Garden Lake

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

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Methods

STUDY AREA ANALYISIS

The watershed containing the Garden Lake was analyzed using ESRI ArcGIS 10.6. Using this software with 2020ESRI 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.

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[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 form GPS satellites in view and retransmit these data to a master control site and then to geostationary satellites. For more information, see end note 2.

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, 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

Garden 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 Garden Lake is dominated by Residential (97.6%) and Natural (2.4%) land uses. The resulting LDI value for the 100 meter buffer around Garden Lake is 7.21.

FIGURE 1: 2021 Garden Lake ASSESSMENT STUDY AREA MAP
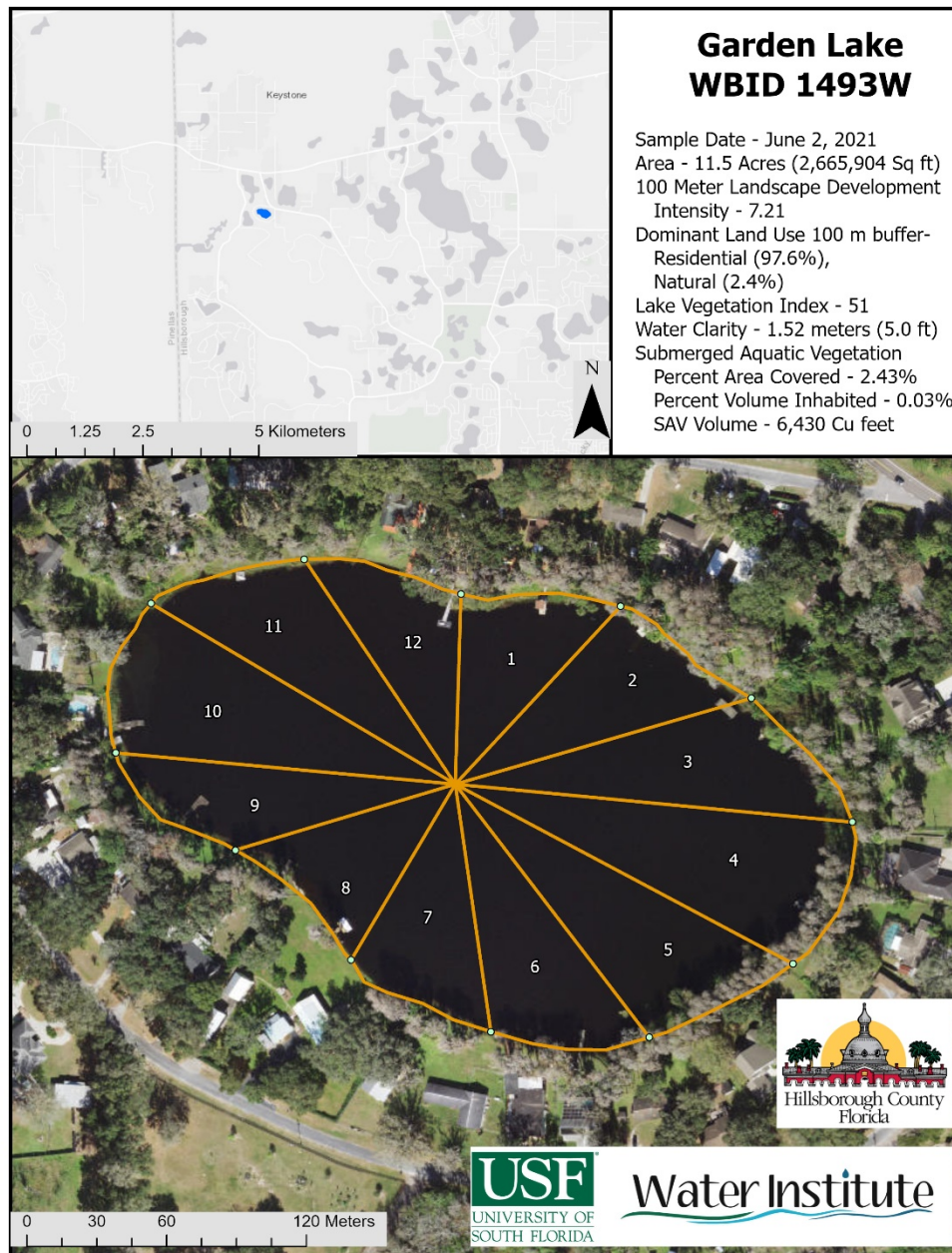
Lake Bathymetry and Morphological Characterization

At the time of the assessment, Garden Lake was experiencing normal water levels (27.52 feet above sea level NAVD 88) resulting in a 11.5 acre water body. Garden Lake at the time of the assessment had a mean water depth of 5.3 feet and a maximum observed depth of 18.99 feet. The volume at this time was approximately 19,942,482 gallons. Figure 2 shows the resulting bathymetric contour map for Garden Lake from data collected on June 2, 2021. The collected data has been overlain the 2020 Hillsborough County aerials.

Table 1: Morphological Calculations for Garden Lake

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	498,963	46,355	11.5		
Mean Depth	5.3	1.63			
Maximum Depth	18.99	5.79			
Volume (cubic)	2,665,904	75,489		61.2	19,942,482
Gauge (NAVD 88)	27.52	8.39			

Figure 2: 2021 2-Foot Bathymetric Contour Map for Garden Lake

Garden Lake WBID 1493W

Contour
— 1
— 2
— 3
— 4
— 5
— 6
— 7
— 8
— 9
— 10
— 11
— 12
— 13
— 14
— 15
— 16
— 17
— 18
▭ Perimeter

EXPLANATION:
Survey Date: June 2, 2021
Water level was 27.52 ft NAVD 88
at the time of the assessment.
Contours are expressed in absolute depth
below this level.

LAKE MORPHOLOGY:
Perimeter 2,744 ft;
Area 11.5 Acres;
Mean Depth 5.3 ft;
Volume 61.2 Acre-ft, (19,942,482 gallons);
Deepest point 18.99 ft

DATA SOURCES:
2020 aerial photography provided by
ESRI.
Lake perimeter digitized from ESRI 2020
aerial imagery.
All contours generated by the USF Water
Institute from survey data collected by
USF Water Institute Lake and Stream
Assessment Program.

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

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Hillsborough County Florida
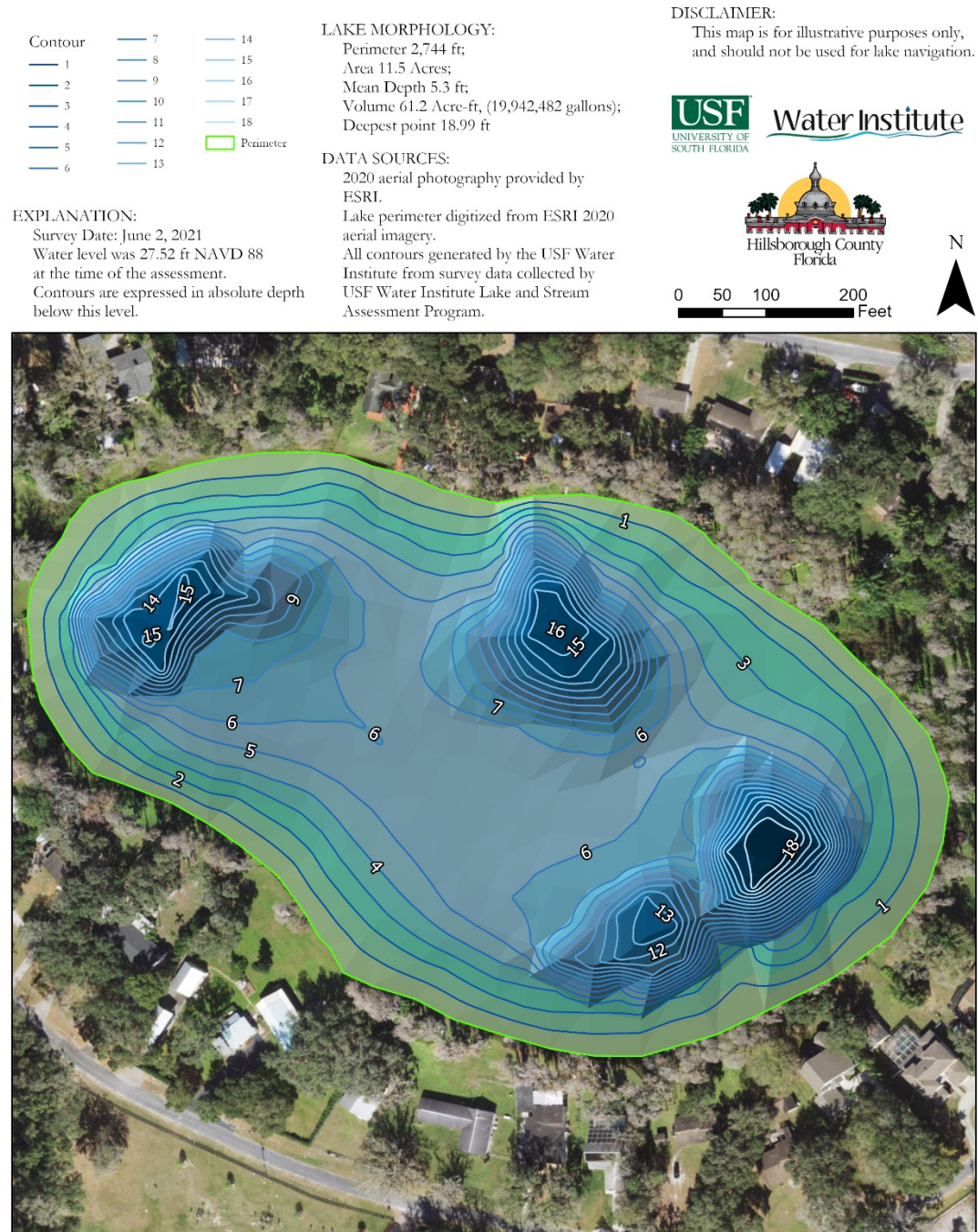
N

0   50   100   200
Feet

Figure 3 Overview photograph of Garden Lake showing a section cleared of shoreline vegetation

Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Garden Lake was conducted on June 2, 2021. The water in Garden Lake was characterized as clear with a color value of 30 PCU. The secchi disk depth was 1.5 meters in part due to the low tannins and turbidity. The vegetation quality of the plants in and buffering Garden Lake are predominantly native species with minor growths of non-native nuisance species such as *Ludwigia peruviana, Panicum repens and Oxycaryum cubense*. Stormwater reaches the lake via sheet flow from surrounding natural land cover. The bottom substrate quality was dominated by silty sand with coarse particulate organic matter near shore. The level of development along the shoreline has greatly reduced the number of species seen in the emergent vegetation community with only 24 total species observed.

Figure 4 Nuphar was a common floating leaved vegetation in Garden Lake during the assessment.

The Lake Vegetation Index identified 24 species of wetland vegetation growing in the four selected sections along Garden Lake. The majority of these species (21) are native species. The remaining 3 species (*Panicum repens*, *Oxycaryum cubense* and *Ludwigia peruviana*) are non-native and invasive to this region. The vegetation community along Garden Lake has been greatly reduced by residential development and clearing of the lake shoreline. The emergent vegetation community is dominated by *Panicum repens* and *Ludwigia peruviana.* The floating leaved vegetation zone was reduced and was dominated by *Nuphar*. With the reductions to the emergent and floating leaved vegetation communities, the largest vegetation biomass was in the submersed vegetation community. A total of four species of submerged aquatic vegetation were observed including *Eleocharis baldwinii, Chara, Nitella* and *Najas guadalupensis* with *Chara* being the dominant species in region 5 and 8 as well as codominant in region 11. *Najas guadalupensis* was dominant in region 2. *Nitella* was codominant in region 11. Submerged vegetation was abundant in Garden Lake in part due to abundant available light and suitable bottom substrates. By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 2.43% of the surface area of Garden Lake. This submerged vegetation inhabits an estimated 0.03% of the water volume in Garden Lake. Figure 5 shows the results of the SAV analysis indicating the location and height of the submerged aquatic vegetation community.

The calculated LVI score for Garden Lake was 51, above the impairment threshold of 43 indicating that the vegetation community is "Healthy". Figure 6 shows the map of Garden Lake 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.

Garden Lake

Perimeter

Height of Vegetation (ft)

- 0.6 - 0.8
- 0.4 - 0.6
- 0.2 - 0.4
- 0 - 0.2

N

0 50 100   200
Feet

EXPLANATION:
Survey Date: June 2, 2021
Water level was 27.52 ft NAVD 88
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 0.2 foot increments.

DATA SOURCES:
2020 aerial photography provided by
ESRI.
Lake perimeter digitized from Hillsborough
County 2020 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 12,146 square ft; 0.3 Acres;
(2.43% of Lake Surface Area)
Mean SAV Height 0.1 ft;
Volume 860 Cubic ft, (6,430 gallons);
(0.03% of Lakes Volume)

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Hillsborough County
Florida

Figure 5 Garden Lake Submerged Aquatic Vegetation Assessment Results

**Garden Lake
WBID 1493W**

Sample Date - June 2, 2021
Area - 11.5 Acres (2,665,904 Sq ft)
100 Meter Landscape Development
 Intensity - 7.21
Dominant Land Use 100 m buffer-
 Residential (97.6%),
 Natural (2.4%)
Lake Vegetation Index - 51
Water Clarity - 1.52 meters (5.0 ft)
Submerged Aquatic Vegetation
 Percent Area Covered - 2.43%
 Percent Volume Inhabited - 0.03%
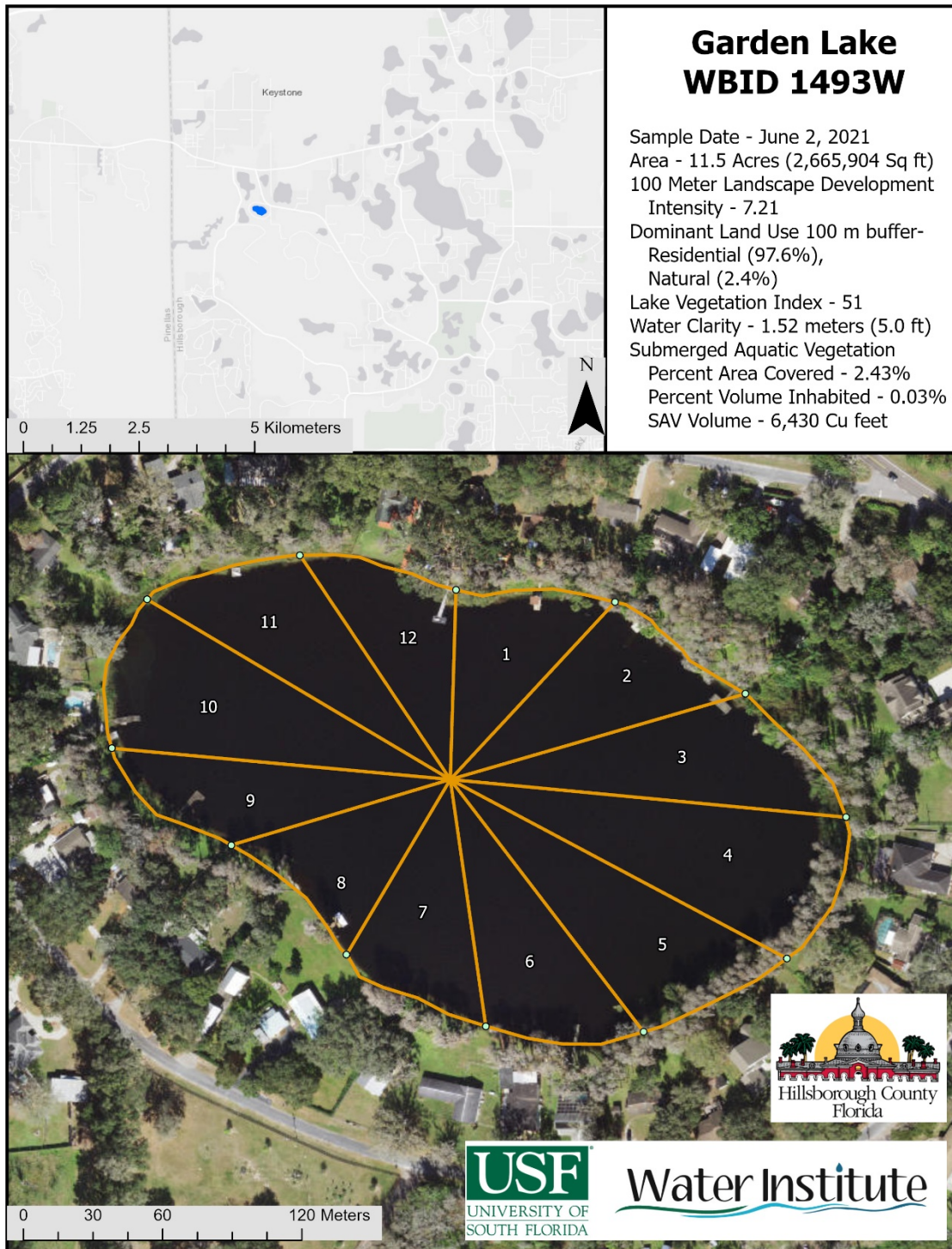 SAV Volume - 6,430 Cu feet

Figure 6: Lake Vegetation Index region map for Garden Lake

Table 2: Lake Vegetation Index results for Garden Lake June 2, 2021. "D" and "C" denote dominant or codominant species in the region. Species in bold indicate non-native invasives.

SPECIES	CofC	2	5	8	11
Chara	3.90	1	D	D	C
Eleocharis baldwinii	2.82	1	1	1	1
Ludwigia peruviana	0.00	1	1	1	1
Mikania scandens	1.95	1	1	1	1
Najas guadalupensis	5.07	D	1	1	1
Panicum repens	0.00	1	1	1	1
Cyperus odoratus	3.00	1	1		1
Eupatorium capillifolium	0.83	1	1		1
Hydrocotyle	2.00	1	1	1	
Pontederia cordata	5.38	1	1		1
Taxodium	7.00	1	1	1	
Cyperus polystachyos	1.56	1			1
Nitella	6.00			1	C
Nuphar	3.50		1	1	
Oxycaryum cubense	0.50		1		1
Sacciolepis striata	5.35	1			1
Sagittaria lancifolia	3.00	1			1
Spartina bakeri	5.98	1	1		
Bacopa monnieri	3.50		1		
Diodia virginiana	3.00		1		
Habenaria repens	3.50		1		
Ludwigia leptocarpa	3.00				1
Ludwigia octovalvis	2.00		1		
Phyla nodiflora	1.92		1		

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Score Summary	2	5	8	11
Total # of taxa in sampling unit	15	19	10	15
% Native taxa in sampling unit	86.66667	84.21053	80	80
% FLEPPC CAT 1 taxa in sampling unit	13.33333	10.52632	20	13.33333
% Sensitive taxa in sample unit	6.666667	5.263158	10	0
Dominant CoC in sample unit	5.07	3.9	3.9	4.95

	2	5	8	11
Native Score ((x-62.5)/37.5) or ((x-66.67)/25.89)=	0.77237	0.677502	0.514871	0.514871
Invasive FLEPPC 1 Score (1 - (x/30))=	0.555556	0.649123	0.333333	0.555556
Sensitive Score (x/(27.78 or 20)) =	0.333333	0.263158	0.5	0
Dominant CoC Score (x/(7.91 or 7)) =	0.724286	0.557143	0.557143	0.707143
Raw Score Total = N+I+S+D =	2.385545	2.146926	1.905347	1.777569
Division Factor = (3 D=0 or 4) =	4	4	4	4
Average LVI dividend = Raw /DF South	0.596386	0.536731	0.476337	0.444392
LVI Score for sampling unit =	59.63862	53.67314	47.63367	44.43923

Total LVI SCORE = 51

Water Quality Assessment

Limited long-term water quality data is available for Garden Lake. The available data was collected by Southwest Florida Water Management District, Hillsborough County and University of Florida LAKEWATCH program (1991-2021). As part of this assessment four samples were taken during June, July and August of 2021. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of the Garden Lake during the assessment in 2021.

Table 4: Garden Lake Water Quality (Field)

Date	Depth (m)	Temp °C	pH	DO (mg/L)	DO (%sat)	Cond (unho/cm)	Salinity (ppt)	Secchi Depth (m)
5/13/21	0.25	26.3	8.49	7.75	98.7	136	0.1	1.5
5/13/21	3.1	25.8	8.38	0	0	136	0.1	
6/2/2021	0.5	29.9	7.74	7.55	98.5	139	0.06	
6/10/21	0.5	31.5	7.88	7.41	101	160	0.07	
7/28/21	0.5	32.2	7.61	8.08	111	155	0.07	
8/10/21	0.5	30.8	7.13	8.15	109	167	0.08	

The chemical water quality analysis for Garden Lake is shown in Table 5 for the samples taken on 5/13/21, 6/2/21, 6/10/21, 7/28/21 and 8/10/21. Table 6 includes this data in the numeric nutrient criteria framework using the data from this assessment as well as the available geometric mean values for the past three years for available parameters. Color values for the period of record data have a geometric mean value of 61.23 PCU, classifying it as a colored water lake (greater than or equal to 40 PCU). Total Alkalinity period of record geometric mean value is 22.3 mg/L classifying the lake as alkaline (greater than or equal to 20 mg/L). The NNC thresholds for a colored, alkaline lake with sufficient data to calculate NNC (Previous three years with at least 3 samples per year in separate seasons) are 20 µg/L for Chlorophyll-a Corrected for Phaeophytin, 0.16 mg/L for Total Phosphorous and 2.23 mg/L for Total Nitrogen.

Geometric mean Chloropyll-a corrected values for the 2019-2021 data is 7.71 µg/L (13.01 µg/L in 2019, 7.19 µg/L in 2020 and 3.61 µg/L in 2021. Total Phosphorous geometric mean values for the most recent 3 years of data was 0.045 mg/L (0.042 mg/L in 2019, 0.043 mg/L in 2020 and 0.068 mg/L in 2021, however the 2021 data all carried a value of 0.068 mg/l due to the four samples carrying QA qualifiers indicating a value below the minimum detection limit for the method used. Total Nitrogen values were below the nutrient threshold for colored, alkaline lakes with sufficient data developed by FDEP of 2.23 mg/l with a value of 1.021 mg/l for the most recent 3 years of data (1.029 mg/L in 2019, 1.097 mg/L in 2020 and 0.798 mg/L in 2021.

Bacteria testing from 6/2/21 showed low levels of E. Coli (<1 colonies/100ml, 2.03 colonies/100ml for 2021 data) and Enterococci (1.0 colonies/100ml, 5.0 colonies/100ml for 2021 data) below the rules set forth in FDEP 62-302.530 (https://www.flrules.org/gateway/RuleNo.asp?title=SURFACE%20WATER%20QUALITY%20STA

NDARDS&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: Garden Lake 2021 Water Quality Results (Laboratory)

Parameter	6/2/2021	6/10/2021	7/28/2021	8/10/2021	POR Mean Value	Units
Alkalinity	23.3	21.4	22.5	22.0	22.3	mg/LCaCO3
E Coli	< 1.0	2.0	1.0	3.10	2.03	#/100ml
Enterococci	1.0	< 1.0	8.0	6.1	5.0	#/100 ml
Chlorophyll a	5.2	5.5	13.5	12.5	10.98	ug/L
Chlorophyll b	1.0	1.0	1.6	1.0	1.2	ug/L
Chlorophyll c	1.1	1.0	1.6	1.0	1.2	ug/L
Chlorophyll t	6.3	5.5	13.5	12.5	9.5	ug/L
Chlorophyll a Corrected	3.0	1.0	1.6	1.2	10.9	ug/L
Ammonia	<0.073	<0.073	<0.073	<0.073	<0.073	mg/L
Nitrates/Nitrites	< 0.043	< 0.043	< 0.043	< 0.043	< 0.043	mg/L
Kjeldahl Nitrogen	0.757	0.686	0.843	0.918	0.801	mg/L
Total Nitrogen	0.76	0.69	0.84	0.92	0.710	mg/L
Total Phosphorus	<0.068	<0.068	<0.068	<0.068	0.011	mg/L

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean (Geomean) Color (pcu)	61.23
Number of Samples	19
Geometric Mean Alkalinity (mg/L CACO3)	22.3
Number of Samples	4
Lake Type	Colored-Alkaline
Chlorophyll a Criteria (ug/L)	20
Sufficient for Geomean Criteria then P mg/L	0.16
Suffcient for Geomean Criteria then N mg/L	2.23
Geomean Chla Corrected ug/L (3-year)	7.71
Geomean TP mg/L (3-year)	0.045
Geomean TN mg/L (3-year)	1.021
Number of Samples (3-year)	28
Potential Impaired Chlorophyll a	Not Impaired
Potential Impaired TP	Not Impaired
Potential Impaired TN	Not Impaired

Conclusion

The results of the assessment of Garden Lake shows a healthy lake based on Total Nitrogen, Total Phosphorous and Chlorophyll-a corrected concentrations according to the FDEP numeric nutrient criteria using the most recent 3 years of available data taken prior to and during this assessment. It should be noted that the most recent year of data for Total Phosphorous is inconclusive for the nutrient threshold as the minimum detection limit of the method used was not suitable. The system also shows health in the vegetation communities according to the Lake Vegetation Index with moderate overall species (24), moderate occurrences of non-native, invasive species and few sensitive plant species with an overall LVI score of 51. The assessment also revealed abundant submerged aquatic vegetation community comprising four species occupying 2.43% of the surface area and 0.03% of the volume of Garden Lake.