A Paleolimnological Study of the Water Quality Trends in Oconomowoc Lake, Waukesha County, Wisconsin

Written By

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The other lakes included in this assessment were Ashippun Lake, Druid Lake, Friess Lake, Fowler Lake, Moose Lake, Okauchee Lake, Pike Lake, Pine Lake and Silver Lake.

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Objective

This study's objective was to determine the water quality trends in Oconomowoc Lake, dating back to presettlement. A sediment core was collected and dated using Lead-210 to determine sediment age and accumulation rate. Total carbon, organic carbon, organic nitrogen, total phosphorus, total iron and total manganese were also analyzed. Diatom frustules were identified in the core. Known changes in watershed landuse activities from early settlement to present were correlated with measured changes in sedimentation rate, sediment chemistry, and changes in water quality inferred from changes in the diatom community composition.

Introduction

Oconomowoc Lake is Located in northwestern Waukesha County, southeastern Wisconsin. It is an oligotrophic (low productivity), hardwater drainage lake in the Oconomowoc River chain of lakes. Oconomowoc Lake is 804 acres, 62 feet deep and the direct drainage area is 2,020 acres resulting in a direct drainage area to lake area ratio of 2.5 to 1. The 1990 land use in the direct drainage area is summarized in table 1 (SEWRPC, 1990).

Table 1. 1990 Land use in the direct drainage area of Oconomowoc Lake, Waukesha County, Wisconsin.

Land Use Type	Percent	Acres
Developed	28.1	225.9
Agriculture/Open	28.3	227.5
Woodlands	7.4	59.5
Wetlands	8.5	68.3
water	27.7	222.7

Background

The water quality of Oconomowoc Lake was monitored periodically between 1973 and 1979. This information is summarized in a report entitled *A Water Quality Management Plan For Oconomowoc Lake* (SEWRPC, 1990). The Village of Oconomowoc has hired the United States Geological Survey to monitor the water quality of Oconomowoc Lake since 1986. This information provides an excellent record of the most recent water quality trends.

The historical water quality of Oconomowoc Lake can be determined by using techniques which rely upon known relationships between algal communities, sediment/water interactions, and the rate of sedimentation. An analogy would be counting and measuring the width of tree rings for determining the age and rate of growth of a tree. The concentration of nutrients and other chemical parameters in the core provides a clue to the condition of the lake at a known period in time. The relative water quality is determined by examining the algal remains, specifically diatom frustules in the core. Diatoms are algae which have cell walls composed of silica which resist degradation. The sedimentation rate is determined by the lead-210 activity in the sediment core. Lead-210 is a naturally occurring radionucleid with a half life of 22.3 years. The decay of lead-210 provides a means for determining the age of sediment and the rate of sedimentation.

Materials and Methods

The following discussion describes the methods used to analyze the sediment parameters as well as what each parameter means in regards to interpreting watershed land use activities and water quality changes.

Field Sampling

A sediment core was collected from the deepest part of the lake (Figure 1), with a gravity corer. The core was taken back to the lab and sectioned into 2 centimeters (cm) sections. The samples of sediment were placed into labeled preweighed bottles, weighed again then dried to a constant weight. The difference in wet and dry weight is used to calculate the porosity of the sediment (Formula A). The samples are then ground to a fine powder and stored until used.

Formula A

$$\text{Porosity} = \frac{(1-f)/D_w}{(1-f)/D_w + (f/D_s)}$$

Where: D_w = Water Density (1.0 g/cm^3)
D_s - Sediment Density (2.45 g/cm^3)
f = Fraction Dry Weight (g/cm^3)

Sediment porosity is used to determine the size of sedimenting particles. A high porosity value indicates finer or smaller grained material compared to low porosity values which mean coarser material. Coarser material is characteristic of upland erosion. luring periods of land disturbance or high erosion we would expect the sediment porosity to decrease.

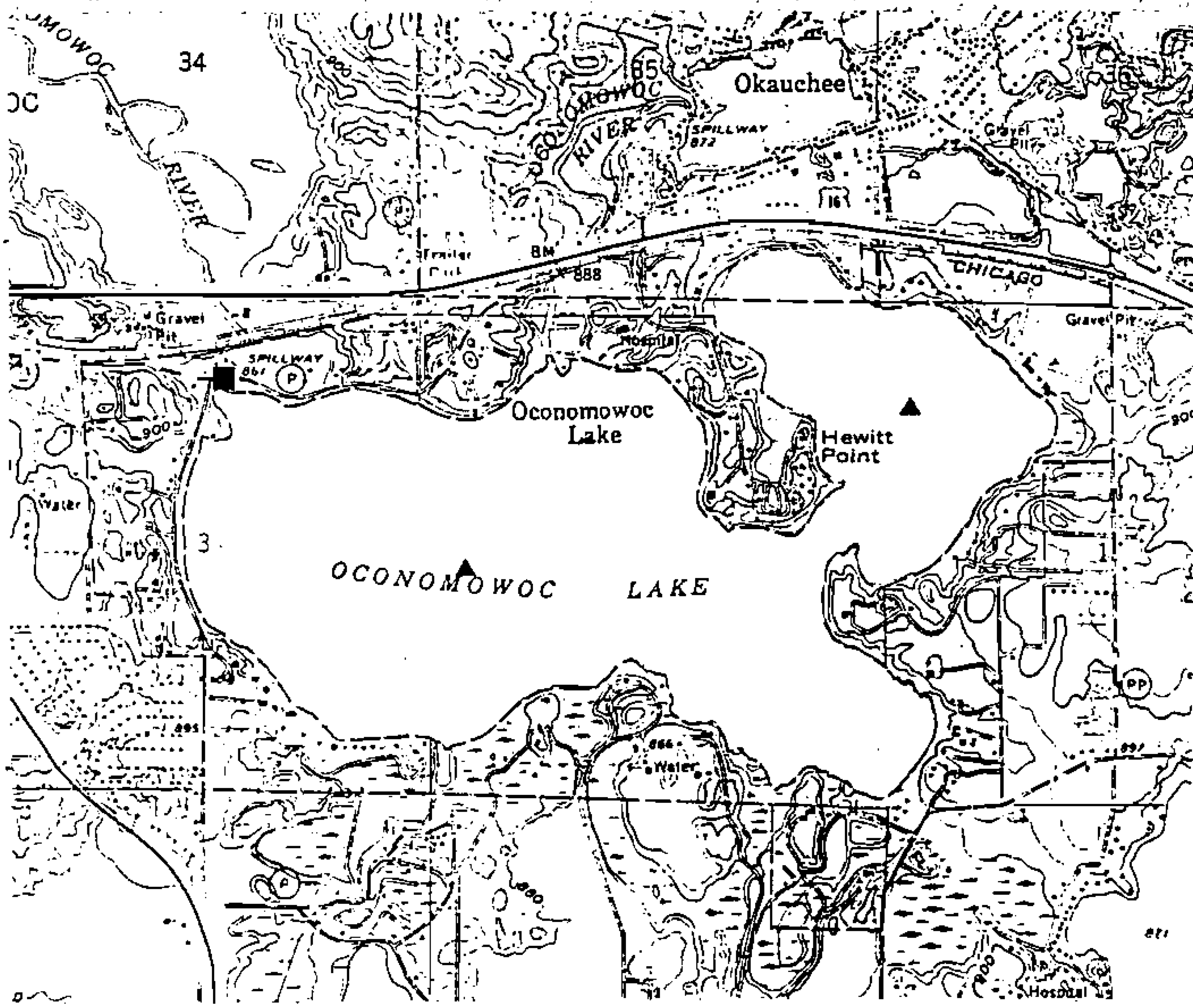


Figure 1. **Oconomowoc Lake Map.**

Lead-210 (Aging specific sediment samples)

Geochronology with the naturally occurring Lead-210 is based on the principle that the isotope has been continuously delivered to the earth's surface and undergoes continuous radioactive decay following incorporation into steadily accumulating sediments. The activity of Lead-210 in the 2 cm sections from the Oconomowoc Lake sediment core was used to determine the rate of sediment accumulation. Lead-210, a weak beta emitter with low activity is not readily detected therefore Polonium-210, is actually measured, Polonium-210 is the alpha emitting granddaughter of Lead-210, and can be used to represent the actual Lead-210 activiyty in each sample because the two isotopes are assumed to be in seqular equilibrium. The daughter is used because in an acidic solution it will spontaneously plate on to a copper disk, which can then be counted on a high resolution alpha spectrometry system. A yield monitor, Polonium-208, is added to each sample so that the exact activity of Polonium-210 can be determined. The activity of Lead-210 at the time of sediment sampling is calculated from the count rates corrected for counting background, growth and decay, counting efficiency and recovery of the yield monitor.

The sediment accumulation rate is expressed as an accumulation of a mass of sediment (gm/cm2/yr) rather than as an accumulated depth. Since layers of sediment will become compacted by the addition of new sediment the depth can not be used to determine accumulation rates. Sediment mass is used to determine accumulation rates since no matter how compacted a layer becomes it's mass will remain.

The rate of sediment accumulation will vary depending on the sampling location in the lake. The greatest accumulation rate occurs at the maximum depth because of the lateral movement of sediment from shallow depths towards the deepest part of the lake (sediment focusing).

Total Iron and Total Manganese Analysis

Analysis of the Total Ircn, and Total Manganese concentration in the sediment was done using a acid digestion followed by analysis with a Atomic Absorption Analyzer.

A known quantity of dried and ground sediment was digested using nitric acid and hydrogen peroxide. Following heated digestion the solution is filtered, and brought up to a known volume. This solution is then analyzed for iron and manganese.

The ratio of iron to manganese is used to assess the presence of oxygen in the hypolimnion of a lake. In addition the ratio of iron to phosphorus can be used to indicate periods of erosion in the watershed.

Carbon and Nitrogen Analysis

Total Carbon, Organic Nitrogen and Organic Carbon are measured in a Carlo Erba Elemental Analyzer 1106. The technique used is flash combustion. The samples are held in a lightweight tin container and dropped at preset intervals of time into a vertical quartz tube, maintained at 1,030 Celsius (°C), through which a constant flow of helium is run. When the samples are introduced, the helium stream is temporarily enriched with pure oxygen. Flash combustion takes place, primed by the oxidation of the container. The individual components are then separated and eluted as N_2, CO_2, and H_2O. They are measured by a thermal conductivity detector, whose signal is fed into an integrator with digital printout of peak area. The instrument is calibrated by combustion of standards of known elemental composition. A sediment sample of known composition is also included in each sample run. The inorganic carbon in the sample is calculated by subtracting the organic carbon from the total carbon.

The total carbon accumulation rate is a combination of organic and inorganic carbon (carbonates) sources. Organic carbon accumulation rates are used to infer overall lake productivity. Productive lakes have more algae, and aquatic plants and the sediment organic carbon is higher. Inorganic carbon accumulation rates are useful in determining the overall water quality and the source of sediment. The accumulation of inorganic carbon is typically found in hardwater or marl lakes which tend to be less productive.

Total Phosphorus

A known amount of dried, ground sediment is digested with nitric and sulfuric acids. Following digestion the solution is filtered, diluted and analyzed with a spectrophotometer.

The iron to phosphorus ratio is used as a surrogate to watershed erosion. As erosion in the watershed increases the ratio of iron to phosphorus also tends to increase. The phosphorus accumulation rate can be used alone as an indicator of water nutrient levels. The sediment/water interactions regulating phosphorus are complex and can make the interpretation of the profile difficult. Therefare, the phosphorus accumulation rate is generally used as supportive evidence with other sediment parameters.

Diatoms

A known amount of wet sediment is digested with hydrogen peroxide and potassium dichromate. Following digestion the residue is washed with distilled water at least four times. A known amount of glass microspheres is added to the sample to more accurately determine diatom concentrations within the sediment. A portion of the diatom suspension is dried on a coverslip and samples are mounted in Hyrax. A minimum of 100 frustules were identified and counted under oil immersion objectives (1400X).

All partial valves containing unique features such as identifiable central areas, or ends were tabulated. Counts were made continuously along randomly selected transects and all identifiable fragments were included in the count. When a fragment or frustule could not be identified, it was recorded as unknown and included in the total count. When valve ends were tabulated, the number recorded was divided by the number of ends a complete frustule would possess. Frustules and fragments were counted if they were completely in the field of view or in the case when only a portion of the frustule was visible, when the appropriate characteristic was visible in the right half of the field of view.

The diatom accumulation rate is used as a surrogate to lake productivity. As a Lake becomes more nutrient rich and productive the diatcm accumulation rate also increases. Changes in the diatom community within a core can also be used to indicate periods of changing water quality. The species also indicate the relative water quality. Since the relationship between certain species of diatoms and general water quality conditions is known, they provide an excellent tool to determine the historical water quality changes.

Results

The results are presented as accumulation rates rather than concentration for a particular period of time, with the exception of porosity and chemical ratios. The accumulation rats is calculated by multiplying the parameter concentration at a particular sediment depth with the corresponding calculated instantaneous sediment accumulation rate. The rate of accumulation gives the most accurate picture of changing lake conditions. An analogy is a small river flowing into Oconomowoc Lake. The concentration cf phosphorus in the water may be very high but if there is little flow in the river the total quantity reaching the lake is small, however if the concentration of phosphorus is low but the river is in flood stage then the total amount of phosphorus entering the lake may be very high. While the concentration is important it is the load to the lake or sediment which is critical to measure.

Appendix 1 graphically summarizes the sediment results and appendix 2 contains the sediment chemistry concentrations for future reference. Appendix 3 summarizes the sediment accumulation results. The sediment core results are truncated at the early 1800's since the lead-210 sediment dating technique is accurate for the last 150 years. Prior to the early 1800's the dates are only marginally accurate.

Lead-210 (Sedimentation Rate)

The presettlement accumulation rate was 0.030 gram per square centimeter per year ($gm/cm^2/yr$) (Figure 2). Between the 1850's and 1890's the sediment accumulation rate increased to a peak of 0.072 gm/cm2/yr. The rate then decreased to approximately 0.04 gm/cm2/yr around the 1920's then increased again to 0.054 $gm/cm^2/yr$ by the 1930's. After the 1930's the accumulation rate decreased to the presettlement accumulation rate by the 1960's and remained low to present.

Carbon Accumulation Rates

The accumulation rates of carbon in the Oconomowoc Lake sediment is shown in figure 3. The rate of accumulation of organic carbon in the sediment changed little with time. The inorganic carbon (carbonates) changed substantially and accounts for the majority of the change in the, total carbon profile. The increase in inorganic accumulation rate occurred between the mid 1800's and the 1890's. In the early 1900's the inorganic carbon accumulation rate decreased until the 1920's increased slightly during the 1930's, then decreased to presettlement levels by the 1960's. This profile is the same as the sediment accumulation rate (*See* discussion above).

Iron/Phosphorus Ratio

The total iron to total phosphorus ratio is shown in figure 4. The ratio is nearly constant until the early 1900's when it increased substantially. The ratio reached a peak between the 1940's and 1960's then decreased to presettlement values by the 1970's. The iron to phosphorus ratio has remained at presettlement level since the 1970's.

Diatoms

The diatom accumulation rate increased substantially after the 1920's. The rate peaked in the 1970's then decreased to its present (1995) rate.

The diatom community during presettlement was dominated by *Cyclotella michiganiana* and *Cyclotella* sp. (Figure 6). Between the late 1800's and the 1940's these taxa decreased in abundance and were replaced with *Fragilaria* crotcnensis, *Asterionella formosa, Stephanodiscus medius* and *Achnanthes linearis*. With the exception of the last species each indicate elevated nutrient levels. *Achnanthes linearis* is an epiphytic species and indicates an increase in the density of rooted aquatic plants.

Discussion

The following discussion will first focus on the watershed activites which were taking place at known periods of time. This will then be related to the sediment core results to show the impact land use activites had on the water quality of Oconomowoc Lake.

Initial settlement of southeastern Wisconsin started in the 1830's and continued through the 1850's. German farmers settled the area and cultivated predominately wheat and lesser amounts of corn, oats and hay. Around the 1880's wheat farming declined and farmers turned to corn, oats, hay and began to develop dairy herds. By the 1930's agriculture was beginning to grow rapidly, and was becoming mechanized. Through the 1980's dairy farms were numerous in southeastern Wisconsin. In the early 1990's dairy farming has declined and cash cropping which require Less labor but can also result in greater soil loss has increased.

From the 1940's to the 1960's there was a tremendous increase in the population, especially around the lakes in the Washington, Waukesha County areas. Lake shorelines that: were once farmed were being sold for seasonal homes. By 1963 the majority of the shoreline had been developed with seasonal homes.

Continued urbanization of the watershed contributes increased stormwater inputs to the lakes and rivers. Stormwater is the source of nutrients and other pollutants which are conveyed in stormsewers directly to the surface waters rather than being filtered in vegetated drainage ways.

The results of the sediment analysis will be broken into time periods which reflect either a period of status quo or periods of substantial change. These periods can then be ocmpased to watershed activities to show the impact activities on the land had on the water quality. Table 2 summarizes the watershed activities and corresponding sediment core results.

1800 - 1850

From presettlement to early settlement the water quality conditions of Oconomowoc Lake were very good. The lake experienced a sedimentation rate of 0.030 $gm/cm^2/yr$ and had diatom taxa which were indicative of excellent water clarity and low nutrient levels.

Table 2. Summary of watershed activities and sediment core results.

Time Period	Watershed Activity	Sediment Core Result
1800 - 1850	Presettlement conditions Minimal land disturbance	Diatom taxa indicative of good water clarity and low nutrient levels Sedimentation rate of 0.030 $gm/cm^2/yr$
1850 - 1890	Period of intensive wheat farming	Diatom taxa indicative of good water clarity and low nutrient levels
1890 - 1940	Wheat farming replaced Dairy farming becoming more popular Farming becoming mechanized, greater interest. in higher yields	Deposition of carbonates decreasing Increase in iron to phos. ratio Diatom accumulation rate increases Diatom taxa indicative of greater nutrient availability
1940 - 1960	Dairy farming booming Rapid development of shoreline	Iron to phosphorus ratio remains high Sedimentation rate decreases indicating less internally derived sediment Diatom accumulation rate and community structure suggest increasing nutrient levels
1960 - 1995	Continued development of shoreline Dairy farming still dominant agricultural practice Improved land protection abilities ie. ordinances and techniques	Iron to phosphorus ratio decreasing Sedimentation rate back to presettlement times Diatom community struture and accumulation rates suggest continued nutrient loading

1850 - 1890

The sedimentation rate increased from the 1850's until the peak in the 1890's (Figure 2). This was due to the increase in deposition of inorganic carbon (carbonates) rather than from erosion of the watershed. This is supported by the inorganic carbon profile which is the same as the sediment accumulation profile. The iron to phosphorus ratio does not increase during this same time period, which indicates that the increased sedimentation rate is due to internal processes rather than from watershed sources. The water quality of Oconomowoc Lake was still very good during this period.

1890 - 1940

After the 1890's the sedimentation (deposition of carbonates) rate began to decrease. Simultaneously the ratio of iron to phosphorus increases indicating an increase in the external sediment load to the lake. As the lake received more sediment and nutrients from the watershed it changed the water quality. This change reduced the conditions under which the carbonates would precipitate and become incorporated into the sediment. The diatom accumulation rate also begins to increase indicating increased nutrient levels and primary productivity (algae). The diatom community also changed during this period suggesting elevated nutrient levels and decreased water clarity.

1940 - 1960

The iron to phosphorus ratio remained elevated between the 1943's and 1960's indicating a period sf higher erosion in the watershed. The sedimentation rate decreased during this time period suggesting that the source of sediment changed from internal to external. By the 1960's the sedimentation rate had reached presettlement rates. There was no decrease in the nutrient loading to Oconomowoc Lake during this period as seen in the diatom accumulation rate and the diatom community.

1960 - Present

After the 1960's the sedimentation rate, and the inorganic carbon accumulation rate increased slightly, while the iron to phosphorus ratio decreased. This suggests that conditions in the lake may be improving to pre-1900 conditions. The diatom accumulation rate has peaked and is decreasing slightly suggesting a slight decrease in lake productivity. The diatom community also suggests a slight imprcvement in nutrient levels. *Stephanodiscus medius* is decreasing and *Fragilaria crotonensis* is increasing.

Conclusions

Watershed activities during the early to mid 1900's had the greatest impact upon the water quality of Oconomowoc Lake. Increased sediment load and more importantly nutrient loading to Oconomowoc Lake has increased lake productivity and reduced water quality. Most recent information suggests a slight improvement in the water quality of Oconomowoc Lake.

The management implications of this work clearly point to the need to manage nutrient loading to Oconomowoc Lake. Since Oconomowoc Lake is phosphorus limited every effort should be made to reduce the phosphorus load. Sediment appears to be less of a problem than phosphorus at the present time.

Acknowledgments

The author would like to acknowledge the assistance of Mr. Paul Garrison and Molli MacDonald from the Department of Natural Resources for completion of the diatom profiles and interpretation of the sediment profiles. Mr. Pat Anderson from the Center for Great Lakes Studies for his assistance in sediment chemistry analysis and interpretation. Mike Bruch from the Department of Natural Resources for his assistance in collection of the sediment core. The Southeastern Wisconsin Regional Planning Commission was very helpful in providing information on the soils, land use and extent of urban development within the watershed. Mr. Dan Helsel was extremely helpful in reviewing drafts of this report and providing constructive comments on organization and content. The author also wishes to thank the Village of Oconomowoc for participating in this study, The results provide a great deal of information on the historical water quality trends in Oconomowoc Lake and the importance of managing nutrient loads to the lake.

Sediment Accumulation Rate

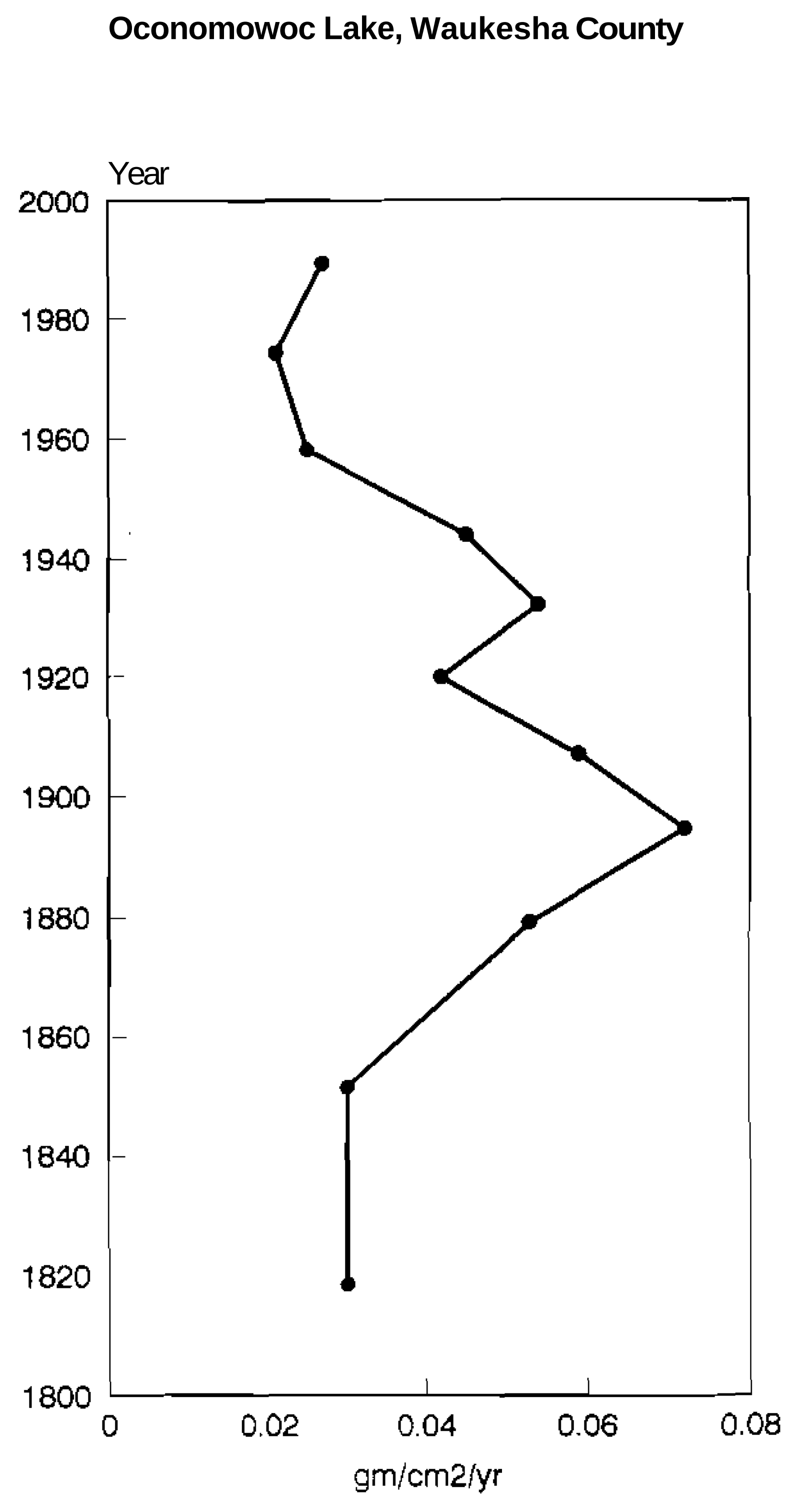


Figure **2.** 1995 Upper Rock River Basin **Assessment**

Carbon Accumulation Rate

Oconomowoc Lake, Waukesha County

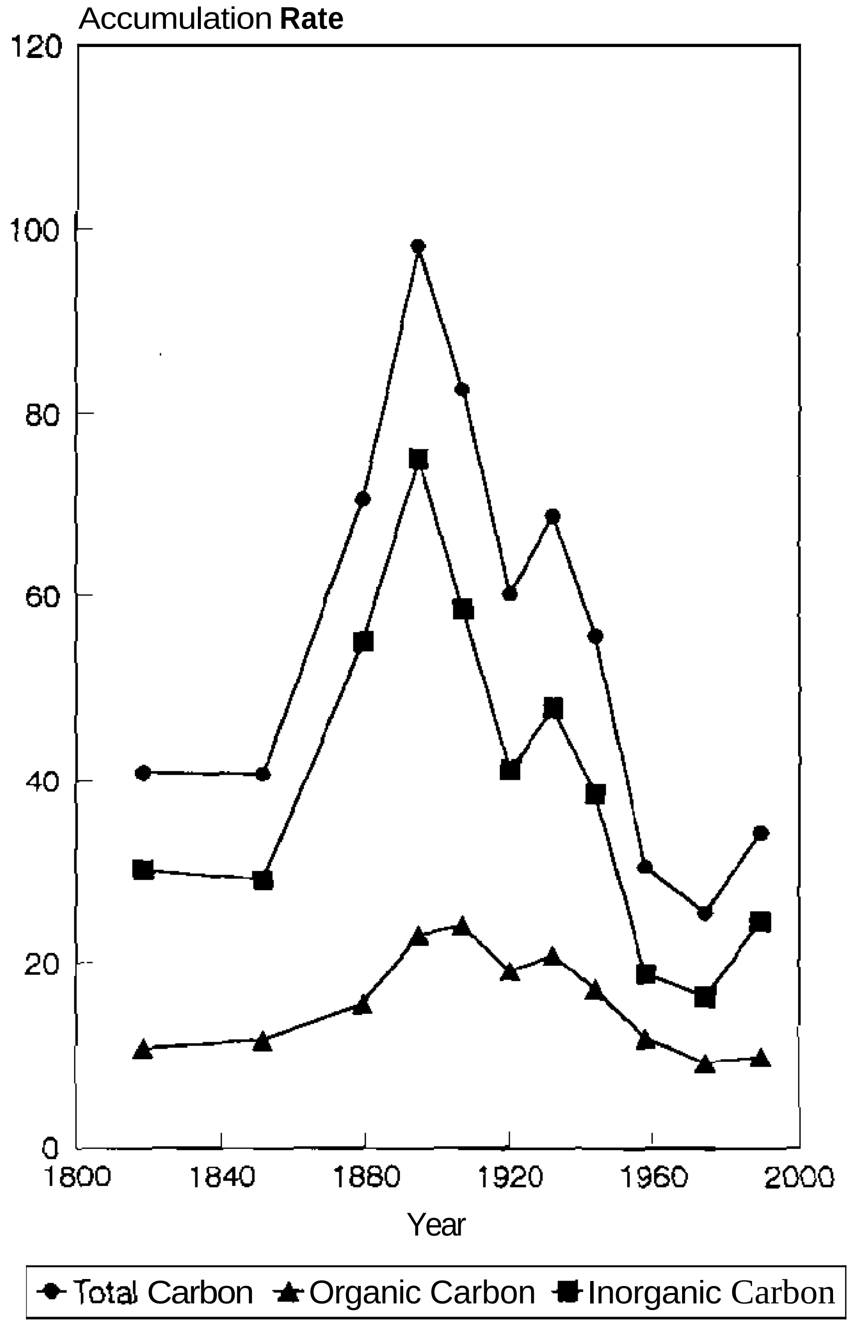


Figure *3*. **1995** Upper Rock River Basin Assessment

Iron/Phosphorus Ratio

Oconomowoc Lake, Waukesha County

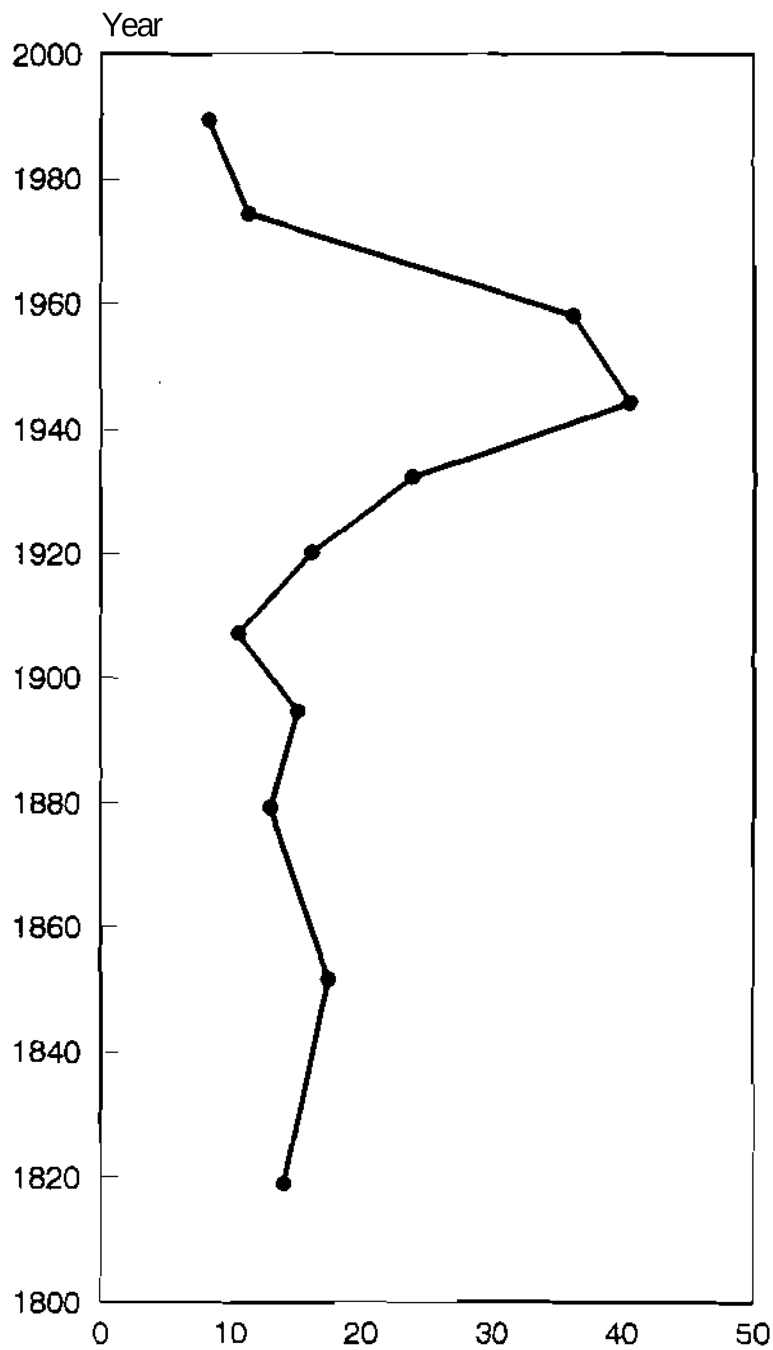


Figure 4. 1995 **Upper** Rock **River** Basin **Assessment**

Diatom Accumulation Rate

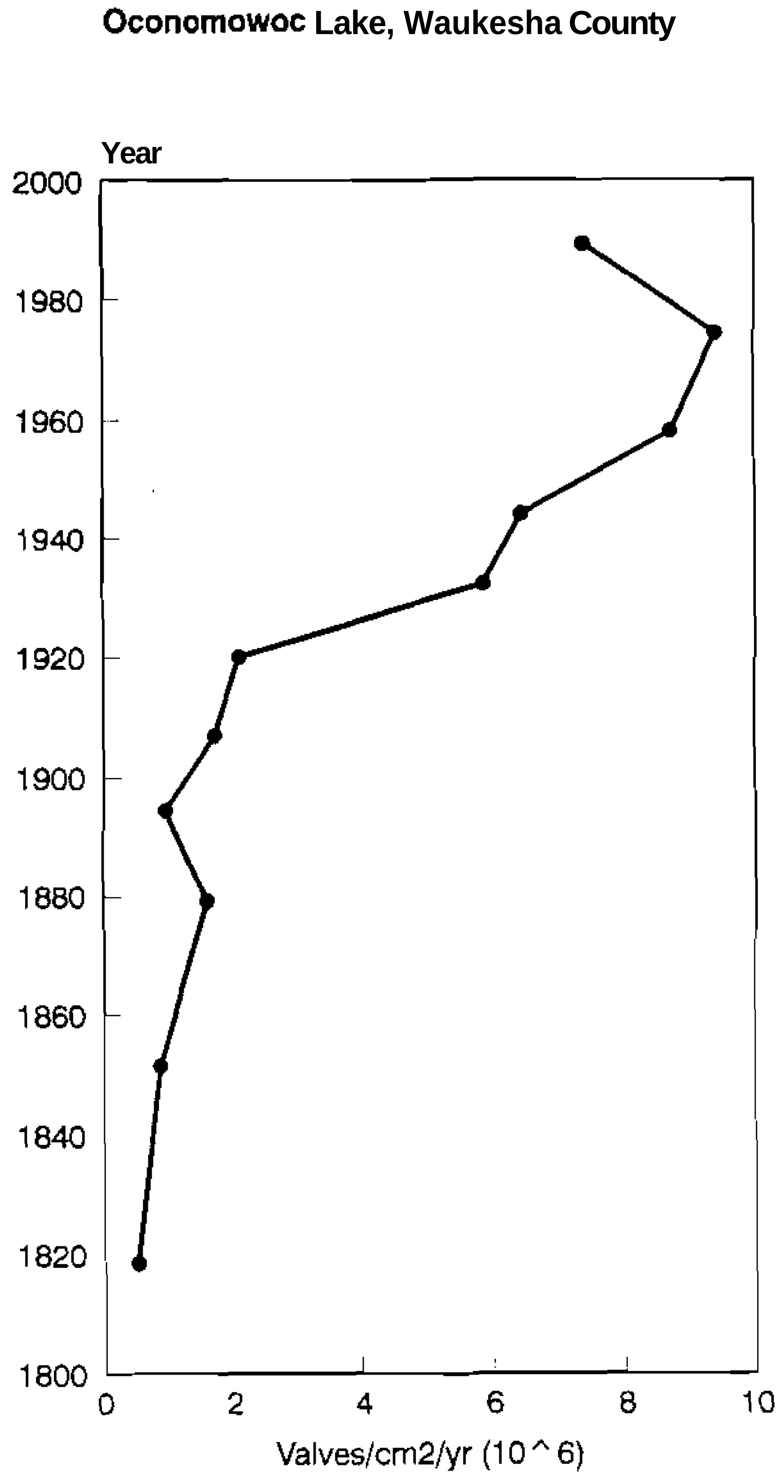
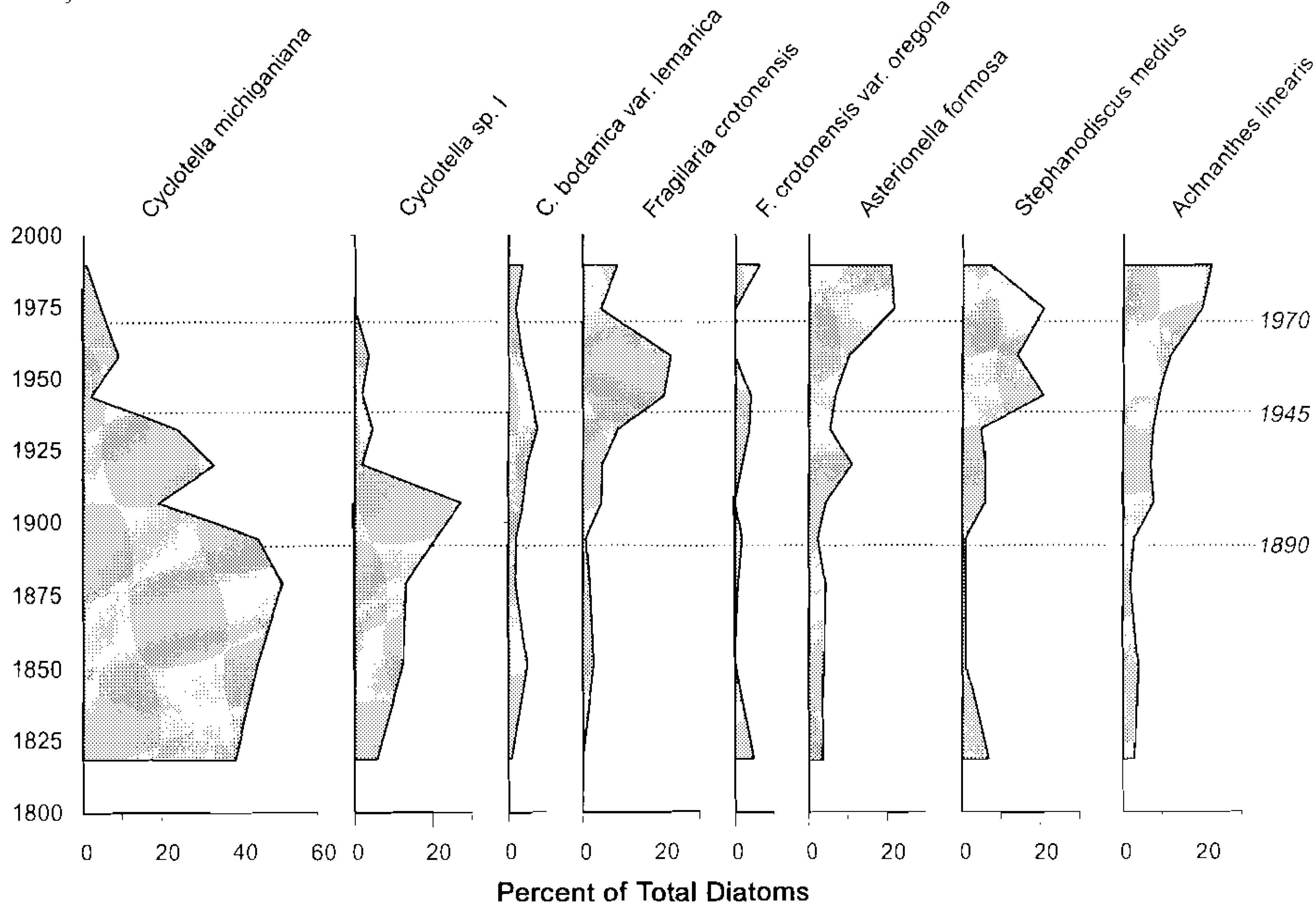


Figure 5. 1995 Upper Rock River Basin Assessment

Oconomowoc Lake

Waukesha County

Analyst: M. MacDonald



Oconomowoc Lake, Waukesha County sediment chemistry results.

SEDIMENT DEPTH	POROSITY	TOTAL PHOSPHORUS	TOTAL CARBON	TOTAL NITROGEN	TOTAL ORGANIC CARBON	IRON Fe	MANGANESE Mn	YEAR (M10)
cm		ug/gm	WT. %	WT. %	WT. %	ug/gm	ug/gm	
0-2	0.9342	602	12.91	0.46	3.71	4990	435	1989.4
2-4	0.9267	542	12.38	0.49	4.45	6190	489	1974.3
4-6	0.9259	228	12.32	0.50	4.75	8273	562	1958.0
6-8	0.8834	257	12.31	0.36	3.79	10415	500	1944.1
8-10	0.8822	302	12.78	0.38	3.88	7208	476	1932.3
10-12	0.8842	379	14.19	0.44	4.50	6138	440	1920.1
12-14	0.8498	402	14.07	0.32	4.10	4257	307	1907.0
14-16	0.8244	246	13.67	0.27	3.22	3711	249	1894.6
16-18	0.8038	270	13.36	0.25	2.95	3521	224	1879.2
18-20	0.7934	204	13.38	0.24	3.82	3562	214	1851.5
20-22	0.7958	274	13.44	0.27	3.52	3845	262	1819
22-24	0.7849	412	13.54	0.26	3.97	3829	247	1784
24-26	0.7887	278	13.71	0.27	4.70	3663	257	1750
26-28	0.7927	332	13.55	0.28	3.43	4271	271	1717
28-30	0.7783	264	13.35	0.25	3.02	3982	269	1681
30-32	0.7756	231	13.10	0.24	3.00	4019	249	1645
32-34	0.7772	339	13.58	0.27	2.96	3682	257	1609
36-38	0.7771	180	13.84	0.27	2.95	3990	246	1537
38-40	0.7631	284	13.68	0.25	3.24	3591	240	1499
40-42	0.7620	287	13.88	0.25	2.87	3534	217	1461
42-44	0.7480	282	13.66	0.23	3.51	3728	216	1420
44-46	0.7487	306	13.31	0.22	2.71	3271	215	1379

Oconomowoc Lake, Waukesha County sediment chemistry results.

SEDIMENT DEPTH	Fe:Mn	Fe:P	YEAR (MID)	SEDIMENT ACCUM. RATE	TOTAL DIATOMS
cm				gm/cm2/yr	valves/g dry wt.
0-2	11.5	8.3	1989.4	0.027	2.78e+08
2-4	12.7	11.4	1974.3	0.021	4.57e+08
4-6	14.7	36.3	1958.0	0.025	3.52e+08
6-8	20.8	40.6	1944.1	0.045	1.42e+08
8-10	15.1	23.9	1932.3	0.054	1.09e+08
10-12	14.0	16.2	1920.1	0.042	4.98e+07
12-14	13.9	10.6	1907.0	0.059	2.93e+07
14-16	14.9	15.1	1894.6	0.072	1.32e+07
16-18	15.7	13.0	1879.2	0.053	3.02e+07
18-20	16.6	17.5	1851.5	0.030	2.86e+07
20-22	14.7	14.1	1819	0.030	1.74e+07
22-24	15.5	9.3	1784	0.030	1.60e+07
24-26	14.2	13.2	1750	0.030	2.02e+07
26-28	15.8	12.9	1717	0.030	2.36e+07
28-30	14.8	15.1	1681	0.030	1.60e+07
30-32	16.2	17.4	1645	0.030	1.78e+07
32-34	14.3	10.9	1609	0.030	7.58e+06
34-36	15.3	11.3	1573	0.030	1.35e+07
36-38	16.2	22.1	1537	0.030	1.72e+07
38-40	15.0	12.7	1499	0.030	1.45e+07
40-42	16.3	12.3	1461	0.030	5.89e+06
42-44	17.3	13.2	1420	0.030	1.51e+07
44-46	15.2	10.7	1379	0.030	6.01e+06

Oconomowoc Lake, Waukesha County **sediment chemistry accumulation results.**

YEAR	TOTAL PHOSPHORUS	TOTAL NITROGEN	TOTAL CARBON	ORGANIC CARBON	INORGANIC CARBON (CaCO3)	IRON Fe	MANGANESE Mn	TOTAL DIATOMS
	gm/cm2/yr					ug/cm2 yr	ug/cm2/yr	valves/cm2/yr *10^6
1989.4	0.16	1.2	31.3	9.8	24.5	1.33	0.12	7.40
1974.3	0.11	1.0	25.5	9.2	16.3	1.27	0.10	9.41
1958.0	0.06	1.2	30.5	11.8	18.8	2.05	0.14	8.71
1944.1	0.12	1.6	55.6	17.1	38.5	4.71	0.23	6.44
1431.3	0.16	2.0	68.8	20.9	47.9	3.88	0.26	5.85
1920.1	0.16	1.9	60.2	19.1	41.1	2.60	0.19	2.11
1907.0	0.24	1.9	82.7	24.1	58.6	2.50	0.18	1.72
1894.6	0.18	1.9	98.2	23.1	75.1	2.67	0.18	0.25
1879.2	0.14	1.3	70.5	15.5	55.0	1.86	0.12	1.
1851.5	(1.06	U.7	40.7	11.6	29.1	1.08	0.07	0.87
1818.6	0.08	0.8	40.9	10.7	30.2	1.17	0.08	0.53
1784.0	0.13	0.8	41.2	12.1	23.1	1.16	0.08	0.49
1750.1	0.08	0.8	41.7	14.3	27.4	1.11	0.08	0.61
1716.7	0.10	0.9	41.2	10.4	30.8	1.30	0.08	72
1681.1	0.08	0.8	40.6	9.2	31.4	1.21	0.08	0.49
1644.9	0.07	0.7	39.8	9.1	30.7	1.22	0.08	0.54
1609.1	0.10	0.8	41.3	3.0	32.3	1.12	0.08	0.23
1572.8	0.11	0.8	41.1	9.6	31.5	1.21	0.08	0.41
1536.9	0.05	0.8	42.1	9.0	33.1	1.21	0.37	0.52
1498.8	0.09	0.8	41 [illegible]	8	31.8	1.09	0.07	0.44
1360.5	0.09	0.8	42.2	8.7	33.5	1.08	0.07	0.18
1420.0	0.09	0.7	41.5	13.7	30.9	1.13	0.07	0.46
1379.5	0.04	0.7	40.5	8.2	32.3	1.00	0.07	0.18