DUNHAM LAKE

HIGHLAND TOWNSHIP, OAKLAND COUNTY
&
HARTLAND TOWNSHIP, LIVINGSTON COUNTY

1984-2009 WATER QUALITY STUDIES

DUNHAM LAKE DATA

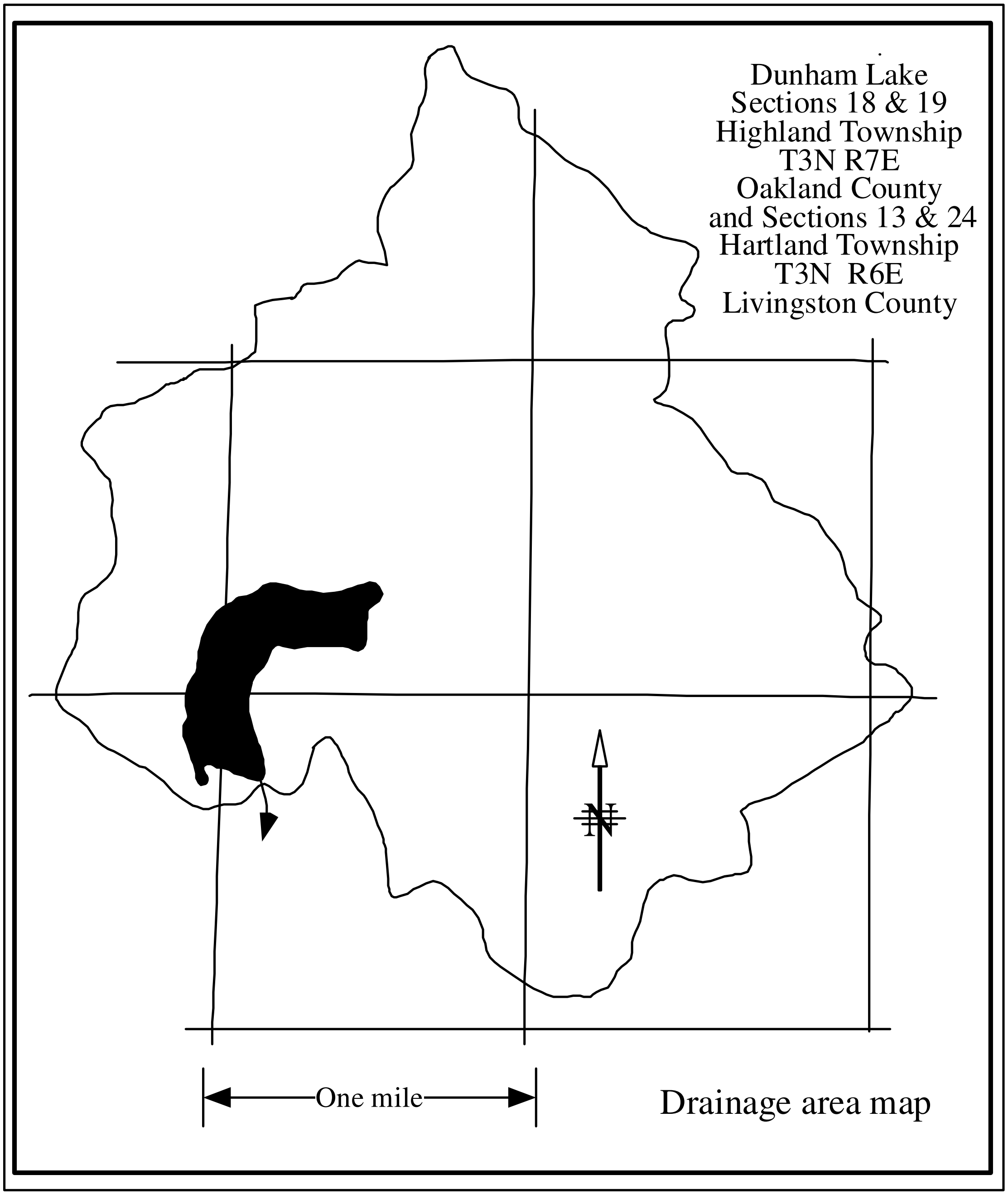
Dunham Lake is a 110-acre natural moderately hard water kettle lake located in Sections 18 and 19, Highland Township (T3N R7E), Oakland County, and Sections 13 and 24, Hartland Township (T3N R6E), Livingston County, Michigan. The lake has no islands above the surface. Dunham Lake has a maximum depth of 118 feet, a water volume of 5158 acre-feet, and a mean depth of 46.9 feet. It has 12738 feet of shoreline. The elevation of the lake is 1000 feet above sea level.

The L-shaped lake consists of three basins, a 118-foot-deep south basin, 85-foot-deep northwest basin and a 65-foot deep northeast basin. Shallower shelves about 50-55 feet deep connect the basins.

The longitude and latitude of the 118-foot deep-hole is 83° 40.840W and 42° 38.986N.

The size of the watershed, which is the land area that contributes water to the lake, but does not include the lake, is 2589 acres. The drainage area, which includes the lake and the watershed, is 2699 acres. (See map below.) The watershed to lake ratio is 23.5 to 1, which is high for a Michigan inland lake. The lake flushes once every 2.2 years, on an average.

Water from the Dunham Lake outlet, located on the south end of the lake, flows into North Ore Creek. North Ore Creek joins the Shiawassee River northwest of Argentine. The Shiawassee River flows into the Flint River southwest of Saginaw. The Flint River becomes part of the Saginaw River in Saginaw. The Saginaw River flows into Saginaw Bay north of Bay City, Michigan.

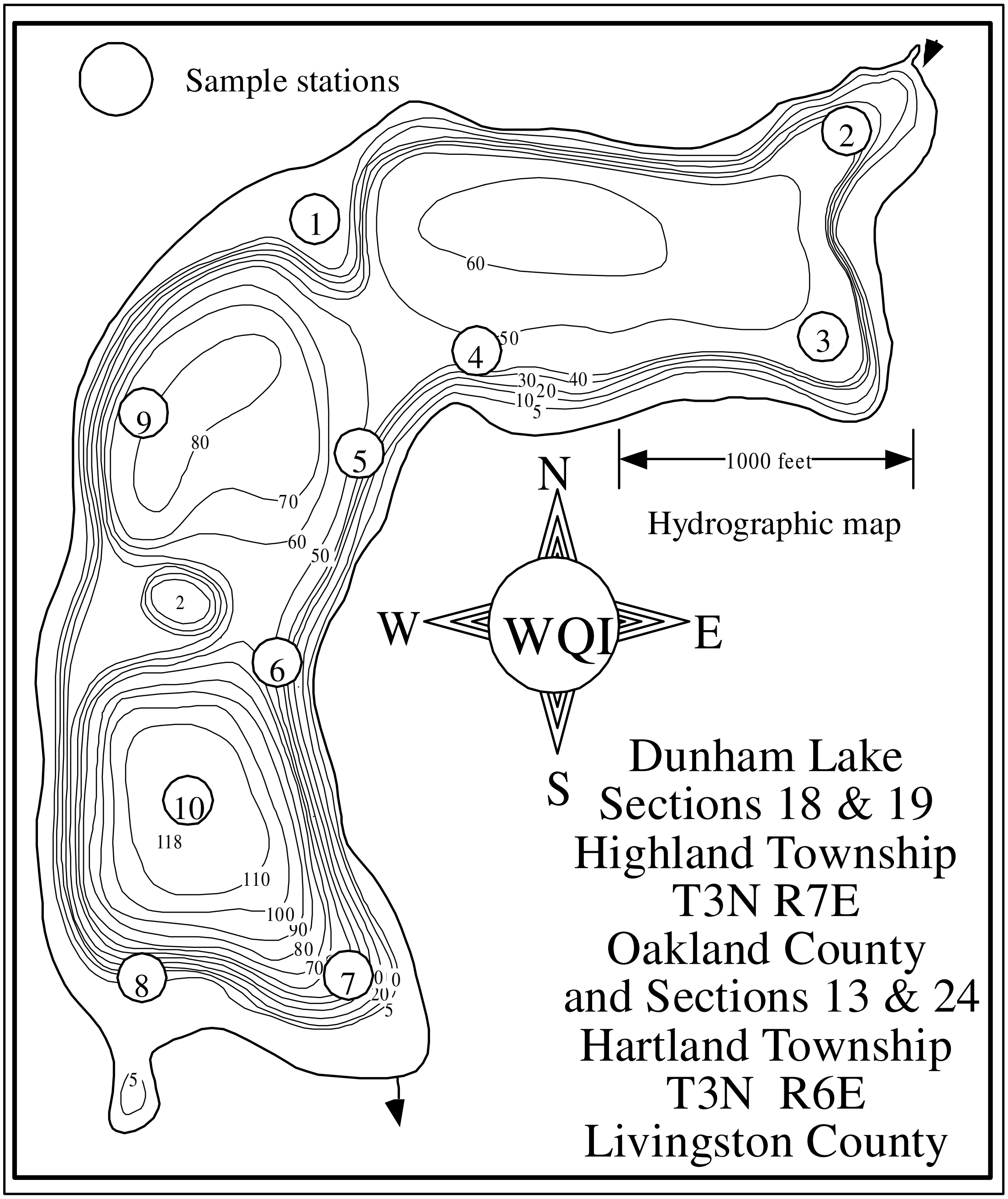


THE SAMPLE DATES

WQI collected ten surface samples for water quality testing, plus top to bottom samples every ten feet from Dunham Lake in summer 1984, and spring and summer 1989, 1995, 2000 and 2006. In 2009 they collected three surface samples in spring and in summer at Stations 4, 9 and 10.

Bottom sediment samples were collected in 1984, 1989 and 2000 from the ten sample sites. Top to bottom dissolved oxygen and temperature profile data were collected each time the lake was sampled.

THE SAMPLE STATIONS



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

THE ANALYSES

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

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

THE TEST RESULTS

The results of the tests are found in the text and graphs below 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 gasses and biological activity.

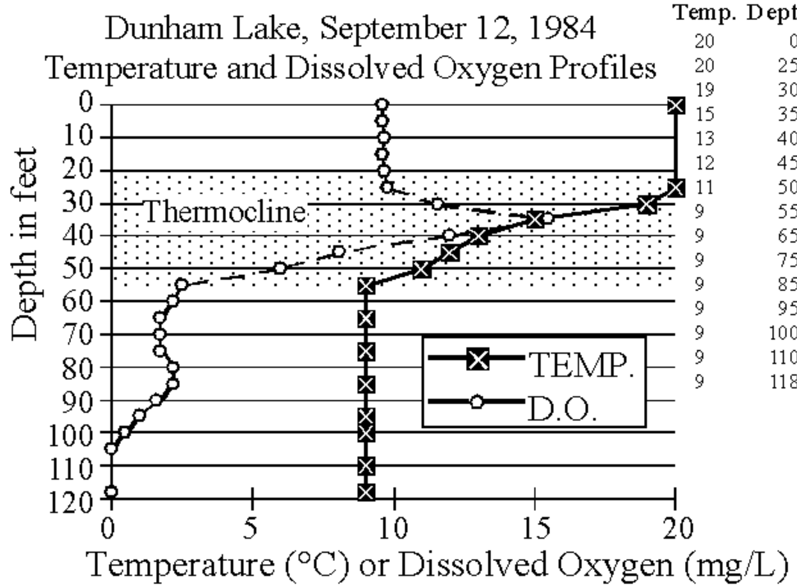
Dissolved oxygen is the test most often selected by lake scientists as being important. Besides its importance in providing oxygen for aquatic organisms, in natural lakes oxygen is involved in the capture and release of various chemicals, such as iron and phosphorus.

Dissolved oxygen and temperature profiles were measured in the 118-foot deep hole every time the lake was sampled in both spring and summer.

1984

Dissolved oxygen and temperature data were not collected in spring 1984. The graph below shows the late summer data.

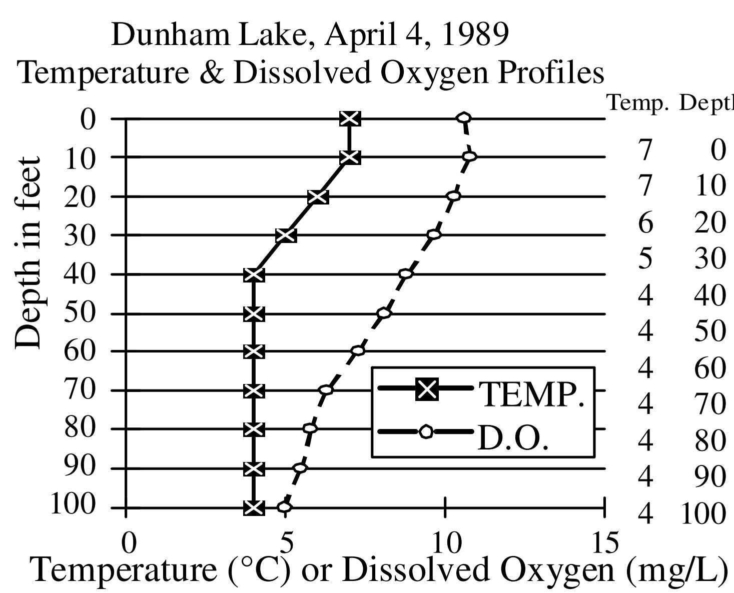
In late summer, 1984, the lake formed a 30-foot-thick thermocline (where the temperature changes rapidly with depth and shown shaded on the graphs) from 25 to 55 feet. Dissolved oxygen was plentiful above the thermocline.



Temp.	Depth	D.O.	Depth
20	0	9.6	0
20	25	9.6	5
19	30	9.7	10
15	35	9.6	15
13	40	9.7	20
12	45	9.8	25
11	50	11.6	30
9	55	15.5	35
9	65	12.0	40
9	75	8.1	45
9	85	6.0	50
9	95	2.5	55
9	100	2.2	60
9	110	1.7	65
9	118	1.7	70
		1.7	75
		2.2	80
		2.2	85
		1.6	90
		1.0	95
		0.5	100
		0.0	105
		0.0	118

It reached a maximum of 15.5 milligrams per liter in the thermocline at 35 feet, probably the result of an algal bloom which settled there. Below the thermocline, the dissolved oxygen concentration was low (less than 3 milligrams per liter). However the lake did not run out of dissolved oxygen until 105 feet. That condition remained to the bottom at 118 feet. The hypsographic (depth-area) graph shows about 6 percent of the lake is deeper than 105 feet.

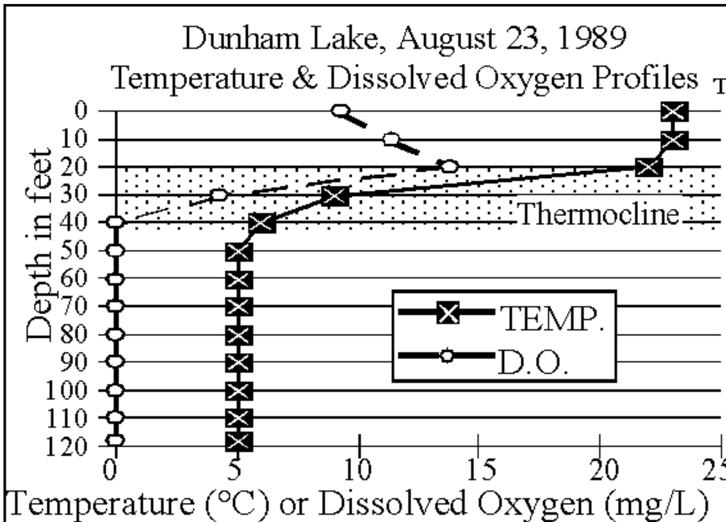
Spring 1989



Temp.	Depth	D.O.	Depth
7	0	10.6	0
7	10	10.8	10
6	20	10.3	20
5	30	9.7	30
4	40	8.8	40
4	50	8.1	50
4	60	7.3	60
4	70	6.3	70
4	80	5.8	80
4	90	5.5	90
4	100	5.0	100

In spring 1989, temperature and dissolved oxygen were essentially uniform, top to bottom. However, the bottom temperature was four degrees C. Since this is the temperature at which water is most dense (heaviest), the graph indicates the lake may have mixed early in the year, when the entire lake was four degrees C, and no later. The evidence that it probably mixed was dissolved oxygen was present top to bottom in spring. Lakes that do not mix in spring usually have no dissolved oxygen in the bottom water in spring.

Summer 1989



Temp.	Depth	D.O.	Depth
23	0	9.3	0
23	10	11.4	10
22	20	13.8	20
9	30	4.3	30
6	40	0.0	40
5	50	0.0	50
5	60	0.0	60
5	70	0.0	70
5	80	0.0	80
5	90	0.0	90
5	100	0.0	100
5	110	0.0	110
5	118	0.0	118

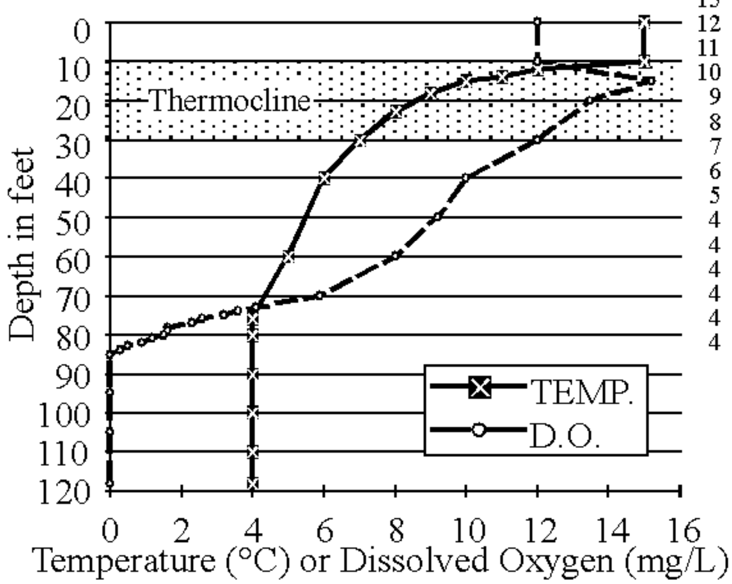
In late summer 1989, Dunham Lake formed a 20-foot-thick thermocline from 20 to 40 feet. Dissolved oxygen was plentiful above the thermocline, reaching a maximum of 13.8 milligrams per liter at the top of the thermocline. From that high, dissolved oxygen dropped to zero at the bottom of the thermocline at 40 feet. That condition remained to the bottom. About 62 percent of the lake is deeper than 40 feet.

Spring 1995

In spring 1995, when the lake was sampled on May 15, it had already formed a 20-foot thick thermocline from 10 to 30 feet. The temperature of the water in the bottom of the lake was again 4 degrees C, indicating in 1989 the lake was meromictic.

The lake ran out of dissolved oxygen at 85 feet, another indication that the lake did not mix totally top to bottom. If it had, dissolved oxygen would have been distributed through the entire water column, especially in spring as was the case in spring 1989.

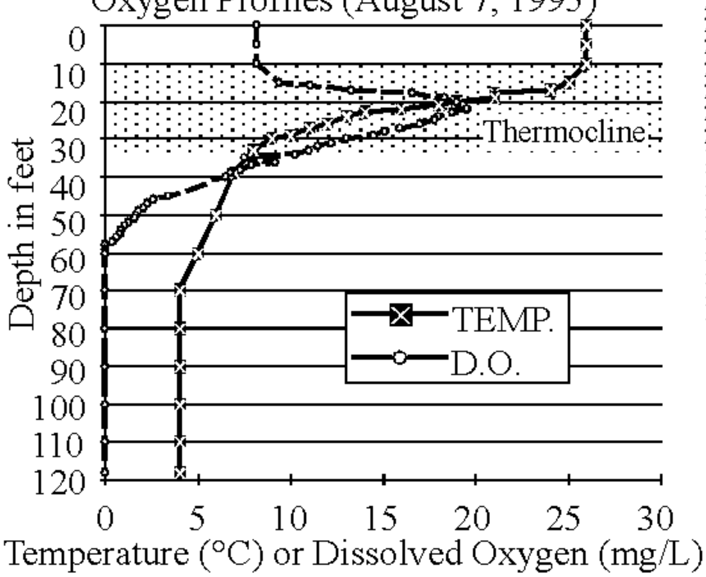
Dunham Lake, Temperature & Dissolved Oxygen Profiles (May 15, 1995)



Temp.	Depth	D.O.	Depth
15	0	12.0	0
15	10	12.0	10
12	12	15.2	15
11	14	13.5	20
10	15	12.0	30
9	18	10.0	40
8	23	9.2	50
7	30	8.0	60
6	40	5.9	70
5	60	4.1	73
4	76	3.6	74
4	80	3.2	75
4	90	2.6	76
4	100	2.3	77
4	110	1.6	78
4	118	1.6	79
		1.5	80
		1.2	81
		0.9	82
		0.5	83
		0.3	84
		0.0	85
		0.0	95
		0.0	105
		0.0	118

Summer 1995

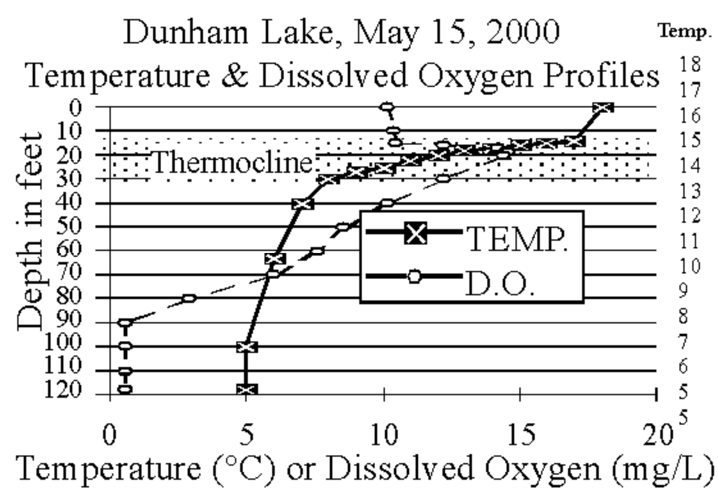
Dunham Lake, Temperature & Dissolved Oxygen Profiles (August 7, 1995)



Temp.	Depth	D.O.	Depth	D.O.	Depth
26	0	8.2	0	7.3	38
26	5	8.2	5	6.8	39
26	10	8.2	10	6.5	40
25	15	9.4	15	3.4	45
24	17	11.1	16	2.6	46
21	18	13.3	17	2.3	47
21	19	16.6	18	2.1	48
19	20	18.3	19	1.8	49
18	21	19.0	20	1.7	50
16	22	19.3	21	1.6	51
14	23	19.5	22	1.3	52
13	24	18.7	23	1.1	53
12	26	18.0	24	0.9	54
11	27	17.8	25	0.8	55
10	29	17.0	26	0.6	56
9	30	15.9	27	0.4	57
8	33	15.1	28	0.0	58
7	39	14.5	29	0.0	59
6	50	13.0	30	0.0	60
5	60	12.2	31	0.0	70
4	70	11.5	32	0.0	80
4	80	11.0	33	0.0	90
4	90	10.3	34	0.0	100
4	100	7.5	35	0.0	110
4	110	9.2	36	0.0	118
4	118	7.9	37		

In late summer 1995, Dunham Lake formed a 25-foot-thick thermocline from 10 to 35 feet. Dissolved oxygen reached a maximum at 19.5 milligrams per liter in the middle of the thermocline at 22 feet, again the result of an algal bloom which settled there. From that maximum, dissolved oxygen concentrations decreased until at 57 feet, (about 20 feet below the bottom of the thermocline) it was zero. The anoxic (no dissolved oxygen) condition remained to the bottom. About 36 percent of the lake is deeper than 57 feet. The temperature from 70 to 118 feet was 4 degrees C, indicating the lake didn't mix in spring. This year the lake was meromictic.

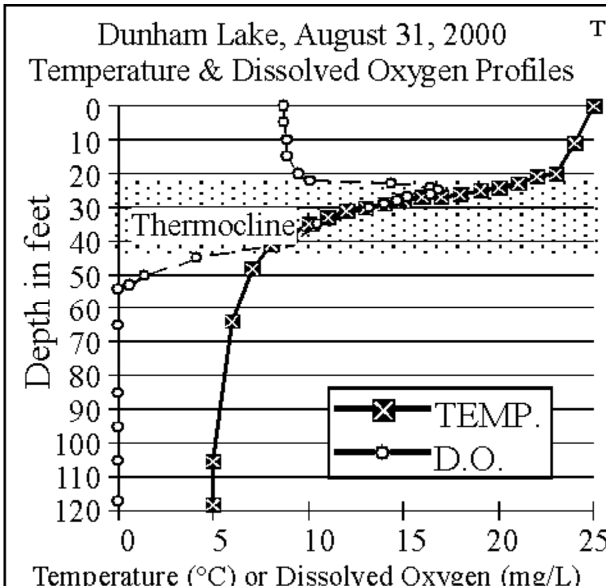
Spring 2000



Temp.	Depth	D.O.	Depth
18	0	10.2	0
17	14	10.4	10
16	15	10.5	15
15	16	12.2	16
14	17	14.2	17
13	18	14.6	18
12	20	14.6	19
11	22	14.4	20
10	25	12.2	30
9	27	10.2	40
8	30	8.6	50
7	40	7.6	60
6	63	6.0	70
5	100	2.9	80
5	118	0.6	90
		0.6	100
		0.6	110
		0.6	118

In spring 2000, when the lake was sampled on May 15, it formed a 14-foot-thick thermocline from 17 to 31 feet. Dissolved oxygen was plentiful above the thermocline and reached a maximum in the thermocline, again due to an algal bloom. In spring the lake did not run out of dissolved oxygen at any depth, plus the bottom temperature of five degrees C indicated the lake mixed top to bottom in 2000. In other words, the lake was not meromictic in 2000.

Summer 2000

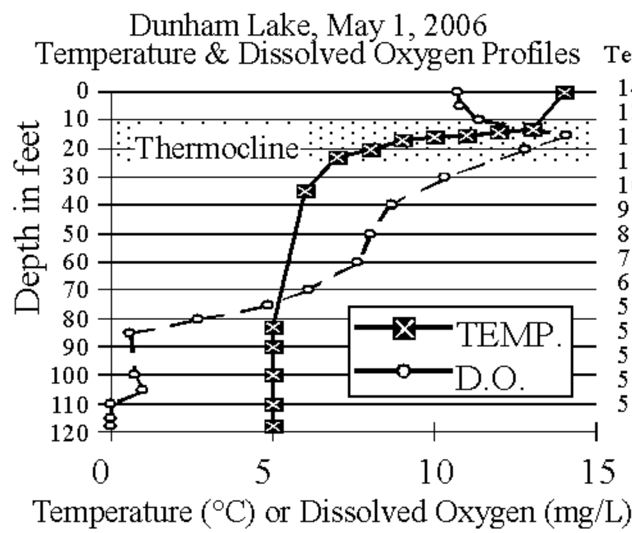


Temp.	Depth	D.O.	Depth
25	0	8.7	0
24	11	8.7	5
23	20	8.9	10
22	21	8.9	15
21	23	9.5	20
20	24	10.1	22
19	25	14.4	23
18	26	16.4	24
17	27	16.8	25
16	27	16.4	26
15	28	15.2	27
14	29	14.7	28
13	30	14.0	29
12	31	13.2	30
11	33	10.5	35
10	35	9.1	40
9	38	4.1	45
8	41	1.4	50
7	48	0.6	53
6	64	0.0	54
5	105	0.0	85
5	118	0.0	118

In late summer, 2000, the lake formed a 20-foot-thick thermocline from 20 to 40 feet. Dissolved oxygen concentrations were plentiful above the thermocline. It again reached a maximum of 16.8 milligrams per liter in the thermocline at 25 feet.

The lake ran out of dissolved oxygen at 54 feet, and that condition remained to the bottom. About 39 percent of the lake is deeper than 54 feet.

Spring 2006

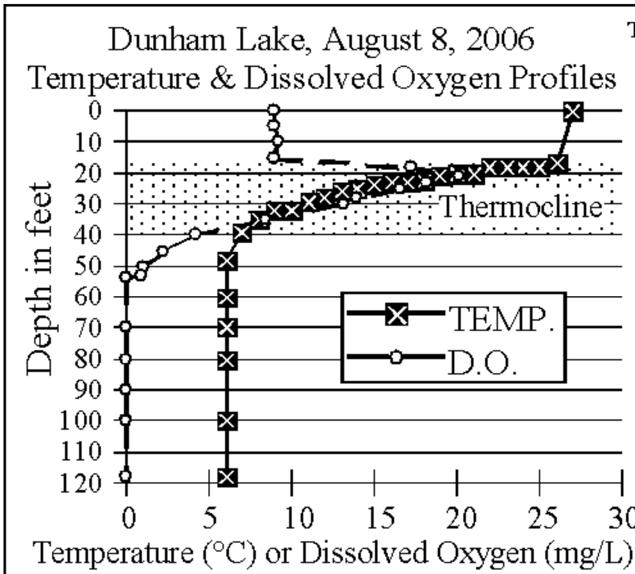


Temp.	Depth	D.O.	Depth
14	0	10.7	0
13	13	10.8	5
12	14	11.4	10
11	15	14.1	15
10	16	12.8	20
9	17	10.3	30
8	20	8.7	40
7	23	8.0	50
6	35	7.6	60
5	83	6.1	70
5	90	4.9	75
5	100	2.7	80
5	110	0.6	85
5	118	0.7	100
		1.0	105
		0.0	110
		0.0	115
		0.0	118

On May 1, 2006 the lake formed a 12-foot thick thermocline from 10 to 22 feet. The water at the bottom of the lake was five degrees C, so the lake mixed in spring.

A dissolved oxygen maxima occurred in the thermocline at 15 feet. From that depth dissolved oxygen gradually decreased, and was zero at 110 feet.

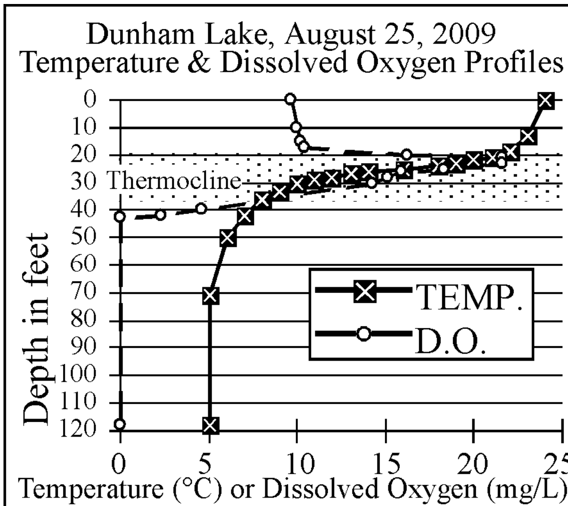
Summer 2006



Temp.	Depth	D.O.	Depth
27	0	8.9	0
26	17	8.9	5
25	18	9.2	10
22	19	8.9	15
20	20	17.3	18
19	21	20.2	20
18	22	20.1	21
16	23	18.2	23
15	24	16.6	25
14	25	14.0	28
13	26	13.2	30
12	28	8.4	35
11	29	4.2	40
10	32	2.3	45
9	32	1.1	50
8	35	0.9	53
7	39	0.0	54
6	48	0.0	70
6	60	0.0	80
6	80	0.0	90
6	100	0.0	100
6	118	0.0	118

In late summer 2006, the lake formed a 21-foot thick thermocline from 19 to 40 feet. A dissolved oxygen maxima again occurred in the thermocline at 20 feet. From that depth, dissolved oxygen concentrations gradually decreased, reaching zero mg/l at 54 feet.

That condition remained to the bottom. The hypsographic graph shows about 55 percent of the lake is deeper than 54 feet.



Temp.	Depth	D.O.	Depth
24	0	9.6	0
23	13	10.0	10
22	19	10.2	15
21	21	10.4	17
20	22	16.2	20
19	23	21.6	21
18	24	21.6	23
16	25	18.3	25
14	26	15.9	26
13	27	15.1	28
12	28	14.2	30
11	29	4.6	40
10	30	2.3	42
9	33	0.0	43
8	36	0.0	118
7	42		
6	50		
5	71		
5	118		

2009

In late summer 2009, the lake formed a 17-foot thick thermocline from 19 to 36 feet.

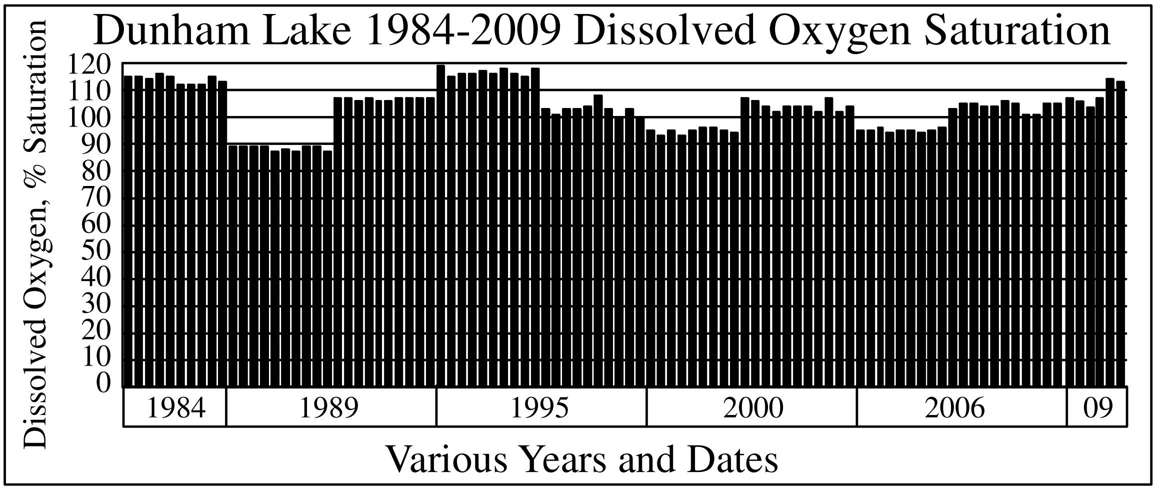
Dissolved oxygen was adequate above the thermocline and reached a maximum (the meter was pegged) of more than 21.6 mg/L from 21 to 23 feet in the thermocline. Below that depth the dissolved oxygen concentration decreased. It was zero at 43 feet and that condition remained to the bottom. About 57 percent of the lake is deeper than 43 feet.

The presence of an algal bloom in the thermocline is neither a good or bad sign. We see these algal blooms in about 20 percent of the lakes we study. Some feel they are an indication of a high quality lake because light can penetrate that far into the water column to permit algae to grow.

SURFACE DISSOLVED OXYGEN SATURATION

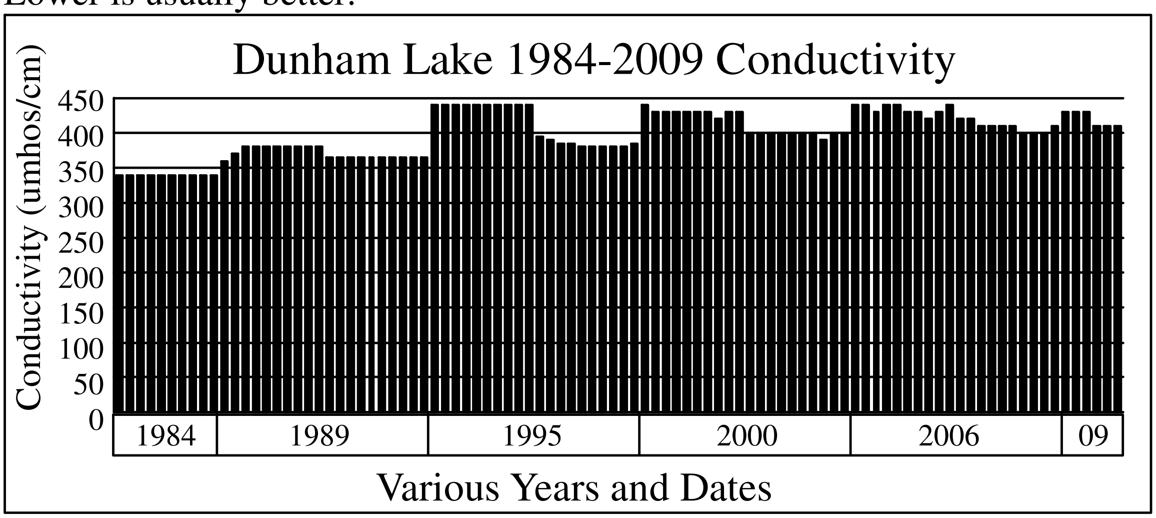
Since the amount of oxygen dissolved in the water is temperature dependent, with cold water holding more oxygen than warm water, dissolved oxygen saturation is often a better way to determine if dissolved oxygen supplies are adequate. Best is between 90 and 110 percent.

The dissolved oxygen saturation graph shows most of the time, surface dissolved oxygen concentrations were near saturation, which is good. The lake did have an algal bloom in summer 1984 and spring 1995 (see chlorophyll a below), which is the reason for the supersaturated conditions at those times. In 2009 spring dissolved oxygen was not measured. Summer values ranged from 107 to 114 percent, which are a bit higher than desirable.



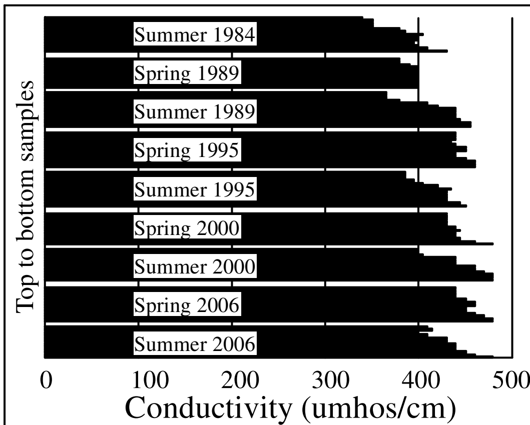
CONDUCTIVITY

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, since only dissolved materials (salts)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 of surface data shows the conductivity of Dunham Lake ranges from a low of 340 micromhos per centimeter (in summer 1984), to a high of 440 micromhos per centimeter in spring 1995 and 2006. These are normal conductivities for a Michigan moderately hard water inland lake. The graph shows in 2009, the conductivity did not change much from 2006. That's a plus. On the other hand, the graph seems to show conductivities are increasing as years pass.

TOP TO BOTTOM CONDUCTIVITIES



Dunham Lake 1984-2006 Spring & Summer Top to Bottom Conductivities

	9/12/84	4/4/89	8/23/89	5/14/95	8/6/95	5/15/00	8/31/00	5/1/06	8/8/06
10-0	340	380	365	440	385	430	400	440	410
10-10	350	380	365	440	385	430	400	440	415
10-20	350	390	365	440	385	430	405	440	400
10-30	350	400	380	435	395	430	440	440	410
10-40	380	400	410	440	405	430	440	450	430
10-50	395	400	420	450	420	440	440	460	430
10-60	405	400	440	450	435	445	460	460	440
10-70	400	400	440	440	430	440	460	450	440
10-80	395	400	440	440	430	440	470	450	440
10-90	400	400	440	450	430	445	480	460	450
10-100	410	400	445	460	430	460	480	470	460
10-110	430	---	455	460	445	480	480	480	480
10-118	---	---	455	460	450	---	---	480	---

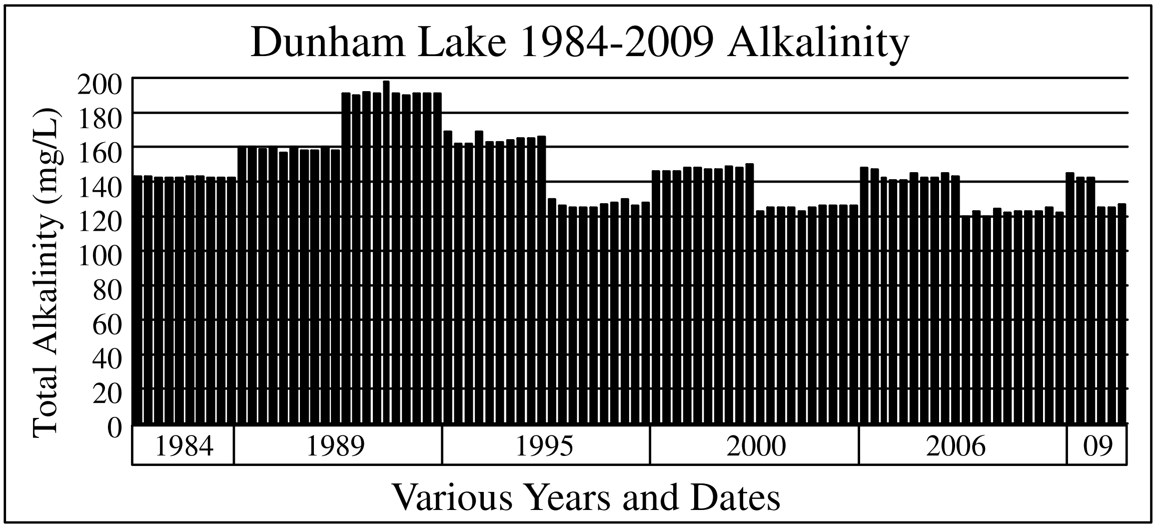
Top to bottom conductivities are shown on the graph in both spring and summer. The reason for this is it shows the similarities and differences between the data. Early spring conductivities are generally more uniform top to bottom, which is what would be expected if lakes mix. On the other hand, late spring and summer conductivities usually increase with depth, probably caused by increased solubility with depth.

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.

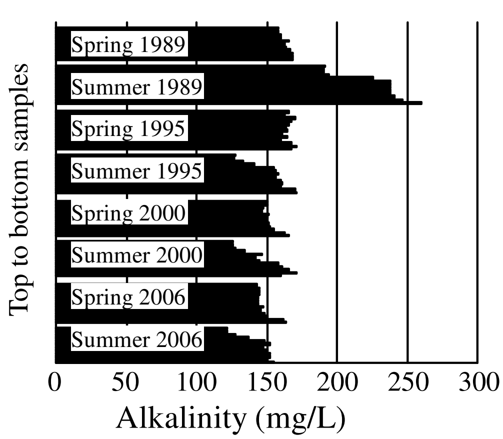
The graph shows the alkalinity of Dunham Lake ranges from 120 to 198 milligrams per liter. This indicates Dunham Lake is a moderately hard water to hard water lake. The graph shows since a high in summer 1989, alkalinity may be decreasing in the lake. That's not a problem.



The graph seems to show alkalinities are decreasing as years pass. That's not a problem.

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 which pretty much ties it up. Soft water lakes lack that ability.

TOP TO BOTTOM ALKALINITY



Dunham Lake 1989-2006 Spring & Summer Top to Bottom Alkalinity

	4/4/89	8/23/89	5/14/95	8/6/95	5/15/00	8/31/00	5/1/06	8/8/06
10-0	158	191	166	128	150	126	143	122
10-10	158	190	163	127	150	126	145	122
10-20	160	190	170	133	148	128	145	128
10-30	160	194	168	141	147	134	145	137
10-40	166	226	166	155	151	147	144	149
10-50	163	238	164	156	150	142	144	152
10-60	164	238	165	158	150	145	144	148
10-70	167	238	161	156	151	158	148	150
10-80	169	238	165	160	152	161	146	152
10-90	169	238	160	161	155	166	149	152
10-100	169	241	168	160	163	171	150	150
10-110	---	247	171	170	166	160	162	155
10-118	---	260	168	171	---	---	164	---

The graph shows alkalinity, like conductivity in spring is relatively uniform top to bottom, while in summer, alkalinity increases with depth. This graph also shows alkalinity in Dunham Lake may be decreasing.

The lower alkalinities in the top 30 feet or so in summer are because carbonates and bicarbonates, which are what the alkalinity test measures, are less soluble in warm water than in cold water, and therefore precipitate and settle to the bottom in the warm summer surface water. These materials from the top 30 or so feet, which settle to the bottom are what we find are often filling Michigan hard water and moderately hard water inland lakes.

NITRATE NITROGEN

Nitrate, measured in the parts per billion range, has traditionally been considered by lake scientists to 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.

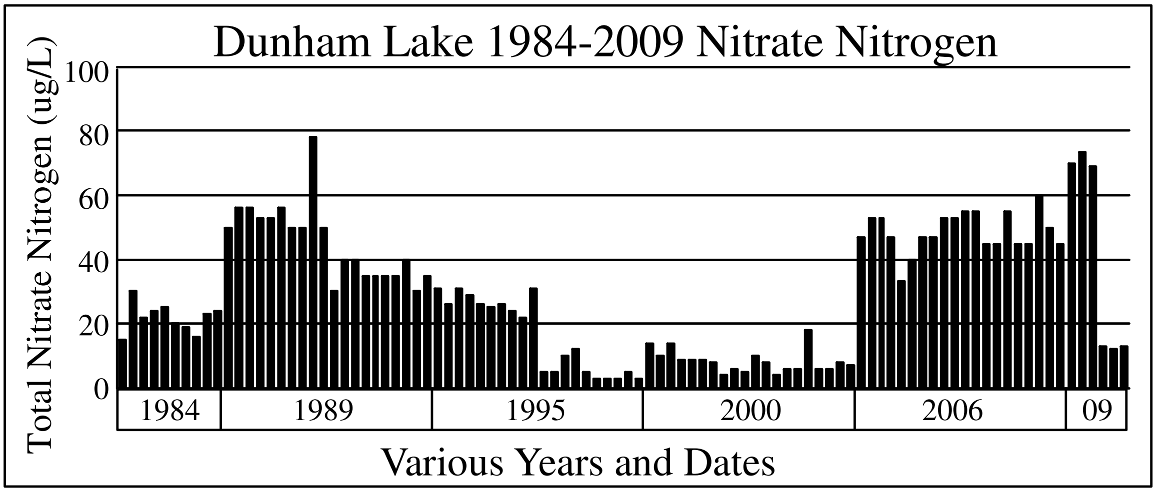
On the other hand, we've studied hundreds of Michigan inland lakes, and many times we find them nitrate limited (very low nitrate nitrogen concentrations), especially in summer.

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).

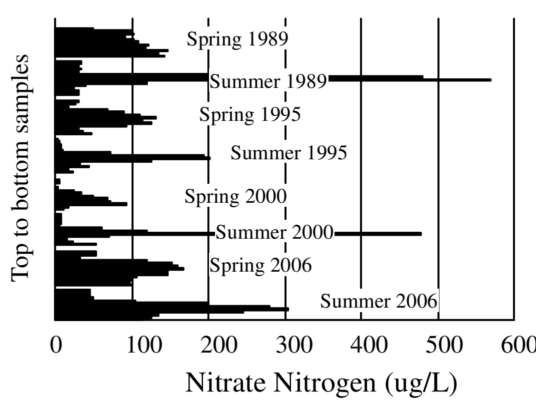
Summer nitrate nitrogen concentrations are generally much lower, in the 10 to 40 micrograms per liter range.



The graph shows spring surface Dunham Lake nitrate nitrogen concentrations range from 4 to 78 micrograms per liter. Summer values are generally lower, ranging from 4 to 60 micrograms per liter. These are low nitrate nitrogen concentrations in spring, and normal ones in summer.

In 2000, both spring and summer nitrate nitrogen concentrations were low. 2006 nitrates were low in spring and normal in summer. 2009 data were more normal in both spring and summer. These data indicate Dunham Lake is probably phosphorus limited in both spring and summer. It also means no fertilizers containing either nitrogen or phosphorus should be used on near lake areas.

TOP TO BOTTOM NITRATE NITROGEN CONCENTRATIONS



Dunham Lake 1989-2006 Spring & Summer
Top to Bottom Nitrate Nitrogen

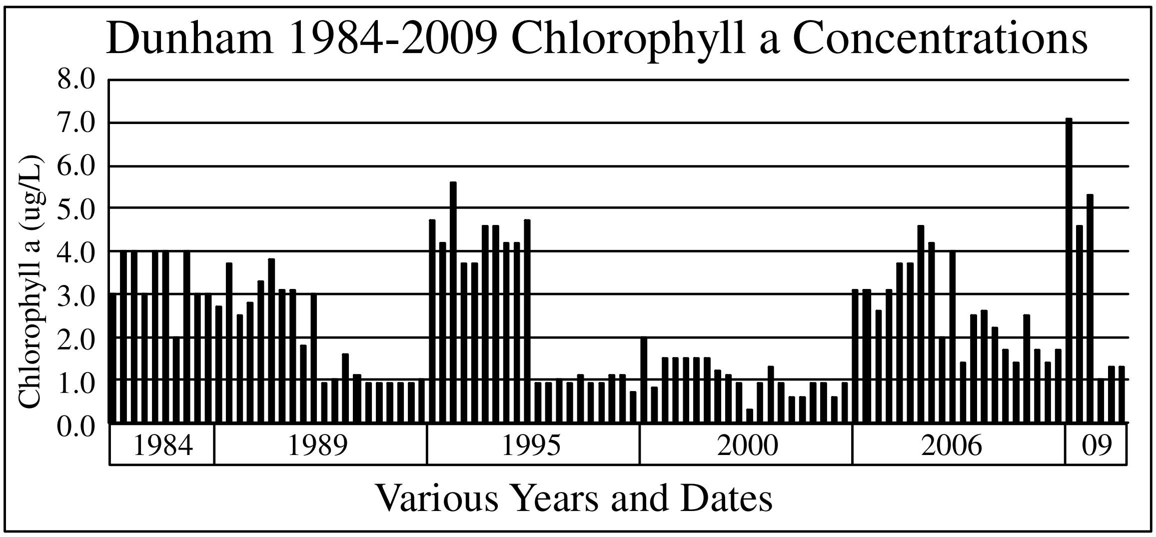
	4/4/89	8/23/89	5/14/95	8/6/95	5/15/00	8/31/00	5/1/06	8/8/06
10-0	50	35	31	3	5	7	53	45
10-10	100	35	26	5	5	8	53	45
10-20	102	30	18	8	2	7	33	45
10-30	92	35	68	7	3	8	120	50
10-40	102	30	89	10	24	6	153	105
10-50	108	205	110	73	34	60	160	200
10-60	122	480	131	195	49	120	167	280
10-70	118	570	115	202	68	478	147	305
10-80	147	120	126	125	73	70	147	245
10-90	135	40	94	33	93	15	107	135
10-100	143	25	31	43	17	23	100	125
10-110	---	30	37	18	12	53	97	115
10-118	---	30	47	22	---	---	100	---

The top to bottom nitrate graphs show nitrates generally increase at mid-depth in both spring and summer.

This is something we usually find in better quality lakes.

CHLOROPHYLL A

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



The graph shows Dunham Lake had algal blooms in summer 1984, spring 1989, spring 1995, spring 2006 and spring 2009. The graph also shows many chlorophyll a concentrations, especially in summer are at or below 1 microgram per liter. This is ideal.

The graph shows spring 2000 chlorophyll a concentrations were about the same as summer values, and were low. It also shows summer 2006 chlorophylls were somewhat higher than previous years in summer. And in 2009 spring chlorophylls were the highest so far, although summer chlorophylls were fine.

pH (Hydrogen ion concentration)

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

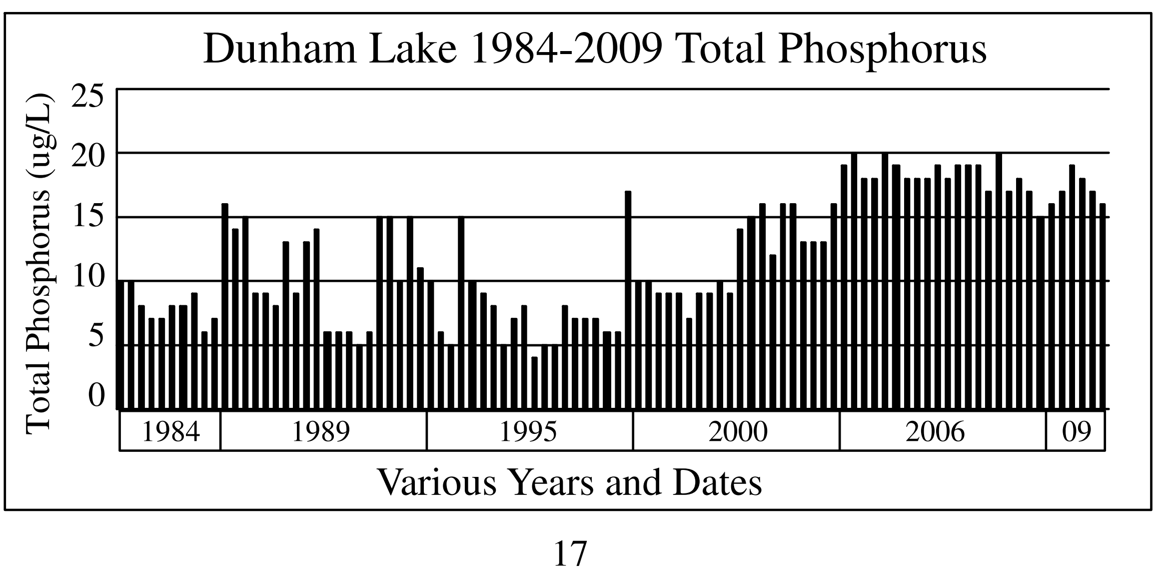
Surface pH values (no graph) ranged from 8.1 to 8.8. These are normal values for a high quality Michigan inland lake.

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

TOTAL PHOSPHORUS

Although there are several forms of phosphorus found in lakes, the experts selected total phosphorus as being most important. This is probably because all forms of phosphorus can be converted to the other forms. Currently, most lake scientists feel phosphorus, which is measured in parts per billion (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 communities so often found in eutrophic lakes.

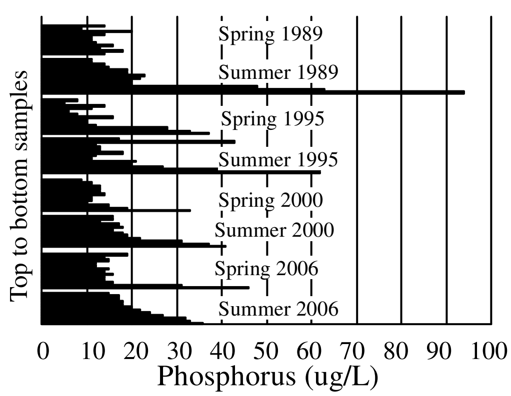
However, based on our studies of many Michigan inland lakes, we've found many lakes were phosphorus limited in spring (so don't add phosphorus) and nitrate limited in summer (so don't add nitrogen).



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

The graph shows Dunham Lake has phosphorus concentrations in the 4 to 20 micrograms per liter range and average 12 micrograms per liter. Best is below 10 micrograms per liter.

The graph shows, however, that the phosphorus concentration appears to be increasing in the lake, with 2006 and 2009 having the highest values so far. Every effort should be made to prevent this from happening. Residents should not expect the green belt around the lake to prevent lawn phosphorus from getting into the lake because all water which falls as rain or snow around the lake eventually gets to the lake with its accompanying nutrient load, especially if it flows in storm drains or open ditches rather than through the green belt. They need to quit using lawn fertilizers.



Dunham Lake 1989-2006 Spring & Summer
Top to Bottom Phosphorus Concentrations

	4/4/89	8/23/89	5/14/95	8/6/95	5/15/00	8/31/00	5/1/06	8/8/06
10-0	14	11	8	17	9	16	19	15
10-10	9	11	5	43	11	16	19	17
10-20	20	14	14	12	13	13	18	17
10-30	14	15	11	13	13	17	17	18
10-40	11	19	6	13	13	18	17	18
10-50	11	19	8	18	14	16	13	20
10-60	12	23	16	12	11	18	18	22
10-70	16	22	10	11	11	19	16	24
10-80	13	20	10	21	10	22	19	27
10-90	18	20	12	20	15	31	21	32
10-100	14	48	28	27	19	37	26	33
10-110	---	63	33	62	33	41	31	36
10-118	---	94	37	62	---	---	46	---

TOP TO BOTTOM PHOSPHORUS CONCENTRATIONS

The graph of top to bottom phosphorus concentrations shows phosphorus is being released from the bottom sediments during anoxic (no dissolved oxygen) conditions in the bottom water. And this seems to occur in both spring and in late summer samples.

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. (Would you consider a very clear lake a good quality lake, even if it had no fish in it? It would be almost like a swimming pool.) 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.

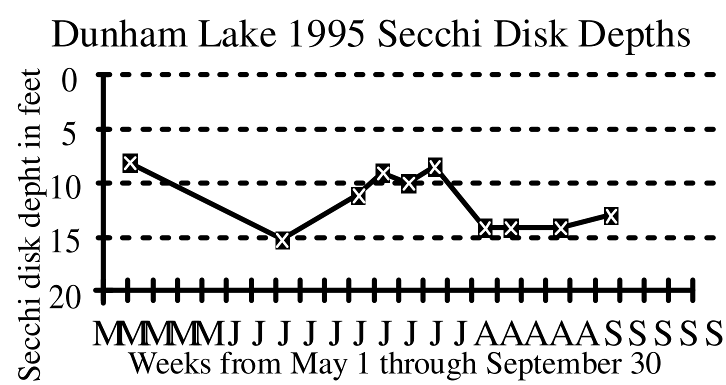
Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency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

DUNHAM LAKE SECCHI DISK DATA



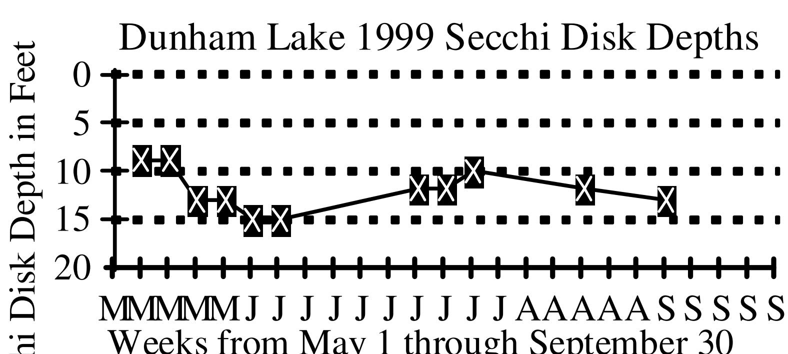
MAY	.	8	.	.
JUN	.	.	15.2	.
JUL	11	9	10	8.5
AUG	14	14	.	14
SEP	13	.	.	.

We have Secchi disk data for 1995, 1999, 2006 and 2009. The graphs below show the data.

1995

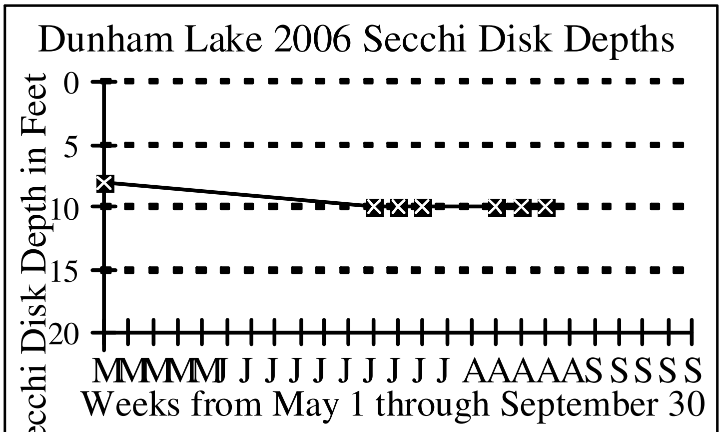
In 1995, the graph shows Dunham Lake may have had an early spring algal bloom (probably diatoms). In late May and early June, the lake got clearer, then less clear in July. In August when the water was still warm the water clarity increased by about five feet. That continued through the fall.

1999



MAY	.	9	9	13	13
JUN	15	15	.	.	.
JUL	.	12	12	10	.
AUG	.	.	12	.	.
SEP	13	.	.	.	.

In 1999, spring Secchi disk readings (collected by Denise Maxwell and Diane Hallinen) were 9 feet, indicating an early spring algal bloom. They increased to 15 feet in early June, before decreasing to 10-12 feet in July. From that point they increased a bit to 13 feet. Had Secchi disk readings continued to be taken through September, the trend to deeper readings would probably have continued.

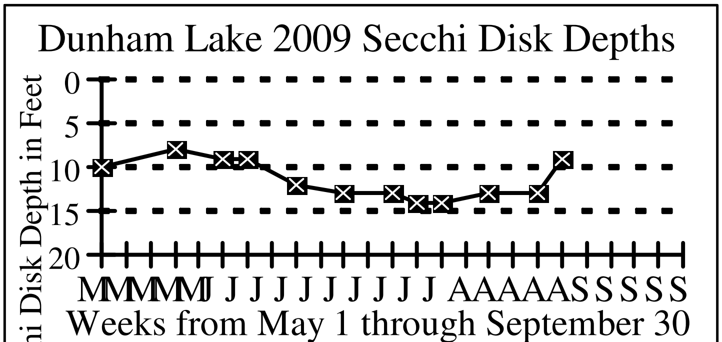


MAY	8	.	.	.	.
JUN	.	.	.	.	.
JUL	.	10	10	10	.
AUG	.	10	10	10	.

2006

Eric Gustafson collected Secchi disk data in 2006. His data show 8-foot readings in early spring and 10 foot readings from July on.

2009



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

In 2009 Hank Pielack collected Secchi disk data through the warm months.

The graph shows spring readings of 8 to 10 feet, increasing to between 12 and 14 feet in July and August. In late September they decreased to 9 feet.

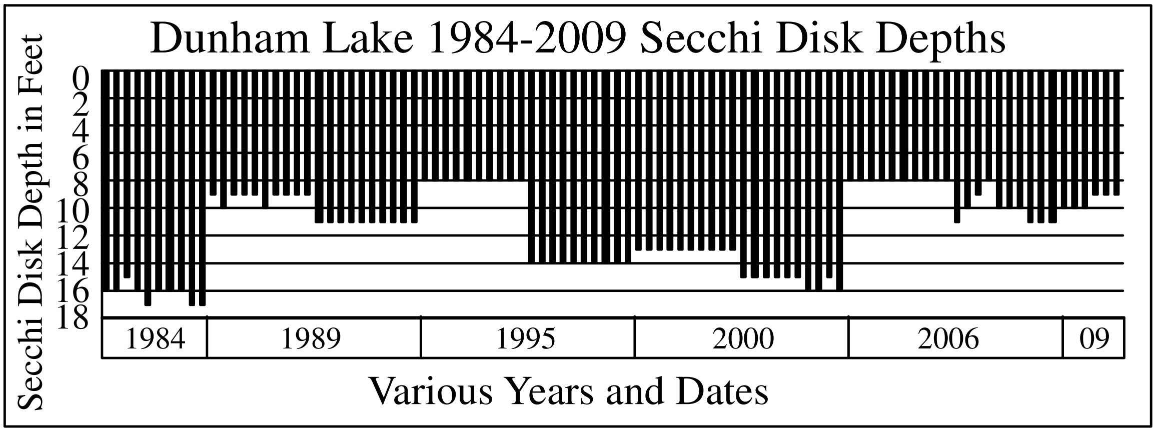
Secchi disk readings should continue being taken regularly on a weekly basis through the warm months every year to follow lake processes.

SECCHI DISK TREND GRAPH

We do not have enough data to construct a Secchi disk trend graph.

SECCHI DISK READINGS TAKEN WITH THE SAMPLES

The graph shows the Secchi disk readings taken with the samples. It shows the deepest readings were in late summer 1984 and shallowest readings were in spring 1995 and 2006.



Late summer 2009 Secchi disk readings were among the shallowest summer readings so far.

This is going in the wrong direction. Let's hope this trend doesn't continue.

THE LAKE WATER QUALITY INDEX

The Lake Water Quality Index used in this study to define the water quality of Dunham 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 was 16 at an Ottawa County lake.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

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

HOW TO READ THE LAKE WATER QUALITY INDEX CALCULATION SHEETS.

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

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

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

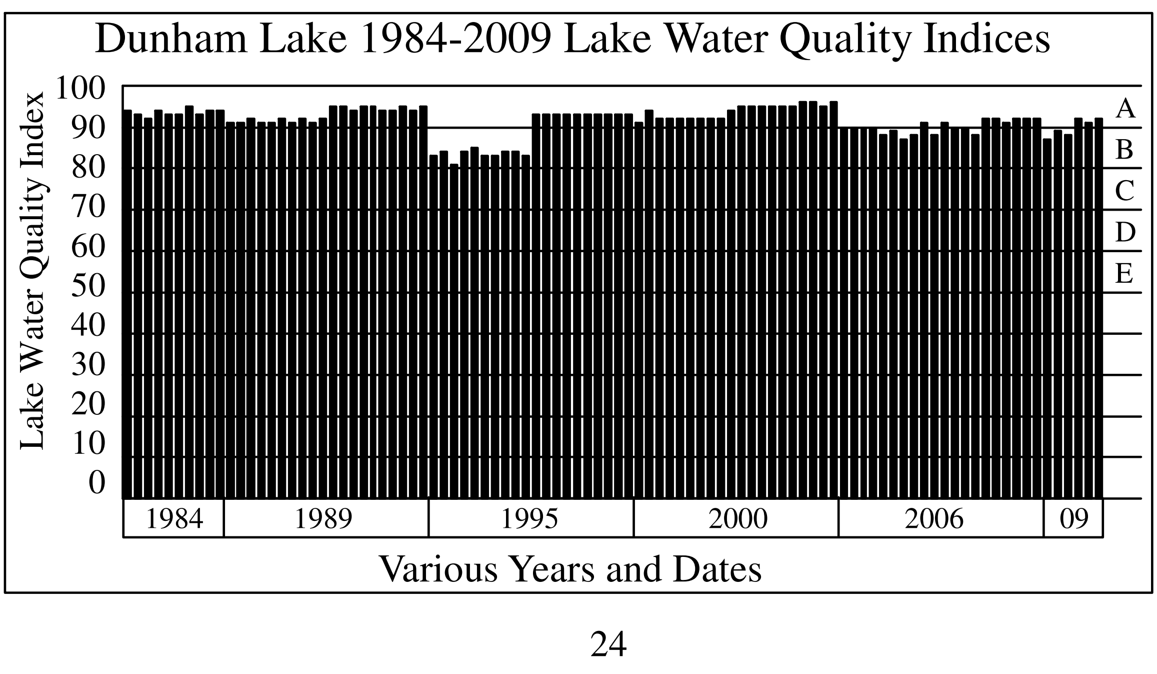
The position of the red lines across the thermometer indicates how the results of each test compare in terms of lake water quality. Test results indicating excellent water quality are indicated by red lines near the top of the thermometer. Test results indicating poor water quality are indicated by red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

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

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

THE LAKE WATER QUALITY INDICES FOR DUNHAM LAKE

The graph shows the Lake Water Quality Indices for Dunham Lake range from a low of 81 (B) in spring 1995 to a high of 96 (A), in summer 2000. In 2006, spring LWQIs ranged from 87 to 91 (B to A) and summer LWQIs ranged from 88 to 92 (B to A). In 2009 spring LWQIs ranged from 87 to 89 (B) and summer values were 91 or 92 (A).



These data indicate Dunham Lake is a good quality lake, with LWQIs above 90 (or in the A range) every time it was sampled except spring 1995, 2006 and 2009. The 2006 and 2009 LWQIs indicated a decrease in the water quality. Let's hope this trend doesn't continue.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

Because the three spring 2009 surface LWQIs were similar (87 89 88) and the three summer 2009 surface LWQIs were also similar (92 91 92), only two Lake Water Quality Index calculation sheets are included in this report, one for the three spring surface samples, using averaged data and another for the three summer surface samples, again using averaged data.

In the report marked MASTER, all 6 of the 2009 LWQI calculation sheets are included. That is the only difference between the MASTER and the rest of the reports.

DUNHAM LAKE 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 bicarbonates and 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 bicarbonates and 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.

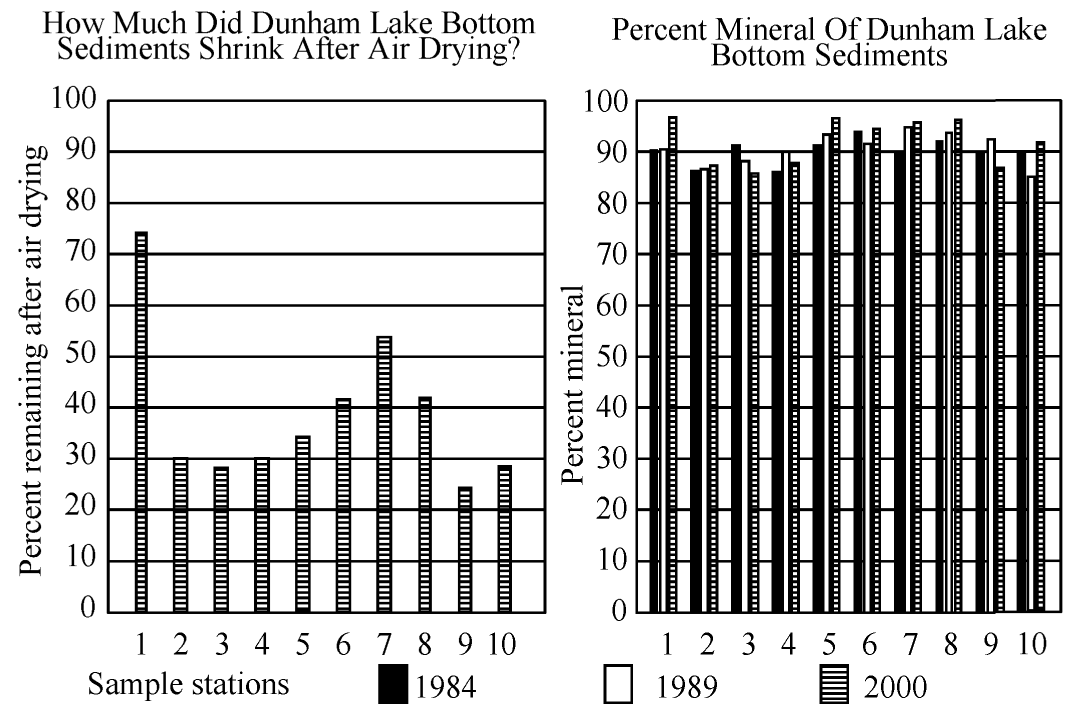
If the tan bottom sediments turn red after burning, it means the lake is filling with clay. Clay enters the lake from near-lake activities such as road building, home building or farming. Usually clay is not a material that makes up the bottom sediments of most inland lakes.

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.

Bottom sediment samples were collected at the ten in-lake stations in 1984, 1989 and 2000. The graph below shows the data.

The 2000 bottom sediment samples shrunk between 26 and 76 percent. This is a normal amount of shrinkage for a Michigan inland lake. (We did not start calculating the amount shrinkage until after 1989.) All samples turned gray after air-drying.



Characteristics of Dunham Lake Bottom Sediments (1984, 1989 & 2000)								
Sample I.D.	Percent Shrinkage	Percent Mineral			Dried at 100°C Color	Color after burning at 550°C	Depth of water (feet)	
	2000	1984	1989	2000	All years	All years	1989	2000
1	26	90	90	97	Gray	Gray	3	3
2	70	87	87	88	Gray	Gray	33	45
3	72	91	88	86	Gray	Gray	45	36
4	70	87	90	88	Gray	Gray	44	50
5	65	91	93	97	Gray	Gray	36	40
6	59	94	91	93	Gray	Gray	50	30
7	46	90	95	95	Gray	Gray	43	26
8	59	91	93	97	Gray	Gray	14	34
9	76	90	92	87	Gray	Gray	76	90
10	71	90	85	91	Gray	Gray	118	115
Average mineral content of bottom sediments: 1984 = 90%, 1989 = 90%, 2000 = 92%								

After burning at 550 degrees C, all samples remained gray, which meant bicarbonates and carbonates made up the majority of those sediments. The mineral content of the lake samples ranged from 85 to 97 percent. In 1984 the mineral content averaged 90 percent. In 1989 the mineral content averaged 90 percent. And in 2000, the mineral content of Dunham Lake bottom sediments averaged 92 percent. These data indicate Dunham Lake is not accumulating organic material at a faster than normal rate. That's great.

One of the most important things Dunham Lake homeowners can do is to make sure the mineral content doesn't change, and organic material starts to build up in the bottom sediments. If the mineral content of the bottom sediments doesn't change, it means the homeowners around the lake are taking proper care of their lake.

Wallace E. Fusilier, Ph.D.
Consulting Limnologist
Water Quality Investigators
Dexter, Michigan
January 2010

Dunham Lake Water Quality Data

Date	Sample Station Number	Temperature °C	Dissolved Oxygen		Chlorophyll a ug/L	Secchi Disk Depth (feet)	Total Nitrate Nitrogen ug/L	Alkalinity mg/L	pH	Conductivity umhos per cm at 25°C	Total Phosphorus ug/L	Lake Water Quality Index	Grade
			(mg/L)	Percent Saturation									
9/4/84	1	21	9.4	115	3	16	15	143	8.4	340	10	94	A
9/4/84	2	21	9.4	115	4	16	30	143	8.4	340	10	93	A
9/4/84	3	21	9.3	114	4	15	22	142	8.4	340	8	92	A
9/4/84	4	21	9.5	116	3	16	24	142	8.4	340	7	94	A
9/4/84	5	21	9.4	115	4	17	25	142	8.4	340	7	93	A
9/4/84	6	21	9.2	112	4	16	20	143	8.4	340	8	93	A
9/4/84	7	21	9.2	112	2	16	19	143	8.4	340	8	95	A
9/4/84	8	21	9.2	112	4	16	16	142	8.4	340	9	93	A
9/4/84	9	21	9.4	115	3	17	23	142	8.4	340	6	94	A
9/4/84	10	21	9.3	113	3	17	24	142	8.4	340	7	94	A
9/12/84	10-10	21	9.7	118	---	---	---	143	---	350	---	---	---
9/12/84	10-20	21	9.7	118	---	---	---	142	---	350	---	---	---
9/12/84	10-30	21	11.6	142	---	---	---	143	---	350	---	---	---
9/12/84	10-40	21	12.0	146	---	---	---	160	---	380	---	---	---
9/12/84	10-50	21	6.0	73	---	---	---	162	---	385	---	---	---
9/12/84	10-60	21	2.2	27	---	---	---	179	---	405	---	---	---
9/12/84	10-70	21	1.7	21	---	---	---	174	---	400	---	---	---
9/12/84	10-80	21	2.2	27	---	---	---	---	---	400	---	---	---
9/12/84	10-90	21	1.6	20	---	---	---	---	---	395	---	---	---
9/12/84	10-100	21	0.5	6	---	---	---	---	---	400	---	---	---
9/12/84	10-110	21	0.0	0	---	---	---	---	---	410	---	---	---
9/12/84	10-118	21	0.0	0	---	---	---	---	---	430	---	---	---
4/4/89	1	7	10.8	89	2.7	9	50	160	8.1	360	16	91	A
4/4/89	2	7	10.8	89	3.7	10	56	160	8.1	370	14	91	A
4/4/89	3	7	10.8	89	2.5	9	56	159	8.1	380	15	92	A
4/4/89	4	7	10.8	89	2.8	9	53	160	8.1	380	9	91	A
4/4/89	5	7	10.6	87	3.3	9	53	157	8.1	380	9	91	A
4/4/89	6	7	10.7	88	3.8	10	56	160	8.1	380	8	92	A
4/4/89	7	7	10.6	87	3.1	9	50	158	8.1	380	13	91	A
4/4/89	8	7	10.8	89	3.1	9	50	158	8.1	380	9	92	A
4/4/89	9	7	10.8	89	1.8	9	78	160	8.1	380	13	91	A
4/4/89	10	7	10.6	87	3.0	9	50	158	8.1	380	14	92	A
4/4/89	10-10	7	10.6	87	---	---	100	158	8.1	380	9	---	---
4/4/89	10-20	6	10.3	83	---	---	102	160	8.1	390	20	---	---
4/4/89	10-30	5	9.7	76	---	---	92	160	8.1	400	14	---	---
4/4/89	10-40	4	8.8	67	---	---	102	166	8.0	400	11	---	---
4/4/89	10-50	4	8.1	62	---	---	108	163	8.0	400	11	---	---
4/4/89	10-60	4	7.3	56	---	---	122	164	8.0	400	12	---	---
4/4/89	10-70	4	6.3	48	---	---	118	167	7.9	400	16	---	---
4/4/89	10-80	4	5.8	44	---	---	147	169	7.9	400	13	---	---
4/4/89	10-90	4	5.5	42	---	---	135	169	7.9	400	18	---	---
4/4/89	10-100	4	5.0	38	---	---	143	169	7.9	400	14	---	---
4/4/89	Outlet	7	10.8	89	---	---	78	158	8.1	390	18	---	---
8/23/89	1	23	9.2	107	0.9	11	30	191	8.2	365	6	95	A
8/23/89	2	23	9.2	107	1.0	11	40	190	8.3	365	6	95	A
8/23/89	3	23	9.1	106	1.6	11	40	192	8.2	365	6	94	A
8/23/89	4	23	9.2	107	1.1	11	35	191	8.2	365	5	95	A
8/23/89	5	23	9.1	106	0.9	11	35	198	8.2	365	6	95	A
8/23/89	6	23	9.1	106	0.9	11	35	191	8.2	365	15	94	A
8/23/89	7	23	9.2	107	0.9	11	35	190	8.2	365	15	94	A
8/23/89	8	23	9.2	107	0.9	11	40	191	8.2	365	10	95	A
8/23/89	9	23	9.2	107	0.9	11	30	191	8.2	365	15	94	A
8/23/89	10	23	9.3	107	1.0	11	35	191	8.2	365	11	95	A
8/23/89	10-10	23	11.4	133	---	---	35	190	8.2	365	11	---	---
8/23/89	10-20	22	13.8	158	---	---	30	190	8.2	365	14	---	---
8/23/89	10-30	9	4.3	37	---	---	35	194	8.2	380	15	---	---
8/23/89	10-40	6	0.0	0.0	---	---	30	226	8.0	410	19	---	---
8/23/89	10-50	5	0.0	0.0	---	---	205	238	7.8	420	19	---	---
8/23/89	10-60	5	0.0	0.0	---	---	480	238	7.8	440	23	---	---
8/23/89	10-70	5	0.0	0.0	---	---	570	238	7.7	440	22	---	---
8/23/89	10-80	5	0.0	0.0	---	---	120	238	7.6	440	20	---	---
8/23/89	10-90	5	0.0	0.0	---	---	40	238	7.6	440	20	---	---
8/23/89	10-100	5	0.0	0.0	---	---	25	241	7.6	445	48	---	---
8/23/89	10-110	5	0.0	0.0	---	---	30	247	7.6	455	63	---	---
8/23/89	10-118	5	0.0	0.0	---	---	30	260	7.6	455	94	---	---
8/23/89	Outlet	---	---	---	---	---	30	191	8.2	365	11	---	---

Dunham 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
5/14/95	1	15	12.1	119	4.7	8	31	169	8.8	440	10	83	B
5/14/95	2	15	11.7	115	4.2	8	26	162	8.8	440	6	84	B
5/14/95	3	16	11.6	116	5.6	8	31	162	8.8	440	5	81	B
5/14/95	4	15	11.8	116	3.7	8	29	169	8.8	440	15	84	B
5/14/95	5	15	11.9	117	3.7	8	26	163	8.8	440	10	85	B
5/14/95	6	15	11.8	116	4.6	8	25	163	8.8	440	9	83	B
5/14/95	7	16	11.8	118	4.6	8	26	164	8.8	440	8	83	B
5/14/95	8	15	11.8	116	4.2	8	24	165	8.8	440	5	84	B
5/14/95	9	15	11.7	115	4.2	8	22	165	8.8	440	7	84	B
5/14/95	10	15	12.0	118	4.7	8	31	166	8.8	440	8	83	B
5/14/95	10-10	15	12.0	118	---	---	26	163	8.8	440	5	---	---
5/14/95	10-20	8	13.5	114	---	---	18	170	8.8	440	14	---	---
5/14/95	10-30	7	12.0	99	---	---	68	168	8.6	435	11	---	---
5/14/95	10-40	6	10.0	80	---	---	89	166	8.4	440	6	---	---
5/14/95	10-50	6	9.2	74	---	---	110	164	8.2	450	8	---	---
5/14/95	10-60	5	8.0	68	---	---	131	165	8.1	450	16	---	---
5/14/95	10-70	5	5.9	50	---	---	115	161	8.2	440	10	---	---
5/14/95	10-80	4	1.5	11	---	---	126	165	8.0	440	10	---	---
5/14/95	10-90	4	0.0	0.0	---	---	94	160	7.9	450	12	---	---
5/14/95	10-100	4	0.0	0.0	---	---	31	168	7.7	460	28	---	---
5/14/95	10-110	4	0.0	0.0	---	---	37	171	7.7	460	33	---	---
5/14/95	10-118	4	0.0	0.0	---	---	47	168	7.8	460	37	---	---
5/14/95	Outlet	16	11.6	116	---	---	15	162	8.8	440	9	---	---
8/6/95	1	27	8.2	103	0.9	14	5	130	8.7	395	4	93	A
8/6/95	2	27	8.1	101	0.9	14	5	126	8.7	390	5	93	A
8/6/95	3	27	8.2	103	1.0	14	10	125	8.7	385	5	93	A
8/6/95	4	27	8.2	103	0.9	14	12	125	8.7	385	8	93	A
8/6/95	5	27	8.3	104	1.1	14	5	125	8.7	380	7	93	A
8/6/95	6	27	8.6	108	0.9	14	3	127	8.7	380	7	93	A
8/6/95	7	27	8.2	103	0.9	14	3	128	8.7	380	7	93	A
8/6/95	8	26	8.2	100	1.1	14	3	130	8.7	380	6	93	A
8/6/95	9	27	8.3	103	1.1	14	5	126	8.7	380	6	93	A
8/6/95	10	26	8.2	100	0.7	14	3	128	8.7	385	17	93	A
8/6/95	10-10	26	8.2	101	---	---	5	127	8.7	385	43	---	---
8/6/95	10-20	19	19.0	205	---	---	8	133	8.6	385	12	---	---
8/6/95	10-30	9	13.0	112	---	---	7	141	8.6	395	13	---	---
8/6/95	10-40	7	6.5	54	---	---	10	155	8.3	405	13	---	---
8/6/95	10-50	6	1.7	14	---	---	73	156	8	420	18	---	---
8/6/95	10-60	6	0.0	0.0	---	---	195	158	7.8	435	12	---	---
8/6/95	10-70	4	0.0	0.0	---	---	202	156	7.8	430	11	---	---
8/6/95	10-80	4	0.0	0.0	---	---	125	160	7.7	430	21	---	---
8/6/95	10-90	4	0.0	0.0	---	---	33	161	7.7	430	20	---	---
8/6/95	10-100	4	0.0	0.0	---	---	43	160	7.7	430	27	---	---
8/6/95	10-110	4	0.0	0.0	---	---	18	170	7.5	445	62	---	---
8/6/95	10-118	4	0.0	0.0	---	---	22	171	7.5	450	62	---	---
8/6/95	Outlet	27	---	---	---	---	7	151	8.7	390	7	---	---
5/15/00	1	18	9.0	95	2.0	13	14	146	8.7	440	10	91	A
5/15/00	2	18	8.8	93	0.8	13	10	146	8.6	430	10	94	A
5/15/00	3	18	9.0	95	1.5	13	14	146	8.7	430	9	92	A
5/15/00	4	17	9.0	93	1.5	13	9	148	8.7	430	9	92	A
5/15/00	5	18	9.0	95	1.5	13	9	148	8.7	430	9	92	A
5/15/00	6	18	9.1	96	1.5	13	9	147	8.7	430	7	92	A
5/15/00	7	18	9.1	96	1.5	13	8	147	8.7	430	9	92	A
5/15/00	8	18	9.0	95	1.2	13	4	149	8.7	420	9	92	A
5/15/00	9	18	8.9	94	1.1	13	6	148	8.7	430	10	92	A
5/15/00	10	18	10.2	107	0.9	13	5	150	8.6	430	9	94	A
5/15/00	10-10	18	10.4	109	---	---	5	150	8.7	430	11	---	---
5/15/00	10-20	12	14.4	130	---	---	2	148	8.8	430	13	---	---
5/15/00	10-30	8	12.2	103	---	---	3	147	8.6	430	13	---	---
5/15/00	10-40	7	10.2	84	---	---	24	151	8.3	430	13	---	---
5/15/00	10-50	7	8.6	70	---	---	34	150	8.2	440	14	---	---
5/15/00	10-60	7	7.6	62	---	---	49	150	8.1	445	11	---	---
5/15/00	10-70	6	6.0	48	---	---	68	151	8.0	440	11	---	---
5/15/00	10-80	5	2.9	23	---	---	73	152	7.9	440	10	---	---
5/15/00	10-90	5	0.6	5	---	---	93	155	7.8	445	15	---	---
5/15/00	10-100	5	0.6	5	---	---	17	163	7.6	460	19	---	---
5/15/00	10-110	5	0.6	5	---	---	12	166	7.5	480	33	---	---

Dunham 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
8/31/00	1	25	8.9	106	0.3	15	10	123	8.5	400	14	95	A
8/31/00	2	25	8.7	104	0.9	15	8	125	8.5	400	15	95	A
8/31/00	3	25	8.6	102	1.3	15	4	125	8.5	400	16	95	A
8/31/00	4	25	8.7	104	0.9	15	6	125	8.5	400	12	95	A
8/31/00	5	25	8.7	104	0.6	15	6	123	8.5	400	16	95	A
8/31/00	6	25	8.7	104	0.6	15	18	125	8.4	400	16	95	A
8/31/00	7	25	8.6	102	0.9	16	6	126	8.5	400	13	96	A
8/31/00	8	25	9.0	107	0.9	16	6	126	8.4	390	13	96	A
8/31/00	9	25	8.6	102	0.6	15	8	126	8.4	400	13	95	A
8/31/00	10	25	8.7	104	0.9	16	7	126	8.4	400	16	96	A
8/31/00	10-10	25	8.4	100	---	---	8	126	8.4	400	16	---	---
8/31/00	10-20	23	9.0	103	---	---	7	128	8.4	405	13	---	---
8/31/00	10-30	13	12.5	118	---	---	8	134	8.3	440	17	---	---
8/31/00	10-40	9	8.6	72	---	---	6	147	8.0	440	18	---	---
8/31/00	10-50	7	1.3	10	---	---	60	142	7.9	440	16	---	---
8/31/00	10-60	7	0.6	5	---	---	120	145	7.8	460	18	---	---
8/31/00	10-70	6	0.0	0	---	---	478	158	7.4	460	19	---	---
8/31/00	10-80	6	0.0	0	---	---	70	161	7.3	470	22	---	---
8/31/00	10-90	6	0.0	0	---	---	15	166	7.3	480	31	---	---
8/31/00	10-100	6	0.0	0	---	---	23	171	7.3	480	37	---	---
8/31/00	10-110	5	0.0	0	---	---	53	160	7.4	480	41	---	---
5/1/06	1	14	9.9	95	3.1	8	47	148	8.5	440	19	90	A
5/1/06	2	14	9.9	95	3.1	8	53	147	8.5	440	20	90	A
5/1/06	3	14	10.0	96	2.6	8	53	142	8.5	430	18	90	A
5/1/06	4	14	9.8	94	3.1	8	47	141	8.5	440	18	90	A
5/1/06	5	14	9.9	95	3.7	8	333	141	8.5	440	20	88	B
5/1/06	6	14	9.9	95	3.7	8	40	145	8.5	430	19	89	B
5/1/06	7	14	9.8	94	4.6	8	47	142	8.6	430	18	87	B
5/1/06	8	14	9.9	95	4.2	8	47	142	8.5	420	18	88	B
5/1/06	9	14	10.0	96	2.0	8	53	145	8.5	430	18	91	A
5/1/06	10	14	10.7	103	4.0	8	53	143	8.5	440	19	88	B
5/1/06	10-10	14	14.2	137	---	---	53	145	8.5	440	14	---	---
5/1/06	10-20	8	15.9	134	---	---	33	145	8.4	440	15	---	---
5/1/06	10-30	7	12.8	105	---	---	120	145	8.1	440	12	---	---
5/1/06	10-40	6	10.8	86	---	---	153	144	8.0	450	12	---	---
5/1/06	10-50	6	10.0	80	---	---	160	144	7.9	460	15	---	---
5/1/06	10-60	6	9.4	75	---	---	167	144	8.0	460	14	---	---
5/1/06	10-70	6	7.6	61	---	---	147	148	8.1	450	16	---	---
5/1/06	10-80	6	3.3	26	---	---	147	146	7.8	450	14	---	---
5/1/06	10-90	5	0.8	6	---	---	107	149	7.6	460	14	---	---
5/1/06	10-100	5	0.9	6	---	---	100	150	7.7	470	16	---	---
5/1/06	10-110	5	1.2	7	---	---	97	162	7.5	480	31	---	---
5/1/06	10-118	5	0.0	0	---	---	100	164	7.5	480	46	---	---
8/8/06	1	27	8.4	105	1.4	11	55	120	8.7	420	18	91	A
8/8/06	2	27	8.4	105	2.5	10	55	123	8.6	420	19	90	A
8/8/06	3	27	8.3	104	2.6	9	45	120	8.6	410	19	90	A
8/8/06	4	27	8.3	104	2.2	8	45	124	8.7	410	19	88	B
8/8/06	5	27	8.5	106	1.7	10	55	122	8.6	410	17	92	A
8/8/06	6	27	8.4	105	1.4	10	45	123	8.6	410	20	92	A
8/8/06	7	27	8.1	101	2.5	10	45	123	8.6	400	17	91	A
8/8/06	8	27	8.1	101	1.7	11	60	123	8.6	400	18	92	A
8/8/06	9	27	8.4	105	1.4	11	50	125	8.6	400	17	92	A
8/8/06	10	27	8.4	105	1.7	11	45	122	8.6	410	15	92	A
8/8/06	10-10	27	8.7	108	---	---	45	122	8.6	415	17	---	---
8/8/06	10-20	21	19.7	218	---	---	45	128	8.6	400	17	---	---
8/8/06	10-30	11	12.7	114	---	---	50	137	8.5	410	18	---	---
8/8/06	10-40	7	3.7	30	---	---	105	149	8.0	430	18	---	---
8/8/06	10-50	6	0.7	6	---	---	200	152	7.9	430	20	---	---
8/8/06	10-60	6	0.0	0.0	---	---	280	148	7.9	440	22	---	---
8/8/06	10-70	6	0.0	0.0	---	---	305	150	7.9	440	24	---	---
8/8/06	10-80	6	0.0	0.0	---	---	245	152	7.8	440	27	---	---
8/8/06	10-90	6	0.0	0.0	---	---	135	152	7.8	450	32	---	---
8/8/06	10-100	6	0.0	0.0	---	---	125	150	7.7	460	33	---	---
8/8/06	10-110	6	0.0	0.0	---	---	115	155	7.6	480	36	---	---
4/29/09	4	---	---	---	7.1	10	13	145	8.3	430	16	87	B
4/29/09	9	---	---	---	4.6	10	12	142	8.3	430	17	89	B
4/29/09	10	---	---	---	5.3	10	13	142	8.3	430	19	88	B
8/25/09	4	24	9.1	107	1.0	9	176	125	8.5	410	18	92	A
8/25/09	9	24	9.7	114	1.3	9	132	125	8.4	410	17	91	A
8/25/09	10	24	9.6	113	1.3	9	120	127	8.6	410	16	92	A