4350 West Cypress Street
Suite 950
Tampa, FL 33607
813.207.7200 phone
813.207.7201 fax
www.esassoc.com

memorandum

date September 16, 2015

to Joanne Vernon, P.E., Charlotte County

from David Tomasko, Ph.D.
Emily Keenan, M.S.
Ed Cronyn, M.S.

subject Annual Report

Background

The Sunshine Lake/Sunrise Waterway system, located in Port Charlotte, previously experienced extensive and persistent algal blooms, with noxious odors and deep organic-rich sediments. This condition resulted in Charlotte County enacting a lake-wide dredging operation to remove the algal material from the Sunshine Lake/Sunrise Waterway system. Two reports, a preliminary assessment (Atkins 2012) and a more-detailed water quality management plan (Atkins and ESA 2014) determined that nutrient concentrations within the lake and waterway are lower than nutrient concentrations in stormwater runoff and groundwater seepage. These results indicate that the algal bloom in the lake was associated with plant forms not in the water column itself. Instead, the algal bloom that previously occurred throughout the lake and waterway system was a form that assimilated nutrients into a mass of material associated with the bottom of the lake and waterway. The factors that helped to create the algal bloom appear to include elevated levels of phosphorus in the surficial aquifer and in stormwater runoff, which appears to be due to naturally phosphorus-rich surface geology in the surrounding watershed.

Due to the phosphorus-rich surface geology, there is the potential that some sort of algal bloom may reoccur. In response, Charlotte County initiated a monitoring program as part of the water quality management plan. This technical memorandum presents the results of the first four quarterly sampling events, which occurred in October 2015, January 2016, April 2016, and then July 2016. On all four occasions, water quality and benthic assessment were performed during the same week, but not the same day, in both the lake and waterway.

Regulatory Implications

Water quality results illustrated in this report are presented such that the County can determine whether or not the water quality in Sunshine Lake and the Sunrise Waterway is problematic in terms of regulatory criteria. For these results to be interpreted correctly, the basis for water quality criteria must be fully understood.

Since 2013, the State of Florida has had Numeric Nutrient Concentration (NNC) Criteria to determine if waterbodies meet or don't meet their relevant water quality criteria. Both Sunshine Lake and the Sunrise Waterway are non-tidal freshwater systems that do not support water supply needs. As such, both waterbodies are classified as Class III-freshwater water bodies. Consistent with the FDEP's NNC criteria (FAC 62-302.531) water quality targets for Class III freshwater water bodies are first derived based on their amount of colored

dissolved organic matter (CDOM). Levels of CDOM are quantified in units of "color" expressed as Platinum-Cobalt Units. As a rough analogy, water bodies with high levels of CDOM look like "iced tea" while water bodies with low levels of CDOM look more like bottled water. Lakes with levels of color higher than 40 PCU are termed "high color" lakes, while those with color levels lower than 40 PCU are termed "low color" lakes.

The level of color in a lake influences the targets for the amount of algae allowable in the water column in a lake. The amount of algae in the water column is quantified in terms of the amount of the photosynthetic pigment found in the water, which is quantified in units of µg chlorophyll-a / liter. Lakes with high color levels (i.e., > 40 PCU) have a default chlorophyll-a target of 20 µg chlorophyll-a / liter.

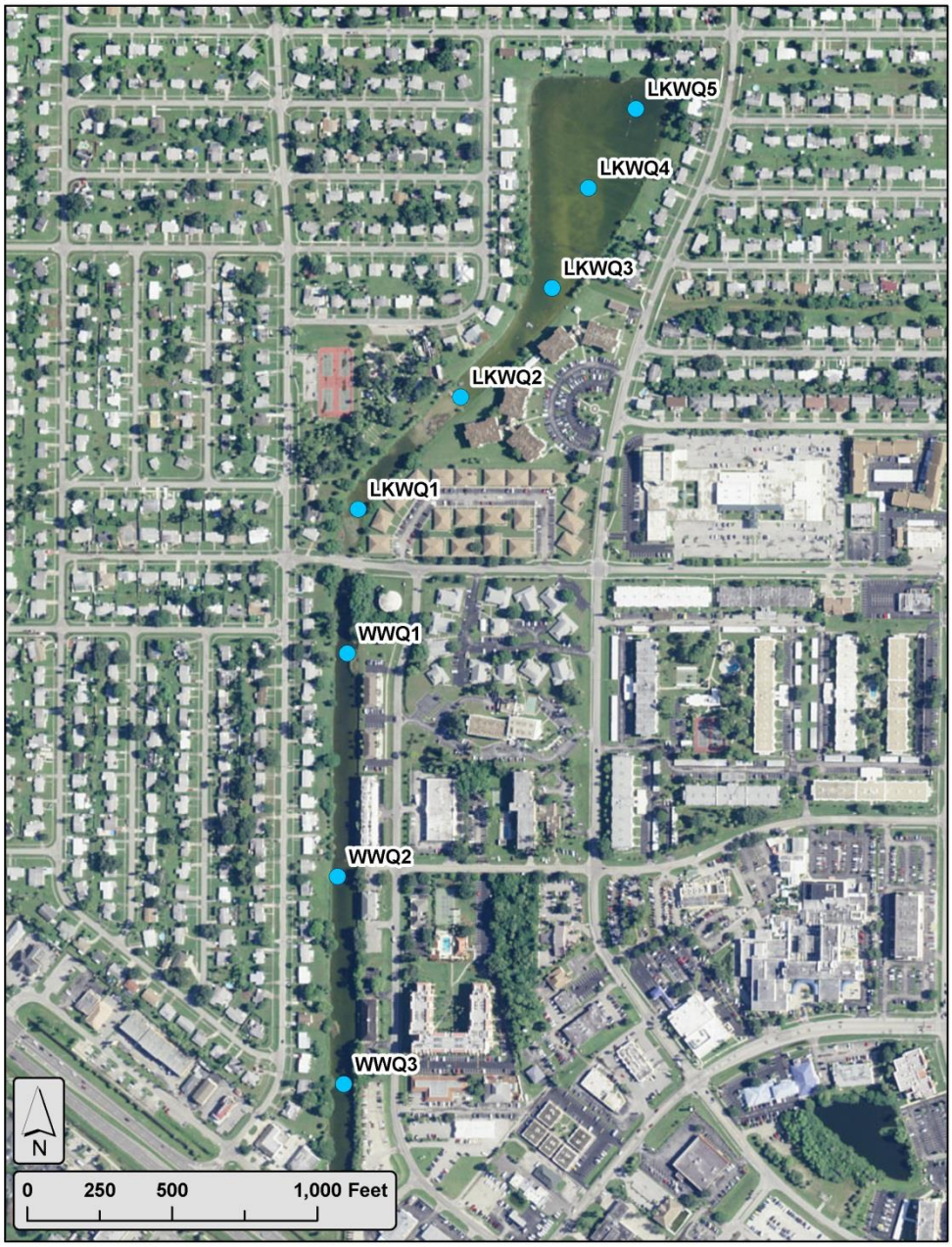
For low color lakes, the target chlorophyll-a value depends upon the alkalinity level of the lake. FDEP determined that low-color lakes fit into two broad categories, low color and acidic, and low color and alkaline. These low-color lakes are thus divided into either low-alkalinity (≤ 20 mg/L $CaCO_3$) or high-alkalinity (> 20 mg/L $CaCO_3$) categories. Unfortunately, most lakes do not have data on levels of alkalinity, and so, FDEP allows for the use of specific conductance as a surrogate for alkalinity. For lakes with no data on alkalinity, the more commonly measured term of specific conductance can be used, with the value of 100 µmhos/cm acting as a proxy for the 20 mg/L $CaCO_3$ alkalinity threshold. Low color and acidic lakes (i.e., those with specific conductance less than 100 µmhos/cm) have a default target of 6 µg chlorophyll-a / liter, while low color and alkaline lakes have a default target of 20 µg chlorophyll-a / liter. Based on these criteria, both Sunshine Lake and the Sunrise Waterway are considered to be low-color and alkaline lakes, with a target of 20 µg chlorophyll-a / liter.

Methods

Surface Water Sampling

Quarterly monitoring of 8 surface water sites (5 in the lake and 3 within the waterway) were collected and analyzed for total and dissolved nutrients (nitrogen and phosphorus), chlorophyll-a, and fecal coliform bacteria at the stations indicated in Figure 1.

Figure 1. Location of sampling sites for water quality assessment of Sunshine Lake and the Sunrise Waterway.

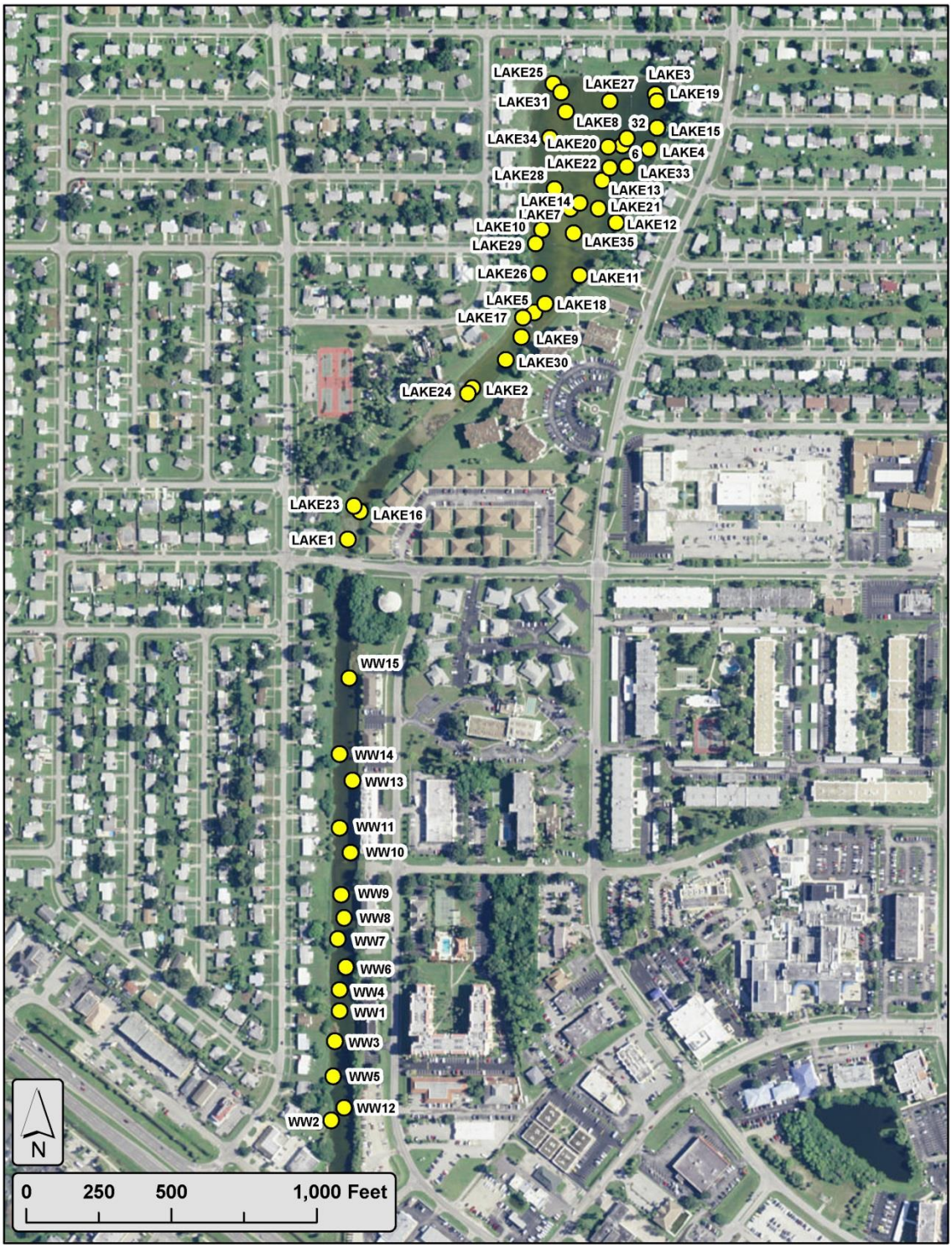


One blank and one replicate surface water quality sample were collected as well, for total of 10 samples each time water quality was sampled. *In situ* water quality profiles were performed using a YSI instrument at each surface water sampling site. Water quality parameters measured included water temperature, dissolved oxygen, pH and conductivity. Secchi disk depth and total water depth were also measured.

Benthic Sampling

Quarterly sampling of the amount of algae associated with the bottom of the lake and waterway was undertaken at the locations shown in Figure 2.

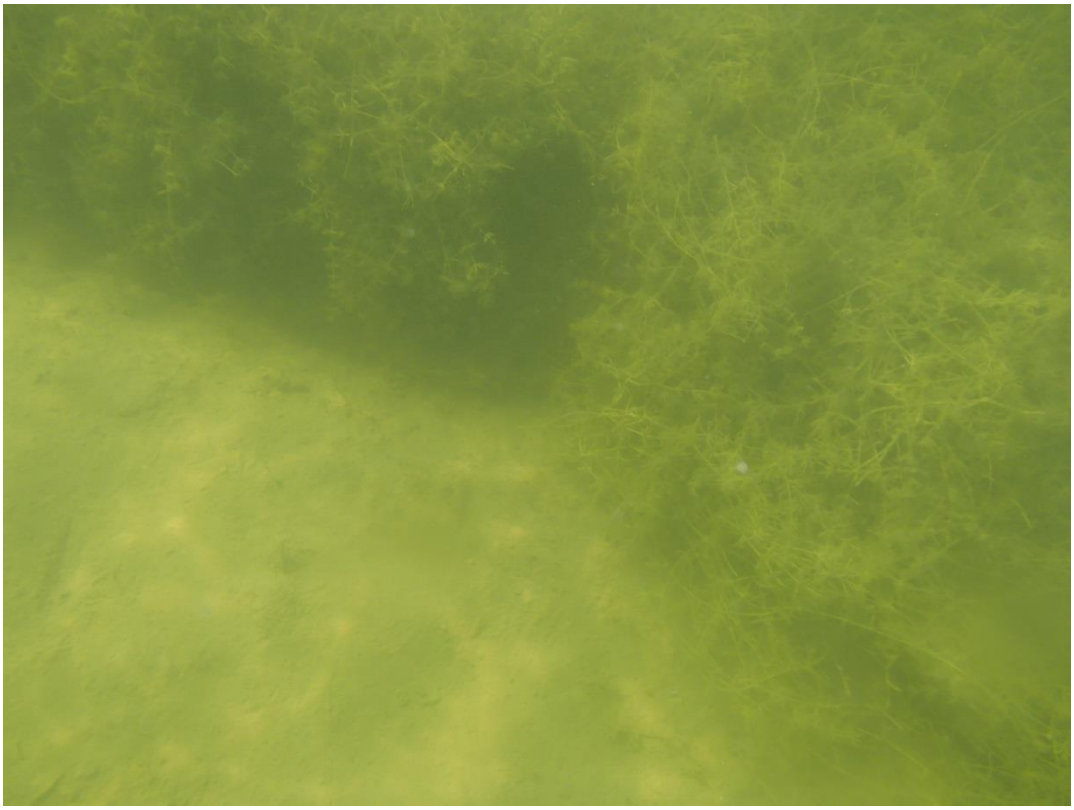
Figure 2. Location of sampling sites for benthic algal assessment of Sunshine Lake and the Sunrise Waterway.



The sampling techniques were the same as those employed in the original assessment of the algal bloom in the lake and waterway. At each of 50 randomly-chosen stations (35 in the lake and 15 in the waterway) a pole with a flat plate affixed to the bottom was lowered into the water. In the preliminary lake assessment, the pole was lowered into the water column until it reached the top of the algal mat, and the depth recorded. The pole was then lowered through the algal mat until the point of refusal, which was recorded as the bottom of the lake itself.

On each occasion sampled, we found no evidence of the prior benthic algal mat, which in the past was composed almost entirely of cyanobacteria (aka "blue-green algae"), with the dominant species being *Aphanothece conglomerata*. Instead, sampling events in October 2015, January 2016, April 2016 and July 2016 found varying amounts of a near monoculture of the green algal genus *Chara* (Figure 3).

Figure 3. Underwater photograph from within Sunshine Lake, showing presence of *Chara* sp.



On several occasions, but only in a few locations, there was a mixture of filamentous species of algae mixed in with the *Chara* sp., especially in areas where the *Chara* had "topped out" and grown to the surface. Most of the filamentous algae appeared to be from the genus *Chaetomorpha*, a type of green algae. Where *Chara* was encountered, the top of the canopy was recorded, as well as the total depth of the water column, using techniques similar to those utilized in prior assessments of algal abundance in the lake and waterway.

This annual report will focus on the interpretation of findings of both water quality and benthic sampling, with a focus on determining adherence with appropriate water quality criteria, as well as to discuss any trends and/or spatial patterns associated with the abundance of algae within the lake and waterway.

Results

Water Quality - Nutrients

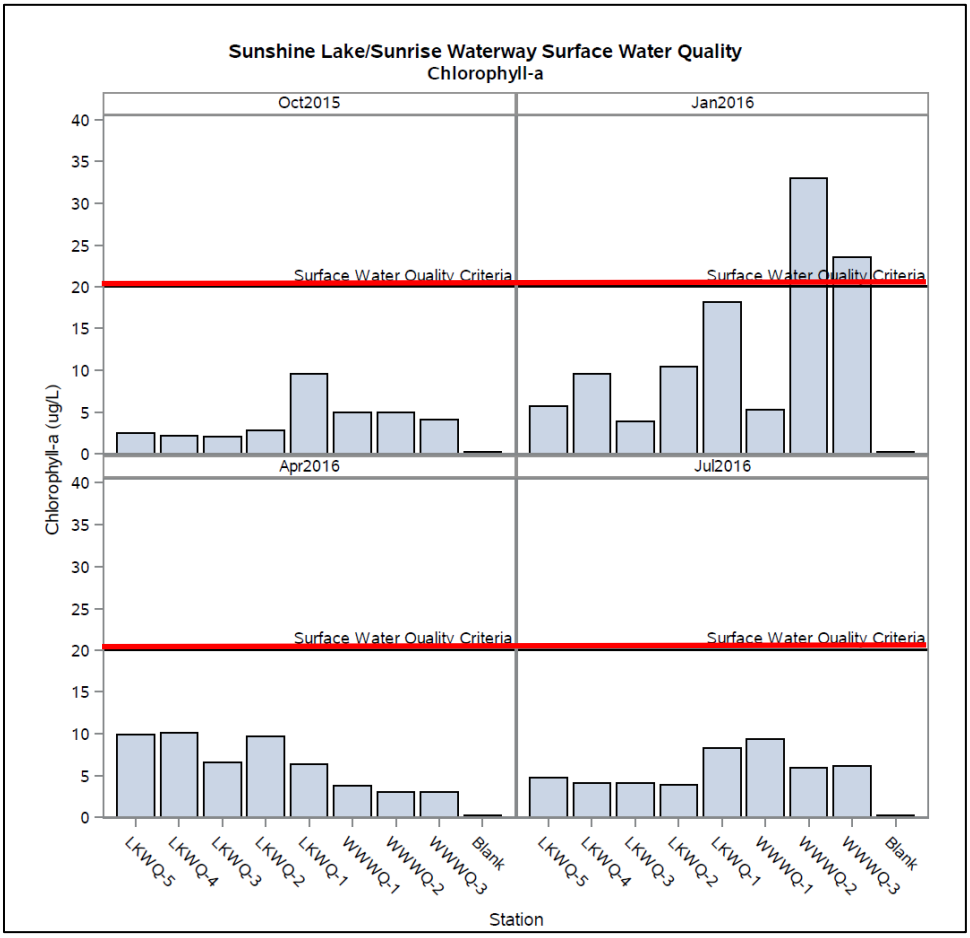
The nutrient targets for low-color and alkaline lakes vary further dependent upon whether or not the lake first meets (or exceeds) its relevant target for chlorophyll-a. FDEP concluded that if lakes had not exceeded their relevant target for chlorophyll-a, then it would be possible for the lake to be considered "healthy" from a nutrient content standpoint even if it had higher levels of either Total Nitrogen (TN) or Total Phosphorous (TP). Thus, if a waterbody exceeds its chlorophyll-a target, it would be considered to have a potential nutrient problem, and its nutrient targets would thus be stricter than a lake that did not have a problem with algal biomass in the water column. Consequently, the target nutrient concentration values for Sunshine Lake and the Sunrise Waterway are a function of its level of color, its alkalinity, and whether or not the waters met or exceeded their chlorophyll-a target.

Using the data collected on all four monitoring events, the lake and waterway would be classified as a low-color and alkaline lake. Therefore, its water column algal biomass target is 20 µg chlorophyll-a / liter. Considered as a whole, for the four sampling efforts, the lake and waterway averaged well under 20 µg chlorophyll-a / liter. However, two locations exceeded 20 µg chlorophyll-a / liter in January 2016. Those two stations were located in the middle reach and the southern portion, respectively, of the Sunrise Waterway. Those two stations did not exceed 20 µg chlorophyll-a / liter in subsequent sampling events in April and July of 2016.

Based on these findings, and based on both a regulatory and weight of evidence approach, the appropriate water quality standards for nutrients for Sunshine Lake and the Sunrise Waterway are 0.09 and 1.91 mg / liter for TP and TN, respectively. Data will be compared to these standards (20 µg chlorophyll-a / liter, 0.09 mg TP / liter, and 1.91 mg TN / liter) in the graphics displayed below.

As shown in Figure 4, levels of chlorophyll-a were below the NNC criteria of 20 µg / liter on most occasions and at most locations.

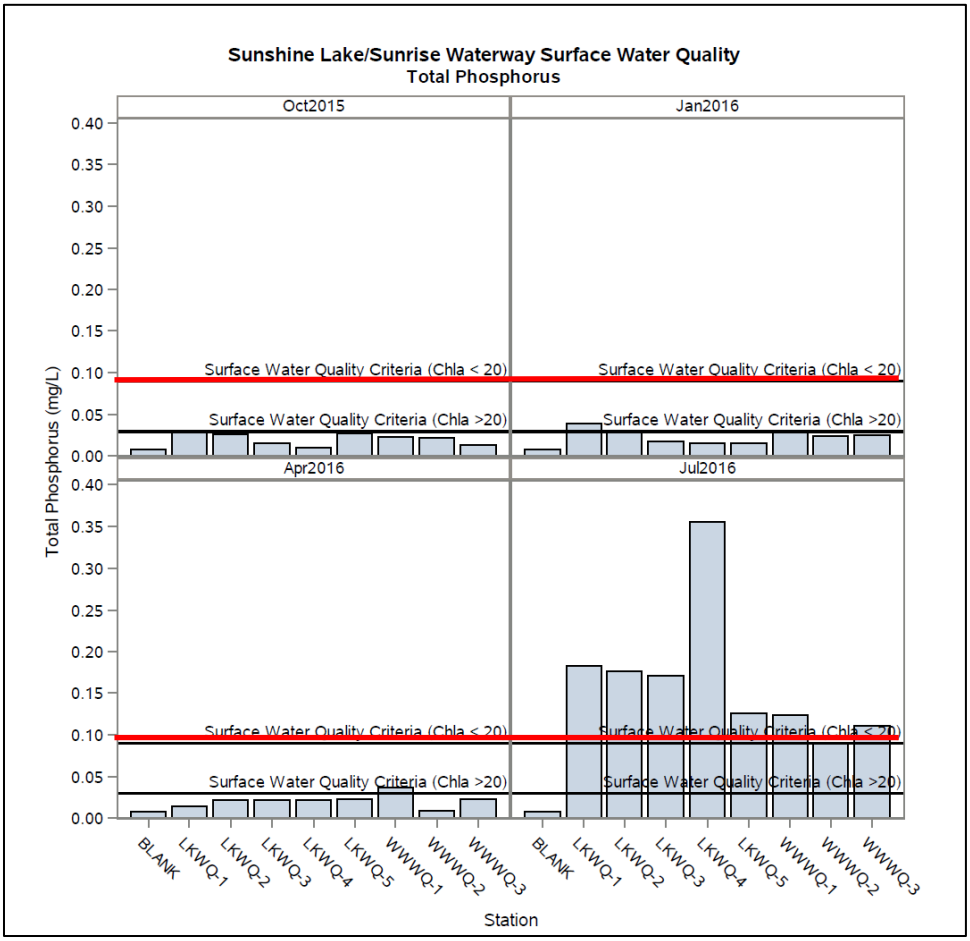
Figure 4 – Chlorophyll-a concentrations (µg / liter) for each station for each sampling period. For sampling locations, see Figure 1. The relevant NNC criterion for chlorophyll-a (20 µg / liter) is shown in red.



Of the 32 data points shown in Figure 4 (8 stations visited 4 times) only two stations exceeded the NNC criteria of 20 µg chlorophyll-a / liter, and even then only on one occasion (January 2016). Those two stations are located in the mid and lower portions of the Sunrise Waterway, and subsequent values at these two sites did not exceed 20 µg chlorophyll-a / liter. The State of Florida's water quality standards (FAC 62-302.531) require a year's worth of data collection to determine if a waterbody is "impaired" and it requires the years' worth of water quality to be collected in one calendar year. The data shown in Figure 4 (which extends over two calendar years) nonetheless can be interpreted (with caution) using the same methodology. The results in Figure 4 show that only 2 of 32 samples exceeded the 20 µg chlorophyll-a / liter NNC criteria; this degree of exceedance (6.25 percent of values) is below the threshold that would be required to be considered impaired. As such, the water quality data displayed in Figure 4 can be interpreted as indicating that Sunshine Lake and the Sunrise Waterway, considered together, would not be considered impaired for the eutrophication indicator of chlorophyll-a. As water quality data indicate that the lake and waterway are not impaired for chlorophyll-a, the relevant nutrient targets are 0.09 mg TP / liter, and 1.91 mg TN / liter.

Results from the phosphorous sampling are shown in Figure 5.

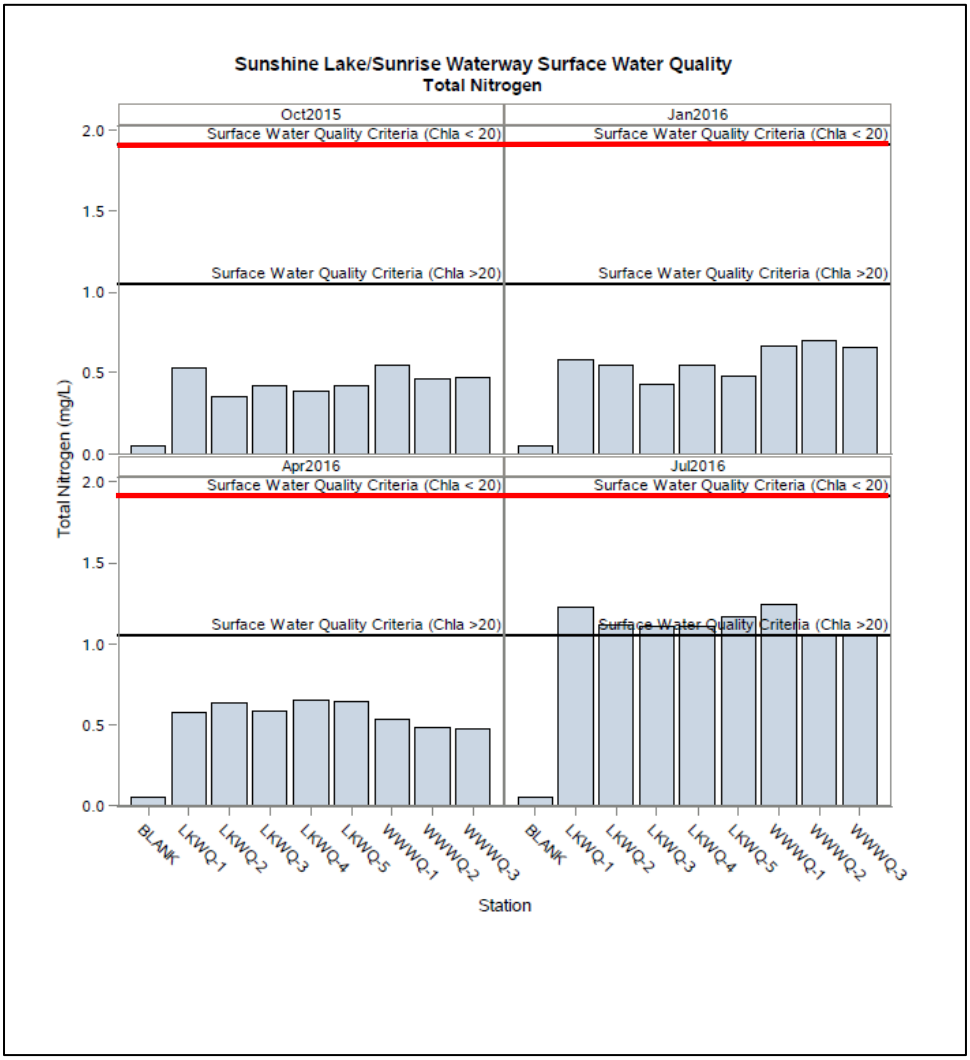
Figure 5 – Total Phosphorous concentrations (mg TP / liter) for each station for each sampling period. For sampling locations, see Figure 1. The relevant NNC criterion for phosphorous (0.09 mg TP / liter) is shown in red.



Based on the low exceedance rate of the 20 µg chlorophyll-a / liter NNC criteria, Sunshine Lake and the Sunrise Waterway would be considered to be impaired for phosphorous only if TP concentrations exceeded 0.09 mg TP / liter, and if values exceeded that threshold value on a frequent enough basis. In the first three sampling events, phosphorous concentrations never exceeded 0.09 mg TP / liter, and more often than not fell below the lower TP criteria set for water bodies that also would have exceeded the chlorophyll-a criterion. However, results in July 2016 show that all stations exceeded the relevant phosphorous concentration of 0.09 mg TP / liter. With all locations exceeding the NNC criterion for phosphorous in July 2016, the percentage of total values exceeding NNC criteria thus exceeded 25 percent of all samples collected; this frequency of impairment exceeds guidance in FAC 62-302.531. Consequently, the results shown in Figure 5 indicate that Sunshine Lake and the Sunrise Waterway would be considered impaired for phosphorous. Importantly, if the number of chlorophyll-a values that exceeded 20 µg chlorophyll-a / liter increased from 2 samples to 4 samples, then the frequency of exceedance for chlorophyll-a would be determined to be sufficiently high that the lower, more restrictive targets for TP would apply. In that case, the lake and waterway would likely be impaired as well, but with a TP target much harder to achieve to meet NNC criteria.

Results from the nitrogen sampling are shown in Figure 6.

Figure 6 – Total Nitrogen concentrations (mg TN / liter) for each station for each sampling period. For sampling locations, see Figure 1. The relevant NNC criterion for nitrogen (1.91 mg TN / liter) is shown in red.



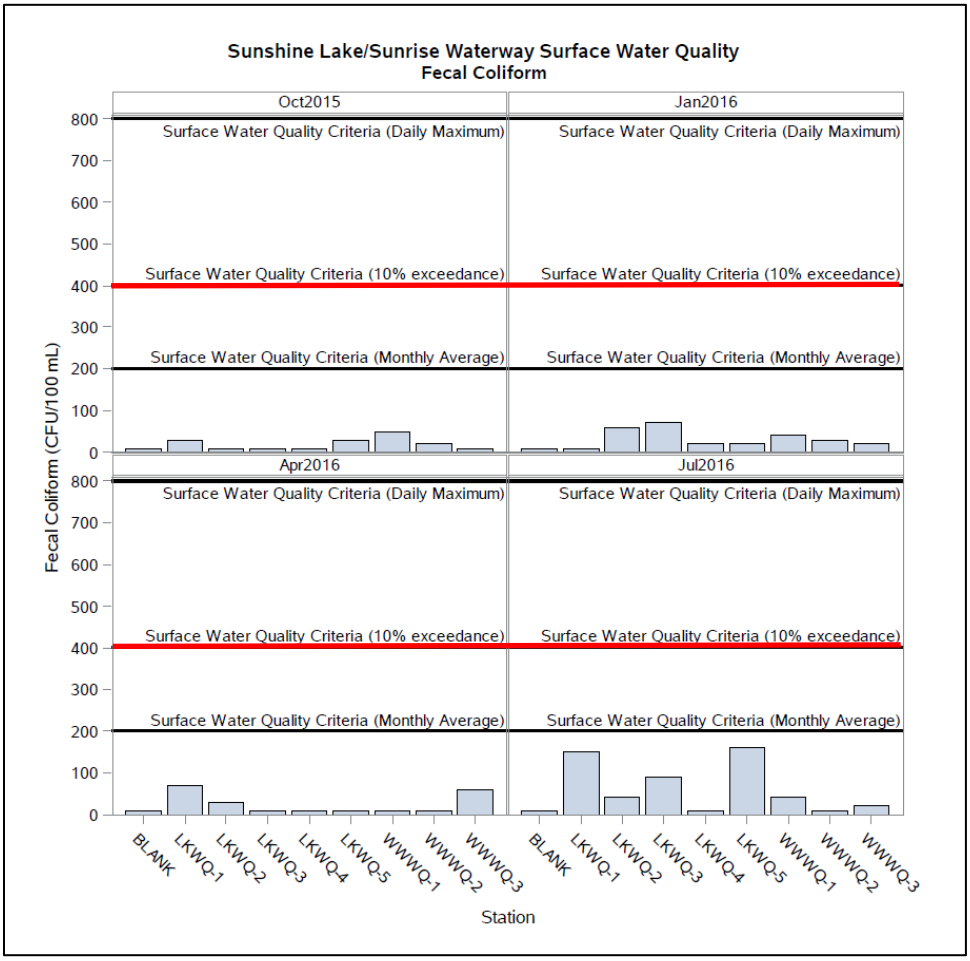
Based on the non-exceedance of the 20 µg chlorophyll-a / liter NNC criteria, Sunshine Lake and the Sunrise Waterway would be considered to be impaired for nitrogen only if TN concentrations exceeded 1.91 mg TN / liter, and if values exceeded that threshold value at a frequent enough basis. None of the values shown in Figure 6 exceeded 1.91 mg TN / liter, and in the first three sampling events, nitrogen concentrations never exceeded the more restrictive criteria imposed with an exceedance of 20 µg chlorophyll-a / liter. However, it should be noted that TN concentrations were elevated in July 2016, just as they were for phosphorous. However, results shown in Figure 6 show that for nitrogen, Sunshine Lake and the Sunrise Waterway would not be considered "impaired" for nitrogen. As was the case for phosphorous, if the number of chlorophyll-a values that exceeded 20 µg chlorophyll-a / liter increased from 2 samples to 4 samples, then the frequency of exceedance for chlorophyll-a would be determined to be sufficiently high that the lower, more restrictive targets for TN would apply. In that case, the lake and waterway would likely be impaired for TN, which is not currently the situation.

Water Quality – Bacteria

Water quality criteria for bacteria have varied over time in Florida. In prior years, waterbodies were compared to criteria for both "total" and "fecal" coliform bacteria. Over time, FDEP had dropped the criterion for total coliform bacteria, and had focused on fecal coliform bacteria. Recently, FDEP has adopted further changes in criteria such that Class III freshwater water bodies will now be determined to be impaired based on the abundance of *E. coli* bacteria. The use of *E. coli* is based on findings that even "fecal" coliform bacteria are not specific to humans as a source. In fact, a recent study conducted for Charlotte County determined that decomposing grass clippings appear to be the dominant source of "fecal" coliform bacteria in stormwater runoff to Sunshine Lake and the Sunrise Waterway (Atkins and ESA 2015).

When the water quality monitoring program for Sunshine Lake and the Sunrise Waterway was initiated, the appropriate criterion for tracking pathogens was that of fecal coliform bacteria. The criterion for fecal coliform bacteria concentrations varies as a function of the number of samples in a month. The "never to exceed" value for fecal coliform bacteria is 800 colony forming units (cfu) / 100 ml. If 10 or more samples are collected in a month, the geometric mean of those samples should not exceed 200 cfu / 100 ml, and no more than 10 percent of samples should exceed 400 cfu / 100 ml. Since most water quality sampling programs do not sample 10 times per month (nor does this program) FDEP has determined impairment based on the 10 percent exceedance threshold. Therefore the appropriate threshold value used to determine the degree of impairment for bacteria in the lake and waterway is that of 400 cfu of fecal coliform bacteria / 100 ml (Figure 7).

Figure 7 – Fecal coliform bacteria concentrations (cfu / 100 ml) for each station for each sampling period. For sampling locations, see Figure 1. The relevant criterion for fecal coliform bacteria (400 cfu / 100 ml) is shown in red.



Fecal coliform bacteria levels in the lake and waterway were consistently below the regulatory standard of 400 colony forming units (cfu) per 100 ml (Figure 7). As such, the bacteriological status of the lake and waterway would be classified as unimpaired even though levels of bacteria in stormwater runoff itself can be very high.

Benthic Assessment

An assessment of the amount of algae in the lake and waterway was conducted on four occasions (October 2015, January 2016, April 2016 and July 2016) at the 50 randomly selected sites shown in Figure 2. On each occasion, the amount of the water column occupied by the algae was assessed by determining the difference between the depth of water at a given location and the depth from the surface of the lake to the top of any algal bed or mat. Figures 8 through 11 display the data in terms of the percent of the water column occupied by *Chara* at each station in Sunshine Lake for each sampling period. Figures 12 through 15 display the data in terms of the percent of the water column occupied by *Chara* at each station in the Sunrise Waterway for each sampling period. For locations with "0" percent of the water column occupied, no algae were found. While *Chara* is in fact a type of algae, it has good habitat value, is a Florida native plant, and it serves as an "alternative destination" for nutrients; nutrients assimilated by *Chara* are not directly available to fuel a phytoplankton bloom or a return of the former cyanobacteria bloom that was found in the lake.

Figure 8 – Abundance of algae (*Chara* sp.) found in Sunshine Lake in October 2015. See legend for interpreting points in terms of the percentage of the water column occupied.

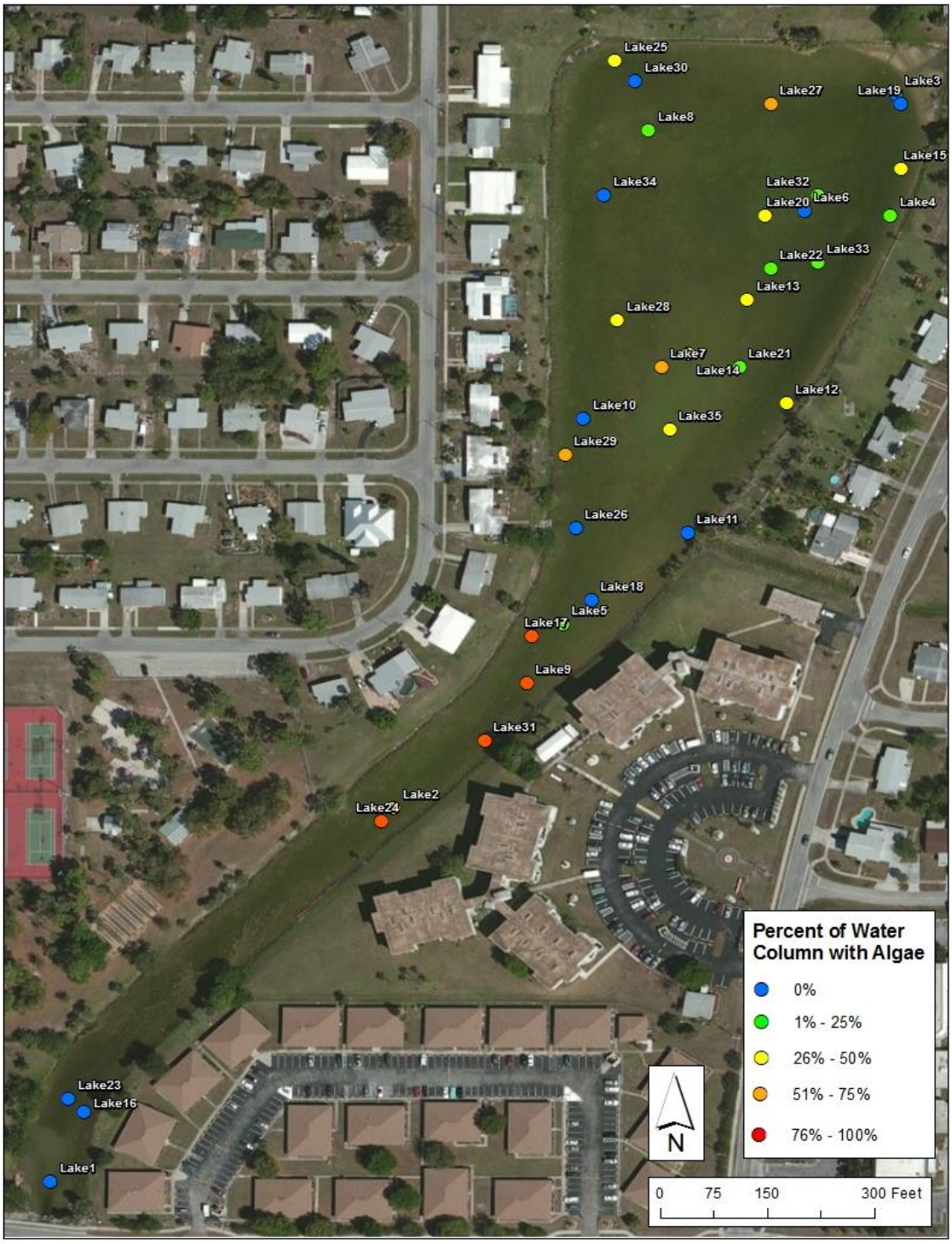


Figure 9 – Abundance of algae (*Chara* sp.) found in Sunshine Lake in January 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

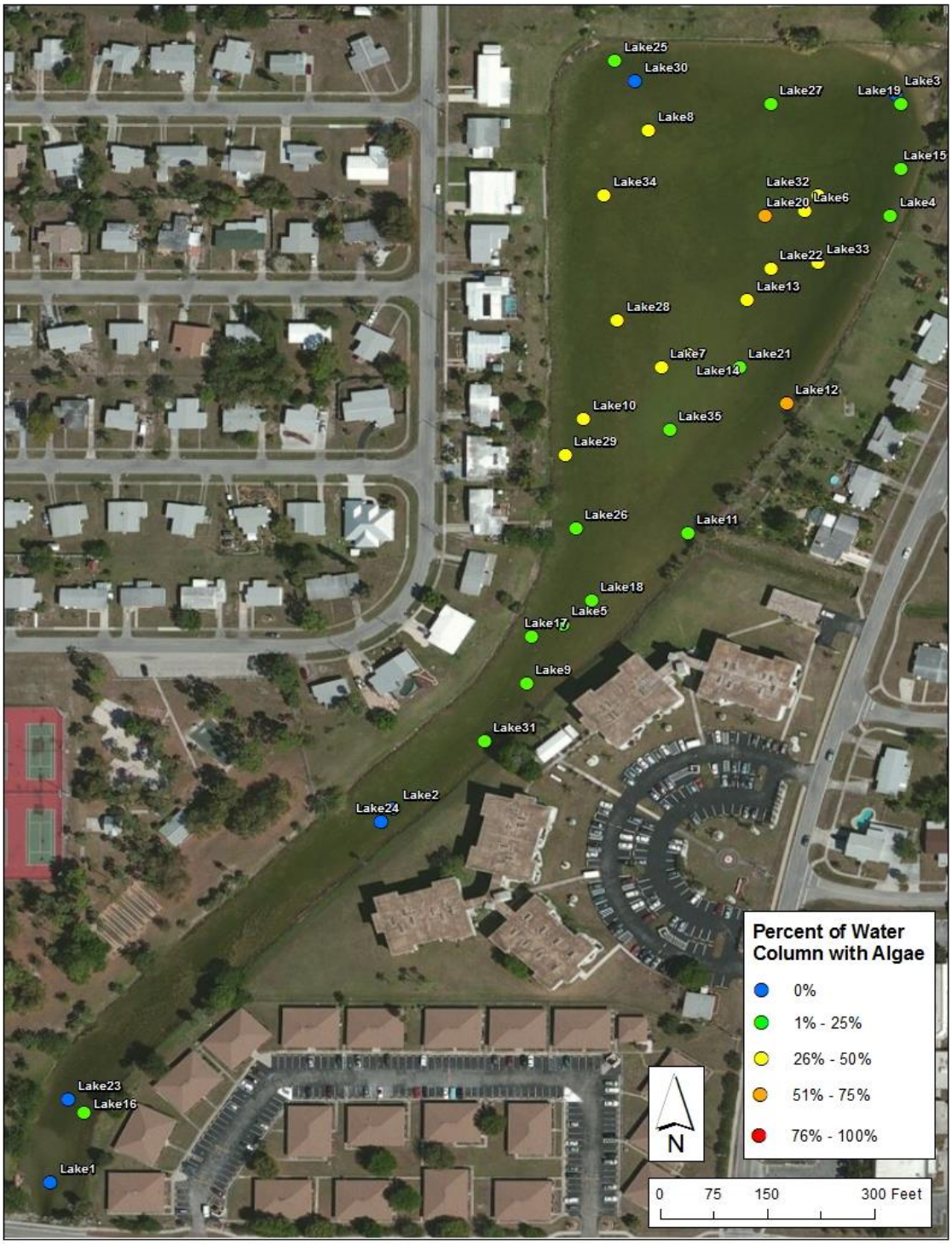


Figure 10 – Abundance of algae (*Chara* sp.) found in Sunshine Lake in April 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

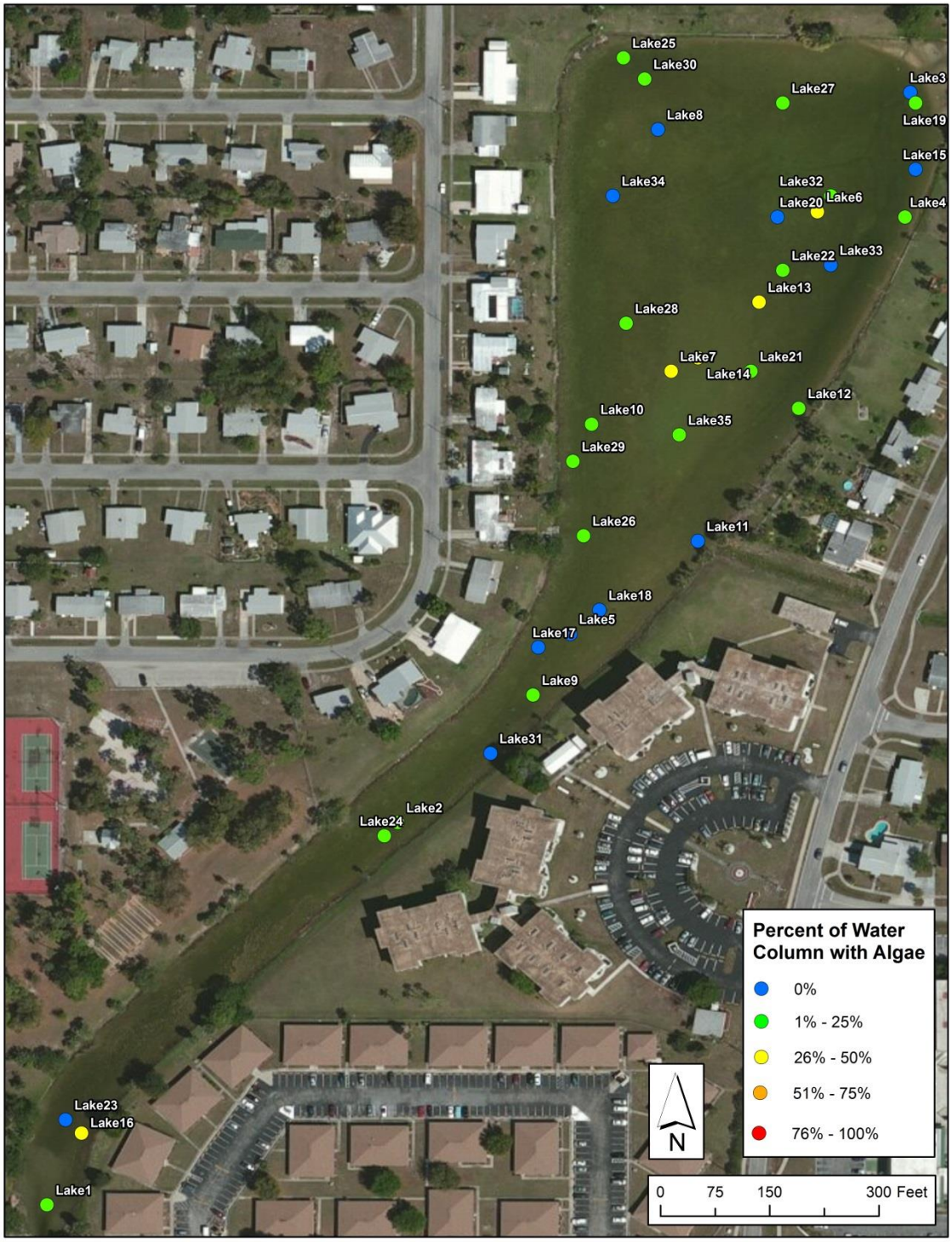


Figure 11 – Abundance of algae (*Chara* sp.) found in Sunshine Lake in July 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

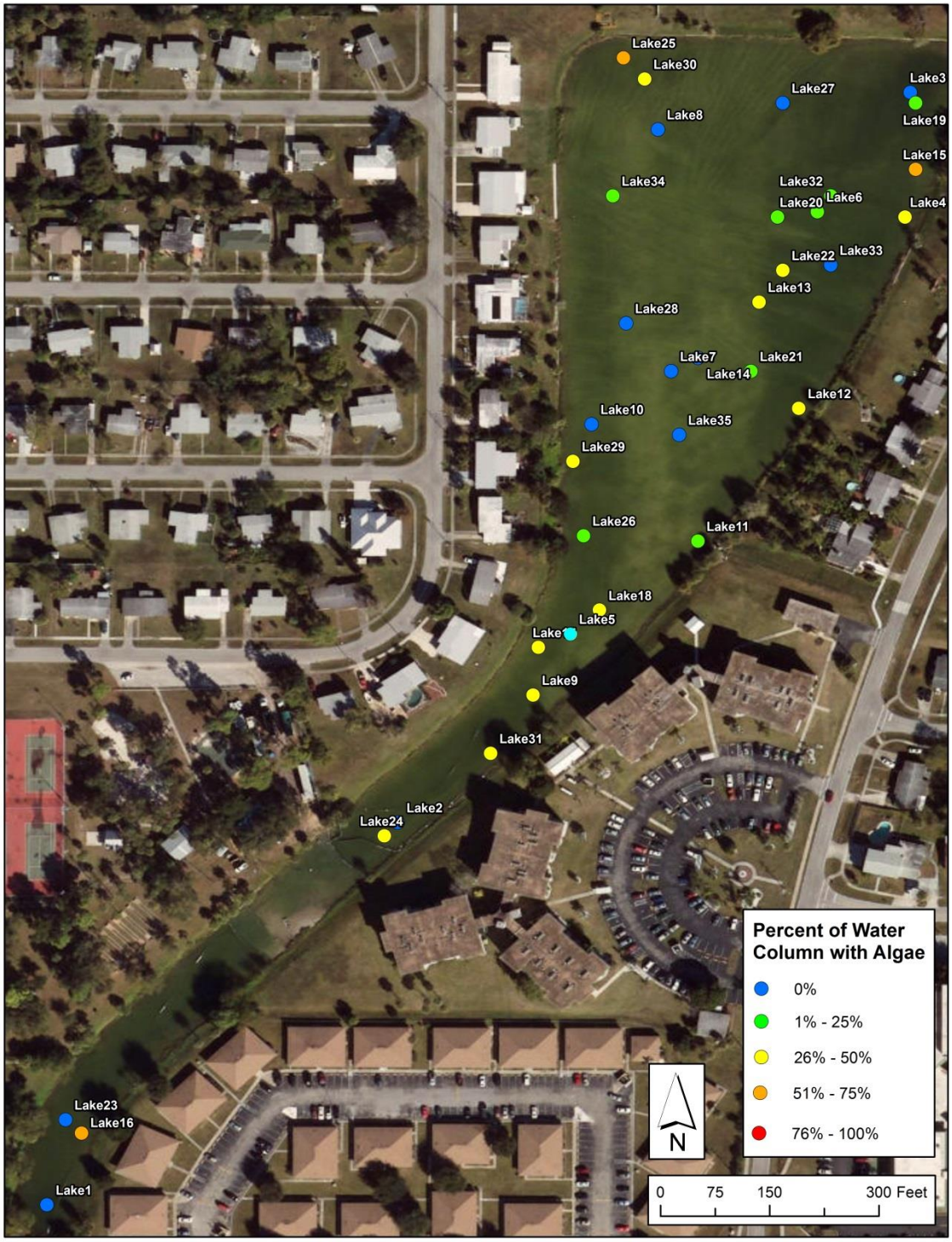


Figure 12 – Abundance of algae (*Chara* sp.) found in the Sunrise Waterway in October 2015. See legend for interpreting points in terms of the percentage of the water column occupied.

Figure 13 – Abundance of algae (*Chara* sp.) found in the Sunrise Waterway January 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

Figure 14 – Abundance of algae (*Chara* sp.) found in the Sunrise Waterway April 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

Figure 15 – Abundance of algae (*Chara* sp.) found in the Sunrise Waterway July 2016. See legend for interpreting points in terms of the percentage of the water column occupied.

If, as an example,one considers areas with between 75 to 100 percent of the water column occupied by *Chara* as being "infested" with *Chara*, then in October of 2015, approximately 11 percent of Sunshine Lake (4 of 35 stations) would have been considered to be infested. In subsequent sampling, none of the stations in the lake itself would be considered infested with *Chara*. Instead, where *Chara* was found, it typically only occupied between 25 to 50 percent of the water column.

In the Sunrise Waterway, fully a third of the system (5 of 35 stations) would be classified as "infested" with *Chara* in October 2015, at stations located throughout the waterway. By April and July of 2016, only one or two stations had *Chara* occupying more than 75 percent of the water column, and those stations were limited to the lowest (farthest south) portions of the waterway.

Results from the benthic monitoring program are summarized for both the lake and waterway in Table 1.

Table 1 – Average water depth (feet), algal coverage (percent of bottom) and algal abundance (percent of water column) for all dates for both Sunshine Lake and the Sunrise Waterway.

Date	Water depth (feet)		Percent of bottom with algae present		Percent of water column occupied by algae	
	Lake	Waterway	Lake	Waterway	Lake	Waterway
October 2015	4.1	3.8	65.7	86.7	28.0	63.1
January 2016	4.9	4.8	82.9	73.3	20.1	29.7
April 2016	4.8	4.8	65.7	73.3	13.0	21.6
July 2016	5.0	4.9	65.7	46.7	22.1	29.6

The water depth in both Sunshine Lake and the Sunrise Waterway appears to have increased by about 0.8 to 1.0 foot, respectively, sometime between October 2015 and January 2016, with water levels maintained at higher and stable values since January 2016. The maintenance of a higher lake level was recommended in the Water Quality Management Plan for Sunshine Lake and the Sunrise Waterway (Atkins and ESA 2014) based on prior studies that typically found water quality was often degraded with low water level conditions. The sustained increase in lake levels would suggest that the combination of modifications of water levels and the use of three wells to maintain a higher lake level in the dry season have likely combined to raise and maintain lake levels; these efforts should continue.

The coverage of algae, as quantified as the percent of the lake bottom where *Chara* was found, increased in the lake from October 2015 to January 2016, but then declined to identical percentages (equal to 23 out of 35 stations) in April and July of 2016. In the waterway, there was a general pattern of decline in the coverage of *Chara* over time, from 86.7 percent in October 2015 down to 46.7 percent in July 2016.

The percentage of the water column of Sunshine Lake occupied by *Chara* declined from October 2015 to April 2016, with a subsequent increase in July 2016. However, the amount of the water column occupied by *Chara* was lower in July 2016 than in October 2015. The magnitude of decline in the amount of water occupied by *Chara* in the lake is similar to that which would be expected due to the increase in water depth alone. Since the occurrence of *Chara* in the lake did not change between October 2015 and July 2016, it could be that the decline in the abundance of *Chara* in the lake varied mostly as a function of increased water levels, rather than diminished biomass.

In the Sunrise Waterway, both the occurrence and the abundance of *Chara* decreased between October 2015 and July 2016. However, results from July 2016 suggest that *Chara* became less common, but denser when found, compared to what was found in April 2016. The reduction in occurrence and abundance of *Chara* in the

waterway is of a greater magnitude than the increase in water depth, suggesting that the abundance of *Chara* in the waterway varied by more than that which could be explained by increased water levels alone.

Discussion

In terms of regulatory criteria, it should be kept in mind that FDEP's techniques for assessing water quality are compiled on a calendar-year basis. Although the data presented in this report are from four sampling events separated by three-month intervals, only three of the four events occurred within the same calendar year. Nonetheless, the results shown here are likely very similar to what would be expected with four sampling events within the same calendar year.

Based on the results obtained from the four sampling events, Sunshine Lake and the Sunrise Waterway would not be considered "impaired" for either chlorophyll-a or total nitrogen, using guidance in FAC 62-302.531. However the lake and waterway would likely be determined to be impaired for phosphorous, based on elevated levels in July 2016. While it is not exactly known why phosphorous concentrations were elevated in July 2016, those results came from the only sampling event that occurred during Southwest Florida's typical wet season of mid-June to September. Other sampling events occurred during dryer months of the year, on average.

The Water Quality Management Plan for the lake and waterway (Atkins and ESA 2014) found very high levels of phosphorus in stormwater runoff in the watershed, which was attributed to a natural occurrence of phosphorus-rich geologic formations. As such, the finding that the lake exceeded NNC guidance for phosphorous in the wet season should come as no surprise, and is suggestive of the need for Charlotte County to continue to monitor and actively manage the lake and waterway to ensure they do not return to the highly-impacted and algae-filled systems they were prior to the County's dredging project.

Although very high levels of fecal coliform bacteria are found in stormwater runoff into the lake (Atkins and ESA 2014) a follow-up study found that most of those "fecal" coliform bacteria were likely associated with the decomposition of grass clippings, rather than human sewage or pet waste (Atkins and ESA 2015). Despite the high levels of fecal coliform bacteria that have been found in stormwater runoff in the watershed, the lake and waterway would not be classified as impaired for fecal coliform bacteria. FDEP's recent adoption of the use of *E. coli* as the bacteriological indicator of choice should not result in any future determination of impairment, as *E. coli* bacteria are a sub-set of fecal coliform bacteria, and the relevant guidance criteria are similar between fecal coliform bacteria (400 cfu / 100 ml) and *E. coli* (410 cfu / 100 ml).

If one considers *Chara* to be a nuisance when it occupies more than 75 percent of the water column, then the level of nuisance algae has declined from roughly a tenth of Sunshine Lake in October 2015 to none of the lake in July 2016. While the overall amount of the water column occupied by *Chara* has decreased by just over 20 percent over that time, the portion of the lake that has "topped out" with algae has been effectively eliminated. The reduction in the abundance of *Chara* in the lake has likely decreased due to three factors: 1) the increase in the lake level that occurred between October 2015 and January 2016, 2) the *Chara* harvesting program that was undertaken in and around April 2016, and 3) the implementation of whole-lake circulation (aka "Solar Bees") that took place between April and July of 2016. Further, the increase in water levels in Sunshine Lake and the Sunrise Waterway are most likely associated not only with changes in the outfall structures at Gertrude Avenue and North Tamiami Trail, but with supplementation of lake levels via groundwater wells located along the lake, which were designed to maintain a higher lake level during Southwest Florida's typical 8 to 9 month dry season.

The finding that *Chara* was not completely eradicated from the lake and waterway should not be a surprise, nor should it be an objective of the County in its management actions. As noted above, and first documented in the Water Management Plan (Atkins and ESA 2014) phosphorous levels in stormwater runoff from the watershed will likely continue to be elevated for years to come, as they represent elevated concentrations from a naturally phosphorous-rich geology, rather than an anthropogenic activity that can be shut down or minimized. As long as

it rains, it is likely that stormwater runoff into Sunshine Lake and the Sunrise Waterway will continue to contain elevated phosphorus concentrations.

As phosphorus concentrations in stormwater runoff are not likely to decrease over time, the challenge for managing Sunshine Lake and the Sunrise Waterway will be influencing the "destination" of those incoming nutrient loads. Prior to the County's dredging efforts, incoming phosphorous loads likely allowed for the proliferation of the cyanobacteria bloom that was found associated with the bottom of the lake, and which had previously occupied approximately 50 percent of the lake's volume (Atkins 2012). None of the four monitoring efforts found evidence of the recurrence of the former cyanobacteria bloom.

In most lakes in Florida, a similarly elevated phosphorous load would likely give rise to a bloom of floating microscopic algae termed phytoplankton. Elevated levels of phytoplankton are quantified by the parameter chlorophyll-a. Since neither Sunshine Lake nor the Sunrise Waterway are impaired for chlorophyll-a, incoming nutrient loads do not appear to be causing a bloom of phytoplankton.

Instead, it appears that a significant amount of incoming phosphorous loads are contained within the biomass of *Chara* found in the lake and waterway. In many locations in Florida, the default response to the amount of *Chara* would involve "controlling" the vegetation through the application of herbicides. However, this has often been associated with "flipping" a lake from a clear lake with macrophytes (aka "large plants") to one with no macrophytes but with a newly-created phytoplankton bloom (e.g., Atkins and ESA 2016). Instead, a management program focused on controlling the abundance of *Chara* without the expectation of eliminating it is warranted. The County should seek to pursue funding sources from FDEP and/or the Southwest Florida Water Management District that could be used to continue to manage the effects of incoming nutrient loads by physically harvesting *Chara* biomass from the lake and waterway, rather than relying on stormwater treatment ponds and/or herbicide applications.

Conclusions and Recommendations

While performing the water quality and benthic sampling whose results are presented here, researchers on the lake often are in fairly close proximity to lakeside residents. We have not similarly encountered waterfront residents along the Sunrise Waterway. On many occasions, local residents have spoken out about how much better the lake looks to them, and often these residents have stated their gratitude that the County's efforts to restore the lake had been so successful.

To continue to successfully manage the lake, we would encourage the County to continue to adhere to the main recommendations of the Water Quality Management Plan (Atkins and ESA 2014). These recommendations, which have been implemented already, include the following:

- Raising the lake level, and maintaining a higher lake level in the dry season through the use of supplementing the lake and waterway through the use of groundwater from deeper, less nutrient-rich waters of the surficial aquifer
- Physical harvesting of *Chara* from the lake on an annual to bi-annual basis, rather than controlling macrophyte abundance via the application of herbicides
- Increasing whole-lake circulation and likely enhancing phosphorous sequestration in oxygenated bottom waters through the use of SolarBee or similar systems
- Continued monitoring of water quality and benthic communities in Sunshine Lake and the Sunrise Waterway to ensure that ongoing management actions continue to be successful

There is no question that the lake and waterway are healthier and more aesthetically appealing than was the case several years ago. The improvement has not only been documented both here and in earlier reports, as well as noted by lakeside residents. The County should continue ongoing efforts to manage and monitor the lake and

waterway, as the actions to date appear to be working successfully to restore this previously highly-degraded eyesore into a neighborhood amenity.

Literature Cited

Atkins. 2012. Sunshine Lake / Sunrise Waterway Study. Final Report to Charlotte County. 33 pp.

Atkins and ESA. 2014. Sunshine Lake/Sunrise Waterway Water Quality Management Plan. Final Report to Charlotte County. 60 pp.

Atkins and ESA. 2015. Bacteria Source Identification for Sunshine Lake and the Sunrise Waterway. Final Report to Charlotte County. 12 pp.

Before…

After…