



Keystone Lake

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

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Methods

STUDY AREA ANALYSIS

The watershed containing the Keystone Lake was analyzed using ESRI ArcGIS Pro. Using this software with 2022 ESRI Basemaps aerial, 2017 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.

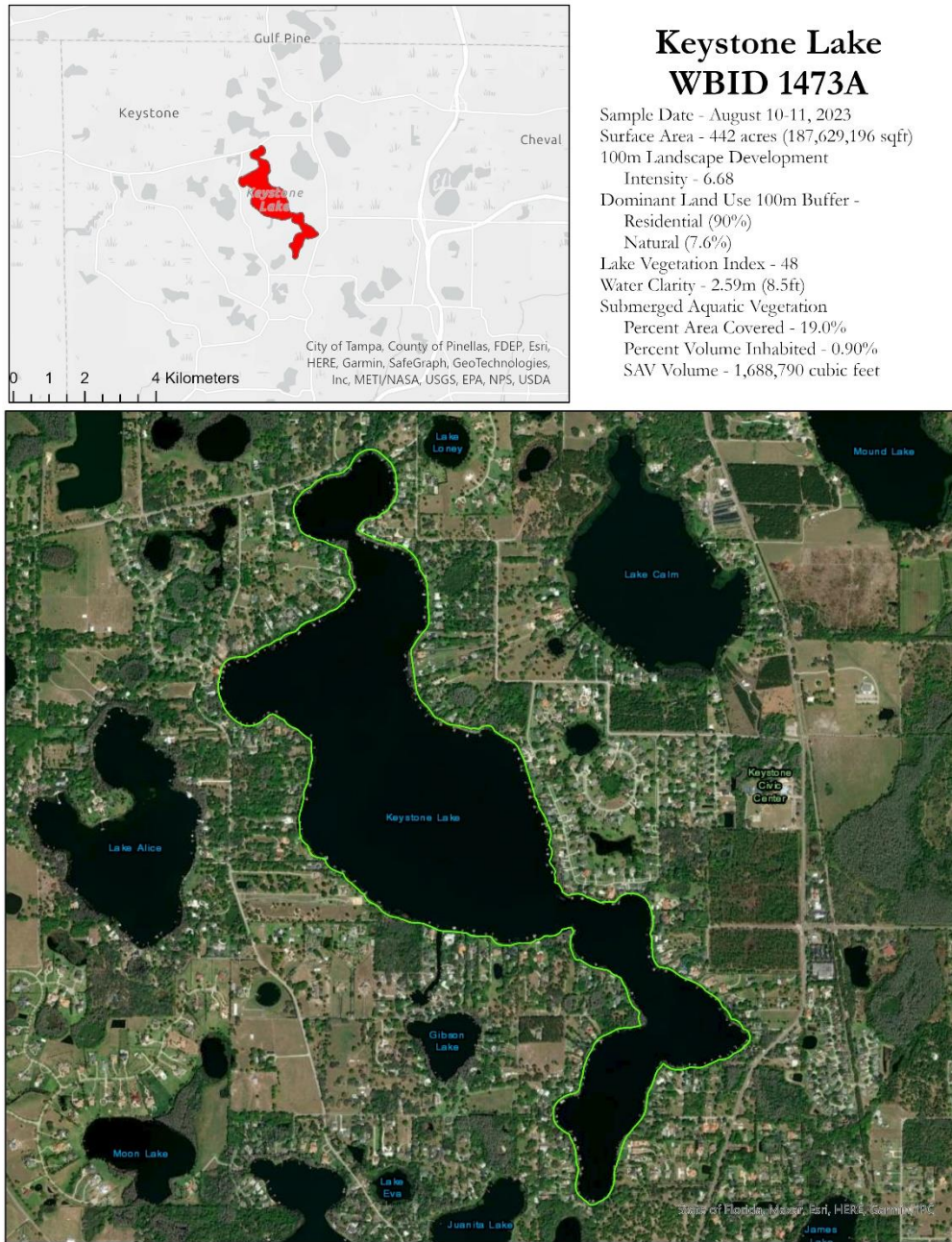
WATER QUALITY ASSESSMENT

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

Keystone Lake 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 Keystone is dominated by residential (90%) and natural (7.6%) land uses. The resulting LDI value for the 100 meter buffer around Keystone Lake is 6.68.

FIGURE 1: 2023 KEYSTONE LAKE ASSESSMENT STUDY AREA MAP



Lake Bathymetry and Morphological Characterization

At the time of the assessment, Keystone Lake was experiencing normal water levels (40.15 feet NAVD88 on staff gauge) resulting in a 441.6 acre water body. Keystone Lake at the time of the assessment had a mean water depth of 6.2 feet and a maximum observed depth of 15.79 feet. The volume at this time was approximately 125,556,558 gallons. Figure 2 shows the resulting bathymetric contour map for Keystone Lake from data collected on August 10-11, 2023. The collected data has been overlain the 2022 ESRI Basemap aeriels.

Table 1: Morphological Calculations for Keystone Lake

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	19,237,313	1,787,190	441.6		
Mean Depth	9.8	2.97			
Maximum Depth	24.51	7.47			
Volume (cubic)	187,629,196	5,313,017		4,307.4	1,403,573,582
Gauge (NAVD 88)	40.15	12.24			

Figure 2: 2023 4-Foot Bathymetric Contour Map for Keystone Lake

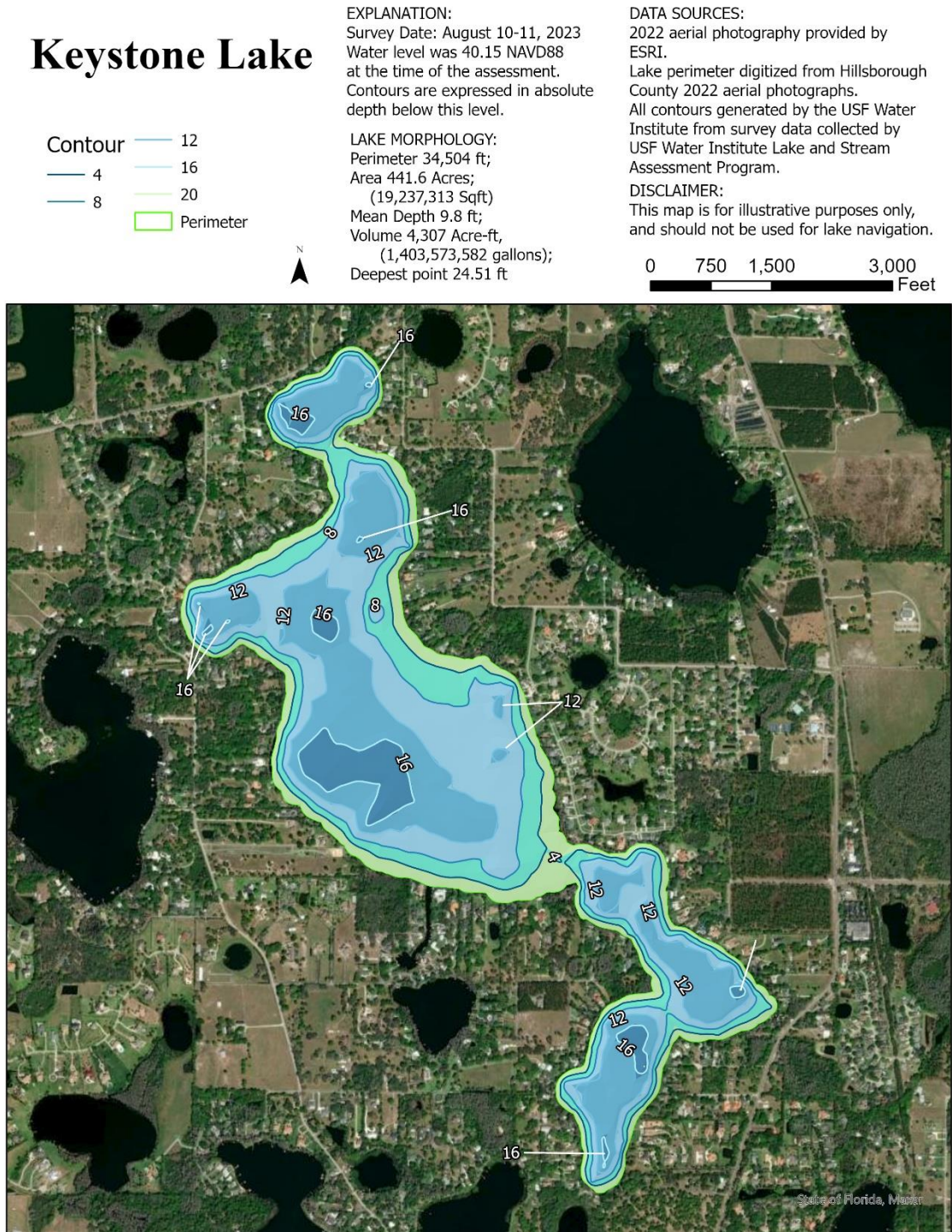




Figure 3 Overview photograph of Keystone Lake showing the typical residential shoreline featuring a *Taxodium* canopy with the sub-canopy and groundcover strata altered.

Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Keystone Lake was conducted on August 10-11, 2023. The water in Keystone Lake was characterized as tannic and slightly turbid. The secchi disk depth was 2.59 meters allowing for an abundant submerged aquatic vegetation community along the littoral zone. The vegetation quality of the plants in and buffering Keystone Lake are predominantly native species with moderate growths of non-native invasive species such as *Limnophila sessiliflora* and *Panicum repens*. The percentage of non-native FLEPPC 1 species ranged from 13% (region 12) to 20% (region 9). Stormwater reaches the lake predominately via sheet flow from surrounding residential land cover. The development along the shoreline has maintained the nearshore *Taxodium* however the shrub and native ground cover communities have largely been maintained for residential turf grasses and many cleared shoreline beaches or seawalls. The bottom substrate quality was dominated by sandy/silt with coarse particulate organic matter near shore and submersed vegetation.



Figure 4 *Mayaca fluviatilis*, Bogmoss, was co-dominant in regions 3 and 9 as well as dominant in region 12 of the Lake Vegetation Index on Keystone Lake

The Lake Vegetation Index identified 57 species of wetland vegetation growing in the four selected sections along Keystone Lake. The majority of these species (47) are native species. The remaining 10 species (*shown in bold in Table 2*) are non- native or invasive to this region. The vegetation community along the shorelines of Keystone Lake has been altered by lawn maintenance activities leaving a *Taxodium* canopy with a sparse shrub and ground cover community. The edges of the lake are dominated by species able to rapidly colonize following the frequent disturbance of mowing, such as *Panicum repens* and *Ludwigia peruviana*. At the time of the assessment the water transparency was 2.59 m (8.5 ft). High annual average secchi disk depths allow for an extensive littoral zone with establishment of floating leaved and submerged aquatic vegetation. Eight species of submersed aquatic vegetation were observed during the lake vegetation index. *Bacopa caroliniana*, *Limnophila sessiliflora* and *Mayaca fluviatilis* were co-dominant and dominant species in LVI regions. The floating leaved vegetation community had 4 species observed with both *Nuphar* and *Nymphaea odorata* being the most abundant in LVI regions.

By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 18.99% of the surface area of Keystone Lake. This submerged vegetation inhabits an estimated 0.90% of the water volume in Keystone Lake. 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 Keystone Lake was 48, above the impairment threshold of 43 indicating the vegetation community is showing evidence of being “Healthy” though showing numerous invasive species. Figure 6 shows the map of Keystone Lake detailing the LVI regions used for the assessment (Regions 3, 6, 9, 12). Table 2 details the species list results of the Lake Vegetation Index. Table 3 details the scoring result for the Lake Vegetation Index.

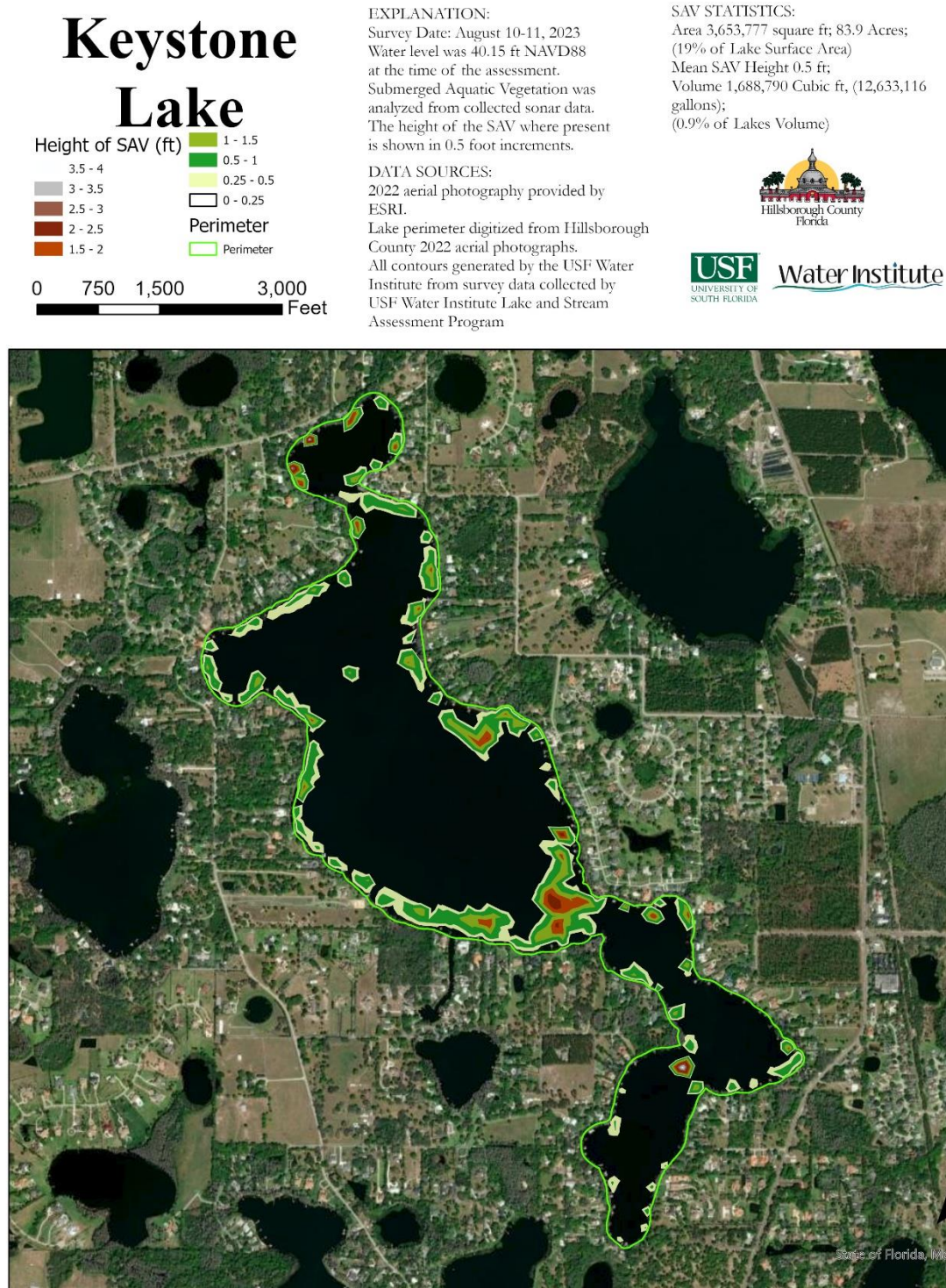


Figure 5 Keystone Lake Submerged Aquatic Vegetation Assessment Results

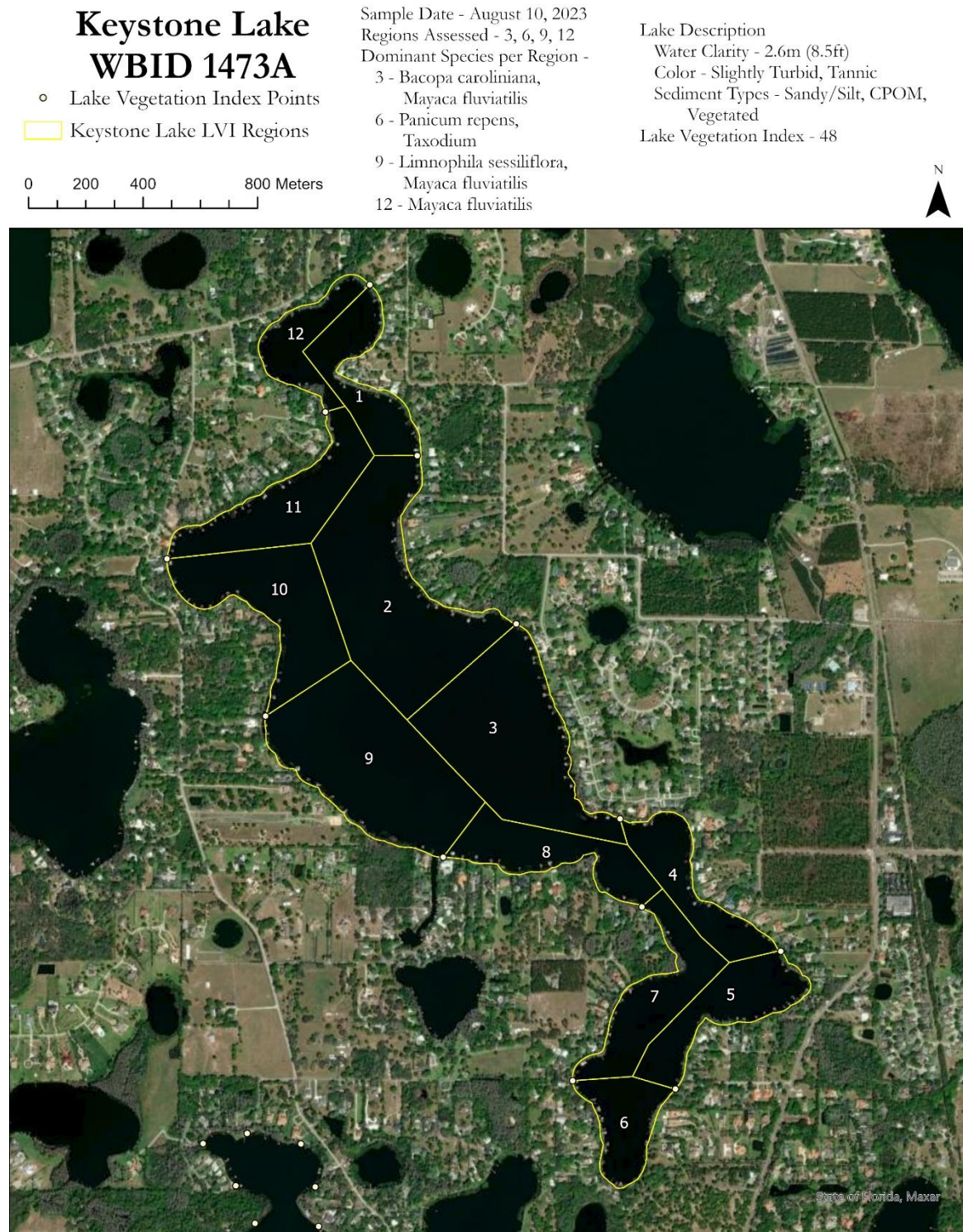


Figure 6: Lake Vegetation Index region map for Keystone Lake

Table 2: Lake Vegetation Index results for Keystone Lake August 10-11, 2023. 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	CofC Score	FLEPPC Status	Wetland Status	Nativity	Region				Occurrence
					3	6	9	12	
<i>Acer rubrum</i>	4.65	-	FACW	Native	p	p	p	p	4
<i>Bacopa caroliniana</i>	4.50	-	OBL	Native	c	p	p	p	4
<i>Cyperus odoratus</i>	3.00	-	FACW	Native	p	p	p	p	4
<i>Eleocharis baldwinii</i>	2.82	-	OBL	Native	p	p	p	p	4
<i>Limnophila sessiliflora</i>	0.00	Category 2	OBL	Exotic	p	p	c	p	4
<i>Ludwigia octovalvis</i>	2.00	-	OBL	Native	p	p	p	p	4
<i>Ludwigia peruviana</i>	0.00	Category 1	OBL	Exotic	p	p	p	p	4
<i>Mayaca fluviatilis</i>	8.45	-	OBL	Native	c	p	c	d	4
<i>Melaleuca quinquenervia</i>	0.00	Category 1	FAC	Exotic	p	p	p	p	4
<i>Myrica cerifera</i>	2.00	-	FAC	Native	p	p	p	p	4
<i>Nitella</i>	6.00	-	OBL	Native	p	p	p	p	4
<i>Nuphar</i>	3.50	-	OBL	Native	p	p	p	p	4
<i>Nymphaea odorata</i>	5.00	-	OBL	Native	p	p	p	p	4
<i>Panicum hemitomon</i>	5.82	-	OBL	Native	p	p	p	p	4
<i>Panicum repens</i>	0.00	Category 1	FACW	Exotic	p	c	p	p	4
<i>Pontederia cordata</i>	5.38	-	OBL	Native	p	p	p	p	4
<i>Sagittaria lancifolia</i>	3.00	-	OBL	Native	p	p	p	p	4
<i>Sphagneticola trilobata</i>	0.00	Category 2	FACW	Exotic	p	p	p	p	4
<i>Taxodium</i>	7.00	-	OBL	Native	p	c	p	p	4
<i>Blechnum serrulatum</i>	5.50	-	FACW	Native	p	p	-	p	3
<i>Cyperus blepharoleptos</i>	0.00	-	OBL	Exotic	p	p	-	p	3
<i>Cyperus haspan</i>	4.00	-	OBL	Native	p	-	p	p	3

Taxon	CofC Score	FLEPPC Status	Wetland Status	Nativity	Region				Occurrence
					3	6	9	12	
<i>Hydrocotyle</i>	2.00	-	FACW	Native	p	p	-	p	3
<i>Nymphoides cristata</i>	0.00	Category 1	OBL	Exotic	p	p	p	-	3
<i>Schinus terebinthifolius</i>	0.00	Category 1	FAC	Exotic	-	p	p	p	3
<i>Utricularia gibba</i>	6.37	-	OBL	Native	p	-	p	p	3
<i>Boehmeria cylindrica</i>	5.00	-	OBL	Native	-	p	-	p	2
<i>Cinnamomum camphora</i>	0.00	Category 1	UPL	Exotic	-	p	-	p	2
<i>Colocasia esculenta</i>	0.00	Category 1	OBL	Exotic	-	p	-	p	2
<i>Eupatorium capillifolium</i>	0.83	-	FAC	Native	-	p	-	p	2
<i>Fuirena scirpoidea</i>	5.50	-	OBL	Native	p	-	p	-	2
<i>Leersia hexandra</i>	5.61	-	OBL	Native	-	-	p	p	2
<i>Liquidambar styraciflua</i>	2.50	-	FACW	Native	-	p	-	p	2
<i>Luziola fluitans</i>	4.00	-	OBL	Native	p	p	-	-	2
<i>Paspalidium geminatum</i>	5.50	-	OBL	Native	p	p	-	-	2
<i>Persea</i>		-	-	Native	-	p	-	p	2
<i>Typha</i>	1.00	-	OBL	Native	p	-	p	-	2
<i>Vitis rotundifolia</i>	1.18	-	-	Native	-	-	p	p	2
<i>Canna flaccida</i>	5.50	-	OBL	Native	-	-	-	p	1
<i>Casuarina equisetifolia</i>	0.00	Category 1	FAC	Exotic	-	-	p	-	1
<i>Cephalanthus occidentalis</i>	5.00	-	OBL	Native	-	p	-	-	1
<i>Cyperus polystachyos</i>	1.56	-	FACW	Native	-	p	-	-	1
<i>Eleocharis interstincta</i>	7.80	-	OBL	Native	-	p	-	-	1
<i>Hydrilla verticillata</i>	0.00	Category 1	OBL	Exotic	-	p	-	-	1
<i>Ilex cassine</i>	6.00	-	OBL	Native	-	-	-	p	1
<i>Ipomoea indica</i>	1.23	-	-	Native	-	-	-	p	1
<i>Iris virginica</i>	5.50	-	OBL	Native	-	-	-	p	1
<i>Lachnanthes caroliniana</i>	3.76	-	FAC	Native	-	-	p	-	1

Taxon	CofC Score	FLEPPC Status	Wetland Status	Nativity	Region				Occurrence
					3	6	9	12	
<i>Ludwigia linearis</i>	5.72	-	OBL	Native	p	-	-	-	1
<i>Lycopus rubellus</i>	4.00	-	OBL	Native	-	p	-	-	1
<i>Melaleuca viminalis</i>	0.00	-	-	Exotic	-	-	-	p	1
<i>Osmunda regalis</i>	7.60	-	OBL	Native	-	p	-	-	1
<i>Sabatia grandiflora</i>	6.00	-	FACW	Native	-	-	p	-	1
<i>Sagittaria filiformis</i>	7.24	-	OBL	Native	p	-	-	-	1
<i>Triadenum virginicum</i>	5.00	-	OBL	Native	p	-	-	-	1
<i>Urochloa mutica</i>	0.00	Category 1	FACW	Exotic	p	-	-	-	1
<i>Vallisneria americana</i>	7.00	-	OBL	Native	-	-	-	p	1

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Sample Result: 48				
Region		South		
Metric / Section	3	6	9	12
Total # Taxa	33	37	30	38
% Native Taxa	76%	73%	73%	76%
% FLEPPC 1 Taxa	15%	19%	20%	13%
% Sensitive Taxa	9%	11%	7%	8%
Dom Taxa Count	2	2	2	1
CofC Dom Taxa	6.48	3.50	4.23	8.45
Section LVI	56	41	38	58

Water Quality Assessment

Long-term water quality data is available for Keystone Lake. The available data was collected by Lakewatch, 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 the Keystone Lake during the assessment in 2023.

Table 4: Keystone Lake Water Quality 8/10/2023 (Field)

Meter	Depth	Temp	pH	D.O	D.O Sat.	Cond.	Salinity
Readings:	(M)	(°C)	(SU)	(MG/L)	(%)	(UMHO/CM)	(PPT)
Top:	0.43	32.4	6.47	98.3	7.62	111	0.05
Mid-Depth:	1.81	32.3	6.21	96.2	7.47	111	0.05
Bottom:	3.54	32.3	6.18	93.6	7.27	110	0.05

The chemical water quality analysis for Keystone Lake is shown in Table 5 for the period record. Table 6 includes this data in the numeric nutrient criteria framework using the data from this assessment. The long term color data have a geometric mean value of 43 PCU, classifying it as a colored water lake (greater than or equal to 40 PCU). Total Alkalinity period of record geometric mean value is 4.0 mg/L. The NNC thresholds for a colored lake with sufficient data to calculate NNC (Previous three years with at least 4 samples per year in separate seasons) are 20 µg/L for Chlorophyll-a Corrected for Phaeophytin, 0.05-0.16 mg/L for Total Phosphorous and 1.27-2.23 mg/L for Total Nitrogen.

Geometric mean Chlorophyll-a corrected values for the past three years are below the threshold with annual geometric means of 0.6 µg/L (2021), 1.6 µg/L (2022) and 1.8 µg/L (2023). Total Phosphorous geometric mean values for the most recent data were below of the nutrient threshold for colored lakes in the peninsula region with sufficient data with a value of 0.015 mg/l (2021), 0.014 mg/L (2022) and 0.013 mg/L (2023). Total Nitrogen values were below the nutrient threshold for colored lakes with sufficient data with a value of 0.642 mg/l (2021), 0.608 mg/L (2022) and 0.600 mg/L (2023).

Table 5: Keystone Lake Period of Record Water Quality Results (Laboratory)

Parameter	POR Mean Value	Units
Alkalinity	4.0	mg/LCaCO₃
Color	43	PCU
Enterococci	36.6	#/100 ml
Chlorophyll a	3.95	ug/L
Chlorophyll a Corrected	1.7	ug/L
Ammonia	0.016	mg/L
Nitrates/Nitrites	0.270	mg/L
Kjeldahl Nitrogen	0.573	mg/L
Total Nitrogen	0.582	mg/L
Total Phosphorus	0.015	mg/L

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean Color (pcu)	43
Number of Samples	87
Geometric Mean Alkalinity (mg/L CaCO ₃)	4
Number of Samples	82
Lake Type	Colored

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)
2021 (12)	0.6	< 20	0.015	< 0.16	0.642	< 2.23
2022 (12)	1.57	< 20	0.014	< 0.16	0.608	< 2.23
2023 (7)	1.78	< 20	0.013	< 0.16	0.600	< 2.23

Conclusion

Keystone Lake is a predominately residential lake in the Coastal Old Tampa Bay Watershed of Hillsborough County, Florida. The results of the assessment of Keystone shows healthy lake based on Chlorophyll-a, Total Nitrogen and Total Phosphorous concentrations according to the FDEP numeric nutrient criteria using a combination of Lakewatch, Southwest Florida Water Management District and Hillsborough County Environmental Services datasets.

The system also shows health in the vegetation communities according to the Lake Vegetation Index with moderate invasive species (10) and an overall LVI score of 48. The assessment also revealed a submerged aquatic vegetation community comprising 8 species occupying 18.99% of the surface area and 0.90% of the volume of Keystone Lake.