Lake Assessment Report for Hayes Bayou in Hillsborough County, Florida

Date Assessed: July 12, 2011
Assessed by: David Eilers
Reviewed by: Jim Griffin

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Hayes Bayou on the Hillsborough County & City of Tampa Water Atlas. 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. The project has, as its primary goal, the rapid assessing of up to 150 water bodies in Hillsborough County during a five-year period. The product of these investigations will provide the County, bayou property owners and the general public a better understanding of the general health of Hillsborough County bayous, in terms of shoreline development, water quality, bayou 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 bayous and coastal river based watersheds.

Figure 1. . General photograph of Hayes Bayou

The first section of the report provides the results of the overall morphological assessment of the bayou. Primary data products include: a contour (bathymetric) map of the bayou, 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 bayou volume are needed.

The second section provides the results of the vegetation assessment conducted on the bayou. These results can be used to better understand and manage vegetation in the bayou. A list is provided with the different plant species found at various sites around the bayou. 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.

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

The intent of this assessment is to provide a starting point from which to track changes in the bayou, and where previous comprehensive assessment data is available, to track changes in the bayou'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 bayou.

Section 1: Lake Morphology

Bathymetric Map[ii]. Table 1 provides the bayou's morphologic parameters in various units. The bottom of the bayou was mapped using a Lowrance LCX 28C HD Wide Area Augmentation System (WAAS)[iii] enabled Global Positioning System (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 bayou'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 bayou, the morphologic data derived from this part of the assessment can be valuable to overall management of the bayou vegetation as well as providing flood storage data for flood models.

Table 1. Bayou Morphologic Data (Area, Depth and Volume)

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	8,058,318.31	748,642.27	184.99		
Mean Depth	3.91	1.19			
Maximum Depth	6.33	1.93			
Volume (cubic)	35,683,642.89	1,010,448.24		819.19	266,934,036
Gauge (relative)	5.12	1.56			

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[i] The trophic state index is used by the Water Atlas to provide the public with an estimate of their bayou resource quality. For more information, see end note 1.

[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. Bayou volumes, hydraulic retention time and carrying capacity are important parts of bayou 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. For more information, see end note 2.

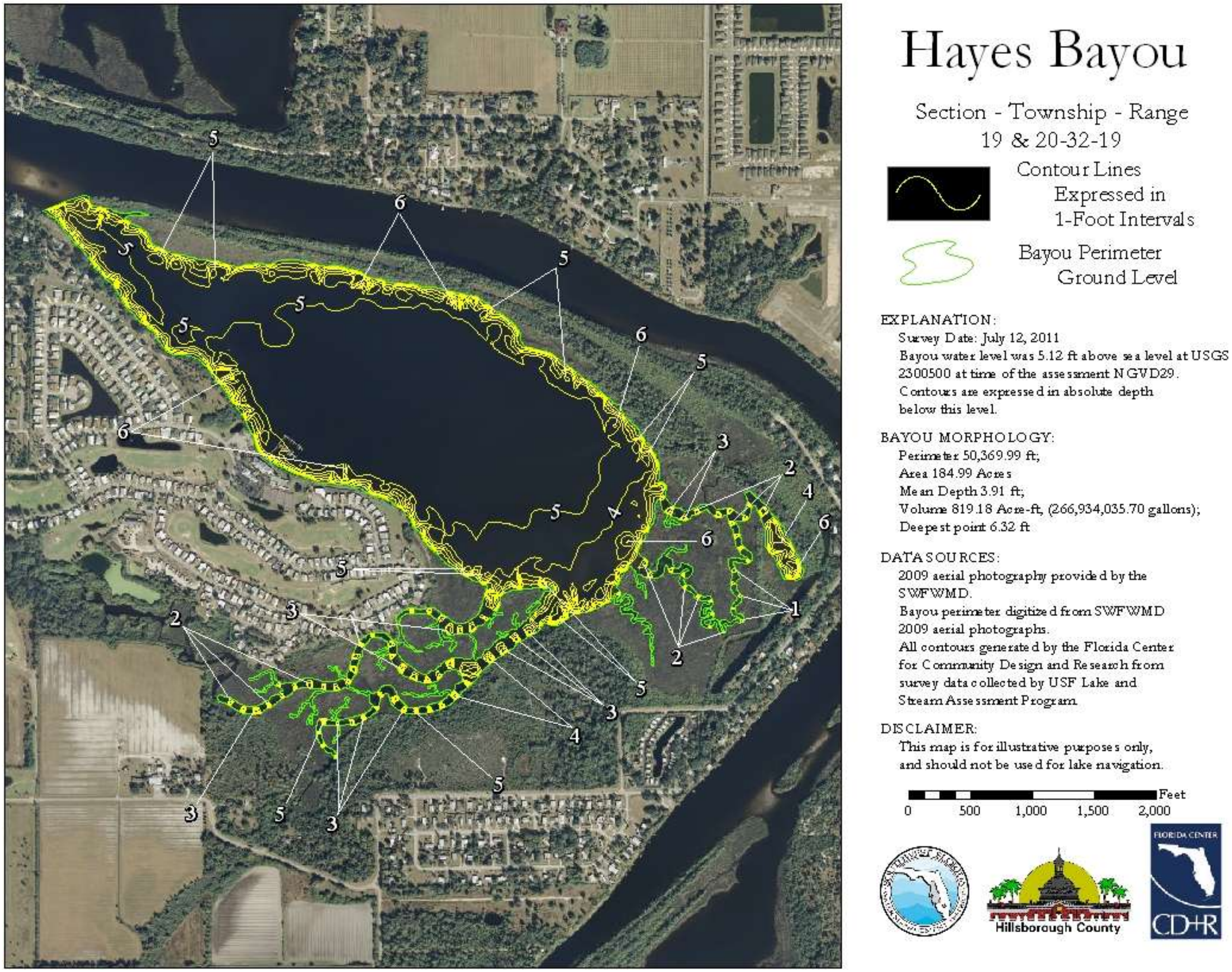


Figure 2. 2011 Bathymetric Contour map for Hayes Bayou

Section 2: Bayou Ecology (Vegetation)

The bayou's apparent vegetative cover and shoreline detail are evaluated using the latest bayou aerial photograph as shown in and by use of WAAS-enabled GPS. Submerged vegetation is determined from the analysis of bottom returns from the Lowrance 28c HD combined GPS/fathometer described earlier. As depicted in

Figure 3. 2011 Vegetation Assessment Region Map for Hayes Bayou

, 12 vegetation assessment sites were chosen for intensive sampling based on the *Bayou Assessment Protocol* (copy available on request) for a bayou of this size. The site positions are set using GPS and then loaded into a GIS mapping program (ArcGIS) for display. Each site is sampled in the three primary vegetative zones (emergent, submerged and floating)[iv]. The latest high resolution aerial photos 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 bayou, percent area coverage (PAC) and percent volume infestation (PVI), are determined by transiting the bayou 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 is determined from the presence and absence analysis of 100 sites in the bayou and the PVI 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 bayou (Table 2). The Watershed value in Table 2 only includes lakes, rivers and bayous sampled during the lake assessment project begun in May of 2006. These data will change as additional water bodies are sampled. Table 3 through **Error! Reference source not found.** detail the results from the 2011 aquatic plant assessment for the bayou. These data are determined from the 12 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 (indicated by a 1) or absence (indicated by a blank space) 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 codes N and E0 denote species native to Florida. The code E1 denotes Category I invasive species, as defined by the Florida Exotic Pest Plant Council (FLEPPC); these are species "that are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives." The code E2 denotes Category II invasive species, as defined by FLEPPC; these species "have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species." Use of the term invasive indicates the plant is commonly considered invasive in this region of Florida. The term "pest" indicates a plant (native or non-native) that has a greater than 55% occurrence in the bayou and is also considered a problem plant for this region of Florida, or is a non-native invasive that is or has the potential to be a problem plant in the lake and has at least 40% occurrence. These two terms are somewhat subjective; however, they are provided to give bayou property owners some guidance in the management of plants on their property. Please remember that to remove or control plants in a wetland (bayou shoreline) in Hillsborough County the property owner must secure an Application To Perform Miscellaneous Activities In Wetlands permit from the Environmental Protection Commission of Hillsborough County and for management of in-bayou vegetation outside the wetland fringe (for bayous with an area greater than ten acres), the property owner must secure a Florida Department of Environmental Protection Aquatic Plant Removal Permit.

Table 2. Total Diversity, Percent Exotics, and Number of Pest Plant Species

Parameter	Lake	Watershed
Number of Vegetation Assessment Sites	**12**	**29**

[iv] See end note 3.

Total Plant Diversity (# of Taxa)	**34**	**73**
% Non-Native Plants	**23.53%**	**26.03%**
Total Pest Plant Species	**1**	**2**

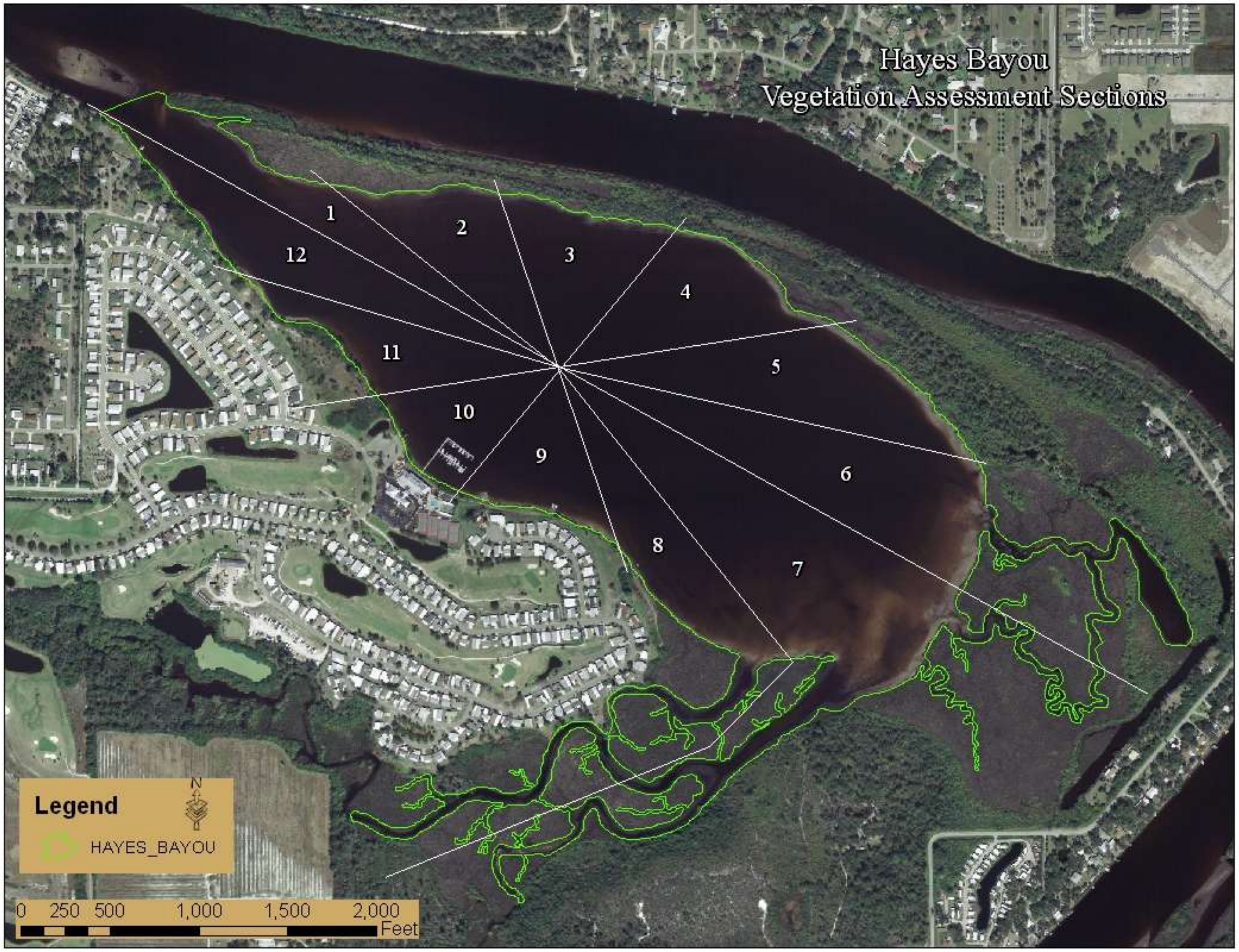


Figure 3. 2011 Vegetation Assessment Region Map for Hayes Bayou

Table 3. List of Floating Leaf Zone Aquatic Plants Found

Plant Species Code	Scientific Name	Common Name	Percent Occurrence	Type
LEN	*Lemna spp.*	Duckweed	8%	N, E0

Figure 4. Photograph of the shoreline of Hayes Bayou

Table 4. List of Emergent Zone Aquatic Plants Found

Plant Species Code	Scientific Name	Common Name	Percent Occurrence	Type
JRO	*Juncus roemerianus*	Needle Rush, Black Rush	100%	N, E0
SPO	*Sabal palmetto*	Sabal Palm, Cabbage Palm	100%	N, E0
STS	*Schinus terebinthifolius*	Brazilian Pepper	100%	E1, P
PIN	*Pinus spp.*	Pine Tree	66%	N, E0
QLA	*Quercus laurifolia*	Laurel Oak; Diamond Oak	66%	N, E0
ADM	*Acrostichum danaeifolium*	Leather Fern	66%	N, E0
BHA	*Baccharis halimifolia*	Sea Myrtle	58%	N, E0
JVA	*Juniperus virginiana*	Red cedar	50%	N, E0
WAX	*Myrica cerifera*	Wax Myrtle	50%	N, E0
TYP	*Typha spp.*	Cattails	33%	N, E0
AJN	*Albizia julibrissin*	Silk Tree, Mimosa	33%	E2
AVS	*Andropogon virginicus var. glaucus*	Broomsedge Bluestem, Broom grass	25%	N, E0
CAL	*Callicarpa americana*	Beautyberry	25%	N, E0
LPA	*Ludwigia peruviana*	Peruvian Primrosewillow	25%	E0
EUP	*Eupatorium capillifolium*	Dog Fennel	25%	N, E0
VRA	*Vitis rotundifolia*	Muscandine Grape	25%	N, E0
PEP	*Persea palustris*	Swampbay	25%	N, E0
SPA	*Spartina spp.*	Cordgrass	16%	N, E0
ACE	*Acer rubrum*	Southern Red Maple	8%	N, E0
SCA	*Salix caroliniana*	Carolina Willow	8%	N, E0
SCF	*Schefflera actinophylla*	Australian Umbrella Tree; Octopus Tree	8%	E1
SOL	*Solidago spp.*	Goldenrod	8%	N, E0
PLU	*Pluchea spp.*	Marsh Fleabane,Camphorweed	8%	N, E0
PQA	*Parthenocissus quinquefolia*	Virginia Creeper, Woodbine	8%	N, E0
PRS	*Panicum repens*	Torpedo Grass	8%	E1
HTM	*Hypericum tetrapetalum*	Fourpetal St. John's-Wort	8%	N, E0
BOC	*Boehmeria cylindrica*	Bog Hemp, False Nettle	8%	N, E0
CAA	*Centella asiatica*	Asian Pennywort, Coinwort	8%	N, E0
MEL	*Melaleuca quinquenervia*	Punk Tree, Melaleuca	8%	E1
CEA	*Colocasia esculenta*	Wild Taro	8%	E1
CJE	*Cladium jamaicense*	Jamaica Swamp Saw Grass	8%	N, E0
DBA	*Dioscorea bulbifera*	Air Potato	8%	E1
BAA	*Bidens alba*	White Beggar-ticks, Romerillo	8%	N, E0

Figure 5. Photograph of Juncus roemerianus on Hayes Bayou

Figure 6. Typical Shoreline of Hayes Bayou

Table 5. List of All Plants and Sample Sites

Plant Common Name	Found at Sample Sites	Percent Occurrence	Growth Type
Brazilian Pepper	1,2,3,4,5,6,7,8,9,10,11,12	100	Emergent
Needle Rush, Black Rush	1,2,3,4,5,6,7,8,9,10,11,12	100	Emergent
Sabal Palm, Cabbage Palm	1,2,3,4,5,6,7,8,9,10,11,12	100	Terrestrial
Laurel Oak; Diamond Oak	1,2,3,4,6,9,11,12	66	Emergent
Leather Fern	2,3,4,5,7,8,10,11	66	Emergent
Pine Tree	1,2,3,4,5,7,10,11	66	Emergent
Sea Myrtle	1,5,6,8,9,10,11	58	Emergent
Red cedar	1,3,4,5,7,8	50	Terrestrial
Wax Myrtle	1,2,3,7,8,9	50	Emergent
Cattails	8,9,10,12	33	Emergent
Silk Tree, Mimosa	8,10,11,12	33	Emergent
Beautyberry	3,8,9	25	Emergent
Broomsedge Bluestem, Broom grass	9,10,11	25	Emergent
Dog Fennel	8,9,10	25	Emergent
Muscandine Grape	8,11,12	25	Emergent
Peruvian Primrosewillow	9,10,11	25	Emergent
Swampbay	8,9,12	25	Emergent
Cordgrass	5,8	16	Emergent
Air Potato	12	8	Emergent
Asian Pennywort, Coinwort	12	8	Emergent
Australian Umbrella Tree; Octopus Tree	9	8	Emergent
Bog Hemp, False Nettle	9	8	Emergent
Carolina Willow	9	8	Emergent
Duckweed	8	8	Floating
Fourpetal St. John's-Wort	10	8	Emergent
Goldenrod	9	8	Emergent
Jamaica Swamp Saw Grass	8	8	Emergent
Marsh Fleabane,Camphorweed	8	8	Emergent
Punk Tree, Melaleuca	3	8	Emergent
Southern Red Maple	9	8	Emergent
Torpedo Grass	8	8	Emergent
Virginia Creeper, Woodbine	8	8	Emergent

Plant Common Name	Found at Sample Sites	Percent Occurrence	Growth Type
White Beggar-ticks, Romerillo	11	8	Terrestrial
Wild Taro	12	8	Emergent

Section 3: Long-term Ambient Water Chemistry

A critical element in any bayou assessment is the long-term water chemistry data set. These data are obtained from several data sources that are available to the Water Atlas and are managed in the Water Atlas Data Download and graphically presented on the water quality page for bayous in Hillsborough County. The Hayes Bayou Water Quality Page can be viewed at http://www.hillsborough.wateratlas.usf.edu/bay/waterquality.asp?wbodyid=6041&wbodyatlas=bay

A primary source of bayou water chemistry in Hillsborough County is the Hillsborough County Stream Waterwatch, a volunteer-based program implemented through Hillsborough Community College and funded by Hillsborough County and Southwest Florida Water Management District (SWFWMD). Hayes Bayou does not have an active Stream Waterwatch volunteer, which makes trend analysis impossible. Other source data are used as available; however these data can only indicate conditions at time of sampling.

These data are displayed and analyzed on the Water Atlas as shown in Figure 7Figure 7, Figure 8, and Figure 9 for Hayes Bayou. The figures are graphs of: (1) the overall trophic state index (TSI)[i], which is a method commonly used to characterize the productivity of a bayou, and may be thought of as a bayou's ability to support plant growth and a healthy food source for aquatic life; (2) the chlorophyll *a* concentration, which indicates the bayou's algal concentration, and (3) the bayou's Secchi Disk depth which is a measure of water visibility and depth of light penetration. These data are used to evaluate a bayou's ecological health and to provide a method of ranking bayous and are indicators used by the US Environmental Protection Agency (USEPA) and the Florida Department of Environmental Protection (FDEP) to determine a bayou's level of impairment. The chlorophyll a and Secchi Disk depth graphs include benchmarks which indicate the median values for the various parameters for a large number of bayous in Florida expressed as percentiles.

Based on best available data, Hayes Bayou has a color value determined as a platinum cobalt unit (pcu) value of 161.5 and is considered a dark bayou (has a mean color in pcu greater than 40). The FDEP and USEPA may classify a bayou as impaired if the bayou is a dark bayou and has a TSI greater than 60, or is a clear bayou (has a mean color in pcu less than or equal to 40) and has a TSI greater than 40. Hayes Bayou has a TSI of 61 and meets the FDEP Impaired Waters Rule (IWR) criteria and could be classified as impaired. See also Table 6.

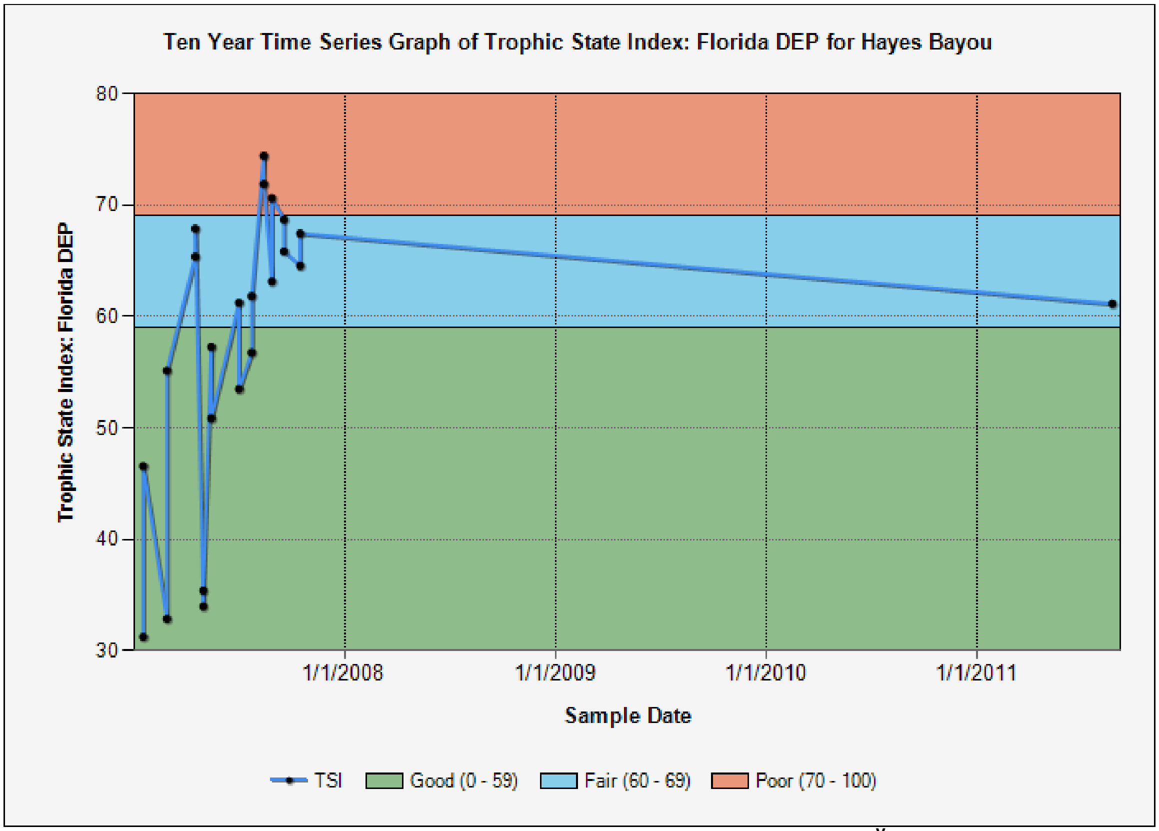


Figure 7. Recent Trophic State Index (TSI) graph for Hayes Bayou[v]

[v] Graph source: Hillsborough County Water Atlas. For an explanation of the Good, Fair and Poor benchmarks, please see the notes at the end of this report. For the latest data go to: http://www.hillsborough.wateratlas.usf.edu/graphs20/graph_it.aspx?wbodyid=6041&data=TSI&datatype=WQ&waterbodyatlas=bay&ny=10

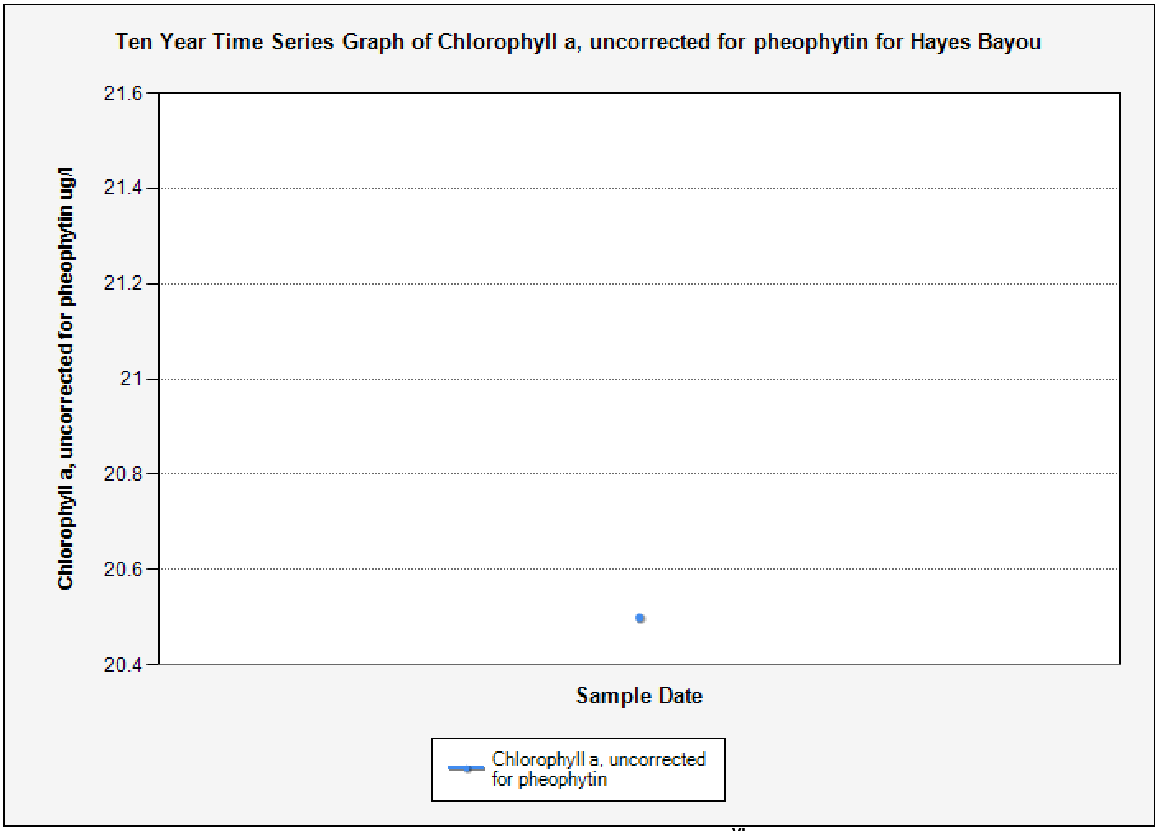


Figure 8. Recent Chlorophyll a graph for Hayes Bayou[vi]

[vi] Graph Source: Hillsborough County Water Atlas. For the latest data go to http://www.hillsborough.wateratlas.usf.edu/graphs20/seasonal_graph_it.aspx?wbodyid=6041&data=CHLA_ugl

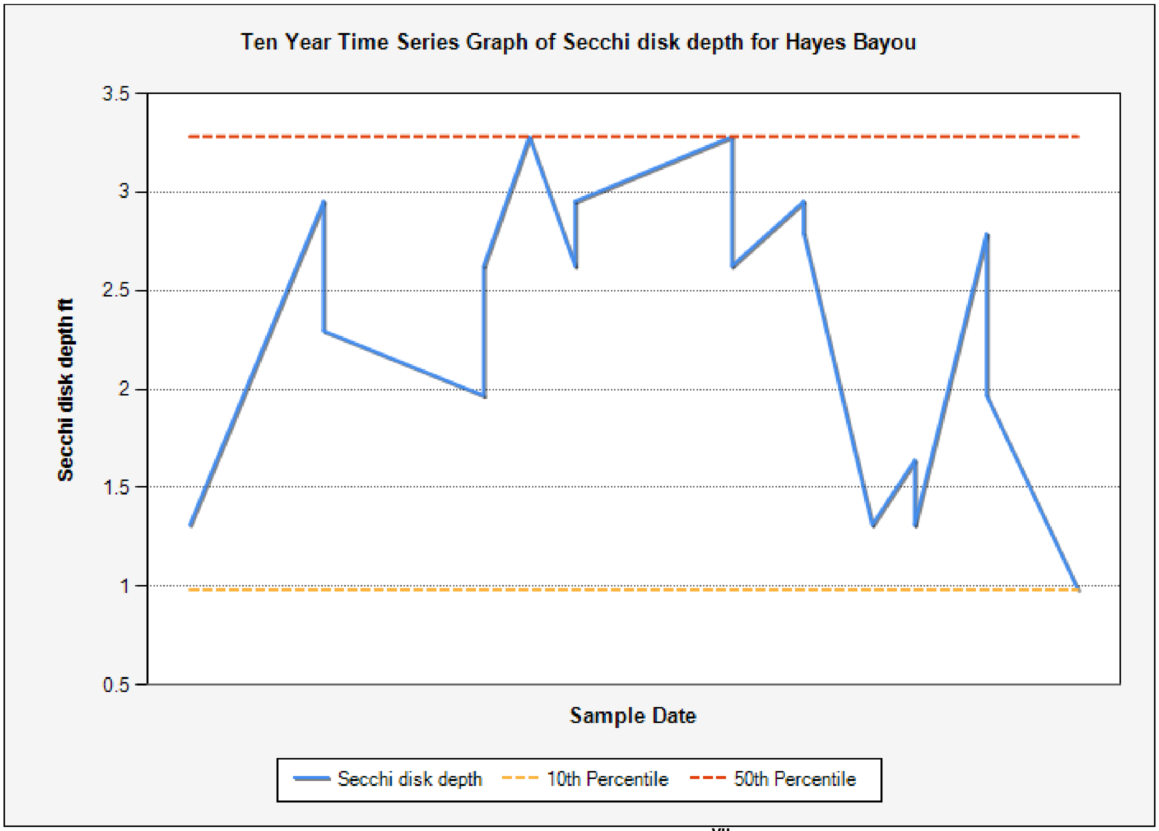


Figure 9. Recent Secchi Disk graph for Hayes Bayou[vii]

As part of the bayou assessment the physical water quality and chemical water chemistry of a bayou are measured. These data only indicate a snapshot of the bayou's water quality; however they are useful when compared to the trend data available from Stream Waterwatch or other sources. Table 6 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.

The growth of plants (planktonic algae, macrophytic algae and rooted plants) is directly dependent on the available nutrients within the water column of a bayou and to some extent the nutrients which are held in the sediment and the vegetation biomass of a bayou. Additionally, algae and other plant growth are limited by the nutrient in lowest concentration relative to that needed by a plant. Plant biomass contains less phosphorus by weight than nitrogen so phosphorus is many times the limiting nutrient. When both nutrients are present at a concentration in the bayou so that either or both may restrict plant growth, the limiting factor is called "balanced". The ratio of total nitrogen to total phosphorous, the "N to P" ratio (N/P), is used to determine the limiting factor. If N/P is greater than or equal to 30, the bayou is considered phosphorus limited, when this ratio is less than or equal to 10, the bayou is considered nitrogen limited and if between 10 and 30 it is considered balanced.

[vii] Graph Source: Hillsborough County Water Atlas. For the latest data go to http://www.hillsborough.wateratlas.usf.edu/graphs20/seasonal_graph_it.aspx?wbodyid=6041&data=Secchi_ft

Table 6. Water Quality Parameters (Laboratory) for Hayes Bayou

Parameter	Value	Mean Value
Bayou Area (Acres)	184.99	
Bayou Area (m^2)	748,642.27	
Bayou Volume (m^3)	1,010,448.24	
Number of Vegetation Sites	12	
Average Station SAV Weight	0.00	
Wet Weight of Vegetation (g)	0.00	
Dry Weight of Vegetation (g)	0.00	
Total Phosphorus (ug/L)	465.00	333.33
Total Nitrogen (ug/L)	1118.00	1142.00
Chlorophyll a (ug/L)	20.50	20.50
TN/TP	2.4	3.4
Limiting Nutrient	Nitrogen	Nitrogen
Chlorophyll TSI	60	60
Phosphorus TSI	95	89
Nitrogen TSI	62	62
TSI	61	61
Color (PCU)	161.50	98.55
Secchi disk depth (ft)	2.70	2.21
Impaired TSI for Bayou	60	60
Bayou Status (Water Column)	Impaired	Impaired

The color of a bayou is also important to the growth of algae. Dark, tannic bayous tend to suppress algal growth and can tolerate a higher amount of nutrient in their water column; while clear bayous tend to support higher algal growth with the same amount of nutrients. The color of a bayou, which is measured in a unit called the “platinum cobalt unit (PCU)” because of the standard used to determine color, is important because it is used by the State of Florida to determine bayou impairment as explained earlier. A new rule which is being developed by USEPA and FDEP, will use alkalinity in addition to color to determine a second set of “clear-alkaline bayous” which will be allowed a higher TSI than a “clear-acid” bayou. This is because alkaline bayous have been found to exhibit higher nutrient and algal concentrations than acid bayous. Additionally, bayous connected to a river or other “flow through” system tend to support lower algal growth for the same amount of nutrient concentration. All these factors are important to the understanding of your bayou’s overall condition. Table 7 includes many of the factors that are typically used to determine the actual state of plant growth in your bayou. These data should be understood and reviewed when establishing a management plan for a bayou; however, as stated above other factors must be considered when developing such a plan. Please contact the Water Atlas Program if you have questions about this part or any other part of this report.

Table 7 provides data derived from the vegetation assessment which is used to determine an adjusted TSI. This is accomplished by calculating the amount of phosphorus and nitrogen that could be released by existing submerged vegetation (Adjusted Nutrient) if this vegetation were treated with an herbicide or managed by the addition of Triploid Grass Carp (*Ctenopharyngodon idella*). The table also shows the result of a model that calculates the potential algae, as chlorophyll a (Adjusted Chlorophyll), which could develop due to the additional nutrients held within the plant biomass. 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 0.00 % of the bayou has submerged vegetation present (PAC) and this vegetation represents about 0.00 % of the available bayou volume (PVI). Please see additional parameters for adjusted values where appropriate in Table 7. The vegetation holds enough nutrients to add about 0 μg/L of phosphorus and 0 μg/L of nitrogen to the water column and increase the algal growth potential within the bayou.

Hayes Bayou is a balanced lake, in terms of limiting nutrient, and an increase in either phosphorus or nitrogen could change the TSI and increase the potential for algal growth.Hayes Bayou is nitrogen-limited; i.e., an increase in nitrogen could change the TSI and increase the potential for algal growth.

Table 7. Field parameters and calculations used to determine nutrients held in Submerged Aquatic Vegetation (SAV) biomass.

Parameter	Value	Mean Value
% Area Covered (PAC)	**0.0 %**	
PVI	**0.0 %**	
Total Phosphorus - Adjusted (ug/L)	**0.00**	
Total Phosphorus - Combined (ug/L)	**465.00**	
Total Nitrogen - Adjusted (ug/L)	**0.00**	
Total Nitrogen - Combined (ug/L)	**1118.00**	
Chlorophyll - Adjusted from Total Nutrients (ug/L)	**0.00**	
Chlorophyll - Combined (ug/L)	**20.50**	
Adjusted Chlorophyll TSI	**60**	
Adjusted Phosphorus TSI	**95**	
Adjusted Nitrogen TSI	**62**	
Adjusted TSI (for N, P, and CHLA)	**61**	
Impaired TSI for Bayou	**60**	**60**

Table 8 contains the field data taken in the center of the bayou using a multi-probe (we use a Eureka Manta) which has the ability to directly measure the temperature, pH, dissolved oxygen (DO), percent DO (calculated from DO, temperature and conductivity). These data are listed for three levels in the bayou and a mean measurement.

Table 8. Water Chemistry Data Based on Manta Water Chemistry Probe for Hayes Bayou

Sample Location	Sample Depth (m)	Time	Temp (deg C)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	pH
Surface	0.49	8/24/2011 11:30:00 AM	30.19	1.318	82.65	6.34	6.97
Mean Value	1.01	8/24/2011 11:35:00 AM	29.83	1.407	79.88	6.16	6.95
Middle	0.94	8/24/2011 11:35:00 AM	29.77	1.308	79.86	6.16	6.96
Bottom	1.61	8/24/2011 11:40:00 AM	29.53	1.596	77.15	77.15	6.93

To better understand many of the terms used in this report, we recommend that the reader visit the Hillsborough County & City of Tampa Water Atlas and explore the “Learn More” areas which are found on the resource pages. Additional information can also be found using the Digital Library on the Water Atlas website.

Section 4: Conclusion

Hayes Bayou is a large area (184.99-acre) bayou that would be considered in the Eutrophic category of bayous based on water chemistry. It has a plant diversity of 34 species relative to the total watershed plant diversity of 73 species with about 0.00 % percent of the open water areas containing submerged aquatic vegetation. Vegetation helps to maintain the nutrient balance in the bayou as well as provide good fish habitat. The bayou has many open water areas to support various types of recreation and has a good diversity of plant species. The primary pest plant in the bayou includes *Schinus terebinthifolius*.

This assessment was accomplished to assist bayou property owners to better understand and manage their lakes. Hillsborough County supports this effort as part of their Stream Waterwatch Program (SWW) and has developed guidelines for lake property owner groups to join the SWW and receive specific assistance from the County in the management of their bayou. For additional information and recent updates please visit the Hillsborough County & City of Tampa Water Atlas website.

Bayou Assessment Notes

1. The trophic state index is used by the Water Atlas to provide the public with an estimate of their bayou resource quality. A "Good" quality bayou is one that meets all bayou use criteria (swimmable, fishable and supports healthy habitat). Based on the discussion above, bayous that are in the oligotrophic through low eutrophic range, for the most part, meet these criteria. A trophic state below 60 indicates lakes in this range and these bayous are given the "Good" descriptor. A trophic state above 60 but below 70 can be considered highly productive and a reasonable bayou for fishing and most water sports. This bayou is considered "Fair", while a bayou in the Hypereutrophic range with a TSI greater than 70 will probably not meet the bayou use criteria and these bayous are considered to be poor. Please see Table 9 below.

Table 9. Comparison of Classification Schemes

Trophic State Index	Trophic State Classification	Water Quality
0 – 59	Oligotrophic through Mid-Eutrophic	Good
60 – 69	Mid-Eutrophic through Eutrophic	Fair
70 – 100	Hypereutrophic	Poor

Also see the Florida LAKEWATCH publication, "Trophic State: A Waterbody's Ability to Support Plants Fish and Wildlife" and the Trophic State Index Learn More page on the Hillsborough County & City of Tampa Water Atlas.

In recent years FDEP staff have encountered problems interpreting Secchi depth data in many tannic (tea or coffee-colored) waterbodies where transparency is often reduced due to naturally-occurring dissolved organic matter in the water. As a result, Secchi depth has been dropped as an indicator in FDEP's recent TSI calculations (1996 Water-Quality Assessment for The State of Florida Section 305(b) Main Report). This modification for black water TSI calculation has also been adopted by the Water Atlas.

Also, according to Florida LAKEWATCH use of the TSI is often misinterpreted and/or misused from its original purpose, which is simply to describe biological productivity. It is not meant to rate a bayou's water quality. For example, higher TSI values represent bayous that support an abundance of algae, plants and wildlife. If you love to fish, this type of bayou would not be considered to have "poor" water quality. However, if you are a swimmer or water skier, you might prefer a bayou with lower TSI values.

The trophic state index is one of several methods used to describe the biological productivity of a waterbody. Two scientists, Forsberg and Ryding, 1980, developed another method that is widely used. It's known as the Trophic State Classification System. Using this method, waterbodies can be grouped into one of four categories, called trophic states:

Oligotrophic (oh-lig-oh-TROH-fik) where waterbodies have the lowest level of productivity;

Mesotrophic (mees-oh-TROH-fik) where waterbodies have a moderate level of biological productivity;

Eutrophic (you-TROH-fik) where waterbodies have a high level of biological productivity;

Hypereutrophic (HI-per-you-TROH-fik) where waterbodies have the highest level of biological productivity. The trophic state of a waterbody can also affect its use or perceived utility. Figure 10 illustrates this concept.

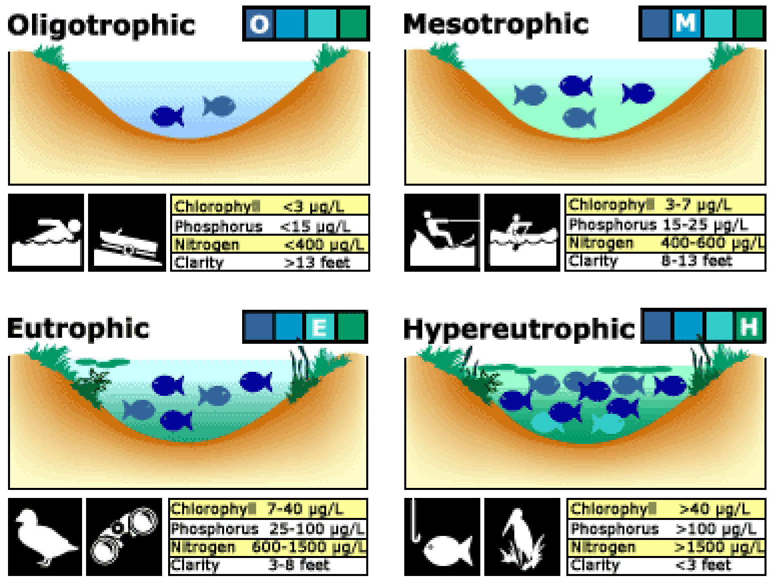
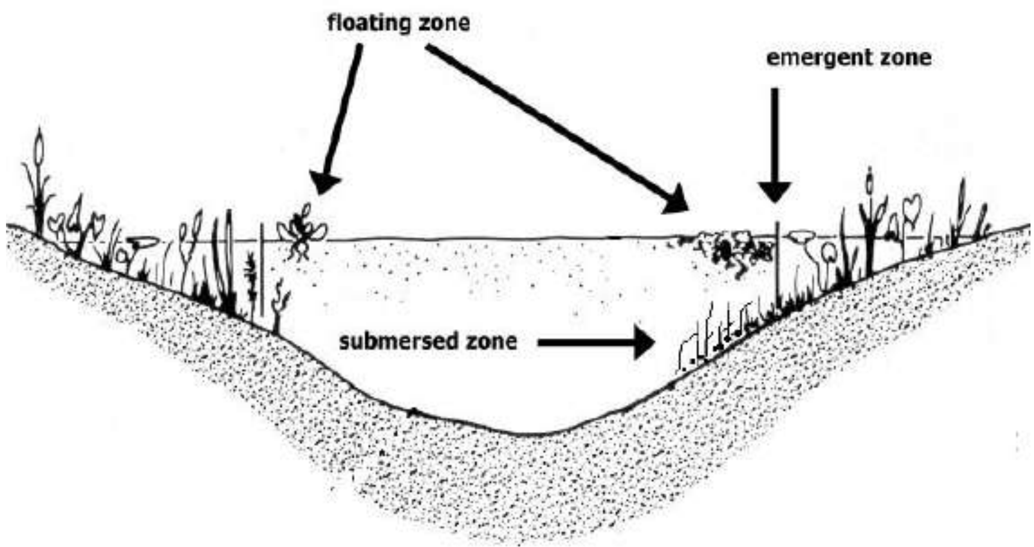


Figure 10. Tropic States

2. **Wide Area Augmentation System** (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.

3. The three primary aquatic vegetation zones are shown below:



4. A lake is **impaired** if: "For the purposes of evaluating nutrient enrichment in lakes, TSIs shall be calculated based on the procedures outlined on pages 86 and 87 of the State's 1996

305(b) report, which are incorporated by reference. Lakes or lake segments shall be included on the planning list for nutrients if:(1) For lakes with a mean color greater than 40 platinum cobalt units, the annual mean TSI for the lake exceeds 60, unless paleolimnological information indicates the lake was naturally greater than 60, or (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 (3) 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 require at least a 5 unit increase in TSI over the assessment period and 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."

References: 62-303.352—Nutrients in Lakes. Specific Authority 403.061, 403.067 FS. Law Implemented 403.062, 403.067 FS. History - New 6- 10-02, Amended 12-11-06. Please see page 12 of the Impaired Waters Rule. Updated activity regarding impaired waters may be tracked at: http://www.dep.state.fl.us/water/tmdl/

5. An **adjusted chlorophyll a value** (µg/L) was calculated by modifying the methods of Canfield et al (1983). The total wet weight of plants in the lake (kg) was calculated by multiplying lake surface area (m^2) by PAC (percent area coverage of macrophytes) and multiplying the product by the biomass of submersed plants (kg wet weight m^2) and then by 0.25, the conversion for the 1/4 meter sample cube. The dry weight (kg) of plant material was calculated by multiplying the wet weight of plant material (kg) by 0.08, a factor that represents the average percent dry weight of submersed plants (Canfield and Hoyer, 1992) and then converting to grams. The potential phosphorus concentration (mg/m^3) was calculated by multiplying dry weight (g) by 1.41 mg TP g-1 dry weight, a number that represents the mean phosphorus (mg) content of dried plant material measured in 750 samples from 60 Florida lakes (University of Florida, unpublished data), and then dividing by lake volume (m^3) and then converting to µg/L (1000/1000). From the potential phosphorus concentration, a predicted chlorophyll a concentration was determined from the total phosphorus and chlorophyll a relationship reported by Brown (1997) for 209 Florida lakes. Adjusted chlorophyll a concentrations were then calculated by adding each lake's measured chlorophyll a concentration to the predicted chlorophyll a concentration.