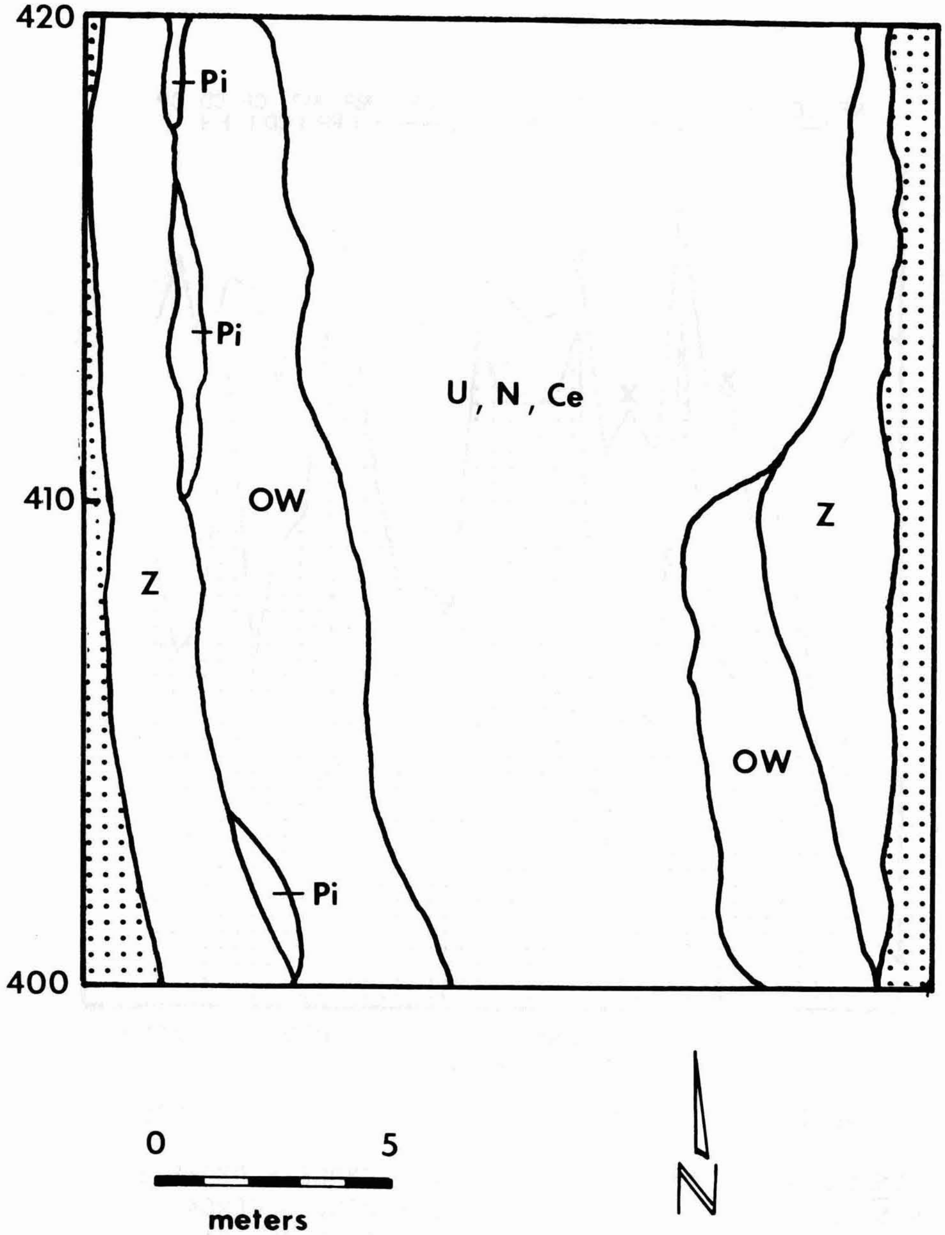
Figure 4. Aquatic vegetation for segment of Turner River 200 to 220 meters north of Bridge 83. See Figure 2 for location of plot.



Symbols on Map

A - Azolla caroliniana
Ce - Ceratophyllum demersum
Cr - Crinum americanum
H - Hydrilla verticillata
N - Najas guadalupensis
Pa - Panicum hemitomon
Pi - Pistia stratiotes
Po - Pontederia lanceolata
Sa - Salix caroliniana
Sc - Scirpus validus
Sp - Spirodela polyrhiza
U - Utricularia inflata
Z - Zizaniopsis miliacea
OW Open Water
--- Overhanging trees
Terrestrial vegetation

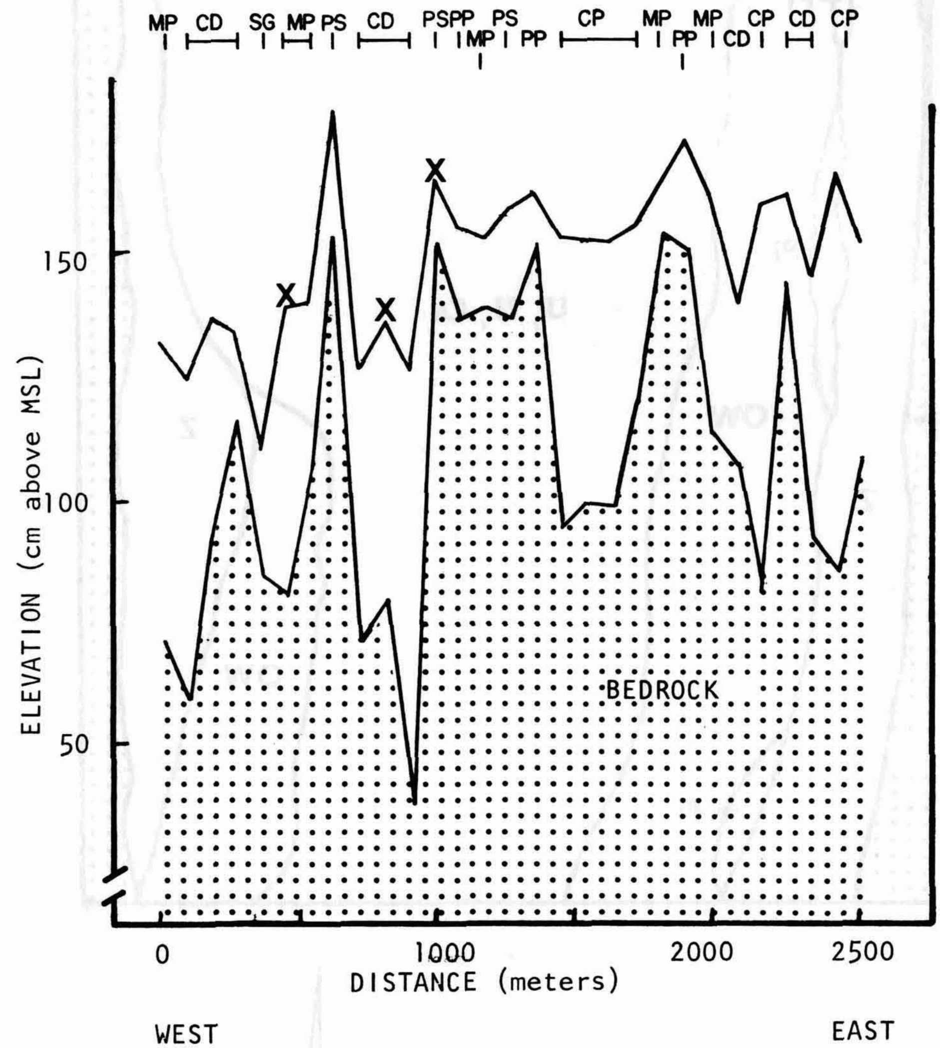
Figure 5. Aquatic vegetation for segment of Turner River 300 to 320 meters north of Bridge 83. See Figure 2 for location of plot.



Symbols on Map

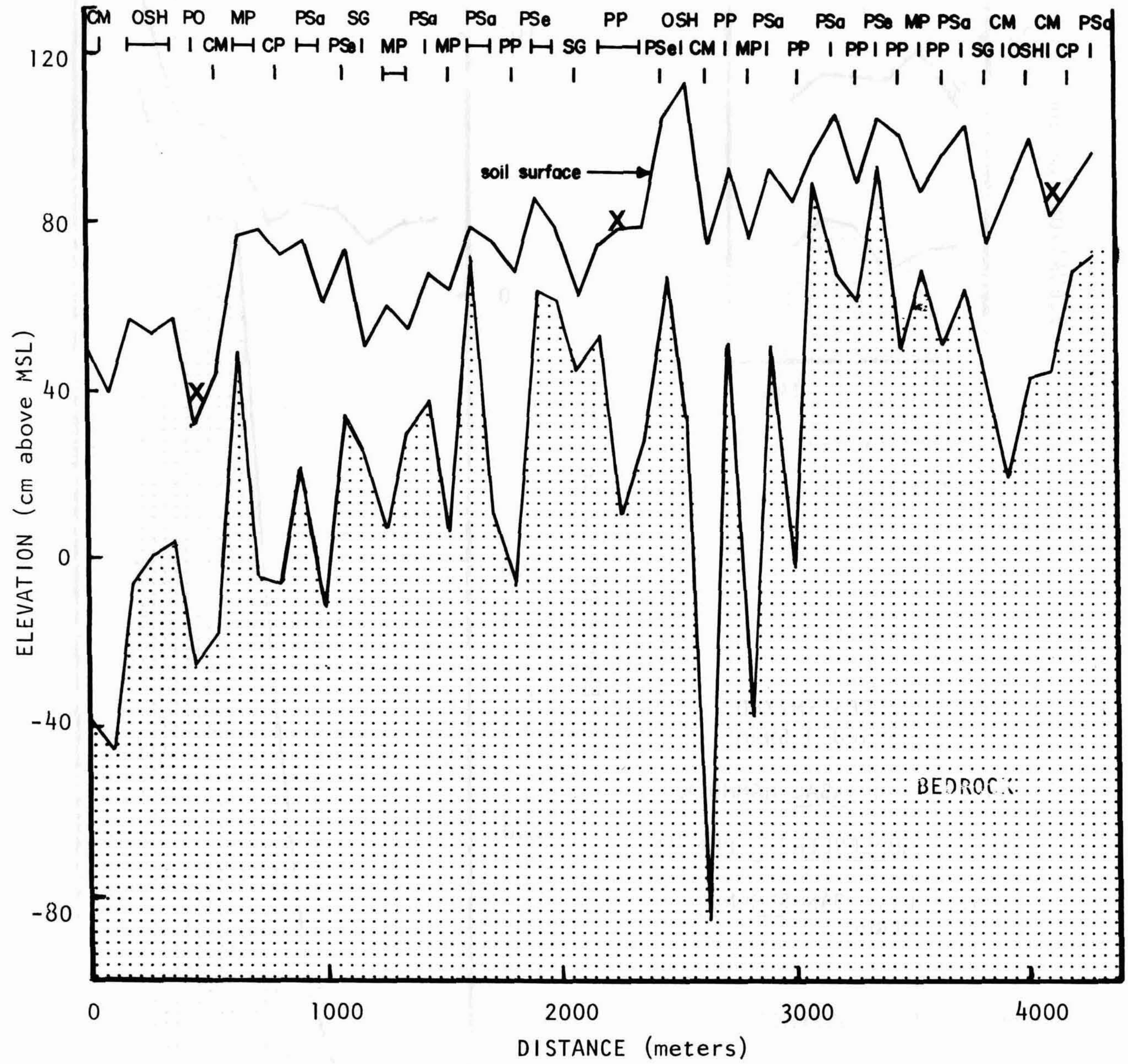
A - Azolla caroliniana
Ce - Ceratophyllum demersum
Cr - Crinum americanum
H - Hydrilla verticillata
N - Najas guadalupensis
Pa - Panicum hemitomon
Pi - Pistia stratiotes
Po - Pontederia lanceolata
Sa - Salix caroliniana
Sc - Scirpus validus
Sp - Spirodela polyrhiza
U - Utricularia inflata
Z - Zizaniopsis miliacea
OW Open Water
--- Overhanging trees
Terrestrial vegetation

Figure 6. Aquatic vegetation for segment of Turner River 400 to 420 meters north of Bridge 83. See Figure 2 for location of plot.



MP - MUHLENBERGIA PRAIRIE
CD - CYPRESS DOME
SG - SAWGRASS
CP - CYPRESS PRAIRIE
PS - PINE SERENOA
PP - PINE PRAIRIE
X - WATER WELL

Figure 7. Elevational profile of transect # 1, showing plant community, associated soil surface elevation and average bedrock elevation at each surveyed benchmark.



CM -CYPRESS MIXED HARDWOOD SWAMP
CP -CYPRESS PRAIRIE
MP-MUHLENBERGIA PRAIRIE
OSH -OAK-SABAL HAMMOCK
PP -PINE PRAIRIE
PSa-PINE-SABAL
PSe -PINE-SERENOA
PO -PONDAPPLE-POPASH
SG-SAWGRASS

X - WATER WELL

Figure 8. Elevational profile of transect # 2, showing plant community, associated soil surface elevation and average bedrock elevation at each surveyed benchmark.

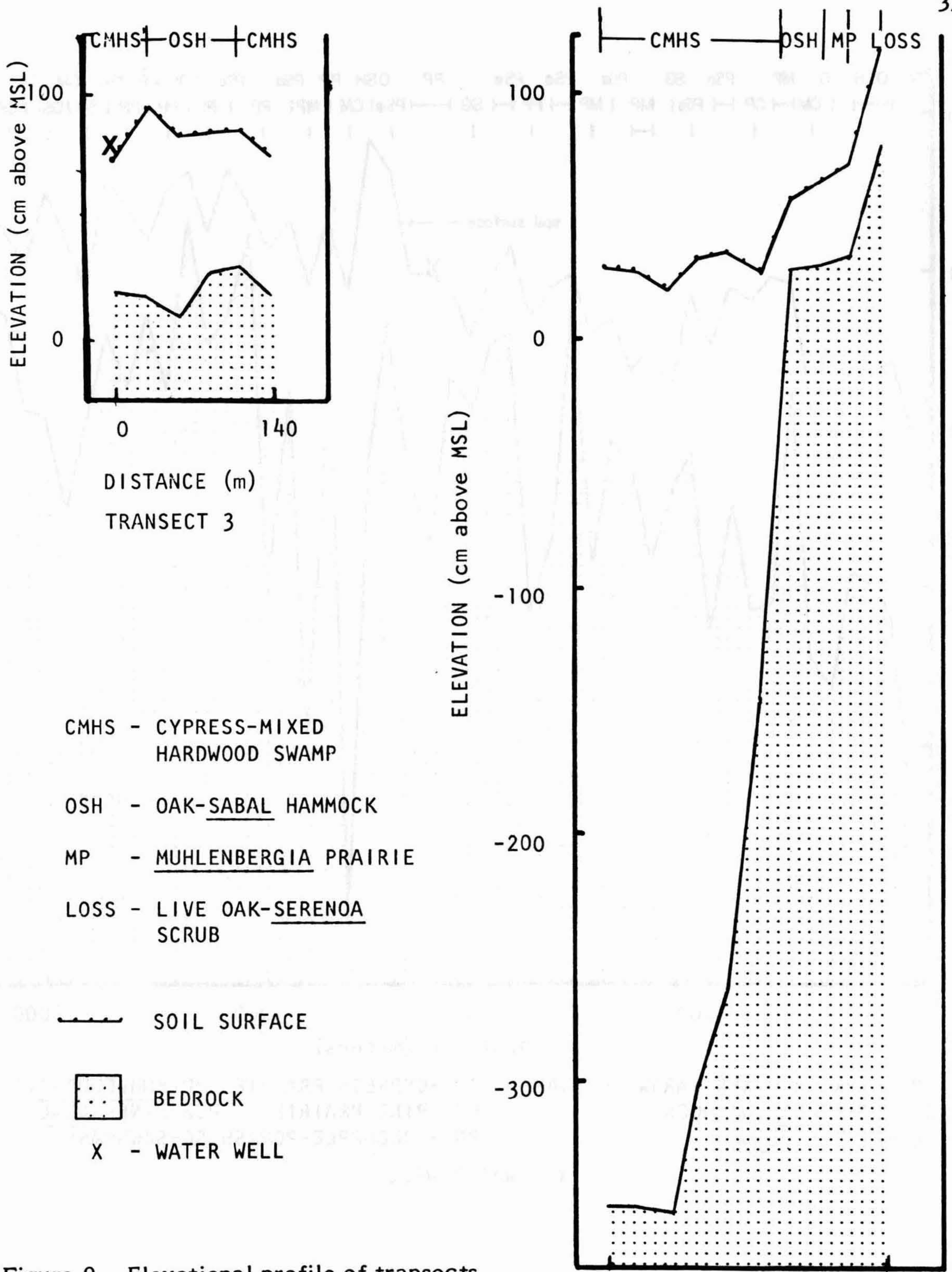
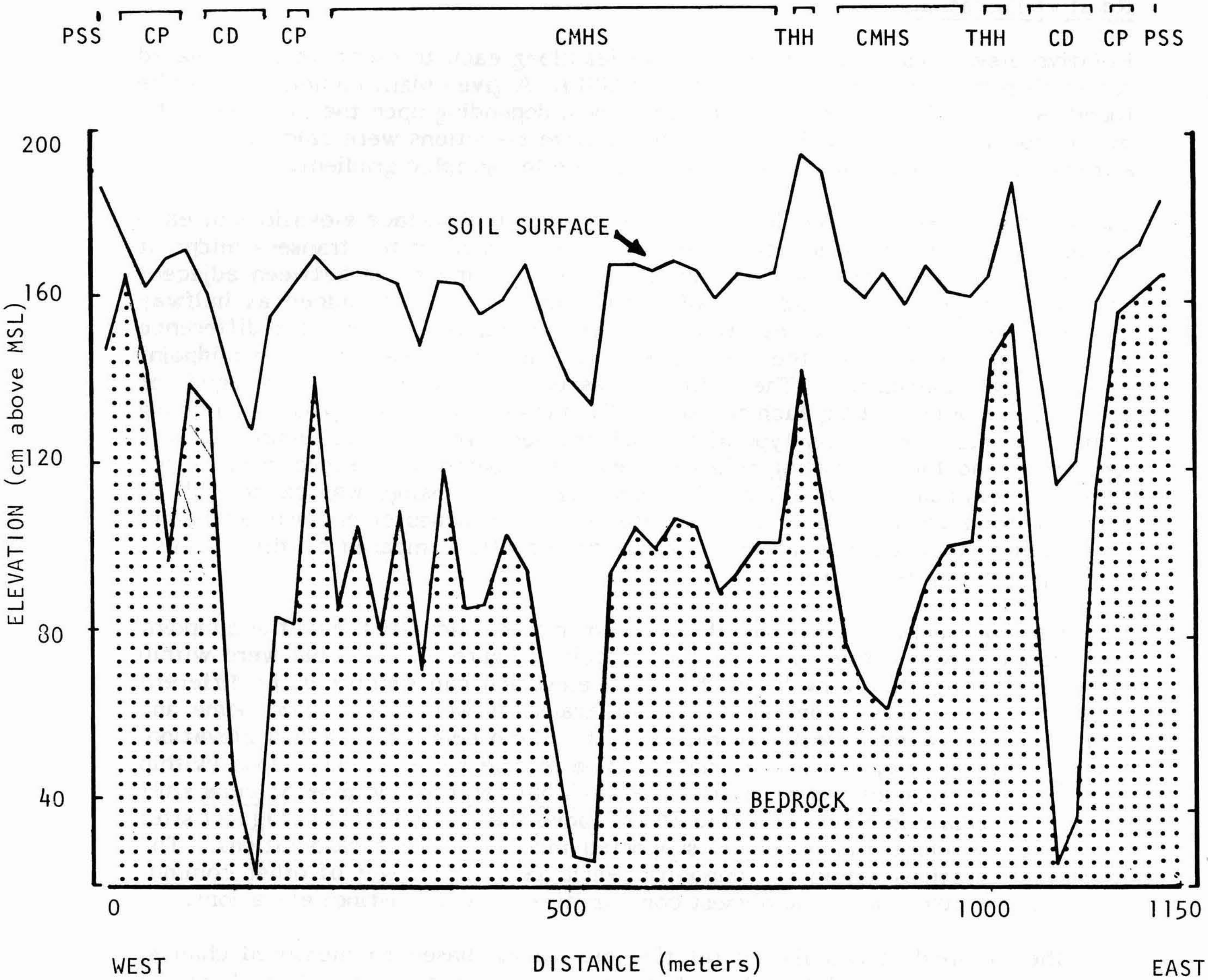


Figure 9. Elevational profile of transects # 3 & 4, showing plant community, associated soil surface elevation and average bedrock elevation at each surveyed benchmark.



PSS - PINE-SABAL-SERENOA
CP - CYPRESS PRAIRIE
CD - CYPRESS DOME
CMHS - CYPRESS MIXED HARDWOOD SWAMP
THH - TROPICAL HARDWOOD HAMMOCK

Figure 10. Elevational profile of transect # 5, showing plant community, associated soil surface elevation and average bedrock elevation at each surveyed benchmark.

Relative Elevations

Relative elevations of the plant communities along each transect were calculated rather than the absolute elevation (above MSL). A given plant community may be found over a wide range of absolute elevations, depending upon the location in the overall topographic slope. Therefore, the relative elevations were calculated along a transect which was placed perpendicular to the topographic gradient.

Two methods were used to calculate the relative ground surface elevations of each community along each transect. One method was based on the transect midpoint elevation and the other based on elevational changes measured between adjacent community types. The midpoint of each transect was determined as halfway between the lowest and highest elevations on the transect. Then, the difference between the elevation of the soil surface, at each benchmark and the midpoint elevation was calculated. These differences or delta values were averaged for similar communities along each transect. The mean delta values, plus high and low values, for each community type along each transect are shown in Figure 11. The second method for calculating relative elevation is based on the measured change from one community to another. The mean elevation change was calculated for adjacent communities. But in some cases only one measurement was available. Communities that are not adjacent cannot be directly compared by this method, but may be compared indirectly.

The mean soil surface elevations of the communities, calculated from the midpoint elevation, all were within 50 cm of the midpoint (Figure 11), and most were within 20 cm indicating that very little change in elevation can support quite different vegetation. The lowest communities on all transects were the cypress dome and cypress-mixed swamp forests, averaging 10 to 20 cm below the median elevation. Muhlenbergia prairie, cypress-prairie and pine prairie were all very close (within 10 cm) to the midpoint and each other. Pine-Sabal-Serenoa and pine-Serenoa sites were intermediate in elevation (10 to 30 cm above the midpoint). The highest sites (30 to 50 cm above the midpoint) supported mixed hardwood associations. The ranges of elevations within a community overlapped with ranges of other communities and only the lowest and highest communities occupied distinct elevations.

The other method of calculating relative elevations, based on measured change, showed similar trends. Although each community was not compared to all of the rest, all were compared to the cypress-prairie. The median elevation of cypress prairie was then set to equal zero, and the rest graphed in relation to cypress-prairie (Figure 12). The variation within each community again was large, but elevational differences appear to be more distinct than those calculated in relation to the median of each transect. The range in mean elevation values for the other communities was from -20 to +40 cm from the mean cypress-prairie elevation. The values seem to be consistent, in that relative elevations of each community fell within the variances measured within each community. For example, the average elevational difference between the pine-Sabal-Serenoa sites and the cypress dome sites places the cypress dome at a relative elevation within the range of elevations measured within cypress domes (Figure 12).

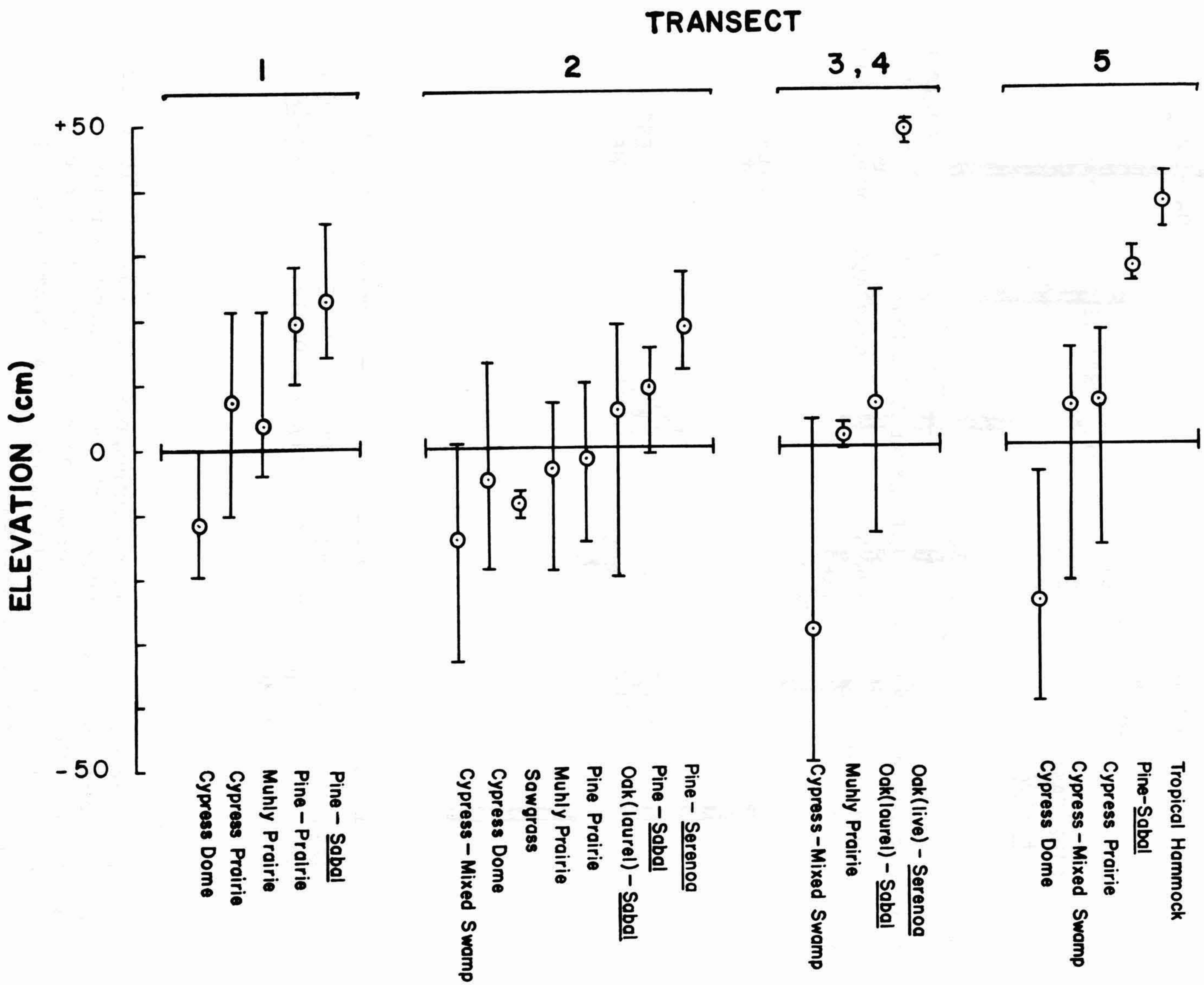


Figure 11. Relative elevations of plant communities along each transect, based on the midpoint of each transect equal to zero. Dots represent mean difference from midpoint, bars represent a range of values.

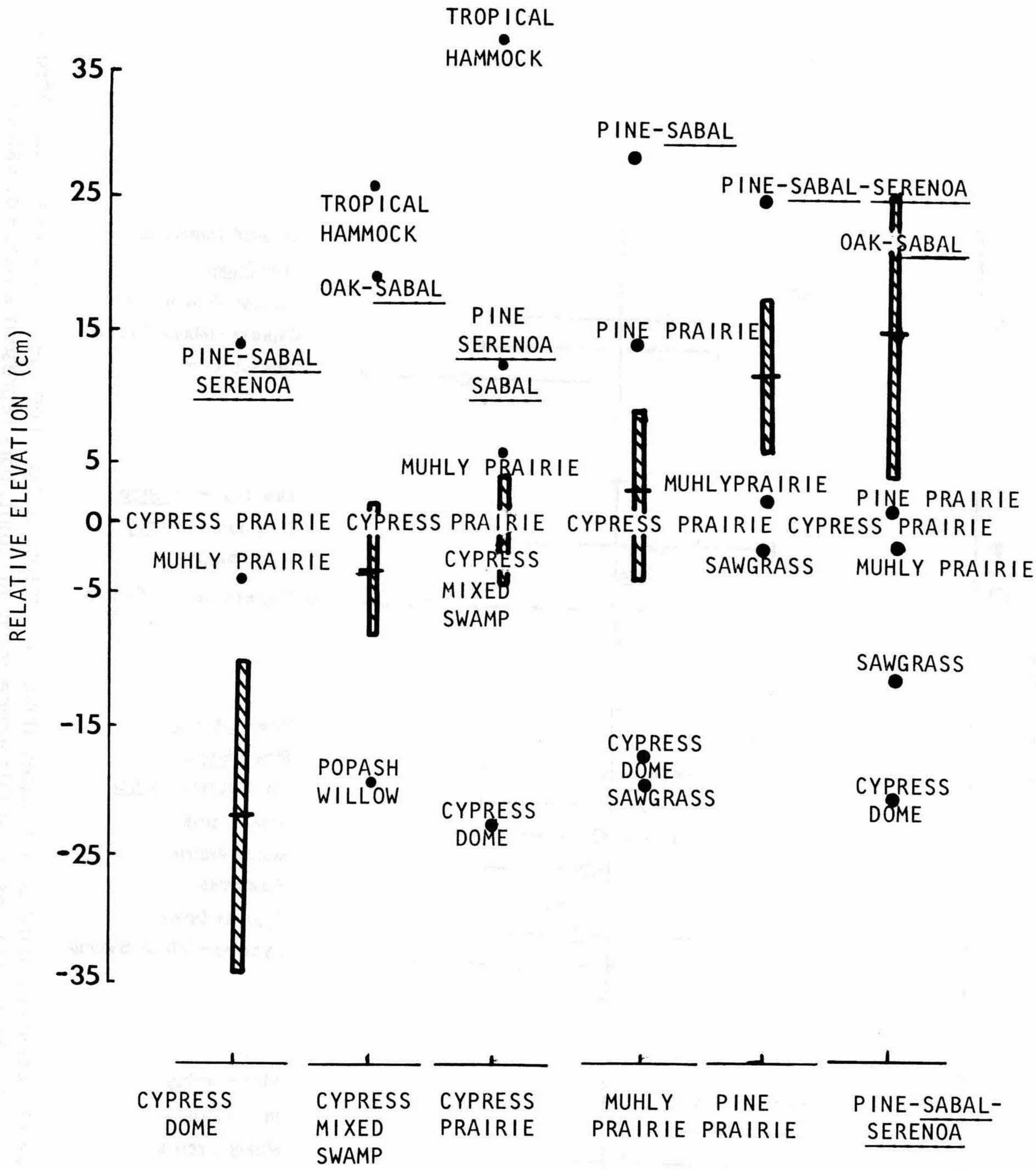


Figure 12. Relative elevation of plant communities, based on measured differences. Bars represent measured changes within each commnity listed on bottom row. Dots represent average measured change from mean intra-community elevation. All values were normalized by setting cypress prairie in each category equal to zero.

The ascending order of community elevations was similar in both methods. Cypress domes, cypress-mixed swamps, pop-ash sloughs and sawgrass were found on the lowest sites. Cypress-prairies were at the next highest sites, then Muhly prairie and pine-prairies. Pine-Sabal-Serenoa sites were slightly lower than the mixed hardwood associations, which were found on the highest sites.

Hydroperiods

Hydroperiods were calculated and used as a characteristic of the hydrologic pattern of the plant communities. The first step in calculating hydroperiods was to generate regression equations between the water level in each test well and the water level at Bridge 84 (the bridge at U.S. 41 and the Turner River Canal). The regression equations and correlation coefficients are given in Table 9 (Sikkema and Rosendahl, pers. comm.) Using the regression equation, a critical water level was predicted at Bridge 84 that corresponded to a condition at the test well when water level equaled the ground level. The number of days that the stage at Bridge 84 equaled or exceeded the critical value was tallied for water years 1964 to 1978. These years constitute the available daily water level records for Bridge 84 (Sikkema, pers. comm.) Only correlations with regression coefficients greater than $r^2 = 0.80$ were used. The calculated hydroperiods should be viewed as preliminary; further data collection would increase the confidence of these correlations.

The mean hydroperiods and ranges are depicted in Figure 13. The means ranged from a low of 54 days/year in a low pine site (pine-prairie) to a high of 190 days/year in a pondapple/popash slough. The well at the second pine site was actually placed in the ecotone between the pine-prairie and a Muhlenbergia prairie and, as shown by the average value, probably reflects the conditions of the prairie. The ranges of the hydroperiods were broad, approximately 130 days in the pine area and 260 days in the pondapple/popash slough. Even though a wide range of hydroperiod values were calculated for each site, the data seemed to follow a fairly normal distribution about the mean (Figure 14).

The hydroperiod data met the assumptions of an analysis of variance and were analyzed using a one-way classification (Sokal and Rohlf, 1969). The ANOVA test resulted in a significant difference between all of the groups, indicating that hydroperiod differences exist among the plant communities. Further comparisions of the means were done using a least significant range test (Sokal and Rohlf, 1969). No significant difference ($p = 0.05$) was noticed among the pine, pine-prairie sites and the Muhlenbergia prairie. The mean hydroperiods in the cypress-mixed swamp areas were not significantly different from the Muhlenbergia prairie or the second pine-prairie well, nor the cypress slough. The cypress strand was not significantly different from the cypress-mixed swamp, but was significantly different from the pondapple-popash slough. Mean hydroperiods in the pondapple-popash slough were different from all the other sites.

Soil Depths

The mean, standard deviations, standard errors and ranges of soil depths beneath the plant communities along the transects are shown in Figure 15. Soil types are also given. Some types are mixtures of two particle types, but no measurements were made to quantify the composition. Shallow sands were generally found beneath the pine areas, but bedrock was exposed in some areas. Soil depths averaged 30 cm in all of the pine types and ranged from 0 to 114 cm deep. Soils in

Table 9. Correlation equations between water wells in various vegetation communities and Bridge 84 used in hydroperiod calculations (All equations and coefficients provided by Sikkema and Rosendahl, SFRC, unpubl. data)

Vegetation Type	Transect #	Equation	Correlation Coefficient
Pine forest	1	$y = .85x + 2.27$	0.91
Cypress strand	1	$y = 1.03x + 1.53$	0.92
Muhlenbergia prairie	1	$y = 0.90x + 1.78$	0.84
Cypress-mixed swamp	2	$y = 0.87x + 0.12$	0.97
Pine-prairie	2	$y = 0.62x + 0.25$	0.92
Pondapple-popash slough	2	$y = 0.62x - 0.20$	0.91
Cypress-mixed swamp	3	$y = .58x + 1.10$	0.81

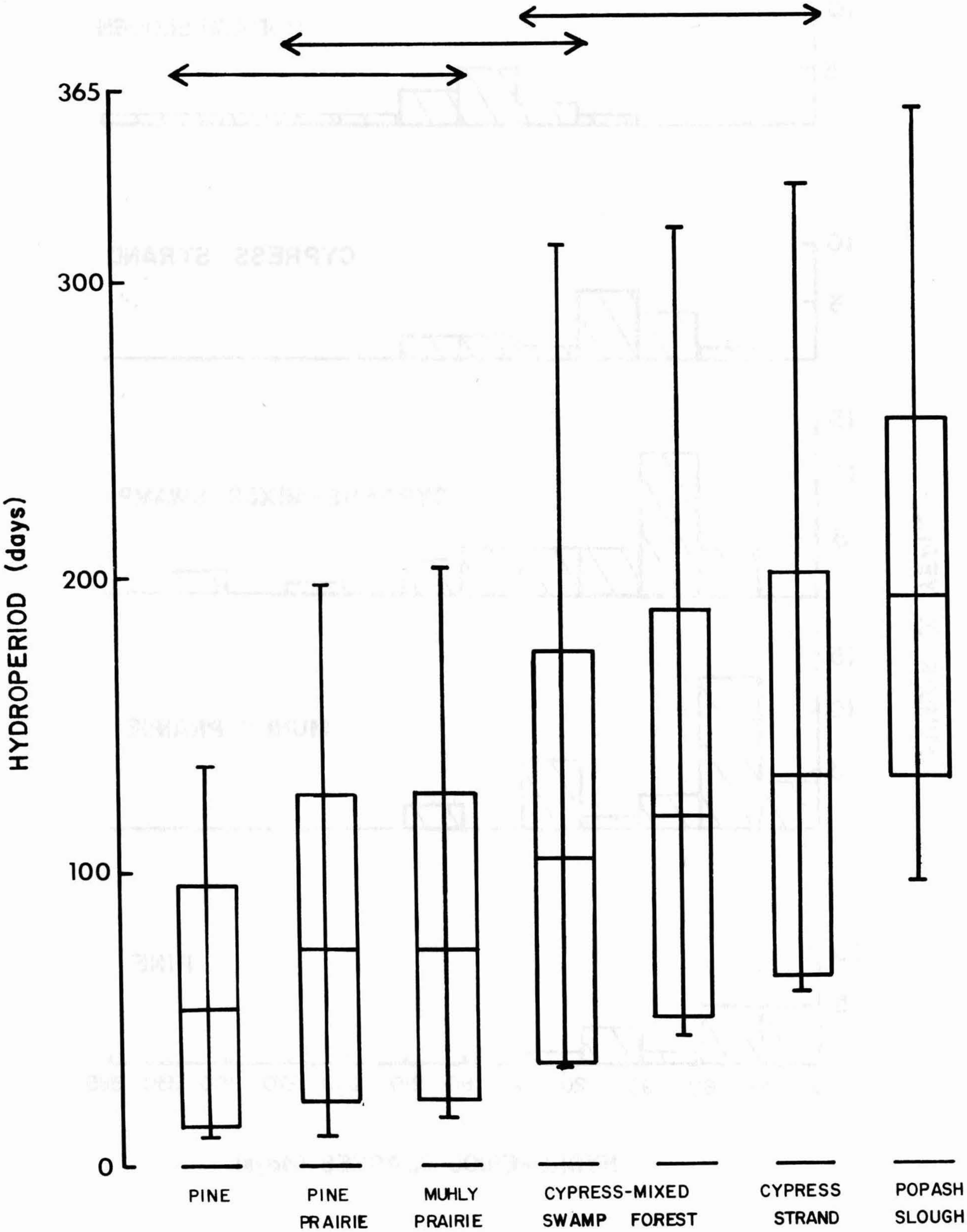


Figure 13. Hydroperiods for plant communities in the Turner River Area. Values are means, plus and minus one standard deviation, and range of values. Segments at top enclose communities with mean values not significantly different at P= 0.05.

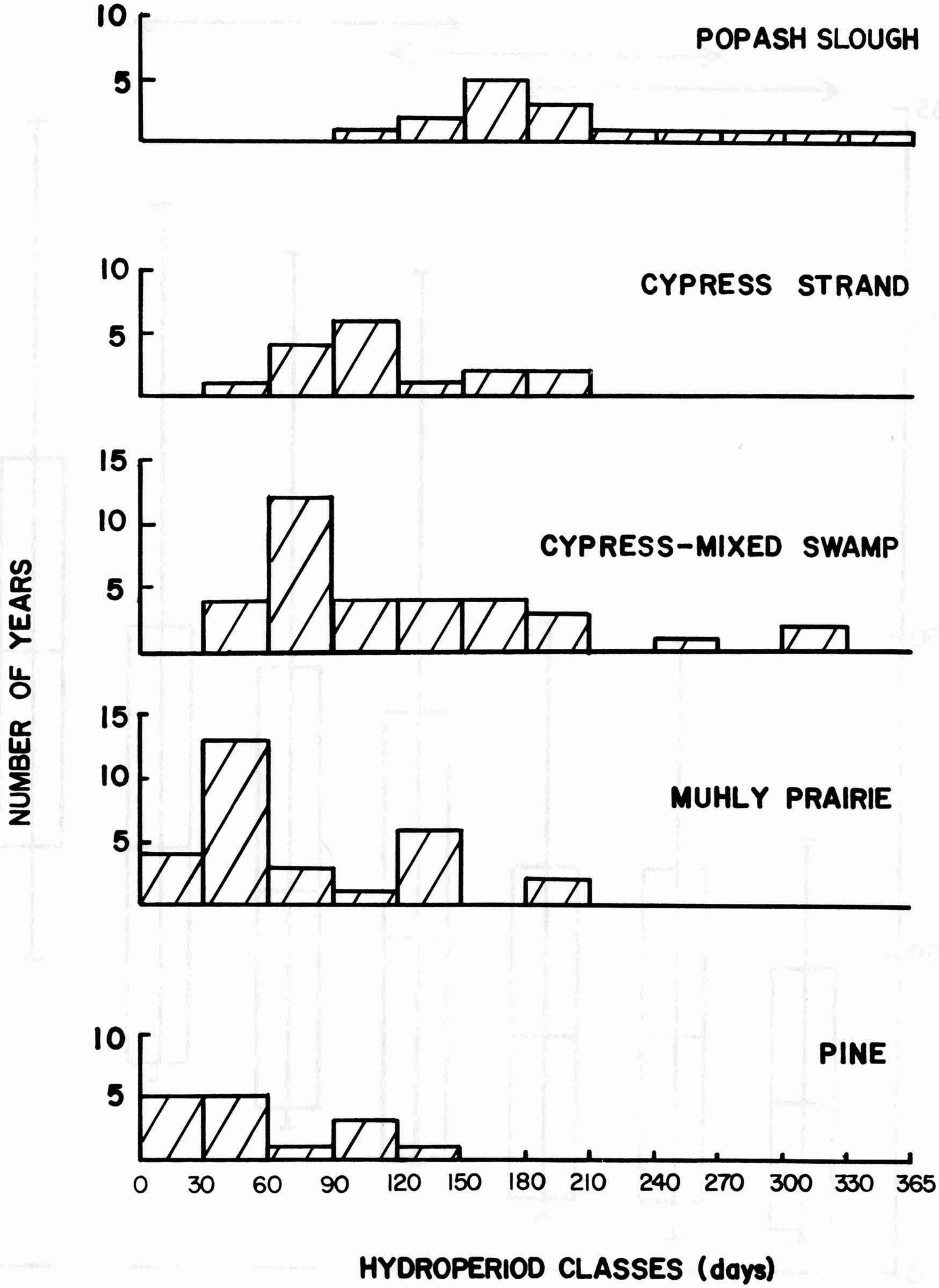


Figure 14. Distribution of hydroperiods in selected plant communities of Turner River Area for years 1962 through 1978.

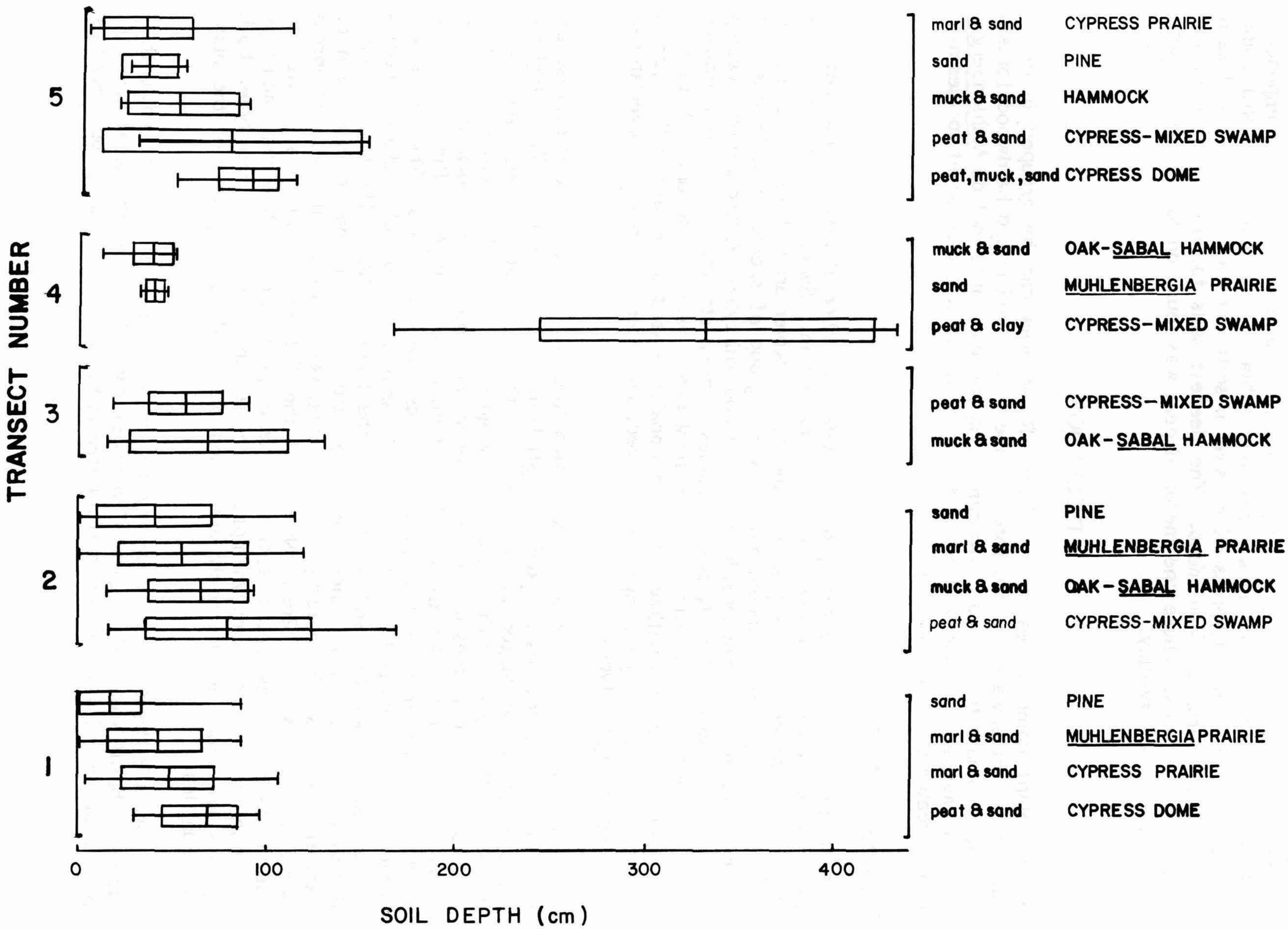


Figure 15. Soil depths and types beneath plant communities along each transect. Values are means, plus and minus one standard deviation and range of values.

the Muhlenbergia prairie averaged 45 cm deep, and were a mixture of sand and marl. The sandy marl found in the cypress prairies averaged 40 cm deep. The soils in the swamp forests and hammock areas both had pronounced organic component. Soils in the Oak-Sabal hammock areas were a black muck and sand mixture and averaged 56 cm deep. Cypress-mixed swamp soils were a brown peat and sand mixture and averaged 70 cm deep. The deepest soils found were beneath the cypress-mixed forest, where one meter of peat was found on top of two to three meters of white silty-clay.

DISCUSSION

Native plant communities in the Turner River area can be grouped in major categories. Freshwater swamp forests, pine forests and mixed hardwood forests are the dominant tree groups. Graminoid vegetation groups include Muhlenbergia prairies, sawgrass, marshes and mixed emergent marshes. Exotic plant species also form sizeable stands in the area.

Freshwater Swamp Forests

The freshwater swamp forest group includes all arboreal associations that are found on sites with extended periods of inundation. Swamp forests cover the largest percentage of ground area in the Turner River area of all the vegetation groups. Swamp forests encompass a diverse group of species associations, and occupy a variety of elevations, hydroperiods and soil types. Cypress-mixed swamp forests, mixed swamp forest, cypress domes, cypress strands, and cypress-prairies are the principal associations in the freshwater swamp category. Stands of pondapple, popash, and willow are successionally related to certain of the cypress forests. The cypress groupings are idealized, and a certain amount of overlap can be found among the types.

Cypress is the dominant tree in the swamp forests and two types of cypress are recognized: Baldcypress, *Taxodium distichum*, and pondcypress, *T. ascendens*. Baldcypress is the larger in diameter and the taller of the two types, with diameters (DBH) greater than 50 cm and heights up to 40m (Langdon, 1958). This species has linear needles which are flattened and opposite along horizontal stems. Pondcypress is a smaller tree, both in diameter and height. The needles on pondcypress are subulate and appressed to ascending branches. The distinction between the species is difficult to establish, as both sets of foliar characteristics can appear on one tree and the sizes of the trees overlap. The morphological differences of leaf and branch orientation are thought to be an expression of habitat conditions. The baldcypress is found on wetter sites, while the pondcypress occurs on slightly drier sites. Not all of the differences can be attributed to habitat conditions, as recent studies (Gunderson, unpub. data) show that each type retain intrinsic foliar shapes when planted in the habitat of the opposite type. Both species are found in the study areas and are used as indicators of the plant communities.

Baldcypress is the dominant overstory tree in cypress-mixed swamp forest, both in terms of basal area and height. Cypress comprised 55% of the total basal (65 m^2/ha, largest of any vegetation type) area in this plant community, but only 44%

of the total number of stems (2133 stems/ha). Assorted swamp hardwood species make up the remainder of the total basal area and density, and were observed to reach sub-canopy heights. Acer rubrum, (red maple), Fraxinus caroliniana (pop ash), Persea palustris (swamp bay), Ficus aurea (strangler fig), Salix caroliniana (willow), Annona glabra (pondapple), and Ilex cassine (dahoon holly) are common hardwoods of this association. Understory plants are sparse. The most abundant understory species found was swamp fern, Blechnum serrulatum. Other ferns and epiphytes, including orchids and bromeliads are common. Saplings or seedlings of the overstory hardwoods comprise the remainder of understory species. The understory species composition was quite dissimilar from the other vegetation types (Figure 16). No species of the cypress-mixed swamp forest was held in common with the Muhlenbergia prairie and only Ilex cassine and Myrica cerifera were found in both the cypress-mixed swamp and the pine forests. The large differences in species composition is shown in the Bray-Curtis (1957) ordination of all the inventory plots (Figure 16).

Cypress-mixed swamp forests are found in deep, wide and elongated bedrock depressions. In the deepest bedrock areas, a white silty-clay seems to have been deposited over the bedrock, and subsequently peat has accumulated over the clay or bedrock. The ground surface elevations in these swamp forests were not lowest measured, but the peat accumulations were deepest beneath this vegetation type.

The elevational and edaphic conditions should combine to create long hydroperiods in the cypress-mixed swamp forest, yet a mean hydroperiod of only 100 days/year was calculated. This is only 34% of the 290 day/year value reported by Duever et al. (1978) for a similar community at Corkscrew Swamp Sanctuary. This large discrepancy may be in part due to the technique of analysis, yet it appears highly unlikely that such errors could account for the entire difference. A shortened hydroperiod would be expected to result in successful regeneration of hardwood species and succession toward mixed swamp forest. Evidence that this successional trend is actually occurring is shown in the inventory plot (Table 7) by the abundance of hardwood saplings and seedlings.

Mixed swamp forests are closely related to cypress-mixed swamp forests and can occupy similar or altered sites. Mixed swamp forests lack baldcypress overstory and are dominated by the same swamp hardwoods found in the cypress-mixed swamp. Even in hydrologically undisturbed sites, mixed swamp forests often have a history of cypress removal, either by logging or fire. Insufficient regeneration of baldcypress will allow establishment and dominance of hardwood species in a post-lumbering sere (Alexander and Crook, 1976, Gunderson, 1977) and a post-fire sere (Gunderson, 1977; Wade et al., 1980). Mixed swamp forests can also be a result of shortened hydroperiod in the cypress-mixed swamp. The regeneration of cypress is closely linked to narrow range of hydroperiods. The seeds must soak in water for one to three months, and germinate as water levels receed. A shortening of the wet season could result in insufficient soaking periods and too rapid a loss of soil moisture for survival of the seedling. The hydroperiod shift decreases the number of "wetter" years which are required for cypress regeneration and increases the number of "drier" years suitable for hardwood regeneration. With continued regeneration of hardwood species and no regeneration of cypress, the stand becomes a mixed swamp forest. This succession may take a long period of time due to the longevity of cypress.

Cypress domes and strands are characterized by an overstory of pondcypress. Domes have a hemispherical profile, with smaller trees on the outside and larger trees on the inside. This physiognomy usually reflects the growth conditions of the trees and not necessarily the ages. (Craighead, 1971). In this report, strands are considered elongated or riverine-type domes. Although not measured, both the size of the trees are smaller and the density of trees are greater in domes and strands than in the cypress-mixed swamp forests. The understory species composition is variable. Hardwoods such as Myrica cerifera, Persea palustris, and Chrysobalanus icaco are common. Dense stands of sawgrass, Cladium jamaicense, can also be an understory component. The understory is usually dominated by graminoid species on the periphery of the domes and strands.

Domes occupy circular bedrock depressions, whereas strands occupy elongated depressions. The lowest soil surface elevations of any plant association were found in the central portion of domes. Soils were a mixture of sand and black muck in the deeper central portions and graded into shallow sand in the peripheral areas. Hydroperiods were calculated from the central portion of a strand and presumably decrease towards the edges. Hydroperiods averaged 120 days/year, roughly 50% of the value reported by Duever et al. (1978). In addition to impairing cypress regeneration, a shortened hydroperiod acts to increase the frequency and severity of fire in all cypress communities (Wade et al., 1980).

Evidence of fire occurrence seems to be greater in dome and strand communities than in mixed swamp forests, although these types seem to occupy similar sites in terms of bedrock, soils and hydrologic conditions. The pondcypress trees in domes seem to have more fire scars, the soils are lower in elevation (perhaps due to removal of organic matter by fire) and the remaining soils contain a black charcoal. Many of the domes also have had the central trees removed by fire, accounting for the "doughnut"-like appearance of these domes.

Severe fires can enter the cypress-mixed swamp, mixed swamp and cypress dome communities during extremely dry years. The fires can consume not only the vegetation but the organic soil. Denuded sites are susceptible to invasion by successional species. Cladium and other aquatic marsh species can capture these sites as will be discussed below under marshes and prairies. Popash (Fraxinus caroliniana) and/or pondapple (Annona glabra) frequently invade the deepest water areas of these denuded sites and form mono- specific or mixed stands. The longest hydroperiods measured were in a pondapple-popash slough. The calculated mean of 190 days/year at this site was also 100 to 150 days per year less than Duever's (1978) values. Willow (Salix caroliniana) invades post-fire sites, but seems to be found on slightly higher and drier sites than pondapple and popash. The pondapple-popash sites often contain abundant bromeliads and orchids, with few if any aquatic plants in the understory. Willow is found as dense, thick stands and occurs sometimes in association with Cladium. All three of these successional trees are found on fire-influenced sites in the cypress-mixed swamp and cypress dome associations. Nearby seed sources may play an important role in determining species composition of these early successional sites, but there do seem to be some edaphic, elevational and hydrologic differences among these types.

Cypress-prairie areas are characterized by an overstory of stunted (generally less than 5 m tall) pondcypress. Pondcypress was the only tree present and a density of 1370 trees/ha was calculated. Basal area (based on DBH) extrapolated to 7 m^2/ha. The understory species composition is similar to a Muhlenbergia prairie association, hence the name cypress-prairie is used. This vegetation type has been previously referred to as dwarf or hatrack cypress (Davis, 1943; Craighead, 1971). Muhlenbergia filipes and Rhynchospora microcarpa were the dominant understory plants. The cypress-prairie, Muhlenbergia prairie, and pine-prairie plots were all quite similar in species composition (Figure 16) with the only consistent difference being the presence or absence of overstory cypress or pine. Differences in hydrologic conditions, fire frequency and/or nearby seed sources may determine the presence or absence of the tree species whereas the understory species may be able to survive over a broad range of such conditions.

Soil surface elevations in the cypress-prairie areas were slightly lower than at the Muhlenbergia prairie or pine-prairie sites. Hydroperiods were not calculated at the cypress-prairie sites, because of poor correlation with gauges, but are presumably longer than the prairie or pine-prairie sites. The soils in the cypress-prairie consisted of shallow sand and marl.

Fires can burn through the cypress-prairie with little or no effects under natural conditions (Wade et al. 1980). The cypress-prairies in the Turner River Area are dry during the winter months and have burned frequently during these times (sometimes as much as twice in the two previous years). This increasing frequency, a result of man-caused ignitions (Taylor, 1980), appears to be decreasing the density of cypress. The cypress burn and are removed, not because of large fuel accumulations, but because the fires act to erode the protective bark. Once a fire scar is initiated, each successive fire destroys a greater portion of the cambium, as well as the interior heart and sapwood, until finally the tree falls over.

Pine Forests

The pine forests have a single dominant overstory tree: the South Florida slash pine, Pinus elliottii var. densa. Cabbage palm, Sabal palmetto, is found throughout the pine forests, but does not achieve the heights nor densities of pine. Pine density is low in the Turner River Area, compared to other south Florida areas, averaging only 90 trees/ha and 7 m^2 basal area/ha. The low densities are a result of prior logging (Duever et al., 1979). Pine regeneration is occurring at some of the logged sites, as evidenced by the occurrence of pine in the shrub and understory inventory plots.

Pine forests were found at slightly below the highest ground surface elevations within the spectrum of the plant communities. The soil surface "highs" seemed to be a result of slightly elevated bedrock and/or a deep deposit of sand. Variations in elevation of 20-30 cm within the pine forests occurred and correlated with variations in understory species composition. Graminoid species dominated on the lower sites, such as the pine-prairie and pine-Sabal plots (Tables 3 and 4). Dense coverings of saw palmetto, Serenoa repens, were found on the higher, drier pine sites. The understory species composition at the pine-prairie site was similar to the pine-Sabal, Muhlenbergia prairie and cypress-prairie sites (Figure 16).

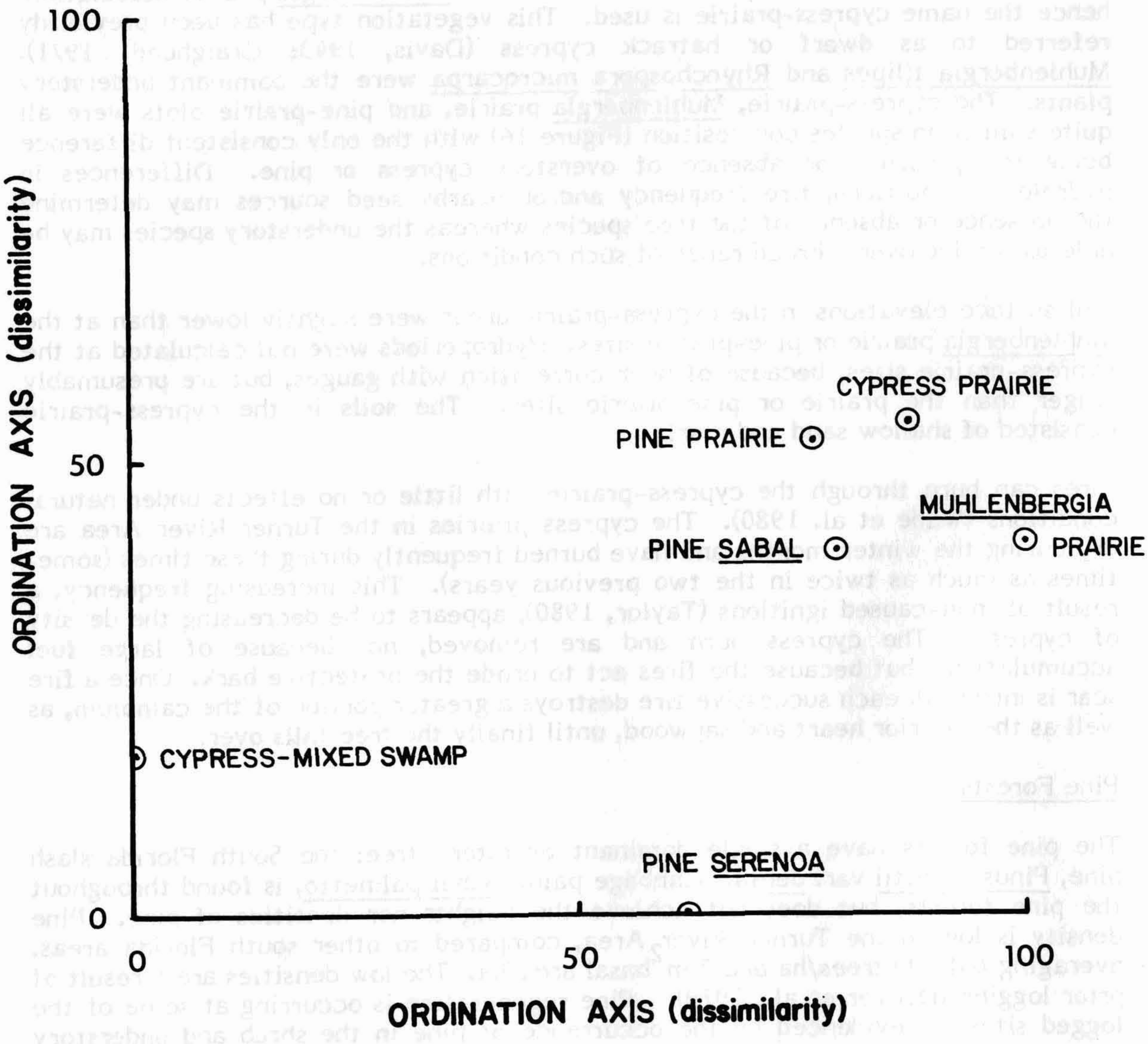


Figure 16. Ordination of quantitative inventory plots. The ordination follows methods of Bray and Curtis (1957). Proximity of points indicates increasing similarity in species composition, a distance of 100 units indicates no common species.

Schizachyrium rhizomatum had a higher importance value at the pine sites, whereas Muhlenbergia was the most important understory species at the other sites. The pine-Serenoa site was quite different from the lower sites in understory species composition, having high importance values of species such as Andropogon, Satureja and Lyonia. Hardwood species such as Myrica cerifera, Lyonia fruticosa and Ilex cassine are present as shrubs and seedlings at the pine-Serenoa sites. The cabbage palm (Sabal), was found throughout the pine sites.

The South Florida variety of slash pine is well adapted to the conditions of flooding and drought encountered in the Big Cypress region (McNab, 1965) as well as the fire regime (Ketcham and Bethune, 1963). Pine seedlings were found in all the pine plots, indicating that regeneration can occur over a range of wet and dry conditions. Hydroperiods were calculated for a pine-prairie site and averaged 45 days/years. Hydroperiods were not calculated for the pine-Serenoa sites but are presumably shorter. Pine seedlings can also be found in wetter areas such as the cypress-prairie or periphery of a cypress dome. This pine establishment can occur under natural conditions during a dry year. Exclusion of fire in these wet sites provides potential for continued growth of pine seedlings. Although the pine can grow in fairly wet conditions, continued soil saturation probably results in their mortality. The presence of dense pine saplings and seedlings in a cypress-prairie or dome can also be an indication of decreasing hydroperiod. Evidence of this trend is documented by the fact that pine is establishing extensively in drained cypress areas of the nearby Golden Gates region (Tabb et al., 1976).

Most of the logged pinelands in the Turner River area have regenerated or are regenerating the overstory pine trees, but some areas have not. Two types of communities are recognized with this history; Sabal-Serenoa stands and hardwood scrub. The hardwood scrub will be discussed under Mixed Hardwood Associations. The Sabal-Serenoa areas are similar in species composition to the pine-Serenoa areas except for the lack of pines. A dense layer of Serenoa with scattered emergent Sabal characterizes these areas. A combination of dense Serenoa, frequent fires and lack of a nearby pine seed source probably hinders pine reestablishment.

Mixed Hardwood Associations

Three mixedhardwood forests are recognized; Oak-Sabal hammocks, Tropical Hardwood Hammocks and Hardwood Scrub.

Oak-Sabal hammocks have a canopy of laurel oak, (Quercus laurifolia) with a subcanopy of Sabal palmetto. Myrsine floridana and Psychotria nervosa are principal understory species. These hammocks are located on elevated bedrock in or near cypress-mixed swamp forests. A black organic muck covers the bedrock. The increase in elevation from the surrounding cypress-mixed swamp forest results in a shorter hydroperiod than in the swamp forest. The higher hardwood islands do not seem to burn very frequently due to the protective effects of the surrounding swamp forest.

Tropical hardwood hammocks are a more diverse tree association than the Oak-Sabal hammocks and are also found close to cypress-mixed swamp forests. Bursera simaruba, Bumelia salicifolia, Nectandra coriacea, Myrcianthes fragrans and Eugenia axillaris are common tree components of these hammocks. The tropical hammocks appear to be on higher bedrock outcrops and are also edaphically different from the oak-Sabal hammocks. The soils in the tropical hammocks are decomposed litter over rock with a small amount of sand. As with the Oak-Sabal hammocks, the hydroperiods are shorter than the surrounding swamp forest and also benefit from the buffering actions of these wetlands by decreasing fire frequency.

Hardwood scrub describes a dense thicket of hardwood species which have a low canopy profile. Myrica cerifera, Ilex cassine, and Quercus spp. are in this association, and sometimes Serenoa is present. Scrub areas are a result of lumbered pinelands or a severe disturbance, usually fire, in a hammock area.

Marshes and Prairies

Marshes and prairies are strictly graminoid and forb associations. Marshes include wetter areas that usually have an organic component in the soils, whereas prairies are slightly drier and have a sandy soil. Communities in the Turner River Area include Muhlenbergia prairie, sawgrass (Cladium) marsh, and mixed emergent marsh.

Muhlenbergia prairies are dominated by Muhlenbergia filipes, but other species such as Cladium jamaicense, Rhynchospora microcarpa or Spartina bakerii can be locally dominant. These prairies are extensive features in the Turner River area. Elevationally and hydrologically, the prairies are intermediate to the pine-prairie and cypress-prairie. The species composition in the Muhlenbergia prairie is similar to cypress-prairie and pine-prairie sites (Figure 16). A combination of poor hydrologic conditions and frequent fires probably exclude establishment of either cypress or pine in these prairies.

Sawgrass marshes are minor features in the Turner River Area. They are stands of dense, tall Cladium jamaicense, with Kosteletzkya virginica and Crinum americanum found as common associates. The substrate is usually a black peat with some sand. The ground surface elevations in these areas are lower than the prairies, approximately equal to those measured in cypress domes. Sawgrass marshes are perpetuated by periodic fire (Wade et al., 1980).

The emergent aquatic marshes are usually dominated by species such as Sagitarria spp., Pontedaria lanceolata, and Nymphaea odorata. Adjacent to the Turner River, the marshes consist of Zizanopsis miliacea and Scirpus validus. These marshes are on lower, wetter sites than the sawgrass areas, and also have organic substrates.

Exotic Plant Areas

Extensive stands of Schinus terebinthifolius are located on old farm fields immediately west of the Turner River Study area. Individuals of Schinus were found in cypress-mixed swamp forests, cypress domes, and pine forests. Thickets of Schinus were found in disturbed hammock sites. A strip of Schinus also is found in the roadside area along SR 839. The large stand of Schinus immediately east of the Turner River and north of US 41 is on an Indian midden site. Part of this large Schinus stand also has a history of recent use as a homesite.

Scattered plantings of Melaleuca quinquenervia were found at many homesites along SR 839. Most of these have now been removed by National Park Service personnel. A few scattered individuals are still present in the pinelands and prairies of the area, but no extensive stands remain.

Melaleuca and Casuarina sp. are not widespread at this time. Schinus is already a component of all the major vegetation types, except prairies, marshes and cypress prairies. At this time, the areas with the worst Schinus infestations are the disturbed hammocks. With the presence of abundant seed sources, any disturbance to the area would probably result in the expansion of Schinus populations.

SUMMARY

1) Relative elevations, soil depths and hydroperiods were calculated for plant communities in the Turner River Area.

2) Soil surface elevations were lowest in cypress domes and pondapple-popash sloughs and increased in order through cypress-mixed swamp, cypress-prairie, Muhlenbergia prairie, pine-prairie, and pine-Sabal-Serenoa. Oak-Sabal hammocks and mixed tropical hammocks were found on the highest elevations. The range in relative soil surface elevations was approximately one meter.

3) The deepest (up to 4m) soils were measured beneath the cypress-mixed swamp forests. Soil depths in other plant communities averaged less than 100 cm.

4) Preliminary hydroperiod calculations indicate that average hydroperiods may have been shortened in the cypress-mixed swamp forests, cypress strand, and pondapple-popash slough that were monitored in the area.

5) A quantitative inventory was made in each of the following plant associations: cypress-mixed swamp, pine-Sabal, pine-Serenoa, pine-prairie, cypress- prairie and Muhlenbergia prairie. Permanent plots were established at these sites for future comparisons.

6) Comparisons of species compositions among the inventoried communities indicate that the cypress-mixed swamp and pine-Serenoa plots are quite different from each other and also from the other communities. Pine-Sabal, pine-prairie, cypress-prairie and Muhlenbergia prairie were quite similar in overall species composition.

7) A vegetation map was prepared of the Turner River area to document current patterns of the plant communities.

8) Aquatic vegetation maps were also prepared to document current patterns in the Turner River, in the event of enactment of proposed hydrologic changes to the River.

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