

# Lake Assessment Report for Lake Carroll in Hillsborough County, Florida

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Reviewed by: Jim Griffin

## INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake Carroll 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'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 Carroll shoreline

**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 the 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.

**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)<sup>i</sup> 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. These data are derived from 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 the 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**<sup>ii</sup>. Table 1 provides the lake's morphologic parameters in various units. The bottom of the lake was mapped using a Lowrance LCX 28C HD Wide Area Augmentation System (WAAS)<sup>iii</sup> 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 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. Lake Morphologic Data (Area, Depth and Volume)**

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	9,152,392	850,285	210.11		
Mean Depth	10	3			
Maximum Depth	25	7.60			
Volume (cubic)	143,105,176	4,052,287		3,285.20	1,070,501,055
Gauge (relative)	35.42	10.80			

<sup>i</sup> The trophic state index is used by the Water Atlas to provide the public with an estimate of their lake resource quality. For more information, see end note 1.

<sup>ii</sup> 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.

<sup>iii</sup> 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. For more information, see end note 2.



# Lake Carroll

Section - Township - Range  
15-28-18

-  Contour Lines  
Expressed in  
2-Foot Intervals
-  Lake Perimeter  
Ground Level

**EXPLANATION:**  
 Survey Date: June 21 2006  
 Lake water level was 39.40 feet  
 above sea level at time of assessment.  
 Contours are expressed in absolute depth  
 below this level.

**DATA SOURCES:**  
 2005 aerial photography provided by the  
 SWFWMD.  
 Lake perimeter digitized from SWFWMD  
 2005 aerial photographs.  
 All contours generated by the Florida Center  
 for Community Design and Research from  
 survey data provided by the Hillsborough  
 County Lake Management Program.

**LAKE MORPHOLOGY:**  
 Perimeter 1,045,670.881 ft;  
 Area 210.11 acres;  
 Median Depth 9.8 ft;  
 Volume 3,285.24 Acre-ft (1,070,501,054.51 gal)  
 Deepest point 25.01 ft

**DISCLAIMER:**  
 This map is for illustrative purposes only,  
 and should not be used for lake navigation.

0 350 700 1,050 1,400 Feet




Figure 2. Lake Carroll Bathymetric map created By USF-FCCDR using 2006 data

## Section 2: Lake Ecology (Vegetation)

The lake's apparent vegetative cover and shoreline detail are evaluated using the latest lake 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, 20 vegetation assessment sites were chosen for intensive sampling based on the *Lake Assessment Protocol* (copy available on request) for a lake 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)<sup>iv</sup>. 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 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 is determined from the presence and absence analysis of 100 sites in the lake 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.

Beginning with the 2010 Lake Assessments, the Water Atlas Lake Assessment Team has added the Florida Department of Environmental Protection (FDEP) Lake Vegetation Index (LVI)<sup>v</sup> method to the methods used to evaluate a lake. The LVI method was designed by DEP to be a rapid assessment of ecological condition, by determining how closely a lake's flora resembles that expected from a minimally disturbed condition.

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. Table 3 through Table 5 detail the results from the 2010 aquatic plant assessment for the lake. These data are determined from the 20 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 lake 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 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](#) permit from the [Environmental Protection Commission of Hillsborough County](#) and for management of in-lake vegetation outside the wetland fringe (for lakes with an

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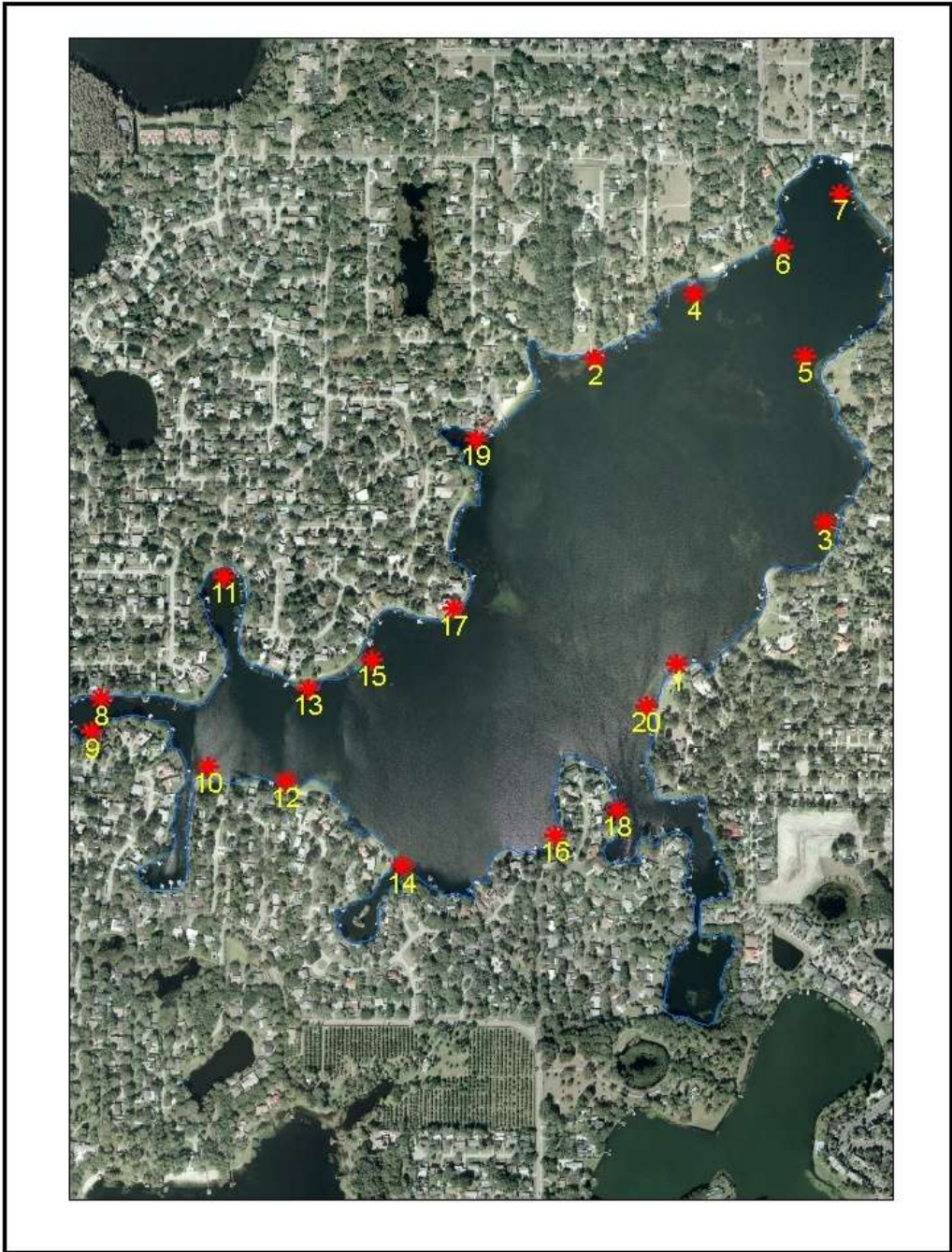
<sup>iv</sup> See end note 3.

<sup>v</sup> See end note 4.

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	20	138
Total Plant Diversity (# of Taxa)	77	164
% Non-Native Plants	23	21
Total Pest Plant Species	4	20



**Figure 3. Image of the vegetation assessment sites used by USF-FCCDR for Lake Carroll assessments**

**Table 3. List of Floating Leaf Zone Aquatic Plants Found**

<b>Plant Species Code</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Percent Occurrence</b>	<b>Type</b>
NNA	<i>Nymphoides aquatica</i>	Banana Lily, Big Floatingheart	95%	N, E0
NOA	<i>Nymphaea odorata</i>	American White Water Lily, Fragrant Water Lily	60%	N, E0
ALG	<i>Algal spp.</i>	Algal Mats, Floating	60%	P
SMA	<i>Salvinia minima</i>	Water Spangles, Water Fern	10%	N, E0
SPI	<i>Spirodela polyrhiza</i>	Giant Duckweed	10%	N, E0
IVA	<i>Iris virginica</i>	Southern Blue Flag	5%	E0
NLM	<i>Nuphar lutea</i>	Spatterdock, Yellow Pondlily	5%	N, E0



**Figure 4. Photograph of the floating vegetation zone in Lake Carroll**

**Table 4. List of Emergent Zone Aquatic Plants Found**

<b>Plant Species Code</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Percent Occurrence</b>	<b>Type</b>
PRS	<i>Panicum repens</i>	Torpedo Grass	100%	E1, P
APS	<i>Alternanthera philoxeroides</i>	Alligator Weed	90%	E2, P
HYE	<i>Hydrocotyl umbellata</i>	Manyflower Marshpennywort, Water Pennywort	90%	N, E0
FSR	<i>Fuirena scirpoidea</i>	Southern Umbrellasedge	85%	N, E0
PNA	<i>Phyla nodiflorea</i>	Frog-fruit, Carpetweed, Turkey Tangle Fogfruit	55%	N, E0
LOS	<i>Ludwigia octovalvis</i>	Mexican Primrosewillow, Long-stalked Ludwigia	50%	N, E0
TYP	<i>Typha spp.</i>	Cattails	40%	N, E0
LOA	<i>Ludwigia arcuata</i>	Piedmont Primrosewillow	40%	N, E0
EAA	<i>Eclipta alba</i>	Yerba De Tajo	35%	N, E0
CCA	<i>Cinnamomum camphora</i>	Camphor-tree	35%	N, E1
CYO	<i>Cyperus odoratus</i>	Fragrant Flatsedge	35%	N, E0
LPA	<i>Ludwigia peruviana</i>	Peruvian Primrosewillow	35%	E0
TAS	<i>Taxodium acendens</i>	Pond Cypress	25%	N, E0
SCA	<i>Salix caroliniana</i>	Carolina Willow	25%	N, E0
CSS	<i>Cyperus surinamensis</i>	Sedge	25%	N, E0
COM	<i>Commelina spp.</i>	Dayflower	25%	N, E0
MSS	<i>Mikania scandens</i>	Climbing Hempvine	20%	N, E0
WTA	<i>Wedelia trilobata</i>	Creeping Oxeye	20%	E2
POL	<i>Polygonum spp.</i>	Smartweed, Knotweed	20%	N, E0
MEL	<i>Melaleuca quinquenervia</i>	Punk Tree, Melaleuca	15%	E1

Plant Species Code	Scientific Name	Common Name	Percent Occurrence	Type
SLA	<i>Sagittaria lancifolia</i>	Duck Potato	15%	N, E0
DVA	<i>Diodia virginiana</i>	Buttonweed	15%	N, E0
JMS	<i>Juncus megacephalus</i>	Bighead Rush	15%	N, E0
EIA	<i>Eleocharis interstincta</i>	Knotted Spikerush, Giant-Spikerush	15%	N, E0
CLA	<i>Casuarina equisetifolia</i>	Australian Pine	15%	E1
CPT	<i>Cyperus polystachyos</i>	Flat Sedge	15%	N, E0
AVS	<i>Andropogon virginicus var. glaucus</i>	Broomsedge Bluestem, Broom grass	15%	N, E0
BLS	<i>Blechnum serrulatum</i>	Swamp fern, Toothed Midsorus Fern	15%	N
CEA	<i>Colocasia esculenta</i>	Wild Taro	10%	E1
CAA	<i>Centella asiatica</i>	Asian Pennywort, Coinwort	10%	N, E0
ACE	<i>Acer rubrum</i>	Southern Red Maple	10%	N, E0
FBA	<i>Furinea brevista</i>	Saltmarsh Umbrellasedge	10%	N, E0
HCC	<i>Hibiscus coccineus</i>	Scarlet Rosemallow	10%	N, E0
JUM	<i>Juncus marginatus</i>	Shore Rush, Grassleaf Rush	10%	N, E0
NEA	<i>Nephrolepis exaltata</i>	Sword Fern, Wild Boston Fern	10%	N, E0
SCC	<i>Scirpus californicus</i>	Giant Bulrush	10%	N, E0
TDM	<i>Taxodium distichum</i>	Bald Cypress	10%	N, E0
PLU	<i>Pluchea spp.</i>	Marsh Fleabane, Camphorweed	10%	N, E0
QLA	<i>Quercus laurifolia</i>	Laurel Oak; Diamond Oak	10%	N, E0
RHE	<i>Rhexia spp.</i>	Meadow Beauties	10%	E0

<b>Plant Species Code</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Percent Occurrence</b>	<b>Type</b>
SAM	<i>Sambucus canadensis</i>	Elderberry	5%	N, E0
LRS	<i>Ludwigia repens</i>	Creeping Primrosewillow, Red Ludwigia	5%	N, E0
SSM	<i>Sapium sebiferum</i>	Chinese Tallow Tree	5%	E1
STS	<i>Schinus terebinthifolius</i>	Brazilian Pepper	5%	E1
PCA	<i>Pontederia cordata</i>	Pickereel Weed	5%	N, E0
PFO	<i>Paederia foetida</i>	Skunkvine, Stinkvine	5%	E1
PGA	<i>Psidium guajava</i>	Guava	5%	E1
ICE	<i>Ilex cassine</i>	Dahoon Holly	5%	N, E0
JES	<i>Juncus effusus var solutus</i>	Soft Rush	5%	N, E0
FPA	<i>Fimbristylis spathacea (cymosa)</i>	Hurricane Grass	5%	N, E0
ECA	<i>Eleocharis cellulosa</i>	GULF COAST SPIKERUSH	5%	N, E0
COS	<i>Cephalanthus occidentalis</i>	Buttonbush	5%	N, E0
CYP	<i>Cyperus spp.</i>	Sedge	5%	E0
DBA	<i>Dioscorea bulbifera</i>	Air Potato	5%	E1
CAN	<i>Canna spp.</i>	Canna	5%	E0
CIS	<i>Cyperus involucratus</i>	Umbrella Flat Sedge	5%	E2
BOC	<i>Boehmeria cylindrica</i>	Bog Hemp, False Nettle	5%	N, E0
BHA	<i>Baccharis halimifolia</i>	Sea Myrtle	5%	N, E0
BID	<i>Bidens spp.</i>	Bur Marigold	5%	N, E0



**Figure 5. Photograph of *Panicum repens*, a non-native invasive species, on Lake Carroll**

**Table 5. List of Submerged Zone Aquatic Plants Found.**

<b>Plant Species Code</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Percent Occurrence</b>	<b>Type</b>
VAA	<i>Valisneria americana</i>	Tapegrass	100%	N, E0
HVA	<i>Hydrilla verticillata</i>	Hydrilla, waterthyme	100%	E1, P
PIS	<i>Potamogeton illinoensis</i>	Pond Weed	95%	N, E0
MGM	<i>Micranthemum glomeratum</i>	Manatee Mudflower, Baby's Tears	90%	N, E0
BCA	<i>Bacopa caroliniana</i>	Lemon Bacopa	85%	N, E0
BMI	<i>Bacopa monnieri</i>	Common Bacopa	65%	N, E0
NGS	<i>Najas guadelupensis</i>	Southern Naiad	65%	N, E0
NIT	<i>Nitella spp.</i>	Stonewort	65%	N, E0
EBI	<i>Eleocharis baldwinii</i>	Baldwin's Spikerush, Roadgrass	60%	N, E0
UTA	<i>Utricularia spp.</i>	Bladderwort	25%	N, E0
CHA	<i>Chara spp.</i>	Muskgrass	10%	N, E0



**Figure 6. Photograph of the submerged vegetation community in Lake Carroll**

**Table 6. List of All Plants and Sample Sites**

<b>Plant Common Name</b>	<b>Found at Sample Sites</b>	<b>Percent Occurrence</b>	<b>Growth Type</b>
Hydrilla, waterhyme	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	100	Submersed
Tapegrass	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	100	Submersed
Torpedo Grass	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	100	Emergent
Banana Lily, Big Floatingheart	1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,17,18,19,20	95	Floating
Pond Weed	1,2,3,4,5,6,7,8,10,11,12,13,14,15,16,17,18,19,20	95	Submersed
Alligator Weed	1,2,3,5,6,7,8,9,10,11,12,13,15,16,17,18,19,20	90	Emergent
Manatee Mudflower, Baby's Tears	1,2,3,4,5,6,7,9,10,12,13,14,15,16,17,18,19,20	90	Submersed
Manyflower Marshpennywort, Water Pennywort	1,2,3,4,5,6,7,8,9,10,11,12,13,15,16,18,19,20	90	Emergent
Lemon Bacopa	1,2,3,4,5,6,7,10,11,12,13,14,15,17,18,19,20	85	Submersed
Southern Umbrellasedge	1,2,3,5,6,8,9,10,11,12,13,15,16,17,18,19,20	85	Emergent
Common Bacopa	1,2,3,4,6,7,10,11,12,13,15,19,20	65	Submersed
Southern Naiad	1,2,3,6,7,11,13,14,15,16,17,18,19	65	Submersed
Stonewort	1,2,4,5,6,7,11,12,13,15,18,19,20	65	Submersed
Algal Mats, Floating	1,3,7,8,9,11,12,14,15,16,18,19	60	Floating
American White Water Lily, Fragrant Water Lily	1,2,3,4,6,8,9,10,11,12,19,20	60	Floating
Baldwin's Spikerush, Roadgrass	2,3,4,5,6,7,10,12,13,15,19,20	60	Submersed
Frog-fruit, Carpetweed, Turkey Tangle Fogfruit	1,2,3,5,6,7,10,11,18,19,20	55	Emergent
Mexican Primrosewillow, Long-stalked Ludwigia	1,4,6,8,9,11,12,16,17,19	50	Emergent
Cattails	2,4,7,12,13,15,17,20	40	Emergent
Piedmont Primrosewillow	1,4,10,11,12,16,17,19	40	Emergent
Camphor-tree	1,2,3,6,7,14,16	35	Emergent
Fragrant Flatsedge	2,7,11,12,18,19,20	35	Emergent
Peruvian Primrosewillow	2,3,6,7,9,15,17	35	Emergent
Yerba De Tajo	1,7,11,12,16,19,20	35	Emergent
Bladderwort	11,16,17,18,19	25	Submersed
Carolina Willow	4,6,7,15,16	25	Emergent
Dayflower	2,3,4,7,20	25	Emergent
Pond Cypress	2,4,7,9,10	25	Emergent
Sedge	1,10,12,18,20	25	Emergent
Climbing Hempvine	3,4,17,19	20	Emergent
Creeping Oxeye	7,9,18,20	20	Emergent
Smartweed, Knotweed	2,7,15,19	20	Emergent

<b>Plant Common Name</b>	<b>Found at Sample Sites</b>	<b>Percent Occurrence</b>	<b>Growth Type</b>
Australian Pine	1,4,6	15	Emergent
Bighead Rush	1,7,20	15	Emergent
Broomsedge Bluestem, Broom grass	1,6,16	15	Emergent
Buttonweed	2,11,20	15	Emergent
Duck Potato	11,12,15	15	Emergent
Flat Sedge	1,2,20	15	Emergent
Knotted Spikerush, Giant-Spikerush	12,15,20	15	Emergent
Punk Tree, Melaleuca	3,4,6	15	Emergent
Swamp fern, Toothed Midsorus Fern	2,3,4	15	Emergent
Asian Pennywort, Coinwort	2,7	10	Emergent
Bald Cypress	2,10	10	Emergent
Giant Bulrush	18,20	10	Emergent
Giant Duckweed	8,9	10	Floating
Laurel Oak; Diamond Oak	2,9	10	Emergent
Marsh Fleabane,Camphorweed	3,19	10	Emergent
Meadow Beauties	1,3	10	Terrestrial
Muskgrass	4,15	10	Submersed
Saltmarsh Umbrellasedge	11,20	10	Emergent
Scarlet Rosemallow	3,20	10	Emergent
Shore Rush, Grassleaf Rush	1,2	10	Emergent
Southern Red Maple	2,3	10	Emergent
Sword Fern, Wild Boston Fern	4,19	10	Terrestrial
Water Spangles, Water Fern	4,9	10	Floating
Wild Taro	2,3	10	Emergent
Air Potato	4	5	Emergent
Bog Hemp, False Nettle	8	5	Emergent
Brazilian Pepper	1	5	Emergent
Bur Marigold	1	5	Emergent
Buttonbush	18	5	Emergent
Canna	3	5	Emergent
Chinese Tallow Tree	4	5	Emergent
Creeping Primrosewillow, Red Ludwigia	4	5	Emergent
Dahoon Holly	3	5	Emergent

<b>Plant Common Name</b>	<b>Found at Sample Sites</b>	<b>Percent Occurrence</b>	<b>Growth Type</b>
<b>Elderberry</b>	<b>7</b>	<b>5</b>	<b>Emergent</b>
<b>Guava</b>	<b>3</b>	<b>5</b>	<b>Emergent</b>
<b>GULF COAST SPIKERUSH</b>	<b>11</b>	<b>5</b>	<b>Emergent</b>
<b>Hurricane Grass</b>	<b>20</b>	<b>5</b>	<b>Emergent</b>
<b>Pickereel Weed</b>	<b>2</b>	<b>5</b>	<b>Emergent</b>
<b>Sea Myrtle</b>	<b>4</b>	<b>5</b>	<b>Emergent</b>
<b>Sedge</b>	<b>15</b>	<b>5</b>	<b>Emergent</b>
<b>Skunkvine, Stinkvine</b>	<b>3</b>	<b>5</b>	<b>Terrestrial</b>
<b>Soft Rush</b>	<b>20</b>	<b>5</b>	<b>Emergent</b>
<b>Southern Blue Flag</b>	<b>3</b>	<b>5</b>	<b>Floating</b>
<b>Spatterdock, Yellow Pondlily</b>	<b>19</b>	<b>5</b>	<b>Floating</b>
<b>Umbrella Flat Sedge</b>	<b>3</b>	<b>5</b>	<b>Emergent</b>

### Section 3: Long-term Ambient Water Chemistry

A critical element in any lake 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 lakes in Hillsborough County. The Lake Carroll Water Quality Page can be viewed at <http://www.hillsborough.wateratlas.usf.edu/lake/waterquality.asp?wbodyid=5187&wbodyatlas=lake>.

A primary source of lake water chemistry in Hillsborough County is the [Florida LAKEWATCH](#) volunteer lake monitor and the Florida LAKEWATCH laboratory at the University of Florida. Lake Carroll is fortunate to have an active LAKEWATCH volunteer who has collected lake water samples for significant time period which allow an analysis of lake trends. 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 7, Figure 8, and Figure 9 for Lake Carroll. The figures are graphs of: (1) the overall trophic state index (TSI)<sup>1</sup>, which is a method commonly used to characterize the productivity of a lake, and may be thought of as a lake's ability to support plant growth and a healthy food source for aquatic life; (2) the chlorophyll *a* concentration, which indicates the lake's algal concentration, and (3) the lake's Secchi Disk depth which is a measure of water visibility and depth of light penetration. These data are used to evaluate a lake's ecological health and to provide a method of ranking lakes and are indicators used by the US Environmental Protection Agency (USEPA) and the Florida Department of Environmental Protection (FDEP) to determine a lake'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 Lakes in Florida expressed as percentiles.

Based on best available data, Lake Carroll has a color value determined as a platinum cobalt unit (pcu) value of 5 and is considered a Clear lake (has a mean color in pcu equal to or below 40). The FDEP and USEPA may classify a lake as impaired if the lake is a dark lake (has a mean color in pcu greater than 40) and has a TSI greater than 60, or is a clear lake and has a TSI greater than 40. Lake Carroll has a TSI of 39 and does not meet the FDEP Impaired Waters Rule (IWR) criteria for impaired lakes. See also Table 7.

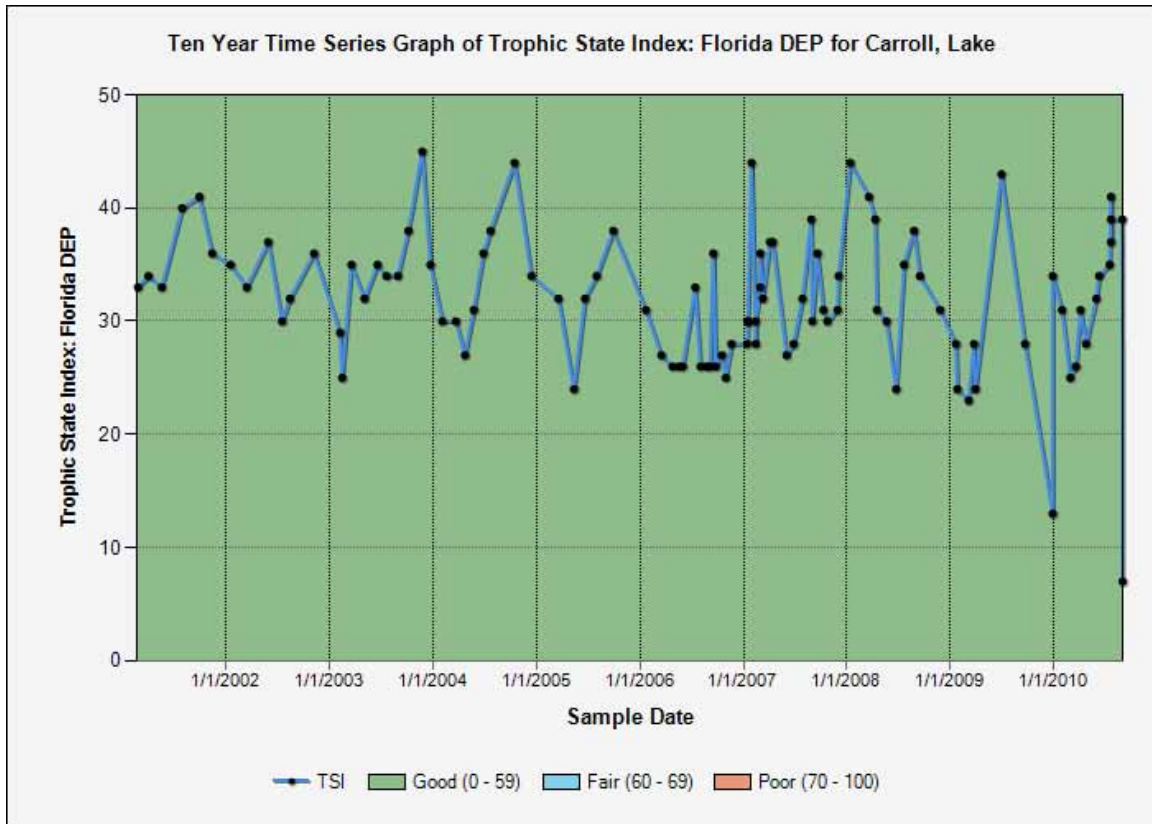


Figure 7. Recent Trophic State Index (TSI) graph for Lake Carroll<sup>vi</sup>

<sup>vi</sup> 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=5187&data=TSI&data type=WQ&waterbodyatlas=lake&ny=10&bench=1](http://www.hillsborough.wateratlas.usf.edu/graphs20/graph_it.aspx?wbodyid=5187&data=TSI&data type=WQ&waterbodyatlas=lake&ny=10&bench=1)

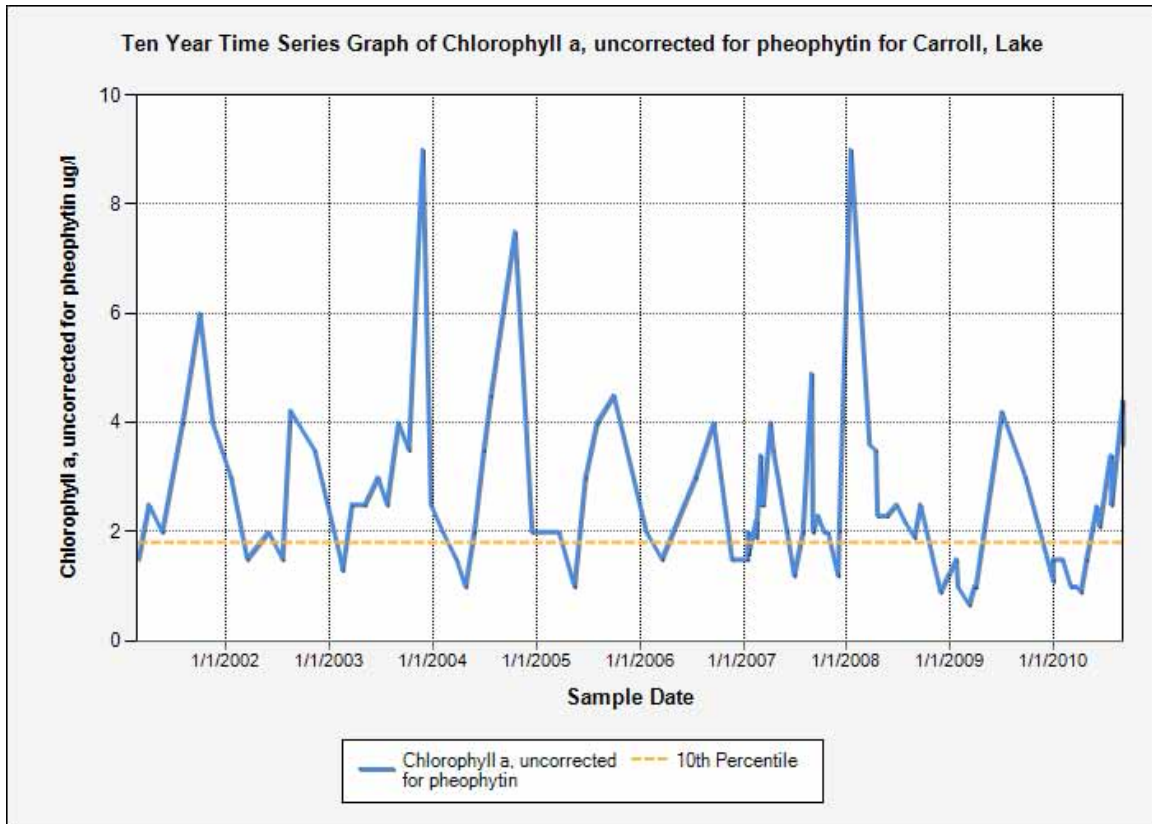
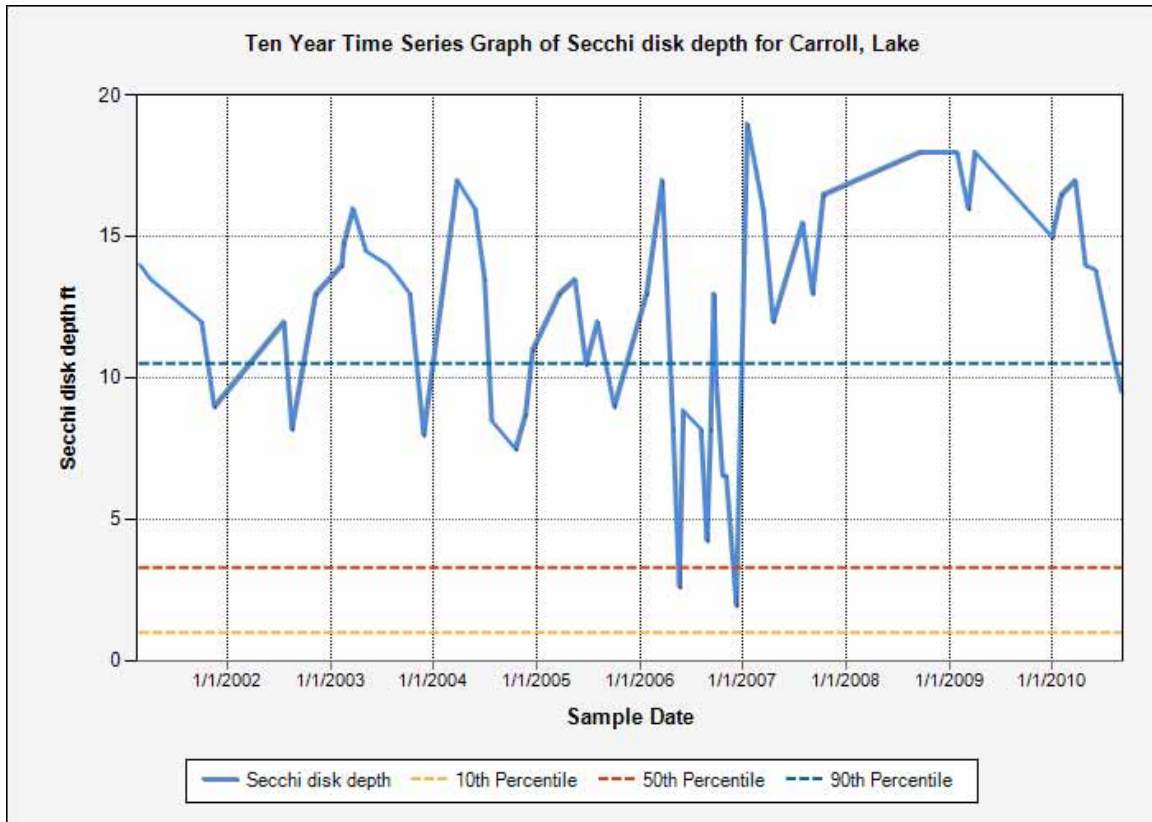


Figure 8. Recent Chlorophyll a graph for Lake Carroll<sup>vii</sup>

<sup>vii</sup> Graph Source: Hillsborough County Water Atlas. For the latest data go to [http://www.hillsborough.wateratlas.usf.edu/graphs20/graph\\_it.aspx?wbodyid=5187&data=Chla\\_ugl&datatype=WQ&waterbodyatlas=lake&ny=10&bench=1](http://www.hillsborough.wateratlas.usf.edu/graphs20/graph_it.aspx?wbodyid=5187&data=Chla_ugl&datatype=WQ&waterbodyatlas=lake&ny=10&bench=1)



**Figure 9. Recent Secchi Disk graph for Lake Carroll<sup>viii</sup>**

As part of the lake assessment the physical water quality and chemical water chemistry of a lake are measured. These data only indicate a snapshot of the lake’s water quality; however they are useful when compared to the trend data available from LAKEWATCH or other sources. Table 7 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 lake and to some extent the nutrients which are held in the sediment and the vegetation biomass of a lake. 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 lake 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 lake is considered phosphorus limited, when this ratio is less than or equal to 10, the lake is considered nitrogen limited and if between 10 and 30 it is considered balanced.

<sup>viii</sup> Graph Source: Hillsborough County Water Atlas. For the latest data go to [http://www.hillsborough.wateratlas.usf.edu/graphs20/graph\\_it.aspx?wbodyid=5187&data=secchi\\_ft&datatype=WQ&waterbodyatlas=lake&ny=10&bench=1](http://www.hillsborough.wateratlas.usf.edu/graphs20/graph_it.aspx?wbodyid=5187&data=secchi_ft&datatype=WQ&waterbodyatlas=lake&ny=10&bench=1)

**Table 7. Water Quality Parameters (Laboratory) for Lake Carroll**

<b>Parameter</b>	<b>Value</b>
Lake Area (Acres)	210.11
Lake Area (m2)	850,285.00
Lake Volume (m3)	4,052,287.00
Number of Vegetation Sites	20
Average Station SAV Weight	1.08
Wet Weight of Vegetation (g)	659,038,900.47
Dry Weight of Vegetation (g)	52,723,112.04
Total Phosphorus (ug/L)	41.33
Total Nitrogen (ug/L)	510.00
Chlorophyll a (ug/L)	2.90
TN/TP	12.3
Limiting Nutrient	Balanced
Chlorophyll TSI	32
Phosphorus TSI	Not Calculated
Nitrogen TSI	42
TSI	39
Color (PCU)	9.92
Secchi disk depth (ft)	10.80
Impaired TSI for Lake	40
Lake Status (Water Column)	Not Impaired

The color of a lake is also important to the growth of algae. Dark, tannic lakes tend to suppress algal growth and can tolerate a higher amount of nutrient in their water column; while clear lakes tend to support higher algal growth with the same amount of nutrients. The color of a lake, which is measured in a unit called the “cobalt platinum unit (PCU)” because of the standard used to determine color, is important because it is used by the State of Florida to determine lake 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 lakes” which will be allowed a higher TSI than a “clear-acid” lake. This is because alkaline lakes have been found to exhibit higher nutrient and algal concentrations than acid lakes. Additionally, lakes 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 lake’s overall condition. Table 7 includes many of the factors that are typically used to determine the actual state of plant growth in your lake. These data should be understood and reviewed when establishing a management plan for a lake; 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.

We have concern that an error exists in the phosphorus sample data from our 2010 lake assessment of Lake Carroll. This may be a sampling error or a laboratory error. This conclusion is based on a comparison of these data with sample data from previous years and from other sampling agencies (Florida LAKEWATCH, SWFWMD and FDEP). We will issue corrections to these data at a later date after lakes have been re-sampled; however until that time we are using the TSI based only on Chlorophyll a. This value from Table 7 is 46. Additionally, nutrient limitation cannot be determined from the sample data alone; however, from previous data, the lake is phosphorus limited. Lake Carroll is in the “Clear” category of lakes based on its mean color value of 11.5 pcu. This means that to not be considered impaired, the TSI must be equal to or less than 40. The TSI for Lake Carroll is 32 (we are using Chlorophyll TSI) so the lake would not be considered impaired by the FDEP criteria based on this single data set. Figure 7, however; includes enough single occurrences of TSI greater than 40 for the lake to be considered impaired.

Table 8 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 72 % of the lake has submerged vegetation present (PAC) and this vegetation represents about 20.7 % of the available lake volume (PVI). Please see additional parameters for adjusted values where appropriate in Table 8. The vegetation holds enough nutrients to add about 18.35 µg/L of phosphorus and 247.2 µg/L of nitrogen to the water column and increase the algal growth potential within the lake.

Lake Carroll 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.

**Table 8. Field parameters and calculations used to determine nutrients held in Submerged Aquatic Vegetation (SAV) biomass.**

Parameter	Value
% Area Covered (PAC)	72.0 %
PVI	20.7 %
Lake Vegetation Index	57
Total Phosphorus - Adjusted (ug/L)	18.35
Total Phosphorus - Combined (ug/L)	59.6833
Total Nitrogen - Adjusted (ug/L)	247.20
Total Nitrogen - Combined (ug/L)	757.2
Chlorophyll - Adjusted from Total Nutrients (ug/L)	6.60
Chlorophyll - Combined (ug/L)	9.50
Adjusted Chlorophyll TSI	49
Adjusted Phosphorus TSI	Not Calculated
Adjusted Nitrogen TSI	50
Adjusted TSI (for N, P, and CHLA)	49
Impaired TSI for Lake	40

For Lake Carroll this reservoir represents a potential available nutrient concentration of 18 µg/L total phosphorus, 247 µg/L total nitrogen with the potential chlorophyll (produced from released nutrients) concentration of 6.6 µg/L. These data indicate that the removal of submerged vegetation in Lake Carroll would result in a TSI increase from 32 to 49 and would cause a the lake to move into the “impaired” category of lakes.

Since one of the primary emergent species in the lake is the invasive species Hydrilla, it may be necessary for vegetation to be controlled in the lake, but this should be accomplished in a manner that does not cause an immediate loss of submerged vegetation which would cause the lake to move from a macrophyte-dominant system to a microphyte-dominated system. The Lake Carroll lake association has been managing Hydrilla with the use of Grass Carp and herbicides. They should continue this method of control and continue to be judicious in the use of carp. Lake Carroll is fortunate to have a large diversity of submerged vegetation and their management practices seem to encourage this diversity which is healthy for the lake.

Table 9 contains the field data taken in the center of the lake using a multi-probe (we use either a YSI 6000 or 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 lake and twice for the surface measurement. The duplicate surface measurement is taken as a quality assurance check on measured data.

**Table 9. Water Chemistry Data Based on Manta Water Chemistry Probe for Lake Carroll**

Sample Location	Sample Depth (m)	Time	Temp (deg C)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	pH
Surface - South	0.58	7/22/2010 11:00:00 AM	31.92	0.224	107.62	8.10	7.64
Middle - South	2.03	7/22/2010 11:05:00 AM	31.58	0.224	111.71	8.46	7.75
Bottom - South	3.73	7/22/2010 11:07:00 AM	31.37	0.224	110.52	8.40	8.12
Mean Value - South	2.11	7/22/2010 11:09:00 AM	31.62	0.224	109.95	8.32	7.83
Surface - Middle	0.93	7/22/2010 11:11:00 AM	32.05	0.227	104.47	7.85	7.53
Middle - Middle	2.56	7/22/2010 11:13:00 AM	31.79	0.227	103.08	7.77	7.67
Bottom-Middle	4.25	7/22/2010 11:15:00 AM	31.44	0.227	91.41	6.93	7.67
Mean Value - Middle	2.58	7/22/2010 11:17:00 AM	31.76	0.227	99.65	7.52	7.62
Surface - North	1.10	7/22/2010 11:21:00 AM	32.37	0.227	104.13	7.78	7.49
Middle - North	3.02	7/22/2010 11:24:00 AM	31.75	0.227	100.56	7.59	7.47
Bottom - North	5.07	7/22/2010 11:26:00 AM	31.26	0.226	72.50	5.51	7.18
Mean Value - North	3.06	7/22/2010 11:30:00 AM	31.79	0.227	92.39	6.96	7.38

Lake Carroll seems to be well mixed (water chemistry is consistent down the water column) and exhibits a healthy level of dissolved oxygen and should provide a good habitat for fish and other aquatic plants and animals.

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

Lake Carroll is a large area (210.11-acre) lake that would be considered in the [Mesotrophic to Eutrophic](#) category of lakes based on water chemistry. It has a plant diversity of 77 species relative to the total watershed plant diversity of 164 species with about 72.00 % percent of the open water areas containing submerged aquatic vegetation. Vegetation helps to maintain the nutrient balance in the lake as well as provide good fish habitat. The lake has many open water areas to support various types of recreation and has a good diversity of plant species. The primary pest plants in the lake include Algal spp., Panicum repens, Alternanthera philoxeroides, Hydrilla verticillata.

The lake vegetative assessment also was used to calculate a Lake Vegetative Index (LVI) for the lake ([See Note 4](#)). The LVI can be used to help determine if a lake is impaired in terms of types and quantities of vegetation found in and along the lake shore. An LVI threshold of 37 is used by FDEP to establish a point below which the lake could be considered heavily disturbed and possibly impaired. This threshold is intended to assist the analyst in classifying a lake as impaired when used with water quality data. For example, a clear water lake may have a TSI of 42 but have an LVI of 70. Since the LVI is significantly above the threshold and indicates low human disturbance, the analyst might declare the lake unimpaired even with a TSI slightly above the water quality threshold for a clear lake. Your lake has an LVI of 57 and would be considered not impaired based on LVI alone. Lake Carroll was assessed by FDEP in July of 2010 and received a score of 57 which indicates a lake with a good diversity of native plants and a moderately low human disturbance impact.

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

## Lake Assessment Notes

1. The trophic state index is used by the Water Atlas to provide the public with an estimate of their lake resource quality. A "Good" quality lake is one that meets all lake use criteria (swimmable, fishable and supports healthy habitat). Based on the discussion above, lakes 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 lakes are given the "Good" descriptor. A trophic state above 60 but below 70 can be considered highly productive and a reasonable lake for fishing and most water sports. This lake is considered "Fair", while a lake in the Hypereutrophic range with a TSI greater than 70 will probably not meet the lake use criteria and these lakes are considered to be poor. Please see Table 10 below.

**Table 10. 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 lake's water quality. For example, higher TSI values represent lakes that support an abundance of algae, plants and wildlife. If you love to fish, this type of lake would not be considered to have "poor" water quality. However, if you are a swimmer or water skier, you might prefer a lake 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.

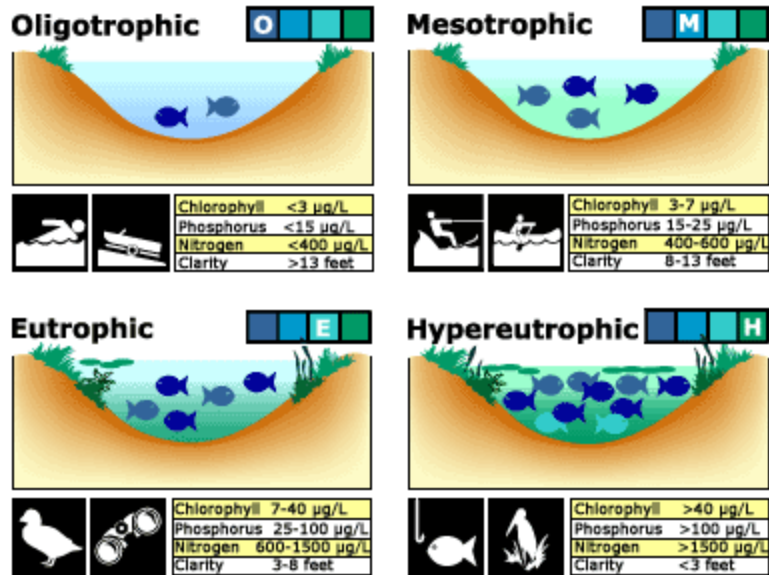
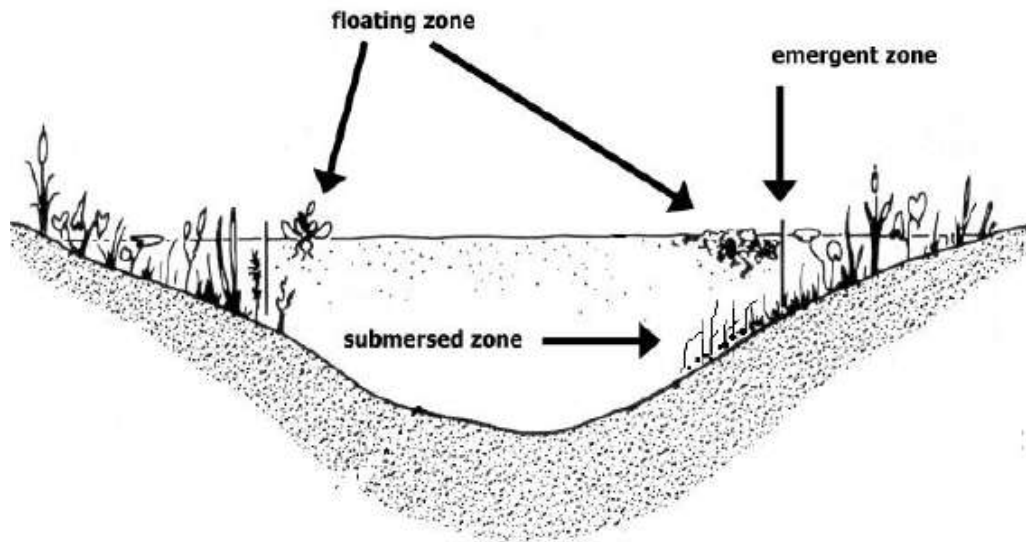


Figure 10. Tropic States

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



- The **Lake Vegetation Index (LVI)** is a rapid assessment protocol in which selected sections of a lake are assessed for the presence or absence of vegetation through visual observation and through the use of a submerged vegetation sampling tool called a **Frodus**. The

assessment results provide a list of species presents and the dominant and where appropriate co-dominant species that are found in each segment. These results are then entered into a scoring table and a final LVI score is determined. LVI scores provide an estimate of the vegetative health of a lake. Our assessment team was trained and qualified by FDEP to conduct these assessment as an independent team and must prequalify each year prior to conducting additional assessments. The LVI method consists of dividing the lake into twelve pie-shaped segments (see diagram below) and selecting a set of four segments from the twelve to include in the LVI. The assessment team then travels across the segment and identifies all unique species of aquatic plant present in the segment. Additionally, a Frodus is thrown at several points on a single five-meter belt transect that is established in the center of the segment from a point along the shore to a point beyond the submerged vegetation zone. For scoring, the threshold score for impairment is 37. Below is a table of LVI scores recorded in Hillsborough County for comparison:

Lake Name	Sample Date	LVI Score
Lake Magdalene	5/26/2005	64
Lake Magdalene	10/20/2005	38
Burrell Lake, off Nebraska in Lutz area. Ambient Monitoring Program	8/4/2005	16
Silver lake just south of Waters between Habana and Himes Avenues, Tampa. Ambient Monitoring Program	7/29/2005	36
Unnamed lake on Forest Hills Drive south of Fletcher Avenue. Ambient Monitoring Program	8/3/2005	34
Hanna Pond, off Hanna Rd in Lutz. Ambient Monitoring Program	7/25/2005	38
Small lake, Lutz, just east pf Livingston. Ambient Monitoring Program	7/22/2005	39
Small lake, Lutz, adj to Lake Keene. Ambient Monitoring Program	8/5/2005	28
Unnamed small lake, Tampa, off Fowler behind University Square Mall. Ambient Monitoring Program	7/19/2005	16
Tiffany Lake, Lutz, north of Whittaker. Ambient Monitoring Program	7/25/2005	40
Cedar Lake, south of Fletcher, Forest Hills. Ambient Monitoring Program	7/22/2005	37
Unnamed small lake behind Natives Nursery, Lutz. Ambient Monitoring Program	8/5/2005	20
Unnamed lake on Curry Road off Livingston, Lutz. Ambient Monitoring Program	7/19/2005	46
Unnamed lake in Lutz. Ambient Monitoring Program	7/20/2005	45
Lake Josephine - HIL538UL	10/12/2006	40
Lake Magdalene - HIL546UL	10/18/2006	40
Starvation Lake - HIL540NL	9/28/2006	48
Egypt Lake - HIL556UL	10/31/2006	34
Unnamed Lake - HIL544UL	9/25/2008	58
Lake Rogers - L63P	7/22/2009	65
Lake Alice/Odessa, profundal zone	8/6/2009	71
Lake Carroll (Center)	7/15/2009	64
Unnamed Small Lake - Z4-SL-3011	7/21/2009	24
Unnamed Small Lake - Z4-SL-3020	7/21/2009	40
Lake Ruth - Z4-SL-3031	7/16/2009	71
Lake Juanita - Z4-SL-3036	7/20/2009	72
Chapman Lake	6/8/2009	42
Island Ford Lake	8/10/2010	50
Lake Magdalene	7/29/2010	56
Lake Stemper	7/13/2010	38
Lake Carroll	7/20/2010	57

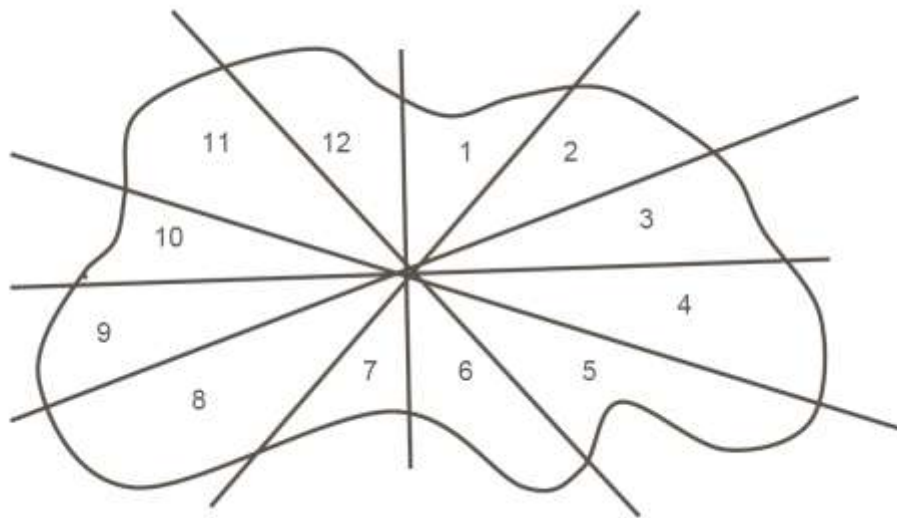
5.

Reference: "[Assessing the Biological Condition of Florida Lakes: Development of the Lake Vegetation Index \(LVI\) Final Report](#)", December, 2007, page 7. Prepared for: Florida Department of Environmental Protection, Twin Towers Office Building, 2600 Blair Stone Road, Tallahassee, FL 32399-2400, Authors: Leska S. Fore\*, Russel Frydenborg\*\*, Nijole Wellendorf\*\*, Julie Espy\*\*, Tom Frick\*\*, David Whiting\*\*, Joy Jackson\*\*, and Jessica Patronis\*\*

\* Statistical Design

\*\* Florida Department of Environmental Protection

Diagram showing the method used to divide a typical lake into 12 sections for replicate sampling:



6. 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/>

7. An **adjusted chlorophyll a value** ( $\mu\text{g/L}$ ) 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 ( $\text{m}^2$ ) by PAC (percent area coverage of macrophytes) and multiplying the product by the biomass of submersed plants ( $\text{kg wet weight m}^2$ ) 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 ( $\text{mg/m}^3$ ) was calculated by multiplying dry weight (g) by 1.41 mg TP g<sup>-1</sup> 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 ( $\text{m}^3$ ) and then converting to  $\mu\text{g/L}$  (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.