NORTH LAKE

DEXTER & LYNDON TOWNSHIPS

WASHTENAW COUNTY

1993 – 2010 WATER QUALITY STUDIES

NORTH LAKE DATA

North Lake is a 246-acre natural moderately hard water kettle lake located in Section 18, Dexter Township (T1S R4E) and Section 13, Lyndon Township (T1S R3E), Washtenaw County, Michigan. The lake has a maximum depth of 58 feet, a water volume of 2661 acre-feet, and a mean depth of 10.8 feet. It has 17,518 feet of shoreline. The elevation of the lake is 938 feet above sea level. There is a 0.4-acre island on the south side of the lake.

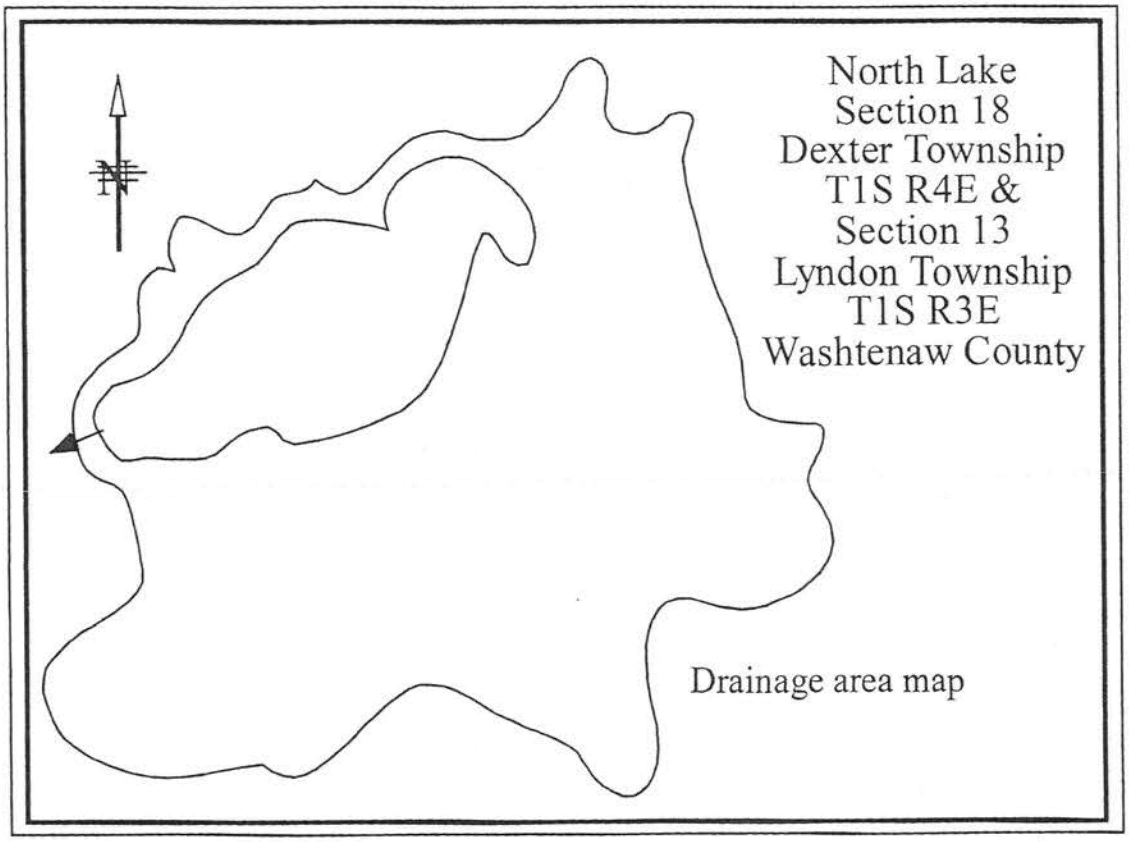
The size of the watershed, which is the land area that contributes water to the lake, but does not include the lake, is 952 acres. The drainage area, which includes the lake and the watershed, is 1198 acres (see map below). The watershed to lake ratio is 3.87 to 1, which is normal for a Michigan inland lake. Based on these data, the lake flushes about once every 3.1 years, on an average.

There are no inlets. The outlet is on the southwest corner. Water from North Lake flows through South Lake and Joslin Lake before joining Portage Creek north of Unadilla. Portage Creek flows through Woodburn, Patterson, Watson, and Halfmoon lakes before flowing through Hiland Lake. Portage Creek apparently changes to the Portage River after flowing through Hiland Lake. The Portage River flows into Little Portage Lake, Big Portage Lake and joins the Huron River as it leaves Big Portage Lake. The Huron River flows into Lake Erie at Monroe, Michigan.

The longitude and latitude of the 58-foot deep hole is 84° 00.421W and 42° 23.641N.

THE ICE FREE AND LAKE MIXING DATES

The lake was ice-free on March 18, 1999, March 27, 2003 and March 26, 2005. It mixed April 4, 1998, April 6, 1999 and March 28, 2003.



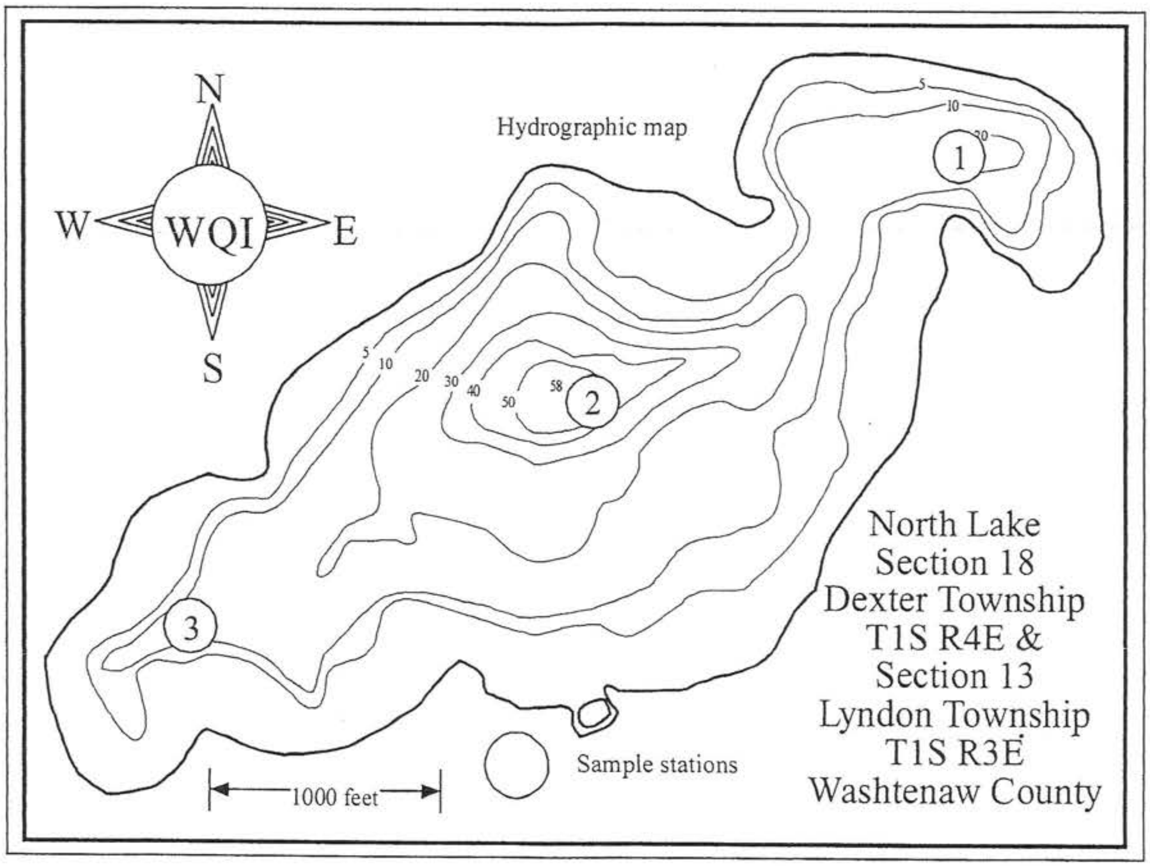
THE SAMPLE DATES

Three spring surface samples for water quality testing were collected by Dr. Charlie Taylor May 5, 1993, April 12, 1997, May 6, 2000, April 28, 2001, June 4, 2002, March 28 and April 27, 2003, May 23, 2005, and May 21, 2006. David Pruess collected samples on May 20, 2010. Taylor collected three fall surface samples for water quality testing October 21, 1999. Dr. Howard Booth collected three late spring surface samples for water quality testing June 4, 2002 and March 28, 2003. WQI limnologists collected three spring surface samples May 27, 2003

Three late summer surface samples for water quality testing were collected by WQI limnologists August 2, 1993, August 5, 1996, September 4, 1997, August 30 and October 21, 1999, August 8, 2000, August 2, 2001, August 6, 2002, August 3, 2003, August 3, 2004, August 4, 2005, August 2, 2006 and August 3, 2010. Bottom sediment samples were collected at the three sites in August 1996. Top to bottom dissolved oxygen and temperature profile data were collected in the 58-foot deep hole each time the lake was sampled in late summer.

THE SAMPLE STATIONS

The locations of the three sample stations are shown as circles on the hydrographic map of the lake.



THE ANALYSES

The tests performed on the samples included total phosphorus, total nitrate nitrogen, total alkalinity, pH, conductivity, chlorophyll a, Secchi disk depth, and in summer, temperature and dissolved oxygen.

Temperature, dissolved oxygen and Secchi disk depths were measured in the field. Chlorophyll a, phosphorus, nitrate nitrogen, alkalinity, pH and conductivity tests were performed at the Water Quality Investigators laboratory in Dexter, Michigan. All test procedures followed those outlined in *APHA's Standard Methods for the Examination of Water and Wastewater* (1985).

THE TEST RESULTS

The results of the tests are found in the text, in the table at the end of this report and the enclosed atlas pages.

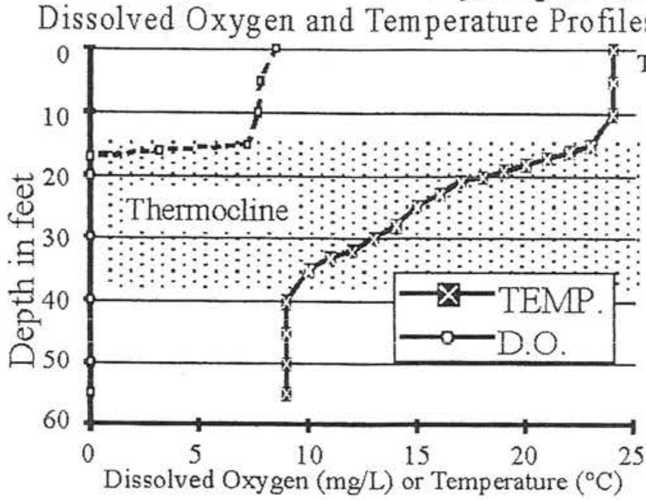
TEMPERATURE AND DISSOLVED OXYGEN

Temperature exerts a wide variety of influences on most lakes, such as the separation of layers of water (stratification), solubility of gasses and biological activity. In spring temperature generally doesn't need to be determined because we've found temperatures are low and dissolved oxygen is near saturation at that time.

Dissolved oxygen is the test most often selected by lake scientists as being important. Besides providing oxygen for aquatic organisms, in natural lakes oxygen is involved the capture and release of various chemicals, such as iron and phosphorus.

1993

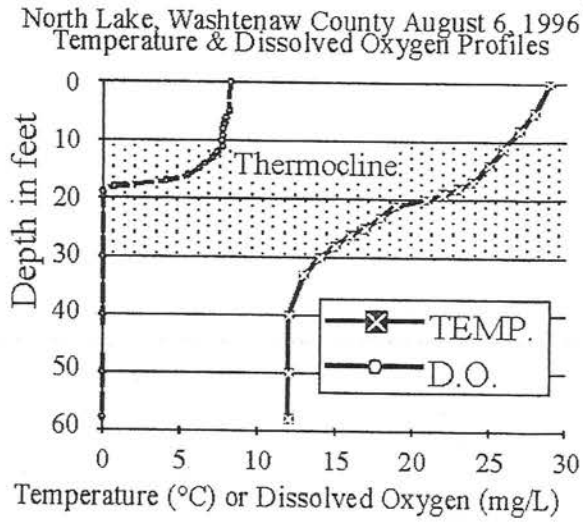
North Lake, Washtenaw County, August 2, 1993
Dissolved Oxygen and Temperature Profiles



Temp.	Depth	D.O.	Depth
24	0	8.5	0
24	5	7.8	5
24	10	7.7	10
23	15	7.2	15
22	16	3.2	16
21	17	0	17
20	18	0	20
19	19	0	30
18	20	0	40
17	21	0	50
16	23	0	55
15	25		
14	28		
13	30		
12	32		
11	33		
10	35		
9	40		
9	55		

In late summer 1993 the lake formed a 23-foot thick thermocline from 15 to 38 feet. (A thermocline is defined as a change in temperature of more than one degree Centigrade per meter of depth, and is shown shaded on the graphs.) The lake ran out of dissolved oxygen at 17 feet, and that condition remained to the bottom. The hypsographic (depth-area) graph shows about 25 percent of the lake is deeper than 17 feet.

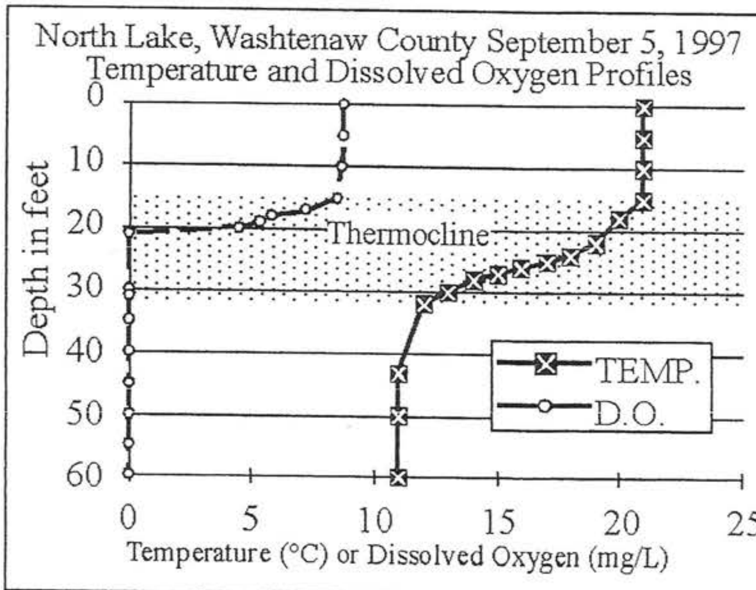
1996



Temp.	Depth	D.O.	Depth
29	0	8.3	0
28	5	8.2	5
27	8	8.0	6
26	11	7.9	7
25	14	7.8	8
24	17	7.8	9
23	18	7.7	10
22	19	7.8	11
21	20	7.4	12
19	21	7.1	13
18	23	6.6	14
17	25	6.2	15
16	26	5.5	16
15	28	4.1	17
14	30	0.7	18
13	33	0.0	19
12	40	0.0	30
12	50	0.0	40
12	58	0.0	50
		0.0	58

In late summer 1996 the lake formed a 20-foot thick thermocline from 10 to 30 feet. The lake ran out of dissolved oxygen this year at 19 feet, and that condition remained to the bottom. About 20 percent of the lake is deeper than 19 feet.

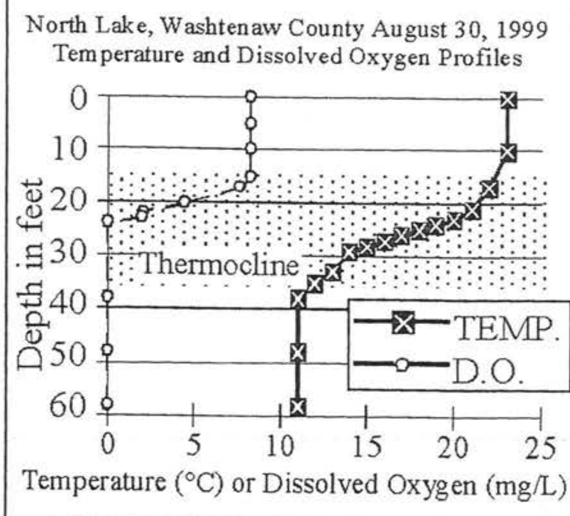
1997



Temp.	Depth	D.O.	Depth
21	0	8.7	0
21	5	8.7	5
21	10	8.6	10
21	15	8.5	15
20	18	7.2	17
19	22	5.8	18
18	24	5.3	19
17	25	4.5	20
16	26	0.0	21
15	27	0.0	30
14	28	0.0	31
13	30	0.0	35
12	32	0.0	40
11	43	0.0	45
11	50	0.0	50
11	60	0.0	55
		0.0	60

In late summer 1997 the lake formed a 16-foot thick thermocline from 15 to 31 feet. The lake ran out of dissolved oxygen this year at 21 feet, and that condition remained to the bottom. About 15 percent of the lake is deeper than 21 feet.

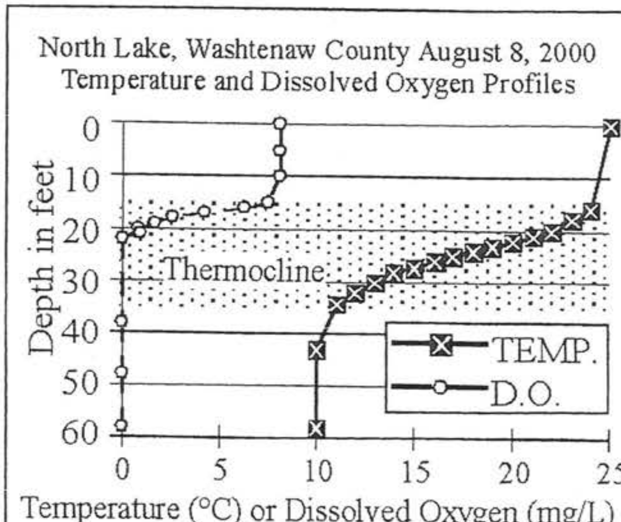
1999



Temp.	Depth	D.O.	Depth
23	0	8.3	0
23	10	8.3	5
22	17	8.3	10
21	21	8.3	15
20	23	7.7	17
19	24	4.5	20
18	25	2.1	22
17	26	2.0	23
16	27	0.0	24
15	28	0.0	38
14	29	0.0	48
13	33	0.0	58
12	35		
11	38		
11	48		
11	58		

In late summer 1999 the lake formed a 20-foot thick thermocline from 15 to 35 feet. The lake ran out of dissolved oxygen this year at 24 feet, and that condition remained to the bottom. About 11 percent of the lake is deeper than 24 feet.

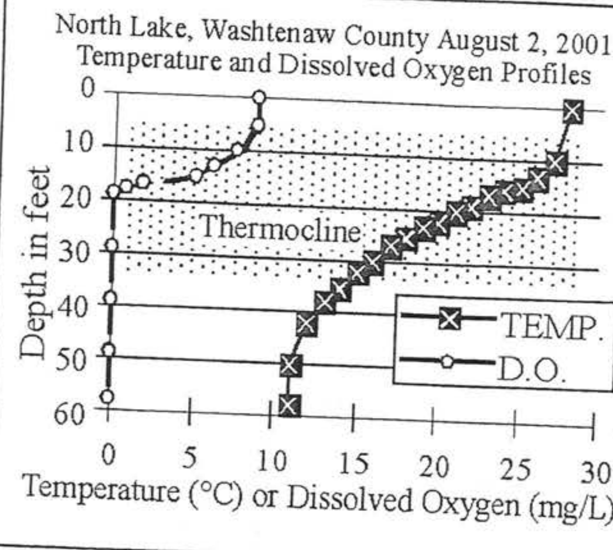
2000



Temp.	Depth	D.O.	Depth
25	0	8.1	0
24	16	8.1	5
23	18	8.1	10
22	20	7.5	15
21	21	6.3	16
20	22	4.2	17
19	23	2.6	18
18	24	1.6	19
17	25	0.8	20
16	26	0.9	21
15	27	0.0	22
14	28	0.0	38
13	30	0.0	48
12	32	0.0	58
11	34		
10	43		
10	58		

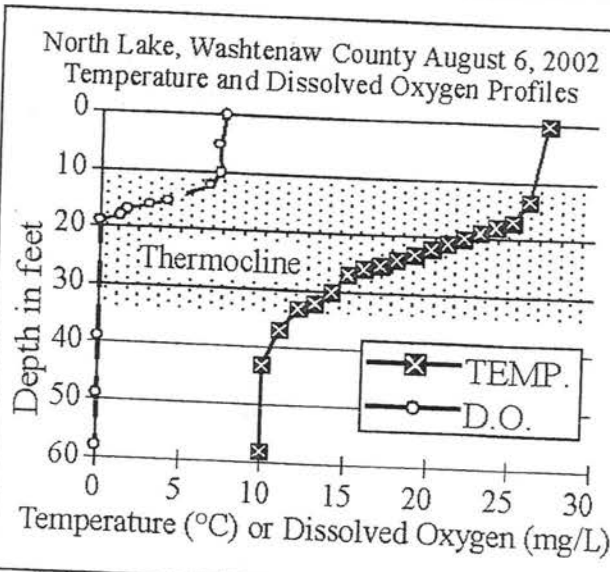
In late summer 2000 the lake formed a 24-foot thick thermocline from 13 to 37 feet. The lake ran out of dissolved oxygen this year at 22 feet, and that condition remained to the bottom. About 15 percent of the lake is deeper than 22 feet.

2001



Temp.	Depth	D.O.	Depth
28	0	8.7	0
27	10	8.7	5
26	13	7.6	10
25	15	6.2	13
24	16	5.0	15
23	17	1.9	17
22	19	0.7	18
21	20	0.0	19
20	22	0.0	29
19	23	0.0	39
18	25	0.0	49
17	27	0.0	58
16	30		
15	32		
14	35		
13	38		
12	42		
11	50		
11	58		

In late summer 2001 the lake formed a 28-foot thick thermocline from 5 to 33 feet. The lake ran out of dissolved oxygen this year at 19 feet, and that condition remained to the bottom. About 20 percent of the lake is deeper than 19 feet.



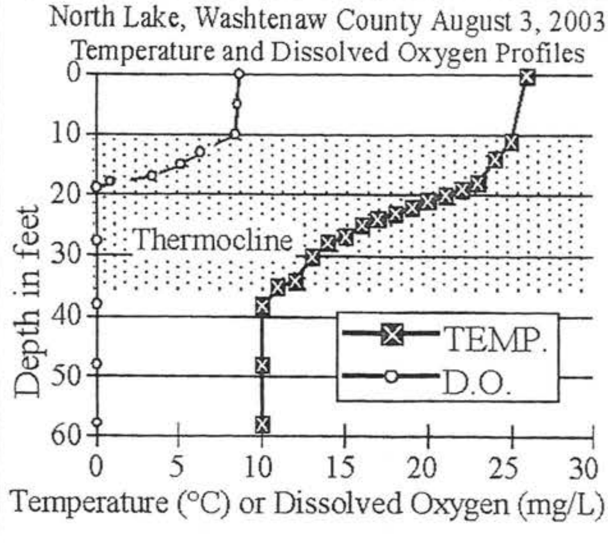
Temp.	Depth	D.O.	Depth
27	0	7.5	0
26	13	7.1	5
25	17	7.2	10
24	18	6.7	12
23	19	4.0	15
22	20	3.0	16
21	21	1.6	17
20	22	1.2	18
19	23	0.0	19
18	24	0.0	39
17	25	0.0	49
16	26	0.0	58
15	27		
14	30		
13	32		
12	33		
11	37		
10	43		
10	58		

2002

In late summer 2002 the lake formed a 23-foot thick thermocline from 10 to 33 feet. The lake ran out of dissolved oxygen this year at 19 feet, and that condition remained to the bottom.

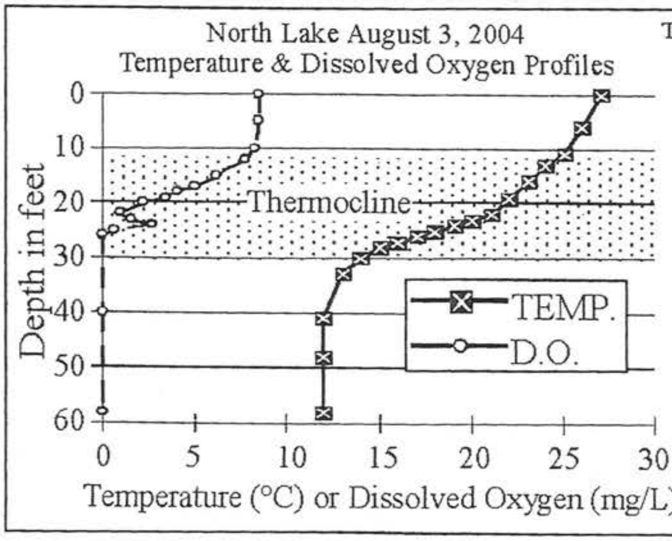
2003

In late summer 2003 the lake formed a 27-foot thick thermocline from 10 to 37 feet. The lake ran out of dissolved oxygen this at 19 feet, and that condition remained to the bottom.



Temp.	Depth	D.O.	Depth
26	0	8.7	0
25	11	8.6	5
24	14	8.5	10
23	18	6.3	13
22	19	5.2	15
21	20	3.4	17
20	21	0.8	18
19	22	0.0	19
18	23	0.0	28
17	24	0.0	38
16	25	0.0	48
15	27	0.0	58
14	28		
13	30		
12	34		
11	35		
10	38		
10	48		
10	58		

2004

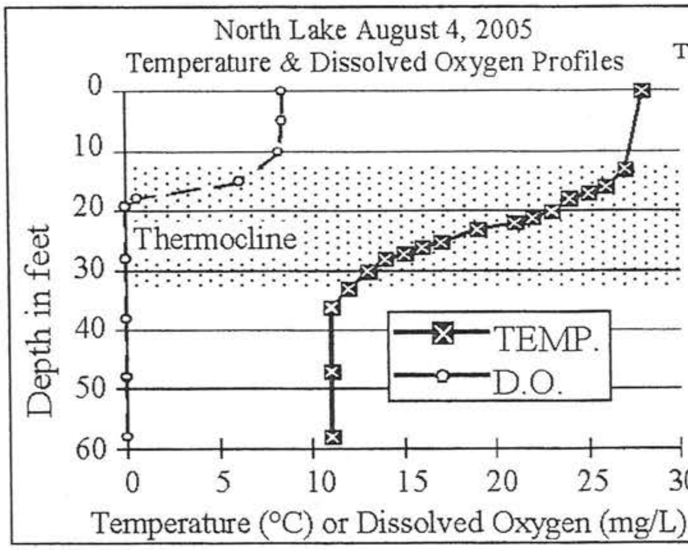


Temp.	Depth	D.O.	Depth
27	0	8.5	0
26	6	8.5	5
25	11	8.3	10
24	13	7.8	12
23	16	6.2	15
22	19	5.1	17
21	22	4.1	18
20	23	3.5	19
19	24	2.2	20
18	25	0.9	22
17	26	1.6	23
16	27	2.7	24
15	28	0.6	25
14	30	0.0	26
13	33	0.0	40
12	41	0.0	58
12	48		
12	58		

In late summer 2004 the lake formed a 20-foot thick thermocline from 10 to 30 feet. Dissolved oxygen was plentiful above 10 feet. The lake ran out of dissolved oxygen this year at 26 feet, and that condition remained to the bottom. About 10 percent of the lake is deeper than 26 feet.

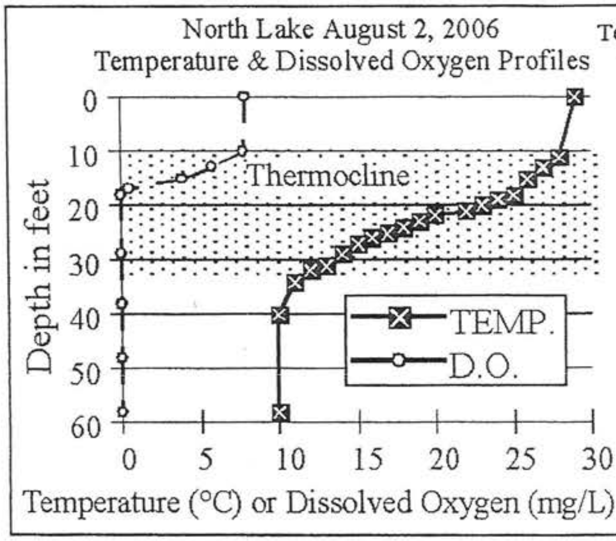
2005

In late summer 2005 the lake formed a 22-foot thick thermocline from 10 to 32 feet. Dissolved oxygen was again plentiful above 10 feet. The lake ran out of dissolved oxygen this at 19 feet, and that condition remained to the bottom. About 20 percent of the lake is deeper than 19 feet.



Temp.	Depth	D.O.	Depth
28	0	8.5	0
27	13	8.5	5
26	16	8.3	10
25	17	6.2	15
24	18	0.6	18
23	20	0.0	19
22	21	0.0	28
21	22	0.0	38
19	23	0.0	48
17	25	0.0	58
16	26		
15	27		
14	28		
13	30		
12	33		
11	36		
11	47		
11	58		

2006

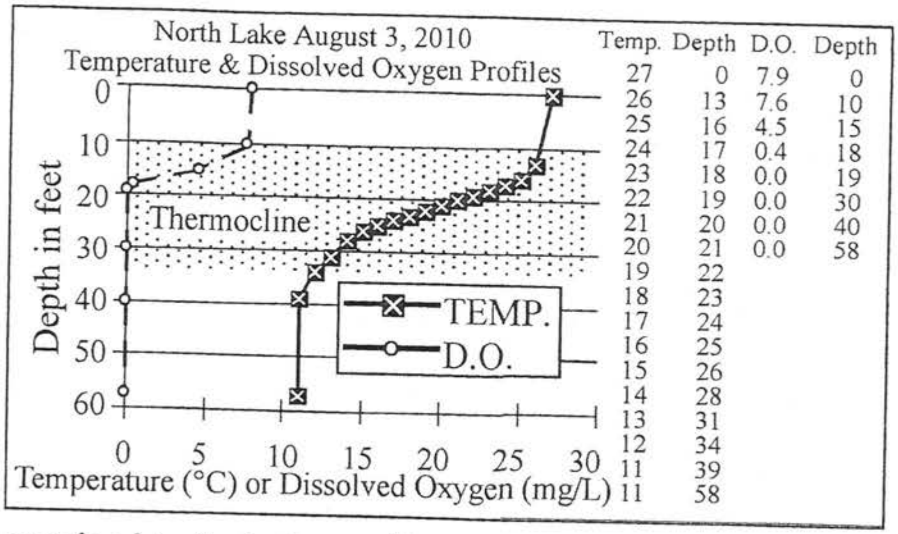


Temp.	Depth	D.O.	Depth
29	0	8.0	0
28	11	7.9	10
27	13	5.8	13
26	15	3.9	15
25	18	0.5	17
24	19	0.0	18
23	20	0.0	29
22	21	0.0	38
20	22	0.0	48
19	23	0.0	58
18	24		
17	25		
16	26		
15	27		
14	29		
13	31		
12	32		
11	34		
10	40		
10	58		

In late summer 2006 the lake formed a 22-foot thick thermocline from 10 to 32 feet. Dissolved oxygen was adequate to support fish life above 15 feet. The lake started to run out of dissolved oxygen at ten feet, the top of the thermocline. It ran out of dissolved oxygen at 18 feet, and that condition remained to the bottom. About 21 percent of the lake is deeper than 18 feet.

2010

In late summer 2010 the lake formed a 24-foot thick thermocline from 10 to 34 feet. Dissolved oxygen was adequate to support fish life above 15 feet.



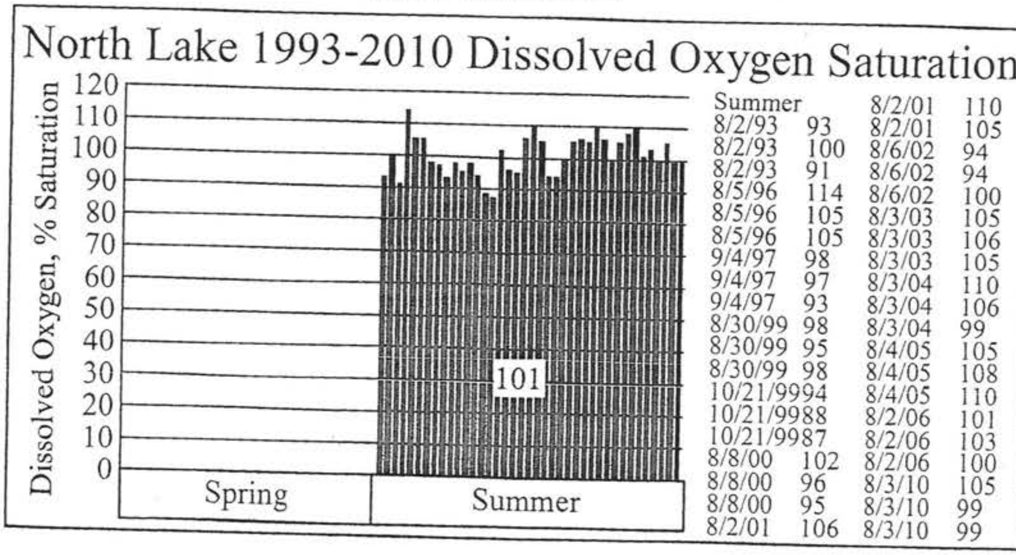
The lake started to run out of dissolved oxygen below ten feet, the top of the thermocline. It ran out of dissolved oxygen at 19 feet, and that condition remained to the bottom. About 20 percent of the lake is deeper than 19 feet.

The fact that the lake is running out of dissolved oxygen in late summer at about the same depth each year is good. If it was running out of dissolved oxygen at shallower and shallower depths as the years passed, that would indicate a problem.

A NOTE ABOUT THE GRAPHS WHICH FOLLOW

The data on the graphs below are first sorted by spring and summer, then by date, and finally sample station. The purpose of this is to detect differences between the spring and summer data over time. The average for each data set is on the bars.

DISSOLVED OXYGEN SATURATION

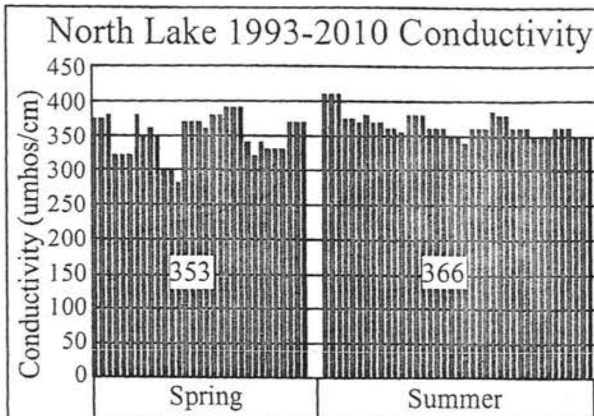


Because the amount of oxygen dissolved in water varies with temperature, with cold water holding more than warm water, dissolved oxygen saturation is often a better way to determine if dissolved oxygen supplies are adequate.

The graph shows late summer dissolved oxygen saturation ranges from 87 to 114 percent, and average 101 percent, which is good. 2010 dissolved oxygen saturation values were good, ranging from 99 to 105 percent.

CONDUCTIVITY

Conductivity, measured with a meter, detects the capacity of a water to conduct an electric current. More importantly however, it measures the amount of materials (salts) dissolved in the water, since only dissolved materials will permit an electric current to flow. Theoretically, pure water will not conduct an electric current. It is the perception of the experts that poor quality water has more dissolved materials than good quality water. I agree. Lower is usually better.

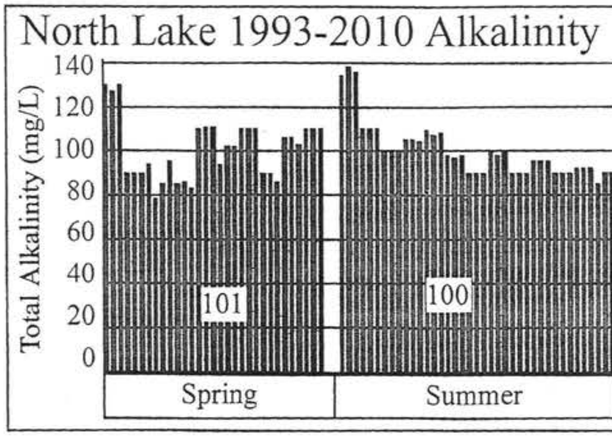


Spring		3/28/03	380	8/5/96	375	8/6/02	360
5/5/93	375	5/27/03	390	8/5/96	370	8/3/03	385
5/5/93	375	5/27/03	390	9/4/97	380	8/3/03	380
5/5/93	380	5/27/03	390	9/4/97	370	8/3/03	380
4/12/97	320	5/23/05	340	9/4/97	370	8/3/04	360
4/12/97	320	5/23/05	320	8/30/99	360	8/3/04	360
4/12/97	320	5/23/05	340	8/30/99	360	8/3/04	360
3/28/00	380	5/21/06	330	8/30/99	355	8/4/05	350
5/6/00	350	5/21/06	330	10/21/99	380	8/4/05	350
5/6/00	360	5/21/06	330	10/21/99	380	8/4/05	350
5/6/00	350	5/20/10	370	10/21/99	380	8/2/06	360
4/28/01	300	5/20/10	370	8/8/00	360	8/2/06	360
4/28/01	300	5/20/10	370	8/8/00	360	8/2/06	360
4/28/01	280			8/8/00	360	8/3/10	350
6/4/02	370	Summer		8/2/01	350	8/3/10	350
6/4/02	370	8/2/93	410	8/2/01	350	8/3/10	350
6/4/02	370	8/2/93	410	8/2/01	340		
3/28/03	360	8/2/93	410	8/6/02	360		
3/28/03	380	8/5/96	375	8/6/02	360		

The graph shows spring conductivities of North Lake range from 280 to 390 micromhos per centimeter and average 353 umhos/cm while summer conductivities range from 340 to 410 umhos/cm and average 366 umhos/cm. These are normal conductivities for a Michigan moderately hard water inland lake. The data does not show salts are building up in North Lake. If they were, conductivities would be much higher, usually above 650 micromhos per centimeter. The graph seems to show summer conductivities are decreasing, which is good. Spring values are a lot more variable, but there does not appear to be any noticeable trend.

TOTAL ALKALINITY

Alkalinity measures carbonates and bicarbonates in water. Soft water lakes have alkalinities below 75 milligrams per liter. Moderately hard water lakes have alkalinities between 75 and 150 milligrams per liter. Hard water lakes have alkalinities above 150 milligrams per liter.



Spring		3/28/03	102	8/5/96	110	8/6/02	99
5/5/93	130	5/27/03	110	8/5/96	110	8/3/03	90
5/5/93	127	5/27/03	110	9/4/97	100	8/3/03	90
5/5/93	130	5/27/03	110	9/4/97	100	8/3/03	90
4/12/97	90	5/23/05	90	9/4/97	100	8/3/04	95
4/12/97	90	5/23/05	90	8/30/99	105	8/3/04	95
4/12/97	90	5/23/05	86	8/30/99	105	8/3/04	95
3/28/00	94	5/21/06	106	8/30/99	104	8/4/05	90
5/6/00	78	5/21/06	106	10/21/99	109	8/4/05	90
5/6/00	85	5/21/06	103	10/21/99	107	8/4/05	90
5/6/00	95	5/20/10	110	10/21/99	108	8/2/06	92
4/28/01	85	5/20/10	110	8/8/00	98	8/2/06	92
4/28/01	86	5/20/10	110	8/8/00	97	8/2/06	92
4/28/01	83			8/8/00	98	8/3/10	85
6/4/02	110	Summer		8/2/01	90	8/3/10	90
6/4/02	111	8/2/93	134	8/2/01	90	8/3/10	90
6/4/02	111	8/2/93	138	8/2/01	90		
3/28/03	94	8/2/93	136	8/6/02	99		
3/28/03	102	8/5/96	110	8/6/02	98		

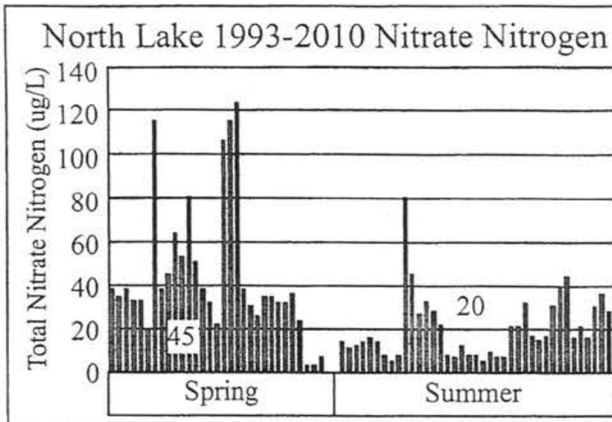
The graph shows the spring alkalinity of North Lake ranges from 78 to 130 milligrams per liter and averages 101 mg/L. Summer alkalinities range from 85 to 138 mg/L and average 100 mg/L. Based on these data, North Lake is a moderately hard water lake.

Usually spring alkalinities are higher than summer alkalinities due to the fact that carbonates and bicarbonates (which are what the alkalinity test measures) precipitate to the bottom sediments as the water warms. That doesn't seem to be the case in North Lake. The graph shows summer alkalinities are decreasing. Spring alkalinities are more variable but do not show any specific trend.

Hard water lakes are tougher than soft water lakes because they have the ability to precipitate some phosphorus to the bottom sediments as calcium phosphate. This process pretty effectively ties up that phosphorus in the deeper parts of the lake.

NITRATE NITROGEN

Most Michigan inland lakes have spring nitrate nitrogen concentrations around 200 micrograms per liter (or parts per billion). Summer nitrate nitrogen concentrations are generally much lower, in the 10 to 40 micrograms per liter range.



Spring		3/28/03	123	8/5/96	16	8/6/02	7
5/5/93	38	5/27/03	38	8/5/96	14	8/3/03	21
5/5/93	35	5/27/03	30	9/4/97	8	8/3/03	21
5/5/93	38	5/27/03	26	9/4/97	5	8/3/03	32
4/12/97	33	5/23/05	35	9/4/97	8	8/3/04	17
4/12/97	33	5/23/05	35	8/30/99	81	8/3/04	15
4/12/97	20	5/23/05	32	8/30/99	45	8/3/04	17
3/28/00	115	5/21/06	32	8/30/99	27	8/4/05	31
5/6/00	38	5/21/06	36	10/21/99	33	8/4/05	40
5/6/00	45	5/21/06	24	10/21/99	28	8/4/05	44
5/6/00	64	5/20/10	3	10/21/99	22	8/2/06	16
4/28/01	53	5/20/10	3	8/8/00	8	8/2/06	21
4/28/01	81	5/20/10	7	8/8/00	7	8/2/06	16
4/28/01	51			8/8/00	12	8/3/10	30
6/4/02	38	Summer		8/2/01	8	8/3/10	36
6/4/02	32	8/2/93	14	8/2/01	8	8/3/10	28
6/4/02	22	8/2/93	11	8/2/01	5		
3/28/03	106	8/2/93	12	8/6/02	9		
3/28/03	115	8/5/96	14	8/6/02	7		

North Lake spring nitrate nitrogen concentrations range from 5 to 123 micrograms per liter and average 45 ug/L while summer nitrates are lower, ranging from 7 to 81 ug/L and average 20 ug/L. The graph shows the data. These are low nitrate nitrogen concentrations in spring and normal nitrate nitrogen concentrations in summer for a Michigan inland lake. These data indicate North Lake is probably nitrogen limited in both spring and summer. That means no fertilizers containing either nitrogen or phosphorus should be used on near-lake areas.

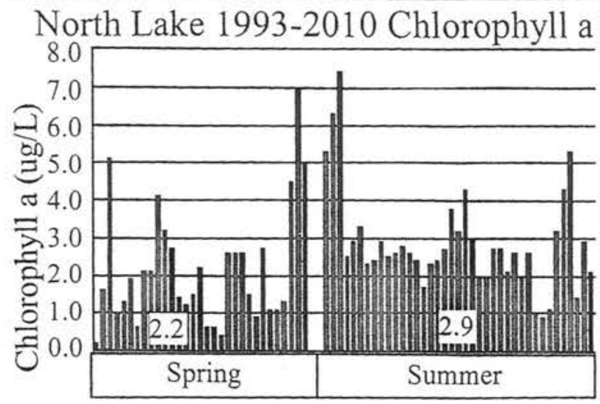
Although the DNR/DEQ recommends only limiting the amount of phosphorus entering the lake, I recommend limiting both nitrogen and phosphorus. The reason for this is aquatic plants generally have root systems which penetrate the sediments, and most lake sediments in Michigan are phosphorus-rich. Because of that, limiting the amount of phosphorus which enters the lake will do little good when trying to control aquatic plants. In this case nitrogen is the nutrient which needs to be limited because aquatic plants must get this from the water, not the bottom sediments.

CHLOROPHYLL A

Chlorophyll a, reported in micrograms per liter (or parts per billion), generally gives an estimate of algal densities. Best is below 1 microgram per liter.

Spring North Lake chlorophylls range from 0.2 to 7.0 ug/L and average 2.2

ug/L, while summer chlorophylls range from 0.9 to 7.4 ug/L and average 2.9 ug/L. These data indicate North Lake has small algal blooms in spring and larger ones in summer. Most chlorophyll a concentrations are in the 1 to 3 micrograms per liter range. In summer 1993 the lake had a significant bloom (chlorophyll a concentrations = 5.3 to 7.4 ug/L). Conditions have improved since that time.



Spring		3/28/03	0.4	8/5/96	2.9	8/6/02	2.0
5/5/93	0.2	5/27/03	2.6	8/5/96	3.3	8/3/03	2.7
5/5/93	1.6	5/27/03	2.6	9/4/97	2.3	8/3/03	2.7
5/5/93	5.1	5/27/03	2.6	9/4/97	2.4	8/3/03	2.1
4/12/97	1.0	5/23/05	1.5	9/4/97	2.9	8/3/04	2.6
4/12/97	1.3	5/23/05	0.9	8/30/99	2.5	8/3/04	2.0
4/12/97	1.9	5/23/05	2.7	8/30/99	2.6	8/3/04	2.6
3/28/00	0.6	5/21/06	1.1	8/30/99	2.8	8/4/05	1.0
5/6/00	2.1	5/21/06	1.1	10/21/99	2.6	8/4/05	0.9
5/6/00	2.1	5/21/06	1.3	10/21/99	2.4	8/4/05	1.1
5/6/00	4.1	5/20/10	4.5	10/21/99	1.7	8/2/06	3.2
4/28/01	3.2	5/20/10	7.0	8/8/00	2.3	8/2/06	4.3
4/28/01	2.7	5/20/10	5.0	8/8/00	2.4	8/2/06	5.3
4/28/01	1.4			8/8/00	2.7	8/3/10	1.4
6/4/02	1.2	Summer		8/2/01	3.8	8/3/10	2.9
6/4/02	1.5	8/2/93	5.3	8/2/01	3.2	8/3/10	2.1
6/4/02	2.2	8/2/93	6.3	8/2/01	4.3		
3/28/03	0.6	8/2/93	7.4	8/6/02	3.0		
3/28/03	0.6	8/5/96	2.5	8/6/02	2.0		

In 2010 spring chlorophylls as a group were the highest so far, 4.5 to 7.0.ug/L. Summer 2010 chlorophylls were lower, ranging from 1.4 to 2.9 ug/L.

pH (Hydrogen ion concentration) (no graph)

pH has traditionally been a measure of water quality. Today it is an excellent indicator of the effects of acid rain on lakes. About 99% of the rain events in southeastern Michigan are below a pH of 5.6 and are thus considered acid. However, there seems to be no lakes in southern Michigan which are being affected by acid rain. Most lakes have pH values between 7.5 and 9.0.

pH values ranged from 7.4 to 8.9. These are normal values for a southern Michigan inland lake.

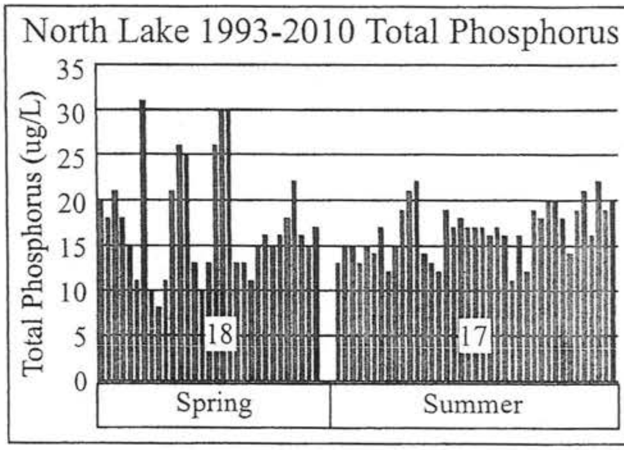
Lakes with extensive plant communities often have high summer pH values (greater than 9) because the plants use the carbonates and bicarbonates in the water as a carbon source. This causes a decrease in the buffering capacity of the water, and allows the pH to rise.

TOTAL PHOSPHORUS

Although there are several forms of phosphorus found in lakes, the experts selected total phosphorus as being most important. This is probably because all forms of phosphorus can be converted to the other forms. Currently, most lake scientists feel phosphorus, which is measured in parts per billion or micrograms per liter (ug/L), is the one nutrient which might be controlled. If its addition to lake water could be limited, the lake might not become covered with the algal communities so often found in eutrophic lakes.

However, based on our studies of many Michigan inland lakes, we've found many lakes were phosphorus limited in spring (so don't add phosphorus) and nitrate limited in summer (so don't add nitrogen).

10 parts per billion is considered a low concentration of phosphorus in a lake and 50 parts per billion is considered a high value in a lake by many limnologists.



Spring		3/28/03	30	8/5/96	15	8/6/02	16
5/5/93	20	5/27/03	13	8/5/96	14	8/3/03	11
5/5/93	18	5/27/03	13	9/4/97	17	8/3/03	16
5/5/93	21	5/27/03	11	9/4/97	12	8/3/03	12
4/12/97	18	5/23/05	15	9/4/97	15	8/3/04	19
4/12/97	15	5/23/05	16	8/30/99	19	8/3/04	18
4/12/97	11	5/23/05	15	8/30/99	21	8/3/04	20
3/28/00	31	5/21/06	16	8/30/99	22	8/4/05	20
5/6/00	10	5/21/06	18	10/21/99	14	8/4/05	18
5/6/00	8	5/21/06	22	10/21/99	13	8/4/05	14
5/6/00	11	5/20/10	16	10/21/99	12	8/2/06	19
4/28/01	21	5/20/10	15	8/8/00	19	8/2/06	21
4/28/01	26	5/20/10	17	8/8/00	17	8/2/06	16
4/28/01	25			8/8/00	18	8/3/10	22
6/4/02	13	Summer		8/2/01	17	8/3/10	19
6/4/02	10	8/2/93	13	8/2/01	17	8/3/10	20
6/4/02	13	8/2/93	15	8/2/01	17		
3/28/03	26	8/2/93	15	8/6/02	16		
3/28/03	30	8/5/96	13	8/6/02	17		

The graph shows North Lake has spring phosphorus concentrations in the 8 to 31 micrograms per liter range in spring (average = 18 ug/L) and in the 11 to 22 micrograms per liter range in summer (average = 17 ug/L). Best is below 10 micrograms per liter.

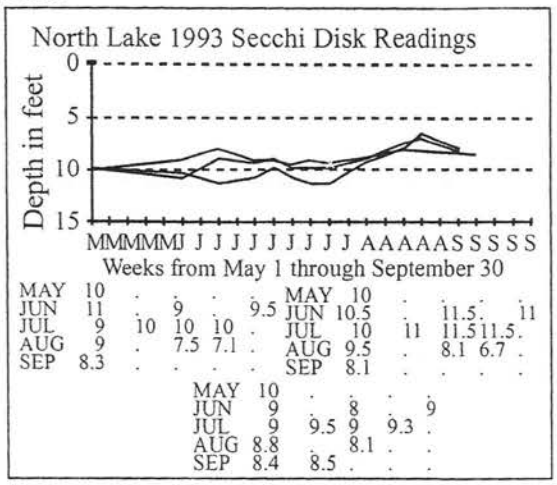
2010 spring phosphorus concentrations ranged from 15 to 17 ug/L while summer values ranged from 19 to 22 ug/L.

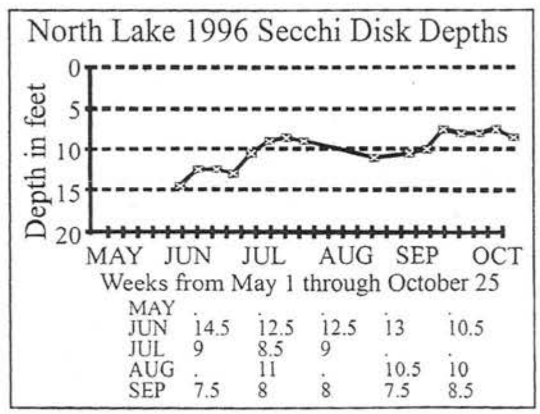
When the phosphorus concentration approaches 20 micrograms per liter, if sufficient nitrogen is present, algal blooms will occur. This is why it is important to not only limit the amount of phosphorus, but also the amount of nitrogen. In other words, no fertilizers containing either nitrogen or phosphorus should be applied to near-lake areas. How close? The farther the better.

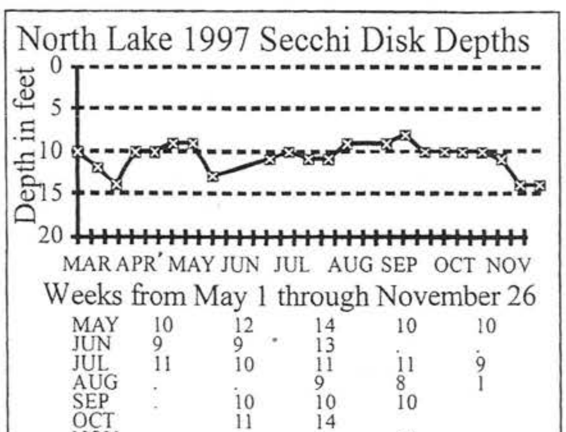
NORTH LAKE SECCHI DISK DATA

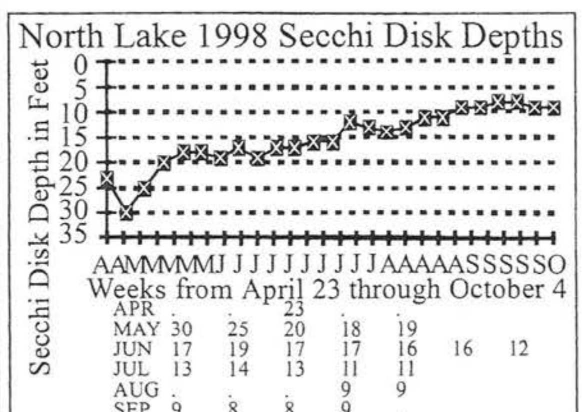
Dr. Charlie Taylor did a good job taking Secchi disk readings through the warm months in 1997, 1998, 1999, 2000 and 2005. David Pruess collected Secchi disk data in 2010. The graphs below show their data. No Secchi disk data were received for 2001, 2002, 2006, 2007, 2008 or 2009.

1993









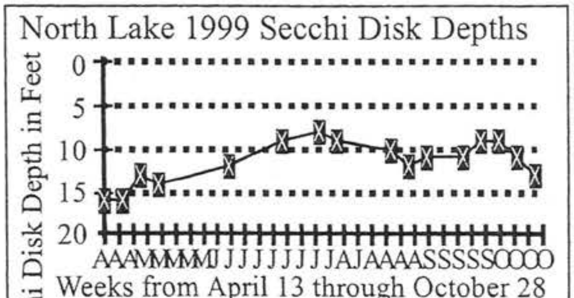
In 1993 the clarity of North Lake did not vary a lot. It ranged from a low of 7 feet in August, to a maximum of about 12 feet in June and July.

1996

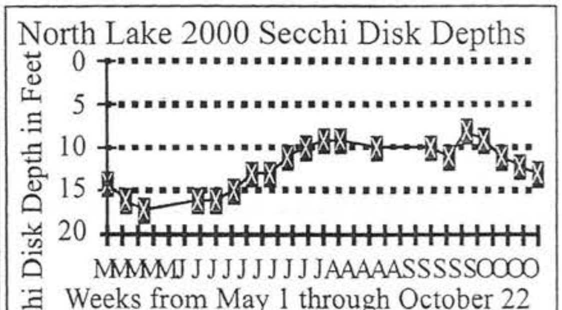
In 1996 Secchi disk readings were deepest at the end of May, 14.5 feet. The clarity of the lake decreased from that point to around ten feet through mid-September. It then decreased even more to 7-8 feet.

1997

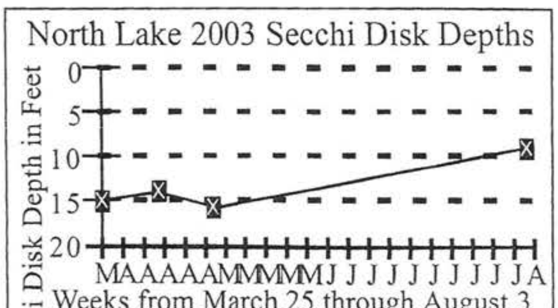
In 1997 the clarity of the lake varied from a low of eight feet in August to a maximum of 14 feet in November. The graph shows essentially a straight line, which indicates the clarity of the lake didn't change much though the warm months.



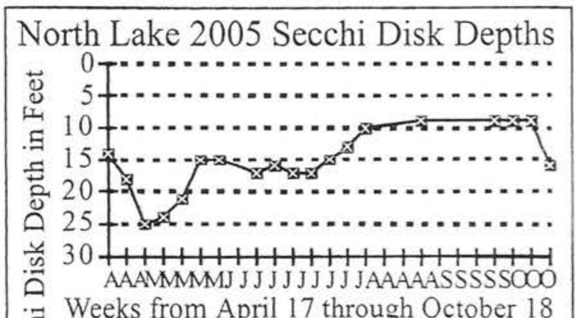
APR	.	.	16	16	.
MAY	.	.	13	14	.
JUN	.	.	12	.	.
JUL	9	.	8	9	.
AUG	.	.	10	12	11
SEP	11	9	9	.	.
OCT	.	.	11	13	.



MAY	14	16	17	.	.
JUN	16	16	15	13	13
JUL	11	10	9	9	.
AUG	10	.	.	10	11
SEP	8	.	9	.	.
OCT	11	12	13	.	.



MAR	.	.	15	.	.
APR	.	14	.	.	.
MAY	.	.	.	16	.
JUN	.	.	.	.	.
JUL	.	.	.	.	.
AUG	9	.	.	.	.



APR	.	.	14	18	.
MAY	25	24	21	15	.
JUN	15	.	17	16	
JUL	17	17	15	13	10
AUG	.	.	9	.	.
SEP	.	9	9	.	.
OCT	9	16	.	.	.

1998

1998 Secchi disk readings were the best so far, 30 feet at the beginning of May. From that point they gradually decreased to 8 and 9 feet by September.

1999

Early spring 1999 Secchi disk readings were 16 feet, about half what the early spring 1998 readings were. However as the summer continued, they decreased to between 8 and 12 feet, which was slightly better than in fall 1998. The clarity ended up at 13 feet in October.

2000

In spring 2000, Secchi disk readings were in the 14 to 17 foot range, then as the water warmed July through September, they decreased to between 9 and 11 feet. In October, they increased to a maximum of 13 feet.

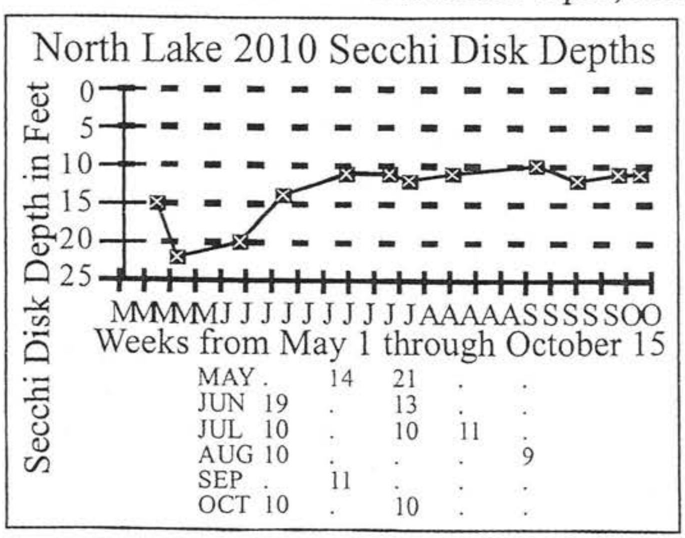
2003

In 2003 Dr. Howard Booth and WQI limnologists took Secchi disk readings. The graph shows their data. The graph shows early spring readings were 14 to 16 feet. Then in August, a single Secchi disk reading was 9 feet.

2005

Dr. Charlie Taylor took Secchi disk readings in 2005. His data are much more complete than the 2003 data, and besides being similar, sort of fill in for the missing 2003 data.

The 2005 data show 14 feet in mid-April, increasing to 25 feet the first part of May, then gradually decreasing to 9-10 feet in August and September. In the middle of October, the clarity increased to 16 feet.



2010

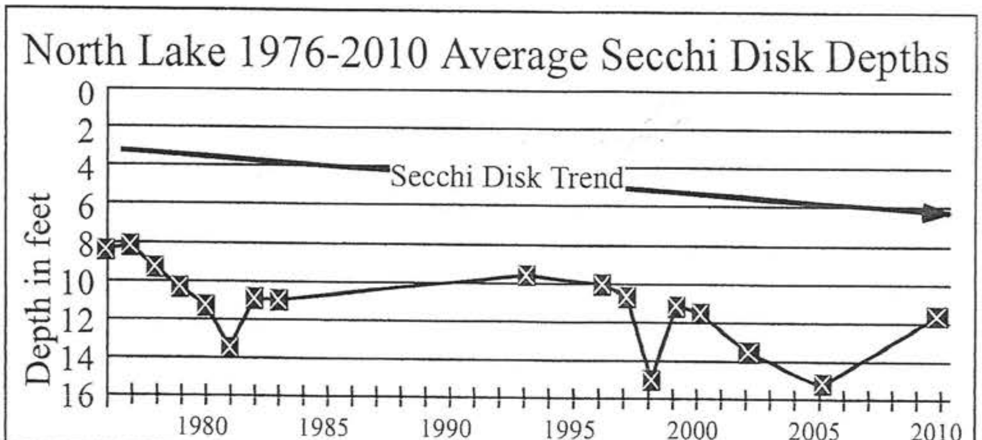
David Pruess's 2010 data show 15-foot readings in mid-May, increasing to 21 feet the end of May, then gradually decreasing to between 10 and 12 feet through the remainder of the warm months.

The graphs show Secchi disk readings generally range from about 8 to 25 feet, with the warmer months having shallower readings. However, in 1998, the Secchi disk readings went from 30 feet in early spring to eight feet in late summer. These were unusual compared to the other data. It almost seems like zebra mussels infested North Lake in 1998. The spring 2005 reading of 25 feet was also very good.

Secchi disk readings should continue being taken regularly on a weekly basis through the warm months to follow water clarity.

THE SECCHI DISK TREND GRAPH

Because North Lake residents started their Secchi disk program in 1976 we were able to construct a Secchi disk trend graph showing the average Secchi disk data collected over the years.



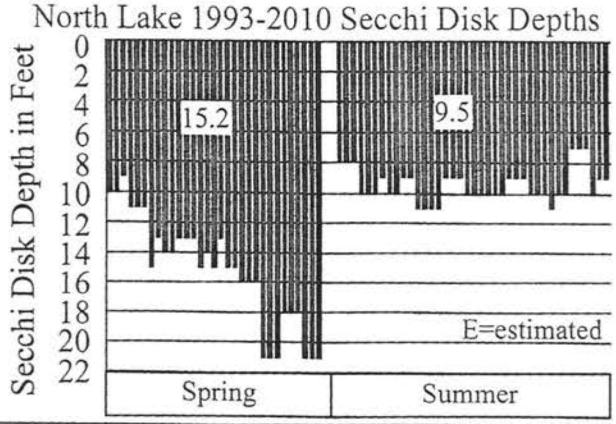
Data:								
	1976	1977	1978	1979	1980	1981	1982	1983
	8.4	8.2	9.3	10.3	11.3	13.5	10.9	11.0
1993	1996	1997	1998	1999	2000	2003	2005	2010
9.6	10.0	10.7	15.0	11.1	11.5	13.5	15.4	11.9

The graph shows the trend for North Lake through 2005 was to clearer water. However the average Secchi disk readings decreased significantly in 2010 to 11.9 feet. Unfortunately we were missing 2006 through 2009 data.

SECCHI DISK READINGS TAKEN WITH THE SAMPLES

The graph shows the Secchi disk readings taken with the samples. In spring

2006 no Secchi disk data were received so they were estimated. The graph shows in spring the water is getting clearer as years pass. That's a plus. It



Spring		3/28/03	15	8/5/96	10	8/6/02	10
5/5/93	10	5/27/03	16	8/5/96	10	8/3/03	9
5/5/93	10	5/27/03	16	9/4/97	9	8/3/03	9
5/5/93	9	5/27/03	16	9/4/97	10	8/3/03	9
4/12/97	11	5/23/05	21	9/4/97	10	8/3/04	10
4/12/97	11	5/23/05	21	8/30/99	9	8/3/04	10
4/12/97	11	5/23/05	21	8/30/99	9	8/3/04	10
3/28/00	15	5/21/06	18	8/30/99	11	8/4/05	11
5/6/00	13	5/21/06	18	10/21/99	11	8/4/05	10
5/6/00	14	5/21/06	18	10/21/99	11	8/4/05	10
5/6/00	14	5/20/10	21	10/21/99	11	8/2/06	7
4/28/01	13	5/20/10	21	8/8/00	9	8/2/06	7
4/28/01	13	5/20/10	21	8/8/00	9	8/2/06	7
4/28/01	13			8/8/00	9	8/3/10	10
6/4/02	15	Summer		8/2/01	10	8/3/10	9
6/4/02	14	8/2/93	8	8/2/01	10	8/3/10	9
6/4/02	15	8/2/93	8	8/2/01	10		
3/28/03	13	8/2/93	8	8/6/02	10		
3/28/03	15	8/5/96	10	8/6/02	10		

would be better if the summer data showed the same. In late summer 2006 Secchi disk readings were the shallowest (7 feet) we've seen since we started sampling the lake.

THE LAKE WATER QUALITY INDEX

The Lake Water Quality Index used in this study to define the water quality of North Lake was developed for two reasons. First, there was no agreement among lake scientists regarding which tests should be used to define the water quality of lakes, and second, there was no agreement among lake scientists regarding what the results of various tests meant in terms of lake water quality.

Development of the index involved the use of two questionnaires sent to a panel of 555 lake scientists who were members of the American Society of Limnology and Oceanography. The panel was specifically selected because they were chemists and biologists with advanced degrees who studied lake water quality.

The first questionnaire asked the scientists to select tests which they felt should be used to define lake water quality. The tests most often selected by the panel became the index parameters (or tests). They were:

Dissolved oxygen (percent saturation)
Total phosphorus
Chlorophyll a
Secchi disk depth
Total alkalinity
Temperature
Conductivity

Total nitrate nitrogen pH

The second questionnaire, sent out after the first was returned, asked the scientists what the results of the tests they selected as good indicators of lake water quality meant.

After the responses to the second questionnaire were returned and tabulated, the nine parameters and the accompanying rating curves were combined into a Lake Water Quality Index.

The index ranges from 1 to 100 and rates lakes about the same way professors rate students: 90-100=A, 80-90=B, 70-80=C, 60-70=D, and below 60 = E. The lake with the highest LWQI was Long Lake in Grand Traverse County, with a spring LQWI of 100. The lowest was 16 at an Ottawa County lake.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

The Lake Water Quality Index calculation sheets which follow were developed to show graphically what the results of the nine different lake water quality tests mean in terms of lake water quality.

HOW TO READ THE LAKE WATER QUALITY INDEX CALCULATION SHEETS.

Listed across the top of the calculation sheets are the tests selected by the panel of experts as being good indicators of lake water quality. The results of the tests are entered into the square boxes immediately under the names of the tests.

The figures which look like thermometers are actually graphs which convert the test results (the numbers found outside the thermometer) to a uniform 1-100 lake water quality rating (found inside the thermometer).

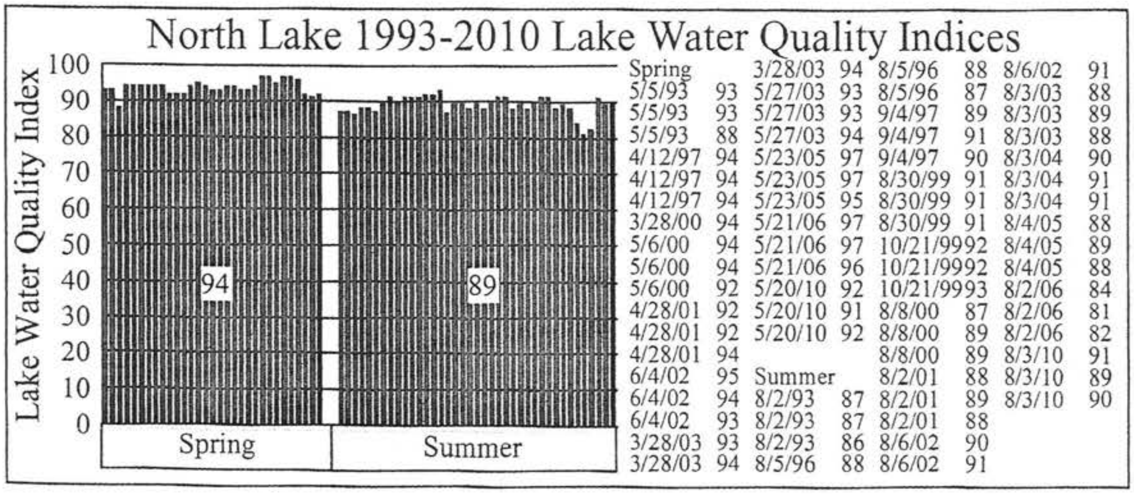
The calculation sheet permits calculation of the Lake Water Quality Index, using the results of all nine lake water quality tests.

The position of the red lines across the thermometer indicates how the results of each test compare in terms of lake water quality. Test results indicating excellent water quality are indicated by red lines near the top of the thermometer. Test results indicating poor water quality are indicated by red lines lower on the thermometer. And the lower the red line on the thermometer, the greater the water quality problem. A glance at the top of the calculation sheet indicates the test and the actual test results.

The thermometer rating scales also allow you to determine what test results would be considered excellent in terms of lake water quality. They are the numbers found outside the thermometer near the top.

The index is shown three different ways, as a number between 1 and 100 in the circle marked LWQI, and by a color and position on the sheet edge scale. The purpose of the sheet edge scale is to review quickly large numbers of lakes or test sites within a lake, and determine how the water quality of the various lakes, or test sites within a lake compare.

NORTH LAKE 1993-2010 LAKE WATER QUALITY INDICES



The graph shows spring Lake Water Quality Indices for North Lake ranged from 88 to 97 (average = 94) at the three sample stations. This means the water quality of the lake in spring was in the B to A range. Summer LWQIs ranged from 81 to 93 (Average = 89), also in the B to A range.

The graph shows the water quality of North Lake in spring is better than the water quality in summer. Summer 2006 LWQIs were the worse so far, ranging from 81 to 84, or in the low B range. Spring 2006 LWQIs were among the highest, 96 and 97, or in the A range.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

Because the spring Lake Water Quality Indices for North Lake in 2010 were relatively uniform (92 91 92), and the 2010 summer Lake Water Quality Indices for North Lake were also relatively uniform (91 89 90), only two Lake Water Quality Index calculation sheets are included in this report, one for the three 2010 spring surface samples, using averaged data, and a second for the three summer 2010 surface samples, using averaged data.

In the report marked MASTER, all 6 of the LWQI calculation sheets are included. That is the only difference between the MASTER and the rest of the reports.

BOTTOM SEDIMENTS

Many times bottom sediments tell us more about what is happening in a lake than the water quality tests do. That's because bottom sediments provide sort of a history of what's been happening in a lake, while water testing just provides a snapshot.

Bottom sediments are collected with a Pederson dredge, transferred to pint freezer containers and allowed to air dry. Once they are dry, the (usually) shrunken block of material is measured to determine volume, then ground, placed in porcelain dishes, dried at 100 degrees C, weighed, burned at 550 degrees C, and weighed again. Color after air-drying and after burning is also noted.

Bottom sediments almost always come up from the lake bottom black, and many people consider these black sediments "muck".
However that's not usually the case. The bottom sediments are black because no oxygen penetrates them, so the decomposition processes which occur use sulfur rather than oxygen, and in this process, iron sulfides, which are black, are produced. However once the sediments are exposed to air, they usually turn some other color.

If the sediments remain black after air drying it usually means they are less than about 65 percent mineral (or more than 35% organic material). Sediments also remain black if they are from soft water lakes, but there's a reason for that.

If the sediments turn gray after air drying it usually means they are made up primarily of carbonates. This is what we usually see in moderately hard water and hard water lakes.

If the sediments turn tan, it usually means they are made up primarily of clays. Further evidence of this occurs when we burn the sediments at 550 degrees C.

We determine how much bottom sediments shrink when they air dry because this information is useful when considering dredging a lake. Normal shrinkage after air-drying is in the range of 50 to 80 percent. However sands and gravels don't shrink at all. Excessive shrinkage is more than 95 percent. In other words, there is only five percent or less of the material remaining after air-drying.

If gray bottom sediments remain gray after burning they are considered carbonates, and the loss of material during this process is considered organic material. The results are expressed in the percentage of minerals in the bottom sediments.

If the tan bottom sediments turn red after burning, it means the lake is filling with clay. Clay enters the lake from near-lake activities such as road building, home building or farming. Usually clay is not a material that makes up the bottom sediments of most inland lakes.

Highly organic sediments that remained black after air drying usually turn tan after burning, but the mineral content is usually quite low.

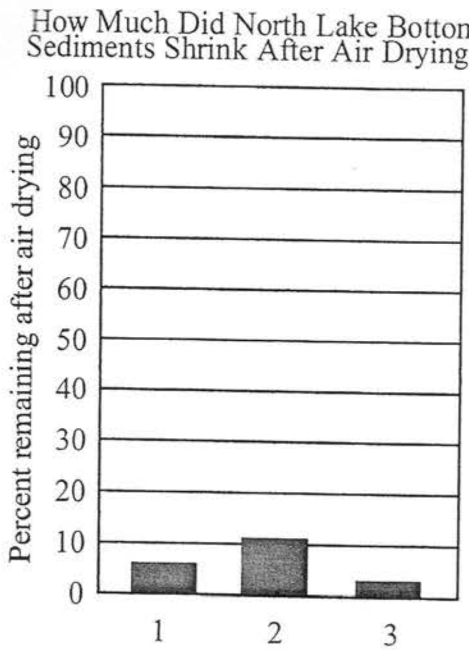
I consider high quality bottom sediments from natural hard water lakes to be above 85 percent mineral. And I consider bottom sediments less than 50 percent mineral to be muck.

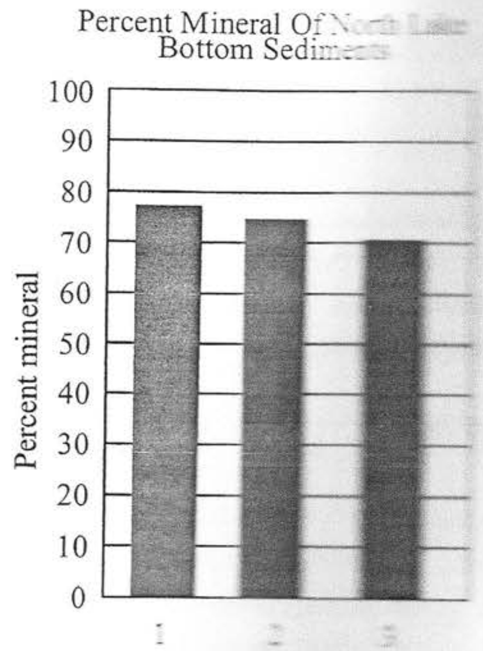
On the other hand, softwater lakes which have few carbonates and bicarbonates, often have highly organic bottom sediments. It would be better if they did not have lots of organic material in the bottom sediments. A source of these organics are algal blooms which occur in the lake.

NORTH LAKE BOTTOM SEDIMENTS

Three bottom sediment samples were collected at the sample stations shown on the map in late summer 1996.

The sample from Station 1, collected in 16 feet of water was black when recovered, remained black after air-drying and turned light red after burning at 550 degrees C. It shrunk 94 percent, and was 78 percent mineral.





Sample stations

Characteristics of North Lake Bottom Sediments (1996)

Sample I.D.	Percent Shrinkage	Percent Mineral	Dried at 100°C Color & Description	Color after burning at 550°C	Depth of water (feet)
1	94	78	Black smooth	Lite red	16
2	89	74	Black smooth	Lite red	57
3	98	70	Black smooth	Red gray	14

74 percent = average mineral content of bottom sediments

The sample from Station 2, collected in 57 feet of water was black when recovered, remained black after air-drying and turned light red after burning at 550 degrees C. It shrunk 89 percent, and was 74 percent mineral.

The sample from Station 3, collected in 14 feet of water was black when recovered, remained black after air-drying and turned red gray after burning at 550 degrees C. It shrunk 98 percent, and was 70 percent mineral.

The bottom sediment samples shrunk a lot, 94, 89 and 98 percent. This means they were light and fluffy and easily mixed into the water column by wind, wave and/or boat action. All remained black after air-drying.

The mineral content of the sediments ranged from 70 to 78 percent, and averaged 74 percent. These data show organic material is building up in the bottom sediments of North Lake at a faster than normal rate.

All samples turned red after burning at 550 degrees C. This indicates the presence of clay in the bottom sediments. Clay is not a normal constituent of bottom sediments. It is usually washed into the lake by near-shore activities such as home building, farming or road building.

COMMENTS AND OBSERVATIONS

The lake appears to be nitrate rather than phosphorus limited in both spring and summer. At least that's what the data shows. That means no fertilizers containing either nitrogen or phosphorus should be used in the near-lake areas, and by near-lake areas, I mean no closer than 400 feet from the lake.

Secchi disk readings should continue being taken on a weekly basis at a single station in the middle of the lake through the warm months to follow changes in water clarity if that occurs.

Organic materials are starting to build up in the bottom sediments of the lake. Residents should make every effort to prevent this from happening, because if they can prevent the build-up of organic material in the bottom sediments, they are doing everything else right.

Long term Secchi disk data seems to show the lake is getting clearer,in spring but not in summer.

Wallace E Fusilier

Wallace E. Fusilier, Ph.D.
Consulting Limnologist
Water Quality Investigators

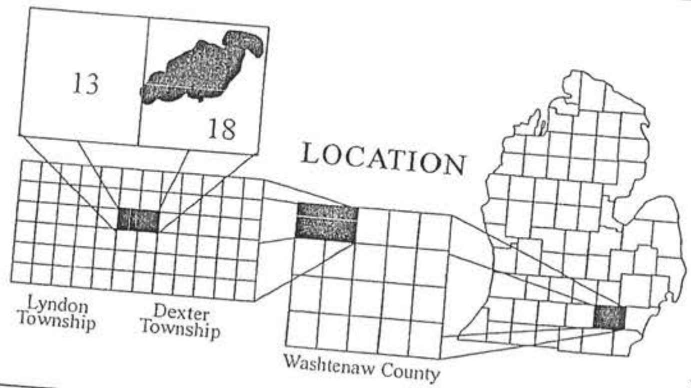
Dexter, Michigan
June 2011

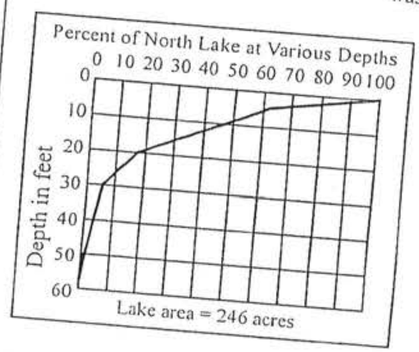
Surface Lake Water Quality Data E = estimated

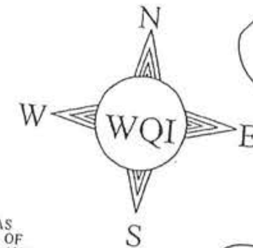
Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
5/5/93	1	---	---	---	0.2	10	38	130	8.3	375	20	93	A
5/5/93	2	---	---	---	1.6	10	35	127	8.2	375	18	93	A
5/5/93	3	---	---	---	5.1	9	38	130	8.2	380	21	88	B
8/2/93	1	25	7.8	93	5.3	8	14	134	8.2	410	13	87	B
8/2/93	2	24	8.5	100	6.3	8	11	138	8.2	410	15	87	B
8/2/93	3	24	7.7	91	7.4	8	12	136	8.1	410	15	86	B
8/5/96	1	29	9.0	114	2.5	10	14	110	8.4	375	13	88	B
8/5/96	2	29	8.3	105	2.9	10	16	110	8.4	375	15	88	B
8/5/96	3	29	8.3	105	3.3	10	14	110	8.4	370	14	87	B
4/12/97	1	---	---	---	1.0	11	33	90	7.6	320	18	94	A
4/12/97	2	---	---	---	1.3	11	33	90	7.4	320	15	94	A
4/12/97	3	---	---	---	1.9	11	20	90	7.4	320	11	94	A
9/4/97	1	21	8.8	98	2.3	9	8	100	8.7	380	17	89	B
9/4/97	2	21	8.7	97	2.4	10	5	100	8.6	370	12	91	A
9/4/97	3	21	8.4	93	2.9	10	8	100	8.6	370	15	90	A
8/30/99	1	24	8.3	98	2.5	9	81	105	8.3	360	19	91	A
8/30/99	2	23	8.3	95	2.6	9	45	105	8.3	360	21	91	A
8/30/99	3	23	8.5	98	2.8	11	27	104	8.4	355	22	91	A
10/21/99	1	12	10.1	94	2.6	11	33	109	8.4	380	14	92	A
10/21/99	2	12	9.5	88	2.4	11	28	107	7.8	380	13	92	A
10/21/99	3	12	9.4	87	1.7	11	22	108	7.8	380	12	93	A
5/6/00	1	---	---	---	2.1	13	38	78	7.6	350	10	94	A
5/6/00	2	---	---	---	2.1	14	45	85	7.6	360	8	94	A
5/6/00	3	---	---	---	4.1	14	64	95	7.8	350	11	92	A
8/8/00	1	26	8.4	102	2.3	9	8	98	8.9	360	19	87	B
8/8/00	2	25	8.1	96	2.4	9	7	97	8.7	360	17	89	B
8/8/00	3	25	8.0	95	2.7	9	12	98	8.7	360	18	89	B
4/28/01	1	---	---	---	3.2	13	53	85	7.6	300	21	92	A
4/28/01	2	---	---	---	2.7	13	81	86	7.5	300	26	92	A
4/28/01	3	---	---	---	1.4	13	51	83	7.7	280	25	94	A
8/2/01	1	28	8.4	106	3.8	10	8	90	8.3	350	17	88	B
8/2/01	2	28	8.7	110	3.2	10	8	90	8.3	350	17	89	B
8/2/01	3	27	8.4	105	4.3	10	5	90	8.2	340	17	88	B
6/4/02	1	---	---	---	1.2	15	38	110	8.5	370	13	95	A
6/4/02	2	---	---	---	1.5	14	32	111	8.6	370	10	94	A
6/4/02	3	---	---	---	2.2	15	22	111	8.6	370	13	93	A
8/6/02	1	27	7.5	94	3.0	10	9	99	8.2	360	16	90	A
8/6/02	2	27	7.5	94	2.0	10	7	98	8.3	360	17	91	A
8/6/02	3	27	8.0	100	2.0	10	7	99	8.2	360	16	91	A
3/28/03	1	---	---	---	0.6	13	106	94	8.0	360	26	93	A
3/28/03	2	---	---	---	0.6	15	115	102	8.2	380	30	94	A
3/28/03	3	---	---	---	0.6	15	123	102	8.2	380	30	94	A
5/27/03	1	---	---	---	2.6	16	38	110	8.6	390	13	93	A
5/27/03	2	---	---	---	2.6	16	30	110	8.6	390	13	93	A
5/27/03	3	---	---	---	2.6	16	26	110	8.6	390	11	94	A
8/3/03	1	26	8.6	105	2.7	9	21	90	8.8	385	11	88	B
8/3/03	2	26	8.7	106	2.7	9	21	90	8.7	380	16	89	B
8/3/03	3	26	8.6	105	2.1	9	32	90	8.8	380	12	88	B
8/3/04	1	28	8.7	110	2.6	10	17	95	8.5	360	19	90	A
8/3/04	2	27	8.5	106	2.0	10	15	95	8.5	360	18	91	A
8/3/04	3	26	8.1	99	2.6	10	17	95	8.5	360	20	91	A
5/23/05	1	---	---	---	1.5	21	35	90	7.5	340	15	97	A
5/23/05	2	---	---	---	0.9	21	35	90	7.2	320	16	97	A
5/23/05	3	---	---	---	2.7	21	32	86	7.2	340	15	95	A
8/4/05	1	29	8.4	105	1.0	11	31	90	8.8	350	20	88	B
8/4/05	2	28	8.5	108	0.9	10	40	90	8.7	350	18	89	B
8/4/05	3	28	8.7	110	1.1	10	44	90	8.8	350	14	88	B
5/21/06	1	---	---	---	1.1	18 E	32	106	8.5	330	16	97	A
5/21/06	2	---	---	---	1.1	18 E	36	106	8.3	330	18	97	A
5/21/06	3	---	---	---	1.3	18 E	24	103	8.4	330	22	96	A
8/2/06	1	30	7.7	101	3.2	7	16	92	8.9	360	19	84	B
8/2/06	2	29	8.0	103	4.3	7	21	92	9.0	360	21	81	B
8/2/06	3	29	7.8	100	5.3	7	16	92	8.9	360	16	82	B
5/20/10	1	---	---	---	4.5	21	3	110	8.6	370	16	92	A
5/20/10	2	---	---	---	7.0	21	3	110	8.4	370	15	91	A
5/20/10	3	---	---	---	5.0	21	7	110	8.4	370	17	92	A
8/3/10	1	28	8.3	105	1.4	10	30	85	8.4	350	22	89	A
8/3/10	2	27	7.9	99	2.9	9	36	90	8.3	350	19	89	B
8/3/10	3	27	7.7	99	2.1	9	28	90	8.3	350	20	90	A

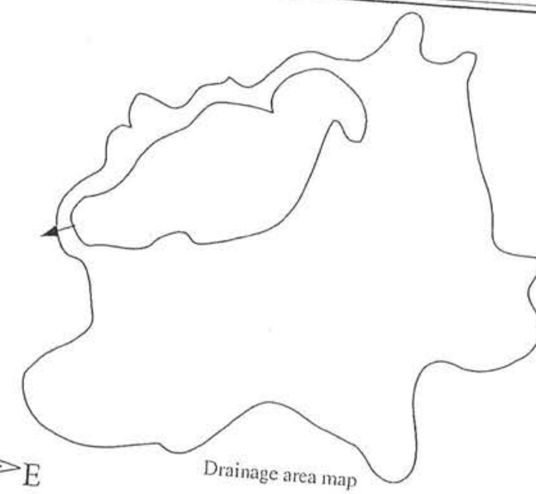
TABLE OF LAKE DATA

Lake name	North Lake
County	Washtenaw
U.S.G.S. Map	Gregory
Type of lake	Natural kettle
River basin	Huron
Lake area (acres)	246
Maximum depth (feet)	58
Mean depth (feet)	10.8
Lake volume (acre feet)	2661
Shoreline length (feet)	17518
Watershed area (acres)	952
Drainage area (acres)	1198
Watershed to lake ratio	3.87
Flushing rate	3.1 years
Elevation	938
Longest dimension (feet)	6325
Ice out date	
	3/18/99
	3/27/03
	3/26/05
Date lake mixed	4/4/98
	4/6/99
	3/28/03
Lake Water Quality Indices	
Spring 1993	
Summer 1993	93 93 88
Spring 1996	87 87 86
Summer 1996	No samples
Spring 1997	88 88 87
Summer 1997	94 94 94
Spring 1999	89 91 90
Summer 1999	No samples
Fall 1999	91 91 91
Spring 2000	92 92 93
Summer 2000	94 94 92
Spring 2001	87 89 89
Summer 2001	92 92 94
Spring 2002	88 89 88
Summer 2002	95 94 93
Spring 2003	90 91 91
Summer 2003	93 93 94
Spring 2004	88 89 88
Summer 2004	No samples
Spring 2005	90 91 91
Summer 2005	97 97 95
Spring 2006	88 89 88
Summer 2006	97 97 96
Spring 2010	84 81 82
Summer 2010	92 91 92
Bottom Sediments, % mineral	91 89 90
Latitude	78 74 70
Longitude	42° 23.641N
	84° 00.421W
Official lake monitor	David Pruess





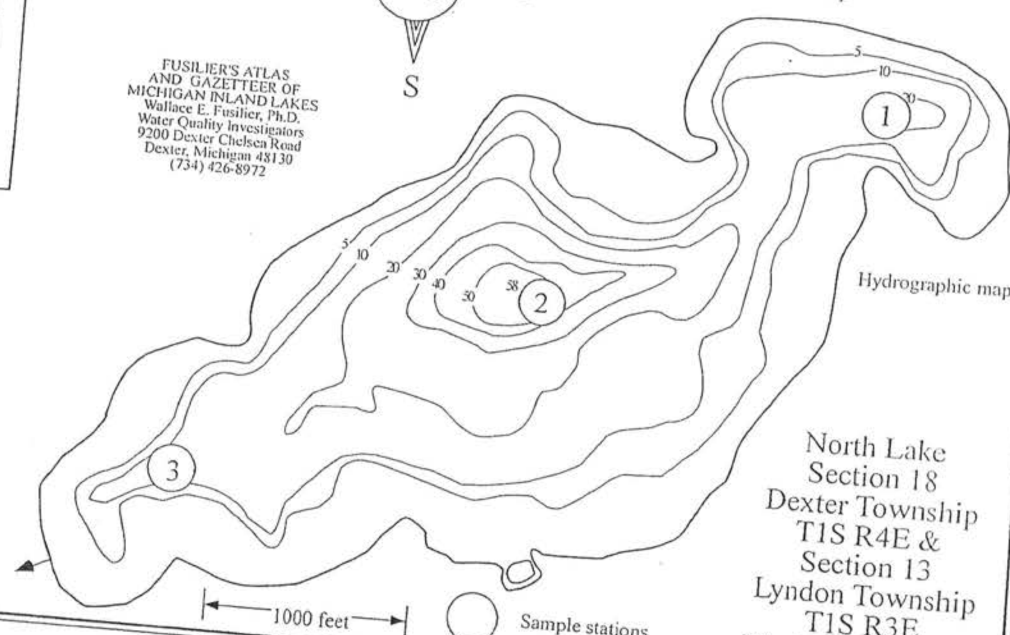




FUSILIER'S ATLAS AND GAZETTEER OF MICHIGAN INLAND LAKES
Wallace E. Fusilier, Ph.D.
Water Quality Investigators
9200 Dexter Chelsea Road
Dexter, Michigan 48130
(734) 426-8972

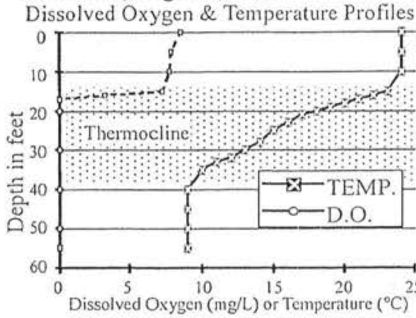
North Lake Contour Areas & Volumes

Area of various contours	Volume in Acre Feet
Lake area = 246.44 acres	
Island = .39 acres	
Surface area = 246.05 acres	
5 feet = 154.57 acres	1002
10 feet = 117.49 acres	680
20 feet = 46.31 acres	819
30 feet = 16.52 acres	63
40 feet = 8.39 acres	25
50-58 feet = 3.36 acres	59
	13
Lake volume = 2661 acre feet	



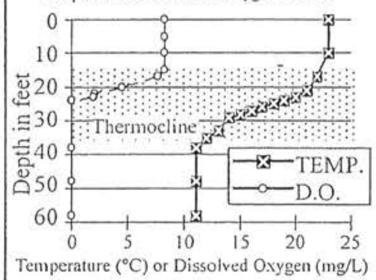
North Lake
Section 18
Dexter Township
T1S R4E &
Section 13
Lyndon Township
T1S R3E
Washtenaw County

North Lake, August 2, 1993
Dissolved Oxygen & Temperature Profiles



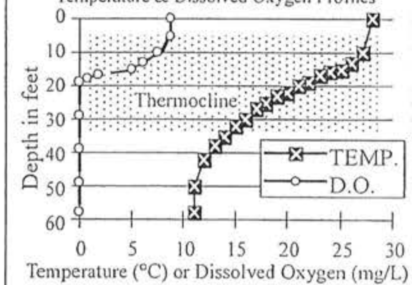
Temp.	Depth	D.O.	Depth
24	0	8.5	0
24	5	7.8	5
24	10	7.7	10
23	15	7.2	15
22	16	3.2	16
21	17	0	17
20	18	0	20
19	19	0	30
18	20	0	40
17	21	0	50
16	23	0	55
15	25		
14	28		
13	30		
12	32		
11	33		
10	35		
9	40		
9	55		

North Lake August 30, 1999
Temperature & Dissolved Oxygen Profiles



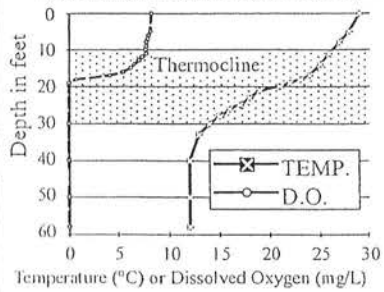
Temp.	Depth	D.O.	Depth
23	0	8.3	0
23	10	8.3	5
22	17	8.3	10
21	21	8.3	15
20	23	7.7	17
19	24	4.5	20
18	25	2.1	22
17	26	2.0	23
16	27	0.0	24
15	28	0.0	38
14	29	0.0	48
13	33	0.0	58
12	35		
11	38		
11	48		
11	58		

North Lake August 2, 2001
Temperature & Dissolved Oxygen Profiles



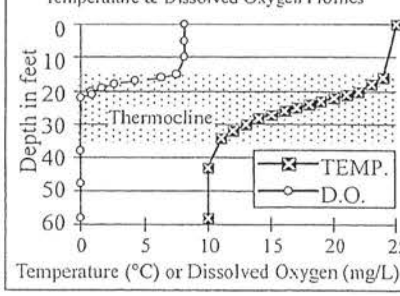
Temp.	Depth	D.O.	Depth
28	0	8.7	0
27	10	8.7	5
26	13	7.6	10
25	15	6.2	13
24	16	5.0	15
23	17	1.9	17
22	19	0.7	18
21	20	0.0	19
20	22	0.0	29
19	23	0.0	39
18	25	0.0	49
17	27	0.0	58
16	30		
15	32		
14	35		
13	38		
12	42		
11	50		
11	58		

North Lake August 6, 1996
Temperature & Dissolved Oxygen Profiles



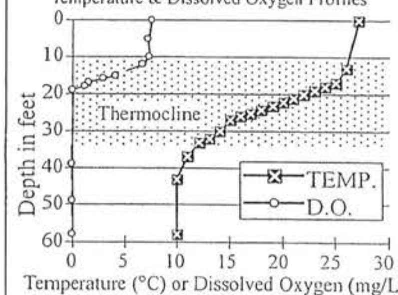
Temp.	Depth	D.O.	Depth
29	0	8.3	0
28	5	8.2	5
27	8	8.0	6
26	11	7.9	7
25	14	7.8	8
24	17	7.8	9
23	18	7.7	10
22	19	7.8	11
21	20	7.4	12
19	21	7.1	13
18	23	6.6	14
17	25	6.2	15
16	26	5.5	16
15	28	4.1	17
14	30	0.7	18
13	33	0.0	19
12	40	0.0	30
12	50	0.0	40
12	58	0.0	50
		0.0	58

North Lake August 8, 2000
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
25	0	8.1	0
24	16	8.1	5
23	18	8.1	10
22	20	7.5	15
21	21	6.3	16
20	22	4.2	17
19	23	2.6	18
18	24	1.6	19
17	25	0.8	20
16	26	0.9	21
15	27	0.0	22
14	28	0.0	38
13	30	0.0	48
12	32	0.0	58
11	34		
10	43		
10	58		

North Lake August 6, 2002
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
27	0	7.5	0
26	13	7.1	5
25	17	7.2	10
24	18	6.7	12
23	19	4.0	15
22	20	3.0	16
21	21	1.6	17
20	22	1.2	18
19	23	0.0	19
18	24	0.0	39
17	25	0.0	49
16	26	0.0	58
15	27		
14	30		
13	32		
12	33		
11	37		
10	43		
10	58		

FUSILIER'S ATLAS
AND GAZETTEER OF
MICHIGAN INLAND LAKES
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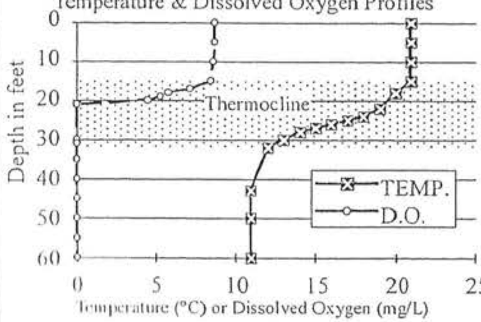
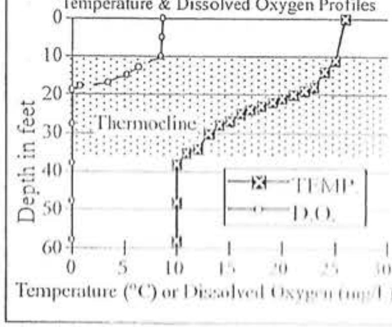
North Lake
Section 18
Dexter Township
T1S R4E &
Section 13
Lyndon Township
T1S R3E
Washtenaw County

North Lake September 5, 1997
Temperature & Dissolved Oxygen Profiles



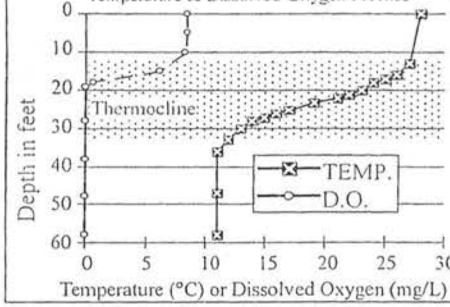
Temp.	Depth	D.O.	Depth
21	0	8.7	0
21	5	8.7	5
21	10	8.6	10
21	15	8.5	15
20	18	7.2	17
19	22	5.8	18
18	24	5.3	19
17	25	4.5	20
16	26	0.0	21
15	27	0.0	30
14	28	0.0	31
13	30	0.0	35
12	32	0.0	40
11	43	0.0	45
11	50	0.0	50
11	60	0.0	55
		0.0	60

North Lake August 3, 2003
Temperature & Dissolved Oxygen Profiles



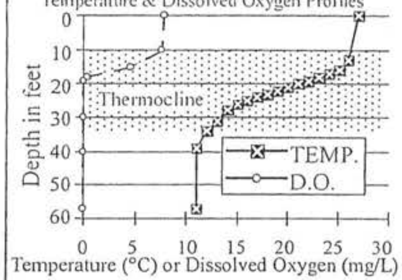
Temp.	Depth	D.O.	Depth
26	0	8.7	0
25	11	8.6	5
24	14	8.5	10
23	18	6.3	13
22	19	5.2	15
21	20	3.4	17
20	21	0.8	18
19	22	0.0	19
18	23	0.0	28
17	24	0.0	38
16	25	0.0	48
15	27	0.0	58
14	28		
13	30		
12	34		
11	35		
10	38		
10	48		
10	58		

North Lake August 4, 2005
Temperature & Dissolved Oxygen Profiles



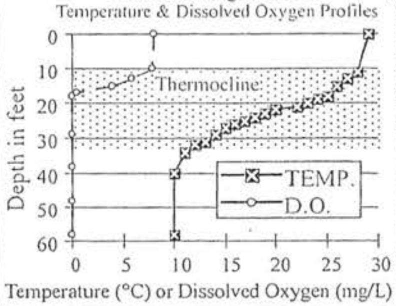
Temp.	Depth	D.O.	Depth
28	0	8.5	0
27	13	8.5	5
26	16	8.3	10
25	17	6.2	15
24	18	0.6	18
23	20	0.0	19
22	21	0.0	28
21	22	0.0	38
19	23	0.0	48
17	25	0.0	58
16	26		
15	27		
14	28		
13	30		
12	33		
11	36		
11	47		
11	58		

North Lake August 3, 2010
Temperature & Dissolved Oxygen Profiles



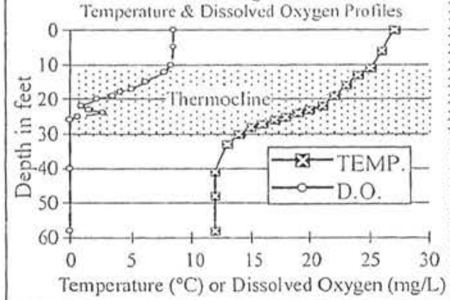
Temp.	Depth	D.O.	Depth
27	0	7.9	0
26	13	7.6	10
25	16	4.5	15
24	17	0.4	18
23	18	0.0	19
22	19	0.0	30
21	20	0.0	40
20	21	0.0	58
19	22		
18	23		
17	24		
16	25		
15	26		
14	28		
13	31		
12	34		
11	39		
11	58		

North Lake August 2, 2006
Temperature & Dissolved Oxygen Profiles



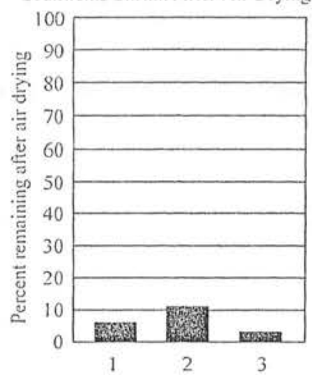
Temp.	Depth	D.O.	Depth
29	0	8.0	0
28	11	7.9	10
27	13	5.8	13
26	15	3.9	15
25	18	0.5	17
24	19	0.0	18
23	20	0.0	29
22	21	0.0	38
20	22	0.0	48
19	23	0.0	58
18	24		
17	25		
16	26		
15	27		
14	29		
13	31		
12	32		
11	34		
10	40		
10	58		

North Lake August 3, 2004
Temperature & Dissolved Oxygen Profiles

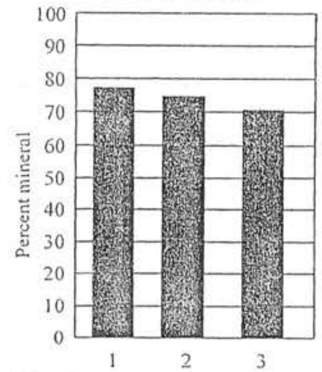


Temp.	Depth	D.O.	Depth
27	0	8.5	0
26	6	8.5	5
25	11	8.3	10
24	13	7.8	12
23	16	6.2	15
22	19	5.1	17
21	22	4.1	18
20	23	3.5	19
19	24	2.2	20
18	25	0.9	22
17	26	1.6	23
16	27	2.7	24
15	28	0.6	25
14	30	0.0	26
13	33	0.0	40
12	41	0.0	58
12	48		
12	58		

How Much Did North Lake Bottom Sediments Shrink After Air Drying?



Percent Mineral Of North Lake Bottom Sediments



Sample stations

Characteristics of North Lake Bottom Sediments

Sample I.D.	Percent Shrinkage	Percent Mineral	Dried at 100¡C Color & Description	Color after burning at 550¡C	Depth of water (feet)
1	94	78	Black smooth	Lite red	16
2	89	74	Black smooth	Lite red	57
3	98	70	Black smooth	Red gray	14

74 percent = average mineral content of bottom sediments

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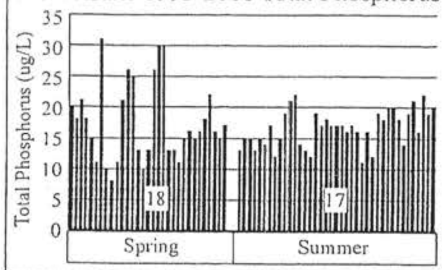
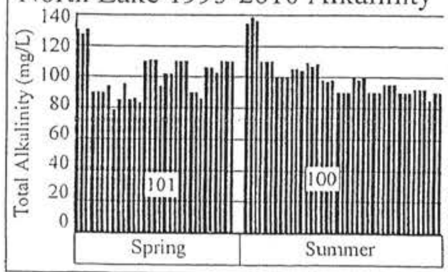
Section 13
Lyndon Township
T1S R3E
Washtenaw County

North Lake 1993-2010 Total Phosphorus



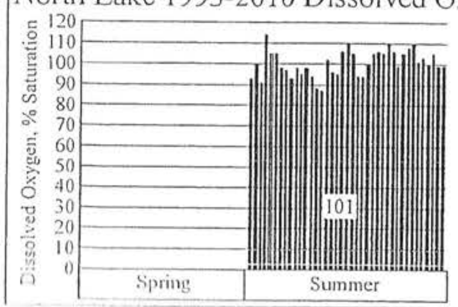
Spring		3/28/03	30	8/5/96	15	8/6/02	16
5/5/93	20	5/27/03	13	8/5/96	14	8/3/03	11
5/5/93	18	5/27/03	13	9/4/97	17	8/3/03	16
5/5/93	21	5/27/03	11	9/4/97	12	8/3/03	12
4/12/97	18	5/23/05	15	9/4/97	15	8/3/04	19
4/12/97	15	5/23/05	16	8/30/99	19	8/3/04	18
4/12/97	11	5/23/05	15	8/30/99	21	8/3/04	20
3/28/00	31	5/21/06	16	8/30/99	22	8/4/05	20
5/6/00	10	5/21/06	18	10/21/99	14	8/4/05	18
5/6/00	8	5/21/06	22	10/21/99	13	8/4/05	14
5/6/00	11	5/20/10	16	10/21/99	12	8/2/06	19
4/28/01	21	5/20/10	15	8/8/00	19	8/2/06	21
4/28/01	26	5/20/10	17	8/8/00	17	8/2/06	16
4/28/01	25			8/8/00	18	8/3/10	22
6/4/02	13	Summer		8/2/01	17	8/3/10	19
6/4/02	10	8/2/93	13	8/2/01	17	8/3/10	20
6/4/02	13	8/2/93	15	8/2/01	17		
3/28/03	26	8/2/93	15	8/6/02	16		
3/28/03	30	8/5/96	13	8/6/02	17		

North Lake 1993-2010 Alkalinity



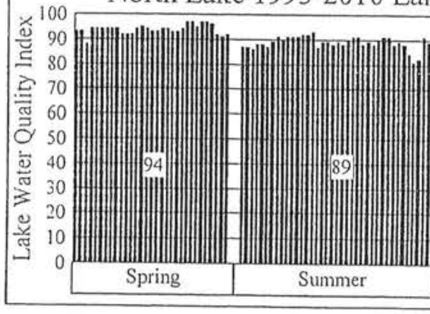
Spring		3/28/03	102	8/5/96	110	8/6/02	99
5/5/93	130	5/27/03	110	8/5/96	110	8/3/03	90
5/5/93	127	5/27/03	110	9/4/97	100	8/3/03	90
5/5/93	130	5/27/03	110	9/4/97	100	8/3/03	90
4/12/97	90	5/23/05	90	9/4/97	100	8/3/04	95
4/12/97	90	5/23/05	90	8/30/99	105	8/3/04	95
4/12/97	90	5/23/05	86	8/30/99	105	8/3/04	95
3/28/00	94	5/21/06	106	8/30/99	104	8/4/05	90
5/6/00	78	5/21/06	106	10/21/99	109	8/4/05	90
5/6/00	85	5/21/06	103	10/21/99	107	8/4/05	90
5/6/00	95	5/20/10	110	10/21/99	108	8/2/06	92
4/28/01	85	5/20/10	110	8/8/00	98	8/2/06	92
4/28/01	86	5/20/10	110	8/8/00	97	8/2/06	92
4/28/01	83			8/8/00	98	8/3/10	85
6/4/02	110	Summer		8/2/01	90	8/3/10	90
6/4/02	111	8/2/93	134	8/2/01	90	8/3/10	90
6/4/02	111	8/2/93	138	8/2/01	90		
3/28/03	94	8/2/93	136	8/6/02	99		
3/28/03	102	8/5/96	110	8/6/02	98		

North Lake 1993-2010 Dissolved Oxygen Saturation



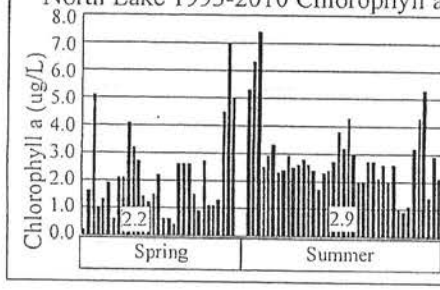
Summer		8/2/01	110
8/2/93	93	8/2/01	105
8/2/93	100	8/6/02	94
8/2/93	91	8/6/02	94
8/5/96	114	8/6/02	100
8/5/96	105	8/3/03	105
8/5/96	105	8/3/03	106
9/4/97	98	8/3/03	105
9/4/97	97	8/3/04	110
9/4/97	93	8/3/04	106
8/30/99	98	8/3/04	99
8/30/99	95	8/4/05	105
8/30/99	98	8/4/05	108
10/21/99	94	8/4/05	110
10/21/99	88	8/2/06	101
10/21/99	87	8/2/06	103
8/8/00	102	8/2/06	100
8/8/00	96	8/3/10	105
8/8/00	95	8/3/10	99
8/2/01	106	8/3/10	99

North Lake 1993-2010 Lake Water Quality Indices



Spring		3/28/03	94	8/5/96	88	8/6/02	91
5/5/93	93	5/27/03	93	8/5/96	87	8/3/03	88
5/5/93	93	5/27/03	93	9/4/97	89	8/3/03	89
5/5/93	88	5/27/03	94	9/4/97	91	8/3/03	88
4/12/97	94	5/23/05	97	9/4/97	90	8/3/04	90
4/12/97	94	5/23/05	97	8/30/99	91	8/3/04	91
4/12/97	94	5/23/05	95	8/30/99	91	8/3/04	91
3/28/00	94	5/21/06	97	8/30/99	91	8/4/05	88
5/6/00	94	5/21/06	97	10/21/99	92	8/4/05	89
5/6/00	94	5/21/06	96	10/21/99	92	8/4/05	88
5/6/00	92	5/20/10	92	10/21/99	93	8/2/06	84
4/28/01	92	5/20/10	91	8/8/00	87	8/2/06	81
4/28/01	92	5/20/10	92	8/8/00	89	8/2/06	82
4/28/01	94			8/8/00	89	8/3/10	91
6/4/02	95	Summer		8/2/01	88	8/3/10	89
6/4/02	94	8/2/93	87	8/2/01	89	8/3/10	90
6/4/02	93	8/2/93	87	8/2/01	88		
3/28/03	93	8/2/93	86	8/6/02	90		
3/28/03	94	8/5/96	88	8/6/02	91		

North Lake 1993-2010 Chlorophyll a



Spring		3/28/03	0.4	8/5/96	2.9	8/6/02	2.0
5/5/93	0.2	5/27/03	2.6	8/5/96	3.3	8/3/03	2.7
5/5/93	1.6	5/27/03	2.6	9/4/97	2.3	8/3/03	2.7
5/5/93	5.1	5/27/03	2.6	9/4/97	2.4	8/3/03	2.1
4/12/97	1.0	5/23/05	1.5	9/4/97	2.9	8/3/04	2.6
4/12/97	1.3	5/23/05	0.9	8/30/99	2.5	8/3/04	2.0
4/12/97	1.9	5/23/05	2.7	8/30/99	2.6	8/3/04	2.6
3/28/00	0.6	5/21/06	1.1	8/30/99	2.8	8/4/05	1.0
5/6/00	2.1	5/21/06	1.1	10/21/99	2.6	8/4/05	0.9
5/6/00	2.1	5/21/06	1.3	10/21/99	2.4	8/4/05	1.1
5/6/00	4.1	5/20/10	4.5	10/21/99	1.7	8/2/06	3.2
4/28/01	3.2	5/20/10	7.0	8/8/00	2.3	8/2/06	4.3
4/28/01	2.7	5/20/10	5.0	8/8/00	2.4	8/2/06	5.3
4/28/01	1.4			8/8/00	2.7	8/3/10	1.4
6/4/02	1.2	Summer		8/2/01	3.8	8/3/10	2.9
6/4/02	1.5	8/2/93	5.3	8/2/01	3.2	8/3/10	2.1
6/4/02	2.2	8/2/93	6.3	8/2/01	4.3		
3/28/03	0.6	8/2/93	7.4	8/6/02	3.0		
3/28/03	0.6	8/5/96	2.5	8/6/02	2.0		

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Lyndon Township
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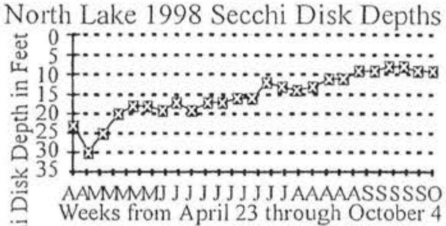
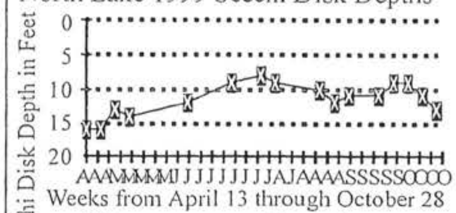
Washtenaw County

North Lake 1998 Secchi Disk Depths



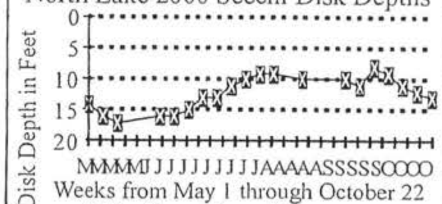
APR	.	.	23	.	.		
MAY	30	25	20	18	19		
JUN	17	19	17	17	16	16	12
JUL	13	14	13	11	11		
AUG	.	.	.	9	9		
SEP	9	8	8	9	.		
OCT	8	.	.	.	.		

North Lake 1999 Secchi Disk Depths



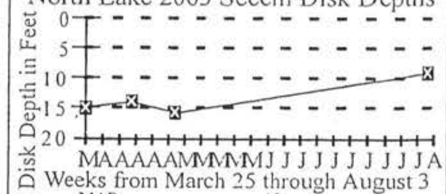
APR	.	.	16	16	.
MAY	.	.	13	14	.
JUN	.	.	12	.	.
JUL	9	.	8	9	.
AUG	.	.	10	12	11
SEP	11	9	9	.	.
OCT	.	.	11	13	.

North Lake 2000 Secchi Disk Depths

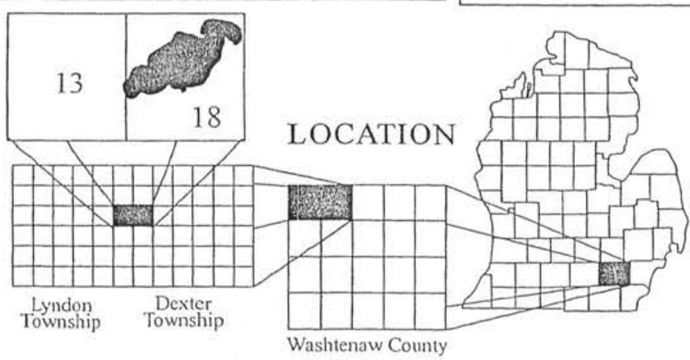


MAY	14	16	17	.	.
JUN	16	16	15	13	13
JUL	11	10	9	9	.
AUG	10	.	.	10	11
SEP	8	.	9	.	.
OCT	11	12	13	.	.

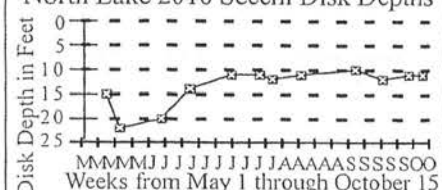
North Lake 2003 Secchi Disk Depths



MAR	.	.	15	.	.
APR	.	14	.	.	.
MAY	.	.	.	16	.
JUN	.	.	.	.	.
JUL	.	.	.	.	.
AUG	9	.	.	.	.

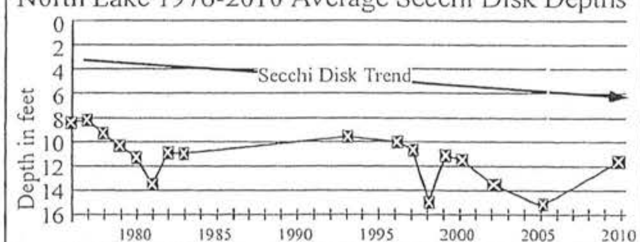


North Lake 2010 Secchi Disk Depths



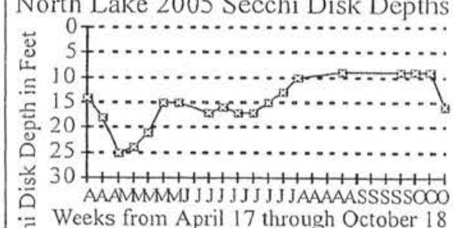
MAY	.	14	21	.	.
JUN	19	.	13	.	.
JUL	10	.	10	11	.
AUG	10	.	.	.	9
SEP	.	11	.	.	.
OCT	10	.	10	.	.

North Lake 1976-2010 Average Secchi Disk Depths



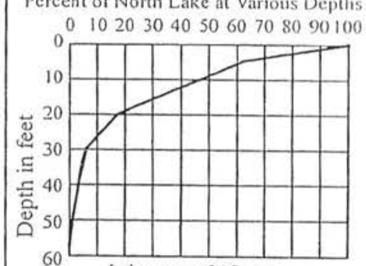
Data:								
	1976	1977	1978	1979	1980	1981	1982	1983
	8.4	8.2	9.3	10.3	11.3	13.5	10.9	11.0
1993	1996	1997	1998	1999	2000	2003	2005	2010
9.6	10.0	10.7	15.0	11.1	11.5	13.5	15.4	11.9

North Lake 2005 Secchi Disk Depths



APR	.	.	14	18	.
MAY	25	24	21	15	.
JUN	15	.	17	16	
JUL	17	17	15	13	10
AUG	.	.	9	.	.
SEP	.	9	9	.	.
OCT	9	16	.	.	.

Percent of North Lake at Various Depths



Lake area = 246 acres

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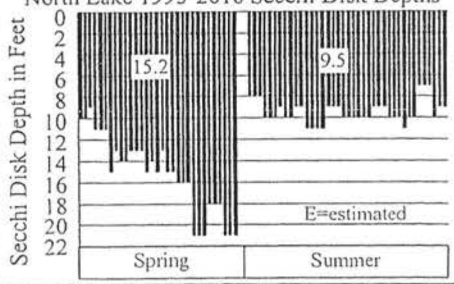
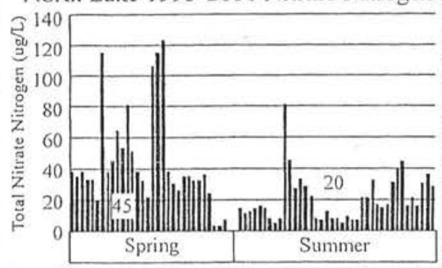
North Lake 1993-2010 Secchi Disk Depths



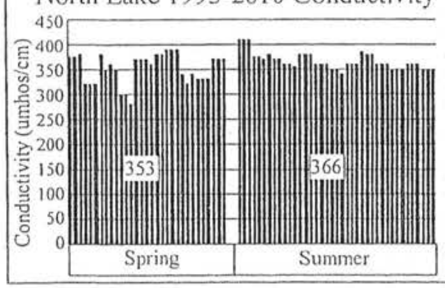
Spring		3/28/03	15	8/5/96	10	8/6/02	10
5/5/93	10	5/27/03	16	8/5/96	10	8/3/03	9
5/5/93	10	5/27/03	16	9/4/97	9	8/3/03	9
5/5/93	9	5/27/03	16	9/4/97	10	8/3/03	9
4/12/97	11	5/23/05	21	9/4/97	10	8/3/04	10
4/12/97	11	5/23/05	21	8/30/99	9	8/3/04	10
4/12/97	11	5/23/05	21	8/30/99	9	8/3/04	10
3/28/00	15	5/21/06	18	8/30/99	11	8/4/05	11
5/6/00	13	5/21/06	18	10/21/99	11	8/4/05	10
5/6/00	14	5/21/06	18	10/21/99	11	8/4/05	10
5/6/00	14	5/20/10	21	10/21/99	11	8/2/06	7
4/28/01	13	5/20/10	21	8/8/00	9	8/2/06	7
4/28/01	13	5/20/10	21	8/8/00	9	8/2/06	7
4/28/01	13			8/8/00	9	8/3/10	10
6/4/02	15	Summer		8/2/01	10	8/3/10	9
6/4/02	14	8/2/93	8	8/2/01	10	8/3/10	9
6/4/02	15	8/2/93	8	8/2/01	10		
3/28/03	13	8/2/93	8	8/6/02	10		
3/28/03	15	8/5/96	10	8/6/02	10		

North Lake 1993-2010 Nitrate Nitrogen



Spring		3/28/03	123	8/5/96	16	8/6/02	7
5/5/93	38	5/27/03	38	8/5/96	14	8/3/03	21
5/5/93	35	5/27/03	30	9/4/97	8	8/3/03	21
5/5/93	38	5/27/03	26	9/4/97	5	8/3/03	32
4/12/97	33	5/23/05	35	9/4/97	8	8/3/04	17
4/12/97	33	5/23/05	35	8/30/99	81	8/3/04	15
4/12/97	20	5/23/05	32	8/30/99	45	8/3/04	17
3/28/00	115	5/21/06	32	8/30/99	27	8/4/05	31
5/6/00	38	5/21/06	36	10/21/99	33	8/4/05	40
5/6/00	45	5/21/06	24	10/21/99	28	8/4/05	44
5/6/00	64	5/20/10	3	10/21/99	22	8/2/06	16
4/28/01	53	5/20/10	3	8/8/00	8	8/2/06	21
4/28/01	81	5/20/10	7	8/8/00	7	8/2/06	16
4/28/01	51			8/8/00	12	8/3/10	30
6/4/02	38	Summer		8/2/01	8	8/3/10	36
6/4/02	32	8/2/93	14	8/2/01	8	8/3/10	28
6/4/02	22	8/2/93	11	8/2/01	5		
3/28/03	106	8/2/93	12	8/6/02	9		
3/28/03	115	8/5/96	14	8/6/02	7		

North Lake 1993-2010 Conductivity



Spring		3/28/03	380	8/5/96	375	8/6/02	360
5/5/93	375	5/27/03	390	8/5/96	370	8/3/03	385
5/5/93	375	5/27/03	390	9/4/97	380	8/3/03	380
5/5/93	380	5/27/03	390	9/4/97	370	8/3/03	380
4/12/97	320	5/23/05	340	9/4/97	370	8/3/04	360
4/12/97	320	5/23/05	320	8/30/99	360	8/3/04	360
4/12/97	320	5/23/05	340	8/30/99	360	8/3/04	360
3/28/00	380	5/21/06	330	8/30/99	355	8/4/05	350
5/6/00	350	5/21/06	330	10/21/99	380	8/4/05	350
5/6/00	360	5/21/06	330	10/21/99	380	8/4/05	350
5/6/00	350	5/20/10	370	10/21/99	380	8/2/06	360
4/28/01	300	5/20/10	370	8/8/00	360	8/2/06	360
4/28/01	300	5/20/10	370	8/8/00	360	8/2/06	360
4/28/01	280			8/8/00	360	8/3/10	350
6/4/02	370	Summer		8/2/01	350	8/3/10	350
6/4/02	370	8/2/93	410	8/2/01	350	8/3/10	350
6/4/02	370	8/2/93	410	8/2/01	340		
3/28/03	360	8/2/93	410	8/6/02	360		
3/28/03	380	8/5/96	375	8/6/02	360		

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Surface Lake Water Quality Data

E = estimated

Date	Sample Station Number	Temperature °C	Dissolved Oxygen (mg/L)	Dissolved Oxygen Percent Saturation	Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
5/5/93	1	---	---	---	0.2	10	38	130	8.3	375	20	93	A
5/5/93	2	---	---	---	1.6	10	35	127	8.2	375	18	93	A
5/5/93	3	---	---	---	5.1	9	38	130	8.2	380	21	88	B
8/2/93	1	25	7.8	93	5.3	8	14	134	8.2	410	13	87	B
8/2/93	2	24	8.5	100	6.3	8	11	138	8.2	410	15	87	B
8/2/93	3	24	7.7	91	7.4	8	12	136	8.1	410	15	86	B
8/5/96	1	29	9.0	114	2.5	10	14	110	8.4	375	13	88	B
8/5/96	2	29	8.3	105	2.9	10	16	110	8.4	375	15	88	B
8/5/96	3	29	8.3	105	3.3	10	14	110	8.4	370	14	87	B
4/12/97	1	---	---	---	1.0	11	33	90	7.6	320	18	94	A
4/12/97	2	---	---	---	1.3	11	33	90	7.4	320	15	94	A
4/12/97	3	---	---	---	1.9	11	20	90	7.4	320	11	94	A
9/4/97	1	21	8.8	98	2.3	9	8	100	8.7	380	17	89	B
9/4/97	2	21	8.7	97	2.4	10	5	100	8.6	370	12	91	A
9/4/97	3	21	8.4	93	2.9	10	8	100	8.6	370	15	90	A
8/30/99	1	24	8.3	98	2.5	9	81	105	8.3	360	19	91	A
8/30/99	2	23	8.3	95	2.6	9	45	105	8.3	360	21	91	A
8/30/99	3	23	8.5	98	2.8	11	27	104	8.4	355	22	91	A
10/21/99	1	12	10.1	94	2.6	11	33	109	8.4	380	14	92	A
10/21/99	2	12	9.5	88	2.4	11	28	107	7.8	380	13	92	A
10/21/99	3	12	9.4	87	1.7	11	22	108	7.8	380	12	93	A
5/6/00	1	---	---	---	2.1	13	38	78	7.6	350	10	94	A
5/6/00	2	---	---	---	2.1	14	45	85	7.6	360	8	94	A
5/6/00	3	---	---	---	4.1	14	64	95	7.8	350	11	92	A
8/8/00	1	26	8.4	102	2.3	9	8	98	8.9	360	19	87	B
8/8/00	2	25	8.1	96	2.4	9	7	97	8.7	360	17	89	B
8/8/00	3	25	8.0	95	2.7	9	12	98	8.7	360	18	89	B
4/28/01	1	---	---	---	3.2	13	53	85	7.6	300	21	92	A
4/28/01	2	---	---	---	2.7	13	81	86	7.5	300	26	92	A
4/28/01	3	---	---	---	1.4	13	51	83	7.7	280	25	94	A
8/2/01	1	28	8.4	106	3.8	10	8	90	8.3	350	17	88	B
8/2/01	2	28	8.7	110	3.2	10	8	90	8.3	350	17	89	B
8/2/01	3	27	8.4	105	4.3	10	5	90	8.2	340	17	88	B
6/4/02	1	---	---	---	1.2	15	38	110	8.5	370	13	95	A
6/4/02	2	---	---	---	1.5	14	32	111	8.6	370	10	94	A
6/4/02	3	---	---	---	2.2	15	22	111	8.6	370	13	93	A
8/6/02	1	27	7.5	94	3.0	10	9	99	8.2	360	16	90	A
8/6/02	2	27	7.5	94	2.0	10	7	98	8.3	360	17	91	A
8/6/02	3	27	8.0	100	2.0	10	7	99	8.2	360	16	91	A
3/28/03	1	---	---	---	0.6	13	106	94	8.0	360	26	93	A
3/28/03	2	---	---	---	0.6	15	115	102	8.2	380	30	94	A
3/28/03	3	---	---	---	0.6	15	123	102	8.2	380	30	94	A
5/27/03	1	---	---	---	2.6	16	38	110	8.6	390	13	93	A
5/27/03	2	---	---	---	2.6	16	30	110	8.6	390	13	93	A
5/27/03	3	---	---	---	2.6	16	26	110	8.6	390	11	94	A
8/3/03	1	26	8.6	105	2.7	9	21	90	8.8	385	11	88	B
8/3/03	2	26	8.7	106	2.7	9	21	90	8.7	380	16	89	B
8/3/03	3	26	8.6	105	2.1	9	32	90	8.8	380	12	88	B
8/3/04	1	28	8.7	110	2.6	10	17	95	8.5	360	19	90	A
8/3/04	2	27	8.5	106	2.0	10	15	95	8.5	360	18	91	A
8/3/04	3	26	8.1	99	2.6	10	17	95	8.5	360	20	91	A
5/23/05	1	---	---	---	1.5	21	35	90	7.5	340	15	97	A
5/23/05	2	---	---	---	0.9	21	35	90	7.2	320	16	97	A
5/23/05	3	---	---	---	2.7	21	32	86	7.2	340	15	95	A
8/4/05	1	29	8.4	105	1.0	11	31	90	8.8	350	20	88	B
8/4/05	2	28	8.5	108	0.9	10	40	90	8.7	350	18	89	B
8/4/05	3	28	8.7	110	1.1	10	44	90	8.8	350	14	88	B
5/21/06	1	---	---	---	1.1	18 E	32	106	8.5	330	16	97	A
5/21/06	2	---	---	---	1.1	18 E	36	106	8.3	330	18	97	A
5/21/06	3	---	---	---	1.3	18 E	24	103	8.4	330	22	96	A
8/2/06	1	30	7.7	101	3.2	7	16	92	8.9	360	19	84	B
8/2/06	2	29	8.0	103	4.3	7	21	92	9.0	360	21	81	B
8/2/06	3	29	7.8	100	5.3	7	16	92	8.9	360	16	82	B
5/20/10	1	---	---	---	4.5	21	3	110	8.6	370	16	92	A
5/20/10	2	---	---	---	7.0	21	3	110	8.4	370	15	91	A
5/20/10	3	---	---	---	5.0	21	7	110	8.4	370	17	92	A
8/3/10	1	28	8.3	105	1.4	10	30	85	8.4	350	22	91	A
8/3/10	2	27	7.9	99	2.9	9	36	90	8.3	350	19	89	B
8/3/10	3	27	7.7	99	2.1	9	28	90	8.3	350	20	90	A