Special Publication SJ 91-SP10

1990 Annual Report For Research Project Entitled:

WETLAND MACROPHYTE PRODUCTION AND HYDRODYNAMICS IN HOPKINS PRAIRIE, OCALA NATIONAL FOREST, FLORIDA MARCH 1989 - DECEMBER 1990

Prepared for

St. Johns River Water Management District

Submitted by:

Ken S. Clough and
G. Ronnie Best

G. Ronnie Best, Ph.D.
Principal Investigator

Center for Wetlands
University of Florida
Gainesville, Florida 32611

April 1991
July 1991
July 1991

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

WETLAND MACROPHYTE PRODUCTION AND HYDRODYNAMICS IN HOPKINS PRAIRIE, OCALA NATIONAL FOREST, FLORIDA MARCH 1989 - DECEMBER 1990

EXECUTIVE SUMMARY

Hopkins Prairie is a "wet prairie" located in the Ocala National Forest in north central Florida, approximately five miles southwest of the town of Salt Springs, Marion County. Wet prairies occur scattered throughout the Ocala National Forest (Snedaker and Lugo 1972). The U.S. Fish and Wildlife Service classifies this ecosystem as a persistent emergent wetland with organic soil (Cowardin et al 1979). Wet prairies with similar plant communities are also found in the Okefenokee Swamp of south Georgia and the Everglades of south Florida. The hydrology of Hopkins Prairie is characterized by cyclic periods of flooded conditions (surface water present) and drained conditions (water table below the soil surface) of varying frequency and duration. The prairie is largely unaffected by anthropogenic activities, with the exception of prescribed burning conducted periodically by the U.S. Forest Service. The St. Johns River Water Management District (SJRWMD) has identified Hopkins Prairie as a long term ecological research site to examine the effects of hydrology on wetland functions. The present study examines the effects of water level and season on plant community dynamics and the distribution of some nutrients in the prairie. The objectives were to examine the effects of water level fluctuations and season on: 1) plant biomass; 2) species relative dominance; 3) species diversity and richness; and 4) the distribution of inorganic forms of nitrogen (N) and phosphorus (P) in the soil and organic forms of N and P in plant tissues. This report covers the period from March 1989 to December 1990 during which a shift from flooded to drained conditions occurred.

Mean annual stage data provided by the SJRWMD indicated a cyclic pattern of hydrologic conditions at Hopkins Prairie over the last 10 years. Shifts between flooded and drained conditions occurred in 1983, 1985, 1987 and 1990. In June 1990, the water table dropped below the soil surface and remained belowground throughout the remainder of the calendar year. Although the water table was below the soil surface (maximum of 39 cm below) during most of 1990, soil moisture content in the top 10 cm remained between 80 and 90 percent.

Most species recorded during this study were "obligate" wetland plants as described by Reed (1988). Under flooded conditions, White waterlily (*Nymphaea odorata*), a floating-leaved aquatic species, co-dominated with Soft-headed pipewort (*Eriocaulon compressum*) and Spikerush (*Eleocharis elongata)*, both highly water tolerant emergent species. Following drawdown, waterlily decreased and co-dominance shifted to pipewort, Inundated beak rush (*Rhynchospora inundata*) and Blue maidencane (*Amphicarpum muhlenbergianum*), the later two species are less water tolerant emergents. In addition to the shift in species dominance following drawdown, the number of species (species richness) increased. Four species were present during the flooded months in 1989 and 1990 compared to 11 species during the drained period of 1990. A seed bank and/or seed dispersal from outside the site are likely mechanisms which increased species richness during that period. As the water table dropped below the soil surface, conditions for seed germination became favorable for additional species. Total biomass above and belowground shifted from greater allocation belowground under flooded conditions to greater aboveground allocation under drained conditions.

The plant community at Hopkins Prairie responded to drawdown by shifting dominance to species favoring drained conditions, increasing the number of species present and allocating more biomass aboveground. This shift may be part of a recurring cycle in which plant community changes coincide with cyclic changes in water level. Repeated shifts in the plant community with varying hydrology may result in few gaps in standing crop and a continued turnover of biomass. This may contribute to continued peat accumulation and maintenance of Hopkins Prairie as a wet prairie.

The rate of oxygen (O_2) supplied to wetland soils is reduced under flooded conditions due to the slower rate of O_2 diffusion through water than through air (Ponnamperuma 1984). Oxygen is consumed by microbes within the soil, if O_2 is consumed faster than it can be replaced, anaerobic conditions will develop in the soil profile. The amount of water extractable nitrogen (N) and phosphorus (P) in Hopkins Prairie soil appeared to be related to water level, presumably due to changes in O_2 availability. Most biologically available N was in ammonium N (NH_4-N) form under flooded conditions. Available P as soluble reactive P (SRP) was at its maximum under flooded conditions. Nitrate N (NO_3-N) increased and SRP decreased following drawdown. Ammonification under flooded conditions was likely controlling N availability. Nitrification became important under drained conditions with higher O_2 availability. The decrease in available P under drained conditions probably resulted from uptake by increased microbial activity under aerobic conditions. Adsorption-desorption and chemical precipitation were probably not important processes since the organic soil at Hopkins Prairie lacks the high mineral content necessary for these processes to be significant.

Macrophyte tissue N and P was relatively constant in all compartments except the aboveground live shoots. Aboveground live tissue N increased and P decreased following drawdown. The different trends in N and P tissue content of aboveground shoots suggests that N and P uptake by plants may be controlled by their availability in the soil. The increase in NO_3-N in the soil under drained conditions provided an additional form of N (in addition to NH_4-N) for plants and microbes. Lower P availability in the soil and in plant tissues suggests that demand for P by the plants was greater than available P in the soil, particularly under drained conditions. Periphyton/algae N and P content was as great or greater than aboveground live plant tissues. The periphyton/algae provided a storage compartment for N and P in addition to its role in providing N through N_2 fixation.

The decrease in water level at Hopkins Prairie during this study produced rapid changes in the plant community and the distribution of various forms of N and P within the wetland. The rapid adaptability by the plant community to recurring shifts between flooded and drained conditions suggests that the prairie is a stable community in which vegetation changes oscillate on a repeatable cycle controlled by water level.

INTRODUCTION

Hydrology is a major factor controlling the structure and function of wetlands (Carter et al. 1978 and LaBaugh 1986), particularly in systems characterized by peat soils (Veery and Boelter 1978). Water presence, quality, movement, and depth and duration of flooding may produce varied responses from flora and fauna of wetland ecosystems (Chimney and Helmers 1990, Kadlec 1987 and Kozlowski 1984).

The St. Johns River Water Management District (SJRWMD) has undertaken a research project to investigate ecological functions of wetlands in relation to hydrology (SJRWMD 1985). Hopkins Prairie, located in the Ocala National Forest, Florida has been chosen as a long-term ecological research site for this purpose. Ongoing research at Hopkins Prairie includes vegetation dynamics, soil biogeochemistry, water quality and fish and macroinvertebrate populations. The present study examined the effects of water level and season on vegetation structure and production and the distribution of nitrogen (N) and phosphorus (P) in the soil, water column and plant tissues from May through December 1990.

Wetlands generally exhibit high productivity, combining energy sources of both terrestrial and aquatic environments (Odum 1983). Hutchinson, in Lindeman (1942), defined productivity as the total rate of energy flow into a trophic level. Odum (1971) defined primary productivity of an ecosystem as the rate of photo- and chemosynthesis by which radiant energy is converted to organic substances by primary producers (mainly green plants). Using the concept of energy production, which may be measured as biomass, nutrients, carbon etc., Colinvaux (1986) defined gross primary production as the amount of plant biomass produced plus the energy which was used to produce it (respiration). Net primary production can then be defined as the biomass produced in excess of respiration during production.

Shew et al. (1981) outlined five commonly used methods for estimating aboveground net primary productivity using sequential standing crop measurements. Net primary production can be calculated from standing crop measurements as biomass changes per unit area per unit time (grams dry weight per m^2 per day). However, this does not account for loss through decomposition and herbivory. The quantity of biomass lost through decomposition is a function of sample frequency (Dickerman et al. 1986). Methods which do not account for decomposition may underestimate net primary production, particularly at low sampling frequency. In addition to biomass production measurements, standing crop data (if separated by species) can be used to examine plant community dynamics. Odum (1960) investigated the relationship between net primary production and succession.

Past macrophyte productivity studies have focused on aboveground productivity while ignoring belowground production (Mason and Bryant 1975 and Peverly 1985). Growth and senescence of rooted plants occurs aboveground (shoots, stems and leaves) and belowground (roots, rhizomes etc.). Studies which attempt to quantify biomass of rooted plants should include both above and belowground measurements. Information on belowground biomass allocation and production can then be used to investigate plant dynamics not visible at the soil surface.

The objectives of this study were to investigate the effects of water level and season on (1) plant community structure, (2) above and belowground biomass production and (3) distribution of nitrogen (N) and phosphorus (P) in the soil, plant and water compartments at Hopkins Prairie.

METHODS

Study site description

Hopkins Prairie is located within the Ocala National Forest, approximately five miles southwest of the town of Salt Springs, Marion County, north central Florida (Figure 1). This type of wetland is considered a wet prairie (Snedaker and Lugo 1972), classified by the U.S. Fish and Wildlife Service as a persistent emergent wetland with organic soil (Cowardin et al. 1979). Hydrology of Hopkins Prairie is characterized by recurring periods of flooded conditions (surface water present) and drained conditions (water table below the soil surface) of varying frequency and duration. The prairie is situated in a closed basin surrounded by pine flatwoods and managed timber lands. Several plant communities are represented within the prairie. Sawgrass-buttonbush (*Cladium jamaicense-Cephalanthus occidentalis*) dominated islands of higher soil elevation occur scattered throughout the prairie. Lower elevation areas are dominated by various emergent or floating leaved species. During flooded periods, floating-leaved plants such as white waterlily (*Nymphaea odorata*) or spatterdock (*Nuphar luteum*) dominate these areas. Under drained conditions, emergents such as beak rush (*Rhynchospora* spp.) or blue maidencane (*Amphicarpum muhlenbergianum*) predominate.

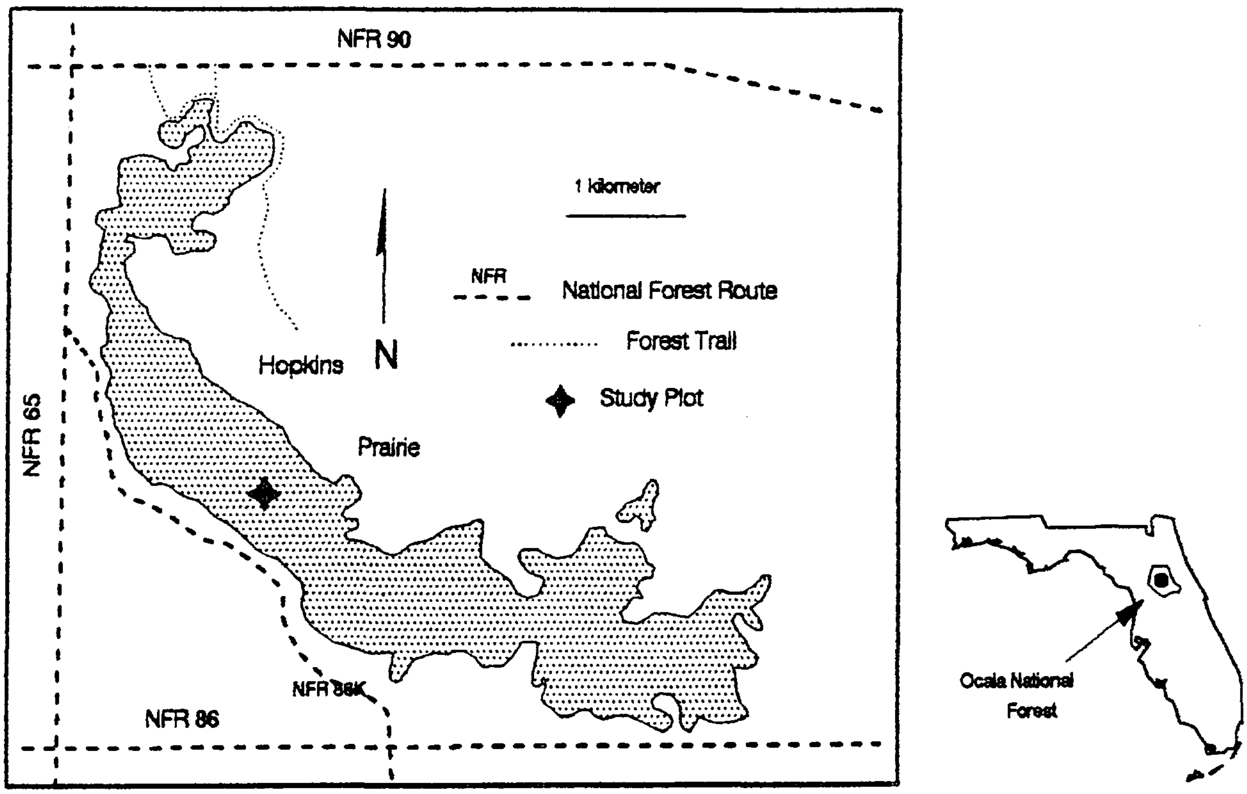


Figure 1. Study site of wetland macrophyte production and hydrodynamics study at Hopkins Prairie, Ocala National Forest, Florida, 1990.

Sampling design

A 10 m X 18 m study plot was established within a plant community typical of the lower elevation areas in Hopkins Prairie (Figure 2). The plot was divided into six subplots 10 m X 3 m. Each subplot was further divided into 30, 1 m^2 sampling sites. Monthly measurements were collected in replicates of six by sampling one randomly chosen 1 m^2 site within each subplot. Monthly measurements included the following: water level; plant species percent cover; above ground plant biomass; below ground plant biomass; water extractable soil N and P; and plant tissue N and P. Biomass (separated by species) and soil were separated into the following categories:

Biomass	Soil
Aboveground-live	
Aboveground-dead	
Belowground 0-10 cm	0-10 cm
Belowground 10-20 cm	10-20 cm
Belowground 20-30 cm	20-30 cm

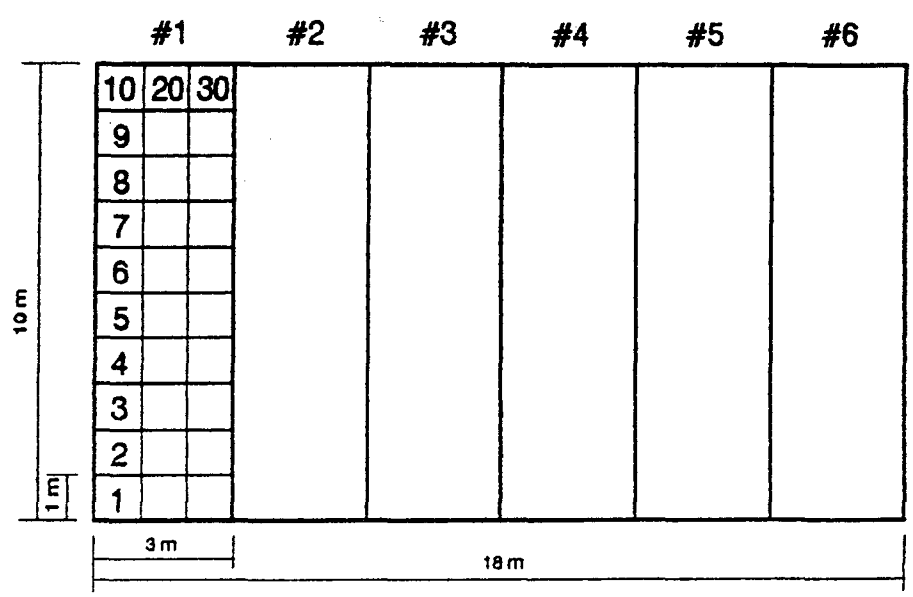


Figure 2. Study plot design showing subplots (#1-6) and sample sites (1-30) for wetland macrophyte production and hydrodynamics study at Hopkins Prairie, Ocala National Forest, Florida, 1990.

Water level

Water levels relative to the soil surface were recorded at each sample site by measuring the water depth (flooded conditions) or the depth to the water table (drained conditions). Under drained conditions, depth from the soil surface to the water table was measured in the hole excavated by the soil sample core (see below) after allowing the level to equilibrate. Hydrologic data for the past 10 years were provided by the SJRWMD. Stage level, water depth and rainfall from 1981 to 1990 was used to examine hydrologic variability for comparison with conditions during the study period.

Plant cover and biomass

A 25cm X 25cm sample frame (Figure 3) was placed 10 cm deep into the soil in the center of the randomly chosen 1 m^2 sample site. A hand pump was used to remove any standing water within the sample frame. Percent cover of each species was visually estimated in categories 0%, less than 1%, 1%, 3%, 5%, and intervals of 5% from 10% to 100%. Aboveground biomass was kept intact while all material within the sample frame was excavated to a depth of 10 cm (avoiding disturbance of the soil surface). Aboveground biomass was collected by cutting shoots at the soil surface and separated by species into live and dead categories. All periphyton/algae biomass was separated from plant material and collected (Periphyton/algae present in the water column under flooded conditions, formed a dry layer on the soil surface upon draining). The remainder of the sample was processed to determine belowground biomass from 0-10 cm. A 10.2 cm diameter (4 in) PVC core was pushed 20 cm into the soil at the center of the hole created by the 0-10 cm sample. This sample was cut in half and processed to determine belowground biomass at 10-20 and 20-30 cm soil depths. Belowground biomass samples were sieved through a U.S. standard no. 14 sieve then placed in a pan of water, forceps were used to remove belowground plant materials. Belowground biomass was separated by species when possible, unidentified biomass was placed in a general category (live and dead biomass was not separated). Aboveground, belowground and periphyton/algae biomass was oven dried at 60° C to constant weight for dry weight measurements, results are reported in grams dry weight (DWT) m^{-2} day^{-1}. Percent cover and biomass data were used to examine plant community dynamics and biomass production.

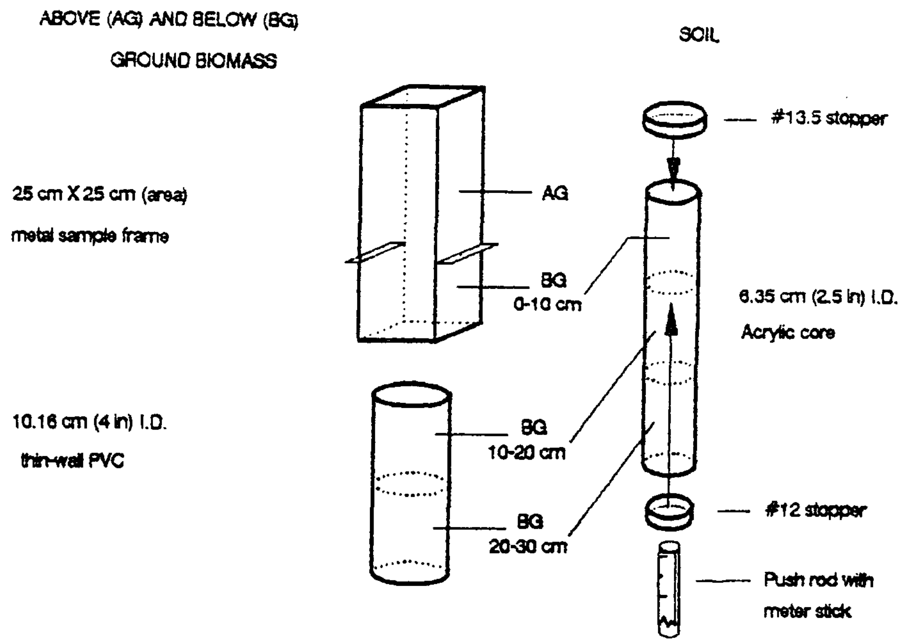


Figure 3. Vegetation and soil sampling equipment used in wetland macrophyte production and hydrodynamics study at Hopkins Prairie, Ocala National Forest, Florida, 1990.

Plant species diversity and richness

Several measures of species diversity are used in ecological research, the most widely used statistic is the Shannon-Wiener Diversity Index, H' (Colinvaux 1986) as follows:

$$H' = -\sum (p_i \log p_i) \qquad \text{where, } p_i = \text{proportion of species i in total sample}$$

This formula has been calculated using $\log_2$, $\log_{10}$ or ln; $\log_2$ is used in this report for comparison to previous studies using $\log_2$. Plant species richness (R) is a direct count of the number of species recorded in a sampling event. The Shannon-Wiener index combines relative abundance and species richness to indicate the 'evenness' of the distribution of species.

Wetland Index Value

The wetland index value represents the degree of association of a plant community with wetland habitat (the lower the WIV, the higher the association with wetlands). Reed (1988) assigned a value of 1-5 to plant species occurring in wetlands. These indicator categories represent estimated probabilities of occurrence in wetlands as follows: 1=obligate wetland; 2=facultative wetland; 3=facultative; 4=facultative upland; and 5=obligate upland. Monthly wetland index values (WIV) for the study site were calculated using the following formula:

$$WIV = \frac{\sum (R * I)}{\sum R}$$

where, R = Relative abundance
I = Wetland indicator number

The wetland indicator number of each species was multiplied by its relative dominance (using aboveground live biomass), the sum of these values for all species was divided by the sum of the relative dominances[1].

Net aboveground primary production

Aboveground live and dead biomass of all species was combined and totaled each month. Monthly increases in total aboveground biomass were used to calculate net aboveground primary production (NAPP) by dividing the dry weight increases by the number of days in the sample period. Results are reported in grams dry weight (DWT) m^{-2} day^{-1}. This method of sequential sampling of biomass assumes negligible loss of aboveground biomass between sampling dates. Therefore, estimation of NAPP may be underestimated since decomposition and herbivory between sampling periods was not measured. A litter bag study (see below) is currently underway in order to quantify decomposition.

---

[1]The sum of the relative dominance of species used in this calculation may be less than 1.00 if identification to species was not possible, precluding placement into a wetland indicator category, or if a species has not been given a wetland indicator number.

Decomposition

Decomposition sampling is not included in this report. Data will be forthcoming using a modified litter bag method (Wiegert and Evans 1964). Decomposition rates are being examined with 12 nylon mesh litter bags, six containing live and six recently dead aboveground plant material. A known fresh weight of the three most abundant species each month (based on percent cover) is placed in each litter bag in the same relative proportions as the cover estimates. Subsamples are collected for percent dry matter determination. One bag of each type is placed at each sampling site for approximately one month. Dry weight of plant material at the end of one month is compared to initial dry weight to calculate loss rates. Dry weight loss from bags containing live plant material is used to estimate biomass loss during senescence. This loss rate is applied to the amount of dead biomass produced during the period resulting in an estimate of loss as aboveground live becomes aboveground dead biomass. Dry weight loss from bags containing dead plant material is used to estimate biomass loss to decomposition. This loss is applied to the initial standing crop of aboveground dead biomass to estimate loss of dead biomass during the period. Results will be reported in grams DWT m^{-2} day^{-1}. Addition of estimated biomass loss between sampling events to changes in aboveground biomass may result in more accurate estimates of net aboveground primary production. Seasonal differences in loss rates may also be identified.

Soil "available" nitrogen and phosphorus

Nitrogen and phosphorus content of the soil, plant tissues and water column were used to examine changes in distributions and concentrations with changing water levels. Soil samples were collected within each 1 m^2 sampling site using a 6.4 cm (2.5 in) acrylic core (Figure 3). Aboveground litter was cleared from an area adjacent to the biomass sample to expose the soil surface. The soil core was inserted 30-35 cm deep into the soil. Slow insertion by "hammering" with a wood 2 X 4 board prevented soil compaction inside the core. Three 10 cm samples (soil depths of 0-10, 10-20 and 20-30 cm) were collected using a no. 12 rubber stopper and push rod to extrude the soil from the core. Samples were stored in zip-lock plastic bags and transported on ice to the laboratory. Extraction procedures to determine water extractable ammonium N (NH_4-N), nitrate+nitrite N (NO_3+NO_2-N) and soluble reactive P (SRP) were performed using method ASA (1982) 33-3.2.2. A fresh sample of soil was extracted with deionized water in a ratio of approximately 1:20 soil dry weight (DWT) to extractant. Fresh soil and deionized water were placed in 40 ml plastic cultures tubes, shaken for 1 hr on a mechanical shaker, centrifuged at 6000 rpm for 18 min, then filtered through a 0.45um membrane filter and acidified to pH < 2.0. Analyses were conducted on a Technicon Autoanalyzer II using methods USEPA (1979) 351.2 for NH_4-N, APHA (1989) 4500-NO_3^--F for NO_3-N and APHA (1989) 4500-P-F for SRP. Soil moisture content was determined by measuring weight loss of oven dried samples at 70° C, using method ASA (1986) 21-2.2.2. Nitrogen and P content is reported in mg N or P per kg DWT of soil.

Plant tissue nitrogen and phosphorus

Plant tissues were analyzed for total kjeldahl nitrogen (TKN) and total phosphorus (TP). All species were combined in each plant tissue category, ie., aboveground live, aboveground dead and belowground biomass at three soil depths. Samples were ground using a Whiley Mill. A subsample of 0.100 g was digested on a block digester as follows: 0.5 g of Sel-dahl digestion powder (copper sulfate, potassium sulfate mixture) and 5.0 ml of concentrated sulfuric acid (H_2SO_4) was added to the subsample, digested at 380° C for 5-7 hrs then diluted after cooling to 50 ml total volume with deionized water. Determination of TKN and TP was done on a Technicon Autoanalyzer II using methods USEPA (1979) 351.2 for TKN and APHA (1989) 4500-P-F for TP. Nitrogen and P content is reported in mg of N or P per kg DWT of plant tissue.

Water column nitrogen and phosphorus

Nitrogen and phosphorus analyses were initiated after drawdown; therefore, data on water column N and P are not available for the time period of this report.

Statistical analysis

Linear regression analysis (Ott 1988) was used to test for correlation between mean monthly water level, plant biomass (total and by species), species diversity and species richness. Student-Newman Keuls (SNK) multiple comparison procedure was used to test for differences between monthly mean values of the above parameters. Statistical analyses were performed using SAS/PC (SAS 1988). Nutrient data included in this report covers the months May through August, Statistical analysis of nutrient data will be conducted on the complete data set (May through December) when data are available.

RESULTS

Water level

Rainfall and water depth at Hopkins Prairie have been monitored by the St. Johns River Water Management District since 1986, the U.S. Fish and Wildlife Service measured stage level from 1981-1986. Water level, rainfall and stage level at Hopkins Prairie from 1981 through 1990 were provided by the SJRWMD. These data are presented in addition to monthly water level measurements at the study site. Mean annual stage was below the soil surface for the years 1981-82, 1985-86 and 1990 (Figure 4). Mean annual stage was above the soil surface 1983-84 and 1987-89. Monthly water level during the latest shift from flooded to drained conditions (1987-1990) indicates that standing water was present during all but one month from April 1987 through May 1990 (Figure 5). Rainfall during that period was highest in August and September of all years. Maximum rainfall was recorded during the period June to September 1989. Frequency of inundation during 1990 was approximately 20% compared to 65% in 1989 (Figure 6). Inundation frequency during the period 1981-90 was approximately 65%. Water level at the study site during the period of this report (1989-1990) shifted from flooded to drained conditions in June 1990 (Figure 7; Appendix 1). Flooded conditions persisted during 1989 in all months except June. Flooding continued in 1990 until June, followed by drained conditions throughout the remainder of the calendar year. Mean monthly water levels decreased throughout the study period with significant decreases in May, August and November ($p<0.0001$). Soil moisture content of the upper 10 cm ranged from 88.5% (-32.0 cm water depth) to 90.9% (-39.0 cm water depth), averaging 89.3% during the period May to December 1990 (Table 1). Soil moisture in May (flooded conditions) was significantly greater than the remainder of the year ($p<0.03$).

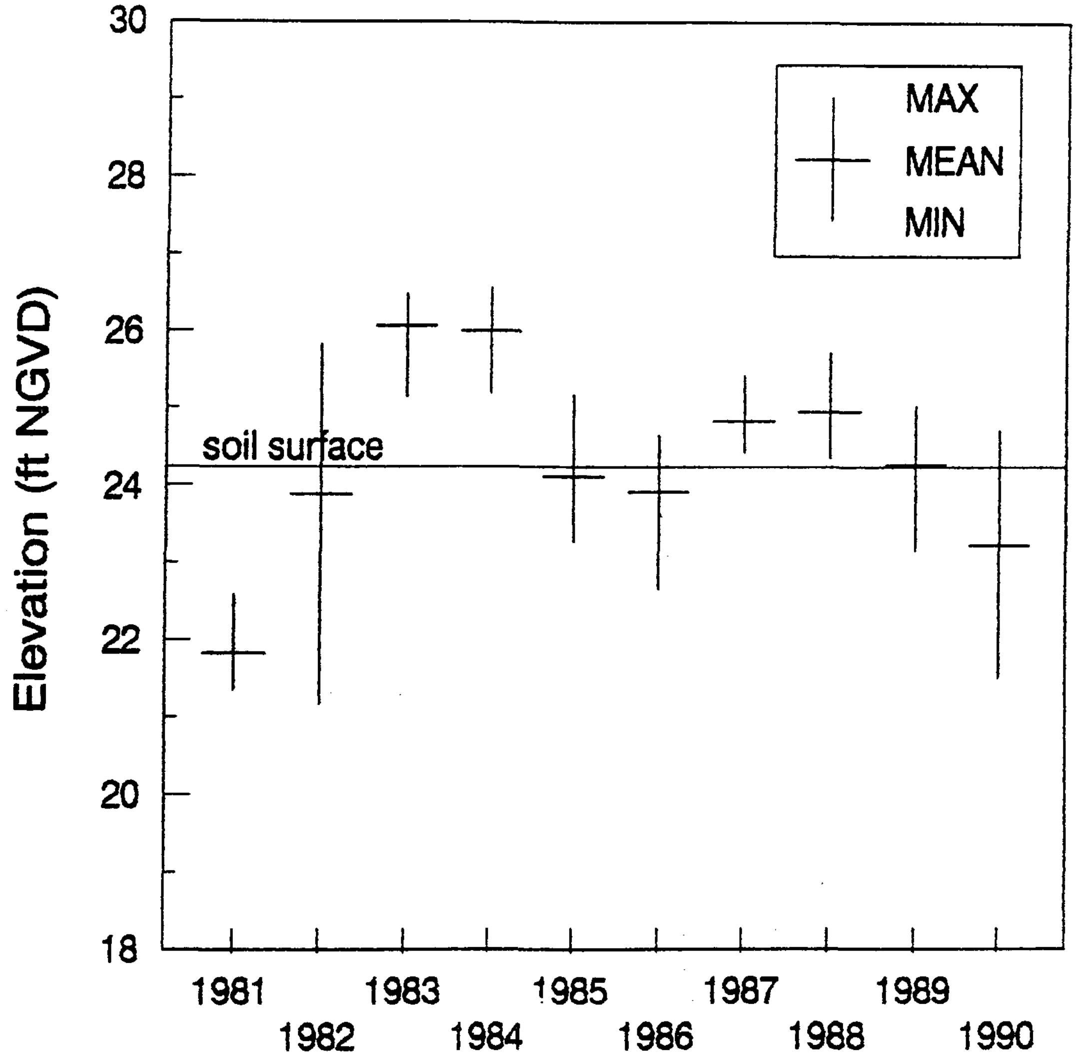


Figure 4. Mean annual stage level at Hopkins Prairie, Ocala National Forest, Florida, 1981-90 (Data provided by the St. Johns River Water Management District).

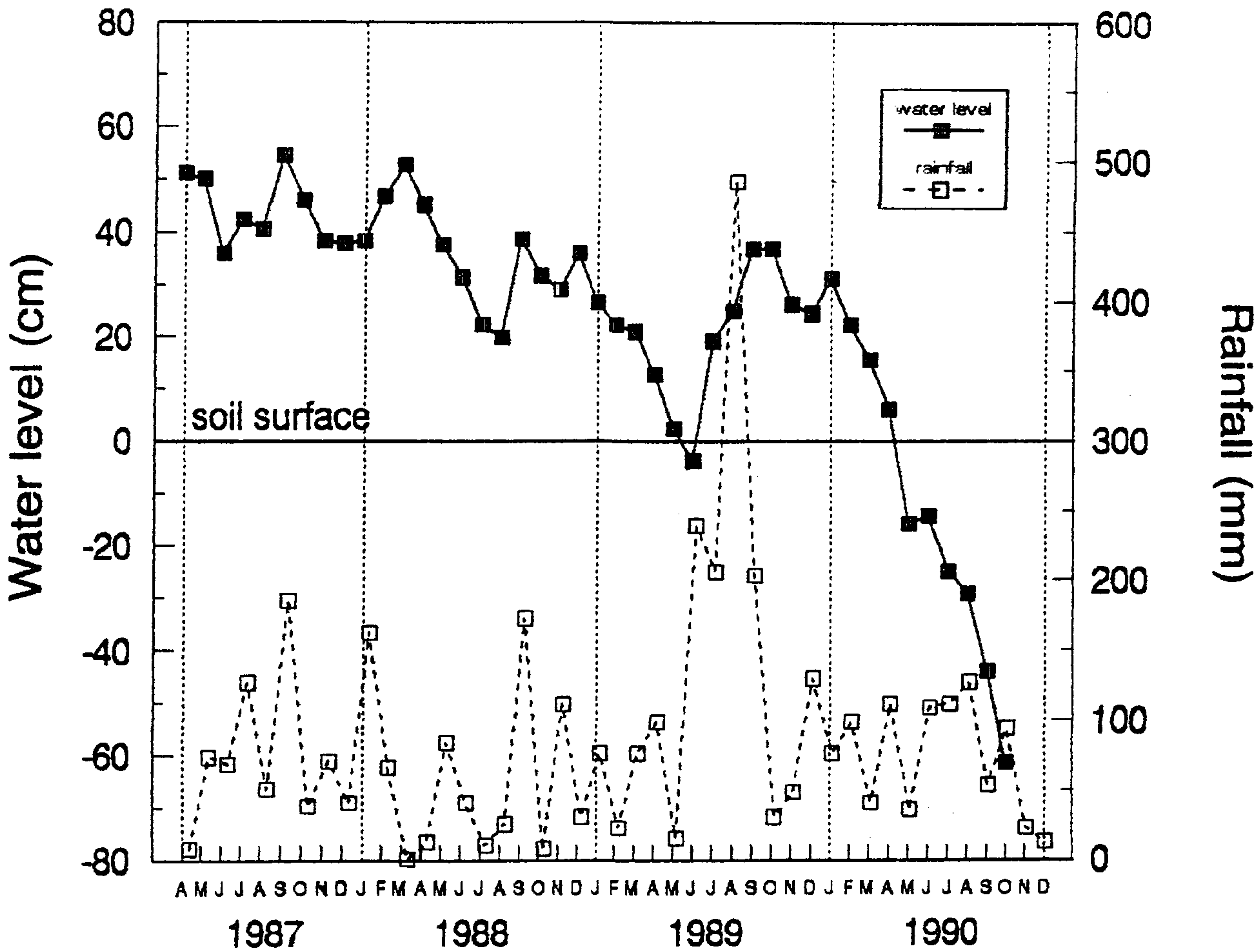


Figure 5. Monthly water depth relative to soil surface, and rainfall at Hopkins Prairie, Ocala National Forest, Florida, 1987-90 (Data provided by the St. Johns River Water Management District).

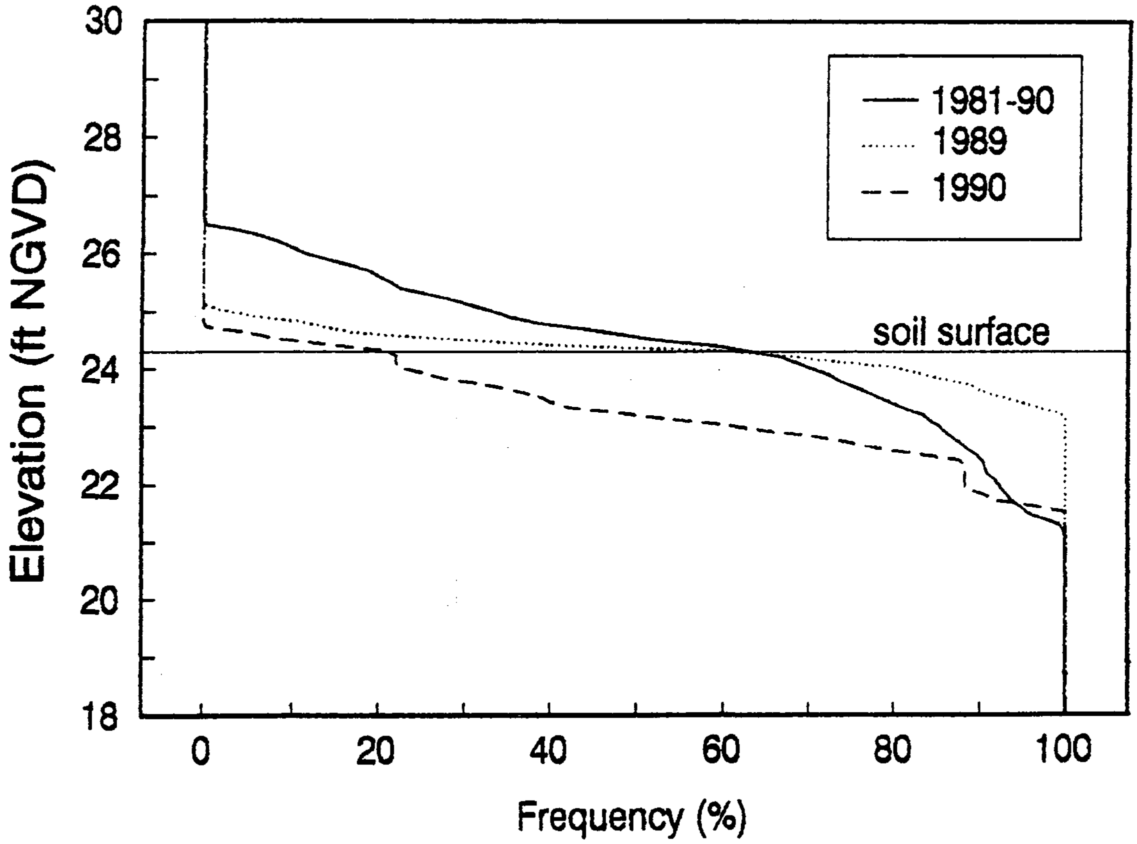


Figure 6. Frequency of inundation, as percent of time flooded at Hopkins Prairie, Ocala National Forest, Florida. Data provided by the St. Johns River Water Management District.

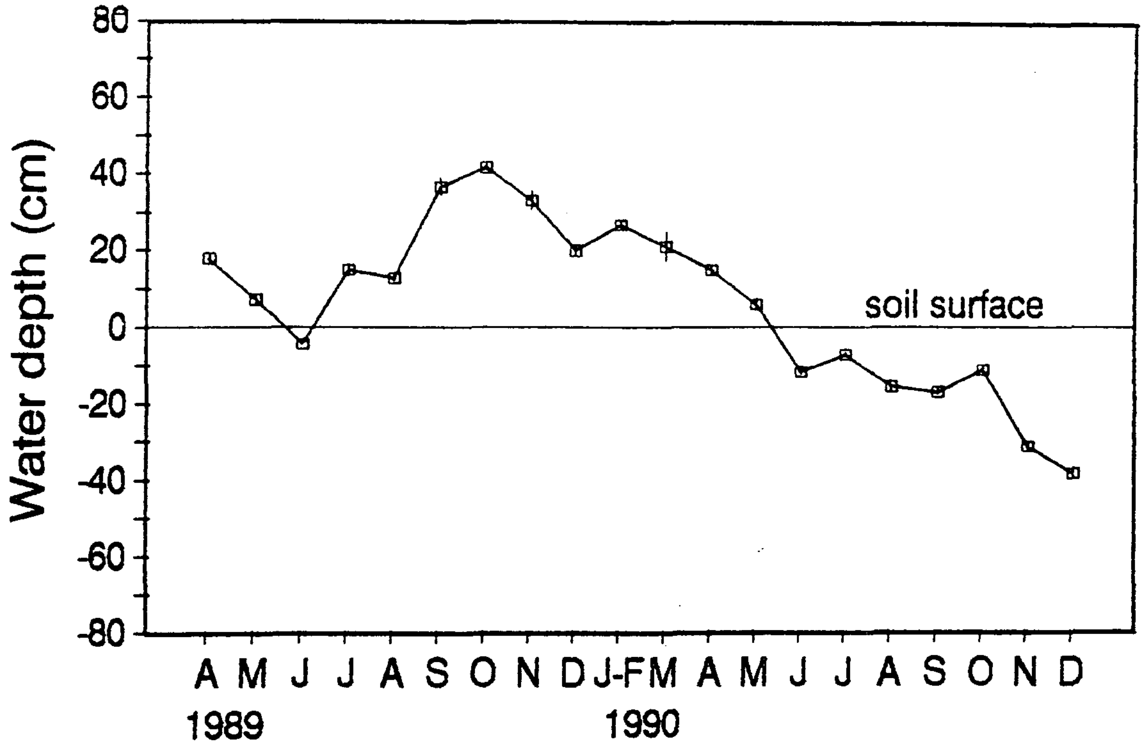


Figure 7. Mean (n=6) monthly water level relative to soil surface at wetland macrophyte production and hydrodynamics study site, Ocala National Forest, Florida. April 1989 - December 1990.

Table 1. Mean (n=6) moisture content of soils at Hopkins Prairie, Ocala National Forest, Florida. May - December 1990.

Soil Depth (cm)	1990 Soil moisture content (%)							
	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0-10	90.9	90.4	90.1	89.1	89.3	88.7	88.5	87.8
10-20	89.4	90.1	89.9	89.1	89.6	89.3	89.2	89.0
20-30	88.4	90.4	90.0	89.0	90.0	89.0	88.6	89.1

Plant species composition 1989-90

Four plant species were observed in the subplots during 1989 (1 month of drained conditions) compared to 11 species during 1990 (7 months of drained conditions). *Nymphaea odorata* was present throughout 1989, increasing during October through December and decreasing in 1990 to zero following drawdown (Figure 8; Appendix 2). *Eriocaulon compressum* and *Eleocharis elongata* were present during most of 1989 and 1990, *E. compressum* showing no obvious peak or dip while *E. elongata* was highest during the flooded period from November 1989 to April 1990. *Rhynchospora inundata* was present from June 1989 to January/February 1990 and from June to December 1990. The additional seven species present in 1990 were recorded in the period October to December, after four months of drained conditions.

Aboveground and belowground plant biomass

Total aboveground (AG) biomass (all species combined) averaged 24.01 g DWT m^{-2} under flooded conditions and 47.99 g DWT m^{-2} under drained conditions (Table 2). Total belowground (BG) biomass (0-30cm) averaged 1075.72 under flooded and 515.82 g m^{-2} under drained conditions. Vertical separation of total belowground biomass at soil depths 0-10 cm, 10-20 cm and 20-30 cm averaged 67%, 23% and 10%, respectively, when flooded and 73%, 18% and 9%, respectively, when drained.

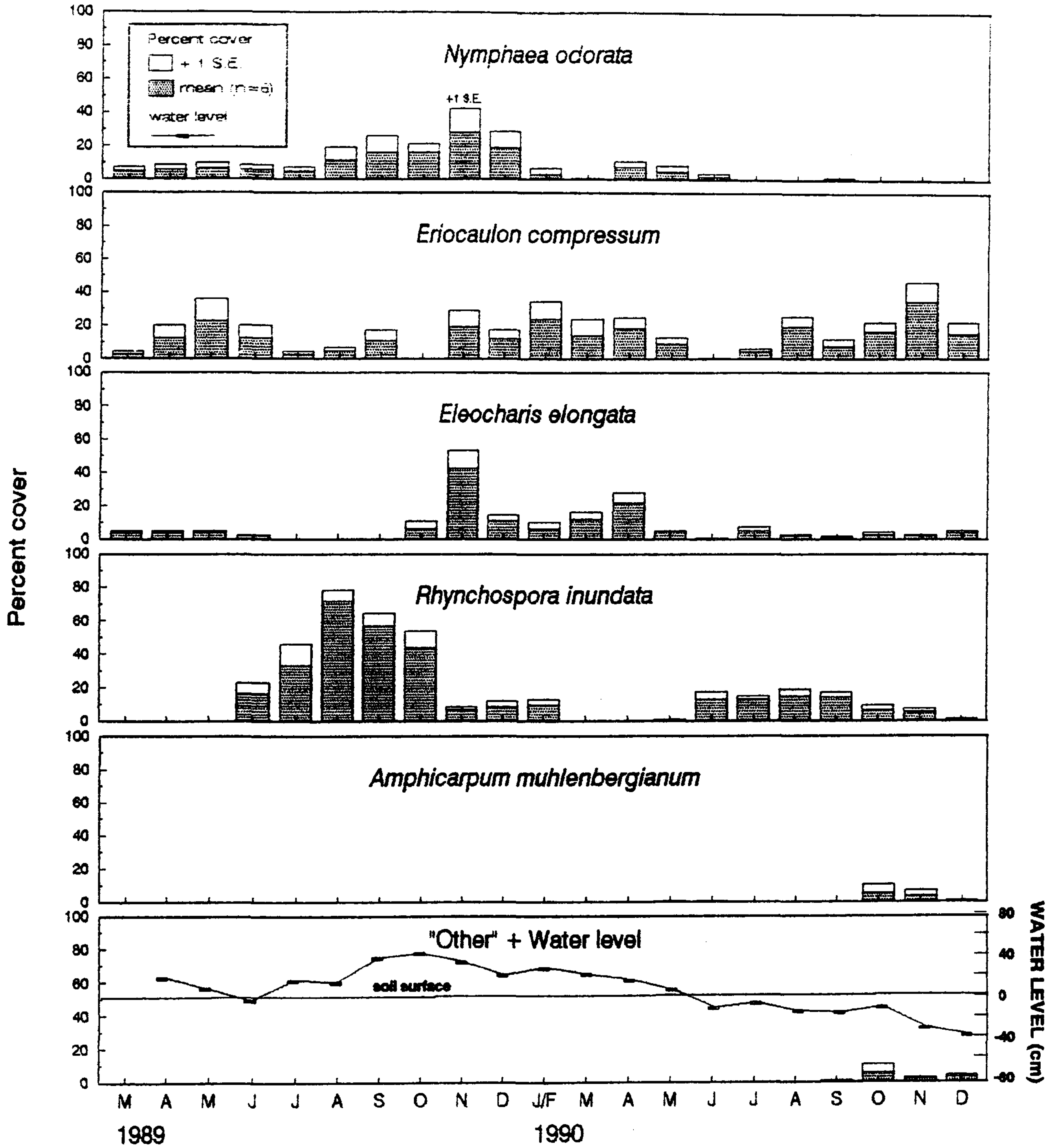


Figure 8. Mean (n=6) percent cover of plant species recorded at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990. ("Other" includes *Rhynchospora tracyi*, *Xyris* sp., *Lachnanthes caroliniana*, *Triadenum virginicum*, *Eupatorium capillifolium* and Mosses).

Table 2. Mean (n=6) aboveground (AG) and belowground (BG) biomass under flooded and drained conditions for plant species recorded at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species	[a]Hydrologic condition	Biomass g DWT m^{-2} Total AG	Total BG	% of total at each soil depth 0-10 cm	10-20 cm	20-30 cm
Nymphaea odorata	Flooded	4.02	484.09	81	12	8
	Drained	2.45	182.01	80	10	10
Eriocaulon compressum	Flooded	9.83	16.04	99	1	<1
	Drained	19.46	20.45	98	2	<1
Eleocharis elongata	Flooded	6.55	38.22	84	10	6
	Drained	2.46	17.16	82	11	7
Rhynchospora inundata	Flooded	3.52	152.44	54	30	16
	Drained	18.74	91.84	73	20	7
Amphicarpum muhlenbergianum	Flooded	<1.00	0.00	100	0	0
	Drained	3.81	4.15	100	0	0
Total (all species)	Flooded	24.01	1075.72	67	23	10
	Drained	47.99	515.82	73	18	9

[a]Flooded=surface water present
Drained=water table below soil surface (saturated soil conditions)

Total aboveground biomass was lowest in March and April under flooded conditions, and greatest in October and November, the fifth and sixth month of drained conditions (Figure 9; Table 3). Mean belowground biomass in May was significantly greater than all other months ($p<0.003$). The greatest total belowground biomass was recorded in March and April with lowest values in October and December. Monthly means of total aboveground biomass were not significantly different ($p<0.13$). Regression analysis of water level with aboveground and belowground total biomass revealed a negative correlation with aboveground biomass ($r^2=0.37$), and a positive correlation with belowground biomass ($r^2=0.40$). Aboveground and belowground biomass (g m^{-2}) of all species occurring at the study site are presented in Appendix 3; regression and ANOVA outputs are given in Appendix 4.

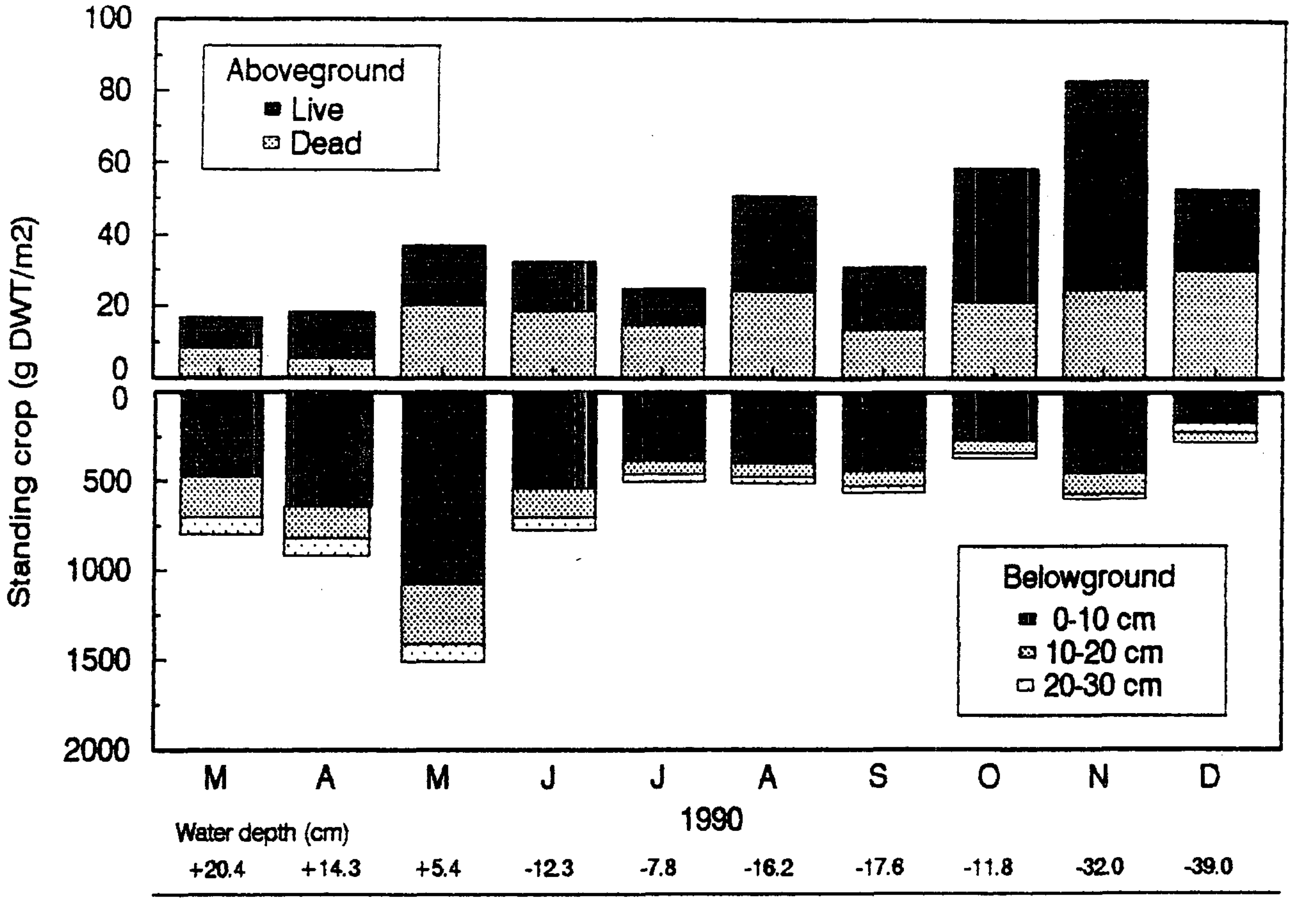


Figure 9. Mean (n=6) total aboveground and total belowground plant biomass (Note difference in y-scales) at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 3. Mean (n=6) allocation of aboveground and belowground plant biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2)		% of total				
	Aboveground live+dead	Belowground 0-30 cm	Aboveground live	Aboveground dead	Belowground 0-10cm	Belowground 10-20cm	Belowground 20=30cm
Total (all species combined)							
March	16.82	797.21	51.2	48.8	60.0	28.1	11.8
April	18.25	919.73	70.0	30.0	70.3	18.9	10.8
May	36.95	1510.22	45.1	54.9	71.6	21.7	6.7
June	32.65	774.82	43.0	57.0	70.0	20.8	9.3
July	24.96	502.59	41.2	58.8	76.8	15.2	8.0
August	51.01	512.91	52.5	47.5	78.7	14.5	6.7
September	31.36	562.91	55.9	44.1	78.7	14.9	6.4
October	59.18	371.43	63.6	36.4	73.2	19.1	7.7
November	83.37	602.02	70.1	29.9	76.3	19.2	4.5
December	53.38	284.03	42.7	57.3	60.2	20.3	19.6

Total aboveground biomass of *N. odorata* was greatest when surface water was present (Figure 10; Table 4). Belowground total biomass was also greatest during the flooded period. May aboveground live and belowground total *N. odorata* biomass values were significantly greater than all other months ($p<0.02$). Aboveground and belowground biomass of *E. compressum* was lower under flooded conditions than under drained conditions (Figure 11; Table 5). *Eleocharis elongata* above and belowground biomass was higher under flooded conditions (Figure 12; Table 6). Belowground biomass of *R. inundata* was greater under flooded conditions, while aboveground biomass was greater during the drained period (Figure 13; Table 7). *Amphicarpum muhlenbergianum* was recorded during the flooded period only in May, above and belowground biomass was greatest during the drained period (Figure 14; Table 8). Additional species were recorded in the aboveground and belowground components from September to December, after four months of continuously drained conditions (Figure 15, Table 9). This "other" category included one or more of the following species: *Rhynchospora tracyi, Xyris sp., Lachnanthes caroliniana, Triadenum virginicum, Eupatorium capillifolium* and/or mosses. Mean monthly water level was negatively correlated with aboveground live biomass of *R. inundata* ($r^2=0.37$), *Xyris* sp. ($r^2=0.55$), *E. capillifolium* ($r^2=0.32$), and belowground biomass of *E. capillifolium* ($r^2=0.31$). A positive linear relationship existed between water level and belowground biomass of *E. elongata* ($r^2=0.49$) and *R. inundata* ($r^2=0.76$).

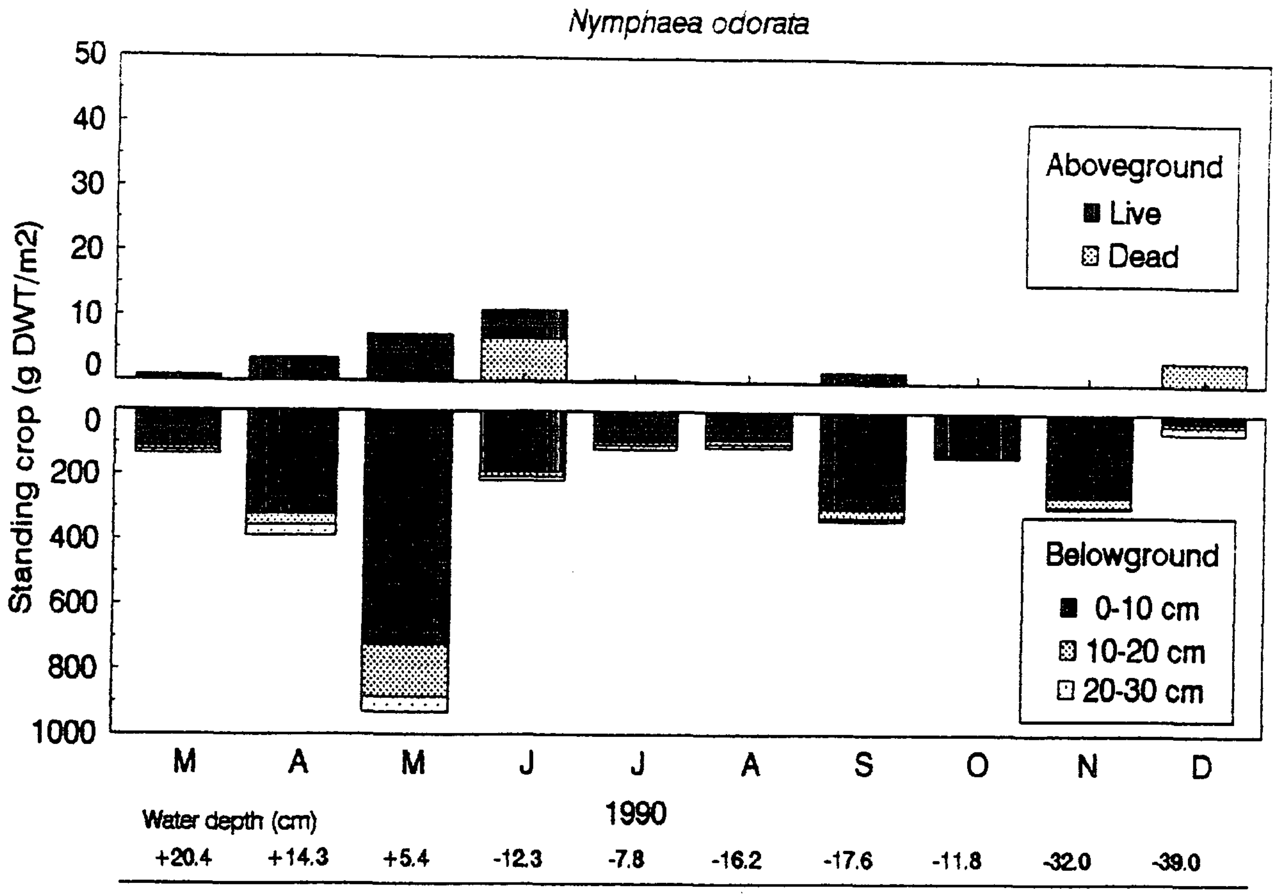


Figure 10. Mean (n=6) *Nymphaea odorata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 4. Mean (n=6) allocation of *Nymphaea odorata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Belowground 0-30 cm	% of total Aboveground live	dead	Belowground 0-10cm	10-20cm	20-30cm
Nymphaea odorata							
March	1.04	134.40	100.0	0.0	82.4	8.7	8.9
April	3.62	386.91	100.0	0.0	82.5	8.9	8.5
May	7.40	930.96	100.0	0.0	77.6	17.3	5.1
June	11.06	212.79	40.3	59.7	87.4	8.5	4.1
July	0.43	118.07	0.0	100.0	78.1	9.7	12.2
August	0.00	111.70	0.0	0.0	77.9	12.5	9.6
September	1.83	337.19	100.0	0.0	89.3	8.1	2.6
October	0.00	140.44	0.0	0.0	100.0	0.0	0.0
November	0.00	295.52	0.0	0.0	87.8	11.8	0.4
December	3.80	58.37	0.0	100.0	38.6	20.2	41.2

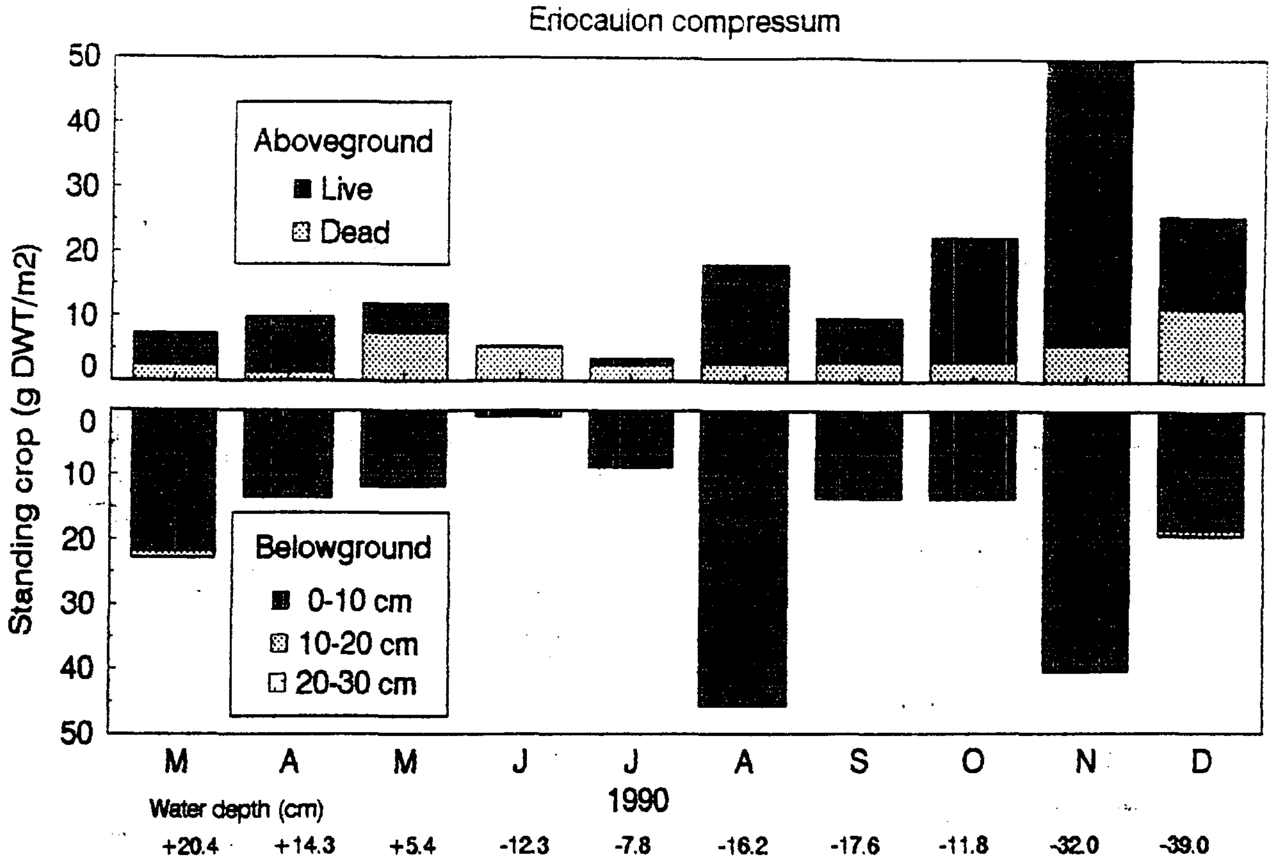


Figure 11. Mean (n=6) *Eriocaulon compressum* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 5. Mean (n=6) allocation of *Eriocaulon compressum* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Total biomass (g DWT/m2) Belowground 0-30 cm	% of total Aboveground live	% of total Aboveground dead	% of total Belowground 0-10cm	% of total Belowground 10-20cm	% of total Belowground 20=30cm
Eriocaulon compressum							
March	7.44	22.75	66.9	33.1	95.6	4.0	0.5
April	10.02	13.48	86.5	13.5	100.0	0.0	0.0
May	12.03	11.88	37.9	62.1	100.0	0.0	0.0
June	5.62	1.07	5.1	94.9	100.0	0.0	0.0
July	3.62	8.76	30.4	69.6	99.3	0.7	0.0
August	18.19	45.81	84.9	15.1	99.3	0.6	0.1
September	9.99	13.62	69.5	30.5	96.8	3.2	0.0
October	22.60	13.85	86.4	13.6	97.3	2.7	0.0
November	50.21	40.61	88.3	11.7	99.1	0.5	0.4
December	25.98	19.44	55.4	44.6	95.3	3.6	1.1

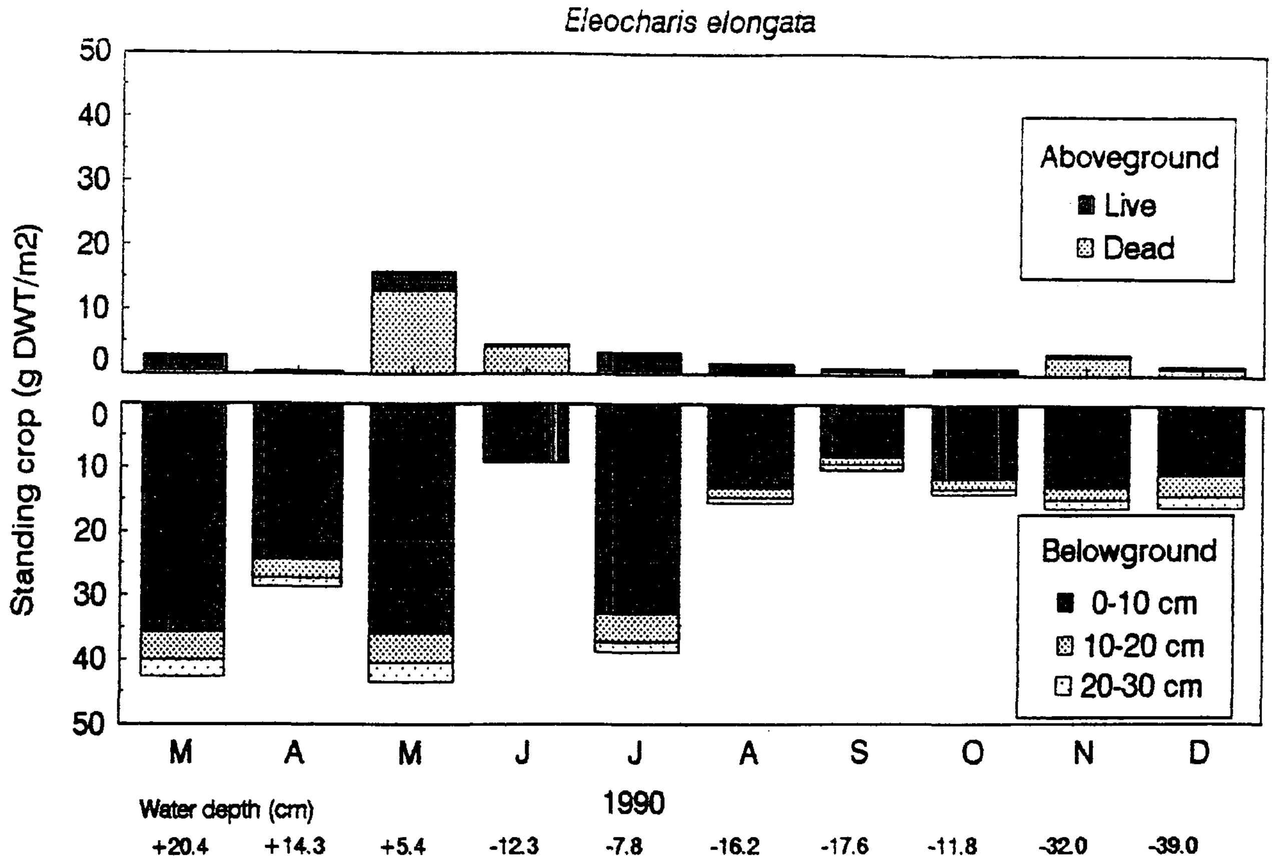


Figure 12. Mean (n=6) *Eleocharis elongata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 6. Mean (n=6) allocation of *Eleocharis elongata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Belowground 0-30 cm	% of total Aboveground live	dead	Belowground 0-10cm	10-20cm	20=30cm
Eleocharis elongata							
March	3.10	42.58	83.7	16.3	83.7	10.2	6.1
April	0.58	28.68	83.9	16.1	84.7	10.2	5.2
May	15.97	43.40	19.8	80.2	82.5	10.9	6.6
June	4.77	9.10	9.8	90.2	95.9	2.3	1.8
July	3.51	38.79	85.4	14.6	84.6	11.3	4.1
August	1.78	15.49	83.6	16.4	84.5	9.7	5.8
September	1.04	10.23	49.1	50.9	80.3	11.1	8.6
October	1.07	14.07	59.6	40.4	82.6	11.3	6.1
November	3.45	16.33	16.5	83.5	79.2	11.8	8.9
December	1.59	16.13	33.8	66.2	68.3	20.5	11.2

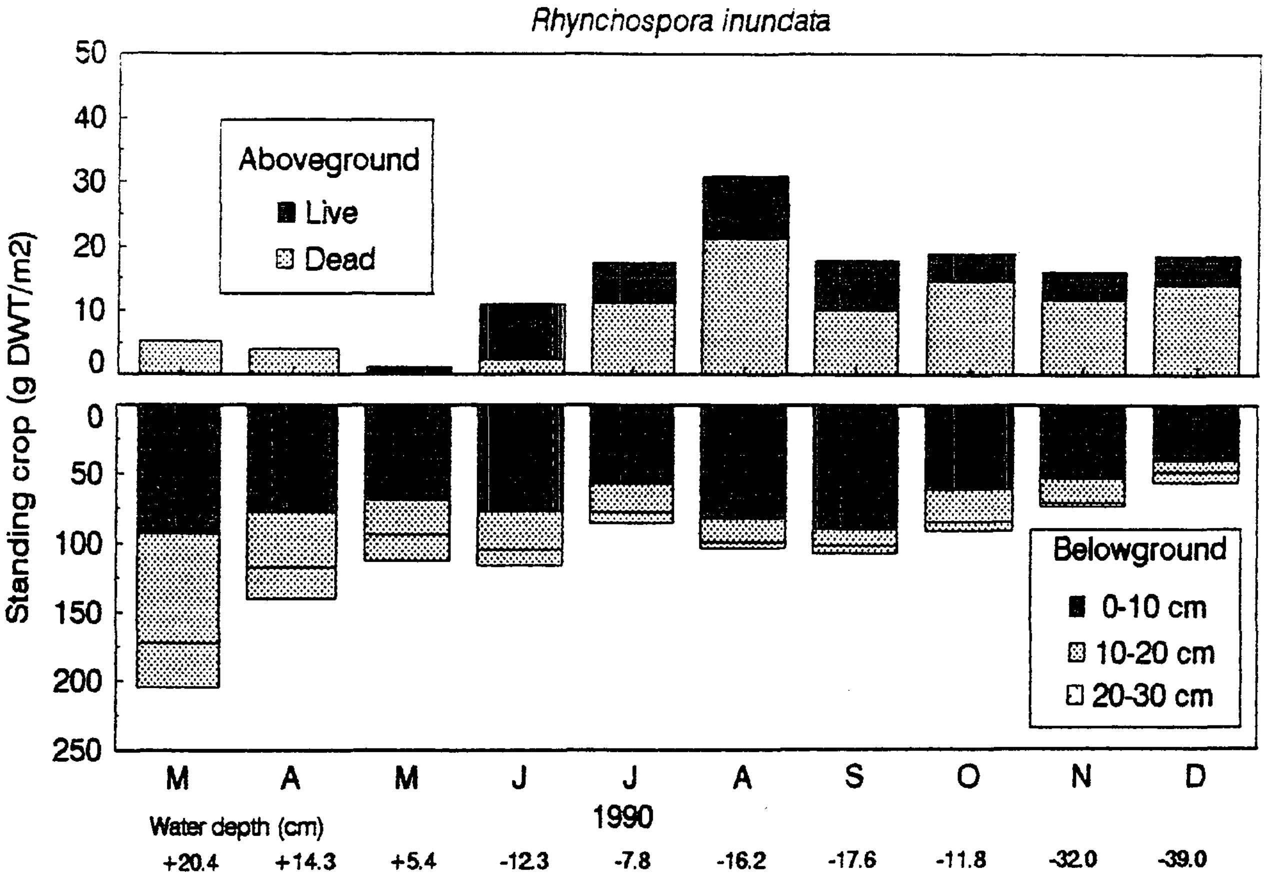


Figure 13. Mean (n=6) *Rhynchospora inundata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 7. Mean (n=6) allocation of *Rhynchospora inundata* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Belowground 0-30 cm	% of total Aboveground live	dead	Belowground 0-10cm	10-20cm	20=30cm
Rhynchospora inundata							
March	5.24	204.52	0.0	100.0	45.4	38.8	15.8
April	4.03	140.44	0.0	100.0	55.3	28.3	16.4
May	1.30	112.36	100.0	0.0	61.2	22.1	16.7
June	10.97	115.96	78.2	21.8	66.5	23.6	9.9
July	17.40	85.95	35.6	64.4	66.4	24.3	9.4
August	31.05	103.90	31.7	68.3	78.9	16.4	4.6
September	17.94	107.94	43.1	56.9	83.6	10.6	5.7
October	18.98	91.22	22.5	77.5	67.3	25.9	6.8
November	16.14	73.76	27.2	72.8	73.2	23.9	3.0
December	18.69	57.14	24.4	75.6	71.6	14.2	14.2

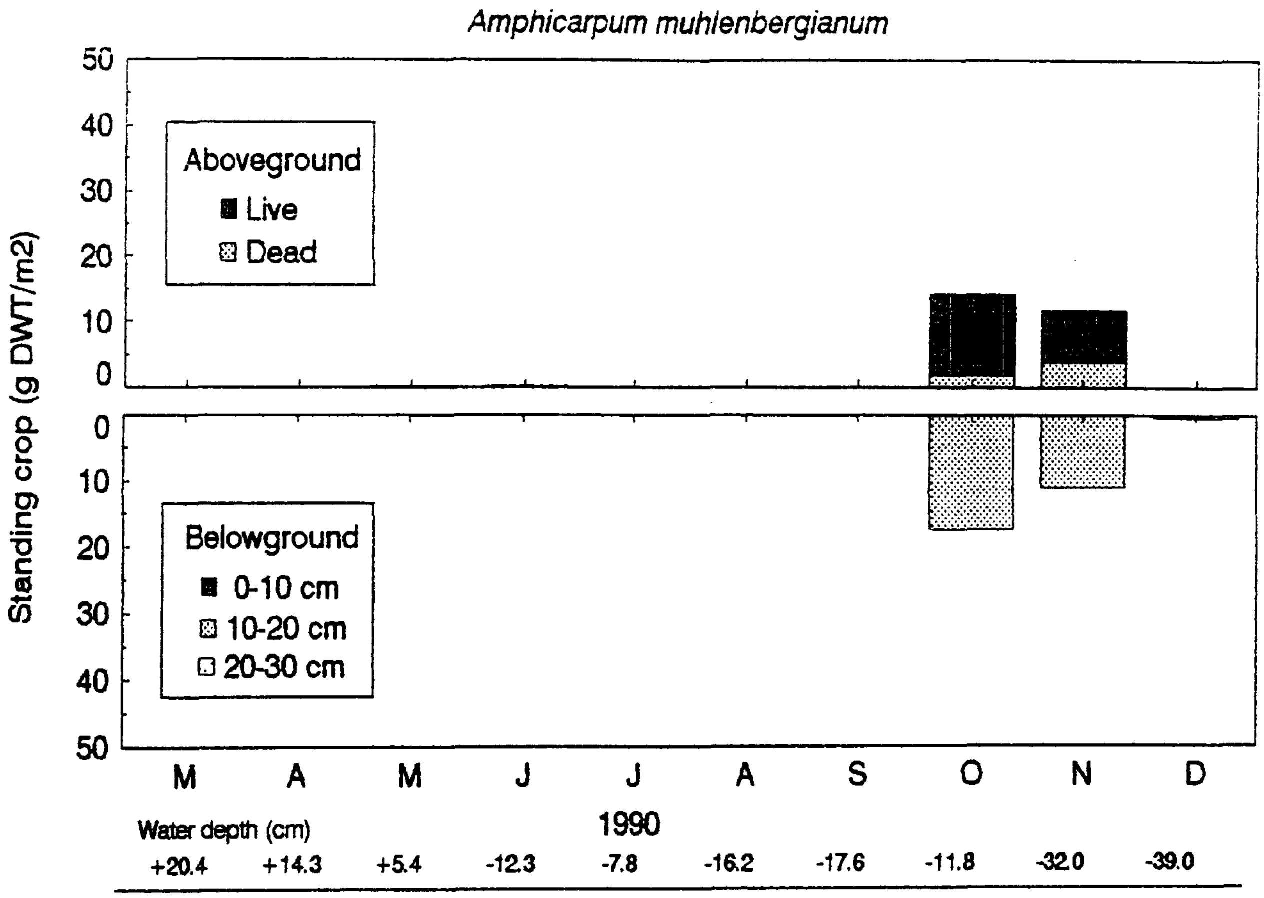


Figure 14. Mean (n=6) *Amphicarpum muhlenbergianum* aboveground and belowground and biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 8. Mean (n=6) allocation of *Amphicarpum muhlenbergianum* aboveground and belowground biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Total biomass (g DWT/m2) Belowground 0-30 cm	% of total Aboveground live	% of total Aboveground dead	% of total Belowground 0-10cm	% of total Belowground 10-20cm	% of total Belowground 20=30cm
Amphicarpum muhlenbergianum							
March	0.00	0.00	0.0	0.0	0.0	0.0	0.0
April	0.00	0.00	0.0	0.0	0.0	0.0	0.0
May	0.25	0.00	100.0	0.0	0.0	0.0	0.0
June	0.24	0.00	100.0	0.0	0.0	0.0	0.0
July	0.00	0.00	0.0	0.0	0.0	0.0	0.0
August	0.00	0.00	0.0	0.0	0.0	0.0	0.0
September	0.00	0.00	0.0	0.0	0.0	0.0	0.0
October	14.37	17.43	87.1	12.9	100.0	0.0	0.0
November	11.93	11.11	67.0	33.0	100.0	0.0	0.0
December	0.11	0.50	100.0	0.0	100.0	0.0	0.0

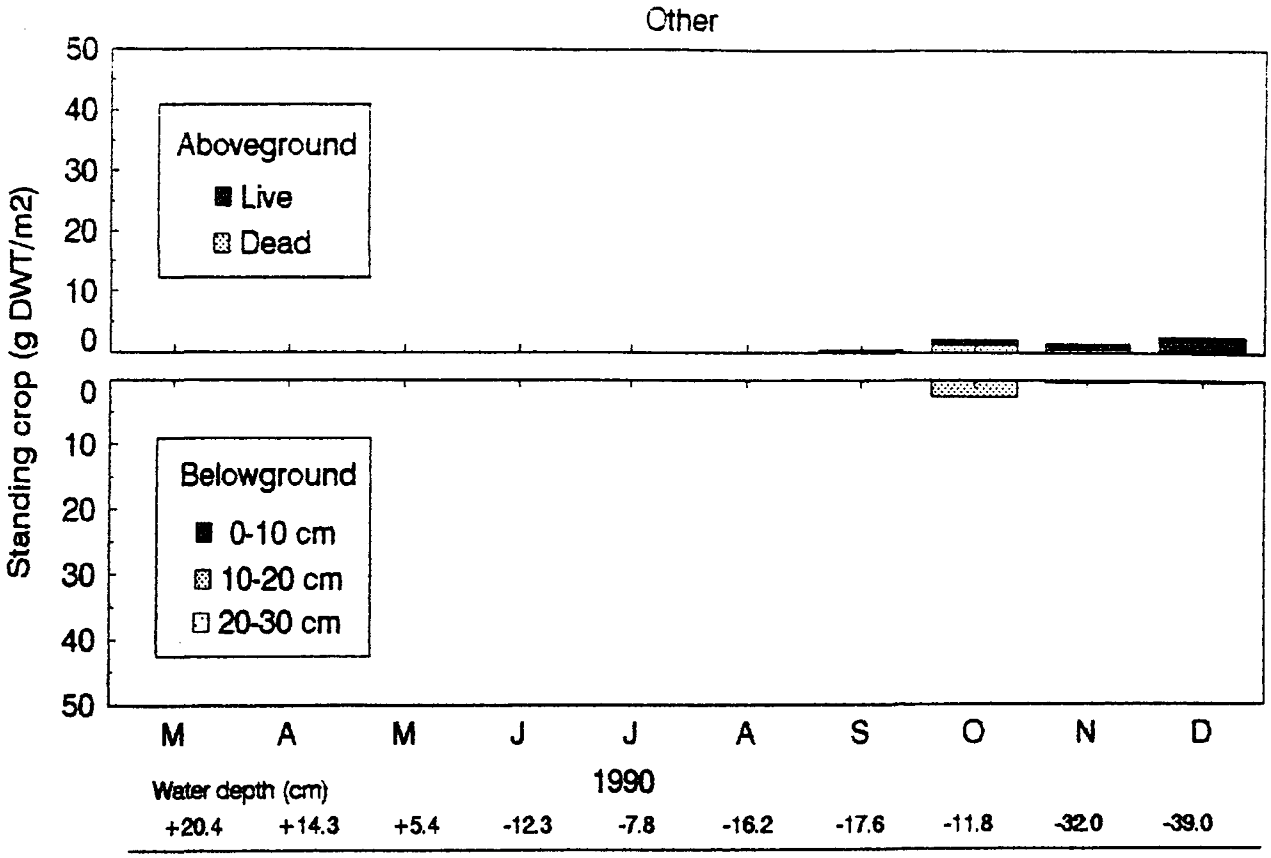


Figure 15. Mean (n=6) aboveground and belowground plant biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990 ("Other" species include *Rhynchospora tracyi*, *Xyris* sp., *Lachnanthes caroliniana*, *Triadenum virginicum*, *Eupatorium capillifolium* and Mosses).

Table 9. Mean (n=6) allocation of aboveground and belowground plant biomass at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Species/ Month	Total biomass (g DWT/m2) Aboveground live+dead	Belowground 0-30 cm	% of total Aboveground live	dead	Belowground 0-10cm	10-20cm	20=30cm
*Other							
March	0.00	0.00	0.0	0.0	0.0	0.0	0.0
April	0.00	0.00	0.0	0.0	0.0	0.0	0.0
May	0.00	0.00	0.0	0.0	0.0	0.0	0.0
June	0.00	0.00	0.0	0.0	0.0	0.0	0.0
July	0.00	0.00	0.0	0.0	0.0	0.0	0.0
August	0.00	0.00	0.0	0.0	0.0	0.0	0.0
September	0.56	0.10	91.9	8.1	100.0	0.0	0.0
October	2.16	2.53	32.0	68.0	100.0	0.0	0.0
November	1.63	0.33	70.0	30.0	100.0	0.0	0.0
December	2.78	0.20	100.0	0.0	100.0	0.0	0.0

*Other=*Rhynchospora tracyi*, *Xyris* sp., *Lachnanthes caroliniana*, *Triadenum virginicum*, *Eupatorium capillifolium* and Mosses.

Plant species diversity: relative abundance and richness

Nymphaea odorata, Eriocaulon compressum and *Eleocharis elongata* dominated the study site from March through May (Figure 16). During March and April, when the prairie was flooded, only these three species were present. *Rhynchospora inundata* and *Amphicarpum muhlenbergianum* first appeared as the water level dropped to 5 cm in May. The two most abundant species in June, the first month of drained conditions, were *R. inundata* and *N. odorata*. July co-dominants were *R. inundata* and *E. elongata*. The remainder of the year, August through December, was co-dominated by *E. compressum* and either *R. inundata* or *A. muhlenbergianum*. *Eriocaulon compressum* and *E. elongata* were present throughout the 1990 study period. *Nymphaea odorata*, present throughout the flooded period, was recorded on only one sampling date when drained conditions existed (after June 1990). *Rhynchospora inundata* and *A. muhlenbergianum* were recorded one month prior to and throughout the drained period (*Amphicarpum* was absent from July through September). Additional species were recorded in September through December.

Species richness ranged from 3 to 5 species during flooded conditions and 3 to 8 species during drained conditions (Table 10). Species diversity ranged from 1.07 to 1.86 during flooding and 1.16 to 1.71 during drained conditions. Linear regression between mean monthly water level and species richness indicated a positive correlation ($r^2=0.46$), no correlation was found between water level and species diversity. Appendix 5 lists plant species dominance at the study site based on aboveground live biomass.

Wetland index value

Most plant species occurring on the study plot were "obligate" wetland plants (Table 11) as described by Reed (1988). The exceptions were *A. muhlenbergianum* (facultative wetland) and *Eupatorium capillifolium* (facultative upland). Therefore, one would expect the weighted wetland index value to be very close to 1.00. Wetland index values ranged from 1.00 to 1.01 under flooded conditions and from 1.00 to 1.34 under drained conditions (Table 10).

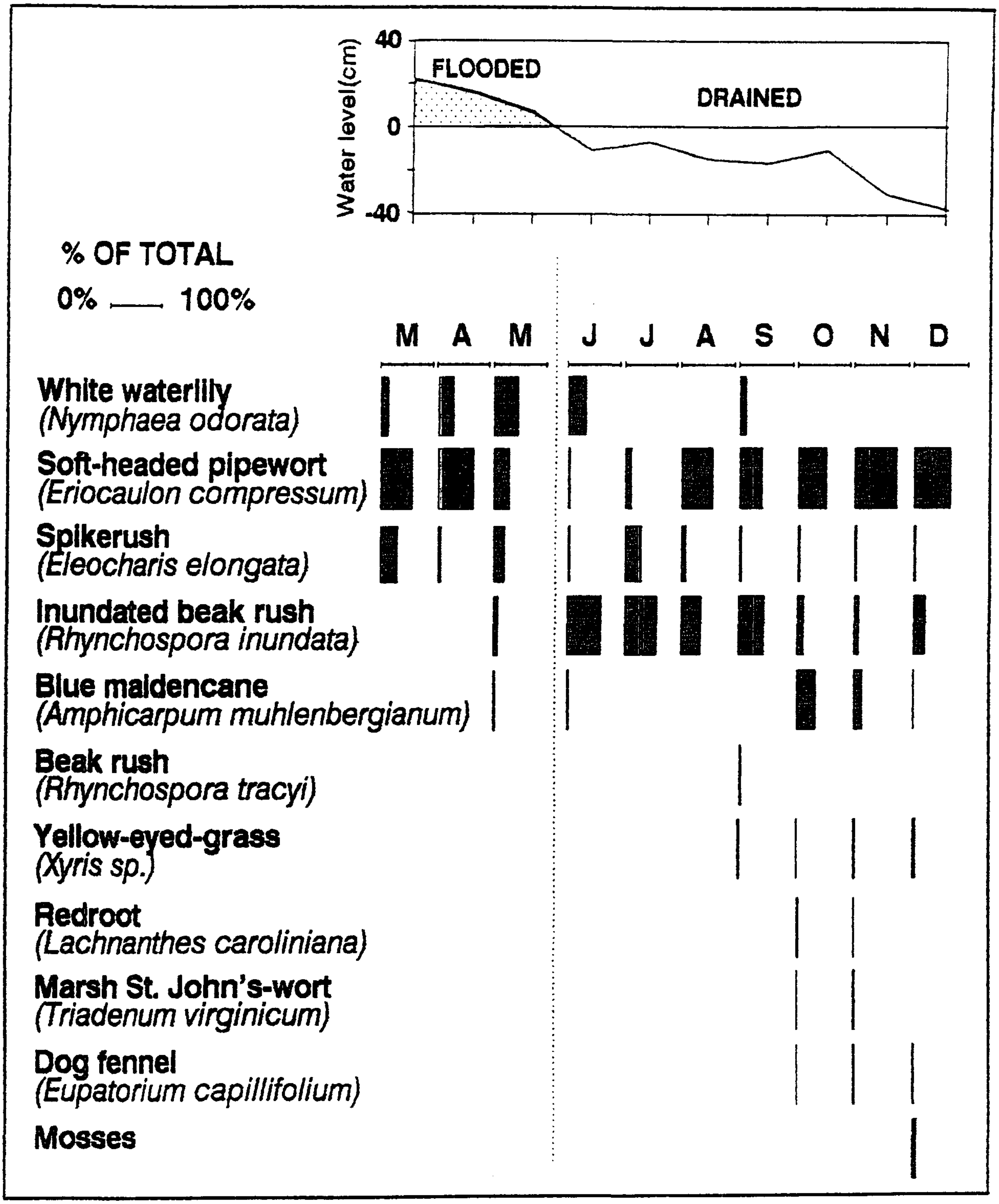


Figure 16. Mean (n=6) percent of total aboveground live biomass of plant species recorded at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Table 10. Plant species Shannon-Wiener diversity index (H'), species richness (R) and wetland index value (WIV) of vegetation at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
[a]Shannon-Wiener diversity index	1.35	1.07	1.86	1.34	1.30	1.22	1.71	1.60	1.16	1.60
[b]Species richness	3	3	5	5	3	3	6	8	8	7
[c]Wetland index value	1.00	1.00	1.01	1.02	1.00	1.00	1.00	1.34	1.14	1.07

[a]$H' = -\Sigma\ p_i \log_2 p_i$, where p_i is the proportion of the total number of individuals in the ith species (above values are calculated using biomass in place of number of individuals)
[b]R=Number of species recorded
[c]$WIV = \Sigma\ R*I\ /\ \Sigma\ R$, where R is relative abundance and I is wetland indicator value.

Table 11. Wetland indicator category and corresponding number (Reed 1988) for plant species recorded at Hopkins Prairie, Ocala National Forest, Florida.

Species	[a]Wetland indicator Category	Number
Amphicarpum muhlenbergianum	FACW	2
Eleocharis elongata	OBL	1
Eriocaulon compressum	OBL	1
Eupatorium capillifolium	FACU	4
Lachnanthes caroliniana	OBL	1
Mosses	NA	NA
Nymphaea odorata	OBL	1
Rhynchospora inundata	OBL	1
Rhynchospora tracyi	OBL	1
Triadenum virginicum	OBL	1
Xyris sp.	NA	NA

[a]1=Obligate wetland (OBL), 2=Facultative wetland (FACW), 3=Facultative (FAC), 4=Facultative upland (FACU) and 5=Obligate upland species; 0=unidentified to species.

Net aboveground primary production

Net aboveground primary production (NAPP) during 1990 averaged 0.69 g (dry weight) m^{-2} day^{-1}; values ranged from 0 to 1.05 g m^{-2} day^{-1} (Figure 17). June, July, September and December NAPP was zero. The data showed no net increase in aboveground biomass during those months. May, August, October and November NAPP was 0.55, 0.87, 0.93 and 1.05 g m^{-2} day^{-1}, respectively (Appendix 6).

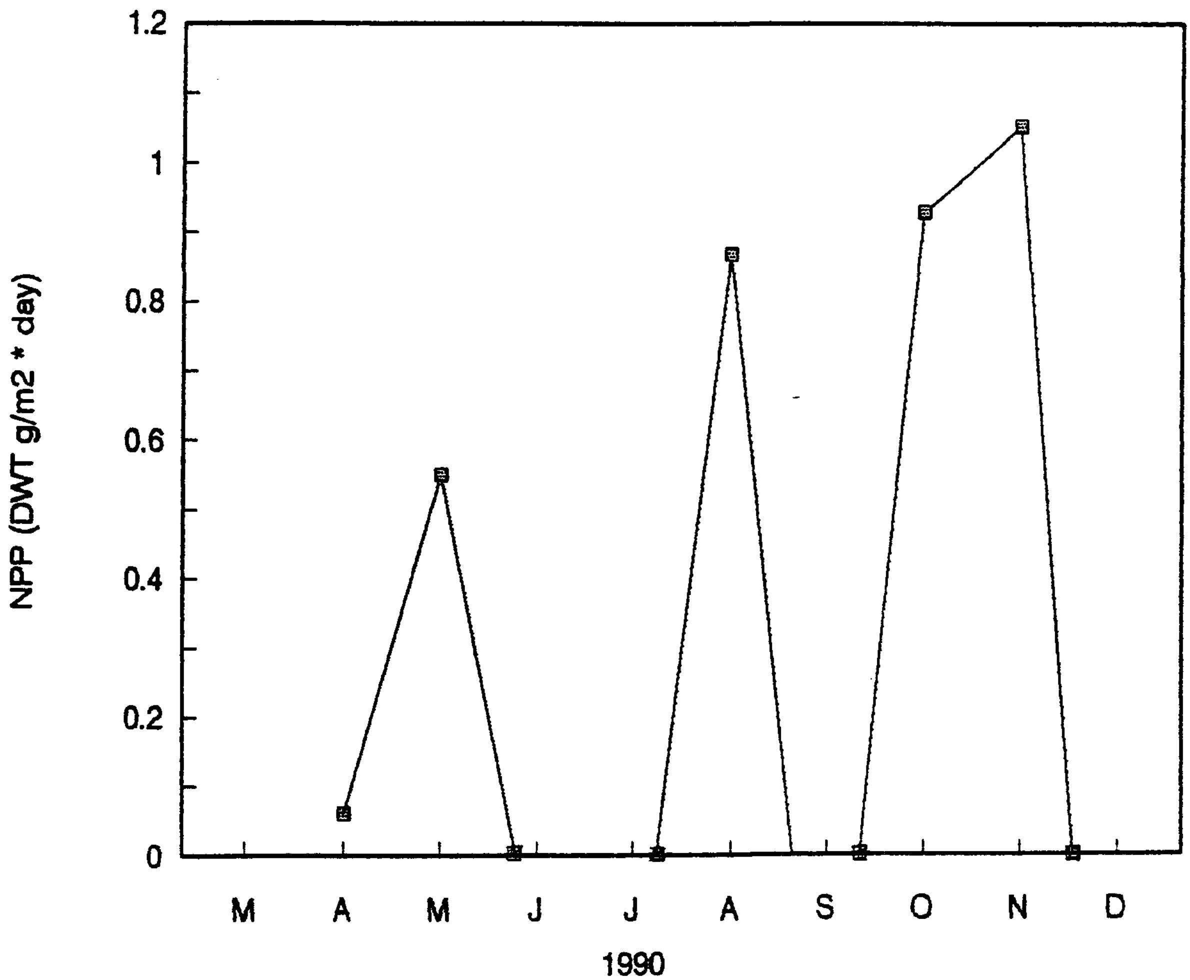


Figure 17. Mean (n=6) net aboveground primary production (NAPP) of vegetation at Hopkins Prairie, Ocala National Forest, Florida. March - December 1990.

Periphyton/algae

Periphyton/algae biomass was measured only during the drained period, from June to December. Total periphyton/algae biomass ranged from 142.95 g (dry weight) m^{-2} in July to 276.29 g m^{-2} in June, averaging 195.99 g m^{-2} (Figure 18; Appendix 7) .

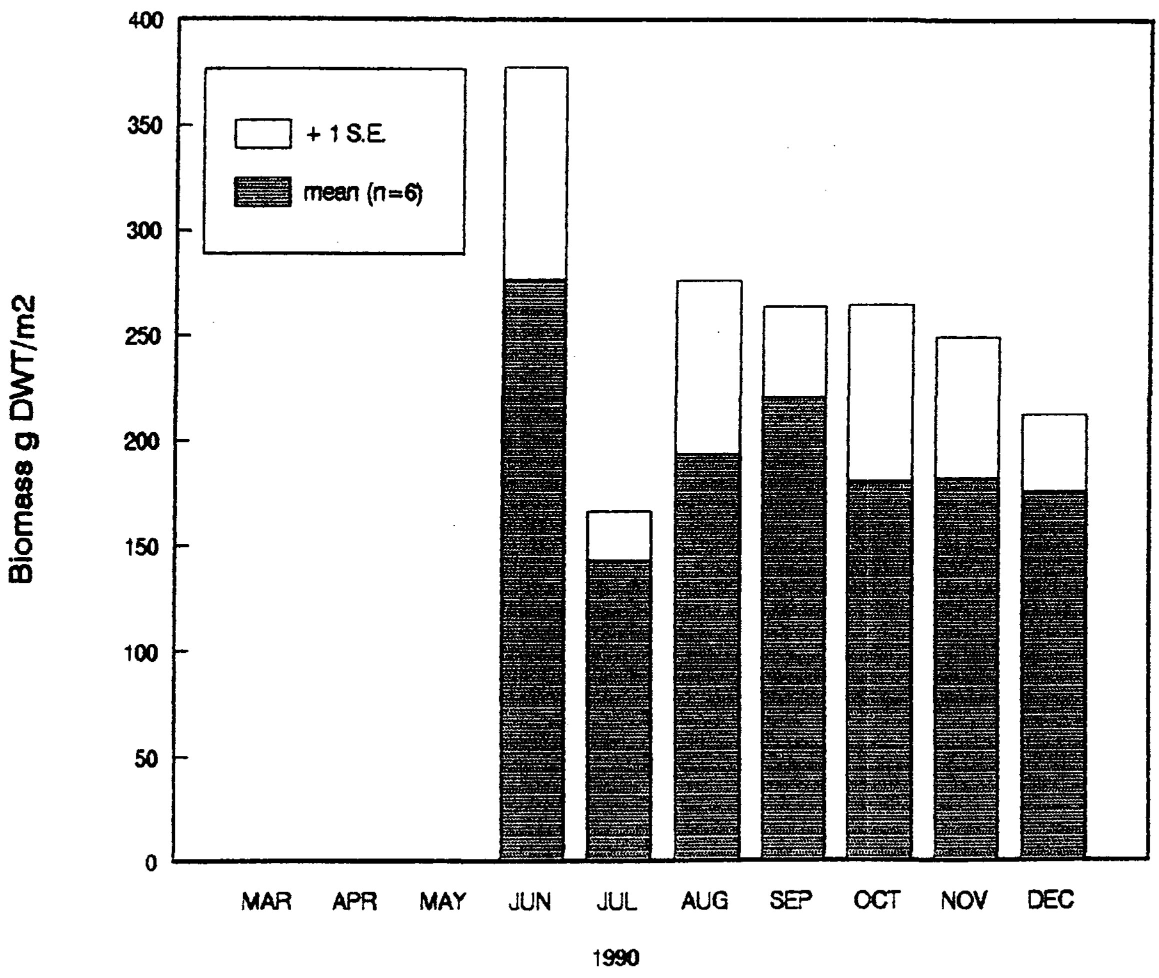


Figure 18. Mean (n=6) periphyton/algae biomass at Hopkins Prairie, Ocala National Forest, Florida, 1990.

Soil "available" nitrogen and phosphorus

Available ammonium (NH_4-N), as water extractable, under flooded conditions ranged from 31.28 mg kg^{-1} (of DWT soil) at 20-30 cm soil depth to 40.73 mg kg^{-1} at 10-20 cm (Figure 19; Appendix 8). Available NH4-N during the drained period ranged from 26.69 mg kg^{-1} at 0-10 cm to 38.13 mg kg^{-1} at 20-30 cm. Available nitrate (NO3-N) ranged from 0.97 to 1.57 mg kg^{-1} at 0-10 and 20-30 cm, respectively when flooded. Available NO3-N under drained conditions ranged from 3.21 mg kg^{-1} at 20-30 cm to 124.05 mg kg^{-1} at 0-10 cm. Maximum concentrations of NH4-N at 0-10 cm were recorded in July (45.45 mg kg^{-1}), minimum concentrations were recorded in August (26.69 mg kg^{-1}). Maximum NO3-N concentrations in the same soil profile range occurred in June (124.05 mg kg^{-1}), and minimum concentrations in May (0.97 mg kg^{-1}). Available SRP at 0-10 cm ranged from 0 in July and August to 3.13 mg kg^{-1} in May. The maximum available SRP at 0-10 cm was recorded in May (3.13 mg kg^{-1}), the minimum level at this soil depth was recorded in July and August (0 mg kg^{-1}).

Plant tissue nitrogen and phosphorus

Nitrogen and phosphorus content of aboveground live plant tissue (live shoots) averaged 19.54 and 0.44 mg kg^{-1}, respectively (Figure 20; Appendix 9). Aboveground live tissue N ranged from 16.87 mg kg^{-1} in May to 21.36 mg kg^{-1} in August. Plant tissue P content ranged from 0.37 mg kg^{-1} in August to 0.48 mg kg^{-1} in May. Aboveground dead tissue N and P averaged 15.53 and 0.20 mg kg^{-1}, respectively. Belowground tissues averaged 14.35 mg N kg^{-1} and 0.13 mg P kg^{-1} at 0-10 cm; 8.33 mg N kg^{-1} and 0.07 mg P kg^{-1} at 10-20 cm; and 7.18 mg N kg^{-1} and 0.08 mg P kg^{-1} at 20-30 cm. Periphyton N and P averaged 34.87 and 0.39 mg kg^{-1}, respectively.

Water column nitrogen and phosphorus

Water column data is not available for the flooded period during this study, samples will be collected and analyzed when flooded conditions return.

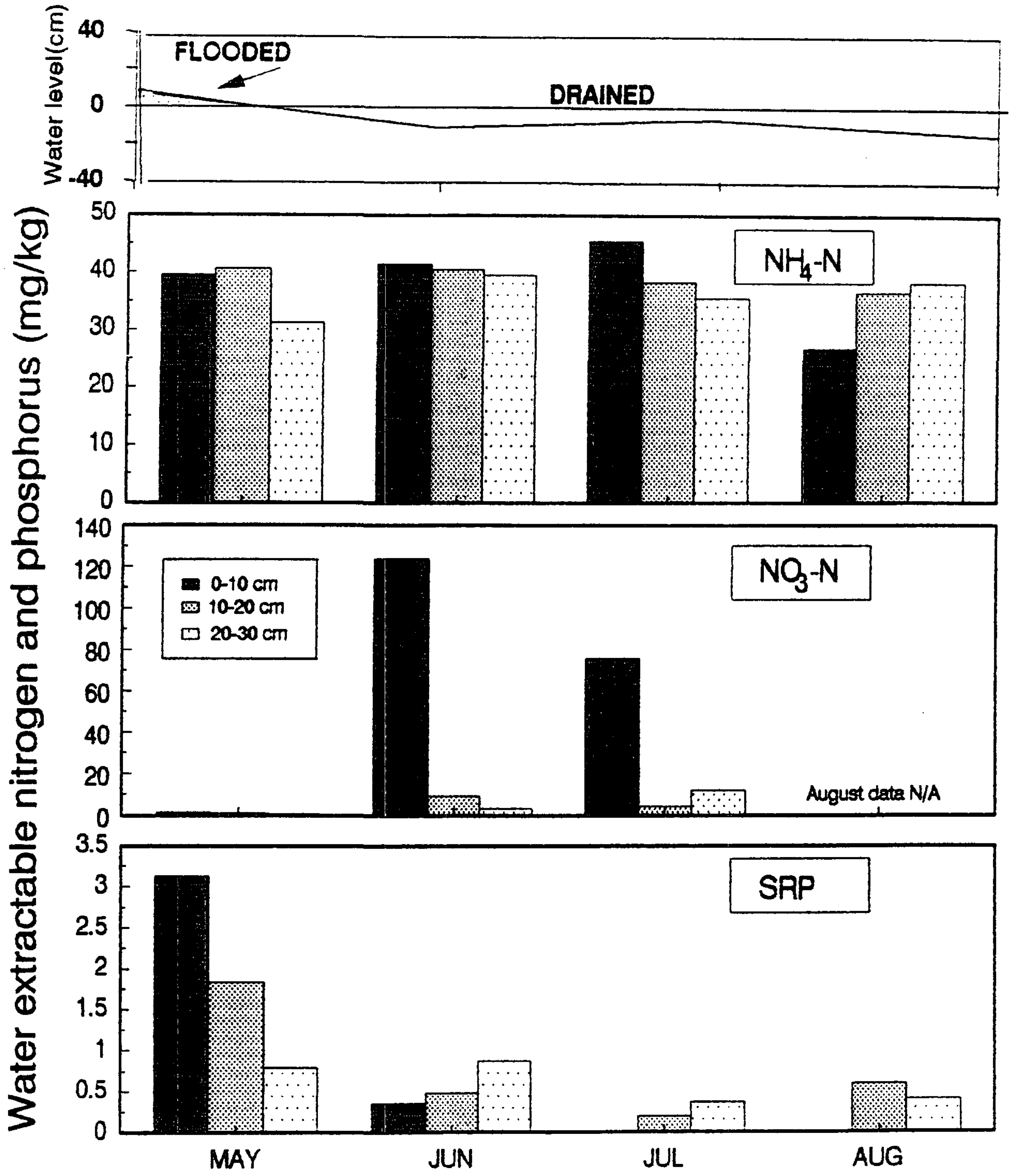


Figure 19. Mean (n=6) water extractable ammonium nitrogen (NH4-N), nitrate nitrogen (NO3-N) and soluble reactive phosphorus (SRP) in soil from Hopkins Prairie, Ocala National Forest, Florida. May - August 1990.

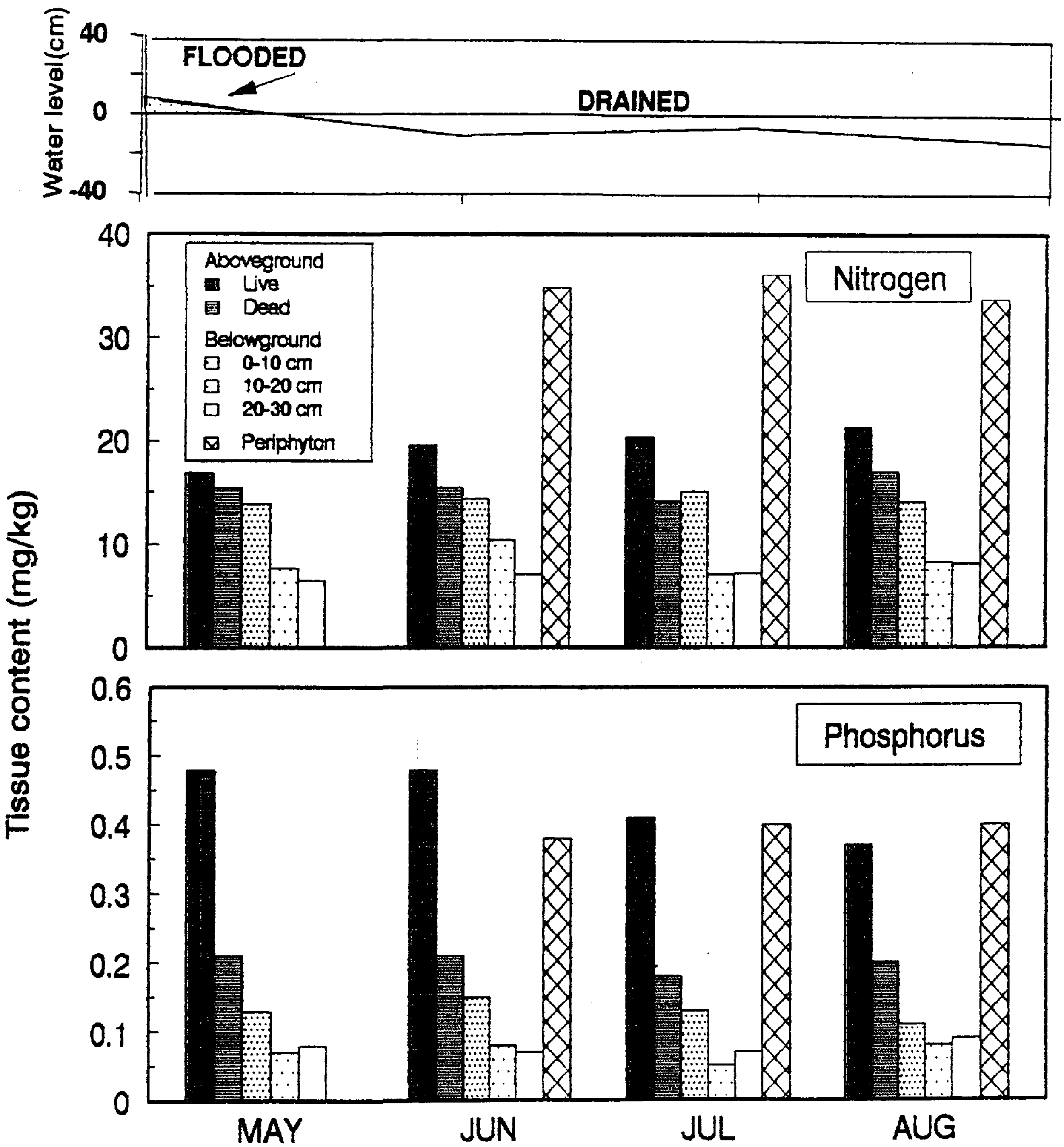


Figure 20. Mean (n=6) plant tissue nitrogen and phosphorus content of vegetation at Hopkins Prairie, Ocala National Forest, Florida. May - August 1990.

DISCUSSION

Water level

Peninsular Florida has experienced drought conditions for the past several decades resulting in regional declines in surface water levels. Hopkins Prairie may be less affected during drought periods due to its local and regional hydrogeology. Hopkins Prairie and other wet prairies in the Ocala National Forest are poorly drained basins which receive regional ground water flow from surrounding higher elevation areas (Snedaker and Lugo 1972). Dominant inflows to Hopkins Prairie are from rainfall and groundwater, major outflows include: evaporation and transpiration. Water levels at the prairie fluctuate naturally in response to local conditions, standing water may be present in some years and absent in other years. Mean annual water level during the past 10 years (1981-90) shifted between drained and flooded conditions, showing several cycles of 'dry' and 'wet' years. These cycles from 1981 to 1986 switched between drained and flooded conditions on approximately 2 year cycles. The wet period which began in 1987, lasted approximately 3 years, shifting to drained conditions in June 1990. Drained conditions continued through the end of 1990, at the time of this report the water table is below the soil surface at the study site. The 1990 shift to drained conditions can also be seen in frequency of inundation. The frequency of inundation data fir 1989 was similar to data for the period 1981 to 1990. The frequency of inundation curve for 1990 showed a lower inundation frequency for any given elevation. This was a drier year with fewer days of flooded conditions than 1989 and the previous 10 year period.

Fluctuating water levels at Hopkins Prairie during the past 10 years with cyclic changes in surface water hydrology produced shifts between drained and flooded conditions. These cyclic changes in hydrologic conditions can be seen as a continuous disturbance to the plant community with drained and flooded conditions favoring different sets of species. It should be noted that the soil moisture content remained relatively constant during this period. This is probably due to the high water retention capacity of peat soils (Ponnamperuma 1984).

Plant species composition 1989-90

Fewer species occurred in 1989 under extended flooded conditions (four species) than in 1990 when drained conditions predominated (eleven species). The four species occurring in

1989, *N. odorata*, *E. compressum*, *E. elongata* and *R. inundata* are listed as obligate wetland species in the National list of plant species that occur in wetlands (Reed 1988). This designation is given to species which occur almost always in wetlands. All but two of the species occurring in 1990 belonged in this category. *Amphicarpum muhlenbergianum* and *E. capillifolium* are listed as facultative wetland (usually occurring in wetlands) and facultative upland (usually occurring in nonwetlands), respectively. Presence of these species is likely due to the drawdown state of the soils during 1990 as conditions became favorable for germination and production in saturated soils without standing water. All species recorded in 1989 were also present in 1990; however, *N. odorata* declined rapidly following drawdown of the water table below the soil surface in June 1990. *Nymphaea odorata* is a floating-leaved aquatic species favoring inundated soils (Godfrey and Wooten 1979); therefore, its lower occurrence under drained conditions is expected. In contrast, *E. compressum* and *E. elongata* favor inundated or saturated soils, providing for their occurrence under both hydrologic conditions; *R. inundata* favors saturated soils. *Rhynchospora inundata* showed the most evident seasonality, occurring during early spring through late fall and absent during winters of both years. Several additional species occurred in the later part of 1990, after four months of continuous drained conditions. These species may be appearing when propagules (seeds, rhizomes, etc.) are present and favorable conditions for germination or regeneration develop (drained conditions).

Aboveground and belowground plant biomass

Total belowground biomass was greater than aboveground biomass during the flooded period; whereas, total aboveground biomass was greater under drained conditions. This shows a shift in biomass allocation from belowground under flooded conditions to aboveground under drained conditions. The shift from belowground to aboveground allocation was most evident in *R. inundata*. A shift from aboveground to belowground biomass allocation occurred in *N. odorata* following drawdown of the water level below the soil surface. *Nymphaea odorata* was not present in the aboveground component during most of the drained period and was reduced in the belowground component. Its reduction belowground following drawdown controlled the trend toward lower total belowground biomass due to its dominance belowground compared to other species. Though *N. odorata* belowground biomass decreased after drawdown, it remained throughout the drained period. Aboveground biomass of *E. compressum* and *R. inundata* increased following drawdown. The amount of increase in these species exceeded the amount of decrease in *N. odorata* aboveground resulting in greater overall total biomass aboveground under drained conditions. The vegetation at the community level seems to be capable of adjusting to changes in water level. Aboveground and belowground components were maintained under flooded and drained conditions and during the transition period as some species decreased and other species increased in relative abundance.

Increased production of *E. compressum* and *R. inundata* and invasion by other emergent species following drawdown suggests that vegetative expansion and germination from a seed bank and/or seed immigration are important mechanisms at Hopkins Prairie for regeneration of species favoring drained conditions. The persistence of *N. odorata* in the belowground component (rhizomes) may be a mechanism which would allow survival under drained conditions and subsequent vegetative regeneration should flooded conditions return. Grime (1979) suggested that vegetative expansion and seed dispersal are important mechanisms for regeneration in continuously disturbed ecosystems. Vegetational expansion after disturbance may be advantageous in providing rapid invasion with more vigorous genotypes which have survived previous disturbances.

The shift from flooded to drained conditions occurred during the growing season. Season may have caused an additional effect on the observed shifts in plant species relative abundance and biomass allocation. Following drawdown, the percent contribution of live biomass to the total aboveground biomass increased from July to November, then decreased in December. This trend was most evident in *E. compressum*, *E. elongata* and *R. inundata*. Using decreases in aboveground biomass and increases in percent dead biomass as indicators of lower growth rates and senescence, the end of the growing season for these species seemed to occur in August (*R. inundata*), and November-December (*E. compressum* and *E. elongata*). Water level appeared to have a greater effect on *N. odorata* than season. Presumably, *N. odorata* would be influenced by season under continuously flooded conditions.

Belowground biomass of all species was greatest in the 0-10 cm soil horizon and decreased with depth. All *N. odorata* rhizomes occurred within the first 10 cm with secondary roots extending into the lower soil horizons. Belowground biomass decreased following drawdown. However, the relative distribution of belowground biomass in the soil profile remained similar.

Plant species diversity: relative abundance and richness

Relative abundance and species richness are used in this discussion to examine plant community changes. Viewed separately, these parameters reveal changes in dominance and increases or decreases in numbers of species represented in an ecosystem. The Shannon-Wiener diversity index combines relative abundance and richness, calculating a diversity value (H') representative of the relative "evenness" of species present. This index gives less weight to rarer species so that higher values represent species compositions with less variation in relative abundance as well as greater species richness.

Plant species co-dominance shifted from *N. odorata-E. compressum-E. elongata* when standing water was present to *E. compressum-R. inundata-A. muhlenbergianum* after the water table dropped below the soil surface. In June, the first month of drained conditions, *N. odorata* co-dominated with *R. inundata*. During this 'transition' period, flood tolerant and less flood tolerant species coexisted. Drained conditions continued after June and *N. odorata* did not persist as a dominant, though it did not disappear completely (as indicated by its presence in September). *E. compressum* remained prevalent during flooded and drained periods, its co-dominant species shifting from *N. odorata* to *R. inundata* or *A. muhlenbergianum* following drawdown. *E. elongata* was also present throughout the study period, seeming to favor flooded conditions.

The shift in plant species dominance following drawdown occurred relatively rapidly. As suggested previously, belowground biomass and a seed bank may allow plants to persist during periods of unfavorable conditions. All *R. inundata* biomass during the initial period of drained conditions was from seed germination, presumably from a seedbank established during previous drained periods (data quantifying seed bank will be forthcoming). Rhizomatous growth was not observed until October. Storage of seeds in the soil during flooded periods may serve to reestablish *R. inundata* when drained conditions return. Soil moisture content of the top 10 cm remained near 90% under flooded and drained conditions (Table 1). This consistently high soil moisture during drained periods may allow *N. odorata* rhizomes to survive under drained conditions.

Shifts in species relative abundance associated with changes in water level at Hopkins Prairie are similar to wet prairies of the Okefenokee swamp of south Georgia and the Everglades of south Florida. Hamilton (1982) describes two types of prairies in the Okefenokee swamp differing in extent of flooding and dominant plant species. The first, a persistent emergent wetland has less open water and is dominated by emergents such as *Carex* spp., and *Andropogon* spp.; associated species may include *N. odorata* and *E. compressum* among others. The second type is more aquatic, described as a mixed aquatic bed. This prairie is dominated by aquatic macrophytes such as *N. odorata*, *Nuphar luteum* and *Nymphoides aquaticum* and emergents such as *E. compressum* and *Xyris smalliana*. Loveless (1959) describes wet prairies of the everglades as areas with less than 125 cm water depth and annual drained periods. Characteristic plants found in these prairies include *Rhynchospora* spp, *Eleocharis* spp. and several associated species which germinate during the dry periods. Zaffke in Wood and Tanner (1990) suggest that wet prairies of parts of the everglades have been replaced by aquatic communities due to extended hydroperiods and increased water depth. *Bacopa caroliniana*, *N. odorata* and *E. elongata* were the three most dominant species in these areas. The Okefenokee swamp and Everglades give a spacial and temporal example of vegetation-hydrology dynamics in wet prairie ecosystems.

An ecosystem with a continuous disturbance (such as repeated changes in hydrologic conditions) may develop into a proclimax in which several species co-dominate at different times, shifting relative abundances in a dynamic equilibrium (Grime 1979). At Hopkins Prairie the proclimax species may be *N. odorata* and *R. inundata* with *E. compressum* associated with both. Gopal (1985) suggested that in ecosystems with large water level fluctuations, oscillating changes in community structure may reflect shifts in species dominance within an otherwise stable community. Odum (1983) uses "circular succession" to describe a system with oscillating dominance.

Early stages of succession, on recently available space, may be characterized by high species diversity due to high energy and space availability (Odum 1983). Reduction in aquatic species and exposure of the soil surface upon draining may have provided available space and favorable conditions for regeneration of some species and invasion by additional species. However, this change may not be analogous to early stages of succession as the shift in hydrologic conditions did not produce complete extermination of existing species. Species diversity (Shannon-Wiener) did not show obvious changes between flooded and drained conditions. This is likely due to the rareness of the additional species. Shannon-Wiener diversity for several other ecosystems (Best 1984) is provided for comparison with Hopkins Prairie diversity (Table 12).

Table 12. Shannon-Wiener diversity index (H') for selected wetland ecosystems in Florida.

Community	Diversity (H')
Hopkins Prairie	1.42
Mesic mixed hardwood	2.50
Bayheads	1.75
Cypress domes	1.16

$H' = -\Sigma\ pi\ \log_2 pi$, where pi is the proportion of the total number of individuals in the ith species

Wetland index value

As stated above, the shift in hydrology from flooded to drained conditions was accompanied by a change in species relative abundance and richness. Since these parameters are used to calculate the wetland index value, this index of plant community "wetlandness" also changed. However, the wetland index value remained near 1, suggesting that the plant community is highly associated with wetland ecosystems. All species recorded at the study site are categorized as obligate wetland species with two exceptions, *Amphicarpum muhlenbergianum* and *Eupatorium capillifolium*, which are facultative wetland and facultative upland, respectively. The higher wetland index values under drained conditions, indicating a lower "wetlandness," is explained by the appearance of these two species following drawdown. This change would be expected in a system undergoing drawdown and invasion of less water tolerant species.

Net aboveground primary production

Primary production plays an important role in ecosystem energetics. Herbivore food chains are based entirely on the production of green plants and detritovore food chains are at least partially dependent on green plants. Much literature is available on plant biomass and primary production in wetland ecosystems (Good et al. 1978, Bradbury and Grace 1983). Many studies have measured biomass production in freshwater emergent marshes (Bernard and Gorham 1978, Bernard et al. 1988, Twilley et al. 1985, Wood and Tanner 1990). Two methods have been commonly used to measure net primary production of macrophytes (Whigham et al. 1978). The first method bases net primary production (NPP) on a single harvest during peak biomass. The second technique collects biomass at intervals throughout the growing season. Net aboveground primary production (NAPP) at Hopkins Prairie was calculated with both methods and compared to several other freshwater marshes (Table 13). Aboveground standing biomass at Hopkins Prairie was similar to that measured in wet prairies of the Everglades by Wood and Tanner (1990). A marsh dominated by *Nuphar luteum* (similar life form to *N. odorata*) in North Carolina (Twilley et al 1985) showed similar NAPP to Hopkins Prairie. Values for NAPP at Hopkins Prairie were low compared to other freshwater wetlands, this was also the case during 1989 (Clough et al. 1989). The observed lower production may be due to the oligotrophic nature of wet prairies of this type. Oligotrophic systems are characterized by low dissolved nutrients and low production (Wetzel 1983).

Table 13. Mean annual aboveground (AG) biomass and net aboveground primary production (NAPP) of selected freshwater marsh ecosystems.

Marsh type/ plant species	Location	AG biomass g m-2	NAPP $g\ m^{-2}\ day^{-1}$	Reference
Wet prairie	Hopkins Prairie, (Florida)	40.8	[a]383 [b]252	
Wet prairie	South Florida	20.2-57.5		Wood and Tanner 1990
Nuphar luteum	North Carolina	35.7	215	Twilley et al. 1985
Eleocharis quadrangulata	South Carolina		725	Polisini and Boyd 1972
Panicum hemitomon	South Carolina		1075	Polisini and Boyd 1972
Nuphar advena	Atlantic coast, USA		863	Whigham et al. 1978
Carex spp.	Czechoslovakia		628	Bernard et al. 1988

[a]calculated based on peak standing crop
[b]calculated based on monthly measurements during growing season

Plant species dominance shifted from lower species richness of highly water tolerant species under flooded conditions, to higher species richness of variable water tolerance under drained conditions. Net aboveground primary production showed three peaks with low production periods following each peak. The first peak occurred in May and suggests the beginning of the growing season. The water level fell below the soil surface in June and the change in hydrologic conditions may be the cause of lower production at that time. *Nymphaea odorata* and *R. inundata* coexisted during the "transition" period immediately following the shift from flooded to drained conditions (June). The second peak was in August, this may be an indication of the combined effects of drawdown and season as emergents responded to the newly exposed soil surface. The low NAPP of September resulted from lower *R. inundata* biomass after a peak in August (suggested end of *R. inundata* growing season). The third peak occurred in October-November and corresponded to an invasion by *A. muhlenbergianum* and other species. The low production in December may have signaled the end of the growing season for most species.

Odum (1982) suggests that ecosystems with intermittent energy sources may adapt by storing energy for later use. Favorable growing conditions occur at different times for different species at Hopkins Prairie. During unfavorable periods plants took advantage of energy stored during favorable conditions. For example, *N. odorata* was present aboveground only under flooded conditions. During unfavorable periods (drained) *N. odorata* maintained belowground biomass using stored energy in rhizomes. *Rhynchospora inundata* germinated from a stored seed bank during favorable drained conditions. This arrangement may contribute to only short periods of low production under varying hydrologic and seasonal conditions. Other systems may operate on similar principles. In a phytoplankton model developed by O'Neill and Giddings (in Odum 1982) different responses to light and nutrients were observed by different species. Each species developed different times of growth and decline contributing to an overall seasonal pattern of sustained community production (O'Neill and Giddings, in Odum 1982).

The cyclic disturbance of fluctuating hydrologic conditions produced rapid shifts in species dominance resulting in few gaps in standing crop and a continuous turnover of biomass. This "circular succession" may contribute to continued peat accumulation and maintenance of Hopkins Prairie as a wet prairie. Decomposition under flooded conditions is slower than drained conditions. Belowground processes under both hydrologic regimes may be slowed by the consistently high moisture content of the soil. These processes may contribute to the accumulation of biomass on the soil surface as dominant species replace each other leading to the continuous build up of peat.

Periphyton/algae

The periphyton/algae at Hopkins Prairie formed an organic crust over the soil surface following drawdown of the water below soil surface level. Periphyton/algae biomass remained relatively constant throughout the drained period. Tissue nutrient content of the periphyton/algae also remained relatively constant throughout the drained period. This suggests that loss of periphyton/algae biomass and nutrients through senescence and decomposition may be lacking. As previously suggested, the vegetation at Hopkins Prairie may be adapted to the periodic "catastrophes" brought about by the changes in hydroperiod. The periphyton/algae may survive as spores or in other resting states until favorable conditions return.

Soil, plant and water column nitrogen and phosphorus

Nitrogen and P most readily available to plants and microorganisms in wetland soils is in porewater solution. Water presence, depth, duration and quality play important roles in chemical processes which control N and P availability. Chemical transformations which control N availability include: ammonification, ammonia volatilization, nitrification-denitrification and nitrogen fixation (Ponnamperuma 1972). Chemical processes which control P levels include: adsorption-desorption and chemical precipitation-solubility processes. Plant and microorganism uptake (biological immobilization) also influences N and P concentrations in soils. Hopkins Prairie soil was extracted with deionized water in order to extract the pore water component of available N and P.

The rate of oxygen (O_2) supply to the soil surface and underlying profile is reduced under flooded conditions (O_2 diffusion through water is approximately 10,000 times slower than in air). If O_2 is consumed faster than it can be replaced, anaerobic conditions will develop in the soil profile. The amount of water extractable N and P in Hopkins Prairie soil changed with water level, presumably due to changes in O_2 availability in the soil. Most N was available as NH_4-N in May when flood water was present. The absence of NO_3-N suggests that ammonification is controlling inorganic N availability. Available P (SRP) was at its maximum under flooded conditions. Nitrate N increased and SRP decreased in June when the water table fell below the soil surface. Increased O_2 availability allowed nitrification of NH_4-N to NO_3-N. Lower SRP likely resulted from biological immobilization. Hopkins Prairie soil is highly organic with low mineral content. Microbial activity under aerobic conditions would increase in these organic soils where carbon is not likely to be limiting. Chemical precipitation is probably not an important process in the peat soil which lacks appreciable amounts of mineral ions such as Fe^{2+}, Mn^{4+} or Ca^{2+} which can form chemical precipitates with phosphate. The water level increased in July but remained below the soil surface. Nitrate remained higher than under flooded conditions but was lower than in June; NH_4-N increased. Again, this suggests that water level may be controlling nitrification. Available SRP decreased with depth under flooded conditions. When the water level was below the soil surface this trend was reversed. This suggests that SRP in the higher soil layers where O_2 was in greater supply may have been immobilized while the deeper layers which remained below the water table maintained higher SRP in solution.

Concentrations of N and P in plant tissues were relatively constant in all compartments except the aboveground live shoot tissues. Aboveground live tissue N increased and P decreased following drawdown. These opposite changes occurred simultaneously suggesting that plant uptake rates are not controlling tissue concentrations. That is, if plant species with differential uptake capacity were controlling N and P availability, the shift in relative abundances following drawdown would probably cause both N and P to increase or decrease together. The different trends in N and P tissue content suggests that different controls affect their availability in the soil. The increase in NO_3-N in the soil under drained conditions may provide an additional form of N to plants. Lower P availability in the soil and lower tissue P as described above suggests that demand for P by the plants may be greater than available P in the soil. Hopkins Prairie may be a phosphorus limited system, particularly under drained conditions. The low variability in aboveground dead tissue N and P is expected since most nutrients are leached soon after senescence (Guntensperger 1989). Reasons for the relatively stable N and P content of belowground tissues are less evident. The more static belowground environment may contribute to the low variation. However, the short period of available data (4 months) may not be sufficient to show nutrient dynamics in belowground tissues. Additionally, belowground live and dead tissues were not separated, differences in live tissue content may be masked by combining with dead tissues. Periphyton/algae N and P content was as great or greater than aboveground live tissues. The periphyton/algae mat may serve as a storage for N and P under drained conditions.

CONCLUSIONS

The hydrology of Hopkins Prairie is characterized by recurring periods of flooded conditions (surface water present) and drained conditions (water table below the soil surface) of varying frequency and duration. Mean annual stage data evidence the cyclic nature of hydrologic conditions at Hopkins Prairie. Shifts between flooded and drained conditions occurred in 1983, 1985, 1987 and 1990. The 1990 shift from flooded to drained conditions occurred in June. The water table dropped below the soil surface in June and remained belowground throughout the remainder of the calendar year.

Changes in plant species relative abundance and richness resulted. Under flooded conditions, *N. odorata* (floating-leaved aquatic) co-dominated with *E. compressum* and *E. elongata* (both water tolerant emergents). Following drawdown, *N. odorata* decreased and co-dominance rapidly shifted to *E. compressum*, *R. inundata* and *A. muhlenbergianum* (the later two species are less water tolerant emergents). After four months of drained conditions, the exposed soil surface was invaded by several other species not recorded under flooded conditions. The plant community at Hopkins Prairie responded to changes in water level by shifting dominance to species favoring drawdown conditions. This shift may be part of a recurring cycle in which species dominance changes coincide with changes in water level.

Amount of water extractable N and P in Hopkins Prairie soil changed with water level, presumably due to changes in O_2 availability. Under flooded conditions, most available N was in NH_4-N form. Available NH_4-N and SRP were highest under flooded conditions. Available NH_4-N remained in slightly lower amounts under drained conditions, NO_3-N increased and SRP decreased. These changes were most dramatic in the zone of greatest root biomass (0-10 cm). Under drained conditions SRP may be limiting, as suggested by the low availability in July and August. Live shoot tissue N and P also suggest high N availability and low P availability under drained conditions.

Plant tissue N and P was relatively constant in all compartments except the aboveground live shoots. Aboveground live tissue N increased and P decreased following drawdown. The different trends in N and P tissue content suggests that different controls affect their availability in the soil. The increase in NO_3-N in the soil under drained conditions provides an additional form of N (in addition to NH_4-N) for plants and microbes. Lower P availability in the soil and in plant tissues suggests that demand for P by the plants may be greater than available P in the soil. Periphyton/algae may serve as a storage compartment for N and P under drained conditions. Continuing to monitor Hopkins Prairie throughout the current drained period and into the next flooded cycle may provide additional insight to the response of the vegetation and soil to changing hydrology.

LITERATURE CITED

American Society of Agronomy (ASA). 1982. Methods of soil analysis, part 2-chemical and microbiological properties, 2nd edition. American Society of Agronomy, Inc., Madison, WI.

American Society of Agronomy (ASA). 1986. Methods of soil analysis, part 1-physical and mineralogical methods, 2nd ed. American Society of Agronomy, Inc., Madison, WI.

Bernard, J.M., D. Solander and J. Kvet. 1988. Production and nutrient dynamics in *Carex* wetlands. Aquatic Botany 30:125-147.

Best, G.R., D.B. Hamilton and G.T. Auble. 1984. An old-growth cypress stand in Okefenokee swamp. In, Okefenokee swamp: its natural history, geology, and geochemistry. A.D. Cohen, D.J. Casagrande, M.J. Andrejko, and G.R. Best (eds.). Los Alamos, NM.

Bradbury, I.K. and J. Grace. 1983. Primary production in wetlands. In, Ecosystems of the world (4A) mires: swamp, bog, fen and moor. A.J. P. Gore (ed.). Elsevier Scientific Publ. Co. New York, NY.

Carter, V., M.S. Bedinger, R.P. Novitzki and N.O. Wilen. 1978. Water Resources and wetlands. In, Wetland functions and values: the state of our understanding. P.E. Greeson, J.R. Lark and J.E. Lark (ed.). Am. Wat. Res. Assoc. Minneap, MN

Chimney, M.J. and R. Helmers. 1990. A baseline study of the effects of wetland hydrology and water quality on the macroinvertebrate community of Hopkins Prairie, Ocala National Forest, Florida. St. Johns River Wat. Manag. Distr. Special Publ. SJ 90-SP8.

Clough, K.S., S.B. Everett and G.R. Best. 1989. Wetland macrophyte production and hydrodynamics in Hopkins Prairie, Ocala National Forest, Florida. 1989 annual report to St. Johns River Water Management District. Center for Wetlands, Univ. of Fl. CFW-90-03.

Colinvaux, P. 1986. Ecology. John Wiley & Sons. New York, NY.

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

Dickerman, J.A., A.J. Stewart and R.G. Wetzel. 1986. Estimates of net annual aboveground production: sensitivity to sampling frequency. Ecology 67(3)650-659.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of the southeastern United

States: monocotyledons. Univ. of Georgia Press, Athens, GA.

Good, R.E., D.F. Whigham and R.L. Simpson. 1978. Freshwater wetlands, ecological processes and management potential. Academic Press. New York, NY.

Gopal, B. 1985. Vegetation dynamics in temporary and shallow freshwater habitats. Aquatic Botany 23:391-396.

Grime, J.P. 1979. Plant strategies and vegetative processes. John Wiley & Sons. New York, NY.

Guntenspergen, G.R., F. Stearns and J.A. Kadlec. 1989. Wetland vegetation. In, constructed wetlands for wastewater treatment. D.A. Hammer (ed.). Lewis Publ. Chelsea, MI.

Hamilton, D.B. 1982. Plant succession and the influence of disturbance in the Okefenokee Swamp, Georgia. Okefenokee Ecosystem Investigations, Tech. Rep. no. 9. Athens, GA.

Kadlec, R.H. 1987. The hydrodynamics of wetland water treatment systems. In, Aquatic plants for water treatment and resource recovery. K.R. Reddy and W.H. Smith (ed.). Magnolia Publ. Orlando, Florida.

Kershaw, K.A. and J.H.H. Looney. 1985. Quantitative and dynamic plant ecology, third edition. Thomson Litho Ltd., East Kilbride, Scotland.

Koslowski, T.T. 1984. Plant responses to flooding of soil. Bioscience 34(3):162-167.

LaBaugh, J.W. 1986. Wetland ecosystem studies from a hydrologic perspective. Water Res. Bull. Am. Wat. Res. Assoc. 22:1.

Lindeman, R.L. 1942. The trophic dynamic aspects of ecology. Ecology 23:399-418.

Loveless, C.M. 1959. A study of the vegetation of the Florida Everglades. Ecology 40:1-9.

Mason, F. and R.J. Bryant. 1975. Production, nutrient content and decomposition of *Phragmites communis* trin. and *Typha angustifolia* L. J. of Ecol. 63:71-95.

Odum, E.P. 1960. Organic production and turnover in old field succession. Ecology 41(1):34-49.

Odum, E.P. 1971. Fundamentals of ecology, third ed. W.B. Saunders Co., Philadelphia, PA.

Odum, H.T. 1983. Systems ecology: an introduction. John Wiley & Sons, New York, NY.

Ott, L. 1988. An introduction to statistical methods and data analysis, 3rd ed. PWS-Kent Pub. Co., Boston, Mass.

Peverly, J.H. 1985. Element accumulation and release by marcophytes in a wetland stream. J of Envir. Qual. 14:1.

Polisini, J.M. and C.E. Boyd. 1972. Relationships between cell-wall fractions, nitrogen and standing crop in aquatic macrophytes. Ecology 53:484-488.

Ponnamperuma, F.N. 1972. The chemistry of submerged soils. Adv. Agron. 24:29-96.

Ponnamperuma, F.N. 1984. Effects of flooding on soils. In, Flooding and plant growth. Academic Press. New York, NY.

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands: southeast (Region 2). U.S. Fish and Wildlife Biological Report 88(26.2). May 1988.

SAS 1988. SAS for personal computers, release 6.03 ed. SAS Institute, Inc., Cary, NC.

Shew, D.M., R.A. Linthurst and E.D. Seneca. 1981. Comparison of production computation methods in a southeastern North Carolina *Spartina alterniflora* salt marsh. Estuaries 4:97-109.

Smith, R.L. (ed.). 1974. Ecology and field biology, 2nd edition. Harper and Row. New York, NY.

Snedaker, S. and A.E. Lugo. 1972. Ecology of the Ocala National Forest. U.S. Forest Service, Tallahassee, Florida.

St. Johns River Water Management District (SJRWMD). 1985. Investigation of wetland functions and hydrology - a research proposal. (unpub.).

Twilley, R.R., L.R. Blanton, M.M. Brinson and G.J. Davis. 1985. Biomass production and nutrient cycling in aquatic macrophyte communities of the Chowan River, North Carolina. Aquatic Botany 22:231-252.

Veery, E.S. and D.H. Boelter. 1978. Peatland hydrology. In, Wetland functions and values: the state of our understanding. P.E. Greeson, J.R. Lark and J.E. Lark (ed.). Am. Wat. Res. Assoc. Minneapolis, MN.

United States Environmental Protection Agency (USEPA). 1979. Methods for chemical analysis of water and wastes. EPA-600/4-79-020. National Environmental Research Center, Cincinnati, Ohio.

Wetzel R.G. 1983. Limnology, 2nd edition. Saunders College Pub. New York, NY.

Whigham, D.F., J. McCormick, R.E. Good and R.L. Simpson. 1978. Biomass and primary production in freshwater tidal wetlands of the middle atlantic coast. In, R.E. Good, D.F. Whigham and R.L. Simpson (ed.). Freshwater wetlands, ecological processes and management potential. Academic Press. New York, NY.

Wiegert, R.G. and F.C. Evans. 1964. Primary production and the disappearance of dead vegetation on an old field in southeastern Michigan. Ecology 45:49-63.

Wood, J.M. and G.W. Tanner. 1990. Graminoid community composition and structure within four Everglades management areas. Wetlands 10(2):127-149.

APPENDICES

Appendix 1. Water level (relative to soil surface) at Hopkins Prairie, Ocala National Forest, Florida. April 1989 to December 1990.

Year	Month	Subplot # 1	2	3	4	5	6	Mean	S.E.
		- - - - - Water depth (cm) - - - - -							
1989	APR	15.00	19.00	14.00	18.00	19.00	18.00	17.17	0.87
	MAY	7.00	5.00	11.00	2.00	8.00	7.00	6.67	1.23
	JUN	reps not recorded						-5.00	
	JUL	15.00	13.00	20.00	14.00	14.00	10.00	14.33	1.33
	AUG	10.00	12.00	14.00	10.00	15.00	12.00	12.17	0.83
	SEP	43.00	34.00	39.00	37.00	29.00	33.00	35.83	2.01
	OCT	40.00	40.50	40.00	44.00	40.00	41.50	41.00	0.65
	NOV	31.00	38.00	38.00	25.00	27.00	35.00	32.33	2.28
	DEC	24.00	21.00	22.00	19.00	17.00	13.00	19.33	1.61
1990	JAN/FEB	26.00	22.00	26.00	27.00	29.00	26.00	26.00	0.93
	MAR	26.50	27.00	26.00		9.50	13.00	20.40	3.78
	APR	17.00	15.50	14.00	9.80	14.80	14.80	14.32	0.99
	MAY	5.00	7.00	4.50	9.60	6.50	0.00	5.43	1.31
	JUN	-9.00	-10.00	-11.50	-13.50	-15.50	-14.00	-12.25	1.02
	JUL	-5.50	-9.00	-8.00	-7.00	-9.00	-8.50	-7.83	0.56
	AUG	-22.00	-13.50	-16.00	-14.00	-16.50	-15.00	-16.17	1.26
	SEP	-14.50	-15.50	-18.80	-17.50	-18.50	-20.50	-17.55	0.91
	OCT	-10.00	-12.00	-10.00	-11.00	-12.50	-15.00	-11.75	0.77
	NOV	-31.00	-34.00	-30.00	-31.00	-30.00	-36.00	-32.00	1.00
	DEC	-35.50	-39.00	-35.50	-40.00	-40.00	-44.00	-39.00	1.31

Appendix 2. Percent cover of plant species recorded at Hopkins Prairie, Ocala National Forest, Florida. March 1989 to December 1990.

Species	Year	Mo.	Subplot no. 1	2	3	4	5	6	Mean	S.E.
			- - - - - -	Percent cover (%)	- - - - - -					
Nymphaea odorata	1989	M	0.00	0.00	0.00	10.00	10.00	10.00	5.00	2.24
		A		(avg mar and may)					5.83	2.65
		M	0.00	15.00	15.00	10.00	0.00	0.00	6.67	3.07
		J		(avg may and july)					5.83	2.65
		J	10.00	0.00	10.00	0.00	10.00	0.00	5.00	2.24
		A	0.00	0.00	40.00	30.00	0.00	0.00	11.67	7.49
		S	0.00	60.00	0.00	18.00	0.00	20.00	16.33	9.53
		O	20.00	30.00	27.00	0.00	20.00	0.00	16.17	5.36
		N	20.00	15.00	4.00	35.00	95.00	0.00	28.17	14.30
		D	0.00	27.00	0.00	60.00	0.00	25.00	18.67	9.77
	1990	J/F	0.00	0.00	0.00	0.00	20.00	0.00	3.33	3.33
		M	0.00	0.00	2.00		0.00	0.00	0.40	0.40
		A	0.00	0.00	5.00	15.00	5.00	20.00	7.50	3.35
		M	15.00	0.00	0.00	0.00	0.00	15.00	5.00	3.16
		J	2.00	0.00	10.00	0.00	0.00	0.00	2.00	1.63
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	5.00	0.00	0.00	0.00	0.83	0.83
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eriocaulon compressum	1989	M	0.00	0.00	0.00	0.00	5.00	10.00	2.50	1.71
		A		(avg mar and may)					12.50	7.43
		M	0.00	0.00	0.00	40.00	80.00	15.00	22.50	13.15
		J		(avg may and july)					12.50	7.43
		J	0.00	0.00	0.00	0.00	10.00	5.00	2.50	1.71
		A	0.00	10.00	0.00	8.00	10.00	0.00	4.67	2.11
		S	0.00	0.00	15.00	0.00	10.00	40.00	10.83	6.38
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	8.00	8.00	50.00	0.00	0.00	50.00	19.33	9.81
		D	0.00	20.00	2.00	0.00	30.00	20.00	12.00	5.29
	1990	J/F	0.00	0.00	25.00	7.00	60.00	50.00	23.67	10.67
		M	0.00	0.00	0.00		50.00	20.00	14.00	9.80
		A	40.00	10.00	25.00	30.00	5.00	1.00	18.50	6.32
		M	15.00	0.00	0.00	15.00	5.00	20.00	9.17	3.52
		J	0.00	1.00	0.00	0.00	0.00	1.00	0.33	0.21
		J	10.00	5.00	0.00	10.00	0.00	0.00	4.17	2.01
		A	1.00	40.00	20.00	30.00	20.00	4.00	19.17	6.09
		S	20.00	5.00	0.00	20.00	0.00	0.00	7.50	4.03
		O	2.00	30.00	0.00	10.00	25.00	30.00	16.17	5.66
		N	80.00	40.00	50.00	1.00	15.00	20.00	34.33	11.62
		D	2.00	20.00	2.00	1.00	40.00	25.00	15.00	6.54
Eleocharis elongata	1989	M	10.00	5.00	5.00	2.00	0.00	0.00	3.67	1.56
		A		(avg mar and may)					3.92	1.20
		M	5.00	5.00	5.00	5.00	5.00	0.00	4.17	0.83
		J		(avg may and july)					2.08	0.42
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	5.00	30.00	0.00	0.00	0.00	5.83	4.90
		N	75.00	40.00	8.00	40.00	70.00	20.00	42.17	10.83
		D	25.00	0.00	15.00	10.00	5.00	10.00	10.83	3.52

Appendix 2. continued.

	1990	J/F	0.00	0.00	10.00	0.00	0.00	25.00	5.83	4.17
		M	10.00	15.00	25.00		0.00	10.00	12.00	4.06
		A	15.00	20.00	0.00	20.00	35.00	40.00	21.67	5.87
		M	5.00	5.00	5.00	2.00	5.00	5.00	4.50	0.50
		J	0.00	1.00	1.00	0.00	0.00	0.00	0.33	0.21
		J	5.00	5.00	5.00	1.00	15.00	0.00	5.17	2.17
		A	0.00	3.00	0.00	5.00	0.00	1.00	1.50	0.85
		S	0.00	3.00	3.00	0.00	0.00	0.00	1.00	0.63
		O	2.00	10.00	0.00	2.00	2.00	0.00	2.67	1.52
		N	0.00	0.00	2.00	2.00	5.00	0.00	1.50	0.81
		D	2.00	2.00	5.00	10.00	2.00	1.00	3.67	1.38
Rhynchospora	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
inundata		A		(avg mar and may)					0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J		(avg may and july)					16.42	6.34
		J	30.00	25.00	90.00	7.00	5.00	40.00	32.83	12.69
		A	70.00	70.00	60.00	50.00	90.00	90.00	71.67	6.54
		S	60.00	40.00	70.00	80.00	60.00	30.00	56.67	7.60
		O	25.00	30.00	20.00	75.00	75.00	35.00	43.33	10.22
		N	5.00	4.00	12.00	5.00	10.00	5.00	6.83	1.35
		D	0.00	15.00	0.00	10.00	20.00	5.00	8.33	3.33
	1990	J/F	20.00	15.00	0.00	10.00	5.00	7.00	9.50	2.93
		M	0.00	0.00	0.00		0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	2.00	0.33	0.33
		J	0.00	15.00	5.00	20.00	30.00	5.00	12.50	4.61
		J	5.00	15.00	15.00	10.00	10.00	20.00	12.50	2.14
		A	25.00	25.00	2.00	5.00	10.00	20.00	14.50	4.15
		S	10.00	25.00	15.00	20.00	7.00	5.00	13.67	3.18
		O	3.00	2.00	20.00	5.00	5.00	3.00	6.33	2.78
		N	0.00	5.00	10.00	5.00	1.00	10.00	5.17	1.74
		D	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Amphicarpum	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
muhlenbergianum		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00		0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	1.00	0.17	0.17
		J	0.00	0.00	0.00	0.00	1.00	0.00	0.17	0.17
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	30.00	5.00	5.00
		N	0.00	0.00	0.00	0.00	0.00	20.00	3.33	3.33
		D	0.00	2.00	0.00	0.00	0.00	0.00	0.33	0.33
Rhynchospora	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tracyi		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 2. continied.

		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	1.00	0.00	0.00	0.17	0.17
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xyris sp.	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	1.00	0.17	0.17
		O	0.00	0.00	0.00	0.00	1.00	0.00	0.17	0.17
		N	5.00	0.00	0.00	0.00	0.00	3.00	1.33	0.88
		D	0.00	2.00	0.00	0.00	1.00	5.00	1.33	0.80
Lachnanthes caroliniana	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	30.00	5.00	5.00

Appendix 2. continued.

		N	0.00	0.00	0.00	0.00	0.00	1.00	0.17	0.17
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triadenum virginicum	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.10	0.02	0.02
		N	0.00	0.00	0.00	0.10	0.00	0.00	0.02	0.02
		D	0.00	0.00	0.10	0.10	0.10	0.10	0.07	0.02
Eupatorium capillifolium	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	1.00	0.17	0.17
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	5.00	2.00	1.17	0.83
Mosses	1989	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1990	J/F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 2. continued.

M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.10	30.00	0.10	5.03	4.99

Appendix 3. Aboveground (AG) and belowground (BG) biomass of plant species recorded at Hopkins Prairie, Ocala National Forest, Florida.

Species/ Date	Compartm	Biomass g DWT/m2 1	2	3	4	5	6	Mean	S.E.
NYMPHAEA ODORATA									
Mar-90	AG-LIVE	0.00	0.00	5.20		0.00	0.00	1.04	1.04
Apr-90	AG-LIVE	0.00	0.00	0.91	6.34	0.00	14.46	3.62	2.39
May-90	AG-LIVE	20.61	0.05	0.00	0.00	0.00	23.76	7.40	4.69
Jun-90	AG-LIVE	16.64	0.00	10.10	0.00	0.00	0.00	4.46	2.94
Jul-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-LIVE	0.00	0.00	10.99	0.00	0.00	0.00	1.83	1.83
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90	AG-DEAD	0.00	0.00	0.00		0.00	0.00	0.00	0.00
Apr-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	AG-DEAD	0.00	0.00	0.00	39.65	0.00	0.00	6.61	6.61
Jul-90	AG-DEAD	0.00	2.58	0.00	0.00	0.00	0.00	0.43	0.43
Aug-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	AG-DEAD	0.00	0.00	0.00	22.80	0.00	0.00	3.80	3.80
Mar-90	BG 0-10	412.0	110.6	124.4	0.0	0.0	17.4	110.7	64.3
Apr-90	BG 0-10	62.6	149.3	17.3	1518.1	8.6	160.1	319.3	241.2
May-90	BG 0-10	2254.5	7.0	110.7	602.5	0.0	1362.5	722.9	373.2
Jun-90	BG 0-10	1112.2	0.0	1.8	2.3	0.0	0.0	186.0	185.2
Jul-90	BG 0-10	0.0	0.0	335.8	0.0	0.0	217.4	92.2	60.3
Aug-90	BG 0-10	0.0	0.0	0.0	0.0	457.8	64.3	87.0	74.9
Sep-90	BG 0-10	0.0	168.1	343.0	0.0	780.2	515.2	301.1	126.0
Oct-90	BG 0-10	0.0	276.8	80.8	485.0	0.0	0.0	140.4	81.7
Nov-90	BG 0-10	0.0	1416.8	132.4	0.0	0.0	8.3	259.6	232.4
Dec-90	BG 0-10	0.0	0.0	135.4	0.0	0.0	0.0	22.6	22.6
Mar-90	BG 10-20	1.73	0.00	9.37	1.36	8.76	49.21	11.74	7.67
Apr-90	BG 10-20	63.89	5.55	3.45	30.71	103.61	0.00	34.54	16.98
May-90	BG 10-20	826.41	20.72	2.47	16.77	0.00	99.42	160.97	133.93
Jun-90	BG 10-20	62.78	0.00	37.62	0.49	7.40	0.00	18.05	10.74
Jul-90	BG 10-20	15.05	5.67	16.40	24.67	6.78	0.00	11.43	3.64
Aug-90	BG 10-20	18.01	0.00	40.70	25.16	0.00	0.00	13.98	6.93
Sep-90	BG 10-20	3.08	0.00	157.76	0.00	0.00	3.45	27.38	26.08
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	209.07	0.00	0.00	0.00	0.00	34.85	34.85
Dec-90	BG 10-20	0.00	0.00	0.00	39.47	0.00	31.21	11.78	7.53
Mar-90	BG 20-30	0.00	0.00	42.80	0.00	3.82	24.92	11.92	7.34
Apr-90	BG 20-30	45.88	20.23	0.00	1.60	112.61	18.01	33.06	17.29
May-90	BG 20-30	141.85	23.44	0.00	12.70	65.50	39.22	47.12	21.09
Jun-90	BG 20-30	24.30	0.86	0.00	21.46	3.45	2.10	8.70	4.53
Jul-90	BG 20-30	0.00	38.48	1.73	43.66	0.00	2.84	14.45	8.46
Aug-90	BG 20-30	17.76	3.58	17.89	12.09	3.45	9.50	10.71	2.63
Sep-90	BG 20-30	1.60	0.00	28.86	0.00	0.00	21.96	8.74	5.35
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	3.21	0.00	3.33	0.00	0.00	0.00	1.09	0.69
Dec-90	BG 20-30	0.00	0.00	0.00	66.61	0.00	77.58	24.03	15.26

Appendix 3. continued.

ERIOCAULON COMPRESSUM									
Mar-90	AG-LIVE	0.00	0.00	0.00		11.92	12.96	4.98	3.05
Apr-90	AG-LIVE	20.77	5.09	8.02	15.39	2.27	0.48	8.67	3.23
May-90	AG-LIVE	6.72	0.00	0.00	5.74	3.78	11.09	4.55	1.74
Jun-90	AG-LIVE	0.00	0.56	0.00	0.00	0.00	1.17	0.29	0.20
Jul-90	AG-LIVE	1.31	1.46	0.00	3.84	0.00	0.00	1.10	0.61
Aug-90	AG-LIVE	0.98	34.88	14.40	24.61	17.25	0.53	15.44	5.47
Sep-90	AG-LIVE	20.85	7.46	0.00	13.38	0.00	0.00	6.95	3.56
Oct-90	AG-LIVE	0.14	33.17	0.00	15.89	23.28	44.66	19.52	7.31
Nov-90	AG-LIVE	130.96	29.17	70.62	0.00	5.38	29.92	44.34	20.10
Dec-90	AG-LIVE	0.26	29.71	0.91	0.00	21.94	33.58	14.40	6.45
Mar-90	AG-DEAD	0.00	0.00	0.00		9.34	2.99	2.47	1.81
Apr-90	AG-DEAD	3.30	0.82	1.09	2.59	0.34	0.00	1.35	0.53
May-90	AG-DEAD	16.77	2.48	0.93	4.34	4.70	15.65	7.48	2.82
Jun-90	AG-DEAD	1.14	4.80	0.00	26.03	0.00	0.00	5.33	4.21
Jul-90	AG-DEAD	1.71	3.84	0.08	2.82	0.77	5.89	2.52	0.87
Aug-90	AG-DEAD	0.00	7.41	1.81	4.21	3.06	0.00	2.75	1.15
Sep-90	AG-DEAD	11.58	2.21	0.38	3.82	0.00	0.26	3.04	1.81
Oct-90	AG-DEAD	0.00	5.14	0.03	0.20	4.32	8.80	3.08	1.48
Nov-90	AG-DEAD	11.57	5.44	10.24	0.00	1.01	6.96	5.87	1.92
Dec-90	AG-DEAD	0.08	8.24	0.27	0.00	45.98	14.91	11.58	7.30
Mar-90	BG 0-10	0.00	0.00	0.00	0.00	113.92	16.51	21.74	18.63
Apr-90	BG 0-10	15.86	9.60	15.62	39.30	0.51	0.00	13.48	5.89
May-90	BG 0-10	30.72	2.94	0.00	4.35	7.55	25.73	11.88	5.30
Jun-90	BG 0-10	0.00	0.00	1.54	1.79	0.38	2.69	1.07	0.45
Jul-90	BG 0-10	12.94	7.95	1.66	17.49	5.50	6.61	8.69	2.31
Aug-90	BG 0-10	6.66	116.21	20.37	67.41	40.16	22.22	45.50	16.52
Sep-90	BG 0-10	26.72	7.22	3.28	40.53	0.00	1.41	13.19	6.78
Oct-90	BG 0-10	0.00	47.62	0.00	7.25	0.00	26.02	13.48	7.97
Nov-90	BG 0-10	90.37	25.86	87.55	1.28	4.35	32.13	40.26	16.16
Dec-90	BG 0-10	6.53	26.75	1.15	6.02	50.18	20.61	18.54	7.47
Mar-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	5.43	0.90	0.90
Apr-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 10-20	0.00	0.37	0.00	0.00	0.00	0.00	0.06	0.06
Aug-90	BG 10-20	0.00	0.12	0.12	0.37	0.37	0.62	0.27	0.09
Sep-90	BG 10-20	0.12	2.10	0.00	0.37	0.00	0.00	0.43	0.34
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	1.48	0.74	0.37	0.25
Nov-90	BG 10-20	0.25	0.00	0.62	0.00	0.00	0.37	0.21	0.10
Dec-90	BG 10-20	0.00	0.49	0.00	0.00	2.59	1.11	0.70	0.42
Mar-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.62	0.10	0.10
Apr-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.25	0.04	0.04
Sep-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.49	0.00	0.00	0.37	0.14	0.09
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.74	0.49	0.21	0.13
ELEOCHARIS ELONGATA									
Mar-90	AG-LIVE	4.13	0.00	6.40		0.00	2.43	2.59	1.23
Apr-90	AG-LIVE	0.90	1.04	0.98	0.00	0.00	0.00	0.49	0.22
May-90	AG-LIVE	0.67	1.58	7.07	0.00	1.10	8.56	3.17	1.50

Appendix 3. continued.

Jun-90	AG-LIVE	0.00	1.89	0.91	0.00	0.00	0.00	0.47	0.32
Jul-90	AG-LIVE	4.51	2.88	3.01	0.46	7.14	0.00	3.00	1.08
Aug-90	AG-LIVE	0.22	3.62	0.00	3.60	0.83	0.64	1.49	0.68
Sep-90	AG-LIVE	0.00	1.84	1.22	0.00	0.00	0.00	0.51	0.33
Oct-90	AG-LIVE	1.10	1.25	0.00	1.07	0.40	0.00	0.64	0.23
Nov-90	AG-LIVE	0.00	1.49	0.83	0.80	0.31	0.00	0.57	0.24
Dec-90	AG-LIVE	0.34	0.53	0.24	1.34	0.69	0.10	0.54	0.18
Mar-90	AG-DEAD	0.70	0.00	0.53		0.00	1.30	0.51	0.24
Apr-90	AG-DEAD	0.24	0.32	0.00	0.00	0.00	0.00	0.09	0.06
May-90	AG-DEAD	16.29	32.00	15.58	5.50	4.69	2.78	12.81	4.50
Jun-90	AG-DEAD	2.00	17.17	0.00	6.62	0.00	0.00	4.30	2.78
Jul-90	AG-DEAD	0.00	0.00	0.93	0.53	1.09	0.54	0.51	0.19
Aug-90	AG-DEAD	0.00	1.01	0.00	0.74	0.00	0.00	0.29	0.19
Sep-90	AG-DEAD	0.00	1.36	1.49	0.27	0.00	0.05	0.53	0.29
Oct-90	AG-DEAD	0.99	0.83	0.00	0.61	0.16	0.00	0.43	0.18
Nov-90	AG-DEAD	0.00	1.65	11.68	1.39	2.58	0.00	2.88	1.81
Dec-90	AG-DEAD	0.16	1.23	0.08	2.35	1.44	1.06	1.05	0.35
Mar-90	BG 0-10	52.10	36.74	100.10	19.97	0.00	4.99	35.65	15.15
Apr-90	BG 0-10	1.28	35.33	5.12	5.38	96.38	2.18	24.28	15.34
May-90	BG 0-10	34.05	11.52	50.43	9.60	99.84	9.47	35.82	14.48
Jun-90	BG 0-10	11.52	20.38	3.33	4.86	7.04	5.25	8.73	2.60
Jul-90	BG 0-10	50.03	11.86	44.45	20.10	54.91	15.65	32.83	7.78
Aug-90	BG 0-10	4.16	13.50	8.00	19.22	4.22	29.39	13.08	4.03
Sep-90	BG 0-10	7.81	12.43	15.71	3.46	0.00	9.86	8.21	2.36
Oct-90	BG 0-10	37.12	7.55	9.30	11.15	0.00	4.61	11.62	5.34
Nov-90	BG 0-10	6.91	8.32	11.78	3.84	41.52	5.25	12.94	5.82
Dec-90	BG 0-10	11.90	4.48	14.21	10.62	20.48	4.35	11.01	2.50
Mar-90	BG 10-20	12.95	1.73	4.81	5.06	0.00	1.48	4.34	1.90
Apr-90	BG 10-20	0.37	7.03	2.47	0.12	7.15	0.37	2.92	1.36
May-90	BG 10-20	0.00	1.97	11.96	1.60	12.83	0.00	4.73	2.45
Jun-90	BG 10-20	0.00	0.00	0.49	0.00	0.74	0.00	0.21	0.13
Jul-90	BG 10-20	8.51	3.58	4.56	4.07	5.55	0.00	4.38	1.13
Aug-90	BG 10-20	0.00	4.81	0.00	0.62	0.25	3.33	1.50	0.84
Sep-90	BG 10-20	2.71	0.12	2.47	0.37	0.25	0.86	1.13	0.47
Oct-90	BG 10-20	6.04	0.49	0.62	0.37	1.97	0.00	1.58	0.93
Nov-90	BG 10-20	0.00	0.00	0.12	0.62	10.85	0.00	1.93	1.79
Dec-90	BG 10-20	0.00	0.00	3.21	6.78	8.51	1.36	3.31	1.47
Mar-90	BG 20-30	7.03	1.97	4.81	0.86	0.00	0.86	2.59	1.12
Apr-90	BG 20-30	0.00	4.81	0.12	0.37	3.45	0.12	1.48	0.86
May-90	BG 20-30	0.00	2.10	9.74	1.60	3.70	0.00	2.86	1.49
Jun-90	BG 20-30	0.00	0.86	0.00	0.00	0.12	0.00	0.16	0.14
Jul-90	BG 20-30	2.59	0.25	0.86	1.97	3.70	0.12	1.58	0.58
Aug-90	BG 20-30	0.25	1.97	0.00	0.62	0.86	1.73	0.90	0.32
Sep-90	BG 20-30	0.86	2.10	2.22	0.00	0.12	0.00	0.88	0.42
Oct-90	BG 20-30	3.21	0.49	0.74	0.00	0.74	0.00	0.86	0.49
Nov-90	BG 20-30	0.00	0.49	1.73	0.86	5.55	0.12	1.46	0.86
Dec-90	BG 20-30	1.60	0.37	3.33	3.33	1.48	0.74	1.81	0.52
RHYNCHOSPORA INUNDATA									
Mar-90	AG-LIVE	0.00	0.00	0.00		0.00	0.00	0.00	0.00
Apr-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	7.81	1.30	1.30
Jun-90	AG-LIVE	2.27	3.50	2.05	7.81	25.66	10.21	8.58	3.67
Jul-90	AG-LIVE	2.34	9.17	7.78	5.33	5.74	6.77	6.19	0.96
Aug-90	AG-LIVE	8.22	23.12	1.20	9.68	10.08	6.80	9.85	2.96
Sep-90	AG-LIVE	6.94	17.87	11.42	7.23	2.03	0.86	7.73	2.56

Appendix 3. continued.

Oct-90	AG-LIVE	1.50	9.18	6.45	1.87	5.14	1.49	4.27	1.30
Nov-90	AG-LIVE	4.96	6.96	7.47	0.24	2.51	4.21	4.39	1.11
Dec-90	AG-LIVE	2.30	4.48	10.00	4.48	1.68	4.43	4.56	1.20
Mar-90	AG-DEAD	6.24	0.00	12.08		7.86	0.00	5.24	2.34
Apr-90	AG-DEAD	0.94	0.74	0.46	10.45	6.32	5.25	4.03	1.64
May-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	AG-DEAD	11.07	0.77	0.00	2.50	0.00	0.00	2.39	1.78
Jul-90	AG-DEAD	14.43	5.82	7.47	10.59	17.62	11.34	11.21	1.78
Aug-90	AG-DEAD	53.46	4.45	26.48	11.84	11.87	19.10	21.20	7.14
Sep-90	AG-DEAD	11.41	9.97	14.43	8.70	9.66	7.10	10.21	1.03
Oct-90	AG-DEAD	6.37	25.31	8.58	35.94	5.09	6.98	14.71	5.24
Nov-90	AG-DEAD	8.62	21.94	2.98	4.43	11.33	21.18	11.75	3.33
Dec-90	AG-DEAD	5.36	18.35	17.66	26.40	0.00	17.01	14.13	3.94
Mar-90	BG 0-10	51.97	141.07	46.34	38.53	220.75	58.67	92.89	29.80
Apr-90	BG 0-10	61.34	84.99	62.59	105.47	97.71	53.81	77.65	8.74
May-90	BG 0-10	27.90	50.72	43.04	36.22	145.74	108.67	68.72	19.35
Jun-90	BG 0-10	97.25	51.06	79.54	55.60	106.88	72.58	77.15	9.05
Jul-90	BG 0-10	35.10	38.43	46.34	90.59	70.75	61.06	57.05	8.70
Aug-90	BG 0-10	93.04	29.04	50.05	110.03	191.01	18.99	82.03	26.20
Sep-90	BG 0-10	66.70	93.49	18.40	31.87	178.45	152.64	90.26	26.34
Oct-90	BG 0-10	99.17	78.13	57.79	25.52	1.60	106.27	61.41	16.93
Nov-90	BG 0-10	24.10	39.78	78.02	65.92	25.95	90.00	53.96	11.40
Dec-90	BG 0-10	33.66	13.95	25.60	48.77	66.56	57.09	40.94	8.15
Mar-90	BG 10-20	3.33	72.16	78.32	67.84	197.85	56.12	79.27	26.17
Apr-90	BG 10-20	45.02	61.55	1.60	81.16	22.08	27.38	39.80	11.74
May-90	BG 10-20	0.00	0.00	0.37	26.27	43.17	79.19	24.83	13.07
Jun-90	BG 10-20	30.59	17.76	26.77	50.57	16.65	21.83	27.36	5.12
Jul-90	BG 10-20	13.07	15.17	47.49	22.45	14.31	12.58	20.85	5.53
Aug-90	BG 10-20	11.10	18.87	0.00	30.96	40.09	1.48	17.08	6.57
Sep-90	BG 10-20	3.45	24.55	2.71	11.47	0.00	26.77	11.49	4.75
Oct-90	BG 10-20	24.18	27.51	0.00	3.33	44.53	42.18	23.62	7.67
Nov-90	BG 10-20	0.00	1.60	15.17	7.03	0.00	81.78	17.60	13.05
Dec-90	BG 10-20	10.48	5.43	0.00	7.28	4.07	21.34	8.10	3.00
Mar-90	BG 20-30	0.00	52.05	11.96	60.32	51.93	17.89	32.36	10.37
Apr-90	BG 20-30	26.64	10.36	4.56	68.21	0.99	27.14	22.98	10.10
May-90	BG 20-30	0.00	0.00	0.37	45.88	28.25	38.36	18.81	8.66
Jun-90	BG 20-30	5.80	12.46	0.00	15.05	32.81	2.59	11.45	4.87
Jul-90	BG 20-30	3.58	6.91	13.69	5.43	5.43	13.32	8.06	1.78
Aug-90	BG 20-30	3.45	9.37	0.00	9.87	2.59	3.45	4.79	1.61
Sep-90	BG 20-30	0.00	1.23	1.23	8.14	9.87	16.65	6.19	2.67
Oct-90	BG 20-30	4.32	2.84	11.10	2.84	5.80	10.24	6.19	1.49
Nov-90	BG 20-30	0.00	0.00	1.73	0.00	0.00	11.47	2.20	1.88
Dec-90	BG 20-30	4.07	2.84	1.85	7.40	7.77	24.67	8.10	3.46
AMPHICARPUM MUHLENBERGIANUM									
Mar-90	AG-LIVE	0.00	0.00	0.00		0.00	0.00	0.00	0.00
Apr-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	1.47	0.25	0.25
Jun-90	AG-LIVE	0.00	0.00	0.00	0.00	1.42	0.00	0.24	0.24
Jul-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	75.09	12.51	12.51
Nov-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	47.98	8.00	8.00
Dec-90	AG-LIVE	0.00	0.64	0.00	0.00	0.00	0.00	0.11	0.11

Appendix 3. continued.

Mar-90	AG-DEAD	0.00	0.00	0.00		0.00	0.00	0.00	0.00
Apr-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	11.10	1.85	1.85
Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	23.60	3.93	3.93
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	104.61	17.43	17.43
Nov-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	66.66	11.11	11.11
Dec-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	2.99	0.50	0.50
Mar-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RHYNCHOSPORA TRACYI

Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	AG-LIVE	0.00	0.00	0.00	2.70	0.00	0.00	0.45	0.45
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Nov-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Mar-90									
Apr-90									
May-90									
Jun-90									

Appendix 3. continued.

Jul-90									
Aug-90									
Sep-90	AG-DEAD	0.00	0.00	0.00	0.27	0.00	0.00	0.05	0.05
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 0-10	0.00	0.00	0.00	0.53	0.00	0.00	0.09	0.09
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Nov-90	BG 0-10								ERR
Dec-90	BG 0-10								ERR
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XYRIS SP.									
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.40	0.07	0.07
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.61	0.00	0.10	0.10
Nov-90	AG-LIVE	4.27	0.30	0.00	0.00	0.00	2.03	1.10	0.71
Dec-90	AG-LIVE	0.00	3.73	0.00	0.00	0.67	1.47	0.98	0.60
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3. continued.

Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.01
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Nov-90	BG 0-10	0.96	0.16	0.00	0.00	0.00	0.48	0.27	0.16
Dec-90	BG 0-10	0.00	0.00	0.00	0.00	0.18	0.00	0.03	0.03
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 10-20								
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90	BG 20-30								
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

LACHNANTHES CAROLINIANA

Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	3.31	0.55	0.55
Nov-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.03
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	8.82	1.47	1.47
Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	2.91	0.49	0.49
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									

Appendix 3. continued.

May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	15.14	2.52	2.52
Nov-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.40	0.07	0.07
Dec-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TRIADENUM VIRGINICUM									
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.02	0.00	
Nov-90	AG-LIVE	0.00	0.00	0.00	0.03	0.00	0.00	0.01	
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Nov-90	AG-DEAD	0.00	0.00	0.00	0.02	0.00	0.00	0.00	
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									

Appendix 3. continued.

Aug-90								
Sep-90								
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	<0.02
Nov-90	BG 0-10							
Dec-90	BG 0-10							
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EUPATORIUM CAPILLIFOLIUM								
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.21	0.03
Nov-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.06	0.01
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	2.22	0.40	0.44
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.03	0.01
Nov-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	

Appendix 3. continued.

Dec-90	BG 0-10	0.00	0.45	0.00	0.00	0.51	0.06	0.17
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MOSSES								
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90								
Nov-90								
Dec-90	AG-LIVE	0.00	0.00	0.00	0.00	8.16	0.00	1.36
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90								
Nov-90								
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90								
Apr-90								
May-90								
Jun-90								
Jul-90								
Aug-90								
Sep-90								
Oct-90								
Nov-90								
Dec-90	BG 0-10							ERR
Mar-90								
Apr-90								

Appendix 3. continued.

May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90									
Nov-90									
Dec-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Mar-90									
Apr-90									
May-90									
Jun-90									
Jul-90									
Aug-90									
Sep-90									
Oct-90									
Nov-90									
Dec-90	BG 20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTHER: (RHY TRA, XYR SP, LAC CAR, TRA VIR, EUP CAP, MOS SP)									
Mar-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	AG-LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-LIVE	0.00	0.00	0.00	2.70	0.00	0.40	0.52	0.44
Oct-90	AG-LIVE	0.00	0.00	0.00	0.00	0.61	3.54	0.69	0.58
Nov-90	AG-LIVE	4.27	0.30	0.00	0.03	0.00	2.26	1.14	0.72
Dec-90	AG-LIVE	0.00	3.73	0.00	0.00	11.06	1.88	2.78	1.76
Mar-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	AG-DEAD	0.00	0.00	0.00	0.27	0.00	0.00	0.05	0.05
Oct-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	8.82	1.47	1.47
Nov-90	AG-DEAD	0.00	0.00	0.00	0.02	0.00	2.93	0.49	0.49
Dec-90	AG-DEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	BG 0-10	0.00	0.00	0.00	0.53	0.00	0.08	0.10	0.09
Oct-90	BG 0-10	0.00	0.00	0.00	0.00	0.00	15.17	2.53	2.53
Nov-90	BG 0-10	0.96	0.16	0.00	0.00	0.00	0.88	0.33	0.19
Dec-90	BG 0-10	0.00	0.45	0.00	0.00	0.69	0.06	0.20	0.12
Mar-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG 10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

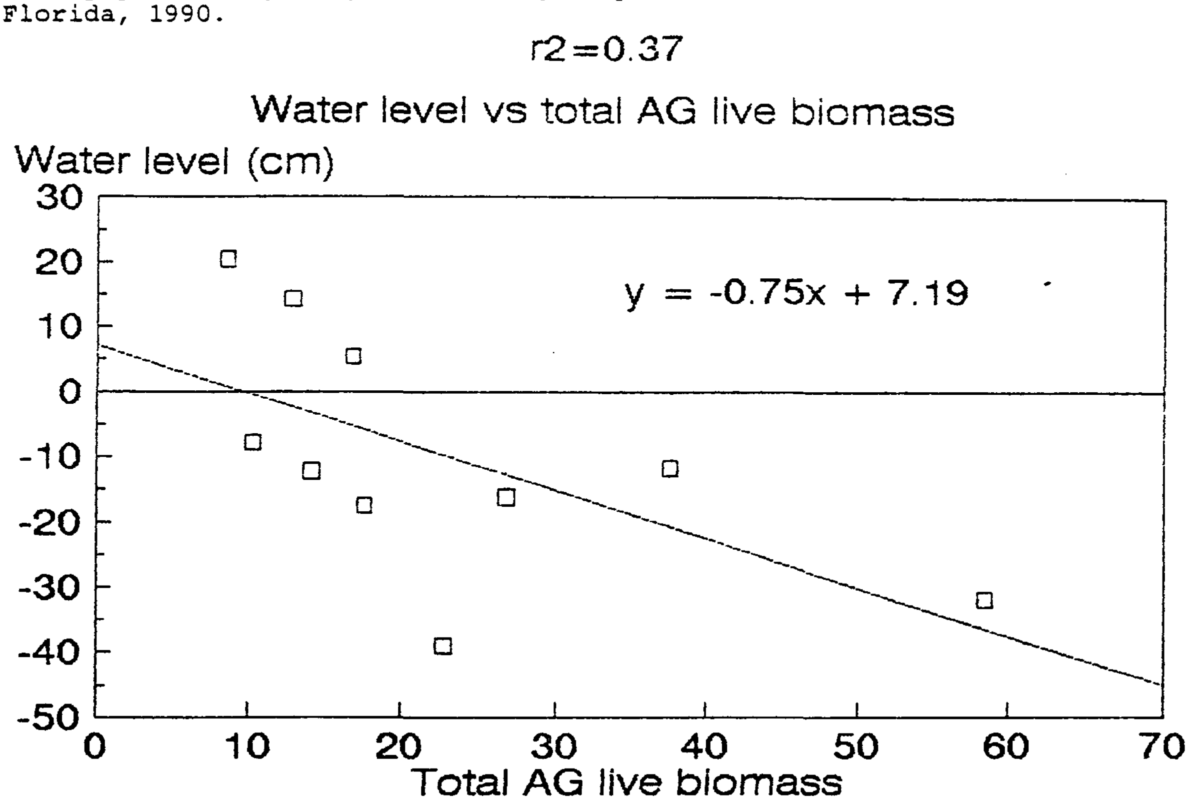
Appendix 3. continued.

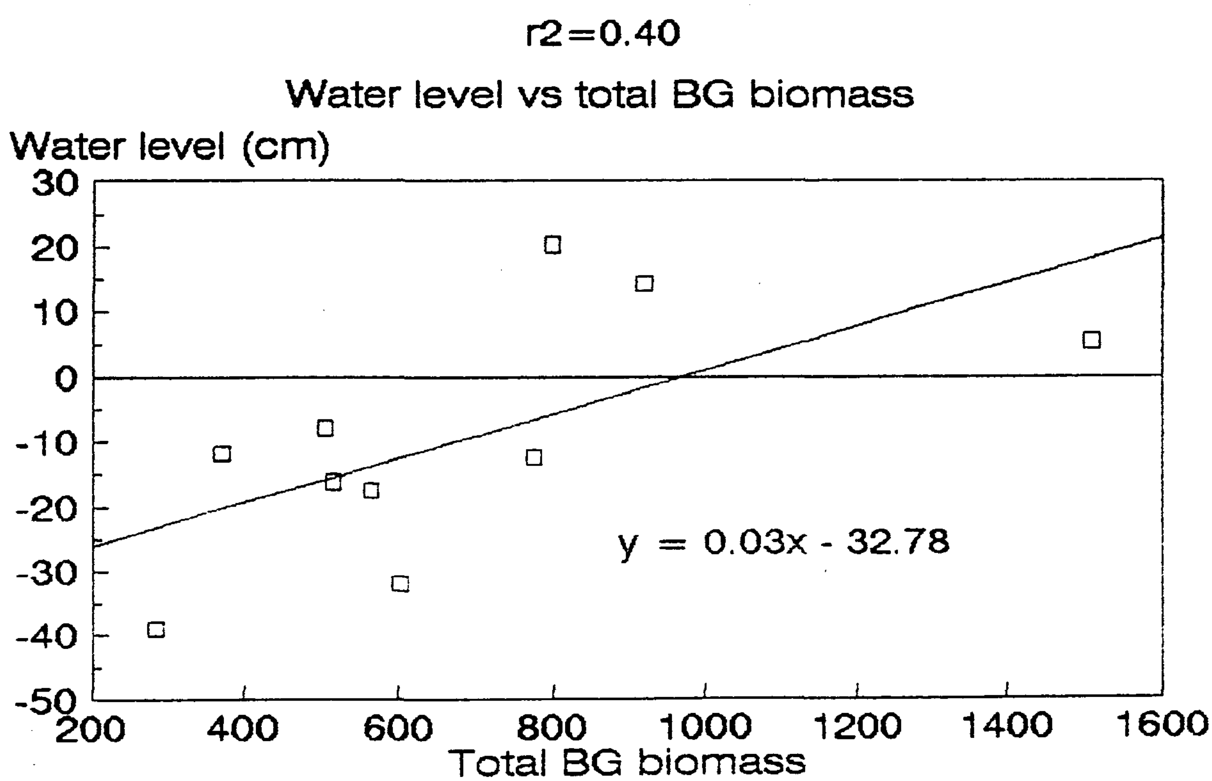
Sep-90	BG	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-90	BG	20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERAL										
Mar-90	BG	0-10	179.46	258.05	238.08	162.94	231.81	234.88	217.54	15.27
Apr-90	BG	0-10	255.87	152.58	158.21	261.12	222.85	220.03	211.78	19.10
May-90	BG	0-10	119.68	174.08	204.16	258.56	405.25	287.23	241.49	40.81
Jun-90	BG	0-10	299.52	274.05	231.30	181.50	415.36	212.61	269.06	33.98
Jul-90	BG	0-10	205.82	186.24	203.26	103.81	204.42	268.29	195.31	21.63
Aug-90	BG	0-10	157.44	104.58	77.18	175.49	405.38	137.47	176.26	48.07
Sep-90	BG	0-10	41.15	31.23	15.33	20.70	24.29	48.00	30.12	5.11
Oct-90	BG	0-10	28.32	22.37	21.41	28.93	0.00	48.54	24.93	6.39
Nov-90	BG	0-10	50.05	16.51	69.89	95.36	104.96	150.02	81.13	18.96
Dec-90	BG	0-10	13.95	62.85	30.46	109.06	68.35	178.05	77.12	24.26
Mar-90	BG	10-20	67.96	31.82	80.42	124.95	262.97	199.94	128.01	35.83
Apr-90	BG	10-20	52.05	46.75	21.71	99.66	101.76	53.04	62.49	12.95
May-90	BG	10-20	24.67	20.35	19.37	30.96	79.80	317.74	82.15	48.03
Jun-90	BG	10-20	45.64	26.64	23.68	61.43	99.17	50.08	51.11	11.25
Jul-90	BG	10-20	31.95	31.21	56.74	28.37	45.02	45.14	39.74	4.51
Aug-90	BG	10-20	42.43	43.17	12.70	54.77	77.71	19.86	41.77	9.64
Sep-90	BG	10-20	26.77	39.72	12.58	39.59	39.59	102.50	43.46	12.60
Oct-90	BG	10-20	24.79	23.07	18.87	32.07	62.41	111.38	45.43	14.66
Nov-90	BG	10-20	10.98	17.02	22.33	20.35	20.35	274.81	60.97	42.80
Dec-90	BG	10-20	18.50	19.74	12.58	32.07	38.11	80.79	33.63	10.18
Mar-90	BG	20-30	24.79	18.87	35.03	43.79	93.13	68.95	47.43	11.61
Apr-90	BG	20-30	26.40	28.99	20.23	41.07	41.94	45.51	34.02	4.16
May-90	BG	20-30	12.33	19.61	22.08	20.23	30.59	91.03	32.65	11.92
Jun-90	BG	20-30	23.56	16.28	14.31	28.25	89.06	24.05	32.58	11.49
Jul-90	BG	20-30	12.83	20.11	18.38	16.90	13.20	14.43	15.97	1.21
Aug-90	BG	20-30	15.29	20.48	11.84	29.48	25.16	5.67	17.99	3.59
Sep-90	BG	20-30	17.27	14.31	13.69	22.08	14.68	39.47	20.25	4.05
Oct-90	BG	20-30	17.64	18.26	4.81	23.68	25.41	39.35	21.52	4.63
Nov-90	BG	20-30	6.04	11.96	13.44	15.42	10.61	76.10	22.26	10.85
Dec-90	BG	20-30	7.89	13.81	6.17	29.11	19.98	52.05	21.50	7.01
TOTAL										
Mar-90	AG-LIVE		4.13	0.00	11.60		11.92	15.39	8.61	2.83
Apr-90	AG-LIVE		21.66	6.13	9.90	21.73	2.27	14.94	12.77	3.30
May-90	AG-LIVE		28.00	1.63	7.07	5.74	4.88	52.69	16.67	8.17
Jun-90	AG-LIVE		18.91	5.95	13.06	7.81	27.09	11.38	14.03	3.20
Jul-90	AG-LIVE		8.16	13.50	10.78	9.63	12.88	6.77	10.29	1.07
Aug-90	AG-LIVE		9.42	61.62	15.60	37.89	28.16	7.97	26.78	8.40
Sep-90	AG-LIVE		27.79	27.17	23.63	23.31	2.03	1.26	17.53	5.08
Oct-90	AG-LIVE		2.75	43.60	6.45	18.83	29.42	124.77	37.64	18.47
Nov-90	AG-LIVE		140.19	37.92	78.93	1.07	8.20	84.37	58.45	21.61

Appendix 3. continued.

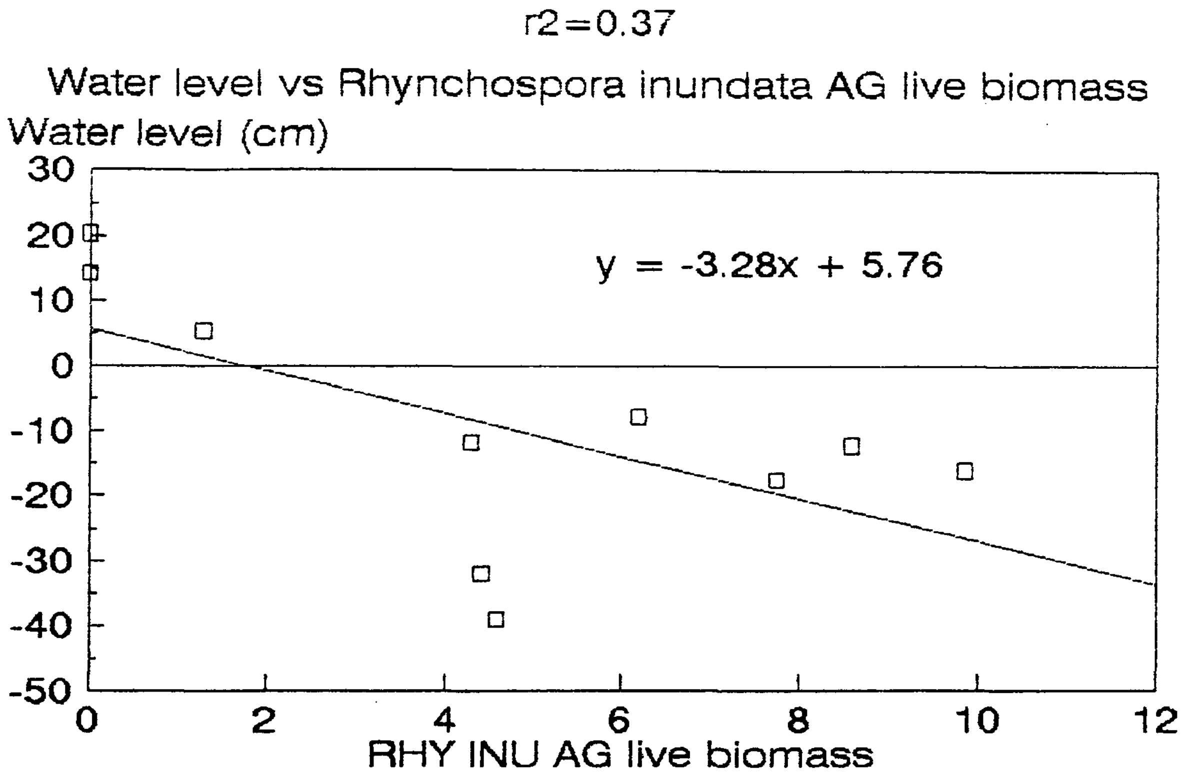
Dec-90	AG-LIVE	2.90	41.65	11.15	5.83	35.36	39.99	22.81	7.37
Mar-90	AG-DEAD	6.94	0.00	12.61		17.20	4.29	8.21	3.04
Apr-90	AG-DEAD	4.48	1.87	1.55	13.04	6.66	5.25	5.47	1.71
May-90	AG-DEAD	33.06	34.48	16.51	9.84	9.39	18.43	20.29	4.51
Jun-90	AG-DEAD	14.21	22.74	0.00	74.80	0.00	0.00	18.62	11.88
Jul-90	AG-DEAD	16.14	12.24	8.48	13.94	19.47	17.77	14.67	1.63
Aug-90	AG-DEAD	53.46	12.86	28.29	16.78	14.93	19.10	24.24	6.24
Sep-90	AG-DEAD	22.99	13.54	16.30	13.07	9.66	7.41	13.83	2.23
Oct-90	AG-DEAD	7.36	31.28	8.61	36.74	9.57	35.70	21.54	5.88
Nov-90	AG-DEAD	20.19	29.02	24.90	5.84	14.91	54.67	24.92	6.80
Dec-90	AG-DEAD	5.60	27.82	18.02	51.55	47.43	32.98	30.57	7.12
Mar-90	BG 0-10	695.6	546.4	508.9	221.4	566.5	332.4	478.5	70.2
Apr-90	BG 0-10	396.9	431.8	258.8	1929.4	426.0	436.1	646.5	258.0
May-90	BG 0-10	2466.8	246.3	408.4	911.3	658.4	1793.6	1080.8	355.2
Jun-90	BG 0-10	1520.5	345.5	317.5	246.0	529.7	293.1	542.0	199.7
Jul-90	BG 0-10	303.9	244.5	631.5	232.0	335.6	569.0	386.1	69.9
Aug-90	BG 0-10	261.3	263.3	155.6	372.1	1098.5	272.4	403.9	141.7
Sep-90	BG 0-10	142.4	312.5	395.7	97.1	982.9	727.2	443.0	141.6
Oct-90	BG 0-10	164.6	432.5	169.3	557.8	1.6	305.2	271.8	82.4
Nov-90	BG 0-10	172.4	1507.4	379.6	166.4	176.8	353.2	459.3	213.2
Dec-90	BG 0-10	66.0	108.5	206.8	174.5	206.3	263.2	170.9	29.4
Mar-90	BG 10-20	85.97	105.71	172.93	199.20	469.58	312.19	224.26	58.98
Apr-90	BG 10-20	181.32	131.24	29.23	259.15	308.61	133.09	173.77	40.78
May-90	BG 10-20	851.08	43.05	34.17	75.61	135.80	828.26	328.00	162.49
Jun-90	BG 10-20	263.34	151.47	88.56	161.71	219.80	80.05	160.82	29.34
Jul-90	BG 10-20	68.58	56.00	125.20	79.56	71.66	57.73	76.45	10.39
Aug-90	BG 10-20	71.54	66.98	53.53	111.87	118.41	25.29	74.60	14.44
Sep-90	BG 10-20	36.14	66.48	175.52	51.81	39.84	133.58	83.90	23.39
Oct-90	BG 10-20	55.01	51.06	19.49	35.77	110.39	154.31	71.01	20.85
Nov-90	BG 10-20	11.22	227.70	38.24	28.00	31.21	356.96	115.55	58.45
Dec-90	BG 10-20	28.99	25.66	15.79	85.60	53.29	135.80	57.52	18.71
Mar-90	BG 20-30	31.82	72.90	94.61	104.97	148.88	113.23	94.40	16.14
Apr-90	BG 20-30	98.92	102.62	24.92	120.51	158.99	90.78	99.46	17.92
May-90	BG 20-30	154.18	45.14	32.19	80.42	128.03	168.61	101.43	23.39
Jun-90	BG 20-30	103.49	94.98	14.31	64.76	125.44	28.74	71.95	17.91
Jul-90	BG 20-30	19.00	65.74	34.66	67.96	22.33	30.71	40.07	8.78
Aug-90	BG 20-30	36.76	35.40	29.73	52.05	32.07	20.60	34.43	4.23
Sep-90	BG 20-30	19.74	17.64	46.01	30.22	24.67	78.08	36.06	9.37
Oct-90	BG 20-30	25.16	21.59	16.65	26.52	31.95	49.58	28.58	4.69
Nov-90	BG 20-30	9.25	12.46	20.72	16.28	16.16	88.07	27.16	12.28
Dec-90	BG 20-30	13.57	17.02	11.35	106.45	29.97	155.54	55.65	24.79

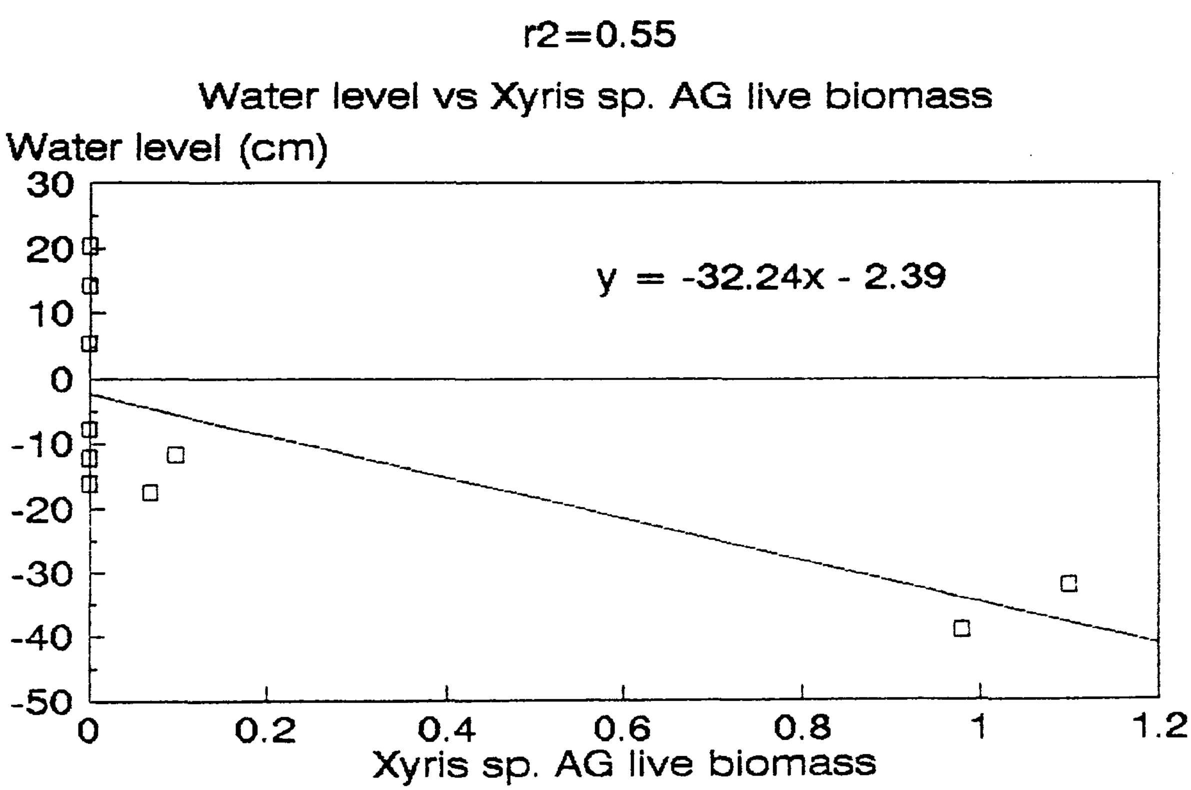
Appendix 4. Results of linear regression analyses and ANOVA tests of wetland macrophyte and hydrodynamics study, Hopkins Prairie, Ocala National Forest, Florida, 1990.





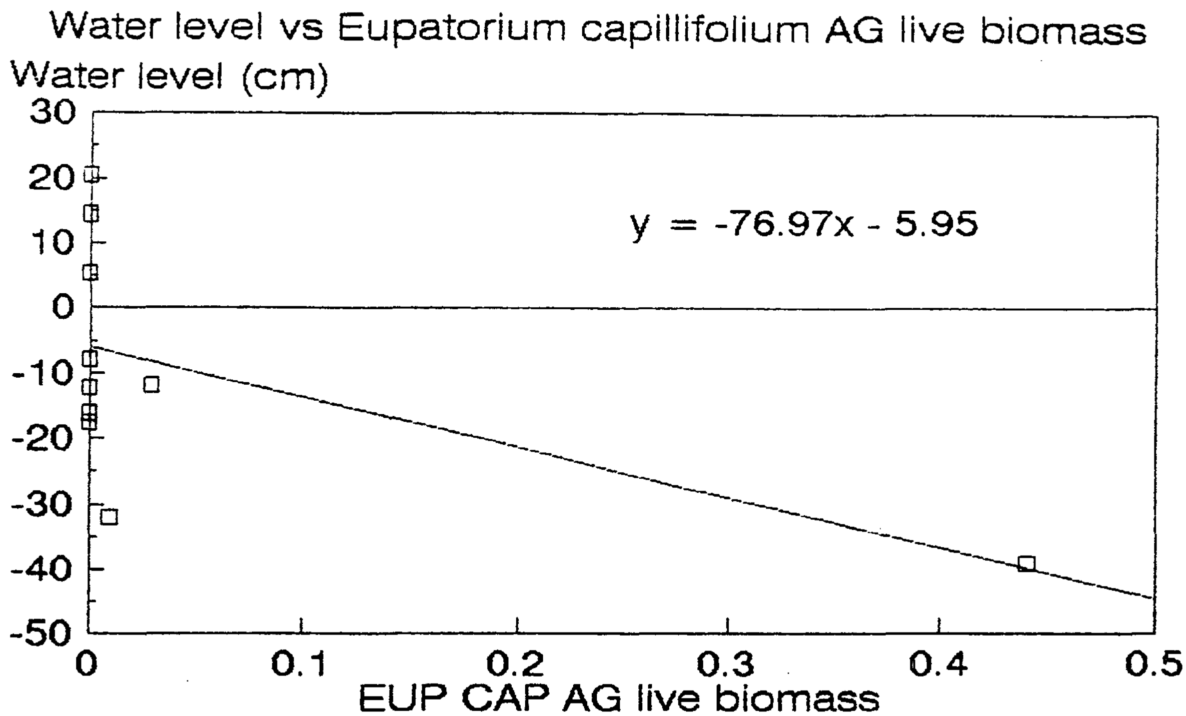
Appendix 4. continued



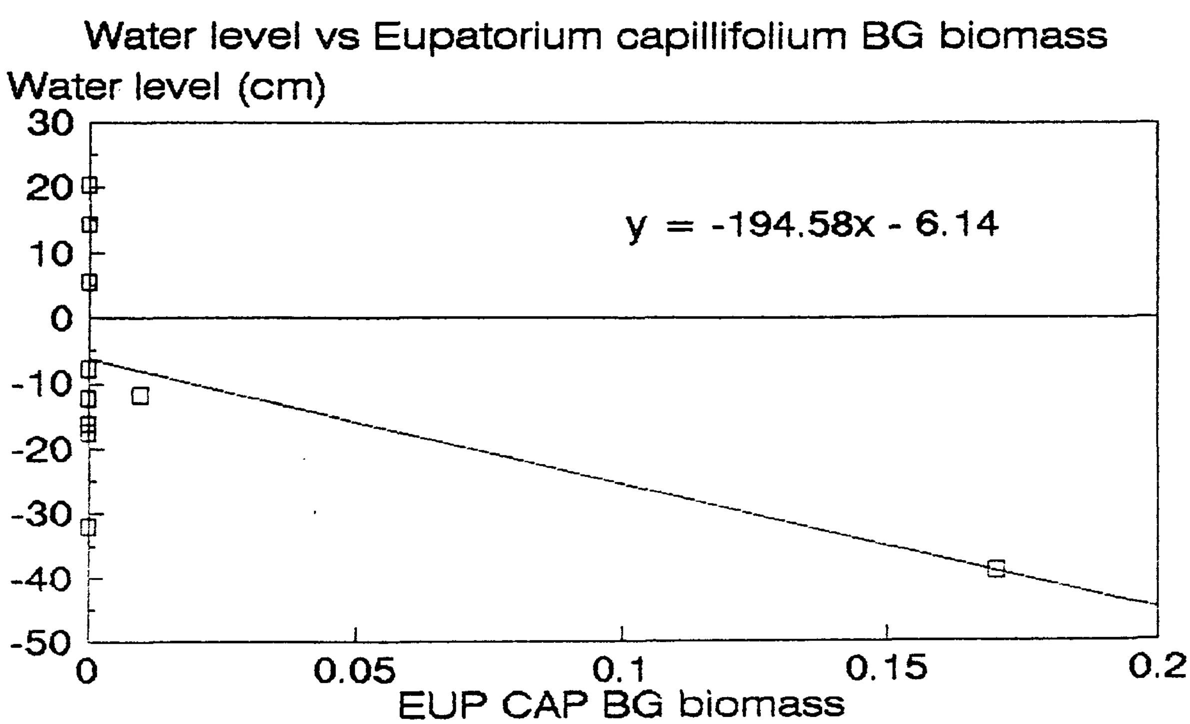


Appendix 4. continued

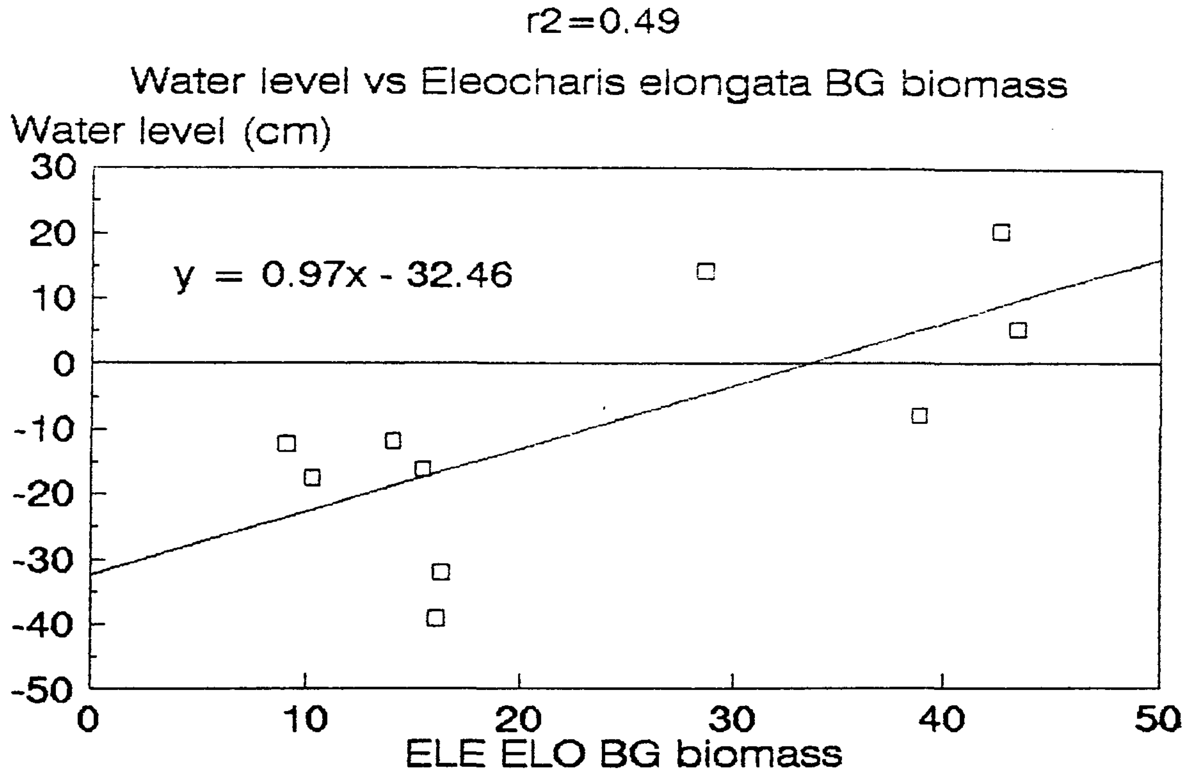
r2=0.32

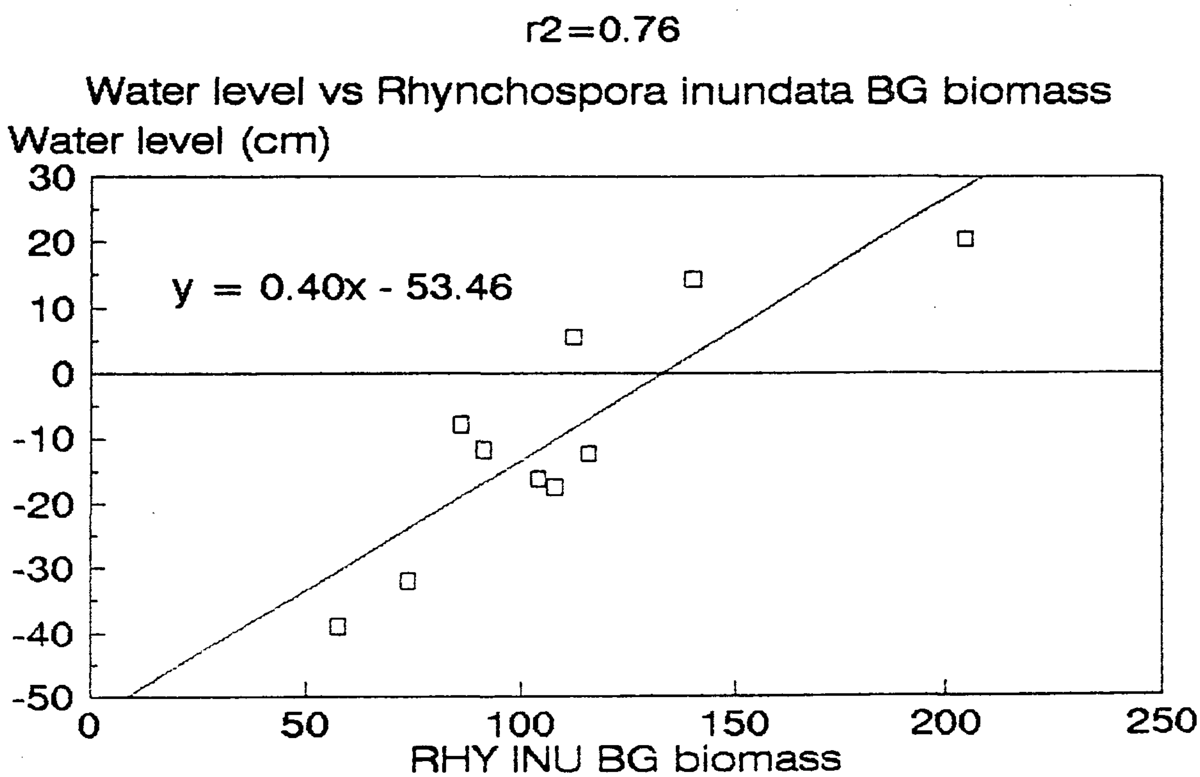


r2=0.31

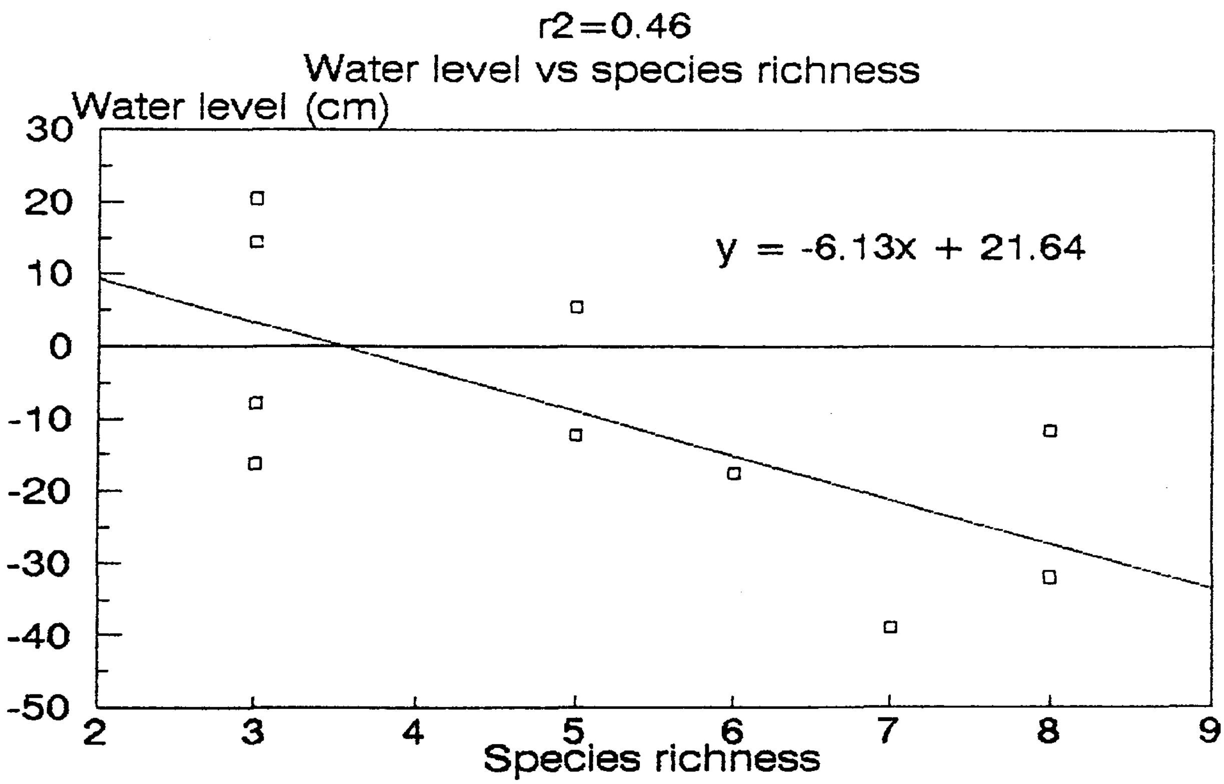


Appendix 4. continued





Appendix 4. continued



Appendix 4. continued

WATER LEVEL 1990 Monday, July [illegible]

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
MONTH	10	APR AUG DEC JUL JUN MAR MAY NOV OCT SEP

Number of observations in data set = 20

pendent Variable: SUBPLOT

urce	DF	Sum of Squares	Mean Square	F Value	Pr > F
del	9	6589.988000	732.220889	32.30	0.0001
ror	10	226.670000	22.667000		
rrected Total	19	6816.658000			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.966748	46.63063	4.760987	-10.210000

pendent Variable: SUBPLOT

urce	DF	Anova SS	Mean Square	F Value	Pr > F
NTH	9	6589.988000	732.220889	32.30	0.0001

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 10 MSE= 22.667

Number of Means	2	3	4	5	6
Critical Range	10.608124	13.05128	14.566295	15.669287	16.536237
Number of Means	7	8	9	10	
Critical Range	17.250273	17.856557	18.382797	18.847856	

Means with the same letter are not significantly different.

Analysis of Variance Procedure

SNK Grouping		Mean	N	MONTH
	A	19.750	2	MAR
	A			
	A	15.900	2	APR
	B	2.500	2	MAY
	B			
C	B	-7.000	2	JUL
C				
C		-11.500	2	JUN
C				
C		-12.500	2	OCT
C				
C		-17.500	2	SEP
C				
C		-18.500	2	AUG

Appendix 4. continued

SOIL MOISTURE (0-10cm) 1990 Monday, July 1, 1991

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
MONTH	8	AUG DEC JUL JUN MAY NOV OCT SEP

Number of observations in data set = 16

endent Variable: SUBPLOT

rce	DF	Sum of Squares	Mean Square	F Value	Pr > F
el	7	25.08010000	3.58287143	4.36	0.0278
or	8	6.57560000	0.82195000		
rected Total	15	31.65570000			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.792278	1.009228	0.906615	89.8325000

endent Variable: SUBPLOT

rce	DF	Anova SS	Mean Square	F Value	Pr > F
TH	7	25.08010000	3.58287143	4.36	0.0278

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 8 MSE= 0.82195

Number of Means	2	3	4	5
Critical Range	2.0906688	2.5905949	2.90346	3.132085
Number of Means	6	7	8	
Critical Range	3.3125086	3.4612272	3.5875587	

Means with the same letter are not significantly different.

SNK Grouping		Mean	N	MONTH
	A	92.395	2	MAY
	A			
B	A	90.790	2	JUL
B	A			
B	A	90.650	2	JUN
B				
B		89.465	2	AUG
B				
B		89.055	2	SEP
B				
B		89.050	2	OCT
B				
B		88.885	2	NOV
B				
B		88.370	2	DEC

Appendix 4. continued

AG [illegible] BIO-TOTAL [illegible] Monday, July [illegible]

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
MONTH	10	APR AUG DEC JUL JUN MAR MAY NOV OCT SEP

Number of observations in data set = 20

[De]pendent Variable: SUBPLOT

[So]urce	DF	Sum of Squares	Mean Square	F Value	Pr > F
[Mo]del	9	20089.26142	2232.14016	2.13	0.1268
[Er]ror	10	10463.26970	1046.32697		
[Cor]rected Total	19	30552.53112			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.657532	103.7693	32.34698	31.1720000

[De]pendent Variable: SUBPLOT

[So]urce	DF	Anova SS	Mean Square	F Value	Pr > F
[MO]NTH	9	20089.26142	2232.14016	2.13	0.1268

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 10 MSE= 1046.327

Number of Means	2	3	4	5	6
Critical Range	72.073443	88.672672	98.96595	106.45987	112.35008
Number of Means	7	8	9	10	
Critical Range	117.20137	121.32056	124.89593	128.05562	

Means with the same letter are not significantly different.

SNK Grouping	Mean	N	MONTH
A	112.28	2	NOV
A			
A	63.76	2	OCT
A			
A	40.35	2	MAY
A			
A	21.44	2	DEC
A			
A	18.30	2	APR
A			
A	15.15	2	JUN
A			
A	14.53	2	SEP
A			
A	9.76	2	MAR
A			
A	8.70	2	AUG
A			

Appendix 4. continued

30 SIC-TOTAL 1990 Monday, July 1, 1991

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
MONTH	10	APR AUG DEC JUL JUN MAR MAY NOV OCT SEP

Number of observations in data set = 20

pendent Variable: SUBPLOT

urce	DF	Sum of Squares	Mean Square	F Value	Pr > F
del	9	12771962.23	1419106.91	7.22	0.0024
ror	10	1965729.15	196572.91		
rrected Total	19	14737691.38			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.866619	52.96430	443.3654	837.102500

pendent Variable: SUBPLOT

urce	DF	Anova SS	Mean Square	F Value	Pr > F
NTH	9	12771962.23	1419106.91	7.22	0.0024

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 10 MSE= 196572.9

Number of Means	2	3	4	5	6
Critical Range	987.87819	1215.3963	1356.4817	1459.1974	1539.9319
Number of Means	7	8	9	10	
Critical Range	1606.4263	1662.8862	1711.8921	1755.2007	

Means with the same letter are not significantly different.

SNK Grouping	Mean	N	MONTH
A	3131.3	2	MAY
B	1144.6	2	JUN
B			
B	785.6	2	MAR
B			
B	668.6	2	APR
B			
B	568.5	2	SEP
B			
B	524.4	2	JUL
B			
B	495.6	2	NOV
B			
B	376.9	2	OCT
B			
B	343.9	2	AUG
B			
B	331.5	2	DEC

Appendix 4. continued

AO LIVE BIO-NYM ODO 1990 Monday, July 1, 1991
Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
MONTH	10	APR AUG DEC JUL JUN MAR MAY NOV OCT SEP

Number of observations in data set = 20

endent Variable: SUBPLOT

rce	DF	Sum of Squares	Mean Square	F Value	Pr > F
el	9	942.5530050	104.7281117	4.22	0.0173
or	10	247.9518500	24.7951850		
rected Total	19	1190.5048550			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.791725	131.9591	4.979476	3.77350000

endent Variable: SUBPLOT

rce	DF	Anova SS	Mean Square	F Value	Pr > F
TH	9	942.5530050	104.7281117	4.22	0.0173

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 10 MSE= 24.79518

Number of Means	2	3	4	5	6
Critical Range	11.094947	13.650223	15.234765	16.388375	17.295111
Number of Means	7	8	9	10	
Critical Range	18.041915	18.676022	19.226412	19.712814	

Means with the same letter are not significantly different.

Analysis of Variance Procedure

SNK Grouping	Mean	N	MONTH
A	22.185	2	MAY
B	8.320	2	JUN
B			
B	7.230	2	APR
B			
B	0.000	2	AUG
B			
B	0.000	2	JUL
B			
B	0.000	2	MAR
B			
B	0.000	2	DEC
B			
B	0.000	2	NOV
B			
B	0.000	2	OCT

Appendix 4. continued

BC BIO-NYM ODO 1992 Monday, Jul. 1, 199.

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
MONTH	10	APR AUG DEC JUL JUN MAR MAY NOV OCT SEP

Number of observations in data set = 20

endent Variable: SUBPLOT

rce	DF	Sum of Squares	Mean Square	F Value	Pr > F
el	9	9221274.159	1024586.018	4.23	0.0172
or	10	2421864.898	242186.490		
rected Total	19	11643139.057			

R-Square	C.V.	Root MSE	SUBPLOT Mean
0.791992	126.3255	492.1245	389.568500

endent Variable: SUBPLOT

rce	DF	Anova SS	Mean Square	F Value	Pr > F
TH	9	9221274.159	1024586.018	4.23	0.0172

Student-Newman-Keuls test for variable: SUBPLOT

NOTE: This test controls the type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha= 0.05 df= 10 MSE= 242186.5

Number of Means	2	3	4	5	6
Critical Range	1096.5199	1349.0593	1505.6605	1619.6724	1709.2856
Number of Means	7	8	9	10	
Critical Range	1783.0927	1845.7618	1900.1571	1948.2285	

Means with the same letter are not significantly different.

SNK Grouping	Mean	N	MONTH
A	2361.9	2	MAY
B	600.7	2	JUN
B			
B	272.6	2	SEP
B			
B	252.6	2	MAR
B			
B	175.2	2	APR
B			
B	117.6	2	JUL
B			
B	54.8	2	AUG
B			
B	54.4	2	DEC
B			
B	5.8	2	NOV
B			
B	0.0	2	OCT

Appendix 5. Percent of total aboveground (AG) live biomass by species at Hopkins Prairie, Ocala National Forest, Florida. March-December 1990.

Date	*Species code	% of total AG live biomass	Code	Species
14-Mar-90	NYM ODO	12.08	NYM ODO	Nymphaea odorata
14-Mar-90	ERI COM	57.81	ERI COM	Eriocaulon compressum
14-Mar-90	ELE ELO	30.11	ELE ELO	Eleocharis elongata
			RHY INU	Rhynchospora inundata
06-Apr-90	NYM ODO	28.33	AMP MUH	Amphicarpum muhlenbergianum
06-Apr-90	ERI COM	67.87	RHY TRA	Rhynchospora tracyi
06-Apr-90	ELE ELO	3.80	XYR SP	Xyris sp.
			LAC CAR	Lachnanthes caroliniana
10-May-90	NYM ODO	44.41	TRI VIR	Triadenum virginicum
10-May-90	ERI COM	27.32	EUP CAP	Eupatorium capillifolium
10-May-90	ELE ELO	18.99	MOSSES	
10-May-90	RHY INU	7.81		
10-May-90	AMP MUH	1.47		
06-Jun-90	NYM ODO	31.76		
06-Jun-90	ERI COM	2.05		
06-Jun-90	ELE ELO	3.33		
06-Jun-90	RHY INU	61.17		
06-Jun-90	AMP MUH	1.69		
04-Jul-90	ERI COM	10.70		
04-Jul-90	ELE ELO	29.16		
04-Jul-90	RHY INU	60.14		
03-Aug-90	ERI COM	57.66		
03-Aug-90	ELE ELO	5.55		
03-Aug-90	RHY INU	36.79		
12-Sep-90	NYM ODO	10.45		
12-Sep-90	ERI COM	39.62		
12-Sep-90	ELE ELO	2.90		
12-Sep-90	RHY INU	44.08		
12-Sep-90	RHY TRA	2.57		
12-Sep-90	XYR SP	0.38		
04-Nov-90	ERI COM	75.87		
04-Nov-90	ELE ELO	0.98		
04-Nov-90	RHY INU	7.51		
04-Nov-90	AMP MUH	13.68		
04-Nov-90	XYR SP	1.88		
04-Nov-90	LAC CAR	0.05		
04-Nov-90	TRI VIR	0.01		
04-Nov-90	EUP CAP	0.02		
09-Dec-90	ERI COM	64.33		
09-Dec-90	ELE ELO	2.41		
09-Dec-90	RHY INU	20.38		
09-Dec-90	AMP MUH	0.48		
09-Dec-90	XYR SP	4.37		
09-Dec-90	EUP CAP	1.95		
09-Dec-90	MOS SP	6.08		

Appendix 6. Net Above ground primary productivity (NAPP) at Hopkins Prairie, Ocala National Forest, Florida. March-December 1990.

			Standing crop DWT g/m2					NPP	
	Sample	#	AG-live		AG-dead			DWT g/m2*day	
Month	Date	Days	Mean	S.D.	Mean	S.D.	Total	Mean	S.D.
F	31-Jan-90								
M	14-Mar-90	42	8.61	6.33	8.21	6.79	16.82		
A	06-Apr-90	23	12.77	8.08	5.47	4.20	18.24	0.06	0.22
M	10-May-90	34	16.67	20.01	20.29	11.05	36.96	0.55	0.37
J	06-Jun-90	27	14.03	7.83	18.62	19.50	32.65	0.00	NA
J	04-Jul-90	28	10.29	2.63	14.67	3.99	24.96	0.00	NA
A	03-Aug-90	30	26.78	20.59	24.24	15.28	51.02	0.87	0.49
S	12-Sep-90	40	17.53	12.44	13.83	5.46	31.36	0.00	NA
O	12-Oct-90	30	37.64	45.25	21.54	14.41	59.18	0.93	0.81
N	04-Nov-90	23	58.45	52.94	24.92	16.66	83.37	1.05	1.24
D	09-Dec-90	35	22.81	18.05	30.57	17.43	53.38	0.00	NA

Appendix 7. Periphyton biomass at Hopkins Prairie, Ocala National Forest, Florida. June-December 1990.

Date	Site:	1	2	3	4	5	6	Mean	S.E.
		Periphyton biomass							
		g DWT/m2							
14-Mar-90	MAR								
06-Apr-90	APR	NO SAMPLES COLLECTED MAR-MAY							
10-May-90	MAY								
06-Jun-90	JUN		174.72		377.86			276.29	101.57
04-Jul-90	JUL	192.30	184.64	123.41	108.82	193.95	54.58	142.95	23.19
03-Aug-90	AUG	138.48	51.68	581.23	226.88	30.48	132.91	193.61	82.63
12-Sep-90	SEP	321.41	220.90	374.91	142.70	140.08	122.96	220.49	43.23
12-Oct-90	OCT	314.85	90.94	533.73	32.46	112.66	0.00	180.77	83.65
04-Nov-90	NOV	46.59	388.64	105.22	372.05	179.63	0.00	182.02	67.37
09-Dec-90	DEC	109.57	96.53	283.76	297.94	121.70	145.10	175.77	37.02

Appendix 8. Water extractable ammonium (NH4-N), nitrate (NO3-N) nitrogen and soluble reactive phosphorus (SRP) at Hopkins Prairie, Ocala National Forest, Florida.

		May			June		
		Water extractable N/P (mg/kg)					
Site	Depth (cm)	NH4	NO3	SRP	NH4	NO3	SRP
1	0-10	37.12	2.04	2.38	34.93	21.39	0.00
	10-20	39.79	1.84	1.95	29.08	27.89	0.00
	20-30	26.33	0.78	0.76	30.00	4.16	0.87
2	0-10	29.62	0.91	2.36	44.98	43.94	0.18
	10-20	29.65	0.81	1.12	41.84	2.85	0.83
	20-30	29.27	1.96	0.60	42.48	1.96	0.78
3	0-10	40.55	1.29	2.73	38.30	118.24	0.37
	10-20	44.76	0.83	1.59	43.25	10.27	0.64
	20-30	33.69	0.82	0.78	41.26	2.24	0.86
4	0-10	36.88	0.93	3.00	42.14	207.66	0.64
	10-20	41.93	1.04	2.00	41.61	4.00	0.34
	20-30	32.39	0.28	0.76	41.07	3.88	0.83
5	0-10	60.65	1.08	3.80	37.37	103.57	0.56
	10-20	47.09	0.77	1.20	45.09	6.31	0.43
	20-30	31.13	0.91	0.16	39.97	3.08	0.94
6	0-10	32.59	3.19	4.51	51.12	249.51	0.43
	10-20	41.17	1.11	3.21	42.82	5.18	0.63
	20-30	34.87	1.07	1.67	42.32	3.92	0.93

		July			August		
1	0-10	47.99	11.42	-0.01	44.98	0.00	0.00
	10-20	34.85	2.68	0.27	54.82	0.00	0.63
	20-30	30.72	2.04	0.28	49.95	0.00	0.38
2	0-10	39.84	59.57	0.00	18.19	0.00	0.00
	10-20	36.83	4.56	0.03	29.34	0.00	0.48
	20-30	35.64	3.65	0.32	30.16	0.00	0.20
3	0-10	29.88	124.42	0.00	30.27	0.00	0.01
	10-20	34.31	4.55	0.00	40.76	0.00	0.63
	20-30	34.14	4.39	0.38	44.40	0.00	0.49
4	0-10	60.23	6.20	0.00	32.23	0.00	-0.01
	10-20	42.66	4.84	0.24	44.34	0.00	0.83
	20-30	34.73	2.62	0.42	43.71	0.00	0.44
5	0-10	48.82	38.29	0.00	20.01	0.00	-0.03
	10-20	41.66	4.27	0.41	27.90	0.00	0.49
	20-30	36.47	5.30	0.42	37.47	0.00	0.61
6	0-10	45.94	214.24	-0.01	14.43	0.00	-0.00
	10-20	39.79	4.43	0.25	21.81	0.00	0.53
	20-30	41.44	53.52	0.39	23.07	0.00	0.28

Appendix 9. Plant tissue nitrogen (N) and phosphorus (P) content at Hopkins Prairie, Ocala National Forest, Florida. May-August 1990.

Date	Component		Subplot	N mg/kg	P mg/kg
10-May-90	AG	Live	1	15.81	0.56
10-May-90	AG	Live	2	18.91	0.75
10-May-90	AG	Live	3	16.33	0.49
10-May-90	AG	Live	4	13.33	0.16
10-May-90	AG	Live	5	19.20	0.53
10-May-90	AG	Live	6	17.66	0.41
10-May-90	AG	Live	Mean	16.87	0.48
10-May-90	AG	Dead	1	14.73	0.22
10-May-90	AG	Dead	2	17.00	0.22
10-May-90	AG	Dead	3	14.06	0.19
10-May-90	AG	Dead	4	16.02	0.20
10-May-90	AG	Dead	5	14.59	0.19
10-May-90	AG	Dead	6	15.98	0.23
10-May-90	AG	Dead	Mean	15.40	0.21
10-May-90	BG	0-10	1	9.73	0.09
10-May-90	BG	0-10	2	19.44	0.19
10-May-90	BG	0-10	3	13.40	0.13
10-May-90	BG	0-10	4	12.67	0.09
10-May-90	BG	0-10	5	16.96	0.17
10-May-90	BG	0-10	6	11.13	0.13
10-May-90	BG	0-10	Mean	13.89	0.13
10-May-90	BG	10-20	1		
10-May-90	BG	10-20	2		
10-May-90	BG	10-20	3	7.22	0.06
10-May-90	BG	10-20	4	7.15	0.08
10-May-90	BG	10-20	5	6.48	0.06
10-May-90	BG	10-20	6	9.66	0.09
10-May-90	BG	10-20	Mean	7.63	0.07
10-May-90	BG	20-30	1		
10-May-90	BG	20-30	2		
10-May-90	BG	20-30	3	8.34	0.09
10-May-90	BG	20-30	4	5.09	0.06
10-May-90	BG	20-30	5	5.79	0.08
10-May-90	BG	20-30	6	6.73	0.07
10-May-90	BG	20-30	Mean	6.48	0.08
06-Jun-90	AG	Live	1	17.28	0.57
06-Jun-90	AG	Live	2	20.35	0.49
06-Jun-90	AG	Live	3	16.86	0.45
06-Jun-90	AG	Live	4	22.48	0.54
06-Jun-90	AG	Live	5	20.59	0.46
06-Jun-90	AG	Live	6	20.07	0.37
06-Jun-90	AG	Live	Mean	19.60	0.48
06-Jun-90	AG	Dead	1	15.36	0.20
06-Jun-90	AG	Dead	2	17.35	0.22
06-Jun-90	AG	Dead	3	14.45	0.22
06-Jun-90	AG	Dead	4	14.17	0.18
06-Jun-90	AG	Dead	5	15.57	0.23
06-Jun-90	AG	Dead	6	16.26	0.19
06-Jun-90	AG	Dead	Mean	15.52	0.21

Appendix 9. continued.

06-Jun-90	BG	0-10	1	13.40	0.13
06-Jun-90	BG	0-10	2	15.91	0.14
06-Jun-90	BG	0-10	3	7.71	0.05
06-Jun-90	BG	0-10	4	17.56	0.15
06-Jun-90	BG	0-10	5	11.83	0.22
06-Jun-90	BG	0-10	6	19.76	0.20
06-Jun-90	BG	0-10	Mean	14.36	0.15
06-Jun-90	BG	10-20	1	12.14	0.12
06-Jun-90	BG	10-20	2	7.11	0.06
06-Jun-90	BG	10-20	3		
06-Jun-90	BG	10-20	4	7.81	0.06
06-Jun-90	BG	10-20	5	15.15	0.08
06-Jun-90	BG	10-20	6	9.59	0.07
06-Jun-90	BG	10-20	Mean	10.36	0.08
06-Jun-90	BG	20-30	1	9.03	0.10
06-Jun-90	BG	20-30	2	6.24	0.06
06-Jun-90	BG	20-30	3	0.00	0.00
06-Jun-90	BG	20-30	4	5.79	0.07
06-Jun-90	BG	20-30	5	6.83	0.05
06-Jun-90	BG	20-30	6	7.39	0.06
06-Jun-90	BG	20-30	Mean	7.06	0.07
04-Jul-90	AG	Live	1	17.80	0.36
04-Jul-90	AG	Live	2	20.84	0.46
04-Jul-90	AG	Live	3	19.69	0.41
04-Jul-90	AG	Live	4	25.03	0.45
04-Jul-90	AG	Live	5	17.59	0.39
04-Jul-90	AG	Live	6	21.08	0.42
04-Jul-90	AG	Live	Mean	20.34	0.41
04-Jul-90	AG	Dead	1	12.32	0.18
04-Jul-90	AG	Dead	2	16.26	0.20
04-Jul-90	AG	Dead	3	13.61	0.19
04-Jul-90	AG	Dead	4	15.46	0.17
04-Jul-90	AG	Dead	5	13.85	0.21
04-Jul-90	AG	Dead	6	13.54	0.15
04-Jul-90	AG	Dead	Mean	14.17	0.18
04-Jul-90	BG	0-10	1	12.88	0.13
04-Jul-90	BG	0-10	2	16.68	0.16
04-Jul-90	BG	0-10	3	14.24	0.12
04-Jul-90	BG	0-10	4	14.94	0.14
04-Jul-90	BG	0-10	5	17.56	0.13
04-Jul-90	BG	0-10	6	14.13	0.10
04-Jul-90	BG	0-10	Mean	15.07	0.13
04-Jul-90	BG	10-20	1	8.93	0.07
04-Jul-90	BG	10-20	2	7.50	0.06
04-Jul-90	BG	10-20	3	7.15	0.07
04-Jul-90	BG	10-20	4	5.79	0.05
04-Jul-90	BG	10-20	5	7.08	0.06
04-Jul-90	BG	10-20	6	5.93	0.03
04-Jul-90	BG	10-20	Mean	7.06	0.05
04-Jul-90	BG	20-30	1	7.50	0.06
04-Jul-90	BG	20-30	2	6.55	0.07
04-Jul-90	BG	20-30	3	6.66	0.04
04-Jul-90	BG	20-30	4	8.93	0.11

Appendix 9. continued.

04-Jul-90	BG	20-30	5	7.01	0.12
04-Jul-90	BG	20-30	6	6.07	0.04
04-Jul-90	BG	20-30	Mean	7.12	0.07
03-Aug-90	AG	Live	1	17.31	0.27
03-Aug-90	AG	Live	2	18.53	0.35
03-Aug-90	AG	Live	3	27.13	0.39
03-Aug-90	AG	Live	4	23.35	0.42
03-Aug-90	AG	Live	5	21.01	0.33
03-Aug-90	AG	Live	6	20.80	0.46
03-Aug-90	AG	Live	Mean	21.36	0.37
03-Aug-90	AG	Dead	1	17.21	0.24
03-Aug-90	AG	Dead	2	13.36	0.11
03-Aug-90	AG	Dead	3	20.84	0.28
03-Aug-90	AG	Dead	4	17.31	0.21
03-Aug-90	AG	Dead	5	14.66	0.14
03-Aug-90	AG	Dead	6	18.71	0.24
03-Aug-90	AG	Dead	Mean	17.01	0.20
03-Aug-90	BG	0-10	1	12.49	0.11
03-Aug-90	BG	0-10	2	16.33	0.15
03-Aug-90	BG	0-10	3	15.57	0.00
03-Aug-90	BG	0-10	4	14.38	0.13
03-Aug-90	BG	0-10	5	12.98	0.08
03-Aug-90	BG	0-10	6	12.77	0.09
03-Aug-90	BG	0-10	Mean	14.09	0.11
03-Aug-90	BG	10-20	1	9.49	0.06
03-Aug-90	BG	10-20	2	7.95	0.13
03-Aug-90	BG	10-20	3	7.04	0.05
03-Aug-90	BG	10-20	4	8.58	0.13
03-Aug-90	BG	10-20	5	10.19	0.09
03-Aug-90	BG	10-20	6	6.34	0.03
03-Aug-90	BG	10-20	Mean	8.27	0.08
03-Aug-90	BG	20-30	1	10.26	0.12
03-Aug-90	BG	20-30	2	7.18	0.07
03-Aug-90	BG	20-30	3	8.79	0.14
03-Aug-90	BG	20-30	4	8.06	0.12
03-Aug-90	BG	20-30	5	6.48	0.03
03-Aug-90	BG	20-30	6	7.67	0.09
03-Aug-90	BG	20-30	Mean	8.07	0.09