

LAKE ASSESSMENT REPORT FOR LAKE KEYSTONE IN HILLSBOROUGH COUNTY FLORIDA

Date Assessed: August 2 & 3, 2006

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Reviewed by: Jim Griffin

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake Keystone 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 Keystone (8/2/2006).



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.

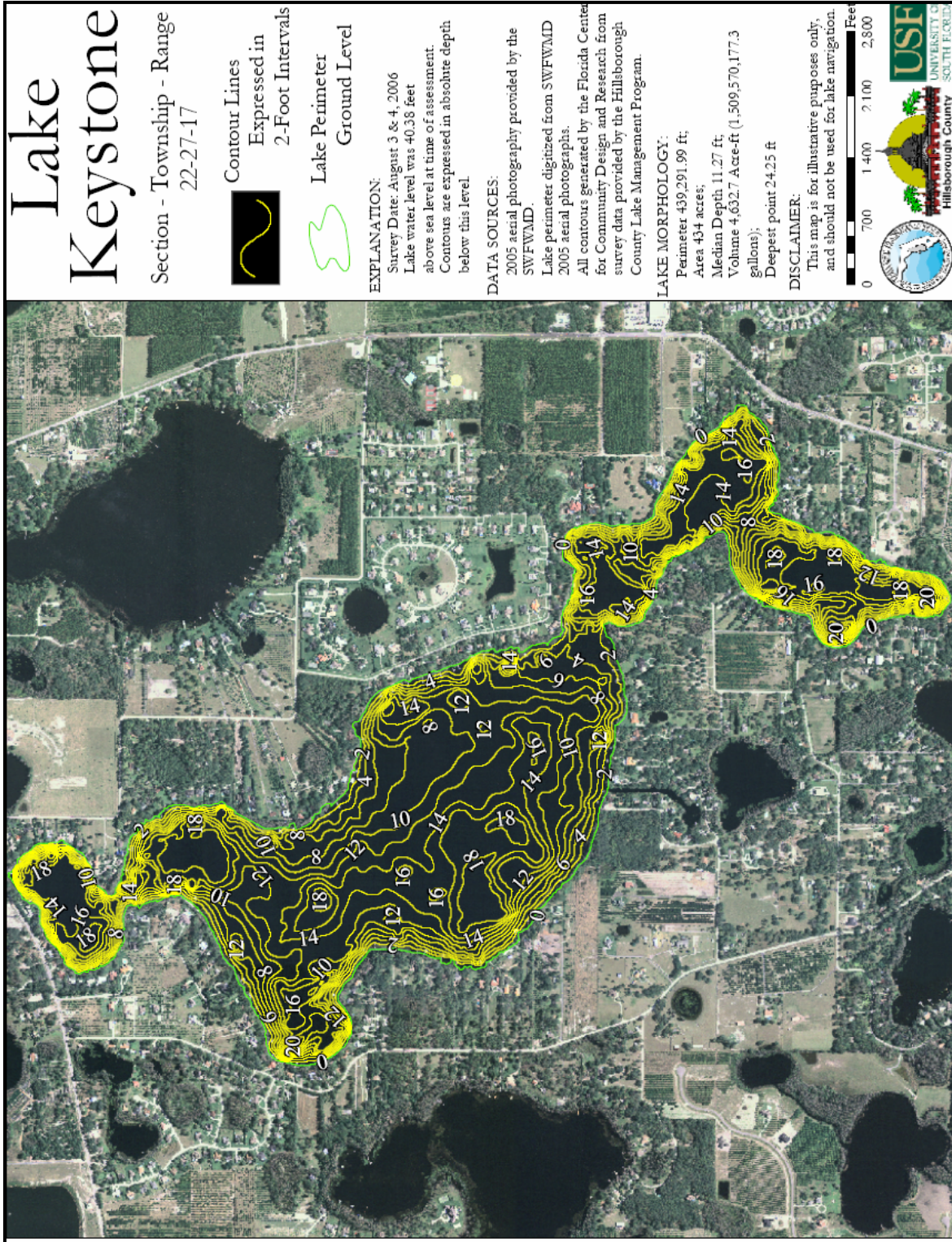
Section 1: Lake Morphology

Bathymetric Mapⁱⁱ. 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 1). 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	Gallons
Surface Area (sq)	18905755.56	1756402.17	434.02	
Mean Depth	10.75			
Maximum Depth	24.25			
Volume (cubic)	201798781.45	5714305.16		1509570177.31
Gage Reading (feet above datum)	40.38			

Figure 2. Contour map for Lake Keystone. 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. Thirty vegetation assessment sites were used for Lake Keystone (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 30 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% occurrence.

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) (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)	85	116
Total Non-Native Plants	16	16
Total Pest Plant Species	3	14

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

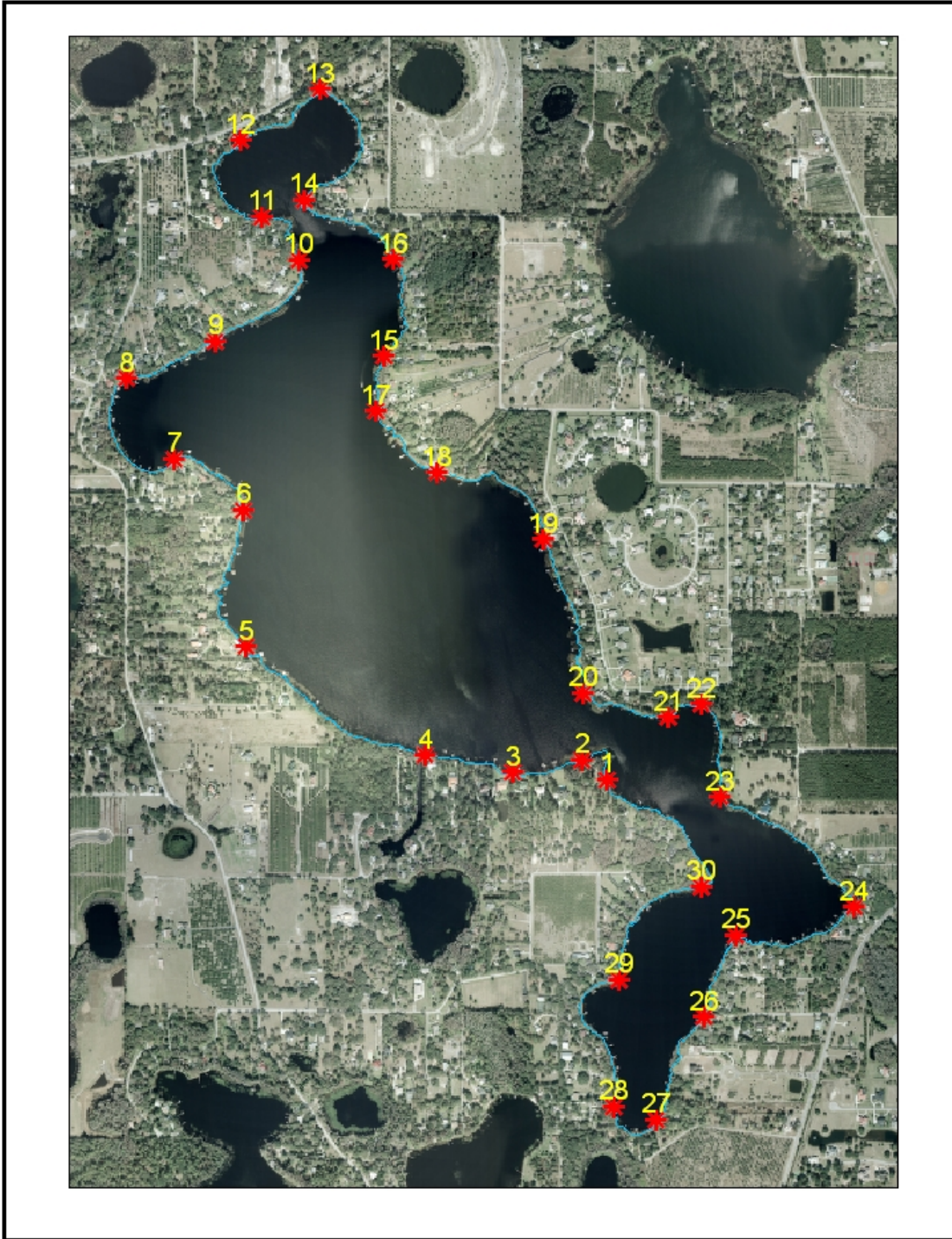


Table 3. List of Floating Leaf Zone Aquatic Plants Found in Lake Keystone

Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	% Occurrence
Manyflower Marshpennywort, Water Pennywort	1	1	1	1	1	1	1	1			1	1		1	1	1	1	1	1	1	1				1	1	1	1	1	1	80.00%
Spatterdock, Yellow Pondlily	1	1		1	1					1	1	1	1	1		1	1	1			1	1	1	1	1				1	1	63.33%
Banana Lily, Big Floatingheart					1	1		1	1										1	1	1		1	1	1						33.33%
Water Spangles, Water Fern		1		1		1		1									1		1	1											23.33%
American White Water lily, Fragrant Water Lily																													1	3.33%	

Note: Codes and Scientific Names have been removed from chart for space.



Figure 4. (Left) Water Spangles (*Salvinia minima*), a non-native invasive species on Lake Keystone.

Figure 5. (Below) Spatterdock (*Nuphar lutea var. advena*) on Lake Keystone.



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

Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	% Occurrence
Torpedo Grass	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	96.67%
Pond Cypress	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1	93.33%
Baldwin's Spikerush, Roadgrass	1	1	1	1		1		1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	86.67%
Pickerel Weed	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1			1	1	1	1	1	1	1			1	1	80.00%
Water Primroses, Primrosewillow	1	1		1	1		1	1		1	1	1			1	1	1	1	1	1	1	1	1	1		1	1	1	1		76.67%
Dayflower	1	1		1	1		1	1	1		1	1			1	1	1	1	1		1	1		1	1	1	1			1	70.00%
Climbing Hempvine	1	1		1	1		1	1		1				1		1	1			1	1		1	1	1	1	1		1	1	63.33%
Bog Hemp, False Nettle	1	1		1	1		1	1	1		1	1		1		1	1	1					1	1	1	1	1				60.00%

Maidencane	1	1		1	1	1		1	1	1	1			1							1	1	1	1			1	53.33%
Swamp Fern	1	1				1				1		1	1			1					1	1	1	1		1	1	50.00%
Wild Taro, Dasheen, Coco Yam	1	1																			1	1	1	1	1	1	1	46.67%
Southern Red Maple	1	1				1								1		1					1	1	1	1		1	1	46.67%
Lemon Bacopa		1	1	1		1	1	1	1		1				1	1			1								1	46.67%
Pine Tree	1	1				1							1	1	1									1	1		1	46.67%
Punk Tree, Melaleuca	1	1								1			1	1	1				1	1	1				1		1	40.00%
Sedge		1		1	1	1	1								1		1	1							1		1	40.00%
Buttonweed					1	1	1	1									1	1							1	1	1	40.00%
False Daisy, Yerba De Tajo	1	1	1				1	1							1									1	1	1		40.00%
Alligator Weed	1	1		1	1	1		1		1	1	1			1						1							36.67%
Camphor-tree						1			1	1					1					1	1	1	1	1				36.67%
Asian Pennywort, Coinwort, Spadeleaf																												36.67%
Laurel oak		1					1	1	1						1	1		1	1	1					1		1	36.67%
Aster spp., Elliot's Aster					1										1	1		1				1		1		1		33.33%
Wax Myrtle		1			1					1											1		1	1			1	30.00%
Creeping Oxeye					1	1	1								1	1	1								1		1	26.67%
Common Bacopa, Herb- Of-Grace	1																											20.00%
Sword Fern							1					1		1													1	16.67%
Para Grass		1			1	1		1																				13.33%
Caesar's Weed	1									1																	1	13.33%

Note: Codes and Scientific Names have been removed from chart for space.



Figure 5. Wild Taro (*Colocasia esculenta*) is a non-native invasive species on Lake Keystone.



Figure 6. Waterspider False Rein orchid (*Habenaria repens*), a Florida native, growing along the shores of Lake Keystone.

Table 5 List of Submerged Zone Aquatic Plants Found in Lake Keystone

Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	% Occurrence
Stream Bog Moss	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1			1				76.67%
Bladderwort	1	1	1	1	1	1	1		1	1		1	1		1		1		1		1	1	1	1	1	1		1	1		76.67%
Southern Water nymph			1	1					1						1					1	1		1				1	1	1		33.33%
Muskgrass															1					1			1		1			1	1	1	23.33%
Shade Mudflower, Baby's Tears											1	1							1	1		1									16.67%
Nitella		1															1			1							1				13.33%
Pond Weed							1																			1		1	1		13.33%
Algal Mats, Floating					1														1												6.67%
Tapegrass		1							1																						6.67%
Hydrilla, water thyme																1															3.33%
Coontail			1																												3.33%



Figure 7. Stream Bog Moss (*Mayaca fluviatilis*) is a common submersed plant in Lake Keystone.

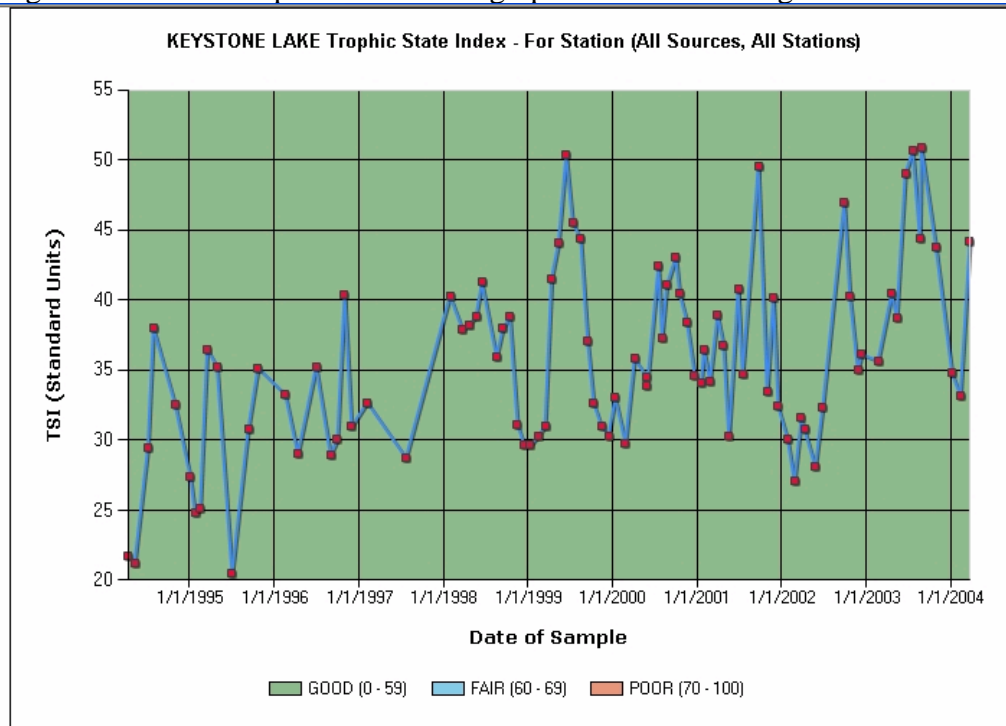


Figure 8. Lemon Bacopa (*Bacopa caroliniana*) growing in Lake Keystone. This submersed plant has a distinct lemon scent.

Section 3: Lake Water Chemistry

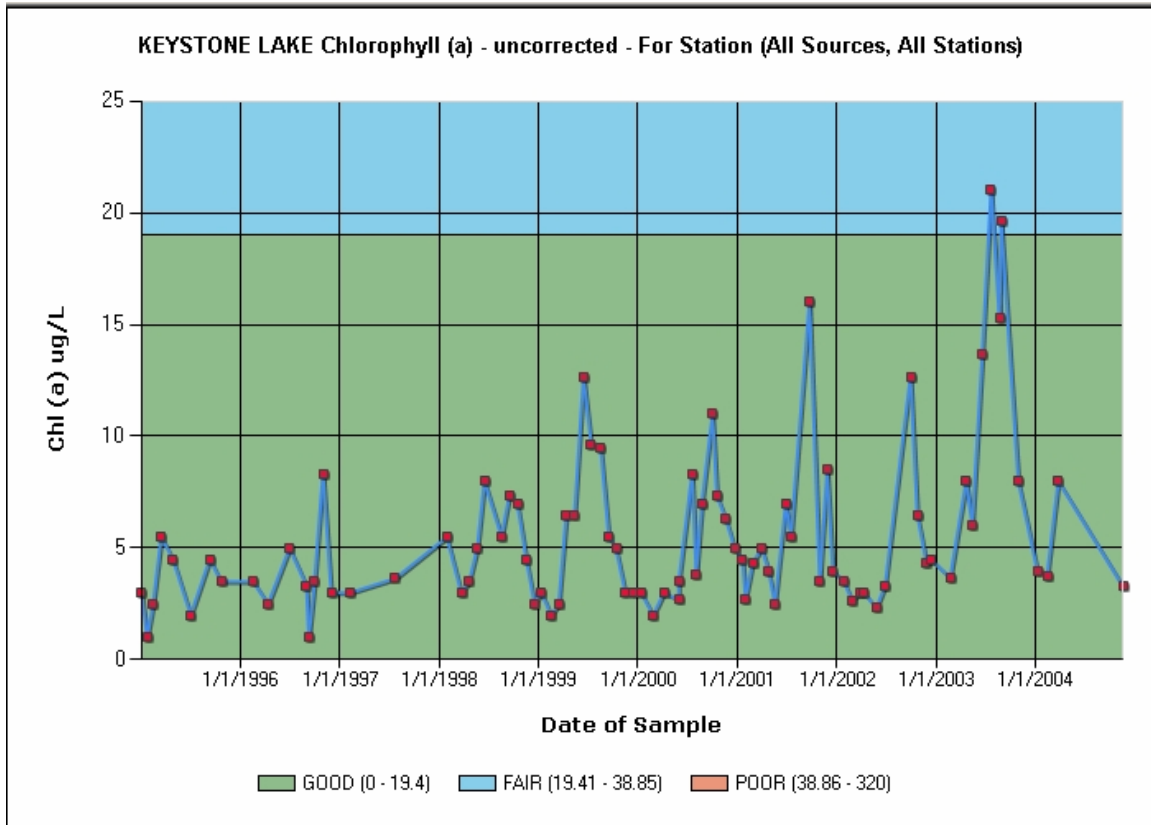
A critical element in any lake assessment is the long-term water chemistry data set. The primary source of water quality trend data for Florida Lakes, is the Florida LAKEWATCH volunteer and the Florida LAKEWATCH water chemistry data. Hillsborough County is fortunate to have a large cadre of volunteers who have collected lake water samples for significant time period. These data are displayed and analyzed on the Water Atlas as shown in Figure 9 for Lake Keystone. 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 9, the lake may be considered in good health in terms of the trophic state index. Lake Keystone 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 Keystone’s long term water quality data indicates enough violations of these criteria to be classified by Florida DEP as impaired. During the last major El Nino event (1997-98), the mean TSI increased from about 30 to just below 43 indicating a shift in water quality. The TSI maintained TSI mean value of about 43 for the remaining data record. The general trend seen in Figure 9 may indicate a relationship between periods of heavy rainfall and increased TSI.

Figure 9. 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.

Figure 10. Chlorophyll a graph from Hillsborough Watershed Atlas.



[select Data Source](#)

ALL

change provider

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 indicate a possible shift towards increased phosphorus in the water column and decreased nitrogen as compared with the mean data from the LAKEWATCH data set for the lake. The trophic state index (TSI) calculated from the sample data (43.9) does; however, agree with that Calculated from the 2003-2004 period of LAKEWATCH data shown in Figure 9. The big change as stated above is for survey water quality TP (25.0 ug/L) which is about twice the LAKEWATCH TP (12.5 ug/L). The reason that the TSI values calculated from LAKEWATCH and survey data are similar is that the Chlorophyll a value for the survey data (3.7ug/L) is significantly below the LAKEWATCH mean value (Figure 10) which is about 10.3 ug/L and shows significant swings in concentration. Because of this significant difference between trend data and survey data, we recommend that the County setup a sampling program for Lake Keystone and re-initiate the LAKEWATCH sampling (recruit a volunteer).

Table 6a. Water Quality Parameters (laboratory).

Summary Table for Water Quality		
Parameter	Value	Comment
TP ug/L	25.00	
TN mg/L	1.13	
Chla ug/L	3.70	
Chla TSI	35.64	
TP TSI	52.17	
TN TSI	62.13	
Secchi Disk (SD)	9' 5"	
TSI	43.90	P limited
PAC	38%	
PVI	12%	
Adj TP	2.31	P from Veg Added
Adj TSI	44.94	With additional P

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), Oxidation and Reduction Potential (ORP) 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. DO and pH values indicate moderate to low phytoplankton activity for a mid-day sample. Turbidity, the measure of suspended particles (algae is a suspended particle), is extremely low which also indicates low productivity. The ORP shows little change in reduction

potential with depth another indication of low productivity. All these values indicate a healthy lake system at the time of our analysis.

Table 6b. Water Quality (field recorded values).

Sample Location	Time	Temp (oC)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	PH (PH)	ORP (ORP)	Turbidity (NTU)
Surface	12:53	33.42	0.128	104.2	7.43	6.27	230.8	-0.7
Mid	12:53	31.68	0.127	82.4	6.05	5.79	246	-0.5
Bottom	12:53	29.72	0.119	6	0.46	5.18	189.9	2
Surface	12:53	33.52	0.128	101.1	7.19	6.14	173.7	-0.6
Surface	13:08	32.9	0.127	101	7.28	6.41	197.6	-0.6
Mid	13:08	31.83	0.126	97.7	7.16	6.36	207.8	-0.4
Bottom	13:08	31.14	0.126	81.5	6.04	6.07	210.3	0
Surface	13:08	33.35	0.127	100.3	7.15	6.38	206.2	-0.5
Surface	13:21	33.82	0.128	99.9	7.07	6.44	210	-0.7
Mid	13:21	31.87	0.128	96.4	7.05	6.36	221.1	-0.7
Bottom	13:21	30.12	0.126	17.9	1.31	5.68	244	0.3
Surface	13:21	33.92	0.129	98.6	6.96	6.39	225.3	-0.8

Table 6a also provides data derived from the vegetation assessment which is used to determine an adjusted TSI. The percent area covered (PAC) is a measure of vegetation coverage of a lake surface. The percent volume infestation (PVI) is the percentage of the total lake volume that contains submerged vegetation. The adjusted TSI values are the calculated contribution of vegetation to the total available lake nitrogen and phosphorus. These values are determined by calculating the amount of phosphorus and nitrogen 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 39% (PVI = 39%) of the lake has submerged vegetation present and this vegetation represents about 12 %t of the available lake volume. The vegetation holds enough phosphorus to add about 2.31 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 to about 45 The lake water clarity which is indicated by the Secchi Disk (SD) value at 9.5 feet would be reduced slightly under these conditions.

Section 4: Conclusion

Lake Keystone is a large sized (434 acre) lake that would be considered in the mesotrophic (good) category of lakes based on water chemistry. It is moderately vegetated with less than 40% of its area containing emergent or submerged vegetation. This vegetation helps to maintain the nutrient balance in the lake as well as provide good

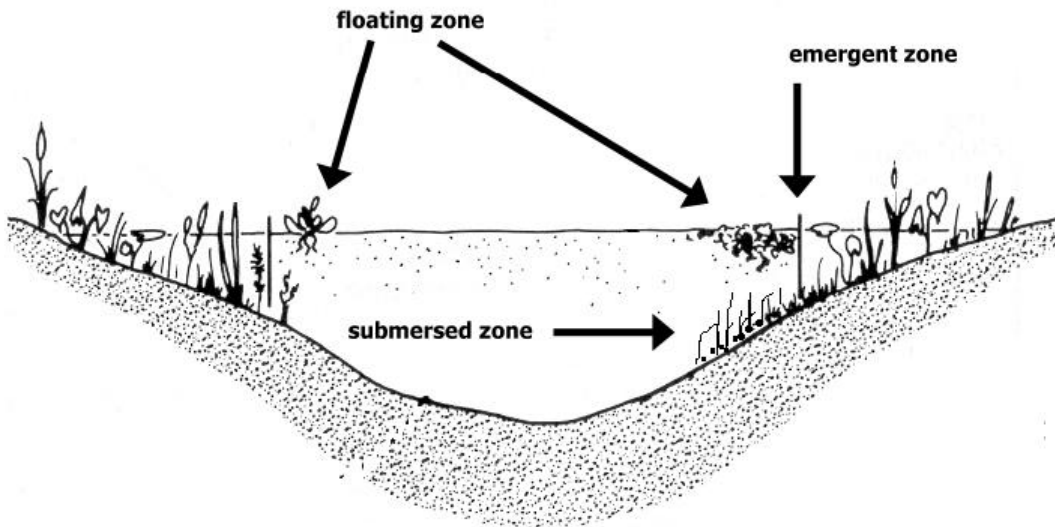
fish habitat. The lake has many open water areas that support various types of recreation and has a good diversity of plant species. The primary nuisance plants in the lake include Punk tree (*Melaleuca*) and Torpedo grass (*Panicum repens*). For more information and recent updates please see the Hillsborough Watershed Atlas (water atlas) website at: <http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5066&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=5066&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, hydrolic 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 from 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 than 10 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>