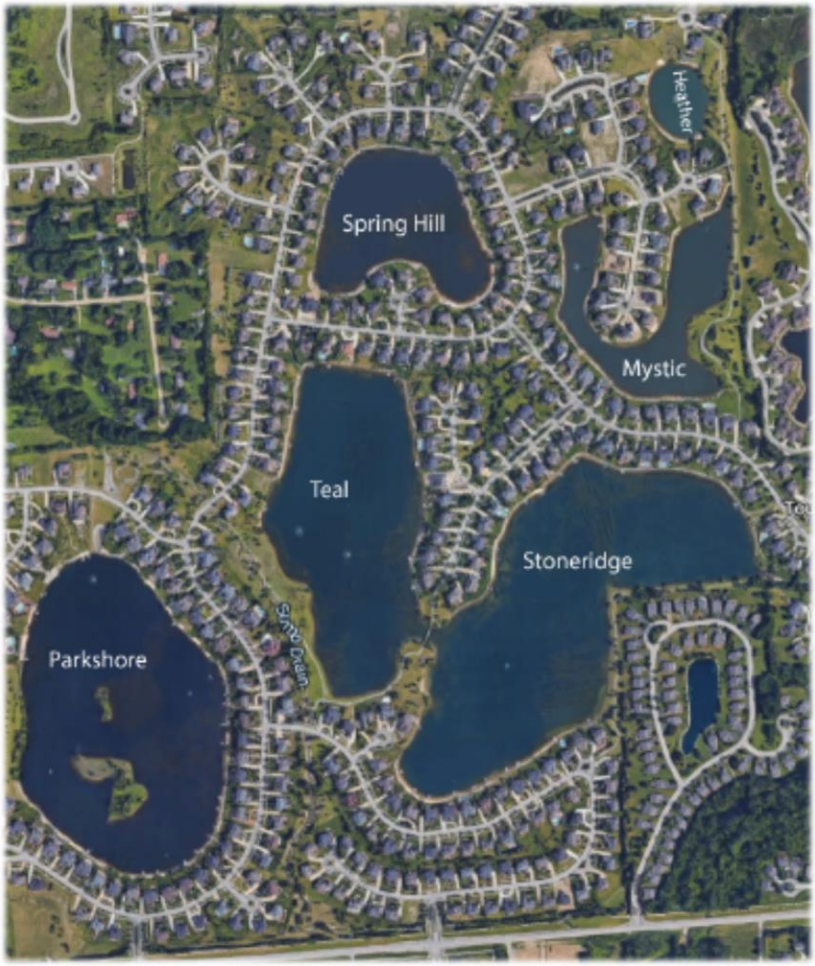

Stonewater Lakes

Lake Management Plan 2023 Update

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Lake Management Plan Update

Introduction

Purpose of the Update

This management plan includes updates on the bathymetric survey, vegetation survey, water quality monitoring, and document management activities to date during the 2023 season. This data helps us to better examine the current conditions in the lake and provide management recommendations for future years. The plan will detail an integrated approach to lake management activities including, but not limited to exotic weed control, water quality monitoring, and aquatic vegetation surveying.

Characteristics of the lake

Stonewater Lakes consists of 6 lakes totaling an area of 112 acres located in Wayne County, Northville Township, Michigan. There is no public access site on the lake, but the Association provides a launch site for residents. The area the lakes now encompass was originally established as a sand and gravel mining area following World War 2 by the Starkweather Family. In 1999, mining operations transferred to Stonewater L.L.C., and the development of the subdivision was started. In the early stages of development, the lake bottom was comprised of fine sand and small filtered gravel. As the lake has aged, the accumulation of organic sediment and the effects of residential development have contributed to increased aquatic plant growth. Currently, rooted vegetation is moderately dense in areas of the shoreline with a fair amount of diversity of submerged aquatic plants. Aquatic vegetation is also found at a medium density along drop-off areas and shallow flats. The lake continues to experience changes in aquatic plant species and density as conditions for aquatic plant growth change.

Limnology

Limnology is the study of freshwater lake ecosystems. This is affected by a variety of factors including chemical, biological, physical, and geological properties. The main goal of any Limnologist is to understand these factors to help better evaluate the aquatic environment.

Management Goals for Stonewater Lakes

- The primary goal of aquatic plant management in Stonewater Lakes is the control of exotic aquatic plants. The exotic plant species, Curly Leaf Pondweed and Starry Stonewort, should be controlled throughout Mystic, Teal, Stoneridge, and Parkshore Lakes. The abundance of these species should be reduced to the maximum extent possible, and efforts should be made to reduce their recovery after treatment.
- Aquatic plant management should preserve species diversity and cover of native plants sufficient to provide habitat for fish and other aquatic organisms. Native plants should be managed to encourage plant growth that supports the Stonewater Lake fishery (by creating structure and habitat) provided that they do not excessively interfere with recreational uses of the lake (e.g., swimming and fishing) in high-use areas. Where they must be managed, management techniques that reduce the stature of native plants without killing them (e.g., harvesting, contact herbicides) should be used whenever possible. Specific areas should be set aside where native plants will not be managed, to provide habitat for fish and other aquatic organisms. Muskgrass (*Chara*) should be allowed to grow throughout the lake, except where it grows so tall as to interfere with boating and swimming.

- The species Starry stonewort, should be actively controlled and managed. Starry stonewort is in the same family as Muskgrass (Chara) but is considered to be an exotic invasive species. Starry stonewort, which looks very similar to the beneficial species Chara, is appearing in more and more lakes. Chara is a highly desired plant because it is typically low growing, keeps the water clear, and can slow down the invasion of exotic weed species. Starry stonewort also forms dense mats, but unlike Chara, it can grow from 5 to 7 feet tall. Starry stonewort can be very detrimental to a lake's ecosystem and has the ability to kill off native plants and have a negative impact on a lake's fisheries.

- The differences between Muskgrass (Chara) and Starry Stonewort are very subtle. In the photos below the two can also be differeniated by noticing the rough edges of the Muskgrass (Chara) as compared the the relatively smooth large mass of Starry. In addition, Starry tends to prefer cooler water temperatures and will tend to grow in deeper areas or along the 5 -10 ft contour, whereas Chara tends to grow near shore in waters 0-5 feet. Another way to differentiate between the two is referred to as the pop test. This is done by holding a sample in your palm and making a fist. If the material in your hand pops it is more than likely Starry Stonewort and if not it is Muskgrass. During this test, you can also notice a very distinct musky smell if the material is Muskgrass.

Muskgrass (Chara)

Starry Stonewort

- The invasive terrestrial plants, Purple loosestrife, and Phragmites should be controlled along the shoreline and adjacent wetlands where present. Both species are exotic and have the ability to displace beneficial native vegetation. Purple loosestrife grows 2 -4 feet tall and is a vibrant magenta color. It is very aggressive and can quickly become the dominant wetland vegetation. Phragmites (common reed) is a wetland grass that ranges in height from 6 to 15 feet tall. "Phrag" quickly becomes the dominant feature in aquatic ecosystems, aggressively invading shorelines, wetlands, and ditches. This plant creates dense "stands" - walls of weeds crowding out beneficial native wetland vegetation and indigenous waterfowl habitats. Spreading by fragmentation and an extensive root system, Phragmites ultimately out-compete native plant life for sun, water, and nutrients.

Phragmites

- Phragmites presence has been noted in the vicinity of Mystic Lake, Heather Pond, and the western shore of Parkshore. In efforts to address this issue, a treatment was administered this autumn using a product known as Aqua Neat, which contains glyphosate. This systemic herbicide is designed to be absorbed into the tuber structure of the Phragmites. Generally, successful containment of Phragmites and prevention of further spread can be achieved with 1-2 years of treatment.

- Conditions in Stonewater Lakes should not be allowed to deteriorate below present levels. Expansion of exotic aquatic plant problems should trigger an adjustment in the aquatic vegetation management strategy. To support such responses, an annual record of vegetation and management should be maintained.
- Preventative measures that protect the lake from further nutrient enrichment should be identified and implemented.

Lake Management Activities Conducted in 2023

Water Quality

Water quality in the lake was evaluated on March 28th & Sept. 5th, 2023. A depth profile of water temperature and dissolved oxygen concentrations was measured at one-meter intervals and the Secchi disk depth was measured in the deepest part of the lake (Deep Hole Site). Lake Check analysis was collected from the deep part of the lake. Spring samples are pulled from the top layer of the lake whereas fall samples are pulled from the bottom meter of each sampling location. Lake Check measures conductivity, total dissolved solids, pH, alkalinity, total phosphorus, soluble reactive phosphorus, nitrates, and ammonia. A complete water quality report is attached to the back of this report for each separate sampling period.

Planning/Evaluation

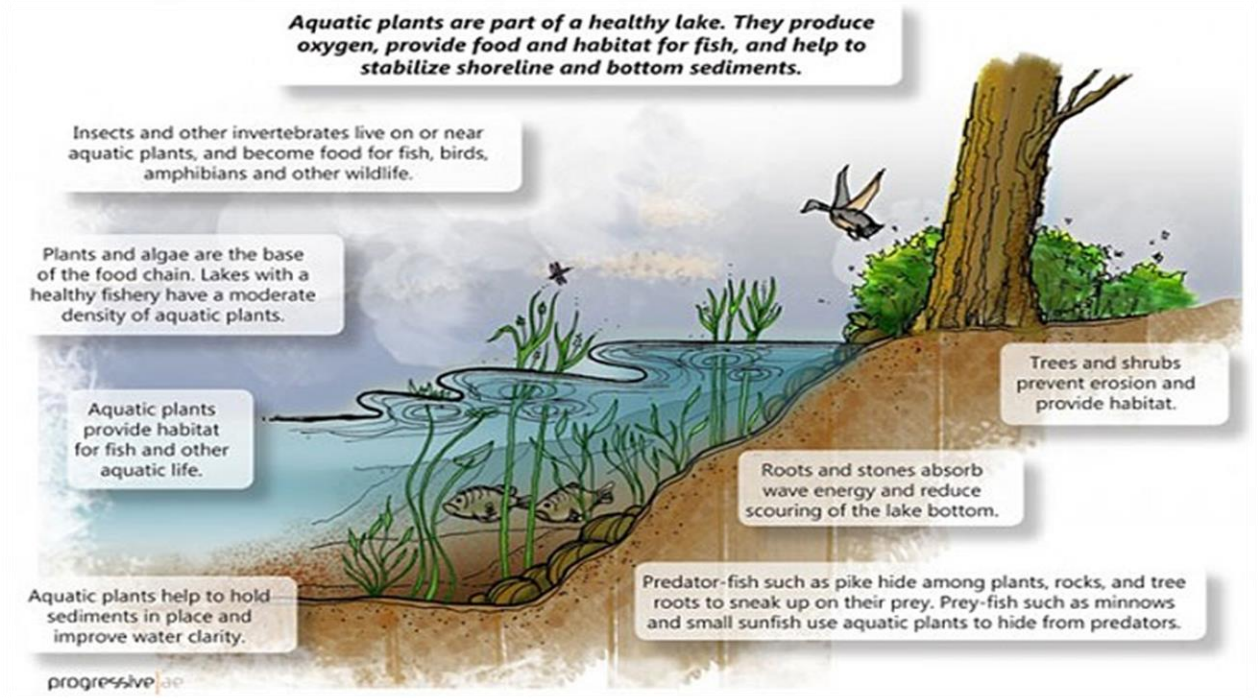
A complete survey of the aquatic vegetation of the lake was conducted on September 5, 2023. Several brief checks of the lake were also made throughout the summer. Vegetation surveys determine the locations of target and non-target plant species. The results of the surveys are used to determine the most appropriate management strategy. The vegetation surveys also document the success of the prescribed management program. An AVAS survey is the State of Michigan's method for conducting a complete aquatic vegetation survey.

The Aquatic Vegetation Assessment Site (AVAS) survey divides the parts of the lake capable of growing plants (littoral zone) into subareas and records the cover of each aquatic plant found in each "site". This method of surveying considers not only the types of plant species present in the lake but also the densities of those species. AVAS surveys are also an excellent way to track plant species trends over time. A goal of invasive plant management is to have native plants increase while exotic plants decrease over time. The success of this goal can be illustrated through the use of the AVAS data collected over several years.

Since different native plants grow at varying times throughout the season, it is important to evaluate the lake multiple times to account for *all* species in the lake. The first evaluation is typically conducted in the spring and is used to determine areas that will require treatment or management. Attached to this report is the AVAS data for all 6 waterbodies. The cumulative cover score on each report indicates the total cover of each plant species for each water body.

Aquatic Vegetation & Aquatic Plant Control

The Stonewater Lakes program in 2023 can be characterized as a relative success. Initial treatments commenced in the last week of April, followed by regular follow-ups every 2-3 weeks throughout the summer until September. Despite encountering challenges in May with a nuisance algae bloom in Mystic Lake, an unscheduled treatment effectively gained control. Furthermore, scaling back treatment in Heather Pond led to a resurgence of native plants, contributing to the suppression of troublesome oscillatoria algae, a persistent issue in recent seasons. This strategic decision to allow native plants to reclaim their space in the pond proved beneficial, minimizing the conducive environment for oscillatoria growth. Looking ahead to 2023, the program will incorporate the management of the invasive shoreline Phragmites to curtail its further proliferation. Ongoing monitoring and treatment are slated for the upcoming season, aiming to eradicate the Phragmites colony across all Stonewater Lakes.



The images provided depict the two predominant native plants in Stonewater Lakes. In the 2023 season, there was a noticeable uptick in both aquatic plants, with a particularly significant increase in Illinois pondweed. While this may pose some inconvenience for boating and swimming, these plants are indicators of a well-balanced and healthy ecosystem, providing an ideal habitat for aquatic invertebrates and fish. Treatment will persist in shoreline areas where these plants are deemed a nuisance but will be limited to ensure the delicate balance of the ecosystem is maintained.

Illinois Pondweed

Chara

Invasive Aquatic Plant Species

The year-end AVAS survey indicates the presences of Eurasian watermilfoil, curly-leaf pondweed, and Starry Stonewort. Strategic treatments spaced throughout the early part of the season successfully controlled all three species, particularly addressing the presence of curly-leaf pondweed in Mystic Lake. Notably, the aggressive treatment applied in the previous season effectively maintained a relatively low overall biomass of Starry Stonewort.

Eurasian watermilfoil made its presence known in both Mystic and Springhill, prompting a focused effort in the upcoming 2024 treatments to aggressively target milfoil. This proactive approach aims to eliminate any potential fragmentation and curb the spread of this invasive species. Recognizing the critical nature of milfoil fragmentation, the imperative to eradicate these colonies is underscored as essential for the overall health of the ecosystem.

Eurasian watermilfoil (EWM)

Curly leaf pondweed

Starry stonewort

AVAS Data & Explanation

Each lake map is divided into the parts of the lake capable of growing aquatic plants into subareas and records the cover of each aquatic plant species found in each area. The attached map shows the breakdown of each waterbody and its corresponding AVAS site. Vegetation summary sheets summarize the information from the maps in the table that tracks plant trends from year to year. Species are numbered according to a standardized numbering system with a Code Number. The cover codes A, B, C, and D are used to describe the approximate coverage of each plant within the map area, where 1-2% is A, 3-20% is B, 21-60% is C, and 61-100% is D. The example “3B” refers to Chara (Muskgrass) covering between 3 and 20 percent of the area of the lake in which this code appears. Notations on the map are interpreted as follows: Number (= plant species) Letter (=approximate cover of this plant). For example: “3B” indicates plant species #3 at a density of B. Notations of each species are recorded in the AVAS map site location (see Appendix A fig. 1). The sum of the total number of species and density in quantified as “Total cumulative cover” with a lower number indicating both lower diversity and density. For example, Mystic Lake has the lowest plant density and species resulting in the lowest score. In comparison, Parkshore, Teal, & Stoneridge's density of Starry Stonewort increases the cover by the sheer volume of Starry Stonewort present. In addition, Springhill, Heather, & Mystic have lower plant diversity compared to Teal, Stoneridge, & Parkshore. Often smaller waterbodies will have a lower diversity due to limited area of growth opportunity referred to as the “littoral zone.” Yellow-coded cells indicate an invasive species. The below table list all common plant species observed within each waterbody during the 2023 AVAS.

Mystic Lake

Plant Name	Percent Cover
Eurasian watermilfoil	0.43
Chara	8.78
Illinois Pondweed	12.78
American Pondweed	0.04
Floating leaf	0.61
Water stargrass	0.87
Wild Celery	0.09
Bulrush	5.00
Purple loosestrife	0.09
Phragmites	1.52
Total Cumulative Cover	30.22

Parkshore

Plant Name	Percent Cover
Chara	21.90
Illinois Pondweed	31.48
Largeleaf Pondweed	2.38
American Pondweed	0.05
Wild Celery	0.52
Coontail	8.67
Bulrush	0.52
Purple loosestrife	0.19
Phragmites	14.29
Total Cumulative Cover	70.00

Springhill Lake

Plant Name	Percent Cover
Eurasian watermilfoil	0.63
Curly leaf Pondweed	1.25
Chara	12.50
Illinois Pondweed	8.31
American Pondweed	0.25
Floating leaf	0.63
Wild Celery	05.00
Coontail	3.94
Sago Pondweed	0.06
Cattail	0.06
Bulrush	1.63
Phragmites	0.88
Total Cumulative Cover	35.13

Stoneridge Lake

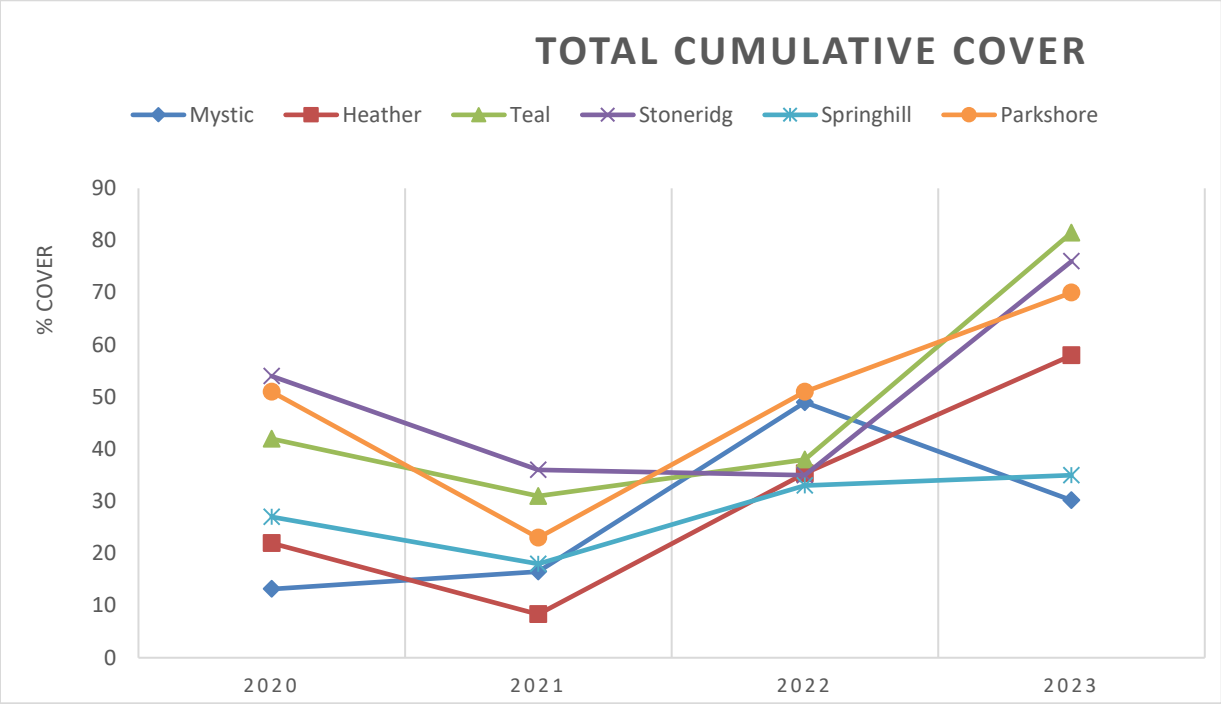
Plant Name	Percent Cover
Chara	35.93
Illinois Pondweed	26.78
Wild Celery	12.74
Starry Stonewort	1.11
Sago Pondweed	0.06
Cattail	0.06
Bulrush	0.07
Total Cumulative Cover	76.67

Teal Lake

Plant Name	Percent Cover
Chara	39.09
Illinois Pondweed	26.82
Wild Celery	13.77
Waterlily	0.50
Bulrush	0.05
Purple loosestrife	0.64
Phragmites	0.45
Total Cumulative Cover	81.50

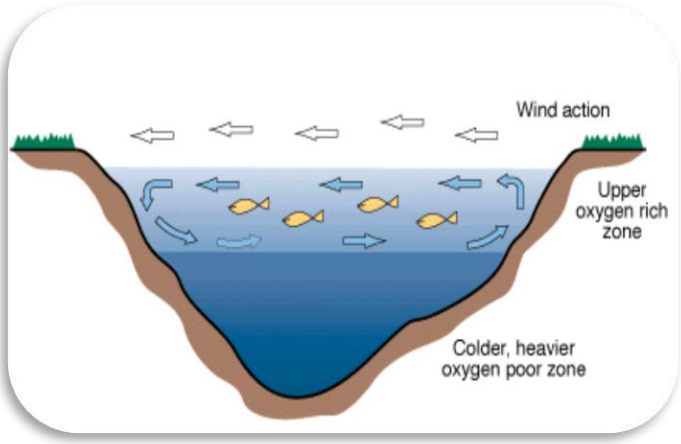
Heather Pond

Plant Name	Percent Cover
Chara	20.00
Illinois Pondweed	8.50
Brittle Naiad	23.50
Bulrush	1.83
Phragmites	3.50
Total Cumulative Cover	57.33



Water Quality Monitoring

Water quality monitoring is a critical part of lake management. Water quality monitoring provides an ongoing record of conditions in a water body. Changes in water quality can indicate threats from sources such as agricultural and lawn runoff, burgeoning development, and erosion from construction sites. Prompt identification of threats to water quality makes it possible to remedy them before irreversible harm has been done. Riparian's enjoyment of the water resource and the value of their property depends on maintaining water quality. For water sampling locations on each water body (see Appendix Fig 2).



Conductivity Total Dissolved Solids, pH and Alkalinity

Conductivity and Total Dissolved Solids (TDS) measure the total concentration of dissolved salts in the water from a variety of factors including but no limited to local runoff from both surface & groundwater penetration. Values for Stonewater Lake indicate moderate to high concentrations of dissolved materials. Alkalinity and pH measure the number of dissolved bases and the balance of acids and bases in the water. Alkalinity and pH values were within normal ranges for hardwater lakes.

Temperature and Dissolved Oxygen Profiles

Depth profiles of temperature and dissolved oxygen indicate that the lakes were well oxygenated, with surface oxygen concentrations within acceptable ranges for the Fall sampling period conducted on Sept.5th, 2023. (see Table 1).

Table 1.

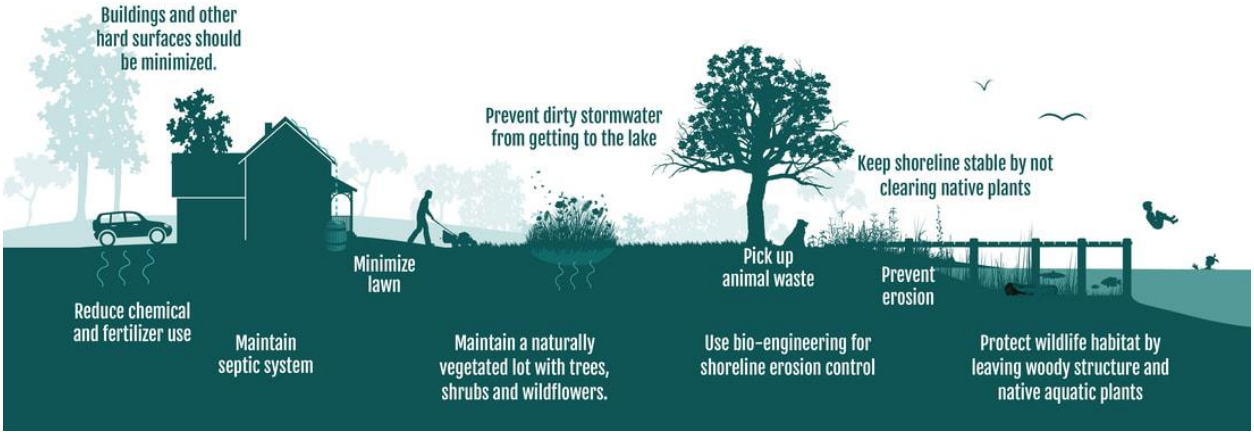
Site Name:	Temp (Celsius)	D.O. (mg/L)	D.O. (%)
Teal	26.0	8.1	87
Stoneridge	25.0	8.7	96
Parkshore	25.3	8.9	85.5
Heather	27.3	8.2	92
Mystic	26.2	8.0	88.0
Springhill	27.3	8.9	86.8

Secchi Disk Depths

The Secchi disk depth is a measure of water clarity, determined by measuring the depth to which a black and white disk can be seen from the surface (see Table 2). The larger numbers represent greater water clarity.

Evaluation of Trophic Status

Carlson's Trophic State Index (TSI) (see appendix A Figure 3.) calculated from Secchi disk depth and total phosphorus measurements made in September yielded values between 33 and 60 (see Table 2). Stonewater Lakes values range with Teal, Stoneridge, Parkshore, & Springhill lakes falling under meso-oligotrophic to mesotrophic with Mystic & Heather Lakes falling in the Mesotrophic to Eutrophic range with more sampling is required to track trends. Lakes with this characterization usually have low to medium nutrient levels and productivity, clear water with beds of submerged aquatic plants. Trophic levels vary based on a variety of factors including climate and nutrient load.



Total Phosphorus

Total Phosphorus measures the total amount of phosphorus in the water. Phosphorus is an important plant nutrient (i.e., fertilizer) and the nutrient most likely to limit algal growth. Elevated phosphorus inputs to lakes caused by human activities are a major cause of cultural eutrophication. The concentrations of phosphorus encountered in Stonewater Lakes during September indicate low to moderate concentrations. During the 2023 season, no samples exceed 10 ug/L which indicates relatively low levels of phosphorus throughout the lakes (see Table 2).

Nitrates

Nitrates measure the total amount of inorganic nitrogen in the water. Nitrogen is an important plant nutrient (i.e., fertilizer) and the nutrient most likely to limit the growth of rooted plants. Overall, nitrate concentrations in the lake were moderate to low. In both spring and fall samples, the nitrate concentrations were all <230 mg N/L at the surface. Nitrate values observed during the 2023 season continue to indicate low levels in the lakes (see Table 2.) US EPA guidelines level of concern for Nitrogen is routine samples above 300 ug/L with 300 ug/L failing into the Mesotrophic range. Samples between 500 ug/L – 1,500 ug/L fail under the Eutrophic scale and all samples above 1,500 ug/L under Hypereutrophic.

Table 2.

Site Name: **Spring (S)** **Fall (F)**	Total Phosphorus ug/L	Total Nitrogen ug/L	Seechi Depth (m)	TSI from Secchi Disk	TSI from Total Phosphorus
Teal – S	10	<230	4.0	40	33
Teal – F	10	<230	3.5	42	42
Parkshore – S	10	<230	2.0	50	33
Parkshore – F	10	<100	1.0	60	33
Mystic – S	10	<230	2.3	48	33
Mystic – F	10	<230	1.0	60	33
Stoneridge – S	10	<230	5.0	35	33
Stoneridge – F	10	<230	3.0	44	33
Heather – S	10	<230	3.0	44	33
Heather – F	10	<230	1.0	60	33
Springhill – S	10	<230	1.0	60	33
Springhill – F	13	<230	1.5	54	33

E-Coli Sampling

Throughout the summer E. coli samples were taken. The below table shows the values for each sampling period. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) standard is "Daily Maximum Geometric Mean: 300 *E. coli* per 100 milliliters (ml)" which is affected by a number of factors including sampling locations, time of day, and recent rain events. From day to day and even location sampled within a water body samples can greatly vary. For example, shoreline samples compared to open water samples can vary greatly. During the 2023 season, no samples were flagged as a level of concern with the highest Geometric Mean sample.

Lake Name	June	July	Aug
Mystic Lake	<4 cfu/100mL	<4 cfu/100mL	<4 cfu/100mL
Teal Lake	<4 cfu/100mL	<4 cfu/100mL	<4 cfu/100mL
Stoneridge Lake	<4 cfu/100mL	<4 cfu/100mL	<4 cfu/100mL
Heather Pond	<4 cfu/100mL	<4 cfu/100mL	<4 cfu/100mL
Parkshore Lake	<4 cfu/100mL	<4 cfu/100mL	<4 cfu/100mL
Springhill Lake	<4 cfu/100mL	<4 cfu/100ml	<4 cfu/100mL

Future Management Recommendations

Management options are dependent on many factors, including but not limited to, species abundance (density), species richness, species location, and many lake characteristics. Whenever an exotic species is found within an aquatic environment, immediate action needs to be taken to prevent long-term ecological damage as well as the recreational and aesthetic loss that will take place.

Submersed Aquatic Plants

Conventional Herbicide treatments

Future aquatic plant management programs should incorporate the treatment of areas where exotic species are identified, particularly focusing on prompt herbicide treatments for Starry Stonewort upon detection. The recent identification of Eurasian watermilfoil in Mystic and Springhill necessitates a renewed emphasis on preventing the spread of this exotic species. Aggressive management initiatives are slated for early 2024 to ensure containment.

It's noteworthy that due to new permit conditions, copper sulfate is no longer available as a management tool in May and June. Despite this limitation, PLMs treatment protocols later in the season have effectively ensured the proper management of Starry Stonewort across all of Stonewater Lakes.

To maintain low abundance and prevent interference with recreational activities, ongoing treatments for Curlyleaf pondweed are crucial. This approach also serves to limit the ecological impact of Curlyleaf pondweed in the lakes.

Moreover, the incorporation of nuisance native plant management into lake management programs can be achieved using conventional herbicide treatments if necessary. Native plant treatments specifically in shoreline residential areas are carried out exclusively with contact herbicides, aligning with a comprehensive strategy for effective lake management.

Monitoring

Aquatic vegetation and water quality will be monitored to document the condition of the lakes and to provide warning of any changes in the condition of the lakes that need to be addressed by additional lake management activities.

Recommended Management Schedule for 2024:

- Vegetation survey and water quality monitoring (to evaluate conditions in the lake and direct management efforts)
- Herbicide treatments to control any Eurasian watermilfoil and/or curly leaf pondweed areas that are found
- Starry stonewort should be monitored and treated as needed to keep it from spreading and creating recreational and ecological issues. These treatments will be conducted with contact chelated copper products starting in May.
- Treatments as needed for nuisance native species among docks and swim areas especially in Teal & Stoneridge lakes.
- Limit treatment on Heather Pond to encourage native plants and algae's to rebound.
- Fall vegetation survey
- Fall water quality sampling

Appendix A: Figures 1-3

Figure 1: AVAS Map locations

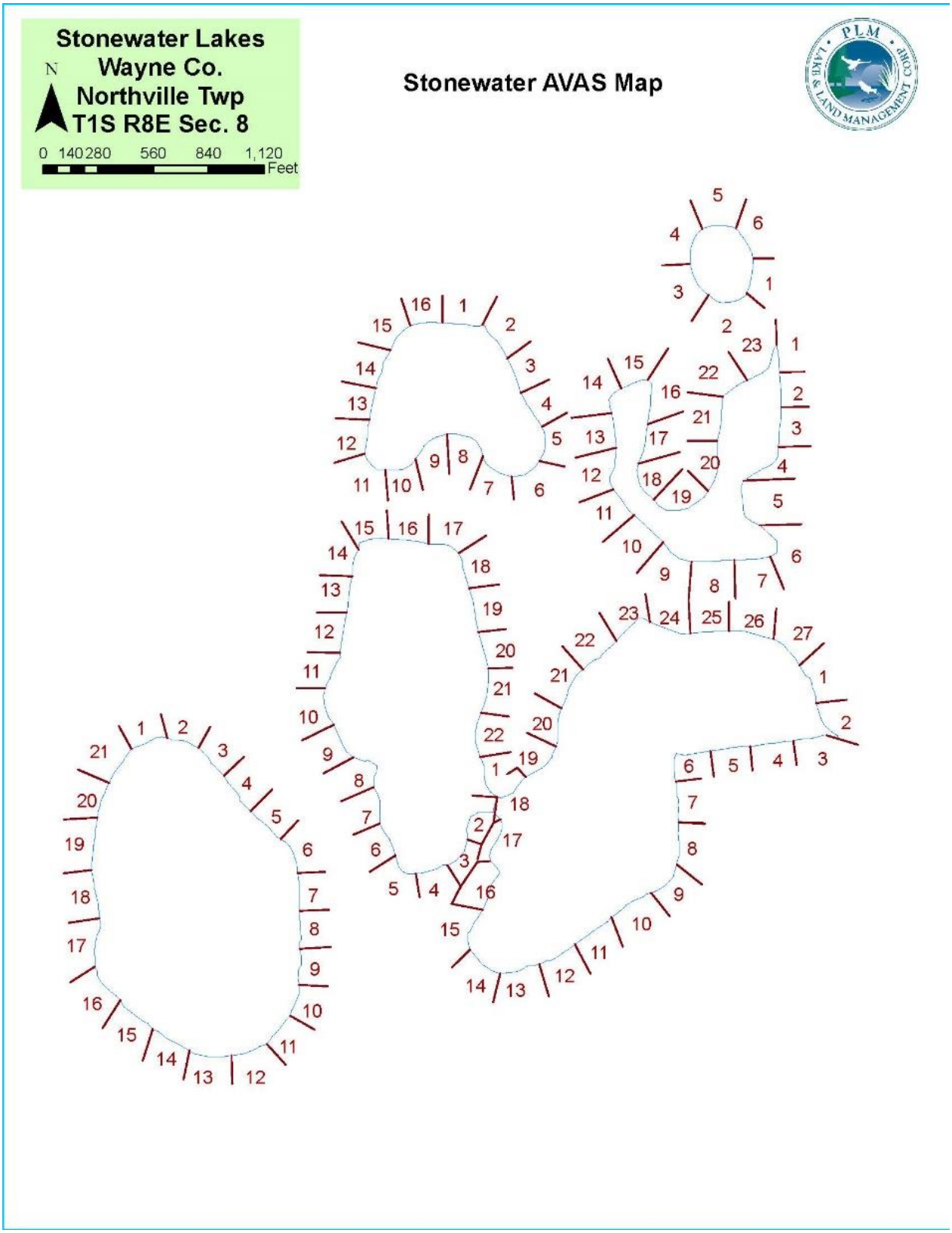


Figure 2: Water Quality Locations

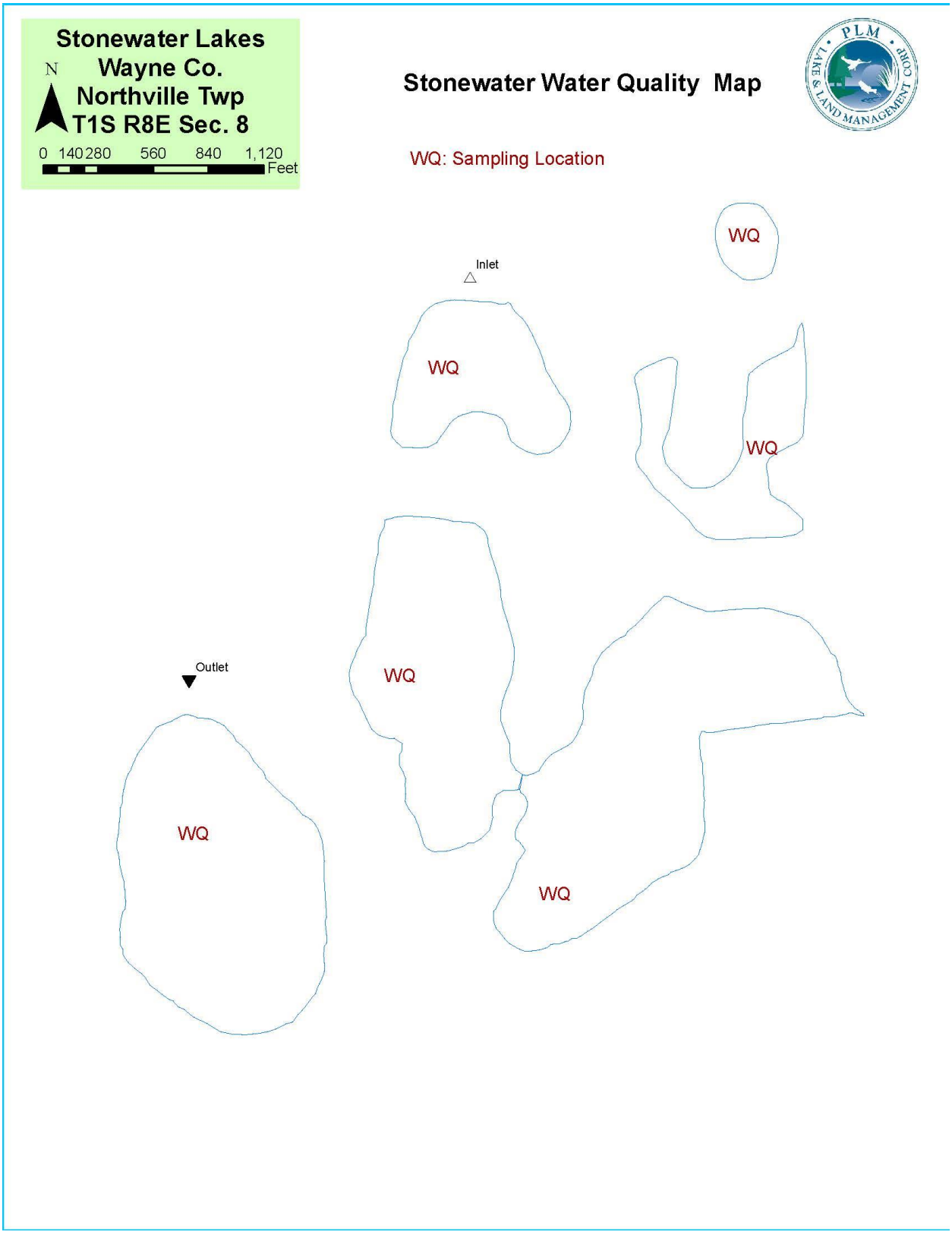
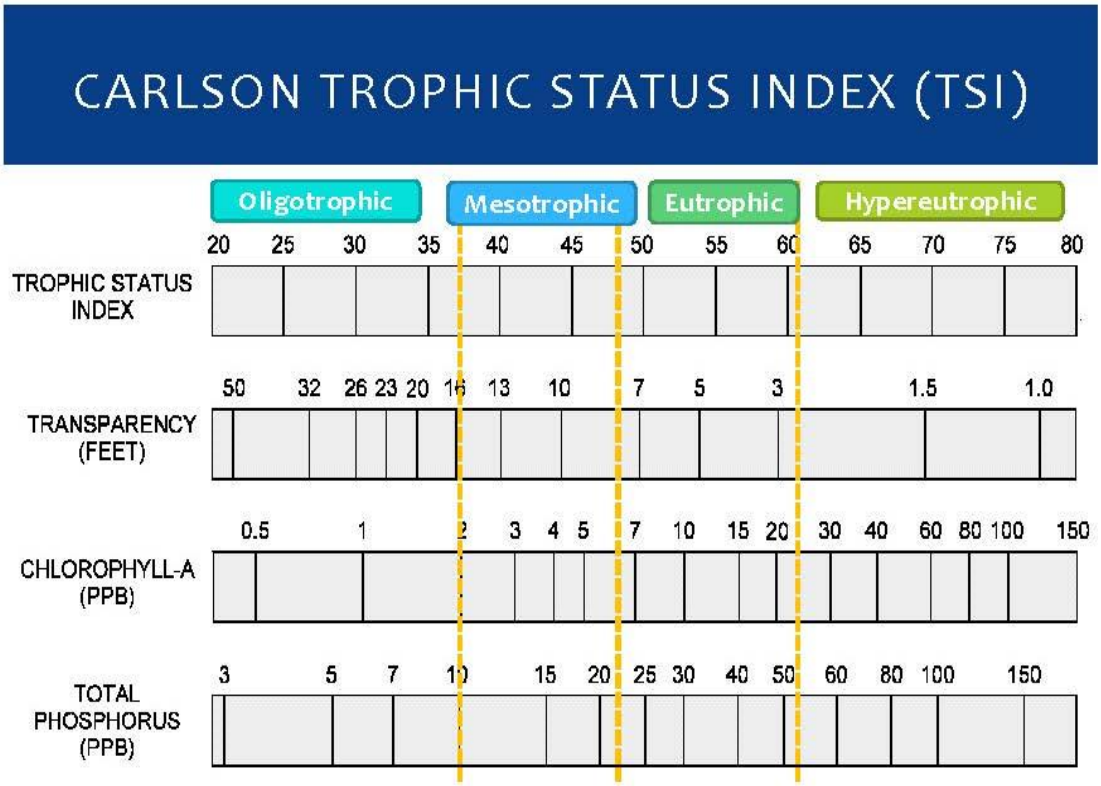


Figure 3: Carlson Trophic Status Index (TSI)



- Oligotrophic – low nutrient level, cooler climate, low plant diversity, good water quality
- Mesotrophic – medium-moderate nutrient levels, high plant diversity, fair water quality
- Eutrophic – excessive nutrient levels, abundance of plant growth, poor water quality
- Hypereutrophic – extreme nutrient levels, toxic algae blooms, low oxygen level, dead zones