MACEDAY LAKE

WATERFORD TOWNSHIP

OAKLAND COUNTY

1990, 2000 & 2010 WATER QUALITY STUDIES

MACEDAY LAKE DATA

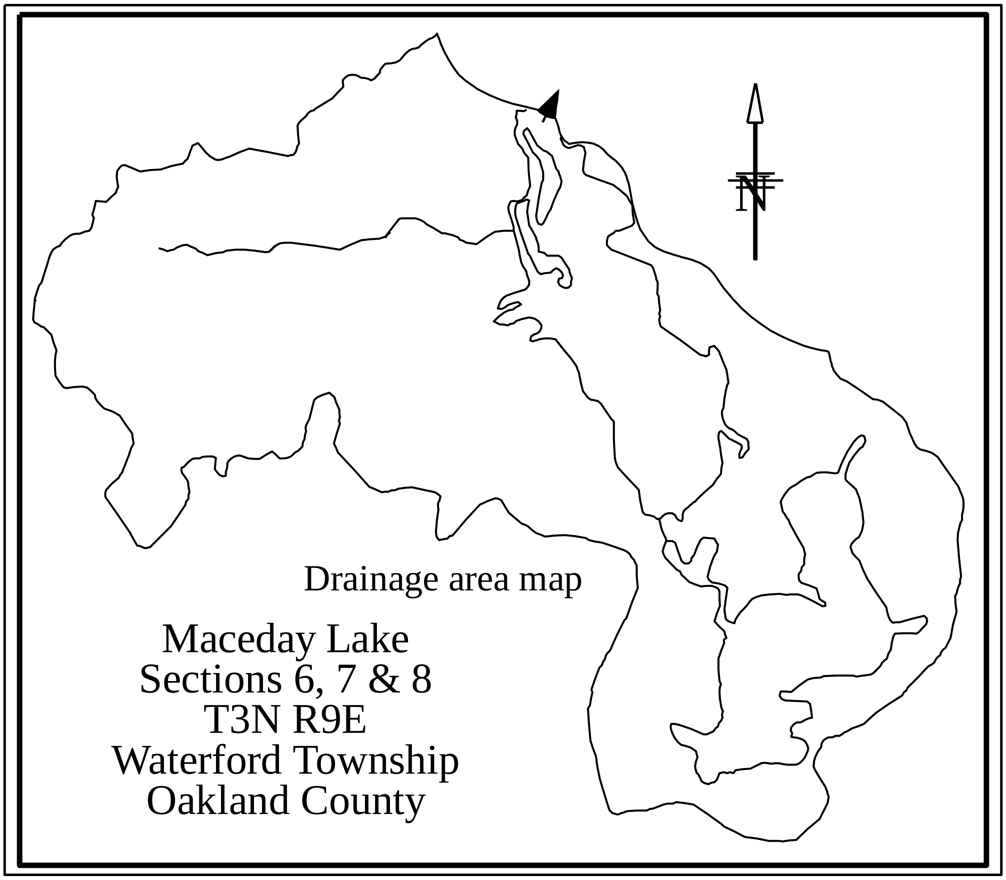
Maceday Lake is a 252-acre natural hard-water kettle lake located in Sections 6, 7 and 8, Waterford Township (T3N R9E) Oakland County, Michigan. There are two islands in the lake totaling 21 acres, so the surface area is 231 acres. It is connected to Lotus Lake through a shallow canal on the north end. Tree stumps in this area indicate the lake was several feet lower in the recent past than it is now. The level was probably raised when the dam was installed in Waterford to create Van Norman Lake. Maceday Lake consists of a single deep basin and is a prime example of a kettle lake. The basin has a maximum depth of 117 feet, a water volume of 7776 acre-feet, and a mean depth of 33.7 feet.

Maceday Lake has 18888 feet of shoreline, not including the islands. The elevation of the lake is 966 feet above sea level. The lake is in the Clinton River basin.

The size of the watershed, which is the land area that contributes water to the lake, but does not include the lake is large, 1823 acres. The drainage area, which includes the lake and the watershed, is 2075 acres. The watershed to lake ratio is 7.23 to 1, which is on the high side of normal for a Michigan inland lake. The lake flushes about once every 4.48 years, on an average.

There is an inlet which flows into the lake from the west. It enters the lake in the canal behind the southern island. A second inlet from Williams Lake is located on the south end of the lake. However there is a gate on this canal. It is unknown if it is ever opened.

The longitude and latitude of the 117-foot deep hole is 83° 25.849W and 42° 41.254N.



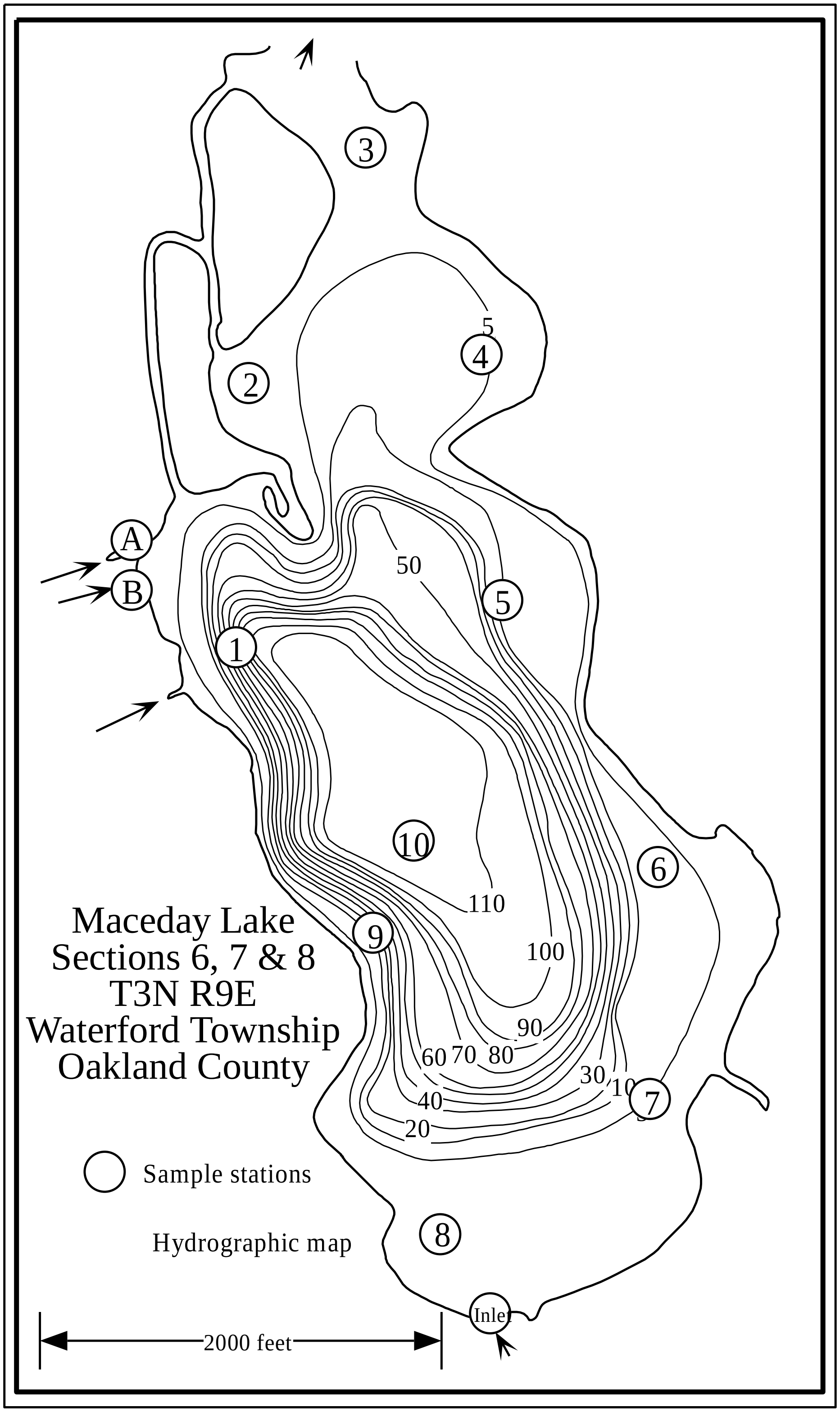
THE SAMPLE STATIONS

The locations of the in-lake and inlet sample stations are shown as circles on the hydrographic map of the lake.

THE SAMPLE DATES

In 1990 WQI limnologists took ten surface samples plus Secchi disk readings at the sites shown on the map and top to bottom samples every ten feet in the117 foot deep hole on March 28th and August 27th. Bottom sediments were also collected at the ten sites in spring.

In 2000 WQI limnologists collected ten surface samples plus Secchi disk readings at the 12 sites shown on the map (1-10 plus A & B) and top to bottom samples every ten feet in the 117-foot deep hole on April 24th, and



August 14th. Bottom sediments were again collected at the ten sites in spring.

In 2010 WQI limnologists collected ten surface samples plus Secchi disk readings at the 10 sites shown on the map and top to bottom samples every ten feet in the117-foot deep hole on April 15th, and August 6th. Bottom sediments were collected at the ten sites in spring.

Although no one collected Secchi disk data during the warm months in 1990, 2000 or 2010, Richard Zieman collected those data during the summers of 1995, 1996 and 1997.

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).

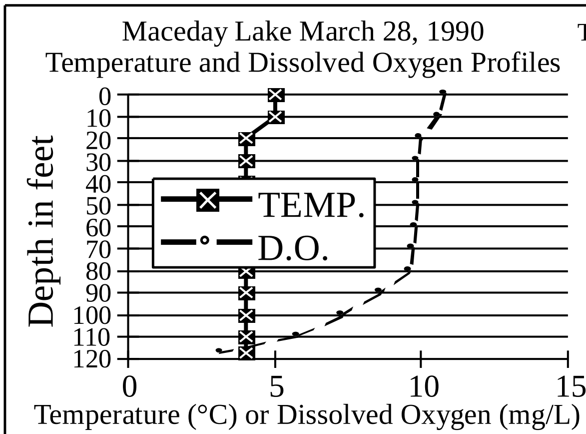
THE TEST RESULTS

The results of the tests are found on graphs, in the tables 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 gasses and biological activity. In spring temperature generally doesn’t need to be determined because we’ve found temperatures are low and dissolved oxygen is near saturation at that time.

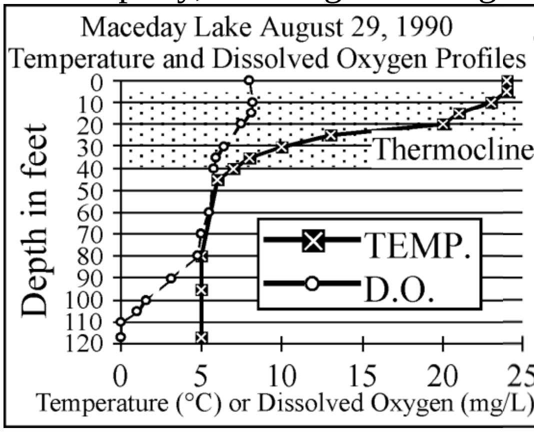
Dissolved oxygen is the test most often selected by lake scientists as being important. Besides its importance in providing oxygen for aquatic organisms to use, in natural lakes oxygen is involved the capture and release of various chemicals, such as iron and phosphorus.



Temp.	Depth	D.O.	Depth
5	0	10.8	0
5	10	10.6	10
4	20	10.0	20
4	30	9.9	30
4	40	9.9	40
4	50	9.9	50
4	60	9.8	60
4	70	9.7	70
4	80	9.6	80
4	90	8.6	90
4	100	7.3	100
4	110	5.8	110
4	117	3.2	117

1990

The graph below shows the spring 1990 top to bottom temperature and dissolved oxygen data. It shows temperature was essentially uniform top to bottom being either four or five degrees Centigrade. Dissolved oxygen exceeded 10 milligrams per liter at the surface, and gradually decreased to 9.6 milligrams per liter at 80 feet. Below that dissolved oxygen dropped more rapidly, reaching 3.2 milligrams per liter at 117 feet.



Temp.	Depth	D.O.	Depth
24	0	8.0	0
24	5	8.2	10
23	10	7.5	20
21	15	6.4	30
20	20	5.8	40
13	25	5.5	50
10	30	5.5	60
8	35	5.1	65
7	40	5.0	75
6	45	4.8	80
5	80	3.1	90
5	90	1.6	100
5	100	1.0	105
5	110	0.0	110
5	117	0.0	117

The graph shows the summer 1990 top to bottom temperature and dissolved oxygen data.

In late summer the water column was divided into the three layers we typically find in deep Michigan inland lakes, the upper and lower layers being separated by a middle layer, called a thermocline, (where the temperature changes more than one degree C per meter of depth, and shown shaded on the graphs).

Above the thermocline temperature was uniform, and at normal summer conditions. It dropped rapidly in the thermocline, which extended from 10 to 40 feet. Below the thermocline, the temperature was again fairly uniform, but colder.

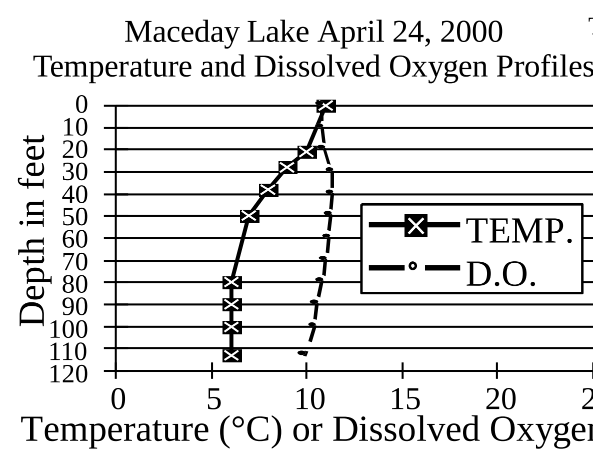
Dissolved oxygen remained above four milligrams per liter until about 85 feet. This means there was a large portion of the water column below the thermocline with sufficient dissolved oxygen to support most fish species. This is a very unusual (and desirable) condition and only occurs in one to two percent of the deep lakes we study. It is by far the best indicator of a high quality lake I am aware of. And I think most limnologists agree on this.

SPRING 2000

The graph below shows the 2000 spring top to bottom temperature and dissolved oxygen data.

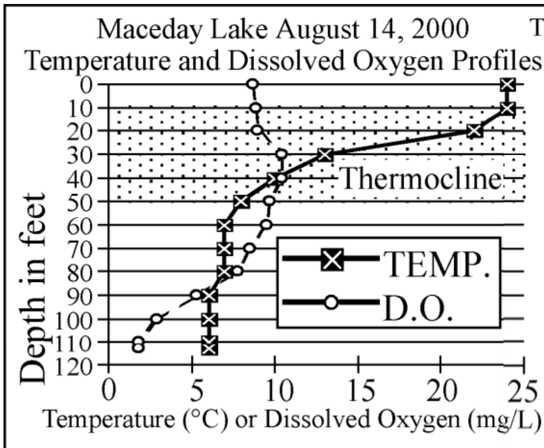
This graph shows much more typical spring conditions. Temperature is relatively uniform top to bottom, and dissolved oxygen is relatively uniform top to bottom. These data indicate the lake just mixed prior to sampling.

SUMMER 2000



Temp.	Depth	D.O.	Depth
11	0	10.8	0
10	21	10.8	10
9	28	10.9	20
8	38	11.4	30
7	50	11.4	40
6	80	11.3	50
6	90	11.2	60
6	100	11.0	70
6	113	10.8	80
		10.5	90
		10.4	100
		9.9	113

The graph shows the summer top to bottom dissolved oxygen and temperature data for the 117-foot deep hole.



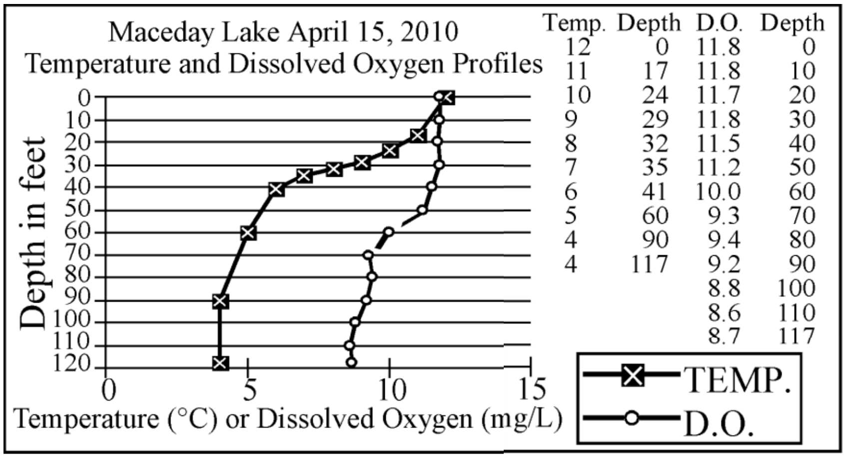
Temp.	Depth	D.O.	Depth
24	0	8.7	0
24	10	8.9	10
22	20	9.0	20
13	30	10.4	30
10	40	10.4	40
8	50	9.7	50
7	60	9.5	60
7	70	8.5	70
7	80	7.8	80
6	90	5.3	90
6	100	2.9	100
6	110	1.8	110
6	113	1.8	113

In mid-August a 40-foot-thick thermocline formed from 10 to 50 feet. Temperature was uniform above the thermocline, and dropped rapidly in it. Below the thermocline, the temperature was considerably colder, 6-8 degrees C, but again fairly uniform.

Dissolved oxygen concentrations were ideal. Above the thermocline, they were normal. However in the thermocline, and down to about 80 feet, dissolved oxygen concentrations were higher than they were at the surface. These high dissolved oxygen conditions are a relic of spring dissolved oxygen levels when the water held more dissolved oxygen because it was colder. The reason the high dissolved oxygen concentrations in and below the thermocline existed is because there was not enough organic material settling out in the lake to remove it when this organic material, generally in the form of algae, was decomposed. These are ideal and optimal conditions for a lake, and again provide evidence of the high quality of Maceday Lake.

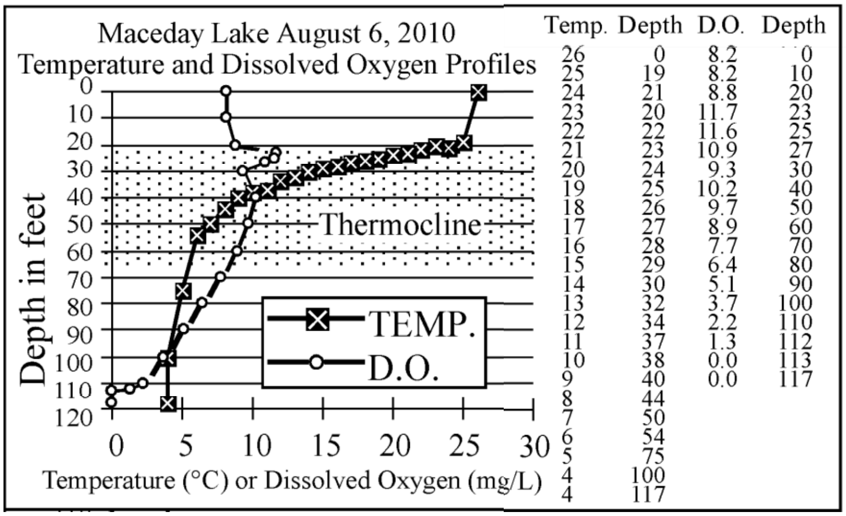
SPRING 2010

The graph below shows the spring 2010 temperature and dissolved oxygen data. It shows on April 15, the lake is starting to stratify in that the surface



Temp.	Depth	D.O.	Depth
12	0	11.8	0
11	17	11.8	10
10	24	11.7	20
9	29	11.8	30
8	32	11.5	40
7	35	11.2	50
6	41	10.0	60
5	60	9.3	70
4	90	9.4	80
4	117	9.2	90
		8.8	100
		8.6	110
		8.7	117

temperature is 12 degrees C and the bottom is 4 degrees C. On the other hand, the dissolved oxygen concentration is essentially uniform top to bottom.



Temp.	Depth	D.O.	Depth
26	0	8.2	0
25	19	8.2	10
24	21	8.8	20
23	20	11.7	23
22	22	11.6	25
21	23	10.9	27
20	24	9.3	30
19	25	10.2	40
18	26	9.7	50
17	27	8.9	60
16	28	7.7	70
15	29	6.4	80
14	30	5.1	90
13	32	3.7	100
12	34	2.2	110
11	37	1.3	112
10	38	0.0	113
9	40	0.0	117
8	44		
7	50		
6	54		
5	75		
4	100		
4	117		

SUMMER 2010

The graph shows the late summer 2010 dissolved oxygen and temperature profiles. It shows the lake formed a 35-foot thick thermocline from 20 to 55 feet. Dissolved oxygen was plentiful above the thermocline and increased in the thermocline to a maximum of 11.7 mg/L at 23 feet, probably the result of an algal bloom which settled there. From that depth the concentration of dissolved oxygen gradually decreased to 1.3 mg/L at 112 feet. It was zero at 113 feet and that condition remained to the bottom. In late summer 2010 Maceday retained its dissolved oxygen under the thermocline, which is very good.

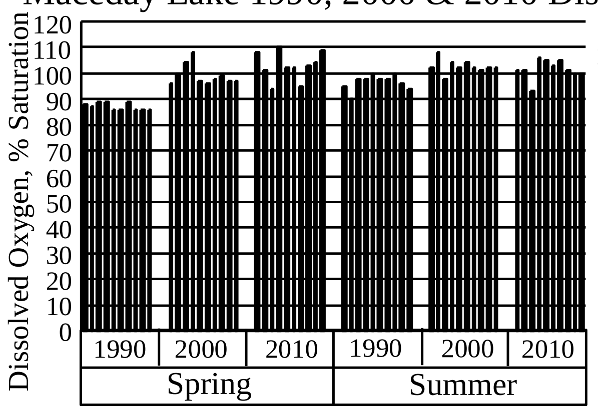
The main reason Maceday retains high quality conditions is not because it is being well treated by riparians. They are essentially doing the same thing most other lakes are doing, which is using lawn fertilizers, a real no-no around lakes. The reason it retains its high quality because it has a lot of water in it. This is a good example of why lakes benefit from having water in them, and the more the better.

A note about the following graphs. The graphs below were sorted first by spring and summer, then by year. The purpose of this is to detect any differences between the data in spring and in summer, and over the years.

DISSOLVED OXYGEN SATURATION

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

Maceday Lake 1990, 2000 & 2010 Dissolved Oxygen Saturation



Spring			Summer		
1990	2000	2010	1990	2000	2010
88	96	108	95	102	101
87	100	101	90	108	101
89	104	94	98	98	93
89	108	110	98	104	106
86	97	102	100	102	105
86	96	102	98	104	103
89	98	95	98	102	105
86	99	103	100	101	101
86	97	104	96	102	100
86	97	109	94	102	100

The graph shows in spring 1990 dissolved oxygen saturations were low (90% or less) at all ten stations. All of the other spring and summer saturations through the years ranged between 90 and 110 percent, which is good.

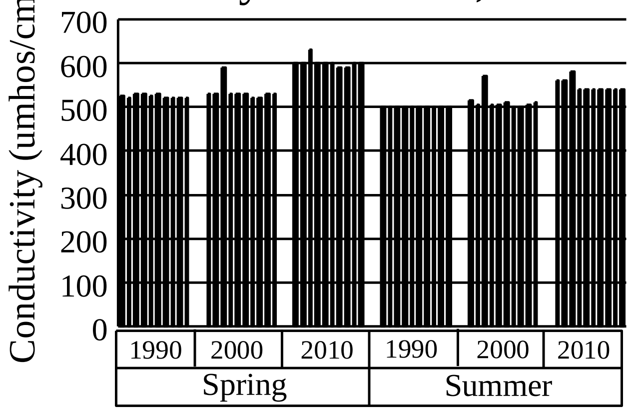
CONDUCTIVITY

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 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 below shows spring and summer conductivities in 1990 and 2000 were about the same. Spring 2010 conductivities were higher, in the 590 to

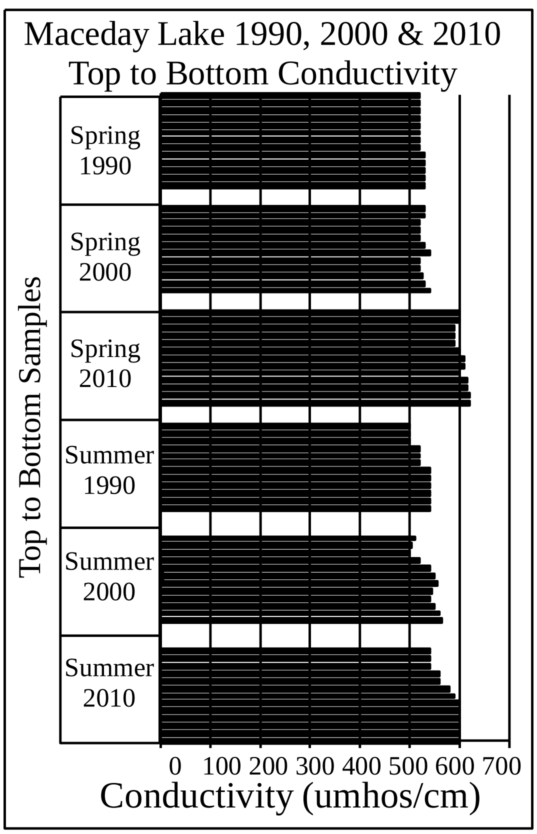
630 umhos/cm range. Summer 2010 conductivities were also higher than the two previous sample periods, in the 540 to 560 umhos/cm range.

Maceday Lake 1990, 2000 & 2010 Conductivity



Spring			Summer		
1990	2000	2010	1990	2000	2010
525	530	600	500	515	560
520	530	600	500	505	560
530	590	630	500	570	580
530	530	600	500	505	540
525	530	600	500	505	540
530	530	600	500	510	540
520	520	590	500	500	540
520	520	590	500	500	540
520	530	600	500	505	540
520	530	600	500	510	540

These 2010 data show salts from road salting operations or water softeners, or both, are probably affecting the lake. During four of the six sample periods, Station 3 at the north end had higher conductivities for some reason.



TOP TO BOTTOM CONDUCTIVITIY

The graph below shows the top to bottom spring and summer conductivities for all three periods.

It shows in spring top to bottom conductivities were about the same, not an unusual condition because the lake usually mixes top to bottom in spring.

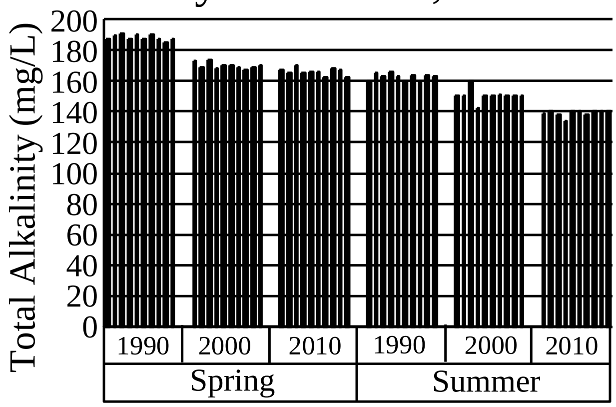
In summer, conductivities were higher near the bottom. This is something we often see, and is probably related to increased solubility with depth.

The graph shows summer conductivities increase top to bottom in all three years.

TOTAL ALKALINITY

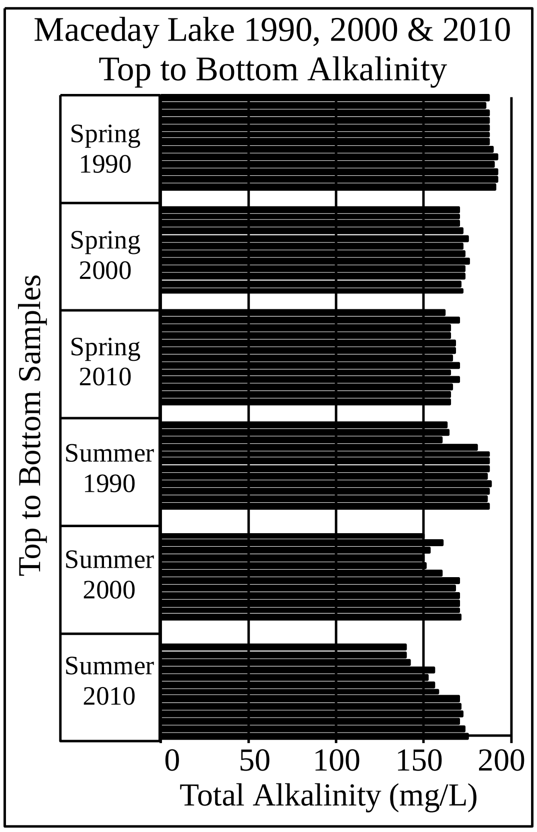
Alkalinity measures carbonates and bicarbonates in water. Soft water lakes have alkalinities below 75 milligrams per liter. Moderately hard water lakes have alkalinities between 75 and 150 milligrams per liter. Hard water lakes have alkalinities above 150 milligrams per liter.

Maceday Lake 1990, 2000 & 2010 Alkalinity



Spring			Summer		
1990	2000	2010	1990	2000	2010
187	173	167	160	150	139
189	169	165	165	150	140
191	174	170	163	150	138
187	168	165	166	142	134
190	170	166	163	150	140
187	170	166	160	150	140
190	169	162	164	151	138
187	167	168	160	150	140
185	169	167	164	150	140
187	170	162	163	150	140

The graph below shows the spring and summer alkalinity data. It shows in spring 1990 alkalinity concentrations were in the 180 to 190 milligrams per liter range, while in spring 2000, they were lower, in the 160s and 170s, and in spring 2010 they were even lower.



In summer 1990 the alkalinities were all in the 160s, while in summer 2000 there were for the most part, in the 150s and in 2010 they were all 140 mg/L or less. The graph seems to show alkalinity concentrations are decreasing in Maceday Lake. This is neither good or bad but it is dramatic.

Top to bottom alkalinities show in spring alkalinities are uniform top to bottom, but decrease as years pass.

The summer alkalinity data show the top 30 to 50 feet have lower alkalinities than the deeper water. The lower summer surface alkalinities are caused by the precipitation of carbonates and bicarbonates, which are what the alkalinity test measures. Carbonates and bicarbonates are less soluble in warm water than in cold water, hence the summer precipitation phenomena.

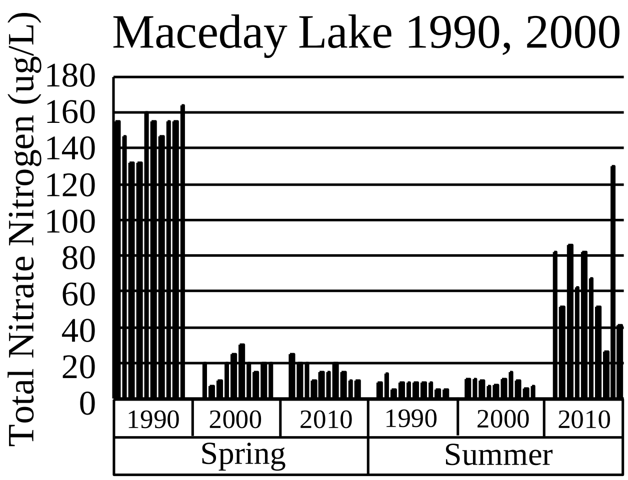
The above data indicates Maceday Lake is a hard water lake. Hard water lakes are tougher than soft water lakes because they have the ability to precipitate some phosphorus to the bottom sediments as calcium phosphate.

NITRATE NITROGEN

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

The graphs show the surface and top to bottom nitrate nitrogen concentrations for the three sample years.

Maceday Lake 1990, 2000 & 2010 Nitrate Nitrogen

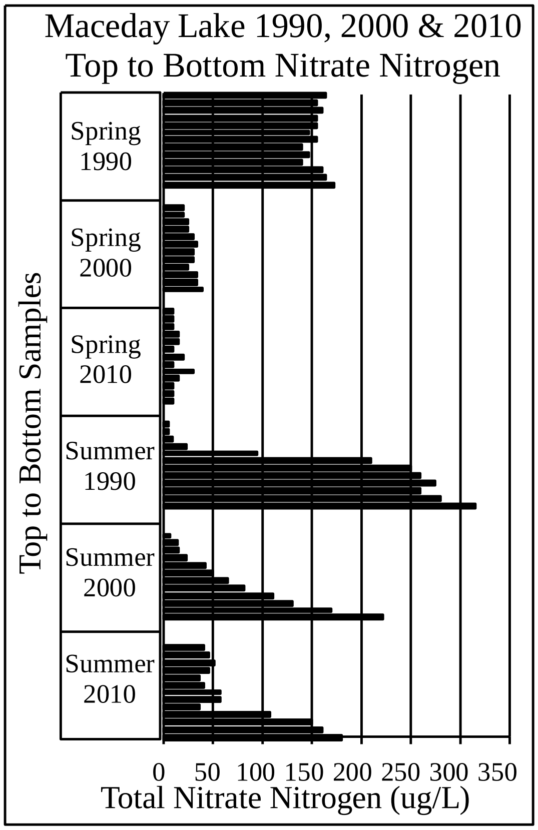


Spring			Summer		
1990	2000	2010	1990	2000	2010
155	20	25	9	11	82
147	7	20	14	11	51
132	10	20	5	10	86
132	20	10	9	7	62
160	25	15	9	8	82
155	30	15	9	11	67
147	20	20	9	15	51
155	15	15	9	10	26
155	20	10	5	6	130
164	20	10	5	7	41

The graph shows spring 1990 nitrates were higher than the other two years. The 1990 data are more normal than the low spring nitrate concentrations in 2000 and 2010.

Summer nitrates are low and normal all three years, even though the 2010 nitrates appear high, they are not.

These data indicate Maceday Lake is probably nitrate rather than phosphorus limited, especially in summer. It also means no fertilizers containing either nitrogen or phosphorus should be used on near lake areas.



The graph of top to bottom nitrates shows in spring 1990 nitrate nitrogen concentrations ranged from a low of 132 micrograms per liter to a high of 164 micrograms per liter. These are normal nitrate nitrogen concentrations.

Spring 2000 and 2010 top to bottom nitrates were lower, ranging from 20 to 39 ug/L in 2000 and from 10 to 30 ug/L in 2010.

Top to bottom spring nitrate nitrogen concentrations were essentially uniform, which is what would be expected if the lake mixed in spring, and it did.

Summer top to bottom nitrates were more interesting because they increased with depth all three years. In summer 1990, they ranged from 5 ug/L at the surface to 318 ug/L at the bottom. In summer 2000 they ranged from 7 ug/L at the surface to 222 ug/L at the bottom, and in 2010 they ranged from 41 ug/L at the surface to 180 ug/L at the bottom.

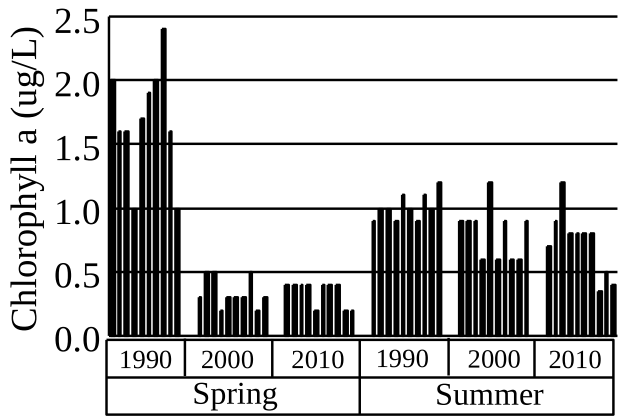
These increases in nitrates in the water under the thermocline in a late summer stratified lake are indicative of a high quality lake. The reason is there is so little organic material in the water column to decompose that bacteria don’t need to use the oxygen from the nitrates to decompose organic material.

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 below shows the spring and summer chlorophyll a data. This is a test for surface water; hence no top to bottom data are included.

Maceday Lake 1990, 2000 & 2010 Chlorophyll a



Spring			Summer		
1990	2000	2010	1990	2000	2010
2.0	0.3	0.4	0.9	0.9	0.7
1.6	0.5	0.4	1.0	0.9	0.9
1.6	0.5	0.4	1.0	0.9	1.2
1.0	0.2	0.4	0.9	0.6	0.8
1.7	0.3	0.2	1.1	1.2	0.8
1.9	0.3	0.4	1.0	0.6	0.8
2.0	0.3	0.4	0.9	0.9	0.8
2.4	0.5	0.4	1.1	0.6	0.4
1.6	0.2	0.2	1.0	0.6	0.5
1.0	0.3	0.2	1.2	0.9	0.4

The chlorophyll data shows in spring 1990 Maceday Lake had a small algal bloom (range 1.0 to 2.4 ug/L). In spring 2000 and 2010, chlorophylls were all 0.5 ug/L or less. These are ideal.

In summer 1990, chlorophylls ranged from 0.9 to 1.2 ug/L. In summer 2000 they ranged from 0.6 to 1.2 ug/L and in 2010 they ranged from 0.4 to 1.2 ug/L.

These data seem to indicate zebra mussels infested the lake some time between 1990 and 2000. In 2010 we found zebra mussel shells in the bottom sediment sample from Station 3.

In any case, these chlorophyll a concentrations are very good for a Michigan inland lake in both spring and summer.

pH (Hydrogen ion concentration) (no graph)

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

Spring and summer surface pH values ranged from 7.8 to 8.6. These are normal pH values for a Michigan inland lake.

The top to bottom pH data did not vary as much as we usually see. That’s not bad. It’s just unusual.

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.

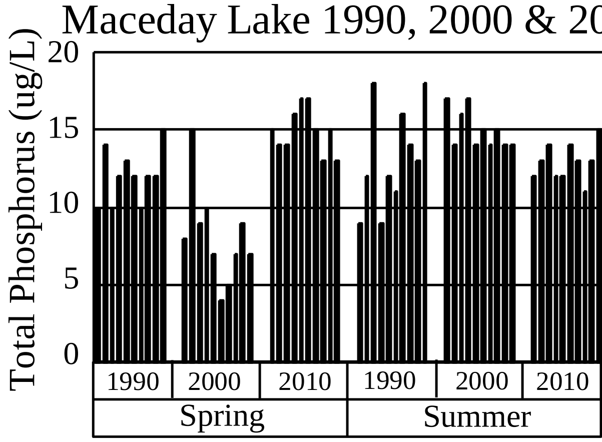
TOTAL PHOSPHORUS

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.

Maceday Lake 1990, 2000 & 2010 Total Phosphorus

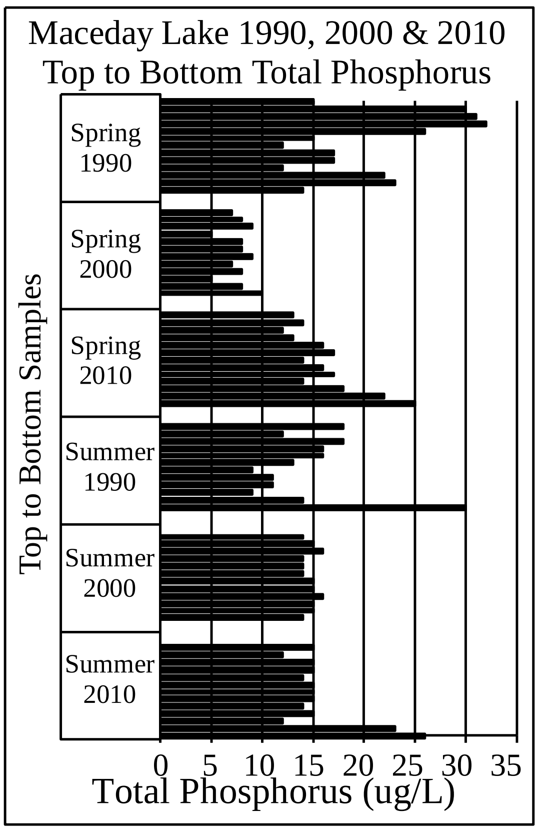


Spring			Summer		
1990	2000	2010	1990	2000	2010
10	8	15	9	17	12
14	15	14	12	14	13
10	9	14	18	16	14
12	10	16	9	17	12
13	7	17	12	14	12
12	4	17	11	15	14
10	5	15	16	14	13
12	7	13	14	15	11
12	9	15	13	14	13
15	7	13	18	14	15

The graph shows spring 1990 surface phosphorus concentrations ranged from 10 to 15 ug/L (average = 12 ug/L), spring 2000 surface concentrations ranged from 4 to 15 ug/L (average = 8 ug/L) and spring 2010 surface phosphorus concentrations ranged from 13 to 17 ug/L (average 15 ug/L).

The graph seems to show spring phosphorus concentrations are increasing.

In summer, 1990 surface phosphorus concentrations ranged from 9 to 18 ug/L (average = 13 ug/L), 2000 surface phosphorus concentrations ranged from 14 to 17 ug/L (average = 15 ug/L), and 2010 surface phosphorus concentrations ranged from 11 to 15 ug/L (average = 13 ug/L). These data show summer phosphorus concentrations do not appear to be increasing. That's a plus.



The graph shows the top to bottom phosphorus concentrations in the spring and summer of 1990, 2000 and 2010.

The main thing we are looking for here is high phosphorus concentrations in the bottom water in late summer. This is phosphorus released from the bottom sediments during anoxic periods (periods of no dissolved oxygen in the bottom water.) This occurred to a slight extent in 1990 and 2010, and not at all in 2000, but then there was dissolved oxygen all the way to the bottom in late summer 2000.

Although there is a small increase in phosphorus concentration in spring 2010 and in summer 1990 and 2010, it is not of concern because of the small amount of water at that depth, and the fact that the phosphorus concentrations are not large.

SECCHI DISK TRANSPARENCY (originally Secchi's disk)

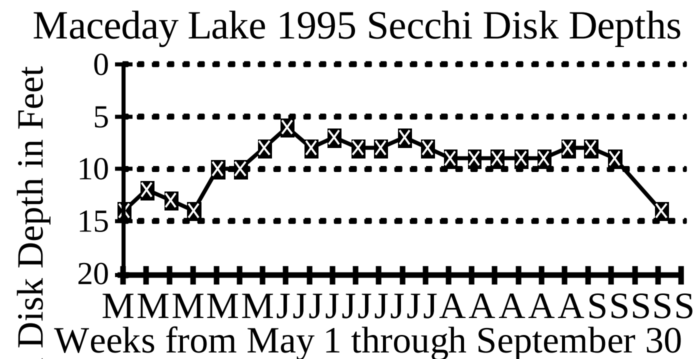
In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20 centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar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

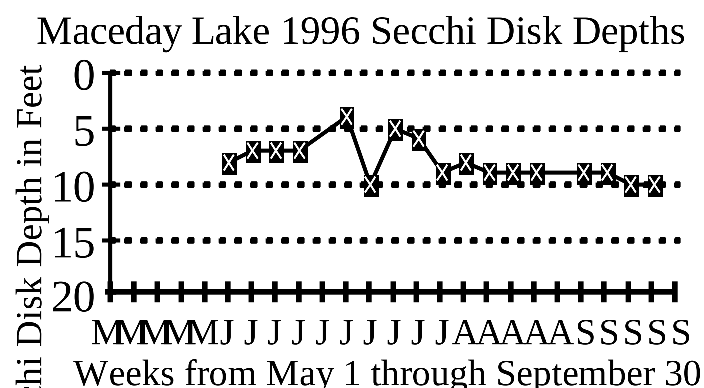
Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency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

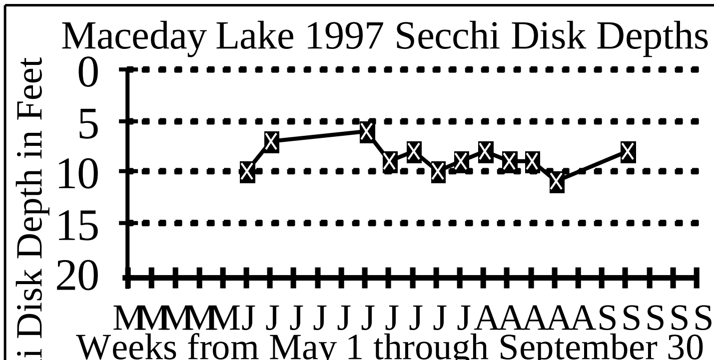
We feel it is only necessary to report Secchi disk measurements to the closest foot. Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness 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.



MAY	14	12	13	14	10
JUN	10	8	6	8	7
JUL	8	8	7	8	9
AUG	9	9	9	9	8
SEP	8	9	.	14	.



JUN	8	7	7	7	.
JUL	4	10	5	6	9
AUG	8	9	9	9	.
SEP	9	9	10	10	.



MAY	.	.	.	.	.
JUN	10	7	.	.	.
JUL	6	9	8	10	9
AUG	8	9	9	11	.
SEP	.	8	.	.	.

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.

MACEDAY LAKE SECCHI DISK DATA

Richard Zieman did a good job taking Secchi disk readings on Maceday Lake in 1995, 1996 and 1997. No one took Secchi disk readings in 1990, 2000 or 2010.

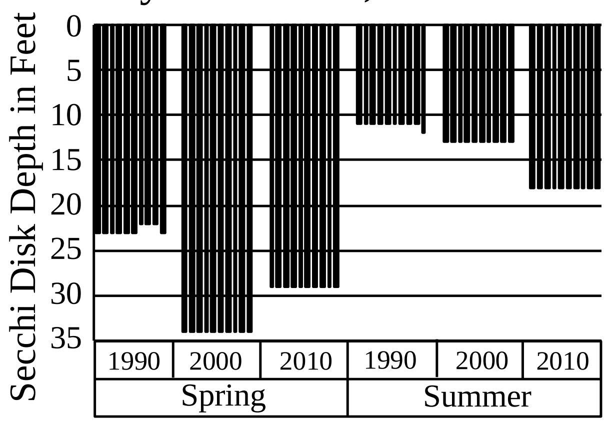
The graphs show the data collected by Zieman in 1995, 1996 and 1997.

The 1995 data is most complete and shows the water in Maceday Lake is clearer when it is cold, and gets less clear when it gets warm. This generally indicates an algae bloom because many algae like warm water.

The data for 1996 and 1997, although missing early spring data, show the same trend as the 1995 data, better water clarity when the water is cold, and more turbid water when it warms up.

SECCHI DISK READINGS TAKEN WITH THE SAMPLES

Maceday Lake 1990, 2000 & 2010 Secchi Disk Depths



Spring 1990	Spring 2000	Spring 2010	Summer 1990	Summer 2000	Summer 2010
23	34	29	11	13	18
23	34	29	11	13	18
23	34	29	11	13	18
23	34	29	11	13	18
23	34	29	11	13	18
23	34	29	11	13	18
22	34	29	11	13	18
22	34	29	11	13	18
22	34	29	11	13	18
23	34	29	12	13	18

The graph shows the Secchi disk readings taken with the samples. It shows spring readings are generally much better than summer readings. It also shows Secchi disk readings in shallow areas are much deeper than the water. This is because the data in the deeper water were used as the shallower water data. This is more valid than noting the disk resting on the bottom.

Spring 1990 readings were 23 feet, spring 2000 readings were 34 feet (which is very good) and spring 2010 readings were 29 feet, which is also very good. Summer 1990 readings were only 11 or 12 feet. This correlates with the high spring chlorophylls that year. Summer 2000 readings were 13 feet and 2010 readings were 18 feet. These are better summer readings than most lakes, but the important thing is they are getting better as years pass. Let’s hope that trend continues.

THE SECCHI DISK TREND GRAPH

If we had long term Secchi disk data, we would be able to develop a Secchi disk Trend graph, which shows whether the lake is getting clearer or cloudier as years pass. Residents of Maceday Lake should take Secchi disk readings on a regular basis through the warm months every year. These are data that will serve them well in the future.

THE LAKE WATER QUALITY INDEX

The Lake Water Quality Index used in this study to define the water quality of Maceday 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
Chlorophyll a
Secchi disk depth
Total nitrate nitrogen
Total alkalinity
Temperature
Conductivity
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.

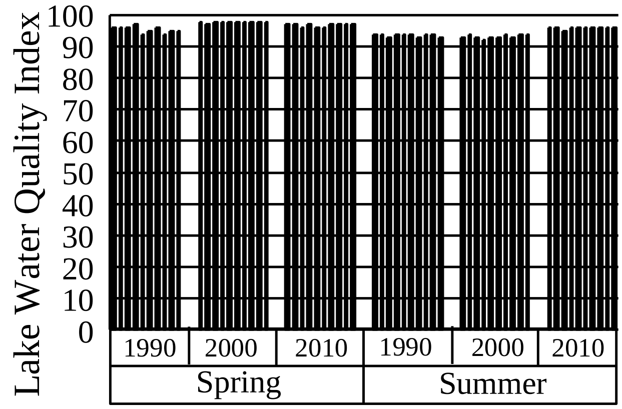
The thermometer rating scales also allow you to determine what test results would be considered excellent in terms of lake water quality. They are the numbers found outside the thermometer near the top.

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 1990, 2000 & 2010 MACEDAY LAKE WATER QUALITY INDICES

The graph shows the Lake Water Quality Indices for Maceday Lake in spring and summer of 1990, 2000 and 2010.

Maceday Lake 1990, 2000 & 2010 Lake Water Quality Indices



Spring			Summer		
1990	2000	2010	1990	2000	2010
96	98	97	94	93	96
96	97	97	94	94	96
96	98	96	93	93	95
97	98	97	94	92	96
94	98	96	94	93	96
95	98	96	94	93	96
96	98	97	93	94	96
94	98	97	94	93	96
95	98	97	94	94	96
95	98	97	93	94	96

The graph shows the Lake Water Quality Indices for Maceday Lake have been in the 90s every time it was sampled, indicating the water quality of Maceday is in the A range in both spring and summer. The graph also shows spring LWQIs are a little better than summer LWQIs.

The graph shows spring LWQIs in 1990 ranged from 94 to 97, while spring 2000 LWQIs were 97 or 98 and spring 2010 LWQIs were 96 or 97.

Summer LWQIs for 1990 and 2000 ranged from 92 to 94, while 2010 LWQIs were all 96.

THE LAKE WATER QUALITY INDEX CALCULATION SHEETS

Because the 2010 Lake Water Quality Indices were relatively uniform in spring and in summer, only a single Lake Water Quality Index calculation sheet is included for spring 2010, using averaged data and for summer 2010, using averaged data.

In the report marked MASTER, all 20 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.

Ten bottom sediment samples were collected from Maceday Lake in 1990, 2000 and 2010. The graph shows the data.

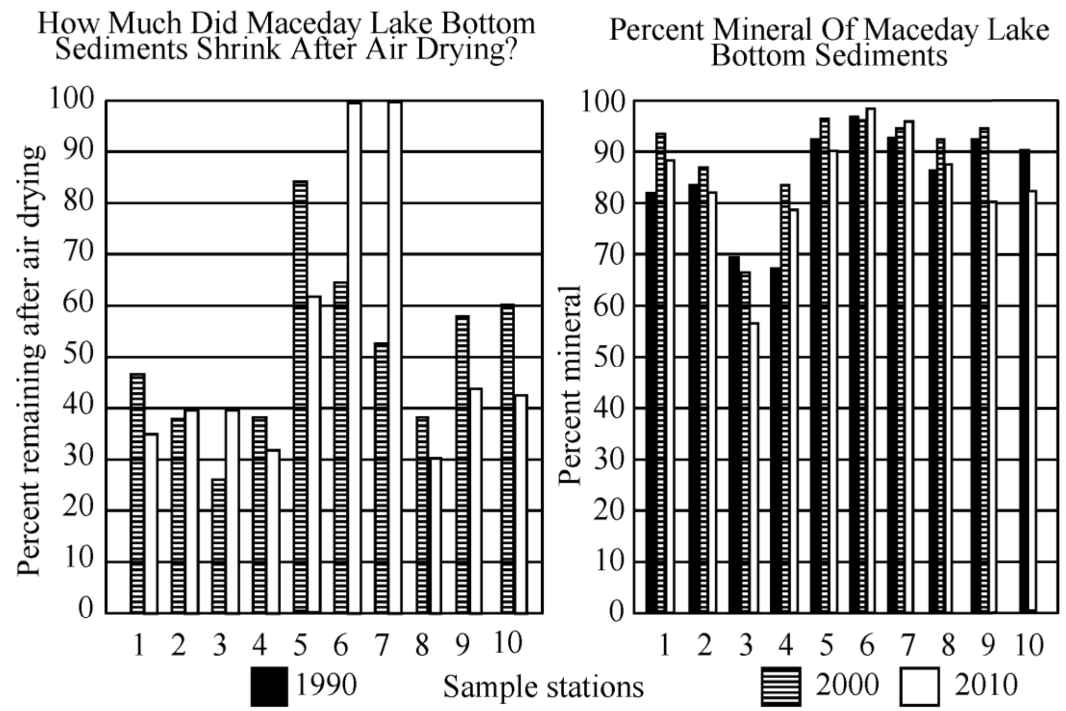
In 1990 we did not determine the amount of shrinkage. The 2000 samples shrunk between 17 and 74 percent and the 2010 samples shrunk 0 to 70 percent. This is a normal amount of shrinkage. Excessive shrinkage is more than 95 percent.

In 1990, all the samples except one turned gray after air-drying. The sample from Station 4 remained black. In 2000 and 2010 all samples except one turned gray after air-drying. The sample from Station 3 remained black both years.

In 1990 the mineral content of Maceday Lake bottom sediments ranged from 67 to 97 percent and averaged 85 percent.

In 2000, the mineral content of Maceday Lake bottom sediments ranged from 83 to 96 percent and averaged 88 percent.

In 2010 the mineral content of Maceday Lake ranged from 56 to 98 percent and averaged 84 percent.



Characteristics of Maceday Lake Bottom Sediments (1990, 2000 & 2010)

I.D.	Percent Shrinkage		Percent Mineral			Dried at 100°C Color & Description			Color after burning at 550°C			Depth of water (feet)		
	2000	2010	1990	2000	2010	1990	2000	2010	1990	2000	2000	1990	2000	2010
1	53	65	82	93	89	Gray	Gray	Gray	Gray	Gray	Gray	64	50	58
2	62	60	83	86	82	Gray	Gray	Gray	Gray	Gray	Gray	5	3	4
3	74	60	69	66	56	Gray	Black	Black	Gray	Gray	Gray	3	3	3
4	62	68	67	83	79	Black	Gray	Gray	Gray	Gray	Gray	3	4	3
5	17	39	92	96	90	Gray	Gray	Gray	Gray	Gray	Gray	29	10	7
6	35	0	97	95	98	Gray	Gray	Gray	Gray	Gray	Gray	6	20	6
7	48	0	92	94	96	Gray	Gray	Gray	Gray	Gray	Gray	9	7	5
8	62	70	86	91	88	Gray	Gray	Gray	Gray	Gray	Gray	12	5	5
9	42	67	92	94	80	Gray	Gray	Gray	Gray	Gray	Tan	71	52	58
10	40	68	90	90	82	Gray	Gray	Gray	Gray	Gray	Gray	117	117	115

Average mineral content of bottom sediments: 1990 = 85%, 2000 = 88%, 2010 = 84%

These data indicate Maceday Lake is not building up organic material in the sediments at a faster than normal rate. Let's hope this trend continues.

And some comments.

We found zebra mussels in the sediments at Sample Station 3, so Maceday Lake does have zebra mussels. And at Stations 2 and 4 we found starry stonewort (*Nitellopsis obtusa*). This alga has the ability to rapidly colonize all of the shallow areas of the lake. And it is very difficult to control because although it can be knocked down, it comes back rapidly. In lakes where we've seen it, it out-competes all other submerged aquatic vegetation with a thick layer of plant material.

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Consulting Limnologist
Water Quality Investigators
Dexter, Michigan
January 2010

Maceday 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
3/28/90	1	6	11.0	88	2.0	23	155	187	8.0	525	10	96	A
3/28/90	2	6	10.9	87	1.6	23	147	189	8.0	520	14	96	A
3/28/90	3	6	11.1	89	1.6	23	132	191	8.0	530	10	96	A
3/28/90	4	6	11.1	89	1.0	23	132	187	8.1	530	12	97	A
3/28/90	5	6	10.8	86	1.7	23	160	190	8.0	525	13	94	A
3/28/90	6	6	10.8	86	1.9	23	155	187	8.0	530	12	95	A
3/28/90	7	6	11.1	89	2.0	22	147	190	8.0	520	10	96	A
3/28/90	8	6	10.8	86	2.4	22	155	187	8.0	520	12	94	A
3/28/90	9	6	10.8	86	1.6	22	155	185	8.0	520	12	95	A
3/28/90	10	5	10.8	86	1.0	23	164	187	8.0	520	15	95	A
3/28/90	10-10	5	10.6	83	---	---	155	185	8.0	520	30	---	---
3/28/90	10-20	4	10.0	76	---	---	160	187	8.0	520	31	---	---
3/28/90	10-30	4	9.9	75	---	---	155	187	8.0	520	32	---	---
3/28/90	10-40	4	9.9	75	---	---	155	187	8.0	520	26	---	---
3/28/90	10-50	4	9.9	75	---	---	147	187	8.0	520	15	---	---
3/28/90	10-60	4	9.8	75	---	---	155	187	8.0	520	12	---	---
3/28/90	10-70	4	9.7	75	---	---	140	189	8.0	520	17	---	---
3/28/90	10-80	4	9.6	74	---	---	147	192	8.0	530	17	---	---
3/28/90	10-90	4	8.6	73	---	---	140	190	8.0	530	12	---	---
3/28/90	10-100	4	7.3	66	---	---	160	192	7.9	530	22	---	---
3/28/90	10-110	4	5.8	44	---	---	164	192	7.9	530	23	---	---
3/28/90	10-117	4	3.2	24	---	---	172	191	7.9	530	14	---	---
3/28/90	Inlet	---	---	---	---	---	89	276	8.0	670	24	---	---
8/27/90	1	24	8.1	95	0.9	11	9	160	8.3	500	9	94	A
8/27/90	2	25	7.6	90	1.0	11	14	165	8.3	500	12	94	A
8/27/90	3	26	8.0	98	1.0	11	5	163	8.3	500	18	93	A
8/27/90	4	26	8.0	98	0.9	11	9	166	8.3	500	9	94	A
8/27/90	5	25	8.4	100	1.1	11	9	163	8.4	500	12	94	A
8/27/90	6	25	8.2	98	1.0	11	9	160	8.3	500	11	94	A
8/27/90	7	25	8.2	98	0.9	11	9	164	8.3	500	16	93	A
8/27/90	8	25	8.4	100	1.1	11	9	160	8.3	500	14	94	A
8/27/90	9	25	8.1	96	1.0	11	5	164	8.3	500	13	94	A
8/27/90	10	24	8.0	94	1.2	12	5	163	8.3	500	18	93	A
8/27/90	10-10	23	8.2	94	---	---	5	164	8.3	500	12	---	---
8/27/90	10-20	20	7.5	82	---	---	9	160	8.3	500	18	---	---
8/27/90	10-30	10	6.4	57	---	---	23	180	8.2	520	16	---	---
8/27/90	10-40	7	5.9	50	---	---	95	187	8.0	520	16	---	---
8/27/90	10-50	6	5.5	44	---	---	210	187	7.9	520	13	---	---
8/27/90	10-60	6	5.5	44	---	---	250	187	7.8	540	9	---	---
8/27/90	10-70	6	5.0	40	---	---	260	186	7.8	540	11	---	---
8/27/90	10-80	5	4.8	38	---	---	275	188	7.8	540	11	---	---
8/27/90	10-90	5	3.1	24	---	---	260	187	7.8	540	9	---	---
8/27/90	10-100	5	1.6	13	---	---	280	186	7.8	540	14	---	---
8/27/90	10-110	5	0.0	0	---	---	315	187	7.8	540	30	---	---
8/27/90	10-117	5	0.0	0	---	---	---	---	---	---	---	---	---
8/27/90	Inlet	---	---	---	---	---	140	297	8.1	700	26	---	---
4/24/00	1	11	10.7	96	0.3	34	20	173	8.3	530	8	98	A
4/24/00	2	12	10.8	100	0.5	34	7	169	8.2	530	15	97	A
4/24/00	3	15	10.6	104	0.5	34	10	174	8.3	590	9	98	A
4/24/00	4	12	11.7	108	0.2	34	20	168	8.3	530	10	98	A
4/24/00	5	11	10.8	97	0.3	34	25	170	8.3	530	7	98	A
4/24/00	6	12	10.4	96	0.3	34	30	170	8.2	530	4	98	A
4/24/00	7	12	10.6	98	0.3	34	20	169	8.3	520	5	98	A
4/24/00	8	13	10.5	99	0.5	34	15	167	8.3	520	7	98	A
4/24/00	9	12	10.5	97	0.2	34	20	169	8.3	530	9	98	A
4/24/00	10	11	10.8	97	0.3	34	20	170	8.3	530	7	98	A
4/24/00	10-10	11	10.8	97	---	---	20	170	8.3	530	8	---	---
4/24/00	10-20	10	10.8	96	---	---	25	170	8.3	520	9	---	---
4/24/00	10-30	9	10.9	94	---	---	25	172	8.3	520	5	---	---
4/24/00	10-40	8	11.4	96	---	---	30	175	8.2	520	8	---	---
4/24/00	10-50	7	11.3	93	---	---	34	172	8.2	530	8	---	---
4/24/00	10-60	7	11.2	92	---	---	30	173	8.2	540	9	---	---
4/24/00	10-70	7	11.0	90	---	---	30	176	8.2	520	7	---	---
4/24/00	10-80	6	10.8	86	---	---	25	173	8.2	520	8	---	---
4/24/00	10-90	6	10.5	84	---	---	34	173	8.1	525	5	---	---
4/24/00	10-100	6	10.4	83	---	---	34	171	8.1	530	8	---	---
4/24/00	10-110	6	9.9	79	---	---	39	172	8.1	540	10	---	---
4/24/00	A	14	11.0	106	---	---	10	177	8.2	560	8	---	---
4/24/00	B	13	11.4	110	---	---	10	172	8.4	540	13	---	---

Maceday 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
8/14/00	1	24	8.7	102	0.9	13	11	150	8.6	515	17	93	A
8/14/00	2	25	9.1	108	0.9	13	11	150	8.6	505	14	94	A
8/14/00	3	24	8.3	98	0.9	13	10	160	8.6	570	16	93	A
8/14/00	4	25	8.7	104	0.6	13	7	142	8.7	505	17	92	A
8/14/00	5	25	8.6	102	1.2	13	8	150	8.6	505	14	93	A
8/14/00	6	25	8.7	104	0.6	13	11	150	8.6	510	15	93	A
8/14/00	7	25	8.6	102	0.9	13	15	151	8.6	500	14	94	A
8/14/00	8	25	8.5	101	0.6	13	10	150	8.6	500	15	93	A
8/14/00	9	25	8.6	102	0.6	13	6	150	8.6	505	14	94	A
8/14/00	10	24	8.7	102	0.9	13	7	150	8.6	510	14	94	A
8/14/00	10-10	24	8.9	105	---	---	14	161	8.6	505	15	---	---
8/14/00	10-20	22	9.0	102	---	---	15	153	8.6	500	16	---	---
8/14/00	10-30	13	10.4	98	---	---	23	150	8.6	520	14	---	---
8/14/00	10-40	10	10.4	92	---	---	42	151	8.6	540	14	---	---
8/14/00	10-50	8	9.7	82	---	---	50	160	8.6	550	14	---	---
8/14/00	10-60	7	9.5	78	---	---	65	170	8.6	555	15	---	---
8/14/00	10-70	7	8.5	70	---	---	81	168	8.6	545	15	---	---
8/14/00	10-80	7	7.8	64	---	---	111	170	8.6	540	16	---	---
8/14/00	10-90	6	5.3	42	---	---	130	170	8.6	550	15	---	---
8/14/00	10-100	6	2.9	23	---	---	169	170	8.6	560	15	---	---
8/14/00	10-110	6	1.8	14	---	---	222	171	8.6	565	14	---	---
8/14/00	10-113	6	1.8	14	---	---	---	---	---	---	---	---	---
8/14/00	A	25	9.6	114	1.5	13	11	161	8.5	540	17	93	A
8/14/00	B	25	9.6	114	1.2	13	12	153	8.7	505	25	90	A
4/15/10	1	12	11.7	108	0.4	29	25	167	8.3	600	15	97	A
4/15/10	2	12	11.1	101	0.4	29	20	165	8.2	600	14	97	A
4/15/10	3	14	9.8	94	0.4	29	20	170	8.1	630	14	96	A
4/15/10	4	14	11.4	110	0.4	29	10	165	8.3	600	16	97	A
4/15/10	5	12	11.2	102	0.2	29	15	166	8.3	600	17	96	A
4/15/10	6	12	11.2	102	0.4	29	15	166	8.3	600	17	96	A
4/15/10	7	13	10.1	95	0.4	29	20	162	8.2	590	15	97	A
4/15/10	8	12	11.3	103	0.4	29	15	168	8.2	590	13	97	A
4/15/10	9	12	11.4	104	0.2	29	10	167	8.2	600	15	97	A
4/15/10	10	12	11.8	109	0.2	29	10	162	8.2	600	13	97	A
4/15/10	10-10	12	11.8	109	---	---	10	170	8.2	600	14	---	---
4/15/10	10-20	11	11	105	---	---	10	165	8.3	590	12	---	---
4/15/10	10-30	9	11.8	102	---	---	15	165	8.2	590	13	---	---
4/15/10	10-40	7	11.5	94	---	---	15	168	8.2	590	16	---	---
4/15/10	10-50	6	11.2	90	---	---	10	168	8.1	600	17	---	---
4/15/10	10-60	5	10	78	---	---	20	166	8.2	610	14	---	---
4/15/10	10-70	5	9.3	74	---	---	10	170	8.1	610	16	---	---
4/15/10	10-80	5	9.4	75	---	---	30	165	8.2	600	17	---	---
4/15/10	10-90	4	9.2	70	---	---	15	170	8.0	615	14	---	---
4/15/10	10-100	4	8.8	73	---	---	10	166	8.3	615	18	---	---
4/15/10	10-110	4	8.6	71	---	---	10	165	8.2	620	22	---	---
4/15/10	10-117	4	8.7	72	---	---	10	165	8.2	620	25	---	---
8/6/10	1	26	8.3	101	0.7	18	82	139	8.3	560	12	96	A
8/6/10	2	26	8.3	101	0.9	18	51	140	8.4	560	13	96	A
8/6/10	3	26	7.6	93	1.2	18	86	138	8.0	580	14	95	A
8/6/10	4	26	8.8	106	0.8	18	62	134	8.3	540	12	96	A
8/6/10	5	26	8.7	105	0.8	18	82	140	8.4	540	12	96	A
8/6/10	6	26	8.5	103	0.8	18	67	140	8.4	540	14	96	A
8/6/10	7	26	8.7	105	0.8	18	51	138	8.4	540	13	96	A
8/6/10	8	26	8.3	101	0.4	18	26	140	8.3	540	11	96	A
8/6/10	9	26	8.2	100	0.5	18	130	140	8.3	540	13	96	A
8/6/10	10	26	8.2	100	0.4	18	41	140	8.4	540	15	96	A
8/6/10	10-10	26	8.2	100	---	---	46	140	8.3	540	12	---	---
8/6/10	10-20	26	8.8	106	---	---	51	142	8.3	540	15	---	---
8/6/10	10-30	14	9.3	89	---	---	46	156	8.3	560	15	---	---
8/6/10	10-40	9	10.2	88	---	---	36	152	8.3	560	14	---	---
8/6/10	10-50	7	9.7	80	---	---	41	156	8.2	580	15	---	---
8/6/10	10-60	6	8.9	71	---	---	57	158	8.0	590	15	---	---
8/6/10	10-70	5	7.7	62	---	---	57	170	8.0	600	15	---	---
8/6/10	10-80	5	6.4	50	---	---	36	171	7.9	600	14	---	---
8/6/10	10-90	4	5.1	40	---	---	108	172	8.2	600	15	---	---
8/6/10	10-100	4	3.7	28	---	---	150	170	8.0	600	12	---	---
8/6/10	10-110	4	2.2	17	---	---	160	173	8.2	600	23	---	---
8/6/10	10-117	4	1.1	9	---	---	180	175	8.2	600	26	---	---