



Physical, Chemical and Biological Assessments of
Selected TMDL Lakes in Polk and Hillsborough Counties

Sampled August 1998

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Environmental Assessment Section
Division of Resources Assessment and Management

Comprehensive Quality Assurance Plan No's:

Laboratories- 870346G & 870688G

Field- 980028

Executive Summary

FDEP's Bureau of Laboratories was requested to assess the status of selected lakes on the 303(d) list by conducting habitat, water quality, and biological monitoring of the lakes. Water bodies on the 303(d) list are required by EPA to have a Total Maximum Daily Load (TMDL) study conducted. The purpose of the TMDL is to determine the amount of pollution reduction needed to restore the system to a condition suitable for its designated use. For this study, seven 303(d) listed lakes (eight lake sites) in Polk or Hillsborough Counties were sampled to assess their status.

Total phosphorus at four of the sites exceeded the concentrations

observed in 80% of other Florida Lakes. Elevated levels of TKN were observed at all lake sites (except Lake Mirror), with concentrations at or above those observed in 60% of other Florida lakes. Algal growth potential was above 5 mg/L at six of the lake sites. Chlorophyll *a* concentrations at seven of the eight lake sites were much higher than those observed in 60% of other Florida lakes with most being higher than concentrations observed in 80% of other Florida lakes. Lake Mirror was the only exception to this, exhibiting a chlorophyll *a* concentration of 22.6 mg/L, which is only slightly higher than the 22 mg/L value for 60% of other Florida lakes. Turbidity values for five of the eight lake sites exceeded the values observed in 60% of other lakes in Florida. However, no exceedances of the State of Florida Class III criterion

for turbidity of 29 NTU above background were observed.

Class III surface water quality violations for dissolved oxygen occurred at Buck Lake and Lake Effie, and exceedances of Class III total coliform criteria were observed at Lake May. BOD was elevated above 5 mg/L at Buck Lake, Lake Effie, Lake May, and Lake Parker.

Habitat assessment scores typically were in the marginal range, with Lake Effie having a poor score and Lakes Lena and Mirror being in the suboptimal range. Primary contributors to lowered habitat quality were low Secchi depths, poor bottom substrate diversity, and poor upland land use (high density urban, residential or industrial). It is recommended that all seven lakes sampled remain on the 303(d) list.

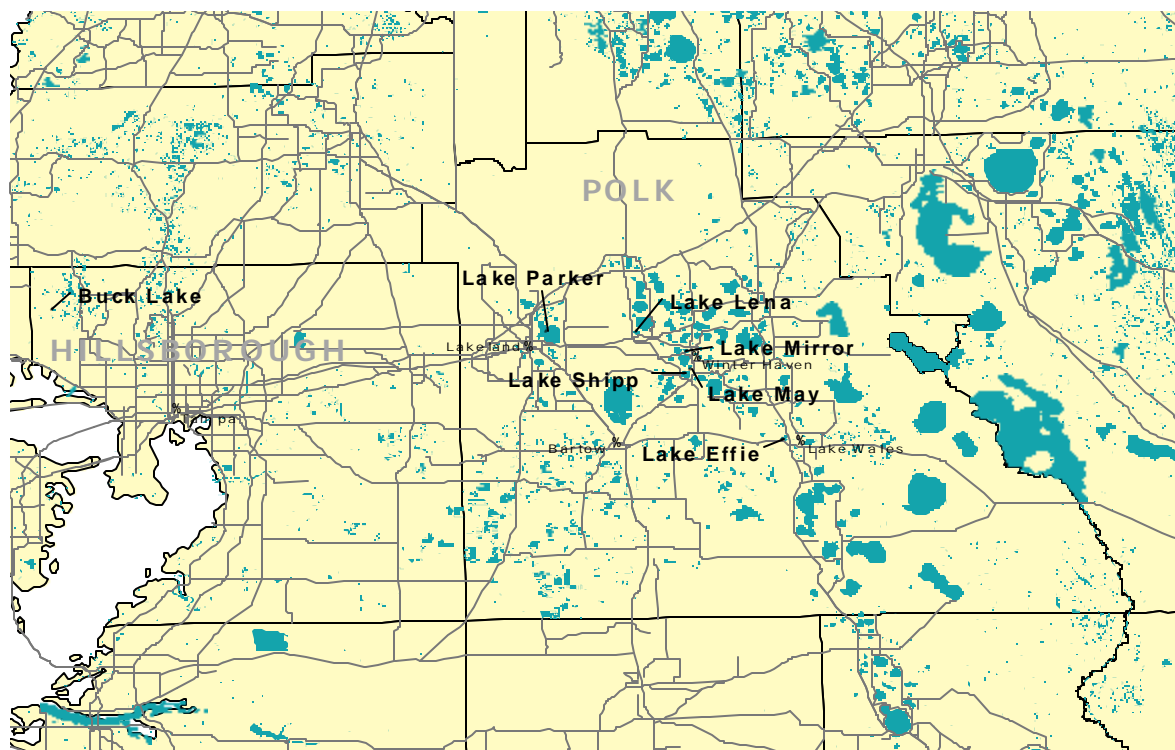


Figure 1: Overview Map

Introduction

FDEP's Environmental Assessment Section was requested to assess the status of seven Polk and Hillsborough County lakes that were placed on the TMDL (303(d)) list with limited data. The data available for these selected water bodies consisted of less than 10 observations in the STORET database, somewhat dated, pre-1990 information, or qualitative non-point source survey data only.

Water bodies on the 303(d) list are required by EPA to have a Total Maximum Daily Load (TMDL) study conducted to assess the quality of the water body with respect to chemical parameters and biological function. The purpose of the TMDL is to determine the amount of pollution reduction needed to restore the system to a condition suitable for its designated use. In this case, the designated use of each of these lakes is for recreation and the maintenance of a healthy, well-balanced aquatic community.

The six Polk County lakes from this study are located within or near the Winter Haven/Lake Henry Ridges. This is an area of small to medium sized lakes which can be characterized as alkaline, eutrophic, moderately hard water lakes of relatively high mineral content (Griffin et al., 1997). Buck Lake is from an area of Hillsborough County characterized as having slightly acidic, darkwater, mesotrophic lakes. Refer to Figure 1 for location of the seven lakes.

Methods

The focus of this investigation was to determine if human activities were affecting the water quality or health of

taxonomic level using a dissecting microscope.

Explanation of Measurements of Community Health

Selected measurements of community health were applied to assess each lake site. These measurements are briefly described here:

Habitat Assessment: Five attributes known to have potential effects on the lake biota were evaluated and scored at the site, with 20 points possible for each factor. The five attributes are: Submerged and Floating Vegetation Quality; Bottom Substrate Diversity; Riparian Zone Alterations; and Visible Upland Land Use. Overall habitat quality is assigned to one of four categories based on the sum of individual scores for those five attributes: Optimal (76-100 Points); Suboptimal (51-75 points); Marginal (26-50 points); and Poor (0-25 points).

Taxa Richness: This measurement is based on the total number of macroinvertebrate taxa found at a site. Stress tends to reduce the number of different types of macroinvertebrates present in a system.

Numbers of pollution sensitive taxa: Some organisms become rare or absent as the intensity or duration of disturbance increases. The Hulbert Index assigns points to lake-dwelling macroinvertebrate taxa (0, 1 or 2) based on their sensitivity to pollution (Hulbert, 1990). A high score for the Hulbert Index typically is considered an

receiving water biota in Buck Lake and Lakes Effie, Lena, May, Mirror, Parker (2 sites) and Shipp. Sampling of these water bodies was conducted on August 31, 1998.

A habitat assessment (FDEP 1997a, Biology Section Standard Operating Procedure, BA-18) and physical/chemical characterization (FDEP 1997b, Biology Section Standard Operating Procedure, BA-17) were conducted at each site. Field measurements were conducted by FDEP Central Laboratory staff at each site for surface water dissolved oxygen (D.O.), pH and conductivity, with bottom, mid and surface depth horizons being measured for most sites. Water quality data in this report are from the mid-depth horizon unless otherwise indicated. Surface water samples were collected from the center of each site and analyzed in the FDEP Central Laboratory for nitrite-nitrate, total Kjeldahl nitrogen (TKN), total ammonia, total phosphorus (TP), total organic carbon (TOC), turbidity, total suspended solids (TSS), chlorophyll *a*, biochemical oxygen demand (BOD), algal growth potential (AGP) and color. Measurements also were conducted on each sample for fecal and total coliforms.

Each of the eight sites (seven lakes) also was sampled to determine the biological health of the systems. Benthic macroinvertebrate samples were collected at each site using a Petite PONAR or an Ekman sampler. For these samples, the 2-4m sublittoral zone of each site basin was divided into 12 equal segments, a grab was collected in each segment with the Petite PONAR or Ekman sampler and combined into a single composite sample for each site, as described in FDEP (1996). Each composite sample was randomly subsampled in the laboratory to a count of at least 100 organisms, which were identified to the lowest practical

indicator of good health for a waterbody.

Community structure: A system generally is considered degraded if a substantial shift in the proportions of the major taxonomic groups is observed. Increases in the percentage of dipteran organisms in a sample are indicative of poorer health of the system.

Ephemeroptera/Trichoptera/Odonata (ETO) Index: This index is expressed in two ways: as the sum of the number of ETO taxa present; and as the percentage of ETO organisms in the sample. This index is analogous to the Ephemeroptera/Plecoptera/Trichoptera Index used in stream systems. Higher numbers of ETO taxa and higher percentages of ETO organisms typically are associated with healthier systems.

Shannon-Weaver Diversity Index: This index is specified in the Florida Administrative Code as a measure of biological integrity. Low diversity values are undesirable, in that they represent conditions where only a few organisms are abundant, to the exclusion of other taxa. Such values may be associated with organic/nutrient enrichment and decreased dissolved oxygen.

Algal Biomass: The density of algal cells and the chlorophyll-*a* concentration of phytoplankton typically are used as estimators of biomass. A lake traditionally has been considered stressed when biomass exceeds problem threshold levels (e.g., approximately 20 mg/L of chlorophyll *a*), although far smaller increases in chlorophyll *a* may be among the first signs of trouble in a system. In this study, algal biomass estimates were based on chlorophyll *a* concentration of phytoplankton.

Descriptions of Study Sites

The seven lakes we sampled were:

1. Buck Lake- An open cattle pasture is located along one margin of Buck Lake. Just beyond the cattle pasture are orange groves, and there is low density residential development around the lake. Buck Lake is on the current 303(d) list because of coliform bacteria.
2. Lake Effie- This lake has been stocked with Nile Perch for ± 10 years. A citrus industry with a wastewater treatment plant discharging to spray fields is located adjacent to the lake. Additionally, there is some residential development around the lake. Lake

Effie is on the current 303(d) list because of nutrients.

3. Lake Lena- Upland land use surrounding Lake Lena is high density urban, residential, and industrial. Lake Lena is on the current 303(d) list because of dissolved oxygen, coliforms, nutrients, turbidity, and total suspended solids.
4. Lake May- There are some areas of high density urban, residential, and industrial development in the Lake May watershed. However other areas consist of native vegetation. Lake May is on the current 303(d) list because of nutrients.
5. Lake Mirror- There are some areas of high density urban and residential and commercial development upland of Lake Mirror. However other areas consist of native vegetation. Lake Mirror is on the

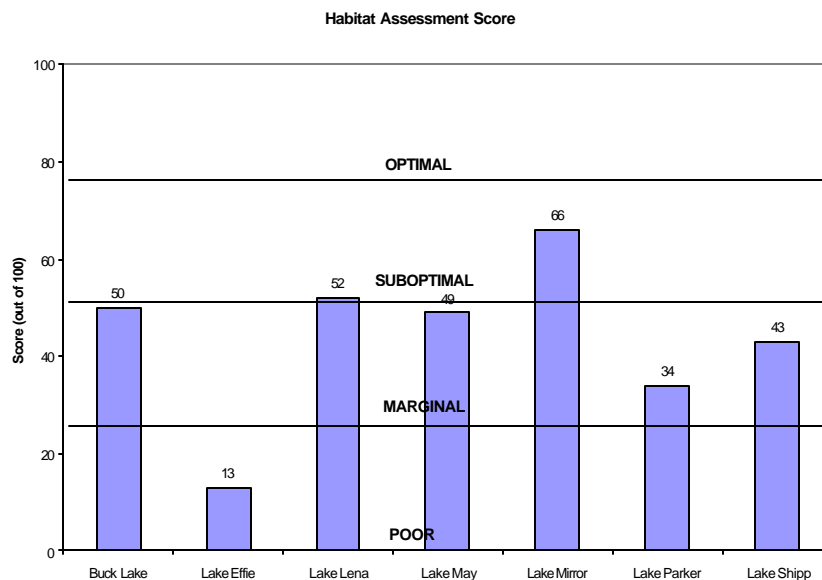


Figure 2: Habitat Assessment Score

current 303(d) list because of nutrients.

6. Lake Parker- Lakes greater than 1,000 acres are divided into two or more basins (FDEP, 1996). Thus, for sampling purposes, Lake Parker, with an area of 2,272 acres was divided into the two sites (Lake Parker North and South). The upland land use surrounding Lake Parker is high density urban, residential, and industrial. Lake Parker is on the current 303(d) list because of nutrients.
7. Lake Shipp- Upland land use surrounding Lake Shipp is high density urban and residential. This lake is on the current 303(d) list because of dissolved oxygen and nutrients.

Results and Discussion

Habitat Parameters

Habitat quality was in the “suboptimal” range for two of the seven lakes, in the “marginal” range for four of the seven lakes and in the “poor” range for one lake (Figure 2). Habitat scores ranged from a high of 66 out of a possible 100 (“suboptimal”) for Lake Mirror to a low of 13 (“poor”) for Lake Effie. The habitat quality score for Lake Lena was in the lower portion of the “suboptimal” range. Buck Lake, and Lake May had habitat quality in the upper portions of the “marginal” range, while Lake Parker and Lake Shipp were in the middle portion of that range.

Major contributors to lowered habitat quality scores at all sites were marginal to poor scores on Secchi depth, marginal to poor bottom substrate diversity and poor scores on visible upland land use (i.e., high density urban, residential or industrial use).

Water Quality Parameters

Dissolved oxygen concentrations at all but two sites complied with the Class III water quality criterion of 5.0 mg/L (refer to Table 1). Dissolved oxygen concentrations at Buck Lake (1.5 mg/L) and Lake Effie (less than 0.1 mg/L) were less than the Class III criterion, potentially due to decomposition/respiration of algae (chlorophyll *a* was 94.5 µg/L at Buck Lake and 140 µg/L at Lake Effie). These two sites exhibited BODs of 6.2 mg/L and 8.3 mg/L, respectively. BOD for the remaining six sites ranged from 2.7 mg/L for Lake Mirror to 6.7 mg/L for Lake Parker South. The pH ranged from a low of 6.6 standard units for Buck

Lake to a high of 9.6 standard units for Lake Parker South. Specific conductance ranged from 125 mmhos/cm² at Buck Lake to 440 mmhos/cm² at Lake Effie. Color ranged from 75 PCU (Lakes Lena, Mirror and Shipp) to 200 PCU (Buck Lake and Lake Parker South).

Nitrite-nitrate concentrations at seven of the sites were below the limit of detection of 0.004 mg/L. The nitrite-nitrate concentration at Lake Parker South also was below the limit of detection. However, because of matrix interference, the detection limit for the sample from Lake Parker South was 0.04 mg/L. All nitrite-nitrate results were below the values found in 60% of other lakes in Florida (below 0.04 mg/L; Table 1; refer to Appendix A, Typical Values for Selected Parameters in Florida Waters). With the possible, but unlikely, exception of Lake Parker South, all nitrite-nitrate results were within or below the values found in 5% of other lakes in Florida. Total ammonia concentrations also were low at all eight sites, with all sites at or below the concentrations found in the lower 10th

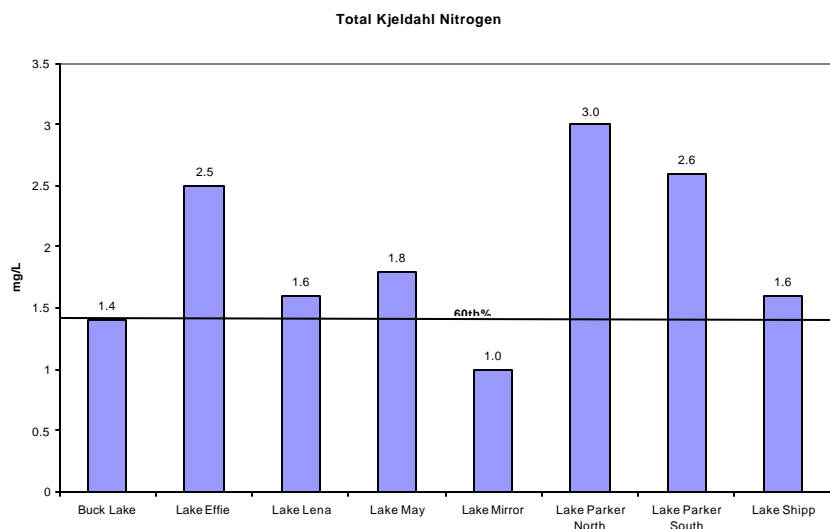


Figure 3: Total Kjeldahl Nitrogen

Table 1: Data Summary Table

Site	Buck Lake	Lake Effie	Lake Lena	Lake May	Lake Mirror	Lake Parker North	Lake Parker South	Lake Shipp
Storet Number	24040154	25020359	25020358	25020357	25020356	25020354	25020340	25020355
Sampling Date	08/31/1998	08/31/1998	08/31/1998	#####	08/31/1998	08/31/1998	08/31/1998	08/31/1998
MACROINVERTEBRATE DATA:								
# Total Taxa	3	7	8	10	8	7	5	13
Hulbert Index	2	1	1	0	1	0	0	0
%Diptera	98.01	6.56	80.91	47.62	72.55	41.38	47.88	79.38
#ETO Taxa	0	0	0	0	0	0	0	0
%ETO	0	0	0	0	0	0	0	0
Shannon-Weaver Index	3	7	8	2.55	1.69	2.23	1.71	2.09
WATER QUALITY DATA:								
DO (mg/L)	1.5	<0.1	7.59	7.4	6.8	6.5	8.07	6.8
pH (SU)	6.56 *	6.97 *	9.17 *	8	8.2	9.3	9.55	8.4
Cond (umhos/cm ²)	125	440	200	164	148	126	129	165
Color (PCU)	200	150	75	100	75	150	200	75
BOD5 (mg/L)	6.2	8.3	4.4	5.7	2.7	6.2	6.7	4.3
Turbidity (NTU)	2.3	13	17	8.6	3.5	20	18	6.3
TSS (mg/L)	6	13	16	14	8	296	68	9
NO ₂ -NO ₃ (mg/L)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.04	<0.004
Ammonia (mg/L)	0.012	0.017	<0.01	<0.01	<0.01	0.016	0.02	0.01
TKN	1.4	2.5	1.6	1.8	1	3	2.6	1.6
TP (mg/L)	0.15	0.22	0.061	0.076	0.032	0.24	0.19	0.05
TOC (mg/L)	17	20	7.7	10	9.3	15	16	9.8
Fecal Coliforms (#/100 mL)	4	75	16	40	16	1	2	2
Total Coliforms (#/100 mL)	60	1850	200	8600	30	1	10	10
AGP (mg dry wt/L)	5.504	8.835	12.762	9.37	0.762	5.718	7.58	0.74
ALGAL BIOMASS DATA:								
Chl- <i>a</i> (ug/L)	94.5	140	63.9	54.3	22.6	196	74.8	50.9
HABITAT ASSESSMENT DATA:								
Secchi Score	8	3	7	7	9	3	No data	7
Submerged and Floating Veg Score	15	3	16	14	17	12	No data	16
Bottom Substrate Diver Score	1	1	13	3	15	11	No data	10
Riparian Zone Alterations Score	11	2	11	13	13	6	No data	5
Visible Upland Land Use	15	4	5	12	12	2	No data	5
Total Habitat Score	50	13	52	49	66	34	No data	43

* Field data are from upper sampling depth. All other field data are from mid-depth sampling.

percentile of other lakes in Florida (0.02 mg/L).

Total Kjeldahl nitrogen (TKN) concentrations at seven of the eight lake sites were equal to or higher than the values found in 60% of other lakes in Florida (1.4 mg/L; refer to Appendix A). TKN concentrations at the eight lake sites ranged from 1.0 mg/L at Lake Mirror to 3.0 mg/L at Lake Parker North. The concentration for Lake Mirror was lower than the TKN concentrations found in 40% of other lakes in Florida.

Total phosphorus concentrations at four of the eight lake sites were above the concentrations found in 80% of other lakes in Florida (0.14 mg/L; Table 1; refer to Appendix A). Concentrations in those four lakes were: 0.15 mg/L (Buck Lake); 0.19 mg/L (Lake Parker South); 0.22 mg/L (Lake Effie); and 0.24 mg/L (Lake Parker North). Total phosphorus concentrations in the remaining four lakes ranged from 0.032

mg/L at Lake Mirror to 0.07 mg/L at Lake May, all of which were at or below the median concentrations in other Florida lakes.

Algal growth potential (AGP) exceeded the "problem threshold" of 5 mg dry wt/L (Raschke and Schultz, 1987) at six of the eight sites. AGP measurements at Lake Mirror (0.8 mg/L dry weight) and Lake Shipp (0.7 mg/L dry weight) were below the threshold.

Total organic carbon (TOC) ranged from 20 mg/L at Lake Effie to 7.7 mg/L at Lake Lena. Turbidity was elevated above the 60th percentile value for other Florida lakes (6.45 NTU) at five of the eight lake sites. Three of those five sites (Lake Lena, Lake Parker North and Lake Parker South) exhibited higher turbidities than 80% of other lakes in Florida (14.1 NTU; refer to Appendix A), with a highest value of 20 NTU for Lake Parker North. However, none of the NTU measurements exceeded the State

of Florida Class III water quality criterion of ≤ 29 NTU above background. Total suspended Solids (TSS) were elevated in Lake Parker North (296 mg/L) and Lake Parker South (68 mg/L), and ranged from 6 to 16 mg/L for all other lake sites.

Fecal coliform bacterial counts all were well below the State of Florida Class III surface water criterion of 800 colonies/100 mL for all lake sites. Total coliform counts complied with the Class III surface water criterion of 2400 colonies/100 mL at all sites except for Lake May. The total coliform count for Lake May was 8,600 colonies/100 mL. It should be noted that the 6 hour holding time for bacteriological analyses was exceeded in all samples.

Algal Biomass Parameters

Chlorophyll *a* was elevated at most sites, ranging from 22.6 mg/L at Lake Mirror to 196 mg/L at Lake Parker North. All of these values exceeded the 60th percentile concentration of 22 mg/L for other lake sites in Florida (refer to Appendix A), and most exceeded the 80th percentile value for other Florida lakes (47.2 mg/L).

Macroinvertebrate Parameters

Macroinvertebrate sampling, using the 12-sample composite from Petite Ponar or Ekman samplers, was conducted at each of the eight lake sites. Resulting macroinvertebrate community measures appear to be low for all seven lakes sampled. However, recent information based on development of a composite Lake Condition Index (LCI), which ranks a lake based on its attainment of eco-regional expectations, in-

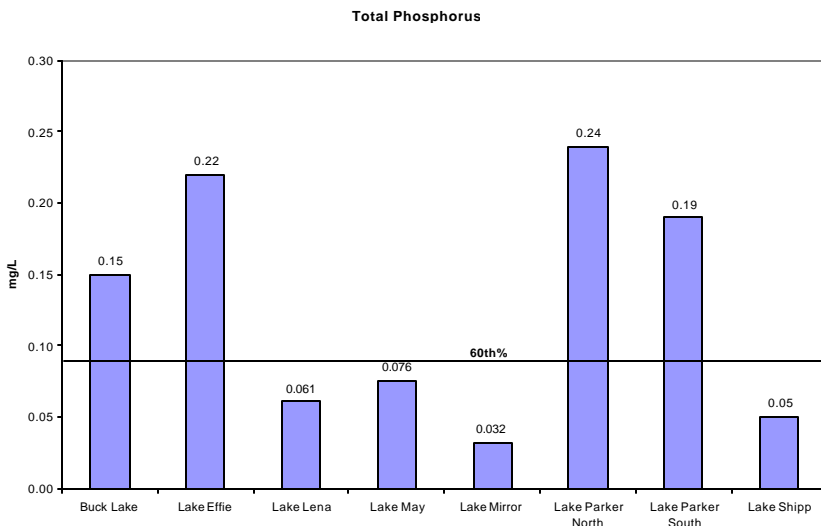


Figure 4: Total Phosphorus

icates that lake macroinvertebrate metrics for the Florida peninsular ecoregion (75) will be inconclusive. Reference and non-reference lakes from the Florida peninsula did not show a clear distinction when compared using the six metrics described previously, namely: taxa richness; Hulbert Index, % Diptera; #ETO taxa; %ETO; and Shannon-Weaver diversity. The conclusion was made that macroinvertebrates are not sensitive biological indicators in the highly colored, organic rich lakes of Ecoregion 75 and it was recommended that they not be used as lake assessment tools for this ecoregion. All seven lakes from this study are highly colored lakes located in Ecoregion 75. Therefore, while the macroinvertebrate metric values are summarized in this report, no definitive conclusions regarding biological condition can be drawn from those data at this time.

Taxa richness ranged from 3 taxa at Buck Lake to 13 taxa at Lake Shipp. The Hulbert Index values for each of the eight lake sites were very low, with a highest value of 2 at Buck Lake and with four of the remaining eight lake sites exhibiting 0 values for this index.

Dipterans accounted for between 7% (Lake Effie) and 98% (Buck Lake) of the macroinvertebrates at the eight lake sites, with all sites but Lake Effie being above 40% dipterans. No Ephemeropteran, Trichopteran, or Odonate organisms were identified in the samples from any of the eight lake sites. Shannon-Weaver diversity index values ranged from 0.2 at Buck Lake to 2.6 at Lake May.

Summary of Results by Site

Buck Lake exhibited low D.O., elevated BOD, elevated total phosphorus concentrations as well as elevated algal growth potential and chlorophyll *a*. The habitat assessment of this site indicated it was in the upper marginal range, mostly as a result of very poor bottom substrate diversity, and secondarily because of marginal Secchi depth.

Lake Effie also exhibited low D.O. (<0.1 mg/L), elevated BOD, elevated total phosphorus, AGP and chlorophyll *a*. Turbidity was elevated as well. The habitat assessment of this site indicated it was poor across all described categories.

Water quality samples from Lake Lena indicated slightly elevated total Kjeldahl nitrogen, elevated turbidity, elevated AGP and chlorophyll *a*. The habitat assessment of this site indicated it was in the low suboptimal range, with poorest ratings due to poor up-

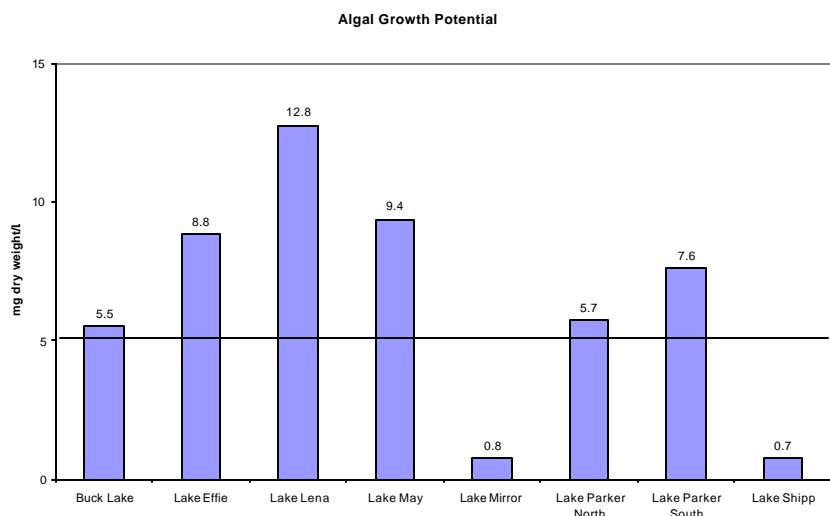
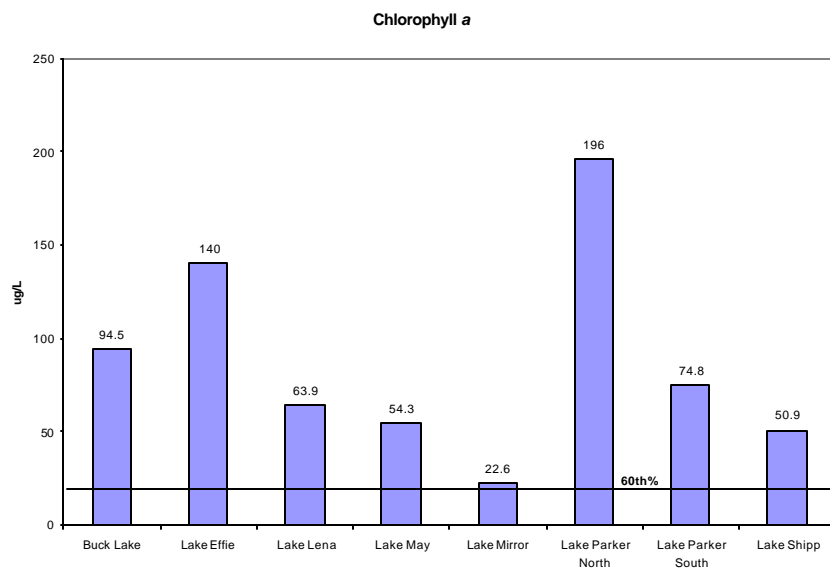


Figure 5: Algal Growth Potential

Figure 6: Chlorophyll *a*

land land use and marginal Secchi depth.

At Lake May, BOD, AGP and chlorophyll *a* were elevated, and TKN, and turbidity were slightly elevated. Total coliforms at this site (8,600 organisms/100 mL) were much higher than the State of Florida Class III criterion of 2,400 organisms/100 mL. The habitat assessment of the site yielded a rating in the upper marginal range, with lowest scores being a result of poor bottom substrate diversity and marginal Secchi depth.

With the exception of slightly elevated chlorophyll *a*, water quality parameters measured at Lake Mirror were not unusual. The habitat assessment of the site yielded a score in the suboptimal range, primarily because of a poor upland land use score and a marginal Secchi depth score.

Both the north and south sites of Lake Parker exhibited elevated levels of BOD, total Kjeldahl nitrogen, total phosphorus, turbidity, algal growth potential, and chlorophyll *a*. The habitat

assessment score for the lake was in the marginal range, with lowest individual scores in Secchi depth and upland land use (poor) and riparian zone alterations (marginal).

Lake Shipp exhibited slightly elevated total Kjeldahl nitrogen and elevated chlorophyll *a*. The habitat as-

essment for this lake site indicated marginal quality, with poor scores in riparian zone alterations and upland land use and marginal scores for Secchi depth and bottom substrate diversity.

Conclusions

Elevated TKN was observed at most of the eight lake sites, with concentrations at or above those observed in 60% of other Florida lakes (except Lake Mirror). Total phosphorus at four of the sites (Buck Lake, Lake Effie, and Lake Parker North and South) exceeded the concentrations observed in 80% of other Florida Lakes. Algal growth potential was above 5 mg dry weight/L at six of the lake sites (excepting Lakes Mirror and Shipp). Chlorophyll *a* concentrations at seven of the eight lake sites were much higher than those observed in 60% of other Florida lakes with most being higher than concentrations observed in 80% of other Florida lakes. Lake Mirror was

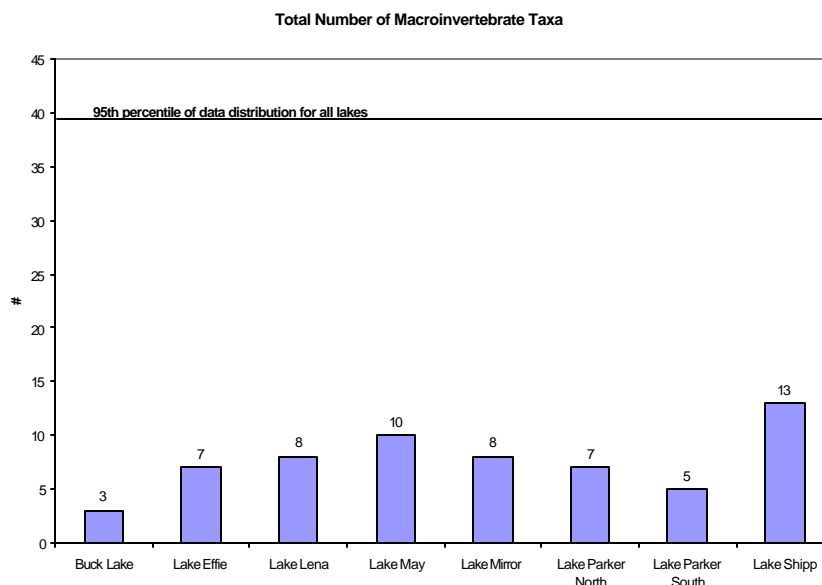


Figure 7: Total Number of Taxa

the only exception to this, exhibiting a chlorophyll *a* concentration of 22.6 mg/L, which is only slightly higher than the 60th percentile value (22 mg/L). Turbidity values for five of the eight lake sites (Lakes Effie, Lena, May, Parker North and South) exceeded the values observed in 60% of other lakes in Florida. However, no exceedances of the State of Florida Class III criterion for turbidity (29 NTU above background) were observed.

Exceedances of State of Florida Class III surface water quality criteria occurred for dissolved oxygen at Buck Lake and Lake Effie, and for total coliforms at Lake May. BOD was elevated above 5 mg/L at Buck Lake,

Lake Effie, Lake May, and Lake Parker North and South.

Habitat assessment scores typically were in the marginal range, with Lake Effie having a poor score and Lakes Lena and Mirror being in the suboptimal range. Primary contributors to lowered habitat quality were low Secchi depths, poor bottom substrate diversity and poor upland land use (high density urban, residential, or industrial).

The assessment of lake condition will be more meaningful when biological indicators are used in conjunction with physical/chemical measurements. There are plans to develop biological

indices for phytoplankton and aquatic macrophytes for use as assessment tools for lake condition. Such indices are particularly needed for areas like Ecoregion 75, where macroinvertebrate measures have been judged not to be useful. In the meantime, on the basis of the physical/chemical data collected in August 1998, it is recommended that all seven lakes sampled remain on the 303(d) list. Lake Mirror exhibited generally good water quality for the parameters measured. However, chlorophyll *a* was marginally elevated, and the habitat assessment score was in the suboptimal range. Until an assessment can be made with biological indicators, it is recommended that Lake Mirror remain on the 303(d) list along with the remaining six lakes.

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