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CHARLES HANLON

BY

(Ctenopharyngodon idella)
YEARS AFTER THE INTRODUCTION OF GRASS CARP
POPULATIONS IN TWO CENTRAL FLORIDA LAKES THIRTEEN
THE CURRENT TROPIC STATUS AND PRIMARY SPORT FISH
collection of field data.

water quality lab, and the people who helped with the
analysis of my data, Mary Rutter for her assistance in the
drug collection for their suggestions and comments regarding the
for their time and assistance. I also thank Mark Hoyer and
committee, Drs. Charles E. Clotuva and Kenneth A. Langeland,
during the past two years and to the rest of my advisory
I thank Dr. Daniel F. Cantrell Jr., for his guidance

ACKNOWLEDGMENTS
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Waters. Submersed macrophytes have not become re-established
approximately 33% of clear lake and as much as 95% of lake
reported during the 1970s when hydrilla covered
mg/L" \( \frac{mg}{L} \) repectively. These values are similar to values
nitrogen (TN) concentrations averaging more than 25 and 75
1987-88, both lakes had total phosphorus (TP) and total
from clear lake in 1976 and from lake waters in 1981. In
aquatic vegetation, submersed macrophytes were estimated
introduced into both lakes in an attempt to control the
In 1974, grass carp (Ctenopharyngodon idella) were
macrophyte hydrilla (Hydrilla verticillata) in the 1970s.
Florida lakes which were infested with the submersed
clear lake and lake waters are eutrophic central

(Phytoextraction and Aquaculture)
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(Ctenopharyngodon idella)
Years After the Introduction of Grass Carp
Populations in Two Central Florida Lakes Under
The Current Eutrophic Status and Primary Sport Fish

Requirements for the degree of Master of Science
University of Florida in Partial Fulfillment of the
Abstract of Thesis Presented to the Graduate School of the
Suppressed macrophytes. Therefore, successful sport fish populations can continue to exist in lakes following the removal of these lakes also had bluegill and largemouth bass populations respectively. In clear water bass, bluegill, and redear sunfish, even in young of the year (YOY) to age 1, species, size on a yearly basis. In clear water bass, bluegill, and redear sunfish, suppression of spawns and recruitment of juvenile fish into harvestable size have been able to largemouth bass, bluegill, and redbreast sunfish with suppressed macrophytes.

Approximately 23% of clear water bass was initially impacted by the effect of macrophyte reduction, which is probably a long-term effect on TP or TP concentrations. Cost-effective control of aquatic macrophytes with little cost-effective control of aquatic macrophytes. Thus, grass carp have provided long term,
In 1985, the labor-intensive and can be very expensive. In 1986, the
portions (Sutton and Vandever 1986). Mechanical control is
most often used to control aquatic macrophyte problems in
currently, mechanical, chemical, and biological organisms are
contributing to excessive aquatic plant growth within the state.
Portions were Climatic and long growing season
at a . 1986,)

Aquatic plant management program is often implemented with
when aquatic plants reach nuisance levels, some form of
seriously interfere with many water-use activities. Thus,
at . 1984, excessive growths of aquatic macrophytes can
(1980), and they can help reduce algal levels (Canfield et
small cormage fish (Barrett and Schneider 1974; Haller et al.
for large populations of juvenile sport fish as well as
such as Hydrilla verticillata) can provide habitat
1987). Although dense submerged aquatic plant communities
(colle and Sutphen 1980; Douchner et al.; 1984; Colle et al.
landers 1982; Canfield et al.; 1983) as well as the intensity
lake water quality (Haster and Jones 1949; Carpenter 1980;
macrophytes, especially submerged macrophytes, can influence
lake ecosystems (Frone 1938; Wetzel and Hough 1973).

INTRODUCTION
been able to successfully spawn and experience yearling waters; (2) determine whether the primary sport fish have assessed the current trophic status of clear lake and lake minimum of 7 years. My specific objectives were to (1) in 1974 and have been void of submerged macrophytes a These two central Florida lakes were stocked with grass carp populations in clear lake and lake waters were evaluated. (Ipectolobus macracanthus) and reared sunfish (Lepomis microlophus) largemouth bass (Micropterus salmoides Florida) bluegill for this investigation, water quality as well as the (Shterman and Hoyt, 1985). (Shterman and Hoyt, 1985) however, grass carp can eliminate nearly all aquatic weeds for as long as 15 years (Steele et al., 1987). Aquatic weeds do require 15 years for control (Shterman and Hoyt, 1986) and can control cost effective (suction and vacuumer 1986) and can control preventable problems (Barker, 1978; Steele et al., 1983). Grass carp are effectiveness as phototactic controls to eliminate aquatic weeds grass carp (Ctenopharyngodon idella) have been used $37.39/ha over a four year period. various treatment levels in ponds ranged from $44.7/ha to Shhterman et al. (1986) stated that herbicide cost for mechanical control, chemical control can also be expensive. Approximately $1,888/ha (Thayer and Ramsey, 1986). Like mechanical plant control cost for Orange Lake, Florida was 2
In clear lake and lake waters, of largemouth bass, bluegill, and redear sunfish populations removed, and (3) determine the abundance and standing crop recruitment in these lakes since submerged vegetation was
titration to a pH of 4.5 using 0.02 N sulfuric acid (AHA).

7.0. Total alkalinity (mg/l as CaCO3) was determined by adding 60A pH meter calibrated against buffers at pH 4.0 and 9.0. Using unfiltered water, pH was measured with an Orion

used at station 2 to measure water transparency. Starting from the surface and a 20 cm secchi disc was also

temperature and dissolved oxygen were measured every meter. Instrument Model 514 temperature and oxygen meter.

oxygen were measured at station 2 using a yellow string

being analyzed. Water column temperature and dissolved

measured. 1-Liter Nalgene bottles and placed on ice before

All samples were collected in acid-washed, triple-

added in July (Figures 1 and 2).

Take waters at four stations located near a culvert pipe was

Take, a near shore station was added in June 1987 and in

sampled throughout the entire study in each lake. In Clear

through January 1988. Three open water stations were

monthly from June through September and from November

collected from lake males in March and April 1987, then

from October through February 1988. Surface water was

February 1987 then monthly from April through August and

surface water (0.5 m) was collected from clear lake in

MATERIALS AND METHODS
Figure 1. Bathymetric map of Clear Lake, Florida, with depth in meters. Sampling stations are indicated by X.
containing aquatic macrophytes was then determined. The percent of the lake surface vegetation plot was determined using a range finder and the vegetation was present, the length and width of the emergent macrophyte coverage was also estimated. Where a Macenta (1981) using a Raytheon model DE-719 fathometer, during the summer and estimated according to Shime, and submerged macrophyte coverage was monitored twice.

Atomic absorption spectrophotometer (APHA 1980).

Concentrations were measured using a Perkin-Elmer model 703 tubes (APHA 1980). Sodium, calcium, magnesium, and potassium was determined by the platinum cobalt method with reagent and phosphate concentrations. Color (ft-cc units) filter filters were used to determine color, sodium, calcium, and water samples filtered through a glass filter were determined (APHA 1980).

Determination mercury with diethylthiocarbamazine at the endpoint.

Chloride levels were measured by titration using 0.014 N Nessler and Summer's 1975.

A modified Kjeldahl technique (Nelson and Sommers 1975) were determined using a modified Kjeldahl technique. The total nitrogen concentrations (mg/l) were determined using a persulfate digestion (Mensel and Corwin 1965).

Determining a phosphate digestion the procedures of Murphy and Riley (1962) were determined. Total phosphorus concentrations (mg/l) were determined using a yellow spectrophotometer and were measured.
sampling. In Clear Lake, largemouth bass and bluegill
generally collected near shore during both night and day
pushator electroshocking until model VIP-15. Fish were
fishing boat equipped with a coil of variable voltage
These primary sport fish were collected using an electro-
readear snuffer populations in Clear Lake and Lake Water.
was conducted to estimate the largemouth bass, bluegill, and
In 1987, a Peterson single census mark-recapture study

University of Florida

Weighted (unweighted data from Darter, E. Caneloed Jr.,
into 40 mm total length (TL) size groups, counted and
three days, fish were identified to species and separated
rotomone and dead fish inside the nets were collected for
Lake Water. Blockage areas were treated with the fish toxin
were used to sample the fish population in Clear Lake and
In September 1986, three near shore 0.08-ha blockages
made.

Strickland (1963). Corrections for phytoplankton were not
were calculated using the equations of Parsons and
strickland (1963) and Venton and Menzel (1963). Chl a
values determined using the methods of Richards with Thompson
until analyzed. Chl a concentrations (ug/l) were
filter, the filters were stored in desiccant and frozen
water was filtered through a German type A-B glass filter
phytoplankton concentration. A measured volume of Lake
Phytoplankton abundance was estimated by measuring
the collected otoliths were then sectioned according to measured from the nucleus to the outer edge. A portion of otoliths were viewed and the annuli were counted and determined according to Bagner (1978). Intuitively, where annuli, back calculated lengths at a given age were removed and viewed in order to determine the number of subsampled and sectioned. The sagittal otoliths were according to 40 mm TL size classes. The fish were then used to collect targemouth bass, buffeltail and reedear sunfish during June and July 1987, electrofishing equipment was marking period then released.

During the marking period, only fish given a left pelvic fin clip during the sunfish were only given a left pelvic fin clip during the recapture. Harvestable (Z > 150 mm TL) buffeltail and reedear number so growth rates could be calculated upon that fish's recapture anchor tag which contained an indelible dye. Targemouth bass greater than 150 mm TL were also given a marking period. In addition, some clip during the marking period, the targemouth bass greater than 254 mm TL were given a left pelvic fin clipp.

Upon capture, fish were measured to the nearest mm (TL) and weighed to the nearest gram. Targemouth crop estimates. Upon capture, fish were measured to the standing crop (kg/ha). In Lake Watets, Targemouth bass, were used to estimate both abundance (number/ha) and sunfish collected from February 24, 1987 to June 26, 1987 collected from February 24, 1987 to July 3, 1987 and reedear
For each sport fish species sampled, the estimate of lake surface hectares to give a biomass (kg/ha) estimate was then divided by the number estimated population abundance obtained from the mark-recapture study. This value was then multiplied by the number of a given species and multiplying that number by the estimated by calculating the mean weight for all harvestable sport fish was

Sundish.

Largemouth bass, and Atlantic salmon for bluegill and redear calculated using both otolith data and tag data for have occurred during the sampling period. Growth rates were therefore calculated instantaneous throughout the sampling period, the therefore estimated instantaneous 2.150 mm TL. These sport fish continued to grow throughout 2.254 mm TL and harvestable bluegill and redear sunfish were harvestable Largemouth bass were considered to be harvestable Largemouth bass were determined for both study lakes.

In addition, subharvestable Largemouth bass (100-253 mm TL) and redear sunfish in clear lake and lake waters. In age and year class strength for harvestable bass, bluegill length frequency histograms were also used to evaluate and sectioned readings were then compared.

cohen et. al. (1984) and the annual counted, while view
water lakes and concluded that lakes in the lake waters ridge

(1981) chemically described these lakes as alkaline, soft
carbons containing numerous lakes within the region. Carrel,
and there are numerous lakes within the region, characterized
formation (Purp and Vernon 1964), the topography is karstic
dominated by sandy calcareous deposits of the Fort Preston
(1981) or Polk county, Florida. The lake waters ridge is
within the lake waters ridge physiographic region (Brooks
Take lake is a 1.32 ha landlocked solution lake located
the present study is located on the north end of the lake.
A small drainage canal which remained intact throughout
of 4.5 m and a maximum depth of 8.3 m (Miller et al. 1979).
approximately 233 ha (Miller et al. 1983), an average depth
Formaration occurs, clear lakes has a watershed of
especially where rich phosphatic deposits of the Hawthorn
could best be classified as naturally meso-eutrophic,
soft-water lakes and concluded that lakes in this region
carrel (1981) chemically described these lakes as alkaline
region dominated by the Shawnee limestone formation.
Pasco county, Florida. Lakes in this area are found in a
Brooksville Hills physiographic region (Brooks 1981).
Chapter 2

RESULTS AND DISCUSSION
found along the shoreline to lake water. Includes umbrellas, Torpedoglossa (Pentaglossa repens), the aquatic macrophytes: tall Sagittaria (Sagittaria thalia), Salix sp., and Sparganium, spatterdock (Nyphaea Lutea), hydrilla, pickerel weed (Hydrocotyle Umbellata), water hyacinth, and the only macrophytes found along clear vegetation. The shoreline clear lake contains both lake contact less than the aquatic clear lake. In 1976 and from lake waters in 1981, October 9th and 1979, and 1980, grass carp were stocked in clear lake (Hartman and Atterson 1980). Grass carp were stocked in clear lake (Reese et al. 1983) and 80% of lake waters (Porter et al.). In 1974, hydrilla covered approximately 3% of the lake. In 1979, hydrilla is present test of San Antonio, communication, Eddie Herrmann, resident of San Antonio, controls were used to remove the plants (personal communication). Both mechanical and chemical treatments from several drains which discharged into clear lake. Stormwater runoff from several drains which discharge into the lake. is located within the city of lake Waters and receives average depth of 1.9 m and a maximum depth of 5.1 m. The lake Waters has a 627 ha watershed (shoemaker et al. 1977), an 12
The target recorded difference between 5.6 and 8 mg/l, and the difference in sulfate averaged 7.1 and 10 mg/l (Figures 2 and 13). The sulfate concentration of sodium averaged 9.8 and 6.5 mg/l, calculated as CaCO₃ (Figure 6).

The total alkalinity in clear lake waters, the average total alkalinity was 27 mg/l, and the total alkalinity ranged from 23 to 42 mg/l (Figures 5). In clear lake waters, the average total alkalinity was 45 mg/l as CaCO₃ and ranged from 44 to 47 mg/l (Figures 3 and 4). The total alkalinity in clear lake waters from 7.2 to 9.1, with a yearly average of 8.5 in clear lake and ranged 9.9 and had a yearly average of 8.9 in clear lake and ranged from 7.7 to 9.1 in 1987-88, the monthly average pH ranged from 7.7 to 8.9.

Water Quality

Clear lake and 7 years in Lake Waters

Controlled aquatic macrophytes, for at least 12 years in either Lake. Grass carp have therefore effectively suppressed macrophytes have not become re-established in submerged macrophytes through biological control (Scirpus sp.), cat-tail (Typha sp.), water primrose (Ludwigia palustris), grass (Pilularia squarrosa), water pennywort, pickerel weed,
Figure 5. Monthly fluctuation in measured water quality parameters in Clear Lake, Florida 1987-88.
Figure 6: Monthly fluctuation in parameters measured in Lake Waters.
Figure 7. Monthly Evaporation in Florida 1987-88.
<table>
<thead>
<tr>
<th>Trophic State</th>
<th>Transparency (m)</th>
<th>Chl-a (μg/L)</th>
<th>Total-P (μg/L)</th>
<th>Total-N (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 - 4.0</td>
<td>&lt; 3</td>
<td>&gt; 15</td>
<td>&gt; 100</td>
<td>&gt; 600</td>
</tr>
<tr>
<td>2.5 - 4.0</td>
<td>3 - 7</td>
<td>7 - 40</td>
<td>25 - 1500</td>
<td>600 - 1500</td>
</tr>
<tr>
<td>1.0 - 2.5</td>
<td>&gt; 40</td>
<td>&lt; 100</td>
<td>&lt; 1500</td>
<td>&lt; 600</td>
</tr>
<tr>
<td>&gt; 1.0</td>
<td>40 - 2.5</td>
<td>400 - 600</td>
<td>15 - 25</td>
<td>600 - 1500</td>
</tr>
</tbody>
</table>

Table 2. Proposed trophic state based on transparency and chlorophyll a as expressed as summer average values from Forsberg and Ryding (1980).
concentration was at the highest fall value recorded, 37
occurred in November 1987 while the total phosphorus
the largest mean chlorophyll A concentration of 56 mg/m²
maximum value recorded, 36 mg/m² (Figure 3). In lake waters,
89 mg/m² while the total phosphorus concentration was at the
chlorophyll A concentrations in clear lake reached a high of
phosphorus concentration (r=0.67) in lake water and with the total
phosphorus (r=0.74) in clear lake and with total
and correlated (p < 0.1) with total nitrogren (r=0.73) and total
and averaged 34 mg/m². Chlorophyll A was positively
the chlorophyll A concentration ranged from 15 to 55 mg/m²
in clear water. In clear water, chlorophyll A values ranged from 5 mg/m² to 89 mg/m² and had
phosphorus limited with respect to aquatic growth.
Thus, it seems that both lakes are
the limiting element. Thus, it seems that both lakes are
when the TN to TP ratio is greater than 27, phosphorus is
27 with a range of 18-44. Sarmiento (1996) suggested that
range of 20-44. The average TN:TP ratio in lake water was
Clear lake had an average TN:TP ratio of 33 with a
concentrations.
are eutrophic when in excess of phosphorus and nitrogren
(1980) proposed trophic state index (Table 2), both lakes
status of either lake. Based on forbs and Ryding's
not have a significant long-term effect on the trophic
23
*Collie and Shireman (1980).

\( p < .05 \)

Same year and size classes are not significantly different.
For each lake, values followed by the same letter within the same season are not significantly different.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine</td>
<td>1.79 (T1)</td>
<td>&gt; 1.50 (T1)</td>
</tr>
<tr>
<td>Winter</td>
<td>1.96 (83)</td>
<td>&gt; 1.50</td>
</tr>
<tr>
<td>Summer</td>
<td>1.71 (144)</td>
<td>0.65 (59)</td>
</tr>
<tr>
<td>Winter</td>
<td>1.75 (67)</td>
<td>&gt; 1.50</td>
</tr>
<tr>
<td>Summer</td>
<td>1.73 (117)</td>
<td>0.57 (79)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lake</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>0.95 (77)</td>
<td>&gt; 0.75</td>
</tr>
<tr>
<td>Winter</td>
<td>1.72 (181)</td>
<td>&gt; 1.50</td>
</tr>
</tbody>
</table>

**Table 13.** Mean coefficients of condition (KTL) for bluegill.
For each take group, values follow by the same letter within the same year and site class are not significantly different.

<table>
<thead>
<tr>
<th>Season</th>
<th>Length (mm)</th>
<th>Take Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>1.25 (75)</td>
<td>b</td>
</tr>
<tr>
<td>Winter</td>
<td>1.72 (42)</td>
<td>a</td>
</tr>
<tr>
<td>Winter</td>
<td>1.53 (29)</td>
<td>a</td>
</tr>
<tr>
<td>Winter</td>
<td>1.42 (42)</td>
<td>a</td>
</tr>
<tr>
<td>Summer</td>
<td>1.71 (45)</td>
<td>a</td>
</tr>
<tr>
<td>Summer</td>
<td>1.68 (51)</td>
<td>a</td>
</tr>
<tr>
<td>Summer</td>
<td>1.60 (23)</td>
<td>a</td>
</tr>
<tr>
<td>Summer</td>
<td>1.60 (7)</td>
<td>a</td>
</tr>
</tbody>
</table>

215 Winter 2.07 (97) b 

206 Winter 1.93 (83) a

114 Winter 1.56 (46) a

118 Winter 1.54 (23) a

218 Winter 2.02 (86) a

224 Winter 1.93 (53) a

132 Winter 1.58 (34) a

120 Summer 1.65 (85) a
River. In this investigation, similar results were found.

First three year classes in eleven Porteria Takes and 1
large-mouth bass populations were typically comprised of
first three year classes. Porack et al. (1987) also found
in seven Porteria Takes and 1 river bass populations
at 1. (1984) bound 65 to 90% of the large-mouth bass population
year classes in both takes (Figures 9 and 10). Coleman et
large-mouth bass (Porack et al. 1987) revealed a number of
population along with known growth rates for Porteria
Length-frequency histograms of the large-mouth bass
species were used.

Frequency data and otolith data from the three sport fish
document spawning activity as well as recruitment, length-
In an attempt to evaluate year class strength and
a negative impact on the condition of these fish,
the removal of submerged macrophytes did not have
consistently greater now when compared to 1970 data.
both bluegill and redear sunfish in lake waters are
seems that the current average coefficients of condition for
1977 by Cole and Shateman (1980). From these data, it
significantly greater than values reported between 1975 and
1975-1978 and the present wither average of 2.07 was
1.93 was significantly larger than values reported between
by Cole and Shateman (1980). The present summer value of
coefficients of condition when compared to values reported
Redear sunfish in lake waters also tended to have larger
Figure 9. Length frequency histogram for harvestable largemouth bass in Clear Lake, Florida.
Figure 10. Length frequency histogram for harvestable largemouth bass in Lake Wales, Florida (Winter 1987).
Figure 11. Length frequency histogram for largemouth bass in Clear Lake, Florida (Winter 1988).
Figure 12. Length frequency histogram for largemouth bass in Lake Wales, Florida (winter 1988).
an estimated 74 mm TL of growth occurred. The back period in which otoliths were collected, during this time transpired between September 1986 and June-July 1987, the size class (0-40 mm TL) approximately 254 growing days population (N=7632) had a length frequency peak in the 40 mm length for the 1986 bluegill year class. The 1986 bluegill was used to estimate the potential 1987 summer calculated instantaneous growth rate (0.26 mm/day) for histogram for young of the year (Y0) bluegill. The back September 1986 were used to construct a length frequency each year, block out data collected in clear lake in the number of otolith annually generated per year. In an attempt to determine only form one annually per year, it has not been demonstrated that these fish in Perso, it has not been demonstrated that these fish age and back-calculate bluegill and rear start. The use of a potential problem exists when using otolith data to absence of submerged macrophytes.

Subharvestable fish into harvestable size classes in the largemouth bass populations in clear lake and lake waters are and younger. From these data, it is obvious that the clear lake and lake waters generally consist of fish age III largemouth bass population consisting of fish age III in the recapture of tagged fish, largemouth bass > 300 mm TL in both clear lake and lake waters had the majority of their figures it and 12). Based on my otolith data and data from
<table>
<thead>
<tr>
<th>Lake</th>
<th>Age</th>
<th>N</th>
<th>Minimum (mm TL)</th>
<th>Maximum (mm TL)</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<td>Clear</td>
<td>I</td>
<td>133</td>
<td>54</td>
<td>94</td>
<td>17.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>104</td>
<td>143</td>
<td>147</td>
<td>22.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>51</td>
<td>207</td>
<td>209</td>
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<td>IV</td>
<td>39</td>
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<td>238</td>
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<tr>
<td></td>
<td>V</td>
<td>6</td>
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<td>244</td>
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<td></td>
<td>VI</td>
<td>2</td>
<td>251</td>
<td>246</td>
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<td>Wales</td>
<td>I</td>
<td>143</td>
<td>43</td>
<td>86</td>
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<td>116</td>
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<td>136</td>
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<td>67</td>
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<td>32</td>
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<td>195</td>
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<td>208</td>
<td>217</td>
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<tr>
<td></td>
<td>Age</td>
<td>N</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Minimum</td>
<td>Maximum</td>
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<td>3</td>
<td>222</td>
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<tr>
<td>III</td>
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<td>10</td>
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<td>9</td>
<td>219</td>
<td>233</td>
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<tr>
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<td>3.3</td>
<td>6</td>
<td>232</td>
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<tr>
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<td>5</td>
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<td>2</td>
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<tr>
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<td>5</td>
<td>218</td>
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<tr>
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<td>4</td>
<td>185</td>
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</tbody>
</table>

For reader's benefit in Clear, Lake, and Wakes, from otolith data, Table 15, back calculated growth rates from otolith data, Florida, 1987-88.
Figure 13. Length frequency histogram for harvestable bluegill in Clear Lake, Florida (Summer 1987).
Figure 14. Length frequency histogram for harvestable bluegill in Lake Wales, Florida (summer 1987).

Length midpoints (mm TL)

150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310

Frequency

0
Figure 15. Length frequency histogram for harvestable length midpoints (mm TL) during summer 1987 (Clare Lake, Florida).
Macrophytes.

has occurred in both lakes in the absence of submerged

sunfish have successfully been reproducing and recruiting

17+ were sampled. It is evident that bluegill and reedear

collected. In lake waters, bluegill age + and reedear age

separate year classes of bluegill and reedear sunfish were

16, figures 13, 14, 15 and 16). In clear lake, at least 6

were found in both clear lake and lake waters (Table 15)

a number of bluegill and reedear sunfish year classes

the first year of bluegill growth.

thus it seems likely that only one annual is formed during

calculated estimate of 94 mm TL falls within this range.

1987 summer length ranges from 74 to 114 mm TL. The back-

40 mm size class bluegill sampled in 1986, their predicted

length mean length for age 1 (only one annual) bluegill

calculated mean length for age I (only one annual) bluegill

Table 15).
was covered by submerged macrophytes, as much as 95%, when due to the fact that a much larger percentage of Lake Wales since submerged macrophytes were removed. This is probably phaeophytus has increased and Secchi transparency have decreased compared to 1970s data. However, in Lake Wales again.

does not appear statistically different in clear Lake when Areal biomass has increased by chondrophylus and concentrations.
In Lake Bartlett after hydrilla exceeded 40% areal coverage, biomass decreased and water clarity increased significantly where removed, can be of at least (1983) found that a 198 mg/L, both before and after macrophytes be greater than 600 mg/L, both before and after macrophytes mg/L and the total nitrogen concentration which tended to phosphorous concentration which tended to be greater than 25 the trophic status of either Lake as indicated by the total the establishment of submerged macrophytes did not change of submerged macrophytes in both study lakes. carp are cost-effective and have yielded long-term control minimum of seven years. It is therefore obvious, that grass systems which have been used of submerged macrophytes a 1974. Indicators: 800 mm in both Conclusions
reduction in the largemouth bass population. Whether the removal of the submerged macrophytes caused a

macrophytes were for the largemouth bass population and

is impossible to determine how important submerged

influence on the largemouth bass population. Therefore, it

cannot compete with largemouth bass could have had a negative

population in 1979, and fish such as black crappie which

wastes which killed an estimated 7% of the largemouth bass

other factors such as a pesticide treatment in lake

population numbers over time.

may account for at least part of any differences in

year classes were produced during these high water years and

Largemouth bass increased in 1977 and 1978. It seems stronger

natural fluctuations. Water levels were higher and the

possible that differences between years were a result of

and predation (Coleman et al., 1984; Palka et al., 1987). It is

seem to be related to local conditions such as water level

basin year class strengths often vary from year to year and

population reported between 1974 and 1979. Since largemouth

is significantly different from the largemouth bass

whether the present largemouth bass population in lake waters

the 1970s data and therefore, it could not be determined

lake waters. Statistical differences were not reported for

fishery data from the 1970s were only available for

macrophyte coverage of approximately 34% compared to clear lake which only experienced submerged
associated with poor condition and an inadequate forage base. Slow growth has been
tended to have a slower growth rate when compared to a
to a number of other Florida lakes. Slow growth rates were within the range reported by
Coffman et al. (1984) and Porcar et al. (1987) for inland Florida.
Clear lake and Laketiles were within the range reported by
Year growth rates for the Largemouth bass in
Lake Clear. Forage bases are sufficient for the growth of Largemouth bass.

Weight (MR) values for these fish suggest that there is an
coefficient of condition (K(TL)) and K(TL)
and relative rates for harvestable Largemouth bass as well as
growth which are cool of submerged macrophytes. However, growth
sufficient forage base for predator fish in these systems
blockers: rotation data are accurate there seems to be a
estimates which were calculated from highly variable
in Lake Tiles. It is available prey to predator fish biomass
water with ARP ratios as high as 67 in Clear Lake and 14
Forage fish were abundant in both Clear Lake and Lake
these smaller size fish to greater predation pressure.
probably the result of decreased cover which has exposed
occurred in the juvenile size classes. This reduction is
effectected, and most of the reduction in the total population
the harvestable populations do not seem to have been as
were when hydrilla was present during the 1970's. However,
surplus populations in Lake Tiles seem smaller now than they
based on blockexit data, the total phytoplankton and reed
the condition of harsvestable bluegill and rearer sunrsh.

vegetation does not appear to have had a negative impact on
during the 1970s. Therefore, the STMtimation of submerged
(to take water values reported by cowle and shi Them (1980)
stantly greater coefficients of condition when compared
juvenr sunnsh population, the harsvestable fish tend to have
rearer sunnsh population, seen mahty by a reduction in the
North America, with a decrease in the total bluegill and
central 50% K(77) range reported for bluegill throughout
and lake waters approached or exceeded cartridge's (1977)
harvestable bluegill and rearer sunnsh in clear lake
macrophytes as well as excessive macrophyte coverage.
affected by the complete estimation of submerged
of condition for largemouth bass have been negativey
and shi Them (1980). Therefore, in lake waters, coefficients
harvestable largemouth bass coefficients of condition (coole
hydrat coverage in excess of 30% can cause a reduction in
shi Them (1980) during the years of hydraTc fluctuation.
condition values similar to values reported by coole and
largemouth bass in lake waters tended to have coefficient of
et al. (1987) for other Florida lakes. Harvestable
were less than the mean of means value calculated from porex
harvestable largemouth bass in clear lake and lake waters
food supply. Average coefficients of condition, K(sl), for
of submerged macrophytes for as long as 13 years.  
into harvestable size classes in lakes which have been void 
successively reproduce and experience year- year recruitment 
that largemouth bass, bluegill, and reed sunfish can 
understandably by some groups of individuals, it was determined 
exists. Although these conditions may be considered 
all plants as well as increasing aquatic concentrations 
gress carp are used, the potential for enhancing nearly 
important to establish desired management objectives. When 
macrophytes and problems associated with them, it is 
before grass carp are used to enhance aquatic 
macrophytes in clear lake and lake waters. 
size classes have been occurring in the absence of submerged 
reproduction of harvestable sport fish into harvestable 
both lakes. It is obvious that successful spawning and 
bluegill and reed sunfish year classes were present in 
most data were used to determine that a number of 
subharvestable year class approaching harvestable size. 
for largemouth bass in both lakes showed a significant 
in both clear lake and lake waters, length frequency data 
largemouth bass, bluegill, and reed sunfish were documented 
reproduction was found. Reproduction and recruitment of 
clear lake and lake waters, but no evidence of their 
A number of grass carp ≥ 800 mm TL were collected in
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Biographical Sketch
degree of Master of Science. 

accepted as partial fulfillment of the requirements for the

college of Agriculture and to the Graduate School and was

the School of Forest Resources and Conservation in the

This thesis was submitted to the Graduate Faculty of
A thesis for the degree of Master of Science, presentation and is fully adequate in scope and quality, as option it conforms to acceptable standards of scholarly certainty that I have read this study and that in my

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