LAKE COUNTY, ILLINOIS

2014 SUMMARY REPORT LAKE CATHERINE

PREPARED BY THE

LAKE COUNTY HEALTH DEPARTMENT

Population Health-Ecological Services

Figure 1. Lake Catherine (right) and Channel Lake (left) 2010 Aerial

Lake Catherine is one of the thirteen lakes within the Fox Chain 'O' Lakes monitored by the LCHD-ES in 2014. It is a glacial lake with a maximum depth of 39 feet and a surface area of 164.7 acres. Water elevations in Lake Catherine are influenced by the McHenry Dam which was built in 1939. Lake Catherine is hydrologicaly connected to Channel Lake, although this was not always the case, as there was once a gravel bar that separated the two, however, most of that bar has eroded away. Currently both lakes form one large footprint. Boaters are still observed anchored at the remaining sandbar on the northwestern edge of the lake; swimming and recreating. Lake Catherine and Channel Lake are both located near the bottom of the Trevor Creek watershed, and are the deepest of the lakes in the Fox Chain 'O' Lakes. Lake Catherine receives water directly from Trevor Creek which flows from Wisconsin and is part of the Fox River Watershed. Lakes feeding Trevor Creek include Cross, Voltz and Rock Lake in Kenosha County, Wisconsin. There are also several small tributaries and stormwater drainage outfalls entering into the lake. Data supplied by the Lake County Mapping Services Division and Southeastern Wisconsin Regional Planning Commission estimate the Trevor Creek watershed to be approximately 12,581.67 acres in

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SUMMARY (CONTINUED)

Lake Facts:

Major Watershed: Fox River

Sub-Watershed: Fox River

Location: T43N, R9E, Section 11

Surface Area: 164.7 acres

Shoreline Length: 6.24 miles

Maximum Depth: 39.00 ft.

Average Depth: 16.7 ft.

Lake Volume: 2881.90 acre-ft.

Watershed Area: 12,581.67 acres (WI and IL)

Lake Type: Glacial

Management Entity:

Fox Waterway Agency

State of Illinois

Homeowners Associations (various)

Current Uses: fishing, swimming, boating, aesthetics

Access: Private although there are public launches on other lakes of Fox Chain 'O' Lakes.

size. Agriculture, single family and wetlands are the dominant land uses in the Trevor Creek watershed. However, single family and transportation contribute the greatest amount of runoff into Lake Catherine.

The lake is well known by anglers. There are two private boat launches on Lake Catherine; as well as other public launches on the Fox Chain 'O' Lakes. Fishing by shoreline is limited along the shoreline of Lake Catherine as most of it is under private ownership, therefore, fishermen usually access the lake from public launches on the Fox Chain 'O' Lakes.

In 2014, the LCHD-ES sampled the lakes for the water quality parameters discussed in this report. Once a month water chemistry samples were collected at the deep hole of the lake at 3 feet from the surface (epilimnion) and lake bottom (hypolimnion) by use of a Van Dorn sampler. A multi-parameter sonde was utilized to collect depth profile data. A Secchi disc was used to measure the water clarity of the lake. Other environmental data recorded included air temperature, water elevation and any observations of wildlife in the area.

The overall water quality of the Lake Catherine is fair. Like many of the lakes in our county, it is impaired for phosphorus based upon the Illinois Environmental Protection Agency's (IEPA) phosphorus standard for general use (≥ 0.05 mg/L TP). The standard applies to lakes with a surface area greater than 20 acres. It only takes one exceedance of the standard during a season to be considered impaired. The average TP concentration during 2014 was 0.062 mg/L. This is well below the median TP concentration of 0.126 for all of the lakes sampled on the Fox Chain in 2014 and is slightly below the county median TP concentration of 0.068 mg/L for lakes sampled for TP since 2000.

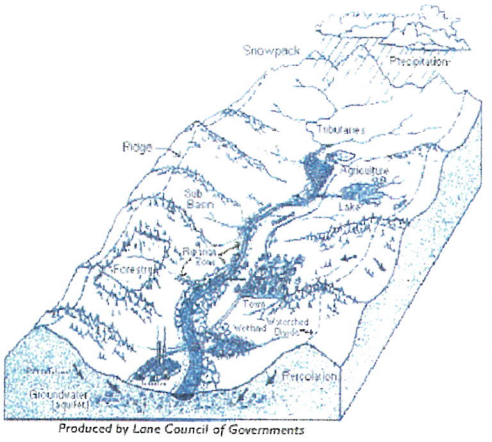
An aquatic vegetation survey was conducted on Lake Catherine in July using the point intercept method. In order to accomplish this a randomized grid was placed over the footprint of the lake using ARCGIS 10.2. In order to sample the aquatic vegetation, a rake was lowered at each point sampled and scored 0—5; "0" where plants were not detected. The data collected was entered into ARCGIS 10.2 and maps were created indicating cover and location of vegetation in the lake. Maps of the indicating abundance of invasive plants were also created to assist in aquatic plant management plans.

Thirteen plant species were detected in Lake Catherine in 2014; 44.9% of the points sampled were colonized with aquatic vegetation. The total average cover of vegetation in Lake Catherine was 14.6%, this was below the total average cover of vegetation estimated for the Fox Chain 'O' Lakes in 2014 of 27.3%. A floristic quality assessment was conducted on the species found in Lake Catherine resulting in a FQI score of 21.8. This is a pretty good score considering that floristic quality assessments are usually performed on terrestrial vegetation. An FQI score between 20 and 35 would indicate that the vegetation had some of the qualities of a natural area.

Lake Catherine has three licensed swim beaches monitored as part of our beach monitoring program. Warriners Subdivision was the only beach to have a swim ban issued since 2004, it occurred during July of 2012 and was likely caused by waterfowl. Bans occur at swim beaches due to the presence of elevated (>235 colonies/100 mL) E-coli found in the water sample collected at the beach. Licensed beaches in the Fox Chain 'O' Lakes are sampled bi-weekly on a rotation between north and south chain beaches. Since 2013, a subset of beaches are routinely sampled for the presence of harmful algal blooms (HABs), Felter's Subdivision beach was selected from Lake Catherine.

Watershed

A general definition of a watershed is an area of land defined by two or more high ridges. However, watersheds are usually much more complex than that due to the engineering of drainage areas designed to efficiently remove storm-water from the landscape. This can make boundaries hard to decipher at times.

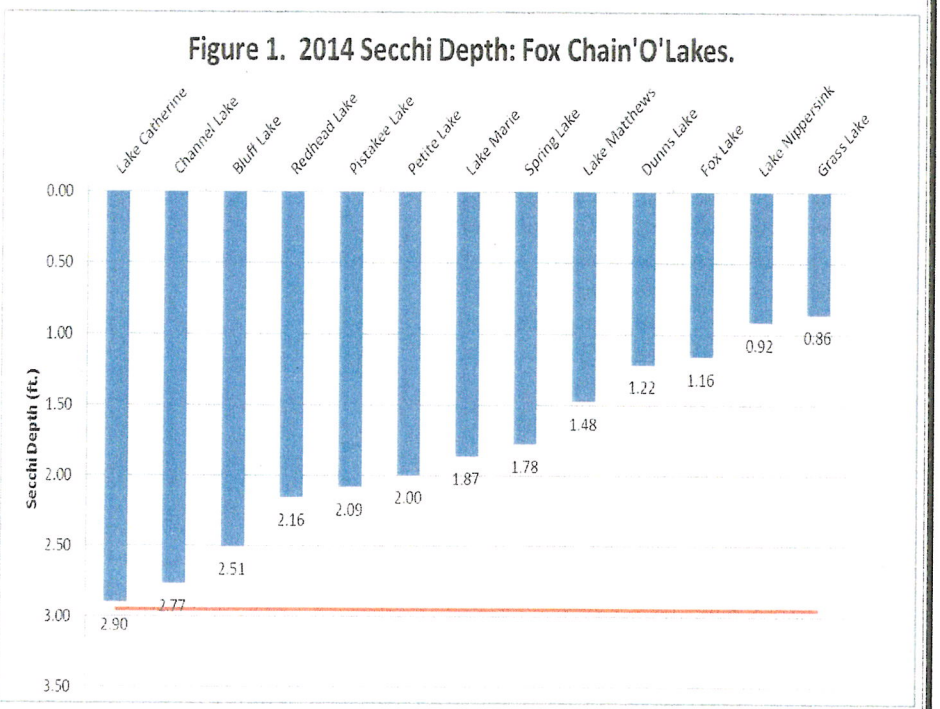


Produced by Lane Council of Governments

Lake Catherine is located at the bottom of the approximately 12, 581.67 acres watershed of Trevor Creek (SEWRPC and Lake County Mapping Division). According to land use data, the watershed was dominated by agriculture (42.5%), single family (15.5%); and wetlands (15.1%). However, single family and transportation contributed the greatest total percent runoff entering into Lake Catherine, representing 36.5% and 26.7% respectively (Appendix A, Table 1). It is recommended that the stakeholders of the watershed work together to educate homeowners and municipalities of the important role that they play in the health of natural resources such as Lake Catherine. Stakeholders should incorporate management practices that reduce nutrients from entering our surface waters as most are impaired for phosphorus; these include, nutrient management plans for agriculture, and the remediation of eroding shorelines by other residents. This is an ideal time to initiate BMP's for the Fox River watershed as the IEPA is prioritizing the implementing of projects to address water quality issues in the Fox River in 2015. The deadline for application is August 1, 2015. For more information feel free to contact the LCHD-ES at 847-377-8030.

Water Clarity

Water clarity is important as it allows light to penetrate into the water column. This light is used by the primary producers (plants and phytoplankton) for their growth. Water clarity is measured by lowering a Secchi disk into the water until it can no longer be seen by the naked eye. The resulting depth is recorded.



In 2014, the water clarity in Lake Catherine ranged from 1.23 feet in September to 7.50 feet in June with an average Secchi depth of 2.90 feet. The county median Secchi depth for lakes whose Secchi depth has been recorded between 2000 and 2014 was 2.95 ft. (Appendix A, Table 2). Although the Secchi depth was slightly below the county median, the water clarity was better than the other

WATER CLARITY (CONTINUED)

lakes monitored in the Fox Chain 'O' Lakes. This is likely due to its relatively small watershed in comparison to most of the other lakes.

However, water clarity has decreased significantly in Catherine since 2002; the average Secchi depth in 2002 was 6.58 mg/L compared to the 2014 average Secchi depth of 2.90 mg/L. This is a 127% decrease in water clarity within 12 years. VLMP data collected since 2011 suggests that a something occurred between 2011 and 2012; and again from 2012 to 2013, that accounts for the decline in water clarity of 75% and 123%, respectively.

Total suspended solids impact water clarity and sources are stormwater, plant and algal blooms, wastewater treatment plants, failing septic, recreational boating and invasive species.

In 2014, algal blooms were observed on Lake Catherine in May and August and during both of those months the Secchi depth was nearly equivalent at 1.61 mg/L and 1.58 mg/L, respectively. Spring rains and a storm event which occurred in August likely contributed nutrient rich sediments into the lake which promoted the blooms.

According to the Long Lake rain gauge (Lake County Stormwater Commission), May precipitation measurements captured at the station accumulated to a total of 3.77 inches of rainfall, which is comparable to average May precipitation (3.21 inches). In June, precipitation was well above the 12 year average of 4.64 in., with a total of 6.93 in. recorded at Long Lake. Two weeks prior to our June sampling event cumulatively only 1.01 inches of rain that fell in the region, the remaining 5.92 inches fell after that sampling . This explains the increase in Secchi depth observed in June (7.5 ft.) followed by the subsequent decrease in July (2.6 ft.). A large storm

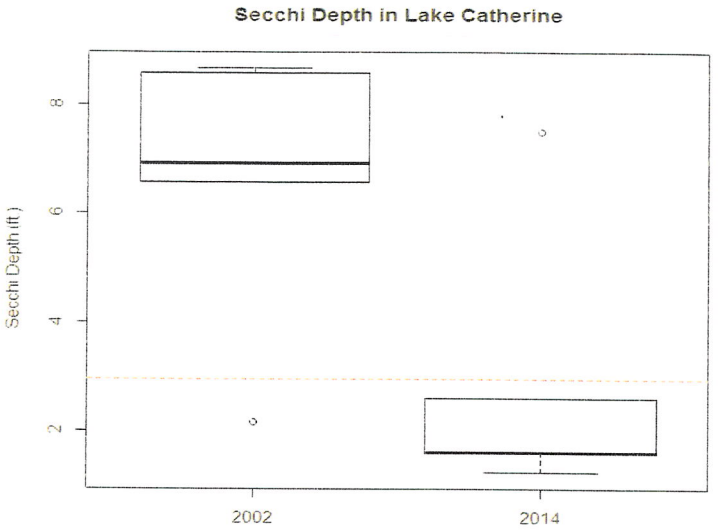
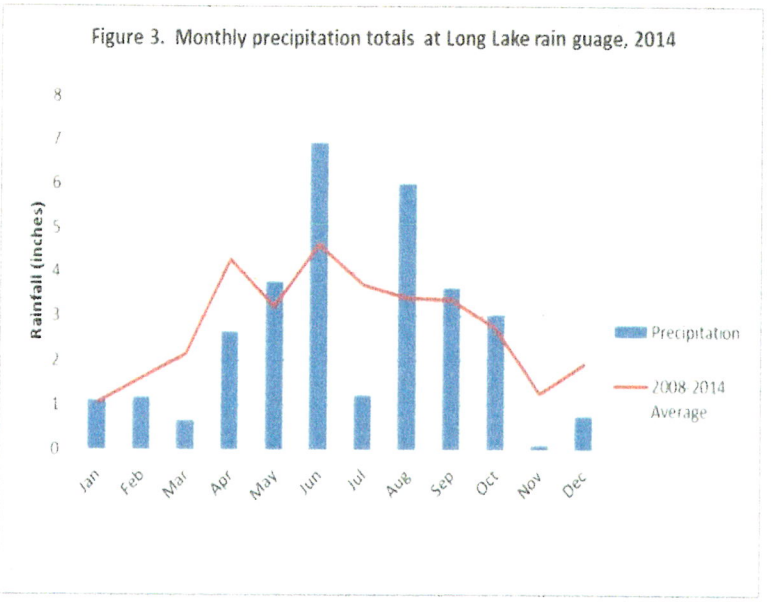


Figure 2. Box Plot showing decreased water clarity between 2002 and 2014.

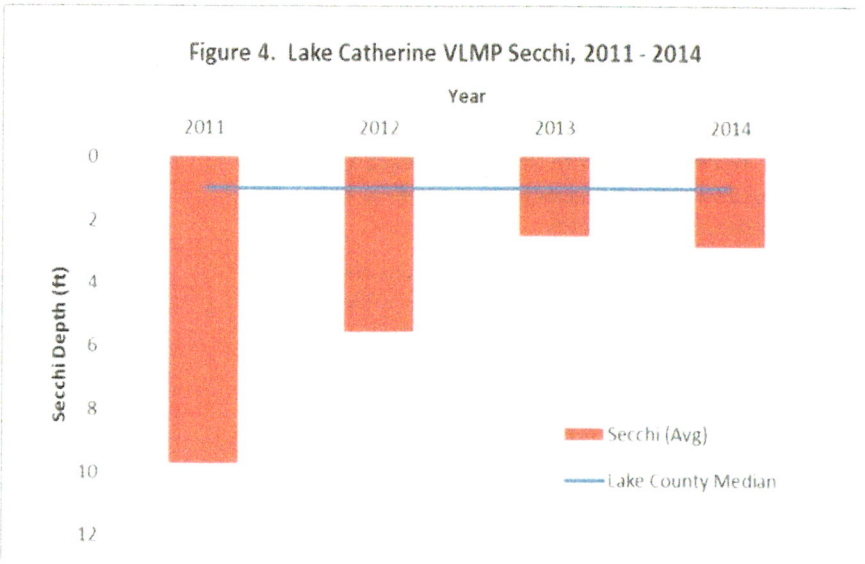


WATER CLARITY (CONTINUED)

event in August introduced stormwater carrying nutrients and other pollutants into the lake. Nutrient demands by plants are reduced as they are no longer actively growing, algae are able to take advantage of the additional nutrients using them for their growth; therefore prolific algae blooms can occur for the remainder of the season.

Water clarity in Lake Catherine suffered in part due to a low abundance of vegetation, however, invasive species such as zebra mussels and gizzard shad can have profound effects on water clarity. Both feed off plankton and are known for their ability to clear water. Recreational boat propellers can increase turbidity, as well as can construction activities in the watershed. With all of the stressors impacting Lake Catherine water clarity it still ranked #87 out of the 158 lakes measured for water clarity based upon Secchi depth measurements taken in the County since 2000 (Appendix A, Table 4).

VOLUNTEER LAKE MONITORING PROGRAM



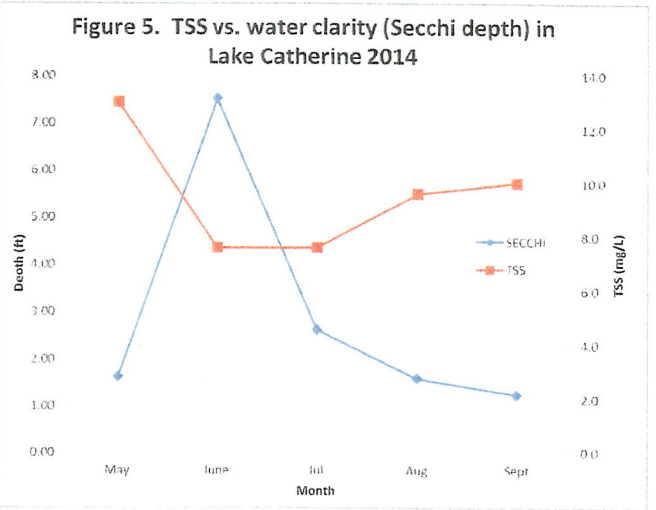
The Volunteer Lake Monitoring Program was established in 1981 to assist in gathering water quality information on Illinois lakes and to provide an educational program for citizens interested in lake water quality. The primary measurement taken by all volunteers in the program is Secchi disk (water clarity). Other observations such as algal blooms, vegetation, water color, and wildlife, plus any observations that the VLMP feels noteworthy are recorded. The sampling season is May through October, two visits per month are required under the program.

VLMP data such as that presented in Figure 4 is just one example on how invaluable VLMP's are on a lake. They assist lake managers in identifying problems early so they can correct them, as well as provide agencies with a continuous dataset that allows them to track changes on the lakes at times when they are not actively monitoring them.

The VLMP Secchi disk data displayed in Figure 4 are of the average annual Secchi disk measurements across all VLMP sites for years 2011—2014. This data indicates that the water clarity in Lake Catherine decreased by 75% and 123% between 2011 through 2012; and 2012 through 2013, respectively. Water clarity started to show signs of improvement in 2014. This could be due to many of the factors discussed above under water clarity.

TOTAL SUSPENDED SOLIDS

Total suspended solids (TSS) are comprised of volatile (organic) materials and nonvolatile (inorganic) materials within the water column. Total suspended solids reduce water clarity and can impact both flora and fauna in a lake when prevalent. Examples of volatile solids are plankton and plant material as well as small macroinvertebrates. Non-volatile solids are sediments. TSS concentrations are inversely correlated to water clarity, hence when TSS concentrations are elevated, water clarity is diminished (Figure 5).



In 2014, TSS concentrations in Lake Catherine ranged from 13.0 mg/L in May to 7.6 mg/L in June and July (Appendix A, Table 3). The average TSS concentration of 9.6 mg/L was greater than the median TSS concentration of 8.2 mg/L for lakes in the county measured for TSS since 2000. TSS concentrations in 2002 averaged 6.6 mg/L, with concentrations ranging from 1.0 mg/L to 16.0 mg/L. TSS concentrations were not as variable in 2014 as they were in 2002 (Figure 6), this could be due to changes in abundance of aquatic vegetation or differences weather patterns between sampling years, 2002 and 2014.

In 2014, total volatile solids (TVS) ranged from 104 mg/L in May to 124 mg/L in June. The 2014 average TVS concentration was 112 mg/L, this is lower than the county median concentration of 121 mg/L for county lakes measured for TVS since 2000. In 2002, TVS concentrations ranged from 1 mg/L to 4 mg/L. The large difference between TVS concentrations between 2014 and 2002 is likely due to analytical differences caused by changes in laboratories used and are therefore not comparable.

In 2014, non-volatile suspended solids (NVSS) ranged from 1.87 mg/L in July to 6.32 mg/L in May, and was likely caused by activities in the watershed.

Algal blooms were noted in May and again in August. Sediments (NVSS) were elevated in May dropping during June and July and rebounding again in August and September. Sediments carry nutrients with them that fuel algal blooms, a combination of the two likely caused decreased water clarity during the season.

It is recommended to provide outreach to residents, businesses and the agriculture community on best management practices that they can incorporate into their daily lives that can reduce sediments from entering into waters that eventually discharge into Lake Catherine.

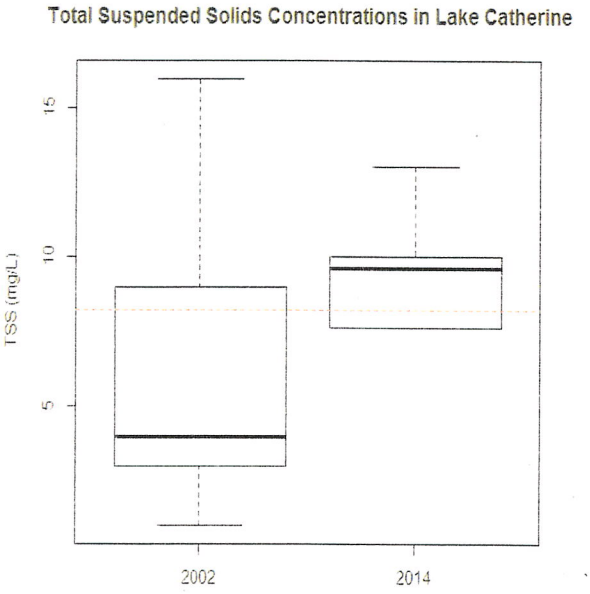


Figure 6. Boxplots illustrating TSS concentrations in Lake Catherine, 2002 and 2014. Red dashed line represents county median.

SEDIMENTS

Sedimentation naturally occurs in our environment, however, human activities can increase the amount of sediment that ends up in surface waters. Sediments are usually fine grained sands, silts and clays that can cover up the coarser bottom sediments and the spaces between rocks and cobbles that provide habitat for aquatic life.

In the Midwest region, sediments entering into surface water from erosion are laden with phosphorus and are a major source of eutrophication (nutrient enrichment). They reduce water clarity which reduces the amount of light penetrating into the water, subsequently impacting the ability of plants to photosynthesize and plant propagules (seeds) to reestablish. They impact fish and macro-invertebrate habitat by burying gravel nests and young vegetation, as well as suffocating fish eggs. Sediment particles in the water absorb warmth from the sun resulting in increased water temperatures. This can cause problems with dissolved oxygen and cause stress to fish.

The Fox Waterway Agency (FWA) provides the service of removing sediments deposited from the Fox River and other tributaries to the lakes within the Fox Chain 'O' Lakes. The sediment load coming from all tributaries has been calculated to be steady at approximately 100,000 yds^3/year. Of that sediment, 12%, or approximately 12,000 yds^3/year enter Lake Catherine from Trevor Creek.

According to the FWA, Grass Lake is the main recipient of the sediment load of the Fox Chain 'O" Lakes, and is at or near capacity, therefore much of the 2014 dredging took place in Grass Lake and Lake Marie. The FWA is not supported through tax revenues but by annual sticker fees required by boaters using the lakes of the Fox Chain 'O' Lakes. Dredged sediments are used to construct islands that provide habitat for birds navigating and nesting in and among the Fox Chain 'O" Lakes. There are threatened and endangered bird species who utilize the islands and other areas of the Chain; however, recently we have observed increased gull activity on the islands as well. The sediments are frequently tested so that the spoils can be recycled as compost. Results from a study conducted by Hey and Associates in 2005 indicate that sediment concentrations for most parameters (total phosphorus as P, Arsenic, Cadmium, Chromium, copper, Lead, Manganese, Nickel, Zinc, and Mercury) were considered "Low" or "Normal" based on the IEPA's Illinois Lake Sediment Classification. The McDonald classification for these pollutants also indicate that adverse effects pollutants are either not expected or would be rarely observed in the majority of the sediment dwelling organisms. Table 1 provides the results of the sampling, the results indicate that the sediments were safe for recycling in that year.

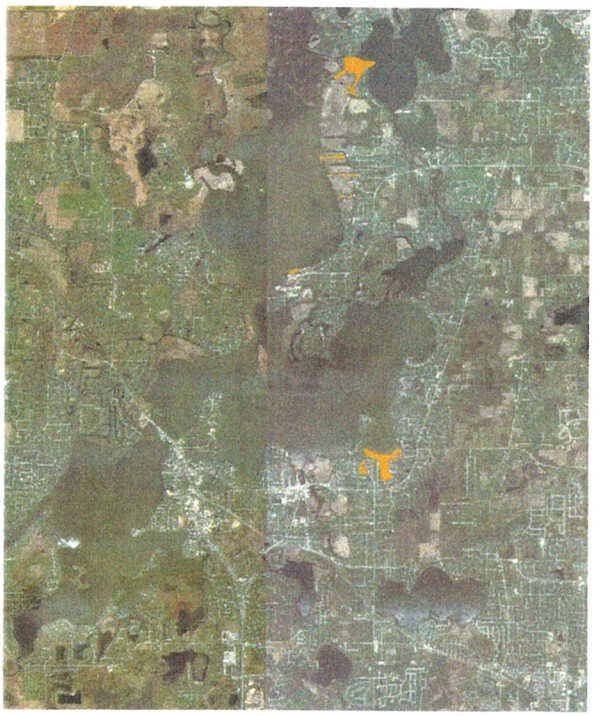


Figure 7. Location of dredging activities on the Fox Chain 'O' Lakes, 2014.

Figure 8. Fox Waterway Agency dredging a channel in Lake Marie, 2014.

SEDIMENTS (CONTINUED)

Table 1. Most of the pollutants sampled in dredging sediments by Hey and Associates compared to IEPA and Macdonald Sediment Classifications

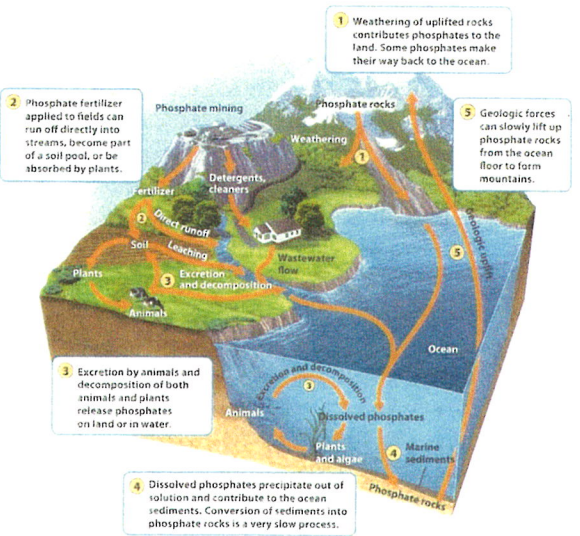
Metal	Value (Hey & Associates)	IEPA Illinois Lake Sediment Classification	MacDonald et al. Sediment Guidelines
Arsenic	12 mg/kg	Normal (4.1 to <14)	Below ERL
Cadmium	<0.5 mg/kg	Normal (<5)	Below LEL
Chromium	20 mg/kg	Normal (13 to <27)	Below LEL
Copper	14 mg/kg	Low (<16.7)	Below LEL
Lead	18 mg/kg	Normal (14 to <59)	Below LEL
Mercury	0.11 mg/kg	Normal (<0.15)	Below LEL
Nickel	14 mg/kg	Low (<14.3)	Below LEL
Zinc	51 mg/kg	Low (<59)	Below LEL

ERL: Effect range-low: represents the chemical concentration below which adverse effects would be rarely observed

LEL: Sediments are considered to be clean to marginally polluted. No effects on the majority of sediment dwelling organisms are expected below this concentration

NUTRIENTS

Phosphorus and nitrogen are essential, naturally occurring nutrients limiting plant growth, however when in excess they can impair water quality. Phosphorus is usually the nutrient responsible for water quality problems in lakes. It comes from both internal and external sources, and in general is the easiest of the limiting nutrients to manipulate due to the ability of some plant and algal species to fix nitrogen from the atmosphere. High phosphorus can lead to excessive algae and aquatic plant growth which can harm aquatic life and impair recreational use. It can cause toxic algae blooms, reduce water clarity, and deplete oxygen levels. External sources are those that occur in the watershed, such as from sept systems as they are still prevalent along properties throughout the Fox Chain 'O' Lakes as well as Lake Catherine. Septic systems can leach into the groundwater and then into the lake if they are not maintained. Lack of maintenance is responsible for overflows into the lakes' as well. Therefore it is important that septic systems are maintained by pumping them on a regular basis. When systems fail, they can cause problems in the lake such as elevated nutrients which can promote blue green algal blooms (HABSs). Therefore it is recom-



NUTRIENTS

mended that septic systems be maintained on Lake Catherine.

Internally, deep lakes such as Catherine, have conditions that cause bottom sediments to become anoxic creating the internal cycling of nutrients. This is prevalent especially in September when the lake begins to mix the phosphorus rich waters from the hypolimnion with waters of the epilimnion. The available phosphorus is quickly metabolized by algae for their growth and is likely responsible for the end of the season algal blooms that occur in Lake Catherine.

Like many of the lakes within Lake County, Lake Catherine is impaired for total phosphorus (TP) under the Illinois Environmental Protection Agency (IEPA) standard. The general use standard applies to lakes whose surface area is greater than 20 acres, and an impairment occurs when concentrations exceed 0.05 mg/L. TP concentrations in 2014 ranged from 0.044 mg/L in August to 0.110 mg/L in May (Appendix A, Table 3). The average TP concentration in Lake Catherine was 0.062 mg/L, and was comparable to the median TP concentration of lakes within the county during the period of 2000—2014 of 0.068 mg/L.

As indicated in Figure 9, the TP concentrations in 2002 were not considered impaired with a maximum concentration of 0.045 mg/L (Appendix A, Table 3) . In 2014, the minimum concentration of 0.044 mg/L equaled the maximum concentration measured in 2002.

A ratio between total nitrogen and total phosphorus (TN:TP) is a tool utilized to determine which nutrient is limiting plant or algal growth. Ratios of less than 10:1 indicate a system limited by nitrogen, while lakes with ratios greater than 20:1 are limited by phosphorus. The TN:TP ratio calculated for Lake Catherine in 2014 was 25, indicating that phosphorus was the limiting nutrient. Therefore any additional phosphorus into Lake Catherine could cause nuisance plant or algal growth. In 2014 the lake had sparse aquatic vegetation so it is likely that algal blooms will be prolific if aquatic vegetation remains at its current levels. The monthly TN:TP ratio in May was 15.5 indicates that both nutrients were plentiful. This further explains the algal blooms observed in Lake Catherine during that time.

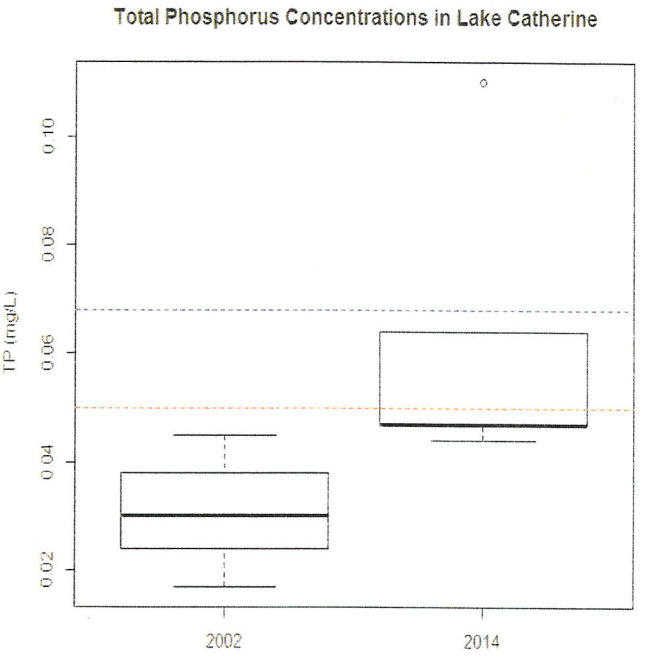
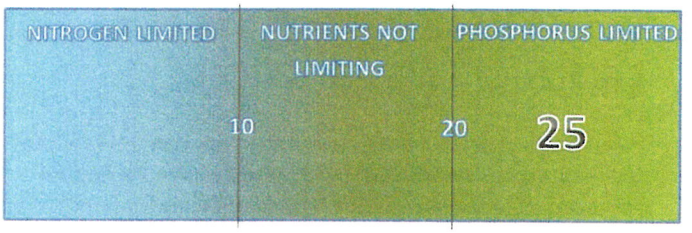


Figure 9. Comparison of TP concentrations in Lake Catherine from 2002 and 2014. Red dashed line is represented of IEPA standard (0.05 mg/L). Blue dashed line is county median (2000 -2014) TP concentration of 0.068 mg/L.



TROPHIC STATE INDECES

OLIGOTROPHIC:

Lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations.

MESOTROPHIC:

Lakes lie between the oligotrophic and eutrophic stages. Devoid of oxygen in late summer, their hypolimnion limit cold water fish and cause phosphorus cycling from sediments.

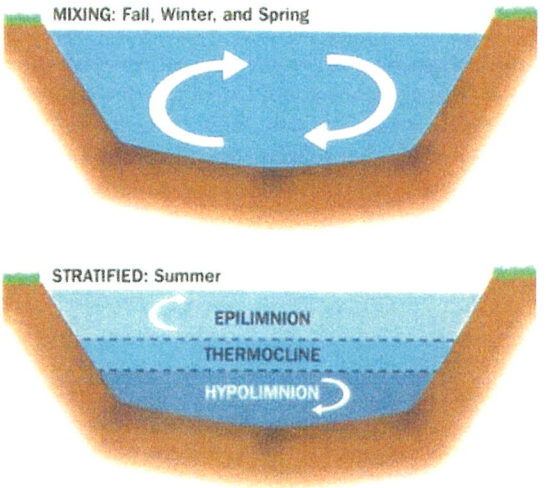
EUTROPHIC:

Lakes are high in nutrients, they are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion.

A Trophic State Index (TSI) based on phosphorus (TSIp) is commonly used to classify and compare lake productivity levels (trophic state). Excessive phosphorus can accelerate the rate of eutrophication. Eutrophication is a natural process of a lake aging where the lake is 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 normally takes thousands of years, however, human activities that supply lakes with additional phosphorus speeds up the eutrophication process significantly. The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive) mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2014 Lake Catherine was considered eutrophic with a TSIp score of 53.7. Lakes with scores between 50—70 are considered eutrophic, scores above 70 mean the lake is hypereutrophic. All of the lakes' of the Fox Chain 'O' Lakes were considered either eutrophic or hypereutrophic. TP concentrations measured in Lake Catherine ranked it #32 out of 165 lakes in the county whose TP concentrations have been measured since 2000 (appendix A, Table 5).

TROPHIC STATE INDECES

Thermal stratification occurs when water temperatures in a lake cause a change in density and cooler waters sink to the bottom (hypolimnion) and are separated by a thermocline from surface waters (epilimnion) Thermal stratification usually takes place in deep lakes where the wind and water currents are not strong enough to continually mix warmer waters with the cooler bottom waters. Eventually waters of the hypolimnion eventually experience anoxic conditions (where dissolved oxygen concentration fall <1 mg/L) as oxygen is consumed by benthic organisms.



In 2014 depth profiles were taken in Lake Catherine at the deep hole, using a multi-parameter sonde. Measurements were recorded at every foot from the surface to 4 ft. below the surface and every foot thereafter until the lake bottom was reached. The temperature and DO measurements are used to determine the depth of relative

STRATIFICATION

thermal resistance or where in the water column that lake stratification has set up (Appendix A, Table 6). DO and temperature profiles are a good visual of stratification taking place in a lake. Figure 8 and 9 present DO and temperature profiles from Lake Catherine for 2014.

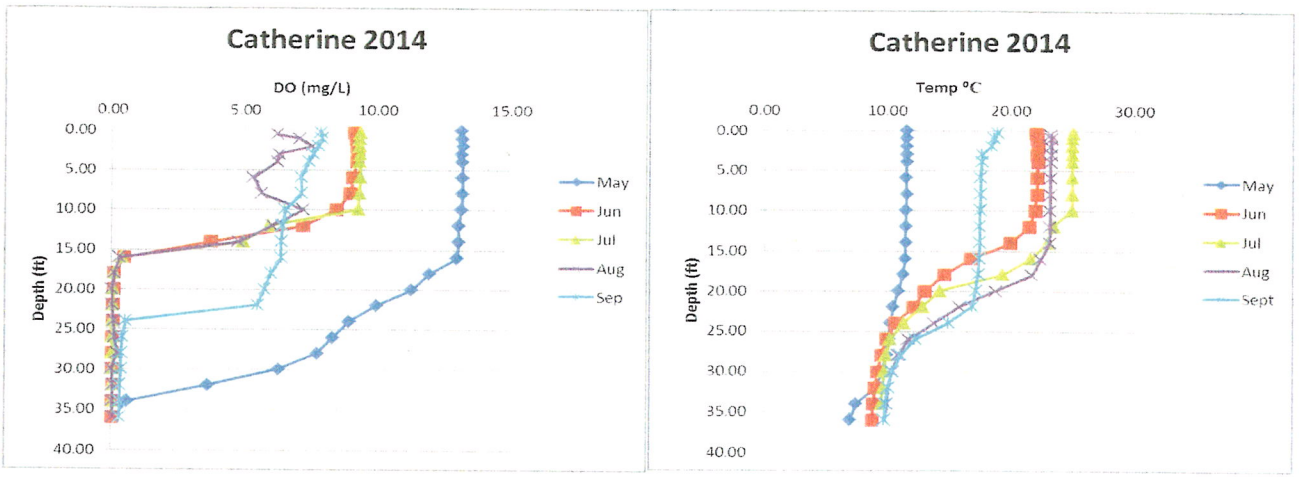


Figure 8 and 9. DO and Temperature profiles measured in Lake Catherine, 2014. Notice the lake becomes anoxic at approximately 15 feet below the surface.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is essential for the survival of fish and invertebrates and influences many different biological and chemical processes (Indiana Department of Environmental Management, 2011). DO is affected by changes in temperature and temperature changes can effect the density of the water resulting in lake stratification. DO gets used up in the hypolimnion as the cooler, better oxygenated waters are not able to mix with those of the bottom, DO is metabolized by benthic (sediment dwelling) organisms and the waters of the hypolimnion eventually become anoxic (<1.0 mg/L DO).

Fish become stressed when DO concentrations are at or below 5 mg/L and avoid areas in the lake where anoxic conditions are present. The fisheries biologist from the IDNR suggests that as long as anoxic conditions do not expand above 14' depths, there will be a sufficient volume of oxygenated water for fish to utilize. The DO concentrations in Lake Catherine Lake did not fall below the 5 mg/L threshold until after 14 feet of the surface and therefore was not a concern in 2014. Lake volume can be calculated using bathymetric data in the form of a morphometric table. The morphometric table breaks the percentage of water volume down by depth The LCHD-ES recommends that bathymetric maps be updated every 10 years, Lake Catherine has a bathymetric map presented on the Interactive Map on the FWA website (http://www.foxwaterway.state.il.us/) however, the LCHD-ES has no record of a bathymetric survey taking place and whether or not a morphometric table accompanied that map.

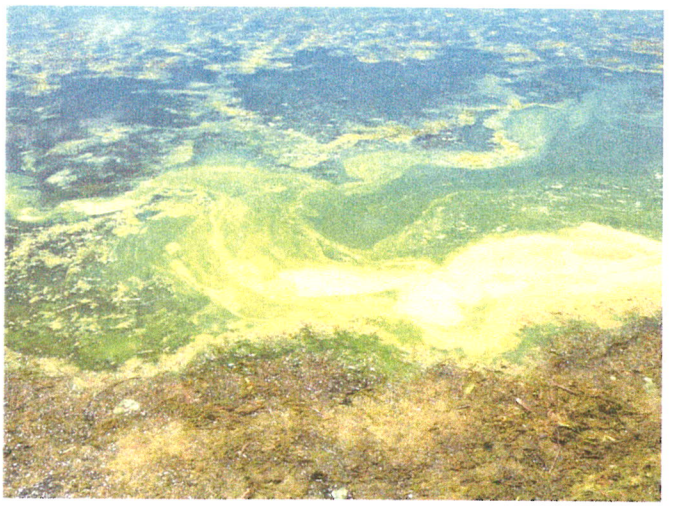
In Lake Catherine %DO was considered supersaturated (DO >100%) from May through July. %DO is considered saturated when the percent DO is 100%, or is equivalent to the ambient oxygen concentration and become supersaturated due to algae and plants producing oxygen more rapidly than it can escape into the atmosphere and %DO is greater than 100%. Although rare, supersaturated %DO can cause "gas bubble disease", this is where oxygen bubbles or emboli block the flow of blood in the blood vessels of fish. Lake Catherine exhibited supersaturated DO in waters of the epilimnion to 18' in May, and to 10 feet below the surface in July.

DISSOLVED OXYGEN (CONTINUED)

While most water quality parameter concentrations increase in the hypolimnion, DO decreases, as DO concentrations approach 2 mg/L near the lake bottom, bottom sediments become anoxic, this allows for phosphorus to release from sediments. As indicated in Figure 8 and 9 above, Lake Catherine was stratified from June through September. By September the average TP concentration in the hypolimnion of Lake Catherine was 0.6 mg/L setting up conditions conducive for fall algal blooms upon the lake mixing.

ALGAE

Historically, algal blooms have occurred on Lake Catherine during our monitoring years and planktonic blooms were again observed in 2014. Algae, like plants utilize dissolved phosphorus and nitrogen for their growth and like plants their populations can be balanced or become imbalanced and a bloom can occur usually because of excess nutrients. Although phosphorus has been identified as the source of algal blooms, it is important to pay attention to the amount of nitrogen present in the system as it has been linked to blue-green algal blooms, which have the potential to produce toxins (HABs). In May, a planktonic algal bloom was observed was supported by elevated TKN (1.70 mg/L) concentrations in the waters of the epilimnion and through the presence of supersaturated DO concentrations.



Recently, there has been an increased awareness of Harmful Algal Blooms (HABs) in Illinois. Blue green algal blooms are actually bacteria and as mentioned above can produce toxins. An initiative by the IEPA and LCHD was started in 2013 monitoring beaches for HAB's on a routine basis. In 2013, a subset of beaches were selected that would be routinely sampled as part of the program. Felter's North Beach on Lake Catherine was selected to participate in the program. The LCHD-ES sampled the water at the beach during sampling for E-coli. the sample taken was sent to an independent laboratory for enzyme-linked immunosorbent assay (ELISA). In 2013, Abraxis tests were not required on Felter's North Beach, and the results of ELISA were well below the recommended level by the World Health Organization for no contact (≥20 ug/L). If a blue-green algal bloom was present at the time of sampling, an Abraxis test was performed on a subsample to determine if toxins were present. If the results of the Abraxis test were positive for toxins, the beach manager would be advised of the results. In 2013 and 2014, none of the beaches in Lake Catherine had blue green algal blooms observed or reported. Septic system failure can contribute to HABs therefore it is important that septics are maintained on Lake Catherine.

CHLORIDES/CONDUCTIVITY

It only takes1 teaspoon of salt to pollute 5 gallons of water.

Conductivity measures the amount of ions in water, the more ions or salts in the water the higher its conductivity. It can be used to estimate both total dissolved solids ($R^2 = 0.96$) and chloride concentrations due to a strong correlation ($R^2 = 0.94$) between these parameters. Sources of chlorides are road salts (40% chloride) which are used in winter deicing programs by both public and private maintenance crews and water softener systems. The USEPA has determined that 230 mg/L of chloride is the critical concentration in which adverse impacts to aquatic ecosystems are possible if the critical concentration is maintained for prolonged periods. However, certain species can be impacted at much lower concentrations. It only takes 1 teaspoon of salt (chloride) to pollute 5 gallons of water (230 mg/L).

Recent trends show increasing chloride concentrations in surface and ground waters in the County. The chloride ion does not bind to soils or sediments so once in the water they remain there indefinitely, unless the water is diluted or treated by a reverse osmosis system, which is a very costly and not very practical for most surface water applications.

In 2014, the average chloride concentration in Lake Catherine was 91 mg/L with concentrations ranging from 87.0 mg/L to 94.0 mg/L. Chloride was not a parameter tested for in 2002, instead Conductivity was used to estimate chloride concentration in Lake Catherine. It is estimated that the average chloride concentration in 2002 was 86.9 resulting in a slight increase of 4.5% in chloride concentration between 2002 and 2014.

Although chloride concentrations were not highly elevated in 2014, single family and transportation were estimated to be the two highest contributors of total percent runoff, and therefore homeowners and those winter road maintenance crews should minimize their salt usage. Many residences in the Fox Chain 'O' Lakes remain on septic. If using a water softener, there is no removal of chloride from the waste water, as it percolates through our soils and eventually into the lake. Shifts in algal populations to blue green algae have been found and many invasive species are more tolerant of high chloride levels which can cause management issues. Saltwater is more dense than freshwater and therefore can get trapped in bottom waters eventually changing the volume of water mixed in the lake which can affect the entire ecosystem in the lake.

The LCHD-ES and Lake County Stormwater Management Commission (LCSMC) have been holding annual training sessions targeting deicing maintenance personnel for both public and private entities. Since 2010 we have provided training to approximately 468 winter maintenance personnel on the recommended application rates for applying deicers while still maintaining safe passageways. Almost all deicing products contain chloride so it is important to read and follow product labels for proper application. For instance, at a pavement temperature of 30° F, rock salt will efficiently melt ice; however at 10°F it is ineffective and therefore another product would be required to melt ice. Check with your HOA to see what is required of private companies hired to deice roads in your subdivisions. Support changes in deicing policies proposed by the local township in their attempts to incorporate best management practices into their routines.

Pavement Temp. °F	One Pound of Salt (NaCl) melts	Melt Times
30	46.3 lbs of ice	5 min.
25	14.4 lbs of ice	10 min.
20	8.6 lbs of ice	20 min.
15	6.3 lbs of ice	1 hour
10	Dry salt is ineffective and will blow away before it melts anything	

AQUATIC PLANTS

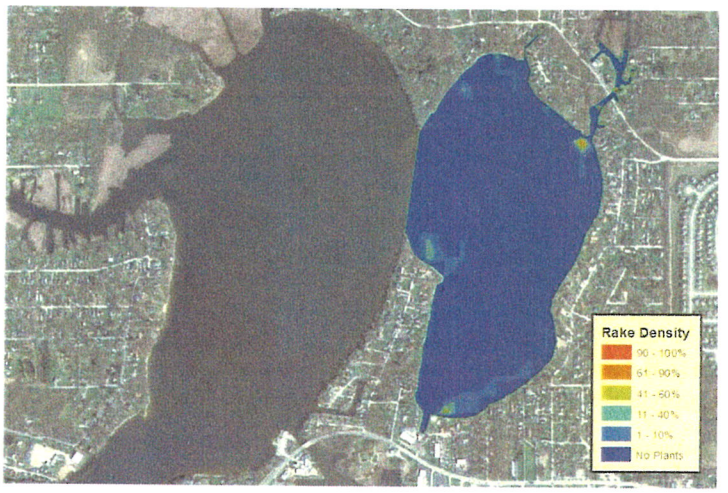


Figure 10. Status of vegetation in Lake Catherine, July, 2014.

Aquatic plants are a critical component in lakes as they uptake available nutrients such as phosphorus from the water column, making them unavailable for use by algae, filter sediments and other pollutants from the water, and stabilize bottom substrates. They also provide habitat for nesting and nursery for fish and other aquatic organisms. At times, nuisance growth has been encountered by lake managers due to invasive species and eutrophication. Aquatic vegetation surveys supply lake managers with valuable data allowing them to be more efficient and effective managers of the aquatic plant community .

In July 2014, an aquatic vegetation survey was conducted on Lake Catherine using a point intercept method. In order to accomplish this a randomized 60-meter grid was overlaid on an aerial photo of Lake Catherine using ARCGIS 10.2. A total of 178 points fell within the lake footprint. Above the 12 ft. depth, which is the average depth that plants are likely to be detected given a 3—5 ft. Secchi depth, every point was sampled regardless of whether plants were detected or not, if plants dropped out of the littoral zone after 12 ft. depth, points lying at greater depths were not sampled. To sample, a rake was lowered into the water and then scored on a scale from 1—5 (Appendix A, Table 7). These scores are associated with percent coverage and the midpoint of the percent range was used to estimate coverage. A total of 89 points were sampled and species cover, relative cover, frequency, relative frequency and relative importance were quantified using a modified Braun- Blanquet scale (Mueller-Dombois, Ellenberg, 2002). Relative importance is the sum of the relative cover and relative frequency for each species. Appendix A, Table 7 presents the estimated cover, frequency and relative importance for each species detected in the July, 2014 survey. A ranking of relative importance determined dominant species in the lake.

In 2014, vegetation was found at 22.5% of the points sampled with an estimated cover of 14.6%. Twelve plant species and Chara, a macro-algae were detected. Three floating plants were co-dominant; Coontail, Common Duckweed and Giant Duckweed. Coontail, is a native submerged aquatic species, and is tolerant of low light conditions. Figure 10 is a map delineating areas of vegetation in Lake Catherine based upon the July survey (Appendix A, Figure 6).

A floristic quality assessment was conducted on the plant species detected in our survey and resulted in an FQI score of 21.8. Floristic quality assessments are commonly used to identify natural areas, for site comparisons, and long term and habitat restoration monitoring. Since plant management occurs in areas of Lake Catherine, FQI can be used to determine the effectiveness of management practices and whether or not they are negatively affecting the quality of the native aquatic plant community. An FQI score of 21.8 indicates that the aquatic vegetation in Lake Catherine has some significance from a natural area perspective. Lake Catherine was ranked #34 out of 170 lakes that have had florist quality assessments conducted on them since 2000 (Appendix A, Table 8).

Eurasian Water milfoil, is a non-native aquatic invasive plant species was detected at 9.0% of the points assessed. The other

AQUATIC PLANTS (CONTINUED)

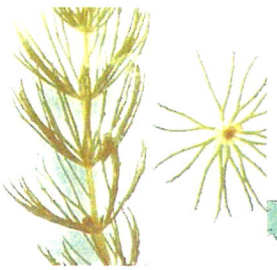
common invasive non-native aquatic plant found in lakes is Curly leaf Pondweed and although it was not detected by the LCHD at the time of the July survey, applications sent in by applicators on behalf of their clients on Lake Catherine have it listed as a targeted species. It was likely not detected either due to the application being successful, or the ephemeral nature of the plant, as it is capable overwintering, emerging early in spring before most other aquatic plants and completing its cycle before mid-July when our survey took place or a combination of both.

The LCHD-ES is recommending that Lake Catherine adopt a long term aquatic plant management plans that is developed by all stakeholders of the lake (lake associations, citizens, townships, park districts etc.). The plan would provide a template that describes the goals of aquatic plant management in Lake Catherine and defines objectives to help attain those goals. If a plan is not developed it is recommended that the native plant community be increased and therefore, if chemical treatments are used to control invasive species, they should occur in when water temperatures are not too warm as to accelerate breakdown of chemical through microbial processes as well as to ensure that chemicals have minimal, if any, impact to native plant populations and do not affect spawning fish.

What type of plants are present in a lake becomes important if using chemicals to control invasive plants. Aquatic plants like terrestrial species are of two types; monocots and dicots. The monocots contain all the pondweeds, duckweeds, naiads, elodeas and others. Dicots include species such as the milfoils such as EWM, White Water Lily, Spatterdock, Coontail, White Water Crowfoot and Water Marigold. The dominant native plants found in Lake Catherine are showcased below.

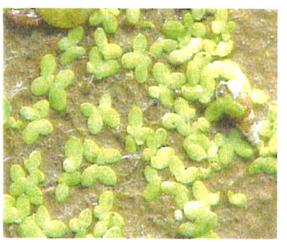
COONTAIL (DICOT

Coontail (*Cerataphyllum demeserum*) is a widespread native in and around the United States and Canada. It is identified by its forked whorl of leaves which extends the length of the stem. Early in the season, plants can be confused with Chara, a macroalgae.



DUCKWEEDS (MONOCOT)

Common duckweed (Lemna minor) and Giant Duckweed (Spirodela polyrhiza) are two widespread natives . Common duckweed has invasive tendencies and under eutrophic conditions has been found to cover entire water surfaces. Giant Duckweed has a red pigment on bottom with multiple roots coming from a cluster of leaves (pictured on bottom left).



AQUATIC PLANT MANAGEMENT

FOR FULL DETAILS OF PART 895 SEE:

HTTP://WWW.ILGA.GOV/COMMISSION/JCAR/ADMINCODE/017/01700895SECTIONS.HTML

Herbicide application is a tool utilized by home owner associations, individual residents and lake managers to control aquatic plants in Lake Catherine. Targeted species are usually non-native invasive species; however our records indicate that there has been some treatments over the years, targeting native species.

By Administrative Code, applying herbicides on Lake Catherine or any other lake in the Fox Chain 'O' Lakes requires a permit by the Illinois Department of Natural Resources (IDNR) In order to obtain the permit an application needs to be filed with the IDNR requesting a permit for pesticide application, the application can be filled out by the applicant or their representative (which is usually the pesticide consultant). It should minimally document the location and area of treatment. The targeted species, pesticide and application rate as well as an estimated time when pesticide will be applied. The application can be obtained at the FWA or its website (http://www.foxwaterway.state.il.us/). The IDNR has 45 days to issue or deny the permit. The FWA has the right to review all applications and can recommend denial of a permit if it feels that it could cause harm to the environment. Chemicals should only be used if they are labelled and registered with the Illinois Environmental Protection Agency. More information is available at the link to Part 895 of the Administrative Code which covers management of aquatic plants on the Fox Chain 'O' Lakes.

A NPDES permit is required before applying pesticides over or near waters of the state. A notice of intent to apply pesticides needs to be filed with the state and can be found at the following website: http://www.epa.state.il.us/water/permits/pesticide/forms/noi.pdf. There is a 14 day public notice period and additional information may be requested so plan ahead. Either the homeowner or its representative can apply for the permit. Once issued the permit is good for 5 years. If your treatments exceed 80 acres annually additional reporting is required. Additional documentation is required in the cases where adverse affects due to a spill or overdosing occur.

The LCHD-ES recommends that a long-term (5 year) Aquatic Plant Management Plan (APMP) be developed for Lake Catherine, and followed by any entity or homeowner applying pesticides into the lake. Developing the plan should consider all stakeholders that utilize the lake. The plan should describe all methods of control and select the best management tool for the lake, explain why it was chosen. The plan should consider timing of pesticide application, targeted species, and pesticide selection. Distributing information on pesticides that are approved for aquatic use should be included so that the stakeholders are knowledgeable about the pesticides being applied to the lake and any risks associated with those chemicals. A well prepared APMP and a morphometric table constructed from bathymetry data allows for construction of a clear concise Request for Proposal (RFP) that addresses the key considerations, sets reasonable goals and the objectives for achieving those goals. The APMP should also require monitoring of the lake vegetation to ensure that the goals are being met. This would provide information to improve the APMP if they are not met.

INVASIVE SPECIES -EURASIAN WATERMILFOIL

ILLUSTRATION OF EURASIAN WATERMILFOIL

Eurasian Watermilfoil (EWM) is a feathery submerged aquatic plant that can quickly form thick mats in shallow areas of lakes and rivers in North America. 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 (Couch & Nelson), EWM has invaded nearly every US state and at least three Canadian Provinces. Milfoil spreads when plant pieces break off and float on water currents. It can cross land to new waters by clinging to sailboats, personal watercraft, powerboats, motors, trailers, and fishing gear.

EWM was found at 9% of the points sampled with an average density of 1.19%. In 2014 chemical applications were applied in May and June, targeting EWM populations. LCHD-ES did not conduct an early season sampling in 2014, however the results of the July sampling suggest that treatments were successful.

EWM rapidly grows as water temperatures approach 59°F. The water temperature at the deep hole in Lake Catherine on May 7th was 53.6°F. In 2014, treatments should have probably occurred by the end of May to have most efficient control of EWM and to have least amount of impact on native aquatic vegetation. Recently a hybrid milfoil (M. spicatum x M. sibiricum) has been encountered. The hybrid milfoil has proven to be less sensitive than either parental species to certain herbicides. Therefore, it is important to know whether the hybrid is present this can be positively identified through genetic testing. Switching chemicals used to treat invasive species reduce the chance of the plants developing a resistance to chemicals.

EURASIAN WATERMILFOIL WAS PRESENT AT 8 SITES ON LAKE CATHERINE IN JULY 2014.

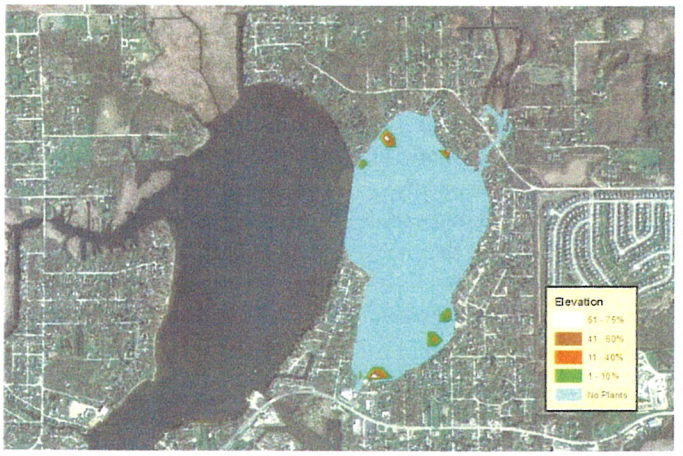


Figure 11. Status of EWM on Lake Catherine, July, 2014.

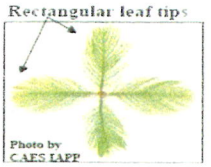
MYRIOPHYLLUM SPICATUM EXOTIC*

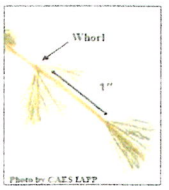
COMMON NAMES:
EURASIAN WATERMILFOIL

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; HYBRID MILFOILWHICH 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.

INVASIVE SPECIES—ZEBRA MUSSELS

ZEBRA MUSSEL

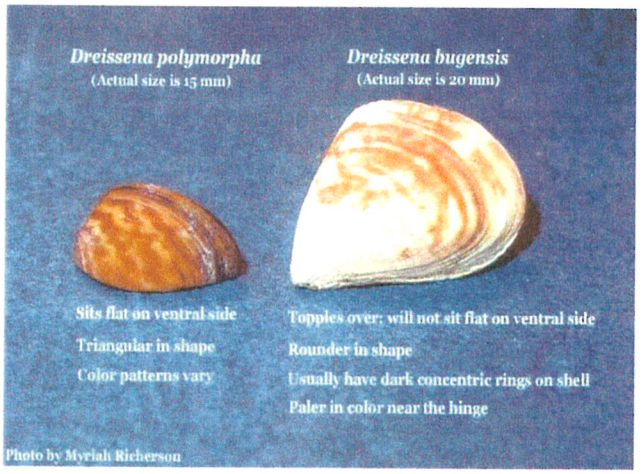
ZEBRA MUSSELS WERE NOT OBSERVED BY LCHD-ES IN LAKE CATHERINE DURING 2014.

In the late 1990's, the presence of zebra mussels (Dreissena polymorpha) was confirmed in the Fox Chain O Lakes. These mussels are believed to have been spread to this country in the mid 1980's by cargo ships from Europe that discharged their ballast water into the Great Lakes. The mussels spread throughout the Great Lakes and by 1991 had made their way into the Illinois and Mississippi Rivers. In 1999, the first sighting of the mussel in Lake County (besides Lake Michigan and the Chain of Lakes) occurred. Currently, 32 inland lakes in the county are known to be infested with the zebra mussel, but this number could be much higher, since the zebra mussel can go unnoticed.

The zebra mussel's reproductive cycle allows for rapid expansion of the population. A mature female can produce up to 40,000 eggs in a cycle and up to one million in a season. They can live as long as five years and have an average life span of about 3.5 years. Adults are typically about the size of a thumbnail but can grow as large as 2 inches in diameter. Colonies can reach densities of 30,000 - 70,000 mussels per square meter. Due to their quick life cycle and explosive growth rate, zebra mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interference with feeding, habitat, growth, movement and reproduction.

The impact that mussels have on fish populations is not fully understood. However, zebra mussels feed on phyto-plankton (algae), which is also a major food source for planktivorous fish, such as minnows and shad and young of the year bluegill. These fish, in turn, are a food source for piscivorus fish (fish eating fish), such as largemouth bass and northern pike.

Zebra mussels clogging water intake pipes have caused economic hardships for power plants, public water supplies, and industrial facilities. Boats stored on the water offer suitable areas for zebra mussels to start a colony. They can eventually affect cooling and exhaust systems on boats and create



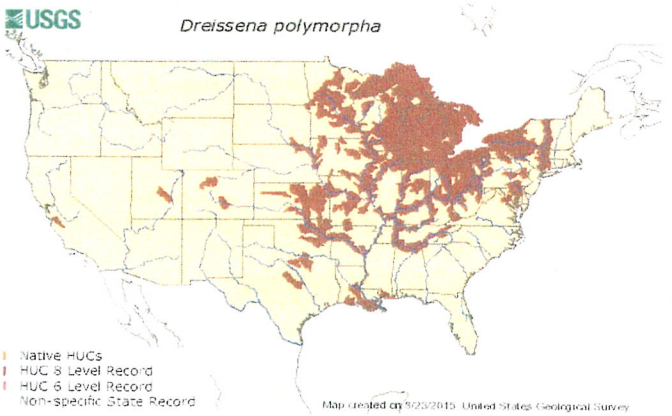


Figure 11. Status of Zebra Mussels in the US (USGS, 2015)

KEY FEATURES:

THE ZEBRA MUSSEL IS A SMALL SHELLFISH NAMED FOR THE STRIPED PATTERN OF ITS SHELL. COLOR PATTERNS CAN VARY TO THE POINT OF HAVING ONLY DARK OR LIGHT COLORED SHELLS AND NO STRIPES. IT IS TYPICALLY FOUND ATTACHED TO OBJECTS, SURFACES, OR OTHER MUSSELS BY THREADS EXTENDING FROM UNDERNEATH THE SHELLS. ALTHOUGH SIMILAR IN APPEARANCE TO THE QUAGGA MUSSEL (*DREISSENA BUGENSIS*), THE TWO SPECIES CAN BE EASILY DISTINGUISHED. WHEN PLACED ON A SURFACE ZEBRA MUSSELS ARE STABLE ON THEIR FLATTENED UNDERSIDE WHILE QUAGGA MUSSELS, LACKING A FLAT UNDERSIDE, WILL FALL OVER. SEE MACKIE AND CHLOSSER (1996) FOR A KEY TO ADULT DREISSENIDS

INVASIVE SPECIES -ZEBRA MUSSELS (CONTINUED)

extra drag causing lower fuel economy. Studies on the transport of the zebra mussel have shown that they can be found in any area of a boat that holds water, including the engine cooling system, bilge water, and bait buckets used in fishing. Researchers found that many of the mussel larvae were being transported via aquatic plants that were taken from one lake to another on boats and trailers. Therefore, it is important that all boats and trailers entering or leaving the Fox Chain O' Lakes are inspected for aquatic plants and all water from the bilge and motors are drained.

Recently, an experimental biocide called Zequanox has shown to be effective against zebra mussels and it is not toxic to humans, native bivalves, and fish. In-lake tests show that it reached 97.1% mortality on zebra mussels within 14 days of treatment . Zequanox is a non-chemical solution made from dead cells of a naturally occurring microbe (Psuedomonas flourescens). It is highly selective to zebra and quagga mussels and has low toxicity (Marrone Bio Innovasions). Currently winter drawdowns have exposed the zebra mussels along the shorelines, however prevention is the best defense against any invasive species spread. The Great Lakes Sea Grant Network provides the following tips to prevent the spread of zebra mussels:

Always inspect your boat and boat trailer carefully before transporting. Studies have shown that transport via aquatic plant fragments is one of the major contributors to the spread of zebra mussels.

Drain all bilge waters, live wells, bait buckets and engine compartments before entering another lake. Make sure water is not trapped in your trailer. Never transport water from one lake to another.

Flush clean water (tap) through the cooling system of your motor to rinse out any larvae.

Full grown zebra mussels can be easily seen but cling stubbornly to surfaces. Boats that have been in the water for long periods of time should be carefully inspected. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 5 days, preferably up to two weeks. The mussels will die and drop off.

In their earlier stages, attached zebra mussels may not be easily seen. Pass your hand across the boat's bottom - if it feels grainy, it's probably covered with mussels. Don't take a chance; clean them off by scraping or blasting.

Dispose of the mussels in a trash barrel or other garbage container. Don't leave them on the shore where they could be swept back into the lake or foul the area.

BEACHES

Lake Catherine has 3 licensed beaches; Felter's North, Warriners Subdivision II, and Club Zobak. Licensed beaches are sampled bi-weekly for E-coli during the beach season, Memorial Day through Labor Day. If E-coli colonies are ≥ 235 colonies/100 mL, a swim ban is issued. Since 2004, there was only one swim ban at Warriners Subdivision, it occurred in July of 2012; E-coli colonies ranged from 290.9—325.5 colonies/100 mL. The elevated concentrations were likely caused by waterfowl and subsided by the next business day sampling, with E-coli colonies measured at 8.6 colonies/100 mL.

In 2013 and 2014, an additional sample collected at Felter's North Beach was routinely tested for the presence of toxins associated with blue-green algae (HABs). Felter's North was randomly selected as part of a pilot program initiated by LCHD and the IEPA. The sample was sent out to an independent laboratory for enzyme-linked immunosorbent assay (ELISA). In 2013, the results of ELISA were well below the recommended level by the World Health Organization for no contact (≥20 ug/L).

FISH

The Illinois Department of Natural Resources continuously monitors the fish populations in the Fox Chain 'O' Lakes through biennial fish surveys. They normally catch between 35—40 fish species during these surveys. In 2013, the IDNR conducted their biennial survey on the Fox Chain 'O' Lakes. During this survey they sampled Lake Catherine and Channel Lake and found 27 species of fish. Bluegill was the most abundant fish caught (354 individuals), however, Muskellunge (3) and Carp (7) were the fish having the greatest average weight, 8.4 lbs. and 7.6 lbs., respectively.

The Fox Chain 'O' Lakes is annually stocked with 243,000 2"walleye fingerlings, 2 million walleye fry, and at least 2000 muskie fingerlings. Sixty-five thousand 4" to 6" largemouth bass fingerlings are stocked every other year. Natural reproduction maintains all other species.

Fish Species in Lake Catherine and Channel Lake, 2013.

- Black Crappie
- Blue Gill
- Blunt nose minnow
- Bowfin
- Brown Bullhead
- Brook Silverside
- Carp
- Channel Catfish
- Emerald Shiner
- Fresh Water Drum
- Golden Shiner
- Green Sunfish
- Gizzard Shad
- Johnny Darter
- Large Mouth Bass
- Log Perch
- Muskellunge
- Northern Pike
- Pumpkinseed
- Spot tail Shiner
- Quillback
- Walleye
- Warmouth
- White Bass
- Yellow Bullhead
- Yellow Perch
- Yellow Bass

FISHING REGULATIONS – Includes the Fox River from the Illinois State line to the Algonquin Dam. Trot line fishing is permitted.

Species	Daily Creel Limit	Minimum Length Limit
Largemouth Bass and	6	14"
Smallmouth Bass (No more than 3 fish can be smallmouth bass, smallmouth must be released immediately between April 1 to June 15, no possession)		
Walleye	4	14" to 18" (18" to 24" protected slot limit, no possession) only 1 fish can be >24"
Muskie	1	48"
Northern Pike	3	24"

(see current Illinois Fishing Information booklet or IFISHILLINOIS website http://www.ifishillinois.org/ for specific details).

LakeCounty
Health Department and
Community Health Center

ENVIRONMENTAL 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.

RECOMMENDATIONS

LCHD-ES recommends the following actions for improving the water quality and overall health of Lake Catherine:

- Develop an aquatic plant management plan for Lake Catherine that can be used as a template for those interested in aquatic plant management on Lake Catherine.
- Encourage groups within the Trevor Creek watershed to incorporate best management practices to reduce the nutrient load (especially phosphorus) into Lake Catherine and the Fox Chain 'O' Lakes.
- Encourage municipalities within the watershed to use chloride products efficiently in their winter road maintenance programs while they still maintain safe passageways.
- Inspect and maintain septic systems as they can be a source for nutrients, E-coli contamination and chlorides in Lake Catherine and the Fox Chain 'O' Lakes.
- Organize a work group for working on an APMP, grants, and other items that can help improve the health of Lake Catherine and the Fox Chain 'O' Lakes. In 2015, the Fox River Watershed is prioritized for receiving 319 grant monies to implement projects that will improve the water quality of the Fox River. The grant application is due on August 1, 2015. The LCHD-ES can provide assistance to the group when formulating and implementing the grant.
- Update bathymetric map and create a morphometric table to assist lake managers in calculating volumes for in order to check for problems with DO or for aquatic plant management or many other lake management activities.

STOP AQUATIC HITCHHIKERS!™

Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

When you leave a body of water:

- Remove any visible mud, plants, fish or animals before transporting equipment.
- Eliminate water from equipment before transporting.
- Clean and dry anything that comes into contact with water (boats, trailers, equipment, clothing, dogs, etc.).
- Never release plants, fish or animals into a body of water unless they came out of that body of water.

APPENDIX A

FIGURES AND TABLES
LAKE CATHERINE
2014

Figure 1. LCHD water quality sampling points – Lake Catherine, 2014.

Table 1. Approximate land uses and retention time for Lake Catherine, 2014. (Lake County Mapping Services and SEWRPC data)

Land Use	Acreage	% of Total
Agricultural	4293.85	42.5%
Disturbed Land	9.38	0.1%
Forest and Grassland	599.96	5.9%
Government and Institutional	76.38	0.8%
Industrial	48.65	0.5%
Multi Family	26.87	0.3%
Office	0.00	0.0%
Public and Private Open Space	312.89	3.1%
Retail/Commercial	49.72	0.5%
Single Family	1565.75	15.5%
Transportation	660.98	6.5%
Utility and Waste Facilities	0.00	0.0%
Water	943.41	9.3%
Wetlands	1522.46	15.1%
Total Acres	**10110.30**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	4293.85	0.05	590.4	16.7%
Disturbed Land	9.38	0.05	1.3	0.0%
Forest and Grassland	599.96	0.05	82.5	2.3%
Government and Institutional	76.38	0.50	105.0	3.0%
Industrial	48.65	0.50	66.9	1.9%
Multi Family	26.87	0.50	36.9	1.0%
Office	0.00	0.85	0.0	0.0%
Public and Private Open Space	312.89	0.15	129.1	3.6%
Retail/Commercial	49.72	0.85	116.2	3.3%
Single Family	1565.75	0.30	1291.7	36.5%
Transportation	660.98	0.50	908.8	25.7%
Utility and Waste Facilities	0.00	0.30	0.0	0.0%
Water	943.41	0.00	0.0	0.0%
Wetlands	1522.46	0.05	209.3	5.9%
TOTAL	**10110.30**		**3538.3**	100.0%

Lake volume	**2188.90**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.62**	**years**
	225.80	**days**

Figure 2. Land Use and Watershed for Lake Catherine (Lake County Mapping Services and SEWRPC data).

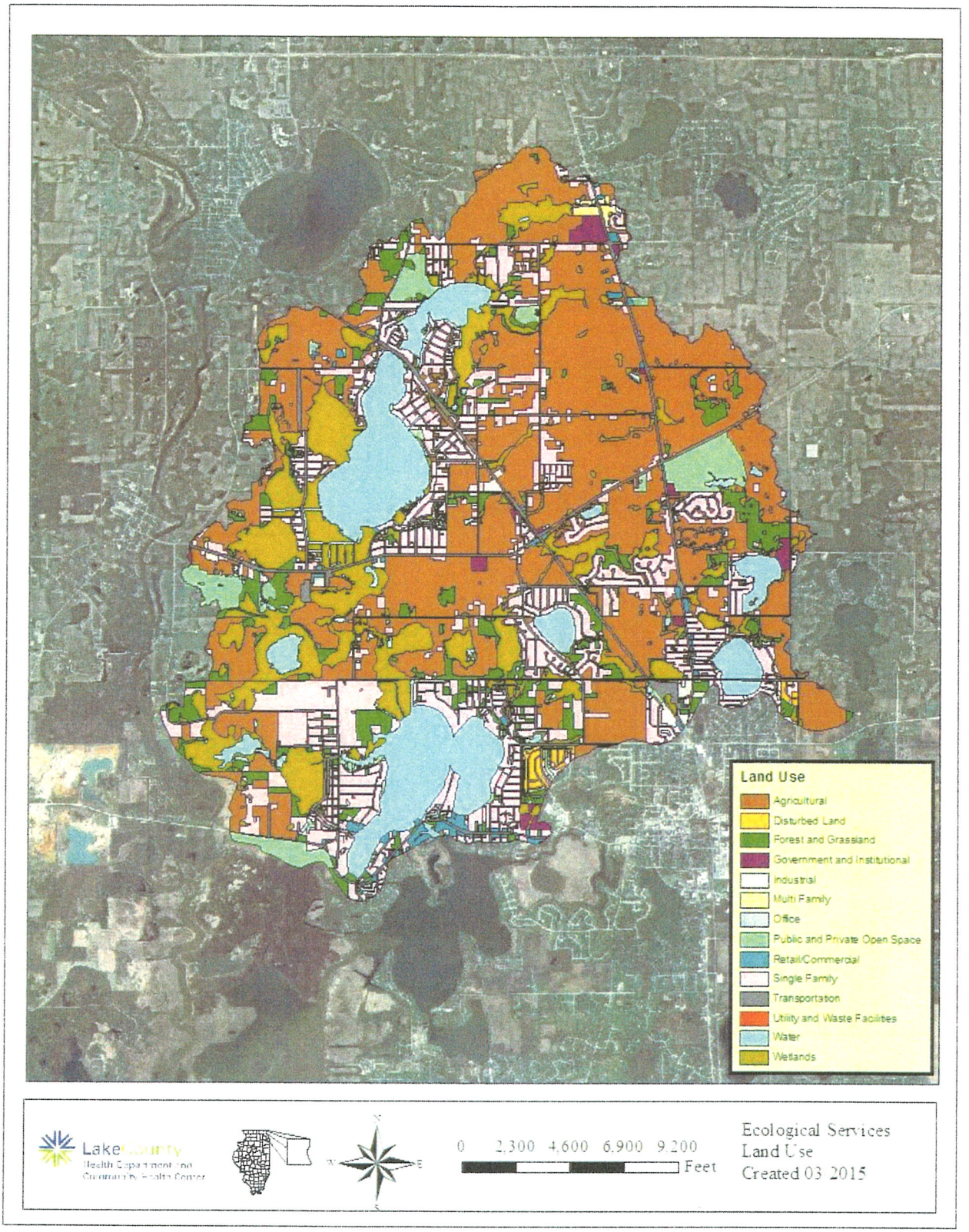


Table 3. Water Quality Data Summary for Lake Catherine, 2014.

Catherine	Epilimnion															
2014	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N*	TP	SRP	Cl-	TDS**	TSS	TS	TVS	SECCHI	COND	pH	DO
7-May	3.00	186	1.70	<0.10	<0.05	0.110	<0.005	94.0	375	13.0	426	104	1.61	0.6522	8.89	13.16
10-Jun	3.00	188	1.22	<0.10	<0.05	0.047	<0.005	93.0	384	7.6	429	124	7.50	0.6696	8.49	9.25
8-Jul	3.00	188	1.22	<0.10	<0.05	0.047	<0.005	87.0	387	7.6	417	122	2.60	0.6752	8.41	9.34
13-Aug	3.00	182	1.29	<0.10	<0.05	0.044	<0.005	90.2	365	9.6	396	106	1.58	0.6307	8.33	6.29
16-Sep	3.00	171	1.57	0.14	<0.05	0.064	<0.005	90.8	359	10.0	400	106	1.23	0.6190	8.03	7.59
	Average	183	1.40	0.11[k]	<0.05	0.062	<0.005	91.0	374	9.6	414	112	2.90	0.6493	8.43	9.13

Catherine	Epilimnion															
2002	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N*	TP	SRP	Cl-**	TDS**	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	1.00	220	1.70	0.15	0.18	0.038	0.018	95.9	385	16.0	ND	4	8.67	0.6707	8.2	ND
12-Jun	3.00	195	1.35	0.01	0.03	0.045	0.006	85.5	368	9.0	ND	3	6.92	0.6367	8.34	ND
17-Jul	3.00	255	1.29	<0.10	<0.05	0.017	0.005	80.1	359	1.0	ND	1	8.58	0.6192	8.33	ND
14-Aug	3.00	195	<0.50	<0.10	<0.05	0.024	0.011	80.9	360	4.0	ND	4	2.17	0.6217	8.44	ND
2-Oct	3.00	255	<0.50	0.15	0.02	0.030	0.004	92.0	378	3.0	ND	3	6.58	0.6581	8.09	ND
	Average	224	1.45[k]	0.10[k]	0.07[k]	0.031	0.009	86.9	370	6.6	ND	3	6.58	0.6413	8.28	ND

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 + Nitrite nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L

TDS = Total dissolved solids, mg/L
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
**=Estimated based on Conductivity
ND = no data; data not available

Table 3. Water Quality Data Summary for Lake Catherine, 2014.

Catherine	Hypolimnion															
2014	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N*	TP	SRP	Cl-	TDS**	TSS	TS	TVS	SECCHI	COND	pH	DO
7-May	33	193	2.71	1.31	<0.05	0.248	0.052	94	386	12.0	442	116	NA	0.6741	7.80	2.13
10-Jun	33	220	5.32	3.89	<0.05	0.619	0.550	93	405	5.0	445	130	NA	0.7104	7.24	0.05
8-Jul	32	237	5.41	4.85	<0.05	0.624	0.618	99	432	4.0	453	126	NA	0.7657	7.22	0.04
13-Aug	33	250	6.62	5.49	<0.05	0.730	0.683	101	421	3.4	450	131	NA	0.7431	7.06	0.05
16-Sep	34	255	7.95	6.49	<0.05	0.783	0.747	100	441	3.2	439	87	NA	0.7820	6.60	0.32
	Average	231	5.60	4.41	<0.05	0.601	0.530	97.3	417	5.5	446	118	NA	0.7351	7.18	0.52

Catherine	Hypolimnion															
2002	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N*	TP	SRP	Cl-**	TDS**	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	33	285	1.27	0.46	0.07	0.085	0.061	97	386	16.0	ND	6	NA	0.6738	7.82	ND
12-Jun	33	220	2.24	1.1	<0.05	0.252	0.233	98	387	6.0	ND	2	NA	0.6760	7.45	ND
17-Jul	33	275	4.34	1.8	0.010	0.301	0.272	99	390	3.0	ND	3	NA	0.6810	7.29	ND
14-Aug	33	265	<0.5	1.8	<0.05	0.28	0.242	107	403	2.0	ND	2	NA	0.7067	7.15	ND
2-Oct	34	350	<0.5	3.8	<0.05	0.494	0.524	122	428	2.0	ND	2	NA	0.7573	6.94	ND
	Average	279	2.62	1.79	0.04	0.282	0.266	104.6	399	5.8	ND	3	NA	0.6990	7.33	ND

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 + Nitrite nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L

TDS = Total dissolved solids, mg/L
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
**=Estimated based on Conductivity
ND = no data; data not available

Figure 3. 2002 and 2014 Secchi Depths compared to 2014 Lake County Median Secchi.

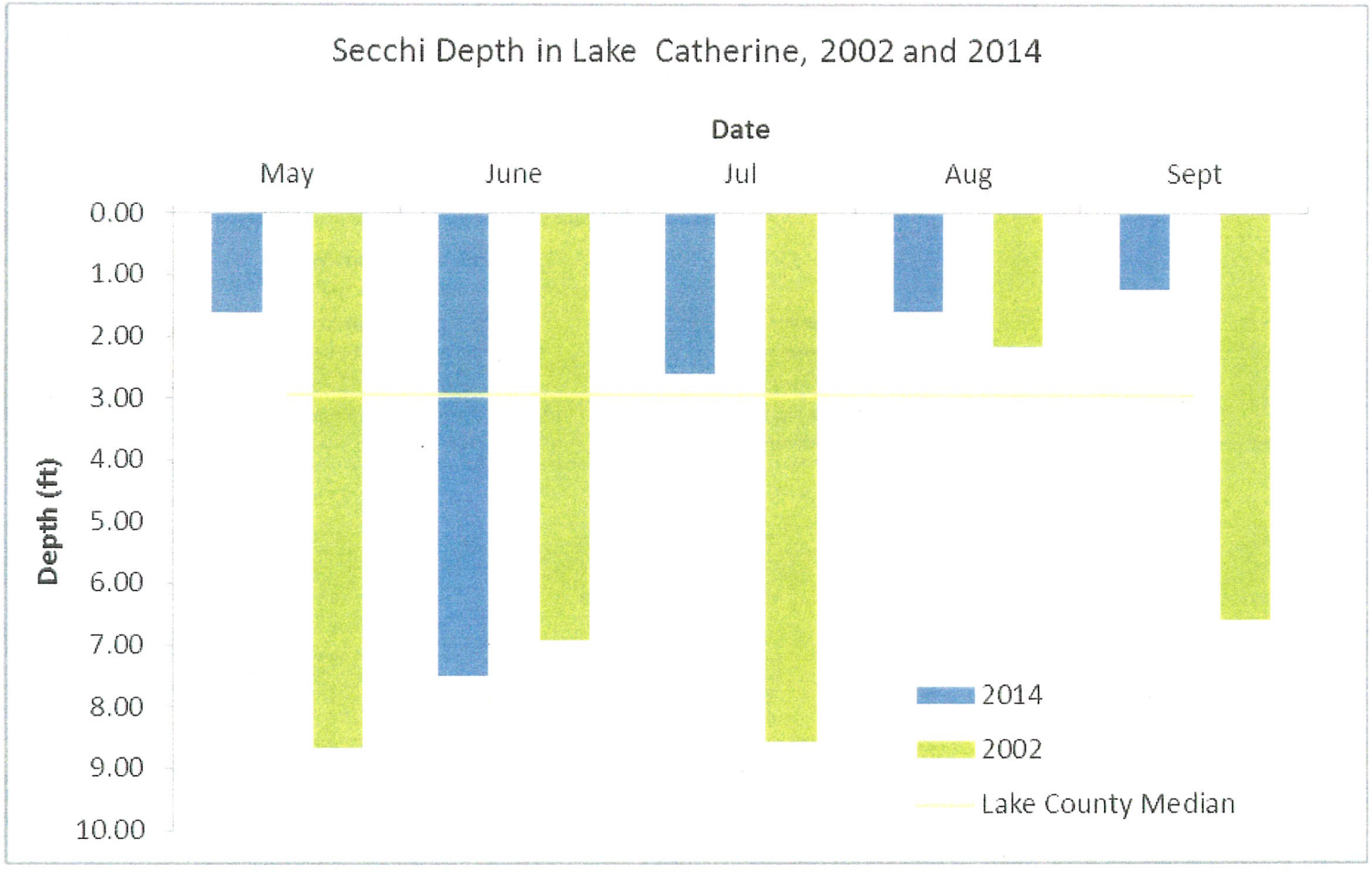


Figure 4. VLMP Secchi Data 2011 – 2014.

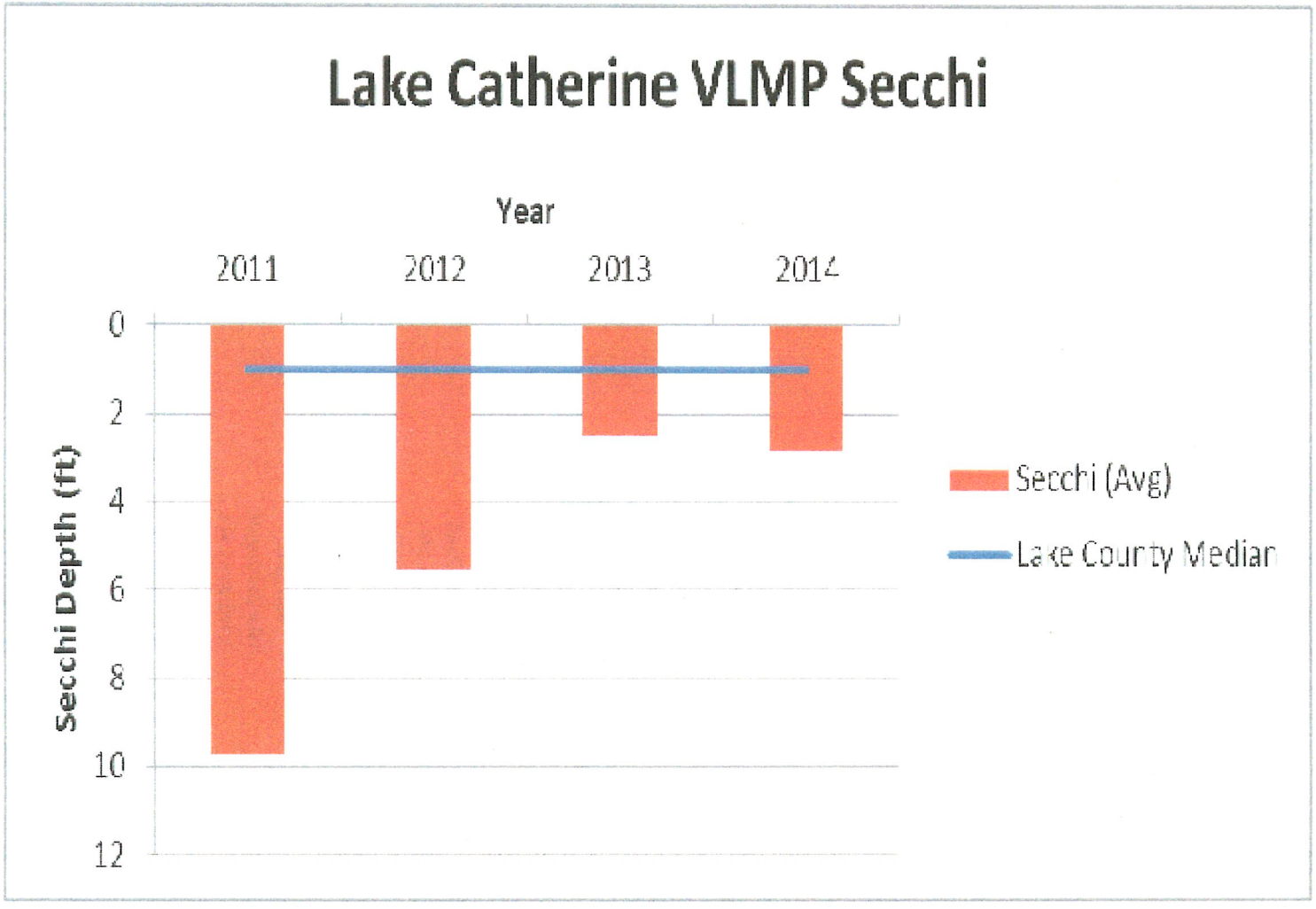


Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2014.

RANK	LAKE NAME	SECCHI AVE	TSIsd
1	Windward Lake	14.28	38.79
2	Lake Carina	13.21	39.92
3	Cedar Lake	12.55	41.00
4	Druce Lake	12.25	41.00
5	Pulaski Pond	11.69	41.68
6	West Loon Lake	11.55	41.85
7	Indpendence Grove	11.50	41.92
8	Sterling Lake	11.35	42.10
9	Lake Zurich	10.40	43.37
10	Third Lake	9.76	44.00
11	Davis Lake	9.65	44.44
12	Harvey Lake	9.47	44.72
13	Little Silver Lake	9.42	44.79
14	Old School Lake	9.40	44.82
15	Lake Kathryn	9.39	44.84
16	Dugdale Lake	9.22	45.10
17	Dog Training Pond	9.04	45.39
18	Banana Pond	8.85	45.69
19	Deep Lake	8.83	45.72
20	Stone Quarry Lake	8.81	45.76
21	Lake of the Hollow	8.74	45.87
22	Cross Lake	8.18	46.83
23	Ames Pit	8.14	46.90
24	Bangs Lake	8.02	47.00
25	Briarcrest Pond	8.00	47.15
26	Sand Lake	7.48	48.12
27	Sand Pond (IDNR)	7.42	48.23
28	Timber Lake (North)	7.37	48.33
29	Lake Miltmore	7.35	48.37
30	Lake Leo	7.31	48.45
31	Schreiber Lake	7.25	48.57
32	Nielsen Pond	7.23	48.61
33	Honey Lake	7.17	48.73
34	Lake Minear	7.13	48.81
35	Round Lake	7.01	49.05
36	Highland Lake	6.97	49.14
37	Lake Helen	6.43	50.30
38	Sun Lake	6.33	50.52
39	Lake Barrington	6.12	51.00
40	Cranberry Lake	5.94	51.00
41	Lake Fairfield	5.89	51.56
42	Gages Lake	5.45	52.68
43	Wooster Lake	5.33	47.00
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

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2014.

RANK	LAKE NAME	SECCHI AVE	TSIsd
50	Peterson Pond	4.51	55.41
51	Timber Lake (South)	4.46	56.00
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	North Tower Lake	3.89	60.00
65	Leisure Lake	3.85	57.69
66	Salem Lake	3.77	58.00
67	Lake Fariview	3.75	58.00
68	Countryside Glen Lake	3.64	58.50
69	Taylor Lake	3.52	58.99
70	Hastings Lake	3.52	58.99
71	Duck Lake	3.49	59.11
72	Fish Lake	3.47	59.19
73	Bishop Lake	3.47	59.19
74	Lake Lakeland Estates	3.41	59.00
75	Lake Holloway	3.40	59.49
76	Stockholm Lake	3.38	59.57
77	East Loon Lake	3.30	59.92
78	Bresen Lake	3.28	60.00
79	Summerhill Estates Lake	3.27	60.05
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	61.00
85	Lake Christa	3.01	61.24
86	Lucy Lake	2.99	61.34
87	Lake Catherine	2.90	62.00
88	St. Mary's Lake	2.79	62.34
89	Channel Lake	2.77	62.00
90	Werhane Lake	2.71	62.76
91	East Meadow Lake	2.61	63.30
92	Buffalo Creek Reservoir 1	2.60	64.00
93	Countryside Lake	2.58	63.00
94	Kemper Lake 1	2.56	63.58
95	Bluff Lake	2.51	64.00
96	Broberg Marsh	2.50	63.92
97	Antioch Lake	2.48	64.03
98	Little Bear Lake	2.38	64.63

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2014.

RANK	LAKE NAME	SECCHI AVE	TSIsd
99	Island Lake	2.32	65.00
100	Tower Lake	2.31	56.00
101	Buffalo Creek Reservoir 2	2.30	67.00
102	Woodland Lake	2.28	65.00
103	Rivershire Pond 2	2.23	65.57
104	Lake Charles	2.20	65.76
105	College Trail Lake	2.18	65.89
106	Loch Lomond	2.17	65.96
107	Redhead Lake	2.16	65.00
108	Pistakee Lake	2.15	66.00
109	Echo Lake	2.11	66.36
110	Eagle Lake (S1)	2.10	66.43
111	West Meadow Lake	2.07	66.64
112	Forest Lake	2.04	66.85
113	Grand Ave Marsh	2.03	66.92
114	Columbus Park Lake	2.03	66.92
115	Grassy Lake	2.00	67.14
116	Petite Lake	2.00	67.00
117	Sylvan Lake	1.98	67.28
118	Bittersweet Golf Course #13	1.98	67.28
119	Fischer Lake	1.96	67.43
120	Spring Lake	1.78	69.00
121	Kemper Lake 2	1.77	68.90
122	Fourth Lake	1.77	68.90
123	Nippersink Lake	1.73	69.23
124	Deer Lake Meadow Lake	1.73	69.23
125	Lake Louise	1.68	69.65
126	Willow Lake	1.63	70.09
127	Slough Lake	1.63	70.09
128	Rasmussen Lake	1.62	70.17
129	Lake Farmington	1.62	70.17
130	Half Day Pit	1.60	70.35
131	Lake Marie	1.56	68.00
132	Longview Meadow Lake	1.51	71.19
133	Lake Matthews	1.48	72.00
134	Big Bear Lake	1.32	73.13
135	Fox Lake	1.28	74.00
136	Dunn's Lake	1.22	74.00
137	Lake Eleanor	1.16	74.99
138	McDonald Lake 1	1.13	75.37
139	Lake Napa Suwe	1.06	105.00
140	Rollins Savannah 1	1.05	76.43
141	Osprey Lake	1.03	76.70
142	Manning's Slough	1.00	77.13
143	Rollins Savannah 2	0.95	77.87
144	Dog Bone Lake	0.94	78.02
145	Redwing Marsh	0.88	78.97
146	Flint Lake Oulet	0.83	79.82
147	Slocum Lake	0.81	80.00

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2014.

RANK	LAKE NAME	SECCHI AVE	TSIsd
148	Fairfield Marsh	0.81	80.17
149	Oak Hills Lake	0.79	80.53
150	Grass Lake	0.78	77.00
151	Lake Nippersink	0.77	81.00
152	South Churchill Lake	0.73	81.67
153	Lake Forest Pond	0.71	82.07
154	ADID 127	0.66	83.12
155	North Churchill Lake	0.61	84.26
156	Hidden Lake	0.56	85.54
157	Ozaukee Lake	0.51	86.84
158	McDonald Lake 2	0.50	87.12

Table 5. Lake County Average TSI phosphorus (TSIp) Ranking 2000-2014.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Cedar Lake	0.0130	41.14
4	Indpendence Grove	0.0130	41.14
5	Lake Zurich	0.0135	41.68
6	Druce Lake	0.0140	42.00
7	Windward Lake	0.0160	44.13
8	Sand Pond (IDNR)	0.0165	44.57
9	West Loon	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Banana Pond	0.0200	47.35
12	Gages Lake	0.0200	47.35
13	Lake Kathryn	0.0200	47.35
14	Lake Minear	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Cross Lake	0.0220	48.72
19	Dog Training Pond	0.0220	48.72
20	Sun Lake	0.0220	48.72
21	Deep Lake	0.0230	49.36
22	Lake of the Hollow	0.0230	49.36
23	Round Lake	0.0230	49.36
24	Stone Quarry Lake	0.0230	49.36
25	Little Silver Lake	0.0250	50.57
26	Bangs Lake	0.0260	51.13
27	Lake Leo	0.0260	51.13
28	Cranberry Lake	0.0270	51.68
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Fourth Lake	0.0360	53.00
32	Lambs Farm Lake	0.0310	53.67
33	Old School Lake	0.0310	53.67
34	Grays Lake	0.0310	54.00
35	Harvey Lake	0.0320	54.50
36	Hendrick Lake	0.0340	55.00
37	Honey Lake	0.0340	55.00
38	Sand Lake	0.0380	56.00
39	Third Lake	0.0384	56.00
40	Sullivan Lake	0.0370	56.22
41	Ames Pit	0.0390	56.98
42	Diamond Lake	0.0390	56.98
43	East Loon	0.0400	57.34
44	Schreiber Lake	0.0400	57.34
45	Waterford Lake	0.0400	57.34
46	Hook Lake	0.0410	57.70
47	Nielsen Pond	0.0450	59.04
48	Seven Acre Lake	0.0460	59.36
49	Turner Lake	0.0460	59.36
50	Willow Lake	0.0460	59.36
51	East Meadow Lake	0.0480	59.97
52	Lucky Lake	0.0480	59.97
53	Old Oak Lake	0.0490	60.27

Table 5. Lake County Average TSI phosphorus (TSIp) Ranking 2000-2014.

RANK	LAKE NAME	TP AVE	TSIp
54	College Trail Lake	0.0500	60.56
55	Hastings Lake	0.0520	61.13
56	Butler Lake	0.0530	61.40
57	West Meadow Lake	0.0530	61.40
58	Wooster Lake	0.0530	61.40
59	Lucy Lake	0.0550	61.94
60	Lake Linden	0.0570	62.45
61	Lake Christa	0.0580	62.70
62	Owens Lake	0.0580	62.70
63	Briarcrest Pond	0.0580	63.00
64	Lake Barrington	0.0600	63.10
65	Redhead Lake	0.0608	63.20
66	Lake Lakeland Estates	0.0620	63.66
67	Lake Naomi	0.0620	63.66
68	Lake Tranquility (S1)	0.0620	63.66
69	Lake Catherine	0.0620	63.76
70	Liberty Lake	0.0630	63.89
71	North Tower Lake	0.0630	63.89
72	Werhane Lake	0.0630	63.89
73	Countryside Glen Lake	0.0640	64.12
74	Davis Lake	0.0650	64.34
75	Leisure Lake	0.0650	64.34
76	St. Mary's Lake	0.0670	64.78
77	Channel Lake	0.0680	64.91
78	Buffalo Creek Reservoir 1	0.0680	65.00
79	Mary Lee Lake	0.0680	65.00
80	Little Bear Lake	0.0680	65.00
81	Timber Lake (South)	0.0720	65.82
82	Lake Helen	0.0720	65.82
83	Grandwood Park Lake	0.0720	65.82
84	Crooked Lake	0.0710	66.00
85	ADID 203	0.0730	66.02
86	Broberg Marsh	0.0780	66.97
87	Redwing Slough	0.0822	67.73
88	Tower Lake	0.0830	67.87
89	Countryside Lake	0.0800	68.00
90	Lake Nippersink	0.0800	68.00
91	Woodland Lake	0.0800	68.00
92	Lake Fairview	0.0890	68.00
93	Potomac Lake	0.0850	68.21
94	White Lake	0.0862	68.42
95	Grand Ave Marsh	0.0870	68.55
96	North Churchill Lake	0.0870	68.55
97	McDonald Lake 1	0.0880	68.71
98	Pistakee Lake	0.0880	68.71
99	Rivershire Pond 2	0.0900	69.04
100	South Churchill Lake	0.0900	69.04
101	McGreal Lake	0.0910	69.20
102	Lake Charles	0.0930	69.40
103	Deer Lake	0.0940	69.66
104	Eagle Lake (S1)	0.0950	69.82
105	International Mine and Chemical Lake	0.0950	69.82
106	Valley Lake	0.0950	69.82

Table 5. Lake County Average TSI phosphorus (TSIp) Ranking 2000-2014.

RANK	LAKE NAME	TP AVE	TSIp
107	Buffalo Creek Reservoir 2	0.0960	69.97
108	Fish Lake	0.0960	69.97
109	Lochanora Lake	0.0960	69.97
110	Big Bear Lake	0.0960	69.97
111	Fox Lake	0.1000	70.52
112	Nippersink Lake - LCFP	0.1000	70.56
113	Sylvan Lake	0.1000	70.56
114	Petite Lake	0.1020	70.84
115	Longview Meadow Lake	0.1020	70.84
116	Lake Marie	0.1030	71.00
117	Dunn's Lake	0.1070	71.53
118	Lake Forest Pond	0.1070	71.53
119	Long Lake	0.1070	71.53
120	Grass Lake	0.1090	71.77
121	Spring Lake	0.1100	71.93
122	Kemper 2	0.1100	71.93
123	Bittersweet Golf Course #13	0.1100	71.93
124	Bluff Lake	0.1120	72.00
125	Middlefork Savannah Outlet 1	0.1120	72.00
126	Osprey Lake	0.1110	72.06
127	Bresen Lake	0.1130	72.32
128	Round Lake Marsh North	0.1130	72.32
129	Deer Lake Meadow Lake	0.1160	72.70
130	Lake Matthews	0.1180	72.94
131	Taylor Lake	0.1180	72.94
132	Island Lake	0.1210	73.00
133	Columbus Park Lake	0.1230	73.54
134	Echo Lake	0.1250	73.77
135	Lake Holloway	0.1320	74.56
136	Antioch Lake	0.1450	75.91
137	Lakewood Marsh	0.1510	76.50
138	Pond-A-Rudy	0.1510	76.50
139	Forest Lake	0.1540	76.78
140	Slocum Lake	0.1500	77.00
141	Middlefork Savannah Outlet 2	0.1590	77.00
142	Grassy Lake	0.1610	77.42
143	Salem Lake	0.1650	77.78
144	Half Day Pit	0.1690	78.12
145	Lake Eleanor	0.1810	79.11
146	Lake Farmington	0.1850	79.43
147	Lake Louise	0.1850	79.43
148	ADID 127	0.1890	79.74
149	Lake Napa Suwe	0.1940	80.00
150	Patski Pond	0.1970	80.33
151	Dog Bone Lake	0.1990	80.48
152	Summerhill Estates Lake	0.1990	80.48
153	Redwing Marsh	0.2070	81.05
154	Stockholm Lake	0.2082	81.13
155	Bishop Lake	0.2160	81.66
156	Ozaukee Lake	0.2200	81.93
157	Kemper 1	0.2220	82.08
158	Hidden Lake	0.2240	82.19
159	McDonald Lake 2	0.2250	82.28

Table 5. Lake County Average TSI phosphorus (TSIp) Ranking 2000-2014.

RANK	LAKE NAME	TP AVE	TSIp
160	Fischer Lake	0.2280	82.44
161	Oak Hills Lake	0.2790	85.35
162	Loch Lomond	0.2950	86.16
163	Heron Pond	0.2990	86.35
164	Rollins Savannah 1	0.3070	87.00
165	Fairfield Marsh	0.3260	87.60
166	ADID 182	0.3280	87.69
167	Slough Lake	0.3860	90.03
168	Manning's Slough	0.3820	90.22
169	Rasmussen Lake	0.4860	93.36
170	Albert Lake, Site II, outflow	0.4950	93.67
171	Flint Lake Outlet	0.5000	93.76
172	Rollins Savannah 2	0.5870	96.00
173	Almond Marsh	1.9510	113.00

Table 6. Multiparameter data for Lake Catherine, 2014.

Lake Catherine Multi-parameter 2014

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.735
5/7/2014	0.25	0.76	11.57	13.16	121.5	0.6523	8.86	1705	Surface	100%	
5/7/2014	1	1.02	11.60	13.18	121.7	0.6524	8.86	1568	Surface	100%	
5/7/2014	2	1.90	11.55	13.20	121.8	0.6523	8.86	296	0.15	19%	11.11
5/7/2014	3	2.79	11.57	13.16	121.5	0.6522	8.89	67	1.04	4%	1.43
5/7/2014	4	4.01	11.54	13.18	121.6	0.6521	8.87	57	2.26	4%	0.07
5/7/2014	6	7.09	11.53	13.18	121.6	0.6522	8.90	9	5.34	1%	0.35
5/7/2014	8	8.02	11.54	13.19	121.6	0.6522	8.88	6	6.27	0%	0.06
5/7/2014	10	10.13	11.52	13.15	121.3	0.6524	8.88	2	8.38	0%	0.13
5/7/2014	12	12.05	11.50	13.05	120.2	0.6526	8.89	1	10.3	0%	0.07
5/7/2014	14	14.11	11.49	13.06	120.3	0.6531	8.86	1	12.36	0%	0.00
5/7/2014	16	16.01	11.45	13.00	119.7	0.6543	8.85	1	14.26	0%	0.00
5/7/2014	18	18.20	11.29	11.95	109.6	0.6546	8.81	1	16.45	0%	0.00
5/7/2014	20	20.06	10.91	11.29	102.6	0.6566	8.68	1	18.31	0%	0.00
5/7/2014	22	22.02	10.47	9.98	89.8	0.6588	8.55	1	20.27	0%	0.00
5/7/2014	24	24.03	10.28	8.94	80.1	0.6607	8.46	1	22.28	0.1%	0.00
5/7/2014	26	26.76	10.11	8.34	74.4	0.6614	8.38	0	25.01	0.0%	0.00
5/7/2014	28	28.04	9.96	7.74	68.8	0.6624	8.34	0	26.29	0.0%	0.00
5/7/2014	30	30.50	9.59	6.29	55.4	0.6653	8.15	0	28.75	0.0%	0.00
5/7/2014	32	32.02	9.08	3.64	31.6	0.6697	7.93	0	30.27	0.0%	0.00
5/7/2014	34	33.97	7.43	0.61	5.1	0.6785	7.66	1	32.22	0.1%	0.00
5/7/2014	36	36.16	6.96	0.10	0.8	0.6843	7.51	1	34.41	0.1%	0.00

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.344
6/10/2014	0.25	0.24	22.07	9.13	104.8	0.6699	8.50	1178	Surface	100%	
6/10/2014	1	1.01	22.14	9.20	105.7	0.6698	8.50	952	Surface	100%	
6/10/2014	2	2.00	22.15	9.23	106.1	0.6695	8.50	349	0.25	37%	4.01
6/10/2014	3	3.01	22.14	9.25	106.2	0.6696	8.49	159	1.26	17%	0.62
6/10/2014	4	3.97	22.15	9.21	105.9	0.6698	8.50	169	2.22	18%	-0.03
6/10/2014	6	6.00	22.13	9.08	104.3	0.6700	8.48	70	4.25	7%	0.21
6/10/2014	8	7.98	22.09	8.97	103.0	0.6719	8.45	45	6.23	5%	0.07
6/10/2014	10	9.96	21.94	8.44	96.6	0.6724	8.40	27	8.21	3%	0.06
6/10/2014	12	11.97	21.52	7.21	81.9	0.6724	8.28	18	10.22	2%	0.04
6/10/2014	14	14.03	19.99	3.72	41.0	0.6743	8.02	11	12.28	1%	0.04
6/10/2014	16	15.98	16.77	0.47	4.9	0.6714	7.78	8	14.23	1%	0.02
6/10/2014	18	18.00	14.62	0.11	1.1	0.6722	7.74	5	16.25	1%	0.03
6/10/2014	20	19.98	13.05	0.09	0.9	0.6738	7.71	3	18.23	0%	0.03
6/10/2014	22	21.99	12.16	0.05	0.5	0.6752	7.64	2	20.24	0%	0.02
6/10/2014	24	23.99	10.64	0.05	0.4	0.6865	7.50	2	22.24	0%	0.00
6/10/2014	26	26.01	9.97	0.04	0.4	0.6908	7.43	1	24.26	0%	0.03
6/10/2014	28	28.02	9.56	0.04	0.3	0.6963	7.36	1	26.27	0%	0.00
6/10/2014	30	29.96	9.23	0.03	0.3	0.7047	7.29	1	28.21	0%	0.00
6/10/2014	32	31.99	9.02	0.05	0.4	0.7083	7.25	1	30.24	0%	0.00
6/10/2014	34	34.02	8.89	0.04	0.3	0.7124	7.23	0	32.27	0%	0.00
6/10/2014	36	36.01	8.78	0.03	0.3	0.7191	7.17	1	34.26	0%	0.00!

Table 6. Multiparameter data for Lake Catherine, 2014.

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.429
7/8/2014	0.25	0.25	24.99	9.34	114.4	0.6747	8.40	4575	Surface	100%	
7/8/2014	1	1.08	24.98	9.33	114.6	0.6746	8.41	4406	Surface	100%	
7/8/2014	2	1.88	24.97	9.32	114.4	0.6744	8.41	2079	0.13	47%	5.78
7/8/2014	3	3.00	24.98	9.34	114.7	0.6752	8.41	279	1.25	6%	1.61
7/8/2014	4	3.92	24.96	9.33	114.5	0.6747	8.41	685	2.17	16%	-0.41
7/8/2014	6	5.91	24.95	9.36	114.8	0.6746	8.41	303	4.16	7%	0.20
7/8/2014	8	7.98	24.96	9.31	114.2	0.6747	8.41	104	6.23	2%	0.17
7/8/2014	10	9.94	24.95	9.28	113.8	0.6747	8.40	51	8.19	1%	0.09
7/8/2014	12	12.05	23.47	5.93	70.7	0.6823	8.01	19	10.3	0%	0.10
7/8/2014	14	13.82	22.98	4.94	58.4	0.6848	7.89	8	12.07	0%	0.07
7/8/2014	16	15.93	21.61	0.39	4.5	0.6929	7.63	3	14.18	0%	0.07
7/8/2014	18	17.98	19.37	0.08	0.9	0.7051	7.62	2	16.23	0%	0.02
7/8/2014	20	19.99	14.30	0.05	0.5	0.7296	7.54	1	18.24	0%	0.04
7/8/2014	22	21.94	12.87	0.05	0.5	0.7292	7.47	0	20.19	0%	0.00
7/8/2014	24	23.96	11.36	0.04	0.4	0.7425	7.40	0	22.21	0%	0.00
7/8/2014	26	26.04	10.29	0.04	0.4	0.7548	7.31	0	24.29	0%	0.00
7/8/2014	28	27.93	9.94	0.04	0.3	0.7596	7.26	0	26.18	0%	0.00
7/8/2014	30	29.84	9.80	0.04	0.4	0.7634	7.24	0	28.09	0%	0.00
7/8/2014	32	32.08	9.68	0.04	0.3	0.7657	7.22	0	30.33	0%	0.00
7/8/2014	34	34.11	9.53	0.04	0.3	0.7696	7.20	1	32.36	0%	0.00

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.288
8/13/2014	0.5	0.59	23.25	6.22	74.6	0.6306	8.21	3766	Surface	100%	
8/13/2014	1	1.50	23.27	7.06	84.6	0.6306	8.32	3628	Surface	100%	
8/13/2014	2	2.17	23.25	7.54	90.3	0.6308	8.31	1274	0.42	35%	2.49
8/13/2014	3	3.06	23.26	6.29	75.4	0.6307	8.33	313	1.31	9%	1.07
8/13/2014	4	3.97	23.22	6.23	74.6	0.6308	8.31	391	2.22	11%	-0.10
8/13/2014	6	6.08	23.19	5.31	63.6	0.6321	8.30	83	4.33	2%	0.36
8/13/2014	8	8.08	23.19	5.64	67.5	0.6313	8.28	19	6.33	1%	0.23
8/13/2014	10	10.06	23.18	7.21	86.3	0.6314	8.28	11	8.31	0%	0.07
8/13/2014	12	12.19	23.18	6.03	72.2	0.6314	8.28	4	10.44	0%	0.10
8/13/2014	14	14.05	23.12	4.77	57.0	0.6336	8.17	2	12.3	0%	0.06
8/13/2014	16	16.12	22.41	0.30	3.6	0.6465	7.82	1	14.37	0%	0.05
8/13/2014	18	18.00	21.72	0.10	1.1	0.6522	7.72	1	16.25	0%	0.00
8/13/2014	20	20.06	18.77	0.00	0.0	0.6722	7.49	1	18.31	0%	0.00
8/13/2014	22	22.00	15.85	0.03	0.3	0.6941	7.43	1	20.25	0%	0.00
8/13/2014	24	24.08	13.77	0.08	0.7	0.7017	7.31	1	22.33	0%	0.00
8/13/2014	26	26.07	11.74	0.12	1.2	0.7166	7.20	0	24.32	0%	0.00
8/13/2014	28	28.10	10.85	0.21	1.9	0.7278	7.14	1	26.35	0%	0.00
8/13/2014	30	30.09	10.45	0.00	0.0	0.7350	7.10	0	28.34	0%	0.00
8/13/2014	32	32.77	10.11	0.06	0.6	0.7424	7.06	1	31.02	0%	0.00
8/13/2014	34	34.00	10.00	0.04	0.3	0.7437	7.05	1	32.25	0%	0.00
8/13/2014	36	36.08	9.78	0.06	0.5	0.7514	7.03	0	34.33	0%	0.00

Table 6. Multiparameter data for Lake Catherine, 2014.

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC	PAR æE/s/mý	Depth of Light Meter feet
9/16/2014	0.25	0.25	18.89	7.88	84.8	0.6190	8.06	40392	NR	Surface
9/16/2014	1	1.00	18.67	7.92	83.8	0.6190	8.00	45000	NR	Surface
9/16/2014	2	2.00	18.43	7.79	83.0	0.6190	8.04	52087	NR	0.25
9/16/2014	3	3.00	17.71	7.59	77.7	0.6190	8.03	55632	NR	1.25
9/16/2014	4	4.00	17.65	7.41	77.7	0.6180	8.03	55713	NR	2.25
9/16/2014	6	6.00	17.56	7.13	74.8	0.6190	7.98	53786	NR	4.25
9/16/2014	8	8.00	17.54	7.14	70.4	0.6190	7.94	55973	NR	6.25
9/16/2014	10	10.00	17.51	6.54	68.4	0.6190	7.93	53307	NR	8.25
9/16/2014	12	12.00	17.47	6.43	66.3	0.6190	7.92	53287	NR	10.25
9/16/2014	14	14.00	17.47	6.39	66.9	0.6190	7.91	549618	NR	12.25
9/16/2014	16	16.00	17.46	6.39	66.9	0.6190	7.90	53670	NR	14.25
9/16/2014	18	18.00	17.37	6.01	62.6	0.6220	7.86	53490	NR	16.25
9/16/2014	20	20.00	17.16	5.75	59.7	0.6230	7.85	50634	NR	18.25
9/16/2014	22	22.00	16.90	5.49	56.7	0.6300	7.78	51318	NR	20.25
9/16/2014	24	24.00	14.95	0.56	5.5	0.7150	7.04	7419	NR	22.25
9/16/2014	26	26.00	12.28	0.42	3.9	0.7440	6.84	6299	NR	24.25
9/16/2014	28	28.00	11.11	0.38	3.4	0.7570	6.79	6260	NR	26.25
9/16/2014	30	30.00	10.43	0.38	3.4	0.7690	6.72	6704	NR	28.25
9/16/2014	32	32.00	10.09	0.33	3.0	0.7780	6.64	7451	NR	30.25
9/16/2014	34	34.00	9.89	0.32	2.8	0.7820	6.60	7376	NR	32.25
9/16/2014	36	36.00	9.78	0.31	2.7	0.7880	6.54	9941	NR	34.25

Figure 5. Monthly TP Concentrations measured in Lake Catherine in 2002 and 2014 compared to Illinois EPA General Use Standard.

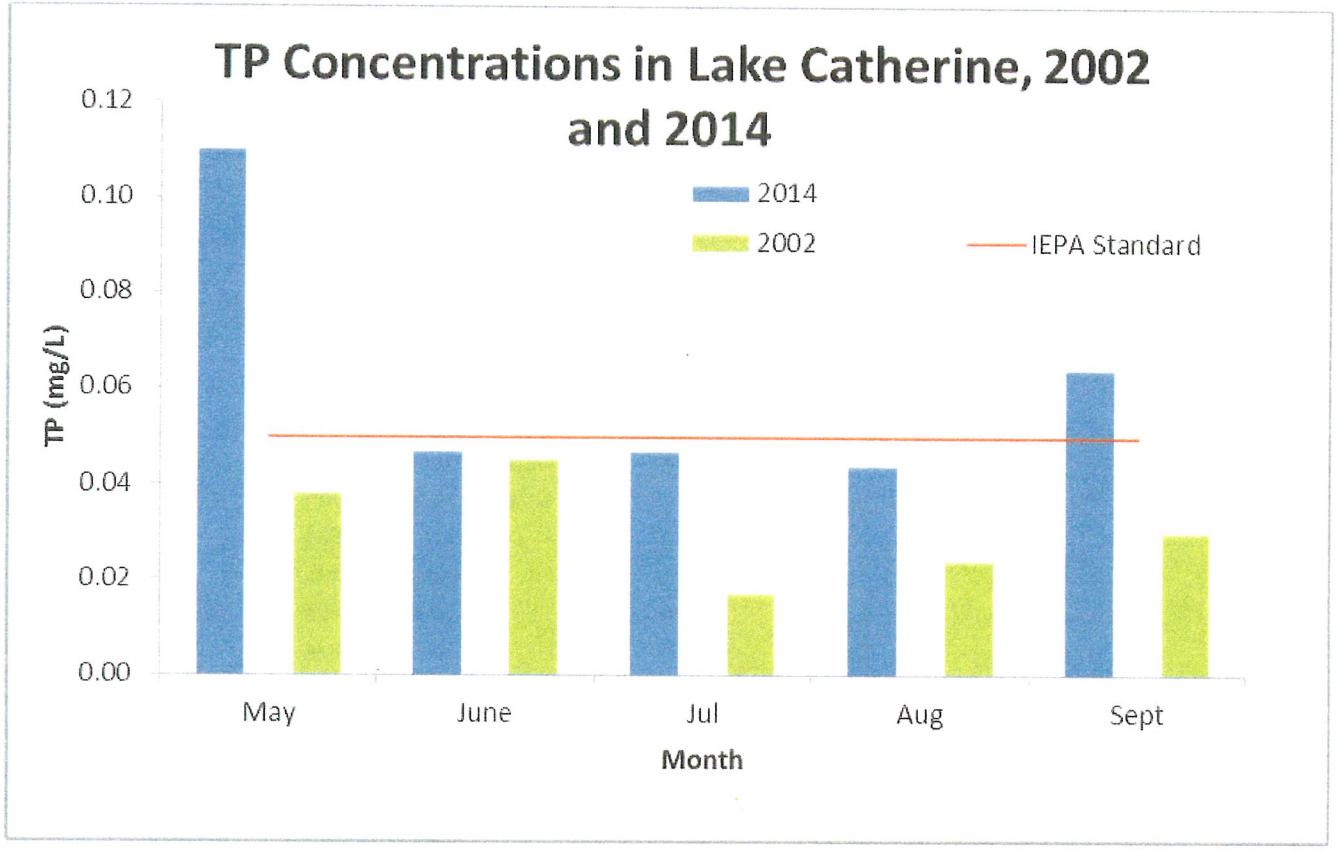


Table 7. Species Cover, Frequency, and Relative Importance per species for Lake Catherine, 2014.

Common Name	Average Cover	Frequency	Importance
Coontail	5.90	22.99	65.10
Common Duckweed	2.49	9.20	26.97
Giant Duckweed	1.79	5.75	18.46
Eurasian Watermilfoil	1.17	9.20	17.87
Vallisneria	0.93	9.20	16.26
Chara (macroalgae)	0.52	10.34	14.66
Slender naiad	0.40	8.05	11.40
White Water Lily	0.58	6.90	11.39
Watermeal	0.17	3.45	4.89
Water Stargrass	0.35	2.30	4.87
Sago Pondweed	0.11	2.30	3.26
Common Bladderwort	0.11	2.30	3.26
Flat-stemmed Pondweed	0.06	1.15	1.63
Total Average Density	**14.59**		

Cover Abundance Scale	
Scale	Estimated Cover
0	No Plants
1	1%-10%
2	11% - 40%
3	41% - 60%
4	61% - 90%
5	≥ 91%

Figure 6. Estimated abundance and location of submersed aquatic vegetatin found in Lake Catherine, 2014.

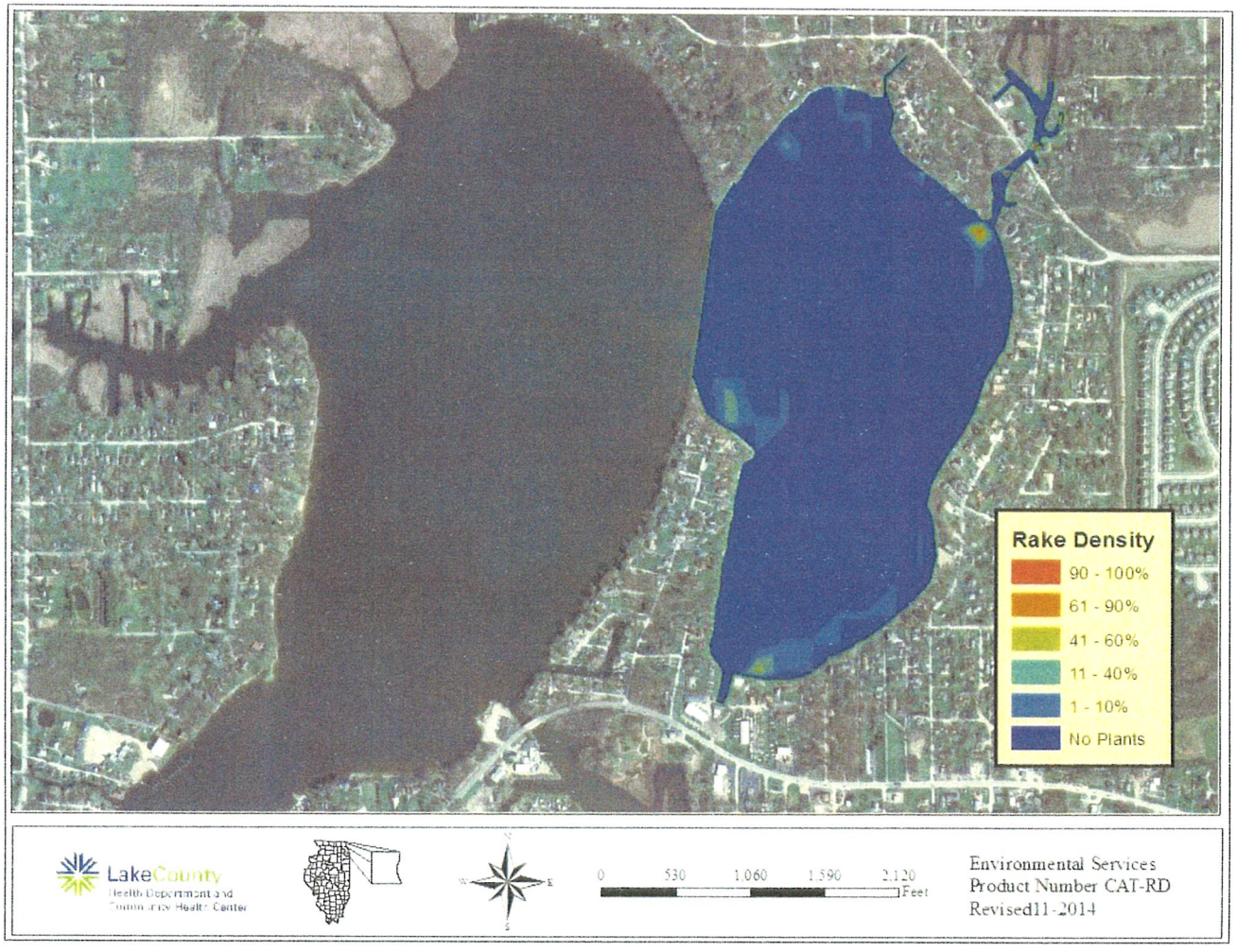


Figure 7. Estimated abundance and location of Eurasian Watermilfoil (EWM) found in Lake Catherine, 2014.

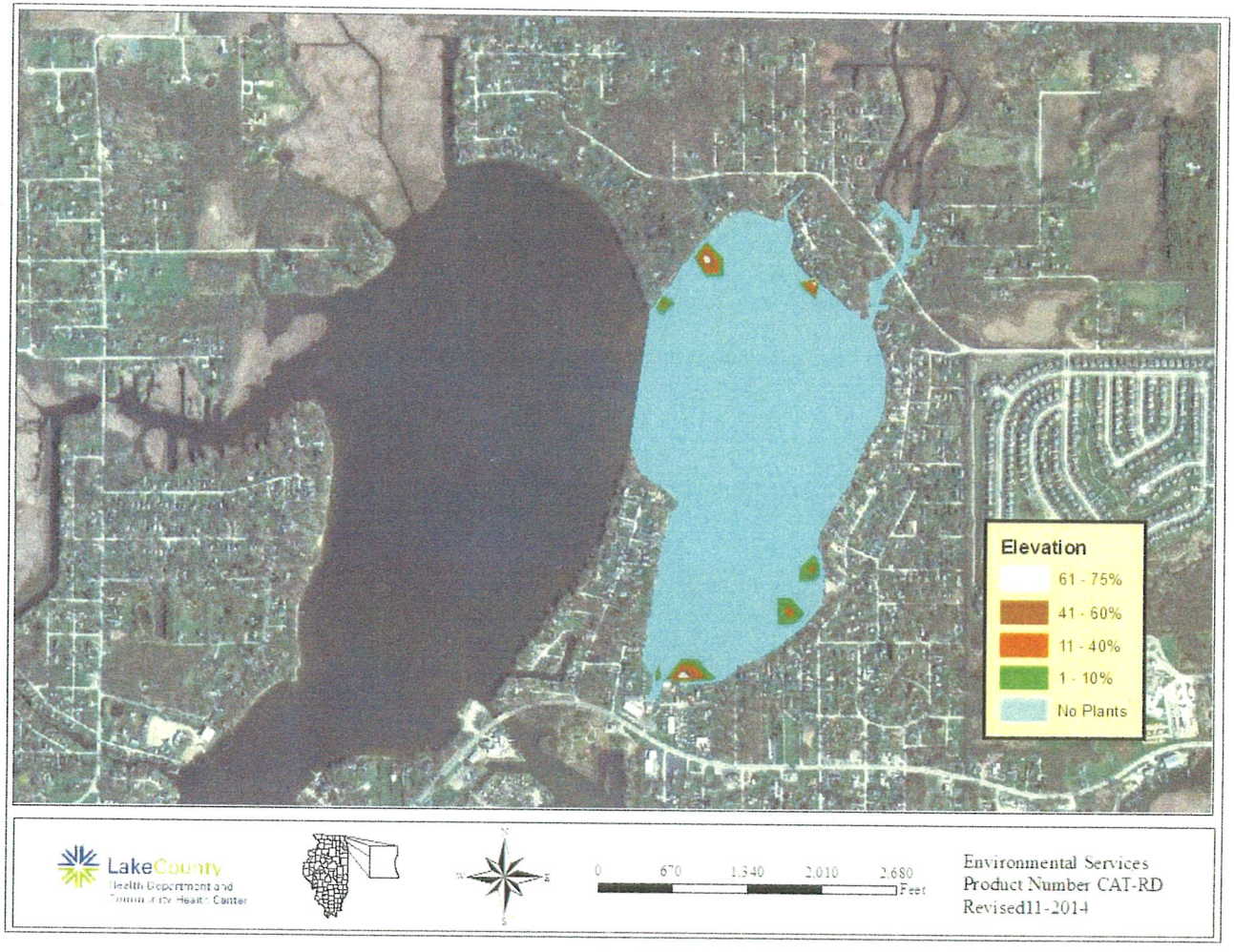


Table 8. Lake County average Floristic Quality Index ranking 2000 – 2014.

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	Little Silver Lake	29.6	31.6
6	Round Lake Marsh North	29.1	29.9
7	West Loon Lake	27.1	29.5
8	Sullivan Lake	26.9	28.5
9	Bangs Lake	26.2	27.8
10	Third Lake	25.1	22.5
11	Fourth Lake	24.7	27.1
12	Indpendence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Sun Lake	24.3	26.1
15	Lake Zurich	24.3	27.1
16	Redwing Slough	24.0	25.8
17	Schreiber Lake	23.9	24.8
18	Lakewood Marsh	23.8	24.7
19	Deer Lake	23.5	24.4
20	Round Lake	23.5	25.9
21	Pistakee Lake	23.5	25.2
22	Lake Marie	23.5	25.2
23	Honey Lake	23.3	25.1
24	Lake of the Hollow	23.0	24.8
25	Cross Lake	22.4	24.2
26	Nippersink Lake (Fox Chain)	22.4	23.2
27	Countryside Glen Lake	21.9	22.8
28	Grass Lake	21.5	22.2
29	Davis Lake	21.4	21.4
30	Butler Lake	21.4	23.1
31	Lake Barrington	21.2	21.2
32	Duck Lake	21.1	22.9
33	Timber Lake (North)	20.9	23.4
34	Lake Catherine	20.8	21.8
35	ADID 203	20.5	20.5
36	Broberg Marsh	20.5	21.4
37	McGreal Lake	20.2	22.1
38	Fox Lake	20.2	21.2
39	Lake Kathryn	19.6	20.7
40	Fish Lake	19.3	21.2
41	Druce Lake	19.1	21.8
42	Turner Lake	18.6	21.2
43	Wooster Lake	18.5	20.2
44	Salem Lake	18.5	20.2
45	Lake Helen	18.0	18.0
46	Old Oak Lake	18.0	19.1
47	Potomac Lake	17.8	17.8
48	Redhead Lake	17.7	18.7
49	Long Lake	17.7	15.8
50	Hendrick Lake	17.7	17.7
51	Rollins Savannah 2	17.7	17.7
52	Grandwood Park Lake	17.2	19.0
53	Seven Acre Lake	17.0	15.5
54	Lake Miltmore	16.8	18.7
55	Petite Lake	16.8	18.7
56	Channel Lake	16.8	18.7
57	McDonald Lake 1	16.7	17.7
58	Highland Lake	16.7	18.9

Table 8. Lake County average Floristic Quality Index ranking 2000 – 2014.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
59	Bresen Lake	16.6	17.8
60	Almond Marsh	16.3	17.3
61	Owens Lake	16.3	17.3
62	Windward Lake	16.3	17.6
63	Grays Lake	16.1	16.1
64	White Lake	16.0	17.0
65	Dunns Lake	15.9	17.0
66	Dog Bone Lake	15.7	15.7
67	Osprey Lake	15.5	17.3
68	Heron Pond	15.1	15.1
69	North Churchill Lake	15.0	15.0
70	Hastings Lake	15.0	17.0
71	Lake Tranquility (S1)	15.0	17.0
72	Forest Lake	14.8	15.9
73	Dog Training Pond	14.7	15.9
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	Bishop Lake	13.4	15.0
86	Ames Pit	13.4	15.5
87	Mary Lee Lake	13.1	15.1
88	Old School Lake	13.1	15.1
89	Summerhill Estates Lake	12.7	13.9
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 Carina	12.1	14.3
99	Lake Leo	12.1	14.3
100	Lambs Farm Lake	12.1	14.3
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	Antioch Lake	11.3	13.4
106	Hook Lake	11.3	13.4
107	Briarcrest Pond	11.2	12.5
108	Lake Naomi	11.2	12.5
109	Pulaski Pond	11.2	12.5
110	Lake Napa Suwe	11.0	11.0
111	Redwing Marsh	11.0	11.0
112	West Meadow Lake	11.0	11.0
113	Lake Minear	11.0	13.9
114	Nielsen Pond	10.7	12.0
116	Sylvan Lake	10.6	10.6
117	Gages Lake	10.2	12.5

Table 8. Lake County average Floristic Quality Index ranking 2000 – 2014.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
118	College Trail Lake	10.0	10.0
119	Valley Lake	9.9	9.9
120	Werhane Lake	9.8	12.0
121	Loch Lomond	9.4	12.1
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	Lake Louise	9.0	10.4
128	Fischer Lake	9.0	11.0
129	Lake Fairview	8.5	6.9
130	Timber Lake (South)	8.5	6.9
131	East Meadow Lake	8.5	8.5
132	South Churchill Lake	8.5	8.5
133	Kemper Lake 2	8.5	9.8
134	Lake Christa	8.5	9.8
135	Lake Farmington	8.5	9.8
136	Lucy Lake	8.5	9.8
137	Bittersweet Golf Course #13	8.1	8.1
138	Lake Linden	8.0	8.0
139	Sand Lake	8.0	10.4
140	Countryside Lake	7.7	11.5
141	Fairfield Marsh	7.5	8.7
142	Lake Eleanor	7.5	8.7
143	Banana Pond	7.5	9.2
144	Slocum Lake	7.1	5.8
145	Lucky Lake	7.0	7.0
146	North Tower Lake	7.0	7.0
147	Lake Forest Pond	6.9	8.5
148	Ozaukee Lake	6.7	8.7
149	Leisure Lake	6.4	9.0
150	Peterson Pond	6.0	8.5
151	Little Bear Lake	5.8	7.5
152	Deer Lake Meadow Lake	5.2	6.4
153	ADID 127	5.0	5.0
154	Island Lake	5.0	5.0
155	Liberty Lake	5.0	5.0
156	Oak Hills Lake	5.0	5.0
157	Slough Lake	5.0	5.0
158	International Mining and Chemical Lake	5.0	7.1
159	Diamond Lake	3.7	5.5
160	Lake Charles	3.7	5.5
161	Big Bear Lake	3.5	5.0
162	Sand Pond (IDNR)	3.5	5.0
163	Harvey Lake	3.3	5.0
164	Half Day Pit	2.9	5.0
165	Lochanora Lake	2.5	5.0
166	Echo Lake	0.0	0.0
167	Hidden Lake	0.0	0.0
168	St. Mary's Lake	0.0	0.0
169	Willow Lake	0.0	0.0
170	Woodland Lake	0.0	0.0
	Mean	**14.1**	**15.2**
	Median	**13.4**	**15.0**