LAKE COUNTY, IL

2016 FISCHER LAKE SUMMARY REPORT

LAKE COUNTY HEALTH DEPARTMENT

ECOLOGICAL SERVICES

Fischer Lake, 2016

Fischer Lake is a 23.4-acre impoundment east of Volo in west-central Lake County. It was excavated in the late 1970s as part of development of Fischer Estates. Fischer Lake receives water from its 4123 acre watershed. The outlet, located at the northeast corner of the lake, flows north into Wooster Lake. Fischer Lake is part of the Fish Lake Drain, which also consists of Fish Lake, Lake Christa, Wooster Lake, and Duck Lake.

In 2016, the Lake County Health Department– Ecological Services (LCHD-ES) monitored Fischer Lake was part of routine water quality sampling. Two water samples were collected once a month from May through September. Fischer Lake was thermally stratified in July and August and water chemistry can be significantly different between the epilimnion (warm upper layer) and hypolimnion (cool bottom layer) within the lake. Fischer Lake, although shallow, can thermally stratify so two water samples were collected at the deepest point in the lake (Appendix A); three feet below the surface and 3 feet above the bottom to represent the epilimnion and hypolimnion. Samples were analyzed for nutrients, solid concentrations and other physical parameters. Additionally, an aquatic plant survey was conducted in August (2016) and a shoreline assessment surveyed in June (2016). This report summarizes the water quality sampling results, aquatic plant survey, and shoreline survey conducted on Fischer Lake by the LCHD-ES for 2016.

ECOLOGICAL SERVICES WATER QUALITY SPECIALISTS

Alana Bartolai	Ecological Services	Gerry Urbanozo
abartolai2@lakecountyil.gov	847-377-8030	gurbanozo@lakecountyil.gov

INSIDE THIS ISSUE:

LAKE FACTS

MAJOR WATERSHED:
FOX RIVER

SUB-WATERSHED:
FISH LAKE DRAIN

SURFACE AREA:
23.4 ACRES

SHORELINE LENGTH:
1.8 MILES

MAXIMUM DEPTH:
11.0 FEET

AVERAGE DEPTH:
5.5 FEET* (ESTIMATED)

LAKE VOLUME:
128.5 ACRE-FEET (ESTIMATED)

WATERSHED AREA:
4117.8 ACRES

LAKE TYPE:
DETENTION

CURRENT USES:
FISHING, NON-MOTORIZED BOATING, AND AESTHETICS

ACCESS:
PRIVATE—NO PUBLIC ACCESS

FISCHER LAKE SUMMARY

Following is a summary of the water quality sampling, shoreline survey and aquatic macrophyte survey from the 2016 monitoring season on Fischer Lake. The complete data sets can be found in Appendix A& B of this report, and discussed in further detail in the following sections.

- Average water clarity as measured by Secchi depth in 2016 was 2.70 ft., which is a 38% increase since 2006 (1.97ft.). However, average Secchi depth still remains below the Lake County Median Secchi depth of 2.98 ft.
- Water clarity is influenced by amount of particles in the water column; this is measured by total suspended solids (TSS). The average TSS concentrations on Fischer Lake was 16.5 mg/L in 2016. This is a 41% decrease since the 2006 concentrations (28 mg/L) and is below the Lake County median of 7.8 mg/L
- Nutrient availability indicated that Fischer Lake had enough of both nutrients (nitrogen and phosphorus) to fuel algal blooms with a TN:TP ratio of 15:1.
- In 2016 the average total phosphorus concentration was 0.138 mg/L. This is more than double the Environmental Protection Agency (IEPA) water quality standard of 0.050 mg/L.
- While Fischer Lake's average total phosphorus concentration is above the IEPA Water Quality Standard, there was a significant decrease of 40 % in total phosphorus levels since 2006, as phosphorus levels decreased from 0.228 mg/L (2006) to 0.138 mg/L (2016).
- The 2016 Trophic State Index (TSIp) value based on phosphorus for Fischer Lake was 75; classifying it as hypereutrophic.
- A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support fisheries, and fish can suffer oxygen stress when DO drops below these levels. DO concentrations did drop below 5 mg/L from June - September.
- Dissolved oxygen concentrations reached anoxic conditions (<1 mg/L) in July and August at depths greater 5 ft. and 8ft. respectively.
- The 2016 aquatic macrophyte survey showed that 76.9% of all sampling sites had plant coverage.
- A total of 9 plant species were present in Fischer Lake during the August 2016 sampling period.
- The most dominant aquatic plants in 2016 in Fischer Lake were Coontail and Eurasian Watermilfoil.
- Aquatic invasive plant species were present in Fischer Lake during the 2016 aquatic macrophyte survey, including Curlyleaf Pondweed found at 10% of the sampling sites, Eurasian Watermilfoil found at 29% of the sampling sites.
- The 2016 shoreline condition assessment indicated that 57% of Fischer Lake shoreline was experiencing some degree of erosion.
- Based on the 2016 shoreline condition assessment, 50% of Fischer Lake's lakeshore buffer condition was classified as poor.
- Abundant wildlife was noted around Fischer Lake including egrets, great blue herons, pelicans, and turtles.

Fischer Lake is in the Fish Lake Drain Watershed

Figure 2: Fish Lake Drain

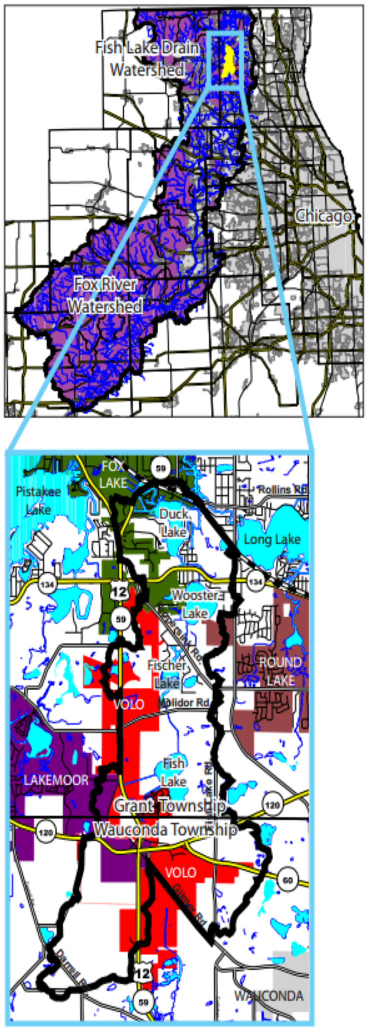


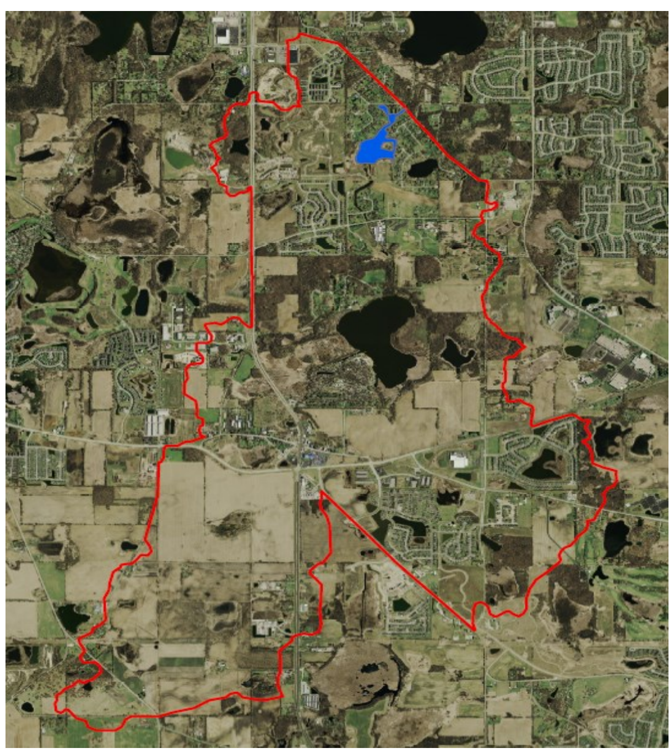
Image (above) courtesty of LCSMC, Fish Lake Drain Watershed Plan

WATERSHED & LANDUSE

A watershed is an area of land where all surface water from rain, melting snow and ice, converge at a lower elevation, usually a lake, river, or other body of water. The source of a lake's water supply is very important in determining its water quality and choosing management practices to protect the lake. Fischer Lake has a large watershed at 4117.8 acres (Figure 1). The watershed to lake ratio is important in understanding how nutrients enter the lake. Fischer Lake has a large watershed to lake ratio (168:1) which means pollutants can enter the lake from a large area.

Fischer Lake is part of the Fish Lake Drain (Figure 2). The Fish Lake Drain Watershed includes four major lakes, numerous large wetlands, several high quality Advanced Identification (ADID) wetlands, and few threatened and endangered species recognized by the State of Illinois. Fish Lake Drain is a man-made channel connecting Fish Lake, Fischer Lake, Wooster Lake and Duck Lake from south to north. The drain joins Squaw Creek and then Squaw Creek discharges to Fox Lake. The Lake County Stormwater Management Commission has developed a watershed-based plan the Fish Lake Drain watershed. The goal of the Watershed-Based Management Plan was to better understand the watershed and to identify actions to improve the quality of life through the reduction of flood risks and protection of water quality. For more information on the Fish Lake Drain Watershed Plan, visit https://www.lakecountyil.gov/2437/Watershed-Management-Plans. The Fish Lake Drain watershed plan also recognizes areas where projects are recommended to improve overall water quality. While the watershed plan focuses on the watershed scale, it does break the Fish Lake drain into subunits. Fischer Lake and it's watershed is mostly contained within subunit 3A within the Fish Lake Drain Watershed Plan. Recommendations in the Fischer Lake watershed include implementing green infrastructure, implement lot level best management practices (rain gardens, pervious pavement, etc.), shoreline stabilization, planting native plant buffer zones and more.

Figure 1: Fischer Lake Watershed Boundary



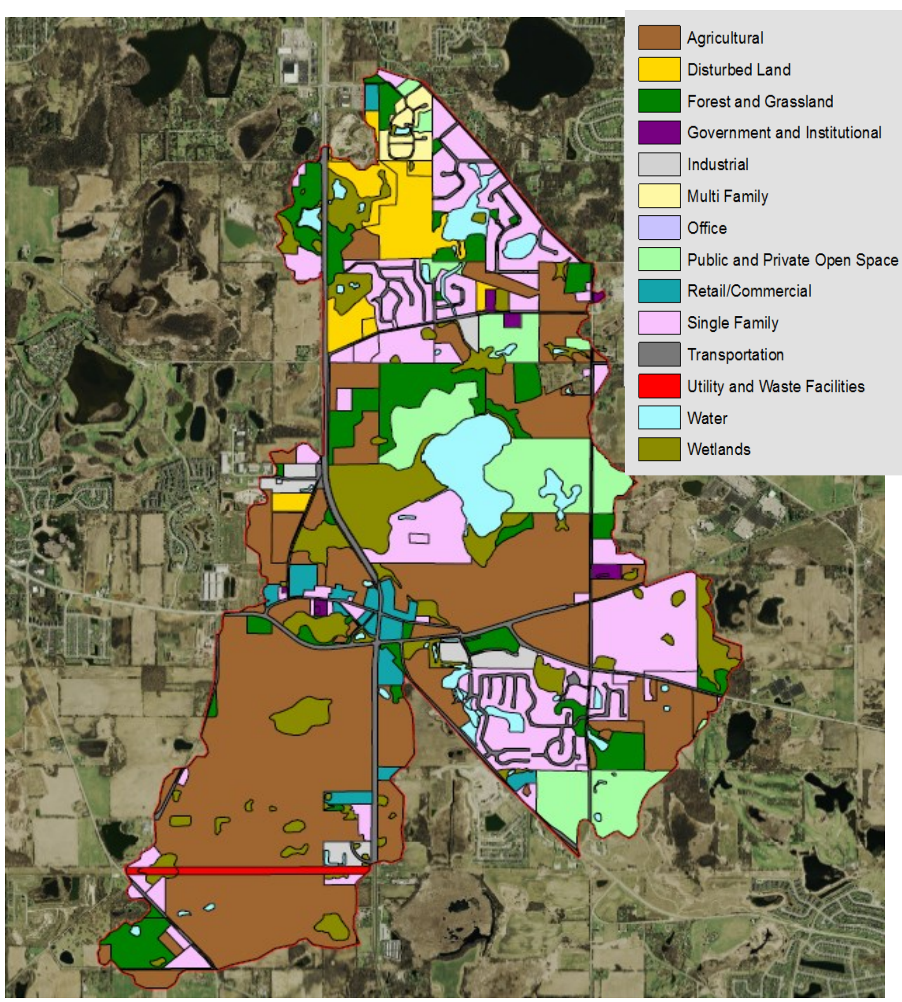
As a watershed is developed, the amount of impervious surface increases resulting in a greater influx of runoff entering our waters due to reduced infiltration of rainwater into the ground.

WATERSHED & LANDUSE

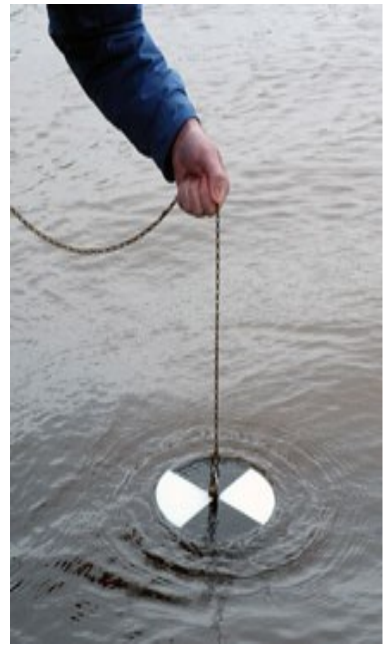
Landuse plays a significant role on water quality of a lake. Based on aerial landuse data, the most dominant land uses in the Fischer Lake watershed are: Agriculture at 37.5% of the watershed and Single Family at 17.5% (Figure 3). Since the previous LCHD monitoring of Fischer Lake in 2006, the watershed has become more developed with a decrease in agricultural land from 47% to 37.5% and an increase in Single Family residential areas. As areas become more developed, that typically means an increase in impervious surfaces, reducing the amount of open space for infiltrating and storing precipitation. Each land use contributes a varied amount of runoff, mostly based on the amount of impervious surfaces within that landuse category. Impervious surfaces (parking lots, roads, buildings, compacted soil) impact water quality in lakes by increasing pollutant loads and water temperature. During storm events, pollutants such as excess nutrients (nitrogen and phosphorus), metals, oil and grease, and bacteria are easily transferred from impervious surfaces to storm drains, rivers, wetlands, and lakes.

Fischer Lake watershed receives the majority of it's runoff from the single family land use with 28.9% of the runoff coming from this category. It's important to note that landuses with high impervious surfaces, such as transportation can contribute a high percentage of runoff even if they are a small fraction of the overall landuse. For instance, in the Fischer Lake watershed, the transportation landuse only accounts for 5.8% of the total watershed but contributes the second largest amount of runoff at 27.2% of the runoff. Lakes that receive a significant amount of stormwater runoff can have variable water quality that is heavily influenced by human activity. For a complete list of landuses in the Fischer Lake watershed, refer to Appendix B.

Figure 3: Landuse in the Fischer Lake Watershed



WATER CLARITY

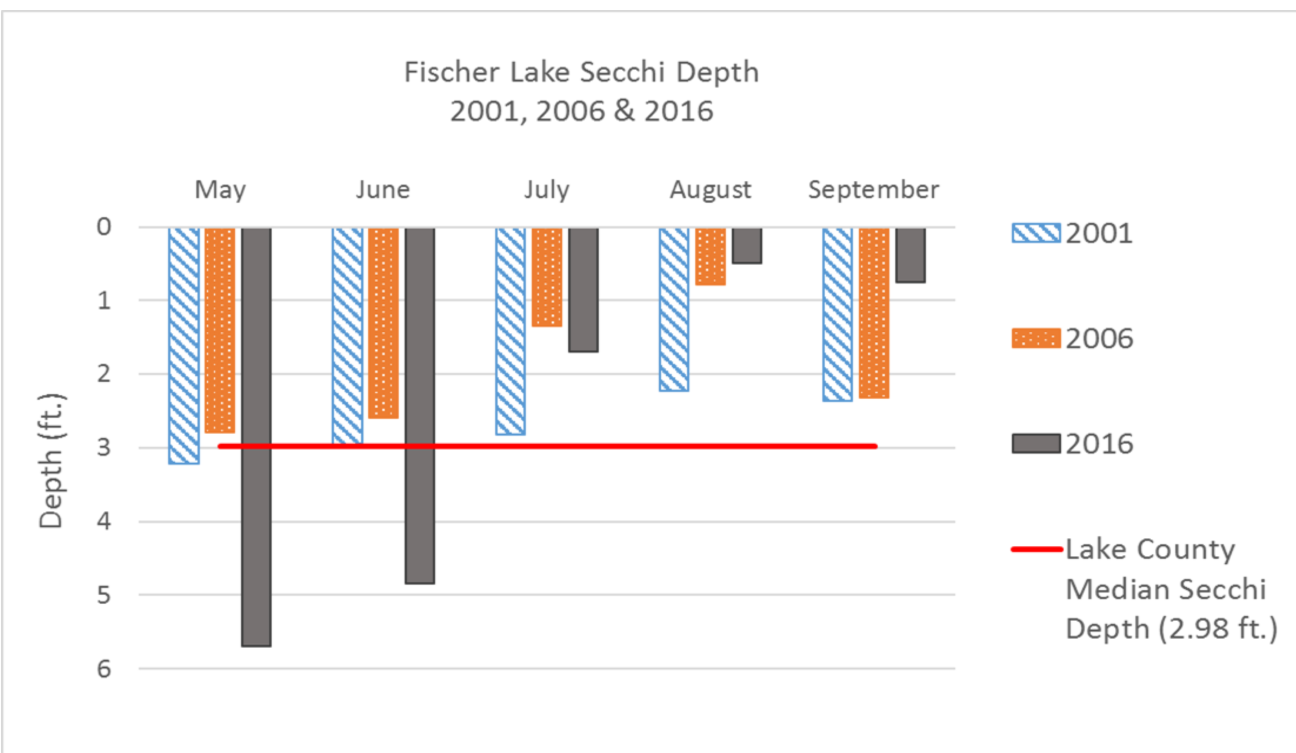


Water clarity, or water transparency, is an indicator of water quality related to chemical and physical properties. Water clarity is typically measured with a Secchi disk and indicates the amount of light penetration into a body of water. It can also provide an indirect measurement of the amount of suspended material in the water. A number of factors can interfere with light penetration and reduce water clarity. This includes: algae, water color, re-suspended bottom sediments, eroded soil and invasive species. Boat propellers can also impact water clarity by redistributing loose bottom sediment and creating more turbid waters. Secchi disk depth is primarily used as an indicator of algal abundance and general lake productivity. Although it is only an indicator, Secchi disk depth is the simplest and one of the most effective tools for estimating a lake's productivity.

The 2016 average water clarity, measured by Secchi depth, in Fischer Lake was 2.70 ft. This is a 38% increase since the 2006 water quality sampling, which had a Secchi depth of 1.96 ft. Compared to other lakes in Lake County, Fischer Lake still remains below the median Lake County Secchi depth of 2.98 ft. (Figure 4). Secchi depth was significantly greater in the early season, May and June, compared thorugh July—September. In fact, in August and September water clarity decreased to below 1 foot clarity. Algae blooms may have contributed to the decrease in water clarity in the late summer months.

The average 2016 Fischer Lake Secchi depth was 2.70 ft., which is below the Lake County median Secchi depth of 2.98 ft.

Figure 4: Fischer Lake Secchi depth by Year



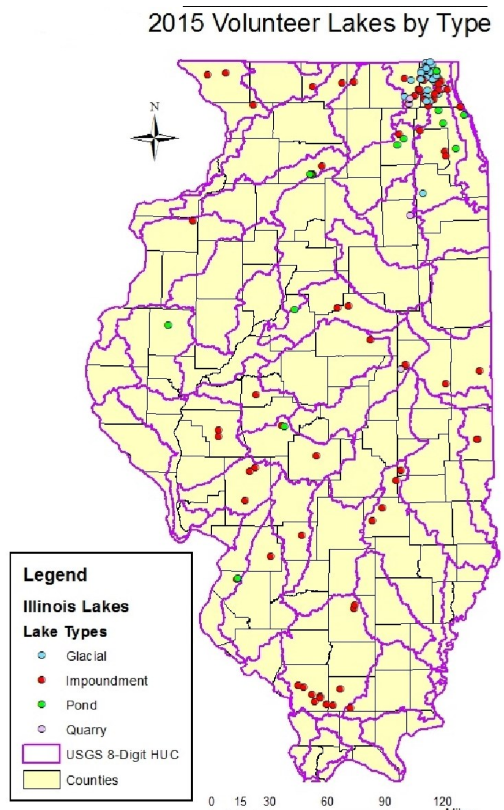
Volunteer lake monitoring program (VLMP)

The VLMP was established in 1981 by the Illinois Environmental Protection Agency (IEPA) to be able to collect additional information on Illinois inland lakes and to provide an educational program for citizens. The volunteers are primarily lakeshore residents, lake owners/managers, members of environmental groups, and citizens with interest in a particular lake. The VLMP is a statewide program (Figure 5). Lake County has the most volunteers by county participating in the program.

The VLMP relies on volunteers to gather information on their chosen lake. The primary measurement by volunteers is Secchi depth (water clarity). Water clarity can provide an indication of the general water quality of the lake. Other observations such as water color, suspended algae and sediment, aquatic plants and odor are also recorded. The sampling season is May through October with measurements taken twice a month.

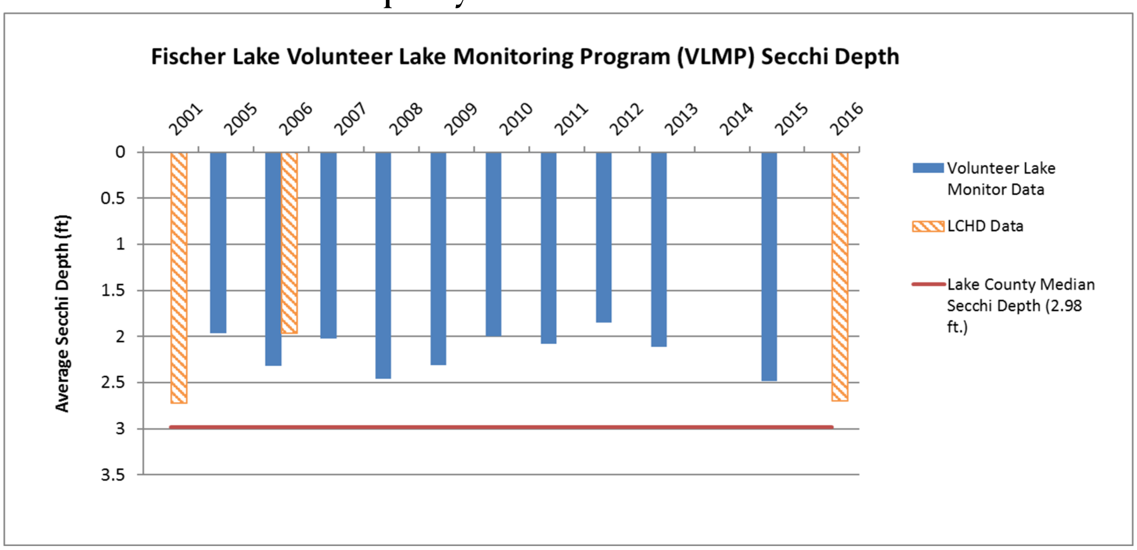
Fischer Lake has been participating in the VLMP program. Dennis Owczarski and Richard Hartman are the current VLMP volunteers who have been collecting Secchi data. VLMP records date back to 2005 for Fischer Lake (Figure 3). Secchi depth data has been fairly consistent throughout the years with slight increases in the past two years.

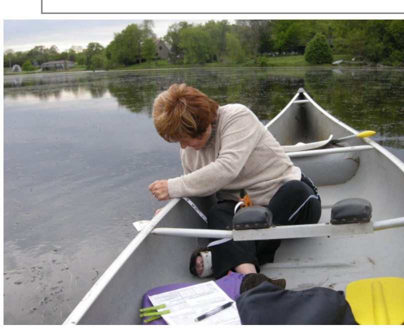
Participating provides annual data that helps document water quality impacts and support lake management decisions. **LCHD recommends that Fischer Lake continues to participate in VLMP Program.** This will provide valuable data for the lake as it provides annual data and can help look at long term trends.



Map of Volunteer lakes for the state of Illinois courtesy of IEPA.

Figure 5: Fischer Lake Secchi depth by Volunteers





FOR MORE INFORMATION ON THE VLMP PROGRAM

Contact:
Alana Bartolai
abartolai2@lakecountyil.gov
847-377-8009

TOTAL SUSPENDED SOLIDS

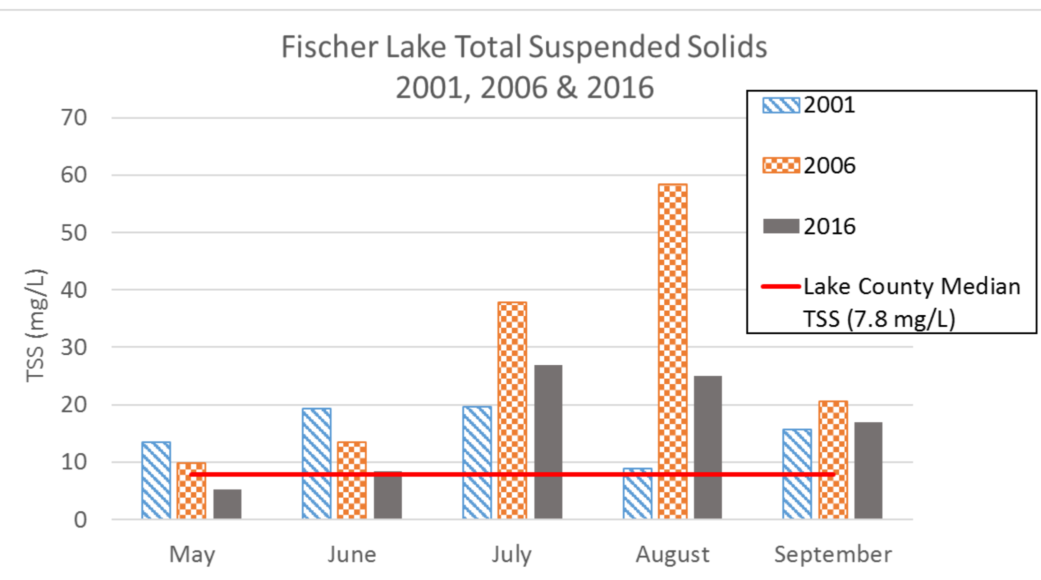
Another measure of water clarity is turbidity and total suspended solids. Suspended particles dissipate light, which affects the depth at which plants can grow. The total suspended solid (TSS) parameter represents the concentration of all organic and inorganic materials suspended in the lake's water column. Typical inorganic components of TSS are referred to as non-volatile suspended solids (NVSS). NVSS originate from weathering and erosion of rocks and soils in the lake's watershed and re-suspension of lake sediments. The organic portion of TSS are called volatile suspended solids (TVS). TVS is mostly composed of algae and other organic matter such as decaying plant and animal matter. Secchi depth and TSS are inversely related as shown in

2016 average TSS concentrations in the epilimnion of Fischer Lake averaged 16.5 mg/L. The 2016 concentration was a decrease of 41% in TSS since the 2006 yet still remains above the Lake County median TSS concentration of 7.8 mg/L (Figure 6). TSS ranged from 5.3 mg/L in May to it's highest TSS concentration of 26.9 mg/L, which occurred in July. High TSS values correlated with poor water clarity and poor Secchi depth readings. The hypolimnetic TSS concentration averaged 15.5 mg/L which is also a decrease since the 2006 sampling

A lake can have a TSS impairment, which is based on if the median surface NVSS is greater or equal to 12 mg/L for the monitoring season. Based on the 2016 sampling data, median surface NVSS was 10.6 mg/L, thus there is no TSS impairment. However, looking at NVSS by month, August had a NVSS concentration of 15.6 mg/L which is above the impairment standard. Total Suspended Solids is a water chemistry parameter that should be watched in Fischer Lake.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The average TVS for Fischer Lake was 149 mg/L. The median TVS value for Lake County is as 122 mg/L, so Fischer Lake is above the Lake County median.

Figure 6: Total Suspended Solids on Fischer Lake



TSS

Total Suspended Solids

TSS are particles of algae or sediment suspended in the water column.

TVS

Total Volatile Solids

TVS represents the fraction of total solids that are organic in nature, such as algae cells.

NVSS

Non-Volatile Suspended Solids

NVSS represents the non-organic clay and sediments that are suspended in the water column.

TDS

Total Dissolved Solids

TDS are the amount of dissolved substance such as salts or minerals in the water after evaporation.

NUTRIENTS: PHOSPHORUS

Organisms take nutrients in from their environment. In a lake, the primary nutrients needed for aquatic plant and algal growth are phosphorus (P) and nitrogen (N). Phosphorus occurs in dissolved organic and inorganic forms or attached to sediment particles. Phosphates, the inorganic form, are preferred for plant growth but other forms can be used. Phosphorus builds up in the sediments of a lake. The source of phosphorus to a lake can be external, internal, or both. Phosphorus originates from a variety of external sources, many of which are related to human activities including: human and animal waste, soil erosion, detergents, sewage treatment plants, septic systems, and runoff from lawns. Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. When phosphorus is bound to sediments it is generally not available for use by algae, however, various chemical and biological processes can allow phosphorus to be released from the sediment and be available in the water column. Carp spawning and feeding activity can release phosphorus by stirring up the bottom sediment and can add phosphorus through their fecal matter. Sediment resuspension and subsequent phosphorus release can occur through wind/wave action or heavy boat traffic. Lakes that experience anoxic conditions also contribute to the release of P from the bottom sediments.

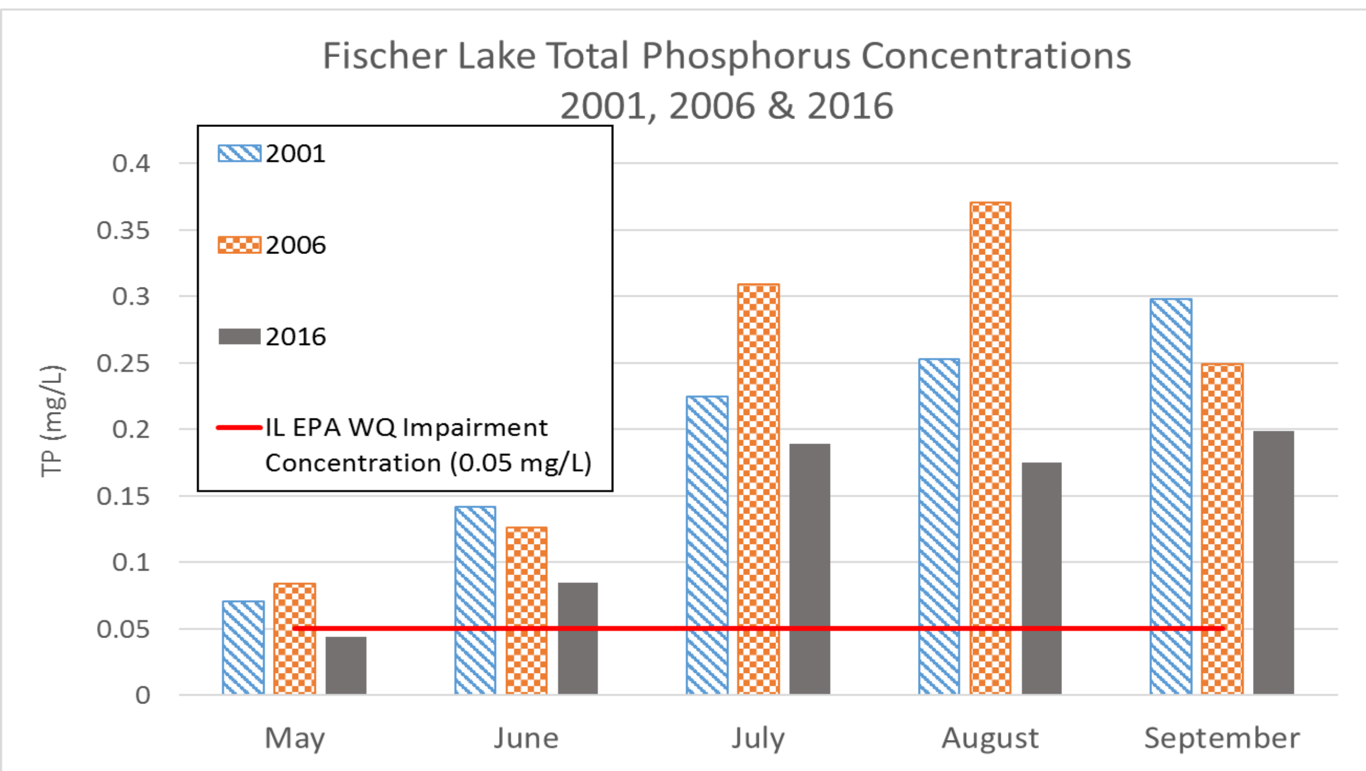
Fischer Lake had anoxic conditions occur in July and August allowing P to be released from the sediments and available in the water . Although anaerobic conditions allow P to be released from sediment, it will not mix throughout the entire water column while the lake is stratified and only mixes after the thermocline weakens. The thermocline weakened after the August sampling date. The highest TP concentration is observed in September (Figure 7) and may be a result of the released phosphorus now available to mix freely in the water column.

WHAT HAS BEEN DONE TO REDUCE PHOSPHORUS LEVELS IN ILLINOIS?

July 2010—*The state of Illinois passed a law to reduce the amount of phosphorus content in dishwashing and laundry detergent*

July 2010: *The state of Illinois passed another law restricting the use of lawn fertilizers containing phosphorus by commercial applicators.*

Table 7: Phosphorus Concentrations in Fischer Lake monitored by LCHD

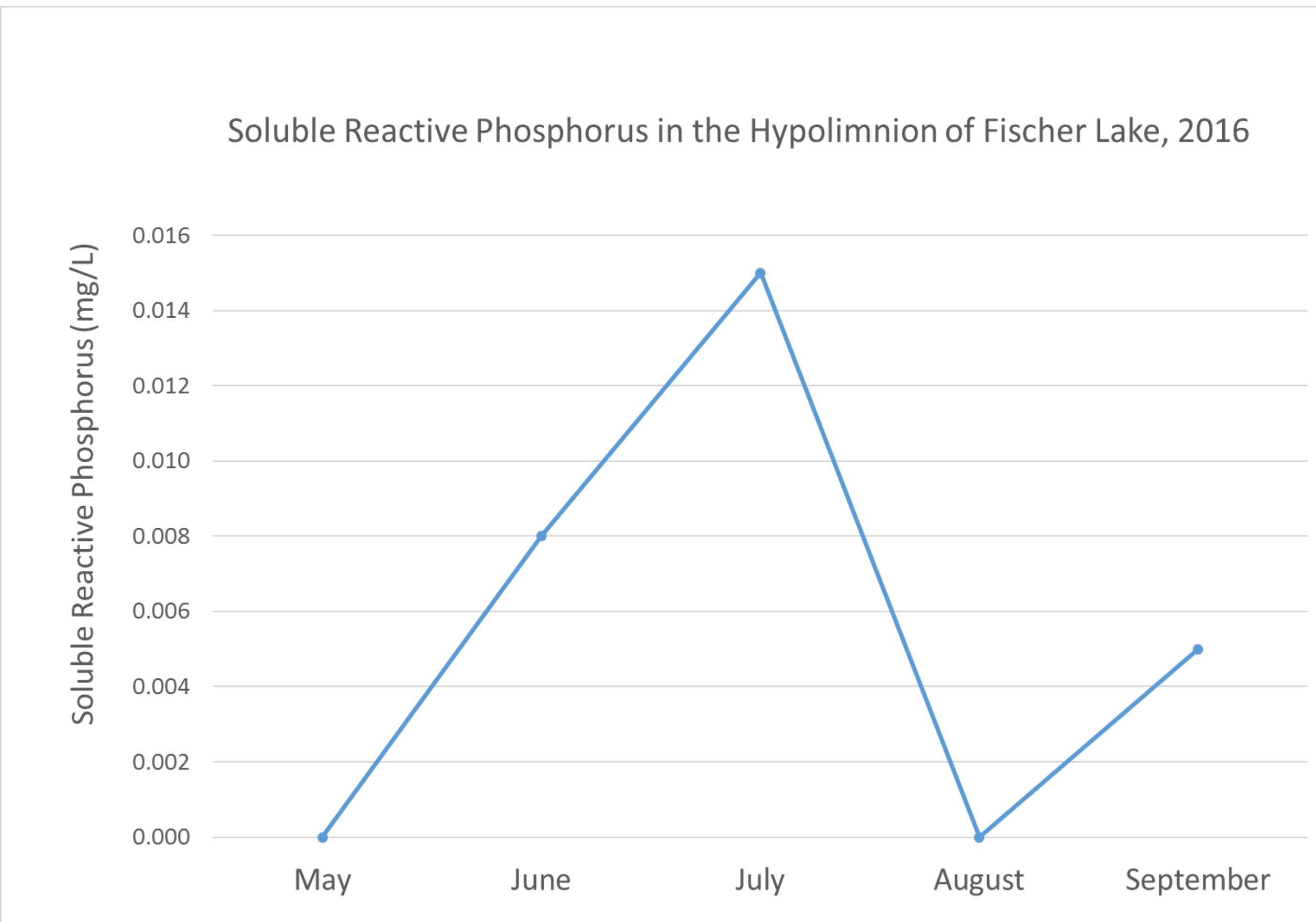


NUTRIENTS: PHOSPHORUS

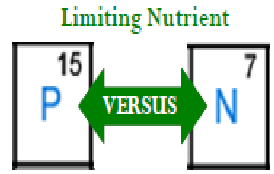
The TP concentrations in the epilimnion of Fischer Lake for 2016 averaged 0.139 mg/L. Average TP values are above the Lake County median (0.067 mg/L) and more than double the IEPA water quality standard of 0.050 mg/L (Figure 7, pg. 8). Compared to the 2006 sampling conducted by LCHD, there was a decrease of 40% in TP concentrations. Concentrations decreased from 0.228 mg/L (2006) to 0.139 mg/L (2016).

Total phosphorus concentrations is a better overall indicator of a lake's nutrient status because its concentrations remain more stable then other forms of phosphorus. However, Soluble Reactive Phosphorus (SRP) is included in water chemistry analysis. SRP is a dissolved form of phosphorus that is readily available for plant and algae growth. SRP can vary throughout the season and is dependent on how plants and algae absorb and release it. SRP can give an indication of how much phosphorus is available for uptake but does not indicate how much phosphorus is present in the water column. SRP concentrations for 2016 were below detection levels except for June, July, and September (Figure 8). The months of June and July were when Fischer Lake was thermally stratified and anoxic. Under these conditions, higher concentrations of SRP are anticipated. This is depicted in Figure 8. When the lake mixes again, in Fischer Lake's case in August, the SRP is now re-available in the water column which can spike overall total phosphorus concentrations.

Figure 8: SRP Concentrations in Fischer Lake monitored by LCHD in 2016



NUTRIENTS: NITROGEN



Nitrogen, in the forms of nitrate (NO_3^-), nitrite (NO_2^-), or ammonium (NH_4^+) is a nutrient needed for plant and algal growth. Nitrogen enters the ecosystem in a several chemical forms and a lake's nitrogen source can vary widely. Sources of nitrogen include septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, and sanitary landfills, and atmospheric deposition. All inorganic forms of nitrogen (NO3-, NO2-, and NH4+) can be used by aquatic plants and algae. If these inorganic forms exceed 0.3 mg/L, there is sufficient nitrogen to support summer algae blooms. If the surface median total nitrogen as N (TKN + NO2/NO3-N) exceeds 3.6 mg/L for the monitoring season, there is a nitrogen impairment for the water body.

Nitrogen concentrations (NO3-N and NH3-N) in the epilimnion of Fischer Lake were below detectable concentrations for most of the monitoring season. Spikes above detection limits in ammonia and nitrates in June and May, respectively, may be a result of pelicans which visited the lake for the first time this year. Over 100 pelicans visited the lake, however, nitrogen levels are still a decrease since the 2006 sampling. There were no nitrogen impairments for Fischer Lake in 2016. Total Kjeldahl nitrogen (TKN), an organically (algae) associated form of nitrogen, in Fischer Lake averaged 1.99 mg/L, which is above the Lake County median of 1.170 mg/L.

Typically lakes are either phosphorus or nitrogen limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than 10:1 suggest the lake is limited by nitrogen, while ratios greater than 20:1 are limited by phosphorus. Fischer Lake has a TN:TP ratio of 15:1, meaning the lake is has enough phosphorus and nitrogen in the system to produce summer algae blooms and neither nutrient is the limiting nutrient. In 2006, the TN:TP ratio was 11:1.

TN:TP Ratio

<10:1 = nitrogen limited

>20:1= phosphorus limited

TN:TP Ratio on Fischer Lake:

15:1

Fischer Lake is neither P or N limited

WAYS TO REDUCE NUTRIENTS IN YOUR LAKE

Waterfowl management (ducks and geese)

- Do not feed or encourage others to feed waterfowl
- Use good landscaping practices to discourage waterfowl. Landscapes with taller plants and shrubbery can discourage geese.

Fertilizer use:

- If you apply fertilizers to lawns and gardens, have your soil tested to determine how much fertilizer to apply.
- Check the weather before applying fertilizer—avoid applying before heavy rainfalls.
- Sweep up any fertilizer which is spilled on impervious surfaces such as walks and driveways.
- Do not spread fertilizer within 75 feet of surface waters or wetlands

Pet Waste Disposal

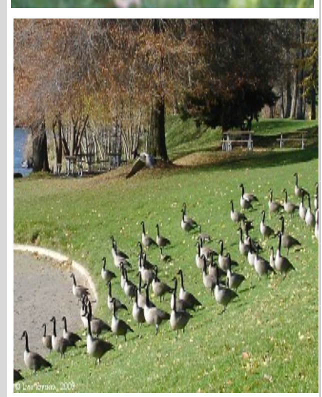
- Regularly scoop up and dispose of pest waste.

Landscaping Practices

- Consider native vegetation as a quality alternative to lawns. Native vegetation provides a more diverse plant community, and can filter out nutrients and also provides habitat for important pollinators.
- Plant a buffer strip of native plants (at least 20 feet) between the lake's edge and your property.

Keep fall leaves out of the storm drains

- Never rake leaves into or near storm drains, ditches, creeks, or on lakeshore.



TROPHIC STATE INDEX

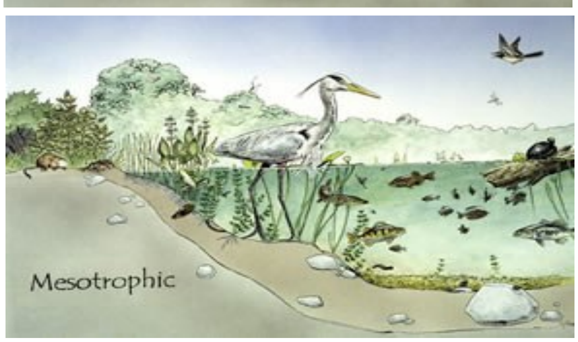
Trophic state describes the overall productivity of a lake and refers to the amount of nutrient enrichment within a lake system. This has implications for the biological, chemical and physical conditions of the lake. Lakes are classified into four main categories of trophic states that reflect nutrient levels and productivity. The four categories are: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. These range from nutrient poor and least productive (oligotrophic) to most nutrient rich and most productive (eutrophic). Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation until the lake becomes a wetland. This process takes thousands of years. However, human activities that supply lakes with additional phosphorus and nitrogen (such as fertilizer, household products, waste by-products, etc.) are accelerating the eutrophication process.

The categorization of a lake into a certain trophic state should not be viewed as a "good to bad" categorization, as most lake residents rate their lake based on desired usage. For example, a fisherman would consider a plant-dominated, clear lake to be desirable, while a water-skier might prefer a turbid lake devoid of plants. Most lakes in Lake County are eutrophic or hypereutrophic. This is primarily a result of cultural eutrophication. However, due to the fertile soil in this area, many lakes (especially man-made) may have started out under eutrophic conditions and will never attain even mesotrophic conditions, regardless of management options. This is not an excuse to allow a lake to continue to deteriorate, but may serve as a reality check for lake owners attempting to create unrealistic conditions in their lakes.

The Trophic State Index (TSI) value is based on phosphorus (TSIp) and Secchi (TSIsd) and are calculated from the monitoring data. In 2016, Fischer Lake had a TSIp value of 75.2 which categorizes it as hypereutrophic. Based on the TSIp, Fischer Lake is ranked 139 of 175 lakes studied by the LCHD-ES from 2000 –2016 (Appendix B).

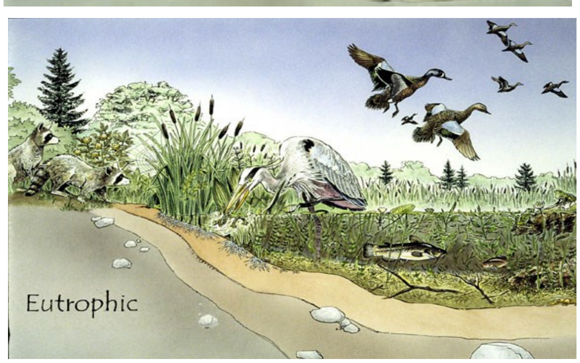
OLIGOTROPHIC

Lakes have low nutrients and are generally deep and free of weeds or large algae blooms. They do not support large fish populations.



MESOTROPHIC

Lakes have medium nutrients and intermediate level of productivity. Mesotrophic lakes typically have clear water with beds of submerged aquatic plants. Mesotrophic lakes can have a diverse fish population.



EUTROPHIC

Lakes are high in nutrients, and are usually weedy or subject to frequent algae blooms. Eutrophic lakes often support large fish populations but are also susceptible to oxygen depletion. Increased sedimentation also is typical of eutrophic lakes

LAKE COUNTY AVERAGE TSIP = 65.8

FISCHER LAKE TSIP = 75.2

TROPHIC STATE: HYPEREUTROPHIC

RANK= 139/175

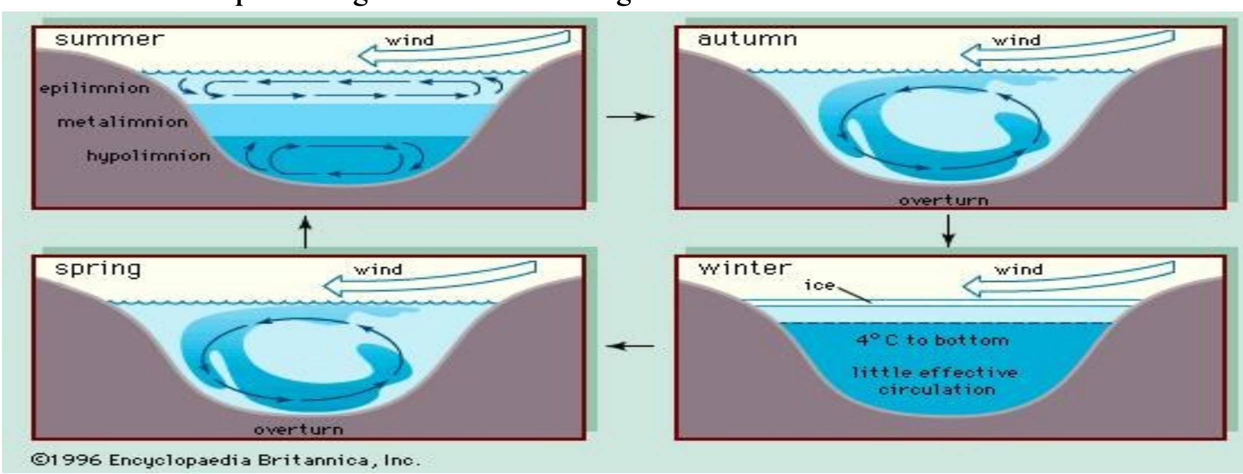
STRATIFICATION

A lake's water quality and ability to support fish are affected by the extent to which the water mixes. The depth, size, and shape of a lake are the most important factors influencing mixing, but climate, lakeshore topography, inflow from streams and vegetation also play a role. Variations in density caused by different temperatures can prevent warm and cold water from mixing, called stratification.

For example: when lake ice melts in early spring, the temperature and density of lake water will be similar from top to bottom. Since it is uniform throughout the water column, the lake can mix completely recharging the bottom water with oxygen and bringing nutrients up to the surface. Some lakes in summer experience stratification where the lake is divided into three zones: epilimnion (warm surface layer), thermocline (transition zone between warm and cold water) and hypolimnion (cold bottom water). Stratification traps nutrients released from bottom sediments in the hypolimnion and prevents mixing (Figure 9).

Monthly depth profiles of water temperature, dissolved oxygen, conductivity, and pH were taken every foot from the lake surface to the lake bottom on Fischer Lake in 2016. The relative thermal resistance to mixing (RTRM) value can be calculated from this data and indicates if a lake stratifies, how great the stratification is, and at what depth the thermocline occurs. In Fischer Lake the lake did stratify during July and August based on RTRM values greater than 20 (Figure 10). The lake water column was free to mix again in September when the RTRM was not large enough to cause stratification.

Figure 9: Schematic representing seasonal lake mixing and stratification



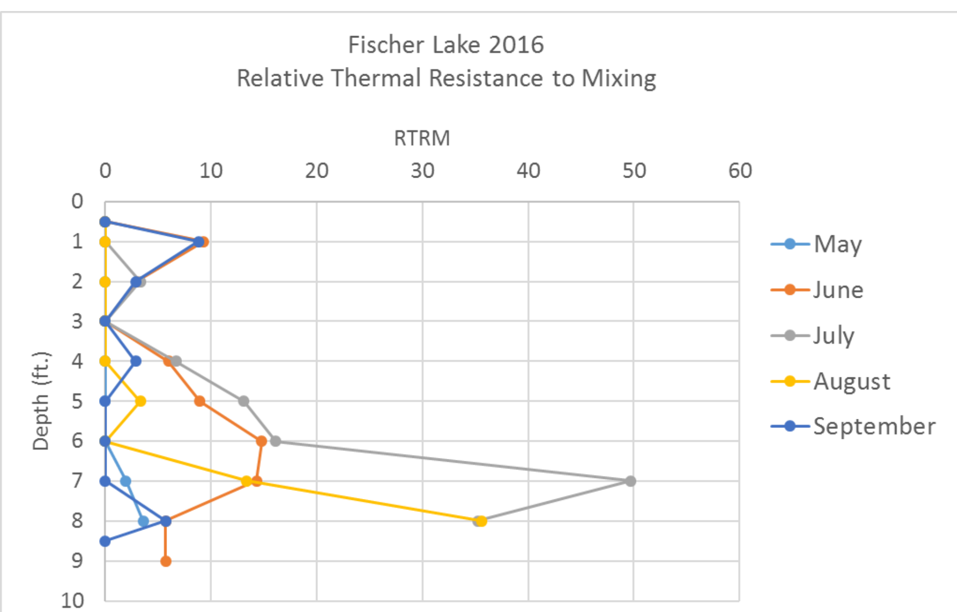


Figure 10 (Left): Relative Thermal Resistance to Mixing (RTRM) values based on depth profile data in Fischer Lake for 2016. Values greater than 20 RTRM indicate stratification.

DISSOLVED OXYGEN

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a fishery since fish can suffer oxygen stress below this concentration level. A dissolved oxygen profile was monitored monthly on Fischer Lake where DO concentrations were observed every foot within the water column (Figure 11). Dissolved oxygen (DO) concentrations in the epilimnion of Fischer Lake were adequate (>5.0 mg/L). DO did drop below 5 mg/L in all months except May. Anoxic conditions, where DO concentrations are <1 mg/L, also occurred in Fischer Lake during July and August at depths greater than 5 and 8 feet, respectively. Since there is no bathymetric map on Fischer Lake, it is unclear what percentage of lake volume is anoxic. In most lakes, oxygen production is greatest in the epiliminion, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters (Figure 12).

Figure 11: The dissolved oxygen depth profile on Fischer Lake shows that DO concentrations generally remain above 5 mg/L near the surface (epiliminion) and drop below 5 mg/L deeper in the lake. Anoxic conditions occurred June—September.

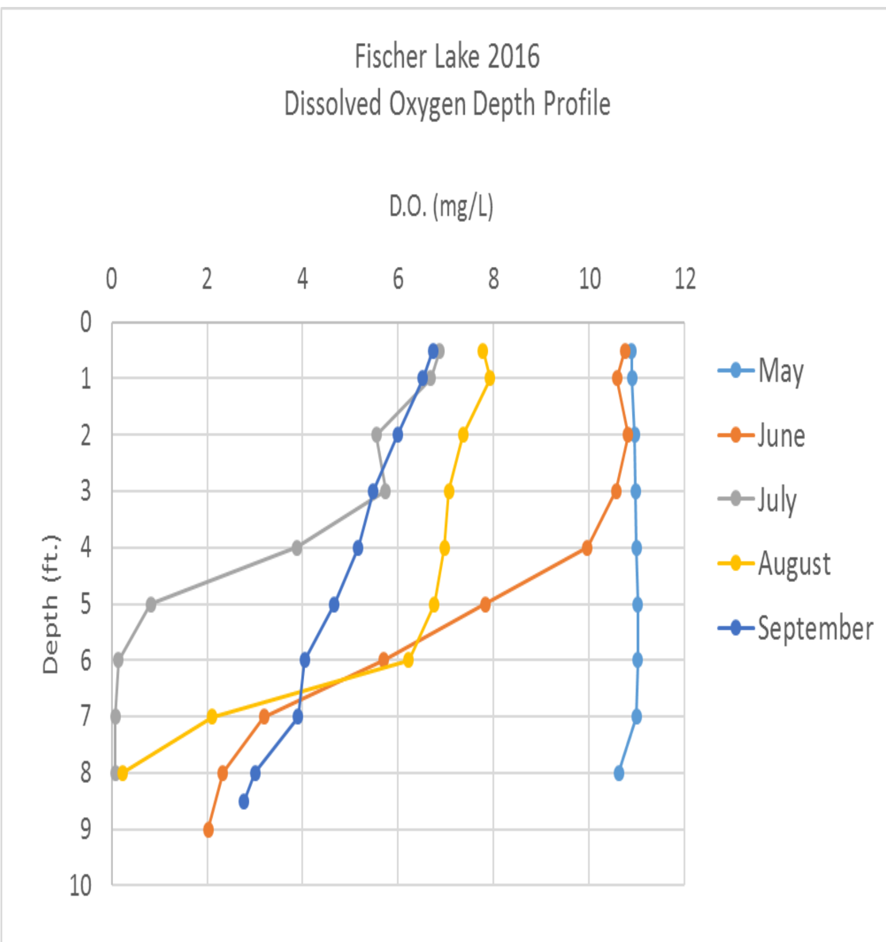
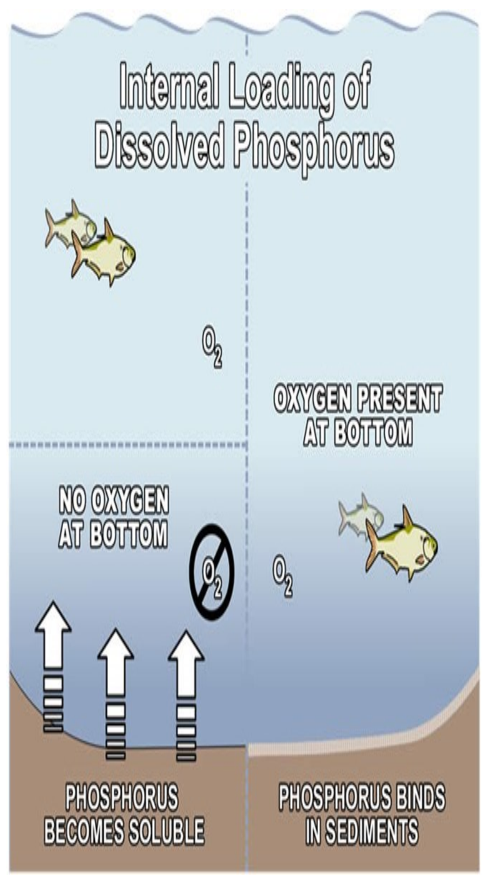


Figure 12: Schematic of how oxygen near the bottom of the lake and can impact phosphorus release from bottom sediments.



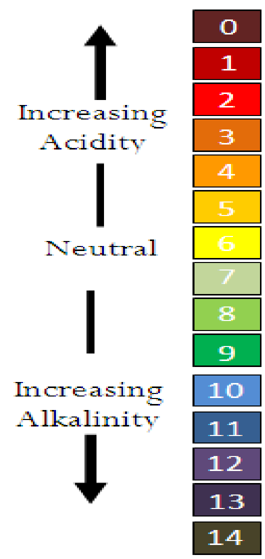
ALKALINITY AND PH

Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases to maintain a stable pH. In a lake, alkalinity acts to buffer lakes from the effects of acid rain. Alkalinity comes from rocks, soils, salts, and certain plant activities. If a lakes watershed contains large quantities of calcium carbonate ($CaCO_3$, limestone), the surface waters tend to be more alkaline; while granite bedrock does not have high amounts of $CaCO_3$ and therefore lacks alkaline materials to buffer acidic inputs.

pH is a measure of the hydrogen ion concentration of water. As the hydrogen ions are removed, pH increases. A well buffered lake also means that daily fluctuations of CO_2 concentrations result in only minor changes in pH throughout the day. Aquatic organisms benefit from stable pH. Each organism has an ideal pH threshold, but most aquatic organisms prefer pH of 6.5—8.0. pH values <6.5 or >9.0 cause a water quality impairment.

In 2016, the average alkalinity concentration in Fischer Lake was 207 mg/L which is above the Lake County median alkalinity concentration of 162 mg/L. The USEPA considers lakes with CaCO3 concentrations greater than 20 mg/L to not be sensitive to acidification. There was no significant change in alkalinity from the 2007 sampling period.

Fischer Lake's average pH in 2016 was 8.36 for the entire season, which is slightly above the Lake County median of 8.32 but remains within an adequate pH value for most aquatic organisms. Additionally, there were no pH impairments, where individual month's pH value was greater than 9 or less than 6.

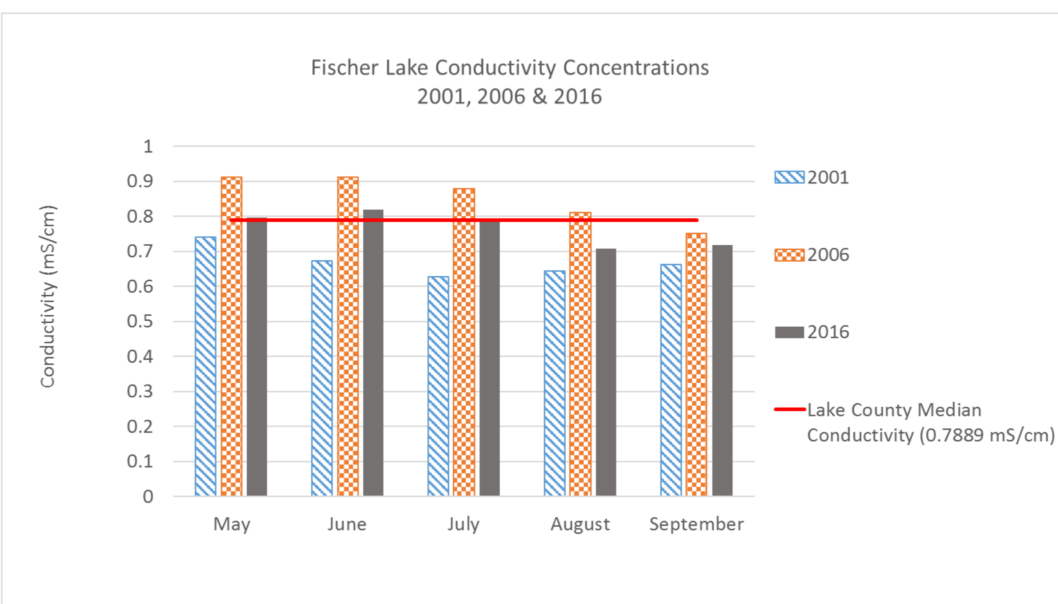


The pH scale ranges from 0 to 14. A pH of 7 is considered neutral. Substances with a pH of less than 7 are acidic, and greater than 7 are basic.

CONDUCTIVITY

Another parameter routinely measured is conductivity. Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, size of the watershed flowing into the lake, land use, evaporation, and bacterial activity. Conductivity in urban areas has been shown to be highly correlated with chloride ions found in road salt mixes. In 2016, Fischer Lake's average conductivity reading was 0.7653 mS/cm. This is slightly below the Lake County median conductivity concentration of 0.7889 mS/cm (Figure 13). This value is a decrease since the 2006 monitoring data although an increase since 2001 concentrations.

Figure 13: Conductivity Concentrations in Fischer Lake

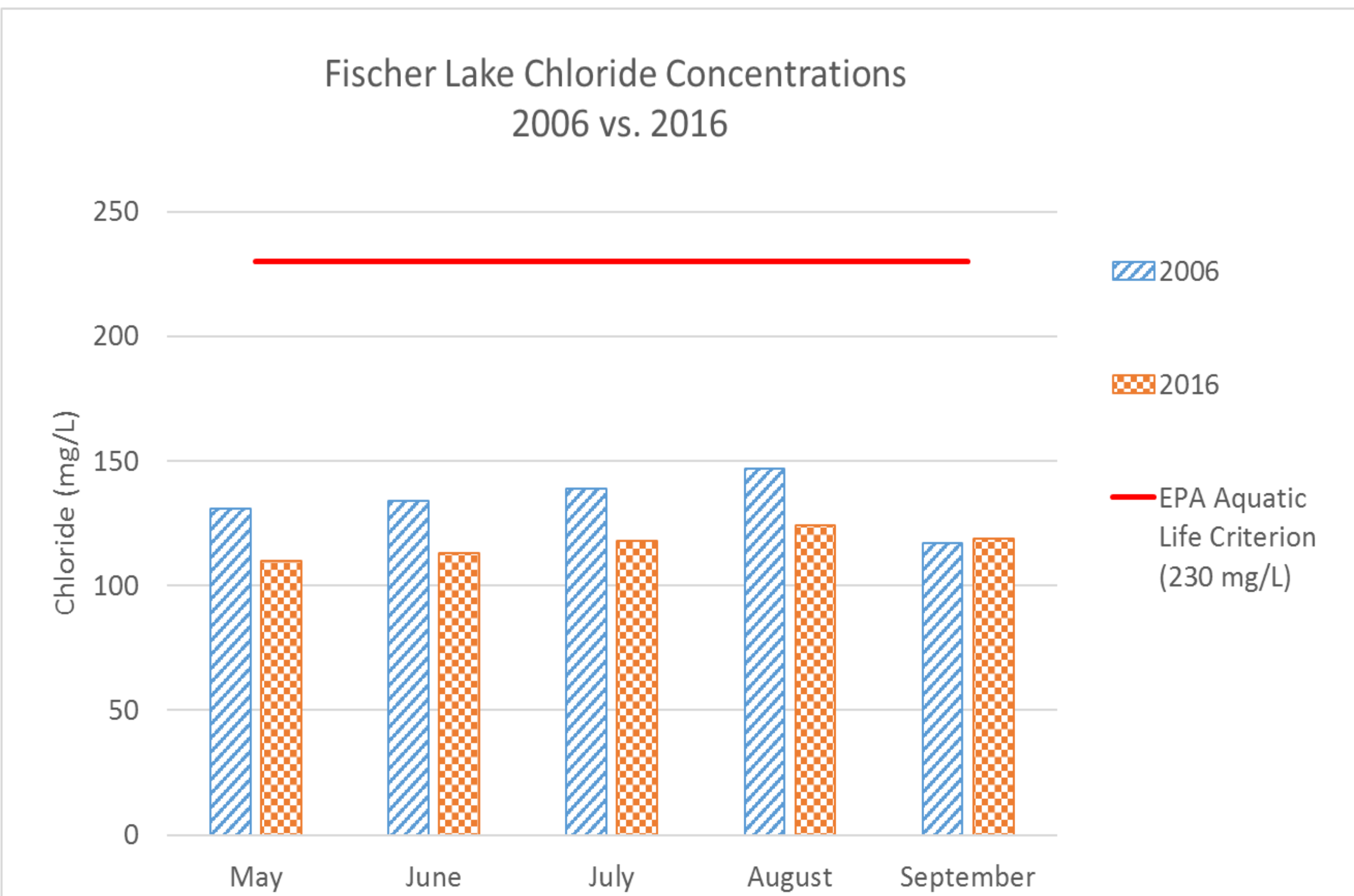


CHLORIDES

One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocynaide salts. Chlorides typically enter the lake through runoff from melt events that carry any road salt on the roads to the storm drains that are directly connected to the rivers, lakes, and wetlands (Figure 12). For 2016, Fischer Lake's chloride concentration averaged 117 mg/L which is below the Lake County median of 127 mg/L (Figure 14). The United States Environmental Protection agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems. Chloride ions do not break down and accumulate within a watershed. High chloride concentrations may make it difficult for many of our native plant species to survive, while many of our invasive species such as Eurasian Watermilfoil, Cattail, and Common Reed are tolerant to higher chloride levels. Chloride concentrations have decreased since the 2006 sampling period from 134 mg/L to 117 mg/L.

While chloride concentrations are not above the 230 mg/L, chloride and conductivity concentrations, it's always important to minimize chloride runoff. Fischer Lake does receive over 50% of it's runoff from Single Family residential and transportation combined which can be large sources of chloride runoff. The LCHD-ES and Lake County Stormwater Management Commission (LCSMC) have been holding annual trainings targeting deicing maintenance personnel for both public and private entities to hopefully reduce the amount of chloride being introduced into our environment while maintaining safe passageways. Almost all deicing products contain chloride so it is important to read an follow product labels for proper application. For instance, at 10F Fahrenheit, rock salt is not at all effective in melting ice and will blow away before it melts anything. Additionally calling your local township office to ask them if they are taking actions to minimize deicers on their properties or supporting changes in their deicing policy to minimize salt usage is encouraged.

Figure 14: Fischer Lake Chlorides



Chlorides & de-icing facts

ICE FACTS

- Anti-icing prevents the bond from forming between pavement and ice.
- Deicers melt snow and ice. They provide no traction on top of snow and ice
- De-icing works best if you plow/shovel before applying material.
- Pick the right material for the pavement temperatures.
- Sand only works on top of snow as traction. It provides no melting.
- Anti-icing chemicals must be applied prior to snow fall.
- NaCl (Road Salt) does not work on cold days, less than 15° F.
- NaCl is more effective at warmer temperatures—when it is warmer out, you do not need to put as much road salt down to melt ice efficiently.

THE CRITICAL VALUE FOR CHLORIDES IN AQUATIC SYSTEMS IS 230 MG/L.

230 mg/L = 1 teaspoon of salt added to 5 gallons of water.

Lake levels and precipitation

Lakes with stable water levels potentially have less shoreline erosion problems. The lake level in Fischer Lake was measured off the top of the seawall. The lake level decreased from May through August by 12.1 inches (~1.0 ft.). The most significant water level fluctuation occurred between July and August where the lake level decreased by 6.7 inches (~0.6 ft.).

In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly). The data provides lake managers a much better idea of lake level fluctuations relative to rainfall events and can aid in future decisions regarding lake level. A staff gauge is a great tool for measuring water level in lakes, rivers, reservoirs. The data collected can be compiled to help understand the natural fluctuations of the lake. Lakes with fluctuating water levels potentially have poorer water quality and have more shoreline erosion problems. Currently, the VLMP volunteers on Fischer Lake are monitoring lake level.

EXAMPLE OF A PERMANENT STAFF GAUGE

Rainfall information is also important for understanding lake water quality, as large rainstorm events can carry in pollutants, sediments, and affect water quality. Lake County Stormwater Management Commission has a number of rain gauges throughout the County. Based on the Libertyville rain gauge stations, below are rainfall totals for the monitoring season.

Month	Level (in)	Seasonal Change (in)	Monthly Change (in)	Precipitation (in)
May	38.9			4.6
June	44.2	5.3	5.3	3.1
July	45.6	6.7	1.4	4.3
August	51.0	12.1	5.4	2.9
September	45.0	6.1	-6.0	1.9

Harmful Algal Blooms

Algae are important to freshwater ecosystems and most species of algae are not harmful. Algae can grow quickly in water and is often associated with increased concentrations of nutrients such as nitrogen and phosphorus. Harmful algal blooms (HABs), also known as Blue-green algae or cyanobacteria, are a type of algae that can bloom and produce toxins. They are called harmful algal blooms because exposure to these blooms can result in adverse health effects to human and animals. Certain environmental conditions such as elevated levels of nutrients, warmer temperatures, still water, and plentiful sunlight can promote the growth of cyanbacteria to higher densities. However, their presence does not mean that toxins are present. It is still unclear what triggers HABs to produce the toxins. HABs tend to occur in late summer and early fall. Due to the potential presence of toxins, the IEPA and the LCHD have initiated a program to collect HABs from beaches and test for presence of microcystin, a common toxin produced by HABs.

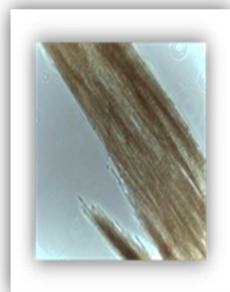
Anabaena Sp.

In 2016, the US EPA has issued a draft of *Human Health Recreational Ambient Water Quality Criteria (AWQC) and/or Swimming Advisories for Microcystins and Cylindrospermospin.* This will be the first time the EPA is issuing recommendation concentrations of microcystins and cylindrospermopsin, two types of toxins associated with harmful algal blooms. Different cyanotoxins have different health effects associated with exposure. For example, microcystins are primarily associated with liver toxicity, while kidney toxicity is a key health effect for cylindrospermopsin. Other toxins have been shown to affect the skin, gastrointestinal, or nervous systems.

Microcystis Sp.

In 2016, Fischer Lake had filamentous algae during the early summer season. No blue-green algae was noted. It is recommended to report any potential blue-green algae blooms by calling the Lake County Health Department and make lake users familiar with what blue-green algae looks like. Blue-green algae blooms can be toxic to pets who drink from the water as well as to human health, so it is important to report it LCHD so it can be properly tested for potential toxins.

For more information or to report a blue-green algae bloom, contact the Lake County Health Department Environmental Services (847) 377-8030.



Aphanizomenon Sp.

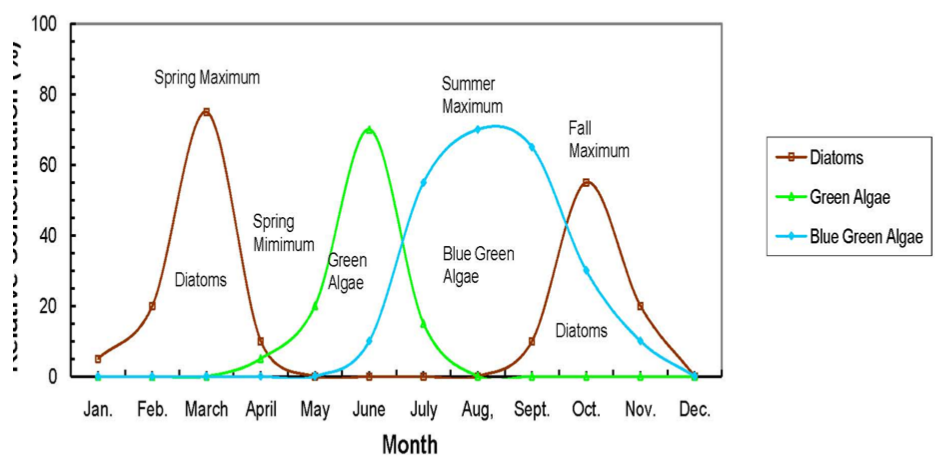
Below are two examples of Blue-Green Algae bloom with a paint like appearance.

Algal Blooms

In 2016, Fischer Lake had substantial filamentous algae bloom in the early season covering most of the lake. While it cleared up throughout monitoring season, some filamentous remained. Figure 15 is a picture of Fischer Lake Estates taken at the end of June showing the coverage of the filamentous algae bloom. Algae are important to lake ecology because they serve as food sources for protozoans, insects, and fish and are a vital component of the food web. However, sometimes algae blooms can reach nuisance levels. An overabundant plant growth is a symptom of excessive nutrients (phosphorus and nitrogen) in the water. Long-term control of overabundant plants and algae concerns are best accomplished by reducing or redirecting nutrient sources to the lake. These filamentous algae blooms, while not aesthetically pleasing, are not harmful to human health and are not considered a harmful algal bloom. They are also commonly mistaken for blue-green algae. Different species of algae have different growth patterns, and the green algae which is mostly filamentous peaks in spring and early summer (Figure 16).

Figure 15: Filamentous algae in Fischer Lake, June 2016

Figure 16: **Seasonal Growth Patterns in Phytoplankton**



SHORELINE EROSION

Erosion is a natural process along lake shorelines primarily caused by wind and wave action resulting in the loss of material from the shoreline. Disturbed shorelines caused by human activity such as clearing of vegetation and beach rocks, and increasing runoff will accelerate erosion. Eroded materials cause turbidity, sedimentation, nutrients, and pollutants to enter a lake. Excess nutrients are the primary cause of algal blooms and increased aquatic plant growth. Once in the lake, sediments, nutrients and pollutants are harder and more expensive to remove so it is important to maintain shorelines to minimize the amount of erosion occurring.

A shoreline erosion study was assessed for Fischer Lake in 2016 (Figure 17). Fischer Lake was divided into reaches and the shoreline was evaluated for none, slight, moderate and severe erosion based on exposed soil and tree/plant roots, failing infrastructure and undercut banks. Based on the 2016 data, 60% of Fischer Lake's shoreline has some degree of erosion; with 40% being slight erosion, 18% moderate erosion and 2% severe. For the complete list of erosion broken down by reaches, refer to Appendix B. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, there are multiple benefits. The erosion that is repaired and the new native plants can stabilize the shoreline to prevent future erosion. The addition of native plants adds habitat for wildlife and can also help filter pollutants and nutrients from the near shore areas. Natives shorelines also help lakes that have problems with geese and gulls, as it is not desirable habitat for them. Figures 18 (a &b) depict typical erosion observed on the shoreline of Fischer Lake. The island has the most severe degree of erosion observed.

Figure 17: Shoreline Erosion Condition on Fischer Lake 2016

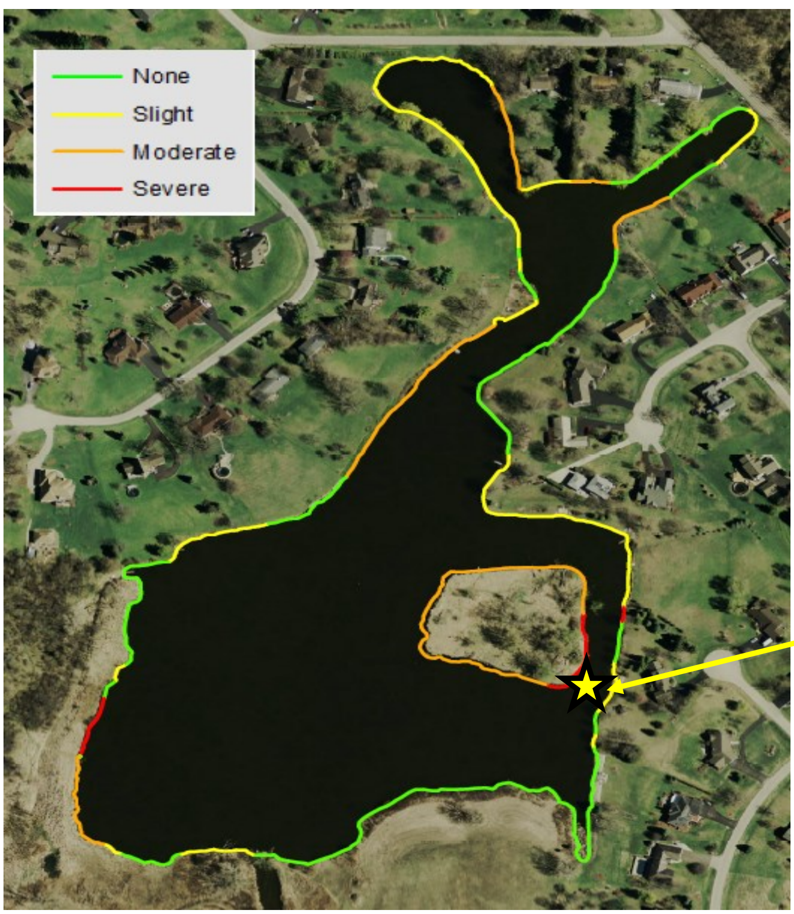


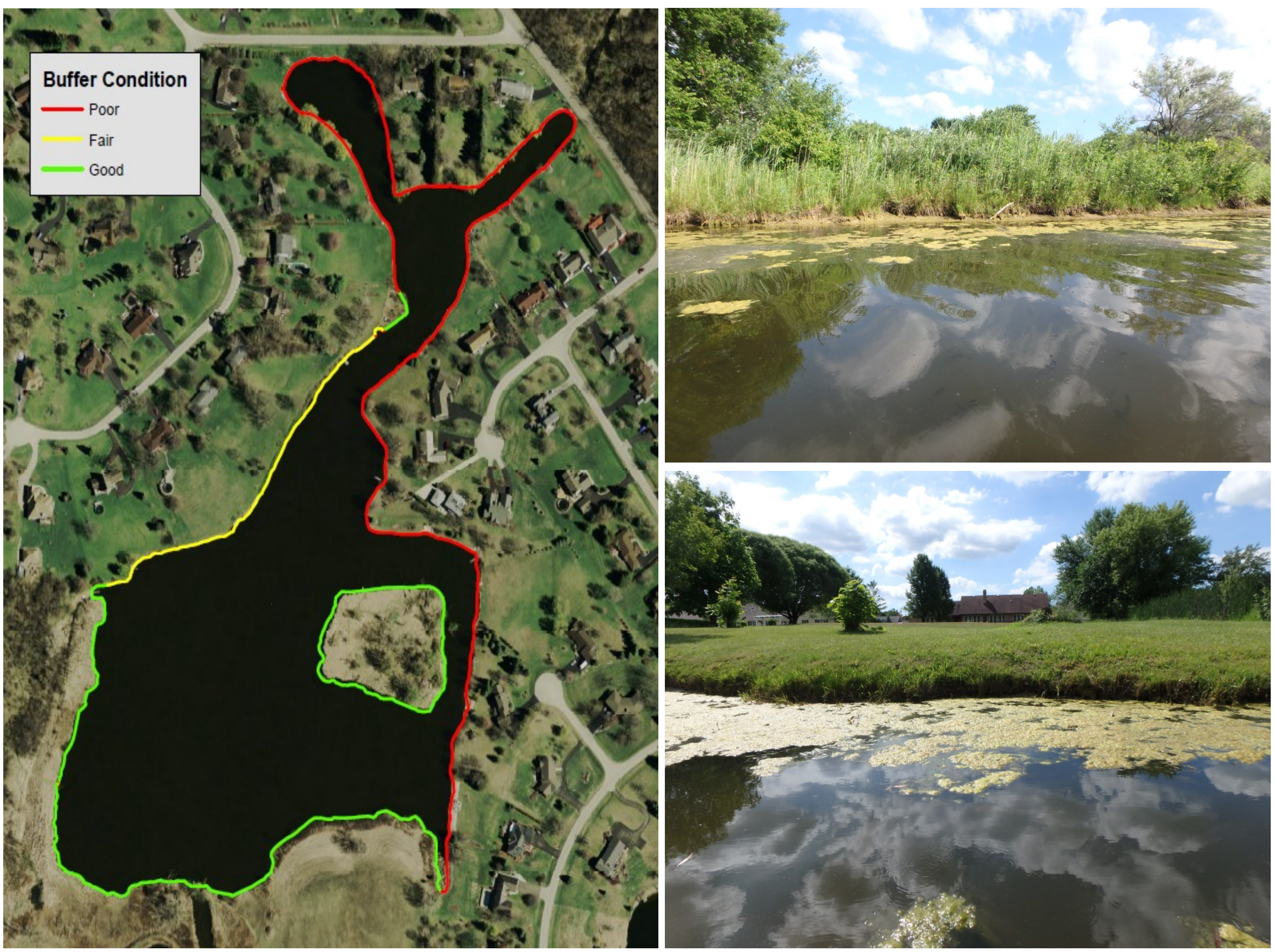
Figure 18(a&b): Example of Shoreline Erosion typical on Fischer Lake

SHORELAND BUFFERS

A shoreland buffer helps stabilize the sediment near the lakes edge which prevents soil erosion. The buffer will also filter out pollutants and unwanted nutrients from entering the lake. Buffer strips should be at least 25 feet wide and can include native wildflowers, native grasses, and native wetland plants. Wider buffers may be needed for areas with a greater slope or additional runoff issues. Areas that are already severely or moderately eroding, a buffer strip of native plants may need to be bolstered for additional stability. Many LCFPD lakes have re-established buffers or do not mow to lakes edge to allow native grasses to grow and these are best management practices.

A shoreland buffer condition survey off Fischer Lake's was conducted by looking at the land within 25 feet of the lake's edge on aerial images in ArcGIS and in the field (Figure 15). Shoreland buffer's were classified into three categories; poor, fair or good based on the amount of unmowed grasses, forbs, tree trunks and shrubs, and impervious surfaces within that 25 foot range. In 2016, Fischer Lake had 49% of the shoreline with poor buffer, 12% with fair, and 39% with good (Table 3). For a complete list of shoreland buffer condition assessment by reach, refer to Appendix B. Many of the properties have mowed grass straight to the lakes edge, although there a few that have installed buffers. Buffers along the Fischer Lake shoreline can either be improved by increasing the buffer width or installing buffers. Many of the properties have ample yard space between the lake shoreline and the house where a buffer could easily enhance water quality. There are many different types of native plants to choose from when deciding to install a buffer. There are options for tall and short grasses, as well as plants that bloom at different seasons to make the buffer aesthetically pleasing.

Figure 19: Lakeshore Buffer Condition on Fischer Lake, 2016

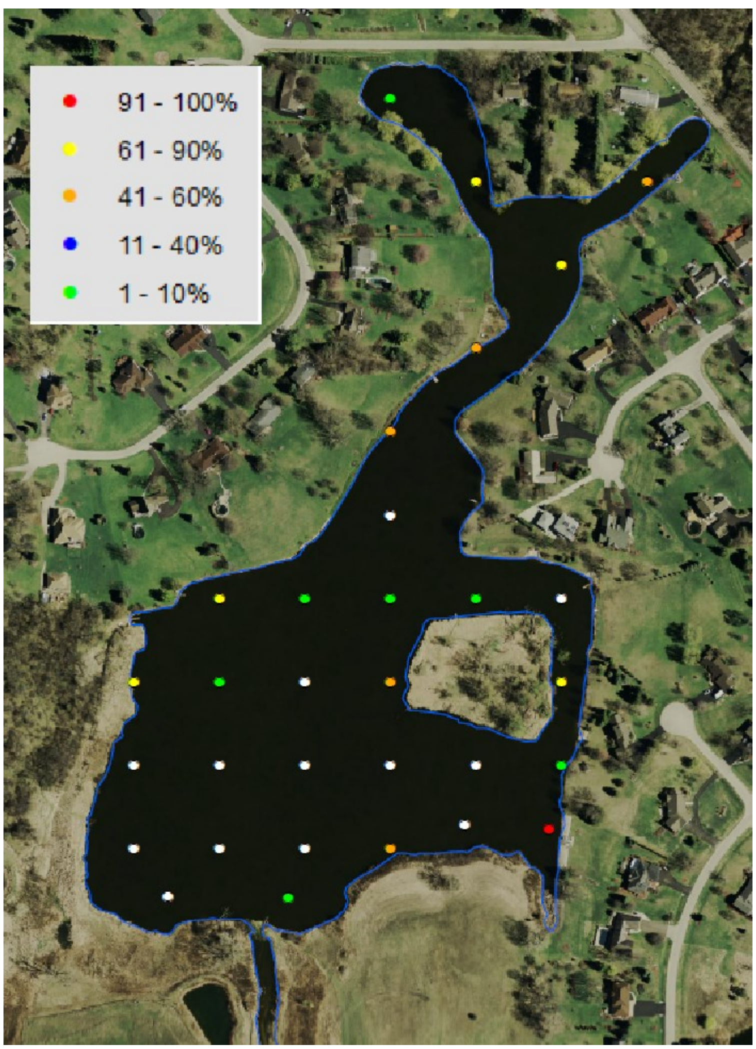


AQUATIC PLANTS

Aquatic plants are a critical component in a lakes ecosystem as they compete against algae for nutrients, improve water quality and provide fish habitat. **Their presence is natural and normal in lakes.** An aquatic macrophyte survey was conducted on Fischer Lake early August 2016. Sampling sites were based on a grid system created by mapping software, with each site located 60 meters apart for a total of 27 sites. At each site, overall plant abundance was ranked and plant species were identified and ranked. Based on the aquatic plant rake survey, plants occurred at 18 of the 27 sites (58% total lake coverage) with plants found at depths up to 5.2 feet (Figure 20). Out of the sample points that did have plants most had lower density coverage (1-10% density).

There were a total of 9 aquatic plant species found in Fischer Lake. Coontail and Eurasian Watermilfoil were the most dominant plant species occurring at 45.2% and 29% of the sample sites, respectively (Appendix B). All other species were found at less then 10% of the sampling sites. The number of plant species is an increase from the 2006 sampling where only six plant species were observed. In 2006, Eurasian Watermilfoil was the most dominant plant species at 78% followed by Sago Pondweed at 26%. The increase in aquatic plant diversity as well as decrease in the rake density of Eurasian watermilfoil are promising in terms of aquatic plant health and overall lake water clarity for Fischer Lake.

Figure 20: Overall plant biovolume for Fischer Lake, August 2016



Rake Density (coverage)	# of Sites	% of Sites
No Plants	13	41.9
>0-10%	7	22.6
10-40%	5	16.1
40-60%	5	16.1
60-90%	1	3.2
>90%	0	0.0
Total Sites with Plants	18	58.1
Total # Sites	31	100

AQUATIC PLANTS (CONTINUED)

The diversity and extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of surface light level, plants can no longer grow. 1% surface light level is roughly at 2 times the average Secchi depth or can be measured with a photosynthetically active radiation (PAR) sensor. For Fischer Lake, the 1% light level based on average Secchi values was 5.4ft. Aquatic plants were found at a maximum depth of 5.2 ft. For a complete list of plant species and rake density, refer to appendix B.

Common Plants found in Fischer Lake, 2016

EURASIAN WATERMILFOIL

Myriophyllum spicatum

This invasive species has a feathered appeared with 12-20 pairs of leaflets per leaf. It can form dense mats that make recreational activities difficult. Found at 29.0% of the sampling sites.

SAGE PONDWEED

Potamogeton pectinatus

Native submerged aquatic plant with long and thin branching leaves. The leaves often grow in thick layers. Sago Pondweed was found at 9.7% of the sampling sites.

COONTAIL

Ceratophyllum demersum

Overwinters as a evergreen plant, it provides important habitat to many invertebrates and fish. Found at 45.2% of the sampling sites.

AQUATIC PLANTS: WHERE DO THEY GROW?

Littoral Zone– the area that aquatic plants grow in a lake.

Algae– have no true roots, stems, or leaves and range in size from tiny, one- celled organisms to large, multicelled plant-like organisms.

Submerged Plants– have stems and leaves that grow entirely underwater, although some may also have floating leaves.

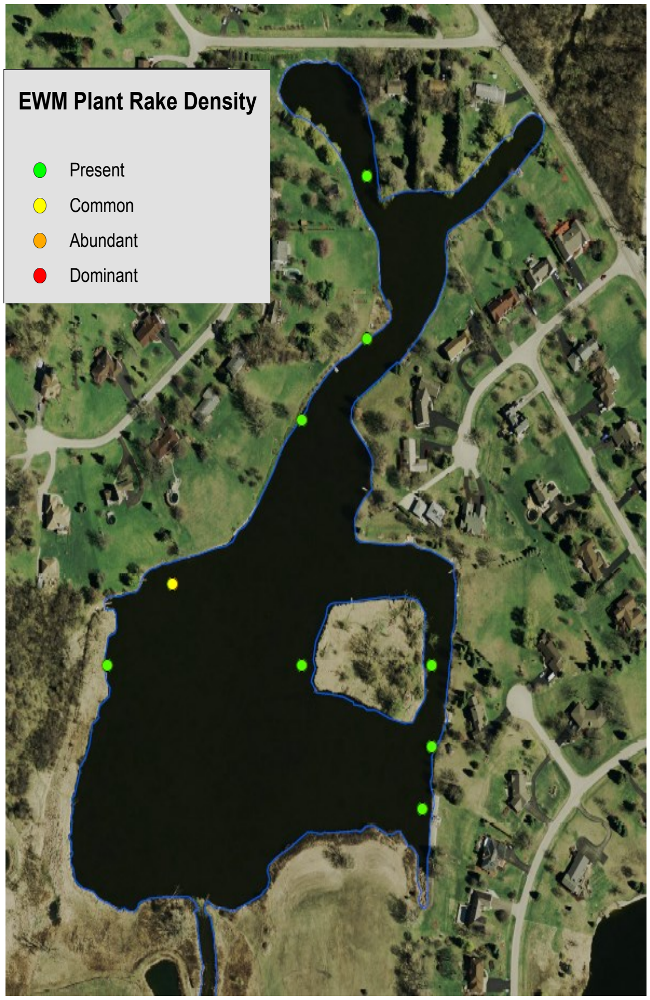
Floating-leaf Plants– are often rooted in the lake bottom, but their leaves and flowers lay flat on the water surface.

List of Plant Species observed 2016 vs. 2006

2016	*2006*
American Pondweed	*American Pondweed*
Coontail	*Coontail*
Curlyleaf Pondweed	*Curlyleaf Pondweed*
Duckweed	*Duckweed*
Elodea	*Eurasian Watermilfoil*
Eurasian Watermilfoil	*Sago Pondweed*
Sago Pondweed	
Leafy Pondweed	
Watermeal	

AQUATIC PLANTS (CONTINUED)

Figure 21: Eurasian Watermilfoil and Overall Plant Biovolume, August 2016



Two aquatic invasive species were observed in Fischer Lake in the 2016 macrophyte survey; Eurasian Watermilfoil (EWM) and Curlyleaf Pondweed (CLP). CLP was found at 9.7% of sampling sites, however, EWM was a dominant plant species in Fischer Lake occurring at 29% of the sampling sites. It should also be noted that while CLP was only found in minor amounts, this is influenced by the time of season that LCHD conducts the plant survey. Most plants are in full capacity in middle to late of summer which is most plant surveys are conducted in July and August. Unlike many other plants, Curlyleaf Pondweed has an earlier lifecycle. It typically peaks in May and June and can be completely gone from a lake by the time the late summer plant survey is conducted. For this reason it's important to understand that if Curlyleaf Pondweed is found in minor amounts in the August sampling, it is likely its' overall abundance is much higher in the beginning of the season.

Eurasian Watermilfoil is a feathery submerged aquatic plant that can quickly form thick mats in shallow areas of lakes and rivers. These mats can interfere with swimming and entangle propellers, which hinders boating, fishing, and waterfowl hunting. Matted milfoil can displace native aquatic plants, impacting fish and wildlife. Since it was discovered in North America in the 1940's, EWM has invaded nearly every US state. Milfoil spreads when plant pieces break off and float on water currents. It can also attach to sailboats, personal watercraft, powerboats, motors, trailers and fishing gear and be spread in transport.

The abundance of EWM in Fischer lake has decreased since 2006. Figure 20 depicts overall plant rake density of Eurasian Watermilfoil. By mapping the plant species, areas with heavy EWM can be noted and managed if desired. From the plant survey data, EWM is not found in heavy density in Fischer Lake. Homeowners around Fischer Lake do not conduct any herbicide treatments.

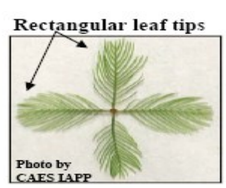
MYRIOPHYLLUM SPICATUM EXOTIC*

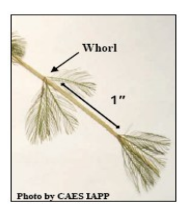
COMMON NAMES:
EURASIAN WATERMILFOIL

ORIGIN: EXOTIC
EUROPE AND ASIA. FOUND THROUGHOUT LAKE COUNTY AND ILLINOIS

IMPORTANCE:
THIS INVASIVE PLANT SPREADS RAPIDLY, CROWDING OUT NATIVE SPECIES, CLOGGING WATERWAYS, AND BLOCKING SUNLIGHT AND OXYGEN FROM UNDERLYING WATERS.

LOOK ALIKES:
NORTHERN WATERMILFOIL
WHICH HAS FEWER THAN 12 LEAFLET PAIRS PER LEAF, AND GENERALLY HAS STOUTER STEMS.





KEY FEATURES:

STEM: LONG, OFTEN ABUNDANTLY BRANCED STEMS FORM A REDDISH OR OLIVE-GREEN SURFACE MAT IN SUMMER.

LEAF: LEAVES ARE RECTANGULAR WITH ≥12 PAIRS OF LEAFLETS PER LEAF AND ARE DISSECTED GIVING A FEATHERY APPEARANCE, ARRANGED IN A WHORL, WHORLS ARE 1 INCH APART.

FLOWER: SMALL PINKISH MALE FLOWERS THAT OCCUR ON REDDISH SPIKES, FEMALE FLOWERS LACK PETALS AND SEPALS AND 4 LOBED PISTIL.

FLORISTIC QUALITY INDEX

Floristic quality index (FQI) is an assessment tool designed to evaluate how close the flora of an area is compared to one of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site 3) monitor long-term floristic trends and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submerged plant species found in the lake. The FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species are present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The median FQI for Lake County lakes from 2000-2016 is 13.9. Fischer Lake had an FQI value of 13.6 ranking it 85out of 171 lakes in Lake County (Appendix A). The FQI has improved since the 2006 sampling when the FQI value was 9.0. A total of nine plant species were observed . Two plant species were aquatic invasive species (Curlyleaf Pondweed and Eurasian Watermilfoil). It is possible the reduction in Eurasian watermilfoil allowed for an increase in plant diversity since aquatic invasives can outcompete natives. LCHD recommends homeowners develop an Aquatic Plant Management Plan (APMP) that is part of your lake management plan.

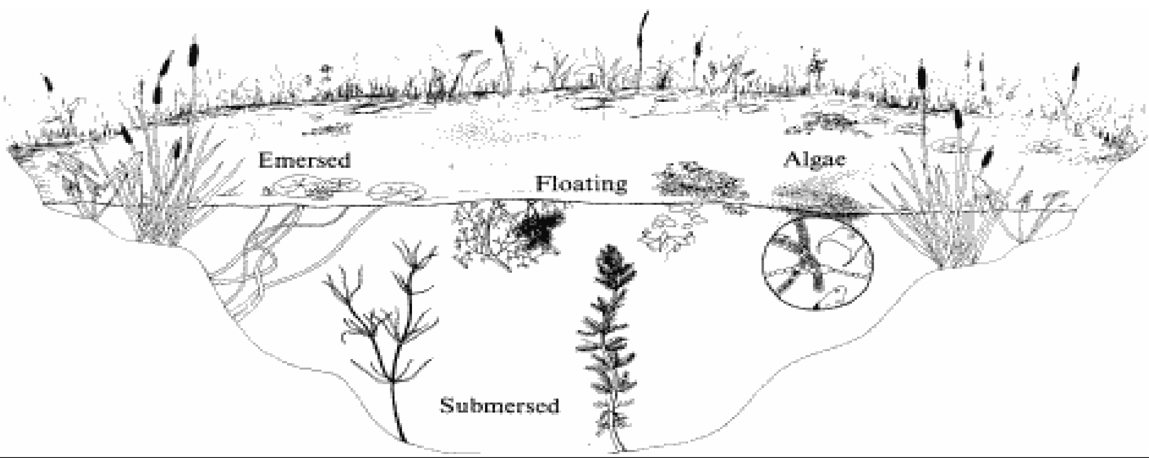
LAKE COUNTY AVERAGE FQI = 13.9

FISCHER LAKE FQI = 13.6

RANK = 85/171

AQUATIC PLANTS SPECIES OBSERVED = 9

NATIVE PLANT SPECIES: 7



In many lakes, macrophytes contribute to the aesthetically pleasing appearance of the setting and are enjoyable in their own right. But even more important, they are an essential element in the life systems of most lakes.

- Macrophyte leaves and stems provide a habitat or home for small attached plants and animals. Some are microscopic in size and some are larger. These attached organisms are valuable as food for animals higher in the food chain, such as fish and birds.
- Many types of small organisms live in the sediment. There are insects that spend the immature stages of life in the sediments, leaving when they become adults. Decomposing plant life provides part of the food supply for these sediment-dwelling organisms and the emerging insects, in turn, are food for fish.
- The submerged portions of macrophytes provide shelter and cover for small or young fish from larger fish that would feed on them.
- Types of plants that extend above the water can provide cover for waterfowl and their young, and many plants can serve directly as food for certain types of waterfowl.
- Aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available nutrients.

AQUATIC PLANTS AND FISH

Fish depend on aquatic plants to provide habitat and forage for food and most freshwater fish rely on aquatic plants at some point during their life stage. The plant composition and density can play an important role in the nesting, growth, and foraging success of these fish (Table 6). While many fish require some aquatic vegetation for growth, excessive amounts of aquatic vegetation can negatively impact growth by reducing foraging success. The parameters of an ideal fish habitat change base on the size and species of fish, the type of lake, structures present in the lake and many other factors. There is no recent or historical survey on file for Fischer Lake. DNR does conduct fish surveys on a rotating basis or environmental consultants can be hired. As the lake is used frequently by fishermen, it is recommended that an updated survey be conducted. The report generated by the IDNR would provide status of the fish populations and also recommendations to keep a healthy fishery.

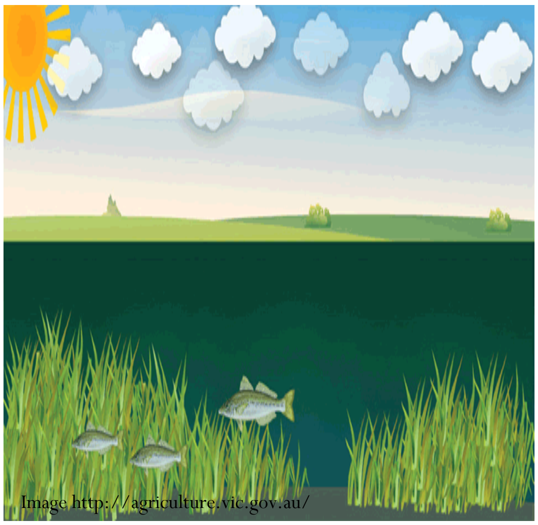


Image http://agriculture.vic.gov.au/

How do plants impact fish?

- *Plants provide critical structure to aquatic habitats.*
- *Plants influence growth of fish by enhancing fish diversity, feeding, growth, and reproduction.*
- *Plants influence spawning. The structure provided by plant beds is important to fish reproduction.*
- *Plants influence the physical environment. Aquatic plants can change water temperatures and available oxygen in habitats.*

Table 5: Common fish and their plant affinity during various life stages and their relationship with plants.

		Life Stage				Relationship	
Fish	**Plant Affinity**	**Larvae**	**Juvenile**	**Adult**	**Spawn**	**Forage**	**Predator avoidance**
Bluegill sunfish	High	X	X	X	X	X	X
Common carp	High	X	X	X	X	X	X
Largemouth bass	High	X	X	X	X	X	X
Musky	High	X	X	X	X	X	X
Northern Pike	High	X	X	X	X	X	X
Black crappie	Moderate		X	X	X	X	X
Smallmouth bass	Moderate		X	X		X	X
Yellow perch	Moderate	X	X			X	X
White crappie	Low		X			X	
Salmon, trout	Low		X				X
Shad	Low	X					
Walleye	Low			X		X	

Table adapted from Gettys, Lynn, William T. Haller and Marc Bellaud. "Biology and Control of Aquatic Plants: A Best Management Practices Handbook". 2009

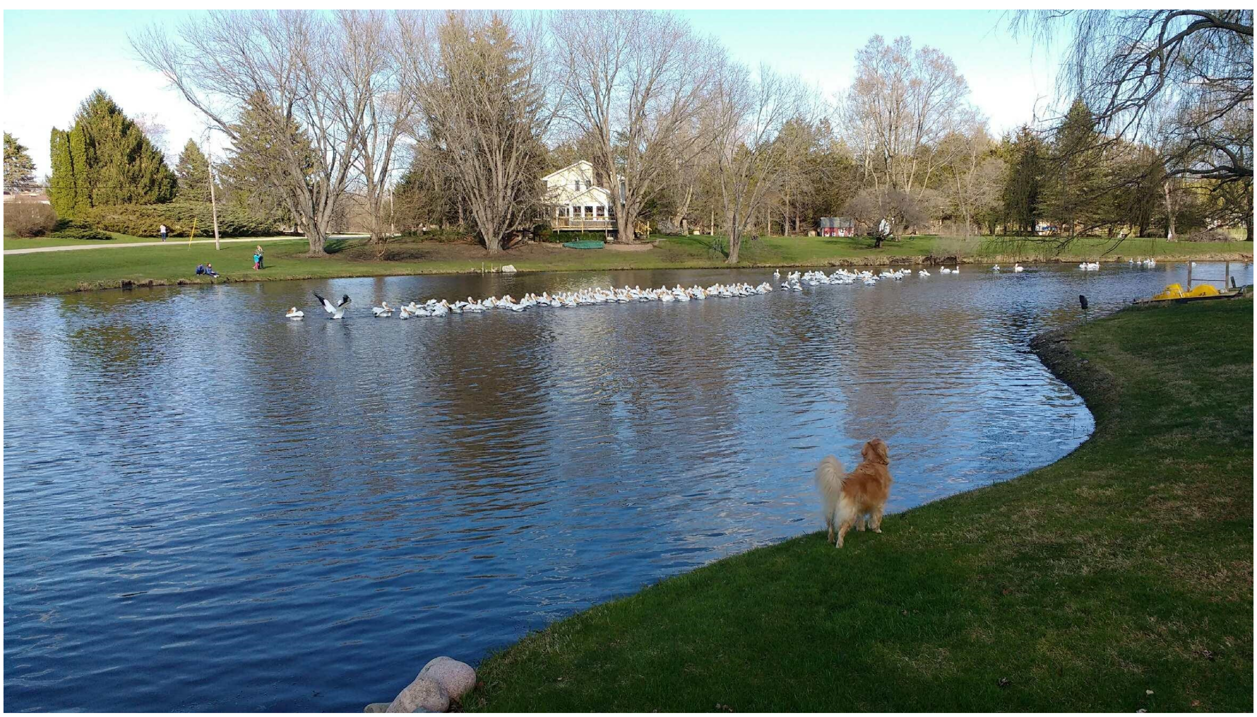
WILDLIFE

Good numbers of wildlife, particularly birds, were noted on and around Fischer Lake. Due to the lake being in the middle of a residential setting with the majority of the shoreline developed, habitat for wildlife was limited. Most of the birds observed were those common in residential settings including egrets and herons. A snapping turtle and painted turtles were both observed during the sampling season. In previous years, Sandhill Crane, listed as Threatened in the state of Illinois, was seen during the sampling period. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians.

One wildlife problem that was identified in the past was the large numbers of resident Canada geese. Resident geese contribute large amounts of feces to the surrounding landscape that eventually wash into the lake, exacerbating the nutrient problems. Controlling resident geese can be difficult and in some cases permits are required by the Illinois Department of Natural Resources. Maintaining the buffer strips around the lake and replacing some of the turfgrass in the watershed will help discourage geese from using these areas.

2016 was a unique year for wildlife for Fischer Lake as it was the first year that a group of pelicans stopped at the lake. The American white pelican typically stops in northern Illinois during their spring migration to the Great Plains and Southern Canada. The pelicans are typically seen in the Fox Chain O'Lakes, however, normally don't make stops on many of the smaller lakes in the watershed. In Spring 2016, the white pelicans were observed in large quantities (hundreds) on Fischer Lake and neighboring lakes. There were concerns that the pelican population could increase nutrient levels for Fischer Lake, however, that is not reflected in the monitoring data.

Figure 22: Pelicans gathering on Fischer Lake, photo courtesy of Richard Hartman, Fischer Lake Resident



AQUATIC PLANT MANAGEMENT OPTIONS

Aquatic plants are essential for maintaining a balanced, healthy lake, but sometimes plants can create a nuisance for recreation, lake aesthetics, and invasive plant species can outcompete native plant species. Aquatic plant management is both controlling undesirable species while encouraging desirable species in important habitat areas. Fischer Lake has two aquatic invasive species that change in density from year to year. There are options to control aquatic plant growth, especially for invasive species. Fischer lake has not previously used aquatic herbicides for plant control. The main types of plant control include: mechanical harvesting, manual harvesting, and herbicides. Mechanical harvesting involves the use of specially designed machines that cut and remove plant material from a lake. Harvesting only reduces the height of aquatic plants in the water column. Manual or hand harvesting is the most environmentally friendly is best for small scale operations. The most common control tool in aquatic plant management is the use of herbicides registered by the U.S. environmental Protection Agency. Below is a table that briefly summarizes some pros and cons of the different aquatic plant management techniques. This is not a comprehensive list and should only be used as a guide to understanding different management options available.

Two sided rake for manual harvesting

Management	Pros	Cons
Mechanical	Cost competitive with chemical controls	Undesirable plants may fragment, spread and col-
	Removes nutrients from the lake but may be minimal compared with input	Desirable plants such as pondweeds may be suppressed
	Removes organic material from the lake	Limited operation in shallow water and around
	May provide some selective control	Machine breakdowns can disrupt operations
		Drifting plant fragments may accumulate at
Hand Harvesting	Low Cost	Lab intensive
	Excellent control in small areas	Not suitable for large areas
	Low environmental impact	
Herbicides	Costs are reasonable in many situations	Involves the introduction of pesticides into shared
	Range of products and combinations available	Potential for misuse
	Some products are highly selective for nuisance	May contribute to the buildup of organic material
	Can provide complete control of plants for swimming beaches	Algal blooms are possible following large herbicide treatments
		Fish kills may occur with misuse of certain products
		Large treatments may encourage shifts in plant
		Water use restrictions may be need to be
		Does not address the cause of cultural eutrophication

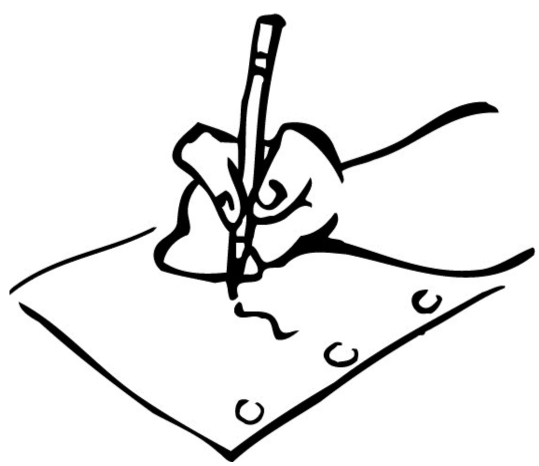
LAKE MANAGEMENT PLANS

It is recommended that a long term Lake Management Plans be developed to effectively manage lake issues. All stakeholders should participate in the development of the plan and include homeowners, recreational users, lake management associations, park districts, townships or any other entity involved in managing Fischer Lake. Lake Management plans should educate the public about specific lake issues, provide a concise assessment of the problem, outline methods and techniques that will be employed to control the problems and clearly define the goals of the program. Mechanisms for monitoring and evaluation should be developed as well and information gathered during these efforts should be used to implement management efforts (Biology and Control of Aquatic Plants, Gettys et al., 2009)

What are the steps in creating a Lake Management Plan?

1. **Getting Started**: Identify lake stakeholders and communication pathways
2. **Setting Goals:** Getting the effort organized, identifying problems to be addressed, and agreeing on the goals
3. **Problem Assessment & Analysis**: collecting baseline information to define the past and existing conditions. Synthesize the information, quantifying and comparing the current conditions to desired conditions, researching opportunities and constraints and setting direction to achieve goals.
4. **Alternatives:** List all possible management alternatives and evaluate their strengths, weakness, and general feasibility.
5. **Recommendations:** Prioritize management options, setting objectives and drafting the plan
6. **Project Management:** Management of assets, detailed records of expenses and time
7. **Implementation:** adopting the plan, lining up funding, and scheduling activities for taking action to achieve goals.
8. **Monitor & Modify:** Develop a mechanism for tracking activities and adjusting the plan as it evolves.

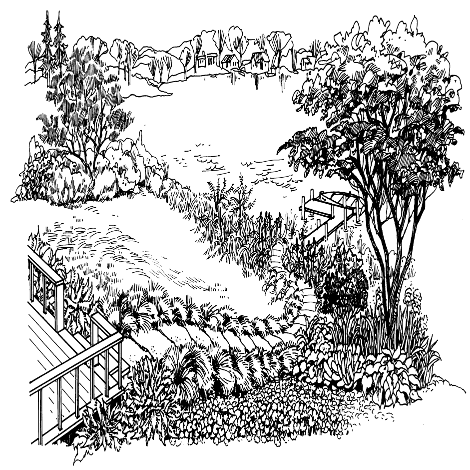
Follow these steps when getting started with writing Lake Management Plans. While each step is necessary, the level of effort and detail for each step will vary depending on the project's goals, size of the lake, and number of stakeholders.



LAKE RECOMMENDATIONS

Fischer Lake water quality has improved since the 2006 sampling although many parameters still remain above the county median. Fischer lake has a high nutrient and high total suspended solids. To improve the overall quality of Fischer Lake the ES (Ecological Services) has the following recommendations:

- LCHD encourages Fischer lake to continue participating in the Volunteer Lake Monitoring Program to give yearly data for Fischer Lake. Participating in this program can provide useful data to observe changes in the lakes water clarity overtime. This may be of particular interest with increasing landuse changes within the watershed.
- While filamentous algae is natural and poses no human health risk, it can be seen as aesthetically displeasing. Fischer lake had an abundant amount of filamentous algae during the 2016 season. Homeowners can rake the algae near there shoreline to minimize their presence in the water column.
- Develop a Lake Management Plan that incorporates aquatic plant management.
- It is recommended to conduct a fisheries survey to assess fish population and in Fischer Lake since there has been no recent surveys.
- There currently is no bathymetric map for Fischer Lake. It is recommended to create a bathymetric maps for the lake that should be updated every 10 years. Bathymetric map will be particularly necessary if any aquatic herbicides begin to be used.



- Become familiar with the appearance of harmful algal blooms and report any blooms to the LCHD-ES by calling 847-837-8030. Also, educate lake users about the appearance of harmful algal blooms so that blooms can be reported to the Lake County Health Department.
- Since Fischer Lake has diverse wildlife, it is recommended to increase wildlife habitat and protect current habitat. Due to Fischer Lake being located in a residential setting and mostly developed shoreline, enhancing wildlife habitat for terrestrial animals such as birds and mammals can be accomplished through the addition of shoreline buffer zones.
- Fischer lake has a resident goose population. The presence of geese can contribute to the nutrients in the lake and methods should be taken to control and discourage the geese from congregating. “No Feeding Waterfowl” signs should be installed around the lake, as feeding geese will attract them to stay in the area. Additionally, native plants near the shoreline will reduce the likelihood of them congregating since they prefer turf grass.
- Homeowners without buffer zones should establish a buffer of native plants to stabilize shorelines, reduce nutrients, and provide valuable habitat for important pollinators and insects.

Lake County Health Department and Community Health Center

ECOLOGICAL SERVICES

Senior Biologist: Mike Adam

madam@lakecountyil.gov

Population Health Services
500 W. Winchester Road
Libertyville, Illinois 60048-1331

Phone: 847-377-8030
Fax: 847-984-5622

For more information visit us at:

http://www.lakecountyil.gov/Health/want/BeachLakeInfo.htm

Protecting the quality of our lakes is an increasing concern of Lake County residents. Each lake is a valuable resource that must be properly managed if it is to be enjoyed by future generations. To assist with this endeavor, Population Health Environmental Services provides technical expertise essential to the management and protection of Lake County surface waters.

Environmental Service's goal is to monitor the quality of the county's surface water in order to:

- Maintain or improve water quality and alleviate nuisance conditions
- Promote healthy and safe lake conditions
- Protect and improve ecological diversity

Services provided are either of a technical or educational nature and are provided by a professional staff of scientists to government agencies (county, township and municipal), lake property owners' associations and private individuals on all bodies of water within Lake County.

2016 LAKES SAMPLED

Ames Pit

Bresen Lake

Lake Carina

Des Plaines Lake

Duck Lake

Fischer Lake

Fish Lake

Independence Grove

Lochanora Lake

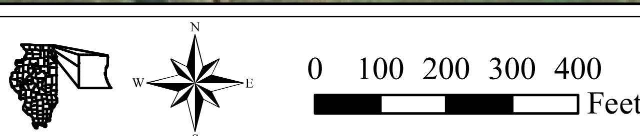
Sterling Lake

Summerhill Lake

Wooster Lake

Appendix A:
Figures

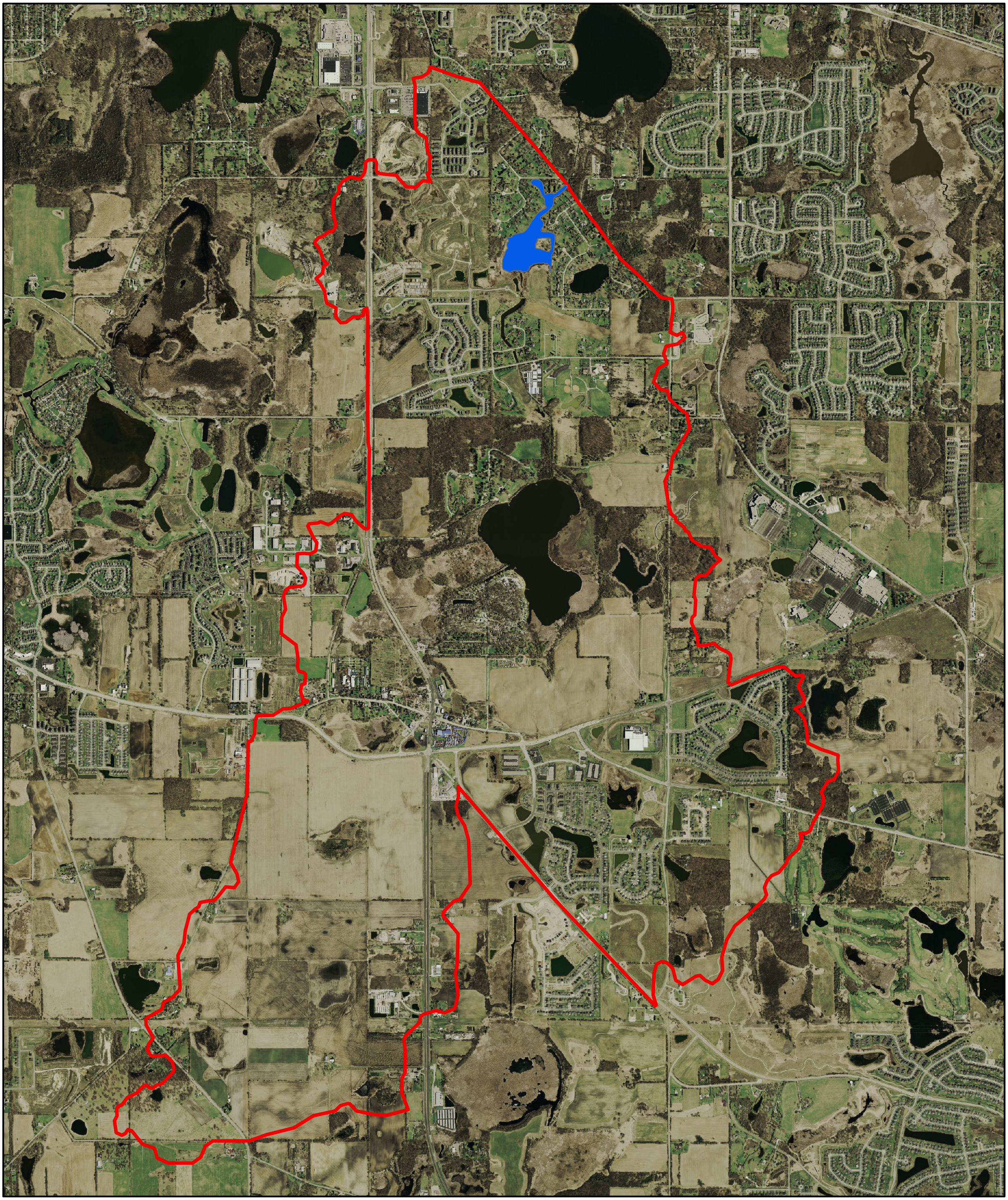
Fischer Lake Sampling Point, 2016



LakeCounty Health Department and Community Health Center

Ecological Services
Product Number FLD16
Revised 05/2016

Fischer Lake Watershed Boundary



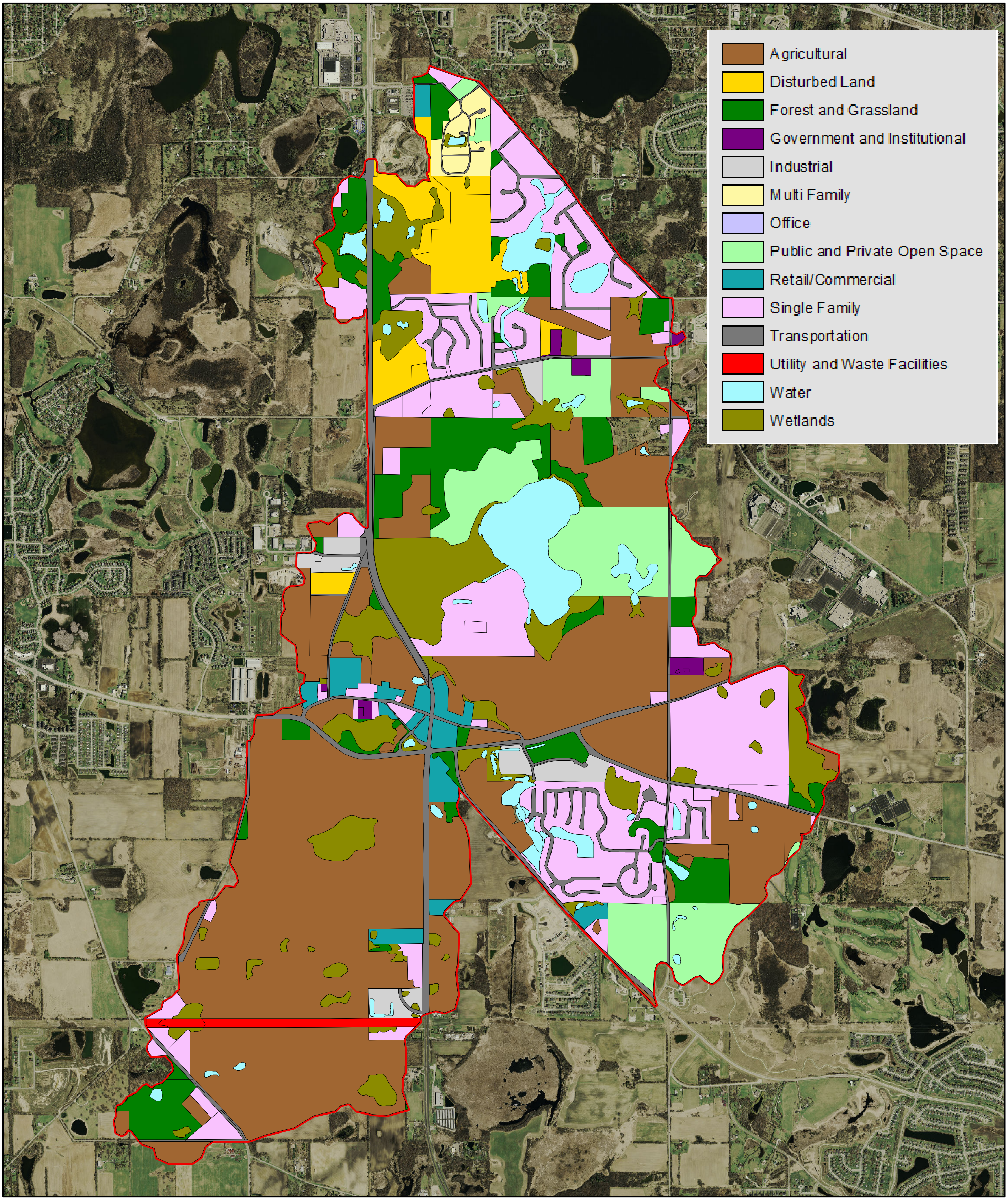
LakeCounty Health Department and Community Health Center

W E N S

0 1,300 2,600 3,900 5,200 Feet

Ecological Services
Product Number FLD16
Revised 1/2017

Fischer Lake Landuse 2016



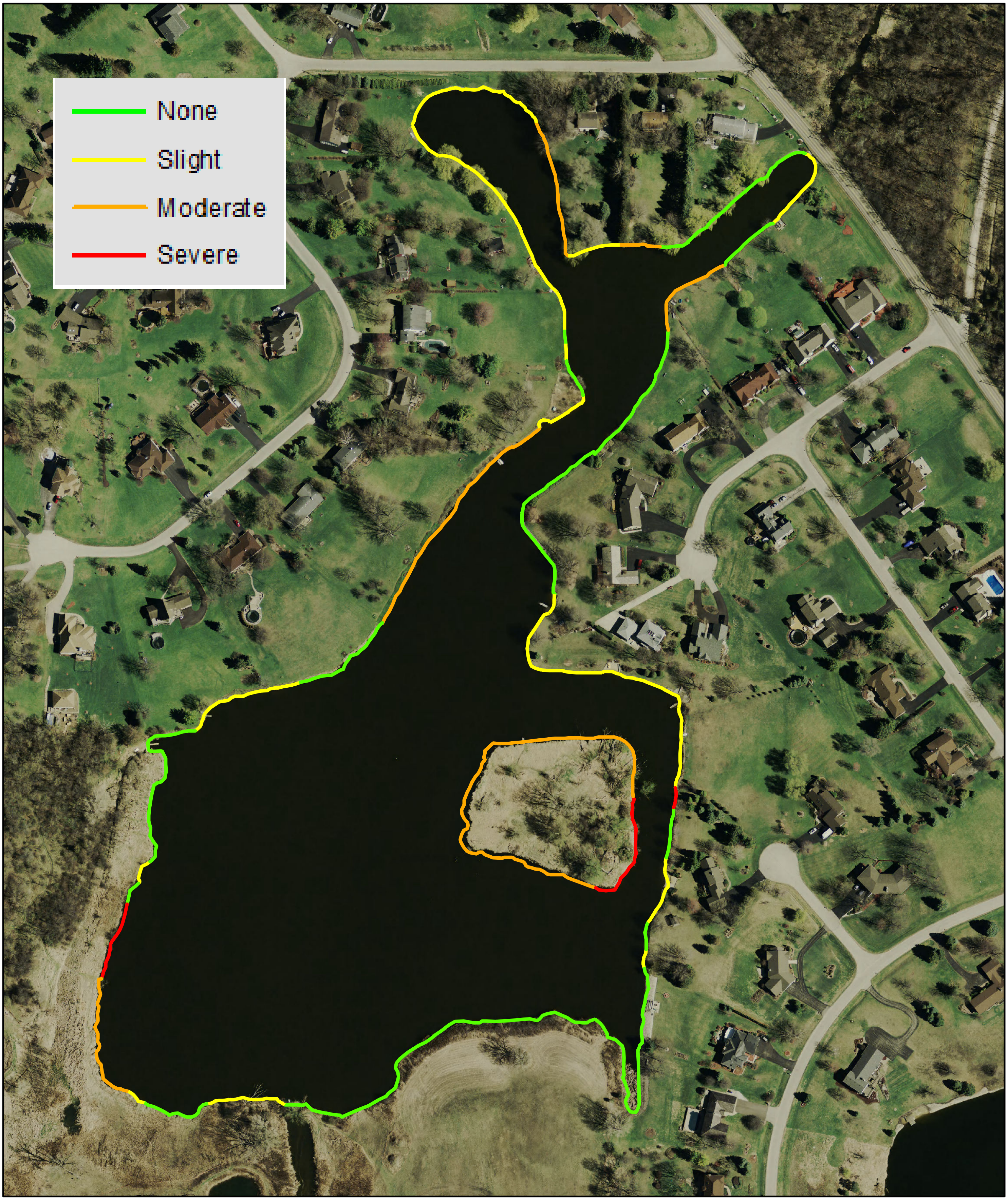
LakeCounty
Health Department and
Community Health Center

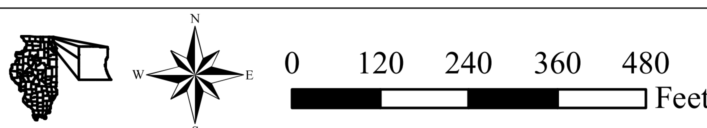
Ecological Services
Product Number FLD16
Revised 1/2017

Fischer Lake Shoreline Reaches, 2016

Ecological Services
Product Number FLD16
Revised 06/2016

Fischer Lake Shoreline Erosion Condtion 2016

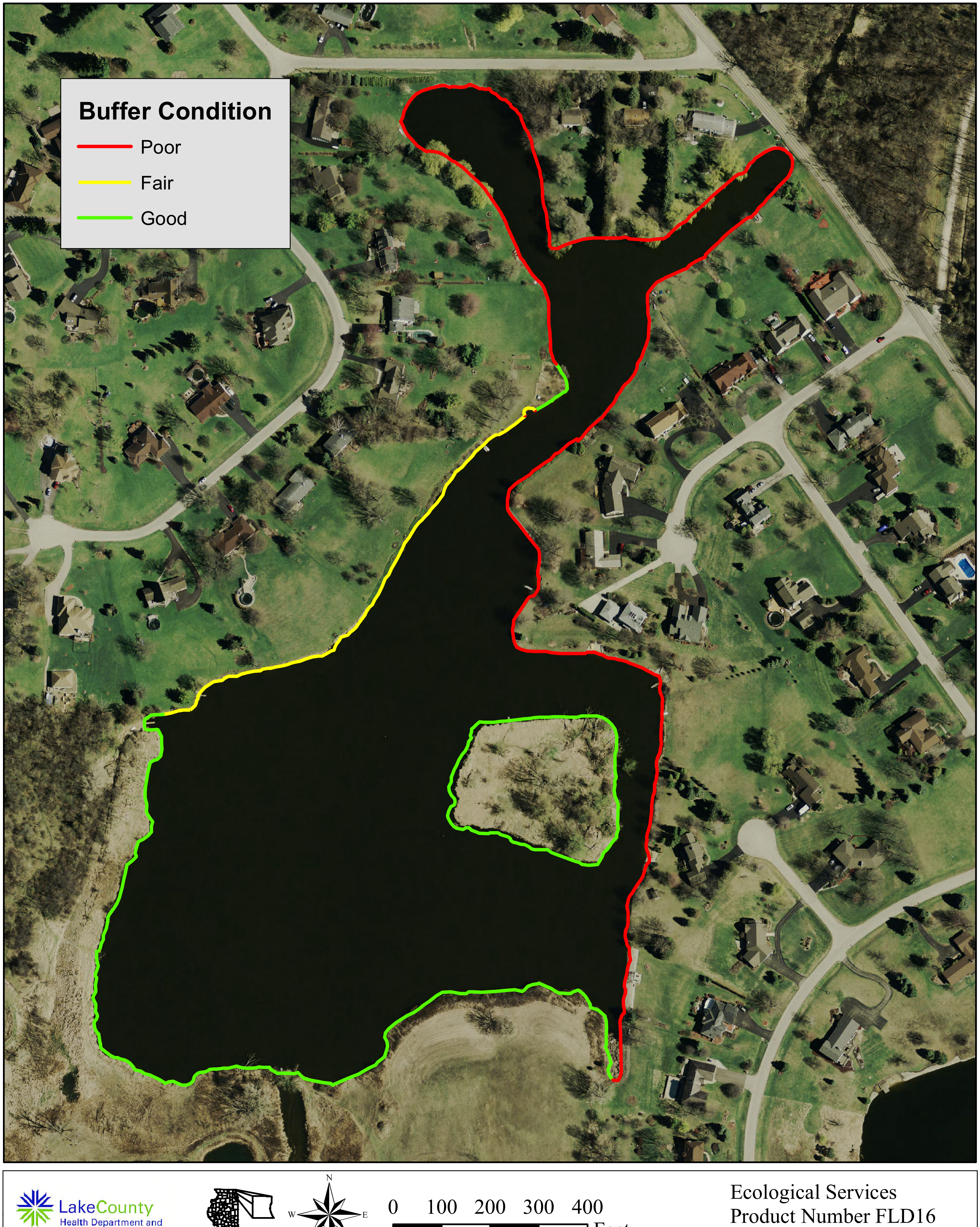




LakeCounty
Health Department and
Community Health Center

Ecological Services
Product Number FLD16
Revised 11/2016

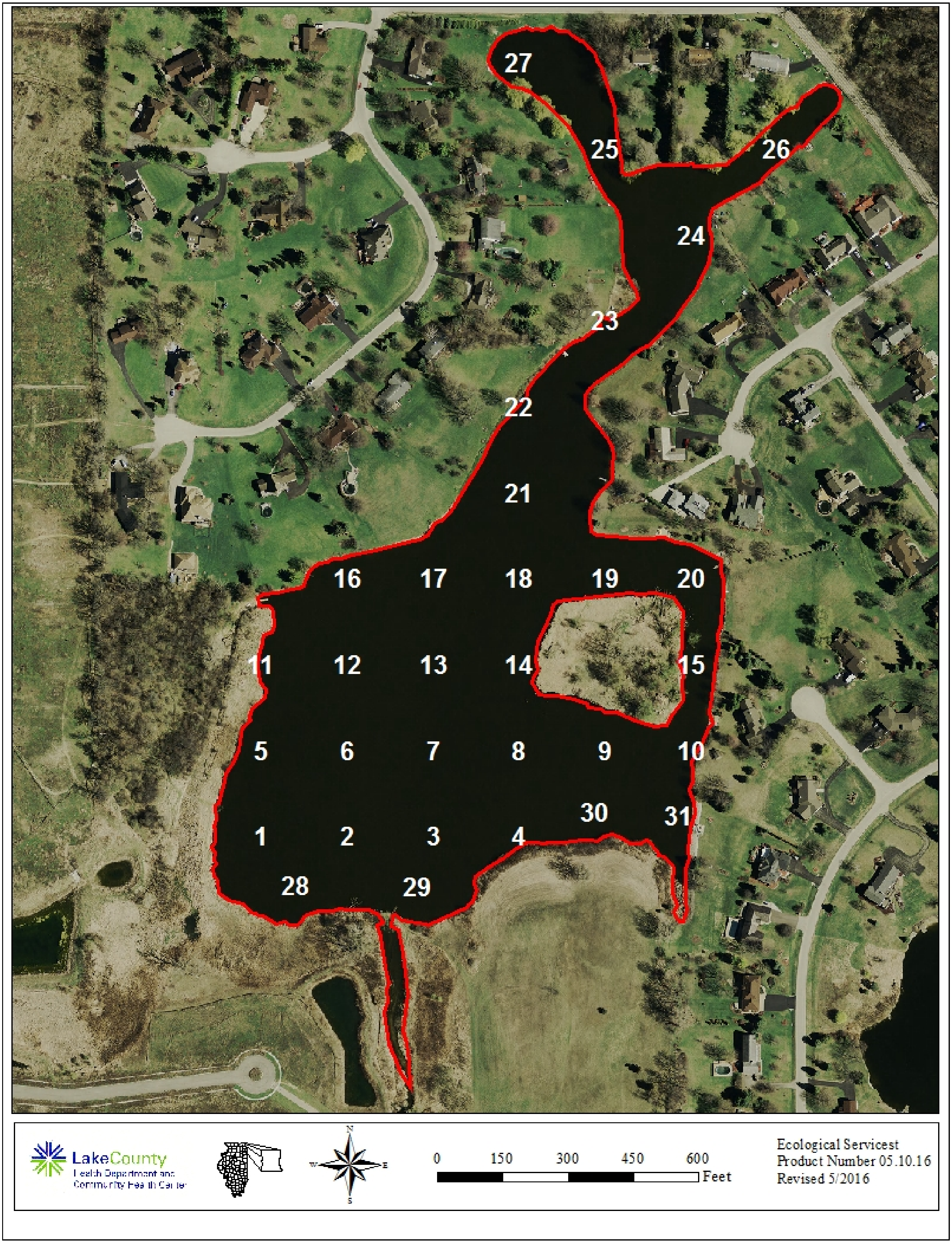
Fischer Lake Lakeshore Buffer Condtion 2016



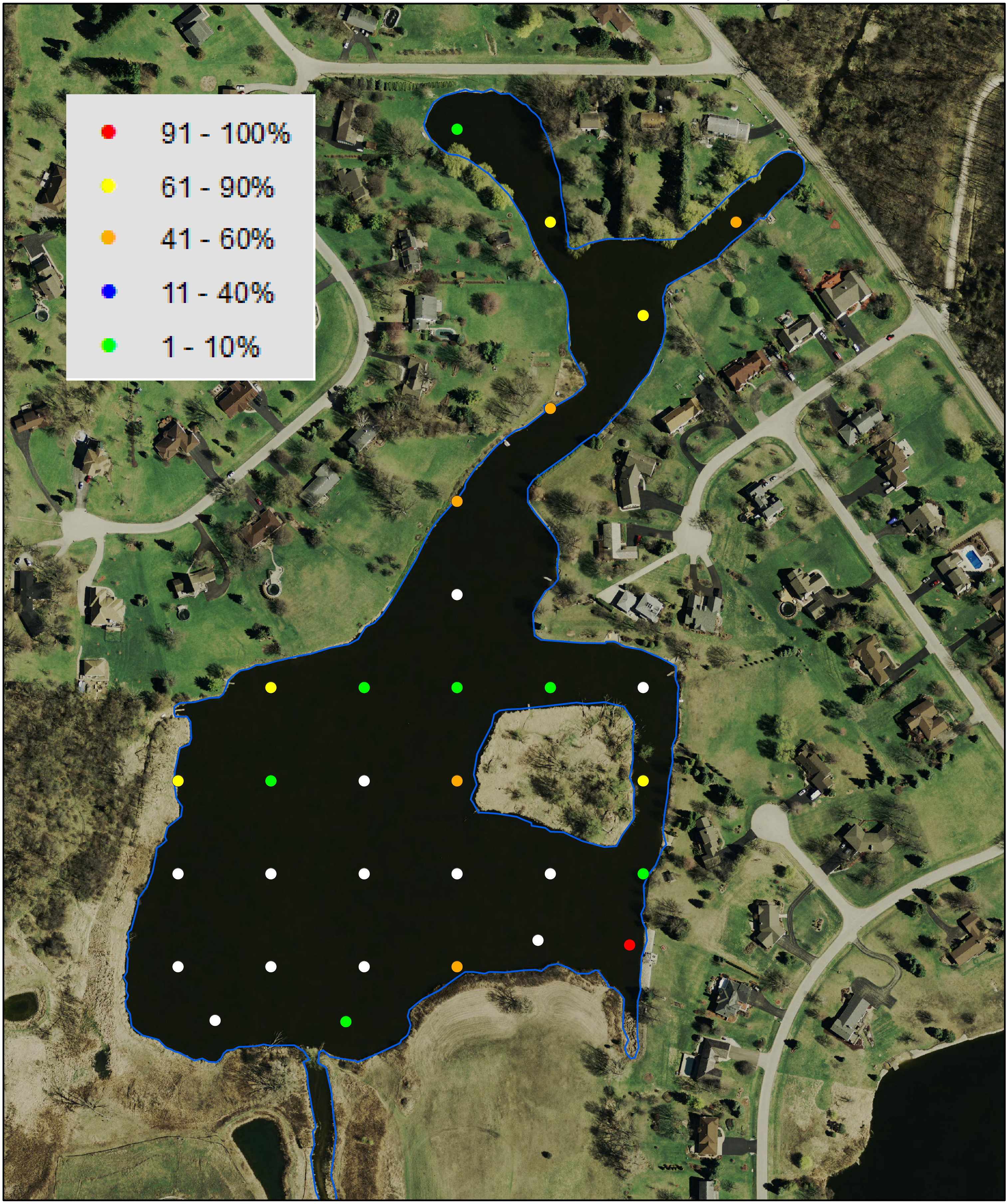
LakeCounty
Health Department and
Community Health Center

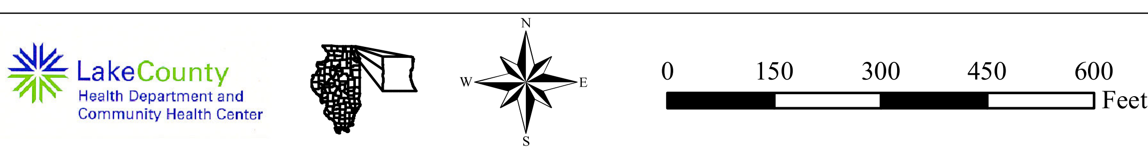
Ecological Services
Product Number FLD16
Revised 11/2016

Fischer Lake Plant Grid 2016



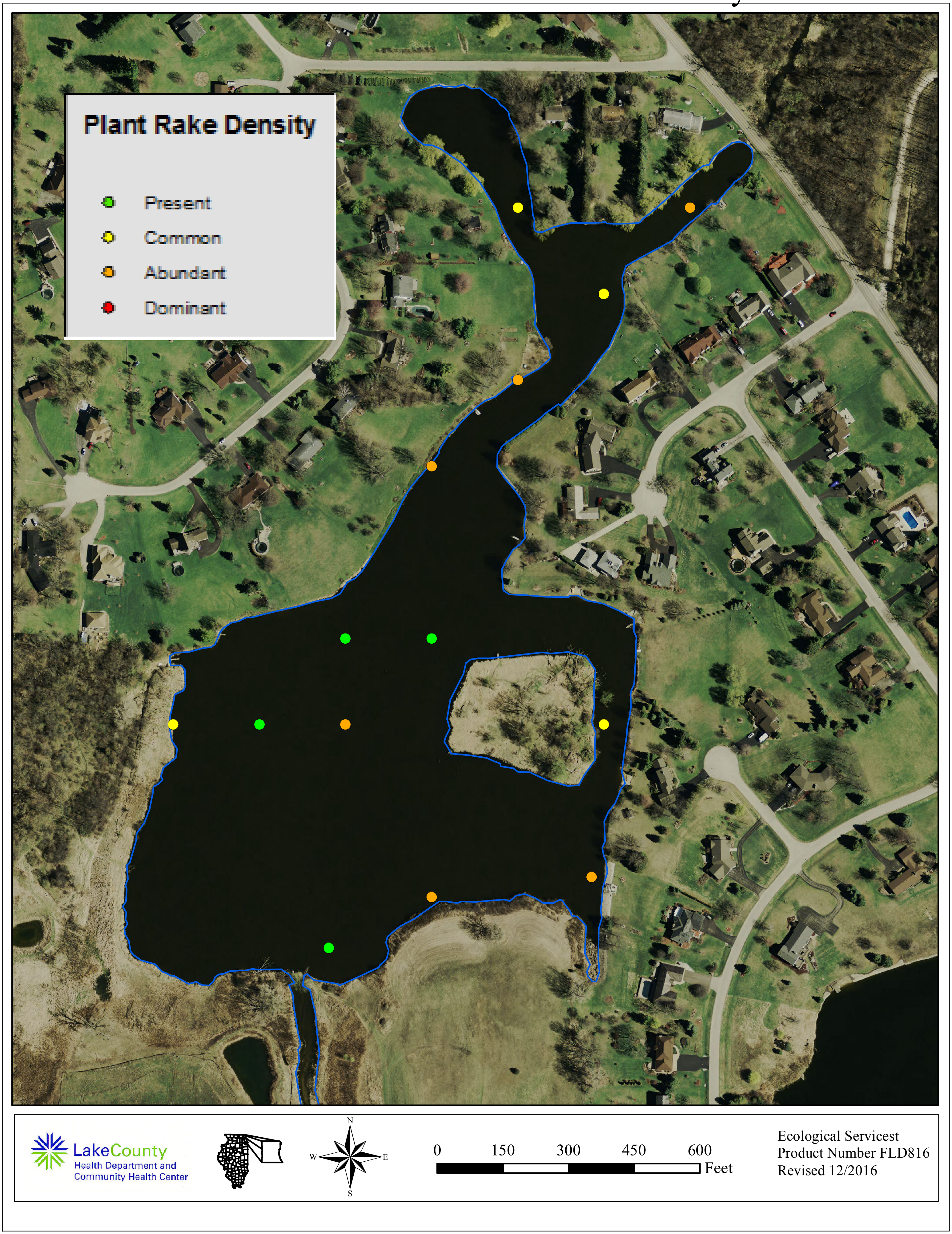
Fischer Lake Overall Plant Rake Density



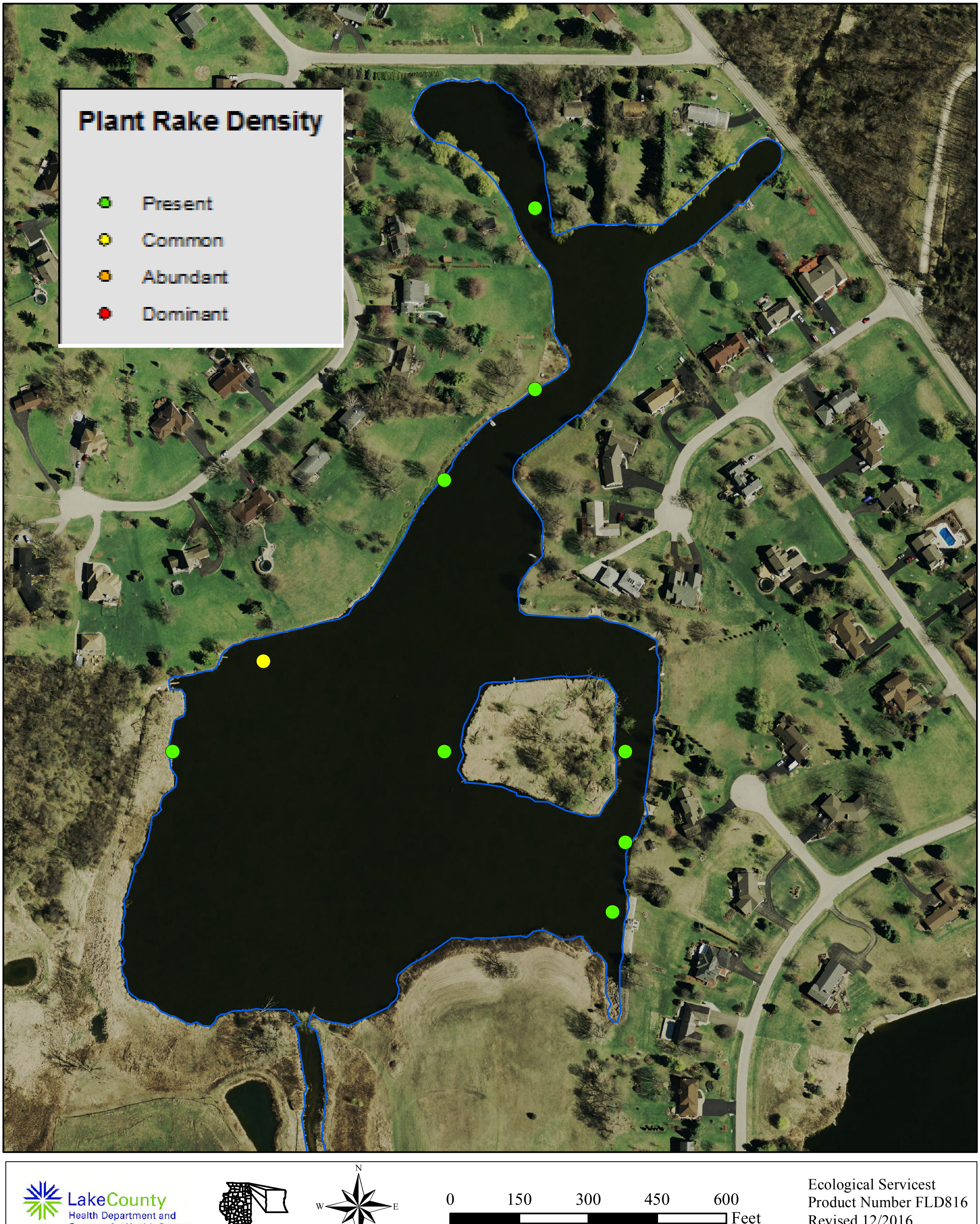


Ecological Servicest
Product Number FLD816
Revised 12/2016

Fischer Lake Coontail Plant Rake Density



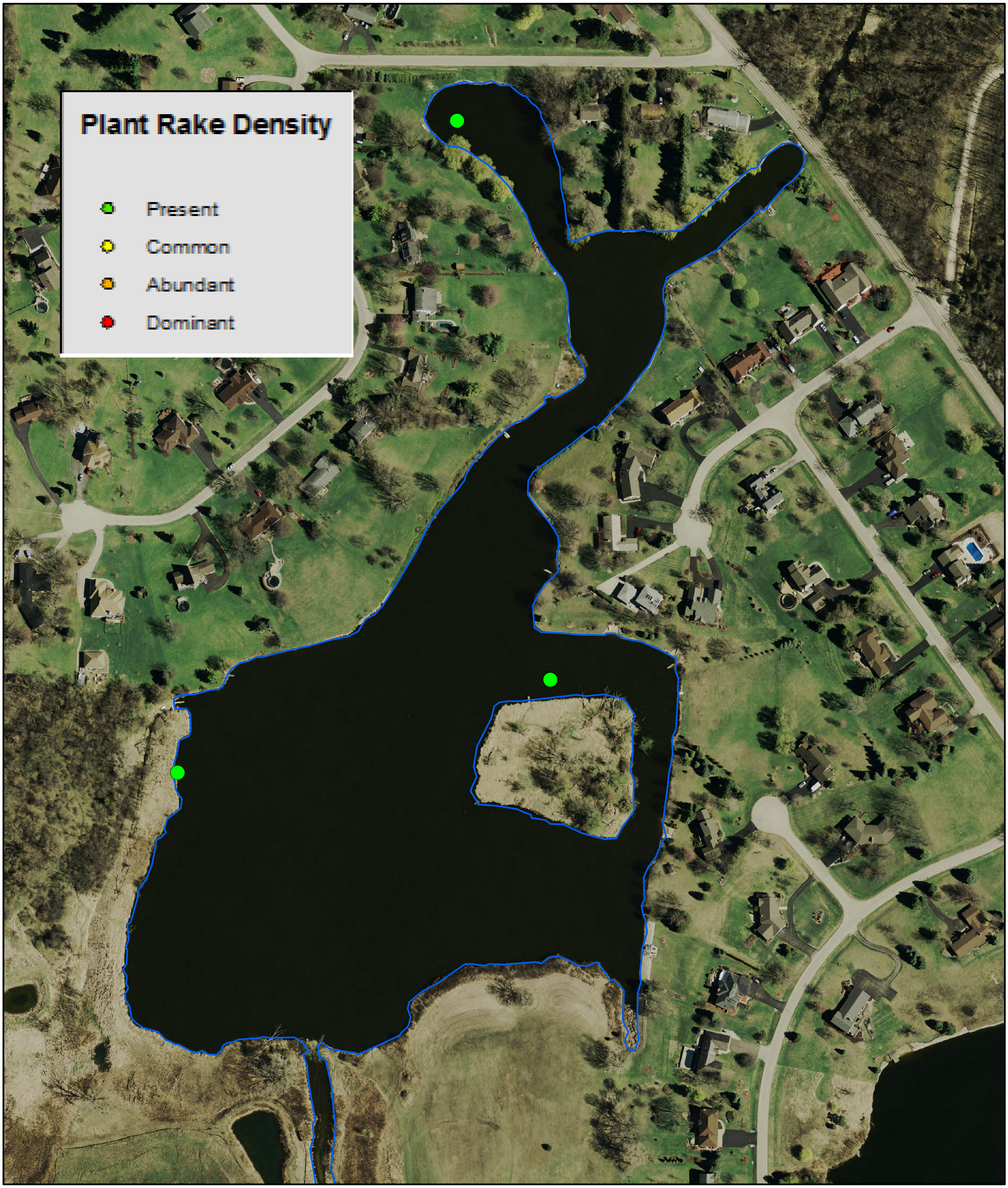
Fischer Lake Eurasian Watermilfoill Plant Rake Density 2016

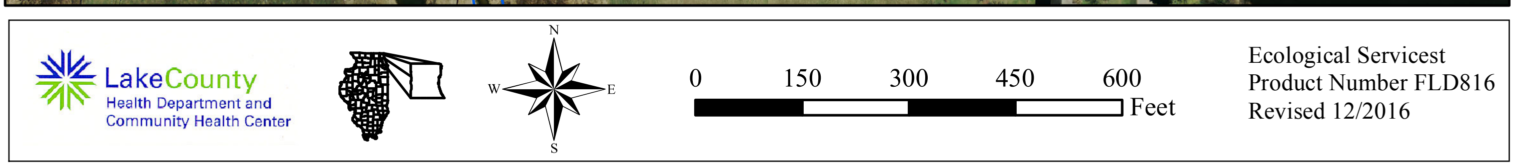


LakeCounty
Health Department and
Community Health Center

Ecological Servicest
Product Number FLD816
Revised 12/2016

Fischer Lake Curlyleaf Pondweed Plant Rake Density 2016





Appendix B:
Tables

Fischer Lake Water Quality Summary (2001, 2006, 2016)

2016	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	3	233	1.04	<0.100	0.088	0.044	<0.005	448	110	5.3	520	110	5.70	0.7970	8.34	11.0
14-Jun	3	232	1.46	0.104	<0.05	0.085	<0.005	459	113	8.4	544	145	4.85	0.8182	8.31	10.6
12-Jul	3	223	1.96	<0.100	<0.05	0.189	0.012	443	118	26.9	561	167	1.70	0.7861	8.29	5.7
16-Aug	3	173	2.82	<0.100	<0.05	0.175	0.009	404	124	25.0	513	175	0.50	0.7082	8.61	7.1
13-Sep	3	172	2.67	0.106	<0.05	0.199	0.007	408	119	17.0	494	149	0.75	0.7169	8.27	5.5
	Average	207	1.99	0.102[k]	0.0576[k]	0.138	.008[k]	432	117	16.5	526	149	2.70	0.7653	8.36	8.0

2006	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	3	197	1.49	0.172	0.213	0.084	0.007	NA	131	9.8	570	144	2.79	0.9110	7.90	8.1
20-Jun	3	205	1.80	<0.1	<0.05	0.126	0.018	NA	134	13.4	615	174	2.59	0.9120	8.18	12.0
18-Jul	3	201	3.09	<0.1	<0.05	0.309	0.077	NA	139	37.8	614	198	1.34	0.8780	8.21	9.8
15-Aug	3	163	3.48	<0.1	<0.05	0.371	0.058	NA	147	58.4	579	199	0.78	0.8100	8.90	8.6
19-Sep	3	163	2.29	<0.1	<0.05	0.249	0.128	NA	117	20.5	486	141	2.32	0.7510	9.11	9.8
	Average	186	2.43	0.172[k]	0.213[k]	0.228	0.058	NA	134	28.0	573	171	1.96	0.8524	8.46	9.7

2001	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	209	0.82	0.113	0.377	0.071	0.005	462	NA	13.5	487	157	3.22	0.7404	8.13	7.5
19-Jun	3	182	2.17	<0.1	<0.05	0.142	<0.005	402	NA	19.3	463	161	2.99	0.6715	8.37	8.6
24-Jul	3	163	2.61	<0.1	<0.05	0.225	0.034	398	NA	19.6	453	157	2.82	0.6266	8.70	9.2
21-Aug	3	178	2.21	<0.1	<0.05	0.253	0.088	426	NA	8.9	456	142	2.23	0.6432	8.35	6.9
18-Sep	3	188	2.85	0.339	<0.05	0.298	0.100	420	NA	15.7	438	158	2.36	0.6619	8.01	6.8
	Average	184	2.13	0.226[k]	0.377[k]	0.198	0.057[k]	422	NA	15.4	459	155	2.72	0.6687	8.31	7.8

Glossary

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L, calculated value
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH_3-N = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
NO_3-N = Nitrate nitrogen, mg/L	SECCHI = Secchi disk depth, ft.
TP = Total phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
SRP = Soluble reactive phosphorus, mg/L	DO = Dissolved oxygen, mg/L
Cl^- = Chloride, mg/L	

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

Fischer Lake Water Quality Summary (2001, 2006, 2016)

2016	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	6	236	1.04	<0.1	0.092	0.038	<0.005	NA	111	4.5	538	125	NA	0.7960	8.35	11.02
20-Jun	6	237	1.33	0.199	<0.05	0.071	0.008	NA	119	5.4	536	135	NA	0.8297	7.97	5.69
18-Jul	5	224	1.89	<0.1	<0.05	0.198	0.015	NA	118	23.6	550	160	NA	0.8050	7.90	0.82
15-Aug	6	172	2.85	<0.1	<0.05	0.174	<0.005	NA	120	27.0	491	141	NA	0.7100	8.57	6.22
19-Sep	6	177	2.78	<0.1	<0.05	0.194	0.005	MA	119	17.0	480	138	NA	0.7203	8.13	4.04
	Average	209	1.98	0.120[k]	0.06[k]	0.135	0.008[k]	NA	117	15.5	519	140	NA	0.7722	8.18	5.56

Fischer Lake Water Quality Summary (2001, 2006, 2016)

2006	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	6	197	1.46	0.169	0.202	0.066	0.006	NA	132	9.4	573	142	NA	0.9120	7.89	7.98
20-Jun	6	210	1.66	<0.1	<0.05	0.129	0.027	NA	135	10.7	602	170	NA	0.9180	8.10	7.95
18-Jul	6	205	2.88	<0.1	<0.05	0.336	0.117	NA	139	36.0	602	187	NA	0.8980	8.21	9.17
15-Aug	6	163	3.48	<0.1	<0.05	0.365	0.058	NA	146	60.0	579	195	NA	0.8130	8.78	6.31
19-Sep	6	163	2.20	<0.1	<0.05	0.265	0.133	NA	117	21.6	495	144	NA	0.7510	9.12	9.74
	Average	188	2.34	0.169^k	0.202^k	0.232	0.068	NA	134	27.5	570	168	NA	0.8584	8.42	8.23

2001	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	7	211	0.96	0.205	0.325	0.093	0.007	458	NA	18.0	507	177	NA	0.7496	7.83	4.6
19-Jun	7	185	1.14	<0.1	<0.05	0.096	<0.005	422	NA	11.0	447	145	NA	0.6803	8.16	5.7
24-Jul	7	194	2.71	1.080	<0.05	0.520	0.407	400	NA	13.0	451	141	NA	0.6973	7.11	0.1
21-Aug	8	177	1.84	0.112	<0.05	0.207	0.087	416	NA	7.8	455	143	NA	0.6562	7.89	2.3
18-Sep	7	188	2.13	0.372	<0.05	0.262	0.098	412	NA	13.0	416	147	NA	0.6655	7.84	5.0
	Average	191	1.76	0.442^k	0.325^k	0.236	0.150^k	422	NA	12.6	455	151	NA	0.6898	7.77	3.6

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L
TDS = Total dissolved solids, mg/L, calculated value
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Fischer Lake Multiparameter Data 2016

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA RFU
5/17/2016	0.41	0.5	15.148	10.89	108.6	0.7972	8.29	0.43
5/17/2016	1.03	1	15.181	10.9	108.8	0.7971	8.33	0.38
5/17/2016	2.11	2	15.169	10.95	109.2	0.7968	8.34	0.38
5/17/2016	2.94	3	15.158	10.97	109.4	0.7970	8.34	0.35
5/17/2016	3.91	4	15.12	10.99	109.6	0.7964	8.35	0.36
5/17/2016	5.03	5	15.122	11.02	109.9	0.7963	8.35	0.43
5/17/2016	6.01	6	15.107	11.02	109.8	0.796	8.35	0.35
5/17/2016	7.00	7	15.074	10.99	109.4	0.7958	8.35	0.43
5/17/2016	7.54	8	14.839	10.62	105.2	0.7972	8.3	0.87

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA RFU
6/14/2016	0.58	0.5	24.375	10.75	128.8	818.9	8.3	0.6
6/14/2016	1.02	1	24.088	10.58	126.2	818.9	8.31	0.68
6/14/2016	2.06	2	23.95	10.81	128.5	818.0	8.32	0.8
6/14/2016	3.02	3	23.909	10.56	125.5	818.2	8.31	0.69
6/14/2016	4.09	4	23.767	9.96	118.0	819.3	8.27	0.5
6/14/2016	5.04	5	23.414	7.82	92.1	824.2	8.13	0.27
6/14/2016	6.18	6	22.995	5.69	66.5	829.7	7.97	0.09
6/14/2016	7.16	7	22.416	3.19	36.8	835.6	7.75	0.07
6/14/2016	8.07	8	22.211	2.33	26.8	836.5	7.66	0.1
6/14/2016	8.83	9	22.088	2.02	23.2	837.1	7.55	0.11

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA RFU
7/12/2016	0.52	0.5	26.473	6.87	85.5	0.7839	8.37	2.65
7/12/2016	0.91	1	26.456	6.68	83.1	0.7843	8.38	2.65
7/12/2016	2.07	2	26.359	5.54	68.8	0.7868	8.32	2.07
7/12/2016	2.94	3	26.406	5.74	71.5	0.7861	8.29	2.32
7/12/2016	3.82	4	26.288	3.88	48.2	0.7898	8.18	1.9
7/12/2016	5.00	5	25.886	0.82	10.4	0.8050	7.9	2.82
7/12/2016	6.00	6	25.359	0.14	1.7	0.8064	7.79	0.61
7/12/2016	7.06	7	23.728	0.08	0.9	0.8343	7.4	0.22
7/12/2016	8.21	8	22.589	0.08	0.9	0.8668	7.12	0.23

Fischer Lake Multiparameter Data 2016

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA RFU
8/16/2016	0.59	0.5	26.613	7.78	97.1	0.707	8.64	12.78
8/16/2016	1.02	1	26.62	7.92	98.9	0.7069	8.65	12.62
8/16/2016	2.06	2	26.615	7.36	91.9	0.7079	8.62	12.37
8/16/2016	2.99	3	26.611	7.06	88.2	0.7082	8.61	12.26
8/16/2016	3.98	4	26.606	6.97	87	0.7085	8.6	12.23
8/16/2016	5.09	5	26.596	6.76	84.4	0.7088	8.6	11.85
8/16/2016	6.03	6	26.588	6.22	77.6	0.71	8.57	11.78
8/16/2016	7.15	7	26.158	2.11	26.2	0.7344	8.18	9.99
8/16/2016	8.04	8	25.057	0.23	2.8	0.7856	7.55	8.58

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA RFU
9/13/2016	0.58	0.5	23.256	6.73	79	717.7	8.3	8.46
9/13/2016	1.02	1	22.914	6.52	76.1	715.5	8.31	8.78
9/13/2016	1.91	2	22.843	5.99	69.7	716.2	8.3	8.29
9/13/2016	3.04	3	22.808	5.48	63.7	716.9	8.27	8.12
9/13/2016	3.97	4	22.771	5.16	60	717.4	8.24	7.99
9/13/2016	5.02	5	22.757	4.66	54.2	718.8	8.2	7.78
9/13/2016	6.03	6	22.756	4.04	47	720.3	8.13	7.43
9/13/2016	7.00	7	22.741	3.9	45.3	721.3	8.11	7.63
9/13/2016	8.02	8	22.561	3	34.7	727	8.03	7.33
9/13/2016	8.62	8.5	22.545	2.77	32.1	730	7.95	7.88

Fischer Lake Landuse 2016

Land Use	Acreage	% of Total
Agricultural	1936.89	47.0%
Disturbed Land	165.91	4.0%
Forest and Grassland	302.84	7.4%
Government and Institutional	139.79	3.4%
Industrial	56.22	1.4%
Multi Family	38.97	0.9%
Public and Private Open Space	249.34	6.1%
Retail/Commercial	83.46	2.0%
Single Family	350.82	8.5%
Transportation	199.10	4.8%
Utility and Waste Facilities	26.13	0.6%
Water	181.08	4.4%
Wetlands	387.25	9.4%
Total Acres	**4117.81**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	1936.89	0.05	266.3	13.7%
Disturbed Land	165.91	0.05	22.8	1.2%
Forest and Grassland	302.84	0.05	41.6	2.1%
Government and Institutional	139.79	0.85	326.8	16.8%
Industrial	56.22	0.85	131.4	6.7%
Multi Family	38.97	0.30	32.2	1.6%
Public and Private Open Space	249.34	0.15	102.9	5.3%
Retail/Commercial	83.46	0.85	195.1	10.0%
Single Family	350.82	0.30	289.4	14.9%
Transportation	199.10	0.85	465.4	23.9%
Utility and Waste Facilities	26.13	0.30	21.6	1.1%
Water	181.08	0.00	0.0	0.0%
Wetlands	387.25	0.05	53.2	2.7%
TOTAL	**4117.81**		**1948.7**	**100.0%**

Lake volume	**128.5**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.07**	**years**
	24.07	**days**

Table 1: Fischer Lake Shoreline Erosion Condition 2016

Reach	No Erosion		Slight Erosion		Moderate Erosion	
	ft.	%	ft.	%	ft.	%
FLD01	428.3	58%	308.0	42%	0.0	0%
FLD02	0.0	0%	36.2	100%	0.0	0%
FLD03	468.6	47%	492.7	49%	0.0	0%
FLD04	955.8	100%	0.0	0%	0.0	0%
FLD05	471.3	41%	256.6	22%	273.2	24%
FLD06	414.0	32%	372.9	29%	513.0	39%
FLD07	28.0	4%	718.4	96%	0.0	0%
FLD08	0.0	0%	175.9	39%	277.4	61%
FLD09	362.9	66%	107.3	19%	82.0	15%
FLD10	382.1	50%	182.7	24%	198.2	26%
FLD11	0.0	0%	910.4	79%	242.3	21%
Total	3510.9	40%	3560.9	40%	1586.0	18%

Table 2: Fischer Lake Lakeshore Buffer Condition 2016

Reach	Poor		Fair		Good	
	ft.	%	ft.	%	ft.	%
FLD01	736.2	100%	0.0	0%	0.0	0%
FLD02	36.2	100%	0.0	0%	0.0	0%
FLD03	1000.7	100%	0.0	0%	0.0	0%
FLD04	0.0	0%	0.0	0%	955.8	100%
FLD05	0.5	0%	0.0	0%	1160.5	100%
FLD06	31.0	2%	1067.0	82%	201.9	16%
FLD07	746.3	100%	0.0	0%	0.0	0%
FLD08	453.3	100%	0.0	0%	0.0	0%
FLD09	552.1	100%	0.0	0%	0.0	0%
FLD10	762.9	100%	0.0	0%	0.0	0%
FLD11	0.0	0%	0.0	0%	1152.7	100%
Total	4319.3	49%	1067.0	12%	3470.8	39%

Severe Erosion		Total	Lateral Recession Rate
ft.	%	ft	ft/yr
0.0	0%	736.2	0.02
0.0	0%	36.2	0.03
39.4	4%	1000.7	0.03
0.0	0%	955.8	0.01
159.9	14%	1161.0	0.09
0.0	0%	1299.9	0.05
0.0	0%	746.3	0.02
0.0	0%	453.3	0.07
0.0	0%	552.1	0.03
0.0	0%	762.9	0.03
0.0	0%	1152.7	0.04
199.3	2%	8857.2	

Total
ft.
736.2
36.2
1000.7
955.8
1161.0
1299.9
746.3
453.3
552.1
762.9
1152.7
8857.2

Aquatic plants found at 18 sampling sites on Fischer Lake in August 2016.
The maximum depth that plants were found was 5.2 ft.

Plant Density	American Pondweed	Coontail	Curlyleaf Pondweed	Duckweed	Elodea
Absent	30	17	28	29	28
Present	1	4	3	2	3
Common	0	4	0	0	0
Abundant	0	6	0	0	0
Dominant	0	0	0	0	0
% Plant Occurrence	3.2	45.2	9.7	6.5	9.7
Total Sites	31	31	31	31	31

Plant Density	Eurasian Watermilfoil	Sago Pondweed	Leafy Pondweed	Watermeal
Absent	22	28	29	29
Present	8	1	2	2
Common	1	2	0	0
Abundant	0	0	0	0
Dominant	0	0	0	0
% Plant Occurance	29.0	9.7	6.5	6.5
Total Sites	31	31	31	31

Distribution of Rake Density across all sampling sites.

Rake Density (cover	# of Sites	% of Sites
No Plants	13	41.9
>0-10%	7	22.6
10-40%	5	16.1
40-60%	5	16.1
60-90%	1	3.2
>90%	0	0.0
Total Sites with Plants	18	58.1
Total # Sites	31	100.0

Lake County average Floristic Quality Index (FQI) ranking 2000-2016.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	37.4	38.9
2	East Loon Lake	34.7	36.1
3	Cranberry Lake	29.7	29.7
4	Deep Lake	29.7	31.2
5	Round Lake Marsh North	29.1	29.9
6	West Loon Lake	27.1	29.5
7	Sullivan Lake	26.9	28.5
8	Bangs Lake	26.2	27.8
9	Little Silver Lake	25.2	26.7
10	Third Lake	25.1	22.5
11	Fourth Lake	24.7	27.1
12	Indpendence Grove	24.4	26.8
13	Sun Lake	24.3	26.1
14	Redwing Slough	24.0	25.8
15	Schreiber Lake	23.9	24.8
16	Lakewood Marsh	23.8	24.7
17	Sterling Lake	23.6	25.4
18	Deer Lake	23.5	24.4
19	Round Lake	23.5	25.9
20	Pistakee Lake	23.5	25.2
21	Lake Marie	23.5	25.2
22	Lake of the Hollow	23.0	24.8
23	Nippersink Lake (Fox Chain)	22.4	23.2
24	Countryside Glen Lake	21.9	22.8
25	Grass Lake	21.5	22.2
26	Davis Lake	21.4	21.4
27	Timber Lake (North)	20.9	23.4
28	Lake Catherine	20.8	21.8
29	Cross Lake	20.7	18.7
30	ADID 203	20.5	20.5
31	Broberg Marsh	20.5	21.4
32	McGreal Lake	20.2	22.1
33	Fox Lake	20.2	21.2
34	Honey Lake	20.0	20.0
35	Lake Barrington	19.9	21.8
36	Lake Kathryn	19.6	20.7
37	Druce Lake	19.1	21.8
38	Turner Lake	18.6	21.2
39	Salem Lake	18.5	20.2
40	Duck Lake	18.3	19.2
41	Wooster Lake	18.0	20.1
42	Lake Helen	18.0	18.0
43	Old Oak Lake	18.0	19.1
44	Lake Minear	18.0	20.1
45	Potomac Lake	17.8	17.8
46	Lake Zurich	17.7	18.9
47	Redhead Lake	17.7	18.7
48	Long Lake	17.7	15.8
49	Hendrick Lake	17.7	17.7
50	Rollins Savannah 2	17.7	17.7
51	Grandwood Park Lake	17.2	19.0
52	Seven Acre Lake	17.0	15.5
53	Lake Miltmore	16.8	18.7
54	Petite Lake	16.8	18.7
55	Channel Lake	16.8	18.7
56	McDonald Lake 1	16.7	17.7
57	Highland Lake	16.7	18.9
58	Almond Marsh	16.3	17.3

Lake County average Floristic Quality Index (FQI) ranking 2000-2016.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
59	Owens Lake	16.3	17.3
60	Windward Lake	16.3	17.6
61	Butler Lake	16.1	18.1
62	Grays Lake	16.1	16.1
63	White Lake	16.0	17.0
64	Dunns Lake	15.9	17.0
65	Dog Bone Lake	15.7	15.7
66	Osprey Lake	15.5	17.3
67	Heron Pond	15.1	15.1
68	Ames Pit	15.1	17.6
69	North Churchill Lake	15.0	15.0
70	Hastings Lake	15.0	17.0
71	Forest Lake	14.8	15.9
72	Dog Training Pond	14.7	15.9
73	Summerhill Estates Lake	14.5	15.5
74	Grand Ave Marsh	14.3	16.3
75	Nippersink Lake	14.3	16.3
76	Taylor Lake	14.3	16.3
77	Manning's Slough	14.1	16.3
78	Tower Lake	14.0	14.0
79	Dugdale Lake	14.0	15.1
80	Eagle Lake (S1)	14.0	15.1
81	Crooked Lake	14.0	16.0
82	Spring Lake	14.0	15.2
83	Lake Matthews	13.9	15.5
84	Longview Meadow Lake	13.9	13.9
85	Fischer Lake	13.6	14.7
86	Bishop Lake	13.4	15.0
87	Mary Lee Lake	13.1	15.1
88	Old School Lake	13.1	15.1
89	Lake Tranquility (S1)	12.6	12.6
90	Buffalo Creek Reservoir 1	12.5	11.4
91	Buffalo Creek Reservoir 2	12.5	11.4
92	McDonald Lake 2	12.5	12.5
93	Rollins Savannah 1	12.5	12.5
94	Stone Quarry Lake	12.5	12.5
95	Kemper Lake 1	12.2	13.4
96	Pond-A-Rudy	12.1	12.1
97	Stockholm Lake	12.1	13.5
98	Lake Leo	12.1	14.3
99	Lambs Farm Lake	12.1	14.3
100	Bresen Lake	12.0	13.9
101	Grassy Lake	12.0	12.0
102	Flint Lake Oulet	11.8	13.0
103	Albert Lake	11.5	10.3
104	Rivershire Pond 2	11.5	13.3
105	Hook Lake	11.3	13.4
106	Briarcrest Pond	11.2	12.5
107	Lake Naomi	11.2	12.5
108	Pulaski Pond	11.2	12.5
109	Lake Napa Suwe	11.0	11.0
110	Redwing Marsh	11.0	11.0
111	West Meadow Lake	11.0	11.0
112	Nielsen Pond	10.7	12.0
113	Lake Holloway	10.6	10.6
114	Sylvan Lake	10.6	10.6
115	Echo Lake	10.4	10.4
116	Gages Lake	10.2	12.5

Lake County average Floristic Quality Index (FQI) ranking 2000-2016.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
117	College Trail Lake	10.0	10.0
118	Valley Lake	9.9	9.9
119	Werhane Lake	9.8	12.0
120	Fish Lake	9.6	10.6
121	Lake Carina	9.5	12.5
122	Columbus Park Lake	9.2	9.2
123	Lake Lakeland Estates	9.2	9.2
124	Waterford Lake	9.2	9.2
125	Bluff Lake	9.1	11.0
126	Lake Fairfield	9.0	10.4
127	Des Plaines Lake	8.6	9.9
128	Antioch Lake	8.5	8.5
129	Loch Lomond	8.5	8.5
130	Lake Fairview	8.5	6.9
131	Timber Lake (South)	8.5	6.9
132	East Meadow Lake	8.5	8.5
133	South Churchill Lake	8.5	8.5
134	Kemper Lake 2	8.5	9.8
135	Lake Christa	8.5	9.8
136	Lake Farmington	8.5	9.8
137	Lucy Lake	8.5	9.8
138	Lake Louise	8.4	8.4
139	Bittersweet Golf Course #13	8.1	8.1
140	Lake Linden	8.0	8.0
141	Sand Lake	8.0	10.4
142	Countryside Lake	7.7	11.5
143	Fairfield Marsh	7.5	8.7
144	Lake Eleanor	7.5	8.7
145	Banana Pond	7.5	9.2
146	Slocum Lake	7.1	5.8
147	Lucky Lake	7.0	7.0
148	North Tower Lake	7.0	7.0
149	Lake Forest Pond	6.9	8.5
150	Ozaukee Lake	6.7	8.7
151	Leisure Lake	6.4	9.0
152	Peterson Pond	6.0	8.5
153	Little Bear Lake	5.8	7.5
154	Deer Lake Meadow Lake	5.2	6.4
155	ADID 127	5.0	5.0
156	Island Lake	5.0	5.0
157	Liberty Lake	5.0	5.0
158	Oak Hills Lake	5.0	5.0
159	Slough Lake	5.0	5.0
160	International Mining and Chemical Lake	5.0	7.1
161	Lochanora Lake	5.0	5.0
162	Diamond Lake	3.7	5.5
163	Lake Charles	3.7	5.5
164	Big Bear Lake	3.5	5.0
165	Sand Pond (IDNR)	3.5	5.0
166	Harvey Lake	3.3	5.0
167	Half Day Pit	2.9	5.0
168	Hidden Lake	0.0	0.0
169	St. Mary's Lake	0.0	0.0
170	Willow Lake	0.0	0.0
171	Woodland Lake	0.0	0.0
	Mean	**13.9**	**14.9**
	Median	**13.4**	**14.7**

Lake County average TSI phosphorus (TSIp) ranking 2000-2016.

RANK	LAKE NAME	TP AVE	TSIp
1	Sterling Lake	0.0110	38.73
2	Lake Carina	0.0110	38.73
3	Indpendence Grove	0.0130	41.14
4	Cedar Lake	0.0130	41.14
5	Druce Lake	0.0140	42.21
6	Windward Lake	0.0160	44.13
7	Lake Minear	0.0164	44.49
8	Sand Pond (IDNR)	0.0165	44.57
9	West Loon	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Ames Pit	0.0190	46.61
12	Banana Pond	0.0200	47.35
13	Gages Lake	0.0200	47.35
14	Lake Kathryn	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.05
17	Timber Lake (North)	0.0210	48.05
18	Lake Zurich	0.0210	48.05
19	Cross Lake	0.0216	48.46
20	Dog Training Pond	0.0220	48.72
21	Sun Lake	0.0220	48.72
22	Deep Lake	0.0230	49.36
23	Lake of the Hollow	0.0230	49.36
24	Round Lake	0.0230	49.36
25	Stone Quarry Lake	0.0230	49.36
26	Bangs Lake	0.0260	51.13
27	Lake Leo	0.0260	51.13
28	Lake Barrington	0.0270	51.68
29	Cranberry Lake	0.0270	51.68
30	Dugdale Lake	0.0270	51.68
31	Peterson Pond	0.0270	51.68
32	Little Silver Lake	0.0280	52.20
33	Wooster Lake	0.0290	52.71
34	Lambs Farm Lake	0.0310	53.67
35	Old School Lake	0.0310	53.67
36	Grays Lake	0.0310	53.67
37	Harvey Lake	0.0320	54.13
38	Butler Lake	0.0324	54.31
39	Hendrick Lake	0.0340	55.00
40	Fourth Lake	0.0360	55.82
41	Sullivan Lake	0.0370	56.22
42	Sand Lake	0.0380	56.60
43	Third Lake	0.0384	56.77
44	Diamond Lake	0.0390	56.98
45	East Loon	0.0400	57.34
46	Schreiber Lake	0.0400	57.34
47	Waterford Lake	0.0400	57.34
48	Hook Lake	0.0410	57.70
49	Lake Tranquility (S1)	0.0412	57.77
50	Nielsen Pond	0.0450	59.04
51	Seven Acre Lake	0.0460	59.36

Lake County average TSI phosphorus (TSIp) ranking 2000-2016.

RANK	LAKE NAME	TP AVE	TSIp
52	Turner Lake	0.0460	59.36
53	Willow Lake	0.0460	59.36
54	East Meadow Lake	0.0480	59.97
55	Lucky Lake	0.0480	59.97
56	Old Oak Lake	0.0490	60.27
57	College Trail Lake	0.0500	60.56
58	Summerhill Estates Lake	0.0514	60.96
59	Hastings Lake	0.0520	61.13
60	West Meadow Lake	0.0530	61.40
61	Lucy Lake	0.0550	61.94
62	Lake Linden	0.0570	62.45
63	Lake Christa	0.0580	62.70
64	Owens Lake	0.0580	62.70
65	Briarcrest Pond	0.0580	62.70
66	Honey Lake	0.0586	62.85
67	Redhead Lake	0.0608	63.38
68	St. Mary's Lake	0.0608	63.38
69	Duck Lake	0.0610	63.43
70	Lake Lakeland Estates	0.0620	63.66
71	Lake Naomi	0.0620	63.66
72	Lake Catherine	0.0620	63.66
73	Liberty Lake	0.0630	63.89
74	North Tower Lake	0.0630	63.89
75	Werhane Lake	0.0630	63.89
76	Countryside Glen Lake	0.0640	64.12
77	Davis Lake	0.0650	64.34
78	Leisure Lake	0.0650	64.34
79	Channel Lake	0.0680	65.00
80	Buffalo Creek Reservoir 1	0.0680	65.00
81	Mary Lee Lake	0.0680	65.00
82	Little Bear Lake	0.0680	65.00
83	Crooked Lake	0.0710	65.62
84	Timber Lake (South)	0.0720	65.82
85	Lake Helen	0.0720	65.82
86	Grandwood Park Lake	0.0720	65.82
87	ADID 203	0.0730	66.02
88	Fish Lake	0.0730	66.02
89	Broberg Marsh	0.0780	66.97
90	Echo Lake	0.0790	67.16
91	Countryside Lake	0.0800	67.34
92	Lake Nippersink	0.0800	67.34
93	Woodland Lake	0.0800	67.34
94	Redwing Slough	0.0822	67.73
95	Tower Lake	0.0830	67.87
96	Antioch Lake	0.0850	68.21
97	Potomac Lake	0.0850	68.21
98	White Lake	0.0862	68.42
99	Grand Ave Marsh	0.0870	68.55
100	North Churchill Lake	0.0870	68.55
101	McDonald Lake 1	0.0880	68.71
102	Pistakee Lake	0.0880	68.71

Lake County average TSI phosphorus (TSIp) ranking 2000-2016.

RANK	LAKE NAME	TP AVE	TSIp
103	Lake Fairview	0.0890	68.88
104	Rivershire Pond 2	0.0900	69.04
105	South Churchill Lake	0.0900	69.04
106	McGreal Lake	0.0910	69.20
107	Lake Charles	0.0930	69.51
108	Deer Lake	0.0940	69.66
109	Eagle Lake (S1)	0.0950	69.82
110	International Mine and Chemical Lake	0.0950	69.82
111	Valley Lake	0.0950	69.82
112	Buffalo Creek Reservoir 2	0.0960	69.97
113	Big Bear Lake	0.0960	69.97
114	Fox Lake	0.1000	70.56
115	Nippersink Lake - LCFP	0.1000	70.56
116	Sylvan Lake	0.1000	70.56
117	Petite Lake	0.1020	70.84
118	Longview Meadow Lake	0.1020	70.84
119	Lake Marie	0.1030	70.98
120	Dunn's Lake	0.1070	71.53
121	Lake Forest Pond	0.1070	71.53
122	Long Lake	0.1070	71.53
123	Grass Lake	0.1090	71.80
124	Des Plaines Lake	0.1090	71.80
125	Spring Lake	0.1100	71.93
126	Kemper 2	0.1100	71.93
127	Bittersweet Golf Course #13	0.1100	71.93
128	Osprey Lake	0.1110	72.06
129	Bluff Lake	0.1120	72.19
130	Middlefork Savannah Outlet 1	0.1120	72.19
131	Lochanora Lake	0.1120	72.19
132	Round Lake Marsh North	0.1130	72.32
133	Deer Lake Meadow Lake	0.1160	72.70
134	Lake Matthews	0.1180	72.94
135	Taylor Lake	0.1180	72.94
136	Island Lake	0.1210	73.31
137	Columbus Park Lake	0.1230	73.54
138	Lake Holloway	0.1320	74.56
139	Fischer Lake	0.1380	75.20
140	Slocum Lake	0.1500	76.40
141	Lakewood Marsh	0.1510	76.50
142	Pond-A-Rudy	0.1510	76.50
143	Forest Lake	0.1540	76.78
144	Bresen Lake	0.1580	77.15
145	Middlefork Savannah Outlet 2	0.1590	77.24
146	Grassy Lake	0.1610	77.42
147	Salem Lake	0.1650	77.78
148	Half Day Pit	0.1690	78.12
149	Lake Louise	0.1810	79.11
150	Lake Eleanor	0.1810	79.11
151	Lake Farmington	0.1850	79.43
152	ADID 127	0.1890	79.74

Lake County average TSI phosphorus (TSIp) ranking 2000-2016.

RANK	LAKE NAME	TP AVE	TSIp
153	Lake Napa Suwe	0.1940	80.11
154	Loch Lomond	0.1960	80.26
155	Patski Pond	0.1970	80.33
156	Dog Bone Lake	0.1990	80.48
157	Redwing Marsh	0.2070	81.05
158	Stockholm Lake	0.2082	81.13
159	Bishop Lake	0.2160	81.66
160	Ozaukee Lake	0.2200	81.93
161	Kemper 1	0.2220	82.06
162	Hidden Lake	0.2240	82.19
163	McDonald Lake 2	0.2250	82.25
164	Oak Hills Lake	0.2790	85.35
165	Heron Pond	0.2990	86.35
166	Rollins Savannah 1	0.3070	86.73
167	Fairfield Marsh	0.3260	87.60
168	ADID 182	0.3280	87.69
169	Manning's Slough	0.3820	89.88
170	Slough Lake	0.3860	90.03
171	Rasmussen Lake	0.4860	93.36
172	Albert Lake, Site II, outflow	0.4950	93.62
173	Flint Lake Outlet	0.5000	93.76
174	Rollins Savannah 2	0.5870	96.08
175	Almond Marsh	1.9510	113.40
	Average	***0.1113***	***65.8***

Lake County Secchi Disk Clarity Ranking, 2000-2016.

RANK	LAKE NAME	SECCHI AVE	TSIsd
1	Lake Carina	16.96	36.31
2	Windward Lake	14.28	38.79
3	Sterling Lake	13.84	39.24
4	Cedar Lake	12.55	40.66
5	Druce Lake	12.25	41.00
6	Pulaski Pond	11.69	41.68
7	West Loon Lake	11.55	41.85
8	Lake Zurich	10.40	43.37
9	Indpendence Grove	10.31	43.49
10	Ames Pit	9.97	43.97
11	Third Lake	9.76	44.28
12	Davis Lake	9.65	44.44
13	Harvey Lake	9.47	44.72
14	Little Silver Lake	9.42	44.79
15	Old School Lake	9.40	44.82
16	Lake Kathryn	9.39	44.84
17	Dugdale Lake	9.22	45.10
18	Dog Training Pond	9.04	45.39
19	Banana Pond	8.85	45.69
20	Deep Lake	8.83	45.72
21	Stone Quarry Lake	8.81	45.76
22	Wooster Lake	8.74	45.87
23	Lake of the Hollow	8.74	45.87
24	Cross Lake	8.18	46.83
25	Bangs Lake	8.02	47.11
26	Briarcrest Pond	8.00	47.15
27	Sand Lake	7.48	48.12
28	Sand Pond (IDNR)	7.42	48.23
29	Timber Lake (North)	7.37	48.33
30	Lake Miltmore	7.35	48.37
31	Lake Leo	7.31	48.45
32	Schreiber Lake	7.25	48.57
33	Nielsen Pond	7.23	48.61
34	Honey Lake	7.17	48.73
35	Lake Minear	7.13	48.81
36	Round Lake	7.01	49.05
37	Highland Lake	6.97	49.14
38	Lake Helen	6.43	50.30
39	Sun Lake	6.33	50.52
40	Lake Barrington	6.12	51.01
41	Cranberry Lake	5.94	51.44
42	Lake Fairfield	5.89	51.56
43	Gages Lake	5.45	52.68
44	Owens Lake	5.30	53.08
45	Valley Lake	5.05	53.78
46	McGreal Lake	5.04	53.81
47	Old Oak Lake	4.85	54.36
48	Waterford Lake	4.70	54.82
49	Lake Linden	4.60	55.13
50	Timber Lake (South)	4.46	55.57
51	Peterson Pond	4.51	55.41

Lake County Secchi Disk Clarity Ranking, 2000-2016.

RANK	LAKE NAME	SECCHI AVE	TSIsd
52	Crooked Lake	4.39	55.79
53	Mary Lee Lake	4.35	55.93
54	Butler Lake	4.35	55.93
55	Crooked Lake	4.28	56.17
56	Deer Lake	4.20	56.45
57	Seven Acre Lake	4.18	56.51
58	Lambs Farm Lake	4.17	56.54
59	Grays Lake	4.08	56.86
60	Lake Naomi	4.05	56.96
61	White Lake	3.96	57.29
62	Hook Lake	3.95	57.32
63	Turner Lake	3.92	57.43
64	Leisure Lake	3.85	57.69
65	Summerhill Estates Lake	3.84	57.73
66	North Tower Lake	3.89	57.74
67	Salem Lake	3.77	58.00
68	Lake Fariview	3.75	58.07
69	Duck Lake	3.71	58.23
70	Countryside Glen Lake	3.64	58.50
71	Fish Lake	3.57	58.78
72	Lochanora	3.52	58.99
73	Taylor Lake	3.52	58.99
74	Hastings Lake	3.52	58.99
75	Bishop Lake	3.47	59.19
76	Lake Lakeland Estates	3.41	59.44
77	Lake Holloway	3.40	59.49
78	Stockholm Lake	3.38	59.57
79	East Loon Lake	3.30	59.92
80	Lucky Lake	3.22	60.27
81	Diamond Lake	3.17	60.50
82	Liberty Lake	3.16	60.54
83	International Mining and Chemical Lake	3.08	60.91
84	Long Lake	3.05	61.05
85	Lake Christa	3.01	61.24
86	Lucy Lake	2.99	61.34
87	Lake Catherine	2.9	61.78
88	St. Mary's Lake	2.79	62.34
89	Channel Lake	2.77	62.44
90	Werhane Lake	2.71	62.76
91	Bresen Lake	2.69	62.86
92	East Meadow Lake	2.61	63.30
93	Buffalo Creek Reservoir 1	2.60	63.35
94	Countryside Lake	2.58	63.46
95	Kemper Lake 1	2.56	63.58
96	Bluff Lake	2.51	63.86
97	Broberg Marsh	2.50	63.92
98	Antioch Lake	2.48	64.03
99	Little Bear Lake	2.38	64.63
100	Island Lake	2.32	65.00
101	Tower Lake	2.31	65.06
102	Buffalo Creek Reservoir 2	2.30	65.12

Lake County Secchi Disk Clarity Ranking, 2000-2016.

RANK	LAKE NAME	SECCHI AVE	TSIsd
103	Woodland Lake	2.28	65.25
104	Rivershire Pond 2	2.23	65.57
105	Lake Charles	2.20	65.76
106	Fischer Lake	2.70	62.81
107	College Trail Lake	2.18	65.89
108	Loch Lomond	2.17	65.96
109	Redhead Lake	2.16	66.03
110	Pistakee Lake	2.15	66.09
111	Echo Lake	2.11	66.36
112	Eagle Lake (S1)	2.10	66.43
113	West Meadow Lake	2.07	66.64
114	Forest Lake	2.04	66.85
115	Grand Ave Marsh	2.03	66.92
116	Columbus Park Lake	2.03	66.92
117	Grassy Lake	2.00	67.14
118	Petite Lake	2	67.14
119	Des Plaines Lake	2.14	66.16
120	Sylvan Lake	1.98	67.28
121	Bittersweet Golf Course #13	1.98	67.28
122	Spring Lake	1.78	68.82
123	Kemper Lake 2	1.77	68.90
124	Fourth Lake	1.77	68.90
125	Nippersink Lake	1.73	69.23
126	Deer Lake Meadow Lake	1.73	69.23
127	Lake Louise	1.68	69.65
128	Willow Lake	1.63	70.09
129	Slough Lake	1.63	70.09
130	Rasmussen Lake	1.62	70.17
131	Lake Farmington	1.62	70.17
132	Half Day Pit	1.60	70.35
133	Lake Marie	1.56	70.72
134	Longview Meadow Lake	1.51	71.19
135	Lake Matthews	1.48	71.48
136	Big Bear Lake	1.32	73.13
137	Fox Lake	1.28	73.57
138	Dunn's Lake	1.22	74.26
139	Lake Eleanor	1.16	74.99
140	McDonald Lake 1	1.13	75.37
141	Lake Napa Suwe	1.06	76.29
142	Rollins Savannah 1	1.05	76.43
143	Osprey Lake	1.03	76.70
144	Manning's Slough	1.00	77.13
145	Rollins Savannah 2	0.95	77.87
146	Dog Bone Lake	0.94	78.02
147	Redwing Marsh	0.88	78.97
148	Flint Lake Oulet	0.83	79.82
149	Fairfield Marsh	0.81	80.17
150	Slocum Lake	0.81	80.17
151	Oak Hills Lake	0.79	80.53
152	Grass Lake	0.78	80.71
153	Lake Nippersink	0.77	80.90

Lake County Secchi Disk Clarity Ranking, 2000-2016.

RANK	LAKE NAME	SECCHI AVE	TSIsd
154	South Churchill Lake	0.73	81.67
155	Lake Forest Pond	0.71	82.07
156	ADID 127	0.66	83.12
157	North Churchill Lake	0.61	84.26
158	Hidden Lake	0.56	85.54
159	Ozaukee Lake	0.51	86.84
160	McDonald Lake 2	0.50	87.12

Appendix C:
Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (see sample site map), three feet below the surface, and 3 feet above the bottom. Samples were collected with a horizontal Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every two feet until reaching the bottom.

Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.3) overlaid a grid pattern onto an aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Plankton Sampling

Plankton were sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a or YSI 6600 Sonde® 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 63µm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton were collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Prior to sub-sample being removed for enumeration, the sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed in a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and 1 mm deep. The slide was then placed under the microscope and counted at a 20X magnification (phytoplankton) or 10X magnification (zooplankton). For phytoplankton, twenty fields of view were randomly counted with all species within each field counted. Due to their larger size, zooplankton were counted throughout the entire slide. Through calculations, it was determined how many of each species were in 1 mL of lake water.

Phytoplankton (algae) are free-floating and microscopic and are distinguished from plants because they lack roots, stems and leaves. There are four distinct groups of phytoplankton found in Lake County lakes: blue-greens, greens, diatoms, and dinoflagellates/chrysophytes. Blue-greens are also known as cyanobacteria because they are the only group of bacteria that obtain their energy from photosynthesis like plants. Some of these species can be toxic. Green algae are the closest ancestors of land plants and are the most common group. Diatoms are unique because they are encased in a cell wall made of silica that can be very ornate. Dinoflagellates and chrysophytes are almost always flagellated (able to move by flagella, a whip-like tail) and some can both photosynthesize and consume bacteria for food.

Zooplankton are made up of rotifers and two crustacean groups; the cladocerans and the copepods (broken down further into calanoids and cyclopoids). Rotifers are smaller and most have a crown of cilia (hair-like structure) used for movement and drawing in suspended particles to eat. Crustaceans have jointed appendages and are enclosed in an exoskeleton. Cladocerans, such as the “water flea” Daphnia species, are filter-feeding like rotifers, while the copepod group contains both filter-feeders (calanoids and cyclopoids) and raptorial species (cyclopoids).

Shoreline Assessment

<u>Shoreline Assessment Protocol</u>

Each lake was divided into reaches in ArcGIS based on nearshore landuse. For each reach, a shoreline assessment worksheet was filled out in the field focusing on shoreline conditions (land use, slope, erosion, buffer, etc) that describe the overall reach segment of the lake.

A GPS Trimble unit was used to collect the degree of shoreline erosion along the entire length of the lake. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

Table 1: Degree of Shoreline Erosion

Category	Description
None	Includes man-made erosion control such as rip-rap and sea wall.
Slight	Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as "slight". Beaches have been included as "slight" erosion.
Moderate	Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.
Severe	Recession is characterized by eroding of exposed soil on nearly vertical banks, exposed roots, fallen vegetation or extensive slumping of bank material, undercutting, washouts or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

Lateral recession rates were calculated on a per reach basis based on the IL EPA stream methodology, defining lateral recession into four main categories (slight, moderate, severe, and very severe). Descriptions of each category are defined in the Table 2.

Table 2: Lateral Recession Rate Categories

Lateral Recession Rate	Description	Description
0.01 – 0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetation overhanging. No exposed tree roots.
0.06 – 0.2	Moderate	Bank mostly bare with some rills and vegetation overhanging.
0.3 – 0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and streamcourse or gully may be meandering.

Shoreline Buffer Condition

Lakeshore buffer condition was assessed using a qualitative methodology that considered an area up to 25 feet inland from the shoreline for each reach. The assessment was done by viewing high resolution 2014 aerial images in ArcGIS. A 25 foot buffer was chosen based on research that indicates a 25-foot vegetated buffer is the minimum effective width for in-lake habitat maintenance (a 15 foot buffer is the minimum effective width for bank stability). Criteria used for category assignment are shown in table below.

Table 3: Shoreline Buffer Condition Categories

Category	Criteria	Percentage
Good	Unmowed grasses & forbs + tree trunks + shrubs *and* impervious surfaces	≥70% ≤5%
Fair	Unmowed grasses & forbs + tree trunks + shrubs *and* Impervious surface	≥50% and <70% ≤10%
Poor	Unmowed grasses & forbs +tree trunks + shrubs *and* Impervious surface	<50% ≥50%

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal.
Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical methods used for water quality parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde ®4a or YSI 6600 Sonde®
Nitrate and Nitrite nitrogen	USEPA 353.2 rev. 2.0 EPA-600/R-93/100 Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18th ed. Electrode method, #4500 NH_3-F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18th ed, 4500-N_{org} C Semi-Micro Kjeldahl, plus 4500 NH_3-F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18th ed, Method #2540B
Total suspended solids	SM 18th ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18th ed, Method #4500C1-D
Total volatile solids	SM 18th ed, Method #2540E, from total solids
Alkalinity	SM 18th ed, Method #2320B, patentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18th ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

Lakes possess a unique set of physical and chemical characteristics that will change over time. These in-lake water quality characteristics, or parameters, are used to describe and measure the quality of lakes, and they relate to one another in very distinct ways. As a result, it is virtually impossible to change any one component in or around a lake without affecting several other components, and it is important to understand how these components are linked.

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2010 will be used in the following discussion.

Temperature and Dissolved Oxygen:

Water temperature fluctuations will occur in response to changes in air temperatures, and can have dramatic impacts on several parameters in the lake. In the spring and fall, lakes tend to have uniform, well-mixed conditions throughout the water column (surface to the lake bottom). However, during the summer, deeper lakes will separate into distinct water layers. As surface water temperatures increase with increasing air temperatures, a large density difference will form between the heated surface water and colder bottom water. Once this difference is large enough, these two water layers will separate and generally will not mix again until the fall. At this time the lake is thermally stratified. The warm upper water layer is called the ***epilimnion***, while the cold bottom water layer is called the ***hypolimnion***. In some shallow lakes, stratification and destratification can occur several times during the summer. If this occurs the lake is described as polymictic. Thermal stratification also occurs to a lesser extent during the winter, when warmer bottom water becomes separated from ice-forming water at the surface until mixing occurs during spring ice-out.

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. Many of the plants or algae die at the end of the growing season. Their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

External pollution in the form of oxygen-demanding organic matter (i.e., sewage, lawn clippings, soil from shoreline erosion, and agricultural runoff) or nutrients that stimulate the growth of excessive organic matter (i.e., algae and plants) can reduce average DO concentrations in the lake by increasing oxygen consumption. This can have a detrimental impact on the fish community, which may be squeezed into a very small volume of water as a result of high temperatures in the epilimnion and low DO levels in the hypolimnion.

Nutrients:

Phosphorus:

For most Lake County lakes, phosphorus is the nutrient that limits plant and algae growth. This means that any addition of phosphorus to a lake will typically result in algae blooms or high plant densities during the summer. The source of phosphorus to a lake can be external or internal (or both). External sources of phosphorus enter a lake through point (i.e., storm pipes and wastewater discharge) and non-point runoff (i.e., overland water flow). This runoff can pick up large amounts of phosphorus from agricultural fields, septic systems or impervious surfaces before it empties into the lake.

Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. In lakes with high oxygen levels (oxic), phosphorus can be released from the sediment through plants or sediment resuspension. Plants take up sediment-bound phosphorus through their roots, releasing it in small amounts to the water column throughout their life cycles, and in large amounts once they die and begin to decompose. Sediment resuspension can occur through biological or mechanical means. Bottom-feeding fish, such as common carp and black bullhead can release phosphorus by stirring up bottom sediment during feeding activities and can add phosphorus to a lake through their fecal matter. Sediment resuspension, and subsequent phosphorus release, can also occur via wind/wave action or through the use of artificial aerators, especially in shallow lakes. In lakes that thermally stratify, internal phosphorus release can occur from the sediment through chemical means. Once oxygen is depleted (anoxia) in the hypolimnion, chemical reactions occur in which phosphorus bound to iron complexes in the sediment becomes soluble and is released into the water column. This phosphorus is trapped in the hypolimnion and is unavailable to algae until fall turnover, and can cause algae blooms once it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2010 was 0.065 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on seven lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2010 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove Lake to a maximum of 3.800 mg/L in Taylor Lake.

The analysis of phosphorus also included soluble reactive phosphorus (SRP), a dissolved form of phosphorus that is readily available for plant and algae growth. SRP is not discussed in great detail in most of the water quality reports because SRP concentrations vary throughout the season depending on how plants and algae absorb and release it. It gives an indication of how much phosphorus is available for uptake, but, because it does not take all forms of phosphorus into account, it does not indicate how much phosphorus is truly present in the water column. TP is considered a better indicator of a lake's nutrient status because its concentrations remain more stable than soluble reactive phosphorus. However, elevated SRP levels are a strong indicator of nutrient problems in a lake.

Nitrogen:
Nitrogen is also an important nutrient for plant and algae growth. Sources of nitrogen to a lake vary widely, ranging from fertilizer and animal wastes, to human waste from sewage treatment plants or failing septic systems, to groundwater, air and rainfall. As a result, it is very difficult to control or reduce nitrogen inputs to a lake. Different forms of nitrogen are present in a lake under different oxic conditions. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2 (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

The ratio of TKN plus nitrate nitrogen to total phosphorus (TN:TP) can indicate whether plant/algae growth in a lake is limited by nitrogen or phosphorus. Ratios of less than 10:1

suggest a system limited by nitrogen, while lakes with ratios greater than 20:1 are limited by phosphorus. It is important to know if a lake is limited by nitrogen or phosphorus because any addition of the limiting nutrient to the lake will, likely, result in algae blooms or an increase in plant density.

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County was 8.1 mg/L, ranging from below the 0.1 mg/L detection limit to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 123.0 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 mg/L in Fairfield Marsh.

Total dissolved solids (TDS) are the amount of dissolved substances, such as salts or minerals, remaining in water after evaporation. These dissolved solids are discussed in further detail in the *Alkalinity* and *Conductivity* sections of this document. TDS concentrations were measured in Lake County lakes prior to 2004. This practice was discontinued due to the strong correlation of TDS to conductivity and chloride concentrations. Since 2004, chloride concentrations data are collected..

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact both plant and fish communities. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The median Secchi depth for Lake County lakes is 2.95 feet. From 2000-2010, both Ozaukee Lake and McDonald Lake #2 had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (23.50 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

Another measure of clarity is the use of a light meter. The light meter measures the amount of light at the surface of the lake and the amount of light at each depth in the water column. The amount of attenuation and absorption (decreases) of light by the water column are major factors controlling temperature and potential photosynthesis. Light intensity at the lake surface varies seasonally and with cloud cover, and decreases with depth. The deeper into the water column light penetrates, the deeper potential plant growth. The maximum depth at which algae and plants can grow underwater is usually at the depth where the amount of light available is reduced to 0.5%-1% of the amount of light available at the lake surface. This is called the euphotic (sunlit) zone. A general rule of thumb in Lake County is that the 1% light level is about 1 to 3 times the Secchi disk depth.

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:
Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ($CO_3^{=}$) and bicarbonate (HCO_3^-) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate ($CaCO_3$) or dolomite ($CaMgCO_3$), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.
Conductivity and Chloride:
Conductivity is the inverse measure of the resistance of lake water to an electric flow. This means that the higher the conductivity, the more easily an electric current is able to flow through water. Since electric currents travel along ions in water, the more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Accordingly, conductivity has been correlated to total dissolved solids and chloride ions. The amount of dissolved solids or conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Many Lake County lakes have elevated conductivity levels in May, but not during any other month. This was because chloride, in the form of road salt, was washing into the lakes with spring rains, increasing conductivity. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Beginning in 2004, chloride concentrations are one of the parameters measured during the lake studies. Increased chloride concentrations may have a negative impact on aquatic organisms. Conductivity changes occur seasonally and with depth. For example, in stratified lakes the conductivity normally increases in the hypolimnion as bacterial decomposition converts organic materials to bicarbonate and carbonate ions depending on the pH of the water. These newly created ions increase the conductivity and total dissolved solids. Over the long term, conductivity is a good indicator of potential watershed or lake problems if an increasing trend is noted over a period of years. It is also important to know the conductivity of the water when fishery assessments are conducted, as electroshocking requires a high enough conductivity to properly stun the fish, but not too high as to cause injury or death.

Since 2004 measurements taken in Lake County lakes have exhibited a trend of increasing salinity measured by chloride concentrations. The median near surface chloride concentration of Lake County Lakes was 142 mg/L. In 2009, Schreiber Lake had the lowest chloride concentration recorded at 2.7 mg/L. The maximum average chloride measurement was at 2760 mg/L at IMC. It is important to note that salt water is denser than fresh water and so it accumulates in the hypolimnion or near the bottom of the lake, this can impact mixing of bottom waters into surface waters in lakes that experience turnover. This phenomenon could have far reaching impacts to an entire ecosystem within a lake. Further, in studies conducted in

Minnesota, chloride concentrations as low as 12 mg/L have been found to impact some species of algae.

pH:

pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life they may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes was 8.37, with a minimum average of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

Eutrophication and Trophic State Index:

The word *eutrophication* comes from a Greek word meaning "well nourished." This also describes the process in which a lake becomes enriched with nutrients. Over time, this is a lake's natural aging process, as it slowly fills in with eroded materials from the surrounding watershed and with decaying plants. If no human impacts disturb the watershed or the lake, natural eutrophication can take thousands of years. However, human activities on a lake or in the watershed accelerate this process by resulting in rapid soil erosion and heavy phosphorus inputs. This accelerated aging process on a lake is referred to as cultural eutrophication. The term trophic state refers to the amount of nutrient enrichment within a lake system. *Oligotrophic* lakes are usually deep and clear with low nutrient levels, little plant growth and a limited fishery. *Mesotrophic* lakes are more biologically productive than oligotrophic lakes and have moderate nutrient levels and more plant growth. A lake labeled as *eutrophic* is high in nutrients and can support high plant densities and large fish populations. Water clarity is typically poorer than oligotrophic or mesotrophic lakes and dissolved oxygen problems may be present. A *hypereutrophic* lake has excessive nutrients, resulting in nuisance plant or algae growth. These lakes are often pea-soup green, with poor water clarity. Low dissolved oxygen may also be a problem, with fish kills occurring in shallow, hypereutrophic lakes more often than less enriched lakes. As a result, rough fish (tolerant of low dissolved oxygen levels) dominate the fish community of many hypereutrophic lakes. The categorization of a lake into a certain trophic state should not be viewed as a "good to bad" categorization, as most lake residents rate their lake based on desired usage. For example, a fisherman would consider a plant-dominated, clear lake to be desirable, while a water-skier might prefer a turbid lake devoid of plants. Most lakes in Lake County are eutrophic or hypereutrophic. This is primarily as a result of cultural eutrophication. However, due to the fertile soil in this area, many lakes (especially man-made) may have started out under eutrophic conditions and will never attain even mesotrophic conditions, regardless of any amount of money put into the management options. This is not an excuse to allow a lake to continue to deteriorate, but may serve as a reality check for lake owners attempting to create unrealistic conditions in their lakes.

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average total phosphorus concentration, its average Secchi depth (water transparency) and/or its average chlorophyll *a* concentration (which represent algae biomass). It is based on the principle that as phosphorus levels increase, chlorophyll *a* concentrations increase and Secchi depth decreases. The higher the TSI score, the more nutrient-rich a lake is, and once a score is obtained, the lake can then be designated as oligotrophic, mesotrophic or eutrophic. Table 1 (below) illustrates the Trophic State Index using phosphorus concentration and Secchi depth.

Table 1. Trophic State Index (TSI).

Trophic State	TSI score	Total Phosphorus (mg/L)	Secchi Depth (feet)
Oligotrophic	<40	≤ 0.012	>13.12
Mesotrophic	≥40<50	>0.012 ≤ 0.024	≥6.56<13.12
Eutrophic	≥50<70	>0.024 ≤ 0.096	≥1.64<6.56
Hypereutrophic	≥70	>0.096	< 1.64