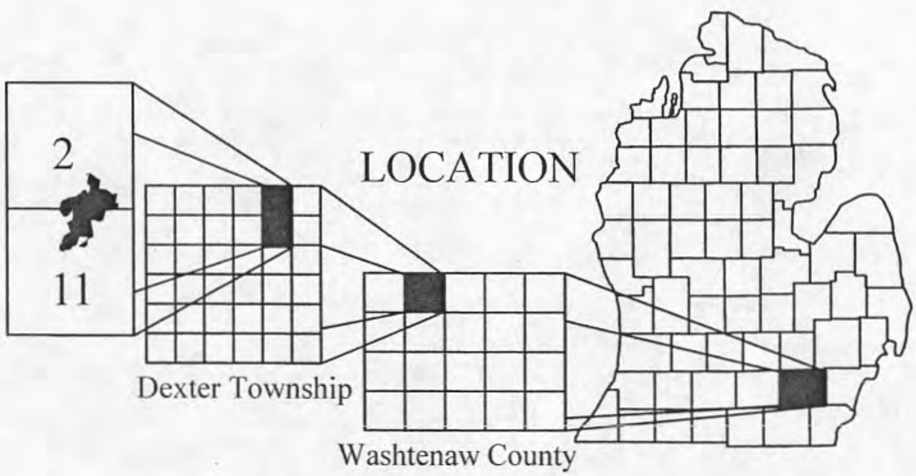
LITTLE PORTAGE LAKE
DEXTER TOWNSHIP
WASHTENAW COUNTY
MICHIGAN

WATER QUALITY STUDIES
1997-2010



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LITTLE PORTAGE LAKE

DEXTER TOWNSHIP

WASHTENAW COUNTY

1997-2010 WATER QUALITY STUDIES

LITTLE PORTAGE LAKE DATA

Little Portage Lake is a 112-acre natural hard water kettle lake located in Sections 2 and 11, Dexter Township (T1S R4E), Washtenaw County, Michigan. The lake has a maximum depth of 42 feet, a water volume of 1813 acre-feet, and a mean depth of 17.3 feet. The elevation of the lake is 850 feet above sea level. The lake consists of a single basin.

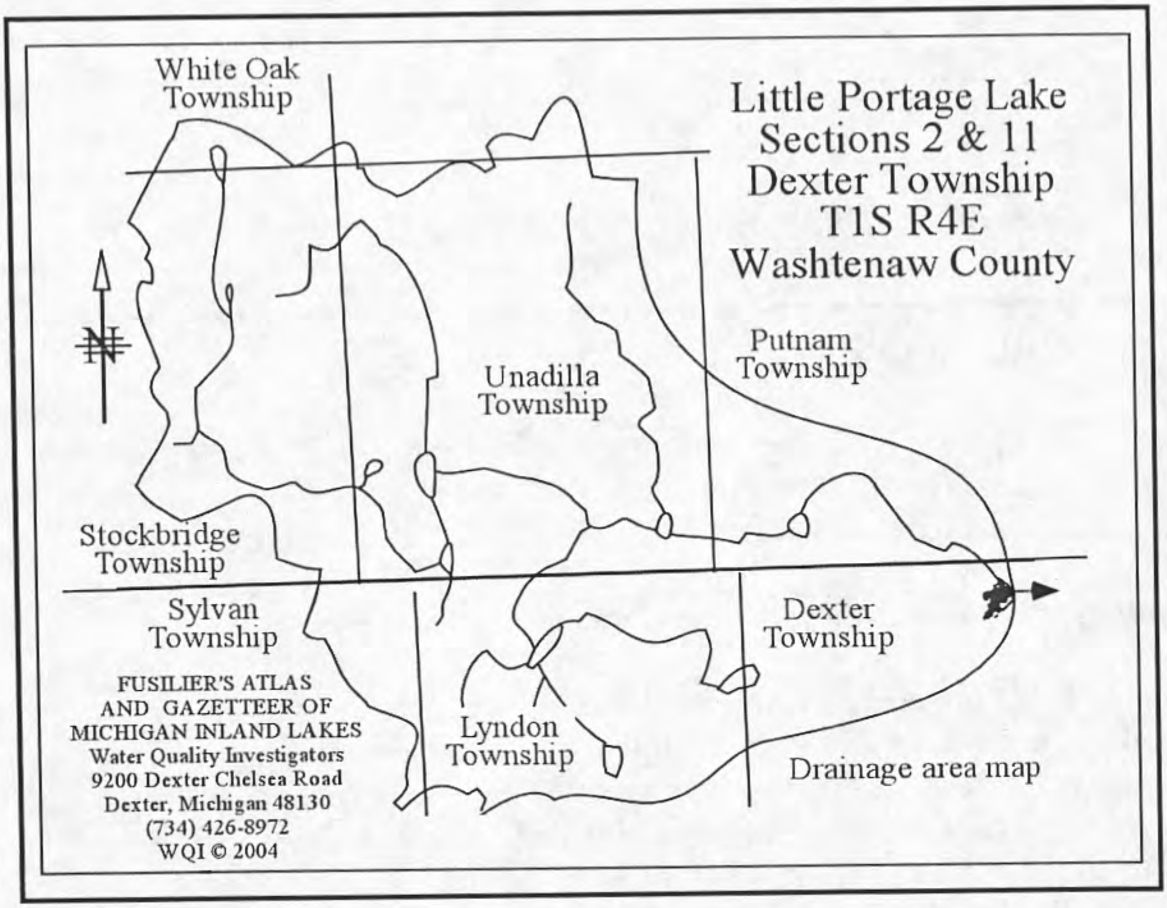
Defining the watershed of the lake is a bit difficult because of the John Flook dam on the Huron River just below the Big Portage Lake outlet. Although water from the Huron River probably does not contribute water to Little Portage Lake, the dam does influence the level of the lake, so in terms of maintaining or raising the level of the lake, the entire Huron River watershed above the dam could be considered part of the Little Portage Lake watershed.

The size of the upstream watershed, which is the land area that contributes water to the lake, but does not include the lake, is 54,672 acres. The drainage area, which includes the lake and the watershed, is 54,784 acres. The watershed to lake ratio is large, 488 to 1. Because of this the lake flushes rapidly, once every 0.04 years (or 15 days) on an average.

There are two inlets. A small unnamed inlet flows into the lake on the east side. The Portage River, which drains 51,136 acres, flows into the lake on the north end.

The lake has 15099 feet of shoreline.

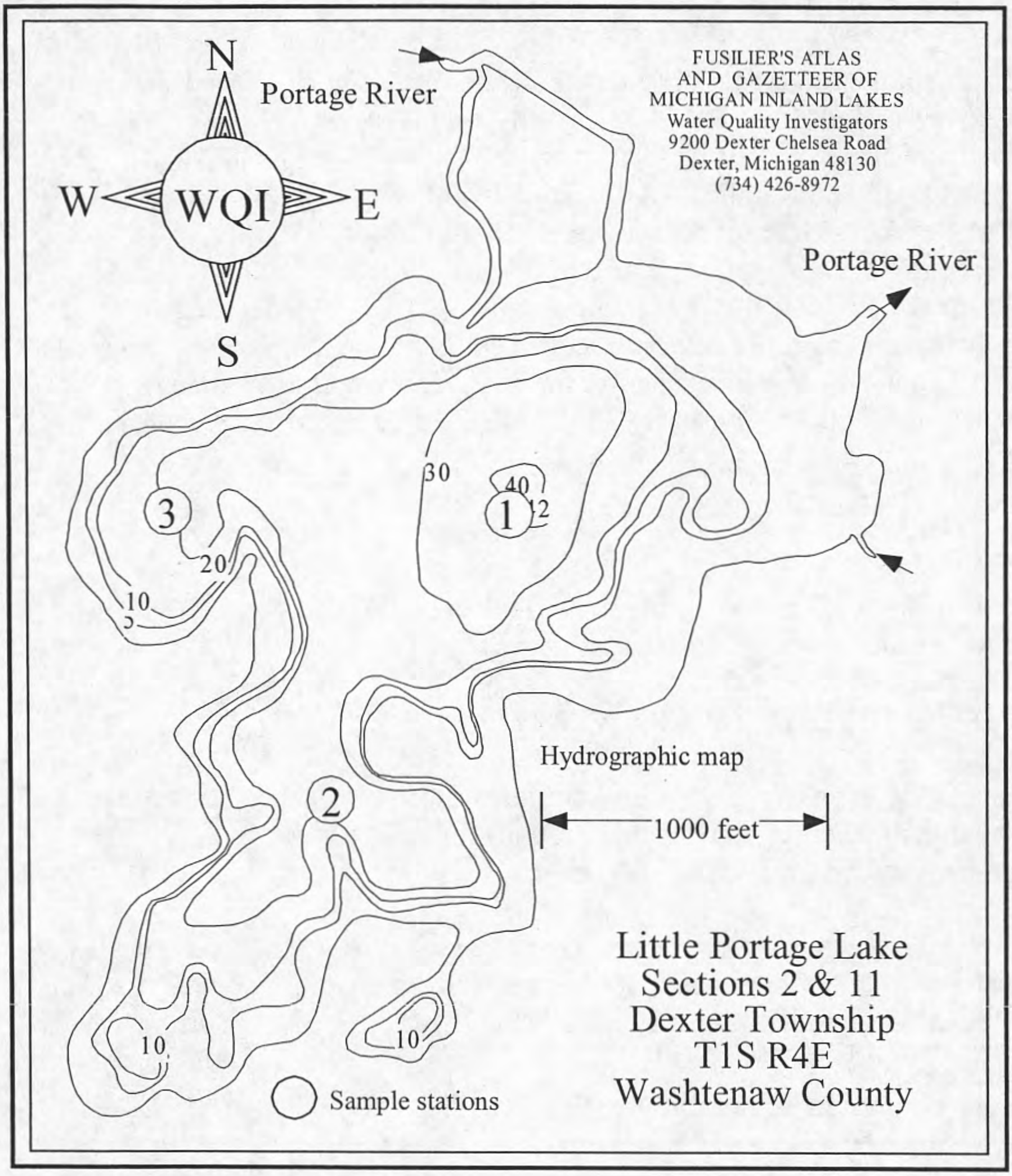
Water from the outlet (the Portage River) flows into Portage Lake on the northeast corner. The Portage River joins the Huron River on the east side of Portage Lake. The Huron River flows into Lake Erie at Monroe, Michigan.



The longitude and latitude of the 42-foot deep hole is 83° 55.795W and 42° 24.912N.

THE ANALYSES

The tests performed on the samples included total phosphorus, total nitrate nitrogen, total alkalinity, pH, conductivity, chlorophyll a, Secchi disk depth, 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 BOTTOM CONTOURS AND SAMPLE STATIONS

The hydrographic map shows the bottom contours, the locations of the inlets and the outlet, and the locations of the in-lake sample stations.

THE SAMPLE DATES

WQI limnologists took spring and summer surface samples at Stations 1, 2 and 3 May 12 and August 25, 1997, April 19 and August 10, 1998, April 25 and August 27, 1999, April 15 and August 4, 2000, May 13 and August 1, 2001, April 15 and August 2, 2002, April 28 and August 1, 2003, April 16 and August 2, 2004, April 18 and August 3, 2005, April 19 and August 1, 2006, April 21 and August 1, 2007, April 18 and August 1, 2008, April 18 and August 3, 2009 and April 20 and August 9, 2010. Temperature and dissolved oxygen profile data were collected each time the lake was sampled in late summer at the deepest part of the lake. Three bottom sediment samples were collected in spring 2005. The Portage River was sampled a number of times in 2004-5 and again in 2009-10.

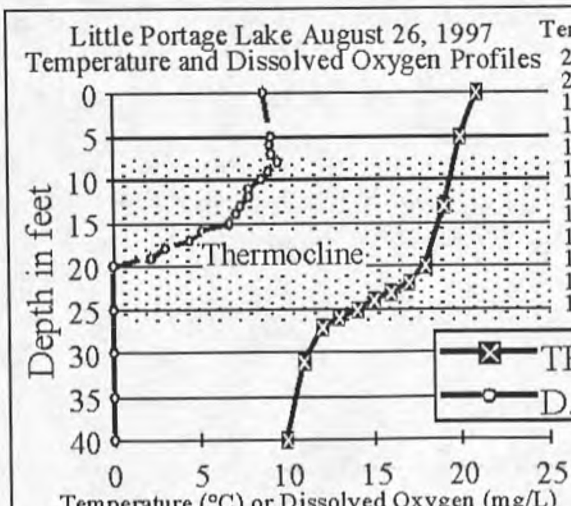
THE DATA

The data discussed below can be found in the text, in the table at the end of this report, and on 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 gases, and biological activity.

Dissolved oxygen is the parameter most often selected by lake water quality scientists as being important. Besides providing oxygen for aquatic organisms, in natural lakes, dissolved oxygen is involved in phenomena such as phosphorus precipitation and release from the lake bottom sediments and decomposition of organic material in the lake.

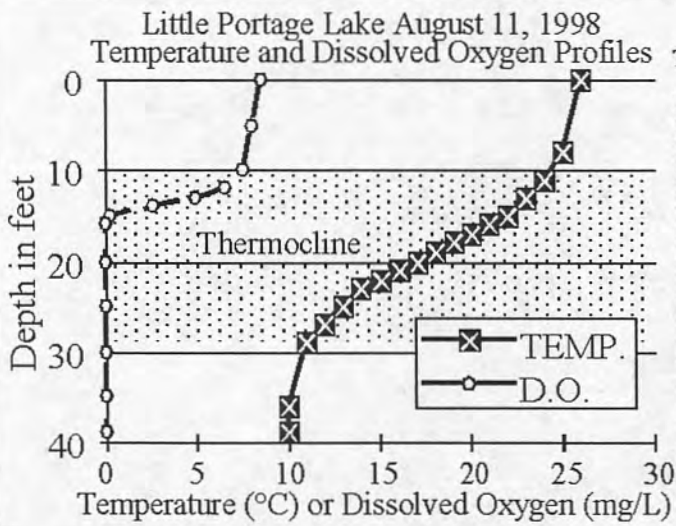


Temp.	Depth	D.O.	Depth
21	0	8.8	0
20	5	9.2	5
19	13	9.1	6
18	20	9.2	7
17	22	9.6	8
16	23	9.0	9
15	24	8.6	10
14	25	7.9	11
13	26	7.9	12
12	27	7.4	13
11	31	7.2	14
10	40	6.8	15
		5.2	16
		4.4	17
		3.0	18
		2.2	19
		0.0	20
		0.0	25
		0.0	30
		0.0	35
		0.0	40

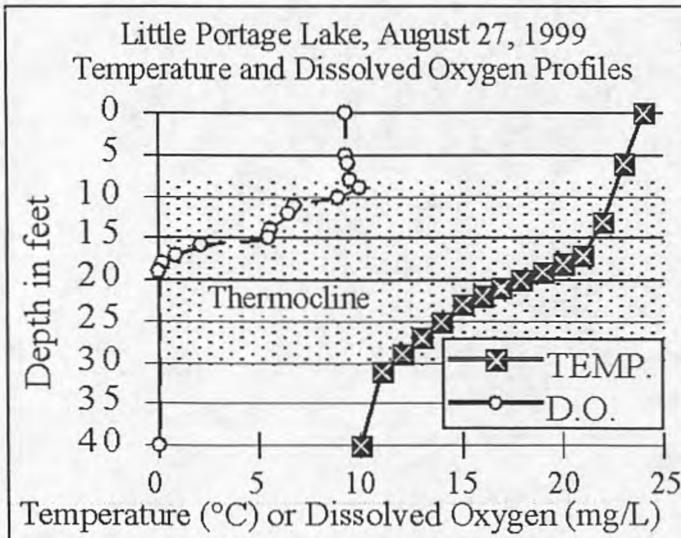
1997

On August 26, 1997 (late summer), Little Portage Lake formed a 19-foot-thick thermocline (defined as a layer of water in a lake where the temperature changes rapidly with depth, and shown shaded on the graphs) from 8 to 27 feet. Dissolved oxygen was plentiful above the thermocline. The lake ran out of dissolved oxygen at 20 feet and that condition remained to the bottom. The hypsographic (depth-area) graph shows about 35 percent of the lake is deeper than 20 feet.

1998



Temp.	Depth	D.O.	Depth
26	0	8.6	0
25	8	8.1	5
24	11	7.6	10
23	13	6.6	12
22	15	5.0	13
21	16	2.6	14
20	17	0.3	15
19	18	0.0	16
18	19	0.0	20
17	20	0.0	25
16	21	0.0	30
15	22	0.0	35
14	23	0.0	39
13	25		
12	27		
11	29		
10	36		
10	39		

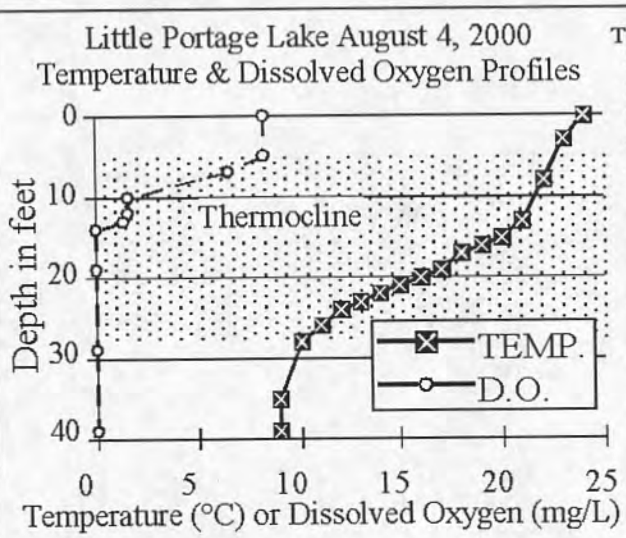


Temp.	Depth	D.O.	Depth
24	0	9.3	0
23	6	9.3	5
22	13	9.4	6
21	17	9.5	8
20	18	10.0	9
19	19	8.9	10
18	20	6.7	11
17	21	6.4	12
16	22	5.6	14
15	23	5.5	15
14	25	2.1	16
13	27	0.9	17
12	29	0.2	18
11	31	0.0	19
10	40	0.0	40

On August 11, 1998, Little Portage Lake formed a 19-foot-thick thermocline from 10 to 29 feet. Dissolved oxygen was plentiful above the thermocline. The lake ran out of dissolved oxygen at 16 feet and that condition remained to the bottom. About 44 percent of the lake is deeper than 16 feet.

1999

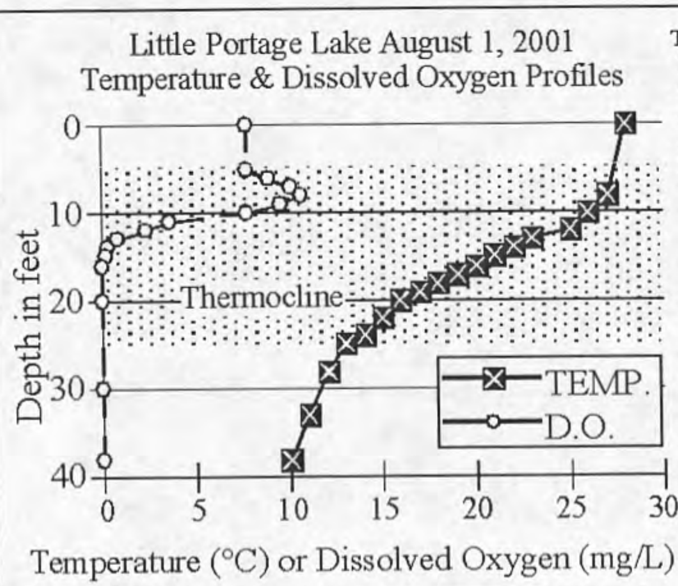
On August 27, 1999, Little Portage Lake formed a 22-foot-thick thermocline from 8 to 30 feet. The lake ran out of dissolved oxygen at 19 feet and that condition remained to the bottom. About 38 percent of the lake is deeper than 19 feet.



Temp.	Depth	D.O.	Depth
24	0	8.3	0
23	3	8.3	5
22	8	6.5	7
21	13	1.6	10
20	15	1.6	12
19	16	1.4	13
18	17	0.0	14
17	19	0.0	19
16	20	0.0	29
15	21	0.0	39
14	22		
13	23		
12	24		
11	26		
10	28		
9	35		
9	39		

2000

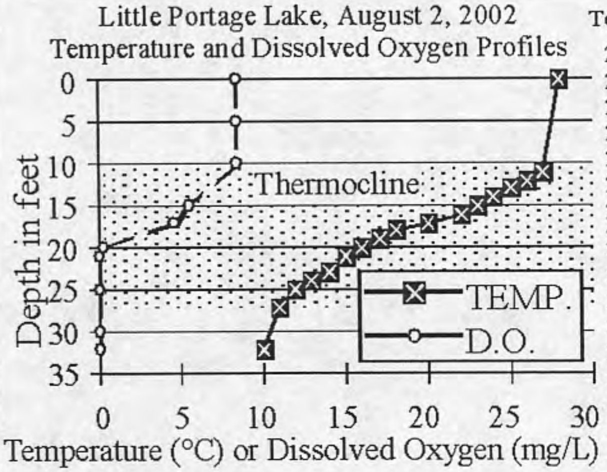
On August 4, 2000 Little Portage Lake formed a 23-foot-thick thermocline from 5 to 28 feet. Dissolved oxygen was plentiful in the first five feet. The lake ran out of dissolved oxygen at 14 feet and that condition remained to the bottom. About 46 percent of the lake is deeper than 14 feet.



Temp.	Depth	D.O.	Depth
28	0	7.8	0
27	8	7.8	5
26	10	8.9	6
25	12	10.1	7
23	13	10.6	8
22	14	9.6	9
21	15	7.8	10
20	16	3.6	11
19	17	2.3	12
18	18	0.8	13
17	19	0.3	14
16	20	0.2	15
15	22	0.0	16
14	24	0.0	20
13	25	0.0	30
12	28	0.0	38
11	33		
10	38		

2001

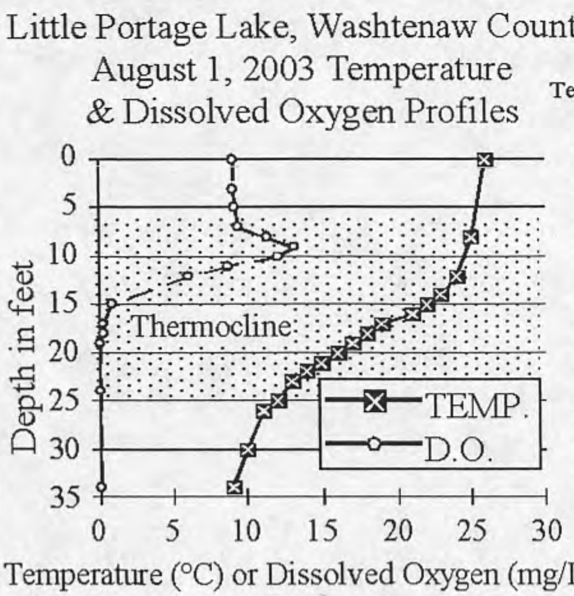
On August 1, 2001 Little Portage Lake formed a 20-foot-thick thermocline from 5 to 25 feet. Dissolved oxygen was plentiful above the thermocline, and reached a maximum of 10.6 milligrams per liter in the thermocline, probably the result of an algal bloom which settled there. The lake ran out of dissolved oxygen at 16 feet and that condition remained to the bottom. About 44 percent of the lake is deeper than 16 feet.



Temp.	Depth	D.O.	Depth
28	0	8.5	0
27	11	8.5	5
26	12	8.5	10
25	13	5.6	15
24	14	4.6	17
23	15	0.3	20
22	16	0.0	21
20	17	0.0	25
18	18	0.0	30
17	19	0.0	32
16	20		
15	21		
14	23		
13	24		
12	25		
11	27		
10	32		

2002

On August 2, 2002, the lake formed a 17-foot-thick thermocline from 10 to 27 feet. Dissolved oxygen was plentiful above the thermocline. The lake ran out of dissolved oxygen at 21 feet and that condition remained to the bottom. About 32 percent of the lake is deeper than 21 feet.

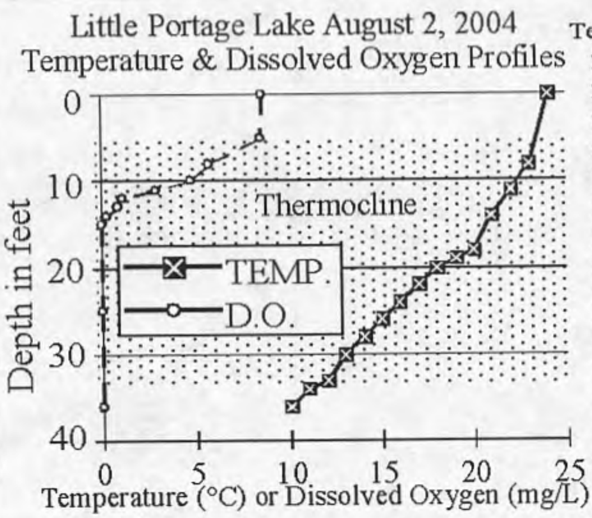


Temp.	Depth	D.O.	Depth
26	0	9.1	0
25	8	9.1	3
24	12	9.2	5
23	14	9.5	7
22	15	11.4	8
21	16	13.2	9
19	17	12.2	10
18	18	8.8	11
17	19	6.1	12
16	20	0.8	15
15	21	0.2	17
14	22	0.2	18
13	23	0.0	19
12	25	0.0	24
11	26	0.0	34
10	30		
9	34		

2003

On August 1, 2003, the lake formed a 19-foot-thick thermocline from 7 to 26 feet. Dissolved oxygen was plentiful above the thermocline. A dissolved oxygen maximum again occurred in the thermocline, a result of an algal bloom which settled there. The lake ran out of dissolved oxygen at 19 feet and that condition remained to the bottom.

About 39 percent of the lake is deeper than 19 feet.

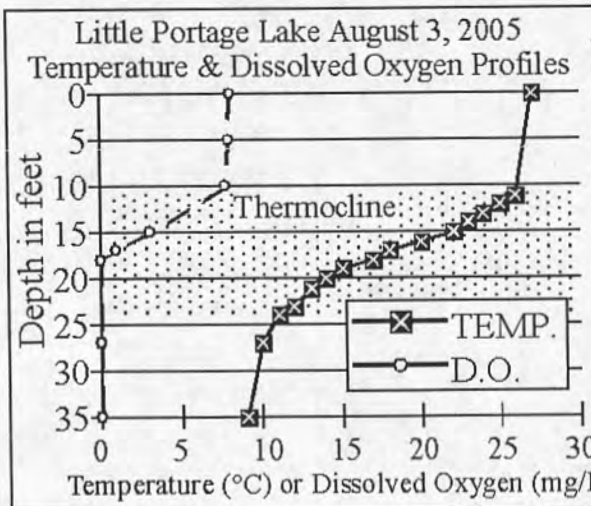


Temp.	Depth	D.O.	Depth
24	0	8.6	0
23	8	8.5	5
22	11	5.7	8
21	14	4.7	10
20	18	2.9	11
19	19	1.1	12
18	20	0.9	13
17	22	0.3	14
16	24	0.0	15
15	26	0.0	25
14	28	0.0	36
13	30		
12	33		
11	34		
10	36		

2004

On August 2, 2004, the lake formed a 30-foot-thick thermocline from 5 to 35 feet. Dissolved oxygen was plentiful above the thermocline. The lake started to lose its dissolved oxygen below 5 feet. The lake ran out of dissolved oxygen at 15 feet and that condition remained to the bottom.

About 45 percent of the lake is deeper than 15 feet.



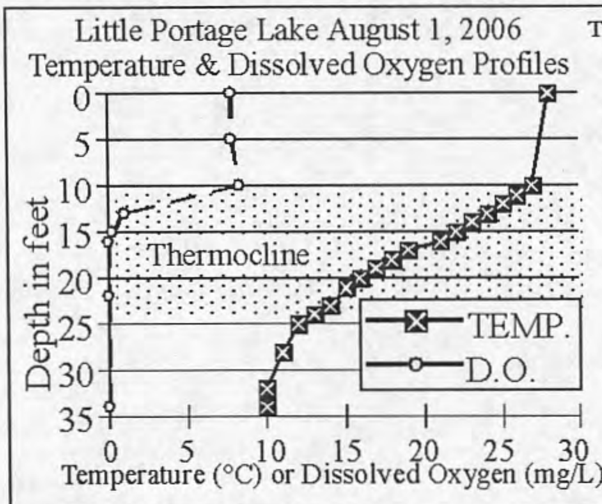
Temp.	Depth	D.O.	Depth
27	0	8.1	0
26	11	8.0	5
25	12	7.7	10
24	13	3.1	15
23	14	0.9	17
22	15	0.0	18
20	16	0.0	27
18	17	0.0	35
17	18		
15	19		
14	20		
13	21		
12	23		
11	24		
10	27		
9	35		

2005

In late summer 2005 Little Portage Lake formed a 15-foot-thick thermocline from 10 to 25 feet. Dissolved oxygen was plentiful above ten feet, and started to decrease below that depth. It was zero at 18 feet, and that condition remained to the bottom. About 40 percent is deeper than 18 feet.

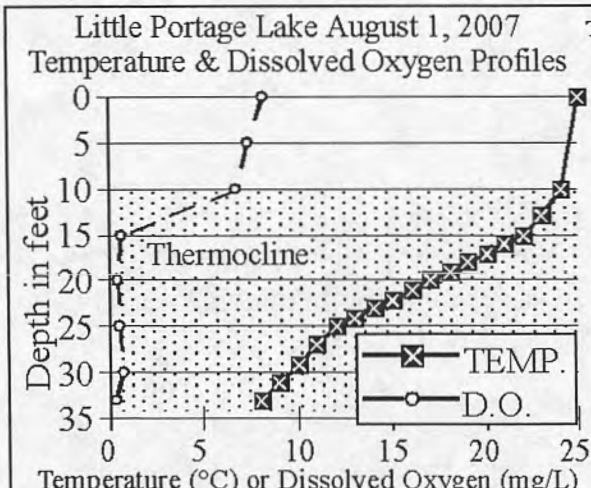
2006

In late summer 2006 Little Portage Lake formed a 15-foot-thick thermocline from 10 to 25 feet. Dissolved oxygen was plentiful above ten feet, and started to decrease below that depth. It was zero at 16 feet, and that condition remained to the bottom. About 42 percent is deeper than 16 feet.



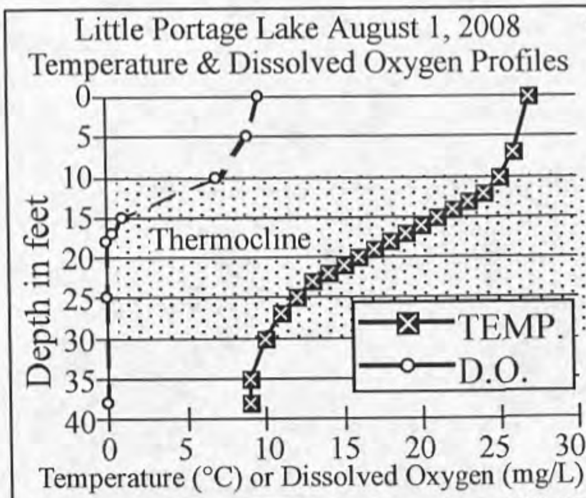
Temp.	Depth	D.O.	Depth
28	0	7.8	0
27	10	7.9	5
26	11	8.3	10
25	12	1.0	13
24	13	0.2	15
23	14	0.0	16
22	15	0.0	22
21	16	0.0	34
19	17		
18	18		
17	19		
16	20		
15	21		
14	23		
13	24		
12	25		
11	28		
10	32		
10	34		

2007



Temp.	Depth	D.O.	Depth
25	0	8.2	0
24	10	7.4	5
23	13	6.7	10
22	15	0.6	15
21	16	0.4	20
20	17	0.5	25
19	18	0.7	30
18	19	0.3	33
17	20		
16	21		
15	22		
14	23		
13	24		
12	25		
11	27		
10	29		
9	31		
8	33		

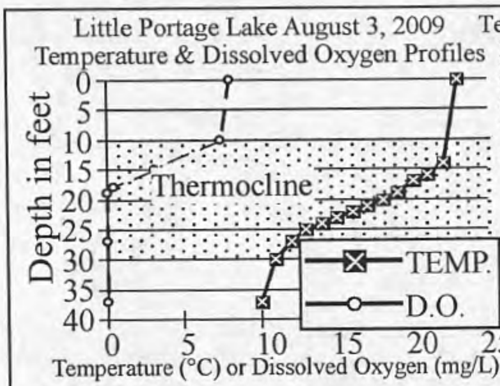
In late summer 2007 the lake formed a 24-foot-thick thermocline from 10 to 34 feet. Dissolved oxygen supplies were adequate above 10 feet. The concentration of dissolved oxygen started to decrease below that depth and was low (0.6 mg/L) at 15 feet. Low levels of dissolved oxygen remained to 33 feet. The depth finder showed a dense layer from 25 to 35 feet. That dense layer may have been photosynthetic bacteria, which would account for the low levels of dissolved oxygen in the deeper water.



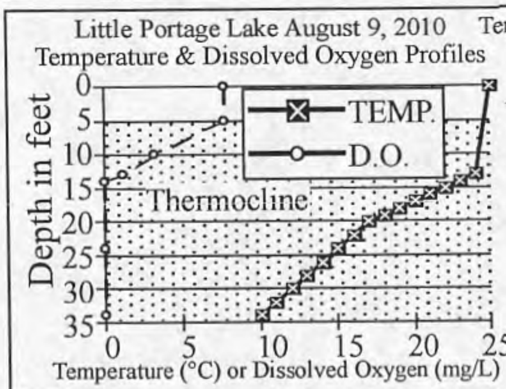
Temp.	Depth	D.O.	Depth
27	0	9.7	0
26	7	9.0	5
25	10	6.9	10
24	12	1.0	15
23	13	0.4	17
22	14	0.0	18
21	15	0.0	25
20	16	0.0	38
19	17		
18	18		
17	19		
16	20		
15	21		
14	22		
13	23		
12	25		
11	27		
10	30		
9	35		
9	38		

2008

In late summer 2008 Little Portage Lake formed a 20-foot thick thermocline from 10 to 30 feet. Dissolved oxygen was supersaturated at the surface and started to decrease almost immediately. The lake ran out of dissolved oxygen at 18 feet, and that condition remained to the bottom. About 43 percent of the lake is deeper than 18 feet.



Temp.	Depth	D.O.	Depth
23	0	8.0	0
22	14	7.4	10
21	16	3.1	15
20	17	0.4	18
19	19	0.0	19
18	20	0.0	27
17	21	0.0	37
16	22		
15	23		
14	24		
13	25		
12	27		
11	30		
10	37		



Temp.	Depth	D.O.	Depth
25	0	7.7	0
24	13	7.7	5
23	14	3.2	10
22	15	1.2	13
21	16	0.0	14
20	17	0.0	24
19	18	0.0	34
18	19		
17	20		
16	22		
15	24		
14	26		
13	28		
12	30		
11	32		
10	34		

2009

In late summer 2009 the lake again formed a 20-foot thick thermocline from 10 to 30 feet. Dissolved oxygen was adequate in the top ten feet and started to decrease below that depth. The lake ran out of dissolved oxygen at 19 feet, and that condition remained to the bottom. About 37 percent of the lake is deeper than 19 feet.

2010

In late summer 2010 the lake formed a 29-foot thick thermocline from 5 to 34 feet. Dissolved oxygen was low but adequate in the top five feet and started to decrease below that depth. The lake ran out of dissolved oxygen at 14 feet, and that condition remained to the bottom. About 41 percent of the lake is deeper than 19 feet.

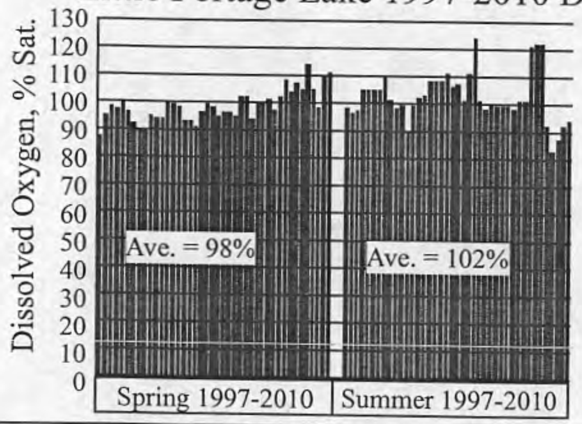
A NOTE ABOUT THE FOLLOWING GRAPHS

The lake data on the graphs below are first sorted by spring and summer then by year. The reason for this is to detect trends and/or differences between the spring and summer data over time. The average for each data set are on the spring and summer bars on the graphs.

DISSOLVED OXGEN SATURATION

Since the amount of oxygen a water will hold is dependent on temperature, with cold water holding more dissolved oxygen than warm water, dissolved oxygen saturation is often a better way to determine if oxygen supplies are adequate. Best is between 90 and 110 percent.

Little Portage Lake 1997-2010 Dissolved Oxygen Saturation



Spring		4/16/04	95	Summer		8/2/04	101
5/12/97	87	4/16/04	96	8/25/97	98	8/2/04	111
5/12/97	95	4/16/04	96	8/25/97	96	8/2/04	124
5/12/97	98	4/21/05	95	8/25/97	97	8/3/05	101
4/19/98	97	4/18/05	102	8/10/98	105	8/3/05	98
4/19/98	100	4/15/05	102	8/10/98	105	8/3/05	100
4/19/98	96	4/18/06	94	8/10/98	105	8/1/06	99
4/25/99	92	4/18/06	100	8/17/99	105	8/1/06	99
4/25/99	90	4/18/06	100	8/27/99	109	8/1/06	99
4/25/99	90	4/21/07	101	8/27/99	101	8/1/07	98
4/15/00	95	4/21/07	97	8/4/00	98	8/1/07	101
4/15/00	94	4/21/07	102	8/4/00	99	8/1/07	101
4/15/00	94	4/18/08	108	8/4/00	90	8/1/08	121
5/13/01	100	4/18/08	104	8/1/01	99	8/1/08	122
5/13/01	99	4/18/08	107	8/1/01	102	8/1/08	122
5/13/01	98	4/18/09	105	8/1/01	103	8/3/09	92
4/15/02	93	4/18/09	114	8/2/02	108	8/3/09	83
4/15/02	93	4/18/09	105	8/2/02	108	8/3/09	87
4/15/02	91	4/20/10	98	8/2/02	108	8/2/10	92
4/28/03	96	4/20/10	109	8/1/03	111	8/2/10	94
4/28/03	99	4/20/10	111	8/1/03	106	8/2/10	94
4/28/03	98			8/1/03	107		

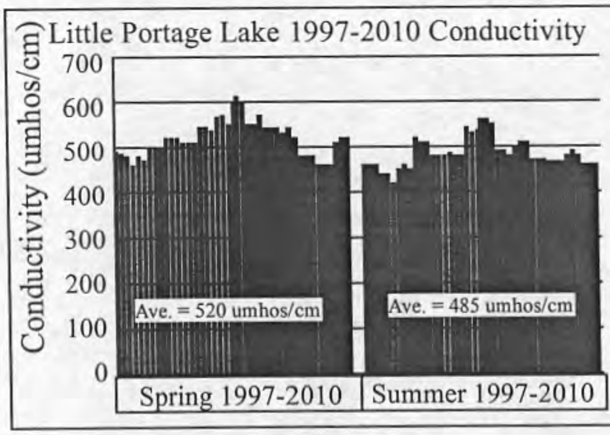
The graph shows surface dissolved oxygen saturation values ranged from 84 to 114 percent in spring and from 83 to 124 percent in summer. The graph seems to show spring saturation values are increasing while summer values are decreasing. For some unknown reason, saturation values in summer 2008 were high, 121 and 122 percent. In 2009 spring saturation values ranged from 105 to 114 percent while summer values ranged from 83 to 92 percent. Spring 2010 values were 98, 109 and 111 percent while summer values were lower, 92 and 94 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 dissolved in the water (salts), 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.

The graph shows the conductivity of Little Portage Lake in spring ranges from 460 micromhos per centimeter to a 610 micromhos per centimeter and average 520 umhos/cm. The summer conductivities range from 420 to 560 umhos/cm and average 485 umhos/cm. These are high normal conductivities for a Michigan hard water inland lake.

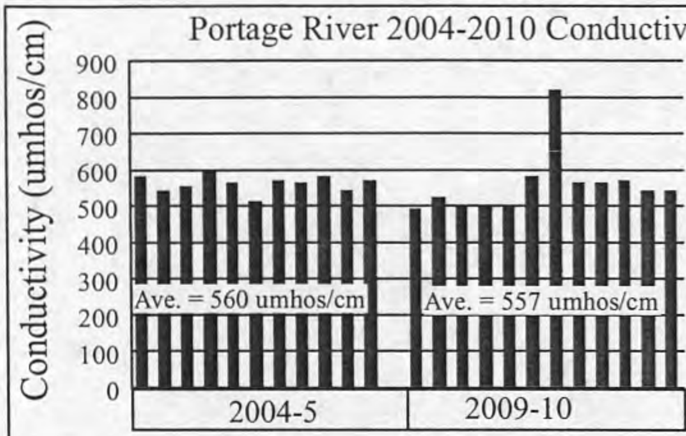


Spring		4/16/04	600	Summer		8/2/04	560
5/12/97	490	4/16/04	610	8/25/97	460	8/2/04	560
5/12/97	485	4/16/04	595	8/25/97	460	8/2/04	550
5/12/97	480	4/21/05	550	8/25/97	460	8/3/05	490
4/19/98	460	4/18/05	550	8/10/98	440	8/3/05	490
4/19/98	480	4/15/05	570	8/10/98	440	8/3/05	480
4/19/98	470	4/18/06	540	8/10/98	420	8/1/06	500
4/25/99	500	4/18/06	540	8/17/99	450	8/1/06	510
4/25/99	500	4/18/06	540	8/27/99	460	8/1/06	510
4/25/99	500	4/21/07	530	8/27/99	450	8/1/07	470
4/15/00	520	4/21/07	540	8/4/00	520	8/1/07	470
4/15/00	520	4/21/07	520	8/4/00	510	8/1/07	470
4/15/00	520	4/18/08	480	8/4/00	510	8/1/08	465
5/13/01	510	4/18/08	480	8/1/01	480	8/1/08	465
5/13/01	510	4/18/08	480	8/1/01	480	8/1/08	465
5/13/01	510	4/18/09	460	8/1/01	480	8/3/09	480
4/15/02	545	4/18/09	460	8/2/02	485	8/3/09	490
4/15/02	545	4/18/09	460	8/2/02	480	8/3/09	480
4/15/02	535	4/20/10	510	8/2/02	480	8/2/10	460
4/28/03	565	4/20/10	520	8/1/03	540	8/2/10	460
4/28/03	570	4/20/10	520	8/1/03	530	8/2/10	460
4/28/03	550			8/1/03	535		

These data show the same hump in conductivities as Portage and Base Lakes in that conductivities increased through 2004. Since then they have been decreasing.

It probably has something to do with removing water softener brine from the sewage system. It would seem conductivities should increase when the brines are discharged into the soils around the lake, but the opposite appears to be the case so far.

The graph of Portage River conductivities shows little change between the 2004-5 data and the 2009-10 data, except for the single high spike in November 2009. The average Portage River conductivities (560 umhos/cm



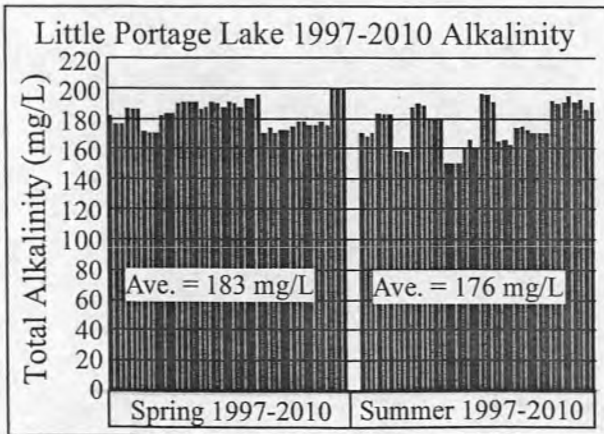
2004-5		2009-10	
5/26/04	580	5/28/09	490
6/29/04	540	6/29/09	520
7/28/04	550	7/31/09	500
8/29/04	600	8/28/09	500
10/1/04	560	9/23/09	500
11/30/04	510	10/21/09	580
12/31/04	570	11/23/09	820
1/28/05	560	12/26/09	560
2/26/05	580	1/23/10	560
3/29/05	540	3/9/10	570
4/18/05	570	3/31/10	540
		4/20/10	540

in 2004-5 and 557 umhos/cm in 2009-10) are higher than average Little Portage Lake conductivities (520 umhos/cm in spring and 485 umhos/cm in summer.)

TOTAL ALKALINITY

Alkalinity is a measure of the ability of the water to absorb acids (or bases) without changing the hydrogen ion concentration (pH). It is, in effect, a chemical sponge. In most Michigan lakes, alkalinity is due to the presence of carbonates and bicarbonates which were introduced into the lake from ground water or streams which flow into the lake. In lower Michigan, acidification of most lakes should not be a problem because of the high alkalinity concentrations

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.

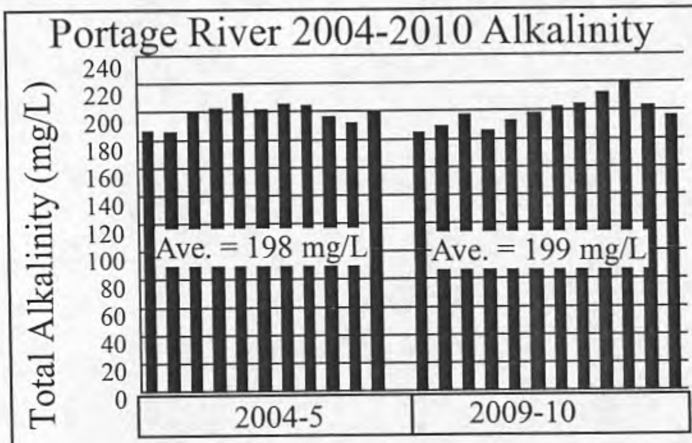


Spring		4/16/04	190	Summer		8/2/04	196
5/12/97	181	4/16/04	189	8/25/97	170	8/2/04	195
5/12/97	176	4/16/04	187	8/25/97	168	8/2/04	190
5/12/97	176	4/21/05	193	8/25/97	170	8/3/05	164
4/19/98	186	4/18/05	193	8/10/98	183	8/3/05	165
4/19/98	185	4/15/05	195	8/10/98	182	8/3/05	162
4/19/98	185	4/18/06	170	8/10/98	182	8/1/06	173
4/25/99	171	4/18/06	173	8/17/99	158	8/1/06	174
4/25/99	170	4/18/06	170	8/27/99	158	8/1/06	172
4/25/99	170	4/21/07	172	8/27/99	157	8/1/07	170
4/15/00	181	4/21/07	172	8/4/00	187	8/1/07	170
4/15/00	183	4/21/07	174	8/4/00	189	8/1/07	170
4/15/00	183	4/18/08	177	8/4/00	188	8/1/08	191
5/13/01	189	4/18/08	177	8/1/01	180	8/1/08	189
5/13/01	190	4/18/08	175	8/1/01	180	8/1/08	190
5/13/01	190	4/18/09	175	8/1/01	180	8/3/09	194
4/15/02	190	4/18/09	177	8/2/02	150	8/3/09	190
4/15/02	185	4/18/09	175	8/2/02	150	8/3/09	192
4/15/02	187	4/20/10	200	8/2/02	150	8/2/10	185
4/28/03	190	4/20/10	200	8/1/03	160	8/2/10	190
4/28/03	189	4/20/10	200	8/1/03	165	8/2/10	185
4/28/03	187			8/1/03	160		

The graph shows the alkalinity of Little Portage Lake ranges from 170 to 200 milligrams per liter in spring and from 150 to 196 mg/L in summer.

These data indicate Little Portage Lake is a hard water lake. Alkalinity varies more in Little Portage Lake than in most natural lakes, but that is probably a result of the streams feeding the lake. Streams generally have higher alkalinities than lakes.

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.



2004-5		2009-10	
5/26/04	186	5/28/09	184
6/29/04	185	6/29/09	189
7/28/04	200	7/31/09	197
8/29/04	202	8/28/09	185
10/1/04	213	9/23/09	192
11/30/04	201	10/21/09	198
12/31/04	205	11/23/09	202
1/28/05	204	12/26/09	204
2/26/05	196	1/23/10	212
3/29/05	191	3/9/10	220
4/18/05	199	3/31/10	203
		4/20/10	196

The graph shows the alkalinities of the Portage River have essentially not changed between 2004-5 and 2009-10. That would be what is expected.

NITRATE NITROGEN

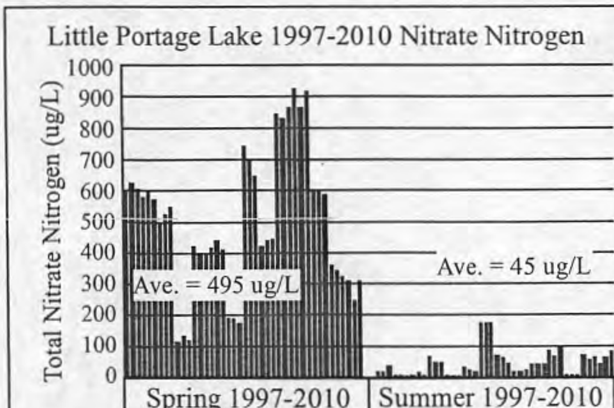
Nitrate, also measured in the parts per billion range, has traditionally been considered by lake scientists to also be a limiting nutrient. The experts felt any concentration below 200 parts per billion was excellent in terms of lake water quality. The highest value found by this author was 48,000 parts per billion in a river which flowed into an Ottawa County lake.

On the other hand, we've studied hundreds of Michigan inland lakes, and many times we find them nitrate limited (very low nitrate nitrogen concentrations), especially in summer.

We're finding many lakes have lower nitrate nitrogen concentrations in summer than in spring. This is probably due to two factors. First, plants and algae growing in lakes as water warms can remove nitrates from the water column. And second, bacterial denitrification (where nitrates are converted to nitrogen gas by bacteria) also occurs at a much faster rate in summer when the water is warmer.

Generally limnologists feel optimal nitrate nitrogen concentrations (which encourage maximum plant and algal growth) are about 10-20 times higher than phosphorus concentrations. The reason more nitrogen than phosphorus is needed is because nitrogen is one of the chemicals used in the production of plant proteins, while phosphorus is used in the transfer of energy, but is not used to create plant material. If the nitrate concentration is less than 10-20 times the phosphorus concentration, the lake is considered nitrogen limited. If the nitrate concentration is higher than 10-20 times the phosphorus concentration, the lake is considered phosphorus limited.

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.

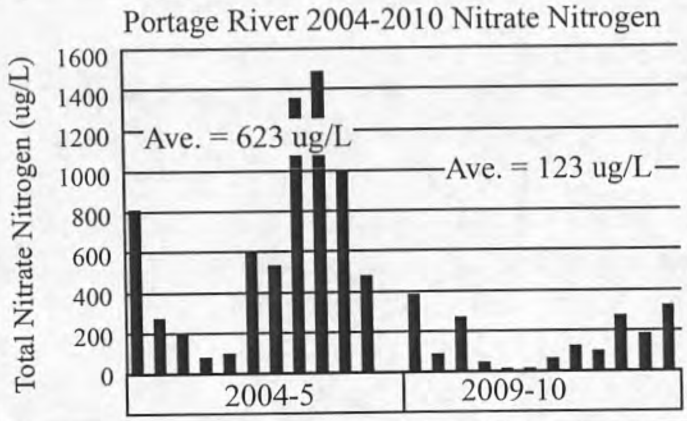


Spring				Summer			
		4/16/04	741			8/2/04	70
5/12/97	594	4/16/04	697	8/25/97	17	8/2/04	61
5/12/97	623	4/16/04	643	8/25/97	17	8/2/04	44
5/12/97	604	4/21/05	422	8/25/97	35	8/3/05	18
4/19/98	578	4/18/05	438	8/10/98	7	8/3/05	18
4/19/98	594	4/15/05	444	8/10/98	9	8/3/05	22
4/19/98	572	4/18/06	842	8/10/98	5	8/1/06	42
4/25/99	495	4/18/06	828	8/17/99	9	8/1/06	42
4/25/99	523	4/18/06	864	8/27/99	14	8/1/06	42
4/25/99	544	4/21/07	922	8/27/99	7	8/1/07	83
4/15/00	112	4/21/07	864	8/4/00	66	8/1/07	66
4/15/00	132	4/21/07	915	8/4/00	46	8/1/07	92
4/15/00	117	4/18/08	593	8/4/00	46	8/1/08	7
5/13/01	423	4/18/08	600	8/1/01	8	8/1/08	7
5/13/01	398	4/18/08	587	8/1/01	5	8/1/08	7
5/13/01	398	4/18/09	358	8/1/01	3	8/3/09	70
4/15/02	419	4/18/09	340	8/2/02	32	8/3/09	56
4/15/02	439	4/18/09	321	8/2/02	22	8/3/09	61
4/15/02	410	4/20/10	306	8/2/02	18	8/2/10	41
4/28/03	192	4/20/10	244	8/1/03	173	8/2/10	62
4/28/03	185	4/20/10	306	8/1/03	173	8/2/10	82
4/28/03	173			8/1/03	173		

The graph shows spring nitrates range from 112 to 922 ug/L and average 495 ug/L while summer nitrates range from 3 to 173 ug/L and average 45 ug/L. Nitrates higher than about 300 in spring are considered high. The summer nitrates are normal for a Michigan inland lake.

In 2009 spring nitrates ranged from 321 to 358 ug/L while summer nitrates ranged from 56 to 70 ug/L. In 2010 spring nitrates ranged from 244 to 306 ug/L while summer nitrates ranged from 41 to 82 ug/L. Both 2009 and 2010 nitrate data sets are normal for a Michigan inland lake.

These data indicate Little Portage Lake is probably phosphorus limited in spring and nitrate limited in summer. It also means no fertilizers containing either nitrogen or phosphorus should be used on near lake areas.



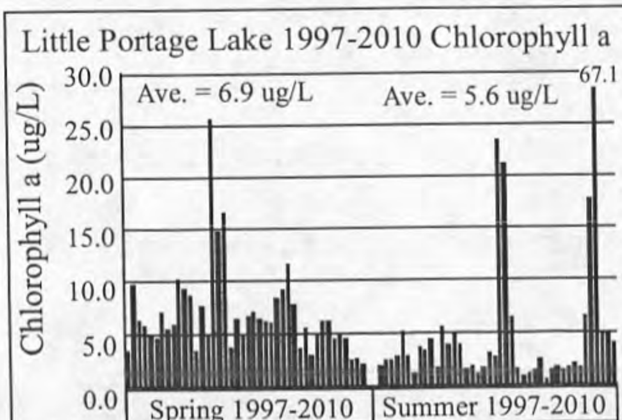
2004-5		2009-10	
5/26/04	806	5/28/09	380
6/29/04	268	6/29/09	87
7/28/04	186	7/31/09	266
8/29/04	76	8/28/09	42
10/1/04	96	9/23/09	10
11/30/04	590	10/21/09	10
12/31/04	528	11/23/09	58
1/28/05	1356	12/26/09	119
2/26/05	1485	1/23/10	95
3/29/05	989	3/9/10	270
4/18/05	473	3/31/10	178
		4/20/10	319

The graph of 2004-5 and 2009-10 nitrates shows the earlier samples ranged from 76 to 1485 ug/L and averaged 623 ug/L while the later samples ranged from 10 to 380 ug/L and averaged 123 ug/L.

The lower Portage River nitrates are a plus for Little Portage Lake. Let's hope this trend continues.

CHLOROPHYLL A

Chlorophyll a generally gives an estimate of algal densities. Best is below 1



Spring		S4/16/04	6.7	Summer		8/2/04	23.5
5/12/97	3.4	4/16/04	7.1	8/25/97	1.9	8/2/04	21.1
5/12/97	9.6	4/16/04	6.4	8/25/97	2.5	8/2/04	6.4
5/12/97	6.3	4/21/05	6.1	8/25/97	2.5	8/3/05	1.5
4/19/98	5.8	4/18/05	6.0	8/10/98	2.8	8/3/05	0.9
4/19/98	4.9	4/15/05	8.3	8/10/98	5.1	8/3/05	1.2
4/19/98	4.6	4/18/06	9.1	8/10/98	2.8	8/1/06	1.4
4/25/99	7.1	4/18/06	11.5	8/17/99	1.1	8/1/06	2.4
4/25/99	5.5	4/18/06	7.7	8/27/99	3.6	8/1/06	0.5
4/25/99	5.9	4/21/07	3.6	8/27/99	3.3	8/1/07	1.4
4/15/00	10.1	4/21/07	5.5	8/4/00	4.4	8/1/07	1.7
4/15/00	9.2	4/21/07	3.0	8/4/00	1.7	8/1/07	1.4
4/15/00	8.6	4/18/08	4.9	8/4/00	5.5	8/1/08	1.7
5/13/01	3.5	4/18/08	6.1	8/1/01	3.8	8/1/08	2.0
5/13/01	7.6	4/18/08	6.1	8/1/01	5.0	8/1/08	1.7
5/13/01	5.0	4/18/09	4.5	8/1/01	3.8	8/3/09	6.6
4/15/02	25.6	4/18/09	4.9	8/2/02	1.5	8/3/09	17.7
4/15/02	14.8	4/18/09	4.5	8/2/02	1.8	8/3/09	69.1
4/15/02	16.5	4/20/10	2.5	8/2/02	1.2	8/2/10	4.8
4/28/03	3.7	4/20/10	2.6	8/1/03	1.7	8/2/10	4.8
4/28/03	6.4	4/20/10	2.0	8/1/03	3.1	8/2/10	4.0
4/28/03	5.0			8/1/03	2.7		

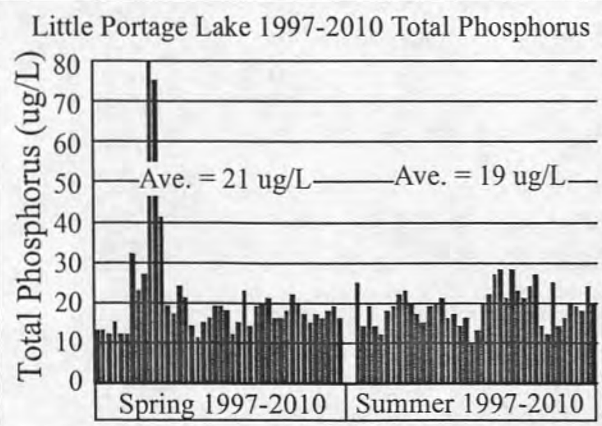
microgram per liter.

The graph of chlorophyll data shows spring chlorophylls are generally higher than summer chlorophylls, and the averages bear this out. The spring average chlorophylls are 6.9 ug/L while the summer chlorophylls average 5.6 ug/L, even though the summer has the highest single value, 67.1 ug/L in summer 2009 at Station 3. The other two summer 2009 samples also had high chlorophylls as well. 2010 spring chlorophylls were the lowest so far, 2.0 to 2.6 ug/L. 2010 summer chlorophylls were about twice the spring values, 4.0 to 4.8 ug/L.

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 (1 part per billion is one second in 31 years) 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 blooms 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).

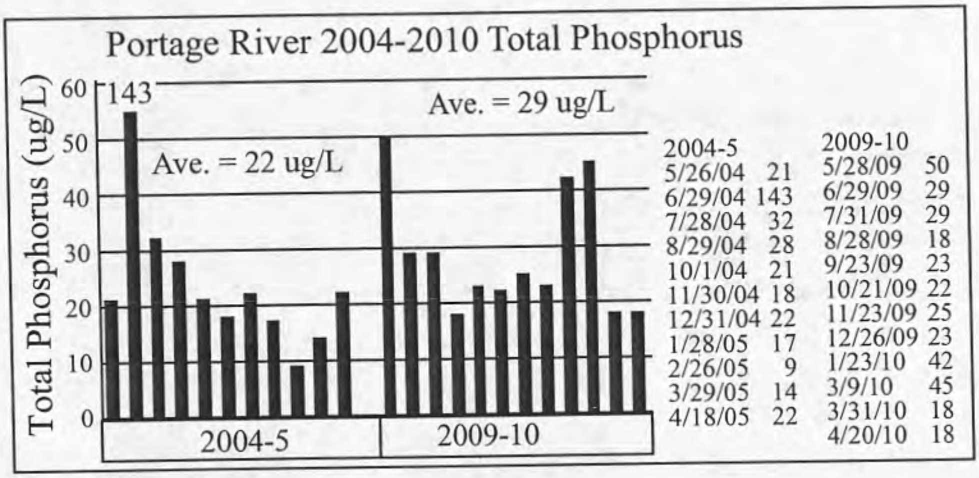


Spring		4/16/04	19	Summer		8/1/03	13
5/12/97	13	4/16/04	18	8/25/97	25	8/2/04	20
5/12/97	13	4/16/04	12	8/25/97	14	8/2/04	22
5/12/97	12	4/21/05	15	8/25/97	19	8/2/04	27
4/19/98	15	4/18/05	23	8/10/98	14	8/3/05	28
4/19/98	12	4/15/05	14	8/10/98	12	8/3/05	21
4/19/98	12	4/18/06	19	8/10/98	18	8/3/05	28
4/25/99	32	4/18/06	20	8/17/99	19	8/1/06	23
4/25/99	23	4/18/06	21	8/27/99	22	8/1/06	21
4/25/99	27	4/21/07	16	8/27/99	23	8/1/06	24
4/15/00	80	4/21/07	16	8/4/00	20	8/1/07	27
4/15/00	75	4/21/07	18	8/4/00	17	8/1/07	14
4/15/00	41	4/18/08	22	8/4/00	15	8/1/07	12
5/13/01	19	4/18/08	20	8/1/01	19	8/1/08	25
5/13/01	17	4/18/08	17	8/1/01	20	8/1/08	14
5/13/01	24	4/18/09	15	8/1/01	21	8/1/08	16
4/15/02	21	4/18/09	17	8/2/02	16	8/3/09	20
4/15/02	14	4/18/09	16	8/2/02	17	8/3/09	19
4/15/02	11	4/20/10	18	8/2/02	14	8/3/09	18
4/28/03	15	4/20/10	19	8/1/03	16	8/2/10	24
4/28/03	16	4/20/10	16	8/1/03	10	8/2/10	20
4/28/03	19					8/2/10	18

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

The graph shows, other than three high spring phosphorus concentrations, that there is not a lot of difference between the spring and summer phosphorus concentrations. Summer phosphorus concentrations appear to be a bit higher, but not significantly so. In 2010 spring phosphorus concentrations ranged from 16 to 19 ug/L while summer phosphorus concentrations ranged from 18 to 24 ug/L.

The graph shows phosphorus concentrations range from a low of 10 micrograms per liter (which is good) to a high of 80 micrograms (which is not good at all). Those three high spring values may be related to sewage treatment plant discharges.



The graph of Portage River concentrations shows in 2004-5 they ranged from 9 to 143 ug/L and averaged 22 ug/L. In 2009-10 they ranged from 18 to 50 ug/L and averaged 29 ug/L. Higher phosphorus concentrations in the Portage River where it discharges into Little Portage Lake is not a plus.

SECCHI DISK TRANSPARENCY (originally Secchi's disk)

In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20 centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar with today.

The Secchi disk transparency is a lake test widely used and accepted by limnologists. The experts generally felt the greater the Secchi disk depth, the better quality the water. However, one Canadian scientist pointed out acid lakes have very deep Secchi disk readings. Most lakes in southeast Michigan have Secchi disk transparencies of less than ten feet. On the other hand, Elizabeth Lake in Oakland County had 34 foot Secchi disk readings in summer 1996, evidently caused by a zebra mussel invasion a couple of years earlier.

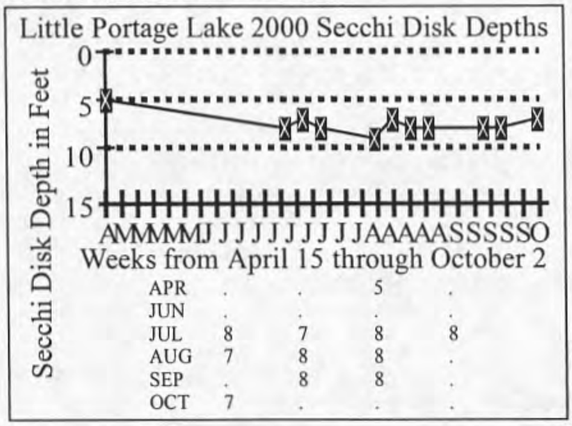
Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency depth.

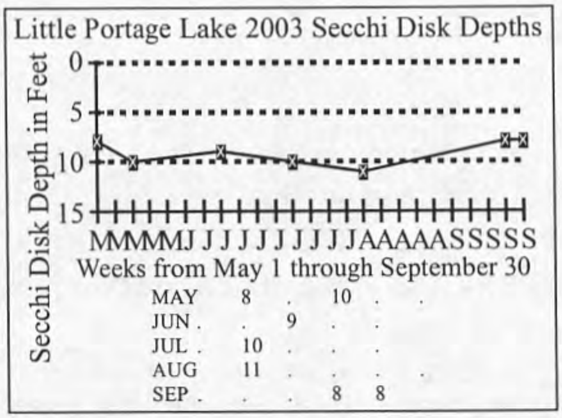
We do it slightly differently. We lower the disk on the shaded side of an anchored boat until the disk disappears, and note the depth, then report the depth to the next deepest foot. For example if the disk disappears at six and a half feet, we report the Secchi disk depth as 7 feet. The reason we do this is that some suggest using a water telescope (a device that works like an underwater mask and eliminates water roughness) to view the disk as it disappears. Since we don't use this device, we compensate for it by noting the slightly deeper depth.

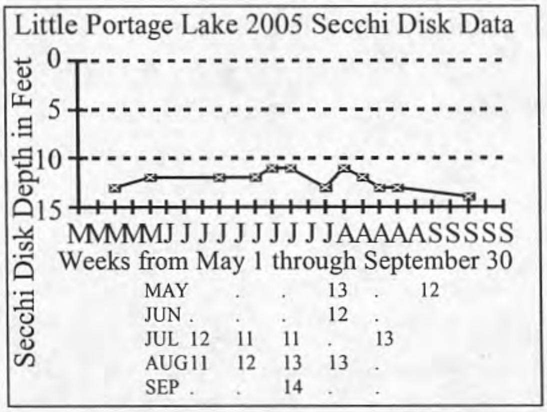
We feel it is only necessary to report Secchi disk measurements to the closest foot. Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness influences the visibility of the disk more than sunny or cloudy days. Furthermore, it's been reported that most adults can see the Secchi disk disappear at about the same depth, but grand-children see it disappear 3-4 feet deeper than grand-parents.

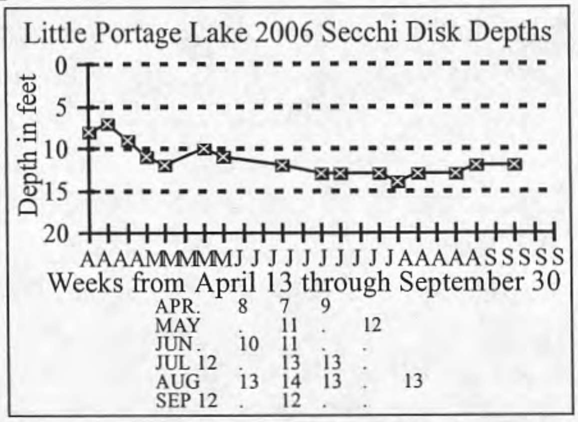
If there are sample sites where the lake is too shallow and the disk is visible when resting on the bottom, the reading should be taken at a nearby deeper site. Since the sampling procedure is designed to obtain "representative samples" moving the boat to an area where a Secchi disk transparency reading can be properly taken is appropriate. In the case of Secchi disk readings, this procedure is more valid than reporting the disk is visible on the lake bottom.

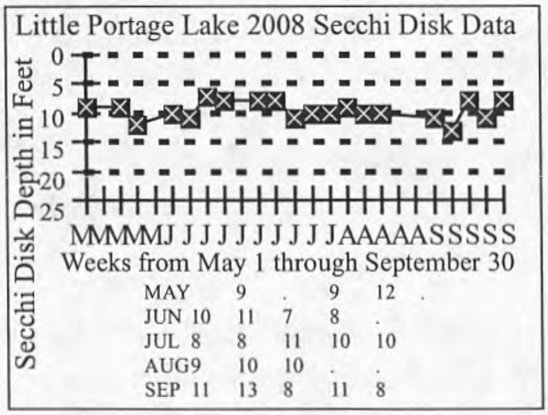
SECCHI DISK DATA

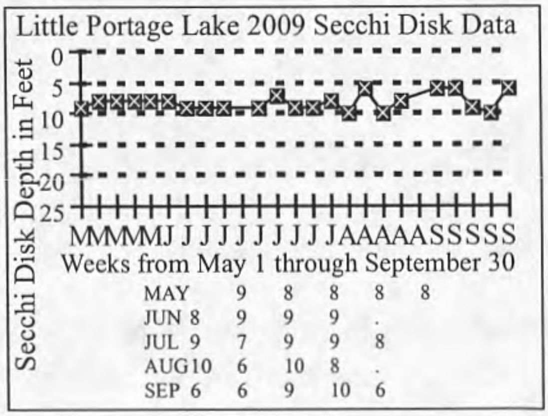












2000

Dan Doran collected Secchi disk data on Little Portage Lake in 2000. The graph shows his data. It shows Little Portage Lake got clearer as the water warmed from spring to summer, but not a lot clearer. The chlorophyll a data shows why. Algal blooms.

2003

WQI limnologists collected monthly Secchi disk data in 2003. The graph shows the data. The graph shows the clarity of the water in Little Portage Lake didn't change much as the water warmed from spring to summer. This indicates nutrient additions are fairly uniform throughout the warm months.

2005

Steve Morehouse did a good job collecting Secchi disk data on Little Portage Lake in 2005. The graph shows his data, which ranged from 11 to 14 feet.

These data indicate the clarity of the lake did not change much as the water warmed from spring to summer in 2005. Usually this indicates a fairly uniform delivery of nutrients to the lake.

2006

Morehouse did a good job collecting Secchi disk data on Little Portage Lake in 2006. The graph shows his data, which ranged from 7 to 14 feet.

These data indicate the clarity of the lake was worse in early spring (7-9 feet). After the middle of May the clarity gradually improved (11-14 feet).

2007

We did not receive Secchi disk data in 2007.

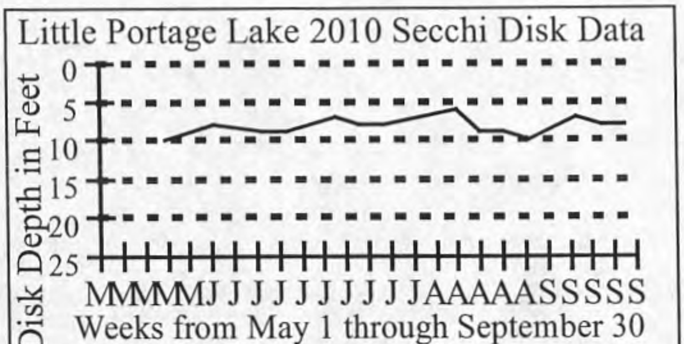
2008

Bill Ferrington did a great job collecting Secchi disk data on Little Portage Lake in 2008, 2009 and 2010. The graphs show his data. The graph shows in 2008 the clarity of the lake did not vary much from spring, when the water was cold, to summer, when the water was warm. In 2008, the water clarity ranged between 7 and 13 feet, but was pretty much a straight line.

2009

Ferrington collected Secchi disk data from Little Portage Lake in 2009. As in 2008, his data was essentially a straight line, indicating little difference in clarity between the cold spring water and the warm summer water.

2010

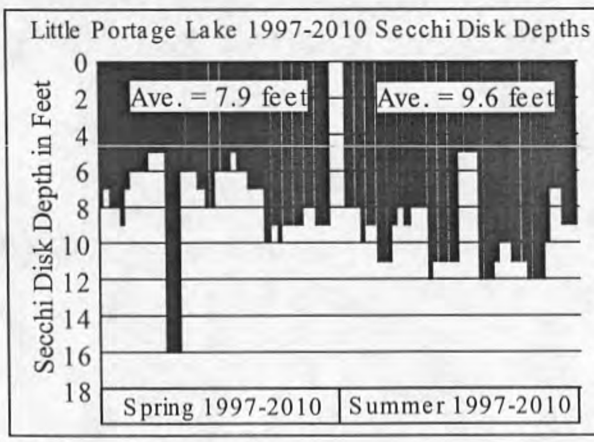


MAY	.	.	.	10	.
JUN	8	.	9	9	.
JUL	7		8	8	.
AUG	6	9	9	10	.
SEP	7	8	8	.	.

In 2010 Ferrington's data shows the water clarity ranged from 6 to 10 feet through the warm months, with the deepest being in mid May and the shallowest being in August.

SECCHI DISK DATA COLLECTED WITH THE SAMPLES

The graph shows the Secchi disk readings collected at the same time as the spring and summer samples. It shows that although the deepest reading was in spring 2001 (16 feet), summer Secchi disk readings are generally deeper



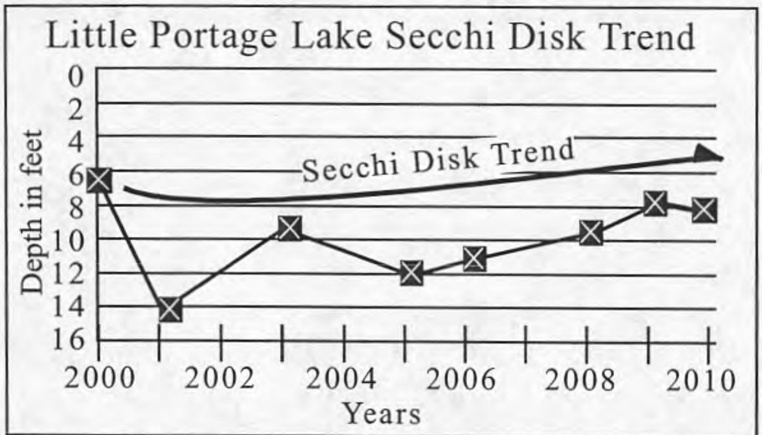
Spring				Summer			
		4/16/04	6			8/2/04	5
5/12/97	8	4/16/04	6	8/25/97	8	8/2/04	5
5/12/97	7	4/16/04	6	8/25/97	8	8/2/04	5
5/12/97	8	4/21/05	5	8/25/97	8	8/3/05	12
4/19/98	8	4/18/05	6	8/10/98	10	8/3/05	12
4/19/98	9	4/15/05	6	8/10/98	9	8/3/05	12
4/19/98	7	4/18/06	7	8/10/98	9	8/1/06	11
4/25/99	6	4/18/06	7	8/17/99	11	8/1/06	10
4/25/99	6	4/18/06	7	8/27/99	11	8/1/06	10
4/25/99	6	4/21/07	10	8/27/99	11	8/1/07	11
4/15/00	5	4/21/07	9	8/4/00	9	8/1/07	11
4/15/00	5	4/21/07	10	8/4/00	8	8/1/07	11
4/15/00	5	4/18/08	9	8/4/00	9	8/1/08	12
5/13/01	16	4/18/08	9	8/1/01	8	8/1/08	12
5/13/01	16	4/18/08	9	8/1/01	8	8/1/08	12
5/13/01	16	4/18/09	9	8/1/01	8	8/3/09	10
4/15/02	6	4/18/09	8	8/2/02	12	8/3/09	7
4/15/02	6	4/18/09	8	8/2/02	11	8/3/09	7
4/15/02	6	4/20/10	9	8/2/02	11	8/2/10	9
4/28/03	7	4/20/10	9	8/1/03	11	8/2/10	9
4/28/03	8	4/20/10	9	8/1/03	11	8/2/10	9
4/28/03	8			8/1/03	11		

than spring readings.

The graph does not show a lot of change in the spring readings, but the summer readings may be getting better. 2010 spring Secchi disk readings were 9 feet. 2010 summer readings were 9 feet as well.

THE SECCHI DISK TREND GRAPH

Because we have 8 years of Secchi disk data, we were able to construct a Secchi disk Trend Graph. The graph shows the deepest average reading was in 2001 while the shallowest reading was in 2000, followed by 2009. 2010 average Secchi disk readings were third worse.



Data:	2000	2001	2003	2005	2006	2008	2009	2010
	6.7	14.4	9.6	12.3	11.4	9.7	7.9	8.2

The graph seems to show the trend is to less clear water, which is not a plus. Because of the scarcity of homes on the lake, the source of water quality problems is probably upstream.

THE LAKE WATER QUALITY INDEX

The Lake Water Quality Index used in this study to define the water quality of Little Portage 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 invoked 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

Total alkalinity

Chlorophyll a	Temperature
Secchi disk depth	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 LWQI seen by this author was 16 in 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.

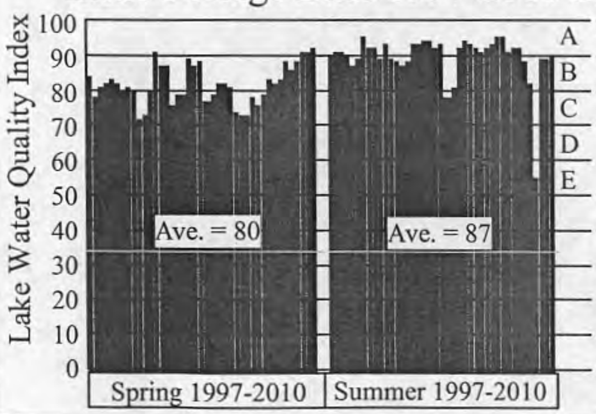
The position of the red lines across the thermometer indicates how the results of each test compare in terms of lake water quality. Test results indicating excellent water quality are indicated by red lines near the top of the thermometer. Test results indicating poor water quality are indicated by red 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.

THE SPRING AND SUMMER LAKE WATER QUALITY INDICES

Little Portage Lake 1997-2010 Lake Water Quality Indices



Spring				Summer			
		4/16/04	75			8/2/04	76
5/12/97	82	4/16/04	75	8/25/97	88	8/2/04	76
5/12/97	76	4/16/04	77	8/25/97	89	8/2/04	79
5/12/97	79	4/21/05	80	8/25/97	89	8/3/05	90
4/19/98	80	4/18/05	80	8/10/98	88	8/3/05	92
4/19/98	81	4/15/05	79	8/10/98	85	8/3/05	91
4/19/98	80	4/18/06	72	8/10/98	87	8/1/06	90
4/25/99	78	4/18/06	71	8/17/99	93	8/1/06	89
4/25/99	79	4/18/06	71	8/27/99	90	8/1/06	90
4/25/99	78	4/21/07	76	8/27/99	90	8/1/07	91
4/15/00	70	4/21/07	74	8/4/00	87	8/1/07	93
4/15/00	71	4/21/07	77	8/4/00	91	8/1/07	93
4/15/00	78	4/18/08	81	8/4/00	87	8/1/08	89
5/13/01	89	4/18/08	80	8/1/01	86	8/1/08	90
5/13/01	85	4/18/08	81	8/1/01	85	8/1/08	90
5/13/01	85	4/18/09	86	8/1/01	86	8/3/09	86
4/15/02	74	4/18/09	84	8/2/02	91	8/3/09	80
4/15/02	77	4/18/09	86	8/2/02	91	8/3/09	54
4/15/02	77	4/20/10	89	8/2/02	92	8/2/10	87
4/28/03	87	4/20/10	89	8/1/03	92	8/2/10	87
4/28/03	85	4/20/10	90	8/1/03	90	8/2/10	88
4/28/03	86			8/1/03	91		

The graph shows the spring Lake Water Quality Indices for Little Portage Lake range from a low of 70 to a high of 90. This indicates the water quality of Little Portage Lake in spring was in the C to A range.

The graph shows the late summer Lake Water Quality Indices for Little Portage Lake range from 54 to 93. This indicates the water quality of Little Portage Lake in summer is in the E to A range.

The graph shows summer water quality (average = 87) is generally better than spring water quality (average = 80). The main reasons for the lower spring LWQIs are the higher chlorophylls, the shallower Secchi disk readings and high nitrates.

In 2010 spring LWQIs were 89 or 90, or in the B to A range, while in summer they were 87 or 88, or in the B range. The summer LWQI of 54 was caused, more than anything else, by the high chlorophyll a concentration.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

Because the spring Lake Water Quality Indices for the three surface samples in 2010 were similar (89 89 90) one LWQI calculation sheet is included in this report for these three samples, using averaged data.

Because the summer Lake Water Quality Indices in 2010 at the three surface stations were similar (87 87 88) a second Lake Water Quality Index calculation sheet is included for the three surface samples, again using averaged data.

In the report marked MASTER, all 6 of the 2010 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, they produce iron sulfides, which are black. 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.

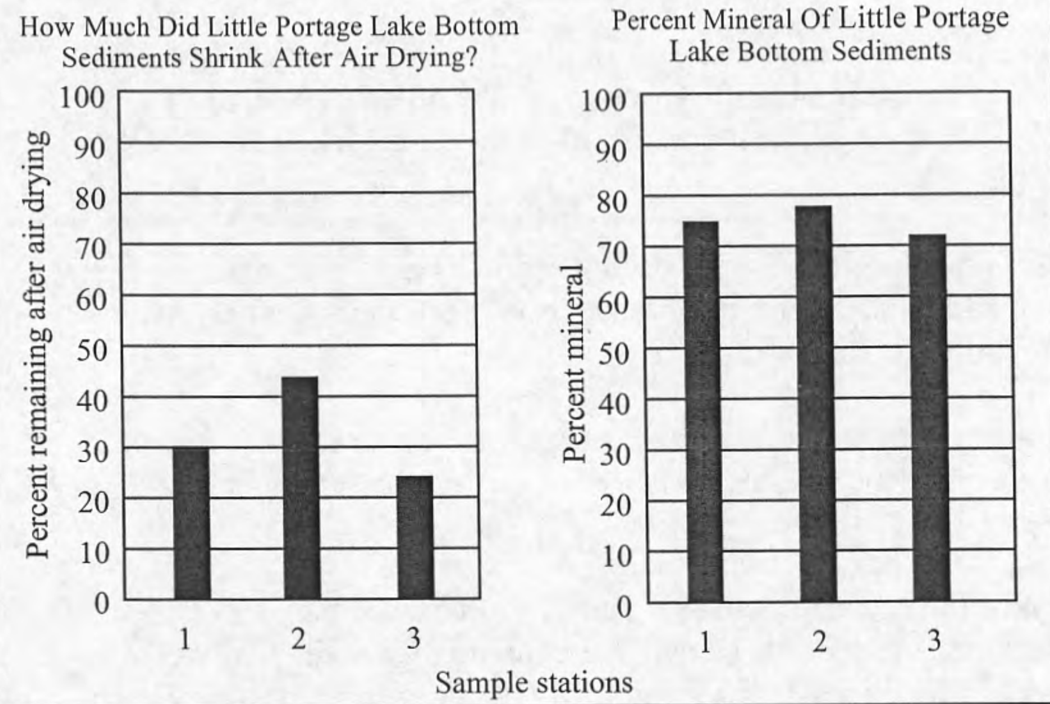
If the gray bottom sediments remain gray after burning they are considered carbonates, and the loss of material during this process is considered organic material. The results are expressed in the percentage of minerals in the bottom sediments.

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 lakes to be above 85 percent mineral. And I consider bottom sediments less than 50 percent mineral to be muck.

LITTLE PORTAGE LAKE BOTTOM SEDIMENTS



Characteristics of Little Portage Lake Bottom Sediments (2005)

Sample I.D.	Percent Shrinkage	Percent Mineral	Dried at 100°C Color & Description	Color after burning at 550°C	Depth of water (feet)
1	70	74	Gray	Gray	35
2	56	78	Gray	Red	21
3	77	71	Gray	Gray	17

Average mineral content of bottom sediments = 74%.

Bottom sediment samples were collected from Little Portage Lake in spring 2005. The graph shows the data.

The sample from Station 1 collected in 35 feet of water was gray when air dried, shrunk 70 percent, was 74 percent mineral and gray in color after burning at 550 degrees C.

The sample from Station 2 collected in 21 feet of water was gray when air dried, shrunk 56 percent, was 78 percent mineral and red in color after burning at 550 degrees C.

The sample from Station 3 collected in 17 feet of water was gray when air dried, shrunk 77 percent, was 71 percent mineral and gray in color after burning at 550 degrees C.

None of the samples shrunk excessively (excessive is greater than 95%). This means the sediments are fairly well consolidated and not easily mixed into the water column when the lake mixes in spring or fall. Two samples turned gray after air-drying and remained gray after burning. A third turned red after burning at 550 degrees C.

The average mineral content of the sediments was 74 percent indicating the lake is starting to build up organic material at a faster than normal rate.

The gray color after air drying and after burning at 550 degrees C indicate the deep water samples were essentially calcium and magnesium carbonate and bicarbonate, which is what we often see filling Michigan's inland lakes.

The sediment sample that turned red after burning at 550 degrees C indicated the presence of clay in the sediments, which is not a normal constituent to Michigan inland lake bottom sediments. Clay is usually washed into lakes from road or home building activities, or farming operations.

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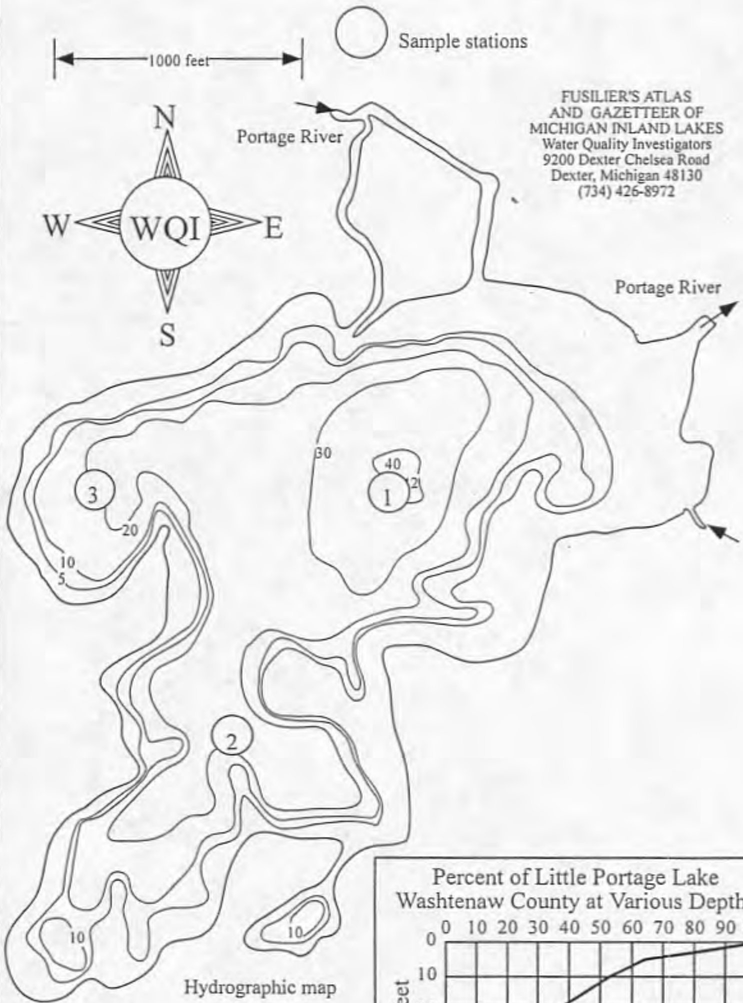
Consulting Limnologist
Water Quality Investigators
Dexter, Michigan
May 2011

Surface Lake Water Quality Data

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
5/12/97	1	12	9.7	87	3.4	8	594	181	8.2	490	13	82	B
5/12/97	2	12	10.3	95	9.6	7	623	176	8.2	485	13	76	C
5/12/97	3	12	10.4	98	6.3	8	604	176	8.3	480	12	79	C
8/25/97	1	21	8.8	98	1.9	8	17	170	8.4	460	25	88	B
8/25/97	2	21	8.6	96	2.5	8	17	168	8.4	460	14	89	B
8/25/97	3	21	8.7	97	2.5	8	35	170	8.3	460	19	89	B
4/19/98	1	13	10.3	97	5.8	8	578	186	8.3	460	15	80	B
4/19/98	2	13	10.6	100	4.9	9	594	185	8.2	480	12	81	B
4/19/98	3	13	10.2	96	4.6	7	572	185	8.3	470	12	80	B
8/10/98	1	26	8.6	105	2.8	10	7	183	8.6	440	14	88	B
8/10/98	2	26	8.6	105	5.1	9	9	182	8.5	440	12	85	B
8/10/98	3	26	8.6	105	2.8	9	5	182	8.6	420	18	87	B
4/25/99	1	13	9.8	92	7.1	6	495	171	8.1	500	32	78	C
4/25/99	2	13	9.5	90	5.5	6	523	170	8.2	500	23	79	C
4/25/99	3	13	9.5	90	5.9	6	544	170	8.1	500	27	78	C
8/27/99	3	24	8.9	105	1.1	11	9	158	8.3	450	19	93	A
8/27/99	1	24	9.3	109	3.6	11	14	158	8.3	460	22	90	A
8/27/99	2	23	8.8	101	3.3	11	7	157	8.3	450	23	90	A
4/15/00	1	12	10.3	95	10.1	5	112	181	8.4	520	80	70	C
4/15/00	2	10	10.6	94	9.2	5	132	183	8.4	520	95	71	C
4/15/00	3	10	10.6	94	8.6	5	117	183	8.4	520	91	78	C
8/4/00	1	24	8.3	98	4.4	9	66	187	8.3	520	20	87	B
8/4/00	2	23	8.6	99	1.7	8	46	189	8.4	510	17	91	A
8/4/00	3	23	7.8	90	5.5	9	46	188	8.3	510	15	87	B
5/13/01	1	19	9.4	100	3.5	16	423	189	8.4	510	19	89	B
5/13/01	2	19	9.3	99	7.6	16	398	190	8.4	510	17	85	B
5/13/01	3	19	9.2	98	5.0	16	398	190	8.3	510	24	85	B
8/1/01	1	28	7.8	99	3.8	8	8	180	8.0	480	19	86	B
8/1/01	2	27	8.2	102	5.0	8	5	180	8.0	480	20	85	B
8/1/01	3	28	8.1	103	3.8	8	3	180	8.0	480	21	86	B
4/15/02	1	10	10.5	93	25.6	6	419	190	8.5	545	21	74	C
4/15/02	2	10	10.5	93	14.8	6	439	185	8.4	545	14	77	C
4/15/02	3	9	10.6	91	16.5	6	410	187	8.4	535	11	77	C
8/2/02	1	28	8.5	108	1.5	12	32	150	7.5	485	16	91	A
8/2/02	2	28	8.5	108	1.8	11	22	150	7.6	480	17	91	A
8/2/02	3	28	8.5	108	1.2	11	18	150	7.6	480	14	92	A
4/28/03	1	14	9.9	96	3.7	7	192	190	8.2	565	15	87	B
4/28/03	2	14	10.2	99	6.4	8	185	189	8.2	570	16	85	B
4/28/03	3	14	10.1	98	5.0	8	173	187	8.2	550	19	86	B
8/1/03	1	26	9.1	111	1.7	11	173	160	8.5	540	16	92	A
8/1/03	2	25	8.9	106	3.1	11	173	165	8.6	530	10	90	A
8/1/03	3	25	9.0	107	2.7	11	173	160	8.6	535	13	91	A
4/16/04	1	11	10.6	95	6.7	6	741	190	8.2	600	19	75	C
4/16/04	2	11	10.7	96	7.1	6	697	189	8.2	610	18	75	C
4/16/04	3	11	10.7	96	6.4	6	643	187	8.3	595	12	77	C
8/2/04	1	24	8.6	101	23.5	5	70	196	8.3	560	20	76	C
8/2/04	2	24	9.4	111	21.1	5	61	195	8.4	560	22	76	C
8/2/04	3	24	10.5	124	6.4	5	44	190	8.4	550	27	79	C
4/18/05	1	16	9.5	95	6.1	5	422	193	8.2	550	15	80	B
4/18/05	2	16	10.2	102	6.0	6	438	193	8.3	550	23	80	B
4/18/05	3	16	10.2	102	8.3	6	444	195	8.3	570	14	79	C
8/3/05	1	27	8.1	101	1.5	12	18	164	8.2	490	28	90	A
8/3/05	2	27	7.8	98	0.9	12	18	165	8.1	490	21	92	A
8/3/05	3	27	8.0	100	1.2	12	22	162	8.2	480	28	91	A
4/19/06	1	14	9.8	94	9.1	7	842	170	8.2	540	19	72	C
4/19/06	2	14	10.4	100	11.5	7	828	173	8.3	540	20	71	C
4/19/06	3	14	10.4	100	7.7	7	864	170	8.2	540	21	71	C
8/1/06	1	28	7.8	99	1.4	11	42	173	8.4	500	23	90	A
8/1/06	2	28	7.8	99	2.4	10	42	174	8.4	510	21	89	A
8/1/06	3	28	7.8	99	0.5	10	42	172	8.4	510	24	90	C
4/21/07	1	14	10.5	101	3.6	10	922	172	8.2	530	16	76	C
4/21/07	2	13	10.3	97	5.5	9	864	172	8.2	540	16	74	C
4/21/07	3	13	10.8	102	3.0	10	915	174	8.2	520	18	77	C
8/1/07	1	25	8.2	98	1.4	11	83	170	8.3	470	27	91	A
8/1/07	2	26	8.3	101	1.7	11	66	170	8.3	470	14	93	A
8/1/07	3	26	8.3	101	1.4	11	92	170	8.3	470	12	93	A

Surface Lake Water Quality Data

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
4/18/08	1	13	11.4	108	4.9	9	593	177	7.9	480	22	81	B
4/18/08	2	12	11.2	104	6.1	9	600	177	7.9	480	20	80	B
4/18/08	3	13	11.2	107	6.1	9	587	175	7.9	480	17	81	B
8/1/08	1	27	9.7	121	1.7	12	7	191	8.4	465	25	89	B
8/1/08	2	27	9.8	122	2.0	12	7	189	8.4	465	14	90	A
8/1/08	3	27	9.9	122	1.7	12	7	190	8.4	465	16	90	A
4/18/09	1	12	11.3	105	4.5	9	358	175	8.1	460	15	86	B
4/18/09	2	12	12.3	114	4.9	8	340	177	8.1	460	17	84	B
4/18/09	3	12	11.3	105	4.5	8	321	175	8.1	460	16	86	B
8/3/09	1	23	8	92	6.6	10	70	194	8.2	480	20	86	B
8/3/09	2	23	7.2	83	17.7	7	56	190	8.1	490	19	80	B
8/3/09	3	23	7.6	87	67.1	7	61	192	8.2	480	18	54	E
4/20/10	1	13	11.4	98	2.5	9	306	200	8.3	510	18	89	B
4/20/10	2	13	11.6	109	2.6	9	244	200	8.3	520	19	89	B
4/20/10	3	13	11.8	111	2.0	9	306	200	8.3	520	16	90	A
8/9/10	1	25	7.7	92	4.8	9	41	185	8.2	460	24	87	B
8/9/10	2	25	7.9	94	4.8	9	62	190	8.2	460	20	87	B
8/9/10	3	25	7.9	94	4.0	9	82	185	8.2	460	18	88	B
5/26/04	Portage R.	---	---	---	---	---	806	186	7.9	580	21	---	---
6/29/04	Portage R.	---	---	---	---	---	268	185	8.6	540	143	---	---
7/28/04	Portage R.	---	---	---	---	---	186	200	8.0	550	32	---	---
8/29/04	Portage R.	---	---	---	---	---	76	202	8.1	600	28	---	---
10/1/04	Portage R.	---	---	---	---	---	96	213	7.9	560	21	---	---
11/30/04	Portage R.	---	---	---	---	---	590	201	8.0	510	18	---	---
12/31/04	Portage R.	---	---	---	---	---	528	205	8.0	570	22	---	---
1/28/05	Portage R.	---	---	---	---	---	1356	204	7.8	560	17	---	---
2/26/05	Portage R.	---	---	---	---	---	1485	196	7.9	580	9	---	---
3/29/05	Portage R.	---	---	---	---	---	989	191	8.0	540	14	---	---
4/18/05	Portage R.	---	---	---	---	---	473	199	8.2	570	22	---	---
5/28/09	Portage R.	---	---	---	---	---	380	184	7.7	490	50	---	---
6/29/09	Portage R.	---	---	---	---	---	87	189	8.0	520	29	---	---
7/31/09	Portage R.	---	---	---	---	---	266	197	8.0	500	29	---	---
8/28/09	Portage R.	---	---	---	---	---	42	185	8.0	500	18	---	---
9/23/09	Portage R.	---	---	---	---	---	10	192	7.9	500	23	---	---
10/21/09	Portage R.	---	---	---	---	---	10	198	8.0	580	22	---	---
11/23/09	Portage R.	---	---	---	---	---	58	202	8.1	820	25	---	---
12/26/09	Portage R.	---	---	---	---	---	119	204	8.0	560	23	---	---
1/23/10	Portage R.	---	---	---	---	---	95	212	8.0	560	42	---	---
3/9/10	Portage R.	---	---	---	---	---	270	220	8.1	570	45	---	---
3/31/10	Portage R.	---	---	---	---	---	178	203	8.2	540	18	---	---
4/20/10	Portage R.	---	---	---	---	---	319	196	8.2	540	18	---	---



FUSILIER'S ATLAS
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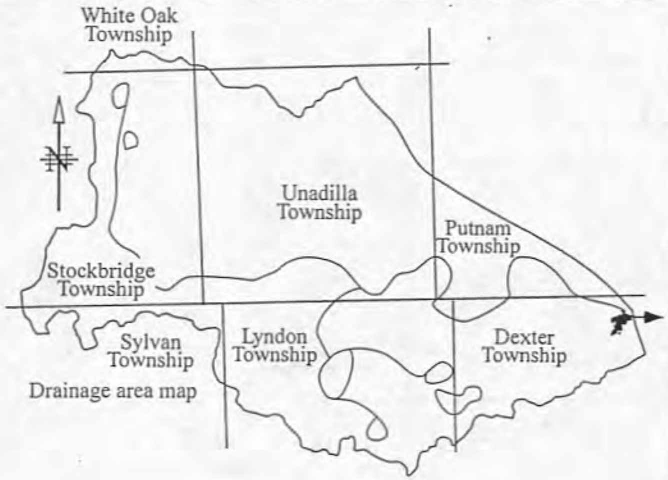


Drainage area map

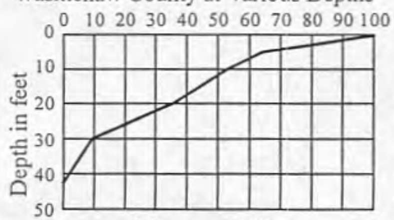
TABLE OF LAKE DATA

Lake Name	Little Portage Lake
County	Washtenaw
U.S.G.S. Map	Pinckney
Type of lake	Natural kettle
River basin	Huron
Lake area (acres)	112
Maximum depth (feet)	42
Mean depth (feet)	17.3
Lake volume (acre feet)	1813
Shoreline length (feet)	15099
Watershed area (acres)	54672
Drainage area (acres)	54784
Watershed to lake ratio	488
Flushing rate	0.04 years
Elevation	850
Longest dimension (feet)	3925
Ice out date	3/11/06
	4/6/08
	3/17/09
Date lake mixed	3/12/06
	4/6/08
	3/31/09
Lake Water Quality Indices	
Spring 1997	82 76 79
Summer 1997	88 89 89
Spring 1998	80 81 80
Summer 1998	88 85 87
Spring 1999	78 79 78
Summer 1999	90 90 93
Spring 2000	70 71 78
Summer 2000	87 91 87
Spring 2001	70 71 78
Summer 2001	87 91 87
Spring 2002	74 77 77
Summer 2002	91 91 92
Spring 2003	87 85 86
Summer 2003	92 90 91
Spring 2004	75 75 77
Summer 2004	76 76 79
Spring 2005	80 80 79
Summer 2005	90 92 91
Spring 2006	72 71 71
Summer 2006	90 89 90
Spring 2007	76 74 77
Summer 2007	91 93 93
Spring 2008	81 80 81
Summer 2008	89 90 90
Spring 2009	86 84 86
Summer 2009	86 80 54
Spring 2010	89 89 90
Summer 2010	87 87 88
Bottom Sediments, % mineral	74 78 71
Latitude	42° 24.912N
Longitude	83° 55.795W
Official lake monitor	Bill Ferrington

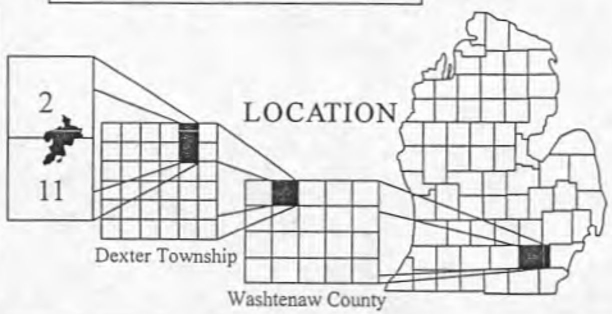
Little Portage Lake Contour Areas & Volumes

Area of various contours	Volume in Acre Feet
Lake area = 111.82 acres	
Island area = 6.47 acres	
Surface area = 104.73 acres	
5 foot = 66.90 acres	429
10 foot = 56.43 acres	617
20 foot = 37.92 acres	472
30 foot = 10.11 acres	240
40-42 foot = .70 acres	55
Lake volume = 1813 acre feet	

Percent of Little Portage Lake
Washtenaw County at Various Depths

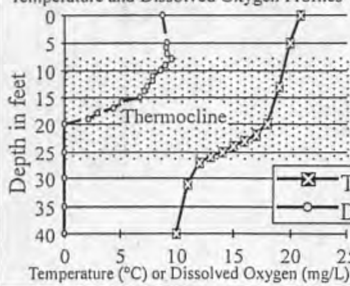


Lake area = 112 acres



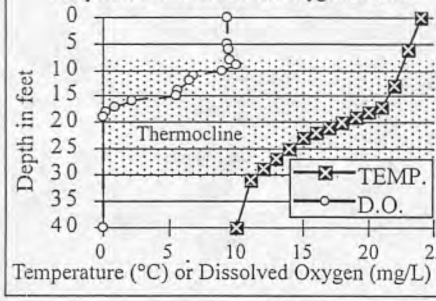
Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

Little Portage Lake August 26, 1997
Temperature and Dissolved Oxygen Profiles



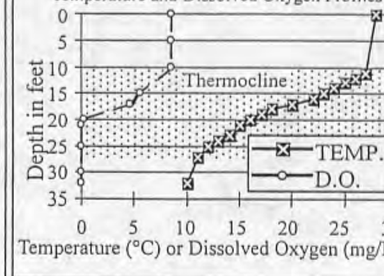
Temp.	Depth	D.O.	Depth
21	0	8.8	0
20	5	9.2	5
19	13	9.1	6
18	20	9.2	7
17	22	9.6	8
16	23	9.0	9
15	24	8.6	10
14	25	7.9	11
13	26	7.9	12
12	27	7.4	13
11	31	7.2	14
10	40	6.8	15
		5.2	16
		4.4	17
		3.0	18
		2.2	19
		0.0	20
		0.0	25
		0.0	30
		0.0	35
		0.0	40

Little Portage Lake, August 27, 1999
Temperature and Dissolved Oxygen Profiles



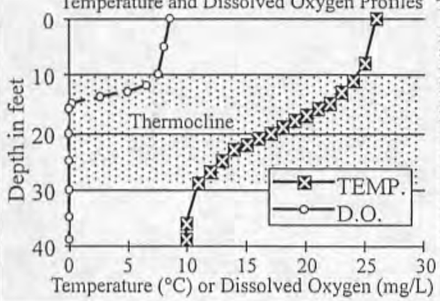
Temp.	Depth	D.O.	Depth
24	0	9.3	0
23	6	9.3	5
22	13	9.4	6
21	17	9.5	8
20	18	10.0	9
19	19	8.9	10
18	20	6.7	11
17	21	6.4	12
16	22	5.6	14
15	23	5.5	15
14	25	2.1	16
13	27	0.9	17
12	29	0.2	18
11	31	0.0	19
10	40	0.0	40

Little Portage Lake, August 2, 2002
Temperature and Dissolved Oxygen Profiles



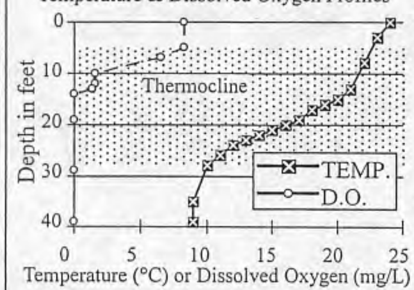
Temp.	Depth	D.O.	Depth
28	0	8.5	0
27	11	8.5	5
26	12	8.5	10
25	13	5.6	15
24	14	4.6	17
23	15	0.3	20
22	16	0.0	21
20	17	0.0	25
18	18	0.0	30
17	19	0.0	32
16	20		
15	21		
14	23		
13	24		
12	25		
11	27		
10	32		

Little Portage Lake August 11, 1998
Temperature and Dissolved Oxygen Profiles



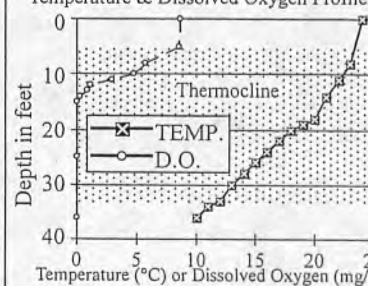
Temp.	Depth	D.O.	Depth
26	0	8.6	0
25	8	8.1	5
24	11	7.6	10
23	13	6.6	12
22	15	5.0	13
21	16	2.6	14
20	17	0.3	15
19	18	0.0	16
18	19	0.0	20
17	20	0.0	25
16	21	0.0	30
15	22	0.0	35
14	23	0.0	39
13	25		
12	27		
11	29		
10	36		
10	39		

Little Portage Lake August 4, 2000
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
24	0	8.3	0
23	3	8.3	5
22	8	6.5	7
21	13	1.6	10
20	15	1.6	12
19	16	1.4	13
18	17	0.0	14
17	19	0.0	19
16	20	0.0	29
15	21	0.0	39
14	22		
13	23		
12	24		
11	26		
10	28		
9	35		
9	39		

Little Portage Lake August 2, 2004
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
24	0	8.6	0
23	8	8.5	5
22	11	5.7	8
21	14	4.7	10
20	18	2.9	11
19	19	1.1	12
18	20	0.9	13
17	22	0.3	14
16	24	0.0	15
15	26	0.0	25
14	28	0.0	36
13	30		
12	33		
11	34		
10	36		

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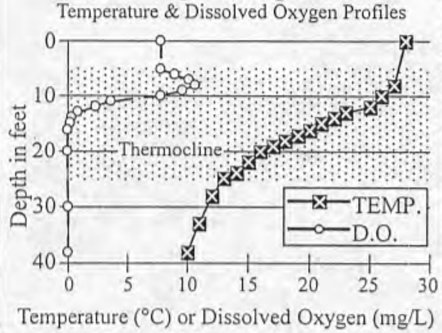
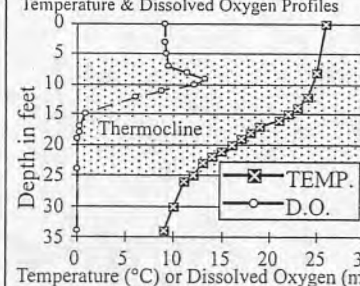
Little Portage Lake August 1, 2001
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
28	0	7.8	0
27	8	7.8	5
26	10	8.9	6
25	12	10.1	7
23	13	10.6	8
22	14	9.6	9
21	15	7.8	10
20	16	3.6	11
19	17	2.3	12
18	18	0.8	13
17	19	0.3	14
16	20	0.2	15
15	22	0.0	16
14	24	0.0	20
13	25	0.0	30
12	28	0.0	38
11	33		
10	38		

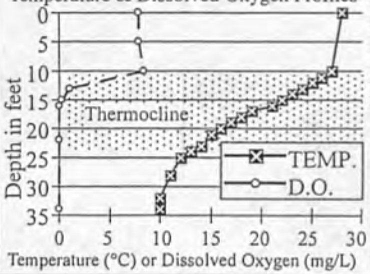
Little Portage Lake August 1, 2003
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
26	0	9.1	0
25	8	9.1	3
24	12	9.2	5
23	14	9.5	7
22	15	11.4	8
21	16	13.2	9
19	17	12.2	10
18	18	8.8	11
17	19	6.1	12
16	20	0.8	15
15	21	0.2	17
14	22	0.2	18
13	23	0.0	19
12	25	0.0	24
11	26	0.0	34
10	30		
9	34		

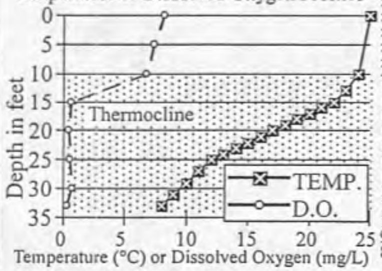
Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

Little Portage Lake August 1, 2006
Temperature & Dissolved Oxygen Profiles



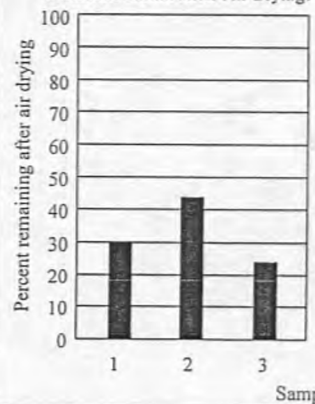
Temp.	Depth	D.O.	Depth
28	0	7.8	0
27	10	7.9	5
26	11	8.3	10
25	12	1.0	13
24	13	0.2	15
23	14	0.0	16
22	15	0.0	22
21	16	0.0	34
19	17		
18	18		
17	19		
16	20		
15	21		
14	23		
13	24		
12	25		
11	28		
10	32		
10	34		

Little Portage Lake August 1, 2007
Temperature & Dissolved Oxygen Profiles

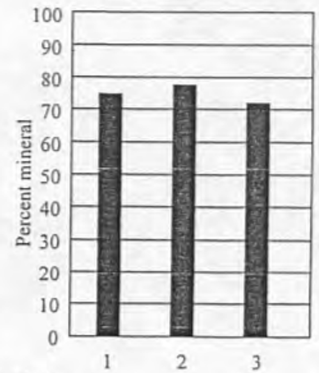


Temp.	Depth	D.O.	Depth
25	0	8.2	0
24	10	7.4	5
23	13	6.7	10
22	15	0.6	15
21	16	0.4	20
20	17	0.5	25
19	18	0.7	30
18	19	0.3	33
17	20		
16	21		
15	22		
14	23		
13	24		
12	25		
11	27		
10	29		
9	31		
8	33		

How Much Did Little Portage Lake Bottom Sediments Shrink After Air Drying?



Percent Mineral Of Little Portage Lake Bottom Sediments

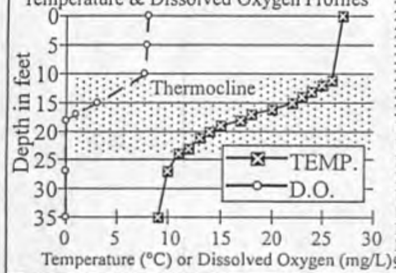


Characteristics of Little Portage Lake Bottom Sediments (2005)

Sample I.D.	Percent Shrinkage	Percent Mineral	Dried at 100°C Color & Description	Color after burning at 550°C	Depth of water (feet)
1	70	74	Gray	Gray	35
2	56	78	Gray	Red	21
3	77	71	Gray	Gray	17

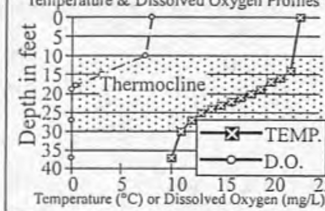
Average mineral content of bottom sediments = 74%.

Little Portage Lake August 3, 2005
Temperature & Dissolved Oxygen Profiles



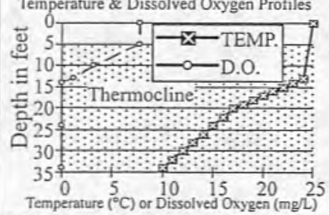
Temp.	Depth	D.O.	Depth
27	0	8.1	0
26	11	8.0	5
25	12	7.7	10
24	13	3.1	15
23	14	0.9	17
22	15	0.0	18
20	16	0.0	27
18	17	0.0	35
17	18		
15	19		
14	20		
13	21		
12	23		
11	24		
10	27		
9	35		

Little Portage Lake August 3, 2009
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
23	0	8.0	0
22	14	7.4	10
21	16	3.1	15
20	17	0.4	18
19	19	0.0	19
18	20	0.0	27
17	21	0.0	37
16	22		
15	23		
14	24		
13	25		
12	27		
11	30		
10	37		

Little Portage Lake August 9, 2010
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
25	0	7.7	0
24	13	7.7	5
23	14	3.2	10
22	15	1.2	13
21	16	0.0	14
20	17	0.0	24
19	18	0.0	34
18	19		
17	20		
16	22		
15	24		
14	26		
13	28		
12	30		
11	32		
10	34		

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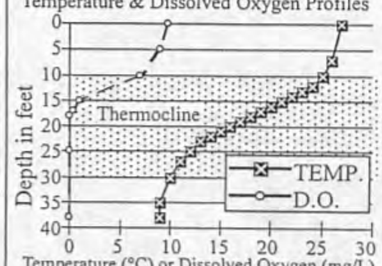
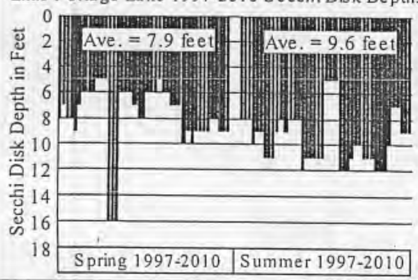
Little Portage Lake August 1, 2008
Temperature & Dissolved Oxygen Profiles



Temp.	Depth	D.O.	Depth
27	0	9.7	0
26	7	9.0	5
25	10	6.9	10
24	12	1.0	15
23	13	0.4	17
22	14	0.0	18
21	15	0.0	25
20	16	0.0	38
19	17		
18	18		
17	19		
16	20		
15	21		
14	22		
13	23		
12	25		
11	27		
10	30		
9	35		
9	38		

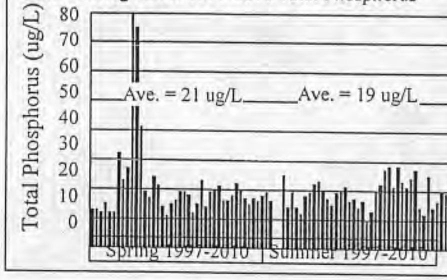
Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

Little Portage Lake 1997-2010 Secchi Disk Depths



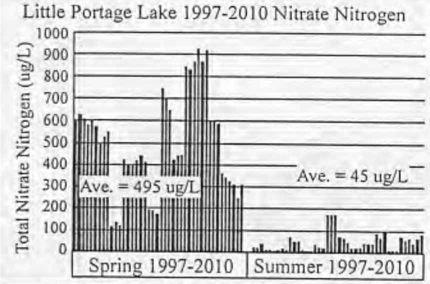
Spring		4/16/04	6	Summer		8/2/04	5
5/12/97	8	4/16/04	6	8/25/97	8	8/2/04	5
5/12/97	7	4/16/04	6	8/25/97	8	8/2/04	5
5/12/97	8	4/21/05	5	8/25/97	8	8/3/05	12
4/19/98	8	4/18/05	6	8/10/98	10	8/3/05	12
4/19/98	9	4/15/05	6	8/10/98	9	8/3/05	12
4/19/98	7	4/18/06	7	8/10/98	9	8/1/06	11
4/25/99	6	4/18/06	7	8/17/99	11	8/1/06	10
4/25/99	6	4/18/06	7	8/27/99	11	8/1/06	10
4/25/99	6	4/21/07	10	8/27/99	11	8/1/07	11
4/15/00	5	4/21/07	9	8/4/00	9	8/1/07	11
4/15/00	5	4/21/07	10	8/4/00	8	8/1/07	11
4/15/00	5	4/18/08	9	8/4/00	9	8/1/08	12
5/13/01	16	4/18/08	9	8/1/01	8	8/1/08	12
5/13/01	16	4/18/08	9	8/1/01	8	8/1/08	12
5/13/01	16	4/18/09	9	8/1/01	8	8/3/09	10
4/15/02	6	4/18/09	8	8/2/02	12	8/3/09	7
4/15/02	6	4/18/09	8	8/2/02	11	8/3/09	7
4/15/02	6	4/20/10	9	8/2/02	11	8/2/10	9
4/28/03	7	4/20/10	9	8/1/03	11	8/2/10	9
4/28/03	8	4/20/10	9	8/1/03	11	8/2/10	9
4/28/03	8			8/1/03	11		

Little Portage Lake 1997-2010 Total Phosphorus



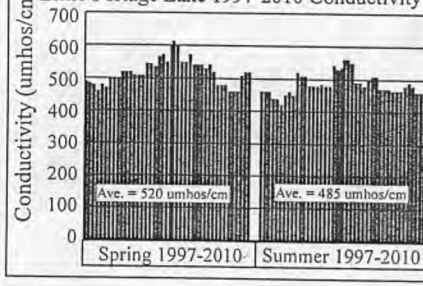
Spring		4/16/04	19	Summer		8/1/03	13
5/12/97	13	4/16/04	18	8/25/97	25	8/2/04	20
5/12/97	13	4/16/04	12	8/25/97	14	8/2/04	22
5/12/97	12	4/21/05	15	8/25/97	19	8/2/04	27
4/19/98	15	4/18/05	23	8/10/98	14	8/3/05	28
4/19/98	12	4/15/05	14	8/10/98	12	8/3/05	21
4/19/98	12	4/18/06	19	8/10/98	18	8/3/05	28
4/25/99	32	4/18/06	20	8/17/99	19	8/1/06	23
4/25/99	23	4/18/06	21	8/27/99	22	8/1/06	21
4/25/99	27	4/21/07	16	8/27/99	23	8/1/06	24
4/15/00	80	4/21/07	16	8/4/00	20	8/1/07	27
4/15/00	75	4/21/07	18	8/4/00	17	8/1/07	14
4/15/00	41	4/18/08	22	8/4/00	15	8/1/07	12
5/13/01	19	4/18/08	20	8/1/01	19	8/1/08	25
5/13/01	17	4/18/08	17	8/1/01	20	8/1/08	14
5/13/01	24	4/18/09	15	8/1/01	21	8/1/08	16
4/15/02	21	4/18/09	17	8/2/02	16	8/3/09	20
4/15/02	14	4/18/09	16	8/2/02	17	8/3/09	19
4/15/02	11	4/20/10	18	8/2/02	14	8/3/09	18
4/28/03	15	4/20/10	19	8/1/03	16	8/2/10	24
4/28/03	16	4/20/10	16	8/1/03	10	8/2/10	20
4/28/03	19					8/2/10	18

Little Portage Lake 1997-2010 Nitrate Nitrogen



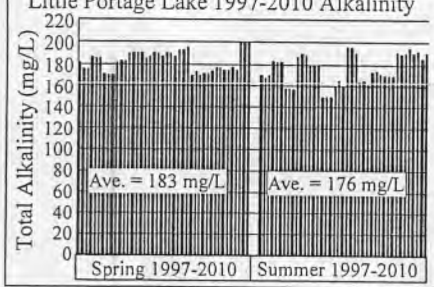
Spring		4/16/04	741	Summer		8/2/04	70
5/12/97	594	4/16/04	697	8/25/97	17	8/2/04	61
5/12/97	623	4/16/04	643	8/25/97	17	8/2/04	44
5/12/97	604	4/21/05	422	8/25/97	35	8/3/05	18
4/19/98	578	4/18/05	438	8/10/98	7	8/3/05	18
4/19/98	594	4/15/05	444	8/10/98	9	8/3/05	22
4/19/98	572	4/18/06	842	8/10/98	5	8/1/06	42
4/25/99	495	4/18/06	828	8/17/99	9	8/1/06	42
4/25/99	523	4/18/06	864	8/27/99	14	8/1/06	42
4/25/99	544	4/21/07	922	8/27/99	7	8/1/07	83
4/15/00	112	4/21/07	864	8/4/00	66	8/1/07	66
4/15/00	132	4/21/07	915	8/4/00	46	8/1/07	92
4/15/00	117	4/18/08	593	8/4/00	46	8/1/08	7
5/13/01	423	4/18/08	600	8/1/01	8	8/1/08	7
5/13/01	398	4/18/08	587	8/1/01	5	8/1/08	7
5/13/01	398	4/18/09	358	8/1/01	3	8/3/09	70
4/15/02	419	4/18/09	340	8/2/02	32	8/3/09	56
4/15/02	439	4/18/09	321	8/2/02	22	8/3/09	61
4/15/02	410	4/20/10	306	8/2/02	18	8/2/10	41
4/28/03	192	4/20/10	244	8/1/03	173	8/2/10	62
4/28/03	185	4/20/10	306	8/1/03	173	8/2/10	82
4/28/03	173			8/1/03	173		

Little Portage Lake 1997-2010 Conductivity



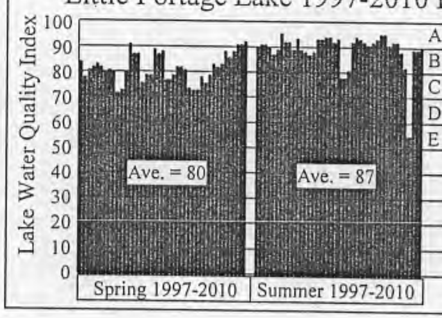
Spring		4/16/04	600	Summer		8/2/04	560
5/12/97	490	4/16/04	610	8/25/97	460	8/2/04	560
5/12/97	485	4/16/04	595	8/25/97	460	8/2/04	550
5/12/97	480	4/21/05	550	8/25/97	460	8/3/05	490
4/19/98	460	4/18/05	550	8/10/98	440	8/3/05	490
4/19/98	480	4/15/05	570	8/10/98	440	8/3/05	480
4/19/98	470	4/18/06	540	8/10/98	420	8/1/06	500
4/25/99	500	4/18/06	540	8/17/99	450	8/1/06	510
4/25/99	500	4/18/06	540	8/27/99	460	8/1/06	510
4/25/99	500	4/21/07	530	8/27/99	450	8/1/07	470
4/15/00	520	4/21/07	540	8/4/00	520	8/1/07	470
4/15/00	520	4/21/07	520	8/4/00	510	8/1/07	470
4/15/00	520	4/18/08	480	8/4/00	510	8/1/08	465
5/13/01	510	4/18/08	480	8/1/01	480	8/1/08	465
5/13/01	510	4/18/08	480	8/1/01	480	8/1/08	465
5/13/01	510	4/18/09	460	8/1/01	480	8/3/09	480
4/15/02	545	4/18/09	460	8/2/02	485	8/3/09	490
4/15/02	545	4/18/09	460	8/2/02	480	8/3/09	480
4/15/02	535	4/20/10	510	8/2/02	480	8/2/10	460
4/28/03	565	4/20/10	520	8/1/03	540	8/2/10	460
4/28/03	570	4/20/10	520	8/1/03	530	8/2/10	460
4/28/03	550			8/1/03	535		

Little Portage Lake 1997-2010 Alkalinity



Spring		4/16/04	190	Summer		8/2/04	196
5/12/97	181	4/16/04	189	8/25/97	170	8/2/04	195
5/12/97	176	4/16/04	187	8/25/97	168	8/2/04	190
5/12/97	176	4/21/05	193	8/25/97	170	8/3/05	164
4/19/98	186	4/18/05	193	8/10/98	183	8/3/05	165
4/19/98	185	4/15/05	195	8/10/98	182	8/3/05	162
4/19/98	185	4/18/06	170	8/10/98	182	8/1/06	173
4/25/99	171	4/18/06	173	8/17/99	158	8/1/06	174
4/25/99	170	4/18/06	170	8/27/99	158	8/1/06	172
4/25/99	170	4/21/07	172	8/27/99	157	8/1/07	170
4/15/00	181	4/21/07	172	8/4/00	187	8/1/07	170
4/15/00	183	4/21/07	174	8/4/00	189	8/1/07	170
4/15/00	183	4/18/08	177	8/4/00	188	8/1/08	191
5/13/01	189	4/18/08	177	8/1/01	180	8/1/08	189
5/13/01	190	4/18/08	175	8/1/01	180	8/1/08	190
5/13/01	190	4/18/09	175	8/1/01	180	8/3/09	194
4/15/02	190	4/18/09	177	8/2/02	150	8/3/09	190
4/15/02	185	4/18/09	175	8/2/02	150	8/3/09	192
4/15/02	187	4/20/10	200	8/2/02	150	8/2/10	185
4/28/03	190	4/20/10	200	8/1/03	160	8/2/10	190
4/28/03	189	4/20/10	200	8/1/03	165	8/2/10	185
4/28/03	187			8/1/03	160		

Little Portage Lake 1997-2010 Lake Water Quality Indices

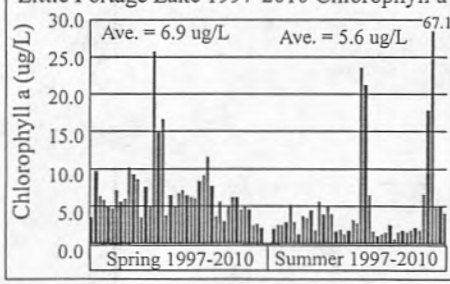


Spring		4/16/04	75	Summer		8/2/04	76
5/12/97	82	4/16/04	75	8/25/97	88	8/2/04	76
5/12/97	76	4/16/04	77	8/25/97	89	8/2/04	79
5/12/97	79	4/21/05	80	8/25/97	89	8/3/05	90
4/19/98	80	4/18/05	80	8/10/98	88	8/3/05	92
4/19/98	81	4/15/05	79	8/10/98	85	8/3/05	91
4/19/98	80	4/18/06	72	8/10/98	87	8/1/06	90
4/25/99	78	4/18/06	71	8/17/99	93	8/1/06	89
4/25/99	79	4/18/06	71	8/27/99	90	8/1/06	90
4/25/99	78	4/21/07	76	8/27/99	90	8/1/07	91
4/15/00	70	4/21/07	74	8/4/00	87	8/1/07	93
4/15/00	71	4/21/07	77	8/4/00	91	8/1/07	93
4/15/00	78	4/18/08	81	8/4/00	87	8/1/08	89
5/13/01	89	4/18/08	80	8/1/01	86	8/1/08	90
5/13/01	85	4/18/08	81	8/1/01	85	8/1/08	90
5/13/01	85	4/18/09	86	8/1/01	86	8/3/09	86
4/15/02	74	4/18/09	84	8/2/02	91	8/3/09	80
4/15/02	77	4/18/09	86	8/2/02	91	8/3/09	54
4/15/02	77	4/20/10	89	8/2/02	92	8/2/10	87
4/28/03	87	4/20/10	89	8/1/03	92	8/2/10	87
4/28/03	85	4/20/10	90	8/1/03	90	8/2/10	88
4/28/03	86			8/1/03	91		

Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

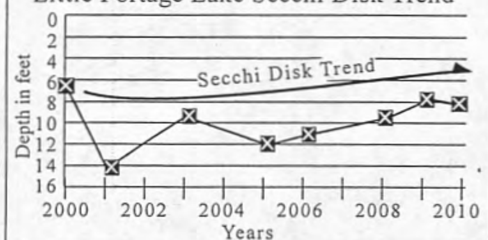
FUSILIER'S ATLAS
AND GAZETTEER OF
MICHIGAN INLAND LAKES
Water Quality Investigators
9200 Dexter Chelsea Road
Dexter, Michigan 48130
(734) 426-8972

Little Portage Lake 1997-2010 Chlorophyll a



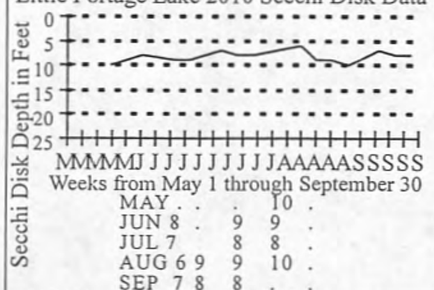
Spring		S4/16/04	6.7	Summer		8/2/04	23.5
5/12/97	3.4	4/16/04	7.1	8/25/97	1.9	8/2/04	21.1
5/12/97	9.6	4/16/04	6.4	8/25/97	2.5	8/2/04	6.4
5/12/97	6.3	4/21/05	6.1	8/25/97	2.5	8/3/05	1.5
4/19/98	5.8	4/18/05	6.0	8/10/98	2.8	8/3/05	0.9
4/19/98	4.9	4/15/05	8.3	8/10/98	5.1	8/3/05	1.2
4/19/98	4.6	4/18/06	9.1	8/10/98	2.8	8/1/06	1.4
4/25/99	7.1	4/18/06	11.5	8/17/99	1.1	8/1/06	2.4
4/25/99	5.5	4/18/06	7.7	8/27/99	3.6	8/1/06	0.5
4/25/99	5.9	4/21/07	3.6	8/27/99	3.3	8/1/07	1.4
4/15/00	10.1	4/21/07	5.5	8/4/00	4.4	8/1/07	1.7
4/15/00	9.2	4/21/07	3.0	8/4/00	1.7	8/1/07	1.4
4/15/00	8.6	4/18/08	4.9	8/4/00	5.5	8/1/08	1.7
5/13/01	3.5	4/18/08	6.1	8/1/01	3.8	8/1/08	2.0
5/13/01	7.6	4/18/08	6.1	8/1/01	5.0	8/1/08	1.7
5/13/01	5.0	4/18/09	4.5	8/1/01	3.8	8/3/09	6.6
4/15/02	25.6	4/18/09	4.9	8/2/02	1.5	8/3/09	17.7
4/15/02	14.8	4/18/09	4.5	8/2/02	1.8	8/3/09	69.1
4/15/02	16.5	4/20/10	2.5	8/2/02	1.2	8/2/10	4.8
4/28/03	3.7	4/20/10	2.6	8/1/03	1.7	8/2/10	4.8
4/28/03	6.4	4/20/10	2.0	8/1/03	3.1	8/2/10	4.0
4/28/03	5.0			8/1/03	2.7		

Little Portage Lake Secchi Disk Trend



Data:	2000	2001	2003	2005	2006	2008	2009	2010
	6.7	14.4	9.6	12.3	11.4	9.7	7.9	8.2

Little Portage Lake 2010 Secchi Disk Data



FUSILIER'S ATLAS
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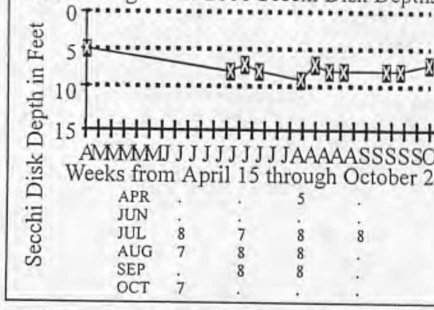
MICHIGAN INLAND LAKES
Water Quality Investigators
9200 Dexter Chelsea Road
Dexter, Michigan 48130
(734) 426-8972

Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

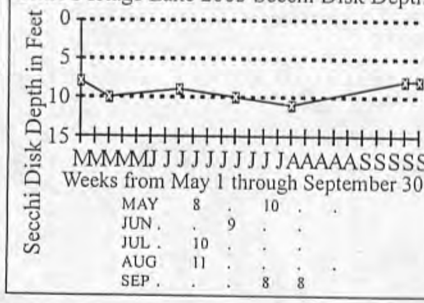
Surface Lake Water Quality Data

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
5/12/97	1	12	9.7	87	3.4	8	594	181	8.2	490	13	82	B
5/12/97	2	12	10.3	95	9.6	7	623	176	8.2	485	13	76	C
5/12/97	3	12	10.4	98	6.3	8	604	176	8.3	480	12	79	C
8/25/97	1	21	8.8	98	1.9	8	17	170	8.4	460	25	88	B
8/25/97	2	21	8.6	96	2.5	8	17	168	8.4	460	14	89	B
8/25/97	3	21	8.7	97	2.5	8	35	170	8.3	460	19	89	B
4/19/98	1	13	10.3	97	5.8	8	578	186	8.3	460	15	80	B
4/19/98	2	13	10.6	100	4.9	9	594	185	8.2	480	12	81	B
4/19/98	3	13	10.2	96	4.6	7	572	185	8.3	470	12	80	B
8/10/98	1	26	8.6	105	2.8	10	7	183	8.6	440	14	88	B
8/10/98	2	26	8.6	105	5.1	9	9	182	8.5	440	12	85	B
8/10/98	3	26	8.6	105	2.8	9	5	182	8.6	420	18	87	B
4/25/99	1	13	9.8	92	7.1	6	495	171	8.1	500	32	78	C
4/25/99	2	13	9.5	90	5.5	6	523	170	8.2	500	23	79	C
4/25/99	3	13	9.5	90	5.9	6	544	170	8.1	500	27	78	C
8/27/99	3	24	8.9	105	1.1	11	9	158	8.3	450	19	93	A
8/27/99	1	24	9.3	109	3.6	11	14	158	8.3	460	22	90	A
8/27/99	2	23	8.8	101	3.3	11	7	157	8.3	450	23	90	A
4/15/00	1	12	10.3	95	10.1	5	112	181	8.4	520	80	70	C
4/15/00	2	10	10.6	94	9.2	5	132	183	8.4	520	95	71	C
4/15/00	3	10	10.6	94	8.6	5	117	183	8.4	520	91	78	C
8/4/00	1	24	8.3	98	4.4	9	66	187	8.3	520	20	87	B
8/4/00	2	23	8.6	99	1.7	8	46	189	8.4	510	17	91	A
8/4/00	3	23	7.8	90	5.5	9	46	188	8.3	510	15	87	B
5/13/01	1	19	9.4	100	3.5	16	423	189	8.4	510	19	89	B
5/13/01	2	19	9.3	99	7.6	16	398	190	8.4	510	17	85	B
5/13/01	3	19	9.2	98	5.0	16	398	190	8.3	510	24	85	B
8/1/01	1	28	7.8	99	3.8	8	8	180	8.0	480	19	86	B
8/1/01	2	27	8.2	102	5.0	8	5	180	8.0	480	20	85	B
8/1/01	3	28	8.1	103	3.8	8	3	180	8.0	480	21	86	B
4/15/02	1	10	10.5	93	25.6	6	419	190	8.5	545	21	74	C
4/15/02	2	10	10.5	93	14.8	6	439	185	8.4	545	14	77	C
4/15/02	3	9	10.6	91	16.5	6	410	187	8.4	535	11	77	C
8/2/02	1	28	8.5	108	1.5	12	32	150	7.5	485	16	91	A
8/2/02	2	28	8.5	108	1.8	11	22	150	7.6	480	17	91	A
8/2/02	3	28	8.5	108	1.2	11	18	150	7.6	480	14	92	A
4/28/03	1	14	9.9	96	3.7	7	192	190	8.2	565	15	87	B
4/28/03	2	14	10.2	99	6.4	8	185	189	8.2	570	16	85	B
4/28/03	3	14	10.1	98	5.0	8	173	187	8.2	550	19	86	B
8/1/03	1	26	9.1	111	1.7	11	173	160	8.5	540	16	92	A
8/1/03	2	25	8.9	106	3.1	11	173	165	8.6	530	10	90	A
8/1/03	3	25	9.0	107	2.7	11	173	160	8.6	535	13	91	A
4/16/04	1	11	10.6	95	6.7	6	741	190	8.2	600	19	75	C
4/16/04	2	11	10.7	96	7.1	6	697	189	8.2	610	18	75	C
4/16/04	3	11	10.7	96	6.4	6	643	187	8.3	595	12	77	C
8/2/04	1	24	8.6	101	23.5	5	70	196	8.3	560	20	76	C
8/2/04	2	24	9.4	111	21.1	5	61	195	8.4	560	22	76	C
8/2/04	3	24	10.5	124	6.4	5	44	190	8.4	550	27	79	C
4/18/05	1	16	9.5	95	6.1	5	422	193	8.2	550	15	80	B
4/18/05	2	16	10.2	102	6.0	6	438	193	8.3	550	23	80	B
4/18/05	3	16	10.2	102	8.3	6	444	195	8.3	570	14	79	C
8/3/05	1	27	8.1	101	1.5	12	18	164	8.2	490	28	90	A
8/3/05	2	27	7.8	98	0.9	12	18	165	8.1	490	21	92	A
8/3/05	3	27	8.0	100	1.2	12	22	162	8.2	480	28	91	A
4/19/06	1	14	9.8	94	9.1	7	842	170	8.2	540	19	72	C
4/19/06	2	14	10.4	100	11.5	7	828	173	8.3	540	20	71	C
4/19/06	3	14	10.4	100	7.7	7	864	170	8.2	540	21	71	C
8/1/06	1	28	7.8	99	1.4	11	42	173	8.4	500	23	90	A
8/1/06	2	28	7.8	99	2.4	10	42	174	8.4	510	21	89	A
8/1/06	3	28	7.8	99	0.5	10	42	172	8.4	510	24	90	A
4/21/07	1	14	10.5	101	3.6	10	922	172	8.2	530	16	76	C
4/21/07	2	13	10.3	97	5.5	9	864	172	8.2	540	16	74	C
4/21/07	3	13	10.8	102	3.0	10	915	174	8.2	520	18	77	C
8/1/07	1	25	8.2	98	1.4	11	83	170	8.3	470	27	91	A
8/1/07	2	26	8.3	101	1.7	11	66	170	8.3	470	14	93	A
8/1/07	3	26	8.3	101	1.4	11	92	170	8.3	470	12	93	A

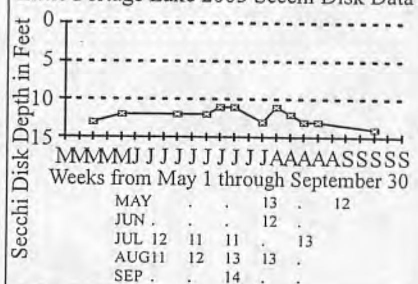
Little Portage Lake 2000 Secchi Disk Depths



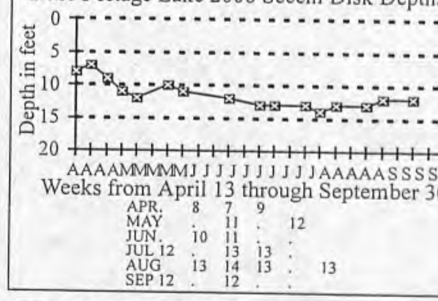
Little Portage Lake 2003 Secchi Disk Depths



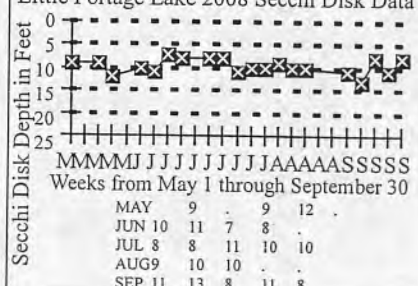
Little Portage Lake 2005 Secchi Disk Data



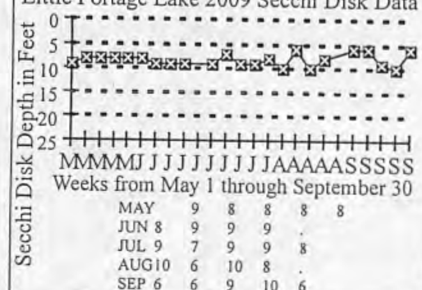
Little Portage Lake 2006 Secchi Disk Depths



Little Portage Lake 2008 Secchi Disk Data



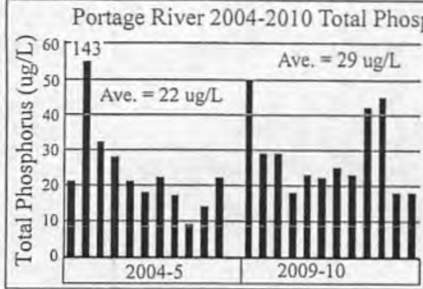
Little Portage Lake 2009 Secchi Disk Data



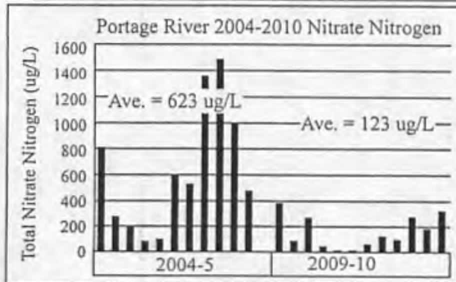
FUSILIER'S ATLAS
AND GAZETTEER OF
MICHIGAN INLAND LAKES

Water Quality Investigators
9200 Dexter Chelsea Road
Dexter, Michigan 48130
(734) 426-8972

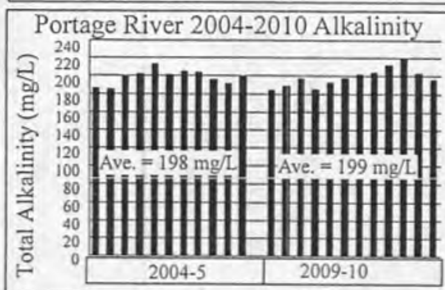
Little Portage Lake
Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County



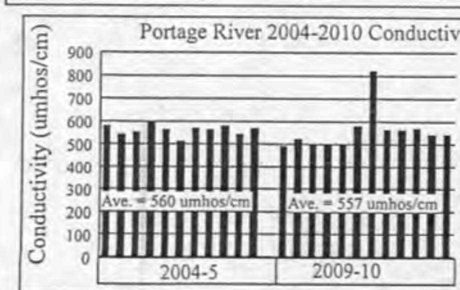
2004-5		2009-10	
5/26/04	21	5/28/09	50
6/29/04	143	6/29/09	29
7/28/04	32	7/31/09	29
8/29/04	28	8/28/09	18
10/1/04	21	9/23/09	23
11/30/04	18	10/21/09	22
12/31/04	22	11/23/09	25
1/28/05	17	12/26/09	23
2/26/05	9	1/23/10	42
3/29/05	14	3/9/10	45
4/18/05	22	3/31/10	18
		4/20/10	18



2004-5		2009-10	
5/26/04	806	5/28/09	380
6/29/04	268	6/29/09	87
7/28/04	186	7/31/09	266
8/29/04	76	8/28/09	42
10/1/04	96	9/23/09	10
11/30/04	590	10/21/09	10
12/31/04	528	11/23/09	58
1/28/05	1356	12/26/09	119
2/26/05	1485	1/23/10	95
3/29/05	989	3/9/10	270
4/18/05	473	3/31/10	178
		4/20/10	319

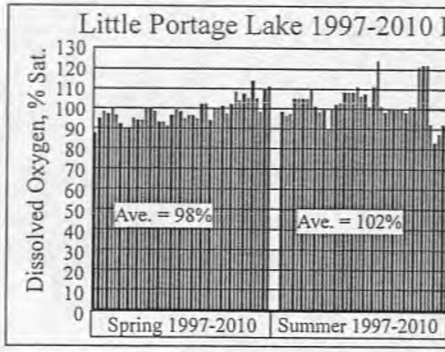


2004-5		2009-10	
5/26/04	186	5/28/09	184
6/29/04	185	6/29/09	189
7/28/04	200	7/31/09	197
8/29/04	202	8/28/09	185
10/1/04	213	9/23/09	192
11/30/04	201	10/21/09	198
12/31/04	205	11/23/09	202
1/28/05	204	12/26/09	204
2/26/05	196	1/23/10	212
3/29/05	191	3/9/10	220
4/18/05	199	3/31/10	203
		4/20/10	196



2004-5		2009-10	
5/26/04	580	5/28/09	490
6/29/04	540	6/29/09	520
7/28/04	550	7/31/09	500
8/29/04	600	8/28/09	500
10/1/04	560	9/23/09	500
11/30/04	510	10/21/09	580
12/31/04	570	11/23/09	820
1/28/05	560	12/26/09	560
2/26/05	580	1/23/10	560
3/29/05	540	3/9/10	570
4/18/05	570	3/31/10	540
		4/20/10	540

Little Portage Lake 1997-2010 Dissolved Oxygen Saturation



Spring				Summer			
		4/16/04	95			8/2/04	101
5/12/97	87	4/16/04	96	8/25/97	98	8/2/04	111
5/12/97	95	4/16/04	96	8/25/97	96	8/2/04	124
5/12/97	98	4/21/05	95	8/25/97	97	8/3/05	101
4/19/98	97	4/18/05	102	8/10/98	105	8/3/05	98
4/19/98	100	4/15/05	102	8/10/98	105	8/3/05	100
4/19/98	96	4/18/06	94	8/10/98	105	8/1/06	99
4/25/99	92	4/18/06	100	8/17/99	105	8/1/06	99
4/25/99	90	4/18/06	100	8/27/99	109	8/1/06	99
4/25/99	90	4/21/07	101	8/27/99	101	8/1/07	98
4/15/00	95	4/21/07	97	8/4/00	98	8/1/07	101
4/15/00	94	4/21/07	102	8/4/00	99	8/1/07	101
4/15/00	94	4/18/08	108	8/4/00	90	8/1/08	121
5/13/01	100	4/18/08	104	8/1/01	99	8/1/08	122
5/13/01	99	4/18/08	107	8/1/01	102	8/1/08	122
5/13/01	98	4/18/09	105	8/1/01	103	8/3/09	92
4/15/02	93	4/18/09	114	8/2/02	108	8/3/09	83
4/15/02	93	4/18/09	105	8/2/02	108	8/3/09	87
4/15/02	91	4/20/10	98	8/2/02	108	8/2/10	92
4/28/03	96	4/20/10	109	8/1/03	111	8/2/10	94
4/28/03	99	4/20/10	111	8/1/03	106	8/2/10	94
4/28/03	98			8/1/03	107		

Surface Lake Water Quality Data

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
4/18/08	1	13	11.4	108	4.9	9	593	177	7.9	480	22	81	B
4/18/08	2	12	11.2	104	6.1	9	600	177	7.9	480	20	80	B
4/18/08	3	13	11.2	107	6.1	9	587	175	7.9	480	17	81	B
8/1/08	1	27	9.7	121	1.7	12	7	191	8.4	465	25	89	B
8/1/08	2	27	9.8	122	2.0	12	7	189	8.4	465	14	90	A
8/1/08	3	27	9.9	122	1.7	12	7	190	8.4	465	16	90	A
4/18/09	1	12	11.3	105	4.5	9	358	175	8.1	460	15	86	B
4/18/09	2	12	12.3	114	4.9	8	340	177	8.1	460	17	84	B
4/18/09	3	12	11.3	105	4.5	8	321	175	8.1	460	16	86	B
8/3/09	1	23	8	92	6.6	10	70	194	8.2	480	20	86	B
8/3/09	2	23	7.2	83	17.7	7	56	190	8.1	490	19	80	B
8/3/09	3	23	7.6	87	67.1	7	61	192	8.2	480	18	54	E
4/20/10	1	13	11.4	98	2.5	9	306	200	8.3	510	18	89	B
4/20/10	2	13	11.6	109	2.6	9	244	200	8.3	520	19	89	B
4/20/10	3	13	11.8	111	2.0	9	306	200	8.3	520	16	90	A
8/9/10	1	25	7.7	92	4.8	9	41	185	8.2	460	24	87	B
8/9/10	2	25	7.9	94	4.8	9	62	190	8.2	460	20	87	B
8/9/10	3	25	7.9	94	4.0	9	82	185	8.2	460	18	88	B
5/26/04	Portage R.	---	---	---	---	---	806	186	7.9	580	21	---	---
6/29/04	Portage R.	---	---	---	---	---	268	185	8.6	540	143	---	---
7/28/04	Portage R.	---	---	---	---	---	186	200	8.0	550	32	---	---
8/29/04	Portage R.	---	---	---	---	---	76	202	8.1	600	28	---	---
10/1/04	Portage R.	---	---	---	---	---	96	213	7.9	560	21	---	---
11/30/04	Portage R.	---	---	---	---	---	590	201	8.0	510	18	---	---
12/31/04	Portage R.	---	---	---	---	---	528	205	8.0	570	22	---	---
1/28/05	Portage R.	---	---	---	---	---	1356	204	7.8	560	17	---	---
2/26/05	Portage R.	---	---	---	---	---	1485	196	7.9	580	9	---	---
3/29/05	Portage R.	---	---	---	---	---	989	191	8.0	540	14	---	---
4/18/05	Portage R.	---	---	---	---	---	473	199	8.2	570	22	---	---
5/28/09	Portage R.	---	---	---	---	---	380	184	7.7	490	50	---	---
6/29/09	Portage R.	---	---	---	---	---	87	189	8.0	520	29	---	---
7/31/09	Portage R.	---	---	---	---	---	266	197	8.0	500	29	---	---
8/28/09	Portage R.	---	---	---	---	---	42	185	8.0	500	18	---	---
9/23/09	Portage R.	---	---	---	---	---	10	192	7.9	500	23	---	---
10/21/09	Portage R.	---	---	---	---	---	10	198	8.0	580	22	---	---
11/23/09	Portage R.	---	---	---	---	---	58	202	8.1	820	25	---	---
12/26/09	Portage R.	---	---	---	---	---	119	204	8.0	560	23	---	---
1/23/10	Portage R.	---	---	---	---	---	95	212	8.0	560	42	---	---
3/9/10	Portage R.	---	---	---	---	---	270	220	8.1	570	45	---	---
3/31/10	Portage R.	---	---	---	---	---	178	203	8.2	540	18	---	---
4/20/10	Portage R.	---	---	---	---	---	319	196	8.2	540	18	---	---

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Sections 2 & 11
Dexter Township
T1S R4E
Washtenaw County

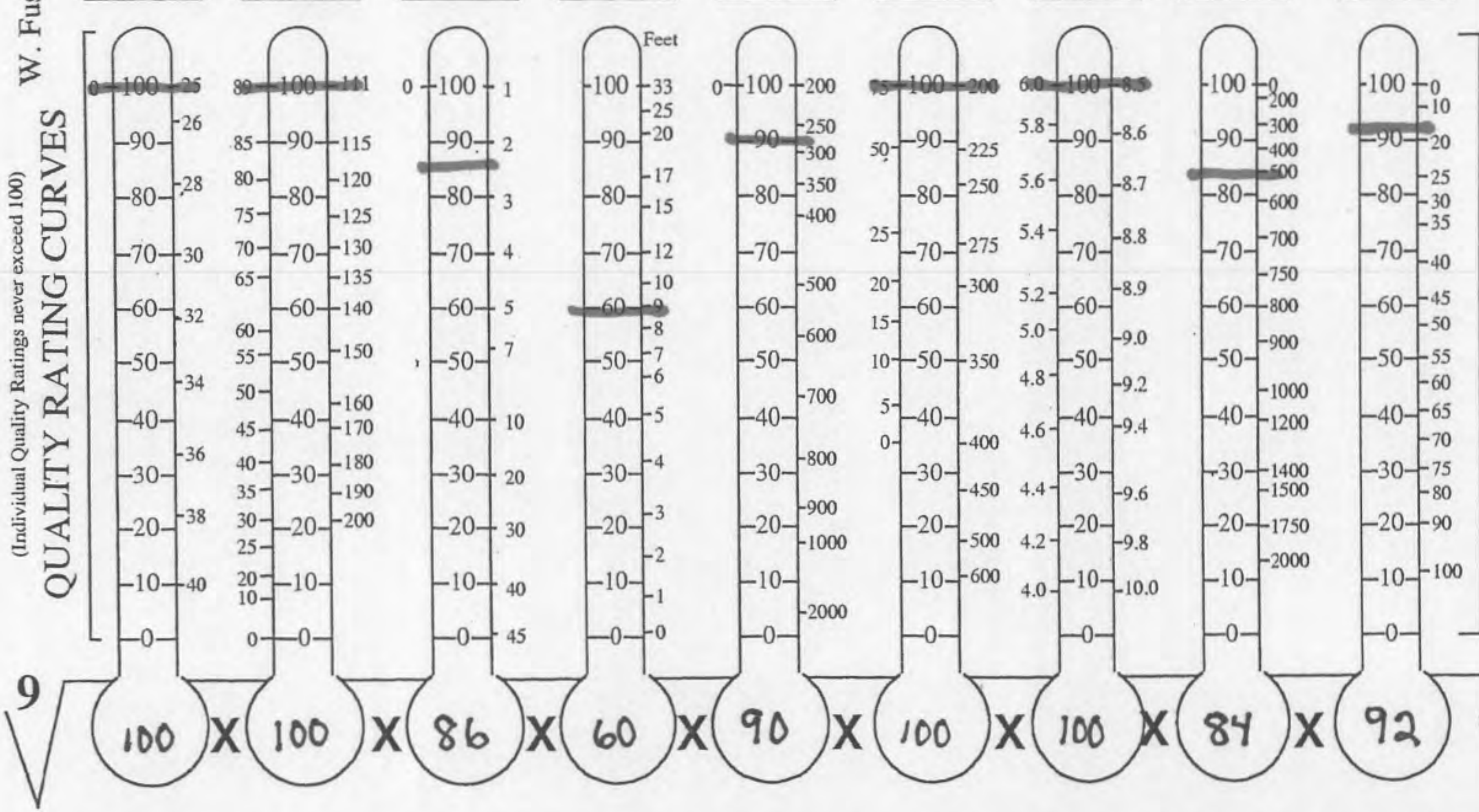
CALCULATION SHEET FOR THE UNWEIGHTED MULTIPLICATIVE LAKE WATER QUALITY INDEX

W. Fusilier, Ph.D.

QUALITY RATING CURVES

(Individual Quality Ratings never exceed 100)

Temperature in degrees C	Dissolved Oxygen, % Saturation	Chlorophyll a ug/L	Secchi Disk Depth in feet	Nitrate-N ug/L	Alkalinity mg/L	pH S. U.	Specific Conductivity umhos/cm@ 25C	Total Phosphorus ug/L
13°	11.3/10.6 106	2.4	9'	285	200	8.3	517	18



LWQI 89

487
Watershed to lake ratio

0.04 years
Flushing rate

Huron
Drainage Basin

54784
Drainage Area

1813
Lake Volume

Washtenaw
County

Dexter
Township

WQI
Analyst

42'
Lake Depth

112
Lake Area

SET THE PARAMETER QUALITY RATING AT 1 IF THE EXTERNAL EXTREME VALUE RANGE IS EXCEEDED

LAKE WATER QUALITY INDEX

0–15	15–25	25–35	35–45	45–55	55–65	65–75	75–85	85–100
Red	Red Orange	Orange	Orange Yellow	Yellow	Yellow green	Green	Blue Green	Blue

DATE 20 April 2010

STATION AVE 1-3

LAKE Little Portage

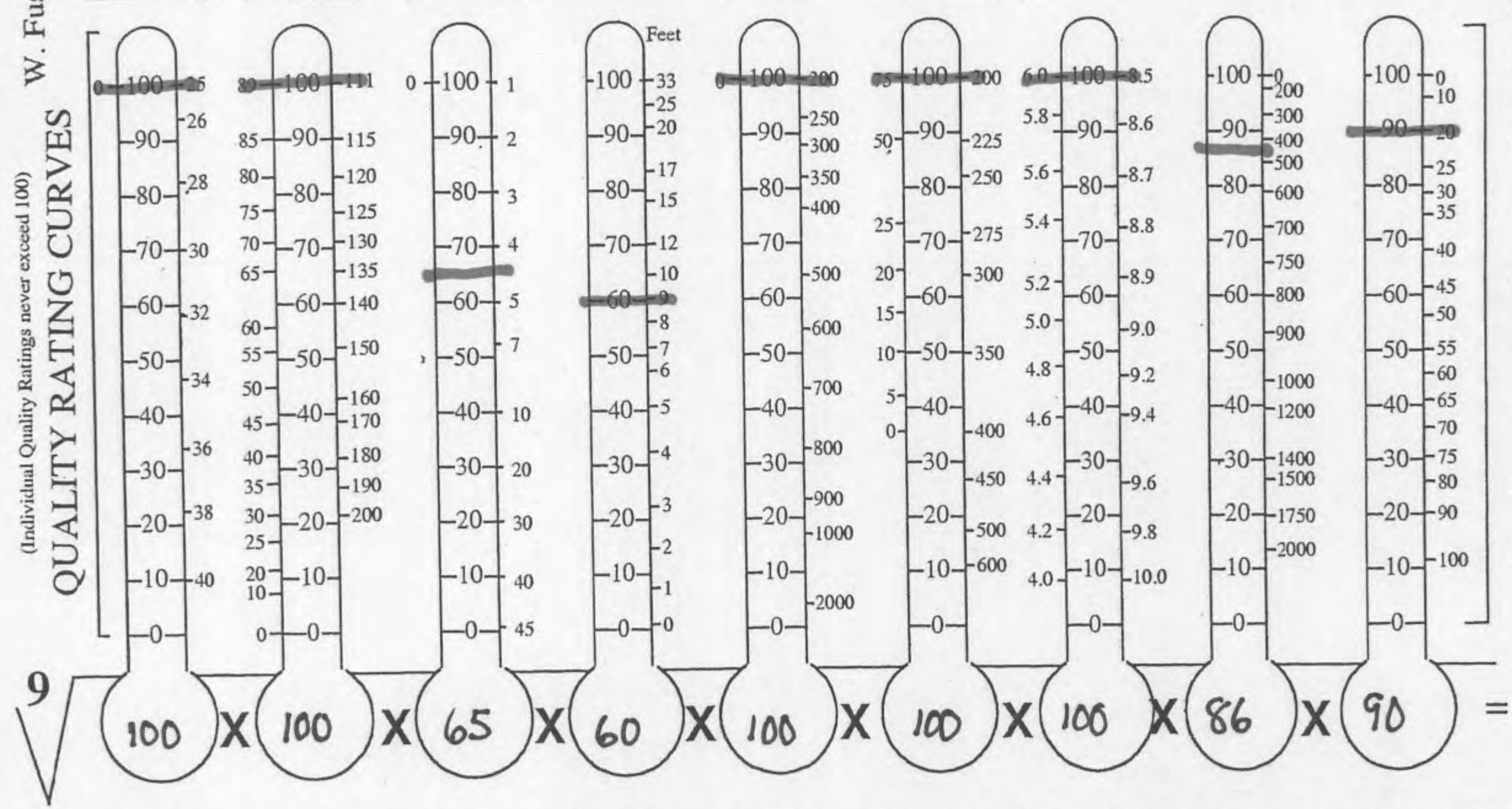
CALCULATION SHEET FOR THE UNWEIGHTED MULTIPLICATIVE LAKE WATER QUALITY INDEX

W. Fusilier, Ph.D.

QUALITY RATING CURVES

(Individual Quality Ratings never exceed 100)

Temperature in degrees C	Dissolved Oxygen, % Saturation	Chlorophyll a ug/L	Secchi Disk Depth in feet	Nitrate-N ug/L	Alkalinity mg/L	pH S. U.	Specific Conductivity umhos/cm@ 25C	Total Phosphorus ug/L
25°	7.8/8.4 93	4.5	9'	62	187	8.2	460	21



$$\sqrt[9]{100 \times 100 \times 65 \times 60 \times 100 \times 100 \times 100 \times 86 \times 90} = 88$$

LWQI 88

487
Watershed to lake ratio

0.04 years
Flushing rate

Huron
Drainage Basin

54784
Drainage Area

1813
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Washtenaw
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42'
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SET THE PARAMETER QUALITY RATING AT 1 IF THE EXTERNAL EXTREME VALUE RANGE IS EXCEEDED

LAKE WATER QUALITY INDEX

0–15	15–25	25–35	35–45	45–55	55–65	65–75	75–85	85–100
Red	Red Orange	Orange	Orange Yellow	Yellow	Yellow green	Green	Blue Green	Blue

DATE 9 August 2010

STATION AVE 1-3

LAKE Little Portage