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Orange Lake, Oakland County *December 21st, 2018*

2018 Water Quality Summary

The goal of this testing protocol was to monitor various water quality parameters of the lake, compare results to historical data, and identify any potential risks to the health of Orange Lake. Water samples were taken from two points in lake and tested for various parameters. Field tests and water samples were taken on June 11th and August 23rd. This report describes conditions at the times the samples were taken. The quality of the water was tested only to the parameters listed below.

	June 11th, 2018		August 23rd, 2018		
Parameter	**West**	**East**	**West**	**East**	**Target Range**
Temperature	69.6 ˚F	71.5 ˚F	79.5 ˚F	79.6 ˚F	Less Than 80 ˚F
Dissolved Oxygen – Concentration	7.5 mg/L	7.7 mg/L	6.8 mg/L	5.9 mg/L	4.0 – 12.0 mg/L
Phosphate	80 ppb	120 ppb	50 ppb	60 ppb	0 – 100 ppb
Nitrate	528 ppb	484 ppb	396 ppb	352 ppb	0 – 1,000 ppb
Transparency	8.0 feet		7.2 feet		More than 6.5 Feet
pH	8.6	8.2	8.0	7.9	7.0 – 9.0 S.U.
Total Dissolved Solids	342 ppm	356 ppm	319 ppm	325 ppm	0 – 1,000 ppm
Conductivity	661 µS	700 µS	618 µS	641 µS	0 – 1,500 µS
Alkalinity	155 ppm	150 ppm	138 ppm	141 ppm	0 – 250 ppm
Hardness	192 ppm	185 ppm	167 ppm	172 ppm	100 – 300 ppm
Salinity	310 ppm	330 ppm	280 ppm	300 ppm	0 – 500 ppm
E. coli	0 CFU	0 CFU	0 CFU	0 CFU	0 – 300 CFU / 100 mL

Preface

2018 was the tenth year of our water quality testing on Orange Lake. We are now able to compare annual averages over the testing history. The trend lines on the following graphs show the change from 2009 to 2018. Each successive year of testing will provide more insight into how the lake changed on a long-term scale.

Each test represents a snapshot of the water quality when the sample was pulled. Water quality parameters can change from morning to night, day to day, or year to year. The discussion below will focus on the results listed above. We drew conclusions from the data, timing, and weather, but it is important to understand that each successive year of testing will help support trends and averages and improve our discussion.

2018 was marked by very high temperatures and little rainfall until later in the summer. Rain and runoff normally have a large influence on the water quality, so we will discuss how the lack of precipitation affected each parameter.

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Discussion

The results of this year's testing indicate that the water of Orange Lake remained very healthy throughout 2018. The results show that the aquatic environment was very suitable to support natural wildlife. Also, the lake was safe for recreational uses, such as swimming, boating, fishing, etc., as there are no signs of pollution.

The **Temperature** of the surface water was warmer during the spring test than previous years. Colder water can hold more oxygen, so having warmer water to start the summer created a small concern that the lake would hold enough oxygen throughout the warmer months. The spring temperature also depends on the dates selected for sampling and this year was slightly later than previous years. Despite the higher temperatures, the **Dissolved Oxygen** in the spring was healthy (85% Saturation).

We performed the second test in August and the temperature of the water was warm, but not quite into the 80's. The Dissolved Oxygen remained at a healthy level (79% Saturation), which meant the lake could support a very healthy fishery late into the year. Furthermore, the healthy oxygen concentration eliminated any concerns headed into winter when ice seals the lake off from atmospheric oxygen.

At the spring test, the concentrations of **Phosphate**, the usable form of phosphorus, was near the upper limit of the target range. During the late summer test, this nutrient decreased to the middle of the range. The lower than average precipitation over summer resulted in fewer nutrients washing into the lake. Also, this decrease was likely helped by aquatic plants utilizing nutrients, removing them from the water column. Also, the biological augmentation program introduced beneficial bacteria to the water to consume nutrients.

The **Nitrate** concentration showed a similar pattern. In the spring, the concentration was within the target range and decreased further by the summer testing event. The improvement was most likely due to plant uptake, outflow, and the lack of rain limiting external loading of nutrients. The probiotics of the biological augmentation program also consumed nutrients. Although concentrations are still in the target range, it is important that residents take measures to ensure their property is not contributing excess fertilizers to the lake.

The **Transparency** was beyond the target depth during both tests. There was a slight decrease from spring to summer, which was expected because of the increased plant production in the summer. Transparency can be affected by many different factors, including suspended solids, dissolved solids, acids, and algae growth. The clear water is generally a positive attribute, but it also allows more sunlight to reach the lake bottom to fuel plant growth.

The **pH** was within the target during both tests.

The **Total Dissolved Solids** and **Conductivity** were within their target ranges and decreased from spring to summer. This usually occurs in most lakes and aligned with the nutrient decreases.

The **Alkalinity** and **Hardness** both decreased from spring to summer, while remaining within their target ranges. The primary reason for the decreases was biological productivity. As organisms become more active in the summer time, they produce more carbon dioxide. As this gas dissolves, it needs to be buffered, using up the carbonate ions.

The **Salinity** decreased from spring to summer, which aligned with the other chemistry parameters.

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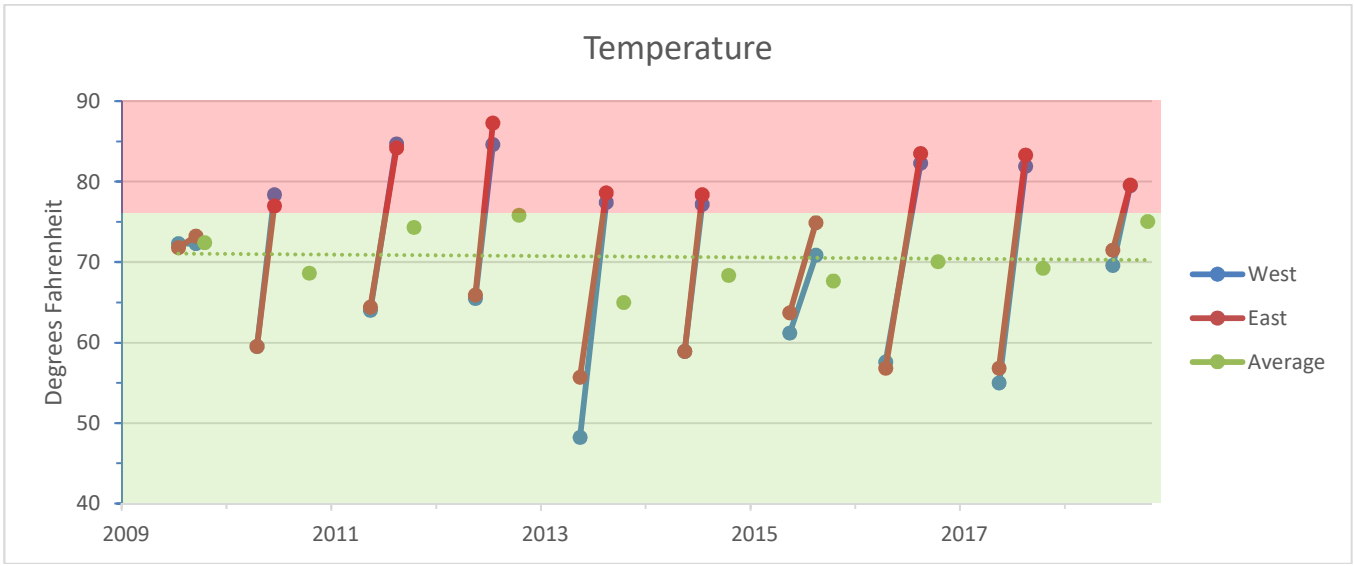
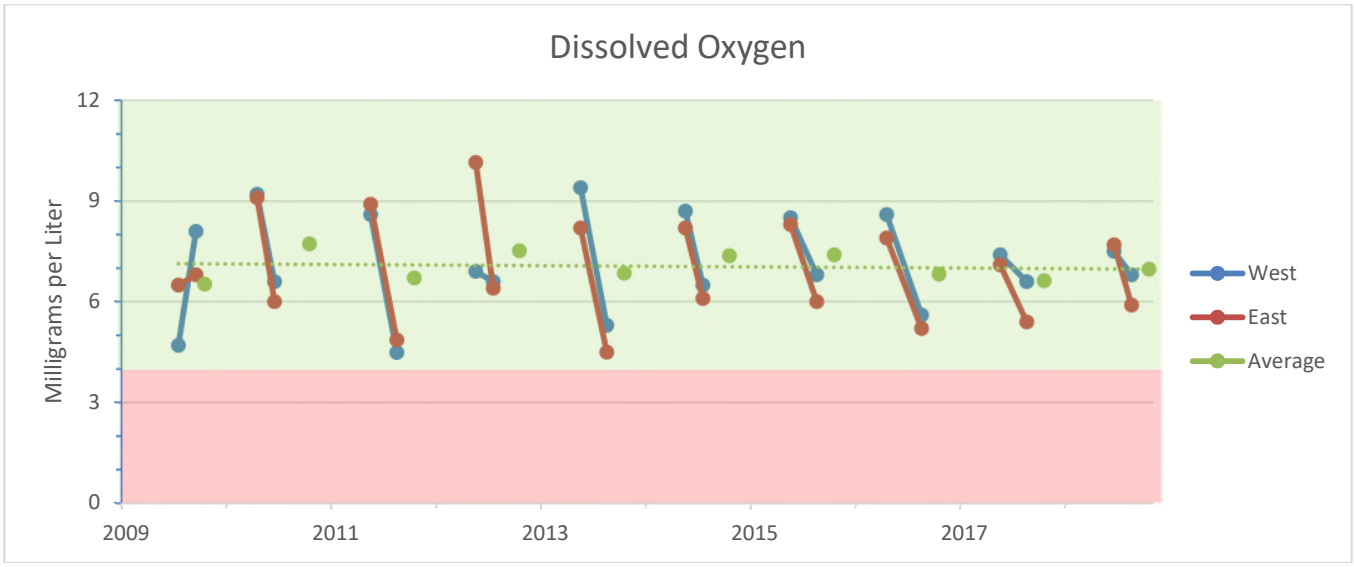
Historical Trends



Target Range: < 75˚F

The temperature was affected by the dates selected for testing and the weather of each year. As we collect data in subsequent years, the trend line should become a more accurate indicator of the changes in the lake. Overall, the trend did not show any significant changes in the surface temperatures.



Target Range: 4.0 – 12.0 mg/L

As the temperature increases, water holds less oxygen. Despite temperature fluctuations over the testing history, the oxygen concentrations remained very healthy. We will continue to watch this trend and recommend further actions if it starts to decrease more sharply.

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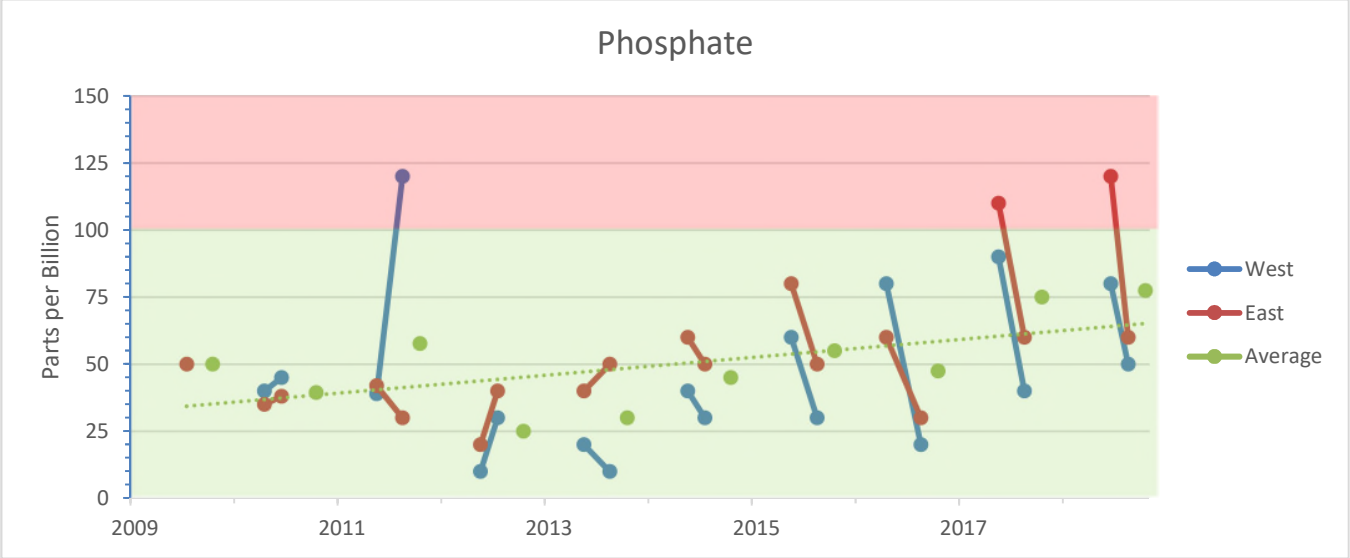
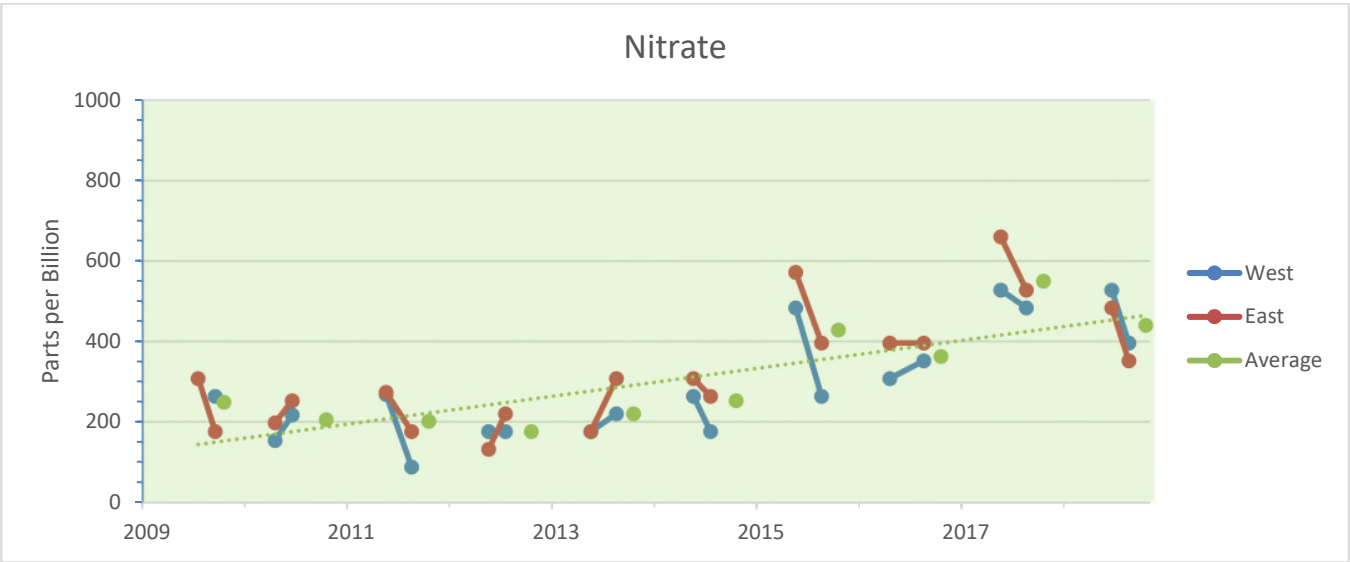


Target Range: 0 – 100 ppb

Phosphate is a major nutrient that fuels aquatic plant growth. The historical trend showed a significant increase over the testing history. Lakes are basins that undergo eutrophication, the process of accumulating sediment and nutrients, leading to shallower depth and more plant growth. This process speeds up over time, so it is important to act now to maintain the lake health. The biological augmentation, aeration, and plant management are all essential management tools for the lake.



Target Range: 0 – 1,000 ppb

Nitrate is another vital nutrient for the growth of aquatic plants. This nutrient also increased over the testing history, despite an improvement in 2018. It is important residents continue to be conscience of their properties and landscaping methods to ensure more nutrients do not enter the lake.

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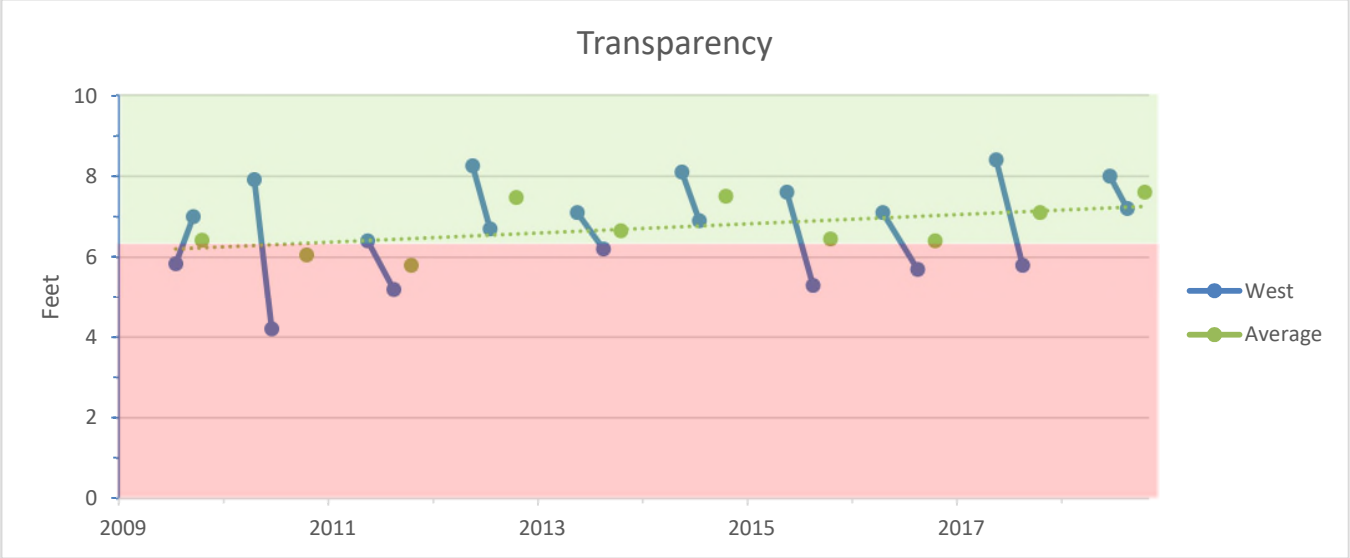
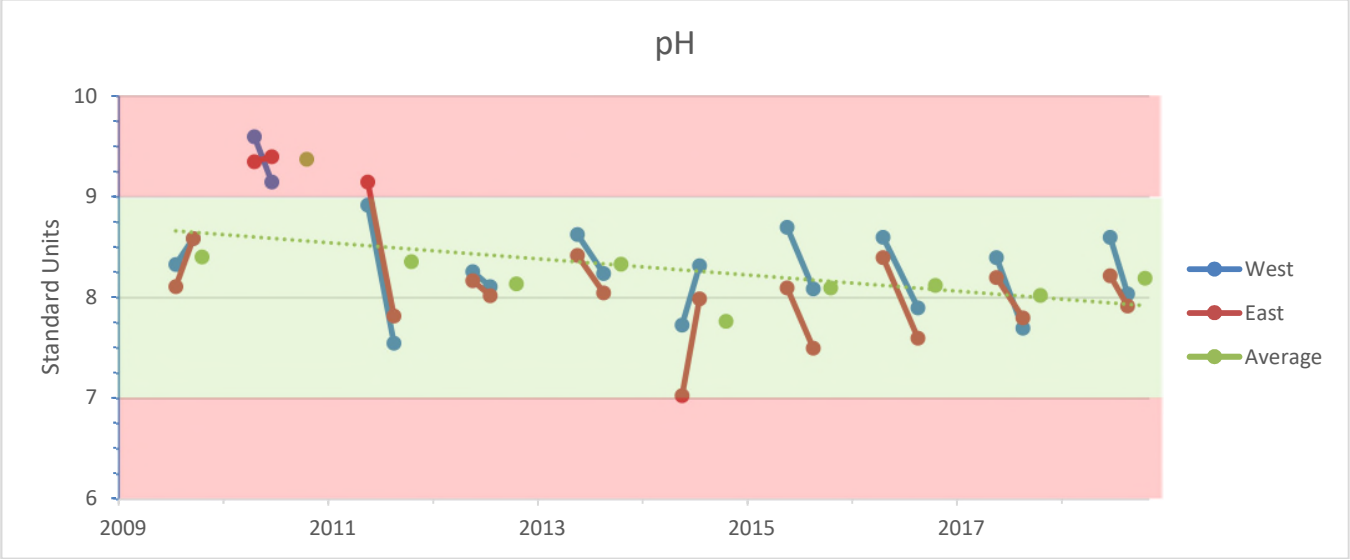


Target Range: > 6.5 feet

Transparency was affected by different factors including total dissolved solids, total suspended solids, algae growth, and rain frequency and amount. Overall, the transparency of the lake increased over the testing history.



Target Range: 7.0 – 9.0 S.U.

There was a slight decrease in pH, but it stayed in the target range of 7 to 9. We will look for the pH to level off in future years. If the pH ever changes drastically, we will look for the cause of that change in order to mitigate the trend.

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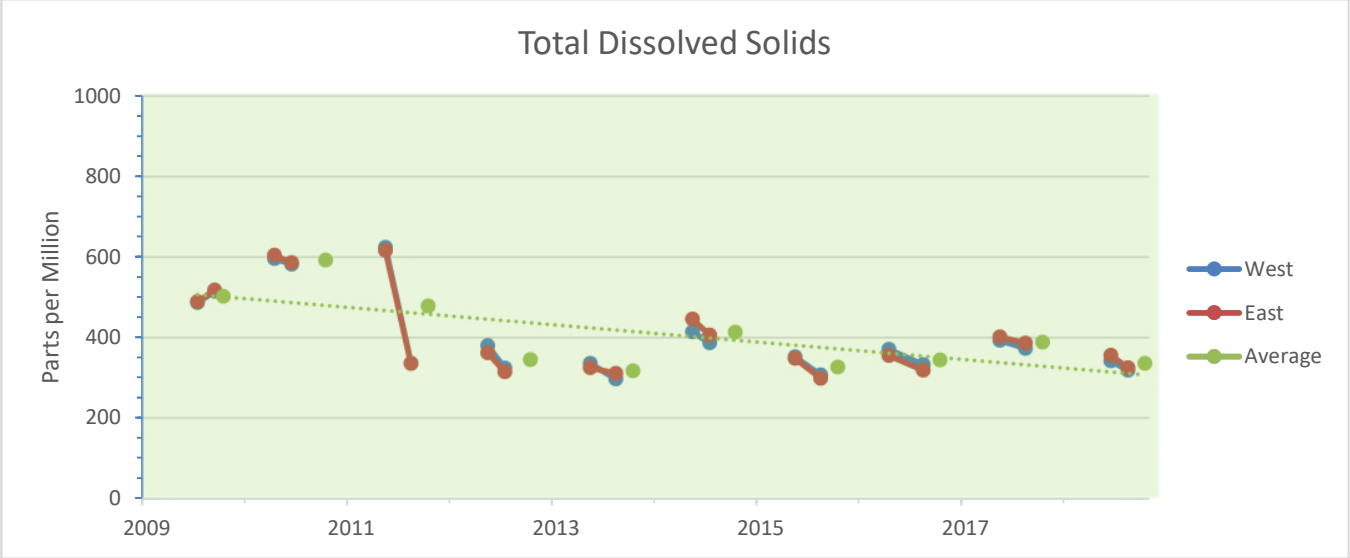
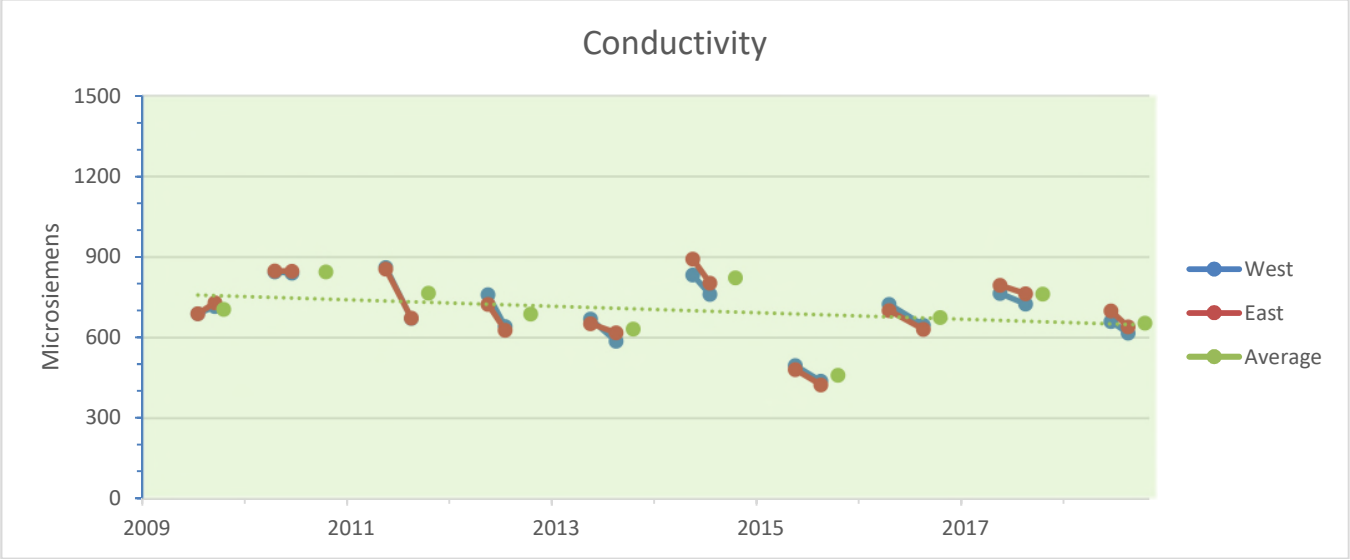


Target Range: 0 – 1,000 ppm

The Total Dissolved Solids show a downward trend over the testing history. Despite the lake gaining more nutrients, other dissolved substances decreased in the lake. This could be due to dilution and flow out of the lake. Also, increased plant growth will help to filter dissolved substances out of the water column.



Target Range: 0 – 1,500 µS

Like the TDS, Conductivity showed a downward trend. Conductivity is an extension of TDS and measures the amount of ionic molecules in the water (which conduct electricity, usually salts).

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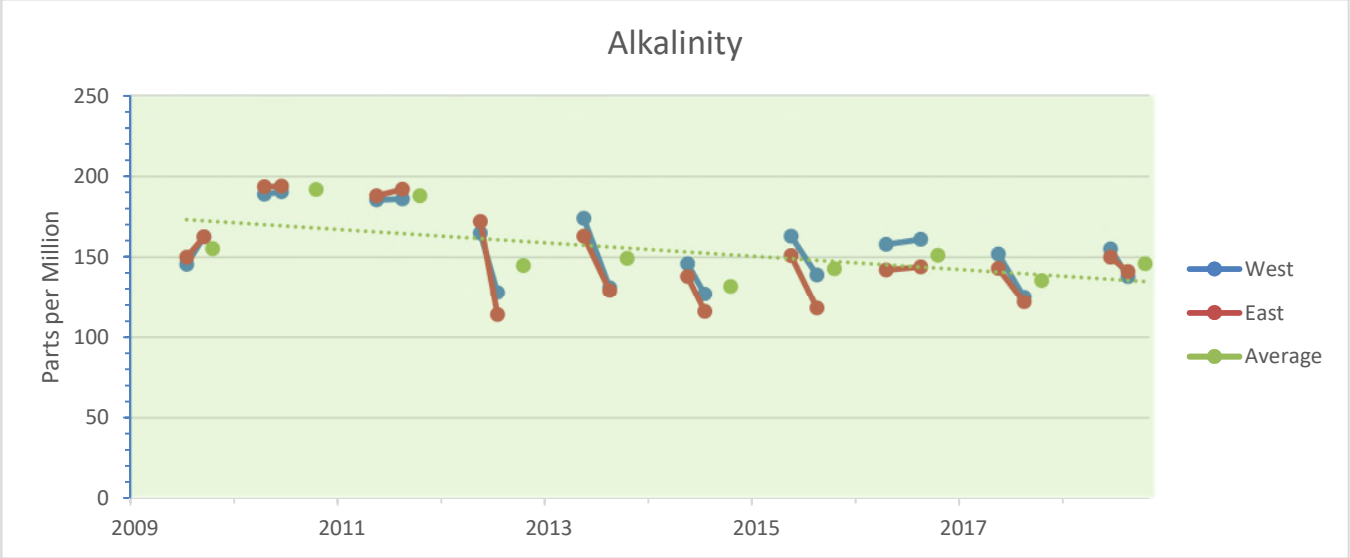
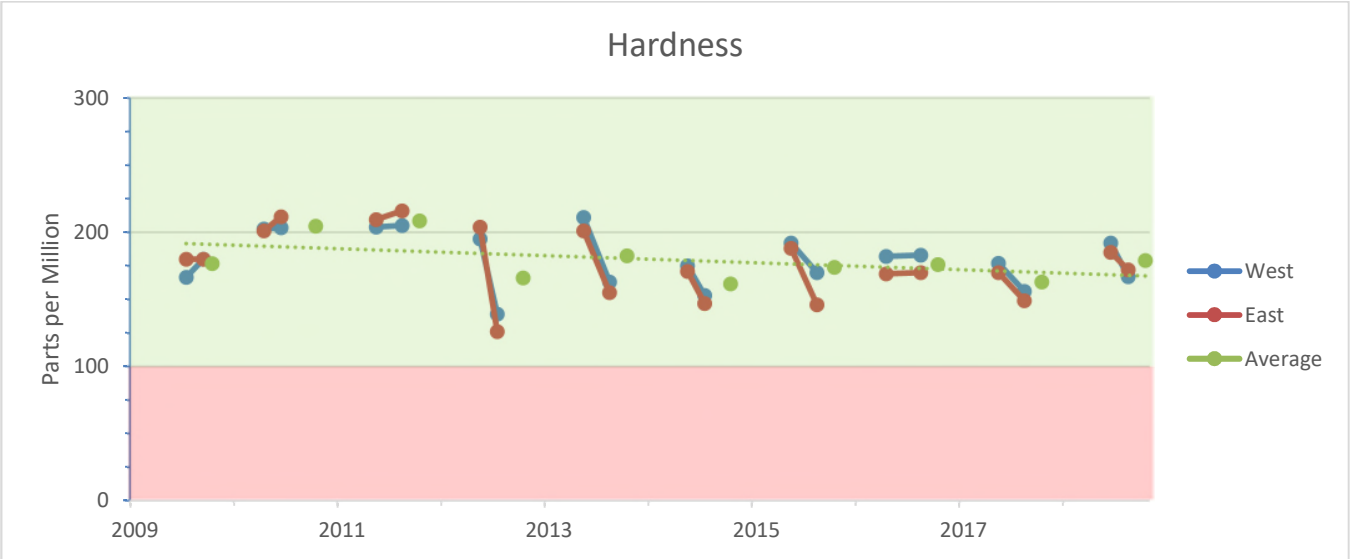


Target Range: 0 – 250 ppm

The Alkalinity decreased over the testing history. Alkalinity works as a buffer to stabilize the pH when foreign substances enter the lake or when there is an accumulation of carbon dioxide. The decrease in alkalinity aligned with the decreased in both dissolved solids and conductivity.



Target Range: 100 – 300 ppm

While alkalinity measures the acidic neutralizing capacity, mainly in the form of carbonate, hardness measures the polyvalent cations, such as calcium ions. Since one of the most commons salts in the water is Calcium Carbonate, hardness generally followed alkalinity.

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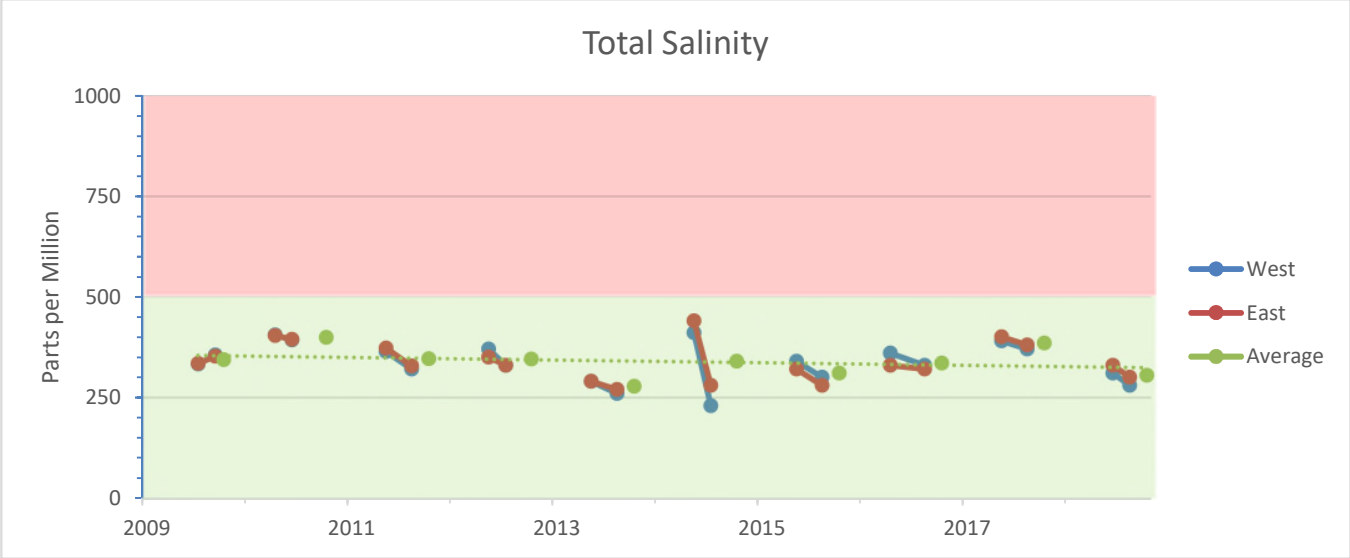

Target Range: 0 – 500 ppm

The Salinity decreased slightly over the testing history. A major concern for lakes is the accumulation of salts, particularly from road salt. It is important to continue monitoring the salinity in future years to see if this trend worsens.

Conclusion

Overall, the water quality of Orange Lake was very good this year. The dissolved oxygen remained very healthy even in the heat of summer. Nutrient levels were within their target ranges, but we will continue to watch the long-term increases. The transparency was very good in the spring and summer. All other water quality parameters were excellent.

Despite a heavily developed watershed and homes surrounding the lake, Orange Lake is a valuable water resource with healthy water quality. There will always be areas that the quality of the water could improve, primarily nutrients. You should take pride in the lake and continue your efforts toward improving it.

Completed and Certified by: _____ Date: December 21st, 2018

Peter Filpansick, B.S.
Aquatic Biologist

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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.

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 bottom 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.

Hardness: Hardness is very closely related to alkalinity. It is a measure of the dissolved salts and metals in the water, including but not limited to $CaCO_3$.

Salinity: Salinity is the measure of the dissolved salt content of water. Salinity influences the types of organisms that can survive in the water. Salinity also affects the chemistry of the water, including conductivity and potability.

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.

Phosphates: Phosphorus is an essential nutrient for plant growth. 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.

Fecal Coliforms: Non-fecal coliforms are naturally found as soil organisms. Fecal Coliforms, such as *E. coli*, are coliforms found in the intestines of warm-blooded animals and humans. The presence of fecal coliforms indicates contamination from either animals or humans.

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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.