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AQUATIC MACROPHYTES AND THEIR RELATION TO THE LIMNOLOGY OF FLORIDA LAKES

Submitted to:

Bureau of Aquatic Plant Management
Florida Department of Natural Resources
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INTRODUCTION

Florida has over 7,700 lakes that range in size from 4 hectares to over 180,000 hectares. The lakes are used for agricultural, domestic, industrial, and recreational purposes. The productivity and limnological characteristics of these lakes, however, varies greatly (Canfield and Hoyer 1988a; Brenner et al. 1990). The lakes range from oligotrophic to hypereutrophic and some support only a shoreline fringe of aquatic macrophytes whereas other lakes support an abundance of aquatic macrophytes (Crisman et al. 1986; Canfield and Duarte 1988; Canfield et al. 1990). In some lakes, non-native aquatic macrophytes like hydrilla (*Hydrilla verticillata*) have created serious aquatic weed problems (Langeland 1990).

The Florida Department of Natural Resources is state agency charged with managing and regulating the management of aquatic plants in Florida's public water bodies. Whether it be homeowners requesting the removal of shoreline vegetation on a public sand-bottom, oligotrophic lake to create a swimming beach or water management districts attempting to manage hydrilla problems in public eutrophic lakes, the Florida Department of Natural Resources ultimately must answer two simple questions: 1) Are aquatic macrophytes an important component of the lake's ecosystems? and 2) If macrophytes are determined to be important, how much aquatic vegetation is needed to support the intended uses of the lake?

Deciding how much aquatic vegetation should be maintained in an individual Florida lake and defending the decision based on sound ecological principals has proven to be difficult. The role of aquatic macrophytes in individual lakes has been studied for over 50 years (e.g., Reighard 1915; Baker 1918; Klugh 1926) and collectively these studies strongly suggest that natural or man-made changes in macrophyte species composition or biomass can have powerful effects on the biological structure and productivity of lakes (see reviews by Shireman et al. 1983 and Carpenter and Lodge 1986). Most of these studies, however, have been conducted on north-temperate lakes and the relevance of these studies to the Florida situation has often been questioned because of a general belief that southern lakes are somehow different. Critical ecosystem-level experiments also have not been conducted to test the expectations of major changes in biological structure and productivity (Carpenter and Lodge 1986). Consequently, the amount of aquatic macrophytes considered necessary for a "healthy" lake remains the subject of considerable debate (Shireman et al.

1983; Hoyer et al. 1985; Carpenter and Lodge 1986).

Schramm et al. (1983) conducted a study for the Florida Department of Natural Resources on Orange Lake and Lake Henderson to determine the relative ecological value of common aquatic plants. The purpose of their project was to evaluate the effects of different quantities and qualities of aquatic macrophytes on water quality, phytoplankton and epiphytic algae, zooplankton, benthic macroinvertebrates, and fishes. Although Schramm et al. (1983) demonstrated significant effects of aquatic macrophytes, they recommended that additional Florida lakes representative of the wide range of trophic conditions occurring in Florida be studied to insure the generality of their findings. In 1986, we began a 5-year research project for the Florida Department of Natural Resources to further investigate relations between aquatic macrophytes and the limnology and fisheries of Florida lakes. Although the project was designed to address issues such as the effects of aquatic macrophytes on lake trophic status, water clarity, phytoplankton abundance and harvestable sportfish abundance in a large number of Florida lakes, our primary purpose was to develop quantitative relationships that could be used by the Florida Department of Natural Resources to predict how changes in the abundance of aquatic macrophytes will influence the limnology and fisheries of Florida lakes. During the last two years of our study, we also examined relationships between limnological factors and bird abundance and species richness. These investigations were initiated because it came to our attention that some wildlife experts had concerns regarding the potential effects of aquatic plant management programs on bird populations.

We present here the major findings of our studies. We, however, have collected an enormous amount of information on Florida lakes over the last 5 years and it will take years to completely analyze all the data. Consequently, we present a considerable amount of our data in tables throughout this report so that the information will be directly available to others for their own analyses. We also fully expect that aquatic plant management programs in Florida will continue to evolve as new research occurs, but we offer here some general guidance regarding the development of aquatic plant management programs because we believe our findings provide a scientific framework for assessing how much aquatic vegetation should be controlled to achieve specific management objectives for the various types of Florida lakes.

method is needed to remove grass carp from lakes once desired levels of aquatic plant abundance are achieved. There is also a strong need to determine what aquatic macrophytes should be in a specific lake. Aquascaping and the revegetation of lakes are major components of some lake management programs. The manipulation of living organisms for lake management, however, must be compatible with the biology of the organism. For example, wild rice is an aquatic plant that has value to wildlife, but it only occurs naturally in Florida's river systems. Using wild rice, in a revegetation program for lake systems would, therefore not be compatible with the biology of wild rice. Thus, we suggest that the environmental ranges of individual species of aquatic macrophytes be determined so that the potential survival of each plant type will be known. Our study and others suggest that water chemistry and lake morphology have a major influence on the type of plants found in each lake. We, therefore, suggest an investigation of relations between water chemistry, lake morphology and the macrophyte species composition of lakes might be fruitful.

Lake management is an active ongoing process and better information is needed on how best to educate and involve the public in determining specific management objectives for each water body. For example, education of the general public will be needed to better inform them on how Florida lakes function and of the value of aquatic macrophytes. Education will also be needed to inform the public of the risk and benefits of different aquatic plant management programs such as aquatic herbicide management programs that might be employed to maintain a desirable aquatic macrophyte community. Reaching a consensus on specific lake uses also may prove difficult if more than one organization is involved in the management of the lake, especially if conflicting uses or unrealistic policies are already established.

Several approaches are available that can be used to reach a consensus on desired lake uses and to identify various lake problems. These approaches should be further investigated and studies should be made of how statewide agency policies affect aquatic plant management programs and potential uses of individual lakes. It is important, however, to remember that each lake is different and each lake will need its own management plan. No one level of aquatic macrophyte abundance will be suitable for all lakes. Informed citizens, therefore, must be encouraged to become involved in the lake management process if desired and attainable lake uses are to be achieved and conflicts over aquatic plant management programs reduced.

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CONVERSION TABLE

Metric to U. S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (L)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
Celsius degrees (C)	1.8 (C) + 32	Fahrenheit degrees

COMMON AND SCIENTIFIC NAMES OF FISH COLLECTED

Common Name	Scientific Name
American eel	*Anguilla rostrata*
Atlantic needlefish	*Strongylura marina*
Black crappie	*Pomoxis nigromaculatus*
Blackbanded darter	*Percina nigrofaciata*
Blackbanded sunfish	*Enneacanthus chaetodon*
Blue tilapia	*Tilapia aurea*
Bluefin killifish	*Lucania goodei*
Bluegill	*Lepomis macrochirus*
Bluespotted sunfish	*Enneacanthus gloriosus*
Bowfin	*Amia calva*
Bream	*Lepomis sp.*
Brook silverside	*Labidesthes sicculus*
Brown bullhead	*Ictalurus nebulosus*
Chain pickerel	*Esox niger*
Channel catfish	*Ictalurus punctatus*
Dollar sunfish	*Lepomis marginatus*
Everglades pygmy sunfish	*Elassoma evergladei*
Flagfish	*Jordanella floridae*
Flier	*Centrarchus macropterus*
Florida gar	*Lepisosteus platyrhincus*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Golden topminnow	*Fundulus chrysotus*
Grass carp	*Ctenopharyngodon idella*
Lake chubsucker	*Erimyzon sucetta*
Largemouth bass	*Micropterus salmoides*
Least killifish	*Heterandria formosa*
Lined topminnow	*Fundulus lineolatus*
Longear sunfish	*Lepomis megalotis*
Longnose gar	*Lepisosteus osseus*
Mosquitofish	*Gambusia holbrooki*
Pirate perch	*Aphredoderus sayanus*
Pygmy killifish	*Leptolucania ommata*
Redbreast sunfish	*Lepomis auritus*
Redear sunfish	*Lepomis microlophus*
Redfin pickerel	*Esox americanus americanus*
Sailfin molly	*Poecilia latipinna*
Seminole killifish	*Fundulus seminolis*
Sharpfin chubsucker	*Erimyzon tenuis*
Shiners	*Notropis sp.*
Speckled madtom	*Noturus leptacanthus*
Spotted sunfish	*Lepomis punctatus*

COMMON AND SCIENTIFIC NAMES OF FISH COLLECTED (CONCLUDED)

Common Name	Scientific Name
Striped bass	*Morone saxatilis*
Sunshine bass	*Morone chrysops x Morone saxatilis*
Suwannee bass	*Micropterus notius*
Swamp darter	*Etheostoma fusiforme*
Tadpole madtom	*Noturus gyrinus*
Taillight shiner	*Notropis maculatus*
Threadfin shad	*Dorosoma petenense*
Tidewater silverside	*Menidia peninsulae*
Walking catfish	*Clarias batrachus*
Warmouth	*Lepomis gulosus*
White catfish	*Ictalurus catus*
Yellow bullhead	*Ictalurus natalis*

COMMON AND SCIENTIFIC NAMES OF BIRDS COUNTED

Common Name	Scientific Name
American Coot	*Fulica americana*
American Kestrel	*Falco sparverius*
American White Pelican	*Pelecanus erythrorhynchos*
Anhinga	*Anhinga anhinga*
Bald Eagle	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Belted Kingfisher	*Ceryle alcyon*
Black Vulture	*Coragyps atratus*
Black-crowned Night-heron	*Nycticorax nycticorax*
Blue-winged Teal	*Anas discors*
Boat-tailed Grackle	*Quiscalus major*
Canada Goose	*Branta canadensis*
Cattle Egret	*Bubulcus ibis*
Common Moorhen	*Gallinula chloropus*
Common Snipe	*Gallinago gallinago*
Crows	*Corvidae* (2)
Double-crested Cormorant	*Phalacrocorax auritus*
Fulvous Whistling Duck	*Dendrocygna bicolor*
Glossy Ibis	*Plegadis falcinellus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Green-backed Heron	*Butorides striatus*
Gulls	*Laridae Larinae*(1)
Killdeer	*Charadrius vociferus*
Least Bittern	*Ixobrychus exilis*
Lesser Yellowlegs	*Tringa solitaria*
Limpkin	*Aramus guarauna*
Little Blue Heron	*Egretta caerulea*
Mallard	*Anas platyrhynchos*
Mottled Duck	*Anus fulvigula*
Northern Harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Pied-billed Grebe	*Podilymbus podiceps*
Purple Gallinule	*Porphyrula martinica*
Purple Martin	*Progne subis*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-necked Duck	*Aythya collaris*
Sandhill Crane	*Grus canadensis*
Semipalmated Plover	*Charadrius semipalmatus*
Snowy Egret	*Egretta thula*

COMMON AND SCIENTIFIC NAMES OF BIRDS COUNTED (CONCLUDED)

Common Name	Scientific Name
Sora	*Porzana carolina*
Terns	*Laridae Sterninae* (1)
Tree Swallow	*Tachycineta bicolor*
Tricolored Heron	*Egretta tricolor*
Turkey Vulture	*Cathartes aura*
White Ibis	*Eudocimus albus*
Wood Duck	*Aix sponsa*
Wood Stork	*Mycteria americana*

(1) Listed as subfamily.
(2) Listed as Family.

COMMON AND SCIENTIFIC NAMES OF AQUATIC MACROPHYTES

Common Name	Scientific Name
water-lettuce	*Pistia stratiotes*
water-aloe	*Stratiotes aloides*
common duckweed	*Lemna minor*
giant duckweed	*Spirodela polyrhiza*
floating water-hyacinth	*Eichhornia crassipes*
azolla	*Azolla caroliniana*
common salvinia	*Salvinia rotundifolia*
duck-potato	*Sagittaria lancifolia*
common arrowhead	*Sagittaria latifolia*
alligator-weed	*Alternanthera philoxeroides*
golden-club	*Orontium aquaticum*
slender spikerush	*Eleocharis baldwinii*
banana-lily	*Nymphoides aquatica*
parrot's-feather	*Myriophyllum aquaticum*
frog's-bit	*Limnobium spongia*
water-shield	*Brasenia schreberi*
American lotus	*Nelumbo lutea*
spatterdock	*Nuphar luteum*
fragrant water-lily	*Nymphaea odorata*
red ludwigia	*Ludwigia repens*
smartweed	*Polygonum hydropiperoides*
pickerelweed	*Pontederia cordata*
lizard's-tail	*Saururus cernuus*
lemon bacopa	*Bacopa caroliniana*
bacopa	*Bacopa monnieri*
baby-tears	*Micranthemum umbrosum*
exotic bur-reed	*Sparganium erectum*
cat-tail	*Typha* spp.
water-pennywort	*Hydrocotyle umbellata*
dwarf arrowhead	*Sagittaria subulata*
coontail	*Ceratophyllum demersum*
water-moss	*Fontinalis* spp.
variable-leaf milfoil	*Myriophyllum heterophyllum*
hydrilla	*Hydrilla verticillata*
tapegrass	*Vallisneria americana*
cone-spur bladderwort	*Utricularia gibba*
purple bladderwort	*Utricularia purpurea*
bog-moss	*Mayaca fluviatilis*

COMMON AND SCIENTIFIC NAMES OF AQUATIC MACROPHYTES
(CONTINUED)

Common Name	Scientific Name
southern naiad	*Najas guadalupensis*
purple fanwort	*Cabomba pulcherrima*
Illinois pondweed	*Potamogeton illinoensis*
elephant-ear	*Colocasia esculenta*
wax myrtle	*Myrica ceriferia*
water primrose	*Ludwigia octovalis*
buttonbush	*Cephalanthus occidentalis*
willow	*Salix* spp.
carex sedge	*Carex* spp.
sawgrass	*Cladium jamaicense*
flat-sedge	*Cyperus odoratus*
giant bulrush	*Scirpus californicus*
soft stem bulrush	*Scirpus validus*
maidencane	*Panicum hemitomon*
para grass	*Brachiaria mutica*
torpedograss	*Panicum repens*
napier grass	*Pennisetum purpureum*
cordgrass	*Spartina bakeri*
giant cutgrass	*Zizaniopsis miliacea*
soft rush	*Juncus effusus*
green algae	Chlorphyta
musk-grass	*Chara* spp.
stonewort	*Nitella* spp.
.	*Fuirena sciropoidea*
.	*Leersia hexandra*
.	*Websteria confervoides*
.	*Utricularia floridana*
pipewort	*Eriocaulon* spp.
St. John's wort	*Hypericum* spp.
.	*Rhynchyospora tracyi*
.	*Rhynchospora inundata*
red root	*Lachnanthes carolininana*
yellow-eyed grass	*Xyris* spp.
.	*Eleocharis elongata*
knot grass	*Paspalum distichum*
.	*Utricularia foliosa*
hatpin	*Eriocaulon decangulare*
leconte sedge	*Cyperus lecontei*
egyptian paspalidium	*Paspalidium geminatum*
.	*Scirpus americanus*
bald cypress	*Taxodium distichum*
.	*Eleocharis cellulosa*

COMMON AND SCIENTIFIC NAMES OF AQUATIC MACROPHYTES
(CONCLUDED)

Common Name	Scientific Name
.	*Utricularia resupinata*
.	*Cyperus elegans*
blue maidencane	*Amphicarpum muhlenbergianum*
.	*Scirpus cubensis*
elderberry	*Sambucus canadensis*

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EXECUTIVE SUMMARY

The water quality, aquatic macrophyte communities and fish populations of 60 Florida lakes were sampled over a five year period from 1986 to 1990. Bird populations were also quantified on a subset of 44 lakes. The study lakes were selected to include not only a wide range of trophic states (oligotrophic to hypereutrophic), but a wide range of macrophyte coverages (< 5% to >70%) within each trophic type. Eight of the 60 lakes (Lake Wales, Clear Lake, Lake Baldwin, Lake Pearl, Lake Killarny, Lake Holden, Lake Bell, and Lake Orienta) were studied because grass carp were used as a biological control for aquatic vegetation and virtually all macrophytes had been removed from these systems for 10 to 15 years. Intensive fisheries studies of all 60 lakes were conducted using rotenone sampling, experimental gillnets, and electrofishing to determine the species composition and abundance of fishes. The size structures of different populations of fishes were also examined as were the age and growth of the major sportfish in Florida lakes (largemouth bass, *Micropterus salmoides*; bluegill, *Lepomis macrochirus*; redear sunfish, *Lepomis microlophus*; black crappie, *Pomoxis nigromaculatus*). The relations among water quality, aquatic macrophytes, fish populations and bird populations were examined to determine how macrophyte management plans may effect water quality, fish populations and bird populations in Florida lakes.

The 60 study lakes varied considerably in size ranging from 1.8 ha (Little Fish Pond) to 12,400 ha (Lake Apopka), but the majority of the lakes were < 300 ha. Most of the lakes were shallow (mean depth < 3 m), but mean depths ranged from 0.6 to 5.9 m. Total nitrogen concentrations ranged from 82 to 6340 μg/L and total phosphorus concentrations ranged 1 to 1043 μg/L. Water transparency (measured with a Secchi disc) ranged from 0.3 to 5.8 m and chlorophyll *a* concentrations ranged from 1 to 241 μg/L. Areal coverage of aquatic macrophytes ranged from < 1 to 100%, with the average submersed macrophyte biomass ranging from 0 to 16.6 kg wet wt/m^2.

Total number of fish species collected per lake ranged from 4 species in Lawbreaker to 34 species in Lake Harris. Whole-lake estimates of total fish biomass based on rotenone sampling ranged from 6 kg/ha in oligotrophic Cue lake to 675 kg/ha in hypereutrophic Bivens Arm and harvestable fish biomass ranged from 1.4 kg/ha in oligotrophic Lawbreaker to 431 kg/ha in hypereutrophic Bivens Arm. Electrofishing catch per unit

effort for total fish weight ranged from 0.7 to 116 kg/hr and harvestable sportfish weight from 0.0 to 69 kg/hr. Experimental gillnet catch per unit effort for total fish weight ranged from 0.0 to 134 kg/net/24 hr and harvestable sportfish fish weight from 0.0 to 9 kg/net/24 hr.

The total number of bird species observed per lake ranged from 1 to 30 and annual average bird numbers ranged from 7 to 800 birds/km^2 and biomass from 1 to 465 kg/km^2. Whole-lake bird abundance ranged from 0 to 840 birds/km^2 in the spring, 0 to 650 birds/km^2 in summer and 0 to 1300 bird/km^2 in the winter. Bird populations using Florida lakes were greatest in the winter due to the migratory populations visiting Florida.

Multiple regression analysis indicated that total nitrogen (TN) and total phosphorus (TP) concentrations and the percent volume infested with aquatic macrophytes (PVI) accounted for 83% of the variance in chlorophyll *a* concentrations (CHLA) for the study lakes. The empirical model for this relation was:

$$\text{Log(CHLA)} = -1.80 + 0.77\ \log(\text{TN}) + 0.55\ \log(\text{TP}) - 0.003\ \text{PVI}$$

where chlorophyll *a*, total nitrogen and total phosphorus concentrations are in µg/L. These results suggest that chlorophyll *a* concentrations decrease as more of a lake's volume is occupied with aquatic macrophytes and because chlorophyll *a* is inversely related to water clarity, water clarity increases with an increase in PVI. The coefficient for the PVI value, however, is small (- 0.003) suggesting that the change in PVI must be large before a significant change in chlorophyll *a* occurs.

An areal macrophyte coverage between 30% and 50% is needed before a significant depression in whole-lake chlorophyll *a* concentrations can typically be measured or observed based on an increase in water clarity. Thus, removal of aquatic vegetation in lakes with less then 30% macrophyte coverage will probably have no noticeable effect on the whole-lake trophic state parameters (total phosphorus, total nitrogen, chlorophyll *a*, and Secchi transparency) of the lake. Conversely, leaving a small fringe of vegetation in a lake for the purpose of water quality improvement will have little or no effect on the whole-lake trophic state values for a lake.

Lake trophic status was positively related to total and harvestable fish weight when the fish populations were collected with rotenone sampling (kg/ha), experimental gillnets (kg/net/24 hr) and electrofishing (kg/hr). This was consistent with several previous studies from Florida and other parts of North America that showed positive relations between fish standing crop or yield and some measure or correlate of lake trophic status. To account for the overriding effect of lake trophic status, we calculated the ratio of fish biomass (estimated with rotenone sampling) to adjusted chlorophyll *a* (g fish/g chlorophyll *a*) and used this ratio to examine the relation between fish populations and aquatic macrophytes.

LOWESS regression analyses indicated that total and harvestable fish biomass to chlorophyll *a* ratios increase rapidly up to approximately 15% PVI. After macrophyte abundance reaches 15% PVI, the ratios continue to increase, but less rapidly, up to a PVI value of approximately 20% to 40%. The ratios in fish biomass per unit of chlorophyll *a* till about 15% volume infested and then a steady decline. Total and harvestable fish biomass to chlorophyll *a* ratios decrease steadily once PVI values become > 50%. This is probably due to an increased habitat complexity, caused by aquatic macrophytes, that can make it difficult for fish to forage effectively. There was also a parabolic relation between total and harvestable fish biomass to chlorophyll *a* ratios and lake plant concentration (total lake plant biomass divided by lake volume, g/m^3). Although these findings are consistent with other published studies and suggests that some intermediate amount of vegetation will maximize fish populations, some lakes with PVI values < 15% or > 80% have high fish biomass to chlorophyll *a* ratios. Thus, our lake surveys suggest that only the potential for depressed fish populations exist at both low and high levels of aquatic macrophytes.

Total fish, harvestable fish and largemouth bass population data from eight lakes, which have experienced the long-term removal of all aquatic vegetation with grass carp (10 to 15 years), showed no consistent trends with aquatic macrophyte removal. Some grass carp lakes supported excellent fish populations (Lake Baldwin, Lake Bell, and Lake Orienta) and some did not (Lake Wales, Clear Lake and Lake Holden). This finding is also consistent with other published research on the effect grass carp have on fish populations. Thus, the long-term loss of aquatic macrophytes from a lake ecosystem will not necessarily lead to a decrease in a lake's total or sportfish population, but there exists a potential for such a decrease.

Fifty bird species were observed on 46 Florida lakes with some species occurring on only one lake and others on as many as 38 lakes. Average annual bird numbers ranged from 7 to 800 birds km^{-2} and bird biomass ranged from 1 to 465 kg km^{-2}. Total species richness ranged from 1 to 30 species per lake. Annual average bird numbers and biomass were positively correlated to lake trophic status as assessed by total phosphorus (r=0.61), total nitrogen (r=0.60) and chlorophyll *a* (r=0.56) concentrations. Species richness was positively correlated to lake area (r=0.86) and trophic status (r=0.64 for total phosphorus concentrations).

The percentage of the total annual phosphorus load contributed to 14 Florida lakes by bird populations was low, averaging 2.4 %. Bird populations using Florida lakes, therefore, do not significantly impact the trophic status of the lakes under natural situations, but lake trophic status is a major factor influencing bird abundance and species richness on lakes. Bird abundance and species richness were not significantly correlated to other lake morphology or aquatic macrophyte parameters after the effects of lake area and trophic status were accounted for using stepwise multiple regression. The lack of significant relations between annual average bird abundance and species richness and macrophyte abundance seems to be related to changes in bird species composition. Bird abundance and species richness remain relatively stable as macrophyte abundance increases, but birds that use open-water habitats (e.g., double-crested cormorant, *Phalacrocorax auritus*) are replaced by species that use macrophyte communities (e.g., ring-necked duck, *Aythya collaris*).

Aquatic plant management programs in Florida have often been conducted independently of other lake management programs. Lakes, however, are important resources and they often must be managed for a variety of purposes including flood control, water supply, fishing, and general recreation. Lake usage, however, is a match between people's desires and the lake's capacity to satisfy these desires. Lake problems are defined in terms of the limits on desired uses. Many limitations can be prevented or corrected with proper lake management, but desired uses need to be clearly defined, limitations on the uses identified, and the causes understood.

An attempt was made in this study to describe the relations among aquatic macrophytes, water quality, fish populations and bird populations in order to give those individuals or agencies charged with managing Florida's lake systems a quantitative basis on which to base their management decisions. We strongly urge that lake management programs ascertain what are the desired uses for each lake. The lake management programs, however, must also reflect the limnological properties of lakes. Oligotrophic lakes with their low biological productivity certainly have attributes that make them more desirable than hypereutrophic lakes for many uses, but there are only a limited number of geographic regions in Florida where oligotrophic lakes can occur. Regional lake management strategies, therefore, must be developed based on specific aquatic ecoregions rather than on statewide standards for lake quality. Although statewide standards ease the application of regulations, it would be foolish to set oligotrophic water quality standards for a region that has nutrient rich soils and naturally occurring eutrophic lakes (e.g., Polk County). It also must be recognized that although aquatic macrophytes can be beneficial for lakes, the complete removal of aquatic macrophytes by use of plant management techniques such as grass carp will not necessarily destroy the long-term viability of the lake.

We suggest, as others have, that a moderate amount of aquatic macrophytes would be beneficial to most Florida lakes. A macrophyte coverage of at least 15% with emergent, floating-leaved, and submersed vegetation seems to preclude the probability of any adverse fisheries problems, so this may be a reasonable management objective for many lakes. The presence of aquatic macrophytes in a Florida lake, however, will require a long-term commitment to some level of aquatic plant management. Non-native species such as hydrilla and water hyacinth will continue to be a problem in many Florida lakes and maintenance control of these plants should be a major goal of most aquatic plant management programs to prevent these plants from totally taking over a lake. We advocate maintenance control rather than complete elimination because these plants like any plant can have beneficial effects for some lakes. For example, hydrilla could be very important for reestablishing the fisheries of hypereutrophic lakes where light limitation has eliminated most native species. It, however, should also be recognized that many native species including those like Vallisneria that have been classified as desirable aquatic plants can also cause weed problems and will need to be managed in some lakes. Extensive growths of emergents such cat-tails can also be problematic, especially in lakes that experience large fluctuations in water levels.

We believe that there are a number of future research needs if we are to optimize aquatic plant management in Florida lakes. For example, better biocontrol techniques will be needed if aquatic plant abundance is to be managed more precisely. There is a need to manage specific macrophyte species and a need to control plants in specific areas. A

METHODS

Research Approach and Lake Selection

Most investigations of the effects of aquatic macrophytes on ecosystem processes have generally been an intensive study of a single lake or perhaps a couple of lakes (e.g., Schramm et al. 1983; Carpenter and Lodge 1986). Although information obtained from these studies has been extremely valuable, the information has often proven to be of limited use when applied to lakes having vastly different limnological characteristics. Empirical studies of large numbers of lakes, however, have led to the development of general nutrient loading (Vollenweider 1975; Canfield and Bachmann 1981), nutrient-chlorophyll (Smith 1982; Canfield 1983), chlorophyll-Secchi (Dillon and Rigler 1975; Canfield and Hodgson 1983), chlorophyll-zooplankton (Bays and Crisman 1983; Canfield and Watkins 1984), and chlorophyll-fish (Oglesby 1977; Jones and Hoyer 1982) models. These models are now used by most state and federal regulatory agencies to provide a preliminary assessment of what effect eutrophication (i.e., the nutrient enrichment of an aquatic ecosystem) will have on natural and artificial lakes.

Canfield et al. (1984) developed an empirical multivariate model that related chlorophyll *a* concentrations to in-lake nutrient concentrations and the percentage of the lake's total volume occupied by aquatic macrophytes. This work suggested that the empirical approach might prove successful for elucidating other limnological and fisheries relationships with aquatic macrophytes. If these relationships could be quantified, linkage of the empirical macrophyte models to existing empirical models would provide a quantitative method for assessing how changes in the abundance of aquatic macrophytes might influence the limnology and fisheries of Florida's lakes. There would also then be a quantitative basis for natural resource planning and the allocation of limited resources for lake or aquatic weed management. We, therefore, chose the empirical approach recommended by Rigler (1982) for this research project.

We selected 60 Florida lakes for study during this project (Figure 1; Table 1). Ten to 17 lakes were sampled each year between June 1986 and June 1990. Unlike the intensive single lake study research approach, each lake in an empirical study is sampled less intensively, often only once as was the case for many of our study lakes. The study lakes, however, are selected such that the ecosystem **(Text continued on page 6)**

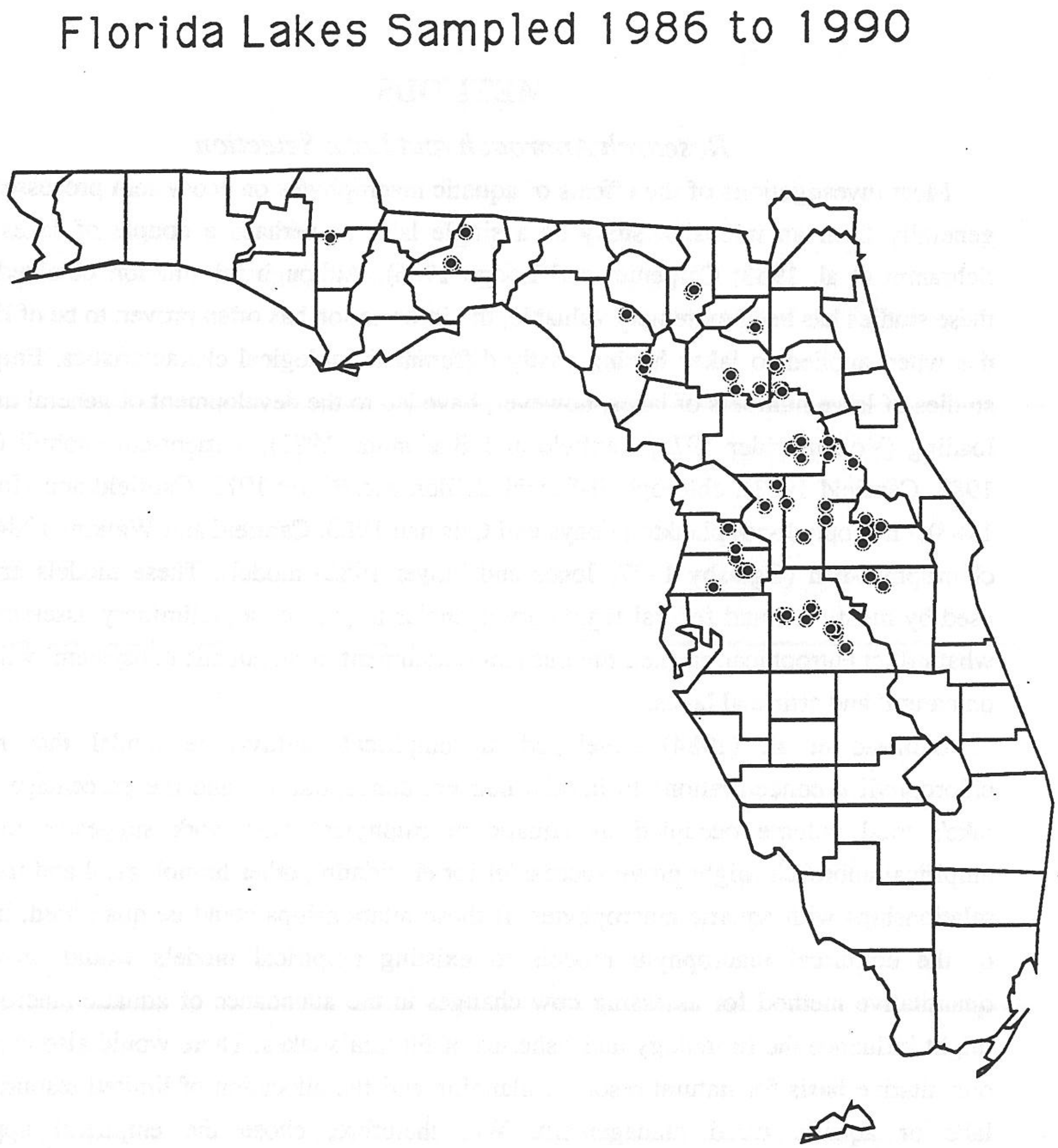

Figure 1. Location of Florida lakes sampled between 1986 and 1990.

Table 1. Lake location, year sampled, and morphology of the Florida lakes sampled between 1986 and 1990.

Lake	County	Latitude North	Longitude West	Year Sampled	Surface Area (ha)	Mean Depth (m)	Shoreline Length (km)
Keys Pond	Putnam	29.31	81.58	86	5.3	2.9	1.02
Brim Pond	Putnam	29.31	81.59	86	3.2	4.0	0.72
Okahumpka	Sumter	28.45	82.05	86	271.0	0.9	5.86
Clay	Lake	29.02	81.27	86	4.9	2.3	0.92
Wauberg	Alachua	29.31	82.18	86	100.0	3.6	8.35
Bivens Arm	Alachua	29.37	82.20	86	76.0	1.2	6.18
Apopka	Orange	28.39	81.39	86	12412.0	1.6	54.86
Miona	Sumter	28.54	82.00	86	169.0	2.3	5.86
Wales	Polk	27.54	81.34	86	132.0	3.4	4.98
Clear	Pasco	28.20	82.15	86	64.0	5.9	3.14
Baldwin	Orange	28.34	81.19	86	80.0	4.0	3.09
Baldwin	Orange	28.34	81.19	88	80.0	4.8	3.09
Baldwin	Orange	28.34	81.19	89	80.0	4.6	3.09
Susannah	Orange	28.33	81.19	86	31.0	4.2	1.89
Susannah	Orange	28.33	81.19	88	31.0	3.8	1.89
Susannah	Orange	28.33	81.19	89	31.0	3.6	1.89
Pearl	Orange	28.36	81.15	86	24.0	2.0	1.98
Pearl	Orange	28.36	81.15	88	24.0	2.0	1.98
Pearl	Orange	28.36	81.15	89	24.0	2.1	1.98
Cue	Putnam	29.40	82.58	86	59.0	3.5	2.86
Cue	Putnam	29.40	82.58	87	59.0	3.5	2.86
Alligator	Columbia	30.10	82.37	87	137.0	1.1	5.32
Crooked	Lake	29.09	81.36	87	8.4	2.3	2.02
Deep	Putnam	29.43	82.57	87	4.0	3.0	1.61
Lawbreaker	Lake	29.10	81.37	87	4.8	4.3	1.23
Round Pond	Marion	29.04	81.49	87	4.0	1.3	0.88
Carr	Leon	30.34	84.17	87	254.0	1.9	5.05
Hollingsworth	Polk	28.01	81.56	87	144.0	1.5	4.23
Hunter	Polk	28.02	81.58	87	40.0	1.7	2.33
Hartridge	Polk	28.03	81.44	87	176.0	3.4	5.51
Killarny	Orange	28.35	81.22	87	96.0	4.7	5.78
Holden	Orange	28.30	81.23	87	102.0	4.5	5.03
Catherine	Marion	29.11	81.49	87	41.0	3.2	4.46
Bell	Pasco	28.13	82.27	87	32.0	2.7	2.75
Bonny	Polk	28.02	81.55	87	143.0	2.0	6.37
Harris	Lake	28.46	81.56	87	5580.0	4.0	61.26
Lindsey	Hernando	28.37	82.21	88	55.0	2.2	3.19
Loften	Leon	30.21	84.23	88	5.0	2.6	2.03
Moore	Leon	30.23	84.24	88	28.0	2.9	1.77
Live Oak	Osceola	28.13	81.14	88	152.0	3.0	4.99
Koon	Lafayette	30.02	83.06	88	44.0	1.5	3.58
Watertown	Columbia	30.11	82.36	88	19.0	3.8	1.64
Patrick	Polk	27.48	81.30	88	159.0	1.8	4.65

Table 1. (Concluded)

Lake	County	Latitude North	Longitude West	Year Sampled	Surface Area (ha)	Mean Depth (m)	Shoreline Length (km)
Orienta	Seminole	28.39	81.22	88	52.0	3.4	6.26
Conine	Polk	28.03	81.43	88	96.0	3.5	3.60
Tomahawk	Marion	29.08	81.54	88	15.0	4.4	4.01
Barco	Putnam	29.40	82.00	88	13.0	4.4	1.29
Suggs	Putnam	29.41	82.01	88	73.0	2.0	2.30
Carlton	Orange	28.45	81.39	88	155.0	3.6	4.51
Rowell	Bradford	29.55	82.09	88	147.0	1.3	5.18
Lochloosa	Alachua	29.31	82.08	88	2309.0	1.8	22.57
Turkey Pen	Calhoun	30.33	85.17	88	6.0	5.0	0.89
Fish	Osceola	28.16	81.20	88	89.0	1.9	4.01
Bull Pond	Putnam	29.31	81.58	89	11.0	2.3	1.38
Mill Dam	Marion	29.10	81.50	89	85.0	5.7	3.56
West Moody	Pasco	28.24	82.18	89	39.0	3.5	2.50
Grasshopper	Lake	29.08	81.37	89	59.0	2.7	5.07
Mountain	Hernando	28.28	82.18	89	51.0	1.6	2.25
Douglas	Lake	28.33	81.48	89	16.0	1.2	1.75
Pasadena	Pasco	28.19	82.13	89	151.0	3.1	8.10
Marianna	Polk	28.04	81.45	89	204.0	3.8	6.22
Mountain 2	Polk	27.56	81.35	89	55.0	3.3	3.87
Gate Lake	Polk	27.56	81.36	89	7.8	1.8	1.43
Thomas	Polk	28.00	81.46	89	55.0	3.9	1.71
Little Fish	Putnam	29.31	81.59	89	1.8	1.3	0.60
Picnic	Putnam	29.30	81.58	89	18.0	3.3	1.89
Swim Pond	Marion	29.10	81.49	89	9.0	0.6	1.94

components of interest (e.g., the abundance of aquatic macrophytes) varies as much as possible. The purpose of this type of sampling strategy is not to describe the individual lake, but to obtain information from as many systems as possible so that statistical techniques can then used to elaborate the general behavior patterns of lakes (Reckhow and Chapra 1983). Fifty-two of our study lakes were, therefore, selected based on lake trophic status and their abundance of aquatic macrophytes. These study lakes ranged in trophic status from oligotrophic to hypereutrophic. Within each of the major trophic categories (oligotrophic, mesotrophic, eutrophic, and hypereutrophic), we also chose lakes that had macrophyte coverage ranging from <10% to over 75%.

Many aquatic ecologists predict that modifications in macrophyte composition or biomass lead to significant changes in ecosystem structure and productivity. Carpenter and

Lodge (1986), however, observed that these predictions are based primarily on recent population or community studies and have not been tested with whole-lake manipulations of macrophytes. We, therefore, also selected Lake Baldwin, Bell Lake, Clear Lake, Lake Holden, Lake Killarny, Lake Pearl, Lake Orienta, and Lake Wales for study. Aquatic macrophytes in these lakes had been experimentally removed by stocking grass carp (*Ctenopharyngodon idella*). Macrophytes have been eliminated from some of these lakes for over 10 years. Thus the lakes provided a unique opportunity to test the long-term effects of vegetation removal.

Limnological Characteristics

The surface area (SA) of each study lake was obtained primarily from the Gazetteer of Florida Lakes (Shafer et al. 1986). Shoreline length (SL) was measured from aerial photographs with a 1:20,000 or 1:40,000 reduction depending on the year the most recent photographs were taken. A boat-mounted Raytheon recording fathometer was used at all lakes to record water depths. Four to ten transects were made across each lake to provide representative bottom transects. Fathometer data were then used to estimate mean depth (Z). Lake volume (V) was determined by multiplying the lake's surface area by its mean depth:

$$(1) \quad V = SA \times Z$$

where V = lake volume in m^3, SA = surface area (m^2), and Z = mean depth (m).

Six water quality sampling stations were established at each lake. Three stations were placed in open water and three stations were placed in the littoral zone. Summer water samples were collected from the six stations on a single date at the time the fish populations were sampled. Additional water samples were collected from the three open-water stations on two additional dates after the summer sampling. Water was collected from just below the surface (0.5 m) in acid-cleaned Nalgene bottles. Samples were placed on ice and returned to the laboratory for analysis. Water temperature (C) and dissolved oxygen (mg/L) were measured at the surface and bottom at each station by using a Yellow Springs Instrument Model 51a dissolved oxygen meter. Temperature and dissolved oxygen were also measured at 1-m intervals from the surface to the bottom at a single open-water station. Secchi depth (m) was measured at each station where water was collected.

At the laboratory, pH was measured within 24 hr of collection using an Orion Model 601A pH meter calibrated against buffers at pH 4.0, 7.0, and 10.0. Total alkalinity (mg/L as $CaCO_3$) was determined by titration with 0.02 N H_2SO_4 (APHA 1985). Specific conductance (µS/cm @ 25 C) was measured by using a Yellow Springs Instrument Model 31 conductivity bridge. Chloride (mg/L) concentrations were measured by titration with 0.0141 N mercuric nitrate and using diphenylcarbazone for determining endpoints (Hach Chemical Company 1975). Total phosphorus concentrations (µg/L) were determined using the methods of Murphy and Riley (1962) after a persulfate oxidation (Menzel and Corwin 1965). Total nitrogen concentrations (µg/L) were determined by a modified Kjeldahl technique (Nelson and Sommers 1975). Total suspended solids (mg/L), organic suspended solids (mg/L) and inorganic suspended solids (mg/L) were determined according to standard methods (APHA 1985).

Water samples were analyzed for color, calcium, magnesium, and potassium following filtration through a Gelman type A-E glass fiber filter. Color (Pt-Co units) was determined by using the platinum-cobalt method and matched Nessler tubes (APHA 1985). Calcium, magnesium, and potassium concentrations (mg/L) were determined by atomic absorption spectrophotometry (APHA 1985).

The biomass of planktonic algae in each lake was estimated by measuring chlorophyll *a* concentrations. Total chlorophyll *a* concentrations (µg/L) were determined by filtering a measured portion of lake water through a Gelman type A-E glass fiber filter. Nannochlorophyll *a* concentrations (µg/L) were determined by first prefiltering lake water through a 35 µm nitex filter and then filtering the filtrate through a Gelman type A-E glass fiber filter. Chlorophyll *a* was determined by using the method of Yentsch and Menzel (1963) and the equations of Parson and Strickland (1963).

Aquatic macrophytes in the emergent, floating-leaved and submersed plant zones of each lake were sampled once in the summer. The plant zones were determined using the criteria of Wetzel (1975). The percent lake area covered by macrophytes (PAC) and percent volume infested with aquatic macrophytes (PVI) at each lake were determined with a Raytheon DE-719 fathometer (Maceina and Shireman 1980). The above-ground biomass of emergent, floating-leaved and submersed vegetation (kg wet wt/m^2) were measured along ten uniformly placed transects around the lake. A single 0.25 m^2 sample of vegetation (when present) was taken in each plant zone at each transect. The sampled vegetation was placed in nylon mesh bags, spun to remove excess water, and weighed to the nearest 0.10 kg (Canfield et al. 1990).

The width of the floating-leaved and emergent plant zones (W) was also measured at each transect. The percent area covered with floating-leaved and emergent plants (PACFE) in each lake was then calculated by multiplying shoreline length by W and dividing by the lake's surface area:

$$(2)\ PACFE =((SL \times W)/SA) \times 100$$

where PACFE = percent area covered with floating-leaved and emergent vegetation, SL = shoreline length (m), W = width of the floating-leaved and emergent plant zone (m), and SA = lake surface area (m^2). The percent area covered with submersed vegetation (PACS) was calculated by subtracting the estimated PACFE value from the lake's PAC value:

$$(3)\ PACS = PAC - PACFE$$

where PACS = percent area covered with submersed vegetation, PAC = percent of lake's area covered with aquatic macrophytes, and PACFE = percent area covered with floating-leaved and emergent vegetation.

The average above-ground biomass for the floating-leaved and emergent plant zones (PBFE) was calculated by averaging the 20 biomass samples taken within these two plant zone. The average above-ground biomass in the submersed plant zone (PBS) was calculated by averaging the 10 biomass samples taken within the submersed plant zone. The average percent wet weight of the floating-leaved and emergent plant types collected during our study was 89% and the average percent wet weight of submersed plants types collected during our study was 92%. Each lake's total plant biomass expressed as dry weight (TPBDW) was, therefore, calculated by:

$$(4)\ TPBDW = (((PACFE/100) \times SA) \times (PBFE \times 0.11)) + (((PACS/100) \times SA) \times (PBS \times 0.08))$$

where TPBDW = total plant biomass (kg dry weight), PACFE = percent area covered by floating-leaved and emergent vegetation (%), SA = lake surface area (m^2), PBFE = average plant biomass of floating and emergent vegetation (kg wet wt/m^2), PACS = percent area covered by submersed vegetation (%), and PBS = average plant biomass of submersed vegetation (kg wet wt/m^2).

Composite samples of all plant types present on five of the ten transects from several lakes were taken for phosphorus (n = 44 lakes) and nitrogen (n = 6 lakes) content analyses. The plant material was dried at 70 C to a constant weight and ground in a Wiley Mill until fragments were < 0.85 mm. The dried plant material was then given a persulfate digestion diluted and analyzed for phosphorus and nitrogen as reported earlier in this methods section for water samples. Phosphorus averaged 1,380 mg/kg dried plant material and nitrogen averaged 15,400 mg/kg dried plant material. A potential total phosphorus (PTP) concentration and total nitrogen (PTN) concentration (assuming all the nutrients associated with the aquatic macrophyte community were returned to the water column) were calculated for each lake by multiplying the lake's TPBDW value by the average total phosphorus and total nitrogen concentrations measured for our lakes and dividing by each lake's volume:

$$(5)\ PTP = (TPBDW \times 1{,}380 \text{ mg P/kg})/V$$

and

$$(6)\ PTN = (TPBDW \times 15{,}400 \text{ mg N/kg})/V$$

where PTP and PTN = the potential total phosphorus and total nitrogen concentration in the water column (mg/m^3), TPBDW = total plant biomass (kg dry weight), and V = lake volume (m^3).

Measured chlorophyll *a* values are often not good indicators of lake trophic status when large amounts of aquatic macrophytes are present (Canfield et al. 1984). Chlorophyll *a* values in these lake types are generally less than would be expected because of factors like competition for nutrients by macrophytes and their associated periphyton. Thus, we calculated an adjusted chlorophyll *a* value for each lake by adding the measured chlorophyll *a* value to a chlorophyll *a* value predicted from the total phosphorus and total nitrogen associated with the aquatic macrophyte community. This is similar to the approach used by Canfield et al. (1983a) for assessing the trophic status of lakes dominated by aquatic macrophytes.

Adjusted chlorophyll *a* (ACHLA) values were calculated by adding each lake's measured total chlorophyll *a* value (MTCHLA) to the chlorophyll *a* value predicted (PCHLA) from each lake's PTP and PTN values. The predicted chlorophyll *a* values were obtained using the chlorophyll-total phosphorus-total nitrogen relationship developed by Canfield (1983) from data on 165 Florida lakes:

$$(7)\ ACHLA = MTCHLA + PCHLA$$

where ACHLA = adjusted chlorophyll *a* (µg/L), MTCHLA = measured total chlorophyll *a* (µg/L), PCHLA (µg/L) = -2.49 + 0.27 log(PTP) + 1.06 log(PTN), and PTP and PTN = total phosphorus and total nitrogen concentration potentially contributed to the water column from the plant community.

An adjusted chlorophyll *a* value, in the majority of lakes, can be used to accurately estimate the trophic status of lakes with large abundances of aquatic macrophytes. Lakes with a tremendous biomass of aquatic macrophytes, however, may contain sufficient nutrients that if released into a lakes system the nutrients would no longer limit the growth of algae. Lake Okahumpka for example, was the only lake sampled in this study that fit into this category. Due to the tremendous plant biomass in Okahumpka (17 kg wet wt/ha submersed vegetation) the adjusted chlorophyll *a* value was calculated at over 900 µg/L, which is higher than any recorded average chlorophyll *a* value found in Florida (Huber et al. 1982). Average chlorophyll *a* values for nearly all of the world's lakes rarely reach levels exceeding 300 µg/L because intrinsic factors such as self-shading limit phytoplankton populations instead of nutrients (Canfield 1983). Thus, we placed a cap on our adjusted chlorophyll *a* values of 350 µg/L, which was slightly greater than the highest measured average reported for over 750 Florida Lakes by Huber et al (1982).

Periphyton biomass (mg chlorophyll a/cm^2) of host plant and mg chlorophyll *a*/kg wet wt of host plant) was estimated on the most common plants sampled along ten transects using a method modified after Gough and Woelkering (1976) and Schramm et al. (1983). Approximately 100 g wet weight of each macrophyte sampled was cut from 0.1 to 0.5 m below the surface of the water and placed in 500 ml of tap water in a 1-L widemouth

Nalgene bottle and placed on ice. Periphyton was removed by shaking within seven hours of sampling. Each sample was shaken manually for 30 seconds and the supernatant poured through a 1.0 mm screen. This procedure was repeated three times for each plant sample, adding 500 ml of tap water for each shaking, which produced a total of 1500 ml of supernatant. The supernatant was subsampled and analyzed for total mg of chlorophyll *a* as described above for planktonic algae. The total amount of chlorophyll *a* was then divided by the surface area of the plant samples, which was estimated according to the methods of Hoyer and Canfield (1986), and the wet weight of the plant sample.

Epiphytic macroinvertebrates (individuals/kg wet wt of host plants and g wet wt/kg wet wt of host plants) were removed from plant material collected at four to six locations around each lake. Benthic macroinvertebrates (individuals/m^2 and g wet wt/m^2) and zooplankton samples (individuals/m^3) were collected from six stations (three littoral and three open-water). Benthic macroinvertebrates were collected with a petite ponar and zooplankton were collected with a Wisconsin net (12 cm mouth diameter and 80 μm mesh net). The net was towed vertically through the water column from 0.5 m above the bottom to the surface. All invertebrates were preserved in 80% alcohol for later processing. Epiphytic and benthic macroinvertebrates were counted and weighed (wet weight) to the nearest mg. Zooplankton were enumerated as cladocerans, copepods, nauplii and rotifers.

Fish

Rotenone sampling was conducted once during the warm season (May - November) at each lake to determine fish stock, standing crop and community structure. Two to twelve 0.08-ha blocknets were set at each lake depending on the size of the lake. The majority of the lakes were sampled with six nets, but Little Fish Pond (surface area 2 ha) was sampled with only 2 nets while Lake Apopka (surface area > 12,000 ha) was sampled with 12 nets. Equal numbers of blocknets were set in littoral (with one side being the shore) and limnetic habitats. Blocknet sampling followed procedures outlined in Shireman et al. (1983). Biomass (kg/hectare) and density (number/hectare) estimates were calculated for each fish species in each net and weighted by habitat (littoral and open-water area) to obtain whole-lake estimates. Estimates were not weighted by the type of vegetation.

Fish populations in the open-water areas of each lake were sampled by use of experimental gillnets. Three to six experimental gillnets, depending on lake size, were set once in each lake during the warm season. Three nets were set in the majority of the lakes, but six nets were set at Lake Apopka and Lake Harris. We, however, only retrieved one net in three lakes and two nets in seven lakes due to vandalism, accidental boat damage or alligator damage. Nets were set once for 24 hr during the summer sampling period to obtain catch per unit effort statistics (number and kg/experimental gillnet/24 hr). Gillnets were 50 m by 2.4 m and each gillnet had five 10-m panels of different mesh size (bar mesh sizes: 19, 25, 38, 51, and 76 mm). Nets were fished along the bottom in water depths > 2 m. Fish collected in gillnets were identified to species, separated into 40 mm total length (TL) size groups, and counted. Only the whole-fresh fish were weighed because some fish were partially decomposed or eaten. The average weights of each species and size group for the whole-fresh fish were multiplied by the corresponding number of fish collected in each size class that could not be weighed to yield a biomass for those fish. The number and weight of fish were summed by net and then the nets were averaged to yield a gillnet catch per unit effort (number or kg/experimental gillnet/24 hr).

Electrofishing was conducted at each lake once during the warm season sampling period in near-shore areas in all habitats. Two to ten electrofishing samples were taken at each lake depending on lake size. Six samples were taken at most of the lakes, but only two samples were taken at Little Fish Pond (lake surface area 2 ha). Ten samples were taken from Lake Harris (lake surface area 5580 ha). Electrofishing transects were evenly spaced around the lake and electrofishing was done for 10 minutes with continuous current. Shocked fish were collected, identified to species, separated into 40 mm TL size groups, counted and weighed. The number and weight of fish were summed by sample and then averaged by lake to yield a catch per unit electrofishing effort (number or kg/hr of shocking) statistic.

An intensive mark-recapture program was initiated on most of the lakes to further assess the abundance of harvestable sportfish. Some lakes, however, were not sampled or population estimates were not obtained because of environmental conditions (e.g., low conductivity, low water, or lake size). The mark-recapture programs were conducted between January and June following the warm season rotenone, gillnet and electrofishing sampling. Bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), and black crappie (*Pomoxis nigromaculatus*) > 150 mm TL and largemouth bass (*Micropterus salmoides*) > 250 mm TL were collected by electrofishing and given a left pelvic fin-clip.

Electrofishing and marking with left pelvic clips continued until approximately 10% of each species collected showed marks, then a recapture phase started giving all fish a right pelvic clip. Population estimates (fish/hectare) for each species were estimated with an adjusted Petersen method (Ricker 1975).

Individual length and weight were measured on subsamples of bluegill, redear sunfish, black crappie and largemouth bass collected in blocknets, gillnets, and electroshocking runs. Ten fish were measured in each 40-mm TL size group to determine individual length-weight relations for each lake using the following order of sampling methods to fill the size groups: electroshocking, gillnets, and blocknets. All first day, or fresh largemouth bass over 160 mm TL were measured. Otoliths were collected on all fish > 120 mm TL that were measured individually. The otoliths were read in whole-view according to the methods of Hoyer et al. (1985) to determine age and length at age.

Statistical Analyses

Statistical analyses were conducted using SYSTAT (Wilkinson, 1987). Because the trophic state, fish and aquatic macrophyte values spanned orders of magnitude and variances were proportional to means, all data values with the exception of percent data values, were transformed to their logarithms (base 10) prior to statistical analyses. All percent data values were transformed with an arcsine transformation (angular transformation, Snedecor and Cochran 1979). We used least square and multivariate regression analyses for the development of simple empirical models including trophic state, fish standing crop and aquatic macrophyte models.

When we sought to identify the trend and shape of relationships between our measured variables, we plotted and visually examined smoothed points calculated using LOWESS, a locally weighted robust regression (Cleveland 1979; Cleveland 1981). LOWESS is a method for smoothing scatterplots in which fitted value at x_k is the value of a line fit to the data using weighted least squares, where the weight for (x_i, y_i) is large if x_i is close to x_k and small if x_i is not close to x_k. The robust fitting procedure guards against outliers distorting the smoothed points.

RESULTS AND DISCUSSION

Limnological and Fisheries Characteristics

A wide range of limnological and fisheries conditions existed in the 60 lakes sampled during this study (Table 1, 2, 3, 4, 5, 6, 7, 8). The lakes ranged in size from small lakes like Little Fish Pond (2 ha) to large lakes like Lake Apopka (12412 ha). Mean depth for the lakes ranged from 0.6 m to 5.9 m. Mean total phosphorus concentrations ranged from 1 to 1043 µg/L and average total nitrogen concentrations ranged from 82 to 6340 µg/L. Secchi depths ranged 0.3 to 5.8 m and total chlorophyll *a* concentrations ranged from 1.0 to 241 µg/L. Total alkalinity and specific conductance ranged from 0 to 131 mg/L as $CaCO_3$ and 17 to 384 µS/cm at 25 C, respectively (Table 8).

Many different aquatic macrophyte communities were sampled. There was an average of 13 species of aquatic macrophytes per lake with percent aquatic macrophyte coverage and percent volume infested with macrophytes ranging from < 1 to 100%, respectively (Table 8). The mean emergent, floating-leaved and submersed above-ground biomass for all lakes was 3.4, 1.1 and 1.6 kg wet wt/m^2, respectively (Table 8). While these values are less than the values for analogous plant groupings listed by Wetzel (1975) for seasonal maximum above-ground biomass, they do support Wetzel's (1975) conclusion that emergent plants maintain a higher biomass than floating-leaved or submersed plants.

Epiphytic macroinvertebrate abundance and biomass ranged 30 to 2885 individuals/kg wet wt of plant and < 0.1 to 35.8 g/kg wet wt of plant, respectively (Table 8). Benthic macroinvertebrate abundance and biomass ranged 7 to 2733 individuals/m^2 and < 0.1 to 68.8 g/m^2, respectively (Table 8). These benthic macroinvertebrate abundance estimates bracket the ranges (318 to 1523 individuals/m^2) reported by Schramm et al. (1983) for two eutrophic Florida lakes.

The average zooplankton populations for this study were dominated by rotifers followed by cladocerans, nauplii, and copepods, with 148,300, 68,000, 67,100 and 66,800 individuals/m^3,respectively. These zooplankton abundances are well within the ranges listed by Canfield and Watkins (1984) for 165 Florida lakes. Several lakes also had significant populations of ostracods and Chaoborus in the water column, **(Text Continued on page 66)**

Table 2. Mean, median, and the standard error of the mean for lake trophic state variables (total phosphorus, total nitrogen, total chlorophyll *a*, and Secchi) and water chemistry values estimated from water samples collected on three different dates from 60 Florida lakes between 1986 and 1990.

Lake	Year	Total Phosphorus (µg/L)			Total Nitrogen (µg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	2	2	1.1	208	173	44.7
Brim Pond	86	9	9	0.6	624	628	18.3
Okahumpka	86	21	25	5.4	1033	947	125.2
Clay	86	7	1	6.0	356	356	0.0
Wauberg	86	166	158	19.4	1478	1567	106.5
Bivens Arm	86	384	443	96.9	3256	3600	1043.9
Apopka	86	140	134	29.6	3789	3900	293.8
Miona	86	12	14	2.0	867	927	98.3
Wales	86	27	22	5.6	899	857	87.6
Clear	86	21	22	2.2	761	720	94.9
Baldwin	86	21	22	2.1	510	510	20.0
Baldwin	88	23	23	1.2	581	581	77.5
Baldwin	89	20	21	2.2	498	510	60.6
Susannah	86	23	23	5.0	612	612	38.7
Susannah	88	23	23	2.8	748	748	0.0
Susannah	89	21	22	0.6	664	630	96.6
Pearl	86	28	29	1.8	798	798	44.7
Pearl	88	28	28	0.0	820	820	0.0
Pearl	89	28	28	1.8	838	838	178.9
Cue	86	5	5	0.6	91	90	27.4
Alligator	87	371	320	91.1	2367	2367	1200.0
Crooked	87	7	7	1.4	313	333	52.4
Deep	87	2	2	0.7	158	158	0.0
Lawbreaker	87	1	1.0	0.3	108	105	31.6
Round Pond	87	3	3	0.7	444	444	100.0
Carr	87	19	15	5.5	874	874	165.8
Hollingsworth	87	113	109	10.8	2517	2517	483.2
Hunter	87	98	104	9.1	1723	1723	643.4
Hartridge	87	11	10	1.8	485	477	25.8
Killarny	87	21	21	0.3	603	608	77.5
Holden	87	44	44	2.0	1226	1400	200.0
Catherine	87	2	3	0.7	303	303	57.7
Bell	87	17	15	3.2	641	693	79.6
Bonny	87	59	50	11.1	1858	1858	124.5
Harris	87	28	28	0.0	1550	1550	0.0
Lindsey	88	19	17	3.7	636	647	38.9

Table 2. (Continued)

Lake	Year	Total Phosphorus (µg/L)			Total Nitrogen (µg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Loften	88	5	4	1.4	633	385	267.2
Moore	88	5	5	0.2	353	348	26.1
Live Oak	88	13	14	1.7	389	347	68.8
Koon	88	5	5	0.2	687	727	48.9
Watertown	88	27	25	3.6	777	740	63.3
Patrick	88	10	10	1.6	1808	1467	380.1
Orienta	88	25	25	2.7	448	415	49.5
Conine	88	1043	1096	65.7	2056	2067	202.1
Tomahawk	88	6	4	1.4	192	207	31.2
Barco	88	2	1	1.1	82	83	2.9
Suggs	88	66	58	15.8	1249	1367	187.9
Carlton	88	92	95	12.4	3228	3217	20.0
Rowell	88	66	69	5.2	910	807	230.1
Lochloosa	88	32	32	1.3	1053	1053	123.2
Turkey Pen	88	2	1	0.6	132	118	28.7
Fish	88	25	32	9.4	935	938	61.6
Bull Pond	89	11	11	1.5	522	525	27.0
Mill Dam	89	11	13	2.8	462	467	23.7
West Moody	89	14	13	1.2	584	543	47.9
Grasshopper	89	6	6	0.6	259	257	50.0
Mountain	89	37	32	5.6	813	770	62.0
Douglas	89	11	10	1.3	1122	1167	44.4
Pasadena	89	15	15	1.0	702	707	11.8
Marianna	89	26	25	1.4	1054	1117	159.0
Mountain 2	89	17	18	2.0	331	300	34.5
Gate Lake	89	28	27	2.8	407	407	2.4
Thomas	89	22	21	1.6	759	818	73.5
Little Fish	89	21	21	1.5	1161	1133	45.5
Picnic	89	8	8	0.3	137	130	19.5
Swim Pond	89	25	27	1.8	1025	1058	48.2

Table 2. (Continued)

Lake	Year	Total Chlorophyll *a* (µg/L)			Nannochlorophyll *a* (µg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	1	1	0.0	1.0	1.0	.0.0
Brim Pond	86	8	8	0.9	7	8	0.9
Okahumpka	86	11	6	7.3	5	4	2.6
Clay	86	4	2	1.6	1	1	0.3
Wauberg	86	102	115	28.0	99	119	28.0
Bivens Arm	86	241	259	62.5	224	238	61.2
Apopka	86	127	156	30.7	57	63	9.2
Miona	86	8	6	3.5	4	2	2.5
Wales	86	42	43	5.8	39	42	5.6
Clear	86	21	20	8.3	18	13	7.4
Baldwin	86	17	16	3.6	14	15	2.5
Baldwin	88	24	24	3.4	19	19	2.5
Baldwin	89	14	14	1.8	12	11	1.7
Susannah	86	16	16	3.6	11	11	4.2
Susannah	88	43	43	0.4	18	18	5.4
Susannah	89	16	16	4.5	7	3	4.5
Pearl	86	22	19	4.0	19	16	3.6
Pearl	88	24	24	0.0	20	20	0.0
Pearl	89	19	19	3.2	16	16	4.3
Cue	86	2	2	0.5	1	1	0.3
Alligator	87	84	25	62.0	59	22	38.3
Crooked	87	2	2	0.6	1	1	0.2
Deep	87	1.0	1.0	0.2	1.0	1.0	0.2
Lawbreaker	87	1.0	1.0	0.3	1.0	1.0	0.3
Round Pond	87	3	2	2.0	1	1	0.3
Carr	87	11	7	5.9	4	3	0.9
Hollingsworth	87	135	135	33.1	119	119	29.5
Hunter	87	82	80	10.9	76	71	10.5
Hartridge	87	4	4	1.6	4	3	1.4
Killarny	87	22	17	6.3	21	14	7.6
Holden	87	64	52	14.4	58	45	15.1
Catherine	87	2	2	0.7	1	1	0.3
Bell	87	20	23	9.2	19	21	9.1
Bonny	87	40	37	3.7	37	37	4.7
Harris	87	37	37	0.0	30	30	0.0
Lindsey	88	6	5	2.5	2	2	0.3
Loften	88	2	1	0.5	1.0	1.0	0.2
Moore	88	3	4	1.1	2	1	0.9
Live Oak	88	9	5	5.8	3	4	1.0

Table 2. (Continued)

Lake	Year	Total Chlorophyll *a* (μg/L)			Nannochlorophyll *a* (μg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Koon	88	3	2	0.6	2	2	0.2
Watertown	88	24	21	4.3	20	17	4.7
Patrick	88	5	4	0.7	3	3	0.7
Orienta	88	9	10	2.2	7	8	1.8
Conine	88	110	119	14.9	100	110	17.3
Tomahawk	88	1	1	0.3	1.0	1	0.3
Barco	88	1.0	1.0	0.2	0	0	0.10
Suggs	88	4	3	2.0	2	2	0.8
Carlton	88	173	196	28.6	165	179	23.7
Rowell	88	47	38	26.0	51	49	26.3
Lochloosa	88	22	27	7.5	16	20	5.5
Turkey Pen	88	1.0	1.0	0.10	1.0	1.0	0.0
Fish	88	18	18	3.3	16	16	3.1
Bull Pond	89	3	3	0.9	2	2	0.6
Mill Dam	89	4	3	1.3	2	3	0.5
West Moody	89	2	2	0.3	2	2	0.3
Grasshopper	89	1	1.0	0.5	1.0	1.0	0.3
Mountain	89	10	10	1.5	6	5	1.9
Douglas	89	2	3	0.4	2	2	0.3
Pasadena	89	3	3	0.7	2	2	0.8
Marianna	89	21	24	5.7	17	21	5.5
Mountain 2	89	2	1	0.6	2	1	0.7
Gate Lake	89	20	19	3.7	17	17	1.9
Thomas	89	10	10	2.3	9	9	2.2
Little Fish	89	13	10	4.7	10	9	3.6
Picnic	89	1	1	0.4	1	1	0.3
Swim Pond	89	11	10	1.6	7	6	3.0

Table 2. (Continued)

Lake	Year	Secchi Depth (m)			Specific Conductance (μS/cm at 25 C)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	5.3	5.3	0.00	43	43	1.6
Brim Pond	86	2.2	2.2	0.12	95	95	12.4
Okahumpka	86	1.4	1.4	0.30	188	176	19.4
Clay	86	4.0	4.0	0.00	51	52	2.0
Wauberg	86	0.6	0.6	0.08	79	80	2.6
Bivens Arm	86	0.4	0.3	0.07	227	226	4.7
Apopka	86	0.3	0.3	0.10	371	369	14.0
Miona	86	1.5	1.5	0.00	122	119	6.2
Wales	86	0.8	0.7	0.10	118	116	4.0
Clear	86	1.3	1.3	0.28	195	193	3.7
Baldwin	86	1.7	1.7	0.21	166	164	2.3
Baldwin	88	1.3	1.3	0.13	185	185	5.5
Baldwin	89	1.8	1.8	0.15	187	185	3.4
Susannah	86	1.5	1.5	0.23	132	132	4.6
Susannah	88	1.2	1.2	0.06	119	119	2.7
Susannah	89	1.7	1.6	0.26	127	130	3.3
Pearl	86	1.0	1.0	0.07	119	118	1.3
Pearl	88	0.9	0.9	0.00	118	118	0.0
Pearl	89	0.9	0.9	0.07	116	116	1.4
Cue	86	5.8	6.0	0.59	45	45	0.9
Alligator	87	0.5	0.5	0.20	137	144	11.3
Crooked	87	3.1	3.1	0.55	45	44	0.4
Deep	87		Bottom		36	37	0.8
Lawbreaker	87	5.5	5.5	0.00	65	65	1.2
Round Pond	87		Bottom		41	41	0.8
Carr	87	1.8	1.8	0.36	26	25	0.7
Hollingsworth	87	0.3	0.3	0.06	163	163	3.5
Hunter	87	0.5	0.5	0.03	182	174	13.7
Hartridge	87	2.3	2.3	0.32	217	219	3.1
Killarny	87	1.0	1.0	0.04	193	194	1.7
Holden	87	0.5	0.5	0.05	232	233	6.9
Catherine	87	3.2	3.2	0.30	48	48	0.5
Bell	87	1.5	1.1	0.61	116	114	2.6
Bonny	87	0.6	0.6	0.03	255	256	2.4
Harris	87	0.6	0.6	0.00	248	248	0.0
Lindsey	88	1.9	1.9	0.18	33	34	1.7
Loften	88	2.5	2.5	0.52	20	19	0.9
Moore	88	5.3	5.3	2.97	17	16	1.0

Table 2. (Continued)

Lake	Year	Secchi Depth (m)			Specific Conductance (µS/cm at 25 C)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Live Oak	88	2.6	2.6	1.30	132	131	2.3
Koon	88	1.4	1.4	0.00	29	29	1.2
Watertown	88	1.0	0.9	0.12	147	144	5.3
Patrick	88	2.0	2.0	0.09	323	320	9.5
Orienta	88	2.2	1.9	0.32	114	115	2.1
Conine	88	0.5	0.5	0.15	346	347	3.7
Tomahawk	88	4.2	4.0	0.17	35	35	1.0
Barco	88	5.4	6.2	0.91	43	42	1.2
Suggs	88	0.5	0.5	0.09	60	58	2.1
Carlton	88	0.4	0.5	0.10	384	387	7.4
Rowell	88	0.8	0.7	0.19	286	290	63.1
Lochloosa	88	1.0	1.0	0.05	96	88	15.4
Turkey Pen	88	3.2	3.0	0.20	21	21	0.5
Fish	88	1.0	1.0	0.00	187	185	6.5
Bull Pond	89	1.4	1.5	0.47	57	57	1.2
Mill Dam	89	2.7	2.5	0.46	45	45	0.2
West Moody	89	2.8	2.8	0.00	127	132	5.4
Grasshopper	89	3.7	3.4	0.30	61	60	3.0
Mountain	89	1.7	1.9	0.30	113	110	3.1
Douglas	89	1.5	1.5	0.00	245	240	5.2
Pasadena	89	2.2	2.2	0.30	131	129	6.7
Marianna	89	1.3	1.0	0.34	299	300	4.0
Mountain 2	89	2.4	2.3	0.17	201	203	6.0
Gate Lake	89	1.1	1.1	0.04	282	282	3.2
Thomas	89	1.8	1.5	0.36	169	167	3.5
Little Fish	89	1.4	1.4	0.19	83	85	5.7
Picnic	89	2.6	2.5	0.08	69	70	1.4
Swim Pond	89	0.6	0.6	0.00	43	43	1.2

Table 2. (Continued)

Lake	Year	Total Alkalinity (mg/L as $CaCO_3$)			Color (Pt-Co units)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	1.7	1.6	0.18	1.7	0.0	1.66
Brim Pond	86	29.1	30.0	6.42	10.0	10.0	0.00
Okahumpka	86	54.6	44.0	10.89	36.7	30.0	9.28
Clay	86	0.7	0.8	0.24	2.5	0.8	2.10
Wauberg	86	20.6	21.2	1.38	29.4	21.7	8.62
Bivens Arm	86	101.3	99.7	5.74	25.0	23.3	2.54
Apopka	86	111.0	101.3	10.68	34.2	32.5	3.01
Miona	86	22.2	22.3	1.30	15.6	15.0	2.42
Wales	86	25.6	24.0	2.08	10.0	10.0	0.00
Clear	86	44.9	44.3	0.78	13.3	15.0	1.66
Baldwin	86	54.4	53.3	1.82	11.7	11.7	0.97
Baldwin	88	68.5	68.5	2.83	13.8	13.8	3.75
Baldwin	89	66.4	65.0	2.70	10.0	10.0	0.00
Susannah	86	32.8	32.8	0.75	11.7	11.7	1.67
Susannah	88	30.8	30.8	0.17	10.8	10.8	2.50
Susannah	89	28.9	28.8	0.58	10.0	10.0	0.00
Pearl	86	21.1	21.0	0.48	70.0	80.0	10.00
Pearl	88	18.0	18.0	0.00	70.0	70.0	0.00
Pearl	89	17.4	17.4	0.08	65.0	65.0	5.00
Cue	86	0.5	0.4	0.14	0.0	0.0	0.00
Alligator	87	45.9	47.0	2.75	50.3	49.2	9.16
Crooked	87	0.4	0.3	0.08	3.9	5.0	1.11
Deep	87	0.3	0.4	0.13	3.9	5.0	1.11
Lawbreaker	87	0.0	0.0	0.00	0.0	0.0	0.00
Round Pond	87	0.9	0.8	0.12	10.3	10.0	0.73
Carr	87	7.5	7.8	0.37	21.7	20.0	1.66
Hollingsworth	87	50.8	50.8	0.67	16.4	15.8	1.00
Hunter	87	69.0	66.0	4.58	16.7	15.0	1.66
Hartridge	87	37.6	37.8	0.31	11.7	10.0	1.66
Killarny	87	65.4	66.0	1.15	18.9	15.0	3.89
Holden	87	69.2	70.7	4.63	10.6	10.0	0.55
Catherine	87	0.4	0.5	0.12	3.1	4.3	1.56
Bell	87	13.3	18.0	5.76	21.1	23.3	3.09
Bonny	87	53.2	53.3	1.06	32.8	31.7	2.00
Harris	87	86.5	86.5	0.00	15.0	15.0	0.00
Lindsey	88	10.2	11.0	1.02	36.9	33.3	6.7[illegible]
Loften	88	1.0	0.9	0.25	20.0	13.3	

Table 2. (Continued)

Lake	Year	Total Alkalinity (mg/L as $CaCO_3$)			Color (Pt-Co units)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Moore	88	2.2	2.2	0.16	18.9	20.0	4.84
Live Oak	88	11.5	11.7	1.53	22.2	20.0	4.00
Koon	88	2.6	2.4	0.21	63.3	70.0	12.02
Watertown	88	59.2	62.0	3.12	26.7	20.0	6.67
Patrick	88	58.9	57.7	7.24	15.6	16.7	2.94
Orienta	88	6.6	7.2	1.73	16.9	15.8	1.55
Conine	88	64.4	68.2	5.94	30.0	30.0	2.89
Tomahawk	88	1.0	1.0	0.21	0.0	0.0	0.00
Barco	88	0.10	0.0	0.09	1.7	0.0	1.66
Suggs	88	2.0	2.2	0.29	400.0	400.0	115.47
Carlton	88	104.7	105.7	3.07	36.9	37.5	1.00
Rowell	88	22.3	20.3	3.18	86.7	45.0	57.32
Lochloosa	88	24.8	24.0	4.02	115.6	120.0	50.09
Turkey Pen	88	0.4	0.5	0.07	0.8	0.0	0.84
Fish	88	25.9	25.7	1.16	42.5	42.5	1.45
Bull Pond	89	0.7	0.2	0.56	9.2	10.0	3.16
Mill Dam	89	3.9	3.3	0.91	6.9	7.5	1.94
West Moody	89	30.6	32.0	1.97	19.7	16.7	3.92
Grasshopper	89	0.1	0.0	0.11	0.0	0.0	0.00
Mountain	89	25.6	26.3	1.13	38.9	38.3	3.38
Douglas	89	27.1	26.5	1.94	30.3	30.0	0.26
Pasadena	89	20.4	20.7	0.83	19.4	18.3	2.00
Marianna	89	59.4	58.0	2.00	16.4	15.8	1.94
Mountain 2	89	82.3	80.0	3.93	6.7	5.0	1.66
Gate Lake	89	130.6	132.3	2.12	6.1	5.0	1.11
Thomas	89	46.6	46.3	1.31	23.3	25.0	1.66
Little Fish	89	31.8	34.0	2.22	28.9	30.0	1.11
Picnic	89	0.0	0.0	0.00	0.0	0.0	0.00
Swim Pond	89	0.9	1.0	0.29	26.1	25.0	2.94

Table 2. (Continued)

Lake	Year	pH			Chloride (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	5.4	5.4	0.03	6.0	6.3	0.38
Brim Pond	86	7.8	7.8	0.10	6.8	6.9	0.41
Okahumpka	86	9.0	9.4	0.50	24.1	23.3	1.26
Clay	86	4.8	4.8	0.11	9.9	10.0	0.46
Wauberg	86	7.7	7.4	0.51	11.3	12.0	0.67
Bivens Arm	86	9.7	9.6	0.23	13.6	14.0	1.56
Apopka	86	9.4	9.4	0.23	39.8	41.3	1.90
Miona	86	7.9	7.5	0.45	17.7	17.0	1.20
Wales	86	8.7	8.7	0.25	12.3	12.0	0.33
Clear	86	8.6	8.6	0.23	23.4	24.0	0.56
Baldwin	86	8.0	8.1	0.07	12.6	12.7	0.34
Baldwin	88	8.3	8.3	0.29	12.4	12.4	0.08
Baldwin	89	7.9	7.9	0.07	13.3	13.8	0.64
Susannah	86	7.8	7.8	0.03	10.8	10.8	0.17
Susannah	88	8.7	8.7	0.23	12.2	12.2	0.17
Susannah	89	7.4	7.4	0.13	12.6	13.0	0.84
Pearl	86	7.6	7.4	0.19	16.4	16.0	0.42
Pearl	88	7.3	7.3	0.00	21.2	21.2	0.00
Pearl	89	7.2	7.2	0.01	18.4	18.4	1.42
Cue	86	4.6	4.6	0.04	6.8	7.0	0.34
Alligator	87	8.0	7.9	0.06	12.5	13.8	1.59
Crooked	87	4.6	4.6	0.03	7.3	7.1	0.29
Deep	87	4.6	4.6	0.04	6.3	6.2	0.70
Lawbreaker	87	4.4	4.4	0.04	7.8	7.6	0.24
Round Pond	87	4.8	4.8	0.04	8.3	8.5	0.32
Carr	87	6.4	6.3	0.14	3.6	3.5	0.29
Hollingsworth	87	8.8	9.1	0.43	17.8	18.0	0.92
Hunter	87	9.0	9.0	0.12	13.4	12.7	0.81
Hartridge	87	7.8	7.8	0.02	22.7	23.0	0.33
Killarny	87	8.4	8.3	0.19	14.0	14.0	0.00
Holden	87	8.6	8.7	0.28	20.0	20.0	0.00
Catherine	87	4.7	4.7	0.04	9.0	9.0	0.02
Bell	87	7.6	7.6	0.19	17.7	18.0	0.33
Bonny	87	7.8	7.7	0.15	26.4	26.5	0.20
Harris	87	8.5	8.5	0.00	19.7	19.7	0.00
Lindsey	88	6.9	6.8	0.11	4.6	4.8	0.34
Loften	88	4.9	4.8	0.15	2.6	3.0	0.48
Moore	88	5.8	5.8	0.07	2.9	3.1	0.22
Live Oak	88	7.1	7.0	0.22	24.7	24.3	0.88

Table 2. (Continued)

Lake	Year	pH			Chloride (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Koon	88	5.2	5.2	0.04	6.2	5.5	0.76
Watertown	88	7.9	7.9	0.09	8.4	8.2	0.28
Patrick	88	8.1	8.1	0.23	28.8	27.3	1.61
Orienta	88	6.8	7.0	0.27	15.7	15.3	0.88
Conine	88	9.5	9.6	0.28	43.5	45.2	2.10
Tomahawk	88	4.9	4.9	0.05	6.3	6.2	0.74
Barco	88	4.5	4.5	0.04	5.4	5.2	0.72
Suggs	88	5.0	4.9	0.15	12.8	11.0	2.18
Carlton	88	8.9	8.7	0.19	42.4	45.7	3.39
Rowell	88	7.9	7.7	0.58	33.3	24.0	14.66
Lochloosa	88	8.1	7.7	0.48	12.3	12.0	2.24
Turkey Pen	88	4.7	4.6	0.05	2.1	2.1	0.35
Fish	88	7.6	7.6	0.14	27.6	25.7	2.76
Bull Pond	89	5.3	5.4	0.21	12.3	12.0	0.88
Mill Dam	89	6.6	6.5	0.12	9.4	9.3	0.17
West Moody	89	8.1	8.7	0.64	20.5	19.5	1.80
Grasshopper	89	4.5	4.6	0.08	12.2	12.0	0.17
Mountain	89	7.3	7.2	0.07	19.3	18.0	2.40
Douglas	89	7.2	7.3	0.13	43.7	43.7	2.12
Pasadena	89	7.8	7.8	0.57	26.2	24.7	1.76
Marianna	89	7.9	7.9	0.28	30.6	30.7	0.29
Mountain 2	89	7.9	7.9	0.10	10.8	10.7	0.67
Gate Lake	89	8.2	8.2	0.05	9.9	10.0	0.23
Thomas	89	7.6	7.7	0.21	17.4	17.8	0.53
Little Fish	89	6.8	6.8	0.00	5.6	5.6	0.00
Picnic	89	4.3	4.4	0.11	10.6	10.8	0.31
Swim Pond	89	5.6	5.6	0.08	9.7	9.3	0.48

Table 2. (Continued)

Lake	Year	Calcium (mg/L)			Magnesium (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	2.4	2.4	0.02	0.8	0.7	0.00
Brim Pond	86	11.5	12.0	17.15	1.4	1.4	0.12
Okahumpka	86	19.1	15.3	60.56	3.5	3.4	0.14
Clay	86	0.4	0.5	0.00	0.8	0.8	0.00
Wauberg	86	6.3	6.3	0.03	1.5	1.5	0.00
Bivens Arm	86	31.9	28.7	34.48	3.1	3.1	0.02
Apopka	86	27.2	23.3	83.59	17.7	17.7	0.11
Miona	86	9.1	9.1	0.05	2.4	2.3	0.06
Wales	86	8.1	8.2	0.38	3.8	3.7	0.03
Clear	86	14.8	15.0	1.81	6.0	6.0	0.03
Baldwin	86	14.6	13.0	1.66	3.8	3.5	0.05
Baldwin	88	24.3	24.3	1.13	4.2	4.2	0.01
Baldwin	89	23.0	22.0	3.00	3.9	3.7	0.08
Susannah	86	13.5	13.5	0.50	1.8	1.8	0.01
Susannah	88	13.1	13.1	0.01	1.6	1.6	0.00
Susannah	89	12.7	12.7	0.06	1.6	1.6	0.00
Pearl	86	9.7	9.6	0.06	3.0	3.0	0.00
Pearl	88	8.3	8.3		3.2	3.2	
Pearl	89	8.5	8.5	0.25	3.1	3.1	0.06
Cue	86	0.8	0.9	0.03	0.8	0.8	0.00
Alligator	87	14.9	15.0	0.26	2.7	2.8	0.16
Crooked	87	0.9	1.0	0.14	0.8	0.8	0.00
Deep	87	0.3	0.4	0.01	0.6	0.6	0.01
Lawbreaker	87	0.8	0.8	0.01	1.3	1.3	0.00
Round Pond	87	0.4	0.4	0.01	0.8	0.8	0.00
Carr	87	2.2	2.2	0.01	1.0	1.0	0.00
Hollingsworth	87	18.8	19.0	1.58	3.5	3.6	0.03
Hunter	87	24.9	23.7	17.90	2.9	2.9	0.01
Hartridge	87	13.8	13.8	1.36	6.7	6.7	0.01
Killarny	87	22.3	22.7	2.62	4.3	4.3	0.01
Holden	87	25.6	26.7	4.93	4.5	4.6	0.03
Catherine	87	0.7	0.7	0.01	0.8	0.8	0.00
Bell	87	7.3	7.2	0.30	3.0	3.0	0.00
Bonny	87	29.0	29.0	0.00	4.4	4.4	0.00
Harris	87	27.8	27.8		7.1	7.1	
Lindsey	88	4.0	4.1	0.33	0.9	0.9	0.00
Loften	88	0.3	0.3	0.00	0.2	0.2	0.00
Moore	88	0.6	0.6	0.00	0.5	0.6	0.00
Live Oak	88	4.5	4.5	0.00	4.4	4.4	0.02
Koon	88	1.8	1.7	0.03	0.5	0.5	0.00

Table 2. (Continued)

Lake	Year	Calcium (mg/L)			Magnesium (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Watertown	88	19.7	20.0	2.33	2.7	2.7	0.00
Patrick	88	19.9	19.0	2.37	15.9	16.0	1.37
Orienta	88	7.3	6.9	0.85	2.8	2.7	0.03
Conine	88	20.6	21.0.	2.62	6.7	6.7	0.04
Tomahawk	88	0.6	0.5	0.00	0.6	0.6	0.00
Barco	88	0.8	0.8	0.00	0.7	0.7	0.00
Suggs	88	1.8	1.7	0.03	1.5	1.5	0.00
Carlton	88	33.6	33.7	2.26	16.2	16.7	1.15
Rowell	88	28.3	30.0	74.33	3.5	3.2	1.26
Lochloosa	88	9.7	9.2	3.57	2.9	2.7	0.43
Turkey Pen	88	0.4	0.3	0.01	0.2	0.2	0.00
Fish	88	10.2	10.0	0.53	4.6	4.4	0.09
Bull Pond	89	1.7	1.7	0.04	1.1	1.1	0.00
Mill Dam	89	2.4	2.4	0.01	0.9	0.9	0.00
West Moody	89	8.7	8.7	0.80	4.8	4.9	0.00
Grasshopper	89	1.0	1.0	0.00	0.9	0.9	0.00
Mountain	89	11.9	7.9	53.08	5.8	5.0	3.99
Douglas	89	5.1	5.3	0.34	4.8	4.7	0.06
Pasadena	89	6.0	5.8	0.62	5.6	5.7	0.05
Marianna	89	20.9	20.7	1.04	8.1	8.6	1.45
Mountain 2	89	16.8	19.2	74.48	6.9	8.0	5.01
Gate Lake	89	39.1	39.7	1.12	8.1	8.1	0.00
Thomas	89	20.0	19.7	1.44	2.0	2.0	0.00
Little Fish	89	11.2	11.7	1.23	1.8	1.8	0.03
Picnic	89	1.4	1.3	0.02	1.1	1.1	0.01
Swim Pond	89	2.1	2.1	0.02	0.9	0.9	0.01

Table 2. (Continued)

Lake	Year	Inorganic suspended Solids (mg/L)			Organic Suspended Solids (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	0.1	0.0	0.07	0.3	0.3	0.04
Brim Pond	86	0.3	0.4	0.12	2.4	2.3	0.36
Okahumpka	86	0.6	0.3	0.37	2.3	1.0	1.54
Clay	86	0.1	0.1	0.07	1.5	0.4	1.19
Wauberg	86	1.0	0.6	0.41	8.1	8.2	0.25
Bivens Arm	86	10.1	10.4	1.57	40.1	45.5	12.66
Apopka	86	9.7	9.7	1.72	53.8	51.4	9.20
Miona	86	0.2	0.10	0.17	2.5	2.2	1.10
Wales	86	1.0	0.9	0.45	8.2	6.8	1.83
Clear	86	0.5	0.4	0.12	4.0	4.0	0.09
Baldwin	86	0.3	0.3	0.05	3.0	3.2	0.26
Baldwin	88	0.2	0.2	0.03	5.0	5.0	0.02
Baldwin	89	0.6	0.5	0.33	2.3	2.4	0.29
Susannah	86	0.4	0.4	0.08	3.9	3.9	0.53
Susannah	88	0.4	0.4	0.18	5.6	5.6	0.17
Susannah	89	0.2	0.3	0.11	2.9	2.5	0.58
Pearl	86	1.0	0.9	0.28	6.0	5.2	0.86
Pearl	88	1.2	1.2	0.00	5.0	5.0	0.00
Pearl	89	0.4	0.4	0.17	5.4	5.4	1.92
Cue	86	0.2	0.2	0.06	0.6	0.6	0.12
Alligator	87	3.6	3.0	0.91	14.2	10.4	7.71
Crooked	87	0.2	0.2	0.04	0.8	0.7	0.20
Deep	87	0.2	0.2	0.04	0.2	0.1	0.13
Lawbreaker	87	0.1	0.1	0.04	0.3	0.3	0.06
Round Pond	87	0.4	0.4	0.18	2.0	2.0	0.67
Carr	87	0.5	0.5	0.33	3.4	3.4	2.25
Hollingsworth	87	4.7	4.7	0.70	26.2	26.2	3.93
Hunter	87	3.7	3.9	1.04	11.6	11.4	0.36
Hartridge	87	0.4	0.4	0.03	1.2	1.3	0.45
Killarny	87	0.9	1.0	0.34	3.1	3.4	0.98
Holden	87	1.3	1.1	0.37	7.3	7.6	1.22
Catherine	87	0.3	0.3	0.02	0.8	0.8	0.12
Bell	87	0.9	0.9	0.04	4.3	4.4	2.06
Bonny	87	2.4	1.4	1.49	12.3	11.1	2.21
Harris	87	3.3	3.3	0.00	13.2	13.2	0.00
Lindsey	88	0.3	0.3	0.07	2.2	1.1	1.16
Loften	88	0.4	0.1	0.31	1.1	0.8	0.30
Moore	88	0.1	0.0	0.09	1.0	0.9	0.19

Table 2. (Continued)

Lake	Year	Inorganic suspended Solids (mg/L)			Organic Suspended Solids (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Live Oak	88	0.4	0.4	0.06	2.5	1.7	1.29
Koon	88	0.2	0.2	0.03	1.1	1.3	0.26
Watertown	88	0.4	0.4	0.03	5.4	5.2	0.29
Patrick	88	0.4	0.4	0.04	1.8	1.6	0.24
Orienta	88	0.6	0.5	0.32	2.0	2.3	0.66
Conine	88	1.6	1.2	0.60	18.7	17.9	5.43
Tomahawk	88	0.2	0.1	0.07	0.6	0.7	0.18
Barco	88	0.1	0.0	0.09	0.5	0.5	0.14
Suggs	88	0.2	0.10	0.19	1.1	0.5	0.58
Carlton	88	1.5	1.0	0.57	18.4	19.3	1.91
Rowell	88	2.5	2.7	0.19	5.3	5.0	1.45
Lochloosa	88	0.6	0.7	0.19	3.7	3.0	1.65
Turkey Pen	88	1.1	0.5	0.70	0.7	0.6	0.22
Fish	88	1.3	1.2	0.31	5.2	4.2	1.48
Bull Pond	89	0.9	0.9	0.46	3.0	2.2	1.06
Mill Dam	89	0.3	0.2	0.09	1.6	1.8	0.29
West Moody	89	0.2	0.2	0.07	0.4	0.3	0.05
Grasshopper	89	0.4	0.4	0.13	0.9	0.9	0.05
Mountain	89	0.5	0.5	0.08	1.7	1.4	0.31
Douglas	89	0.2	0.2	0.01	1.0	1.1	0.32
Pasadena	89	0.2	0.2	0.01	0.9	0.8	0.15
Marianna	89	1.5	0.7	0.74	2.6	2.5	0.36
Mountain 2	89	0.9	0.9	0.38	1.0	1.0	0.16
Gate Lake	89	1.4	1.7	0.40	5.0	3.0	2.56
Thomas	89	0.6	0.6	0.12	2.3	2.7	0.55
Little Fish	89	0.3	0.2	0.11	1.2	1.1	0.27
Picnic	89	0.6	0.5	0.17	1.0	0.9	0.15
Swim Pond	89	1.1	1.0	0.39	5.7	5.5	0.53

Table 2. (Continued)

Lake	Year	Sodium (mg/L)			Potassium (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	3.3	3.2	0.21	0.3	0.3	0.05
Brim Pond	86	3.2	3.3	0.11	2.0	2.0	0.12
Okahumpka	86	13.4	12.7	1.07	1.2	0.3	0.90
Clay	86	5.7	5.9	0.35	0.10	0.10	0.01
Wauberg	86	6.8	6.8	0.21	0.9	0.9	0.04
Bivens Arm	86	7.9	8.5	0.61	2.1	2.2	0.16
Apopka	86	16.1	16.2	0.77	11.6	11.0	0.56
Miona	86	9.4	9.4	0.36	0.6	0.3	0.41
Wales	86	6.3	6.4	0.10	2.9	2.8	0.07
Clear	86	9.6	9.6	0.21	4.4	4.4	0.04
Baldwin	86	6.7	7.6	1.12	3.3	1.8	1.53
Baldwin	88	7.0	7.0	0.15	1.7	1.7	0.02
Baldwin	89	7.2	7.3	0.14	1.7	1.8	0.11
Susannah	86	7.0	7.0	0.11	2.2	2.2	0.05
Susannah	88	6.9	6.9	0.23	2.2	2.2	0.00
Susannah	89	7.5	7.6	0.18	2.3	2.3	0.11
Pearl	86	7.0	6.8	0.16	3.4	3.4	0.04
Pearl	88	6.9	6.9	0.00	4.7	4.7	0.00
Pearl	89	7.4	7.4	0.58	3.7	3.7	0.10
Cue	86	3.7	3.6	0.10	0.6	0.2	0.36
Alligator	87	8.6	9.6	1.70	1.9	2.1	0.22
Crooked	87	3.8	3.7	0.27	0.4	0.10	0.36
Deep	87	3.2	3.2	0.06	0.2	0.2	0.05
Lawbreaker	87	4.5	4.4	0.04	0.7	0.7	0.03
Round Pond	87	4.5	4.5	0.04	0.10	0.10	0.02
Carr	87	1.4	1.4	0.12	0.3	0.3	0.00
Hollingsworth	87	7.4	7.3	0.18	1.2	1.2	0.05
Hunter	87	7.1	6.8	0.35	1.8	1.8	0.09
Hartridge	87	14.0	14.0	0.00	5.2	5.2	0.12
Killarny	87	9.2	9.2	0.02	2.2	2.2	0.03
Holden	87	13.1	13.0	0.11	4.2	4.1	0.17
Catherine	87	4.7	4.7	0.02	0.4	0.4	0.03
Bell	87	7.5	7.2	0.34	4.4	4.4	0.04
Bonny	87	12.4	12.2	0.31	3.6	3.6	0.11
Harris	87	9.6	9.6	0.00	3.7	3.7	0.00
Lindsey	88	1.3	1.3	0.14	0.1	0.1	0.03
Loften	88	1.4	1.4	0.08	0.2	0.2	0.04
Moore	88	1.6	1.6	0.11	0.10	0.10	0.00
Live Oak	88	10.9	11.0	0.11	3.4	4.2	0.79

Table 2. (Concluded)

Lake	Year	Sodium (mg/L)			Potassium (mg/L)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Koon	88	2.6	2.7	0.11	0.0	0.0	0.02
Watertown	88	5.6	5.6	0.12	3.0	3.0	0.03
Patrick	88	11.1	11.0	0.43	10.2	10.0	0.42
Orienta	88	7.1	7.1	0.16	3.1	3.0	0.11
Conine	88	32.8	35.0	2.91	9.1	8.8	0.29
Tomahawk	88	3.6	3.6	0.03	0.2	0.2	0.00
Barco	88	3.3	3.2	0.14	0.2	0.2	0.01
Suggs	88	5.1	4.6	0.56	3.1	3.1	0.19
Carlton	88	15.0	15.0	0.58	12.8	12.3	0.62
Rowell	88	18.2	17.8	4.24	1.8	1.9	0.07
Lochloosa	88	6.2	5.3	1.17	0.4	0.4	0.09
Turkey Pen	88	1.2	1.2	0.06	0.3	0.3	0.02
Fish	88	15.4	15.0	0.44	5.2	5.3	0.38
Bull Pond	89	5.9	5.9	0.03	0.4	0.4	0.02
Mill Dam	89	4.4	4.1	0.33	0.4	0.3	0.06
West Moody	89	5.3	5.3	0.08	5.2	5.4	0.82
Grasshopper	89	5.8	5.8	0.15	0.3	0.3	0.01
Mountain	89	6.2	6.4	0.20	2.2	2.2	0.23
Douglas	89	30.7	30.2	0.64	8.6	8.8	0.27
Pasadena	89	7.8	8.0	0.26	2.0	1.9	0.35
Marianna	89	18.5	19.0	0.90	8.2	8.5	0.47
Mountain 2	89	6.2	5.9	0.35	1.9	2.2	0.31
Gate Lake	89	5.9	5.8	0.17	2.1	2.1	0.03
Thomas	89	9.0	8.8	0.18	2.5	2.4	0.19
Little Fish	89	1.4	1.5	0.13	0.1	0.1	0.01
Picnic	89	5.5	5.5	0.03	0.5	0.5	0.02
Swim Pond	89	3.9	3.9	0.14	0.10	0.10	0.01

Table 3. Percent volume infested (PVI) and percent area covered (PAC) with macrophytes and above-ground biomass of emergent, floating leaf and submersed macrophytes for 60 Florida lakes sampled between 1986 and 1990. PVI and PAC were calculated with a recording fathometer. Above-ground biomass estimates are listed as the mean, median, and standard error of the mean for ten samples placed evenly around the lake.

Lake	Year	PVI	PAC	Emergent Biomass (kg wet wt/m^2) Mean	Median	Standard Error
Keys Pond	86	7.9	40.0	2.8	2.9	0.56
Brim Pond	86	1.2	3.4	2.8	3.0	0.36
Okahumpka	86	98.1	100.0	11.9	12.2	1.72
Clay	86	76.3	100.0	8.1	7.5	0.70
Wauberg	86	0.0	0.0	12.1	7.7	3.21
Bivens Arm	86	1.4	6.7	10.2	9.2	1.31
Apopka	86	2.1	3.3	2.5	1.8	0.43
Miona	86	86.0	96.6	4.6	3.7	1.06
Wales	86	0.3	3.4	2.6	0.9	1.43
Clear	86	0.0	0.0	2.1	1.8	0.59
Baldwin	86	3.5	34.5	1.9	0.7	0.74
Baldwin	88	0.6	3.3	0.2	0.0	0.09
Baldwin	89	0.0	0.0	0.0	0.0	0.00
Susannah	86	0.8	3.4	11.1	11.0	3.14
Susannah	88	2.0	13.3	1.8	0.8	0.77
Susannah	89	0.5	3.3	1.8	0.9	0.81
Pearl	86	3.4	3.4	1.1	0.0	0.85
Pearl	88	1.0	3.3	0.0	0.0	0.00
Pearl	89	0.0	0.0	0.10	0.0	0.06
Cue	86	0.0	0.0	4.1	3.1	1.39
Alligator	87	10.2	10.2	1.7	0.0	0.86
Crooked	87	2.8	26.7	26.8	18.8	6.25
Deep	87	20.5	96.7	10.6	10.1	1.23
Lawbreaker	87	0.0	0.0	3.8	3.5	0.69
Round Pond	87	79.4	100.0	2.8	2.7	0.24
Carr	87	100.0	100.0	12.7	11.9	3.27
Hollingsworth	87	0.0	0.0	9.3	10.1	1.47
Hunter	87	0.0	0.0	6.6	3.9	2.36
Hartridge	87	11.5	60.0	4.9	3.2	1.14
Killarny	87	0.0	0.0	1.2	0.9	0.29
Holden	87	0.0	0.0	3.7	3.0	1.39
Catherine	87	9.3	48.4	4.6	2.5	2.09
Bell	87	0.0	0.0	2.3	1.7	0.74
Bonny	87	6.5	10.0	8.1	4.8	2.30
Harris	87	2.4	26.7	2.4	1.7	0.49

Table 3. (Continued)

Lake	Year	PVI	PAC	Emergent Biomass (kg wet wt/m^2)		
				Mean	Median	Standard Error
Lindsey	88	79.6	100.0	3.0	3.3	0.50
Loften	88	21.9	86.7	0.3	0.2	0.07
Moore	88	13.9	40.0	1.7	1.3	0.29
Live Oak	88	55.1	100.0	2.0	2.1	0.32
Koon	88	92.6	96.7	0.8	0.8	0.22
Watertown	88	0.8	6.7	1.0	0.0	0.49
Patrick	88	42.1	93.3	1.1	1.2	0.27
Orienta	88	0.0	0.0	0.5	0.2	0.25
Conine	88	0.0	0.0	2.7	2.5	0.38
Tomahawk	88	12.1	43.3	1.4	1.0	0.46
Barco	88	1.3	36.7	1.6	1.3	0.42
Suggs	88	0.0	0.0	0.9	0.9	0.15
Carlton	88	0.0	0.0	2.4	2.2	0.38
Rowell	88	10.3	43.3	0.4	0.3	0.14
Lochloosa	88	57.2	83.3	2.2	2.5	0.25
Turkey Pen	88	2.6	16.7	0.2	0.10	0.10
Fish	88	1.4	3.3	0.9	0.8	0.16
Bull Pond	89	11.4	20.0	1.8	2.0	0.28
Mill Dam	89	9.1	33.3	2.1	1.6	0.74
West Moody	89	89.3	100.0	1.3	0.5	0.56
Grasshopper	89	17.2	80.0	0.3	0.3	0.06
Mountain	89	20.7	40.0	1.9	1.9	0.23
Douglas	89	67.3	96.7	0.6	0.6	0.13
Pasadena	89	61.6	73.3	2.4	1.8	0.76
Marianna	89	35.7	53.3	1.1	0.9	0.25
Mountain 2	89	4.6	13.3	0.9	0.6	0.24
Gate Lake	89	17.5	36.7	0.9	0.8	0.16
Thomas	89	0.5	6.7	1.2	1.2	0.22
Little Fish	89	30.7	80.0	0.7	0.7	0.16
Picnic	89	5.4	86.7	0.8	0.8	0.13
Swim Pond	89	77.8	86.7	1.2	0.6	0.30

Table 3. (Continued)

Lake	Year	Floating-leaved Biomass (kg wet wt/m^2)			Submersed Biomass (kg wet wt/m^2)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	0.0	0.0	0.00	1.0	0.9	0.11
Brim Pond	86	1.2	1.3	0.14	0.10	0.0	0.02
Okahumpka	86	8.8	9.4	1.31	16.6	15.6	1.78
Clay	86	4.5	4.4	0.98	6.8	6.7	1.29
Wauberg	86	11.2	7.8	3.25	4.4	4.6	0.68
Bivens Arm	86	7.6	7.8	0.79	0.0	0.0	0.00
Apopka	86	1.1	0.0	0.92	0.0	0.0	0.00
Miona	86	2.6	2.0	0.97	5.4	3.2	2.26
Wales	86	0.0	0.0	0.00	0.0	0.0	0.00
Clear	86	0.10	0.0	0.10	0.0	0.0	0.00
Baldwin	86	0.0	0.0	0.0	0.0	0.0	0.0
Baldwin	88	0.0	0.0	0.0	0.0	0.0	0.0
Baldwin	89	0.0	0.0	0.0	0.0	0.0	0.0
Susannah	86	0.3	0.0	0.3	1.7	1.1	0.0
Susannah	88	0.6	0.0	0.2	0.2	0.10	0.0
Susannah	89	0.4	0.0	0.3	0.8	0.8	0.0
Pearl	86	2.0	1.7	0.5	0.0	0.0	0.0
Pearl	88	0.3	0.3	0.0	0.0	0.0	0.0
Pearl	89	0.2	0.2	0.0	0.0	0.0	0.0
Cue	86	0.0	0.0	0.00	0.1	0.0	0.13
Alligator	87	1.2	0.5	0.59	0.0	0.0	0.02
Crooked	87	3.8	4.1	0.39	2.4	2.2	0.24
Deep	87	2.5	2.6	0.65	11.7	10.7	1.39
Lawbreaker	87	0.0	0.0	0.00	0.1	0.0	0.08
Round Pond	87	2.0	0.1	1.00	1.5	1.6	0.19
Carr	87	7.0	6.0	0.93	9.9	6.9	2.70
Hollingsworth	87	0.3	0.0	0.12	0.0	0.0	0.00
Hunter	87	0.0	0.0	0.00	0.0	0.0	0.00
Hartridge	87	0.0	0.0	0.00	8.0	6.9	1.47
Killarny	87	0.1	0.0	0.10	0.0	0.0	0.00
Holden	87	0.0	0.0	0.00	0.0	0.0	0.00
Catherine	87	1.1	0.8	0.41	2.9	1.5	1.29
Bell	87	0.2	0.0	0.22	0.2	0.0	0.16
Bonny	87	0.0	0.0	0.00	3.0	1.2	1.62
Harris	87	0.8	0.0	0.45	0.9	0.0	0.65
Lindsey	88	1.3	1.2	0.20	1.8	1.6	0.25
Loften	88	0.6	0.4	0.22	0.6	0.5	0.18
Moore	88	0.2	0.0	0.13	1.3	1.4	0.18

Table 3. (Concluded)

Lake	Year	Floating-leaved Biomass (kg wet wt/m^2)			Submersed Biomass (kg wet wt/m^2)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Live Oak	88	0.3	0.0	0.13	1.6	1.4	0.27
Koon	88	0.9	0.9	0.12	0.9	0.7	0.20
Watertown	88	0.0	0.0	0.00	0.0	0.0	0.00
Patrick	88	0.4	0.5	0.12	1.3	0.9	0.38
Orienta	88	0.0	0.0	0.00	0.0	0.0	0.00
Conine	88	0.0	0.0	0.04	0.0	0.0	0.00
Tomahawk	88	0.5	0.3	0.18	0.9	0.8	0.12
Barco	88	0.0	0.0	0.00	0.7	0.5	0.17
Suggs	88	0.4	0.3	0.16	0.0	0.0	0.00
Carlton	88	0.2	0.0	0.17	0.4	0.0	0.24
Rowell	88	0.3	0.0	0.29	0.0	0.0	0.00
Lochloosa	88	0.6	0.0	0.29	2.6	2.3	0.32
Turkey Pen	88	0.0	0.0	0.00	0.10	0.0	0.03
Fish	88	1.0	0.0	0.55	0.0	0.0	0.00
Bull Pond	89	0.3	0.3	0.05	0.0	0.0	0.01
Mill Dam	89	1.2	1.0	0.26	0.7	0.4	0.24
West Moody	89	2.1	2.4	0.41	3.2	3.1	0.41
Grasshopper	89	0.2	0.10	0.07	0.3	0.2	0.10
Mountain	89	1.8	2.1	0.40	2.0	2.1	0.28
Douglas	89	0.4	0.4	0.06	0.8	0.8	0.19
Pasadena	89	1.4	1.0	0.37	2.1	2.1	0.52
Marianna	89	0.0	0.0	0.00	1.1	0.7	0.34
Mountain 2	89	0.0	0.0	0.00	0.4	0.4	0.08
Gate Lake	89	0.0	0.0	0.00	0.2	0.0	0.13
Thomas	89	0.0	0.0	0.00	1.2	1.1	0.21
Little Fish	89	0.3	0.4	0.05	0.1	0.1	0.04
Picnic	89	0.7	0.7	0.19	0.2	0.0	0.10
Swim Pond	89	0.9	0.8	0.20	0.4	0.6	0.10

Table 4. Epiphytic algal abundance (periphyton) for 60 Florida lakes sampled between 1986 and 1990. Algal abundance was estimated from plant samples collected from ten evenly placed transects around each lake. The mean, median, and Standard error of the mean are listed as mg chlorophyll *a*/m ^{2} of host plant and mg chlorophyll *a*/kg wet wt of host plant. The year sampled and the number of samples from each lake are also listed.

Lake	Year	Epiphytic Biomass (mg chlorophyll *a*/m ^{2} of host plant)			
		Number of Samples	Mean	Median	Standard Error
Keys Pond	86	20	58.5	32.9	16.24
Brim Pond	86	27	9.1	7.0	1.42
Okahumpka	86	30	30.4	18.5	5.99
Clay	86	29	21.7	10.8	5.07
Wauberg	86	23	10.8	6.8	3.84
Bivens Arm	86	20	41.8	35.6	6.19
Apopka	86	25	18.0	16.2	1.99
Miona	86	18	28.5	20.3	7.53
Wales	86	9	36.5	6.2	18.49
Clear	86	12	4.8	4.2	0.83
Baldwin	86	7	24.3	27.2	4.49
Baldwin	88	12	11.2	7.6	2.48
Baldwin	89	0	0	0	0
Susannah	86	7	29.2	21.5	9.55
Susannah	88	13	13.9	11.8	.2.93
Susannah	89	8	39.5	19.5	18.75
Pearl	86	18	13.6	11.8	1.79
Pearl	88	10	25.9	16.1	7.26
Pearl	89	9	8.5	4.7	3.51
Cue	86	20	16.1	13.3	3.03
Cue	87	22	15.5	7.8	4.33
Alligator	87	30	32.0	23.3	5.74
Crooked	87	29	27.1	20.0	4.37
Deep	87	30	14.0	7.9	3.09
Lawbreaker	87	28	10.3	6.4	3.10
Round Pond	87	29	23.1	12.7	4.65
Carr	87	27	24.0	8.7	7.45
Hollingsworth	87	18	13.8	10.5	2.45
Hunter	87	23	13.3	11.4	2.07
Hartridge	87	30	19.5	16.2	2.85
Killarny	87	20	5.8	4.2	1.06
Holden	87	20	4.1	1.8	1.48
Catherine	87	30	24.5	21.1	3.49
Bell	87	23	6.5	4.0	1.55

Table 4. (Continued)

Lake	Year	Epiphytic Biomass (mg chlorophyll *a*/m² of host plant)			
		Number of Samples	Mean	Median	Standard Error
Bonny	87	29	16.1	1.8	5.84
Harris	87	22	4.6	3.4	0.93
Lindsey	88	30	19.0	9.6	4.07
Loften	88	30	9.4	3.8	2.25
Moore	88	30	14.9	12.6	2.13
Live Oak	88	30	20.3	16.2	2.71
Koon	88	29	17.3	9.8	3.46
Watertown	88	12	6.4	4.7	1.20
Patrick	88	29	21.4	16.9	3.10
Orienta	88	12	4.6	4.0	0.79
Conine	88	35	5.8	6.1	0.83
Tomahawk	88	30	14.7	5.8	4.15
Barco	88	12	22.8	23.4	4.85
Suggs	88	11	15.4	9.4	4.56
Carlton	88	30	14.3	11.6	1.97
Rowell	88	23	10.6	4.9	2.03
Lochloosa	88	30	12.5	5.5	3.11
Turkey Pen	88	18	17.1	15.0	2.35
Fish	88	18	23.1	10.5	8.29
Bull Pond	89	20	33.8	27.2	6.07
Mill Dam	89	30	14.2	7.7	3.59
West Moody	89	21	14.4	12.6	3.14
Grasshopper	89	11	29.2	12.9	17.29
Mountain	89	20	19.8	14.5	3.87
Douglas	89	29	21.4	18.6	2.57
Pasadena	89	17	12.3	3.8	3.90
Marianna	89	25	12.7	6.6	2.70
Mountain 2	89	13	15.8	6.6	7.22
Gate Lake	89	0	0	0	0
Thomas	89	18	23.4	13.4	5.01
Little Fish	89	14	30.6	12.5	11.91
Picnic	89	20	19.2	14.5	2.79
Swim Pond	89	20	29.1	14.8	7.79

Table 4. (Continued)

Lake	Year	Epiphytic Biomass (mg chlorophyll *a*/kg wet wt of host plant)			
		Number of Samples	Mean	Median	Standard Error
Keys Pond	86	20	68.2	35.1	16.92
Brim Pond	86	27	4.3	2.8	1.24
Okahumpka	86	30	38.1	32.5	8.23
Clay	86	29	44.7	3.5	18.66
Wauberg	86	23	3.1	2.2	0.77
Bivens Arm	86	20	22.4	20.4	2.85
Apopka	86	25	5.7	5.0	0.88
Miona	86	18	25.1	16.2	6.39
Wales	86	9	13.1	4.2	6.12
Clear	86	12	1.9	1.4	0.35
Baldwin	86	7	11.4	10.7	2.72
Baldwin	88	12	8.0	7.2	1.43
Baldwin	89	0	0	0	0
Susannah	86	7	18.2	18.8	2.16
Susannah	88	13	22.8	13.7	6.15
Susannah	89	8	53.2	15.8	37.41
Pearl	86	18	2.8	3.0	0.33
Pearl	88	10	2.7	2.7	0.37
Pearl	89	9	5.0	2.4	1.89
Cue	86	20	5.2	4.6	0.67
Alligator	87	30	19.2	16.2	3.23
Crooked	87	29	16.1	7.1	4.45
Deep	87	30	11.7	4.3	2.75
Lawbreaker	87	28	8.2	5.8	2.35
Round Pond	87	29	23.3	6.8	5.12
Carr	87	27	13.8	1.8	4.47
Hollingsworth	87	18	3.8	3.0	0.64
Hunter	87	23	8.5	7.7	1.48
Hartridge	87	30	30.5	17.4	6.19
Killarny	87	20	2.2	1.8	0.37
Holden	87	20	1.4	0.5	0.44
Catherine	87	30	30.2	18.4	6.85
Bell	87	23	7.1	3.6	2.07
Bonny	87	29	14.1	1.3	4.17
Harris	87	22	2.3	1.7	0.45
Lindsey	88	30	15.4	2.8	4.88
Loften	88	30	11.7	3.0	3.21
Moore	88	30	25.2	12.2	5.54
Live Oak	88	30	21.5	10.8	4.55
Koon	88	29	34.7	9.1	7.83

Table 4. (Concluded)

Lake	Year	Epiphytic Biomass (mg chlorophyll *a*/kg wet wt of host plant)			
		Number of Samples	Mean	Median	Standard Error
Watertown	88	12	4.7	3.3	0.98
Patrick	88	29	42.1	17.7	10.26
Orienta	88	12	4.8	4.0	1.06
Conine	88	35	3.1	1.8	0.63
Tomahawk	88	30	40.8	3.8	14.96
Barco	88	12	44.2	46.1	9.84
Suggs	88	11	14.5	8.5	5.16
Carlton	88	30	5.5	4.1	1.05
Rowell	88	23	9.2	7.1	1.95
Lochloosa	88	30	32.0	9.4	8.99
Turkey Pen	88	18	29.4	26.3	4.08
Fish	88	18	20.1	11.2	6.35
Bull Pond	89	20	17.0	6.5	4.97
Mill Dam	89	30	28.0	5.7	7.35
West Moody	89	21	46.6	40.8	9.11
Grasshopper	89	11	18.6	8.1	7.95
Mountain	89	20	34.0	20.0	12.20
Douglas	89	29	12.2	10.0	1.88
Pasadena	89	17	29.2	7.9	15.87
Marianna	89	25	31.1	12.0	9.78
Mountain 2	89	13	34.6	13.8	16.63
Gate Lake	89	0	0	0	0
Thomas	89	18	44.7	17.7	15.90
Little Fish	89	14	11.1	4.9	4.10
Picnic	89	20	39.4	21.8	12.09
Swim Pond	89	20	74.7	8.7	35.34

Table 5. Epiphytic macroinvertebrate, benthic macroinvertebrate, zooplankton abundance, epiphytic macroinvertebrate and benthic macroinvertebrate biomass for 60 Florida lakes sampled between 1986 and 1990. Epiphytic macroinvertebrates were removed from plants sampled in four to six locations evenly spaced around each lake. Benthic macroinvertebrates were collected with a petite ponar sampler from six stations (three littoral and three open-water) in each lake. Zooplankton were collected with a Wisconsin net (12 cm mouth diameter and 80 µm mesh net) with a vertical tow 0.5 m from the bottom to the surface from six stations (three littoral and three open-water) in each lake.

Lake	Year	Epiphytic Macroinvertebrates (Individuals/kg wet wt of plants)			Epiphytic Macroinvertebrates (g wet wt/kg wet wt of plants)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	147	134	48	1.03	1.07	0.20
Brim Pond	86	121	125	29	0.55	0.43	0.21
Okahumpka	86	104	57	42	0.45	0.27	0.20
Clay	86	200	83	106	0.09	0.05	0.04
Wauberg	86	2885	2570	627	2.68	2.05	1.00
Bivens Arm	86	1941	1324	586	2.39	1.96	0.83
Apopka	86	398	101	265	0.45	0.25	0.20
Miona	86	208	195	74	0.15	0.13	0.04
Wales	86	351	284	113	1.08	0.64	0.41
Clear	86	42	40	9	3.26	0.44	2.71
Baldwin	86						
Baldwin	88	383	163	197	0.63	0.38	0.30
Baldwin	89						
Susannah	86						
Susannah	88	438	64	381	1.25	0.29	0.68
Susannah	89	235	308	60	0.93	0.90	0.23
Pearl	86						
Pearl	88	319	305	88	1.68	0.33	1.44
Pearl	89	186	142	61	0.46	0.31	0.20
Cue	86	233	258	37	0.16	0.15	0.04
Alligator	87	871	627	281	1.27	1.02	0.42
Crooked	87	55	26	25	0.10	0.06	0.04
Deep	87	131	112	68	0.08	0.09	0.00
Lawbreaker	87	200	58	139	0.22	0.09	0.12
Round Pond	87	192	114	102	0.32	0.08	0.25
Carr	87	116	22	67	0.75	0.11	0.51
Hollingsworth	87	116	97	43	0.14	0.09	0.06
Hunter	87	1247	470	662	35.82	0.69	35.06
Hartridge	87	35	34	10	1.21	0.02	0.97
Killarny	87	213	248	59	0.51	0.39	0.22
Holden	87	161	105	77	1.80	0.21	1.32
Catherine	87	90	34	51	0.37	0.09	0.22

Table 5. (Continued)

Lake	Year	Epiphytic Macroinvertebrates (Individuals/kg wet wt of plants)			Epiphytic Macroinvertebrates (g wet wt/kg wet wt of plants)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Bell	87	59	37	27	0.07	0.06	0.00
Bonny	87	381	163	234	0.92	0.10	0.80
Harris	87	151	152	27	0.10	0.10	0.00
Lindsey	88	48	27	24	0.24	0.34	0.10
Loften	88	35	25	12	0.03	0.02	0.00
Moore	88	84	44	48	0.21	0.08	0.13
Live Oak	88	60	48	25	0.06	0.06	0.00
Koon	88	406	12	391	1.12	0.06	0.93
Watertown	88	428	196	202	0.87	0.70	0.17
Patrick	88	49	53	16	0.06	0.04	0.00
Orienta	88	63	46	26	0.32	0.13	0.22
Conine	88	475	173	222	1.61	1.12	0.81
Tomahawk	88	107	24	69	0.06	0.03	0.04
Barco	88	104	59	44	0.19	0.09	0.11
Suggs	88	167	42	127	0.53	0.29	0.28
Carlton	88	406	477	118	0.99	0.73	0.39
Rowell	88	120	52	53	0.28	0.29	0.08
Lochloosa	88	34	22	14	0.22	0.14	0.13
Turkey Pen	88	253	236	66	0.37	0.33	0.08
Fish	88	491	62	417	0.99	0.62	0.50
Bull Pond	89	96	53	47	0.10	0.08	0.04
Mill Dam	89	77	42	35	0.11	0.08	0.06
West Moody	89	147	96	51	0.24	0.16	0.11
Grasshopper	89	78	56	33	0.06	0.06	0.00
Mountain	89	278	145	140	1.01	1.11	0.34
Douglas	89	34	18	20	0.04	0.03	0.00
Pasadena	89	30	9	24	0.04	0.01	0.00
Marianna	89	248	207	95	0.59	0.27	0.37
Mountain 2	89	239	128	102	13.48	0.51	8.42
Gate Lake	89	40	24	16	0.59	0.54	0.25
Thomas	89	316	270	138	0.65	0.57	0.28
Little Fish	89	160	160	36	0.79	0.20	0.57
Picnic	89	188	51	111	0.32	0.20	0.14
Swim Pond	89	268	98	186	0.56	0.38	0.28

Table 5. (Continued)

Lake	Year	Benthic Macroinvertebrates (Individuals/m^2)			Benthic Macroinvertebrates (g wet wt/m^2)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	307	240	64	2.24	1.24	1.0
Brim Pond	86	1507	820	834	1.06	0.80	0.4
Okahumpka	86	147	140	61	0.84	0.04	0.8
Clay	86	853	540	341	0.30	0.26	0.0
Wauberg	86	1313	80	1100	1.07	0.18	0.6
Bivens Arm	86	520	240	301	0.40	0.06	0.0
Apopka	86	1224	320	1026	40.81	0.35	40.6
Miona	86	260	180	106	0.95	0.06	0.6
Wales	86	287	260	55	35.43	0.35	22.6
Clear	86	1227	880	545	1.23	0.77	0.6
Baldwin	86	464	240	187	0.60	0.59	0.0
Baldwin	88	113	100	33	139.72	0.12	133.9
Baldwin	89	180	140	51	139.35	8.82	108.3
Susannah	86	40	0	33	0.01	0.00	0.0
Susannah	88	193	80	127	0.35	0.02	0.0
Susannah	89	160	140	43	0.52	0.09	0.4
Pearl	86	440	480	101	0.88	0.53	0.4
Pearl	88	304	120	140	270.67	0.40	203.1
Pearl	89	127	80	68	178.29	0.14	178.2
Cue	86	513	340	247	2.08	2.43	0.4
Alligator	87	2113	1740	571	4.75	4.41	0.9
Crooked	87	500	580	125	1.46	0.77	0.9
Deep	87	513	340	166	1.77	0.63	0.8
Lawbreaker	87	593	260	277	1.39	0.53	0.9
Round Pond	87	747	820	199	1.70	0.57	1.2
Carr	87	700	700	213	0.98	0.70	0.0
Hollingsworth	87	240	80	154	1.82	0.24	1.6
Hunter	87	153	160	36	0.67	0.08	0.6
Hartridge	87	213	140	63	5.07	1.69	2.6
Killarny	87	160	140	56	184.30	110.95	86.3
Holden	87	2260	860	1479	63.02	2.01	51.8
Catherine	87	113	120	32	0.47	0.35	0.0
Bell	87	900	520	460	13.51	0.68	9.8
Bonny	87	293	240	131	6.58	4.99	3.1
Harris	87	633	280	389	189.97	1.34	188.3
Lindsey	88	1327	1220	401	1.65	1.69	0.4
Loften	88	307	240	91	0.43	0.43	0.0

Table 5. (Continued)

Lake	Year	Benthic Macroinvertebrates (Individuals/m^2)			Benthic Macroinvertebrates (g wet wt/m^2)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Moore	88	607	480	121	2.01	1.34	0.7
Live Oak	88	253	180	111	1.77	0.23	1.5
Koon	88	433	340	171	0.45	0.32	0.0
Watertown	88	2180	1060	1034	6.60	2.30	3.5
Patrick	88	200	140	66	47.98	0.17	46.7
Orienta	88	273	120	162	830.16	761.85	323.2
Conine	88	2560	200	1648	56.31	0.34	40.8
Tomahawk	88	227	80	135	0.16	0.06	0.0
Barco	88	747	360	422	2.37	2.07	0.7
Suggs	88	713	580	192	1.47	0.28	1.2
Carlton	88	2733	580	1768	6.02	0.87	4.4
Rowell	88	133	0	85	0.03	0.00	0.0
Lochloosa	88	207	140	91	0.20	0.22	0.0
Turkey Pen	88	533	300	306	1.40	1.37	0.4
Fish	88	1433	700	854	32.13	1.12	31.1
Bull Pond	89	640	560	144	4.07	3.81	1.3
Mill Dam	89	827	900	229	2.57	2.66	0.6
West Moody	89	80	60	37	0.15	0.06	0.0
Grasshopper	89	144	160	57	1.15	0.14	0.8
Mountain	89	200	220	68	0.22	0.08	0.0
Douglas	89	213	220	81	0.29	0.06	0.0
Pasadena	89	7	0	7	0.00	0.00	0.0
Marianna	89	47	40	24	0.06	0.01	0.0
Mountain 2	89	160	100	90	77.26	2.72	52.2
Gate Lake	89	647	120	505	23.71	0.41	19.4
Thomas	89	27	20	13	0.28	0.01	0.0
Little Fish	89	320	80	226	0.29	0.01	0.0
Picnic	89	93	60	55	0.42	0.04	0.4
Swim Pond	89	53	60	20	0.08	0.01	0.0

Table 5. (Continued)

Lake	Year	Cladocerans (Individuals/m^3)			Copepods (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	32215	24910	8482	40641	43929	5932
Brim Pond	86	11266	7886	4787	82086	88814	11136
Okahumpka	86	42451	45553	9387	38338	23731	17423
Clay	86	29669	19199	9570	50605	29740	19788
Wauberg	86	24876	5148	14445	51746	43229	10554
Bivens Arm	86	5217	4598	2437	13673	14324	4264
Apopka	86	201812	208930	40548	114369	111170	28860
Miona	86	130998	103926	44243	24926	28771	4000
Wales	86	3803	3074	820	3586	3561	1031
Clear	86	12290	11273	3112	175515	153286	40203
Baldwin	86	12975	13244	3801	8006	5378	2558
Baldwin	88	21464	19405	5448	57617	50345	9933
Baldwin	89	193864	90718	93209	76456	52034	22758
Susannah	86	141477	144332	53992	24879	23767	5868
Susannah	88	82494	70663	17470	66645	68736	13400
Susannah	89	114525	111282	11144	36578	36891	5948
Pearl	86	275169	271883	87262	66644	69717	15462
Pearl	88	.	.	.	.	.	.
Pearl	89	76623	62157	16828	67412	74845	10784
Cue	86	2961	2688	962	20670	4126	12238
Cue	87	3971	666	2347	9071	4164	3717
Alligator	87	622401	525558	186662	206639	191080	54626
Crooked	87	84083	74704	14546	182944	178558	56624
Deep	87	5352	3456	1702	44365	31561	11750
Lawbreaker	87	1976	1294	939	41771	33864	11140
Round Pond	87	124553	127816	26443	161903	181049	28736
Carr	87	259966	184285	111981	180940	117100	64754
Hollingsworth	87	68738	63254	20089	54573	50970	13589
Hunter	87	8371	8434	2409	14006	8863	6215
Hartridge	87	56960	29165	24903	59844	45641	15710
Killarny	87	3530	3556	449	7372	7555	870
Holden	87	5551	3988	1684	22468	18338	5521
Catherine	87	46017	45393	10656	161127	129443	42408
Bell	87	71270	19593	52015	12141	12644	1139
Bonny	87	21267	16375	4477	85197	70628	19988
Harris	87	184113	180965	21783	154017	143646	25007
Lindsey	88	25588	19837	8540	34898	22028	13561
Loften	88	113646	113719	28254	51250	41687	15154

Table 5. (Continued)

Lake	Year	Cladocerans (Individuals/m^3)			Copepods (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Moore	88	55276	50115	10673	52434	50937	11113
Live Oak	88	58706	53722	14441	70213	65724	10655
Koon	88	104281	71916	45394	125698	133478	29850
Watertown	88	88042	39257	39283	47164	28134	17348
Patrick	88	174553	160301	32114	163054	95137	79858
Orienta	88	39226	36588	7773	39261	34598	12831
Conine	88	16273	7882	7072	106824	80728	26830
Tomohawk	88	13777	13692	2207	36279	30946	10159
Barco	88	1075	1171	409	63118	68729	19433
Suggs	88	21865	21123	6482	125818	114416	39285
Carlton	88	2780	2078	1332	142007	155290	37659
Rowell	88	42340	12750	29144	1002	0	1002
Lochloosa	88	53753	38609	15485	11644	9706	3588
Turkey Pen	88	15356	7122	6402	14965	15670	4013
Fish	88	92772	99367	13014	28939	25459	8296
Bull Pond	89	36101	29856	9465	58594	54718	14052
Mill Dam	89	29577	18303	13238	39431	46130	7960
West Moody	89	234300	70557	176576	119337	94649	42360
Grasshopper	89	34502	31140	7448	53185	47922	13694
Mountain	89	39135	34730	9891	47156	41874	16334
Douglas	89	51940	40060	18349	119180	89596	41445
Pasadena	89	57497	48028	17936	61340	64444	8427
Sanitary	89	148877	57838	91287	91330	46909	40033
Mountain 2	89	11577	3775	6892	5878	4901	2365
Gate Lake	89	6903	6742	1353	15436	8302	6445
Thomas	89	63049	54540	20884	60392	57065	6615
Little Fish	89	22046	19192	3848	37300	38019	6680
Picnic	89	24421	18144	8956	28282	22541	9677
Swim Pond	89	33414	29178	6438	26098	28635	5720

Table 5. (Continued)

Lake	Year	Nauplii (Individuals/m^3)			Rotifers (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	31017	31424	4353	11621	10641	2523
Brim Pond	86	50926	51205	5745	0	0	0
Okahumpka	86	61896	45305	28009	62833	70027	12711
Clay	86	70116	37473	29783	1689	613	916
Wauberg	86	99383	71913	23535	260169	235868	68784
Bivens Arm	86	83689	85942	28977	345995	248276	107760
Apopka	86	305772	207879	155167	2310307	1982788	546992
Miona	86	20817	15758	6742	84035	58545	20490
Wales	86	22384	23596	4182	24323	25889	2604
Clear	86	82183	86897	14659	87554	77988	10046
Baldwin	86	16327	15959	2294	17088	14734	3417
Baldwin	88	20443	23814	4284	107381	102847	19869
Baldwin	89	2815	2529	1246	44244	49080	6368
Susannah	86	48237	43245	9970	33275	25818	14604
Susannah	88	245857	181238	100980	62558	39100	27400
Susannah	89	159588	127307	50043	92118	89390	24557
Pearl	86	131484	125995	11465	84048	62378	29666
Pearl	88	.	.	.	.	.	.
Pearl	89	83714	84461	19880	139367	121297	20017
Cue	86	44562	20838	20669	33045	35491	11138
Cue	87	9259	6564	3006	10453	9820	1730
Alligator	87	231630	222507	43656	410695	435342	91211
Crooked	87	67331	61764	21595	37010	35208	2757
Deep	87	21302	13373	9041	11557	6954	5645
Lawbreaker	87	20795	23537	4524	8512	4014	4438
Round Pond	87	68595	65137	13381	99729	79133	37328
Carr	87	19807	19187	7044	121911	91465	46021
Hollingsworth	87	47437	48028	7285	285792	334005	53769
Hunter	87	8037	7887	2470	31211	19744	11281
Hartridge	87	47305	52352	9193	27673	20414	10186
Killarny	87	25466	26508	3928	90529	93595	10465
Holden	87	27961	25316	4941	39697	32166	11739
Catherine	87	86498	86073	18101	26491	27248	7441
Bell	87	7160	8515	2292	3643	3183	1133
Bonny	87	41590	47121	7505	273830	216611	81618
Harris	87	59071	59096	5050	131294	130071	10629
Lindsey	88	36615	22469	20345	170810	168258	33616
Loften	88	88734	72663	26823	216099	247625	41604

Table 5. (Continued)

Lake	Year	Nauplii (Individuals/m^3)			Rotifers (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Moore	88	36145	36764	10153	128456	125128	16661
Live Oak	88	174006	62599	107725	78393	60253	19623
Koon	88	70587	66932	22462	95223	94580	20371
Watertown	88	9926	11123	1795	47789	39300	17410
Patrick	88	25097	31376	7212	105106	59833	48047
Orienta	88	1505	1173	712	102719	102266	30617
Conine	88	217338	209035	41670	134384	75837	52003
Tomohawk	88	25536	27211	7263	15449	16770	1946
Barco	88	3338	1169	1931	284	103	185
Suggs	88	65475	24823	41636	153626	144655	16831
Carlton	88	178108	170185	31099	878451	822738	121349
Rowell	88	18043	15544	3887	120920	98187	45288
Lochloosa	88	50556	47173	9804	126237	117189	22629
Turkey Pen	88	23615	23837	4778	5139	3769	1897
Fish	88	77118	67029	17516	85604	71795	21453
Bull Pond	89	77525	74010	14198	109518	103117	8097
Mill Dam	89	67785	59441	14140	49892	27770	27896
West Moody	89	18487	2946	11482	22691	12241	11818
Grasshopper	89	103563	63068	36169	35078	34657	8184
Mountain	89	126707	104315	31785	64246	48194	25062
Douglas	89	155656	162224	22986	440154	387834	69266
Pasadena	89	113037	94695	20113	125540	132405	33114
Sanitary	89	141091	117131	42447	267036	246783	18752
Mountain 2	89	23776	16691	7092	32953	31630	6118
Gate Lake	89	20408	19859	5499	41397	33305	13176
Thomas	89	70858	63731	14687	40309	40245	5779
Little Fish	89	44322	39092	12762	53932	53708	15290
Picnic	89	52129	40627	9582	17563	16097	3632
Swim Pond	89	40449	34247	8834	128427	111571	26368

Table 5. (Continued)

Lake	Year	Ostracods (Individuals/m^3)			Chaoborus (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Keys Pond	86	140	0	93	1222	0	884
Brim Pond	86	0	0	0	652	627	248
Okahumpka	86	6667	6472	1955	0	0	0
Clay	86	0	0	0	0	0	0
Wauberg	86	1444	0	1444	0	0	0
Bivens Arm	86	0	0	0	0	0	0
Apopka	86	0	0	0	0	0	0
Miona	86	41146	32881	10563	0	0	0
Wales	86	1246	1747	399	75	0	75
Clear	86	1545	1519	430	1162	849	510
Baldwin	86	1265	1448	338	0	0	0
Baldwin	88	260	0	166	72	0	72
Baldwin	89	2505	0	2505	436	0	436
Susannah	86	31549	21515	15227	430	0	430
Susannah	88	8700	6439	2745	442	0	442
Susannah	89	2874	1993	1050	338	0	338
Pearl	86	10378	2446	7589	510	0	313
Pearl	88	.	.	.	.	.	.
Pearl	89	2302	786	1233	0	0	0
Cue	86	749	0	528	0	0	0
Cue	87	0	0	0	1320	0	1320
Alligator	87	31357	16210	13237	300	0	300
Crooked	87	686	0	686	0	0	0
Deep	87	88	0	88	0	0	0
Lawbreaker	87	1347	0	1075	548	0	548
Round Pond	87	395	0	395	1785	0	1354
Carr	87	62377	57436	22899	3480	4297	914
Hollingsworth	87	3949	2370	1908	0	0	0
Hunter	87	3026	1446	1811	1568	0	1568
Hartridge	87	643	0	428	0	0	0
Killarny	87	564	221	346	542	0	542
Holden	87	6985	2087	4621	1379	0	1379
Catherine	87	719	0	719	278	0	278
Bell	87	97	0	97	0	0	0
Bonny	87	1992	1627	820	1556	0	1194
Harris	87	43627	36041	9841	0	0	0
Lindsey	88	10780	5619	5928	0	0	0
Loften	88	3320	1464	1711	159	0	159

Table 5. (Concluded)

Lake	Year	Ostracods (Individuals/m^3)			Chaoborus (Individuals/m^3)		
		Mean	Median	Standard Error	Mean	Median	Standard Error
Moore	88	0	0	0	0	0	0
Live Oak	88	9852	5859	4612	0	0	0
Koon	88	11267	1250	7816	417	0	417
Watertown	88	2459	2423	738	3618	3324	1208
Patrick	88	3360	0	3360	11999	796	11189
Orienta	88	261	0	261	0	0	0
Conine	88	5172	4180	2519	2162	1174	1064
Tomohawk	88	496	332	236	251	0	251
Barco	88	0	0	0	143	0	143
Suggs	88	398	0	398	357	0	357
Carlton	88	0	0	0	0	0	0
Rowell	88	1910	0	1910	0	0	0
Lochloosa	88	1095	973	499	0	0	0
Turkey Pen	88	0	0	0	0	0	0
Fish	88	252	0	252	0	0	0
Bull Pond	89	0	0	0	0	0	0
Mill Dam	89	344	0	218	0	0	0
West Moody	89	2904	1417	1560	1158	1537	384
Grasshopper	89	886	491	493	0	0	0
Mountain	89	23988	10115	13393	825	0	825
Douglas	89	912	0	598	0	0	0
Pasadena	89	8542	7819	2468	102	0	102
Sanitary	89	5440	4466	1385	373	0	373
Mountain 2	89	2075	0	2075	0	0	0
Gate Lake	89	4212	1653	2360	402	0	341
Thomas	89	3699	4100	852	0	0	0
Little Fish	89	3643	1386	2120	0	0	0
Picnic	89	406	0	265	0	0	0
Swim Pond	89	909	0	689	0	0	0

Table 6. Mean length of bluegill, redear sunfish, largemouth bass, and black crappie for age classes I-IV, back calculated from examination of otolith annuli in whole view. Length is recorded in mm total length (TL). The number of lakes in which fish were examined, the mean of means and the corresponding standard error of the mean are listed by species.

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Bluegill:						
Keys Pond	86	0				
Brim Pond	86	7	70	157	201	218
Okahumpka	86	6	58	116	152	152
Clay	86	22	88	136	159	
Wauberg	86	38	73	139	188	205
Bivens Arm	86	30	61	118	155	190
Apopka	86	23	82	130	148	
Miona	86	27	56	100	146	
Wales	86	28	61	111	147	173
Clear	86	14	51	105	135	162
Baldwin	86	24	74	132	163	203
Baldwin	88	0				
Baldwin	89	16	76	130	165	185
Susannah	86	17	61	117	157	187
Susannah	88	0				
Susannah	89	20	62	118	159	
Pearl	86	26	66	122	165	178
Pearl	88	0				
Pearl	89	22	68	120	158	189
Cue	86	0				
Cue	87	0				
Alligator	87	19	104	175	200	218
Crooked	87	18	61	106	142	168
Deep	87	6	45	89	119	146
Lawbreaker	87	0				
Round Pond	87	9	93	121	146	158
Carr	87	19	74	144	183	210
Hollingsworth	87	15	87	154	194	
Hunter	87	3	110	156		
Hartridge	87	13	101	143	165	196
Killarny	87	0				
Holden	87	9	66	117	144	162
Catherine	87	15	43	89	129	158
Bell	87	17	102	156	189	
Bonny	87	9	92	140	166	175
Harris	87	0				

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Bluegill:						
Lindsey	88	37	56	122	163	193
Loften	88	22	43	97	143	166
Moore	88	18	38	95	141	154
Live Oak	88	31	53	111	155	183
Koon	88	5	48	113	165	177
Watertown	88	24	55	130	182	200
Patrick	88	21	60	113	155	181
Orienta	88	17	63	129	161	
Conine	88	26	71	130	168	183
Tomahawk	88	7	38	102	134	163
Barco	88	11	58	96	120	141
Suggs	88	8	46	111	167	192
Carlton	88	28	69	133	175	193
Rowell	88	29	64	130	180	203
Lochloosa	88	31	65	136	189	215
Turkey Pen	88	11	47	86	111	134
Fish	88	26	63	127	167	188
Bull Pond	89	27	53	103	142	172
Mill Dam	89	17	40	101	151	210
West Moody	89	6	69	132	187	210
Grasshopper	89	23	49	97	133	165
Mountain	89	25	73	160	212	235
Douglas	89	8	40	96	133	158
Pasadena	89	30	59	133	189	223
Marianna	89	23	83	140	185	198
Mountain 2	89	21	44	106	150	183
Gate Lake	89	13	57	105	141	199
Thomas	89	28	69	133	175	197
Little Fish	89	15	53	105	155	
Picnic	89	19	47	89	127	148
Swim Pond	89	10	76	118	152	

Bluegill	Age 1	Age 2	Age 3	Age 4
Number of Lakes	58	58	57	48
Mean of Means	64	121	159	183
Standard Error	2.3	2.7	2.9	3.4

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Redear sunfish:						
Keys Pond	86	0				
Brim Pond	86	0				
Okahumpka	86	12	50	105	147	184
Clay	86	0				
Wauberg	86	27	106	186	235	266
Bivens Arm	86	21	79	140	176	
Apopka	86	9	69	134	179	176
Miona	86	43	58	99	135	
Wales	86	25	67	135	172	141
Clear	86	13	61	128		
Baldwin	86	24	66	126	161	181
Baldwin	88	0				
Baldwin	89	31	69	125	168	207
Susannah	86	15	64	118	161	190
Susannah	88	0				
Susannah	89	26	61	119	168	206
Pearl	86	26	77	156	208	240
Pearl	88	0				
Pearl	89	29	88	167	217	241
Cue	86	0				
Cue	87	0				
Alligator	87	18	93	162	208	216
Crooked	87	0				
Deep	87	0				
Lawbreaker	87	0				
Round Pond	87	0				
Carr	87	1	67	123	175	204
Hollingsworth	87	17	109	162	208	250
Hunter	87	4	107	159		
Hartridge	87	4	78	117	125	171
Killarny	87	12	103	143	183	217
Holden	87	18	93	137	151	182
Catherine	87	0				
Bell	87	9	86	152	198	
Bonny	87	12	135	175	209	236
Harris	87	0				
Lindsey	88	10	69	136	169	189
Loften	88	0				
Moore	88	0				

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Redear sunfish:						
Live Oak	88	12	64	118	163	
Koon	88	0				
Watertown	88	7	67	137	180	
Patrick	88	19	52	101	147	175
Orienta	88	27	72	136	183	191
Conine	88	29	81	149	189	218
Tomahawk	88	0				
Barco	88	0				
Suggs	88	1	64	131	167	194
Carlton	88	0				
Rowell	88	25	98	161	197	208
Lochloosa	88	26	57	119	167	203
Turkey Pen	88	30	77	143	199	219
Fish	88	24	61	126	196	219
Bull Pond	89	4	52	97	161	194
Mill Dam	89	6	57	110	161	187
West Moody	89	8	70	111	136	189
Grasshopper	89	11	66	137	198	231
Mountain	89	24	80	152	203	
Douglas	89	14	55	126	167	184
Pasadena	89	1	46	112	169	
Marianna	89	12	75	112	142	191
Mountain 2	89	39	71	124	175	207
Gate Lake	89	26	69	129	176	218
Thomas	89	19	64	129	179	237
Little Fish	89	2	95			
Picnic	89	0				
Swim Pond	89	3	82	143	170	

Redear sunfish:	Age 1	Age 2	Age 3	Age 4
Number of Lakes	46	45	43	35
Mean of Means	75	133	176	205
Standard Error	2.7	3.1	3.6	4.4

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Largemouth bass:						
Keys Pond	86	22	141	210		
Brim Pond	86	13	159	264	277	309
Okahumpka	86	32	151	224	279	341
Clay	86	11	169	246	325	375
Wauberg	86	15	155	276	347	476
Bivens Arm	86	6	191	327	398	424
Apopka	86	2	182	287	341	378
Miona	86	59	131	215	282	
Wales	86	24	153	289	355	407
Clear	86	11	161	291	369	406
Baldwin	86	29	170	303	363	
Baldwin	88	0				
Baldwin	89	30	136	287	382	421
Susannah	86	30	157	266	337	376
Susannah	88	0				
Susannah	89	57	157	261	334	404
Pearl	86	18	172	285	349	
Pearl	88	0				
Pearl	89	15	170	273	320	330
Cue	86	10	164	261		
Cue	87	25	153	223	324	
Alligator	87	24	178	313	354	
Crooked	87	27	146	232	280	328
Deep	87	11	124	210	266	314
Lawbreaker	87	0				
Round Pond	87	8	114	191	258	306
Carr	87	22	129	249	317	342
Hollingsworth	87	31	171	283	363	427
Hunter	87	26	196	276	380	440
Hartridge	87	53	126	204	263	301
Killarny	87	21	166	268	350	474
Holden	87	18	126	241	314	327
Catherine	87	40	139	216	265	304
Bell	87	36	172	260	329	377
Bonny	87	5	186	270	338	375
Harris	87	0				
Lindsey	88	28	146	244	304	350
Loften	88	20	125	219	314	359
Moore	88	14	138	219	287	300

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Largemouth bass:						
Live Oak	88	44	146	241	305	369
Koon	88	9	147	268	328	
Watertown	88	38	166	288	366	430
Patrick	88	75	170	249	300	392
Orienta	88	38	158	278	330	344
Conine	88	57	171	281	352	418
Tomahawk	88	18	141	215	260	297
Barco	88	6	175	271	400	
Suggs	88	2	142	196		
Carlton	88	17	166	272	350	420
Rowell	88	25	152	263	361	384
Lochloosa	88	31	148	250	303	314
Turkey Pen	88	9	108	192	247	312
Fish	88	99	152	271	338	
Bull Pond	89	36	142	227	269	310
Mill Dam	89	33	144	236	275	297
West Moody	89	52	148	266	339	411
Grasshopper	89	50	142	232	304	387
Mountain	89	61	169	284	341	
Douglas	89	29	157	274	331	361
Pasadena	89	49	151	278	364	420
Marianna	89	57	132	244	295	347
Mountain 2	89	28	150	246	302	400
Gate Lake	89	26	199	291	351	395
Thomas	89	71	140	228	362	359
Little Fish	89	17	152	274	378	382
Picnic	89	27	134	204	246	260
Swim Pond	89	17	162	258		

Largemouth bass:	Age 1	Age 2	Age 3	Age 4
Number of Lakes	62	62	58	49
Mean of Means	153	254	323	367
Standard Error	2.4	4.0	5.2	7.2

Table 6. (Continued)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Black crappie:						
Keys Pond	86	0				
Brim Pond	86	0				
Okahumpka	86	0				
Clay	86	0				
Wauberg	86	36	128	192		
Bivens Arm	86	0				
Apopka	86	73	113	178	226	260
Miona	86	3	123	203		
Wales	86	31	118	238	283	303
Clear	86	1	96			
Baldwin	86	0				
Baldwin	88	0				
Baldwin	89	1	149	236		
Susannah	86	0				
Susannah	88	5	128	200		
Susannah	89	12	141	213	246	260
Pearl	86	2	121	201	240	
Pearl	88	0				
Pearl	89	11	110	191	244	
Cue	86	0				
Cue	87	0				
Alligator	87	9	126	221		
Crooked	87	0				
Deep	87	0				
Lawbreaker	87	0				
Round Pond	87	0				
Carr	87	0				
Hollingsworth	87	16	110	135	164	178
Hunter	87	0				
Hartridge	87	1	135	204	236	269
Killarny	87	0				
Holden	87	0				
Catherine	87	0				
Bell	87	0				
Bonny	87	8	122	185	216	228
Harris	87	0				
Lindsey	88	4	119	192	227	239
Loften	88	0				
Moore	88	0				

Table 6. (Concluded)

Lake	Year	Total Fish	Age 1	Age 2	Age 3	Age 4
Black crappie:						
Live Oak	88	1	131			
Koon	88	0				
Watertown	88	14	128	243	296	
Patrick	88	7	106	197	233	
Orienta	88	0				
Conine	88	3	103	156	203	
Tomahawk	88	0				
Barco	88	0				
Suggs	88	0				
Carlton	88	16	106	166		
Rowell	88	0				
Lochloosa	88	12	102	187	237	283
Turkey Pen	88	0				
Fish	88	16	110	191	233	254
Bull Pond	89	6	130	192	237	242
Mill Dam	89	6	99	180	231	250
West Moody	89	7	112	176	232	259
Grasshopper	89	2	134	209	237	
Mountain	89	2	151			
Douglas	89	0				
Pasadena	89	20	115	201	249	306
Marianna	89	11	137	215		
Mountain 2	89	0				
Gate Lake	89	3	149	252	292	314
Thomas	89	18	109	193		
Little Fish	89					
Picnic	89					
Swim Pond	89					

Black crappie:	Age 1	Age 2	Age 3	Age 4
Number of Lakes	31	28	20	14
Mean of Means	121	198	238	260
Standard Error	2.7	4.9	6.5	9.4

Table 7. Modified Peterson mark-recapture estimates for harvestable bluegill (> 149 mm TL), redear sunfish (> 149 mm TL), and largemouth bass (> 249 mm TL) for Florida lakes sampled between 1986 and 1990. The estimates are listed with the 95 % confidence limits.

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Bluegill:				
Keys Pond	86-87	43	13	78
Brim Pond	86-87			
Okahumpka	86-87	5	3	7
Clay	86-87	5	4	7
Wauberg	87-88	471	385	577
Bivens Arm	86-87	272	175	417
Apopka				
Miona				
Wales	86-87	78	52	117
Clear	86-87	23	13	40
Baldwin	86-87	168	116	242
Baldwin				
Baldwin				
Susannah	86-87	43	29	63
Susannah				
Susannah				
Pearl	86-87	23	56	9
Pearl				
Pearl				
Cue				
Cue				
Alligator	87-88	21	17	26
Crooked	87-88			
Deep	87-88	18	7	44
Lawbreaker				
Round Pond	87-88	14	19	11
Carr				
Hollingsworth	87-88	84	59	118
Hunter				
Hartridge	87-88	5	10	3
Killarny	87-88	100	66	151
Holden	87-88	155	125	193
Catherine				
Bell	87-88	9	7	11
Bonny	87-88	4	3	5
Harris				
Lindsey				
Loften				

Table 7. (Continued)

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Bluegill:				
Moore				
Live Oak				
Koon				
Watertown	88-89	402	284	566
Patrick	88-89	1	1	2
Orienta	88-89	125	91	171
Conine	88-89	469	375	587
Tomahawk				
Barco	88-89	154	69	384
Suggs	88-89	22	13	35
Carlton	88-89	210	191	232
Rowell	88-89	233	149	385
Lochloosa				
Turkey Pen	88-89	2	1	5
Fish	88-89	225	159	317
Bull Pond	89-90	31	23	43
Mill Dam	89-90	2	1	3
West Moody				
Grasshopper				
Mountain				
Douglas				
Pasadena				
Marianna	89-90	91	49	162
Mountain 2	89-90	59	24	118
Gate Lake	89-90	31	15	58
Thomas	89-90	15	10	23
Little Fish	89-90	797	478	1084
Picnic	89-90	44	13	76
Swim Pond				

Table 7. (Continued)

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Redear sunfish:				
Keys Pond				
Brim Pond				
Okahumpka				
Clay				
Wauberg	87-88	42	29	60
Bivens Arm	86-87	86	51	142
Apopka				
Miona				
Wales	86-87	78	43	136
Clear	86-87	40	25	63
Baldwin	86-87	155	88	265
Baldwin				
Baldwin				
Susannah	86-87	53	35	80
Susannah				
Susannah				
Pearl	86-87	205	333	132
Pearl				
Pearl				
Cue				
Cue				
Alligator	87-88	7	5	9
Crooked				
Deep				
Lawbreaker				
Round Pond				
Carr				
Hollingsworth	87-88	60	43	82
Hunter	87-88	5	3	8
Hartridge	87-88			
Killarny	87-88	235	180	307
Holden	87-88	90	59	137
Catherine				
Bell	87-88	33	24	44
Bonny	87-88	23	17	32
Harris				
Lindsey				
Loften				
Moore				
Live Oak	87-88	2	2	3

Table 7. (Continued)

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Redear sunfish:				
Koon				
Watertown	88-89	13	9	18
Patrick				
Orienta	88-89	26	18	37
Conine	88-89	39	26	57
Tomahawk				
Barco				
Suggs	88-89	1	0	2
Carlton	88-89	135	108	168
Rowell	88-89	143	83	268
Lochloosa				
Turkey Pen				
Fish	88-89	14	10	18
Bull Pond	89-90	1	1	1
Mill Dam				
West Moody				
Grasshopper				
Mountain				
Douglas				
Pasadena				
Marianna	89-90	1	1	2
Mountain 2	89-90	55	38	79
Gate Lake	89-90	237	153	364
Thomas	89-90	6	4	7
Little Fish	89-90	80	29	200
Picnic				
Swim Pond				

Table 7. (Continued)

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Largemouth bass:				
Keys Pond	86-87	6	3	13
Brim Pond	86-87	38	24	59
Okahumpka	86-87	13	8	21
Clay	86-87	23	13	37
Wauberg	87-88	17	13	22
Bivens Arm	86-87	13	9	18
Apopka				
Miona	86-87	18	11	29
Wales	86-87	12	8	18
Clear	86-87	8	6	11
Baldwin	86-87	19	15	25
Baldwin				
Baldwin				
Susannah	86-87	44	37	52
Susannah				
Susannah				
Pearl	86-87	30	44	21
Pearl				
Pearl				
Cue	87-88	7	4	13
Cue				
Alligator	87-88	28	22	35
Crooked	87-88	56	28	122
Deep	87-88	32	14	67
Lawbreaker				
Round Pond	87-88	16	10	27
Carr				
Hollingsworth	87-88	14	12	16
Hunter	87-88	20	16	26
Hartridge	87-88	24	17	34
Killarny	87-88	14	11	18
Holden	87-88	10	8	12
Catherine	87-88	18	11	28
Bell	87-88	34	26	44
Bonny	87-88	6	3	11
Harris				
Lindsey				
Loften				
Moore	87-88	14	7	33
Live Oak	88-89	24	19	31

Table 7. (Concluded)

Lake	Year of Sample	Stock (fish/ha)	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Largemouth bass:				
Koon				
Watertown	88-89	26	21	33
Patrick	88-89	34	28	42
Orienta	88-89	37	32	43
Conine	88-89	40	36	45
Tomahawk	87-88	11	4	26
Barco	88-89	1	1	2
Suggs	88-89	1	1	2
Carlton	88-89	8	7	9
Rowell	88-89	48	40	59
Lochloosa	88-89	17	12	26
Turkey Pen				
Fish	88-89	17	14	20
Bull Pond	89-90	12	7	21
Mill Dam	89-90	8	5	12
West Moody	89-90	28	17	47
Grasshopper	89-90	13	7	23
Mountain	89-90	26	17	40
Douglas				
Pasadena	89-90	42	30	58
Marianna	89-90	22	18	27
Mountain 2	89-90	17	14	20
Gate Lake	89-90	23	18	30
Thomas	89-90	13	10	17
Little Fish	89-90	75	57	101
Picnic	89-90	6	2	11
Swim Pond	89-90	19	8	38

Table 8. The mean, range, standard error of the mean, and coefficient of variation for parameters measured on Florida lakes sampled between 1986 and 1990.

Parameters	Mean	Minimum	Maximum	Standard Error	Coefficient of Variation
Morphology:					
Surface Area (ha)	373.4	1.8	12412.0	204.3	447.9
Mean Depth (m)	2.9	0.6	5.9	0.2	42.6
Shoreline Length (km)	5.3	0.6	61.3	1.2	187.4
Trophic State and Water Chemistry:					
Total Phosphorus (µg/L)	53	1.0	1043	17	266
Total Nitrogen (µg/L)	990	82	6340	124	103
Total Chlorophyll *a* (µg/L)	27	1.0	241	5	163
Nannochlorophyll *a* (µg/L)	23	0	224	5	177
Secchi Depth (m)	1.8	0.3	5.8	0.2	78.3
Specific Conductance (µS/cm at 25 C)	136	17	384	11	68
Total Alkalinity (mg/L as $CaCO_3$)	31.9	0.0	130.6	3.9	100.2
Color (Pt-Co units)	28	0	400	6	183
pH	7.1	4.3	9.7	0.2	22.0
Chloride (mg/L)	15.5	2.1	43.7	1.2	64.2
Calcium (mg/L)	11.5	0.3	39.1	1.2	87.9
Magnesium (mg/L)	3.5	0.2	17.7	0.4	101.8
Inorganic Suspended Solids (mg/L)	1.1	0.1	10.1	0.2	166.8
Organic Suspended Solids (mg/L)	5.5	0.2	53.8	1.1	163.0
Potassium (mg/L)	2.6	0.0	12.8	0.3	111.5
Aquatic Macrophytes:					
Percent Volume Infested (%)	20.9	0.1	100.0	3.7	146.7
Percent Area Covered (%)	37.4	0.1	100.0	4.7	103.2
Emergent Biomass (kg wt wt/m^2)	3.4	0.0	26.8	0.5	130.1
Floating-leaf Biomass (kg wt wt/m^2)	1.1	0.0	11.2	0.3	187.9

Table 8. (Continued)

Parameters	Mean	Minimum	Maximum	Standard Error	Coefficient of Variation
Aquatic Macrophytes:					
Submersed Biomass (kg wt wt/m^2)	1.6	0.0	16.6	0.4	192.3
Periphyton (mg chlorophyll *a*/ m^2 of host plant)	18.6	0.0	58.5	1.3	56.3
Periphyton (mg chlorophyll *a*/ kg of host plant)	20.4	0.0	74.7	2.1	81.9
Invertebrates:					
Epiphytic Macroinvertebrates (number/kg wet wt of plants)	287	30	2885	58	158
Epiphytic Macroinvertebrates (g/kg wet wt of plants)	1.4	0.0	35.8	0.6	335.6
Benthic Macroinvertebrates (number/m^2)	591	7	2733	79	109
Benthic Macroinvertebrates (g/m^2)	6.9	0.0	68.8	1.9	220.5
Cladocerans (number/m^3)	68018	1075	622401	12064	137
Copepods (number/m^3)	66865	1002	206639	6872	80
Nauplii (number/m^3)	67146	1505	305772	7790	90
Rotifers (number/m^3)	148277	0	2310307	40578	212
Ostracods (number/m^3)	5649	0	62377	1496	205
Chaoborus (number/m^3)	632	0	11999	216	264
Total zooplankton (number/m^3)	356587	55418	2932260	54394	118
Whole-lake blocknet estimates:					
Total fish (number/ha)	18837	232.3	211405	3943	162
Total fish (kg/ha)	127	6.4	675	17	105
Harvestable fish (number/ha)	239	6.4	3701	61	199
Harvestable fish (kg/ha)	38	1.4	431	7	151

Table 8. (Concluded)

Parameters	Mean	Minimum	Maximum	Standard Error	Coefficient of Variation
Electrofishing catch per unit effort:					
Total fish (number/hr)	492	25.2	5860	108	170
Total fish (kg/hr)	26	0.7	116	3	87
Harvestable fish (number/hr)	39	0.0	254	5	109
Harvestable Fish (kg/hr)	12	0.0	69	2	100
Experimental gillnet catch per unit effort:					
Total fish (number/net/24 hr)	49.4	0.0	365.2	10.4	163
Total fish (kg/net/24 hr)	12.5	0.0	134.0	2.6	159
Harvestable fish (number/net/24 hr)	6.4	0.0	33.7	1.0	117
Harvestable fish (kg/net/24 hr)	2.1	0.0	8.7	0.3	96
Mark-recapture estimates for harvestable fish:					
Bluegill (number/ha)	120	1	797	28	141
Redear sunfish (number/ha)	67	1	237	13	105
Largemouth bass (number/ha)	22	1	75	2	65

reaching maximum densities of 62,400 and 12,000 individuals/m^3, respectively (Table 8).

The total fish biomass, estimated with rotenone and blocknet samples and adjusted for limnetic and littoral areas, for the 60 lakes in this study averaged 127 kg/ha with a range of 6.4 to 675 kg/ha (Table 8). Williams et al. (1988) reported similar average total fish biomass values for 9 Florida lakes, with littoral and limnetic nets averaging 173 and 68 kg/ha, respectively. Electrofishing catch per unit effort values for total and harvestable fish biomass ranged < 0.1 to 116 fish/hr and 0 to 69 kg/hr, respectively (Table 8). Experimental gillnet catch per unit effort values for total and harvestable fish biomass ranged 0 to 134 kg/net/24 hr and 0 to 8.7 kg/net/24 hr, respectively (Table 8). Mark-recapture population estimates for harvestable fish indicate the average population of largemouth bass, redear sunfish, and bluegill in Florida is 22, 67, and 120 fish/ha, respectively (Table 8).

The limnological parameters listed in Table 2 are similar to those reported by Canfield and Hoyer (1988a) for 165 Florida lakes and the aquatic macrophyte parameters listed in Table 3 cover similar ranges of coverage and above-ground biomass reported for 69 Florida lakes by Canfield and Duarte (1988). Thus, we submit that the study lakes should represent Florida lakes, as a group, for the purpose of examining the relations among lake trophic status, aquatic macrophytes, and fish populations because the lakes range from oligotrophic to hypereutrophic with low to high aquatic macrophytes abundances.

Descriptions of Study Lakes

Keys Pond

Location and Morphology

Keys Pond is located in Putnam County, Florida (Latitude 29.31 N; Longitude 81.58 W). The lake lies in the Interlachen Sand Hills division of the Central Lake District (Brooks 1981). The geology is dominated by highly leached sands of the Hawthorne Formation. Keys Pond was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 5.3 ha, 1.02 km, and 2.9 m, respectively (Table 1).

Trophic Status and Water Chemistry

Keys Pond is a mesotrophic lake. During this study, the lake had an average total phosphorus concentration of 2.0 µg/L and an average total nitrogen concentration of 208 µg/L. Total chlorophyll *a* concentrations averaged 1 µg/L and the water clarity as measured by use of a Secchi disc averaged 5.3 meters (Table 2). Keys Pond, however, had a substantial amount of aquatic macrophytes and the adjusted chlorophyll *a* value in Keys Pond was estimated at 4.4 µg/L.

Keys Pond is also an acidic, clear water lake with low salinity. The lake had an average pH of 5.4 and an average total alkalinity of 1.7 mg/L as $CaCO_3$. The average water color was 2 Pt-Co units and average specific conductance was 43 µS/cm @ 25 C.

Aquatic Plants

Keys Pond had a moderate abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 40% and 7.9%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved, and submersed vegetation was 2.8, < 0.1, and 1.0 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 58.5 mg chlorophyll *a*/cm^2 of host plant and 68.2 mg chlorophyll *a*/kg wet wt of host plant (Table 3). A total of 14 species of aquatic macrophytes were collected in Keys Pond (Table 9). The most commonly encountered plant species were *Panicum hemitomon, Fuirena sciropoidea* and *Utricularia floridana* which occurred in 100%, 100%, and 100% of the transects, respectively.

Table 9. Occurrence of plant species in ten evenly-spaced transects around Keys Pond.

Common name	Scientific name	Percent of Transects
slender spikerush	*Eleocharis baldwinii*	80
banana-lily	*Nymphoides aquatica*	10
spatterdock	*Nuphar luteum*	10
dwarf arrowhead	*Sagittaria subulata*	70
purple bladderwort	*Utricularia purpurea*	80
maidencane	*Panicum hemitomon*	100
green algae	*Chlorphyta*	10
	Fuirena sciropoidea	100
	Leersia hexandra	10
	Utricularia floridana	100
St. John's wort	*Hypericum* spp.	80
yellow-eyed grass	*Xyris* spp.	70
	Eleocharis elongata	10
hatpin	*Eriocaulon decangulare*	100

No previous vegetation studies have been conducted on Keys Pond, but the lake is private and located on undeveloped land. The owner (Mr. Jack Williams of Gainesville, Florida) and his land caretaker, however, informed us that the lake's vegetation and general appearance was the same for several years prior to our sampling. Thus, the fish population in Keys Pond can be considered the product of an mesotrophic lake with a moderate level of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Keys Pond was 147 individuals/kg wet wt of host plants and 1.03 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Keys Pond, as estimated with a ponar dredge, was 307 individuals/m^2 and 2.24 g wet wt/m^2 (Table 5). The zooplankton population was dominated by copepods and cladocerans with 40,600 and 32,200 individuals/m^3 (Table 5).

Fish

A total of 10 species of fish were collected in Keys Pond (Tables 10, and 11). The most abundant species, estimated with rotenone sampling, were the lined topminnow and warmouth. These species had average standing stocks in the littoral blocknets of 729 and 725 fish/ha, respectively (Table 10). No fish were collected by use of gillnets. The most abundant species collected using electrofishing were the lined topminnow and largemouth bass with catch per unit efforts of 30 and 6 fish per hour, respectively (Table 11). The first year growth of largemouth bass was 141 mm TL (Table 6). Mark-recapture estimates indicated that there were 6 harvestable largemouth bass and 43 harvestable bluegill per hectare in Keys Pond.

No previous fisheries studies have been done on Keys Pond. Mr. Williams and his land caretaker, however, have observed no major change in the fish population over the last several years.

Brim Pond

Location and Morphology

Brim Pond is located in Putnam County, Florida (Latitude 29.31 N; Longitude 81.58 W). The lake lies in the Interlachen Sand Hills physiographic division of the Central Lake District (Brooks 1981). The geology is dominated by the highly leached sands of the Hawthorne Formation. Brim Pond was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 3.2 ha, 0.72 km, and 4.0 m, respectively (Table 1). **(Text continued on page 72)**

Table 10. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Keys Pond. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for total fish				
Lake chubsucker	12	7.1	1.3	0.8
Brown bullhead	4	4.1	0.0	0.0
Golden topminnow	29	17.9	0.0	0.0
Lined topminnow	729	37.7	0.9	0.10
Bluefin killifish	12	12.4	0.0	0.0
Mosquitofish	37	12.4	0.0	0.0
Warmouth	725	193.6	5.7	2.1
Bluegill	181	85.7	21.5	10.1
Largemouth bass	309	14.3	11.4	2.1
Swamp darter	70	28.8	0.10	0.0
Total	2107		40.9	
Open-water nets (n=3) for total fish				
Lake chubsucker	0	0.0	0.0	0.0
Brown bullhead	0	0.0	0.0	0.0
Golden topminnow	0	0.0	0.0	0.0
Lined topminnow	25	7.1	0.0	0.0
Bluefin killifish	0	0.0	0.0	0.0
Mosquitofish	12	12.4	0.0	0.0
Warmouth	1149	321.8	2.0	0.6
Bluegill	17	10.9	2.1	1.2
Largemouth bass	329	57.6	6.3	2.5
Swamp darter	37	18.9	0.0	0.0
Total	1568		10.5	

Table 10. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.0
Warmouth	4	4.1	0.3	0.3
Bluegill	181	85.7	21.5	10.1
Largemouth bass	4	4.1	0.8	0.8
Total	189		22.6	
Open-water nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.0
Warmouth	0	0.0	0.0	0.0
Bluegill	16	10.9	2.1	1.2
Largemouth bass	4	4.1	2.0	2.0
Total	21		4.1	

Table 11. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Keys Pond. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=3) for total fish				
Lined topminnow	30.0	6.00	0.4	0.00
Largemouth bass	6.0	6.00	6.2	0.62
Total	36.0		6.6	
Electrofishing runs (n=3) for harvestable fish				
Largemouth bass	2.0	2.00	0.2	0.23
Total	2.0		0.2	

Trophic Status and Water Chemistry

The lake had an average total phosphorus concentration of 9.0 µg/L and an average total nitrogen concentration of 624 µg/L. Total chlorophyll *a* concentrations averaged 8.0 µg/L and water clarity as measured by use of a Secchi disc averaged 2.2 meters (Table 2). The lake had an average pH of 7.8 and an average total alkalinity of 29.1 mg/L as $CaCO_3$. The average specific conductance was 95 µS/cm @ 25 C and the average water color was 10 Pt-Co units. The adjusted chlorophyll *a* value for Brim Pond was 8.6 µg/L. Using this value and the classification system of Forsberg and Ryding (1980), Brim Pond was a eutrophic lake during this study.

Aquatic Plants

Brim Pond had a low abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 3.4% and 1.2%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved, and submersed vegetation was 2.8, 1.2, and 0.1 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 9.1 mg chlorophyll *a*/cm^2 of host plant and 4.3 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Seven species of aquatic macrophytes were collected in Brim Pond (Table 12). The most commonly encountered plant species were *Eleocharis baldwinii, Hydrocotyle umbellata,* and *Panicum hemitomon* which occurred in 100%, 100%, and 100% of the transects, respectively.

Table 12. Occurrence of plant species in ten evenly-spaced transects around Brim Pond.

Common name	Scientific name	Percent of Transects
slender spikerush	*Eleocharis baldwinii*	100
spatterdock	*Nuphar luteum*	10
water-pennywort	*Hydrocotyle umbellata*	100
dwarf arrowhead	*Sagittaria subulata*	90
maidencane	*Panicum hemitomon*	100
	Fuirena sciropoidea	100
	Leersia hexandra	30

Brim pond is a private lake on undeveloped land. The owner (Mr. Jack Williams of Gainesville, Florida) and his land caretaker both agree the lake's vegetation and general appearance has remained the same for several years prior to our sampling. Thus, the fish population in Brim Pond can be considered the product of a eutrophic lake with low levels of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Brim Pond was

121 individuals/kg wet wt of host plants and 0.55 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Brim Pond, as estimated with a ponar dredge, was 1507 individuals/m^2 and 1.06 g wet wt/m^2 (Table 5). The zooplankton population was dominated by copepods and nauplii with 82,100 and 50,900 individuals/m^3 (Table 5).

Fish

A total of six species of fish were collected in Brim Pond (Table 13, 14, and 15). The most abundant species (by number) collected with rotenone sampling were bluegill, and largemouth bass. These species had average standing stocks in littoral blocknets of 20,000 and 3,100 fish/ha, respectively (Table 13). The most abundant open-water species collected in the experimental gillnets were golden shiner, and bluegill with 9.3 and 34 fish/net/24 hr, respectively (Table 14). The most abundant species collected using electrofishing were bluegill and largemouth bass with catch per unit efforts of 406 and 6 fish per hour, respectively (Table 15). First year growth of bluegill and largemouth bass were 70 and 159 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were 38 largemouth bass per hectare in Brim Pond.

No previous fisheries studies have been done on Brim Pond. The owner (Mr. Jack K. Williams) and his caretaker, however, have observed no major change in the fish population over the last several years.

Okahumpka

Location and Morphology

Okahumpka is located in Sumter County, Florida (Latitude 28.45 N; Longitude 82.05 W). The lake lies in the Tsala Apopka Basin division of the Ocala Uplift District (Brooks 1981). The geology is dominated by limestone with thin surficial sands and recently deposited freshwater marl and peat. Okahumpka was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 271 ha, 5.86 km, and 0.9 m, respectively (Table 1). **(Text continued on page 78)**

Table 13. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Brim Pond. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for total fish				
Mosquitofish	278	240.8	0.1	0.1
Warmouth	679	148.2	0.9	0.6
Bluegill	19951	1130.0	53.0	0.9
Largemouth bass	3100	679.2	25.4	5.3
Black crappie	74	61.7	0.2	0.2
Total	24082		79.6	
Open-water nets (n=1) for total fish				
Mosquitofish	124	0.0	0.0	0.0
Warmouth	2581	0.0	1.4	0.0
Bluegill	3989	0.0	95.1	0.0
Largemouth bass	6447	0.0	43.4	0.0
Black crappie	25	0.0	0.1	0.0
Total	13165		140.0	

Table 13. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for harvestable fish				
Warmouth	0	0.0	0.0	0.00
Bluegill	49	12.3	10.3	3.32
Largemouth bass	49	0.0	18.9	5.12
Black crappie	0	0.0	0.0	0.00
Total	99		29.3	
Open-water nets (n=1) for harvestable fish				
Warmouth	0	0.0	0.0	0.00
Bluegill	469	0.0	89.8	0.00
Largemouth bass	86	0.0	34.6	0.00
Black crappie	0	0.0	0.0	0.00
Total	556		124.4	

Table 14. Experimental gillnet (five, 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh which were 2.4 meter deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Brim Pond. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=3) for total fish				
Golden shiner	9.3	2.18	2.1	0.55
Warmouth	0.3	0.32	0.0	0.01
Bluegill	34.0	6.24	7.6	1.48
Largemouth bass	0.7	0.32	0.2	0.10
Total	44.3		9.9	
Gillnets (n=3) for harvestable fish				
Warmouth	1.3	0.88	0.2	0.16
Bluegill	0.0	0.00	0.0	0.00
Largemouth bass	0.3	0.33	0.1	0.14
Total	1.7		0.4	

Table 15. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Brim Pond. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=3) for total fish				
Warmouth	2.0	2.00	2.6	0.26
Bluegill	406.0	170.49	44.8	1.50
Largemouth bass	6.0	3.46	8.3	0.82
Total	414.0		55.7	
Electrofishing runs (n=3) for harvestable fish				
Warmouth	2.0	2.00	0.3	0.26
Bluegill	18.0	12.49	3.0	1.81
Largemouth bass	2.0	2.00	0.8	0.82
Total	22.0		4.1	

Trophic Status and Water Chemistry

Okahumpka had an average total phosphorus concentration of 21 µg/L, and an average total nitrogen concentration of 1033 µg/L. Total chlorophyll *a* concentrations averaged 11 µg/L and water clarity as measured by use of a Secchi disc averaged 1.4 m (Table 2). The lake had an average pH of 9.0 and an average total alkalinity of 54.6 mg/L as $CaCO_3$. The average specific conductance was 188 µS/cm @ 25 C and the average water color was 37 Pt-Co units. The adjusted chlorophyll *a* value in Okahumpka was 350 µg/L. Using this value and the classification system of Forsberg and Ryding (1980), Okahumpka is classified as a hypereutrophic lake.

Aquatic Plants

Okahumpka had a high abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 100% and 98%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved, and submersed vegetation was 11.9, 8.8, and 16.6 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 30.4 mg chlorophyll *a*/cm^2 of host plant and 38.1 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Fifteen species of aquatic macrophytes were collected in Okahumpka (Table 16). The most commonly encountered plant species were *Sagittaria lancifolia, Ceratophyllum demersum,* and *Hydrilla verticillata* which occurred in 90%, 90%, and 90% of the transects, respectively.

Table 16. Occurrence of plant species in ten evenly-spaced transects around Lake Okahumpka.

Common name	Scientific name	Percent of Transects
water-lettuce	*Pistia stratiotes*	20
floating water-hyacinth	*Eichhornia crassipes*	60
common salvinia	*Salvinia rotundifolia*	50
duck-potato	*Sagittaria lancifolia*	90
alligator-weed	*Alternanthera philoxeroides*	10
frog's-bit	*Limnobium spongia*	70
spatterdock	*Nuphar luteum*	80
fragrant water-lily	*Nymphaea odorata*	30
smartweed	*Polygonum hydropiperoides*	10
cat-tail	*Typha* spp.	40
water-pennywort	*Hydrocotyle umbellata*	30
coontail	*Ceratophyllum demersum*	90
hydrilla	*Hydrilla verticillata*	90
sawgrass	*Cladium jamaicense*	10
	Rhynchyospora tracyi	10

The plant community of Okahumpka has been monitored by the Florida Department of Natural Resources from 1982 to present. The major aquatic plant in the lake during that time period has been *Hydrilla verticillata.* The areal coverage of *Hydrilla* *verticillata* in Okahumpka ranged between 190 and 240 hectares of coverage. Our study also found high areal coverage (Table 16). Thus, the fish population in Okahumpka can be considered the product of a hypereutrophic lake with high levels of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Okahumpka was 104 individuals/kg wet wt of host plants and 0.45 g wet wt/kg wet wt of host plant (Table 4). Average number and biomass of benthic macroinvertebrates in Okahumpka, as estimated with a ponar dredge, was 147 individuals/m^2 and 0.84 g wet wt/m^2, respectively (Table 4). The zooplankton population was dominated by rotifers and nauplii with 62,800 and 61,900 individuals/m^3 (Table 5).

Fish

Twenty-five species of fish were collected from Okahumpka (Table 17, 18, and 19). The most abundant species (by numbers) collected with rotenone sampling were bluefin killifish and bluespotted sunfish. These species had average standing stocks in littoral blocknets of 7,600 and 3,700 fish/ha, respectively (Table 17). The most abundant open-water species collected in the experimental gillnets were gizzard shad and warmouth with 3.7 and 3.7 fish/net/24 hr, respectively (Table 18). The most abundant species collected using electrofishing were the mosquitofish, redear sunfish, and largemouth bass with catch per unit efforts of 54, 26 and 26 fish per hour, respectively (Table 19). The first year growth of bluegill, redear sunfish, and largemouth bass was 58, 50, and 151 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were 5 bluegill and 13 largemouth bass per hectare in Okahumpka (Table 7).

The Florida Game and Fresh Water Fish Commission (GFC) collected 15 species of fish by use of electrofishing in 1986 and 1987 (McKinney et al. 1986, 1987), which is similar to the 16 species of fish collected in our electrofishing samples in 1986 (Table 19). The total number and weight of fish collected by GFC ranged from 255 to 489 fish/hr and 30.2 to 81.6 kg/hr, respectively. These values are also similar our values of 189 fish/hr and 75 kg/hr listed in Table 19. **(Text continued on page 86)**

Table 17. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Okahumpka. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for total fish				
Florida gar	12	7.1	3.3	1.7
Bowfin	4	4.1	4.5	4.5
Golden shiner	66	29.7	0.2	0.1
Lake chubsucker	82	41.2	0.2	0.2
Brown bullhead	268	182.9	0.9	0.5
Golden topminnow	432	37.7	0.6	0.1
Flagfish	914	327.8	1.1	0.4
Bluefin killifish	7608	1689.9	2.1	0.5
Mosquitofish	280	273.8	0.1	0.1
Sailfin molly	239	232.6	0.4	0.4
Brook silverside	4	4.1	0.0	0.0
Bluespotted sunfish	3672	1213.0	2.9	0.9
Warmouth	2972	406.4	21.9	3.5
Bluegill	1182	279.1	7.6	1.2
Dollar sunfish	12	12.4	0.0	0.0
Redear sunfish	1515	802.0	11.8	6.5
Spotted sunfish	17	16.5	0.4	0.4
Largemouth bass	951	195.4	10.1	3.2
Black crappie	29	17.9	0.0	0.0
Swamp darter	8	4.1	0.0	0.0
Total	20266		68.1	

Table 17. (Continued)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Open-water nets (n=3) for total fish				
Florida gar	12	7.1	6.8	3.5
Bowfin	0	0.0	0.0	0.0
Golden shiner	4	4.1	0.4	0.4
Lake chubsucker	41	25.0	1.9	1.0
Brown bullhead	0	0.0	0.0	0.0
Golden topminnow	0	0.0	0.0	0.0
Flagfish	0	0.0	0.0	0.0
Bluefin killifish	6891	1715.1	2.5	0.8
Mosquitofish	17	16.5	0.0	0.0
Sailfin molly	0	0.0	0.0	0.0
Brook silverside	482	229.5	0.2	0.1
Bluespotted sunfish	329	168.2	0.4	0.2
Warmouth	5125	2216.1	5.8	4.1
Bluegill	1885	819.6	7.2	2.8
Dollar sunfish	0	0.0	0.0	0.0
Redear sunfish	5698	1398.9	64.6	26.3
Spotted sunfish	0	0.0	0.0	0.0
Largemouth bass	362	136.5	5.9	1.7
Black crappie	54	36.6	0.1	0.0
Swamp darter	161	114.8	0.1	0.0
Total	21061		95.8	

Table 17. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.00
Warmouth	8	4.1	0.8	0.38
Bluegill	12	7.1	1.0	0.60
Dollar sunfish	0	0.0	0.0	0.00
Redear sunfish	12	7.1	2.2	1.50
Spotted sunfish	0	0.0	0.0	0.00
Largemouth bass	8	4.1	1.6	0.82
Black crappie	0	0.0	0.0	0.00
Total	41		5.6	
Open-water nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.00
Warmouth	0	0.0	0.0	0.00
Bluegill	0	0.0	0.0	0.00
Dollar sunfish	0	0.0	0.0	0.00
Redear sunfish	25	7.1	2.4	0.64
Spotted sunfish	0	0.0	0.0	0.00
Largemouth bass	8	4.1	2.5	1.45
Black crappie	0	0.0	0.0	0.00
Total	33		4.9	

Table 18. Experimental gillnet (five, 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 meter deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Okahumpka. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=3) for total fish				
Florida gar	3.3	1.33	1.0	0.35
Longnose gar	0.3	0.32	0.2	0.24
Bowfin	1.0	0.00	0.6	0.24
Gizzard shad	3.7	1.76	1.7	0.84
Golden shiner	0.3	0.32	0.1	0.06
Lake chubsucker	1.0	1.00	0.4	0.44
Yellow bullhead	0.3	0.32	0.2	0.15
Warmouth	3.7	1.20	0.2	0.07
Bluegill	1.3	0.88	0.1	0.07
Redear sunfish	0.3	0.32	0.1	0.06
Largemouth bass	2.3	1.20	0.4	0.23
Total	17.7		5.0	
Gillnets (n=3) for harvestable fish				
Yellow bullhead	0.3	0.33	0.2	0.15
Warmouth	0.3	0.33	0.0	0.04
Bluegill	0.7	0.33	0.1	0.06
Redear sunfish	0.3	0.33	0.1	0.06
Largemouth bass	0.7	0.67	0.2	0.23
Total	2.3		0.6	

Table 19. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Okahumpka. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=6) for total fish				
Florida gar	10.0	3.70	26.4	0.94
Bowfin	2.0	2.00	10.7	1.07
Chain pickerel	1.0	1.00	0.4	0.04
Lake chubsucker	3.0	1.35	5.1	0.40
Golden topminnow	3.0	2.04	0.1	0.01
Flagfish	4.0	2.97	0.1	0.01
Bluefin killifish	2.0	1.29	0.0	0.00
Mosquitofish	54.0	50.49	0.1	0.01
Least killifish	1.0	1.00	0.0	0.00
Sailfin molly	21.0	19.82	0.1	0.01
Bluespotted sunfish	5.0	3.27	0.0	0.00
Warmouth	9.0	4.83	2.2	0.11
Bluegill	21.0	6.34	3.3	0.09
Redear sunfish	26.0	5.73	4.1	0.09
Spotted sunfish	1.0	1.00	0.4	0.04
Largemouth bass	26.0	6.87	21.8	0.65
Total	189.0		74.9	
Electrofishing runs (n=6) for harvestable fish				
Chain pickerel	0.0	0.00	0.0	0.00
Warmouth	0.0	0.00	0.0	0.00
Bluegill	1.0	1.00	0.1	0.07
Redear sunfish	0.0	0.00	0.0	0.00
Spotted sunfish	0.0	0.00	0.0	0.00
Largemouth bass	4.0	1.26	1.1	0.60
Total	5.0		1.18	

Clay Lake

Location and Morphology

Clay Lake is located in Lake County, Florida (Latitude 29.02 N; Longitude 81.27 W). The lake lies in the Ocala Scrub division of the Ocala Uplift District (Brooks 1981). The geology is dominated by highly leached sands of the Hawthorne Formation. Clay Lake was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 4.9 ha, 0.92 km, and 2.3 m, respectively (Table 1).

Trophic Status and Water Chemistry

Clay Lake had an average total phosphorus concentration of 7 µg/L and an average total nitrogen concentration of 356 µg/L. Total chlorophyll *a* concentrations averaged 4 µg/L and water clarity as measured by use of a Secchi disc averaged 4.0 meters (Table 2). Although these values indicate Clay Lake is an oligotrophic lake, the lake has a high abundance of aquatic macrophytes and the adjusted chlorophyll *a* value for Clay Lake was 96.6 µg/L. Based on the adjusted chlorophyll *a* value and the classification system of Forsberg and Ryding (1980), Clay Lake would be classified as a hypereutrophic lake.

Clay Lake is an acidic, low salinity, clearwater lake. The lake had an average pH of 4.8 and an average total alkalinity of 0.7 mg/L as $CaCO_3$. The average specific conductance was 51 µS/cm @ 25 C and the average water color was 2.5 Pt-Co units.

Aquatic Plants

Clay Lake had a high abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 100% and 76%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 8.1, 4.5, and 6.8 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 21.7 mg chlorophyll *a*/cm^2 of host plant and 44.7 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Eleven species of aquatic macrophytes were collected from Clay Lake (Table 20). The most commonly encountered plant species were *Nymphoides aquatica, Myriophyllum heterophyllum,* and *Fuirena*

Table 20. Occurrence of plant species in ten evenly-spaced transects around Clay Lake.

Common name	Scientific name	Percent of Transects
banana-lily	*Nymphoides aquatica*	100
spatterdock	*Nuphar luteum*	10
fragrant water-lily	*Nymphaea odorata*	80
pickerelweed	*Pontederia cordata*	50
water-moss	*Fontinalis* spp.	10
variable-leaf milfoil	*Myriophyllum heterophyllum*	100
purple bladderwort	*Utricularia purpurea*	60
maidencane	*Panicum hemitomon*	10
	Fuirena sciropoidea	100
	Leersia hexandra	80
St. John's wort	*Hypericum* spp.	100

sciropoidea which occurred in 100%, 100% and 100% of the transects, respectively.

The plant community of Clay Lake was sampled by the University of Florida in 1985 (Canfield and Joyce 1985) and aquatic macrophytes were found to be very abundant (100% coverage). The dominant submersed species in the lake during 1985 were *Utricularia floridana* and *U. purpurea.* Clay lake is located in the Ocala National Forest and is undeveloped. Thus, the fish population in Clay Lake can be considered the product of a hypereutrophic lake with high levels of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Clay Lake was 104 individuals/kg wet wt of host plants and 0.45 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Clay Lake, as estimated with a ponar dredge, was 147 individuals/m^2, and 0.84 g wet wt/m^2 (Table 5). The zooplankton population was dominated by nauplii and copepods with 71,000 and 50,600 individuals/m^3, respectively (Table 5).

Fish

Seven species of fish were collected from Clay Lake (Table 21, 22 and 23). The most abundant species (by numbers) collected **(Text continued on page 91)**

Table 21. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Clay Lake. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for total fish				
Golden topminnow	1927	913.9	1.9	0.7
Lined topminnow	568	123.5	0.5	0.2
Mosquitofish	457	123.5	0.1	0.0
Least killifish	321	197.6	0.0	0.0
Warmouth	8133	2797.3	25.8	7.3
Bluegill	2050	494.0	55.0	10.3
Largemouth bass	12	0.0	1.5	0.0
Total	13468		84.9	
Open-water nets (n=1) for total fish				
Golden topminnow	1149	0.0	1.4	0.0
Lined topminnow	259	0.0	0.2	0.0
Mosquitofish	333	0.0	0.1	0.0
Least killifish	593	0.0	0.1	0.0
Warmouth	6484	0.0	21.8	0.0
Bluegill	3619	0.0	136.2	0.0
Largemouth bass	74	0.0	29.8	0.0
Total	12510		189.4	

Table 21. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for harvestable fish				
Warmouth	19	6.2	1.9	0.63
Bluegill	86	12.3	6.7	0.86
Largemouth bass	0	0.0	0.0	0.00
Total	105		8.6	
Open-water nets (n=1) for harvestable fish				
Warmouth	37	0.0	3.6	0.00
Bluegill	235	0.0	18.7	0.00
Largemouth bass	74	0.0	29.8	0.00
Total	346		52.0	

Table 22. Experimental gillnet (five, 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 m deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Clay Lake. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=3) for total fish				
Bluegill	1.0	1.00	0.1	0.07
Largemouth bass	4.5	3.50	1.1	0.96
Total	5.5		1.2	
Gillnets (n=3) for harvestable fish				
Bluegill	0.5	0.50	0.1	0.05
Largemouth bass	2.5	2.50	0.8	0.84
Total	3.0		0.9	

Table 23. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Clay Lake. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=3) for total fish				
Golden topminnow	10.0	5.00	0.2	0.01
Lined topminnow	15.0	8.66	0.3	0.02
Warmouth	10.0	10.00	0.6	0.06
Bluegill	50.0	21.79	21.3	0.70
Largemouth bass	15.0	8.66	49.0	3.67
Total	100.0		71.3	
Electrofishing runs (n=3) for harvestable fish				
Warmouth	0.0	0.00	0.0	0.00
Bluegill	5.0	5.00	0..4	0.38
Largemouth bass	15.0	8.66	4.9	3.67
Total	20.0		5.3	

with rotenone sampling were warmouth and bluegill. These species had average standing stocks in littoral blocknets of 8,100 and 2,100 fish/ha, respectively (Table 21). The most abundant open-water species collected in experimental gillnets were bluegill and largemouth bass with 1.0 and 4.5 fish/net/24 hr, respectively (Table 22). The most abundant species collected using electrofishing were the lined topminnow, bluegill, and largemouth bass with catch per unit efforts of 15, 50, and 15 fish per hour, respectively (Table 23). The first year growth of bluegill and largemouth bass was 88 and 169 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were five bluegill and 23 largemouth bass per hectare (Table 7) in Clay Lake. No previous fisheries studies of Clay Lake could be found.

Wauberg

Location and Morphology

Wauberg is located in Alachua County, Florida (Latitude 29.31 N; Longitude 82.18 W). The lake lies in the Fairfield Hills subdivision of the Marion Hills division of the Ocala Uplift District (Brooks 1981). The geology is dominated by sand and clay of the phosphatic Hawthorne Formation. Wauberg was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 100 ha, 8.35 km, and 3.6 m, respectively (Table 1).

Trophic Status and Water Chemistry

Wauberg had an average total phosphorus concentration of 166 µg/L and an average total nitrogen concentration of 1478 µg/L. Total chlorophyll *a* concentrations averaged 102 µg/L and water clarity as measured by use of a Secchi disc averaged 0.6 m (Table 2). The lake had an average pH of 7.7 and an average total alkalinity of 20.6 mg/L as $CaCO_3$. The average specific conductance was 79 µS/cm @ 25 C and average water color was 30 Pt-Co units. The adjusted chlorophyll *a* value in Wauberg was 112 µg/L. Using this value and the classification system of Forsberg and Ryding (1980), Wauberg was classified as a hypereutrophic lake.

Aquatic Plants

Wauberg had a low abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of <1%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 12.1, 11.2 and 4.4 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 10.8 mg chlorophyll *a*/cm^2 of host plant and 3.1 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Twelve species of aquatic macrophytes were collected from Wauberg (Table 24). The most commonly encountered plant species were *Eichhornia crassipes, Pontederia cordata* and *Nuphar luteum* which occurred in 90%, 80% and 70% of the

Table 24. Occurrence of plant species in ten evenly-spaced transects around Lake Wauberg.

Common name	Scientific name	Percent of Transects
common duckweed	*Lemna minor*	10
floating water-hyacinth	*Eichhornia crassipes*	90
duck-potato	*Sagittaria lancifolia*	20
golden-club	*Orontium aquaticum*	10
spatterdock	*Nuphar luteum*	70
pickerelweed	*Pontederia cordata*	80
cat-tail	*Typha* spp.	20
water-pennywort	*Hydrocotyle umbellata*	60
coontail	*Ceratophyllum demersum*	20
hydrilla	*Hydrilla verticillata*	10
maidencane	*Panicum hemitomon*	30
knot grass	*Paspalum distichum*	40

transects, respectively.

The plant community of Wauberg has been monitored by the Florida Department of Natural Resources from 1982 to present.n The major aquatic plant in the lake was *Eichhornia crassipes* with areal coverage ranging from ranging 0.4 to 2.4 ha, which is similar to our findings (Table 24). Thus, the fish population in Wauberg can be considered the product of a hypereutrophic lake with low levels of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Wauberg was 2885 individuals/kg wet wt of host plants and 2.68 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Wauberg, as estimated with a ponar dredge, was 1313 individuals/m^2 and 1.07 g wet wt/m^2 (Table 5). The zooplankton population was dominated by rotifers and nauplii with 260,000 and 99,400 individuals/m^3, respectively (Table 5).

Fish

Twenty-two species of fish were collected from Wauberg (Table 25, 26, and 27). The most abundant species (by numbers) collected with rotenone sampling were warmouth and bluegill. These species had average standing stocks in littoral blocknets of 3,000 and 8,100 fish/ha, respectively (Table 25). The most abundant open-water species collected in the experimental gillnets were gizzard shad and black crappie with 198 and 93 fish/net/24 hr, respectively (Table 26). The most abundant species collected using electrofishing were bluegill and golden shiner with catch per unit efforts of 91 and 32 fish per hour, respectively (Table 27). Average first year growth of bluegill, redear sunfish, and largemouth bass was 73, 106, and 155 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were 471 harvestable bluegill, 42 harvestable redear sunfish, and 17 harvestable largemouth bass per hectare (Table 7) in Lake Wauberg. No previous fisheries data were available for Lake Wauberg.

Bivens Arm

Location and Morphology

Bivens Arm is located in Alachua County, Florida (Latitude 29.37 N; Longitude 82.20 W). The lake lies in the Alachua Prairies subdivision of the Northern Peninsual Plains division of the Ocala Uplift District (Brooks 1981). The geology is dominated by sand and clay of the phosphatic Hawthorne Formation. Bivens Arm was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 76 ha, 6.18 km and 1.2 m, respectively (Table 1).

Trophic Status and Water Chemistry

Bivens Arm had an average total phosphorus concentration of 384 µg/L and an average total nitrogen concentration of 3256 µg/L. Total chlorophyll *a* concentrations averaged 241 µg/L and the water clarity as measured by use of a Secchi disc averaged 0.4 m (Table 2). Based on these values and the classification system of Forsberg and Ryding (1980), Bivens Arm was classified as a hypereutrophic lake. **(Text continued on page 100)**

Table 25. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Wauberg. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for total fish				
Florida gar	49	37.7	24.0	20.5
Bowfin	29	10.9	35.9	9.7
Gizzard shad	782	128.4	53.8	15.3
Golden shiner	2248	550.3	34.0	6.6
Taillight shiner	2449	1802.9	1.4	0.9
Brown bullhead	194	120.2	7.2	3.5
Tadpole madtom	202	140.1	0.6	0.4
Golden topminnow	12	12.4	0.1	0.1
Seminole killifish	177	152.5	1.2	0.7
Bluefin killifish	189	110.5	0.1	0.1
Mosquitofish	745	526.9	0.3	0.2
Brook silverside	103	66.3	0.1	0.1
Everglades pygmy sunfish	0	0.0	0.0	0.0
Warmouth	3013	413.7	48.0	2.9
Bluegill	8077	3298.0	161.3	80.5
Dollar sunfish	527	300.9	1.6	1.0
Redear sunfish	1519	715.6	30.7	17.8
Spotted sunfish	78	32.2	2.4	1.1
Largemouth bass	1708	585.3	53.3	28.4
Black crappie	572	178.4	7.5	4.2
Swamp darter	140	62.3	0.1	0.0
Total	22674		463.5	

Table 25. (Continued)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Open-water nets (n=3) for total fish				
Florida gar	0	0.0	0.0	0.0
Bowfin	4	4.1	6.8	6.8
Gizzard shad.	6854	2031.0	624.6	261.9
Golden shiner	78	22.9	6.2	2.5
Taillight shiner	2696	1072.3	2.1	1.1
Brown bullhead	0	0.0	0.0	0.0
Tadpole madtom	0	0.0	0.0	0.0
Golden topminnow	0	0.0	0.0	0.0
Seminole killifish	0	0.0	0.0	0.0
Bluefin killifish	0	0.0	0.0	0.0
Mosquitofish	0	0.0	0.0	0.0
Brook silverside	128	4.1	0.2	0.0
Everglades pygmy sunfish	4	4.1	0.0	0.0
Warmouth	86	68.0	0.5	0.3
Bluegill	2935	1757.1	61.2	31.0
Dollar sunfish	0	0.0	0.0	0.0
Redear sunfish	362	153.6	18.1	9.4
Spotted sunfish	0	0.0	0.0	0.0
Largemouth bass	226	59.8	1.8	0.4
Black crappie	729	594.3	6.7	5.4
Swamp darter	0	0.0	0.0	0.0
Total	14104		728.3	

Table 25. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for harvestable fish				
Brown bullhead	16	10.9	6.3	3.5
Warmouth	99	14.3	10.9	1.1
Bluegill	539	362.6	121.3	88.3
Dollar sunfish	0	0.0	0.0	0.0
Redear sunfish	124	75.1	23.1	14.1
Spotted sunfish	4	4.1	0.4	0.4
Largemouth bass	37	21.4	42.4	27.7
Black crappie	16	16.5	2.2	2.2
Total	836		206.6	
Open-water nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.0
Warmouth	0	0.0	0.0	0.0
Bluegill	173	87.6	27.8	13.7
Dollar sunfish	0	0.0	0.0	0.0
Redear sunfish	82	46.4	15.2	8.3
Spotted sunfish	0	0.0	0.0	0.0
Largemouth bass	0	0.0	0.0	0.0
Black crappie	0	0.0	0.0	0.0
Total	255		430.0	

Table 26. Experimental gillnet (five, 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 m deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Wauberg. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=3) for total fish				
Florida gar	4.5	1.5	2.7	1.3
Bowfin	1.0	1.0	2.0	2.0
Gizzard shad	197.5	9.5	37.3	3.4
Golden shiner	8.0	6.0	0.9	0.4
Warmouth	0.5	0.5	0.0	0.0
Bluegill	8.0	1.0	1.5	0.1
Redear sunfish	3.0	2.0	1.0	0.7
Largemouth bass	3.0	1.0	0.9	0.5
Sunshine bass	2.0	0.0	1.1	0.6
Black crappie	93.0	39.0	7.1	3.8
Total	320.5		54.5	
Gillnets (n=3) for harvestable fish				
Warmouth	0.0	0.0	0.0	0.0
Bluegill	7.5	0.5	1.5	0.0
Redear sunfish	3.0	2.0	1.0	0.7
Largemouth bass	2.0	1.0	0.8	0.5
Sunshine bass	1.0	0.0	1.0	0.6
Black crappie	16.0	12.0	2.8	2.2
Total	29.5		7.2	

Table 27. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Wauberg. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=5) for total fish				
Florida gar	6.7	3.7	41.9	2.7
Bowfin	5.5	2.5	102.5	5.9
Gizzard shad	7.3	5.8	1.9	0.2
Golden shiner	32.4	11.0	1.8	0.1
Seminole killifish	1.5	1.5	0.4	0.0
Brook silverside	2.8	1.7	0.1	0.0
Bluegill	90.9	49.7	95.2	3.4
Dollar sunfish	3.0	3.0	0.4	0.0
Redear sunfish	5.7	3.5	16.2	1.0
Largemouth bass	25.0	8.2	50.1	2.1
Black crappie	5.7	3.5	2.1	0.1
Total	186.5		312.4	
Electrofishing runs (n=5) for harvestable fish				
Bluegill	32.8	12.3	8.3	2.8
Dollar sunfish	0.0	0.0	0.0	0.0
Redear sunfish	4.2	2.7	1.6	1.0
Largemouth bass	6.8	2.1	4.9	2.1
Black crappie	0.0	0.0	0.0	0.0
Total	43.8		14.7	

The lake had an average pH of 9.7 and an average total alkalinity of 101 mg/L as $CaCO_3$. The average specific conductance was 227 µS/cm @ 25 C and average water color was 25 Pt-Co units.

Aquatic Plants

Bivens Arm had a low abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of < 7% and < 2%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 10.2, 7.6, and 0 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 41.8 mg chlorophyll *a*/cm^2 of host plant, and 22.4 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Five species of aquatic macrophytes were collected from Bivens Arm (Table 28). The most commonly encountered plant species were *Zizaniopsis miliacea, Eichhornia crassipes,* and *Colocasia esculenta* which occurred in 100%, 90% and 40% of the transects, respectively. The residents living on the lake agree that the coverage of *Eichhornia crassipes* occasionally increases and has to be controlled, but *Eichhornia crassipes* has never covered more than 15 to 20% of the lake before control measures were instituted. Thus the fish population in Bivens Arm can be considered the product of a hypereutrophic lake with low levels of aquatic macrophytes.

Table 28. Occurrence of plant species in ten evenly-spaced transects around Bivens Arm.

Common name	Scientific name	Percent of Transects
floating water-hyacinth	*Eichhornia crassipes*	90
American lotus	*Nelumbo lutea*	10
elephant-ear	*Colocasia esculenta*	40
giant cutgrass	*Zizaniopsis miliacea*	100
knot grass	*Paspalum distichum*	10

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Bivens Arm was 1941 individuals/kg wet wt of host plants and 2.39 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Bivens Arm, as estimated with a ponar dredge, was 520 individuals/m^2 and 0.4 g wet wt/m^2 (Table 5). The zooplankton population was dominated by rotifers and nauplii with 248,000 and 83,700 individuals/m^3, respectively (Table 5).

Fish

A total of 22 species of fish were collected from Bivens Arm (Table 29, 30 and 31). The most abundant species (by number) collected with rotenone sampling were gizzard shad and bluegill. These species had average standing stocks in littoral blocknets of 44,500 and 22,800 fish/ha, respectively (Table 29). The most abundant open-water species collected in the experimental gillnets were gizzard shad and black crappie with 294 and 19 fish/net/24 hr, respectively (Table 30). The most abundant species collected using electrofishing were gizzard shad and mosquitofish with catch per unit efforts of 584 and 407 fish per hour, respectively (Table 31). Average first year growth of bluegill, redear sunfish, and largemouth bass was 61, 79 and 191 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were 272 harvestable bluegill, 86 harvestable redear sunfish, and 13 harvestable largemouth bass per hectare in Bivens Arm (Table 7). No previous fisheries data were available for Bivens Arm.

Apopka

Location and Morphology

Apopka is located in Orange County, Florida (Latitude 28.39 N; Longitude 81.39 W). The lake lies in the Central Lakes Division of the Central Lakes District (Brooks 1981). The geology is composed of undifferentiated sand, shell, clay, marl, and peat. Apopka was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 12,412 ha, 54.86 km, and 1.6 m, respectively (Table 1). **(Text continued on page 105)**

Table 29. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Bivens Arm. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Littoral nets (n=2) for total fish

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Gizzard shad	44540	14134.6	121.7	18.7
Golden shiner	364	179.1	1.4	0.9
Brown bullhead	679	382.8	58.6	0.0
Mosquitofish	6379	2414.4	2.7	0.6
Bream	0	0.0	0.0	0.0
Warmouth	1476	1463.5	8.3	7.0
Bluegill	22767	13504.7	96.2	26.0
Redear sunfish	6583	2371.2	27.0	1.7
Largemouth bass	62	49.4	3.1	0.6
Black crappie	778	123.5	3.2	1.9
Blue tilapia	179	55.6	4.0	1.3
Total	83807		326.1	

Open-water nets (n=1) for total fish

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Gizzard shad	13190	0.0	42.9	0.0
Golden shiner	0	0.0	0.0	0.0
Brown bullhead	37	0.0	6.0	0.0
Mosquitofish	74	0.0	0.0	0.0
Bream	1643	0.0	0.6	0.0
Warmouth	37	0.0	0.6	0.0
Bluegill	15549	0.0	665.9	0.0
Redear sunfish	3359	0.0	46.4	0.0
Largemouth bass	37	0.0	13.6	0.0
Black crappie	803	0.0	2.7	0.0
Blue tilapia	0	0.0	0.0	0.0
Total	34728		778.7	

Table 29. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for harvestable fish				
Brown bullhead	253	43.2	51.8	6.79
Warmouth	19	6.2	2.2	0.93
Bluegill	179	117.3	21.1	14.25
Redear sunfish	43	6.2	4.6	1.10
Largemouth bass	6	6.2	1.2	1.23
Black crappie	6	6.2	1.0	0.97
Total	506		81.9	
Open-water nets (n=1) for harvestable fish				
Brown bullhead	37	0.0	6.0	0.00
Warmouth	0	0.0	0.0	0.00
Bluegill	4458	0.0	500.7	0.00
Redear sunfish	136	0.0	15.3	0.00
Largemouth bass	25	0.0	13.5	0.00
Black crappie	0	0.0	0.0	0.00
Total	4656		535.5	

Table 30. Experimental gillnet (five 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 m deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Bivens Arm. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=1) for total fish				
Florida gar	4.0	0.0	2.1	0.0
Gizzard shad	294.0	0.0	41.9	0.0
Bluegill	4.0	0.0	0.3	0.0
Redear sunfish	4.0	0.0	0.4	0.0
Black crappie	19.0	0.0	3.0	0.0
Total	325.0		47.7	
Gillnets (n=1) for harvestable fish				
Bluegill	2.0	0.0	0.2	0.0
Redear sunfish	3.0	0.0	0.3	0.0
Black crappie	11.0	0.0	2.6	0.0
Total	16.0		3.1	

Table 31. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Bivens Arm. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=5) for total fish				
Florida gar	1.5	1.5	22.1	2.2
Gizzard shad	584.1	175.1	35.0	0.9
Golden shiner	3.2	3.2	0.1	0.0
Brown bullhead	38.4	17.3	72.1	2.5
Mosquitofish	407.0	116.6	2.0	0.1
Bluegill	242.7	80.0	114.4	5.2
Redear sunfish	23.1	12.2	20.2	1.2
Largemouth bass	11.1	3.3	15.1	0.9
Total	1311.1		281.0	
Electrofishing runs (n=5) for harvestable fish				
Brown bullhead	38.4	17.30	7.2	2.5
Bluegill	53.6	42.0	6.9	5.5
Redear sunfish	9.4	4.5	1.1	0.6
Largemouth bass	3.0	1.9	1.4	1.0
Total	104.4		16.6	

Trophic Status and Water Chemistry

Apopka had an average total phosphorus concentration of 140 µg/L and an average total nitrogen concentration of 3800 µg/L. Total chlorophyll *a* concentrations averaged 127 µg/L and water clarity as measured by use of a Secchi disc averaged 0.3 m (Table 2). The lake had an average pH of 9.4 and an average total alkalinity of 111 mg/L as $CaCO_3$. The average specific conductance was 371 µS/cm @ 25 C and average water color was 34 Pt-Co units. The adjusted chlorophyll *a* value in Apopka was 127 µg/L. Using this value and the classification system of Forsberg and Ryding (1980), Apopka was a hypereutrophic lake during this study.

Aquatic Plants

Apopka had a low abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 3.3% and 2.1%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 2.5, 1.1, and 0 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 18.0 mg chlorophyll *a*/cm^2 of host plant and 5.7 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Ten species of aquatic macrophytes were collected from Apopka (Table 32). The most commonly encountered plant species were Typha spp., *Eichhornia crassipes* and *Sagittaria lancifolia* which occurred in 63%, 27% and 17% of the transects, respectively.

Table 32. Occurrence of plant species in thirty evenly-spaced transects around Lake Apopka.

Common name	Scientific name	Percent of Transects
floating water-hyacinth	*Eichhornia crassipes*	27
duck-potato	*Sagittaria lancifolia*	17
alligator-weed	*Alternanthera philoxeroides*	7
pickerelweed	*Pontederia cordata*	10
cat-tail	*Typha* spp.	63
water-pennywort	*Hydrocotyle umbellata*	17
elephant-ear	*Colocasia esculenta*	17
soft stem bulrush	*Scirpus validus*	7
maidencane	*Panicum hemitomon*	3
egyptian paspalidium	*Paspalidium geminatum*	13

The plant community of Apopka has been monitored by the Florida Department of Natural Resources from 1982 to present and macrophyte abundance has remained at low levels throughout this time period. Two of the major aquatic plants were *Typha* spp. and

Eichhornia crassipes, but these plants covered only 26 to 49 ha and 3 to 34 ha, respectively. These plants were also dominant and at low levels of coverage in our study (Table 32). Thus, the fish population in Apopka during our study can be considered the product of a hypereutrophic lake with low levels of aquatic vegetation.

Invertebrates

The average number and biomass of epiphytic macroinvertebrates in Apopka was 398 individuals/kg wet wt of host plant and 0.45 g wet wt/kg wet wt of host plant (Table 5). Average number and biomass of benthic macroinvertebrates in Apopka, as estimated with a ponar dredge, was 1224 individuals/m^2 and 40.81 g wet wt/m^2 (Table 5). The zooplankton populations of Apopka were dominated by rotifers and nauplii with 1,983,000 and 306,000 individuals/m^3, respectively (Table 5).

Fish

Twenty-four species of fish were collected from Apopka (Table 33, 34 and 35). The most abundant species collected with rotenone sampling were mosquitofish and golden shiner. These species had average standing stocks in littoral blocknets of 3,100 and 1,500 fish/ha, respectively (Table 33). The most abundant open-water species collected in the experimental gillnets were gizzard shad and black crappie with 348 and 7 fish/net/24 hr, respectively (Table 34). The most abundant species collected using electrofishing were threadfin shad and white catfish with catch per unit efforts of 102 and 31 fish per hour, respectively (Table 35). Average first year growth for bluegill, redear sunfish and largemouth bass was 82, 69 and 182 mm TL (Table 6). Lake Apopka was too large to attempt a mark-recapture study.

Rotenone sampling was used to sample the fish population of Apopka during the fall of 1974 and the spring of 1975 (Holcomb et al. 1975). Littoral nets averaged 210 kg/ha and open-water nets averaged 60 kg/ha. These values seem higher then those reported for this study (Table 33), but Holcomb et al. (1975) captured a much larger biomass of gizzard shad (84 kg/ha littoral and 40 kg/ha open-water) than this study (5.9 kg/ha littoral and 12.5 kg/ha open water). Holcomb et al. (1975) collected 22 species of fish and we collected 24 species. Electrofishing largemouth bass catch per unit effort samples were collected almost every month from April 1981 through **(Text continued on page 113)**

Table 33. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Apopka. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=6) for total fish				
Longnose gar	4	4.1	0.2	0.2
Gizzard shad	716	565.8	5.9	5.3
Threadfin shad	266	96.1	0.3	0.2
Golden shiner	1538	802.4	2.8	2.2
Grass carp	0	0.0	0.0	0.0
Taillight shiner	140	69.8	0.1	0.1
Yellow bullhead	241	75.8	8.0	4.8
Brown bullhead	47	31.0	1.4	0.9
White catfish	91	52.9	0.5	0.3
Tadpole madtom	150	74.5	0.4	0.2
Seminole killifish	475	299.3	2.7	1.6
Mosquitofish	3125	1271.3	1.0	0.4
Sailfin molly	414	272.6	0.6	0.3
Tidewater silverside	163	75.2	0.1	0.0
Warmouth	91	37.0	0.3	0.2
Bluegill	54	26.0	0.2	0.1
Redear sunfish	233	60.7	3.5	1.8
Largemouth bass	2	2.0	2.0	2.0
Striped bass	0	0.0	0.0	0.0
Black crappie	107	35.2	8.8	5.7
Blue tilapia	1035	373.9	42.4	12.1
Atlantic needlefish	4	4.1	0.0	0.0
Total	8894		81.4	

Table 33. (Continued)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Open-water nets (n=6) for total fish				
Longnose gar	0	0.0	0.0	0.0
Gizzard shad	618	306.9	12.5	3.8
Threadfin shad	782	394.7	0.6	0.4
Golden shiner	10	3.8	0.0	0.0
Grass carp	109	109.1	0.1	0.1
Taillight shiner	74	28.2	0.0	0.0
Yellow bullhead	156	88.9	0.4	0.3
Brown bullhead	97	65.7	0.3	0.3
White catfish	47	47.3	0.5	0.5
Tadpole madtom	14	14.4	0.0	0.0
Seminole killifish	29	16.5	0.0	0.0
Mosquitofish	4	4.1	0.0	0.0
Sailfin molly	0	0.0	0.0	0.0
Tidewater silverside	47	16.7	0.0	0.0
Warmouth	0	0.0	0.0	0.0
Bluegill	490	165.4	1.2	0.3
Redear sunfish	315	89.7	1.0	0.3
Largemouth bass	0	0.0	0.0	0.0
Striped bass	2	2.0	1.2	1.2
Black crappie	111	34.0	3.0	1.1
Blue tilapia	130	60.9	0.9	0.7
Atlantic needlefish	4	2.6	0.4	0.4
Total	3040		22.2	

Table 33. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=6) for harvestable fish				
Yellow bullhead	16	14.1	3.6	3.18
Brown bullhead	2	2.0	0.8	0.78
White catfish	0	0.0	0.0	0.00
Warmouth	0	0.0	0.0	0.00
Bluegill	0	0.0	0.0	0.00
Redear sunfish	10	5.9	1.7	1.16
Largemouth bass	2	2.0	2.0	2.04
Black crappie	33	21.8	7.8	5.31
Total	64		15.9	
Open-water nets (n=6) for harvestable fish				
Yellow bullhead	0	0.0	0.0	0.00
Brown bullhead	2	2.1	0.2	0.18
White catfish	0	0.0	0.0	0.00
Warmouth	0	0.0	0.0	0.00
Bluegill	0	0.0	0.0	0.00
Redear sunfish	0	0.0	0.0	0.00
Largemouth bass	0	0.0	0.0	0.00
Black crappie	6	4.2	1.1	0.86
Total	8		1.3	

Table 34. Experimental gillnet (five 10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 meter deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Apopka. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=6) for total fish				
Florida gar	1.2	0.48	0.7	0.29
Longnose gar	1.2	0.48	2.4	1.19
Gizzard shad	347.8	48.11	128.5	77.49
Yellow bullhead	0.2	0.18	0.0	0.02
Brown bullhead	0.2	0.18	0.0	0.02
White catfish	0.7	0.43	0.1	0.05
Bluegill	5.8	1.30	0.2	0.06
Redear sunfish	0.2	0.18	0.0	0.01
Striped bass	0.3	0.34	1.1	1.11
Sunshine bass	0.5	0.34	0.1	0.09
Black crappie	7.2	2.02	0.9	0.29
Total	365.2		134.0	
Gillnets (n=6) for harvestable fish				
Yellow bullhead	0.2	0.17	0.0	0.02
Brown bullhead	0.2	0.17	0.0	0.02
White catfish	0.0	0.00	0.0	0.00
Bluegill	0.2	0.17	0.0	0.01
Redear sunfish	0.0	0.00	0.0	0.00
Sunshine bass	0.2	0.17	0.1	0.07
Black crappie	3.3	1.23	0.7	0.25
Total	4.0		0.8	

Table 35. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Apopka. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=9) for total fish				
Florida gar	0.7	0.67	2.6	0.26
Gizzard shad	9.3	4.14	9.3	0.38
Threadfin shad	100.7	82.32	1.3	0.10
Golden shiner	7.3	4.88	0.1	0.01
Yellow bullhead	2.7	2.03	1.3	0.09
Brown bullhead	2.0	1.00	4.4	0.28
White catfish	30.5	18.81	3.2	0.15
Tadpole madtom	0.7	0.67	0.0	0.00
Seminole killifish	1.3	1.33	0.10	0.01
Mosquitofish	22.7	18.46	0.0	0.00
Tidewater silverside	12.8	9.76	0.0	0.00
Bluegill	1.3	0.88	0.4	0.03
Redear sunfish	3.3	2.26	3.8	0.28
Largemouth bass	1.3	1.33	13.7	1.36
Sunshine bass	2.0	2.00	0.10	0.01
Black crappie	9.5	5.74	28.7	1.93
Total	208.2		68.8	
Electrofishing runs (n=9) for harvestable fish				
Yellow bullhead	0.00	0.00	0.0	0.00
Brown bullhead	1.30	0.88	0.4	0.28
White catfish	0.00	0.00	0.0	0.00
Bluegill	0.00	0.00	0.0	0.00
Redear sunfish	2.70	2.03	0.4	0.28
Largemouth bass	1.30	1.33	1.4	1.36
Sunshine bass	0.00	0.00	0.0	0.00
Black crappie	9.50	5.74	2.9	1.93
Total	14.80		5.0	

June 1984 (Johnson et al. 1985). The average largemouth bass catch per unit effort reported by Johnson et al. (1984) was 7 fish/hr. We captured only 1.3 largemouth bass/hr (Table 35). Both of these values, however, are extremely low when compared to other Florida lakes. These data, however, suggest that the fish population of Apopka has remained relatively constant for the last several years.

Miona

Location and Morphology

Miona is located in Sumter County, Florida (Latitude 28.54 N; Longitude 82.00 W). The lake lies in Anthony Hills subdivision of the Marion Hills division of the Ocala Uplift District (Brooks 1981). The geology is dominated by limestone with thin surficial sands, and recently deposited freshwater marl and peat. Miona was sampled from 1986 to 1987 and had a surface area, shoreline length, and mean depth of 169 ha, 5.86 km and 2.3 m, respectively (Table 1).

Trophic Status and Water Chemistry

Miona had an average total phosphorus concentration of 12 µg/L and an average total nitrogen concentration of 867 µg/L. Total chlorophyll *a* concentrations averaged 8 µg/L and water clarity as measured by use of a Secchi disc averaged 1.5 m (Table 2). The lake had an average pH of 7.9 and an average total alkalinity of 22.2 mg/L as $CaCO_3$. The average specific conductance was 122 µS/cm @ 25 C and the average water color was 16 Pt-Co units. The adjusted chlorophyll *a* value in Miona was 61.9 µg/L. Using this value and the classification system of Forsberg and Ryding (1980), Miona was classified as a hypereutrophic lake during this study.

Aquatic Plants

Miona had a high abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 97% and 86%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 4.6, 2.6, and 5.4 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 28.5 mg chlorophyll *a*/cm^2 of host plant and 25.1 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Fifteen species of aquatic macrophytes were collected from Miona (Table 36). The most commonly encountered plant species were *Hydrilla verticillata, Sagittaria lancifolia,* and *Panicum hemitomon* which occurred in 90%, 80% and 80% of the transects, respectively.

Table 36. Occurrence of plant species in ten evenly-spaced transects around Lake Miona.

Common name	Scientific name	Percent of Transects
duck-potato	*Sagittaria lancifolia*	80
banana-lily	*Nymphoides aquatica*	30
fragrant water-lily	*Nymphaea odorata*	70
pickerelweed	*Pontederia cordata*	10
lemon bacopa	*Bacopa caroliniana*	20
water-pennywort	*Hydrocotyle umbellata*	10
hydrilla	*Hydrilla verticillata*	90
tapegrass	*Vallisneria americana*	10
purple bladderwort	*Utricularia purpurea*	40
southern naiad	*Najas guadalupensis*	10
Illinois pondweed	*Potamogeton illinoensis*	50
sawgrass	*Cladium jamaicense*	20
maidencane	*Panicum hemitomon*	80
	Fuirena sciropoidea	50
	Rhynchyospora tracyi	10

The plant community of Miona has been monitored by the Florida Department of Natural Resources from 1982 to present. The major aquatic plant in the lake has been *Hydrilla verticillata*, which is similar to our findings (Table 36). The areal coverage of *Hydrilla verticillata* in Miona has remained at high levels ranging between 45 and 120 ha from 1983 to 1986. Thus, the fish population in Miona during this study can be considered the product of a hypereutrophic lake with high levels of aquatic vegetation.

<u>Invertebrates</u>

The average number and biomass of epiphytic macroinvertebrates in Miona was 208 individuals/kg wet wt of host plants and 0.15 g wet wt/kg wet wt of host plant (Table 5).

Average number and biomass of benthic macroinvertebrates in Miona, as estimated with a ponar dredge, was 260 individuals/m^2 and 0.95 g wet wt/m^2 (Table 5). The zooplankton population was dominated by cladocerans and rotifers with 131,000 and 84,000 individuals/m^3, respectively (Table 5).

<u>Fish</u>

Twenty-four species of fish were collected from Miona (Table 37, 38, and 39). The most abundant species collected with rotenone sampling were bluefin killifish and warmouth. These species had average standing stocks in littoral blocknets of 2,850 and 1,980 fish/ha, respectively (Table 37). The most abundant open-water species collected in the experimental gillnets were lake chubsucker and largemouth bass with 15, and 12.5 fish/net/24 hr, respectively (Table 38). The most abundant species collected using electrofishing were bluegill and largemouth bass with catch per unit efforts of 136 and 60 fish per hour, respectively (Table 39). Average first year growth of bluegill, redear sunfish and largemouth bass was 56, 58 and 131 mm TL, respectively (Table 6). Mark-recapture estimates indicated that there were 18 largemouth bass per hectare in Lake Miona (Table 7).

Rotenone sampling was used to sample the fish population of Miona in 1967 and 1976 (McKinney et al. 1976). The standing crop of fish in these two years was estimated at 30 and 187 kg/ha, respectively. These values bracketed the average standing crop reported for this study (58 kg/ha, Table 37). The number of fish species collected in these studies were 10, 13 and 24 in 1967, 1976 and 1986, respectively. The standing crop and species richness ranged considerably and suggest there may have been a major change in the fish population of Miona over the last 20 years. **(Text continued on page 121)**

Table 37. Blocknet-rotenone estimates of total and harvestable fish stock (number/hectare) and standing crop (kg/hectare) for Miona. Mean values for littoral and open-water nets are listed by species with the corresponding standard error of the mean.

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=2) for total fish				
Golden shiner	216	43.2	3.1	2.8
Taillight shiner	0	0.0	0.0	0.0
Lake chubsucker	25	12.3	0.5	0.3
Brown bullhead	6	6.2	0.0	0.0
Tadpole madtom	19	18.5	0.0	0.0
Golden topminnow	247	197.6	0.2	0.2
Seminole killifish	130	105.0	0.4	0.4
Lined topminnow	74	49.4	0.1	0.1
Flagfish	241	179.1	0.2	0.2
Bluefin killifish	2847	487.8	0.7	0.1
Mosquitofish	247	222.3	0.1	0.1
Brook silverside	12	12.3	0.0	0.0
Bluespotted sunfish	1741	1556.1	0.7	0.7
Bream	2328	228.5	0.8	0.1
Warmouth	1976	1259.7	12.1	4.0
Bluegill	1334	284.1	8.0	1.8
Dollar sunfish	914	370.5	1.5	0.5
Redear sunfish	1797	327.3	22.9	2.0
Largemouth bass	259	61.7	10.4	2.1
Swamp darter	43	6.2	0.0	0.0
Shiners	74	49.4	0.1	0.0
Total	14530		62.0	

Table 37. (Continued)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Open-water nets (n=1) for total fish				
Golden shiner	49	0.0	0.9	0.0
Taillight shiner	5434	0.0	20.3	0.0
Lake chubsucker	0	0.0	0.0	0.0
Brown bullhead	0	0.0	0.0	0.0
Tadpole madtom	0	0.0	0.0	0.0
Golden topminnow	0	0.0	0.0	0.0
Seminole killifish	0	0.0	0.0	0.0
Lined topminnow	0	0.0	0.0	0.0
Flagfish	0	0.0	0.0	0.0
Bluefin killifish	0	0.0	0.0	0.0
Mosquitofish	0	0.0	0.0	0.0
Brook silverside	0	0.0	0.0	0.0
Bluespotted sunfish	86	0.0	0.1	0.0
Bream	22329	0.0	7.4	0.0
Warmouth	0	0.0	0.0	0.0
Bluegill	3816	0.0	20.0	0.0
Dollar sunfish	74	0.0	0.2	0.0
Redear sunfish	457	0.0	1.2	0.0
Largemouth bass	247	0.0	4.9	0.0
Swamp darter	0	0.0	0.0	0.0
Shiners	0	0.0	0.0	0.0
Total	32493		55.0	

Table 37. (Concluded)

Common Name	Stock (number/ha)	Standard Error	Standing Crop (kg/ha)	Standard Error
Littoral nets (n=3) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.00
Warmouth	19	6.2	1.6	0.53
Bluegill	6	6.2	1.2	1.16
Dollar sunfish	0	0.0	0.0	0.00
Redear sunfish	12	0.0	0.8	0.03
Largemouth bass	37	0.0	6.6	0.59
Total	74		10.2	
Open-water nets (n=1) for harvestable fish				
Brown bullhead	0	0.0	0.0	0.00
Warmouth	0	0.0	0.0	0.00
Bluegill	12	0.0	1.0	0.00
Dollar sunfish	0	0.0	0.0	0.00
Redear sunfish	0	0.0	0.0	0.00
Largemouth bass	12	0.0	1.9	0.00
Total	24		2.9	

Table 38. Experimental gillnet (five10-meter long sections of 1.9, 2.5, 3.8, 5.1, and 6.4 cm bar mesh, which were 2.4 m deep) catch per unit effort estimates of total and harvestable fish number (number/net/24 hr) and weight (kg/net/24 hr) for Miona. Mean values for experimental gillnets are listed by species with the corresponding standard error of the mean.

Common Name	Fish number (number/net/24 hr)	Standard Error	Fish weight (kg/net/24 hr)	Standard Error
Gillnets (n=2) for total fish				
Bowfin	3.5	0.50	3.2	0.52
Golden shiner	9.0	1.00	0.8	0.08
Lake chubsucker	15.0	11.00	4.2	3.54
Yellow bullhead	0.5	0.50	0.2	0.15
Brown bullhead	0.5	0.50	0.2	0.17
Warmouth	1.5	1.50	0.1	0.08
Bluegill	2.0	2.00	0.1	0.07
Largemouth bass	12.5	0.50	2.3	0.33
Black crappie	1.0	1.00	0.1	0.15
Total	45.5		11.1	
Gillnets (n=2) for harvestable fish				
Yellow bullhead	0.5	0.50	0.2	0.15
Brown bullhead	0.5	0.50	0.2	0.17
Warmouth	0.0	0.00	0.0	0.00
Bluegill	0.0	0.00	0.0	0.00
Largemouth bass	7.5	1.50	1.7	0.38
Black crappie	1.0	1.00	0.1	0.15
Total	9.5		2.1	

Table 39. Electrofishing catch per unit effort estimates of total and harvestable fish number (number/hr) and weight (kg/hr) for Miona. Mean values are listed by species with the corresponding standard error of the mean.

Common Name	Number (number/hr)	Standard Error	Weight (kg/hr)	Standard Error
Electrofishing runs (n=6) for total fish				
Bowfin	3.3	3.34	20.5	2.05
Golden shiner	11.9	10.67	2.6	0.25
Lake chubsucker	13.1	7.94	7.9	0.49
Seminole killifish	1.1	1.08	0.0	0.00
Bluefin killifish	1.7	1.68	0.0	0.00
Brook silverside	1.1	1.08	0.0	0.00
Bluespotted sunfish	1.3	1.22	0.0	0.00
Warmouth	6.4	5.45	0.9	0.06
Bluegill	135.6	35.66	14.3	0.43
Dollar sunfish	6.8	5.45	0.10	0.00
Redear sunfish	40.4	13.92	7.2	0.27
Largemouth bass	59.9	14.98	69.6	1.79
Black crappie	0.8	0.82	2.6	0.26
Total	283.4		125.7	
Electrofishing runs (n=6) for harvestable fish				
Warmouth	0.0	0.00	0.0	0.00
Bluegill	2.9	1.33	0.3	0.14
Dollar sunfish	0.0	0.00	0.0	0.00
Redear sunfish	1.3	1.25	0.1	0.11
Largemouth bass	21.1	6.80	5.2	1.50
Black crappie	0.8	0.83	0.3	0.26
Total	26.2		5.9	

Lake Wales

Location and Morphology

Lake Wales is located in Polk County, Florida (Latitude 27.54 N; Longitude 81.34 W). The lake lies in Iron Mountain subdivision of the Lake Wales Ridge division of the Central Lake District (Brooks 1981). The geology is dominated by residual sandhills of the Hawthorne Formation. Lake Wales was sampled from 1986 to 1987 and had a surface area, shoreline length and mean depth of 132 ha, 4.98 km and 3.4 m, respectively (Table 1).

Trophic Status and Water Chemistry

Lake Wales was classified as a hypereutrophic lake during this study. Lake Wales had an average total phosphorus concentration of 27 μg/L and an average total nitrogen concentration of 899 μg/L. Total chlorophyll *a* concentrations averaged 42 μg/L and the water clarity as measured by use of a Secchi disc averaged 0.8 m (Table 2). The lake had an average pH of 8.7 and an average total alkalinity of 25.6 mg/L as $CaCO_3$. The average specific conductance was 118 μS/cm @ 25 C and the average water color was 10 Pt-Co units.

Aquatic Plants

Due to the addition of grass carp for aquatic macrophyte control in 1975, Lake Wales had a low abundance of aquatic macrophytes with a percent area coverage (PAC) and percent volume infested (PVI) with aquatic macrophytes of 3.4% and 0.3%, respectively (Table 3). The average above-ground biomass of emergent, floating-leaved and submersed vegetation was 2.6, 0, and 0 kg wet wt/m^2, respectively (Table 3). The average epiphytic algal concentration associated with the aquatic macrophytes was 36.5 mg chlorophyll *a*/cm^2 of host plant and 13.1 mg chlorophyll *a*/kg wet wt of host plant (Table 3). Six species of aquatic macrophytes were collected from Lake Wales (Table 40). The most commonly encountered plant species were *Hydrocotyle umbellata, Panicum repens,* and *Alternanthera philoxeroides* which occurred in 70%, 60%,and 30% of the transects, respectively.

In 1974, hydrilla was the dominant plant in Lake Wales and it covered a large portion of the lake (Hardin and Atterson 1980). After grass carp were stocked in 1975, hydrilla was