Lake County, IL

2015 Lake Zurich Summary Report

LAKE COUNTY HEALTH DEPARTMENT

Ecological Services

Lake Zurich, 2015

Lake Zurich is a 232 acre glacial lake in southwestern Lake County. Lake Zurich is part of the Flint Lake drainage of the Fox River watershed. It is at the top of the Flint Creek Watershed and has relatively good water quality. There are numerous bottom owners of the lake, however, it is managed by the Lake Zurich Property Owners Association (LZPOA). The association meets monthly and has a Lake Management Committee.

In 2015, the Lake County Health Department– Ecological Services (LCHD-ES) monitored Lake Zurich. Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (Appendix A) three feet below the surface, and 3 feet above the bottom. Water chemistry can be significantly different between the epilimnion (warm upper layer) and hypolimion (cool bottom layer) of a lake. Samples were analyzed for nutrients, solid concentrations and other physical parameters. Additionally, an aquatic plant survey was conducted in July (2015) and a shoreline assessment surveyed in October (2015). The following report summarizes the findings from the 2015 monitoring season.

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Inside this issue:

LAKE FACTS

MAJOR WATERSHED:

FOX RIVER

SUB-WATERSHED:

FLINT CREEK

SURFACE AREA:

232.3 ACRES

SHORELINE LENGTH:

2.80 MILES

MAXIMUM DEPTH:

33.0 FEET

AVERAGE DEPTH:

7.0 FEET

LAKE VOLUME:

1635.5 ACRE-FEET

WATERSHED AREA:

605 ACRES

LAKE TYPE:

GLACIAL

CURRENT USES:

SWIMMING, FISHING, BOATING,

ACCESS:

ALL ACCESS LOCATIONS ARE PRIVATE, OPEN TO THE PUBLIC (WITH A PERMIT STICKER)

Lake Zurich Summary

Following are summary highlights of the water quality sampling, shoreline survey and aquatic macrophyte surveys from the 2015 monitoring season. The water quality of Lake Zurich is good compared to Lake County median values. The complete data sets for water quality, aquatic plant sampling, and shoreline surveys conducted on Lake Zurich can be found in Appendix A of this report, and discussed in further detail in the following sections.

- Average water clarity based on Secchi depth in 2015 was 7.24 ft., which is a 30% decrease since 2008; yet remains well above the Lake County median Secchi depth of 2.96 ft.
- Water clarity is influenced by amount of particles in the water column; this is measured by total suspended solids. The average TSS concentrations on Lake Zurich was 3.0 mg/L in 2015, which is below the Lake County median of 8.2 mg/L and only a slight increase from 2.7 mg/L since 2008.
- Nutrient availability indicated that Lake Zurich was phosphorus limited with an average TN:TP ratio of 40:1.
- In 2015 the average total phosphorus concentration was 0.021 mg/L. This is below the Illinois Environmental Protection Agency (IEPA) water quality standard of 0.050 mg/L.
- Total phosphorus concentrations have increased since 2008 by 31% from 0.016 mg/ L to 0.021 mg/L.
- Trophic State index (TSIp) for Lake Zurich was 48; meaning Lake Zurich is considered mesotrophic.
- Lake Zurich thermally stratified throughout the monitoring season; May—August.
- Dissolved oxygen (DO) concentrations dropped below 5 mg/L during all June - September. DO dropped below 5 mg/L at depths greater than 20 ft. (June), 16 ft. (July), 18ft. (August), and 22 ft. (September).
- Dissolved oxygen concentrations reached anoxic conditions (<1 mg/L) June - August.
- The July aquatic macrophyte survey showed that 63% of all sampling sites had plant coverage.
- A total of 8 plant species and Chara (a macro-algae) were present, which is a decrease since previous monitoring years.
- The most dominant aquatic plant species in 2015 were Chara, a macro-algae, at 46.5% and large-leaf pondweed at 31.5% of the sampling sites.
- Eurasian watermilfoil and zebra mussels, two aquatic invasive species were present during the 2015 sampling season.
- 35% of the Lake Zurich shoreline was experiencing some degree of erosion.
- Based on the 2015 shoreline condition survey, 66% of Lake Zurich's lakeshore buffer condition was classified as poor.
- Lake Zurich has three licensed beach including Oakwood Beach Club, Inc., Breezewald Park, and Henry J Paulus Park Beach. There was only one beach closures due to E.coli in 2015 which occurred at Henry J Paulus Park Beach from June 8th sampling, closing the beach on June 9th.

Lake Zurich is in the Flint Creek Watershed, which is part of the larger Fox River Watershed.

LAKES SAMPLED IN 2015

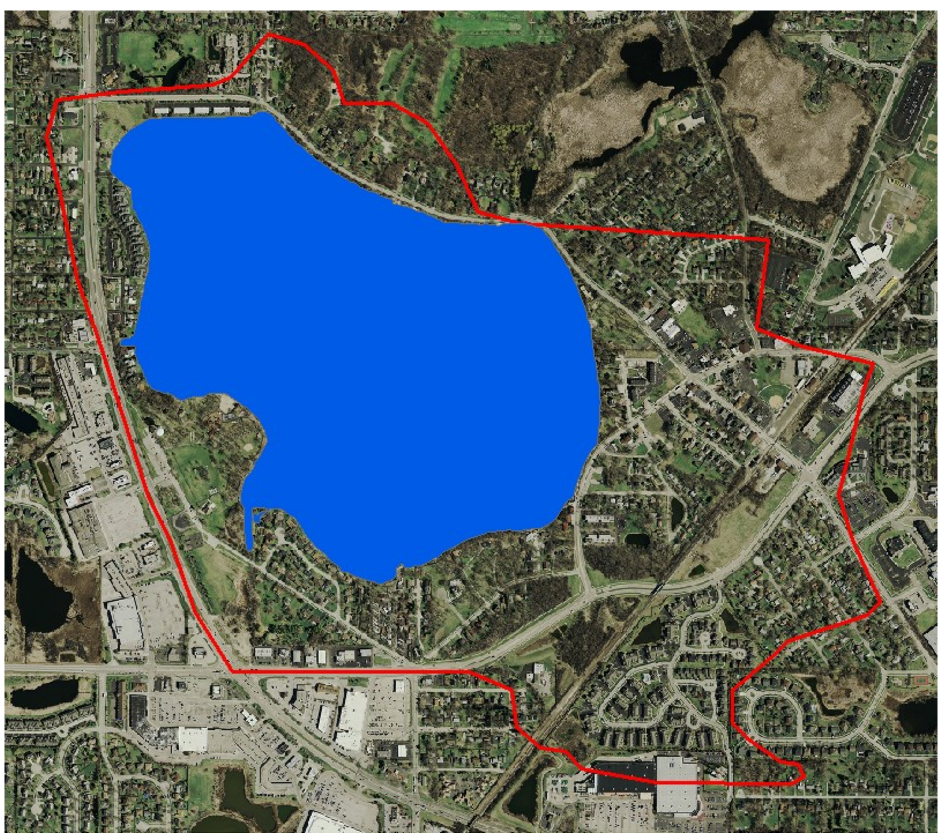
Echo Lake
Lake Zurich
Lake Barrington
Honey Lake
Lake Antioch
Little Silver Lake
Lake Tranquility
Cross Lake
Lake Minear
Lake Louise
St. Mary's Lake
Loch Lomond Lake
Butler Lake

WATERSHED & LANDUSE

A watershed is an area of land where all surface water from rain, melting snow and ice, converge at a lower elevation, usually a lake, river, or other body of water. The source of a lake's water supply is very important in determining its water quality and choosing management practices to protect the lake. The Lake Zurich watershed is 605 acres; and is in the upper portion of the Flint Creek Watershed (Figure 1). The watershed to lake ratio is important in understanding how nutrients enter the lake. Lake Zurich has a small watershed to lake ratio (3:1), which can make it easier to manage external inputs of nutrients. The retention time of Lake Zurich, meaning how long water stays in the lake, is 3.11 years. This emphasizes the importance of reducing external nutrient loads since they can remain in the water for longer periods of time.

Land use plays a significant role on water quality of a lake. Based on the 2008 land use data, the current external sources affecting Lake Zurich are from the following dominant land uses: Water (38.2%), Single-Family (19.8%) and Transportation (14.8%) (Figure 2, Page 4). As areas become more developed, that typically means an increase in impervious surfaces, reducing the amount of open space for infiltrating and storing precipitation. Based on the amount of impervious surfaces each land use contributes varied amounts of runoff. Impervious surfaces (parking lots, roads, buildings, compacted soil) impact water quality in lakes by increasing pollutant loads and water temperature. During storm events, pollutants such as excess nutrients (nitrogen and phosphorus), metals, oil and grease, and bacteria are easily transferred from impervious surfaces to rivers, wetlands, and lakes.

Figure 1: Lake Zurich Watershed Delineation



WATERSHED & LANDUSE (CONT.)

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

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

Lake Zurich receives the majority of it's runoff from roads in watershed. Approximately 39.7% of runoff is attributed to the transportation land use; followed by Retail/Commercial land use (21%), and Single Family Residential land use (18.9%) (Table 1). Lakes that receive a significant amount of stormwater runoff can have variable water quality that is heavily influenced by human activity. It's also important to note that while other land uses may contribute a smaller percentage of runoff, they can still deliver high concentrations of total suspended solids and total phosphorus (Appendix B). Alternatively, low percentage of land use can still deliver higher amounts of runoff, for instance, the retail/commercial land use is not a dominant land use at only 8% of the watershed but contributes 21% of the runoff.

Figure 2: Land use in the Lake Zurich Watershed

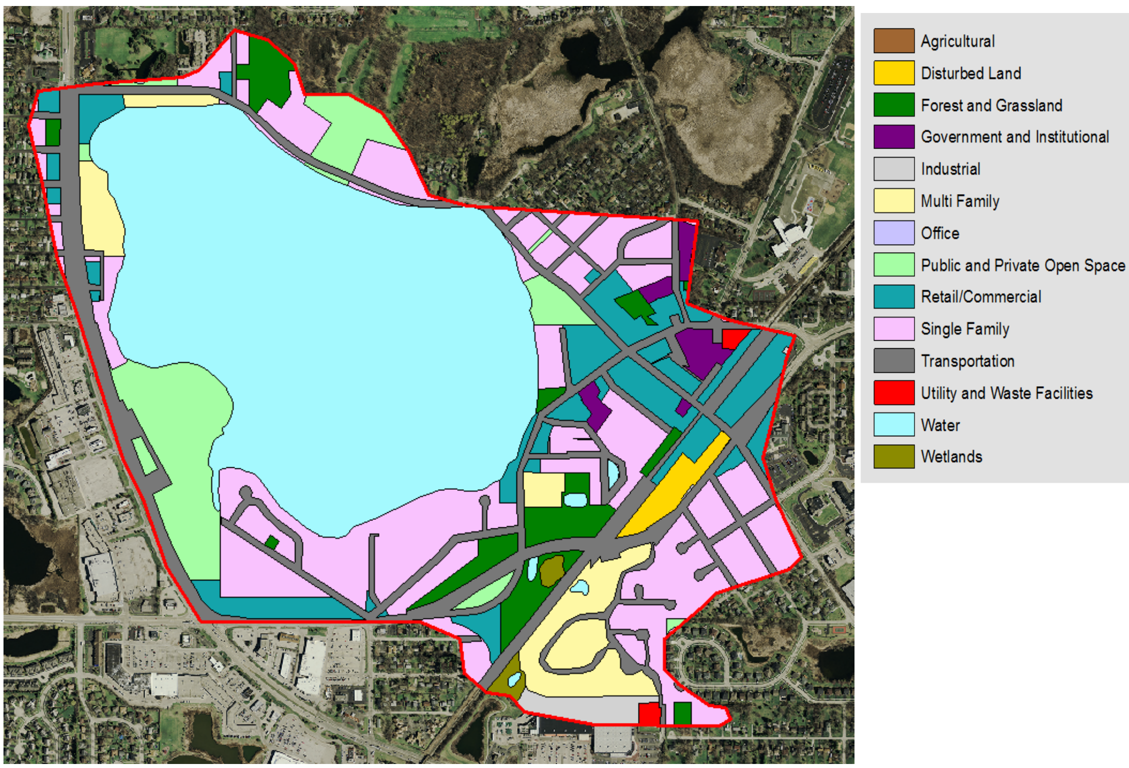


Table 1: Runoff Percentages by Land use in the Lake Zurich Watershed

Land Use	Acreage	% of Total Watershed	% Total of Estimated
Disturbed Land	5.60	0.9%	0.1%
Forest and Grassland	24.29	4.0%	0.6%
Government and Institutional	7.26	1.2%	1.9%
Industrial	5.82	1.0%	1.5%
Multi Family	28.37	4.7%	12.6%
Public and Private Open Space	41.97	6.9%	3.3%
Retail/Commercial	47.10	7.8%	21.0%
Single Family	120.07	19.8%	18.9%
Transportation	89.34	14.8%	39.7%
Utility and Waste Facilities	1.65	0.3%	0.3%
Water	230.86	38.2%	0.0%
Wetlands	2.63	0.4%	0.1%
TOTAL	**604.97**	**100.0%**	100.0%

WATER CLARITY

Water clarity, or water transparency, is an indicator of water quality related to chemical and physical properties. Water clarity is typically measured with a Secchi disk and indicates the amount of light penetration into a body of water. It can also provide an indirect measurement of the amount of suspended material in water. A number of factors can interfere with light penetration and reduce water transparency. This includes: algae, water color, re-suspended bottom sediments, eroded soil and invasive species. Boat propellers can also impact water clarity by redistributing loose bottom sediment and creating more turbid waters.

Secchi disk depth is primarily used as an indicator of algal abundance and general lake productivity. Although it is only an indicator, Secchi disk depth is the simplest and one of the most effective tools for estimating a lake's productivity.

The 2015 average water clarity in Lake Zurich was 7.24 ft., a 30% decrease in water clarity from 2008 sampling; but above the 2002 sampling. Compared to other lakes in Lake County, Lake Zurich is above the median Lake County Secchi depth of 2.96 ft. (Figure 3). A decrease in water clarity in Lake Zurich could be attributed to a decrease in aquatic plant diversity and frequency, which may increase algae and mobilize TSS, decreasing water clarity. Zebra mussels have been observed in Lake Zurich since 2002; which increase water clarity. There has not been an updated study on the population of zebra mussels in the lake, but it is possible it is beginning to decline.

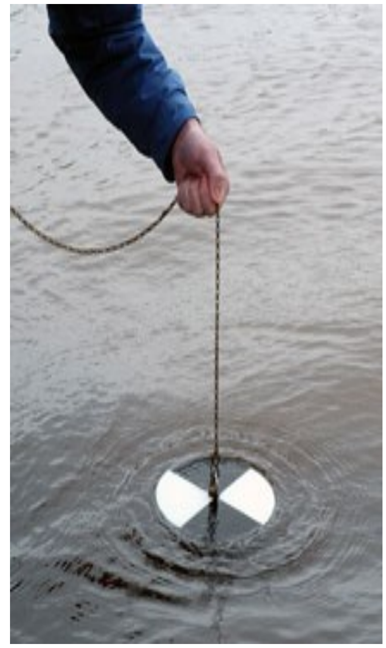
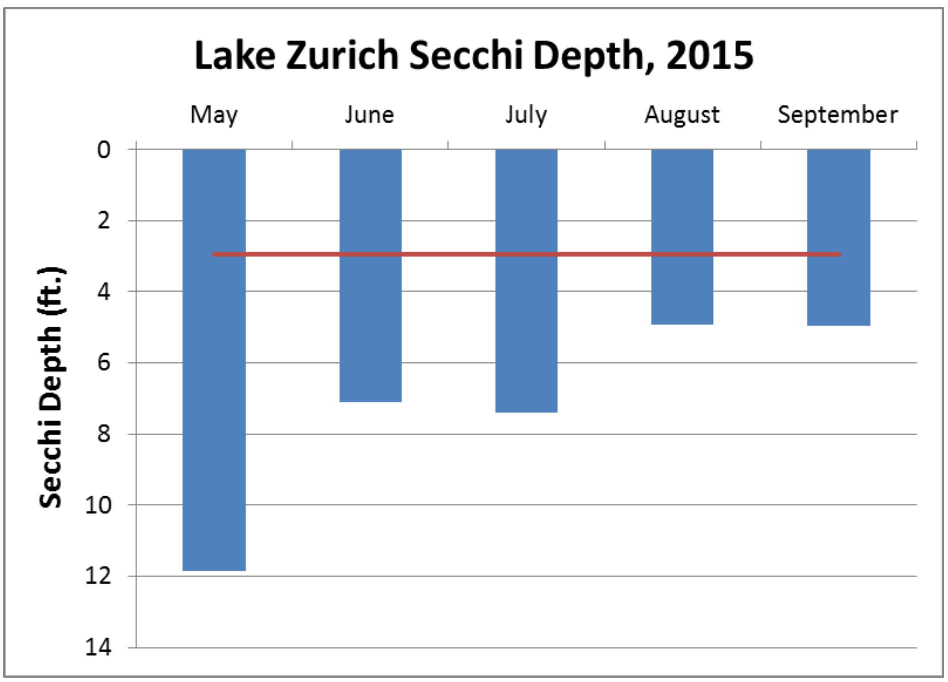


Figure 3: Secchi Depth values measured by LCHD - ES



LAKE ZURICH SECCHI DEPTH WAS 7.24 FT.;
WHICH IS ABOVE THE LAKE COUNTY MEDIAN.

WHAT YOU CAN DO TO IMPROVE WATER QUALITY ON LAKE ZURICH?

- Do not throw leaves, grass clippings, pet waste, and other organic debris into the street or driveway. Runoff carries these through storm sewers, directly into Lake Zurich.
- Build a rain garden to filter run-off from roofs, driveways, and streets. This allows the phosphorus to be bound to the soil so it does not reach surface waters.
- Plant a buffer around your lake shoreline to reduce runoff and filter nutrients from entering your lake.
- Sweep up fertilizer that is spilled or inadvertently applied to hard surface areas, do not hose it away.

VOLUNTEER LAKE MONITORING PROGRAM (VLMP)

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.

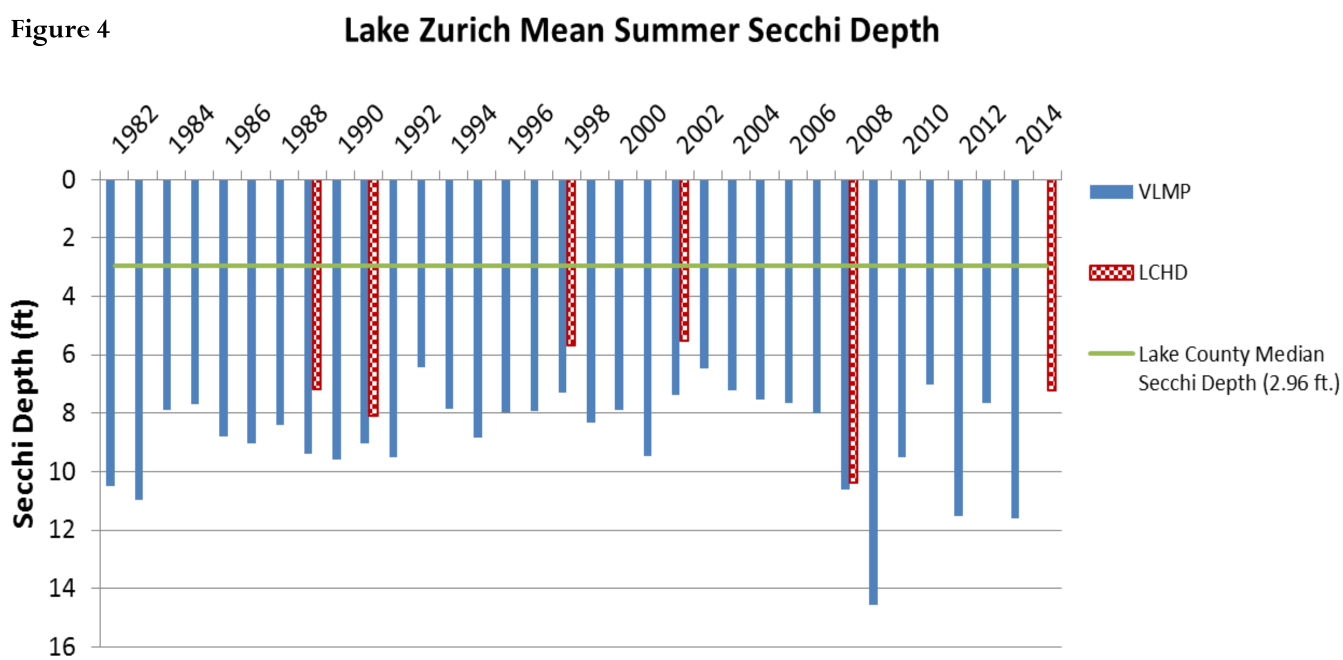
Lake Zurich has participated in the VLMP since 1982. Participating provides annual data that helps document water quality impacts and support lake management decisions. It is recommended that an homeowner association member continue to participate in the VLMP program. Lake Zurich is lucky to have such an extensive VLMP dataset, and it is recommended to continue in the VLMP program.

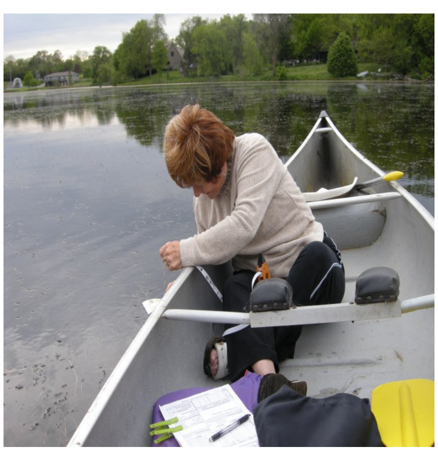
LAKE MONITORING
VOLUNTEER PROGRAM
ILLINOIS

For more information visit:

www.epa.state.il.us/water/vlmp/index.html

Figure 4





For More Information on the VLMP PROGRAM

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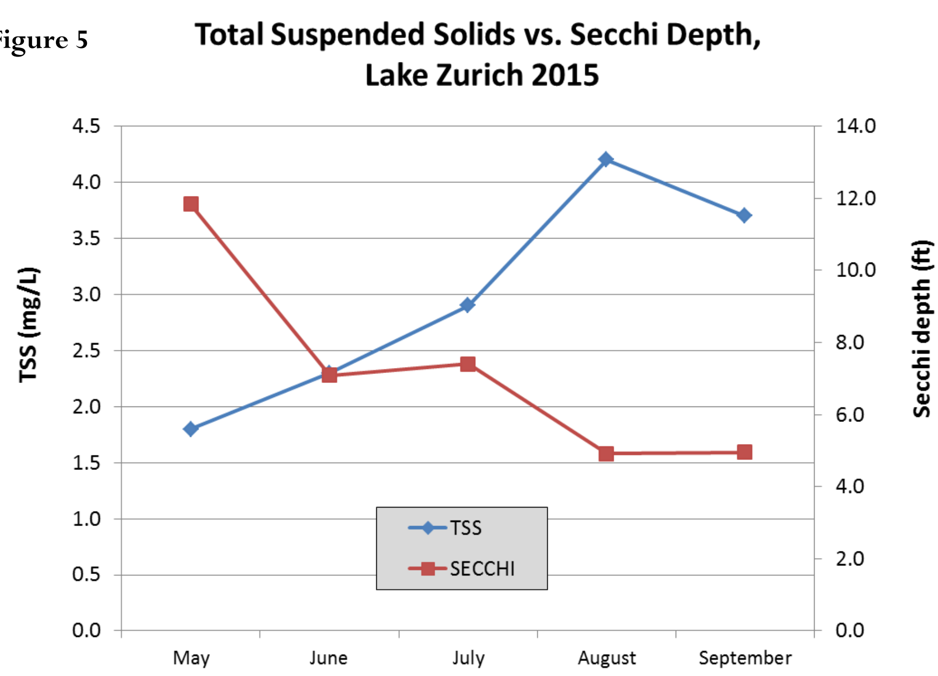
TOTAL SUSPENDED SOLIDS

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

2015 TSS concentrations in the epilimnion of Lake Zurich averaged 3.0 mg/L. The 2015 concentrations were a slight increase since the 2008 sampling, but still remains below the Lake County median of 8.2 mg/L. High TSS values correlated with poor water clarity, measured by Secchi depth, and can be detrimental to many aspects of lake ecosystem including the plant and fish communities. Secchi depth and total suspended solids are inversely related (Figure 5)

A lake can have a TSS impairment which is based on if the median surface NVSS is greater or equal to 12 mg/L for the monitoring season. Based on the 2015 sampling data, median surface NVSS was <1 mg/L, thus there is no TSS impairment.

Figure 5



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.

TOTAL SUSPENDED SOLIDS (CONTINUED)

The percentage of TSS that are non-volatile suspended solids gives insight into the source of the suspended solids. Lakes that have a higher percentage of NVSS to TSS represent more allochthonous (originating outside of the lake) input into the lakes or re-suspended sediment (Jones and Knowlton, 2005). Lakes with a higher ratio of NVSS to TSS indicate that the suspended solids represent more inorganic material whereas lakes with lower % NVSS may represent more algae and organic material. The calculated average nonvolatile suspended solids (NVSS) was 0.97 mg/L. For June, July and August the NVSS to TSS ratio is less than 30%, meaning the total suspended solids concentration in these months can be attributed to algae and organic material. Algae blooms were noted on Lake Zurich in September sampling.

The algae and organic matter in the water column was higher in August. The average TVS for the monitoring season was 136 mg/L which is slightly above the county median of 121.0 mg/L. Algae blooms were noted in August and September. For a complete list of water quality results (including hypoliminion values), refer to the Water Quality Table Summary in Appendix B.

There was a slight increase in TSS in Lake Zurich from 2008 to 2015. This correlated with an decrease in water clarity and an increase in phosphorus concentrations.

Table 2. 2015 Solid concentrations in the Epiliminion of Lake Zurich.

Month	Total Suspended Solids (mg/L)	Total Solids (mg/L)	Total Volatile Solids (mg/L)	Total Dissolved Solids (mg/L)
May	1.8	502	69	458
June	2.3	501	97	474
July	2.9	486	74	466
August	4.2	515	88	500
September	3.7	530	102	488
Average	*3.0*	*507*	*86*	*477*

NUTRIENTS: PHOSPHORUS

Organisms take nutrients in from their environment. In a lake, the primary nutrients needed for aquatic plant and algal growth are phosphorus (P) and nitrogen (N). Phosphorus is a vital nutrient for converting sunlight into usable energy and essential for cellular growth and reproduction. Phosphorus occurs in dissolved organic and inorganic forms or attached to sediment particles. Phosphates, the inorganic form, are preferred for plant growth but other forms can be used. Phosphorus builds up in the sediments of a lake.

The source of phosphorus to a lake can be external, internal, or both. Phosphorus originates from a variety of external sources, many of which are related to human activities including: human and animal waste, soil erosion, detergents, sewage treatment plants, septic systems, and runoff from lawn. Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. When it remains in the sediments it is generally not available for use by algae, however, various chemical and biological processes can allow phosphorus to be released from the sediment and be available in the water column. Carp spawning and feeding activity can release phosphorus by stirring up the bottom sediment and can add phosphorus through their fecal matter. Sediment resuspension and subsequent phosphorus release can occur through wind/wave action or heavy boat traffic. Lakes that experience anoxic conditions also contribute to the release of P from the bottom sediments.

NUTRIENTS: PHOSPHORUS

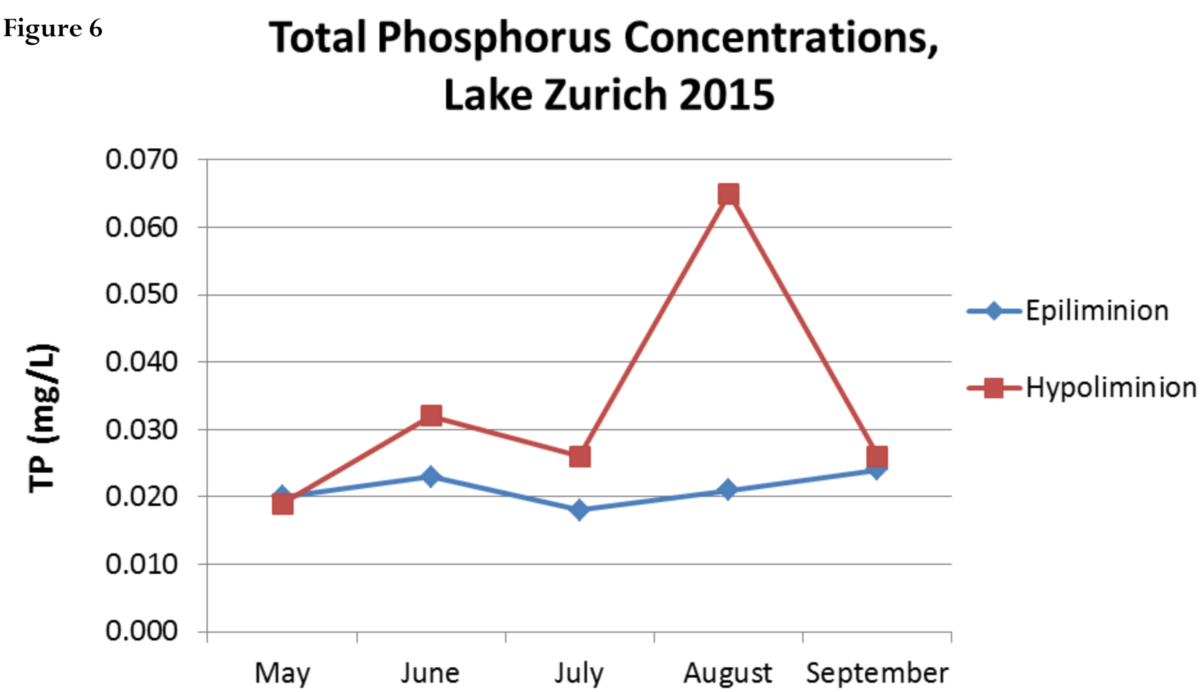
2015 phosphorus concentrations in the epiliminion of Lake Zurich averaged 0.021 mg/L. There was a 31% increase in TP since the 2008 sampling—from 0.016 (2008) to 0.021 mg/L (2015).

Surface total phosphorus did not exceeded 0.05 mg/L on Lake Zurich, which is the IEPA water quality standard. Lake Zurich did reach anoxic conditions in 2015 during May - August. During anaerobic conditions, TP can be released from bottom sediments and become available in the water column. This is seen in increased TP and SRP values in the hypoliminion during these months. During September, Lake Zurich began to turn over, which allowed this excess TP to be available throughout the whole column. The highest TP concentration of 0.024 mg/L is observed in September, most likely a result of this turnover (Figure 6). An algae bloom was also noted during the September sampling month which may be a result of the excess phosphorus concentrations

DATE	TP Epiliminion	SRP Epiliminion	TP Hypolimnion	SRP Hypolimnion
13-May	0.020	<0.005	0.019	<0.005
17-Jul	0.023	<0.005	0.032	0.011
15-Jul	0.018	<0.005	0.026	<0.005
12-Aug	0.021	0.006	0.065	0.011
17-Sep	0.024	<0.005	0.026	<0.005
Average	0.021	<0.005	0.034	.007[k]

K = value is less than described due to concentrations that were below the detection limit.

Figure 6



WHAT HAS BEEN DONE TO REDUCE PHOSPHORUS LEVELS IN ILLINOIS?

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

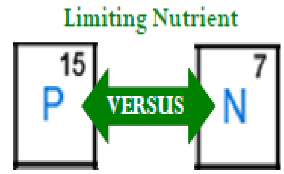
***July 2010:** The state of Illinois passed another law restricting the use of lawn fertilizers containing phosphorus by commercial applicators.*

NUTRIENTS: NITROGEN

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

Nitrogen concentrations (NO3-N and NH3-N) were below detectable concentrations in the eplimінion for the entire sampling period. Overall, there were no nitrogen impairments for Lake Zurich. Total Kjeldahl nitrogen (TKN), an organically (algae) associated form of nitrogen, in Lake Zurich averaged 0.80 mg/L, which is below the Lake County median of 1.200 mg/L. Total Kjeldahl nitrogen is a measure of organic nitrogen, and is typically bound up in algal and plant cells.

The TN:TP ratio looks at TKN + NO3 to total phosphorus. This ratio can indicate whether plant and algae growth in a lake is limited by nitrogen of phosphorus. Typically ratios of less than 10:1 suggest the lake is limited by nitrogen, while ratios greater than 20:1 are limited by phosphorus. Lake Zurich has a TN:TP ratio of 40:1, meaning the lake is phosphorus limited and additions of phosphorus into the lake system can contribute to algae issues.



TN:TP Ratio

<10:1 = nitrogen limited

>20:1= phosphorus limited

TN:TP Ratio on Lake Zurich: 40:1

Lake Zurich is Phosphorus Limited

WAYS TO REDUCE NUTRIENTS IN YOUR LAKE

Phosphorus and nitrogen originate from a variety of sources, many of which are related to human activities. Some sources include: human and animal waste, soil erosion, detergents, septic systems, common carp, and runoff from lawns and fields, fertilizers, manure and atmospheric deposition. Installing best management practices, such as buffer strips, planting more native plants, rain gardens, and using minimal amount of fertilizer are ways to help reduce nutrient runoff from your own property. Below are some suggestions to reduce nutrients to your lake:

Waterfowl management (ducks and geese)

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

Fertilizer use:

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

Pet Waste Disposal

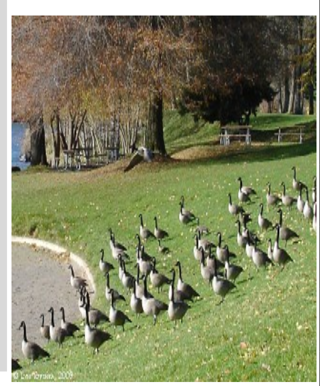
- Regularly scoop up and dispose of pest waste.

Landscaping Practices

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

Keep fall leaves out of the storm drains

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



TROPHIC STATE INDEX

Trophic state describes the overall productivity of a lake, which has implications for the biological, chemical and physical conditions of the lake. The Trophic State Index (TSI) value is based on phosphorus (TSIp) and Secchi (TSIsd) and are calculated from the monitoring data. Lakes are classified into four main categories of trophic states that reflect nutrient levels and productivity. The four categories are: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. These range from nutrient poor and least productive (oligotrophic) to most nutrient rich and most productive (eutrophic).

A lake's response to additional phosphorus is an accelerated rate of eutrophication. Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation until the lake becomes a wetland. This process takes thousands of years. However, human activities that supply lakes with additional phosphorus and nitrogen (such as fertilizer, household products, waste by-products, etc.) are accelerating the eutrophication process.

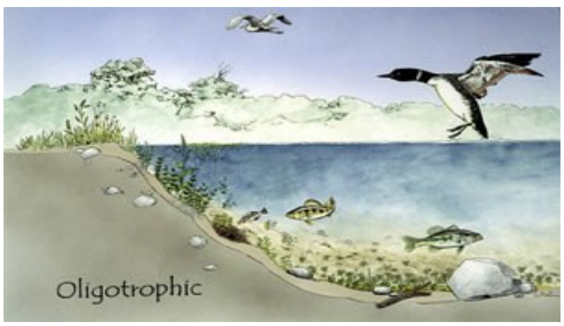
In 2015, Lake Zurich was considered mesotrophic with a TSIp value of 48.2 Based on the TSIp, Lake Zurich ranked 18 out of 173 lakes studied by the LCHD-ES from 2000 –2015 (Appendix B). This a decrease in ranking from 2008, when it ranked 4th out of 173 lakes in Lake County.

LAKE COUNTY AVERAGE
TSIP = 66.1

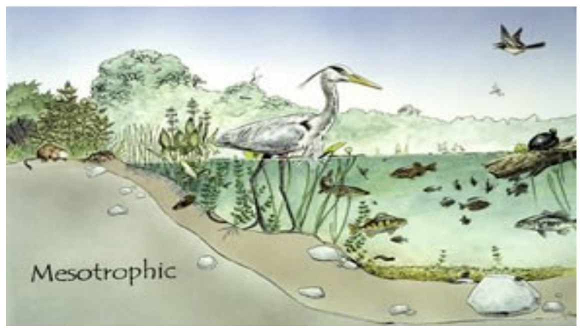
LAKE ZURICH
TSIP = 48.2

TROPHIC STATE:
MESOTROPHIC

RANK = 18/173

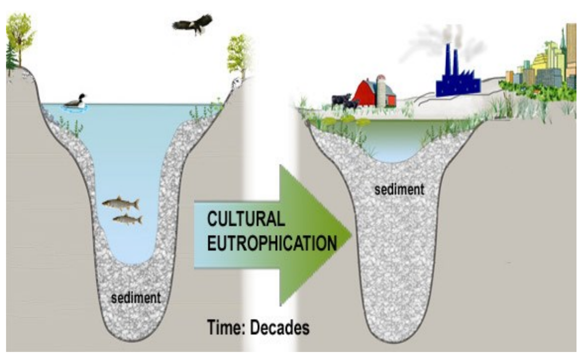


OLIGOTROPHIC
Lakes have low nutrients and are generally deep and free of weeds or large algae blooms. They do not support large fish populations.



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

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

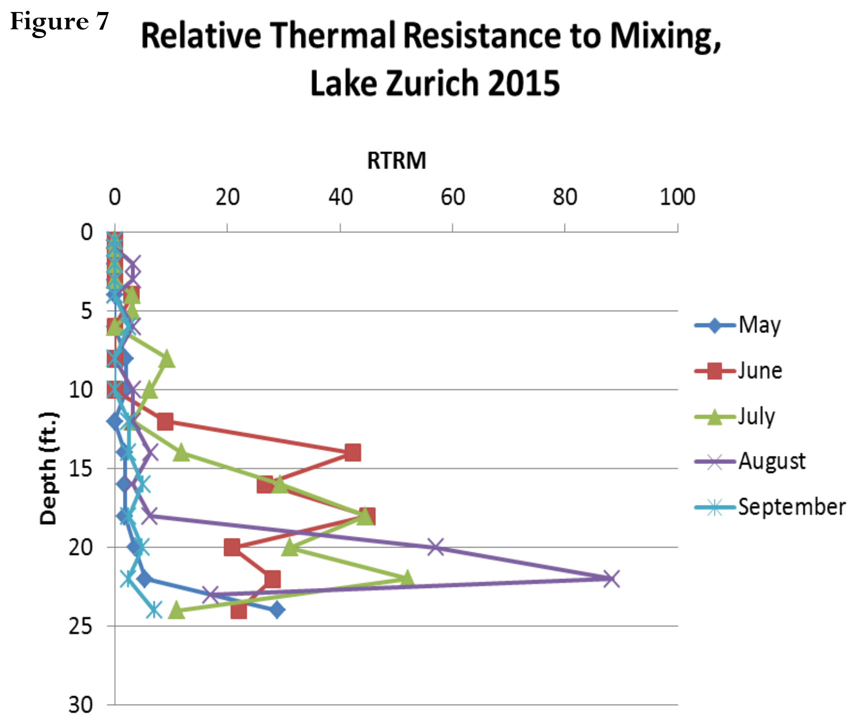


CULTURAL EUTROPHICATION
An enrichment and accumulation of a lake with nutrients, sediments, and organic matter from the surrounding watershed. It can be a natural process in lakes, occurring as they age through geologic time. Human activity that occurs in the watershed can accelerate eutrophication, known as cultural eutrophication and can lead to increased algal growth, increased rooted plant growth, and lower dissolved oxygen concentrations.

STRATIFICATION

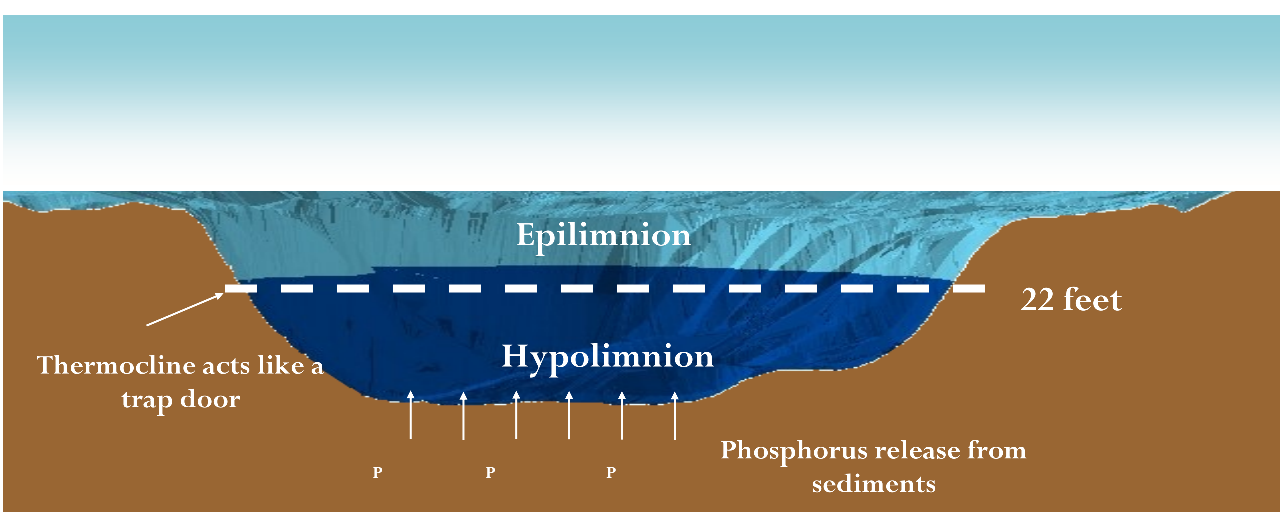
A lake's water quality and ability to support fish are affected by the extent to which the water mixes. Lake Zurich was thermally stratified throughout the monitoring season. Thermal stratification is when a lake divides into an upper, warm water layer (epiliminion) and a lower, cold water layer (hypoliminion).

Figure 7



Monthly depth profiles were measured on Lake Zurich by measuring water temperature, dissolved oxygen, conductivity, and pH every foot from the lake surface to 4 feet, and then every 2 feet thereafter to the lake bottom. Temperature is used to determine the relative thermal resistance to mixing (RTRM), an index for quantifying thermal stratification in lakes. Calculating the RTRM for each month's depth profiles can identify the thermocline and stability of stratification. The peak RTRM identifies the location and intensity of the thermocline (steepest density gradient). When an RTRM value is greater than 20, it is identified as strong enough to stratify. The maximum RTRM indicates the thermocline. Figure 8 shows the RTRM values by month for Lake Zurich, showing that RTRM values reached >20 for all months except September; with the greatest density gradient occurring in August (Figure 7). The peak thermocline occurred at a depth of 24 ft. (May), 18 ft. (June), 22 ft. (July), and 22 ft. (August).

During anoxic conditions lake sediments release phosphorus (internal phosphorus) into the water column. While the lake is stratified the phosphorus remains in the hypolimnion but once turn over occurs the internal phosphorus is released into the entire water column. The water quality data shows higher levels of both TP and SRP in the hypoliminon while the lake is stratified. Deeper, more stratified lakes, lakes have stronger thermoclines making it more difficult for the phosphorus to mix and re-enter the eplimínion. Lake Zurich did turnover during the month of September, and there is an increase in TP concentrations during this month.

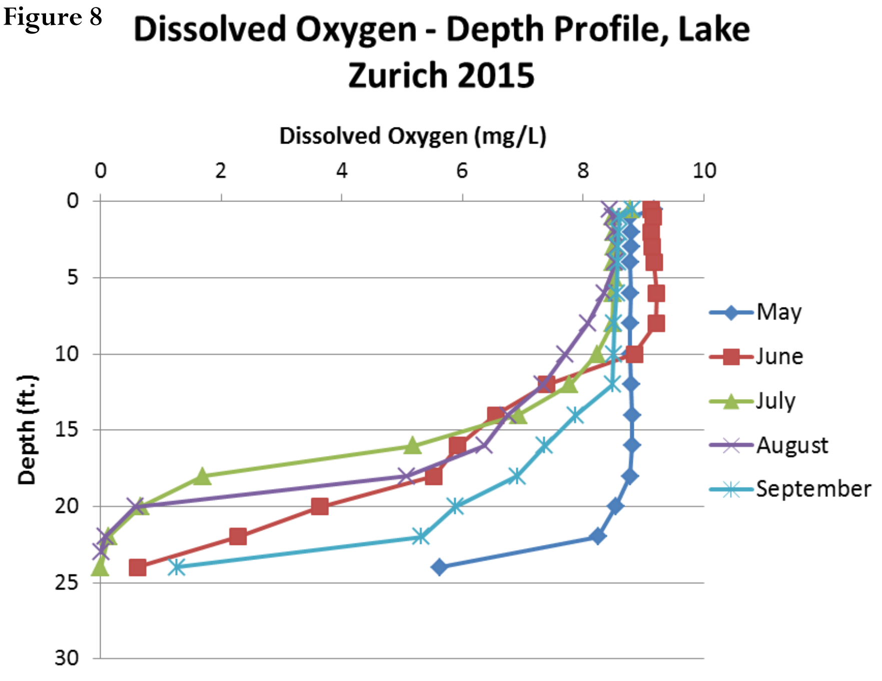


Schematic of stratification in Lake Zurich, 2015

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentrations on Lake Zurich dropped below 5.0 mg/L June - September at depths greater than 18 ft. (June), 16 ft. (July), 18 ft. (August), and 22 ft. (September) (Figure 8). When oxygen drops below 5 mg/L it can stress aquatic life, meaning the fisheries may be restricted to the epiliminion. Lake Zurich did reach anoxic conditions, where dissolved oxygen drops below 1 mg/L, from June - August. Anoxic conditions occurred at depths greater than 14 ft. (May) , 9 ft. (June), 8 ft. (July) and 8 ft. (August) and 12 ft. (September). Under anaerobic conditions, phosphorus releases from bottom sediments into the water column becoming a source of phosphorus entering the lake. Stratification and low dissolved oxygen concentrations that occur in the hypoliminion of the lake are normal conditions for deep glacial lakes.

Figure 8



The dissolved oxygen depth profile on Lake Zurich shows that anoxic conditions (<1 mg/L) are reached June - August. Additionally, DO dropped below 5 mg/L at depths greater than 16 ft.

LAKE LEVELS

Lakes with stable water levels potentially have less shoreline erosion problems. Water levels on Lake Zurich are primarily impacted by precipitation and runoff.

During the monitoring season (May - September), lake levels only fluctuated at most 2.5 inches. The lowest lake level occurred in September the highest was in August. The high lake levels in June corresponds with the significant rainfalls experienced during the month.

http://www.mymlsa.org/

Month	Lake Level (in)	Seasonal Change (in)	Monthly Change (in)
May	26.16		
June	NA	NA	NA
July	26.4	0.24	0.24
August	24	-2.16	-2.4
September	26.52	0.36	2.52

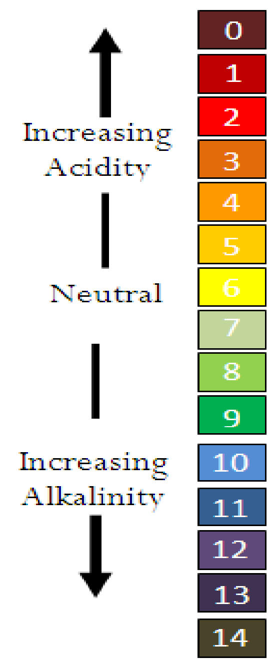
ALKALINITY AND PH

Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases to maintain a stable pH. In a lake, alkalinity acts to buffer lakes from the effects of acid rain. Alkalinity comes from rocks, soils, salts, and certain plant activities. If a lakes watershed contains large quantities of calcium carbonate (CaCO3, limestone), the surface waters tend to be more alkaline.; while granite bedrock does not have high amounts of CaCO3 and therefore lacks alkaline materials to buffer acidic inputs.

pH is a measure of the hydrogen ion concentration of water. As the hydrogen ions are removed, pH goes up or halts its decline. A well buffered lake also means that daily fluctuations of CO2 concentrations result in only minor changes in pH throughout the day. Aquatic organisms benefit from stable pH. Each organism has an ideal pH threshold, but most aquatic organisms prefer pH of 6.5—8.0. pH values <6.5 or >9.0 cause a water quality impairment.

In 2015, the average alkalinity (CaCO3) concentration in the epiliminion of Lake Zurich was 118 mg/L, which is below the Lake County median of 163 mg/L. The USEPA considers lakes with CaCO3 concentrations greater than 20 mg/L to not be sensitive to acidification.

Lake Zurich's average pH in 2015 was 8.72, which is slightly below the Lake County median of 8.33 but remains within an adequate pH value for most aquatic organisms.

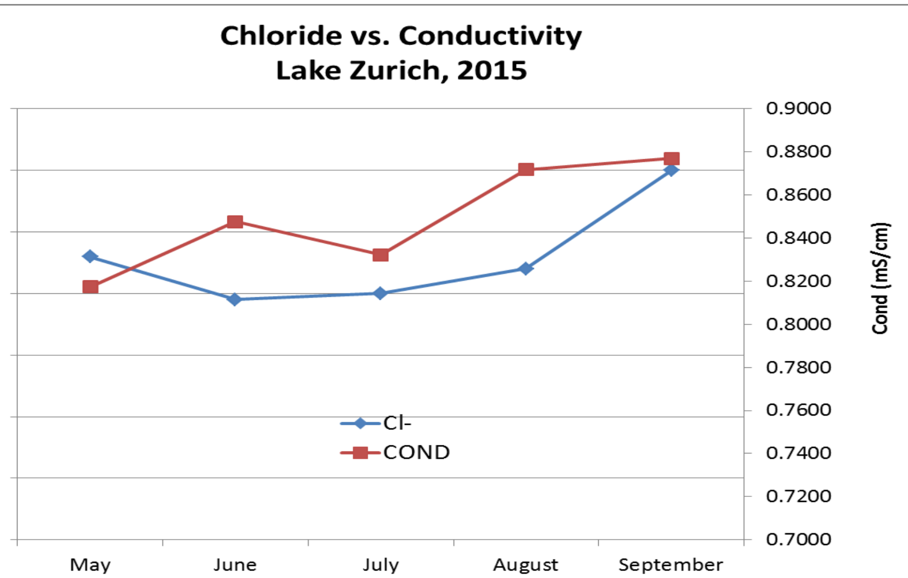


The pH scale ranges from 0 to 14. A pH of 7 is considered neutral. Substances with a pH of less than 7 are acidic, and greater than 7 are basic.

CONDUCTIVITY

Another parameter measured during the 2015 monitoring season that is important in comparing data from year to year is conductivity. Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, size of the watershed flowing into the lake, the land use, evaporation, and bacterial activity. Conductivity in urban areas has been shown to be highly correlated with chloride ions found in road salt mixes (Figure 9). In 2015, Lake Zurich's average conductivity reading was 1.074 mS/cm which is above the lake county median of 0.8492 mS/cm. Conductivity has decreased since the 2008 monitoring by LCHD-ES by 8%.

Figure 9



CHLORIDES

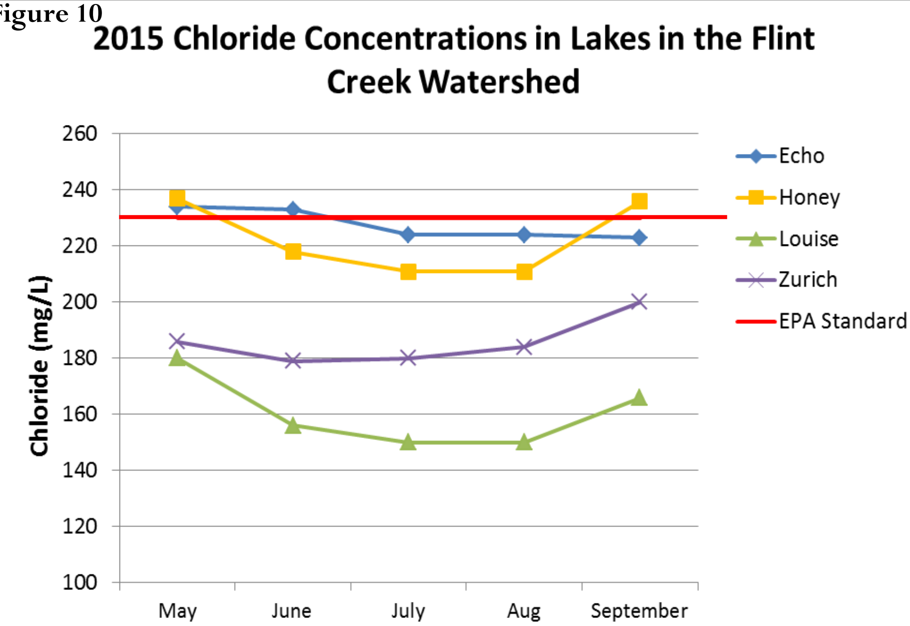
One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocynaide salts. Lake Zurich's average chloride concentration was 186 mg/L which is well above the Lake County median of 139 mg/L. The U.S. EPA has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems. Chloride ions do not break down and accumulate within a watershed. High chloride concentrations may make it difficult for many of our native plant species to survive while many of our invasive species such as Eurasian Watermilfoil, Cattail, and Common Reed are tolerant to high chloride levels. Lake Zurich is the upper portion of the Flint Creek Watershed and has a small watershed relative to its size, but approximately 39.7% of runoff is attributed to the transportation land use; followed by Retail/Commercial land use (21%), and Single Family Residential land use (18.9%). This means that runoff plays a major role in nutrient loading into Lake Zurich; and runoff from road salt contributes to high chloride concentrations in the lake.

The LCHD-ES and Lake County Stormwater Management Commission (LCSMC) have been holding annual training sessions targeting deicing maintenance personnel for both public and private entities to hopefully reduce the amount of chloride being introduced into our environment while maintaining safe passageways. Almost all deicing products contain chloride so it is important to read an follow product labels for proper application. For instance, at 10°F Fahrenheit, rock salt is not at all effective in melting ice and will blow away before it melts anything. The Flint Creek Watershed had a range of chloride values in the 2015 sampling season from the lowest concentration in Lake Louise (160 mg/L) and the highest at Echo Lake (228 mg/L) (Figure 9). It appears that road salt is compounding in many lakes in the county with conductivity and chloride readings increasing.

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

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

Figure 10



ICE FACTS

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

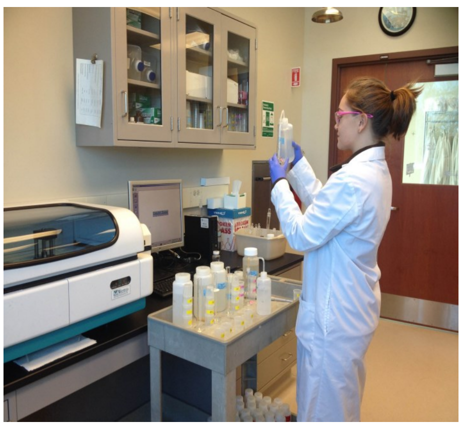
Pavement Temp (F)	One Pound of Salt (NaCl) melts	Melt times
30	46.3 lbs. of ice	5 min.
25	14.4 lbs. of ice	10 min.
20	8.6 lbs. of ice	20 min.
15	6.3 lbs. of ice	1 hour
10	4.9 lbs. of ice	Dry salt is ineffective and will blow away before it melts anything

BEACHES

There are three licensed swimming beaches on Lake Zurich including: Oakwood Beach Club, Breezewald Park, and Henry J Paulus Park Beach. These three beaches were monitored every two weeks from mid May to the end of August by LCHD-ES . The water samples are tested for E. coli bacteria, which are found in the intestines of warm-blooded animals. While not all strains of E. coli are the same, certain strains can make humans sick if ingested in high enough concentrations. If water samples come back high for E. coli (>235 E. coli/100 ml), the management body for the bathing beach is notified and a sign is posted indicating the swim ban. E. coli is used as an indicator organism, meaning that high concentrations of E. coli might suggest the presence of harmful pathogens such as, Salmonella, Giardia, etc.

In 2015, Lake Zurich only had one beach closure at Henry J Paulus Park Beach related to bacteria that occurred on June 8th, 2015.

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



Lake Zurich Beaches	2015 Beach ClosureS	E. Coli/100 mL
Oakwood	0	—
Breezewald	0	—
Henry J Paulus Park Beach	1	307.6 (June 8th)

HOW TO PREVENT ILLNESS AND BEACH CLOSURE

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

- If you are sick or have diarrhea, do NOT swim.
- Do NOT drink the water while swimming.
- Avoid swimming during heavy algae blooms.
- Keep pets, ducks, and geese out of the beach area
- Children who are not toilet trained should wear tight-fitting rubber or plastic pants.
- Take a shower before entering the water, and have kids take frequent bathroom breaks.
- Wash your hands after exiting the lake.

HARMFUL ALGAL BLOOMS

Algae are important to freshwater ecosystems and most species of algae are not harmful. Algae can grow quickly in water and is often associated with increased concentrations of nutrients such as nitrogen and phosphorus. Blue-green algae, or "cyanobacteria" are a type of algae that can bloom and produce toxins, hence termed HAB's (harmful algal blooms). HABs are similar to bacteria in structure but utilize photosynthesis to grow. However, their presence does not mean that toxins are present. It is still unclear what triggers HABs to produce the toxins. Due to the potential presence of toxins, the IEPA and the LCHD have initiated a program to collect HABs from beaches and test for presence of microcystin, a common toxin produced by this algae.

In 2015, there were no significant blue-green algae blooms were noticed during sampling or reported by homeowner associations on Lake Zurich. Henry J Paulus Beach at Lake Zurich was monitored throughout the beach season for routine samples for microcystin toxin. All results were below <1 ug/L; which is below any levels of concern for recreational uses.

Phosphorus and nitrogen fuel algal growth. HAB's additionally can fix atmospheric nitrogen as well as utilize other forms. It becomes important to maintain or control nutrients inputs for this reason. Lake Zurich has low nutrient levels and a healthy plant community. Maintaining the healthy plant community and reducing nutrient input will help keep blue-green algae away in Lake Zurich. Blooms should always be reported to LCHD-ES to be tested for toxins.

2015 Harmful Algal Bloom Sampling Results

Collection Date	Microcystin (ug/L)
6/8/2015	ND
6/22/2015	0.75
7/6/2015	0.81
7/20/2015	0.33
8/3/2015	0.26
8/17/2015	0.19

The World Health Organization (WHO) guidance values for the relative probability of acute health effects during recreational exposure to cyanobacteria and microcystins are:

Relative Probability of Acute Health Effects	Microcystin-LR (µg/L)
Low	<10
Moderate	10 - 20
High	20-2,000
Very High	>2,000

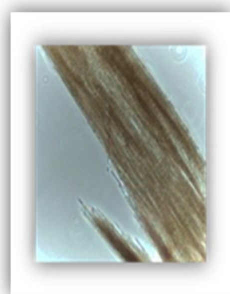
For more information or to report a blue-green algae bloom, contact the Lake County Health Department Environmental Services (847) 377-8030.

FOR MORE INFORMATION ON BLUE-GREEN ALGAE:
www.epa.state.il.us/water/surface-water/blue-green-algae.html

TO REPORT BLUE-GREEN ALGAE BLOOM:
Lake County Health Department 847-377-8030

Anabaena Sp.

Microcystis Sp.



Aphanizomenon Sp.

BATHYMETRIC MAPS

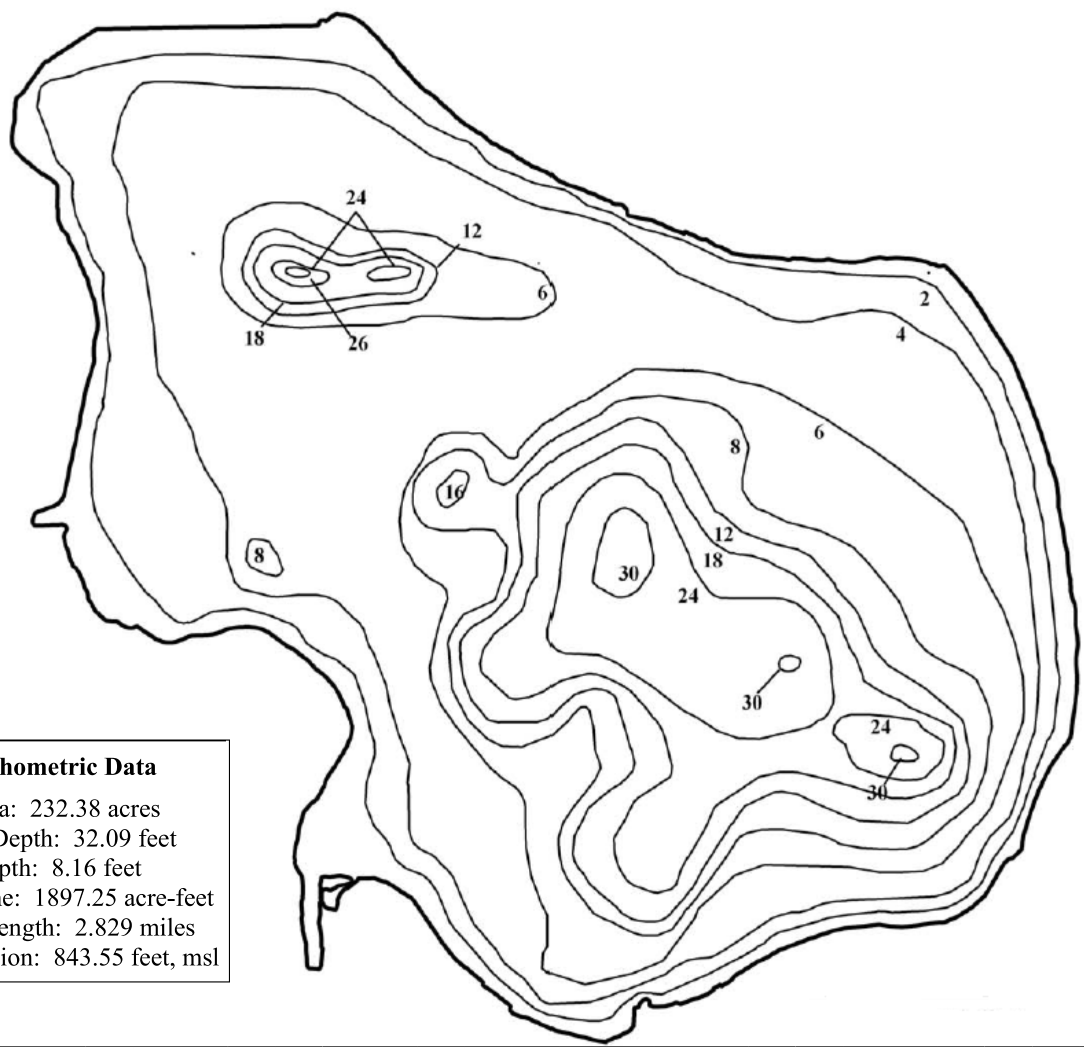
Bathymetric maps provide lake managers with an accurate lake volume that can be used for herbicide application and help anglers find potential fishing spots.

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 for bathymetrics using a Lowrance HDS-5 Gen2; Lowrance cites accuracy measures of approximately 5m however actual accuracy is typically better than this conservative estimate and has been discovered to be sub-meter (CIBiobase,2013). Once collected, the data was analyzed and imported into ArcGiS 10.2 for further analysis. In ArcGIS 10.2, the contours and volumes were generated from the triangular irregular network (TIN).

Lake Zurich had a bathymetric map conducted by LCHD-ES in 2010. LCHD-ES recommends bathymetric maps be updated every 10 years as the maps and their corresponding morphometric data are useful tools for assisting lake managers to make decisions about their lake such as fish habitat, plant management, etc. For a complete morphometric table based on the 2010 survey data for Lake Zurich, refer to Appendix B.

Figure 11: Lake Zurich Bathymetric Map; survey data collected October 19, 2010.



Morphometric Data

Surface Area: 232.38 acres
Maximum Depth: 32.09 feet
Average Depth: 8.16 feet
Lake Volume: 1897.25 acre-feet
Shoreline Length: 2.829 miles
Lake Elevation: 843.55 feet, msl

SHORELINE EROSION

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

A shoreline erosion study was assessed for Lake Zurich in 2015. Lake Zurich was divided into reaches, and the shoreline evaluated for none, slight, moderate and severe erosion based on exposed soil and tree/plant roots, failing infrastructure, undercut banks, and other signs of erosion. Based on the 2015 data, 35% of Lake Zurich's shoreline has some degree of erosion; with 22% being slight erosion , 7 % being moderate erosion, and 6 % being severe (Table 4). Severe erosion has increased from 1% in 2008 to 6% in 2015. When possible, areas with slight erosion should be addressed as soon as possible, as it is more cost efficient to do so. For a complete look at erosion conditions by lake reach, refer to the Shoreline Condition in Appendix B.

Figure 12: Shoreline Erosion Condition in Lake Zurich, 2015

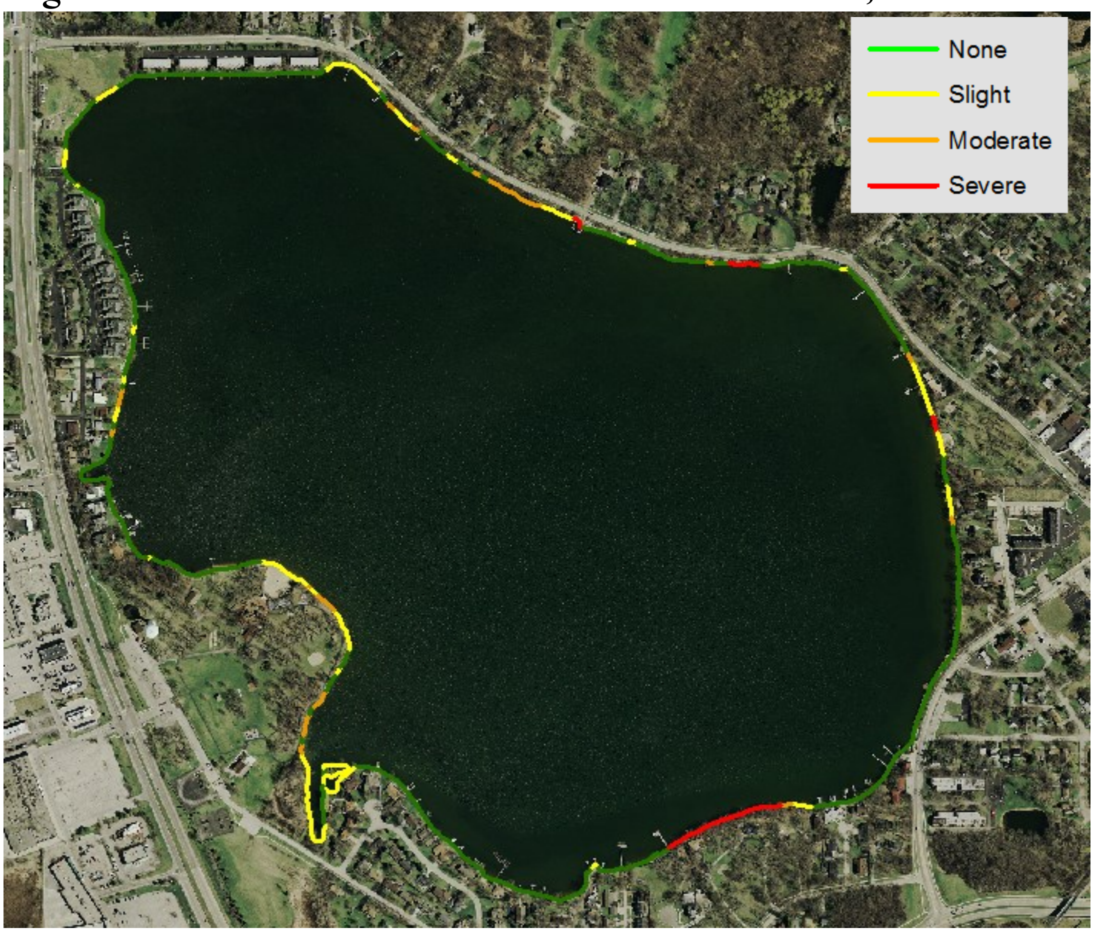


Table 5: Shoreline Erosion Condition in Lake Zurich, 2015

Erosion Condition	Linear ft.	% of Total Shoreline
None	9665.4	65.0%
Slight	3255.1	21.9%
Moderate	1106.6	7.4%
Severe	850.6	5.7%
Total	14877.7	100%

SHORELAND BUFFERS

Many properties along the lake have manicured lawn and turf up to the lakes edge. Replacing lawn and turf grass at the shoreline with a buffer strip containing native deep-rooted plants will help with erosion and add wildlife habitat. A shoreland buffer helps stabilize the sediment near the lakes edge which prevents soil erosion. The buffer will also filter out pollutants and unwanted nutrients from entering the lake.

Buffer strips should be at least 25 feet wide and can include native wildflowers, native grasses, and native wetland plants. Wider buffers may be needed for areas with a greater slope or additional runoff issues. Areas that are already severely or moderately eroding, a buffer strip of native plants may need to be bolstered for additional stability. A concern with shoreland buffers is often that it may limit access to the lakefront. A smaller mowed path to the shoreline can still allow access to the lake while not interrupting the integrity of the buffer strip. The mowed path for lake access should be kept at least 6 inches tall and not more than 6 feet wide. Buffers do not have to block the view of the lake as there are many colorful, low-growing plants that can be incorporated in the buffer strip and will provide all the benefits of improved water quality.

A shoreland buffer condition of Lake Zurich was assessed by looking at the land within 25 feet of the lake's edge on aerial images in ArcGIS. Shoreland buffer's were classified into three categories; poor, fair or good based on the amount of unmowed grasses, forbs, tree trunks and shrubs, and impervious surfaces within that 25 foot range. In 2015, Lake Zurich had 66% of the shoreline with poor buffer, 8% with fair, and 27% with good (Table 7). It is recommended that Lake Zurich encourage homeowners to plant shoreland buffers along their lakeshore property as this practice improves water quality by trapping nutrients and sediments and also provides some wildlife habitat. For a complete look at shoreland buffer data collected, refer to the shoreline condition table in Appendix B.

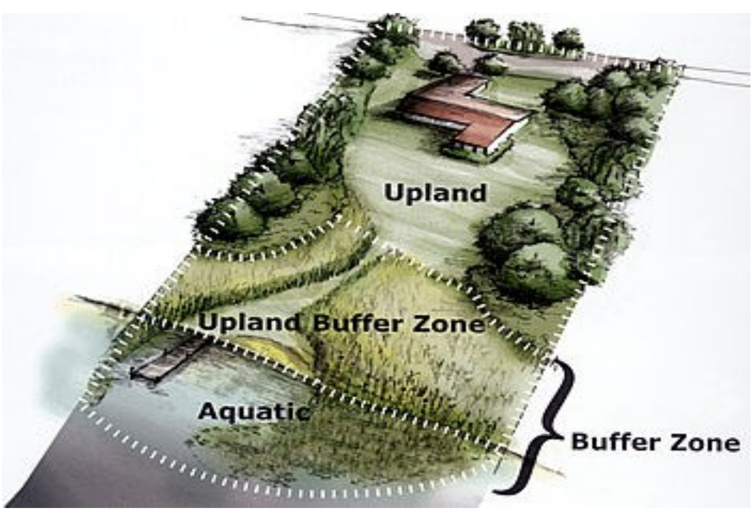
Table 7. Shoreland Buffer Condition on Lake Zurich, 2015

Poor		Fair		Good		Total
Linear ft.	% Reach	Linear ft.	% Reach	Linear ft.	% Reach	ft.
9791	66%	1139	8%	3947	27%	14878

Vertical seawalls can reflect wave energy

Rip rap with a native plant buffer

Buffer strip between upland area and lake edge



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

AQUATIC PLANTS

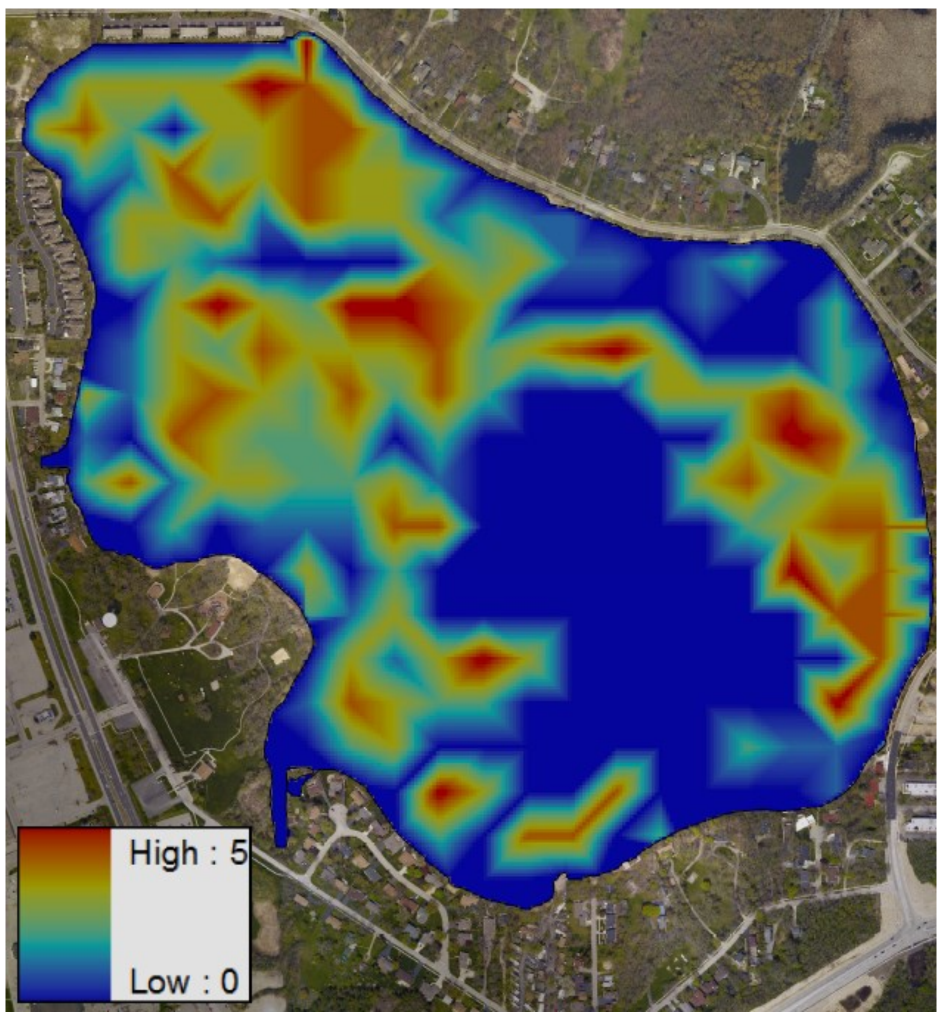
Aquatic plants are a critical feature in lakes as they compete against algae for nutrients, improve water quality and provide fish habitat for nesting and nursery. **Their presence is natural and normal in lakes.** An aquatic vegetation survey was conducted on Lake Zurich in July 2015. There were 257 points generated based on a 60-meter computer grid system that were assessed. During the July survey when most aquatic plants are growing, plants occurred at 161 of the 257 sites (62.6% total lake coverage) with plants found at depths up to 11.0 feet. There were a total of 8 aquatic plant species and Chara, a macro-algae, found in the lake. The most dominant species found in Lake Zurich were Chara and Large-leaf Pondweed. There was a significant decline in aquatic plant species from 2008 to 2015. In 2008, 15 aquatic plant species were present and Chara (macro-algae). The most dominant species in 2008 were Chara and Water Stargrass. Average water clarity did decrease from 2008 to 2015 most likely attributing to the change in plant communities. Plants that were observed in 2008 that were not observed in 2015 include: Common Bladderwort, Curlyleaf Pondweed, Northern Watermilfoil, Spiny Naiad and Whitewater Crowfoot. Many of these plants, excluding Curlyleaf Pondweed, are native plants.

The diversity and extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of surface light level, plants can no longer grow. 1% surface light level is roughly at 2 times the average Secchi depth or can be measured with a photosynthetically active radiation (PAR) sensor. For Lake Zurich the 1% light level based on PAR sensor averages approximately 22 ft.

Aquatic plants provide many water quality benefits and play an important role in the lakes ecosystem by providing habitat

Figure 13: Overall plant rank density for all species on Lake Zurich, July 2015

Rake Density (coverage)	# of Points	% of Sites
No Plants	96	37.4%
>0-10%	27	10.5%
10-40%	38	14.8%
40-60%	52	20.2%
60-90%	33	12.8%
>90%	11	4.3%
Total Sites	161	62.6%
Total # of	257	100%



AQUATIC PLANTS (CONTINUED)

for fish and shelter for aquatic organism. Plants provide oxygen, reduce nutrients such as phosphorus to prevent algae blooms, and help stabilize sediment. A native plant community tends to be diverse and usually does not impede lake activities such as boating, swimming and fishing. The large reduction in aquatic plants in 2015 are of concern, as changes in the plant community can drastically alter water quality of the lake.

While Eurasian Watermilfoil (aquatic invasive plant) was observed in the 2015 sampling it was observed at less than 1% of the sampling sites. While Curlyleaf Pondweed was not noted in the 2015 survey, Curlyleaf Pondweed has an earlier life cycle than most plant species so may be underrepresented in the survey. For a complete list of plant species by frequency and a historical reference to aquatic plants throughout the year, refer to the Plant Summary Table and Historical Aquatic Plant Table in Appendix B.

Common Plants found in Lake Zurich, 2015

LARGE LEAF PONDWEED

Potamogeton amplifolius

This native plant shows rapid early season growth with plants over 3 meters tall observed in early May. Seeds and entire plant are good wildlife food and habitat. Largleaf Pondweed was observed at 31.5% of the sampling sites on Lake Zurich.

CHARA (Macro-Algae)

Chara

Chara is a considered a macro algae and often called skunkweed or muskgrass because of its foul, musty almost garlic odor. It is a food source for waterfowl and also provides protection for invertebrates and young fish.

Table 3. Plant species found in Lake Zurich

Plants 2015	Plants 2008	
Chara	American Pondweed	Small Pondweed
Coontail	Bladderwort	Spatterdock
Eurasian Watermilfoil	Chara	Spiny Naiad
Largeleaf Pondweed	Curlyleaf Pondweed	Vallisneria
Sago Pondweed	Eurasian Watermilfoil	Widgeon Grass
Spatterdock	Horned Pondweed	Water Stargrass
Water Stargrass	Largeleaf Pondweed	White Water Lily
Vallisneria	Sago Pondweed	
White Water Lily	Slender Naiad	

AQUATIC PLANTS: WHERE DO THEY GROW?

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

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

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

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

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

Aquatic invasive plant species

Aquatic invasive species (AIS) are species that are typically not native to Illinois and cause economic or environmental harm, or harm to human health.

Curlyleaf pondweed

Curlyleaf Pondweed was not detected in the 2015 aquatic plant survey, but this aquatic invasive plant has been a concern in Lake Zurich in the past. Past plant management records show the treatment of Curlyleaf Pondweed in Lake Zurich with success. Curlyleaf Pondweed was treated for in 2015 and 2014, indicating that there may be some small communities of this invasive species that are not showing up in our latest aquatic plant survey. It is recommended to do an aquatic plant survey before treatments to identify which plants are actively growing in the lake.

Curlyleaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidently introduced to the United States water in the mid-1880's by hobbyists who use it as an aquarium plant. Unlike our native pondweeds, Curlyleaf Pondweed begins growing in the early spring. The vegetative part of the plant dies back completely in early summer and only seeds and turions remain over summer. The turions (which are the main source of reproduction in CLP) sprout in fall, and are rapidly able to elongate in spring after ice melts as temperatures reach 5°C. CLP becomes invasive in some areas because of its adaptations for low light tolerance and low water temperatures which allow the plant to get a head start and outcompete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Large populations of CLP also can cause changes in nutrient availability. In midsummer, CLP plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms.

Curlyleaf Pondweed, an invasive plant that has a tolerance for low light and water temperatures that allow the plant to get a head start on native plants.

Eurasian Watermilfoil, an invasive plant that spreads rapidly, crowing out native species, clogging waterways, and blocking sunlight and oxygen from underlying waters.

Eurasian watermilfoil

Eurasian Watermilfoil was found at less than 1% of the sampling sites during the aquatic plant survey conducted in July 2015. The early fluridone treatment on Lake Zurich was targeting this invasive species.

Eurasian Watermilfoil (EWM) is an invasive, submersed aquatic plant accidently introduced in the 1940s to North America from Europe from the aquarium trade. Eurasian watermilfoil can reproduce through stem fragmentation and runners meaning a single segment of stem and leaves can take root and form an entire new colony. Removing native vegetation allows for EWM to overtake a lake. EWM can have a difficult time becoming established in lakes with well established populations of native plants. EWM can be controlled using aquatically approved herbicides, mechanical (i.e. harvester or cutter) methods, or biological controls (i.e. weevil). Aquatic management methods for EWM that cause as little damage to native aquatic plants as possible are encouraged and early season treatments will have the least impact on native populations.

FLORISTIC QUALITY INDEX

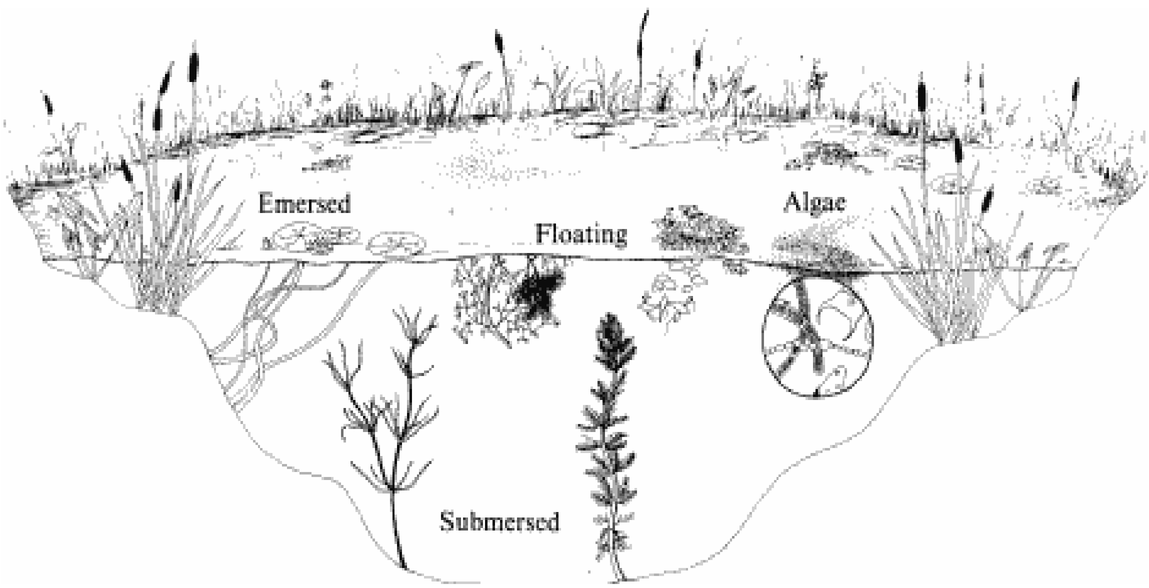
Floristic quality index (FQI) is an assessment tool designed to evaluate how close the flora of an area is compared to one of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site 3) monitor long-term floristic trends and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submerged plant species found in the lake. The FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species are present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The median FQI for Lake County lakes from 2000-2015 was 13.4. Lake Zurich had an FQI value of 18.9 ranking 47 out of 170 lakes in Lake County (Appendix A) which shows high plant diversity for the county. 9 aquatic plant species were observed including Chara (a macro-algae). Development of an Aquatic Plant Management Plan (APMP) should take into consideration maintaining high level of aquatic biodiversity and controlling invasive species.

LAKE COUNTY AVERAGE FQI = 13.4

LAKE ZURICH FQI = 18.9

RANK = 47/170

AQUATIC PLANTS SPECIES OBSERVED = 9



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

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

AQUATIC HERBICIDES

Aquatic herbicides are used to reduce the abundance of invasive species, help maintain a healthy native plant community that is beneficial for fish, to improve navigational access to lakes and rivers to make boat navigation safe, and to control nuisance plant and algae growth that can pose a hazard to swimmers. Herbicides are chemical pesticides used to disrupt the growth cycle of plants, and typically work by inhibiting photosynthesis from occurring within the plant. Each herbicides will impact vegetation differently. In 2015, Lake Zurich treated April 30th with fluridone at a targeted rate of 7 PPB; and 30 PPB of pelleted fluridone on 8 acres on the northwest side of the lake. An addition 3.5PPB was applied to the Lake on May 22, 2015. Due to heavy precipitation events in spring, fluridone concentrations were low. There was reported good control of Curlyleaf Pondweed and Eurasian Watermilfoil. They also treated for Largeleaf Pondweed, but was not too successful. Treatments must have permission of lake bottom owners on parcels where treatment occurs. If a whole-lake application takes place, all lake bottom owners need to give permission.

Fluridone is an herbicide that stops the plant from making a protective pigment that keeps chlorphyll from breaking down in the sun. Treated plants will turn white or pink at the growing tips after a week and will die in one to two months after treatment as it is unable to make food for itself. It is only effective it plants are growing at time of treatment. Fluridone is used at low concentrations but for long contact time and it can move rapidly through the water. It is typically applied as a whole lake treatment but the pellet slow-release formulations can be used as spot treatments. Plants have shown to develop resistance to repeated fluridone use, so it is recommended to rotate herbicides. For more information on fluridone and other aquatic herbicides, see Appendix D that contains chemical fact sheets from the Wisconsin DNR.

The LCHD-ES cautions the treatment of native pondweeds as the absence of natives provides openings for the re-establishment of undesirable, non-native species. A diverse balanced plant assemblage provides a diverse array of habitats for other aquatic organisms such as macro-invertebrates and fish.

PLANT SUSCEPTIBILTY

	Complexed Copper	2,4-D Butoxyethyl Ester	2,4-D Dimethylamine (DMA)	Diquat	Diquat + Complexed Copper	Endothall Dipotassium Salt (K_2)	Endothall K_2 + Complexed Copper	Endothall Dimethylalkylamine Salts	Fluridone	Glyphosate	
EMERGENT											
American Lotus		E	E			G	G	F		G	*Nelumbo lutea*
Bulrush		E	E	F						E	*Scirpus spp.*
Cattail		G	G	G					G	E	*Typha spp.*
Common Reed										G	*Phragmites australis*
Pickerelweeds		G	G							F	*Pontederia spp.*
Smartweeds		G	G	F		G	G		F	F	*Polygonum spp.*
Water Primrose		E	E	F		F	F	F	F		*Ludwigia uruguayensis*
Waterwillow			E	F					G		*Justicia americana*
FLOATING LEAF											
Waterlily		E	G			G	G	F	G	E	*Nymphaea odorata*
Spatterdock		E	G			G	G	F	G	E	*Nuphar luteum*
Watershield		E	E	F	F	G	G	F	G		*Brasenia schreberi*
FREE FLOATING											
Duckweed		G	G	E	E	F			E		*Lemna minor*
Giant Duckweed		G	G	E	E				G		*Spirodela polyrhiza*
Watermeal				G					F		*Wolffia columbiana*
SUBMERSED											
Bladderworts		G		G					G		*Utricularia spp.*
Coontail		F	F	E	E	E	E	E	G		*Ceratophyllum demersum*
Elodea				E	E	E	F	G	G		*Elodea canadensis*
Eurasian Watermilfoil		E	E	E	E	E	E	E	G		*Myriophyllum spicatum*
Hydrilla	G			G	E	G	G	G	G		*Hydrilla verticillata*
Naiads		F		E	E	E	E	E	G		*Naiads spp.*
Pondweeds				G	G	E	E	E	G		*Potamogeton spp.*
Wild Celery				F	F			F			*Vallisneria americana*

NOTE: F = FAIR, G = GOOD, and E = EXCELLENT

This table has been reformated, from its original version; Aquatic Plant Identification and Herbicide Use Guide Volume II Aquatic Plants and Susceptibility to Herbicides Westerdahl et al. 1988 pages 66-69.

Systemic herbicides: *absorbed and transported throughout the plant, killing the entire plant including the roots.*

Contact herbicides: *only kill the portions of the plant in which the chemical comes into contact with.*

Non-selective: *will kill or injure a wide variety of plant species*

Selective: *effective on only certain plant species*

Aquatic herbicides

New Permit Requirements for Applying Pesticides in Waters

A National Pesticide Elimination System (NPDES) permit is required when pesticides are applied to, over or near the waters of the State. This permit applies to all public waters that have an outflow to the State waters. If an individual is applying the herbicide, they must fill it out. If you contract with an applicator, they can apply for NPDES coverage. A Notice of Intent (NOI) must be filled and submitted electronically to the Illinois Environmental Protection Agency (IEPA) at least 14 days prior to any application of pesticides. You can find the application at the website listed on the right.

For full details of the rule see:

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

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

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

Is anything else needed besides the permit?

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

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

Request for service (RFP)

A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake.

Putting together a good aquatic plant management plan should include a Request for Proposal (RFP). The RPF for aquatic plants ensures lake managers are able simultaneously distribute bids to qualified vendors with type of services, the frequency of needs, budget allocation and the length of the contract terms to get competitive prices.

In order to establish a plant management goal, a pre-treatment survey is necessary to identify the location, density and diversity of the aquatic plants in your lake. Set your goals within your budget and targeting areas that meets recommendations for maintaining the viability of the lake.

A pretreatment survey of your lakes aquatic plants is necessary prior to sending out a bid for your lakes survey. This will help determine success of controls and locate potential

FISH

Fish depend on aquatic plants to provide habitat and forage for food and most freshwater fish rely on aquatic plants at some point during their life stage. The plant composition and density can play an important role in the nesting, growth, and foraging success of these fish (Table 9). 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. A fish survey was last conducted on Lake Zurich in 2005 by the Illinois Department of Natural Resource (IDNR). They collected 17 species and a total of 2114 fish collected (Table 8). There were no threatened or endangered species collected. In 2008, there was a large common carp die off. Fish were collected by IDNR and sent to lab for testing, which showed the bacterium Aeromonas hydrophila, was responsible for the fish kill. It is estimated that greater than 1000 to 1500 common Carp were likely impacted. Fish species such as Bluegill, Black Crappie and Largemouth Bass should benefit from the reduced common carp population.

Table 8: 2005 IDNR Fish Survey, Lake Zurich

Fish Species	Count
Black Crappie	5
Bluegill	930
Blutnose Minnow	1
Brown Bullhead	7
Brookesilverside	1
Carp	95
Golden Shiner	3
Grass Pickerel	2
Largemouth Bass	75
Northern Pike	1
Pumpkinseed	96
Spotfin Shiner	1
Walleye	9
Warmouth	5
Yellow Bullhead	4
Yellow Perch	23
Yellow Bass	90

Table 8. Common fish and their plant affinity during various life stages and their relationship with plants

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

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

Fish—Carp

Carp (Cyprinus carpio)

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. They are also highly tolerant of poor water quality.

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. Many eggs succumb to predation, fungus, and bacteria.

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. This can be particularly a problem in shallow lakes, or lakes that do not stratify, allowing nutrients to easily cycle throughout the water column.

In 2008, there was a large common carp die off. Fish were collected by IDNR and sent to lab for testing, which showed the bacterium *Aeromonas hydrophila* was responsible for the fish kill. It is estimated that greater than 1000 to 1500 Common Carp were likely impacted. Bacteria such as Aeromonas and Columnaris are common in lakes and impact species that are stressed by spawning, low oxygen or other environmental factors. Die-offs relating to these bacteria are generally considered natural events that help balance un-balanced populations.

Carp spawning and feeding can both cause increase in turbidity, especially in shallow waters where they uproot plants, and resuspend bottom sediments.

Actions you take as a responsible boater are critical in preventing the spread of invasive species in Lake County. Remember, before leaving a lake or river:

- INSPECT and REMOVE all aquatic plants and animals
- DRAIN water from motors, live wells, and bait containers
- DISPOSE of unwanted live bait on land
- RINSE your boat and equipment with hot (104°F) high pressure tap water or
- DRY your boat and equipment for at least 5 days

AQUATIC INVASIVE SPECIES—ZEBRA MUSSELS

Aquatic invasive species (AIS) are species that are typically not native to Illinois and cause economic or environmental harm, or harm to human health. Illinois has a number of invasive species with the most common including: common carp, grass carp, and zebra mussels. Water recreation is a main transport of AIS, as these species can get transported from boats or trailers and then introduced into the water. Exotic species usually outcompete habitat of native species and are more tolerant to variations in water quality. Lake Zurich struggles with issues with aquatic invasive, including zebra mussels.

Zebra mussels were first documented in Lake Zurich in 2003 and were found in large numbers in the lake in 2008. In 2015, Zebra mussels are still present in high numbers, frequently found during sampling and seen on rocks on near-shore areas.

Zebra mussels are small, fingernail-sized mollusks originally native to eastern Europe and western Asia. Zebra mussels were most likely introduced to North America in 1985 or 1986 by ballast water of ships that traveled across the Atlantic and emptied their ballast in the Great Lakes ports. Zebra mussels spread by attaching to boats, nets, docks, swim platforms, boat lifts, and can be moved on any of these objects. They also can attach to aquatic plants which are often transported accidently when they become entangled on the boat parts. Microscopic larvae (called veligers) can also be carried in water contained in bait buckets, bilges, or any other water removed from an infested lake. They can even live out of the water for up to 10 days in high humidity and cool temperatures and during average summer temperatures, Zebra Mussels can survive out of the water for average of five days.

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 reproductive. The impact that the mussels have on fish populations is not fully understood. However, they feed on phytoplankton which is a major food source for planktivorous fish, such as Bluegill. These fish, in turn , are a food source for piscivorus fish (fish eating fish) such as Largemouth Bass and Northern Pike. There is also thought that Zebra Mussels may increase the presence of blue-green algae blooms since they do not prefer to filter this form of algae. Zebra mussels have damaged natural ecosystems, industrial infrastructure and recreational equipment including boats and motors.

Some positive impacts have been observed from Zebra Mussel infestations. Since they are filter feeders, they typically improve water clarity, which allows light to penetrate further into the water column, increasing the depth at which aquatic plants can grow. This can provide more habitat for fish species. Unfortunately, the negative ecological and economical impacts associated with Zebra Mussels far outweigh any positive

Since Lake Zurich has Zebra Mussels, it is crucial to check your boat and trailer for aquatic plants and zebra mussels every time you exit the lake. Remove vegetation and drain your boat.

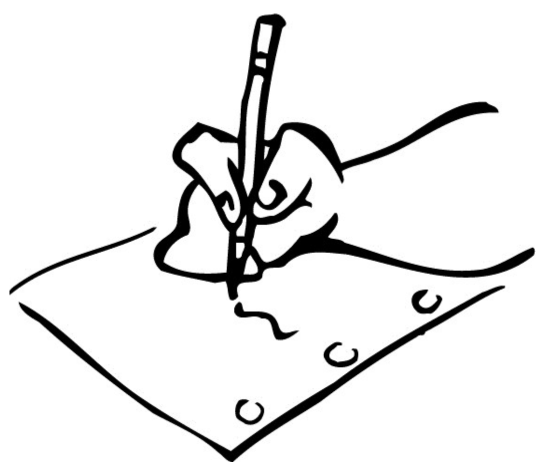
LAKE MANAGEMENT PLANS

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 Lake Zurich. Lake Management plans should educate the public about specific lake issues, provide a concise assessment of the problem, outline methods and techniques that will be employed to control the problems and clearly define the goals of the program. Mechanisms for monitoring and evaluation should be developed as well and information gathered during these efforts should be used to implement management efforts (Biology and Control of Aquatic Plants, Gettys et al., 2009)

What are the steps in creating a Lake Management Plan?

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

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

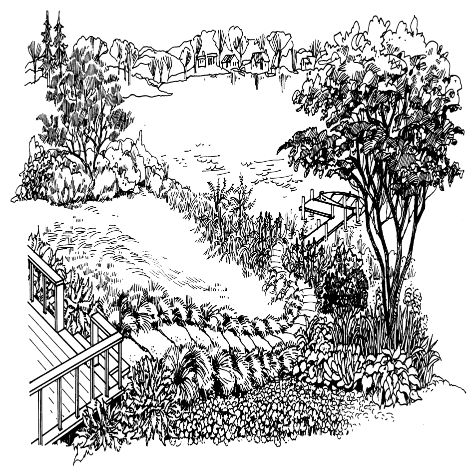


LAKE RECOMMENDATIONS

Lake Zurich's water quality has declined since the 2008 sampling but remains above the Lake County median concentrations for many parameters.

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

- Continue to participate in the Volunteer Lake Monitoring Program to give yearly data on water clarity for Lake Zurich and observe changes in the lakes water clarity. Contact the LCHD-ES at 847-377-8009 to get more information on the VLMP program.
- Development of a Lake Management Plan based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. A good lake management plan considers both the short and long term needs of the lake and incorporates all stakeholders in the planning process.
- Develop an Aquatic Plant Management Plan that targets the reduction of invasive species and promotes native plant diversity. Aquatic plant management plans should consider all alternatives, including the timing of pesticide applications and quantity of pesticide use. Early season herbicide use is better for the native plant community. APMP can also include developing requests for proposals (RFPs) for herbicide application; which can better help associations properly manage their lake.



- Reduce conductivity and chloride concentrations. While the Lake Zurich watershed to lake size ratio is relatively small, a large percentage of land use is of impervious surfaces such as retail/commercial, single family, and transportation. These contribute the largest amount of runoff to lake, including chlorides. Proper salt application procedures and alternative methods can be used to keep these concentrations under control. Consider the benefit of attending one of Lake County Health Departments De-Icing workshops held annually in October to learn about these best management practices.
- The last fisheries survey was conducted in 2005 on Lake Zurich and no fish survey has occurred after the large carp die off in 2008. An updated fish survey should be conducted to determine the diversity and health of the fish community.

- Currently, Lake Zurich has 66% poor buffer around the shoreline. Consider installing Best Management Practices (BMPs) to minimize phosphorus and sediment runoff into Lake Zurich. This can include: rain gardens, native buffers between shoreline and homeowner property, and increasing native plantings around the lake.
- Become familiar with the appearance of harmful algal blooms and report any blooms to the LCHD-ES by calling 847-837-8030.

ECOLOGICAL SERVICES

Senior Biologist: Mike Adam

madam@lakecountyil.gov

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

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

For more information visit us at:

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

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

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

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

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

LAKE ZURICH

MAJOR WATERSHED:
FOX RIVER

SUB-WATERSHED:
FLINT CREEK DRAIN

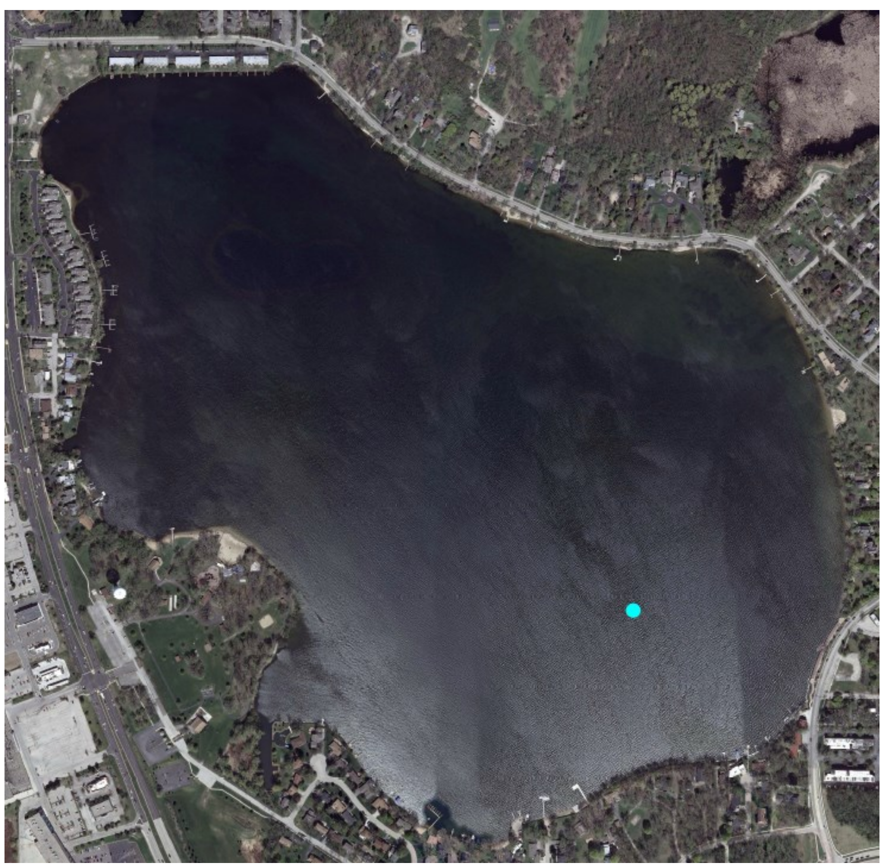
WATERSHED AREA:
605 ACRES

SURFACE AREA:
232.30 ACRES

SHORELINE LENGTH:
2.8 MILES

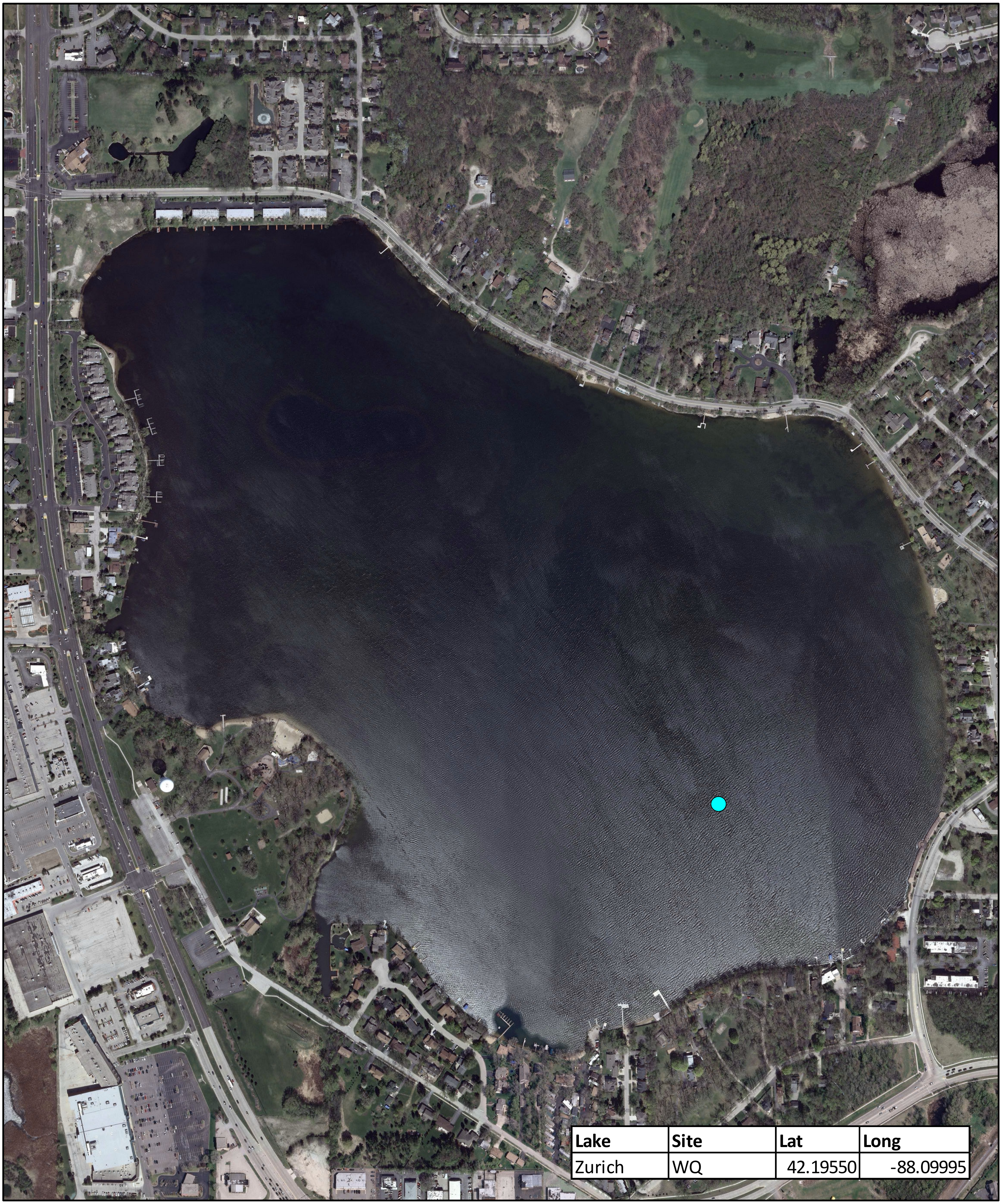
MAXIMUM DEPTH:
33.0 FEET

2015 Sampling Location on Lake Zurich



Appendix A:
Figures

Lake Zurich Sampling Location



Lake	Site	Lat	Long
Zurich	WQ	42.19550	-88.09995

LakeCounty
Health Department and
Community Health Center

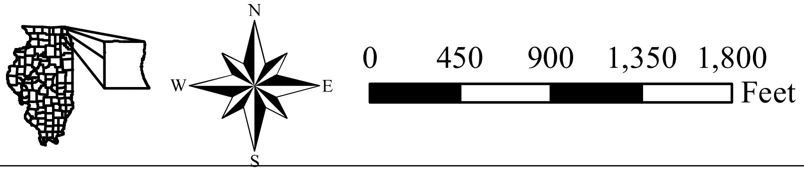
N W E S

0100200300400
Feet

Environmental Services Unit
Product Number 2015
Revised 05/2015

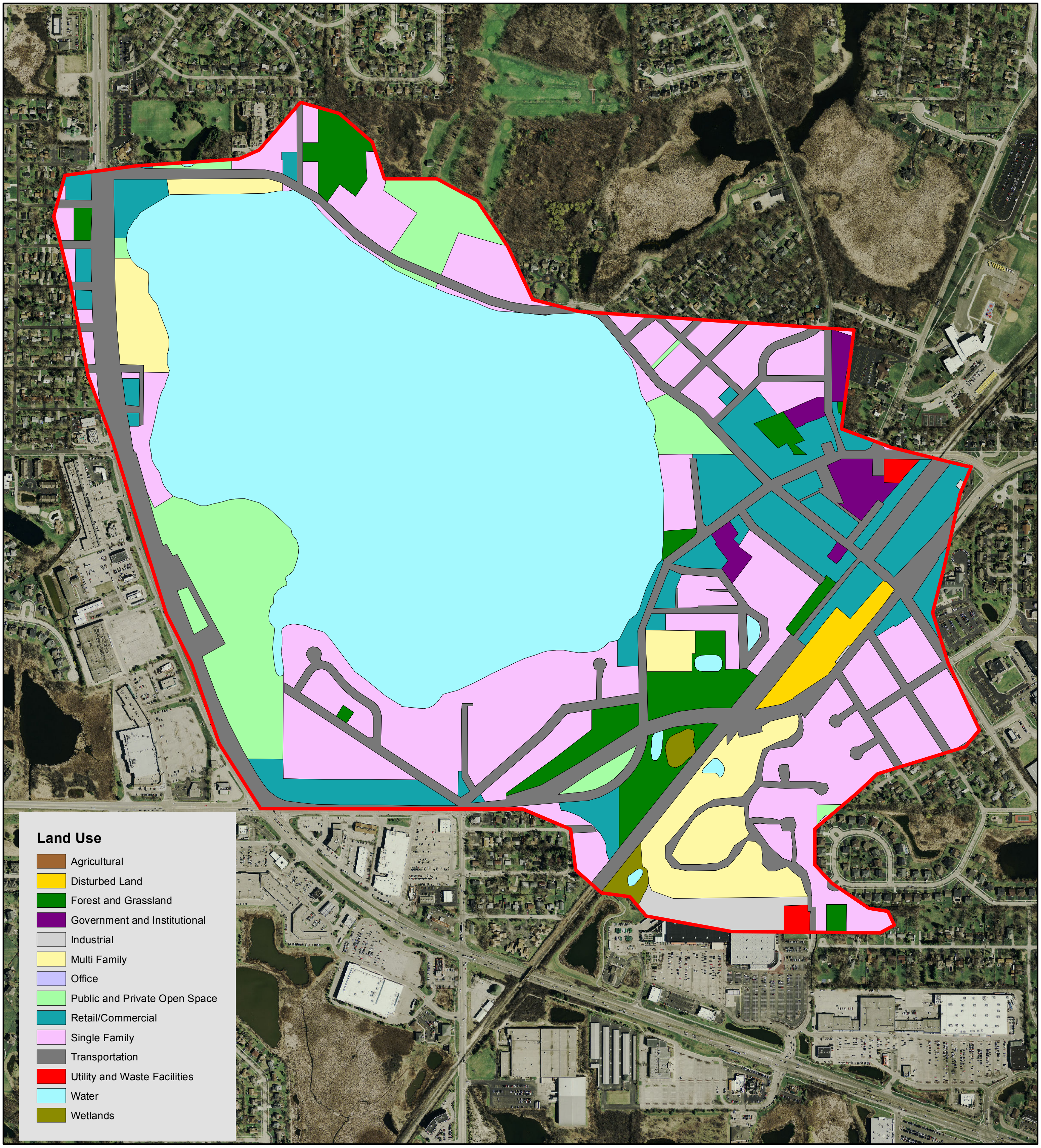
Lake Zurich Watershed Delineation

LakeCounty
Health Department and Community Health Center

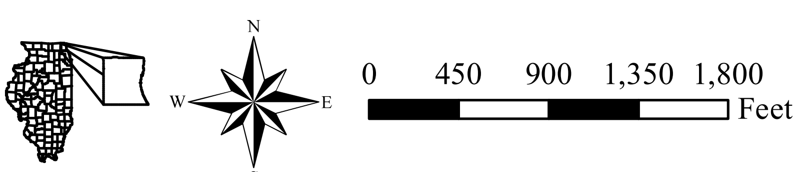


Ecological Services
Product Number ZRH.08
Revised 1/2016

Lake Zurich Landuse and Watershed Delineation

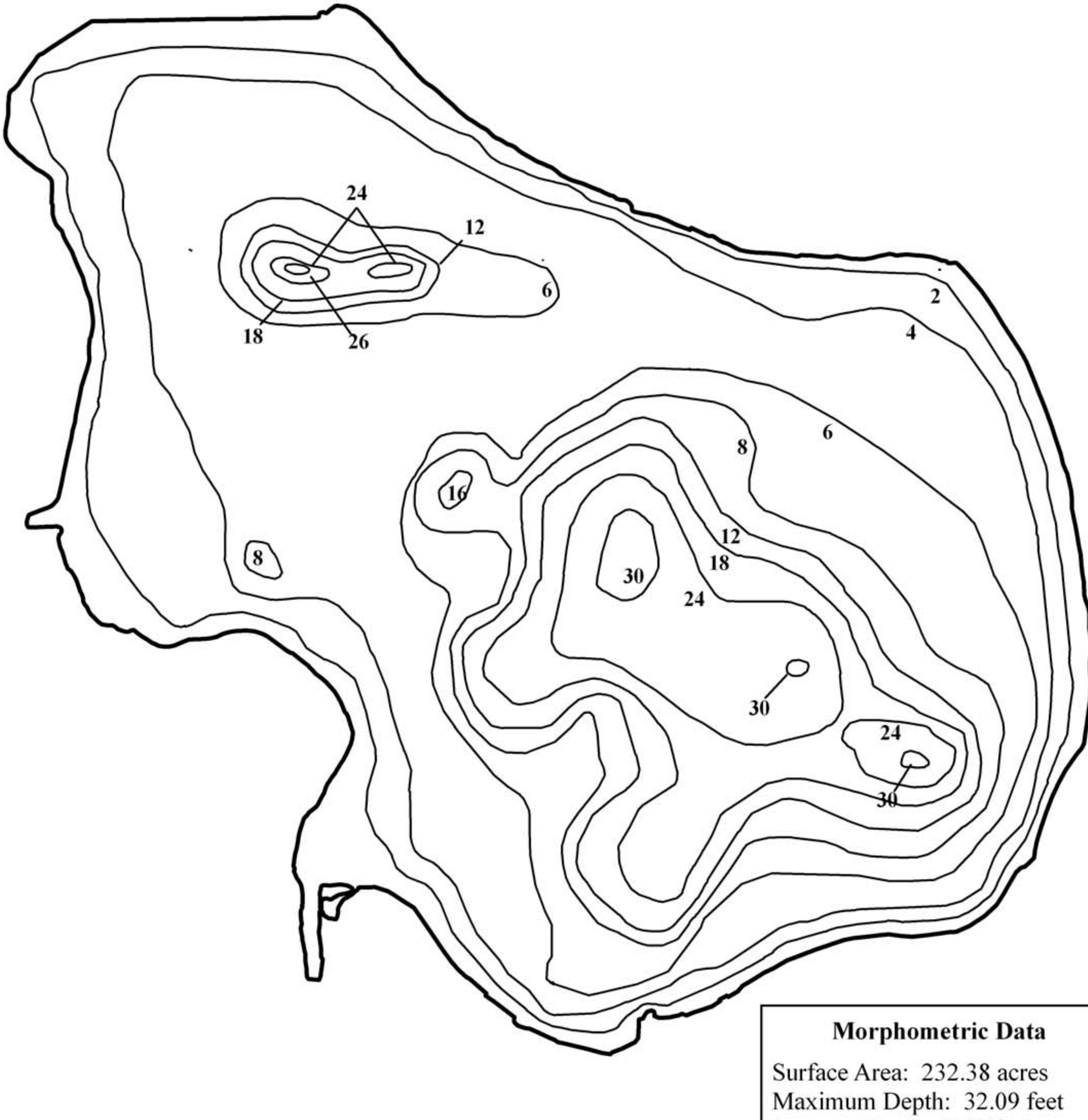


LakeCounty
Health Department and
Community Health Center



Ecological Services
Product Number ZRH.08
Revised 1/2016

Bathymetric Map of Lake Zurich, Lake County, IL



Morphometric Data

Surface Area: 232.38 acres
Maximum Depth: 32.09 feet
Average Depth: 8.16 feet
Lake Volume: 1897.25 acre-feet
Shoreline Length: 2.829 miles
Lake Elevation: 843.55 feet, msl

Survey Data Collected October 19, 2010

This map is intended for water quality reference only, not intended for navigational, swimming, or diving purposes.

LakeCounty
Health Department and Community Health Center

0 250 500 750 1,000 Feet

Environmental Services
Product Number ZRHbathymap
Revised 7/2011

Lake Zurich Shoreline Reaches, 2015

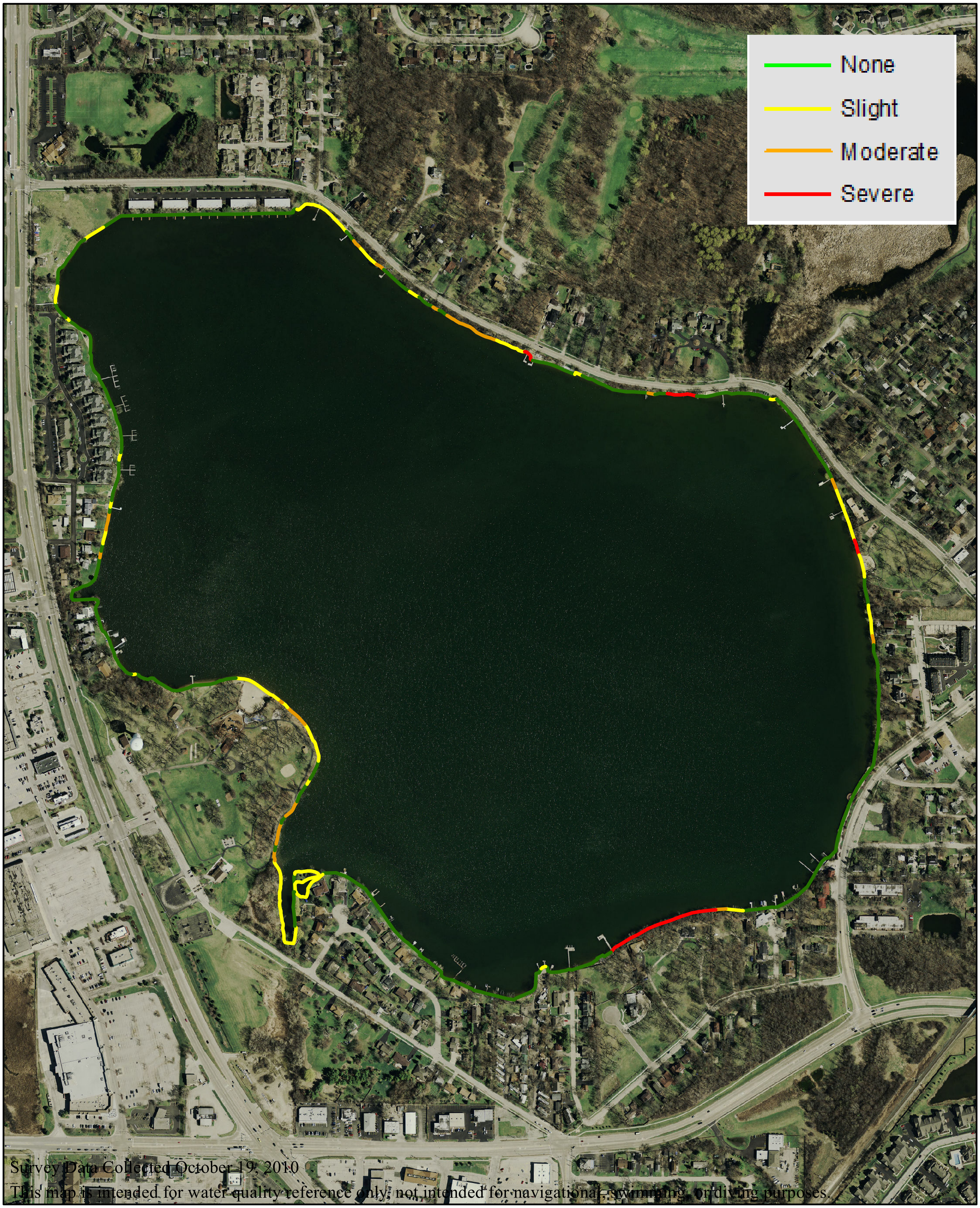
LakeCounty
Health Department and
Community Health Center

N
W
E
S

0 250 500 750 1,000 Feet

Environmental Services
Product Number ZRH10.15
Revised 1/2016

Lake Zurich Shoreline Erosion Condition, 2015



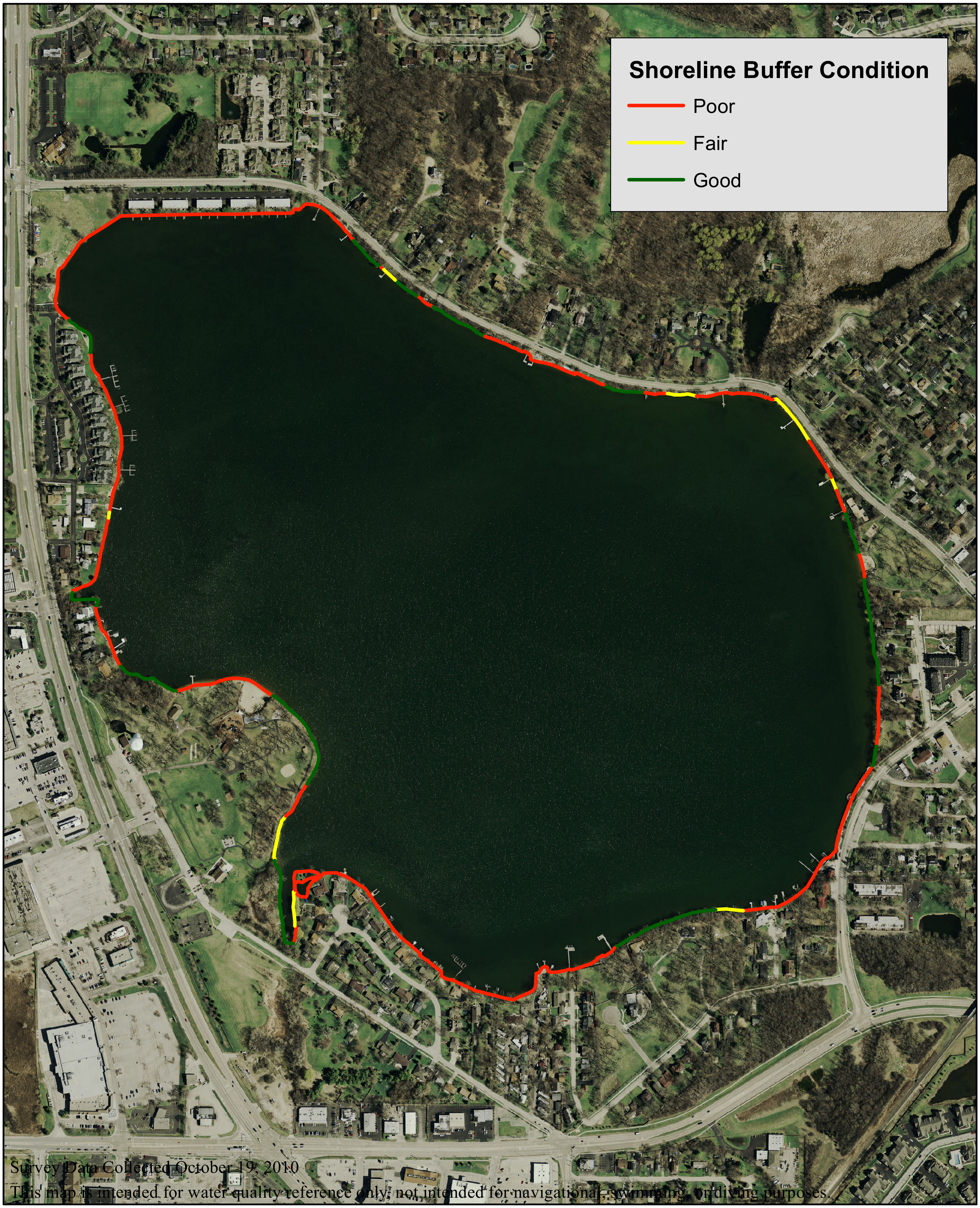
LakeCounty
Health Department and
Community Health Center

N W E S

0 250 500 750 1,000
Feet

Environmental Services
Product Number ZRH10.15
Revised 1/2016

Lake Zurich Shoreland Buffer Condition, 2015



LakeCounty
Health Department and Community Health Center

0 250 500 750 1,000 Feet

Environmental Services
Product Number ZRH10.15
Revised 1/2016

Lake Zurich Plant Grid 2015

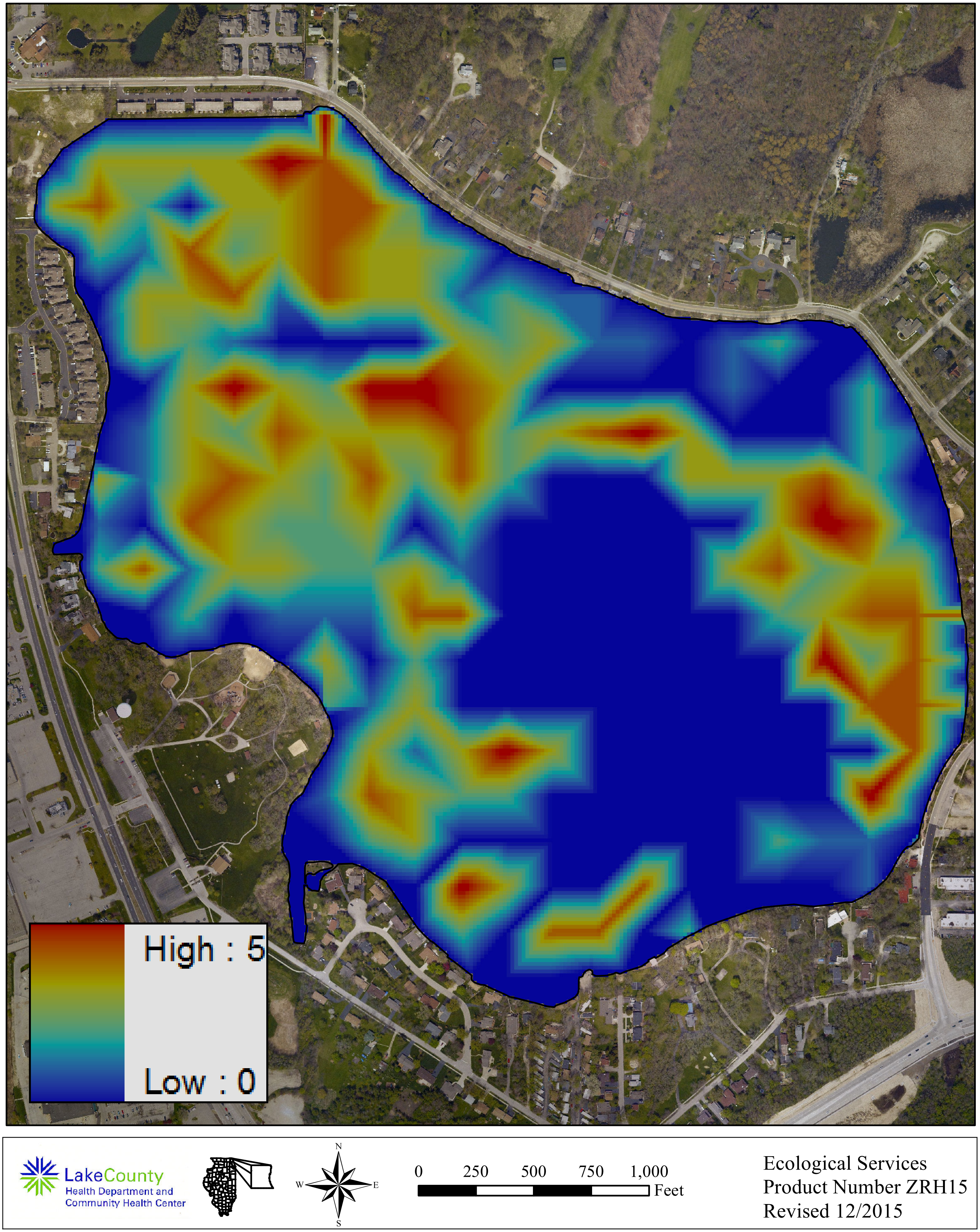
LakeCounty Health Department and Community Health Center

N W E S

0 250 500 750 1,000 Feet

Lakes Management Unit
Product Number ZRH15
Revised 4/2015

Lake Zurich Plant Rake Density, June 2015



Ecological Services
Product Number ZRH15
Revised 12/2015

Appendix B:
Tables

Lake Zurich Water Quality Summary
(2002, 2008, 2015)

2015	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	3	121	0.70	<0.100	<0.050	0.020	<0.005	186	458[a]	458	502	69	11.84	0.8173	8.18	8.80
17-Jul	3	116	0.75	<0.100	<0.050	0.023	<0.005	179	474[a]	474	501	97	7.09	0.8476	8.56	9.15
15-Jul	3	110	0.76	<0.100	<0.050	0.018	<0.005	180	466[a]	466	486	74	7.40	0.8323	8.40	8.51
12-Aug	3	116	0.88	<0.100	<0.050	0.021	0.006	184	500	500	515	88	4.92	0.8718	8.43	8.57
17-Sep	3	125	0.89	<0.100	<0.050	0.024	<0.005	200	488a	488	530	102	4.95	0.8770	8.35	8.58
	Average	118	0.80	<0.100	<0.050	0.021	<0.005	186	477	477	507	86	7.24	0.8492	8.38	8.72

2008	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	120	0.72	<0.100	0.133	<0.010	<0.005	213	NA	2.0	547	80	14.11	0.9778	8.42	9.52
18-Jun	3	118	0.67	<0.100	<0.050	0.015	<0.005	213	NA	3.5	557	100	10.01	0.9828	8.41	8.17
16-Jul	3	114	0.75	<0.100	<0.050	0.016	<0.005	209	NA	3.8	560	103	3.94	0.9721	8.77	8.76
20-Aug	3	98.8	0.66	<0.100	<0.050	0.015	<0.005	217	NA	2.3	557	110	10.83	0.9659	8.88	9.47
17-Sep	3	89.4	0.63	<0.100	<0.050	0.018	<0.005	201	NA	2.1	518	106	13.10	0.8881	8.59	7.50
	Average	108	0.68	<0.100	0.133	0.016[k]	<0.005	211	NA	2.7	548	100	10.40	0.9573	8.61	8.68

2002	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	127	0.97	<0.100	<0.050	0.029	0.005	NA	436	4.4	449	98	5.55	0.7873	8.19	9.87
24-Jun	3	104	0.97	<0.100	<0.050	0.024	<0.005	NA	420	2.7	442	101	8.60	0.7559	8.73	8.84
29-Jul	3	98	1.15	<0.100	<0.050	0.029	0.008	NA	420	7.5	462	115	4.40	0.7755	8.82	7.48
26-Aug	3	93	1.09	<0.100	<0.050	0.030	0.006	NA	422	5.8	435	99	3.45	0.7316	8.74	8.50
23-Sep	3	93	1.27	<0.100	<0.050	0.029	<0.005	NA	416	4.0	439	101	5.64	0.7461	8.14	7.00
	Average	103	1.09	<0.100	<0.050	0.028	0.006[k]	NA	423	4.9	445	103	5.53	0.7593	8.52	8.34

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
a= TDS is a calculated value, based on conductivity

Lake Zurich Water Quality Summary
(2002, 2008, 2015)

2015	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS[a]	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	21	122	0.700	<0.100	<0.05	0.019	<0.005	189	459	2.8	493	61	NA	0.8193	8.05	8.40
17-Jul	22	132	0.829	0.216	<0.05	0.032	0.011	185	491	2.1	526	103	NA	0.8827	7.66	2.28
15-Jul	21	123	0.730	<0.100	<0.05	0.026	<0.005	183	482	3.4	515	88	NA	0.8638	7.52	0.39
12-Aug	20	122	1.540	<0.100	<0.05	0.065	0.011	183	491	13.6	516	84	NA	0.8824	7.51	0.33
17-Sep	21	126	0.870	<0.100	<0.05	0.026	<0.005	199	490	5.2	524	100	NA	0.8800	7.9	5.60
	Average	125	0.934	0.123[k]	<0.05	0.034	.007[k]	188	483	5.4	515	87	NA	0.8656	7.73	3.40

2008	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	25	119	0.706	<0.100	0.132	0.02	<0.005	212	NA	4.1	538	76	NA	0.9780	8.45	9.24
18-Jun	20	118	0.712	0.000	<0.05	0.011	<0.005	213	NA	3.6	564	98	NA	0.9850	8.36	7.48
16-Jul	27	135	1.680	0.723	<0.05	0.055	<0.005	214	NA	10.0	562	95	NA	1.0335	7.29	0.23
20-Aug	25	135	1.130	<0.100	<0.05	0.079	<0.005	213	NA	17.0	572	105	NA	1.0224	7.59	0.31
17-Sep	27	93.1	0.807	0.102	<0.05	0.014	<0.005	201	NA	3.9	519	106	NA	0.8928	8.42	7.54
	Average	120	1.01	0.275	0.132	0.036	<0.005	211	NA	7.7	551	96	NA	0.9823	8.02	4.96

2002	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	27	129	1.02	<0.100	<0.05	0.045	0.008	NA	454	12.0	458	105	NA	0.7892	7.89	7.48
24-Jun	27	136	1.35	0.444	<0.05	0.051	0.010	NA	424	3.9	463	111	NA	0.8113	7.33	0.06
29-Jul	26	127	1.33	0.215	<0.05	0.037	<0.005	NA	432	6.5	464	112	NA	0.8156	7.07	0.07
26-Aug	27	178	2.68	1.530	<0.05	0.059	0.016	NA	448	5.0	481	109	NA	0.8320	6.92	0.10
23-Sep	27	180	3.99	2.790	<0.05	0.110	<0.005	NA	468	5.0	487	113	NA	0.8641	6.77	0.10
	Average	150	2.07	1.245	<0.05	0.060	0.011	NA	445	6.5	471	110	NA	0.8224	7.20	1.56

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
a= TDS is a calculated value, based on conductivity

Lake Zurich Multiparameter Data, 2015.

Date	Text Depth feet	Dep25 feet	Temp øC	LDO mg/l	LDO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.2785629
5/13/2015	0.5	0.39	15.28	9.18	92.5	0.8176	8.26	4254	Surface		
5/13/2015	1	1.05	15.27	8.78	88.4	0.8174	8.2	4052	Surface	100%	
5/13/2015	2	1.96	15.29	8.8	88.7	0.8173	8.18	1476	0.29	36%	3.4823271
5/13/2015	3	3.02	15.26	8.8	88.6	0.8173	8.18	2385	1.35	59%	-0.355454
5/13/2015	4	4.04	15.23	8.78	88.3	0.8173	8.17	1621	2.37	40%	0.162935
5/13/2015	6	6	15.22	8.79	88.4	0.8173	8.16	1128	4.33	28%	0.0837407
5/13/2015	8	8.05	15.13	8.78	88.1	0.8171	8.18	989	6.38	24%	0.0206124
5/13/2015	10	10.08	15.06	8.78	88	0.817	8.14	538	8.41	13%	0.0723943
5/13/2015	12	12.05	15.02	8.8	88.2	0.817	8.14	367	10.38	9%	0.0368494
5/13/2015	14	13.99	14.9	8.82	88.1	0.8169	8.15	332	12.32	8%	0.0081353
5/13/2015	16	16.02	14.81	8.82	88	0.8169	8.15	226	14.35	6%	0.0268014
5/13/2015	18	18.02	14.74	8.78	87.4	0.8167	8.13	182	16.35	4%	0.0132433
5/13/2015	20	20.08	14.56	8.54	84.6	0.8177	8.09	109	18.41	3%	0.0278468
5/13/2015	22	21.98	14.22	8.25	81.3	0.8209	8.01	81	20.31	2%	0.0146184
5/13/2015	24	24.05	12.41	5.63	53.2	0.8356	7.75	44	22.38	1%	0.0272681

Date	Text Depth feet	Dep25 feet	Temp øC	LDO mg/l	LDO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.2291841
6/17/2015	0.5	0.51	23.42	9.13	109.6	0.8475	8.57	1315	Surface		
6/17/2015	1	1	23.42	9.16	110	0.8475	8.56	1413	Surface	100%	
6/17/2015	2	2.14	23.42	9.13	109.7	0.8475	8.56	478	0.47	34%	2.3060844
6/17/2015	3	3	23.4	9.15	109.9	0.8476	8.56	351	1.33	25%	0.2321989
6/17/2015	4	4.07	23.39	9.18	110.3	0.8475	8.56	252	2.4	18%	0.1380655
6/17/2015	6	6.05	23.38	9.22	110.7	0.8475	8.56	156	4.38	11%	0.1094916
6/17/2015	8	8.09	23.37	9.21	110.5	0.8481	8.55	125	6.42	9%	0.0345081
6/17/2015	10	10.17	23.3	8.85	106.1	0.8484	8.49	85	8.5	6%	0.0453721
6/17/2015	12	12.12	23.04	7.39	88.1	0.8544	8.27	61	10.45	4%	0.031749
6/17/2015	14	14.08	21.58	6.55	76	0.8741	8.18	44	12.41	3%	0.0263243
6/17/2015	16	16.07	20.51	5.92	67.2	0.8772	8.03	36	14.4	3%	0.0139355
6/17/2015	18	18.19	18.79	5.53	60.6	0.8791	7.92	30	16.52	2%	0.0110364
6/17/2015	20	20.03	17.84	3.64	39.1	0.8821	7.76	25	18.36	2%	0.0099304
6/17/2015	22	22.02	16.58	2.28	23.9	0.8827	7.66	21	20.35	1%	0.0085677
6/17/2015	24	24.09	15.44	0.61	6.2	0.8909	7.55	16	22.42	1%	0.0121291

Lake Zurich Multiparameter Data, 2015.

Date		Dep25 feet	Temp øC	LDO mg/l	LDO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.4428728
7/15/2015	0.5	0.21	21.18	8.78	101	0	14	4102	Surface		
7/15/2015	1	0.78	24.87	8.5	105.2	0.832	8.42	3963	Surface	100%	
7/15/2015	2	2.04	24.86	8.51	105.4	0.8323	8.4	329	0.37	8%	6.7262131
7/15/2015	3	2.82	24.85	8.51	105.4	0.8323	8.4	1946	1.15	49%	-1.545629
7/15/2015	4	4.81	24.79	8.5	105.1	0.8322	8.39	274	3.14	7%	0.6243322
7/15/2015	5	5.58	24.65	8.51	105	0.8319	8.39	776	3.91	20%	-0.266247
7/15/2015	6	6.25	24.63	8.5	104.7	0.8318	8.39	1001	4.58	25%	-0.05559
7/15/2015	8	8.94	24.37	8.49	104.2	0.8313	8.38	545	7.27	14%	0.0836271
7/15/2015	10	10.25	24.19	8.23	100.6	0.8324	8.34	497	8.58	13%	0.0107454
7/15/2015	12	12.76	24.03	7.78	94.9	0.8327	8.28	278	11.09	7%	0.0523867
7/15/2015	14	14.43	23.61	6.93	83.9	0.8341	8.16	246	12.76	6%	0.0095838
7/15/2015	16	16.66	22.67	5.19	61.7	0.8385	7.92	155	14.99	4%	0.0308143
7/15/2015	18	18.37	21.02	1.7	19.6	0.8483	7.69	108	16.7	3%	0.0216344
7/15/2015	20	20.55	19.87	0.66	7.4	0.8571	7.57	71	18.88	2%	0.0222167
7/15/2015	22	23.18	17.66	0.13	1.4	0.8706	7.47	28	21.51	1%	0.0432578
7/15/2015	24	23.95	17.12	0	0	0.8851	7.4	14	22.28	0%	0.0311107

Date	Text Depth feet	Dep25 feet	Temp øC	LDO mg/l	LDO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient #REF!
8/12/2015	0.5	0.48	25.65	8.44	105.3	0.8739	8.44	1126	Surface		
8/12/2015	1	1.67	25.6	8.5	106	0.8728	8.42	189	Surface	100%	
8/12/2015	2	2.68	25.54	8.52	106.2	0.8725	8.42	295	1.01	156%	-0.44082
8/12/2015	3	3.79	25.49	8.57	106.7	0.8718	8.43	290	2.12	153%	0.0080634
8/12/2015	4	4.58	25.44	8.53	106	0.8725	8.41	196	2.91	104%	0.1346276
8/12/2015	6	6.42	25.39	8.35	103.7	0.8726	8.4	152	4.75	80%	0.053523
8/12/2015	8	8.42	25.33	8.08	100.3	0.8734	8.36	81	6.75	43%	#REF!
8/12/2015	10	10.41	25.25	7.71	95.5	0.8738	8.31	48	8.74	25%	0.0598682
8/12/2015	12	12.12	25.1	7.33	90.6	0.8717	8.25	36	10.45	19%	0.0275294
8/12/2015	14	14.9	24.93	6.76	83.3	0.8731	8.16	20	13.23	11%	0.0444283
8/12/2015	16	16.27	24.88	6.36	78.3	0.873	8.1	14	14.6	7%	0.0244298
8/12/2015	18	18.48	24.63	5.08	62.2	0.8742	7.92	9	16.81	5%	0.0262839
8/12/2015	20	20.51	22.75	0.58	6.9	0.8769	7.59	5	18.84	3%	0.0311989
8/12/2015	22	22.51	19.48	0.08	0.9	0.8878	7.43	1	20.84	1%	0.0772283
8/12/2015	23	23.3	18.74	0.01	0.1	0.9323	7.3	1	21.63	1%	0

Lake Zurich Multiparameter Data, 2015.

Date	Depth	Dep25	Temp	LDO	LDO%	SpCond	pH	BGA
	feet	feet	øC	mg/l	Sat	mS/cm	Units	
9/17/2015	0.50	0.48	19.77	8.82	96.8	0.877	8.41	1843
9/17/2015	1.00	1.02	19.77	8.6	94.4	0.877	8.36	4482
9/17/2015	2.00	2.06	19.77	8.59	94.2	0.878	8.35	8383
9/17/2015	3.00	3.00	19.75	8.58	94.1	0.877	8.35	3203
9/17/2015	4.00	4.02	19.73	8.58	94.1	0.878	8.34	3655
9/17/2015	6.00	6.08	19.67	8.56	93.8	0.878	8.33	6041
9/17/2015	8.00	8.11	19.66	8.52	93.3	0.878	8.32	5140
9/17/2015	10.00	10.07	19.62	8.51	93.1	0.878	8.32	7092
9/17/2015	12.00	12.10	19.59	8.49	92.8	0.878	8.31	7168
9/17/2015	14.00	14.04	19.49	7.88	86	0.879	8.24	5305
9/17/2015	16.00	16.02	19.20	7.37	80	0.879	8.19	2550
9/17/2015	18.00	18.04	19.14	6.91	74.9	0.879	8.13	4222
9/17/2015	20.00	20.02	18.98	5.88	63.5	0.88	8.02	4409
9/17/2015	22.00	22.12	18.87	5.32	57.4	0.879	7.96	4959
9/17/2015	24.00	23.92	18.58	1.26	13.5	0.887	7.71	35649

Lake Zurich Landuse 2015

Land Use	Acreage	% of Total
Disturbed Land	5.60	0.9%
Forest and Grassland	24.29	4.0%
Government and Institutional	7.26	1.2%
Industrial	5.82	1.0%
Multi Family	28.37	4.7%
Public and Private Open Space	41.97	6.9%
Retail/Commercial	47.10	7.8%
Single Family	120.07	19.8%
Transportation	89.34	14.8%
Utility and Waste Facilities	1.65	0.3%
Water	230.86	38.2%
Wetlands	2.63	0.4%
Total Acres	**604.97**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Disturbed Land	5.60	0.05	0.8	0.1%
Forest and Grassland	24.29	0.05	3.3	0.6%
Government and Institutional	7.26	0.50	10.0	1.9%
Industrial	5.82	0.50	8.0	1.5%
Multi Family	28.37	0.85	66.3	12.6%
Public and Private Open Space	41.97	0.15	17.3	3.3%
Retail/Commercial	47.10	0.85	110.1	21.0%
Single Family	120.07	0.30	99.1	18.9%
Transportation	89.34	0.85	208.8	39.7%
Utility and Waste Facilities	1.65	0.30	1.4	0.3%
Water	230.86	0.00	0.0	0.0%
Wetlands	2.63	0.05	0.4	0.1%
TOTAL	**604.97**		**525.4**	100.0%

Lake volume	**1635.47**	**acre-feet**
Retention Time (years)= lake volume/runoff	**3.11**	**years**
	1136.10	**days**

Morphometric Features of Lake Zurich~
Data From the October 2010 Bathymetric Survey, LCHD Environmental Services

Contour (Feet)	Area Enclosed (Acres)	Percent of total acres	Volume (Acre-feet)	Depth Zone (Feet)	Area (Acres)	Percent (Depth zone to total acres)	Percent (Acre-feet to Total Volume)
0	232.38	100%	225.76	0 - 1	13.17	5.7%	11.9%
1	219.21	94%	213.69	1 - 2	11.00	4.7%	11.3%
2	208.21	90%	200.43	2 - 3	15.46	6.7%	10.6%
3	192.75	83%	183.05	3 - 4	19.22	8.3%	9.6%
4	173.52	75%	154.17	4 - 5	37.92	16.3%	8.1%
5	135.60	58%	114.52	5 - 6	40.93	17.6%	6.0%
6	94.67	41%	85.68	6 - 7	17.67	7.6%	4.5%
7	76.99	33%	70.51	7 - 8	12.78	5.5%	3.7%
8	64.22	28%	60.75	8 - 9	6.87	3.0%	3.2%
9	57.35	25%	55.31	9 - 10	4.05	1.7%	2.9%
10	53.30	23%	51.69	10 - 11	3.20	1.4%	2.7%
11	50.09	22%	48.73	11 - 12	2.72	1.2%	2.6%
12	47.37	20%	46.14	12 - 13	2.46	1.1%	2.4%
13	44.91	19%	43.74	13 - 14	2.34	1.0%	2.3%
14	42.57	18%	41.40	14 - 15	2.33	1.0%	2.2%
15	40.24	17%	39.04	15 - 16	2.39	1.0%	2.1%
16	37.85	16%	36.54	16 - 17	2.61	1.1%	1.9%
17	35.25	15%	33.90	17 - 18	2.67	1.1%	1.8%
18	32.58	14%	31.12	18 - 19	2.90	1.2%	1.6%
19	29.68	13%	27.99	19 - 20	3.35	1.4%	1.5%
20	26.33	11%	24.93	20 - 21	2.76	1.2%	1.3%
21	23.56	10%	22.42	21 - 22	2.27	1.0%	1.2%
22	21.29	9%	19.97	22 - 23	2.61	1.1%	1.1%
23	18.68	8%	17.29	23 - 24	2.76	1.2%	0.9%
24	15.93	7%	14.53	24 - 25	2.76	1.2%	0.8%
25	13.17	6%	11.82	25 - 26	2.65	1.1%	0.6%
26	10.52	5%	8.96	26 - 27	3.03	1.3%	0.5%
27	7.48	3%	6.02	27 - 28	2.82	1.2%	0.3%
28	4.66	2%	3.67	28 - 29	1.90	0.8%	0.2%
29	2.76	1%	2.08	29 - 30	1.29	0.6%	0.1%
30	1.47	1%	1.08	30 - 31	0.73	0.3%	0.1%
31	0.74	0%	0.29	31 - 32	0.72	0.3%	0.0%
32	0.02	0%	0.05	32+	0.02	0.0%	0.0%
			1897.25		232.38	100%	100%

Maximum Depth of Lake: 32.09 Feet
Average Depth of Lake: 8.16 Feet
Volume of Lake: 1897.25 Acre-Feet

Area of Lake: 232.38 Acres
Shoreline Length: 2.82 Miles
Water elevation at 843.55 feet above mean sea level

LakeCounty
Health Department and
Community Health Center

Shoreline Condition Assessment, Lake Zurich 2015

Shoreline Erosion Condition, Lake Zurich 2015

Reach	None		Slight		Moderate		Severe	
	Linear ft.	% of Reach	Linear ft.	% of Reach	Linear ft.	% of Reach	Linear ft.	% of Reach
ZR01	1372.0	79.7	349.0	20.3	0.0	0.0	0.0	0.0
ZR02	645.4	94.4	37.9	5.6	0.0	0.0	0.0	0.0
ZR04	843.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR05	388.7	28.2	580.5	42.1	409.0	29.7	0.0	0.0
ZR06	995.6	74.6	93.6	7.0	35.6	2.7	209.6	15.7
ZR07	469.6	96.0	19.6	4.0	0.0	0.0	0.0	0.0
ZR08	0.0	0.0	111.2	100.0	0.0	0.0	0.0	0.0
ZR09	10.6	2.6	260.2	64.2	57.6	14.2	76.8	19.0
ZR10	744.1	79.2	151.7	16.1	44.1	4.7	0.0	0.0
ZR11	460.7	100.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR12	577.2	46.1	87.9	7.0	48.4	3.9	538.3	43.0
ZR13	603.5	92.2	25.4	3.9	0.0	0.0	25.9	4.0
ZR14	81.9	21.5	298.8	78.5	0.0	0.0	0.0	0.0
ZR15	273.8	20.0	707.1	51.5	390.8	28.5	0.0	0.0
ZR16	576.3	72.0	103.3	12.9	121.1	15.1	0.0	0.0
ZR17	431.4	67.7	206.0	32.3	0.0	0.0	0.0	0.0
ZR18	496.6	96.3	18.8	3.7	0.0	0.0	0.0	0.0
ZR19	387.6	77.8	110.4	22.2	0.0	0.0	0.0	0.0
ZR20	306.6	76.6	93.5	23.4	0.0	0.0	0.0	0.0
Total	9665.4	65.0	3255.1	21.9	1106.6	7.4	850.6	5.7

Shoreland Buffer Condition, Lake Zurich 2015

Reach	Poor		Fair		Good		
	Linear ft.	% of Reach	Linear ft.	% of Reach	Linear ft.	% of Reach	
ZR01	1503	87	173	10	45	3	1721
ZR02	683	100	0	0	0	0	683
ZR04	844	100	0	0	0	0	844
ZR05	673	49	76	6	629	46	1378
ZR06	979	73	145	11	211	16	1334
ZR07	209	43	281	57	0	0	489
ZR08	111	100	0	0	0	0	111
ZR09	109	27	68	17	228	56	405
ZR10	306	33	0	0	634	67	940
ZR11	461	100	0	0	0	0	461
ZR12	577	46	136	11	538	43	1252
ZR13	655	100	0	0	0	0	655
ZR14	381	100	0	0	0	0	381
ZR15	193	14	230	17	949	69	1372
ZR16	583	73	30	4	188	23	801
ZR17	509	80	0	0	128	20	637
ZR18	331	64	0	0	185	36	515
ZR19	498	100	0	0	0	0	498
ZR20	188	47	0	0	212	53	400
Total	9791	66	1139	8	3947	27	14878

Lake Zurich Aquatic Plant Summary, 2015

Aquatic plants found at 161 sampling sites on Lake Zurich in July 2015.
The maximum depth that plants were found was 11 ft.

Plant Density	Chara	Coontail	Eurasian Water Milfoil	Largeleaf Pondweed	Sago Pondweed	Spatterdock	Water Stargrass	Vallisneria	White Water Lily
Absent	145	243	256	176	252	255	217	255	256
Present	28	6	1	18	3	0	13	1	0
Common	31	2	0	35	1	2	9	1	1
Abundant	29	3	0	26	1	0	15	0	0
Dominant	24	3	0	2	0	0	3	0	0
% Plant Occurance	43.6	5.4	0.4	31.5	1.9	0.8	15.6	0.8	0.4

Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	96	37.4
>0-10%	27	10.5
10-40%	38	14.8
40-60%	52	20.2
60-90%	33	12.8
>90%	11	4.3
Total Sites with Plants	161	62.6
Total # of Sites	257	100

Historical records of Aquatic Plants in Lake Zurich, 1960-2015.

Common Name	Scientific Name	2015	2008	2002	1998	1995	1994	1993	1991	1980	1974	1968	1966	1960
Coontail	*Ceratophyllum demersum*	X		X	X	X	X	X	X			X		
Muskgrass	*Chara*	X	X	X	X	X	X	X	X			X		
American Elodea	*Elodea canadensis*								X	X	X			
Slender Waterweed	*Elodea nuttalii*								X					
Water Stargrass	*Heteranthera dubia*	X	X	X	X	X	X	X	X		X			
Parrotfeather [a]	*Myriophyllum brasiliense*											X		
Milfoil	*Myriophyllum sibiricum*				X	X	X	X	X	X	X			
Milfoil	*Myriophyllum spicatum*	X	X	X	X	X	X	X	X	X	X			
Slender Naiad	*Najas flexilis*		X	X	X	X			X					
Spiny Naiad	*Najas marina*		X											
Unknown Naiad	*Najas sp.*				X									
Yellow Pond Lily or Spatterdock	*Nuphar sp.*				X	X		X	X	X	X			
Spatterdock	*Nuphar variegata*	X	X	X										
White Water Lily	*Nymphaea tuberosa*	X	X	X	X	X		X	X		X			X
Largeleaf Pondweed	*Potamogeton amplifolius*	X	X	X	X	X								
Curlyleaf Pondweed	*Potamogeton crispus*		X	X	X	X	X	X	X	X	X	X		X
Leafy Pondweed	*Potamogeton foliosus*			X			X	X	X					
Grass-leaved Pondweed	*Potamogeton gramineus*								X					
Illinois Pondweed	*Potamogeton illinoensis*								X					
American Pondweed	*Potamogeton nodosus*		X			X			X					
Small Pondweed	*Potamogeton pusillus*		X	X					X					
Pondweed	*Potamogeton richardsonii*								X					
Wigeon Grass	*Ruppia maritima*		X	X	X	X	X	X	X	X	X	X	X	X
Great Bladderwort	*Utricularia vulgaris*		X											
Sago Pondweed	*Stuckenia pectinatus*	X	X	X	X	X	X	X	X		X	X		X
Eel grass	*Vallisneria americana*	X	X	X					X					
Horned Pondweed	*Zannichellia palustris*		X	X										

*Data compiled by LCHD (1991-1995, 2002), Illinois Department of Conservation (1960-1980), and Aquatic Weed Technology (1998).
**Note: Sampling methodologies were not the same in all years. Plant identification skills vary by observer.
[a] Parrotfeather has

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

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

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

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

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

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

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

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Cedar Lake	0.0130	41.14
4	Indpendence Grove	0.0130	41.14
5	Druce Lake	0.0140	42.00
6	Windward Lake	0.0160	44.13
7	Lake Minear	0.0164	44.44
8	Sand Pond (IDNR)	0.0165	44.57
9	West Loon	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Cross Lake	0.0216	46.80
12	Banana Pond	0.0200	47.35
13	Gages Lake	0.0200	47.35
14	Lake Kathryn	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Lake Zurich	0.0210	48.19
19	Dog Training Pond	0.0220	48.72
20	Sun Lake	0.0220	48.72
21	Deep Lake	0.0230	49.36
22	Lake of the Hollow	0.0230	49.36
23	Round Lake	0.0230	49.36
24	Stone Quarry Lake	0.0230	49.36
25	Lake Barrington	0.0270	50.60
26	Bangs Lake	0.0260	51.13
27	Lake Leo	0.0260	51.13
28	Cranberry Lake	0.0270	51.68
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Little Silver Lake	0.0280	52.22
32	Fourth Lake	0.0360	53.00
33	Lambs Farm Lake	0.0310	53.67
34	Old School Lake	0.0310	53.67
35	Grays Lake	0.0310	54.00
36	Butler Lake	0.0324	54.33
37	Harvey Lake	0.0320	54.50
38	Hendrick Lake	0.0340	55.00
39	Sand Lake	0.0380	56.00
40	Third Lake	0.0384	56.00
41	Sullivan Lake	0.0370	56.22
42	Ames Pit	0.0390	56.98
43	Diamond Lake	0.0390	56.98
44	East Loon	0.0400	57.34
45	Schreiber Lake	0.0400	57.34
46	Waterford Lake	0.0400	57.34
47	Lake Tranquility (S1)	0.0412	57.38
48	Hook Lake	0.0410	57.70
49	Nielsen Pond	0.0450	59.04
50	Seven Acre Lake	0.0460	59.36
51	Turner Lake	0.0460	59.36

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

RANK	LAKE NAME	TP AVE	TSIp
52	Willow Lake	0.0460	59.36
53	Honey Lake	0.0590	59.69
54	East Meadow Lake	0.0480	59.97
55	Lucky Lake	0.0480	59.97
56	Old Oak Lake	0.0490	60.27
57	College Trail Lake	0.0500	60.56
58	Hastings Lake	0.0520	61.13
59	West Meadow Lake	0.0530	61.40
60	Wooster Lake	0.0530	61.40
61	Lucy Lake	0.0550	61.94
62	Lake Linden	0.0570	62.45
63	Lake Christa	0.0580	62.70
64	Owens Lake	0.0580	62.70
65	Briarcrest Pond	0.0580	63.00
66	Redhead Lake	0.0608	63.20
67	St. Mary's Lake	0.0608	63.41
68	Lake Lakeland Estates	0.0620	63.66
69	Lake Naomi	0.0620	63.66
70	Lake Catherine	0.0620	63.76
71	Liberty Lake	0.0630	63.89
72	North Tower Lake	0.0630	63.89
73	Werhane Lake	0.0630	63.89
74	Countryside Glen Lake	0.0640	64.12
75	Davis Lake	0.0650	64.34
76	Leisure Lake	0.0650	64.34
77	Channel Lake	0.0680	64.91
78	Buffalo Creek Reservoir 1	0.0680	65.00
79	Mary Lee Lake	0.0680	65.00
80	Little Bear Lake	0.0680	65.00
81	Timber Lake (South)	0.0720	65.82
82	Lake Helen	0.0720	65.82
83	Grandwood Park Lake	0.0720	65.82
84	Crooked Lake	0.0710	66.00
85	ADID 203	0.0730	66.02
86	Broberg Marsh	0.0780	66.97
87	Echo Lake	0.0790	67.20
88	Redwing Slough	0.0822	67.73
89	Tower Lake	0.0830	67.87
90	Countryside Lake	0.0800	68.00
91	Lake Nippersink	0.0800	68.00
92	Woodland Lake	0.0800	68.00
93	Lake Fairview	0.0890	68.00
94	Antioch Lake	0.0850	68.18
95	Potomac Lake	0.0850	68.21
96	White Lake	0.0862	68.42
97	Grand Ave Marsh	0.0870	68.55
98	North Churchill Lake	0.0870	68.55
99	McDonald Lake 1	0.0880	68.71
100	Pistakee Lake	0.0880	68.71
101	Rivershire Pond 2	0.0900	69.04
102	South Churchill Lake	0.0900	69.04

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

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

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

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

Appendix C:
Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

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

Plant Sampling

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

Plankton Sampling

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

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

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

Shoreline Assessment

Shoreline Assessment Protocol

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

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

Table 1: Degree of Shoreline Erosion

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

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

Table 2: Lateral Recession Rate Categories

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

Shoreline Buffer Condition

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

Table 3: Shoreline Buffer Condition Categories

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

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

Appendix D:
Wisconsin Department of Natural Resources
Chemical Fact Sheets

Wisconsin Department of Natural Resources

January 2012

Diquat Chemical Fact Sheet

Formulations

Diquat, or diquat dibromide, is the common name of the chemical 6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium dibromide. Originally registered by the EPA in 1986, diquat was reregistered in 1995 and is currently being reviewed again. It is sold for agricultural and household uses as well as for use on certain floating-leaf and submersed aquatic plants and some algae. The aquatic formulations are liquids: two of the more commonly used in Wisconsin are Reward™ and Weedtrine-D™ (product names are provided solely for your reference and should not be considered endorsements).

Aquatic Use and Considerations

Diquat is a fast-acting herbicide that works by disrupting cell membranes and interfering with photosynthesis. It is a non-selective herbicide and will kill a wide variety of plants on contact. It does not move throughout the plants, so will only kill parts of the plants that it contacts. Following treatment, plants will die within a week.

Diquat will not be effective in lakes or ponds with muddy water or where plants are covered with silt because it is strongly attracted to silt and clay particles in the water. Therefore, bottom sediments must not be disturbed during treatment, such as may occur with an outboard motor. Only partial treatments of ponds or bays should be conducted (1/2 to 1/3 of the water body). If the entire pond were to be treated, the decomposing vegetation may result in very low oxygen levels in the water. This can be lethal to fish and other aquatic organisms. Untreated areas can be treated 10-14 days after the first treatment.

Diquat is used to treat duckweed (*Lemna* spp.), which are tiny native plants. They are a food source for waterfowl but can grow thickly and become a nuisance. Navigation lanes through cattails (*Typha* spp.) are also maintained with diquat. Diquat is labeled for use on the invasive Eurasian watermilfoil (*Myriophyllum spicatum*) but in practice is not frequently used to control it because other herbicide options are more selective.

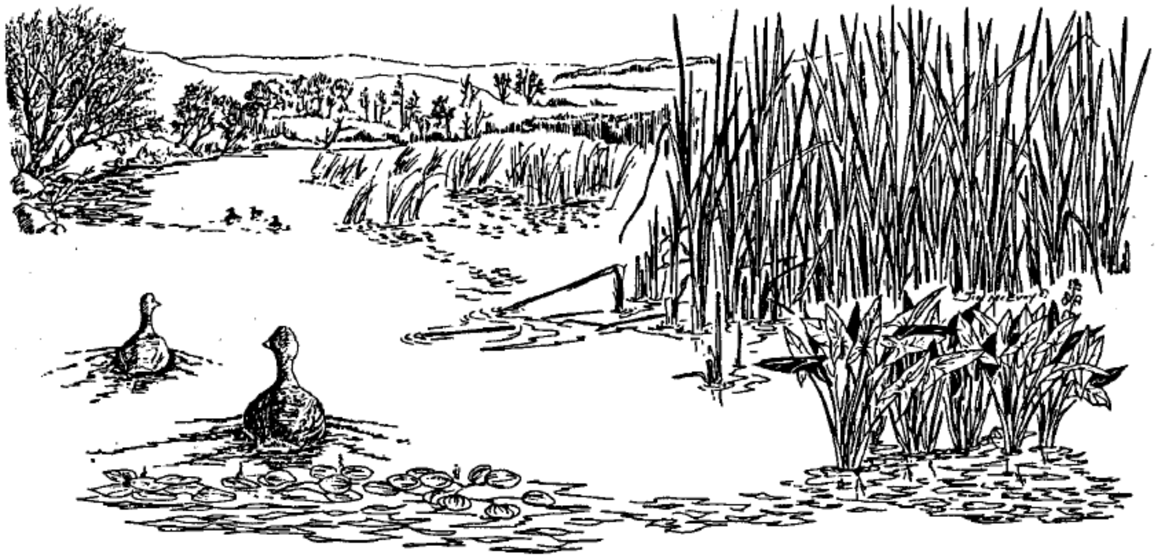
Post-Treatment Water Use Restrictions

There are no restrictions on swimming or eating fish from water bodies treated with diquat. Treated water should not be used for drinking water for one to three days, depending on the concentration used in the treatment. Do not use treated water for pet or livestock drinking water for one day following treatment. The irrigation restriction for food crops is five days, and for ornamental plants or lawn/turf, it varies from one to three days depending on the concentration used.

Herbicide Degradation, Persistence and Trace Contaminants

Diquat is not degraded by microbes. When applied to a waterbody, diquat binds with the organic matter in the sediment indefinitely. It does not degrade and will accumulate in the sediments. Diquat is usually detectable in the water column for less than a day to ~35 days after treatment. Diquat will remain in the water column longer when treating a waterbody with sandy soils due to the low organic matter and clay content. Because of its persistence and very high affinity for the soil, diquat does not leach into groundwater.

Ethylene dibromide (EDB) is a trace contaminant in diquat products. It originates from the manufacturing process. EDB is a carcinogen, and the EPA has evaluated the health risk of its presence in formulated diquat products. The maximum level of EDB in diquat dibromide is 10 ppb (parts per billion), it degrades over time, and it does not persist as an impurity.



Impacts on Fish and Other Aquatic Organisms

At application rates, diquat does not have any apparent short-term effects on most of the aquatic organisms that have been tested. However, certain species of important aquatic food chain organisms such as amphipods and Daphnia (water fleas) can be adversely affected at label application rates. Direct toxicity and loss of habitat are believed to be the causes. Tests on snails have shown that reproductive success may be affected, as well. These organisms only recolonize the treated area as vegetation becomes re-established.

Laboratory tests indicate walleye are the fish most sensitive to diquat, displaying toxic symptoms when confined in water treated with diquat at label application rates. Other game and panfish (e.g. northern pike, bass, and bluegills) are apparently not affected at these application rates. Limited field studies to date have not identified significant short or long-term impacts on fish and other aquatic organisms in lakes or ponds treated with diquat.

The bioconcentration factors measured for diquat in fish tissues is low. Therefore, bioconcentration is not expected to be a concern with diquat.

Human Health

The risk of acute exposure to diquat would be primarily to chemical applicators. Diquat causes severe skin and eye irritation and is toxic or fatal if absorbed through the skin, inhaled or swallowed. Wearing skin and eye protection (e.g. rubber gloves, apron, and goggles) to minimize eye and skin irritation is required when applying diquat.

The risk to water users of serious health impacts (e.g. birth defects and cancer) is not believed to be significant according to the EPA. Some risk of allergic reactions or skin irritation is present for sensitive individuals.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources

January 2012

2,4-D Chemical Fact Sheet

Formulations

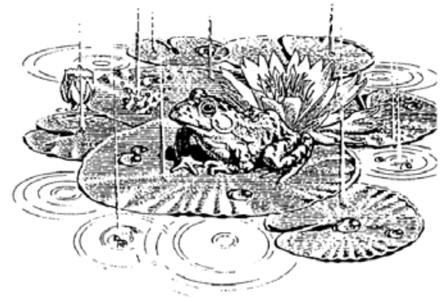
2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.



Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

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Box 7921
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DNR PUB-WT-964 2012

Wisconsin Department of Natural Resources

January 2012

Endothall Chemical Fact Sheet

Formulations

Endothall is the common name of the active ingredient endothal acid (7-oxabicyclo[2,2,1] heptane-2,3-dicarboxylic acid). Endothall products are used to control a wide range of terrestrial and aquatic plants. Both granular and liquid formulations of endothall are available for aquatic use in Wisconsin. Two types of endothall are available: dipotassium salt (such as Aquathol®) and monoamine salts (such as Hydrothol 191). Trade names are provided for your reference only and are neither exhaustive nor endorsements of one product over another.

Aquatic Use and Considerations

Endothall is a contact herbicide that prevents certain plants from making the proteins they need. Factors such as density and size of the plants present, water movement, and water temperature determine how quickly endothall works. Under favorable conditions, plants begin to weaken and die within a few days after application.

Endothall products vary somewhat in the target species they control, so it is important to always check the product label for the list of species that may be affected. Endothall products are effective on Eurasian watermilfoil (*Myriophyllum spicatum*) and also kill desirable native species such as pondweeds (*Potamogeton* spp.) and coontail (*Ceratophyllum* spp.). In addition, Hydrothol 191 formulations can also kill wild celery (*Vallisneria americana*) and some species of algae (*Chara, Cladophora, Spirogyra, and Pithophora*).

Endothall will kill several high value species of aquatic plants (especially *Potamogeton* spp.) in addition to nuisance species. The plants that offer important values to aquatic ecosystems often resemble, and may be growing with those plants targeted for treatment. Careful identification of plants and application of endothall products is necessary to avoid unintended harm to valuable native species.

For effective control, endothall should be applied when plants are actively growing. Most submersed weeds are susceptible to Aquathol formulations. The choice of liquid or granular formulations depends on the size of the area requiring treatment. Granular is more suited to small areas or spot treatments, while liquid is more suitable for large areas.

If endothall is applied to a pond or enclosed bay with abundant vegetation, no more than 1/3 to ½ of the surface should be treated at one time because excessive decaying vegetation may deplete the oxygen content of the water and kill fish. Untreated areas should not be treated until the vegetation exposed to the initial application decomposes.

Post-Treatment Water Use Restrictions

Due to the many formulations of this chemical the post-treatment water use restrictions vary. Each product label must be followed. For all products there is a drinking water standard of 0.1 ppm and can not be applied within 600 feet of a potable water intake. Use restrictions for Hyrdtohol products have irrigation and animal water restrictions.

Herbicide Degradation, Persistence and Trace Contaminants

Endothall disperses with water movement and is broken down by microorganisms into carbon, hydrogen, and oxygen. Field studies show that low concentrations of endothall persist in water for several days to several weeks depending on environmental conditions. The half-life (the time it takes for half of the active ingredient to degrade) averages five to ten days. Complete degradation by microbial action is 30-60 days. The initial breakdown product of endothall is an amino acid, glutamic acid, which is rapidly consumed by bacteria.

Impacts on Fish and Other Aquatic Organisms

At recommended rates, the dipotassium salts (Aquathol and Aquathol K) do not have any apparent short-term effects on the fish species that have been tested. In addition, numerous studies have shown the dipotassium salts induce no significant adverse effects in aquatic invertebrates (such as snails, aquatic insects, and crayfish) when used at label application rates. However, as with other herbicide use, some plant-dwelling populations of aquatic organisms may be adversely affected by application of endothall formulations due to habitat loss.

In contrast to the low toxicity of the dipotassium salt formulations, laboratory studies have shown the monoamine salts (Hydrothol 191 formulations) are toxic to fish at dosages above 0.3 parts per million (ppm). In particular, the liquid formulation will readily kill fish present in a treatment site. By comparison, EPA approved label rates for plant control range from 0.05 to 2.5 ppm. In recognition of the extreme toxicity of the monoamine salt, product labels recommend no treatment with Hydrothol 191 where fish are an important resource.

Other aquatic organisms can also be adversely affected by Hydrothol 191 formulations depending upon the concentration used and duration of exposure. Tadpoles and freshwater scuds have demonstrated sensitivity to Hydrothol 191 at levels ranging from 0.5 to 1.8 ppm.

Findings from field and laboratory studies with bluegills suggest that bioaccumulation of dipotassium salt formulations by fish from water treated with the herbicide is unlikely. Tissue sampling has shown residue levels become undetectable a few days after treatment.

Human Health

Most concerns about adverse health effects revolve around applicator exposure. Liquid endothall formulations in concentrated form are highly toxic. Because endothall can cause eye damage and skin irritation, users should minimize exposure by wearing suitable eye and skin protection.

At this time, the EPA believes endothall poses no unacceptable risks to water users if water use restrictions are followed. EPA has determined that endothall is not a neurotoxicant or mutagen, nor is it likely to be a human carcinogen.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
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http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources

January 2012

Fluridone Chemical Fact Sheet

Formulations

Fluridone is an aquatic herbicide that was initially registered with the EPA in 1986. The active ingredient is 1-methyl-3-phenyl-5-3-(trifluoromethyl)phenyl|-41H|-pyridinone. Both liquid and slow-release granular formulations are available. Fluridone is sold under the brand names Avast!, Sonar, and Whitecap (product names are provided solely for your reference and should not be considered endorsements).

Aquatic Use and Considerations

Fluridone is an herbicide that stops the plant from making a protective pigment that keeps chlorophyll from breaking down in the sun. Treated plants will turn white or pink at the growing tips after a week and will die in one to two months after treatment as it is unable to make food for itself. It is only effective if plants are growing at the time of treatment.

Fluridone is used at very low concentrations, but a very long contact time is required (45-90 days). If the fluridone is removed before the plants die, they will once again be able to produce chlorophyll and grow.

Fluridone moves rapidly through water, so it is usually applied as a whole-lake treatment to an entire waterbody or basin. There are pellet slow-release formulations that may be used as spot treatments, but the efficacy of this is undetermined. Fluridone has been applied to rivers through a drip system to maintain the concentration for the required contact time.

Plants vary in their susceptibility to fluridone, so typically some species will not be affected even though the entire waterbody is treated.

Plants have been shown to develop resistance to repeated fluridone use, so it is recommended to rotate herbicides with different modes of action when using fluridone as a control.

Fluridone is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). It also is commonly used for control of invasive hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*), neither of which are present in Wisconsin yet. Desirable native species that are usually affected at concentrations used to treat the invasives include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of fluridone (the time it takes for half of the active ingredient to degrade) ranges from 4 to 97 days depending on water conditions. After treatment, the fluridone concentration in the water is reduced through dilution due to water movement, uptake by plants, adsorption to the sediments, and break down from light and microbial action.

There are two major degradation products from fluridone: n-methyl formamide (NMF) and 3-trifluoromethyl benzoic acid. NMF has not been detected in studies of field conditions, including those at the maximum label rate.

Fluridone residues in sediments reach a maximum in one to four weeks after treatment and decline in four months to a year depending on environmental conditions. Fluridone adsorbs to clay and soils with high organic matter, especially in pellet form, and can reduce the concentration of fluridone in the water. Adsorption to the sediments is reversible; fluridone gradually dissipates back into the water where it is subject to chemical breakdown.

Impacts on Fish and Other Aquatic Organisms

Fluridone does not appear to have any apparent short-term or long-term effects on fish at application rates.

Fish exposed to water treated with fluridone absorb fluridone into their tissues. Residues of fluridone in fish decrease as the herbicide disappears from the water. The EPA has established a tolerance for fluridone residues in fish of 0.5 parts per million (ppm).

Studies on Fluridone's effects on aquatic invertebrates (i.e. midge and water flea) have shown increased mortality at label application rates.

Studies on birds indicate that fluridone would not pose an acute or chronic risk to birds. No studies have been conducted on amphibians or reptiles.

Human Health

The risk of acute exposure to fluridone would be primarily to chemical applicators. The acute toxicity risk from oral and inhalation routes is minimal. Concentrated fluridone may cause some eye or skin irritation. No personal protective equipment is required on the label to mix or apply fluridone.

Fluridone does not show evidence of causing birth defects, reproductive toxicity, or genetic mutations in mammals tested. It is not considered to be carcinogenic nor does it impair immune or endocrine function.

There is some evidence that the degradation product NMF causes birth defects. However, since NMF has only been detected in the lab and not following actual fluridone treatments, the manufacturer and EPA have indicated that fluridone use should not result in NMF concentrations that would adversely affect the health of water users. In the re-registration assessment that is currently underway for fluridone, the EPA has requested additional studies on both NMF and 3-trifluoromethyl benzoic acid.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

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Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

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Wisconsin Department of Natural Resources

January 2012

Triclopyr Chemical Fact Sheet

Formulations

Triclopyr was initially registered with the EPA in 1979 and was reregistered in 1997. Triclopyr acid has different formulations for aquatic and terrestrial use. The active ingredient triethylamine salt (3,5,6-trichloro-2-pyridinyloxyacetic acid), commonly called triclopyr, is the formulation registered for use in aquatic systems. It is sold both as a liquid (Renovate 3™) as well as a granular form (Renovate OTF™) for control of submerged, emergent and floating-leaf vegetation. There is also a liquid premixed formulation (Renovate Max G™) that contains triclopyr plus 2,4-D, another aquatic herbicide.

Aquatic Use and Considerations

Triclopyr is used to treat the invasive Eurasian watermilfoil (Myriophyllum spicatum). Desirable native species that may also be affected include native milfoils, water shield (*Brasenia schreberi*), pickerelweed (*Pontederia cordata*), and lilies (*Nymphaea* spp. and *Nuphar* spp.).

Triclopyr is a systemic herbicide that moves throughout the plant tissue and works by interfering with cell growth and division. Following treatment, plant growth will be abnormal and twisted, and then plants will die within two to three weeks after application. Plants will decompose over several weeks.

Triclopyr needs to be applied to plants that are actively growing. A water body should not be treated with triclopyr if there is an outlet, or in moving waters such as rivers or streams. If there is water movement at a treated site, higher concentrations or a repeated application may be required.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, or pet/livestock drinking water use. Before treated water can be used for irrigation, the concentration must be below one part per billion (ppb), or at least 120 days must pass. Treated water should not be used for drinking water until concentrations of triclopyr are less than 400 ppb.

Herbicide Degradation, Persistence and Trace Contaminants

Triclopyr is broken down rapidly by light and microbes and has a half-life (the time it takes for half of the active ingredient to degrade) of about a day. Dissipation studies in lakes indicate that the half-life in natural systems ranges from 0.5 to 7.5 days. Lakes with more organic matter in the soil will have more rapid degradation.

The initial breakdown products of triclopyr are TCP (3,5,6-trichloro-2-pyridinol) and TMP (3,5,6-trichloro-2-methoxypridine). TCP and TMP appear to be slightly more toxic to aquatic organisms than triclopyr; however the peak concentration of these degradates is very low following treatment, so that they do not pose a concern to aquatic organisms. The half-lives for TCP and TMP are similar to those of triclopyr.

Triclopyr doesn't bind to soil, and limited leaching of triclopyr and its degradation products may occur. It likely is not mobile enough to contaminate groundwater, and EPA has determined that the evidence of possible leaching is not sufficient to require further study.

Impacts on Fish and Other Aquatic Organisms

Testing indicates that the aquatic formulation of triclopyr is practically non-toxic to fish and invertebrates. Species tested included catfish, trout, bluegill, minnows, crayfish and water fleas (*Daphnia* sp.). Triclopyr is slightly toxic to mallards, but at concentrations well above (400x) the highest allowed application rate. Water pH will affect toxicity because greater exposure to triclopyr will occur in low pH water. Tests have not been conducted in low pH water except for salmon species. However, the margin of safety in the toxicity tests that were conducted suggest that even in low pH water there would not be toxic effects on fish.

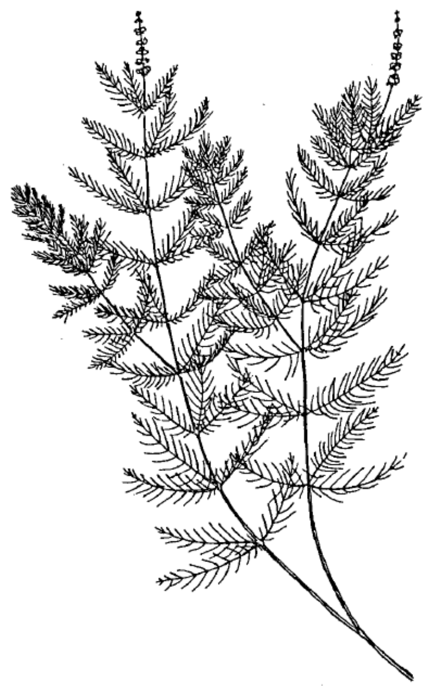
Tests on the degradation product TCP indicate that acute effects to bluegill and rainbow trout would not occur at label usage rates, although it is slightly more toxic than triclopyr. The degradation product TMP is moderately toxic to fish, but after treatment is found only in low proportions if it is detected at all. The EPA has requested additional data to evaluate the fate of the degradation product TCP in aquatic systems as well as its chronic toxicity to fish.

Triclopyr and TCP do not bioaccumulate and clear from fish and crayfish tissues at rates similar to that which occurs in the water. TMP does appear to bioaccumulate in fatty fish tissues, such as inedible and visceral tissues, but does not persist in fish following TMP disappearance from the water.

Human Health

The risk of acute exposure to triclopyr would be primarily to chemical applicators. Concentrated triclopyr does not pose an inhalation risk, but can cause skin irritation and eye corrosion. Persons who mix or apply triclopyr need to protect their skin and eyes from contact. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with triclopyr.

Triclopyr does not show evidence of birth defects, reproductive toxicity or genetic mutations in mammals tested. Triclopyr is not metabolized by humans and the majority is excreted intact. Some tumors of breast tissue occurred in tests on rodents; however there was no consistent pattern and insufficient evidence to list triclopyr as a carcinogen. Based on its low acute toxicity to mammals, and its rapid disappearance from the water column due to light and microbial degradation, triclopyr is not considered to pose a risk to water users.



For Additional Information

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Wisconsin Department of Natural Resources

January 2012

Copper Compounds Chemical Fact Sheet

Formulations

Copper has been used as an aquatic herbicide and algaecide since 1950. Copper compounds for aquatic use are manufactured either as copper sulfate, or as a copper chelate. Both forms contain metallic copper as the active ingredient, but in the chelate forms the copper is combined with other compounds to keep the copper in solution and active in the water longer. Chelated copper is also less toxic to non-target organisms.

There are copper sulfate products available as fungicides and other terrestrial uses, which are not allowed for use in water. Aquatic copper products are sold under a variety of brand names, including Nautique™, Komeen®, Captain™, K-Tea™, Earthec®, Cutrine®-Plus, Clearigate® and SeClear (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

Copper products are primarily used to treat algae but certain formulations will affect some plants, as well. The target species vary by product, so it is important to confirm that the intended target is listed on the label of the product being used.

Copper works by interfering with enzyme production. Results from treatments for algae occur within hours, while the effects of treatment on plants will be evident in about a week. Large-scale algae die-off can deplete oxygen levels in the water quickly, which can be lethal to fish and other aquatic life. If more than a 1/3 of the total water area is covered in algae, treatments should be done in sections, and applied in a pattern that allows fish an escape route to untreated water. Ten to fourteen days are needed between treatments to protect fish and aquatic life.

Copper products will treat blue-green (free-floating) algae and filamentous (mat-forming)

algae as well as larger algae species that look like plants, such as *Chara* spp. and *Nitella* spp.. In Wisconsin, copper is not typically used to treat aquatic plants, but some are labeled to treat the invasives Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), as well as the native species coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*), sago pondweed (*Stuckenia pectinata*) and water celery (*Vallisneria americana*).

Determining the correct copper formulation and calculating the proper dosage are key factors in determining how well copper will control undesirable algae. Applicators need to consider target species, water hardness, water temperature, amount of algae present, as well as water clarity and flow.

In hard or alkaline waters, copper sulfate tends to settle to the bottom within 24 hours after application. Chelated copper remains in solution longer, allowing for a longer contact time with the algae.

All copper formulations can be toxic to some species of fish at recommended application rates, especially if the water has less than 50 ppm (parts per million) of carbonate hardness (soft water). However, toxicity generally decreases as water hardness increases.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, human drinking water, pet/livestock drinking water, or irrigation.

Herbicide Degradation, Persistence and Trace Contaminants

Copper is an element, and so is not broken down like other herbicides. Copper precipitates out of the water over a few days and settles into the sediments, where it persists indefinitely and accumulates over time. The buildup of copper in lake sediments is a serious concern, because high concentrations of copper in the sediment are toxic to both plant and animal life.

Impacts on Fish and Other Aquatic Organisms

Copper sulfate is rarely used in Wisconsin, in part due to its high toxicity to invertebrates (water fleas, crustaceans, mollusks, mayflies, snails, and crayfish) and multiple species of fish (trout, bluegill and minnow) at typical application concentrations. The chelated forms of copper have different toxicology profiles from each other and from copper sulfate.

The chelated copper products can also be toxic to fish at application rates, particularly to trout and bluegill in soft water ($CaCO_3$ <50ppm). Applications to harder water provide a greater margin of safety to fish.

Many of the chelated copper products are also toxic to invertebrates at application rates. High concentrations of copper in lake sediment can be toxic to invertebrates that live on the lake bottom, as well. These invertebrates are an important source of fish food.

Copper does temporarily accumulate in fish, but more in the gills and the liver than in muscle tissue. The copper in fish tissues are reduced once the copper level in the water is reduced.

The EPA risk assessment for birds and small mammals (based on dietary consumption) indicates that some risk may be present to birds or mammals at the worst-case scenario. However, this maximum dietary exposure scenario is likely much higher than the exposure level that might occur to birds when copper is released into the environment as an algaecide. Birds, like humans, can physiologically acclimate to higher concentrations of copper in order to slow its uptake. Studies of copper's effects on birds have shown to be toxic at high levels; however, effects at standard treatment levels have not been shown to be harmful. Studies have shown that even at low levels (.07ppm) copper sulfate can have detrimental effects on amphibians, including slowed growth rates, decreased mobility and death. Effects on reptiles have not been documented.

Human Health

The risk of acute exposure to copper is primarily to chemical applicators. The acute toxicity risk from oral and inhalation routes is minimal; however concentrated copper products can be corrosive to the eyes and cause irreversible damage. Prolonged or frequent skin contact can cause allergic reactions in some people. Goggles, protective clothing, and rubber gloves are required when handling.

Even with regular use for many years, very few chronic health concerns have been documented. In one study agricultural applicators of copper were found to have some signs of liver damage, and there is some evidence that high copper may impair immune function. Copper is not carcinogenic.

For Additional Information

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