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# STUDIES OF FLOODPLAIN VEGETATION AND WATER LEVEL FLUCTUATION IN THE KISSIMMEE RIVER VALLEY

CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT

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# Studies of Floodplain Vegetation and Water Level Fluctuation in the Kissimmee River Valley

by

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## INTRODUCTION

The Central and Southern Florida Flood Control Project in the Kissimmee River Basin consisted of enlarging existing canals connecting the upper chain of lakes, installing water control structures in several of these canals, and channelizing and providing control structures in the River proper which extends from Lake Kissimmee to Lake Okeechobee.

Prior to the project, the Kissimmee River meandered through a mile wide floodplain, dominated by buttonbush swamp, wet prairie, and bordered by pine flatlands and turkey oak. The original river channel measured 90 miles in length, over which distance the elevation decreased from 52 feet m.s.l. at Lake Kissimmee to about 14 feet m.s.l. at Lake Okeechobee.

One major canal, designated C-38, was constructed within the Kissimmee River floodplain, and reduced the linear distance to about 51 miles (Plate 1). Six regulatory structures (S-65 series) were situated along the canal to control the drop in elevation (Figure 1). Construction of this project resulted in the formation of five separate impounded pools along the length of the canal. Since the project specifically called for water elevations to be stabilized in each pool, all fluctuation of the water in the surrounding marshlands was eliminated.

The resulting stabilized water levels have had a pronounced influence on the vegetational composition of these pools. The diversity of aquatic and wetland plants which was evident in the marshes and on the floodplain of the Kissimmee River prior to the project has declined. The permanently

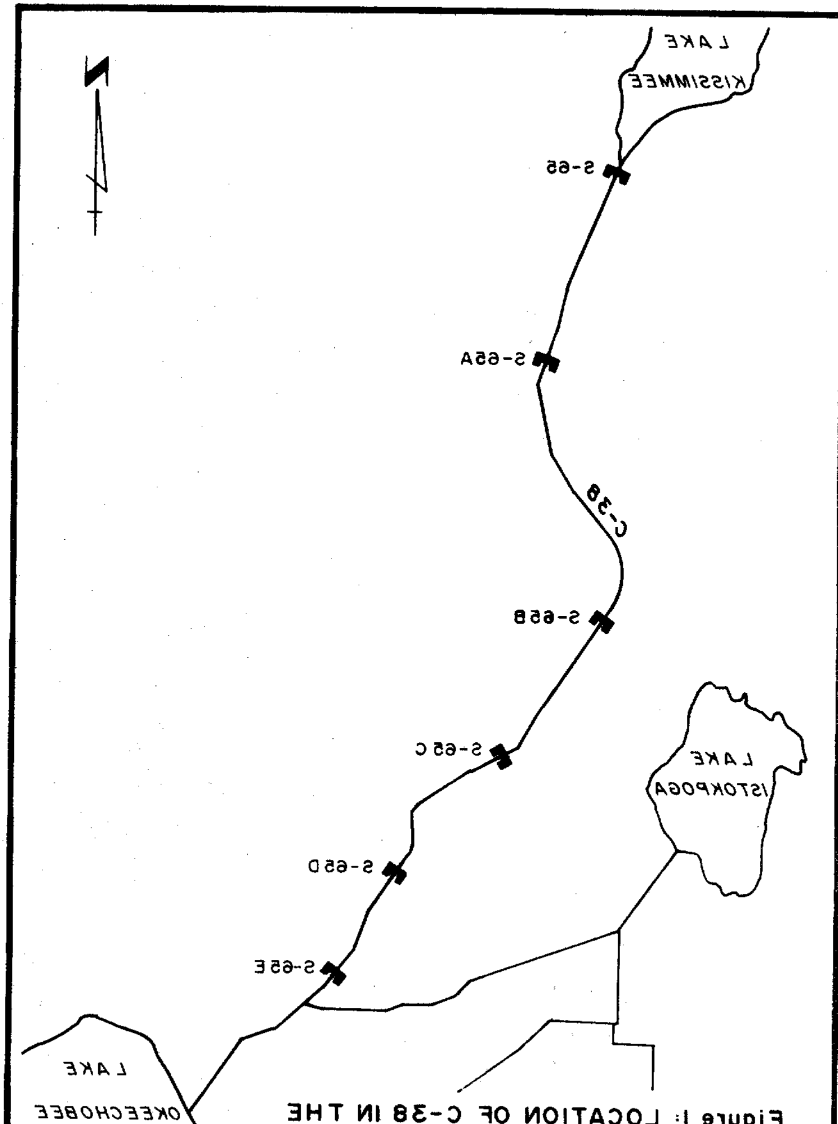


Figure 1: LOCATION OF C-38 IN THE KISSIMMEE RIVER BASIN

flooded lower portions of each pool became dominated by a few species of plants, such as water hyacinth or pickerelweed, which are well adapted to the high water. In the dry, northern sections of the pools, dry prairie species became dominant. As the stabilized conditions persisted, those few selected species of plants thrived.

As vegetational changes in the Kissimmee marshes were noted, it became apparent that more detailed studies were necessary. Therefore, investigations were initiated to gain a better understanding of the effects of water stabilization and form the base for subsequent corrective measures.

The most obvious influence was believed to be related to the lack of natural fluctuation. On this basis, an experimental drawdown was initiated in one of the impoundments, Pool B. In addition, prior observations suggested that competition from existing vegetation could negate the beneficial effects of the drawdown. Therefore, experimental treatments were designed to evaluate the importance of competition from existing vegetation.

The timing of water fluctuation was also considered to be a potentially important factor in producing changes in vegetative composition. To test the effects of this variable, seed germination studies were conducted in connection with the field experiments.

This report on vegetational studies in Pool B is part of the continuing investigations of the ecology of the Kissimmee River Valley.

## LOCATION AND DESCRIPTION OF AREA

Pool B is that portion of the Kissimmee River, C-38 and the surrounding impounded marshland which lies north of water control strucutre S-65B and its tieback levees, and south of water control structure S-65A and associated levees. Biological investigations were concentrated in the southern portion of the pool where four study areas were selected (Figure 2). These study areas lie entirely within Township 34S and Range 31E. The river channel, which forms the boundary between Highlands and Okeechobee counties, lies to the west of C-38 in this section of the pool. The surrounding marshland to the west of the river channel is limited in its expanse by the western dike of the Boney Area. To the east the marsh is bordered by C-38.

The old channels of the river are bordered in many areas by elevated ridges. These ridges are covered with stands of oak which are sometimes used for camping. Sportsmen often catch Largemouth Bass, assorted brim and several species of catfish. Local cattlemen graze their range herds throughout the valley in moderate numbers.

Four distinct areas in different vegetation type zones were selected for use in studies designed to measure the effects of water fluctuation, herbicides, fires and combinations of these on the marshland vegetation (Plate 2).

The first of these, Study Area I, was located about 10,000 feet north of S-65B, just south of a dead end slough which ran west from the river channel. The area was a small, flat plain with elevation of about 39.5

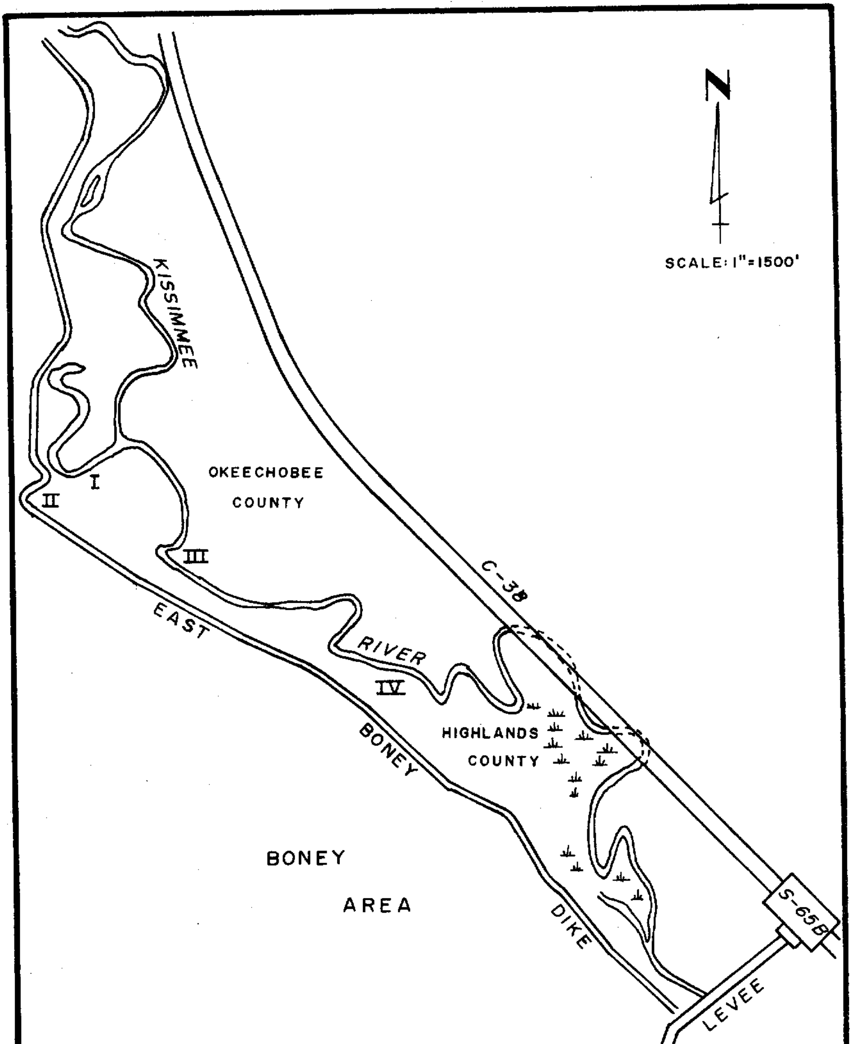


Figure 2: LOCATION OF STUDY AREAS
POOL B, C-38

feet m.s.l. Eichhornia crassipes, water hyacinth, was spread uniformly over the area and was the most dominant species of vegetation. Scirpus cubensis, Hydrocotlye umbellata, Polygonum sp., Alternanthera philoxeroides, Panicum paludivagum, Panicum repens, Paspalum distichum and Leersia hexandra were also present among the hyacinth. A few hundred feet to the south and the east ground elevations rose above 40.0 feet m.s.l. and Juncus effusus became the dominant vegetation. To the west a path utilized by cattle marks a division between the hyacinth plain of Study Area I and a stand of Pontederia lanceolata, pickerelweed.

This stand of pickerelweed just mentioned was selected as Study Area II. It was bordered to the north and the west by the east dike of the Boney Area. The average ground elevation was slightly above 39 feet m.s.l. Other species among the pickerelweed were small amounts of Sagittaria lancifolia, A. philoxeroides, Polygonum sp. and L. hexandra and floating on the water was Salvinia rotundifolia.

About 1500 feet to the south of the first two study areas, and to the east of the river was Study Area III. This location was once part of the river's channel, but has since filled with sediment and vegetation. Ground elevations in excess of 40 feet m.s.l. with hardwood trees border both the east and west sides of this 100 foot wide strip. Bottom elevations within the old channel vary from about 39.5 feet m.s.l. to less than 38 feet m.s.l. Hyacinth and S. cubensis were the most dominant vegetation types, forming a thick, floating mat over most of the area (Plate 5). In addition, A. philoxeroides, Hydrocotyle umbellata, Polygonum sp., Jussiaea leptocarpa, Jussiaea peruviana, Mikania scandens, and L. hexandra were present in the designated area. Further to the south P. lanceolata growth was common.

Finally, the fourth study area was situated just to the west side of the river, approximately 3000 feet south of Study Area III. This area was an old river run which was left as an oxbow when the river changed its course. Basically, the area was covered with a floating mat of S. cubensis, but some hyacinth, floating orchid, S. rotundifolia, A. philoxeroides and J. leptocarpa were also present. The ground elevation in this area was bordered by the eastern dike of the Boney Area. A slight naturally occurring levee along the river channel was present to the east.

## WATER CONTROL HISTORY

After the completion of the water control structure S-65B and the accompanying tieback levees, and extension of canal C-38 north of the structure, operations were initiated to maintain stabilized water levels in the impoundment area. From January 11, 1969 until March 15, 1972, the water stage was maintained at 40.0 feet m.s.l., except for a brief period in December 1970 and January 1971 when the stage was raised to 41 feet m.s.l. The result of this action was not only that water in the Kissimmee River channel and C-38 was maintained at 40.0 feet m.s.l. but that all land north of the structure with elevation less than 40 feet m.s.l. would remain submerged.

The water drawdown from 40 to 39 feet m.s.l. began on March 15, 1972 and by March 21 the one foot reduction in stage was complete. Subject only to very minor fluctuations, the stage at S-65B remained at 39 feet m.s.l. until May 16, 1972. On this date operations were initiated to reflood the pool to 40.0 feet m.s.l. A stage of 39.95 feet m.s.l. was first obtained on June 9, 1972, at which time reflooding was considered complete.

Water levels were again maintained at 40 feet until March 26, 1973, when a second drawdown was initiated. A stage level of 39.0 feet was obtained on April 3, 1973, and maintained at this level until May 30, 1973. Then the stage was again returned to 40.0 feet.

Thus, pool B of the Kissimmee River has been subjected to two drawdowns of one foot each in magnitude and duration of approximately 60 days.

## MATERIALS AND METHODS

Prior to the initial drawdown, stakes were placed along the 40 foot contour line at the edge of the river channel in the southern three mile portion of the pool. Elevations in the study areas were estimated by relating water depth to pool elevation. Several days after the drawdown was completed, stakes were again placed at corresponding locations in the river to mark the 39 foot contour. Any changes occurring between these contour lines due to the drawdown could be easily noted.

Field work was conducted to prepare the study areas for the tests to be performed. In each area, three $10m^2$ areas were selected so that tests could be conducted independent of other variables. Ample space was provided between plots to negate the influence of other tests. Wooden posts, four inches in diameter and six feet in length, were driven about 18 inches into the substrate to mark the four corners of the plots. Additional post and wire supports were added where necessary due to the loose substrate. In those areas where water hyacinth or other floating vegetation was present, the plots were fenced with one inch mesh chicken wire, measuring four feet in height. This was to prevent the vegetation from floating back into the plot with the return of higher water. In addition, where cattle were observed nearby in the marsh, several strands of barbed wire were added to eliminate any possible influence from grazing.

In Study Area I, the three plots were oriented generally along an east-west line. The corner posts of each plot were color coded with spray paint to indicate the treatment which they were to receive. The color orange signified that the vegetation within the plot was to be treated with the herbicide Silvex. Black indicated that the vegetation was to be burned. Silver indicated that all vegetation was to be mechanically removed with rakes and white was the control plot.

The easternmost plot in the first study area was coded orange and black. On April 6, 1972, vegetation within this area was treated with the herbicide Weedone (2,4,5 TP) which was comprised of 58.9% Silvex and 41.1% inert ingredients. The herbicide was added to river water in concentration of one part to forty, and then sprayed in a fine mist over the plot with a pressure sprayer. The first burning of the plot on May 12, 1972 was unsuccessful due to saturation of the plant detritus with recent rainfall.

Re-burning occurred on May 26, 1972 and was considered more successful in consumption of the available fuel. In both instances, diesel fuel was lightly sprayed over the plot before being ignited.

The middle plot, color coded silver, was cleared of all vegetation using rakes and pitchforks on April 4, 1972. Any small broken pieces of plant matter were removed so that this area was completely void of vegetation and rich, black soil was exposed. On July 12, 1972 after reflooding had occurred four ¼$m^2$ biomass samples were taken of the plants growing in the plot. All vegetation was sorted by species, stems counted, and then weighed to the nearest 0.1 g on an OHAUS triple beam balance. The third plot was color coded white and served as a control. Since cattle grazing was eliminated from the previous two plots in Study Area I, it was necessary to eliminate that variable from the control also.

Study Area II also consisted of the three plots lying along an east to west line. The eastern plot was coded orange and black and was treated in a matter identical to that in Study Area I. However, the middle plot was coded only black. Vegetation which had not been treated with a herbicide was burned using diesel fuel for ignition. Because of heavy local rainfall, the May 12 burn was cancelled, but burning on May 26 was considered adequate. The control plot, coded white, was located 40 feet to the west of the burned plot. Cattle were never seen grazing in this dense stand of pickerelweed so no barbed wire was required.

Study plots which were located in Study Area III were situated north to south, with the northernmost plot subjected to treatment with the herbicide and burned on the same schedule as previously stated. The middle plot, coded silver, was cleared of vegetation with rakes and pitchforks on April 5, 1972. Because floating vegetation like hyacinth and S. cubensis were the dominant plants, very little plant matter remained in the soil after clearing. On July 12, 1972 four $\frac{1}{4}m^2$ biomass samples were secured from this plot and treated in the same manner as Study Area I. The control was situated about 10 feet south of the silver plot. Since cattle had been noticed in the surrounding area, barbed wire was employed on all three plots.

In Study Area IV the three plots were situated along a north-south line about 80 feet west of the river. The southernmost plot was treated with herbicide and fire, while in the center plot all S. cubensis was removed. The control plot was situated to the north. The cleared plot was not sampled on July 12 because there was no vegetation present. Cattle were not a factor here so barbed wire was not necessary.

Operations were initiated at water control structure S-65B on May 13, 1972 to return the level to 40 feet m.s.l. in the pool. This process was dependent on rainfall and consequent drainage and by May 26, 1972 water levels were up to only 39.6 feet m.s.l. However, by the next examination of the area on June 7, 1972 water had returned to 40.0 feet m.s.l.

Beginning on July 12, 1972 and monthly thereafter, qualitative data were recorded on the progress and changes occurring in each study plot. In addition, a photographic record was kept to illustrate these changes and supplement observations with a permanent pictorial record.

A concurrent study was initiated in July 1972 to document the ability of seeds to germinate at different times of the year when subjected to exposure. Results of this study are important in determining the proper time to employ drawdown procedures. Appendix II presents this study (Plate 8).

A second sixty day, one foot drawdown was initiated on March 26, 1973 and extended through May 30. Monthly examinations of each study area continued during this period and were finally terminated on June 6, 1973.

Biological investigations were conducted on other portions of the pool as well as the four study areas. On July 11, 1972 the entire pool, including the canal, adjacent fish breeding canals, oxbows and river were examined for evidence of any changes in the natural vegetation resulting from the drawdown. As a control, pool A which remained stabilized, was examined in the same way, and observations compared.

## RESULTS

The first actual documented results of the effects of the drawdown on the marsh vegetation were observations made in late June and early July, 1972. The most obvious change in vegetation occurred in the land between elevation 39 and 40 feet m.s.l. This area which had previously been inundated, but was exposed during the drawdown, produced growth of several types of annual plants. The most noticeable of these plants was wild millet, Echinochloa walteri. Wild millet is a very coarse, annual Poaceous plant considered by wildlife experts to be prime feed for waterfowl. It grows, in only a few months time, to a height of over six feet with large distinct seed heads. This plant, due to the large amounts of it growing in pool B after the drawdown, and its recognizability, served well as an indicator of effective water drawdown (Plate 7).

Wild millet was in fact observed throughout the pool between 39 and 40 foot contours except where one or more of three different conditions prevailed. (1) The 39 and 40 foot contours were so close together that suitable soil was not exposed. (2) The site was already occupied by a competitor such as Panicum repens or hyacinth. (3) Seeds were not present due to local flow patterns. By late summer, however, wild millet which completes its life cycle in a few months, was absent from pool B.

Observations made at the same time in pool A, the area north of S-65A, which was not subjected to a drawdown, produced the expected results. E. walteri was virtually absent from the flora in this portion of the river. However, soil samples from under 8 to 18 inches of water which were returned to a screen enclosed structure at the Flood Control District Field Station in West Palm Beach and exposed did in fact produce growths of wild millet.

The remainder of this section presents the results of the various tests conducted on each plot during the study period. For clarity, the observations for each plot are presented in their entirety, followed by the discussion and comparison between plots.

I. STUDY AREA I

Plot A

One month after treatment with Silvex, observations of the orange and black coded study plot indicated that all of the vegetation had apparently been killed except for P. paludivagum and L. hexandra. These two grasses remained green while all the other vegetation was brown and brittle.

The fire ignited with diesel fuel on May 12, 1972, succeeded in destroying at least the aerial portions of these two grasses and most of the available fuel. At this time however, it was felt that a thorough burn had not been achieved because of recent rains. In order to assure ourselves of a thorough burn, we again set fire to the area on May 26. Although the water level had risen to 39.57 feet m.s.l. by this date, a thorough burn was achieved.

By July 12, vegetation within this plot consisted of one millet plant and 5 P. paludivagum stems. In contrast, just to the outside of the fence surrounding this plot wild millet was growing profusely. The millet seeds in the soil were disturbed and exposed when the fence around the plot was installed. By the middle of August, the amount of millet had increased to 4 plants consisting of 36 stems and reaching a height of 4½ feet. Wild millet, an annual plant, was completely absent from the plot by October.

Panicum paludivagum continued to spread through the plot, and became more dense, until by March 14, 1973, one uniform stand of the grass covered approximately 65% of the surface area.

Water hyacinth seedlings were first noted in August 1972 and these increased to about 20% coverage by March 1973. Cabomba caroliniana, a true submergent, flourished in the open water of this plot from November 1972 until the drawdown in March 1973 at which time it disappeared.

When the second year drawdown was begun, approximately 30% of the plot, or $3m^2$ of bare soil was exposed. An annual plant species rapidly claimed this area. The majority of these plants were *E. walteri*, probably germinating from seeds deposited in the area from the previous year's growth.

In effect, the particular treatment of this area with Silvex and fire, accompanied by two drawdowns, one year apart, had eliminated all of the original vegetation except for the grass, *P. paludivagum*. Hyacinth and *C. caroliniana* were re-introduced into the area by the growth from seed. With other plant competition eliminated, the second year drawdown exposed viable seeds and induced the growth of wild millet.

Plot B

When all of the vegetation in the middle plot of Study Area I was removed on April 6, 1972, the soil underneath was exposed to the air for the first time since at least January 1969. Although every effort was made to completely clear all vegetative pieces of plant, some undoubtedly did remain. Of those species of plants which were identifiable in the lush, green growth on May 12, 1972, we suspected that *A. philoxeroides* and *H. umbellata* probably did not grow from seed, but propagated vegetatively. The growth of new species of plants within this plot was observed carefully through the remainder of May and June.

By the beginning of July, wild millet had reached a height of over six feet and bore mature seed heads (Plate 3). The results of the four $\frac{1}{4}m^2$ biomass samples obtained on July 12, 1972 are presented in Table 1. Of the nine plant species earlier listed as comprising the vegetation of Study Area I, all but two, S. cubensis and P. paludivagum were also present in the samples. However, twelve entirely new species of plants were also growing within the cleared plot. Seeds of these twelve plant species were most likely present in the soil underlying the hyacinth mat. Removal of the hyacinth competition and exposure of the soil by the drawdown apparently induced germination of the seeds and subsequent plant growth.

By far the most opportunistic of the plant species were two of the annuals, wild millet and Eclipta alba. Together, these two species comprised over 78% of the sample by weight, and millet alone comprised 62% of the sample by weight.

The phenomenal growth of E. walteri becomes apparent when the values obtained from the sampling are expanded to more easily visualized proportions (Table 2). The total wet weights of wild millet within the $10m^2$ enclosure was 41.3 pounds. If an acre in area had been cleared of vegetation in the same manner, the total wet weight of millet would be in excess of 16,700 pounds. In fact, that same acre would have produced 686 pounds of seeds alone.

By August 11, nearly all of the millet and E. alba had died, only to allow one other annual plant, Sesbania exaltata, to develop.

TABLE 1. Results of 4 ¼$m^2$ biomass samples from cleared plot of Study Area I, July 12, 1972

| SPECIES | # (Stems) | Wet Weight in grams | % Number | % Weight |
|---|---|---|---|---|
| Echinochola walteri | 166 | 1874 | 51.9 | 62.3 |
| Eclipta alba | 66 | 492 | 20.6 | 16.4 |
| Sesbania exaltata | 7 | 151 | 2.2 | 5.0 |
| Alternanthera philoxeroides | 40 | 143 | 12.5 | 4.8 |
| Eichhornia crassipes | 6* | 68 | 1.9 | 2.3 |
| Cyperus odoratus | 10 | 67 | 3.1 | 2.2 |
| Eleocharis sp. (acicularis) | - | 50 | - | 1.7 |
| Leersia hexandra | - | 47 | - | 1.6 |
| Panicum repens | - | 37 | - | 1.2 |
| Unknown sedge | 2 | 17 | 0.6 | 0.6 |
| Polygonum sp. | 5 | 15 | 1.6 | 0.5 |
| Hydrocotyle umbellata | 4 | 14 | 1.3 | 0.5 |
| Psilocarya nitens | 1 | 11 | 0.3 | 0.4 |
| Pluchea purpurescens | 1 | 8 | 0.3 | 0.3 |
| Ludwigia repens | 7 | 7 | 2.2 | 0.2 |
| Pontederia lanceolata | 4 | 6 | 1.3 | 0.2 |
| Paspalum dissectum | 1 | 1 | 0.3 | TR |
| Total | 320 | 3008 | 100.1 | 100.2 |

* plants

TABLE 2. Expanded Values from Vegetation Samples in Study Area I and III, July 12, 1972

| | STUDY AREA | SAMPLE UNIT NUMBER (wet weight in grams) 1 | 2 | 3 | 4 | GRAMS/ METER2 | kg/ HECTARE |
|---|---|---|---|---|---|---|---|
| <u>Echinochloa</u> <u>walteri</u> seed head weight | I | 9.4 | 16.2 | 34.6 | 16.7 | 76.9 | 769.0 (689)* |
| | III | 61.0 | 23.6 | 26.4 | 26.3 | 137.3 | 1,373.0 (1,225)* |
| Total biomass of <u>Echinochloa</u> <u>walteri</u> | I | 266.0 | 676.0 | 603.0 | 329.0 | 1874.0 | 18,740.0 (16,719)* |
| | III | 2245.0 | 1205.0 | 1731.0 | 1045.0 | 6226.0 | 62,260.0 (55,584)* |
| Total biomass of Study Plots | I | 581.0 | 886.0 | 757.0 | 784.0 | 3008.0 | 30,080.0 (26,837)* |
| | III | 2543.0 | 1495.0 | 1902.0 | 1470.0 | 7410.0 | 74,100.0 (66,112)* |

*pounds per acre

About 40 to 50 individual Sesbania exltata were counted in August, before they finally died by September. Pickerelweed, a perennial plant, was then faced with little competition from the fast growing annuals, and began to flourish.

P. lanceolata was first noted to have produced flowers on September 14. Those particular plants had grown from seed to mature plants in about 5 months time. Pickerelweed quickly became the dominant emergent aquatic plant and remained so for the duration of the study, comprising about 50% of the emergent vegetation.

Cyperus haspan and Rhynchospora innundata, two perennial sedges and S. lancifolia, an emergent aquatic, were also successful in becoming established in the once cleared plot (Plate 4).

Remnants of the original plant community however, did still persist. Hyacinth, growing from seed, was present in small quantities in the July 1972 sample. From then until just before the second drawdown, E. crassipes flourished and grew into a well-developed mat. S. cubensis, which is often found growing among water hyacinth, was first noted in the plot in November 1972. Other plants which remained as part of the ground cover associated with the hyacinth and S. cubensis mat were L. hexandra, Ludwigia repens, A. philoxeroides and smartweed.

When the second drawdown was initiated in late March 1973, virtually no bare soil was exposed due to the very dense covering of vegetation which had been produced over the past year. Despite the tremendous amount of E. walteri seed which must be present, no wild millet germinated during the drawdown.

By removing all of the competition due to vegetation, this plot in Study Area I progressed from a hyacinth and S. cubensis covered plain, to an area dominated by annual plant growth, and finally to a situation where emergent perennial plants like pickerelweed, S. lancifolia, R. innundata, and C. haspan can exist in a community with the hyacinth and S. cubensis.

Plot C

Since both of the treated plots in Study Area I had been fenced, the control plot was also fenced in with barbed wire. The major function of this fencing was to eliminate the grazing pressure on the vegetation by range cattle. It was originally noted that the young green shoots of Scirpus cubensis were prime cattle feed, and often seen cropped at the water level.

Within one month of the selection and fencing of this control, changes were evident which illustrated the influence of cattle on the vegetation. There were substantially more and larger S. cubensis plants growing within the fenced area than in the surrounding area.

By July 12, 1972, E. walteri was noted in some abundance around each of the fence posts where the soil had been previously disturbed. Within the confines of the plot, two plants of wild millet, totaling five stems, were recorded as present.

Throughout the remainder of the year, the species present remained relatively constant. Of the nine original species recorded for Study Area I only two, P. paludivagum and P. distichum, were not found in the control plot. Jussiaea leptocarpa is the only new species of plant to grow within the plot.

Considering the relative abundance of plant species, S. cubensis showed the most drastic change, as it grew far more dense when unaffected by cattle grazing.

II. STUDY AREA II

Plot A

On May 4, 1972 the first plot in this study was observed to have had no vegetation survive the treatment with Silvex, and the burnings on May 12 and May 26 effectively consumed all available fuel. However, since reflooding of the marshes began on May 15, the soil was actually exposed for a very short time, and no growth of annual plants occurred.

Pickerelweed seedlings were noted in July, and by September several plants had attained heights of 24 inches. Except for S. rotundifolia and creeping invaders of cut grass and alligator weed, no other plants occupied this area until January 1973. At this time, the first of two Sagittaria lancifolia plants were observed.

Density remained low and by the second drawdown, an estimated 70% of the plot was void of vegetation and bare soil exposed. Hundreds of seedlings were noticed in May 1973, and when these were later identifiable, the three most common, in order of abundance, were Polygonum sp., P. lanceolata, and E. walteri.

Due to the surrounding high density of pickerelweed, seeds were no doubt introduced almost continuously into the plot. In time, after the millet dies, pickerelweed will probably reclaim this portion of the marsh.

In summary, while treatment with Silvex and fire eliminated all living plant material and detritus, vegetation of the same type as before treatment reclaimed the area. After treatment the plant density was lowered, but the occurrence of favorable conditions for seed germination induced growth of many more perennial pickerelweed plants.

Plot B

Conditions were not favorable for the burning of the second plot until May 26, 1972. At this time, fire consumed all of the built up detritus and killed the aerial portions of *P. lanceolata* and *S. lancifolia*, but did not destroy underground portions, which rapidly produced new shoots. By November, only 6 months later, the vegetation in this plot was indistinguishable in height and density from the surrounding marsh. The only indication that any treatment had occurred was the presence of less plant detritus covering the ground than in the rest of the area.

No noticeable changes resulted from the 1973 spring drawdown.

Plot C

The control plot served only as a means for comparison of species composition changes in the other two plots, which were subject to external artificially created stimulii.

No cattle were at any time observed in the pickerelweed area, so these plots were not fenced, and this variable was not a factor.

III. STUDY AREA III

Plot A

Treatment with Silvex appeared to have killed all of the vegetation within the first $10m^2$ plot of Study Area III. The two successive fires in May 1972 consumed the available fuel, but a floating mat of ash, burned hyacinth, and S. cubensis roots still remained. On August 11, the first evidence of plant growth was noted, as about 30% of the mat was covered with a dense growth of small, sedge-like plants. A few other broadleaf seedlings were also noticeable at this time.

By October, these sedge-like plants were positively identified as Scirpus cubensis. The manner in which these plants appeared in such high density lead us to believe that Silvex and fire did not kill the underlying, vegetative portions of the plant, and that this growth was not from seed.

Jussiaea leptocarpa, M. scadens, S. lancifolia and Pluchea purpurpescens were also growing in the plot by December 1972. By the spring of 1973, Typha sp. and Polygonum sp. were also observed.

The 1973 drawdown had no effect on the vegetation inside of this plot because no ground was exposed.

While treatment with Silvex and fire was unable to destroy Scirpus cubensis, competition of this dominant sedge was reduced for a period of time sufficient to allow germination and growth of other perennial plants, and produce a more diverse marsh plant community (Plate 6).

Plot B

Although the second plot in this area was cleared and subjected to the same drawdown procedures as those in Study Area I, more and larger plants resulted from the soil exposure. This trend was noted as early as May 12, and well documented by the quantitative sample of July 12 (Table 3).

It should first be noted that three Thalia geniculata plants, to five feet tall were present in the plot, but deliberately excluded from the quantitative sample. Exclusive of this T. geniculata, wild millet, to eight feet in height, which was harvested from the plot, comprised 84% of the vegetation by wet weight. The total biomass from this area contained in one square meter was approximately 16.3 pounds, as compared to only 6.6 pounds in Study Area I (Table 2).

Thirteen species of plants were recorded from the sampling, of which seven were entirely new species to the area. Four of these, E. walteri, S. exaltata, C. odoratus and E. alba were annual plants and were not present past the end of the summer.

Hyacinth, growing from seed, formed a thick mat within six months of reflooding. S. cubensis also became quite common once the hyacinth mat formed. Other species found in association with the hyacinth mat-like ground cover were A. philoxeroides, H. umbellata, L. hexandra, L. repens, and Polygonum sp. Whether these plants grew from seed during the drawdown, or invaded from the surrounding marshland can only be speculation.

TABLE 3. Results of 4 ¼m$^2$ biomass samples from cleared plot of Study Area III, July 12, 1972

| SPECIES | # Stems | Wet Weight in grams | % Number | % Weight |
|---|---|---|---|---|
| Echinochloa walteri | 301 | 6226 | 70.5 | 84.0 |
| Eichhornia crassipes | 57* | 461 | 13.3 | 6.2 |
| Hydrocotyle umbellata | 21 | 224 | 4.9 | 3.0 |
| Paspalum distichum | - | 169 | - | 2.3 |
| Alternanthera philoxeroides | 19 | 102 | 4.4 | 1.4 |
| Leersia hexandra | - | 96 | - | 1.3 |
| Eclipta alba | 9 | 53 | 2.1 | 0.7 |
| Sesbania exaltata | 7 | 30 | 1.6 | 0.4 |
| Pontederia lanceolata | 7 | 17 | 1.6 | 0.2 |
| Cyperus odoratus | 1 | 18 | 0.2 | 0.2 |
| Polygonum sp. | 1 | 10 | 0.2 | 0.1 |
| Ludwigia repens | 4 | 4 | 0.9 | 0.1 |
| Total | 427 | 7410 | 99.8 | 99.9 |

* plants

When the millet died back in the summer, Thalia geniculata grew rapidly, putting out leaves seven feet high and flower spikes to 12 feet. By December, it covered about 50% of the total area of the plot. Pickerelweed, the other perennial emergent of concern which was able to become initially established during the drawdown, persisted with reflooding and has gradually increased in size and quantity.

Vegetation in the mat and the emergent perennials had become so dense, that no soil was exposed by the 1973 drawdown, and virtually no changes were evident in the vegetative composition within the plot.

Although the same hyacinth--S. cubensis mat-like complex from the surrounding marsh eventually claimed the cleared plot, competition was eliminated long enough during a drawdown period that emergent perennials such as pickerelweed and T. geniculata had the opportunity to become established. Some annuals did thrive when conditions were favorable during the first drawdown, but were subjected to unsurmountable competition by various kinds of perennials during the second drawdown.

Plot C

No changes occurred in the vegetational composition of the control during the course of the study due to drawdown or reflooding. Seasonal growth and diebacks of vegetation were noted.

IV. STUDY AREA IV

Plot A

In the plot subjected to Silvex treatment and fire, the aerial portions of all plants present were killed and consumed, but a floating mat of semi-burned hyacinth, S. cubensis and ash remained.

By August 1972 some vegetation was noted growing on the floating mat. In addition to young S. cubensis, alligator weed, a Ludwigia type and Pluchea purpurescens were identifiable.

Jussiaea leptocarpa, P. lanceolata, E. crassipes, M. scandens, and Eupatorium sp. also grew on this floating mat before the Scirpus cubensis began to flourish. By December, S. cubensis was the most dominant species, and covered about 95% of the area within the plot. Most of the other plants remained, but were completely overshadowed by the S. cubensis.

Plot B

Even though all of the vegetation was removed from the second plot during the drawdown, the soil was still covered by 15 inches of water or more. At no time was any growth evident from the submerged substrate in the cleared area.

Invading stolens of S. cubensis grew through the chicken wire barrier and eventually reclaimed most of the cleared $10m^2$, as efforts to remove them proved futile.

Plot C

No changes were evident in the control plot as Scirpus cubensis remained the dominant plant species throughout the study period.

## DISCUSSION

The 60 day, 1 foot drawdowns in the Spring of 1972 and 1973 produced changes in the composition of vegetation throughout pool B. Exclusive of the experimental study areas, significant changes in vegetational composition of the impoundment were restricted to those areas between the 39 and 40 foot m.s.l. contours where the soil was actually exposed as a result of the drawdown. This condition usually occurred along the river bank, canal sides, on sand bars and shoals, and at the edges of spoil piles. The most distinguishable change was the growth of Echinochloa walteri during and shortly after the drawdown. Since there was no drawdown in pool A and very little millet growth was observed there, it can then be assumed that from January 1969 to March 1972, millet growth was also restricted in pool B. Therefore, E. walteri seeds which germinated during the drawdown were probably present prior to water stabilization. The environmental factors necessary for the germination of wild millet seeds are not known by District biologists, however, when soil samples were returned to West Palm Beach and exposed, E. walteri germinated from samples secured from every month of the year (Appendix II). It is thus apparent that two conditions which are necessary for germination include water drawdown to expose the soil and the absence of severe plant competition.

A summary of the experimental treatments and drawdown results is presented in Table 4. Limiting experimental manipulations to small, isolated $10m^2$ study plots provided the opportunity to evaluate changes occurring to a specific plant community. To coincide with each experimental plot, one

TABLE 4. Summary of Experimental Treatments and Drawdown Results

| | | STUDY AREA NUMBER | | | |
|---|---|---|---|---|---|
| | | I | II | III | IV |
| Initial Dominant Vegetation | | Water Hyacinth | Pickerelweed | Water Hyacinth *Scirpus cubensis* | *Scirpus cubensis* |
| Experimental Treatments (during first drawdown) | A | Silvex + fire | Silvex + fire | Silvex + fire | Silvex + fire |
| | B | Mechanical clearing | Fire | Mechanical clearing | Mechanical clearing |
| | C | Control | Control | Control | Control |
| Drawdown Results | A | *P. paludivagum*; 2nd year - *E. walteri* | Reduced pickerelweed density; 2nd year - *E. walteri* | Complete elimination *S. cubensis*; later diverse emergent marsh | Floating mat survived burning; reclaimed by *S. cubensis* |
| | B | Immed. annual plant growth; later more diverse perennial marsh | Reduced plant litter, no composition change | Same as I-B | No germination due to standing water. *S. cubensis* reinvaded |
| | C | Young *S. cubensis* evident with elimination of grazing | No change | No change | No change |

control was also selected for comparison. However, since the entire pool was fluctuated, the only variable the control plots were subjected to was water drawdown.

It was suspected that due to the length of time which water levels were stabilized in the impoundment, the competition from the resulting vegetation would be severe, in fact so severe as to preclude any changes resulting from the 60 day drawdown. Observations of the control plots in all four study areas indicated very little change in the overall species composition. In Study Area I, the drawdown alone induced millet growth of only 0.5 stems per meter$^2$, while elimination of all other competition resulted in millet density of 16 stems per meter$^2$ following drawdown. Controls in Study II, III, and IV remained unchanged throughout the observation period. Although viable seeds for many plant species may be present in the underlying substrate, water drawdown in most cases is not sufficient to induce germination.

The primary purpose of the various treatments of the other study plots was to eliminate the competition which could prevent seed germination during the drawdown.

Mechanical clearing of the 10m$^2$ plot was the most selective method employed, and assured us of thorough elimination of competition with the least possibility of introducing other variables. In Areas I and III, manual clearing during the drawdown readily provided an exposed substrate. Germination and rapid growth of several annual species proceeded. Although water hyacinth and other perennials also germinated under these conditions, these plants did not mature as rapidly as annuals, and thus offered little initial competition. After the annuals died, some of the emergent perennials in Area I, like P. lanceolata, C. haspan and R. innundata became established before the hyacinth population reached inhibitory levels. This resulted in the establishment of a more diverse community. In all probability, the seeds of annual species which germinated were present in the substrate for at least three years, having been deposited prior to pool stabilization. In Study Area IV all of the vegetation was manually removed from one of the plots. However, even with a one foot drawdown there was water over the soil, and no subsequent germination or growth resulted. This indicated that exposure of the soil was as necessary as the elimination of competition to induce germination.

The combination of treatment with herbicide (Silvex) and subsequent burning was employed on plots in all four study areas. Silvex was applied basically to prepare the plot for burning since we felt that 60 days of drawdown would not have provided substantial dessication of the ground cover. Silvex was effective in killing most of the vegetation, most notably hyacinth, alligator-weed, and pickerelweed. The grasses, P. paludivagum and L. hexandra were not affected by the herbicide; and while the aerial portion of S. cubensis was killed, the root system survivied.

The burning which followed Silvex treatment in Study Area III and IV consumed all of the available fuel, but left a floating mat of ash and the roots of Silvex-resistant species. P. paludivagum in Study Area I and S. cubensis in Study Area III and IV grew back shortly after the burning and reflooding. In Study Area I, a few seeds of E. walteri and E. crassipes which were probably present in the soil beneath the hyacinth mat were unaffected by either the Silvex or fire. These seeds germinated in the little time remaining before reflooding. Moreover, with the occurrence of the second drawdown one year later, plant competition from the P. paludivagum was still slight and bare soil was exposed. Wild millet germination was again observed in these clear areas. Where the S. cubensis root mat remained, the underlying substrate was never exposed. The temporary reduction in competition caused by the burning, however, provided an opportunity for other perennial plants to become established. It is not possible to determine whether these seeds were present on the mat prior to treatment or whether they were introduced after the burning.

In Study Area II, where Silvex was effective against P. lanceolata and S. lancifolia, the interval between burning and reflooding was very brief and no annual growth was observed. A few pickerelweed and S. lancifolia plants germinated after reflooding, but the density remained low, permitting the second drawdown to provide conditions favorable for annual plant germination and growth.

Within the limitations of a 60 day, one foot drawdown, Silvex treatment and subsequent burning served to reduce previous competition. Major vegetative composition changes occurred either after the reflooding of those plots in which the S. cubensis mat remained, or during the second drawdown for plots in which underlying soil was exposed.

When one of the pickerelweed plots of Study Area II was burned without prior treatment with Silvex, the resulting species composition and density was unchanged. The fire was successful in destroying the aerial portion of the plants and consuming the surround debris. The underground vegetative portions of the pickerelweed and S. lancifolia, however, were not affected by the fire as they quickly produced new leaves to replace the burned portions. Perhaps had the water level been lower, or the drawdown extended longer, fire would have been more effective in eliminating the competition.

One other factor which was considered to be of importance in determining species composition and density in the study areas was cattle grazing. Since range cattle were often observed grazing in the vicinity of Study Area I, each plot was enclosed with several strands of barbed wire. S. cubensis grew to maturity within the control while it was constantly cropped by cattle in the surrounding area. In effect, cattle have contributed to the dominance of water hyacinths over S. cubensis.

In a marshland where water levels have remained stabilized for a period of years, conditions tend to select for only a few vegetation types which out-compete all other species. That this was the case in Pool B was apparent by the large areas of marshland covered by hyacinth and/or Scirpus cubensis. The drawdowns in this impoundment caused some of the land to be exposed, and where conditions were favorable, induced germination of some plants whose seeds remained in viable condition in the exposed substrate. The experimental study plots showed the necessity to eliminate or reduce competition in order to produce substantial vegetational changes in conjunction with water fluctuation.

## SUMMARY AND CONCLUSIONS

1. Stabilization of the water level in the impoundment area behind S-65B since January 1969 has had a pronounced impact on the vegetational composition of the marshes. The lack of seasonal fluctuation has resulted in the dominance of terrestrial plants in the north end of the impoundment, the dominance of aquatic plants in the south end of the impoundment, and the inhibition of growth for most aquatic annuals.

2. A 60 day, one foot drawdown in pool B during the spring of 1972 and 1973 exposed soil along the river and canal between the 39 and 40 foot contours. Where the exposed shoreline sloped gradually, competition was slight, and seeds were present, several species of plants germinated. The most noticeable of these was *Echinochloa walteri*, wild millet.

3. Very few changes in plant composition were observed in areas between the 39 and 40 foot contour adjacent to the river channel due to the fierce competition afforded by such dominant plants as *Eichhornia crassipes*, *Scirpus cubensis*, and *Pontederia lanceolata*.

4. When competition was eliminated or reduced substantially and the underlying substrate was exposed during a drawdown, many additional species of both annual and perennial plants germinated and flourished.

5. A succession of annual to perennial plants was observed following the first year's drawdown. Although perennial plants generally persisted during the second drawdown, a substantial growth of annual species occurred only in plots with remaining uncolonized substrate.

6. The study results indicated that the 60 day one foot drawdown alone was ineffective in reducing competition. Other experimental methods, herbicides and fire, were necessary to achieve this objective. The use of drawdowns of lower stage and longer duration may alleviate the need for these other management practices.

7. A substantial body of information is being accumulated which indicates that the stabilization of water levels is detrimental to the ecology of freshwater marshes. Our current knowledge of the factors which control the species composition of a marsh indicates that the water level of pool B should be fluctuated.

## RECOMMENDATIONS

The construction of C-38 and the provision of a series of water level control structures (S-65A through S-65E) has altered the previously existing stage regime of the Kissimmee River and adjacent flood plain. The former natural water slope, generally conforming with the topography, has been replaced by a "stair-step" series of pool-channel systems in which stable (non-fluctuating) stages are maintained except during discharge periods.

The vegetation studies conducted to date in the S-65B impoundment pool reveal that the new stage regime has had a pronounced effect on the vegetative character of that portion of the flood plain. The intermittent flooding and drying which is essential to the well-being of an emergent marsh has been eliminated. The experimental work described in this report indicates that water level management changes, and possibly other supplemental management techniques, can reverse the effects of several years of stage stabilization.

It is recommended that:

1) The District pursue its present effort for the acquisition of additional flood plain lands upstream of impoundment pools S-65B through S-65E. This will permit initiation of a long-term program of water level fluctuation and marsh restoration.

2) Studies be conducted to determine the optional plan for water level fluctuation in terms of marsh restoration, consistent with other objectives.

3) Studies be conducted to evaluate the effectiveness of supplemental management techniques.

4) The above studies, including raising the pool stage above S-65B to 41.0 feet m.s.l., be conducted to the extent possible prior to acquisition of the lands needed to institute a long range water level management program.

## APPENDIX I

### PLANT SPECIES ENCOUNTERED IN POOL B STUDY AREAS

A minimum of 38 species of plants were recorded during this study. Twenty-nine of these plants are emergents, eight are floating or floating-leaf plants and one is a submergent. Twenty-eight species are perennials, seven are annuals and three can be classified as annual or perennial. Approximately 40% of these plants are grasses and sedges. Eight species of sedges and six grasses were recorded.

PLANT DESCRIPTIONS

1. Alternanthera philoxeroides

   Alligator-weed is a perennial mat forming herb. The stems are decumbent, often rooting at the nodes. The glabrous leaves are thick and fleshy and oppositely arranged on the stem. The white flowers are grouped in composite spikes. This plant belongs to the same family as pigweed. In this study it was not found in any large concentrations but occurred mixed in with the other marsh plants. Alligator-weed has been naturalized from Central and South America.

2. Azolla caroliniana

   The mosquito fern is a tiny (5mm - 15mm) floating fern. This plant is easily recognized by the green and red imbricate leaves. Six species of Azolla occur in the American tropics and subtropics. Only one, A. caroliniana is present in Florida. It has been naturalized in Old World tropics.

3. Cabomba caroliniana

Fan wort is a delicate aquatic herb. It is the only submergent species encountered in this study. The leaves are palmately dissected into filiform segments. The flowers are solitary on slender peduncles and are white to creamish with yellow spots at the base. The genus contains about a half dozen species in the Western Hemisphere, only one is present in North America.

4. Centella asiatica

Coin wort is a small rhizomatous perennial herb. Groups of simple, ovate leaves are produced at each node. This plant belongs to the celery family (Apiaceae) and has the characteristic umbel type of infloresence so typical of this family. The umbel is made up of short pedicelled or subsessile flowers with white corollas. This is a genus of about twenty species of wide distribution. C. asiatica is the only one in Florida.

5. Cyperus spp.

This genus is a most difficult taxon. Even with flowers and achenes specific identification can be difficult. There are about 550 species throughout the tropical and warm temperate regions of the world. Ward (1968) lists 43 species for Florida and Long and Lakela (1971) record 34 species for tropical Florida. Many species of this sedge genus are wetland plants.

6. Cyperus haspan

In Florida this sedge is a perennial which grows from short rhizomes. The sharply trigonous culms are spongy and usually with bladeless sheaths. C. haspan is the most common Cyperus species in the Everglades marshes and it is one of the easiest to identify.

7. Cyperus odoratus

Unlike C. haspan, this robust annual sedge has conspicuous foliage. This species is found in coastal regions from Massachusetts to California and is also present in tropical America.

8. Echinochloa walteri

Wild millet is a large coarse annual grass with stems to six or eight feet. The purple leaf sheaths are densely pubescent. The dense flower panicles are 20 to 30 cm long and the spikelets are easily recognized by the awns on the second plume and the sterile lemna. Wildlife experts claim that this genus is an important waterfowl food item. Five species of Echinochloa occur in Florida.

9. Eclipta alba

E. alba is an annual herb with trailing stems which often root at the nodes. This species has opposite leaves which are elliptic to lanceolate. The flower heads are 5-6 mm wide and contain many white disc flowers. This plant is spread throughout the warmer parts of the world. Some authors claim this plant is native to the Old World and has been introduced into the Western Hemisphere.

10. Eichhornia crassipes

The water hyacinth is a noxious aquatic weed which was introduced in the U.S. from South America. This is a free-floating stoloniferous plant with inflated petioles. The light bluish-purple flowers are borne on a loose terminal spike. Not only are water hyacinths a navigational problem, but this species can be a serious competitor to the natural vegetation on river flood plains.

11. *Eleocharis sp.* (*acicularis* type)

The one species of *Eleocharis* which was present in this study never flowered and so positive identification was incomplete. However, we suspect that this is *E. acicularis* as it best fits the description of that species. It is a mat-forming perennial spikerush with very slender stolons. *Eleocharis* is a cosmopolitan genus of about 200 species, twenty-nine of which occur in Florida.

12. *Furiena pumila*

The umbrella grasses are actually sedges. They belong to a genus of about 40 species in the warmer regions of the world. Some botantists feel *Furiena* should be included in the genus *Scirpus*. *F. pumila* is a tufted annual with a terminal cluster of spikelets. There are only 3 to 5 species of *Furiena* in Florida.

13. *Habenaria repens*

The water-spider orchid belongs to a large Polymorphic genus of some 600 species. This plant is usually encountered growing on floating mats of water hyacinths. Both the leaves and flowers are pale green in color. Ward (1968) lists 11 species of *Habenaria* in Florida.

14. *Hydrocotyle umbellata*

The penny wort like the coin wort (*Centella asiatic*) belongs to the celery family, Apiaceae. The genus contains about 100 species chiefly of the tropics and southern temperate zone. This common creeping perennial herb is readily identified by the peltate leaves and the simple

umbellate inflorescence. This species is considered to be especially desirable as a duck food.

15. Hypericum mutilum

The dwarf St. Johns wort belongs to the family Hypericaceae. This is a family of about 50 genera and 1000 species, most of which are tropical. H. mutilum is a perennial or annual herb with weak slender stems. The small leaves are sessile and partly clasping at the base. The small (4 mm) light yellow flowers are produced on a branching inflorescence.

16. Jussiaea leptocarpa

In recent years most authors have placed this genus in Ludwigia. This plant belongs to the evening primrose family, Onagraceae. The group contains 19 genera and 650 species. J. leptocarpa is a pubescent semi-woody shrub with erect stems. The best identifying characteristics of this species are the narrowly cylindrical unwinged capsule and the 5 sepaled flowers. This species and the following one are found throughout the Kissimmee marshes. They both grow rooted in soil and on floating tussocks.

17. Jussiaea peruviana

The primrose willow is similar to J. leptocarpa, but this species tends to grow considerably larger. The yellow flowers are also larger but the best way to differentiate it from the former species is by the four-angled, winged seed capsules.

18. *Leersia hexandra*

*Leersia* is a genus of rhizomatous grasses of wet habitats. There are about 15 species found in the tropics and subtropics. *L. hexandra*, southern cutgrass, is a perennial species with retrorsely scabrous leaf blades. The stems are usually decumbent, rooting at the lower nodes. The spikelets are borne in open panicles. Five species of cutgrass occur in Florida.

19. *Lindernia anagallidea*

The false pimpernel is a gladbrous annual with slender diffusely branched stems. The small zygomorphic flowers are usually white or pale lavender. This species belongs to the snapdragon family, Scrophulariaceae, which contains over 3,000 species.

20. *Ludwigia repens*

Like the two species of *Jussiaea* already mentioned the floating primrose willow also belongs to the family Onagraceae. This species is a glabrous herb with creeping stems that root at the nodes. The petioled leaves are basically elliptical and oppositely arranged along the stem.

21. *Mikania scandens*

*Mikania* is an American genus of about 175 species. *M. scandens*, climbing hemp-weed, is a perennial vine which is commonly found in fresh water marshes. This plant belongs to the Asteraceae. The disk flowers are uniformly four per head with white corollas, ray flowers are absent.

22. *Nymphaea sp.*

The water lilies are perennial herbs with stout rhizomes and long petioled floating leaves. The leaves are subpeltate with a cleft at the base. There are about 50 species which are mostly tropical. Three species occur in Florida. The plants encountered in this study could not be identified to species because flowers were not present.

23. *Nymphoides aquaticum*

Although the floating heart superficially resembles the water lilies, these plants are not even remotely related. Long and Lakela (1971), in the phylogenetic system for the plants of tropical Florida, have numbered the water lily family (Nymphaeaceae) 79 and the floating heart family (Gentianaceae) is numbered 157 out of a total of 179. *N. aquaticum* is a perennial aquatic plant with floating leaves. The leaves are heart shaped--green above and purple on the underside. The undersurface of the leaf is rough to the touch. The fertile stems produce an umbel of white flowers.

24. *Panicum paludivagum*

The panic grasses have been described (Radford, Ahles, and Bell, 1964) as, "Taxonomically our most difficult and least understood genus of grasses." Long and Lakela (1971) have placed *Panicum paludivagum* in the genus *Paspalidium*. Correll and Correll (1972) state the *Panicum paludivagum* is probably just a variety of *P. geminatum*. There may be as many as 500 species of *Panicum* throughout the warm parts of the world.

Ward lists 87 species for Florida. P. paludivagum is a perennial aquatic grass which can be recognized by the succulent, striated internodes. This species seems to prefer wetter areas than does our common maidencane, P. hemitomon.

25. Panicum repens

Torpedo grass is a perennial plant which grows from strong creeping rhizomes. This species is found in coastal subtropical regions of both hemispheres, but may have possibly been introduced in North America. Ranchers in the Kissimmee Valley consider P. repens to be a very important component of the winter pastures.

26. Paspalum dissectum

P. dissectum is a mat-forming perennial grass. This plant can be identified by the foliaceous rachis which covers the spikelet. This and the following species belong to a very important genus of forage grasses. The genus is comprised of approximately 250 species in warm regions. Ward lists 35 Paspalums in Florida.

27. Paspalum distichum

Knot grass is a mat-forming stoloniferous perennial. This species can be separated from the other Paspalums by the non-foliaceous conjugate racemes and the pubescent second glume.

28. Pluchea purpurescens

Camphor weed is one of the marsh fleabanes. This genus of the Aster Family contains about 35 species in tropical and temperate regions. P. purpurescens can be distinguished from the other marsh fleabanes by the petiolate leaves and the fact that the flowering lateral branches are longer than the terminal ones.

29. Polygonum sp.

The smartweeds belong to the buckwheat family, Polygonaceae. This family contains about 40 genera and 800 species, mostly of the north temperate zones. Plants in this family usually have sheathing petioles. Polygonum is a cosmopolitan genus with about 300 species. Many of the smartweeds are aquatic herbs. These plants are very important wildlife food items. They are utilized by waterfowl, songbirds, and mammals.

30. Pontederia lanceolata

Pickerelweed belongs to a genus which is found in the warm parts of the New World. This plant is in the same family as the water hyacinth. For years there has been considerable argument as to whether North America has one or two species of pickerelweed. Some botanists recognize Pontederia lanceolata, some P. cordata, and others acknowledge both species. In some circles one is recognized as a valid species and the other as a variety. Pickerelweed (whichever one we have) is an emergent, perennial plant which grows from thick creeping rhizomes. The flowers are borne on an erect spike and are bluish purple and spotted with yellow. Upon close examination the similarity between Eichhornia and Pontederia flowers become apparent. There can be considerable variation in leaf blade shape from one plant to the next. The best field and laboratory identifying characteristic for pickerelweed is the sheathing stipule within the petiole. Pickerelweed is one of the most common plants in the Kissimmee Basin and in many cases it is the dominant species.

31. Psilocarya nitens

The bald-rushes are separated from the beak-rushes by their lack of perianth bristles. Recently some authors have placed this genus in the beak-rush genus, Rhynchospora. P. nitens, is an annual sedge which has the leaves crowded in the lower half of the stem. The spikelets are in terminal and auxillary umbel-like clusters. The mature achene is traversely corrugate and black in color, with a broad depressed white tubercle.

32. Rhynchospora inundata

The beak-rushes are a cosmopolitan genus of approximately 200 species, most of which are tropical. With but a few exceptions these sedges are perennial plants. R. inundata is a strongly stoloniferous plant with stout triangular stems. This species can be distinguished from the other beak-rushes by the shape of the tubercle and the relative length of the perianth bristles. Ward (1968) lists 50 species of Rhynchospora for Florida.

33. Sagittaria lancifolia

The arrowheads belong to the water plantain family, Alismataceae. It is a cosmopolitan family of about 30 genera and 90 species. S. lancifolia is an emergent perennial which grows from stout rhizomes. The unlobed leaves exhibit considerable variation in width and shape.

The unisexual flowers have 3 white petals and are borne in whorls. The lower whorls are made up of pistillate flowers and the upper staminate. This species is usually found in association with Pontederia lanceolata. Small (1933) claims that the Seminole Indians used this plant medicinally in cases of shock following an alligator bite.

34. Salvinia rotundifolia

The water fern is a small floating plant which belongs to the same family as the mosquito fern, Salviniaceae. The leaves are green and papillose above and brown and pubescent below. There are about ten species found in tropical and subtropical regions. S. rotundfolia is the only species found in Florida. The genus is named in honor of the Italian scientist, Antonia Salvini. This plant was not discovered in Florida (St. Johns River) until 1928 (Small).

35. Scirpus cubensis

This member of the bulrush genus is a naturalized species which probably came from the West Indies or Central America. S. cubensis superficially resembles a Cyperus much more than it does a Scirpus. However, upon closer examination, one finds that the scales of the spikelets are spirally arranged as in the genus Scirpus rather than two-ranked as in Cyperus. This species can be differentiated from the other bulrushes because it is the only one that has the spikelet arranged in dense spherical heads and has leaf-like bracts. This plant grows in large floating mats. Most of the old isolated oxbows in the Kissimmee Basin are covered with dense growths of this sedge. The succession appears to be that hyacinths initially cover the open water and they are then invaded by S. cubensis.

36. Sesbania exaltata

This plant is an annual and is a member of the legume family, Fabaceae. The legumes are a large group of plants (500 genera and 15,000 species) found throughout the world. S. exaltata has compound leaves which are even-pinnate and contain 20 to 70 leaflets. The fruit is a slender legume with 30 to 40 seeds. The only plant this species could be confused with is Glotiddium vesicarium, but G. vesicarium has a two seed fruit.

37. Thalia geniculata

The arrowroot is the only member of this genus which occurs in Florida. There are about 10 more species found in Africa and tropical America. Thalia belongs to the family Marantaceae, which fits phylogenetically somewhere between the cannas and the orchids. The very large leaves are mostly basal and arise from strong rhizomes. The bluish purple flowers are arranged on a branched inflorescence.

38. Typha sp.

The cattails are the most primitive Monocotyledonous plants. They are perennial plants with creeping root stocks. The unisexual flowers are divided into two parts--the upper part is made up of staminate flowers and the lower pistiliate. The genus contains about 15 species which are found in marshes throughout the world. Three species of cattail are listed for Florida.

# APPENDIX II

## SEED GERMINATION STUDY

In conjunction with the 1972 Pool B Vegetative Studies, a series of seed germination experiments were conducted. The purpose of these tests was to gain information as to what species of marsh plants could be expected to grow if the pool was fluctuated at different times of the year. Since it would have been rather difficult to fluctuate the pool on a monthly basis, soil samples were secured from the marsh and exposed at the West Palm Beach Field Station. Instead of lowering the water in Pool B we simply raised samples of the submerged soil each month.

The soil samples were taken from the vicinity of Study Areas I and III. These samples were placed in 12" x 20" x 3" metal trays lined with plastic bags. The trays were fitted with glass tubing drains to remove surface water. In order to keep the substrate damp and to hold seed invasion to a minimum, the experiments were conducted in the District Mist House. The samples were observed for a period of sixty days and records were kept of all species which germinated during that period. In many cases, individual plants had to be observed much longer until they flowered so they could be identified. When some species never flowered, their identification was impossible or incomplete.

At least nineteen plant species germinated during the course of these experiments (Table 1). There were eight perennials and six annuals. One species could be classified as annual or perennial. The remaining four plants could not be categorized because three of them could only be identified to genus and these genera contain both types. One other plant (a grass) could not even be identified to genus as it never flowered.

Sixteen of the nineteen species mentioned above have been recorded from the Pool B Study Areas. Only two plant species germinated in the seed trays that were not observed within the Study Area boundaries. Both species belong to the genus Juncus; J. effusus and J. biflora. Although J. effusus occupies the higher sites adjacent to the Study Areas it was not found in the flooded marshes. J. biflorus was observed in Pool C and the Boney Marsh this past spring but was not encountered in the Pool B Studies.

Twenty of the thirty-six Angiosperms which were encountered in the Pool B Study Areas did not germinate in the soil samples. With one possible exception (Cyperus odorotus), all of these plants which failed to germinate in these experiments were perennial species. Here it must be concluded that either viable seeds of these twenty species were not present or that the conditions under which these germination tests were conducted did not meet the requirements of these species.

Of the nineteen species which germinated in the Study, thirteen displayed germination trends throughout the length of the experiments. The other six; Sesbania exaltata, and unidentified grass, Jussiaea leptocarpa, Hydrocotyle umbellata, Hypericum mutilum and Furinea pumila appeared in the trays too infrequently or spasmodically to draw any valid conclusions.

Throughout the ten month Study only two species, Echinochloa walteri and Lindernia anagallidea had perfect germination records. Cyperus spp. germinated in each of the ten months but in this case more than one species could be involved.

Only one grass of the six grass species found in the Pool B Study Areas germinated in the exposed soil samples. This plant was wild millet, Echinochloa walteri, which was the only annual grass of the six. Why the five perennial species did not germinate in the mist house remains a mystery. All five of these species were observed in flower at some time during the Pool B Vegetation Studies.

Eight species of sedges are listed in Appendix I. Four of these plants, Cyperus spp.; Eleocharis (acicularis type), Furiena pumila and Psilocarya nitens germinated in the mist house. Cyperus spp. germinated every month but as mentioned previously more than one species may be involved in this case. The acicularis type of Eleocharis germinated each month except August and February. This species probably germinates year round. Furiena pumila germinated in July and August and did not appear from September to April. However, F. pumila could have a summer germination period of May through August as there are no data on May and June. Psilocarya nitens exhibited a definite germination pattern. This species failed to germinate from November through February but was present July through October and March and April.

Pickerelweed, Pontederia lanceolata and water hyacinths, Eichhornia crassipes, both important plant species in the Kissimmee basin did not germinate during the winter months. Pickerelweed failed to germinate during October, November, December and January. Hyacinths did not germinate from October through March. These plants belong to the same family, Pontederiaceae. Since E. crassipes is an exotic species from tropical regions it may require higher germination temperatures.

Two Asteraceous species appeared in these germination tests. They are Eclipta alba and Pluchea purpurescens. Both of these plants occurred in Pool B study plots, and had almost identical germination records. Both of them germinated from July through December. Neither appeared in the January or February samples and both germinated in March. However, only P. purpurescens germinated in April.

Smartweeds, Polygonum spp, germinated every month except July. None of these plants ever bloomed so it was impossible to determine exactly what species were present. In fact, there may have been more than one species in the trays. It appears that the smartweeds may germinate throughout the year.

Ludwigia repens germinated in the same pattern as Psilocarya nitens. These plants did not germinate during the colder months. Neither species germinated from November through February.

Juncus effusus, the softrush, is the only species encountered which is primarily a winter germinator. This species occurred in the soil trays from October through January and was also present in March. J. biflorus did not germinate July through December, however, this rush germinated from January through April.

Although Sagittaria lancifolia obviously grew from seed in all four of the Pool B Study Areas, this species never germinated in the mist house. S. lancifolia germinated in three of the four plots which were sprayed with Silvex and burned. It also grew in one plot which was mechanically harvested. This species had to germinate under water in two of the plots and upon floating mats of burned vegetation in the other two. Why this important emergent marsh species failed to germinate in the soil samples remains an enigma.

In addition to the monthly soil samples taken from Study Areas I and III, two other germination tests were made. These samples came from Study Area IV and from the river shore line in July 1972.

The Area IV sample was taken from an old oxbow which has been completely covered with a mat of Hyacinths and Scirpus cubensis. The water depth at this site was twenty inches. Nine species of plants which germinated in this sample are: Polygonum sp., Jussiaea leptocarpa, Ludwigia repens, Psilocarya nitens, Pontederia lanceolata, Eleocharis acicularis type, Echinochloa walteri, Cyperus sp. and Eichhornia crassipes.

The sample taken from the shore line of the river was also under twenty inches of water. This site is located approximately 100 yards north of Study Area IV. The number of species which germinated in this sample was low. The only plants which germinated were Echinochloa walteri, Pontederia lanceolata, and two unidentified plants, one a sedge and the other a grass.

TABLE 1. Germination Record of plant species which germinated in the Pool B soil samples.

| | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|---|---|---|---|
| *Cyperus spp.* (annual or perennial) | X | X | X | X | X | X | X | X | X | X |
| *Eclipta alba* (annual) | X | X | X | X | X | | | | X | |
| *Echinochloa walteri* (annual) | X | X | X | X | X | X | X | X | X | X |
| *Eichhornia crassipes* (perennial) | X | X | X | | | | | | | X |
| *Eleocharis acicularis* type (perennial) | X | | X | X | X | X | X | | X | X |
| *Furiena pumila* (annual) | X | X | | | | | | | | |
| *Hypericum mutilum* (annual or perennial) | | | | | | | X | | | X |
| *Hydrocotyle umbellata* (perennial) | | | | | | | | X | X | |
| *Juncus biflorus* (perennial) | | | | | | | X | X | X | X |
| *Juncus effusus* (perennial) | | | | X | X | X | X | | X | |
| *Jussiaea leptocarpa* (perennial) | X | | | X | | | | | X | X |
| *Lindernia anagallidea* (annual) | X | X | X | X | X | X | X | X | X | X |
| *Ludwigia repens* (perennial) | X | X | X | X | | | | | X | X |
| *Polygonum sp.* (annual or perennial) | | X | X | X | X | X | X | X | X | X |
| *Pluchea purpurescens* (annual or perennial) | X | X | X | X | X | X | | | X | X |
| *Psilocarya nitens* (annual) | X | X | X | X | | | | | X | X |
| *Sesbania sp.* (annual) | | X | | | | | | X | X | |
| Unidentified Grass (unknown) | | X | | X | | | | | | |

Plate 1. Dredging of the Kissimmee River, C-38. June 1966.

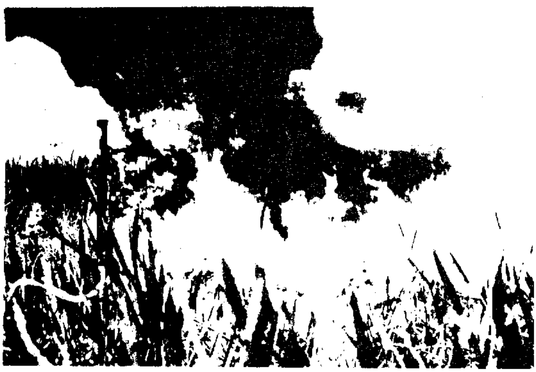

Plate 2. Treatment of an experimental plot by vegetation burning. May 1972.

Plate 3. Sampling of wild millet, Echinochloa walteri, three months following drawdown and removal of hyacinths. July 12, 1972.

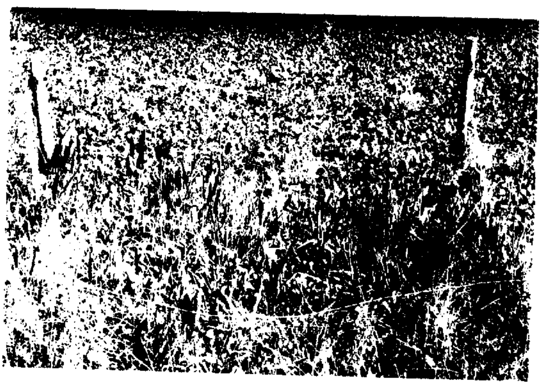

Plate 4. Increase of emergent perennial plants ten months after first drawdown. February 16, 1973.

Plate 7. Growth of wild millet which resulted throughout Pool B, three months after the 60-day, one foot drawdown. July 12, 1972.

Plate 8. A typical seed germination sample, drained and exposed at West Palm Beach.

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