LAKE COUNTY, IL

2019 BIG BEAR AND LITTLE BEAR SUMMARY REPORT

LAKE COUNTY HEALTH DEPARTMENT

ECOLOGICAL SERVICES

Bear Lake 2019

Big Bear and Little Bear Lakes are located within Century Park in the Village of Vernon Hills. Both lakes were created in the mid-1970's as residential and commercial areas were developed. Both lakes are situated along the Seavey Drainage Ditch. Big Bear Lake receives flow from the Seavey Ditch at the northwest corner of the lake. It is directly connected to Little Bear Lake by a short channel at its southwest corner. Little Bear Lake is the recipient of Big Bear Lake and Harvey lake located to it's east. Once water passes through these lakes it is delivered via the outlet back into the Seavey Drainage Ditch, and eventually the Des Plaines River.

The Lake County Health Department - Ecological Services (LCHD-ES) monitored Big Bear and Little Bear as part of routine water quality sampling. Additionally, LCHD-ES conducted an aquatic plant survey in August 2019 and a shoreline assessment in September 2019. Due to the connectivity of the two lakes, this report will discuss the study results for both lakes.

In 2019, the Des Plaines River Watershed Workgroup Lakes Committee contracted with the Lake County Health Department to monitor inlets on Big Bear, Little Bear, and Lake Charles to get a better understanding of pollutant loads entering the lake, specifically looking at total suspended solids (TSS), total phosphorus (TP), and chlorides. LCHD monitored 10 inlets including Seavey Ditch on Big Bear Lake and 7 inlets on Little Bear Lake.

ECOLOGICAL SERVICES WATER QUALITY SPECIALISTS

Gerard Urbanozo
gurbanozo@lakecountyil.gov

Ecological Services
847-377-8020

Alana Bartolai
abartolai2@lakecountyil.gov

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BIG BEAR LAKE SUMMARY

LAKE FACTS

MAJOR WATERSHED:

Des Plaines

SUB-WATERSHED:

Seavey Ditch/ Indian Creek

SURFACE AREA:

25.14

SHORELINE LENGTH:

Big Bear 1.00 Mile

MAXIMUM DEPTH:

9.98 Feet

AVERAGE DEPTH:

5.01 Feet

LAKE VOLUME:

125.84 acre-feet

WATERSHED AREA:

4277.07 acres

LAKE TYPE:

Impoundment

MANAGEMENT ENTITY:

Village of Vernon Hills

CURRENT USES:

Boating, Fishing, and Aesthetics

ACCESS:

Public

The following is a summary of the water quality sampling, shoreline survey and aquatic macrophyte survey from the 2019 monitoring season on Big Bear Lake. The complete data sets can be found in Appendix A & B of this report, and discussed in further detail in the following sections. Included in the Appendix is an "Understanding Your Lake Data" guide that will help with additional questions about water chemistry results.

- Average water clarity as measured by Secchi depth in 2019 was 2.58 ft., which is an increase from 2012 (1.32 ft.), and is below the Lake County median Secchi depth of 3.0 ft.
- Big Bear Lake ranks 100 out of 161 lakes surveyed in Lake County between 2000 and 2019 for Secchi disk clarity.
- Water clarity is influenced by the amount of particles in the water column; this is measured by total suspended solids (TSS). The average epilimnion TSS concentration in Big Bear Lake was 10.4 mg/L in 2019, which is above the Lake County median of 8.3 mg/L and a decrease since 2012 (18.1 mg/L).
- Nutrient availability indicated that Big Bear had an average TN:TP ratio of 24:1 which indicates that the lake is phosphorus limited.
- In 2019, the average total epilimnion phosphorus concentration was 0.051 mg/L. This is above the Illinois Environmental Protection Agency (IEPA) water quality standard of 0.05 mg/L. This was a decrease in Total Phosphorus concentration since 2012 (0.096 mg/L). Big Bear Lake, like many of the lakes in Lake County, is impaired for total phosphorus.
- The average conductivity of Big Bear Lake was 0.6438 mS/cm which is lower than the county median (0.7870 mS/cm). This was an decrease from the 2012 average (0.9866 mS/cm). The average chloride concentration for Big Bear Lake in 2019 was 101 mg/L which was lower than the county median of 139 mg/L. Road salts are the primary source of Cl^- in Lake County.
- Trophic State Index (TSIp) value for Big Bear Lake is 60.96, meaning it is eutrophic. This means that the lake is high in nutrients, Eutrophic lakes are usually either weedy or subject to frequent algae blooms, or both.
- Surface dissolved oxygen (DO) concentration averaged of 10.85 mg/L in Big Bear Lake and is considered adequate to support fisheries. Fish can suffer oxygen stress when DO drops below 5 mg/L. Epilimnion DO concentration ranged from 9.47 mg/L in September to 14.98 mg/L in May.
- The aquatic plant community was assessed in August 2019 when most of the plants are likely to be present. Seventy seven percent of the sites sampled had aquatic plants present with 6 different species. Eurasian Watermilfoil and Coontail were the most abundant species found at 61.5% of the sites followed by White Water Lily at 11.5%. Eurasian Watermilfoil is an exotic and invasive aquatic plant species.
- Based on the shoreline assessment, 83% of Big Bear Lake had no erosion along the shoreline and 11% had slight,4% had moderate, and 2% had severe erosion observed.
- Based on the shoreline buffer assessment, only 8.5% of the shoreline had good shoreline buffer, where >25 feet of the shoreline had minimal impervious surfaces and abundant native vegetation.

LITTLE BEAR LAKE SUMMARY

LAKE FACTS

MAJOR WATERSHED:

Des Plaines

SUB-WATERSHED:

Seavey Ditch/ Indian Creek

SURFACE AREA:

26.44

SHORELINE LENGTH:

1.66 Mile

MAXIMUM DEPTH:

21.88 Feet

AVERAGE DEPTH:

7.04 Feet

LAKE VOLUME:

186.03 acre-feet

WATERSHED AREA:

4277.07 acres

LAKE TYPE:

Impoundment

MANAGEMENT ENTITY:

Village of Vernon Hills

CURRENT USES:

Boating, Fishing, and Aesthetics

ACCESS:

Public

The following is a summary of the water quality sampling, shoreline survey and aquatic macrophyte survey from the 2019 monitoring season on Big Bear Lake. The complete data sets can be found in Appendix A & B of this report, and discussed in further detail in the following sections. Included in the Appendix is an "Understanding Your Lake Data" guide that will help with additional questions about water chemistry results.

- Average water clarity as measured by Secchi depth in 2019 was 4 ft., which is an increase from 2012 (2.38 ft.), and is above the Lake County median Secchi depth of 3.0 ft.
- Little Bear Lake ranks 57th out of 161 lakes surveyed in Lake County between 2000 and 2019 for Secchi disk clarity.
- Water clarity is influenced by the amount of particles in the water column; this is measured by total suspended solids (TSS). The average epilimnion TSS concentration in Little Bear Lake was 5.0 mg/L in 2019, which is below the Lake County median of 8.3 mg/L and a decrease since 2012 (11.4 mg/L).
- Nutrient availability indicated that Little Bear had an average TN:TP ratio of 23:1 which indicates that the lake is phosphorus limited.
- In 2019, the average total epilimnion phosphorus concentration was 0.036 mg/L. This is below the Illinois Environmental Protection Agency (IEPA) water quality standard of 0.05 mg/L. This was a decrease in Total Phosphorus concentration since 2010 (0.068 mg/L). Little Bear Lake, like many of the lakes in Lake County, is impaired for total phosphorus.
- The average conductivity of Little Bear Lake was 0.9305 mS/cm which is higher than the county median (0.7870 mS/cm). This was decrease from the 2012 average (1.0220 mS/cm). The average chloride concentration for Little Bear Lake in 2019 was 108 mg/L which was lower than the county median of 139 mg/L. Road salts are the primary source of Cl^- in Lake County.
- Trophic State index (TSIp) value for Little Bear Lake is 55.7, meaning it is eutrophic. This means that the lake is high in nutrients, Eutrophic lakes are usually either weedy or subject to frequent algae blooms, or both.
- Surface dissolved oxygen (DO) concentration averaged of 11.29 mg/L in Little Bear Lake and is considered adequate to support fisheries. Fish can suffer oxygen stress when DO drops below 5 mg/L. Epilimnion DO concentration ranged from 9.27 mg/L in July to 15.60 mg/L in May.
- The aquatic plant community was assessed in August 2019 when most of the plants are likely to be present. Seventy seven percent of the sites sampled had aquatic plants present with 6 different species. Coontail was the most abundant species found at 76.7% of the sites followed by Eurasian Watermilfoil and Brittle Naiad occurring at 46.7% and 10%, respectively. Eurasian Watermilfoil is an exotic and invasive aquatic plant species.
- Based on the shoreline assessment, 60% of Little Bear Lake had no erosion along the shoreline, 27% had slight, 8% had moderate, and 5% had severe erosion observed.
- Based on the shoreline buffer assessment, only 1.6% of the shoreline had fair and 98.4% had poor shoreline buffer, where >25 feet of the shoreline had minimal impervious surfaces and abundant native vegetation.

WATERSHED & LAND USE

Big and Little Bear Lake's watershed is 4277.07 acres (Figure 1). The dominant land uses in the watershed are Single Family (37.3%), Public and Private Open Space (20.2%), and Public and Transportation (16.8%). Overall, the watershed has 37.6% developed land, whereas the majority is undeveloped. The lakes retention time (lake volume/run off) is 10.12 days. It is important to properly manage the lands in a way that minimizes pollutants such as phosphorus, nitrogen, and chlorides from entering the lake.

Based on the amount of impervious surfaces each land use contributes varied amounts of runoff. Because impervious surfaces (parking lots, roads, buildings, compacted soil) do not allow rain to infiltrate into the ground, more runoff is generated than in the undeveloped condition. The major sources of runoff for Big Bear Lake were Transportation (37%) and Single Family (29%). Runoff is referring to the amount of water making its way to the lake, however, each land use contributes different amount of pollutant loads associated with it's runoff. The water land use does not have high pollutants associated with it since it refers to the rainfall falling directly on the lake. Pollutants in rainfall are mostly related to atmospheric deposition and while contribute contaminants do so at a lower quantity than other land uses in urbanized areas. For example, the transportation land use, and other impervious surfaces, contain higher pollutants that are carried to the lake by runoff. In Big and Little Bear Lakes most pollutants are likely a result of the runoff from transportation and single family homes land uses.

Figure 1: *Big Bear and Little Bear Lake 2019 Land Use and Watershed Boundary*

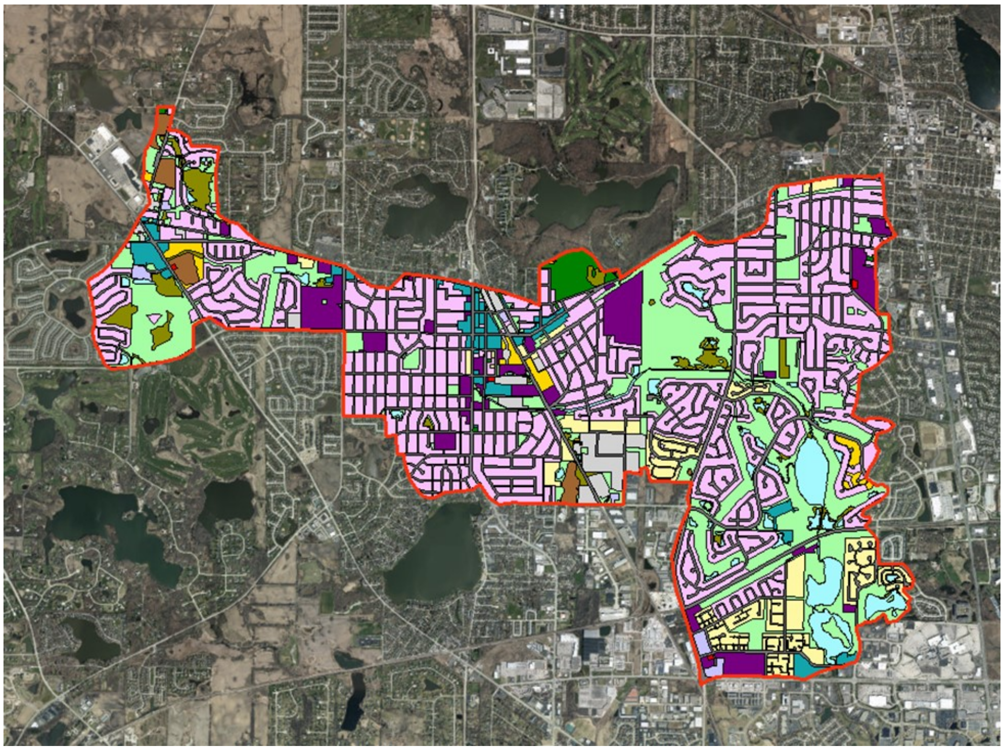


Table 1: *Big Bear & Little Bear Lake 2019 Land Use and Estimated Runoff*

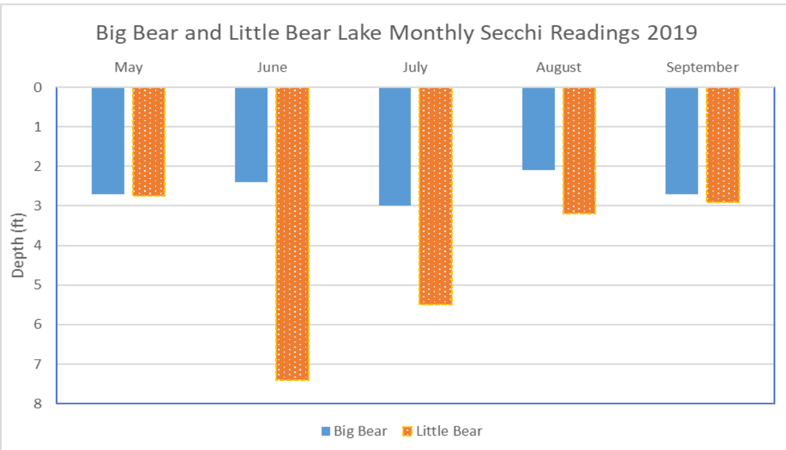
Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	45.08	0.05	6.2	0.1
Disturbed Land	43.12	0.05	5.9	0.1
Forest and Grassland	46.11	0.05	6.3	0.1
Government and Institutional	227.84	0.50	313.3	6.9
Industrial	100.59	0.80	221.3	4.9
Multi Family	233.59	0.50	321.2	7.1
Office	22.83	0.85	53.4	1.2
Public and Private Open Space	862.80	0.15	355.9	7.8
Retail/Commercial	105.31	0.85	246.2	5.4
Single Family	1593.61	0.30	1314.7	29.0
Transportation	717.55	0.85	1677.3	37.0
Utility and Waste Facilities	3.04	0.30	2.5	0.1
Water	171.57	0.00	0.0	0.0
Wetlands	104.05	0.05	14.3	0.3
TOTAL	**4277.07**		**4538.5**	**100.0**

WATER CLARITY

Water clarity is typically measured with a Secchi disk and is primarily used as an indicator of algal abundance and general lake productivity. Although it is only indicator, Secchi disk depth is the simplest and one of the most effective tools for estimating a lakes' productivity. It can also provide an indirect measurement of the amount of suspended materials in the water. A number of factors can interfere with light penetration and reduce water clarity. This includes: algae, water color, re-suspended bottom sediments, eroded soil, and invasive species.

The 2019 average water clarity in Big Bear and Little Bear Lake, based on Secchi depth, was 2.58 ft and 4.35 ft respectively. The highest water clarity reading for Big Bear was in May at 3 ft. and the lowest water clarity reading was in August (2.10 ft.) Big Bear Lake has lower water clarity than Little Bear Lake since it is shallower and more susceptible to sediment resuspension from wind, wave and carp activity. Sediments from Seavey Ditch inlet that flows into Big Bear also contributes to the decrease in water clarity. Aquatic plants help filter out nutrients and sediments as water flows through Big Bear and into Little Bear Lake the water clarity increases. The highest water clarity reading for Little Bear Lake, based on Secchi depth, was in June at 7.40 ft and the lowest reading was in May at 2.75 ft.

Figure 2: *Big and Little Bear Lakes Monthly Secchi Readings 2019*



The increase in water clarity in the Bear Lake system can be attributed to the increase in aquatic plant density and shoreline stabilization around most of the lakes. Aquatic plants compete with algae for nutrients and stabilize lake bottom sediments. The stabilized banks around the lake has lessened the impacts of wind and wave activity.

Secchi readings have significantly increased in Big Bear from 1.32 ft (2012) to 2.58 ft (2019) and in Little Bear from 2.38 ft (2012) to 4.35 ft (2019). Increase in water clarity should help extend aquatic plant growth deeper into the lake and will benefit the fish communities and lessen the impact of algae blooms during the summer months.

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). The sampling season is May through October with measurements taken twice a month.

LCHD recommends that Big & Little Bear Lakes continue participating in the VLMP Program. This will provide valuable data for the lake as it provides annual data and can help look at long term trends.

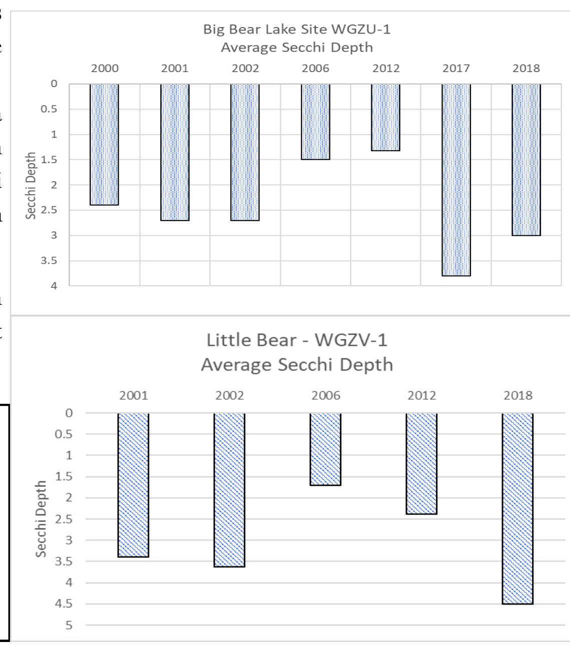
FOR MORE INFORMATION ON THE VLMP PROGRAM

Contact: Alana Bartolai

abartolai2@lakecountyil.gov

847-377-8009

Figure 3: *Big and Little Bear VLMP Data*



TOTAL SUSPENDED SOLIDS

The Total Suspended Solids (TSS) parameter represents the concentration of all organic and inorganic materials suspended in the lakes water column, which includes both sediment and algal cells. Typical inorganic components of TSS are referred to as non-volatile suspended solids (NVSS) and originate from weathering and erosion of rocks and solids in the lakes watershed. The organic portion of TS are referred to as volatile suspended solids (TVS) and are mostly composed of algae and other organic matter such as decaying plants.

Chnges in seasonal Secchi readings are affected by algal growth. The absence or low density of algae in early spring usually provides deeper clarity but as the water warms clarity decreases with more algae present in the water. The 2019 TSS concentrations in the epilimnion of Big Bear and Little Bear Lake averaged 10.4 mg/L and 4.7 mg/L respectively. TSS concentrations have decreased since 2012 for Big Bear (18.1 mg/L) and Little Bear (11.4 mg/L) Lakes.

Big Bear Lake was above the Lake County median of 8 mg/L. TSS ranged from a high of 21 mg/L in September to it's lowest concentration of 6.5 mg/L, which occurred in June (Figure 4). High TSS values correlated with decrease in water clarity (Secchi disk depth) and can be detrimental to many aspects of lake ecosystem including the plant and fish communities. Over 1" of rain was recorded just 3 days before the September water sample was taken which contributed to the highest TSS concentration for Big Bear Lake.

Big Bear Lake acts as a buffer by allowing sediments and nutrients from Seavey Ditch to settle before entering Little Bear Lake. The result is a lower TSS and TP concentration in Little Bear. The Little Bear TSS values ranged from 2.4 mg/L in June to it's highest concentration in August of 6.6 mg/L. The higher density of aquatic plants in Big and Little Bear also helps absorb and stabilize nutrients and sediments as it flows through the lake.

Figure 4: *Total Suspended Solid Concentrations in Big and Little Bear Lake, 2019.*

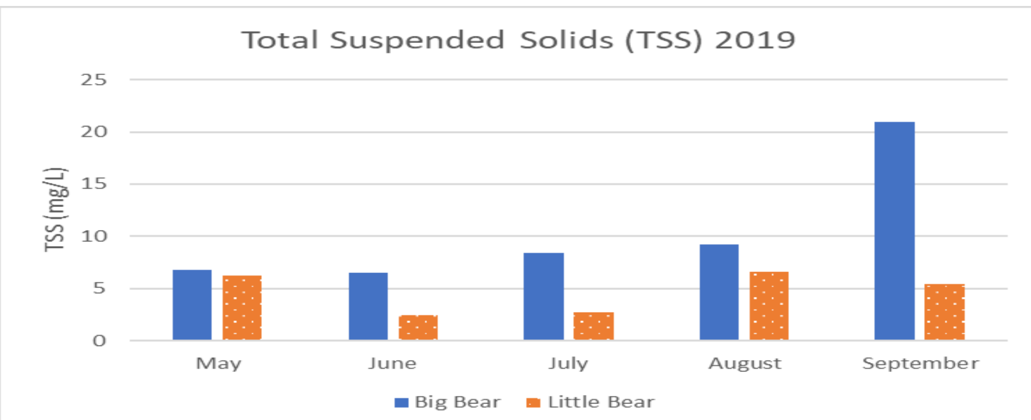
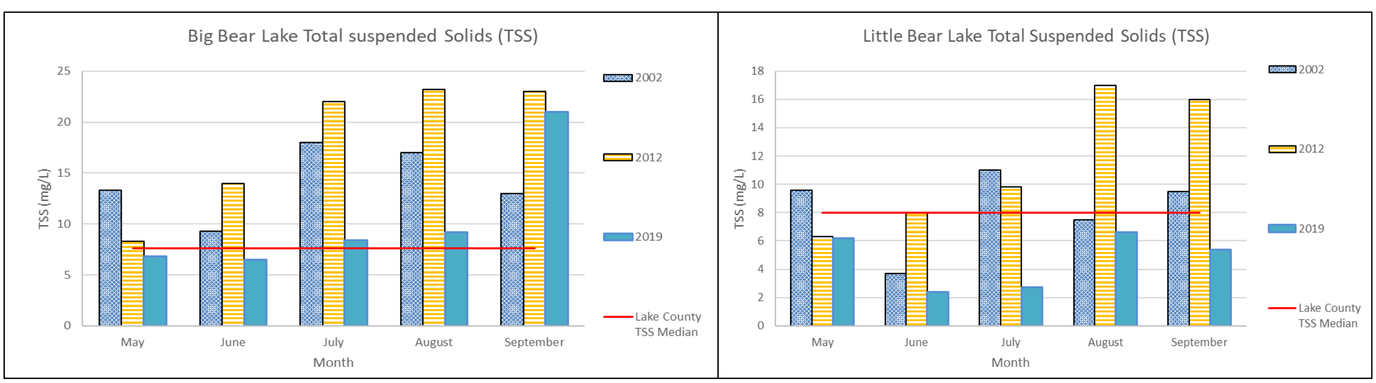


Figure 5: *Total Suspended Solid Concentrations for Big and Little Bear Lake, 2019.*



TSS

Total Suspended

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

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.

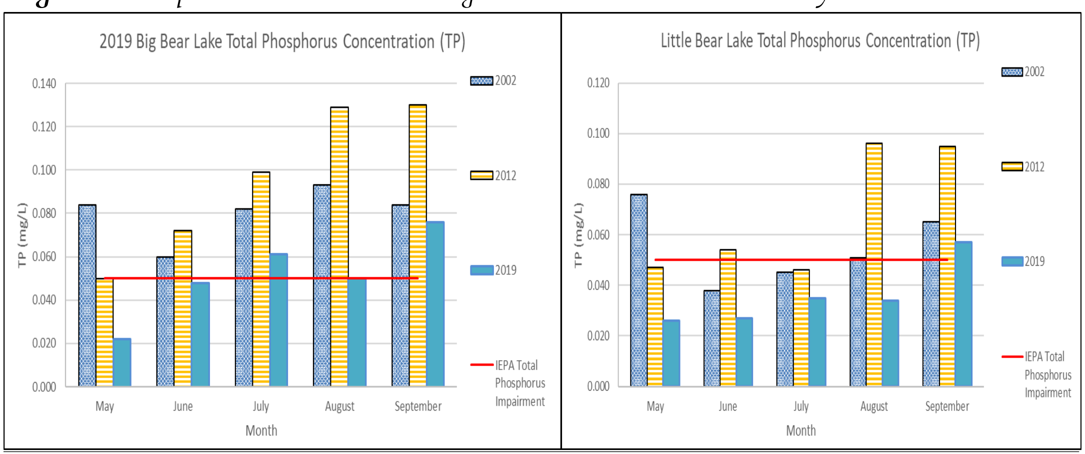
NUTRIENTS: PHOSPHORUS

In a lake, the primary nutrients needed for aquatic plant growth are phosphorus (P) and nitrogen (N). Sources of phosphorus can be external, internal, or both. External sources include: human and animal waste, soil erosion, detergents, sewage treatment plants, septic systems, and runoff from lawns. Internal sources of phosphorus originate with the lake and are typically linked to the lake sediment. When phosphorus is bound to 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, making it available in the water column.

The 2019 average total phosphorus (TP) concentrations in the epilimnion of Big and Little Bear Lake was 0.051 mg/L and 0.036 mg/L respectively. This is a decrease in TP concentration when compared to the 2012 sampling for Big Bear (0.096 mg/L) and Little Bear (0.068 mg/L). Bear Lakes, like most lakes in Lake County, are impaired for total phosphorus with samples exceeding the Illinois Environmental Protection Agency's (IEPA) water quality standard of 0.05 mg/L. The TP concentration for lakes sampled in Lake County from 2000 to 2019 averaged 0.10 mg/L. Aquatic plants are efficient at absorbing nutrients and can be attributed to the lower TP levels in the Bear Lakes.

The highest TP concentration occurred in September for both Big Bear (0.076 mg/L) and Little Bear (0.057 mg/L) (Figure 6). Phosphorus are released from sediments during anoxic conditions. The excess phosphorus can be trapped in the hypolimnion layer of the lake when it stratifies during the summer. Big Bear Lake did not have a strong thermal stratification and had anoxic conditions in August and September which allowed the phosphorus to mix with in the water column. In addition, heavy rains a few days before the samples were collected along with decaying aquatic plants contributed to the highest TP concentrations for both lakes in September.

Figure 6: *Phosphorus Concentrations in Big and Little Bear Lake monitored by LCHD*



TROPHIC STATE INDEX

Total phosphorus is also used to calculate the Trophic State Index (TSI) value. Trophic states describe the overall productivity of a lake and refers to the amount of nutrient enrichment. This has implications for the biological, chemical and physical conditions of the lake. Lakes are classified into four main categories: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. These range from nutrient poor and least productive (oligotrophic) to most nutrient rich and most productive (eutrophic). In 2019, Big Bear Lake and Little Bear Lake had a TSIp value of 61 and 55.7 respectively, which categorizes both lakes as eutrophic. This means that the lake is high in nutrients, they are usually either weedy or subject to frequent algae blooms, or both. Based on the TSIp, Big Bear Lake ranked 66th & Littler Bear Lake was 44th out of 177 lakes surveyed by the LCHD-ES from 2000 –2019 (Appendix B).

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*

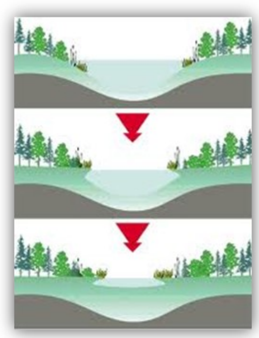
July 2010: *The state of Illinois passed another law restricting the use of lawn fertilizers containing phosphorus by commercial applicators.*

LAKE COUNTY AVERAGE TSIP = 65.7

BIG BEAR LAKE TSIP = 61 RANK= 62 /177

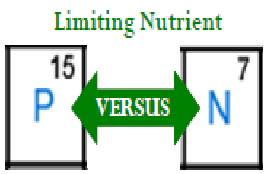
LITTLE BEAR LAKE TSIP = 55.7 RANK= 44 /175

TROPHIC STATE: MESOTROPHIC



Eutrophication Process

NUTRIENTS: NITROGEN



Nitrogen in the form of nitrate (NO_3^-), nitrite (NO_2^-), or ammonium (NH_4^+) is a nutrient needed for plant and algal growth. Sources of nitrogen include septic systems, animal feed lots, agricultural fertilizers, manure, industrial wastewaters, sanitary landfills and atmospheric deposition. The average Nitrate/Nitrite concentrations in the epilimnion of Big and Little Bear Lakes were below detectable concentration for 2019. Total Kjeldahl Nitrogen (TKN), an organically associated form of nitrogen averaged 0.92 mg/L for Big Bear and 0.78 for Little Bear, less than the Lake County Median of 1.17 mg/L.

Typically lakes are either phosphorus or nitrogen limited. This means that one of the nutrients is in shorter supply and any addition of that nutrient to the lake will result in an increase of plant/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Big Bear Lake had and Little Bear Lake had an average TN:TP of 24:1and 23:1 respectively, and are considered a phosphorus limited system. Any additional inputs of phosphorus can increase algae/aquatic plant growth.

TN:TP Ratio

<10:1 = nitrogen limited

>20:1= phosphorus limited

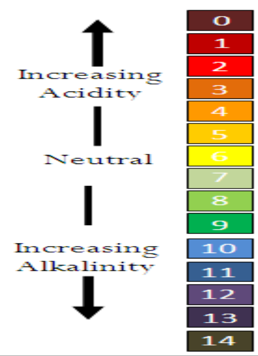
TN:TP Ratio on Big Bear Lake is 24:1
TN:TP Ratio on Big Bear Lake is 23:1

Big & Little Bear Lakes are Phosphorus Limited

pH

pH is a measure of the hydrogen ion concentration of water. As the hydrogen ions are removed, pH increases. A well buffered lake also means that daily fluctuations of CO_2 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.

The average pH for Big Bear and Little Bear Lake was 8.23 and 8.43 respectively. Big and Little Bear Lake's pH was within the reasonable range the entire season for aquatic life and no pH impairments were observed.

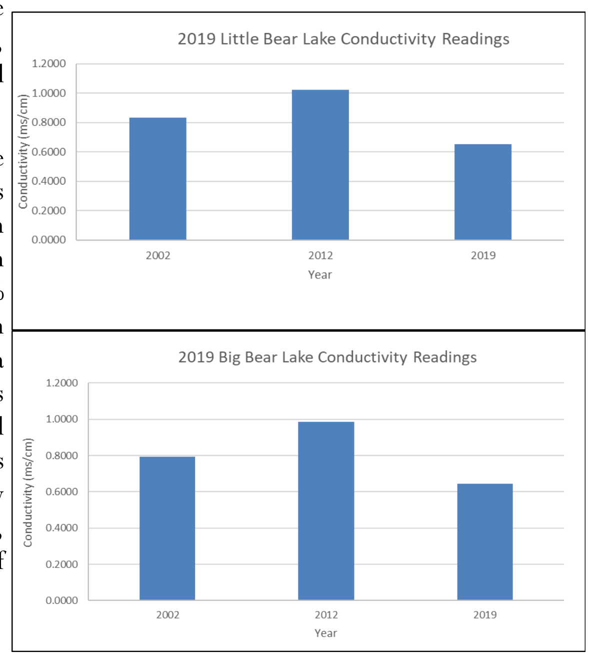


CONDUCTIVITY

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, land use, evaporation, and bacterial activity.

In 2019, Big Bear Lake's average conductivity was 0.6438 mS/cm. Little Bear Lake was a slightly higher at 0.6514 mS/cm because chloride settles at the bottom of the lake. Big Bear (<10 ft) is much shallower and can easily flush out chloride. These are below the Lake County median conductivity concentration of 0.7870 mS/cm. This value is a ~5% increase since the 2010 concentration of 0.8843 (Figure 5). From 2002—2019 conductivity has been decreasing in the Bear Lakes, likely a result of road salt use in the watershed. Since 2012, the conductivity has been declining, partially due to wetter years in both 2010 and 2019 and potentially improvements in de-icing practices. In 2019, there was steady decline in conductivity during the season, as a result of the heavy rain events that took place in the County from May through September, flushing out ions in solution. Conductivity is also a good indicator of chlorides (Figure 7).

Figure 7: *Conductivity Readings in Bear Lakes*

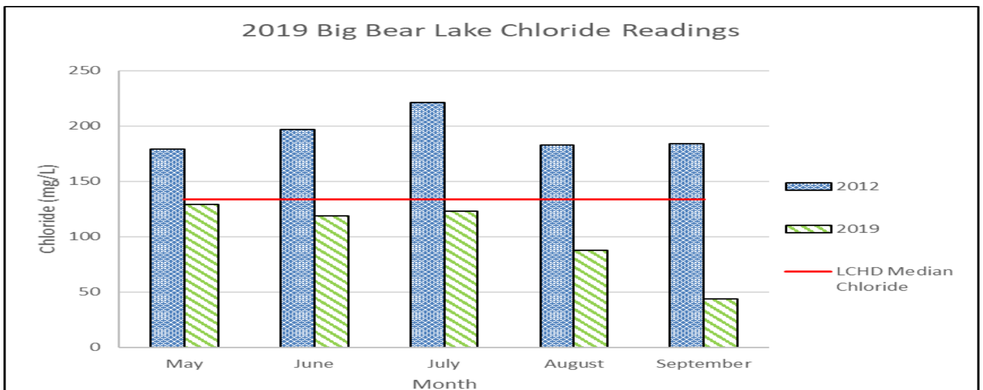


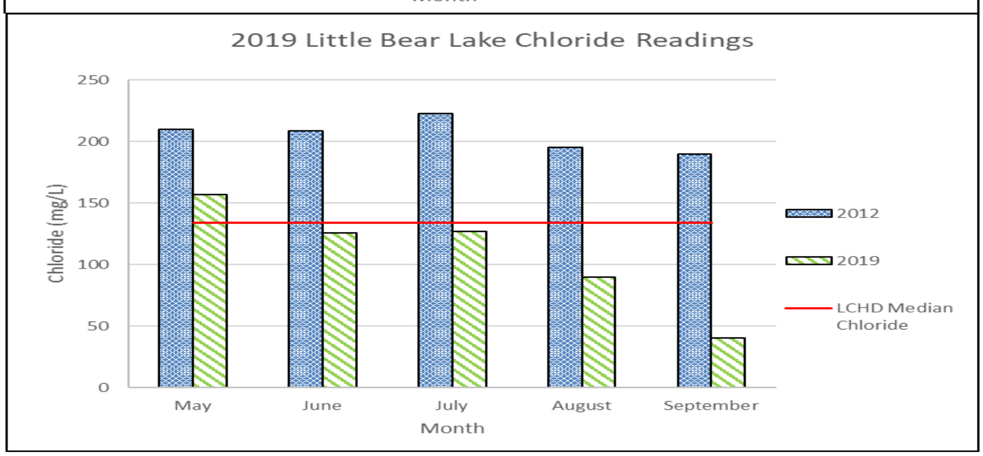
CHLORIDES

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 ferrocyanides salts. In 2019, Big Bear and Little Bear Lake's chloride concentration averaged 101 mg/L and 108 mg/L which are below the Lake County median of 127 mg/L (Figure 8). The United States Environmental Protection agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems. While Bear Lake's chloride concentrations are significantly below the aquatic life criteria, recent research has indicated organisms can get stressed at values lower than 230 mg/L. Chloride ions do not break down and can 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.

The LCHD-ES and Lake County Stormwater Management Commission (LCSMC) have been holding annual trainings 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. Additionally calling your local township office to ask them if they are taking actions to minimize deicers on their properties or supporting changes in their deicing policy to minimize salt usage is encouraged. Since Bear Lakes have low chloride concentrations, it is important to maintain these low levels by using best management practices in the watershed to protect and maintain the health of the lake.

Figure 8: *Big Bear Lake's Chloride Concentrations*





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

230 mg/L = 1 teaspoon of salt added to

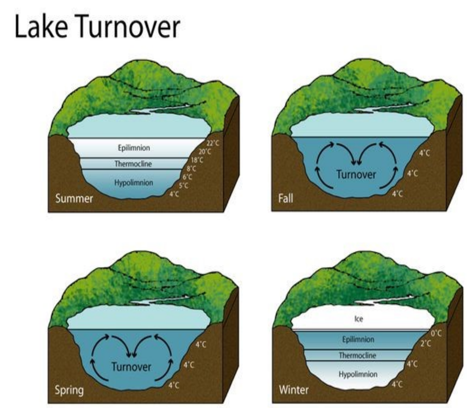
ICE FACTS

- Deicers 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.
- NaCl is more effective at warmer temperatures—when it is warmer out, you do not need to put as much road salt down to melt ice efficiently.

STRATIFICATION

Lake stratification is a result of variations in density caused by temperature (or salinity) and can prevent warm and cold water from mixing. A lake's water quality and ability to support fish are affected by the extent to which the water mixes. Lakes that experience stratification have the water column divided in three zones: epilimnion (warm surface layer), thermocline (transition zone between warm and cold water) and hypolimnion (cold bottom water) (Figure 9). Stratification traps nutrients released from bottom sediments in the hypolimnion and prevents mixing. Lakes in lake county are either dimictic or polymictic. Dimictic means there are only two lake turnovers (spring and fall), whereas polymictic means that the thermocline is never that strong so the lake can go mix multiple times throughout the season.

Figure 9: *Lake Turnover/Stratification diagram*



Monthly depth profiles of water temperature, dissolved oxygen, conductivity, and pH were taken every foot from the lake surface to the lake bottom on Big Bear Lake. The relative thermal resistance to mixing (RTRM) value can be calculated from this data and indicates if a lake stratifies, how strong the stratification is, and at what depth the thermocline occurs. Due to its shallow nature, Big Bear Lake was weakly stratified and can be easily mixed by wind activity. Little Bear Lake began to stratify in May and continued into September. Due to the depth and strong thermocline, Little Bear Lake is a dimictic lake that experiences turnover twice a season.

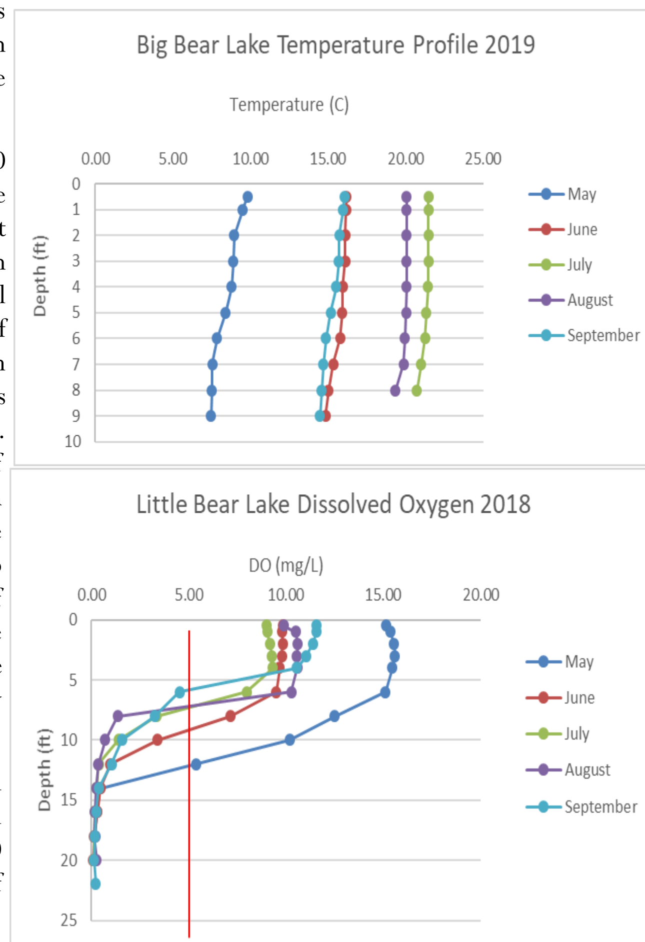
DISSOLVED OXYGEN

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a fishery since fish can suffer oxygen stress below this concentration. Fish and other aquatic animals depend on dissolved oxygen gas that enters the water from plants and the atmosphere.

The top 5 ft of Big Bear Lake's water column maintained >5.0 mg/L of DO while the bottom 1 foot layer of water became anoxic (<1 mg/L) in August and September. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters (Figure 8). Phosphorus release from anoxic sediments represents additional phosphorus load into the water column. Since Big Bear Lake was weakly stratified, internal loading of phosphorus can often occur as the water becomes mixed through wind activity or lake turn over as it cool down in the fall. Little Bear Lake is deeper and the oxygen difference between the top and bottom water layers can be dramatic. There was plenty of oxygen near the epilimnion, but practically none near the hypolimnion. The average epilimnion DO for Big Bear and Little Bear Lake in 2019 was 10.85 mg/L and 11.29 mg/L respectively which are adequate to supporting aquatic life.

Oxygen levels at certain depths can be used as a guide when placing artificial fish structures in the lake. These artificial structures should be located in depths where the DO levels are 5.0 mg/L or better. Both lakes were able to maintain a DO average of 5 mg/L in 5 feet or less during the summer months.

Figure 10: *Big Bear Lake2019 DO Profile*



HARMFUL ALGAL BLOOMS

Algae are important to freshwater ecosystems and most species of algae are not harmful. Algae can grow quickly in water and are often associated with increased concentrations of nutrients such as nitrogen and phosphorus. Harmful algal blooms (HABs), also known as blue-green algae or cyanobacteria, are a type of algae that can bloom and produce toxins. They are called harmful algal blooms because exposure to these blooms can result in adverse health effects to human and animals. Certain environmental conditions such as elevated levels of nutrients, warmer temperatures, still water, and plentiful sunlight can promote the growth of cyanobacteria to higher densities. However, their presence does not mean that toxins are present. It is still unclear what triggers HABs to produce the toxins. HABs tend to occur in late summer and early fall. 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 HABs. Table 3 shows guidelines for microcystin toxins based on the World Health Organization. EPA is in the process of releasing microcystin toxin criteria for recreational waters.

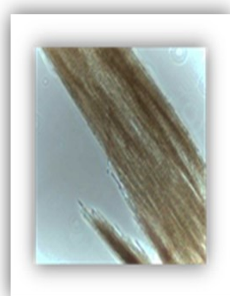
In 2019, blue-green algae blooms were observed on Big and Little Bear Lakes in August and filamentous algae in July. Since the Bear Lakes have a boat launch and a walking trail around the lake, it is important that all lake users are educated on the appearance of harmful algal blooms as it can have health concerns for lake users as well as pets. Any blue-green algae blooms should be reported to the LCHD. Filamentous algae blooms can often be mistaken for blue-green algae. Filamentous algae does not pose any health concern, just can be an aesthetic nuisance. Figure 11 and 12 show images of typical blue-green algae and filamentous algae that are seen in Lake County.

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
847-377-8020

Anabaena Sp.

Microcystis Sp.



Aphanizomenon Sp.

Table 2: *World Health Organization Microcystin Toxin Guidelines*

Relative Probability of Acute Health Effects	Cyanobacteria (cells/mL)	Microcystin-LR (µg/L)	Chlorophyll-a (µg/L)
Low	< 20,000	<10	<10
Moderate	20,000-100,000	10-20	10-50
High	100,000-10,000,000	20-2,000	50-5,000
Very High	> 10,000,000	>2,000	>5,000

Figure 11: *Example of a Blue-Green Algae Bloom in Lake County*

Figure 12: *Example of a Filamentous algae bloom in Lake County*

Bathymetric map

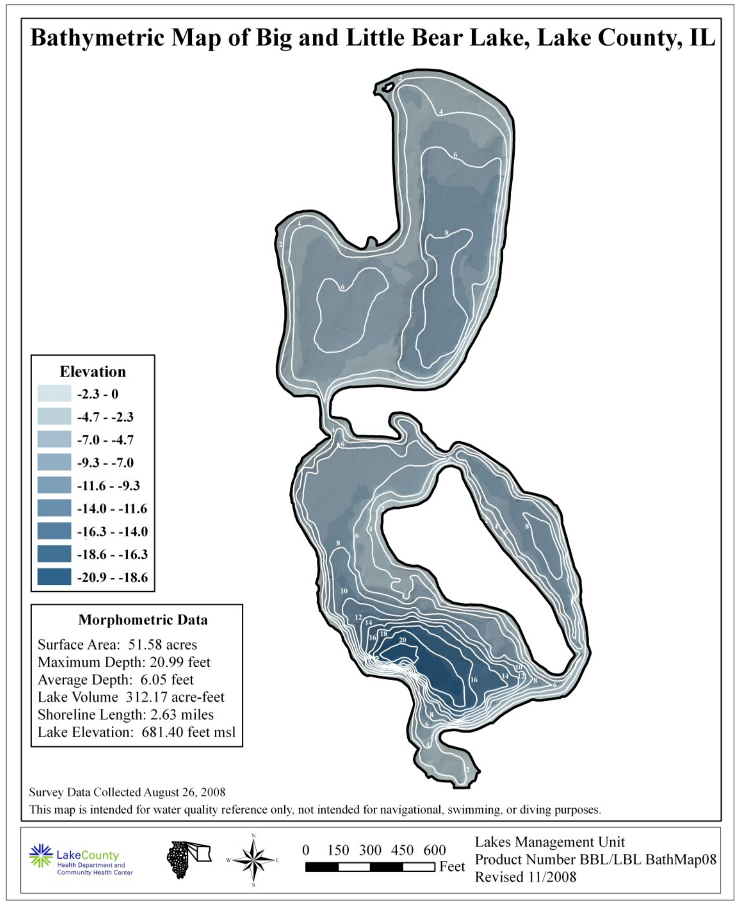
Bathymetric maps are also known as depth contour maps and display the shape and depth of a lake. They are valuable tools for lake managers because they provide information about the surface area and volume of the lake at certain depths. This information can then be used to determine the volume of lake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

Bear Lakes had a bathymetric survey conducted in 2008 by LCHD (Figure 13). The maximum depth was 20.99 feet and average depth was 6.05 ft. Lake volume was estimated 312.17 acre-feet. LCHD recommends updating bathymetric map every 10 years. For a complete list of the morphometric table for Big Bear and Little Bear Lake refer to Appendix B.

Table 3: *Morphometric Data for Big and Little Bear Lake*

Big Bear Morphometric Data	
Maximum Depth of Lake: 9.06 Feet	Area of Lake: 25.14 Acres
Average Depth of Lake: 5.01 Feet	Shoreline Length: 1.00 Miles
Volume of Lake: 125.84 Acre-Feet	Water elevation at 681.40 feet above mean sea level
Little Bear Morphometric Data	
Maximum Depth of Lake: 20.93 Feet	Area of Lake: 26.44 Acres
Average Depth of Lake: 7.04 Feet	Shoreline Length: 1.66 Miles
Volume of Lake: 186.03 Acre-Feet	Water elevation at 681.40 feet above mean sea level

Figure 13: *Bathymetric Map of Big Bear Lake*



Water level

Lakes with stable water levels potentially have less shoreline erosion problems. The lake level in Big Bear Lake was measured from the top of the top railing of the fishing dock next to the boat launch (S.W. corner) to the water level. The lake level decreased from May to September by 0.6 inches. The highest water level recorded occurred in September (3.70 ft) and the lowest level in July (4.35 ft). The rain events in August and September caused the most significant water level fluctuation with an increase of 7.8 inches. The Seavey Ditch is the main contributor to the water level in the lake. The lake outlet is located on the south end of Little Bear Lake where it flows over a spillway and eventually into the Des Plains River . In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly). The data provides lake managers a much better idea of lake level fluctuations relative to rainfall events and can aid in future decisions regarding lake level. Staff gauge is a great tool for measuring water level in lakes, rivers, reservoirs. The data collected can be compiled to help understand the natural fluctuations of the lake. Lakes with fluctuating water levels potentially have poorer water quality and have more shoreline erosion problems.

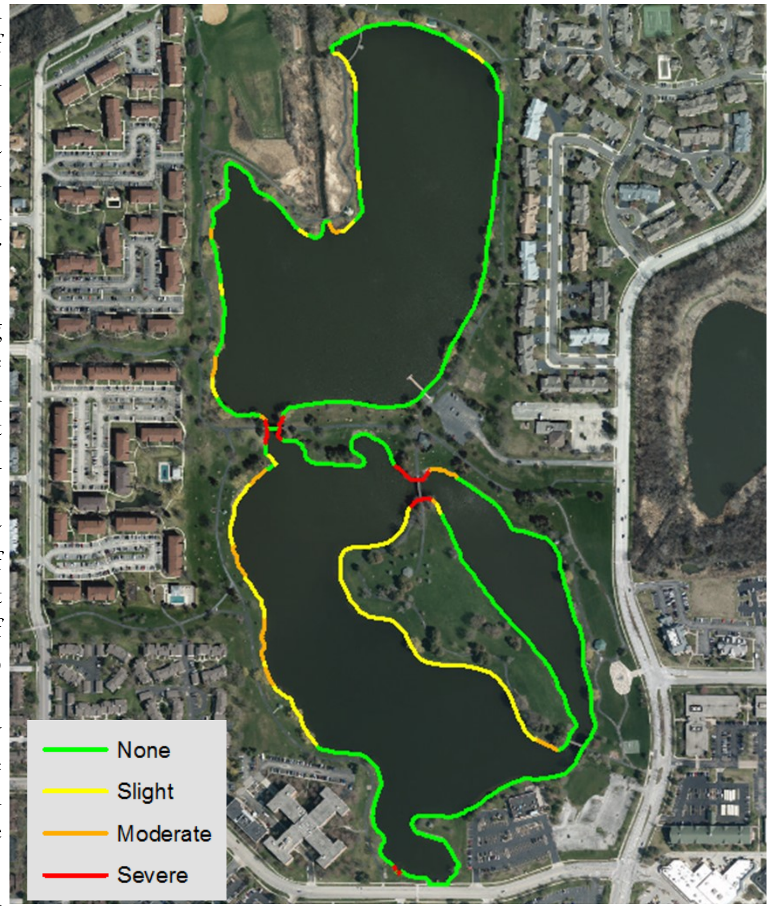
Table 4: *2019 Lake Level on Big and Little Bear Lake*

2019	Level (ft)	Seasonal Change (ft)	Monthly Change (ft)
May	3.75		
June	3.94	0.19	0.19
July	4.35	0.60	0.41
August	3.90	0.15	-0.45
September	3.70	-0.05	-0.20

SHORELINE EROSION

Erosion is a natural process along lake shorelines primarily caused by wind and wave action 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.

Figure 14: *Shoreline Erosion Condition around Big Bear Lake, 2019*



A shoreline erosion assessment was conducted on Big Bear and Little Bear Lake in 2019 (Figure 14). The shoreline evaluated for none, slight, moderate and severe erosion based on exposed soil and tree/plant roots, failing infrastructure and undercut banks. Based on the 2019 data, 20.8% of the shoreline had slight , 6.7% moderate, and 3.4% severe erosion. A majority (69%) of the shoreline had no erosion, likely a result of the retaining blocks and emergent vegetation that protects the shoreline against erosion. The addition of retaining blocks and shoreline riprap (Figure 15) addressed some of the past erosion shoreline problems. The areas of slight and moderate and were mostly located along west side of the Little Bear Lake. The areas underneath the walk bridges have severe erosion that need to be addressed since they may affect the structural integrity of the bridge support (Figure 16). Frequent increase or decrease of the water level can negatively influence a variety of the lake parameters including: nutrients, suspended solids, lake volume, and aquatic plants by increasing shoreline erosion. Overall, Vernon Hills has stabilized most of the shoreline around the lake.

Emergent plants absorb wind and wave energy preventing soil erosion. Native plants adds habitat for wildlife and can also help filter pollutants and nutrients from the near shore areas. Natives shorelines also help lakes that have problems with geese and gulls, as it is not desirable habitat for them.

To see the complete dataset of shoreline erosion broken down by reach, refer to the shoreline condition assessment tables in Appendix B.

Table 5: *Big Bear & Little Bear Lake 2019 Shoreline Erosion Condition*

Lake	None		Slight		Moderate		Severe		Total	Lateral Recession Rate
	Linear ft.	%	Linear Ft.	%	Linear Ft.	%	Linear Ft.	%	Linear Ft.	Ft/Yr.
Little Bear Lake	5317.9	60%	2362.3	27%	713.6	8%	400.1	5%	8794.0	0.04
Big Bear Lake	4437.2	83%	566.9	11%	234.4	4%	83.8	2%	5322.4	0.02
Total	9755.1	69.1%	2929.2	20.8%	948.0	6.7%	483.9	3.4%	14116.3	0.06

SHORELINE EROSION

Figure 15: *Good Shoreline Condition*

Figure 16: *Severe Shoreline Condition*

SHORELAND BUFFERS

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.

Lake Managers are encouraged to establish buffers or not mow to lakes edge to allow native grasses to grow. Buffers composed of tall grass along the shoreline will discourage geese from coming ashore. Geese have a natural fear of predators lurking in the bushes.

A shoreland buffer condition of Big and Little Bear Lake 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 un-mowed grasses, forbs, tree trunks and shrubs, and impervious surfaces within that 25 foot range. In 2019, Big Bear Lake had 53.4% of the shoreline with good, 12.2% fair, and 84.4% poor buffer conditions (Table 6). For a complete list of buffer condition by lake, refer to Appendix B.

Figure 17: *Shoreline Buffer Condition*

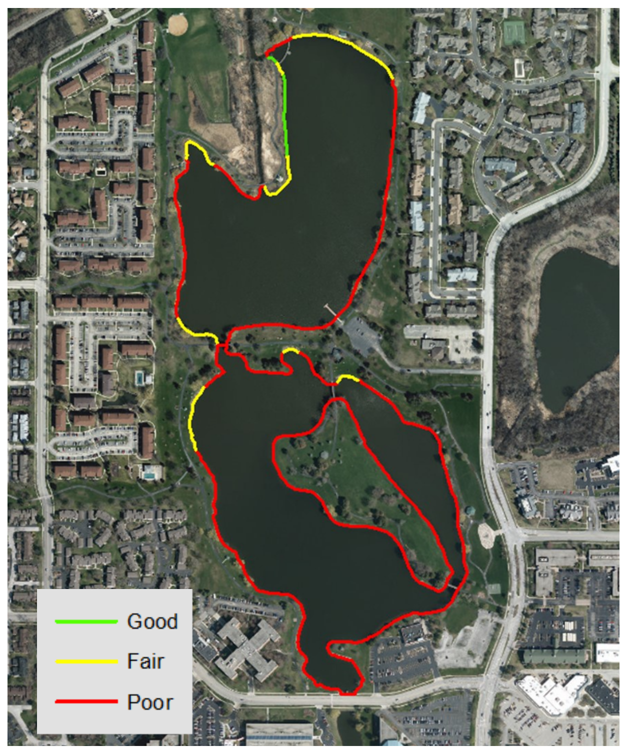


Table 6: *Tree/shrub buffer on the south side of Big Bear Lake*

Buffer	Good Condition		Fair Condition		Poor Condition		Shoreline Length Assessed
	Linear ft.	%	Linear Ft.	%	Linear Ft.	%	Linear Ft.
Little Bear Lake	0.0	0.0	129.5	1.6	7953.9	98.4	8083.4
Big Bear Lake	452.4	8.5	1507.4	28.3	3362.6	63.2	5322.4
Total	452.4	3.4%	1636.9	12.2%	11316.6	84.4%	13405.8

Aquatic plants and Biovolume

Aquatic plants play an important role in the lakes ecosystem by providing habitat for fish and shelter for aquatic organism. Aquatic plants provide oxygen, reduce nutrients such as phosphorus to prevent algae bloom, and help stabilize sediment.

An aquatic macrophyte survey provides information based on the species, density and distribution of plant communities in a particular lake. An aquatic macrophyte survey was conducted on Big and Little Bear Lake in August 2019. Big Bear had 26 points while Little Bear had 30 points generated based on a computer grid system with points 60 meters apart randomly overlaid on an aerial photo.

Aquatic plants in Big Bear Lake occurred at 20 of the 26 sites (77% total lake coverage) while Little Bear Lake had 23 of the 30 sites (77% total lake coverage). This included 7 aquatic plants of which three were exotic invasive species. Curlyleaf usually begin to senescence in June and may have been higher in density in May. The Illinois Department of Natural Resources (IDNR) recommends that lakes should have 30-40% aquatic plant coverage for healthy sport fisheries. The plant composition and density can play an important role in the success of the fishery.

Figure 17 shows the aquatic plant biovolume on Big and Little Bear Lake for 2019. Biovolume refers to the volume of the water column taken up by plants. The extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When light level in the water column falls below 1% of the surface light level, plants can no longer grow. The extent of the 1% light can be obtained by doubling the Secchi disk reading. Since 2012 the average Secchi disk reading increased for Big Bear and Little Bear Lake from 1.32 feet and 2.38 feet to 2.58 feet and 4.35 feet in respectively in 2019. The increase in light penetration allowed aquatic plants do grow deeper in 2019 when Coontail was observed at 9 ft compared to only 4.8 ft in 2012.

In 2019, the most commonly occurring species for Big and Little Bear Lakes were Coontail (69.6%), Eurasian Watermilfoil (53.6%), and White Water Lily (7.1%). Monitoring for Eurasian Watermilfoil and Curlyleaf Pondweed and Brittle Naiad should continue every year in order to actively manage these non-native and invasive aquatic plants.

Figure 17: *Plant Biovolume Big & Little Bear Lake, August 2019*

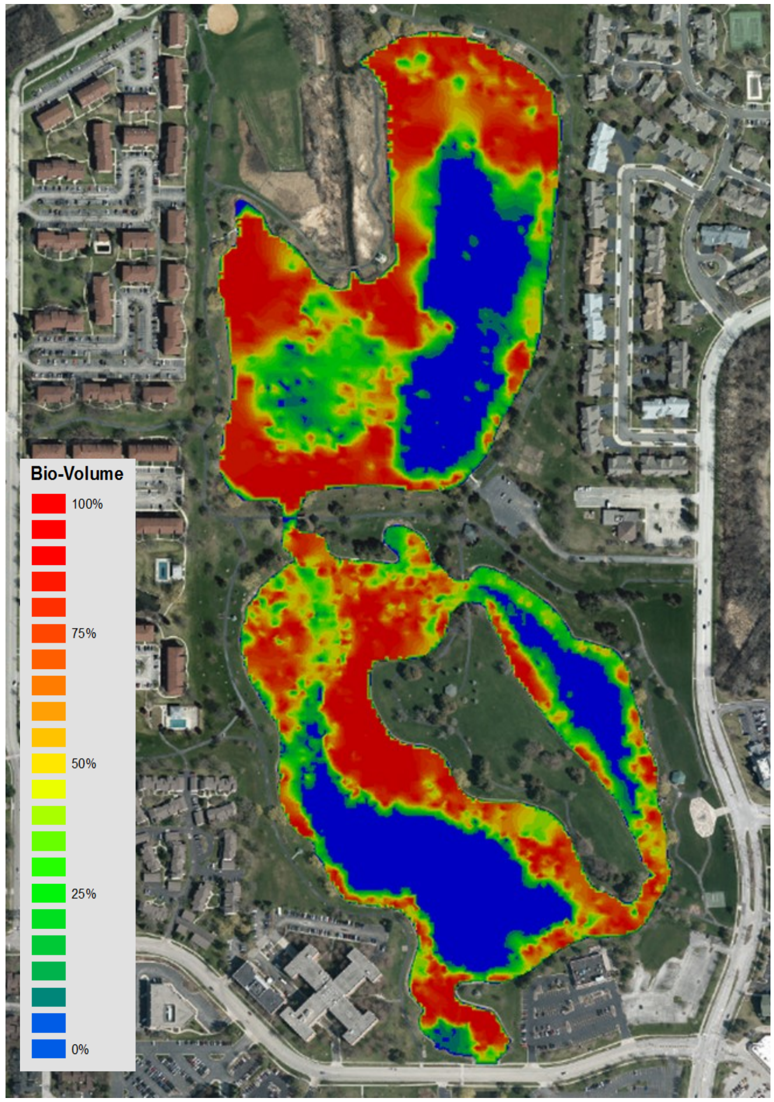
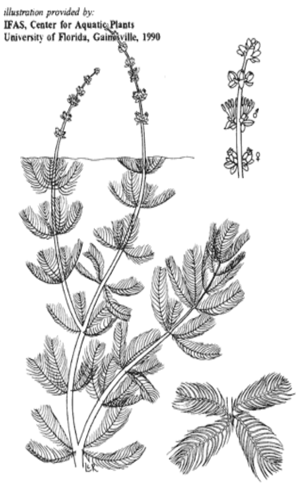


Table 6: *Plant Rake Density on Big & Little Bear Lake, August 2019*

Rake Density (Big Bear)	# of Sites	% of Sites
No Plants	6	23
>0-10%	3	12
10-40%	6	23
40-60%	6	23
60-90%	5	19
>90%	0	0
Total Sites with Plants	20	77
Total # of Sites	26	100

INVASIVE SPECIES: EURASIAN WATERMILFOIL

ILLUSTRATION OF EURASIAN WATERMILFOIL

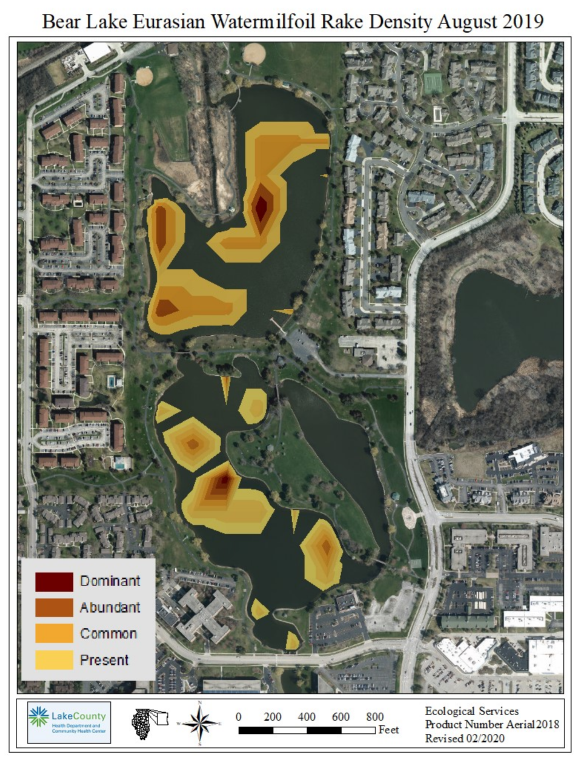


ERASIAN WATERMILFOIL DENSITY AT 56 SITES ON BIG AND LITTLE BEAR LAKE IN AUGUST 2019

Eurasian Watermilfoil (EWM) is a feathery submerged aquatic plant that can quickly form thick mats in shallow areas of lakes and rivers in North America. These mats can interfere with swimming and entangle propellers, which hinders boating fishing, and waterfowl hunting. Matted milfoil can displace native aquatic plants, impacting fish and wildlife. Since it was discovered in North America in the 1940's, EWM has invaded nearly every US state and at least three Canadian Provinces. Milfoil spreads when plant pieces break off and float on water currents. It can cross land to new waters by clinging to sailboats, personal watercraft, powerboats, motors, trailers, and fishing gear.

The occurrence of EWM in Bear Lakes has increased from 2012 (10.7%) to 2019 (53.6%) of the sample sites. An aquatic plant management plan is critical to maintaining the health of the lake and a balanced aquatic plant community. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. The primary focus of the plan must include the control of exotic aquatic species including EWM and Curlyleaf Pondweed. Follow up is critical to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake. At this time there is a growing population of native aquatic plants that should be protected to keep the Eurasian water milfoil from expanding in the lake. Native aquatic plants tend to grow later than the EWM. Chemical treatment of EWM should be done early in the season to avoid the native aquatic plants.

Figure 17: *Bear Lake EWM Rake Density 2019*



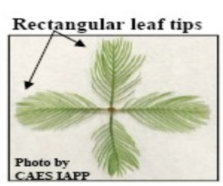
MYRIOPHYLLUM SPICATUM EXOTIC*

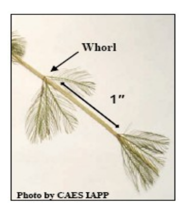
COMMON NAMES:
EURASIAN WATERMILFOIL

ORIGIN: EXOTIC
EUROPE AND ASIA. FOUND THROUGHOUT LAKE COUNTY AND ILLINOIS

IMPORTANCE:
THIS INVASIVE PLANT SPREADS RAPIDLY, CROWDING OUT NATIVE SPECIES, CLOGGING WATERWAYS, AND BLOCKING SUNLIGHT AND OXYGEN FROM UNDERLYING WATERS.

LOOK ALIKES:
NORTHERN WATERMILFOIL
WHICH HAS FEWER THAN 12 LEAFLET PAIRS PER LEAF, AND GENERALLY HAS STOUTER STEMS.





KEY FEATURES:

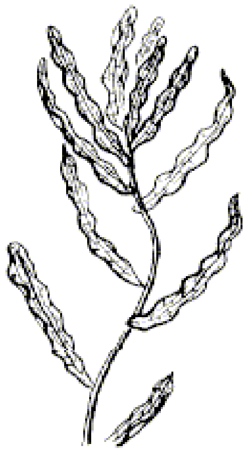
STEM: LONG, OFTEN ABUNDANTLY BRANCED STEMS FORM A REDDISH OR OLIVE-GREEN SURFACE MAT IN SUMMER.

LEAF: LEAVES ARE RECTANGULAR WITH ≥12 PAIRS OF LEAFLETS PER LEAF AND ARE DISSECTED GIVING A FEATHERY APPEARANCE, ARRANGED IN A WHORL, WHORLS ARE 1 INCH APART.

FLOWER: SMALL PINKISH MALE FLOWERS THAT OCCUR ON REDDISH SPIKES, FEMALE FLOWERS LACK PETALS AND SEPALS AND 4 LOBED PISTIL.

INVASIVE SPECIES: CURLYLEAF PONDWEED

ILLUSTRATION OF CURLYLEAF PONDWEED



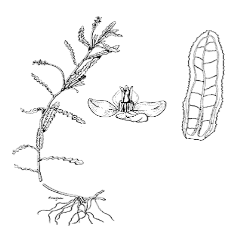
CURLYLEAF PONDWEED DENSITY AT 3 SITES IN BIG BEAR AND LITTLE BEAR LAKES IN AUGUST 2019

Curlyleaf Pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. This aquatic plant has an unusual life history. Unlike our native pondweeds it begins growing in the early spring. CLP has even been documented growing under the ice in lakes! The plant then reaches maturity in mid summer typically June in Lake County when our natives are starting to emerge. CLP becomes invasive in some areas because of its adaptations for low light tolerance and low water temperatures which allow the plant to get a head start and outcompete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Large populations of CLP also can cause changes in nutrient availability. In midsummer, CLP plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms. CLP can form dense mats that may interfere with boating and other recreational uses. In August 2019, CLP were present, plants being found at 5.4% of the sampled sites. There were more CLP observed in May and June in Big Bear and Little Bear Lakes. At this time the density of CLP is not causing fluctuations in nutrient availability. CLP should be monitored annually and if possible manually remove the plants using a hand rake to keep the population from expanding.

Figure 18: *CLP Rake Density August 2019*

POTAMOGETON CRISPUS EXOTIC*

Turion



KEY FEATURES:

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

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

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

COMMON NAMES:
CURLY LEAF PONDWEED

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

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

LOOK ALIKES:
NONE

INVASIVE SPECIES: BRITTLE NAIAD

Brittle Naiad was found in Little Bear Lake. Brittle Naiad is a rooted, submersed aquatic plant and it has a bushy appearance. Its coloration can vary from green to green-brown. The leaves of brittle naiad are thin and stiff with "toothed" or serrated edges and pointed tips. Brittle Naiad is an annual plant that spreads primarily by seeds but can also spread by plant fragments (similar to Eurasian Watermilfoil). The plant leaves curve strongly downward and grow one to two inches long. Brittle Naiad is native to Europe, Western Asia, and Northern Africa and has been introduced to the United States. Brittle naiad can form dense mats that outcompete native species and can interfere with recreational activities such as boating, swimming, and fishing. Since brittle naiad can spread by fragmentation, people can spread brittle naiad primarily through the movement of water-related activities.

Figure 19: *Brittle Naiad Rake Density August 2019*

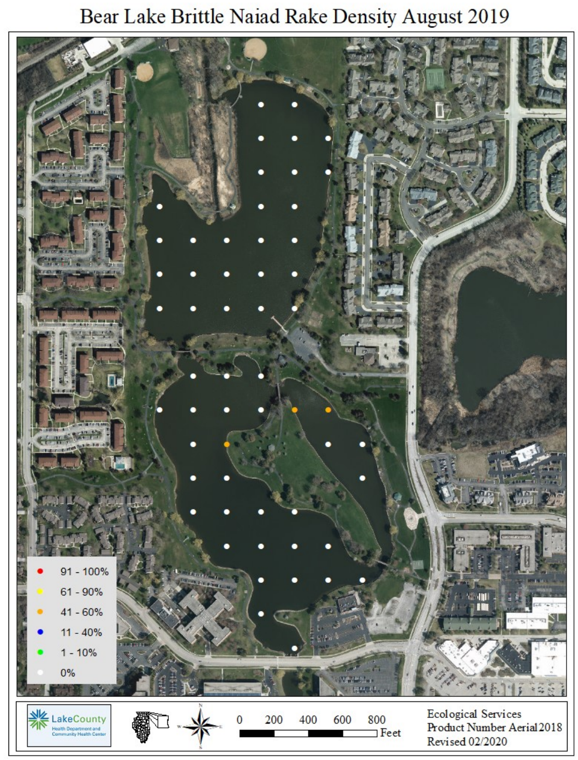
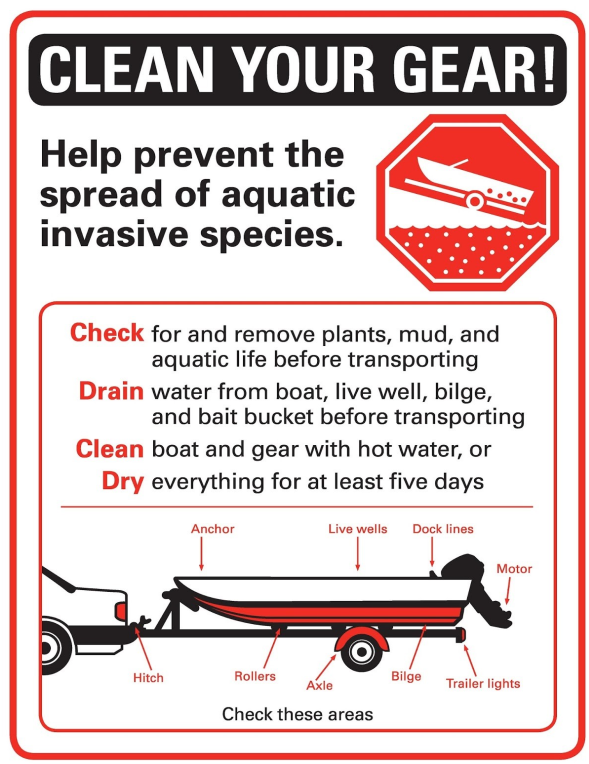


Figure 20: *Brittle Naiad*

AQUATIC INVASIVE SPECIES PREVENTION

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

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



AQUATIC PLANTS

The most dominant plants found in Big and Little Bear Lake were Coontail and Eurasian Watermilfoil at 69.6% and 53.6% respectively. Table 7 depicts the plant species observed in Big and Little Bear Lake in 2019 with the percent occurrence based of the plant rake survey. 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 can be found. A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources.

Coontail (*Ceratophyllum demersum)*

Description

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

Sago Pondweed (*Potamogeton pectinatus)*

Description

This perennial plant is a submerged aquatic about 1-3' long. There is more branching of the stems above than below, creating fan-like aggregations of leaves. The stems are up to 1.0 mm. across, light green to nearly white, terete to slightly compressed (flattened), and hairless; they are slender and flexible. The slender leaves are 1½-5" long, up to 1.0 mm. across, and mostly alternate; they are filiform, medium green to olive-green, hairless, and toothless, tapering to acute tips.

***Table 7**: 2019 Plant Species and % Plant Occurrence on Big and Little Bear Lake*

Plant Density	Brittle Naiad	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Sago Pondweed	White Water Lily
Absent	53	17	53	54	26	53	52
Present	0	4	3	2	12	2	3
Common	0	13	0	0	13	1	1
Abundant	3	17	0	0	4	0	0
Dominant	0	5	0	0	1	0	0
% Plant Occurrence	5.4	69.6	5.4	3.6	53.6	5.4	7.1

AQUATIC PLANT MANAGEMENT

Aquatic plants are essential for maintaining a balanced, healthy lake, but sometimes plants can create a nuisance for recreation, lake aesthetics, and invasive plant species can outcompete native plant species. Aquatic plant management is both controlling undesirable species while encouraging desirable species in important habitat areas. For Big and Little Bear Lake, it is important to monitor the invasive species to determine if future control will be needed. A whole lake plant survey is recommended in order to fully understand the extent or lack of aquatic invasive species.

The main types of plant control include: mechanical harvesting, manual harvesting, and herbicides. Mechanical harvesting involves the use of specially designed machines that cut and remove plant material from a lake. Harvesting only reduces the height of aquatic plants in the water column. Manual or hand harvesting is the most environmentally friendly is best for small scale operations. The most common control tool in aquatic plant management is the use of herbicides registered by the U.S. Environmental Protection Agency. Below is a table that briefly summarizes some pros and cons of the different aquatic plant management techniques. This is not a comprehensive list and should only be used as a guide to understanding different management options available. Lake Managers should keep a yearly record of all aquatic plant herbicide treatments.

Management Options	Pros	Cons
Mechanical	Cost competitive with chemical controls	Undesirable plants may fragment, spread and colonize new areas
	Removes nutrients from the lake but may be minimal compared with input	Desirable plants such as pondweeds may be suppressed
	Removes organic material from the lake	Limited operation in shallow water and around docks and rafts
	May provide some selective control	Machine breakdowns can disrupt operations
		Drifting plant fragments may accumulate at nuisance levels in quiet water areas
Hand Harvesting	Low Cost	Labor intensive
	Excellent control in small areas	Not suitable for large areas
	Low environmental impact	
Herbicides	Costs are reasonable in many situations	Involves the introduction of pesticides into shared water resources
	Range of products and combinations available provides flexibility in management options	Potential for misuse
	Some products are highly selective for nuisance species	May contribute to the buildup of organic material
	Can provide complete control of plants for swimming beaches	Algal blooms are possible following large herbicide treatments
		Fish kills may occur with misuse of certain products
		Large treatments may encourage shifts in plant communities
		Water use restrictions may be need to be imposed
		Does not address the cause of cultural eutrophication

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 2000-2019 is 14. Big Bear Lake had an FQI value of 9 ranking it 128th out of 171 lakes while Little Bear had an FQI value of 6.9 ranking it 153rd out of 171 lakes in Lake County (Appendix A). The FQI has increased since the 2012 sampling when the FQI value for Big Bear and Little Bear was 3.5 and 5.8 respectively. LCHD recommends the an Aquatic Plant Management Plan (APMP) should be taken into consideration to improve the diversity and density of native plants.

2019Lake county Average
FQI = 14

Big Bear Lake
FQI = 9
Rank = 128/171
Aquatic Plants Species: 6
Native plant species: 4

Little Bear Lake
FQI = 6.9
Rank = 153/171
Aquatic Plants Species: 6
Native plant species: 3

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.

Manual removal of aquatic plants

Controlling exotic aquatic plants by hand removal is effective on small areas and if done prior to heavy infestation. Eurasian Watermilfoil can be controlled to some degree by hand pulling or raking of entire plants including the roots. Just before the peak growth is the best time for removal to prevent re-growth and plant seed dispersal. Working in windblown areas will help contain fragments near shore which makes cleanup easier. All fragments of EWM plants must be removed to achieve adequate control. Most regeneration are from fragmented stems that drift into different areas of the lake and form new colonies. Small populations of Curlyleaf can be manually removed with a rake or by hand pulling. All plant materials should be carefully removed as floating pieces of Curlyleaf that may contain turions can float away and colonize a different part of the lake so removal of this plant should be done no later that the end of May.

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

Aquatic Plant Rake

Pesticide permit requirements for pesticide application

Copper Sulfate Application

Chemical applications for algae is a temporary solution that often requires multiple applications. As the treated algae sink to the bottom to decompose (use oxygen) they release nutrients that the surviving algae uses to rebound

A National Pesticide Discharge Elimination System (NPDES) permit is required when pesticides are applied to, over or near the waters of the State. This permit applies to all public waters that have an outflow to the State waters. A Notice of Intent (NOI) must be filled and submitted electronically to the Illinois Environmental Protection Agency (IEPA) at least 14 days prior to any application of pesticides. In order to obtain the permit an application needs to be filed with the IDNR requesting a permit for pesticide application, the application can be filled out by the applicant or their representative (which is usually the pesticide consultant).

For full details of the rule see:

http://www.epa.state.il.us/water/permits/pesticide/index.html

A pretreatment survey of your lake's aquatic plants is necessary prior to sending out a Request For Proposal (RFP) in order to assess the location and the amount of invasive plants.

Request For Proposal (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 RFP 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.

AQUATIC PLANTS AND FISH

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

How do plants impact fish?

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

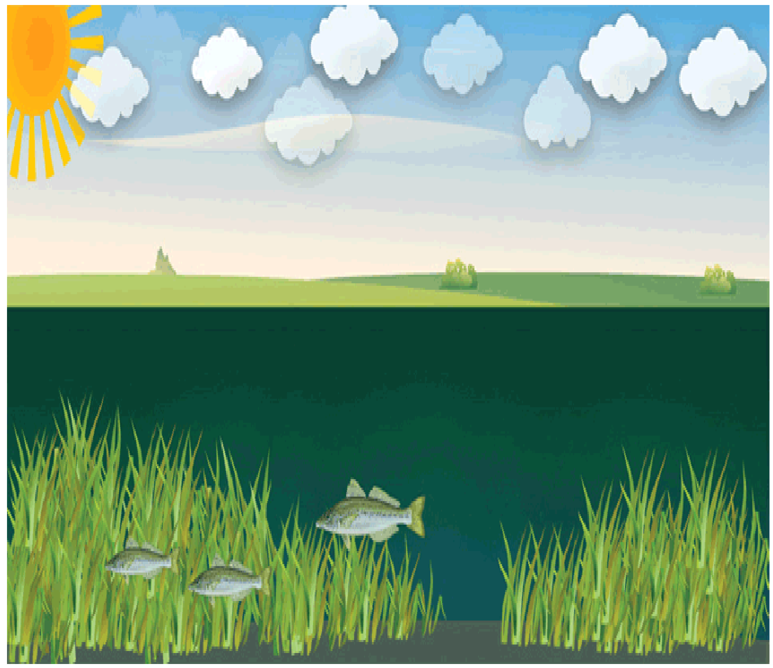


Image http://agriculture.vic.gov.au/

Table 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

Big and Little Bear Lakes are located in a suburban setting with a mixture of developed and undeveloped shoreline which provided excellent habitat for birds, mammals, and other wildlife. The undeveloped areas have a mix of open grass and small woods with deadfalls located along the western shorelines providing habitat for many species. Fishing is allowed on the lake and there is a boat launch for non-motorized boats.

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

An updated fish survey can reveal the size distribution and population of fish in the lake as well as the presence of T/E species. The last fish survey was conducted in 2008. Contact the Illinois Department of Natural Resources to update the fish survey.

Table 9: *Fish Species Found in Bear Lakes*

Common Name	Scientific Name
Largemouth Bass	*Micropterus salmoides*
Bluegill	*Lepomis macrochirus*
Pumpkinseed Sunfish	*Lepomis gibbosus*
Green Sunfish	*Lepomis cyanellus*
Warmouth	*Lepomis gulosus*
Black Crappie	*Pomoxis nigromaculatus*
Yellow Bass	*Morone mississippiensis*
Yellow Perch	*Perca flavescens*
Channel Catfish	*Ictalurus punctatus*
Carp	*Cyprinus carpio*
Golden Shiner	*Notemigonus crysoleucas*
Gizzard Shad	*Dorosoma cepedianum*

Coarse Woody Habitat

Downed trees are often removed from the lake as an eyesore or a hazard for navigation. This results in the lack of coarse woody habitat (CWH) that is important to a lake's ecosystems. CWH often happens naturally as trees or large branches fall into the lake become material is critical habitat for tiny aquatic organisms that feed fish, turtles, birds, and other wildlife. Adding CWH in the north and south bays where it is away from the main boating traffic, can provide excellent cover for fish.

Bluegills and young of the year game fish often seek shelter in and around CWH. Larger logs with branching limbs provide shade and protection for the smaller fish. Black Bass species (smallmouth and largemouth) often build spawning nests in proximity to CWH, particularly large logs (Hunt and Annett 2002; Lawson et al. 2011; Weis and Sass 2011).

Adding CWH in the littoral or near-shore zone serves many functions within a lake ecosystem including erosion control, as a carbon source, and as a surface for algal growth which is an important food base for aquatic macroinvertebrates (Engel and Pederson 1998; Sass 2009). Macroinvertebrates provide food for panfish and young of the year gamefish. Logs and branches that are out of the water are used by turtles, birds and other wildlife. Vernon Hills has added CWH and rocks in Big and Little Bear Lakes. This should provide cover fish and other wildlife around the lakes.

Figure 21: *Coarse Woody Habitat providing cover for bluegill.*

CARP (CYPRINUS CARPIO)

Family:

Cyprinidae (Minnows or carps)

Order:

Cypriniformes (carps)

Class: Actinopterygii (ray-finned fishes)

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

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

The common carp has a dark copper-gold back with sides that are lighter, a yellowish belly and olive fins. They have 2 pairs of short barbells on their upper lip and their dorsal and anal fins have a leading spine that are serrated. They spawn from early spring to late summer in water ranging from 15 – 28 C and prefer freshly flooded vegetation as spawning substrate. They prefer to spawn in shallow weedy areas in groups consisting of one female and several males. A single female can produce up to 100,000-500,000 which hatch in 5-8 days. The spawning ritual involves a lot of thrashing in shallow water contributing to turbidity problems (Fig. 22). Carp are omnivorous and feed over soft bottom substrate where they suck up silt and filter out crustaceans, insect larvae and other desirable food items. Carp are very active when feeding and can be observed around shallow areas where they uproot plants which increases turbidity and nutrient concentrations. Increase in nutrients causes algal blooms and reduction in light penetration that impacts aquatic plants.

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

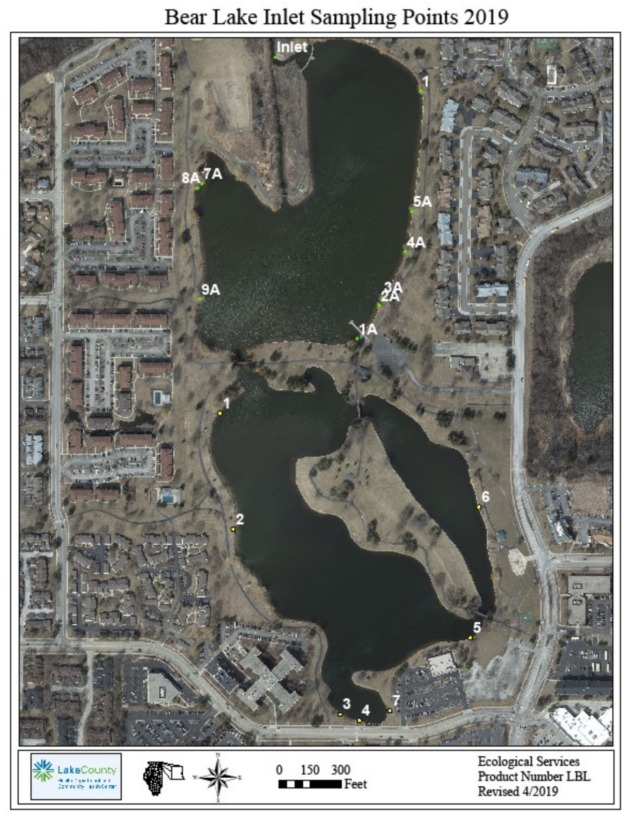
Assess current fish population to ensure that there are enough native predator fish such as bass, catfish and northern pike to help control the carp population. Bluegills are also effective on helping control carp populations by feeding on carp eggs and fry.

Figure 22: *Carp Spawning activity resuspends sediments in the lake.*

Inlet sampling

In 2019, the **Des Plaines River Watershed Workgroup Lakes Committee** contracted with the Lake County Health Department to monitor inlets on Big Bear, Little Bear, and Lake Charles to get a better understanding of pollutant loads entering the lake, specifically looking at total suspended solids (TSS), total phosphorus (TP), and chlorides. LCHD monitored 10 inlets including Seavey Ditch (Inlet) on Big Bear Lake and 7 inlets on Little Bear Lake.

Figure 23: Inlet Monitoring Locations on Bear Lakes, 2019



Inlets were monitored once a month and during 3 storm events. Little Bear Inlet 5 on the south east side of the lake had the highest concentration for total suspended solids averaging 19.3 mg/L for the season (Table 5). This was evident visually as after heavy rainfall events this inlet would be a murky brown entering the lake. Inlet 5 was only sampled twice after storm events and had the highest TP concentration averaging 0.109 mg/L. Seavey Ditch flows out of Charles Lake had the most amount of water flowing through had a larger range as well , with the lowest TSS (4.7 mg/L) and TP (.038 mg/L) concentrations in June. The highest TP (0.148 mg/L) and TSS (28 mg/L) concentrations occurred after a storm event in July.

Seavey Ditch at the Charles Lake outlet has a lower TP (.067 mg/L), TSS (9.0 mg/L), and Cl (100.0 mg/L) when compared to the concentrations at Big Bear Inlet. There are several detention basins that flow into Seavey Ditch before it reaches Big Bear Lake where there are slight increases in TP (0.072 mg/L), TSS (10.9 mg/L), and Cl (99.4 mg/L). The surrounding inlets in the Bear Lakes have an intermittent flow that can only be sampled after a significant rain event. Little Bear inlet 6 was supposed to receive water from Harvey Lake but when the water levels was high it would flow into the culvert. For a complete dataset of the inlet sampling, refer to the Inlet Sampling tables in Appendix A.

Table 10: *2019 Average Inlet Concentrations Big and Little Bear Lakes.*

Big Bear Inlet	TP (mg/L)	TSS (mg/L)	Cl (mg/L)
1	0.041	5.9	68.3
1A	0.036	6.3	40.9
2A	0.037	6.1	6.0
3A	0.057	2.3	7.3
5A	0.056	9.4	66.0
8A	0.070	12.1	50.5
Inlet	0.072	10.9	99.4
Average	0.055	8.3	64.9

Little Bear Inlet	TP (mg/L)	TSS (mg/L)	Cl (mg/L)
1	0.054	6.3	78.1
2	0.060	5.9	65.4
3	0.057	4.2	271.0
5	0.109	19.3	44.1
Average	0.064	7.2	153.2

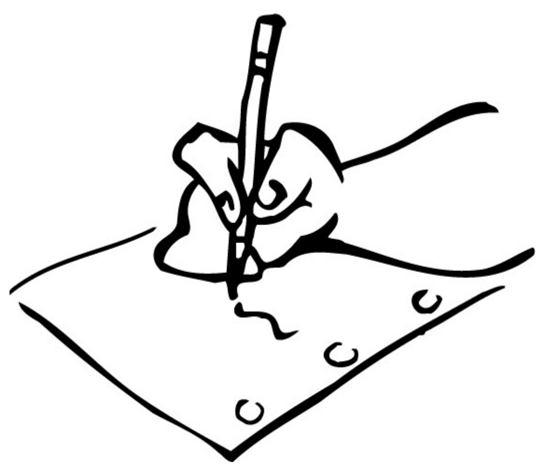
LAKE MANAGEMENT PLANS

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

What are the steps in creating a Lake Management Plan?

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

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



LAKE RECOMMENDATIONS

To improve the overall quality of Big Bear Lake, the LCHD-ES has the following recommendations:

- LCHD encourages the home owners or Vernon Hills participate in the Volunteer Lake Monitoring Program.
- Chloride, while the trend is declining since 2012, it is recommended to follow best management practices for salt and de-icing of roads, sidewalks, and driveways in the watershed. Consider the benefit of attending one of Lake County's De-Icing workshops held annually in October to learn about these best management practices.
- Develop a Lake Management Plan that incorporates aquatic plant management. It is recommended that the Village of Vernon Hills have a separate document as part of their strategic plan related to lakes and lake management that can include their rules and regulations on how they manage the lakes.
- Develop an aquatic plant management plan that targets the monitoring of invasive species including Eurasian Watermilfoil and Curlyleaf Pondweed. Early season survey should be conducted to capture the presence of CLP.
- Become familiar with the appearance of harmful algal blooms and report any blooms to the LCHD-ES by calling 847-837-8030. Also, educate lake users about the appearance of harmful algal blooms so that blooms can be reported to LCHD.
- Continue to add Coarse Woody Habitat to increase fish habitat in Big Bear Lake.
- Remove carp from the lake through carp fishing derbies and in coordination with the IDNR.
- Have an updated fish survey for both lakes since the last fish survey was conducted in 2008. Contact the Illinois Department of Natural Resources to update the fish survey.
- Mitigate shoreline exhibiting erosion and improve shoreline buffer.
- Investigate drainage areas that indicated high nutrient loads to see if any best management practices can be implemented to reduce nutrient loads. Check Harvey Lake to Little Bear Lake drain since it was flowing out of Little Bear Lake.

LakeCounty
Health Department and
Community Health Center

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.