LAKE NOQUEBAY

PRIORITY LAKE PROJECT

WATER RESOURCES APPRAISAL

Final Report

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LAKE NOQUEBAY APPRAISAL REPORT

INTRODUCTION

The Lake Noquebay Priority Watershed program offers a unique opportunity for government officials, land owners, scientists, lake managers and the public to provide long term protection from nonpoint source water pollution. A sequence of activities have to occur before time and money can be committed to the project. The first of these activities involves an appraisal.

The appraisal is a compilation of biological, chemical and physical data related to the water resources of Lake Noquebay, as well as all other water resources (ground and surface) in the Noquebay Watershed. The data becomes a point of reference to establish achievable water quality goals. A goal may be as simple as cutting off the source of nutrients or sediments to a particular reach of stream and measuring the improvement. Or it could be as complex as establishing an inlake nutrient value or number that we target, realizing that the sources are not easily understood or controlled. Sources difficult to control could include atmospheric (especially to a large lake-2409 acres-Noquebay) and internal cycling.

METHODS

Water chemistry information that will be used in the Noquebay appraisal goes back to a 1977 report (Knauer). He completed a nutrient budget for the lake. Additional data includes USGS information from 1987 through 1992, fisheries and other biological data from 1993, as well as lake information from as recent as the last week in April 1994.

Lake models that predict phosphorus input/output, inlake chemical and physical conditions are also used. Fisheries and other biological information is presented from the lakes and tributaries. A paleoecological core was collected and results are presented in the appendices. Historical water chemistry information is presented from various sources including: Northern Lake Services in Crandon, UW Marinette, Wis. DNR, USGS. Landuse issues are a part of this report and expanded on in the overall report.

A key measure of water quality in lakes is trophic status. Carlson 1977 developed a correlation between productivity, secchi disc transparency, chlorophyll a, and spring turnover total phosphorus. He uses a scale from 1 to 100. Oligotrophic conditions are indicted from 1 to 40, mesotrophic conditions from 40 to approximately 50, and anything greater than 50 is eutrophic. In 1993 Lillie, Graham and Rasmussen revised Carlsons 1977 coefficients and regionalized them for Wisconsin. Those values are calculated for Lake Noquebay, Elbow, Mary and Big Newton lakes data sets, in tables 3 - 6 & figures 2 - 6.

WATER QUALITY INFORMATION

The water resources in the Noquebay Watershed drain 109 mi^2 (69,504 acres), see figure 1. Tables 1 & 2 provide information on the physical features of Lake Noquebay and its tributaries.

Inlets and Outlet

Limited water chemistry data exists from the inlets and outlet, see table 7. Fisheries information (IBI) and biotic index values using Hilsenhoff (1987) are a part of the data set, see table 8. Information regarding special status and stream classifications (NR 102) are also a part of table 7. Separate reports outlining fisheries and biological information are included in the bibliography, see (Gansberg 1994) and appendix A (Kornely 1994).

Lakes Information

An extensive water chemistry data base exists for Lake Noquebay, see table 3. Water quality information was collected before 1977 and compiled in a report "Lake Noquebay Report", (Knauer April 12, 1977). Additional information is included in a report "Lake Noquebay Demonstration Project Final Report" Bedrosian (September 1983). The United States Geological Service collected information from 1987 through 1992 and is reported separately. USGS data is tabulated in table 3. Results from a paleoecological core provide a historical perspective. The information is contained in appendix B.

Data from the other 27 lakes in the watershed is limited. Some minimal self-help information has been collected. Three of the lakes were monitored in the past year using the DNR lake monitoring protocol (5 x's/year). Results are presented in tables 4, 5, 6, & 9 and figures 4, 5, & 6. Aquatic macrophyte surveys were conducted annually from 1979 through 1982. The surveys were repeated in 1991 and 1992, jointly funded by Marinette County, the District and DNR through the Lake Planning Grant Program. The Noquebay watershed lakes are listed in Table 9.

The information is available in separate reports and referenced in the attached bibliography.

PHOSPHORUS AND NITROGEN SOURCES TO NOQUEBAY

The Lake Noquebay watershed (109 mi^2) is a subwatershed in the Peshtigo River drainage area (1,080 mi^2).

Runoff coefficients have been calculated at the mouth of the Peshtigo River (USGS-Steve Fields 1993) that can be transposed to Lake Noquebay tributaries and the outlet using annual mean runoff values and watershed ratios. Table 1 summarizes this data.

Other sources of nutrients in the immediate drainage area of Lake Noquebay and the other water resources include: inadequate functioning or maintained septic systems, runoff from impermeable surfaces, and application of fertilizers by riparians. These sources contribute to the buildup of nutrients in the sediments. They also create localized impacts adjacent to shore that promote the growth of aquatic plants.

Additional sources of nutrients and sediments delivered to surface and groundwater are discussed in the overall plan.

Noquebay Septic Systems

A total of 459 dwellings surround Lake Noquebay, to a distance of 1,000 feet from shore. Most of the dwellings are on private septic systems. A small percentage use holding tanks. A breakdown of the Noquebay private on site septic situation is summarized in table 10.

Nutrient Input/Output Relationships

Through a system of tables and graphs nutrient inputs are presented. Table 1 lists the three inlets and outlet as well as the total phosphorus and inorganic nitrogen contributions. Figures 7 & 8 represent summaries of the inlet/outlet nutrient values. Table 7 lists data from the individual sample dates.

The sources used to develop a phosphorus budget for Noquebay are listed in tables 1 & 2.

Lake Modeling

Mathematical coefficients apply measured and estimated data to predict physical and chemical conditions in lakes. A more detailed explanation of the process is contained in "Wisconsin Lake Model Spreadsheet User's Manual", John C. Panuska and Anita D. Wilson-June 1994.

Panuska applied phosphorus loading data to his "Wisconsin Lake Model Spreadsheet, Version 1.00 - June 1994". The results are included in table 11.

AQUATIC PLANTS

The Lake Noquebay Management District was created in the mid 1970's for the primary purpose of managing aquatic plants. The chronology of events that have resulted in the successful management of aquatic plants is reported in the January 13, 1991 "Lake Noquebay Rehabilitation District Aquatic Plant Management Plan For Harvesting" by William L. Kowalski-Marinette County Conservationist.

The document is listed in the attached bibliography.

The cutting and harvesting of aquatic plants in Noquebay play a significant role in removing or mining phosphorus and nitrogen from the lake, see tables 2 & 12.

Table 12 is a summary of aquatic plant harvesting results over the years.

SPECIAL CONCERN TERN

A nesting colony of Black Terns, or Chlidonias niger, are found on the northwest end of Noquebay. The colony is designated "special concern" by Wisconsin State Statute.

WILD RICE BEDS

ZIZANIA sp. are found along the east shore of Noquebay. Special seasons and protection are granted these plants by Wisconsin State Statute.

DISCUSSION

The Lake Noquebay Management District has focused their attention for over 20 years on **managing aquatic plants**. They have budgeted $50,000 per year for over 10 years on managing plants, (Bedrosian 1993). Water quality improvement or protection programs normally target phosphorus control. Phosphorus has been shown to be the limiting nutrient, responsible for primary production in our surface waters. "In fact, Hutchinson (1957) and Lee (1970) indicated that most natural waters respond to additions of phosphorus with greater plant production", Water Quality in Ponds For Aquaculture. Barko (1992) more recently has "identified **nitrogen (N) as more limiting** than phosphorus (P) for the growth of rooted aquatic plants".

A dramatic reduction in Myriophyllum heterophyllum in the eastern 1/3 of the lake was reported by Kowalski (January 1991) between survey data from the late 70's early 80's and more recent data. Northern Lakes in 1992 reported, that M.heterophyllum did appear in scattered beds on the eastern end of the lake. The report also points out that "average depth-to-vegetation which dropped from about 1.6 feet in 1979 to 2.6 in 1991, was nearly three feet in 1992".

Lake Michigan District of DNR has conducted aquatic plant surveys on 9 lakes in Northeast Wisconsin since 1986. The surveys are repeated every three years. At least two data sets, and in some cases three sets exist for the lakes. The data indicates very dramatic swings in certain taxa. Coontail or Ceratoplyllum demersum dramatically declined in two lakes over a three year period, as an example. These shifts or declines like those in Noquebay are difficult to explain.

Barko gives a variety of scenarios for these shifts (1992).

Our **tributary data**, see tables 1 & 7, shows excessive N input. Areal loading values from tributaries in table 1 indicate that nitrogen and phosphorus contributions are greatest from the Smith Creek/Lower Middle Inlet watershed. Areal water loading measures how concentrated nutrient input is to the system. Upper Middle Inlet/Middle Inlet and Upper Inlet values are quite similar. Aquatic plants obtain nutrients primarily from the sediments (Barko 1992, Barko & Smart 1986). Precipitation was above normal in 1979 and 1993. A great deal more nutrients were deposited to Lake Noquebay and likely will, or have had a major impact on production. A greater data set linking nutrient input specifically to aquatic plant growth could provide some of the answers.

<u>A priority should be placed on controlling Phosphorus and nitrogen sources from Smith Creek/Lower Middle Inlet.</u>

Druckrey (Marinette Co 1994), applied coefficients developed by the state of Maine EP to land use practices adjacent to Noquebay. Slope, percent impermeable surfaces and other factors are introduced to determine phosphorus from land use within 1,000 feet of the shore. The results are shown in table 2.

Water quality data applied to the revised Carlson trophic index from Lake **Noquebay shows good water quality** with values primarily in the mesotrophic range, see table 3 & figures 2 & 3. Mary Lake trophic values are in the meso-lower eutrophic range, see figure 5 & table 5. Elbow lake values are from the higher oligotrophic to lower eutrophic range, see figure 4 & table 4. Big Newton goes from the higher oligotrophic to the mesotrophic range with one lower eutrophic value, see figure 6 & table 6. Additional physical and watershed/subwatershed information is contained in table 9.

Phosphorus contributions from **private sanitary systems** in the direct drainage area (<1,000 feet) of Noquebay were estimated based on soils, age of the systems, number of full time and seasonal residents and number of holding tanks. The information is contained in table 10. The systems are separated into those along the north shore and those along the south shore. 73% of the development is along the south shore. However, the greatest number of failing systems is along the north shore.

Although the north shore has only 27% of the development 80% of those systems are failing. 20% of the systems are failing along the south shore.

An excellent discussion of what happens to nitrogen and phosphorus generated from septic systems is contained in "Fate of Nitrogen and Phosphorus in Soils Under Waste Disposal Fields", L.J. Sikora, R.B. Corey 1976. To quote directly, "we conclude that from a pollution standpoint, nitrogen in septic tank effluent is a greater concern that phosphorus. Since nitrate is formed in nearly all but the heavier textured soils, a groundwater nitrate monitoring program may be advisable in areas where the density of septic systems is high, such as a resort area." The report makes a case for the rapid movement of nitrogen through soil and its impact on nitrate concentrations in drinking water supplies. The current limit for NO_3 in drinking water is 10 mg/l. The report also implies nearshore waters impact, and the buildup of N in the sediment. The N could promote macrophyte growth.

The report also discusses phosphorus from septic systems. "Phosphorus contamination of groundwater is expected primarily in sandy soils low in organic matter, soils with high water tables, or shallow soils over crevice bedrock. Since some P sorption occurs in all these cases, contamination would not become apparent until the soil absorption field has been in operation for a number of years".

Many lake residents use fertilizers, pesticides and other chemicals to **maintain their shoreline property.** Most of these chemicals used along the shore end up in the lake. When they enter the lake they trigger the growth of algae, accumulate in the sediments and promote the growth of other forms of plant life.

Table 2 includes Lake Noquebay physical features as well as sources of phosphorus used to estimate surface total phosphorus, secchi disc transparency and chlorophyll a concentrations. Table 2 also provides a break down by percentage of the various sources of phosphorus. Contributions from septic systems and near shore land use are significant, particularly during low water years. The information is applied to Dillon & Rigler 1974B through a method devised by Jim Vennie WDNR. The model results are from five different data sets. Inlake phosphorus is underestimated from 1979 through 1982 and overestimated for 1993. Chlorophyll a and secchi disc values are slightly lower from 1979 through 1982 than measured values. 1993 estimated values are slightly higher than measured values.

Application of "Version 1.00 of the Wisconsin Lake Model Spreadsheet" appears in table 11, Panuska & Wilson 6/94. Estimated phosphorus loadings are considerably higher than measured. The information is provided.

Lake residents should receive incentives to test soils to determine the need for fertilizers or other chemical growth enhancements. Private landowners or clusters of landowners should be given incentives to work with professional landscapers adept at designing vegetative buffers along the shoreline that reduce impact from runoff. Width as well as kinds of vegetation to incorporate into the buffer should be considered.

Dr. John Barko should be contacted to discuss the limiting nutrient concept as it relates to N concentrations and macrophyte growth. A provision should be made to test sediments for various forms of nitrogen and relate those values to macrophyte growth. The results could be used to encourage land use practices that prevent the buildup of N in lake bed sediments. Cutting and harvesting aquatic plants could be encouraged where N levels are high or excessive. Critical habitat would have to be evaluated and no clear cutting, that negatively affects aquatic life, would be allowed.

A **sediment core** was collected in February 1993. The results and discussion are attached in appendix B. The author, Paul Garrison WDNR, Research concludes by saying, "it appears that land disturbance around the turn of the century caused increased erosion in the watershed. These elevated erosional rates continued to increase until about 1960 and have declined during the last decade. The water quality probably was not dramatically affected by this until about 1940 when both N and P increased resulting in an expansion of the macrophyte community. The increase in plants may have resulted in an increase in the planktivorous fish community with a resultant decline in the larger zooplankters. The macrophyte community appears to be declining in the past decade probably as a result of the harvesting operation".

SUMMARY

The reader should direct their attention to the attached tables and figures. The key information for evaluating the water resources is contained in the measured data. Water quality overall is good in the Noquebay watershed. The watershed program will offer greater protection from nonpoint source pollution. Key phrases are highlighted in the discussion and recommendations are underlined. A great deal of effort should be devoted to nearshore activities and the localized impact they create. The 696 lbs of phosphorus delivered from land use within 1,000 feet of shoreline is concentrated in a relatively small area of the 9 plus miles of shoreline. That amount along with the 642 lbs from septic systems makes up 25% to 34% of the total phosphorus delivered to Noquebay during normal water years. Incentives and best management practices have to be developed to address this very significant source of nutrients.

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Tables 1 through 12

1. Trib., Outlet, & Drainage Information
2. Noquebay specs., P delivery, Walker 1987.
3. Noquebay Historical water quality data.
4. Elbow Lake water quality data.
5. Mary Lake water quality data.
6. Big Newton water quality data.
7. Three major trib. water quality data.
8. Tributary including outlet classifications.
9. Other 27 lakes in the Noquebay Watersheds.
10. P Contributions from septic systems
11. Application of WILMS Version 1 - June 1994.
12. Aquatic Plant Harvesting P & N Removal.

Noquebay Tributary, Outlet, & Drainage Information

Waterbody	Drainage Size	Pollutant Source	Discharge cfs*	Inorganic N (lbs/yr)	Total P (lbs/yr)	Inorganic N (lbs/a)	Total P (lbs/a)
Smith Cr./Lower Middle Inlet	29.9 sq. mi/19,143 a	Runoff	1979-38.6 cu ft	46,513	1,120	2.43	0.059
			1980-25.0 cu ft	21,804	639	1.14	0.033
			1981-23.9 cu ft	32,600	1,322	1.70	0.070
			1982-27.7 cu ft	40,145	690	2.10	0.033
			1993-36.4 cu ft	48,123	7,877	2.51	0.411
Upper Middle Inlet/Mid Inlet	53.1 sq mi/34,012 a	Runoff	1979-68.7 cu ft	35,817	1,588	1.05	0.047
			1980-44.3 cu ft	11,620	1,162	0.34	0.034
			1981-42.4 cu ft	30,307	1,529	0.89	0.045
			1982-49.1 cu ft	27,691	547	0.81	0.016
			1993-64.6 cu ft	14,997	3,177	0.44	0.093
Upper Inlet	25.6 sq mi/16,362 a	Runoff	1979-33.1 cu ft.	15,059	871	0.92	0.053
			1980-21.4 cu ft	3,368	617	0.21	0.038
			1981-20.4 cu ft	15,385	548	0.94	0.033
			1982-23.7 cu ft	4,196	824	0.26	0.050
			1993-31.1 cu ft	7,832	857**	0.48	0.052
Outlet	109 sq mi/69,504 a	Runoff	1979-141.0 cu ft	56,866	2,843	0.82	0.041
			1980-91.0 cu ft	8,354	2,148	0.12	0.031
			1981-87.0 cu ft	74,740	1,255	1.08	0.018
			1982-100.8 cu ft	46,272	1,256	0.67	0.018
			1993-132.5 cu ft	No Data	No Data	No Data	No Data

*From Runoff Coefficients & Drainage Ratios
**Estimated Concentration of 0.014 mg/l

Lake Noquebay Specifications								Table 2		
Surface Acerage	2,409 acres		976 hectares							
Maximum depth	51 feet		15.5 meters							
Lake Volume	23,985.5 acre/feet									
Shoreline miles	9.8 miles									
Water retention-114 cfs@outlet	106.3 days									
Water retention-161 cfs@pit;et	75 days									
	Phosphorus Delivery									
Year	1979	1979	1980	1980	1981	1981	1982	1982	1993	1993
Sources	(lbs)	(%'s)	(lbs)	(%'s)	(lbs)	(%'s)	(lbs)	(%'	(lbs)	(%'s)
Smith Cr.	1120	Tribs	639	Tribs	1322	Tribs	690	Tribs	7877	Tribs
Upper Mid/Mid Inlet	1588	64%	1162	55%	1529	63%	547	51%	3177	86%
Upper Inlet	871		617		548		824		857	
Atmospheric*	646	12%	646	15%	646	12%	646	16%	646	5%
Septic Systems	642	12%	642	15%	642	12%	642	16%	642	5%
Development & <1,000'	696	13%	696	16%	696	13%	696	17%	696	5%
Totals (lbs)	5563		4402		5383		4045		13895	
Phosphorus removed from harvesting	1139	20%	2149	49%	2016	37%	1466	36%	1307	9%
*From Panuska 1994										
	Walker 1987									
Year	1979		1980		1981		1982		1993	
Pounds of Phosphorus Delivered To Noquebay	4424		2253		3367		2579		12588	
Mean Depth (M)	3.03		3.03		3.03		3.03		3.03	
Areal H2O loading (m/yr)	12.92		8.34		7.97		9.23		12.14	
Hydraulic Residence Time (yr)	4.256		2.747		2.626		3.042		3.999	
Flushing Rate (Parts of lake/year)	0.235		0.364		0.381		0.329		0.249	
P Areal H2O load Gm/m2/year	0.2104		0.1004		0.1522		0.1155		0.5811	
P Volumetric Load (mg/m3/year)	66.36		33.08		50.15		38.07		191.49	
P Retention Coefficient	0.521		0.575		0.581		0.561		0.527	
Current Total Areal P Load Gm/m2/yr	0.2014		0.1004		0.1522		0.1155		0.5811	
Acceptable Areal P Load Gm/m2/yr	0.2694		0.1961		0.1903		0.2102		0.2568	
Excessive Total P Areal Load Gm/m2/yr	0.5389		0.3921		0.3807		0.4204		0.5137	
P Steady State mg/m3	13		10		14		10		30	
Chl a mg/m3	1.339		0.773		1.476		0.857		6.671	
Secchi m	4.528		5.853		4.325		5.577		2.135	
Mean Optimal Photosyntheses Mg Carbon/m3/day	66.4962		21.3053		76.5245		28.5445		357.4397	
Growing season Photosynthesis mg carbon/m3/day	-3.515		-27.2873		1.7603		-23.4792		149.5334	

Table 3

Lake Noquebay Historical Water Chemistry Data 1972 through 1982 Northern Lakes From Crandon 1987 through 1992 USGS

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
1/29/79	0.5				7.6	0.008	0.002	495	168	0	0.200	0.300	
	1.0												
	2.0												
	3.0												
	4.0												
	5.0				7.6	0.010	0.003	500	170	0	0.210	0.480	
	6.0												
	7.0												
	8.0				7.5	0.010	0.009	545	182	0	0.280	0.520	
	9.0												
TSI						44.314							
2/26/79	1.0				7.50	0.007	0.004	490	168	0	0.220	0.000	
	2.0												
	3.0												
	4.0				7.50	0.006	0.005	530	188	0	0.340	0.000	
	5.0												
	6.0												
	7.0												
	8.0												
	9.0				7.38	0.005	0.001	605	226	0	0.320	0.160	
TSI						43.282							
5/4/79	1.0	3.3			7.64	0.011	0.005	325	102	0.01	0.060	0.520	2.79
	2.0												
	3.0												
	4.0												
	5.0				7.84	0.010	0.004	325	104	0	0.070	0.420	
	6.0												
	7.0												
	8.0												
	9.0												
	10.0				7.72	0.010	0.003	325	104	0	0.070	0.420	
		42.77168				46.776							42.58
5/29/79	0.5	3.1			8.00	0.009	0.004	340	112	0.03	0.030	0.700	4.42
	1.0												
	2.0												
	3.0												
	4.0												
	5.0				7.80	0.009	0.005	345	114	0.02	0.010	0.660	
	6.0												
	7.0												

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	8.0												
	9.0												
	10.0												
	11.0												
	12.0				7.60	0.009	0.005	360	120	0.04	0.030	0.670	
TSI		43.67385				45.225							46.06
7/2/79	0.5	3.0			8.50	0.013	0.003	350	130	0.02	0.010	0.560	5.91
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												
	7.0												
	8.0				7.60	0.012	0.003	380	132	0.05	0.070	0.520	
	9.0												
	10.0												
	11.0												
	12.0												
	13.0				7.40	0.016	0.005	365	130	0.08	0.080	0.640	
TSI		44.14701				48.067							48.25
7/31/79	1.0	3.1			8.70	0.017	0.003	410	138				
	2.0												
	3.0												
	4.0												
	4.5				8.40	0.021	0.005	405	140				
	5.0												
	6.0												
	7.0												
	8.0												
	9.0												
	10.0												
	10.5				8.30	0.018	0.008	400	134				
TSI		43.67385				50.141							
10/22/79	0.5	4.3			8.20	0.007	0.001	425	148	0.18	0.070	0.590	2.30
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0				8.20	0.007	0.003	425	148	0	0.050	0.480	
	7.0												

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	8.0												
	9.0												
	10.0												
	11.0												
	12.0												
	13.0				8.30	0.007	0.005	425	148	0.14	0.070	0.810	
TSI		38.95216				43.282							41.12
3/12/80	1.0				8.30	<0.02	0.004	360	164	0.04	0.040	0.600	
	2.0												
	3.0				8.60	<0.02	<0.004	340	158	0.04	0.040	0.600	
4/23/80	0.5	2.0			8.40	0.011	0.003	220	118	0	0.090	0.670	12.60
	1.0												
	2.0												
	3.0												
	4.0				8.10	0.010	0.003	220	120	0.03	0.070	0.870	
	5.0												
	6.0												
	7.0												
	8.0				8.00	0.012	0.003	220	120	0.03	0.070	0.700	
TSI		49.99788				46.776							53.97
4/24/80	1.0				7.60	0.020	<0.004	230	107	<0.02	0.030	0.600	
	2.0												
	3.0												
	4.0												
	5.0				7.90	0.020	<0.004	230	78	0.54	1.000	<0.2	
						51.397							
8/27/80	0.3	3.2			8.40	0.011	0.007	260	142	0.04	0.040	0.620	3.60
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												
	7.0				8.25	0.015	0.007	260	142	0	0.010	0.560	
	8.0												
	9.0												
	10.0												
	11.0												
	12.0												
	13.0												
	14.0				7.70	0.026		280	160	0.46	0.110	1.040	

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
TSI		43.21572				46.776							44.50
10/6/80	0.5	3.0			8.40	0.006	0.002	290	143	0	0.060	0.700	9.06
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0				8.38	0.006	0.001	290	144	0.03	0.060	0.760	
	7.0												
	8.0												
	9.0												
	10.0												
	11.0				8.24	0.005	0.005	295	148	0.06	0.070	0.810	
TSI		44.14701				42.090							51.48
2/25/81	1.0				7.55	0.016	0.005	245	116	0.25	0.280	0.810	
	2.0												
	3.0												
	4.0												
	5.0												
	6.0				7.55	0.006	0.000	375	194	0.14	0.280	0.700	
	7.0												
	8.0												
	9.0				7.55	0.008	0.002	390	194	0.08	0.500	0.760	
TSI						49.672							
4/30/81	0.5	3.1			8.10	0.018	0.016	255	126	0	0.110	0.450	3.68
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0				8.00	0.010	0.004	255	126	0.06	0.110	0.620	
	7.0												
	8.0												
	9.0												
	10.0												
	11.0												
	12.0				7.90	0.010	0.005	240	130	0.06	0.39	0.840	
		43.67385				50.583							44.67
1/11/82	0.5				8.00	0.093 ?	0.086?	350	168	0.11	0.14	0.500	
	1.0												
	2.0												

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	3.0												
	4.0												
	5.0												
	6.0				7.85	0.009	0.008	365	174	0.08	0.31	0.530	
	7.0												
	8.0												
	9.0												
	10.0												
	11.0												
	12.0												
	13.0				7.80	0.006	0.005	390	172	0	0.28	0.560	
						45.225							
2/11/82	1.0				7.50	0.010	0.007	330	173				
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												
	7.0												
	8.0				7.42	0.005	<0.002	380	199				
	9.0												
	10.0												
	11.0												
	12.0				7.40	0.005	0.002	405	212				
						46.039							
3/23/82	0.5				7.50	0.014	0.01	330	176	0	0.36	0.390	
	1.0												
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												
	7.0				7.40	0.021	0.010	410	210	0	0.39	0.390	
	8.0												
	9.0												
	10.0												
	11.0				7.41	0.024	0.010	475	244	0	0.36	0.420	
						48.640							
4/23/87	0.5	2.8			8.30	0.011	0.008	274	143	<0.010	0.09	0.600	6.00
	1.0		12.7	9.4									
	2.0		12.5	9.4									
	3.0		12.5	9.4									

[redacted]

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	4.0		12.5	9.3									
	5.0		12.4	9.3									
	6.0		12.3	9.3									
	7.0		12.1	9.2									
	8.0		11.6	9.2									
	9.0		11.4	9.1	8.1	0.008	0.002	270	142	<0.010	0.09	0.800	
	10.0		11.3	8.8									
		45.14258				46.776							48.37
6/12/87	1.0	3.7	20.7	7.7		0.015	0.008						6.00
	2.0		20.7	7.9									
	3.0		20.7	7.9									
	4.0		20.8	7.9									
	5.0		20.8	7.9									
	6.0		20.8	7.7									
	7.0		20.8	4.9									
	8.0		15.2	3.5		0.010	0.002						
	9.0		14.7	3.2									
	10.0												
TSI		41.0				41.000							47.00
7/16/87	1.0	2.8	22.2	7.6		0.012	<0.004						3.00
	2.0		22.2	7.4									
	3.0		22.2	7.1									
	4.0		22.1	6.8									
	5.0		22	6.6									
	6.0		21.4	5.2									
	7.0		20.5	1									
	8.0		18.8	0.5									
	9.0		17.2	0.5									
	10.0		16.6	0.5		0.013	<0.004						
TSI		45.0				42.000							43.13
8/16/87	1.0	3.2	24.3	7.9		0.013	0.008						6.00
	2.0		24.2	7.9									
	3.0		24.1	7.8									
	4.0		23.4	6.4									
	5.0		23	5.9									
	6.0		22.5	4.1									
	7.0		22.2	3.3									
	8.0		21.3	1.9									
	9.0		21.2	0.5									
	10.0		17.8	0.0		0.046	0.002						
TSI		43				44.000							47.00

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
2/17/88	1.0		0.4	9.6									
	2.0		1	8.8									
	3.0		2.2	8.6									
	4.0		2.6	7.5									
	5.0		2.9	5.5									
	6.0		3	5.0									
	7.0		3.1	3.4									
	8.0		3.4	2.9									
	9.0		3.7	2.6									
	10.0		3.7	2.7									
TSI													
4/21/88	1.0	1.5	7	11.2	7.6	0.010	0.002						4.00
	2.0		7	11.3									
	3.0		6.9	11.3									
	4.0		6.9	11.3									
	5.0		6.8	11.3									
	6.0		6.7	11.2									
	7.0		6.7	11.2									
	8.0		6.7	11.2									
	9.0		6.7	11.1									
	10.0				7.4	0.013	0.002						
		54				40.000							44.00
6/24/88	1.0	3.1	23.4	8.1		0.004	<0.002						5.00
	2.0		23.4	8.1									
	3.0		23.4	8.0									
	4.0		23.4	7.5									
	5.0		23.2	7.8									
	6.0		21.9	4.9									
	7.0		20.7	3.7									
	8.0		18.6	1.2									
	9.0		15.6	0.2		0.006							46.00
	10.0												
TSI		44				27.000							
7/27/88	0.0	2.5	24	8.0		0.005							4.00
	1.0		24	8.0									
	2.0		23.8	7.8									
	3.0		23.6	7.1									
	4.0		23.5	6.2									
	5.0		22.9	4.3									
	6.0		22.4	2.7									
	7.0		21.4	1.1									
	8.0		20.2	0.0									

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	9.0		18.5	0.0									
	10.0		17.8	0.0			0.006						
TSI		47				30.000							44.00
8/29/88	0.0	1.4	20.3			0.017							7.00
	1.0		20.3										
	2.0		20.2										
	3.0		20.1										
	4.0		20										
	5.0		20.1										
	6.0		19.9										
	7.0		19.9										
	8.0		19.8										
	10.0		19.7			0.020	0.003						
TSI		55				47.000							49.00
4/15/91	0.5	3.5	5.0	11.9		0.014	0.004						3.00
	1.0		5.0	11.9									
	2.0		5.0	11.9									
	3.0		5.0	11.9									
	4.0		5.0	11.9									
	5.0		5.0	11.9									
	6.0		5.0	11.9									
	7.0		5.0	11.9									
	8.0		5.0	11.9									
	9.0		5.0	11.9									
	10.0		5.0	11.9									
	11.0		5.0	11.9									
	12.0		5.0	11.9									
	13.0		5.0	11.9		0.012	0.004						
TSI		42				45.000							42.00
6/24/91	0.0	8.2	23.5	7.8		<0.020							
	1.0		21.5	7.4									
	2.0		21.0	7.7									
	3.0		20.5	7.6									
	4.0		18.5	5.7									
	5.0		17.0	3.0									
	6.0		14.5	0.5									
	7.0		13.5	0.6									
	8.0		13.0	0.4									
	9.0		13.0	0.3									
	10.0		12.5	0.2									
	11.0		12.0	0.0									
	12.0		11.5	0.0		<0.020							

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	13.0												42.00
		47											
7/16/91	1.0	2.4	23.5	8.2		0.012							4.00
	2.0		23.5	8.2									
	3.0		23.5	8.2									
	4.0		23.5	6.7									
	5.0		23.5	1.0									
	6.0		16.0	1.0									
	7.0		15.0	1.0									
	8.0		14.0	1.0		0.012							
	9.0		14.0	1.0									
	10.0		13.5	1.0									
TSI		48				42.000							44.00
8/27/91	1.0	2.6	24.5	8.4		0.011							5.00
	2.0		24.5	8.4									
	3.0		24.5	8.4									
	4.0		22.5	8.0									
	5.0		21.0	5.2									
	6.0		21.0	3.9									
	7.0		20.0	2.0									
	8.0		17.0	1.2									
	9.0		16.0	1.2									
	10.0		15.0	1.2									
	11.0		14.0	1.2									
	12.0		14.0	1.2									
	13.0		14.0	1.2		0.080							
TSI		46				41.000							46.00
2/3/92	1.0		1.0	11.2									
	2.0		2.5	10.4									
	3.0		3.0	9.3									
	4.0		3.5	8.4									
	5.0		3.5	8.2									
	6.0		3.5	8.1									
	7.0		3.5	8.1									
	8.0		3.5	8.1									
	9.0		3.5	8.1									
	10.0		3.5	8.1									
	11.0		3.5	8.1									
4/27/92	1.0	3.2	7.0	11.6		0.011	0.002						3.00
	2.0		7.0	11.7									
	3.0		7.0	11.6									

Table 3

Date	Depth M	Secchi M	Temp C	DO ppm	pH	Total P	Ortho P	Cond	Alk	NH3N	NO2-NO3	TKN	Chl a
	4.0		7.0	11.8									
	5.0		7.0	11.7									
	6.0		7.0	11.6									
	7.0		7.0	11.7		0.011	0.002						
	8.0		7.0	11.7									43.00
TSI		43				47.000							
6/9/92	1.0	2.9	21	9.3		0.013							4.00
	2.0		20	9.3									
	3.0		20	9.2									
	4.0		18.5	6.4									
	5.0		16.5	6.0									
	6.0		16	5.5									
	7.0		16	5.0									
	8.0		15.5	4.9									
	9.0		15	4.6									
	10.0		15	4.3		0.011							
	11.0					48.000							45.00
		45											
7/28/92	1.0	4.2	22.5	8.7		0.008							3.18
	2.0		22.5	8.7									
	3.0		22.5	8.7									
	4.0		22.5	8.6									
	5.0		20.0	4.6									
	6.0		18.5	3.2									
	7.0		18.0	2.0									
	8.0		17.5	1.4									
	9.0		17.5	1.0		0.020							
	10.0					44.000							44.00
		39											
8/25/92	1.0	2.8	23.5	9.1		0.013							4.74
	2.0		23.5	9.1									
	3.0		23.5	9.1									
	4.0		23	9.1									
	5.0		23	8.9									
	6.0		22.5	8.1									
	7.0		21.5	7.2									
	8.0		21	5.2									
	9.0		18.5	0.2		0.020							
	10.0					48.000							47.00
		45											

Table 4

					Elbow Lake - Marinette Co. 384003																	
Date	Depth M	Temp C	DO mg/l	Secchi M	pH	fld pH	Tot. P mg/l	Ortho P	Kjel N	NH3-N	NO2-NO3	T-Alk	Chl a	Ca	Mg	K	Na	SO4	Cl	Cond	Hard	Turb
					Elbow Lake - Marinette Co. 384003																	
Date	Depth M	Temp C	DO mg/l	Secchi M	pH	fld pH	Tot. P mg/l	Ortho P	Kjel N	NH3-N	NO2-NO3	T-Alk	Chl a	Ca	Mg	K	Na	SO4	Cl	Cond	Hard	Turb
June 9, 1993	0	17.0	10.2	6.0			0.006	<0.002					2.63									
June 9, 1993	1																					
June 9, 1993	2	15.5	10.4																			
June 9, 1993	3																					
June 9, 1993	4	12.0	10.0																			
June 9, 1993	5																					
June 9, 1993	6	8.0	6.8																			
June 9, 1993	7																					
June 9, 1993	8	6.0	2.8																			
June 9, 1993	9																					
June 9, 1993	10	5.5	0.8																			
June 9, 1993	11																					
June 9, 1993	12	4.5	0.5																			
June 9, 1993	13																					
June 9, 1993	14	4.0	0.0																			
June 9, 1993	15																					
June 9, 1993	16	4.0	0.0				0.013	0.002														
TSI				34.1			48.067						42.13									
July 8, 1993	0	24.0	8.4	2.4																		
July 8, 1993	1	23.5	8.4																			
July 8, 1993	2	19.5	7.5																			
July 8, 1993	3	14.5	9.2																			
July 8, 1993	4	10.5	5.6																			
July 8, 1993	5	8.5	3.5																			
July 8, 1993	6	7.5	3.3																			
July 8, 1993	7	7.0	1.0																			
July 8, 1993	8	6.5	0.5																			
July 8, 1993	9	6.0	0.5																			
July 8, 1993	10	5.5	0.3																			
July 8, 1993	11	5.0	0.3																			
July 8, 1993	12	5.0	0.2																			
July 8, 1993	13	5.0	0.2																			
July 8, 1993	14	5.0	0.2																			
July 8, 1993	15	5.0	0.2																			
July 8, 1993	16	4.5	0.2			8.5	0.043	0.017														
TSI				47.4			57.314															
Sept 9, 1993	0	17.5	8.9	5.7			0.005	<0.002					1.34									
Sept 9, 1993	1																					
Sept 9, 1993	2	17.5	9.0																			
Sept 9, 1993	3																					
Sept 9, 1993	4	12.5	8.0																			
Sept 9, 1993	5																					
Sept 9, 1993	6	8.5	1.5																			
Sept 9, 1993	7																					

Table 4

					Elbow Lake - Marinette Co. 384003																	
Date	Depth M	Temp C	DO mg/l	Secchi M	pH	fld pH	Tot. P mg/l	Ortho P	Kjel N	NH3-N	NO2-NO3	T-Alk	Chl a	Ca	Mg	K	Na	SO4	Cl	Cond	Hard	Turb
Sept 9, 1993	8	7.0	0.9																			
Sept 9, 1993	9																					
Sept 9, 1993	10	6.0	0.7																			
Sept 9, 1993	11																					
Sept 9, 1993	12	6.0	0.7																			
Sept 9, 1993	13																					
Sept 9, 1993	14	5.0	0.5																			
Sept 9, 1993	15																					
Sept 9, 1993	16	5.0	0.4				0.037	<0.002														
TSI				34.9			51.774						37.03									
Feb. 7, 1994	1	3.0	9.7				0.006	0.004														
Feb. 7, 1994	2	4.0	8.4																			
Feb. 7, 1994	3	4.0	8.1																			
Feb. 7, 1994	4	4.0	8.0																			
Feb. 7, 1994	5	4.0	8.0																			
Feb. 7, 1994	6	4.0	8.0																			
Feb. 7, 1994	7	4.0	8.0																			
Feb. 7, 1994	8	4.0	8.0																			
Feb. 7, 1994	9	4.0	7.7																			
Feb. 7, 1994	10	4.0	7.4																			
Feb. 7, 1994	11	4.0	7.4																			
Feb. 7, 1994	12	4.0	7.0																			
Feb. 7, 1994	13	4.0	6.5																			
Feb. 7, 1994	14	4.0	1.5																			
Feb. 7, 1994	15	4.0	1.1																			
Feb. 7, 1994	16	4.0	1.0				0.021	0.003														
Feb. 7, 1994	17	4.0	0.5																			
TSI							48.359															

Mary Lake - Marinette Co.383208

Table 5

Date	Depth M	Temp C	DO ppm	Secchi M	pH	Field pH	T-Alk	Tot P mg/l	Diss P mg/l	Kjel N mg/l	NH3-N mg/l	NO2-NO3	Chl a	Cl	SO4	Si	Ca	Hard	Mg	K	Na	Fe
Date	Depth M	Temp C	DO ppm	Secchi M	pH	Field pH	T-Alk	Tot P mg/l	Diss P mg/l	Kjel N mg/l	NH3-N mg/l	NO2-NO3	Chl a	Cl	SO4	Si	Ca	Hard	Mg	K	Na	Fe
07/29/82	0.0	22.4	8.8	2.2			134	0.020	<0.004	0.80	<0.02	<0.02	7.00									
07/29/82	1.0	22.3	8.8																			
07/29/82	2.0	22.6	8.6																			
07/29/82	3.0	22.7	8.0				138	0.020	<0.004	0.80	<0.02	<0.02										
07/29/82	4.0																					
TSI				48.6				51.397					49.53									
10/28/82	0.0	8.5	10.3	2.8	7.9		130	0.020	<0.004	0.80	0.09	0.03	3.00									
10/28/82	1.0	8.5	10.2																			
10/28/82	2.0	8.5	10.0																			
10/28/82	3.0	8.5	10.0																			
10/28/82	4.0	8.5	9.9																			
10/28/82	5.0	8.0	9.6																			
10/28/82	6.0	8.0	9.5																			
TSI				45.1				51.397					43.13									
01/18/83	0.0	1.0	12.1		7.6		129	<0.02	<0.004	0.70	0.08	0.06	<5									
01/18/83	1.0	3.0	12.3																			
01/18/83	2.0	4.0	11.6																			
01/18/83	3.0	4.0	9.3																			
01/18/83	4.0	4.0	8.5																			
01/18/83	5.0	4.5	5.3		7.6		130	<0.02	<0.004	0.70	0.10	0.05										
TSI																						
04/28/83	0.0	12.5	10.8	3.0			114	<0.02	<0.004	0.50	<.02	0.02	6.00									
04/28/83	1.0	12.5	10.8																			
04/28/83	2.0	12.5	10.8																			
04/28/83	3.0	12.0	10.4																			
04/28/83	4.0	11.0	10.4																			
04/28/83	5.0	9.0	10.0																			
04/28/83	6.0	8.0	9.3																			
04/28/83	7.0	8.0	8.4							0.50	0.03	0.02										
TSI				44.1									48.37									
11/17/83	0.0	3.0	11.8																			
11/17/83	1.0	3.0	11.8																			
11/17/83	2.0	3.0	11.8																			
11/17/83	3.0	3.0	11.8																			
11/17/83	4.0	3.0	11.7																			
11/17/83	5.0	3.0	11.7																			
11/17/83	6.0	3.0	11.7																			
02/20/84	0.0	2.0	6.6		8.1		114	0.030	<0.004	0.80	0.23	0.28	<5									
02/20/84	1.0	3.5	5.0																			
02/20/84	2.0	4.0	4.4																			
02/20/84	3.0	3.5	3.4																			
02/20/84	4.0	3.5	3.3																			
02/20/84	5.0	4.0	2.2																			
02/20/84	6.0	4.0	1.6		8.3			0.020	<0.004	0.60	0.27	0.08										

Mary Lake - Marinette Co.383208

Table 5

Date	Depth M	Temp C	DO ppm	Secchi M	pH	Field pH	T-Alk	Tot P mg/l	Diss P mg/l	Kjel N mg/l	NH3-N mg/l	NO2-NO3	Chl a	Cl	SO4	Si	Ca	Hard	Mg	K	Na	Fe
TSI								53.122														
05/10/84	0.0	11.0	10.6	2.7	8.1		106	0.020	<0.004	0.60	<0.02	<0.02	7.00									
05/10/84	1.0	11.0	10.6																			
05/10/84	2.0	11.0	10.6																			
05/10/84	3.0	11.0	10.6																			
05/10/84	4.0	11.0	10.6																			
05/10/84	5.0	11.0	10.6																			
05/10/84	6.0	10.5	10.3		8.0		106	<0.02	0.004	0.50	<0.02	<0.02										
TSI				45.7				51.397					49.53									
05/06/93	0.0	15.0	10.9	3.1		7.5	100	0.006	<0.002	0.40	0.036	0.023	3.51	2.0		5.0	6.0	110	12	0.55	<1	0.18
05/06/93	1.0	15.0	10.9																			
05/06/93	2.0	12.0	11.2																			
05/06/93	3.0	12.0	11.2																			
05/06/93	4.0	11.0	11.2																			
05/06/93	5.0	10.0	10.0				103	0.009	<0.002	0.50	0.052	0.026		2.0	<5		6.4	120	12	0.59	<1	0.21
05/06/93	6.0																					
TSI				43.7				43.815					44.31									
06/09/93	0.0	17.5	10.2	2.3				0.010	<0.002													
06/09/93	1.0	17.5	10.2																			
06/09/93	2.0	17.5	10.2																			
06/09/93	3.0	17.5	10.2																			
06/09/93	4.0	13.0	8.4					0.010	<0.002				4.94									
06/09/93	5.0	13.0	8.4																			
06/09/93	6.0																					
TSI				48.0				46.039					46.90									
07/08/93	0.0	24.5	7.8	2.1		8.3																
07/08/93	1.0	24.5	7.8																			
07/08/93	2.0	24.0	7.9																			
07/08/93	3.0	21.0	4.3																			
07/08/93	4.0	18.0	2.3					0.013	0.002													
TSI				49.3				48.067														
09/09/93	0.0	18.0	7.9	1.8				0.011	<0.002				6.19									
09/09/93	1.0	18.0	7.9																			
09/09/93	2.0	18.0	7.9																			
09/09/93	3.0	18.0	7.9																			
09/09/93	4.0	18.0	8.0																			
09/09/93	5.0	17.5	4.3					0.014	<0.002													
09/09/93	6.0																					
TSI				51.5				47.764					48.60									
02/07/94	0.0																					
02/07/94	1.0	4.0	4.3					0.011	<0.002													
02/07/94	2.0	4.0	4.3																			
02/07/94	3.0	4.0	4.0																			
02/07/94	4.0	4.0	3.5																			
02/07/94	5.0	4.0	2.9																			

Table 6

Big Newton - Marinette Co. #383057

Big Newton - Marinette Co. #383057
Date Depth Temp C DO ppm Secchi pH fld pH P-Tot P-Dis Org-N Kjel-N NH3-N NO2-NO3 T-Alk Chl a Ca Mg K Na SO4 Cl Cond Hard Turb

Date	Depth	Temp C	DO ppm	Secchi	pH	fld pH	P-Tot	P-Dis	Org-N	Kjel-N	NH3-N	NO2-NO3	T-Alk	Chl a	Ca	Mg	K	Na	SO4	Cl	Cond	Hard	Turb
02/10/76	0.0	1.5	10.9				0.012	0.005	0.21		0.310	0.02	102.0		24.0	11.0	0.8	1.0	5.0	<1.0	197.0	105.0	<0.06
02/10/76	1.0	1.5	10.9																				
02/10/76	2.0	2.5	10.5																				
02/10/76	3.0	2.5	10.1																				
02/10/76	4.0	2.5	10.1																				
02/10/76	5.0	2.5	10.0																				
02/10/76	6.0	2.5	9.9																				
02/10/76	7.0	3.0	9.6																				
02/10/76	8.0	3.0	9.1																				
02/10/76	9.0	3.0	6.8																				
02/10/76	10.0	3.0	6.3																				
	11.0	3.0	3.3																				
TSI							47.448																
05/04/76	0.0	9.3	10.8																				
05/04/76	1.0	9.3	10.8																				
05/04/76	2.0	9.2	11.0																				
05/04/76	3.0	9.1	11.1																				
05/04/76	4.0	8.9	11.1																				
05/04/76	5.0	8.8	11.2	3.75	7.80		0.010	0.004	0.10		0.170	0.06	89.0		23.0	10.0	0.8	1.0	6.0	<1	183.0	98.0	1.0
05/04/76	6.0	8.8	11.1																				
05/04/76	7.0	8.7	11.1																				
05/04/76	8.0	8.7	11.0																				
05/04/76	9.0	8.5	11.0																				
05/04/76	10.0	8.3	7.5																				
TSI				40.93			46.039																
07/21/76	0.0	24.0	8.3																				
07/21/76	1.0	24.0	8.3																				
07/21/76	2.0	23.8	8.2																				
07/21/76	3.0	23.8	7.9																				
07/21/76	4.0	23.5	7.9																				
07/21/76	5.0	23.4	7.9																				
07/21/76	6.0	23.1	7.9	4.00	8.60		0.010	0.005	0.26		0.080	less .02	92.0		22.0	10.0	0.8	1.0	8.0	less 1	190.0	96.0	0.9
07/21/76	7.0	21.5	7.3																				
07/21/76	8.0	17.5	4.1																				
07/21/76	9.0	14.8	0.6																				
07/21/76	10.0	13.8	0.4																				
07/21/76	11.0	13.1	0.2																				
07/21/76	12.0	13.1	0.2																				
TSI				40.00			46.039																
10/28/76	0.0	7.9	11.4																				
10/28/76	1.0	7.9	11.4																				
10/28/76	2.0	7.9	11.8																				
10/28/76	3.0	7.7	11.8																				
10/28/76	4.0	7.5	11.9																				
10/28/76	5.0	7.5	11.9	3.75	6.70		0.2(?)	0.19	0.29		0.040	<0.02	92		22	10	0.7	1	5	0	171.0	98.0	1.2
10/28/76	6.0	7.5	12.0																				
10/28/76	7.0	7.3	12.1																				
10/28/76	8.0	7.3	12.2																				
10/28/76	9.0	7.2	12.3																				
10/28/76	10.0	7.2																					
TSI				40.93																			
05/06/93	0.0	14.0	12.2	6.3M		8	<0.004	<0.002		0.4	0.170	0.073	100	1.42	25	12	0.84	5	5	3	203.0	110.0	
05/06/93	1.0	14.0	12.2																				
05/06/93	2.0	11.0	13.0																				
05/06/93	3.0	11.0	13.0																				
05/06/93	4.0	9.0	13.0																				
05/06/93	5.0	9.0	13.0																				
05/06/93	6.0	7.0	13.0																				
05/06/93	7.0	7.0	13.0																				
05/06/93	8.0	6.0	9.2		8.28	8	<0.004	0.002		0.4	0.188	0.063	102		25	12	0.65	1	5	3	207.0	110.0	
05/06/93	9.0		8.5																				
TSI				33.44										37.5									
06/09/93	0.0	17.0	11.2	5.8M			0.008	<0.002						3.48									
06/09/93	1.0	17.0	11.2																				
06/09/93	2.0	16.0	11.2																				
06/09/93	3.0	16.0	11.2																				
06/09/93	4.0	15.0	11.9																				

Taable 6

Big Newton - Marinette Co. #383057

Date	Depth	Temp C	DO ppm	Secchi	pH	fld pH	P-Tot	P-Dis	Org-N	Kjel-N	NH3-N	NO2-NO3	T-Alk	Chl a	Ca	Mg	K	Na	SO4	Cl	Cond	Hard	Turb
06/09/93	5.0	15.0	11.9																				
06/09/93	6.0	13.0	12.0																				
06/09/93	7.0	13.0	12.0																				
06/09/93	8.0	11.0	10.2																				
06/09/93	9.0	11.0	10.2																				
06/09/93	10.0	9.0	2.5																				
06/09/93	11.0	9.0	2.5																				
06/09/93	12.0	7.0	1.2																				
06/09/93	13.0	7.0	1.2																				
06/09/93	14.0	7.0	0.9			6.86	0.017	<0.002															
TSI				34.63			47.764							44.2									
07/08/93	0.0	23.5	8.9	4.4																			
07/08/93	1.0	23.0	8.9																				
07/08/93	2.0	23.0	8.9																				
07/08/93	3.0	23.0	9.0																				
07/08/93	4.0	22.5	9.1																				
07/08/93	5.0	20.5	12.4																				
07/08/93	6.0	17.0	14.6																				
07/08/93	7.0	14.5	9.0																				
07/08/93	8.0	13.5	4.4																				
07/08/93	9.0	11.0	3.2																				
07/08/93	10.0	10.0	0.8																				
07/08/93	11.0	9.5	0.5																				
07/08/93	12.0	9.5	0.5																				
07/08/93	13.0	9.0	0.0			8.13	0.020	0.002															
TSI				36.62			51.397																
09/09/93	0.0	19.5	8.2	5.8			0.008	<0.002						1.99									
09/09/93	1.0	19.5	8.2																				
09/09/93	2.0	19.5	8.2																				
09/09/93	3.0	19.5	8.2																				
09/09/93	4.0	19.5	8.2																				
09/09/93	5.0	19.5	8.2																				
09/09/93	6.0	19.5	8.2																				
09/09/93	7.0	17.5	2.8																				
09/09/93	8.0	17.5	2.8																				
09/09/93	9.0	11.0	0.5				0.007	<0.002															
09/09/93	10.0																						
TSI				34.63			43.815							40									
02/07/94	0.0	1.0	13.0				<0.004	<0.002															
02/07/94	1.0	4.0	13.0																				
02/07/94	2.0	4.0	13.0																				
02/07/94	3.0	4.0	13.0																				
02/07/94	4.0	4.0	11.6																				
02/07/94	5.0	4.0	10.8																				
02/07/94	6.0	4.0	11.0				<0.004	<0.002															
02/07/94	7.0	4.0	10.5																				

Table 7

Site	Date	C	pH	Cond	NH3-N	NO2-NO3-N	TK-N	Ortho-P	Tot-P	cfs	BOD	Sus S	Inorganic N ug/l
Lower Middle Inlet	1/29/79	3.5	7.70	560	0.000	0.870	0.92	0.005	0.009				870
& Smith Ck. #1	2/26/79	2.0	7.76	575	0.000	0.950	1.14	0.004	0.006				950
(79-82 Northern Lakes	3/26/79	1.2	7.60	365	0.140	0.430	1.04	0.008	0.011				570
Crandon - 93 DNR)	5/4/79	9.8	7.68	375	0.010	0.210	0.70	0.005	0.010				220
	5/29/79	16.2	7.90	485	0.040	0.530	0.94	0.008	0.014				570
	7/2/79	16.4	8.10	500	0.070	0.650	0.49	0.010	0.015				720
	7/31/79	16.5	8.30	525	0.020	0.480	1.07	0.013	0.040				500
	10/22/79	11.0	8.20	545	0.000	0.500	0.22	0.010	0.013				500
	4/23/80	9.1	7.60	282	0.030	0.440	0.62	0.013	0.025				470
	8/27/80	13.8	7.73	285	0.030	0.270	1.76	0.054	0.007				300
	10/6/80	8.0	8.10	365	0.000	0.560	0.32	0.006	0.007				560
	2/25/81	0.1	7.60	215	0.340	0.640	1.06	0.009	0.025				980
	3/30/81	5.7	7.40	265	0.340	0.590	0.95	0.022	0.025				930
	4/30/81	6.4	7.80	240	0.000	0.170	0.02	0.035	0.035				170
	1/11/82	0.1	7.79	400	0.030	0.780	0.50	0.020	0.025				810
	2/11/82	0.1	7.45	340	<0.03	0.780	1.12	<0.002	0.005				780
	3/23/82	0.0	7.65	345	<0.03	0.620	0.59	0.007	0.008				620
	3/25/93				0.501	0.703	1.90	0.100	0.190	10.7	8.3	16	1204
	6/10/93				0.030	0.110	0.70	0.010	0.030	27.5	<1	4	140
Middle Inlet #2	1/29/79	3.6	7.58	490	0.000	0.270	0.30	0.005	0.009				270
Eagles Nest Ck.	2/26/79	2.9	7.54	490	0.000	0.320	0.02	0.004	0.007				320
(79-82 No. Lakes	3/26/79	1.1	7.62	335	0.170	0.440	0.87	0.006	0.011				610
Crandon, 93 DNR)	5/4/79	8.0	7.92	350	0.010	0.040	0.50	0.003	0.008				50
	5/29/79	16.3	7.90	425	0.030	0.130	0.64	0.007	0.012				160
	7/2/79	19.3	8.40	475	0.060	0.210	0.42	0.008	0.015				270
	7/31/79	19.1	8.20	490	0.020	0.190	0.49	0.009	0.024				210
	10/22/79	11.3	8.10	485	0.110	0.120	1.12	0.005	0.008				230
	4/23/80	10.7	7.90	260	0.030	0.160	0.42	0.006	0.014				190
	8/27/80	16.4	7.73	275	0.000	0.030	0.76	0.010	0.022				30
	10/6/80	12.0	8.10	340	0.000	0.180	0.56	0.004	0.004				180
	2/25/81	0.3	7.55	205	0.000	0.280	0.92	0.010	0.027				280
	3/30/81	6.8	7.60	265	0.000	0.360	0.45	0.009	0.015				360
	4/30/81	8.7	7.10	239	0.110	0.340	0.62	0.004	0.013				450
	1/11/82	0.1	7.70	380	0.000	0.280	0.59	0.002	0.007				280
	2/11/82	0.1	7.49	300	<0.03	0.220	0.53	<0.002	0.004				220
	3/23/82	0.1	7.49	315	0.110	0.250	0.81	0.002	0.006				360
	3/25/93				0.009	0.157	0.20	0.002	<0.02	23.9	<1	6	166
	6/10/93				0.018	0.052	0.70	0.003	0.030	65.9	<1	18	70
Upper Inlet #3	1/29/79	2.7	7.20	500	0.170	0.070	1.86	0.004	0.015				240
(79-82 No. Lks Crandon	2/26/79	2.3	7.32	600	0.200	0.130	1.50	0.004	0.008				330
93 DNR)	3/26/79	1.8	7.54	350	0.530	0.230	1.04	0.009	0.010				760
	5/4/79	11.3	7.48	300	0.010	0.030	0.53	0.004	0.009				40
	5/29/79	19.5	7.40	345	0.030	0.020	0.88	0.005	0.012				50
	7/2/79	24.5	7.40	375	0.040	0.020	0.82	0.005	0.017				60
	7/31/79	23.3	7.40	390	0.030	0.030	1.09	0.006	0.026				60
	10/22/79	12.1	7.60	460	0.240	0.070	1.34	0.006	0.010				310
	4/23/80	7.7	8.20	180	0.100	0.020	0.98	0.006	0.015				120
	8/27/80	19.9	7.11	270	0.000	0.080	1.04	0.004	0.023				80
	10/6/80	12.0	7.32	290	0.000	0.040	0.73	0.003	0.006				40
	2/25/81	0.3	7.05	170	0.280	0.300	0.87	0.009	0.017				580
	3/30/81	7.6	7.20	215	0.310	0.140	0.36	0.006	0.014				450
	4/30/81	11.3	7.00	199	0.060	0.060	0.62	0.002	0.010				120
	1/11/82	0.1	7.40	380	0.000	0.080	0.98	0.011	0.020				80
	2/11/82	0.1	7.10	380	0.080	0.030	1.06	0.017	0.022				110
	3/23/82	0.1	6.99	305	<0.03	0.080	0.89	0.006	0.011				80
	3/25/93				0.043	0.085	0.60	0.002	<0.02	2.4	1.0	<2	128
Outlet	1/29/79	4.6	7.58	505	0.000	0.190	0.47	0.002	0.009				190
(79-82 No. Lks Crandon	2/26/79	3.9	7.50	490	0.000	0.200	0.00	0.003	0.005				200
93 DNR)	3/26/79	4.2	7.70	425	0.250	0.370	1.07	0.007	0.009				620
	5/4/79	10.8	7.80	350	0.000	0.140	0.66	0.005	0.011				140
	5/29/79	18.9	8.10	355	0.030	0.050	0.74	0.005	0.011				80
	7/2/79	24.1	8.70	380	0.040	0.010	0.68	0.003	0.013				50
	7/31/79	22.8	8.60	395	0.020	0.010	0.64	0.005	0.018				30
	10/22/79	11.3	8.00	440	0.240	0.090	0.31	0.003	0.006				330
	4/23/80	12.9	8.40	212	0.000	0.020	0.42	0.003	0.011				20
	8/27/80	20.0	7.70	260	0.000	0.030	0.56	0.015	0.019				30

	10/6/80	11.0	8.50	310	0.000	0.090	0.64	0.003	0.006					90
	2/25/81	2.8	7.75	310	0.080	0.560	0.31	0.001	0.009					640
	3/30/81	10.3	8.00	320	0.000	0.220	0.45	0.005	0.005					220
	4/30/81	11.1	8.00	258	0.340	0.110	0.76	0.000	0.008					450
	1/11/82	0.7	8.20	360	0.000	0.080	0.53	0.004	0.010					80
	2/11/82	0.8	7.52	340	<0.03	0.170	0.31	<0.02	0.004					170
	3/23/82	2.9	7.50	355	0.170	0.280	0.36	0.002	0.005					450
	6/10/93				0.026	0.011	0.50	0.002	<0.02		<1	<2		37
Smith Ck. DNR data	3/25/93				0.022	0.704	0.40	0.005	<0.02	6.2	1.2		7	726
	6/10/93				0.026	0.059	1.00	0.003	0.030	23.6	1.1		11	85
Upper Middle Inlet	3/25/93				0.012	0.399	0.30	0.003	<0.02	9.1	1.1		7	411
(DNR data)	6/10/93	12.2	7.30		0.021	0.039	0.50	0.006	<0.02	43.2	<1		4	60

Lake Noquebay Tributary Streams Including the Outlet

Waterbody	Description	Stream Classification *	IBI Score*	Special Status**	Habitat Rating/Biotic Index Rating**
Upper Middle Inlet Creek	Coldwater Trout Stream	Class I - above middle of T33N,R21E,S18 (10.3 miles) Class II-downstream this point (3.3 miles)	500 feet below Nejaldo Rd. Score 100, rating was excellent	ORW	1992-Nejeldo Rd-Good,103/Excellent,2.93 1993-Nejeldo Rd-Good,114/Excellent,3.40
Middle Inlet Creek	Coldwater Trout Stream 15.5 miles in length	Class I above CTH X Class II 2.2 miles below X to Noquebay.	1050 feet below Moonshine Hill Rd & 500 feet upstream Camp 5 Rd. Score was 80 and rating was excellent	ORW	1992-Moonshine Hill Rd-Good,102/Excellent,2.71 1993-Moonshine Hill Rd.-Good,102/Excellent,3.2
Lower Middle Inlet Creek	Coldwater Trout Stream 8.3 miles in length	Class I entire length of stream.	HWY 141 upstream 1000 ft. Score 90, rating excellent. 466 feet below Cemetry Rd. Score was 100 and rating excellent	ERW	1992-Cemetery Rd.-Good,96/Excellent,1.61 1993-Cemetery Rd.-Good,94/Excellent, 1.96
Smith Creek	Coldwater Trout Stream 8.2 miles in length	Class I entire lenght.	HWY 141 upstream 600 ft. Score was 70, and rating was good (new bridge construction, lots of silt) Smith Creek 300 feet upstream Score was 100 and rating was excellent.	ERW	1992-St. Paul Rd-Good, 110/Excellent, 2.73 1993-St. Paul Rd-Fair,143/Good, 4.73
Upper Inlet Creek	Warmwater Stream 5.9 miles in length	Class B, Warmwater Sport Fishery	500 feet above CTH X Using Ball WDNR "Stream capable of supporting a warmwater sport fishery or serving as a spawning area for warmwater sport fish."	-------	1992-Lk Mary Rd.-Good,160/Fair, 5.94 1993-Lk Mary Rd-Fair, 136/Fairly Poor, 6.67
Outlet		Warmwater Sport Fishery		------	1993-St. Paul Rd-Good, 79/Very Good 4.04

*See appendix_____, Kornely (1994)
**See appendix_____, Gansberg (1994)

Table 9

Lake	Twn,Range,Sec	Size (Acres)	Max. Depth (Ft.)	Drainage (Sq. Mi)	Shoreline (Miles)	Self-Help	TSI T-P (n)	TSI SD (n)	TSI Chl a (n)	TSI Class	P Sens	Lake Type	Notes
Butterfly	T34N,R20E,S30	6	15	0.09	0.60							Seepage	
Campbell	T32N,R19E,S11	24	8	0.12	1.21							Seepage	
Charles	T32N,R19E,S11												
Chrizel	T33N,R19E,S35	1	8	0.01	0.10							Drained	Headwaters of Lower Middle Inlet
Elbow	T34N,R19E,S27	62	60	1.19	2.31		51 (4)	39 (3)	40 (2)	Mesotrophic	I	Drainage	See Table______
Engleman	T33N,R20E, S22	13	4	0.17	0.55							Seepage	
Finnegan	T33N,R20E,S22	6	3										
Jug	T34N,R20E,S30												
Julia	T33N,R21E,S25	47	20	1.65	1.17						I Ins	Drainage	Inlet/Outlet is part of Up. Mid Inlet
Lily	T34N,R19E,S27	11	10	0.54	0.80							Drainage	
Lit. Newton	T33N,R19E,S4	60	53	0.44	1.19			41 (5)	46 (4)	Mesotrophic	I Ins	Seepage	
Mary	T33N,R21E,S25	167	20	1.27	2.28	Yes	49 (9)	41 (8)	47 (7)	Mesotrophic	II A	Drainage	Outlet goes to Julia Table___
Mud	T33N,R22E,S19	8	19	0.93	0.47							Drainage	
Newton (Big)	T33N,R19E,S3	68	40	0.44	1.3		47 (6)	38 (7)	41 (3)	Mesotrophic	I	Seepage	See Table______
Noquebay	T33N,R21E,S8	2,409	51	132	9.4	Yes	45 (31)	47 (24)	46 (24)	Mesotrophic	I A	Drainage	See Table _____
Perch	T34N,R20E,S34	27	15	0.09	0.82						I Ins	Spring	
Reicof	T33N,R20E,S31	47	14	0.16	1.07							Seepage	
Rollins	T34N,R19E,S34	9	4	0.06	0.47							Seepage	
Roosevelt	T33N,R20E,S10	1	3	0.20	0.10							Spring	
Round	T32N,R20E,S5	3	3	0.30	0.25							Seepage	
Rush	T32N,R20E,S6	17	31	0.14	0.66							Spring	
Silver	T34N,R19E,S27	8	19	0.04	0.44							Seepage	
Simpson	T33N,R19E,S13	13	24	0.08	0.74							Spring	
Spencer	T34N,R19E,S21	3	4	0.04	0.26							Seepage	
Spies	T34N,R20E,S30	27	5	1.16	0.80						II Ins	Drainage	
Springer	T34N,R19E,S27	2	18	0.08	0.25							Spring	
Stephenson	T33N,R22E,S8	19	24	0.78	0.69							Drainage	
Wolf	T33N,R20E,S23	22	7	0.22	0.82							Seepage	

P Contribution from Noquebay Septic Systems

North Shore	
123 dwellings	
36 permanent	
87 seasonal	
25 Holding Tanks	
98 systems failing	
0.4 retention coefficient	
4 persons/household	
28 permanent	
70 seasonal	
1.1 lbs of P/person/year*	
lbs of phosphorus from full time residents =	120.96
lbs of phosphorus from seasonal residents =	151.2
South Shore	
336 dwellings	
27 holding tanks	
93 systems on poor soils	
66 systems failing	
0.4 retention coefficient	
4 persons/household	
40 full time residents	
26 seasonal residents	
1.1 lbs of P/person/year	
lbs. of phosphorus from full time residents=	172.8
lbs. of phosphorus from seasonal residents=	56.16
243 systems on suitable soils	
0.9 retention coefficient	
1.1 lbs. of P/person/year	
4 persons/household	
148 permanent residents	
95 seasonal residents	
lbs of phosphorus from full time residents=	106.56
lbs. of phosphorus from part time residents=	34.2
Total lbs of P from septic systems	641.88

Figure 1

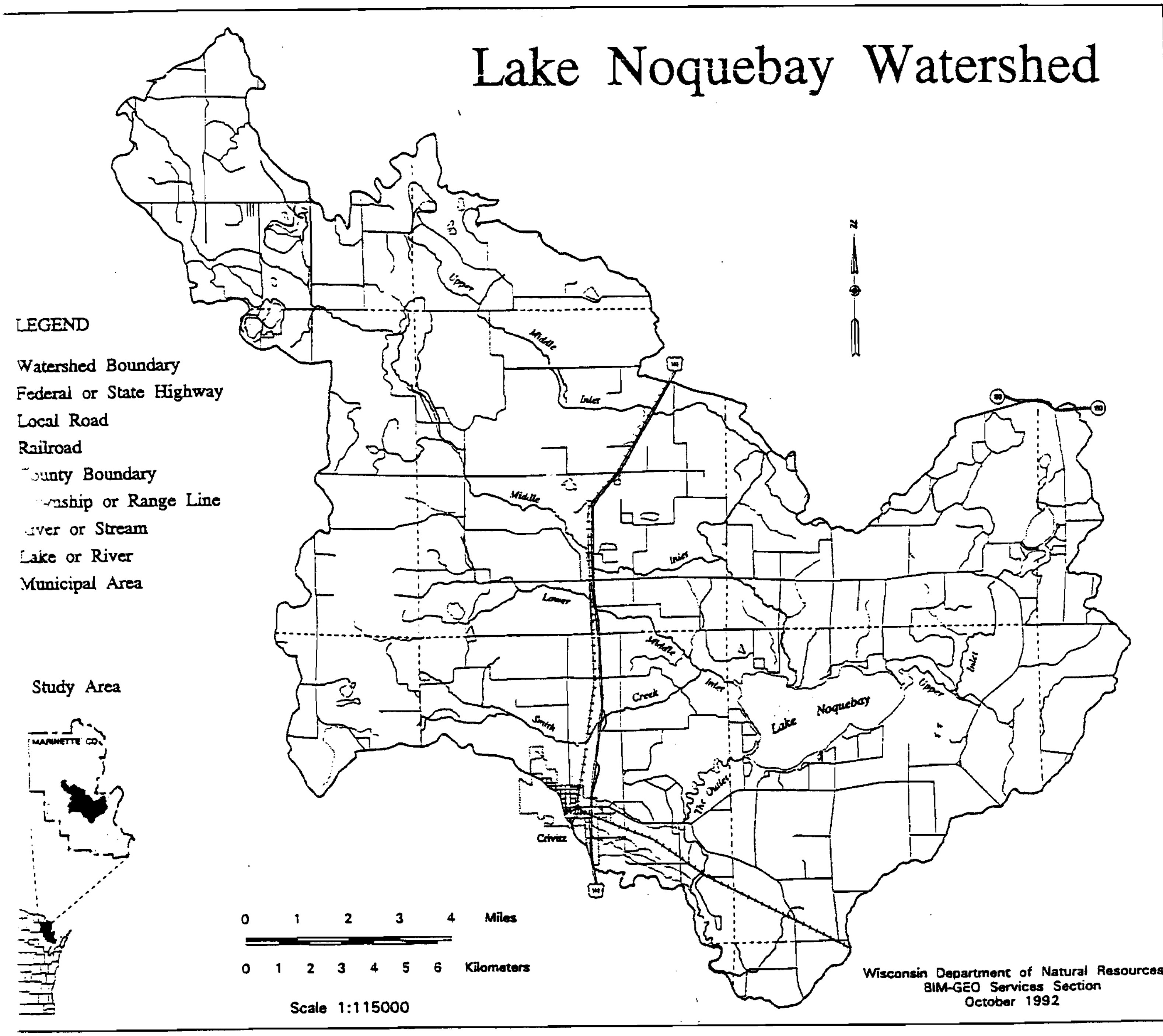

Lake Noquebay Watershed
LEGEND
Watershed Boundary
Federal or State Highway
Local Road
Railroad
County Boundary
Township or Range Line
River or Stream
Lake or River
Municipal Area
Study Area
MARINETTE CO.
Upper
Middle
Inlet
Middle
Inlet
Lower
Middle
Inlet
Creek
Smith
Lake Noquebay
Upper
Inlet
The Outlet
Crivitz
0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers
Scale 1:115000
Wisconsin Department of Natural Resources
BIM-GEO Services Section
October 1992

Figure 2

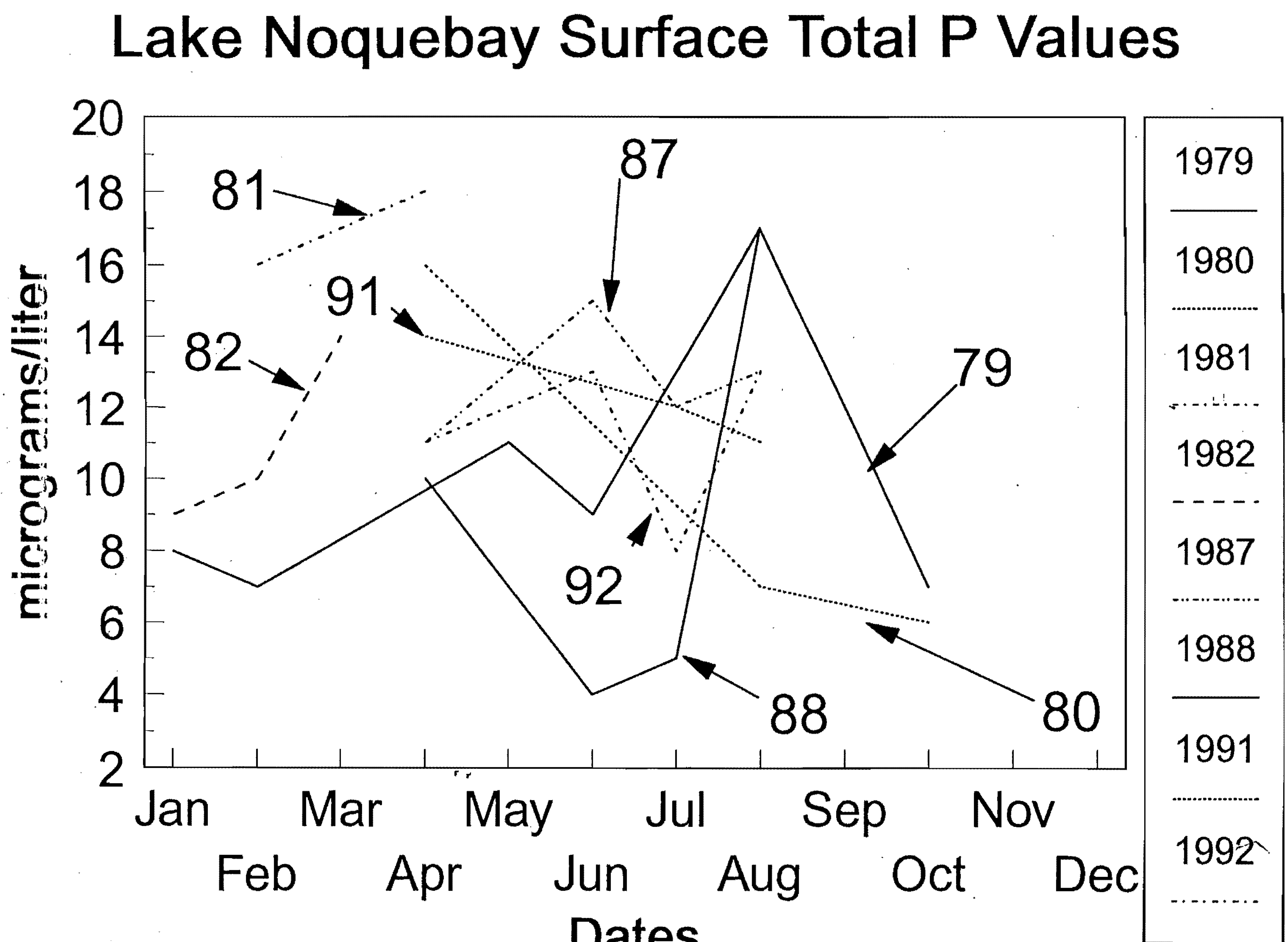
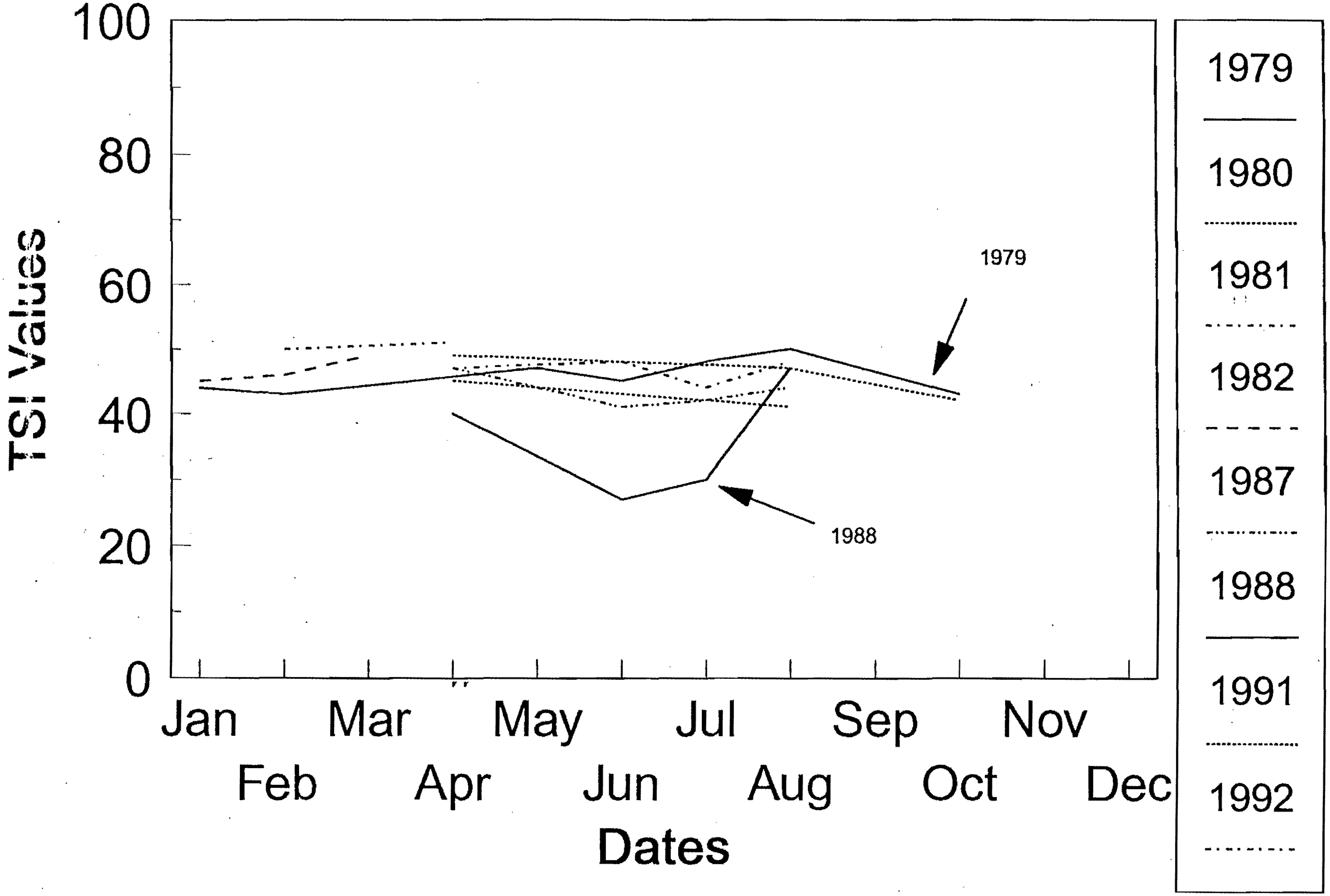

Lake Noquebay Surface Total P Values
micrograms/liter
20
18
16
14
12
10
8
6
4
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dates
81
87
91
82
79
92
88
80
1979
1980
1981
1982
1987
1988
1991
1992

Figure 3

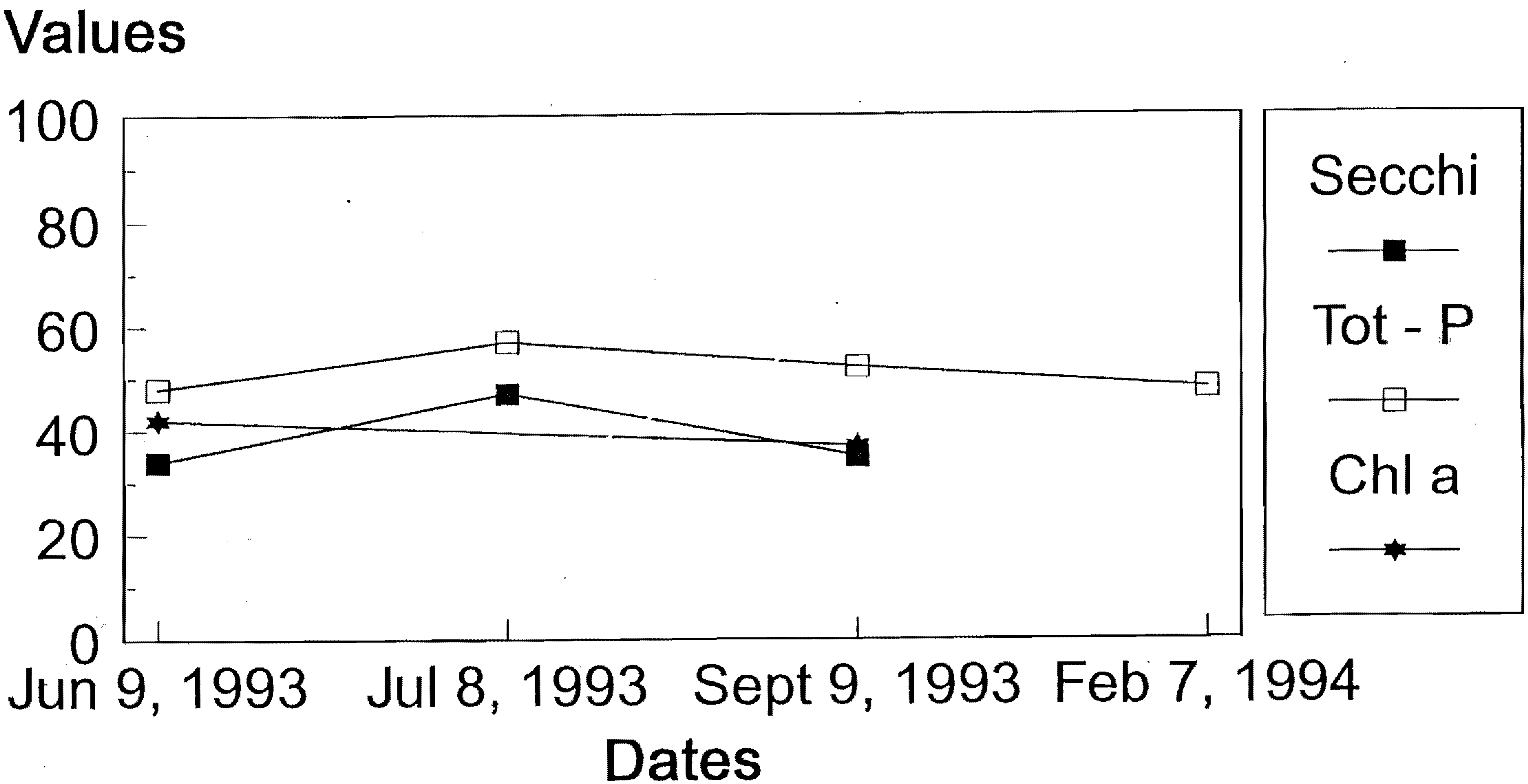
Lake Noquebay Phosphorus TSI Values



Elbow Lake - Marinette Co

Figure 4

Carlson Trophic Index Values



0 - 40 Oligotrophic

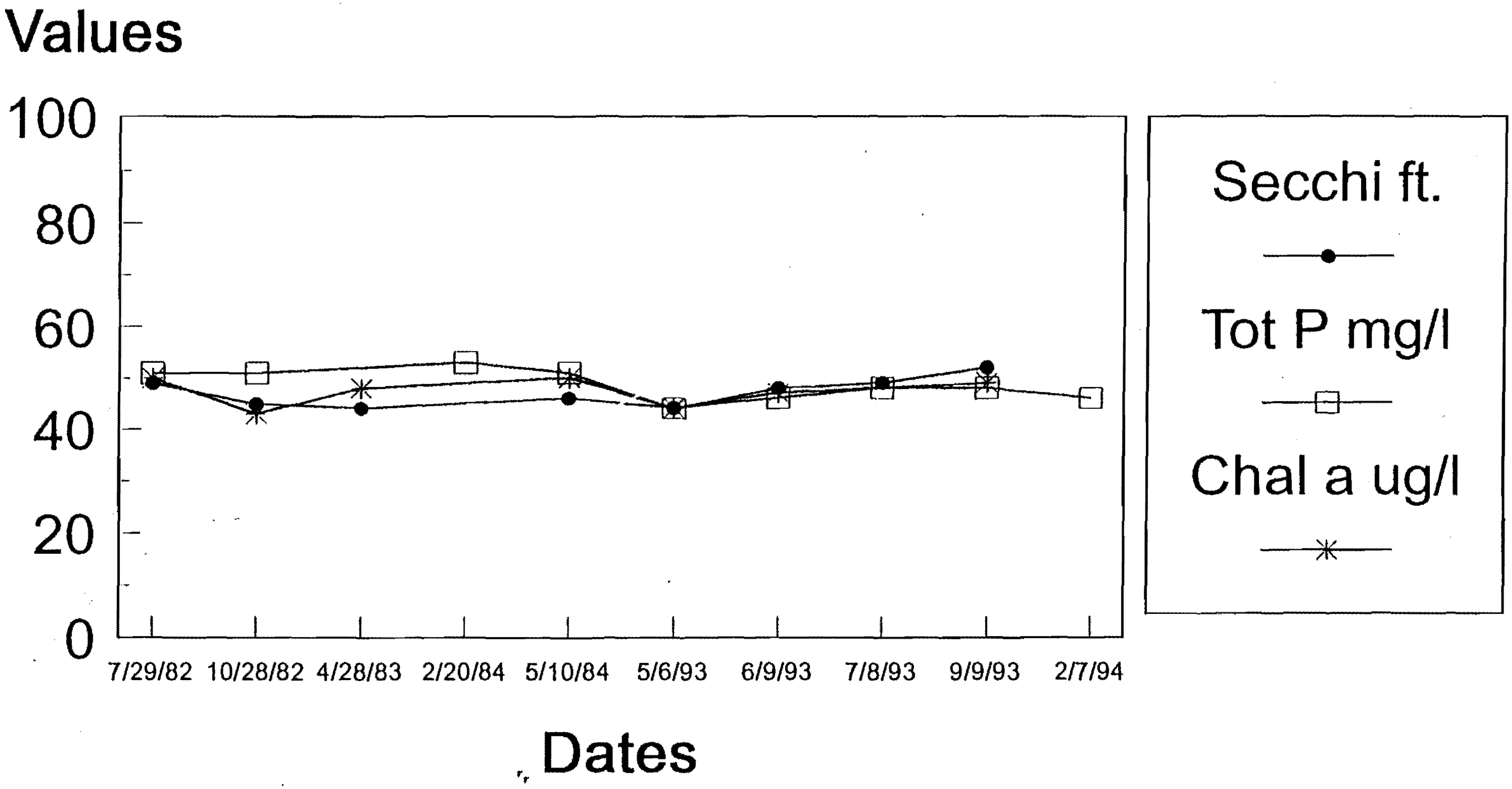
40 - 50 Mesotrophic

50 - 100 Eutrophic

Figure 5

Mary Lake - Marinette Co.

Carlson's Trophic State Index Values

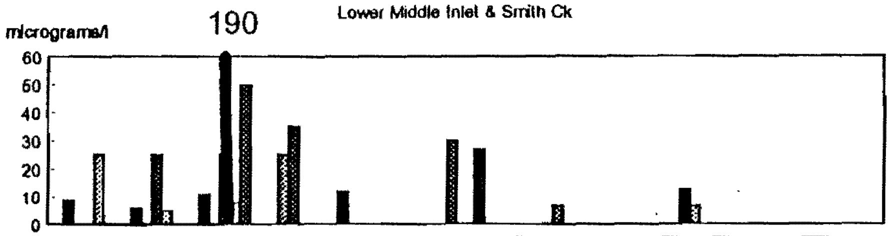


0-40 Oligotrophic
40-50 Mesotrophic
50-100 Eutrophic

Noquebay Tributaries & The Outlet

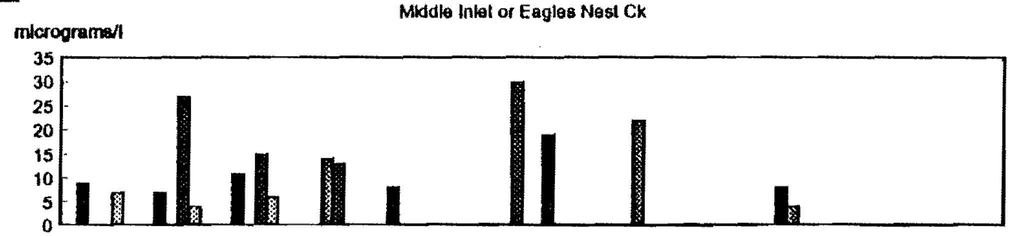
Figure 7

Total Phosphorus
Lower Middle Inlet & Smith Ck



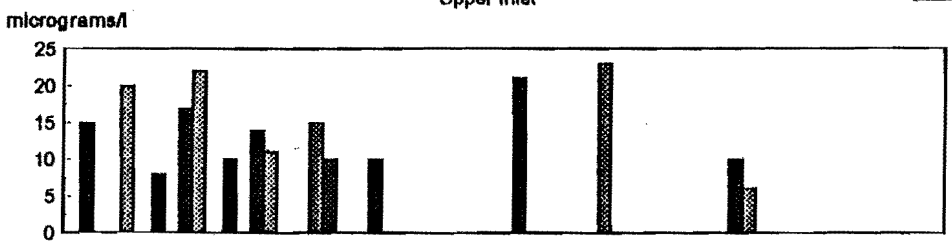
Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	9	6	11		12		27			13		
1980				25				7		7		
1981		25	25	35								
1982	25	5	6									
1983			190			30						

Total Phosphorus
Middle Inlet or Eagles Nest Ck



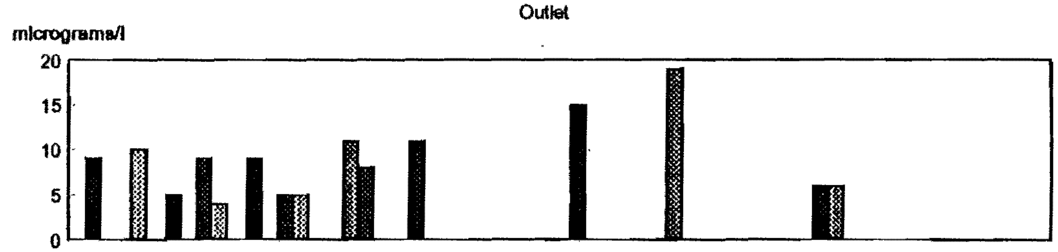
Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	9	7	11		8		19			8		
1980				14				22		4		
1981		27	15	13								
1982	7	4	6									
1983						30						

Total Phosphorus
Upper Inlet



Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	15	8	10		10		21			10		
1980				15				23		6		
1981		17	14	10								
1982	20	22	11									

Total Phosphorus
Outlet

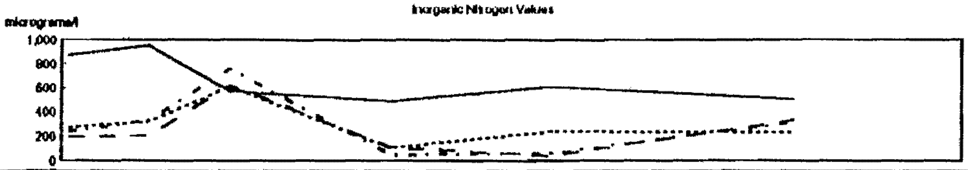


Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	9	5	9		11		15			6		
1980				11				19		6		
1981		9	5	8								
1982	10	4	5									

Noquebay Tributaries
Inorganic Nitrogen

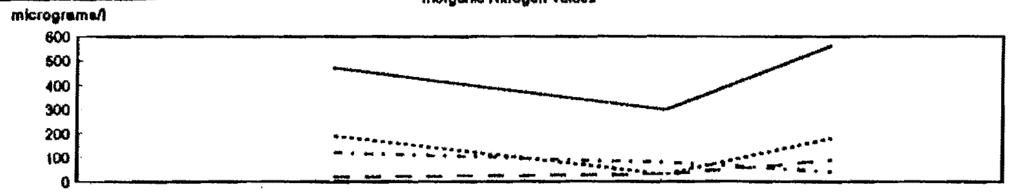
Figure 8

1979
Inorganic Nitrogen Values



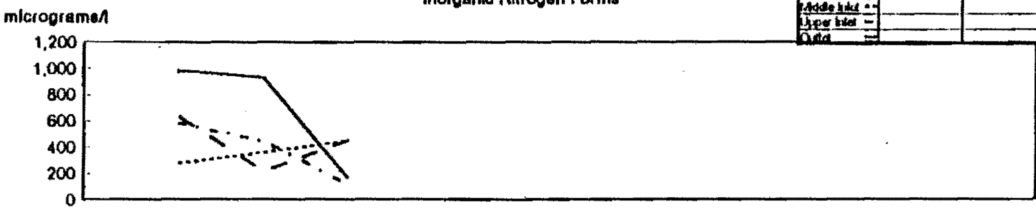
Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Middle	870	960	670		486		610			500		
Middle Inlet	270	320	610		106		210			230		
Upper Inlet	240	330	760		46		80			310		
Outlet	190	200	620		110		40			330		

1980
Inorganic Nitrogen Values



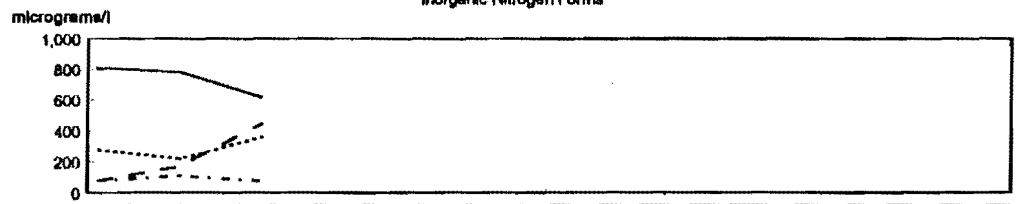
Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Middle				470				300		560		
Middle Inlet				190				30		180		
Upper Inlet				120				80		40		
Outlet				20				30		90		

1981
Inorganic Nitrogen Forms



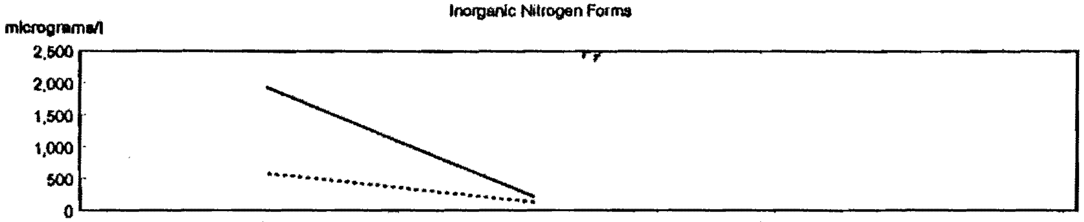
Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Middle		960	930	170								
Middle Inlet		280	360	450								
Upper Inlet		580	450	120								
Outlet		640	220	450								

1982
Inorganic Nitrogen Forms



Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Middle	810	780	620									
Middle Inlet	260	220	360									
Upper Inlet	80	110	80									
Outlet	80	170	450									

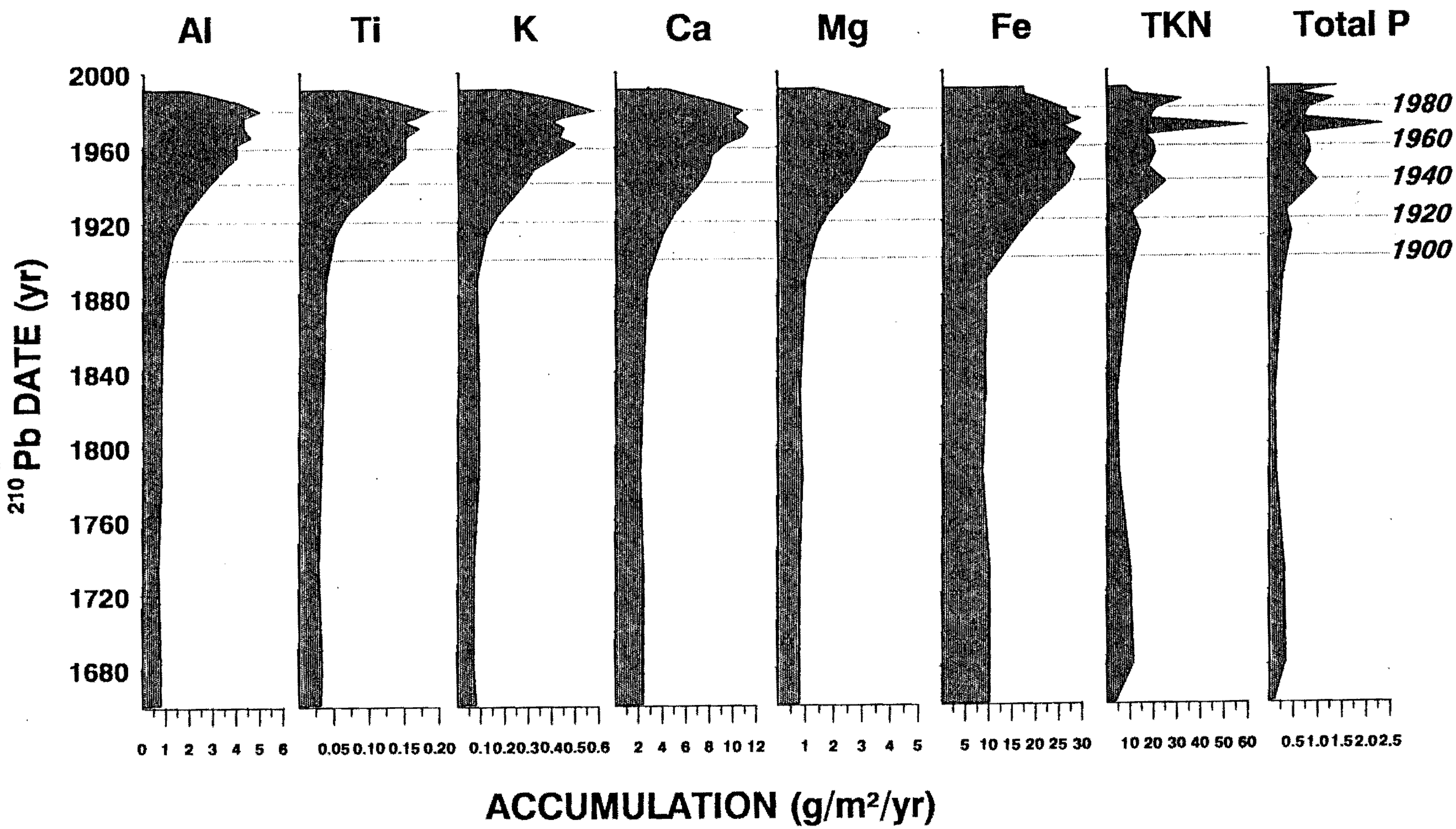
1993
Inorganic Nitrogen Forms



Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Middle			1,930			225						
Middle Inlet			577			130						
Upper Inlet			126									
Outlet						37						

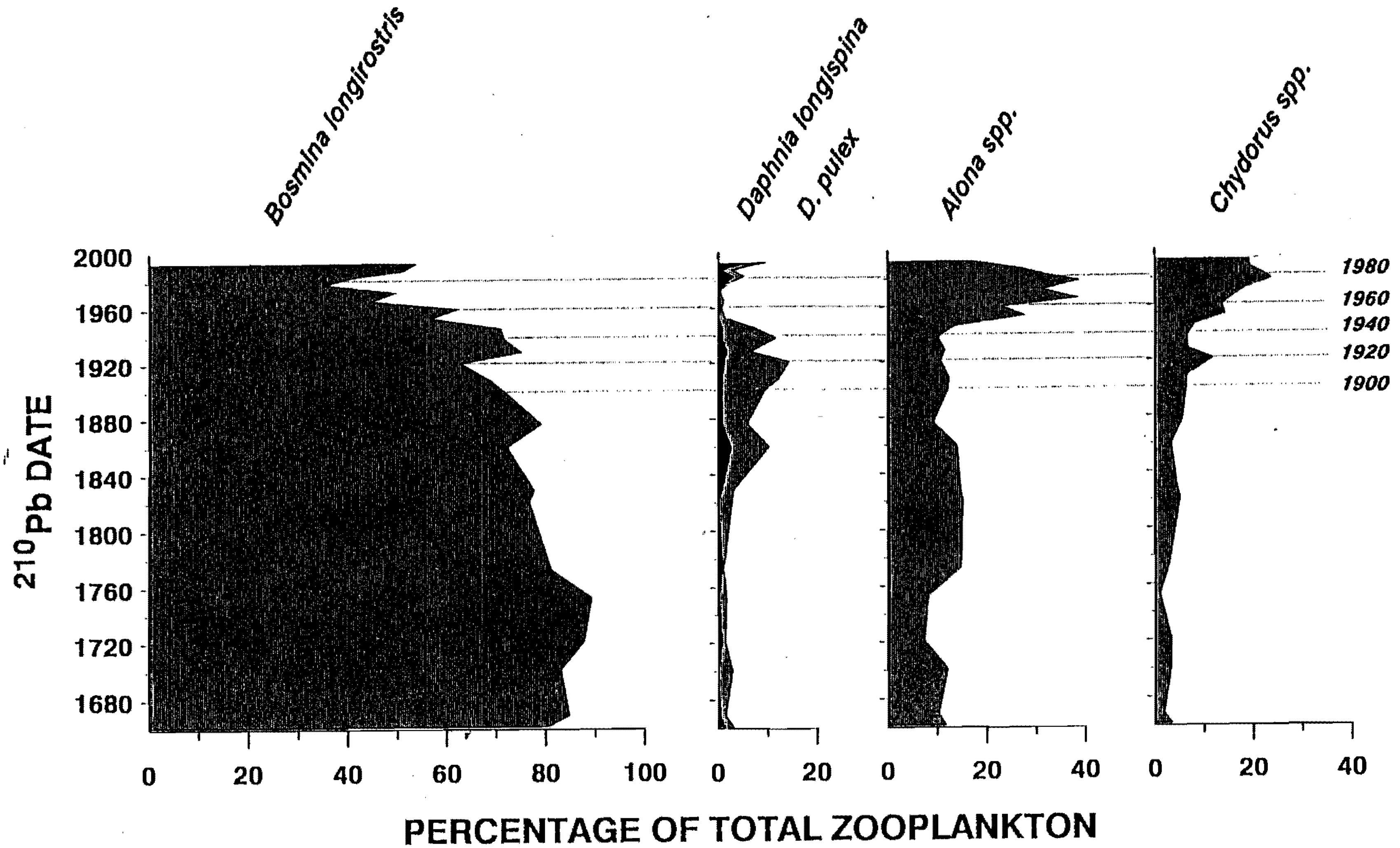
LAKE NOQUEBAY

Marinette County



LAKE NOQUEBAY

Marinette County



LAKE NOQUEBAY

Marinette County