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2020 Island Lake Water Quality Review

Introduction

The goals of this testing protocol were to monitor various water quality parameters of the lake, compare results to historical data, and identify any potential risks to the health of Island Lake. Water samples were taken at two different locations and tested for 14 parameters. Tests were conducted on a monthly basis from April through August. This report describes conditions at the times the samples were taken. The quality of the water was tested only to the parameters listed below.

Test results were compared to historical data from the report "2019 Island Lake Water Quality Review" by LakePro, Inc.

In this report, we included historical data from Water Quality Investigators. Their report provided annual averages for many of the parameters from 2002 to 2009. Including this data allowed us to see more accurate trends in the water quality data. In order to make the analysis easier, we added annual averages for our data and trendlines on the graphs. The trend lines provide quick indication of how each water quality parameter changed over the testing history.

Results

Parameter	2020 Season Average	Target Range	Status
Temperature	71.2 ˚F	Less than 75 ˚F	● Healthy
Dissolved Oxygen	7.5 mg/L	4.0 – 12.0 mg/L	● Healthy
Total Phosphorus	102 ppb	0 – 100 ppb	● Slightly High
Phosphate	52 ppb	0 – 100 ppb	● Healthy
Nitrate-Nitrogen	87 ppb	0 – 200 ppb	● Healthy
Chlorophyll-a	4.9 ppb	0 – 7.3 ppb	● Healthy
Transparency	6.6 feet	More than 6.5 feet	● Healthy
pH	7.7 S.U.	7.0 – 9.0 S.U.	● Healthy
Total Dissolved Solids	355 ppm	0 – 1,000 ppm	● Healthy
Conductivity	710 ppm	0 – 1,500 ppm	● Healthy
Alkalinity	120 ppm	100 – 250 ppm	● Healthy
Sulfate	11.3 ppm	3 – 30 ppm	● Healthy
Fluoride	0.10 ppm	0.01 – 0.30 ppm	● Healthy
Chloride	126 ppm	0 – 230 ppm	● Healthy

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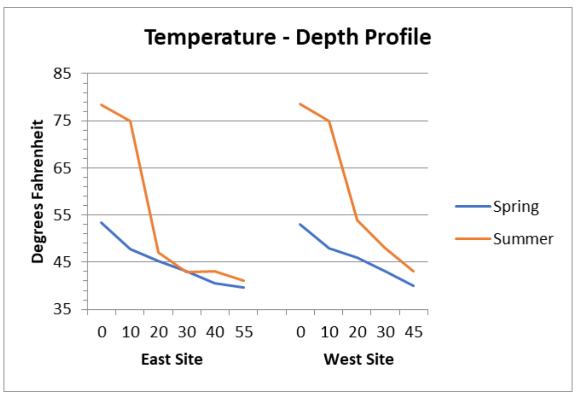
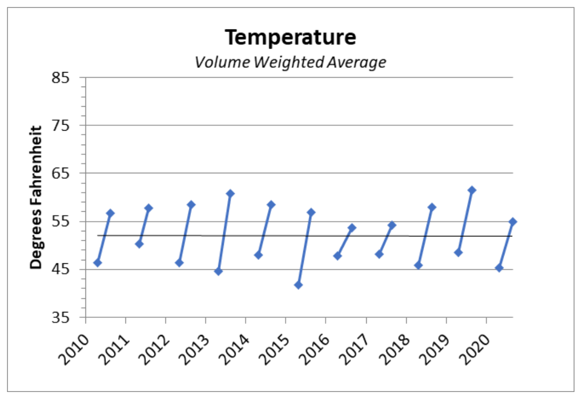
Year-End Discussion
Island Lake's water quality was excellent again this summer. All season averages were within the target ranges except for Total Phoshporus.

Temperature and Dissolved Oxygen
The average **Temperature** of the surface water was within the target range, but the water temperatures rose above the target in July and stayed through August. Colder water can hold more oxygen, so cooler water is preferred to promote healthy lake ecology. Despite the warmer water temperatures, the **Dissolved Oxygen** concentrations stayed within the target range for the entire summer.

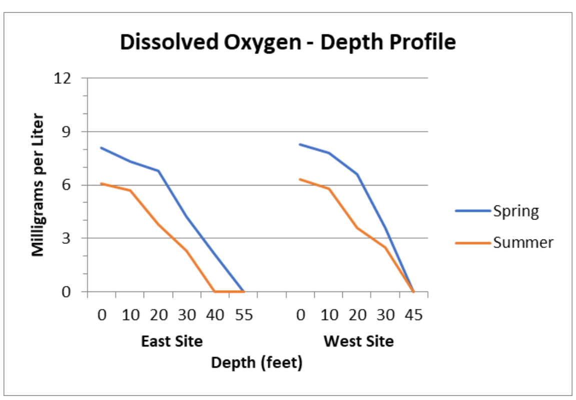
We also measured temperature at different depths to create a temperature profile. This data shows how the temperature changed with depth and whether or not a thermocline was present in the lake. The first graph below shows the data we collected this year. In the spring, the water temperatures decreased somewhat evenly from the surface to the lake bottom. During the summer testing events, there was a thermocline in the water, between ten and twenty feet, where the temperatures decreased sharply.

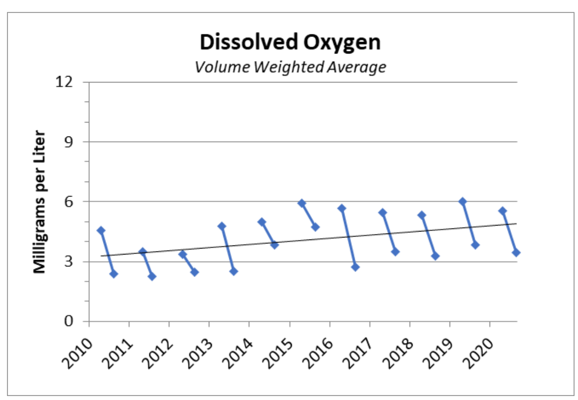
We used the water temperature and volume at each depth to calculate a volume weighted average. The results of those calculations are presented in the second graph below. The trend line shows that over our testing history, the average temperatures of the lake remained steady.





The depth profile methodology was repeated to measure dissolved oxygen. This allowed us to see how the oxygen concentrations changed throughout the water column. We also used the dissolved oxygen and volume at each depth to calculate a volume weighted average. The trend line shows that over our testing history, the dissolved oxygen of the entire lake increased.





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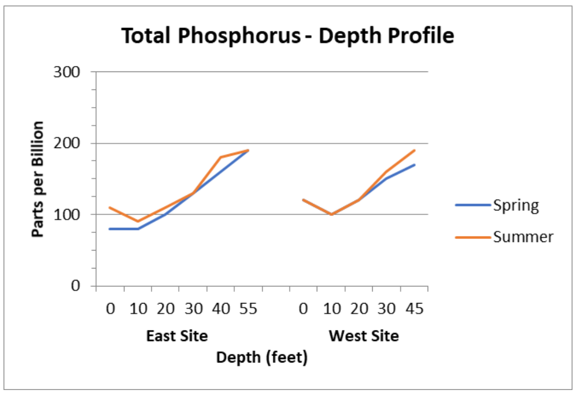
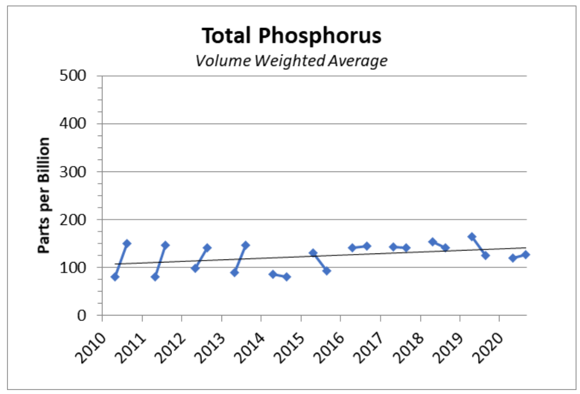
Nutrients, Plant Production, and Transparency

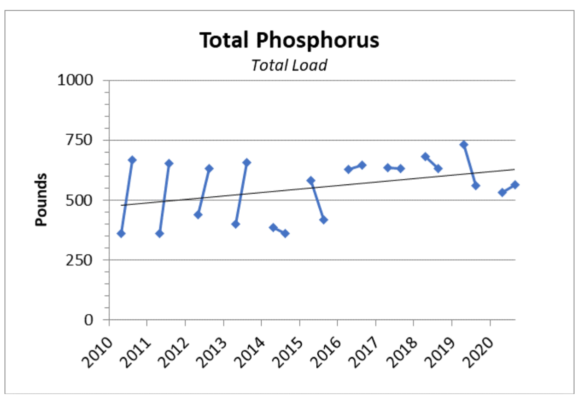
Nutrients in the water are the fuel for plant growth. Measuring the nutrient concentrations reveals the potential for additional plant growth. Phosphorus is a major nutrient necessary for aquatic plant growth, so it is important that this nutrient remains low in the lake. The **Total Phosphorus** was elevated throughout the season, peaking in July and staying above the target range in August. **Phosphate**, which is the form of phosphorus usable to plants, was within the target range for all samples and tests.

The depth profile methodology was repeated and measurements taken for total phosphorus. This revealed how its concentration changed with increasing depth. We also used the concentration and volume at each depth to calculate a volume weighted average. The trend line shows that over our testing history, the total phosphorus within the entire lake increased, which is normal for all lakes.





Additionally, we used the concentration of phosphorus and the lake volume to calculate the total phosphorus load. This quantified the amount of phosphorus in the lake. The following graph shows the results of this calculation over the years of our testing. The old adage states 1 pound of phosphorus can support 500 pounds of plant growth, so the spring average load of 532 pounds of phosphorus could support almost 133 tons of plants!



Nitrate is another major nutrient for aquatic plant growth. The nitrate concentrations remained within the target range this summer. Although concentrations were in the target range, it is important that residents take measures to ensure their properties are not contributing excess fertilizers to the lake.

We also measured **Chlorophyll** concentrations because it is a reliable indicator of plant production. The target for chlorophyll is below 7.3 parts per billion. The chlorophyll concentrations were below the target level to start the summer, but creeped above the target range in July. The concentrations ebbed back down in August.

A major effect of plant growth on the lake is the reduction of water clarity. Before algae forms the green mats of "scum" on the surface, it is suspended in the water column. Algae floating in the water can decrease water clarity even before you see a tint of green. This year, the **Transparency** averaged a depth of 6.6 feet. The measurements were low in April and May, then showed tremendous improvement in June. The clear water persisted through August, showing only some clouding toward the end of the summer. Clearer water is generally a positive attribute, but it does allow more sunlight to reach the lake bottom to fuel plant growth.

Trophic State Indices
In order to better understand the relationship between nutrients, plant production, and clarity, limnologists use Trophic State Indices (TSI) to score each category and examine the relationship between them. In general, lower scores indicate a less productive lake. The TSIs for Island Lake this year were:

Category	**Water Quality Parameter**	**Trophic State Index (season average)**	**Classifciation**
Nutrients	Total Phosphorus	71	Hypereutrophic
Plant Production	Chlorophyll	46	Mesotrophic
Clarity	Transparency	52	Eutrophic

The TSI for total phosphorus classified the lake as hypereutrophic, or extremely productive, based on the availability of nutrients to fuel plant growth. The TSI for chlorophyll was lower than the nutrient index. This shows that despite the availability of nutrients, the plants were not at the levels predicted by the nutrient concentrations. This was due, in part, to the plant management on the lake. Finally, the TSI for transparency was higher than the production index and classified the lake as eutrophic. This shows that the water clarity was worse than typical for the plant production. The additional decrease of clarity may have been due to dissolved solids or suspended particles.

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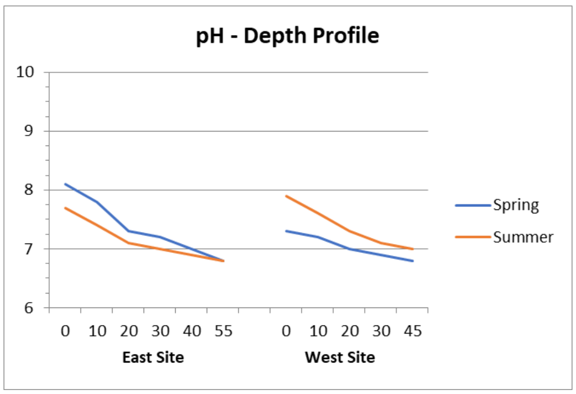
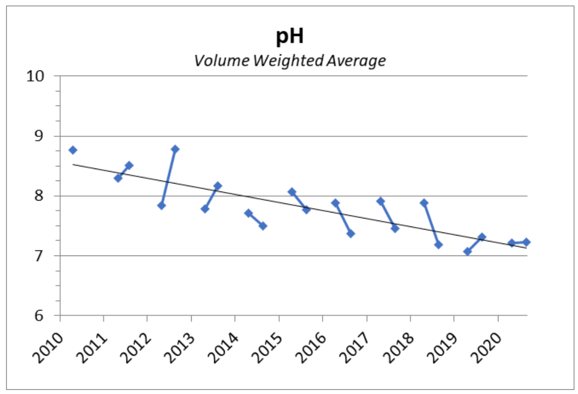
Water Chemistry Parameters

It is important to monitor the basic water chemistry of the lake water. Shifts in these parameters can indicate major changes to the lake that may need to be further investigated.

The **pH** of the lake remained within the target range across all tests this year. This showed that the pH did not fluctuate to a point of concern despite changes in dissolved oxygen, alkalinity, and rainfall/runoff.

The depth profile methodology was repeated and measurements were taken for pH. This revealed how this parameter changed throughout the water column. We also used the readings and volume at each depth to calculate a volume weighted average. The trend line shows that over our testing history, the pH of the entire lake decreased.





The **Total Dissolved Solids** (TDS) were in the bottom half of the target range throughout summer, showing there were low amounts of dissolved molecules in the water. This parameter includes nutrients, salts, and other substances, so it is a positive that this parameter remained low.

Conductivity measures ionic molecules in the water and usually follows the TDS. This parameter measures the molecules in the water ability to conduct electricity. So, it is particularly sensitive to salts, which are excellent conductors. The conductivity was in the middle of the target range this year, indicating a normal amount of ionic molecules in the lake and no immediate concern of salts.

Alkalinity measures the concentration of one salt, Calcium Carbonate, which is beneficial to the aquatic ecosystem. The carbonate ions are able to accept protons from acids, making it a natural buffer. This means that as acidic substances enter the lake, the carbonate is able to buffer against severe changes in pH that would pose a threat to the ecosystem. The alkalinity was at a healthy concentration for all tests this year.

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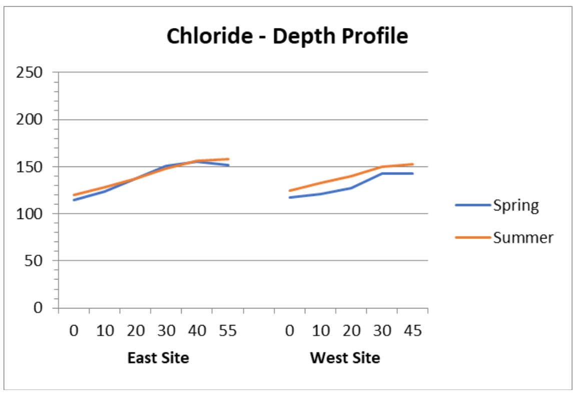
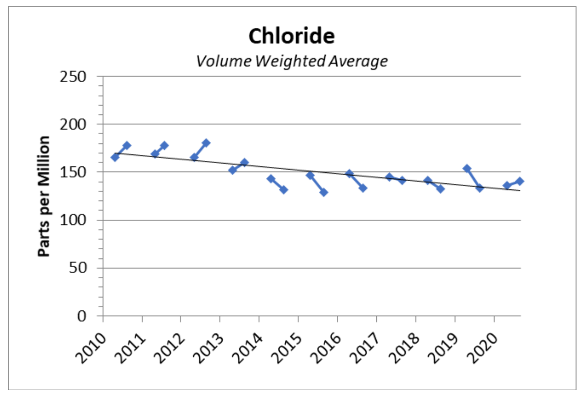
Pollutants

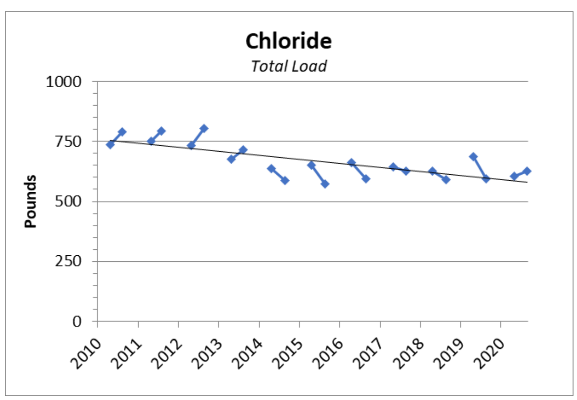
The lake was tested for **Sulfate**, **Fluoride**, and **Chloride** as indicators of pollution. These molecules should be present in the water naturally, but elevevated levels can indicate pollution from within the watershed and may pose a risk to the ecosystem. All three parameters were within their target ranges for all tests.

The depth profile methodology was repeated and measurements were taken for chloride. This allowed us to see how this parameter changed throughout the water column. We also used the results and volume at each depth to calculate a volume weighted average. The trend line shows that over our testing history, the chloride in the lake decreased slightly.

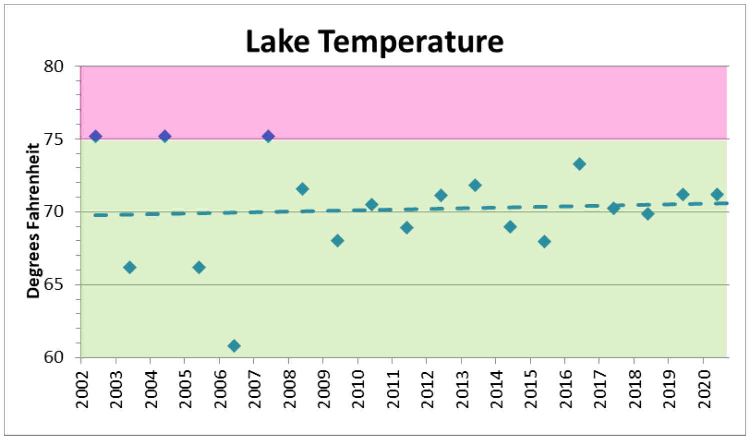




Finally, we used the concentration of chloride and the water volume of the lake to calculate the lake's chloride load. The following graph shows the results of this calculation over the years of our testing. This quantified the amount of chloride in the lake.



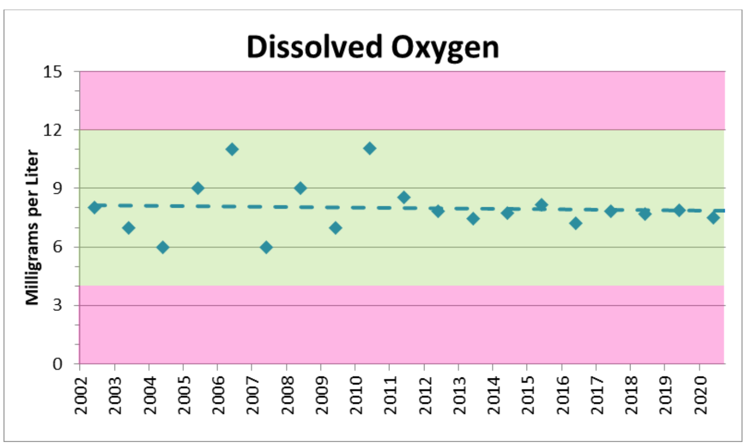
Historical Trends & Monthly Data



Lake Temperature (°F)					
	April	May	June	July	August
West	53.5	70.4	73.6	79.0	78.5
East	53.1	71.4	74.7	79.3	78.5
				Season Average	71.2

Target Range: < 75˚F

The long-term trend for water temperature was very slightly upward and the 2020 season average was right on track. Water temperature is dependent upon air temperatures and the dates selected for testing. For that reason, LakePro tried to select similar dates for testing each year. The primary concern with warmer water temperatures decreasing oxygen solubility.



Dissolved Oxygen (mg/L)					
	April	May	June	July	August
West	8.1	7.5	7.3	8.4	6.1
East	8.3	7.2	7.0	8.6	6.3
				Season Average	7.5

Target Range: 4.0 – 12.0 mg/L

Dissolved oxygen concentrations varied but followed a slightly downward trend, opposite to the increasing temperatures. Although the concentrations varied through the testing history, there has always been adequate oxygen for a healthy aquatic ecosystem.

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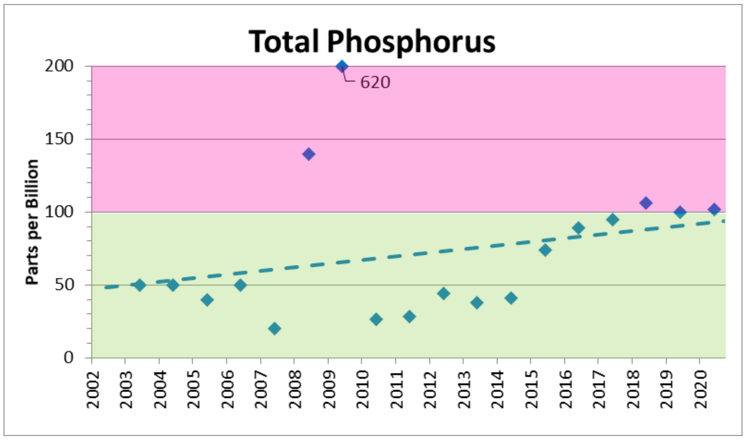
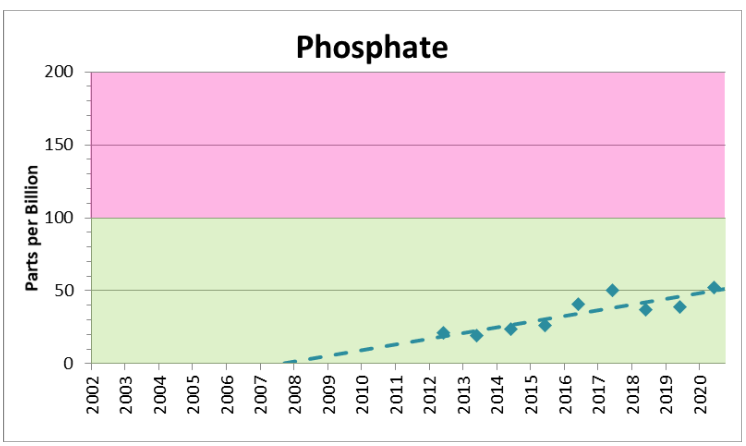


Total Phosphorus (ppb)					
	April	May	June	July	August
West	80	70	70	110	110
East	120	110	100	130	120
				Season Average	102

Target Range: 0 – 100 ppb

Lakes generally accumulate the substances and materials that flow into it, including nutrients. Since testing began in 2003, the trend for phosphorus in the surface water tracked upward. The 2008 and 2009 concentrations were significantly higher than other years of testing, which pulled the trendline up. Since 2010 total phosphorus steadily increased, averaging at or above the target range since 2018.

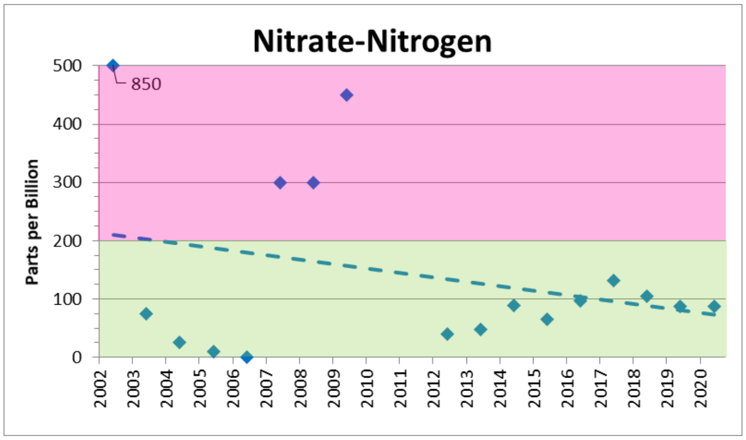
There are ways to remove phosphorus, such as mechanical harvesting and heavy rain events that create strong mixing and outflow. However, it is much easier to prevent excess nutrients from entering the lake. For this reason, it is vital that residents around the lake fertilize and use their land responsibly to prevent phosphorus from reaching the lake.



Phosphate (ppb)					
	April	May	June	July	August
West	50	40	30	40	50
East	80	50	50	70	60
				Season Average	52

Target Range: 0 – 100 ppb

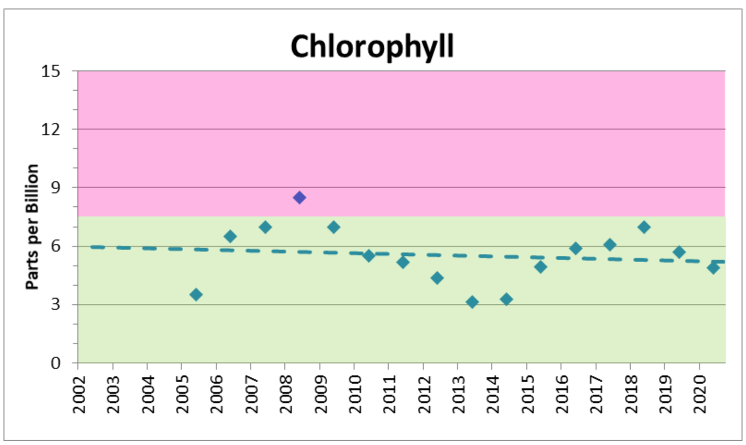
Phosphate is the form of phosphorus that is most usable by plants and algae. As the total phosphorus accumulates, phosphate usually follows. There is no historical data available for phosphates, so the trendline reflected the changes only during the years of LakePro's testing. The trend was upward, but the phosphate concentrations remained within the target range.



Nitrate-Nitrogen (ppb)					
	April	May	June	July	August
West	130	90	40	40	20
East	90	80	60	20	40
				Season Average	87

Target Range: 0 – 200 ppb

Nitrate is another major nutrient that accumulates in lakes. The historical trend for nitrate is downward, due to consistently lower values since 2012 and despite wild variability in previous years of testing. It is important that residents fertilize and use their land responsibly to prevent additional nitrates from reaching the lake.



Chlorophyll (ppb)					
	April	May	June	July	August
West	2.7	3.6	3.9	7.8	4.6
East	3.1	4.6	4.8	7.0	6.9
				Season Average	4.9

Target Range: 0 – 7.3 ppb

The linear trend for Chlorophyll was slightly downward. However, the average concentrations show a strong cyclical pattern. Except for 2008, the chlorophyll remained within the target range. Continuing the plant management activities will continue to suppress the algae and plants to acceptable levels. Continuing to mechanically harvest aquatic plants and to conduct herbicide treatments for dense invasive species will help keep the plant community to acceptable levels.

Another key to limiting plant production is to slow the influx of nutrients from both around the lake and throughout the watershed. Responsible land use practices, especially fertilizing, will limit the nutrients entering the lake, starving the plants and algae of the food they need for growth.

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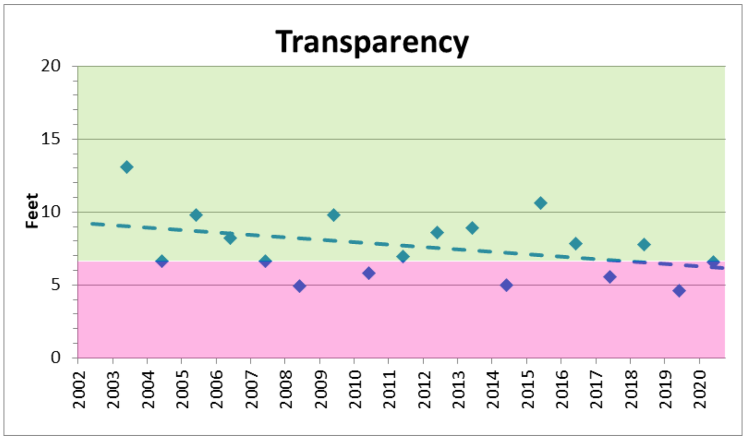
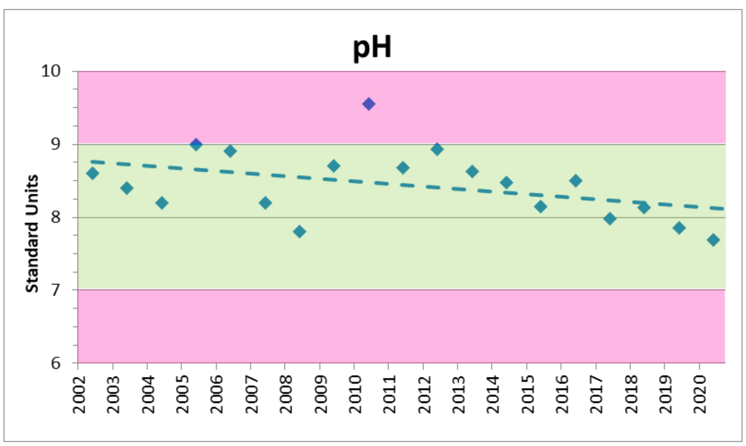


Transparency					
	April	May	June	July	August
West	2.3	3.6	11.0	9.1	7.3
East	2.1	4.0	8.6	9.4	8.2
				Season Average	6.6

Target Range: > 6.5 feet

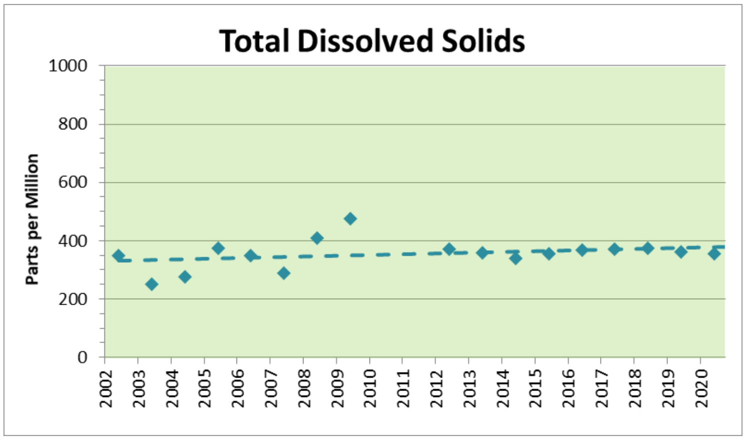
Less chlorophyll generally leads to higher transparency. Despite the downward trend of chlorophyll, the transparency also trended down. In 2014, additional tests revealed the brown color in the early summer was due to high concentrations of the algae Planktothrix. The decreasing transparency is a concern for the lake. It ruins the appearance of the lake and can pose a threat to the safety of the lake, because swimmers cannot accurately judge depth or see underwater obstructions.



pH					
	April	May	June	July	August
West	8.1	7.7	7.5	7.7	7.7
East	7.3	7.7	7.7	7.6	7.9
				Season Average	7.7

Target Range: 7.0 – 9.0 S.U.

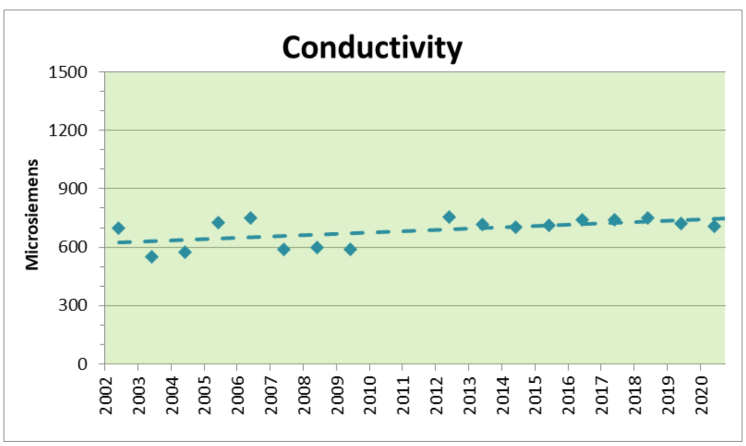
The pH at the lake surface trended downward over the testing history. It is important to look for the trend to flatten with additional years of data. Some fluctuation is expected, but major shifts or changes beyond the target range may indicate a larger problem. Despite the downward trend, the pH remained comfortably within the target range.



Total Dissolved Solids (ppm)					
	April	May	June	July	August
West	379	351	340	341	358
East	379	359	341	346	357
				Season Average	355

Target Range: 0 – 1,000 ppm

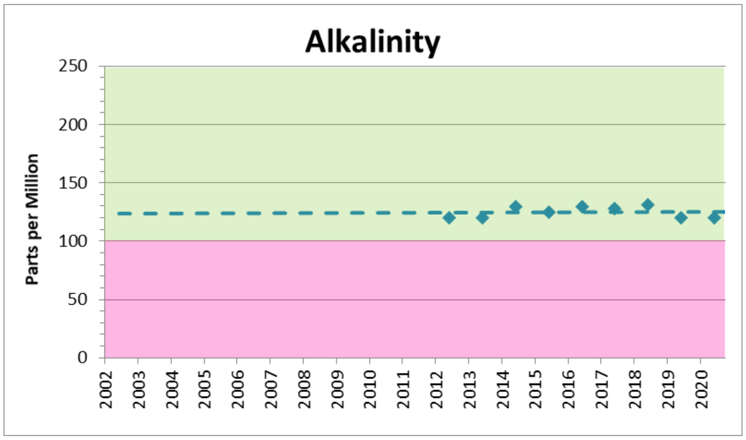
The total dissolved solids increased slowly during the testing history, showing that the lake is accumulating more substances. Continuing to harvest will remove substances from the lake, including nutrients, as they are bound into the plant biomass. Fewer plants also allows easier and faster water movement, which prevents deposition of sediments and increased flushing of excess substances.



Conductivity (µS)					
	April	May	June	July	August
West	757	701	679	683	715
East	757	716	682	692	714
				Season Average	710

Target Range: 0 – 1,500 µS

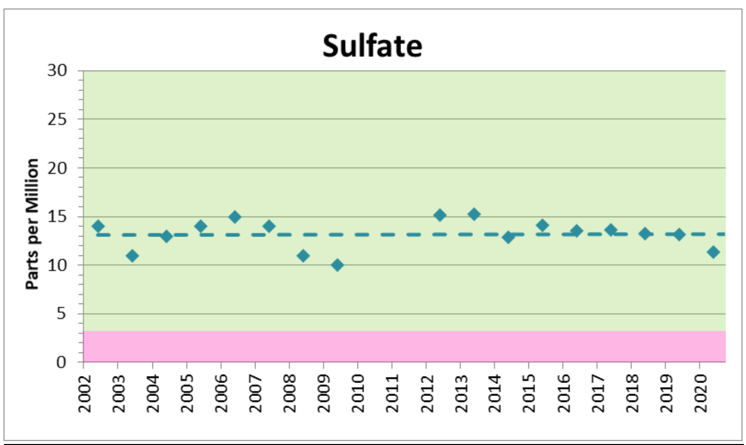
Like the TDS, Conductivity increased over the testing history. Conductivity is a function of TDS and measures the amount of ionic molecules in the water (which conduct electricity; usually salts). We will look for this trend to slow in future years of testing.



Alkalinity (ppm)					
	April	May	June	July	August
West	135	124	115	115	115
East	138	116	111	119	109
				Season Average	120

Target Range: 0 – 250 ppm

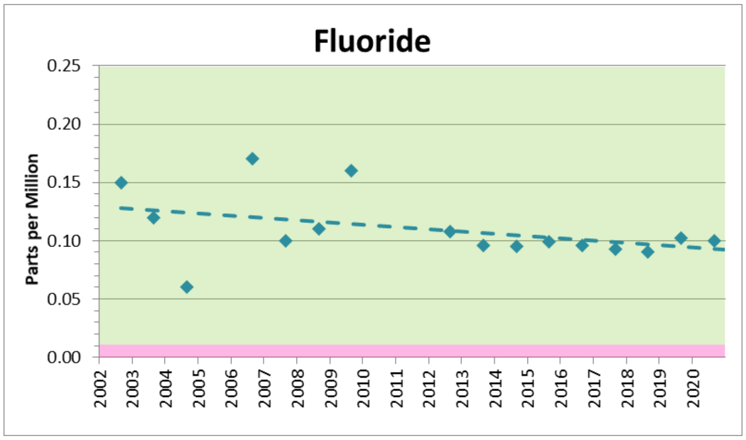
Alkalinity was first tested in 2012, so the historical data is limited. Since testing began, the alkalinity fluctuated mildly but did not show any significant trend. Additional carbonates are beneficial to the lake because they are natural buffers. Also, the changes in alkalinity contributed to the increases in total dissolved solids and conductivity.



Sulfate (ppm)					
	April	May	June	July	August
West	12.5	12.2	11.2	10.0	11.1
East	12.2	11.7	11.6	10.0	10.8
				Season Average	11.3

Target Range: 3 – 30 ppm

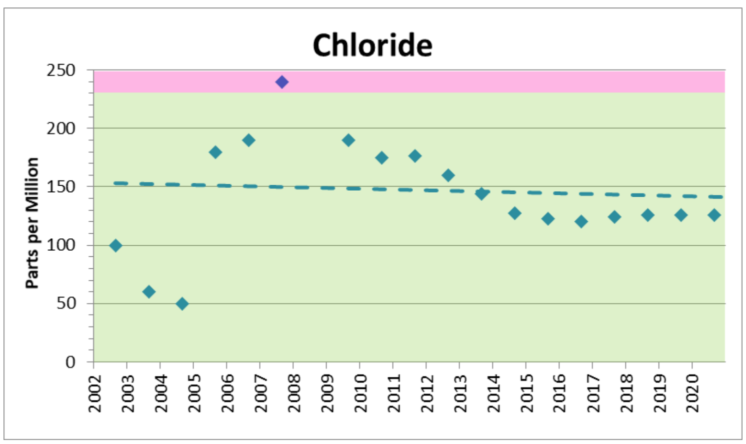
Sulfate has not changed significantly since 2002. It is important that this parameter stay within the target range and any significant increases should be investigated.



Fluoride (ppm)					
	April	May	June	July	August
West	0.09	0.10	0.10	0.10	0.10
East	0.09	0.10	0.11	0.10	0.11
				Season Average	0.10

Target Range: 0.01 – 0.30 ppm

Fluoride decreased in the lake since testing began. It is important that this parameter stay within the target range and any significant increases will be investigated.



Chloride (ppm)					
	April	May	June	July	August
West	115	134	124	130	120
East	117	129	129	133	125
				Season Average	126

Target Range: 0 – 230 ppm

The trend line for Chloride was slightly downward, but recent years have been relatively flat. With concerns about road salt entering lakes, it is important that this parameter remain within the target range and any increases will be investigated.

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Analysis Information

Temperature:	The water temperature directly affects the amount of oxygen that can dissolve into the water. The temperature of surface waters is not indicative of the entire water column.
Dissolved Oxygen:	D.O. is a measure of the amount of oxygen dissolved in the water. This oxygen is available to fish and other animals for respiration. Vegetation generally increases DO, particularly during the day and early evening. Animals and other respiring organisms consume the oxygen, mostly during the day. Oxygen is also added to the lake through wave action, rain, fountains and aerators.
Total Phosphorus:	Phosphorus is an essential nutrient for plant growth. However, concentrations exceeding 100 ppb can impair the water and results in nuisance vegetation growth.
Phosphates:	Phosphate is the form of phosphorous that is most readily available to plants and algae.
Nitrate:	Nitrogen is also essential for plant growth. Nitrate is the predominant form of nitrogen in water. Excessive nitrate concentrations may also result in pollution and increased vegetation.
Chlorophyll-a:	Chlorophyll-a is a direct measurement of the amount of green pigment produced by plants and phytoplankton. This indicates the amount of plant growth and is used to calculate a Trophic State Index.
Transparency:	The ability of light to penetrate the water column is determined by the amount of dissolved and suspended particles in the water. Although aesthetically desirable, transparent water allows increased light to reach the lake bed and may result in vegetation growth.
pH:	pH is a measure of acidity or alkalinity. pH is a general measure of lake health and can roughly indicate the range of other measurements such as alkalinity and hardness.
TDS:	Total Dissolved Solids is the amount of all organic and inorganic substances in the water in a molecular or ionized state. Higher values generally indicate richer and more productive water. Lower values usually indicate cleaner and less productive water.
Conductivity:	Conductivity is a measure of the ability of water to conduct electricity. Dissolved ions in the water increase conductivity, thus TDS and Conductivity are closely related.
Alkalinity:	Alkalinity refers to the ability of the water to neutralize acids, mainly through the hydrogenation of carbonate ions. Therefore, the alkalinity is expressed as "ppm as $CaCO_3$". However, other basic molecules in the water can also contribute to alkalinity.
Sulfate:	Sulfate occurs naturally as minerals, such as calcium sulfate and magnesium sulfate. In fresh water, sulfate is usually the second or third most abundant anion. Other sources of sulfate include water material from pulp mills, steel mills, food processing operations, and municipal wastes. Under low oxygen conditions, sulfate can by reduced to hydrogen sulfide gas, which smells like rotten eggs.
Fluoride:	Fluoride may occur naturally or be added to public drinking water supplies.
Chloride:	Chloride is one of the major anions found in water and sewage. The presence of chlorides may be due to water passing through salt formations in the earth or pollution from industrial processes, domestic wastes, or road salt. The salt content of water affects the distribution of plant and animal life in an aquatic system, based on the amount of slat they can tolerate.

Trophic States

Oligotrophic: Water is very clear. Nutrient levels are generally low. Plant and algae productivity are also low. Sufficient dissolved oxygen in the bottom, cooler waters allows cold-water fish to survive, such as salmon and trout.

Mesotrophic: Water is moderately clear. Nutrient levels are slightly elevated. Plant and algae productivity are present, but generally not a nuisance. Oxygen and temperature in the lower portion of the lake allow walleye and perch to survive.

Eutrophic: Water is not clear due to high nutrients levels, increased turbidity, and excessive algal growth. There is no oxygen in the bottom, cooler waters, restricting the lake to warm water species, such as bass and bluegill.

Hypereutrophic: Nutrient levels are extremely high, promoting very high algae productivity. Blue-green algae blooms are likely. High turbidity and algae growth make the water opaque. Little plant growth is restricted to invasive plants. The only fish that can survive this environment are rough fish, such as carp, catfish, and mudminnows.

Sample Sites: