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STUDIES OF A METHOD OF WETLAND RECONSTRUCTION FOLLOWING PHOSPHATE MINING

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STUDIES OF A METHOD OF WETLAND RECONSTRUCTION FOLLOWING PHOSPHATE MINING

FINAL REPORT

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TABLE OF CONTENTS

PERSPECTIVE

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The successful recreation and replacement of wetland ecosystems following mining is among the phosphate industry's highest priorities. Approximately 15 percent of Florida's phosphate reserves are located beneath wetlands, and the state has enacted legislation insuring that most of these wetlands will be reclaimed as such. In order to extract the resources buried under wetlands, the phosphate industry has invested heavily in projects to demonstrate that reclamation technology has been refined to the point that restoration of wetland values is virtually assured.

Since reclamation became mandatory in 1975, the phosphate industry has undertaken at least 30 wetland reclamation projects. Perhaps the most significant finding that has emerged from this decade of research is the value of spreading organic topsoil excavated from undisturbed wetlands onto recontoured sites that will be reclaimed as wetland ecosystems. Spreading topsoil (also referred to as muck, mulch or peat) onto reclaimed wetland basins enhances reclamation in two ways. First, the peat introduces a nutrient-rich inoculum onto droughty, bare mineral soil. As long as the peat remains moist and is not allowed to oxidize, the soil structure will approximate that found in the original wetland and the conditions present in the undisturbed soil will be duplicated at the new site. Secondly, the propagules and herbaceous rhizomes that are present in the soil will also be transferred to the reclaimed site, thereby replacing and enriching the area in the same operation. Success in introducing vegetation with the mulch depends upon the viability of the individual plant species and their ability to withstand disturbance. Repeated demonstrations using organic topsoil in herbaceous marsh reclamation have led to the widespread adoption of the technique for all wetland projects. In an effort to evaluate the potential benefits conferred by spreading peat salvaged from a cypress dome onto a swamp reclamation site, the Institute sponsored this research, which was conducted by Dr. Mark Brown of the Center for Wetlands, University of Florida.

The organizing theme of the project was the need to quantify the establishment and survival of wetland plant species on an area that had been spread with salvaged peat. To accomplish this goal, Dr. Brown evaluated mulching from three perspectives: the influence of thickness, the pattern of application, and the cost of excavating, transporting and spreading the material. When originally proposed, the project called for peat to be spread in plots at three depths and in two configurations. The site chosen was a lakeside reclamation area at Occidental Chemical Company's Suwannee River Mine in Hamilton County, Florida. As the soil was being delivered, Dr. Brown soon realized that precise application to predetermined specifications would be impossible. In the end, soil thickness ranged from 8 cm to 45 cm. The two configurations consisted of complete coverage at a uniform thickness and of alternating strips of peat and bare ground. The alternating pattern was incorporated into the study to test the ability of wetland vegetation to colonize unmulched soils, a matter of particular concern since reclamation planners rarely have enough peat at hand to effect complete coverage. Detailed cost data were developed to evaluate the effectiveness of this method of wetland reconstruction. In addition, tree seedlings were planted in the peat and growth and survival were compared to seedlings at other locations.

Prior to the inception of Dr. Brown's research, the value of applying peat during swamp reclamation had never been gauged, although mulching was routinely practiced. In 1982, Agrico Mining Company began reclamation of a 366 acre watershed restoration site at its Fort Green Mine. On site, 240 acres of upland containing two lakes were designed to spill over into a 126 acre wetland. The wetland consisted of 75 acres of march, one acre of bayhead swamp and 50 acres of floodplain hardwoods. Agrico reported that spreading organic soil from donor wetlands was very beneficial in inoculating the site.

Three projects begun in 1983 incorporated mulching into the reclamation plans. Mobil Chemical Company began work on a project in the headwaters of McCullough Creek which lie partially within the boundaries of the company's Ft. Meade Mine. The total wetland area in the project was 21 acres, consisting of two acres of marsh and 19 acres of hardwood swamp. Mobil mulched the site with peat material borrowed from similar habitats slated for mining. Brewster Phosphates received approval of dredge-and-fill plans to relocate two small tributaries of the South Prong of the Alafia River at the Lonesome Mine: Lizard Branch and Dogleg Branch. These projects are model demonstrations with considerable chance for successful reclamation of stream channels and associated forests. In addition to transplanting large numbers of mature trees, stumps and seedlings onto the site, Brewster spread wetland topsoil over a significant portion of the reclaimed area. Revegetation was also recently completed on a project at Gardinier's Fort Meade Mine. This wetland project was designed by the Center for Wetlands in cooperation with Gardinier, Inc. Two perched bayheads in the upper watershed were sealed with phosphatic clays topped with organic muck soils. These wetlands drain through a series of swales and an herbaceous wetland into a small lake. Eventually, the water finds its way through a forested channel into Whidden Creek. The total wetland area on the site is about 10.5 acres with a watershed of 153 acres, most of which encompasses two consolidated clay settling areas.

The Institute has also been actively involved in swamp and floodplain forest reclamation investigations that have incorporated mulching. Since 1982, the Institute has been a partner in a cooperative agreement with the U.S. Bureau of Mines, the United States Geological Survey and the U.S. Fish and Wildlife Service to reclaim a stream and its associated floodplain forest at AMAX Chemical's Big Four Mine. The revegetation plan for the mine, developed by AMAX reclamation planners and the Fish and Wildlife Service, "Reestablishment of a Forested Wetland" (FIPR #83-03-052), involves spreading wetland peat over the reclaimed overburden soil.

In mid-1983, Dr. Howard Odum and his graduate researchers at the Center for Wetlands completed work on a two-year project supported by the Institute detailing the impact of mining on wetlands. The investigation was primarily a descriptive study of the vegetative communities that develop in response to a wide variety of landscape modifications produced by phosphate mining. Using data from the project as a foundation, Dr. Odum prepared a follow-up study, "Interactions of Wetlands with Phosphate Mining" (FIPR #83-03-041R) which takes an experimental approach to wetland reclamation. Ms. Betty Rushton, one of the project researchers, has been conducting research designed to break arrested succession on clay settling areas dominated by willows. Her primary goal is to accelerate succession by introducing wetland peat, seeds and seedlings from four swamp communities into heavily vegetated settling areas. This project, currently in progress, is scheduled for completion in 1987.

The Institute's most recently funded project, "Viability of Stock-piled Peat for Wetland Reclamation" (FIPR #85-03-063) is an in-house examination of the potential for storing wetland peat between the time it is excavated and the time it is spread onto reclaimed basins. Several mining companies routinely stockpile peat for mulching but have not evaluated the effects of length or depth of storage on the physical, chemical and biological characteristics of the soil. If this research proves that stockpiling is feasible, topsoil could be applied on reclaimed sites as needed, instead of as available, making coordination of mining and reclamation less critical and reducing the possibility that wetland areas will be reclaimed without addition of peat. In addition, valuable topsoil could be preserved for later use as a mulch and inoculum in reclamation projects even if a site is not ready. Results of this investigation will be available in 1988.

INTRODUCTION

Wetland reconstruction involving the transfer of peat from a forested wetland about to be mined to a recently recontoured reclamation site was the goal of this project. The research was conducted at a site known as Block "B" of Occidental Chemical Company's reclamation project SR-8 near White Springs, Florida (Figure 1). Mining of the reclamation site was completed in 1981 and recontouring was completed just before September 1982. Wetland development was monitored through January 1984.

The original project design called for three different thicknesses and two different treatments of the applied peat. In reality, limitations on accurately estimating volume of material as it was delivered to the site led to a variety of thicknesses ranging from about 8 cm to 45 cm. The treatments consisted of complete coverage in a uniform thickness and of alternating strips of peat and bare ground. Detailed cost data were recorded to evaluate cost effectiveness of this method of wetland reconstruction. In addition, tree seedlinqs were planted in the peat material, and growth and survival were compared to seedlinqs at other locations.

At 3-month intervals, project personnel completed a census of plants, recorded biomass of major species, and measured depth of peat. Water level and pH of water in an adjacent lake were recorded weekly. Germination studies of undisturbed peat from a forested wetland similar to the "donor swamp" were also conducted at the Center for Wetlands for comparison with germination on the experimental sites. Trays of sterilized soil were placed throuqhout the experimental sites to account for windblown and waterborne seeds.

Application of Peat

With all site recontouring completed, the peat material was applied to the experimental sites on 23 and 24 November 1982. The peat was dug from the donor swamp and transported to the experimental site usinq Cat 627 scrapper pans. In all, 64 scrapper pan loads were applied to the experimental sites.

Approximately three-fourths of the 3-mile round trip haul distance was over freshly recontoured overburden, which resulted in difficulties due to the weight of the equipment. A motor grader was necessary to maintain the haul road in passable condition. Difficulties were also encountered in digging the peat from the donor swamp with the scrapper pans. It was necessary to push the pans through the swamp with a D-8 dozer and at one point even the D-8 dozer bogged

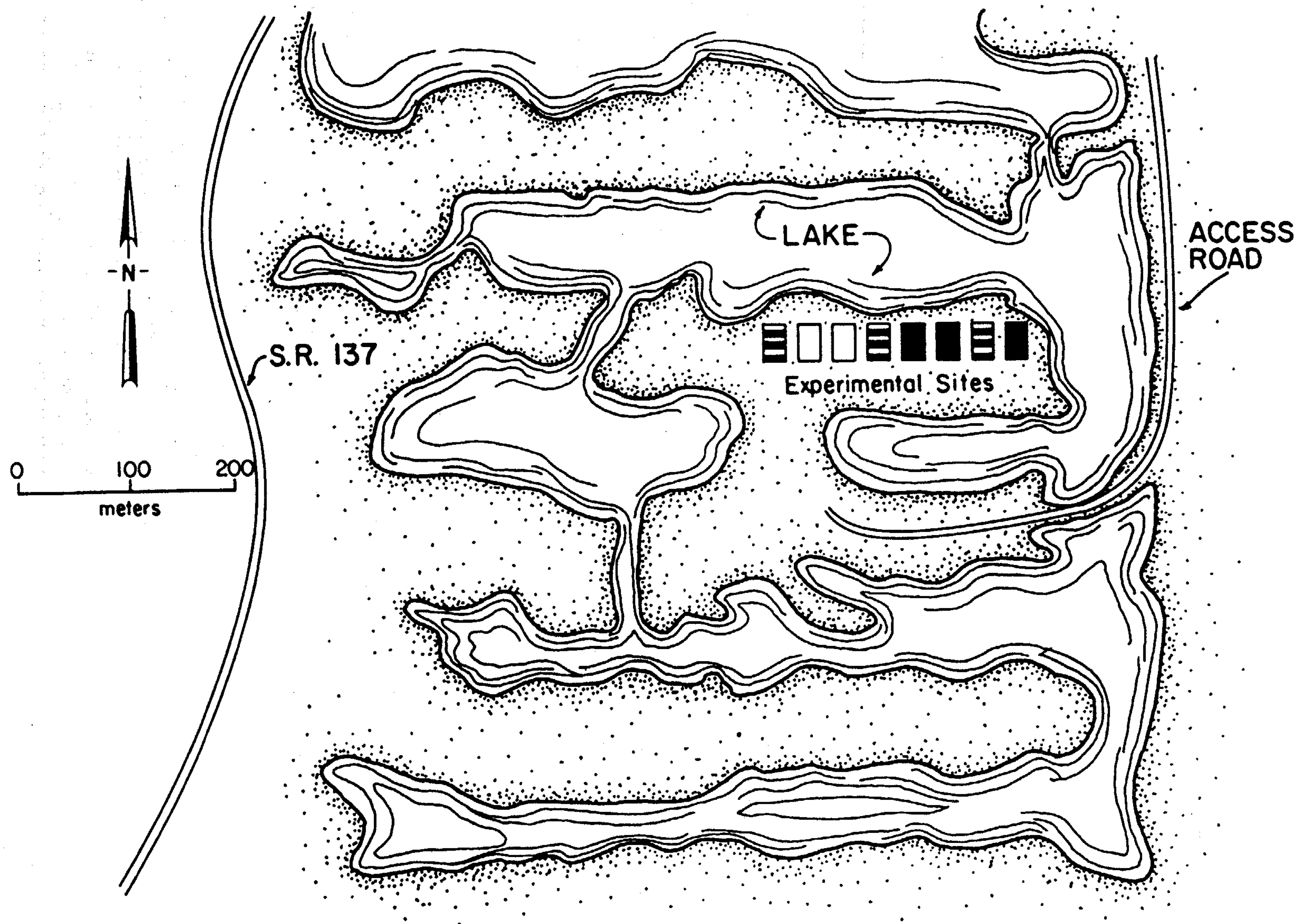

Figure 1. Map of the research area with experimental sites as indicated. The site is on Occidental's reclamation area known as SR-8.

down, requiring a second dozer for its retrieval. Once the peat was deposited on the experimental sites, a small dozer spread the material to the desired thickness.

Elevation of Experimental Sites

Shown in Figure 2 are the elevations of the experimental sites. Since there is much variation within experimental sites, the elevations in Figure 2 are expressed as the mean of 12 study plots within each of the sites. The fluctuation in water level for the first 5 months of 1983 is also given in Figure 2. As shown in the graph, water levels could not be maintained at levels sufficient to inundate the experimental sites. This, combined with the fact that expected compaction of the site by the heavy equipment used to transport the peat did not occur, resulted in the experimental sites being much drier than desired.

Proper water depth and period of inundation are two of the most critical parameters necessary to establish and maintain wetland systems. Without sufficient water depth and hydroperiod, the germination, growth, and survival of the wetland species contained in the peat material was, in all likelihood, adversely affected. These unfortunate circumstances led to an early termination of the research project.

However, while the sites were drier than desired, the sites were inundated for a period of time. Germination and one full year's growth under these somewhat adverse conditions still resulted in colonization by herbaceous wetland vegetation. The results of this study indicate that significant differences in species composition and total biomass between the control and areas where peat was applied did occur and that colonization by wetland species is far quicker and greater in biomass and number than can be expected without such treatments.

Description of Study Sites

Given in Figure 3 and summarized in Table 1 are the layout and pertinent data for the 10 experimental sites. The long axis of each site runs in a north-south direction with the lake's edge on the north. Peat was applied in alternating strips of peat and bare ground to sites 3, 6, and 9, while sites 7, 8, and 10 had peat applied uniformly. Each site had a different thickness of peat applied. Sites 1, 2, 4, and 5 were set aside as controls, for which, site 5 was used as a control in this first year. The remaining three sites were intended to be used as controls for additional work in the second year that was abandoned as a result of inadequate water levels over the experimental sites.

The first experimental site to have peat applied was site 10, second was site 9, and so on, until the final application to site 3. The order of application was to prove important later, as the material applied to site 10 was from the perimeter of the donor swamp and was far sandier than peat dug from the middle of the swamp. Later, as the plant censuses were taken, this site had far

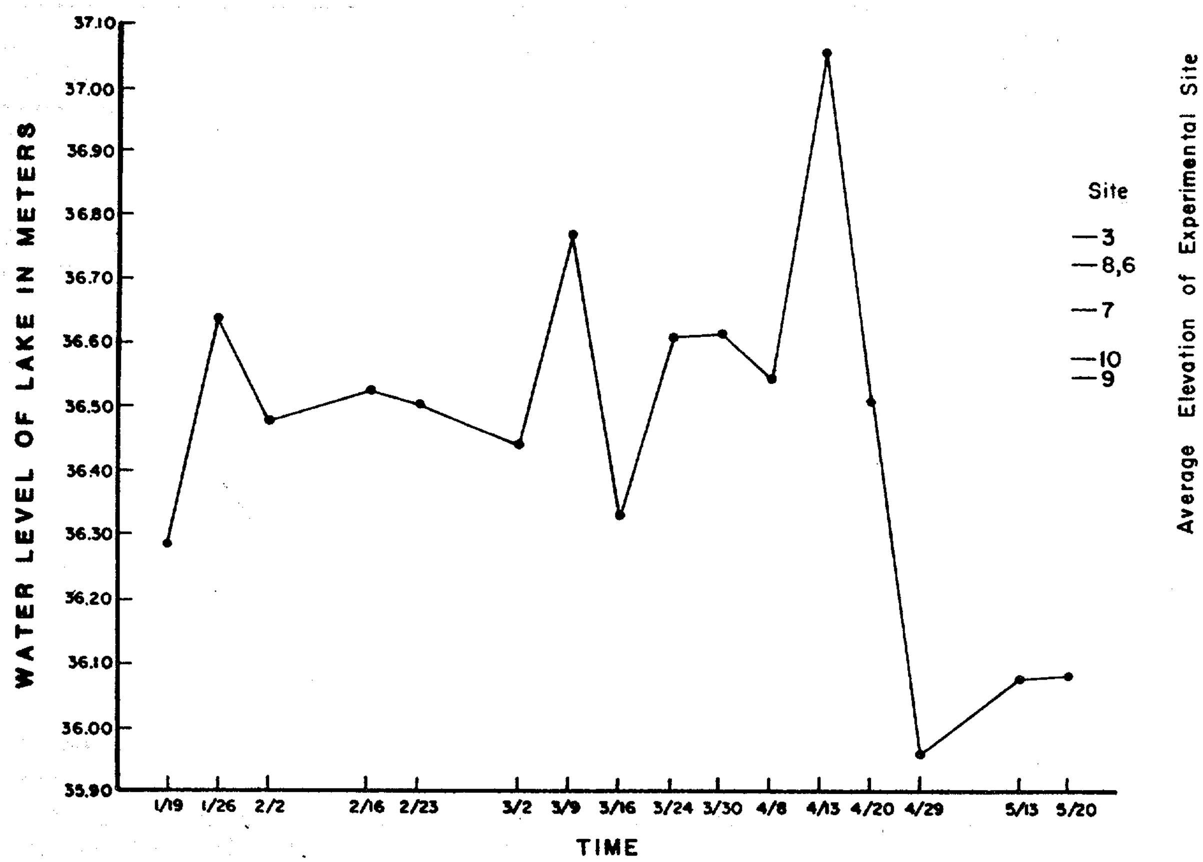

Figure 2. Elevations of experimental sites compared to lake water levels during the period January to May 1983.

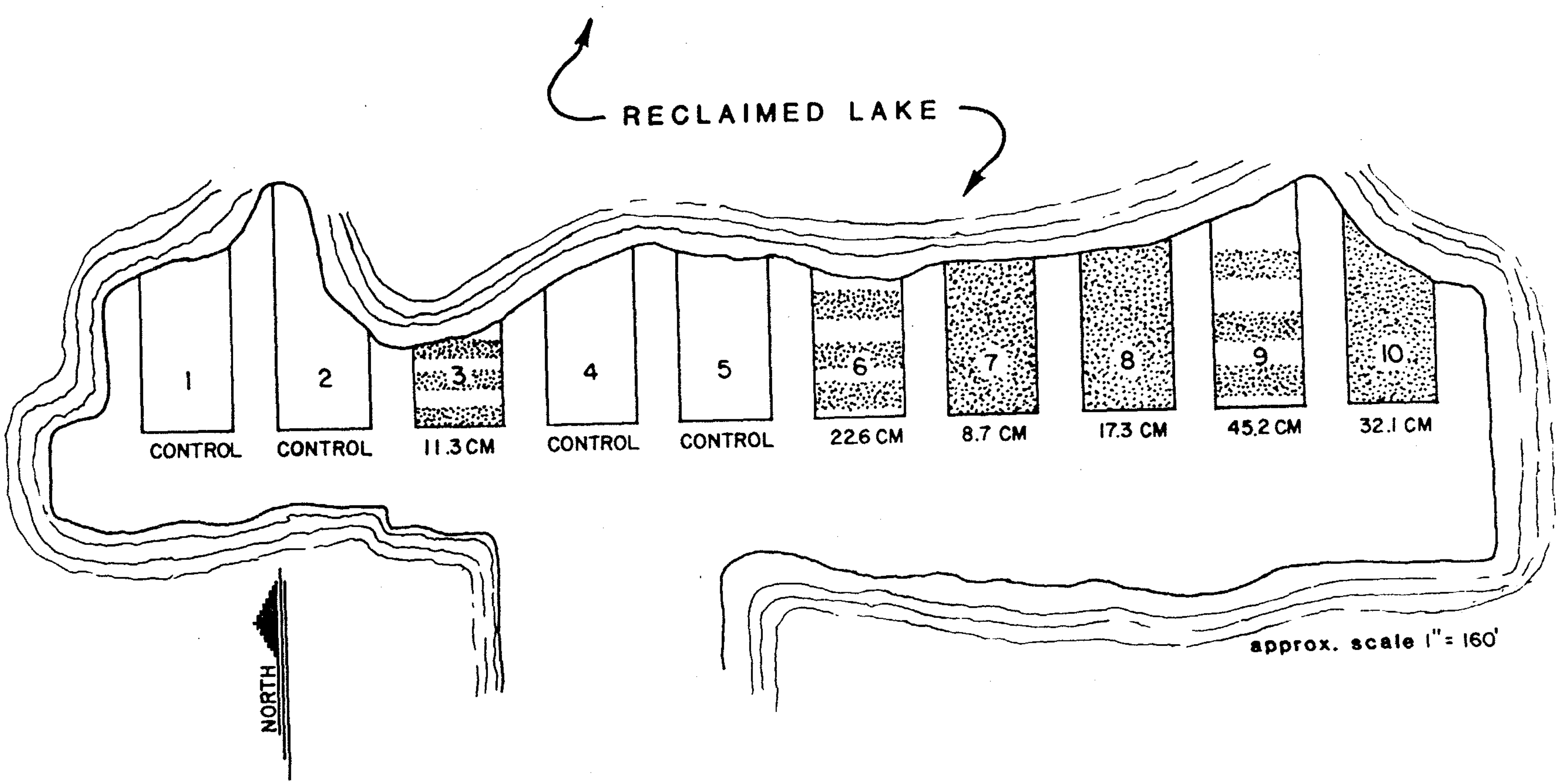

Figure 3. Layout of experimental sites. Stippled areas are those where peat was applied. Numbers below sites indicate the average thickness of peat.

Table 1. Estimated volume and average thickness of peat applied to experimental sites.

Site	Volume Applied		Area of Application		Average Thickness		Comment
	yd^3	m^3	yd^2	m^2	in.	cm	
1	--	--	--	--	--	--	Control
2	--	--	--	--	--	--	Control
3	54	41.3	437	365.4	4.45	11.3	3 strips 16' x 82'
4	--	--	--	--	--	--	Control
5	--	--	--	--	--	--	Control
6	108	82.6	437	365.4	8.89	22.6	3 strips 16' x 82'
7	108	82.6	1139	952.3	3.41	8.7	Complete coverage
8	216	165.2	1139	952.3	6.83	17.3	Complete coverage
9	216	165.2	437	365.4	17.79	45.2	3 strips 16' x 82'
10	432	330.4	1230	1028.4	12.64	32.1	Complete coverage

greater numbers and diversity of upland species characteristic of pineland systems.

An accurate estimate of the total volume of material applied to the experimental sites is difficult. The total number of pan loads was recorded, and a visual estimate of the volume within each pan was made. The application rate was controlled by the number of pan loads and the assumption that each pan carried approximately 20 cubic yards. This assumption later proved to be inaccurate since measured depths of material suggested that the average volume per pan was nearer 18 cubic yards.

Within each experimental site, 12 1-m^2 study plots were randomly located. These study plots were the basis for plant population structure, biomass, and seed germination studies. Those experimental sites that had peat applied in strips had some study plots located in the bare areas between strips, thus data for these sites are considerably more variable than for sites that had complete coverage. This was purposely done to test overall germination, growth, and survival in situations where peat may not be applied evenly, but it is important to bear this in mind since these sites had greater variability in measured parameters.

Background Data for Undisturbed Swamps

To quantify community structure of typical cypress/gum swamps like the chosen donor swamp, vegetation transects were undertaken in two swamps near the donor site. Vegetation transects could not be done in the donor swamp since it had been partially cleared in August 1982 in preparation for mining. Observations indicated, however, that the selected cypress/gum swamps where transects were performed had similar vegetative structure.

Companion Project for Cost Comparison

In March 1983, a second project involving the reconstruction of wetlands was begun in central Florida. This project, funded by Gardinier near Fort Meade, Florida, had a total of approximately 3 ha (8 acres) of wetlands that were to be "inoculated" with peat from a donor swamp. Typical wetlands in this area of central Florida are bayheads rather than the cypress/gum swamps of north Florida; thus, comparisons between vegetative structure were not made. However, different techniques of digging and hauling peat material were employed, affording a cost comparison between techniques used at the Occidental site with those employed at the Gardinier site.

METHODS

Vegetation Transects

To quantify community structure in typical cypress/gum swamps, two vegetation transects were undertaken near the swamps from which peat was to be transferred to the experimental sites. Total woody vegetation was inventoried based on varying quadrat (sample) size. Site I was a typical cypress/gum community with standing water up to about 40 cm at the time of sampling (November). It was somewhat oblong in character, the longer, thinner axis running in a northwest-southeast direction. It was along this axis that the transect was run for 200 m. Site II was a more characteristic dome-shaped system—almost circular in nature and about 110 m across. It was situated about 1000 m north of Site I and had up to 50 cm of standing water at the time of sampling (November).

Two size classes of species (trees, >10 cm diameter breast height [dbh]; and samplings, ≤10 cm dbh) were established in order to make comparisons with the transects made in similar communities by Monk (1966) in the mid-1960's and by Breedlove Associates in the early 1980's. Evident in the swamps were the preponderance of swamp blackgum tupelo (*Nyssa sylvatica*) and the relatively few numbers of pond cypress (*Taxodium ascendens*) on both sites. This is a result of the fact that both sites had been extensively logged (apparently in the last decade) for *Taxodium* as evidenced by the number of stumps.

Germination Studies

To evaluate germination success, samples of peat from the source swamps were brought to the Center for Wetlands for germination studies in a more controlled environment. Peat samples were also taken from the swamps in which transects were run to determine similarities. Two replications of each site were spread in plastic trays (25.4 cm x 50.8 cm x 7.6 cm) with controlled drainage and were kept saturated.

Plant Population Structure

Twelve 1-m^2 study plots were randomly located within each experimental site, and quarterly censuses of plant populations were undertaken. The census consisted of recording species and abundance of individuals in each 1-m^2 plot. In the early stages of germination and growth, identification was difficult and thus resulted in a large percentage of unknowns. The first census was conducted in February 1983 (3 months after peat application), the second was conducted in May 1983, the third was conducted in August 1983, and the final census was conducted in October 1983.

Censuses of plant population structure for the germination studies under controlled conditions at the Center for Wetlands were also conducted. Six samples of the peat material that was applied to the experimental sites and two samples of undisturbed soil from cypress/gum swamps where vegetative transects were conducted were returned to the greenhouse, and censuses of plant population structure were done at the same intervals as those on the experimental sites.

Relative density, frequency, relative frequency, and importance values were calculated for each study plot, and means for each experimental site were determined. Statistical comparisons between plots and sites were then conducted to test differences in response of these variables with elevation, peat depth, and treatment (complete coverage versus strip application).

To compare germination, growth, and survival of wetland species versus upland species, a list of typical wetland plants, transitional plants, and upland plants was compiled using the latest information from the Department of Environmental Regulation (proposed Rule 17-4.02 (17) and Rule 17-4.022, F.A.C.) and from Godfrey and Wooten (1979) and are given in Table 2.

Biomass

The change in biomass over time and under differing conditions was of importance. Biomass was determined without destructive sampling of the study plots due to the limited area of each experimental site. Instead, after the plant population census, the most abundant species were determined (in all cases these species represented over 96% of individuals present and an estimated 98% of total biomass), and 10 individuals of each species on each experimental site were harvested, dried, and weighed. Selection was carried out in the following manner: a line running north to south was established randomly within each experimental site and a starting point was randomly selected. From this starting point, the first 10 individuals of each species that came in contact with the line were harvested. An exception to this strict method was made only if one of these first 10 individuals was within one of the square meter study plots, then the plot was skipped and the next individual was harvested outside the plot.

Statistical analyses were conducted on the differences in biomass between experimental sites only, since data could not be reduced to the individual square meter study plots with the method used to determine biomass. During April 1983, the experimental sites were completely covered with water due to extremely high rainfall. Water hyacinth (Eichhornia crassipes) drifted over the sites during this time. As the water receded, much of the hyacinth remained, covering some areas of the experimental plots. Using field maps of each site, the area of coverage was mapped, and percent cover was calculated. Biomass (dry weight) was determined by harvesting, drying, and weighing a 0.25-m2 section

Table 2. List of submerged, transitional, and upland species found on the experimental sites.*

DER SUBMERGED SPECIES

Cephalanthus occidentalis	Button bush
Cyperus haspan	
Cyperus spp.	
Eleocharis baldwinii	Spike rush
Eriocaulon compressum	Pipewort
Juncus repens	Creeping rush
Juncus spp.	Rush
Ludwigia spp.	Marsh purslane
Panicum hemitomon	Madiencane
Polygonum punctatum	Dotted smartweed
Potamogeton spp.	Pondweed
Rhexia spp.	Meadowbeauty
Sagittaria lancifolia	Arrowhead
Salix caroliniana	Swamp willow
Salix spp.	Willow
Saururus cernuus	Lizards tail
Scirpus californicus	Bulrush
Spartina bakerii	Cordgrass

UPLAND SPECIES

Andropogon gerardi	Bluestem
Cassia fasciculata	Partridge pea
Coreopsis leavenworthii	
Crotalaria spp.	Rattle box
Digitaria sanguinalis	Crab grass
Eupatorium capillifolium	Dog fennel
Heterotheca subaxillaris	Camphor telegraphplant
Hyptis alata	Bushmint
Indigofera spp.	Indigo
Indigofera hersuta	Hairy indigo
Lepidium virginicum	Poor-man's pepper
Myrica cerifera	Wax myrtle
Panicum clandestinum	Panic grass
Panicum commutatum	Panic grass
Panicum spp. #1	Panic grass
Panicum spp. #2	Panic grass
Panicum spp. #3	Panic grass
Rubus spp.	Berry
Rubus trivialis	Dew berry
Smilax auriculata	Greenbrier
Stylosanthes biflora	Pencil flower
Vaccinium crassifolium	Creeping blueberry

Table 2. (Continued).

DER TRANSITIONAL SPECIES	
Acer rubrum	Red maple
Baccharis angustifolia	Baccharis
Boehmeria cylindrica	False nettle
Hydrocotyle umbellata	Marsh penneywort
Lyonia lucida	Fetterbush
Quercus spp.	Oak
WEEDY MOIST TRANSITIONAL (Godfrey & Wooten)	
Aeschynomene americana	American jointvetch
Dulichium arundinaceum	
Eupatorium perfoliatum	Dog fennel
Juncus acuminatus	Tapertip rush
Panicum bartowense	Bartow panic
Panicum dichotomiflorum	Spreading panic
Paspalum urvillei	Vaseygrass paspalum
Sesbania vesicaria	Bagpod sesbania

*Species listed are those found on the experimental sites, and categorized using DER proposed Rule 17-4.02 and Rule 17.04.022, F.A.C. into submerged and transitional species. All other plants were categorized upland or weedy moist transitional from descriptions in Godfrey and Wooten (1979).

of the hyacinth. Total input of organic matter was then estimated using dry weight per square meter and area of coverage.

Planted Seeds and Seedlings

Three types of wetland tree species were planted as bare root seedlings in each of the experimental sites. Seedlings were planted on the 2nd and 23rd of February 1983 in a north-south line through each site and were marked for later identification. Swamp blackgum tupelo (Nyssa biflora) seedlings were collected from a natural area where disturbance had caused several thousand seedlings to germinate at the same time. These seedlings were washed and kept under refrigeration for approximately 1 wk before transferring them to the experimental sites. Bald cypress (Taxodium distichum) and sweetgum (Liquidambar styraciflua) were obtained from the Florida Department of Agriculture, Division of Forestry. The height of each seedling was recorded, and growth rates for the 1983 growing season were determined by measuring heights at the end of the growing season (21 October 1983).

Four other reclamation sites planted within the last 4 years were selected to compare the growth rates of seedlings planted on the peat material. One of the sites was planted at roughly the same time as the seedlings on the experimental sites. This site (site D) was used for direct comparison of survival and growth with the experimental sites. Only bald cypress (Taxodium distichum) was planted at this site. Other sites were planted at various times starting in 1981 and were selected as long-term comparisons for the experimental sites. All four Occidental reclamation seedling sites were surveyed 13 May 1983 and again on 21 October 1983. Percent survival was calculated and percent change in height was determined.

Physical Parameters

Lake water pH and interstitial water pH were recorded throughout the year. An Orion Research Ionanalyzer model 339A was used in the field to determine weekly pH of the lake water. Interstitial water pH was measured on 30 March, 8 April, and 20 April 1983. On all other dates, the experimental sites were either inundated or too dry for measurements.

Soil pH was determined in two ways: first using distilled water and second using 0.01 M CaCl. Soil samples were collected on 24 November 1982, 30 March, 13 May, and 15 December 1983, returned to the Center for Wetlands laboratory, and analyzed. In addition, overburden samples were analyzed for comparative purposes.

Peat depth was measured shortly after application to the experimental sites and again in January 1984 to determine a rate of subsidience over time. Three permanent sampling locations were established (one at the north end, one in the middle, and one at the south end) at each experimental site. A hole was dug through the peat and into the underlaying overburden. Several measurements in each soil pit were made and a mean was calculated for each location.

Lake water levels were monitored from January 1983 to January 1984. In the early phases of the project, a Stevens water level recorder was set up for a continuous recording of the lake water fluctuations. Later in the year, as water levels stabilized, weekly water levels were recorded.

Economic Costs

Detailed records were kept throughout the 2 days of peat application to the sites. The number of loads, estimates of volume per load, round-trip travel time, and hours of equipment operation were recorded as the application progressed. The round-trip travel distance and total dollar costs (charged at Occidental's internal rate) were also determined. Later, estimates of total volume of peat applications were adjusted using the measurements of peat depth and area of each experimental site.

Later during 1983, we had a second opportunity to evaluate the dollar costs of peat mulching when Gardinier reclaimed two areas of wetlands (the first consisting of approximately 3 ha (8 acres) and the second of approximately 2.5 ha (6 acres). Their methods of digging and transporting the material were quite different, so these trials offered a comparison. Billing records were obtained courtesy of Gardinier staff, and only the costs associated with equipment used in the digging, transporting, and spreading of the peat were used in the evaluation. Of the two trials, accurate cost records were kept for the 2.5 ha wetland project. Those data were used as a comparison to those of the Occidental trials.

Statistical Evaluation

Statistical methods were applied to collected data to examine the relationships of experimental site characteristics (average elevation, peat depth, and percent area covered by peat) to vegetation parameters (biomass and species diversity).

The data were organized along two lines: 1) totals and averaqes of biomass and diversity for experimental sites, thereby reflecting the effects of site characteristics (i.e., treatment), and 2) unaveraged values of diversity by study plot, providing a larger statistical basis for examining the effects of elevation and peat depth regardless of context.

Computer facilities of the Northeast Regional Data Center on the campus of University of Florida were used. The followinq procedures (elements of the Statistical Analysis Systems package) were used: correlation, analysis of variance, general linear model, multiple regression, and a plottinq routine.

RESULTS

Vegetation Transects

Summary data for vegetation transects through two cypress/gum swamps that had no recent disturbance are given in Tables A-l and A-2 in the appendix. The sites had been logged for pond cypress (Taxodium ascendens), however, within the last decade and thus the population of this species within both swamps was lower than that found in like ecosystems by Monk and Brown 1965, and Brown 1978. The only evidence of logging was the number of stumps still present. Other signs of disturbance such as open canopy and trampled shrub vegetation had been repaired.

By far, the most important tree species (>l0 cm dbh) was swamp blackgum tupelo (Nyssa sylvatica) with pond cypress (Taxodium ascendens) the second most important. The most prevalent sapling species (<10 cm dbh) was fetterbush (Lyonif lucida). Other species present included sweetbay magnolia (Maqnolia virginiana), red maple (Acer rubrum), swampbay persea (Prersea palustris), summersweet clethra (Clethra alnifolia), and wax (Myrica cerifera) among others.

Herbaceous vegetation was not included in these surveys since tree species were the primary focus of the study.

Plant Population Structure on Experimental Sites

Four detailed censuses of the plant population structure were performed over the year following peat application to the experimental sites. The data from each census by experimental site and plot summaries of each census are presented in the appendix of this report (Tables A-3 through A-6). Values for relative density (number of individuals of a species per total number of all individuals of all species times l00), frequency (number of plots on which species occur per total number of plots), relative frequency (number of plots of occurrence of a species per number of plots of occurrence of all species times l00), and species importance (relative density plus relative frequency converted on a basis of 100% for all species) are given.

All plant species identified are listed in Table 3 by date of each plant census. In the very early stages of germination, plants were difficult to identify and few individuals had germinated. In the second census quite a few species remained unidentifiable, but there were fewer and fewer unknowns as the plants matured. In a few cases, plants were misidentified in the second or

Table 3. List of species found in all square-meter study plots.

Species	Sampling Date			
	2/04/83	5/05/83	8/09/83	10/21/83
Acer rubrum	-	x	-	-
Aeschynomene americana	-	-	x	x
Andropogon gerardi	-	-	-	x
Baccharis angustifolia	-	x	x	x
Boehmeria cylindrica	-	-	x	x
Cassia fasciculata	-	x	-	x
Cephalanthus occidentalis	-	x	-	x
Coreopsis leavenworthii	-	-	-	x
Crotalaria spp.	-	-	-	x
Cyperus haspan	-	-	-	x
Cyperus spp.	-	-	x	x
Digitaria sanguinalis	-	-	-	x
Dulichium arundinaceum	-	x	x	x
Eleocharis baldwinii	x	x	x	x
Eriocaulon compressum	-	-	x	-
Eupatorium capillifolium	-	x	x	x
Eupatorium perfoliatum	-	-	x	-
Heterotheca subaxillaris	-	-	-	x
Hydrocotyle umbellata	x	x	x	x
Hyptis alata	-	-	-	x
Indigofera hirsuta	-	-	-	x
Indigofera spp.	-	-	x	x
Juncus acuminatus	-	x	-	-
Juncus repens	-	-	x	x
Juncus spp.	-	-	-	x
Lepidium virginicum	-	x	-	-
Ludwigia spp.	-	-	x	x
Lyonia lucida	-	-	x	-
Myrica cerifera	-	-	-	x
Panicum bartowense	-	-	-	x
Panicum clandestinum	-	x	-	-
Panicum commutatum	-	-	-	x
Panicum dichotomiflorum	-	-	-	x
Panicum hemitomon	-	-	x	-
Panicum spp.	-	x	-	-
Panicum spp. #1	-	-	x	-
Panicum spp. #2	-	-	x	-

Table 3. (continued.)

Species	Sampling Date			
	2/04/83	5/05/83	8/09/83	10/21/83
Panicum spp. #3	-	-	x	-
Paspalum urvillei	-	x	x	x
Polygonum punctatum	x	x	x	x
Potamogeton spp.	-	x	-	-
Quercus spp.	-	-	x	x
Rhexia spp.	-	-	x	-
Rhus spp.	-	-	-	x
Rubus spp.	-	-	x	-
Rubus trivialis	-	x	-	-
Sagittaria lancifolia	-	-	x	x
Salix caroliniana	-	x	x	-
Saururus cernuus	-	x	x	x
Scirpus californicus	-	-	x	x
Sesbania vesicaria	-	-	x	x
Smilax auriculata	-	-	x	x
Spartina bakerii	-	x	-	-
Stylosanthes biflora	-	-	x	x
Unknown A1	-	-	x	-
Unknown A2	-	-	x	-
Unknown A3	-	-	x	-
Unknown A4	-	-	x	-
Unknown A5	-	-	x	-
Unknown A6	-	-	x	-
Unknown A7	-	-	x	-
Unknown A8	-	-	x	-
Unknown A9	-	-	x	-
Unknown A10	-	-	x	-
Unknown A11	-	-	x	-
Unknown A12	-	-	x	-
Unknown A13	-	-	x	-
Unknown B1	-	-	-	x
Unknown B2	-	-	-	x
Unknown B3	-	-	-	x
Unknown B4	-	-	-	x
Unknown B5	-	-	-	x

Table 3. (continued.)

Species	Sampling Date			
	2/04/83	5/05/83	8/09/83	10/21/83
Unknown B6	-	-	-	x
Unknown composite A	-	x	-	-
Unknown composite 1	x	-	-	-
Unknown composite 2	x	-	-	-
Unknown composite 3	-	x	-	-
Unknown grass 1	x	-	-	-
Unknown grass A	-	x	-	-
Unknown grass B	-	x	-	-
Unknown grass C	-	x	-	-
Unknown grass D	-	x	-	-
Unknown herb A	-	x	-	-
Unknown herb B	-	x	-	-
Unknown herb C	-	x	-	-
Unknown herb D	-	x	-	-
Unknown herb E	-	x	-	-
Unknown herb F	-	x	-	-
Unknown herb G	-	x	-	-
Unknown herb H	-	x	-	-
Unknown herb I	-	x	-	-
Unknown herb J	-	x	-	-
Unknown herb K	-	x	-	-
Unknown herb L	-	x	-	-
Unknown herb M	-	x	-	-
Unknown herb N	-	x	-	-
Unknown herb O	-	x	-	-
Unknown legume	-	x	-	-
Unknown mint	-	x	-	-
Unknown mushroom	-	-	x	-
<u>Vaccinium crassifolium</u>	-	-	x	-

third census, thus, in these instances, they were shown to be present in the second or third census, but not in the fourth.

Germination Studies

Germination studies of peat samples from each experimental plot and wetland transects run previous to the plot sampling were monitored during the course of the project at the Center for Wetlands. Statistics for relative density, frequency, relative frequency, and importance values were calculated for the germination study. Tables of germination tray data for three census periods are given in the appendix as Tables A-7 through A-9.

Species composition in the germination trays was similar to that on the experimental sites. In the first census, the dominant species (determined by importance values), on both the experimental sites and the germination trays was smart weed (Polygonurn punctatum), while the most frequent species was spike rush (Eleocharis baldwinii) in the germination trays and Polygonum on the experimental sites.

Both the germination trays and the experimental sites had very low species counts early in the year, increasing over time. By the August census, there were 42 different species present on the experimental sites and 21 in the germination trays. At this time Panicum (total of 3 species) and Polygonum were the most important species in the germination trays, while Polygonum, Panicum (I species) and Sesbania were the most important on the experimental sites. By the end of the growing season, Polygonum and Panicum bartowense were clearly the most abundant, important, and dominant species on the experimental sites (see Tables A-6 and A-12 in the appendix).

Biomass

Biomass samples were taken the same day the population data were taken. Three biomass samples were obtained over a year's time. Plants were not abundant enough during the February sampling period for biomass to be measured. May, August, and October data are presented in Tables A-10 through A-12 in the appendix.

Five of the 16 species taken for biomass determination were represented in each of the three sampling periods. These species were smartweed (Polygonurn punctatum), dog fennel (Eupatorium capillifolium), panic grass (Panicum spp.), bagpod Sesbania (Sesbania vesicaria), and indigo (Indigofera spp.)

Given in Table 4 and Figure 4 are the biomass data for the experimental sites and control site for the three sampling periods of May, August, and October. Biomass was not determined for the first sampling period since little vegetative growth had occurred prior to the beginning of February. As expected, biomass of upland and wetland species increased over time. Average wetland species biomass was greater than upland species biomass on all sites during the entire year except for sites 3 and 10 in August and for site 10 at year's end. Site 10 had the greatest upland species of all sites, and no wetland species biomass at the year end census.

Table 4. Biomass (g dry wt/m^2) of wetland species compared to upland species on experimental sites in May, August, and October 1983.

Sampling Period		Site	Wetland Biomass	Upland Biomass
05/83		3	11.88	2.95
		6	22.74	1.09
		7	32.49	1.17
		8	75.91	0.52
		9	6.67	0.03
		10	---	---
	Mean		29.94	1.15
		C	2.65	0.39
08/83		3	5.82	19.10
		6	26.76	17.98
		7	188.08	29.85
		8	186.14	9.49
		9	40.10	6.32
		10	2.43	4.92
	Mean		74.89	14.61
		C	6.07	74.98
10/83		3	96.12	33.93
		6	135.94	28.83
		7	157.28	43.34
		8	353.11	59.44
		9	303.19	142.75
		10	---	149.14
	Mean		209.13	76.24
		C	---	85.53

C = control site.

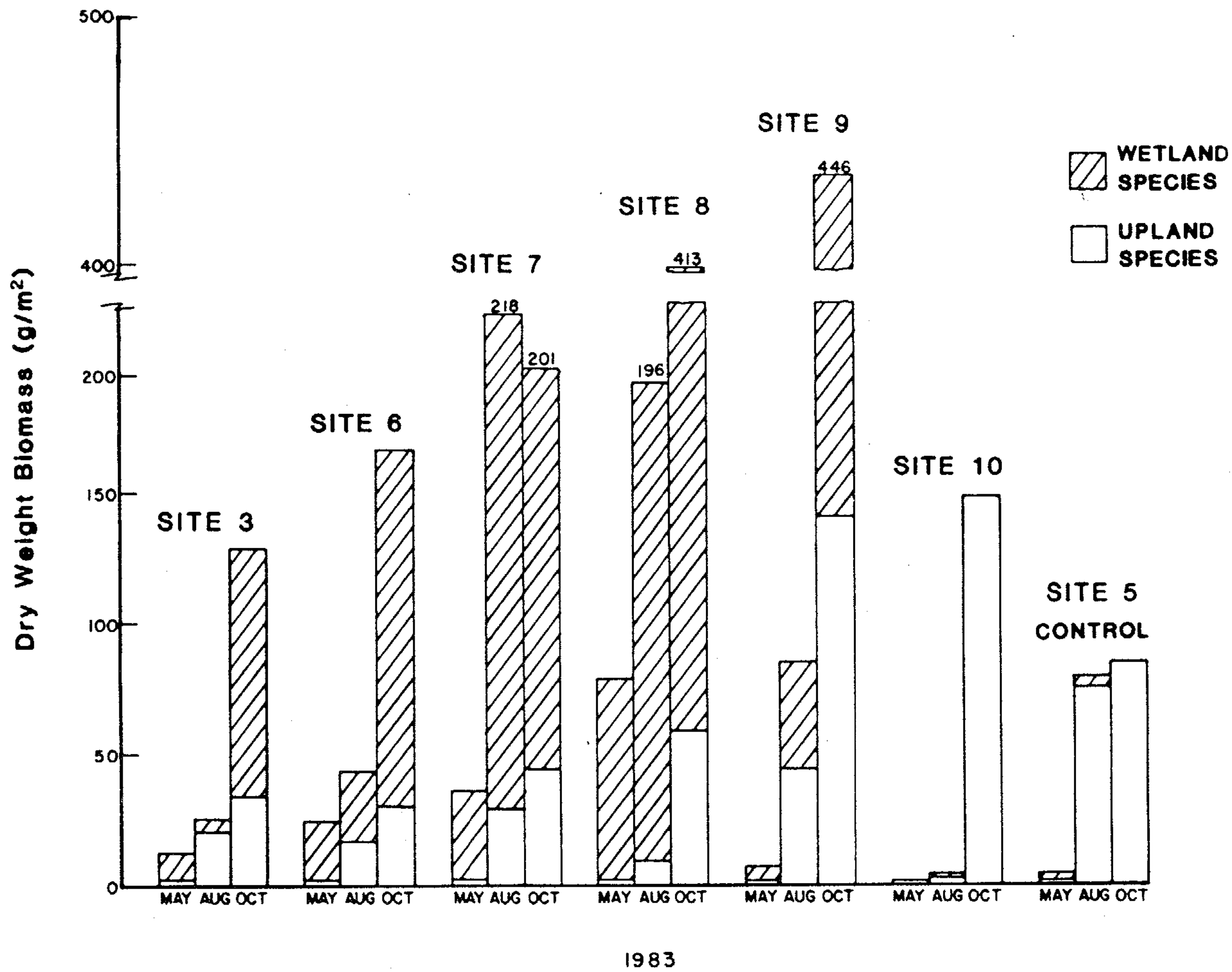

Figure 4. Wetland and upland species biomass at three census times during 1983.

The control site wetland biomass throughout the year was lower when compared to the mean for all sites, and showed an increase above the mean for uplands species biomass. Sites 8 and 9 showed the greatest increase above the mean wetland species biomass, while sites 9 and 10 showed the greatest increase in upland species biomass. At the end of the growing season, sites 8 and 9 had the greatest wetland species biomass.

At the end of the growing season sites 9 and 10 had the greatest upland biomass of all sites, including the control. This is probably the result of the differences in peat applied to these two sites verses the other sites. These were the first two sites to have peat applied and consequently, the material was dug from the edges of the donor swamp and may have contained more upland species' genetic material than other peat that was obtained from more interior locations. This is particularly unfortunate, since these two sites had the lowest elevations and greatest thicknesses of peat applied of all sites, and correlations of wetland biomass with elevation and peat thickness showed no strong relationships.

Site 3 (the highest and driest site) had lowest total biomass and lowest wetland biomass at year end, while site 9 (the wettest site) had highest total biomass and second highest wetland biomass. Site 9 also had the greatest depth of applied peat. Site 8, one of the drier sites, had the highest wetland biomass at year's end.

The contribution to non-living biomass on the experimental sites from the water hyacinth (<u>Eichhornia crassipes</u>) that drifted over the sites during the high water of April 1983 was determined. Percent cover of each site was calculated from detailed maps and is shown schematically in Figure 5. The overall contribution to non-living biomass based on percent cover of each site and measured non-living biomass of hyacinth of 1594.84 q dry weight/m^2 is given in Table 5. Sites 6 and 7 were most affected with 30.19% and 35.87% cover, respectively.

<u>Seedling Census</u>

Three types of tree seedlings were planted in each experimental plot. Swamp blackgum tupelo (Nyssa <u>biflora</u>) seedlings were collected from the natural area and bald cypress (<u>Taxodium distichum</u>) and sweetgum (<u>Liquidambar styraciflua</u>) were purchased from the Florida Division of Forestry. Growth and survival rates of these seedlings were compared to four other seedling sites on Occidental's reclamation areas, which were planted over the past 4 years. Each of these sites varied in ape and growth conditions. A 10-m wide transect was plotted in each of the four areas. Originally not less than 30 individuals were tagged and measured for height at each site. Average heights of trees planted on the experimental sites and on Occidental's reclamation sites are given in Table A-13 of the appendix. Survival on some plots was affected by excessive flooding in April 1983 and wild animal grazing.

Survival and growth rates are given in Table 6 for the experimental sites and Occidental's other reclamation areas. Growth rates on the experimental sites were highest for sweetgum, followed by blackgum and bald cypress.

Table 5. Percent cover and nonliving biomass contribution of water hyacinth.

Site	Average % Cover m^2 Plots	Average % Cover Total Experimental Sites	*Contribution of Biomass on Experimental Sites, g dry wt/m^2
C	0.07	9.78	155.98
3	17.67	12.20	194.57
6	13.83	30.19	481.43
7	33.25	35.87	572.07
8	26.50	17.63	281.17
9	43.83	18.48	294.17
10	8.25	5.91	94.26

*Based on 1594.84 g dry wt/m^2 measured nonliving biomass of hyacinth and percent cover on each experimental site.

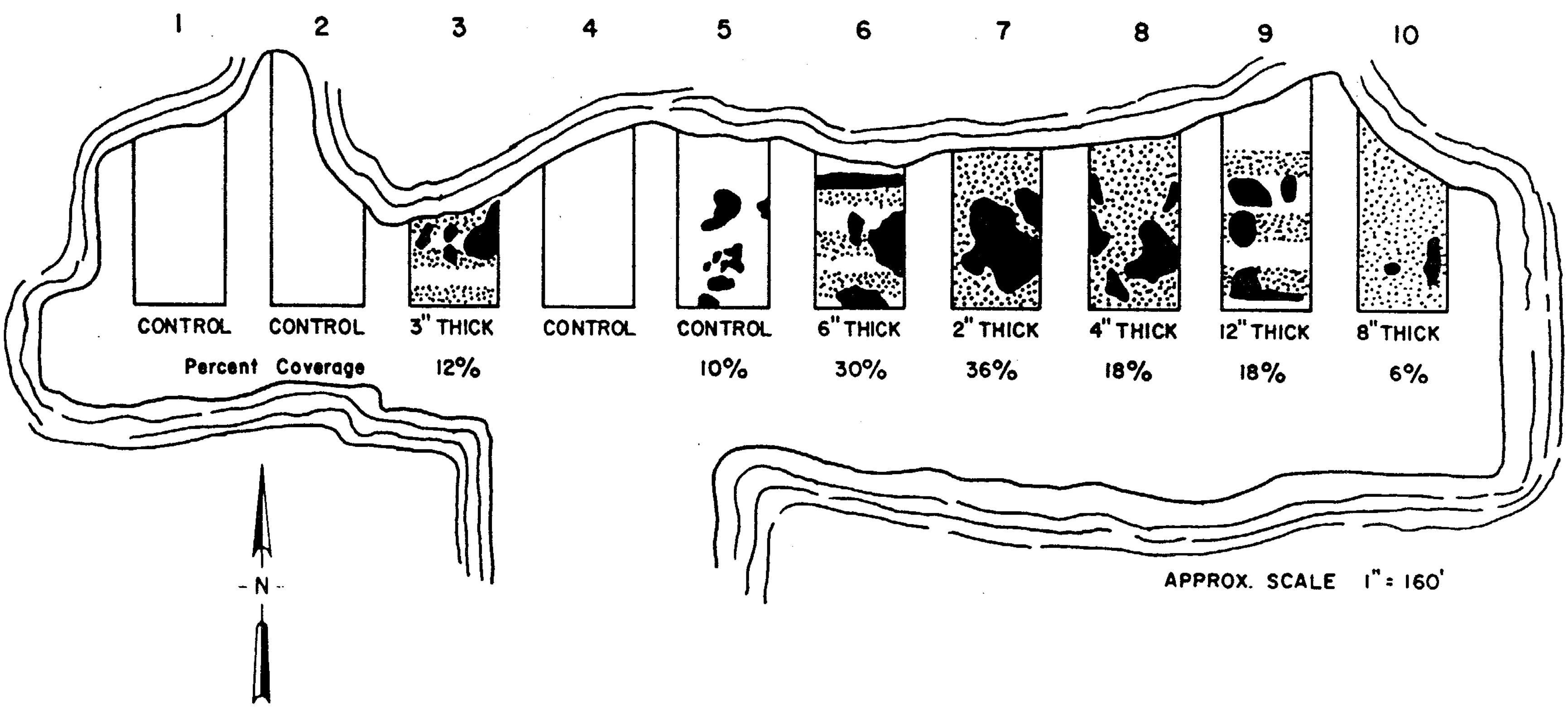

Figure 5. Extent of coverage of experimental sites by water hyacinth after the high water event in the week prior to 4/20/83.

Table 6. Survival and growth rates for species planted on experimental sites and other reclamation sites.

Site	Nyssa biflora		Taxodium distichum		Liquidambar styraciflua			
	% Survival	% Growth	% Survival	% Growth	% Survival	% Growth	Total Survival Rate, %	Total Growth Rate, %
Experimental Sites								
3	53	26	100	8	96	18	87.5	16
6	45	28	86	16	1.12	22	84	20
7	14	27	72	*	67	15	47	18
8	11	4	90	19	87	31	67	19
9	47	20	95	19	84	30	76	22
10	0	0	1.05	19	78	10	49	17
Reclamation Sites								
A planted 1981	--	--	100	16	100	20	100	19
B planted 1982	--	--	73	21	--	--	73	21
C planted 1982	--	--	58	8	--	--	58	8
D planted 1983	--	--	90	15	--	--	90	15

*Negative growth rates due to extensive grazing of Taxodium.

Survival rates sites were highest for cypress, followed by sweet gum and black gum, respectively.

During the very high water of April, many seedlings were covered by hyacinth that floated across the sites. Site 7 (note Figure 5) was particularly hard hit. The lowest site, site 10, had highest seedling mortality of blackgum and cypress, and significant mortality of sweetgum, probably as a result of the length of time and depth of inundation. If sites 7 and 10 are not included, percent survival over the remaining sites for blackgum, cypress, and sweetgum averaged 39%, 93%, and 67% respectively.

The only comparison in this first years growth, between the seedlings planted on the experimental sites and those planted elsewhere on overburden is a comparison between the experimental sites and site "D" in Table 6. The site "D" cypress were planted at about the same time and were from basically the same source, although different purchases. Overall growth rates and survival on the experimental sites were not statistically different from those planted on the overburden at site "D".

Accumulation/Loss of Peat

Peat depth was initially calculated from estimates of the volume of peat applied to each experimental site and measured for more accurate determination in April 1983 and January 1984. Water seldom covered the sites during the year, thus peat was exposed to weathering and oxidation. Given in Table 7 are the measured depths of peat at three locations on each of the experimental sites. While there is no clear indication of trends of peat loss, half of the sites showed decreases in depth, the majority of which were along the northern edge next to the lake. The average loss of peat at these points was 8.5 cm. The remaining locations showed a net increase in peat depth, probably due to differences in measuring technique rather than an actual increase in peat.

pH of Soils, Interstitial Waters, and Lake

Weekly measurements of lake water pH were made using an Orion Research Ion-analyzer model 339A. When the experimental peat sites were saturated with water, interstitial pH was measured. Given in Table 8 are the measured pH's of interstitial water and the lake water for those periods when the peat on the experimental sites was saturated. The experimental sites remained too dry to hold measureable interstitial water from 29 April 1983 to 5 January 1984. Shown in Figure 6 is the fluctuation of pH in the lake water adjacent to the experimental sites.

The pH of the peat on the experimental sites was measured initially when the peat was applied, again in March and May 1983, and finally in December 1983. Given in Table 9 are the pH measurements in distilled water and 0.01 M CaCl solution on the experimental sites. Representative samples of overburden and

Table 7. Peat depth (cm) on experimental sites.

Site	Initial* Estimate, cm	04/29/83			01/05/84		
		South	Middle	North	South	Middle	North
3	11.3	11	8	19	6	11	7
6	22.6	25	20	16	24	24	20
7	8.7	7	11	19	9	10	9
8	17.3	18	15	15	18	13	8
9	45.2	32	26	29	37	28	27
10	32.1	38	32	40	41	36	28.5

*Calculated from area covered by peat and estimation of volumes applied.

Table 8. pH of lake and interstitial water.*

Date	Lake	Study Site					
		3	6	7	8	9	10
1/19	8.3	D	D	D	D	D	D
3/30	6.3	4.5	4.2	4.6	4.4	4.2	3.6
4/08	6.3	4.0	3.9	4.6	4.0	4.3	4.1
4/13	5.9	I	I	I	I	I	I
4/20	5.7	4.5	4.5	4.5	4.4	4.4	4.1
4/29	8.2	D	D	D	D	D	D
5/06	6.8	D	D	D	D	D	D
5/13	7.3	D	D	D	D	D	D
5/20	7.1	D	D	D	D	D	D

*Interstitial water in peat of experimental plots.
I = Inundated, D = Peat too dry to hold measurable water.

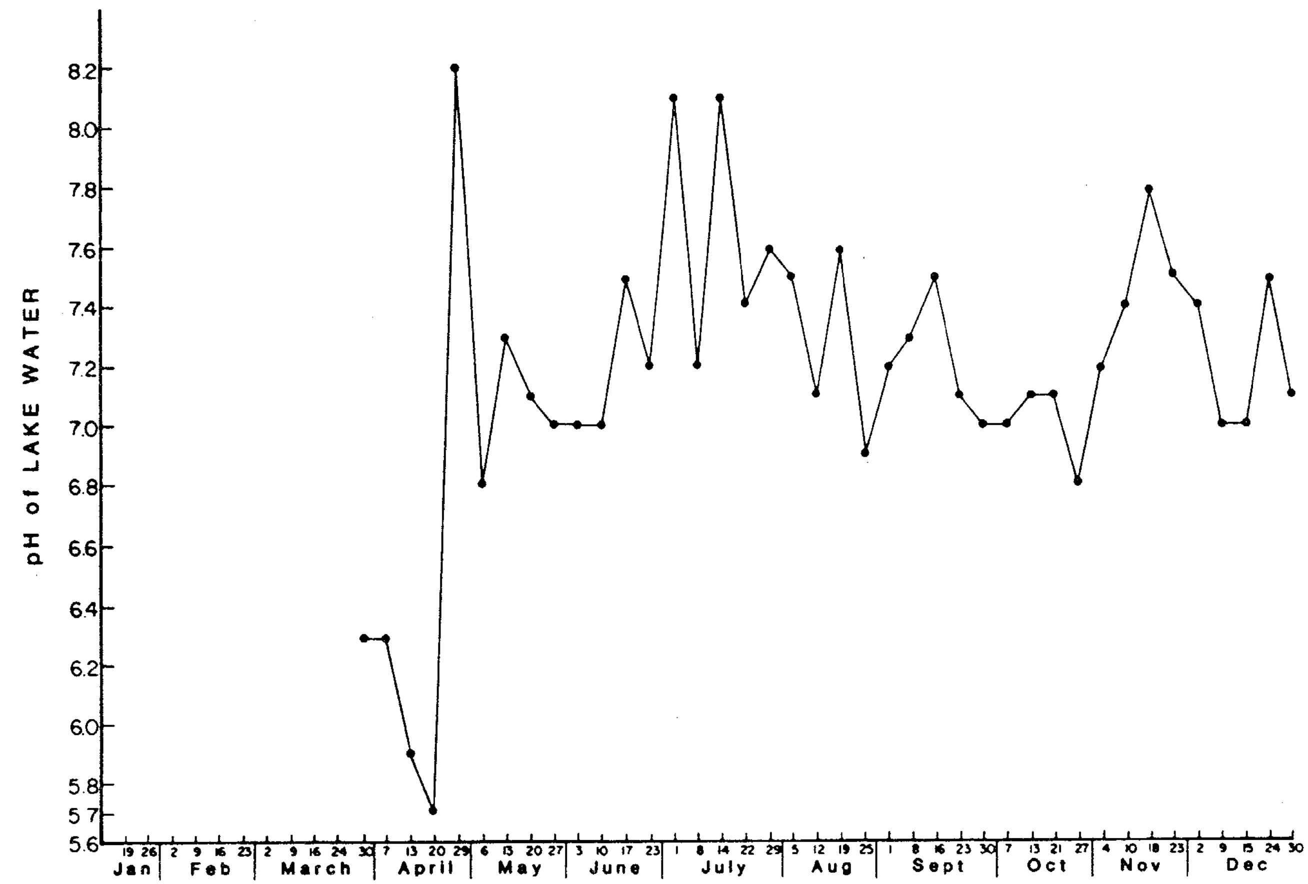

Figure 6. Lake water pH over the duration of the project. The wide fluctuation in April coincides with very high rainfall and lake levels.

Table 9. Soil pH determined in distilled water and 0.01 M CaCl.

	11/24/82		03/30/83		05/13/83*		12/15/83	
Study Site	Distilled Water	CaCl	Distilled Water	CaCl	Distilled Water	CaCl	Distilled Water	CaCl
Site 3	3.70	2.80	4.30	3.45	4.80	3.50	4.40	3.70
Site 6	3.75	2.80	4.30	3.35	4.50	3.65	4.50	3.80
Site 7	4.30	3.80	4.50	3.60	4.60	3.70	4.45	3.80
Site 8	3.70	2.95	4.30	3.60	4.75	3.70	4.40	3.70
Site 9	3.70	2.90	4.30	3.50	4.80	3.70	4.40	2.90
Site 10	4.20	3.60	4.30	3.60	4.50	3.70	4.40	3.70
Control	--	--	4.50	3.70	5.80	4.40	--	--
Overburden	5.55	4.70	5.30	3.95	--	--	--	--
Overburden	5.55	4.75	--	--	--	--	--	--
Cypress/gum Swamp peat	4.05	3.20	--	--	--	--	--	--
Cypress/gum Swamp peat	4.05	3.15	--	--	--	--	--	--

*05/13/83, supernatant pH for distilled water.

peat from an undisturbed cypress/gum swamp are given for comparison. No significant trends in pH changes over the duration of the project are apparent.

Water Levels

Rainfall was monitored daily by Occidental Chemical Company on weekdays: weekend values were summed. Monthly totals are given in Table A-14. Amounts were typical for north-central Florida, though the summer rainfall made up a smaller proportion of the total than was expected. During the early stages of the project, January through April, total rainfall was greater than usual. May and October were very dry.

Figure 7 *is* a histogram of daily rainfall during 1983. It is apparent that most rainfall events were of limited depth, with 29 (46%) less than 0.5 cm, and 38 (60%) less than 1 cm. This is significant when considering soil moisture. The soils at these sites are high in moisture-holding ability, and the groundwater level was below the surface for nearly the entire year. Runoff channels were well developed where water pooled and, after a rainfall, percolation was very slow. Under these conditions, most small rainfall events wet very little soil. In the peats most water cycled internally, rainfall to evapotranspiration. Thus, in the absence of direct groundwater connections or significant internal runoff, these limited rainfall events only wet the soil for a day or two at the most. In spite of abundant rainfall, sites located above the water table were dry most of the time, at least in the root zone.

Since most rainfall events provide little long-term soil moisture, wetland soil conditions at a site such as this depend on a high groundwater table. The experimental sites are located directly adjacent to a lake. Water levels in the lake were measured weekly, and a water level recorder provided continuous monitoring for most periods. Due to the proximity of the sites to the lake, groundwater levels were assumed equal to lake levels. With the exception of transient conditions, such as during and immediately after a rainfall, or while lake levels are being artificially lowered, this is probably an accurate assumption. Thus for the purposes of comparison of groundwater levels with elevation of experimental sites, lake levels were used as indicative of groundwater levels.

Lake levels, weekly rainfall amounts, and mean site elevations are plotted in Figure 8. While lake levels are controlled artificially by Occidental, they track rainfall amounts in a general manner during most of the year, though major exceptions are found. Most prominent is the rapid and extreme lowering of the lake level from April 13 to April 29. During this period the level decreased from 37.06 m to 35.95 m, or 1.11 m. This followed a substantial rainfall of 9.45 cm the previous week and 5.56 cm during the period when the lake level was lowered. Lake levels remained low during most of summer and rose again to a peak of 36.84 m on September 16. Once again the level dropped precipitously despite apparently adequate rainfall. During autumn, rainfall amounts decreased and lake levels were very low until the heavy rainfalls in early winter. The lowering of lake levels for much of the growing season contributed to very short hydroperiods for the experimental sites.

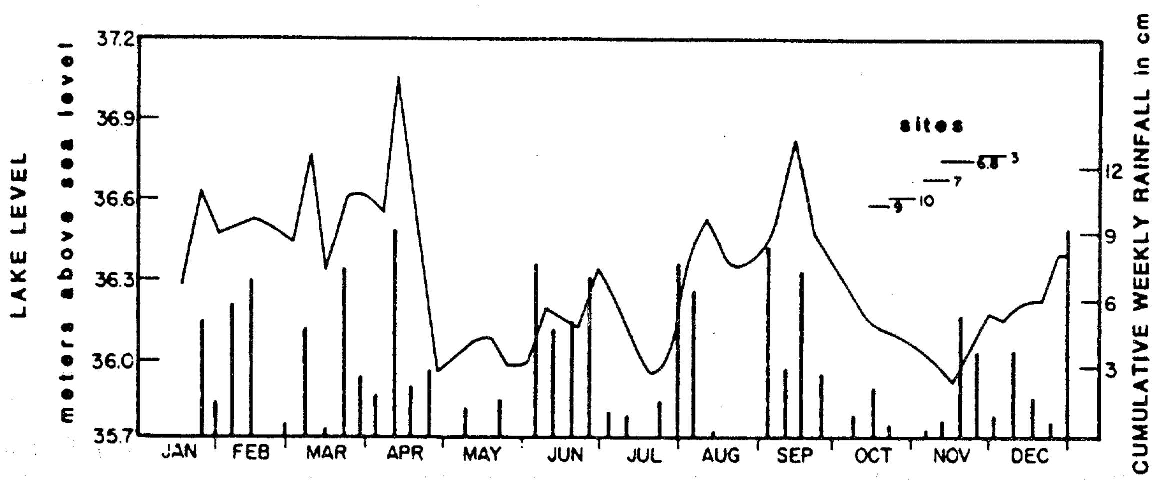

Figure 7. Frequency distribution of week day rainfall amounts near experimental sites during 1983.

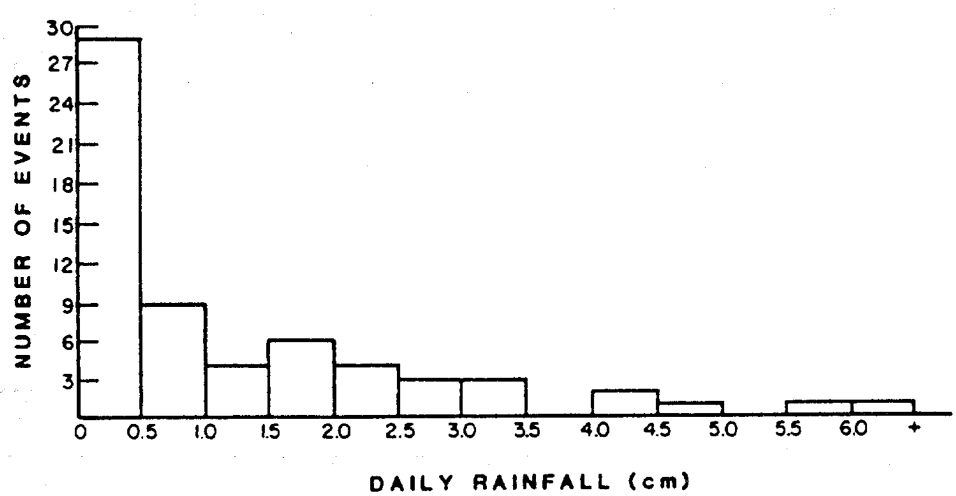

Figure 8. Weekly rainfall and lake levels during 1983 with mean elevations of experimental sites.

Hydroperiod

Hydroperiod, or the total number days during the year when water is at or above the soil surface, is a critical parameter in the establishment and differentiation of wetlands types. Approximate hydroperiods have been measured for different wetlands ecosystems in Florida by Wharton et al. (1977) and Brown and Starnes (1983). Hydroperiods range from 365 days a year for marshes to 100-150 days for hydric hammocks. Given in Table 10 are the mean elevations and hydroperiods (determined from water level records and mean elevations) for the experimental sites. The longest hydroperiod was 48 days for experimental site 9, indicating that appropriate wetland hydroperiods fell short of those observed for natural wetland communities. The timing of inundation was also inappropriate for wetland formation, with little flooding occurring during the active growing season. It is thus clear that hydrologic conditions were generally not conducive to wetland development.

It is apparent from Table 10 that very small changes in elevation can make major changes in hydroperiods. The hydroperiods for each of the square meter study plots were determined using elevation of each plot and water level recordings, and compared with the number of wetland, transitional, and upland species found on each plot. These data are given in Table 11. The majority of plots had short hydroperiods with 74% having hydroperiods less than 30 days. While there are fewer species in all groups as hydroperiod increases (probably due to the decreasing sample size [i.e., number or plots]), some trends are apparent. Transition zone species make up a larger proportion of the species found at longer hydroperiods and upland species make up a smaller proportion. This could indicate that the upland species are at a competitive disadvantage on the wetter sites and that some of these plot hydroperiods are approaching wetland duration. It is interesting that only two upland species, panic grass (*Panicum commutatum*) and crab grass (*Digitaria sanguinalis*) are found at hydroperiods greater than 50 days. However, there are too few plots in these longer hydroperiod classes to be conclusive and one year may be too short a time to draw hard conclusions. The number of submerged species exhibits no obvious pattern, indicating again that these hydroperiods may be too short for establishment of species requiring greater periods of saturated and/or inundated soils.

The relationships of hydroperiod to number and mean biomass of submerged, transitional, and upland species are given in Figures 9A and 9B. The graphs express hydroperiod as a mean for each experimental site. While there are no significant differences between numbers of species of each class versus hydroperiod, total biomass in each class exhibits some change with increasing hydroperiod. As might be expected the biomass of upland species decreases rapidly with increasing hydroperiod, while the biomass of transitional species increases. The biomass of submerged species is lowest with a hydroperiod of 40 days. This low point corresponds to experimental site 10 and as stated previously, may be the result of differences in the peat material instead of any relationship to hydroperiod.

A more detailed picture of the relationships of hydroperiod to mean biomass is given in Figures 10A and 10B. The hydroperiod and mean biomass for each of the square meter study plots are graphed. Since there is much greater variation in elevation for each of the study plots as compared to the mean elevation of the experimental sites, there are a number of plots with hydroperiods greater

Table 10. Mean elevation and hydroperiod of experimental sites.

Site	Elevation, m	Hydroperiod, days
3	36.77	11
6	36.74	13
8	36.73	14
7	36.66	21
10	35.59	40
9	35.57	48

Table 11. Number of species found in plots by hydroperiod class.

Hydroperiod, days	Number of Plots	Submerged	Transitional	Upland
0-9	19	10	7	11
10-19	19	8	6	8
20-29	14	8	8	6
30-39	5	3	4	4
40-49	2	5	2	2
50-59	1	2	2	0
60-69	1	0	2	1
70-79	0	0	0	0
80-89	2	1	4	0
90-99	3	2	4	0
100-109	2	2	4	1
110-119	2	2	4	1
120+	2	2	4	0

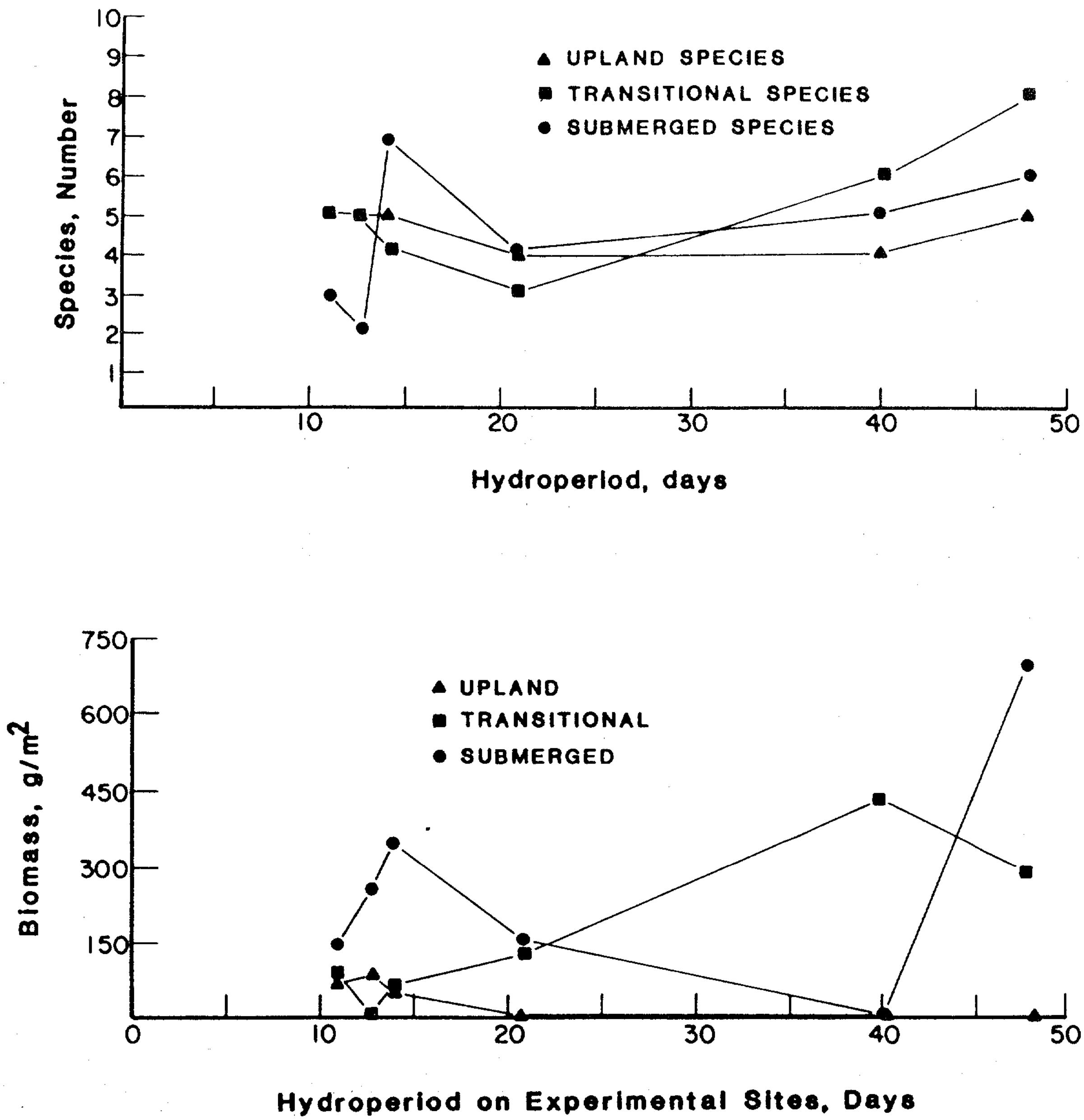

Figure 9. a. Number of upland, transitional, and submerged species found versus the hydroperiod of experimental site.

b. Mean biomass of upland, transitional, and submerged species versus hydroperiod of experimental sites.

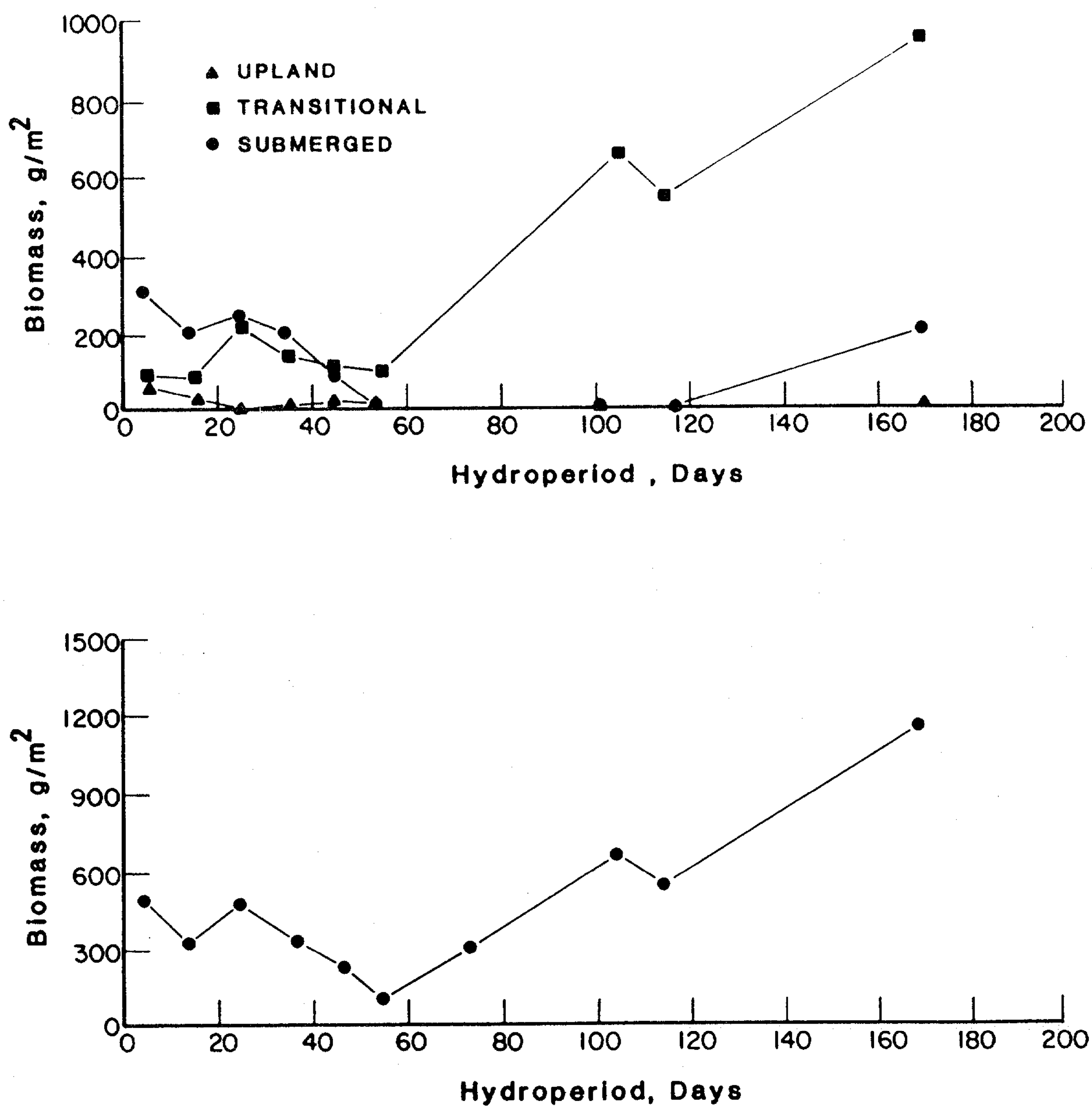

Figure 10. a. Mean biomass of upland, transitional, and submerged species on plots having peat versus hydroperiod.

b. Mean total biomass versus hydroperiod for plots having peat.

than 50 days (see Tables 10 and 11). In Figure 10A the larger number of data points gives a clearer picture of the increase in transitional species biomass with increasing hydroperiod when compared to the graph in Figure 9B. Total mean biomass (the sum of upland, transitional, and submerged biomass) versus hydroperiod is graphed in Figure 10B. The trend indicates increasing biomass with increasing hydroperiod; however, it is important to bear in mind the relatively small number of sites that had hydroperiods greater than 50 days when drawing conclusions from both Figures 10A and 10B.

Topographic Diversity

Natural wetland ecosystems, whether young or mature, tend to have small-scale topographic variation. The variation results from geologic forces, tree growth and uprooting, animal activity, and hydrologic events, and creates many potential habitat types. In ecosystems with a fluctuating water table close to the surface, this variation in topography may be of great importance to micro-habitat conditions and the development of community plant diversity.

During the application of peat to the experimental sites, large equipment was used to deposit and spread the material under somewhat adverse conditions. Some unevenness of the applied peat could be expected, adding to the existing variation in terrain resulting from initial contouring. Elevations at all 12 study plots within each of the experimental sites were determined and the standard deviation of these elevations, expressed in meters, was used as the measure of topographic diversity. Given in Table 12 are the mean depths of peat, volume applied, and topographic diversity (s) for each of the experimental sites. The first three sites are strip treatments, and the second three sites are uniform spreading treatments. Within each of the major treatment categories (strips and uniform spreading) greater topographic diversity was associated with greater volumes of material. For the same volume, there was greater diversity with the strips than the uniform treatment, as would be expected.

To test whether the biotic factors are closely related to microhabitat variation at this early stage of ecosystem development, overall plant diversity was calculated for each study site using the Shannon Index (Shannon and Weaver 1949) and was regressed on topographic diversity (Figure 11). The positive linear correlation ($r = 0.79$) is significant at the 90% level, using a t-test for population correlation (Steel and Torrie 1980). Site 3 has the greatest divergance from the general pattern. This site is at the highest elevation relative to water level and had peat applied in strips. These two factors may explain the higher plant diversity because of the inclusion of a larger number of upland species. Presence of peat was highly significant at early sampling dates but became less significant as high-growth legumes took over the nonpeat areas.

Table 12. Topographic diversity (s) and experimental treatment. Topographic diversity is calculated as standard deviation of elevations within each site.

	Depth, cm	Volume, m^3	s, m
STRIPS			
Site 3	12.67	46.30	0.06
Site 6	20.33	74.29	0.12
Site 9	29.00	105.97	0.18
UNIFORM			
Site 7	12.33	117.42	0.05
Site 8	16.00	152.37	0.08
Site 10	36.67	377.11	0.17

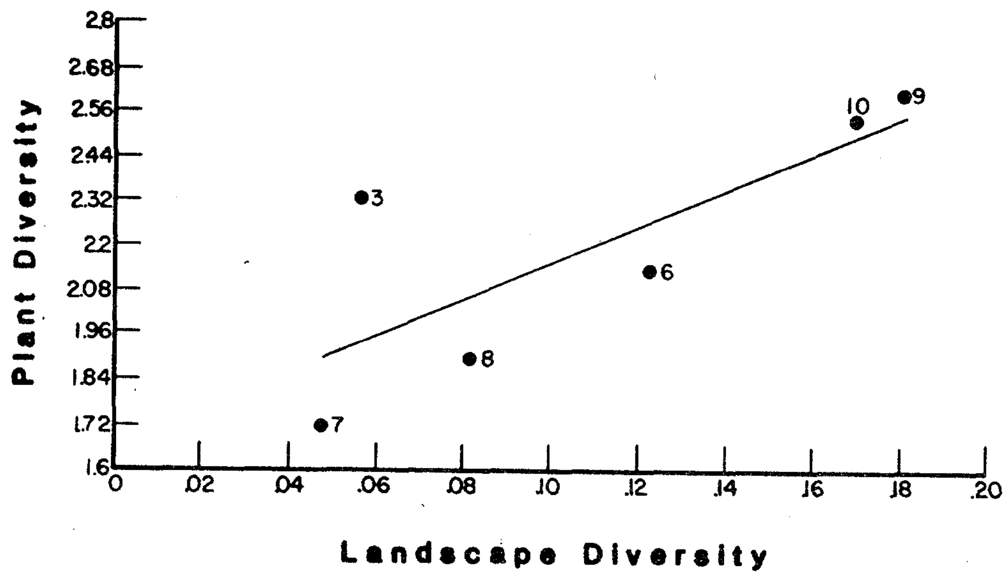

Figure 11. Relation of plant diversity to topographic diversity (landscape diversity) for experimental sites. Plant diversity is the Shannon Index, $H' = -\Sigma p_i \log p_i$, and topographic diversity is the standard deviation of elevations within each site in meters. Data point numbers correspond to experimental sites (see Figure 3).

Statistical Evaluation of Results

Various statistical tests were performed to evaluate the effects of the treatments, presence and absence of peat, elevation, hydroperiod, and thickness of peat on the numbers, diversity, and biomass of plant species on the experimental sites. With only one year's data, and the complications induced because of the low water levels, the statistical evaluations are not as strong as one would like. Where correlation coefficients were close to "1" the results were not statistically significant.

Differences in mean biomass between plots that received peat and those that did not were evaluated with t-tests. Figure 12 shows the relationships between peat and non-peat plots. The non-peat plots are all plots in the strip treatment experimental sites that were not on the peat and the control plot. The differences (assuming unequal variances) between total biomass on plots with peat and without peat are significant to the 96% confidence level. The tests for differences in submerged species biomass were also significant at the 99.95 confidence level. However, such high confidence levels were not associated with the differences in peat and no peat for transitional and upland species biomass. There was no significant difference in transitional or upland species biomass between peat and non-peat plots.

Multiple regressions on plot data for upland, transitional, and submerged species versus peat depth and hydroperiod were performed. The regression equations, R-squared, and sum of squares explained by each variable are given in Table 13. These statistical results are given for comparative purposes, since the R^2 for regression equations suggests that there still exists significant unexplained variation in the biomass occurring on the study plots.

Economic Costs

Two nomograms relating travel distance and application rate to the costs per acre of applying peat material to reclamation sites are given in Figure 13. These relationships based on data obtained from the experimental plots at the Occidental reclamation site are shown in Figure 13a. Data from a reclamation site at the Gardinier mine near Fort Meade, Florida, are used to construct the nomogram in Figure 13b.

The differences in costs reflect different conditions and different methods of transporting the material from the donor swamps to the reclamation site. At the Occidental sites, Cat 627 scrapper pans were used to transport the material, while at the Gardinier site, lo-yard dump trucks were used. Conditions at the Occidental site were much different than those at Gardinier. Much of the haul road at Occidental was over newly recontoured land, and due to the weight of the pans, the condition of the road deteriorated rapidly. An additional piece of equipment (motor grader) was necessary to maintain the condition of the haul road. The road conditions did not seem to affect the round trip travel time significantly, however, since travel times were almost identical when the differences in distance were considered.

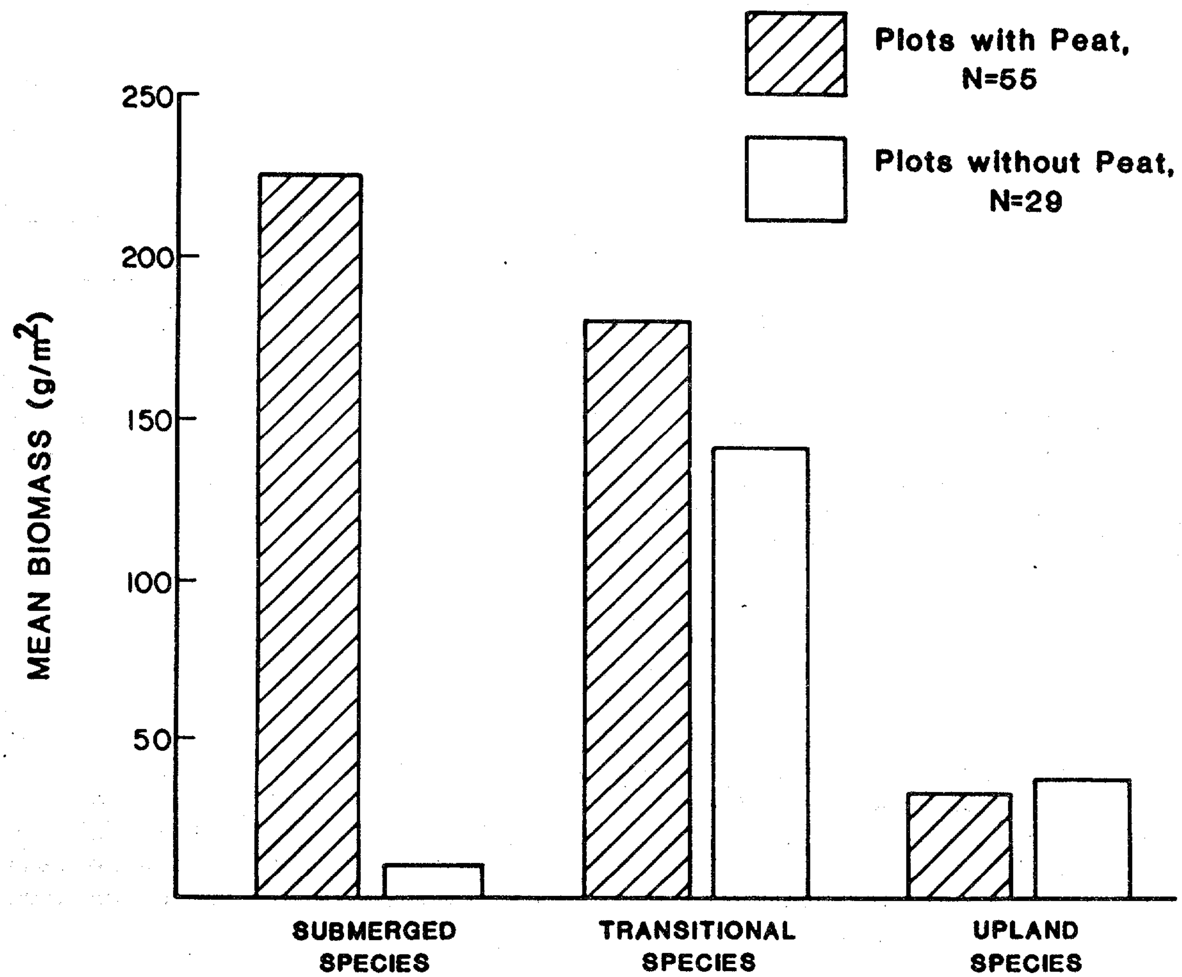

Figure 12. Mean biomass of submerged, transitional, and upland species on plots with peat and plots without peat at the end of the growing season, 1983.

Table 13. Multiple regression equations, R-squared, and sum of squares explained by each variable for submerged, transitional, upland, and total biomass versus peat depth and hydroperiod for study plots.

Equation	R^2	Sum of Squares Explained By Peat Depth	Sum of Squares Explained By Hydroperiod
Submerged Biomass			
Biomass = 151 + 3.12 P + 1.27 H	8.3%	23%	67%
Transitional Biomass			
Biomass = -44.7 + 5.61 P + 3.82 H	43.9%	29%	71%
Upland Biomass			
Biomass = 59.7 - 0.668 P - 0.437 H	16.6%	30%	70%
Total Biomass			
Biomass = 166 + 8.06 P + 2.12 H	25.7%	67%	33%

Biomass in g/m^2.

P = peat depth in cm; H = hydroperiod in days.

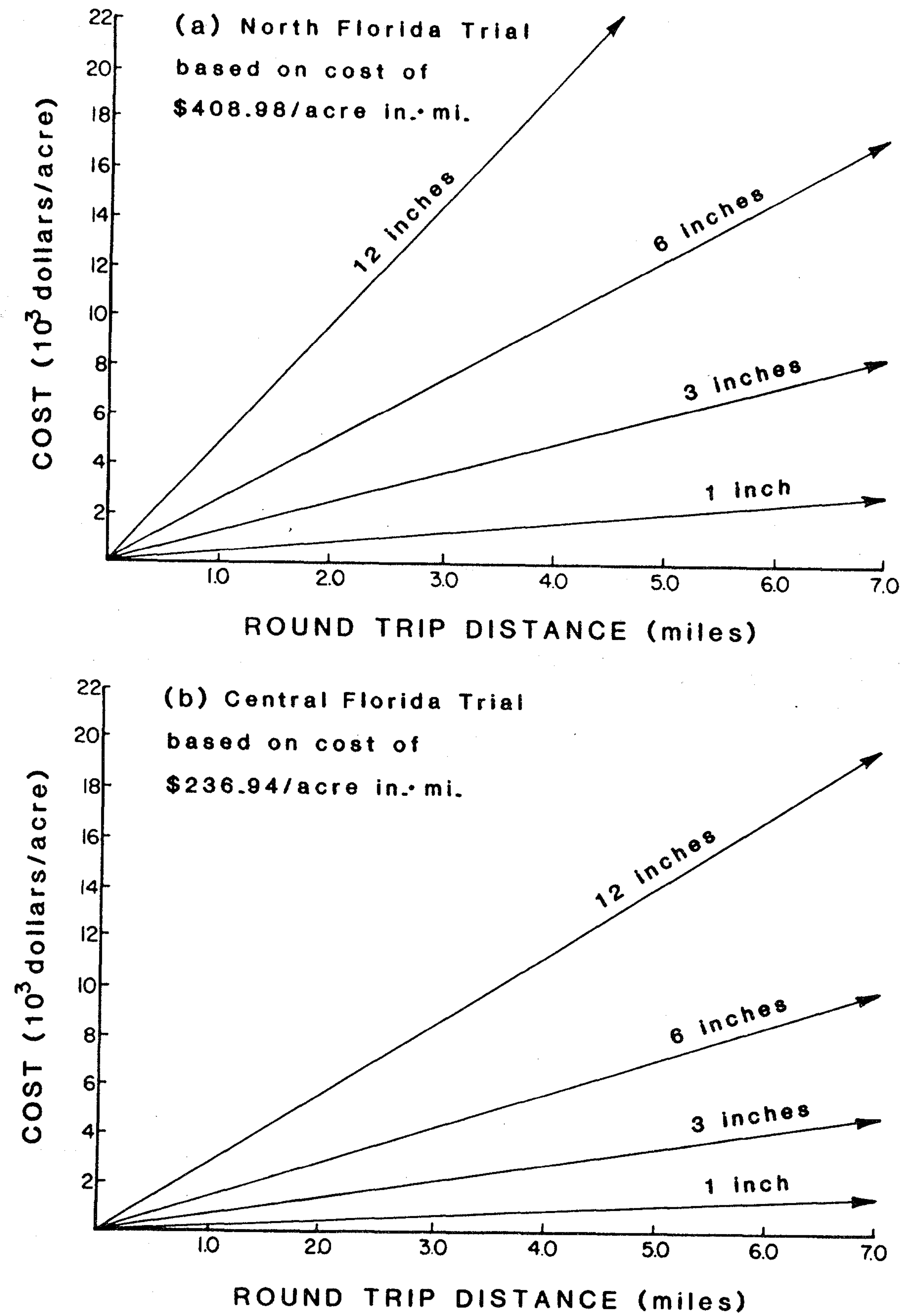

Figure 13. Travel distance and application rate versus cost per acre of applying peat material. a. based on Occidental's reclamation site. b. based on Gardinier's reclamation site.

Generally, the Occidental trials were done as follows: The peat material was obtained from a swamp after the vegetative cover had been removed by a Cat D-8 dozer. Groundwater levels were lowered prior to the work progressing; however, there were still saturated soils within the swamp. The material in the swamp could not be removed by the Cat 627 pans alone and the help of a D-8 dozer was required. Once loaded, travel time over the 4.8 km (3-mile) round trip was about 25 minutes. Spreading of material was accomplished directly with the pans and was finished using a small Komatsu dozer.

The trials at Gardinier were done as follows: The peat material was dug from the donor swamp using a 30B dragline and stockpiled whenever a dump truck was not available for loading, otherwise the material was placed directly into the dump truck. The travel time over the 3.6 km (2.25-mile) round trip was about 20 minutes. The material was dumped along the edges of the wetland area and pushed into the wetland by dozers. The conditions within the wetlands were quite wet, causing spreading costs to be somewhat higher than might be expected with drier conditions.

The cost breakdown for transporting and spreading the material to both sites is given in Figure 14. Details of calculations are given as notes to Figure 14. Costs are calculated on a cubic-yard basis and do not reflect the differences in round-trip travel distances. The bulk of the costs for transporting material at the Occidental site was for the Cat 627 pans (costing nearly 3 times what a dump truck costs while delivering only about 39% more material per trip). Spreading costs at the Gardinier site were over twice those at the Occidental site reflecting the difficulty in spreading material in very low areas with unstable soils due to standing water. At the Occidental site, enough drawdown of water levels had occurred so as to minimize effect of unstable soils in the application process.

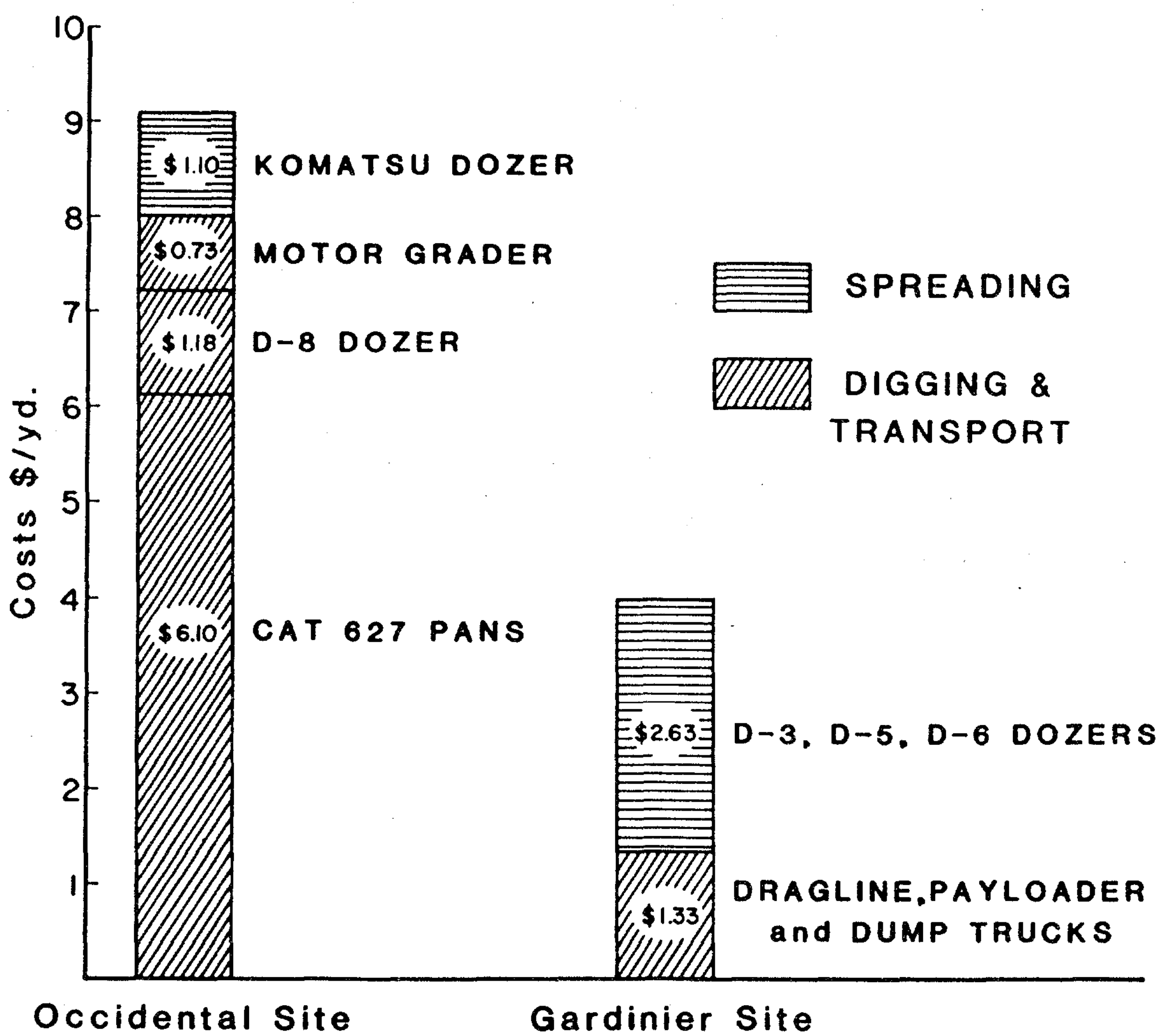

Figure 14. Cost breakdown for transporting and spreading the peat material for each reclamation site.

Notes to Figure 13 and Figure 14.

1. Occidental Experimental Sites.

Total Cost, $10,484.00
Material Moved, 1148.8 yd3 (878.4 m3)
Round Trip Travel Distance, 3 miles (4.8 km)
Area of Application, 0.986 acres (.4 ha)

Four Cat 627 scrapper pans were used to dig and transport material. A D-6 dozer was required to push pans through the donor wetland, and a 16 G motor grader was required for continual maintenance of about half of the haul road. A Komatsu dozer was used to spread the material on the sites.

The calculations for Figure 13a are as follows:

$(1148.8\ yd^3 \times 27\ ft3/yd3)/(43560\ ft^2/acre) = 0.712$ acre ft applied

= 8.54 acre inches applied.

($10,484)/(8.54 acre in x 3 mi) = $408.98/acre·in·mi.

In Figure 14 the 627 scrapper pans, D-8 dozer and motor grader were charged to digging and transport, while the Komatsu dozer was charged to spreading.

2. Gardinier Site.

Total Cost, $13,406.50
Material Moved, 3381 CU yd (2585.1 m3)
Round Trip Travel Distance, 2.25 miles (3.6 km)
Area of Application, 6.1 acres (2.5 ha)

Four 10-yard dump trucks were used to transport material. A 30B dragline and 966 payloader were used to dig and load material. D-6, D-5, and D-3 dozers were used to spread material.

The calculations for Figure 13b are as follows:

$(3381\ yd^3 \times 27\ ft3/yd3)/(43560\ ft2/acre) = 2.1$ acre ft applied

= 25.15 acre inces applied.

($13,406.50)/(25.15 acre in x 2.25 mi) = $236.94/acre·in·mi.

In Figure 14 the dump trucks, dragline, and payloader were charged to digging and transport, while the 3 dozers were charged to spreading.

DISCUSSION

The lower than anticipated water levels over the experimental sites have overshadowed the results of this test of peat "inoculation" as a means of forested wetland re-creation. Undoubtedly, the lower water levels and the fact that the sites were dry for long periods of the year affected the germination, survival, and growth rates of the plant species present as propagules and seeds. While no woody species were seen to germinate on the experimental sites, the sites were quite rapidly colonized by herbaceous wetland species. The preponderance of wetland species and their contribution to total biomass on each of the experimental sites, especially when compared with the control site where no peat was applied, is strong evidence that this method warrants serious consideration as a method of wetland re-creation.

Biomass at the end of the growing season on the experimental sites when compared to the control was impressive. Total biomass on two of the sites was nearly 5 times the biomass on the control. Wetland species biomass was nonexistent on the control while the mean standing crop of wetland species was greater than 200 g dry wt./m^2 for the 6 experimental sites. Two of the experimental sites had over 300 g dry wt./m^2 of wetland species biomass at the end of the growing season (sites 8 and 9).

The survival and growth rates of tree seedlings planted in peat are encouraging. Of the three species planted, bald cypress (Taxodium distichum) had the highest survival rate (when those damaged by grazing were excluded). The best growth rates were exhibited by sweetgum (Liquidambar styraciflua), although survival rates were not as high as Taxodium. The survival of swamp blackgum tupelo (Nyssa biflora) was lower, but growth rates of those that survived were excellent.

The lack of a sufficient hydroperiod undoubtedly affected the overall results of the project, yet the strong relationships between biotic factors within wetland systems and hydroperiod are reinforced. Generally the amount and types (upland, transitional, and submerged species) of plants that survived and grew on the experimental sites were controlled by the hydroperiod. It cannot be stressed enough how important hydroperiod is to developing and maintaining wetland ecological systems.

The amount of peat applied and method of application seems to have some affect on the survival and growth of wetland species and overall community structure. The relationship is not as clear as one would like, when the effect of decreased hydroperiod due to higher elevations is taken into account. Generally, as the thickness of peat increases, survival and growth of submerged and transitional species increases while upland species show a marked decline in growth and survival. Highest wetland biomass at the end of the growing season was on site 8 where peat thickness averaged about 16 cm (6 inches). Average biomass per experimental site is higher on those sites where peat was spread uniformly, yet greatest diversity is achieved where there is greater variation in topographic relief created by uneven application of peat in strips.

The quality of peat strongly influences the quality of wetland achieved after inoculation. Of importance is the area and depth from which the peat is dug. The first material removed from the donor swamp was dug from the edge where the material resembled the sandier soils of the surrounding pine flatwoods community. Germination of wetland species on this material was not nearly as prevalent as with material that was obtained from more interior locations. Many studies in a variety of ecological systems (for example see Harper, 1977) have confirmed that viable seeds drop off rapidly with increasing soil depth. As a consequence it is recommended that material should be taken from the top 1 foot or so of the soil column within the donor wetland.

While it is impossible to tell in only one year if this method of wetland re-creation will establish sufficient numbers of wetland tree species to meet current reclamation rules, these tests do show that a herbaceous cover of wetland species can be established. Even without the successful germination of woody species, the inoculating method might be used in conjunction with direct planting of wetland tree seedlings where forested wetlands are needed. In this way, rapid colonization by wetland herbaceous species is insured to help establish some wetland function from the outset, rather than waiting years for such establishment and the resulting functional equivalency. A second benefit of the inoculation technique used in conjunction with direct planting may be the establishment of a diverse wetland capable of competing with cattail (Typha spp.) and thus preventing the monospecific strands of cattail that sometimes develop in wetland reclamation areas.

There is no question that of the two techniques of transporting the peat material analyzed in this study, the use of draglines to dig and dump trucks to transport the peat is far more cost effective than using scrapper pans. The costs of digging and transporting peat using a dragline and dump trucks were $\$1.33/yd^3$ (2.25 miles round trip distance) as compared to \$8.01 for digging and transporting the material using scrapper pans (3.0 round trip miles). When the costs of spreading are included, the north Florida trial costs were \$9.13 per yd^3 while the costs at the central Florida trial were \$3.97 per yd^3. The differences in spreading costs between the two trials can be attributed to the differences in site conditions. The central Florida site was lower and wetter than the north Florida site, and required extra effort for spreading.

In summary, the following points can be made:

1. Proper hydroperiod is one of the most critical parameters that must be controlled when reconstructing wetland systems.
2. Herbaceous wetland species are easily established through inoculation or mulching with wetland peats, although it has yet to be established if woody species germination will be a success.
3. It is possible to develop a high quality herbaceous wetland within one (1) growing season using wetland peat mulching that has greater total biomass, far greater wetland biomass, and greater

species diversity than is possible on sites with no peat inoculation.

4. A high degree of variation in elevation within wetland system tends to increase diversity of plant species. With hummocks and low areas present within the wetland, more micro-environments are present that are colonized by a greater variety of species tolerant to a variety of hydrologic conditions.
5. The costs of wetland peat mulching can vary considerably depending on the equipment and techniques used but are competitive with other techniques such as purchase and direct planting of wetland species.

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APPENDIX A
Summary Data for Experimental Sites

Table A-1. Summary vegetation data, cypress/gum reference swamp, site I (length of transect, 200 m; 20 plots).

Species	Number of Individuals	Number of Plots	Frequency	Basal Area	Relative Frequency	Relative Density	Relative Basal Area	Importance Value
TREES (>10 cm dbh)								
Acer rubrum	2	2	0.10	409	0.049	0.015	0.010	2.5
Cephalanthus occidentalis	1	1	0.05	129	0.024	0.008	0.003	1.2
Magnolia virginiana	5	3	0.15	1166	0.073	0.038	0.029	4.7
Nyssa sylvatica	101	20	1.00	31529	0.488	0.777	0.774	68.0
Persea palustris	1	1	0.05	82	0.024	0.008	0.002	1.1
Pinus elliottii	1	1	0.05	179	0.024	0.008	0.004	1.2
Taxodium distichum	15	9	0.45	5857	0.220	0.115	0.144	15.9
Standing dead	4	4	0.20	1407	0.098	0.031	0.034	5.4
TOTAL	130	41	2.05	40758	1.000	1.000	1.000	100.0
SAPLINGS (<10 cm dbh)								
Acer rubrum	11	4	0.20	220	0.071	0.057	0.120	8.3
Agarista populifolia	3	1	0.05	10	0.018	0.015	0.005	1.3
Cephalanthus occidentalis	20	4	0.15	80	0.071	0.103	0.042	7.2
Clethra alnifolia	27	8	0.40	69	0.143	0.139	0.036	10.6
Lyonia lucida	73	10	0.50	288	0.179	0.374	0.151	23.5
Magnolia virginiana	11	2	0.10	129	0.036	0.056	0.068	5.3
Myrica cerifera	19	7	0.35	332	0.125	0.097	0.175	13.2
Nyssa sylvatica	15	9	0.45	331	0.161	0.077	0.174	13.7
Persea palustris	3	3	0.15	132	0.054	0.015	0.069	4.6
Taxodium ascendens	6	4	0.20	75	0.071	0.031	0.040	4.7
Standing dead	7	4	0.20	229	0.071	0.036	0.120	7.6
TOTAL	195	56	2.75	1904	1.000	1.000	1.000	100.0

Table A-2. Summary vegetation data, cypress/gum reference swamp, site II (length of transect, 1100 m; 11 plots).

Species	Number of Individuals	Number of Plots	Frequency	Basal Area	Relative Frequency	Relative Density	Relative Basal Area	Importance Value
TREES (>10 cm dbh)								
Magnolia virginiana	2	1	0.09	712	0.059	0.036	0.030	4.2
Nyssa sylvatica	48	11	1.00	20868	0.065	0.857	0.881	79.5
Taxodium ascendens	3	2	0.18	1280	0.118	0.054	0.054	7.5
Standing dead	3	3	0.27	829	0.176	0.054	0.035	8.8
TOTAL	56	17	1.54	23689	1.000	1.000	1.000	100.0
SAPLINGS (<10 cm dbh)								
Acer rubrum	2	2	0.18	4	0.057	0.009	0.007	2.4
Clethra alnifolia	72	8	0.73	94	0.228	0.306	0.156	23.0
Itea virginica	11	3	0.27	16	0.086	0.047	0.027	5.3
Lyonia ligustrina	17	3	0.27	37	0.086	0.072	0.061	7.3
Lyonia lucida	100	8	0.73	106	0.228	0.426	0.176	27.7
Myrica cerifera	16	2	0.18	62	0.057	0.068	0.103	7.6
Nyssa sylvatica	6	4	0.36	201	0.114	0.025	0.333	15.7
Persea palustris	7	3	0.27	20	0.086	0.030	0.033	5.0
Taxodium ascendens	3	1	0.09	8	0.029	0.013	0.013	1.8
Standing dead	1	1	0.09	55	0.029	0.004	0.091	4.1
TOTAL	235	35	3.17	603	1.000	1.000	1.000	100.0

Table A-3. Plant population structure on experimental sites, February 4, 1983.

Species	Site 3					Site 6					Site 7				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Eleocharis baldwinii	5	1.02	0.83	7.14	4.08	19	4.53	0.83	4.55	4.54	1	0.17	0.08	2.86	1.52
Hydrocotyle umbellata	--	--	--	--	--	--	--	--	--	--	1	0.17	0.08	2.86	1.48
Polygonum punctatum	455	92.67	0.58	50.00	71.34	368	87.83	0.66	36.36	62.10	495	81.82	1.00	34.29	58.06
Unknown composite 1	2	0.41	0.17	14.29	7.35	5	1.19	0.33	18.18	9.69	12	1.98	0.33	11.43	6.71
Unknown composite 2	23	4.68	0.17	14.29	9.49	17	4.06	0.42	22.73	13.40	82	13.55	0.92	31.43	22.5
Unknown grass 1	6	1.22	0.17	14.29	7.76	10	2.39	0.33	18.18	10.29	14	2.31	0.50	17.14	9.73
TOTAL	491	100		100	100	419	100		100	100	605	100		100	100

Table A-3. (continued.)

Species	Site 8					Site 9					Site 10*				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Eleocharis baldwinii	1	0.28	0.08	4.16	2.22	13	12.50	0.25	23.08	17.79	--	--	--	--	--
Hydrocotyle umbellata	--	--	--	--	--	4	3.85	0.83	7.69	5.77	--	--	--	--	--
Polygonum punctatum	346	95.32	1.00	50.00	72.66	78	75.00	0.42	38.46	56.73	--	--	--	--	--
Unknown composite 1	3	0.83	0.16	8.33	4.58	2	1.92	0.16	15.38	8.65	--	--	--	--	--
Unknown composite 2	7	1.93	0.42	20.83	11.38	--	--	--	--	--	--	--	--	--	--
Unknown grass 1	6	1.65	0.33	16.67	9.16	7	6.73	0.16	15.38	11.06	--	--	--	--	--
TOTAL	363	100		100	100	104	100		100	100	--	--	--	--	--

*No plant species growth.

Table A-3. (Continued.)

Species	Control Site NO	RD	FREQ	RF	IMP	Site Total NO	RD	FREQ	RF	IMP
Eleocharis baldwinii	--	--	--	--	--	39	1.97	0.10	6.48	4.23
Hydrocotyle umbellata	--	--	--	--	--	5	0.25	0.03	1.85	1.03
Polygonum punctatum	--	--	--	--	--	1742	87.89	0.61	40.74	64.32
Unknown composite 1	--	--	--	--	--	24	1.21	0.19	12.96	7.09
Unknown composite 2	--	--	--	--	--	129	6.51	0.32	21.30	13.91
Unknown grass 1	--	--	--	--	--	43	2.17	0.25	16.67	9.42
TOTAL	--	--	--	--	--	1982	100		100	100

Table A-4. Plant population structure on experimental sites, May 5, 1983.

Species	Site 3 NO	Site 3 RD	Site 3 FREQ	Site 3 RF	Site 3 IMP	Site 6 NO	Site 6 RD	Site 6 FREQ	Site 6 RF	Site 6 IMP	Site 7 NO	Site 7 RD	Site 7 FREQ	Site 7 RF	Site 7 IMP
Acer rubrum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Baccharis angustifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cassia fasciculata	16	1.24	0.42	10.42	5.83	3	0.23	0.08	2.04	1.14	9	0.69	0.08	1.82	1.26
Cephalanthus occidentalis	--	--	--	--	--	1	0.08	0.08	2.04	1.06	--	--	--	--	--
Dulichium arundinaceum	6	0.46	0.17	4.17	2.32	29	2.21	0.25	6.12	4.16	5	0.38	0.16	3.64	2.01
Eleocharis baldwinii	4	0.31	0.25	6.25	3.28	4	0.30	0.16	4.08	2.19	--	--	--	--	--
Eupatorium capillifolium	76	5.86	0.58	14.58	10.22	64	4.87	0.66	16.33	10.60	185	14.11	1.00	21.82	17.97
Hydrocotyle umbellata	--	--	--	--	--	--	--	--	--	--	1	0.08	0.08	1.82	0.95
Juncus acuminatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepidium virginicum	--	--	--	--	--	1	0.08	0.08	2.04	1.06	--	--	--	--	--
Panicum clandestinum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum spp.	6	0.46	0.33	8.33	4.40	--	--	--	--	--	--	--	--	--	--
Paspalum urvillei	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polygonum punctatum	621	47.92	0.50	12.50	30.21	870	66.16	1.00	24.49	45.32	878	66.97	1.00	21.82	44.40
Potamogeton spp.	--	--	--	--	--	--	--	--	--	--	3	0.23	0.25	5.45	2.84
Rubus trivialis	2	0.15	0.83	2.08	1.12	--	--	--	--	--	--	--	--	--	--
Salix caroliniana	2	0.14	0.83	2.08	1.12	--	--	--	--	--	--	--	--	--	--
Saururus cernuus	16	1.24	0.33	8.33	4.79	37	2.81	0.42	10.20	6.51	11	0.84	0.50	10.91	5.88
Spartina bakerii	--	--	--	--	--	1	0.08	0.08	2.04	1.06	--	--	--	--	--
Unknown composite A	1	0.08	0.83	2.08	1.08	--	--	--	--	--	--	--	--	--	--
Unknown composite 3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown grass A	541	41.74	0.92	22.92	32.33	301	22.89	0.92	22.45	22.67	194	14.80	0.92	20.00	17.40
Unknown grass B	3	0.23	0.83	2.08	1.16	--	--	--	--	--	5	0.38	0.08	1.82	1.10
Unknown grass C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown grass D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb A	1	0.08	0.83	2.08	1.08	--	--	--	--	--	--	--	--	--	--
Unknown herb B	--	--	--	--	--	2	0.15	0.16	4.08	2.12	--	--	--	--	--
Unknown herb C	--	--	--	--	--	1	0.08	0.08	2.04	1.06	1	0.08	0.08	1.82	0.95
Unknown herb D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb E	--	--	--	--	--	--	--	--	--	--	15	1.14	0.08	1.82	1.48
Unknown herb F	--	--	--	--	--	--	--	--	--	--	1	0.08	0.08	1.82	0.95
Unknown herb G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb K	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb M	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb O	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown legume	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown mint	1	0.08	0.83	2.08	1.08	1	0.08	0.08	2.04	1.06	3	0.23	0.25	5.45	2.84
TOTAL	1296	100		100	100	1315	100		100	100	1311	100		100	100

Table A-4. (continued.)

	Site 8					Site 9					Site 10				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Acer rubrum	--	--	--	--	--	1	0.19	0.08	2.86	1.53	--	--	--	--	--
Baccharis angustifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cassia fasciculata	4	0.34	0.17	3.39	1.87	--	--	--	--	--	1	1.37	0.08	5.00	3.19
Cephalanthus occidentalis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dulichium arundinaceum	5	0.42	0.33	6.78	3.60	3	0.57	0.25	8.57	4.57	4	5.48	0.17	10.00	7.74
Eleocharis baldwinii	2	0.17	0.17	3.39	1.78	48	9.09	0.33	11.43	10.26	--	--	--	--	--
Eupatorium capillifolium	64	5.36	1.00	20.34	12.85	4	0.76	0.17	5.71	3.24	1	1.37	0.08	5.00	3.19
Hydrocotyle umbellata	--	--	--	--	--	18	3.41	0.08	2.86	3.14	--	--	--	--	--
Juncus acuminatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepidium virginicum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum clandestinum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Paspalum urvillei	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polygonum punctatum	922	77.28	1.00	20.34	4.81	215	40.72	0.50	17.14	28.93	2	2.74	0.17	10.00	6.39
Potamogeton spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rubus trivialis	1	0.08	0.08	1.69	0.89	--	--	--	--	--	--	--	--	--	--
Salix caroliniana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Saururus cernuus	7	0.59	0.42	8.47	4.53	6	1.14	0.17	5.71	3.43	--	--	--	--	--
Spartina bakerii	2	0.17	0.08	1.69	0.93	--	--	--	--	--	--	--	--	--	--
Unknown composite A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown composite 3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown grass A	177	14.84	0.92	18.64	16.74	199	37.69	0.83	28.57	33.13	53	72.60	0.66	40.00	56.30
Unknown grass B	2	0.17	0.17	3.39	1.78	8	1.52	0.17	5.71	3.62	4	5.48	0.17	10.00	7.74
Unknown grass C	2	0.17	0.17	3.39	1.78	--	--	--	--	--	--	--	--	--	--
Unknown grass D	--	--	--	--	--	--	--	--	--	--	3	4.11	0.08	5.00	4.56
Unknown herb A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb D	1	0.08	0.08	1.69	0.89	--	--	--	--	--	--	--	--	--	--
Unknown herb E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb G	1	0.08	0.08	1.69	0.89	--	--	--	--	--	--	--	--	--	--
Unknown herb H	1	0.08	0.08	1.69	0.89	--	--	--	--	--	--	--	--	--	--
Unknown herb I	--	--	--	--	--	3	0.57	0.08	2.86	1.72	--	--	--	--	--
Unknown herb J	--	--	--	--	--	2	0.38	0.08	2.86	1.62	--	--	--	--	--
Unknown herb K	--	--	--	--	--	6	1.14	0.08	2.86	2.00	--	--	--	--	--
Unknown herb L	--	--	--	--	--	--	--	--	--	--	2	2.74	0.08	5.00	3.87
Unknown herb M	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown herb O	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown legume	--	--	--	--	--	15	2.84	0.04	2.86	2.85	3	4.11	0.17	10.00	7.06
Unknown mint	2	0.17	0.17	3.37	1.78	--	--	--	--	--	--	--	--	--	--
TOTAL	1193	100		100	100	528	100		100	100	73	100		100	100

Table A-4. (continued.)

	Control Site					Site Total				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Acer rubrum	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Baccharis angustifolia	4	0.23	0.25	6.52	3.37	4	0.05	0.04	0.96	0.50
Cassia fasciculata	274	15.63	0.92	23.91	19.77	307	4.11	0.25	6.73	5.42
Cephalanthus occidentalis	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Dulichium arundinaceum	15	0.86	1.00	26.09	13.47	67	0.90	0.33	8.97	4.93
Eleocharis baldwinii	3	0.17	0.25	6.52	3.34	61	0.82	0.17	4.49	2.65
Eupatorium capillifolium	6	0.34	0.33	8.70	4.52	400	5.36	0.55	14.74	10.05
Hydrocotyle umbellata	--	--	--	--	--	19	0.25	0.02	0.64	0.44
Juncus acuminatus	15	0.86	0.08	2.17	1.52	15	0.20	0.01	0.32	0.26
Lepidium virginicum	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Panicum clandestinum	3	0.17	0.17	4.35	2.26	3	0.04	0.02	0.64	0.34
Panicum spp.	--	--	--	--	--	6	0.08	0.05	1.28	0.68
Paspalum urvillei	1064	60.70	0.17	4.35	32.52	1064	14.25	0.02	0.64	7.44
Polygonum punctatum	63	3.59	0.08	2.17	2.88	3571	47.81	0.61	16.35	32.08
Potamogeton spp.	--	--	--	--	--	3	0.04	0.04	0.96	0.50
Rubus trivialis	--	--	--	--	--	3	0.04	0.02	0.64	0.34
Salix caroliniana	--	--	--	--	--	2	0.03	0.01	0.32	0.17
Saururus cernuus	--	--	--	--	--	77	1.03	0.26	7.05	4.04
Spartina bakerii	--	--	--	--	--	3	0.04	0.02	0.64	0.34
Unknown composite A	1	0.06	0.08	2.17	1.11	2	0.03	0.02	0.64	0.34
Unknown composite 3	6	0.34	0.17	4.35	2.34	6	0.08	0.02	0.64	0.36
Unknown grass A	--	--	--	--	--	1465	19.61	0.74	19.87	19.74
Unknown grass B	--	--	--	--	--	22	0.29	0.10	2.56	1.42
Unknown grass C	--	--	--	--	--	2	0.03	0.02	0.64	0.33
Unknown grass D	--	--	--	--	--	3	0.04	0.01	0.32	0.18
Unknown herb A	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Unknown herb B	--	--	--	--	--	2	0.03	0.02	0.64	0.33
Unknown herb C	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Unknown herb D	--	--	--	--	--	2	0.03	0.02	0.64	0.33
Unknown herb E	--	--	--	--	--	15	0.20	0.01	0.32	0.26
Unknown herb F	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Unknown herb G	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Unknown herb H	--	--	--	--	--	1	0.01	0.01	0.32	0.16
Unknown herb I	--	--	--	--	--	3	0.04	0.01	0.32	0.18
Unknown herb J	--	--	--	--	--	2	0.03	0.01	0.32	0.18
Unknown herb K	--	--	--	--	--	6	0.08	0.01	0.32	0.20
Unknown herb L	--	--	--	--	--	2	0.03	0.01	0.32	0.18
Unknown herb M	8	0.46	0.08	2.17	1.31	8	0.11	0.01	0.32	0.21
Unknown herb N	73	4.16	0.17	4.35	4.25	73	0.98	0.02	0.64	0.81
Unknown herb O	218	12.44	0.08	2.17	7.30	218	2.92	0.01	0.32	1.62
Unknown legume	--	--	--	--	--	18	0.24	0.04	0.96	0.60
Unknown mint	--	--	--	--	--	7	0.09	0.08	2.24	1.16
TOTAL	1753	100		100	100	7469	100		100	100

Table A-5. Plant population structure on experimental sites, August 9, 1983.

Species	Site 3					Site 6					Site 7				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Aeschynomene americana	4	0.41	0.17	3.39	1.90	--	--	--	--	--	--	--	--	--	--
Baccharis angustifolia	1	0.10	0.08	1.69	0.90	--	--	--	--	--	--	--	--	--	--
Boehmeria cylindrica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyperus spp.	2	0.21	0.08	1.69	0.95	--	--	--	--	--	--	--	--	--	--
Dulichium arundinaceum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Eleocharis baldwinii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Eriocaulon compressum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Eupatorium capillifolium	69	7.10	0.67	13.56	10.33	47	4.83	0.67	15.09	9.96	154	8.94	1.00	16.22	12.58
Eupatorium perfoliatum	1	0.10	0.08	1.69	0.90	--	--	--	--	--	--	--	--	--	--
Hydrocotyle umbellata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Indigofera spp.	9	0.93	0.33	6.78	3.86	26	2.67	0.58	13.21	7.94	5	0.29	0.33	5.41	2.85
Juncus repens	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ludwigia spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lyonia lucida	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum hemitomon	103	10.60	0.50	10.17	10.39	27	2.77	0.33	7.55	5.16	50	2.90	0.75	12.16	7.53
Panicum spp. (#1)	235	24.18	0.67	13.56	18.87	155	15.93	0.75	16.98	16.46	163	9.46	0.92	14.86	12.16
Panicum spp. (#2)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum spp. (#3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Paspalum urvillei	55	5.66	0.67	13.55	9.61	17	1.75	0.50	11.32	6.54	58	3.37	0.67	12.16	7.77
Polygonum punctatum	424	43.62	0.50	10.17	26.90	646	66.39	0.75	16.98	41.69	1238	71.85	1.00	16.22	44.04
Quercus spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhexia spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rubus spp.	1	0.10	0.08	1.69	0.90	--	--	--	--	--	1	0.06	0.08	1.35	0.71
Sagittaria lancifolia	--	--	--	--	--	--	--	--	--	--	1	0.06	0.17	1.35	0.71
Salix caroliniana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Saururus cernuus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scirpus californicus	--	--	--	--	--	--	--	--	--	--	1	0.06	0.08	1.35	0.71
Sesbania vesicaria	63	6.48	0.75	15.25	10.87	52	5.34	0.67	15.09	10.22	46	2.67	0.92	14.86	8.77
Smilax auriculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stylosanthes biflora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A2	1	0.10	0.08	1.69	0.90	--	--	--	--	--	1	0.06	0.08	1.35	0.71
Unknown A3	--	--	--	--	--	--	--	--	--	--	5	0.29	0.17	2.70	1.50
Unknown A4	1	0.10	0.08	1.69	0.90	--	--	--	--	--	--	--	--	--	--
Unknown A5	2	0.21	0.08	1.69	0.95	--	--	--	--	--	--	--	--	--	--
Unknown A6	1	0.10	0.08	1.69	0.90	--	--	--	--	--	--	--	--	--	--
Unknown A7	--	--	--	--	--	1	0.10	0.08	1.89	1.00	--	--	--	--	--
Unknown A8	--	--	--	--	--	2	0.21	0.08	1.89	1.05	--	--	--	--	--
Unknown A9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown mushroom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vaccinium crassifolium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	972	100		100	100	973	100		100	100	1723	100		100	100

Table A-5. (continued.)

Species	Site 8 NO	Site 8 RD	Site 8 FREQ	Site 8 RF	Site 8 IMP	Site 9 NO	Site 9 RD	Site 9 FREQ	Site 9 RF	Site 9 IMP	Site 10 NO	Site 10 RD	Site 10 FREQ	Site 10 RF	Site 10 IMP
Aeschynomene americana	2	0.24	0.17	3.08	1.66	16	2.00	0.42	6.67	4.34	8	1.74	0.17	2.56	2.15
Baccharis angustifolia	2	0.24	0.17	3.08	1.66	--	--	--	--	--	--	--	--	--	--
Boehmeria cylindrica	3	0.36	0.17	3.08	1.72	5	0.62	0.08	1.33	0.98	--	--	--	--	--
Cyperus spp.	--	--	--	--	--	--	--	--	--	--	25	5.42	0.42	6.41	5.92
Dulichium arundinaceum	3	0.36	0.08	1.54	0.95	--	--	--	--	--	1	0.22	0.08	1.28	0.75
Eleocharis baldwinii	--	--	--	--	--	32	4.00	0.33	5.33	4.67	33	7.16	0.75	11.54	9.35
Eriocaulon compressum	1	0.12	0.08	1.54	0.83	--	--	--	--	--	--	--	--	--	--
Eupatorium capillifolium	62	7.46	0.92	16.92	12.19	7	0.87	0.25	4.00	2.44	3	0.65	0.17	2.56	1.61
Eupatorium perfoliatum	--	--	--	--	--	4	0.50	0.25	4.00	2.25	--	--	--	--	--
Hydrocotyle umbellata	--	--	--	--	--	4	0.50	0.08	1.33	0.92	--	--	--	--	--
Indigofera spp.	--	--	--	--	--	8	1.00	0.25	4.00	2.50	1	0.22	0.08	1.28	0.75
Juncus repens	--	--	--	--	--	9	1.12	0.42	6.67	3.90	14	3.04	0.42	6.41	4.73
Ludwigia spp.	1	0.12	0.08	1.54	0.83	8	1.00	0.25	4.00	2.50	9	1.95	0.42	6.41	4.18
Lyonia lucida	--	--	--	--	--	--	--	--	--	--	1	0.22	0.08	1.28	0.75
Panicum hemitomon	16	1.93	0.25	4.62	3.28	--	--	--	--	--	--	--	--	--	--
Panicum spp. (#1)	137	16.49	1.00	18.46	17.48	297	37.08	0.92	14.67	25.88	--	--	--	--	--
Panicum spp. (#2)	--	--	--	--	--	3	0.37	0.25	4.00	2.19	--	--	--	--	--
Panicum spp. (#3)	--	--	--	--	--	--	--	--	--	--	8	1.74	0.25	3.85	2.80
Paspalum urvillei	22	2.66	0.50	9.23	5.95	160	19.98	0.92	14.67	17.33	85	18.44	0.75	11.54	14.99
Polygonum punctatum	553	66.55	1.00	18.46	42.51	101	12.61	0.58	9.33	10.97	175	37.96	1.00	16.66	27.31
Quercus spp.	2	0.24	0.08	1.54	0.89	--	--	--	--	--	1	0.22	0.08	1.28	0.75
Rhexia spp.	--	--	--	--	--	2	0.25	0.08	1.33	0.79	--	--	--	--	--
Rubus spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sagittaria lancifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Salix caroliniana	--	--	--	--	--	--	--	--	--	--	2	0.43	0.17	2.56	1.50
Saururus cernuus	2	0.24	0.08	1.54	0.89	5	0.62	0.08	1.33	0.98	--	--	--	--	--
Scirpus californicus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sesbania vesicaria	21	2.53	0.58	10.77	6.65	129	16.10	0.67	10.67	13.39	75	16.27	0.92	14.20	15.19
Smilax auriculata	--	--	--	--	--	--	--	--	--	--	2	0.43	0.17	2.56	1.50
Stylosanthes biflora	4	0.48	0.25	4.62	2.55	8	1.00	0.33	5.33	3.17	--	--	--	--	--
Unknown A1	--	--	--	--	--	3	0.37	0.08	1.33	0.85	--	--	--	--	--
Unknown A2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown A12	--	--	--	--	--	--	--	--	--	--	1	0.22	0.08	1.28	0.75
Unknown A13	--	--	--	--	--	--	--	--	--	--	15	3.25	0.25	3.85	3.55
Unknown mushroom	--	--	--	--	--	--	--	--	--	--	1	0.22	0.08	1.28	0.75
Vaccinium crassifolium	--	--	--	--	--	--	--	--	--	--	1	0.22	0.08	1.28	0.75
TOTAL	831	100		100	100	801	100		100	100	461	100		100	100

Table A-5. (continued.)

Species	Control Site NO	RD	FREQ	RF	IMP	Site Total NO	RD	FREQ	RF	IMP
Aeschynomene americana	17	2.66	0.33	6.78	4.72	47	0.73	0.18	3.25	1.99
Baccharis angustifolia	2	0.31	0.17	3.39	1.85	5	0.08	0.06	1.08	0.58
Boehmeria cylindrica	--	--	--	--	--	8	0.13	0.04	0.65	0.39
Cyperus spp.	--	--	--	--	--	27	0.42	0.07	1.30	0.86
Dulichium arundinaceum	--	--	--	--	--	4	0.06	0.02	0.43	0.25
Eleocharis baldwinii	--	--	--	--	--	65	1.02	0.15	2.81	1.92
Eriocaulon compressum	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Eupatorium capillifolium	5	0.78	0.25	5.08	2.93	347	5.42	0.56	10.17	7.80
Eupatorium perfoliatum	--	--	--	--	--	5	0.08	0.05	0.87	0.48
Hydrocotyle umbellata	--	--	--	--	--	4	0.06	0.01	0.22	0.14
Indigofera spp.	40	6.27	0.58	11.86	9.07	89	1.39	0.31	5.63	3.51
Juncus repens	--	--	--	--	--	23	0.36	0.12	2.16	1.26
Ludwigia spp.	20	3.13	0.17	3.39	3.26	38	0.59	0.13	2.38	1.49
Lyonia lucida	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Panicum hemitomon	--	--	--	--	--	196	3.06	0.26	4.76	3.91
Panicum spp. (#1)	184	28.84	0.75	15.25	22.05	1171	18.30	0.26	12.99	15.51
Panicum spp. (#2)	--	--	--	--	--	3	0.05	0.04	0.65	0.35
Panicum spp. (#3)	--	--	--	--	--	8	0.13	0.04	0.65	0.39
Paspalum urvillei	71	11.03	0.75	15.25	13.20	468	7.31	0.69	12.55	9.93
Polygonum punctatum	40	6.27	0.42	8.47	7.37	3177	49.65	0.75	13.64	31.65
Quercus spp.	--	--	--	--	--	3	0.05	0.02	0.43	0.24
Rhexia spp.	--	--	--	--	--	2	0.03	0.01	0.22	0.13
Rubus spp.	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Sagittaria lancifolia	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Salix caroliniana	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Saururus cernuus	--	--	--	--	--	7	0.11	0.02	0.43	0.27
Scirpus californicus	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Sesbania vesicaria	222	35.80	0.92	18.64	27.22	608	9.50	0.77	14.07	11.79
Smilax auriculata	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Stylosanthes biflora	--	--	--	--	--	12	0.19	0.08	1.52	0.86
Unknown A1	--	--	--	--	--	3	0.05	0.01	0.22	0.14
Unknown A2	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Unknown A3	--	--	--	--	--	5	0.08	0.02	0.43	0.25
Unknown A4	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown A5	--	--	--	--	--	2	0.03	0.01	0.22	0.13
Unknown A6	1	0.16	0.08	1.69	0.93	2	0.03	0.02	0.43	0.23
Unknown A7	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown A8	--	--	--	--	--	2	0.03	0.01	0.22	0.13
Unknown A9	9	1.41	0.17	3.39	2.40	9	0.14	0.02	0.43	0.29
Unknown A10	8	1.25	0.17	3.39	2.32	8	0.13	0.02	0.43	0.28
Unknown A11	19	2.98	0.17	3.39	3.19	19	0.30	0.02	0.43	0.37
Unknown A12	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown A13	--	--	--	--	--	15	0.23	0.04	0.65	0.44
Unknown mushroom	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Vaccinium crassifolium	--	--	--	--	--	1	0.02	0.01	0.22	0.12
TOTAL	638	100		100	100	6399	100		100	100

Table A-6. Plant population structure on experimental sites, October 21, 1983.

Species	Site 3					Site 6					Site 7				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Aeschynomene americana	13	1.48	0.50	9.37	5.42	1	0.15	0.08	1.66	0.90	1	0.09	0.08	1.69	0.89
Andropogon gerardi	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Baccharis angustifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boehmeria cylindrica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cassia fasciculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cephalanthus occidentalis	2	0.22	0.17	3.12	1.67	--	--	--	--	--	--	--	--	--	--
Coreopsis leavenworthii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Crotalaria spp.	--	--	--	--	--	--	--	--	--	--	2	0.18	0.17	3.39	1.78
Cyperus haspan	--	--	--	--	--	--	--	--	--	--	4	0.36	0.17	3.39	1.87
Cyperus spp.	--	--	--	--	--	--	--	--	--	--	15	1.37	0.50	10.17	5.77
Digitaria sanguinalis	171	18.90	0.42	7.81	13.35	193	29.47	0.58	11.67	20.57	--	--	--	--	--
Dulichium arundinaceum	5	0.55	0.25	6.25	3.40	5	0.76	0.17	3.33	2.04	--	--	--	--	--
Eleocharis baldwinii	1	0.11	0.08	1.56	0.83	2	0.31	0.08	1.66	0.98	--	--	--	--	--
Eupatorium capillifolium	66	7.29	0.75	12.50	9.89	32	4.88	0.75	13.33	9.10	133	12.14	1.00	20.33	16.24
Heterotheca subaxillaris	1	0.11	0.08	1.56	0.83	1	0.15	0.08	1.66	0.90	--	--	--	--	--
Hydrocotyle umbellata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hyptis alata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Indigofera hirsuta	3	0.33	0.33	4.69	2.51	--	--	--	--	--	--	--	--	--	--
Indigofera spp.	--	--	--	--	--	26	3.97	0.75	13.33	8.65	2	0.18	0.08	1.69	0.93
Juncus repens	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juncus spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ludwigia spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Myrica cerifera	--	--	--	--	--	1	0.15	0.08	1.66	0.90	--	--	--	--	--
Panicum bartowense	184	20.73	1.00	18.74	19.73	22	3.36	0.83	16.66	9.74	155	14.14	0.75	13.56	13.85
Panicum commutatum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum dichotomiflorum	44	4.86	0.42	7.81	6.33	48	7.33	0.58	11.67	9.50	56	5.10	0.75	13.56	9.33
Paspalum urvillei	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polygonum punctatum	361	41.02	0.75	12.50	26.76	310	47.33	0.75	13.33	30.33	699	63.78	1.00	20.33	42.05
Quercus spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhus spp.	1	0.11	0.08	1.56	0.83	--	--	--	--	--	--	--	--	--	--
Sagittaria lancifolia	--	--	--	--	--	--	--	--	--	--	3	0.27	0.08	1.69	0.98
Saururus cernuus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scirpus californicus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sesbania vesicaria	27	3.07	0.58	10.94	7.01	11	1.68	0.33	6.67	4.17	25	2.28	0.42	8.47	5.37
Smilax auriculata	--	--	--	--	--	--	--	--	--	--	1	0.09	0.08	1.69	0.89
Stylosanthes biflora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B1	--	--	--	--	--	1	0.15	0.08	1.66	0.90	--	--	--	--	--
Unknown B2	1	0.11	0.08	1.56	0.83	--	--	--	--	--	--	--	--	--	--
Unknown B3	--	--	--	--	--	2	0.31	0.08	1.66	0.98	--	--	--	--	--
Unknown B4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	880	100	100		100	655	100		100	100	1096	100		100	100

Table A-6. (continued.)

Species	Site 8					Site 9					Site 10				
	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP	NO	RD	FREQ	RF	IMP
Aeschynomene americana	--	--	--	--	--	15	1.52	0.50	8.22	4.87	4	0.64	0.17	2.94	1.79
Andropogon gerardi	--	--	--	--	--	2	0.20	0.08	1.37	0.78	2	0.32	0.08	1.47	0.89
Baccharis angustifolia	2	0.21	0.17	2.82	1.51	--	--	--	--	--	--	--	--	--	--
Boehmeria cylindrica	--	--	--	--	--	2	0.20	0.17	2.74	1.47	--	--	--	--	--
Cassia fasciculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cephalanthus occidentalis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Coreopsis leavenworthii	--	--	--	--	--	4	0.41	0.08	1.37	0.89	--	--	--	--	--
Crotalaria spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyperus haspan	2	0.21	0.08	1.41	0.81	--	--	--	--	--	--	--	--	--	--
Cyperus spp.	1	0.11	0.08	1.41	0.76	--	--	--	--	--	--	--	--	--	--
Digitaria sanguinalis	3	0.32	0.08	1.41	0.86	--	--	--	--	--	--	--	--	--	--
Dulichium arundinaceum	--	--	--	--	--	--	--	--	--	--	2	0.32	0.17	2.94	1.63
Eleocharis baldwinii	--	--	--	--	--	54	5.49	0.33	5.48	5.48	123	19.65	0.50	8.82	14.23
Eupatorium capillifolium	61	6.32	1.00	16.90	11.61	7	0.71	0.25	4.11	2.41	1	0.16	0.08	1.47	0.81
Heterotheca subaxillaris	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrocotyle umbellata	--	--	--	--	--	11	1.12	0.08	1.37	1.25	--	--	--	--	--
Hyptis alata	1	0.11	0.08	1.41	0.76	3	0.30	0.08	1.37	0.83	--	--	--	--	--
Indigofera hirsuta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Indigofera spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juncus repens	31	3.26	0.08	1.41	2.33	2	0.20	0.17	2.74	1.47	7	1.12	0.25	4.41	2.76
Juncus spp.	2	0.21	0.08	1.41	0.81	--	--	--	--	--	--	--	--	--	--
Ludwigia spp.	--	--	--	--	--	1	0.10	0.08	1.37	1.47	3	0.48	0.17	2.94	1.71
Myrica cerifera	1	0.11	0.08	1.41	0.76	--	--	--	--	--	--	--	--	--	--
Panicum bartowense	60	6.32	0.75	11.27	8.79	29	2.95	0.58	9.59	6.27	95	15.17	1.00	17.65	16.41
Panicum commutatum	--	--	--	--	--	23	2.34	0.33	5.48	3.91	11	1.76	0.33	5.88	3.82
Panicum dichotomiflorum	71	7.47	0.83	14.08	10.77	62	6.30	0.33	5.48	5.89	1	0.16	0.08	1.47	0.81
Paspalum urvillei	84	8.84	0.92	15.49	12.16	413	41.97	0.83	13.70	27.84	244	38.98	0.83	14.71	26.84
Polygonum punctatum	615	64.74	1.00	16.90	40.82	231	23.48	0.75	12.33	17.90	20	3.19	0.42	7.35	5.27
Quercus spp.	--	--	--	--	--	1	0.10	0.08	1.37	0.73	--	--	--	--	--
Rhus spp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sagittaria lancifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Saururus cernuus	2	0.21	0.08	1.41	0.81	11	1.12	0.25	4.11	2.61	--	--	--	--	--
Scirpus californicus	--	--	--	--	--	13	1.32	0.42	6.85	4.08	31	4.95	0.58	10.29	7.62
Sesbania vesicaria	8	0.84	0.25	4.23	2.53	100	10.16	0.67	10.96	10.56	78	12.45	0.75	13.24	12.85
Smilax auriculata	5	0.53	0.33	5.63	3.08	--	--	--	--	--	4	0.64	0.25	4.41	2.52
Stylosanthes biflora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B4	1	0.11	0.08	1.41	0.76	--	--	--	--	--	--	--	--	--	--
Unknown B5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unknown B6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	950	100		100	100	984	100		100	100	626	100		100	100

Table A-6. (continued.)

Species	Control Site NO	RD	FREQ	RF	IMP	Site Total NO	RD	FREQ	RF	IMP
Aeschynomene americana	11	1.09	0.33	5.71	3.40	45	0.73	0.24	4.30	2.52
Andropogon gerardi	--	--	--	--	--	4	0.06	0.02	0.43	0.25
Baccharis angustifolia	5	4.98	0.33	5.71	5.34	7	0.11	0.07	1.29	0.70
Boehmeria cylindrica	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Cassia fasciculata	155	15.42	0.92	15.71	15.56	155	2.50	0.13	2.37	2.44
Cephalanthus occidentalis	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Coreopsis leavenworthii	--	--	--	--	--	4	0.06	0.01	0.22	0.14
Crotalaria spp.	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Cyperus haspan	--	--	--	--	--	6	0.10	0.04	0.65	0.37
Cyperus spp.	--	--	--	--	--	16	0.26	0.83	1.51	0.88
Digitaria sanguinalis	108	10.75	0.33	5.71	8.23	475	7.67	0.20	3.66	5.15
Dulichium arundinaceum	--	--	--	--	--	12	0.19	0.10	1.72	0.95
Eleocharis baldwinii	1	0.01	0.08	1.43	0.72	181	2.92	0.15	2.80	2.86
Eupatorium capillifolium	7	0.07	0.33	5.71	2.89	307	4.95	0.57	10.32	7.63
Heterotheca subaxillaris	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Hydrocotyle umbellata	--	--	--	--	--	11	0.18	0.01	0.22	0.20
Hyptis alata	--	--	--	--	--	4	0.06	0.02	0.43	0.25
Indigofera hirsuta	--	--	--	--	--	3	0.05	0.04	0.65	0.35
Indigofera spp.	46	4.58	0.67	11.43	8.00	74	1.19	0.20	3.66	2.42
Juncus repens	--	--	--	--	--	40	0.65	0.07	1.29	0.97
Juncus spp.	--	--	--	--	--	2	0.03	0.01	0.22	0.13
Ludwigia spp.	148	14.72	0.17	2.86	8.79	152	2.45	0.06	1.08	1.76
Myrica cerifera	--	--	--	--	--	2	0.03	0.02	0.43	0.23
Panicum bartowense	416	41.39	0.92	15.71	28.55	961	15.51	0.81	14.62	15.06
Panicum commutatum	1	0.01	0.08	1.43	0.72	35	0.56	0.11	1.94	1.23
Panicum dichotomiflorum	13	1.29	0.25	4.29	2.79	295	4.76	0.45	8.17	6.46
Paspalum urvillei	3	0.03	0.25	4.29	2.16	744	12.01	0.40	7.31	9.66
Polygonum punctatum	55	5.47	0.50	8.57	7.02	2291	36.98	0.71	12.90	24.94
Quercus spp.	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Rhus spp.	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Sagittaria lancifolia	--	--	--	--	--	3	0.05	0.01	0.22	0.14
Saururus cernuus	--	--	--	--	--	13	0.01	0.05	0.86	0.53
Scirpus californicus	23	2.29	0.33	5.71	4.00	67	1.08	0.19	3.44	2.26
Sesbania vesicaria	--	--	--	--	--	249	4.02	0.43	7.74	5.88
Smilax auriculata	--	--	--	--	--	10	0.16	0.10	1.72	0.94
Stylosanthes biflora	6	0.06	0.17	2.86	1.46	6	0.10	0.02	0.43	0.26
Unknown B1	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown B2	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown B3	--	--	--	--	--	2	0.03	0.01	0.22	0.13
Unknown B4	--	--	--	--	--	1	0.02	0.01	0.22	0.12
Unknown B5	1	0.01	0.08	1.43	0.72	1	0.01	0.01	0.22	0.12
Unknown B6	6	0.06	0.08	1.43	0.74	6	0.10	0.01	0.22	0.16
TOTAL	1005	100		100	100	6196	100		100	100

Table A-7. Plant population structure in germination trays under controlled conditions, February 3, 1983.

Species	RD	FREQ	RF	IMP
Baccharis angustifolia	--	--	--	--
Cassia fasciculata	--	--	--	--
Cyperus sp.	--	--	--	--
Dulichium arundinaceum	--	--	--	--
Eleocharis baldwinii	14.61	0.71	50.00	32.31
Eupatorium capillifolium	--	--	--	--
Ludwigia spp.	--	--	--	--
Panicum spp.	--	--	--	--
Polygonum punctatum	66.85	0.29	20.00	43.43
Saururus cernuus	--	--	--	--
Sesbania exaltata	--	--	--	--
Solaum spp.	--	--	--	--
*Sphagnum**	--	--	--	--
Trifolium spp.	--	--	--	--
Ulmus spp.	--	--	--	--
Unknown composite A	6.18	0.29	20.00	13.09
Unknown composite B	--	--	--	--
Unknown composite C	--	--	--	--
Unknown grass A	12.36	0.14	10.00	11.18
Unknown grass 1	--	--	--	--
Unknown grass 2	--	--	--	--
Unknown grass 3	--	--	--	--
Unknown grass 4	--	--	--	--
Unknown herb A	--	--	--	--
Unknown mint	--	--	--	--
Woodwardia virginiana	--	--	--	--

*Sphagnum coverage 100% of 2 samples.

RD = Relative Density: (Individuals of species/total individuals of all species) x 100.

FREQ = Frequency: (Number of points at which species occur/total number of points sampled).

RF = Relative Frequency: (Frequency value for species/total frequency value for all species) x 100.

IMP = Importance Value: (Relative density + relative frequency for all species/2) x 100.

Table A-8. Plant population structure in germination trays under controlled conditions, May 12, 1983.

Species	RD	FREQ	RF	IMP
Baccharis angustifolia	0.43	0.22	4.26	2.35
Cassia fasciculata	1.28	0.11	2.13	1.71
Cyperus sp.	0.64	0.22	4.26	2.45
Dulichium arundinaceum	17.31	0.66	12.77	15.04
Eleocharis baldwinii	--	--	--	--
Eupatorium capillifolium	8.33	0.44	8.51	8.42
Ludwigia spp.	0.43	0.22	4.26	2.35
Panicum spp.	0.21	0.11	2.13	1.17
Polygonum punctatum	26.92	0.33	6.38	16.65
Saururus cernuus	1.28	0.33	6.38	3.83
Sesbania exaltata	0.21	0.11	2.13	1.17
Solaum spp.	0.21	0.11	2.13	1.17
Sphagnum*	--	--	--	--
Trifolium spp.	0.21	0.11	2.13	1.17
Ulmus spp.	14.10	0.55	10.64	12.37
Unknown composite A	--	--	--	--
Unknown composite B	0.21	0.11	2.13	1.17
Unknown composite C	0.21	0.11	2.13	1.17
Unknown grass A	--	--	--	--
Unknown grass 1	12.61	0.22	4.26	8.44
Unknown grass 2	7.91	0.55	10.64	9.28
Unknown grass 3	0.64	0.11	2.13	1.39
Unknown grass 4	0.43	0.11	2.13	1.28
Unknown herb A	3.85	0.22	4.26	4.06
Unknown mint	0.21	0.11	2.13	1.17
Woodwardia virginiana	2.35	0.11	2.13	2.24

*Sphagnum coverage 100% of 2 samples.

RD = Relative Density: (Individuals of species/total individuals of all species) x 100.

FREQ = Frequency: (Number of points at which species occur/total number of points sampled).

RF = Relative Frequency: (Frequency value for species/total frequency value for all species) x 100.

IMP = Importance Value: (Relative density + relative frequency for all species/2) x 100. Importance

Table A-9. Plant population structure in germination trays under controlled conditions, August 9, 1983.

Species	NO	RD	FREQ	RF	IMP
Andropogon spp.	24	7.48	0.66	10.53	9.01
Baccharis angustifolia	1	0.31	0.17	2.63	1.47
Cyperus odoratus	23	7.17	0.66	10.53	8.85
Dulichium arundinaceum	30	9.35	0.33	5.26	7.31
Eleocharis baldwinii	4	1.25	0.17	2.63	1.94
Eupatorium capillifolium	23	7.17	0.50	7.89	7.53
Juncus repens	14	4.36	0.33	5.26	4.81
Ludwigia spp.	7	2.18	0.50	7.89	5.04
Panicum spp. (#1)	11	3.43	0.17	2.63	3.03
Panicum spp. (#2)	72	22.43	0.33	5.26	13.85
Panicum spp. (#3)	2	0.62	0.17	2.63	1.63
Polygonum punctatum	49	15.26	0.33	5.26	10.26
Saururus cernuus	2	0.62	0.17	2.63	1.63
Sesbania vesicaria	1	0.31	0.17	2.63	1.47
Smilax auriculata	8	2.49	0.33	5.26	3.88
Ulmus spp.	26	8.10	0.50	7.89	8.00
Unknown GA-1	1	0.31	0.17	2.63	1.47
Unknown composite 1	1	0.31	0.17	2.63	1.47
Unknown composite 2	1	0.31	--	2.63	1.47
Woodwardia virginiana	19	5.92	0.17	2.63	4.28
Xyris spp.	2	0.62	0.17	2.63	1.63
TOTAL	321	100		100	100

***Sphagnum* coverage 100% of 2 samples.

Table A-10. Biomass (g dry weight) of major species found in experimental plots, May 6, 1983.

Species	Site: Control Ind*	Control Total	3 Ind*	3 Total	6 Ind*	6 Total	7 Ind*	7 Total
Eupatorium capillifolium			0.465	35.34	0.204	13.06	0.076	14.06
Saururus cernuus			0.115	1.84	0.146	5.40	--	--
Polygonum punctatum	0.505	31.82	0.456	283.18	0.621	540.27	0.444	389.83
Unknown grass A	0.054	57.46	0.012	6.49	0.011	3.311	0.032	6.21
Cassia fasciculata	0.017	4.66	--	--	--	--	--	--
Unknown herb O	0.188	40.98	--	--	--	--	--	--

*Individual = average biomass per individual from 10 sampled.
Total = average biomass per individual multiplied by number of individuals in m^2 study plots. Divide total by 12 to calculate biomass in g/m^2.

Table A-10. (continued.)

Species	Site: 8 Ind*	8 Total	9 Ind*	9 Total	10 Ind*	10 Total	TOT	AVER
Eupatorium capillifolium	0.097	6.21	0.083	0.332	No biomass taken		0.185	13.8
Saururus cernuus	--	--	--	--			0.128	3.62
Polygonum punctatum	0.988	910.94	0.372	79.98			0.564	515.215
Unknown grass A	--	--	--	--			0.027	18.37
Cassia fasciculata	--	--	--	--			0.017	4.66
Unknown herb O	--	--	--	--			0.188	40.98

Table A-11. Biomass (g dry weight) of major species found in experimental sites (August 10, 1983).

Species	Control Ind.	Control Total	3 Ind.	3 Total	6 Ind.	6 Total	7 Ind.	7 Total
Aeschynomene americana	---	---	---	---	---	---	---	---
Eleocharis baldwinii	---	---	---	---	---	---	---	---
Eupatorium capillifolium	---	---	6.45	445.19	5.33	250.60	4.22	650.03
Indigofera spp.	2.41	96.44	0.20	1.83	1.00	25.92	---	---
Juncus repens	---	---	---	---	---	---	---	---
Ludwigia spp.	---	---	---	---	---	---	---	---
Panicum hemitomon	---	---	0.24	24.31	0.24	6.37	0.55	27.50
Panicum spp. (#1)	0.02	3.68	0.19	45.12	0.57	87.89	0.49	79.71
Panicum spp. (#3)	---	---	---	---	---	---	---	---
Paspalum urvillei	2.66	185.85	1.09	58.64	5.25	78.69	---	---
Polygonum punctatum	1.82	72.80	2.82	1195.26	4.29	2771.99	3.62	4486.51
Sesbania vesicaria	14.92	3312.91	9.45	595.04	12.23	635.80	7.50	334.86

*Individual = average biomass per individual from 10 sampled.
Total = average biomass per individual multiplied by number of individuals in m^2 study plots. Divide total by 12 to calculate biomass in g/m^2.

Table A-11. (continued.)

Species	8 Ind.	8 Total	9 Ind.	9 Total	10 Ind.	10 Total	Average per Individual	Average per Site
Aeschynomene americana	---	---	0.83	13.22	13.13	105.06	6.98	59.14
Eleocharis baldwinii	---	---	---	---	1.92	63.20	1.92	63.20
Eupatorium capillifolium	1.57	97.46	5.85	40.92	2.59	7.78	4.34	248.67
Indigofera spp.	---	---	---	---	---	---	1.20	41.40
Juncus repens	---	---	---	---	0.93	13.01	0.93	13.01
Ludwigia spp.	---	---	---	--	2.46	22.13	2.46	22.13
Panicum hemitomon	---	---	---	---	---	---	0.34	19.39
Panicum spp. (#1)	0.39	53.29	0.76	230.18	2.50	429.83	0.70	132.81
Panicum spp. (#3)	---	---	---	---	3.89	31.08	3.89	31.08
Paspalum urvillei	8.67	190.78	3.69	590.08	21.27	1807.78	17.10	485.30
Polygonum punctatum	11.20	6193.60	4.76	481.16	6.13	18.38	4.95	2174.24
Sesbania vesicaria	---	---	15.54	2004.66	15.77	1182.60	12.57	1344.31

Table A-12. Biomass (g dry weight) of major species found in experimental sites (October 21, 1983).

	Site							
	Control		3		6		7	
Species	Ind.	Total	Ind.	Total	Ind.	Total	Ind.	Total
Digitaria sanguinalis	0.18	19.55	1.26	215.12	1.19	229.67	---	---
Eupatorium capillifolium	---	---	9.25	610.37	16.89	540.48	---	---
Indigofera spp.	3.98	183.17	---	---	10.30	267.80	---	---
Panicum bartowense	4.72	1963.52	3.76	691.29	---	---	4.09	633.95
Panicum dichotomiflorum	---	---	0.72	31.68	---	---	1.85	103.60
Paspalum urvillei	---	---	---	---	---	---	---	---
Polygonum punctatum	---	---	3.20	1153.40	5.26	1631.22	2.70	1887.30
Sesbania vesicaria	12.51	1939.05	18.05	487.24	---	---	32.91	822.75

*Individual = average biomass per individual from 10 sampled.
Total = average biomass per individual multiplied by number of individuals in m^2 study plots. Divide total by 12 to calculate biomass in g/m^2.

Table A-12. (continued.)

	Site							
	8		9		10		Average	Average
Species	Ind.	Total	Ind.	Total	Ind.	Total	per Individual	per Site
Digitaria sanguinalis	---	---	---	---	---	---	0.88	154.78
Eupatorium capillifolium	10.26	626.10	---	---	---	---	12.13	592.32
Indigofera spp.	---	---	---	---	---	---	7.14	225.49
Panicum bartowense	13.34	800.40	---	---	28.84	2739.80	10.95	1365.79
Panicum dichotomiflorum	---	---	6.35	393.70	---	---	2.97	176.33
Paspalum urvillei	---	---	---	---	1.11	269.62	1.11	269.62
Polygonum punctatum	6.89	4237.35	15.75	3638.25	---	---	6.76	2509.38
Sesbania vesicaria	---	---	30.32	3032.20	30.25	2359.50	24.81	1728.15

Table A-13. Height of tree species planted on experimental sites and other reclamation sites.

Site, Date Measured	*Nyssa biflora* Number	*Nyssa biflora* Average height, cm	*Taxodium distichum* Number	*Taxodium distichum* Average height, cm	*Liquidambar styraciflua* Number	*Liquidambar styraciflua* Average height, cm
EXPERIMENTAL SITES	Planted 02/02/83		Planted 02/23/83		Planted 02/23/83	
3 (03/30/83)	15	30.07	23	56.22	26	32.65
(10/21/83)	8	40.75	23	61.26	25	39.64
6 (03/30/83)	20	19.35	22	56.55	25	30.68
(10/21/83)	9	26.89	19	67.25	28	39.18
*7 (03/30/83)	37	17.38	21	56.67	37	26.86
(10/21/83)	5	23.8	15	48.2	25	30.24
8 (03/30/83)	19	26.53	21	52.52	30	23.93
(10/21/83)	2	27.5	19	64.74	26	34.69
9 (03/30/83)	19	19.26	19	62.79	25	22.92
(10/21/83)	9	24.22	18	77.55	21	32.81
10 (03/30/83)	17	29.94	20	51.25	23	22.91
(10/21/83)	0	---	21	63.38	18	25.44
RECLAMATION SITES						
Planted 1981, 1982						
A (05/13/83)	--	---	30	118.83	8	188.13
(10/21/83)	--	---	30	141.87	8	235.63
Planted 04/82						
B (05/13/83)	--	---	30	59.92	--	---
(10/21/83)	--	---	22	75.95	--	---
Planted 02/82						
†C (05/13/83)	--	---	45	90.29	--	---
(10/21/83)	--	---	26	98.42	--	---
Planted 01/83						
D (05/13/83)	--	---	60	46.49	--	---
(10/21/83)	--	---	54	54.51	--	---

*Reduced growth of species in this plot due to animal grazing destruction.
†Reduced growth of species in this plot due to flooding conditions and animal grazing destruction.

Table A-14. Monthly rainfall near experimental sites (rainfall data from Occioental Chemical Company).

Month	Rainfall in.	Rainfall cm.
January	5.83	14.81
February	4.72	11.99
March	6.34	16.10
April	6.06	15.39
May	1.24	3.15
June	9.49	24.10
July	4.17	10.59
August	3.85	9.78
September	7.60	19.30
October	1.43	3.63
November	4.19	10.64
December	6.14	15.60
TOTAL	61.06	155.09