

LAKE COUNTY, IL

# 2015 ST. MARY'S LAKE SUMMARY REPORT

PREPARED BY THE LAKE COUNTY HEALTH DEPARTMENT  
ECOLOGICAL SERVICES



**St. Mary's Lake**

St. Mary's of the Lake Seminary is a privately owned, 105-acre impoundment located in central Lake County, with  $\frac{3}{4}$  in the Village of Mundelein and  $\frac{1}{4}$  in the Village of Libertyville. The lake was created sometime between 1915 and 1920 by damming Bull Creek, which enters the lake on the southwest corner. This is a "flow through" system, with the water entering the lake from Loch Lomond Lake via Bull Creek and then exiting on the east side over a spillway that flows to Butler Lake eventually reaching the Des Plaines River. Seminary students and staff use St. Mary's Lake for fishing, non-motorized boating and aesthetics.

The water quality in St. Mary's is poor with low water clarity, high total suspended solid (TSS) concentrations, high total phosphorous (TP) concentrations, and no aquatic plants. The lake is classified as eutrophic, and ranked 67th out of 173 lakes in Lake County based on average TP.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured each month from May-September 2015. St. Mary's Lake was weakly thermally stratified all season and epilimnetic oxygen concentrations remained high. TSS concentrations were also relatively high all summer and, as a result, Secchi transparen-

**INSIDE THIS ISSUE:**

Summary	1
Watershed	2
Watershed	3
Land Use	
VLMP	4
Water Clarity	
Total Suspended Solids	5
Nutrients	6
Conductivity - Chloride	
Trophic State Index	7
Lake Level	
Bathymetric Maps	8
Stratification	
Aquatic Plants	9
Carp Enclosures	
Floristic Quality Index	10
Revegetation	11
Dissolved Oxygen	12
Aquatic Plants and Fish	13
Shoreline Erosion	14
Blue-Green Algae	15
Zebra Mussels	16
Carp	17
Lake Management Plans	18
Lake Recommendations	19

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**LAKE FACTS****Municipality:**

Mundelein and Libertyville  
T44N, R10E, Section 24

**Major Watershed:**

Des Plaines River

**Sub-Watershed:**

Bull Creek

**Surface Area:**

104.57 acres

**Shoreline Length:**

3.55 miles

**Maximum Depth:**

14.0 feet

**Average Depth:**

8.23 feet

**Lake Volume:**

951 acre-feet

**Watershed Area:**

2944.65 acres

**Lake Type:**

Impoundment

**Current Uses:**

Fishing, non-motorize  
boating, and aesthetics

**ST. MARY'S LAKE**

cy (water clarity) was lower than the county average.

No aquatic plants were present in St. Mary's Lake, possibly due to carp activity, morphometry of the lake, and the hard, rocky substrate of the lake bottom. Despite the absence of aquatic plants, a large number of upland plants and trees were observed along the shoreline. These plants and trees provide valuable habitat for a large number of birds and other wildlife species and should be preserved as much as possible.

There is a wastewater treatment plant at St. Mary's of the Lake Seminary, which likely contributes to the nutrient loading of the St. Mary's Lake. Although specific phosphorus loading from this plant is not monitored, a conservative estimate of the loading was calculated using 1.0 mg/L as the daily load being discharged into St. Mary's Lake. Based on the 0.030 million gallons per day (MGD) design average flow (DAF), approximately 91.4 pounds of phosphorus enters St. Mary's Lake each year. The total phosphorus in St. Mary's Lake averaged 0.061 mg/L which is a 9% decrease from the 2005 concentration of 0.067 mg/L and higher than the Illinois Environmental Protection Agency impairment rate of 0.050 mg/L. Other sources of phosphorus include inputs from the watershed, local sources (i.e., lawn fertilizers and agricultural runoff) and internal loading from the sediment caused by wind and wave action and carp.

Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen (TKN) concentration for St. Mary's Lake was 1.04 mg/L, which was lower than the county median of 1.20 mg/L. A total nitrogen to total phosphorus (TN:TP) ratio of 17:1 indicates that phosphorus was the nutrient limiting aquatic plant and algae growth in St. Mary's Lake. By using phosphorus as an indicator, the trophic state index (TSIp) ranked St. Mary's Lake as eutrophic with a TSIp value of 63.4. This means that the lake nutrient rich which can result in excess plant and algae growth. The 2015 average total suspended solids (TSS) concentration for St. Mary's Lake was 8.5 mg/L, which was slightly higher than the county median of 8.2 mg/L and an 11.7% decrease from the 2005 average of 10.8 mg/L.

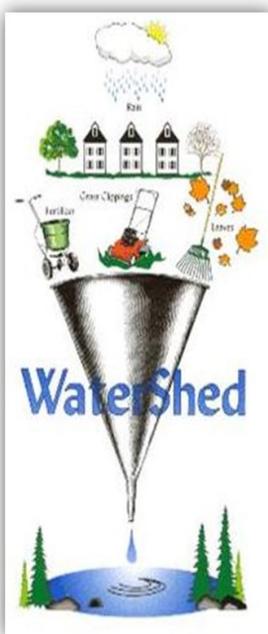
Water clarity was measured by Secchi depth, with the lowest reading in May (1.75 ft) and the deepest was in July (3.83 ft). The average Secchi depth for the season was 2.98 ft, which was lower than the county median (2.96 ft). The average conductivity of St. Mary's Lake was 0.9982 mS/cm which is higher than the county median (0.7920 mS/cm). This was an 43.73% decrease from the 2005 average (1.1774 mS/cm). The average chloride concentration for St. Mary's Lake

**ST. MARY'S LAKE WATERSHED**

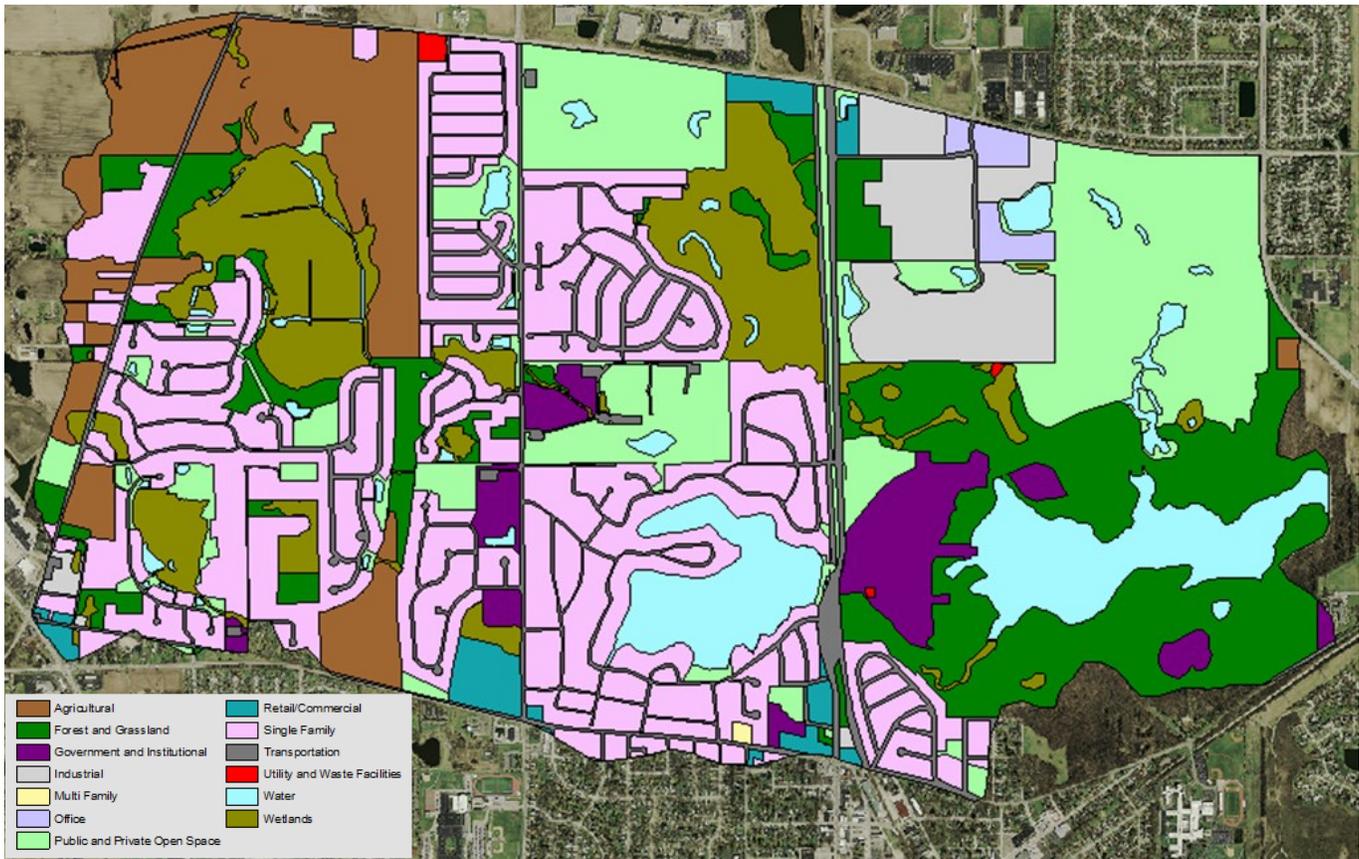
The lake is located in the Bull Creek sub basin, within the Des Plaines River watershed. A watershed is a drainage basin where water from rain or snow melt drains into a body of water, such as a river, lake, reservoir, wetland or storm drain. The source of a lakes water supply is very important in determining its water quality and choosing management practices to protect the lake.

The lake has several inflow locations, including Bull Creek where it drains from Loch Lomond from the west and IMC lake from the north. St. Mary's Lake empties through a spillway on the east side of the lake. The water flows into Bull Creek, which flows to Butler Lake and eventually into the Des Plaines River. IMC Lake was sampled in 2003 and 2005 but was not sampled in 2015.

The major sources of runoff for St. Mary's were Residential (31.1%), Transportation (22.5%) and Industrial (14.6%). 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 drainage lakes. The retention time, the time it takes for water entering a lake to flow out again was calculated to be approximately 173 days.



# ST. MARY'S LAKE WATERSHED AND LAND USE



ST. MARY'S LAKE AREA LAND USE 2015

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	234.25	0.05	32.2	3.4
Forest and Grassland	87.43	0.05	12.0	1.3
Government and Institutional	35.38	0.50	48.6	5.1
Industrial	4.61	0.80	10.1	1.1
Multi Family	1.50	0.50	2.1	0.2
Public and Private Open Space	117.26	0.15	48.4	5.0
Retail/Commercial	31.39	0.85	73.4	7.6
Single Family	562.19	0.30	463.8	48.3
Transportation	105.10	0.85	245.7	25.6
Water	93.03	0.00	0.0	0.0
Wetlands	167.19	0.05	23.0	2.4
<b>TOTAL</b>	<b>1439.33</b>		<b>959.3</b>	<b>100.0</b>

COMPARISON OF EPILIMNETIC AVERAGES FOR SECCHI DISK TRANSPARENCY, TOTAL SUSPENDED SOLIDS, TOTAL PHOSPHORUS, AND CONDUCTIVITY READINGS IN THE BULL CREEK WATERSHED (LOCH LOMOND LAKE, ST. MARY'S LAKE, AND BUTLER LAKE).

	Loch Lomond Lake	Loch Lomond Lake	Loch Lomond Lake	Loch Lomond Lake	IMC Lake	MC Lake	St. Mary's Lake	St. Mary's Lake	St. Mary's Lake	St. Mary's Lake	Butler Lake	Butler Lake	Butler Lake	Butler Lake
Year	1999	2004	2005	2015	2003	2005	1995	2002	2005	2015	1995	2001	2005	2015
Secchi (feet)	1.89	3.27	2.17	2.74	4.96	3.08	2.26	2.68	2.79	2.98	5.83	6.65	4.35	6.49
TSS (mg/L)	19.2	13.2	13.1	10.96	4.4	9.7	12.2	11.8	10.8	8.52	3.1	2.1	6.3	2.3
TP (mg/L)	0.235	0.245	0.295	0.196	0.039	0.095	0.065	0.075	0.067	0.068	0.031	0.048	0.053	0.032
Conductivity (milliSiemens/cm)	0.7076	0.8232	1.3298	0.7736	1.9958	6.1436	0.5958	1.0272	1.1774	0.998	0.5852	1.0893	1.1602	0.9946

**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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TURBID WATERS BECOME WARMER AS SUSPENDED PARTICLES ABSORB HEAT FROM SUNLIGHT, CAUSING OXYGEN LEVELS TO FALL. (WARM WATER HOLDS LESS OXYGEN THAN COOLER WATER.) PHOTOSYNTHESIS DECREASES WITH LESSER LIGHT, RESULTING IN EVEN LOWER OXYGEN LEVELS.

**VLMP — WATER QUALITY**

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.

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.



A SECCHI DISK IS AN EIGHT-INCH DIAMETER WEIGHTED METAL PLATE PAINTED BLACK AND WHITE IN ALTERNATING QUADRANTS. A CALIBRATED ROPE IS USED TO LOWER THE DISC INTO THE WATER AND MEASURE THE DEPTH TO WHICH IT IS VISIBLE.



**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 St. Mary's Lake was 2.98 feet (ES); this was a 6.8% increase in the lakes transparency since 2005 of 2.79 feet and the water clarity was slightly above the county median of 2.96 feet. The shallowest Secchi depth for St. Mary's Lake was in May and the deepest was in July at 3.83 feet. There was constant precipitation from May 3-11 prior to the Secchi reading on May 13, 2015 that attributed to a shallow Secchi reading. The total suspended solids (TSS) was also the highest for the sampling season. Carp spawning activity in May and June, shoreline erosion along with algae blooms from June to September, are the other major factors that affect the water clarity in St Mary's Lake. Aquatic plants would help stabilize bottom sediment and compete for nutrients with blue-green algae resulting in increased water clarity.

(ft.)  
24  
94  
54  
50

## 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. The 2015 TSS concentrations in St. Mary’s Lake averaged 8.5 mg/L which was slightly above the county median of 8.2 mg/L and 21% lower than the 2005 average concentration of 10.8 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  $\geq 12$  mg/l could cause impairment for aquatic life in inland lakes.

There are internal and external sources of sediment affecting the turbidity in St. Mary’s Lake. Internal sources of sediment suspension include wind and wave, and carp population (Common Carp). Carp are one of the most damaging aquatic invasive species due to their feeding behavior that disrupts shallowly rooted plants, decreasing water clarity. External sources include sediments that are transported into the lake from a feeder creek, bank erosion and other sources in the watershed. The average calculated nonvolatile suspended solids (NVSS) was 4.44 mg/L. The low NVSS means that nearly half of the TSS concentration in 2015 can be attributed to solids that 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

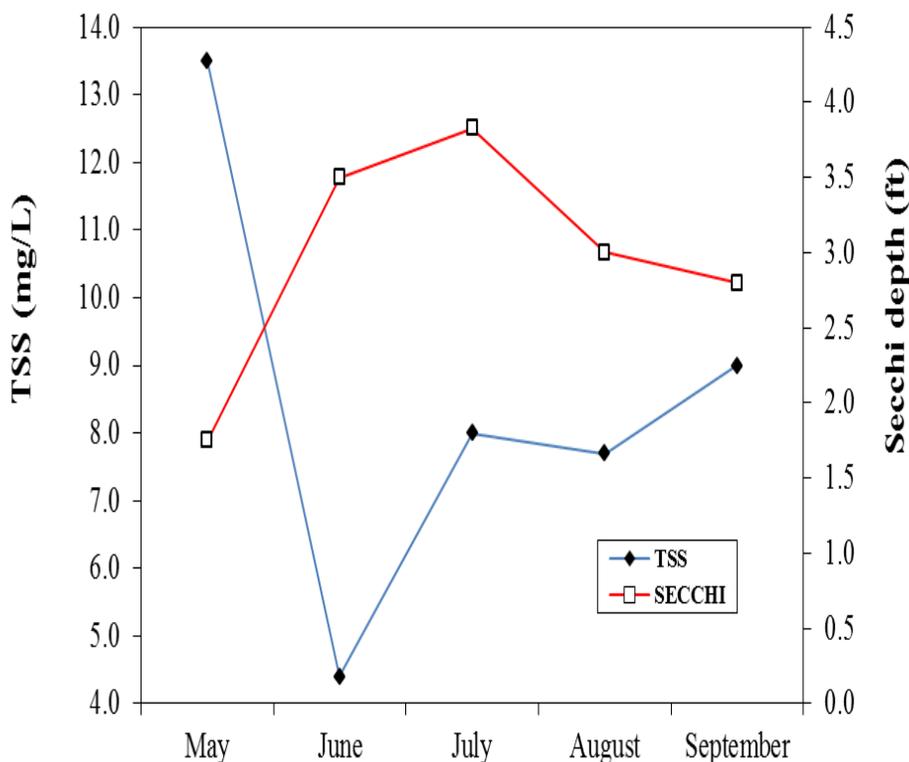
**NVSS**  
Non-Volatile Suspended Solids

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.

**TSS VS SECCHI**



DATE	TSS (mg/L)	SECCHI (ft)
May	13.5	1.75
June	4.4	3.50
July	8.0	3.83
August	7.7	3.00
September	9.0	2.80

**WHAT HAS BEEN DONE  
TO REDUCE PHOSPHORUS  
LEVELS IN ST. MARY'S 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, 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 St. Mary's Lake was 0.061 mg/L, this was a 9% decrease from the 2005 concentration (0.067 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. Since there was very little aquatic plants found in St. Mary's Lake during the 2015 survey, algae blooms were frequent during the later part of the summer as TP concentration steadily increased.

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. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate there are enough of both nutrients to facilitate excess algae or plant growth. St. Mary's Lake had an average TN:TP ratio of 17:1 in 2015, this indicates the lake was phosphorus limited. The concentration of total Kjeldahl nitrogen (TKN) increased during the season, averaging 1.02 mg/L, which is lower than the Lake County median of 1.20 mg/L. Nitrogen is difficult to control because it can come from a variety of external sources including being transformed by blue-green algae from an atmospheric form to an organic form.

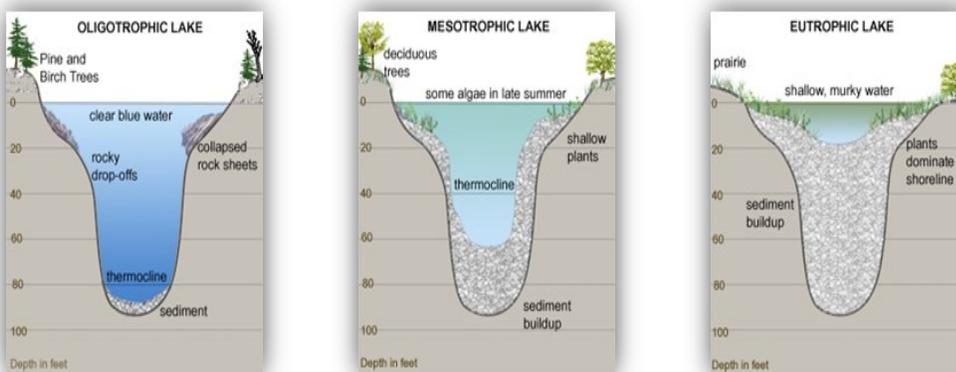
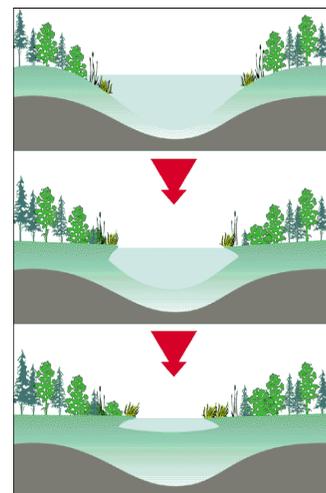
## CONDUCTIVITY AND CHLORIDE

Conductivity is a measure of a water's 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<sup>-</sup> 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 St. Mary's Lake 0.9982 mS/cm. This parameter was above the county median of 0.7920 mS/cm and is a 43.73% decrease from the 2005 value of 1.1174 mS/cm. These values are influenced by the winter road maintenance of Route 45, 176 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. St. Mary's Lake Cl<sup>-</sup> concentration was 198 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 Water-milfoil, 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 (TSI<sub>p</sub>). TSI<sub>p</sub> values are commonly used to classify and compare lake productivity levels (trophic state). A lake's response to additional phosphorus is an accelerated rate of eutrophication. Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation until the lake becomes a wetland. This process takes thousands of years 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 TSI<sub>p</sub> 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, St. Mary's Lake was eutrophic with a TSI<sub>p</sub> Value of 63.4, placing it 67th out of 173 lakes in the county. Lake Carina was 1st with a 37.4 TSI<sub>p</sub> 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 St. Mary's Lake was measured from the corner of a concrete step by the boat house. The lake level decreased from May to September by 0.34 feet. The highest water level recorded occurred in May at 1.29 feet. The most significant water level fluctuation occurred from May to June with a decrease in the lake level of 0.49 feet. St. Mary's water level appears to be significantly 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.



EXAMPLE OF A PERMANENT STAFF GAUGE

Month	Level (ft)	Seasonal Change (ft)	Monthly Change (ft)
May	1.29		
June	0.80	-0.49	-0.49
July	0.90	-0.39	0.10
August	1.00	-0.29	0.10
September	0.95	-0.34	-0.05

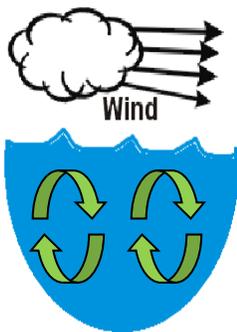
## BATHYMETRIC MAPS

BATHYMETRIC MAPS PROVIDE LAKE MANAGERS WITH AN ACCURATE LAKE VOLUME THAT CAN BE USED FOR HERBICIDE APPLICATION AND HELP ANGLERS FIND POTENTIAL FISHING SPOTS.

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.

During stratification, oxygen is nearly depleted in the hypolimnion, triggering chemical reactions at the sediment interface. These reactions result in the release of phosphorus from the sediment into the water column and are known as internal phosphorus loading



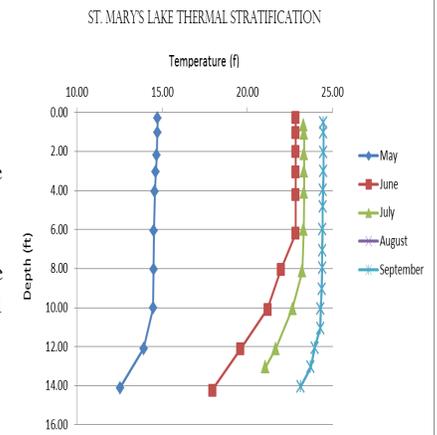
## STRATIFICATION

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.

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 hypolimnion (cold bottom water). Stratification traps nutrients (phosphorus) released from bottom sediments in the hypolimnion and prevents mixing until the fall turn over.

Monthly depth profiles were measured on St. Mary's 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. St. Mary's Lake weakly stratified in 2015.

However, St. Mary's Lake epilimnetic TP concentrations were relatively high throughout the season. St. Mary's Lake appears to be polymictic, which means the lake stratified, mixed, and then stratified again, which is common in shallow systems. Each time the lake mixes it distributes the hypolimnetic phosphorus throughout the water column and can produce algal blooms. As St. Mary's Lake destratified in August and September, the TP concentrations were almost equal from the epilimnion and hypolimnion.



## 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 St. Mary's Lake on July 2015. There were 123 points generated based on a computer grid system with points 60 meters apart. 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 2.98 feet. St. Mary's Lake could have supported plants to a depth of 6.0 feet. However, possibly due to carp activity, morphometry of the lake, and the hard, rocky substrate of the lake bottom, there were no aquatic plants present in 2002, 2005 and 2015. Aquatic plants play an important role in the lakes ecosystem by providing habitat for fish and shelter for aquatic organism. To maintain a healthy fishery, the Illinois Department of Natural Resources (IDNR) suggests that aquatic plants cover approximately 20% to 40% of the lake bottom.

Plants provide oxygen, reduce nutrients such as phosphorus to prevent algae bloom, and help stabilize sediment. Aquatic plants can reduce the occurrence algae blooms late in the summer by competing with algae for phosphorus that is available in the water. Reducing carp, creating buffer strips, and planting emergent vegetation should help reduce some of the total suspended solids in the lake.

## CARP EXCLOSURES

In shallow lakes where carp are overabundant, waters are often turbid with dense algae and few submersed macrophytes. In order to determine if aquatic plants can grow in St. Mary's Lake, Carp exclosures could be installed to see how much impact carp may have on the macrophytes. Studies have shown that by excluding or reducing carp from an area of the lake, aquatic plants actually begin to revegetate areas with out carp.



LCHD Staff identifying plants during sampling.

IT MIGHT BE WORTHWHILE TO ATTEMPT EMERGENT OR SUBMERSED AQUATIC PLANT REVEGETATION IN THESE AREAS, BUT IT IS UNLIKELY THAT THE PLANTS WILL SPREAD INTO THE MAIN LAKE. AT THIS TIME, THERE ARE NO CONTROL RECOMMENDATIONS REGARDING THE PLANT COMMUNITY IN ST. MARY'S LAKE, BUT AQUATIC PLANT REVEGETATION IS HIGHLY RECOMMENDED IN APPROPRIATE AREAS.



Carp exclosure experiment showing the much clearer water and luxuriant aquatic macrophytes growing in deeper water inside the 1-ha vinyl-wall exclosure as compared to the surrounding water in Lake Wingra. (Photo: Mike DeVries, July 2007)

<https://lter.limnology.wisc.edu>



Test Plot - Carp Exclosure



Carp Exclosure with Aquatic Plants

## FLORISTIC QUALITY INDEX

### LAKE COUNTY

AVERAGE  
FQI = 13.4

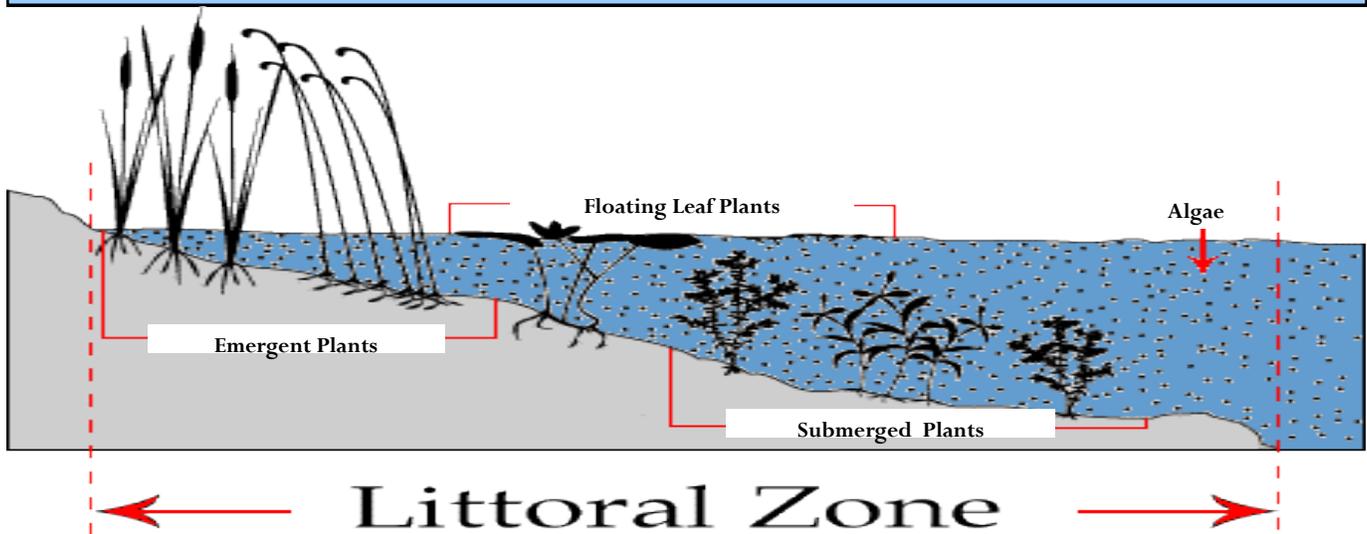
ST. MARY'S LAKE  
FQI = 0

RANK = 168/170  
(TIED WITH 3 LAKES)

AQUATIC PLANTS  
SPECIES  
OBSERVED = 0

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, St. Mary's Lake had an FQI of 0 ranking 168th 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.



Source: Minnesota Department of Natural Resources

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

## NATIVE PLANTS FOR REVEGETATION

### AQUATIC PLANTS: WHERE DO THEY GROW?



Paul Skawinski, 2009

### AMERICAN PONDWEED

American pondweed is a perennial plant that has both floating and a few submerged leaves in an alternate pattern. Submerged leaves are not abundant and are blade-like, somewhat transparent and smaller than floating leaves. Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species and some other types of wildlife. The root system helps stabilize the lake bottom.

**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 the water.



(C) Paul Skawinski, 2009

### VALLISNERIA AMERICANA

Vallisneria is an almost completely underwater perennial herb with long, narrow, green to sometimes reddish, ribbon-like leaves growing from rhizomes. Vallisneria can be distinguished from similar plants by a prominent midrib running down the center of each leaf. The presence of coiled, corkscrew-like flower stalks can also help identify this plant. Leaves, fruits, and rootstocks are excellent food for waterfowl. Also provides habitat for fish and invertebrates.



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.



### SAGO PONDWEED

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. It also produces a seed in the fall of the year that the ducks will feed on.

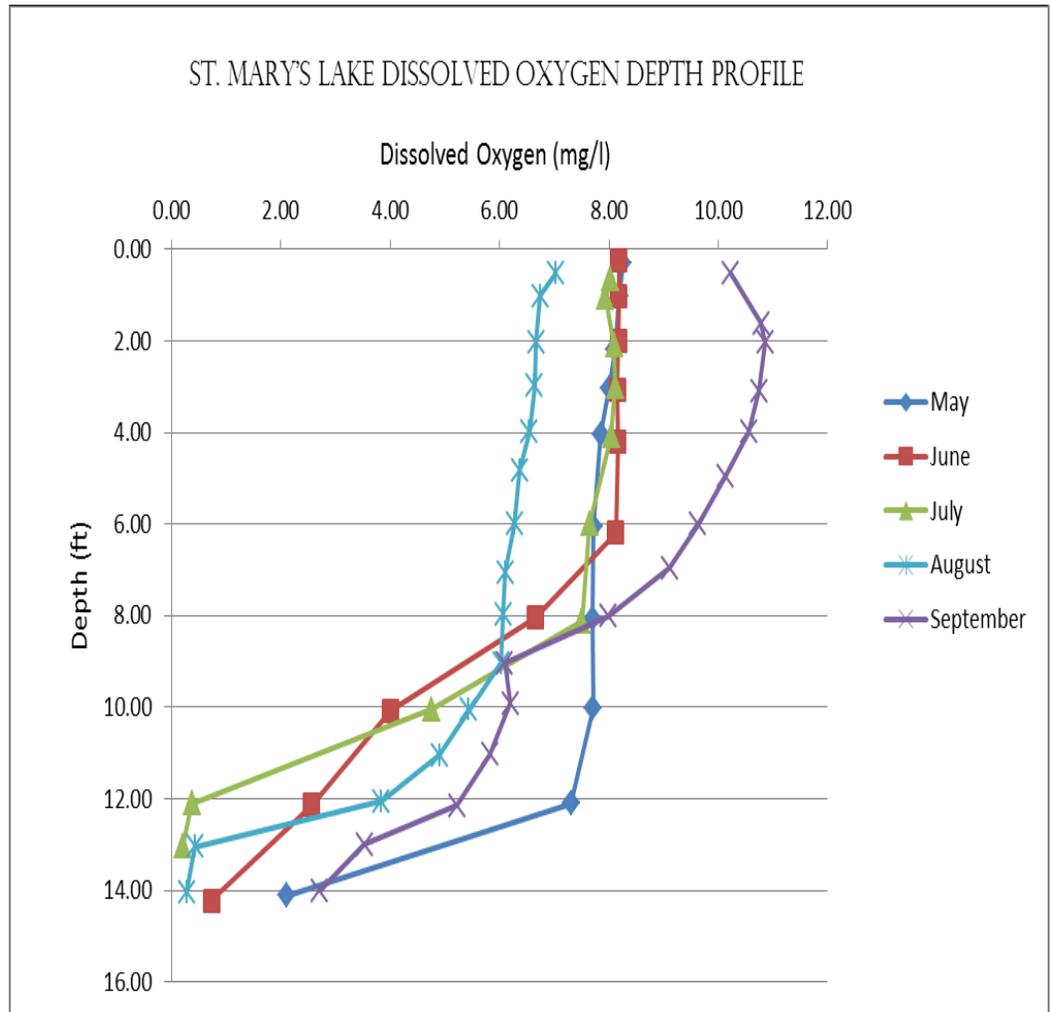
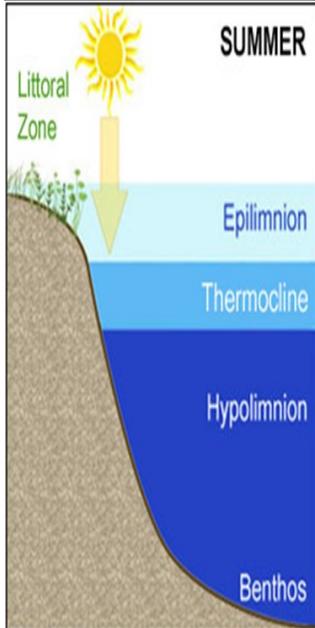
## DISSOLVED OXYGEN

RANGE OF TOLERANCE FOR DISSOLVED OXYGEN IN FISH PARTS PER MILLION (PPM)	DISSOLVED OXYGEN
1	
2	<3.0 PPM too low for fish populations
3	
4	3.0-5.0 PPM 12-24 Hour range of tolerance /stressful conditions
5	
6	>6.0 PPM Supports Spawning
7	
8	>7.0 PPM Supports Growth and Activity
9	
10	>9.0 PPM Supports abundant fish populations

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 (hypolimnion) where organic matter accumulates and decomposes.

The surface waters of St. Mary's Lake were well oxygenated during the summer, and DO concentrations did not fall below 5.0 mg/L at any time during the sampling period. The DO average was 8.33 mg/l at 3 foot below the lakes 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.*

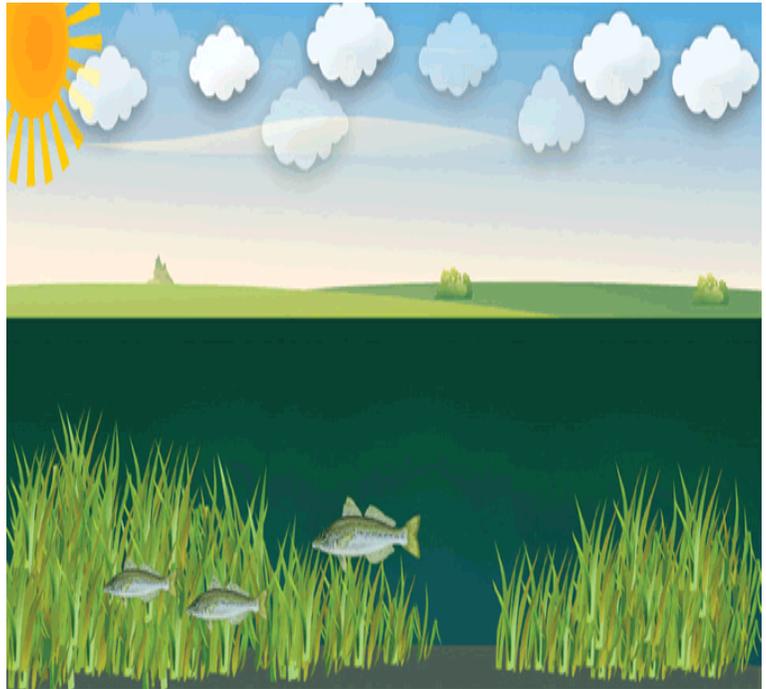


Image <http://agriculture.vic.gov.au/>

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

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

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.

A shoreline erosion study was assessed for St. Mary's Lake in 2015. The shoreline was divided into reaches, and the 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, 78.5% of St. Mary's shoreline has some erosion which is up 78% since 2002. Approximately 26.3% of the eroding shoreline was classified as slightly eroding, with the remainder classified as moderately eroding (30.4%) and severely eroding (21.8%). The moderately and severely eroded shoreline from 2002 has increased significantly. Continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affect water clarity. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

“VEGETATIVE BUFFER ZONES CAN PLAY A KEY ROLE IN LIMITING NEGATIVE WATER QUALITY IMPACTS FROM DEVELOPED SHORELAND PROPERTY”

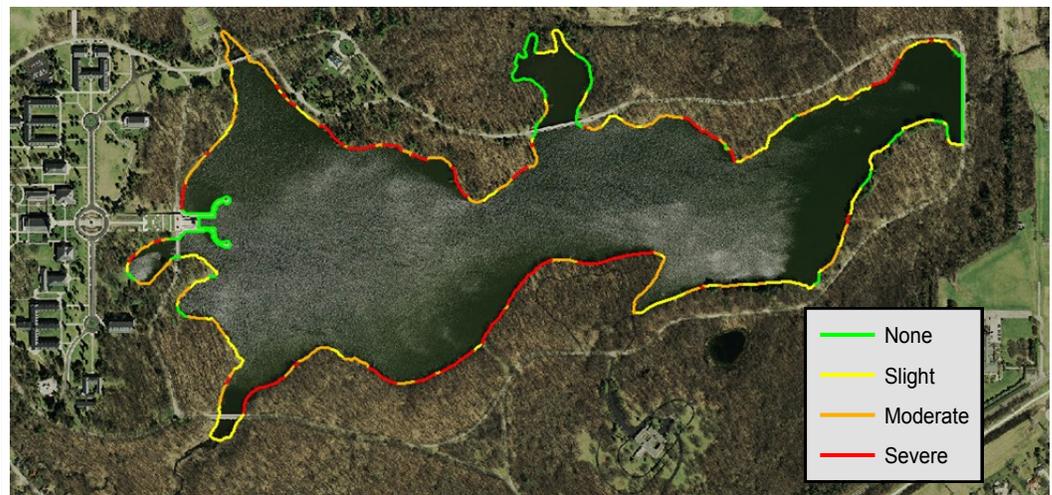


PLANTS HELP STABILIZE THE SHORELINE FROM BEING WASHED AWAY DURING A RAIN EVENT OR WIND AND WAVE ACTION.

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

### ST. MARY'S LAKE 2015 SHORELINE EROSION SURVEY



## 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.

St. Mary’s Lake had seasonal algal blooms due to an increase in Total Phosphorus brought in by heavy rains in May and internal loading during the summer. 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/](http://www.epa.state.il.us/)

[water/surface-water/blue-green-algae.html](http://www.epa.state.il.us/water/surface-water/blue-green-algae.html)

TO REPORT BLUE-GREEN  
ALGAE BLOOM:  
Lake County Health  
Department

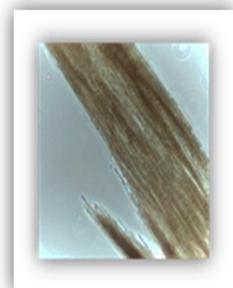
847-377-8030



Anabaena Sp.



Microcystis Sp.



Aphanizomenon Sp.



## ZEBRA MUSSELS *DREISSENA POLYMORPHA*



ZEBRA MUSSEL

For more information:

[http://  
www.seagrant.wisc.edu/  
zebramussels/faqs.html](http://www.seagrant.wisc.edu/zebramussels/faqs.html)



**STOP AQUATIC  
HITCHHIKERS!™**

Prevent the transport of nuisance species  
Clean all recreational equipment.  
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ZEBRA MUSSEL FORM  
A COLONY CALLED  
"DRUSSES"

In the late 1990's, the presence of zebra mussels (*Dreissena polymorpha*) was confirmed in the Fox Chain O Lakes. These mussels are believed to have been spread to this country in the mid 1980's by cargo ships from Europe that discharged their ballast water into the Great Lakes. The mussels spread throughout the Great Lakes and by 1991 had made their way into the Illinois and Mississippi Rivers. The first sighting of the mussel in Lake County (besides Lake Michigan and the Chain of Lakes) occurred in 1999. Currently, 33 inland lakes in the county are known to be infested with the zebra mussel, but this number could be much higher, since the zebra mussel has probably gone unnoticed in many lakes. In St. Mary's Lake zebra mussels was discovered after 2005 and have now spread through out the entire lake and below the spillway.

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

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

Zebra mussels have also caused economic problems for large power plants, public water supplies, and industrial facilities, where they clog water intake pipes. Boats stored on the water offer suitable areas for zebra mussels to start a colony. Researchers found that many of the mussel larvae were being transported via aquatic plants that were taken from one lake to another on boats and trailers. It is important that all boats and trailers entering or leaving St. Mary's Lake are inspected for aquatic plants, zebra mussels and all water from the bilge and motors are drained.

Below are some tips from the Great Lakes Sea Grant Network that can help prevent the spread of zebra mussels:

- Always inspect your boat and boat trailer carefully before transporting. Studies have shown that transport via aquatic plant fragments is one of the major contributors to the spread of zebra mussels.
- Drain all bilge waters, live wells, bait buckets and engine compartments before entering another lake. Make sure water is not trapped in your trailer. Never transport water from one lake to another.
- Flush clean water (tap) through the cooling system of your motor to rinse out any larvae. Full grown zebra mussels can be easily seen but cling stubbornly to surfaces. Boats that have been in the water for long periods of time should be carefully inspected. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 5 days, preferably up to two weeks. The mussels will die and drop off.
- In their earlier stages, attached zebra mussels may not be easily seen. Pass your hand across the boat's bottom - if it feels grainy, it's probably covered with mussels. Don't take a chance; clean them off by scraping or blasting.
- Dispose of the mussels in a trash barrel or other garbage container. Don't leave them on the shore where they could be swept back into the lake or foul the area.

## CARP (CYPRINUS CARPIO)



**Family:**

Cyprinidae  
(Minnows or carps)

**Order:**

Cypriniformes  
(carps)

**Class:** Actinopterygii (ray-finned fishes)



The spawning ritual involves a lot of thrashing in shallow water contributing to turbidity problems.

Carp are considered to be one of the most damaging invasive fish species. Originally introduced to the Midwest waters in the 1800's as a food fish, carp can now be found in 48 States. In the U.S., the common carp is more abundant in manmade impoundments, lakes, and turbid sluggish streams and less abundant in clear waters or streams with a high gradient (Pflieger 1975; Trautman 1981; Ross 2001; Boschung and Mayden 2004). They are also highly tolerant of poor water quality. Participation in the Clean Waters Clean Boats program will help prevent other invasive species from entering the lake. Never release plants, fish or animals into a body of water unless they came out of that body of water.

The common carp has a dark copper-gold back with sides that are lighter, a yellowish belly and olive fins. They have 2 pairs of short barbells on their upper lip and their dorsal and anal fins have a leading spine that are serrated. They spawn from early spring to late summer in water ranging from 15 – 28 C and prefer freshly flooded vegetation as spawning substrate. They prefer to spawn in shallow weedy areas in groups consisting of one female and several males. A single female can produce up to 100,000-500,000 which hatch in 5-8 days. The spawning ritual involves a lot of thrashing in shallow water contributing to turbidity problems. Carp are omnivorous and feed over soft bottom substrate where they suck up silt and filter out crustaceans, insect larvae and other desirable food items. Carp are very active when feeding and can be observed around shallow areas where they uproot plants which increases turbidity and nutrient concentrations. Increase in nutrients causes algal blooms and reduction in light penetration that impacts aquatic plants.

There are several ways to control the carp population in a lake. Rotenone (piscicide) may be used to eradicate carp from a lake. However, it may be expensive because the entire lake and feeder creek needs to be treated to prevent carp from repopulating the lake. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. This piscicide can only be applied by an IDNR fisheries biologist. It is also biodegradable and there is no bioaccumulation. Warm-blooded mammals have low toxicity because they have natural enzymes that would break down the toxin.

Treating the entire system would eradicate carp and allow aquatic plants to become established. Unfortunately, the concentration required to remove carp are high enough to kill native fish species. Native fish species can be restocked 30-50 days after treatment. Assess current fish population to ensure that there are enough native predator fish such as bass, catfish and northern pike to help control the carp population. The removal of carp would certainly increase St. Mary's water clarity and possibly allow for the growth of aquatic plants. This will help increase the DO levels and reduce TP and TSS concentrations.



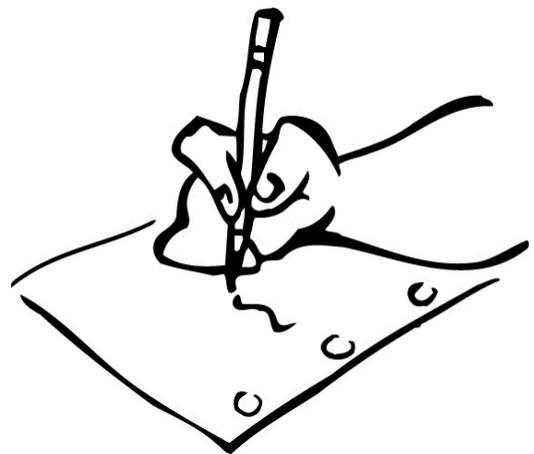
## LAKE MANAGEMENT PLANS

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 Echo 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.**





## 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](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

St. Mary's water quality had improved since 2005 with a significant decrease in conductivity (43%). The chloride and total suspended solids (TSS) decreased by 19% and 21%, respectively. There were no aquatic vegetation found since 2002. St. Mary's Lake management is administered by the University of Saint Mary of the Lake/Mundelein Seminary.

**To improve the overall quality of St. Mary's Lake, ES (Ecological Services) has the following recommendations:**

- **Incorporate native plants in their landscaping through rain gardens shoreline buffer.**
- **Mitigate shoreline exhibiting erosion . These eroded areas should be repaired to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs**  
**When possible, the shorelines should be repaired using natural vegetation instead of riprap or sea-walls.**
- **Participation in Volunteer Lake Monitoring Program.**
- **Participate in Clean Waters Clean Boats Program.**
- **Install a sign to educate on ways to reduce the spread of Aquatic Invasive Species.**
- **Help reduce Cl<sup>-</sup> by supporting wise use of road salt in the watershed.**
- **Assess current fish population and reduce or eradicate common carp .**
- **Monitor staff gauge and record level fluctuation at least once a month.**
- **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 Habitat / Water Clarity restoration plan to bring back aquatic plants into St. Mary's Lake.**

**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.  $\text{NH}_4^+$  (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If  $\text{NH}_4^+$  comes into contact with oxygen, it is immediately converted to  $\text{NO}_2^-$  (nitrite) which is then oxidized to  $\text{NO}_3^-$  (nitrate). Therefore, in a thermally stratified lake, levels of  $\text{NH}_4^+$  would only be elevated in the hypolimnion and levels of  $\text{NO}_3^-$  would only be elevated in the epilimnion. Both  $\text{NH}_4^+$  and  $\text{NO}_3^-$  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 ( $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ ) 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 ( $\text{CO}_3^-$ ) and bicarbonate ( $\text{HCO}_3^-$ ) 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 ( $\text{CaCO}_3$ ) or dolomite ( $\text{CaMgCO}_3$ ), 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	$\leq 0.012$	>13.12
Mesotrophic	$\geq 40 < 50$	$> 0.012 \leq 0.024$	$\geq 6.56 < 13.12$
Eutrophic	$\geq 50 < 70$	$> 0.024 \leq 0.096$	$\geq 1.64 < 6.56$
Hypereutrophic	$\geq 70$	$> 0.096$	< 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 <i>and</i> impervious surfaces	$\geq 70\%$
		$\leq 5\%$
Fair	Unmowed grasses & forbs + tree trunks + shrubs <i>and</i> Impervious surface	$\geq 50\%$ and $< 70\%$
		$\leq 10\%$
Poor	Unmowed grasses & forbs + tree trunks + shrubs <i>and</i> Impervious surface	$< 50\%$
		$\geq 50\%$

## **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.**

<i>Parameter</i>	<i>Method</i>
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 18 <sup>th</sup> ed. Electrode method, #4500 NH <sub>3</sub> -F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18 <sup>th</sup> ed, 4500-N <sub>org</sub> C Semi-Micro Kjeldahl, plus 4500 NH <sub>3</sub> -F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18 <sup>th</sup> ed, Method #2540B
Total suspended solids	SM 18 <sup>th</sup> ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18 <sup>th</sup> ed, Method #4500C1-D
Total volatile solids	SM 18 <sup>th</sup> ed, Method #2540E, from total solids
Alkalinity	SM 18 <sup>th</sup> ed, Method #2320B, potentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18 <sup>th</sup> ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18 <sup>th</sup> 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

**St. Mary's Lake IEPA Ranking**

**TROPHIC STATUS**

Carlson's TSIp 63.4 Eutrophic

**IMPAIRMENT ASSESSMENTS**

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

**AQUATIC LIFE USE IMPAIRMENT INDEX**

Mean Trophic State  
 Macrophyte Impairment  
 Sediment Impairment (NVSS)  
 Degree of Use Support

**SWIMMING USE**

Degree of Use Support

**RECREATION USE IMPAIRMENT INDEX**

Mean Trophic State Index  
 Macrophyte Impairment  
 Sediment Impairment (NVSS)  
 Degree of Use Support

**Overall Use Index**

Weighting Criteria	Points	Overall Use Support Points	Degree of Support
63.4	50		
Substantial	15		
Minimal	0		
	<b>65</b>	0	<b>Full</b>
	<b>63.4</b>	1	<b>Partial</b>
63.4	63.4		
Minimal	0		
Slight	5		
	<b>68.41</b>	1	<b>Partial</b>
		<b>0.67</b>	<b>Partial</b>

**Table 1. 2005 and 2002 water quality data for St. Mary's Lake.**

2015		Epilimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	Cl	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	3	161	0.97	0.156	0.102	0.058	0.010	205	564	13.5	604	79	1.75	1.0270	7.97	8.00
17-Jun	3	161	0.85	0.104	0.090	0.035	<0.005	203	569	4.4	642	143	3.50	1.0370	7.87	8.15
15-Jul	3	160	0.82	<0.1	<0.05	0.053	0.006	199	560	8.0	633	127	3.83	1.0190	8.50	8.12
12-Aug	3	160	0.94	<0.1	<0.05	0.076	0.030	186	538	7.7	586	108	3.00	0.9750	8.21	6.64
13-Sep	3	149	1.53	<0.1	<0.05	0.082	<0.005	199	517	9.0	581	115	2.80	0.9330	8.70	10.75
<b>Average</b>		158	1.02	<0.1	<0.05	0.061	0.009 <sup>k</sup>	198	549.4	8.5	609	114	2.98	0.9982	8.25	8.33

2005		Epilimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	Cl	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	3	165	0.88	<0.1	<0.05	0.034	<0.005	215	NA	5.7	612	98	5.81	1.0940	8.37	13.50
14-Jun	3	166	1.03	<0.1	<0.05	0.046	<0.005	227	NA	11.0	678	132	2.85	1.1720	8.07	7.89
12-Jul	3	144	1.40	<0.1	<0.05	0.085	0.012	257	NA	12.0	729	174	0.98	1.1980	8.47	9.71
9-Aug	3	165	1.10	<0.1	<0.05	0.066	<0.005	246	NA	11.5	719	154	2.49	1.1920	8.61	13.57
13-Sep	3	126	1.94	<0.1	<0.05	0.102	0.006	273	NA	14.0	710	140	1.81	1.2310	8.71	9.50
<b>Average</b>		153	1.27	<0.1	<0.05	0.067	0.009 <sup>k</sup>	244	NA	10.8	690	140	2.79	1.1774	8.45	10.83

2002		Epilimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	Cl	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
6-May	3	174	0.99	<0.1	<0.05	0.074	<0.005	NA	600	10.2	618	124	2.79	1.0030	8.22	9.31
10-Jun	3	176	0.92	<0.1	0.191	0.043	<0.005	NA	612	8.5	665	169	3.45	1.0580	8.13	8.10
15-Jul	3	173	0.99	<0.1	<0.05	0.065	<0.005	NA	564	11.4	672	152	3.12	1.0770	8.57	9.64
12-Aug	3	149	1.38	<0.1	<0.05	0.079	<0.005	NA	582	13.0	590	146	2.05	1.0560	8.60	10.87
9-Sep	3	118	1.68	<0.1	<0.05	0.112	0.006	NA	521	15.7	551	120	1.97	0.9422	8.98	11.65
<b>Average</b>		158	1.19	<0.1	0.19 <sup>k</sup>	0.075	0.006 <sup>k</sup>	NA	576	11.8	619	142	2.68	1.0272	8.50	9.91

Glossary
ALK = Alkalinity, mg/L CaCO <sub>3</sub>
TKN = Total Kjeldahl nitrogen, mg/L
NH <sub>3</sub> -N = Ammonia nitrogen, mg/L
NO <sub>3</sub> -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

**Table 1. 2005 and 2002 water quality data for St. Mary's Lake.**

2015		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
15-Jul	10	159	1.08	ND	ND	0.095	0.019	556	197	24.0	633	116		1.0120	7.96	4.76
13-May	12	164	1.01	0.169	0.110	0.056	0.012	557	202	11.9	635	101		1.0130	7.84	7.31
17-Jun	12	171	1.12	0.427	ND	0.076	0.034	589	211	12.0	673	151		1.0760	7.84	2.56
12-Aug	12	160	1.06	ND	ND	0.088	0.038	537	185	8.9	594	113		0.9740	7.80	3.84
16-Sep	12	151	1.11	ND	ND	0.070	0.010	517	197	6.0	576	117		0.9340	8.07	5.21

**Average** 161 1.08 0.270<sup>k</sup> <0.05 0.077 0.231<sup>k</sup> NA 198 12.6 622 120 NA 1.0018 7.90 4.74

2005		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	13	174	1.46	0.181	<0.05	0.081	<0.005	NA	216	29.1	643	101	NA	1.1140	7.35	2.07
14-Jun	12	184	1.67	0.529	<0.05	0.231	0.043	NA	225	45.0	704	122	NA	1.1850	7.12	0.06
12-Jul	11	154	1.41	0.114	<0.05	0.120	0.015	NA	255	13.0	704	140	NA	1.2160	7.44	0.12
9-Aug	11	176	1.20	<0.1	<0.05	0.140	0.035	NA	245	20.3	723	133	NA	1.2120	7.50	0.22
13-Sep	11	137	2.13	0.556	<0.05	0.178	0.054	NA	273	12.0	708	138	NA	1.2520	7.62	0.11

**Average** 172 1.44 0.270<sup>k</sup> <0.05 0.143 0.231<sup>k</sup> NA 235 26.9 694 124 NA 1.1818 7.35 0.62

2002		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
6-May	13	177	1.06	<0.1	<0.05	0.087	<0.005	570	NA	22.4	601	132	NA	1.0040	7.64	4.22
10-Jun	13	181	1.18	0.318	0.058	0.074	0.005	652	NA	20.3	700	185	NA	1.0640	7.37	0.41
15-Jul	12	186	1.43	0.351	<0.05	0.233	0.025	566	NA	43.1	701	177	NA	1.0980	7.47	0.13
12-Aug	12	167	1.13	0.127	<0.05	0.090	0.010	606	NA	11.0	658	148	NA	1.0840	7.59	0.20
9-Sep	12	130	1.72	0.412	<0.05	0.176	0.046	514	NA	9.2	549	110	NA	0.9680	7.53	0.08

**Average** 168 1.30 0.300<sup>k</sup> 0.058<sup>k</sup> 0.132 0.022<sup>k</sup> 582 NA 21.2 642 150 NA 1.0436 7.52 1.01

Glossary
ALK = Alkalinity, mg/L CaCO <sub>3</sub>
TKN = Total Kjeldahl nitrogen, mg/L
NH <sub>3</sub> -N = Ammonia nitrogen, mg/L
NO <sub>3</sub> -N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl <sup>-</sup> = 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

## 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	Independence 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.

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
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
	<i>Average</i>	<i>0.1130</i>	<i>66.0</i>

St. Mary's Lake 2015 Multiparameter Data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC
5/13/2015	0.5	0.3	14.72	8.26	81.6	1.026	8.16	2767
5/13/2015	1	1.025	14.71	8.19	80.9	1.027	7.99	-908
5/13/2015	2	2.2	14.67	8.11	80.1	1.027	8	1371
5/13/2015	3	3.042	14.61	8	78.9	1.027	7.97	592
5/13/2015	4	4.04	14.56	7.85	77.3	1.026	7.93	-1008
5/13/2015	6	6.051	14.5	7.72	75.9	1.023	7.88	-201
5/13/2015	8	8.058	14.49	7.7	75.7	1.023	7.87	-1764
5/13/2015	10	10.02	14.46	7.71	75.9	1.023	7.86	401
5/13/2015	12	12.102	13.9	7.31	71	1.013	7.84	221
5/13/2015	14	14.117	12.52	2.1	19.7	1.072	7.7	869

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC
6/17/2015	0.5	0.238	22.83	8.18	95.3	1.037	7.86	2733
6/17/2015	1	1.038	22.83	8.18	95.3	1.037	7.86	7163
6/17/2015	2	2.008	22.83	8.17	95.2	1.037	7.87	3072
6/17/2015	3	3.056	22.83	8.15	95.0	1.037	7.87	4542
6/17/2015	4	4.209	22.82	8.16	95.0	1.037	7.88	3535
6/17/2015	6	6.193	22.82	8.13	94.7	1.036	7.89	4291
6/17/2015	8	8.041	21.96	6.65	76.2	1.026	7.84	2993
6/17/2015	10	10.082	21.18	4.01	45.3	1.065	7.81	3353
6/17/2015	12	12.128	19.58	2.56	28.0	1.076	7.84	2775
6/17/2015	14	14.223	17.93	0.73	7.7	1.085	7.86	2174

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC
7/15/2015	0.5	0.657	23.3	8.02	94.3	1.018	8.51	1679
7/15/2015	1	1.07	23.33	7.94	93.4	1.02	8.51	144
7/15/2015	2	2.096	23.33	8.1	95.3	1.021	8.51	-2151
7/15/2015	3	2.993	23.33	8.12	95.6	1.019	8.5	-52
7/15/2015	4	4.088	23.33	8.04	94.6	1.02	8.5	1368
7/15/2015	6	6.007	23.3	7.65	89.9	1.02	8.43	799
7/15/2015	8	8.124	23.22	7.51	88.2	1.019	8.45	-659
7/15/2015	10	10.047	22.64	4.76	55.2	1.012	7.96	2653
7/15/2015	12	12.105	21.66	0.37	4.2	1.051	7.55	1165
7/15/2015	13	13.053	21.05	0.2	2.2	1.052	7.16	-3168

St. Mary's Lake 2015 Multiparameter Data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC
8/12/2015	0.5	0.533	24.47	7.03	84.4	0.973	8.27	3767
8/12/2015	1	1.019	24.46	6.74	81.0	0.975	8.22	1345
8/12/2015	2	2.025	24.46	6.67	80.1	0.975	8.21	1169
8/12/2015	3	2.987	24.46	6.64	79.8	0.975	8.21	6210
8/12/2015	4	3.977	24.43	6.55	78.7	0.975	8.19	3682
8/12/2015	5	4.844	24.42	6.37	76.4	0.976	8.16	5802
8/12/2015	6	6.002	24.41	6.27	75.2	0.975	8.15	6179
8/12/2015	7	7.062	24.39	6.11	73.4	0.976	8.13	8493
8/12/2015	8	7.969	24.39	6.07	72.8	0.976	8.13	4059
8/12/2015	9	9.043	24.36	6.03	72.2	0.976	8.09	1056
8/12/2015	10	10.067	24.30	5.44	65.1	0.976	8.00	2776
8/12/2015	11	11.050	24.28	4.90	58.7	0.977	7.96	1386
8/12/2015	12	12.053	23.95	3.84	45.7	0.974	7.80	2742
8/12/2015	13	13.041	23.71	0.43	5.1	0.982	7.61	2160
8/12/2015	14	14.040	23.13	0.28	3.2	1.003	7.44	2885

Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	BGA-PC
9/13/2015	0.5	0.534	20.27	10.23	113.4	0.932	8.79	16172
9/13/2015	1	1.61	20.25	10.79	119.5	0.933	8.73	17592
9/13/2015	2	2.037	20.26	10.86	120.4	0.933	8.72	13347
9/13/2015	3	3.095	20.18	10.75	119	0.933	8.7	27350
9/13/2015	4	3.994	20.07	10.56	116.6	0.933	8.67	21103
9/13/2015	5	4.961	20	10.13	111.7	0.934	8.63	23008
9/13/2015	6	6.004	19.97	9.63	106.2	0.934	8.57	16238
9/13/2015	7	6.958	19.95	9.11	100.4	0.934	8.52	16574
9/13/2015	8	8.019	19.9	7.99	88	0.936	8.43	9462
9/13/2015	9	9.032	19.65	6.1	66.8	0.936	8.19	10912
9/13/2015	10	9.914	19.56	6.2	67.8	0.935	8.17	10648
9/13/2015	11	11.03	19.48	5.82	63.6	0.934	8.12	9484
9/13/2015	12	12.146	19.45	5.22	56.9	0.933	8.07	5877
9/13/2015	13	13	19.31	3.53	38	0.935	7.91	6000
9/13/2015	14	14	19.3	2.71	29.7	0.938	7.82	3000

St. Mary's Lake RTRM

RTRM: Relative Thermal Resistance to Mixing

RVG: Relative Viscosity Gradient

Date	Depth	Temp	DO	DO%	RTRM	RVG
5/13/2015	0.30	14.72	8.26	81.37	0	0
5/13/2015	1.03	14.71	8.19	80.68	0	0
5/13/2015	2.20	14.67	8.11	79.72	2	9
5/13/2015	3.04	14.61	8.00	78.64	0	0
5/13/2015	4.04	14.56	7.85	77.00	2	9
5/13/2015	6.05	14.50	7.72	75.72	0	0
5/13/2015	8.06	14.49	7.70	75.36	2	9
5/13/2015	10.02	14.46	7.71	75.46	0	0
5/13/2015	12.10	13.90	7.31	70.77	9	43
5/13/2015	14.12	12.52	2.10	19.71	22	120

Date	Depth	Temp	DO	DO%	RTRM	RVG
6/17/2015	0.24	22.83	8.18	94.99	0	0
6/17/2015	1.04	22.83	8.18	94.99	0	0
6/17/2015	2.01	22.83	8.17	94.88	0	0
6/17/2015	3.06	22.83	8.15	94.65	0	0
6/17/2015	4.21	22.82	8.16	94.76	0	0
6/17/2015	6.19	22.82	8.13	94.41	0	0
6/17/2015	8.04	21.96	6.65	75.91	26	36
6/17/2015	10.08	21.18	4.01	45.07	22	32
6/17/2015	12.13	19.58	2.56	27.87	41	64
6/17/2015	14.22	17.93	0.73	7.69	38	64

Date	Depth	Temp	DO	DO%	RTRM	RVG
7/15/2015	0.66	23.30	8.02	94.02	0	0
7/15/2015	1.07	23.33	7.94	93.08	0	0
7/15/2015	2.10	23.33	8.10	94.96	0	0
7/15/2015	2.99	23.33	8.12	95.19	0	0
7/15/2015	4.09	23.33	8.04	94.26	0	0
7/15/2015	6.01	23.30	7.65	89.68	0	0
7/15/2015	8.12	23.22	7.51	87.88	3	4
7/15/2015	10.05	22.64	4.76	55.07	17	24
7/15/2015	12.11	21.66	0.37	4.20	28	40
7/15/2015	13.05	21.05	0.20	2.24	16	24

Date	Depth	Temp	DO	DO%	RTRM	RVG
8/12/2015	0.53	24.47	7.03	84.13	0	0
8/12/2015	1.02	24.46	6.74	80.66	0	0
8/12/2015	2.02	24.46	6.67	79.82	0	0
8/12/2015	2.99	24.46	6.64	79.46	0	0
8/12/2015	3.98	24.43	6.55	78.39	0	0
8/12/2015	4.84	24.42	6.37	76.23	0	0
8/12/2015	6.00	24.41	6.27	75.04	0	0
8/12/2015	7.06	24.39	6.11	72.99	3	4
8/12/2015	7.97	24.39	6.07	72.51	0	0
8/12/2015	9.04	24.36	6.03	72.03	0	0
8/12/2015	10.07	24.30	5.44	64.86	3	4
8/12/2015	11.05	24.28	4.90	58.42	0	0
8/12/2015	12.05	23.95	3.84	45.53	9	12
8/12/2015	13.04	23.71	0.43	5.08	6	8
8/12/2015	14.04	23.13	0.28	3.27	18	24

Date	Depth	Temp	DO	DO%	RTRM	RVG
9/13/2015	0.53	20.27	10.23	112.96	0	0
9/13/2015	1.61	20.25	10.79	119.14	0	0
9/13/2015	2.04	20.26	10.86	119.91	0	0
9/13/2015	3.10	20.18	10.75	118.47	3	4
9/13/2015	3.99	20.07	10.56	116.15	3	4
9/13/2015	4.96	20.00	10.13	111.42	0	0
9/13/2015	6.00	19.97	9.63	105.70	2	4
9/13/2015	6.96	19.95	9.11	100.00	0	0
9/13/2015	8.02	19.90	7.99	87.70	0	0
9/13/2015	9.03	19.65	6.10	66.55	7	12
9/13/2015	9.91	19.56	6.20	67.51	2	4
9/13/2015	11.03	19.48	5.82	63.24	2	4
9/13/2015	12.15	19.45	5.22	56.72	0	0
9/13/2015	13.00	19.31	3.53	38.28	2	4
9/13/2015	14.00	19.30	2.71	29.39	0	0

**St. Mary's Lake Land Use 2015**

<b>Land Use</b>	<b>Acreage</b>	<b>% of Total</b>
Agricultural	262.33	8.9%
Forest and Grassland	430.81	14.6%
Government and Institutional	107.17	3.6%
Industrial	133.46	4.5%
Multi Family	1.50	0.1%
Office	21.86	0.7%
Public and Private Open Space	469.54	15.9%
Retail/Commercial	45.72	1.6%
Single Family	759.81	25.8%
Transportation	193.79	6.6%
Utility and Waste Facilities	3.85	0.1%
Water	228.85	7.8%
Wetlands	286.53	9.7%
<b>Total Acres</b>	<b>2945.20</b>	<b>100.0%</b>

<b>Land Use</b>	<b>Acreage</b>	<b>Runoff Coeff.</b>	<b>Estimated Runoff, acft.</b>	<b>% Total of Estimated Runoff</b>
Agricultural	262.33	0.05	36.1	1.8
Forest and Grassland	430.81	0.05	59.2	2.9
Government and Institutional	107.17	0.50	147.4	7.3
Industrial	133.46	0.80	293.6	14.6
Multi Family	1.50	0.50	2.1	0.1
Office	21.86	0.85	51.1	2.5
Public and Private Open Space	469.54	0.15	193.7	9.6
Retail/Commercial	45.72	0.85	106.9	5.3
Single Family	759.81	0.30	626.8	31.1
Transportation	193.79	0.85	453.0	22.5
Utility and Waste Facilities	3.85	0.30	3.2	0.2
Water	228.85	0.00	0.0	0.0
Wetlands	286.53	0.05	39.4	2.0
<b>TOTAL</b>	<b>2945.20</b>		<b>2012.4</b>	<b>100.0</b>

**Lake volume**

**957.30 acre-feet**

**Retention Time (years)= lake volume/runoff**

**0.48 years**

**173.63 days**

## 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	Independence 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 Outlet	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.

<b>RANK</b>	<b>LAKE NAME</b>	<b>FQI (w/A)</b>	<b>FQI (native)</b>
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
	<i>Mean</i>	<b>14.0</b>	<b>15.0</b>
	<i>Median</i>	<b>13.4</b>	<b>15.0</b>

St. Mary's Lake Shoreline Condition Assessment 2015

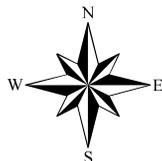
St. Mary 2015 Shoreline Erosion

Reach	None		Slight		Moderate		Severe		Total	Lateral Recession Rate
	Linear ft.	% of Reach								
SM01	0.0	0.0	140.0	12.9	795.5	73.3	149.9	13.8	1085.4	0.35
SM02	30.3	1.7	134.8	7.6	663.0	37.2	952.9	53.5	1781.0	0.4
SM03	1278.2	65.5	580.5	29.8	91.8	4.7	0.0	0.0	1950.4	0.08
SM04	15.3	1.4	196.4	17.4	543.7	48.2	371.6	33.0	1127.0	0.4
SM05	115.2	6.9	818.0	48.8	448.4	26.7	295.9	17.6	1677.5	0.3
SM06	529.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	529.1	0
SM07	454.2	19.2	1286.2	54.4	555.3	23.5	70.0	3.0	2365.7	0.2
SM08	0.0	0.0	319.4	42.3	435.0	57.7	0.0	0.0	754.4	0.2
SM09	0.0	0.0	53.6	3.8	217.7	15.6	1123.9	80.6	1395.3	0.5
SM10	0.0	0.0	108.7	10.9	320.4	32.2	565.1	56.8	994.1	0.5
SM11	0.0	0.0	218.2	23.4	322.0	34.6	391.4	42.0	931.6	0.4
SM12	22.5	2.1	581.7	54.3	419.5	39.2	47.4	4.4	1071.1	0.2
SM13	125.8	18.9	418.0	62.7	123.3	18.5	0.0	0.0	667.1	0.05
SM14	1417.0	92.0	0.0	0.0	0.0	0.0	123.1	8.0	1540.1	0.05
SM15	14.2	1.7	211.8	25.4	533.4	64.0	73.7	8.8	833.2	0.3
SM16	205.1	24.9	59.2	7.2	470.1	57.0	89.8	10.9	824.2	0.3
Total	4206.8	21.5	5126.6	26.3	5939.0	30.4	4254.7	21.8	19527.0	

St. Mary 2015 Lakeshore Buffer Condition

Reach	Poor		Fair		Good		Shoreline Length Assessed
	Linear ft.	% of Reach	Linear ft.	% of Reach	Linear ft.	% of Reach	
SM01	360	33	0	0	725	67	1085
SM02	40	2	0	0	1741	98	1781
SM03	140	7	0	0	1810	93	1950
SM04	10	1	0	0	1117	99	1127
SM05	0	0	0	0	1677	100	1677
SM06	NA						
SM07	25	1	300	13	2041	86	2366
SM08	0	0	45	6	709	94	754
SM09	55	4	105	8	1235	89	1395
SM10	0	0	100	10	894	90	994
SM11	0	0	45	5	887	95	932
SM12	160	15	110	10	801	75	1071
SM13	575	86	0	0	92	14	667
SM14	1417	92	123	8	0	0	1540
SM15	120	14	713	86	0	0	833
SM16	459	56	365	44	0	0	824
Total	3361.0	18	1906.5	10	13730.5	72	18998.0

# St. Mary's Lake Shoreline Reaches, 2015



# St. Mary's Lake Shoreline Erosion Condition, 2015

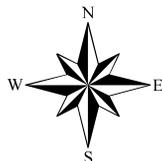
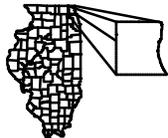
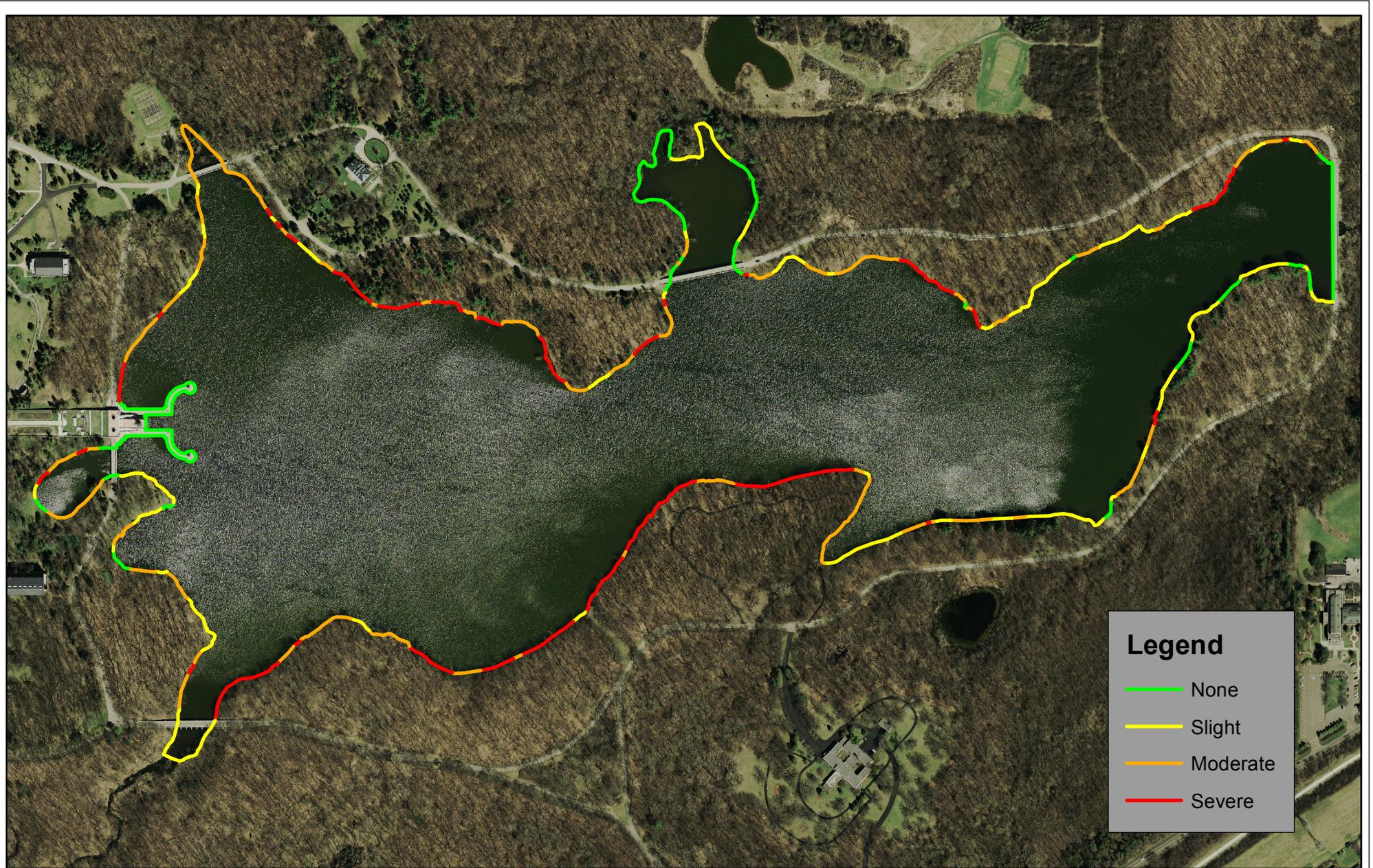


Table 1: St. Mary's Shoreline Erosion Condition 2015

Reach	None		Slight		Moderate		Severe		Total	Lateral Recession Rate
	Linear ft.	% of Reach								
SM01	0.0	0.0	140.0	12.9	795.5	73.3	149.9	13.8	1085.4	0.35
SM02	30.3	1.7	134.8	7.6	663.0	37.2	952.9	53.5	1781.0	0.40
SM03	1278.2	65.5	580.5	29.8	91.8	4.7	0.0	0.0	1950.4	0.08
SM04	15.3	1.4	196.4	17.4	543.7	48.2	371.6	33.0	1127.0	0.40
SM05	115.2	6.9	818.0	48.8	448.4	26.7	295.9	17.6	1677.5	0.30
SM06	529.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	529.1	0.00
SM07	454.2	19.2	1286.2	54.4	555.3	23.5	70.0	3.0	2365.7	0.20
SM08	0.0	0.0	319.4	42.3	435.0	57.7	0.0	0.0	754.4	0.20
SM09	0.0	0.0	53.6	3.8	217.7	15.6	1123.9	80.6	1395.3	0.50
SM10	0.0	0.0	108.7	10.9	320.4	32.2	565.1	56.8	994.1	0.50
SM11	0.0	0.0	218.2	23.4	322.0	34.6	391.4	42.0	931.6	0.40
SM12	22.5	2.1	581.7	54.3	419.5	39.2	47.4	4.4	1071.1	0.20
SM13	125.8	18.9	418.0	62.7	123.3	18.5	0.0	0.0	667.1	0.05
SM14	1417.0	92.0	0.0	0.0	0.0	0.0	123.1	8.0	1540.1	0.05
SM15	14.2	1.7	211.8	25.4	533.4	64.0	73.7	8.8	833.2	0.30
SM16	205.1	24.9	59.2	7.2	470.1	57.0	89.8	10.9	824.2	0.30
Total	4206.8	21.5	5126.6	26.3	5939.0	30.4	4254.7	21.8	19527.0	

Table 2: St. Mary's Lakeshore Buffer Condition 2015

Reach	Poor		Fair		Good		Shoreline Length Assessed
	Linear ft.	% of Reach	Linear ft.	% of Reach	Linear ft.	% of Reach	
SM01	360	33	0	0	725	67	1085
SM02	40	2	0	0	1741	98	1781
SM03	140	7	0	0	1810	93	1950
SM04	10	1	0	0	1117	99	1127
SM05	0	0	0	0	1677	100	1677
SM06	NA						
SM07	25	1	300	13	2041	86	2366
SM08	0	0	45	6	709	94	754
SM09	55	4	105	8	1235	89	1395
SM10	0	0	100	10	894	90	994
SM11	0	0	45	5	887	95	932
SM12	160	15	110	10	801	75	1071
SM13	575	86	0	0	92	14	667
SM14	1417	92	123	8	0	0	1540
SM15	120	14	713	86	0	0	833
SM16	459	56	365	44	0	0	824
Total	3361	18	1907	10	13730	72	18998