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2013 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 different parameters. Tests were conducted on a monthly basis from April through August. We averaged the results from both locations and five months to create a “season average” to discuss trends in the water quality. Tests were conducted with a Hanna Multiparameter Water Quality Meter with 20m cable or a LaMotte SMART2 Colorimeter.

Test results were compared to all historical data available, including data from Aquatic Productions and Consulting from the years 2002 through 2009.

General Discussion:
The general goals for lake water quality were increases in Transparency and Dissolved Oxygen and decreases in most other parameters. Island Lake met these goals for some parameters and fell short in others. The summer of 2013 was a drastic change from 2012 and brought abundant rainfall and cooler temperatures. Continuing to monitor the water quality of the lake into the future will help separate anomalies from trends in the lake’s water quality. Please note the following discussion refers to the averages from both sampling sites over the 5-month testing period. Results are shown by site and month with each graph.

In 2013, Island Lake’s water quality remained in very good condition. The lake had some areas of concern, but most parameters improved from the previous summer.

The long term trends for the parameters should compliment each other to tell the story of how the lake is changing. Generally, increasing nutrients leads to more chlorophyll, which decreases transparency. This year in Island Lake, the Total Phosphorus and Phosphate concentrations decreased and the Nitrate concentrations increased from last year. Despite the mixed nutrient trends, the Chlorophyll concentrations decreased from 2012. As expected, less plant production resulted in clearer water and higher Transparency.

Plant management aided these trends. Mechanical harvesting removed nutrients while they were bound into plant material. This lowered the nutrient loads and reduced the internal recycling of nutrients. The state ban on phosphorus-laden fertilizers contributed to lower Phosphorus concentrations. The fertilizers with nitrogen and abundant rainfall throughout the summer may have increased the Nitrate concentrations. It is important that all homeowners around the lake and in the watershed practice responsible land management, including fertilizing methods, to prevent these increases in the future.

The temperature of the lake increased from 2012, which decreased the oxygen solubility. Correspondingly, the dissolved oxygen decreased slightly relative to last year. Despite a decrease, the oxygen concentrations remained sufficient to support a healthy fishery during all testing events in 2013.

Most water chemistry parameters (pH, TDS, Conductivity) decreased since last year but remained within their target ranges. Alkalinity did not change from 2012 and remained at the low end of its target range. The decrease in TDS showed a general reduction in the load of dissolved molecules in the lake, including the beneficial calcium carbonate that constitutes Alkalinity. The Alkalinity should replenish as more groundwater enters the lake bringing in beneficial carbonate ions.

Finally, the Sulfate did not change from 2012, but the Fluoride and Chloride both decreased. These were positive trends for the lake that coincided with the decrease of TDS. These parameters are all indicators of pollution, so it is important that they stay within their target ranges.

In summary, the water quality of Island Lake was very good in 2013 and showed improvement in most areas. The main priority of the lake should be to continue reducing the nutrient loads of the lake in order to prevent more aggressive plant growth.

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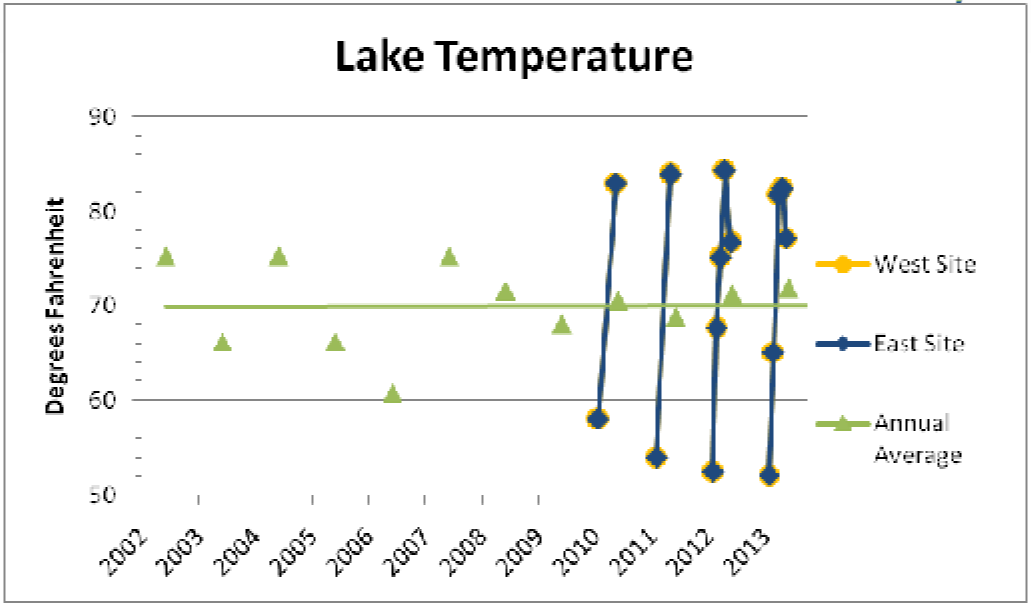
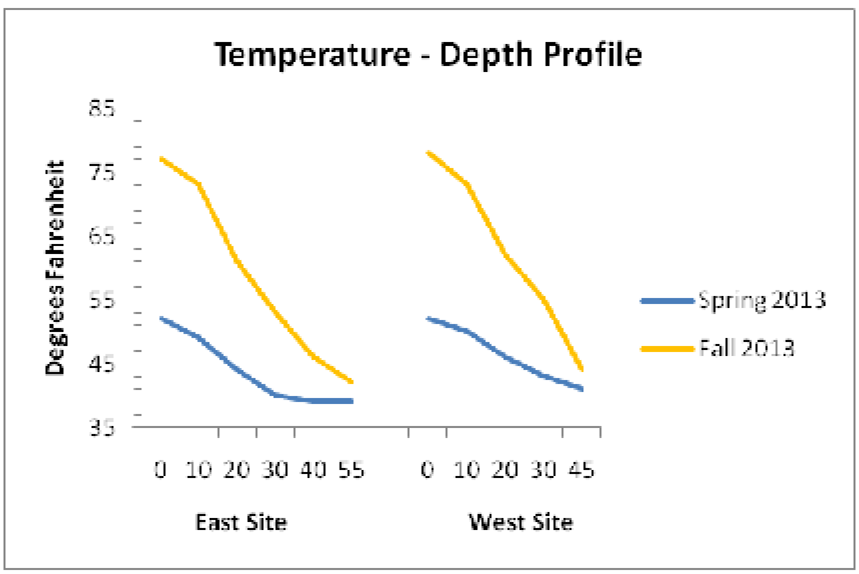


(˚F)	West	East
April	52.1	51.8
May	65.1	65.9
June	81.7	81.4
July	82.4	82.6
August	77.2	78.1

Discussion

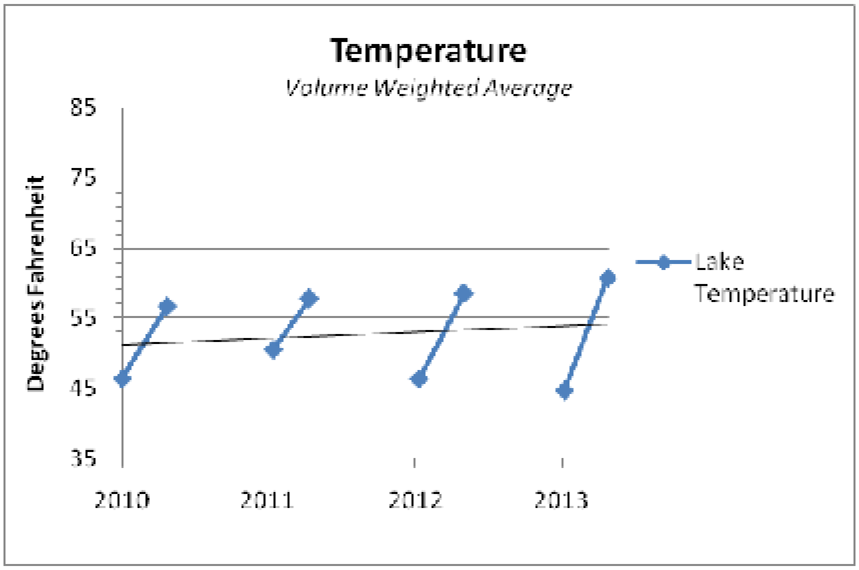
Plants and algae begin their spring growth when water temperatures rise through 50's and reach 60˚F. The water temperatures of the lake were much better than in 2012, especially in April and May. The lake started very cool in April, which kept the plant growth down longer than last year. The cold start also helped ensure summer water temperatures were not extremely high. The long-term trend for lake temperature was very slightly upward.

During the April and August testing events, we also measured water temperature through the water column. The temperature was measured every 10 or 15 feet down. The following graph and chart show the results from this year's tests.

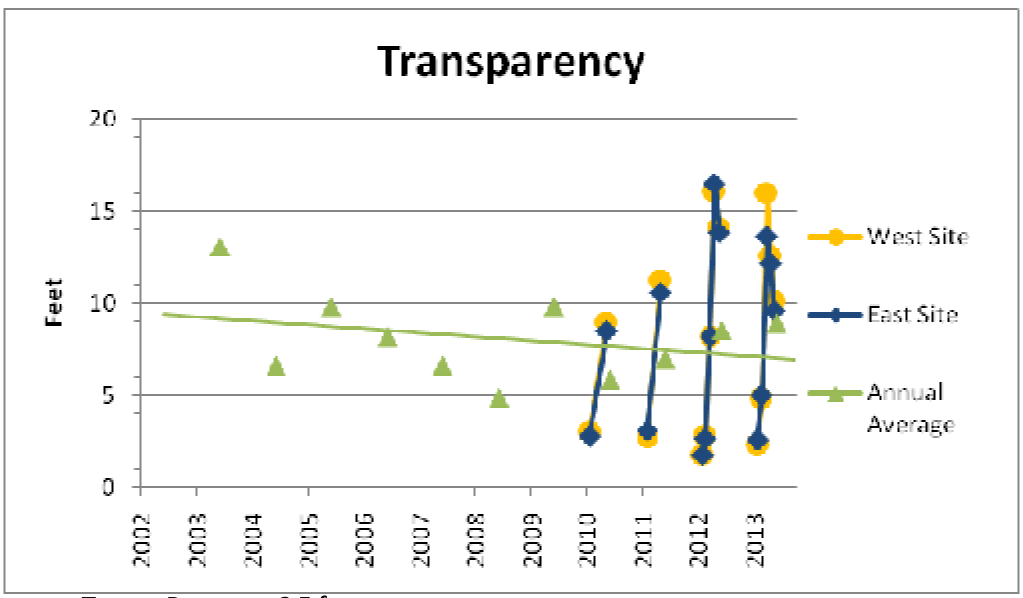


Testing Site	Depth (ft.)	Temperature (°F)	
		April	August
West	0	52	77
	10	49	73
	20	44	61
	30	40	53
	40	39	46
	55	39	42
East	0	52	78
	10	50	73
	20	46	62
	30	43	55
	45	41	44
Volume Weighted Average		45	61

During both testing events, the Temperature-Depth Profile showed a steady decrease in the water temperature from top to bottom. There was only a slight indication of stratification (i.e. separation of warm, top and cool, bottom waters).



The trend for the volume weighted average showed a larger increase in lake temperature since 2010. Water temperatures were subject to the dates selected for testing and the weather of each year. For this reason, this trend could not be asserted as fact, but did raise the issue of increasing lake temperature. If this trend continues, the higher temperatures could decrease oxygen solubility, lowering the dissolved oxygen concentrations, thus posing a potential risk to the aquatic ecosystem and a healthy fishery.



Trophic State Index: 48
Trophic State: Mesotrophic

(feet)	West	East
April	2.3	2.6
May	4.8	5.0
June	16.0	13.6
July	12.6	12.2
August	10.1	9.6

Target Range: >6.5 feet

Discussion

The season average Transparency was above the target at 8.9 feet. Despite the low transparency in the first two months of testing, the clarity increased sharply in the later summer months. This pattern was consistent with last year's data, showing that even with abundant rainfall the lake clears up in the middle of summer. The long-term trend for Transparency is downward, but since 2010, the clarity has increased steadily.

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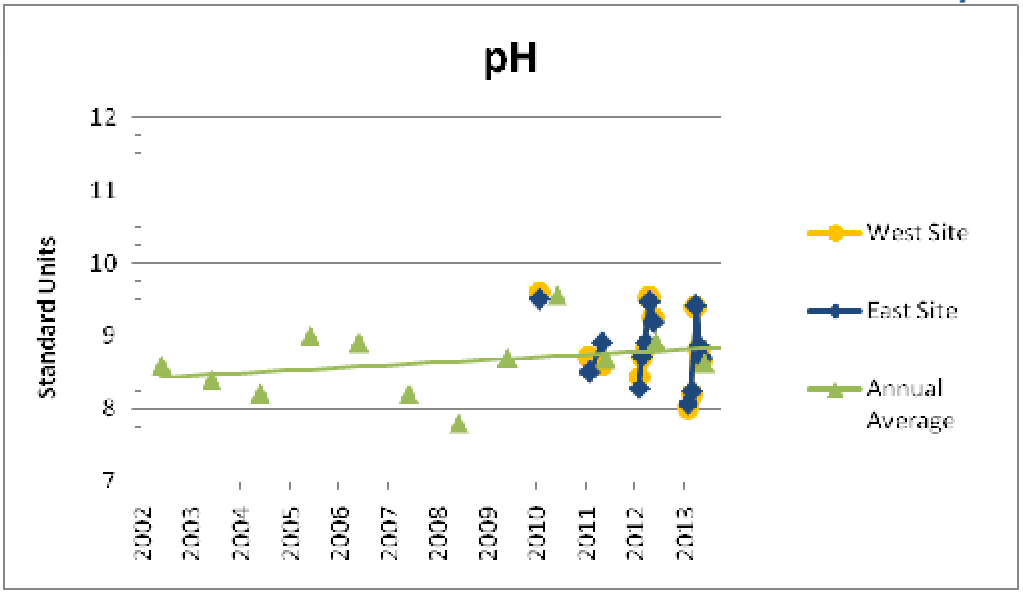
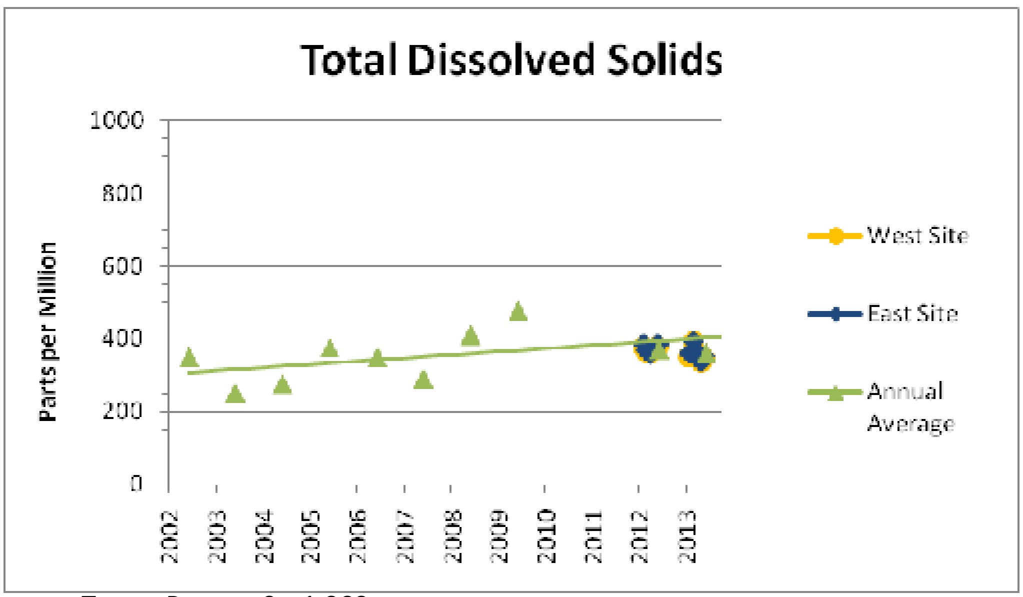


(S.U.)	West	East
April	7.99	8.06
May	8.19	8.24
June	9.38	9.41
July	8.80	8.85
August	8.64	8.70

Target Range: 7.0 – 9.0 S.U.

Discussion

The pH varied slightly throughout the summer, but no changes were severe enough to cause any negative impacts on aquatic life. The season average of 8.63 was normal for Michigan inland lakes and slightly lower than in 2012. The long-term trend for the pH was upward, so it is important to continue monitoring the pH to watch for sustained increases out of the target range.

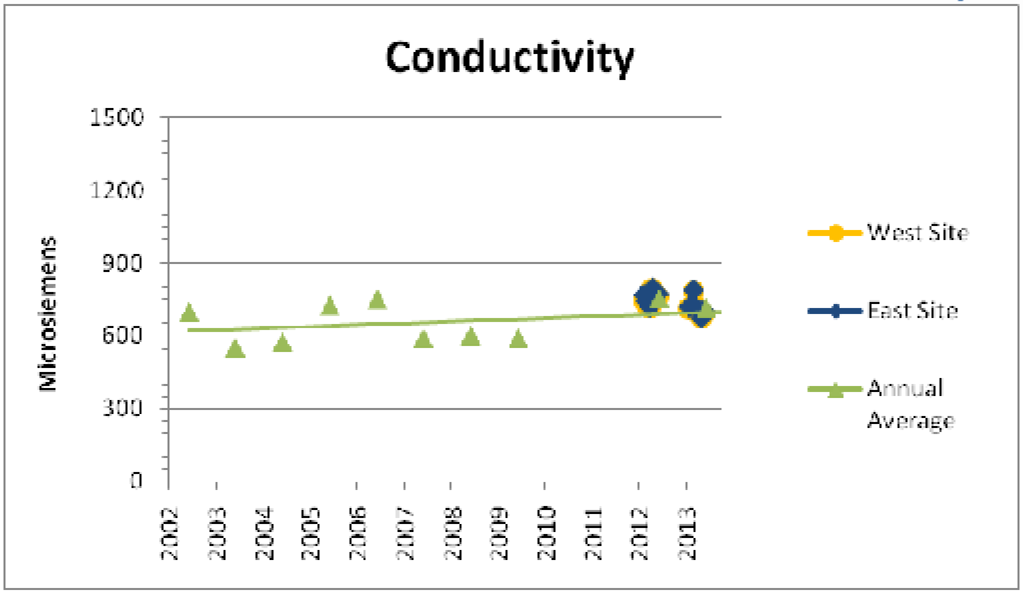


(ppm)	West	East
April	375	384
May	364	369
June	359	361
July	366	372
August	379	384

Target Range: 0 – 1,000 ppm

Discussion

The season average of 359 was well below the action threshold of 1,000 parts per million. The long-term trend for TDS was upward, showing an accumulation of dissolved solids in the lake. However, 2012 and 2013 tracked downward, a positive short-term trend for the lake.

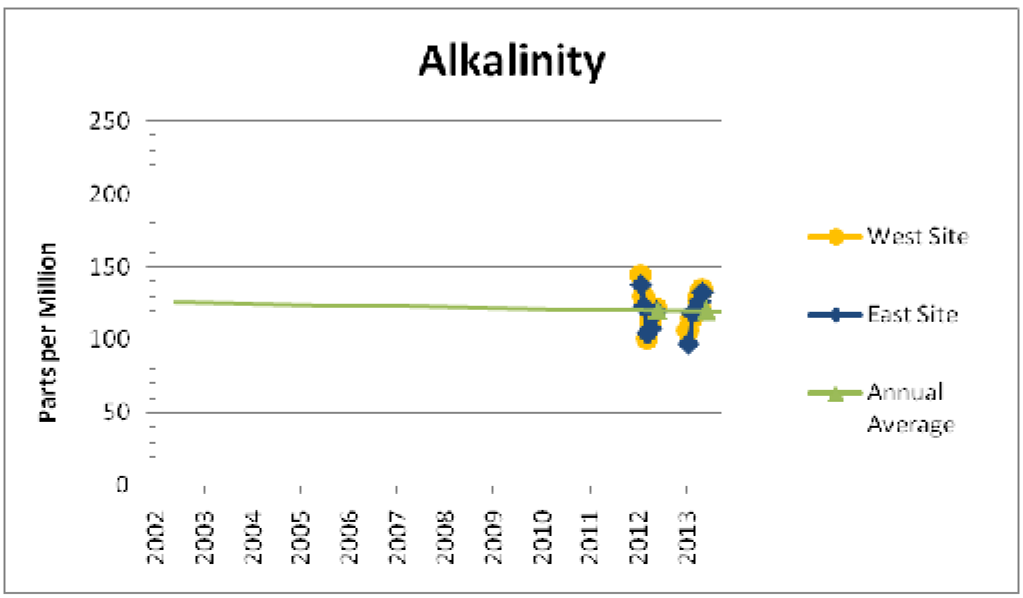


(µS)	West	East
April	709	718
May	786	787
June	715	712
July	673	674
August	691	706

Target Range: 0 – 1,500 µS

Discussion

The season average of 717 µS was well within the target range. The long-term trend for Conductivity was upward, consistent with the increase in TDS.



(ppm)	West	East
April	106	97
May	115	118
June	128	120
July	121	126
August	134	132

Target Range: 100 – 250 ppm

Discussion

The Alkalinity was normal for a freshwater lake. There was some normal fluctuation of alkalinity as the carbonate ions were being utilized as buffers and as more entered the lake with groundwater inputs. At times during the year, the alkalinity was below the target range and the season average of 120 ppm was toward the low end of the target range. The trend over the past two years was slightly downward. It is important that this parameter increase to a higher level in the future.

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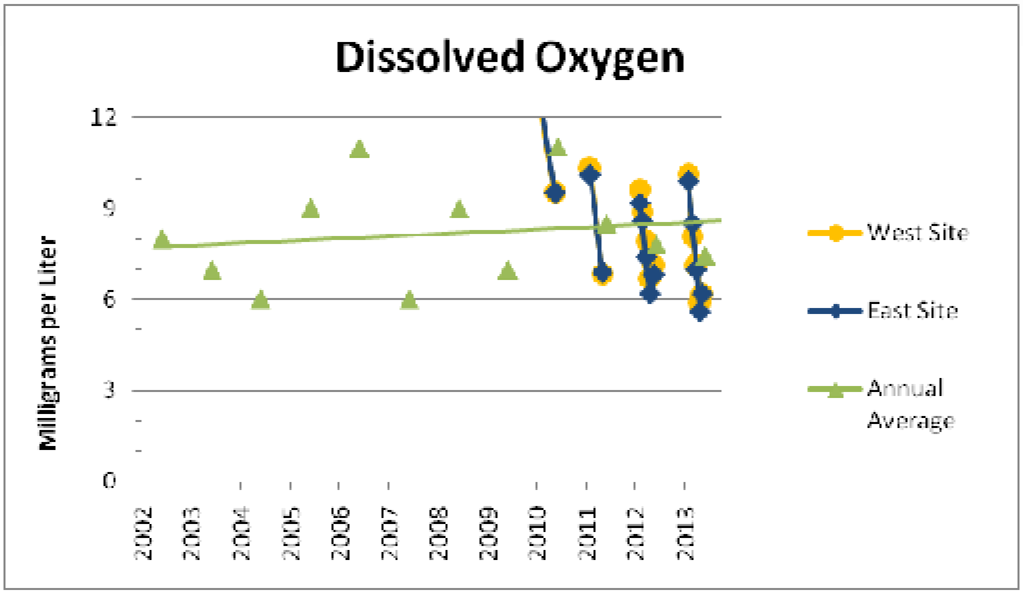


(mg/L)	West	East
April	10.1	9.9
May	8.1	8.5
June	7.1	7.0
July	5.9	5.6
August	6.2	6.2

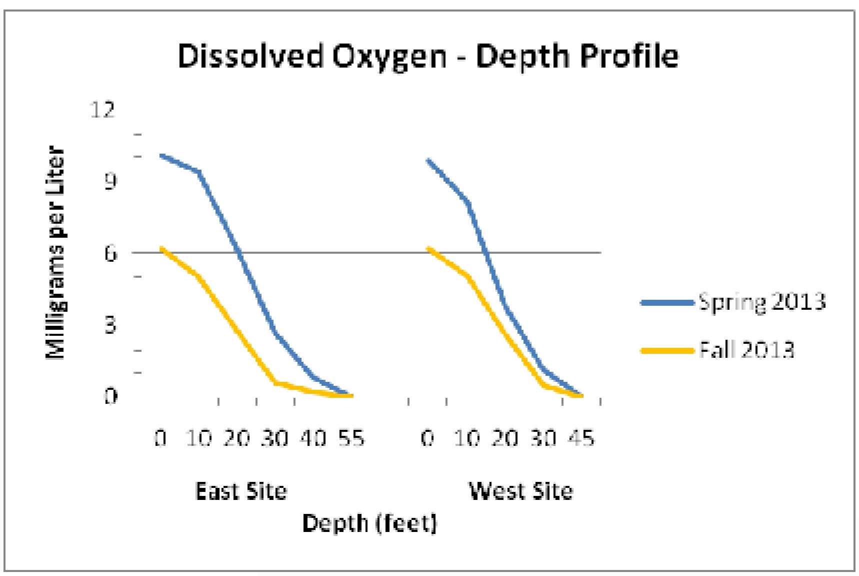
Target Range: 4.0 – 12.0 mg/L

Discussion

The dissolved oxygen remained at healthy levels throughout the summer. Oxygen dissolution is dependent upon water temperatures, so the D.O. generally decreased as water temperatures increased. However, the D.O. concentrations remained at very healthy levels that would sustain the fish population through harvesting and chemical treatments.

The long-term trend for temperatures was upward, which lowered the oxygen solubility. Despite the decrease in solubility, the dissolved oxygen concentrations trended upward over the testing history.

During the April and August testing events, we also measured dissolved oxygen through the water column. The dissolved oxygen was measured every 10 or 15 feet down. The following graph and chart show the results from this year's tests.



Testing Site	Depth (ft.)	Dissolved Oxygen (mg/L)	
		April	August
West	0	10.1	6.2
	10	9.4	5.0
	20	6.2	2.8
	30	2.7	0.6
	40	0.8	0.2
	55	0.0	0.0
East	0	9.9	6.2
	10	8.2	5.1
	20	3.8	2.6
	30	1.1	0.5
	45	0.0	0.0
Volume Weighted Average		4.8	2.5

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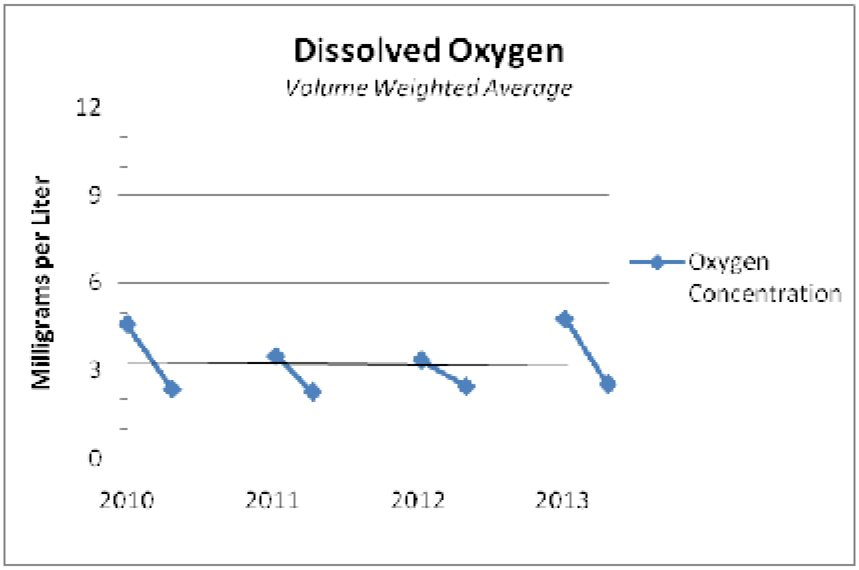
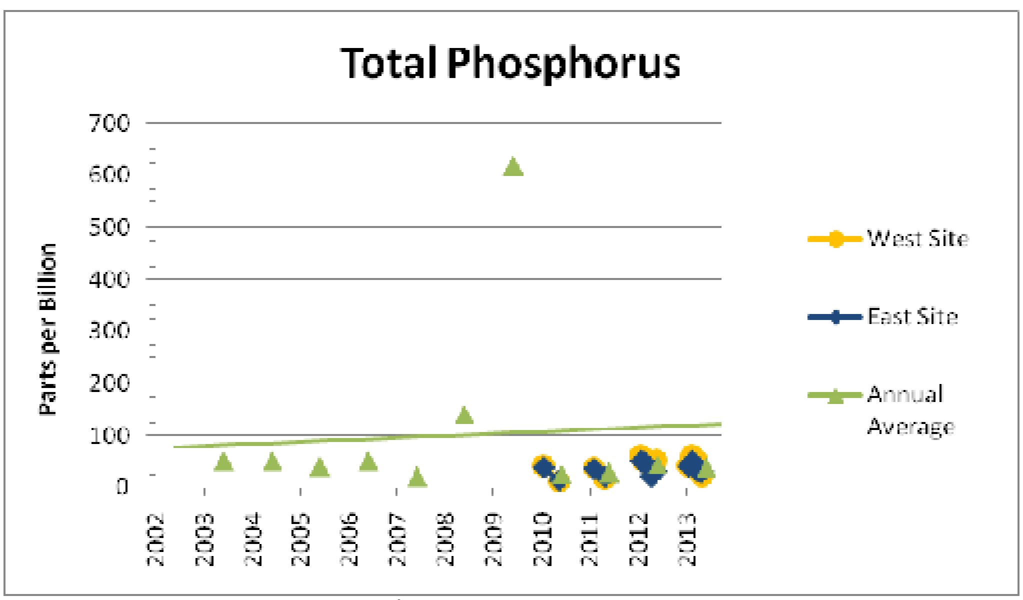
The Dissolved Oxygen-Depth Profile showed a steady decrease in the oxygen concentration from top to bottom. There was only a slight indication of stratification. The dissolved oxygen dropped below 3 mg/L near 20 feet during both tests. This meant fish would stay above this depth for the oxygen. At 20 feet, the water temperatures ranged from 45°F in the spring to 60°F in the summer. With sufficient oxygen and these water temperatures, the lake was able to support some cold water fishes, such as northern pike, walleye, and perch.



The trend for the volume weighted average showed a slight decrease in dissolved oxygen since 2010. The increasing lake temperature decreased oxygen solubility and drove the dissolved oxygen concentrations lower. So far, the decrease has been very small, but if the trend continues, it might become prudent to consider artificial aeration to increase the dissolved oxygen concentrations of the lake.



Target Range: 0 – 100 ppb

Trophic State Index: 56
Trophic State: Eutrophic

(ppb)	West	East
April	40	40
May	60	50
June	50	30
July	30	30
August	20	30

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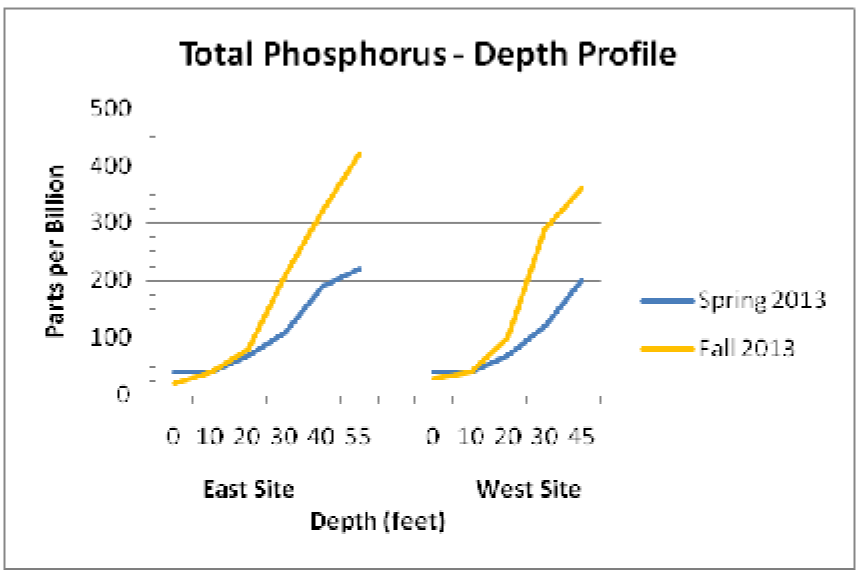
Discussion

The Total Phosphorus test included all forms of organic and inorganic phosphorus. The concentration in Island Lake stayed within the target range throughout 2013. There was still enough phosphorus to support abundant plant growth, as shown by the Trophic State Index of 56. The state ban on phosphorus-laden fertilizers and mechanical harvesting helped to prevent influx and to remove phosphorus from the lake.

The long-term trend for phosphorus was upward. However, this trend was due to two extremely high results that were recorded in 2008 and 2009. Without these two outlying data points, the trend for total phosphorus was downward since 2002.

During the April and August testing events, we also measured total phosphorus through the water column. The total phosphorus was measured every 10 or 15 feet down. The following graph and chart show the results from this year's tests.



Testing Site	Depth (ft.)	Total Phosphorus (ppb)	
		April	August
West	0	40	20
	10	40	40
	20	70	80
	30	110	210
	40	190	320
	55	220	420
East	0	40	30
	10	40	40
	20	70	100
	30	120	290
	45	200	360
Volume Weighted Average		90	147
Total Load (Lbs.)		399	655

The Total Phosphorus-Depth Profile showed a steady increase in the phosphorus concentration from top to bottom. Phosphorus accumulated at the bottom of the lake because it drops with decaying plant material, creating a nutrient-rich, "mucky" bottom. Anoxic conditions at the bottom of the lake facilitated the release of phosphorus from the sediment into the water column.

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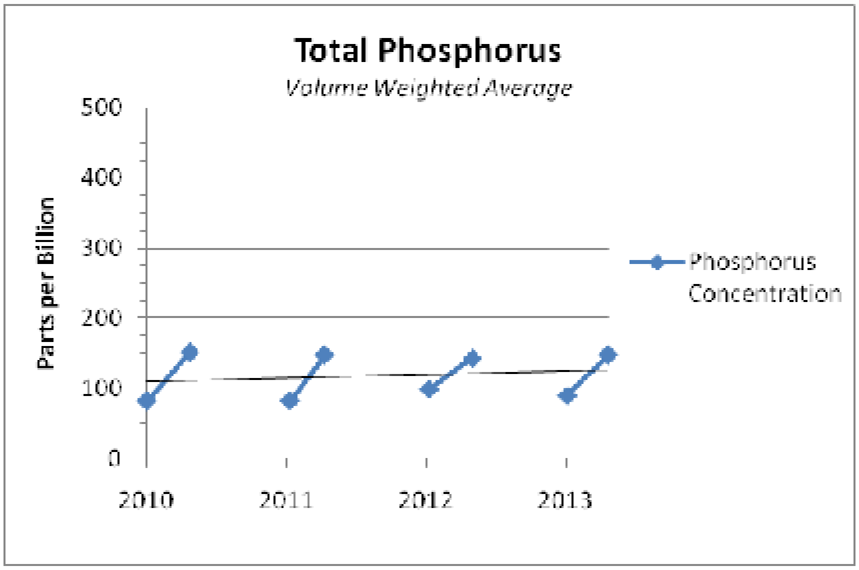
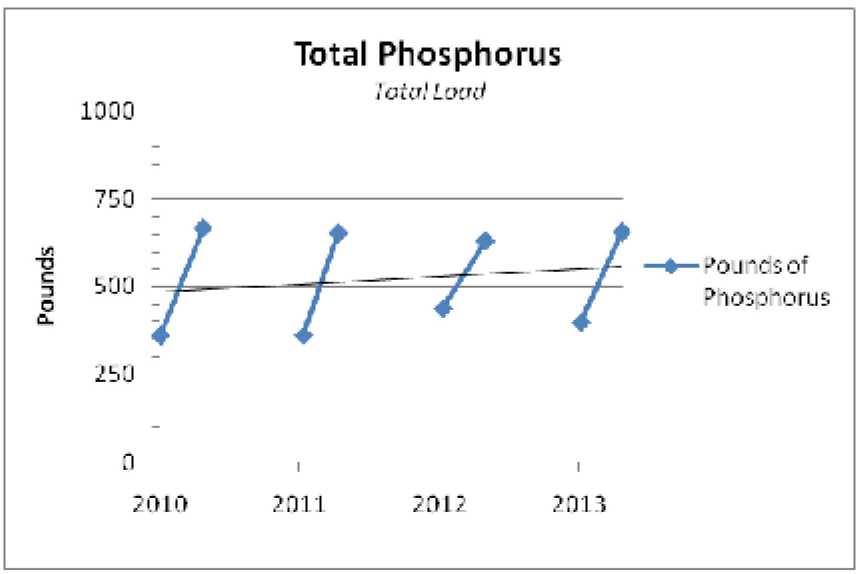


Since 2010, the volume weighted average for total phosphorus concentration tracked slightly upward, showing an accumulation of phosphorus in the lake and general increase in its concentration. Lakes normally collect nutrients and, consequently, the plant growth worsens. The bio-engineering filtration projects and mechanical harvesting should slow or even reduce this trend in future years.



Consistent with the average concentration, the total load of phosphorus steadily increased since 2010. It is vital for the bio-engineering projects to filter nutrients before they enter the lake and mechanical harvesting to continue removing nutrients as part of the biomass.

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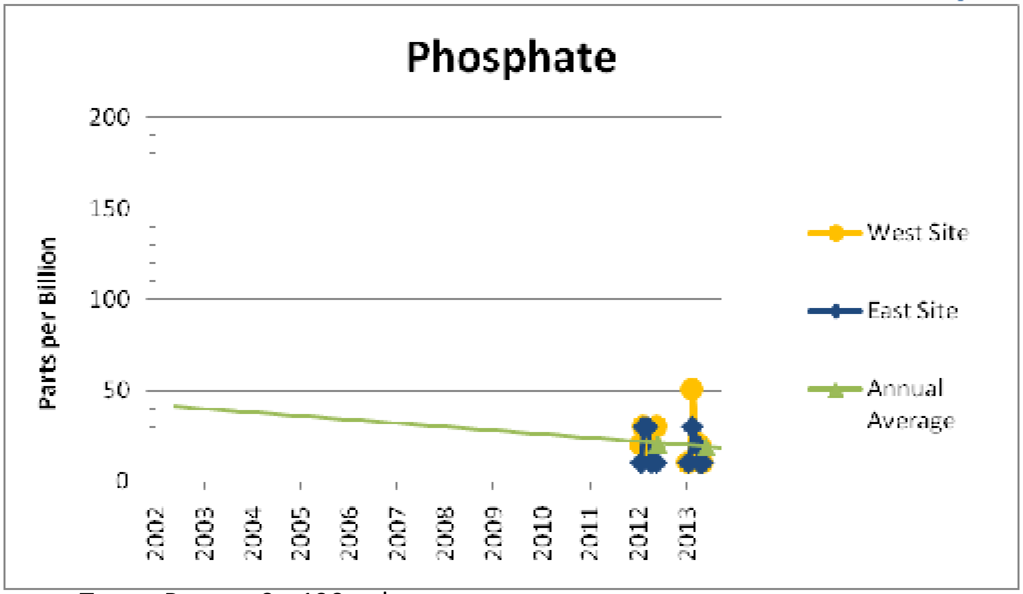
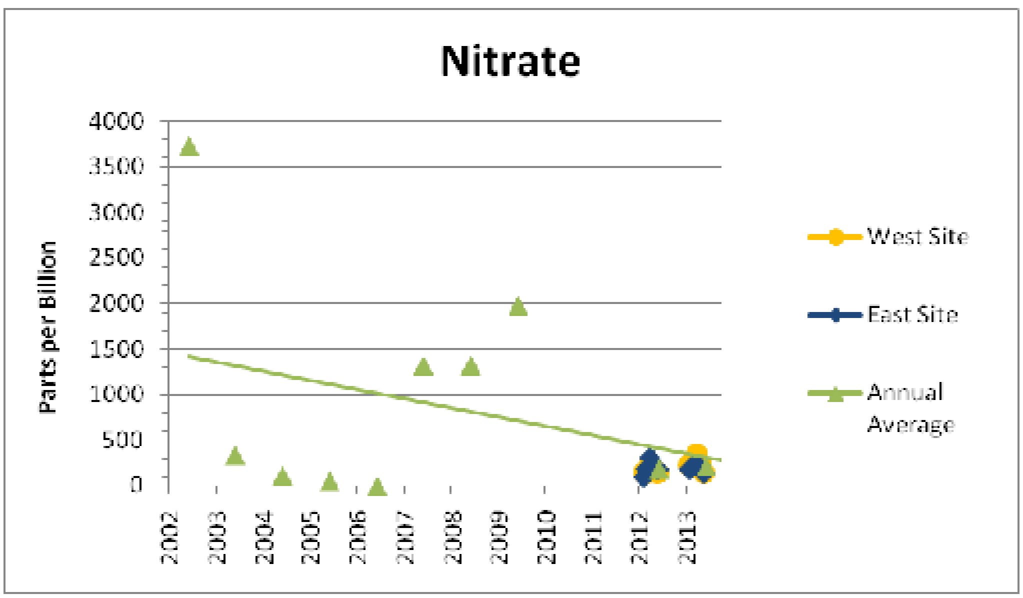


(ppb)	West	East
April	10	10
May	50	30
June	20	20
July	20	10
August	10	10

Target Range: 0 – 100 ppb

Discussion

This test defined the phosphorus that was bio-available in the water column, called orthophosphate. The concentrations were within the target range throughout 2013, but should be monitored closely. The limited historical data showed a downward trend in usable phosphates.



(ppb)	West	East
April	220	176
May	264	220
June	352	220
July	220	176
August	132	132

Target Range: 0 – 1,000 ppb

Discussion

Nitrates are another vital nutrient for plant growth. All 2013 results were well below the target range. Over the course of the testing history, there were some very high results, so the long-term trend was sharply downward. It is important that residents around the lake and in the watershed continue to practice safe fertlizing methods by not applying fertilizers near the water's edge. This simple measure can help ensure more nitrates do not enter the lake.

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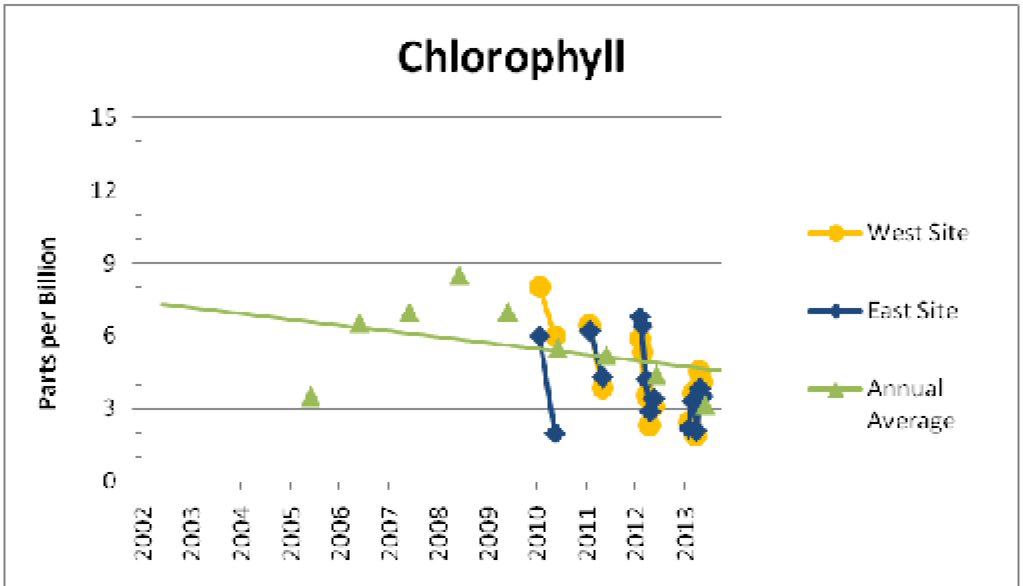


Trophic State Index: 41
Trophic State: Mesotrophic

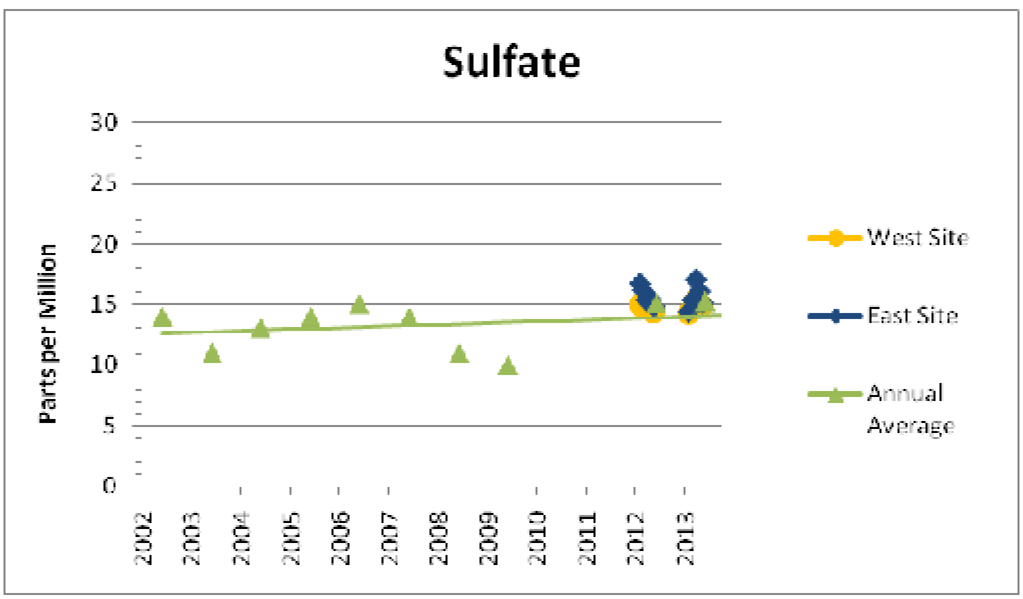
(ppb)	West	East
April	2.4	2.2
May	3.6	3.3
June	1.9	2.1
July	4.5	3.8
August	4.1	3.5

Target Range: 0 – 7.3 ppb

Discussion

Chlorophyll-a is the most direct indicator of the plant (algae) growth of the lake. The season average of 3.1 ppb showed a significant decrease from 2012. Low nutrient concentrations, summer rainfall, and lower temperatures all helped keep plant production down. Furthermore, the three harvests completed in 2013 helped to remove plant biomass.

Chlorophyll was measured since 2005. Overall, the long-term trend was downward. However, from 2005 the Chlorophyll increased until it reached an all-time high in 2008. Since then, the Chlorophyll concentrations decreased steadily and reached an all-time low in 2013.

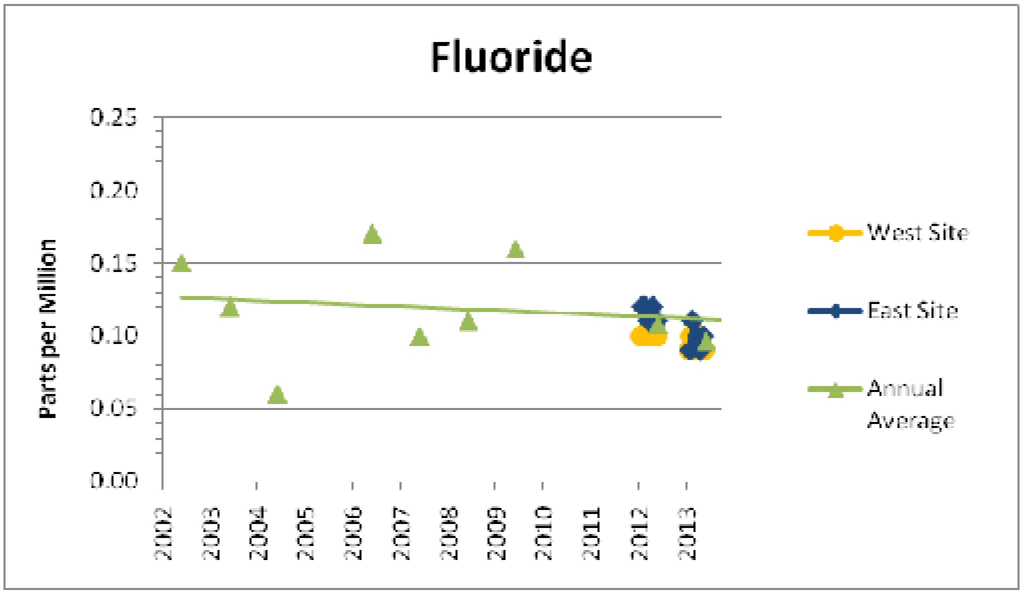


(ppm)	West	East
April	14.2	14.4
May	14.7	15.3
June	15.4	17.0
July	15.0	16.1
August	14.8	15.1

Target Range: 3 – 30 ppm

Discussion

The season average of 15.2 parts per million did not change from 2012. The long-term trend for Sulfates was upward. However, consistency from last year helped show that increased runoff in 2013 did not increase the concentrations in the lake. Bio-filtration at the inlets and increased outflow could have both contributed to the steady sulfate concentrations.

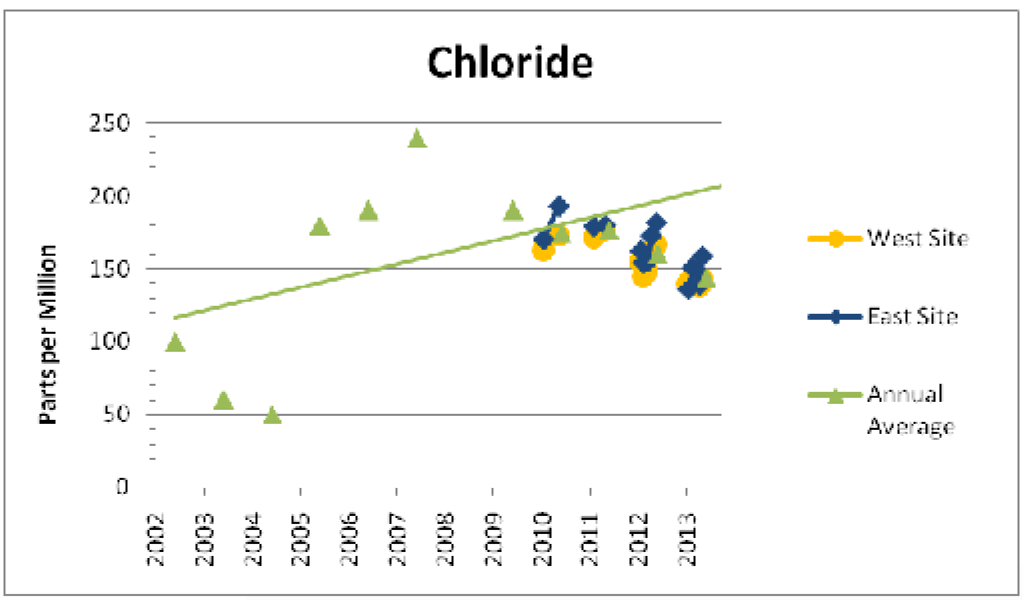


(ppm)	West	East
April	0.09	0.09
May	0.10	0.11
June	0.10	0.10
July	0.09	0.09
August	0.09	0.10

Target Range: 0.01 – 0.30 ppm

Discussion

The Fluoride concentrations were at normal levels in 2013. The season average of 0.10 ppm was well within the target range and was slightly lower than 2012. The annual average concentration fluctuated in the past, but the long-term trend was slightly downward.



(ppm)	West	East
April	139	136
May	144	151
June	143	149
July	138	139
August	144	159

Target Range: 0 – 230 ppm

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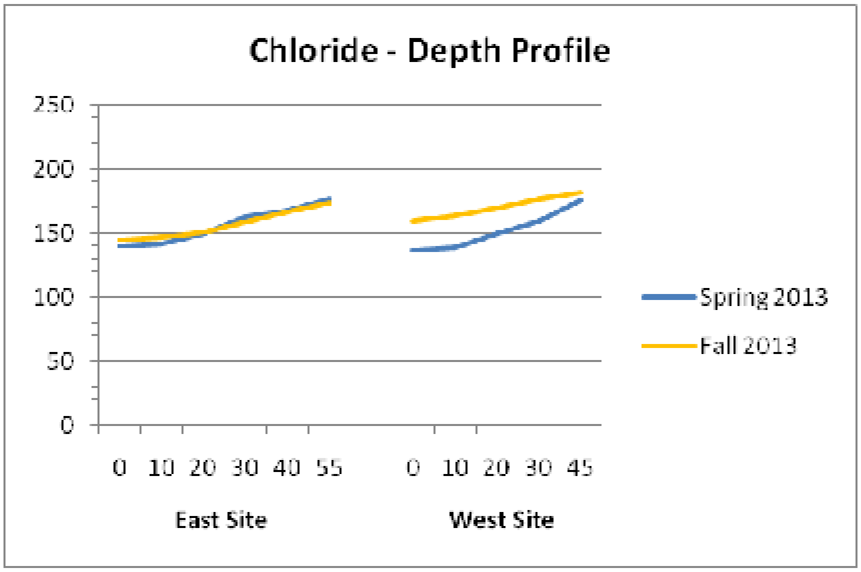
Discussion

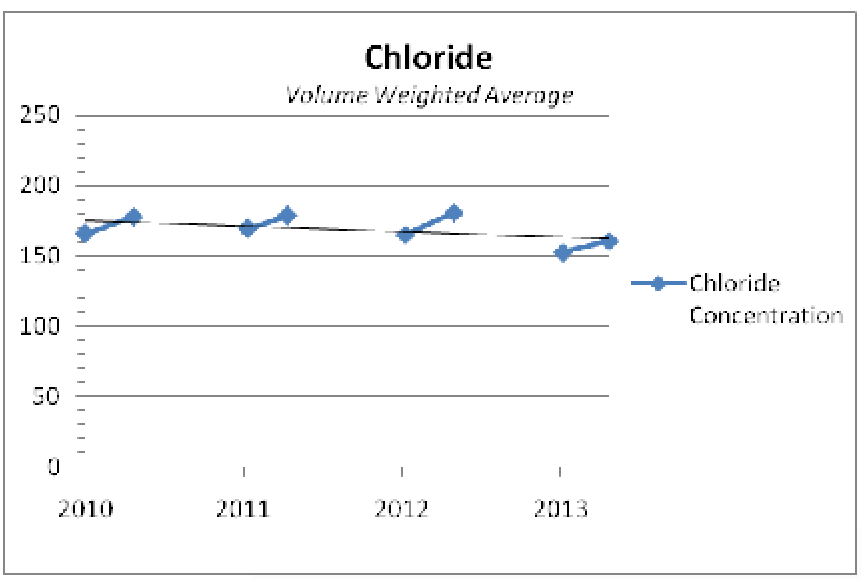
The season average of Chloride was 144 ppm, a decrease from 2012. Overall, the long-term trend was upward due to very low concentrations in 2002-2004. Since 2007, the average Chloride concentration decreased.

During the April and August testing events, we also measured chloride through the water column. The chloride concentration was measured every 10 or 15 feet down. The following graph and chart show the results from this year's tests.

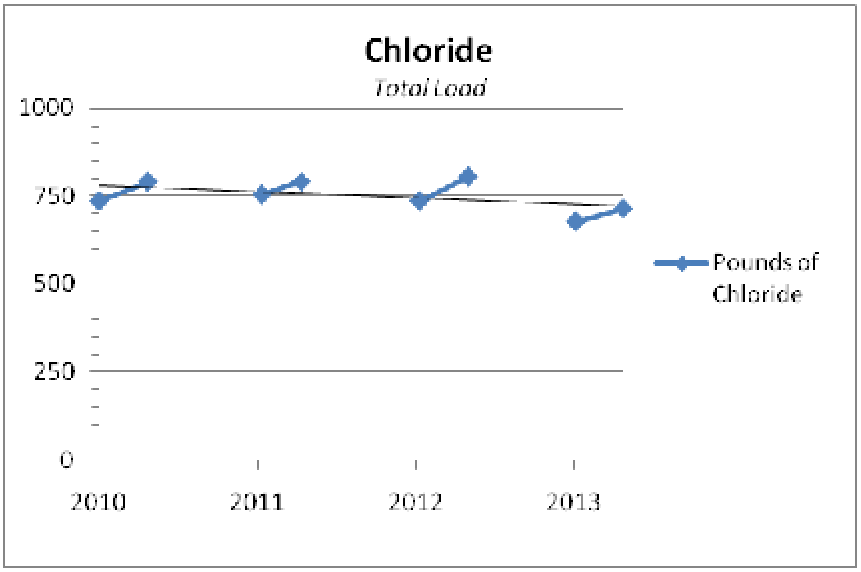


Testing Site	Depth (ft.)	Chloride (ppm)	
		April	August
West	0	139	144
	10	141	146
	20	149	150
	30	162	158
	40	167	166
	55	176	173
East	0	136	159
	10	138	163
	20	149	169
	30	159	176
	45	175	181
Volume Weighted Average		152	161
Total Load (Lbs.)		676	714

The Chloride-Depth Profile showed a steady increase in the chloride concentration from top to bottom. Because saltwater is heavier than freshwater, the salt has accumulated in the bottom portion of the lake. Road salts have been identified as a possible pollutant in urbanized areas. As the road salts wash into the lake, it is possible that they could accumulate to levels that may be harmful to aquatic organisms. In Island Lake, the chloride concentrations never exceeded the upper limit of 230 parts per million during the 2013 testing events.



Since 2010, the volume weighted average for chloride concentration tracked downward, showing the lake has flushed more excess salts than have come into the lake. Less road salt used in the winter and more rain during the spring and summer were possible reasons for the decrease.



Consistent with the average concentration, the total load of chloride trended downward since 2010.

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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 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.
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.
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.

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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.

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.

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.

Testing Sites: