



# Lake Keystone

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

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# Methods

## STUDY AREA ANALYSIS

The watershed containing the Lake Keystone was analyzed using ESRI ArcGIS 10.6. Using this software with 2017 Hillsborough County aerial, 2014 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 Reiss & Brown 2012 (Reiss & Brown, 2012. Landscape Development Intensity (LDI) Index User's Manual. H.T. Odum Center for Wetlands, University of Florida. March 2012). According to Reiss and Brown "The LDI represents a human disturbance gradient for wetland systems. The LDI is an integrated measure of human activity, combining the effects from air and water pollutants, physical damage, changes in the suite of environmental conditions ... on the structure and processes of landscapes and ecosystems... Natural, undeveloped LU/LC classes have a LDI index value of one. In the Florida framework, the maximum LDI index score is approximately 42."

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. LDI values less than two ( $\leq 2$ ) can be considered minimally disturbed."

## LAKE BATHYMETRY AND MORPHOLOGICAL CHARACTERISTICS ASSESSMENT

The **Bathymetric Map**<sup>1</sup> 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)<sup>2</sup> 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.

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<sup>1</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>2</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 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 37.

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  $\geq 7$  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

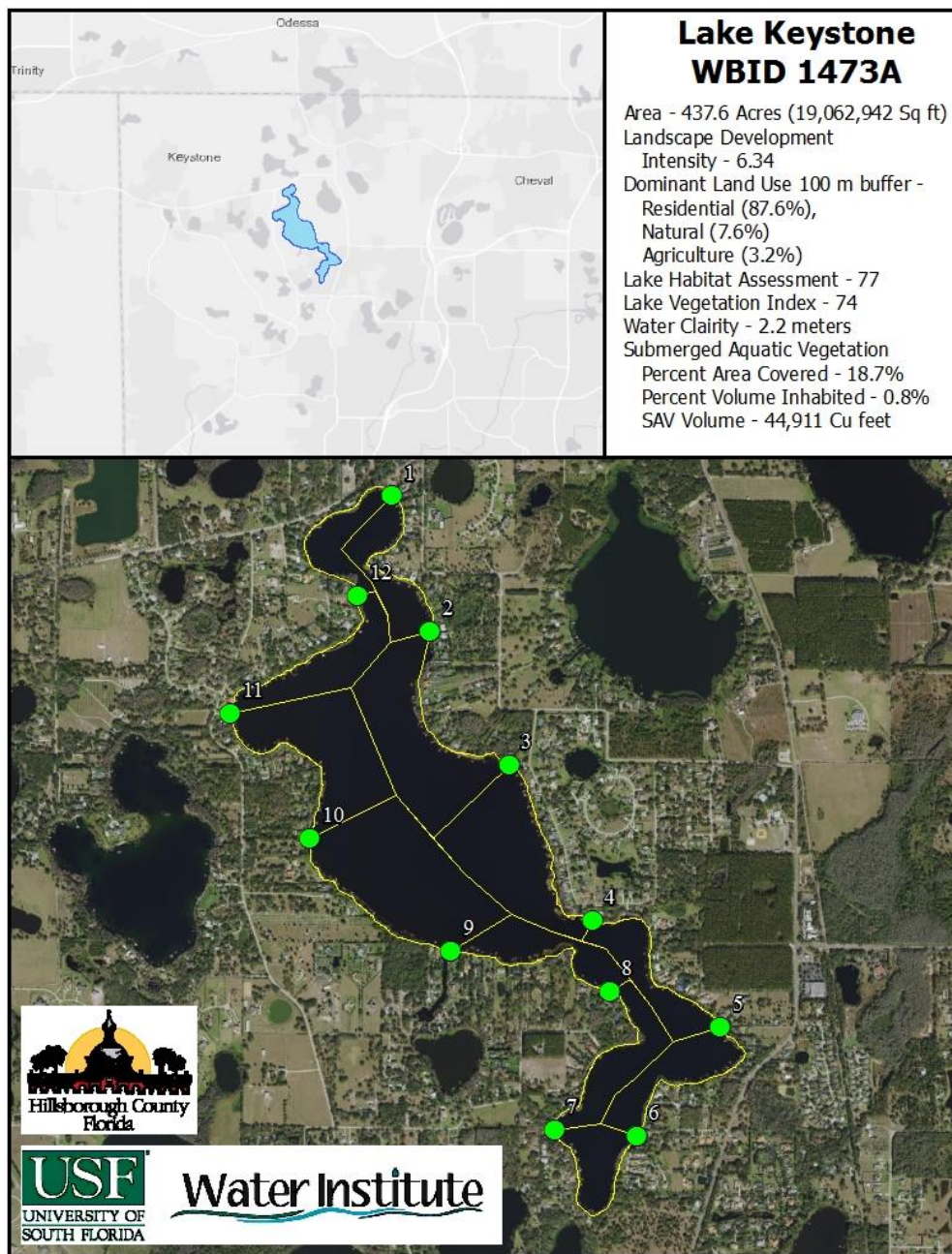
Physical water quality samples were taken using a Eureka Manta Sub-2 multiprobe pre and post calibrated on the day of the assessment. Measurements taken with this device include: depth, conductivity, pH, Dissolved Oxygen (mg/l and % Saturation) and salinity. Chemical water parameters were collected and preserved on ice by USF Water Institute staff and analyzed at the Environmental Protection Commission of Hillsborough County Laboratory. Analysis include; Chlorophyll (a, b, c, t and corrected), Alkalinity, Color, EColi, 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



## Study Area

Lake Keystone is located in the Brooker Creek watershed of north-western Hillsborough County, Florida. The Landscape Development Intensity Index of the 100 meter buffer around Lake Keystone is dominated by Residential (87.6%), Natural (7.6%) and Agricultural (3.2%) land uses. The resulting LDI value for the 100 meter buffer around Lake Keystone is 6.34.

*FIGURE 1: 2019 LAKE KEYSTONE ASSESSMENT STUDY AREA MAP*



## Lake Bathymetry and Morphological Characterization

At the time of the assessment, Lake Keystone was experiencing elevated water levels (39.59 feet above sea level NAVD 88) resulting in a 437.6 acre water body. Lake Keystone at the time of the assessment had a mean water depth of 10.54 feet and a maximum observed depth of 24.25 feet. The volume at this time was approximately 1,502,549,209 gallons. Figure 2 shows the resulting bathymetric contour map for Lake Keystone from data collected on June 3 & 4, 2019. The collected data has been overlain the 2017 Hillsborough County aerals.

*Table 1: Morphological Calculations for Lake Keystone*

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	19,062,942	1,770,991	437.6		
Mean Depth	10.54	3.21			
Maximum Depth	24.25	7.39			
Volume (cubic)	200,860,221	5,687,674		4,611	1,502,549,209
Gauge (NAVD 88)	39.59	12.07			



Figure 2: 2019 4-Foot Bathymetric Contour Map for Lake Keystone

# Lake Keystone WBID 1473A

## EXPLANATION:

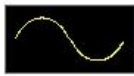
Survey Date: June 3, 2019  
Water level was 39.59 ft NAVD 88  
at the time of the assessment  
Contours are expressed in absolute depth  
below this level.

## LAKE MORPHOLOGY:

Perimeter 34,705 ft;  
Area 437.6 Acres;  
Mean Depth 10.54 ft;  
Volume 4,611 Acre-ft, (1,502,549,209 gallons);  
Deepest point 24.25 ft

## DATA SOURCES:

2017 aerial photography provided by  
Hillsborough County.  
Lake perimeter digitized from Hillsborough  
County 2017 aerial photographs.  
All contours generated by the USF Water  
Institute from survey data collected by  
USF Water Institute Lake and Stream  
Assessment Program.



Contour Lines

Expressed in  
4-Foot Intervals

## DISCLAIMER:

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

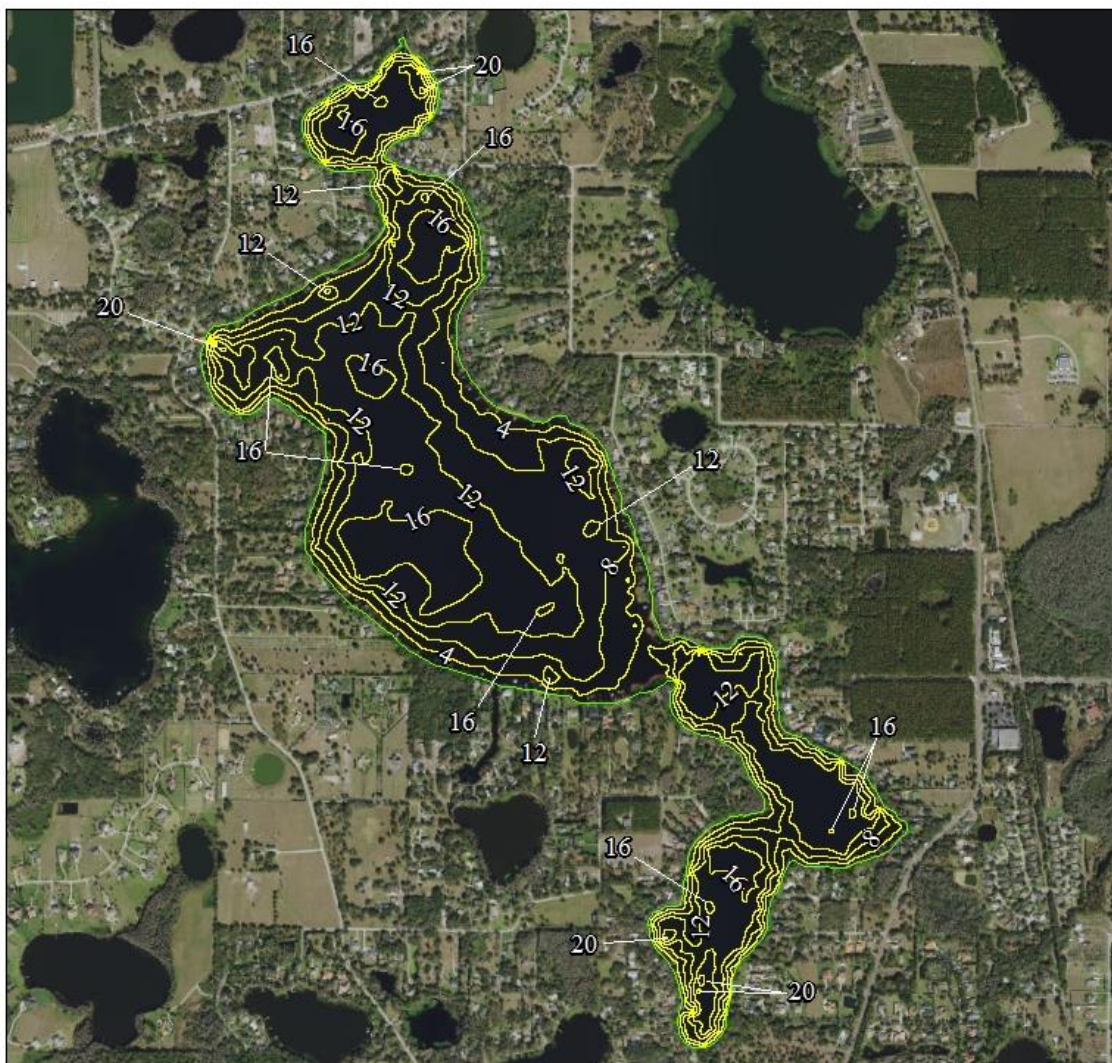


Lake Perimeter  
Ground Level

0 750 1,500 3,000  
Feet



Water Institute





*Figure 3 Overview photograph of Lake Keystone showing typical shoreline vegetation in an undeveloped area.*





## Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Lake Keystone was conducted on June 3 & 4, 2019. Lake Keystone received a lake habitat assessment (FEDP form FD 9000-6) score of 74 due to optimal scores for Bottom Substrate Quality and suboptimal scores for Secchi, Vegetation Quality and Stormwater Inputs. Lakeside Adverse Human Alterations, Upland Buffer Zone and Adverse Watershed Land Use received marginal scores. The water in Lake Keystone was characterized as moderately tannic and moderately turbid with a color value of 38.2 PCU at the time of the assessment. The secchi disk depth was 2.2 meters. The vegetation quality of the plants in and buffering Lake Keystone are predominantly native species with moderate growths of non-native nuisance species such as *Limnophila sessiliflora*, *Ludwigia peruviana*, *Alternanthera philoxeroides*, *Colocasia esculenta*, *Sphagneticola trilobata*, *Urochloa mutica*, *Casuarina equisetifolia*, *Salvinia minima*, *Schinus terebinthifolius*, *Panicum repens* and *Melaleuca quinquenervia*. Some direct inputs of stormwater were noted through pipes and ditches to the lake, but most stormwater reaches the lake via sheet flow from residential lawns. The bottom substrate quality was dominated by sand with coarse particulate organic matter near shore. Approximately 87.6% of the surrounding land has been developed for residential housing including several docks and seawalls. Several homeowners have maintained a vegetated buffer zone along the shoreline, particularly leaving an emergent rim of *Taxodium*.



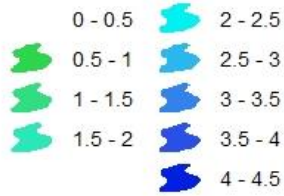
Figure 4 *Panicum repens*, torpedo grass, along a vegetated section of Lake Keystone's shoreline.

The Lake Vegetation Index identified 49 species of wetland vegetation growing in the four selected sections along Lake Keystone. The majority of these species (38) are native species. The remaining 11 species (*Limnophila sessiliflora*, *Ludwigia peruviana*, *Alternanthera philoxeroides*, *Colocasia esculenta*, *Sphagneticola trilobata*, *Urochloa mutica*, *Casuarina equisetifolia*, *Salvinia minima*, *Schinus terebinthifolius*, *Panicum repens* and *Melaleuca quinquenervia*) are non-native and invasive to this region of Florida. The vegetation community along Lake Keystone is dominated by a variety of emergent species including *Panicum repens*, *Taxodium* and *Ludwigia peruviana*. The water's surface in Lake Keystone was dominated by *Nuphar* and *Nymphaea odorata*. A total of 8 species of submerged aquatic vegetation were observed, *Utricularia gibba*, *Utricularia radiata*, *Chara*, *Nitella*, *Bacopa caroliniana*, *Mayaca fluviatilis*, *Limnophila sessiliflora* and *Eleocharis baldwinii* with *Mayaca fluviatilis* being the dominant species. Submerged vegetation was limited in the lake to a depth of approximately 7.3 feet. By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 18.7% of the surface area of Lake Keystone. This submerged vegetation inhabits an estimated 0.8% of the water volume in Lake Keystone. Figure 5 shows the results of the SAV analysis indicating the location and height of SAV.

The calculated LVI score for Lake Keystone was 52, above the impairment threshold of 37 indicating that the vegetation community is "Healthy". Figure 6 shows the map of Lake Keystone 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.

# Lake Keystone

## Height of Vegetation (ft)



Lake Perimeter  
Ground Level

## EXPLANATION:

Survey Date: June 3, 2019  
Water level was 39.59 NAVD 88  
at the time of the assessment  
Submerged Aquatic Vegetation was  
analyzed from collected sonar data.

## DATA SOURCES:

2017 aerial photography provided by  
Hillsborough County.  
Lake perimeter digitized from Hillsborough  
County 2017 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 3,560,114 square ft; 81.7 Acres;  
(18.7% of Lake Surface Area)  
Mean SAV Height 0.45 ft;  
Volume 44,911 Cubic ft (11,864,555 gallons);  
(0.8% of Lakes Volume)



Water Institute



0 750 1,500 3,000  
Feet

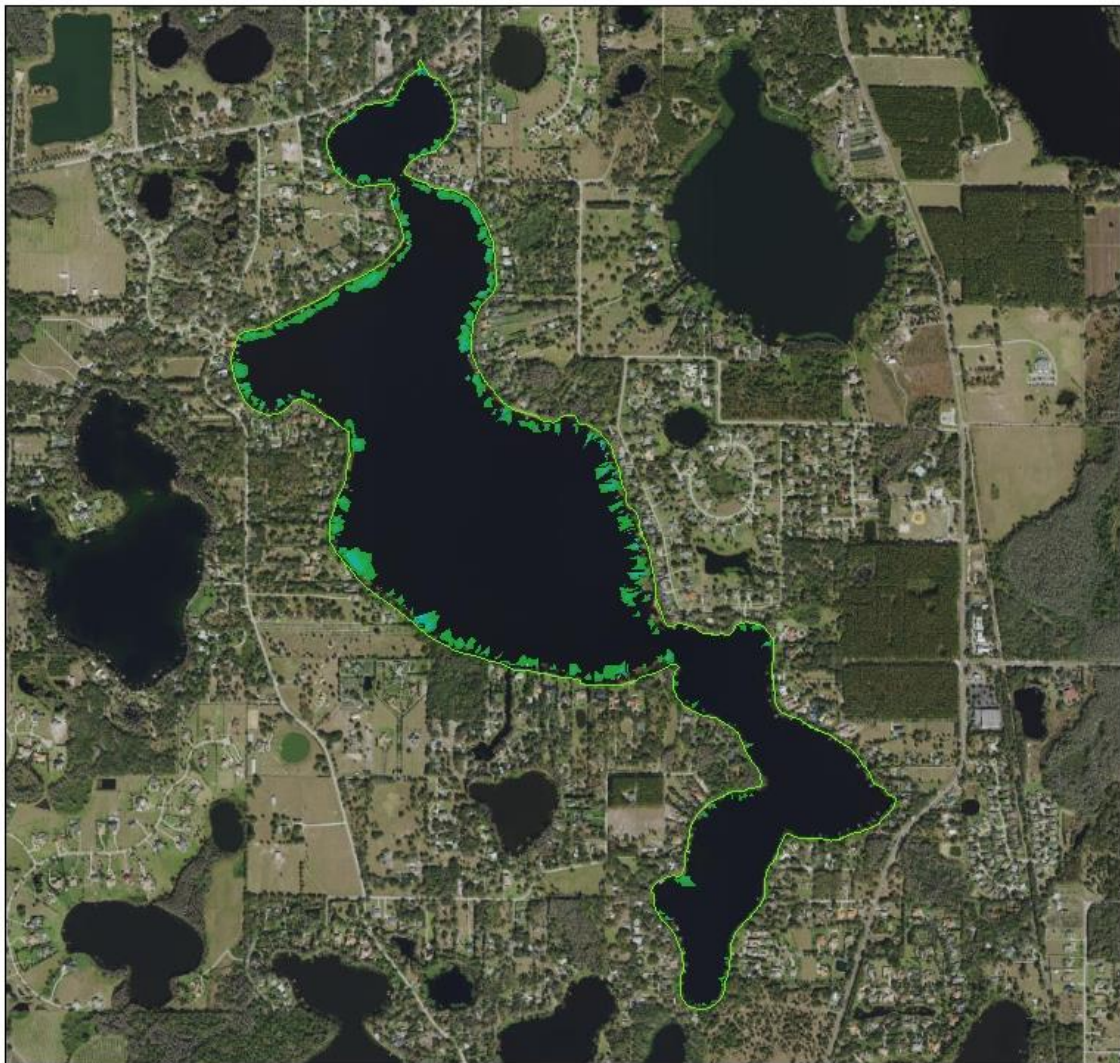


Figure 5 Lake Keystone Submerged Aquatic Vegetation Assessment Results



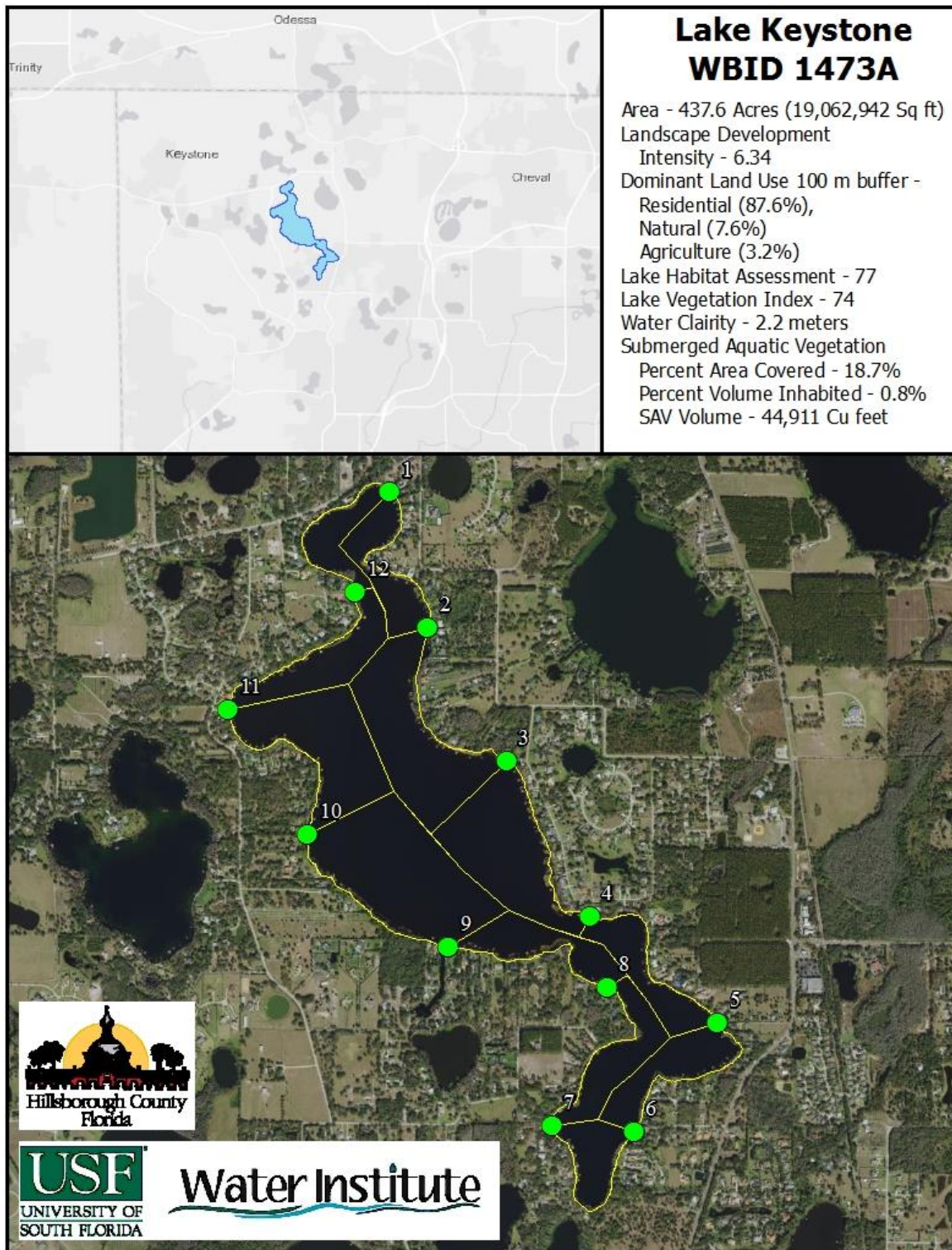


Figure 6: Lake Vegetation Index region map for Lake Keystone

Table 2: Lake Vegetation Index results for Lake Keystone June 3 & 4, 2019 (continued on following page)

SPECIES	CofC	Region			
		3	6	9	12
Acer rubrum	4.65	1	1	1	1
Blechnum serrulatum	5.50	1	1	1	1
Boehmeria cylindrica	5.00	1	1	1	1
Chara	3.90	1	C	1	1
Eleocharis baldwinii	2.82	1	1	1	1
<b>Limnophila sessiliflora</b>	0.00	C	1	1	1
<b>Ludwigia peruviana</b>	0.00	1	1	1	1
Mayaca fluviatilis	8.45	C	1	D	D
<b>Melaleuca quinquenervia</b>	0.00	1	1	1	1
Nuphar	3.50	1	1	1	1
Nymphaea odorata	5.00	1	1	1	1
Panicum hemitomon	5.82	1	1	1	1
<b>Panicum repens</b>	0.00	1	1	1	1
Pontederia cordata	5.38	1	1	1	1
Taxodium	7.00	1	C	1	1
<b>Alternanthera philoxeroides</b>	0.00	1	1		1
<b>Colocasia esculenta</b>	0.00	1	1		1
Hydrocotyle	2.00	1	1		1
Luziola fluitans	4.00	1	1	1	
Mikania scandens	1.95	1	1		1
Myrica cerifera	2.00	1	1		1
Quercus laurifolia	4.00		1	1	1
Sagittaria lancifolia	3.00	1	1		1
<b>Schinus terebinthifolius</b>	0.00		1	1	1
<b>Sphagneticola trilobata</b>	0.00	1	1	1	
Bacopa caroliniana	4.50	1		1	
Cephalanthus occidentalis	5.00		1	1	
Cyperus haspan	4.00	1		1	
Eleocharis interstincta	7.80	1	1		
Fuirena scirpoidea	5.50	1		1	
Ilex cassine	6.00			1	1
Leersia hexandra	5.61	1			1

SPECIES	CofC	Region			
		3	6	9	12
Liquidambar styraciflua	2.50		1		1
Typha	1.00	1		1	
<b>Urochloa mutica</b>	0.00	1	1		
Bacopa monnieri	3.50		1		
<b>Casuarina equisetifolia</b>	0.00			1	
Crinum americanum	9.00				1
Cyperus polystachyos	1.56				1
Eleocharis cellulosa	7.80				1
Ludwigia repens	3.20		1		
Nitella	6.00				1
Osmunda cinnamomea	6.44				1
Osmunda regalis	7.60		1		
Paspalidium geminatum	5.50	1			
Salix caroliniana	2.95			1	
<b>Salvinia minima</b>	0.00	1			
Utricularia gibba	6.37		1		
Utricularia radiata	6.01	1			

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Score Summary	Region			
	3	6	9	12
Total # of taxa in sampling unit	33	33	27	31
% Native taxa in sampling unit	72.72727	72.72727	74.07407	77.41935
% FLEPPC CAT 1 taxa in sampling unit	18.18182	18.18182	18.51852	16.12903
% Sensitive taxa in sample unit	9.090909	12.12121	7.407407	12.90323
Dominant CoC in sample unit	4.225	5.45	8.45	8.48
Native Score ((x-62.5)/37.5) or ((x-66.67)/25.89)=	0.233962	0.233962	0.285982	0.415193
Invasive FLEPPC 1 Score (1 - (x/30))=	0.393939	0.393939	0.382716	0.462366
Sensitive Score (x/(27.78 or 20)) =	0.454545	0.606061	0.37037	0.645161
Dominant CoC Score (x/(7.91 or 7)) =	0.603571	0.778571	1	1
Raw Score Total = N+I+S+D =	1.686018	2.012533	2.039068	2.52272
Division Factor = (3 D=0 or 4) =	4	4	4	4
Average LVI dividend = Raw /DF	0.421505	0.503133	0.509767	0.63068
South				
LVI Score for sampling unit =	42.15045	50.31333	50.97671	63.068

Total LVI SCORE = 52



## Water Quality Assessment

Limited long-term water quality data is available for Lake Keystone. The available data was collected by USGS, FDEP, Hillsborough County and University of Florida LAKEWATCH program (1965-2019). The vast majority of the recent data has been collected by the University of Florida LAKEWATCH program volunteers on the lake. Table 4 provides a summary of the Physical/Chemical conditions recorded in Lake Keystone.

*Table 4: Lake Keystone Water Quality (Field)*

Depth (m)	Temp °C	pH	DO (mg/L)	DO (%sat)	Cond (unho/cm)	Salinity (ppt)	Secchi Depth (m)
0.5	32.9	6.41	7.28	101.0	127	0.06	2.2
2.15	31.83	6.36	7.16	97.7	126	0.06	
4.36	31.14	6.07	6.04	81.5	126	0.06	
POR	22.63	5.99	5.58		122	0.06	2.03

The chemical water quality analysis for Lake Keystone is shown in Table 5 for the sample taken on June 13, 2019. Table 6 includes this data in the numeric nutrient criteria framework using the data from this assessment as well as the available LAKEWATCH geometric mean values for the period of record and the past three years for available parameters. Total Phosphorous values were below the nutrient threshold for colored lakes in the west central region with sufficient data developed by FDEP of 0.16 mg/l with a value of 0.011 mg/l for the POR and below the threshold for the most recent 3 years of samples with a value of 0.013 mg/l.

Total Nitrogen values were below the nutrient threshold for colored lakes with sufficient data developed by FDEP of 2.23 mg/l with a value of 0.574 mg/l for the POR data. The Total Nitrogen value for the most recent 3 years of data was 0.633 mg/l (0.559 mg/l for 2019 samples). Chlorophyll-a corrected values are below the nutrient threshold for colored lakes developed by FDEP of 20.0 µg/l with a value of 2.92 µg/l (1996-2013). The UF LAKEWATCH data is for uncorrected chlorophyll-a and has a mean value for the period of record of 3.96 µg/l (1990-2019).

Bacteria testing showed low levels of E. Coli (13 colonies/100ml) and Enterococci (67 colonies/100ml) below 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 Keystone Water Quality Results from 6/13/19 (Laboratory)*

<b>Parameter</b>	<b>Lake Keystone (Center)</b>	<b>POR Mean Value</b>	<b>Units</b>
Alkalinity	12.0	3.85	mg/LCaCO <sub>3</sub>
E Coli	13		#/100ml
Nitrates/Nitrites	0.018	0.030	mg/L
Enterococci	67	37	#/100 ml
Chlorophyll a	2.4	3.96	ug/L
Chlorophyll b	0.2	0.93	ug/L
Chlorophyll c	0.6	1.12	ug/L
Chlorophyll t	2.8		ug/L
Chlorophylla Corr	1.8	2.92	ug/L
Chlorophyll-pheo	1.4		ug/L
Ammonia	0.012	0.023	mg/L
Kjeldahl Nitrogen	0.552	0.590	mg/L
Total Nitrogen	0.552	0.574	mg/L
Total Phosphorus	0.116	0.113	mg/L
Color(345)F.45	38.2	48.13	Pt/Co

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean (Geomean) Color (pcu)	48.13
Number of Samples	117
Geometric Mean Alkalinity (mg/L CaCO <sub>3</sub> )	3.85
Number of Samples	90
Lake Type	Colored
Chlorophyll a Criteria (ug/L)	20
Sufficient for Geomean Criteria then P mg/L	0.16
Sufficient for Geomean Criteria then N mg/L	2.23
Geomean Chla Corrected ug/L	2.92
Geomean TP mg/L (2017-2019)	0.013
Geomean TN mg/L (2017-2019)	0.633
Number of Samples	83
Potential Impaired Chlorophyll a	Not Impaired
Potential Impaired TP	Not Impaired
Potential Impaired TN	Not Impaired



## Conclusion

The results of the assessment of Lake Keystone shows a healthy lake based on Chlorophyll-a, Total Nitrogen and Total Phosphorous concentrations according to the FDEP numeric nutrient criteria using the available water quality record. The sampling data was sufficient to calculate proper FDEP Numeric Nutrient Criteria values with the exception of Chlorophyll-a since the most recent 3 years of data is from LAKEWATCH, which analyzes Chlorophyll-a and not Chlorophyll-a Corrected. The most recent three years of data for Total Phosphorous and Total Nitrogen is below the nutrient threshold. The system also shows health in the vegetation communities according to the Lake Vegetation Index with high overall species (49), moderate occurrences of non-native, invasive species and dominance in multiple sections by sensitive plant species with an overall LVI score of 52. The assessment also revealed a healthy submerged aquatic vegetation community comprising 8 species occupying 18.7% of the surface area and 0.8% of the volume of Lake Keystone.