

**2017 Water Quality Report
and
Historical Analysis**

**Long Lake
Mickey Lake
Ruth Lake**

Monitoring Years 1993-2017

Submitted to:

Long Lake Association

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Prepared by:



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Figure 1. Water quality sampling sites on Long Lake, 1997-2017



Table 1. Trophic State Classification (Chapra, 1997)

Variable	Oligotrophic	Mesotrophic	Eutrophic
Total Phosphorus (µg/L)	<10	10-20	>20
Chlorophyll a (µg/L)	<4	4-10	>10
Secchi depth (ft)	>13	6.6-13	>6.6

Table 4. Phosphorus Data for Area Lakes and Sediments

<u>Lake</u>	<u>Water Total Phosphorus (µg/L)</u>	<u>Sediment Phosphorus (mg TP/kg DW)</u>
Torch	1.7	86
Burt	2.2	119
Lime	4.4	200
Crystal	4.8	332
North Leelanau	4.8	489
South Leelanau	4.9	398
Glen	5.1	326
Little Traverse	5.1	401
Cedar	5.3	396
Platte	7.7	620
Mickey Site 1	11.5 (top)	1625
	19.1 (bottom)	
Mickey Site 2	7.6 (top)	87
	7.3 (bottom)	

Section I

2017 Long Lake, Mickey Lake, and Page Lake Water Quality Assessment

The 2017 Long Lake, Mickey Lake, and Page Lake monitoring was initiated by the Long Lake Association in partnership with Great Lakes Environmental Center (GLEC) and Great Lakes Water Studies Institute. The point of this monitoring was to continue assessing the lake water quality and compare it to the collection of older data. By looking at emerging trends in water quality, concerns can be addressed and appropriate action plans created.

The 2017 season's monitoring of Long, Mickey and Ruth Lake's water quality data was collected using the following equipment: 1) Water quality and measurement of water chemistry by using a YSI multiparameter water quality probe (supplied by GLEC), as well as collecting water samples for analysis of total phosphorus at the surface and near bottom, and a single calcium sample at each sampling site; 2) levels of Chlorophyll a at each sampling site (an indirect indicator of algae in the water column); and 3) measurement for secchi disk depth at each of the sampling points.

Long Lake

Water Chemistry

Total Phosphorus: As noted in 2014's report, Long Lake's phosphorus numbers were slightly higher than other area lakes. While this year's levels were slightly higher than last year's, Long Lake currently compares favorably in this area. There were higher

concentrations of near bottom phosphorus, especially in the late summer. Site 1 and 2 had the greatest increase when compared to 2014.

Chlorophyll a: Chlorophyll a numbers are comparative to what we saw in the lake between 1999-2000. Levels are slightly up, but not significantly enough to raise question. This may be indicative of a normal increase in the algal community as the water warms. Chlorophyll a numbers can vary widely from year to year and can be influenced by the time of year they were sampled, or by the specific environmental conditions present on the lake during the year.

Secchi Depth: The secchi depths (measure of water clarity) as measured during the 2017 Spring/Summer sampling season fall in range of previous years, but are slightly lower than last year. It should be noted that numbers can vary widely from year to year and can be influenced by the time of year they were sampled, or by the specific environmental conditions present on the lake during the year.

Hydrolab (Physical) Data

Hydrolab profiles for Spring and Summer exhibited much of the same healthy characteristics as we've seen in previous years. As expected, DO levels declined with depth due to temperature stratification of the lake that occurs during summer in the deeper areas, and spring's DO levels were desirable. In 2014, there was concern of anoxic conditions and prolonged DO deficits near bottom sediments that lead to a release of phosphorus bound in the sediments, contributing to the lake's higher phosphorus levels. This year the DO levels seem typical for this lake, but due to historical low oxygen trends in the hypolimnion, could potentially be a significant source of internal loading of phosphorus in Long Lake. Because of past slightly elevated

sediment phosphorus levels, it is recommended that additional sediment samples be taken from the three sampling points and analyzed for phosphorus again within the next two to three years. All other water quality data fell within healthy parameters and oligotrophic conditions are highly observable.

Conclusions

The data from this year's sampling season indicate that Long Lake would continue to be considered an oligotrophic, high quality lake based on total phosphorus in the water, chlorophyll a and secchi disk readings. Long Lake's 1, 2 and 3 testing sites' total phosphorus numbers are well under the cutoff to be considered oligotrophic, according to the state's classifications (table 1.) This oligotrophic classification has been maintained for the past 20 years, since formal documentation of the lake first began. This can be fully determined on the next date that sediment phosphorus samples are taken. It is recommended that Long Lake continue to have a comprehensive outreach and education component regarding nutrient use near the lakeshore, as well as continuing efforts for surface water runoff control. These will all help limit the introduction of additional phosphorus to the lake ecosystem and help preserve its long held oligotrophic status.

Mickey and Ruth Lake

Water Chemistry

Total Phosphorus: Total phosphorus levels in Mickey Lake were within the oligotrophic range, however, Ruth Lake crossed over into mesotrophic. Because Ruth Lake is more hydrologically separated from Long Lake than Mickey, and somewhat shallower, phosphorus accumulations in sediments may be more pronounced.

Chlorophyll a: Chlorophyll a data for Mickey Lake compares to the last sample taken (2014.) Ruth Lake's levels were significantly lower, but Chlorophyll a numbers can vary widely from year to year and can be influenced by the time of year they were sampled, or by the specific environmental conditions present on the lake during the year. A field error is also possible.

Secchi Depth: Clarity of Mickey Lake is down a few meters from last year, and Ruth Lake's clarity has been historically low due to its tannic qualities. It should be noted that secchi readings can vary widely from year to year and can be influenced by the time of year they were sampled, or by the specific environmental conditions present on the lake during the sampling.

Hydrolab (Physical) Data

Hydrolab data is also comparative to previous years for both lakes. Water quality in these lakes are generally good, and dense plant growth, low clarity and slightly elevated phosphorus levels are to be expected from Ruth Lake. Both lakes are not completely hydrologically separate from Long Lake, but the connection is shallow enough, especially with Ruth, that there is likely not a rapid exchange in rate between the lakes.

Conclusions

It is only recommended that approaches which limit phosphorus additions to the lake (lakeshore management) will help to reduce the phosphorus loading and subsequent accumulations in both Mickey and Ruth Lake.

Long Lake Water Chemistry Data

June 9, 2017

Chlorophyll a (µg/L)

<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
.86	.92	1.25

Total Phosphorus (µg/L)

<u>Sample Location</u>	<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
<u>Near Surface</u>	4.2	2.6	2.5
<u>Near Bottom</u>	4.6	0.30	3.5
	---	4.2	---

Calcium (mg/L)

<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
21.6	20.8	20.2

Long Lake Water Chemistry Data

August 9, 2017

Chlorophyll a (µg/L)

<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
1.57	1.44	1.18
1.50	---	---

Total Phosphorus (µg/L)

<u>Sample Location</u>	<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
Near Surface	6.1	4.9	3.4
Near Bottom	22.3	14.8	10.0

Calcium (mg/L)

<u>Site 1</u>	<u>Site 2</u>	<u>Site 3</u>
24.6	24.4	24.6

Mickey Lake Water Chemistry DataJune 9, 2017Chlorophyll a (µg/L)

<u>Site 1</u>	<u>Site 2</u>
2.84	3.10
---	2.97

Total Phosphorus (µg/L)

<u>Sample Location</u>	<u>Site 1</u>	<u>Site 2</u>
<u>Near Surface</u>	8.6	8.9
	8.7	---
<u>Near Bottom</u>	28.1*	9.6

* Possible contamination from bottom sediment

Calcium (mg/L)

<u>Site 1</u>	<u>Site 2</u>
20.6	21.9

Mickey Lake Water Chemistry Data
August 9, 2017

Chlorophyll a(µg/L)

<u>Site 1</u>	<u>Site 2</u>
2.35	2.22

Total Phosphorus (µg/L)

<u>Sample Location</u>	<u>Site 1</u>	<u>Site 2</u>
Near Surface	7.1	8.2
Near Bottom	13.5	6.5

Calcium (mg/L)

<u>Site 1</u>
21.0

Ruth Lake Water Chemistry Data

June 9, 2017

Chlorophyll a (µg/L)

<u>Site 1</u>
6.14
6.27

Total Phosphorus (µg/L)

<u>Sample Location</u>	<u>Site 1</u>
<u>Near Surface</u>	17.8

Calcium (mg/L)

<u>Site 1</u>
20.0

Ruth Lake Chemistry Data

August 9, 2017

Chlorophyll a (µg/L)

<u>Site 1</u>
5.17

Total Phosphorus (µg/L)

<u>Location</u>	<u>Site 1</u>
<u>Near Surface</u>	13.7

Calcium (mg/L)

<u>Site 1</u>
12.2

Physical Data 2017

Long Lake Site #1 May 25th 2017

Air temperature: 52°F	Weather: overcast	Average Secchi Depth: 10.1 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	14.3	10.4	8.08	260.9
3	14.3	10.4	8.07	260.8
6	14.2	10.39	8.06	260.8
9	14.1	10.36	8.04	261.1
12	13.9	10.23	7.99	261.3
14	13.8	9.9	7.94	261.4

Long Lake Site #1 August 9th 2017

Air temperature: 73°F	Weather: Sunny	Average Secchi Depth: 5.95 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	23	8.62	8.26	159.2
3	23	8.6	8.28	159.1
6	23	8.57	8.25	159.2
9	22.8	8.18	8.14	159.4
12	22.6	7.47	7.94	160
15	16.4	0.06	7.13	184.9

Long Lake Site #2 May 25th 2017

Air temperature: 54°F	Weather: overcast	Average Secchi Depth: 9.8 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	15.2	10.38	8.09	260.9
3	14.5	10.41	8.09	260.9
6	14.4	10.42	8.09	260.9
9	14.3	10.41	8.08	261.0
12	14.2	10.38	8.05	261.9
15	12.4	10.57	7.96	261.0
18	12.1	10.52	7.88	261.4
21	11.5	10.32	7.80	261.2
~25	11.4	10.11	7.76	261.9

Long Lake Site #2 August 9th 2017

Air temperature: 76°F	Weather: partly sunny	Average Secchi Depth: 6.1 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	23.2	8.65	8.35	159.1
3	23.1	8.64	8.31	159.1
6	23	8.63	8.3	159.0
9	22.8	8.37	8.21	159.2
12	17.4	1.79	7.39	163.8
15	14.6	0.13	7.12	167.9
18	14.2	0.06	7.04	168.9
21	13.9	0.03	7.01	170.6

Long Lake Site #3 May 25th 2017

Air temperature: 54°F	Weather: light rain	Average Secchi Depth: 10.3 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	14.6	10.46	8.12	260.7
3	14.6	10.48	8.12	260.7
6	14.5	10.46	8.11	261.4
9	14.1	10.48	8.08	261.2
12	13.6	10.48	8.03	261.4
15	12.2	10.55	7.89	261.3
18	11.4	8.78	7.57	262.5

Long Lake Site #3 August 9th 2017

Air temperature: 78°F	Weather: sunny	Average Secchi Depth: 5.75 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	23.2	8.63	8.36	159.1
3	22.9	8.64	8.32	159.0
6	22.8	8.63	8.32	158.9
9	22.8	8.43	8.29	159.2
12	16.7	0.71	7.40	164.2
15	14.7	0.09	7.15	167.1

Mickey Lake Site #1 May 25th 2017

Air temperature: 57°F	Weather: overcast	Average Secchi Depth: 4.1 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	16.6	10.46	8.40	246.1
3	16.4	10.5	8.42	247.7
6	12.3	11.95	8.40	244.7
8	9.7	5.75	7.18	250.1

Mickey Lake Site #1 August 9th 2017

Air temperature: 78°F	Weather: sunny	Average Secchi Depth: 3.85 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	24.1	9.44	8.80	142.7
3	23.4	9.16	8.72	143.1
6	21.1	7.99	7.90	146.7
8	14.7	0.72	7.35	160.2

Mickey Lake Site #2 May 25th 2017

Air temperature: 57°F	Weather: light rain	Average Secchi Depth: 4.4 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	16.6	10.53	8.47	246.0
3	16.2	10.45	8.40	247.8
~4	15.7	9.85	8.24	248.5

Mickey Lake Site #2 August 9th 2017

Air temperature: 78°F	Weather: sunny	Average Secchi Depth: 4.45 m.
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Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	24	9.53	8.74	143.0
3	23.5	9.42	8.76	142.7

Ruth Lake Site #1 May 25th 2017

Air temperature: 52°F	Weather: light rain	Average Secchi Depth: 1.1 m.
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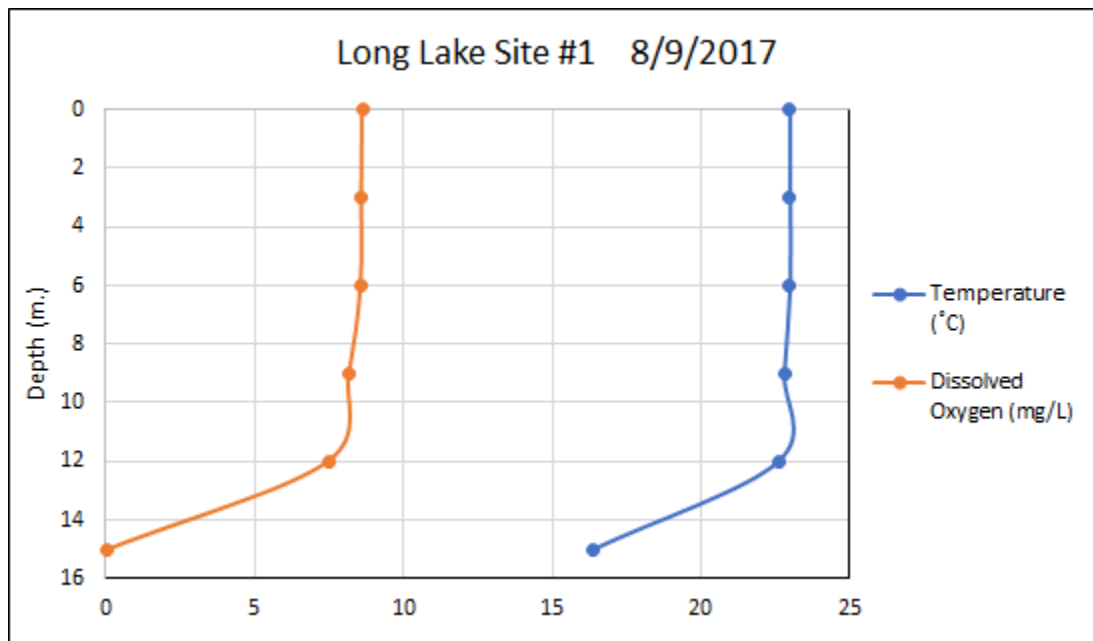
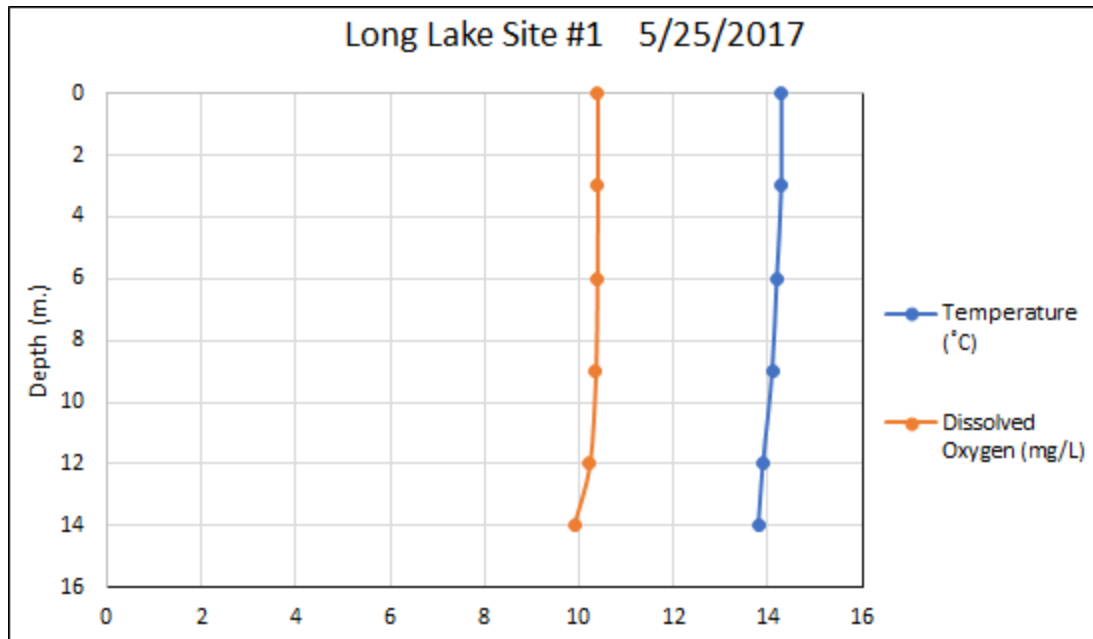
Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	16.5	9.08	7.40	121.0

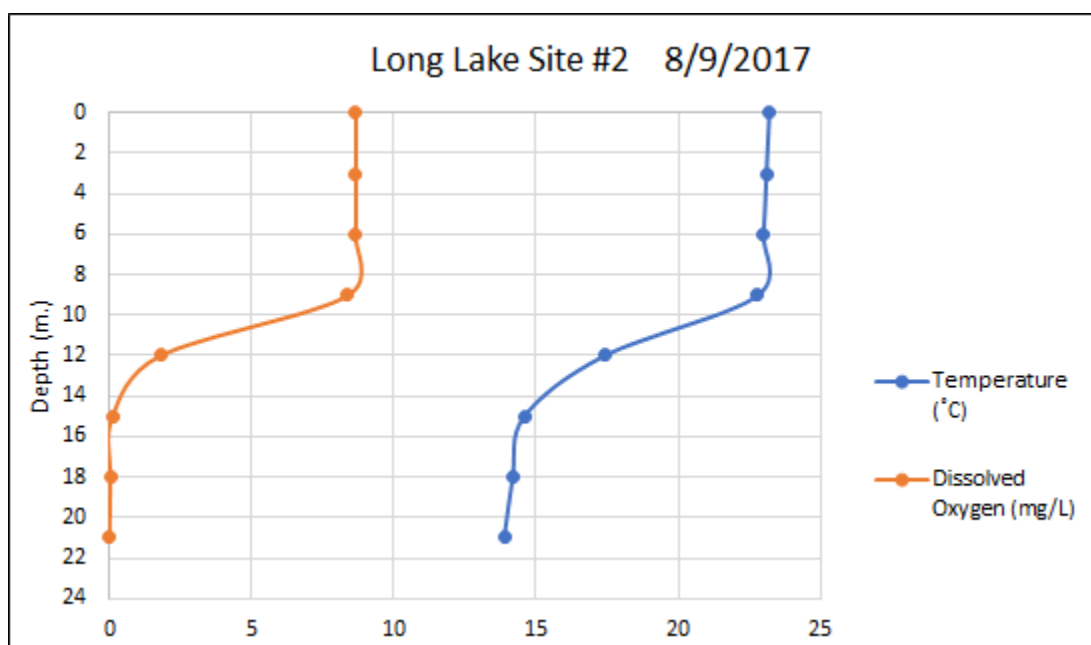
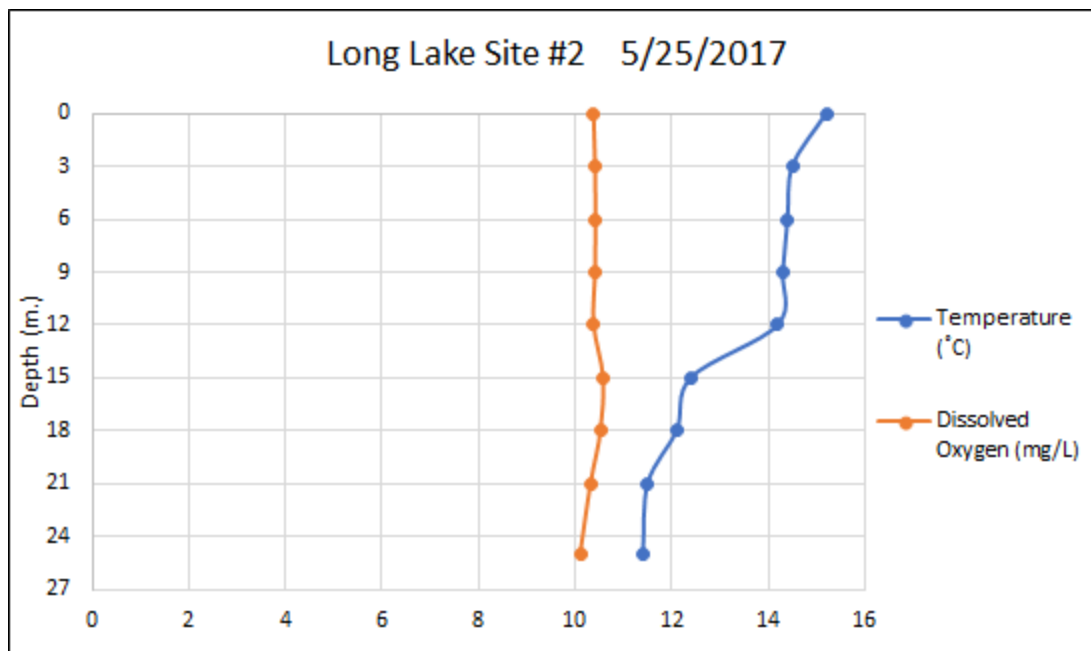
Ruth Lake Site #1 August 9th 2017

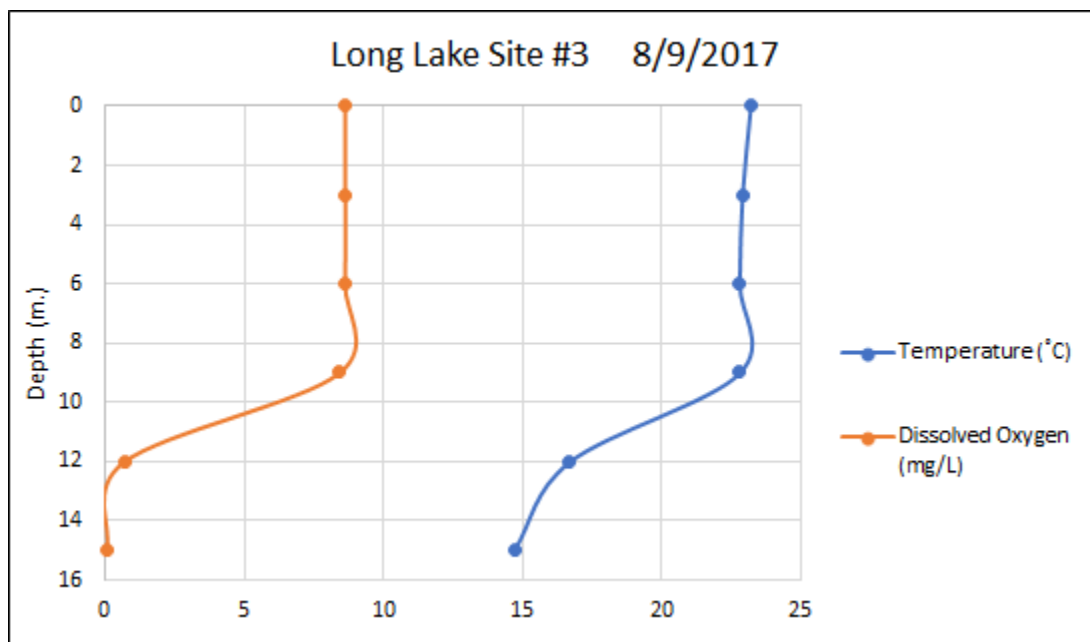
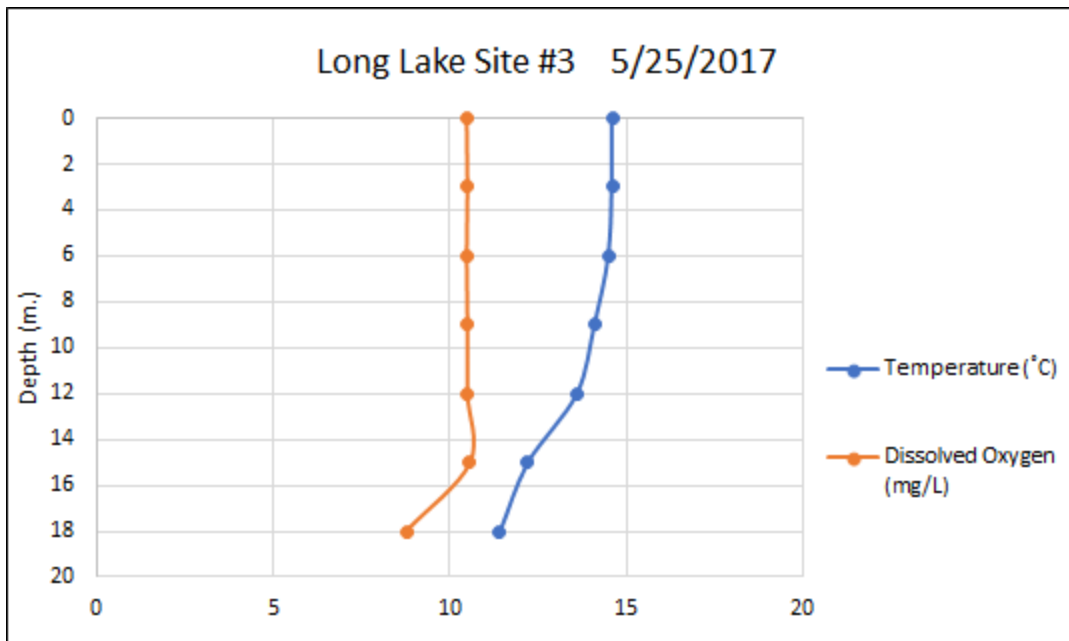
Air temperature: 80°F	Weather: sunny	Average Secchi Depth: 0.75 m.
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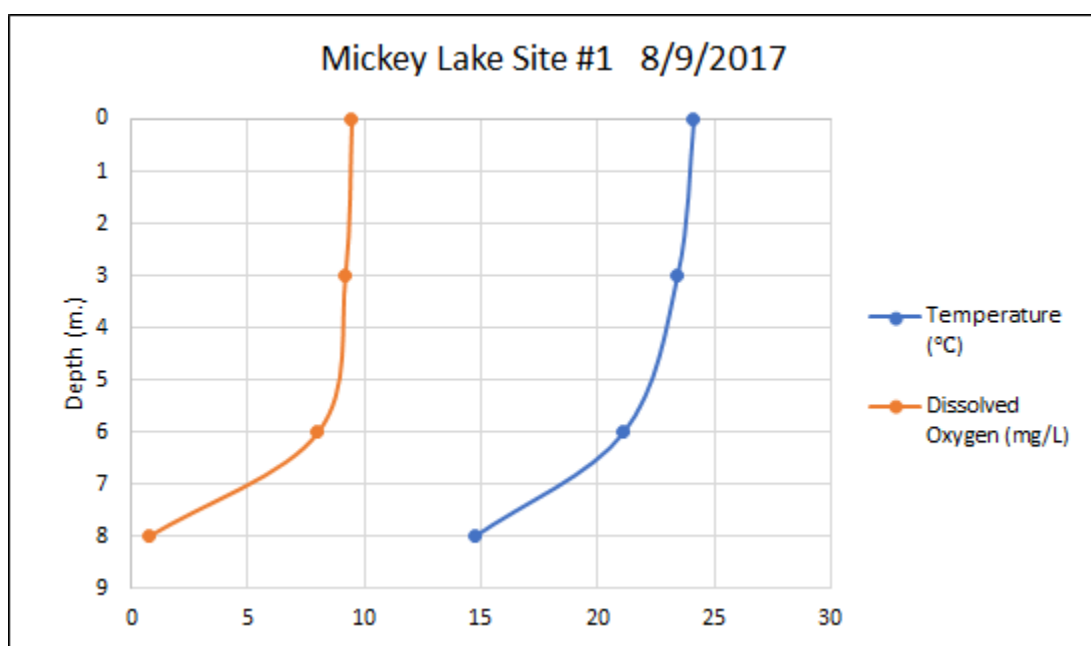
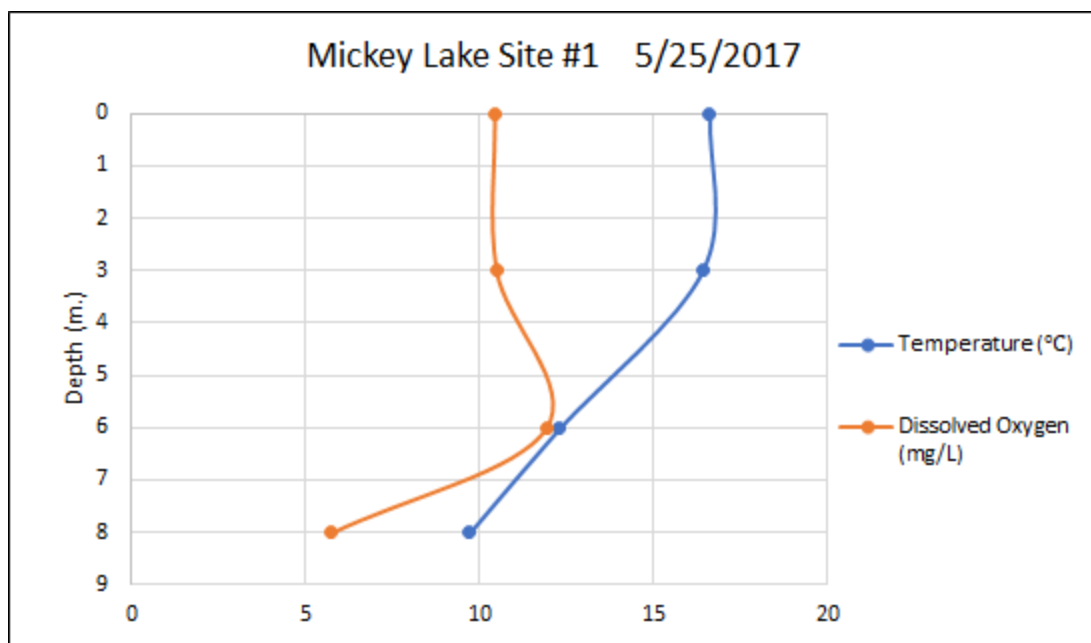
Depth (m.)	Temperature(°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/m)
Surface	24.1	8.49	7.41	74.7
3	18.4	0.14	6.74	84.5

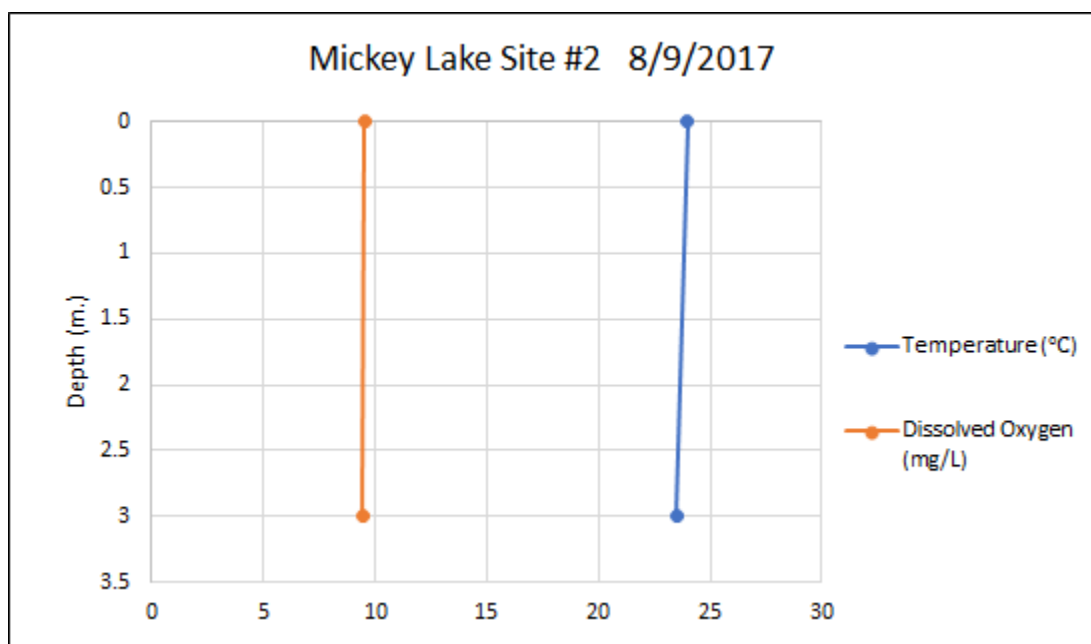
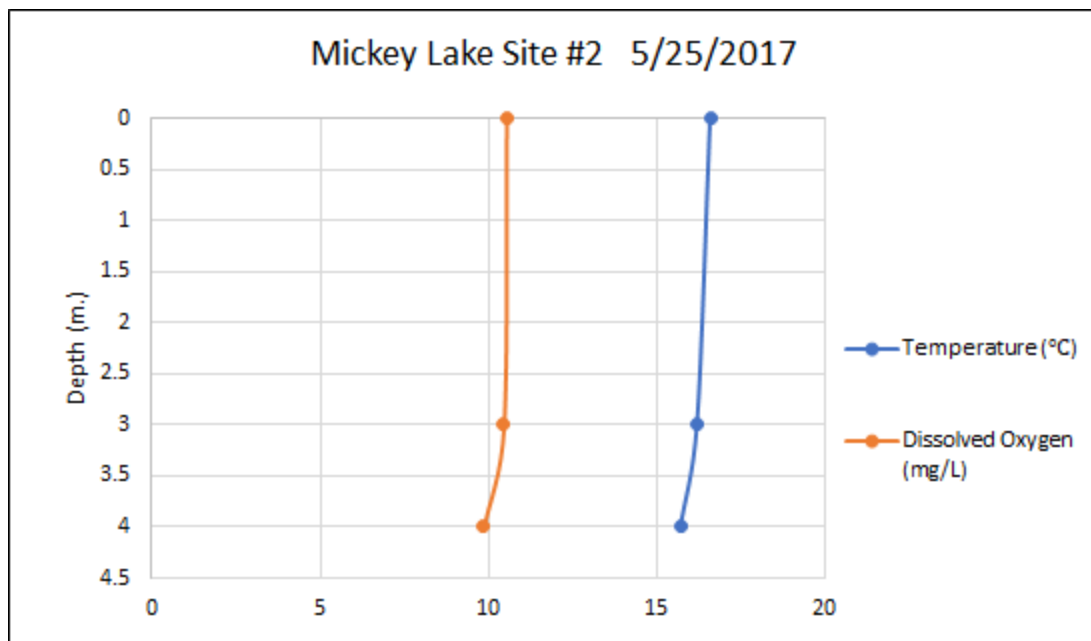
Dissolved Oxygen/Temperature Depth Profiles 2017

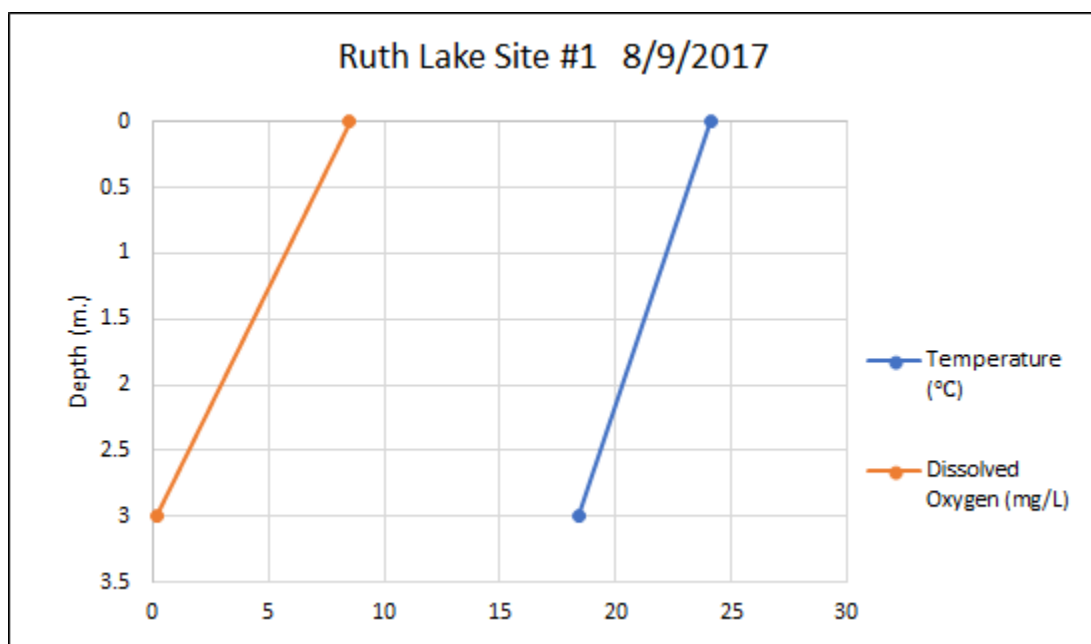
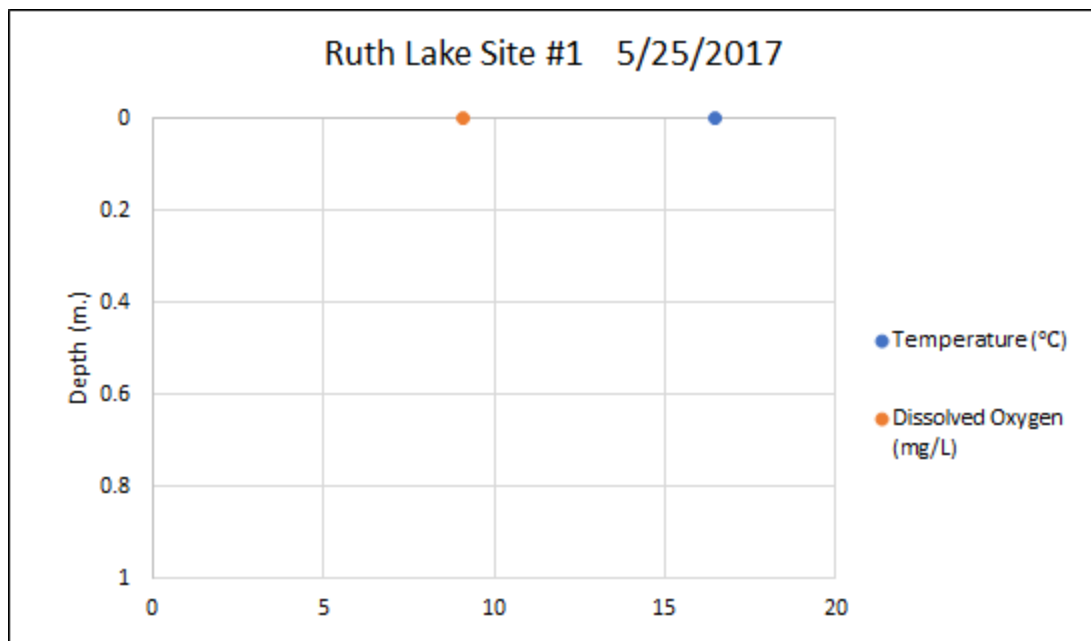












Section II

Historic Data Trends

Historical data trends for Mickey Lake, Ruth Lake, and Long Lake were established by processing yearly data reports from 1993-2017 which were submitted by GLEC, Dr. Fusilier, and raw data collected by the Northwestern Michigan College interns in 2017. The intention is to create a long term picture of the lakes over time. This allows damaging trends in water quality to be identified and corrected, while also maintaining the healthy parameters already established.

Parameters include seasonal total water Phosphorus, sediment Phosphorus, seasonal Chlorophyll a, seasonal secchi depth readings, total Nitrate Nitrogen, and Calcium. Dissolved Oxygen and temperature profiles are not included in this report and it is recommended that this historical data should be included in future reports. There is also historical pH, alkalinity, conductivity, and lake water quality index data that can also be added to this report at a later time.

In collecting the data and creating consistency across the various years, several issues needed to be addressed. Data found within reports was assumed to be accurate, unless discrepancies were noted across the historical data. The original report data was used in instances where there were discrepancies. The transition from Spring/Summer to Autumn was established as October 15. Some measurements were converted to create a complete metric record. Possibly contaminated samples are noted in the data when noted in the reports.

In the cases where only one sample has been collected, no graphs were created since no trend could be established.

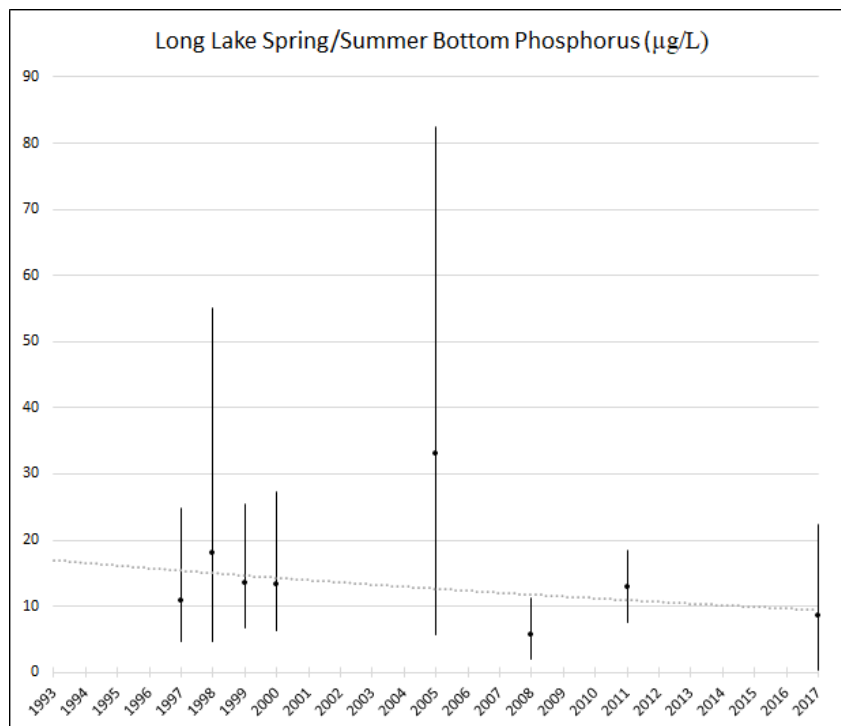
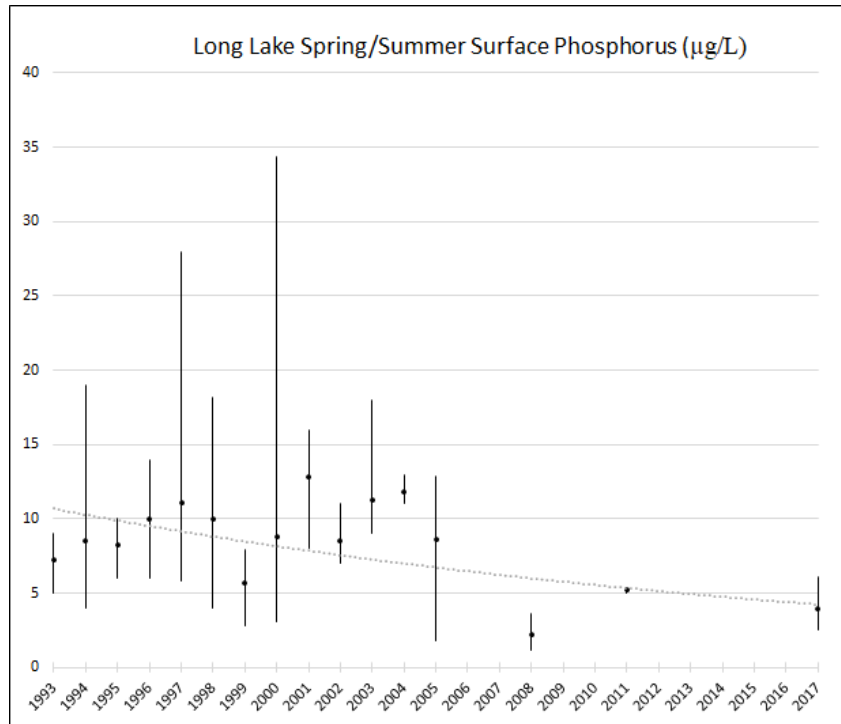
Long Lake

Long Lake

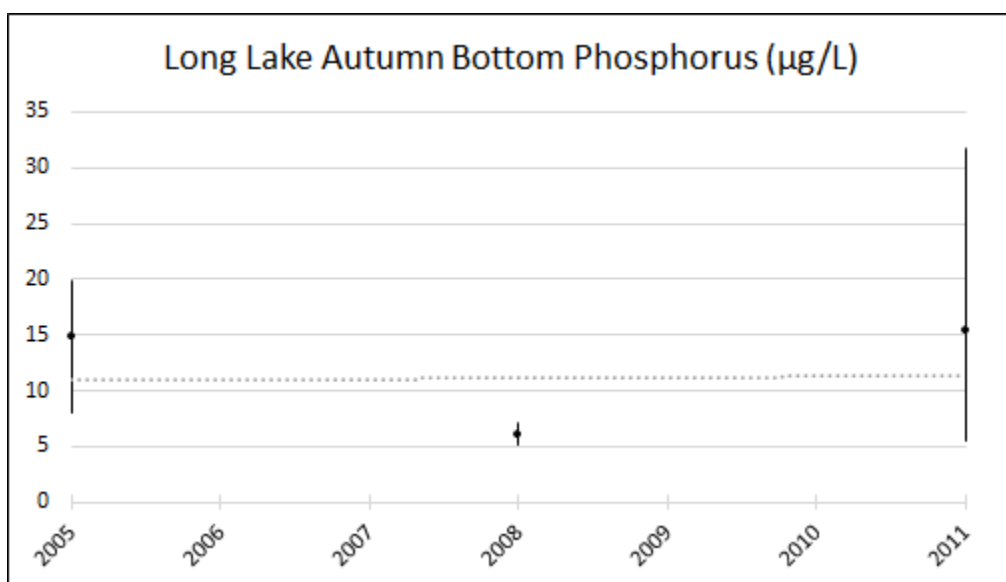
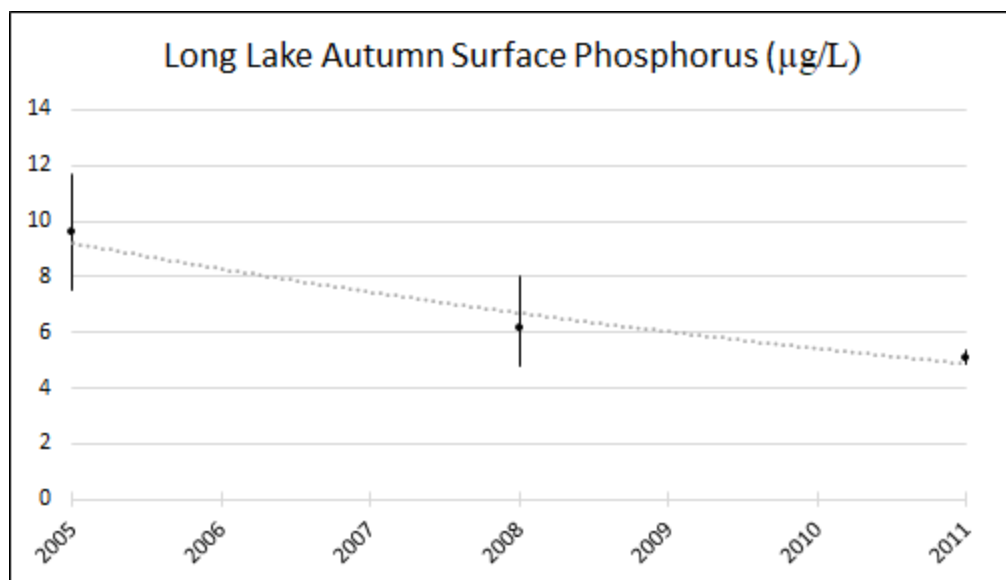
Total Phosphorus (µg/L) SPRING/SUMMER													
Year	# samples			min			max			mean			Mid-Hypolimnion
	Surface	Bottom	Mid-Epi limnion	Surface	Bottom	Mid-Epi limnion	Surface	Bottom	Mid-Epi limnion	Surface	Bottom	Mid-Epi limnion	
1993	4	---	---	5	---	---	9	---	---	7.25	---	---	---
1994	6	---	---	4	---	---	19	---	---	8.50	---	---	---
1995	4	---	---	6	---	---	10	---	---	8.25	---	---	---
1996	4	---	---	6	---	---	14	---	---	10.00	---	---	---
1997	19	6	---	5.8	4.7	---	28	24.9	---	11.09	10.87	---	---
1998	9	6	---	4	4.7	---	18.2	55	---	9.99	18.1	---	---
1999	6	6	---	2.8	6.8	---	7.9	25.4	---	5.67	13.47	---	---
2000	33	27	22	18	6.4	3.3	34.4	27.4	10.6	8.77	13.25	7.37	9.92
2001	6	---	---	8	---	---	16	---	---	12.83	---	---	---
2002	6	---	---	7	---	---	11	---	---	8.50	---	---	---
2003	15	---	---	9	---	---	18	---	---	11.27	---	---	---
2004	6	---	---	11	---	---	13	---	---	11.83	---	---	---
2005	6	3	---	1.8	5.7	---	12.9	82.5*	---	8.65	33.17	---	---
2008	3	3	---	1.2	1.9	---	3.6	11.3	---	2.20	5.77	---	---
2011	2	2	---	5	7.5	---	5.4	18.4	---	5.20	12.95	---	---
2017	6	7	---	2.5	0.3	---	6.1	22.3	---	3.95	8.53	---	---

*Possible contamination from bottom sediment

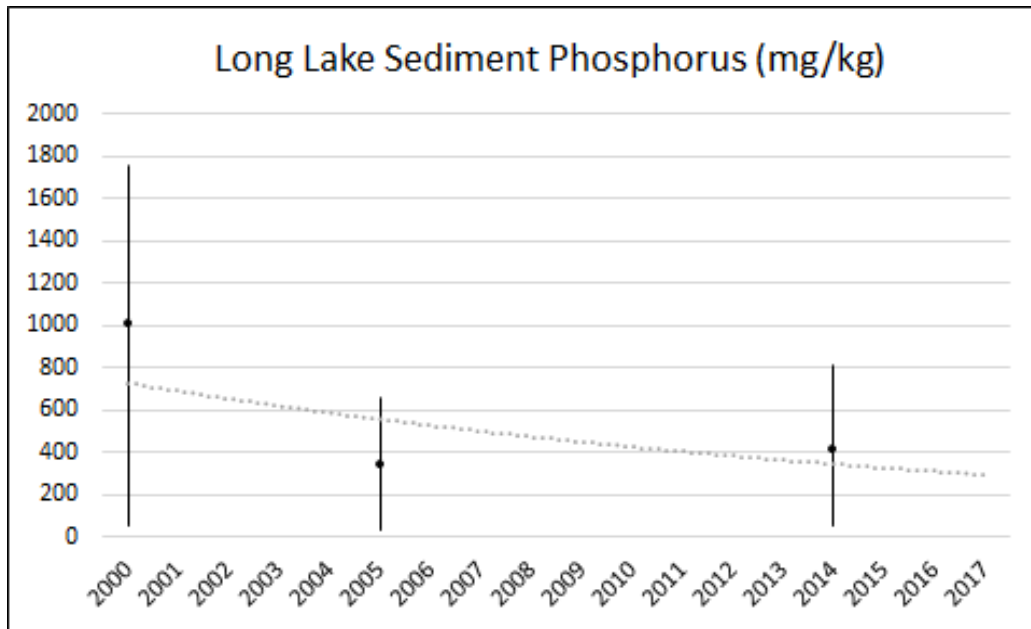
Total Phosphorus (µg/L) AUTUMN						
Year	# samples			min		
	Surface	Bottom	Mid-Epi limnion	Surface	Bottom	Mid-Epi limnion
2005	3	3	---	8.1	11.7	19.9
2008	3	3	---	5.1	8	7.2
2011	3	3	---	5.5	5.4	31.7



* In 2005 there was possible sediment contamination in a sample. This sample was included in the graph, but the overall trend downward is still consistent with what we see in the spring/summer samples. This trend could be slightly more significant if not considering this sample.

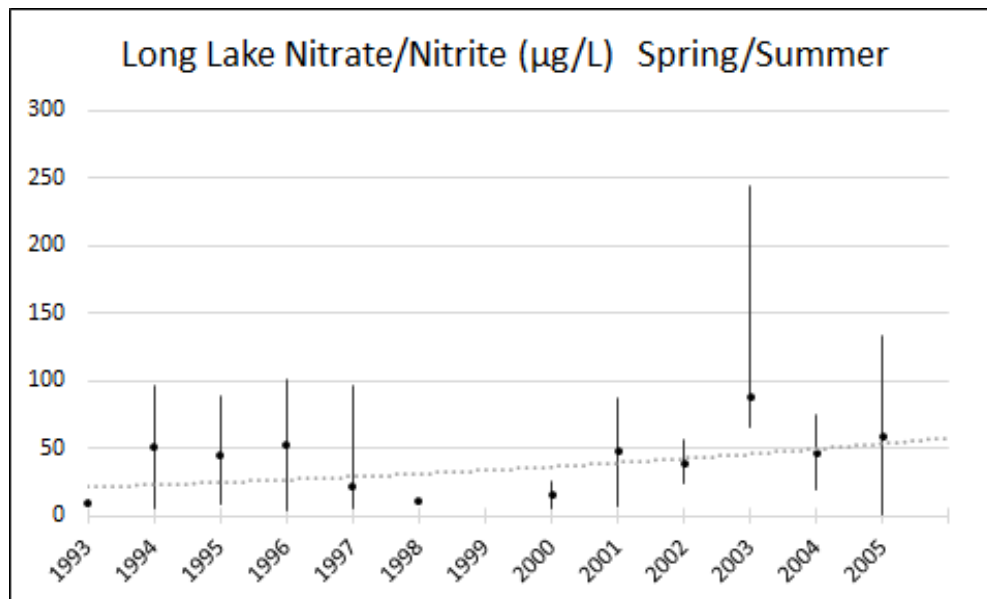


Sediment Phosphorus (mg/kg) SPRING/SUMMER				
Year	# samples	min	max	mean
2000	3	50.6	1754	1005.30
2005	3	33	654	336.33
2014	3	48	811	412.67



Nitrate-Nitrite Nitrogen ($\mu\text{g/L}$) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
1993	4	---	8	---	12	---	10.00	---
1994	6	---	5	---	97	---	51.50	---
1995	4	---	9	---	89	---	44.25	---
1996	4	---	4	---	101	---	52.75	---
1997	13	---	6	---	96	---	22.15	---
1998	3	---	11	---	12	---	11.33	---
1999	---	---	---	---	---	---	---	---
2000	6	---	6	---	26	---	16.17	---
2001	6	---	7	---	88	---	47.50	---
2002	6	---	24	---	57	---	39.33	---
2003	15	---	65	---	245	---	87.87	---
2004	6	---	20	---	75	---	47.17	---
2005	6	3	< 1.4	< 1.4	133	34.1	59.27	16.97
2008	---	---	---	---	---	---	---	---
2011	---	---	---	---	---	---	---	---
2014	---	---	---	---	---	---	---	---
2017	---	---	---	---	---	---	---	---

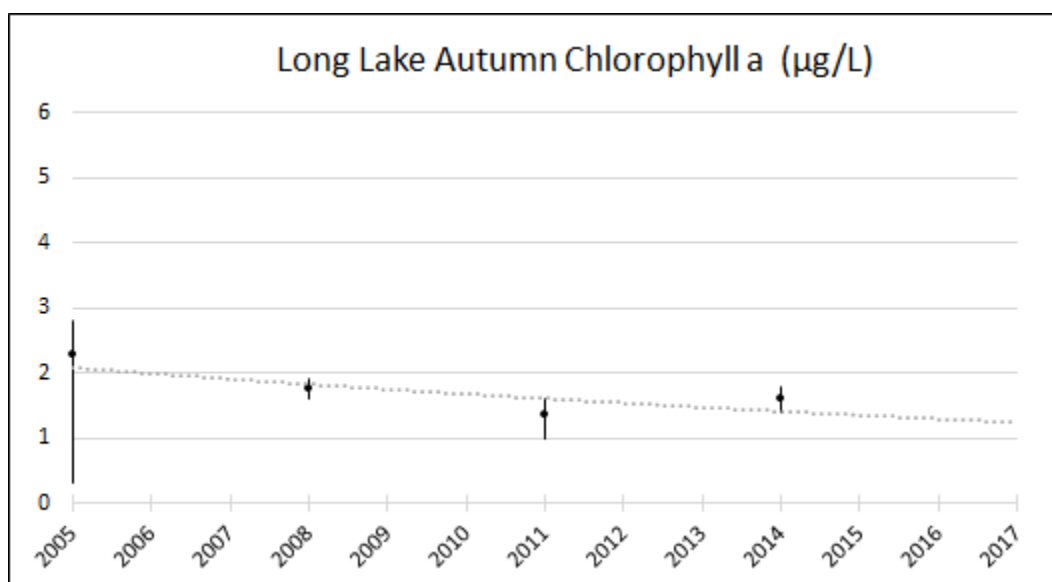
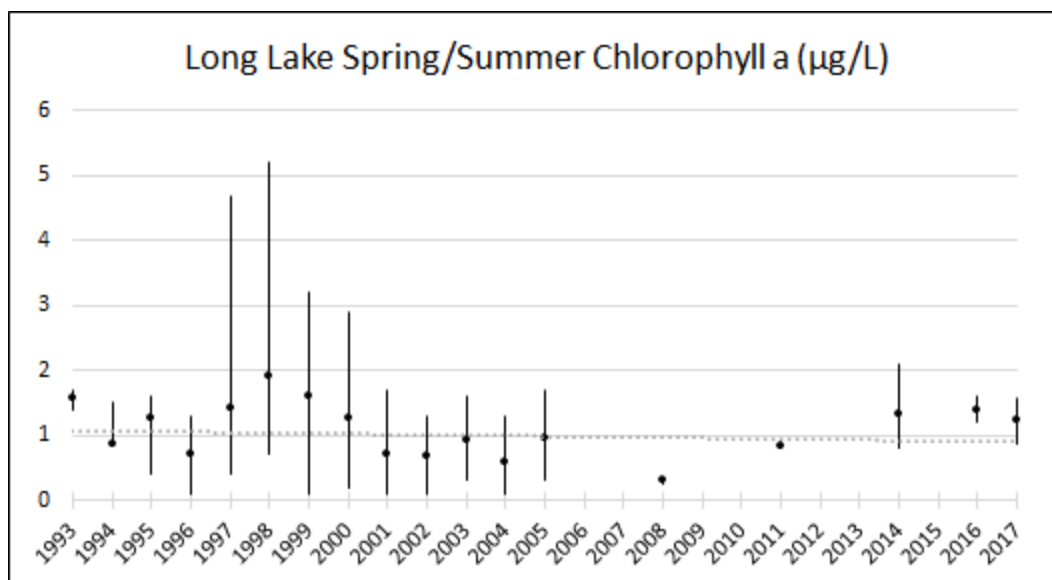
Nitrate-Nitrite Nitrogen ($\mu\text{g/L}$) AUTUMN								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2005	3	3	1.5	5.1	6.1	8	4.1	6.6



* There was only 1 bottom sample taken in 2005, so it is not included in the graph. It would have decreased the slope of the trend slightly, but not significantly. The one autumn sample year, 2005, is also not included since no trend could be established.

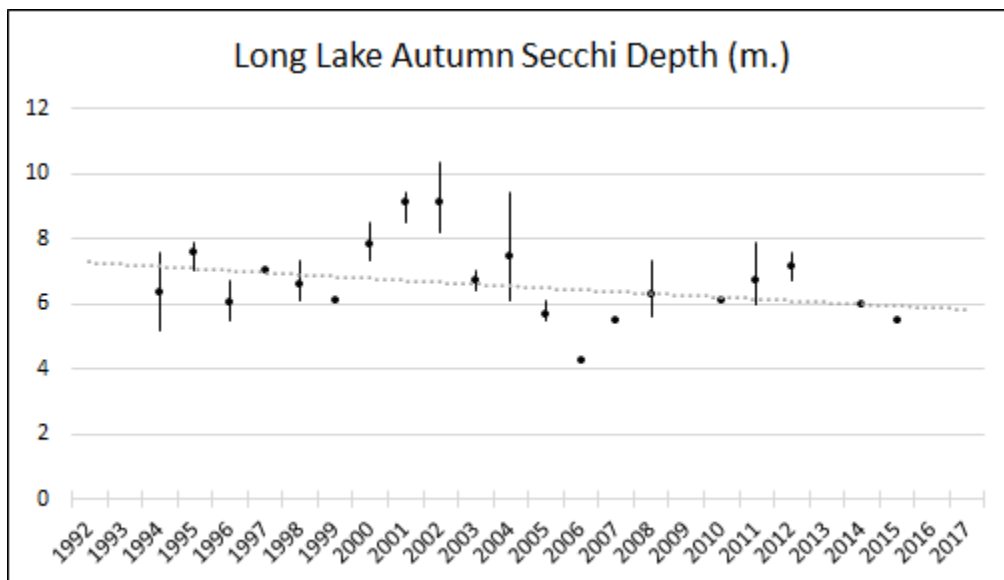
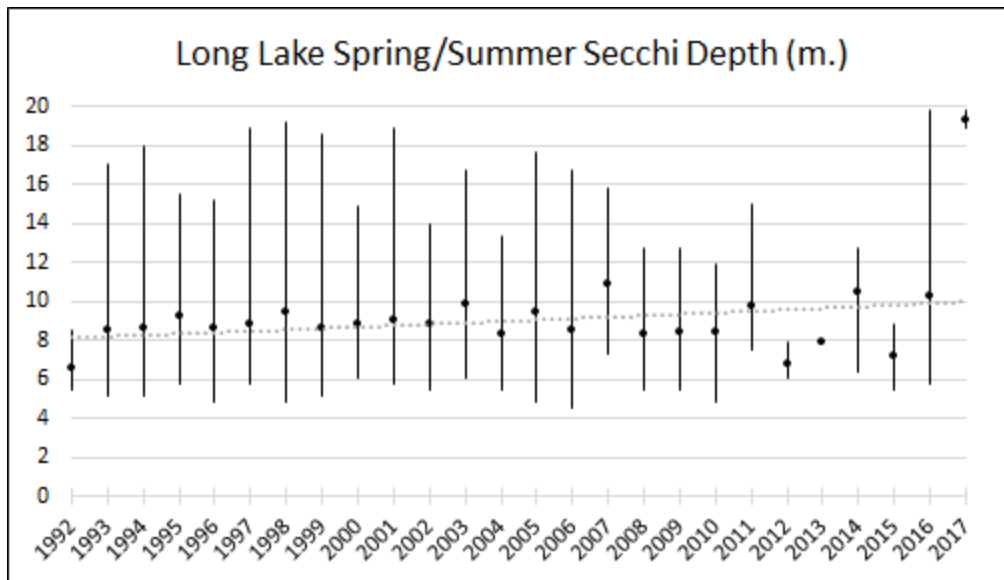
Chlorophyll a (µg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
1993	4	1.4	1.7	1.58
1994	6	0.9	1.5	0.88
1995	4	0.4	1.6	1.28
1996	4	0.1	1.3	0.70
1997	6	0.4	4.7	1.43
1998	5	0.7	5.2	1.92
1999	6	0.1	3.2	1.60
2000	12	0.2	2.9	1.26
2001	6	0.1	1.7	0.72
2002	6	0.1	1.3	0.68
2003	6	0.3	1.6	0.92
2004	6	0.1	1.3	0.60
2005	6	0.3	1.7	0.97
2008	3	0.25	0.35	0.30
2011	2	0.8	0.9	0.85
2014	3	0.8	2.1	1.33
2017	7	0.86	1.57	1.25

Chlorophyll a (µg/L) AUTUMN				
Year	# samples	min	max	mean
2005	3	0.3	2.8	2.27
2008	3	1.61	1.93	1.75
2011	3	1	1.6	1.37
2014	3	1.4	1.8	1.60



Secchi Disk (m.) SPRING/SUMMER				
Year	# samples	min	max	mean
1992	14	5.49	8.53	6.58
1993	25	5.18	17.07	8.56
1994	27	5.18	17.98	8.69
1995	28	5.79	15.54	9.30
1996	25	4.88	15.24	8.66
1997	33	5.79	18.9	8.87
1998	61	4.88	19.2	9.45
1999	24	5.18	18.59	8.65
2000	38	6.1	14.94	8.90
2001	30	5.79	18.9	9.08
2002	30	5.49	14.02	8.86
2003	32	6.1	16.76	9.88
2004	30	5.49	13.41	8.30
2005	27	4.88	17.68	9.42
2006	24	4.57	16.76	8.55
2007	6	7.32	15.85	10.87
2008	10	5.49	12.74	8.37
2009	7	5.49	12.8	8.40
2010	7	4.88	11.89	8.45
2011	4	7.5	15	9.79
2012	3	6.1	7.92	6.81
2013	1	7.92	7.92	7.92
2014	5	6.4	12.74	10.51
2015	2	5.49	8.84	7.17
2016	10	5.79	19.81	10.30
2017	8	5.5	19.81	9.29

Secchi Disk (m.) AUTUMN				
Year	# samples	min	max	mean
1994	4	5.18	7.62	6.33
1995	4	7.01	7.92	7.62
1996	4	5.49	6.71	6.02
1997	1	7.01	7.01	7.01
1998	4	6.1	7.32	6.63
1999	3	6.1	6.1	6.10
2000	3	7.32	8.53	7.82
2001	3	8.53	9.45	9.14
2002	4	8.23	10.36	9.14
2003	2	6.4	7.01	6.71
2004	5	6.1	9.45	7.44
2005	5	5.49	6.1	5.70
2006	1	4.27	4.27	4.27
2007	1	5.49	5.49	5.49
2008	4	5.64	7.32	6.31
2010	1	6.1	6.1	6.10
2011	4	6	7.92	6.73
2012	2	6.71	7.62	7.17
2014	3	6	6	6.00
2015	1	5.49	5.49	5.49
2017	---	---	---	---



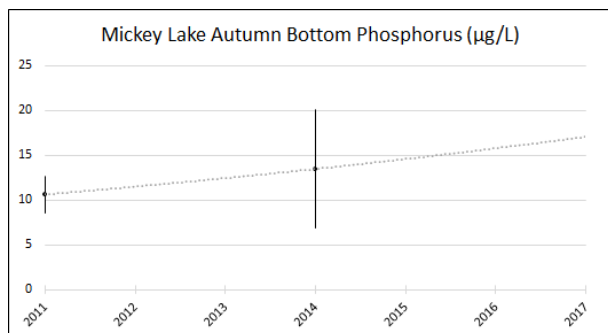
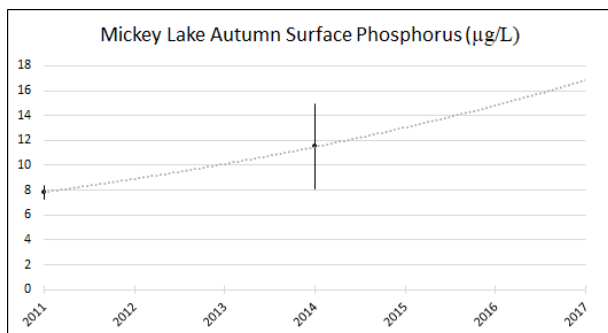
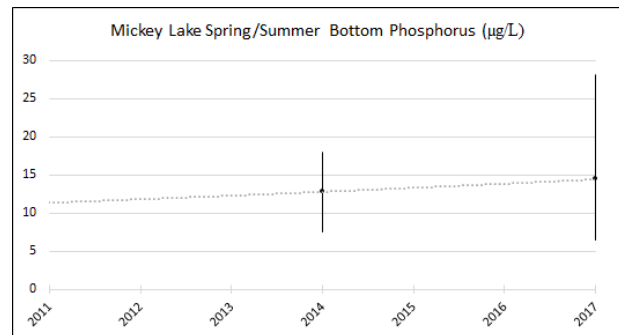
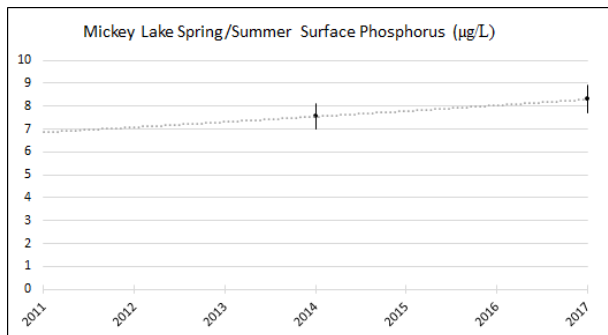
Calcium (mg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2017	6	20.2	24.6	22.70

Mickey Lake

Total Phosphorus (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2011	---	---	---	---	---	---	---	---
2014	2	2	7	7.6	8.1	18	7.55	12.80
2017	5	4	7.71	6.5	8.9	28.1*	8.30	14.43

* Possible contamination from bottom sediment

Total Phosphorus (µg/L) AUTUMN								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2011	2	2	7.3	8.6	8.4	12.7	7.85	10.65
2014	2	2	8.1	6.9	14.9	20.1	11.50	13.50
2017	---	---	---	---	---	---	---	---

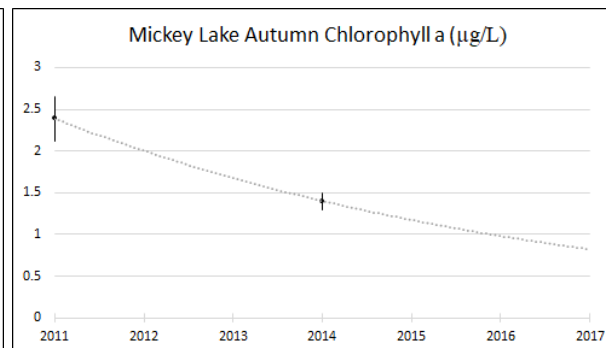
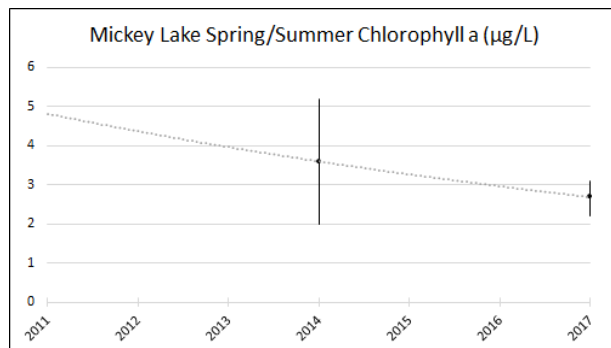


Sediment Phosphorus (mg/kg) SPRING/SUMMER				
Year	# samples	min	max	mean
2014	2	879	1625	1252

* There has been no Nitrate/Nitrite Nitrogen data collected on Mickey Lake.

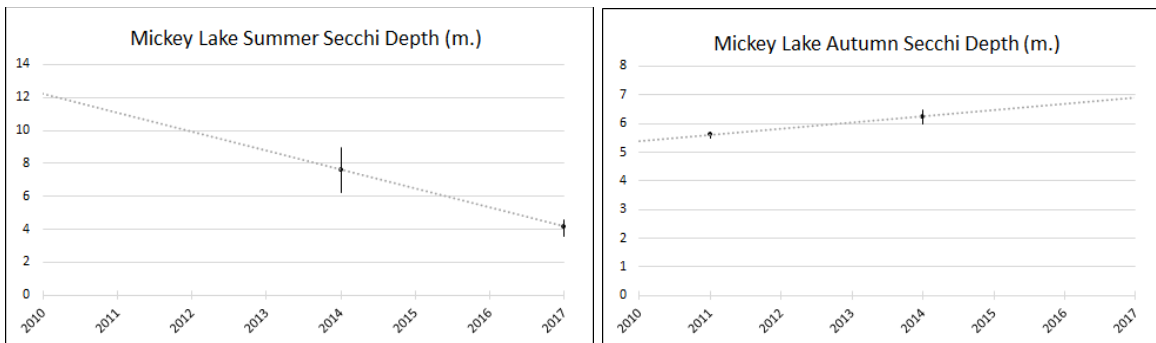
Chlorophyll a (µg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2011	---	---	---	---
2014	2	2	5.2	3.6
2017	2	2.2	3.1	2.69

Chlorophyll a (µg/L) AUTUMN				
Year	# samples	min	max	mean
2011	2	2.12	2.65	2.39
2014	2	1.3	1.5	1.4
2017	---	---	---	---



Secchi Disk (m.) SPRING/SUMMER				
Year	# samples	min	max	mean
2011	---	---	---	---
2014	2	6.25	8.99	7.62
2017	4	3.6	4.6	4.15

Secchi Disk (m.) AUTUMN				
Year	# samples	min	max	mean
2011	2	5.49	5.7	5.60
2014	2	6	6.49	6.25
2017	---	---	---	---



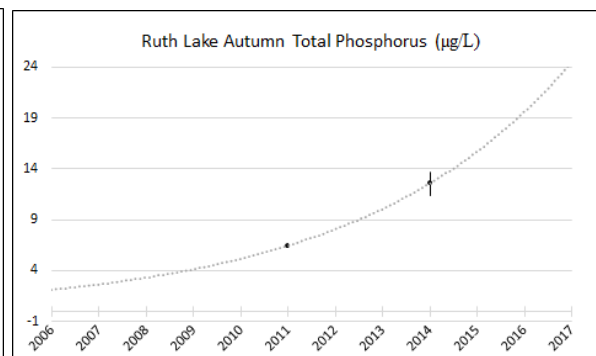
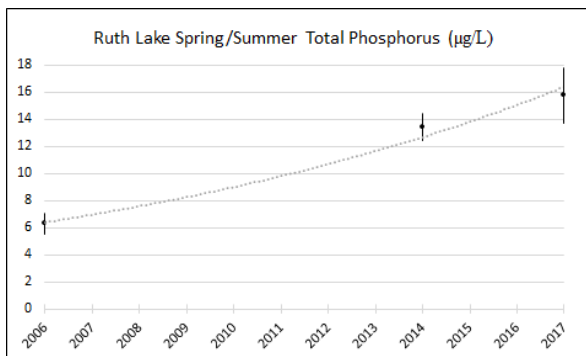
Calcium (mg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2017	3	20.6	21.9	21.17

*No Autumn Calcium data has been collected for Mickey Lake.

Ruth Lake

Total Phosphorus (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2006	2	---	5.5	---	7.1	---	6.30	---
2011	---	---	---	---	---	---	---	---
2014	2	---	12.4	---	14.4	---	13.40	---
2017	2	---	13.7	---	17.8	---	15.75	---

Total Phosphorus (µg/L) AUTUMN								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2006	---	---	---	---	---	---	---	---
2011	2	---	6.3	---	6.6	---	6.45	---
2014	2	---	11.4	---	13.7	---	12.55	---
2017	---	---	---	---	---	---	---	---



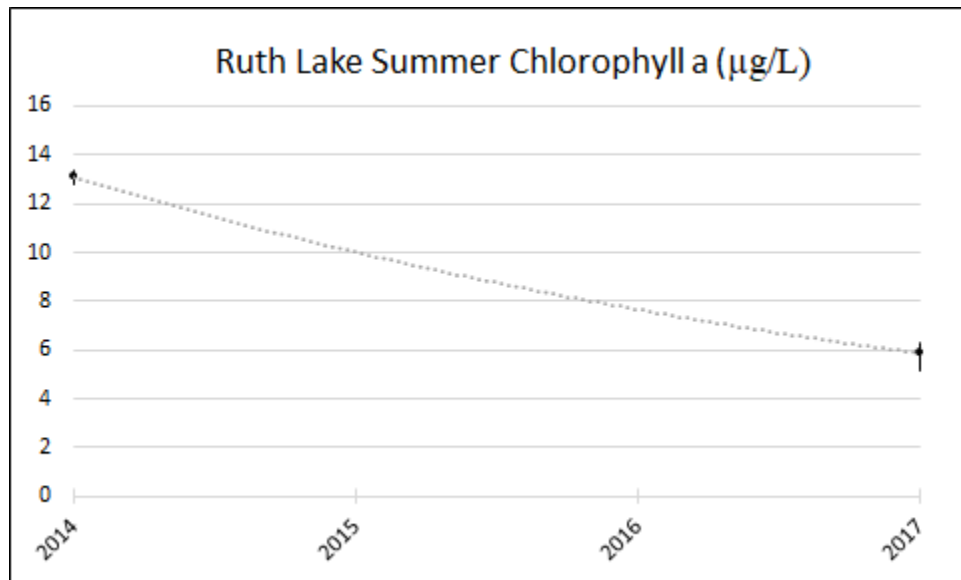
Sediment Phosphorus (mg/kg) SPRING/SUMMER				
Year	# samples	min	max	mean
2014	2	445	461	451
2017	---	---	---	---

Chlorophyll a ($\mu\text{g/L}$) SPRING/SUMMER

Year	# samples	min	max	mean
2014	2	12.8	13.4	13.1
2017	3	5.17	6.27	5.86

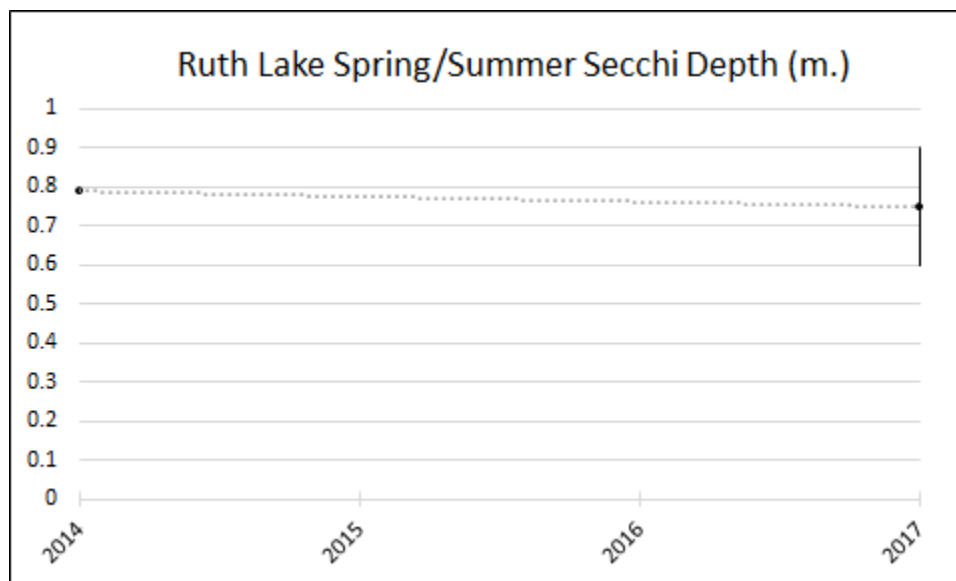
Chlorophyll a ($\mu\text{g/L}$) AUTUMN

Year	# samples	min	max	mean
2014	2	3.7	10.7	7.2
2017	---	---	---	---



Secchi Disk (m.) SPRING/SUMMER				
Year	# samples	min	max	mean
2014	2	0.79	0.79	0.79
2017	2	0.6	0.9	0.75

Secchi Disk (m.) AUTUMN				
Year	# samples	min	max	mean
2014	2	1.01	1.01	1.01
2017	---	---	---	---



Calcium (mg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2017	2	12.2	20	16.10

*No Autumn Calcium data has been collected for Ruth Lake.

Page Lake

Total Phosphorus (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2016	1	1	20.8	63.7	20.8	63.7	20.8	63.7
2017	---	---	---	---	---	---	---	---

* No Autumn Total Phosphorus data has been collected for Page Lake

Sediment Phosphorus (mg/kg) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	1	700	700	700
2017	---	---	---	---

Nitrate-Nitrite Nitrogen (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2016	1	1	<1.1	5.7	<1.1	5.7	<1.1	5.70
2017	---	---	---	---	---	---	---	---

*No Autumn Nitrate-Nitrite Nitrogen data has been collected for Page Lake

Chlorophyll a (µg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	1	12.7	12.7	12.7
2017	---	---	---	---

* Mean of two samples

*No Autumn Chlorophyll a data has been collected for Page Lake.

Secchi Disk (m.) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	1	2.59	2.59	2.59
2017	---	---	---	---

*No Autumn Secchi Disk data has been collected for Page Lake.

Calcium (mg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	1	8.9	8.9	8.9

*No Autumn Calcium data has been collected for Page Lake.

Fern Lake

Total Phosphorus (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2016	2	2	6.5	8.8	7	13.6	6.75	11.20
2017	---	---	---	---	---	---	---	---

*No Autumn Total Phosphorus data has been collected for Fern Lake.

Sediment Phosphorus (mg/kg) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	2	770	791	780.5
2017	---	---	---	---

Nitrate-Nitrite Nitrogen (µg/L) SPRING/SUMMER								
Year	# samples		min		max		mean	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2016	2	2	<1.1	<1.1	<1.1	5.4	<1.1	3.25
2017	---	---	---	---	---	---	---	---

*No Nitrate-Nitrite Nitrogen data has been collected for Fern Lake.

Chlorophyll a (µg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	3	5.3*	5.8	5.55
2017	---	---	---	---

* Mean of two samples

*No Chlorophyll a data has been collected for Fern Lake.

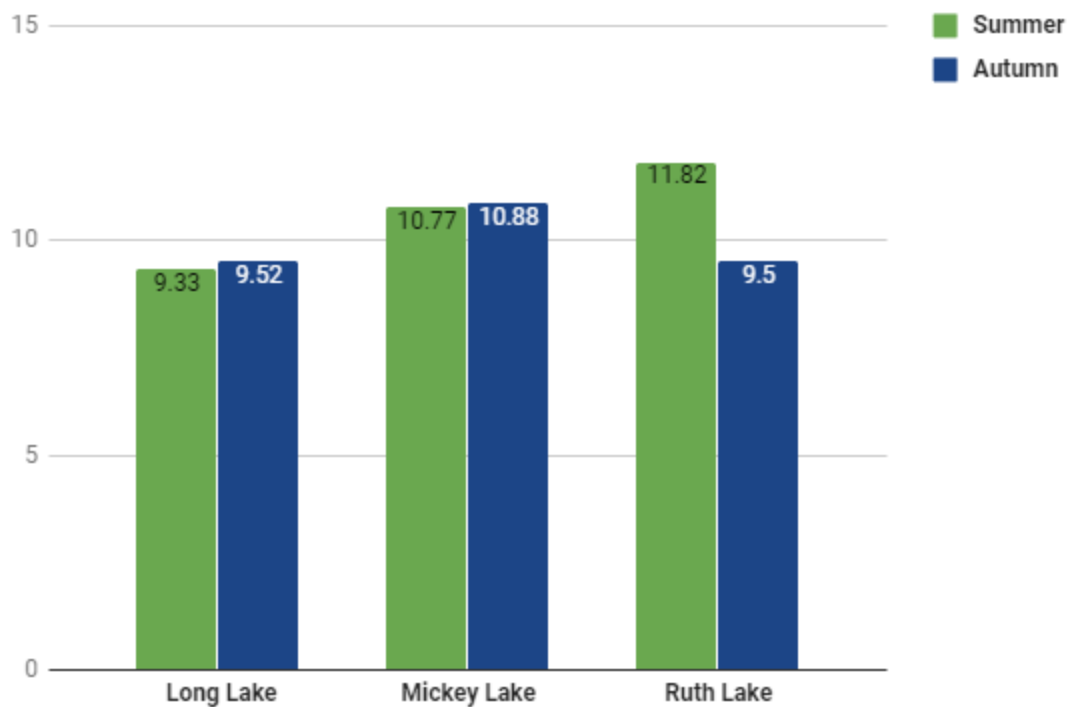
Secchi Disk (m.) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	2	4.39	4.45	4.42
2017	---	---	---	---

*No Secchi depth data has been collected for Fern Lake.

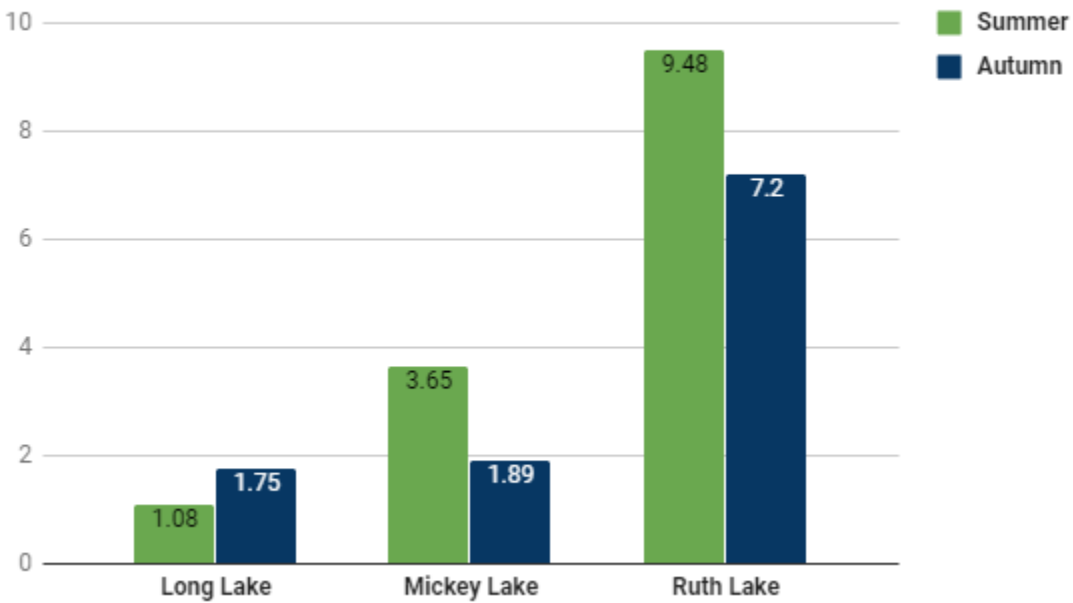
Calcium (mg/L) SPRING/SUMMER				
Year	# samples	min	max	mean
2016	2	30.9	32.2	31.55

*No Autumn Calcium data has been collected for Fern Lake.

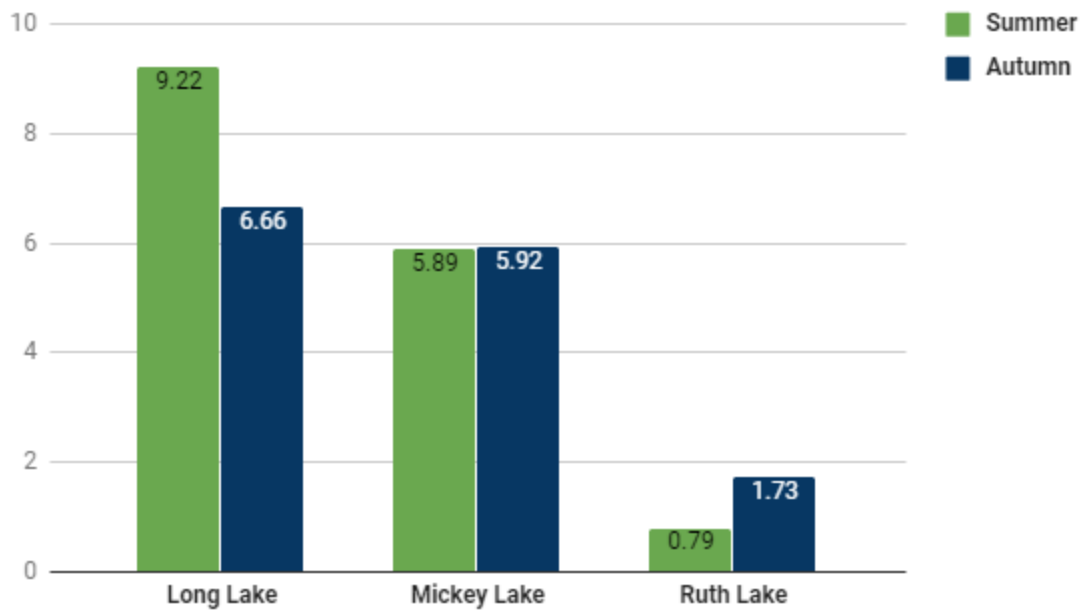
Total Phosphorus (ug/L)



Chlorophyll a (ug/L)



Secchi Disk (m)



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