



2016 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. Tests were conducted with a Hanna Multiparameter Water Quality Meter or LaMotte SMART2 Colorimeter.

Test results were compared to historical data from the report “2015 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 allow us to quickly see which direction each water quality parameter is moving.

Results

Parameter	2016 Season		
	Average	Target Range	Status
Temperature	73.3 °F	Less Than 75 °F	● Healthy
Dissolved Oxygen	7.2 mg/L	4.0 – 12.0 mg/L	● Healthy
Total Phosphorus	89 ppb	0 – 100 ppb	● Healthy
Phosphate	41 ppb	0 – 100 ppb	● Healthy
Nitrate	427 ppb	0 – 1,000 ppb	● Healthy
Chlorophyll-a	5.9 ppb	0 – 7.3 ppb	● Healthy
Transparency	7.8 feet	More than 6.5 feet	● Healthy
pH	8.5 S.U.	7.0 – 9.0 S.U.	● Healthy
Total Dissolved Solids	369 ppm	0 – 1,000 ppm	● Healthy
Conductivity	738 ppm	0 – 1,500 ppm	● Healthy
Alkalinity	130 ppm	100 – 250 ppm	● Healthy
Sulfate	13.5 ppm	3 – 30 ppm	● Healthy
Fluoride	0.10 ppm	0.01 – 0.30 ppm	● Healthy
Chloride	120 ppm	0 – 230 ppm	● Healthy

Year-End Discussion

Island Lake’s water quality was excellent this year. The season average for all parameters were within the target ranges.

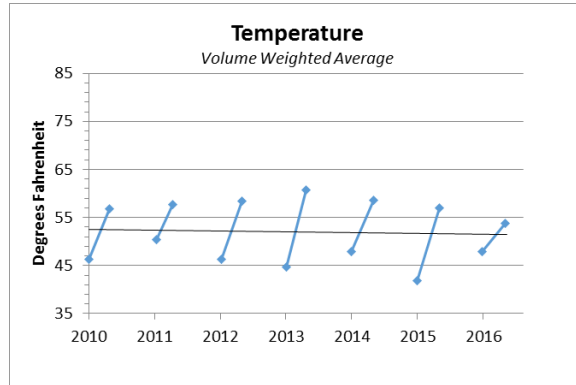
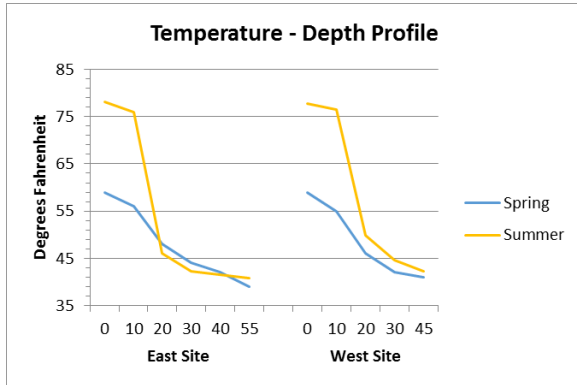
Temperature and Dissolved Oxygen

The average water temperature was similar to previous years. The preceding winter was mild and most Michigan lakes had less than average ice and snow cover. This led to warmer water temperatures in the spring. Summer temperatures quickly increased with little rainfall to cool the water. As a result, the water temperatures later in the summer were into the 80’s.



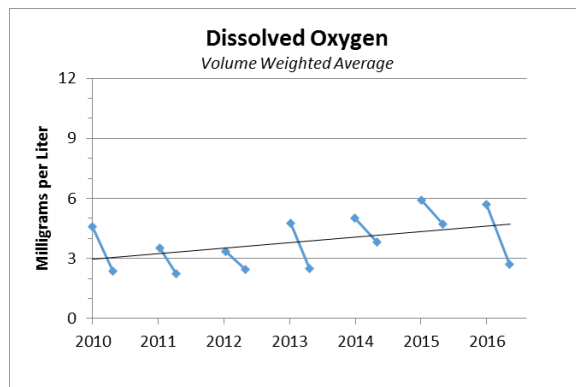
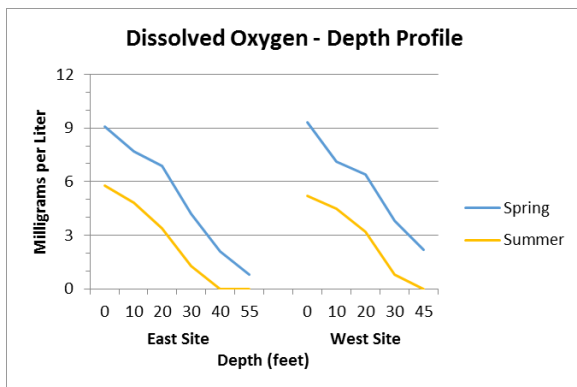
We also measured temperature at different depths to create a temperature profile. This data shows how the temperature changed with depth and whether or not a thermocline was present in the lake. The first graph below shows the data we collected in 2016. This summer, there was a thermocline in the water, near 15 feet. In the spring, the water temperature decreased steadily from the surface to the lake bottom.

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 mostly steady.



There is a limit on how much dissolved oxygen can be in the water, which depends upon temperature. Because water temperatures were higher this summer, the water was able to hold less dissolved oxygen. Despite this disadvantage, Island Lake had excellent dissolved oxygen concentrations throughout the summer. Dissolved oxygen is vital for a healthy aquatic ecosystem, so this year's concentrations were a positive for lake.

The depth profile methodology was followed and measurements taken for dissolved oxygen. This allowed us to see how the oxygen concentration 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.

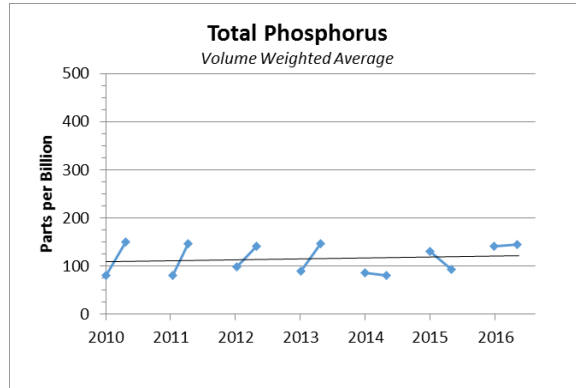
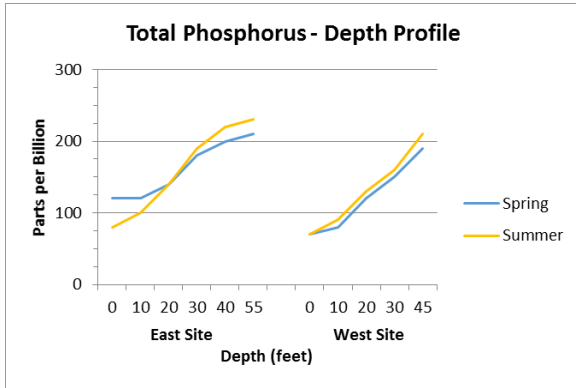


Nutrients, Plant Production, and Transparency

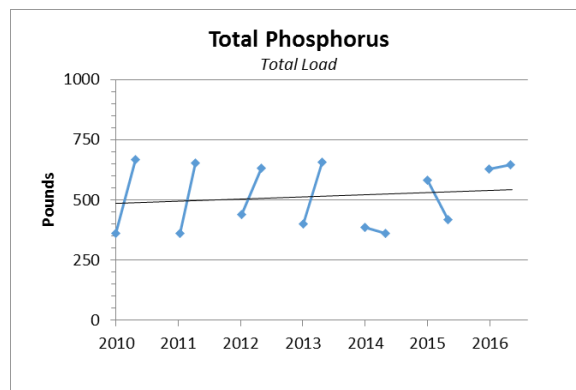
Nutrients in the water are the fuel for plant growth. Measuring the nutrient concentrations reveals the potential for nuisance plant growth. Phosphorus is a main nutrient necessary for aquatic plant growth, so it is important that this nutrient remains low in the lake. The total phosphorus was elevated in April, but returned within the target range throughout the summer. Phosphate, which is the form of phosphorus usable to plants, was also within the target range for all of the summer.



The depth profile methodology was followed and measurements taken for total phosphorus. This allowed us to see how this nutrient concentration changed throughout the water column. 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 slightly.



Finally, we used the concentration of phosphorus and the water volume of the lake to calculate the lake’s phosphorus load. This quantifies the amount of phosphorus in the lake. The following graph shows the results of this calculation over the years of our testing. A generality is that 1 pound of phosphorus can support 500 pounds of plant growth, so the average load of 637 pounds of phosphorus could support almost 160 tons of plants!



Nitrate is another major nutrient for aquatic plant growth. The nitrate concentrations remained within the target range this summer. It is important that residents fertilize and use their land responsibly to prevent additional nutrients from entering the lake.

We also measured Chlorophyll concentrations because it is the most direct indicator of plant production. The target for chlorophyll is below 7.3 parts per billion. The chlorophyll concentrations remained below the target level through the summer but peaked in August. A major factor was the abundance of Eurasian Milfoil in the lake during July and 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 water clarity averaged a depth of 7.8 feet. The April and May measurements were low, but clarity was very good in June through August.



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)	Classification
Nutrients	Total Phosphorus	69	Eutrophic
Plant Production	Chlorophyll	48	Mesotrophic
Clarity	Transparency	50	Mesotrophic

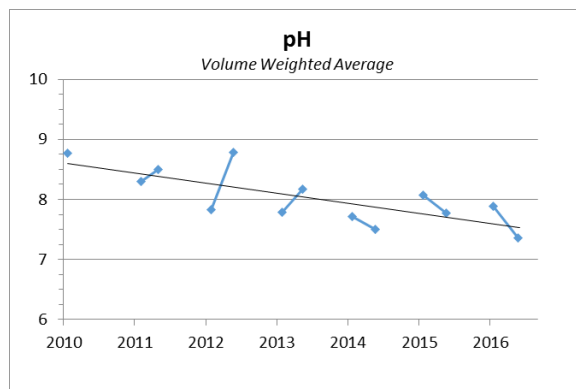
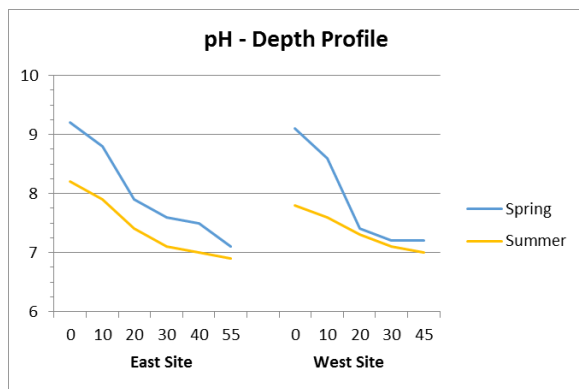
The TSI for total phosphorus classified the lake as eutrophic, or highly productive, based on the availability of nutrients to fuel plant growth. The TSI for chlorophyll is lower than the nutrient index. This shows that despite the availability of nutrients, the plants were not at the levels predicted by the nutrient concentrations. This was due, in part, to the plant management on the lake. Finally, the TSI for transparency classified the lake as mesotrophic and two points higher than the production index. This shows that the water clarity was slightly worse than expected, due to the low clarity in April and May.

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.

The depth profile methodology was followed and measurements were taken for pH. This allowed us to see 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) showed there were low amounts of dissolved substances 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. Thus, 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.

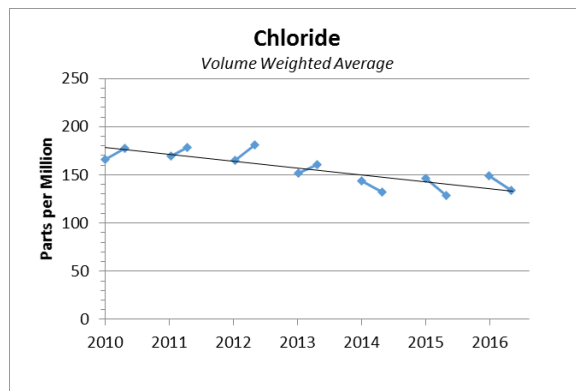
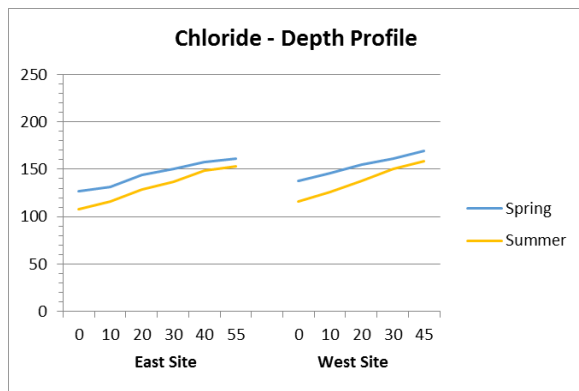


Alkalinity measures the concentration of one salt, Calcium Carbonate, which is beneficial to the aquatic ecosystem. The carbonate ions are able to accept protons from acids, making it a natural buffer. This means that as acidic substances enter the lake, the carbonate is able to buffer against severe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

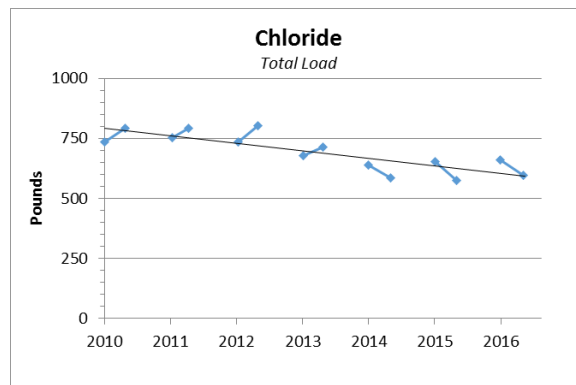
Pollutants

The lake was tested for Sulfate, Fluoride, and Chloride as indicators of pollution. These molecules should be present in the water naturally, but elevated 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 followed and measurements were taken for chloride. This allowed us to see 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 chloride in the lake decreased.

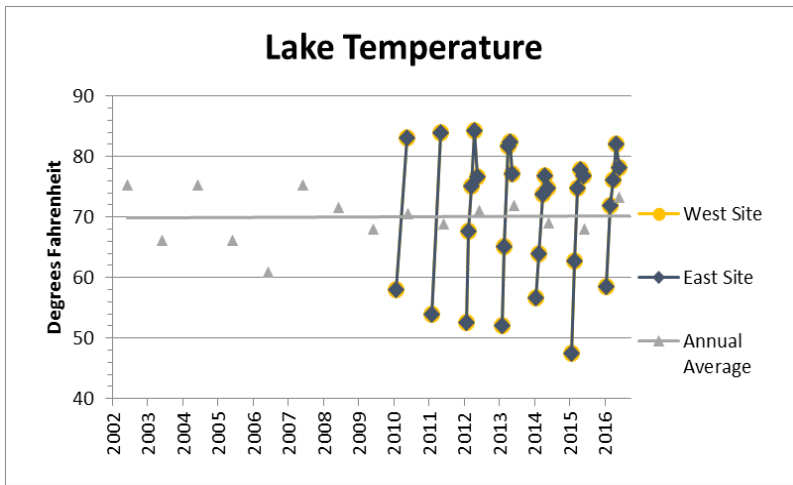


Finally, we used the concentration of chloride and the water volume of the lake to calculate the lake's chloride load. The following graph shows the results of this calculation over the years of our testing. This quantifies the amount of chloride in the lake.





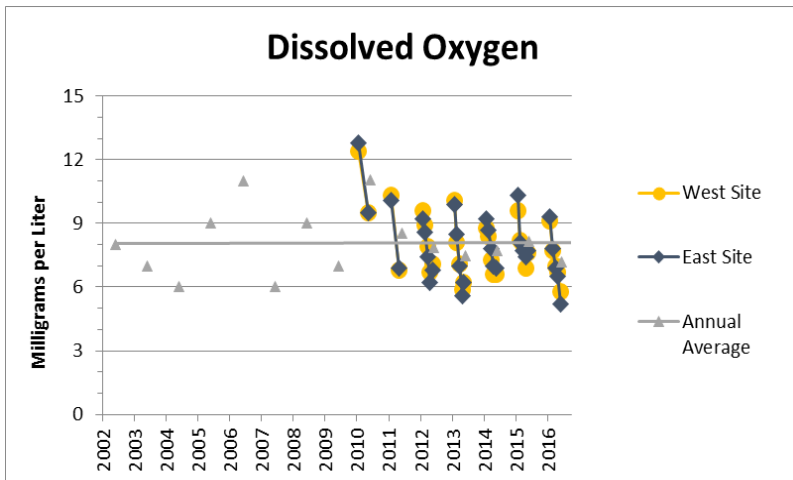
Historical Trends



Lake Temperature (°F)					
	April	May	June	July	August
West	58.5	71.9	76.2	82.0	78.1
East	58.6	72.0	76.5	81.6	77.7
	Season Average				73.3

Discussion

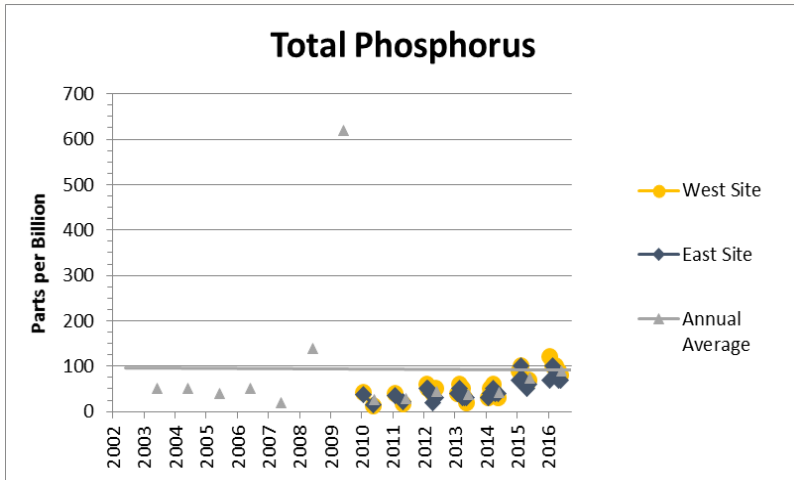
The long term trend for water temperature is generally flat and the 2016 season average was above the trend. Water temperature is dependent upon air temperatures and the dates selected for testing. For that reason, LakePro tried to select similar dates for testing each year. The main concern with increasing water temperatures is the reduction in dissolved oxygen solubility.



Dissolved Oxygen (mg/L)					
	April	May	June	July	August
West	9.1	7.7	7.0	6.7	5.8
East	9.3	7.8	6.9	6.5	5.2
	Season Average				7.2

Discussion

Dissolved oxygen concentrations have a flat trend that corresponds to steady temperatures. Although the concentrations varied through the testing history, there has always been adequate oxygen for a healthy aquatic ecosystem.

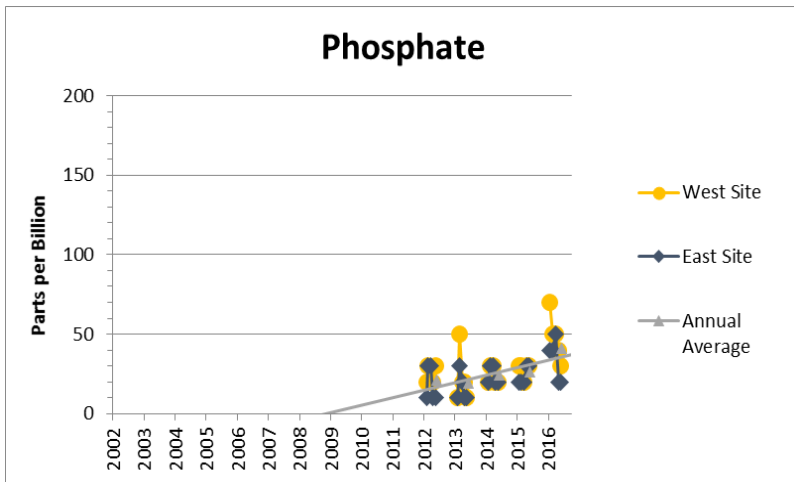


Total Phosphorus (ppb)					
	April	May	June	July	August
West	120	100	100	90	80
East	70	100	90	70	70
Season Average					89
Trophic State Index					69

Discussion

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 is flat. The 2008 and 2009 concentrations were much higher than other years of testing, which pulled the trendline up. Since LakePro began testing the lake in 2010, there has been a slow increase in this nutrient.

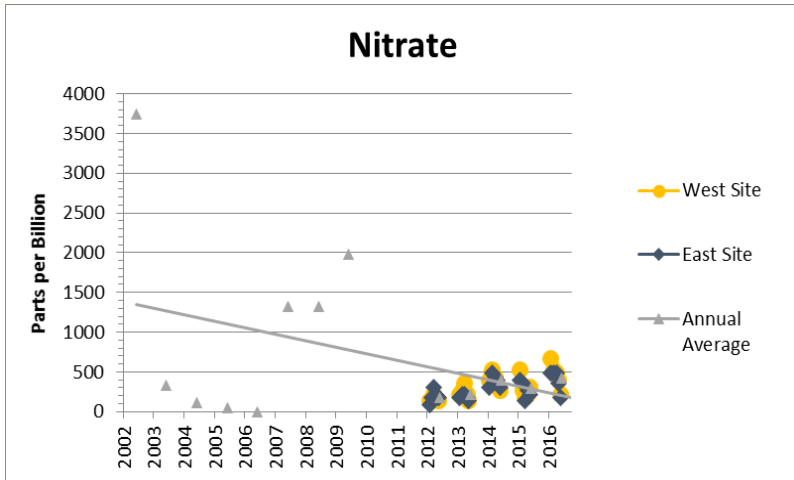
There are ways to remove phosphorus, such as mechanical harvesting and heavy rain events that create excess flow. However, it is much easier to prevent excess nutrients from entering the lake. For this reason, it is vital that residents around the lake fertilize and use their land responsibly to prevent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



Phosphate (ppb)					
	April	May	June	July	August
West	70	50	50	40	30
East	40	40	50	20	20
Season Average					41

Discussion

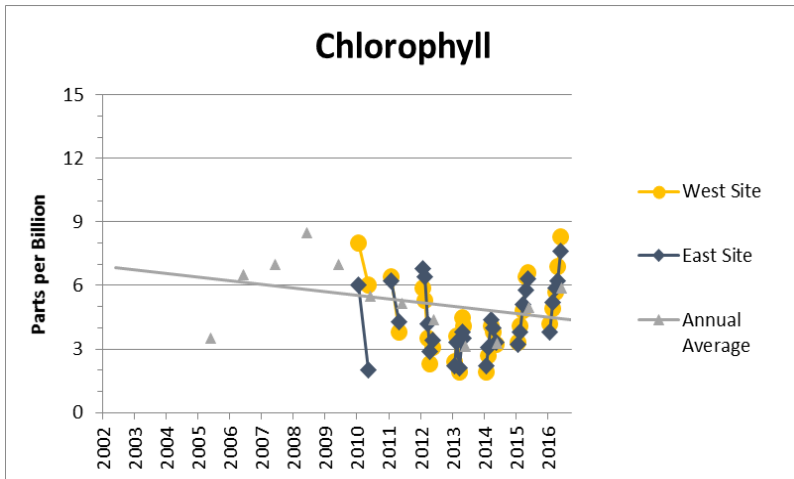
As more phosphorus accumulates in the lake, so too will the usable phosphates. There is no historical data available for phosphates, so the trendline reflects the changes during five years of LakePro’s testing. The trend is slightly upward, but the phosphate concentrations remained well below the target threshold.



Nitrate (ppb)					
	April	May	June	July	August
West	660	528	484	396	220
East	484	484	484	352	176
Season Average					427

Discussion

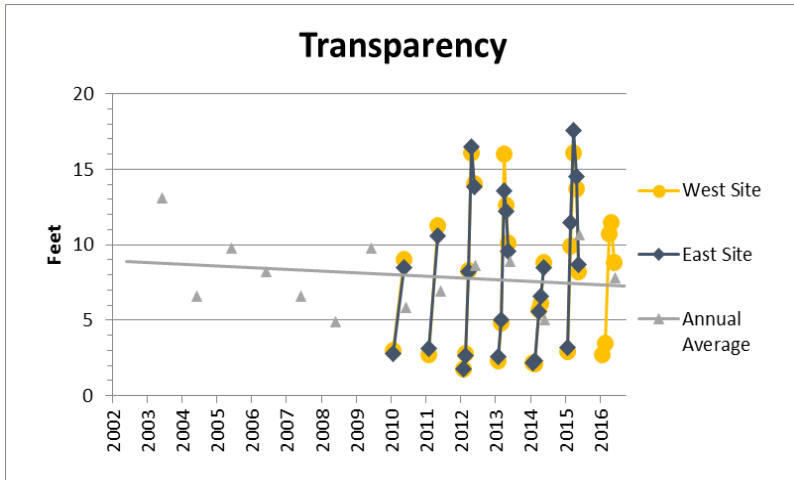
Nitrate is another nutrient that accumulates in lakes. The historical trend for nitrate is downward, due to consistently low values since 2012. The graph shows the concentration of nitrate within the target range over the past five years. It is important that residents fertilize and use their land responsibly so as to prevent nitrates from reaching the lake.



Chlorophyll (ppb)					
	April	May	June	July	August
West	4.2	4.9	5.7	6.9	8.3
East	3.8	5.2	5.9	6.2	7.6
Season Average					5.9
Trophic State Index					48

Discussion

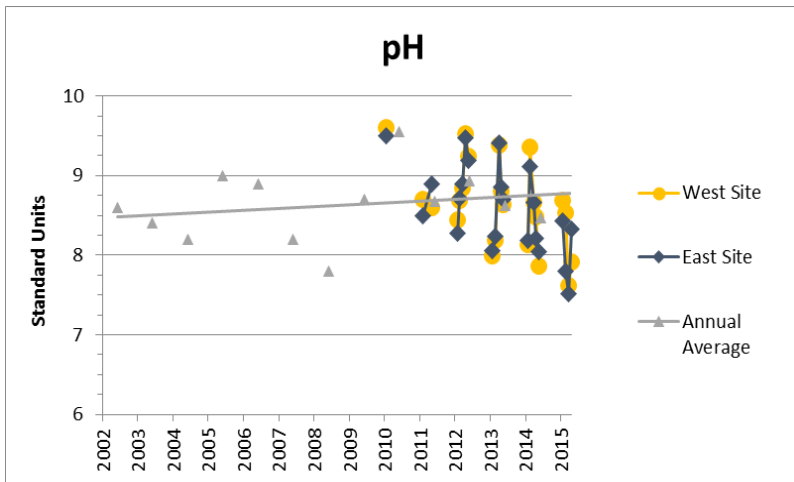
Chlorophyll trended downward over the testing history. Except for 2008, the chlorophyll remained within the target range. This was most likely a product of decreasing nitrate concentrations and aggressive plant management. Continuing to mechanically harvest will remove plant biomass and the nutrients within it. Responsible land management by residents around the lake will help stifle the source of excess nutrients, preventing more plant growth.



Transparency (feet)					
	April	May	June	July	August
West	2.7	3.5	10.7	11.5	8.8
East	2.8	4.5	11.2	12.6	10.1
Season Average					7.8
Trophic State Index					50

Discussion

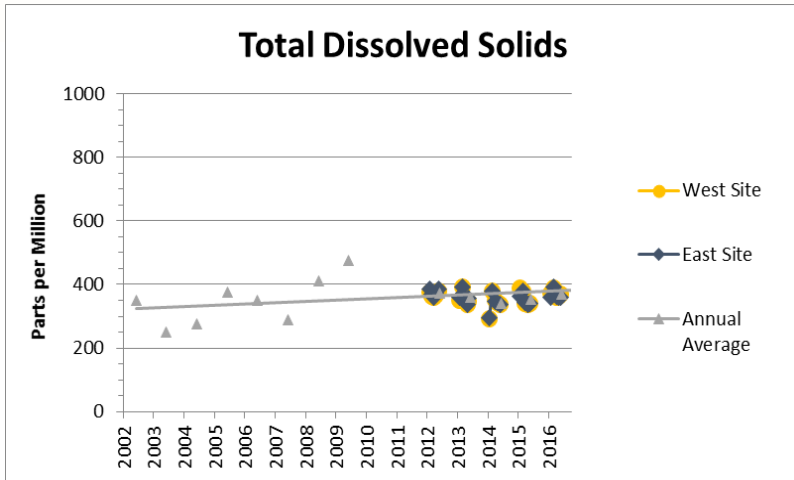
Less chlorophyll generally leads to higher transparency. Despite the downward trend of chlorophyll, the transparency also trended down. In 2014, additional tests revealed the brown color in the early summer was due to high concentrations of the algae Planktothrix. The decreasing transparency is a concern 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 (Standard Units)					
	April	May	June	July	August
West	9.2	8.2	8.3	8.6	8.2
East	9.1	8.1	8.6	9.0	7.8
Season Average					8.5

Discussion

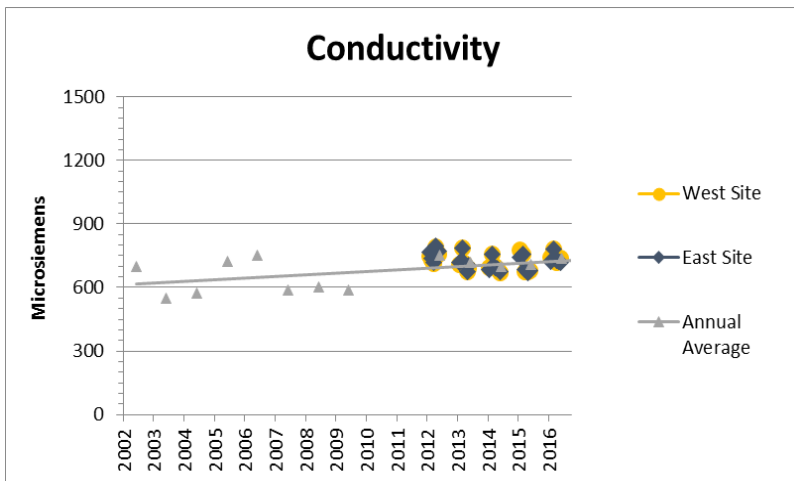
The pH at the lake surface trended upward over the testing history, but recent years have helped to flatten the trend. It is important to look for the upward trend to level off in the future. Some fluctuation is expected, but major shifts or changes beyond the target range may indicate a larger problem.



Total Dissolved Solids (ppm)					
	April	May	June	July	August
West	372	390	360	364	369
East	361	391	364	361	360
Season Average					369

Discussion

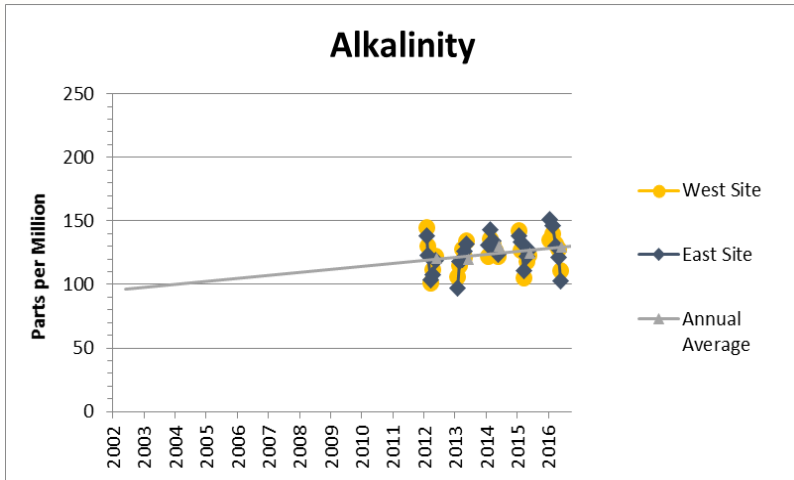
The total dissolved solids increased over the testing history, showing that the lake is accumulating more substances. The increase was slow and the past four years have shown a slowing of the trend. This may have been due to strong snow melt and summer rainfall that helped to flush the lake. Continuing to harvest will remove substances from the lake, including nutrients, as they are bound into the plant biomass.



Conductivity (µS)					
	April	May	June	July	August
West	744	779	720	728	737
East	722	783	728	722	720
Season Average					738

Discussion

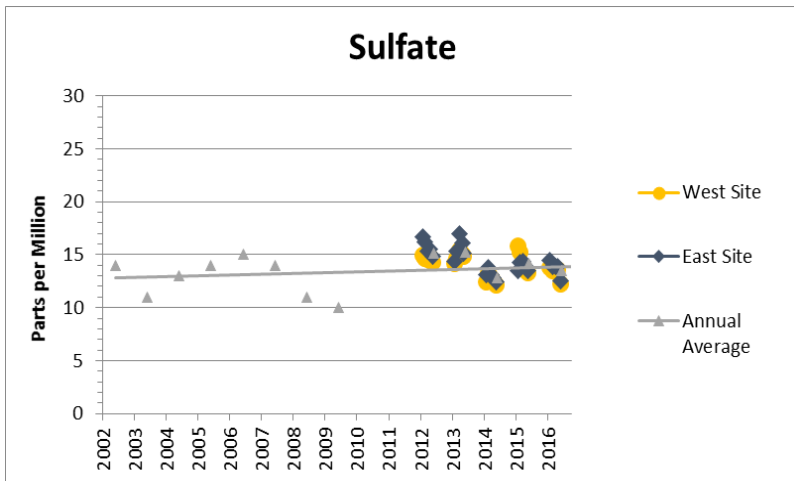
Like the TDS, Conductivity increased over the testing history. Conductivity is a function of TDS and measures the amount of ionic molecules in the water (which conduct electricity; usually salts). We will look for this trend to slow in future years of testing.



Alkalinity (ppm)					
	April	May	June	July	August
West	135	140	132	128	111
East	151	146	130	121	103
Season Average					130

Discussion

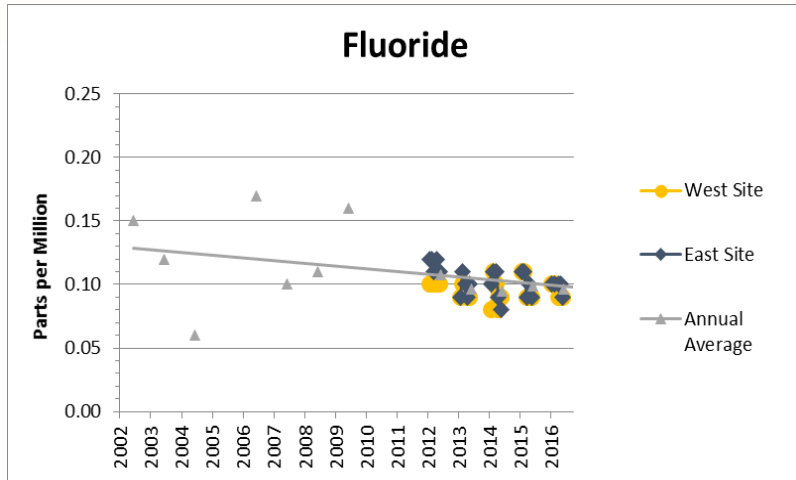
Alkalinity was first included in 2012, so the historical data is limited. During the past five years, alkalinity slowly increased. This could be due to above average precipitation in recent years. As snowmelt and rainfall infiltrate the ground, the water enters the natural groundwater aquifers where it dissolves calcium carbonate and replenishes the alkalinity as it enters the lake.



Sulfate (ppm)					
	April	May	June	July	August
West	13.8	13.5	13.4	13.6	12.2
East	14.5	13.9	13.9	13.9	12.5
Season Average					13.5

Discussion

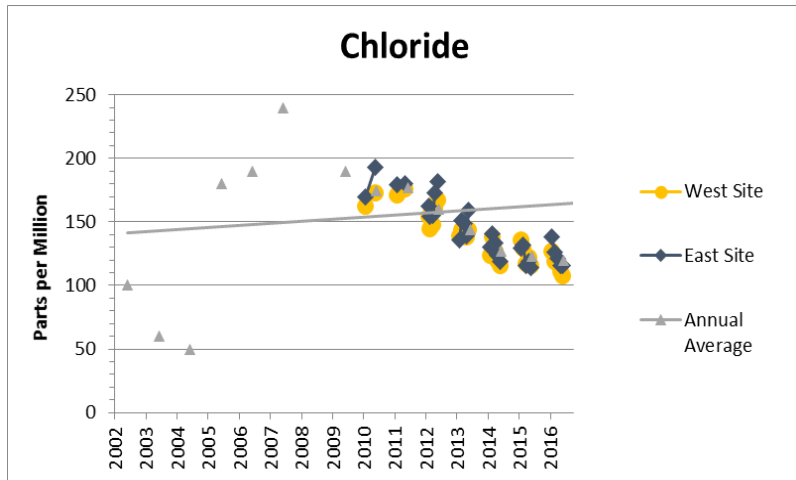
Sulfate increased slightly over the course of testing. It is important that this parameter stay within the target range and any significant increases will be investigated.



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

Discussion

Fluoride decreased in the lake since testing began in 2002. 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	127	119	117	111	108
East	138	126	121	116	116
Season Average					120

Discussion

The trend line for Chloride is upward, but the four latest results were well below the trend. With concerns about road salt entering lakes, it is important that this parameter remain within the target range and any increases will be investigated.



Analysis Information

Temperature:	The water temperature directly affects the amount of oxygen that is able to 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. This is why 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 be 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 salt they can tolerate.

Trophic States

- Oligotrophic:** Water is very clear. Nutrient levels are generally low. Plant and algae productivity is 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 is 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:

