Lake Tarpon Surface Water Improvement and Management (SWIM) Plan

July 2025

Southwest Florida Water Management District

WATERMATTERS.ORG · 1-800-423-1476

ESA

Lizanne Garcia
Lead Project Manager
Surface Water Improvement and Management (SWIM) Program
Southwest Florida Water Management District

Chris J. Anastasiou, Ph.D.
Chief Water Quality Scientist
Surface Water Improvement and Management (SWIM) Program
Southwest Florida Water Management District

Tara Harter
Staff Environmental Scientist
Surface Water Improvement and Management (SWIM) Program
Southwest Florida Water Management District

Doug Robison, PWS
Principal Scientist
Environmental Science Associates, Inc.

CITATION: Garcia, Lizanne, Chris Anastasiou, Tara Harter, and Doug Robison. 2025. Lake Tarpon Surface Water Improvement and Management (SWIM) Plan. Southwest Florida Water Management District, Brooksville, FL. 69 pp.

Executive Summary

In 1987 the Florida Legislature created the Surface Water Improvement and Management (SWIM) Act to protect, restore, and maintain Florida's highly threatened surface water bodies. Under this act, the state's five water management districts identified a list of priority water bodies within their authority and implemented Surface Water Improvement and Management (SWIM) Plans to improve and/or protect them. Each plan is designed to preserve or improve a waterbody's overall ecological health by outlining specific management actions, initiatives, and projects within the purview of the SWIM Program. Currently, there are 12 SWIM Priority Waterbodies including Lake Tarpon.

Lake Tarpon is the largest lake in Pinellas County with a surface area of approximately 2,500 acres, and a watershed of approximately 37,000 acres. It was designated as a SWIM Priority Waterbody following a major blue-green algae bloom in 1987 that covered 80% of the lake. This bloom persisted for much of that summer and was seen as an indicator of degraded water quality and fisheries conditions. Fortunately for the past 20 years, because of better lake and watershed management practices, Lake Tarpon has been a relatively healthy system supporting a robust submerged aquatic vegetative community made up of more than 90% desirable native species. Further, the Florida Fish and Wildlife Conservation Commission consistently ranks Lake Tarpon as one of the top 10 fishing lakes in Florida for bass. Given the lake's overall health, this SWIM Plan takes a "hold the line" strategy for managing Lake Tarpon.

Holding the line, however, does not mean doing nothing. Careful attention is needed to ensure that the progress made over the past two decades is not lost due to land use changes, sea-level rise, climate change, and other impacts. To hold the line, this SWIM Plan Update includes the following overarching water quality and natural systems goals.

Water Quality
Maintain water quality conditions for total nitrogen, total phosphorus and chlorophyll a
Hold the line on nutrient loads to offset potential increases in nutrient loading from continued development and aging infrastructure in the watershed
Natural Systems
Maintain water elevations in Lake Tarpon similar to those over the past 18 years to the extent that the flood control functions of the Lake Tarpon Outfall structure are not compromised
Where feasible work with partners to restore hydrologic function of wetlands on conservation lands within the Lake Tarpon and Brooker Creek watersheds
Support actions to maintain a healthy aquatic plant community that achieve an average Lake Vegetation Index (LVI) score of 43 points or greater

Using the best available science, this SWIM Plan Update identifies management actions that, if implemented, should help achieve the above referenced goals.

For Water Quality, Management Actions include:

Water Quality Protection and Restoration
Work with local, regional and state agencies to implement stormwater best management practices (BMPs)
Support the development of local government stormwater master plans
Support stormwater retrofits where feasible
Monitoring and Research
Support Pinellas County's long term water quality monitoring program
Support continued refinement of the nutrient loading sources to Lake Tarpon
Support periodic reevaluation of the nutrient loading sources using the most recent data
Education and Outreach
Continue to support Florida-Friendly landscaping principles
Continue to support outreach and education programs in the watershed

For Natural Systems, Management Actions include:

Natural Systems and Hydrologic Restoration
Continue to support conservation of priority habitats in the Lake Tarpon and Brooker Creek watersheds that intersect with the priorities of the Tampa Bay Habitat Master Plan (Robison et al., 2020)
Support natural systems and hydrologic restoration projects on conservation lands within the Lake Tarpon and Brooker Creek watersheds
Support Pinellas County's efforts to enhance shoreline emergent aquatic vegetation
Monitoring and Research
Support FWC's continued Long-Term Aquatic Habitat Monitoring Program for Lake Tarpon
Support Pinellas County's continued monitoring to determine Lake Vegetation Indices on an annual basis
Improve our understanding of how rainfall, climate, water levels and aquatic vegetation influence water quality
Education and Outreach
Continue to support water conservation strategies

Table of Contents

List of Figures

List of Tables

Introduction

The SWIM Act and SWIM Priority Waterbodies

In recognition of the need to place additional emphasis on the restoration, protection, and management of the surface water resources of Florida, the Florida Legislature, through the Surface Water Improvement and Management (SWIM) Act of 1987, directed the state's water management districts to "design and implement plans and programs for the improvement and management of surface water" (Section 373.451, Florida Statutes). The SWIM legislation requires the water management districts to protect the ecological, aesthetic, recreational, and economic value of the state's surface water bodies, keeping in mind that water quality degradation is frequently caused by point and non-point source pollution, and that degraded water quality can cause both direct and indirect losses of habitats.

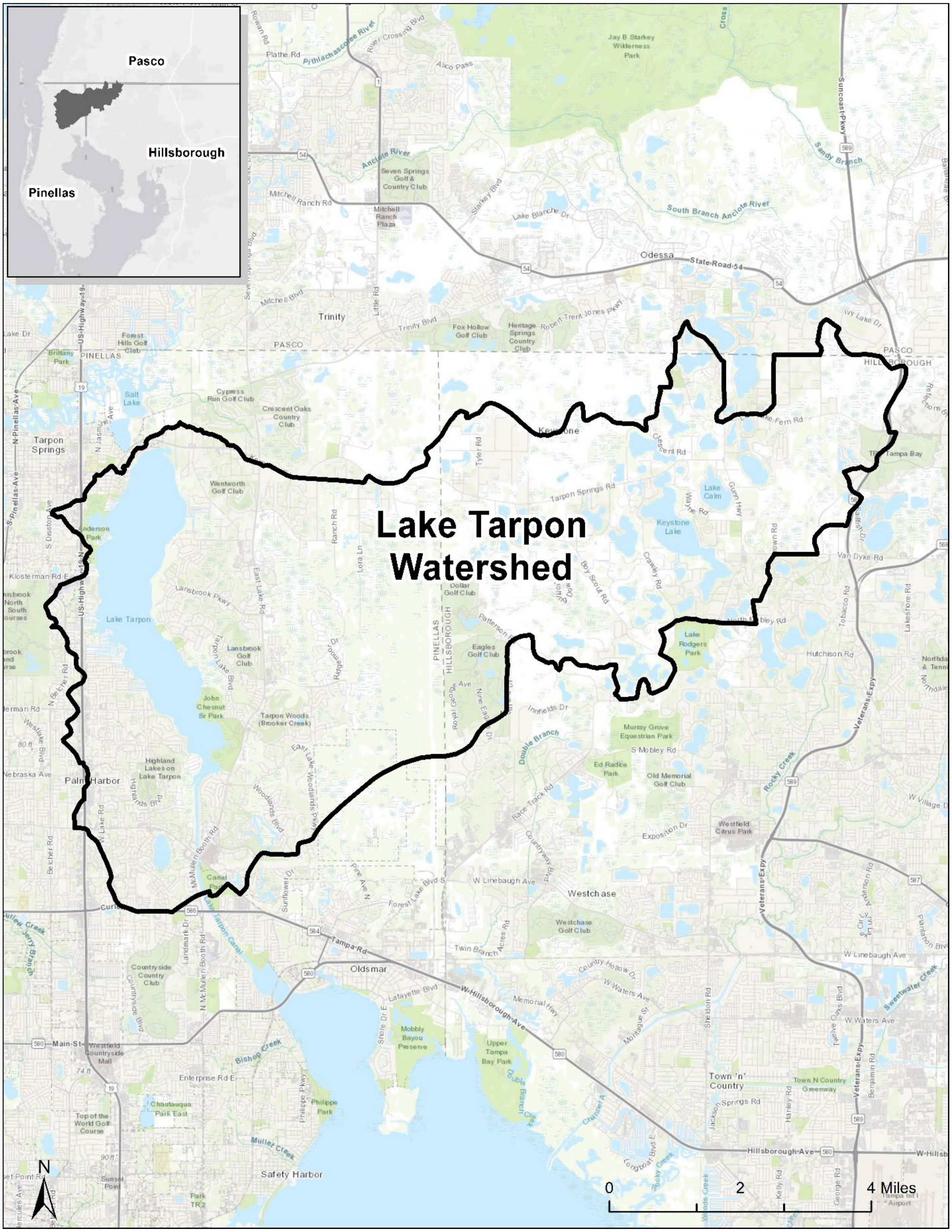
Under the act, water management districts identify water bodies for inclusion in the SWIM program based on their regional significance and their need for protection and/or restoration. This process is carried out in cooperation with the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FFWCC or FWC), the Florida Department of Agriculture and Consumer Services (FDACS) and local governments.

In accordance with the SWIM Act, once a water body is selected, a SWIM plan must be adopted by the water management district's governing board and approved by the FDEP. Before the SWIM plan can be adopted, it must undergo a review process involving the required state agencies. The purpose of this Lake Tarpon SWIM plan is to set forth a course of action by identifying the quantity, scope, and required effort of projects appropriate for the system while considering the levels of funding.

SWIM Plan Geographic Setting

Lake Tarpon, located 1.75 miles east of the city of Tarpon Springs, is the largest lake in Pinellas County with a surface area of approximately 2,500 acres and a watershed, including the open water portion of the lake and the Brooker Creek Watershed, of approximately 37,000 acres. Nearly the entire watershed lies within Pinellas and Hillsborough Counties, with a small portion in Pasco County (Figure 1). Lake Tarpon is a freshwater lake with both groundwater and surface water inputs with Brooker Creek as the main tributary. The headwaters of Brooker Creek originate in northwest Hillsborough County.

Topographically the lake's watershed ranges from an elevation above mean sea level of less than five to greater than 80 feet. The northern and western most portions of the watershed are characterized by steeper slopes and typically well drained soils, while the eastern portion of the watershed is generally flat and consists of poorly drained soils (KEA, 1992). These soil and slope characteristics have been an important factor in the development history of the watershed. Most of the commercial and high-density development in the 1950s and 1960s was generally concentrated in the western portion of the watershed. This development predated stormwater treatment and wetland protection regulations. During this time, much of the eastern shore of the lake and the Brooker Creek watershed were rural and agricultural lands. Urban development in this area began in the 1970s and 1980s when more rigorous stormwater treatment and wetland protection criteria were being adopted.



Source: SWFWMD Mapping and GIS Section

Figure 1 – Basin boundary for Lake Tarpon Watershed

The Lake Tarpon Sink, situated on the northwest shore of the lake, carries significant hydrological importance. This sink, at a depth of 118 feet, was hydrologically connected to Lake Tarpon. Dye studies conducted in 1946 and 1949 confirmed a hydrologic connection between the Lake Tarpon Sink and Spring Bayou in Tarpon Springs, nearly two miles northwest of the sink (Taylor, 1953). The sink acted as both an outflow and inflow depending upon the tide and the water level in the lake. Inflows from the sink resulted in increased salinity concentrations in the lake. A ring dike was constructed around the sink in May 1969 by the District to prevent the exchange of water between the sink and the lake. Until the construction of the Lake Tarpon Outfall Canal, the sink was the only surface water outflow for the Lake. The Lake Tarpon Outfall Canal was constructed as part of the Four River Basins Project by the US Army Corps of Engineers to provide flood control for Lake Tarpon. The Outfall Canal located at the southernmost end of the lake was completed in 1967. The Outfall Canal, which is approximately 3.5 miles long and about 12 feet deep, connects the Lake to Upper Tampa Bay. At the time of construction an earthen dam was placed in the canal to prevent the backflow of salt water into the lake. In 1971, the earthen dam was replaced with an operable structure approximately 1.4 miles upstream of the Outfall Canal's confluence with Tampa Bay. The Lake Tarpon Outfall Structure (S-551) is operated by the District under the guidance of the US Army Corps of Engineers. The primary purpose of the Outfall Canal and S-551 is to provide flood control for Lake Tarpon. The District has operated S-551 since 1998 maintaining the District's flood control objective while providing the benefits of water quality and desirable underwater and shoreline plants (SWFWMD, 2001). This plan recognizes the construction of the Lake Tarpon Outfall Canal created a source of freshwater input to Old Tampa Bay where historically one did not exist. Potential impacts of Lake Tarpon discharges to Old Tampa Bay are beyond the scope of this plan which focuses exclusively on Lake Tarpon. More discussion regarding Lake Tarpon discharge to Old Tampa Bay can be found in the Tampa Bay SWIM Plan (Garcia, et al. 2023).

Lake Tarpon Land Use/Land Cover

Lake Tarpon and its surrounding watershed cover nearly 37,000 acres, predominantly characterized by natural areas and open water. Using data from 1999, which aligns with the recently updated Tampa Bay SWIM Plan, natural areas accounted for 33% of the watershed, totaling 12,212 acres, while open water comprised 13%, amounting to 5,096 acres (Table 1). By 2020, the area designated as natural areas had decreased to 12,035 acres, while open water has slightly increased to 5,147 acres (Table 1).

In 1999, urban and disturbed land constituted 38% of the watershed (14,080 acres). In 2020, urban and disturbed land comprised 45.2% of the watershed, an increase of 2,576 acres (Table 1).

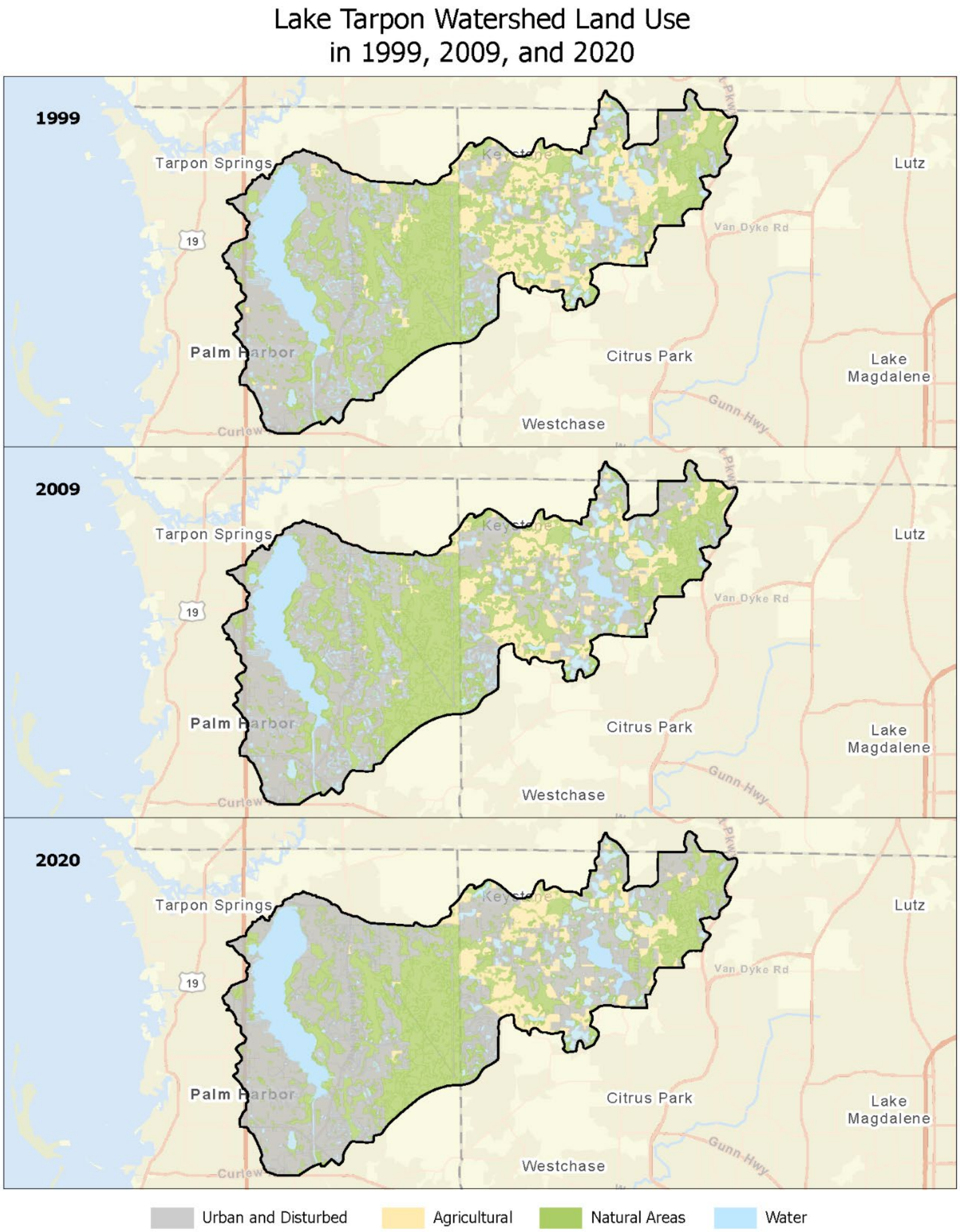
Lake Tarpon						
	1999		**2009**		**2020**	
Use	**Acres**	**Percentage**	**Acres**	**Percentage**	**Acres**	**Percentage**
Urban & Disturbed	14,080	38.2%	16,287	44.2%	16,656	45.2%
Agricultural	5,428	14.7%	3,361	9.1%	2,978	8.1%
Natural Areas	12,212	33.2%	12,100	32.9%	12,035	32.7%
Water	5,096	13.8%	5,069	13.8%	5,147	14.0%
Totals	***36,817***	***100.0%***	***36,817***	***100.0%***	***36,817***	***100.0%***

Source: SWFWMD Mapping and GIS Section

Table 1 – Land use change by acres and percent for Lake Tarpon

This increase in urban and disturbed land was accompanied by a corresponding decline in natural areas and agricultural lands (Table 1). Agricultural lands decreased from 14.7% in 1999 to 8.1% in

2020. Natural areas remained relatively consistent with only a slight decline from 33.2% of the watershed in 1999 to 32.7% in 2020, a decline of 177 acres. This relatively small decline in natural areas is a function of the number of publicly owned lands within the watershed including the Brooker Creek Preserve, the Upper Brooker Creek Preserve, and other protected natural areas (Figure 2).



Source: SWFWMD Mapping and GIS Section

Figure 2 – Land use change map for Lake Tarpon for the years 1999, 2009, and 2020

Issues and Drivers

In 1998, the Lake Tarpon Drainage Basin Management Plan (DBMP; PBS&J, 1998) was published, and laid the foundation for the 2001 SWIM Plan update. The DBMP was a cooperative effort between the District SWIM Program, Pinellas County and the Lake Tarpon Management Committee.

Water Quality

The 2001 Lake Tarpon SWIM plan update identified the following two water quality goals based on the DBMP (PBS&J, 1998).

- Maintain the annual multi-parametric TSI (Trophic State Index) value at or below 55.
- Maintain the mean annual chlorophyll-a concentration at or below 14 μg/L.

Since the 2001 SWIM plan, the Trophic State Index method is no longer used by the State to determine nutrient imbalances in lakes and is therefore obsolete.

The target chlorophyll-a concentration of 14 μg/L was based on data collected in Lake Tarpon between 1990 and 1992. During this period, Lake Tarpon's water quality was perceived to be very good and therefore used as the reference period to set the chlorophyll-a and TSI goals. However, in 2017, the Lake Tarpon Water Quality Management Plan (WQMP; Atkins/ESA, 2017) concluded that 1990-1992 represented an anomalous period of exceptionally low chlorophyll-a concentrations likely caused by two events. The first was an accidental release of water from the Lake Tarpon outfall structure in March 1990, and the second was a dramatic expansion of hydrilla in 1991 and 1992. This expansion of hydrilla was likely caused by the low lake levels and resulted in sharp declines in water column chlorophyll-a.

Hydrilla, in large quantities, can reduce phytoplankton abundance thereby reducing water column chlorophyll-a and increasing water clarity (Langeland, 1996; Canfield, et al. 1984). While highly transparent water is often considered desirable by the public (Langeland, 1996), large monospecific stands of hydrilla do not represent a desirable ecological state. Subsequently, to control the proliferation of hydrilla, a large treatment occurred in 1993 which coincided with a period of reduced rainfall and low lake levels. Following hydrilla treatment, the lake experienced a sharp increase in chlorophyll-a concentration and remained high through 1996. This chlorophyll increase was likely caused by the release of bioavailable nutrients into the water column from the recently treated hydrilla. Over the past twenty years, chlorophyll-a concentrations have remained relatively stable, though well above the 14 μg/L goal set in the 2001 SWIM Plan. Nevertheless, large monospecific stands of hydrilla have not returned to the lake. Today, the lake supports a healthy, mostly submerged native aquatic habitat.

Since the 2001 SWIM Plan update, the FDEP utilized a generally applicable nutrient criteria for Florida lakes of 20 μg/L chlorophyll-a. The 2017 WQMP argued that using a state-wide database to set nutrient and chlorophyll criteria for Lake Tarpon may not be appropriate given the overall health of the lake. The 2017 WQMP found that the Numeric Nutrient Criteria (NNC) established by the FDEP for Total Nitrogen and Total Phosphorus were being met, though it was not met for chlorophyll-a. Additionally, Atkins/ESA (2017) reported that water quality varied over the 20-year time-period analyzed but was generally stable for chlorophyll-a and TN. These findings, together with the findings that Lake Tarpon has a healthy submerged aquatic vegetation (SAV) community and a healthy fishery, lead the authors to conclude that despite not meeting the chlorophyll-a NNC, the weight-of-evidence strongly suggested Lake Tarpon is a very healthy system.

The 2017 WQMP recommendations included a "hold the line" strategy to ensure that the continued development of the watershed does not cause future imbalances in the lake. The 2017 WQMP also suggested that Pinellas County pursue additional studies to determine more lake specific chlorophyll-a and nutrient targets.

The District convened a Technical Working Group, made up of agencies and local governments that manage water resources and natural systems in Lake Tarpon and its watershed (See Appendix B for a list of participants). During the two Technical Working Group meetings, held in 2020, the consensus was that Lake Tarpon is supporting healthy fisheries and submerged and emergent aquatic vegetation communities. The District coordinated with Pinellas County and the FDEP on the County's application for, and FDEP's consideration of, Site-Specific Alternative Criteria (SSAC) for Lake Tarpon in lieu of NNC (Pinellas County Environmental Management, 2021). At the time of this SWIM Plan update, the FDEP had not yet made a final decision on SSAC values. For this SWIM Plan update, a "hold the line" approach is taken based on the recommendations of the 2017 WQMP and considering the overall good health of the lake as evidenced by water quality data analyses conducted for this SWIM Plan Update (Appendix A). Therefore, specific numeric goals or targets are not being proposed for this update.

In addition to the water quality goals identified above, the 2001 SWIM plan included a pollutant loading reduction goal (PLRG). The PLRG is no longer applicable due to the changes in assessing water quality with FDEP's updated methods through the adoption of NNC. Additionally, more recent pollutant loading data shows that the groundwater component of the nutrient budget was underestimated at the time the PLRG was set.

Based on the recommendations in the 2001 SWIM plan, Pinellas County and the District initiated the design, permitting and construction of three alum injection stormwater systems. During design, two projects were determined to be infeasible due to several factors. In 2011, the District, in coordination with Pinellas County, completed the Lake Tarpon Area 6 alum stormwater treatment project to treat stormwater from a 360-acre subbasin within the Lake Tarpon watershed.

The 2017 Water Quality Management Plan reported that partial conversion of on-site wastewater treatment systems to central sewer had been completed in the Lake Tarpon basin.

Water Quality Status and Trends

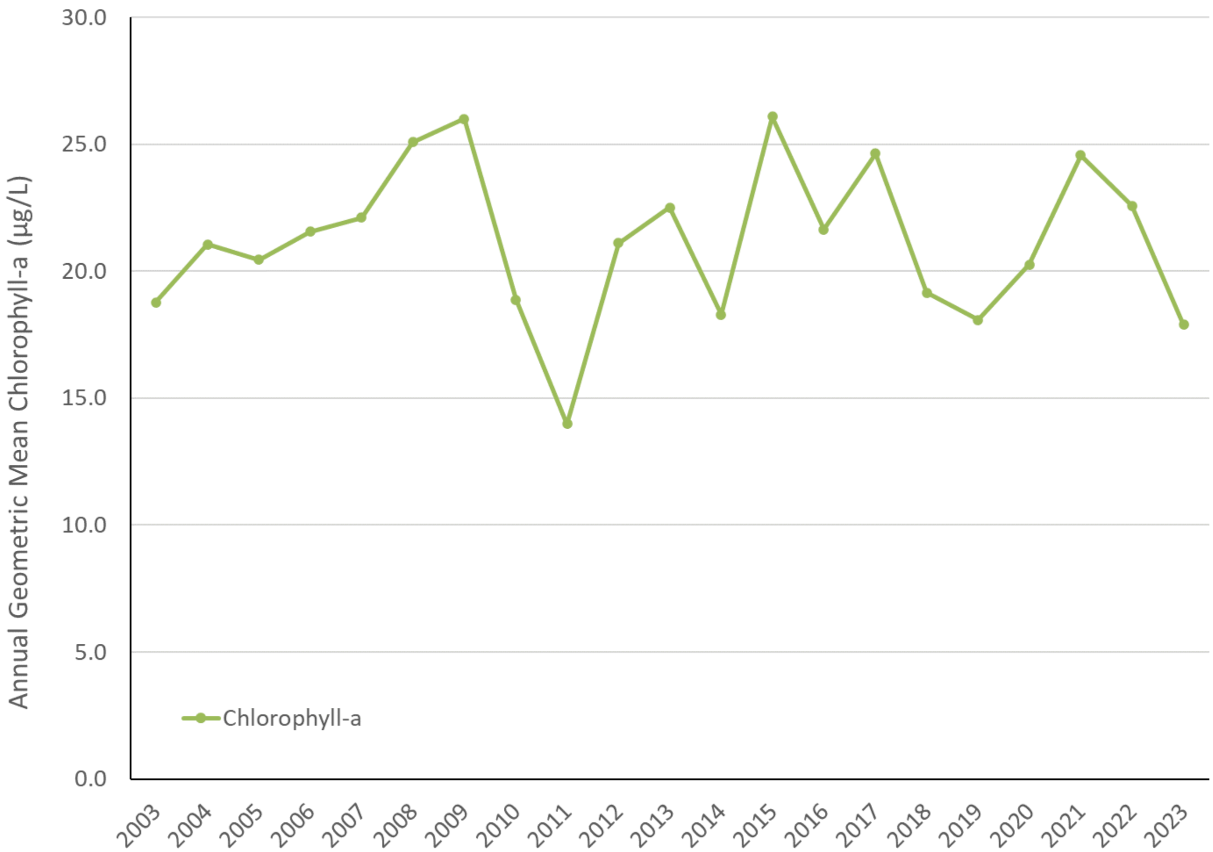
Pinellas County's Lake Tarpon ambient water quality monitoring program has been ongoing since 1987. As part of this SWIM plan update, water quality data collected by Pinellas County were used to characterize ambient water quality conditions in the lake. These data were from the same sources as the data used for analysis in the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017). For this plan, the period of record is 2003 to 2023.

Data were analyzed for water quality status and trends on an annual basis, as outlined by Florida's Impaired Waters Rule (Chapter 62-303, F.A.C.). Data were analyzed on a whole-lake level, and raw data were reviewed to ensure that samples were available from both wet and dry seasons. These data were then used to calculate annual geometric means for Chlorophyll-a, Total Nitrogen (TN), and Total Phosphorus (TP). Data sets for Chlorophyll-a, TN and TP were also tested for trends over time, using parametric and/or non-parametric statistical techniques, as appropriate.

The results of the updated water quality status and trends are summarized below for Chlorophyll-a, TN, and TP, respectively. A more detailed discussion is included in the Technical Memorandum in Appendix A.

Chlorophyll-a

Lake Tarpon annual geometric means for Chlorophyll-a between 2003 to 2023 are displayed in Figure 3. Results were tested for trends over time using annual geometric means as the dependent variable, and years as the independent variable. As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over time ($p>0.05$).

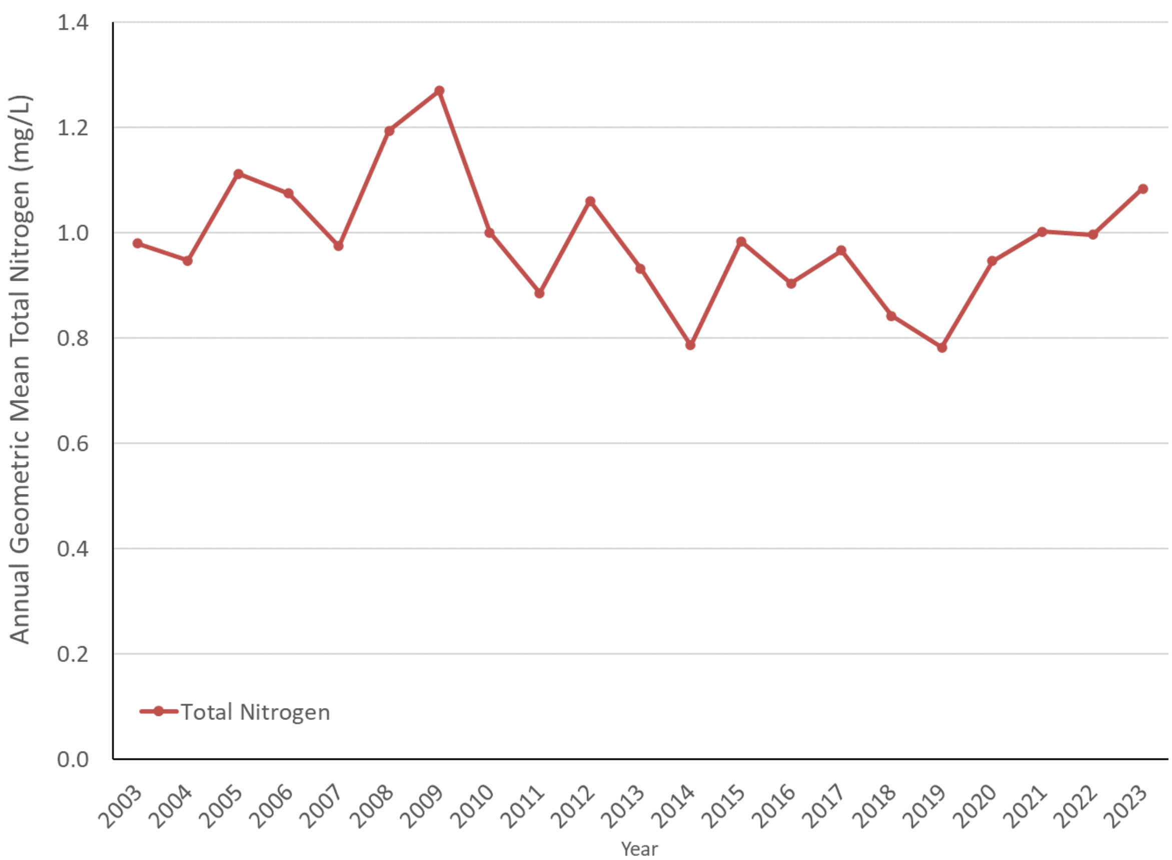


Statistical analysis did not detect a significant trend over the period 2003-2023

Figure 3 – Time series of Chlorophyll-a (µg/L) annual geometric means

Total Nitrogen

Annual geometric means for total nitrogen concentrations in Lake Tarpon over the period 2003-2023 ranged from approximately 0.8 – 1.27 mg/L (Figure 4). At no time did the TN concentration exceed the TN NNC of 1.27 mg/L. In 2009, the annual geometric mean equaled the TN NNC (Figure 4). As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over the period 2003-2023 ($p>0.05$). Pinellas County noted an increasing TN trend for the period 2014 to 2023 (Figure 4) in their 2023 Annual Water Quality Report (https://pcdem.shinyapps.io/dashboard/#section-annual-report). The 2014 to 2023 concentrations remain below the TN NNC and fall within the mean concentration over the period shown in Figure 4. Water quality is closely monitored by Pinellas County.



Statistical analysis did not detect a significant trend

Figure 4 – Time series of TN (mg/L) annual geometric means for the period 2003 to 2023

Total Phosphorus

Annual geometric means for total phosphorous concentrations in Lake Tarpon over the period 2003-2023 ranged from approximately 0.02 – 0.04 mg/L (Figure 5). At no time did the TP concentration exceed the TP NNC. As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over time (p>0.05).

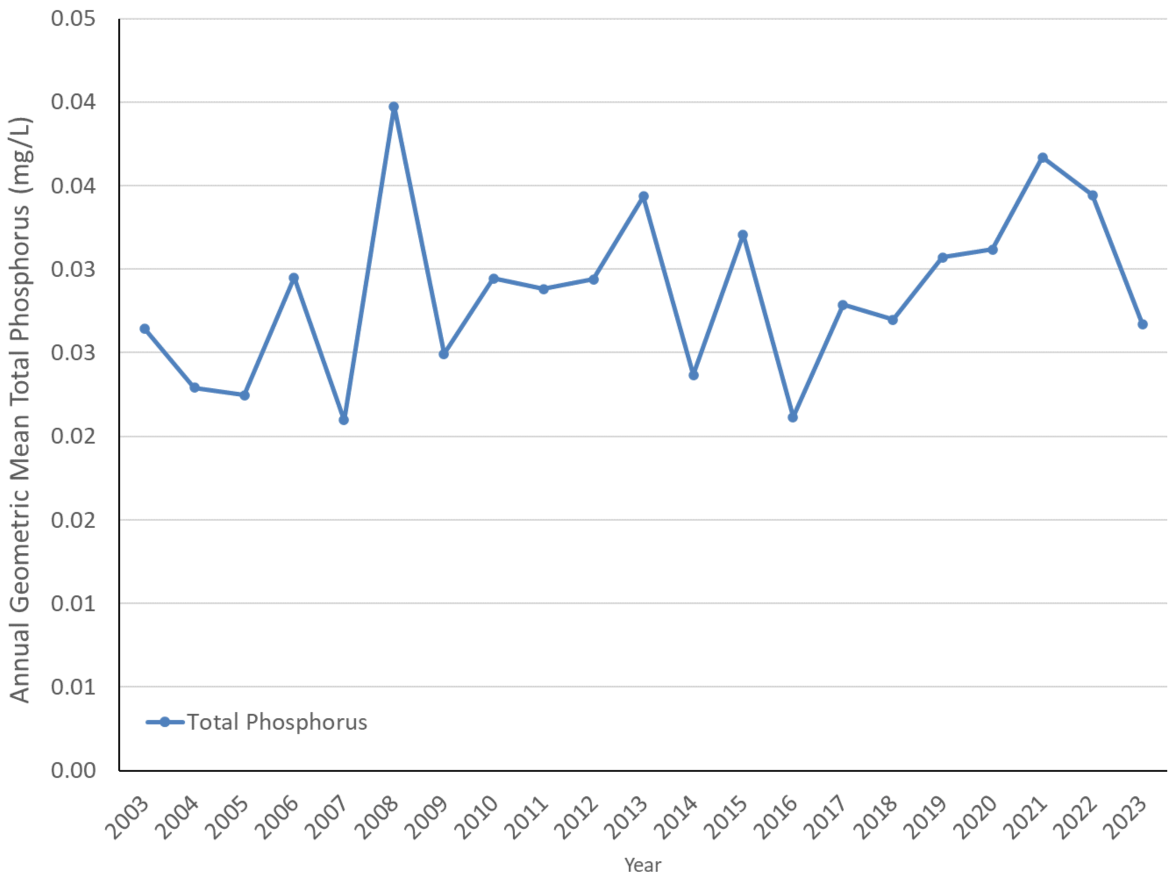


Figure 5 – Time series of TP (mg/L) annual geometric means

In summary, no significant trends in chlorophyll-a, TN, or TP were found over the 2003-2023 period. Table 2 shows the annual geometric means for each parameter over the 21-year period.

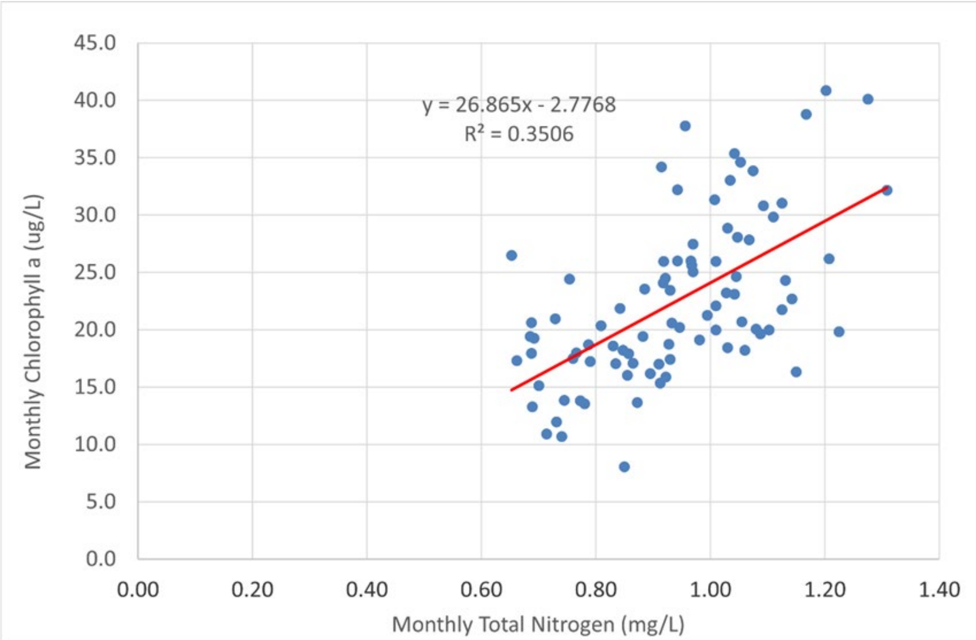
Year	Chlorophyll-a	TN	TP
2003	18.78	0.98	0.026
2004	21.05	0.95	0.023
2005	20.44	1.11	0.022
2006	21.55	1.07	0.029
2007	22.11	0.97	0.021
2008	25.08	1.19	0.040
2009	25.99	1.27	0.025
2010	18.87	1.00	0.029
2011	13.98	0.89	0.029
2012	21.11	1.06	0.029
2013	22.50	0.93	0.034
2014	18.28	0.79	0.024
2015	26.08	0.98	0.032
2016	21.64	0.90	0.021
2017	24.63	0.97	0.028
2018	19.15	0.84	0.027
2019	18.08	0.78	0.031
2020	20.25	0.95	0.031
2021	24.56	1.00	0.037
2022	22.57	1.00	0.034
2023	17.88	1.08	0.027

Table 2 – Annual geometric means for Chlorophyll-a, TN, and TP for the period analyzed

Water Quality Relationships

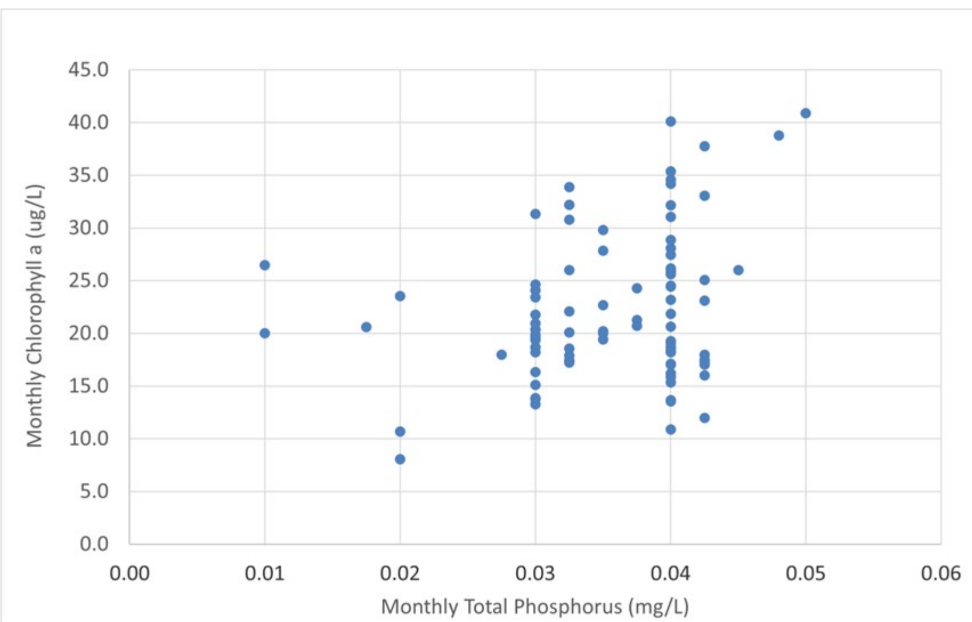
As had been previously noted in the 2001 Lake Tarpon SWIM Plan and the Lake Tarpon Water Quality Management Plan (2017) there is a significant relationship between TN concentrations and

Chlorophyll-a (Figure 6) but no evidence of a similar relationship between TP and chlorophyll-a (Figure 7).



For monthly mean lake values 2013-2018 (N=25). Red line represents the best fit linear regression line ($p<0.001$).

Figure 6 - Plot of Chlorophyll-a vs. TN concentrations



For monthly mean lake values 2013-2018 (N=25)

Figure 7 - Plot of Chlorophyll-a vs. TP concentrations

Lake Tarpon is a nitrogen limited system. However, other factors influence chlorophyll-a concentration including lake level, residence time, and SAV composition. For example, anecdotal evidence suggests a direct relationship between hydrilla expansion in Lake Tarpon and lake levels. Further, the 2017 WQMP found a negative correlation between average annual lake levels and annual average chlorophyll-a values, as well as a positive correlation between the coefficient of variation in lake levels (on an annual time-step) and annual average Chlorophyll-a concentrations (Atkins/ESA, 2017). When lake levels fall, hydrilla can outcompete native species and grow into parts of the lake that would normally be deeper where light levels are insufficient for SAV growth. As lake levels return and those normally deep areas become light limited once again, hydrilla, with its rapid growth rate, can keep up with rising water levels and maintain its connection to the photic zone. Once this happens, hydrilla continues to expand and the only way to control its expansion is through herbicide treatment. Following treatment of large areas, organic nitrogen in decaying plant material is re-mineralized and becomes bioavailable in the water column. Phytoplankton takes advantage of this available nitrogen source resulting in increases in chlorophyll concentrations. Past intensive herbicide treatments have resulted in rapid chlorophyll increases and even cyanobacteria blooms (Atkins/ESA, 2017). Over the past decade however, hydrilla coverage in Lake Tarpon has been effectively managed, due in large part to a commitment by FWC to treat hydrilla early before becoming extensive.

Pollutant Loading Model

As part of the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) a hydrologic and hydraulic (H&H) model was developed to estimate freshwater inflows and associated pollutant loads generated by rainfall in the Lake Tarpon basin, as measured by NexRad data. In addition, empirical models were used to develop estimates for other pollutant loading sources. For the overall Lake Tarpon loading model, the following sources were included:

- Atmospheric Deposition - loads associated with wet deposition falling on the lake surface.
- Basin Inflow – event mean concentrations based loading from drainage basin runoff incorporating applicable load reductions from stormwater Best Management Practices (BMPs).
- Tributary Inflows – Measured Brooker Creek concentrations applied to model generated creek flows, which were calibrated in the Hydrology and Hydraulic model via comparison with gaged inflows.
- Groundwater – Seepage volume applied to seasonal surficial ground water concentrations measured around Lake Tarpon.

As noted in the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) rainfall is the primary driver of the hydraulic model simulation and thus is the primary influence on the load estimates themselves. Analyses in the original "Technical Memorandum for Tasks 4.3 and 4.4" (ESA, 2021) showed statistically significant relationships exist between rainfall and nutrient loads delivered to the lake from all sources. Furthermore, it was demonstrated that monthly county-level rainfall data compiled by the District could be used to estimate monthly Total Nitrogen (TN) and Total Phosphorus (TP) loads delivered to the lake from all sources.

Using the statistical relationships between rainfall and nutrient loadings, monthly rainfall values from District rain gages in Pinellas County were used to estimate TN and TP loads from all sources, over the period of 2013 to 2023 (Tables of rainfall and loads from all sources between 2013 and 2023 are included in the Technical Memo in Appendix A). Figures 8 and 9 show the TN and TP loads to Lake Tarpon varied substantially on a monthly time step. During wet periods in 2015 and 2016, TN loads exceeded 16 tons per month, while dry months typically had TN loads less than 2 tons per month.

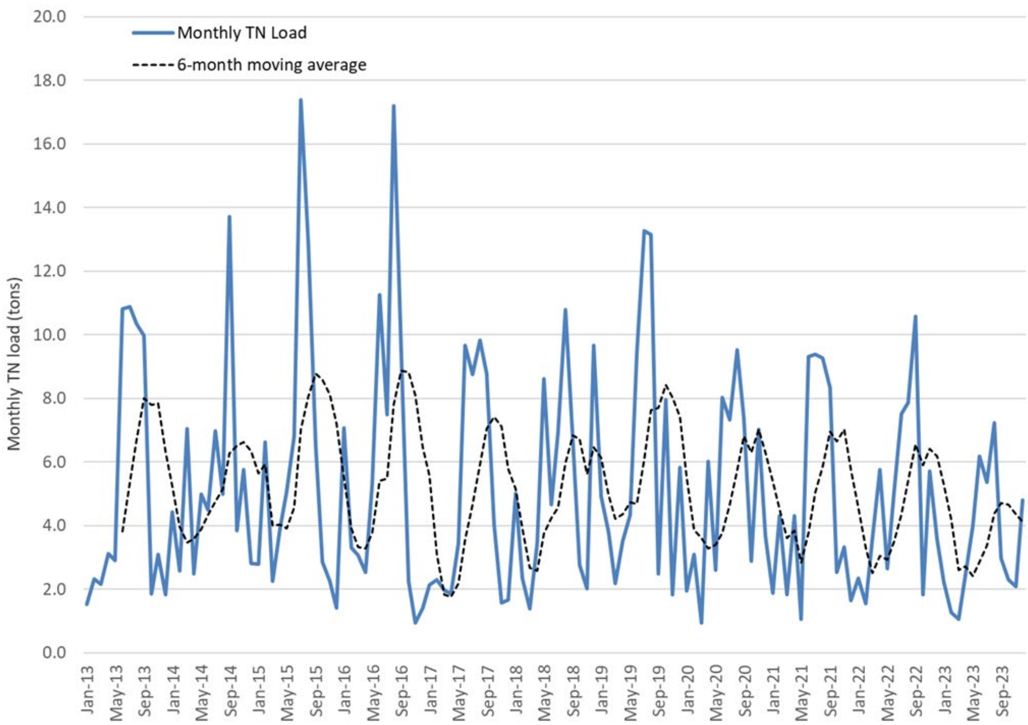


Figure 8 - Monthly TN loads from all sources during 2013 to 2023

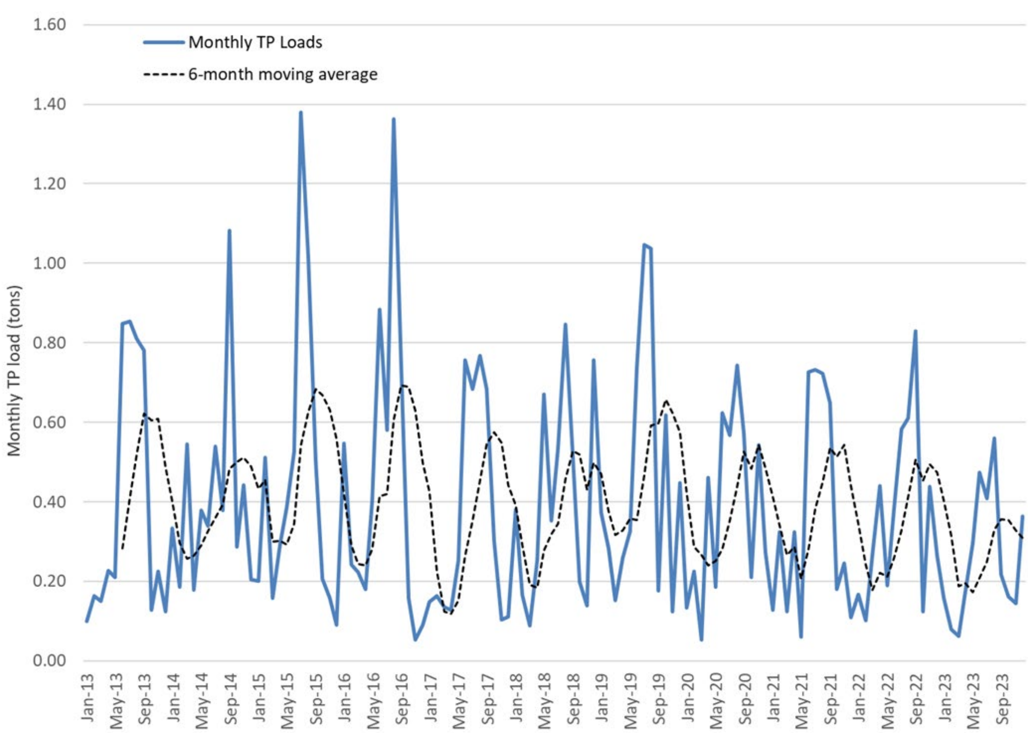


Figure 9 - Monthly TP loads from all sources during 2013 to 2023

Figures 10 and 11 partition out TN and TP loads into the sources of atmospheric deposition, basin runoff, groundwater inflows, and loads from Brooker Creek, respectively.

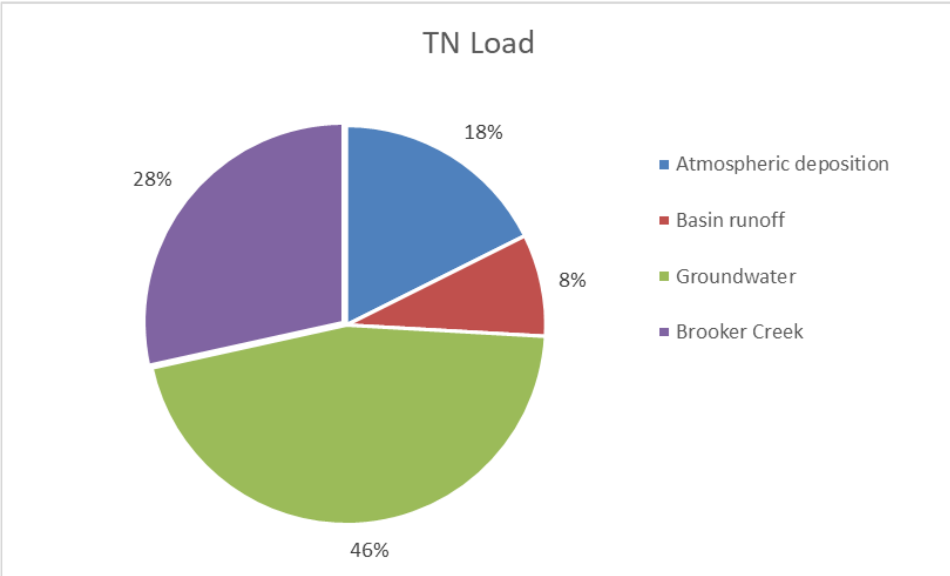


Figure 10 - Pie chart of TN loads from all sources during 2013 to 2023

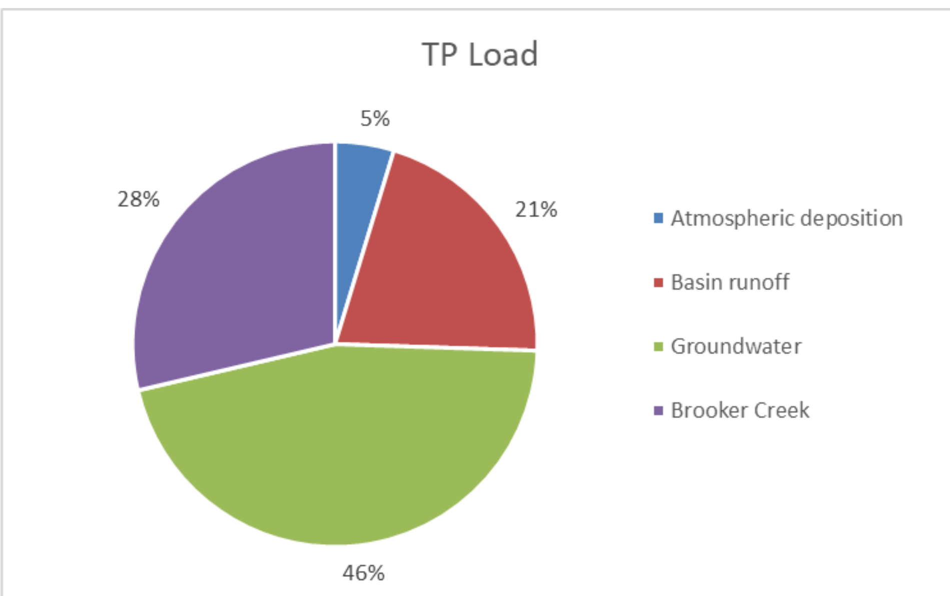


Figure 11 - Pie chart of TP loads from all sources during 2013 to 2023

For both TN and TP, the dominant loading source appears to be surficial groundwater inflows. These findings are consistent with the results of the loading model included in the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017). However, there is a substantial amount of variability in estimates of sources of TN and TP loads, as well as the quantities involved.

For example, based on results from Upchurch (1998) loads of TN and TP from the combination of the surficial and Floridan aquifers were 2.13 and 0.2 tons per year, respectively. These loads would account for less than 4 percent of the total loads to Lake Tarpon. A follow-up study by Leggette, Brashears & Graham, Inc. (2004) concluded that surficial groundwater seepage contributed 4.6 and 0.26 tons per year for TN and TP, respectively. In contrast, the model developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) estimated groundwater to load an average of 25.7 and 1.88 tons per year of TN and TP, respectively. The proportion of TN and TP loads from surficial groundwater seepage reported in the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) calculate out to 41 and 39% of total loads, respectively.

The results of the updated pollutant loading model displayed in Figures 10 and 11 thus differ from the groundwater loading estimates in the 2001 SWIM Plan, as well as the quantities in Upchurch (1998) and Leggette, Brashears & Graham (2004). However, they are in-line with both the quantities and proportions of loads estimated from groundwater inflow developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017).

A potential basis for the more recent estimates showing a greater role of groundwater is that the surficial groundwater elevations in the northern part of the watershed have rebounded substantially over the past 20 years (SWFWMD, 2020). Increased groundwater elevations have been attributed to the combined impacts of reduced groundwater withdrawals at the Eldridge Wilde wellfield since the late 1990s, as well as a general trend of increased regional rainfall over the past 20 years (SWFWMD, 2020). An elevated surficial groundwater table would make it easier for groundwater to flow toward the lake at greater rates, resulting in higher nutrient loads from groundwater than was found for models developed in prior years with lower groundwater inflow rates.

Pollutant Loads

The data presented herein support the prior conclusion that phytoplankton in Lake Tarpon is limited by nitrogen, not phosphorus. Estimates and sources of external nitrogen loads have varied substantially over time. The estimates presented here are dependent upon the nutrient loading assumptions and algorithms developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017), which concluded that surficial groundwater seepage was the major source of TN loads to Lake Tarpon. Earlier estimates suggested that groundwater was a much smaller source of TN loads. This difference in the importance of groundwater could be because the groundwater tables in the northern part of the Lake Tarpon watershed are substantially higher now than in past decades (SWFWMD, 2020).

It is also important to note that the category of "stormwater runoff" is split into two estimates – basin runoff and inflows from Brooker Creek. When those two categories are combined, they account for 36% of the total load compared to 46% of estimated load from groundwater inflows. Based on a combination of analyses using nitrogen isotopes, data parsing based on land uses, and other techniques, Leggette, Brashears & Graham, (2004) concluded that the majority of anthropogenic nitrogen loads associated with groundwater inflows into Lake Tarpon were likely due to over application of fertilizers in residential neighborhoods, particularly in those portions of the watershed on the extreme southwest and northeast borders, where substantial elevation changes occur. A continued and enhanced focus on public education related to overuse of fertilizers would likely benefit Lake Tarpon's water quality, regardless of the exact amount of nitrogen loaded to the lake via groundwater inflows or stormwater runoff.

Natural Systems

Natural Systems issues and drivers for Lake Tarpon include the in-lake systems as well as the natural systems within the watershed. The 2001 SWIM Lake Tarpon SWIM plan included goals for aquatic vegetation, hydrologic restoration, and fisheries. The status of the 2001 goals is included in this section along with a discussion of current issues.

Aquatic Vegetation

The 2001 Lake Tarpon SWIM plan update identified two key aquatic vegetation goals. These goals and their status are identified below.

- Limit the areal coverage of hydrilla to 100 acres or less and, limit the areal coverage of cattails to 60 acres or less.
- Expand the coverage of desirable endemic submerged aquatic vegetation to 600 acres and maintain the areal coverage of emergent aquatic vegetation at 120 acres or more.

Lake Tarpon is generally meeting the aquatic vegetation goals from the 2001 SWIM plan. Maintenance of a healthy aquatic vegetation community is key to maintaining a healthy lake. It is important for protecting water quality and providing habitat for fish and other aquatic species. Monitoring of the aquatic vegetation in Lake Tarpon has been conducted using several methods over various time periods since the 2001 SWIM Plan. FDEP's Draft *Development of Type III Site Specific Alternative Nutrient Criteria for Lake Tarpon in Pinellas County, Florida* (FDEP, 2024), was used in the following discussion related to the health of aquatic vegetation.

Lake Vegetation Index (LVI) Surveys

The following section is taken from the Draft Development of Type III Site Specific Alternative Nutrient Criteria for Lake Tarpon document (FDEP 2024). Pinellas County and the FDEP have surveyed the health of aquatic and wetland plants since 2010 using the FDEP's Lake Vegetation Index (LVI) methodology. The LVI is a multi-metric index of biological integrity that is sampled and calculated using methods described in the FDEP's Standard Operating Procedure LVI 1000. An average score of 43 or above is considered to represent a healthy lake vegetation community.

All LVI data collected by the FDEP and Pinellas County for Lake Tarpon were combined and summarized to demonstrate the health of the system. Lake Tarpon LVI scores ranged from 34 to 52 for the 14 measurements collected during the period 2010 to 2022, for an average and median score of 41 (Table 3). The seven measurements collected in the last five years (i.e., 2017 to 2022) averaged 43.6.

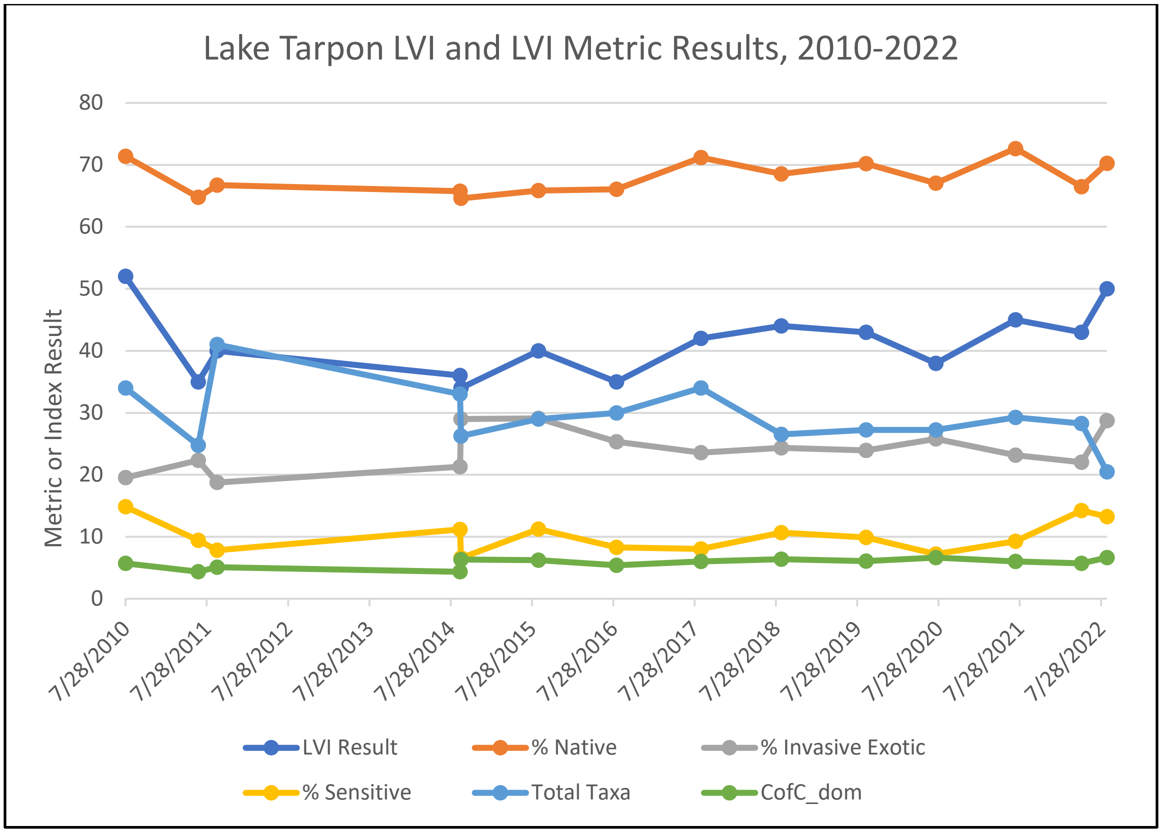
As reported by the FDEP, the range of scores does not clearly indicate an upward or downward trend but is a result of the variability in the relative abundance of taxa from year to year, the inherent variability in the method, and other factors such as water level and management activities. The LVI metric also shows generally consistent quality of codominant plants, and consistent percentages of native, sensitive, and invasive exotic plants, which are affected by the total number of plant species observed (Figure 12). Since three of the LVI scores are calculated based on species presence/absence, minimal occurrence of exotic and nuisance plant species can depress the final LVI score, even if more desirable plants are dominant or codominant. The LVI survey includes emergent vegetation in addition to submerged vegetation. In Lake Tarpon, the emergent vegetation composition has been affected by water level control because maintenance of high water allowed cattails to expand along the shorelines. Cattails are native plants however they can become a nuisance forming monospecific stands which lowers habitat diversity and therefore can contribute to a low LVI score. Active restoration efforts are underway in areas where cattails are abundant to replace them with a more diverse array of native plants.

Since 2017, LVI scores for Lake Tarpon have been 43 or higher, indicative of a healthy aquatic plant community.

Sample Date	Sampling Agency	LVI Result	Dominant Taxa*
7/28/2010	DEP	52	*P. illinoensis, C. demersum*
6/20/2011	DEP	35	*P. illinoensis, C. demersum, Typha*
9/12/2011	DEP	40	*P. illinoensis, S. californicus, Typha*
9/8/2014	DEP	36	*P. illinoensis, C. demersum, Typha*
9/12/2014	Pinellas Co	34	*P. illinoensis, C. demersum*
8/26/2015	Pinellas Co	40	*P. illinoensis, C. occidentalis*
8/10/2016	Pinellas Co	35	*P. illinoensis, C. demersum*
8/25/2017	Pinellas Co	42	*P. illinoensis, C. demersum*
8/21/2018	Pinellas Co	44	*P. illinoesnis, C. demersum, V. americana*
9/6/2019	Pinellas Co	43	*P. illinoesnis, C. demersum, V. americana*
7/16/2020	Pinellas Co	38	*P. illinoensis*
7/9/2021	Pinellas Co	45	*P. illinoensis, C. demersum*
5/1/2022	DEP	43	*P. illinoensis, Typha*
8/23/2022	Pinellas Co	50	*P. illinoensis*

**Potamogeton illinoensis* = Illinois pondweed; *Ceratophyllum demersum* = coontail; *Typha spp.* = cattails; *Schoenoplectus californicus* = bulrush; *Cephalanthus occidentalis* = buttonbush; *Vallisneria americana* = eelgrass.

Table 3 – Lake Vegetation Index results for Lake Tarpon 2010-2022



For each LVI assessment listed in Table 3.

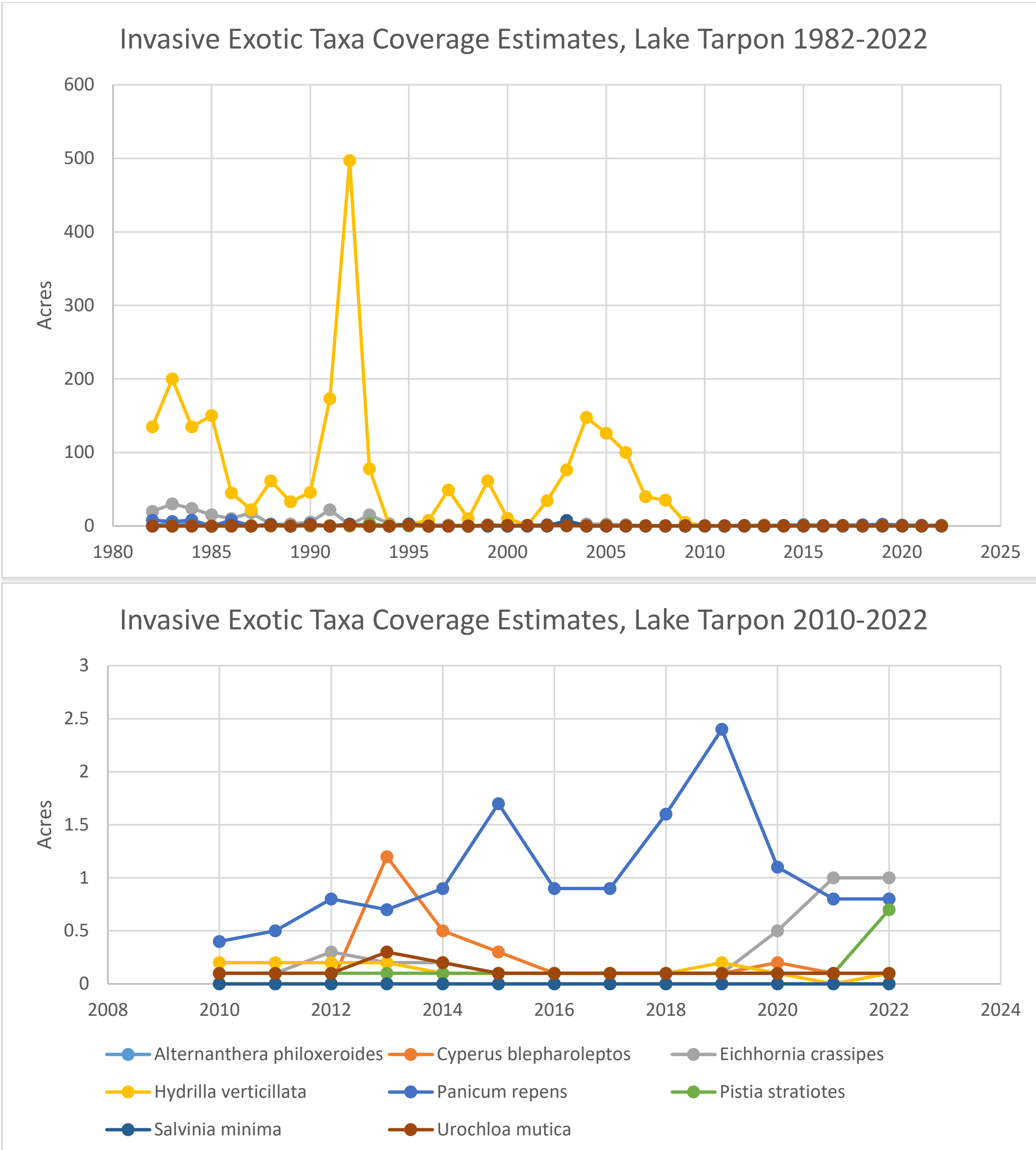
Figure 12 – Total LVI score, total taxa observed, and average scores for LVI metrics

The FDEP further evaluated aquatic plant community in Lake Tarpon by reviewing data from the FWC and the University of South Florida (USF) to help interpret the LVI and the fluctuations observed in the scores. The results of these analyses are provided below.

Integrated Plant Management Surveys and Treatment

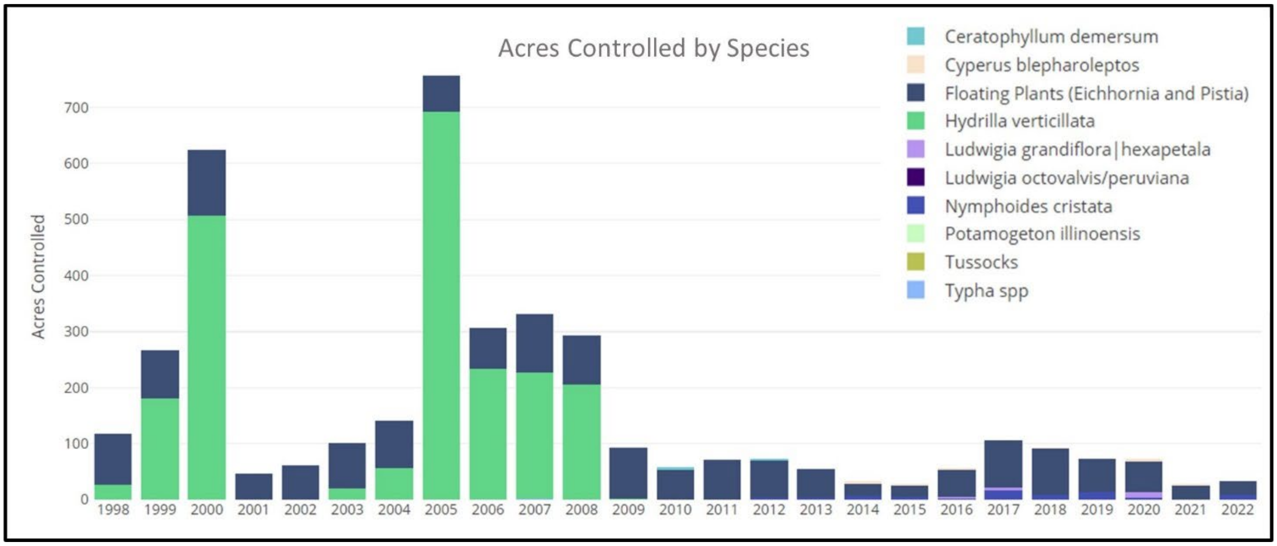
The FWC conducts rapid visual plant surveys on Lake Tarpon for its Integrated Plant Management Program (IPM) to determine if coverage of invasive exotic plants is sufficient to warrant control. These surveys represent estimates of plant coverage but also provide a good long-term view of invasive exotic plant coverage on Lake Tarpon. FWC's management objective for Lake Tarpon is to manage floating invasive plants at low levels to conserve or enhance the major uses and functions of the waterbody. Hydrilla populations will be monitored. Burhead sedge, crested floating heart, and water primrose are all managed to prevent further establishment and expansion throughout the lake and to prevent loss of beneficial native species diversity. FWC works to maintain low abundance of invasive exotics by preventive treatment, and competition from native plants helps to suppress the invasive exotics. Plant survey and treatment data were pulled by FDEP using the FWC's "What's Happening on My Lake" website.

Based on the long term IPM data, large expanses of the invasive non-native submerged hydrilla were present in Lake Tarpon from 1982 to 2008 (Figure 13), with a maximum of 500 acres observed in 1992. While invasive exotic species are still present on the lake, they are much less abundant (Figure 14). Since 2010, fewer than 100 cumulative acres have been treated annually (Figure 14). Atkins/ESA (2017) suggested that higher annual average Chl-*a* concentrations were associated with larger scale hydrilla treatments in Lake Tarpon from 1994 to 2002.



From 1982 to 2022, shown on the upper graph, with the period of 2010-2022 shown on a smaller scale in the lower graph. Taxa were included if they had > 1 acre coverage in at least one year. Source: FWC Invasive Plant Management Section (https://gis.myfwc.com/whoml/).

Figure 13 – Total acres of invasive exotic plants observed per year on Lake Tarpon



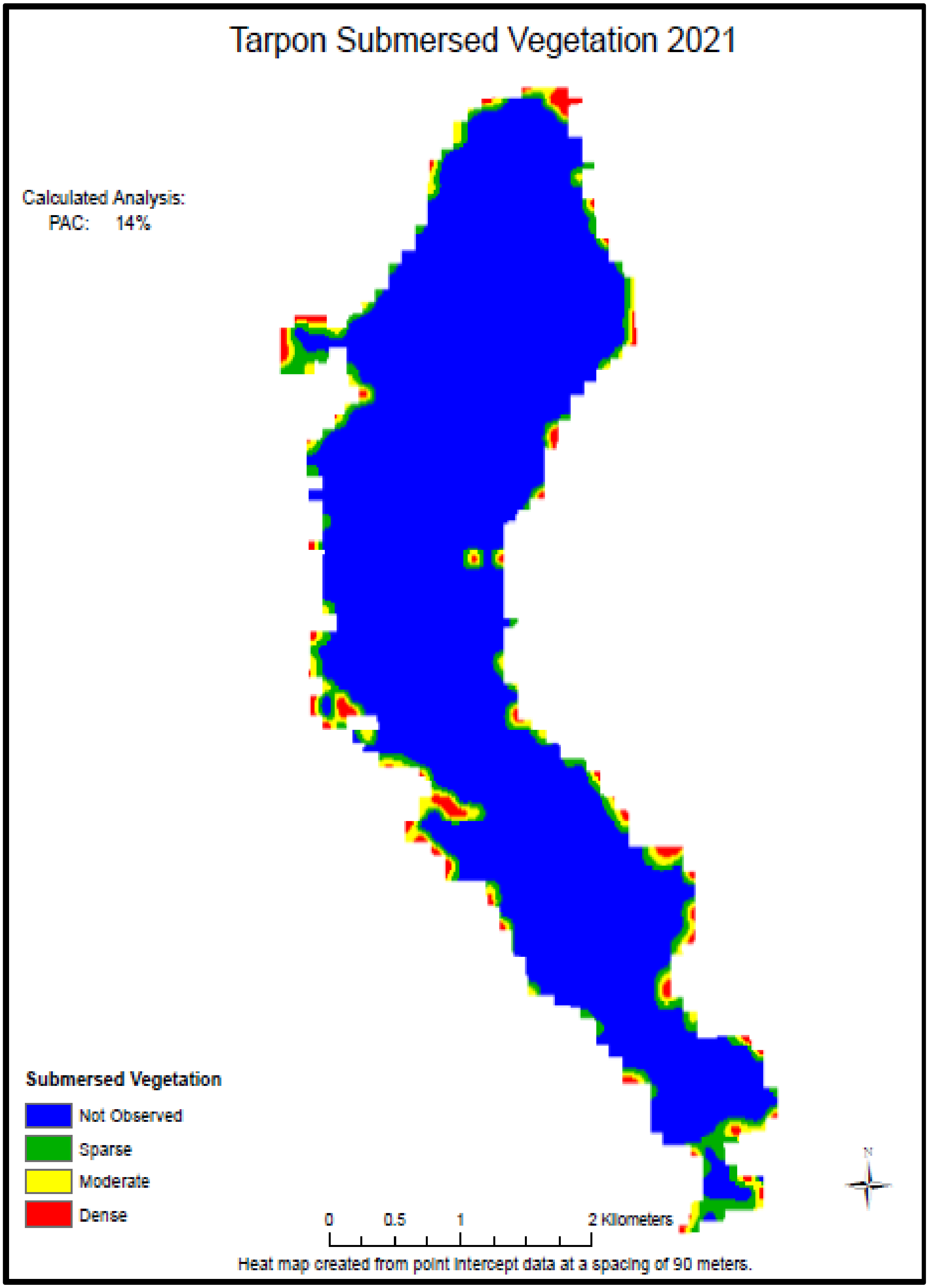
1998-2022. Acres represent the cumulative acres treated throughout each year. Source: FWC Invasive Plant Management Section (https://gis.myfwc.com/whoml/).

Figure 14 - Acres of plants controlled on Lake Tarpon

FWC and USF Lake Vegetation Mapping Surveys

FWC and USF mapped SAV in Lake Tarpon from 2015 to 2021 using underwater sonar coupled with field verification. These surveys include bathymetric mapping along pre-defined grids throughout the lake and detection of SAV with underwater sonar. The sonar data were processed to calculate the percent area covered (PAC) and percent volume inhabited (PVI) by vegetation in Lake Tarpon. The sonar mapping quantified the amount of SAV but not the species composition. To determine which SAV species were present, both USF and FWC used an underwater rake at verification points throughout the areas where SAV signals were picked up by underwater sonar. Emergent species observed at the verification points were noted. FWC investigators noted the density of each taxon at the verification points as sparse, moderate, or dense. Percent coverage of each species sampled with the rake was calculated from the total number of vegetated points.

Due to the lake's bathymetry, results show that the SAV was restricted to the perimeter of Lake Tarpon (Figure 15), and the average deep edge of the SAV beds was typically 7-8 feet. The PAC for FWC surveys was around 20% for all years. Similarly, the USF survey results for 2015 and 2019 showed PAC values of 16% and 20%, respectively. The PVI values for the two USF surveys are 1.6% and 1.9%, respectively, while PVI values for the FWC surveys ranged from 5% to 9%. These PVI estimates probably differ between investigators due to variation in calculation approaches and/or bathymetry data used to estimate volume.



As seen in FWC's 2021 survey

Figure 15 – The location and density ranks of submerged aquatic vegetation in Lake Tarpon

Table 4 lists the most common species found by USF during SAV surveys at their verification points and general estimates of frequency and density. *Potamogeton illinoensis* (Illinois pondweed), *Vallisneria americana* (eelgrass), and *Ceratophyllum demersum* (coontail) were the most common SAV species present during all events by both USF and FWC and each of these species are beneficial Florida natives.

Both FWC and USF surveys show a slight increase in the percent occurrence of hydrilla since 2015, the percentage of verification points where it occurred remained at or below 7% during all years. Further, no increase in the dominance of hydrilla was observed (Table 4 and Table 5). FWC monitors hydrilla annually and will treat to remove it if it becomes too abundant. Some of the changes in the relative abundance of species observed from 2016 to 2017 in FWC surveys may reflect an increase in the density of the survey grid.

The recent FWC and USF surveys show a native plant community that is not dominated by hydrilla, and the LVI assignments of dominance generally show limited prevalence of *Typha* (cattails)(Table 4 and Table 5). This is an improvement from the aquatic plant information found in "Effects of Water Level Fluctuations on the Fisheries of Lake Tarpon (Allen et al., 2003). This report included information on aquatic plant mapping between 1999 to 2002, which indicated that the most common species observed at Lake Tarpon were *Typha* (cattail), *Ceratophyllum demersum* (coontail), *Hydrilla verticillata* (hydrilla), and *Vallisneria americana* (eelgrass). *Typha* (cattail) beds were spaced intermittently along the entire shoreline in 1999 and 2001.

Species	2015 Percentage of Points Present	2015 Percentage of Points Dominant	2019 Percentage of Points Present	2019 Percentage of Points Dominant
Ceratophyllum demersum	58%	32%	63%	37%
Chara spp.	0%	0%	0%	0%
Filamentous Algae	1%	1%	12%	6%
Hydrilla verticillata	3%	1%	7%	0%
Myriophyllum heterophyllum	0%	0%	1%	0%
Najas guadalupensis	13%	3%	9%	0%
Nitella spp.	11%	3%	3%	0%
Potamogeton illinoensis	51%	37%	53%	41%
Vallisneria americana	58%	25%	47%	15%
Total Vegetated Points Assessed	***416***		***371***	

Observed at verification points during SAV surveys conducted by USF in 2015 and 2019

Table 4 – Frequency of occurrence and dominance of most common species

Species	Percentage of Points Present					
	2015	**2016**	**2017**	**2018**	**2019**	**2021**
Ceratophyllum demersum	51% (1.9)	51% (1.9)	47% (1.6)	49% (1.9)	57% (1.9)	28% (1.9)
Eichhornia crassipes	1%	1%	0%	2%	3%	2%
Filamentous algae	15% (1.2)	15% (1.2)	5% (1.4)	15% (1.3)	0%	11% (1.2)
Hydrilla verticillata	0%	0%	6%	3%	6%	7%
Najas guadalupensis	12% (1.6)	12% (1.6)	3% (1.0)	13% (1.1)	8% (1.1)	17% (1.3)
Nitella sp	12%	12%	1%	1%	1%	5%
Nuphar luteum	0%	0%	3%	5%	4%	5%
Nymphoides cristata	0%	0%	5%	5%	6%	5%
Panicum repens	1%	1%	1%	0%	2%	3%
Paspalidium geminatum	0%	0%	1%	1%	2%	2%
Potamogeton illinoensis	47% (1.8)	47% (1.8)	62% (2.0)	49% (1.9)	58% (2.0)	59% (2.0)
Salvinia minima	1%	1%	0%	7%	5%	1%
Schoenoplectus sp	1%	1%	6%	4%	4%	4%
Typha sp	7% (1.3)	7% (1.3)	14% (1.2)	15% (1.4)	12% (1.3)	16% (1.3)
Vallisneria americana	55% (1.6)	55% (1.6)	14% (1.3)	33% (1.6)	34% (1.5)	36% (1.7)
Total Vegetated Points Assessed	**85**	**85**	**156**	**159**	**181**	**182**

(average density [1=sparse, 2=moderate, 3=dense] for most abundant species) of vegetated verification points during SAV surveys conducted by FWC from 2015 to 2021

Table 5 – Plant species composition

Summary of Vegetation Evaluation

Lake Tarpon has recovered from having an ecologically imbalanced plant community dominated by hydrilla to its current and recent state of a diverse community dominated by beneficial native species, as reflected in the LVI scores and more extensively documented by intensive surveys conducted by FWC and USF. Invasive exotic plants continue to be present in low quantities but have been largely controlled by FWC and a healthy native plant community. The invasive exotic plants are ubiquitous components of aquatic plant communities in the Florida peninsular region and can rarely be eliminated altogether, so FWC continues to actively manage invasive exotics on an as needed basis to maintain a low abundance of these species. Due to the generally stable nature of the native plant community in Lake Tarpon, control measures have been drastically reduced in recent years. Because the LVI, which is used by the FDEP to evaluate the biological health of the plant community, is strongly influenced by the presence or absence of exotic species, even the presence of low numbers of exotic species will depress LVI scores. The LVI scores collected in Lake Tarpon since 2017 have passed the 43-point threshold. These LVI scores combined with assessments by FWC and USF indicate that Lake Tarpon has supported a stable and healthy plant community from 2017 through 2021.

Hydrologic Restoration

Hydrologic restoration goals in the 2001 SWIM plan were based on the relationship between a healthy submerged aquatic vegetation community and water quality and the health of its watershed. Hydrologic Restoration Goals in the 2001 SWIM plan and their status is discussed below.

- Manage water levels to improve water quality and aquatic vegetation while maintaining the existing degree of flood control provided by the Lake Tarpon Outfall Structure.
    - Status: Current mapping efforts by the FWC and information from Pinellas County indicate the SAV community is healthy. (See Water Quality and Aquatic Vegetation goals above)
- Restore hydrologic and ecologic functions of wetlands and tributaries in the Lake Tarpon and Brooker Creek watershed where opportunities for such restoration exist.
    - Status: The SWIM program, in cooperation with Pinellas County, completed hydrologic restoration projects including the Brooker Creek Hydrologic Restoration on Channel F and Channel L. These projects restored the historical hydrologic connection and improved ecological functioning of Brooker Creek, the primary tributary to Lake Tarpon. Additionally, in Hillsborough County, the Brooker Creek Preserve Environmental Lands Acquisition and Protection Program (ELAPP) project was completed in 2003. The Brooker Creek Preserve included restoration of the property's historic surface water hydrology and restoration of approximately 25 acres of wetlands that were altered by past agricultural impacts and manmade drainage features.

The goals from the 2001 Lake Tarpon SWIM plan have been met for Hydrologic Restoration. Future natural Systems and hydrologic restoration projects within the Lake Tarpon and Brooker Creek watersheds are limited by available conservation lands within the watersheds. Based on the land use data analysis discussed earlier, since 1999 natural areas account for over 30% of the watershed. Currently, 21% of the natural areas are designated as conservation lands, including state parks, nature preserves, and wildlife management areas (Florida Natural Areas Inventory). Conservation lands within the watershed include Pinellas County's Brooker Creek Preserve and several Preserves within Hillsborough County (Brooker Creek Headwater Nature Preserve, Brooker Creek Buffer Preserves, Lake Frances Preserve and Lake Dan Preserve).

Fisheries

Lake Tarpon was formally designated as a Fish Management Area by a special resolution of the Pinellas County Board of County Commissioners in 1963. The FWC is the resource management agency with primary responsibility for sport fishery management (SWFWMD, 2001). The 2001 SWIM plan identified the following goals for fisheries.

- Maintain a fish community balance of F/C = 3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass)
    - Status: Based information from the FWC (Eric Johnnson, email dated February 14, 2024) the fish community balance has been maintained. The ratio was 2.5 in 2021; 5.5 in 2022, and 2.6 in 2023)
- Maintain indices of Relative Stock Density for major sport fish species of: 20-40 percent >14 inches for largemouth bass; 40-60 percent >6 inches of bluegill; 40-60 percent >7 inches of redear sunfish; and 40-60 percent >9 inches for black crappie.
    - Status: FWC indicated that Lake Tarpon is generally meeting the fisheries goals for the above listed sport fish (Eric Johnnson, email dated February 14, 2024)

Lake Tarpon meets the fisheries goals and is rated by the FWC as one of the top 10 bass lakes in the state of Florida (https://myfwc.com/fishing/freshwater/sites-forecasts/sw/lake-tarpon/; retrieved February 2023).

Outreach

Outreach and community engagement has been an important component of developing and implementing prior SWIM Plans for Lake Tarpon. Pinellas County and the District conduct various activities related to this issue.

The 2001 SWIM plan included the following Community Education Goal

- Provide educational opportunities through programs such as Florida Yards and Neighborhood, related to other goals of the Lake Tarpon SWIM Plan.
  - Status: Since 2001, the District has supported a variety of educational opportunities related to the goals of the Lake Tarpon SWIM plan. Examples of completed projects include numerous Cooperative Funding projects, Community Education Grants and signage, and outreach to hotels and restaurants. Examples of ongoing educational opportunities include supporting the Florida Friendly Landscaping™ program, attending community events and speaking engagements, and sharing messaging through our social media channels, website and email distribution. Additionally, more than 5,000 fourth-grade students and 900 teachers and chaperones attend District-funded educational field trip programs annually in Pinellas County. More than 14,000 students grade 4 to 7 and 850 teachers and chaperones attend District-funded water education field studies, summer camps and educator trainings annually in Hillsborough County.

As the population of the Tampa Bay area continues to grow, community education will remain an important issue to maintain the health of Lake Tarpon and its watershed. The 2023 population estimates (BEBR, 2024) show that Hillsborough and Pinellas are the third and seventh, respectively, most populated counties in the state.

Lake Tarpon SWIM Plan Goals

Water Quality
Maintain water quality conditions for total nitrogen, total phosphorus and chlorophyll a
Hold the line on nutrient loads to offset potential increases in nutrient loading from continued development and aging infrastructure in the watershed
Natural Systems
Maintain water elevations in Lake Tarpon similar to those over the past 18 years to the extent that the flood control functions of the Lake Tarpon Outfall structure are not compromised
Where feasible work with partners to restore hydrologic function of wetlands on conservation lands within the Lake Tarpon and Brooker Creek watersheds
Support actions to maintain a healthy aquatic plant community that achieve an average Lake Vegetation Index (LVI) score of 43 points or greater

Table 6 – Lake Tarpon SWIM Plan Goals

Management Actions

The purpose of this SWIM plan is to identify strategic initiatives that will address the major issues and drivers and provide management actions that will improve and maintain the ecological health of Lake Tarpon. The management actions listed in this section are grouped into the focal areas of water quality and natural systems, though it is recognized that a focus area is not necessarily independent of the others. For example, aquatic vegetation management actions may have direct impacts on achieving the water quality targets. Monitoring and research actions are included for each of the two focus areas and are essential elements to adaptive management.

Water Quality

Water Quality Protection and Restoration
Work with local, regional and state agencies to implement stormwater best management practices (BMPs)
Support the development of local government stormwater master plans
Support stormwater retrofits where feasible
Monitoring and Research
Support Pinellas County's long term water quality monitoring program
Support continued refinement of the nutrient loading sources to Lake Tarpon
Support periodic reevaluation of the nutrient loading sources using the most recent data
Education and Outreach
Continue to support Florida-Friendly landscaping principles
Continue to support outreach and education programs in the watershed

Table 7 – Water Quality Management Actions

Natural Systems

Natural Systems and Hydrologic Restoration
Continue to support conservation of priority habitats in the Lake Tarpon and Brooker Creek watersheds that intersect with the priorities of the Tampa Bay Habitat Master Plan (Robison et al., 2020)
Support natural systems and hydrologic restoration projects on conservation lands within the Lake Tarpon and Brooker Creek watersheds
Support Pinellas County's efforts to enhance shoreline emergent aquatic vegetation
Monitoring and Research
Support FWC's continued Long-Term Aquatic Habitat Monitoring Program for Lake Tarpon
Support Pinellas County's continued monitoring to determine Lake Vegetation Indices on an annual basis
Improve our understanding of how rainfall, climate, water levels and aquatic vegetation influence water quality
Education and Outreach
Continue to support water conservation strategies

Table 8 – Natural Systems Management Actions

Projects and Initiatives

Projects and initiatives for Lake Tarpon identified in this section address specific management actions as outlined in the previous section specific to District resources. However, not every management action has a specific project associated with it. The SWIM Plan is meant to be a living document with adaptive management at its core. Additional projects and initiatives may be included as needed.

The proposed projects and initiatives listed below are categorized into two major focus areas: Water Quality and Natural Systems, which include hydrologic restoration. This plan recognizes that these focus areas are not mutually exclusive. Therefore, some projects may contain elements that overlap across focus areas.

Water Quality

Stormwater
Develop and Implement Regional Stormwater Management Programs and/or Projects Lead Entity: Local Governments/SWFWMD This initiative involves coordination with stakeholder groups to continue ongoing projects and programs which seek to reduce impacts of stormwater from urban land uses. Project types include but are not limited to the following: • Development of regional and local stormwater master plans • Implementation of stormwater ordinances, where appropriate • Design, permitting and implementation of BMPs designed to reduce nutrient loads to receiving waters • Design, permitting and implementation of cost-effective and regional stormwater treatment systems in priority sub-basins
Monitoring and Research
Support Data collection and analysis of water quality status and trends Partners: Pinellas County Part of Pinellas County's Lake Management Plan is to collect ambient water quality data at several fixed stations in the lake. SWIM supports this effort by providing technical assistance when needed to evaluate water quality status and trends.
Urban and Residential Fertilizer Application
Support Outreach, Coordination, and Implementation of Best Management Practices (BMPs) Partners: Pinellas, Hillsborough, and Pasco Counties Education and outreach in the watershed are important elements of maintaining a healthy Lake Tarpon. SWIM and the District support Pinellas, Hillsborough, and Pasco Counties education and outreach programs designed to educate residents on best management practices such as proper fertilizer application, using Florida-friendly landscaping, and implementing good water conservation practices.

Table 9 – Water Quality Projects and Initiatives

Natural Systems

Natural Systems Conservation
Land Acquisition Partners: Local Governments/SWFWMD This initiative continues to promote local government and SWFWMD efforts to conserve natural lands using conservation easements and land acquisition. Part of this initiative includes developing strategies to identify priority wetland and upland parcels of opportunity throughout the Lake Tarpon watershed. Section 373.139, Florida Statutes, authorizes the Governing Boards of the water management districts to acquire the fee or other interest in lands necessary for flood control, water storage, water management, conservation and protection of water resources, aquifer recharge, water resource and water supply development, and preservation of wetlands, streams and lakes.
Natural Systems Restoration
Natural Systems Restoration Partners: Hillsborough County/SWFWMD This initiative continues to promote SWFWMD efforts to restore and protect natural systems by supporting Hillsborough County's endeavors to restore natural communities at the Lake Dan Preserve. As part of this initiative, restoration and enhancement efforts target various upland and wetland communities such as mesic flatwoods, xeric hammocks, cypress domes, and freshwater wetlands. Proposed techniques include prescribed burning, ditch filling, and revegetation strategies. Additionally, the County has intentions to implement restoration initiatives at Lake Frances Preserve, aimed to revitalize the mesic flatwoods, scrubby flatwoods, and herbaceous wetlands. The County's restoration plans align with the mission of the SWIM program.
Support Lake Tarpon Emergent Vegetation Management Partners: Pinellas County, FWCC Pinellas County through their lake management plan actively maintains a robust emergent vegetation management program. The objective is to minimize nuisance and exotic species of emergent plants to promote a native littoral vegetative community. SWIM supports this effort and provides technical assistance as needed.
Monitoring and Research
Support Submerged aquatic vegetation (SAV) survey and mapping Partners: Pinellas County Part of Pinellas County's Lake Management Plan is to survey, and map submerged aquatic vegetation in the lake. SWIM supports this effort by providing technical assistance when needed to evaluate SAV status and trends.

Table 10 – Natural Systems Projects and Initiatives

Literature Cited

Allen, M.S., Tate, W., Tugend, K.I., Rogers, M. and Dockendorf, K.J., 2003. Effects of water level fluctuations on the fisheries of Lake Tarpon. Final Report to Don Hicks, Pinellas County Department of Environmental Management. Clearwater, FL.

Atkins/ESA. 2017. Lake Tarpon Water Quality Management Plan. 105 pp.

Bureau of Economic and Business Research (BEBR). 2024. Florida Estimates of Population 2024. University of Florida. Gainesville, Florida.

Canfield Jr, D. E., Shireman, J. V., Colle, D. E., Haller, W. T., Watkins II, C. E., & Maceina, M. J. 1984. Prediction of chlorophyll a concentrations in Florida lakes: importance of aquatic macrophytes. *Canadian Journal of Fisheries and Aquatic Sciences,* 41(3), 497-501.

ESA. 2021. Lake Tarpon SWIM Plan Technical Memorandum for Tasks 4.3 and 4.4. Task deliverables submitted to the Southwest Florida Water Management District.

Florida Department of Environmental Protection (FDEP). 2024. Draft Development of Type III Site Specific Alternative Nutrient Criteria for Lake Tarpon in Pinellas County, Florida. October 2024. 62pp.

Florida Natural Areas Inventory. 2023. Florida Conservation Lands.

King Engineering Associates, Inc. (KEA) 1992. Final Comprehensive Report: Lake Tarpon Diagnostic/Feasibility Studies. Prepared for Pinellas County Department of Environmental Management and the Southwest Florida Water Management District.

Langeland, K. A. 1996. Hydrilla verticillata (LF) Royle (Hydrocharitaceae)," the perfect aquatic weed". *Castanea*, 293-304.

Leggette, Brashears & Graham. 2004. Lake Tarpon Ground-Water Nutrient Study. Task 4: Final Report. 169 pp.

PBS&J, Inc. 1998. The Lake Tarpon Drainage Basin Management Plan (DBMP). Prepared for the Pinellas County Board of County Commissioners.

Pinellas County Environmental Management. 2021. Lake Tarpon Site-Specific Alternative Criteria (SSAC) Pre-Petition. 27 pp.

Robison, D., T. Ries, J. Saarinen, D. Tomasko, and C. Sciarrino. 2020. Tampa Bay Estuary Program 2020 Habitat Master Plan Update. Technical Report #07-20 of the Tampa Bay Estuary Program. Final report prepared by Environmental Science Associates. 136 pp. + appendix.

SWFWMD. 2001. Lake Tarpon Surface Water Improvement and Management (SWIM) Plan. 98 pp.

SWFWMD. 2020. Increasing groundwater contribution to Lake Tarpon, Pinellas County, Florida. Internal Memorandum from Sammy Smith and Jason Patterson, Water Resources Bureau, to Lizanne Garcia, SWIM Section.

Taylor, R.L. 1953. Hydrologic Characteristics of the Lake Tarpon Area, Florida: U.S. Geological Survey Open File Report.

Upchurch, S. B., 1998. Lake Tarpon Ground-Water Nutrient Study. Final report submitted to the Southwest Florida Water Management District. Prepared by ERM-South.

APPENDICES

Appendix A: Technical Memorandum – Lake Tarpon Update Water Quality Status and Trends and Pollutant Loading Estimates

Technical Memorandum

date	May 29, 2024
to	Lizanne Garcia – Lead Project Manager, SWFWMD SWIM Program
cc	Chris Anastasiou, Ph.D., Tara Harter – SWFWMD SWIM Program
from	Doug Robison, Emily Keenan - ESA
subject	Lake Tarpon Update Water Quality Status & Trends and Pollutant Loading Estimates

Background

This Technical Memorandum presents the methods, results, and conclusions of an updated ambient water quality status and trends analysis and pollutant loading analysis for Lake Tarpon in support of the development of the Lake Tarpon SWIM Plan update. The analyses presented herein update the data analyses through calendar year 2023, consistent with the methods previously presented in the "Technical Memorandum for Tasks 4.3 and 4.4" (ESA, 2021) submitted to the District on May 7, 2021.

Methods

Water Quality Status and Trends

This update of the water quality status and trends analyzed water quality data on an annual time step, as outlined by Florida's Impaired Waters Rule (FAC 62-301). Specifically, data were analyzed on a whole-lake level, and raw data were reviewed to ensure that samples were available from both wet and dry seasons. These data were then used to calculate annual geometric means for Chlorophyll-a, Total Nitrogen (TN), and Total Phosphorus (TP). Only water quality data collected by Pinellas County were used, to ensure that the data reflected efforts to characterize ambient water quality conditions from the open waters of the lake itself, rather than, for example, sampling for permit compliance in drainage features in the watershed, or short time-period sampling efforts for purposes other than monitoring the ambient conditions of the lake. As such, the data set used was the same as the data set used for analysis in the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017), including more recent data. This update included data from 2003 to 2023. Data sets for Chlorophyll-a, TN and TP were also tested for trends over time, using parametric and/or non-parametric statistical techniques, as appropriate.

Pollutant Loading Model

As part of the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) a hydrologic and hydraulic (H&H) model was developed to estimate freshwater inflows and associated pollutant loads generated by rainfall in the Lake Tarpon basin, as measured by NexRad data. In addition, empirical models were used to develop estimates for other pollutant loading sources. For the overall Lake Tarpon loading model, the following sources were included:

- Atmospheric Deposition - loads associated with direct "wet" rainfall falling on the lake surface.
- Basin Inflow – event mean concentrations based loading from drainage basin runoff incorporating applicable load reductions from stormwater Best Management Practices (BMPs).
- Tributary Inflows – Measured Brooker Creek concentrations applied to model generated creek flows, which were calibrated in the Hydrology and Hydraulic model via comparison with gaged inflows.
- Groundwater – Seepage volume applied to seasonal surficial ground water concentrations measured around Lake Tarpon.

As noted in the 2017 Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) rainfall is the primary driver of the hydraulic model simulation and thus is the primary influence on the load estimates themselves. In the May 7, 2021 "Technical Memorandum for Tasks 4.3 and 4.4" it was determined that statistically significant relationships exist between rainfall and nutrient loads delivered to the lake from all sources. Furthermore, it was demonstrated that monthly county-level rainfall data compiled by the District could be used to estimate monthly Total Nitrogen (TN) and Total Phosphorus (TP) loads delivered to the lake from all sources. Using the statistical relationships described in "Technical Memorandum for Tasks 4.3 and 4.4" (ESA, 2021) monthly rainfall values from District rain gages in Pinellas County were then used to estimate TN and TP loads from all sources, over the period of 2013 to 2023.

Results

Water Quality Status and Trends

The results of the updated water quality status and trends update are summarized below for Chlorophyll-a, TN, and TP, respectively.

Chlorophyll-a

Annual geometric means for Lake Tarpon Chlorophyll-a over the period of 2003 to 2023 are displayed in Figure 1. Annual geometric means for Chlorophyll-a exceeded NNC criteria of 20 μg/L on 14 of 21 years (67% of years). Results were tested for trends over time using annual geometric means as the dependent variable, and years as the independent variable. As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over time ($p>0.05$).

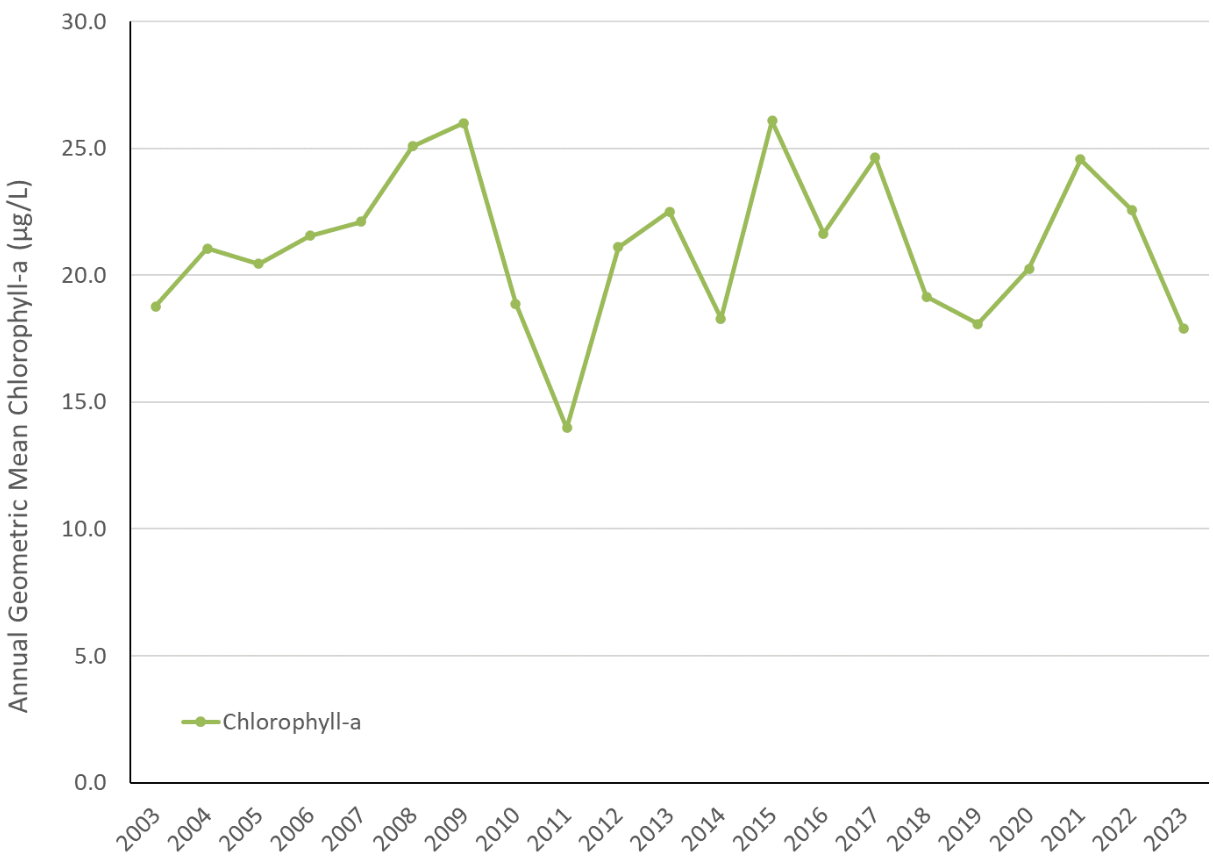


Figure 1 - Time series of Chlorophyll-a (µg/L) annual geometric means.

Total Nitrogen

Annual geometric means for Total Nitrogen for Lake Tarpon over the period of 2003 to 2023 are displayed in Figure 2.

The NNC values for TN for high-color, alkaline lakes like Lake Tarpon vary with the annual geometric mean for Chlorophyll-a for a given year. For years when annual geometric mean values of Chlorophyll-a values exceed 20 µg/L, FDEP would consider Lake Tarpon to be elevated for phytoplankton, and the NNC target value for TN would decrease from 2.23 down to 1.27 mg/L. Thus, for those 14 years when annual geometric means for Chlorophyll-a exceeded 20 µg/L, the more restrictive NNC value for TN would be in place. Even with that more restrictive TN value, only in the year 2009 did the annual geometric mean for TN match (but not exceed) the most restrictive TN criteria. At no time did the annual geometric mean for TN exceed the less restrictive NNC criterion of 2.23. As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over time ($p>0.05$).

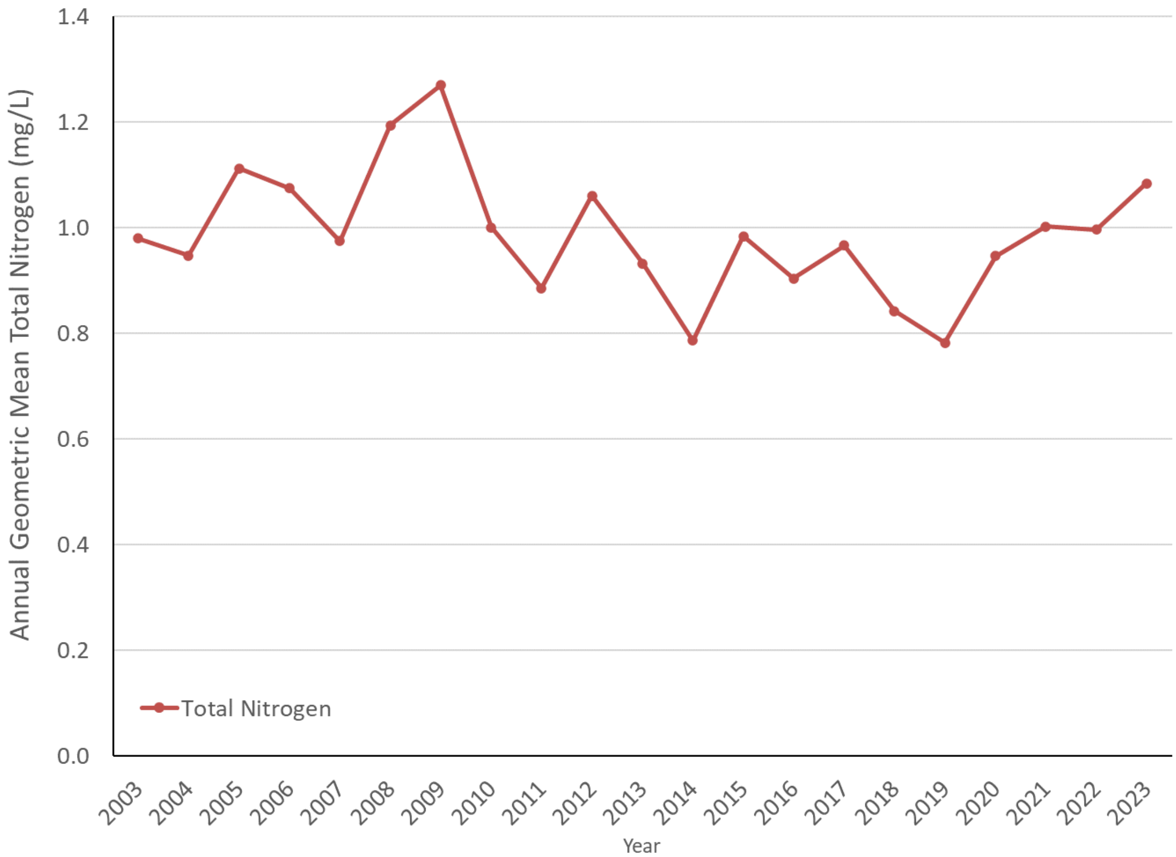


Figure 2 - Time series of TN (mg/L) annual geometric means.

Total Phosphorus

Annual geometric means for Total Phosphorus for Lake Tarpon over the period of 2003 to 2023 are displayed in Figure 3.

The NNC values for TP for high-color, alkaline lakes like Lake Tarpon vary with the annual geometric mean for Chlorophyll-a for a given year. When annual geometric means of Chlorophyll-a values exceed 20 μg/L, FDEP would consider Lake Tarpon to be elevated for phytoplankton, and the NNC target value for TP would decrease from 0.160 down to 0.050 mg/L. Therefore, for those 14 years when annual geometric means for Chlorophyll-a exceeded 20 μg/L, the more restrictive NNC value for TP would be in place. At no time did the annual geometric mean for TP exceed the most restrictive NNC of 0.050 mg/L. As the data sets met the requirements of parametric statistical analysis of normality and homogeneity of variance, linear regression was used. This analysis did not detect a trend over time ($p>0.05$).

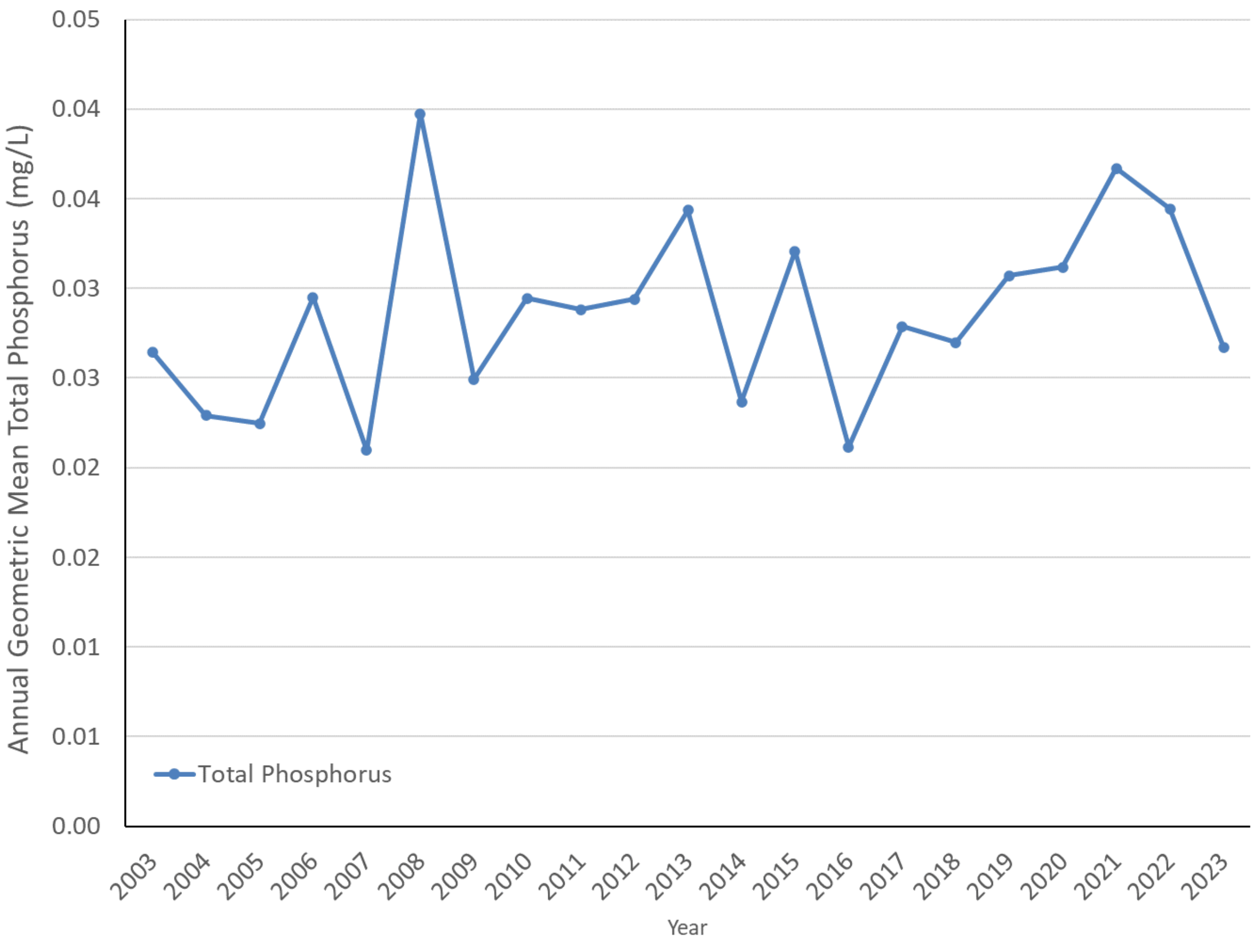


Figure 3 - Time series of TP (mg/L) annual geometric means.

Water Quality Data Summary

The results of updated water quality status and trends analysis can be summarized as follows:

- Chlorophyll-a concentrations exceeded the NNC criterion 14 out of the past 21 years (67%).
- For those 14 years when annual geometric means for Chlorophyll-a exceeded 20 µg/L, the more restrictive NNC value for TN would be in place. Only in the year 2009 did the annual geometric mean for TN match, but not exceed, the most restrictive TN criteria. At no time did the annual geometric mean for TN exceed the less restrictive NNC criterion of 2.23.
- For those 14 years when annual geometric means for Chlorophyll-a exceeded 20 µg/L, the more restrictive NNC value for TP would be in place. At no time did the annual geometric mean for TP exceed the more restrictive NNC of 0.050 mg/L.

Table 1 shows the annual geometric means for Chlorophyll-a, TN, and TP for the 21 years used in this analysis.

Table 1 - Annual geometric means for Chlorophyll-a, TN, and TP for the period analyzed.

Yea	Chl	TN	TP
2003	18.7	0.98	0.02
2004	21.0	0.95	0.02
2005	20.4	1.11	0.02
2006	21.5	1.07	0.02
2007	22.1	0.97	0.02
2008	25.0	1.19	0.04
2009	25.9	1.27	0.02
2010	18.8	1.00	0.02
2011	13.9	0.89	0.02
2012	21.1	1.06	0.02
2013	22.5	0.93	0.03
2014	18.2	0.79	0.02
2015	26.0	0.98	0.03
2016	21.6	0.90	0.02
2017	24.6	0.97	0.02
2018	19.1	0.84	0.02
2019	18.0	0.78	0.03
2020	20.2	0.95	0.03
2021	24.5	1.00	0.03
2022	22.5	1.00	0.03
2023	17.8	1.08	0.02

Pollutant Loading Model

Using previously developed statistical relationships between rainfall and nutrient loadings (ESA, 2021), monthly rainfall values from District rain gages in Pinellas County were used to estimate TN and TP loads from all sources, over the period of 2013 to 2023. Figures 4 and 5 show that the TN and TP loads to Lake Tarpon varied substantially over both monthly time steps and 6-month moving average values. During wet periods in 2015 and 2016, TN loads exceeded 16 tons per month, while dry months typically had TN loads less than 2 tons per month. Appendices 1 and 2 provide a tabular breakdown of monthly rainfall and loads from all sources for the period 2013-2023.

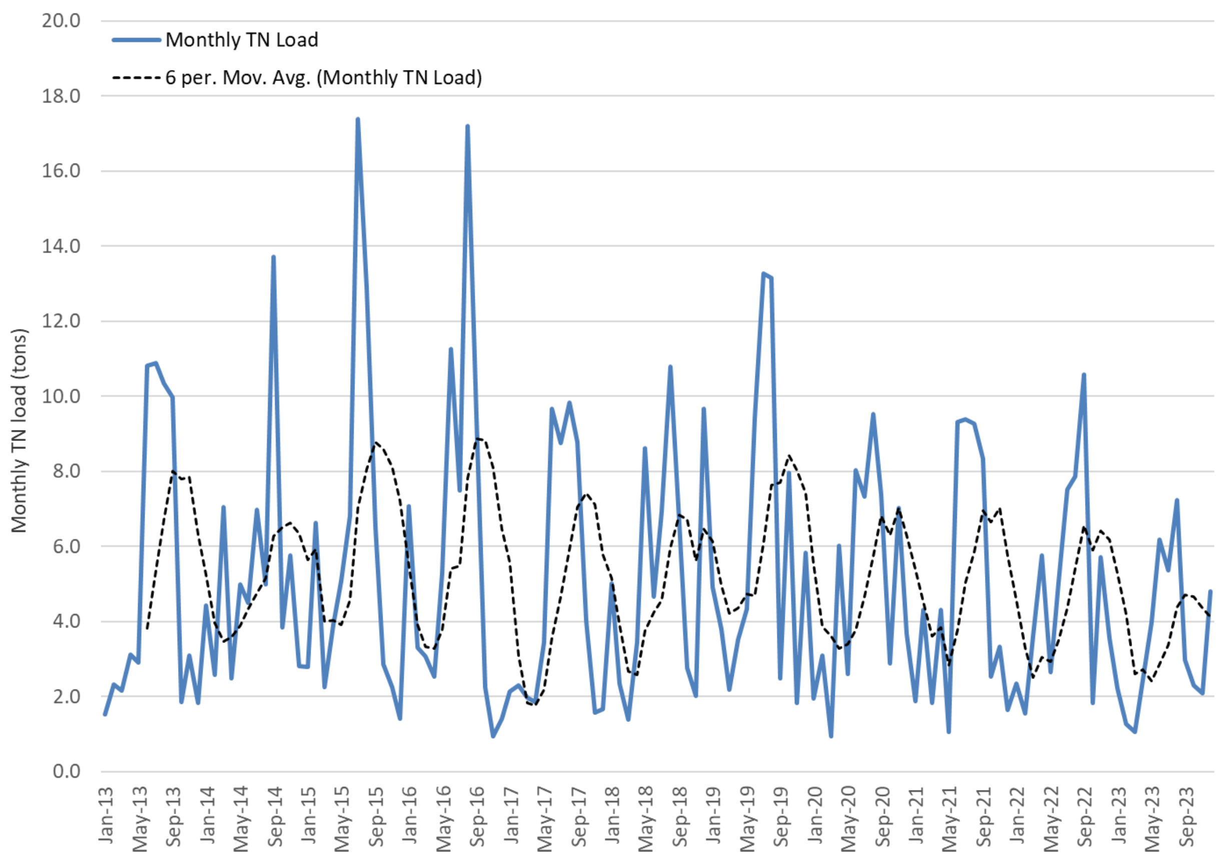


Figure 4 – Monthly TN loads from all sources during 2013 to 2023.

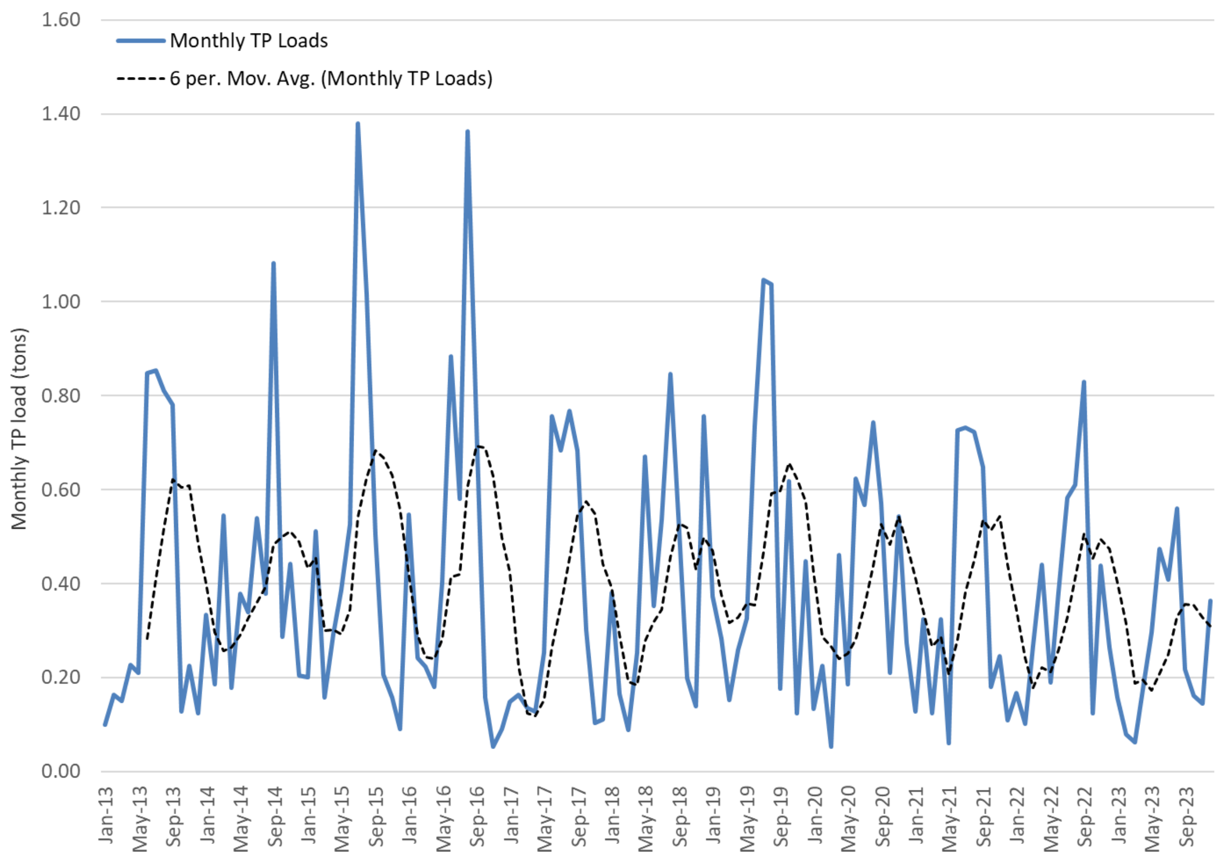


Figure 5 – Monthly TP loads from all sources during 2013 to 2023.

Figures 6 and 7 partition out TN and TP loads into the sources of atmospheric deposition, basin runoff, groundwater inflows, and loads from Brooker Creek, respectively.

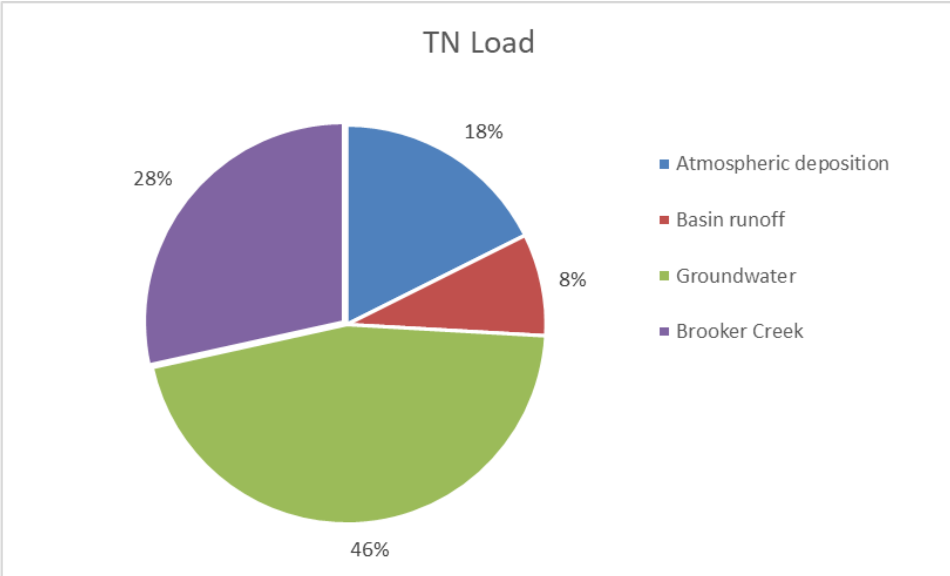


Figure 6 - Pie chart of TN loads from all sources during 2013 to 2023.

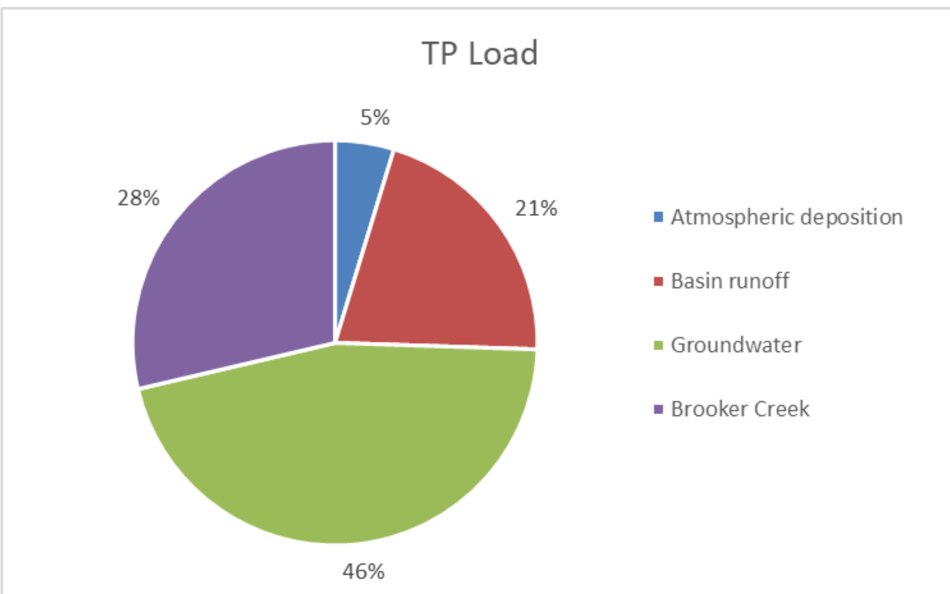


Figure 7 - Pie chart of TP loads from all sources during 2013 to 2023.

For both TN and TP, the dominant loading source appears to be surficial groundwater inflows. These findings are consistent with the results of the loading model included in the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017). However, there is a substantial amount of variability in estimates of sources of TN and TP loads, as well as the quantities involved.

For example, the 2001 SWIM Plan for Lake Tarpon cites results from Upchurch (1998) for their work on the sources and quantities of nutrient loads. Based on results from Upchurch (1998) loads of TN and TP from the combination of the surficial and Floridan aquifers were 2.13 and 0.2 tons per year, respectively. These loads would account for less than 4 percent of the total loads to Lake Tarpon.

A follow-up study by Leggette, Brashears & Graham, Inc. (2004) concluded that surficial groundwater seepage contributed 4.6 and 0.26 tons per year for TN and TP, respectively. In contrast the model developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) estimated groundwater to load an average of 25.7 and 1.88 tons per year of TN and TP, respectively. The proportion of TN and TP loads from surficial groundwater seepage reported in the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) calculate out to 41 and 39% of total loads, respectively.

The results of the updated pollutant loading model displayed in Figures 6 to 7 thus differ from the groundwater loading estimates in the 2001 SWIM Plan, as well as the quantities in Upchurch (1998) and Leggette, Brashears & Graham (2004). However, they are in-line with both the quantities and proportion of loads estimated from groundwater inflow developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017). A potential basis for the more recent estimates showing a greater role of groundwater is that the surficial groundwater elevations in the northern part of the watershed have rebounded substantially over the past 20 years (SWFWMD, 2020)

Increased groundwater elevations have been attributed to the combined impacts of reduced groundwater withdrawals at the Eldridge Wilde wellfield since the late 1990s, as well as a general trend of increased regional rainfall over the past 20 years (SWFWMD, 2020). An elevated surficial groundwater table would make it easier for groundwater to flow toward the lake at greater rates, resulting in higher nutrient loads from groundwater than was found for models developed in prior years with lower groundwater inflow rates.

Conclusions

Water Quality

As had been previously noted in the last adopted Lake Tarpon SWIM Plan (2001) and the Lake Tarpon Water Quality Management Plan (2017) there is a strong relationship between TN concentrations and Chlorophyll-a, but there is no evidence of a similar relationship between TP and Chlorophyll-a. Figures 8 and 9 show plots of paired monthly Chlorophyll-a vs. TN and TP concentrations, respectively, over the period 2013-2023 during which rainfall and nutrient loads were highly variable. As shown in these plots, there is a strong relationship between TN and Chlorophyll-a concentrations (Figure 8 - line represents best-fit linear relationship), but no such relationship between TP and Chlorophyll-a concentrations (Figure 9). These findings support previous determinations that Lake Tarpon is primarily Nitrogen limited with regard to phytoplankton growth.

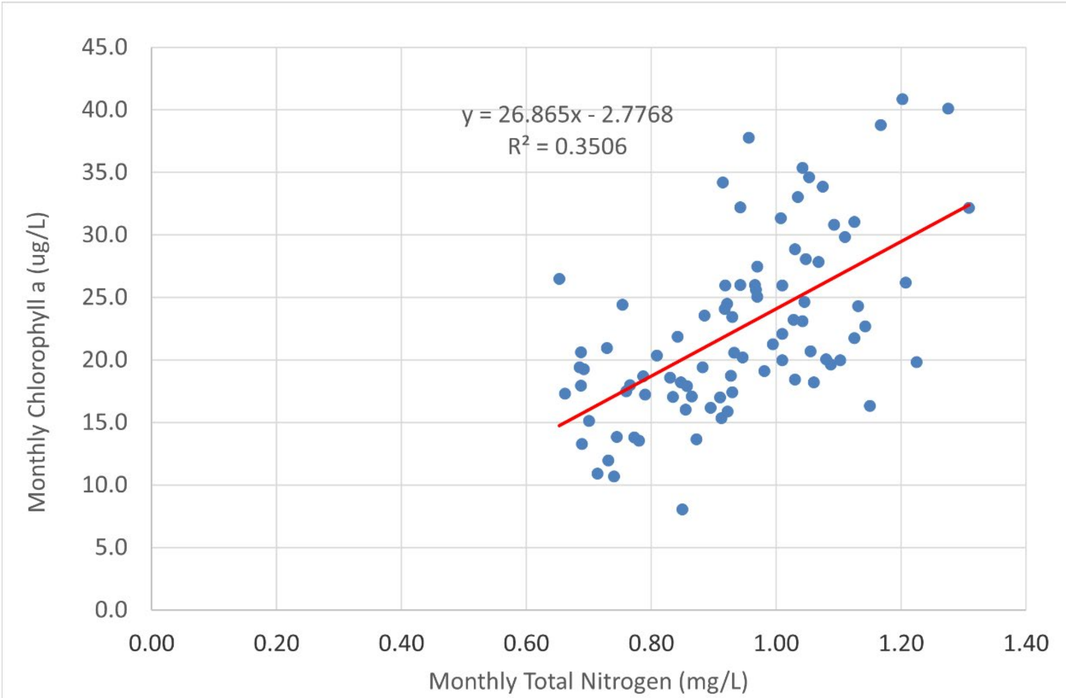


Figure 8 - Plot of Chlorophyll-a vs. TN concentrations for monthly mean lake values 2013–2023 (N=85).

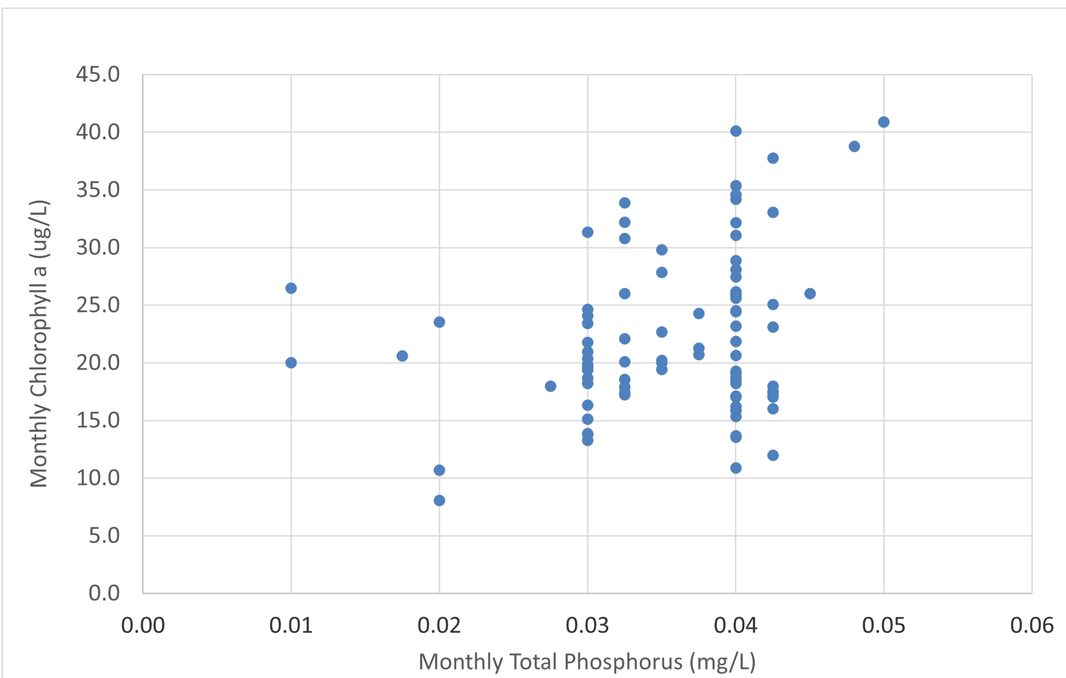


Figure 9 - Plot of Chlorophyll-a vs. TP concentrations for monthly mean lake values 2013-2023 (N=85).

The combined results of this updated water quality status and trends analysis indicate that Chlorophyll-a concentrations in Lake Tarpon are non-trending, and that they exceeded the NNC criteria 14 out of the 21 years (67%) used in this analysis. However, Lake Tarpon met the NNC criteria for TN and TP during the analysis period. Furthermore, Chlorophyll-a concentrations are strongly correlated with TN concentrations, but not with TP concentrations, confirming previously determined nitrogen limitation of algal growth. The observed discontinuity between the observed NNC exceedances in Chlorophyll-a concentrations and NNC compliance in TN concentrations could be explained by variability in lake levels and residence time, and potentially other factors such as hydrilla treatments in Lake Tarpon.

Hydrilla expansion in Lake Tarpon may be related to low lake levels, as well as other factors such as interspecific competition between other SAV species. SAV coverage is typically positively correlated with water clarity, regardless of what SAV species are present. The issue arises when herbicidal treatment of large areas of hydrilla results in decomposition of the organic material and subsequent release of nutrients into the water column, thus contributing to increased phytoplankton production and chlorophyll-a concentrations. Previous large scale Hydrilla control efforts in Lake Tarpon are thought to have resulted in the release of SAV-bound nutrients into the water column that favored the initiation or support of algal blooms, including cyanobacteria blooms (Atkins/ESA, 2017). However, over the past decade or more, hydrilla coverage in Lake Tarpon appears to be largely under control, thus requiring less treatment.

Water quality may also be related to fluctuations in lake levels. The Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017) found a negative correlation between average annual lake levels and annual average Chlorophyll-a values, as well as a positive correlation between the coefficient of variation in lake levels (on an annual time-step) and annual average Chlorophyll-a concentrations.

Pollutant Loads

The data presented herein support the prior conclusion that phytoplankton in Lake Tarpon is limited by nitrogen, not phosphorus. Estimates and sources of external loads of nitrogen have varied substantially over time. The estimates presented here are dependent upon the nutrient loading assumptions and algorithms developed for the Lake Tarpon Water Quality Management Plan (Atkins/ESA, 2017), which concluded that surficial groundwater seepage was the major source of TN loads to Lake Tarpon. However, earlier estimates suggested that groundwater was a much smaller source of TN loads. This difference in the importance of groundwater could be because the groundwater tables in the northern part of the Lake Tarpon watershed are substantially higher now than in past decades (R. Burnes, personal communication).

It is also important to note that the category of "stormwater runoff" is split into two estimates – basin runoff and inflows from Brooker Creek. When those two categories are combined, they account for 36% of the total load compared to 46% of estimated load from groundwater inflows. Based on a combination of analyses using nitrogen isotopes, data parsing based on land uses, and other techniques, Leggette, Brashears & Graham, (2004) concluded that the majority of anthropogenic nitrogen loads associated with groundwater inflows into Lake Tarpon were likely due to over application of fertilizers in residential neighborhoods, particularly in those portions of the watershed on the extreme southwest and northeast borders, where substantial elevation changes occur. A continued and enhanced focus on public education related to overuse of fertilizers would likely benefit Lake Tarpon's water quality, regardless of the exact amount of nitrogen loaded to the lake via groundwater inflows or stormwater runoff.

Literature Cited

Atkins/ESA. 2017. Lake Tarpon Water Quality Management Plan. 105 pp.

ESA. 2021. Lake Tarpon SWIM Plan Technical Memorandum for Tasks 4.3 and 4.4. Task deliverables submitted to the Southwest Florida Water Management District.

Leggette, Brashears & Graham. 2004. Lake Tarpon Ground-Water Nutrient Study. Task 4: Final Report. 169 pp.

SWFWMD 2001. Lake Tarpon Surface Water Improvement and Management (SWIM) Plan. 98 pp.

SWFWMD 2020. Increasing groundwater contribution to Lake Tarpon, Pinellas County, Florida. Internal Memorandum from Sammy Smith and Jason Patterson, Water Resources Bureau, to Lizanne Garcia, SWIM Section.

Upchurch, S. B., 1998. Lake Tarpon Ground-Water Nutrient Study. Final report submitted to the Southwest Florida Water Management District. Prepared by ERM-South.

Appendix 1 - Monthly TN loads from all sources during 2013 to 2023.

Nitrogen Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
2013	Jan-13	Jan	Dry	0.61	0.2	-0.1	1.1	0.3	1.5
	Feb-13	Feb	Dry	1.40	0.3	0.1	1.4	0.6	2.3
	Mar-13	Mar	Dry	1.24	0.3	0.0	1.3	0.5	2.2
	Apr-13	Apr	Dry	2.18	0.5	0.2	1.6	0.8	3.1
	May-13	May	Dry	1.98	0.5	0.2	1.5	0.8	2.9
	Jun-13	Jun	Wet	9.86	2.2	1.5	3.7	3.5	10.8
	Jul-13	Jul	Wet	9.93	2.2	1.5	3.7	3.5	10.9
	Aug-13	Aug	Wet	9.39	2.1	1.4	3.5	3.3	10.3
	Sep-13	Sep	Wet	9.02	2.0	1.3	3.4	3.2	10.0
	Oct-13	Oct	Dry	0.94	0.2	0.0	1.2	0.4	1.9
	Nov-13	Nov	Dry	2.16	0.5	0.2	1.6	0.8	3.1
	Dec-13	Dec	Dry	0.90	0.2	0.0	1.2	0.4	1.8
2014	Jan-14	Jan	Dry	3.49	0.8	0.4	1.9	1.3	4.4
	Feb-14	Feb	Dry	1.66	0.4	0.1	1.4	0.7	2.6
	Mar-14	Mar	Dry	6.10	1.4	0.9	2.6	2.2	7.0
	Apr-14	Apr	Dry	1.57	0.4	0.1	1.4	0.6	2.5
	May-14	May	Dry	4.05	0.9	0.5	2.1	1.5	5.0
	Jun-14	Jun	Wet	3.56	0.8	0.4	1.9	1.3	4.5
	Jul-14	Jul	Wet	6.03	1.3	0.8	2.6	2.2	7.0
	Aug-14	Aug	Wet	4.05	0.9	0.5	2.1	1.5	5.0
	Sep-14	Sep	Wet	12.74	2.8	2.0	4.4	4.5	13.7
	Oct-14	Oct	Dry	2.92	0.7	0.3	1.8	1.1	3.9
	Nov-14	Nov	Dry	4.83	1.1	0.6	2.3	1.7	5.8
	Dec-14	Dec	Dry	1.89	0.5	0.1	1.5	0.7	2.8

Nitrogen Load									
Year	Month-Year	Month	Season	Rainfall (SWFWMD for Pinellas)	Atmospheric deposition (tons)	Basin runoff (tons)	Groundwater (tons)	Brooker Creek (tons)	Total inflow (tons)
2015	Jan-15	Jan	Dry	1.86	0.4	0.1	1.5	0.7	2.8
	Feb-15	Feb	Dry	5.68	1.3	0.8	2.5	2.0	6.6
	Mar-15	Mar	Dry	1.32	0.3	0.0	1.3	0.5	2.2
	Apr-15	Apr	Dry	2.99	0.7	0.3	1.8	1.1	3.9
	May-15	May	Dry	4.14	0.9	0.5	2.1	1.5	5.1
	Jun-15	Jun	Wet	5.88	1.3	0.8	2.6	2.1	6.8
	Jul-15	Jul	Wet	16.41	3.6	2.6	5.4	5.7	17.4
	Aug-15	Aug	Wet	11.92	2.6	1.8	4.2	4.2	12.9
	Sep-15	Sep	Wet	5.59	1.3	0.8	2.5	2.0	6.5
	Oct-15	Oct	Dry	1.93	0.5	0.1	1.5	0.7	2.9
	Nov-15	Nov	Dry	1.32	0.3	0.0	1.3	0.5	2.2
	Dec-15	Dec	Dry	0.49	0.1	-0.1	1.1	0.3	1.4
2016	Jan-16	Jan	Dry	6.12	1.4	0.9	2.6	2.2	7.1
	Feb-16	Feb	Dry	2.37	0.6	0.2	1.6	0.9	3.3
	Mar-16	Mar	Dry	2.14	0.5	0.2	1.6	0.8	3.1
	Apr-16	Apr	Dry	1.61	0.4	0.1	1.4	0.6	2.5
	May-16	May	Dry	4.35	1.0	0.6	2.2	1.6	5.3
	Jun-16	Jun	Wet	10.29	2.3	1.6	3.8	3.6	11.3
	Jul-16	Jul	Wet	6.55	1.5	0.9	2.8	2.3	7.5
	Aug-16	Aug	Wet	16.22	3.6	2.6	5.4	5.7	17.2
	Sep-16	Sep	Wet	8.55	1.9	1.3	3.3	3.0	9.5
	Oct-16	Oct	Dry	1.32	0.3	0.0	1.3	0.5	2.2
	Nov-16	Nov	Dry	0.02	0.0	-0.2	1.0	0.1	0.9
	Dec-16	Dec	Dry	0.48	0.1	-0.1	1.1	0.3	1.4
2017	Jan-17	Jan	Dry	1.21	0.3	0.0	1.3	0.5	2.1

Nitrogen Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	Feb-17	Feb	Dry	1.38	0.3	0.0	1.4	0.6	2.3
	Mar-17	Mar	Dry	1.05	0.3	0.0	1.3	0.4	2.0
	Apr-17	Apr	Dry	0.94	0.2	0.0	1.2	0.4	1.9
	May-17	May	Dry	2.51	0.6	0.2	1.7	0.9	3.4
	Jun-17	Jun	Wet	8.72	1.9	1.3	3.4	3.1	9.7
	Jul-17	Jul	Wet	7.81	1.7	1.1	3.1	2.8	8.8
	Aug-17	Aug	Wet	8.87	2.0	1.3	3.4	3.1	9.8
	Sep-17	Sep	Wet	7.83	1.7	1.1	3.1	2.8	8.8
	Oct-17	Oct	Dry	3.10	0.7	0.3	1.8	1.2	4.0
	Nov-17	Nov	Dry	0.65	0.2	-0.1	1.2	0.3	1.6
	Dec-17	Dec	Dry	0.75	0.2	-0.1	1.2	0.3	1.7
2018	Jan-18	Jan	Dry	4.08	0.9	0.5	2.1	1.5	5.0
	Feb-18	Feb	Dry	1.41	0.3	0.1	1.4	0.6	2.3
	Mar-18	Mar	Dry	0.46	0.1	-0.1	1.1	0.2	1.4
	Apr-18	Apr	Dry	2.51	0.6	0.2	1.7	0.9	3.4
	May-18	May	Dry	7.66	1.7	1.1	3.1	2.7	8.6
	Jun-18	Jun	Wet	3.72	0.8	0.4	2.0	1.4	4.7
	Jul-18	Jul	Wet	5.99	1.3	0.8	2.6	2.1	6.9
	Aug-18	Aug	Wet	9.82	2.2	1.5	3.7	3.5	10.8
	Sep-18	Sep	Wet	5.70	1.3	0.8	2.5	2.0	6.6
	Oct-18	Oct	Dry	1.83	0.4	0.1	1.5	0.7	2.8
	Nov-18	Nov	Dry	1.10	0.3	0.0	1.3	0.5	2.0
	Dec-18	Dec	Dry	8.72	1.9	1.3	3.4	3.1	9.7
2019	Jan-19	Jan	Dry	3.98	0.9	0.5	2.1	1.5	4.9
	Feb-19	Feb	Dry	2.86	0.7	0.3	1.8	1.1	3.8

Nitrogen Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	Mar-19	Mar	Dry	1.25	0.3	0.0	1.3	0.5	2.2
	Apr-19	Apr	Dry	2.58	0.6	0.3	1.7	1.0	3.5
	May-19	May	Dry	3.40	0.8	0.4	1.9	1.3	4.3
	Jun-19	Jun	Wet	8.46	1.9	1.3	3.3	3.0	9.4
	Jul-19	Jul	Wet	12.30	2.7	1.9	4.3	4.3	13.3
	Aug-19	Aug	Wet	12.19	2.7	1.9	4.3	4.3	13.2
	Sep-19	Sep	Wet	1.55	0.4	0.1	1.4	0.6	2.5
	Oct-19	Oct	Dry	7.02	1.6	1.0	2.9	2.5	8.0
	Nov-19	Nov	Dry	0.90	0.2	0.0	1.2	0.4	1.8
	Dec-19	Dec	Dry	4.90	1.1	0.6	2.3	1.8	5.8
2020	Jan-20	Jan	Dry	1.03	0.3	0.0	1.3	0.4	2.0
	Feb-20	Feb	Dry	2.16	0.5	0.2	1.6	0.8	3.1
	Mar-20	Mar	Dry	0.02	0.0	-0.2	1.0	0.1	0.9
	Apr-20	Apr	Dry	5.07	1.1	0.7	2.4	1.8	6.0
	May-20	May	Dry	1.67	0.4	0.1	1.4	0.7	2.6
	Jun-20	Jun	Wet	7.08	1.6	1.0	2.9	2.5	8.0
	Jul-20	Jul	Wet	6.38	1.4	0.9	2.7	2.3	7.3
	Aug-20	Aug	Wet	8.57	1.9	1.3	3.3	3.0	9.5
	Sep-20	Sep	Wet	6.43	1.4	0.9	2.7	2.3	7.4
	Oct-20	Oct	Dry	1.96	0.5	0.1	1.5	0.8	2.9
	Nov-20	Nov	Dry	6.09	1.4	0.8	2.6	2.2	7.0
	Dec-20	Dec	Dry	2.75	0.6	0.3	1.7	1.0	3.7
2021	Jan-21	Jan	Dry	0.95	0.2	0.0	1.2	0.4	1.9
	Feb-21	Feb	Dry	3.38	0.8	0.4	1.9	1.2	4.3
	Mar-21	Mar	Dry	0.90	0.2	0.0	1.2	0.4	1.8

Nitrogen Load									
Year	Month-Year	Month	Season	Rainfall (SWFWMD for Pinellas)	Atmospheric deposition (tons)	Basin runoff (tons)	Groundwater (tons)	Brooker Creek (tons)	Total inflow (tons)
	Apr-21	Apr	Dry	3.38	0.8	0.4	1.9	1.2	4.3
	May-21	May	Dry	0.13	0.1	-0.2	1.0	0.1	1.1
	Jun-21	Jun	Wet	8.36	1.9	1.2	3.3	3.0	9.3
	Jul-21	Jul	Wet	8.43	1.9	1.2	3.3	3.0	9.4
	Aug-21	Aug	Wet	8.31	1.8	1.2	3.2	2.9	9.3
	Sep-21	Sep	Wet	7.38	1.6	1.1	3.0	2.6	8.3
	Oct-21	Oct	Dry	1.61	0.4	0.1	1.4	0.6	2.5
	Nov-21	Nov	Dry	2.41	0.6	0.2	1.6	0.9	3.3
	Dec-21	Dec	Dry	0.73	0.2	-0.1	1.2	0.3	1.7
2022	Jan-22	Jan	Dry	1.43	0.4	0.1	1.4	0.6	2.4
	Feb-22	Feb	Dry	0.63	0.2	-0.1	1.2	0.3	1.6
	Mar-22	Mar	Dry	2.69	0.6	0.3	1.7	1.0	3.6
	Apr-22	Apr	Dry	4.82	1.1	0.6	2.3	1.7	5.8
	May-22	May	Dry	1.72	0.4	0.1	1.4	0.7	2.6
	Jun-22	Jun	Wet	4.10	0.9	0.5	2.1	1.5	5.0
	Jul-22	Jul	Wet	6.57	1.5	0.9	2.8	2.3	7.5
	Aug-22	Aug	Wet	6.92	1.5	1.0	2.9	2.5	7.9
	Sep-22	Sep	Wet	9.62	2.1	1.4	3.6	3.4	10.6
	Oct-22	Oct	Dry	0.90	0.2	0.0	1.2	0.4	1.8
	Nov-22	Nov	Dry	4.78	1.1	0.6	2.3	1.7	5.7
	Dec-22	Dec	Dry	2.63	0.6	0.3	1.7	1.0	3.6
2023	Jan-23	Jan	Dry	1.31	0.3	0.0	1.3	0.5	2.2
	Feb-23	Feb	Dry	0.35	0.1	-0.1	1.1	0.2	1.3
	Mar-23	Mar	Dry	0.15	0.1	-0.2	1.0	0.1	1.1
	Apr-23	Apr	Dry	1.52	0.4	0.1	1.4	0.6	2.4

Nitrogen Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	May-23	May	Dry	3.04	0.7	0.3	1.8	1.1	4.0
	Jun-23	Jun	Wet	5.24	1.2	0.7	2.4	1.9	6.2
	Jul-23	Jul	Wet	4.43	1.0	0.6	2.2	1.6	5.4
	Aug-23	Aug	Wet	6.30	1.4	0.9	2.7	2.3	7.2
	Sep-23	Sep	Wet	2.05	0.5	0.2	1.5	0.8	3.0
	Oct-23	Oct	Dry	1.37	0.3	0.0	1.4	0.6	2.3
	Nov-23	Nov	Dry	1.17	0.3	0.0	1.3	0.5	2.1
	Dec-23	Dec	Dry	3.87	0.9	0.5	2.0	1.4	4.8

Appendix 2 - Monthly TP loads from all sources during 2013 to 2023.

Phosphorus Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
2013	Jan-13	Jan	Dry	0.61	0.004	-0.014	0.094	0.016	0.100
	Feb-13	Feb	Dry	1.40	0.007	0.011	0.108	0.039	0.164
	Mar-13	Mar	Dry	1.24	0.006	0.006	0.105	0.034	0.151
	Apr-13	Apr	Dry	2.18	0.010	0.035	0.121	0.061	0.227
	May-13	May	Dry	1.98	0.009	0.029	0.118	0.055	0.211
	Jun-13	Jun	Wet	9.86	0.043	0.275	0.252	0.278	0.849
	Jul-13	Jul	Wet	9.93	0.044	0.277	0.253	0.280	0.854
	Aug-13	Aug	Wet	9.39	0.041	0.260	0.244	0.265	0.811
	Sep-13	Sep	Wet	9.02	0.040	0.249	0.237	0.254	0.781
	Oct-13	Oct	Dry	0.94	0.005	-0.003	0.100	0.026	0.127
	Nov-13	Nov	Dry	2.16	0.010	0.035	0.121	0.060	0.226
	Dec-13	Dec	Dry	0.90	0.005	-0.005	0.099	0.025	0.124
2014	Jan-14	Jan	Dry	3.49	0.016	0.076	0.143	0.098	0.333
	Feb-14	Feb	Dry	1.66	0.008	0.019	0.112	0.046	0.185
	Mar-14	Mar	Dry	6.10	0.027	0.158	0.188	0.172	0.545
	Apr-14	Apr	Dry	1.57	0.008	0.016	0.111	0.044	0.178
	May-14	May	Dry	4.05	0.018	0.094	0.153	0.114	0.379
	Jun-14	Jun	Wet	3.56	0.016	0.078	0.144	0.100	0.339
	Jul-14	Jul	Wet	6.03	0.027	0.155	0.186	0.170	0.539
	Aug-14	Aug	Wet	4.05	0.018	0.094	0.153	0.114	0.379
	Sep-14	Sep	Wet	12.74	0.056	0.365	0.300	0.360	1.082
	Oct-14	Oct	Dry	2.92	0.013	0.058	0.134	0.082	0.287
	Nov-14	Nov	Dry	4.83	0.022	0.118	0.166	0.136	0.442
	Dec-14	Dec	Dry	1.89	0.009	0.026	0.116	0.053	0.204

Phosphorus Load									
Year	Month-Year	Month	Season	Rainfall (SWFWMD for Pinellas)	Atmospheric deposition (tons)	Basin runoff (tons)	Groundwater (tons)	Brooker Creek (tons)	Total inflow (tons)
2015	Jan-15	Jan	Dry	1.86	0.009	0.025	0.116	0.052	0.202
	Feb-15	Feb	Dry	5.68	0.025	0.145	0.180	0.160	0.511
	Mar-15	Mar	Dry	1.32	0.007	0.008	0.106	0.037	0.158
	Apr-15	Apr	Dry	2.99	0.014	0.061	0.135	0.084	0.293
	May-15	May	Dry	4.14	0.019	0.096	0.154	0.116	0.386
	Jun-15	Jun	Wet	5.88	0.026	0.151	0.184	0.166	0.527
	Jul-15	Jul	Wet	16.41	0.071	0.479	0.363	0.464	1.379
	Aug-15	Aug	Wet	11.92	0.052	0.339	0.287	0.337	1.015
	Sep-15	Sep	Wet	5.59	0.025	0.142	0.179	0.157	0.503
	Oct-15	Oct	Dry	1.93	0.009	0.028	0.117	0.054	0.207
	Nov-15	Nov	Dry	1.32	0.007	0.008	0.106	0.037	0.158
	Dec-15	Dec	Dry	0.49	0.003	-0.017	0.092	0.013	0.091
2016	Jan-16	Jan	Dry	6.12	0.027	0.158	0.188	0.172	0.546
	Feb-16	Feb	Dry	2.37	0.011	0.041	0.124	0.066	0.243
	Mar-16	Mar	Dry	2.14	0.010	0.034	0.120	0.060	0.224
	Apr-16	Apr	Dry	1.61	0.008	0.018	0.111	0.045	0.181
	May-16	May	Dry	4.35	0.020	0.103	0.158	0.122	0.403
	Jun-16	Jun	Wet	10.29	0.045	0.288	0.259	0.290	0.884
	Jul-16	Jul	Wet	6.55	0.029	0.172	0.195	0.185	0.581
	Aug-16	Aug	Wet	16.22	0.071	0.473	0.360	0.458	1.363
	Sep-16	Sep	Wet	8.55	0.038	0.234	0.229	0.241	0.743
	Oct-16	Oct	Dry	1.32	0.007	0.008	0.106	0.037	0.158
	Nov-16	Nov	Dry	0.02	0.001	-0.032	0.084	0.000	0.053
	Dec-16	Dec	Dry	0.48	0.003	-0.018	0.092	0.013	0.090
2017	Jan-17	Jan	Dry	1.21	0.006	0.005	0.104	0.033	0.149

Phosphorus Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	Feb-17	Feb	Dry	1.38	0.007	0.010	0.107	0.038	0.163
	Mar-17	Mar	Dry	1.05	0.005	0.000	0.102	0.029	0.136
	Apr-17	Apr	Dry	0.94	0.005	-0.003	0.100	0.026	0.127
	May-17	May	Dry	2.51	0.012	0.046	0.127	0.070	0.254
	Jun-17	Jun	Wet	8.72	0.038	0.239	0.232	0.246	0.757
	Jul-17	Jul	Wet	7.81	0.034	0.211	0.217	0.220	0.683
	Aug-17	Aug	Wet	8.87	0.039	0.244	0.235	0.250	0.769
	Sep-17	Sep	Wet	7.83	0.035	0.212	0.217	0.221	0.685
	Oct-17	Oct	Dry	3.10	0.014	0.064	0.137	0.087	0.302
	Nov-17	Nov	Dry	0.65	0.004	-0.012	0.095	0.018	0.104
	Dec-17	Dec	Dry	0.75	0.004	-0.009	0.097	0.020	0.112
2018	Jan-18	Jan	Dry	4.08	0.018	0.095	0.153	0.115	0.381
	Feb-18	Feb	Dry	1.41	0.007	0.011	0.108	0.039	0.165
	Mar-18	Mar	Dry	0.46	0.003	-0.018	0.092	0.012	0.088
	Apr-18	Apr	Dry	2.51	0.012	0.046	0.127	0.070	0.254
	May-18	May	Dry	7.66	0.034	0.206	0.214	0.216	0.671
	Jun-18	Jun	Wet	3.72	0.017	0.083	0.147	0.104	0.352
	Jul-18	Jul	Wet	5.99	0.027	0.154	0.186	0.169	0.536
	Aug-18	Aug	Wet	9.82	0.043	0.274	0.251	0.277	0.846
	Sep-18	Sep	Wet	5.70	0.025	0.145	0.181	0.161	0.512
	Oct-18	Oct	Dry	1.83	0.009	0.024	0.115	0.051	0.199
	Nov-18	Nov	Dry	1.10	0.006	0.002	0.103	0.030	0.140
	Dec-18	Dec	Dry	8.72	0.038	0.239	0.232	0.246	0.757
2019	Jan-19	Jan	Dry	3.98	0.018	0.091	0.152	0.112	0.373
	Feb-19	Feb	Dry	2.86	0.013	0.057	0.133	0.080	0.282

Phosphorus Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	Mar-19	Mar	Dry	1.25	0.006	0.006	0.105	0.035	0.152
	Apr-19	Apr	Dry	2.58	0.012	0.048	0.128	0.072	0.260
	May-19	May	Dry	3.40	0.016	0.073	0.142	0.095	0.326
	Jun-19	Jun	Wet	8.46	0.037	0.231	0.228	0.239	0.736
	Jul-19	Jul	Wet	12.30	0.054	0.351	0.293	0.347	1.046
	Aug-19	Aug	Wet	12.19	0.053	0.348	0.291	0.344	1.037
	Sep-19	Sep	Wet	1.55	0.008	0.016	0.110	0.043	0.176
	Oct-19	Oct	Dry	7.02	0.031	0.186	0.203	0.198	0.619
	Nov-19	Nov	Dry	0.90	0.005	-0.005	0.099	0.025	0.124
	Dec-19	Dec	Dry	4.90	0.022	0.120	0.167	0.138	0.448
2020	Jan-20	Jan	Dry	1.03	0.005	-0.001	0.101	0.028	0.134
	Feb-20	Feb	Dry	2.16	0.010	0.035	0.121	0.060	0.226
	Mar-20	Mar	Dry	0.02	0.001	-0.032	0.084	0.000	0.053
	Apr-20	Apr	Dry	5.07	0.023	0.125	0.170	0.143	0.461
	May-20	May	Dry	1.67	0.008	0.019	0.112	0.046	0.186
	Jun-20	Jun	Wet	7.08	0.031	0.188	0.204	0.200	0.624
	Jul-20	Jul	Wet	6.38	0.028	0.166	0.192	0.180	0.567
	Aug-20	Aug	Wet	8.57	0.038	0.235	0.230	0.242	0.744
	Sep-20	Sep	Wet	6.43	0.029	0.168	0.193	0.181	0.571
	Oct-20	Oct	Dry	1.96	0.009	0.028	0.117	0.055	0.210
	Nov-20	Nov	Dry	6.09	0.027	0.157	0.187	0.172	0.544
	Dec-20	Dec	Dry	2.75	0.013	0.053	0.131	0.077	0.274
2021	Jan-21	Jan	Dry	0.95	0.005	-0.003	0.100	0.026	0.128
	Feb-21	Feb	Dry	3.38	0.015	0.073	0.141	0.095	0.325
	Mar-21	Mar	Dry	0.90	0.005	-0.005	0.099	0.025	0.124

Phosphorus Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	Apr-21	Apr	Dry	3.38	0.015	0.073	0.141	0.095	0.325
	May-21	May	Dry	0.13	0.001	-0.029	0.086	0.003	0.062
	Jun-21	Jun	Wet	8.36	0.037	0.228	0.226	0.236	0.727
	Jul-21	Jul	Wet	8.43	0.037	0.230	0.227	0.238	0.733
	Aug-21	Aug	Wet	8.31	0.037	0.227	0.225	0.234	0.723
	Sep-21	Sep	Wet	7.38	0.033	0.198	0.209	0.208	0.648
	Oct-21	Oct	Dry	1.61	0.008	0.018	0.111	0.045	0.181
	Nov-21	Nov	Dry	2.41	0.011	0.042	0.125	0.067	0.246
	Dec-21	Dec	Dry	0.73	0.004	-0.010	0.096	0.020	0.110
2022	Jan-22	Jan	Dry	1.43	0.007	0.012	0.108	0.040	0.167
	Feb-22	Feb	Dry	0.63	0.004	-0.013	0.095	0.017	0.102
	Mar-22	Mar	Dry	2.69	0.012	0.051	0.130	0.075	0.269
	Apr-22	Apr	Dry	4.82	0.022	0.118	0.166	0.136	0.441
	May-22	May	Dry	1.72	0.008	0.021	0.113	0.048	0.190
	Jun-22	Jun	Wet	4.10	0.019	0.095	0.154	0.115	0.383
	Jul-22	Jul	Wet	6.57	0.029	0.172	0.196	0.185	0.583
	Aug-22	Aug	Wet	6.92	0.031	0.183	0.202	0.195	0.611
	Sep-22	Sep	Wet	9.62	0.042	0.267	0.247	0.271	0.829
	Oct-22	Oct	Dry	0.90	0.005	-0.005	0.099	0.025	0.124
	Nov-22	Nov	Dry	4.78	0.021	0.116	0.165	0.134	0.438
	Dec-22	Dec	Dry	2.63	0.012	0.049	0.129	0.074	0.264
2023	Jan-23	Jan	Dry	1.31	0.007	0.008	0.106	0.036	0.157
	Feb-23	Feb	Dry	0.35	0.002	-0.022	0.090	0.009	0.079
	Mar-23	Mar	Dry	0.15	0.002	-0.028	0.086	0.003	0.063
	Apr-23	Apr	Dry	1.52	0.007	0.015	0.110	0.042	0.174

Phosphorus Load									
Year	**Month-Year**	**Month**	**Season**	**Rainfall (SWFWMD for Pinellas)**	**Atmospheric deposition (tons)**	**Basin runoff (tons)**	**Groundwater (tons)**	**Brooker Creek (tons)**	**Total inflow (tons)**
	May-23	May	Dry	3.04	0.014	0.062	0.136	0.085	0.297
	Jun-23	Jun	Wet	5.24	0.023	0.131	0.173	0.147	0.475
	Jul-23	Jul	Wet	4.43	0.020	0.106	0.159	0.125	0.409
	Aug-23	Aug	Wet	6.30	0.028	0.164	0.191	0.177	0.561
	Sep-23	Sep	Wet	2.05	0.010	0.031	0.119	0.057	0.217
	Oct-23	Oct	Dry	1.37	0.007	0.010	0.107	0.038	0.162
	Nov-23	Nov	Dry	1.17	0.006	0.004	0.104	0.032	0.146
	Dec-23	Dec	Dry	3.87	0.018	0.088	0.150	0.109	0.364

Appendix B: Lake Tarpon Technical Working Group Membership

The Lake Tarpon SWIM Plan Technical Working group includes members from the District and representatives from academia, the private sector, and local, regional, state, and federal agency scientific and technical staff with regulatory or management mandates that affect Lake Tarpon.

This Technical Working Group was convened to assist the District in review of data and identification of issues, and management actions for consideration in the Lake Tarpon SWIM Plan update. Participants in the District's Lake Tarpon Technical Working group are identified below.

Lake Tarpon SWIM Plan Update Technical Work Group Members	
Member	**Organization**
Ahmed Hamed	SWFWMD - Engineering & Watershed Management
Charles Thompson	FWC - IPM (SAV)
Chris Anastasiou	**SWFWMD - Surface Water Improvement & Management**
Dave Adams	Pinellas County - Utilities ASR Project Manager
David Eilers	USF Water Atlas
Doug Robison	**Environmental Science Associates (ESA)**
Emily Keenan	Environmental Science Associates (ESA)
Eric Johnson	FWC - Fisheries
Garrett Snider	SWFWMD - Vegetation Management
Ken Weaver	FDEP
Kevin Petrus	FDEP
Lisa Baltus	Pinellas County - Brooker Creek Preserve
Lizanne Garcia	**SWFWMD - Surface Water Improvement & Management**
Patrick Casey	SWFWMD - Structure Operations
Rob Burnes	Pinellas County
Robert McDonald	SWFWMD - Surface Water Improvement & Management
Samantha Smith	SWFWMD - Resource Evaluation
Shawn Landry	USF Water Atlas
Spencer Curtis	Pinellas County - Parks & Recreation
Stacey Day	Pinellas County
Tara Harter	SWFWMD - Surface Water Improvement & Management
Tony Mannello	City of Tarpon Springs
Vanessa Bauzo	FDACS
Yuan Li	SWFWMD - Engineering & Watershed Management

Note: Co-chairs of this committee are represented in **bold text**.

Appendix C: Permitted Point Sources within the Lake Tarpon Watershed

This appendix describes point sources of nutrients within the Lake Tarpon Watershed. The data described below were downloaded from FDEP's Geospatial Open Data website on June 2024. For the most up to date point source data visit: http://geodata.dep.state.fl.us/.

Wastewater permits within the Lake Tarpon Watershed include only 1 domestic wastewater facility located in northwest Hillsborough County.

A Municipal Separate Storm Sewer System or MS4 is defined in Rule 62-624.200(8), F.A.C., as follows: Municipal separate storm sewer or MS4 means a conveyance or system of conveyances like roads with stormwater systems, municipal streets, catch basins, curbs, gutters, ditches, constructed channels, or storm drains: Owned or operated by a State, city, town, county, special district, association, or other public body (created by or pursuant to State Law) having jurisdiction over management and discharge of stormwater, or an Indian tribe or an authorized Indian tribal organization, that discharges to waters of the state; Designed or used for collecting or conveying stormwater; Which is not a combined sewer; and Which is not part of a Publicly Owned Treatment Works (POTW). POTW means any device or system used in the treatment of municipal sewage or industrial wastes of a liquid nature which is owned by a "State" or "municipality." This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment. As of March 2024, within the Lake Tarpon Watershed there are 7 MS4 permits.

Based on an email from FDEP Southwest District Office staff in June 2024 there are currently no facilities operating under a Consent Order due to being out of compliance with their permits. For additional information please see the FDEP website for the permits and Consent Orders.

Appendix D: Jurisdictional Authority within the Lake Tarpon Watershed

Various levels of government are involved in resource management and regulatory activities within the Lake Tarpon watershed. These include single purpose local governments (i.e. independent taxing districts), general purpose local governments (i.e. cities and counties), regional agencies (i.e. Southwest Florida Water Management District (SWFWMD) and the Tampa Bay regional planning council (TBRPC), as well as state and federal agencies.

FEDERAL

Federal jurisdiction in Lake Tarpon watershed involves the regulatory responsibilities of the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Coast Guard, the U.S. Fish and Wildlife Service, and the U.S. Department of Interior (which coordinates its many agriculture-related activities with those of the Florida Department of Agriculture and Consumer Services). Their main regulatory functions include overseeing dredge and fill activities, maintaining navigability of the waters of the United States, overseeing cleanups following pollution spills, protecting endangered species, protecting overall environmental quality, and managing offshore activities. These agencies, in conjunction with the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, also contribute to the collection of technical data concerning Lake Tarpon and its watershed.

U.S. Army Corps of Engineers (USACE)

The U.S. Army Corps of Engineers Regulatory Program began in 1890 with the responsibility of protecting and maintaining the nation's navigable waterways. As a result of changing public needs and evolving policy via new laws and court decisions, protection has been extended to all waters of the United States, including many wetlands. The Jacksonville Regulatory Division (https://www.saj.usace.army.mil/Missions/Regulatory/Office-Locations/) of the USACE has jurisdiction over the geographic region of Florida, Puerto Rico, and the U.S. Virgin Islands. The Division is geographically aligned in three Permitting Branches, which are further divided into eleven Sections, and Mitigation Bank Team and Enforcement Section. The Jacksonville District administers the largest regulatory permitting program in the Corps, which provides protection for waters of the United States, including federally delineated wetlands and navigable waters.

U.S. Environmental Protection Agency

The Environmental Protection Agency (Southeast Regional Office, Region IV, Atlanta, Georgia) through its Water Division, implements the Clean Water Act and the Safe Drinking Water Act. The Division works with states and tribes to develop and approve programs to protect public health and natural resources through source water protection, improving aging infrastructure, water reuse and nutrient reduction.

U.S. Coast Guard (USCG)

The U.S Coast Guard is a branch of the U.S. Armed Forces. It encompasses a law enforcement organization, a regulatory agency and many other responsibilities and partnerships. The USCG is the principal Federal agency responsible for maritime safety, security, and environmental stewardship in U.S. ports and inland waterways, inland waters the Coast Guard Auxiliary, a volunteer group, performs boating safety inspections and search and rescue missions. Since Lake Tarpon is a navigable water it is monitored by the Coast Guard.

U.S. Department of Interior

The primary water-related functions performed by this agency involve the review of proposed activities which may impact threatened or endangered species, review of U.S. Army Corps of Engineers permits for potential effects on fish and wildlife, and management of all federally-owned public lands. Within the department, the U.S. Geological Survey conducts investigations concerning hydrology, hydrogeology, water use, and ground and surface water quality. The U.S. Fish and Wildlife Service manages and restores fish and wildlife populations and conducts research on the effects of pollution on those resources.

STATE AGENCIES

Many state agencies are involved in environmental regulation and resource management in the Tampa Bay watershed and estuary. The Florida Department of Environmental Protection is the lead state agency in the protection and management of Lake Tarpon. Other relevant entities include the Florida Fish & Wildlife Conservation Commission, the Marine Fisheries Commission, Florida Department of Agriculture and Consumer Services, and the Florida Department of Health and Rehabilitative Services, and the Florida Department of Transportation.

Florida Department of Agriculture and Consumer Services (FDACS)

The FDACS Division of Agricultural Environmental Services administers various state and federal regulatory programs concerning environmental consumer protection issues. These include state mosquito control program coordination; agricultural pesticide registration, testing and regulation; pest control regulation; and feed, seed and fertilizer production inspection and testing. The division ensures that pesticides are properly registered and used in accordance with federal and state requirements; mosquito control programs are effectively conducted; and feed, seed and fertilizer products are safe and effective.

The FDACS Office of Agricultural Water Policy (OAWP) collaborates with Florida's agricultural landowners and producers to implement best management practices (BMPs) for nutrient reduction, irrigation management, and the protection of water resources. Agricultural BMPs are an integral part of water resource protection required under the regulatory BMP Program implemented by FDACS OAWP. Section 403.067, Florida Statutes (F.S.), directs the Florida Department of Environmental Protection (FDEP) to develop water quality restoration goals for impaired waterbodies. These water quality restoration goals, or total maximum daily loads (TMDLs), are the maximum amount of a pollutant that a waterbody can assimilate and remain suitable for its designated use.[1] Once a TMDL is adopted, FDEP may develop a basin management action plan (BMAP) that identifies enforceable strategies for restoring the impaired waterbody.[2] The agricultural industry is one of many stakeholders identified in most BMAPs and plays an important role in helping meet these water quality goals. Florida law requires agricultural producers and landowners located within BMAP areas to either enroll in the FDACS BMP Program and properly implement BMPs applicable to their property and operation, or to conduct water quality monitoring as required by chapter 62-307, F.A.C. FDACS strongly encourages producers and agricultural landowners located outside of BMAP areas to also enroll in the BMP Program for the many benefits that enrollment provides. Proper implementation of FDACS agricultural BMPs is the industry's strategy to address agricultural nonpoint pollution sources. Producers or landowners who are enrolled in the FDACS BMP Program and properly implement the applicable BMPs identified on the BMP Checklist are entitled to a presumption of compliance with state water quality standards per 403.067(7)(c)3., F.S. FDACS is required to perform BMP Implementation Verification site visits to

[1] FLA. STAT. § 403.067(7) (2022).
[2] *See supra* note 1. BMAP information is available at https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps.

enrolled operations every two years to ensure that BMPs are being properly implemented. Producers and agricultural landowners outside BMAP areas are strongly encouraged to enroll in the BMP Program for the benefits that enrollment provides.

Through the Florida Forest Service (FFS), the FDACS is responsible for developing, implementing, and monitoring BMPs through the Silviculture BMP Program to control forestry-related water quality non-point source pollution. The FFS manages Florida's 34 State Forests and several other parcels of public land. The FFS meets its responsibility for Silviculture BMP implementation by means of a two-prong approach via a formal BMP training program and by providing on-on-one technical advice. The goal of both approaches is to educate forestry practitioners and landowners about the importance of implementing Silviculture BMPs to prevent nonpoint sources pollution. To ensure Florida's Silvicultural BMPs achieve the objectives of the Federal Clean Water Act and prevent nonpoint source pollution from forestry operations entering surface and ground water, effectiveness studies have been conducted since 1996 and are currently ongoing.

As a regulatory branch of the FDACS, the Division of Plant Industry works to detect, intercept and control plant and honeybee pests that threaten Florida's native and commercially grown plants and agricultural resources.

Florida Department of Environmental Protection (FDEP)

The Florida Department of Environmental Protection (FDEP) is the lead state agency involved in water quality, pollution control, and resource recovery programs. The FDEP sets state water quality standards and has permit jurisdiction over point and non-point source discharges, certain dredge and fills activities, drinking water systems, power plant siting, and many construction activities conducted within waters of the state. The FDEP also interacts closely with other federal and state agencies on water-related matters, and the FDEP and the District share responsibilities in non-point source management and wetland permitting. The Southwest District Office in Tampa has responsibility for proprietary and regulatory permitting issues in the Lake Tarpon watershed area.

The Division of State lands oversees the management of state lands, including state parks. The Division of Recreation and Parks and the Office of Resilience and Coastal Protection are directly responsible for day-to-day land management, and beaches in this watershed. The Florida Geological Survey Division provides geoscience products to support initiatives related to water-resource conservation and management, and improvement of the quality of natural resources. The FDEP is the primary reviewer of SWIM plans.

Division of Water Resource Management

The Southwest District Office in Tampa has responsibility for proprietary and regulatory permitting issues in the Lake Tarpon watershed area.

Florida Department of Health (FDOH)

The primary statutes providing FDOH authority are in Chapter 154, 381 and 386 of the Florida Statutes and the 64E Series of the Florida Administrative Code, known as the "Sanitary Code". Each county has a FDOH Office responsible for jurisdiction within the county. The environmental focus of the FDOH is to prevent disease of environmental origin. Environmental health activities include prevention, preparedness, and education and are implemented through routine monitoring, education, surveillance and sampling of facilities and conditions that may contribute to the occurrence or transmission of disease. Responsibilities of the FDOH include the public health functions of water supplies (primarily small to medium supplies), onsite sewage treatment and disposal systems permitting and inspection, septic tank cleaning and waste disposal (in conjunction with FDEP), and solid waste control (secondary role).

Florida Fish & Wildlife Conservation Commission (FFWCC)

The Florida Fish and Wildlife Conservation Commission (FWC) manages fish and wildlife resources for their long-term well-being and the benefit of people. Agency personnel work together to protect and manage more than 575 species of wildlife, 200 species of freshwater fish and 500 species of saltwater fish. The FWC works to balance the needs of these fish and wildlife species and the habitats that support them with the needs of Florida's population of 21.7 million people and approximately 100 million visitors each year. The FWC is comprised of six divisions including the Fish and Wildlife Research Institute, Freshwater Fisheries Management, Habitat and Species Conservation, Hunting and Game Management, Law Enforcement and Marine Fisheries Management.

The FWC accomplishes its mission by pursuing strategic goals such as those highlighted in Florida's State Wildlife Action Plan, a comprehensive, statewide plan for conserving Florida's wildlife and natural areas for future generations (https://myfwc.com/conservation/special-initiatives/swap/). Through collaborative efforts FWC researchers and resource managers have informed and assisted multiple hydrologic and aquatic habitat restoration efforts supporting District SWIM Program objectives.

The FWC's efforts within the SWIM plan area primarily involve freshwater sport and commercial fishing, fisheries and habitat management, fish stocking, fisheries research, wildlife monitoring, enforcement of fisheries/wildlife regulations, listed species protection, wildlife research, development review, and regional planning. The FWC is directed by 62-43 F.A.C. to review SWIM plans to determine if the plan has adverse effects on wild animal life and freshwater aquatic life and their habitats.

Florida Department of Transportation

The Department of Transportation's Project Development and Environmental Offices assist in the design, review, and permitting of road and right-of-way projects in the Lake Tarpon watershed.

REGIONAL AGENCIES

Several regional agencies exist within the SWFWMD boundaries of the Lake Tarpon watershed that are responsible for water resource and natural systems planning and management. These are the Tampa Bay Regional Planning Council, the Southwest Florida Water Management District, and Tampa Bay Water.

Tampa Bay Regional Planning Council (TBRPC)

The TBRPC was established in 1962 and includes the counties of Hillsborough, Manatee, Pasco Pinellas, with Hernando and Citrus added in 2015. The mission of the TBRPC is to serve its citizens and member governments by providing a forum to foster communication, coordination and collaboration to identify and address needs/issues regionally. The TBRPC is a multi-purpose agency responsible for providing a variety of services including natural resource protection and management, emergency preparedness planning, economic development and analysis, transportation and mobility planning, growth management and land use coordination, and technical assistance to local governments.

Southwest Florida Water Management District (SWFWMD)

The mission of the SWFWMD is to manage water and related natural resources to ensure their continued availability while maximizing the benefits to the public. Central to the mission is maintaining the balance between the water needs of current and future users while protecting and maintaining water and related natural resources which provide the SWFWMD with its existing and future water supply. The SWFWMD is responsible for performing duties assigned under Ch. 373, F.S., as well as duties delegated through FDEP for Ch. 253 and 403, F.S., and for local plan review (Ch. 163, F.S.). It performs those duties for the entire Tampa Bay watershed within its boundaries.

Tampa Bay Water (TBW)

Tampa Bay Water (TBW), a special district of the state of Florida, was created to plan, develop, and deliver a high-quality drinking water supply and to protect the water supply sources of its members. Members of TBW include the counties of Hillsborough, Pasco, and Pinellas, as well as the cities of New Port Richey, Tampa, and St. Petersburg. TBW manages several diverse water facilities including 14 wellfields, surface water withdrawals from the Tampa Bypass Canal and Alafia River, and a seawater desalination facility. It is an independent special district authorized by Section 373.1962, F.S., as subsequently reenacted in Section 373.713, F.S., and created by an interlocal agreement executed pursuant to Section 163.01, F.S., in 1998.

LOCAL GOVERNMENTS

There are three local governments that have jurisdiction within the Lake Tarpon watershed. These include two counties and 1 municipality. Each of these local governments have a role in protecting Lake Tarpon and its watershed. Rather than provide a list of these responsibilities for each local government, the Counties are briefly described and the municipalities within the counties are identified. For more information on their water resource management programs the reader is referred to their respective websites.

Hillsborough County

Hillsborough County has an estimated permanent population of approximately 1.54 million in 2023 and a land area of 1,022 square miles (BEBR, 2024). The latest estimates from the Bureau of Economic and Business Research (BEBR) list Hillsborough County as the third most populous county in the state (BEBR, 2024). It is served by the Board of County Commissioners.

The upper Brooker Creek watershed comprises the portion of the Lake Tarpon watershed in Hillsborough County. The County manages the 1121-acre Brooker Creek Headwater Nature Preserve in northwest Hillsborough County.

Pinellas County

Pinellas County has an estimated permanent population of 974,689 in 2023 and a surface area of 274 square miles (BEBR, 2024). It is served by the Board of County Commissioners. The local governments within Pinellas County in the Lake Tarpon watershed include the City of Tarpon Springs.

Since the original SWIM plan in 1989, Pinellas County, through their Department or Environmental Management has been a very active partner with the District in the management and monitoring of Lake Tarpon, The County also has been a cooperative funding partner for stormwater treatment and natural systems restoration projects.

Appendix E: List of Acronyms

Abbreviation	Description
BEBR	Bureau of Economic and Business Research
BMAP	Basin management action plan
BMPs	Best Management Practices
District	Southwest Florida Water Management District
ELAPP	Environmental Lands Acquisition and Protection Program
ESA	Environmental Science Associates
F.S.	Florida Statutes
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FFS	Florida Forest Service
FFWCC	Florida Fish and Wildlife Conservation Commission
FWC	Florida Fish and Wildlife Conservation Commission
H&H	Hydrologic and hydraulic
IPM	Integrated Plant Management Program
LVI	Lake Vegetation Index
mg/L	Milligrams per liter
NNC	Numeric Nutrient Criteria
OAWP	Office of Agricultural Water Policy
PAC	Percent area covered
PLRG	Pollutant Load Reduction Goal
POTW	Publicly Owned Treatment Works
PVI	Percent volume inhabited
SAV	Submerged aquatic vegetation
SSAC	Site-Specific Alternative Criteria
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
TBRPC	Tampa Bay Regional Planning Council
TBW	Tampa Bay Water
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSI	Trophic State Index
µg/L	Micrograms per liter
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USF	University of South Florida
WQMP	Water Quality Management Plan