LAKE COUNTY, ILLINOIS

2013 TIMBER LAKE SUMMARY REPORT

PREPARED BY THE
LAKE COUNTY HEALTH DEPARTMENT
Population Health Environmental Services

Timber Lake South

Timber Lake is a man-made lake located in unincorporated Cuba and Wauconda Townships near the Village of North Barrington. The lake has a surface area of 32.4 acres and a maximum depth of 14.0 feet. The Timber Lake Civic Association's Lake Committee actively manages the lake for non-motorized boating, fishing, swimming, and aesthetics. Timber Lake has also been a participant in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program since 1994.

The Timber Lake shoreline length is 1.41 miles, and is surrounded by low density residential development. Timber Lake receives water from two primary inlets located at the east and south end of the lake and from a small inlet located at the northern bay of the lake; water enters the lake from its approximate 1261 acre watershed and exits the lake through a concrete spillway located at the west bay of the lake. Timber Lake drains into Tower Lake and is at the headwaters of the Tower Lake Drainage, which is part of the Fox River watershed. The primary land uses within the Tower Lake watershed are, single family homes, and agriculture.

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Lake Summary (continued)

LAKE FACTS

Major Watershed: Fox River

Sub-Watershed: Tower Lake Drain

Surface Area: 32.40 acres

Shoreline Length: 1.51 miles

Maximum Depth: 14.00 feet

Average Depth: 7.60 feet

Lake Volume: 244.00 acre-feet

Watershed Area: 1261.03 acres

Lake Type: Impoundment

Current Uses: fishing, non-power boating, and aesthetics

Historically Timber Lake has had a variety of lake quality issues including excessive aquatic plants, an unhealthy fishery, abundance of carp, severe algal blooms, and nutrient enrichment. Water quality in Timber Lake has significantly improved since the 2000 and 2007 lake surveys. A variety of water quality parameters were analyzed during the 2013 Timber Lake assessment including; water clarity, nutrient availability, aquatic plant population and shoreline erosion.

Water clarity, the transparency or clearness of the water, is an important indicator of lake health that affects designated uses such as swimming and other recreational activities. In 2013 the average water clarity was deeper than the County median and 18% and 78% deeper than 2007 and 2000, respectively. Water clarity is influenced by the amount of particles in the water column; this is measured by total suspended solids (TSS). The 2013 average TSS concentration was below the County median, and 67% and 69% reduction from 2007 and 2000.

Typically in lakes the two nutrients critical for aquatic plant and algal growth are phosphorus and nitrogen. In 2013 nutrient availability indicated that Timber Lake, like most lakes in Lake County, was phosphorus limited. The 2013 average total phosphorus concentration exceeded the Illinois Environmental Protection Agency (IEPA) impairment level. However, the concentration was 25% and 35% less than the 2007 and 2000 concentrations, respectively, documenting considerable improvements. Also using phosphorus as an indicator, the trophic state index (TSIp) ranked Timber Lake as 54th of 158 lakes in Lake County.

Conductivity concentrations are correlated with chloride concentrations and are influenced by winter road salting. Typically lakes in the County have experienced increases in chloride concentrations in the past 10 years, many doubling in concentrations. The average conductivity concentration was lower than the County median and a 31% and 17% reduction from 2007 and 2000, respectively.

Aquatic plant sampling was conducted on Timber Lake in July. Only three species of plants and one macro-algae were present covering 58% of the lake. Coontail and Eurasian Watermilfoil (EWM) were abundant, occupying 45% and 40% of the lake, respectively. EWM is an exotic and invasive species that tends to crowd out native species when left unmanaged. Current populations are impairing the recreational uses in the northern bay of the lake.

Watershed

Everyone lives in a watershed! A watershed is an area of land where surface water from rain and melting snow meet at a point, such as a lake or stream.

Which watershed do you live in?

The source of a lake's water supply is very important in determining its water quality and choosing management practices to protect the lake. Lakes like Timber Lake, that receive the majority of their water from streams often have variable water quality that is heavily influenced by human activity. A watershed is an area of land where surface water from rain and melting snow meet at a point, such as a lake or stream. Timber Lake is in the Tower Lake Drainage and receives water from its 1261 acre watershed. Timber Lake receives water from two primary inlets located at the east and south end of the lake and from a small inlet located at the northern bay of the lake. A concrete overflow dam at the west bay of the lake allows water to flow to Tower Lake, the only outlet. The Drain flows west and enters Tower Lake, eventually draining into the Fox River. The size of the watershed feeding the lake

TIMBER LAKE WATERSHED (CONTINUED)

relative to the lakes size is also an important factor in determining the amount of pollutants in the lake. The watershed to lake surface area ratio is 39:1. The calculated retention time is approximately 0.26 years (94 days). Retention time is the amount of time it takes for water entering the lake to flow out of it. The short-retention time in Timber Lake allows the lake to respond quickly to management practices that decrease nutrient input.

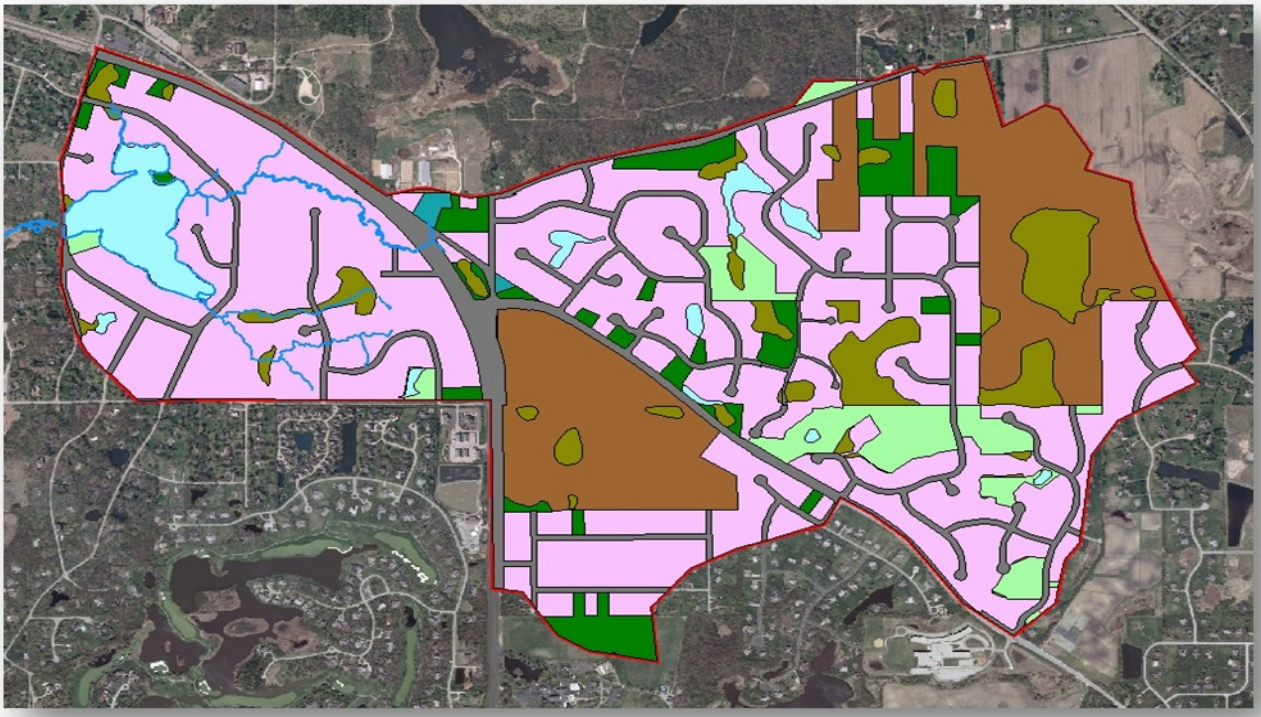
Based on the 2011 land use data the current external sources affecting Timber Lake were from the following land uses: single family homes (50%), agriculture (18%), and transportation (12%). Based on the amount of impervious surfaces, each land use contributes varied amounts of runoff. Because impervious surfaces (parking lots, roads, buildings, compacted soil) do not allow rain to infiltrate into the ground, more runoff is generated than in the undeveloped condition. The major sources of runoff for Timber Lake were single family homes (54%), transportation (37%) and agricultural (3%). The lack of wetland, forest, and grassland areas around the lake increases pollution as runoff and nutrients don't have a chance to be absorbed before entering the lake. When a stream is dammed to create a lake, the natural movement of the water will be restricted, causing sediment and nutrients to collect in the impoundment. Identifying and reducing sources of nutrients and sediments that enter Timber Lake from the land's surface is imperative to improving the water quality.

2013 LAND USE IN THE TIMBER LAKE WATERSHED

- Agricultural
- Forest and Grassland
- Government and Institutional
- Public and Private Open Space
- Retail/Commercial
- Single Family
- Transportation
- Water
- Wetlands

IMPOUNDMENT

A MANMADE LAKE CREATED BY DAMMING A STREAM. THAT IS ALSO DRAINED BY A STREAM.



Direction of watershed:

Timber Lake receives water from its approximate 1261 acre watershed that includes three inlets located on the north, east, and south side of the lake. Water exits Timber Lake through the outlet located on the west bay of the lake and flows southwest to Tower Lake, then into Tower Lake Drain and eventually the Fox River.

VOLUNTEER LAKE MONITORING PROGRAM (VLMP)

The VLMP was established in 1981 to gather information on Illinois inland lakes, and to provide an educational program for citizens. The primary measurement by volunteers is the Secchi depth (water clarity). Other observations such as water color, suspended algae and sediment, aquatic plants and odor are also recorded. The sampling season is May through October with measurements taken twice a month.

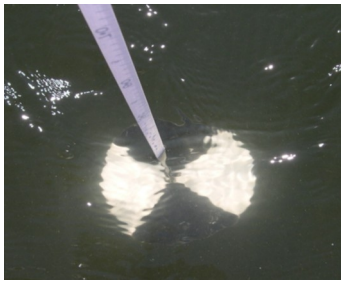
For more information visit: www.epa.state.il.us/water/vlmp/index.html

WATER CLARITY

Water clarity is an indicator of water quality related to chemical and physical properties.

Measurements taken with a Secchi disk indicate the light penetration into a body of water. Algae, microscopic animals, water color, eroded soil, and resuspended bottom sediment are factors that interfere with light penetration and reduce water transparency.

The 2013 average water clarity in Timber Lake of 4.26 feet was above the County median (3.00 feet), and an 18% and 78% increase in the lake's transparency since 2007 and 2000, respectively (3.61 feet and 2.37 feet, respectively). These impressive improvements can be attributed to in lake management, increased plant population, and watershed improvements.



A Secchi disk is an eight-inch diameter weighted metal plate painted black and white in alternating quadrants. A calibrated rope is used to lower the disc into the water and measure the depth to which it is visible.

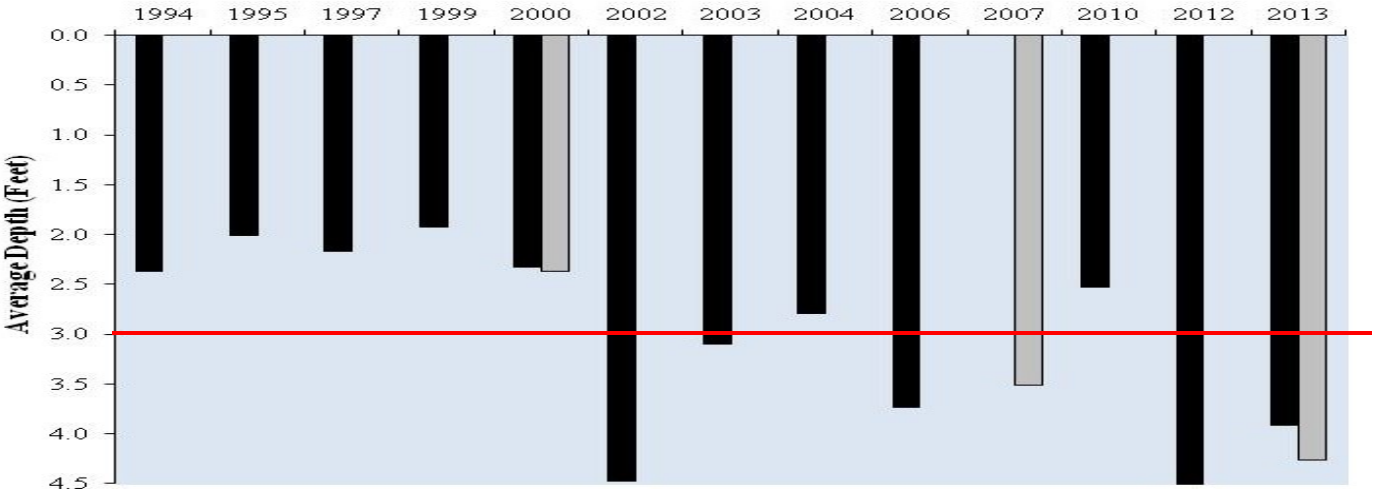
VOLUNTEER LAKE MONITORING

Additional water clarity measurements were taken in Timber Lake through participation in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program (VLMP). Timber Lake residents have participated in the VLMP since 1994. Current volunteer Paul Dietzen has participated in the program since 2010. Participation in the VLMP program has provided Timber Lake with annual baseline data that can be used to determine long-term water quality trends and support current lake management decision making. The average VLMP Secchi disk depth from 2013 was 3.91 feet. Annual VLMP readings have varied from 1.92 feet in 1999 to 6.06 feet in 2012.

The volunteers on Timber Lake have provided data that is vital for the continued monitoring and management of this lake. The LCHD-ES would like to thank them for their efforts and recommend continued involvement in the future.

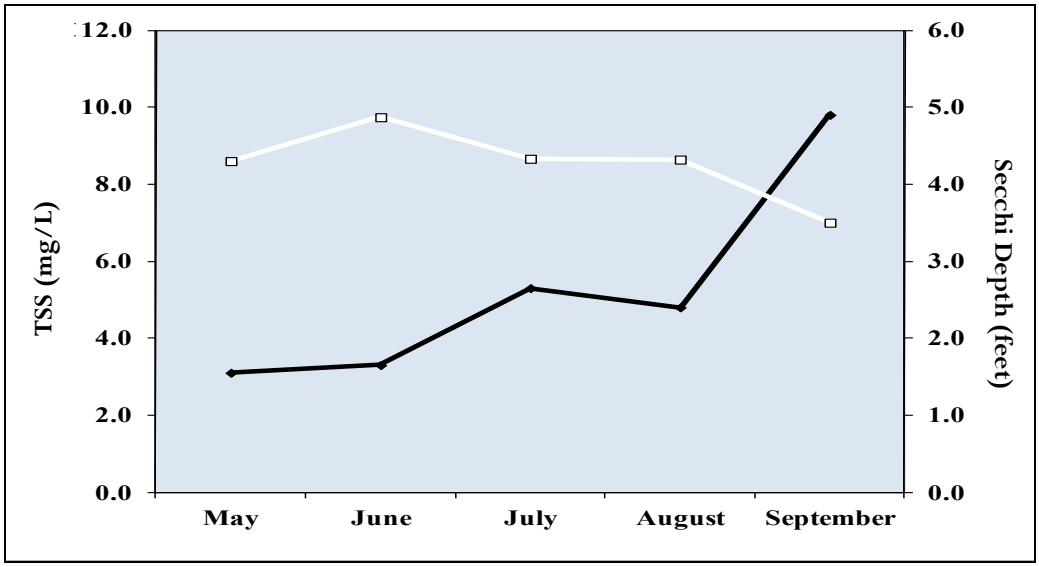
SECCHI DISK AVERAGES FROM VLMP AND LCHD RECORDS FOR TIMBER LAKE 1994—2013.

- VLMP
- LCHD
- LAKE COUNTY 2012 MEDIAN 3.00 FEET



TOTAL SUSPENDED SOLIDS

Another measure of water clarity is turbidity, which is caused by particles of matter rather than dissolved organic compounds. Suspended particles dissipate light, which affects the depth at which plants can grow. The total suspended solid (TSS) parameter (turbidity) is composed of nonvolatile suspended solids (NVSS), non-organic clay or sediment materials, and volatile suspended solids (TVS) (algae and other organic matter).



Monthly Total Suspended Solid Concentrations and Secchi Depth in Timber South, 2013.

TSS (mg/L)

Secchi Depth (feet)

2013 TSS concentrations in Timber Lake averaged 5.3 mg/L which was below the County median of 8.2 mg/L. High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of the lake ecosystem including the plant and fish communities. There are internal and external sources of sediment affecting the turbidity in Timber Lake. Internal sources of sediment suspension include the carp population (Grass and Common Carp). Carp are one of the most damaging aquatic invasive species due to their feeding behavior that disrupts shallowly rooted plants, decreasing water clarity. External sources include sediments that are transported into the lake from bank erosion and other sources in the watershed. Due to the amount of residential area in the Timber Lake watershed residents should be mindful of their land management practices and the impacts to the lake. Several lake management techniques have been implemented during the past couple years that made notable improvements in Timber Lake: the aerators were turned off (as the diffusers can suspend sediments), aquatic plants increased in abundance, and the removal of carp has been ongoing. TSS concentrations have decreased 67% and 69% from 2007 and 2000, respectively (15.9 mg/L and 17.3 mg/L).

The lowest Secchi depth recorded in 2013 occurred in September (3.50 feet) corresponding with the highest 2013 TSS concentration (9.8 mg/L). Calculated nonvolatile suspended solids (NVSS) were 5.95 mg/L in September. This means that slightly more than half of the TSS concentration in 2013 can be attributed to sediment materials. TVS concentrations caused by algae remained below the county median (119 .0 mg/L) through out the sampling season May through September.

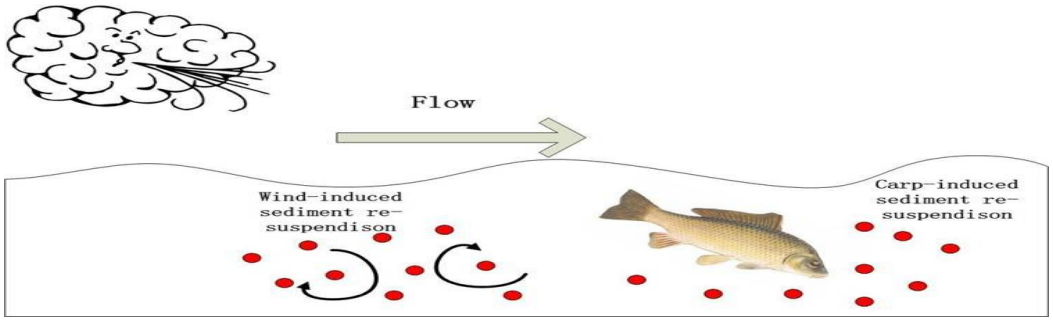


ILLUSTRATION OF INTERNAL SUSPENDED SOLIDS IN TIMBER LAKE

Photo Credit: University of Wisconsin

WHAT HAS BEEN DONE TO REDUCE PHOSPHORUS LEVELS IN ILLINOIS

December 2009– Cuba Township passed a resolution supporting the use of phosphorus free fertilizers

July 2010- The state of Illinois passed a law to reduce the amount of phosphorus content in dishwashing and laundry detergents.

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

WHAT YOU CAN DO TO PROTECT TIMBER LAKE SOUTH

1. Do not throw or burn eaves, grass clippings, other organic debris into the street or driveway. Runoff carries these through storm sewers, directly into Timber Lake

2. Build a rain garden to filter run-off from roofs, driveways, streets. This allows the phosphorus to be bound to the soil so it does not reach surface waters.

3. Sweep up fertilizer that is spilled or inadvertently applied to hard surface areas, do not hose it away.

Nutrients

Organisms take nutrients in from their environment. In a lake, the primary nutrients needed for aquatic plant and algal growth are phosphorus and nitrogen. In most lakes, phosphorus is the limiting nutrient, which means everything that plants and algae need to grow is available in excess: sunlight, warmth, and nitrogen. In Timber Lake, the limiting nutrient was phosphorus, which has a direct effect on how much aquatic plants and algae can grow.

The 2013 average total phosphorus concentration in Timber Lake was 0.071 mg/L. This was 25% and 35% less than the 2007 and 2000 concentrations, respectively (0.094 mg/L and 0.110 mg/L), documenting considerable improvements. However, lakes with concentrations exceeding 0.050 mg/L can support high densities of algae and aquatic plants, which can reduce water clarity and dissolved oxygen levels and are considered impaired by the IEPA.

Phosphorus originates from a variety of sources, many are related to human activities which include: human and animal waste, soil erosion, detergents, septic systems, common carp, and runoff from lawns.

Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average 2013 TKN for Timber Lake was 1.34 mg/L, which was above the county median of 1.17 mg/L. The inorganic form of nitrogen is also important for plant growth and was analyzed in the form of Nitrate (NO3-N). In 2000 nitrate nitrogen was high in May, June, and July. Sources of this nitrogen could be numerous, but could have washed in with from run-off from residential lawns or agricultural fields. Agriculture and lawns utilize fertilizer that contains nitrogen particularly in the spring. In May and June of 2013 concentrations of nitrate/nitrite were above the detection limit (0.34 mg/L and 0.15 mg/L, respectively) while the remainder of the season concentrations were below the detection limit.

Trophic State Index

Another way to look at phosphorus levels and how they affect lake productivity is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). A lake's response to additional phosphorus is an accelerated rate of eutrophication. Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation, until the lake becomes a wetland. This process takes thousands of years. However, human activities that supply lakes with additional phosphorus that drives eutrophication is speeding up this process significantly. The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive, left photo), mesotrophic (intermediate nutrient availability and biological productivity, middle photo), eutrophic (nutrient-rich, highly productive, right photo), or hypereutrophic (extremely nutrient-rich, productive). In 2013, Timber Lake was eutrophic with a TSIp value of 65.6. Based on the TSIp, Timber Lake ranked 54th out of 158 lakes studied by the LCHD-ES from 2000-2013.

Stratification

Timber Lake was thermally stratified from June through August. Thermal stratification is when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold-water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where dissolved oxygen [DO] concentrations drop below 1 mg/L) by mid-summer.

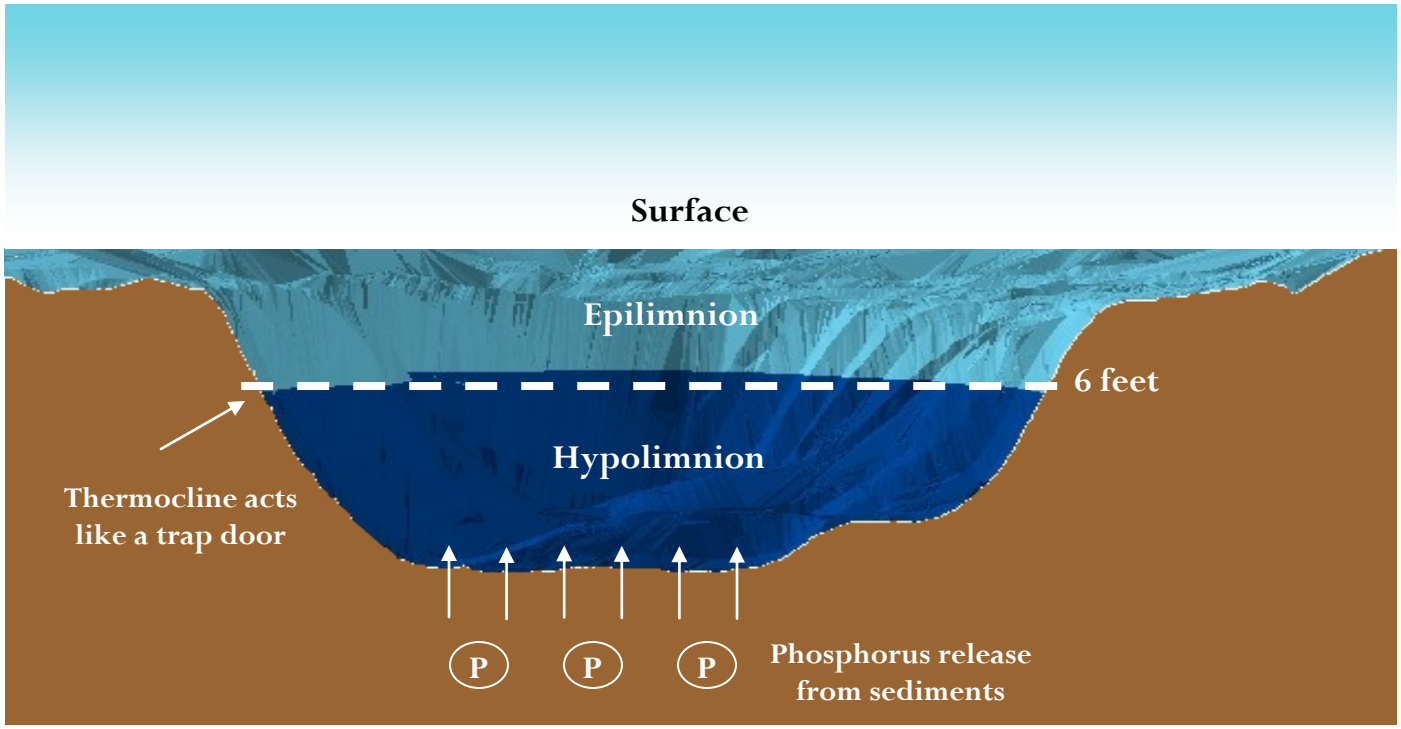
In 2013, Timber Lake was beginning to stratify in May at 5 feet. By July it was strongly stratified at approximately 6 feet. The thermocline (the transitional region between the epilimnion and the hypolimnion) began to weaken in August and a complete turnover (mixing) had occurred by September. This is further documented by the increase in phosphorus and TSS in September. During anoxic conditions lake sediments release phosphorus (internal phosphorus), into the water column. While the lake is stratified the phosphorus remains in the hypolimnion but once turn over occurs the internal phosphorus is released into the entire lake column.

A DO concentration of greater than 5.0 mg/L is required to maintain a healthy fishery in a lake. DO concentrations in the epilimnion did not drop below 5.86 mg/L. However, anoxic conditions existed from May through August in the hypolimnion. This is a normal phenomenon, the anoxic boundary ranged from 6 feet (July) to 12 feet (August). The volume of the lake that was anoxic during the 2013 sampling season could not be calculated based on absence of a bathymetric map.

Month	TSS
May	3.1
June	3.3
July	5.3
August	4.8
September	9.8

TSS concentrations (mg/L) for Timber Lake, 2013

Figure, illustrating the epilimnion and hypolimnion, in Timber Lake July, 2013



Shallow lakes are more susceptible to wind and wave activity, large littoral areas, and small anaerobic hypolimnions. They have more phosphorus release from lake sediments than deeper, more stratified lakes. This is largely influenced by the strength of the thermocline in deeper lakes. Weaker thermoclines erode and fluctuate allowing phosphorus to release under anoxic conditions and reenter the epilimnion.

Conductivity and Chlorides

Conductivity concentrations (mS/cm) for Timber Lake, 2013

Year	Conductivity
2013	0.6476
2007	0.9390
2000	0.7780

Another parameter measured during the 2013 assessment, that is important in comparing data from year to year is conductivity. Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Conductivity has been shown to be highly correlated (in urban areas) with chloride ions found in road salt mixtures. Water bodies most subject to the impacts of road salts are streams, wetlands, or lakes draining major roadways.

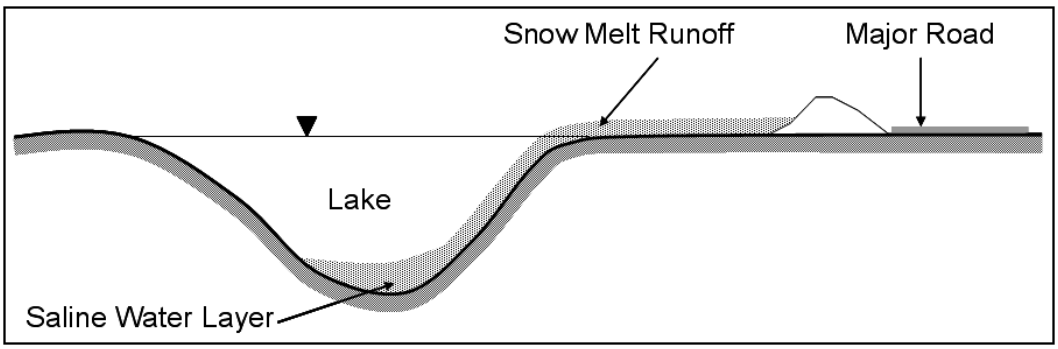
In 2013, Timber Lake average conductivity was 0.6476 mS/cm. This was a below the county median of 0.7875 mS/cm and a 31% and 17% decrease from 2007 (0.9390 mS/cm) and 2000 (0.7780 mS/cm), respectively. One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Timber Lake 2013 average chloride concentration was 99 mg/L. These values are influenced by the winter road maintenance of United States Highway 12 and residential surface streets. Typically lakes in the county have experienced increases in chloride concentrations in the past 10 years many doubling in concentrations. The 37 % decrease in chloride concentration from 2007 (156 mg/L) is influenced by the mild winters (2012 and 2013) and modernized snow removal equipment and techniques.

The United States Environmental Protection Agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems. Chlorides tend to accumulate within a watershed as these ions do not break down and are not utilized by plants or animals. High chloride concentrations may make it difficult for many of our native species to survive. While many of our invasive species, such as Eurasian Watermilfoil, Cattail and Common Reed, are tolerant to high chloride concentrations.

ICE FACTS

1. De-icers melt snow and ice. They provide no traction on top of snow and ice.
2. Anti-icing prevents the bond from forming between pavement and ice.
3. De-icing works best if you plow/shovel before applying material.
4. Pick the right material for the pavement temperatures.
5. Sand only works on top of snow as traction. It provides no melting.
6. Anti-icing chemicals must be applied prior to snow fall.
7. NaCl (Road Salt) does not work on cold days, less than 15° F.

As salts dissolve and move through the watershed with snowmelt and stormwater runoff they tend to remain in the water cycle by settling. Timber Lake has higher concentrations of chlorides in the deeper portions of the lake.



What Has Been Done to reduce Chloride levels in TimberLake

The Lake County Division of Transportation (LCDOT) and Cuba Township are responsible for the winter road maintenance in the Timber Lake watershed. Both entities use an environmentally friendly alternative to salt, a liquid by-product consisting of salt brine mix, beet juice (beet by -product) and calcium chloride. This product will be mixed with the salt on the trucks, and then applied to the streets to help prevent salt from bouncing into the drainage areas along the road. The majority of the fleet have innovative computer software and Global positioning systems (GPS which provided real-time tracking of these vehicles. These trucks are capable of transmitting to a central location a view out their windshield in real time the exact truck location by GPS locating, the speed of the truck, the route it has traveled and is traveling, the air temperature, road temperature, dew point, the rate of material being put down and the rate of liquid being put down during a storm event. The data is then used to better coordinate and target services, saving on salt and gas. In the past ten years Cuba Township estimates a reduced application of salt from approximately 500 pounds per lane mile to less than 200 pounds per lane mile through the use of this equipment. In addition the Cuba Township Highway Department and LCDOT have attended Lake County sponsored deicing workshops. These workshops focus on applications rates, calibration, and environmental effects.

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

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

Beaches

Kerry McCaughey LCHD Lab staff uses black light technology to report E. coli beach data.

There is one state licensed swimming beach on Timber Lake: Timber Lake Civic Association south beach. This beach has been monitored every two weeks from mid May to the end of August by LCHD-ES since 1988. The water samples are tested for E. coli bacteria, which are found in the intestines of warm-blooded animals. While not all strains of E. coli are the same, certain strains can make humans sick if ingested in high enough concentrations. If water samples come back high for E. coli (>235 E. coli/100 ml), the management body for the bathing beach is notified and a sign is posted indicating a swim ban. E. coli is used as an indicator organism, meaning that high concentrations of E. coli might suggest the presence of harmful pathogens such as, Salmonella, Giardia, etc.

From 1988 to 2013 Timber Lake South Beach only had 5 closures related to bacteria levels one occurring in each of the following years: 1989, 1993, 2002, 2003, and 2008.

There are many ways E.coli can end up in a swimming beach. Heavy rainfall and strong wind associated with storms can cause the water to become cloudy with sediment from the lake bottom. Stormwater from rain can also wash in other particles from lawns, streets, and buildings. This sediment and stormwater may contain high concentrations of E. coli. Another source of E. coli contamination is the feces of gulls, geese, and other wildlife.

Practicing common sense and good hygiene will go a long way in preventing illness from swimming beaches.

- If you are sick, do NOT swim.
- Do NOT drink the water while swimming.
- Avoid swimming during heavy algae blooms.
- Keep geese off the beach.
- Children who are not toilet trained should wear tight-fitting rubber or plastic pants.
- Take a shower before entering the water, and have kids take frequent bathroom breaks.

Phytoplanton (algae)

A plankton net was lowered to the 1% light level depth and retrieved vertically. On the way up the water column, plankton was collected within the small cup on the bottom of the net. In the lab a one milliliter sample is analyzed under a microscope. As seen below.

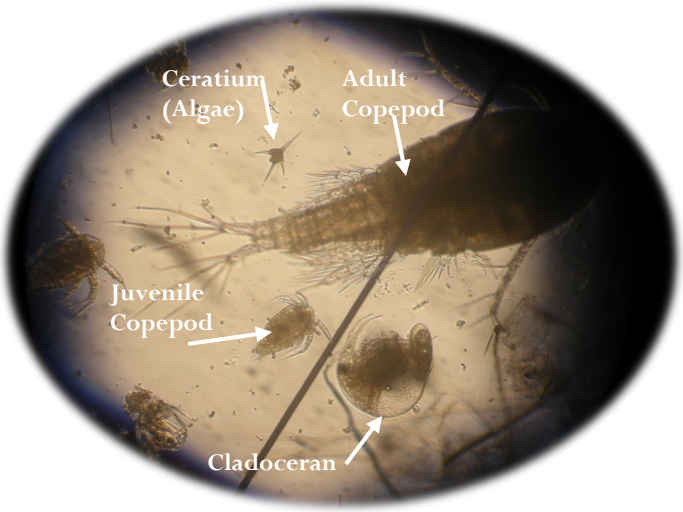
Phytoplankton (algae) are free -floating and microscopic organisms that are distinguished from plants because they lack roots, stems and leaves. There are four distinct groups of phytoplankton found in Lake County lakes: blue-greens, greens, diatoms, and dinoflagellates/chrysophytes. Blue-greens are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

Overall algal populations have dramatically decreased in Timber Lake. The total volatile solids concentration (see page 5 for more information) decreased 20% and 31% from 2007 and 2000, respectively (123 mg/L, 143 mg/L, respectively), indicating a reduction of planktonic algae in Timber Lake.

There was a notable amount of Ceratium, in the lake although the dominant phytoplankton in 2013 was Blue-green. Ceratium are a relatively harmless group of dinoflagelletes that play an important role as both predators and prey in their environment. Blue-green algae populations dramatically decreased from 2000. The 2000 blooms that occurred in Timber Lake were severe. These blooms, dominated by the genera Anabaena and Microcystis were consistently present from June through September with varying degrees of intensity with peak blooms occurring in August In 2013 the dominant genus of Blue-greens was Anabaena, this population was not as prevailing as the past algal populations, suggesting a more balance in the phytoplankton community.

Zooplankton

Zooplankton are small animals that occur in the water column and eat other plankton. Zooplankton are a diverse group defined on the basis of their size and function, rather than on their taxonomic affinities. Zooplankton in Timber Lake were made up of rotifers and two crustacean groups; the cladocerans and the copepods. Rotifers are smaller and most have a crown of cilia (hair-like structure) used for movement and drawing in suspended particles to eat. Crustaceans have jointed appendages and are enclosed in an exoskeleton. Cladocerans, such as the "water flea" Daphnia species, are filter-feeders like rotifers, while the copepod group contains both filter-feeders and raptorial species.



The July 2013 composition of the zooplankton community in Timber Lake was comprised primarily of copepods. Copepods are common in a variety of aquatic habitats including lakes and oceans. They play a pivotal role in the aquatic food web as a major source of food for many larger invertebrates and larval fish. The Cyclopoida was the most abundant copepod, like most copepods this species is small 0.5-2mm with a cylindrical segmented body that tapers at the end. Cylclopoids are distinguished from other copepods by having the antennae shorter than the length of the head.

AQUATIC PLANTS

The tips of the braches are crowded with leaves giving it a "Coontail" resemblance.

COONTAIL

CERATOPHYLLUM DEMERSUM

OVERWINTERS AS A EVERGREEN PLANT. PROVIDES IMPORTANT HABITAT TO MANY INVERTEBRATES AND FISH WITH YEAR ROUND HABITAT.

DISTRIBUTION OF RAKE DENSITY ACROSS ALL SAMPLE SITES IN 2013 (SEE MAP TO RIGHT)

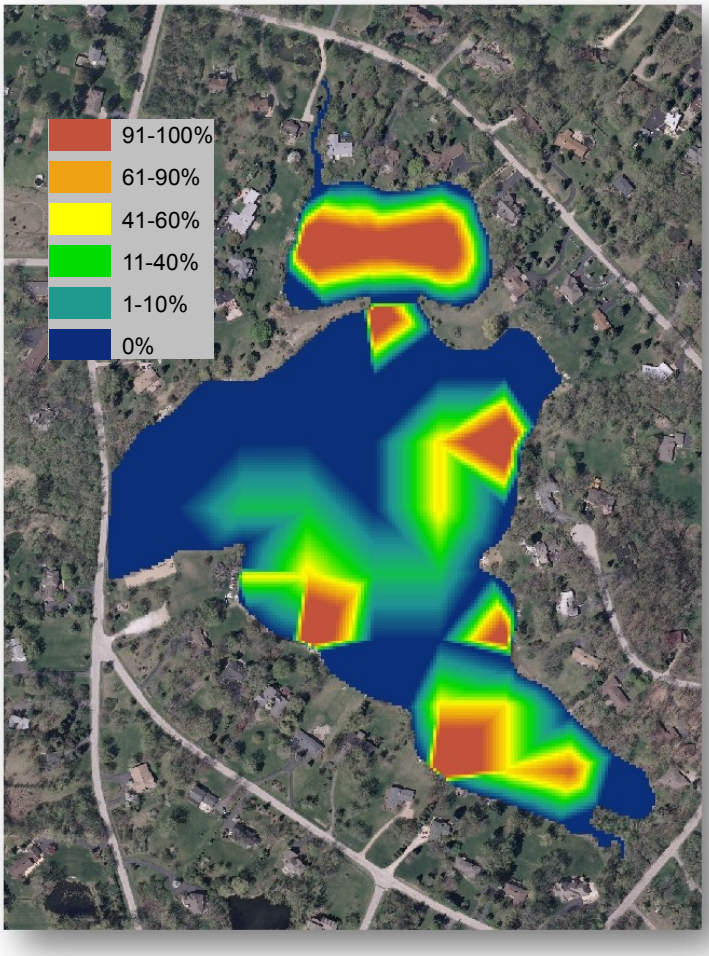
Rake Density (coverage)	# of Sites	% of Sites
No Plants	16	40
>0-10%	5	13
10-40%	7	18
40-60%	1	3
60-90%	2	5
>90%	8	20
Total Sites with Plants	23	58
Total # of Sites	40	100

Plants growing in our lakes, ponds, and streams are called macrophytes. These aquatic plants appear in many shapes and sizes. Some have leaves that float on the water surface, while others grow completely underwater. In moderation, aquatic plants are aesthetically pleasing and desirable environmentally. Their presence is natural and normal in lakes.

Aquatic plant sampling was conducted on Timber Lake in July 2013. There were 40 points generated based on a computer grid system with points 60 meters apart. Aquatic plants occurred at 23 of the sites (58 % total lake coverage) that included 3 aquatic plant species, and one macro-algae. Species diversity decreased from 2007 with the absence of American Pondweed, Elodea, Leafy Pondweed, and Sago Pondweed in the aquatic plant community. In 2013 the most common species were Coontail and Eurasian Watermilfoil, an invasive exotic species at 45% and 40% of the sample sites, respectively.

The overall aquatic plant density has changed since 2007. This is mostly contributed to the significant increase in the Coontail population. In 2007 Coontail was only found at 3% of the samples sites in July. Coontail is a submersed aquatic plant with coarse, bushy stems and no roots. Lacking true roots, the plants may drift between a variety of depths during the growing season. Coontail overwinters as an evergreen plant, providing habitat to invertebrates and fish year round.

The diversity and extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer grow. The 1% light level in Timber Lake ranged from 8-10 feet during the sampling season. Plants were found at a maximum depth of 14.0 feet. A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources. Empirically this can be seen in Timber Lake by the reduction in TSS, NVSS, TP, TVS and the increase in water clarity from 2000 to 2013.

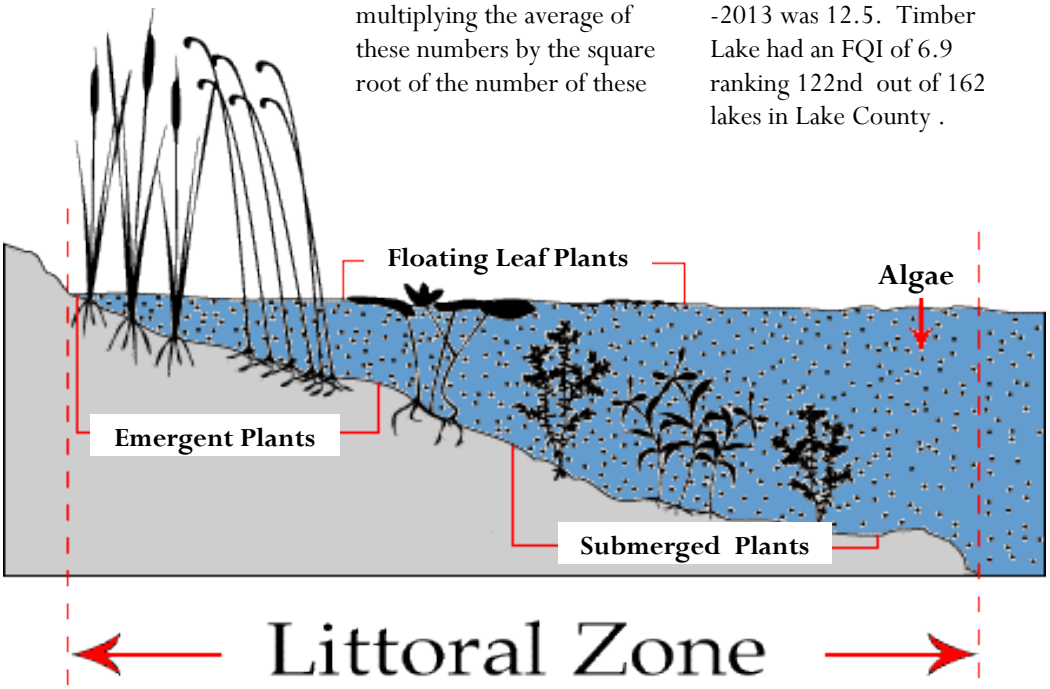


FLORISTIC QUALITY INDEX

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The median FQI for Lake County lakes from 2000 -2013 was 12.5. Timber Lake had an FQI of 6.9 ranking 122nd out of 162 lakes in Lake County .

Lake County Median

FQI = 12.5



Source: Minnesota Department of Natural Resources

AQUATIC PLANTS: WHERE DO THEY GROW?

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

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

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

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

Emergent Plants– are rooted in the lake bottom, but their leaves and stems extend out of the water.

IN MANY LAKES MACROPHYTES CONTRIBUTE TO THE AESTHETICALLY PLEASING APPEARANCE OF THE SETTING AND ARE ENJOYABLE IN THEIR OWN RIGHT. BUT EVEN MORE IMPORTANT, THEY ARE AN ESSENTIAL ELEMENT IN THE LIFE SYSTEMS OF MOST LAKES.

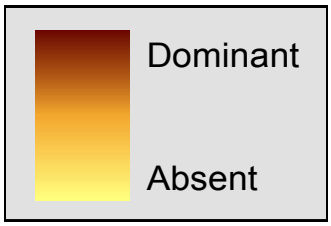
- Macrophyte leaves and stems provide a habitat or home for small attached plants and animals. Some are microscopic in size and some are larger. These attached organisms are valuable as food for animals higher in the food chain, such as fish and birds.
- Many types of small organisms live in the sediment.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

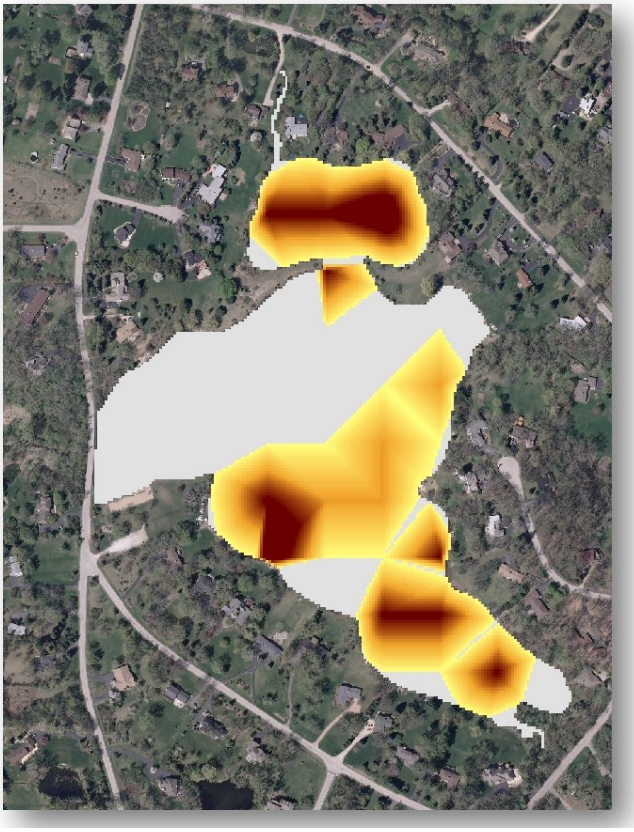
Eurasian Watermilfoil

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, 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.

The overall abundance of EWM in Timber Lake has only increased by 5% since 2007. EWM was the most the most abundant aquatic plant species in 2007, primarily being located along the shoreline at low densities and depths up to 5.5 feet. The 2013 EWM population was most dense in the northern bay of Timber Lake. This topped out population negatively influenced recreational and aesthetic uses of the lake. An aquatic plant management plan is critical to maintaining the health of the lake and a balanced aquatic plant community. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/ restoration, and limitations of the lake. The primary focus of the plan must include the control of exotic aquatic species including EWM.

Follow up is critical to achieve long-term success. A good aquatic plant management plan will also consider both the short and long-term needs of the lake.





Eurasian watermilfoil density at 40 sites on Timber Lake in July, 2013. Maximum depth that plants were found was 10.0 feet (Right).

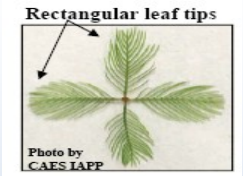
Eurasian Watermilfoil *Myriophyllum spicatum* *Exotic**

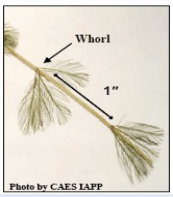
Common Names:
Eurasian watermilfoil

Origin: Exotic
Europe and Asia. Found throughout Lake County and Illinois

Importance:
This invasive plant spreads rapidly, crowding out native species, clogging waterways, and blocking sunlight and oxygen from underlying waters.

Look alikes:
Northern watermilfoil
Which has fewer than 12 leaflet pairs per leaf, and generally has stouter stems.





Key Features:

Stem: Long, often abundantly branced stems form a reddish or olive-green surface mat in summer.

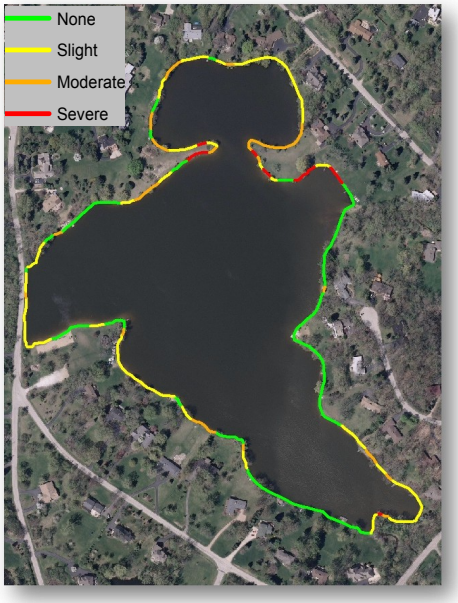
Leaf: Leaves are rectangular with ≥12 pairs of leaflets per leaf and are dissected giving a feathery appearance, arranged in a whorl, whorls are 1 inch apart.

Flower: Small pinkish male flowers that occur on reddish spikes, female flowers lack petals and sepals and 4 lobed pistil.

SHORELINE EROSION

Erosion is the natural process of weathering and transport of solids (sediment, soil, rock and other particles) in the natural environment. It usually occurs due to: transport (by wind, water, or ice), by down-slope creep of soil and other material under the force of gravity, or by living organisms, such as burrowing animals. However, this process has been increased dramatically by human land use, especially industrial, agriculture, deforestation, and urban sprawl.

The shoreline was reassessed in 2013 for significant changes in erosion since 2007. Based on the 2013 assessment, there was a slight increase in shoreline erosion with approximately 61% of the shoreline having some degree of erosion. Overall, 39% of the shoreline had no erosion, 39% had slight erosion, 16% moderate erosion, and 6% had signs of serious erosion. Since 2007 there was an increase in moderate erosion (9%) along Timber Lake shoreline. Areas of moderate and severe erosion were fragmented around the lake, but were common along the shoreline between the main lake and the northern bay. These areas should be addressed soon; it is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. Typically the areas with no erosion or slight erosion had some native vegetation incorporated into the shoreline. Native plants have deep roots which can stabilize sediments and filter nutrients before entering the lake; while hard structures may cause resuspension of sediment from deflected wave action.

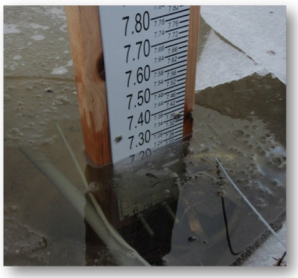


SHORELINE EROSION ON TIMBER LAKE, 2013

SHORELINE EROSION ON TIMBER LAKE, 2013

LAKE LEVEL

Lakes with stable water levels potentially have less shoreline erosion problems. A fluctuation in lake levels was observed during the sampling season. Data from the Stormwater Management Commission's Wauconda rain gauge was correlated to rain events and lake level increases. Over the sample period May to September the lake level decreased 5.50 inches. The highest water level occurred in May and July the wettest months each receiving approximately 6 inches of rainfall. The most significant decrease in lake level occurred from August to September with a decrease in lake level by 5.50 inches. Timber Lake does not appear to be greatly influenced by rain events; the outlet structure maintains the lake level during wet weather. On the other hand the level can drop below normal or full during dry weather, this occurred in September following two months of rainfall around 2 inches. In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly).



EXAMPLE OF A PERMANENT STAFF GAUGE

Watershed Planning in the Fox River Basin

9 Lakes TMDL Implementation Planning Project

Chicago Metropolitan Agency for Planning · Illinois Environmental Protection Agency · Lake County Stormwater Management Commission · Lake County Health Department and Community Health Center · 4 Lakes Initiative · Fox River Ecosystem Partnership

A TMDL (TOTAL MAXIMUM DAILY LOAD)

IS A CALCULATION OF THE MAXIMUM AMOUNT OF A POLLUTANT THAT A WATERBODY CAN RECEIVE AND STILL MEET WATER QUALITY STANDARDS, AND AN ALLOCATION OF THAT LOAD AMONG THE VARIOUS SOURCES OF THAT POLLUTANT.

The Chicago Metropolitan Agency for Planning (CMAP) received Clean Water Act funds from Illinois EPA to facilitate the development of a watershed-based plan for the "9 Lakes Planning Area" in southwestern Lake and southeastern McHenry Counties. The plan will utilize data and information that an ongoing TMDL (Total Maximum Daily Load) analysis will provide. The ultimate goal of the planning process is to determine where and which best management practices (BMPs) can be implemented in order to reduce pollutant loads to the following lakes as well as the Fox River: Island Lake, Woodland Lake, Lake Napa Suwe, Ozaukee Lake, Slocum Lake , Tower Lake, Lake Fairview, Timber Lake, Lake Barrington.

Through the assessment of physical, chemical, and biological data collected by Illinois EPA and the Lake County Health Department – Environmental Services, lakes in the planning area (as well as the section of the Fox River to which the planning area drains) have been found to not support certain of their designated uses (e.g., aquatic life, primary contact recreation) due to various causes of impairment including total phosphorus, total suspended solids, and fecal coliform. Timber Lake is currently listed on the 303(d) impaired waters list for total phosphorus, total suspended solids and aquatic plants. Following the 2013 assessment,Timber Lake impairment for suspended solids will be removed due to improvements in water quality.

PHOTOS: TLCA'S LAKE COMMITTEE

LEFT: CARP REMOVAL

CENTER: WEIR GATE INSTALLATION

RIGHT: SPORT FISHING

OVER THE PAST 6 YEARS THE TIMBER LAKE CIVIC ASSOCIATION'S LAKE COMMITTEE HAS IMPLEMENTED THE FOLLOWING:

1. Removal of aerators from the lake to improve water clarity (pg 4 and pg 5)
2. Removal of grass carp from the lake to improve water clarity (pg 5)
3. Installation of Weir Gate, to increase control of lake levels in an effort to reduce near shore aquatic plant growth and facilitate shoreline erosion restoration.
4. Stocked predator fish to reduce carp recruitment and improve sport fishing in the lake.
5. Installation of shoreline buffer strips to improve shoreline erosion (pg 14)
6. Continued involvement in the Volunteer Lake Monitoring Program to document current and historical lake conditions as a response to active lake management (pg 4).

Future projects for the TLCA's Lake Committee include aquatic plant control and shoreline and inlet erosion restoration.

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

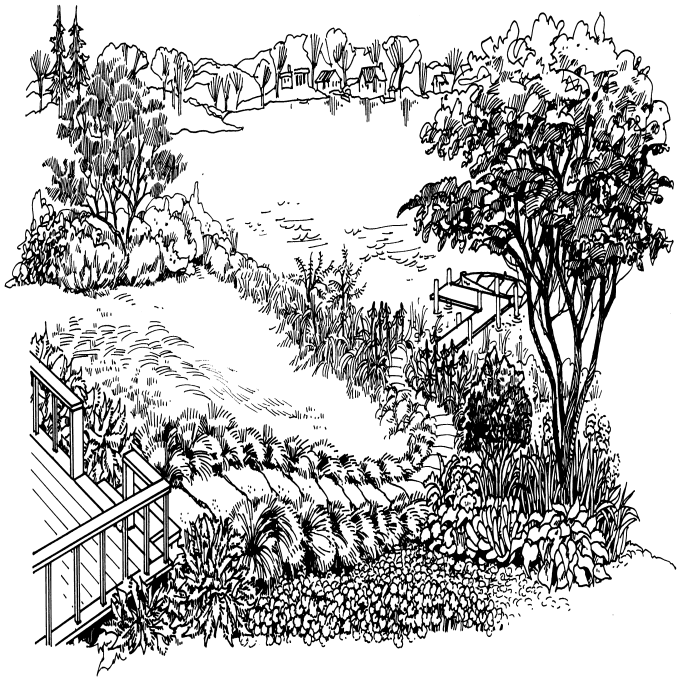
Services provided are either of a technical or educational nature and are provided by a professional staff of scientists to government agencies (county, township and municipal), lake property owners' associations and private individuals on all bodies of water within Lake County.

LAKE RECOMMENDATIONS

Timber Lake water quality has improved dramatically over the last 13 years. Notable reductions have been made in total phosphorus, total suspended solids, and chlorides in addition to increased water clarity. The aquatic plant community has demonstrated a reduction in diversity and an increase in density to the point of nuisance populations in the northern bay of the lake.

Timber Lake, lake's management is administered by Timber Lake Civic Association's lake management committee to improve the overall quality of Timber Lake; the ES (Environmental Services) has the following recommendations:

- **Develop an aquatic plant management plan that targets the reduction of Eurasian Watermilfoil and increases species diversity**
- **Install a permanent staff gauge to monitor lake level fluctuations**
- **Assess current fish population to improve fish stocking programs and determine water quality impacts by current carp populations**
- **Address areas of severe shoreline erosion**
- **Develop a monitoring program to identify upstream sediment concerns**
- **Encourage homeowners to incorporate native plants in their landscaping through rain gardens or shoreline filter strips**
- **Continue participation in Volunteer Lake Monitoring Program**



Water Quality Data for Timber Lake, 2013, 2007, and 2000.

Epilimnion	2013															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	162	1.21	<0.1	0.34	0.054	<0.005	NA	108	3.1	460	116	4.30	0.7240	8.51	10.24
18-Jun	3	164	1.11	<0.1	0.15	0.040	<0.005	NA	123	3.3	510	117	4.87	0.7840	8.41	9.23
16-Jul	3	141	1.26	<0.1	<0.05	0.066	0.007	NA	79	5.3	371	87	4.33	0.5690	8.49	6.47
20-Aug	3	138	1.43	<0.1	<0.05	0.066	<0.005	NA	90.4	4.8	367	88	4.32	0.5850	8.78	10.62
17-Sep	3	128	1.70	<0.1	<0.05	0.128	0.033	NA	93	9.8	366	89	3.50	0.5760	8.39	6.53
	Average	**147**	**1.34**	**<0.1**	**0.25[k]**	**0.071**	**0.040[k]**	**NA**	**99**	**5.3**	**415**	**99**	**4.26**	**0.6476**	**8.52**	**8.62**

Epilimnion	2007															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
8-May	3	215	1.16	<0.1	0.22	0.049	<0.005	NA	170	8.7	597	118	3.12	1.0510	8.66	13.63
12-Jun	3	207	0.99	<0.1	<0.05	0.040	0.005	NA	180	4.2	628	145	5.74	1.0590	8.55	10.32
10-Jul	3	190	1.10	<0.1	<0.05	0.061	<0.005	NA	187	6.7	611	132	3.94	1.0550	8.56	8.71
7-Aug	3	156	1.18	<0.1	0.08	0.094	0.007	NA	163	44.6	568	123	1.97	0.9090	8.80	8.93
11-Sep	3	193	1.98	0.320	<0.05	0.180	0.081	NA	96	8.1	439	92	2.79	0.7330	8.27	6.57
	Average	**187**	**1.31**	**0.320[k]**	**0.15[k]**	**0.094**	**0.031[k]**	**NA**	**156**	**15.9**	**562**	**123**	**3.61**	**0.9390**	**8.55**	**8.63**

Epilimnion	2000															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
2-May	3	171	1.56	<0.1	0.75	0.037	<0.005	602	NA	5.7	627	160	2.30	0.9639	8.66	12.28
6-Jun	3	193	1.60	0.247	0.75	0.049	<0.005	545	NA	7.7	612	183	3.69	0.9035	8.01	7.54
12-Jul	3	183	1.32	0.101	0.76	0.104	0.013	452	NA	11.0	451	129	2.79	0.6729	8.14	8.66
8-Aug	3	187	1.70	<0.1	0.08	0.160	0.040	397	NA	23.0	448	125	1.71	0.6467	8.57	8.06
5-Sep	3	196	1.99	<0.1	<0.05	0.214	0.071	440	NA	27.6	470	120	1.38	0.7030	8.61	7.44
	Average	**186**	**1.63**	**0.174[k]**	**0.58[k]**	**0.110**	**0.04[k]**	**487**	**NA**	**17.3**	**522**	**143**	**2.37**	**0.7780**	**8.40**	**7.93**

Glossary

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

Note: "k" denotes that the actual value is known to be less than the value presented.

NA = Not Applicable

* = Prior to 2006 only Nitrate was analyzed

Water Quality Data for Timber Lake, 2013, 2007, and 2000. Continued.

Hypolimnion	2013															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
8-May	10	169	1.60	0.551	0.15	0.061	<0.005	NA	110	8.2	475	110	NA	0.7840	7.32	0.35
12-Jun	10	174	1.37	0.280	0.142	0.043	<0.005	NA	118	3.8	495	111	NA	0.7860	7.53	15.31
10-Jul	10	184	2.36	0.978	<0.05	0.306	0.219	NA	102	9.5	440	93	NA	0.7910	7.40	0.36
7-Aug	10	170	2.55	1.040	<0.05	0.288	0.179	NA	95.5	9.0	402	96	NA	0.7580	7.73	1.22
11-Sep	9	130	1.95	0.191	<0.05	0.178	0.044	NA	94	13.0	368	85	NA	0.5800	8.39	5.89
	Average	**165**	**1.97**	**0.61**	**0.146[k]**	**0.175**	**0.147[k]**	**NA**	**104**	**8.7**	**436**	**99**	**NA**	**0.7398**	**7.67**	**4.63**

Hypolimnion	2007															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
8-May	10	215	1.14	<0.1	0.27	0.049	<0.005	NA	169	7.0	594	112	NA	1.0730	8.06	3.35
12-Jun	9	226	1.77	0.201	<0.05	0.101	<0.005	NA	177	12.0	621	140	NA	1.0780	7.84	1.93
10-Jul	8	212	1.42	0.147	<0.05	0.131	0.029	NA	185	11.0	633	145	NA	1.0810	8.04	1.45
7-Aug	11	213	2.92	1.360	<0.05	0.406	0.268	NA	185	18.0	630	148	NA	1.0530	8.05	0.19
11-Sep	9	199	2.51	0.847	<0.05	0.293	0.18	NA	99	8.6	446	109	NA	0.7830	7.88	0.86
	Average	**213**	**1.95**	**0.639**	**0.265k**	**0.196**	**0.159[k]**	**NA**	**163**	**11.3**	**585**	**131**	**NA**	**1.0136**	**7.97**	**1.56**

Hypolimnion	2000															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl-	TSS	TS	TVS	SECCHI	COND	pH	DO
2-May	12	180	1.67	0.248	0.704	0.045	<0.005	638	NA	8.4	692	214	NA	1.0620	7.67	2.69
6-Jun	12	193	1.61	0.246	0.747	0.065	<0.005	534	NA	16.0	614	222	NA	0.9073	7.98	7.19
12-Jul	12	181	1.15	0.177	0.741	0.084	0.02	408	NA	9.4	451	135	NA	0.6710	7.79	5.41
8-Aug	12	190	1.60	0.256	0.083	0.157	0.085	406	NA	17.0	434	119	NA	0.6659	7.92	0.40
5-Sep	11	197	2.05	<0.1	<0.05	0.223	0.064	433	NA	28.5	466	128	NA	0.7090	8.64	7.43
	Average	**188**	**1.62**	**0.231[k]**	**0.568[k]**	**0.11**	**0.056[k]**	**484**	**NA**	**15.9**	**531**	**164**	**NA**	**0.8030**	**8.00**	**5.11**

2000 - 2013 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2013	
Average	**164**	
Median	**159**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**863**	

	ALKanoxic 2000-2013	
Average	**198**	
Median	**187**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**53**	
n =	**231**	

	Condoxic <=3ft00-2013	
Average	**0.8667**	
Median	**0.7875**	
Minimum	**0.2260**	**Schreiber Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5239**	
n =	**860**	

	Condanoxic 2000-2013	
Average	**1.0056**	
Median	**0.8360**	
Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**7.4080**	**IMC**
STD	**0.8091**	
n =	**231**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2013	
Average	**0.454**	
Median	**0.145**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.016**	
n =	**863**	

*ND = Many lakes had non-detects (74.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2013	
Average	**2.211**	
Median	**1.530**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.425**	
n =	**231**	

*ND = 29.1% Non-detects from 32 different lakes

	pHoxic <=3ft00-2013	
Average	**8.35**	
Median	**8.34**	
Minimum	**7.06**	**Deer Lake**
Maximum	**10.40**	**Summerhill Estates**
STD	**0.46**	
n =	**860**	

	pHanoxic 2000-2013	
Average	**7.27**	
Median	**7.24**	
Minimum	**6.24**	**Cranberry Lake, Banana Pond**
Maximum	**9.16**	**White Lake**
STD	**0.45**	
n =	**231**	

	All Secchi 2000-2013	
Average	**4.35**	
Median	**3.00**	
Minimum	**0.18**	**McDonald 2/Ozaukee/Rollins 2**
Maximum	**29.23**	**Bangs Lake**
STD	**3.63**	
n =	**783**	

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2000 - 2013 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2013	
Average	**1.525**	
Median	**1.170**	
Minimum	**<0.1**	***ND**
Maximum	**41.200**	**Almond Marsh**
STD	**1.726**	
n =	**863**	

*ND = 3.5% Non-detects from 14 different lakes

	TKNanoxic 2000-2013	
Average	**2.891**	
Median	**2.210**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.372**	
n =	**231**	

*ND = 3.5% Non-detects from 4 different lakes

	TPoxic <=3ft00-2013	
Average	**0.114**	
Median	**0.067**	
Minimum	**<0.01**	***ND**
Maximum	**7.270**	**Almond Marsh**
STD	**0.276**	
n =	**863**	

*ND = 1.8% Non-detects from 6 different lakes

	TPanoxic 2000-2013	
Average	**0.323**	
Median	**0.180**	
Minimum	**0.012**	**Independence Grove, W. Loon**
Maximum	**3.800**	**Taylor Lake**
STD	**0.410**	
n =	**231**	

	TSSall <=3ft00-2013	
Average	**15.8**	
Median	**8.0**	
Minimum	**<1**	***ND**
Maximum	**220.0**	**Rollins 2**
STD	**22.5**	
n =	**848**	

*ND = 1.3% Non-detects from 8 different lakes

	TVSoxic <=3ft00-2013	
Average	**124.7**	
Median	**119.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**1090.0**	**Almond Marsh**
STD	**50.7**	
n =	**818**	

No 2002 IEPA Chain Lakes

	TDSoxic <=3ft00-2004	
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes.

	CLanoxic 2000-2013	
Average	**195**	
Median	**135**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**310**	
n =	**178**	

	CLoxic 2000-2013	
Average	**179**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**200**	
n =	**723**	

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Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 2000-2013 (n=4476).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.

LCHD Environmental Services ~ 1/21/2014

Timber Lake 2013 IEPA Ranking

TROPHIC STATUS		
Carlson's TSIp	64.6	Eutrophic

IMPAIRMENT ASSESSMENTS	
Total Phosphorus	Yes
Total Nitrogen	None
pH	None
Low DO	None
Total Dissolved Solids	None
Total Supended Solids	None
Aquatic Plants-Native	Yes
Non-Native Aquatic Plants	Yes
Non-Native Animals	Yes

AQUATIC LIFE USE IMPAIRMENT INDEX	**Weighting Criteria**	**Points**	**Overall Use Support Points**	**Degree of Support**
Median Trophic State	64.6	50		
Macrophyte Impairment	Moderate	10		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**60**	0	**Full**

RECREATION USE IMPAIRMENT INDEX				
Median Trophic State Index	64.6	64.6		
Macrophyte Impairment	Substantial	15		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**80**	1	**Partial**
Overall Use Index			**0.50**	**Partial**

Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Indpendence Grove	0.0130	41.14
4	Lake Zurich	0.0135	41.68
5	Druce Lake	0.0140	42.00
6	Windward Lake	0.0160	44.13
7	Sand Pond (IDNR)	0.0165	44.57
8	West Loon	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Banana Pond	0.0200	47.35
11	Cedar Lake	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	Bangs Lake	0.0240	50.00
26	Little Silver Lake	0.0250	50.57
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	Lake Fairfield	0.0300	53.20
33	Third Lake	0.0300	53.20
34	Lake Catherine	0.0310	53.67
35	Lambs Farm Lake	0.0310	53.67
36	Old School Lake	0.0310	53.67
37	Grays Lake	0.0310	54.00
38	Harvey Lake	0.0320	54.50
39	Hendrick Lake	0.0340	55.00
40	Honey Lake	0.0340	55.00
41	Sand Lake	0.0380	56.00
42	Sullivan Lake	0.0370	56.22
43	Channel Lake	0.0380	56.60
44	Ames Pit	0.0390	56.98
45	Diamond Lake	0.0390	56.98
46	East Loon	0.0400	57.34

Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
47	Schreiber Lake	0.0400	57.34
48	Waterford Lake	0.0400	57.34
49	Hook Lake	0.0410	57.70
50	Duck Lake	0.0430	58.39
51	Nielsen Pond	0.0450	59.04
52	Seven Acre Lake	0.0460	59.36
53	Turner Lake	0.0460	59.36
54	Willow Lake	0.0460	59.36
55	East Meadow Lake	0.0480	59.97
56	Lucky Lake	0.0480	59.97
57	Old Oak Lake	0.0490	60.27
58	College Trail Lake	0.0500	60.56
59	Hastings Lake	0.0520	61.13
60	Butler Lake	0.0530	61.40
61	West Meadow Lake	0.0530	61.40
62	Lucy Lake	0.0550	61.94
63	Lake Linden	0.0570	62.45
64	Lake Christa	0.0580	62.70
65	Owens Lake	0.0580	62.70
66	Briarcrest Pond	0.0580	63.00
67	Lake Barrington	0.0600	63.10
68	Lake Lakeland Estates	0.0620	63.66
69	Lake Naomi	0.0620	63.66
70	Lake Tranquility (S1)	0.0620	63.66
71	Liberty Lake	0.0630	63.89
72	North Tower Lake	0.0630	63.89
73	Werhane Lake	0.0630	63.89
74	Countryside Glen Lake	0.0640	64.12
75	Countryside Lake	0.0660	65.00
76	Davis Lake	0.0650	64.34
77	Leisure Lake	0.0650	64.34
78	St. Mary's Lake	0.0670	64.78
79	Little Bear Lake	0.0680	65.00
80	Buffalo Creek Reservoir 1	0.0680	65.00
81	Mary Lee Lake	0.0680	65.00
82	Wooster Lake	0.0700	65.41
83	Crooked Lake	0.0710	66.00
84	Timber Lake (South)	0.0720	65.82
85	Lake Helen	0.0720	65.82
86	Grandwood Park Lake	0.0720	65.82
87	ADID 203	0.0730	66.02
88	Bluff Lake	0.0730	66.02
89	Long Lake	0.0730	66.02
90	Spring Lake	0.0730	66.02
91	Broberg Marsh	0.0780	66.97
92	Woodland Lake	0.0800	68.00

Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
93	Redwing Slough	0.0822	67.73
94	Tower Lake	0.0830	67.87
95	Petite Lake	0.0830	67.87
96	Lake Marie	0.0850	68.21
97	Potomac Lake	0.0850	68.21
98	White Lake	0.0862	68.42
99	Grand Ave Marsh	0.0870	68.55
100	North Churchill Lake	0.0870	68.55
101	McDonald Lake 1	0.0880	68.71
102	Lake Fairview	0.0890	68.00
103	Rivershire Pond 2	0.0900	69.04
104	South Churchill Lake	0.0900	69.04
105	McGreal Lake	0.0910	69.20
106	Lake Charles	0.0930	69.40
107	Deer Lake	0.0940	69.66
108	Dunn's Lake	0.0950	69.82
109	Eagle Lake (S1)	0.0950	69.82
110	International Mine and Chemical Lake	0.0950	69.82
111	Valley Lake	0.0950	69.82
112	Big Bear Lake	0.0960	69.97
113	Buffalo Creek Reservoir 2	0.0960	69.97
114	Fish Lake	0.0960	69.97
115	Lochanora Lake	0.0960	69.97
116	Nippersink Lake	0.1000	70.56
117	Sylvan Lake	0.1000	70.56
118	Longview Meadow Lake	0.1020	70.84
119	Lake Forest Pond	0.1070	71.53
120	Bittersweet Golf Course #13	0.1100	71.93
121	Fox Lake	0.1100	71.93
122	Kemper 2	0.1100	71.93
123	Middlefork Savannah Outlet 1	0.1120	72.00
124	Osprey Lake	0.1110	72.06
125	Bresen Lake	0.1130	72.32
126	Round Lake Marsh North	0.1130	72.32
127	Deer Lake Meadow Lake	0.1160	72.70
128	Taylor Lake	0.1180	72.94
129	Island Lake	0.1210	73.00
130	Columbus Park Lake	0.1230	73.54
131	Lake Nipperink	0.1240	73.66
132	Echo Lake	0.1250	73.77
133	Grass Lake	0.1290	74.23
134	Lake Holloway	0.1320	74.56
135	Redhead Lake	0.1410	75.51
136	Antioch Lake	0.1450	75.91
137	Slocum Lake	0.1500	77.00
138	Lakewood Marsh	0.1510	76.50

Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
139	Pond-A-Rudy	0.1510	76.50
140	Lake Matthews	0.1520	76.59
141	Forest Lake	0.1540	76.78
142	Middlefork Savannah Outlet 2	0.1590	77.00
143	Pistakee Lake	0.1590	77.24
144	Grassy Lake	0.1610	77.42
145	Salem Lake	0.1650	77.78
146	Half Day Pit	0.1690	78.12
147	Lake Eleanor	0.1810	79.11
148	Lake Farmington	0.1850	79.43
149	Lake Louise	0.1850	79.43
150	ADID 127	0.1890	79.74
151	Lake Napa Suwe	0.1940	80.00
152	Patski Pond	0.1970	80.33
153	Dog Bone Lake	0.1990	80.48
154	Summerhill Estates Lake	0.1990	80.48
155	Redwing Marsh	0.2070	81.05
156	Stockholm Lake	0.2082	81.13
157	Bishop Lake	0.2160	81.66
158	Ozaukee Lake	0.2200	81.93
159	Kemper 1	0.2220	82.08
160	Hidden Lake	0.2240	82.19
161	McDonald Lake 2	0.2250	82.28
162	Fischer Lake	0.2280	82.44
163	Oak Hills Lake	0.2790	85.35
164	Loch Lomond	0.2950	86.16
165	Heron Pond	0.2990	86.35
166	Rollins Savannah 1	0.3070	87.00
167	Fairfield Marsh	0.3260	87.60
168	ADID 182	0.3280	87.69
169	Manning's Slough	0.3820	90.22
170	Slough Lake	0.3860	90.03
171	Rasmussen Lake	0.4860	93.36
172	Albert Lake, Site II, outflow	0.4950	93.67
173	Flint Lake Outlet	0.5000	93.76
174	Rollins Savannah 2	0.5870	96.00
175	Almond Marsh	1.9510	113.00

Timber Lake 2013 Multiparameter data

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
											0.416
5/21/2013	0.25	0.395	23.06	10.25	119.9	0.723	8.52	0.2	Surface		
5/21/2013	1	1.065	23.12	10.30	120.6	0.723	8.52	3535.7	Surface	100%	
5/21/2013	2	2.023	23.05	10.32	120.7	0.723	8.52	1067.5	0.353	30%	3.39
5/21/2013	3	3.041	22.99	10.24	119.5	0.724	8.51	462.1	1.371	13%	0.61
5/21/2013	4	4.043	20.93	10.11	113.5	0.723	8.20	303.9	2.373	9%	0.18
5/21/2013	5	4.919	19.06	8.39	90.7	0.722	8.01	93.6	3.249	3%	0.36
5/21/2013	6	6.086	16.71	6.33	65.2	0.708	7.74	59.5	4.416	2%	0.10
5/21/2013	7	6.968	14.72	3.35	33.1	0.709	7.53	62.6	5.298	2%	-0.01
5/21/2013	8	7.805	13.45	1.38	13.3	0.716	7.38	49.8	6.135	1%	0.04
5/21/2013	9	9.025	11.81	0.59	5.5	0.742	7.35	31.7	7.355	1%	0.06
5/21/2013	10	10.048	11.17	0.45	4.1	0.764	7.35	18.5	8.378	1%	0.06
5/21/2013	11	11.127	10.44	0.35	3.1	0.784	7.32	11.6	9.457	0%	0.05
5/21/2013	12	12.037	10.17	0.32	2.9	0.792	7.33	9.1	10.367	0%	0.02
5/21/2013	13	13.004	9.72	0.31	2.7	0.806	7.54	2.3	11.334	0%	0.12

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
											0.291
6/18/2013	0.25	0.456	23.17	9.21	108.0	0.784	8.41	2906.9	Surface		
6/18/2013	1	1.140	23.15	9.22	108.0	0.784	8.41	3596.5	Surface	100%	
6/18/2013	2	2.141	23.16	9.23	108.1	0.784	8.40	1026.1	0.471	29%	2.66
6/18/2013	3	3.043	23.14	9.23	108.1	0.784	8.41	1023.8	1.373	29%	0.00
6/18/2013	4	3.945	23.13	9.22	108.0	0.784	8.41	552.1	2.275	16%	0.27
6/18/2013	5	4.911	23.12	9.23	108.1	0.784	8.41	351.0	3.241	10%	0.14
6/18/2013	6	6.010	23.09	9.25	108.2	0.784	8.41	343.1	4.340	10%	0.01
6/18/2013	7	7.262	19.84	5.32	58.4	0.786	7.81	159.1	5.592	4%	0.14
6/18/2013	8	8.034	17.57	4.60	48.3	0.784	7.71	112.3	6.364	3%	0.05
6/18/2013	9	8.924	16.37	3.07	31.4	0.783	7.61	107.2	7.254	3%	0.01
6/18/2013	10	9.878	15.31	1.70	17.0	0.786	7.53	78.5	8.208	2%	0.04
6/18/2013	11	11.096	13.71	1.04	10.0	0.795	7.49	12.7	9.426	0%	0.19
6/18/2013	12	12.063	12.87	0.79	7.5	0.801	7.47	12.0	10.393	0%	0.01
6/18/2013	13	13.035	12.14	0.59	5.5	0.813	7.42	15.0	11.365	0%	-0.02

Timber Lake 2013 Multiparameter data. Continued.

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
											0.548
7/17/2013	0.25	0.467	28.78	0.00	0.0	0.560	8.67	3475.7	Surface		
7/17/2013	1	1.066	28.16	8.58	110.1	0.564	8.70	3513.4	Surface	100%	
7/17/2013	2	1.996	27.40	8.41	106.4	0.559	8.68	1426.7	0.326	40%	2.76
7/17/2013	3	2.927	26.84	6.53	81.8	0.564	8.50	651.2	1.257	18%	0.62
7/17/2013	4	4.014	26.24	5.86	72.7	0.576	8.33	333.8	2.344	9%	0.29
7/17/2013	6	5.972	23.88	0.89	10.5	0.576	7.72	81.1	4.302	2%	0.33
7/17/2013	8	7.858	20.10	0.51	5.7	0.600	7.57	64.6	6.188	2%	0.04
7/17/2013	10	9.871	16.94	0.36	3.7	0.787	7.40	16.8	8.201	0%	0.16
7/17/2013	12	12.179	14.84	0.35	3.5	0.830	7.34	7.0	10.509	0%	0.08
7/17/2013	13	13.372	14.37	0.32	3.1	0.841	7.21	2.2	11.702	0%	0.10

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
											NA
8/20/2013	0	0.554	24.05	10.56	125.8	0.585	8.83	NA	Surface		
8/20/2013	1	1.232	24.03	10.56	125.8	0.584	8.81	NA	Surface		
8/20/2013	2	2.120	23.95	10.64	126.5	0.585	8.81	NA	NA	NA	NA
8/20/2013	3	3.054	23.60	10.54	124.4	0.585	8.79	NA	NA	NA	NA
8/20/2013	4	4.167	23.24	9.33	109.5	0.586	8.69	NA	NA	NA	NA
8/20/2013	6	6.098	22.71	5.87	68.2	0.595	8.37	NA	NA	NA	NA
8/20/2013	8	8.005	22.00	5.99	68.7	0.611	8.17	NA	NA	NA	NA
8/20/2013	10	10.043	18.91	1.36	14.7	0.753	7.72	NA	NA	NA	NA
8/20/2013	12	12.031	16.10	0.71	7.2	0.862	7.45	NA	NA	NA	NA

Timber Lake 2013 Multiparameter data. Continued.

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
											NA
9/17/2013	0	0.47	19.25	7.1	77.1	0.576	8.26	NA	Surface		
9/17/2013	1	1.15	19.24	6.7	72.7	0.576	8.33	NA	Surface		
9/17/2013	2	2.032	19.21	6.57	71.2	0.576	8.37	NA	NA	NA	NA
9/17/2013	3	2.973	19.17	6.53	70.8	0.576	8.39	NA	NA	NA	NA
9/17/2013	4	4.086	19.12	6.45	69.8	0.576	8.40	NA	NA	NA	NA
9/17/2013	5	5.019	19.12	6.26	67.7	0.576	8.40	NA	NA	NA	NA
9/17/2013	6	6.043	19.11	6.11	66.2	0.576	8.41	NA	NA	NA	NA
9/17/2013	7	6.992	19.11	6.06	65.6	0.576	8.41	NA	NA	NA	NA
9/17/2013	8	8.103	19.1	6.03	65.3	0.576	8.42	NA	NA	NA	NA
9/17/2013	9	9.08	19.07	5.9	63.7	0.580	8.39	NA	NA	NA	NA
9/17/2013	10	10.08	18.98	5.9	63.8	0.584	8.34	NA	NA	NA	NA
9/17/2013	11	11.04	18.79	5.2	55.7	0.614	8.21	NA	NA	NA	NA

Approximate Land Use Within the Timber Lake South Watershed, 2013.

Land Use	Acreage	% of Total
Agricultural	230.64	18.3%
Forest and Grassland	65.12	5.2%
Government and Institutional	0.02	0.0%
Public and Private Open Space	57.80	4.6%
Retail/Commercial	3.27	0.3%
Single Family	625.38	49.6%
Transportation	150.75	12.0%
Water	46.30	3.7%
Wetlands	81.73	6.5%
Total Acres	**1261.03**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	230.64	0.05	31.7	3.3%
Forest and Grassland	65.12	0.05	9.0	0.9%
Government and Institutional	0.02	0.50	0.0	0.0%
Public and Private Open Space	57.80	0.15	23.8	2.5%
Retail/Commercial	3.27	0.85	7.6	0.8%
Single Family	625.38	0.30	515.9	54.2%
Transportation	150.75	0.85	352.4	37.0%
Water	46.30	0.00	0.0	0.0%
Wetlands	81.73	0.05	11.2	1.2%
TOTAL	**1261.03**		**951.7**	**100.0%**

Lake volume	**244.00**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.26**	**years**
	93.58	**days**

Aquatic Plants found at the 40 sampling sites on Timber Lake in July, 2013.
The maximum depth that plants were found was 14.0 feet.

Plant Density	Chara	Coontail	Eurasian Watermilfoil	Watermeal
Absent	39	22	24	39
Present	0	2	5	1
Common	1	5	9	0
Abundant	0	2	2	0
Dominant	0	9	0	0
% Plant Occurrence	2.5	45.0	40.0	2.5

Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	16	40
>0-10%	5	13
10-40%	7	18
40-60%	1	3
60-90%	2	5
>90%	8	20
Total Sites with Plants	23	58
Total # of Sites	40	100

Site:
Locale: Timber Lake South
Date: July 21 2013 2 hours
By: Deem
File: Untitled study

FLORISTIC QUALITY DATA						
2 NATIVE SPECIES	Native	2	66.7%	Adventive	1	33.3%
3 Total Species	Tree	0	0.0%	Tree	0	0.0%
6.0 NATIVE MEAN C	Shrub	0	0.0%	Shrub	0	0.0%
4.0 W/Adventives	W-Vine	0	0.0%	W-Vine	0	0.0%
8.5 NATIVE FQI	H-Vine	0	0.0%	H-Vine	0	0.0%
6.9 W/Adventives	P-Forb	1	33.3%	P-Forb	1	33.3%
-5.0 NATIVE MEAN W	B-Forb	0	0.0%	B-Forb	0	0.0%
-5.0 W/Adventives	A-Forb	1	33.3%	A-Forb	0	0.0%
AVG: Obl. Wetland	P-Grass	0	0.0%	P-Grass	0	0.0%
	A-Grass	0	0.0%	A-Grass	0	0.0%
	P-Sedge	0	0.0%	P-Sedge	0	0.0%
	A-Sedge	0	0.0%	A-Sedge	0	0.0%
	Cryptogam	0	0.0%			

ACRONYM	C	SCIENTIFIC NAME	W	WETNESS	PHYSIOGNOMY	COMMON NAME
CERDEM	5	Ceratophyllum demersum	-5	OBL	Nt P-Forb	HORNWORT
MYRSPI	0	MYRIOPHYLLUM SPICATUM	-5	OBL	Ad P-Forb	EUROPEAN WATER MILFOIL
WOLCOL	7	Wolffia columbiana	-5	OBL	Nt A-Forb	AMERICAN WATER MEAL

Lake County average Floristic Quality Index (FQI) ranking 2000-2013.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.0	36.6
2	East Loon Lake	34.7	36.1
3	Cranberry Lake	29.7	29.7
4	Deep Lake	29.7	31.2
5	Bangs Lake	29.6	26.0
6	Little Silver Lake	29.6	31.6
7	Round Lake Marsh North	29.1	29.9
8	West Loon Lake	27.1	29.5
9	Sullivan Lake	26.9	28.5
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	Honey Lake	23.3	25.1
22	Lake of the Hollow	23.0	24.8
23	Wooster Lake	22.8	21.1
24	Cross Lake	22.4	24.2
25	Countryside Glen Lake	21.9	22.8
26	Davis Lake	21.4	21.4
27	Butler Lake	21.4	23.1
28	Lake Barrington	21.2	21.2
29	Duck Lake	21.1	22.9
30	Timber Lake (North)	20.9	23.4
31	ADID 203	20.5	20.5
32	Broberg Marsh	20.5	21.4
33	McGreal Lake	20.2	22.1
34	Lake Kathryn	19.6	20.7
35	Fish Lake	19.3	21.2
36	Redhead Lake	19.3	21.2
37	Druce Lake	19.1	21.8
38	Turner Lake	18.6	21.2
39	Salem Lake	18.5	20.2
40	Lake Helen	18.0	18.0
41	Old Oak Lake	18.0	19.1
42	Potomac Lake	17.8	17.8
43	Long Lake	17.7	15.8
44	Hendrick Lake	17.7	17.7
45	Rollins Savannah 2	17.7	17.7
46	Grandwood Park Lake	17.2	19.0
47	Seven Acre Lake	17.0	15.5
48	Lake Miltmore	16.8	18.7
49	McDonald Lake 1	16.7	17.7
50	Highland Lake	16.7	18.9
51	Bresen Lake	16.6	17.8
52	Almond Marsh	16.3	17.3
53	Owens Lake	16.3	17.3
54	Windward Lake	16.3	17.6

Lake County average Floristic Quality Index (FQI) ranking 2000-2013.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
55	Grays Lake	16.1	16.1
56	White Lake	16.0	17.0
57	Dog Bone Lake	15.7	15.7
58	Osprey Lake	15.5	17.3
59	Heron Pond	15.1	15.1
60	North Churchill Lake	15.0	15.0
61	Hastings Lake	15.0	17.0
62	Lake Tranquility (S1)	15.0	17.0
63	Forest Lake	14.8	15.9
64	Dog Training Pond	14.7	15.9
65	Island Lake	14.7	16.6
66	Grand Ave Marsh	14.3	16.3
67	Nippersink Lake	14.3	16.3
68	Taylor Lake	14.3	16.3
69	Manning's Slough	14.1	16.3
70	Tower Lake	14.0	14.0
71	Dugdale Lake	14.0	15.1
72	Eagle Lake (S1)	14.0	15.1
73	Crooked Lake	14.0	16.0
74	Longview Meadow Lake	13.9	13.9
75	Bishop Lake	13.4	15.0
76	Ames Pit	13.4	15.5
77	Mary Lee Lake	13.1	15.1
78	Old School Lake	13.1	15.1
79	Dunn's Lake	12.7	13.9
80	Summerhill Estates Lake	12.7	13.9
81	Buffalo Creek Reservoir 1	12.5	11.4
82	Buffalo Creek Reservoir 2	12.5	11.4
83	McDonald Lake 2	12.5	12.5
84	Rollins Savannah 1	12.5	12.5
85	Stone Quarry Lake	12.5	12.5
86	Kemper Lake 1	12.2	13.4
87	Pond-A-Rudy	12.1	12.1
88	Stockholm Lake	12.1	13.5
89	Lake Carina	12.1	14.3
90	Lake Leo	12.1	14.3
91	Lambs Farm Lake	12.1	14.3
92	Grassy Lake	12.0	12.0
93	Lake Matthews	12.0	12.0
94	Flint Lake Oulet	11.8	13.0
95	Albert Lake	11.5	10.3
96	Rivershire Pond 2	11.5	13.3
97	Antioch Lake	11.3	13.4
98	Hook Lake	11.3	13.4
99	Briarcrest Pond	11.2	12.5
100	Lake Naomi	11.2	12.5
101	Pulaski Pond	11.2	12.5
102	Lake Napa Suwe	11.0	11.0
103	Redwing Marsh	11.0	11.0
104	West Meadow Lake	11.0	11.0
105	Lake Minear	11.0	13.9
106	Nielsen Pond	10.7	12.0
107	Lake Holloway	10.6	10.6
108	Sylvan Lake	10.6	10.6
109	Crooked Lake	10.2	12.5
110	Gages Lake	10.2	12.5

Lake County average Floristic Quality Index (FQI) ranking 2000-2013.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
111	College Trail Lake	10.0	10.0
112	Valley Lake	9.9	9.9
113	Werhane Lake	9.8	12.0
114	Loch Lomond	9.4	12.1
115	Columbus Park Lake	9.2	9.2
116	Lake Lakeland Estates	9.2	9.2
117	Waterford Lake	9.2	9.2
118	Lake Fairfield	9.0	10.4
119	Lake Louise	9.0	10.4
120	Fischer Lake	9.0	11.0
121	Lake Fariview	8.5	6.9
122	Timber Lake (South)	8.5	6.9
123	East Meadow Lake	8.5	8.5
124	South Churchill Lake	8.5	8.5
125	Kemper Lake 2	8.5	9.8
126	Lake Christa	8.5	9.8
127	Lake Farmington	8.5	9.8
128	Lucy Lake	8.5	9.8
129	Bittersweet Golf Course #13	8.1	8.1
130	Lake Linden	8.0	8.0
131	Sand Lake	8.0	10.4
132	Countryside Lake	7.7	11.5
133	Fairfield Marsh	7.5	8.7
134	Lake Eleanor	7.5	8.7
135	Banana Pond	7.5	9.2
136	Slocum Lake	7.1	5.8
137	Lucky Lake	7.0	7.0
138	North Tower Lake	7.0	7.0
139	Lake Forest Pond	6.9	8.5
140	Ozaukee Lake	6.7	8.7
141	Leisure Lake	6.4	9.0
142	Peterson Pond	6.0	8.5
143	Little Bear Lake	5.8	7.5
144	Deer Lake Meadow Lake	5.2	6.4
145	ADID 127	5.0	5.0
146	Island Lake	5.0	5.0
147	Liberty Lake	5.0	5.0
148	Oak Hills Lake	5.0	5.0
149	Slough Lake	5.0	5.0
150	International Mining and Chemical Lake	5.0	7.1
151	Diamond Lake	3.7	5.5
152	Lake Charles	3.7	5.5
153	Big Bear Lake	3.5	5.0
154	Sand Pond (IDNR)	3.5	5.0
155	Harvey Lake	3.3	5.0
156	Half Day Pit	2.9	5.0
157	Lochanora Lake	2.5	5.0
158	Echo Lake	0.0	0.0
159	Hidden Lake	0.0	0.0
160	St. Mary's Lake	0.0	0.0
161	Willow Lake	0.0	0.0
162	Woodland Lake	0.0	0.0
	Mean	**13.8**	**14.8**
	Median	**12.5**	**13.9**

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

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

Plant Sampling

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

Plankton Sampling

Plankton were sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a or YSI 6600 Sonde® 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 63μm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton were collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning

to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Prior to sub-sample being removed for enumeration, the sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed in a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and 1 mm deep. The slide was then placed under the microscope and counted at a 20X magnification (phytoplankton) or 10X magnification (zooplankton). For phytoplankton, twenty fields of view were randomly counted with all species within each field counted. Due to their larger size, zooplankton were counted throughout the entire slide. Through calculations, it was determined how many of each species were in 1 mL of lake water.

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

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

Shoreline Assessment

In previous years a complete assessment of the shoreline was done. However, this year we did a visual estimate to determine changes in the shoreline. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

> None – Includes man-made erosion control such as beach, rip-rap and sea wall.
>
> Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as “slight”.
>
> Moderate – Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.

Severe – Recession is characterized by eroding of exposed soil on nearly vertical banks, exposed roots, fallen vegetation or extensive slumping of bank material, undercutting, washouts or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

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

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2009 will be used in the following discussion.

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if

this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

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

Nutrients:

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

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

it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2009 was 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2009 was 0.167 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove Lake to a maximum of 3.880 mg/L in Taylor Lake.

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

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

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

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

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County was 7.9 mg/L, ranging from below the 0.1 mg/L detection limit to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 132.8 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 mg/L in Fairfield Marsh.

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

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for

resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact the plant and fish communities, as well as the levels of phosphorus in a lake. The detrimental impacts of low Secchi depth to plants has already been discussed. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The average Secchi depth for Lake County lakes is 3.12 feet. From 2000-2009, Ozaukee Lake had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (24.77 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

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

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ($CO_3^{=}$) and bicarbonate (HCO_3^{-}) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate ($CaCO_3$) or dolomite ($CaMgCO_3$), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

Conductivity and Chloride:

Conductivity is the inverse measure of the resistance of lake water to an electric flow. This means that the higher the conductivity, the more easily an electric current is able to flow through water. Since electric currents travel along ions in water, the more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Accordingly, conductivity has been correlated to total dissolved solids and chloride ions. The amount of dissolved solids or conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Many Lake County lakes have elevated conductivity levels in May, but not during any other month. This was because chloride, in the form of road salt, was washing into the lakes with spring rains, increasing conductivity. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Beginning in 2004, chloride concentrations are one of the parameters measured during the lake studies. Increased chloride concentrations may have a negative impact on aquatic organisms. Conductivity changes occur seasonally and with depth. For example, in stratified lakes the conductivity normally increases in the hypolimnion as bacterial decomposition converts organic materials to bicarbonate and carbonate ions depending on the pH of the water. These newly created ions increase the conductivity and total dissolved solids. Over the long term, conductivity is a good indicator of potential watershed or lake problems if an increasing trend is noted over a period of years. It is also important to know the conductivity of the water when fishery assessments are conducted, as electroshocking requires a high enough conductivity to properly stun the fish, but not too high as to cause injury or death.

pH:
pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes was 8.34, with a minimum of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

Eutrophication and Trophic State Index:

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

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average

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

Table 1. Trophic State Index (TSI).

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