Starvation 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 Starvation 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.

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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.
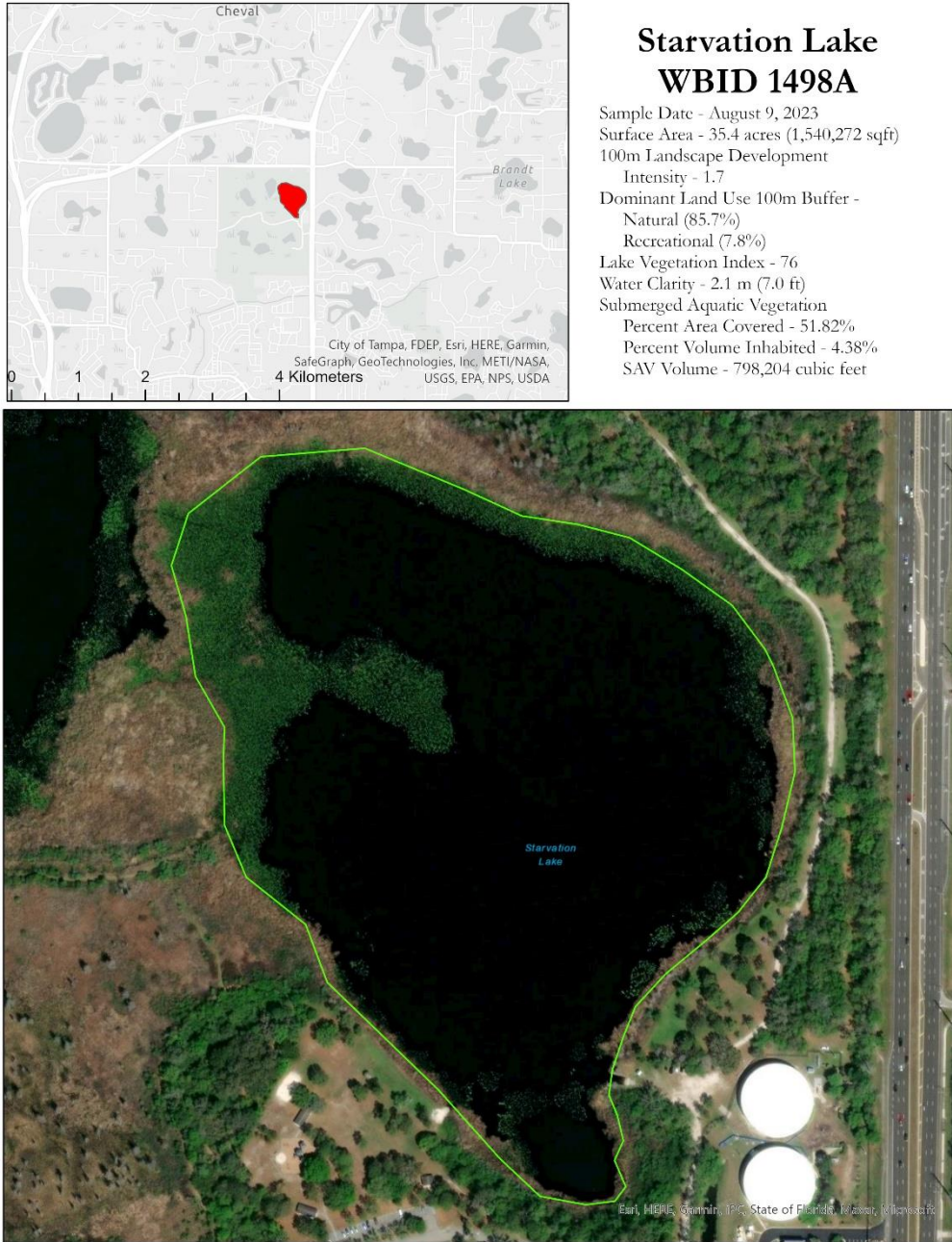
WATER QUALITY ASSESSMENT

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, 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

Starvation 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 Starvation Lake is dominated by natural (85.7%) and recreational (7.8%) land uses. The resulting LDI value for the 100 meter buffer around Starvation Lake is 1.7.

FIGURE 1: 2023 STARVATION LAKE ASSESSMENT STUDY AREA MAP

Starvation Lake
WBID 1498A

Sample Date - August 9, 2023
Surface Area - 35.4 acres (1,540,272 sqft)
100m Landscape Development
    Intensity - 1.7
Dominant Land Use 100m Buffer -
    Natural (85.7%)
    Recreational (7.8%)
Lake Vegetation Index - 76
Water Clarity - 2.1 m (7.0 ft)
Submerged Aquatic Vegetation
    Percent Area Covered - 51.82%
    Percent Volume Inhabited - 4.38%
    SAV Volume - 798,204 cubic feet

Lake Bathymetry and Morphological Characterization

At the time of the assessment, Starvation Lake was experiencing normal water levels (49.38 feet NAVD88 on staff gauge) resulting in a 35.4 acre water body. Starvation Lake at the time of the assessment had a mean water depth of 5.8 feet and a maximum observed depth of 12.95 feet. The volume at this time was approximately 66,511,964 gallons. Figure 2 shows the resulting bathymetric contour map for Starvation Lake from data collected on August 9, 2023. The collected data has been overlain the 2022 ESRI Basemap aerials.

Table 1: Morphological Calculations for Starvation Lake

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	1,540,272	143,095	35.4		
Mean Depth	5.8	1.76			
Maximum Depth	12.95	3.95			
Volume (cubic)	8,891,295	251,771		204.1	66,511,964
Gauge (NAVD 88)	49.38	15.05			

Figure 2: 2023 2-Foot Bathymetric Contour Map for Starvation Lake

Starvation Lake

Contour

— 2
— 4
— 6
— 8
— 10
— 12
☐ Perimeter

EXPLANATION:
Survey Date: August 9, 2023
Water level was 49.38 ft NAVD88
at the time of the assessment.
Contours are expressed in absolute
depth below this level.

LAKE MORPHOLOGY:
Perimeter 4,989 ft;
Area 35.4 Acres;
    (1,540,282 Sqft)
Mean Depth 5.8 ft;
Volume 204.1 Acre-ft,
    (66,511,964 gallons);
Deepest point 12.95 ft

DATA SOURCES:
2022 aerial photography provided by
ESRI.
Lake perimeter digitized from Hillsborough
County 2022 aerial photographs.
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.

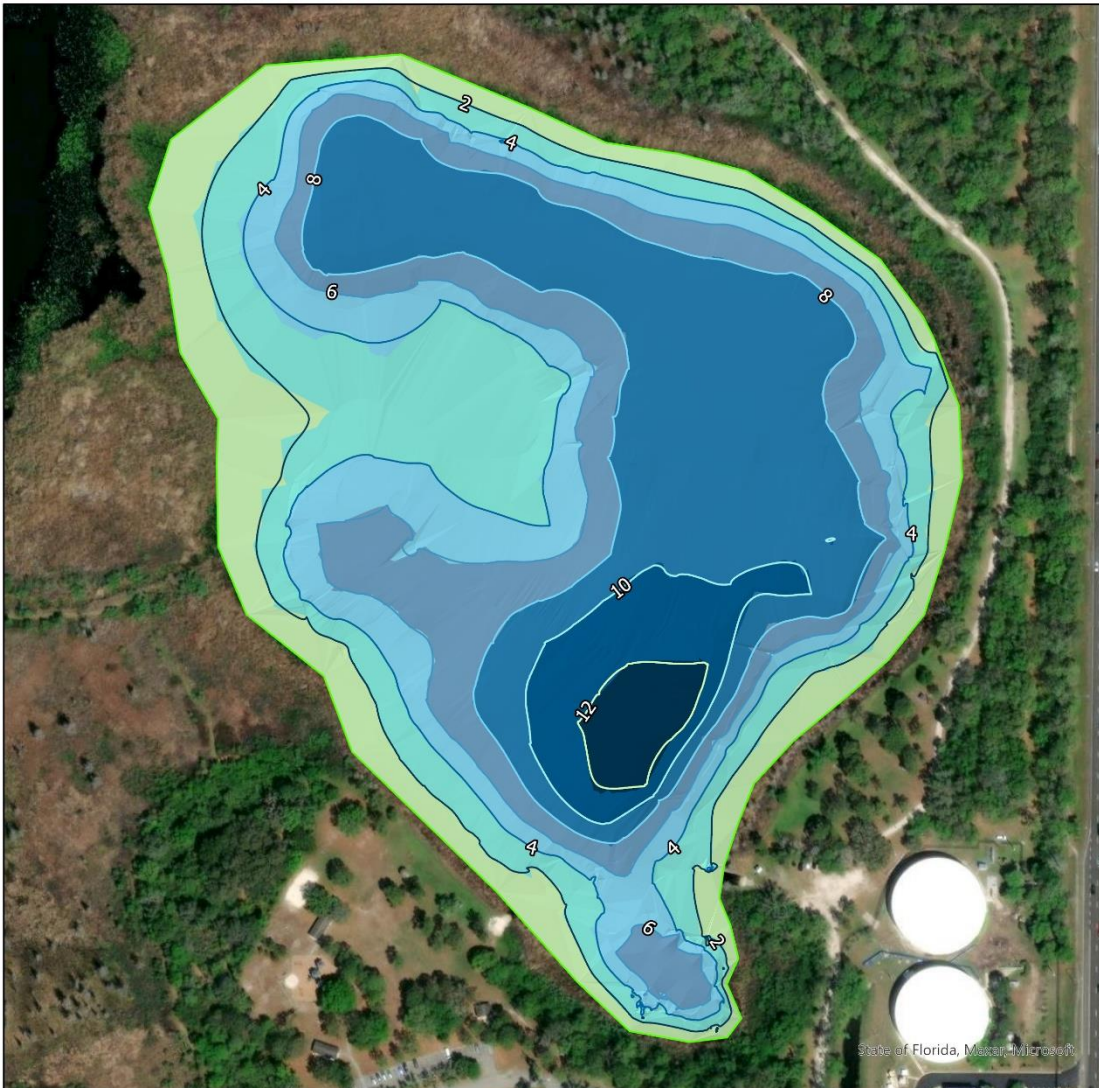0   125   250   500
                    Feet

Figure 3 Overview photograph of Starvation Lake showing the undeveloped portion of shoreline along region 11 of the Lake Vegetation Index.

Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Starvation Lake was conducted on August 9, 2023. The water in Starvation Lake was characterized as clear with low turbidity. The secchi disk depth was 2.13 meters allowing for an abundant submerged aquatic vegetation community. The vegetation quality of the plants in and buffering Starvation lake are native species with no growths of non-native invasive species observed during the LVI. Non-native, invasice FLEPPC type 1 plants were not observed on Starvation Lake. Stormwater reaches the lake predominately via sheet flow from surrounding natural land cover. The lack of development along the shoreline has maintained the nearshore communities, however *Typha*, a native species that can be aggressive, has established itself along the shoreline. The bottom substrate quality was dominated by sandy/silt with coarse particulate organic matter near shore and submersed vegetation.
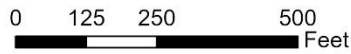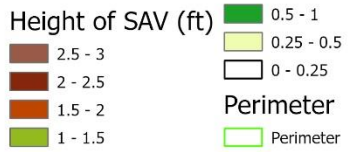
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Figure 4 Typha was abundant along the shorelines of Starvation Lake

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The Lake Vegetation Index identified 29 species of wetland vegetation growing in the four selected sections along Starvation Lake. All of these species (29) are native species. The vegetation community along the shorelines of Starvation Lake has been protected from the common removal of the shrub and groundcover strata that is common in more residential land use lakes in the region. At the time of the assessment the water transparency was 2.13 m (7.0 ft). High annual average secchi disk depths allow for an extensive littoral zone with establishment of floating leaved and submerged aquatic vegetation. Four species of submersed aquatic vegetation were observed during the lake vegetation index. *Eleocharis baldwinii* and *Najas guadalupensis* were both co-dominant species in LVI regions. The floating leaved vegetation community had 3 species observed with both *Nuphar* and *Nymphaea odorata* being co-dominant in LVI regions.

By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 51.82% of the surface area of Starvation Lake. This submerged vegetation inhabits an estimated 4.38% of the water volume in Starvation 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 Starvation Lake was 76, well above the impairment threshold of 43 indicating the vegetation community is showing evidence of being "Healthy". Though Starvation Lake scored high overall in the LVI, the total taxa found in each section was low with only 12 taxa identified in region 8. The region with the highest number of taxa was region 5 with 23 species. Figure 6 shows the map of Starvation 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.

Starvation Lake

Height of SAV (ft)

▨ 2.5 - 3	▨ 0.5 - 1
▨ 2 - 2.5	▨ 0.25 - 0.5
▨ 1.5 - 2	▨ 0 - 0.25
▨ 1 - 1.5	

Perimeter

▨ Perimeter

0   125   250   500
Feet

EXPLANATION:
Survey Date: August 9, 2023
Water level was 49.38 ft
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 0.5 foot increments.

DATA SOURCES:
2022 aerial photography provided by
ESRI.
Lake perimeter digitized from Hillsborough
County 2022 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 798,204 square ft; 18.3 Acres;
(51.82% of Lake Surface Area)
Mean SAV Height 0.5 ft;
Volume 389,794 Cubic ft, (2,915,884
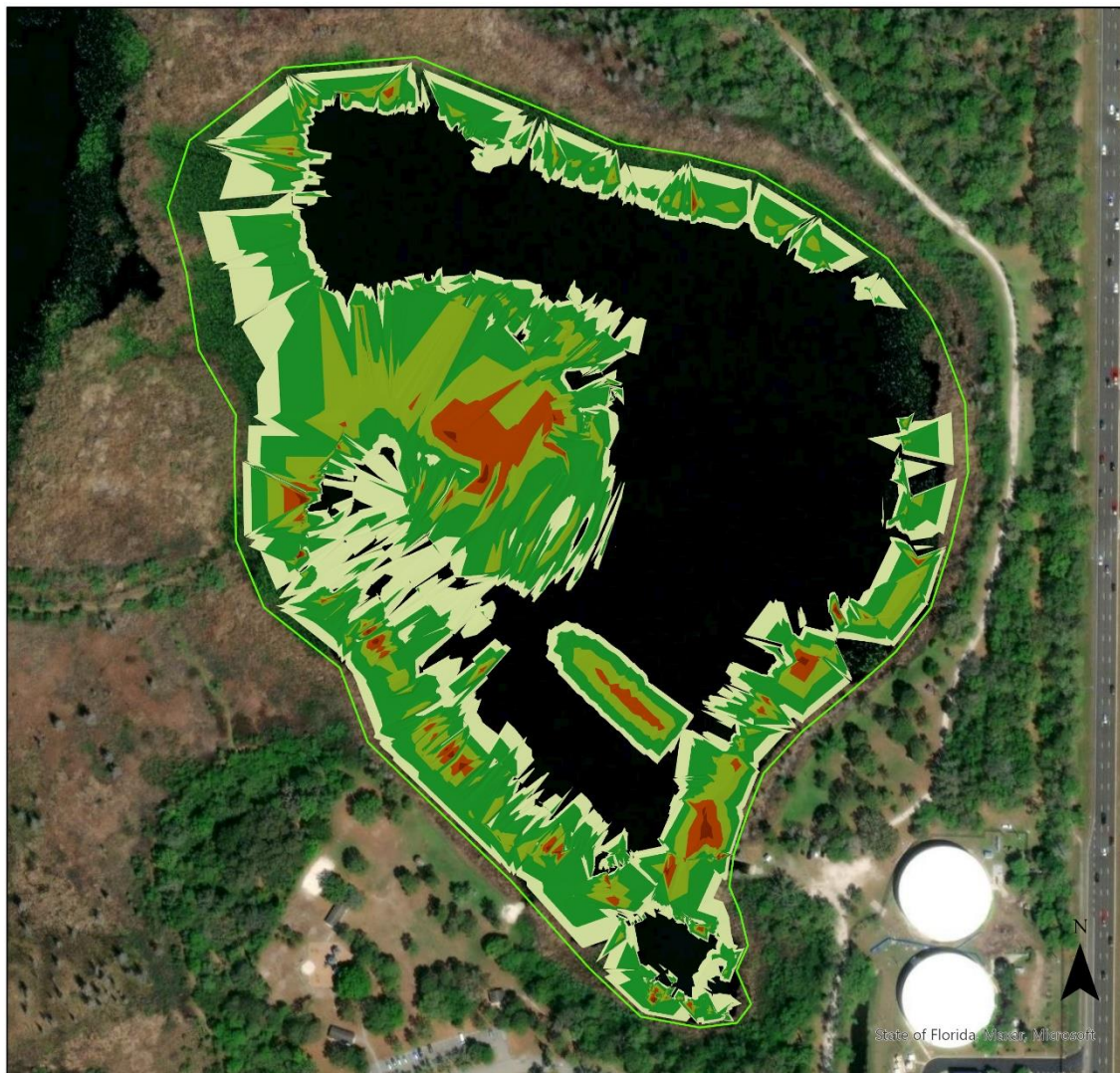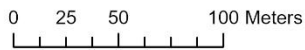gallons);
(4.38% of Lakes Volume)

Hillsborough County
Florida

USF
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SOUTH FLORIDA

Water Institute

Figure 5 Starvation Lake Submerged Aquatic Vegetation Assessment Results

Starvation Lake
WBID 1498A

○ Lake Vegetation Index Points

▭ Starvation Lake LVI Regions

0   25   50   100 Meters

Sample Date - August 9, 2023
Regions Assessed - 2, 5, 8, 11
Dominant Species per Region -
  2 - Eleocharis baldwinii,
    Nymphaea odorata
  5 - Najas guadalupensis, Typha
  8 - Najas guadalupensis,
    Nymphaea odorata
  11 - Eleocharis baldwinii,
    Nymphaea odorata

Lake Description
  Water Clarity - 2.1m (7.0ft)
  Color - Slightly Turbid, Clear
  Sediment Types - Sandy/Silt,
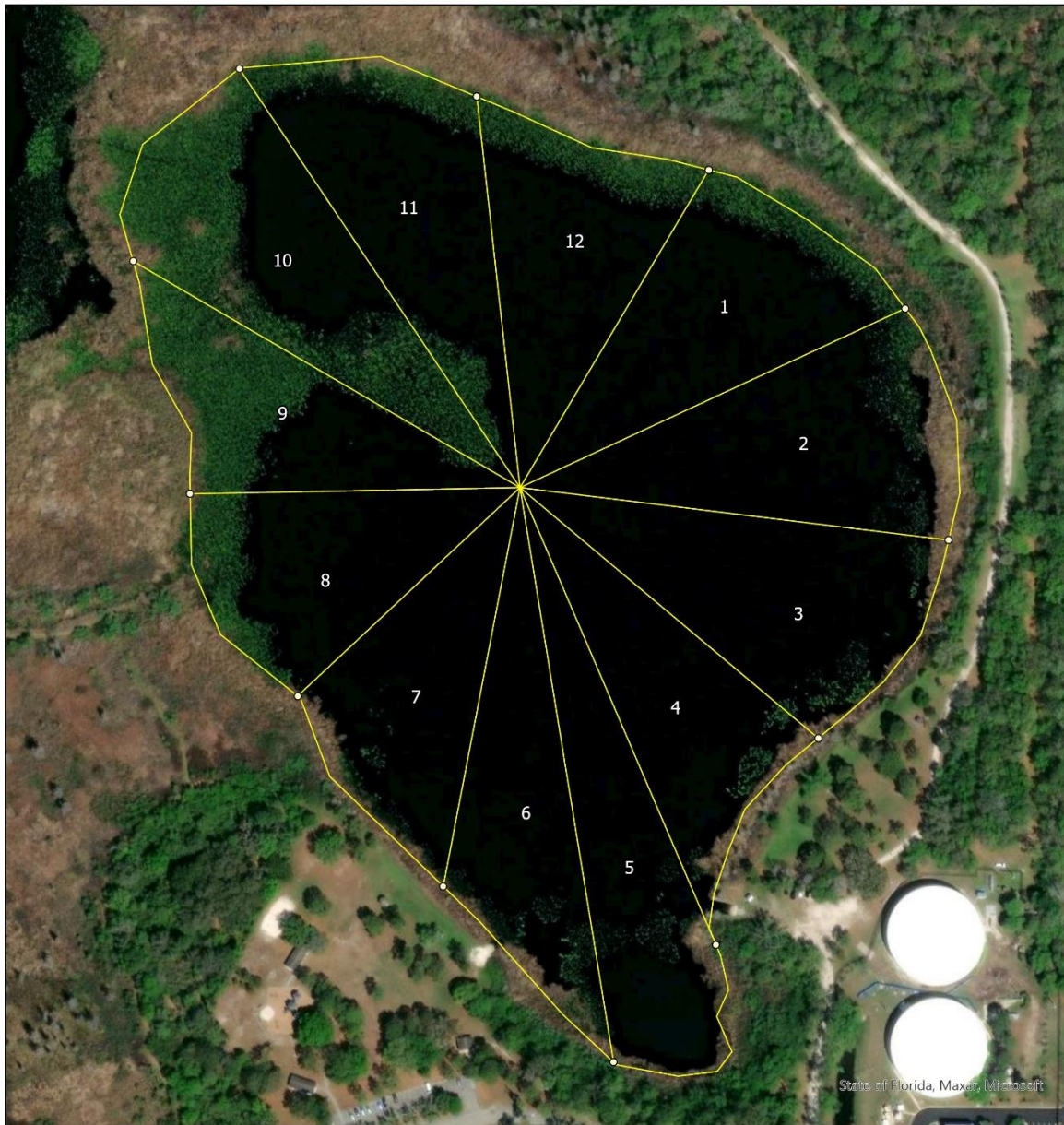   Vegetated, CPOM
Lake Vegetation Index - 76

N

Figure 6: Lake Vegetation Index region map for Starvation Lake

Table 2: Lake Vegetation Index results for Starvation Lake August 9, 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 2	Region 5	Region 8	Region 11	Occurrence
Cyperus blepharoleptos	0.00	-	OBL	Exotic	p	p	p	p	4
Eleocharis baldwinii	2.82	-	OBL	Native	c	p	p	c	4
Najas guadalupensis	5.07	-	OBL	Native	p	c	c	p	4
Nuphar	3.50	-	OBL	Native	c	p	p	p	4
Typha	1.00	-	OBL	Native	p	c	p	p	4
Utricularia gibba	6.37	-	OBL	Native	p	p	p	p	4
Acer rubrum	4.65	-	FACW	Native	p	p	p	-	3
Eupatorium capillifolium	0.83	-	FAC	Native	p	p	-	p	3
Ludwigia octovalvis	2.00	-	OBL	Native	p	p	-	p	3
Nymphaea odorata	5.00	-	OBL	Native	p	-	c	c	3
Potamogeton pusillus	7.80	-	OBL	Native	-	p	p	p	3
Salix caroliniana	2.95	-	OBL	Native	p	p	p	-	3
Taxodium	7.00	-	OBL	Native	p	p	-	p	3
Xyris		-	OBL	Native	p	p	-	p	3
Cephalanthus occidentalis	5.00	-	OBL	Native	p	p	-	-	2
Hydrocotyle	2.00	-	FACW	Native	p	p	-	-	2
Mikania scandens	1.95	-	-	Native	-	p	-	p	2
Panicum hemitomon	5.82	-	OBL	Native	-	-	p	p	2
Pluchea baccharis	5.45	-	FACW	Native	p	-	p	-	2
Triadenum virginicum	5.00	-	OBL	Native	p	p	-	-	2
Ceratophyllum demersum	4.16	-	OBL	Native	-	-	-	p	1
Cyperus odoratus	3.00	-	FACW	Native	-	-	-	p	1
Habenaria repens	3.50	-	FACW	Native	p	-	-	-	1
Ilex cassine	6.00	-	OBL	Native	-	p	-	-	1
Myrica cerifera	2.00	-	FAC	Native	-	p	-	-	1
Osmunda regalis	7.60	-	OBL	Native	-	p	-	-	1
Pontederia cordata	5.38	-	OBL	Native	-	p	-	-	1
Symphyotrichum carolinianum	3.93	-	OBL	Native	-	p	-	-	1
Thelypteris palustris pubescens	5.31	-	FACW	Native	-	p	-	-	1

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Sample Result:			76	
Region	**South**			
Metric / Section	**2**	**5**	**8**	**11**
Total # Taxa	18	23	12	16
% Native Taxa	94%	96%	92%	94%
% FLEPPC 1 Taxa	0%	0%	0%	0%
% Sensitive Taxa	6%	13%	8%	13%
Dom Taxa Count	2	2	2	2
CofC Dom Taxa	3.16	3.04	5.04	3.91
Section LVI	68	77	78	80

Water Quality Assessment

Long-term water quality data is available for Starvation Lake. The available data was collected by Lakewatch, Southwest Florida Water Management District, Florida Department of Environmental Protection and Hillsborough County Environmental Services. The dataset is incomplete with no samples in 2022 and only 2 samples in 2023. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of the Starvation Lake during the assessment in 2023.

Table 4: Starvation Lake Water Quality 8/9/2023 (Field)

Meter Readings:	Depth (M)	Temp (°C)	pH (SU)	D.O (MG/L)	D.O Sat. (%)	Cond. (UMHO/CM)	Salinity (PPT)
Top:	0.39	32.6	6.51	6.96	90.1	123	0.06
Mid-Depth:	1.66	31.9	6.44	5.72	73.2	123	0.06
Bottom:	2.49	30.9	6.42	1.99	25.1	123	0.06

The chemical water quality analysis for Starvation Lake is shown in Table 5 for the samples taken on 6/27/23 and 7/18/23. 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 49 PCU, classifying it as a colored water lake (greater than or equal to 40 PCU). Total Alkalinity period of record geometric mean value is 23 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 2.5 µg/L (2021), no data (2022) and insufficient data (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 0.016 mg/l (2021), no data (2022) and insufficient data (2023). Total Nitrogen values were below the nutrient threshold for colored lakes with sufficient data with a value of 0.566 mg/l (2021), no data (2022) and insufficient data (2023).

Bacteria testing showed low levels of E. Coli (7.5 colonies/100ml) and Enterococci (6.9 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: Starvation Lake 2023 Hillsborough County Environmental Services Water Quality Results (Laboratory)

Parameter	6/27/2023	7/18/2023	POR Mean Value	Units
Alkalinity	23.7	24.4	23	mg/LCaCO3
Color			49	PCU
E Coli	7.5	7.4	7.5	#/100ml
Enterococci	6.3	7.4	6.9	#/100 ml
Chlorophyll a	3.4	3.1	5.4	ug/L
Chlorophyll b	2.5	2.5	2.5	ug/L
Chlorophyll c	2.5	2.5	2.5	ug/L
Chlorophyll a Corrected	4	2.8	3.3	ug/L
Ammonia	<0.073	<0.073	0.012	mg/L
Nitrates/Nitrites	<0.043	<0.043	0.010	mg/L
Kjeldahl Nitrogen	0.565	0.692	0.645	mg/L
Total Nitrogen	0.570	0.690	0.574	mg/L
Total Phosphorus	<0.068	0.150	0.018	mg/L

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean Color (pcu)	49
Number of Samples	59
Geometric Mean Alkalinity (mg/L CACO3)	23
Number of Samples	48
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 (13)	2.52	< 20	0.016	< 0.16	0.566	< 2.23
2022 (0)	No data	< 20	No data	< 0.16	No data	< 2.23
2023 (2)	Insufficient data	< 20	Insufficient data	< 0.16	Insufficient data	< 2.23

Conclusion

Starvation Lake is a predominately natural lake in the Coastal Old Tampa Bay Watershed of Hillsborough County, Florida. The results of the assessment of Starvation Lake shows inconclusive results 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 due to insufficient data issues in recent years. The most recent year with sufficient data was 2021. In that year the Chlorophyll-a corrected, total phosphorous and total nitrogen values were all below thresholds for colored lakes.

The system does show health in the vegetation communities according to the Lake Vegetation Index with no invasive species and an overall LVI score of 76. The assessment also revealed a submerged aquatic vegetation community comprising 4 species occupying 51.82% of the surface area and 4.38% of the volume of Starvation Lake.