Wilke Lake
Manitowoc County, Wisconsin
Comprehensive Lake Management Plan

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TOWN OF SCHLESWIG
Manitowoc County, Wisconsin

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1.0 INTRODUCTION AND BACKGROUND

Wilke Lake is a shallow 93-acre ground-water seepage lake located in southwestern Manitowoc County, Wisconsin. Wilke Lake has a single perennial outlet, a maximum depth of 21 feet, an average depth of nine feet, and approximately 1.7 miles of shoreline with 93 seasonal and year-round dwellings. Wilke Lake has a 697 acre (including the 93-acre lake surface), primarily agricultural, watershed (Figure 1). The watershed to lake ratio is 6 to 1. About 90 percent of the shoreline is developed, while the other 10 percent is wetland. One large wetland system, owned by the Wisconsin Department of Natural Resources (WDNR), is located on the north shore of Wilke Lake and a similar wetland is located on the western shore. Presently, as well as in the past, Wilke Lake is experiencing excessive submerged aquatic plant growth. Most macrophyte growth is Chara and the non-native plant species, Eurasian water-milfoil with some Curly leaf pondweed.

Wilke Lake was formed at the end of the last Ice Age, about 10,000 years ago in an area dominated by soils underlain by glacial outwash deposits adjacent to a terminal moraine running from northeast to southwest. A large piece of glacial ice probably was left behind, and when it melted formed Wilke Lake. This type of lake is typically called a "kettle lake".

Today, Wilke Lake suffers from the effects of human activities. Land use changes from pre-settlement conifer-hardwood forest to agriculture has increased nutrient and sediment loads to Wilke Lake. Wilke Lake is one of the most heavily used lakes in Manitowoc County for recreation by the public.

A WDNR report from the early 1960s documented a maximum depth of 22 feet, while the maximum present depth is 20 feet. This yields a post-settlement sedimentation rate of about one foot per 15 years. During the early 1960s, Wilke Lake began managing aquatic plants. From 1960 to 1964, chemicals were periodically applied to control aquatic plants. During the late 1960s, volunteers on the lake used a small weed cutter as a method to control aquatic plants. This method did not actually harvest the cut plants which may have stimulated aquatic plant growth. During the 1970s, aquatic plants were not managed, and aquatic plant growth was excessive. Water quality data collected during the 1970s showed shallow Secchi disk readings which translate into a high algae content in the water column. A 1972 report titled "A Shoreline and Water Quality Evaluation of Wilke Lake in Manitowoc County" stated that Wilke Lake had " high algae and rooted vegetation growth, high phosphorous and nitrogen levels, and septic system and barnyard runoff problems" (Carpenter, Lathrop. 2014). At this time, aquatic plant growth became so dense that late summer boat traffic was severely restricted.

During 1980, the Town of Schleswig Sanitary District 2 (more commonly known as the "Wilke Lake Sanitary District" [WLSD]) was formed with the authority to control and manage aquatic plants. During 1981, the WLSD purchased an aquatic plant harvester, and a larger harvester was purchased to replace the smaller old one during 1993. Since that time two additional new harvesters (2004 and 2014) have been purchased, with WDNR funding, to replace old harvesters. The WLSD has maintained an aquatic plant management plan since 1981. The plan consists of harvesting and removing aquatic plants each weekday for three to four months during the summer. This plan has allowed unrestricted recreational boating use on Wilke Lake without

noticeably affecting the fish population. Removing aquatic plants from the lake prevents release of plant tissue nutrients during winter decomposition.

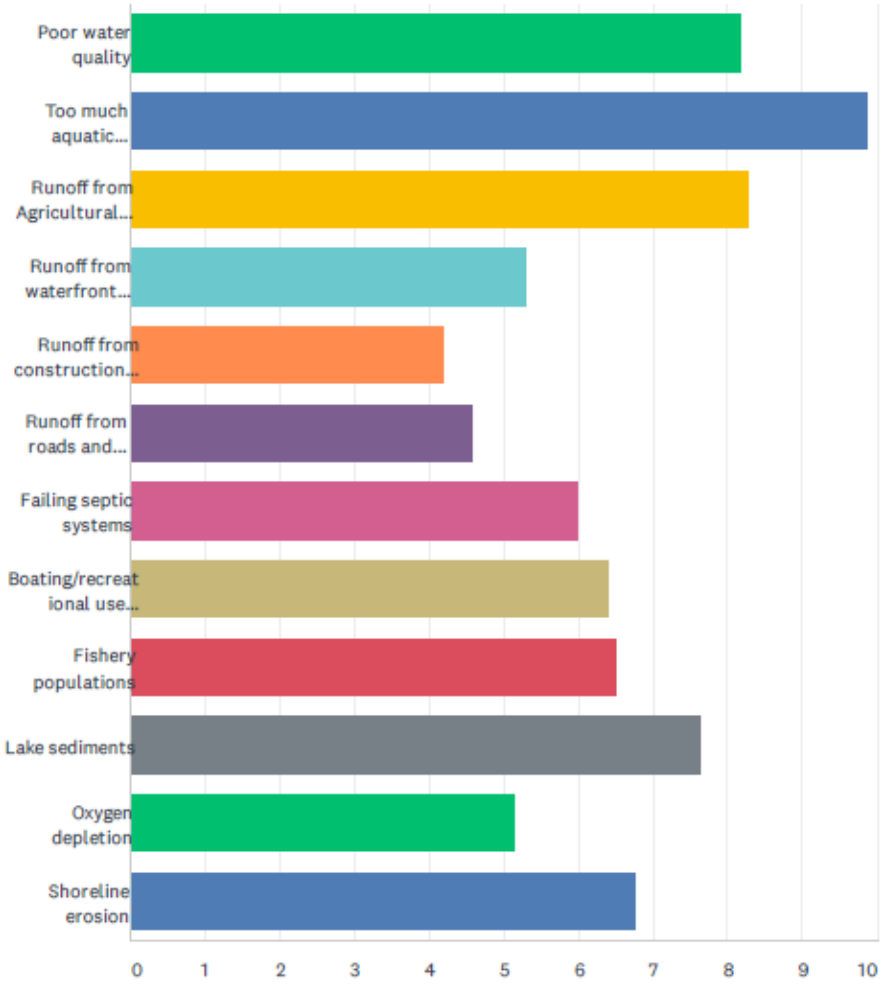
This revised Wilke Lake Comprehensive Management Plan ("the Plan") is being developed to build on previous plans and studies, to recommend on-the-ground conservation measures within the watershed and provide a framework to implement these measures. The Plan includes additional data collection, modeling of nutrient loading, and will establish target objectives for watershed and water quality improvements for Wilke Lake. The Plan will work to create alliances and partnerships between community members, lake users, landowners, scientists, and agencies to leverage funding and implement strategic conservation practices. The desired outcomes will include benefits to these stakeholders, and success will be built on collaboration among a wide range of local community members.

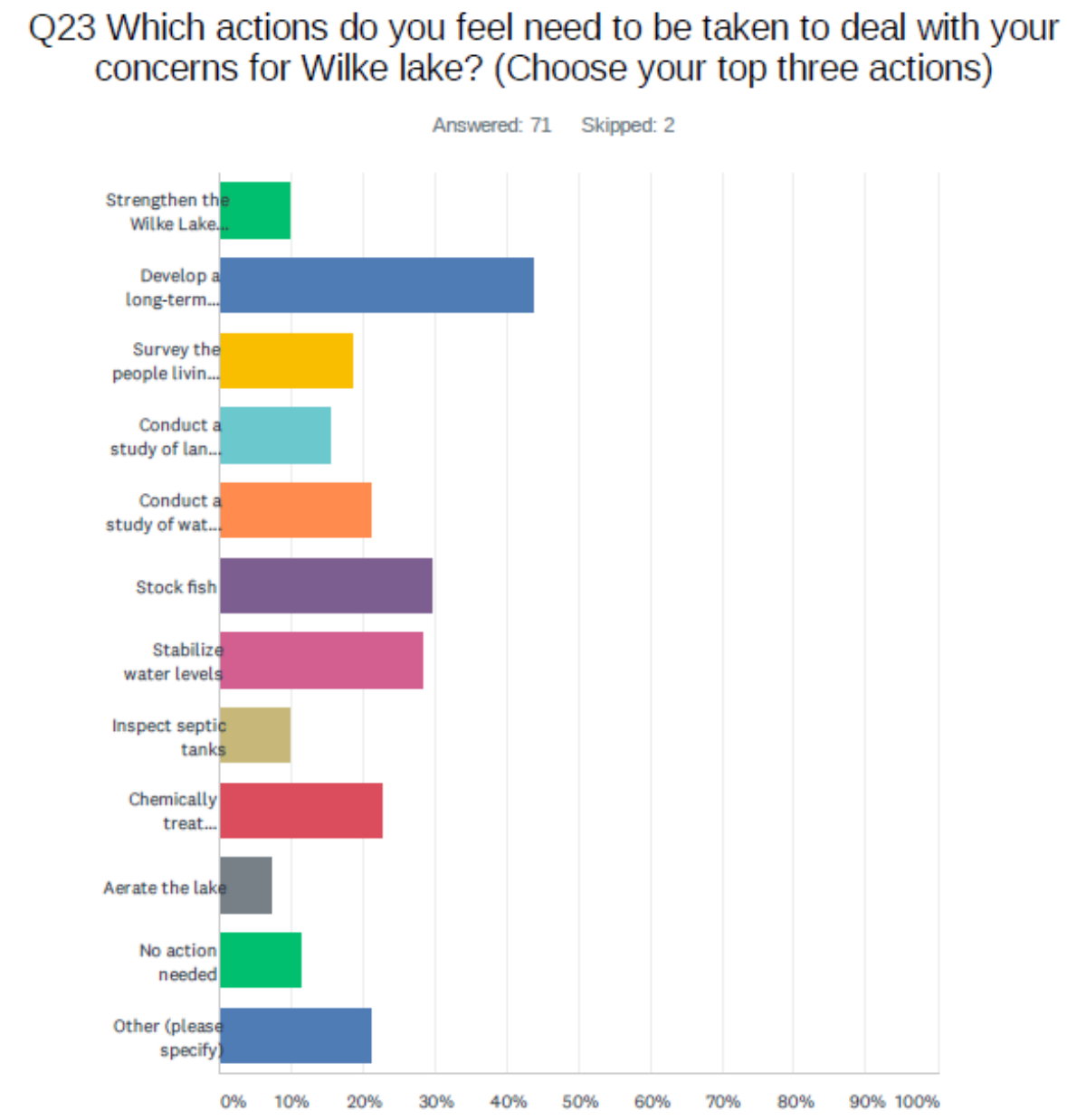
STAKEHOLDERS AND PUBLIC PARTICIPATION

Public engagement and integration of stakeholder input was a priority throughout the development of the Plan. In 2020, a survey was distributed to shoreline owners with the purpose of gaining focus on what the public believes the greatest environmental concerns are for the lake. Respondents overwhelmingly ranked water quality concerns (poor water quality and agricultural runoff) and aquatic plants as most important and feel this is where resources should be devoted. The following are excerpts from the survey results:

Q10 Please rank the problem areas in order of greatest to least concern, where 1 being your greatest concern and 12 being your least concern.

Answered: 72 Skipped: 1





According to the survey, the top priority was to develop a long-term management plan for the lake. The survey results highlight the overwhelming importance of water quality to Wilke Lake residents and the importance of developing a lake management plan that addresses water quality concerns throughout the watershed. Full survey results can be found in Appendix D.

During development of the Plan, stakeholders were informed about the project and its projected outcomes and were invited to comment on the proposed actions identified for inclusion in the Plan. These are some of the avenues used for public participation:

- Multiple forums (phone calls, emails, etc.)

- Newsletter announcements
- Sanitary District Committee open meeting
- Public Opinions Survey

Public informational meetings were held to establish citizen awareness of the Plan, its implications, and receive public feedback. Significant public feedback will be considered for Plan amendments. This Plan will be an evolving document, subject to amendments as new issues emerge and we develop appropriate strategies in response.

PUBLIC OUTREACH

The following outreach activities were used to gather opinions, comments, and suggestions on the proposed Plan from agency partners, local stakeholders, partner organizations, research and educational institutions and the general public.

- Information about the Plan was presented at the Wilke Lake Annual Meeting on July 25, 2020. The majority of lakeshore landowners were in attendance.
- Stantec provided the WDNR a draft Plan on March 19, 2021 to review the Plan and proposed recommendations for improving water quality. WDNR provided useful comments on the Plan content and recommendations.
- All Wilke Lake shoreline owners were provided a link to the public survey that was completed by 72 respondents.
- A second public informational meeting was held on September 15, 2020 to discuss the preliminary Plan results and recommendations to watershed residents and other interested parties were invited attended the meeting.
- Phone calls and virtual meetings with landowners were completed throughout the Plan drafting process.

Overall, all stakeholders are supportive of this Plan and the proposed activities presented within. No objections were noted through this process.

2.0 PREVIOUS MANAGEMENT ACTIONS

Concerns relating to water quality and aquatic vegetation in Wilke Lake have been persistent over the past 25 years. Over this period, surveys and studies of the lake have been performed, identifying impairments and establishing the need for managing aquatic vegetation, improving water quality, and managing the fishery of the lake.

- In the early 1960s, a WDNR report documented the maximum lake depth of 22 feet. Additionally, the Lake was treated several times with chemicals to treat aquatic vegetation. Unfortunately, no records were kept at the time as to the type and amount of chemicals used and applied.
- Fisheries surveys have been occurring in Wilke Lake since the 1950s, with the most recent complete fisheries report completed in 2018 by the WDNR.
- A 1972 report titled "A Shoreline and Water Quality Evaluation of Wilke Lake in Manitowoc County" stated that Wilke Lake had "high algae and rooted vegetation growth, high phosphorous and nitrogen levels, and septic system and barnyard runoff problems" (Reference 2). At this time, aquatic plant growth became so dense that late summer boat traffic was severely restricted.
- A comprehensive lake management plan for the lake was developed in 1995, with funding assistance from the WDNR.
- An aquatic plant survey of the lake was completed in 2010 and 2015 to assess the level of aquatic invasive plant species, to provide recommendations for aquatic vegetation management, and to meet the requirements for ongoing mechanical harvesting of aquatic vegetation (mostly Eurasian water milfoil).

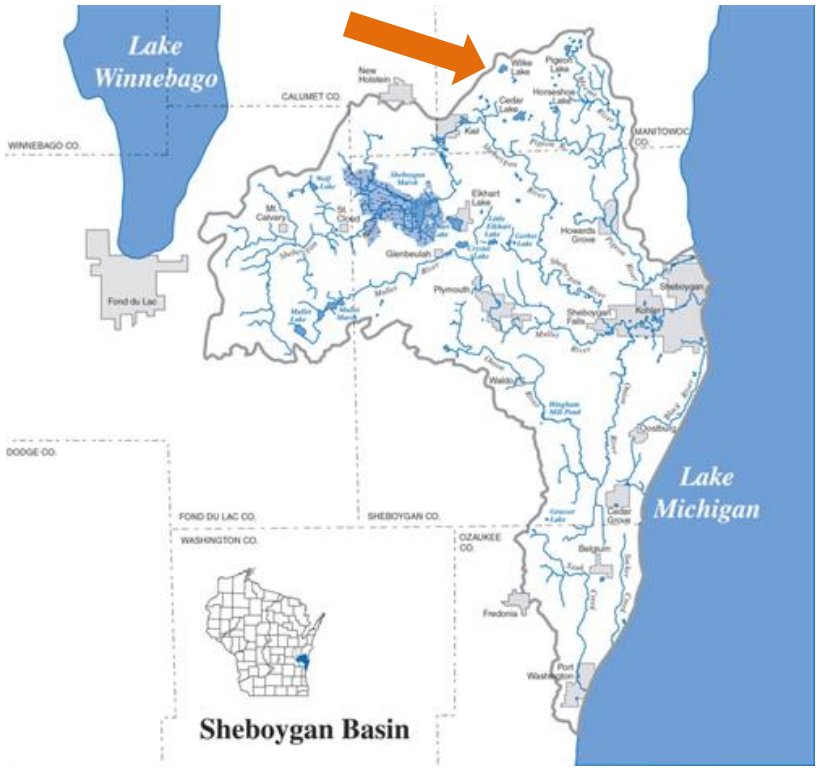
3.0 NATURAL RESOURCE APPRAISALS, OBJECTIVES AND STRATEGY

To improve water quality in Wilke Lake and the watershed, improve fish and shoreline habitat, increase education and outreach, and improve lake management efforts, a set of objectives and strategies are presented below for each natural resource category.

3.1 WATER QUALITY – WATERSHED, TRIBUTARIES & LAKE

A watershed is an area of land in which water drains to a common point such as a stream, lake or wetland. Wilke Lake is located entirely within the Sheboygan River Watershed (Figure 2).

Figure 2. Sheboygan River Watershed



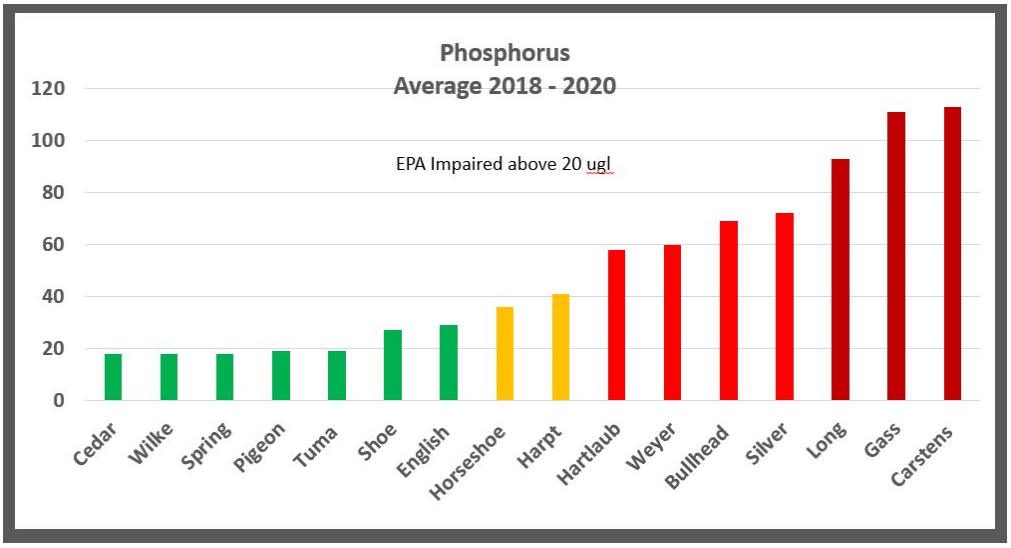
Wilke Lake has been the subject of numerous studies, beginning in the 1950s, focusing primarily on the fishery, aquatic vegetation, and water quality within the lake. Wilke Lake is subject to impairments from a variety of sources. Major nonpoint pollution impacting the lake and its watershed include agricultural runoff and sediment, animal waste, and nutrient enrichment. Sediment is a primary carrier of phosphorus. Phosphorus readily attaches to soil particles and is transported to the water body through the erosion process. When soil erodes, some or most of it, eventually reaches a water body. Once in the water, the sediment increases the turbidity of the water (the water looks muddy) and this turbidity can have adverse effects on fish and other aquatic organisms.

Nutrient enrichment, primarily from animal waste and commercial fertilizer, is detrimental to surface and groundwater quality. Surface water and groundwater contaminated by animal waste can cause serious illnesses if consumed by humans. Animal waste can also be hazardous to aquatic life. Phosphorus from manure enters waterbodies and acts as a fertilizer, stimulating massive algal and aquatic plant growth. When these organisms die, they are broken down by aquatic organisms, and this decomposition process leads to high Biologic Oxygen Demand (BOD), which can consume nearly all the oxygen in lakes and streams, possibly leading to fish kills. Ammonia in manure is toxic and can kill aquatic life. Phosphorus in manure causes long-term eutrophication in lakes and streams.

The most common pathway for phosphorus into the lake is via dissolved phosphorus picked up in rainwater and snowmelt. Phosphorus from manure or chemical fertilizers, if not incorporated into the soil, quickly dissolves, and can be removed by excess precipitation or runoff. A critical factor in phosphorus runoff is the level of phosphorus in the soil. When phosphorus levels in the soil are high, the element is easily dissolved by rainwater and removed from the land by runoff. Once in the runoff, it easily enters streams and lakes causing algae blooms and eutrophication. Thus, high levels of legacy soil phosphorus built up in the watershed from decades of agricultural use can be a persistent source of phosphorus inputs (Motew, et al. 2017).

A three-year study, conducted by Manitowoc County Lakes Association, indicated various levels of phosphorus in 16 lakes located in Manitowoc County. The lakes listed below in Figure 3 were tested by volunteers using WDNR WisCALM protocol and consist of four samples each year. Manitowoc County lakes with phosphorus levels above 40 ppb include: Harpt, Gass, Weyer, Bullhead, Silver, Carstens, and Long Lake. Lakes between 25-39.9 ppb include: Hartlaub and Horseshoe. Wilke Lake was below 25 ppb.

Figure 3. Phosphorus levels in Lakes 2018 - 2020



Phosphorus, Chlorophyll-*a* and Secchi disk transparency are common water quality parameters evaluated in lakes. Monitoring and evaluating concentrations of phosphorus within the lake permits a better understanding of current and potential aquatic plant growth rates.

Chlorophyll-*a* is the green pigment in plants and algae used in photosynthesis. Chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake, and Chlorophyll-*a* is a useful measurement of the intensity of algal blooms.

Secchi disk transparency is a measurement of water clarity and is perhaps the most used and easiest to understand and interpret. Furthermore, measuring Secchi disk transparency over long periods of time is one of the best methods of monitoring the health of a lake.

Wisconsin bases its General Condition Assessment for lakes on the Carlson Trophic State Index (TSI). The Carlson TSI is the most commonly used index of lake productivity. It provides separate, but relatively equivalent TSI calculations based on either chlorophyll *a* concentration or Secchi depth. TSI values range from low (less than 30), representing very clear, nutrient-poor lakes, to high (greater than 70) for extremely productive, nutrient-rich lakes. Total phosphorus, chlorophyll-a and water clarity values are directly related to the trophic state of a lake. As nutrients, primarily phosphorus, accumulate within a lake, its productivity increases, and the lake progresses through the following three trophic states:

- Oligotrophic (low nourishment and productivity) — Oligotrophic lakes tend to be very clear with low phosphorous levels and low production of biological material.
- Mesotrophic (moderate nourishment and productivity) — Mesotrophic lakes are more fertile with higher phosphorous levels, and moderately clear water. Biological productivity is elevated including fish production.
- Eutrophic (high nourishment and productivity) — Eutrophic lakes are very fertile, supporting high productivity of algae, aquatic plants, and abundant quantities of fish. However, extremely eutrophic (hypertrophic) conditions, often due to excessive phosphorus inputs from agricultural runoff, urban stormwater, or leaking septic systems, lead to a variety of impairments to lake water quality. Problems can include excessive aquatic vegetation, frequent and severe algae blooms, low oxygenation, winter fish kills, and reduced usability for recreational boating and swimming.

Water quality parameters within Wilke Lake have been monitored annually by volunteers since 2012 with sampling occurring prior in 2009, 2004, 2003, 1994 and 1988. Volunteers monitor Secchi disk transparency (Figure 4) and collect water samples, three times in 2020 by volunteers, which are sent to the State Lab of Hygiene to be analyzed. In 2020, water quality parameters were sampled by Stantec within Wilke Lake during four different days in May, June, July, and August 2020. The average summer Chlorophyll-a (Stantec July & August samples) was 6.55 µg/l (compared to a Southeast Georegion summer average of 21.7 µg/l). The summer Total Phosphorus average was 21.75 µg/l (Stantec July & August samples). The summer Secchi disk average was 6.5 ft. (Stantec July & August samples). The overall TSI for Wilke Lake based on 2020 data was 46.8 (Stantec July & August samples), indicating a Mesotrophic state, noting a slight improvement from previous eutrophic state (Figure 5). The average summer trophic state for the last 5 years hovered around 51 (Figure 5). Detailed water quality data from 1988 to 2020 can be found on the WDNR Wilke Lake citizen monitoring web site:

https://dnr.wi.gov/lakes/waterquality/Station.aspx?id=363286

Table 1. Trophic Status Index (TSI) thresholds – general assessment of lake Natural Communities.

Condition Level	Shallow			Deep			
	Headwater	Lowland	Seepage	Headwater	Lowland	Seepage	Two-Story
Excellent	< 53	< 53	< 45	< 48	< 47	< 43	< 43
Good	53 – 61	53 – 61	45 – 57	48 – 55	47 – 54	43 – 52	43 – 47
Fair	62 – 70	62 – 70	58 – 70	56 – 62	55 – 62	53 – 62	48 – 52
Poor	≥ 71	≥ 71	≥ 71	≥ 63	≥ 63	≥ 63	≥ 53

Figure 4. 2003 – 2020 Secchi disk measurements from Wilke Lake

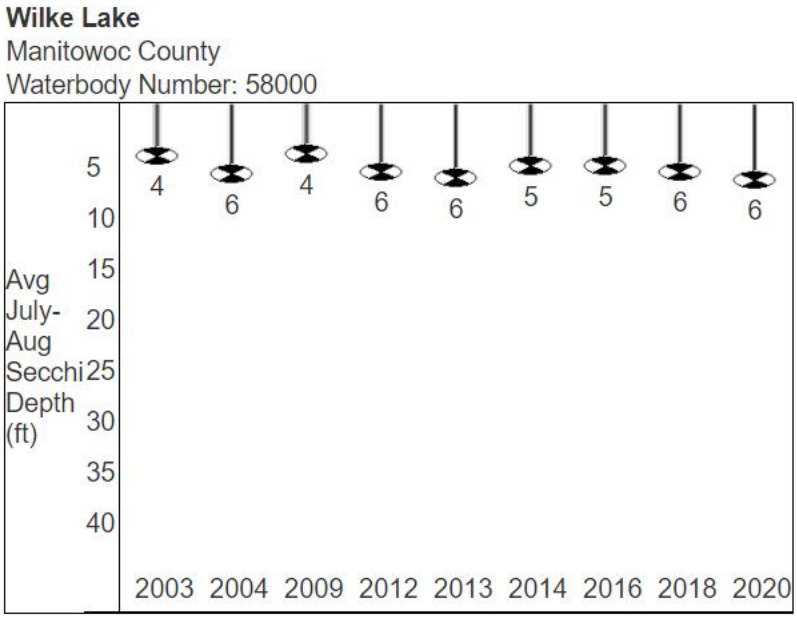
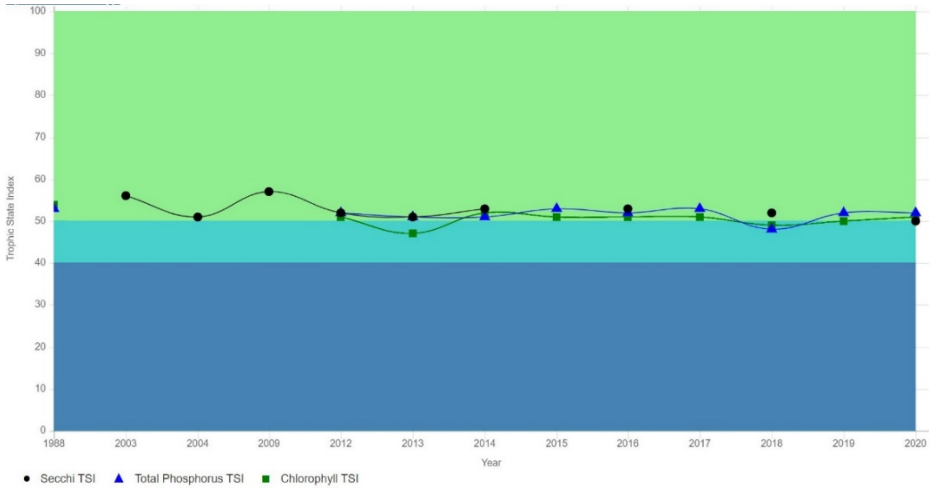


Figure 5. 1988– 2020 TSI results from Wilke Lake



As noted herein, Wilke Lake is a kettle lake and was formed at the end of the last Ice Age. Wilke Lake can be further described as a deep seepage lake. Today, Wilke Lake suffers from post-settlement human activities. Land use changes from pre-settlement conifer-hardwood forest to agriculture has increased nutrient and sediment loads to Wilke Lake. Wilke Lake is one of the most heavily used lakes in Manitowoc County.

Today, Wilke Lake is characterized by dense aquatic vegetation. Excess plant growth can be related to high phosphorus levels, which can come from both internal phosphorus cycling and external sources in the watershed. Reported discharges to the lake have been a serious cause of concern for health and safety for swimming and other recreation on the lake. Bacterial problem can originate from failed septic tanks at homes along the lakeshore, as well as from livestock manure, via runoff from barnyards, pastures, or spreading on crop fields. A Manitowoc County ordinance is now in place that prohibits spreading on frozen ground. Phosphorus is a limiting nutrient for algae; thus, the amount of phosphorus is a critical driver in controlling lake fertility. Simply put, the more phosphorus entering the lake, the more plant growth, including both aquatic macrophytes and algae.

MODELING METHODS

To estimate nonpoint source phosphorus loading for this revised Plan, a model based upon watershed land uses and phosphorus export coefficients was utilized. This method is consistent with the approach used to model nonpoint watershed phosphorus loading in the DNR's Wisconsin Lake Modeling Suite (WiLMS).

To use the Unit Area Loading model, the following categories of data were required:

- Total watershed area, from Geographic Information System (GIS) mapping and analysis
- Land use, from GIS data
- Phosphorus export coefficients (database)

Watershed Mapping

Watershed delineation was performed using a combination of GIS and manual methods (Figure 6). The detailed Manitowoc County contour mapping is based on airborne LIDAR data. In GIS, the watershed boundary was delineated, using the digital topographic data and aerial photography. The outlet of Wilke Lake was selected as the watershed outlet, so the watershed includes the surface area of Wilke Lake. The watershed has an area of 697 acres (including the 97 acres of the lake), or 1.09 square miles.

Table 2. Total Land Use by Major Category

Land use major category	Area (acres)	Percent of Total
Cropland	264	37.9
Forest	26	4
Wetland	96	14

Rural Residential	55	8
Pasture / Grassland	152	22
Medium Urban	1	0.1
Open Water	103	14
Total	697	100

Land Use and Phosphorus Export Coefficients

Another major input in the nonpoint source pollution model was land use data. The WiLMS phosphorus export coefficients are assigned to land use categories. The final input required for the watershed nonpoint phosphorus modeling is phosphorus export coefficients. To be consistent with the DNR's WiLMS, the database of phosphorus loading rates from that model were used in this study.

One benefit of the DNR's database is that three estimates of phosphorus exports coefficients are given: a low value, a most likely value, and a high value. This recognizes the wide variability and uncertainty in phosphorus loads and concentrations for any given watershed. Rather than a single number, phosphorus model results should be viewed as a range of likely loads. Using the variability in phosphorus export coefficients, possible variation in total watershed phosphorus loads can be reported.

Table 3. Phosphorus Unit Area Loading Rates for Modeling

Land Use Description	Loading Rates (kg. of phosphorus / hectare / year)		
	Low	Most Likely	High
Rural Residential	0.05	0.1	0.25
Medium Urban	0.3	0.5	0.8
Row Crops	0.5	1	3
Pasture/Grassland	0.1	0.3	0.5
Open Water	0.1	0.3	1
Forest	0.05	0.09	0.18
Wetlands	0.1	0.1	0.1

MODELING RESULTS

Phosphorus Loads

Using the methods described above, estimated total phosphorus loads to Wilke Lake from nonpoint sources in the upstream watershed were calculated. As stated earlier, the WiLMS loading coefficient allows for the estimate of a range of expected phosphorus loads: low, most likely and high expected values. Table 4 gives the range of estimated annual phosphorus loads for the watershed.

Table 4. Total Nonpoint Phosphorus Loads from Watershed

Estimate Range	Total P (lbs/average year)
Low end	154.2

Most Likely	329.7
High end	923.8

Tables 5 shows the estimated total phosphorus loads ("most likely" loads) summed by by land use.

Table 5. Total Phosphorus Loads by Land Use

Land use major category	Average nonpoint phosphorus load, lbs per year
Cropland	236.9
Forest	8.82
Wetland	2.2
Rural Residential	4.41
Pasture / Grassland	40.57
Medium Urban	0.45
Septic	9.9
Total	329.7

WATER QUALITY STRATEGIES AND OBJECTIVES

Water quality improvement strategies and objectives for Wilke Lake include:

1. Phosphorus Reduction: According to the Manitowoc County Land and Water Resource Management Plan (2016-2025), the County has approved a 10-year phosphorus reduction goal of 10% by 2026, or 1% annually. This Plan proposed at least a 10% phosphorus reduction goal by 2026, with actions proposed to achieve greater than 10% phosphorus reduction by 2026. A 10% reduction in phosphorus over the course of 10 years is not expected to exhibit itself as a dramatic increase in water clarity, but rather a decrease in the severity and frequency of years considered bad by lake stakeholders.

   One strategy to reduce phosphorus and sediment loads in a watershed is to construct engineered infrastructure to trap, settle or filter pollutants in concentrated runoff. A sediment basin is one type of engineered, structural BMP. NRCS Conservation Practice Standard 350 provides guidance on sizing criteria and other design recommendations.

   The lower in a watershed or sub-watershed a sediment basin is located, the more sediment and phosphorus it can manage. The same is true for newly developing areas with increased impervious areas. Sediment basins designed using NRCS methodology typically remove about 80% of the average annual incoming suspended solids load and 60% of the incoming phosphorus load.

   For any structural measures proposed, an Operations and Maintenance plan would be prepared with the design plans. The minimum requirements to be addressed in an Operations and Maintenance plan should include:

- Periodic inspections and maintenance of the embankments, principal and auxiliary spillways and dewatering device especially following significant runoff events.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reached pre-determined storage elevations.
- Periodic mowing or vegetation to control trees, brush and invasive species.
- Periodic inspection of safety components and immediate repair if necessary.

2. Feasibility: Conduct feasibility studies to identify potential future sediment basin locations as the watershed develops, reduce legacy phosphorus in the lake, which may include spot muck dredging, and continuing harvesting of Eurasian water-milfoil (EWM). Pending results of the feasibility studies, actions proposed in these studies would be consistent with this Plan as long as they are consistent with actions to improve water quality.

3. Restore and Protect Habitat Quality: Restore and/or improve stream and shoreline habitat, riparian wetlands and establish upland buffers to improve water quality within the Wilke Lake watershed (Figure 7). Preservation and enhancement of wetlands in a watershed with a low watershed to lake ratio, like Wilke Lake's watershed, is critical to protecting a lake's water quality as well as buffer the effects of water level changes due to precipitation events (flooding and drought). Restoration activities will improve resilience of the watershed and lake ecosystem as it relates to the frequency and magnitude of flood or drought events (water level changes). Resilience of the ecosystem will come from wetland preservation, restoration and possible construction of new wetlands, as well as habitat enhancement. These enhancements could include BMP construction (retention basins, artificial wetlands, storm water detention systems, rain gardens, upland buffers), reconstruction, or modifications to accommodate more flooding events.

   Based on the watershed analysis, the watershed is composed of approximately 4% upland forest, 14% wetland, 22% upland pasture/grassland, and 37.9% cropland, and 8.1% developed areas (Figure 8). The wetlands in the watershed are composed primarily of medium quality hardwood swamp communities, and less commonly, shallow marsh, wet meadow, and farmed wetlands. The wetlands are likely subject to siltation and runoff from surrounding upslope agricultural lands. Additional impairments to wetlands in the watershed have resulted from past ditching and agricultural drainage, which have resulted in disruptions to natural hydrology, and fluctuating or lowered water tables. Protecting or enhancing the ecological integrity of these wetlands, especially shoreline wetlands, are critical to filtering surface water flows and reducing phosphorus inputs to Wilke Lake. Where feasible, wetland restoration should be considered on marginal or fallow agricultural lands.

   At present, the WDNR has a nine-acre parcel on the north shore of the lake under conservation protection within the watershed. Some other natural communities may warrant conservation protection due to their unique aesthetic features and values and the water quality protection afforded the lake.

4. Conservation Practices: Continue to support or expand BMPs funded by the following programs: *Environmental Quality Incentive Program (EQIP); Conservation Reserve Program (CRP); Conservation Stewardship Program (CSP); Conservation Reserve Enhancement Program (CREP); and Agricultural Conservation Easement Program (ACEP)*. Continue to support conservation practices administered by Manitowoc County Soil and Water Conservation Department (Appendix B).

   As an alternative to infrastructure such as sediment basins, conservation practices can be implemented in the watershed to improve water quality. Nonstructural phosphorus and sediment reduction techniques on agricultural land, include:

   - Conservation tillage
   - Contour farming
   - Filter / buffer strips
   - Terracing

   Installing buffers of perennial vegetation adjacent to wetlands and waterways can have a profound effect on reducing phosphorus and sediment inputs, absorbing surface water runoff, and keeping excess nutrients from flowing into Wilke Lake. Water infiltration and uptake by plants from evapotranspiration within perennially vegetated areas can help reduce the flashy behavior of the tributaries flowing into Wilke Lake. This Plan encourages up to a 100 ft riparian buffer to reduce phosphorus loading and sediment loading via runoff and bank erosion.

POTENTIAL FUTURE ANALYSIS

The modeling conducted for this Plan is envisioned as the first step in a process of adaptive analysis, planning and implementation. As scoped in the WDNR grant phosphorus loads were estimated using unit area loading techniques. As resources, time, and funding permit, there are numerous analysis and planning tasks that can be undertaken to refine the analysis of existing conditions and enhance management planning.

Septic Tank Loading

A preliminary estimate of phosphorus loads from septic tanks near Wilke Lake was made using WiLMS. It is estimated that the loading from this source is contributing 9 pounds of phosphorus annually. This is only 3% of the estimated annual contribution from nonpoint sources in the watershed. This estimate could be refined with additional data on population, residence usage, site soil conditions, and age/condition of septic systems.

Comparison of modeled and monitored in-lake phosphorus loads

WiLMS contains procedures for predicting in-lake phosphorus concentrations, based upon predicted watershed loads, predicted runoff and lake hydrographic and bathymetric characteristics. WiLMS predicted average in-lake phosphorus concentrations for Wilke Lake using 12 different prediction equations from lake chemistry research. The means of all 12 predictions

were then calculated. Like pollutant loading, WiLMS reports a range of predicted values, including low, "most likely" and high.

The "most likely" average in-lake phosphorus concentration for Wilke Lake predicted by WiLMS was 80 micrograms/L. In comparison, the monitored July and August growing season phosphorus concentration averaged 21.75 micrograms per liter in 2020 (Stantec July & August samples).

Therefore, model-predicted and monitored in-lake phosphorus concentrations are not in similar ranges, the average modeled results appear to be higher than average monitored results. This analysis could be conducted in more detail in the future, though based upon this initial analysis, the modeling appears to provide reasonable results. If modeled in-lake phosphorus results are very different from measured in-lake phosphorus results, it may indicate that the contributing phosphorus inflows to the lake are incorrectly accounted for, or there is a significant source or sink of phosphorus (such as removal of aquatic plant by harvesting) that is not recognized in the model.

3.2 FISHERY

Wilke Lake historically supported a bass-panfish-northern pike fishery, however excessive aquatic plant growth, degraded fish habitat, population declines, and diverse stocking over the past several decades (WDNR, 2018; Holger, Surendonk, Shrovnal 2018), continue to challenge the fish management for the lake. Wilke Lake experiences heavy recreational use, as a lake with public access with parking and a picnic area.

In 2018 a detailed fish survey was completed by the WDNR fisheries staff. The detailed Wilke Lake 2018 Comprehensive Fish Survey can be found in Appendix E.

Aquatic vegetation provides crucial habitat structure for fish, and the lake has supported a fishery dominated by under sized bluegill, yellow perch, northern pike, and largemouth bass in recent years. Historically hybrid musky, and more recently, walleye have been stocked in the lake.

Based on survey results from 2018 and previous surveys, Wilke Lake continues to be bass-panfish lake that features Largemouth Bass, Northern Pike and stocked Walleye as predators and a diverse panfish community consisting of Bluegill, Black Crappie, Pumpkinseed Sunfish and Hybrid Sunfish. Problems with gamefish abundance, slow growth of bluegill and an abundant plant community identified in the 1950's as problems, continue to make fish management on this lake difficult.

FISHERY RECOMMENDATIONS

1. Establish a more restrictive regulation, 18" minimum, 1 bag for Largemouth Bass to improve bass numbers and to provide more predation on slow growing Bluegill.
2. Evaluate the continuation of Walleye stocking by the State. This survey and other surveys have found poor survival and no natural reproduction by Walleye. If Walleye stocking is continued, consider a more restrictive regulation, 18" minimum and 3 bag to improve Walleye number and to increase predation on Bluegill.

3. Change the Northern Pike regulation from the standard regulation of 26" minimum, 2 bag to no minimum size, with a protected, no harvest slot of 25" to 35" and a 2 bag.
4. Work with the Wilke Lake Association to install fish sticks or other woody habitat design to improve habitat for bass.

3.3 LAKE AND SHORELINE HABITAT AND AQUATIC PLANTS

Shorelands provide value in terms of nutrient retention and filtration, but also play an important role in wildlife habitat. Research has shown that coarse woody habitat, often within natural or undeveloped shorelines, provides many ecosystem benefits in a lake. Coarse woody habitat describes habitat consisting of trees, limbs, branches, roots and wood fragments at least four inches in diameter that occur along the shoreline. Coarse woody habitat provides shoreland erosion control, a carbon source for the lake, prevents suspension of sediments, provides a surface for algal growth which is important for aquatic macroinvertebrates, and perhaps most importantly, provides crucial habitat for fish. Shoreline development, land conversion, cleared and mowed vegetation, pier development and removal of trees and logs have collectively removed important shore structure that would otherwise support habitat for fish and wildlife, increase biodiversity, and improve water quality and general aesthetics.

Wilke Lake shoreline development began sometime in the early 1900s following installation of an outlet structure to keep water levels higher. Shoreline mowing and maintenance as lawn decreases water quality by increased inputs of phosphorus and sediments into the lake. Removal of native plants and deadwood from shallow, near-shore areas, most often to allow for boating and swimming, negatively impacts habitat for fish, mammals, birds, insects, and amphibians, while leaving the bottom and shoreline sediments vulnerable to wave actions. The protection of biologically and structurally diverse shoreline areas and adjacent wetland/upland interface is critical for sustaining a healthy lake.

On September 22, 2020, a shoreline survey was conducted of the approximately 98 parcels around the lake to assess the current shoreline condition; and categorize them as natural, rock, seawall, or combination. The result indicates 85% were hard armored, with more than 50% being rock. The results of the shoreline survey for the 98 parcels surveyed were: 9 parcels natural, 10 parcels combination natural and rock, 56 parcels rock, 21 parcels seawall, and 7 parcels combination seawall and rock.

Aquatic plants form the foundation of healthy and flourishing freshwater ecosystems. They not only protect water quality, but they also produce oxygen which is crucial to fish and other aquatic life. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and reduce shoreline erosion by reducing the effect of waves and current. Healthy native aquatic plant communities can help prevent the establishment of invasive non-native plants.

Beds of aquatic vegetation are important for spawning, habitat and shelter for many species of fish, amphibians, turtles, birds, mammals, and macroinvertebrates, and can require management

or protection, including protection from motorized boat traffic and other recreation usage that may damage the habitat. These areas should be priorities for protection from aquatic invasive species (AIS), which can degrade the habitat and lead to a loss of biodiversity. Continued boating pressure on the lake is another reason the bulrush bed on the north shore of Wilke Lake has almost completely disappeared in the past 20 years.

The most recent aquatic vegetation survey of Wilke Lake was completed in June 2020 by Stantec to update the 2015 aquatic plant management plan which includes the WDNR permitted management of aquatic plants, primarily Eurasian water-milfoil, throughout the lake. An aquatic plant point-intercept survey using WDNR methodology was used to characterize spatial distribution and abundance of submersed native and non-native aquatic plants. Chara was the most dominant species present in the aquatic plant survey with a 77% frequency of occurrence. The data collected during this survey indicated that the species Eurasian water milfoil was the second most dominant plant within the plant community and has increased in occurrence to 42% from 41% since a survey conducted in 2015. Additionally, the non-native curly leaf pondweed increased from 0.5% to 5% from 2015 to 2020. (Stantec, et al. 2020).

During the 2020 survey, Eurasian water-milfoil was observed throughout the entire littoral area of the lake, creating a nuisance condition for boating and swimming. Data collected from the aquatic plant survey indicate that the average Coefficient of Conservatism (C) values from the 2020 survey fall above both the ecoregion and state medians. This indicates that when compared to other lakes within the region and state, the plant community of Wilke Lake is of higher quality and indicative of a relatively healthy system. In lakes with relatively high nutrient inputs, like Wilke Lake, the species that are best adapted to access these nutrients directly from the water, like EWM, out-compete other species for space and light. The plant community within Wilke Lake is comprised of some species that are more tolerant to environmental disturbance. The complete 2020 report, *Wilke Lake Aquatic Plant Management Plan,* is attached in Appendix D.

Abundance of aquatic plants at nuisance level can negatively impact the ecosystem by causing anoxic (without oxygen) conditions that result from the decomposition of plant and algal material during the winter months.

Wilke Lake has been impacted by stressors, including introduction of AIS that are currently spreading in Wisconsin lakes and having an impact on fisheries and aquatic habitats. Eurasian water milfoil is currently the dominant AIS concern in the lake. Nuisance aquatic vegetation levels exists, in part, because of Eurasian water-milfoil's abundance and distribution in the lake.

LAKE AND SHORELINE HABITAT AND AQUATIC PLANT STRATEGIES AND OBJECTIVES

1. Continue to monitor trends in native and AIS populations by completing Point Intercept plant surveys at a minimum frequency of once every 5 years for the entire lake.
2. Continue lake wide Eurasian water milfoil to control for nuisance growth. Study option of future herbicide treatment or biological control options.
3. Continue to staff monitors at the public boat landing trained by the Clean Boats Clean Waters program. Continue to offer boat washing station.

4. Encourage natural, undeveloped or unmanicured views of the shoreline, with abundant coarse woody habitat and diverse submergent, emergent, and floating-leaf plant communities.

3.4 EDUCATION AND OUTREACH

There are numerous regional education and outreach organizations, comprised of environmental advocacy groups, associations and friends' groups, which citizens can utilize for information about water quality. These groups have provided consistent leadership and cooperation with the lake community. Newsletters, community events and educational forums are focused on the fishery, recreation opportunities, ecology, aquatic invasive species, natural history, land stewardship, and more.

EDUCATION AND OUTREACH STRATEGIES AND OBJECTIVES

1. Public Education: Per Manitowoc County Soils and Water Department 10-Year Land and Water Plan, new education and outreach programs shall focus on: improving groundwater and surface water quality, creating awareness of conservation stewardship efforts being implemented, County Ordinance requirements, State Standards for compliance of Farmland Preservation Program income tax credit, incentives and cost share availability for installation of conservation practices and many other environmental topics to enhance the quality of our natural resources.

    - Continue to monitor the lake's water quality using WisCALM protocols and expand the network of volunteer participation. Evaluation of BMPs- Employ USGS or similar methodology to evaluate efficacy of implementation. Continue planning for longer range general lake condition appraisals that will show macro trends. On-going lake and stream monitoring by WDNR and volunteers are examples. More detailed watershed modeling could also be performed.
    - Expand future natural resource inventories and studies. This can involve upstream vs. downstream studies, biotic indexing, physical surveys (Bank Erosion Hazard Index (BEHI), sediment transport modeling, geomorphic modeling, etc.), or other appropriate methods characterizing the before and after conditions, and how it might affect the lake. Other evaluations could involve riparian buffers, stream bank repairs and channel realignment, modeled nutrient and sediment loadings, wetland restoration, anecdotal evidence, images, and other acceptable modifications.
    - Create educational material or packets of information regarding new or existing educational programs and continue to publish lake and watershed trends and monitoring results (newsletters, web sites, radio, newspapers).

2. Aquatic Invasive Species: Conduct annual review of AIS activity and update plan to reflect changed in control needs and those of the lake ecosystem. Integrate all partners

with Wilke Lake AIS actions and regional efforts. Encourage education partners to be part of the AIS program execution.

3.5 LAKE MANAGEMENT

Local leadership from the Town of Schleswig Sanitary District, Town, County, Wilke Lake Advancement Association and local nonprofits have been strong and the engagement by all partners has been exemplary. A challenge for the lake community and its leadership is maintenance of management capacity. Proper attention to management capacity involves all partners, including the general public.

Because multiple interests are involved, clarity of responsibility is critical. There are many stakeholders in addition to the principal management units such the Sanitary District, County, NRCS and WDNR. The challenge for the partnership will be to act on, and promote, continued integration, while improving the public's understanding about the lake management structure.

All individuals on a team must be equipped with good working skills to effectively represent themselves and their respective management unit. Working on cooperative projects and being on a team with common objectives requires knowledge of human nature, consensus building, and team process. Building these skills is not an easy task. Advanced learning for maintaining a long-range strong partnership is necessary.

LAKE MANAGEMENT STRATEGIES AND OBJECTIVES

1. Provide a clear description of management unit responsibilities and interaction with partners. This can be partially completed via existing Education and Outreach vehicles including partner's newsletters and annual meetings. Develop professional publications which list all the organizations, what they do, how they do it, and how they work together.

2. Hold annual meeting (with all partners in attendance) to assess the status of the lake and in the implementation of all strategic initiatives. As appropriate changes to the plans will be discussed and a one- page summation will be written describing the year's relevant events and decisions.

3. Form an Aquatic Invasive Species (AIS) steering team for Wilke Lake (combined with regional effort) to manage aquatic plant harvesting and monitoring, reporting, grant writing, contracting and rapid response treatments as needed.

4. Re-form the Fish Stocking steering team for Wilke Lake (combined with regional effort) to manage lake stocking and monitoring, reporting, and grant writing, as needed.

3.6 CLIMATE CHANGE

Climate change is a controversial and highly charged topic. When developing long-term planning goals and practices, an approach that takes into account potential future conditions

based on the best available science is recommended. Climate trends indicate increasing average temperatures, greater frequency and magnitude of flooding, and longer droughts. Some considerations for Wilke Lake and the region are outlined below.

- **Temperature Increase:** As the average seasonal temperature increases, duration of lake ice cover will be reduced. Fewer days of ice on the lake will allow for greater light penetration into the water. Instead of reflecting light off the ice, it will be absorbed by the water, which will increase the heat the lake absorbs. As a result, water temperature increases, which impacts the fishery. Additionally, intensity and duration of light penetration for plant growth will affect timing, quantity, and diversity of the lake plants.
- **Increased Precipitation:** As average temperatures increase, the atmosphere can hold more water as vapor, resulting in more frequent and intensive rainfall. Increased intensity of storm events has already been observed in recent years in Wisconsin. Heavy rainfall events result in large pulses of water carrying increased sediment loads which enter the lake in a short period of time. Studies suggest that heavy precipitation events are responsible for the majority of phosphorus entering lakes (Motew et al, 2017; Carpenter et al, 2014). Increasing frequency of heavy rainfall is expected to mobilize more soil phosphorus from the watershed. Planning for the next several decades may need to take into account longer growing seasons, greater volumes of runoff, and increasing frequency of 10-year, 100-year or greater flood events.

For further information on climate change in Wisconsin refer to the website "Wisconsin Initiative on Climate Change Impacts (UW WI, 2010): http://www.wicci.wisc.edu/

CLIMATE CHANGE STRATEGIES AND OBJECTIVES

1. Promote innovation and resiliency in existing and future BMP construction
2. Enhance the Education and Outreach program to include local understanding of climate change effects.
3. Encourage robust, native and diverse wetland, riparian, and aquatic plant communities around the lake shoreline and within the entire watershed.
4. Ensure future watershed development meets existing design standards or better, in anticipation of climate change induced flooding in the watershed. This would pertain to storm water structures, agriculture, and new development.

4.0 ALIGNMENT WITH EPA'S 9 KEY ELEMENT CRITERIA

The following provides a summary of this Plans alignment with the EPA's 9 Key Elements for watershed plans.

1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

   The causes and sources that will need to be controlled to achieve the load reductions are described in detail in Section 3.1 – Water Quality – Watershed, Tributaries & Lake.

2. An estimate of the load reductions expected for the management measures.

   An estimate of the load reductions are described in detail in Section 3.1 – Water Quality – Watershed, Tributaries & Lake.

3. A description of the management measures that will need to be implemented to achieve the load reductions estimated above and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this Plan.

   A description of the management measures that need to be implemented to achieve the load reductions are described in detail in Section 3.1 – Water Quality – Watershed, Tributaries & Lake; and illustrated on Figure 7.

4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this Plan.

   The type of financial assistance available to implement this Plan is discussed below in Sections 5.0 and 6.0.

5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the management measures that will be implemented.

   An information/education activity proposed as part of this Plan are outline above in Section 3.4 Education and Outreach.

6. A schedule for implementing the management measures identified in this Plan that is reasonably expeditious.

   This Plan identifies actions that are proposed for on-going management activities or grant funding.

7. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented.

   Measurable milestones include a reduction in phosphorus in the lake as a result of the continued harvesting and removal of EWM from the lake, per the Water Quality Strategies

and Objectives listed in Section 3. 1 – Water Quality – Watershed, Tributaries & Lake. Results will be measured per the environmental monitoring proposed above in Section 3.4 – Education and Outreach.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised.

   Criteria that can be used to determine whether loading reductions are being achieved over time include water quality monitoring data that are collected annually by volunteers. Monitor data includes Secchi disk transparency and collect water samples which are sent to the State Lab of Hygiene to be analyzed. Changes in the overall TSI for Wilke Lake will determined whether progress has been made towards attaining water quality standards.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time.

   A monitoring component is discussed above in Section 3.4 – Education and Outreach.

5.0 FUNDING SOURCES

The following funding source should be consulted for implementing the lake and watershed improvement strategies outline above.

Wisconsin Department of Agricultural, Trade, and Consumer Protection (DATCP)

Soil and Water Resource Management Cost-Share Funds: DATCP allocates cost-share dollars for conservation practices in Manitowoc County. The Soil and Water Conservation Department administers cost sharing for applicants and helps farmers implement conservation practices.

Conservation Reserve Enhancement Program (CREP): The Soil and Water Conservation Department administers state incentives and cost share funds. The Conservation Reserve Enhancement Program (CREP) is an offshoot of the Conservation Reserve Program, the country's largest private-land conservation program. CREP targets high-priority conservation issues identified by local, state or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, farmers, ranchers and agricultural landowners are paid an annual rental rate, along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary and the contract period is typically 10-15 years. Typical practices include filter strips and riparian buffers.

Wisconsin Department of Natural Resources

Targeted Runoff Management Grant: The runoff management grant provides funding and authorizes cost-share reimbursement for practices installed to cure a notice of discharge violation. The Soil and Water Conservation Department administers grants and provides technical assistance under the runoff management grant program.

Well Abandonment: Financial assistance for individuals to properly abandon unused private wells. Unused wells are a direct line for contamination into clean ground water.

Wisconsin Wetland Conservation Trust in Lieu Fee Mitigation Program (WWCT): Land trusts, conservation groups, government organizations, or Wisconsin landowners may apply for a WWCT grant to preserve, enhance, and restore wetland resources in Wisconsin.

Knowles-Nelson Stewardship Program (K-N): Funds are provided to local units of government and nonprofit conservation organizations for land acquisition and recreational development statewide.

Surface Water Grants:

- AIS Prevention and Control Grants - share the costs of aquatic invasive species education programs that teach about the threats posed by invasive species and how to prevent and control them. These grants also help with projects that prevent new introductions, control existing populations, and restore habitat.
- Lake Protection Grants -assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems.

- River Protection Grants – provide assistance in the formation of river management organizations and provides support and guidance to local organizations that are interested in helping to manage and protect rivers, particularly where resources and organizational capabilities may be limited. River management category can fund ordinance development and install BMPs.

United States Fish and Wildlife Service

Partners for Wildlife Program: The U.S. Fish and Wildlife Services provides technical and financial assistance to private landowners with a desire to provide suitable habitat for wildlife on their property.

Coastal Program: Provide funds for restoring and protecting fish and wildlife habitat on public and privately-owned lands.

United States Department of Agriculture: Natural Resource Conservation Service (NRCS)

Conservation Technical Assistance: NRCS assists land-users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. These conservation systems reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands. NRCS provides conservation planning to landowners.

Environmental Quality Incentive Program (EQIP): EQIP provides technical and financial help to farm and forest landowners for conservation practices that protect soil and water quality. Grassed waterways, stream fencing, critical area planting, manure management systems including storage structures and barnyard runoff protection, and many other conservation practices are eligible.

Great Lakes Restoration Initiative (EQIP-GLRI): To improve the health of the Great Lakes, the Natural Resource Conservation Service provides financial and technical resources to Manitowoc County landowners to improve water quality in the region. Through this Initiative, the Natural Resource Conservation Service focuses on helping farmers implement conservation practices that reduce erosion, improve water quality, and maintain agricultural productivity in selected watersheds.

Conservation Stewardship Program (CSP): CSP is a voluntary conservation program that encourages producers to continue to improve and maintain existing conservation activities as well as undertake additional conservation activities.

Conservation Reserve Program (CRP): CRP can reduce erosion, increase wildlife habitat, improve water quality, and increase forestland. Landowners set aside cropland with annual rental payments based on a bid. Tree planting, wildlife ponds, grass cover, and other environmental practices are eligible practices.

Conservation Reserve Enhancement Program (CREP): The Conservation Reserve Enhancement Program is an offshoot of the Conservation Reserve Program, the country's largest private-land conservation program. CREP targets high-priority conservation issues identified by local,

state, or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, landowners are paid an annual rental rate, along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary and the contract period is typically 10-15 years. Typical practices include filter strips and riparian buffers.

Agricultural Conservation Easement Program (ACEP): ACEP provides financial and technical assistance to help conserve agricultural lands and restore wetlands. Under the Agricultural Land Easements component, the Natural Resource Conservation Service helps state and local governments, Native American tribes, and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance wetlands that have been altered for agriculture.

6.0 RECOMMENDATIONS

In accordance with the WDNR Lake Management Planning Grant associated with this Plan (#LPL174620) the following comprehensive lake management recommendations are as outlined below.

1. Update aquatic plant inventory in 2025, and every five years thereafter, and evaluate future control efforts for Eurasian water milfoil and curly-leaf pondweed control on the lake. Funding sources include WDNR Surface Water Grants – AIS Education Prevention and Planning, and Lake Protection (Management Plan Implementation).
2. Work with partners and property owners to preserve and protect sensitive properties and restore and/or enhance stream and shoreline habitat, riparian and watershed wetlands and uplands to improve water quality within Wilke Lake. Funding sources shall include WDNR Knowles-Nelson Stewardship Program, WDNR Lake Protection and USFWS grants.
3. Enhance existing wetland connections to the lake to provide additional spawning and rearing habitat for fish (aquatic bulrush bed near north shore WDNR property), including fish stick installations. Funding sources include WDNR Surface Water Grants Lake Protection (Management Plan Implementation) and USFWS grants.
4. Incorporate WDNR fisheries management recommendations into the WLAA fish committee objectives.
5. Continue to monitor the lake and establish a tributary sample location for water quality using WisCALM or other protocols and expand the network of volunteer participation. Monitor the effectiveness of installed BMPs to evaluate if the Plans objectives have been achieved. This is a partnership between WDNR, MCLA and local volunteers.
6. Integrate watershed objectives with all current and proposed water quality strategies, administered or under the guidance of The Soil and Water Conservation Department. These activities can be funded by Manitowoc County and/or NRCS.

The proposed actions included within the Plan will be subject to ongoing monitoring and evaluation against objectives and target achievements. Proposed timeline for implementation is presented below in Table 6. Investments of time, resources and effort will be evaluated for success, and may be reallocated as part of an adaptive management approach. Modifications of approach, based on new data or changing understandings of the underlying systems, will be integrated as the Project proceeds. Projects not identified in the list above may be funded by WDNR as long as they meet the objectives and strategies of this Plan.

Table 6. Timeline for Management Recommendations

Management Plan Recommendations	Timeline
Update aquatic plant inventory	2025- Apply for funding and perform aquatic plant survey

Preserve and protect sensitive properties and restore and/or enhance stream and shoreline habitat, wetlands, and upland buffers	2022 - Engage interested landowners
Provide additional spawning and rearing habitat for fish	2022 - Engauge interested landowners and seek funding
Incorporate fisheries recommendations	2021+ - Adopt recommendations and begin implementation
Monitor lake and new location on downstream tributary for water quality	2021+ - On-going monitoring will continue

7.0 REFERENCES

Carpenter SR, Lathrop RC. 2014. Phosphorus loading, transport and concentrations in a lake chain: a probabilistic model to compare management options. Aquatic Sciences 76:145–54.

Eggers, S., and D. Reed, *Wetland Plants and Plant Communities of Minnesota and Wisconsin*, U.S. Army Corps of Engineers, St. Paul District, December 1987.

Fassett, N., *A Manual of Aquatic Plants*, The University of Wisconsin Press, Madison, Wisconsin, 1975.

Hogler, S., Surendonk, S., Shrovnal,J. 2018. 2018 Wilke Lake Comprehensive Fish Survey. Unpublished Memorandum dated 2018. Wisconsin Department of Natural Resources. 26 pp.

Horne, A., and C. Goldman, *Limnology*, McGraw-Hill, New York, 1994.

Hotchkiss, N., *Common Marsh, Underwater and Floating-Leaved Plants of the United States and Canada*, Dover Publications, Incorporated, New York, 1972.

Jensen, R., and R. Loud, *An Evaluation of a Survey Technique For Submerged Aquatic Plants*, Minnesota Department of Conservation Game, Investigation Report No. 6.

Krueger, Ronald K. (District Biologist), *A Shoreline and Water Quality Evaluation of Wilke Lake in Manitowoc County*, Wisconsin Department of Natural Resources, May 16, 1972.

Lillie, R., and J. Mason, *Limnological Characteristics of Wisconsin Lakes*, Wisconsin Department of Natural Resources Technical Bulletin No. 138, Madison, Wisconsin, 1983.

Motew, M., Chen, X., Booth, E.G., Carpenter, S.R., Pinkas, P., Zipper, S.C., Loheide, S.P., Donner, S.D., Tsuruta, K., Vadas, P.A. and Kucharik, C.J., 2017. The Influence of Legacy P on Lake Water Quality in a Midwestern Agricultural Watershed. Ecosystems 1-15.

Nonpoint Source Control Plan for the Sheboygan River Priority Watershed Project, Wisconsin Department of Natural Resources, et.al., Publication WR-265-93, July 1993.

Olem, H., and G. Flock, eds., *Lake and Reservoir Restoration Guidance Manual, 2nd Edition*, EPA 440/4-90-006. Prepared by N. Am. Lake Manage, Soco for the U.S.E.P.A., Washington D.C., 1990.

Prescott, G., *How To Know the Aquatic Plants*, Brown Publishers, Dubuque, Iowa, 1980.

School Hill Quadrangle, Wisconsin, *7.5 Minute Series, United States Geological Survey*, 1973.

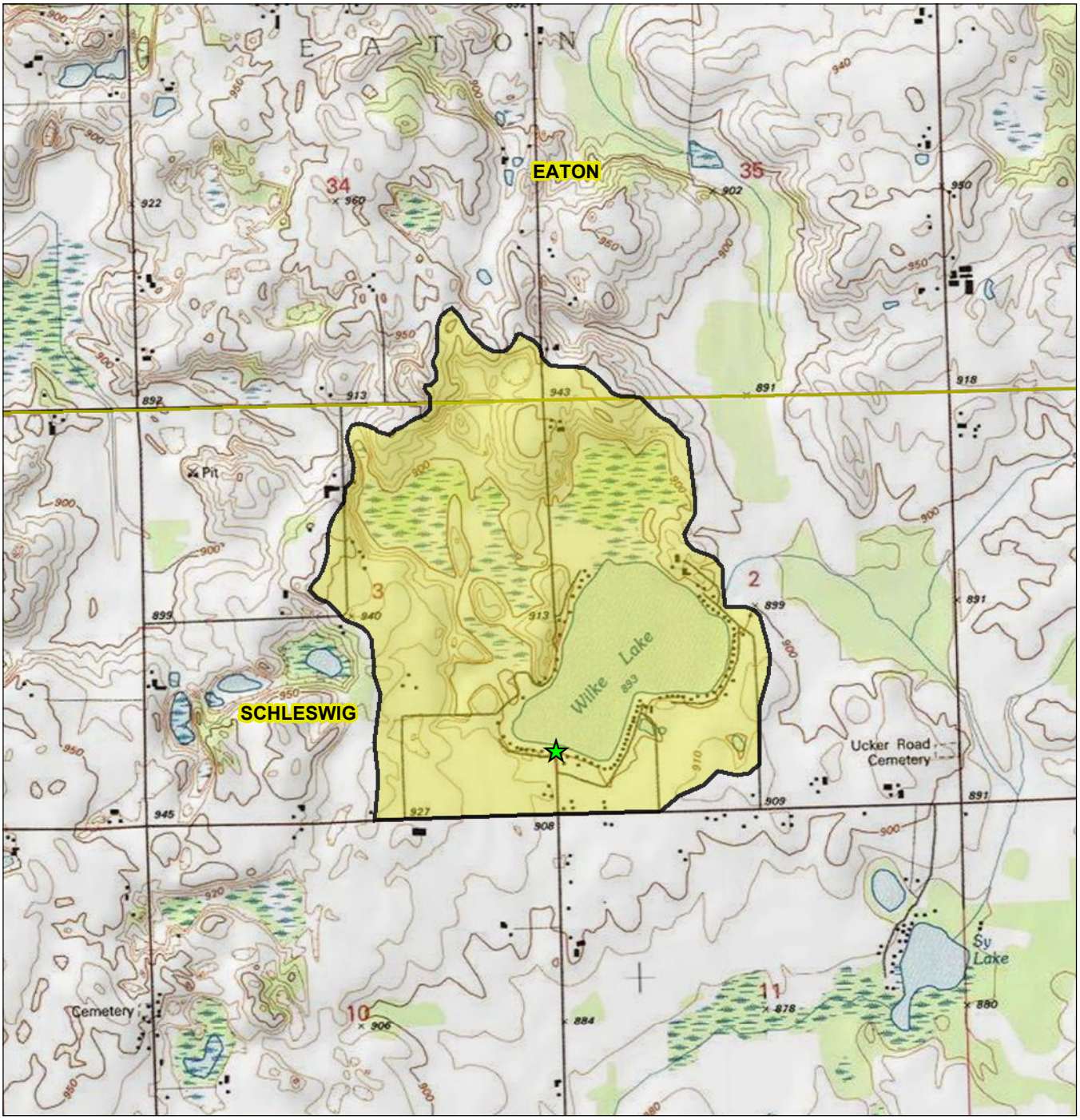
Shaw, B., C. Mechenich, and L. Klessig, *Understanding Lake Data*, University of Wisconsin Extension Publication G3582, Madison, Wisconsin.

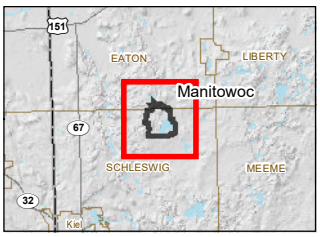
SRBP. 2020. Watershed – Sheboygan River [web page]. https://business.sheboygan.org/list/member/sheboygan-river-basin-partnership-12956. Accessed 11/20/2020

Wisconsin Department of Natural Resources, *Directory of State and Federal Financial Assistance Programs*, PUBL-CA-001-93, September 1993.

Wisconsin Department of Natural Resources [WDNR]. 2017. Spiny waterflea [web page]. http://dnr.wi.gov/lakes/invasives/AISLists.aspx?species=SPINY_WATERFLEA.

Appendix A – FIGURES





Legend

- Wilke Lake Watershed (697 acres)
- Public Access

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Stantec

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR
3. Background: USGS 7.5 Topographic Quadrangles

Project Location
T17N, R21E, S02 & S03
T. of Schleswig, Manitowoc Co., WI

Prepared by AJS on 2020-11-19
TR by MP on 2020-11-19
IR by BL on 2020-03-10

Client/Project 193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Lake Management Plan

Figure No.
1

Title
Project Location Overview

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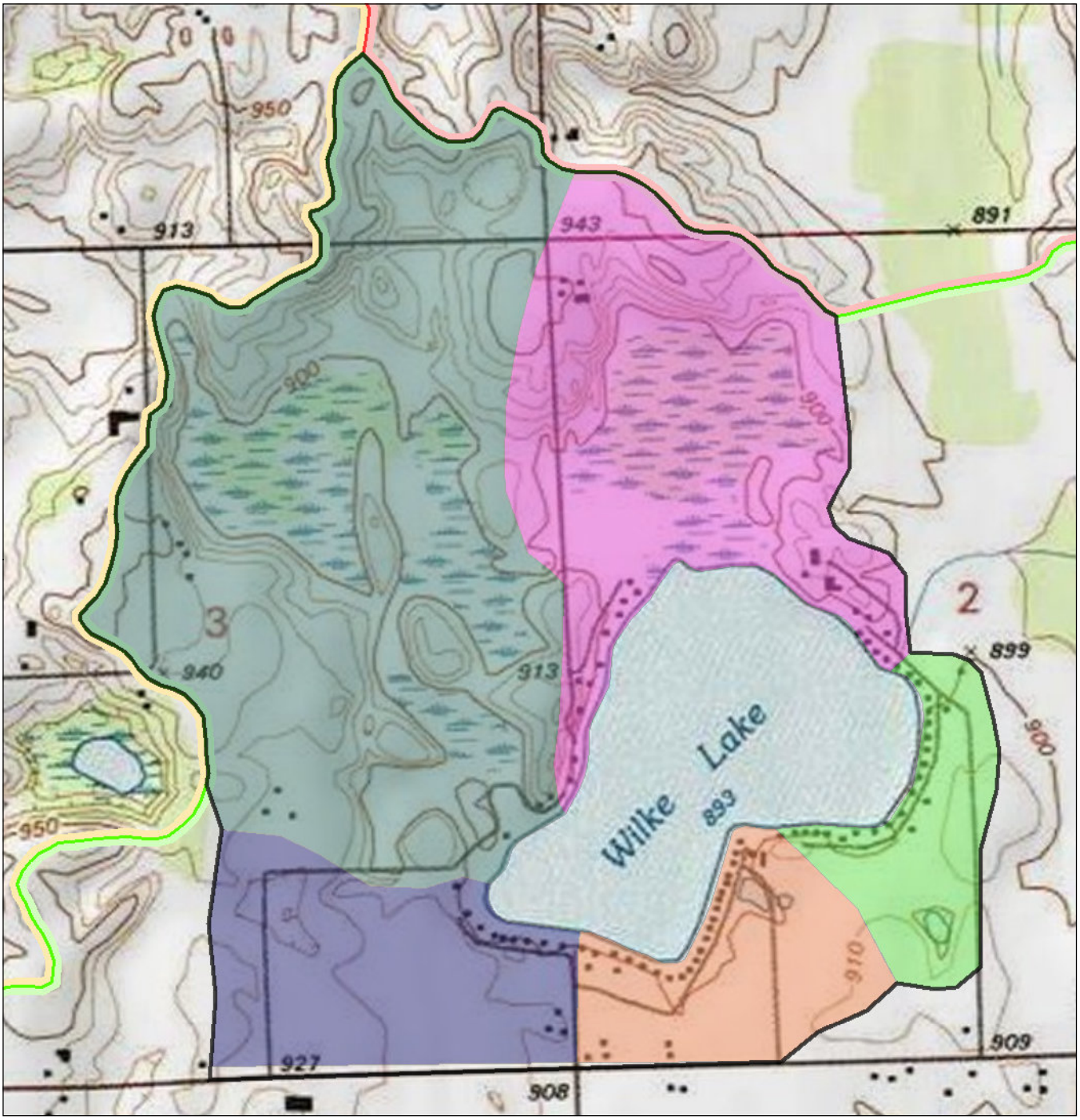

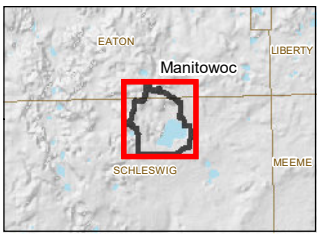

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1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR
3. Background: USGS 7.5 Topographic Quadrangles

Legend

- Wilke Lake Watershed (697 acres)

Sub-Basin

- SP1
- SP2
- SP3
- SP4
- SP5

HUC-12 Watershed

- Cedar Creek
- Cedar Lake
- Lake Oschwald-Mud Creek

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Stantec

Project Location
T17N, R21E, S02 & S03
T. of Schleswig, Manitowoc Co., WI

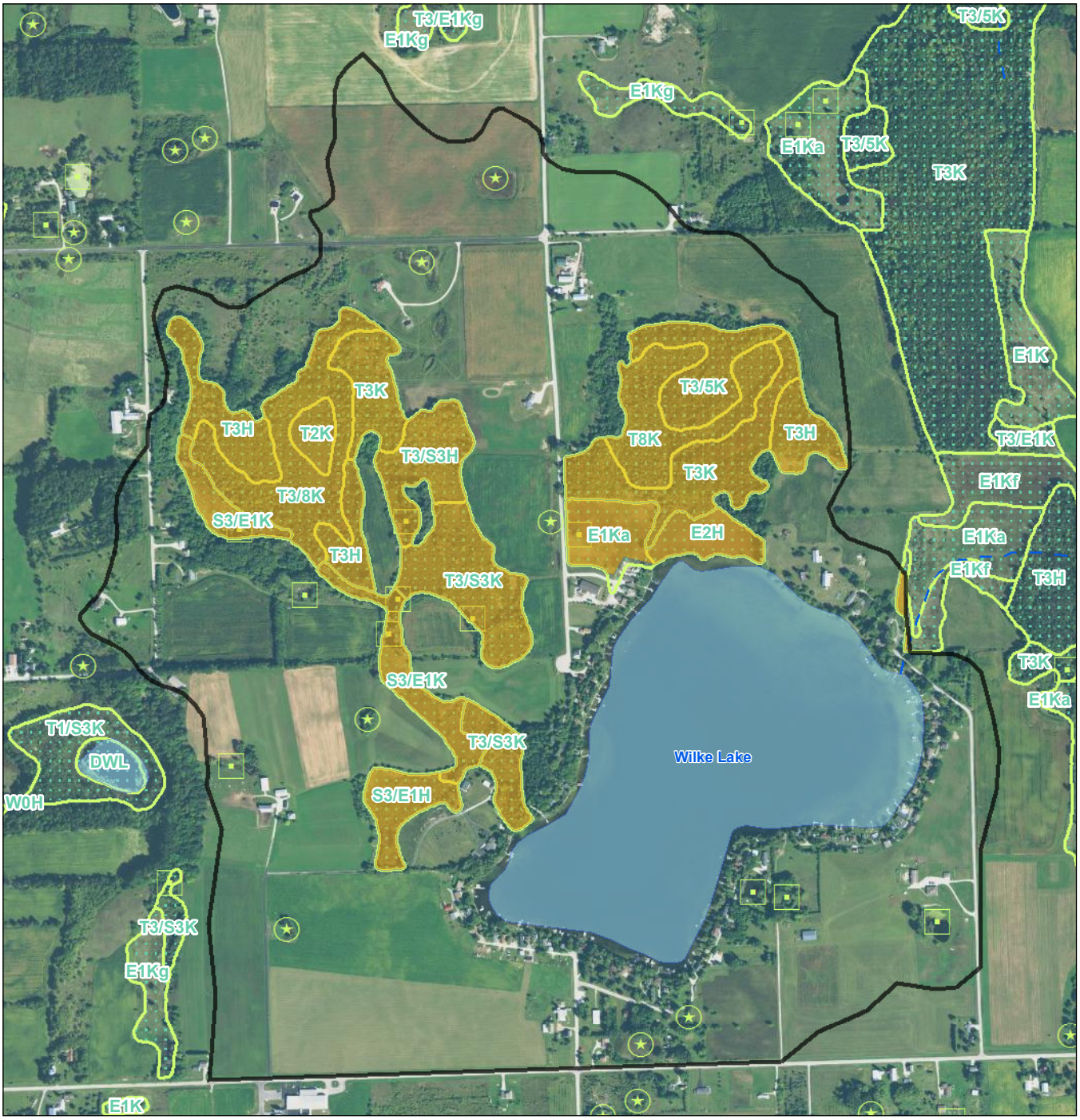
Prepared by AJS on 2020-11-19
TR by MP on 2020-11-19
IR by BL on 2020-03-10

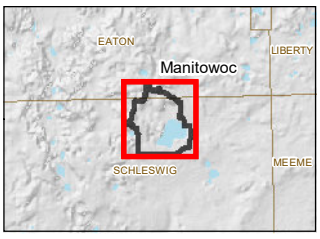
Client/Project
193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Lake Management Plan

Figure No.
6

Title
Subwatershed Boundaries

V:\1937\Active\193707716\03_data\gis_cad\gis\mxds\Management_Plan\fig4_watersheds_193707716.mxd Revised: 2021-03-10 By: aswaim





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1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR
3. Orthophotography: 2018 NAIP

Legend

- Wilke Lake Watershed (697 acres)
- Wetland Preservation Measures

WWI Wetland Class Areas

- Wetland

WWI Wetland Class Points

- Excavated Pond
- Wetland Too Small to Delineate

DNR 24k Hydrography

- Perennial Stream
- Intermittent Stream*
- Waterbody

*No features within data frame

0 500 1,000 Feet

(At original document size of 8.5x11)
1:12,000

N

Stantec

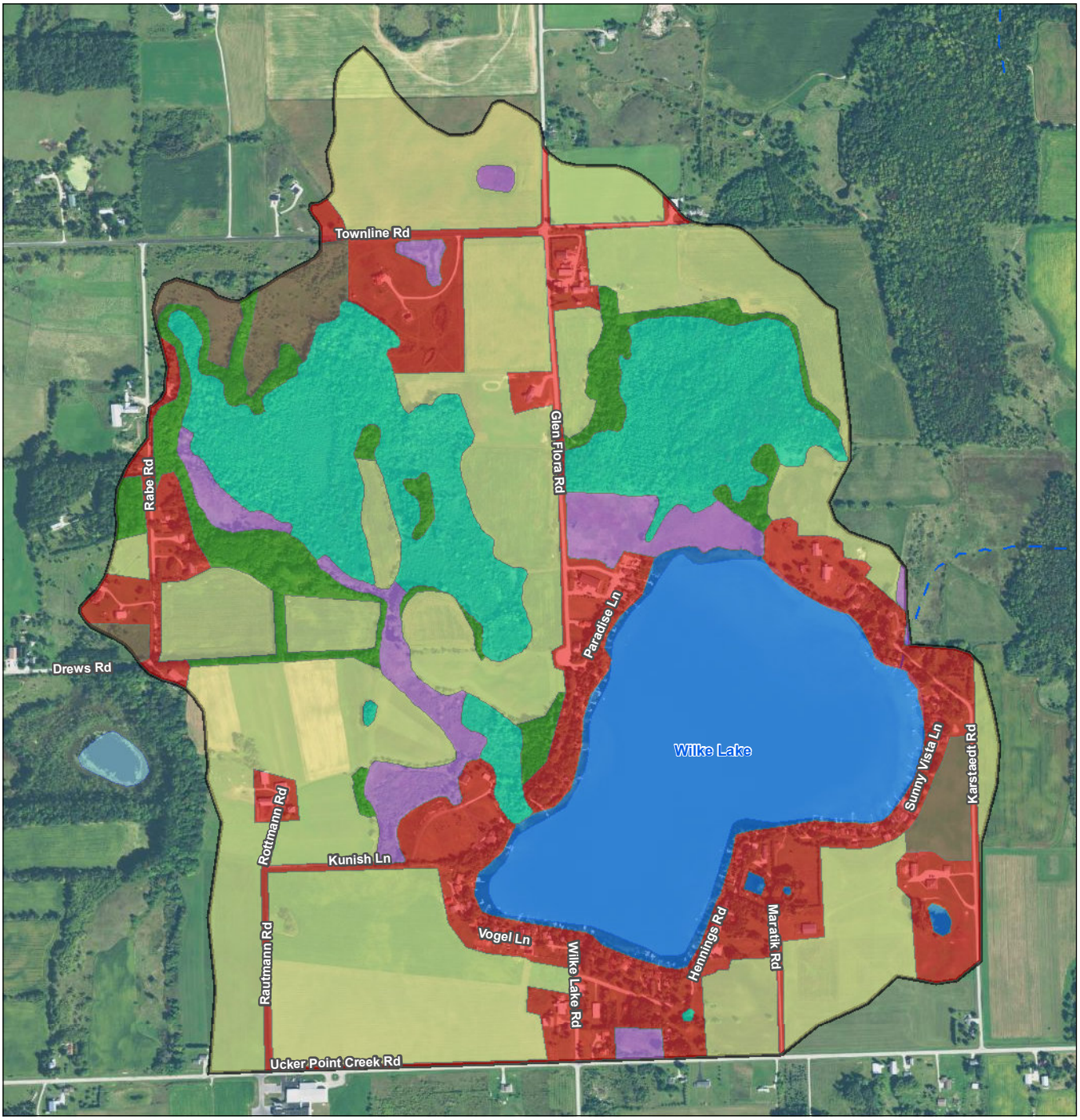
Project Location
T17N, R21E, S02 & S03
T. of Schleswig, Manitowoc Co., WI

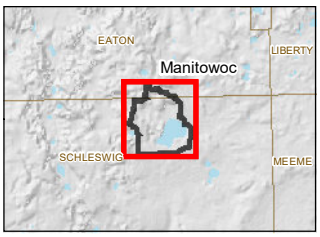
Prepared by AJS on 2020-11-19
TR by MP on 2020-11-19
IR by BL on 2020-03-10

Client/Project 193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Lake Management Plan

Figure No.
7

Title
Recommended Conservation Practices





Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR
3. Orthophotography: 2018 NAIP

Legend

- Wilke Lake Watershed (697 acres)

Land Cover

- Agriculture
- Developed
- Emergent/Wet Meadow
- Forested
- Forested Wetland
- Open Water
- Pasture/Grassland

DNR 24k Hydrography

- Perennial Stream
- Intermittent Stream*
- Waterbody

0 500 1,000 Feet

(At original document size of 8.5x11)
1:12,000

N

Stantec

Project Location
T17N, R21E, S02 & S03
T. of Schleswig, Manitowoc Co., WI

Prepared by AJS on 2020-11-19
TR by MP on 2020-11-19
IR by BL on 2020-03-10

Client/Project 193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Lake Management Plan

Figure No.
8

Title
Land Cover

*No features within data frame

Appendix B MANITOWOC COUNTY CONSERVATION PRACTICES

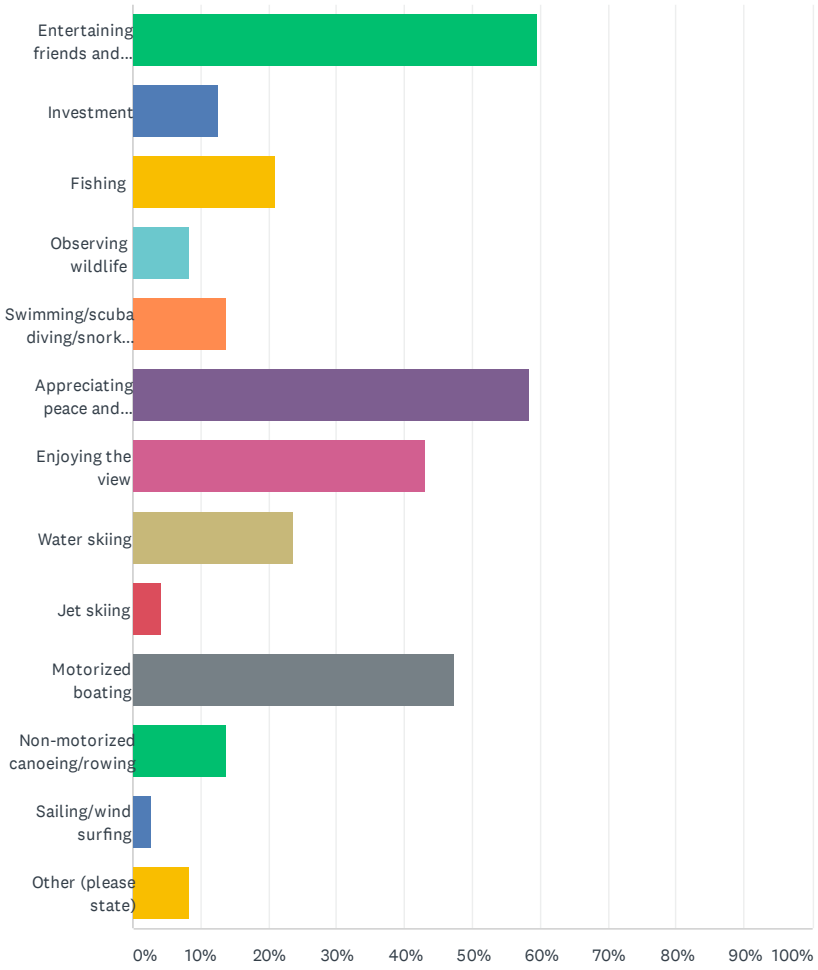
Manitowoc County Soil and Water Conservation Department Practices

Priority Practice	Purpose
Manure Storage Facilities	Allows farmers to store manure until optimum spreading times. This facilitates application of animal waste during seasons when there is decreased runoff vulnerability.
Barnyard Runoff Control Systems	Diverts clean water away from barnyards. Runoff is either collected or filtered to reduce or eliminate discharge. Types include: containments, collection devices, clean water diversions, roofs, grass filters, settling basins, and fencing.
Grassed Waterways	Prevents gully erosion, reduces nutrient and sediment runoff and protects water quality.
Wetland Restorations & Sediment Retention Basins	Traps and treats sediment and nutrients, reduces flooding and provides wildlife habitat.
Conservation Buffers	Traps sediment and nutrients from cropland runoff, provides setback area between cropland application of fertilizer and pesticide and waterways, and provides wildlife habitat.
Conservation Easements	Permanent protection of restored wetlands or stream corridor areas.
Nutrient Management Plans	Intended to minimize nutrient entry into surface water, groundwater, and atmospheric resources while maintaining and improving the physical, chemical, and biological condition of the soil. (30% of cropland is NOT certified in NMP)
Conservation Crop Rotations	Reduces sheet, rill and wind erosion, manages balance of plant nutrients, manages plant pests, and improves soil organic matter content.
Vegetated Treatment Areas	Absorb nutrients, organics, pathogens, and other contaminants associated with livestock, poultry and other agricultural operations.
Feed leachate and milkhouse waste control systems	Reduce or eliminates milking center waste water discharge and discharge from field storage structures.
Cover Crops	Improve soil health, improve soil structure, increase organic matter, manage excess nutrients in the soil, minimize soil compaction, promote nitrogen fixation, and reduce erosion.
Reduced Tillage	Reduce erosion, improve soil condition, reduce energy use, provide food and escape cover for wildlife.
Subsurface Drainage	Repair tile blowouts to eliminate transfer of manure and nutrients to surface water.

Appendix C WILKE LAKE OPINION SURVEY

Q1 Why did you keep property on Wilke lake? (Choose your top three reasons)

Answered: 72 Skipped: 1

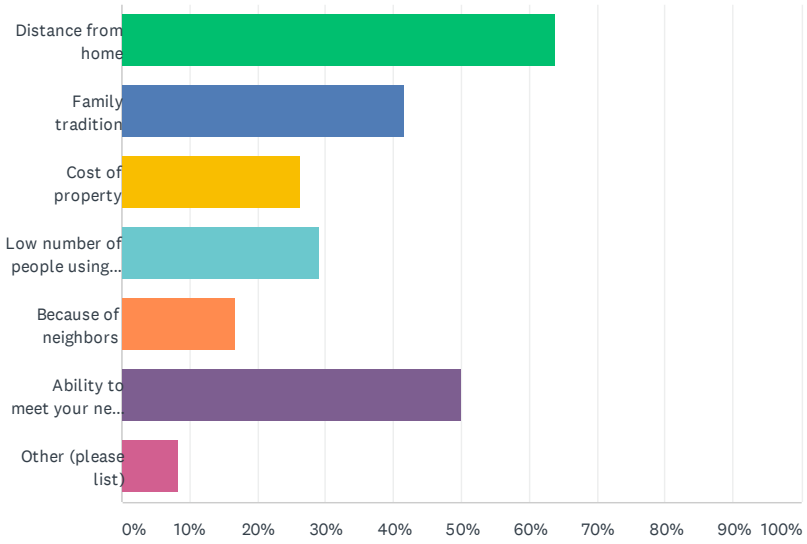


ANSWER CHOICES	RESPONSES	
Entertaining friends and relatives	59.72%	43
Investment	12.50%	9
Fishing	20.83%	15
Observing wildlife	8.33%	6
Swimming/scuba diving/snorkeling	13.89%	10
Appreciating peace and tranquility	58.33%	42
Enjoying the view	43.06%	31
Water skiing	23.61%	17
Jet skiing	4.17%	3
Motorized boating	47.22%	34
Non-motorized canoeing/rowing	13.89%	10
Sailing/wind surfing	2.78%	2
Other (please state)	8.33%	6
Total Respondents: 72		

#	OTHER (PLEASE STATE)	DATE
1	Family property	8/7/2020 8:50 PM
2	Tubing	7/28/2020 4:55 PM
3	Wilke Lake is our home	7/13/2020 9:25 AM
4	It's our primary residence	7/9/2020 9:12 PM
5	Escape - Mini Vacation - Time with FAMILY & Kids (Swimming, Skiing, Tubing, boat rides)	7/9/2020 6:50 PM
6	We have 4 generation enjoying the property. Owned this property for over 60 years.	7/9/2020 4:14 PM

Q2 Why did you choose property on Wilke lake? (Choose your top three reasons)

Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Distance from home	63.89%	46
Family tradition	41.67%	30
Cost of property	26.39%	19
Low number of people using the lake	29.17%	21
Because of neighbors	16.67%	12
Ability to meet your needs from Question 1	50.00%	36
Other (please list)	8.33%	6
Total Respondents: 72		

#	OTHER (PLEASE LIST)	DATE
1	year round home	9/13/2020 8:12 AM
2	Family owned for 48 years	8/10/2020 11:25 AM
3	Privacy	7/29/2020 7:07 AM
4	Friends on lake	7/11/2020 2:08 PM
5	It was in the family for three generations	7/10/2020 10:01 AM
6	Not steep walk to the lake	7/9/2020 9:51 PM

Q3 Approximately how many feet of lake frontage do you own on Wilke lake?

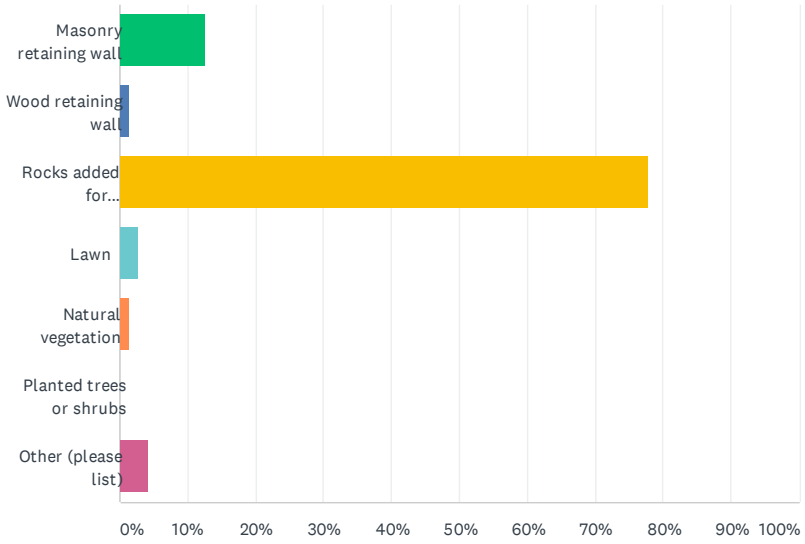
Answered: 70 Skipped: 3

#	RESPONSES	DATE
1	120	9/13/2020 8:12 AM
2	100	8/12/2020 4:57 PM
3	100	8/11/2020 9:28 AM
4	60	8/10/2020 7:37 PM
5	50 feet	8/10/2020 5:45 PM
6	80	8/10/2020 3:19 PM
7	55	8/10/2020 1:33 PM
8	72	8/10/2020 11:25 AM
9	105	8/8/2020 2:24 PM
10	75	8/7/2020 8:50 PM
11	67	8/4/2020 7:58 PM
12	50ft	8/3/2020 4:10 PM
13	50	8/3/2020 8:58 AM
14	14 feet	8/2/2020 1:52 PM
15	238'	8/1/2020 1:52 PM
16	180ft.	8/1/2020 1:26 PM
17	60	7/30/2020 10:54 PM
18	50	7/30/2020 9:19 PM
19	86	7/30/2020 6:20 PM
20	375 feet	7/29/2020 7:07 AM
21	90	7/29/2020 6:43 AM
22	50	7/28/2020 7:56 PM
23	114	7/28/2020 6:37 PM
24	62	7/28/2020 5:01 PM
25	100ft	7/28/2020 4:55 PM
26	110	7/28/2020 4:46 PM
27	50	7/28/2020 4:29 PM
28	51 feet	7/28/2020 4:25 PM
29	120	7/28/2020 4:24 PM
30	100	7/28/2020 4:10 PM
31	50	7/28/2020 3:54 PM
32	127	7/28/2020 3:52 PM
33	50	7/26/2020 7:21 PM
34	120	7/25/2020 11:04 AM
35	71	7/20/2020 10:55 PM
36	50	7/17/2020 9:31 AM
37	40 feet	7/16/2020 9:59 PM
38	100	7/16/2020 6:09 PM
39	82	7/16/2020 5:49 PM
40	100	7/16/2020 3:58 PM
41	75	7/16/2020 1:16 PM
42	75	7/13/2020 6:42 PM
43	124	7/13/2020 3:33 PM
44	50	7/13/2020 2:09 PM
45	100	7/13/2020 11:00 AM
46	75	7/13/2020 9:25 AM
47	100	7/11/2020 2:08 PM
48	68	7/10/2020 2:55 PM

49	51	7/10/2020 12:58 PM
50	80	7/10/2020 10:01 AM
51	90	7/10/2020 9:49 AM
52	68	7/10/2020 7:32 AM
53	100	7/9/2020 10:21 PM
54	50	7/9/2020 9:51 PM
55	100'	7/9/2020 9:12 PM
56	60	7/9/2020 7:36 PM
57	50	7/9/2020 7:35 PM
58	100	7/9/2020 7:19 PM
59	60	7/9/2020 6:50 PM
60	90	7/9/2020 6:47 PM
61	100	7/9/2020 5:48 PM
62	100	7/9/2020 5:46 PM
63	60	7/9/2020 4:34 PM
64	55	7/9/2020 4:18 PM
65	?	7/9/2020 4:14 PM
66	100	7/9/2020 4:06 PM
67	135	7/9/2020 4:06 PM
68	100	7/9/2020 4:05 PM
69	70	7/9/2020 4:04 PM
70	100	7/9/2020 4:02 PM

Q4 Which of the following best describes the lake frontage on your Wilke lake property? (Choose one)

Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Masonry retaining wall	12.50%	9
Wood retaining wall	1.39%	1
Rocks added for stabilization	77.78%	56
Lawn	2.78%	2
Natural vegetation	1.39%	1
Planted trees or shrubs	0.00%	0
Other (please list)	4.17%	3
TOTAL		72

#	OTHER (PLEASE LIST)	DATE
1	combination of riprap and natural	7/28/2020 4:46 PM
2	natural rocks and some seawall	7/13/2020 2:09 PM
3	rip/rap	7/9/2020 7:35 PM

Q5 How many of the following watercraft(s) are kept at your property on Wilke lake?

Answered: 72 Skipped: 1

ANSWER CHOICES	RESPONSES	
Canoes	48.61%	35
Sailboats	15.28%	11
Rowboats	25.00%	18
Jet skis	40.28%	29
Motor boats under 25 HP	20.83%	15
Motor boats over 25 HP	88.89%	64
Rafts	31.94%	23
Other (please list)	47.22%	34

#	CANOES	DATE
1	one	8/10/2020 5:45 PM
2	1	8/10/2020 11:25 AM
3	1	8/8/2020 2:24 PM
4	1	8/7/2020 8:50 PM
5	1	8/4/2020 7:58 PM
6	0	8/3/2020 8:58 AM
7	3	7/30/2020 10:54 PM
8	1	7/30/2020 9:19 PM
9	1	7/29/2020 7:07 AM
10	1	7/29/2020 6:43 AM
11	2	7/28/2020 7:56 PM
12	1	7/28/2020 5:01 PM
13	4	7/28/2020 4:55 PM
14	1	7/28/2020 4:46 PM
15	1	7/28/2020 4:25 PM
16	3	7/28/2020 4:24 PM
17	0	7/28/2020 3:52 PM
18	1	7/26/2020 7:21 PM
19	1	7/25/2020 11:04 AM
20	1	7/20/2020 10:55 PM
21	0	7/16/2020 3:58 PM
22	1	7/16/2020 1:16 PM
23	1	7/13/2020 6:42 PM
24	3	7/13/2020 3:33 PM
25	2	7/13/2020 2:09 PM
26	1	7/10/2020 12:58 PM
27	1	7/10/2020 11:01 AM
28	1	7/10/2020 7:32 AM
29	1	7/9/2020 7:36 PM
30	1	7/9/2020 7:19 PM
31	3	7/9/2020 6:50 PM
32	1	7/9/2020 5:46 PM
33	3	7/9/2020 4:06 PM
34	1	7/9/2020 4:06 PM
35	1	7/9/2020 4:05 PM

#	SAILBOATS	DATE
1	three	8/10/2020 5:45 PM
2	1	8/10/2020 3:19 PM
3	0	8/3/2020 8:58 AM
4	0	7/29/2020 6:43 AM
5	0	7/28/2020 4:55 PM
6	0	7/28/2020 3:52 PM
7	3	7/26/2020 7:21 PM
8	0	7/16/2020 3:58 PM
9	1	7/13/2020 2:09 PM
10	0	7/9/2020 6:50 PM
11	0	7/9/2020 4:06 PM

#	ROWBOATS	DATE
1	none	8/10/2020 5:45 PM
2	1	8/10/2020 11:25 AM
3	1	8/7/2020 8:50 PM
4	0	8/3/2020 8:58 AM
5	1	8/1/2020 1:26 PM
6	1	7/29/2020 7:07 AM
7	0	7/29/2020 6:43 AM
8	0	7/28/2020 4:55 PM
9	0	7/28/2020 3:52 PM
10	1	7/16/2020 5:49 PM
11	0	7/16/2020 3:58 PM
12	1	7/10/2020 11:01 AM
13	1	7/9/2020 10:21 PM
14	1	7/9/2020 9:12 PM
15	1	7/9/2020 6:50 PM
16	1	7/9/2020 4:34 PM
17	0	7/9/2020 4:06 PM
18	1	7/9/2020 4:02 PM

#	JET SKIS	DATE
1	1	8/12/2020 4:57 PM
2	1	8/10/2020 7:37 PM
3	none	8/10/2020 5:45 PM
4	1	8/10/2020 11:25 AM
5	0	8/3/2020 8:58 AM
6	1	7/29/2020 7:07 AM
7	0	7/29/2020 6:43 AM
8	2	7/28/2020 6:37 PM
9	0	7/28/2020 4:55 PM
10	1	7/28/2020 4:29 PM
11	1	7/28/2020 4:24 PM
12	1	7/28/2020 3:54 PM
13	0	7/28/2020 3:52 PM
14	1	7/17/2020 9:31 AM
15	1	7/16/2020 6:09 PM
16	1	7/16/2020 3:58 PM
17	1	7/13/2020 2:09 PM
18	Yes	7/10/2020 2:55 PM
19	2	7/10/2020 9:49 AM
20	1	7/10/2020 7:32 AM
21	1	7/9/2020 10:21 PM
22	1	7/9/2020 9:12 PM
23	1	7/9/2020 7:36 PM
24	1	7/9/2020 6:50 PM
25	2	7/9/2020 5:48 PM
26	1	7/9/2020 4:34 PM
27	0	7/9/2020 4:06 PM
28	1	7/9/2020 4:05 PM
29	1	7/9/2020 4:04 PM

#	MOTOR BOATS UNDER 25 HP	DATE
1	one 70 HP	8/10/2020 5:45 PM
2	1	8/10/2020 11:25 AM
3	0	8/3/2020 8:58 AM
4	1	8/1/2020 1:52 PM
5	1	8/1/2020 1:26 PM
6	0	7/28/2020 4:55 PM
7	0	7/28/2020 3:52 PM
8	1	7/16/2020 6:09 PM
9	1	7/16/2020 3:58 PM
10	1	7/13/2020 2:09 PM
11	1	7/9/2020 9:12 PM
12	0	7/9/2020 6:50 PM
13	0	7/9/2020 4:06 PM
14	1	7/9/2020 4:06 PM
15	1	7/9/2020 4:04 PM

#	MOTOR BOATS OVER 25 HP	DATE
1	yes	8/11/2020 9:28 AM
2	1	8/10/2020 7:37 PM
3	1	8/10/2020 3:19 PM
4	1	8/10/2020 1:33 PM
5	1	8/10/2020 11:25 AM
6	1	8/10/2020 11:25 AM
7	1	8/8/2020 2:24 PM
8	1	8/7/2020 8:50 PM
9	1	8/4/2020 7:58 PM
10	1	8/3/2020 4:10 PM
11	1	8/3/2020 8:58 AM
12	1	8/2/2020 1:52 PM
13	2	8/1/2020 1:52 PM
14	1	8/1/2020 1:26 PM
15	1	7/30/2020 10:54 PM
16	2	7/30/2020 9:19 PM
17	1	7/30/2020 6:20 PM
18	1	7/29/2020 7:07 AM
19	2	7/29/2020 6:43 AM
20	1	7/28/2020 7:56 PM
21	1	7/28/2020 6:37 PM
22	2	7/28/2020 5:01 PM
23	1	7/28/2020 4:55 PM
24	1	7/28/2020 4:46 PM
25	1	7/28/2020 4:29 PM
26	1	7/28/2020 4:25 PM
27	1	7/28/2020 4:24 PM
28	1	7/28/2020 4:10 PM
29	1	7/28/2020 3:54 PM
30	1	7/28/2020 3:52 PM
31	1	7/26/2020 7:21 PM
32	1	7/25/2020 11:04 AM
33	1	7/20/2020 10:55 PM
34	1	7/17/2020 9:31 AM
35	1	7/16/2020 9:59 PM
36	1	7/16/2020 6:09 PM
37	1	7/16/2020 5:49 PM
38	1	7/16/2020 3:58 PM
39	1	7/16/2020 1:16 PM
40	1	7/13/2020 6:42 PM
41	1	7/13/2020 3:33 PM
42	2	7/13/2020 11:00 AM
43	1	7/13/2020 9:25 AM
44	1	7/11/2020 2:08 PM
45	Yes…2	7/10/2020 2:55 PM
46	1	7/10/2020 12:58 PM
47	1	7/10/2020 10:01 AM
48	1	7/10/2020 9:49 AM

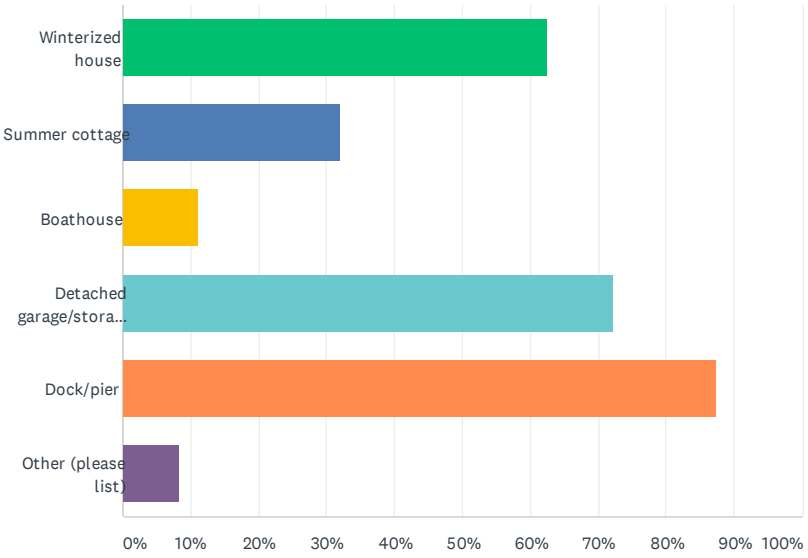
49	2	7/10/2020 7:32 AM
50	1	7/9/2020 10:21 PM
51	1	7/9/2020 9:51 PM
52	2(includes pontoon)	7/9/2020 7:36 PM
53	1	7/9/2020 7:35 PM
54	1	7/9/2020 6:50 PM
55	1	7/9/2020 6:47 PM
56	2	7/9/2020 5:48 PM
57	1	7/9/2020 5:46 PM
58	1	7/9/2020 4:34 PM
59	1	7/9/2020 4:18 PM
60	1	7/9/2020 4:06 PM
61	1	7/9/2020 4:06 PM
62	2	7/9/2020 4:05 PM
63	1	7/9/2020 4:04 PM
64	1	7/9/2020 4:02 PM

#	RAFTS	DATE
1	1	8/10/2020 7:37 PM
2	one	8/10/2020 5:45 PM
3	1	8/7/2020 8:50 PM
4	1	8/4/2020 7:58 PM
5	1	8/3/2020 4:10 PM
6	1	8/3/2020 8:58 AM
7	1	8/1/2020 1:52 PM
8	0	7/29/2020 6:43 AM
9	1	7/28/2020 7:56 PM
10	2	7/28/2020 4:55 PM
11	1	7/28/2020 4:24 PM
12	1	7/28/2020 4:10 PM
13	1	7/28/2020 3:52 PM
14	1	7/13/2020 11:00 AM
15	1	7/9/2020 10:21 PM
16	1	7/9/2020 9:51 PM
17	3	7/9/2020 9:12 PM
18	1	7/9/2020 7:36 PM
19	1	7/9/2020 7:35 PM
20	0	7/9/2020 6:50 PM
21	3	7/9/2020 4:34 PM
22	1	7/9/2020 4:06 PM
23	1	7/9/2020 4:05 PM

#	OTHER (PLEASE LIST)	DATE
1	pontoon	9/13/2020 8:12 AM
2	2 kayak, 1 paddle board, 1 paddle boat	8/10/2020 7:37 PM
3	2 kayaks	8/10/2020 1:33 PM
4	Paddle boat	8/10/2020 11:25 AM
5	Kayak	8/8/2020 2:24 PM
6	Kyacks	8/7/2020 8:50 PM
7	1 pedal boat	8/4/2020 7:58 PM
8	5 kayaks, 1 paddle board	8/3/2020 8:58 AM
9	kayak 2 paddle board 1	8/2/2020 1:52 PM
10	Paddle boat	7/30/2020 9:19 PM
11	Paddle boards	7/30/2020 6:20 PM
12	2 kayaks	7/29/2020 6:43 AM
13	paddle boat	7/28/2020 5:01 PM
14	0	7/28/2020 4:55 PM
15	1 inflatable kayak	7/28/2020 4:46 PM
16	2 kayaks	7/28/2020 4:25 PM
17	Paddle boat, kayaks	7/26/2020 7:21 PM
18	2 kayak	7/25/2020 11:04 AM
19	paddle board, 4 kayaks	7/17/2020 9:31 AM
20	4 kayaks	7/16/2020 5:49 PM
21	2 kayak, 1 standup paddleboard	7/16/2020 3:58 PM
22	1 paddle boat	7/13/2020 2:09 PM
23	2 Kayaks	7/13/2020 9:25 AM
24	3	7/11/2020 2:08 PM
25	Kayak	7/10/2020 12:58 PM
26	paddle boat	7/10/2020 11:01 AM
27	1 paddle boat 1 kayak	7/10/2020 10:01 AM
28	5 kayaks, paddlebooards, paddleboat	7/9/2020 9:51 PM
29	paddle boat	7/9/2020 7:35 PM
30	Kayaks 4	7/9/2020 6:47 PM
31	kayaks (4)	7/9/2020 4:34 PM
32	1 pontoon. 1 paddle boat	7/9/2020 4:14 PM
33	0	7/9/2020 4:06 PM
34	2 kayaks	7/9/2020 4:02 PM

Q6 What structures exist on your Wilke lake property? (Check all that apply)

Answered: 72 Skipped: 1

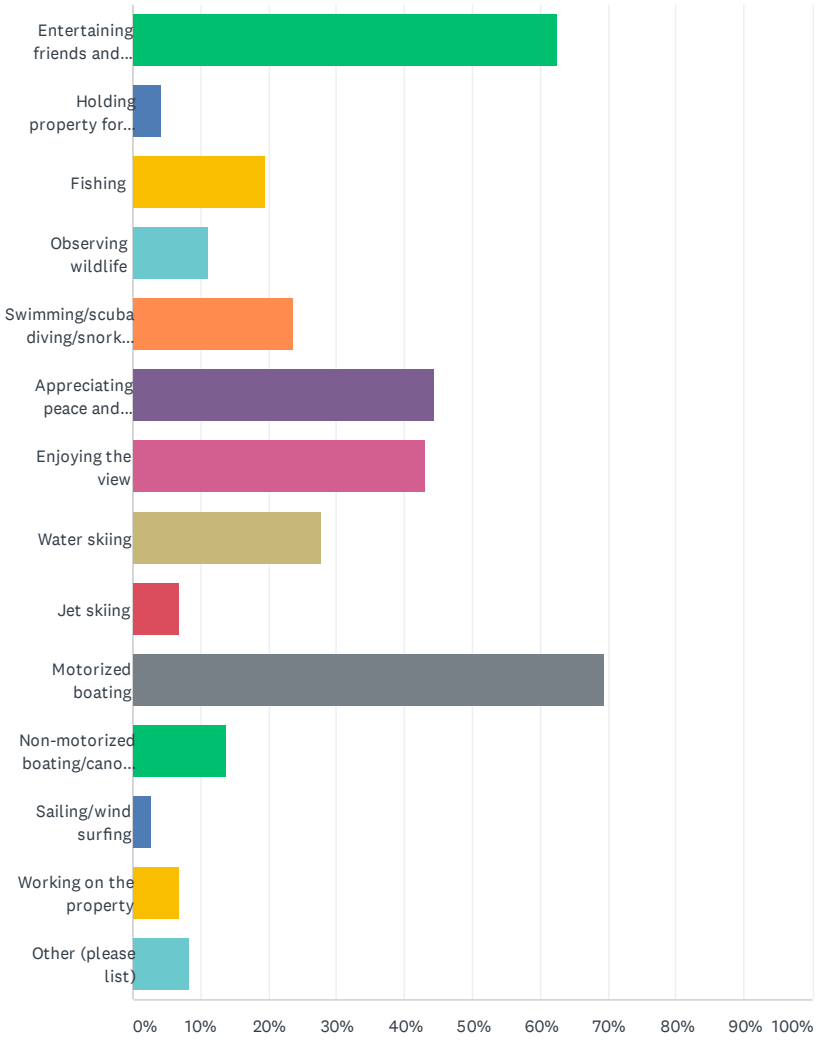


ANSWER CHOICES	RESPONSES	
Winterized house	62.50%	45
Summer cottage	31.94%	23
Boathouse	11.11%	8
Detached garage/storage shed	72.22%	52
Dock/pier	87.50%	63
Other (please list)	8.33%	6
Total Respondents: 72		

#	OTHER (PLEASE LIST)	DATE
1	full season cottage	8/1/2020 1:52 PM
2	Year round home	7/30/2020 6:20 PM
3	Year round resident	7/29/2020 7:07 AM
4	And vacant lot	7/11/2020 2:08 PM
5	pole building	7/9/2020 4:06 PM
6	year round home	7/9/2020 4:06 PM

Q7 How do you actually use your property and Wilke lake? (Choose your top three uses)

Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Entertaining friends and relatives	62.50%	45
Holding property for appreciation in value	4.17%	3
Fishing	19.44%	14
Observing wildlife	11.11%	8
Swimming/scuba diving/snorkeling	23.61%	17
Appreciating peace and tranquility	44.44%	32
Enjoying the view	43.06%	31
Water skiing	27.78%	20
Jet skiing	6.94%	5
Motorized boating	69.44%	50
Non-motorized boating/canoeing/rowing	13.89%	10
Sailing/wind surfing	2.78%	2
Working on the property	6.94%	5
Other (please list)	8.33%	6
Total Respondents: 72		

#	OTHER (PLEASE LIST)	DATE
1	Year round living	7/29/2020 7:07 AM
2	duplicate question please see #1	7/10/2020 11:01 AM
3	wake boarding	7/9/2020 9:51 PM
4	It's our personal residence	7/9/2020 9:12 PM
5	Kids swimming, skiing, tubing, sunning, relaxed	7/9/2020 6:50 PM
6	residence	7/9/2020 4:06 PM

Q8 Regardless of the amount of time you spend doing it, which use of your Wilke lake property is most important to you?

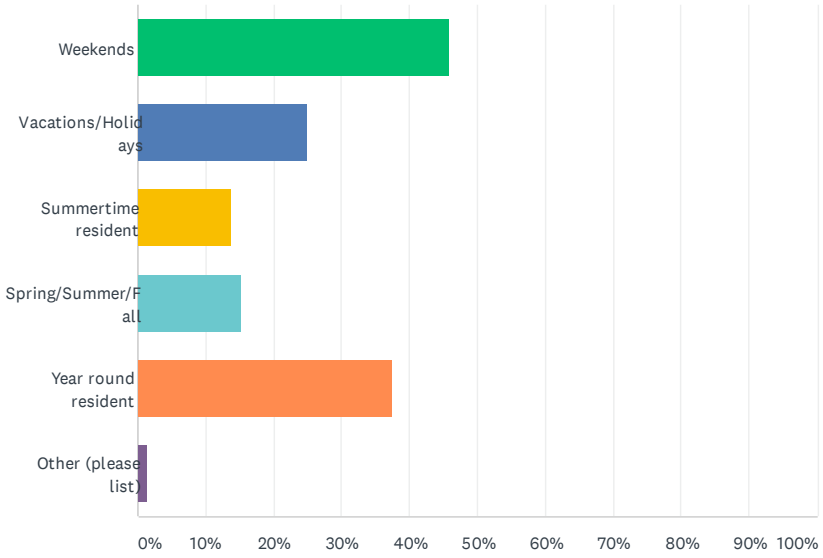
Answered: 69 Skipped: 4

#	RESPONSES	DATE
1	boating and swimming	9/13/2020 8:12 AM
2	Peace and quiet hours 6pm and after	8/12/2020 4:57 PM
3	Spening time with family and friends	8/11/2020 9:28 AM
4	Gatherings with family and friends	8/10/2020 7:37 PM
5	Relaxing, swimming for the grandkids and fishing for some	8/10/2020 5:45 PM
6	entertainment	8/10/2020 3:19 PM
7	Motorized Boating	8/10/2020 1:33 PM
8	Waterskiing	8/10/2020 11:25 AM
9	Watching wildlife and peace and quiet of the water.	8/8/2020 2:24 PM
10	Beauty	8/7/2020 8:50 PM
11	swimming	8/4/2020 7:58 PM
12	having fun with family friends	8/3/2020 4:10 PM
13	Motorized boat use	8/3/2020 8:58 AM
14	entertaining friends	8/2/2020 1:52 PM
15	relaxing	8/1/2020 1:52 PM
16	The View	8/1/2020 1:26 PM
17	Peace and tranquility	7/30/2020 10:54 PM
18	Entertaining friends and family	7/30/2020 9:19 PM
19	Motorized speed boating and water skiing	7/30/2020 6:20 PM
20	Boating	7/29/2020 7:07 AM
21	Appreciating peace and tranquility	7/29/2020 6:43 AM
22	Entertaining family and friends	7/28/2020 6:37 PM
23	motorized boating	7/28/2020 5:01 PM
24	Motorized boating	7/28/2020 4:55 PM
25	Peace and Tranquility	7/28/2020 4:46 PM
26	Swimming	7/28/2020 4:29 PM
27	We live here year around	7/28/2020 4:25 PM
28	motorized boating	7/28/2020 4:24 PM
29	Entertaining	7/28/2020 4:10 PM
30	Relaxation	7/28/2020 3:54 PM
31	Enjoying the view	7/28/2020 3:52 PM
32	Fishing	7/26/2020 7:21 PM
33	enjoying view	7/25/2020 11:04 AM
34	peace and tranquility	7/20/2020 10:55 PM
35	boating	7/17/2020 9:31 AM
36	Boating	7/16/2020 9:59 PM
37	Motorized boating	7/16/2020 6:09 PM
38	Motorized boating	7/16/2020 5:49 PM
39	family time	7/16/2020 3:58 PM
40	Enjoying the lake and friends/neighbors	7/16/2020 1:16 PM
41	Peace and Tranquility	7/13/2020 6:42 PM
42	entertaining friends and family	7/13/2020 3:33 PM
43	boating and swimming	7/13/2020 2:09 PM
44	Entertainment	7/13/2020 11:00 AM
45	Non motorized boating	7/13/2020 9:25 AM
46	Entertaining	7/11/2020 2:08 PM
47	Motorized Boating	7/10/2020 12:58 PM
48	entertainment	7/10/2020 11:01 AM

49	Enjoying the view	7/10/2020 10:01 AM
50	peace and tranqility	7/10/2020 9:49 AM
51	All it is our home	7/10/2020 7:32 AM
52	Enjoying the view	7/9/2020 10:21 PM
53	Relaxation	7/9/2020 9:51 PM
54	Fast Boating	7/9/2020 9:12 PM
55	peace and tranquility	7/9/2020 7:36 PM
56	Cocktail time with friends	7/9/2020 7:35 PM
57	working on property	7/9/2020 7:19 PM
58	RELAX - just like Aaron Rogers says!	7/9/2020 6:50 PM
59	Swim	7/9/2020 6:47 PM
60	family	7/9/2020 5:48 PM
61	boating and view	7/9/2020 5:46 PM
62	Appreciating peace and tranquility	7/9/2020 4:34 PM
63	Entertaining	7/9/2020 4:18 PM
64	Family. Relaxing	7/9/2020 4:14 PM
65	Entertainment	7/9/2020 4:06 PM
66	residence	7/9/2020 4:06 PM
67	Entertaining	7/9/2020 4:05 PM
68	My home	7/9/2020 4:04 PM
69	Water Skiing	7/9/2020 4:02 PM

Q9 Which of the following best describes when you would be most likely to use your Wilke lake property?

Answered: 72 Skipped: 1

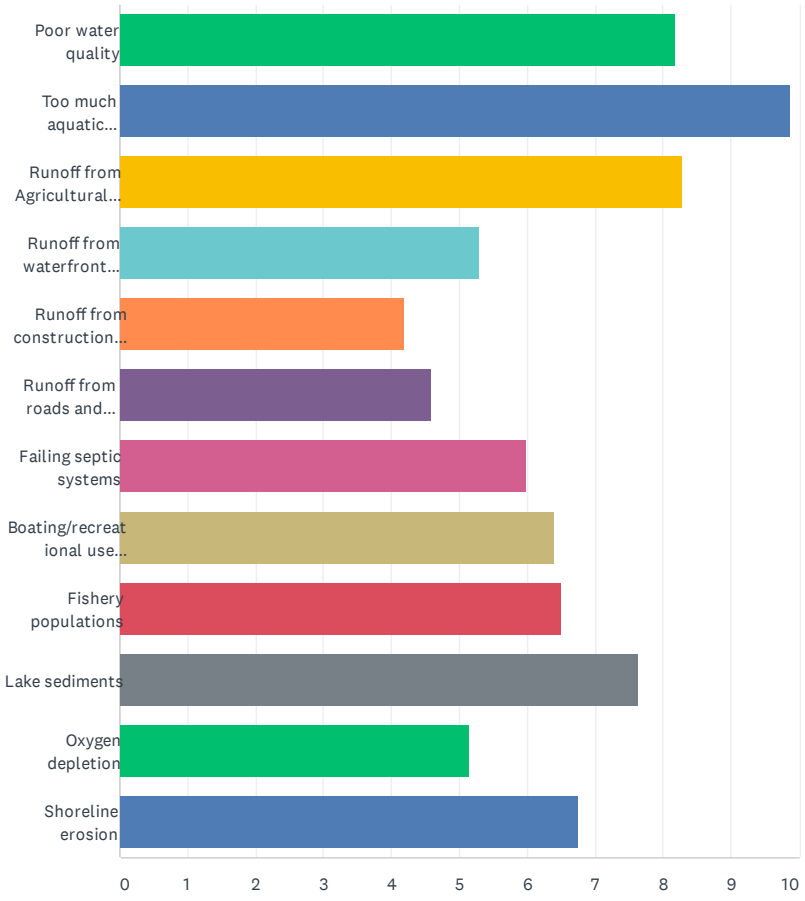


ANSWER CHOICES	RESPONSES	
Weekends	45.83%	33
Vacations/Holidays	25.00%	18
Summertime resident	13.89%	10
Spring/Summer/Fall	15.28%	11
Year round resident	37.50%	27
Other (please list)	1.39%	1
Total Respondents: 72		

#	OTHER (PLEASE LIST)	DATE
1	Snowmobiling, ice skating in winter	8/10/2020 11:25 AM

Q10 Please rank the problem areas in order of greatest to least concern, where 1 being your greatest concern and 12 being your least concern.

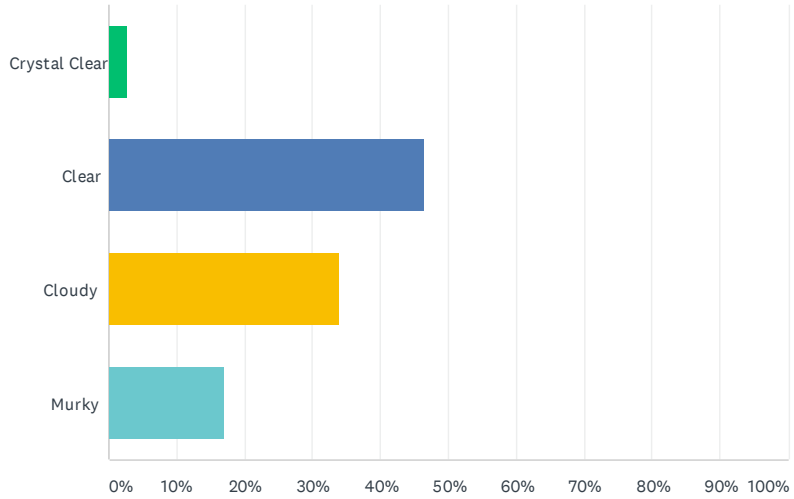
Answered: 72 Skipped: 1



	1	2	3	4	5	6	7	8	9	10	11	12	T
Poor water quality	20.90% 14	14.93% 10	11.94% 8	8.96% 6	4.48% 3	10.45% 7	5.97% 4	1.49% 1	5.97% 4	2.99% 2	5.97% 4	5.97% 4	
Too much aquatic vegetation	24.64% 17	30.43% 21	18.84% 13	7.25% 5	1.45% 1	4.35% 3	4.35% 3	2.90% 2	4.35% 3	0.00% 0	1.45% 1	0.00% 0	
Runoff from Agricultural land	14.06% 9	10.94% 7	15.63% 10	14.06% 9	14.06% 9	6.25% 4	3.13% 2	7.81% 5	6.25% 4	1.56% 1	6.25% 4	0.00% 0	
Runoff from waterfront properties	1.59% 1	3.17% 2	4.76% 3	7.94% 5	7.94% 5	4.76% 3	6.35% 4	15.87% 10	19.05% 12	15.87% 10	4.76% 3	7.94% 5	
Runoff from construction sites	0.00% 0	4.69% 3	0.00% 0	3.13% 2	4.69% 3	3.13% 2	12.50% 8	10.94% 7	14.06% 9	15.63% 10	15.63% 10	15.63% 10	
Runoff from roads and highways	0.00% 0	0.00% 0	1.54% 1	1.54% 1	4.62% 3	20.00% 13	12.31% 8	10.77% 7	12.31% 8	13.85% 9	10.77% 7	12.31% 8	
Failing septic systems	1.52% 1	6.06% 4	4.55% 3	6.06% 4	10.61% 7	10.61% 7	19.70% 13	13.64% 9	7.58% 5	6.06% 4	6.06% 4	7.58% 5	
Boating/recreational use conflicts	11.76% 8	10.29% 7	5.88% 4	5.88% 4	2.94% 2	10.29% 7	5.88% 4	13.24% 9	7.35% 5	8.82% 6	4.41% 3	13.24% 9	
Fishery populations	10.45% 7	7.46% 5	4.48% 3	8.96% 6	13.43% 9	2.99% 2	7.46% 5	5.97% 4	16.42% 11	7.46% 5	11.94% 8	2.99% 2	
Lake sediments	10.61% 7	10.61% 7	16.67% 11	10.61% 7	12.12% 8	9.09% 6	3.03% 2	1.52% 1	3.03% 2	15.15% 10	6.06% 4	1.52% 1	
Oxygen depletion	0.00% 0	1.52% 1	6.06% 4	16.67% 11	7.58% 5	6.06% 4	10.61% 7	7.58% 5	3.03% 2	3.03% 2	24.24% 16	13.64% 9	
Shoreline erosion	10.45% 7	2.99% 2	11.94% 8	8.96% 6	14.93% 10	10.45% 7	7.46% 5	7.46% 5	1.49% 1	5.97% 4	1.49% 1	16.42% 11	

Q11 Which term best defines what you consider the water "clarity" of Wilke lake to be: (Choose one)

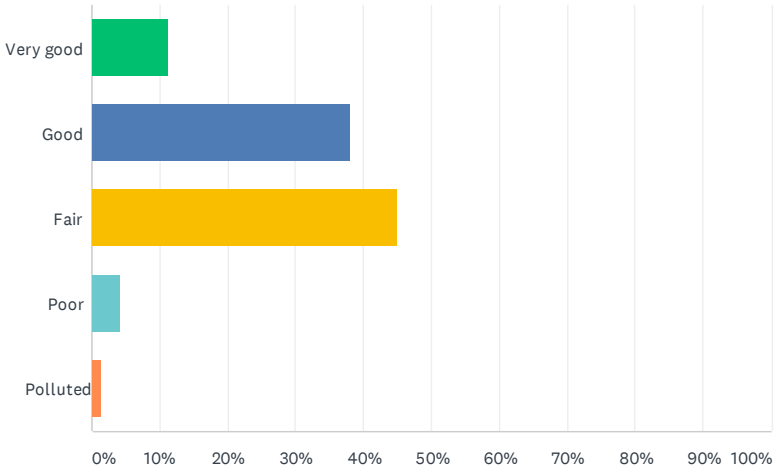
Answered: 71 Skipped: 2



ANSWER CHOICES	RESPONSES	
Crystal Clear	2.82%	2
Clear	46.48%	33
Cloudy	33.80%	24
Murky	16.90%	12
TOTAL		71

Q12 Which term best defines what you consider the water quality of Wilke lake to be: (Choose one)

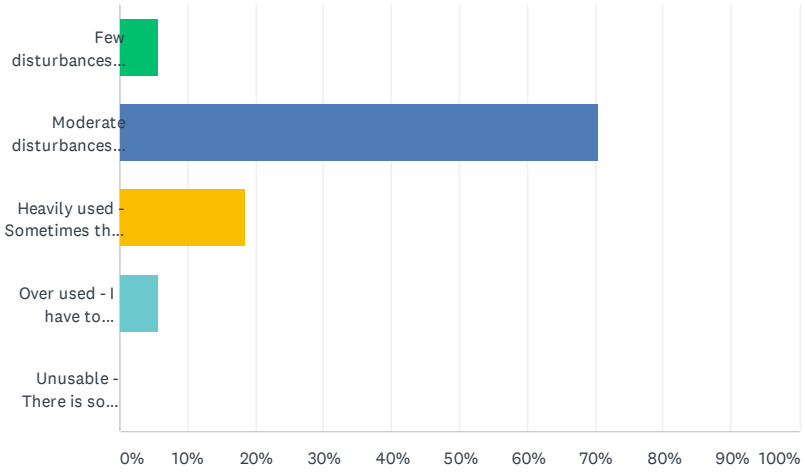
Answered: 71 Skipped: 2



ANSWER CHOICES	RESPONSES	
Very good	11.27%	8
Good	38.03%	27
Fair	45.07%	32
Poor	4.23%	3
Polluted	1.41%	1
TOTAL		71

Q13 Which statement best describes the peace and tranquility at Wilke lake? (Choose one)

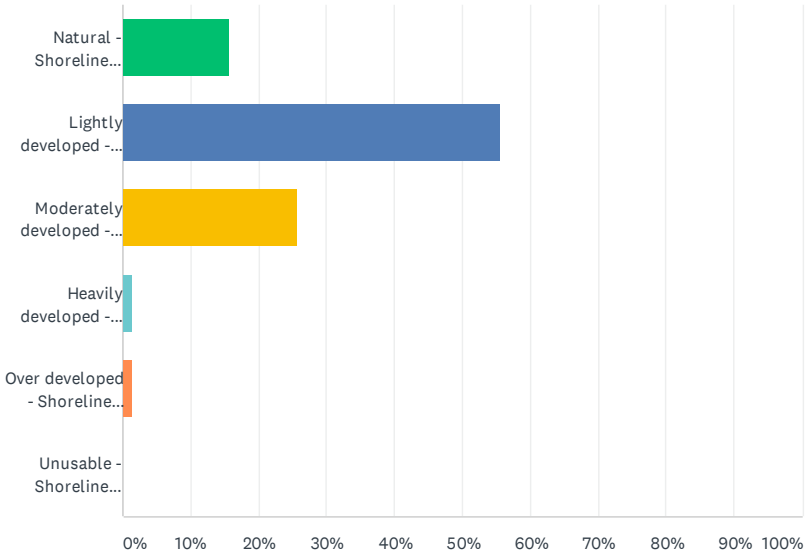
Answered: 71 Skipped: 2



ANSWER CHOICES	RESPONSES	
Few disturbances - Rarely see and hear another person	5.63%	4
Moderate disturbances - It is easy to share the lake	70.42%	50
Heavily used - Sometimes the noise and activities of others disturb me	18.31%	13
Over used - I have to regularly plan around the noise and activities of others	5.63%	4
Unusable - There is so much noise and activity that I normally can't use my lake property	0.00%	0
TOTAL		71

Q14 Which statement best describes the shoreline of your Wilke lake property? (Choose one)

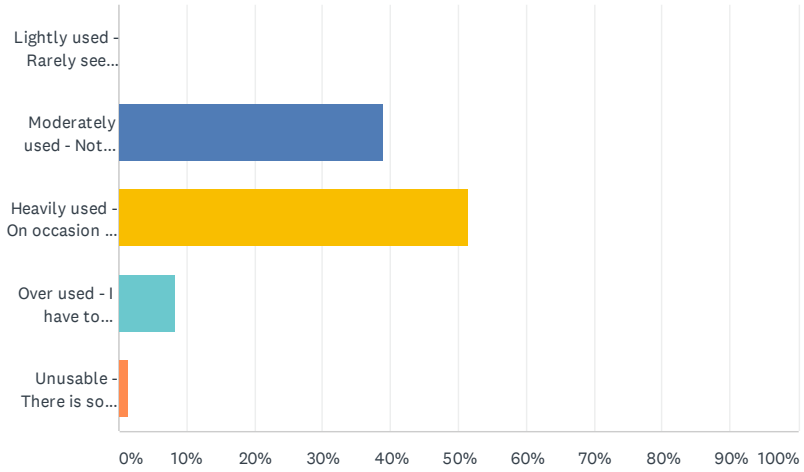
Answered: 70 Skipped: 3



ANSWER CHOICES	RESPONSES	
Natural - Shoreline structures not visible	15.71%	11
Lightly developed - Shoreline structures do not spoil my view	55.71%	39
Moderately developed - Shoreline structures do not spoil my view of only part of the shoreline	25.71%	18
Heavily developed - Shoreline structures are detracting from the natural beauty of much of the shoreline	1.43%	1
Over developed - Shoreline structures are detracting from the natural beauty of most of the shoreline	1.43%	1
Unusable - Shoreline structures have replaced the natural beauty of the shoreline	0.00%	0
TOTAL		70

Q15 Which statement best describes the boat traffic Wilke lake receives? (Choose one)

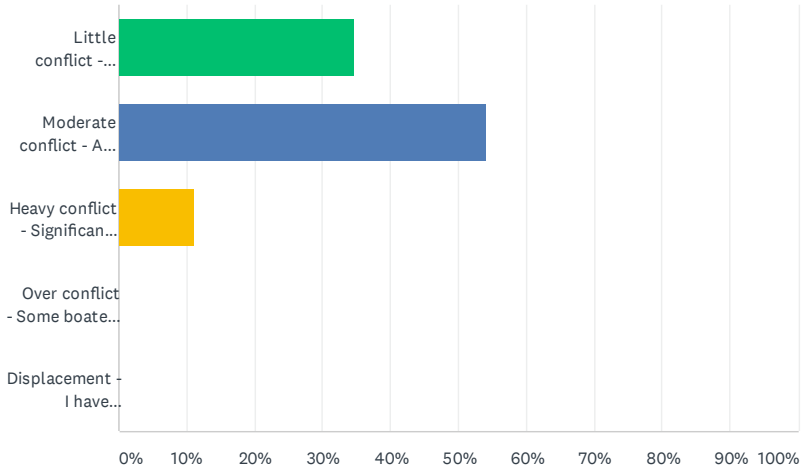
Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Lightly used - Rarely see another boat	0.00%	0
Moderately used - Not enough to bother my use	38.89%	28
Heavily used - On occasion I have to modify my plans because of boat traffic	51.39%	37
Over used - I have to regularly change my plans because of the boat traffic on the lake	8.33%	6
Unusable - There is so much boat traffic that I can't use the lake	1.39%	1
TOTAL		72

Q16 Which best describes your experience with other boaters while on the water? (Choose one)

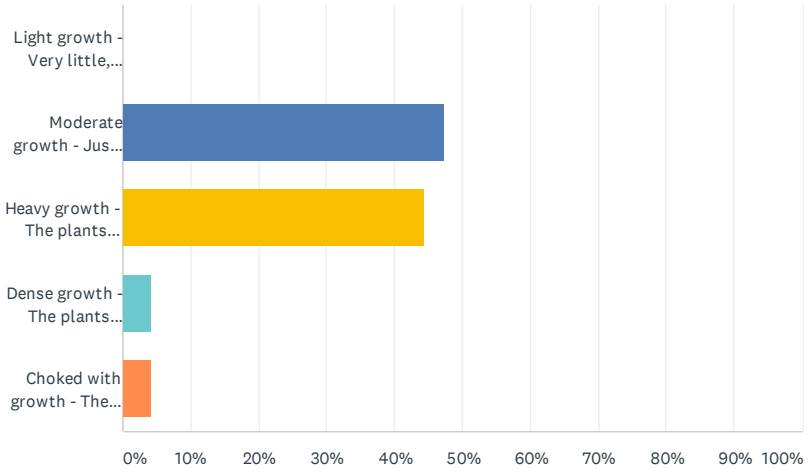
Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Little conflict - Boaters have been courteous and law abiding	34.72%	25
Moderate conflict - A few boaters have not been courteous and have broken rules	54.17%	39
Heavy conflict - Significant number of boaters have not been courteous and have broken rules	11.11%	8
Over conflict - Some boaters intimidate and harass other boaters	0.00%	0
Displacement - I have generally quit boating because of the behavior of other boaters	0.00%	0
TOTAL		72

Q17 Which statement best describes the level of aquatic plant growth in Wilke lake? (Choose one)

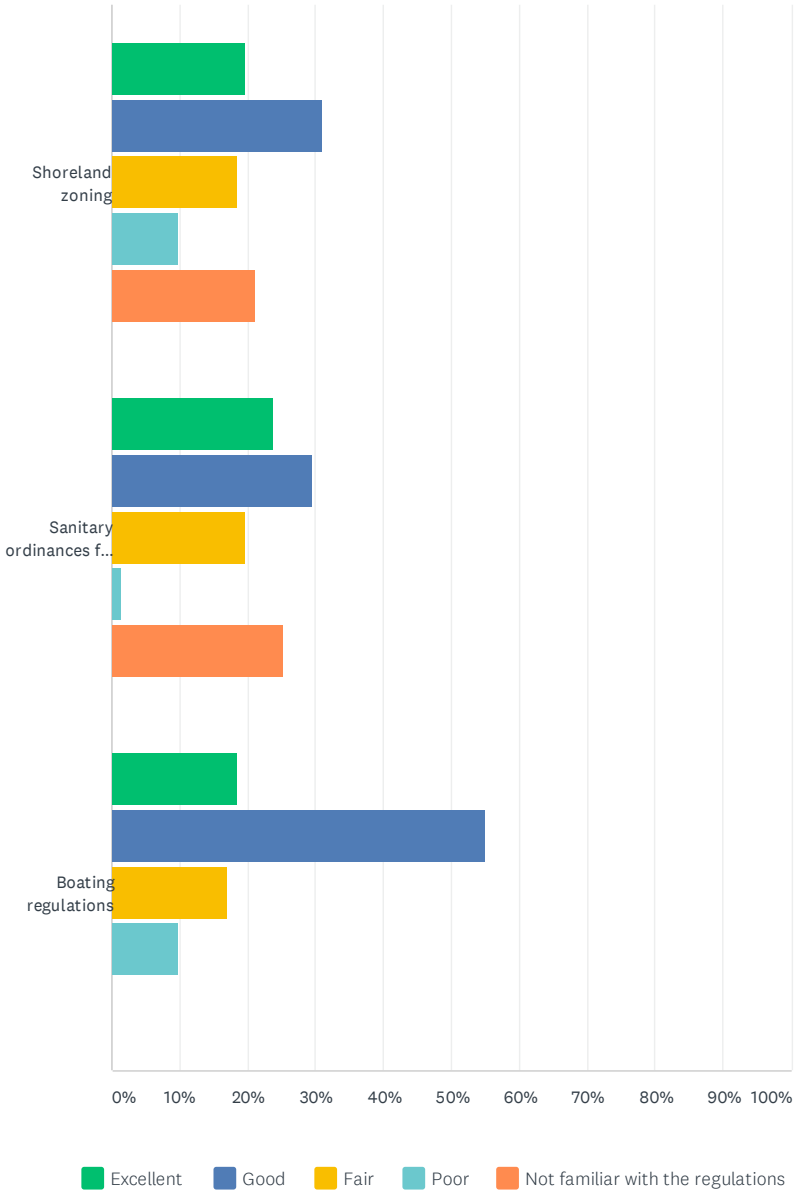
Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Light growth - Very little, less than optimum for fish and wildlife	0.00%	0
Moderate growth - Just the right amount for fish and wildlife	47.22%	34
Heavy growth - The plants limit my use of some parts of the lake and diminish attractiveness	44.44%	32
Dense growth - The plants limit my use of much of the lake and are unattractive	4.17%	3
Choked with growth - The plants ruin my ability to enjoy the lake	4.17%	3
TOTAL		72

Q18 How would you rate the enforcement of the following existing regulations?

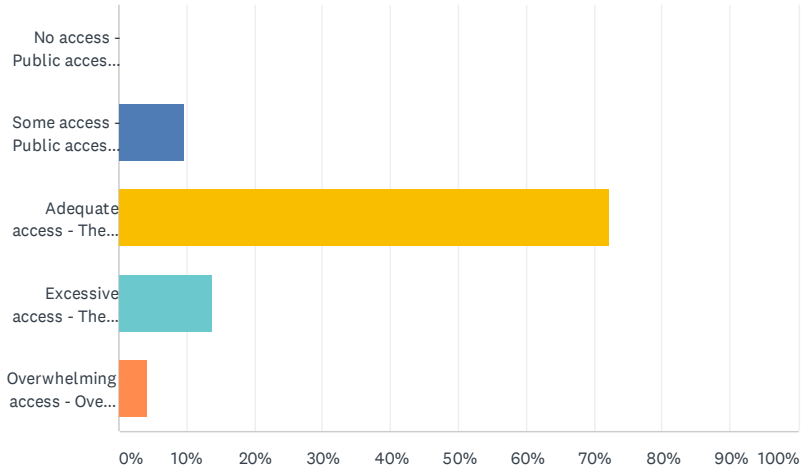
Answered: 71 Skipped: 2



	EXCELLENT	GOOD	FAIR	POOR	NOT FAMILIAR WITH THE REGULATIONS	TOTAL
Shoreland zoning	19.72% 14	30.99% 22	18.31% 13	9.86% 7	21.13% 15	71
Sanitary ordinances for septic systems	23.94% 17	29.58% 21	19.72% 14	1.41% 1	25.35% 18	71
Boating regulations	18.31% 13	54.93% 39	16.90% 12	9.86% 7	0.00% 0	71

Q19 Which statement best describes current public access to Wilke lake? (Choose one)

Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
No access - Public access not available	0.00%	0
Some access - Public access is available but limited	9.72%	7
Adequate access - The number of sites are appropriate to the size of the lake	72.22%	52
Excessive access - The number of public access sites and parking spaces contributes to crowding and user conflict on the lake	13.89%	10
Overwhelming access - Over development of public access causes severe use conflicts and damage to the ecosystem	4.17%	3
TOTAL		72

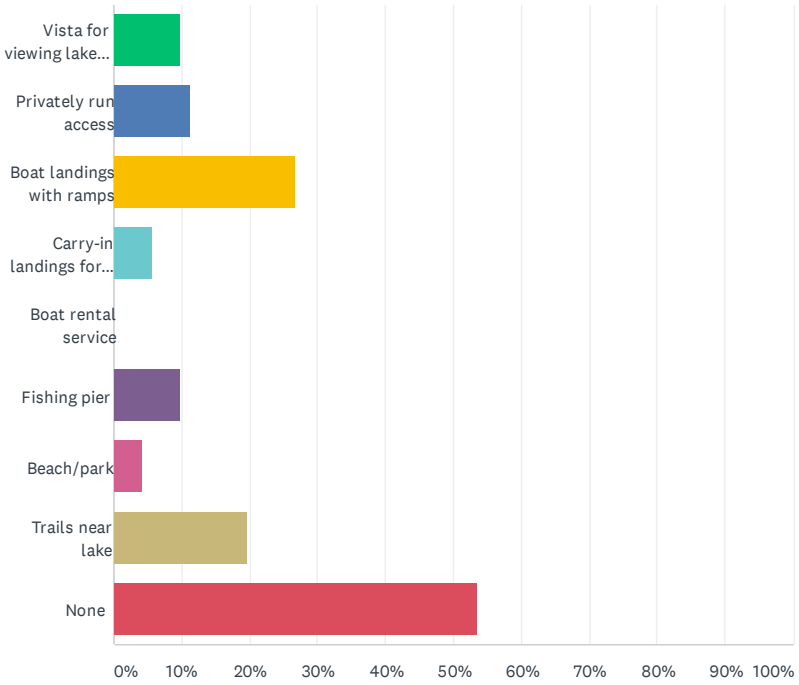
Q20 Do you know of any sources of pollution that should be investigated? If so, please give the location

Answered: 34 Skipped: 39

#	RESPONSES	DATE
1	no	9/13/2020 8:12 AM
2	Constuction on cottage/home on far west end of lake. Tons of erosion and disturbances on property causing lots of run off	8/12/2020 4:57 PM
3	no	8/10/2020 5:45 PM
4	No	8/7/2020 8:50 PM
5	no	8/3/2020 8:58 AM
6	use of fertilizer on shoreline lawns	8/2/2020 1:52 PM
7	no	8/1/2020 1:52 PM
8	no	8/1/2020 1:26 PM
9	No	7/30/2020 9:19 PM
10	Horse farm runoff should not be allowed to discharge into the lake; should have alternative mitigation in place if needed.	7/30/2020 6:20 PM
11	Runoff from rautmans fields	7/29/2020 7:07 AM
12	Horse farm off of Karstaedt Rd.	7/29/2020 6:43 AM
13	None	7/28/2020 6:37 PM
14	Not that I am aware of	7/28/2020 5:01 PM
15	Water balloons in the lake being thrown by kids and not picked up. East side of the lake.	7/28/2020 4:55 PM
16	The horse ranch to the east of the lake disperses a lot of contaminated ground water and manure into the lake every spring. It has gotten much worse over the years, and creates significant hardships for the homeowners on that side of the lake.	7/28/2020 4:24 PM
17	The Horse farm run-off on East side of Lake.	7/28/2020 4:13 PM
18	No	7/28/2020 3:54 PM
19	None	7/16/2020 5:49 PM
20	None	7/13/2020 3:33 PM
21	Horse pasture - east side of lake	7/13/2020 2:09 PM
22	Farmland between Henning Road and Karstaedt road contributes to phosphorous and manure runoff	7/13/2020 11:00 AM
23	None	7/10/2020 2:55 PM
24	Horse farm run off.	7/10/2020 12:58 PM
25	Horses in field next to sunny vista lane	7/10/2020 10:01 AM
26	agricultural use within 100 feet of the lake, horse farm	7/9/2020 9:51 PM
27	No	7/9/2020 9:12 PM
28	do not	7/9/2020 7:36 PM
29	no	7/9/2020 7:35 PM
30	no	7/9/2020 7:19 PM
31	No	7/9/2020 6:47 PM
32	no	7/9/2020 5:48 PM
33	no	7/9/2020 4:06 PM
34	northeast side by horse farm	7/9/2020 4:06 PM

Q21 Which of the following best describes the type of public access you would like to see on Wilke lake? (Choose your top three choices)

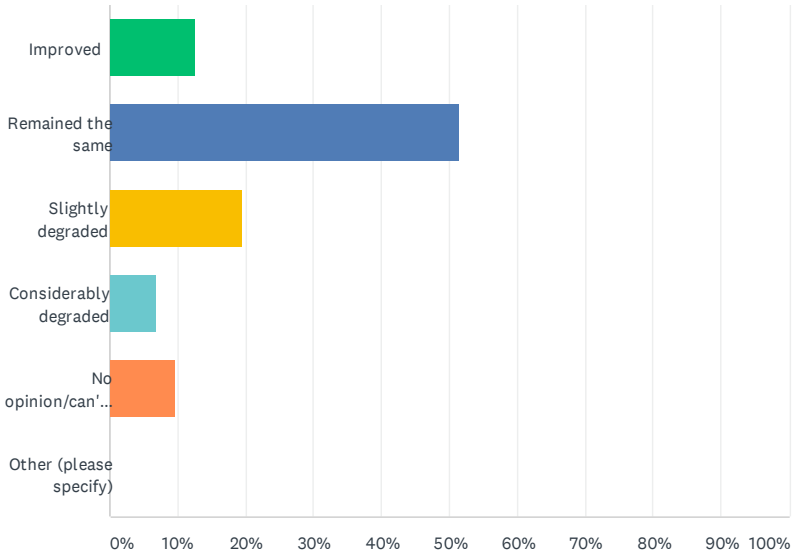
Answered: 71 Skipped: 2



ANSWER CHOICES	RESPONSES	
Vista for viewing lake from a road or park	9.86%	7
Privately run access	11.27%	8
Boat landings with ramps	26.76%	19
Carry-in landings for non-motorized boats	5.63%	4
Boat rental service	0.00%	0
Fishing pier	9.86%	7
Beach/park	4.23%	3
Trails near lake	19.72%	14
None	53.52%	38
Total Respondents: 71		

Q22 Since I have lived on Wilke lake, the water quality has:

Answered: 72 Skipped: 1

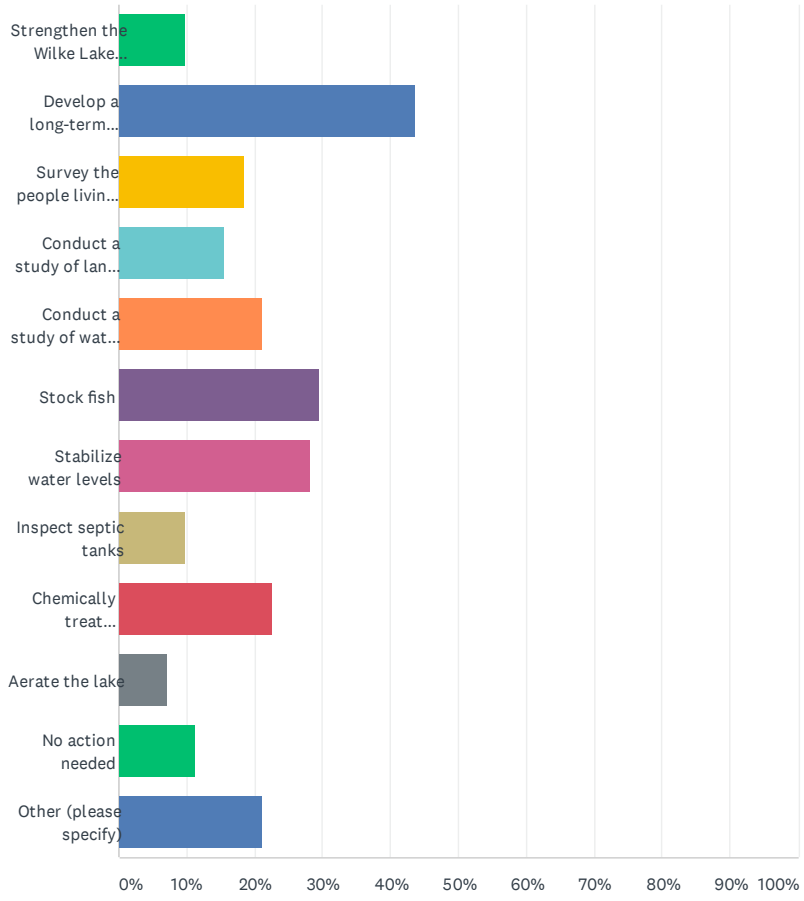


ANSWER CHOICES	RESPONSES	
Improved	12.50%	9
Remained the same	51.39%	37
Slightly degraded	19.44%	14
Considerably degraded	6.94%	5
No opinion/can't tell	9.72%	7
Other (please specify)	0.00%	0
Total Respondents: 72		

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q23 Which actions do you feel need to be taken to deal with your concerns for Wilke lake? (Choose your top three actions)

Answered: 71 Skipped: 2

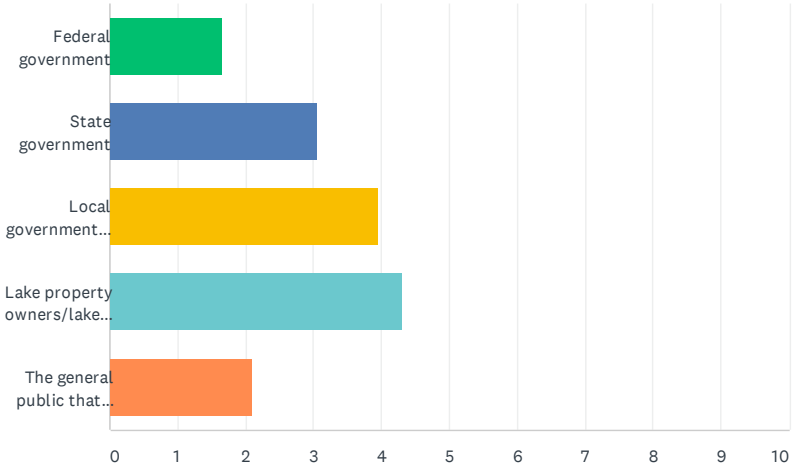


ANSWER CHOICES	RESPONSES	
Strengthen the Wilke Lake Advancement Association	9.86%	7
Develop a long-term management plan for the lake	43.66%	31
Survey the people living on the lake to document concerns	18.31%	13
Conduct a study of land uses in the watershed	15.49%	11
Conduct a study of water chemistry	21.13%	15
Stock fish	29.58%	21
Stabilize water levels	28.17%	20
Inspect septic tanks	9.86%	7
Chemically treat plants/algae	22.54%	16
Aerate the lake	7.04%	5
No action needed	11.27%	8
Other (please specify)	21.13%	15
Total Respondents: 71		

#	OTHER (PLEASE SPECIFY)	DATE
1	harvest weeds	8/1/2020 1:52 PM
2	Maintain boating hours with 11-6 fast boating 7days/week. This is our primary recreational use of the lake access.	7/30/2020 6:20 PM
3	Screen by outlet so fish don't get sucked up and killed.	7/28/2020 4:55 PM
4	tackle the tough issue with a win-win solution for boat traffic overcrowding on weekends and holidays before a significant accident happens	7/28/2020 4:46 PM
5	Dredge areas to remove some of the built up muck, sludge and dead vegetation in order to help restore some of the natural lake bottom.	7/28/2020 4:24 PM
6	Limit boating to “No Wake” whenever water levels exceed regulated maximums.	7/28/2020 4:13 PM
7	water level should be raised	7/20/2020 10:55 PM
8	restore habitat on lake ward side of DNR owned swamp lands for fish & wildlife	7/13/2020 2:09 PM
9	water is lower than it used to be. This is sad.	7/10/2020 11:01 AM
10	Pressure on the shoreline from over sized and over powered boats that are not appropriate for Wilke Lake.	7/10/2020 9:49 AM
11	Muck away, new firm that cares about the lake without conflict of interest	7/9/2020 9:51 PM
12	Stop our fish from going over to Sy Lake	7/9/2020 9:12 PM
13	Improve fish habitat and spawning areas.	7/9/2020 7:19 PM
14	Comprehesive plan to proactively take steps to AVOID unhealthy algae blooms and other impediments to water quality	7/9/2020 6:50 PM
15	remove muck	7/9/2020 4:02 PM

Q24 List in order of importance who you think is responsible for management of Wilke lake, where 1 being the most responsible and 5 being the least responsible.

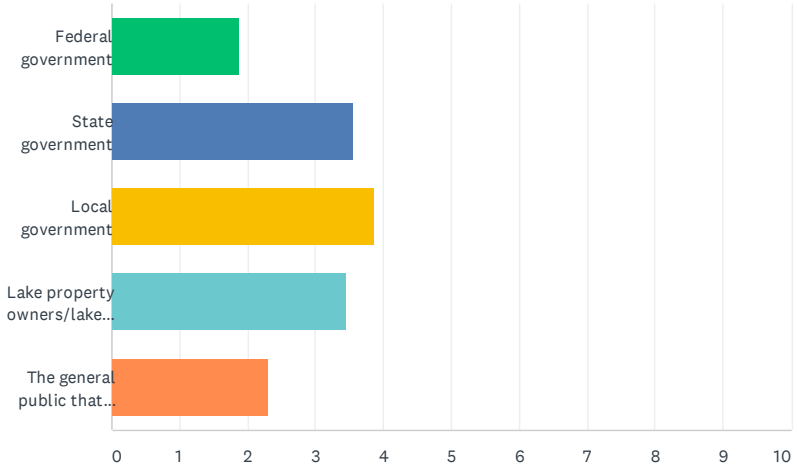
Answered: 71 Skipped: 2



	1	2	3	4	5	TOTAL	SCORE
Federal government	1.47% 1	1.47% 1	8.82% 6	36.76% 25	51.47% 35	68	1.65
State government	13.43% 9	10.45% 7	46.27% 31	28.36% 19	1.49% 1	67	3.06
Local government (i.e., county, city, village, town)	30.00% 21	42.86% 30	21.43% 15	4.29% 3	1.43% 1	70	3.96
Lake property owners/lake organizations	56.34% 40	26.76% 19	9.86% 7	5.63% 4	1.41% 1	71	4.31
The general public that uses the lake	0.00% 0	19.40% 13	13.43% 9	23.88% 16	43.28% 29	67	2.09

Q25 List in order of importance who you think is responsible for paying for the managing of Wilke lake, where 1 being the most responsible and 5 being the least responsible.

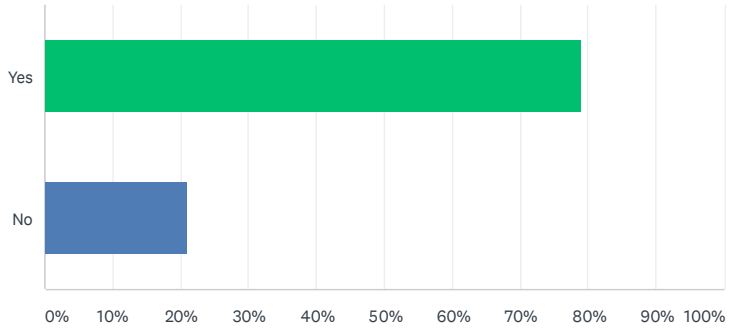
Answered: 69 Skipped: 4



	1	2	3	4	5	TOTAL	SCORE
Federal government	6.25% 4	4.69% 3	15.63% 10	18.75% 12	54.69% 35	64	1.89
State government	24.62% 16	32.31% 21	18.46% 12	23.08% 15	1.54% 1	65	3.55
Local government	31.34% 21	31.34% 21	31.34% 21	5.97% 4	0.00% 0	67	3.88
Lake property owners/lake organizations	32.31% 21	18.46% 12	18.46% 12	23.08% 15	7.69% 5	65	3.45
The general public that uses the lake (user fees)	7.58% 5	15.15% 10	13.64% 9	27.27% 18	36.36% 24	66	2.30

Q26 Have you attended an annual or special meeting of the Wilke Lake Advancement Association in the past two years?

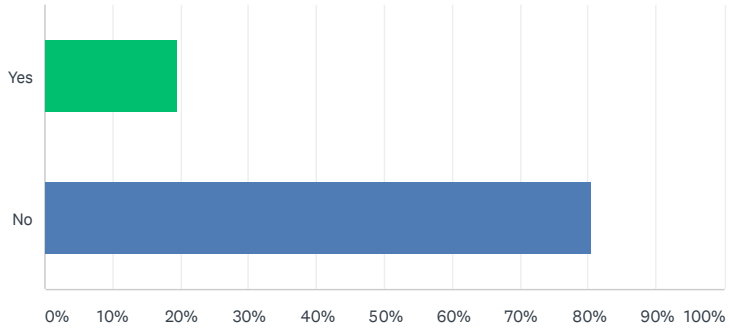
Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	79.17%	57
No	20.83%	15
TOTAL		72

Q27 Have you ever served as an officer of the Wilke Lake Advancement Association or the Sanitary District?

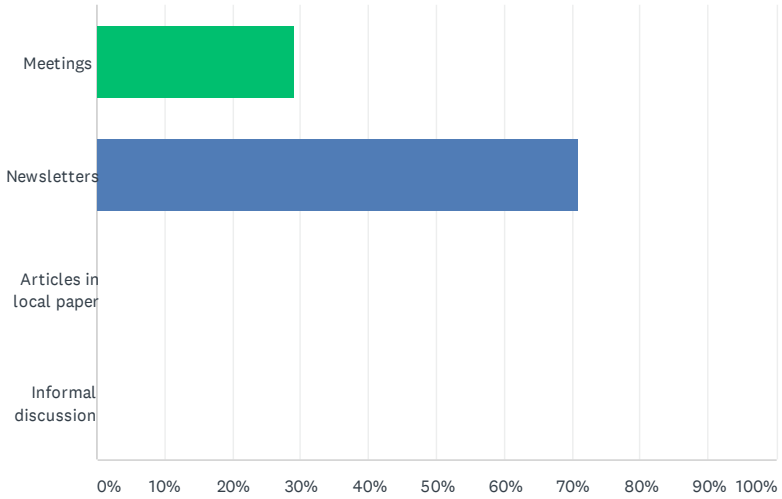
Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	19.44%	14
No	80.56%	58
TOTAL		72

Q28 What is the best way for the Lake Association to communicate with the members? (Choose one)

Answered: 72 Skipped: 1



ANSWER CHOICES	RESPONSES	
Meetings	29.17%	21
Newsletters	70.83%	51
Articles in local paper	0.00%	0
Informal discussion	0.00%	0
TOTAL		72

Q29 What do you like or dislike about the current policies and activities of the lake organization?

Answered: 44 Skipped: 29

#	RESPONSES	DATE
1	Good communication by current officers	8/10/2020 7:37 PM
2	like to know everyone's input is important	8/10/2020 5:45 PM
3	Like all activities of the WLAA.	8/10/2020 3:19 PM
4	To many people think they own the lake and riled only apply to certain people	8/10/2020 11:25 AM
5	doing good job	8/3/2020 4:10 PM
6	none	8/1/2020 1:52 PM
7	Lake organization does a good job	7/30/2020 9:19 PM
8	Decisions should represent all property owners and not a select few.	7/30/2020 6:20 PM
9	Good wake and no wake times	7/29/2020 7:07 AM
10	None	7/29/2020 6:43 AM
11	This is the first year we have more jet skis and boats cutting people off. We should all regulate this	7/28/2020 6:37 PM
12	I like the planned social events by the WLAA. I don't like that property owners have a choice to be a member and pay annual dues. Joining the WLAA should be no different than moving into a subdivision with an HOA. You can either join or move someplace else.	7/28/2020 5:01 PM
13	Like the email updates on the lake.	7/28/2020 4:55 PM
14	The WLAA is a social organization that needs to work in unison with the Sanitary District and other organizations and governmental agencies to mitigate any risk to the health or safe user activity of the lake. Without a healthy lake, all that the current riparian land owners will have is property, not lake or waterfront property.	7/28/2020 4:46 PM
15	The association charges each family of a residence instead of just a residence and they carry a large balance. Should only charge per family.	7/28/2020 4:29 PM
16	I like the friendly social gatherings that are very informative and always full of good ideas.	7/28/2020 4:24 PM
17	Too much of a “Clique “ mentality worry about social politics and not representing unbiased positions in regards to the common good for all users of the resource.	7/28/2020 4:13 PM
18	Love all the fun activities on the lake	7/28/2020 4:10 PM
19	Good idea to complete survey. This would be useful every two years. Email is best way to provide updates.	7/26/2020 7:21 PM
20	I think a good job is done. I'd like to see officers noted on the lake directory to help identify who to communicate with should an issue arise.	7/17/2020 9:31 AM
21	Like , wake and no wake times. Great mix for all.	7/16/2020 9:59 PM
22	Think we have an awesome board in place who is trying their best to keep lake owners happy & love the social events!!	7/16/2020 6:09 PM
23	I think everything is running fine.	7/16/2020 3:58 PM
24	To many large HP boats that seem to be built to create large wakes. Leads to shoreline erosion and reduces lake usability.	7/13/2020 6:42 PM
25	Poor representation at the sanitary district	7/13/2020 3:33 PM
26	Organization is party oriented - which is ok if you like that sort of thing.	7/13/2020 2:09 PM
27	Popularity contest versus fact. You speak up at a meeting and you could be black listed	7/13/2020 11:00 AM
28	Lake level is being controlled much better these days. Water clarity seems to be decreasing. Weeds are growing where they haven't in the past.	7/13/2020 9:25 AM
29	Lack of actions	7/11/2020 2:08 PM
30	Elections every year	7/10/2020 2:55 PM
31	Everythings good.	7/10/2020 12:58 PM
32	no dislikes other than following distanting of covid. I dont think the gathering events sponsored by association should be allowed this year.	7/10/2020 11:01 AM
33	Needs a way to get input on issues from every home owner and a way to address the issues.	7/10/2020 9:49 AM
34	Not properly informed about the condition of the lake	7/9/2020 9:51 PM
35	It's working well.	7/9/2020 9:12 PM
36	its a great association. includes everyone in everything.	7/9/2020 7:36 PM
37	I think things are well organized	7/9/2020 7:35 PM
38	Not enough attention to fish and wildlife.	7/9/2020 7:19 PM
39	I really like and enjoy the mix of formal meetings with informal get together functions. I have missed a many/most recently due to conflicts and health. My absence does not reflect I don't	7/9/2020 6:50 PM

	care or support these meetings/events. I do! I think it is true that for many of us, sometimes life just gets in the way for a little while before you can "rejoin."	
40	None	7/9/2020 4:34 PM
41	New people should be visited by a welcoming committee and given detail of how things work at Wilke. Weed cutting and pickup, garbage rules, burning rules, boating rules, acronyms such as The Point. When they are introduced at a meeting for the first time, it would be nice if people introduce themselves and make an effort to get to know them, especially the officers should do this.	7/9/2020 4:18 PM
42	Nothing	7/9/2020 4:14 PM
43	Like--Family, togetherness, concern for all aspects of the lake Dislike-- spend too much on parties without raising funds to promote lake health	7/9/2020 4:06 PM
44	Chemically treat the weeds	7/9/2020 4:04 PM

Q30 What would you like to see changed in the current policies and activities of your lake organization?

Answered: 39 Skipped: 34

#	RESPONSES	DATE
1	Nothing.....continue open communication	8/10/2020 7:37 PM
2	nothing	8/10/2020 5:45 PM
3	The WLAA should take on productive discussions on issues, not just party schedules.	8/10/2020 3:19 PM
4	nothing	8/3/2020 4:10 PM
5	Nothing	7/30/2020 9:19 PM
6	Decisions should represent all property owners and not a select few.	7/30/2020 6:20 PM
7	Chemical treatment of lake for invasive weeds	7/29/2020 7:07 AM
8	None	7/29/2020 6:43 AM
9	Mandatory WLAA membership for each property owner and the annual dues should be a minimum of $100.	7/28/2020 5:01 PM
10	Open discussion of issues where people LISTEN and respect the veiwpoints of others even if they do not necessarily agree. An external facilitator may be necessary for this.	7/28/2020 4:46 PM
11	They are very clique.	7/28/2020 4:29 PM
12	We currently do not have any control over the management of the lake in our lake organization. It would be nice to be able to have more input to the actual lake use and care. It would be nice to be able to decide our own guidelines on shoreline and pier regulations, as well as allow selective dredging along areas of property owner's shoreline.	7/28/2020 4:24 PM
13	Be more inclusive of everybody.	7/28/2020 4:13 PM
14	Would like to see the wake time adjusted to go from 10:30a to 6:30p	7/28/2020 4:10 PM
15	Keep up the regular communications. This has been helpful.	7/26/2020 7:21 PM
16	I would like for the association to consider limiting wake boats. Some boats specifically those designed to make large wakes are too big for the lake and result in the lake being unusable.	7/17/2020 9:31 AM
17	Nothing	7/16/2020 9:59 PM
18	More control over public access!	7/16/2020 6:09 PM
19	none	7/16/2020 3:58 PM
20	Expanded fast boating hours to one of the three: 10:30-6:00, 10:00-6:00, 10:30-6:30	7/16/2020 1:16 PM
21	Horsepower Limit - maybe 200.	7/13/2020 6:42 PM
22	new sanitary district representatives	7/13/2020 3:33 PM
23	Could have a stronger lake educational role and be an advocate for overall lake health	7/13/2020 2:09 PM
24	Town needs to be more involved. Water issues everywhere from run off and poor planning	7/13/2020 11:00 AM
25	No wake implemented when water is high until it recedes. I don't know what level would be best. Create high level of communication with lake residence and others of interest. Treat milfoil to eliminate. Cutting appears to be spreading the weed.	7/13/2020 9:25 AM
26	None	7/11/2020 2:08 PM
27	Accessibility of lake officers	7/10/2020 2:55 PM
28	Everything is good.	7/10/2020 12:58 PM
29	Help enforce a noise ordinance for disrespectful owners who party well past midnight. Get ride of street lights. Can't enjoy the night sky's anymore.	7/10/2020 10:01 AM
30	more informed, more action on fixing invasive species issues causing health issues with pets and people. Embarrassing when guests no longer can bring dogs due to infections received while swimming in the lake	7/9/2020 9:51 PM
31	Not sure.	7/9/2020 9:12 PM
32	Better participation by many of the younger and newer members	7/9/2020 7:35 PM
33	Do more to improve fish and wildlife habitat.	7/9/2020 7:19 PM
34	Mandatory financial support - it costs so little to belong! Everyone gains and benefits! Events nearly always "pay for themselves." Maybe we should establish a foundation to accept donations/gifts/bequeaths and set up a perpetual fund (only interest from fund can be spent specific lake type maintenance/improvements)? Just a thought, create a legacy... those that donate can have names placed somewhere/somehow?	7/9/2020 6:50 PM
35	None	7/9/2020 4:34 PM
36	No more burning garbage on the lakeside of cottages. I constantly have filthy debris on my boat and lawn furniture from my neighbor.	7/9/2020 4:18 PM
37	No	7/9/2020 4:14 PM
38	Raise funds for lake programs that benefit the property owners	7/9/2020 4:06 PM
39	Weed management	7/9/2020 4:04 PM

Appendix D WILKE LAKE AQUATIC PLANT MANAGEMENT PLAN

Wilke Lake Aquatic Plant Management Plan

Prepared for:
The Town of Schleswig Sanitary District 2

Prepared by:
Stantec Consulting Services Inc.

February 3, 2021

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Executive Summary

The Town of Schleswig Sanitary District #2 (District) was formed in 1980 to address resource management concerns on Wilke Lake. The Committee has been active in a number of lake management activities on Wilke Lake including aquatic plant management, purchasing of three harvesters, water quality sampling, and community education activities. The District contracted Stantec Consulting Services Inc. (Stantec) to help develop an aquatic plant management plan (Plan) for Wilke Lake. The current plan was created and approved in 2015 with recommendations for aquatic plant management to focus on mechanical harvesting. This practice has been used within Wilke Lake, having been in place since the 1980s and currently permitted for 48.6 acres within the lake.

Harvesting permits can be issued for 5-year periods, and the current permit expired after the 2020 season and was based on data collected in 2015. Continuation of harvesting to help alleviate aquatic plant issues is desired by the District and Lake Association. In order to obtain a new mechanical harvesting permit, updated aquatic plant surveys were requested to create an updated aquatic plant management plan (Plan) to reflect current conditions.

The updated Plan is consistent with the goals and objectives of the District and lake users, to reduce nuisance aquatic plant grown (Eurasian water milfoil) to a non-nuisance level in the lake (less than 33% coverage), while preserving recreation, habitat, and water quality. The draft Plan results were presented by the District at an established education and outreach program (Virtual Memorial Day {rescheduled} and Labor Day Lake Association Meetings) meeting on July 25, 2020 and September 13, 2020, as well, and was approved by the District at a public meeting.

1.0 LAKE INFORMATION

Name:	**Wilke**	Surface Area:	**95 acres**
County:	**Manitowoc**	Littoral Area:	**88 acres**
WBIC:	**58000**	Max Depth:	**21 feet**
		Median Depth:	**9 feet**

2.0 WATER QUALITY, PLANT COMMUNITY & PLANT MANAGEMENT HISTORY

2.1 WATER QUALITY

Table 1. Water quality measures observed in Wilke Lake (2020)

Water Quality Measures	Averages	Observations	Months Monitored (2020)
Total Phosphorus [µg per L]	19.65 ppb	4	May, June, July, August
Chlorophyll-a µg per L]	4.39 ppb	4	May, June, July, August
Secchi Depth [Feet]	7.37 feet	4	May, June, July, August

As a seepage lake, Wilke Lake's main source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. Meaning, land use within the watershed directly affects the water quality of the lake. Different land use practices cause varying nutrient runoff. Largely vegetated land, such as forests, slows runoff and uptakes nutrients more than land with sparse vegetation or more intensely managed, such as land with high amounts of impervious surfaces (industrial/commercial) or lands with active agricultural that are regularly tilled or plowed.

Total size of the lake's watershed relative to its own size also plays an important role in water quality. The larger a lake's watershed to surface area ratio, the greater an impact the watershed has on water quality of the lake as more nutrient runoff can be input.

Wilke Lake's watershed is 595 acres with primarily agricultural land use. This gives a watershed to lake ratio of 6.3:1, which is relatively low. This means that Wilke Lake's watershed can have an impact to water quality, even though the ratio is low. As a result, the water quality and trophic status within Wilke Lake has remained stable over recent periods.

A lake's trophic status index (TSI) relates to its productivity based on available nutrients within the water as measured by total phosphorus – the main nutrient for plant growth, chlorophyll *a* – planktonic algae within the water, and secchi – water clarity. As one parameter becomes affected, the other two typically follow suit, for example; as nutrients increase, the amount of planktonic algae increase due to more available food source, as the algae increases, the ability for light to penetrate the water decreases, which leads to lower secchi readings with all of these instances leading to increased TSI and decreased water quality.

TSI values range from 20-80+ and are divided into four segments below. The TSI for Wilke Lake is 47.8 (June–August) – mesotrophic – using secchi, total phosphorus and chlorophyll *a* as parameters. A TSI of 47.8 indicates good water quality for the lake with regard to its watershed. It is likely that the harvesting of dense aquatic vegetation within the lake is up taking enough nutrients to help limit potential algal blooms.

Table 2: Trophic State Index, Wilke Lake, Manitowoc County, WI.

Category	TSI	Lake Characteristics	Total P (ug/l)	Chlorophyll a *(ug/l)*	Water Clarity *(feet)*
Oligotrophic	1-40	Clear water; oxygen rich at all depths, except if close to mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes.	< 12	<2.6	>13
Mesotrophic	41-50	Moderately clear;increasing probability of low to no oxygen in bottom waters.	12 to 24	2.6 to 7.3	13 to 6.5
Eutrophic	51-70	Decreased water clarity; probably no oxygen in bottom waters during summer;warm-water fisheries only; blue-green algae likely in summer in upper range; plants also excessive.	24 to 96	7.3 to 56	6.5 to 1.6
Hyper-eutrophic	>70	Minimal water clarit; no oxygen in bottom water layers; excessive vegetation and and alagal mats	>96	>56	<1.6
Wilke Lake	**46.8**	**Mesotrophic**	**19.65**	**4.39**	**7.37**

2.2 PLANT COMMUNITY

Aquatic plants are vital to the health of a water body. Unfortunately, they are often negatively referred to as "weeds". The misconceptions this type of attitude brings must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants are extremely important for the well-being of a lake community and possess many positive attributes. Despite their importance, they sometimes grow to nuisance levels that hamper recreational activities and are common in degraded ecosystems. The introduction of aquatic invasive species (AIS), such as Eurasian water-milfoil (EWM), often can increase nuisance conditions, particularly when they successfully out-compete native vegetation and occupy large portions of a lake.

To assess the state of the current plant communities, a full point-intercept survey was completed by Stantec on Wilke Lake. The survey followed all WDNR Point Intercept (PI) survey protocol and included sampling pre-determined locations to document the following at each site:

- Individual species present and their density
- Water depth
- Bottom substrate

Each location was assigned coordinates and loaded into a GPS unit, which was used to navigate to each point. Data collected at each point was then entered into a Wisconsin DNR (WDNR) spreadsheet, which outputs various aquatic plant community indexes and data, allowing for a comparison to past data to monitor changes over time. Information on methods and all referenced tables, figures or charts is included in Appendix A - C.

Past management plans for Wilke Lake also included aquatic plant surveys, providing historical background to document potential changes in the communities over time. Surveys were completed in 1992, 2003, 2009, and most recently in 2014 for the current aquatic plant

management plan. Both the 1992 and 2003 sets of surveys were completed as line-transects surveys. These surveys focused on near-shore areas in limited locations throughout the lake.

To help better and more consistently document aquatic communities, the WDNR adopted the point-intercept survey method above. This method allows for repetition of past surveys by reusing pre-established sample locations. The 2009, 2014, and 2020 sampling used the same methodology and points allowing for direct data comparisons.

To compare changes in the plant community over time within Wilke Lake and to similar lakes in Wisconsin, the floristic quality index (FQI) can be used. FQI provides the ability to compare aquatic plant communities based on species presence. This value varies throughout Wisconsin, ranging from 3.0 to 44.6 with a statewide average of 22.2. To achieve this, each plant species, except for AIS, is assigned a coefficient of conservatism value (C values). A plant's C value relates to a plant species' ability to tolerate disturbance. Low C values (0-3) indicate that a species is very tolerant of disturbance, while high C values (7-10) indicate species with a low tolerance of disturbance. Intermediate C values (4-6) indicate plant species that can tolerate moderate disturbance.

Not only does this track changes over time within Wilke Lake, but allows for comparison of the lake to lakes with similar environmental conditions within a delineated area, called an eco-region, to be compared.

Wilke Lake is located in the southern portion of the Southeastern Till Plains eco-region. Lakes within the Southeastern Till Plains are typically natural lakes that, due to higher population density in this area of the State, have developed shoreline. Increased development around the lake and overall use of these lakes leads to more disturbance form an expected natural condition, which can lead to lower plant community metrics like FQI and coefficient of conservatism.

2020 Point Intercept Survey:

The aquatic plant community of the lake was surveyed by Stantec on June 29, 2020. Sampling followed protocol according to the point intercept sampling method described the Wisconsin DNR guidance entitled "Recommended Baseline Monitoring of Aquatic Plants in Wisconsin" (WDNR, 2010). This survey repeated the same sample points as completed in the last Plan as surveyed in 2009 and 2014.

Sample locations were created by the WDNR prior to field deployment by overlaying a 40-meter spaced grid over the lake. In total, 235 locations were sampled during the survey. The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank.

Typically, full point intercept surveys are completed in mid-late summer to capture the native plant community at its peak. However, this often misses the AIS curly-leaf pondweed (CLP), which has typically died back by then. To assure capture of actively growing CLP prior to natural die-off, the 2020 survey was carried out in very late June. Being a fairly small, shallow lake, the aquatic plant community of Wilke Lake is typically near mid-summer biomass peak earlier than most lakes, allowing for an early survey to capture native plants along with presence of CLP. The aquatic macrophyte community of Wilke Lake included 15 submerged, emergent, and free-floating aquatic vascular plant species and filamentous algae.

In 2020, the aquatic plant survey identified a moderately diverse community in Wilke Lake. Total species identified was 15 (Table 3) with two AIS present: Eurasian water-milfoil (*Myriophyllum spicatu*m – EWM) and curly-leaf pondweed (*Potamogeton crispus* – CLP). Species sampled in the lake were present in three categories: emergent, near shore species which are rooted below the

water's surface, but their growth extends above the water (arrowhead- *Sagittaria sp*.), submersed species which root on the lake bottom and remain below the water's surface (coontail – Ceratophyllum demersum), and floating-leaf species which root on the lake bottom with vegetation growing to and floating on the surface (white water lily – Nymphaea odorata).

The photic zone was similar to past surveys, with plant growth noted to 19 feet. Native species richness exhibited good diversity per sample point and with a moderately good spread throughout the system, as exhibited by a Simpson Diversity Index (SDI) of 0.65. An SDI value closer to 1.0 indicates a healthier, more evenly spread plant community (Table 4).

Plants were found growing to a maximum depth of 19 feet, with 210 of the 235 locations shallower than this and 90.5% of locations within the photic zone vegetated (Table 4). Muskgrass (*Chara sp*.), a macro-algae, was the most dominant species sampled in 2020, found at 77.1% of photic-zone locations. This species prefers sandy areas, often times creating a carpet in shallow locations. Much of Wilke Lake provides excellent habitat for muskgrass. Variable pondweed (*Potamogeton gramineus*) and slender naiad (Najas flexilis), both valuable for near-shore sediment stabilization and important food sources for waterfowl with variable pondweed providing excellent habitat for all life cycles of fish, were the next most common native species sampled and third and fifth most common overall (Table 5).

Two AIS were found; Eurasian water-milfoil (EWM) and curly-leaf pondweed (CLP). Both species have been present within the lake since 1993. EWM can grow rapidly and dense, reaching the surface and forming a canopy that shades out native species and hampers recreational use and spreads through fragmentation. Mechanical harvesting cuts growing plants and can potentially provide mechanism for EWM to spread throughout a system if all cut portions are not removed from the water. Even with an intensive harvesting program in place on Wilke Lake, EWM growth does not appear to have increased by harvesting or negatively impacting the native plant community. If this were to change or shift drastically, then re-evaluation of harvesting may need to be reconsidered in favor of another option, like chemical treatments or harvesting in combination with chemical treatments.

Though present, CLP growth on Wilke Lake has not been dense since first being documented. CLP relies on turions, seed-like vegetative structures, to reproduce. With an active early season harvesting program in place, turions are removed by the harvesting, limiting the reproductive potential of plants present. Combined with a moderately diverse plant community, which increases competition, the CLP population within Wilke Lake has simply become a part of the community, blending into the background and not requiring active, directed management.

The FQI for Wilke Lake has varied over time, from a low of 15.5 in 1992 to a high of 20.52 in 2003. In 2014, the FQI was 20.2. Variation is not uncommon as a plant communities' composition widely varies year to year based on numerous ecological and climatic conditions. In 2020, the FQI was 18.67, relatively high for Wilke Lake's history and indicative of a moderate quality plant community. More important, however, are the individual species that make up that community. This is measured by average coefficient of conservatism (C). Each plant species is assigned a C value, which relates to its tolerance for disturbance. A higher average C for a community indicates one that is comprised of high-value plant species. The average C for Wilke Lake in 2020 was relatively high at 6.22 (Table 6).

Use of FQI and average C can also be extrapolated out to lakes in similar eco-regions of Wisconsin to compare communities. Wilke Lake is within the Southeastern Till Plains eco-region and lakes here are typically more developed with higher recreational use. This impacts the plant communities and is shown by lakes in this eco-region typically having FQI and average C values

below those found throughout the State. However, Wilke Lake has an elevated C value, due to the diverse community, which exceeds the upper quartile for all lakes in the eco-region while also comparing favorably to the mean C for the entire State. In conjunction, Wilke Lake's FQI is in line with the mean for the Southeastern Till Plains, indicating a relatively healthy community comparative that to an undisturbed, natural condition (Table 7).

2.3 AQUATIC PLANT MANAGEMENT HISTORY

The District has completed several management activities on Wilke Lake, including multiple lake management plans, actively harvesting nuisance aquatic plants. Nuisance aquatic plants are considered those that substantially interfere with navigation and recreation (swimming) within the shallow Lake conditions of Wilke Lake, including dense EWM in water greater than 6 ft. Management of aquatic plants in Wilke Lake began in the 1960s with a focus on chemical applications with a shift to occasional harvesting in the late 60s. By the 1970s, after a decade of little active management, aquatic plant growth became excessive and limited navigation and recreational uses. The District formed in 1980 to control and management aquatic plants within the lake, soon developing the first Plan and purchasing a new harvester in 1981.

Mechanical harvesting continued to be the primary focus of management activities for the District. On average, the District actively harvests approximately 48.6 acres with a primary focus on top-cutting EWM. In 2018, 83 loads were harvested and removed throughout the year. Since 2007 there has been an average of 43 loads harvested annually. New harvesters were first purchased in 1993, a second harvester was purchased in 2004, and a third harvester in 2015.

3.0 PROBLEM IDENTIFICATION

1. EWM surface matting impairs the recreational (boating and swimming) use of Wilke Lake. EWM creates a nuisance in the navigational use area surrounding the lake's 100 ft. navigation lane, resulting in boating complaints and in the middle of the lake for swimmers.
2. EWM displaces native aquatic vegetation and has spread through the littoral area, in the past EWM was as high as 88% coverage in 1992 and is 42% currently with active management.
3. Increased algal blooms and nutrient release due to the natural, early die-back life cycle of CLP can lead to decreased water clarity and quality, though currently (2020 Survey) there is just 5 acres of CLP in the Lake.
4. Increasing costs of maintenance and operation of harvesters.

4.0 MANAGEMENT RECOMMENDATIONS AND OPTIONS

Management of aquatic plants can take many facets, depending on each lakes' unique condition and desire by the community. To be successful, a management option must be accepted by its users. Though herbicide use has been done in the past within Wilke Lake, its use was eliminated in the 1970s. Herbicides for aquatic plant management can have negative connotations. However, the combinations of periodic large scale "whole lake" type treatments for AIS have shown to reduce the need and frequency of harvesting for several years after treatment. This includes periodic triggers based on frequency of occurrence of the AIS and is a management option that is recommended be further explored by the District in the future (next Plan update). Whole lake chemical treatments may not be approved by the WDNR because they have a high likelihood of negatively impacting the native aquatic plant community.

Currently, mechanical harvesting is practiced and an accepted approach by riparian owners and lake users based on the latest approved Comprehensive Lake Management Plan and the 2020 approval of the Plan. Typically, this entails a high up-front cost to start with the purchase of harvesting equipment. Once started, however, cost can be minimal for upkeep and operation. With the general acceptance of this practice and overall minimal effect on the plant communities of Wilke Lake, continuation of mechanical harvesting is recommended. The following guidance for harvester operation and mechanical harvesting recommendations are based on historical aquatic plant management approaches and incorporate needs by lake users. This guidance and the harvesting map shall be discussed in detail with the harvester operator and/or any new operators to assure proper harvesting within permit guidelines.

GENERAL GUIDANCE FOR HARVESTER OPERATION – Figure 6, Appendix D

- PRIORITIZE HARVESTING AREAS TO FOCUS ON GREATEST NEED – Highest priority should be on maintaining navigation / recreation lane (100 feet offshore) and access to/from the boat landing. Maintain a lane 100' wide cutting to a depth up to 6' around the lake for safe navigation & recreational use. This area also coincides with the local ordinance requiring water-skiers to boat in a counterclockwise manner around the outside of the lake. **In these areas regardless of depth, you must leave at least 12 inches of plant on the lake bottom.**
- TOP CUT IN AREAS FOR SPECIFIC AIS MANAGEMENT – These areas are specific to AIS harvest management under NR 109. **Restrict cutting to 4 feet below the water's surface, leaving a minimum of 12 inches of plant growth on the lake bottom in areas shallower than 5 feet**. **Do not harvest in areas less than 4 feet deep, except in boat launch area. Harvesting shall not commence prior to June 1st.** In Wilke Lake, top-cutting of EWM (invasive species) has resulted in less surface matting in navigational lanes and the center of the lake. Figure 6 shows targeted harvest area.
- **Intentional harvesting of native pondweeds and/or chara is prohibited.**
- ALL CUT MATERIAL SHOULD BE INSPECTED FOR FISH AND ANIMALS. ANY ORGANISMS FOUND SHOULD BE IMMEDIATELY RETURNED TO THE WATER.
- ALL CUT MATERIALS SHOULD BE COLLECTED AND DEP0SITED AT THE DESIGNATED DISPOSAL SITE – Mr. Ronald Rabe property at SW1/4 SW1/4 S3 T17N R21E, Rautmann Road, Kiel, WI.

Harvesting can spread EWM by not removing all fragments cut, and sometimes a multi-faceted approach should be used. For Wilke Lake, EWM populations currently exceed 40% frequency of occurrence. This large-scale population may warrant whole-lake herbicide management and should be given consideration to reduce population, opening up habitat for native species; possibly after the life of the current harvester is exhausted. This would reduce presence and

spread of AIS and reduce harvesting cost and frequency after control actions are initiated. If any herbicide management is desired, pre-, and post-treatment aquatic plant surveys should be completed to document results.

The size of the population tends to dictate the type of the treatment. Small treatment areas or beds less than 5 acres are many times consider spot treatments and usually targeted with granular type herbicides. When there are multiple "spot" treatment areas within a lake, it most often makes more sense from economic and efficacy standpoints to target the "whole" lake for treatment. This typically entails calculating the entire volume of water within the lake, in acre/feet, and applying a liquid herbicide, such as 2,4-d, at a low dose at a lake wide rate, typically between 250 – 350 parts per billion (PPB).

Many times, the amount of herbicide in this type of whole lake treatment can be further reduced by timing the treatment as close as possible to lake stratification. After the thermocline develops in the lake, typically between 60 – 70 degrees surface temperature, this may effectively eliminate the area of the water column below the thermocline from the treatment, reducing the amount of herbicide needed for a whole lake treatment the by 30- 40%. When this technique can be utilized it should be to reduce the amount of herbicide used within the lake and to target the whole lake treatment more effectively. Partial stratification of Wilke Lake may present a challenge in whole lake treatment.

Prior to any whole-lake management, EWM present should be tested for hybridity, which can affect type of action taken. All actions should be based on the strain of water-milfoil using techniques located in Table 8. Currently, harvesting is the chosen approach, but the following table outlines action steps if herbicide management of EWM is chosen in the future.

Additionally, attached in Appendix E is the WDNR's "Frequently Asked Questions about Aquatic Herbicide Use in Wisconsin" for reference.

Table 8: Optional EWM Herbicide Management for Wilke Lake, Manitowoc County, WI

EWM Littoral Zone Frequency	Management Action(s)		
	Task	Action	Timing
< 40.0%	1	Follow harvesting guidance	In the summer
>40.0%	1	Pre-treatment aquatic plant survey	Previous year
	2	**Whole-lake Herbicide Application** 810 ac/feet	May, prior to 65 degree water temperature
	3	Post-treatment aquatic plant survey	July/August
	4	Follow harvesting guidance	Beginning 30 days after herbicide application and continuing as needed throughout the year
Whole-lake Herbicide Application Information by EWM Strain		Pure-strain Eurasian water-milfoil	2,4-D whole-lake at TBD
		Hyrbrid Eurasian water-milfoil	2,4-D / endothall mixture at TBD
			Fluriodone at TBD maintaind for 90+ days

APPENDIX A

Point-Intercept Aquatic Plant Survey Method

Appendix A – Supporting Aquatic Plant Documentation

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

Taxonomic richness (the total number of taxa detected)

- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling sites)
- **Simpson Diversity Index (SDI)** is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.

Floristic Quality Index (FQI) (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site.

APPENDIX B

Tables

Table 3: Taxa Detected During 2020 Aquatic Plant Survey, Wilke Lake, Manitowoc County, WI

Genus	Species	Common Name	Category
Myriophyllum	***spicatum***	**Eurasian water-milfoil**	**Invasive**
Potamogeton	***crispus***	**Curly-leaf pondweed**	**Invasive**
Chara	*sp.*	Muskgrass	Submersed
Najas	*flexilis*	Slender naiad	Submersed
Nuphar	*veriegata*	Spatterdock	Floating-leaf
Nymphaea	*odorata*	White water lily	Floating-leaf
Potamogeton	*amplifolius*	Large-leaf pondweed	Submersed
Potamogeton	*gramineus*	Variable pondweed	Submersed
Potamogeton	*illinoensis*	Illinois pondweed	Submersed
Potamogeton	*natans*	Floating-leaf pondweed	Submersed
Potamogeton	*praelongus*	White-stem pondweed	Submersed
Potamogeton	*richardsonii*	Clasping-leaf pondweed	Submersed
Sagittaria	*sp.*	Arrowhead species	Emergent
Typha	*angustifolia*	Narrow-leaved cattail	Emergent
Stuckenia	*pectinata*	Sago pondweed	Submersed
Utricularia	*vulgaris*	Common bladderwort	Submersed
Filamentous algae			Floating

Table 4: 2020 Aquatic Plant Community Statistics, Wilke Lake, Manitowoc County, WI

Date Sampled	6/29/2020
Points Sampled	235
Points with vegetation	210
Points shallower than maxium depth of plants	232
Frequency of occurrence	90.52%
Simpson Diversity Index	0.7
Maxiumum depth of plants (ft)	19
Average number of species per site (shallower than max depth)	1.38
Average number of species per site (veg. sites only)	1.52
Average number of native species per site (shallower than max depth)	0.95
Average number of native species per site (veg. sites only)	1.21
Species Richness	12

Table 5: 2020 Aquatic Plant Taxa-Specific Statistics, Wilke Lake Manitowoc County, WI

Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
Eurasian water-milfoil	**42.38**	**38.36**	**27.90**	**89**	**1.37**
Curly-leaf pondweed	**4.76**	**4.31**	**3.10**	**10**	**1.10**
Muskgrass	77.14	69.83	50.80	162	1.35
Slender naiad	6.19	5.60	4.10	13	1.00
Spatterdock*	---	---	---	2	---
White water lily*	---	---	---	2	---
Large-leaf pondweed	0.48	0.43	0.30	1	1.00
Variable pondweed	11.43	10.34	7.50	24	1.00
Illinois pondweed	4.29	3.88	2.80	9	1.00
White-stem pondweed	0.95	0.86	0.60	2	1.00
Clasping-leaf pondweed	0.48	0.43	0.30	1	1.00
Arrowhead sp.	1.90	1.72	1.30	4	1.00
Narro-leaved cattail*	---	---	---	1	---
Sago pondweed	0.95	0.86	0.60	2	1.00
Common bladderwort	0.95	0.86	0.60	2	1.00
Filamentous algae*	---	---	---	1	---
* - Species recorded visually only, not data calculated					

Table 6: Historic and 2020 Floristic Quality Indices, Wilke Lake, Manitowoc County, WI

Common Name	1992	2003	2009	2014	2020
Coontail	3	---	3	---	---
Muskgrass	7	7	7	7	7
Small duckweed	4	---	---	---	---
Northern water-milfoil	6	6	---	---	---
Slender naiad	6	6	---	6	6
Spatterdock	6	6	---	---	---
White water lily	6	6	---	6	---
Large-leaf pondweed	7	7	---	7	7
Water-thread pondweed	---	8	---	---	---
Leafy pondweed	---	6	---	---	---
Variable pondweed	---	7	7	7	7
Illinois pondweed	---	6	6	6	6
Floating-leaf pondweed	---	5	---	5	5
White-stem pondweed	---	---	8	8	8
Clasping-leaf pondweed	---	---	---	5	5
Sago pondweed	3	3	---	3	3
Broad-leaved cattail	1	1	---	---	---
Common bladderwort	---	---	7	7	7
Total Species	10	13	6	11	9
Mean C	4.90	5.69	6.33	6.09	6.22
Floristic Quality Index (FQI)	**15.50**	**20.52**	**15.51**	**20.20**	**18.67**

Please note: There is no Coefficient of Conservatism for exotic species such as Eurasian Water-Milfoil or plants not identified to the species level (*Sagittaria sp.*).

Coefficient of Conservatism C

0-3 taxa found in wide variety of plant communities and very tolerant of disturbance.
4-6 taxa typically associated with specific plant communities and tolerate moderate disturbance.
7-8 taxa found in narrow range of plant communities and tolerate minor disturbance.
9-10 taxa restricted to a narrow range of synecological conditions, with low tolerance of disturbance.

Table 7: FQI and Average Coefficient of Wilke Lake Compared to Wisconsin and Southeastern Till Plain lakes.

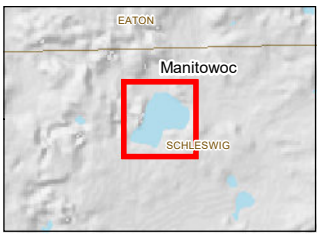
	Average Coefficient of Conservatism			**Floristic Quality**		
Quartile*	Lower	Mean	Upper	Lower	Mean	Upper
Wisconsin Lakes	5.5	6	6.9	16.9	22.2	27.5
Southeastern Till	5.2	5.6	5.8	17	20.9	24.4
Wilke Lake - 2020	6.22			18.7		

* - Values indicate highest value of the lowest quartile, mean, and lowest value of the upper

APPENDIX C

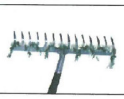
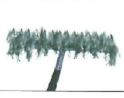
Figures

AREA ID	ACREAGE
A	6.2
B	1.0
C	0.5
D	2.4
E	0.5
F	2.5
G	0.5
H	1.0
I	0.4
J	3.7
K	24.2
L	2.6
TOTAL	45.5



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

Legend
- GPS Sample Points*
- Fullness Rating of 1
- Fullness Rating of 2
- Fullness Rating of 3
- Invasive Aquatic Plant

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

0 250 500 Feet

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N

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Project Location
T17N, R21E, S2 & S3
T. of Schleswig, Manitowoc Co., WI

Prepared by AJS on 2020-11-05
TR by XXX on 2020-XX-XX
IR by XXX on 2020-XX-XX

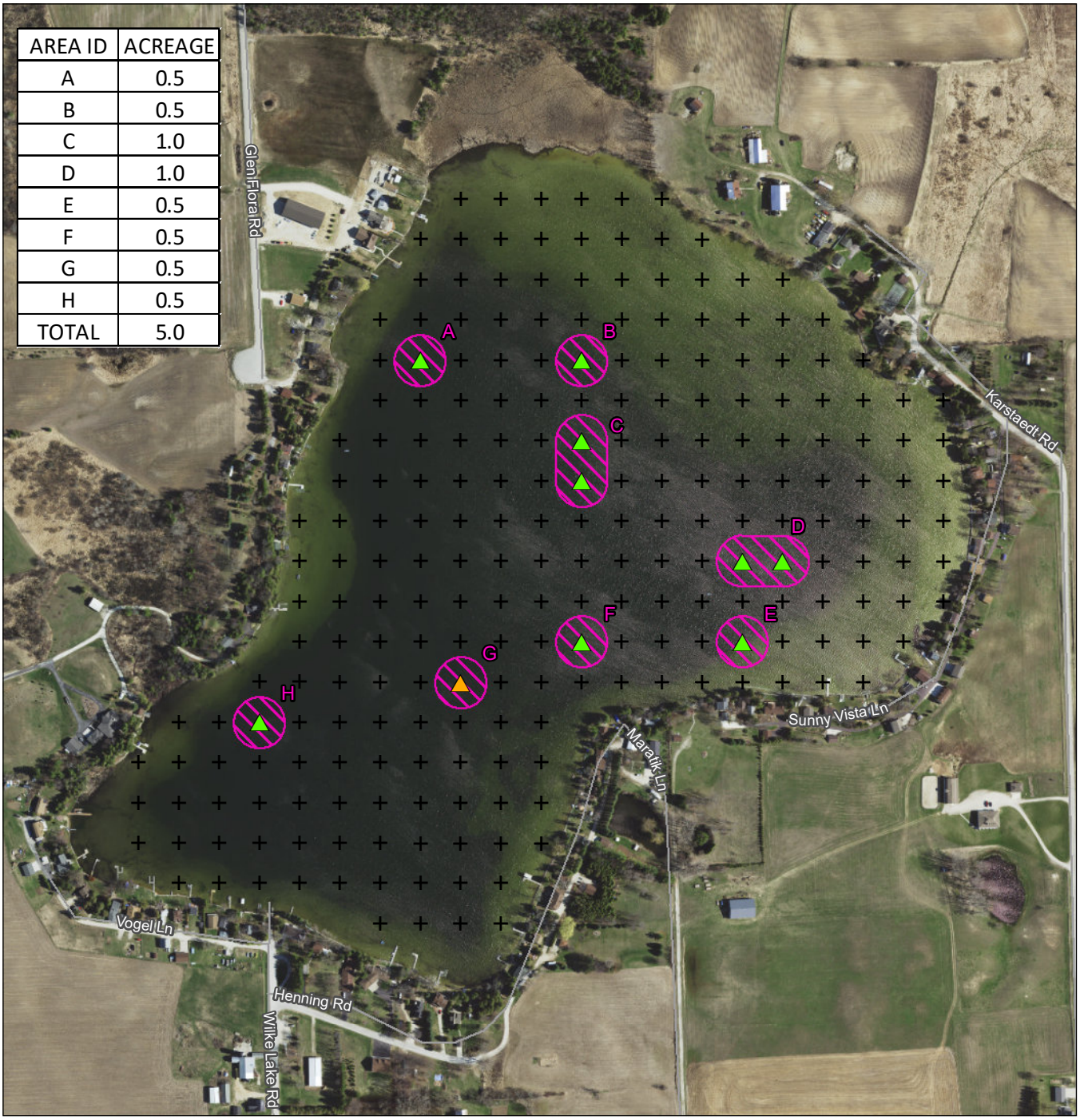
Client/Project 193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Aquatic Plant Management Plan

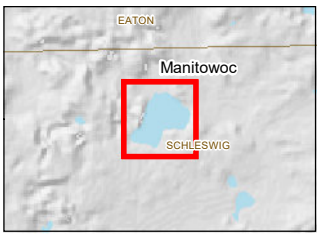
Figure No.
1

Title
2020 PI Survey - Eurasian Water Milfoil

*Survey completed on 2020/06/20 by Brian Lennie and Josh Sulman

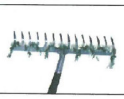
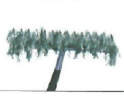
AREA ID	ACREAGE
A	0.5
B	0.5
C	1.0
D	1.0
E	0.5
F	0.5
G	0.5
H	0.5
TOTAL	5.0





Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

Legend
- GPS Sample Points*
- Fullness Rating of 1
- Fullness Rating of 2
- Invasive Aquatic Plant

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

0 250 500 Feet

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Wilke Lake
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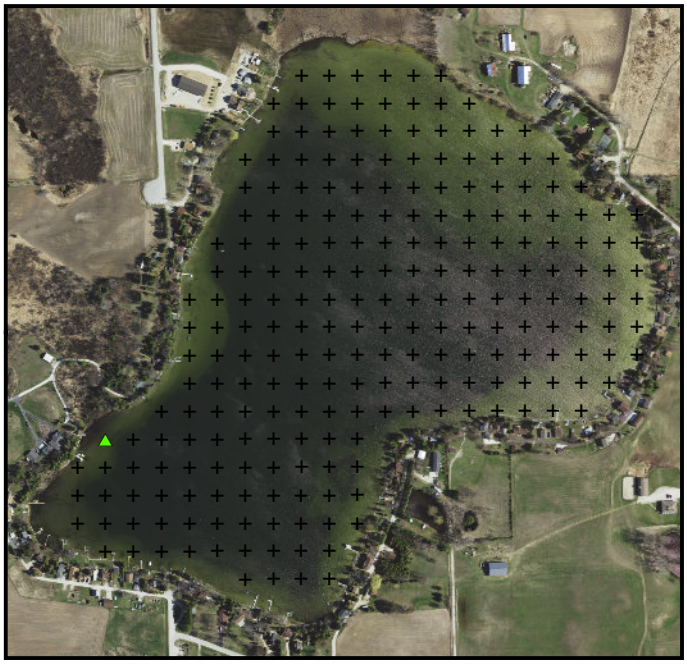
Figure No.
2

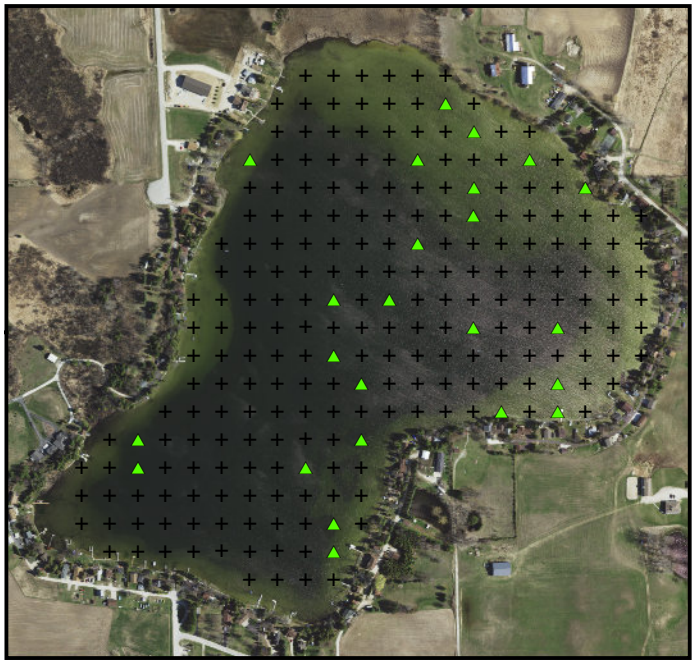
Title
2020 PI Survey - Curly-Leaf Pondweed

*Survey completed on 2020/06/20 by Brian Lennie and Josh Sulman

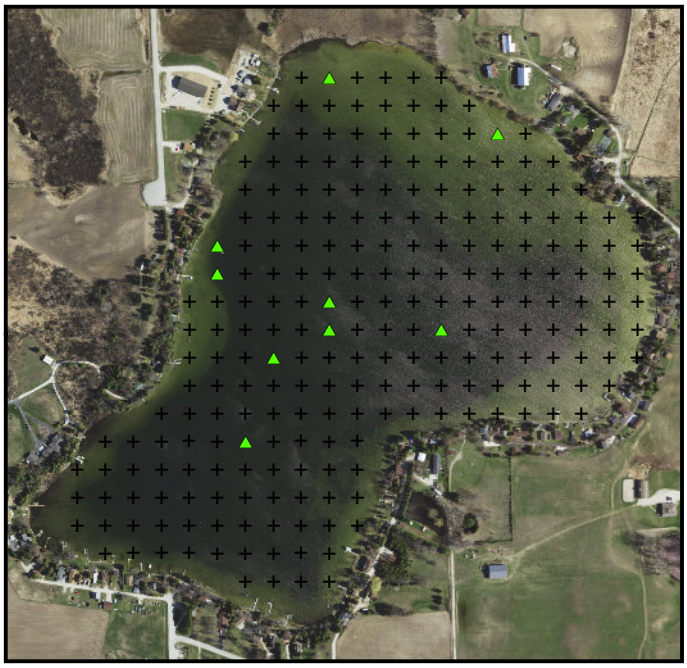
Large-leaf Pondweed



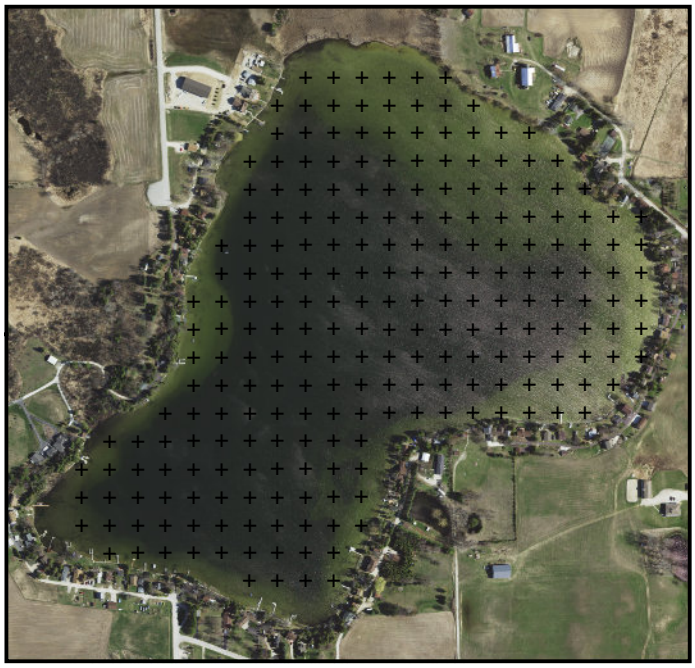
Variable Pondweed

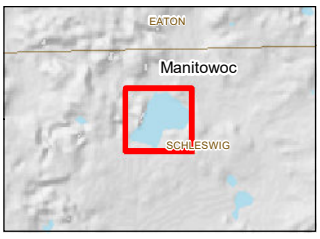


Illinois Pondweed



Floating-leaf Pondweed

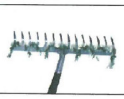




Legend

+ GPS Sample Points*

▲ Fullness Rating of 1

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

0 450 900 Feet

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Stantec

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IR by XXX on 2020-XX-XX

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Town of Schleswig - Sanitary District 2
Wilke Lake
Aquatic Plant Management Plan

Figure No.
3

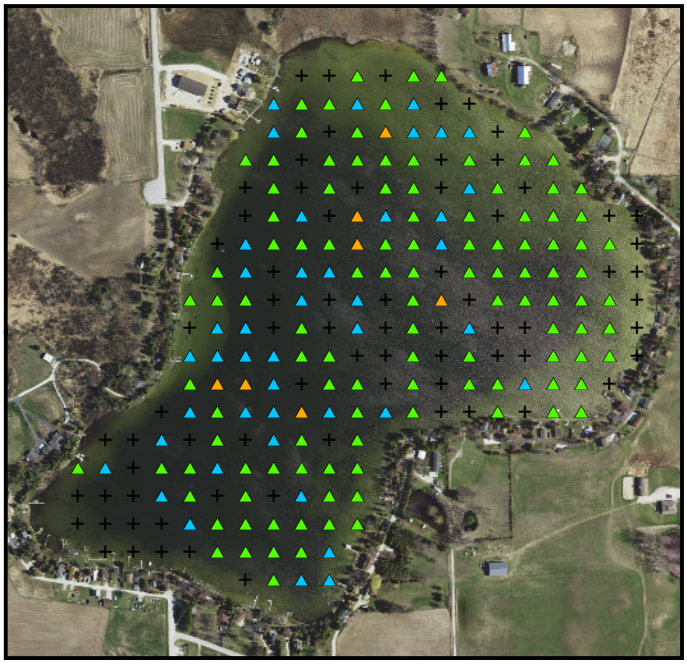
Title
2020 PI Survey - Large-leaf, Variable, Illinois, and Floating-leaf Pondweeds

Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

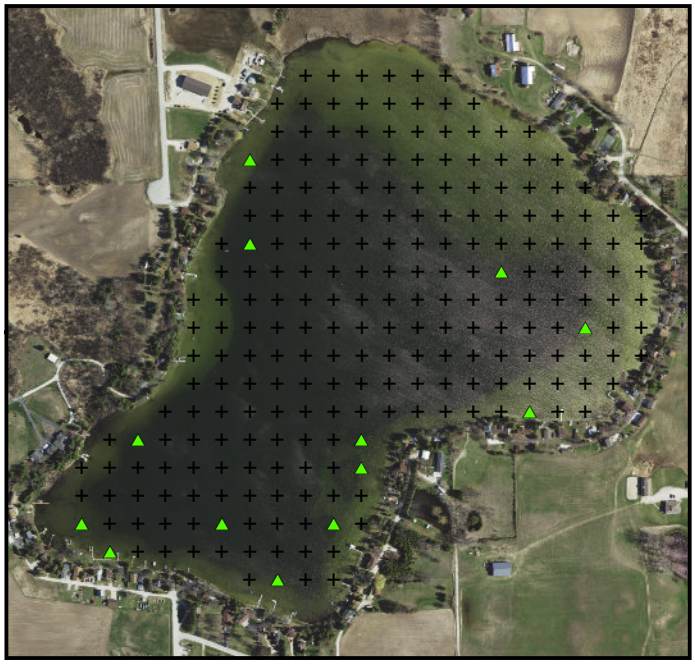
*Survey completed on 2020/06/20 by Brian Lennie and Josh Sulman

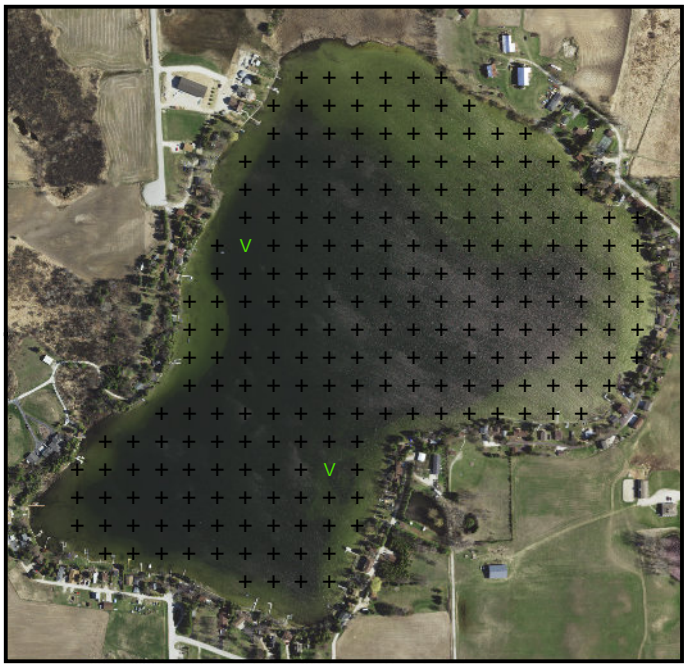
V:\1937\Active\193707716\03_data\gis_cad\gis\mxds\APM_Figures\fig3_LargeLeaf_Variable_Illinois_Floating_193707716.mxd Revised: 2020-11-11 By: aswaim

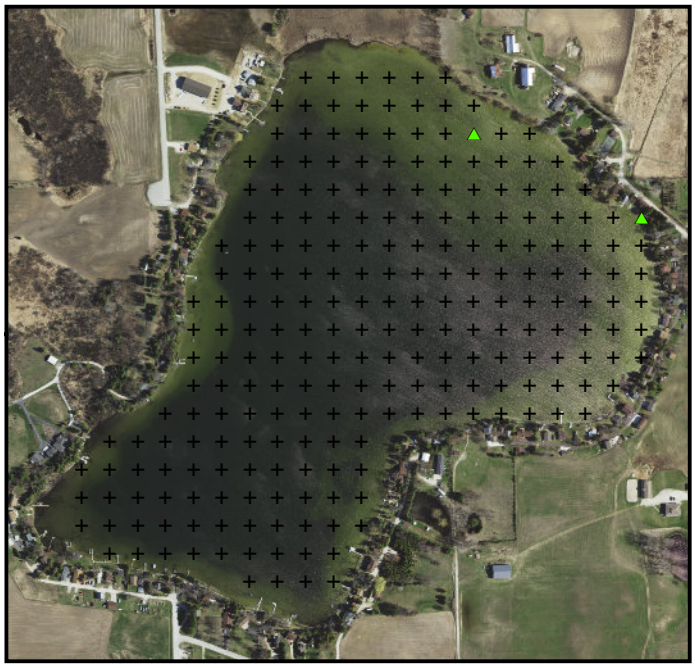
Chara



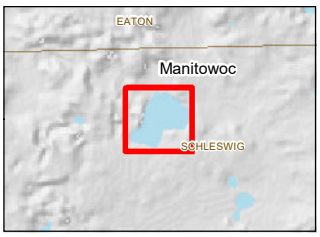
Slender Naiad







White Water Lily



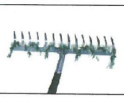
Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

Legend

- \+ GPS Sample Points*
- ▲ Fullness Rating of 1
- ▲ Fullness Rating of 2
- ▲ Fullness Rating of 3
- V Visual

Common Bladderwort

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

0 450 900 Feet

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Project Location
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TR by MP on 2020-11-11
IR by BL on 2020-11-11

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Town of Schleswig - Sanitary District 2
Wilke Lake
Aquatic Plant Management Plan

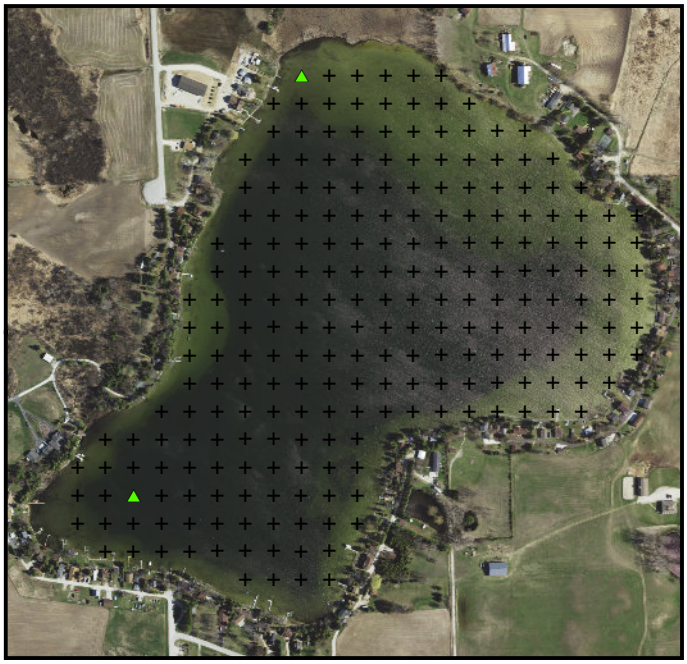
Figure No.
4

Title
2020 PI Survey - Chara, Slender Naiad, White Water Lily, and Common

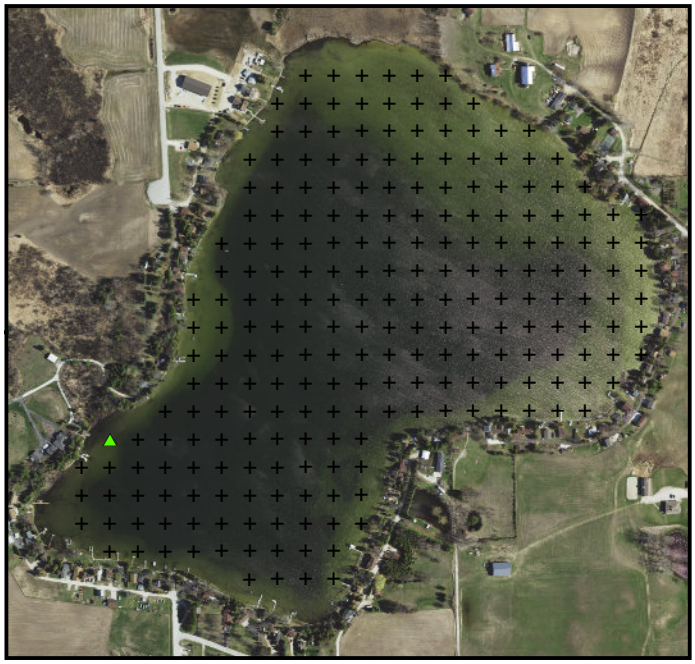
*Survey completed on 2020/06/20 by Brian Lennie and Josh Sulman

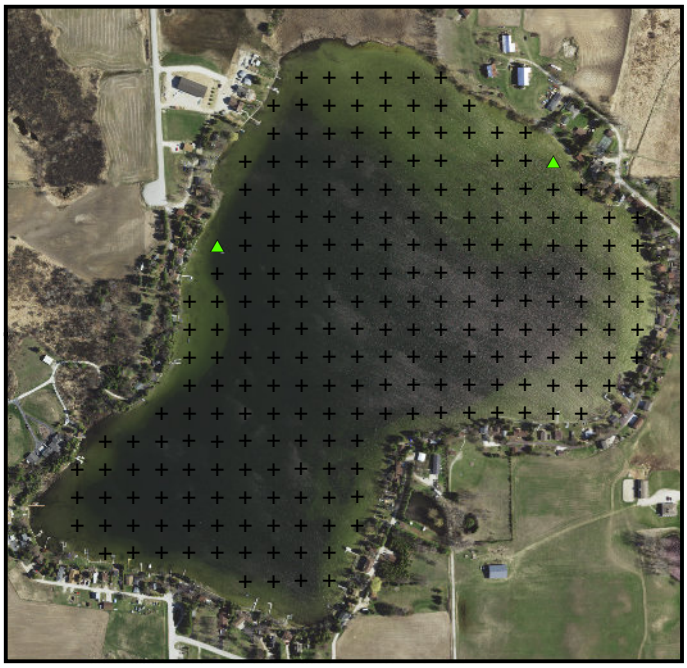
V:\1937\Active\193707716\03_data\gis_cad\gis\mxds\APM_Figures\fig4_Chara_Naiad_WhiteLily_Bladder_193707716.mxd Revised: 2020-11-11 By: aswaim

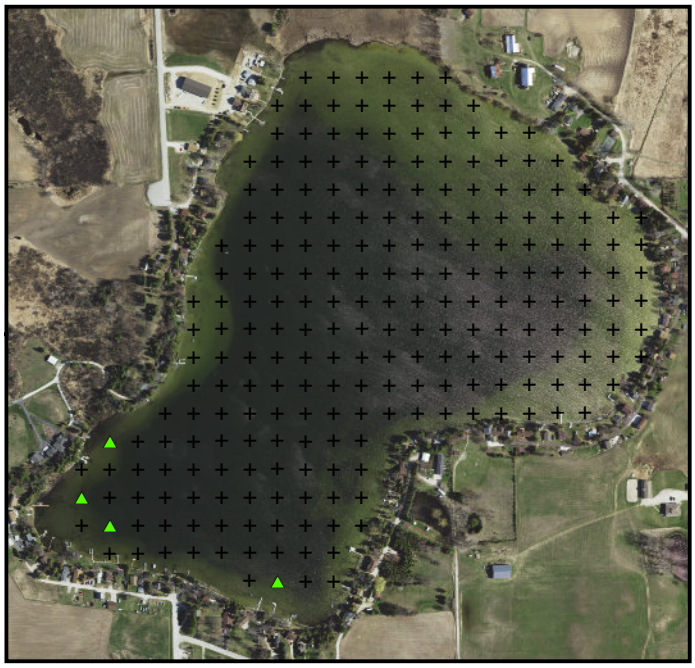
White-stem Pondweed



Clasping-leaf Pondweed

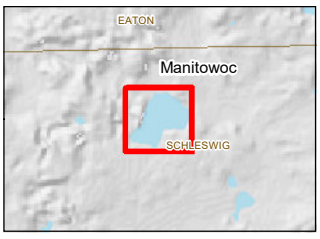






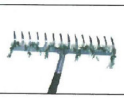
Sago Pondweed

Arrowhead species



Legend

- \+ GPS Sample Points*
- Fullness Rating of 1
- Fullness Rating of 2

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

0 450 900 Feet

(At original document size of 8.5x11)
1:10,800

Stantec

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

Project Location
T17N, R21E, S2 & S3
T. of Schleswig, Manitowoc Co., WI

Prepared by AJS on 2020-11-05
TR by XXX on 2020-XX-XX
IR by XXX on 2020-XX-XX

Client/Project
Town of Schleswig - Sanitary District 2
Wilke Lake
Aquatic Plant Management Plan

193707716

Figure No.
5

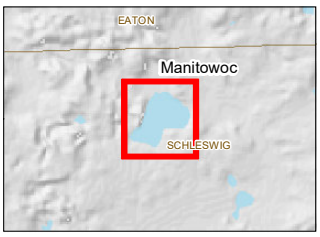
Title
2020 PI Survey - White-stem, Clasping-leaf, & Sago Pondweeds and Arrowhead species

*Survey completed on 2020/06/20 by Brian Lennie and Josh Sulman

V:\1937\Active\193707716\03_data\gis_cad\gis\mxds\APM_Figures\fig5_WhiteStem_Clasping_Arrowhead_Sago_193707716.mxd Revised: 2020-11-11 By: aswaim

APPENDIX D

Harvesting Map



Legend

- Nuisance Top-Cut (Depth to 4 FT) - 48.6 ac
- Navigation / Recreation Lane (100 FT Wide) - 18.1 ac

0 250 500 Feet

(At original document size of 8.5x11)
1:6,000

N

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WisDOT, WDNR, USGS
3. Orthophotography: WROC 2015

Stantec

Project Location
T17N, R21E, S2 & S3
T. of Schleswig, Manitowoc Co., WI

Prepared by AJS on 2020-11-11
TR by MP on 2020-11-11
IR by BL on 2020-11-11

Client/Project 193707716
Town of Schleswig - Sanitary District 2
Wilke Lake
Aquatic Plant Management Plan

Figure No.
6

Title
2020 Harvest Plan

APPENDIX E

"Frequently Asked Questions about Aquatic Herbicide Use in Wisconsin"

Frequently Asked Questions about Aquatic Herbicide Use in Wisconsin

Prepared by Wisconsin Dept. of Natural Resources, Dept. of Health Services and Dept. of Agriculture, Trade, and Consumer Protection

June 23, 2011

Why are herbicides used in Wisconsin lakes and rivers?

Aquatic herbicides are used to reduce the abundance of invasive species to reduce spread to new water bodies, to help maintain a healthy native plant community that is beneficial for fish and other aquatic organisms, to improve navigational access to lakes and rivers and make boat navigation safer, and to control nuisance plant and algae growth that can pose a hazard to swimmers.

How is aquatic herbicide use regulated in Wisconsin?

In order to be used in Wisconsin, an aquatic herbicide must be all of the following:

1) Labeled and registered with U.S. EPA's office of Pesticide Programs;
2) Registered for sale and use by the Department of Agriculture, Trade, and Consumer Protection (DATCP);
3) Permitted by the Department of Natural Resources (DNR); and
4) Applied by a DATCP-certified and licensed applicator, with few exceptions.

Step 1) U.S. EPA's office of Pesticide Programs reviews the chemical and label.

Federal law requires herbicides to be registered with the Environmental Protection Agency (EPA) before they can be sold or used. The registration process determines potential risk to human health and the environment. The human health assessment includes sensitive groups such as infants, and risk is evaluated for both short-term and chronic effects. Ultimately, the EPA registers the herbicide if it determines that use of the pesticide will result in "no unreasonable adverse effects" as defined in federal law. This means that the benefits of using the pesticide according to the label outweigh the risks. Once an herbicide is registered, it is re-assessed by EPA every fifteen years.

Step 2) Herbicides must be registered by DATCP prior to sale or use in Wisconsin.

Most EPA-registered herbicide products are eligible to be registered for sale and use in Wisconsin by DATCP-licensed manufacturers and labelers. DATCP will not register an herbicide for use if it is prohibited for sale, use or distribution in Wisconsin, even if it is registered by EPA.

Step 3) DNR evaluates requests for use of chemicals in public waters when a permit application is submitted.

> When making a decision whether or not to issue a permit, the Department considers the appropriateness of the herbicide selected at the site, the likely non-target organism effects, the potential for adverse effects on the water body, as well as the potential hazard to humans. DNR may then issue the permit, issue the permit with conditions, or deny the permit. Permit conditions are frequently used to make sure that the herbicide is used responsibly and in accordance with best management practices for the plant being managed.

Step 4) Applied by a certified applicator.

> Most herbicide applications to water bodies in Wisconsin must be done by certified applicators. To become certified, an individual must complete a training course and pass a written exam. Businesses that provide herbicide application services must also be licensed by DATCP. A certified applicator is not needed only if the treatment area is less than ¼ acre in size and the product being applied is a granular herbicide.

Are herbicides safe?

The distinction between "EPA registered" and the terms "approved" or "safe" is important. Registration by the EPA does not mean that the use of the herbicide poses no risk to humans or the environment, only that for use in the U.S., the benefits have been determined to outweigh the risks. Because product use is not without risk, the EPA does not define any herbicide as "safe". It is prudent to minimize herbicide exposure whenever possible.

When an herbicide is registered, the EPA sets use requirements to minimize risk that are given on the herbicide label. When using herbicides it is important to follow the label instructions exactly, and never use an herbicide for a use not specified on the label.

What does the DNR do to minimize herbicide use and ensure that herbicides are used responsibly?

The Department of Natural Resources evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The Department frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also means that, in most cases, the herbicide will be degraded by the time peak recreation on the water starts.

The DNR encourages minimal herbicide use by requiring a strategic Aquatic Plant Management (APM) Plan for management projects over 10 acres or 10% of the water body or any projects

receiving state grants. DNR also requires consideration of alternative management strategies and integrated management strategies on permit applications and in developing an APM plan, when funding invasive species prevention efforts, and by encouraging the use of best management practices when issuing a permit.

The Department also supervises treatments, requires that adjacent landowners are notified of a treatment and have an opportunity to request a public meeting, requires that the water body is posted to notify the public of treatment and usage restrictions, and requires reporting after treatment occurs.

How long do the chemicals stay in the water?

The amount of time an herbicide will stay in the water varies greatly based on a number of different factors, including the type of herbicide used. Residues may only be present in the water for a few hours, or for as long as a few months. Each herbicide has different characteristics that affect where the chemical moves (e.g. if it stays in the water column or settles into the sediment), how it is broken down, and how long it can be detected in water, sediments, and aquatic organisms. For more information on the environmental fate of a particular herbicide, please see the individual chemical fact sheets, available by request from your local lake coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=LAKE_COORDINATOR). These are currently being updated and will be available online soon, as well.

Should I let my kids swim in the water?

None of the aquatic herbicides licensed for use in Wisconsin have swimming restrictions. Dilute amounts of herbicide may be present in the water, but EPA has determined that minimal exposure would result from adults or children swimming in treated waters.

Use restrictions for treated water vary by herbicide, but will always be listed on the herbicide label. To find out how to read an herbicide label, see http://www.epa.gov/pesticides/label/. Restrictions must be posted at public access points to the water body for at least one day near an herbicide treatment and sent to shoreline landowners in advance of the treatment. To minimize your risk of direct exposure, it is wise to stay a safe distance from the area being treated while herbicide applications are being made.

What if I accidently ingest some of the water while swimming or my pet drinks the water?

When assessing the risk posed by swimming in treated water, the EPA considers exposure from accidental swallowing of water, as well as from other routes such as through the skin. Any exposure to herbicide in the water while swimming or through accidental ingestion would be small and would not have toxic effects. Similarly, your pet should not have any side effects from swimming in or drinking treated water, so long as any applicable use restriction period is over.

Are there risks to drinking water?

In Wisconsin, most drinking water supplies come from groundwater, not surface water. For water bodies that are used for drinking water, treatments are required to be a minimum distance from any existing intakes (usually ¼ of a mile). Wells are not considered to be intakes, and therefore the setback distance does not apply. Some aquatic herbicides can move through the sediment into the groundwater, but even those that do move through soil have not been detected above drinking water thresholds in wells.

Campers that are treating surface water for drinking should obtain water from an alternate location until after any posted drinking water restrictions have passed.

Can I eat the fish?

There are no restrictions on eating fish for any currently registered aquatic herbicides following application to water. That does not mean you would not be exposed to the herbicide, just that the amount of herbicide that you might be exposed to is not toxic. A common concern with eating fish from treated water is that the herbicide concentration may be higher in fish tissues than in the water, and therefore exposure may be greater from fish than from exposure to lake water. The potential for bioaccumulation in fish varies by herbicide, and is evaluated by the EPA during the registration process.

Can I water my lawn/garden with lake water?

Many of the herbicides used in lakes and ponds are broadleaf herbicides which will damage garden plants including fruits and vegetables. Some aquatic herbicides will also affect grass. Whether you are watering your lawn or your garden, follow water usage restrictions to avoid any unintended damage. These restrictions on watering will be listed on the herbicide label and posted at boat landings and beaches. The limits vary widely, from no restriction to 120 days. If you are unsure about the herbicide used on the lake near your home, the safest option is to use water from your municipal supply or private well to water plants.

How can I find out if an aquatic herbicide treatment is scheduled for my lake, or has occurred recently?

Notices of herbicide applications and the use restrictions of the herbicides used are required to be posted along shore adjacent to a treatment area, as well as at public access points for the day of treatment through the end of the restricted use period. Additionally, landowners adjacent to a treatment area should be sent advance notification of the treatment by mail, email or newsletter. For a large-scale treatment (over 10 acres or over 10% of the area of the lake) all landowners around the lake would receive advance notification.

How can I be notified in advance of when and where an application will occur, even if I am not adjacent to the treatment area?

The DNR will notify any interested person of upcoming applications if they request to be notified in writing each year. To request notification, contact your local DNR aquatic plant management coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=AP_MNGT).

Why can one person or group of people receive a permit to treat my lake if I don't want the treatment?

Any individual or group can request a permit from the DNR for a treatment since water bodies in the state are public property. The DNR is charged with evaluating any proposed treatments to consider the impact on the environment, and permits can be denied.

The permitting process requires that all landowners adjacent to the treated area be notified of the treatment. If you receive the notice and don't want the treatment to occur, you can send a written request to the applicant and the DNR requesting a public informational meeting on topics of concern to you regarding the treatment and alternatives. If 5 or more such requests are received within 5 days of the notice, the applicant is required to conduct such a meeting in a location near the water body.

What can I do to reduce the need for aquatic herbicide use?

Individuals can help reduce requests for herbicide use to control aquatic plants and algae by implementing best management practices on their property to prevent nutrients from running into the water and by preventing the spread of invasive species. To reduce runoff eliminate the use of fertilizers adjacent to a water body, rake leaves out of the street and off the lawn, plant a buffer strip of native vegetation on shore to reduce erosion and filter water coming off lawns, create a rain garden to filter and slow down water from driveways or rooftops, use a rain barrel to collect water from rooftops to use to water plants, or use a pervious option to pave driveways and sidewalks. To prevent the introduction of new invasive species and stop the spread of existing invasives, when boating remove plants, animals, and mud from your boat when leaving a boat launch, drain all water from your boat, and rinse your boat and equipment with hot or high pressure water or allow to dry for at least five days before moving to another water body.

Where can I find more information about a specific herbicide?

The DNR keeps a fact sheet on file for each herbicide used in aquatic systems. These fact sheets can be requested from your local DNR lake coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=LAKE_COORDINATOR), and will be updated and available online soon, as well.

The EPA's risk assessments are available at http://www.epa.gov/pesticides/reregistration/status.htm.

Additional information can be found with these resources:

http://www.co.thurston.wa.us/health/ehipm/ehipm_aquaticreview.html
Health assessment of aquatic herbicides by Thurston County, Washington, Public Health and Social Services

http://extoxnet.orst.edu/pips/ghindex.html
Specific information on pesticides as well as toxicology

http://npic.orst.edu/
Information about pesticides, supported by EPA and Oregon State University

http://www.datcp.wi.gov/Plants/Pesticides/
WI Department of Agriculture, Trade, and Consumer Protection

Appendix E WILKE LAKE 2018 COMPREHENSIVE FISH SURVEY

Wilke Lake 2018 Comprehensive Fish Survey
Steve Hogler, Steve Surendonk and Jeremiah Shrovnal- DNR Green Bay

Wilke Lake is a seepage lake located in the southwest corner of Manitowoc County. The lake has a surface area of 97 acres, a maximum depth of 22 feet and an intermittent outlet. The shoreline is highly developed and the lake experiences heavy recreational use. Wilke Lake has had a history of panfish management and aquatic plant problems since the 1950's.

Fish surveys have been conducted on Wilke Lake since the early 1950's. These surveys found abundant, small, slow growing panfish populations dominated by Bluegill and Yellow Perch. Gamefish populations were dominated by Largemouth Bass and Northern Pike. Over the years, stocked Walleye and Hybrid Muskellunge also provided anglers with additional fishing opportunities. Abundant Carp were also captured during these surveys. Beginning in the late 1950's, various management strategies have been used to reduce panfish number and to improve their size structure. These strategies included: mechanical removal by seine, partial chemical treatment with toxaphene, aquatic plant removals (chemical and mechanical) and predator stocking. The first two strategies provided short-term improvements in growth rates but did not produce lasting results. Predator stocking and plant removals had mixed results with longer term benefits for some species and no impact on others.

Beginning in late April 2018, a comprehensive fish survey was begun on Wilke Lake that followed statewide survey protocols. Fyke nets and electroshocking was used to the assess the fish populations of Wilke Lake.

Seven fyke nets were set in Wilke Lake on April 23rd, 2018 and fished until May 1 when they were removed. The nets were lifted and emptied seven times during the eight days they were deployed for a total effort of 56 net nights. 1,520 individual fish were captured representing thirteen species. Bluegill were the most abundant species caught, with lower numbers of Yellow Bullhead, Black Crappie and Northern Pike captured.

The entire 1.84 mile shoreline was electroshocked on the night of May 22, 2018 to assess the Largemouth Bass and panfish populations of Wilke Lake. In the 1.4 hours of shocking, 539 fish representing nine species were captured. Bluegill, Yellow Perch and Pumpkinseed Sunfish dominated our catch with fewer Largemouth Bass and other species captured.

Changes to selected gamefish regulations and the addition of wood or other habitat to improve fish populations are fish management actions that are recommended for Wilke Lake.

Introduction

Wilke Lake is a seepage lake located in the southwest corner of Manitowoc County (Figure 1). The lake has a surface area of 97 acres, a maximum depth of 22 feet and a shoreline development factor of 1.30 (Figure 2). Wilke Lake has an intermittent outflow that flows eastward though a wetland. The waters of Wilke Lake support large numbers of rooted aquatic plants that in recent years have required harvesting by the Wilke Lake Association. The shoreline is highly developed and the lake experiences heavy recreational use.

Figure 1. Wilke Lake is located in the southwestern corner of Manitowoc County.

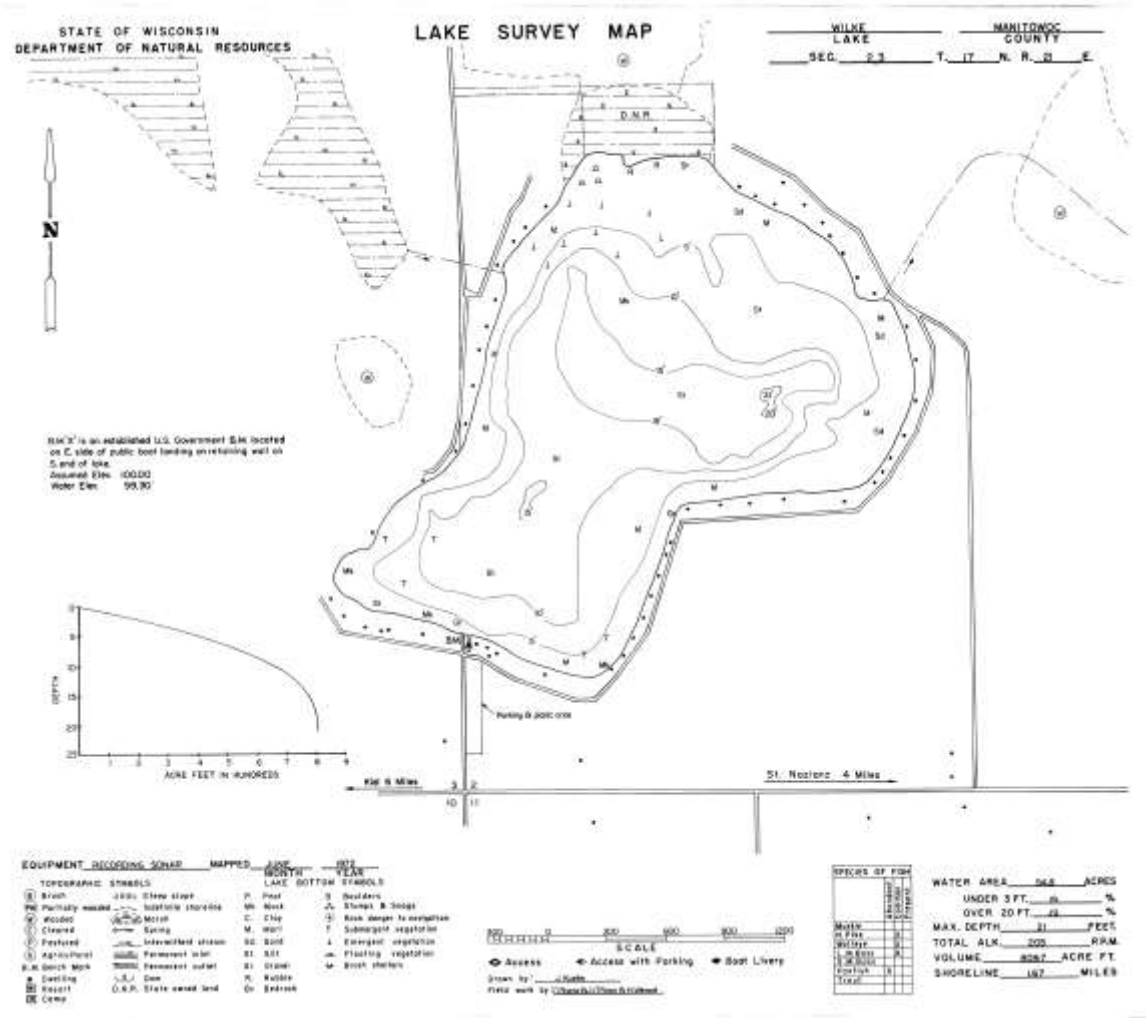


Figure 2. The bathometric map of Wilke Lake showing the extensive littoral area of the lake.

Wilke Lake has had a history of panfish management problems (Wirth 1952). Surveys in the 1950's determined panfish were over abundant and slow growing (Probst 1953, Cline 1956). During 1958 and 1959, the lake was seined several times to remove excess panfish, with no apparent success. Schultz (1963) indicted that the average size of captured Bluegill in follow-up surveys were smaller than their average length in surveys conducted before the removals. A partial chemical treatment with toxaphene to reduce panfish numbers in 1963 only achieved short term reductions in number and improved growth rates before Carp and panfish numbers rebounded quickly and panfish size decreased (Schultz 1965).

From 1963 to 1975, predator fish, consisting of Northern Pike, Walleye and Largemouth Bass were stocked and aquatic plant removals were done to improve panfish size by reducing their abundance through predation and reductions in cover (Belonger 1976) (Table 1). Hybrid Musky were stocked from 1976 to 1979 as an additional predator. Results from predator stocking was mixed, with good predator number and size, but small, overabundant panfish still present. Belonger (1979) suggested that Hybrid Musky survived well but were quickly harvested by anglers once reaching legal size which caused only

minimal impacts to panfish populations. He further indicated that Musky stocking had little effect on panfish size based on several electroshocking and seine surveys.

Table 1. Fish stocking record for Wilke Lake, 1933-2017. Fish were stocked at various ages ranging from small fingerling to adult transfers during this period. The Panfish stockings in 1935 included Yellow Perch and Bluegill. Panfish and Walleye stocked in the even years of 2000's were stocked under permits issued to the Wilke Lake Association. All other stockings were made by the WCD or DNR.

Year	Species	Number Stocked
1933	LARGEMOUTH BASS	154
1934	LARGEMOUTH BASS	392
1935	LARGEMOUTH BASS	3
1935	PANFISH	2450
1936	BLUEGILL	1200
1936	LARGEMOUTH BASS	340
1936	WALLEYE	330
1936	YELLOW PERCH	330
1937	BLUEGILL	8000
1937	SMALLMOUTH BASS	30
1937	YELLOW PERCH	660
1940	BLUEGILL	10000
1940	LARGEMOUTH BASS	3000
1940	YELLOW PERCH	2000
1941	LARGEMOUTH BASS	5000
1943	LARGEMOUTH BASS	800
1944	LARGEMOUTH BASS	2000
1946	LARGEMOUTH BASS	2000
1947	LARGEMOUTH BASS	900
1947	NORTHERN PIKE	900
1948	LARGEMOUTH BASS	500
1949	LARGEMOUTH BASS	2000
1960	NORTHERN PIKE	200
1963	LARGEMOUTH BASS	254
1963	NORTHERN PIKE	745
1964	LARGEMOUTH BASS	15676
1964	NORTHERN PIKE	2462
1964	WALLEYE	4550
1965	NORTHERN PIKE	500
1972	NORTHERN PIKE	100
1972	NORTHERN PIKE	100
1972	WALLEYE	700
1973	NORTHERN PIKE	100
1974	NORTHERN PIKE	100
1975	NORTHERN PIKE	100
1975	WALLEYE	50
1976	HYBRID MUSKY	400
1977	HYBRID MUSKY	400
1978	HYBRID MUSKY	400
1978	WALLEYE	50
1979	HYBRID MUSKY	400
1989	MUSKELLUNGE	115
1989	WALLEYE	4493
1992	WALLEYE	2412
1994	WALLEYE	2368
1995	WALLEYE	2379
1999	WALLEYE	9500
2001	WALLEYE	9500
2002	BLACK CRAPPIE	780
2002	YELLOW PERCH	715
2003	WALLEYE	9500
2004	BLACK CRAPPIE	625
2004	WALLEYE	740
2005	WALLEYE	4700
2006	LARGEMOUTH BASS	993
2007	YELLOW PERCH	1439
2008	WALLEYE	624
2009	WALLEYE	3315
2011	BLACK CRAPPIE	1554
2011	WALLEYE	3653
2013	WALLEYE	3315
2015	BLACK CRAPPIE	497
2015	WALLEYE	3752
2016	WALLEYE	397
2017	WALLEYE	3239

In 1981, a comprehensive fish survey that used fyke nets, a barge seine, and electroshocking gear to assess the lake was conducted (Hogler 1998). This survey found that Northern Pike numbers were high, but small in size. Other gamefish, notably Hybrid Musky and Walleye, were much less abundant. Panfish were numerous, small in size, and somewhat slow growing.

The most recent surveys of Wilke Lake occurred in 2005 and 2010 when the entire shoreline was shocked at night to assess the fish population of the lake. The 2005 survey was conducted in October (Hogler 2006). Three gamefish species, Largemouth Bass, Northern Pike and Walleye were captured during the survey with Largemouth Bass the

dominant gamefish. Panfish were captured in good numbers but were judged to be small in size with most of the captured panfish less than 150 mm (6") in length.

The May 2010 electroshocking survey found that Bass and Bluegill dominated the catch (Hogler 2010). Largemouth Bass was the dominant gamefish in the lake with Walleye and Northern Pike captured in lower numbers. The number of bass that were captured in 2010 was more than twice what was captured in 2005, but few were greater than 14" (356 mm). Since the growth of bass was better than statewide averages, the lack of large fish suggested that anglers may be harvesting many of the legal size bass in the lake. Northern Pike number and size also improved since the 2005 survey. The reasons for the increase in number and size were unknown. Walleye have been stocked in alternate years by DNR to provide an additional fishing opportunity, but despite consistent Walleye stocking (Table 1), stocking continued to produce only a very limited Walleye fishery with few individuals being captured in our surveys or by anglers. Panfish continued to dominate the fish community of the lake, although most were small in size. The 2010 survey also captured mostly small, under 150 mm (6") Bluegill that exhibited slow growth. Yellow Perch were small in size as well, but growth appeared to be near statewide average growth. The lack of older Bluegill and Perch could indicate that high angler harvest once a fish reaches 150 mm (6").

Beginning in late April 2018, a comprehensive fish survey was begun on Wilke Lake following statewide survey protocols. Fyke nets and electroshocking was used to the assess the fish of lake.

METHODS

Spring Fyke Netting

A standard comprehensive fisheries survey on Wilke Lake began in April and continued through May 2018. Seven fyke nets were set on April 23 and were lifted through May 1 (Figure 3). Fyke nets were set to capture and mark adult spring spawning Northern Pike, Walleye and Yellow Perch. Biological data was also collected from the other species that were captured in the nets. All fish were identified and measured, spines, rays or scales were removed from a sub-sample of selected species for age determination and all gamefish were marked to allow a population estimate to be made.

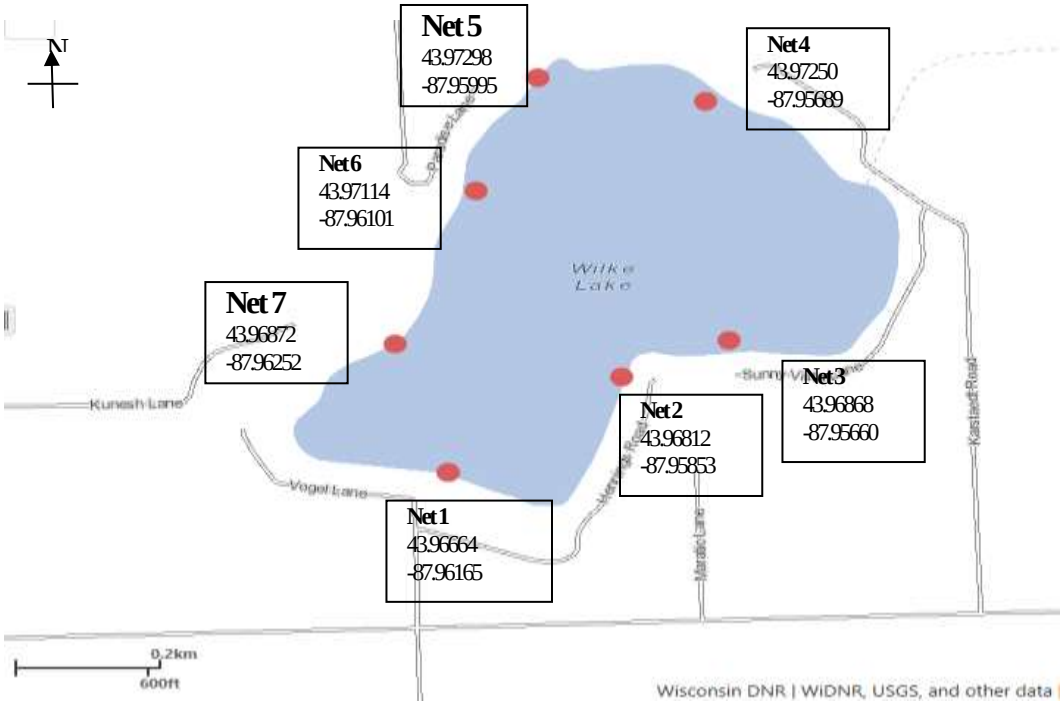


Figure 3. Spring 2018 fyke net locations on Wilke Lake.

Spring Electrofishing

Centrarchid Electrofishing
On the night of May 22, the entire shoreline was electroshocked to estimate adult Largemouth Bass and panfish relative abundance. All fish were netted, identified, checked for marks and measured.

Statistical Analyses

Basic fisheries statistics, such as average length, length frequencies by survey type, age distributions, and population estimates were calculated when possible. Mean length at age was determined first by using an age length key to extrapolate length age distributions from the sub-sample of fish that were aged to the full sample length frequency, then second calculating the arithmetic mean of the length for a given age from the estimated full sample age distribution.

The Schnabel population estimation method was used to estimate community population

size when the recapture numbers were large enough to provide an unbiased estimate of population size. For the Schnabel method, multiple marking and recapture periods were used to calculate the population estimate (Ricker 1975).

RESULTS

Fyke Net

Seven fyke nets were set in Wilke Lake on April 23rd, 2018 and fished until May 1 when they were removed. The nets were lifted and emptied seven times during the eight days they were deployed for a total effort of 56 net nights. 1,520 individual fish were captured representing thirteen species (Table 2). Total CPE was 27.14 fish per net per night. Bluegill were the most abundant species caught, with lower numbers of Yellow Bullhead, Black Crappie and Northern Pike captured. CPE (fish/net/night) ranged from a high of 15.0 for Bluegill to 0.02 for Golden Shiner, Smallmouth Bass and Yellow Perch.

Table 2. Wilke Lake spring 2018 fyke net catch summary. Catch Per Effort (CPE) is expressed as Fish/net/night. Lengths are reported in mm and inches ().

Species	Total Catch	CPE (fish/net/night)	Average Length	Length Range
Northern Pike	195	3.48	494 mm (19.4")	306 mm- 647 mm (12.0"- 25.5")
Golden Shiner	1	0.02	--	-
White Sucker	3	0.05	--	-
Yellow Bullhead	268	4.79	296 mm (11.7")	153 mm- 364 mm (6.0"- 14.3")
Green Sunfish	12	0.21	185 mm (7.3")	138 mm- 212 mm (5.4"- 8.3")
Pumpkinseed	14	0.25	171 mm (6.7")	105 mm- 214 mm (4.1"- 8.4")
Bluegill	840	15.0	132 mm (5.2")	73 mm- 211 mm (2.9"- 8.3")
Smallmouth Bass	1	0.02	435 mm (17.1")	435 mm (17.1")
Largemouth Bass	11	0.20	303 mm (11.9")	207 mm- 415 mm (8.1"- 16.3")
Black Crappie	134	2.39	225 mm (8.9")	113 mm- 317 mm (4.4"- 12.5")
Hybrid Sunfish	24	0.43	145 mm (5.7")	104 mm- 205 mm (4.1"- 8.1")
Yellow Perch	1	0.02	190 mm (7.5")	190 mm (7.5")
Walleye	16	0.29	438 mm (17.2")	263 mm- 605 mm (10.4"- 23.8")
Total	**1520**	**27.14**		

Gamefish

Northern Pike

Northern Pike were the most common gamefish species that was captured during the fyke net portion of the survey. The 195 Northern Pike ranged in length from 306 mm to 647 mm (12" to 25.5") and had an average length of 494 mm (19.4") (Table 3)

Table 3. The length frequency of gamefish captured during the 2018 fyke survey of Wilke Lake. Length is reported in mm and inches ().

Length (in) mm	Northern Pike	Smallmouth Bass	Largemouth Bass	Walleye
(8") 200			1	
210			1	
220			1	
230				
240				
(10") 250			1	
260				1
270				1
280				
290			1	
(12") 300	1		2	1
310				
320	1			
330	2			
340	2			2
(14") 350	1		2	
360	1			
370				
380	3			
390				
(16") 400	5		1	
410	2		1	
420	6			
430	7	1		1
440	7			
(18") 450	9			3
460	11			1
470	18			1
480	15			
490	15			
(20") 500	12			1
510	12			
520	7			
530	14			1
540	7			1
(22") 550	7			1
560	8			
570	6			
580	6			
590	4			
(24") 600	1			1
610	1			
620	3			
630				
640	1			
Total	**195**	**1**	**11**	**16**
Ave. Length	**494 mm (19.4")**	**435 mm (17.1")**	**303 mm (11.9")**	**438 mm (17.2")**
S.D.	**61.3 mm (2.4")**	**--**	**73.4 mm (2.9")**	**103.7 mm (4.1")**

Most of the captured Northern Pike were between 400 mm and 600 mm (16” to 24”) in length (Figure 4). Only a single pike was greater in length than 625 mm (25”).

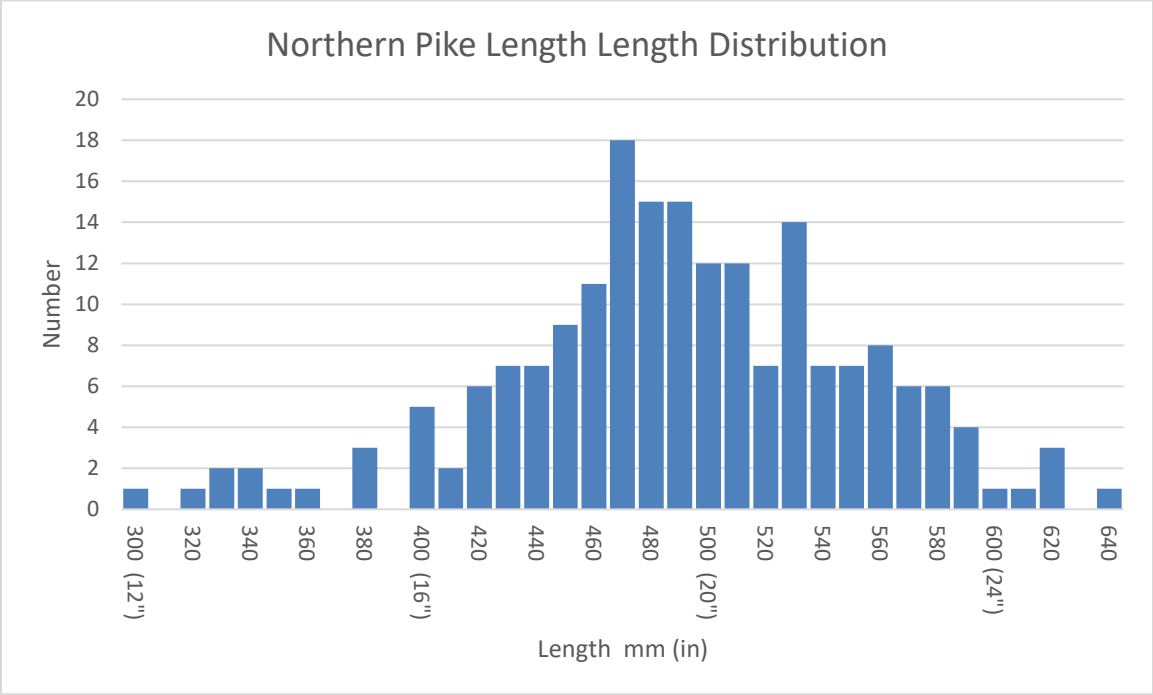


Figure 4. Length distribution of Northern Pike captured by fyke net from Wilke Lake in 2018. Lengths are reported in mm and inches ().

The 2nd and 3rd anal rays were removed from 193 of the captured Northern Pike for age analysis. Rays were cross sectioned and viewed under a microscope to count annular (yearly) rings. Samples indicated that ages 1 through 9 were present in the aged Northern Pike (Table 4). Age 4 and age 5 Northern Pike were the dominant age classes in our sample. These fish were hatched in 2014 and 2013 respectively. Other aged Northern Pike were found in lower abundances.

When the average length at each age for pike from Wilke Lake is compared to pike from other lakes across Wisconsin, pike at all ages are smaller indicating below average growth (Table 5). In general, pike in Wilke Lake show little growth beyond age 6.

Table 4. The age distribution by length of Northern Pike captured by fyke net from Wilke Lake in spring 2018.

Length (in)	mm	Age 1	2	3	4	5	6	7	8	9	Total
(12”)	300	1									1
	310										0
	320				1						1
	330		1		1						2
	340	1	1								2
(14”)	350		1								1
	360		1								1
	370										0
	380		3								3
	390										0
(16”)	400		5								5
	410		1	1							2
	420		2	2	1	1					6
	430		2	1	3	1					7
	440		1		2	4					7
(18”)	450			1	6	2	1				10
	460			1	4	3	2		1		11
	470			1	7	5	1	3	1		18
	480			1	7	4	1	2			15
	490			1	8	3	2	1			15
(20”)	500				7	4	1				12
	510				5	4	1	1	1		12
	520				3	2	1				6
	530			1	6	3	4				14
	540				3	1	1	1		1	7
(22”)	550				1	4	1				6
	560				4	3		1			8
	570					3		3			6
	580				1	1	3		1		6
	590				1	2		1			4
(24”)	600					1					1
	610										0
	620						2	1			3
	630										0
	640							1			1
Total		**2**	**18**	**10**	**71**	**51**	**21**	**15**	**4**	**1**	**193**
Ave. Length		**323 mm (12.7”)**	**398 mm (15.7”)**	**460 mm (18.1”)**	**493 mm (19.4”)**	**510 mm (20.1”)**	**529 mm (20.8”)**	**539 mm (21.2”)**	**507 mm (20.0”)**	**540 mm (21.3”)**	
S.D.		**24.1 mm (0.9”)**	**31.9 mm (1.3”)**	**37.3 mm (1.5”)**	**46.3 mm (1.8”)**	**47.6 mm (1.9”)**	**49.9 mm (2.0”)**	**57.9 mm (2.3”)**	**55.9 mm (2.2”)**	--	

Table 5. Length at age for Largemouth Bass, Bluegill, Northern Pike and Black Crappie captured by fyke nets from Wilke Lake in 2018 compared to Statewide averages. Lengths are in mm and inches (). Northern Pike, Bluegill and Black Crappie age samples were collected from the fyke nets and the Largemouth Bass age samples were collected during spring electroshocking.

Largemouth Bass

Age	2018	Statewide Average
0		
1		97 mm (3.8")
2	193 mm (7.6")	165 mm (6.5")
3	294 mm (11.6")	229 mm (9.0")
4	281 mm (11.0")	290 mm (11.4")
5	--	338 mm (13.3")
6	378 mm (14.9")	384 mm (15.1")
7	409 mm (16.1")	414 mm (16.3")
8	--	447 mm (17.6")
9	444 mm (17.5")	470 mm (18.5")
10	442 mm (17.4")	485 mm (19.1")

Bluegill

Age	2018	Statewide Average
0		
1		64 mm (2.6")
2	96 mm (3.8")	97 mm (3.8")
3	104 mm (4.1")	122 mm (4.8")
4	120 mm (4.7")	147 mm (5.9")
5	142 mm (5.6")	167 mm (6.6")
6	150 mm (5.9")	183 mm (7.2")
7	161 mm (6.4")	196 mm (7.8")
8	166 mm (6.5")	208 mm (8.2")
9	186 mm (7.3")	

Northern Pike

Age	2018	Statewide Average
0		
1	323 mm (12.7")	356 mm (14.0")
2	398 mm (15.7")	406 mm (16.0")
3	460 mm (18.1")	470 mm (21.5")
4	493 mm (19.4")	546 mm (24.0")
5	510 mm (20.1")	610 mm (24.0")
6	529 mm (21.2")	650 mm (25.6")
7	539 mm (21.2")	706 mm (27.8")
8	507 mm (20.0")	762 mm (30.0")
9	540 mm (21.3")	787 mm (30.9")

Black Crappie

Age	2018	Statewide Average
0		
1	113 mm (4.4")	79 mm (3.1")
2	153 mm (6.0")	137 mm (5.4")
3	173 mm (6.8")	183 mm (7.2")
4	208 mm (9.0")	218 mm (8.6")
5	239 mm (9.4")	241 mm (9.5")
6	251 mm (9.9")	267 mm (10.5")
7	251 mm (9.9")	274 mm (10.8")
8	279 mm (11.0")	

Walleye

Sixteen Walleye were captured during fyke netting. The Walleye ranged in length from 263 mm to 605 mm (10.4” to 23.8”) with an average length of 438 mm (17.2”) (Table 2). The lengths of captured Walleye were scattered across the range of captured fish (Table 3, Figure 5)

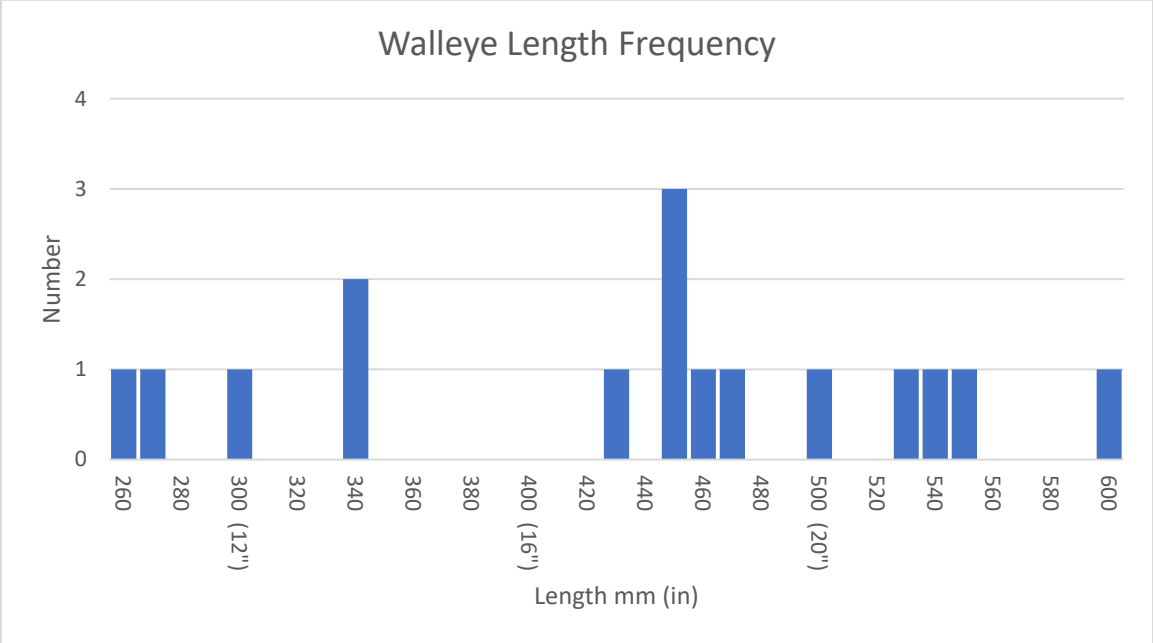


Figure 5. The length frequency of Walleye captured from Wilke Lake by fyke net in 2018. Lengths are reported in mm and inches ().

The 2nd dorsal spine from Walleye was removed for age analysis. The spines were cross sectioned and viewed under a microscope to count annular rings. Ages 2, 3, 7 and 13 or Walleye stocked in 2016, 2015, 2011 and 2005 respectively were found in our aged sample. Too few fish were aged to adequately analyze growth rates.

Bass

During the fyke net survey 11 Largemouth Bass and 1 Smallmouth were captured (Table 2). The 11 Largemouth Bass ranged in length from 207 mm to 415 mm (8.1” to 16.3”) and had an average length of 303 mm (11.9”) (Table 3). Only 3 (27.7%) of the captured Largemouth Bass were greater than the 356 mm (14”) harvest size minimum limit for Wilke Lake (Figure 6).

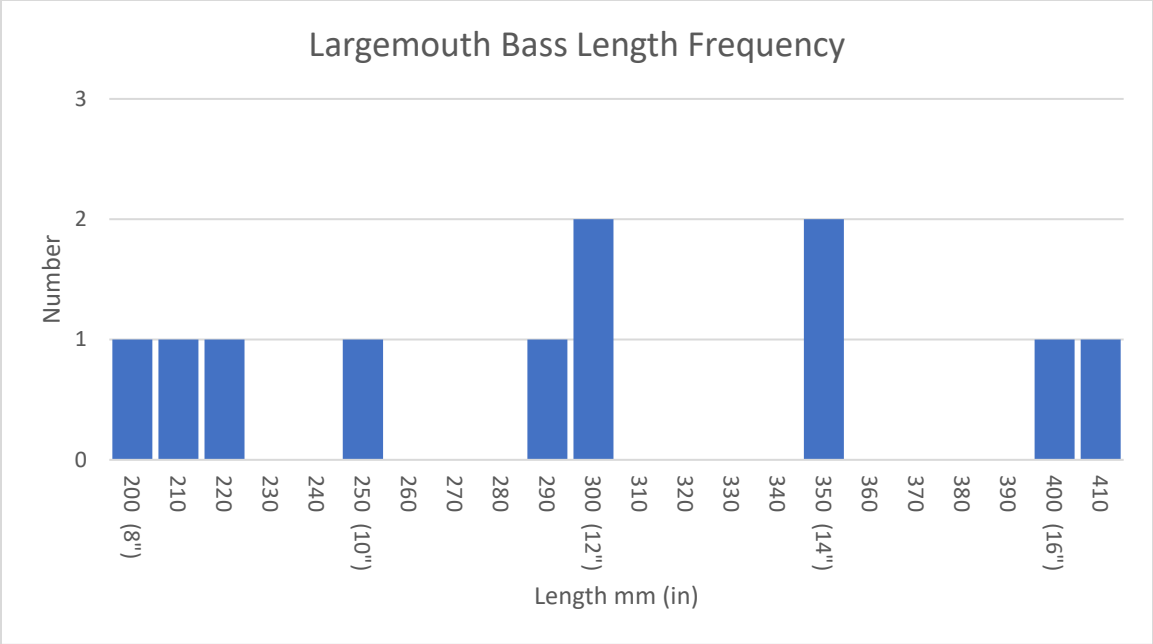


Figure 6. The distribution of Largemouth Bass lengths captured by fyke net.

The single Smallmouth Bass was 435 mm (17.1”) in length.

Panfish

Bluegill

Bluegill were the most common fish species captured during fyke netting. The 840 captured Bluegill ranged in length from 73 mm to 211 mm (2.9 to 8.3”) and had an average length of 132 mm (5.2”) (Table 2). Most of the Bluegill were between 90 mm and 180 mm (3.5” and 7”) in length (Figure 7). Very few Bluegill were greater than 180 mm (7”) in length. 240 of the captured Bluegill (28.6%) were greater in length than 150 mm (6”), while only 4 (0.5%) were greater than 200 mm (8”) in length.

Scales were removed from a subsample of Bluegill for age analysis. Scales were viewed under magnification to count annular rings. Sampled Bluegill from Wilke Lake ranged in age from 2 through 11 (Table 7). Age 2 through age 7 were the most common ages with older aged Bluegill less common.

The average length at age 2 is similar to Statewide averages, but from age 3 and older the average length at each age is less than Statewide average lengths for Bluegill by 25 mm to 50 mm (1 to 2”). In general, Bluegill in Wilke Lake grow slower than Bluegill in other lakes across Wisconsin.

Table 6. The length frequency of panfish captured during the 2018 fyke survey of Wilke Lake. Length is reported in mm and inches ().

Length (in) mm	Yellow Bullhead	Green Sunfish	Pumpkinseed	Bluegill	Black Crappie	Hybrid Sunfish	Yellow Perch
70				2			
80				9			
90				94			
(4”) 100			1	126		4	
110				97	1	4	
120				93		1	
130		1	1	74		3	
140			2	105	4	3	
(6”) 150	1			89	2	1	
160		2	2	71	5	3	
170	1	1	2	46	3		
180	1	2	2	25	10		
190		2	1	5	6	3	1
(8”) 200	2		2	3	9	2	
210	2	3	1	1	16		
220	8				12		
230	10				18		
240	8				20		
(10”) 250	11				7		
260	14				7		
270	16				4		
280	26				3		
290	18				1		
(12”) 300	29				2		
310	40				4		
320	38						
330	25						
340	8						
(14”) 350	9						
360	1						
Total	**268**	**11**	**14**	**840**	**134**	**24**	**1**
Ave. Length	**296 mm (11.7”)**	**185 mm (7.3”)**	**171 mm (6.7”)**	**132 mm (5.2”)**	**225 mm (8.9”)**	**145 mm (5.7”)**	**190 mm (7.5”)**
S.D.	**36.5mm (1.4”)**	**22.6 mm (0.9”)**	**30.6 mm (1.2”)**	**27.1 mm (1.1”)**	**38.7” (1.5”)**	**33.4 mm (1.3”)**	**—**

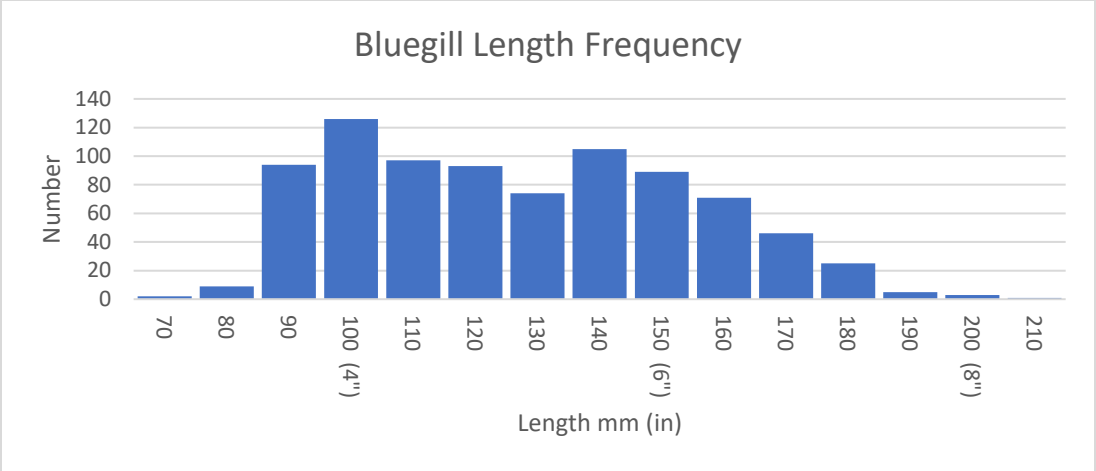


Figure 7. The length distribution of Wilke Lake Bluegill captured by fyke net. Lengths are reported in mm and inches ().

Table 7. The age distribution by length for Bluegill from Wilke Lake captured by fyke net in 2018. The age distribution of the entire measured catch was a projection based on the distribution of ages from scale samples. Lengths are reported in mm and in inches ().

Length (in)	mm	Age									
		2	3	4	5	6	7	8	9	10	11
	70	2									
	80	6	3								
	90	50	38	6							
(4")	100	16	95	15							
	110		26	52	19						
	120		3	35	31	24					
	130			14	14	35	6	5			
	140			4	50	29	17	5			
(6")	150			5	31	33	20				
	160				21	25	25				
	170				2	20	22		2		
	180					4	6	8	6		1
	190							2	1	1	1
(8")	200					1			1	1	
	210							1			
Total		**74**	**165**	**131**	**168**	**171**	**96**	**21**	**10**	**2**	**2**
Ave. Length		**96 mm (3.8")**	**104 mm (4.1")**	**120 mm (4.7")**	**142 mm (5.6")**	**150 mm (5.9")**	**161 mm (6.4")**	**166 mm (6.5")**	**186 mm (7.3")**	**200 mm (7.9")**	**185 mm (7.3")**
S.D.		**6.4 mm (0.3")**	**7.3 mm (0.3")**	**12.7 mm (0.5")**	**15.9 mm (0.6")**	**17.2 mm (0.7")**	**13.5 mm (0.5")**	**26.0 (1.0")**	**8.8 mm (0.4")**	**7.1 mm (0.3")**	**7.1 mm (0.3")**

Black Crappie

Black Crappie were the second most common panfish captured by fyke net (Table 2). The 134 Black Crappie that were captured ranged in length from 113 mm to 317 mm (4.4” to 12.5”) and had an average length of 225 mm (8.9”). Most of the measured crappie were less than 250 mm (10”) in length (Table 6 and Figure 8).

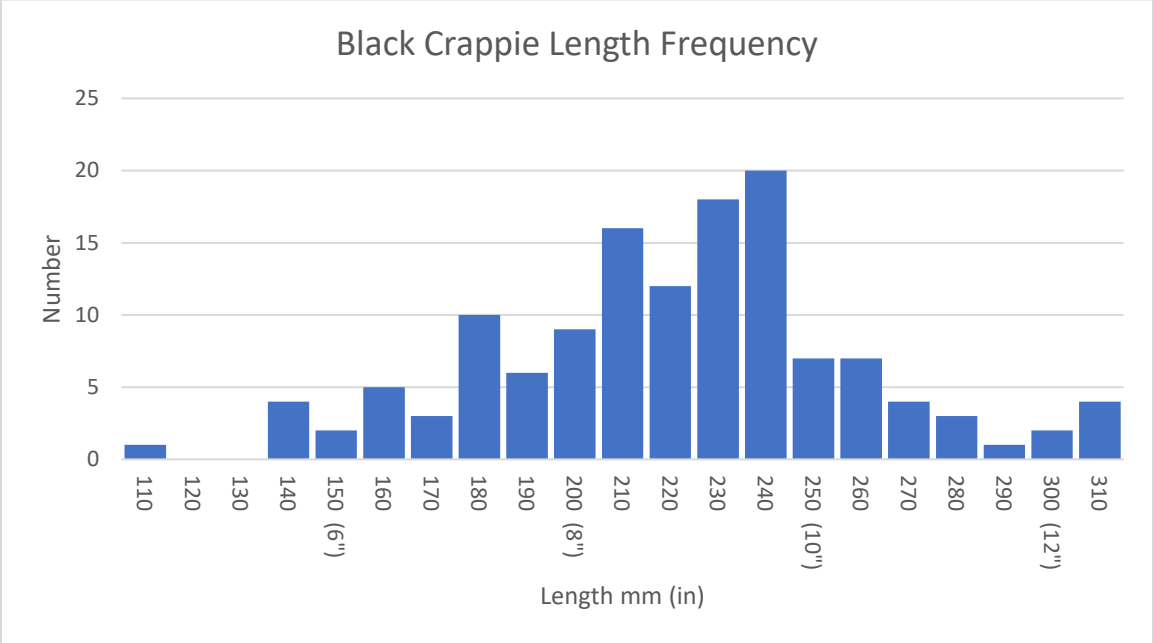


Figure 8. The length distribution of Wilke Lake Black Crappie captured by fyke net. Lengths are reported in mm and inches ().

Scales were collected from a subsample of captured Black Crappie for age analysis. Ages 1 through 10 and age 13 were identified in our sample (Table 8). Age 4 was the most common age followed by ages 5 and 6. Other ages were less common in our sample.

The average length of Black Crappie from Wilke at each age was similar to the length at age for crappie in other lakes across Wisconsin (Table 5). It appears that growth of Black Crappie from Wilke Lake is average.

During fyke netting other panfish species were captured but in lower abundances than Bluegill or Black crappie. Nets captured 24 Hybrid Sunfish, 14 Pumpkinseed Sunfish, 12 Green Sunfish and 1 Yellow Perch. These fish had average lengths of 145 mm (5.7”), 171 mm (6.7”), 185 mm (7.3”) and 190 mm (7.5”) respectively.

Other Species

Three additional species were captured during. These species included 268 Yellow Bullhead, 3 White Sucker and 1 Golden Shiner (Table 2). The Yellow Bullhead ranged in length from153 mm to 364 mm (6.0” to 14.3”) and had an average length of 296 mm (11.7”) (Table 6). The other species were not measured.

Table 8. The age distribution by length for Black Crappie from Wilke Lake captured by fyke net in 2018. The age distribution of the entire measured catch was a projection based on the distribution of ages from scale samples. Lengths are reported in mm and in inches ().

Length		Age												
(in)	**mm**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
	70													
	80													
	90													
(4”)	100													
	110	1												
	120													
	130													
	140		2	1	1									
(6”)	150		1	1										
	160		1	4										
	170			3										
	180			6	3	1								
	190			1	5									
(8”)	200				5	4								
	210				6	6	4	2						
	220				5	5	2							
	230				4	2	8	2	1					
	240				2	3	10	4	1					
(10”)	250							3	1	2				1
	260					1	2	4						
	270					1	1	1			1			
	280						1		1					
	290									1				
(12”)	300								1	1				
	310					1		1	2					
	Total	**1**	**4**	**16**	**31**	**24**	**28**	**17**	**7**	**4**	**1**	**0**	**0**	**1**
	Ave. Length	**113 mm (4.4”)**	**153 mm (6.0”)**	**173 mm (6.8”)**	**208 mm (8.2”)**	**228 mm (9.0”)**	**239 mm (9.4”)**	**251 mm (9.9”)**	**279 mm (11.0”)**	**271 mm (10.7”)**	**279 mm (11.0”)**	**--**	**--**	**257 mm (10.1”)**
	S.D.	**--**	**7.7 mm (0.3”)**	**13.6 mm (0.5”)**	**23.6 mm (0.9”)**	**27.4 mm (1.1”)**	**16.1 mm (0.6”)**	**25.0 mm (1.0”)**	**34.7 mm (1.4”)**	**30.9 mm (1.2”)**	**--**	**--**	**--**	

Spring Electroshocking

The entire 1.84 mile shoreline was electroshocked on the night of May 22, 2018 to assess the Largemouth Bass and panfish populations of Wilke Lake. In the 1.4 hours of shocking, 539 fish representing nine species were captured (Table 9). Total CPE was 292.93 fish per mile or 376.05 fish per hour shocked. Bluegill, Yellow Perch and Pumpkinseed Sunfish dominated our catch with fewer Largemouth Bass and other species captured.

Table 9. Wilke Lake 2018 spring electroshocking catch summary. Catch Per Effort (CPE) is expressed as fish per mile shocked or fish per hour shocked. Population estimated were made using fyke nets as the marking portion and electroshocking as the recapture run. Lengths are reported in mm and inches ().

Species	Total Catch	Fish/mile	Fish/hour	Average Length	Length Range	Population Estimate	P.E. Range
Northern Pike	18	9.78	12.56	485 mm (19.1")	387 mm- 609 mm (15.2"- 24.0")	422	325-603
Golden Shiner	3	1.63	2.09	149 mm (5.8")	132 mm-176 mm (5.2"-6.9")		
Yellow Bullhead	15	8.15	10.47	286 mm (11.3")	228 mm- 347 mm (9.0"-13.7")	293	203-440
Pumpkinseed	63	34.24	43.95	158 mm (6.2")	72 mm-227 mm (2.8"- 9.0")		
Bluegill	301	163.59	210.0	115 mm (4.5")	46 mm- 204 mm (1.8"- 8.0")		
Largemouth Bass	41	22.28	28.60	321 mm (12.6")	181 mm- 462 mm (7.1"-18.2")	97	43-233
Black Crappie	13	7.07	9.07	229 mm (9.0")	193 mm-271 mm (7.6"- 10.7")		
Hybrid Sunfish	10	5.43	6.98	156 mm (6.1")	99 mm- 219 mm (3.9"- 8.7")		
Yellow Perch	75	40.76	52.33	110 mm (4.3")	79 mm- 149 mm (3.1"- 5.9")		
Total	**539**	**292.93**	**376.05**				

Gamefish

Largemouth Bass

Largemouth Bass were the most common gamefish captured during electroshocking. The 41 Largemouth Bass ranged in length from 181 mm to 462 mm (7.1" to 18.2") and had an average length of 321 mm (12.6") (Table 10). Most Largemouth Bass had lengths between 280 mm (11") and 310 mm (12.2") with few fish smaller or larger (Figure 9). Eleven (26.8%) of the captured bass had lengths greater than the 14" (356 mm) minimum harvest size limit for Bass in Wilke Lake.

The population estimate of 97 (confidence range 43-233) for Largemouth Bass should be viewed with caution because of the low number of marked and recaptured bass.

Table 10. The length frequency of fish captured during the 2018 spring electroshocking survey of Wilke Lake. Length is reported in mm and inches ().

Length (in) mm	Northern Pike	Yellow Bullhead	Pumpkin-seed	Bluegill	Largemouth Bass	Black Crappie	Hybrid Sunfish	Yellow Perch
40				3				
(2”) 50				1				
60				20				
70			2	73				1
80			2	19				1
90			4	17			1	13
(4”) 100			1	22			2	25
110				14				25
120			3	11			2	4
130			6	13				1
140			4	28				5
(6”) 150			7	31				
160			10	16				
170			4	19			1	
180			5	9	1			
190			5	4		1	1	
(8”) 200			7	1	1	3	1	
210			1		1	1	2	
220		1	2			2		
230					2	1		
240		1				3		
(10”) 250		2			1	1		
260								
270		2			1	1		
280		4			3			
290					5			
(12”) 300		1			7			
310		2			7			
320		1			1			
330								
340		1						
(14”) 350								
360								
370					1			
380	1				2			
390	1				1			
(16”) 400					1			
410					1			
420					1			
430					1			
440	2				1			
(18”) 450					1			
460	2				1			
470	4							
480	2							
490								
(20”) 500								
510	1							
520	1							
530	3							
540								
(22”) 550								
560								
570								
580								
590								
(24”) 600	1							
Total	**18**	**15**	**63**	**301**	**41**	**13**	**10**	**75**
Ave. Length	**485 mm (191”)**	**286 mm (11.3”)**	**158 mm (6.2”)**	**115 mm (4.5”)**	**299 mm (11.8”)**	**229 mm (9.1”)**	**156 mm (6.1”)**	**110 mm (4.3”)**
S.D.	**52.7 mm (2.1”)**	**30.8 mm (1.3”)**	**37.9 mm (1.5”)**	**39.9 mm (1.6”)**	**67.7 mm (2.7”)**	**22.3 mm (0.9”)**	**50.2 mm (2.0”)**	**13.8 mm (0.5”)**

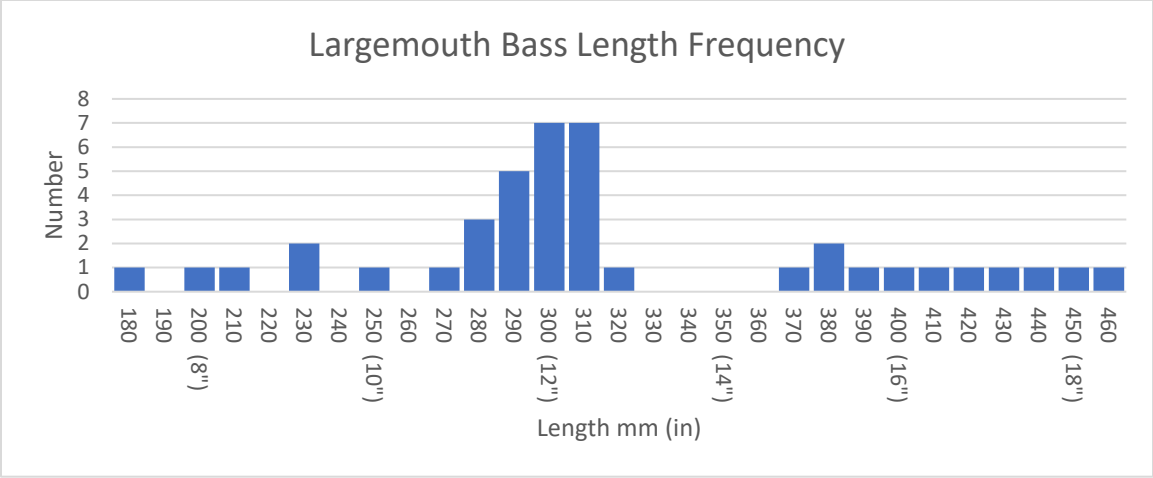


Figure 9. The length distribution of Wilke Lake Largemouth Bass captured by fyke net. Lengths are reported in mm and inches ().

The 2nd dorsal spine was removed from captured bass for age analysis. Spines were cross-sectioned and viewed with a microscope to identify annual age rings. Age 2 through Age 4 and ages 6, 7, 9 and 10 were present in our sample (Table 11). Age 3 was the dominant year class with fish of other ages much less common. Several age classes, age 5 and age 8 were not identified in our sample.

When the average length at age for Largemouth Bass from Wilke Lake are compared to bass in other Wisconsin lakes, it appears that from age 2 through age 7 bass in Wilke Lake grew above or near Statewide averages (Table 5). Older age bass (age 9 and 10), were shorter at age than bass from other lakes. Since the number of bass that were older than age 3 was low, growth comparisons should be viewed with caution.

Table 11. The age distribution by length for Largemouth Bass from Wilke Lake captured by electroshocking in 2018. Lengths are reported in mm and in inches ().

Length			Age								
(in)	mm	Number	2	3	4	5	6	7	8	9	10
	180	1	1								
	190										
(8")	200	1	1								
	210	1		1							
	220										
	230	2		1	1						
	240										
(10")	250	1		1							
	260										
	270	1		1							
	280	3		3							
	290	5		4	1						
(12")	300	7		7							
	310	7		6	1						
	320	1		1							
	330										
	340										
(14")	350										
	360										
	370	1					1				
	380	2					1	1			
	390	1						1			
(16")	400	1						1			
	410	1									1
	420	1						1			
	430	1						1			
	440	1								1	
(18")	450	1									1
	460	1									1
	Total	41	2	25	3	0	2	5	0	1	3
	Ave. Length	321 mm (12.6”)	193 mm (7.6”)	294 mm (11.6”)	281 mm (11.0”)	--	378 mm (14.9”)	409 mm (16.1”)	--	444 mm (17.5”)	442 mm (17.4”)
	S.D.	67.8 mm (2.6”)	17.0 mm ((0.7”)	25.2 mm (1.0”)	45.2 mm (1.8”)	--	4.2 mm (0.2”)	21.3 mm (0.8”)	--	--	24.9 mm (1.0”)

Northern Pike

Eighteen Northern Pike were captured during electroshocking (Table 9). These pike ranged in length from 387 mm to 609 mm (15.2” to 24”) and had an average length of 485 mm (19.1) (Table 11). No captured Northern Pike were greater in length than the 26” (660 mm) minimum size limit for pike in Wilke Lake. A population estimate estimated that there were 422 (confidence range 325 to 663) or 4.44 pike per surface acre in Wilke Lake.

Panfish

Bluegill

During electroshocking, Bluegill were the most abundant panfish captured (Table 10). The 301 captured Bluegill ranged in length from 46 mm to 204 mm (1.8" to 8.0") and had an average length of 115 mm (4.5"). Bluegill length was nearly evenly distributed across the sizes captured (Table 11 and Figure 10). 76 of the 301 (25.2%) captured Bluegill were greater than 150 mm (6") in length. Only one Bluegill (0.3%) was greater in length than 200 mm (8").

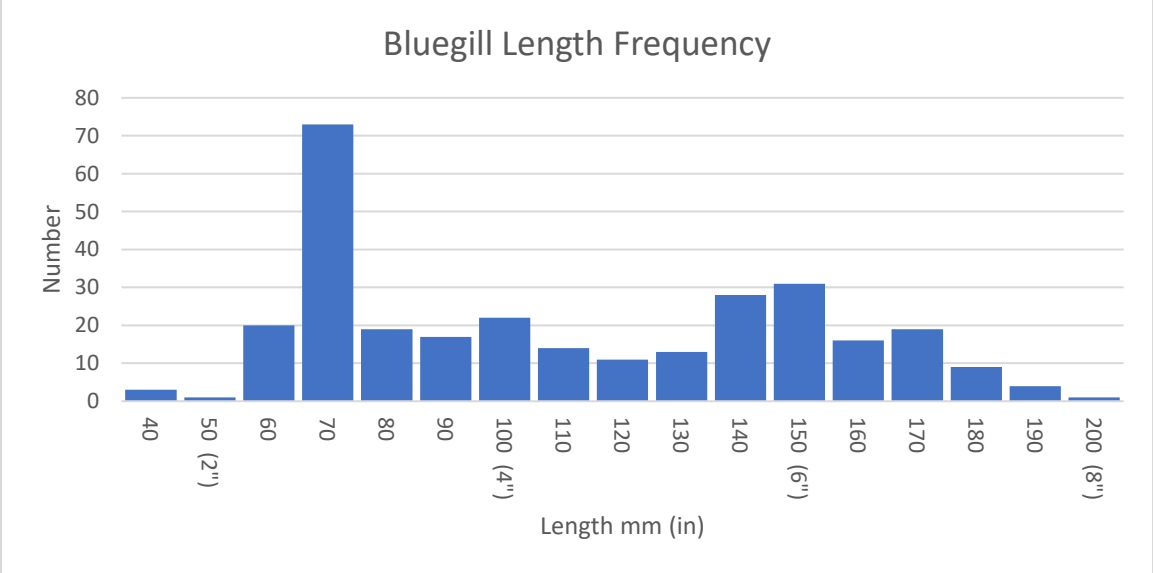


Figure 10. The length distribution of Wilke Lake Bluegill captured by electroshocking. Lengths are reported in mm and inches ().

Yellow Perch

Yellow perch were commonly captured during electroshocking (Table 9). The 75 captured perch ranged in length from 79 mm to 149 mm (3.1" to 5.9") and had an average length of 110 mm (4.3"). The distribution of Yellow Perch lengths was centered around 100 mm (4") with few small or large perch captured (Table 10 and Figure 11). No captured perch were greater than 150 mm (6") in length.

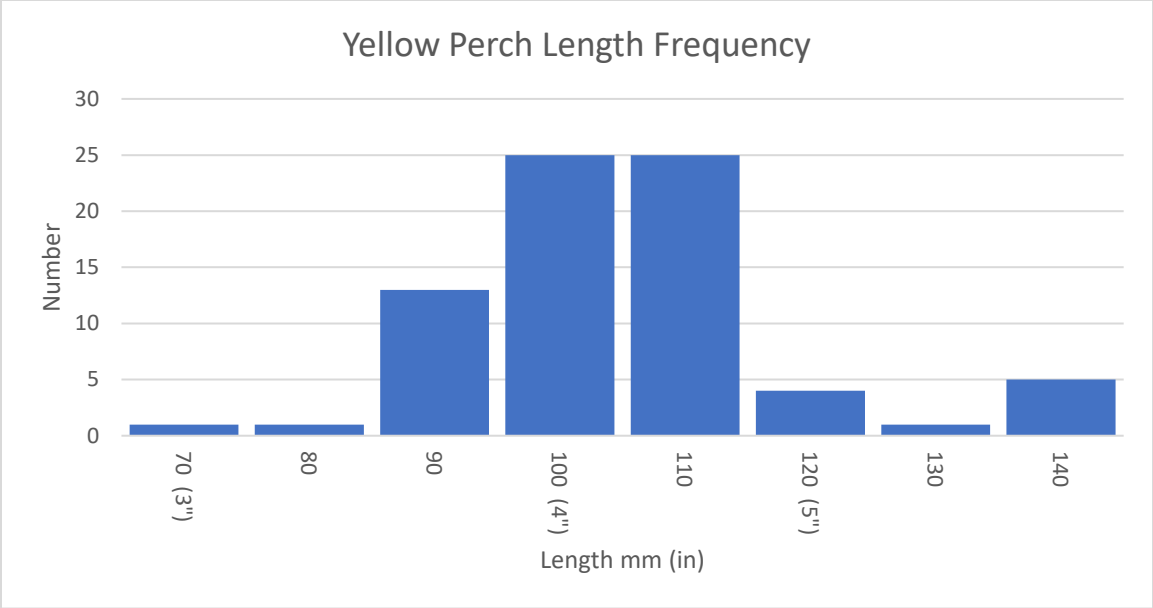


Figure 11. The length distribution of Wilke Lake Yellow Perch captured by electroshocking. Lengths are reported in mm and inches ().

Other Panfish

During electroshocking, we also captured 63 Pumpkinseed Sunfish, 13 Black Crappie and 10 Hybrid Sunfish (Table 9). Average lengths for these species were 158 mm (6.2”), 229 mm (9.0”) and 156 mm (6.1”) respectively (Table 10).

Other Species

Fifteen Yellow Bullhead and 3 Golden Shiner were also captured during spring electroshocking (Table 9). The 15 Yellow Bullhead ranged in length from 228 mm to 347 mm (9.0” to 13.7”) and had an average length of 286 mm (11.3”) (Table 10). It was estimated that there were 293 (range 203 to 440) bullhead in Wilke Lake.

DISCUSSION

A comprehensive fish survey was conducted in 2018 to assess the fish populations of Wilke Lake. A combination of fyke nets and night electroshocking was used to capture fish. A total of 2,059 individual fish representing thirteen species were captured. Across the two surveys, Bluegill, Yellow Bullhead and Northern Pike dominated the catch. Other species were captured in lower number. Bluegill dominated both the fyke net and electroshocking catches with Northern Pike the most common gamefish captured by fyke net and Largemouth Bass the most common gamefish captured by shocking.

Gamefish

Northern Pike were the most common gamefish captured during this survey (Tables 2 and 9). Pike lengths, however, were skewed toward small fish with none of the captured pike

greater in length than 648 mm (25.5”) which is less than the minimum harvest length of 26” (660 mm) (Table 3). The growth of Northern Pike was below Statewide averages at all ages (Table 5). Although weights were not measured, visual observations of captured pike seemed to indicate fish were thin for their length. Compared to past surveys (Hogler 1998), Northern Pike numbers are slowly trending downward.

Largemouth Bass were collected in modest number during this survey as compared to the typical bass catch during surveys of other local lakes (Tables 2 and 9). The lengths of captured bass were typically distributed with 75% below and 25% above the minimum size limit (Figure 9). Analysis of length at age indicated average growth for bass in Wilke lake, however, it also indicated several missing or poor year classes (Table 5). The causes of these weak year classes are not known but could be related poor spawning success, predation by other predators or harvest by anglers. Largemouth Bass numbers may be showing some improvement compared to past surveys (Hogler 2010).

Walleye were captured in limited number. Spawning size fish were collected during the survey, but few small fish and no yearling Walleye were seen (Tables 2 and 9). It appears the population is dependent on stocking or has very limited natural reproduction.

Panfish

The panfish community in this lake is dominated by Bluegill, Black Crappie, Pumpkinseed Sunfish and Yellow Perch (Tables 2 and 9). By total number, these species dominated our fyke net and electroshocking catches. The average size of captured Bluegill was in the 125 mm (5”) range for bluegill which was similar to past surveys (Hogler 2010). Length at age analysis of scales for Bluegill indicated that fish are slow growing at all ages greater than age 2. Compared to past surveys, Bluegill numbers are slowly trending downward (Hogler 1998 and Hogler 2010), but average length has not responded to decreases in abundance.

Black Crappie averaged 225 mm (9”) in length (Tables 2 and 9) in 2018. Length at age analysis indicates that crappie growth in Wilke Lake is at or above Statewide average growth. Black Crappie number in 2018 has improved over catches from past surveys (Hogler 2010).

Yellow perch are also small in size as seen by their length frequencies from each survey type. Perch numbers in 2018 appear to be lower than in past surveys (Hogler 1998 and Hogler 2010).

Yellow Bullhead appear to be present in moderate numbers (Tables 2 and 9). The size of captured bullhead was good. Unlike past surveys, carp were not captured in the 2018 survey.

CONCLUSIONS AND RECOMMENDATIONS

Based on survey results from 2018 and previous surveys, Wilke Lake continues to be bass-panfish lake that features Largemouth Bass, Northern Pike and stocked Walleye as predators and a diverse panfish community consisting of Bluegill, Black Crappie,

Pumpkinseed Sunfish and Hybrid Sunfish. Problems with gamefish abundance, slow growth of bluegill and an abundant plant community identified in the 1950's as problems, continue to make fish management on this lake difficult. It is recommended that:

- Establish a more restrictive regulation, 18" minimum, 1 bag for Largemouth Bass to improve bass numbers and to provide more predation on slow growing Bluegill.
- Evaluate the continuation of Walleye stocking by the State. This survey and other surveys have found poor survival and no natural reproduction by Walleye. If Walleye stocking is continued, consider a more restrictive regulation, 18" minimum and 3 bag to improve Walleye number and to increase predation on Bluegill.
- Change the Northern Pike regulation from the standard regulation of 26" minimum, 2 bag to no minimum size, with a protected, no harvest slot of 25" to 35" and a 2 bag.
- Work with the Wilke Lake Association to install fish sticks or other woody habitat design to improve habitat for bass.

REFERENCES

Belonger, B. 1976. Wilke Lake Survey. Unpublished. Wisconsin Department of Natural Resources. 2 pages.

Belonger, B. 1979. The Wilke Lake Survey. Unpublished. Wisconsin Department of Natural Resources. 6 pages.

Cline, P. 1956. Survey of Wilke Lake, Manitowoc County. Unpublished. Wisconsin Conservation Department. 6 pages.

Hogler, S. 1998. Comprehensive Survey of Wilke Lake, Manitowoc County-1981. Unpublished. Wisconsin Department of Natural Resources. 21 pages.

Hogler, S. 2006. 2005 Electroshocking Survey of Wilke Lake. Unpublished. Wisconsin Conservation Department. 5 pages.

Hogler, S. 2010. 2010 Electroshocking Survey of Wilke Lake. Unpublished. Wisconsin Conservation Department. 6 pages.

Probst, R.T. 1953. Seine Survey of Wilke Lake. Unpublished. Wisconsin Conservation Department. 9 pages.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada. Bulletin 191. Ottawa, Ontario, Canada.

Schultz, P. 1963. Wilke Lake, Manitowoc County 1962 survey. Unpublished. Wisconsin

Department of Natural Resources. 2 pages.

Schultz, P. 1965. Wilke Lake, Manitowoc County 1964 survey. Unpublished. Wisconsin Department of Natural Resources. 7 pages.

Wirth, T.L. 1952. Wilke Lake Fish Survey. Unpublished. Wisconsin Conservation Department. 2 pages.