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Orange Lake, Oakland County *December 18th, 2015*

Water Quality Report

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 May 4th and August 25th, 2014. This report describes conditions at the times the samples were taken. The quality of the water was tested only to the parameters listed below.

	May 4th, 2015		August 25th, 2015		
Parameter	**Deep**	**Shallow**	**Deep**	**Shallow**	**Target Range**
Temperature	61.2 ˚F	63.7 ˚F	70.9 ˚F	74.9 ˚F	Less Than 80 ˚F
Dissolved Oxygen – Concentration	8.5 mg/L	8.3 mg/L	6.8 mg/L	6.0 mg/L	4.0 – 12.0 mg/L
Phosphate	60 ppb	80 ppb	30 ppb	50 ppb	0 – 100 ppb
Nitrate	484 ppb	572 ppb	264 ppb	396 ppb	0 – 1,000 ppb
Transparency	7.6 feet	3.5 feet	5.3 feet	2.9 feet	More than 6.5 Feet
pH	8.7	8.1	8.1	7.5	7.0 – 9.0 S.U.
Total Dissolved Solids	352 ppm	348 ppm	307 ppm	299 ppm	0 – 1,000 ppm
Conductivity	497 µS	482 µS	438 µS	425 µS	0 – 1,500 µS
Alkalinity	163 ppm	151 ppm	139 ppm	118 ppm	0 – 250 ppm
Hardness	192 ppm	188 ppm	170 ppm	146 ppm	100 – 300 ppm
Salinity	340 ppm	320 ppm	300 ppm	280 ppm	0 – 500 ppm
E. coli	0 CFU	0 CFU	0 CFU	0 CFU	0 – 300 CFU / 100 mL

Discussion

We performed the tests in spring and midsummer to capture the water quality at the start of the season and during the stress of warm water conditions. Each testing event captured a snapshot of the water quality when the sample was pulled. Water quality parameters can change from morning to night, day to day, and year to year. The discussion below focused on the results listed above.

2015 was marked by average temperatures and rainfall. Rainwater may enter the lake directly, as runoff, or through groundwater. Each pathway has its own influence on the water quality. We discussed the parameters that may have been influenced by each pathway.

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The results of this year's testing indicated that the water of Orange Lake was healthy in 2015. The results showed 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 were no signs of pollution.

The **Temperature** of the surface water was cool even in the heat of summer. This ensures the water can hold a sufficient amount of oxygen to support the ecosystem. The **Dissolved Oxygen** concentrations were healthy and there was enough oxygen in the lake to support a healthy fishery and other aquatic biota during the spring and summer.

The concentrations of **Phosphate** were in the target range and very low for a developed watershed. This showed that summer rain did not wash excesses of this nutrient into the lake. Rather, the rainwater helped to dilute and flush this nutrient from the lake. The state ban on phosphorus in fertilizers and responsible land management by the residents also helped minimize this nutrient in the lake.

The **Nitrate** concentration was within the target range and showed a similar trend to phosphate. That is, the concentration decreased from spring to summer. It is very important that residents fertilize responsibly and manage their property to not allow excess nutrients into the lake. This is true for both residents around the lake and within the entire watershed that feeds the lake.

In the shallow areas the lake, the **Transparency** exceeded the depth. In the deep area of the lake, the transparency was above the target depth in the spring and decreased slightly into summer. Transparency can be affected by many different factors, including suspended solids, dissolved solids, acids, and algae growth.

The **pH** was within the target range all year. This indicated that the acidic rainwater had little influence on the pH of the lake.

The **Total Dissolved Solids** and **Conductivity** were both healthy and within their target ranges. This was a positive indication for the lake because it showed the rainwater runoff did not delivery excess foreign particles to the lake, which would have driven these parameters upward.

The **Alkalinity** and **Hardness** started near the middle of their target ranges in the spring. Rainwater is slightly acidic and the alkalinity ions worked as a buffer to prevent major shifts in the pH of the lake, reducing the alkalinity results later in the year. As the rainwater infiltrates the ground, dissolves bedrock, and enters the lake as groundwater, it will deliver more Calcium Carbonate, replenishing the alkalinity and hardness of the lake.

The **Salinity** was at normal levels in the lake. This showed that despite a harsh winter, there was not an influx of road salts into the lake that would increase salinity. Furthermore, the salinity decreased from the spring to the summer as rain flushed salts from the lake.

E. coli were not present in the water samples.

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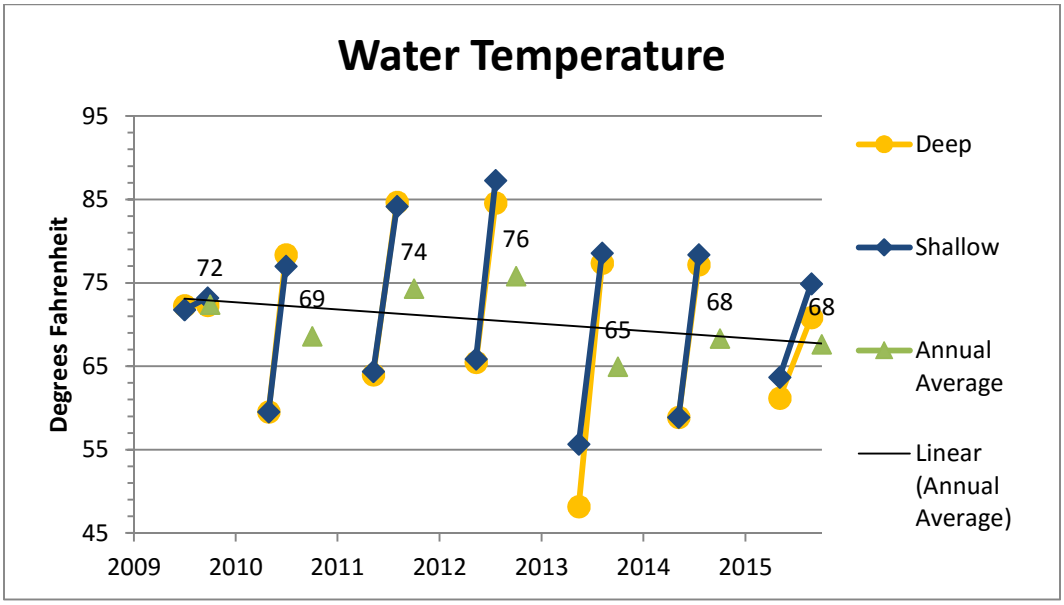
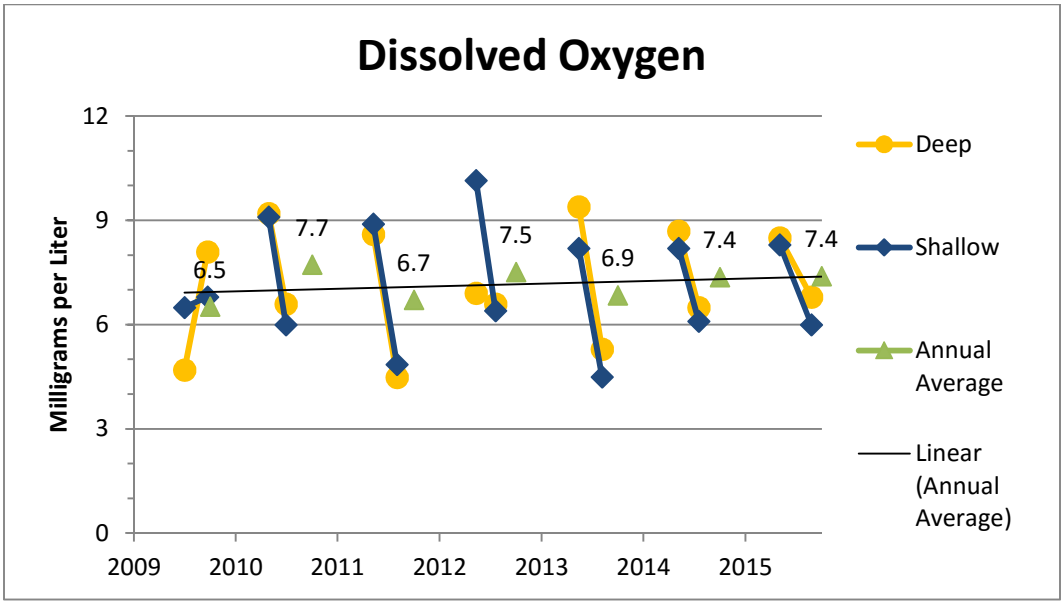
Historical Trends

LakePro began testing the water quality of Orange Lake in 2009. 2015 was the seventh year of testing, which allowed us to compare annual averages. The trend lines on the following graphs show the changes in the water quality since testing began. Each successive year of water quality data will provide more insight into how the lake has changed on a long-term scale.



Target Range: < 75˚F

The temperature showed a slightly downward trend. The temperature was affected by the dates selected for testing and the particular weather of each year. Lower temperatures usually lead to more oxygen in the water.



Target Range: 4.0 – 12.0 mg/L

The dissolved oxygen increased over the testing history and remains within the target range to adequately support a healthy fishery and other aquatic organisms.

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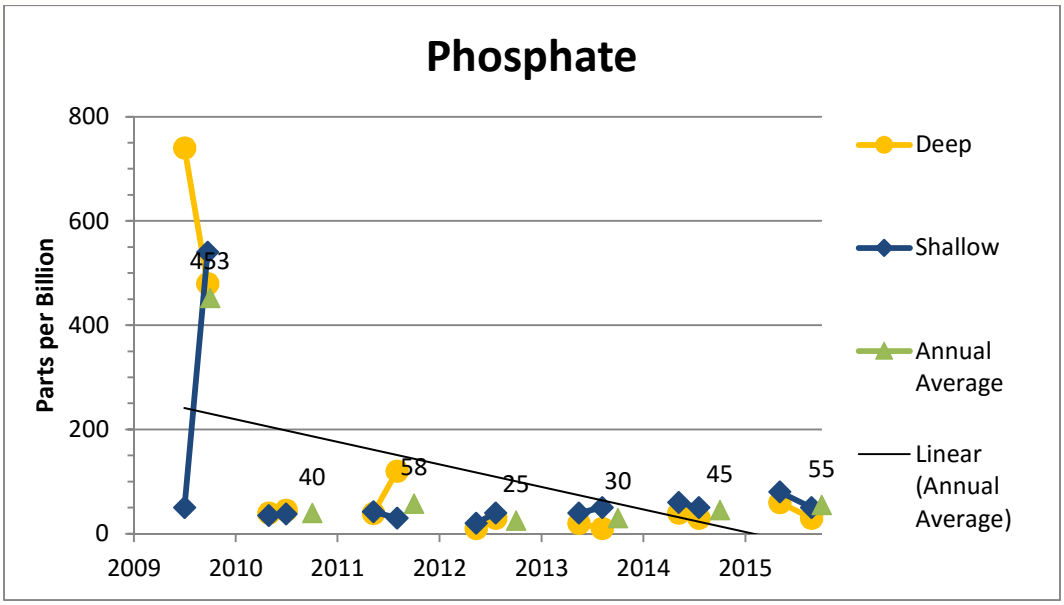
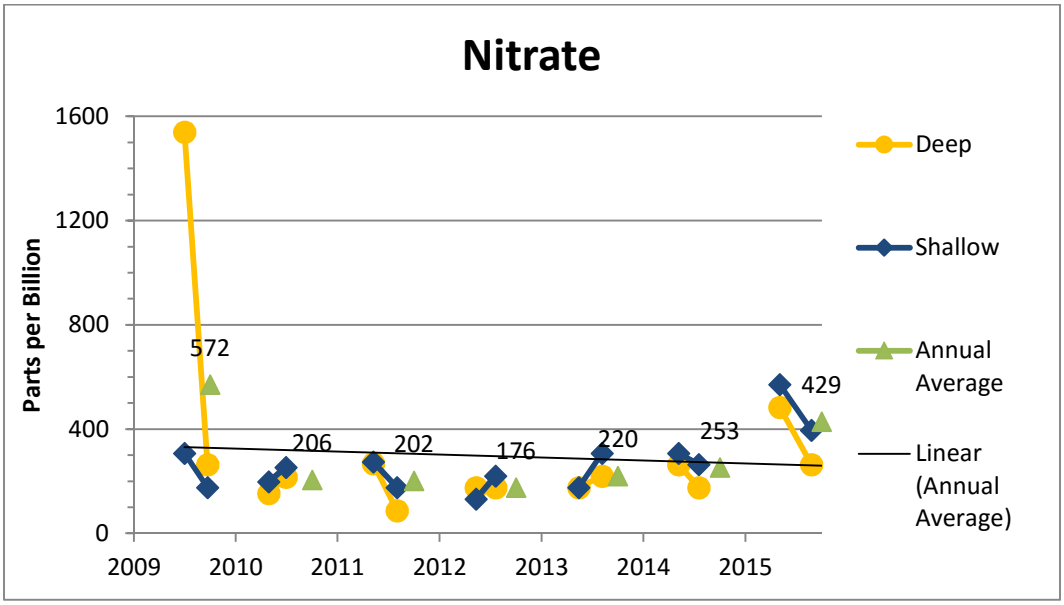


Target Range: 0 – 100 ppb

Phosphate is the form of phosphorus aquatic plants use to grow. This nutrient was very high in 2009, before LakePro started the biological augmentation program. Since that time, the phosphate concentrations have been very low in the lake. Continuing the biological augmentation program and practicing responsible land management around the lake will help keep this nutrient low in future years.



Target Range: 0 – 1,000 ppb

Nitrate is another vital nutrient for the growth of aquatic plants. The trend followed the phosphate results and showed a similar decrease after 2009. It is important that residents practice responsible fertilizing to reduce the amount of nitrates reaching the lake. Continuing the biological augmentation will also help to keep this nutrient at low concentrations in the lake.

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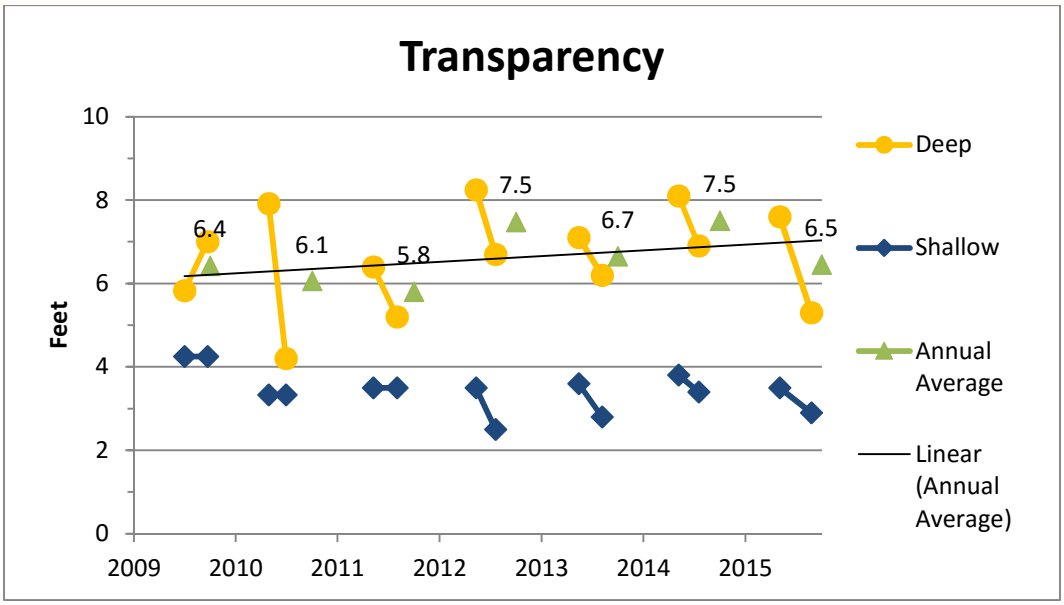
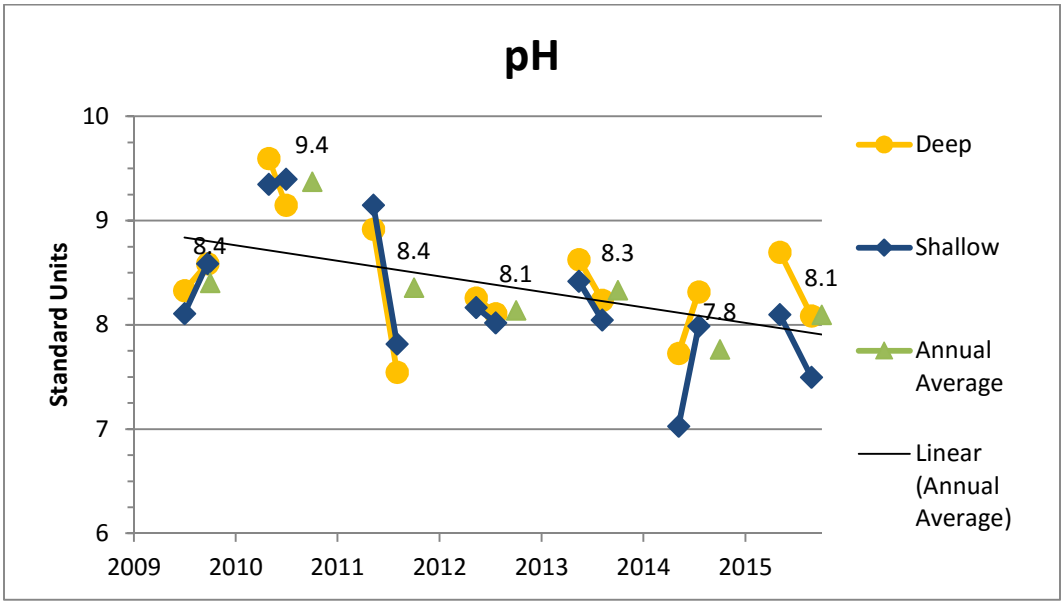


Target Range: > 6.5 feet

The annual averages on this graph represent only the deep portion of the lake, because the shallow readings were limited by the depth of the water. The transparency showed an upward trend over the testing history. This was a positive shift for the lake and could have been due to fewer dissolved solids, suspended solids, or algae growth.



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 continues to decrease toward 7 S.U., we will start looking for the cause of that change in order to mitigate the trend.

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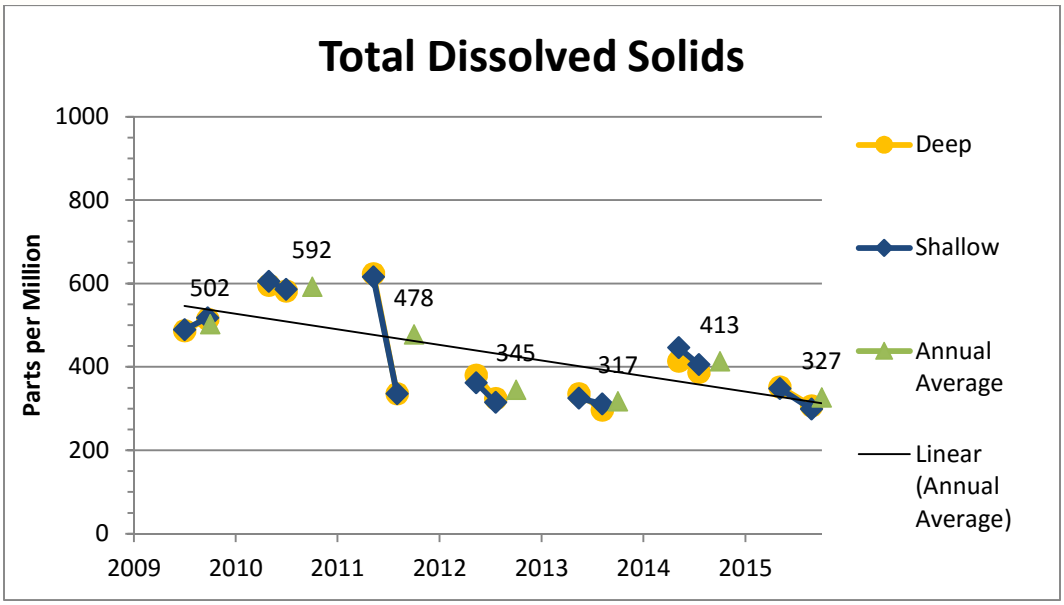
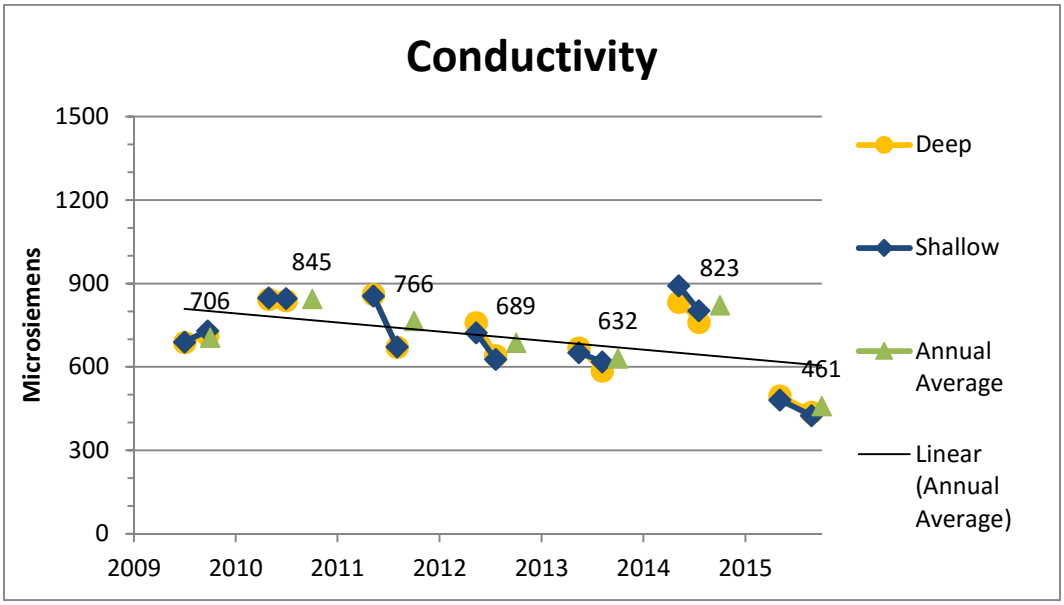


Target Range: 0 – 1,000 ppm
The Total Dissolved Solids have decreased slightly since testing began and remained in the bottom end of the target range.



Target Range: 0 – 1,500 µS
The Conductivity decreased slightly over the testing history. Conductivity is an extension of TDS and measures the amount of ionic molecules in the water (which conduct electricity, usually salts). The downward trend was a positive for the lake, but it should never reach zero because some salts, such as calcium chloride, are necessary for a healthy ecosystem.

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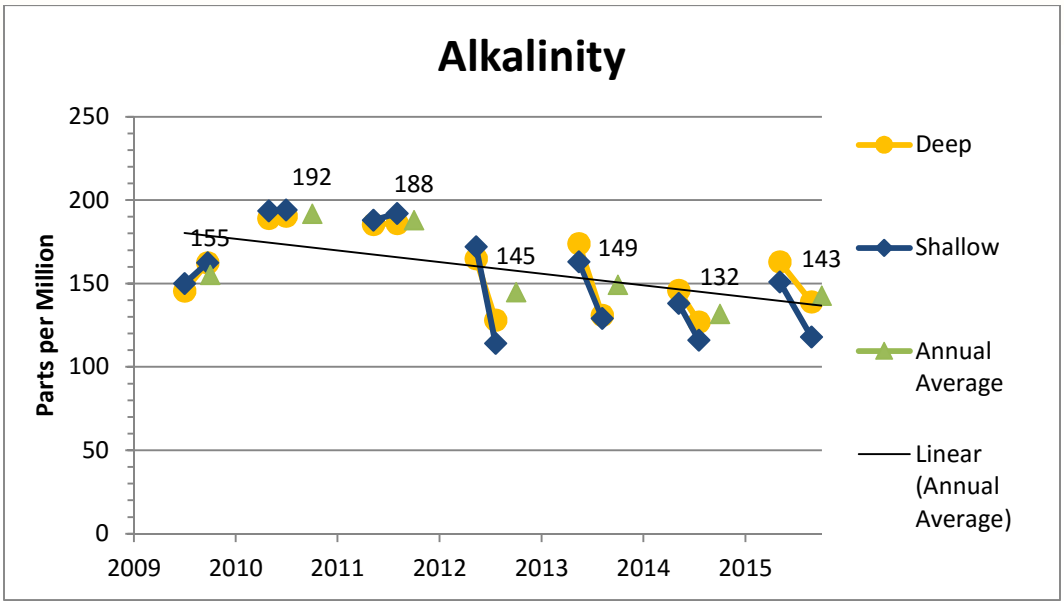
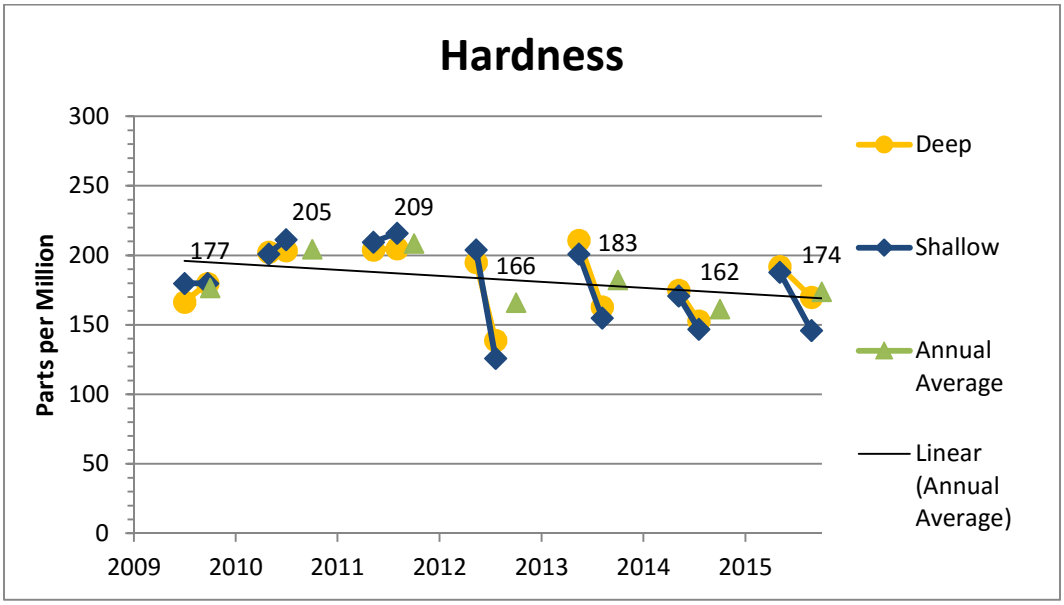


Target Range: 0 – 250 ppm

The alkalinity declined slightly since testing began in 2009. Alkalinity works as a buffer to stabilize the pH when foreign substances enter the lake, such as acidic rainwater. The carbonate ions that buffer changes in pH have been used up to maintain a consistent pH. As more groundwater enters the lake, it should replenish the carbonate ions and alkalinity.



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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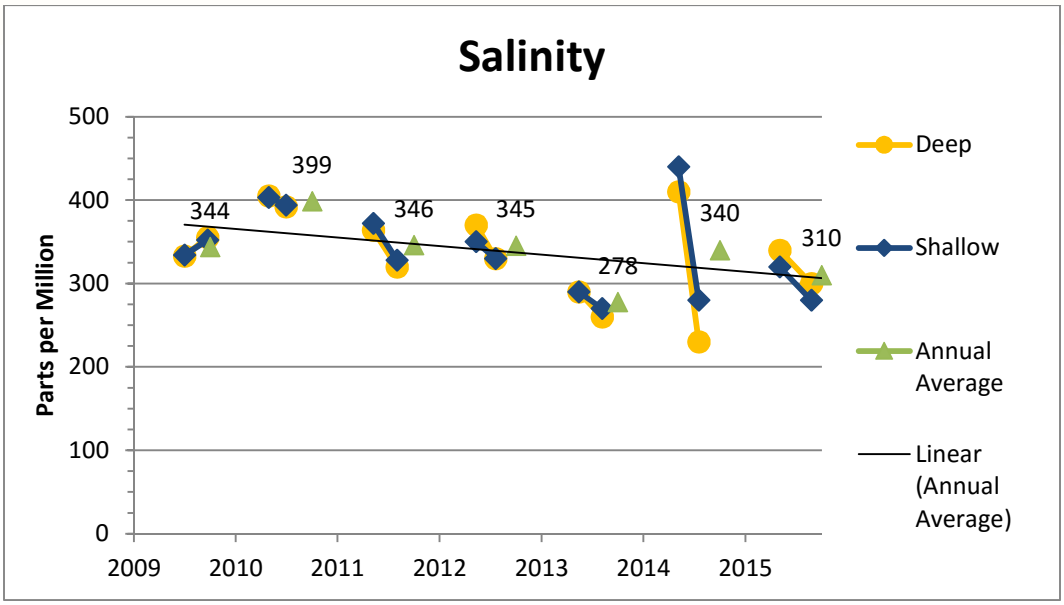

Target Range: 0 – 500 ppm

The Salinity sloped downward since we started testing. Overall this was a positive change for the lake; however, the Salinity should not decrease to zero because some salts (e.g. Calcium Carbonate) are needed for good water quality.

Conclusion

Overall, the water quality of Orange Lake was very good this year. The dissolved oxygen was at adequate levels. Nutrient levels were within their target range, but were slightly higher than last year. The transparency was at a healthy depth. All other water quality parameters were excellent. The long-term trends for all parameters showed positive changes for the lake. We will look for those trends to continue in future years and will be ready to identify problems as they arise.

Despite a heavily developed watershed and homes surrounding the lake, Orange Lake is an excellent water resource with great water quality. There will always be areas that the quality of the water could improve, but the lake remains among the best that we test. You should take pride in this lake and continue your hard work in improving it.

Completed and Certified by: _____ Date: December 18th, 2015

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.
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.
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. This is why 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 are able to survive in the water. Salinity also affects the chemistry of the water, and including conductivity and potability.
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 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.