Lake County, IL

2015 Little Silver Lake Summary Report

Lake County Health Department

Ecological Services

Little Silver Lake

Little Silver Lake is a glacial lake located in unincorporated Lake County and Antioch Township. The lake has a surface area of 42.7 acres and a mean depth of 7.4 feet. It is used by private homeowners for swimming, boating and fishing. Little Silver Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency and an Illinois Natural Areas Inventory (INAI) by the state of Illinois. This indicates that the lake and surrounding natural environments have the potential to have high quality aquatic resources based on water quality and hydrology values.

Water enters Little Silver Lake from a creek on the east side of the lake. The water drains from McGreal Lake where it passes through several wetlands and detention basin before it reaches Little Silver Lake. Water exits Little Silver Lake and flows into Sequoit Creek via two outlets on the western shore. The lake is located in the Sequoit Creek sub basin, within the Fox River watershed.

The Little Silver Lake Improvement Association (LSLIA) manages the lake for non-motorized boating, fishing, swimming, aesthetics and plant management. The primary land

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LAKE FACTS

Township:

Antioch Township

T 46N, R 10E, S 9, 16

Major Watershed:

Fox River

Sub-Watershed:

Sequoit Creek

Surface Area:

42.7 acres

Shoreline Length:

1.3 miles

Maximum Depth:

22.5 feet

Average Depth:

7.5 feet

Lake Volume:

316 acre-feet

Watershed Area:

608 acres

Lake Type:

Glacial

Current Uses:

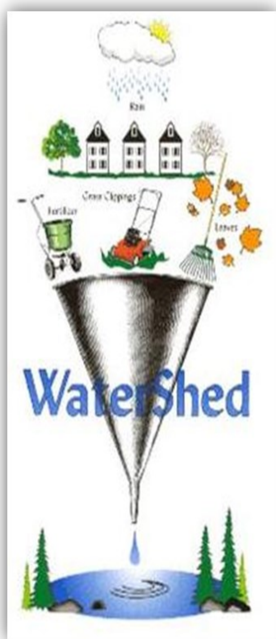
Fishing, non-motorize boating, swimming and aesthetics

LITTLE SILVER LAKE

uses within Little Silver Lake's watershed are single family homes and public and private open space. There are no boat launches but canoes or small boats with electric trolling motors are permitted on the lake. Water quality parameters, such as nutrients, suspended solids, oxygen, temperature, water clarity were measured from May-September 2015. The aquatic plant community was assessed in August when most of the plants are likely to be present. Historically Little Silver Lake is known for its above average water quality despite past storm water concerns. The 2015 water quality parameters in Little Silver Lake has slightly declined since 2008. Total phosphorus in Little Silver Lake averaged 0.028 mg/L which is a 12% increase from the 2008 concentration of 0.025 mg/L and lower than the Illinois Environmental Protection Agency impairment rate of 0.050 mg/L. The Lake County median for phosphorus is 0.068 mg/L. Sources of phosphorus include inputs from the watershed, local sources (i.e., lawn fertilizers and agricultural runoff) and internal loading from the sediment.

Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen (TKN) concentration for Little Silver Lake was 0.869 mg/L, which was lower than the county median of 1.200 mg/L. A total nitrogen to total phosphorus (TN:TP) ratio of 31:1 indicates that phosphorus was the nutrient limiting aquatic plant and algae growth in Little Silver Lake. By using phosphorous as an indicator, the trophic state index (TSIp) ranked Little Silver Lake as eutrophic with a TSIp value of 52.2. This means that the lake is nutrient rich which can result in plant and algae growth. The 2015 average total suspended solids (TSS) concentration for Little Silver Lake was 2.3 mg/L, which was lower than the county median of 8.2 mg/L and a 28% increase from the 2008 average of 1.8 mg/L.

Water clarity was measured by Secchi depth, with the lowest reading in August (6.69 ft) and the deepest was in June (9.90 ft). The average Secchi depth for the season was 8.22 ft which is 13% lower than 2008 (9.42 ft), but deeper than the county median (2.96 ft). The average conductivity of Little Silver Lake was 0.8148 mS/cm which is higher than the county median (0.7920 mS/cm). This was a 12% increase from the 2008 average (0.7270 mS/cm). The average chloride concentration in Little Silver Lake in 2015 was 143 mg/L which was higher than the county median of 139 mg/L.



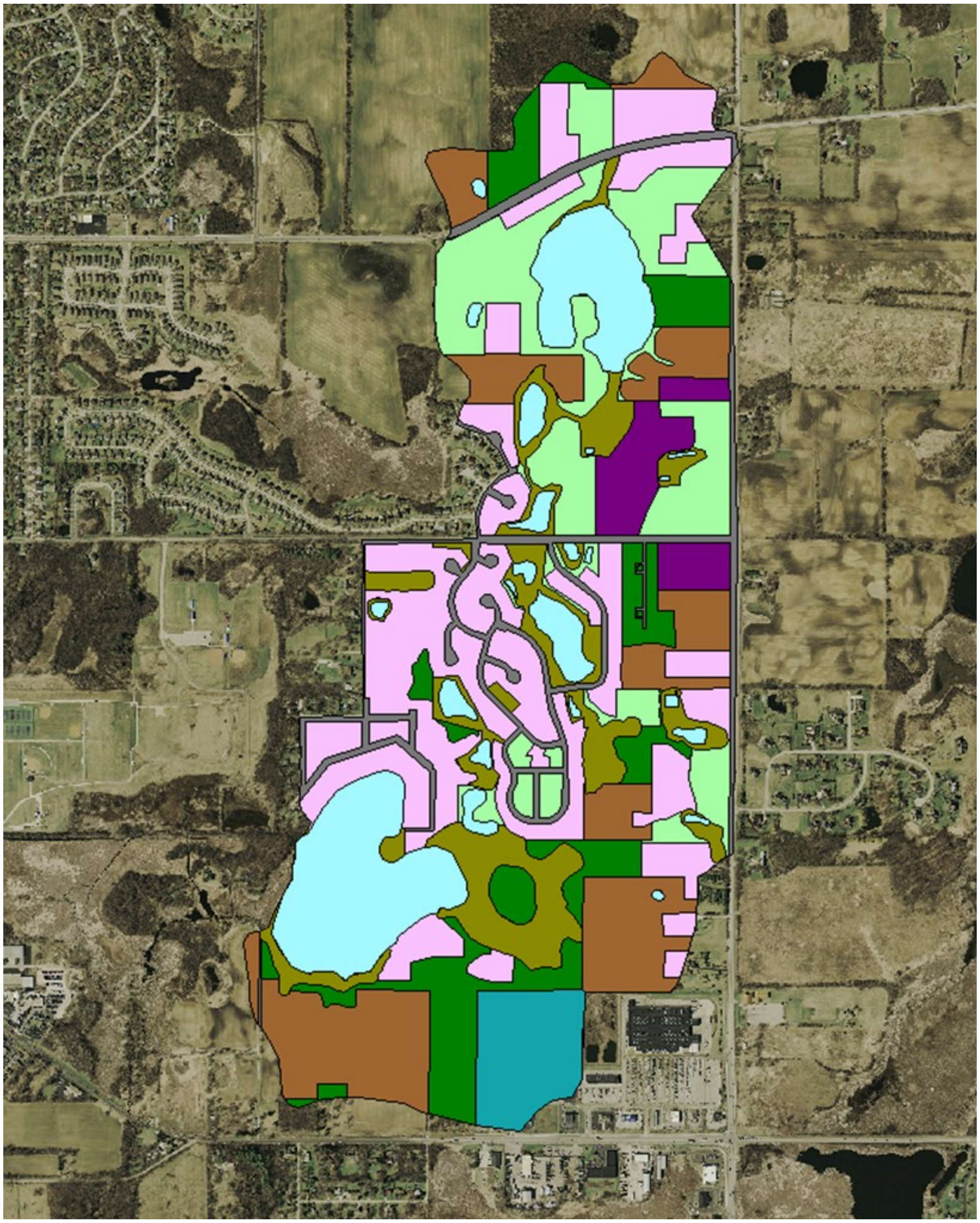
LITTLE SILVER LAKE WATERSHED

The lake is located in the Sequoit Creek sub basin, within the Fox River watershed. A watershed is a drainage basin where water from rain or snow melt drains into a body of water, such as a river, lake, reservoir, wetland or storm drain. The source of a lakes water supply is very important in determining its water quality and choosing management practices to protect the lake. Little Silver Lake receives a majority of its water from inlets from often have variable water quality that is heavily influenced by human activity.

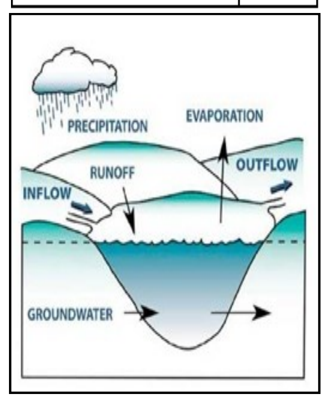
The lake has several inflow locations, including a small creek that originates from McGreal Lake from the north, where it winds through several ponds and marshes before it reaches Little Silver Lake. Water exits Little Silver Lake and flows into Sequoit Creek via two outlets on the western shoreThe retention time, the time it takes for water entering a lake to flow out again was calculated to be approximately 333 days.

The major sources of runoff for Little Silver Lake were Residential (22.3%), Agriculture (15.6%)Public and Private Open Space (14.4%) and Water (13.7%). The impervious surfaces (parking lots, roads, buildings, compacted soil) do not allow rain to infiltrate into the ground. Land management practices of the large amount of residential area in the water shed impacts the lake. Controlling water that runs from the land's surface into the lake is important for maintaining Little Silver Lakes water quality.

Little Silver Lake Watershed and Landuse



Land Use	Acreage
Government & Institutional	22.35
Retail/Commercial	23.61
Transportation	34.87
Forest and Grassland	62.65
Wetlands	63.47
Water	83.47
Public & Private Open Space	87.59
Agricultural	94.70
Single Family	135.97
Total Acres	**608.68**



LITTLE SILVER LAKE AREA LAND USE 2015

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	94.70	0.05	13.0	3.8
Forest and Grassland	62.65	0.05	8.6	2.5
Government and Institutional	22.35	0.50	30.7	8.9
Public and Private Open Space	87.59	0.15	36.1	10.4
Retail/Commercial	23.61	0.85	55.2	15.9
Single Family	135.97	0.30	112.2	32.4
Transportation	34.87	0.85	81.5	23.6
Water	83.47	0.00	0.0	0.0
Wetlands	63.47	0.05	8.7	2.5
TOTAL	**608.68**		**346.1**	**100.0**

VLMP —Water Quality

Volunteer Lake Monitor Program

VOLUNTEERS MEASURE WATER CLARITY USING THE SECCHI DISK TWICE A MONTH MAY THROUGH OCTOBER. IN 2015 THERE WERE 56 LAKES PARTICIPATING IN LAKE COUNTY.

IF YOU WOULD LIKE MORE INFORMATION PLEASE CONTACT:

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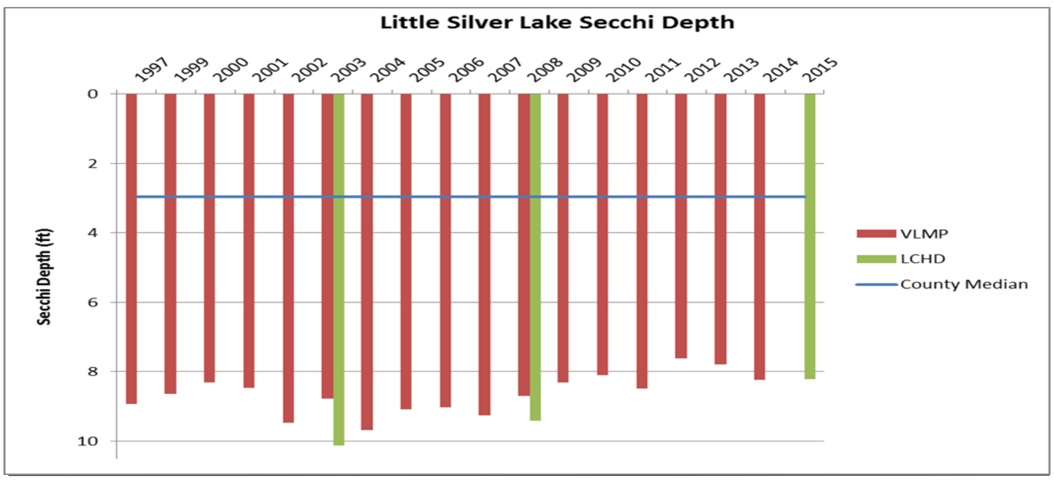
The VLMP was established in 1981 by the Illinois Environmental Protection Agency (IEPA) to be able to collect information on Illinois inland lakes, and to provide an educational program for citizens. The volunteers are primarily lakeshore residents, lake owners/managers, members of environmental groups, and citizens with interest in a particular lake. The VLMP relies on volunteers to gather information on their chosen lake. The primary measurement by volunteers is Secchi depth (water clarity). Water clarity can provide an indication of the general water quality of the lake. Other observations such as water color, suspended algae and sediment, aquatic plants and odor are also recorded. The sampling season is May through October with measurements taken twice a month.

Continued participation provides annual data that helps document water quality impacts and support lake management decisions. The VLMP program has provides Lakes with annual baseline data that can be used to determine long term water quality trends and support current lake management decision making. The volunteers will provide data that is vital for the management of this lake. If you would like to participate or need more information about becoming a VLMP please contact the LCHD-ES. The Average Secchi for Little Silver Lake since 1997 is 8.63 feet.



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 resuspension of bottom sediment are factors that interfere with light penetration and reduce water transparency. If light penetration is reduced significantly, macrophyte growth may be decreased which would in turn impact the organisms dependent upon them for food and cover.

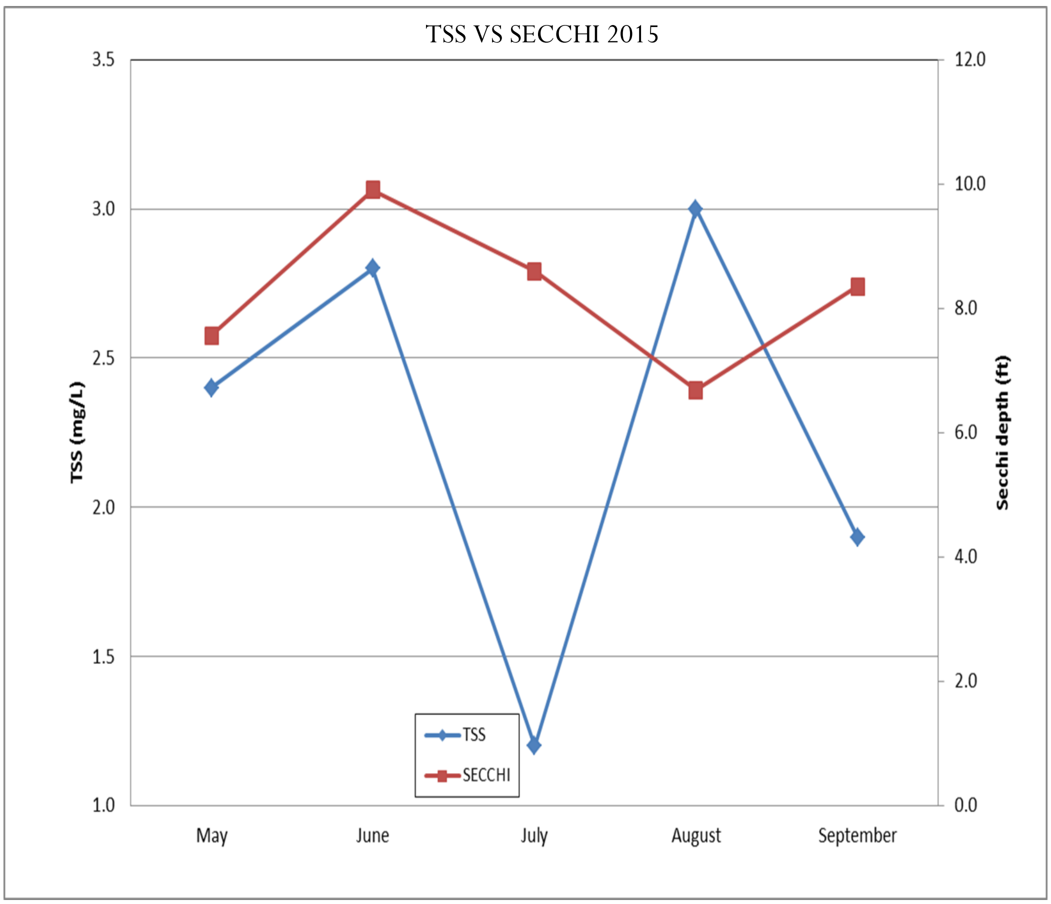
The 2015 average clarity for Little Silver Lake was 8.22 feet (ES); this was a 13% decrease in the lakes transparency since 2008 of 9.42 feet and the water clarity was above the county median of 2.96 feet. The shallowest Secchi depth for Little Silver lake was in August and the deepest was in June 9.90 feet. Overall the good water clarity in Little Silver Lake can be attributed to a healthy plant population that stabilizes the lake bottom and utilizes the available nutrients in the water.

TOTAL SUSPENDED SOLIDS

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

Seasonal Secchi readings changes are affected by algal growth. The absence or low density of algae in early spring usually provides deeper clarity but as the water warms clarity decreases with more algae present in the water. High turbidity caused by sediment or algae can shade out native aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as habitat for many fish species and stabilization of the lake bottom. The 2015 TSS concentrations in Little Silver Lake averaged 2.3 mg/L which was below the county median of 8.2 mg/L and but 28% higher than the 2008 average concentration of 1.8 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. Lakes with TSS values ≥ 12 mg/l could cause impairment for aquatic life in inland lakes.

There are internal and external sources of sediment affecting the turbidity in Little Silver Lake. Internal sources of sediment suspension include wind and wave action especially along eroded shoreline. External sources include sediments that are transported into the lake from a feeder creek, bank erosion and other sources in the watershed. The average calculated nonvolatile suspended solids (NVSS) was 0.84 mg/L. The low NVSS means that the majority of the TSS concentration in 2015 can be attributed to solids that are organic in nature.



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

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

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

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

DATE (2015)	TSS	SECCHI
May	7.0	2.98
June	3.1	5.00
July	4.3	5.00
August	6.6	3.10
September	7.7	3.65

What Has Been Done to Reduce Phosphorus Levels in Little Silver Lake

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.

Storm drains lead to the nearest lake, river, pond or wetland. They do not go to a treatment plant.

Salts dissolve and move downhill or into the nearest storm drain with storm-water and snowmelt runoff to the nearest lake, river or pond. They do not settle out; they remain in the water cycle virtually forever.

Nutrients

The nutrients organisms need to live or grow are typically taken in from the environment. In a lake the primary nutrients needed for aquatic plant and algal growth are phosphorus and nitrogen. In most lakes, including Little Silver, phosphorus is the limiting nutrient, which means everything that plants and algae need to grow is available in excess: sunlight, warm temperature, and nitrogen.

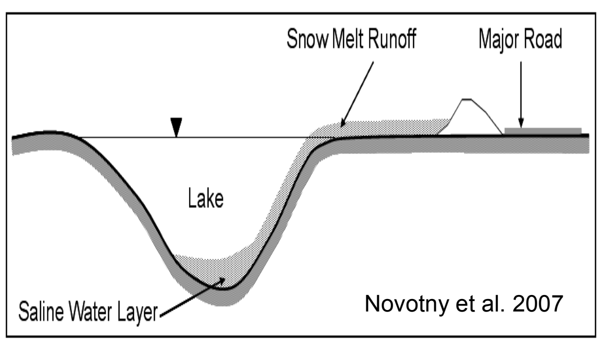
Phosphorus has a direct effect on the amount of plant and algal growth in lakes. The 2015 average total phosphorus (TP) epilimnion (near surface sample) concentration in Little Silver Lake was 0.028 mg/L, this was an 12% increase from the 2008 concentration (0.025 mg/L). Lakes with concentrations exceeding 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 of which are related to human activities which include: human and animal waste, soil erosion, septic systems, common carp, and runoff from farmland and lawns. Little Silver Lake's healthy plant population is responsible for keeping the TP level low preventing severe algae blooms during the summer.

Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average 2015 TKN for Little Silver Lake was 0.87 mg/L. If inorganic nitrogen ($NO2$, $NO3$, $NH4$) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee less algae blooms. The TN:TP ratio for Little Silver Lake was 31:1, which means that the limiting nutrient for aquatic plants was phosphorus.

Conductivity and Chloride

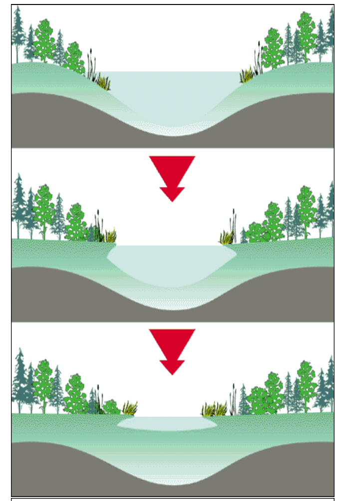
Conductivity is a measure of a waters ability to conduct electricity, measured by the water's ionic activity and content. The higher the concentration of (dissolved) ions the higher the conductivity becomes. Conductivity readings, which are influenced by chloride concentrations, have been increasing throughout the past decade in Lake County. Lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher Cl^- concentrations because of the use of road salts. Storm water run-off from impervious surfaces such as roads and parking lots can deliver high concentrations of Cl^- to nearby water bodies. Road salt used in the winter road maintenance consists of the following ions: sodium chloride, calcium chloride, potassium chloride, magnesium chloride, or ferrocyanides which are detected when chlorides are analyzed.

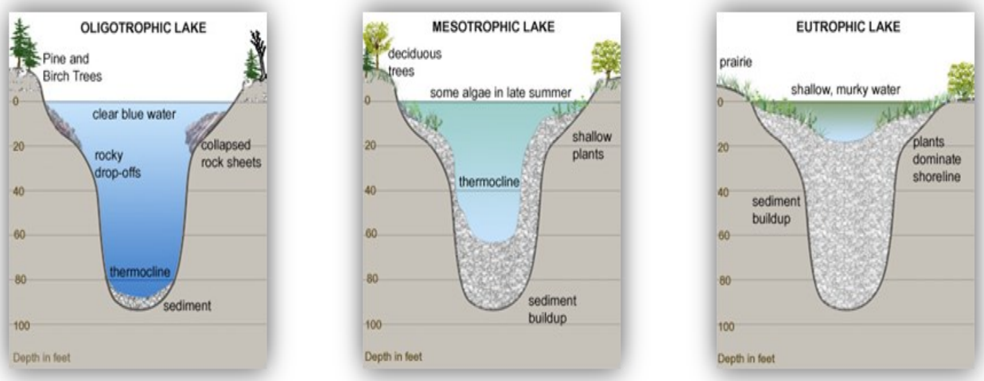
The 2015 average conductivity for Little Silver 0.8148 mS/cm. This parameter was above the county median of 0.7920 mS/cm, a 2.5% decrease from the 2008 value of 0.7270 mS/cm. These values are influenced by the winter road maintenance of Route 173, 59, Deep Lake Rd. and the surrounding residential areas. The United States Environmental Protection Agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems and prolonged exposure can harm 10% of aquatic species. Little Silver Lake's Cl– concentration was 143 mg/L. 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. However, many of our invasive species, such as Eurasian Watermilfoil, Cattail and Common Reed, are tolerant to high chloride concentrations.



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 lakes 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 to take place. 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 TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), and eutrophic (nutrient rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2015, Little Silver Lake was eutrophic with a TSIp Value of 52.2, placing it 31st out of 173 lakes in the county. Lake Carina was 1st with a 37.4 TSIp Value.





Source: RMB Environmental

"WHEN HUMAN ACTIVITIES ACCELERATE LAKE EUTROPHICATION, IT IS REFERRED TO AS CULTURAL EUTROPHICATION. CULTURAL EUTROPHICATION MAY RESULT FROM SHORELINE EROSION, AGRICULTURAL AND URBAN RUNOFF, WASTEWATER DISCHARGES OR SEPTIC SEEPAGE, AND OTHER NON-POINT SOURCE POLLUTION SOURCES."

LAKE LEVEL

Lakes with stable water levels potentially have less shoreline erosion problems. The lake level in Little Silver Lake was measured from a green stake near the outlet. The lake level decreased from May to September by only 1.20 inches. The highest water level recorded occurred in June (0.70 ft) and the lowest level in May (1.06 ft). The most significant water level fluctuation occurred from May to June with a decrease in the lake level of 0.36 (ft) inches. Little Silver Lake's water level appear to be influenced by rain events. The watershed's primary land use of single family homes surrounding the lake has the potential to deliver significant amounts of storm water. In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly). The data provides lake managers a much better idea of lake level fluctuations relative to rainfall events and can aid in future decisions regarding lake level. Staff gauge is a great tool for measuring water level in lakes, rivers, reservoirs. The data collected can be compiled to help understand the natural fluctuations of the lake. Lakes with fluctuating water levels potentially have poorer water quality and have more shoreline erosion problems. However this does not appear to be the case in Little Silver Lake. The wetland complex along the inlet creek likely acts as a buffer for the incoming flow.

2015	Level (ft)	Seasonal Change (ft)	Monthly Change (ft)
May	1.06		
June	0.70	-0.36	-0.36
August	0.70	-0.36	0.00
September	0.96	-0.10	0.26

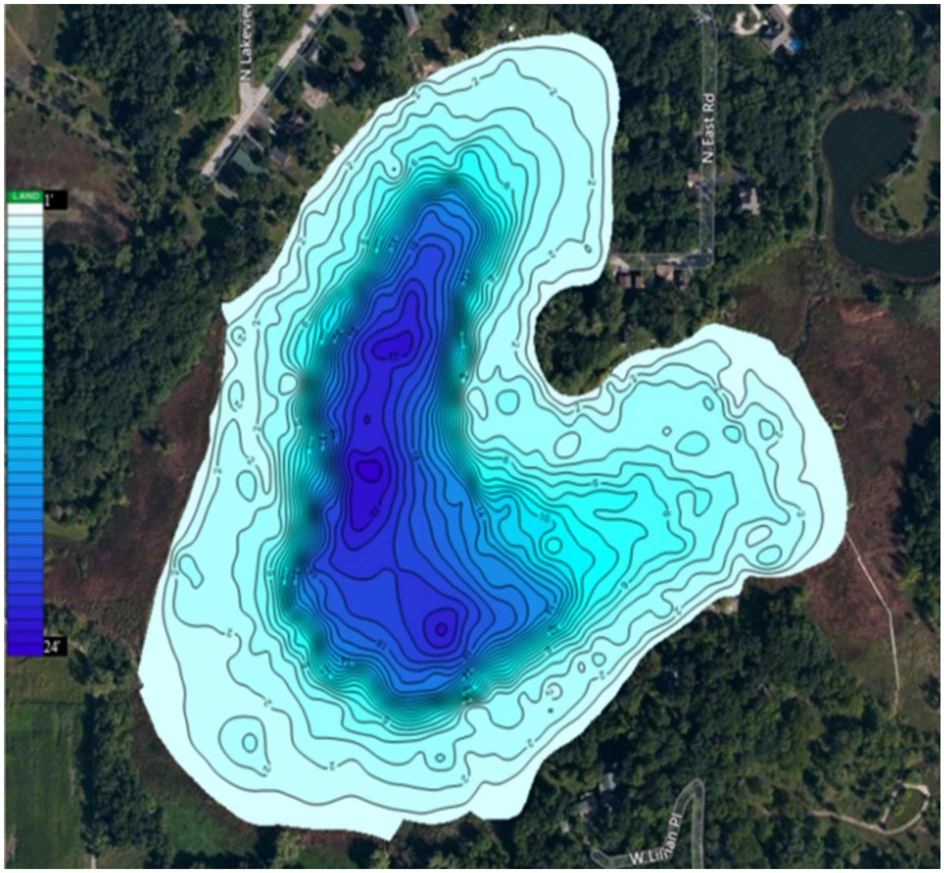
EXAMPLE OF A PERMANENT STAFF GAUGE

BATHYMETRIC MAPS

Bathymetric maps are also known as depth contour maps and display the shape and depth of a lake. They are valuable tools for lake managers because they provide information about the surface area and volume of the lake at certain depths.

This information can then be used to determine the volume of lake that goes anoxic, how much of the lake bottom can be inhabited by plants, and is essential in the application of whole-lake herbicide treatments, harvesting activities and alum treatments of your lake. Other common uses for the map include sedimentation control, fish stocking, and habitat management.

The LCHD-ES collects field data using a Lowrance and transducer. Once collected, the data will be analyzed and imported into ArcGIS for further analysis.

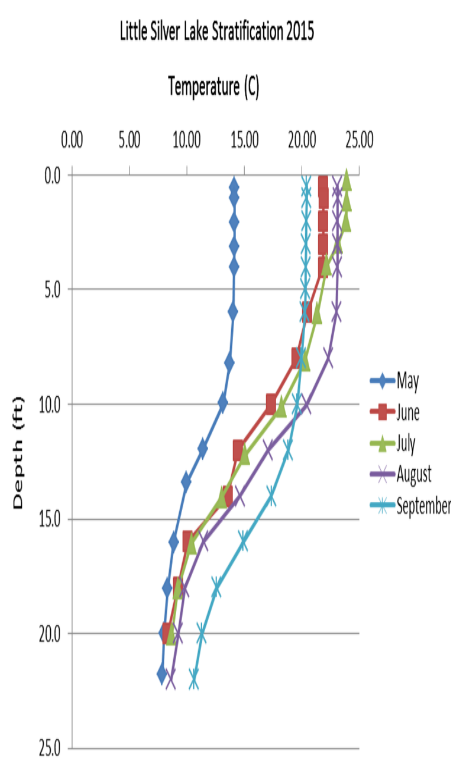


STRATIFICATION

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

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

Monthly depth profiles were measured on Little Silver Lake by measuring water temperature, dissolved oxygen, conductivity, and pH every foot from the lake surface to the lake bottom. The relative thermal resistance to mixing (RTRM) value can be calculated from this data which can tell us if the lake stratifies, how great the stratification is, and what depth it occurs. Little Silver Lake typically stratifies during the summer months and in 2015 it began to stratify in May and continued until September. The thermocline was established around 6 feet in June and began to weaken by September as the water cooled.



Blue-green Algae

Algae are important to the freshwater ecosystems, and most species of algae are not harmful. Algae blooms are often caused by blue-green algae, or "cyanobacteria", which are similar to bacteria in structure but utilize photosynthesis to grow. They have no nucleus and lack the photosynthetic pigments found in algae. They usually are too small to be seen individually, but can form visible colonies that can cover large areas of lakes. Certain species of blue-green algae can produce toxins that could pose a health risk to people and animals when they are exposed to them in large enough quantities.

Little Silver Lake had seasonal algal bloom due to an increase in Total Phosphorus brought in by heavy rains in June and July. Algal blooms may be kept under control by reducing nutrients and sediments entering the lake from the watershed. Blooms can last for an extended period of time, which prevents sunlight from reaching underwater plants and algae that are important to the ecosystem.

The water can appear blue-green, bright green, brown, or red and may look like paint floating on the water. Not all blue-green algae produce harmful toxins. The three types of cyanobacteria that are often associated with Harmful Algal Bloom (HAB) are the Anabaena, Aphanizomenon, and Microcystis. The presence of these cyanobacteria does not generally mean that the toxins are present in the water. The presence of toxins can only be verified through a sample analyzed in the lab. Poisoning has caused the death of cows, dogs, and other animals. Most human cases occurred when people swim or ski in affected recreational water bodies during a bloom.

If you suspect that you are experiencing symptoms related to exposure to blue-green algae such as stomach cramps, diarrhea, vomiting, headache, fever, muscle weakness, or difficulty breathing contact your doctor or the poison control center. For more information or to report a blue-green algae bloom, contact the Lake County Health Department Environmental Services (847) 377-8030.

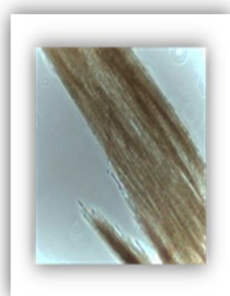
For More Information On Blue-green algae:
www.epa.state.il.us/water/surface-water/blue-green-algae.html

To report blue-green algae bloom:
Lake County Health Department

847-377-8030

Anabaena Sp.

Microcystis Sp.



Aphanizomenon Sp.

FLORISTIC QUALITY INDEX

LAKE COUNTY AVERAGE
FQI = 13.4

LITTLE SILVER LAKE
FQI = 25.2

RANK = 9/170

AQUATIC PLANTS SPECIES OBSERVED = 17

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness that 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. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2015, Little Silver Lake had an FQI of 25.2 ranking 9 out of 170 in Lake County. The median FQI of lakes that we have studied from 2000-2015 is 13.4. Cedar Lake is 1st with an FQI of 37.4.

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.

AQUATIC PLANTS: WHERE DO THEY GROW?

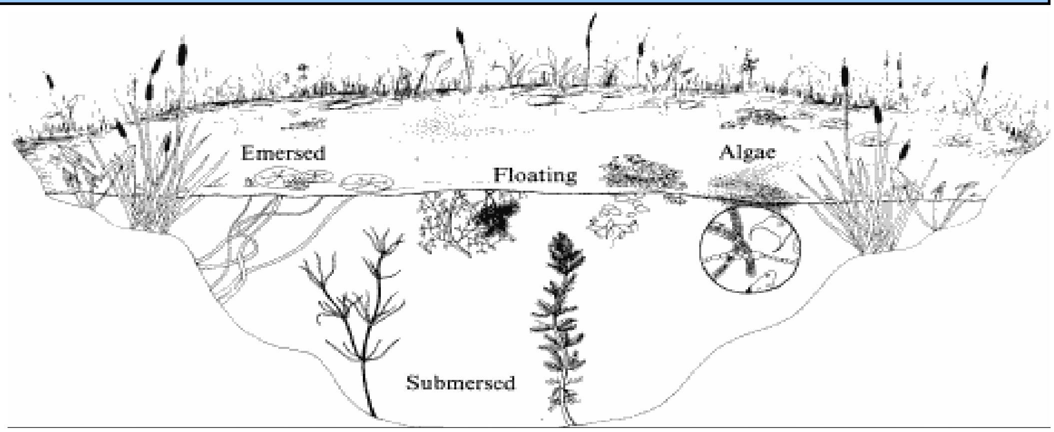
Littoral Zone– the area that aquatic plants grow in a lake.

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

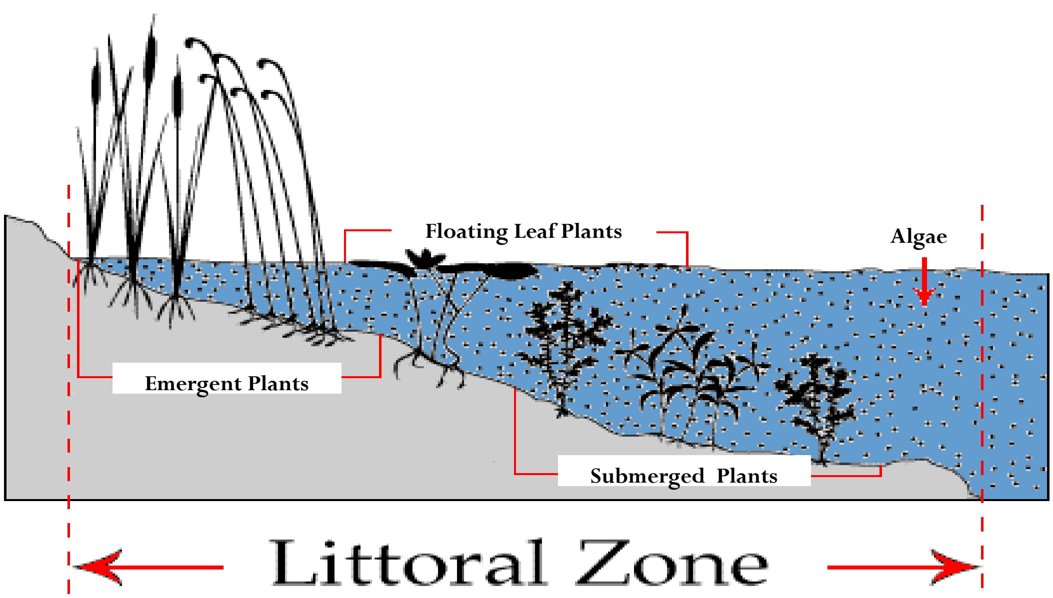
Submerged Plants– have stems and leaves that grow entirely underwater, although some may also have floating leaves.

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

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



LITORAL ZONE

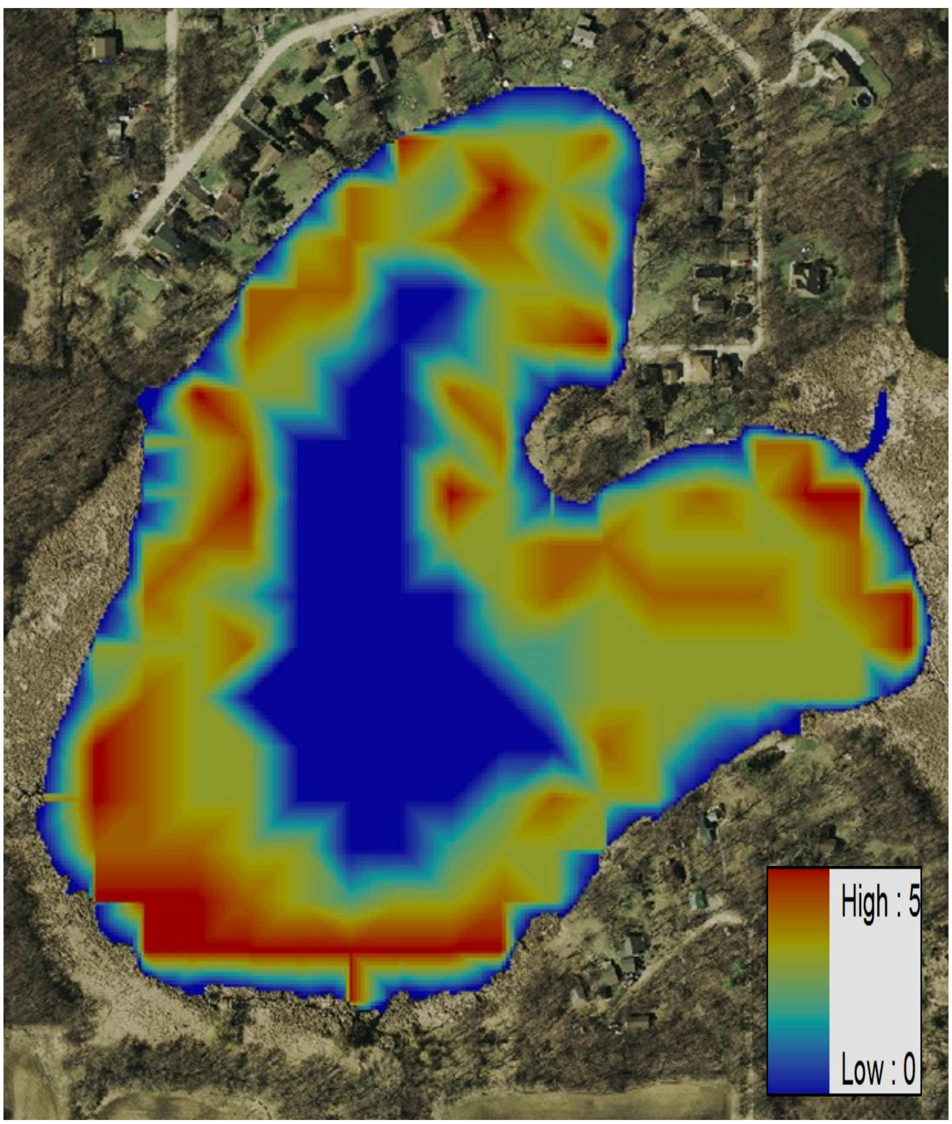


Source: Minnesota Department of Natural Resources

AQUATIC PLANTS

Aquatic plant mapping survey provides information based on the species, density and distribution of plant communities in a particular lake. An aquatic plant sampling was conducted on Little Silver Lake on August 2015 when most plants are present. There were 193 points generated based on a computer grid system with points 60 meters apart. Aquatic plants occurred at 153 of the sites (79% total lake coverage) that included 17 aquatic plant species, plus the macro-algae chara and 2 exotic invasive species: Curlyleaf Pondweed and Eurasian Watermilfoil. The most commonly occurring species were White Water Lily and Coontail at 54.9%, and 51.8%, respectively, while Bladderwort (46%), Curlyleaf Pondweed (35.8%), and Eurasian Watermilfoil (18.1%) were the next abundant species. Glacial lakes, like Little Silver, typically have a very good plant diversity and the 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 light level in the water column falls below 1% of the surface light level, plants can no longer grow. The extent of the 1% light can be obtained by doubling the Secchi disk reading. The average Secchi disk reading for 2015 was 8.2 feet. The deepest aquatic plant, Coontail, was found in 14 feet of water. Aquatic plants play an important role in the lakes ecosystem by providing habitat for fish and shelter for aquatic organism. Aquatic plants provide oxygen, reduce nutrients such as phosphorus to prevent algae bloom, and help stabilize sediment.

AQUATIC PLANT RAKE DENSITY MAP FOR AUGUST 2015



Rake Density (coverage)	# of Sites	% of Sites
No Plants	34	18
>0-10%	2	1
10-40%	16	8
40-60%	63	33
60-90%	42	22
>90%	30	16
Total Sites with Plants	153	79
Total # of Sites	193	100

Aquatic plants

Aquatic plants provide many water quality benefits and play an important role in the lakes ecosystem by providing habitat for fish and shelter for aquatic organism. Plants provide oxygen, reduce nutrients such as phosphorus to prevent algae bloom, and help stabilize sediment. A native plant community tends to be diverse and usually does not impede lake activities such as boating, swimming and fishing.

Common Plants Found in Little Silver Lake in 2015

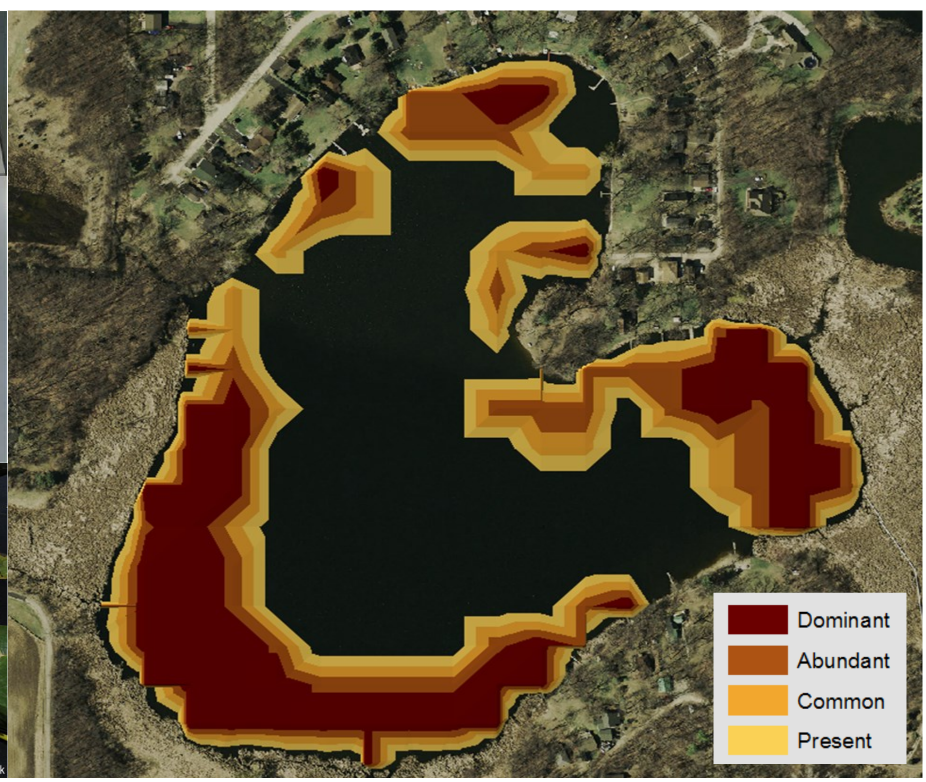
Plant Density	American Pondweed	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed
Absent	189	104	136	93	124	191	158	174	187
Present	3	8	1	1	9	0	3	3	0
Common	1	49	14	27	36	1	15	6	5
Abundant	0	28	24	55	18	1	15	10	1
Dominant	0	4	18	17	6	0	2	0	0
% Plant Occurrence	2.1	46.1	29.5	51.8	35.8	1.0	18.1	9.8	3.1

Plant Density	Illinois Pondweed	Northern Watermilfoil	Sago Pondweed	Slender Naiad	Southern Naiad	Spatterdock	Star Duckweed	Water Stargrass	White Water Lily
Absent	189	190	165	191	191	189	184	183	87
Present	1	1	3	1	2	2	0	6	1
Common	3	1	12	1	0	2	6	2	16
Abundant	0	1	12	0	0	0	2	2	37
Dominant	0	0	1	0	0	0	1	0	52
% Plant Occurrence	2.1	1.6	14.5	1.0	1.0	2.1	4.7	5.2	54.9

White Water Lily

A perennial plant that can grow in waters to 8' deep. The leaves develop directly from the rootstock on long petioles. They are 4-12" across, orbicular in shape, cleft toward the middle on one side, and smooth along the outer margins. The upper surface of the leaf is medium green, while the lower surface is often purplish; its texture is rather leathery and thick. Fine veins radiate outward from the center of the leaf.

August 2015 White Water Lily Density at Little Silver Lake

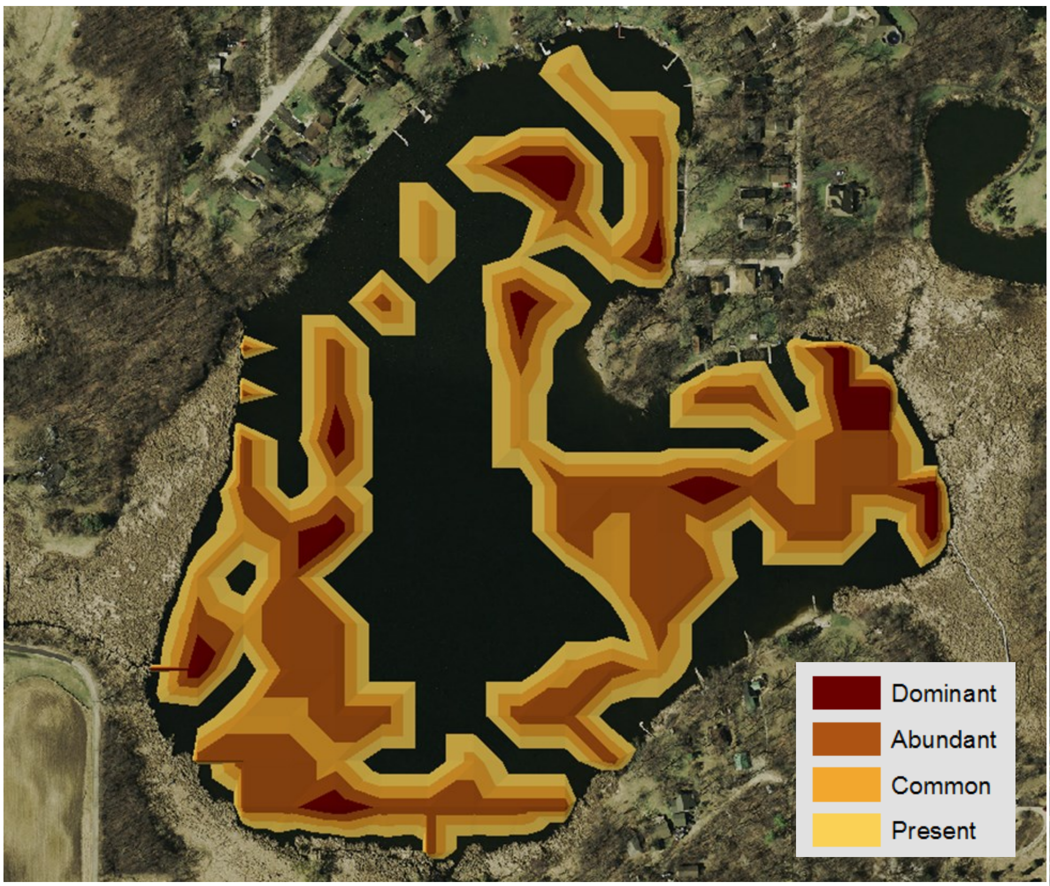


COONTAIL (*Ceratophyllum demersum)*

This perennial plant is a submerged aquatic about 1-3' long. There is more branching of the stems above than below, creating fan-like aggregations of leaves. The stems are up to 1.0 mm. across, light green to nearly white, terete to slightly compressed (flattened), and hairless; they are slender and flexible. The leaves are highly flexible and readily bend. The preference is full sun, shallow water up to 4' deep, and a mucky bottom.

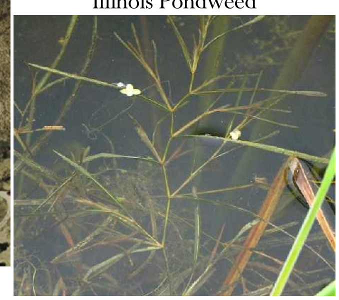
Common Bladderwort

AUGUST 2015 COONTAIL DENSITY AT LITTLE SILVER LAKE



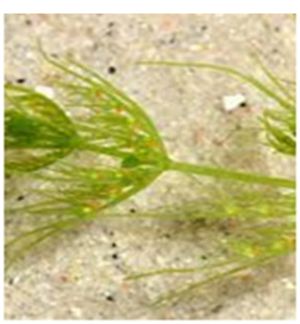
Sago Pondweed

Illinois Pondweed

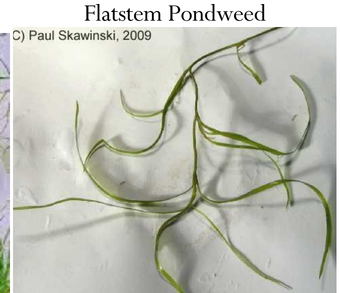


Flatstem Pondweed

CHARA (MACRO-ALGAE)



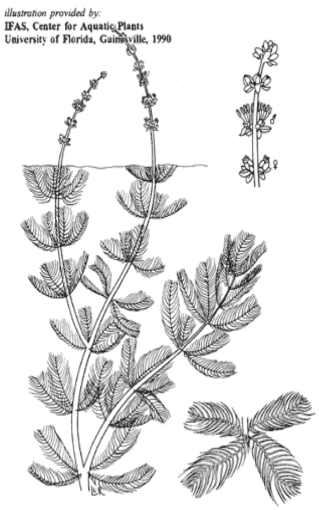
Chara is an advance form of algae which resemble higher plants. Its easily identified by its musky odor and gritty surface due to mineral deposits on its surface. It filters nutrients out of the water and stabilizes the lake bottom.



Water Stargrass

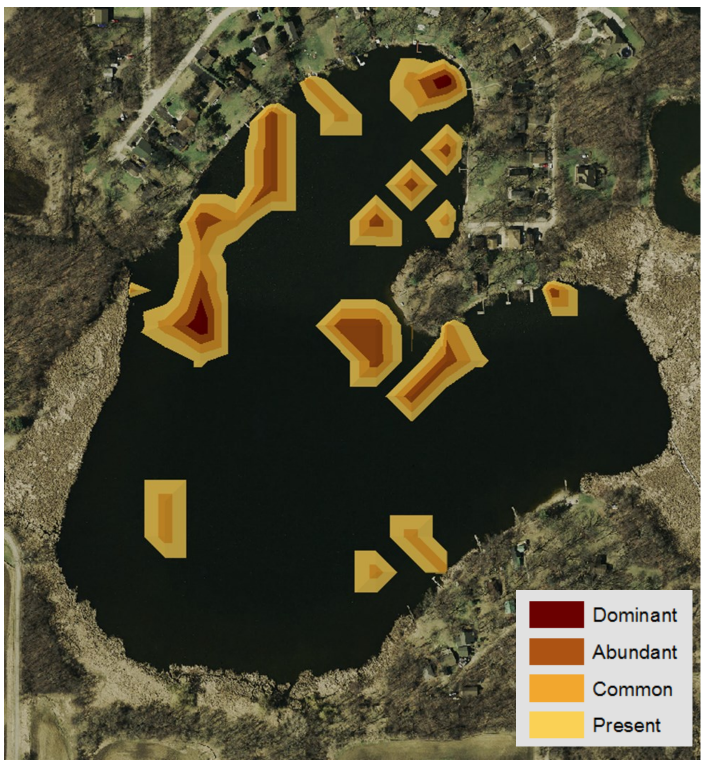
Eurasian Watermilfoil

Illustration of Eurasian Watermilfoil



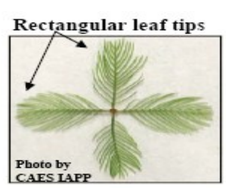
Eurasian Watermilfoil (EWM) is a feathery submerged aquatic plant that can quickly form thick mats in shallow areas of lakes and rivers in North America. These mats can interfere with swimming and entangle propellers, which hinders boating fishing, and waterfowl hunting. Matted milfoil can displace native aquatic plants, impacting fish and wildlife. Since it was discovered in North America in the 1940's, 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.

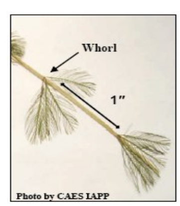
The abundance of EWM in Little Silver Lake has decreased by 71% since 2008. EWM was present at 18% of the sample sites with plants. An aquatic plant management plan is critical to maintaining the health of the lake and a balanced aquatic plant community. The plan should be based on the management goals 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 and Curlyleaf Pondweed. Follow up is critical to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake. At this time there is a healthy population of native aquatic plants to keep the Eurasian water milfoil from becoming the dominant plant in the lake.



Erasian watermilfoil density at 35 sites on Little Silver Lake in August, 2015,

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.

CURLYLEAF PONDWEED

Curlyleaf Pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. This aquatic plant has an unusual life history. Unlike our native pondweeds it begins growing in the early spring. CLP has even been documented growing under the ice in lakes! The plant then reaches maturity in mid summer typically June in Lake County when our natives are starting to emerge. CLP becomes invasive in some areas because of its adaptations for low light tolerance and low water temperatures which allow the plant to get a head start and outcompete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Large populations of CLP also can cause changes in nutrient availability. In midsummer, CLP plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms. CLP can form dense mats that may interfere with boating and other recreational uses. In August 2015, Little Silver Lake CLP were common, plants being found at 35.8 % of the sampled sites. This is a 46.1% increase from 2008 when CLP was found at 24.5% of the sampled sites. At this time the density of CLP is not causing fluctuations in nutrient availability. The Little Silver Lake aquatic plant management plan should prioritize the reduction in CLP in an effort to keep the population from expanding.

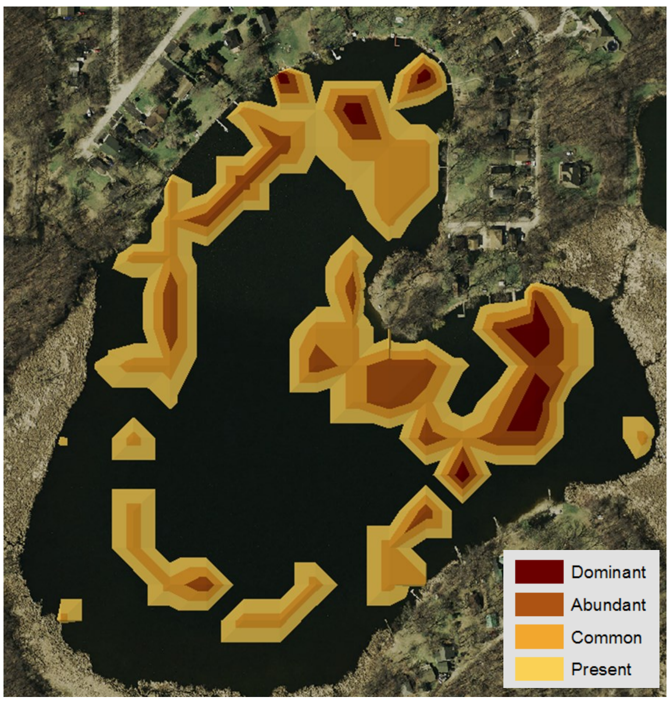
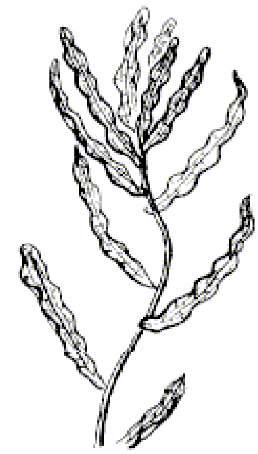


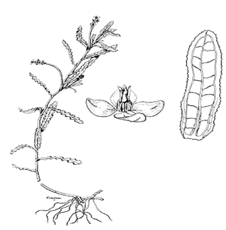
ILLUSTRATION OF CURLYLEAF PONDWEED



CURLYLEAF PONDWEED DENSITY AT 69 SITES ON LITTLE SILVER LAKE IN AUGUST 2015,

POTAMOGETON CRISPUS EXOTIC*

Turion



KEY FEATURES:

STEM: ARE FLATTENED, BRANCHED, CAN FORM DENSE STANDS IN WATER UP TO 15 FEET DEEP.

LEAF: ALTERNATE ALL SUBMERSED, OBLONG, STIFF, TRANSLUCENT LEAVES HAVE DISTINCTLY WAVY EDGES WITH FINE TEETH AND 3 MAIN VEINS.

FLOWER: TINY, WITH 4 PETAL-LIKE LOBES. IN SPIKES 1-3CM LONG ON STALKS UP TO 7CM LONG. (MAY SEE TURIONS WHICH OVER WINTERS AS A HARD, BROWN, BUR-LIKE BUD WITH CROWDED, SMALL HOLLY-LIKE LEAVES).

COMMON NAMES:
CURLY LEAF PONDWEED

ORIGIN: EOXTIC*
ASIA, AFRICA, AND EUROPE FOUND THROUGHOUT LAKE COUNTY AND ILLINOIS

IMPORTANCE:
INVASIVE: HAS A TOLERANCE FOR LOW LIGHT AND WATER TEMPERATURES THAT ALLOW THE PLANT TO GET A HEAD START ON NATIVE PLANTS. BY MID SUMMER WHEN MOST AQUATIC PLANTS ARE GROWING, CURLYLEAF PLANTS ARE DYING OFF. WHICH MAY RESULT IN A CRITICAL LOSS OF DISSOLVED OXYGEN AND AN INCREASE IN NUTRIENTS.

LOOK ALIKES:
NONE

PESTICIDE PERMIT REQUIREMENTS FOR PESTICIDE APPLICATION

A National Pesticide Elimination System (NPDES) permit is required when pesticides are applied to, over or near the waters of the State. This permit applies to all public waters that have an outflow to the State waters. A Notice of Intent (NOI) must be filled and submitted electronically to the Illinois Environmental Protection Agency (IEPA) at least 14 days prior to any application of pesticides.

In order to obtain the permit an application needs to be filed with the IDNR requesting a permit for pesticide application, the application can be filled out by the applicant or their representative (which is usually the pesticide consultant).

- When is a NPDES permit needed?

Prior to any pesticide application made directly to, over or near waters of the state.

- Who should obtain NPDES permit coverage?

The individual pond owner who will apply the herbicide. If the pond owner hires a contract applicator either the contract applicator or the pond owner could apply for NPDES coverage.

- How do I apply for NPDES permit coverage?

File a Notice of Intent (NOI) with the IEPA. The form can be printed from the site listed above. Don't forget the 14 day public notice period and the information regarding the approval and notification process listed above, so plan ahead

- What does the permit cost?

Currently there is no fee however fees may be introduced at a later date.

- How long is the permit good for?

Five years from the date of issuance but not from the date of coverage.

- Is anything else needed besides the permit?

An Adverse Incident Report is needed if there are any adverse impacts related to the application such as spills or accidental overdosing. The incident must be reported to the Illinois Emergency Management Agency immediately and the report must follow within 15 days.

A Pesticide Discharge Management Plan (PDMP) is required if the annual threshold of 80 acres is past and if you do not meet any of the additional exemptions within the permit. The threshold is determined not only by the size of the pond or lake but by the number of treatments. For example, if a 10 acre pond is treated 9 times with different herbicides within a one-year period, it would be counted as 90 treatment acres and the 80 acre threshold limit would have been passed. This would trigger the need for a PDMP. If treated with the same herbicide 9 times, the additional treatments would not count toward the threshold.

- Additional things to remember

You are allowed to apply only a pesticide that is labeled for aquatic use. The General NPDES permit only applies to pesticide applications that will be made directly to or over waters of the State or at water's edge. Pesticide applications to dry ditches which discharge into waters of the State may also require General NPDES permit coverage.

You must file an updated NOI to modify your NPDES permit coverage to add additional use patterns or treatment areas at least 14 days prior to beginning the pesticide applications. The General NPDES permit coverage is good for 5 years from the issuance date on the permit.

Excerpt : Illinois Department of Natural Resources

FOR FULL DETAILS OF THE RULE SEE:

HTTP: / / WWW.EPA.STATE.IL.US/WATER/PERMITS/PESTICIDE/INDEX.HTML

AND

HTTP:// WWW.FOXWATERWAY.COM/PDFATTACHMENTS/HERBICIDE.PDF

Manual removal of aquatic plants

Controlling exotic aquatic plants by hand removal is effective on small areas and if done prior to heavy infestation. Eurasian watermilfoil can be controlled to some degree by hand pulling or raking of entire plants including the roots. Just before the peak growth is the best time for removal to prevent re-growth and plant seed dispersal. Working in windblown areas will help contain fragments near shore which makes cleanup easier. All fragments of EWM plants must be removed to achieve adequate control. Most regeneration are from fragmented stems that drift into different areas of the lake and form new colonies. Small populations of Curlyleaf can be manually removed with a rake or by hand pulling. All plant materials should be carefully removed as floating pieces of Curlyleaf that may contain turions can float away and colonize a different part of the lake.

Removal by hand is labor intensive but it can be a cheaper alternative if home owners are willing to put in the time. This method also eliminates or reduces the need for chemicals treatments that can impact native vegetation and fish. There are different types of rakes. First is a bladed rake that can be used to cut the stems of plants. Secondly, a throwable double sided rake that can be used to pull plants from deeper water or further distances and lastly a long handled rake for working the shoreline and the boat dock area. Its important to remove the entire plant including the roots to prevent regeneration.

Aquatic Rake with Blade

Protec your waters

Helping to prevent the introduction and spread of invasive aquatic plants and animals are the most effective way of protecting healthy, non-infested ecosystems. Listed below are some of the simple steps you can take to prevent invasion.

- Remove all plants, mud, fish, or animals before transporting equipment.
- Eliminate all water from equipment before transporting equipment.
- Dry anything that comes in contact with water (boat, trailers, equipment, clothing, etc.).
- Remove all mud and dirt since it might contain aquatic hitchhikers.
- Never release plants, fish or animals into a body of water unless they came out of that body of water.
- Do not release bait into the waters you are fishing.
- Do not release aquarium fish or aquatic pets in to the lake.

Double-sided Throwable Rake

Aquatic Plant Rake

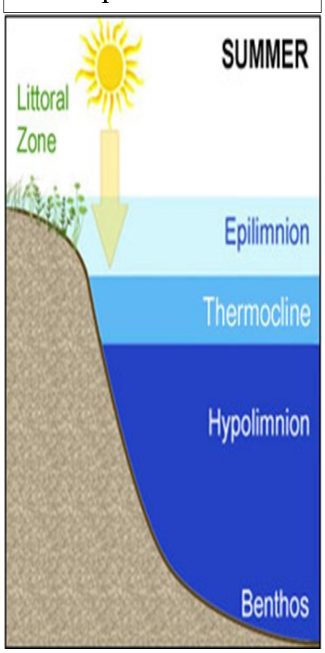
DISSOLVED OXYGEN

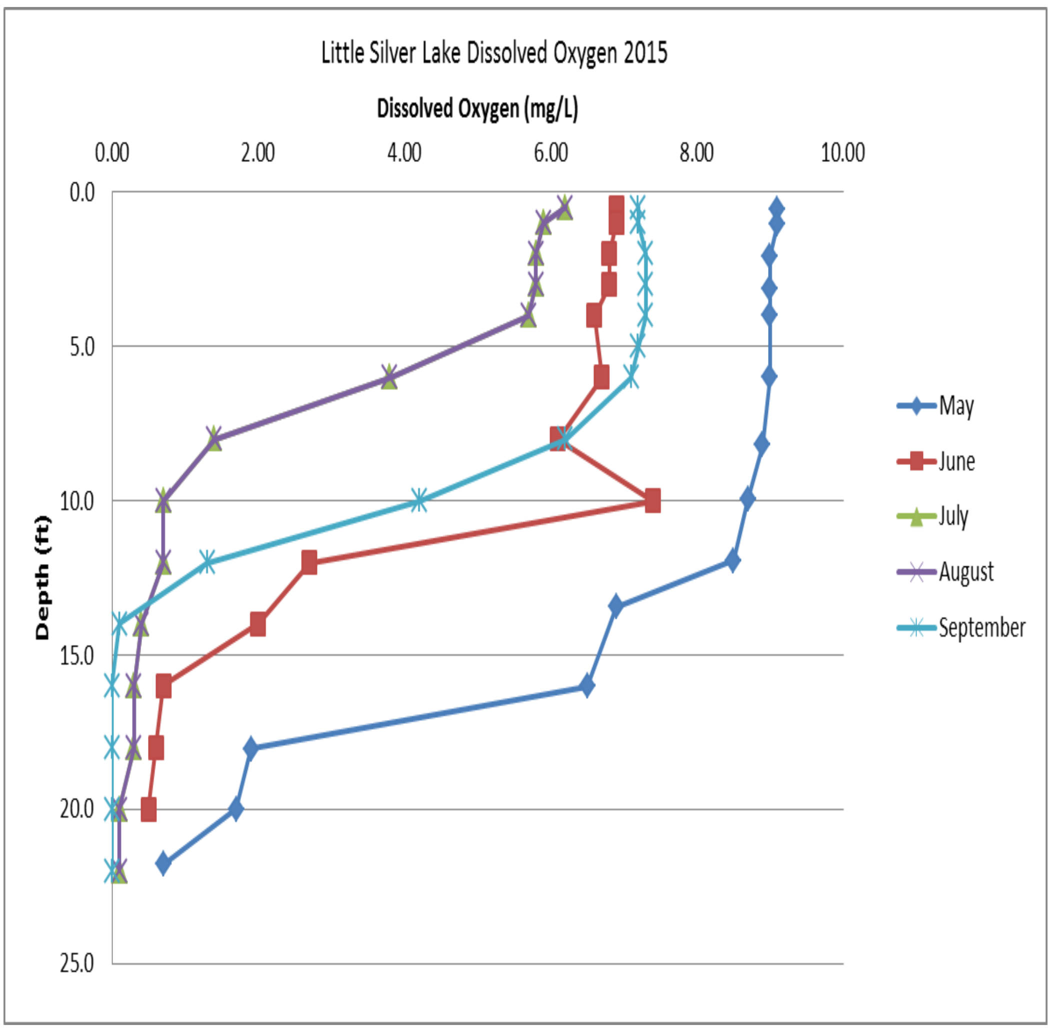
RANGE OF TOLERANCE FOR DISSOLVED OXYGEN IN FISH PARTS PER MILLION (PPM) OXYGEN		
1		< 3.0 PPM TOO LOW FOR FISH POPULATION
2		
3		3.0-5.0 PPM 12-24 HOUR RANGE OF TOLERANCE / STRESSFUL CONDITIONS
4		
5		>6.0 PPM SUPPORTS SPAWNING
6		
7		>7.0 PPM SUPPORTS GROWTH AND ACTIVITY
8		
9		>9.0 PPM SUPPORTS ABUNDANT FISH POPULATIONS
10		

Dissolved oxygen (DO) is a major indicator of water quality and is important for aquatic organisms, algae, macrophytes, and for many chemical reactions to occur that are crucial for lake functions. Dissolved oxygen concentrations can have large variations occurring and are affected by diffusion, aeration, photosynthesis, respiration, and decomposition. Temperature, salinity and pressure changes will also cause DO to fluctuate. Dissolved oxygen will vary both seasonally and by depth throughout the water column in lakes. If dissolved oxygen concentrations drop below levels necessary for sustaining aquatic life (below 5.0 mg/L at 1 foot depth below the lake surface) it becomes a water quality impairment. Low dissolved oxygen primarily is a result of excessive nutrients that stimulate growth of organic matter, such as algae, or the increase of pollutants such as sewage, lawn clippings, and soils that are considered to be "oxygen-demanding". Low dissolved oxygen levels is also often a factor for fish kills. When many of the plants or algae die at the end of the growing season, their decomposition can significantly reduce DO concentrations. In deeper, thermally stratified lakes, oxygen production is greatest in the upper water layer (epilimnion) where sunlight drives photosynthesis and oxygen consumption is greatest near the bottom of the lake (hypoliminion) where organic matter accumulates and decomposes.

Little Silver Lake's dissolved oxygen concentrations remained good all year and did not drop below 5.0 mg/L at 1 foot below the lakes surface, which would qualify it as a DO impairment. The lake averaged 6.97 mg/L at 3 feet below the surface.

Oxygen is vital to the health of aquatic habitats. Plants and animals need oxygen to survive. A low level of oxygen in the water is a sign that the habitat is stressed or polluted.





AQUATIC PLANTS AND FISH

Fish depend on aquatic plants to provide habitat and forage for food and most freshwater fish rely on aquatic plants at some point during their life stage. The plant composition and density can play an important role in the nesting, growth, and foraging success of these fish. While many fish require some aquatic vegetation for growth, excessive amounts of aquatic vegetation can negatively impact growth by reducing foraging success. The parameters of an ideal fish habitat change base on the size and species of fish, the type of lake, structures present in the lake and man other factors.

How do plants impact fish?

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

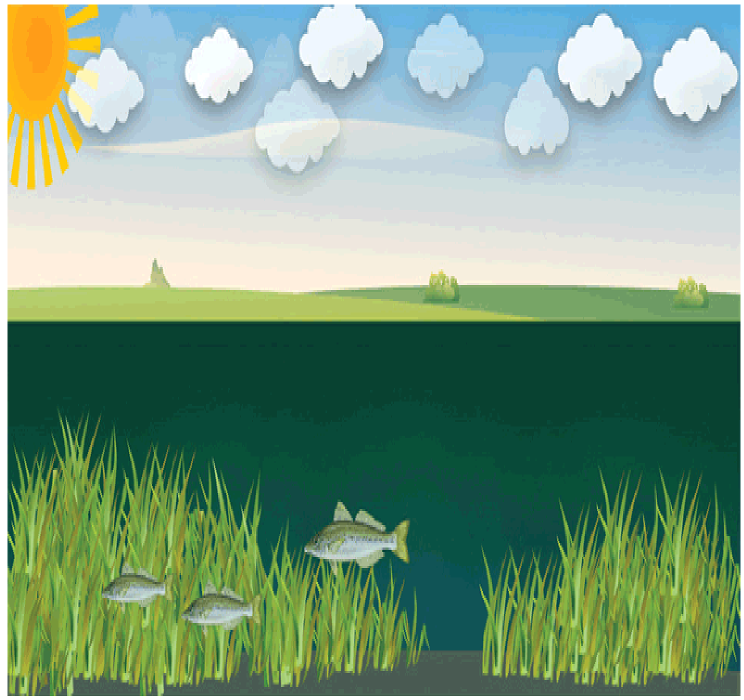


Image http://agriculture.vic.gov.au/

Table 1. Common fish and their plant affinity during various life stages and their relationship with plants.

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

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

Shoreline erosion

"Vegetative buffer zones can play a key role in limiting negative water quality impacts from developed shoreland property"

Plants help stabilize the shoreline from being washed away during a rain event or wind and wave action.

Information on shoreline regulation and permits can be found on the Illinois Department of Natural Resources' website.

http://www.dnr.illinois.gov/waterresources/documents/3704.pdf

Erosion is a natural process primarily caused by water which results in the loss of material from the shoreline. Disturbed shorelines caused by human activity such as clearing of vegetation and beach rocks, and increasing runoff will accelerate erosion. Rain and melting snow and wave action are the main causes of erosion. Rain can loosen soil and wash it down gradient towards the lake. Creating a native plant buffer helps prevent soil erosion as well as filter out pollutants and unwanted nutrients from entering the lake. Native plants can be planted along the shoreline since plant roots hold the soil particles in place so they are not easily washed away during a rain event, melting snow or wave action. Loose rocks and gravel placed on top of a filter fabric prevents soil from washing away before newly planted seed and vegetation has a chance to grow. Eroded materials cause turbidity, sedimentation, nutrients, and pollutants to enter a lake. Shore line buffer zone planted with native vegetation not only reduces runoff by increasing water infiltration into the ground, it also offers food and habitat for wildlife. Less runoff means less nutrients, sediments and other pollutants entering the lakes and streams. Excess nutrients are the primary cause of algal blooms and increased aquatic plant growth. Once in the lake, sediments, nutrients and pollutants are harder and more expensive to remove.

Vertical seawalls reflect wave energy, which can cause scouring of the lakebed, increased turbidity and habitat loss for lake organisms. This can make it difficult for aquatic plants to grow near the seawall edge and may contribute to poor plant coverage near shore.

Stone re-facing is adding layers of stone in front of an existing seawall to create a more natural shoreline. The stones help absorb wave energy that would otherwise reflect back and scour the bottom of the lake. This provides excellent habitat for fish, turtles and other aquatic animals. This minimizes the negative effects of an inflexible vertical seawall. Permits may be required with local or state government agencies prior to any alteration or repair of shoreline.

A shoreline erosion study was assessed for Little Silver Lake in 2015. The lake was divided into reaches, and the shoreline evaluated for none, slight, moderate and severe erosion based on exposed soil and tree/plant roots, failing infrastructure, undercut banks, and other signs of erosion. Based on the 2015 data, 21.2% of Little Silver Lake's shoreline has some erosion; 20.8% slight erosion, 0.4% moderate erosion, and no severe erosion.

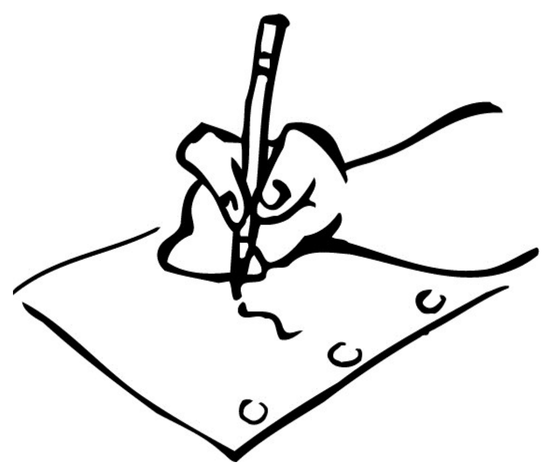
LAKE MANAGEMENT PLANS

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

What are the steps in creating a Lake Management Plan?

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

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



LakeCounty
Health Department and
Community Health Center

ECOLOGICAL SERVICES

Senior Biologist: Mike Adam

madam@lakecountyil.gov

Population Health Services
500 W. Winchester Road

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.

Ecological 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

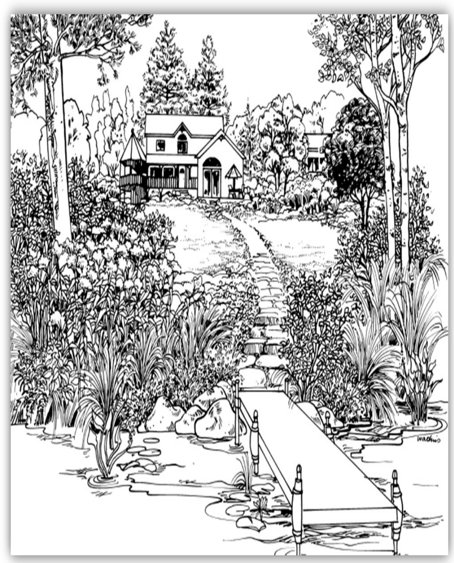
Services provided are either of a technical or educational nature and are provided by a professional staff of scientists to government agencies (county, township and municipal), lake property owners' associations and private individuals on all bodies of water within Lake County.

LAKE RECOMMENDATIONS

Little Silver Lake's water quality has remained stable since 2003 and 2008 with a slight increase in phosphorus and total suspended solids which led to a decrease in Secchi depth. There was also a 71% decrease in Eurasian watermilfoil and a 36% increase in Curlyleaf. Little Silver Lake management is administered by the Little Silver Lake Improvement Association.

To improve the overall quality of Little Silver Lake, ES (Ecological Services) has the following recommendations:

- **Encourage homeowners to incorporate native plants in their landscaping through rain gardens shoreline buffer**
- **Participation in Volunteer Lake Monitoring Program and in the Clean Waters Clean Boats Program**
- **Help reduce Cl^- by supporting wise use of road salt in the watershed**
- **Install a permanent staff gage to monitor lake level fluctuations**
- **Install a sign to educate on ways to reduce the spread of Aquatic Invasive Species**
- **Become familiar with the appearance of harmful algal blooms and report any blooms to the LCHD-ES by calling 847-837-8030**
- **Develop an Aquatic Plant Management Plan (APMP) that targets the reduction of invasive species and promotes native plant diversity. Aquatic plant management plans should consider type, timing of pesticide applications and quantity of pesticide used**
- **Assess current fish population**
- **Manually remove plants around docks instead of using herbicide**



APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

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

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

Temperature and Dissolved Oxygen:

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

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

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

Nutrients:

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

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

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

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

Nitrogen:

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

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

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

Solids:

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

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

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

Water Clarity:

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

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

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

Alkalinity, Conductivity, Chloride, pH:

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

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

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

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

pH:

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

Eutrophication and Trophic State Index:

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

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

Table 1. Trophic State Index (TSI).

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

Appendix C:
Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

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

Plant Sampling

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

Plankton Sampling

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

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

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

Shoreline Assessment

Shoreline Assessment Protocol

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

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

Table 1: Degree of Shoreline Erosion

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

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

Table 2: Lateral Recession Rate Categories

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

Shoreline Buffer Condition

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

Table 3: Shoreline Buffer Condition Categories

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

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

Little Silver 2015 IEPA Ranking

TROPHIC STATUS

Carlson's TSIp	52.2	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	None
Non-Native Animals	Yes

AQUATIC LIFE USE IMPAIRMENT INDEX	**Weighting Criteria**	**Points**	**Overall Use Support Points**	**Degree of Support**
Median Trophic State	52.2	40		
Macrophyte Impairment	Substantial	15		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**55**	0	**Full**
RECREATION USE IMPAIRMENT INDEX				
Median Trophic State Index	52.2	52.2		
Macrophyte Impairment	Substantial	15		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**67**	1	**Partial**
Overall Use Index			**0.50**	**Partial**

Little Silver Lake 2015 Multi-Parameter Data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA
5/12/2015	0.5	0.58	14.14	9.1	88.5	0.8750	7.84	1437
5/12/2015	1	1.02	14.14	9.1	88.5	0.8760	7.73	-2353
5/12/2015	2	2.08	14.15	9.0	88.3	0.8760	7.60	1282
5/12/2015	3	3.13	14.15	9.0	88.2	0.8760	7.61	906
5/12/2015	4	4.01	14.13	9.0	88.0	0.8760	7.64	-1368
5/12/2015	6	5.99	14.04	9.0	87.6	0.8770	7.62	371
5/12/2015	8	8.19	13.74	8.9	86.1	0.8780	7.62	1253
5/12/2015	10	9.95	13.16	8.7	83.0	0.8750	7.60	509
5/12/2015	12	11.95	11.43	8.5	78.5	0.8950	7.59	-528
5/12/2015	14	13.43	9.97	6.9	61.4	0.8970	7.46	998
5/12/2015	16	16.01	8.87	6.5	56.5	0.8990	7.43	-616
5/12/2015	18	18.04	8.34	1.9	16.1	0.9040	7.34	1060
5/12/2015	20	19.99	8.03	1.7	14.2	0.9100	7.31	9660
5/12/2015	22	21.79	7.87	0.7	5.5	0.9130	7.24	9452

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA
6/16/2015	1.02	0.50	21.88	6.9	78.6	0.8060	7.16	-280
6/16/2015	1.256	1.00	21.90	6.9	78.8	0.8070	7.17	131
6/16/2015	2.317	2.00	21.88	6.8	77.6	0.8070	7.20	929
6/16/2015	3.12	3.00	21.88	6.8	77.5	0.8050	7.19	1932
6/16/2015	4.305	4.00	21.86	6.6	75.9	0.8060	7.20	-9
6/16/2015	6.341	6.00	20.48	6.7	74.1	0.8500	7.19	1722
6/16/2015	8.647	8.00	19.54	6.1	66.3	0.8540	7.21	462
6/16/2015	10.49	10.00	17.31	7.4	77.0	0.8590	7.29	2219
6/16/2015	12.24	12.00	14.45	2.7	26.1	0.8810	7.31	16922
6/16/2015	14.49	14.00	13.56	2.0	19.8	0.8840	7.29	11875
6/16/2015	16.56	16.00	10.08	0.7	6.0	0.8990	7.31	7819
6/16/2015	18.81	18.00	9.22	0.6	5.5	0.9100	7.30	6370
6/16/2015	20.81	20.00	8.33	0.5	4.7	0.9340	7.27	3996

Little Silver Lake 2015 Multi-Parameter Data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA
7/14/2015	0	0.25	23.94	7.5	89.6	0.8270	7.93	-2432
7/14/2015	1.00	1.13	23.90	7.5	88.9	0.8270	7.92	-1712
7/14/2015	2	2.01	23.88	7.3	87.2	0.8270	7.91	-136
7/14/2015	3	2.97	23.16	6.0	70.5	0.8280	7.71	-1581
7/14/2015	4	3.94	22.19	4.3	48.9	0.8350	7.45	937
7/14/2015	6	6.06	21.35	4.1	47.0	0.8370	7.46	965
7/14/2015	8	8.09	20.31	1.0	11.7	0.8410	7.30	624
7/14/2015	10	10.09	18.28	0.3	2.9	0.8620	7.35	7204
7/14/2015	12	12.20	15.07	0.5	4.8	0.8850	7.40	13373
7/14/2015	14	14.07	13.04	0.2	2.3	0.8890	7.36	46164
7/14/2015	16	16.08	10.41	0.1	0.7	0.9130	7.21	13689
7/14/2015	18	18.05	9.22	0.0	0.1	0.9400	7.07	8582
7/14/2015	20	20.07	8.69	0.0	-0.2	0.9630	6.94	7422

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA
8/11/2015	0.606	0.50	23.11	6.2	72.2	0.7820	7.95	5447
8/11/2015	1.391	1.00	23.14	5.9	68.9	0.7840	7.87	-43
8/11/2015	2.395	2.00	23.12	5.8	68.3	0.7840	7.85	4186
8/11/2015	3.28	3.00	23.12	5.8	67.5	0.7840	7.84	2151
8/11/2015	3.547	4.00	23.12	5.7	66.3	0.7850	7.82	2613
8/11/2015	6.127	6.00	23.03	3.8	44.8	0.7880	7.66	2804
8/11/2015	8.527	8.00	22.32	1.4	16.0	0.8020	7.52	3006
8/11/2015	10.32	10.00	20.43	0.7	8.2	0.8440	7.48	15542
8/11/2015	12.26	12.00	17.08	0.7	7.4	0.8790	7.50	109446
8/11/2015	13.93	14.00	14.63	0.4	4.0	0.8890	7.44	70717
8/11/2015	16.69	16.00	11.44	0.3	2.4	0.9180	7.31	44240
8/11/2015	18.56	18.00	9.83	0.3	2.2	0.9550	7.18	44240
8/11/2015	19.77	20.00	9.25	0.1	1.2	0.9730	7.06	27948
8/11/2015	21.93	22.00	8.64	0.1	1.1	0.9960	6.85	401

Little Silver Lake 2015 Multi-Parameter Data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA NA
9/15/2015	0.61	0.50	20.43	7.2	82.2	0.7809	7.86	NA
9/15/2015	1.09	1.00	20.43	7.2	81.8	0.7812	7.83	NA
9/15/2015	1.99	2.00	20.41	7.3	82.3	0.7811	7.83	NA
9/15/2015	3.08	3.00	20.39	7.3	82.3	0.7809	7.82	NA
9/15/2015	3.93	4.00	20.35	7.3	82.2	0.7809	7.81	NA
9/15/2015	5.17	5.00	20.34	7.2	81.7	0.7809	7.81	NA
9/15/2015	6.08	6.00	20.29	7.1	80.4	0.7808	7.80	NA
9/15/2015	8.39	8.00	19.96	6.2	69.8	0.7815	7.69	NA
9/15/2015	10.67	10.00	19.62	4.2	47.2	0.7846	7.51	NA
9/15/2015	12.01	12.00	18.84	1.3	14.1	0.8119	7.36	NA
9/15/2015	13.99	14.00	17.37	0.1	0.6	0.8575	7.23	NA
9/15/2015	16.07	16.00	14.93	0.0	0.0	0.8948	7.03	NA
9/15/2015	18.24	18.00	12.59	0.0	0.0	0.9375	6.78	NA
9/15/2015	20.89	20.00	11.31	0.0	0.0	0.9712	6.64	NA
9/15/2015	21.97	22.00	10.65	0.0	0.0	0.9884	6.55	NA

Little Silver Lake Water Quality Summary 1999-2015

2015	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/12/15	3	203	0.882	0	0	0.033	0	488	150	2.4	522	115	7.56	0.8760	7.61	9.04
6/16/15	3	182	0.837	ND	0	0.038	0	452	143	2.8	495	130	9.90	0.8050	7.19	6.78
7/14/15	3	188	0.850	0	0	0.025	0	464	144	1.2	512	141	8.60	0.8280	7.71	6.02
8/11/15	3	181	0.929	0	0	0.024	0	442	133	3.0	491	127	6.69	0.7840	7.84	5.76
9/15/15	3	184	0.850	0	0	0.020	0	440	147	1.9	507	131	8.35	0.7808	7.82	7.25
	Average	188	0.870	<0.1	0.07[k]	0.028	<0.005	457	143	2.3	505	129	8.22	0.8148	7.63	6.97

2008	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/20/08	3	193	0.777	<0.1	0.05	0.013	<0.005	NA	226	1.9	592	92	11.84	0.8570	8.37	10.35
6/17/08	3	166	0.733	<0.1	0.09	0.032	<0.005	NA	121	1.7	427	96	9.84	0.7360	8.05	8.86
7/15/08	3	145	0.754	<0.1	<0.05	0.018	<0.005	NA	103	1.9	361	83	8.14	0.6360	8.25	7.78
8/19/08	3	166	0.814	<0.1	0.07	0.026	<0.005	NA	108	1.5	408	103	9.06	0.6990	8.10	6.36
9/16/08	3	172	0.830	<0.1	<0.05	0.034	<0.005	NA	108	2.0	406	100	8.20	0.7070	7.78	4.07
	Average	168	0.782	<0.1	0.07[k]	0.025	<0.005	NA	133	1.8	439	95	9.42	0.7270	8.11	7.48

2003	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/27/03	3	207	1.060	<0.1	<0.05	0.021	<0.005	468	N/A	1.8	480	147	11.68	0.8010	8.61	11.81
6/24/03	3	170	1.130	<0.1	<0.05	0.015	<0.005	415	N/A	1.3	457	137	10.30	0.7440	8.88	11.64
7/29/03	3	161	0.900	<0.1	<0.05	0.016	<0.005	446	N/A	1.9	481	168	10.79	0.7305	8.74	8.22
8/26/03	3	168	0.946	<0.1	<0.05	0.019	<0.005	394	N/A	1.3	471	171	10.66	0.7310	8.10	8.06
9/30/03	3	206	1.240	0.2	<0.05	0.052	<0.005	428	N/A	2.5	460	117	7.15	0.8030	7.51	3.16
	Average	182	1.055	0.2[k]	<0.05	0.025	<0.005	430	N/A	1.8	470	148	10.12	0.7619	8.37	8.58

1999	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/12/99	3	182	0.680	<0.1	<0.05	0.030	<0.005	396	N/A	1.1	407	160	12.60	0.6240	8.51	11.10
6/22/99	3	143	0.820	<0.1	<0.05	0.012	<0.005	340	N/A	1.0	353	115	10.90	0.5760	9.04	11.90
7/14/99	3	137	0.760	0.100	0.050	<0.010	<0.005	330	N/A	1.6	332	97	12.60	0.5810	8.79	8.30
8/31/99	3	152	0.950	<0.1	0.051	0.016	<0.005	342	N/A	1.6	373	136	8.40	0.6010	8.21	7.90
9/21/99	3	168	0.890	<0.1	<0.05	0.020	<0.005	344	N/A	2.0	371	106	9.10	0.6300	7.97	6.97
	Average	156	0.820	0.100[k]	0.051[k]	0.020[k]	<0.005	350	N/A	1.5	367	123	10.72	0.6024	8.50	9.23

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

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

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

Little Silver Lake Water Quality Summary 1999-2015

2015	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
7/14/15	18	260	4.040	2.78	0	0.538	0.467	520.12	149	7.4	588	144	NA	0.9400	7.07	0.01
5/12/15	19	210	1.060	0.268	0	0.047	0.017	503.5276	150	2.1	529	109	NA	0.9070	7.33	1.78
6/16/15	19	242	3.080	1.74	0	0.376	0.304	511.0696	150	6.6	574	172	NA	0.9220	7.29	0.59
8/11/15	19	247	2.980	1.800	0	0.338	0.267	532.1872	147	6.3	573	134	NA	0.9640	7.12	0.20
9/15/15	19	279	6.260	4.890	0	0.862	0.645	531.6341	160	6.0	602	126	NA	0.9629	6.72	0.00
	Average	248	3.484	2.2956	<0.05	0.432	0.340	NA	151	5.7	573	137	NA	0.9392	7.11	0.52

2008	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/20/08	17	200	0.912	0.145	<0.05	0.024	0.005	NA	226	2.3	577	88	NA	0.8715	7.64	0.61
6/17/08	19	217	2.070	1.080	<0.05	0.183	0.080	NA	136	8.2	517	122	NA	0.8810	7.49	0.23
7/15/08	16	204	1.250	0.145	<0.05	0.092	0.016	NA	137	12.0	516	127	NA	0.8660	7.60	0.37
8/19/08	19	249	3.360	2.190	<0.05	0.426	0.333	NA	134	9.8	543	138	NA	0.9355	7.37	0.15
9/16/08	18	258	4.220	3.180	<0.05	0.533	0.390	NA	136	6.7	533	116	NA	0.8870	7.34	0.23
	Average	226	2.362	1.348	<0.05	0.252	0.165	NA	154	7.8	537	118	NA	0.8882	7.49	0.32

2003	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/27/03	18	219	1.410	0.302	<0.05	0.091	0.031	468	N/A	2.9	467	165	NA	0.8100	7.50	0.30
6/24/03	17	232	2.430	0.790	<0.05	0.530	0.170	428	N/A	7.1	478	137	NA	0.8210	7.31	0.16
7/29/03	17	248	2.790	1.200	<0.05	0.211	0.085	468	N/A	12.0	509	139	NA	0.8256	7.19	0.17
8/26/03	16	213	2.190	<0.1	<0.05	0.112	<0.005	422	N/A	17.2	504	169	NA	0.8320	7.26	3.47
9/30/03	17	209	1.400	0.383	<0.05	0.063	0.022	440	N/A	2.4	462	134	NA	0.8085	7.39	1.77
	Average	224	2.044	0.764[k]	<0.05	0.201	0.077[k]	445	N/A	8.3	484	149	NA	0.8194	7.33	1.17

1999	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
5/12/99	17.5	194	0.900	<0.1	0.052	0.062	<0.005	430	N/A	4.2	419	165	NA	0.6570	7.49	1.00
6/22/99	15	192	1.260	<0.1	0.061	0.077	<0.005	374	N/A	9.0	416	112	NA	0.6630	7.65	1.00
7/14/99	17	208	2.110	0.270	0.106	0.181	0.047	404	N/A	13.6	416	114	NA	0.6960	7.29	2.45
8/31/99	16	200	1.520	<0.1	0.068	0.082	<0.005	364	N/A	12.0	409	126	NA	0.6570	7.24	0.10
9/21/99	16.5	172	1.070	0.176	<0.05	0.034	<0.005	352	N/A	2.9	374	108	NA	0.6310	7.93	3.05
	Average	193	1.372	0.223[k]	0.072[k]	0.087	0.047[k]	385	N/A	8.3	407	125	NA	0.6608	7.52	1.52

Glossary

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

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

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Cedar Lake	0.0130	41.14
4	Indpendence Grove	0.0130	41.14
5	Druce Lake	0.0140	42.00
6	Windward Lake	0.0160	44.13
7	Lake Minear	0.0164	44.44
8	Sand Pond (IDNR)	0.0165	44.57
9	West Loon	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Cross Lake	0.0216	46.80
12	Banana Pond	0.0200	47.35
13	Gages Lake	0.0200	47.35
14	Lake Kathryn	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Lake Zurich	0.0210	48.19
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	Lake Barrington	0.0270	50.60
26	Bangs Lake	0.0260	51.13
27	Lake Leo	0.0260	51.13
28	Cranberry Lake	0.0270	51.68
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Little Silver Lake	0.0280	52.22
32	Fourth Lake	0.0360	53.00
33	Lambs Farm Lake	0.0310	53.67
34	Old School Lake	0.0310	53.67
35	Grays Lake	0.0310	54.00
36	Butler Lake	0.0324	54.33
37	Harvey Lake	0.0320	54.50
38	Hendrick Lake	0.0340	55.00
39	Sand Lake	0.0380	56.00
40	Third Lake	0.0384	56.00
41	Sullivan Lake	0.0370	56.22
42	Ames Pit	0.0390	56.98
43	Diamond Lake	0.0390	56.98
44	East Loon	0.0400	57.34
45	Schreiber Lake	0.0400	57.34
46	Waterford Lake	0.0400	57.34
47	Lake Tranquility (S1)	0.0412	57.38
48	Hook Lake	0.0410	57.70
49	Nielsen Pond	0.0450	59.04
50	Seven Acre Lake	0.0460	59.36
51	Turner Lake	0.0460	59.36

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
52	Willow Lake	0.0460	59.36
53	Honey Lake	0.0590	59.69
54	East Meadow Lake	0.0480	59.97
55	Lucky Lake	0.0480	59.97
56	Old Oak Lake	0.0490	60.27
57	College Trail Lake	0.0500	60.56
58	Hastings Lake	0.0520	61.13
59	West Meadow Lake	0.0530	61.40
60	Wooster Lake	0.0530	61.40
61	Lucy Lake	0.0550	61.94
62	Lake Linden	0.0570	62.45
63	Lake Christa	0.0580	62.70
64	Owens Lake	0.0580	62.70
65	Briarcrest Pond	0.0580	63.00
66	Redhead Lake	0.0608	63.20
67	St. Mary's Lake	0.0608	63.41
68	Lake Lakeland Estates	0.0620	63.66
69	Lake Naomi	0.0620	63.66
70	Lake Catherine	0.0620	63.76
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	Davis Lake	0.0650	64.34
76	Leisure Lake	0.0650	64.34
77	Channel Lake	0.0680	64.91
78	Buffalo Creek Reservoir 1	0.0680	65.00
79	Mary Lee Lake	0.0680	65.00
80	Little Bear Lake	0.0680	65.00
81	Timber Lake (South)	0.0720	65.82
82	Lake Helen	0.0720	65.82
83	Grandwood Park Lake	0.0720	65.82
84	Crooked Lake	0.0710	66.00
85	ADID 203	0.0730	66.02
86	Broberg Marsh	0.0780	66.97
87	Echo Lake	0.0790	67.20
88	Redwing Slough	0.0822	67.73
89	Tower Lake	0.0830	67.87
90	Countryside Lake	0.0800	68.00
91	Lake Nippersink	0.0800	68.00
92	Woodland Lake	0.0800	68.00
93	Lake Fairview	0.0890	68.00
94	Antioch Lake	0.0850	68.18
95	Potomac Lake	0.0850	68.21
96	White Lake	0.0862	68.42
97	Grand Ave Marsh	0.0870	68.55
98	North Churchill Lake	0.0870	68.55
99	McDonald Lake 1	0.0880	68.71
100	Pistakee Lake	0.0880	68.71
101	Rivershire Pond 2	0.0900	69.04
102	South Churchill Lake	0.0900	69.04

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
103	McGreal Lake	0.0910	69.20
104	Lake Charles	0.0930	69.40
105	Deer Lake	0.0940	69.66
106	Eagle Lake (S1)	0.0950	69.82
107	International Mine and Chemical Lake	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Buffalo Creek Reservoir 2	0.0960	69.97
110	Fish Lake	0.0960	69.97
111	Lochanora Lake	0.0960	69.97
112	Big Bear Lake	0.0960	69.97
113	Fox Lake	0.1000	70.52
114	Nippersink Lake - LCFP	0.1000	70.56
115	Sylvan Lake	0.1000	70.56
116	Petite Lake	0.1020	70.84
117	Longview Meadow Lake	0.1020	70.84
118	Lake Marie	0.1030	70.93
119	Dunn's Lake	0.1070	71.53
120	Lake Forest Pond	0.1070	71.53
121	Long Lake	0.1070	71.53
122	Grass Lake	0.1090	71.77
123	Spring Lake	0.1100	71.93
124	Kemper 2	0.1100	71.93
125	Bittersweet Golf Course #13	0.1100	71.93
126	Bluff Lake	0.1120	72.00
127	Middlefork Savannah Outlet 1	0.1120	72.00
128	Osprey Lake	0.1110	72.06
129	Bresen Lake	0.1130	72.32
130	Round Lake Marsh North	0.1130	72.32
131	Deer Lake Meadow Lake	0.1160	72.70
132	Lake Matthews	0.1180	72.94
133	Taylor Lake	0.1180	72.94
134	Island Lake	0.1210	73.00
135	Columbus Park Lake	0.1230	73.54
136	Lake Holloway	0.1320	74.56
137	Lakewood Marsh	0.1510	76.50
138	Pond-A-Rudy	0.1510	76.50
139	Forest Lake	0.1540	76.78
140	Slocum Lake	0.1500	77.00
141	Middlefork Savannah Outlet 2	0.1590	77.00
142	Grassy Lake	0.1610	77.42
143	Salem Lake	0.1650	77.78
144	Half Day Pit	0.1690	78.12
145	Lake Louise	0.1810	79.08
146	Lake Eleanor	0.1810	79.11
147	Lake Farmington	0.1850	79.43
148	ADID 127	0.1890	79.74
149	Lake Napa Suwe	0.1940	80.00
150	Loch Lomond	0.1960	80.23
151	Patski Pond	0.1970	80.33
152	Dog Bone Lake	0.1990	80.48

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
153	Summerhill Estates Lake	0.1990	80.48
154	Redwing Marsh	0.2070	81.05
155	Stockholm Lake	0.2082	81.13
156	Bishop Lake	0.2160	81.66
157	Ozaukee Lake	0.2200	81.93
158	Kemper 1	0.2220	82.08
159	Hidden Lake	0.2240	82.19
160	McDonald Lake 2	0.2250	82.28
161	Fischer Lake	0.2280	82.44
162	Oak Hills Lake	0.2790	85.35
163	Heron Pond	0.2990	86.35
164	Rollins Savannah 1	0.3070	87.00
165	Fairfield Marsh	0.3260	87.60
166	ADID 182	0.3280	87.69
167	Slough Lake	0.3860	90.03
168	Manning's Slough	0.3820	90.22
169	Rasmussen Lake	0.4860	93.36
170	Albert Lake, Site II, outflow	0.4950	93.67
171	Flint Lake Outlet	0.5000	93.76
172	Rollins Savannah 2	0.5870	96.00
173	Almond Marsh	1.9510	113.00
	Average	***0.1130***	***66.0***

Aquatic Plants found at the 193 sampling sites on Little Silver Lake in August, 2015.
The maximum depth that plants were found was 14.0 feet.

Plant Density	American Pondweed	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed
Absent	3	8	1	1	9	0	3	3	0
Present	1	49	14	27	36	1	15	6	5
Common	0	28	24	55	18	1	15	10	1
Abundant	0	4	18	17	6	0	2	0	0
Dominant	0	0	0	0	0	0	0	0	0
% Plant Occurrence	0.5	42.0	29.0	51.3	31.1	1.0	16.6	8.3	3.1

Plant Density	Illinois Pondweed	Northern Watermilfoil	Sago Pondweed	Slender Naiad	Southern Naiad	Spatterdock	Star Duckweed	Water Stargrass	White Water Lily
Absent	1	1	3	1	2	2	0	6	1
Present	3	1	12	1	0	2	6	2	16
Common	0	1	12	0	0	0	2	2	37
Abundant	0	0	1	0	0	0	1	0	52
Dominant	0	0	0	0	0	0	0	0	0
% Plant Occurrence	1.6	1.0	13.0	0.5	0.0	1.0	4.7	2.1	54.4

Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	34	18
>0-10%	2	1
10-40%	16	8
40-60%	63	33
60-90%	42	22
>90%	30	16
Total Sites with Plants	153	79
Total # of Sites	193	100

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	37.4	38.9
2	East Loon Lake	34.7	36.1
3	Cranberry Lake	29.7	29.7
4	Deep Lake	29.7	31.2
5	Round Lake Marsh North	29.1	29.9
6	West Loon Lake	27.1	29.5
7	Sullivan Lake	26.9	28.5
8	Bangs Lake	26.2	27.8
9	Little Silver Lake	25.2	26.7
10	Third Lake	25.1	22.5
11	Fourth Lake	24.7	27.1
12	Indpendence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Sun Lake	24.3	26.1
15	Redwing Slough	24.0	25.8
16	Schreiber Lake	23.9	24.8
17	Lakewood Marsh	23.8	24.7
18	Deer Lake	23.5	24.4
19	Round Lake	23.5	25.9
20	Pistakee Lake	23.5	25.2
21	Lake Marie	23.5	25.2
22	Lake of the Hollow	23.0	24.8
23	Nippersink Lake (Fox Chain)	22.4	23.2
24	Countryside Glen Lake	21.9	22.8
25	Grass Lake	21.5	22.2
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.9	23.4
29	Lake Catherine	20.8	21.8
30	Cross Lake	20.7	18.7
31	ADID 203	20.5	20.5
32	Broberg Marsh	20.5	21.4
33	McGreal Lake	20.2	22.1
34	Fox Lake	20.2	21.2
35	Honey Lake	20.0	20.0
36	Lake Barrington	19.9	21.8
37	Lake Kathryn	19.6	20.7
38	Fish Lake	19.3	21.2
39	Druce Lake	19.1	21.8
40	Turner Lake	18.6	21.2
41	Wooster Lake	18.5	20.2
42	Salem Lake	18.5	20.2
43	Lake Helen	18.0	18.0
44	Old Oak Lake	18.0	19.1
45	Lake Minear	18.0	20.1
46	Potomac Lake	17.8	17.8
47	Lake Zurich	17.7	18.9
48	Redhead Lake	17.7	18.7
49	Long Lake	17.7	15.8
50	Hendrick Lake	17.7	17.7
51	Rollins Savannah 2	17.7	17.7
52	Grandwood Park Lake	17.2	19.0
53	Seven Acre Lake	17.0	15.5
54	Lake Miltmore	16.8	18.7
55	Petite Lake	16.8	18.7
56	Channel Lake	16.8	18.7
57	McDonald Lake 1	16.7	17.7
58	Highland Lake	16.7	18.9

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
59	Bresen Lake	16.6	17.8
60	Almond Marsh	16.3	17.3
61	Owens Lake	16.3	17.3
62	Windward Lake	16.3	17.6
63	Butler Lake	16.1	18.1
64	Grays Lake	16.1	16.1
65	White Lake	16.0	17.0
66	Dunns Lake	15.9	17.0
67	Dog Bone Lake	15.7	15.7
68	Osprey Lake	15.5	17.3
69	Heron Pond	15.1	15.1
70	North Churchill Lake	15.0	15.0
71	Hastings Lake	15.0	17.0
72	Forest Lake	14.8	15.9
73	Dog Training Pond	14.7	15.9
74	Grand Ave Marsh	14.3	16.3
75	Nippersink Lake	14.3	16.3
76	Taylor Lake	14.3	16.3
77	Manning's Slough	14.1	16.3
78	Tower Lake	14.0	14.0
79	Dugdale Lake	14.0	15.1
80	Eagle Lake (S1)	14.0	15.1
81	Crooked Lake	14.0	16.0
82	Spring Lake	14.0	15.2
83	Lake Matthews	13.9	15.5
84	Longview Meadow Lake	13.9	13.9
85	Bishop Lake	13.4	15.0
86	Ames Pit	13.4	15.5
87	Mary Lee Lake	13.1	15.1
88	Old School Lake	13.1	15.1
89	Summerhill Estates Lake	12.7	13.9
90	Lake Tranquility (S1)	12.6	12.6
91	Buffalo Creek Reservoir 1	12.5	11.4
92	Buffalo Creek Reservoir 2	12.5	11.4
93	McDonald Lake 2	12.5	12.5
94	Rollins Savannah 1	12.5	12.5
95	Stone Quarry Lake	12.5	12.5
96	Kemper Lake 1	12.2	13.4
97	Pond-A-Rudy	12.1	12.1
98	Stockholm Lake	12.1	13.5
99	Lake Carina	12.1	14.3
100	Lake Leo	12.1	14.3
101	Lambs Farm Lake	12.1	14.3
102	Grassy Lake	12.0	12.0
103	Flint Lake Oulet	11.8	13.0
104	Albert Lake	11.5	10.3
105	Rivershire Pond 2	11.5	13.3
106	Hook Lake	11.3	13.4
107	Briarcrest Pond	11.2	12.5
108	Lake Naomi	11.2	12.5
109	Pulaski Pond	11.2	12.5
110	Lake Napa Suwe	11.0	11.0
111	Redwing Marsh	11.0	11.0
112	West Meadow Lake	11.0	11.0
113	Nielsen Pond	10.7	12.0
114	Lake Holloway	10.6	10.6
115	Sylvan Lake	10.6	10.6
116	Echo Lake	10.4	10.4

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
117	Gages Lake	10.2	12.5
118	College Trail Lake	10.0	10.0
119	Valley Lake	9.9	9.9
120	Werhane Lake	9.8	12.0
121	Columbus Park Lake	9.2	9.2
122	Lake Lakeland Estates	9.2	9.2
123	Waterford Lake	9.2	9.2
124	Bluff Lake	9.1	11.0
125	Lake Fairfield	9.0	10.4
126	Fischer Lake	9.0	11.0
127	Antioch Lake	8.5	8.5
128	Loch Lomond	8.5	8.5
129	Lake Fairview	8.5	6.9
130	Timber Lake (South)	8.5	6.9
131	East Meadow Lake	8.5	8.5
132	South Churchill Lake	8.5	8.5
133	Kemper Lake 2	8.5	9.8
134	Lake Christa	8.5	9.8
135	Lake Farmington	8.5	9.8
136	Lucy Lake	8.5	9.8
137	Lake Louise	8.4	8.4
138	Bittersweet Golf Course #13	8.1	8.1
139	Lake Linden	8.0	8.0
140	Sand Lake	8.0	10.4
141	Countryside Lake	7.7	11.5
142	Fairfield Marsh	7.5	8.7
143	Lake Eleanor	7.5	8.7
144	Banana Pond	7.5	9.2
145	Slocum Lake	7.1	5.8
146	Lucky Lake	7.0	7.0
147	North Tower Lake	7.0	7.0
148	Lake Forest Pond	6.9	8.5
149	Ozaukee Lake	6.7	8.7
150	Leisure Lake	6.4	9.0
151	Peterson Pond	6.0	8.5
152	Little Bear Lake	5.8	7.5
153	Deer Lake Meadow Lake	5.2	6.4
154	ADID 127	5.0	5.0
155	Island Lake	5.0	5.0
156	Liberty Lake	5.0	5.0
157	Oak Hills Lake	5.0	5.0
158	Slough Lake	5.0	5.0
159	International Mining and Chemical Lake	5.0	7.1
160	Diamond Lake	3.7	5.5
161	Lake Charles	3.7	5.5
162	Big Bear Lake	3.5	5.0
163	Sand Pond (IDNR)	3.5	5.0
164	Harvey Lake	3.3	5.0
165	Half Day Pit	2.9	5.0
166	Lochanora Lake	2.5	5.0
167	Hidden Lake	0.0	0.0
168	St. Mary's Lake	0.0	0.0
169	Willow Lake	0.0	0.0
170	Woodland Lake	0.0	0.0
	Mean	**14.0**	**15.0**
	Median	**13.4**	**15.0**

Little Silver Lake Shoreline Erosion Condition 2015

Reach	None		Slight		Moderate		Severe		Total	Lateral Recession Rate
	Linear ft.	% Reach	Linear Ft.	% Reach	Linear Ft.	% Reach	Linear Ft.	% Reach		ft/yr
LS01	974.8	67.4	443.7	30.7	27.4	1.9	0.0	0.0	1445.9	0.03
LS02	1657.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1657.0	0.01
LS03	980.5	63.7	558.3	36.3	0.0	0.0	0.0	0.0	1538.8	0.03
LS04	432.4	51.5	406.5	48.5	0.0	0.0	0.0	0.0	838.9	0.05
LS05	1279.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1279.6	0.01
Total	5324.3	78.8	1408.5	20.8	27.4	0.4	0.0	0.0	6760.2	

ake Shoreline Buffer Condition 2015

Reach Code	Good Condition (ft/%)		Fair Condition (ft/%)		Poor Condition (ft/%)		Shoreline Length Assessed
LS01	1029	71	137	9	280	19	1446
LS02	1657	100	0	0	0	0	1657
LS03	1259	82	280	18	0	0	1539
LS04	420	50	97	12	322	38	839
LS05	1280	100	0	0	0	0	1280
Total	5645	83	514	8	602	9	6760

Little Silver Lake Landuse 2015

Land Use	Acreage	% of Total
Agricultural	94.70	15.6%
Forest and Grassland	62.65	10.3%
Government and Institutional	22.35	3.7%
Public and Private Open Space	87.59	14.4%
Retail/Commercial	23.61	3.9%
Single Family	135.97	22.3%
Transportation	34.87	5.7%
Water	83.47	13.7%
Wetlands	63.47	10.4%
Total Acres	**608.68**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	94.70	0.05	13.0	3.8
Forest and Grassland	62.65	0.05	8.6	2.5
Government and Institutional	22.35	0.50	30.7	8.9
Public and Private Open Space	87.59	0.15	36.1	10.4
Retail/Commercial	23.61	0.85	55.2	15.9
Single Family	135.97	0.30	112.2	32.4
Transportation	34.87	0.85	81.5	23.6
Water	83.47	0.00	0.0	0.0
Wetlands	63.47	0.05	8.7	2.5
TOTAL	**608.68**		**346.1**	**100.0**

Lake volume	**316.00**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.91**	**years**
	333.26	**days**