Biological Assessment of Morris Lake, Topsail State Preserve, Walton County, Florida

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INTRODUCTION

Freshwater is one of the most important substances on earth; just as important to life as radiant energy from the sun. While over 70% of the earth's surface is covered with water, less than 3% of all water is fresh and most of this is in glacial form, leaving less than 1/2% available for use (Cole, 1983). Thus, with such a limited, valuable resource, it is imperative it be managed with utmost care. Not only is freshwater vital to life, it provides copius recreational opportunities. From fishing for challenging and exciting gamefish (which rely on clean water and insects as a primary food source) to a leisurely afternoon stroll near a soothing brook, or a reflective moment at a lake, freshwater is a priceless resource.

In 1994 the Northwest District of the Florida Department of Environmental Protection (FDEP) undertook the Clean Lakes Program in cooperation with the United States Environmental Protection Agency (USEPA). This study incorporated both public and private lakes for the assessment of water quality strategies for their protection and potential restoration (if needed). Florida characterized its lake water quality conditions by using biological, chemical and physical parameters.

Florida had 41 Lake regions as determined by defining patterns such as chemistry, hydrology and physiography (Griffith, et al. 1995). The initial study was to determine the best available lakes in each lake region to develop a reference, or standard, for lakes in the same lake region possessing similar characteristics.

STUDY AREA

Morris Lake (previously Bald Hill Lake) was an example of a coastal dune lake of the Gulf Coast Lowlands Lake Region (Griffith, et al. 1995) located in the western Florida Panhandle (Fig. 1). This lake was elliptical in shape and had an outlet on the southeastern end; the lake was historically described as landlocked (Florida Division of Water Resources, 1969). The aftermath of Hurricane Opal (October 1995) resulted in tidal surge, and subsequent flooding of the surrounding landscape; thus, threatening a nearby development. Permits were secured and a drainage ditch was opened on the southwestern end of Morris Lake on 28 October 1995.

Typical of dune lakes in this region, xeric coastal strand and pine scrub vegetation were found in association with this lake (Griffith, et al. 1995). Waters of this region were slightly acidic, slightly tannic and low in nutrients (TKN, nitrite, nitrate and ammonia). Salt water spray or overwash had occurred in the past as indicated by salts (ions) that were higher in this lake than inland lakes studied. Waters in these lakes were typically oligotrophic, as the majority of their water came from rainfall and runoff from poorly drained soils.

MATERIALS AND METHODS

Four sample locations were established at random in the lake along a transect (Fig. 1). The criterion for each station (except station 4) was that it be in the sublittoral zone. For consistency, it was determined by FDEP biologists that this sampling zone would be located in 2-4 m of water, as many Florida lakes lack a true sublittoral zone. This region of the lake was selected because it provided a relatively homogenous area, was the largest zone of the lake and this zone provided an overview of the system's health (Gerritsen and Gibson, 1993). Station 4 was chosen as the deep site location. This site was selected as the likely area where marked stress might be apparent in the system. A petite ponar was employed to sample the benthos (organisms that live on and in the lake substrate). Five replicates were collected per station (6 replicates at station 1) during the Winter 1994 period and composited into one sample per station. During the summer 1994 period, the same stations were revisited and 6 replicates were collected and composited as in the winter episode. A multiparameter Hydrolab provided chemical and physical measurements of the water column. These parameters were: temperature; dissolved oxygen concentration (DO); conductivity; and pH (Tables 1 and 2). Water chemistry sampled: total nitrogen (TKN + nitrite-nitrate); ammonia; total phosphorous; chlorophyll *a*; and alkalinity. Other measurements were color, turbidity and Secchi depths. Indicators of nutrient enrichment were assessed by sampling phytoplankton and algal growth potential (AGP). Ranking of lake condition was determined by values gleaned from the various biological and chemical data. Hulbert's Lake Condition Index (LCI) (Hulbert, 1990) was utilized as it incorporated both chemical and benthic data. This ranking system assigned

2 points per class A organism or 1 point per class B organism based on their relative sensitivity to pollution. Included in this index, points were assigned for total phosphorous (mg/L), total nitrogen (mg/L) and chlorophyll *a* (ug/L). The lower the value (indicating little to no organic enrichment to the water column) the more points were assigned for the above mentioned parameters. Hulbert's LCI was incorporated in a multimetric analysis called the Florida Index of Lake Integrity (FILI). This index also included scores derived from: Taxa Richness; Shannon-Wiener Diversity; Ephemeroptera/Trichoptera/Odonata; %Ephemeroptera; % Amphipoda; % suspension feeders (collectors-filterers); phyto-plankton density; and chlorophyll *a.* Calculation of this multimetric index resulted in a score of 45-35 points, interpreted as no impairment, 34-22 interpreted as moderate impairment and below 22 interpreted as degradation. Community similarity was expressed using Sorensen's coefficient of community (Brower and Zar, 1984).

RESULTS

Winter 1994 sample event resulted in 34 total benthic taxa (Table 3) and an average density of 1,151 individuals per m^2. Of these 34 taxa, 12 were LCI Class A organisms and 3 were LCI Class B organisms. Since individual stations resulted in fewer than 100 organisms subsampled, all 4 sample station taxa were combined to compute a valid diversity (EPA, 1990). The average diversity of 3.9 was relatively high. Cumulative percent composition indicated dominance by Chironomidae (midge) taxa (Table 3). This sample period indicated a diverse assemblage of Chironomidae along with the presence of Ephemeroptera (mayflies) and Trichoptera (caddisflies). Functional feeding groups (trophic web) were complex, represented by collector-filterers, collector-gatherers and predators. Physical parameters all indicated a clean, oligotrophic system with high DO concentration throughout the water column to near bottom at station 4 (Table 1). Nutrients (TKN, nitrite-nitrate, and ammonia) were very low, often near the minimum detection limit (Table 1). The FILI score was 39 which indicated no impairment.

Summer 1994 sample event resulted in 22 benthic taxa (Table 4), 5 were class A organisms with 0 class B organisms observed. Density of the benthos averaged 49 individuals per m^2. The diversity of 3.5 was lower in this sample period and was calculated by combining all 4 stations. Percent composition indicated a shift in taxa dominance (Table 4). The phantom midge, *Chaoborus* spp. was the dominant taxa (Table 4). Functional feeding shifted to a dominance by predators. Physical parameters again indicated a relatively healthy system with nutrients at or below detection limits (Table 2). Chlorophyll *a* and phytoplankton density were very low, as expected in a relatively undisturbed water body; however, AGP was above the "problem threshold" of 5 mg Dry wt/L determined by Raschle and Schultz (1987) (Table 2). Dissolved oxygen at station 4 was also unacceptable near the bottom at 0.1 mg/L (Table 2). The FILI score reflected these biological and chemical shifts; summer score was 32, which indicated moderate impairment.

Community of similarity was employed to quantitatively express the community similarity between sample seasons. Sorensen's index of community similarity resulted in 36% similarity between sample seasons.

DISCUSSION

Physical/Chemical

Morris Lake indicated a clean, relatively undisturbed system during the winter 1994 sample event. The parameters that indicated high water quality conditions were possibly related to ambient physical conditions. Dissolved oxygen was high near the lake bottom which allowed support of a diverse benthic community. Primary factors affecting DO during summer 1994 was thought to be prolific plant growth and subsequent decomposition as plants that had senesced during the winter period resulted in high oxygen demand from decomposers. Since cooler temperatures prevailed during winter, certain physical and chemical parameters can recover to acceptable levels for adequate benthic macroinvertebrate community support. Of these parameters, DO concentration increased as temperature decreased providing more suitable habitat conditions (Table 1). Turbidity was found to be negligible during winter 1994; this was in contrast to summer 1994, which showed an increase in turbidity along with an expected decrease in Secchi depth readings (Tables 1 and 2). Also notable was the depletion of DO near the lake bottom to near anoxic conditions in summer (Table 2). Transparency was reduced in summer by approximately 1 m over winter. Station 1 did not receive a depth value as the aquatic macrophyte growth prevented an accurate reading.

These low DO concentrations had been considered natural in shallow lakes. Thienemann (1925) found that deep lakes differed from shallow lakes in regard to DO, even though they shared a common climatic and edaphic region. The bottom in deep lakes had high DO and a diverse benthic community; however, DO in shallow lakes became critical as a result of decay and elevated temperatures. Only low DO tolerant organisms were found in the bottom of such lakes.

Biology

The relatively high diversity of winter 1994 was reflective of a rather healthy lake system. A diverse community of species (Table 3) indicated a balanced ecosystem where the food web was complex and stable.

In winter, a high DO concentration throughout the water column can be attributed to the presence of a more diverse benthic community than was present in summer (Table 4). This diversity resulted in a more complex and species interdependent structure. Collector-filterers and collector-gatherers feed on microorganisms, detrital material and suspended organics. These 2 functional feeding groups contributed 43.6% of the benthic trophic structure. These 2 groups were very important as they were recyclers of nutrients produced by other animals and plants in the system.

The summer sampling event revealed a shift in taxa dominance and feeding strategies. This shift in community similarity (Sorensen's coefficient) was calculated to be 36%. Thus, the community underwent a great change in species composition between winter and summer. Dissolved oxygen tolerant taxa replaced the intolerant ones. Taxa such as *Chaoborus* spp. and *Aulodrilus pigueti* (a worm), which had special adaptations for tolerating low DO, were common. This shift in dominant taxa also resulted in predators comprising the most common feeding strategy, while herbivores and detritivores

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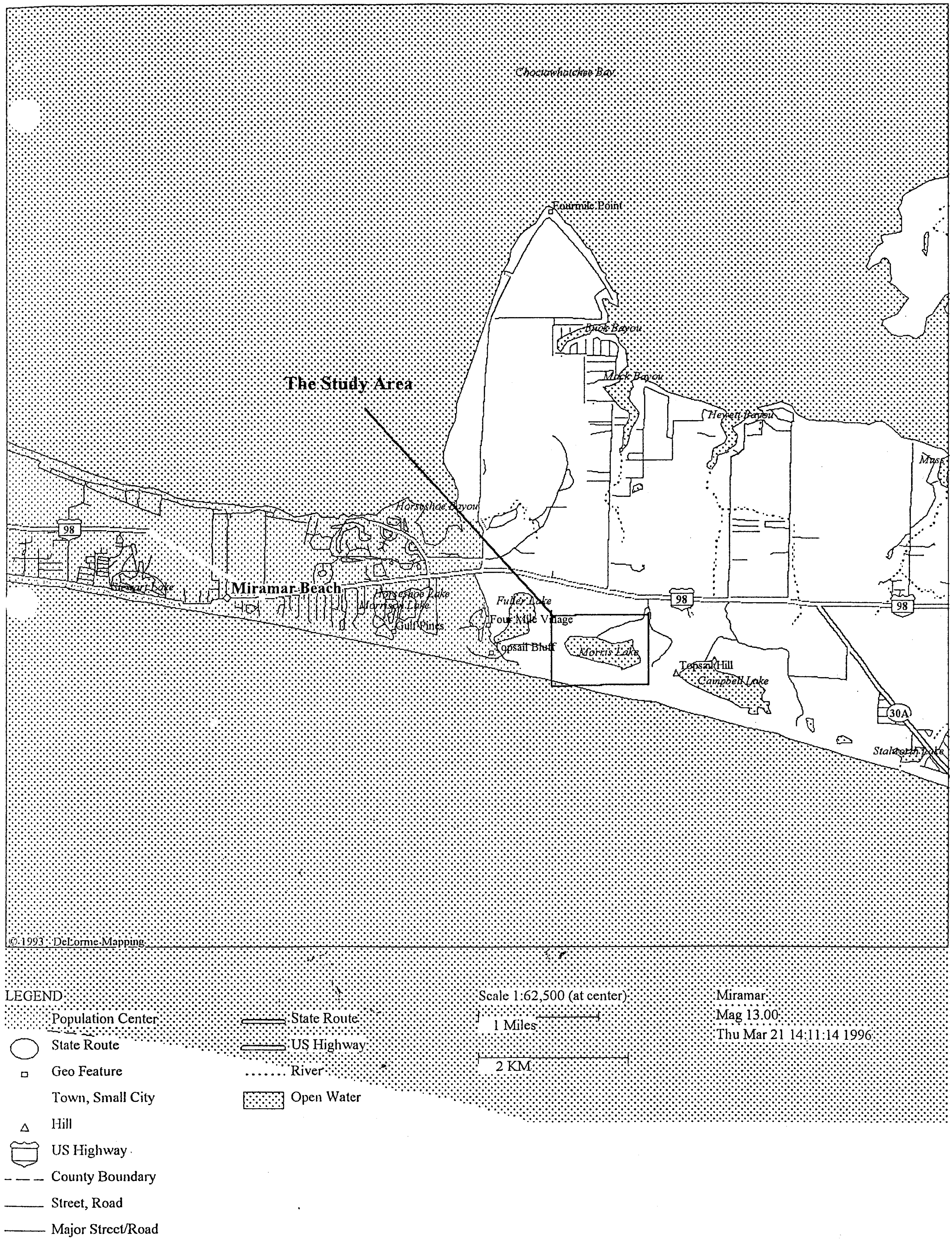
Choctawhatchee Bay
Fourmile Point
Buck Bayou
Mack Bayou
Hewett Bayou
The Study Area
Horseshoe Bayou
98
Miramar Beach
Horseshoe Lake
Morrison Lake
Gulf Pines
Fuller Lake
Four Mile Village
Topsail Bluff
Morris Lake
Topsail Hill
Campbell Lake
30A
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LEGEND
Population Center
State Route
Geo Feature
Town, Small City
Hill
US Highway
County Boundary
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