LAKE ASSESSMENT REPORT FOR LAKE RALEIGH IN HILLSBOROUGH COUNTY FLORIDA

Date Assessed: July 13, 2006
Assessed by: Sarah Koenig and David Eilers
Reviewed by: Jim Griffin, Ph.D.

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake Raleigh on the Hillsborough County Watershed Atlas (**http://www.hillsborough.wateratlas.usf.edu/**). The project is a collaborative effort between the University of South Florida's Center for Community Design and Research and Hillsborough County Stormwater Management Section. The project is funded by Hillsborough County and the Southwest Florida Water Management District's Northwest Hillsborough, Hillsborough River and Alafia River Basin Boards. The project has, as its primary goal, the rapid assessing of up to 150 lakes in Hillsborough County during a five year period. The product of these investigations will provide the County, lake property owners, and the general public a better understanding of the general health of Hillsborough County lakes, in terms of shoreline development, water quality, lake morphology (bottom contour, volume, area etc.) and the plant biomass and species diversity. These data are intended to assist the County and its citizens to better manage lakes and lake centered watersheds.

Figure 1. General photo of Lake Raleigh (7/13/06).

The first section of the report provides the results of the overall morphological assessment of the lake. Primary data products include: a contour (bathymetric) map of the lake, area, volume and depth statistics, and the water level at the time of assessment. These data are useful for evaluating trends and for developing management actions such as plant management where depth and lake volume are needed.

The second section provides the results of the vegetation assessment conducted on the lake. These results can be used to better understand and manage vegetation in your lake. A list is provided with the different plant species found at various sites around the lake. Potentially invasive, exotic (non-native) species are identified in a plant list and the percent of exotics is presented in a summary table. Watershed values provide a means of reference and are derived from the lakes assessed during the 2006 lake assessment project in that watershed.

The third section provides the results of the water quality sampling of the lake. Both field data and laboratory data are presented. The trophic state index (TSI) [i] is used to develop a general lake health statement, which is calculated for both the water column with vegetation and the water column if vegetation were removed (adjusted TSI – Adj_TSI). These data are a combination of the water chemistry and vegetative submerged biomass assessments and are useful in understanding the results of certain lake vegetation management practices.

The intent of this assessment is to provide a starting point from which to track changes in your lake, and where previous comprehensive assessment data is available, to track changes in the lake's general health. These data can provide the information needed to determine changes and to monitor trends in physical condition and ecological health of the lake.

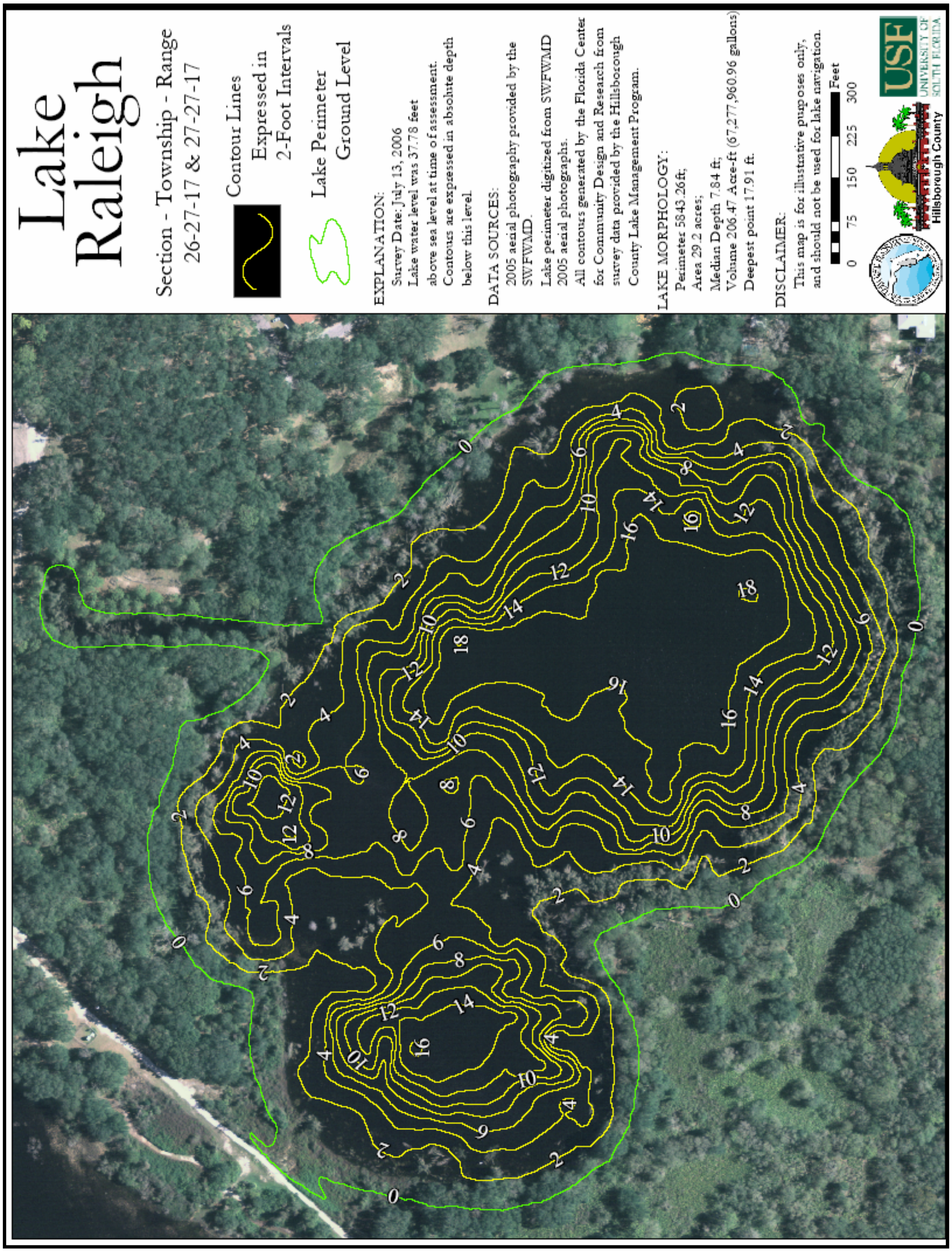
Section 1: Lake Morphology

Bathymetric Map[ii]. The bottom of the lake was mapped using a Lowrance LCX 26C HD Wide Area Augmentation System (WAAS)[iii] enabled Global Positioning System (WAAS-GPS) with fathometer (bottom sounder) to determine the boat's position, and bottom depth in a single measurement. The result is an estimate of the lake's area, mean and maximum depths, and volume and the creation of a bottom contour map (Figure 2). Besides pointing out the deeper fishing holes in the lake, the morphologic data derived from this part of the assessment can be valuable to overall management of the lake vegetation as well as providing flood storage data for flood models. Table 1 provides the lake's morphologic parameters in various units.

Table 1. Lake Area Depth and Volume

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	1,271,942.07	118,168.69	29.20		
Mean Depth	7.84	2.39			
Maximum Depth	17.91	5.46			
Volume (cubic)	8,995,928.66	254,674.74		206.47	67,277,960.96

Figure 2. Contour map for Lake Raleigh. The lake was mapped during the 2006 lake assessment project. A differential global positioning system and fathometer combination instrument was used to obtain simultaneous horizontal and vertical measurements.



Section 2: Lake Ecology (vegetation)

The lake's apparent vegetative cover and shoreline detail are evaluated using the aerial shown in Figure 3 and by use of GPS. Submerged vegetation is determined from evenly spaced contours sampled using a Lowrance 26c HD, combined DGPS/fathometer described earlier. Ten vegetation assessment sites were used for Lake Raleigh (Figure 3) as dictated by the *Lake Assessment Protocol* (copy available on request) for a lake of this size. The site positions are set using a DGPS and then loaded into a GIS mapping program (ArcGIS) for display. Each site is field sampled in the three primary vegetative zones (emergent, submerged and floating). The latest aerials (2005, 6 inch resolution, SWFWMD aerials) are used to provide shore details (docks, structures, vegetation zones) and to calculate the extent of surface vegetation coverage. The primary indices of submerged vegetation cover and biomass for the lake, percent area coverage (PAC) and percent volume infestation (PVI), are determined by transiting the lake by boat and employing a fathometer to collect "hard and soft return" data. These data are later analyzed for presence and absence of vegetation and to determine the height of vegetation if present. The PAC index is determined from the presence and absence analysis of 100 sites in the lake and the PVI index is determined by measuring the difference between hard returns (lake bottom) and soft returns (top of vegetation) for sites (within the 100 analyzed sites) where plants are determined present.

The data collected during the site vegetation sampling include vegetation type, exotic vegetation, predominant plant species and submerged vegetation biomass. The total number of species from all sites is used to approximate the total diversity of aquatic plants and the percent of invasive-exotic plants on the lake (Table 2). The Watershed value in Table 2 only includes lakes sampled during the lake assessment project begun in May of 2006. These data will change as additional lakes are sampled. Tables 3 through 6 detail the results from the 2006 aquatic plant assessment for you lake. These data are determined from the 10 sites used for intensive vegetation surveys. The tables are divided into Floating Leaf, Emergent and Submerged plants and contain the plant code, species, common name and presence (1) or absence (blank) of species and the calculated percent occurrence (number sites species is found/number of sites) and type of plant (Native, Non-Native, Invasive, Pest). In the "Type" category, the term invasive indicates the plant is commonly considered invasive in this region of Florida and the term "Pest" indicates that the plant has a greater than 55% occurrence in your lake and is also considered a problem plant for this region of Florida, or in a non-native invasive that is or has the potential to be a problem plant in your lake and has at least 40% occurence. These two terms are somewhat subjective; however, they are provided to give lake property owners some guidance in the management of plants on their property. Please remember that to remove or control plants in a wetland (lake shoreline) in Hillsborough County the property owner must secure an Application To Perform Miscellaneous Activities In Wetlands (http://www.epchc.org/forms_documents.htm) permit from the Environmental Protection Commission of Hillsborough and for management of in-lake vegetation outside the wetland fringe (for lakes with an area greater than 10 acres), the property owner must secure a Florida Department of Environmental Protection permit (http://www.dep.state.fl.us/lands/invaspec/).

Table 2 Total diversity, Total Non-Native, and number of EPPC pest plants

Parameter	Lake	Watershed
Total Plant Diversity (# of Taxa)	39	116
Total Non-Native Plants	4	16
Total Pest Plant Species	3	14

Figure 3. 2005 six inch resolution aerial and vegetation assessment sites on Lake Raleigh.

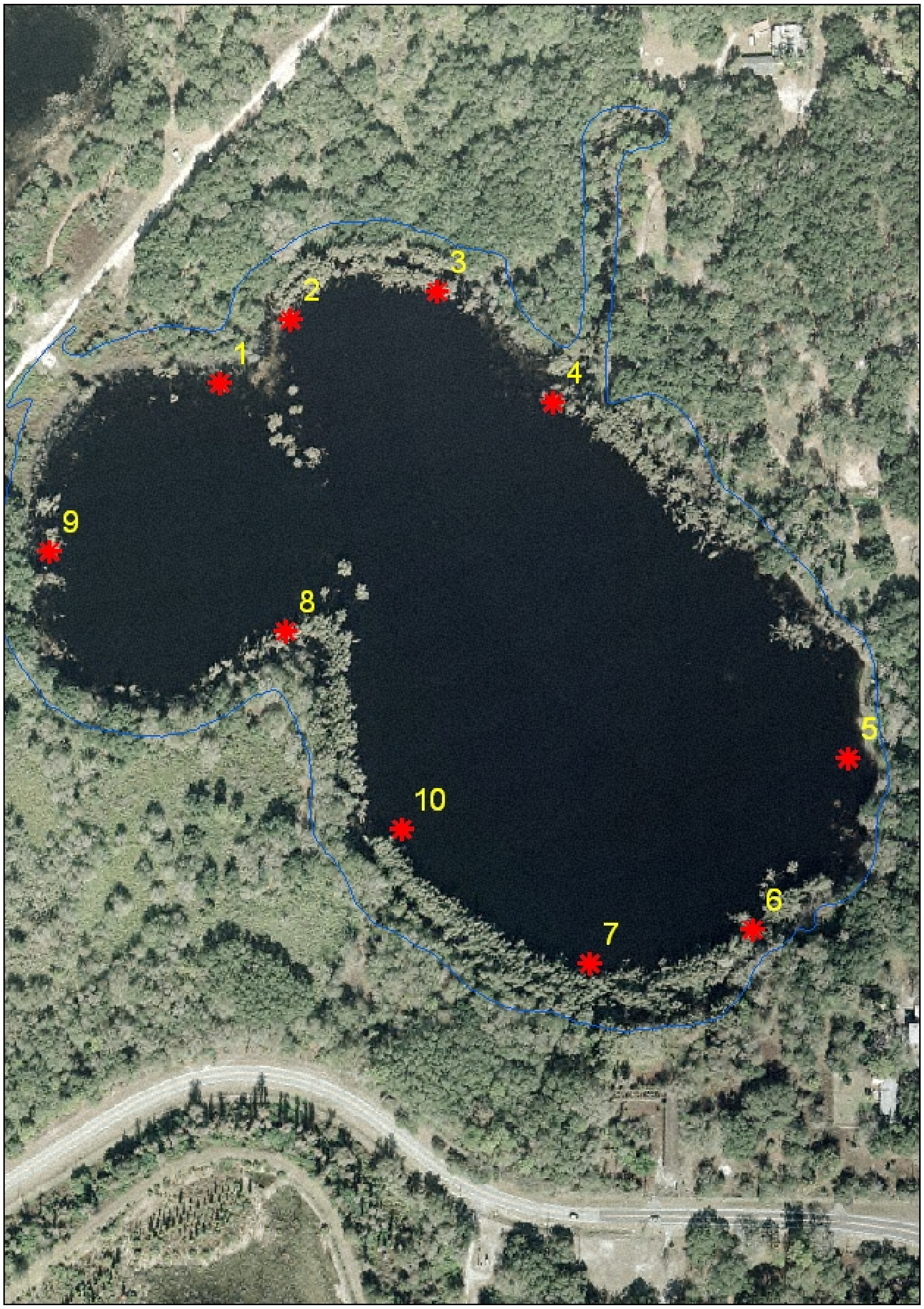


Table 3. List of Floating Leaf Zone Aquatic Plants Found in Lake Raleigh.

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
NOA	Nymphaea odorata	American White Water lily, Fragrant Water Lily	1	1	1	1	1	1		1	1	1	90%	Native
HYE	Hydrocotyl umbellata	Manyflower Marshpennywort, Water Pennywort		1			1					1	30%	Native
NLM	Nuphar lutea var. advena	Spatterdock, Yellow Pondlily										1	10%	Native

Figure 4. American White Water Lily (*Nymphaea odorata*) is the most common floating leaf plant on Lake Raleigh.

Table 4. List of Emergent Zone Aquatic Plants Found in Lake Raleigh.

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
MEL	Melaleuca quinquenervia	Punk Tree, Melaleuca	1	1	1	1	1	1	1	1	1	1	100%	NN-I-P
COS	Cephalanthus occidentalis	Common Buttonbush	1	1	1	1	1	1		1	1	1	90%	Native
EBI	Eleocharis baldwinii	Baldwin's Spikerush, Roadgrass	1	1	1	1	1	1		1	1	1	90%	Native
PHN	Panicum hemitomon	Maidencane	1	1	1	1	1	1		1	1	1	90%	Native
BLS	Blechnum serrulatum	Swamp Fern	1	1	1	1		1		1	1	1	80%	Native
LOP	Ludwigia spp.	Water Primroses, Primrosewillow	1	1		1		1		1	1	1	70%	Native
POL	Polygonum spp.	Smartweed, Knotweed	1	1	1			1		1	1	1	70%	Native
LCA	Lachnanthes caroliniana	Carolina Redroot	1	1	1	1	1	1					60%	Native
MSS	Mikania scandens	Climbing Hempvine	1	1		1				1	1	1	60%	Native
QLO	Quercus laurifolia	Laurel oak		1	1		1			1	1	1	60%	Native
PRS	Panicum repens	Torpedo Grass	1	1		1		1				1	50%	NN-I-P
URL	Urena lobata	Caesar's Weed	1	1		1		1				1	50%	NN-I-P
AST	Aster spp.	Aster spp., Elliot's Aster	1	1	1	1						1	50%	Native
WAX	Myrica cerifera	Wax Myrtle	1	1						1	1	1	50%	Native
PCA	Pontederia cordata	Pickerel Weed		1	1	1					1		40%	Native
RHY	Rhynchospora spp.	Beaksedge	1				1	1			1		40%	Native
BMA	Urochloa mutica	Para Grass		1				1				1	30%	NN-I
CYP	Cyperus spp.	Sedge					1	1					20%	Native
FSC	Fuirena spp.	Rush Fuirena						1				1	20%	Native
GLS	Gordonia lasianthus	Loblolly Bay	1	1									20%	Native
ACE	Acer rubrum var. trilobum	Southern Red Maple					1						10%	Native
CAA	Centella asiatica	Asian Pennywort, Coinwort, Spadeleaf					1						10%	Native
CYO	Cyperus odoratus	Fragrant Flatsedge		1									10%	Native
ELE	Eleocharis spp.	Roadgrass, Spikerushes					1						10%	Native
ICE	Ilex cassine	Dahoon Holly	1										10%	Native

LAC	Lachnocaulon spp.	Bog Buttons					1						10%	Native
MVA	Magnolia virginiana	Sweetbay Magnolia					1						10%	Native
PIN	Pinus spp.	Pine Tree					1						10%	Native
PLU	Pluchea spp.	Marsh Fleabane,Camphorweed				1							10%	Native
SAM	Sambucus canadensis	Elderberry	1										10%	Native
SCS	Scirpus cubensis	Burhead Sedge,Cuban Scirpus						1					10%	Native
SCI	Scirpus spp.	Sedge					1						10%	Native
TAS	Taxodium ascendens	Pond Cypress					1						10%	Native
XYR	Xyris spp.	Yellow-eyed Grass					1						10%	Native

Figures 5a and 5b. Melaleuca tree (*Melaleuca quinquenervia*) is a very common non-native invasive species on Lake Raleigh. If unmanaged this species forms dense colonies along shorelines as seen below on Lake Raleigh.

Table 5. List of Submerged Zone Aquatic Plants Found in Lake Raleigh.

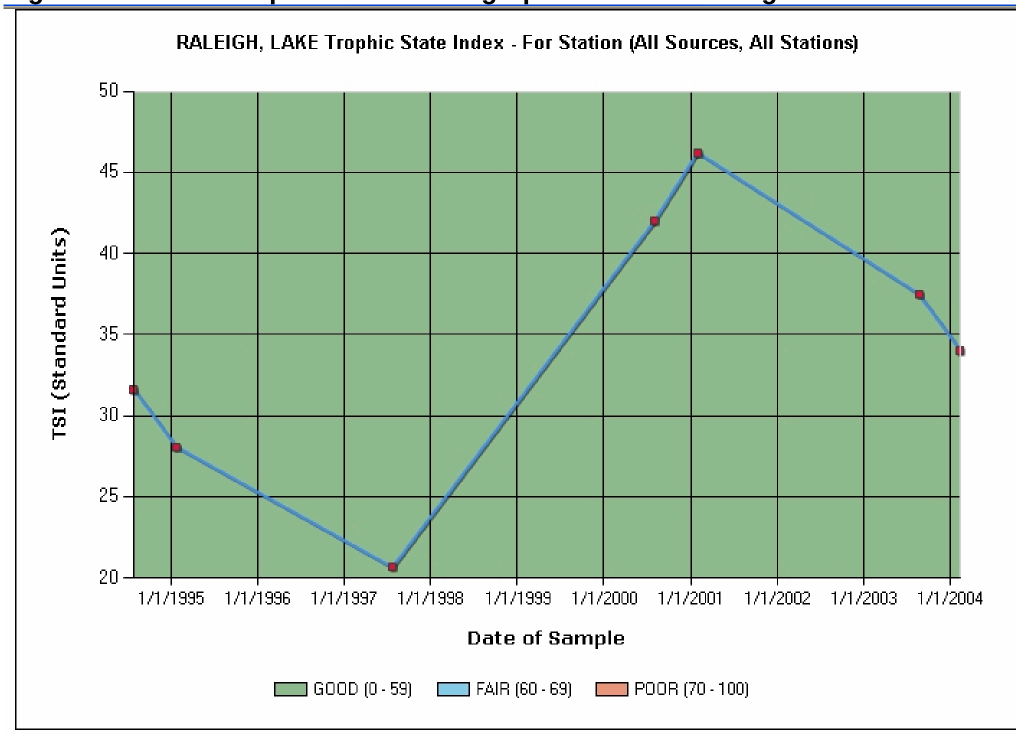
Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
UTA	Utricularia spp.	Bladderwort		1	1	1	1	1	1	1	1		80%	Native
NIT	Nitella spp.	Nitella			1				1	1	1		40%	N-I

Figure 6. Bladderwort (*Utricularia spp*.) is the most common submerged vegetation in Lake Raleigh.

Section 3: Lake Water Chemistry

A critical element in any lake assessment is the long-term water chemistry data set. The primary source of water quality trend data for Florida Lakes is the Florida LAKEWATCH volunteer and the Florida LAKEWATCH water chemistry data. Hillsborough County is fortunate to have a large cadre of volunteers who have collected lake water samples for significant time period. These data are displayed and analyzed on the Water Atlas as shown in Figure 7 for Lake Raleigh. Additional data, when available, is also included on the Water Atlas; however, the LAKEWATCH data remains the primary source. By the trend data shown in Figure 7, the lake may be considered in good health in terms of the trophic state index. Lake Raleigh is a clear water lake and as such it must maintain a TSI of below 40 to not be considered impaired by the State of Florida guidelines[iv]. Lake Raleigh's long term water quality data is sparse and does not indicate enough violations of these criteria to be classified by Florida DEP as impaired.

Figure 7. Recent Trophic State Index graph from Hillsborough Watershed Atlas.



Note: The graph above includes benchmarks for using verbal descriptors of "good", "fair" and "poor". The verbal descriptors for these benchmarks are based on an early determination by stakeholders of the generally acceptable and understood terms for describing the state of lakes. The same benchmarks are used for nutrient graphs (Nitrogen and Phosphorus), chlorophyll graphs and trophic state index (TSI) graphs. The TSI is a calculated index of lake condition based on nutrient and chlorophyll (a) concentrations (please see "Learn more about Trophic State Index"). The benchmarks are established based on the TSI range that relates to a specific descriptor. The source for the TSI concentration relationships is the Florida Water Quality Assessment, 1996, 305(b) (Table 2-8). For many lakes there is more than a single source of water quality data. You have the option with the "Select Data Source" drop down to select any available data source and create the graph using that source or you may select "All" to graph all available data. The graph header will also change to reflect the source used.

As part of the lake assessment, the physical water quality and water chemistry of a lake are measured. These data only indicate a snap shot of the lakes water quality; however they are useful to comparing to the trend data. Table 6a contains the summary water quality data and index values and adjusted values calculated from these data. The total phosphorus (TP), total nitrogen (TN) and chlorophyll (a) water chemistry sample data are the results of chemical analysis of samples taken during the assessment and analyzed by the Hillsborough County Environmental Protection Commission laboratory. These data compare to the SWFWMD and FDEP water quality data taken between 2000 and 2004. Unfortunately, no recent water quality data is available for comparison. The trophic state index (TSI) is calculated from chlorophyll data because the extremely low phosphorus value was considered questionable as compared to lake conditions. FDEP reported a Total Phosphorus of 17µg/L in 2004 and this value is considered more credible than the 3 µg/L determined from our samples. Table 6B contains the field data taken in the center of the lake using a YSI Corporation – 6000 multi-probe which has the ability to directly measure the temperature, pH, dissolve oxygen (DO), percent DO (calculated from DO, temperature and conductivity) and Turbidity. These data are listed for three levels in the lake and twice for the surface measurement. The duplicate surface measurement was taken as a quality assurance check on measured data.

Table 6a. Water Quality Parameters (Laboratory).

Parameter	Value	Comment
TP ug/L	3.00	Questionable value
TN mg/L	0.602	
Chla ug/L	6.9	
Chla TSI	44.61	
TP TSI	43.06	Questionable value
TN TSI	45.95	
Secchi Disk (SD)	0.00	
TSI	44.61	Used Chla TSI
PAC	67%	
PVI	23%	
Adj TP	3.33	P from Veg Added
Adj TN (mg/L)	0.04	
Adj Chla (ug/L)	0.09	
Adj TSI	46.04	

Table 6b. Water Quality Parameters (Field Recorded).

Sample Location	Time	Temp (oC)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	PH (su)	ORP (su)	Tubidity (NTU)	Secchi Depth
Surface	12:05	30.47	0.135	96.2	6.94	6.24	247.7	0.1	
Mid	12:05	30.37	0.135	92.1	6.93	6.22	250.4	0	
Bottom	12:05	30.03	0.135	81.8	6.18	6.09	253.4	-0.1	
Surface	12:05	30.5	0.136	92.3	6.91	6.23	219.1	-0.1	
Mean		30.3425	0.13525	90.6	6.74	6.195	242.65	-0.025	8' 8"

Table 6a also provides data derived from the vegetation assessment which is used to determine an adjusted TSI. This is accomplished by calculating the amount of phosphorus that could be released by existing submerged vegetation if this vegetation were treated with an herbicide or managed by the addition of Triploid Grass carp (*Ctenopharyngodon idella*). While it would not be expected that all the vegetation would be turned into available phosphorus by these management methods, the data is useful when planning various management activities. Approximately 67% of the lake has submerged vegetation present and this vegetation represents about 23% of the available lake volume. The vegetation holds enough phosphorus to add about 3.3 µg/L of the nutrient to the water column. Because the growth of algae in the water is regulated by the availability of phosphorus (the lake is phosphorus limited), the release of this phosphorus would stimulate algal growth. These changes in the water chemistry and biology would be indicated by an increased TSI from 44.61 to about 46. The issue discussed above related to sample TP value required the use of Chlorophyll a data for TSI instead of the average of Chla TSI and TP TSI; however, the estimated increase in TSI from existing vegetation is considered credible. The lake water clarity which is indicated by the Secchi Disk (SD) value at 8 foot 8 inches would be reduced slightly under these conditions.

Section 4: Conclusion

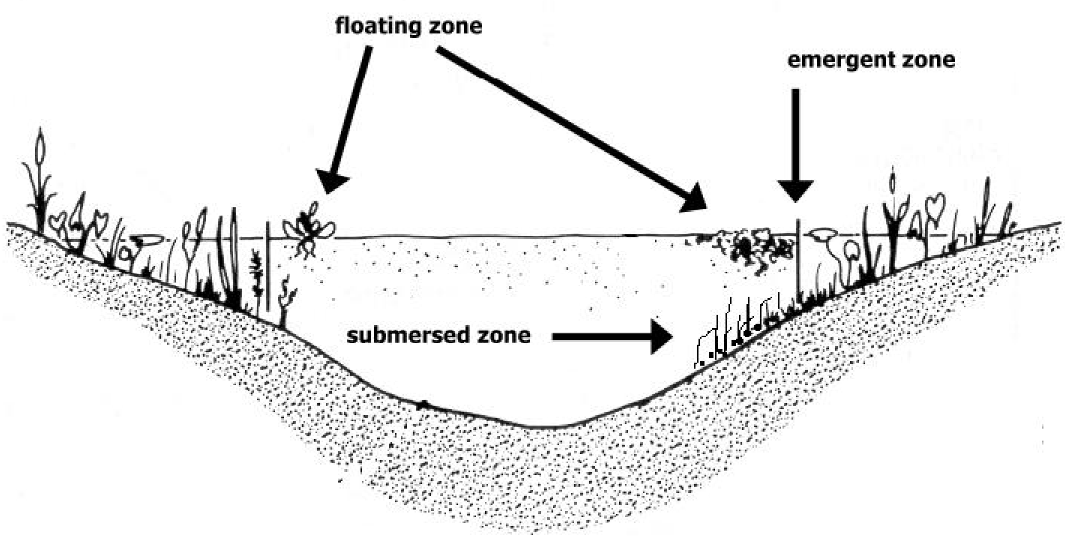
Lake Raleigh is small (29 acre) lake that would be considered in the mesotrophic (good) category of lakes based on water chemistry. It has a slightly higher than normal coverage of aquatic vegetation. About 67% of the open water areas contain submerged vegetation and this vegetation helps to maintain the nutrient balance in the lake as well as provide good fish habitat. The lake has many open water areas that support various types of recreation and has a good diversity of plant species. The primary nuisance plants in the lake are Torpedo grass (*Panicum repens*) and Nitella (*Nitella spp*.). The primary issue is not water quality of nuisance plants. The primary issue is water level and the effects of pumping from near bye well fields. A second potential problem is the mixing of water from the Rock Lake system, which has significant concentrations of tannins and is considered a dark water system, with the Raleigh and Rogers clear water system. For more information and recent updates please see the Hillsborough Watershed Atlas (water atlas) website at:
http://www.hillsborough.wateratlas.usf.edu/lake/waterquality.asp?wbodyid=5135&wbodyatlas=lake

i"Trophic" means "relating to nutrition." The Trophic State Index (TSI) takes into account chlorophyll, nitrogen, and phosphorus, which are nutrients required by plant life. For more information please see *learn more* at:
http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5135&wbodyatlas=lake

[ii] A bathymetric map is a map that accurately depicts all of the various depths of a water body. An accurate bathymetric map is important for effective herbicide application and can be an important tool when deciding which form of management is most appropriate for a water body. Lake volumes, hydraulic retention time and carrying capacity are important parts of lake management that require the use of a bathymetric map.

[iii] WAAS is a form of differential GPS (DGPS) where data from 25 ground reference stations located in the United States receive GPS signals form GPS satellites in view and retransmit these data to a master control site and then to geostationary satellites. The geostationary satellites broadcast the information to all WAAS-capable GPS receivers. The receiver decodes the signal to provide real time correction of raw GPS satellite signals also received by the unit. WAAS enabled GPS is not as accurate as standard DGPS which employs close by ground stations for correction, however; it was shown to be a good substitute when used for this type of mapping application. Data comparisons were conducted with both types of DGPS employed simultaneously and the positional difference was determined to be well within the tolerance established for the project.

[iv] The three primary aquatic vegetation zones are shown below:



[v] A lake is impaired if " (2) For lakes with a mean color less than or equal to 40 platinum cobalt units, the annual mean TSI for the lake exceeds 40, unless paleolimnological information indicates the lake was naturally greater than 40, or
For any lake, data indicate that annual mean TSIs have increased over the assessment period, as indicated by a positive slope in the means plotted versus time, or the annual mean TSI has increased by more than10 units over historical values. When evaluating the slope of mean TSIs over time, the Department shall use a Mann's one-sided, upper-tail test for trend, as described in Nonparametric Statistical Methods by M. Hollander and D. Wolfe (1999 ed.), pages 376 and 724 (which are incorporated by reference), with a 95% confidence

level.”
Excerpt from Impaired Water Rule (IWR). Please see:
http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf