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# Water Fluctuation and the Aquatic Flora of Lake Miccosukee

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## ABSTRACT

A drawdown was conducted on Lake Miccosukee from February to September 1977 for aquatic plant control. The 1.7 m dewatering exposed approximately 90% of the lake bottom to drying conditions. This resulted in a 70% reduction of unconsolidated organic matter. All problematic submersed species were substantially reduced below pre-drawdown levels excluding variable-leaf milfoil (*Myriophyllum heterophyllum* Michx.). Water shield (*Brasenia schreberi* Gmelin.) was important as a waterfowl food source and not a target species for control. Percent germination of water shield seeds under laboratory and lake conditions were 16.4% and 12.8% respectively. Control of other emersed species was less than desired.

## INTRODUCTION

Lake Miccosukee, located 20 miles east of Tallahassee, Florida, is a shallow lake of 2,954 surface hectares with a watershed area of 65,00 hectares. Ward's Creek and Dry Creek are the major tributaries. These two drainage systems compose an extremely large watershed in southern Georgia and northern Florida however, seepage from ground water in the watershed appears to be the principle water source of Lake Miccosukee. Water levels have varied due to a 3 ha sinkhole located at the north end of the lake.

In 1950, after an extensive drought period, the lake went dry via the sinkhole. An earthen dike with a concrete spillway was constructed around the sinkhole in 1954 and a 2.2 m diameter culvert was installed at this time. A timbered dam was installed at the south end to provide a surface overflow point during flood periods and to insure a constant water level.

As a result of this water level stabilization, numerous emersed and submersed aquatic plant species became established and proliferated throughout the lake. Not only did these dense infestations hinder lake recreational activities, but the continual deposition of organic matter from annual plant decline rapidly created undesirable lake substrate.

## METHODS AND MATERIALS

In November 1975, six 100 m modified line transects were established for analysis of percent vegetation coverage and frequency occurrence. Data was taken quarterly along transect lines within a one square meter (wooden frame) at 10 m intervals.

Remote sensing was incorporated through the use of aerial photography to obtain comprehensive vegetational data. Color transparencies were developed from Kodak Ektachrome MS Aerographic 2448 film exposed at an altitude of 3,300 m. Transparencies were analyzed by the National Aeronautics and Space Administration (NASA) with an interactive multispectral image analysis system, designated "IMAGE 100". Its function is to extract thermatic information from multispectral imagery. This system accepts aerial photography and simultaneously processes four channels of spectral data to classify a spectral signature.

Hydrosoil core samples were taken in February 1976 and 1978, with a 5 cm x 4 m plexiglass and plastic pipe sampler. Samples were collected by shoving the sampler into the hydrosoil as deeply as possible by hand. Unconsolidated organic matter of the upper zone of hydrosoil was designated as the peat zone. The next underlying layer consisted of consolidated organic matter which was more decomposed than the peat and designated as the muck zone. Mixed sand and clays beneath the peat characterized the transitional zone which overlayed a heavy bluish-grey clay layer. The Miccosukee region is immediately underlain by the upper Miocene Miccosukee Formation, a thin-bedded laterally discontinuous sequence of clays and clayey sands averaging 15-20 m thick, according to May.[1] All stratified zones were measured in centimeters and core samples were photographed.

Upon analysis of compiled data, a drawdown management plan was recommended through cooperation with the Florida Department of Natural Resources, Northwest Florida Water Management District, Jefferson County Commissioners and the Florida Game and Fresh Water Fish Commission. The plan consisted of a 2 m dewatering below normal pool stage with maximum bottom exposure to occur in late summer. Refilling would begin with gate closure in early fall. Due to dense aquatic vegetation growth and the massive accumulation of unconsolidated organic matter, exposure to heat and drying conditions was expected to be beneficial for the overall lake system. Objectives of the drawdown were to determine the effects on emersed and submersed aquatic species, the amount of hydrosoil consolidation, and the effects of drawdown on floating islands dominated by maidencane (*Panicum hemitomen* Schult.) and water-willow (*Decodon verticillatus* L.).

Upon approval of the drawdown recommendation, an additional objective was established to more precisely document environmental changes. The approximately 800 hectares of water shield in Lake Miccosukee, probably the largest concentration in Florida, was deemed the most preferred waterfowl food species present.[2] A two part seed germination study was conducted to analyze effects of drawdown on seed germination.

Seeds were collected by hand from exposed hydrosoil in December 1977. All seeds were stored frozen dry for 60 days at −10 C prior to treatment. Two replications of 125 seeds per treatment were placed in 39.5 l aquaria containing lake water under laboratory conditions. Light sources were indirect sunlight and grow-lux bulbs with a 12 hour daily photoperiod. Temperature fluctuated 8 to 15 C throughout the observation period (mean 23 C).

Two replications of 250 seeds per treatment were placed in plastic containers measuring 30 x 30 cm containing a hydrosoil layer of approximately 3 cm in depth. Containers were submerged in Lake Miccosukee at a depth of 1.5 m and anchored to the substrate. Weekly observations for seed germination were conducted.

## RESULTS AND DISCUSSION

A drawdown was initiated in February 1977, by opening all gates on both control structures. By late September, the water level had dropped to 1.7 m below normal pool stage, exposing approximately 90% of the lake bottom to drying conditions (Figure 1). This time span was recorded as the minimum required for dewatering due to the extreme drought condition prevailing throughout the drawdown period.

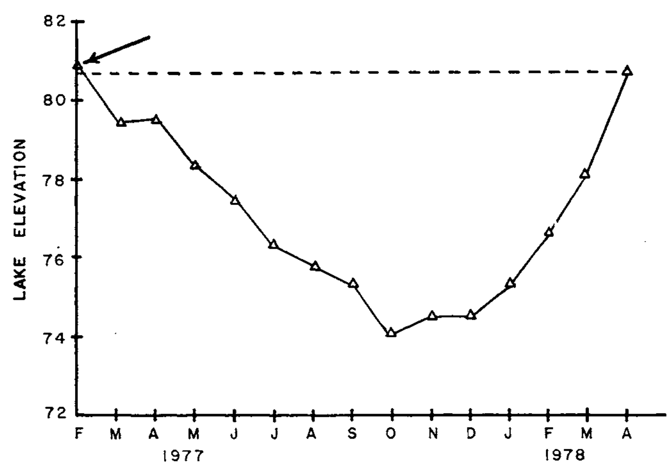


Figure 1. Water level fluctuation of Lake Miccosukee from February 1977 to April 1978 taken at monthly intervals. The arrow indicates initiation of drawdown.

[1]May, J. P. 1972. Preliminary Report on Geologic Evidence for Establishment of Ordinary High Water at Lake Miccosukee, Florida. Memo. State of Florida Board of Trustees.

[2]McDaniel, Jim. Florida Game and Fresh Water Fish Commission, Tallahassee, 1976. Personal Communication.

Prior to drawdown, approximately 80% of the water surface of Lake Miccosukee was dominated by fragrant water lily (*Nymphaea odorata* Aiton), water shield, yellow cow lily (*Nuphar luteum* L.), and floating islands composed of maidencane and water-willow (Table 1 and 2). Unfavorable weather conditions delayed aerial photography for two months in 1978. This additional growth period undoubtedly contributed to an increase in surface coverage and is considered to provide a partial explanation as to the similarities of predrawdown and postdrawdown data.

TABLE 1. COMPARISON OF POINT SURFACE COVERAGE OF AQUATIC VEGETATION ON LAKE MICCOSUKEE, 1976 AND 1978 BY "IMAGE 100."

| Common Name[1] | May 1976 Hectares | May 1976 Percent | July 1978 Hectares | July 1978 Percent |
|---|---|---|---|---|
| 1. Open Water | 573.1 | 19.4 | 567.0 | 19.2 |
| 2. Yellow Cow Lily<br>Fragrant Water Lily | 655.8 | 22.2 | 900.1 | 30.5 |
| 3. Maidencane<br>Water-Willow | 841.9 | 28.5 | 683.4 | 23.1 |
| 4. Water Shield | 883.2 | 29.9 | 803.5 | 27.2 |
| TOTAL | 2954.0 | 100.0 | 2954.0 | 100 |

[1] See text for scientific names of plants.

Percent open water prior to, and following the drawdown remained relatively unchanged (Table 1). No drastic change in surface vegetation distribution was apparent through aerial photography interpretation. However, changes in percent surface coverage and frequency of occurence of some emersed species were obvious.

Fragrant water lily and yellow cow lily, signatured as one species by the IMAGE 100 due to overlapping wave length densities, displayed the largest change by an increase of 8.3% (Table 1). Plants appeared to be more lush and robust in July 1978 than before the drawdown, although the frequency of occurrence at this time was below predrawdown frequency (Table 2). Surface coverage increase is partially explained by this increase in leaf size.

Percent surface coverage changes of fragrant water lily line transect data, varied substantially between June 1976 and February 1979 (Table 2). Comparison of transect data to aerial photography interpretation data revealed a similar 12.8% increase between June 1976 and June 1978 (Table 2).

During the winter in temperature water, or when the water table falls at the onset of the dry season in the tropics, the foliage of many emersed species dies back to the rhizome, and terminal and lateral buds remain dormant until favorable conditions occur (7). This annual die back was evident in February 1977; however, the tremendous decrease in percent cover of fragrant water lily from June 1978 (46.1%) to February 1979 (14.2%) can best be accredited to a combination of factors: 1) stress response from the drawdown, 2) a large population of herbivorous beetles, (*Bagous americanus* Lec.) which fed heavily upon leaves and flowers during late summer, and 3) to an abnormally high water level in late winter. Acording to Lantz (5), the summer drawdown on Anacoco Lake, Louisiana, greatly reduced the growth of water lily and much improved the lake from a fisheries standpoint. The frequency of occurrence of this species indicates that it remained widely scattered subsequent to the drawdown (Table 2) and did not yield dominance due to dewatering. Lantz's (5) success was attributed to three successive summer drawdowns initiated in July extending into October.

Reproduction of water shield is predominately from seed; however, new shoots do arise from parent rootstock (9). Very little vegetation regrowth from rootstock was observed upon refill, especially in shallow water areas exposed to longer dewatering. The change in percent surface coverage of water shield detected by the IMAGE 100 was 2.7% (Table 1). This similar coverage during late spring versus early summer, following a drawdown, is indicative of increased seed germination. Drawdowns have previously been found to stimulate water shield germination in various small ponds in north Florida.[2]

A substantial reduction in percent coverage of water shield was shown in February 1977 (Table 2). Water shield undergoes an annual winter die-back similar to fragrant water lily (7). During February 1977 and 1979, the frequency of occurrence dropped below that of the preceed-

TABLE 2. COMPARISON OF PERCENT SURFACE OF AQUATIC VEGETATION ON LAKE MICCOSUKEE FROM 1976 THROUGH 1979. LAKE DRAWDOWN (2M) WAS CONDUCTED FROM FEBRUARY 1977 TO SEPTEMBER 1977.

| Transect Species | June 1976 Frequency (%) | June 1976 Coverage (%) | February 1977 Frequency (%) | February 1977 Coverage (%) | June 1978 Frequency (%) | June 1978 Coverage (%) | February 1979 Frequency (%) | February 1979 Coverage (%) |
|---|---|---|---|---|---|---|---|---|
| 1. Azolla<br>Duckweed<br>Bog-mat | 2.0 | 0.1 | -0- | -0- | 4.1 | 1.1 | 4.1 | TR |
| 2. Water Shield | 42.1 | 14.1 | 36.2 | 3.1 | 28.1 | 9.8 | 4.8 | 0.2 |
| 3. Cabomba | 40.3 | 7.6 | 18.2 | 0.6 | -0- | -0- | 2.0 | TR |
| 4. Frog's Bit | 12.0 | 0.7 | 6.4 | 1.1 | 20.0 | 3.6 | 12.2 | 4.2 |
| 5. Variable-leaf Milfoil | 12.4 | 3.4 | 10.1 | 0.7 | 2.0 | 2.1 | 8.4 | 3.1 |
| 6. Yellow Cow Lily | 2.0 | 2.5 | -0- | -0- | 2.0 | 1.8 | -0- | -0- |
| 7. Fragrant Water Lily | 74.6 | 33.3 | 58.2 | 21.6 | 62.3 | 46.1 | 68.1 | 14.2 |
| 8. Water-willow<br>Maidencane<br>Buttonbush | 44.1 | 9.5 | 28.4 | 20.8 | 2.0 | 5.7 | 14.3 | 1.8 |
| 9. Bladderwort | 72.2 | 8.8 | 48.1 | 14.6 | 16.1 | 0.7 | 46.1 | 2.5 |
| 10. Terrestial Annuals | 7.4 | 1.0 | -0- | -0- | 18.3 | 4.7 | -0- | -0- |
| TOTAL PERCENT SURFACE COVERAGE | | 81.0 | | 62.5 | | 75.6 | | 26.0 |

ing summer. However, the extremely small frequency of occurrence in February 1978 is considered to be a result of an unanticipated biological stress indirectly related to de-watering. Water shield is a highly preferred food of the ringneck duck (*Aythua collaris*), of which a record 22,500 over-wintered in Lake Miccosukee in 1978-79. During this period, ringneck ducks were found to feed heavily upon seeds, floating leaves and underwater portions of water shield.[3]

Results of the water shield seed germination tests (data not shown) indicated that reproduction from seed was substantial. An average of 14.0% of the seeds germinated over a period of 101 days. This was very similar to levels reported for cabomba (*Cabomba caroliniana* Gray.) seeds in Louisiana (8); the two genera being closely related in the family Nymphaeaceae.

Percent germination was greatest under laboratory conditions in which seeds were subjected to a wider temperature fluctuation regime than occurred in the lake. Under laboratory conditions, more light was available due to water clarity and water depth. The interaction of natural light and fluctuating temperature also appeared to be an important factor in cabomba seed germination (8).

An estimated 200-800 seeds per square meter were present on the hydrosoil in the lake area in which seeds were collected. Assuming a 14% germination rate, this would produce 28-112 plants. This reproductive potential would definitely reestablish water shield in an area void of parental rootstock following control measures such as a drawdown.

The drawdown effectively controlled cabomba; however, variable-leaf milfoil increased in surface coverage during the winter of 1979 (Table 2). This does not infer that variable-leaf milfoil was not affected by the drawdown. It was in the deeper zones that were not dried by exposure, and were not exposed to drying conditions that variable-leaf milfoil survived. Upon refill, variable-leaf milfoil had a competitive advantage over other submersed species by reproducing from fragmentation as well as from seeds. Similar to cabomba and bladderwort (*Utricularia purpurea* Walt.), variable-leaf milfoil was drastically reduced in exposed areas not subjected to variableleaf milfoil fragmentation.

Surface coverage of maidencane and water-willow decreased by 5.4% following lake refill. Due to overlapping wavelength densities, these two species were also signatured as a single species by the IMAGE 100. Transect data, which revealed a 3.8% reduction in total percent coverage or a 40.0% species reduction during the same interim as aerial photography is considered unreliable due to a floating island shift on one transect. During summer, several wildfires burned relatively large areas of maidencane and water-willow, and in these areas vegetation reduction occurred. Reduction of floating island acreage was also attributed to refill over islands which had become anchored by root growth during summer dewatering. Frequency of occurrence dropped from 44.1% to 14.3% following refill (Table 2).

Regrowth of maidencane was predominately from rhizomes on pre-existing islands. Initial establishment of maidencane and water-willow on newly formed islands occurs from seed germination.

In temperate areas, losses due to natural plant decline occur predominantly in the fall and winter, and are probably very small during the growing season, at least until the maximum biomass is attained. Generally, losses from the current year's crop probably do not amount to more than 2 to 10 percent of the maximum biomass (2, 4, 11). As summer temperatures rise and the decomposition rate of dead plants accelerates, various by-product gases such as methane and hydrogen sulfide are produced. Occasionally, a portion of the lake's substrate becomes buoyant and rises to the surface as a result of these gases becoming trapped in decaying organic matter. As seeds from maidencane and water-willow germinate and grow on readily available substrate, a new island is formed.

Floating vegetation is generally considered antagonistic to all other aquatic plant life through its shading and creation of oxygen deficiency problems; however, conditions are often worse under floating mats (3). In 1963, Yount (12) reported the absence of oxygen at only a few centimeters depth in pools on surface limestone in Florida which are thickly covered with *Lemma, Pistia, Salvinia* and *Eichhornia* species. Floating mats drastically curtail light penetration and thus inhibit growth and photosynthesis of phytoplankton and other submersed vegetation (7).

Unconsolidated organic matter composed a layer 6 to 40 cm in depth prior to drawdown (Table 3). Subsequent to the drawdown, this was reduced to 3 to 12 cm, with a 70% average reduction per core sample. The muck zone exhibited an average 7% reduction in depth (Table 3).

TABLE 3. COMPARISON OF LAKE MICCOSUKEE HYDROSOIL SAMPLES, 1977 AND 1978.

| | Peat Zone (cm) | | Muck Zone (cm) | |
|---|---|---|---|---|
| Plot No. | Pre-drawdown | Post-drawdown | Pre-drawdown | Post-drawdown |
| 1 | 6 | 3 | 9 | 6 |
| 2 | 9 | 4 | 6 | 6 |
| 3 | 21 | 9 | 12 | 12 |
| 4 | 37 | 11 | 9 | 12 |
| 5 | 40 | 12 | 24 | 22 |
| 6 | 18 | 3 | 9 | 6 |
| 7 | — | 3 | 12 | 12 |
| 8 | 12 | 3 | 21 | 21 |
| 9 | 15 | 3 | 9 | 7 |
| *10 | 37 | 7 | 30 | 30 |
| 11 | 24 | 8 | 12 | 12 |
| 12 | 12 | 6 | 3 | 3 |
| *13 | 21 | 6 | 40 | 39 |
| *14 | 21 | 3 | 9 | 6 |
| 15 | 9 | 3 | 21 | 18 |
| x | 20 | 6 | 15 | 14 |

* Burned by wildfire.

Drying and plant desiccation caused this desired compaction and a return of physical stabilization to the sediments. Wegener and Williams (10) reported a 50% to 80% reduction in depth of sediments following drawdown on Lake Tohopekaliga. All exposed areas of Lake Miccosukee were firm and solid after summer drying. Lake drawdowns have long been used in sports fisheries management as a

[3]Taylor, S. Florida Game and Fresh Water Fish Commission, Tallahassee, 1978. Personal Communication.

tool for substrate compaction, which is essential for optimum productivity (5).

The objectives of this drawdown were achieved to a large extent although the degree of control over certain emersed species was less than desired.


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