



Lake Raleigh

LAKE HABITAT ASSESSMENT, LAKE VEGETATION INDEX, SUBMERGED
VEGETATION SURVEY AND WATER QUALITY

David Eilers, Abigail Richardson, Towfiqul Islam Khan | USF Water Institute | July 16,
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Methods

STUDY AREA ANALYSIS

The watershed containing Lake Raleigh was analyzed using ESRI ArcGIS Pro. Using this software with 2023 ESRI Basemaps aerial, 2022 Land Use/ Land Cover (LULC), Landscape Development Intensity (LDI) Index values were calculated for the 100 meter buffer surrounding the lake following the procedures of FDEP

(<https://floridadep.gov/dear/bioassessment/content/bioassessment-ldi-hdg-bcg>). “The Landscape Development Intensity index (LDI) is an estimate of how much humans have altered an area of interest around a waterbody. Various land use types (low density residential, row crops, industrial, natural) are assigned coefficients of land use intensity based on estimates of the amount of human energy that is put into those land use types. The LDI is calculated by multiplying each land use coefficient by the percentage of the area of interest occupied by that land use, and then summing the results. The Florida Department of Environmental Protection (DEP) uses the LDI as a tool to estimate potential land use impacts on streams, lakes, and wetlands. For streams and rivers, DEP typically uses a LDI calculated for the 100 m buffer of the waterbody for 10 km upstream of the point of interest. For lakes and isolated wetlands, DEP typically uses a LDI calculated for the 100 m buffer around the waterbody. LDI values less than two (≤ 2) can be considered minimally disturbed.”

LAKE BATHYMETRY AND MORPHOLOGICAL CHARACTERISTICS ASSESSMENT

The **Bathymetric Map**¹ provides the lake’s morphologic parameters in various units. The bottom of the lake was mapped using a Lowrance Elite 7 Ti Wide Area Augmentation System (WAAS)² enabled Global Positioning System (GPS) with Totalscan transducer (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. 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.

¹ 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.

² 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 VEGETATION INDEX ASSESSMENT

Hillsborough County requested the implementation of the Florida Department of Environmental Protection methods for Lake Vegetation Index (LVI 1000) (<http://www.dep.state.fl.us/water/sas/sop/sops.htm>) using forms FD 9000-03 (Physical/Chemical Characterization), FD 9000-06 (Lake Habitat Assessment) FD 9000-27 (LVI Field Sheet) and FD 9000-31 (Lake Observation Field Sheet).

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 43.

Four metrics are utilized in the Lake Vegetation Index Survey; Dominant Coefficient of Conservatism (CoC), Percent Florida Exotic Pest Plant Council Type 1 (% FLEPPC), Percent Native Taxa, Percent Sensitive Taxa.

The Dominant Coefficient of Conservatism (CoC) metric for the dominant or co-dominate species in each section. The CoC applies a score of 0-10 to each species based on its ecological tolerances and fidelity to pre-settlement conditions. Species with higher scores show a high fidelity to native, undisturbed habitats and are typically sensitive to alterations. Available CoC scores can be obtained from LT 7000 from the Florida Department of Environmental Protection at: <http://www.dep.state.fl.us/water/sas/sop/sops.htm>.

The percent FLEPPC (Florida Exotic Pest Plant Council) Category 1 invasive exotic taxa in a single sampling unit (pie slice) by dividing the number of FLEPPC Category I taxa by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 to determine which plants are on the FLEPPC Category 1 list. Note that not all exotic taxa should be included in this metric, only those listed in Appendix LVI 1000-1 as Category 1 FLEPPC. If the FLEPPC updates their list of Category 1 exotics, those updates shall not be reflected in this calculation until they are included in Appendix LVI 1000-1.

The percent native taxa in a single sampling unit (pie slice) is calculated by dividing the number of native taxa by the total number of taxa in that sampling unit. Multiply result times 100. Nativity status is determined by the Plant Atlas from the Institute for Systematic Botany, and is listed in Appendix LVI 1000-1. For informational purposes, visit the website

<http://www.florida.plantatlas.usf.edu/>. Taxa that are native according to the Plant Atlas from the Institute for Systematic Botany but are not on the list in Appendix LVI 1000-1 may be included in this metric calculation, but inclusion of these additional taxa is not required.

The percent sensitive taxa in a single sampling unit by summing the number of taxa with a C of C (Coefficient of Conservatism) score ≥ 7 and then dividing by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 for a list of C of C scores.

The collected bathymetric data is analyzed for submerged aquatic vegetation (SAV) calculations including the percentage of the surface area of the lake inhabited by SAV as well as an estimate of the percent volume of the lake inhabited by SAV. SAV is an important component to a lakes nutrient cycling as well as chlorophyll concentrations due to the SAV and phytoplankton competing for available nutrients in the water column. In addition SAV serves a vital role as habitat for many species of macroinvertebrates and fish as well as substrate for epiphytic algae.

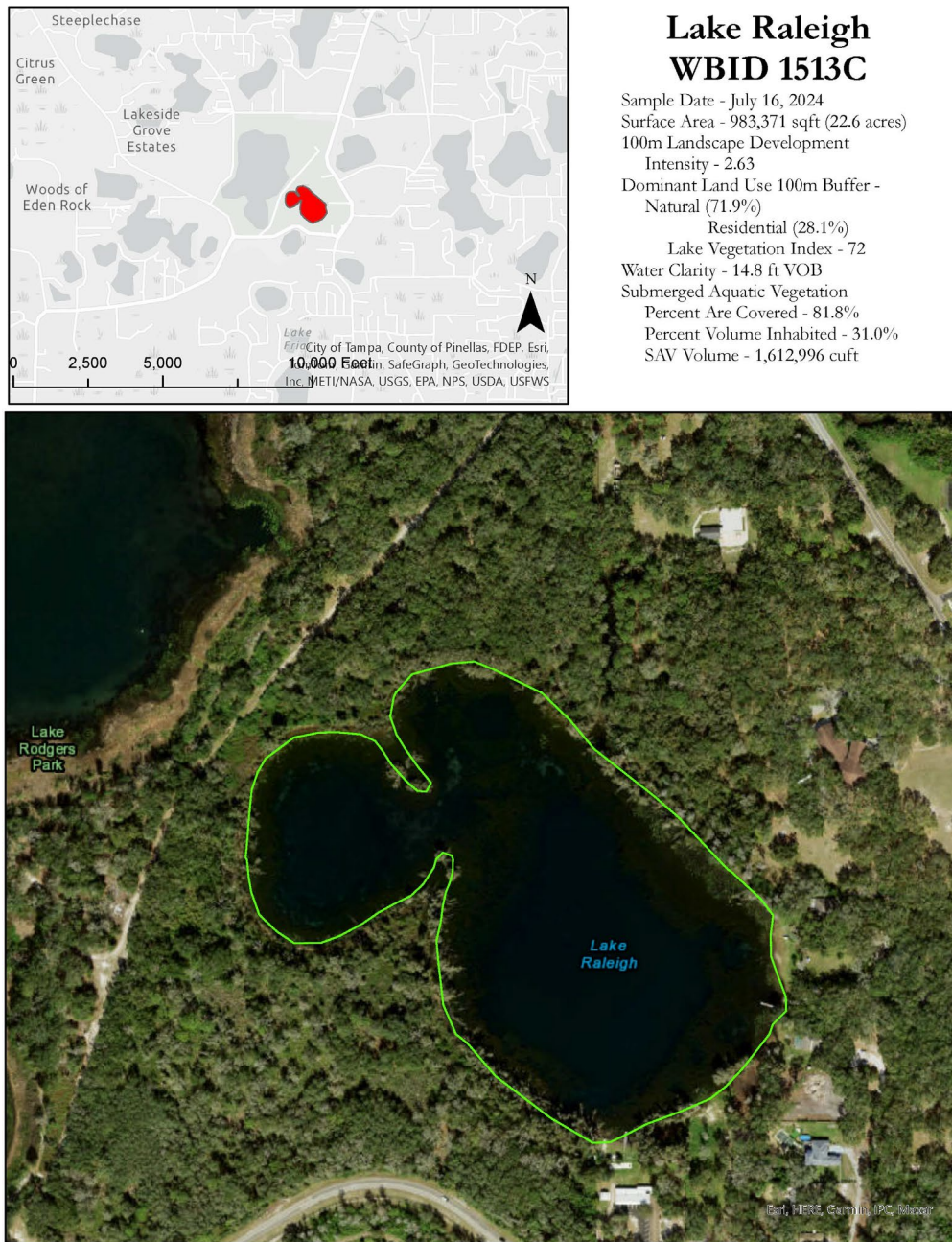
WATER QUALITY ASSESSMENT

Physical water quality samples were taken using a Eureka Manta Sub-2 multiprobe pre and post calibrated on the day of the assessment. Measurements taken with this device include: depth, conductivity, pH, Dissolved Oxygen (mg/l and % Saturation) and salinity. Chemical water parameters were collected and preserved on ice by USF Water Institute staff and analyzed at the Hillsborough County Public Utilities Laboratory Analysis include; Chlorophyll (a, b, c, t and corrected), Alkalinity, Color, E Coli, Enterococci, Ammonia, Nitrates/Nitrites, Total Phosphorous, Kjeldahl Nitrogen and Total Nitrogen. The results of the water quality sampling effort will be discussed in the framework of the FDEP Numeric Nutrient Criteria. Due to the lack of public access to the majority of lakes in Hillsborough County, the majority of available water quality samples are from the resident volunteer LAKEWATCH program. This data is being included in the analysis of Hillsborough County lakes.

Study Area

Lake Raleigh is located in the Coastal Old Tampa Bay Watershed in north-western Hillsborough County, Florida. The Landscape Development Intensity Index of the 100 meter buffer around Lake Raleigh is dominated by natural (71.9%) and residential (28.1%) land uses. The resulting LDI value for the 100 meter buffer around Lake Raleigh is 2.63.

FIGURE 1: 2024 LAKE RALEIGH ASSESSMENT STUDY AREA MAP



Lake Bathymetry and Morphological Characterization

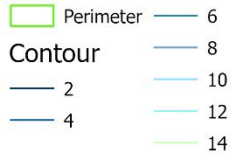
At the time of the assessment, Lake Raleigh was experiencing low water levels (33.45 feet NAVD88 on staff gauge) resulting in a 22.6 acre water body. Lake Raleigh at the time of the assessment had a mean water depth of 5.3 feet and a maximum observed depth of 14.3 feet. The volume at this time was approximately 38,906,772 gallons. Figure 2 shows the resulting bathymetric contour map for Lake Raleigh from data collected on July 16, 2024. The collected data has been overlain the 2023 ESRI Basemap aerials.

Table 1: Morphological Calculations for Lake Raleigh

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	983,371	91,357	22.6		
Mean Depth	5.3	1.61			
Maximum Depth	14.3	4.37			
Volume (cubic)	5,201,043	147,276		119.4	38,906,772
Gauge (NAVD 88)	33.45	10.20			

Figure 2: 2024 2-Foot Bathymetric Contour Map for Lake Raleigh

Lake Raleigh



EXPLANATION:
 Survey Date: July 16, 2024
 Water level was 33.45 ft NAVD88
 at the time of the assessment.
 Contours are expressed in absolute
 depth below this level.

LAKE MORPHOLOGY:
 Perimeter 4,904 ft;
 Area 22.6 Acres;
 (983,371 Sqft)
 Mean Depth 5.3 ft;
 Volume 119.4 Acre-ft,
 (38,906,772 gallons);
 Deepest point 14.34 ft

DATA SOURCES:
 2023 aerial photography provided by
 ESRI.
 Lake perimeter digitized from Hillsborough
 County 2023 aerial photographs.
 All contours generated by the USF Water
 Institute from survey data collected by
 USF Water Institute Lake and Stream

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

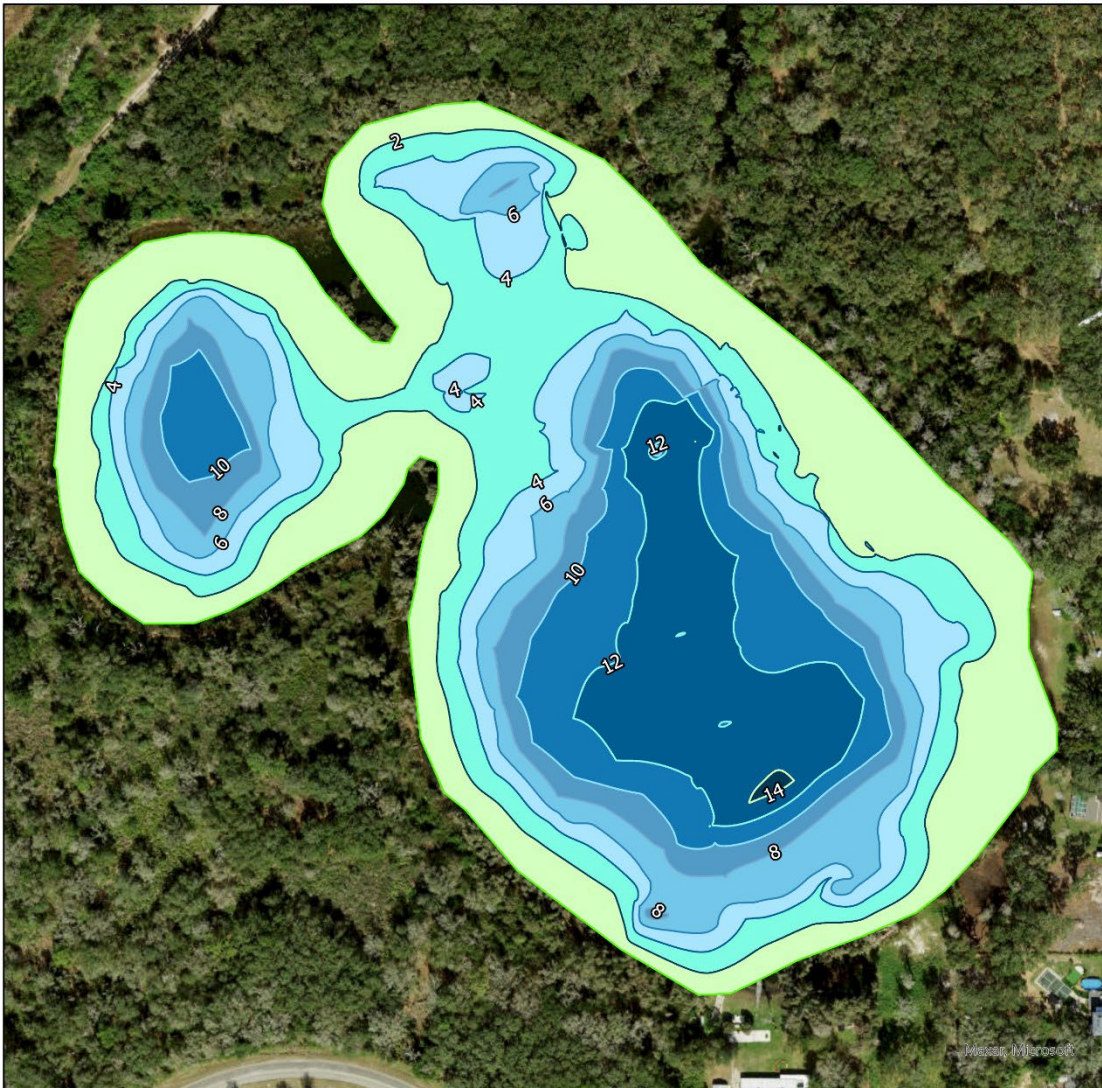




Figure 3 Lake Raleigh had robust growth by the native submersed species *myriophyllum laxum*.

Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Lake Raleigh was conducted on July 16, 2024. The water in Lake Raleigh was characterized as clear with low turbidity. The secchi disk depth was 4.37 meters. The vegetation quality of the plants in and buffering Lake Raleigh are predominantly native species with some extensive growths of non-native *Mekakeuca quinquenervia* and moderate growth of *Panicum repens*. The percentage of non-native FLEPPC 1 species ranged from 6.25% (region 8) to 15% (region 11). Stormwater reaches the lake predominately via sheet flow off undeveloped natural groundcover. The development along the shoreline is limited to the southeastern shoreline. The bottom substrate quality was dominated by sand and submersed vegetation.



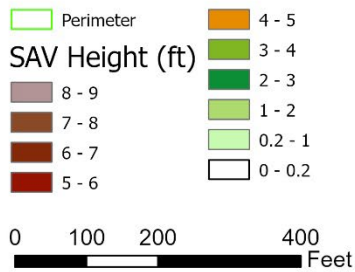
Figure 4 Melaleuca quinquenervia was common along the undeveloped shorelines of Lake Raleigh

The Lake Vegetation Index identified 25 species of wetland vegetation growing in the four selected sections along Lake Raleigh. The majority of these species (21) are native species. The remaining 5 species (*shown in Table 2*) are non- native or invasive to this region. The vegetation community along the shorelines of Lake Raleigh has been largely left natural with a forested upland. At the time of the assessment the water transparency was 4.37 m (14.3 ft). High annual average secchi disk depths allow for an extensive littoral zone with establishment of floating leaved and submerged aquatic vegetation. A single species of submersed aquatic vegetation was observed during the lake vegetation index, *Myriophyllum laxum*. This species dominated the in water habitat of Lake Raleigh to the deepest portions of the lake. The floating leaved vegetation community had 3 species present, including *Nuphar*, *Nymphaea odorata* and *Hydrocotyle*.

By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered 81.79% of the surface area of Lake Raleigh. This submerged vegetation inhabits an estimated 31.01% of the water volume in Lake Raleigh. Figure 5 shows the results of the SAV analysis indicating the location and height of SAV estimated from collected sonar readings.

The calculated LVI score for Lake Raleigh was 72, above the impairment threshold of 43 indicating the vegetation community is not showing evidence of being “Impaired”. Figure 6 shows the map of Lake Raleigh detailing the LVI regions used for the assessment (Regions 2, 5, 8, 11). Table 2 details the species list results of the Lake Vegetation Index. Table 3 details the scoring result for the Lake Vegetation Index.

Lake Raleigh



EXPLANATION:

Survey Date: July 16, 2024
 Water level was 33.45 NAVD88
 at the time of the assessment.
 Submerged Aquatic Vegetation was
 analyzed from collected sonar data.
 The height of the SAV where present
 is shown in 1 foot increments.

DATA SOURCES:

2023 aerial photography provided by
 ESRI.
 Lake perimeter digitized from Hillsborough
 County 2023 aerial photographs.
 All contours generated by the USF Water
 Institute from survey data collected by
 USF Water Institute Lake and Stream
 Assessment Program

SAV STATISTICS:

Area 804,336 square ft; 18.5 Acres;
 (81.79% of Lake Surface Area)
 Mean SAV Height 2.0 ft;
 Volume 1,612,996 Cubic ft, (12,066,128
 gallons);
 (31.01% of Lakes Volume)



Water Institute

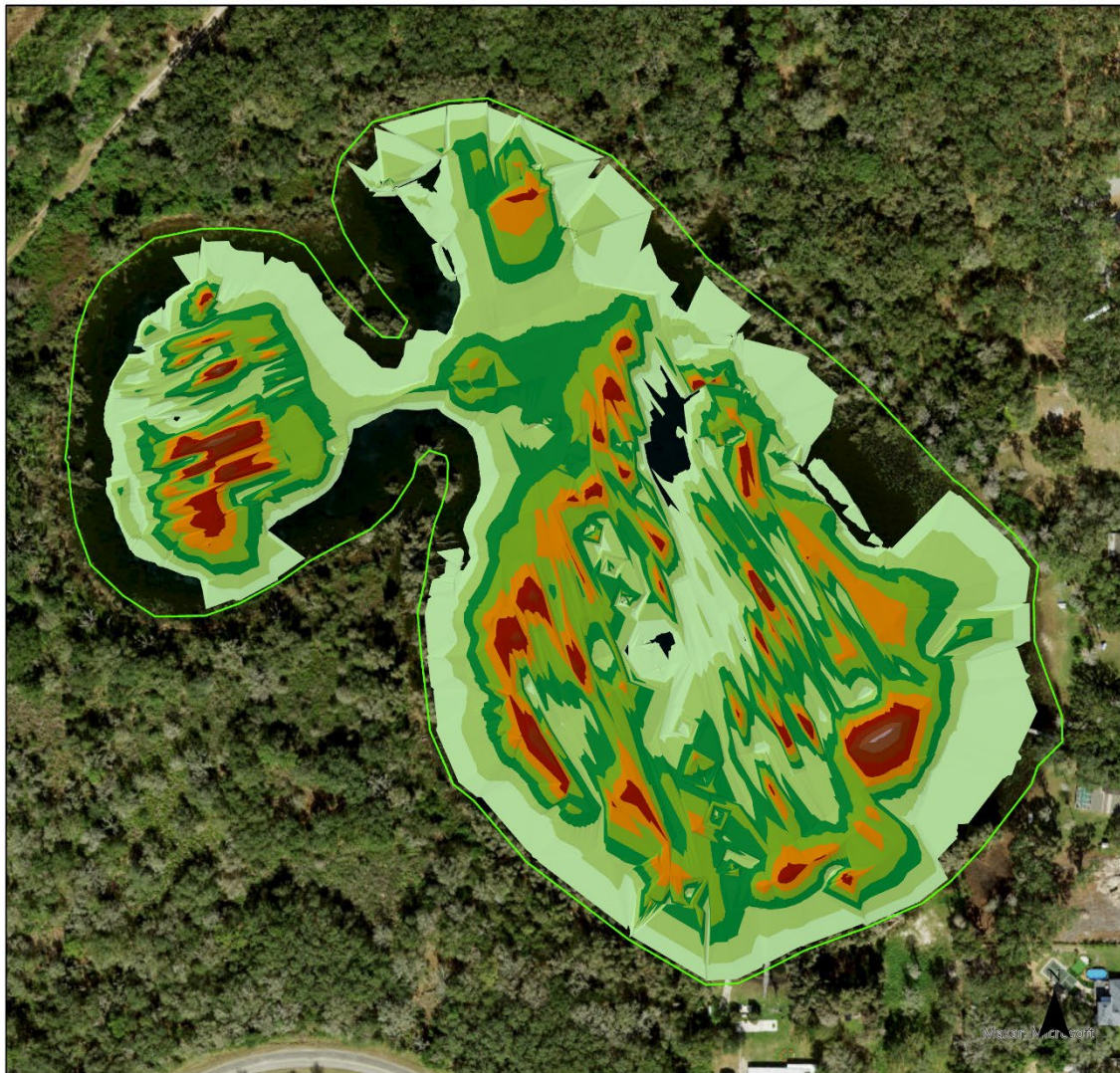


Figure 5 Lake Raleigh Submerged Aquatic Vegetation Assessment Results

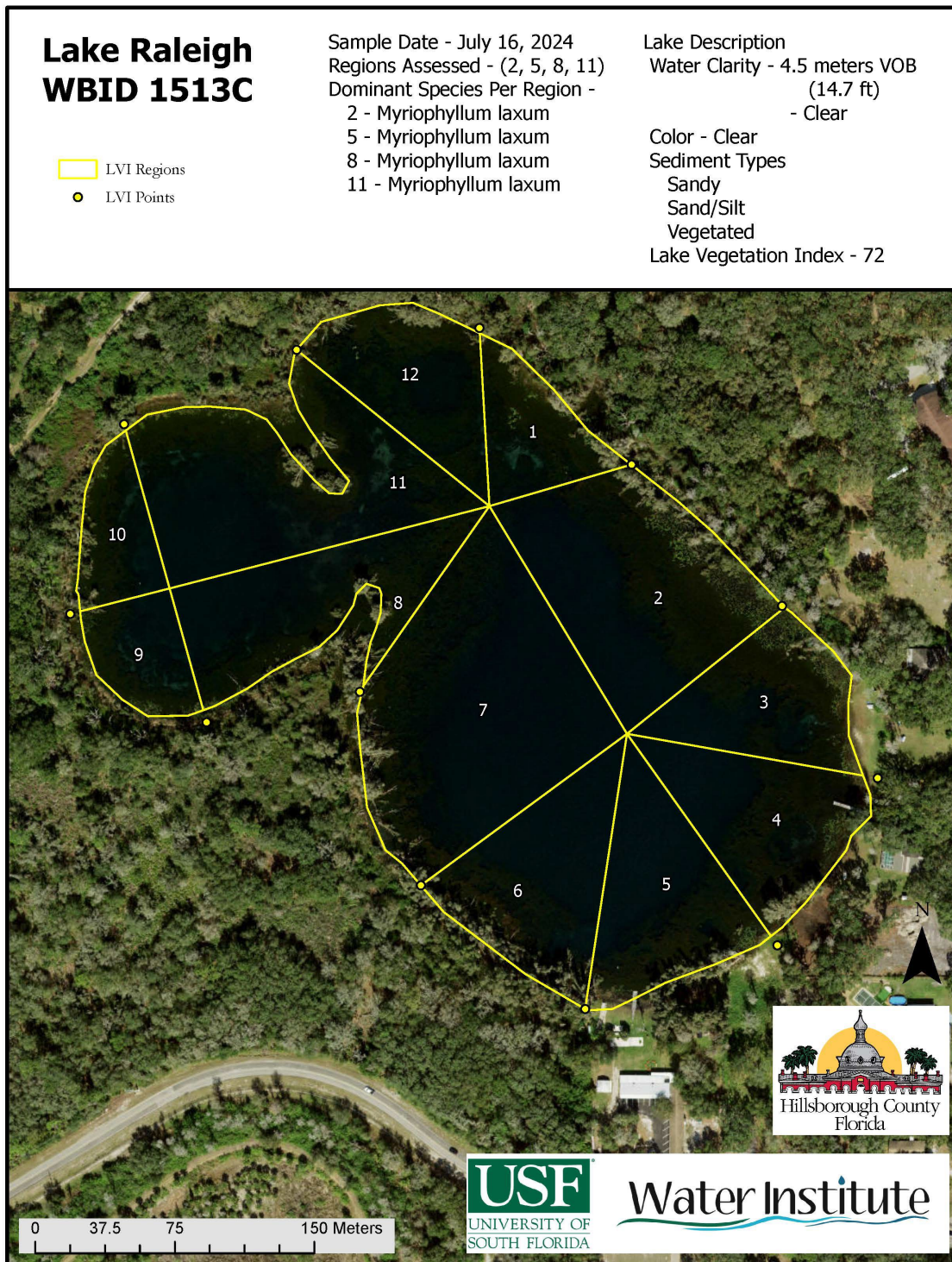


Figure 6: Lake Vegetation Index region map for Lake Raleigh

Table 2: Lake Vegetation Index results for Lake Raleigh July 16, 2024. In this table, “p” represents the taxa was present in the region while “c” and “d” denotes the taxa as being co-dominant or dominant in the vegetation region.

Taxon	2	5	8	11	Occurrences	C of C Score	FLEPPC Status	Wetland Status	Nativity
<i>Andropogon</i>	p	p	p	p	4	-9.00	Not Listed	Var Genus	Native
<i>Cyperus odoratus</i>	p	p	p	p	4	3.00	Not Listed	FACW	Native
<i>Eleocharis baldwinii</i>	p	p	p	p	4	2.82	Not Listed	OBL	Native
<i>Eleocharis geniculata</i>	p		p	p	3	2.50	Not Listed	OBL	Native
<i>Eupatorium capillifolium</i>	p	p	p	p	4	0.83	Not Listed	FAC	Native
<i>Fuirena scirpoidea</i>				p	1	5.50	Not Listed	OBL	Native
<i>Hydrocotyle</i>		p		p	2	2.00	Not Listed	FACW	Native
<i>Lachnanthes caroliniana</i>	p	p	p	p	4	3.76	Not Listed	FAC	Native
<i>Ludwigia octovalvis</i>	p		p	p	3	2.00	Not Listed	OBL	Native
<i>Ludwigia peruviana</i>				p	1	0.00	Category 1	OBL	Exotic
<i>Melaleuca quinquenervia</i>	p	p	p	p	4	0.00	Category 1	FAC	Exotic
<i>Myrica cerifera</i>	p				1	2.00	Not Listed	FAC	Native
<i>Myriophyllum laxum</i>	D	D	D	D	4	7.50	Not Listed	OBL	Native
<i>Nuphar</i>	p	p	p	p	4	3.50	Not Listed	OBL	Native
<i>Nymphaea odorata</i>	p	p		p	3	5.00	Not Listed	OBL	Native
<i>Panicum hemitomon</i>		p	p		2	5.82	Not Listed	OBL	Native
<i>Panicum repens</i>				p	1	0.00	Category 1	FACW	Exotic
<i>Persicaria hydropiperoides</i>				p	1	2.50	Not Listed	OBL	Native
<i>Pluchea baccharis</i>				p	1	5.45	Not Listed	FACW	Native
<i>Rhynchospora microcephala</i>			p		1	3.50	Not Listed	FACW	Native
<i>Rhynchospora nitens</i>	p		p	p	3	4.00	Not Listed	OBL	Native
<i>Triadenum virginicum</i>			p	p	2	5.00	Not Listed	OBL	Native
<i>Typha</i>		p			1	1.00	Not Listed	OBL	Native
<i>Urena lobata</i>			p		1	0.00	Category 2	UPL	Exotic
<i>Xyris</i>	p		p	p	3	-9.00	Not Listed	OBL	Native

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Sample Result: 72				
Region		South		
Metric / Section	2	5	8	11
Total # Taxa	14	12	16	20
% Native Taxa	92.9	91.7	87.5	85.0
% FLEPPC 1 Taxa	7.14	8.33	6.25	15.00
% Sensitive Taxa	7.14	8.33	6.25	5.0
Dom Taxa Count	1	1	1	1
CofC Dom Taxa	7.50	7.50	7.50	7.50
Section LVI	78.0	77.6	72.7	61.5

Water Quality Assessment

Limited long-term water quality data is available for Lake Raleigh. The available data was collected by Southwest Florida Water Management District, Florida Department of Environmental Protection and Hillsborough County Environmental Services. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of Lake Raleigh during the University of South Florida/ Hillsborough County Environmental Services assessment in 2024.

Table 4: Lake Raleigh Water Quality 7/16/2024 (Field)

Meter Readings:	Depth m	Temp (°C)	pH (SU)	D.O (mg/L)	D.O Sat. (%)	Cond. (µMho/cm)	Salinity (ppt)
Top:	0.25	32.3	8.1	7.37	94.8	179.5	0.08
Mid-Depth:	2.2	32.1	8	7.32	93.8	178.2	0.08
Bottom:	4.06	31.8	7.8	7.42	95.1	178.9	0.08

The chemical water quality analysis for Lake Raleigh is shown in Table 5. These values are the geometric mean value of available data for each annual period as well as the period of record. The FDEP Numeric Nutrient Criteria splits lakes into separate types based on color at 40 PCU. The “clear” water lakes below this value are further split into alkaline and acidic based on an alkalinity value of 20 mg/L CaCO₃. The long term color data have a geometric mean value of 11 PCU, classifying it as a clear water lake (less than 40 PCU). Total Alkalinity period of record geometric mean value is 2 mg/L. The NNC thresholds for a clear acidic lake with insufficient data to calculate NNC (Previous three years with at least 4 samples per year in separate seasons) are 6 µg/L for Chlorophyll-a Corrected for Phaeophytin, 0.01 mg/L for Total Phosphorous and 0.51 mg/L for Total Nitrogen.

The past three years of sampling consists of a single sample in 2022 and 7 samples in 2024 between April and September. Geometric mean Chlorophyll-a corrected values for the past three years are below the threshold with annual geometric means of 3.3 µg/L (2022) and 3.01 µg/L (2024). The period of record geometric mean for chlorophyll-a corrected is 2.97 µg/L. Total Phosphorous geometric mean values for the most recent data were below the nutrient threshold for clear acidic lakes in the peninsula region with insufficient data with a value of 0.005 mg/L (2022), however, the 2024 samples were below the laboratory detection limit of 0.068 mg/L for the Hillsborough County Public Utilities Laboratory. Total Nitrogen values were below the nutrient threshold for clear acidic lakes with insufficient data with a value of 0.120 mg/l (2022), and 0.162 mg/L (2024). Table 6 includes this data in the numeric nutrient criteria framework using the data from this assessment and the previous 3 years of data collected by Hillsborough County and FDEP.

Bacteria testing showed low levels of E. Coli (1.0 colonies/100ml) and Enterococci (1 colonies/100ml) exceeding the rules set forth in FDEP 62-302.530 (<https://www.flrules.org/gateway/RuleNo.asp?title=SURFACE%20WATER%20QUALITY%20STANDARDS&ID=62-302.500>) “Most Probable Number (MPN) or Membrane Filter (MF) counts shall

not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period.”

Table 5: Lake Raleigh FDEP and Hillsborough County Environmental Services Water Quality Results Laboratory Results

Parameter	2022	2023	2024	POR Mean Value	Units
Alkalinity	No data	No data	5.0	2.0	mg/LCaCO₃
Color	No data	No data	No data	11	PCU
E Coli	3.1	No data	1	1.16	#/100ml
Enterococci	No data	No data	1	1.51	#/100 ml
Chlorophyll a	2.9	No data	2.72	3.39	ug/L
Chlorophyll b	No data	No data	2.59	1.93	ug/L
Chlorophyll c	No data	No data	2.71	2.02	ug/L
Chlorophyll a Corrected	3.3	No data	3.01	2.97	ug/L
Ammonia	0.003	No data	<0.073	0.003	mg/L
Nitrates/Nitrites	0.004	No data	<0.043	0.004	mg/L
Kjeldahl Nitrogen	0.160	No data	0.159	0.159	mg/L
Total Nitrogen	0.120	No data	0.162	0.409	mg/L
Total Phosphorus	0.005	No data	<0.068	0.011	mg/L

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean Color (pcu)	11
Number of Samples	102
Geometric Mean Alkalinity (mg/L CaCO ₃)	2
Number of Samples	97
Lake Type	Clear-acidic

Year (# of Samples)	Geomean Chla Corrected (µg/L)	Chlorophyll a Criteria (µg/L)	Geomean Total Phosphorous (mg/L)	Total Phosphorous Criteria (mg/L)	Geomean Total Nitrogen (mg/L)	Total Nitrogen Criteria (mg/L)
2022 (1)	3.3	< 6	0.005	< 0.01	0.120	< 0.51
2023 (0)	No Data	< 6	No Data	< 0.01	No Data	< 0.51
2024(7)	3.01	< 6	<0.068	< 0.01	0.162	< 0.51

Conclusion

Lake Raleigh is a predominately natural lake in the Coastal Old Tampa Bay Watershed of Hillsborough County, Florida. The results of the assessment of Lake Raleigh shows a potentially healthy lake based on Chlorophyll-a, Total Nitrogen and Total Phosphorous concentrations according to the FDEP numeric nutrient criteria however there is insufficient data to calculate the past three years of data.

The system does not show impairment in the vegetation communities according to the Lake Vegetation Index with low invasive species (3) and an overall LVI score of 72. The native species *Myriophyllum laxum* is largely responsible for the high LVI score due to being dominant in each of the four regions assessed. The assessment revealed a robust submerged aquatic vegetation community currently occupying 81.79% of the surface area and 31.01% of the volume of Lake Raleigh.