Lake Management Planning Grant
Final Report

for

Lake Noquebay

August, 2002

Marinette County Land & Water Conservation Department
1926 Hall Ave.
Marinette, WI 54143-1717

Project Setting

Lake Noquebay is a relatively shallow, 2,406 acre drainage lake located in central Marinette County. There are approximately 270 private homes on the shoreline along with four resorts, a public park and four public boat landings. The Lake Noquebay wildlife area, owned by the State of Wisconsin is located on the east end of the lake. With all of it's amenities and it's proximity to Crivitz, Marinette, and population centers in the Fox River Valley, Lake Noquebay is a popular tourist destination for fishing and motorized water sports.

Lake Management History

Lake Noquebay has a long history of lake management efforts aimed at reducing excessive aquatic macrophyte growth, controlling swimmers itch and reducing nonpoint source inputs to improve water quality. Prior to 1970 most lake management efforts were sporadic and aimed at reducing the incidence of swimmers itch. In the early 1970's, a three phase interdisciplinary study was conducted to study the proliferation of variable-leaf water milfoil and recommend management alternatives. The Lake Noquebay Rehabilitation District (LNRD) was formed in 1975 to implement the resulting plan and undertake a lake-wide aquatic plant harvesting operation.

The Lake Noquebay watershed was designated a priority watershed in 1992. A plan to control nonpoint sources in the watershed was approved in 1995. Since its inception it is estimated that annual phosphorus loading from agricultural sources has been reduced by 1,492 lbs and sediment delivery by 2,460 tons through the installation of best management practices. The watershed project also provides cost-share incentives to lakefront property owners to restore shoreline habitat to protect water quality and improve fish and wildlife habitat on the lake. The priority watershed is slated to end in 2006.

There is also a relatively large body of water quality data for Lake Noquebay. During the last 23 years, the Wisconsin Department of Natural Resources, the University of Wisconsin and private consultants have all been involved in water quality sampling and analysis.

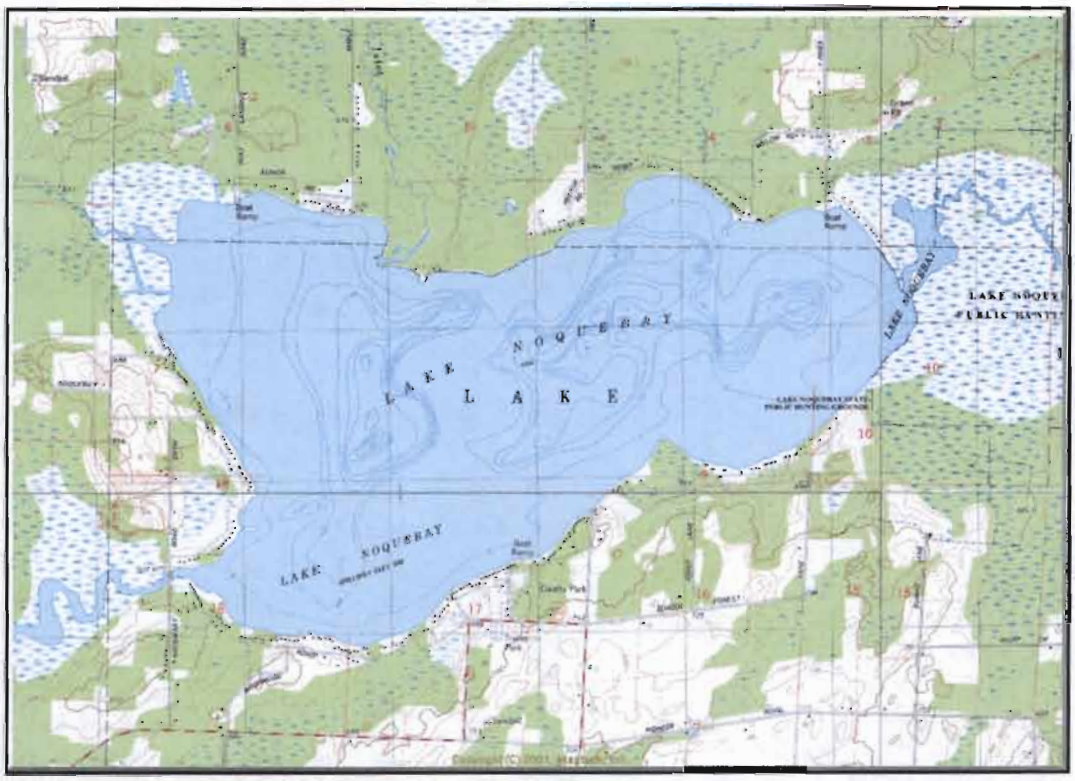


Figure 1. Map of project area.

Project Description The current lake management planning grant project was designed to; determine the current water quality conditions of Lake Noquebay and build upon the already substantial body of water quality data, to detect any changes or trends in water quality, and to evaluate the effects of the aquatic plant management program. In addition to the field work and analysis, an educational component of the planning grant called for the creation of a video in support of the ongoing priority watershed project and the long term harvesting program.

Water Quality Analysis

The water quality characterization program called for water quality monitoring in 1996, 1998, and 2000. The monitoring program closely follows the U.S. Geological Survey's water quality trend monitoring which was completed in 1994. The program also meets the requirements of the Wisconsin DNR ambient lakes water chemistry monitoring protocol. A complete listing of water quality results can be found in appendix A.

Lake Size and Depth Lake Noquebay is 2,406 acres in size. The lake has two main deep basins. The west basin has a maximum depth of 52 feet while the east basin has a maximum depth of 36 feet. Approximately 76 percent of the lake is less than 15 feet in depth (figure 1).

Temperature and Mixing Temperature and mixing are important since the frequency of mixing plays a role in dissolved oxygen concentration and internal nutrient cycling. Shallow lakes typically remain mixed throughout the year while deep lakes often stratify during the summer months. Summer stratification is a separation of the water into two distinct layers, a warmer top layer (epilimnion) and a much cooler bottom layer (hypolimnion). These two layers are separated by a transition zone (metalimnion) which anglers know as the thermocline. A difference in density prevents these two layers from mixing until fall when the surface temperature falls and equals the temperature of the hypolimnion.

Due to its relatively shallow depth and large fetch, Lake Noquebay remains fairly well mixed

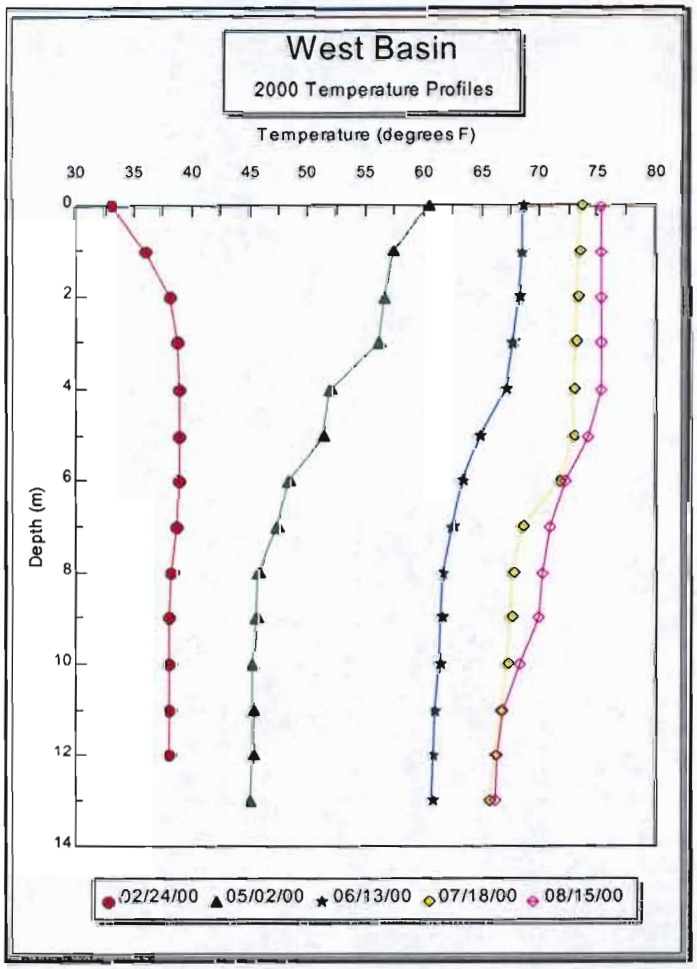


Figure 2. Lake Noquebay-west basin temperature profiles for 2000.

throughout the summer months. Prolonged sunny windless periods can lead to temporary stratification in the deep basins but this condition is localized. Figure 2 shows typical annual temperature profiles for Lake Noquebay.

Dissolved Oxygen (D.O.) Dissolved oxygen is vital for fish and most other aquatic life. When D.O. levels fall below 5 mg/l, sport fish species will not survive long. Few fish can tolerate D.O. levels below 2 mg/l. The amount of oxygen water can hold varies with temperature. Water at 33 degrees contains approximately 14.2 mg/l at saturation while water at 75 degrees is saturated at 8.4 mg/l.

Dissolved oxygen comes from two sources, oxygen exchange with the atmosphere and oxygen production by aquatic plants and algae. Oxygen exchange with the atmosphere only occurs at the lake's surface. Plants and algae are found only to the depth of light penetration. Since Lake Noquebay remains relatively well mixed throughout the summer, the entire water column remains well oxygenated. Monitoring shows that oxygen depletion is infrequent and limited to deep areas during periods of little mixing (figure 3).

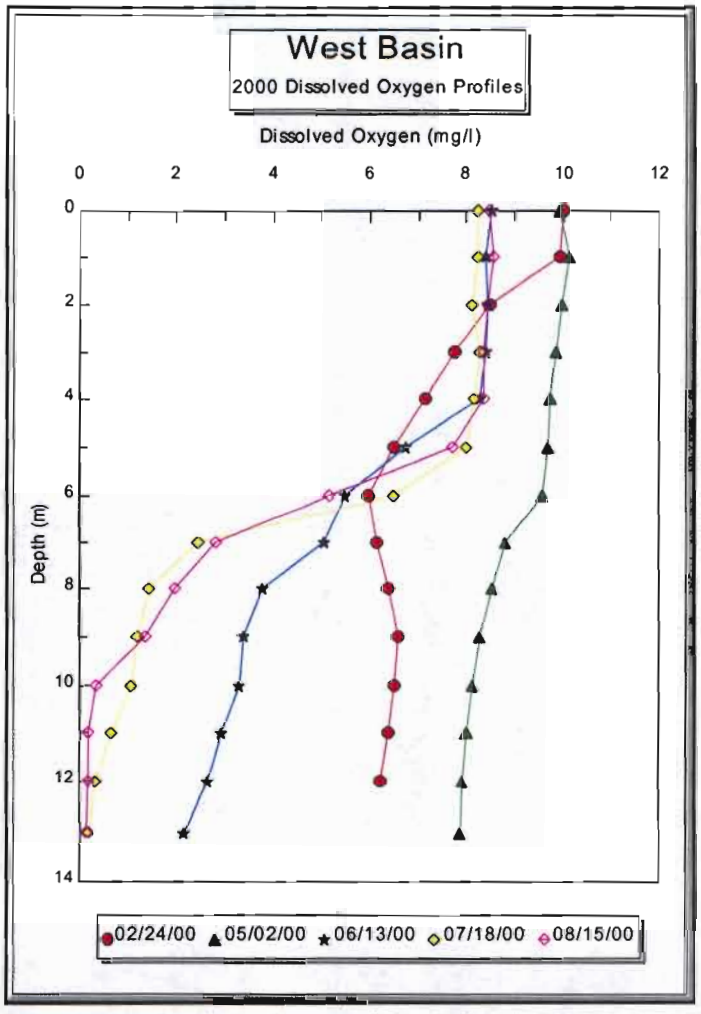


Figure 3. Lake Noquebay-west basin dissolved oxygen profiles.

Nutrient Levels Water samples were collected and analyzed for important lake nutrients including total phosphorus, dissolved phosphorus, nitrogen, ammonia, nitrates and nitrites.

In Lake Noquebay, as in most Wisconsin lakes, phosphorus is the nutrient which limits algae, and to a lesser degree, rooted aquatic plant growth. Phosphorus concentration can vary with the time of year, differing weather conditions, and many biological factors. Generally, surface phosphorus levels should be maintained below 20 ug/l at spring turnover to prevent nuisance algae blooms. The major source of phosphorus in most lakes is surface water runoff. All runoff will contain some phosphorus. However, it has been shown that the concentration of phosphorus in runoff from the typical lakefront development will be ten times greater than from the same area if it were forested.

The average surface total phosphorus concentration in Lake Noquebay during the 5 year sampling period was 15.4 ug/l in the west basin and 13.5 ug/l in the east basin. This level is below the average for similar lakes statewide, and should limit algae production.

Nitrogen is less important than phosphorus as a nutrient source since it is seldom the limiting nutrient and some types of algae are able to take nitrogen from the air when it is in short supply in the water. There has been some research which points to nitrogen in the lake sediment being important for rooted aquatic plant growth.

The average total nitrogen concentration in Lake Noquebay during the sample period was 540 ug/l. This level is average for lakes in

Wisconsin. The ratio of nitrogen to phosphorus (N:P ratio) in Lake Noquebay was 36:1 during the sampling period. Lakes with an N:P ratio greater than 10:1 are considered to be phosphorus limited.

Water Clarity Water clarity was measured with a Secchi disk. A Secchi disk is an 8 inch black and white disk which is lowered into the water until it disappears. This distance is the Secchi disk depth. Secchi disk depth is affected by naturally stained water, suspended sediment and algae growth.

Lake Noquebay has clear, slightly stained water. Secchi disk depth during the inventory period averaged 8.75 feet in 1996, 10.2 feet in 1998, and 10.8 feet in 2000. The average Secchi disk depth for the entire sampling period was 9.9 feet. Since 1993 a volunteer lake monitor has also been recording Secchi disk depths on Lake Noquebay. The volunteer monitoring data indicates a gradual improvement in the Secchi disk depth since 1993. Overall, the Secchi disk depth for Lake Noquebay is better than the statewide average for similar lakes and indicates limited algae production.

Chlorophyll-a Chlorophyll-a is a pigment found in all green plants. The amount of chlorophyll-a is used as an indicator of the amount of algae in the water. The average chlorophyll-a concentration for the sample period was 3.4 ug/l. This level is quite low and indicates limited production of planktonic (free floating) algae. This level is well below the statewide average.

Trophic State Secchi disk depth, phosphorus concentration and chlorophyll-a concentration are commonly used to calculate a lakes trophic state. Trophic state index (TSI) is a measure of the nutrient enrichment level of a lake. Oligotrophic lakes (**<40**) are nutrient poor, these lakes are unproductive and have very clear water. Eutrophic lakes (**>50**) have excessive nutrients. These lakes are very productive (able to grow lots of plants, fish and insects) and usually weedy, or support large algae blooms, or both. Mesotrophic lakes (**40-50**) have moderate nutrient levels and fall somewhere between the two extremes in aquatic plant and fish productivity.

Based on the measurements taken during the study period, Lake Noquebay can be classified as mesotrophic, or moderately nutrient rich (figure 4). Based on the Secchi disk and chlorophyll-a measurements, the lake is in the lower mesotrophic range. Trophic state indices based solely on the phosphorus level are typically in the upper mesotrophic range.

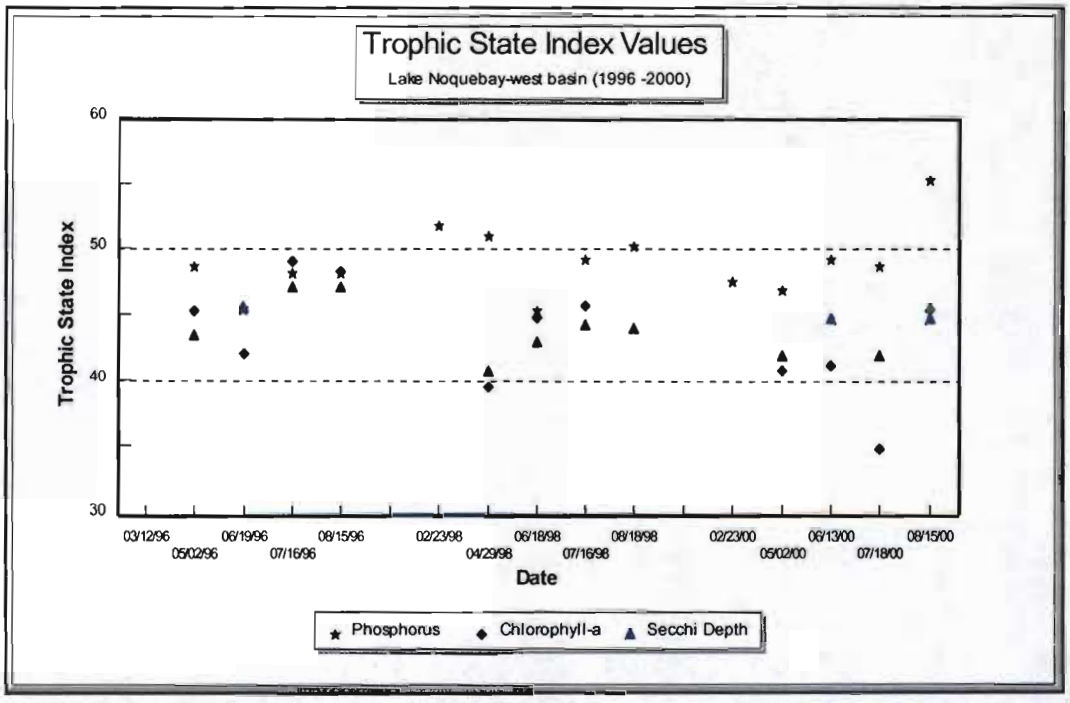


Figure 4. Trophic state values for Lake Noquebay.

Long Term Trends in Water Quality

Lakes are complicated and dynamic systems. Seasonal variation in many water quality parameters can often confuse the data and make the detection of trends difficult if not impossible. The identification of trends requires extensive water quality monitoring spread out over a long period of time. Fortunately, Lake Noquebay benefits from a relatively long history of water quality monitoring. Although the early data is somewhat sparse, since 1979 the data set is much more complete and should be reliable.

Trophic state values for Seccki disk, chlorophyll-a, and phosphorus were plotted for the period between 1979 and 2000. Secchi disk measurements for the period show a large amount of variability and no distinct trend in water clarity. Chlorophyll-a TSI values likewise show a lot of variability, but with a sharp drop in the TSI value in since 1996. The phosphorus TSI values show somewhat less variability and discernible upward trend between 1979 and 2000. The increase in phosphorus has not lead to a noticeable change in water clarity or algae production. This is due to the fact that Lake Noquebay is a macrophyte dominated system. Shallow lakes tend to be in one of two stable states. A Macrophyte dominated state where the lake is clear water and abundant rooted plants, or an algae dominated state where the lake is cloudy, green and has few rooted aquatic plants. Lakes in the clear & weedy state tend to remain in that condition until some environmental stressor causes a shift in the system. The stressor is often a severe weather event, invasion by exotic species, or some drastic management action. Nutrient levels alone can cause the shift to take place when levels reach some upper threshold. Once a shift has taken place it has proven very difficult to shift a lake back to the clear water state. Control of nutrient inputs is an important step in maintaining the lake in its present condition.

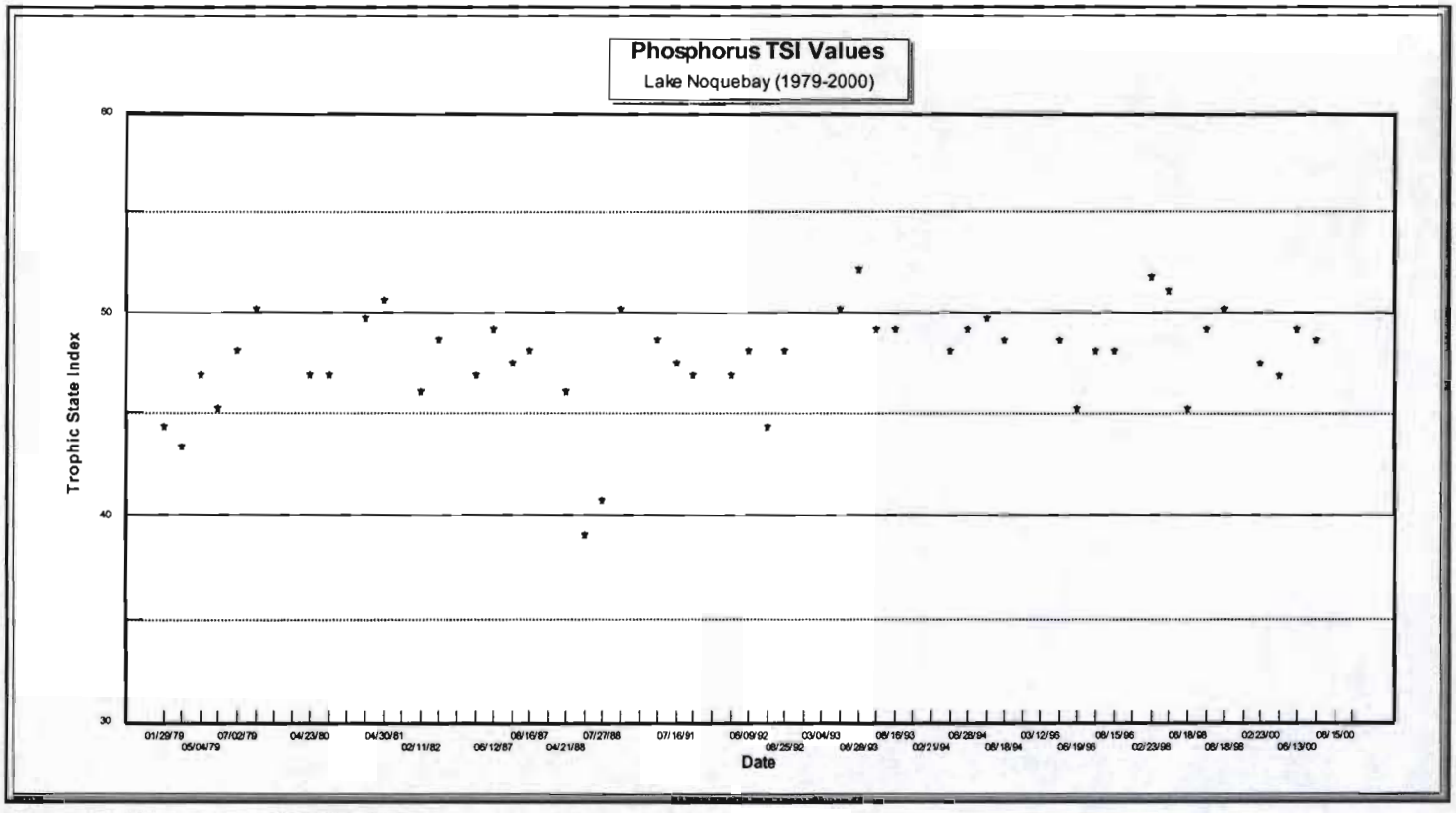


Figure 5. Phosphorus trophic state trend for Lake Noquebay.

Aquatic Plant Community

Lake Noquebay contains an abundant and diverse aquatic plant community. With a maximum depth of colonization of approximately 15 feet, 76% of the lake is capable of supporting aquatic macrophytes. The macrophyte community is currently dominated by variable-leaf water milfoil (*Myriophyllum heterophyllum*), bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), and Illinois pondweed (*Potamogeton illinoensis*).

Changes in the aquatic plant community of Lake Noquebay have been fairly well documented. Early aquatic plant surveys (1931, 1942, and 1968) provide species lists for the lake with relative abundance rankings. Distribution data is lacking for this time period. According to these early surveys, the aquatic plant community of Lake Noquebay was quite diverse with a wide variety of submersed pondweeds and floating leaf vegetation. Variable-leaf water milfoil was not identified in these early surveys.

Variable-leaf water milfoil was first identified in 1970. At that time it was limited to approximately 78 acres on the east and south shores of the lake. By 1971, the plant had spread to nearly 333 acres of the lake. Five years later (in 1976), variable-leaf milfoil could be found lake-wide and covered more than 1000 acres.

More recently, aquatic plant surveys were conducted in 1982, 1992. A third survey using the same methods was conducted as part of the grant in the summer of 2000 to determine the distribution and density of aquatic plants in the lake and the effect of harvesting on the aquatic plant population.

Figure 6 shows the frequency of occurrence for aquatic plants in Lake Noquebay during the

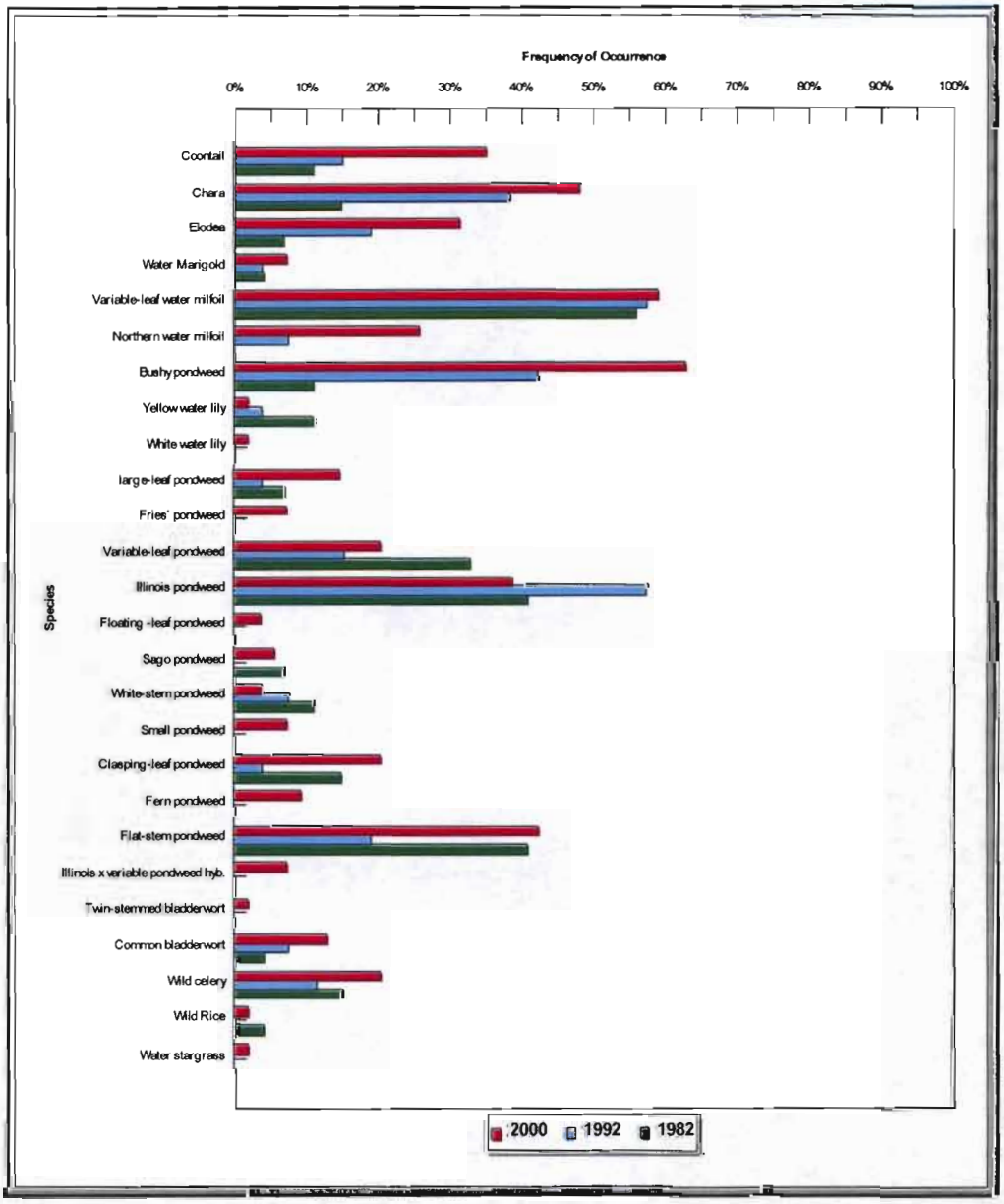


Figure 6. Frequency of occurrence for aquatic plants in Lake Noquebay.

most recent surveys. There were eight plants found in 2000 which were not identified during the preceding surveys, mostly smaller pondweeds and a hybrid between Illinois pondweed and variable-leaf pondweed. Also in the 2000 survey, coontail, chara (*Chara sp.*), elodea (*Elodea canadensis*), northern water milfoil (*Myriophyllum sibericum*), large-leaf pondweed (*Potamogeton amplifolius*), and bushy pondweed all increased significantly in frequency. Most of the pondweeds (*Potamogeton sp.*) decreased in frequency or remained relatively stable. Although the frequency of the most troublesome plant, variable-leaf water milfoil, did not change appreciably during the 17 year study period, the plant is less dense where found. A complete data set for the 2000 aquatic plant survey and a comparison to previous surveys can be found in appendix B.

Evaluation of the LNRD Aquatic Plant Harvesting Program

The Lake Noquebay Rehabilitation District (LNRD) was formed in 1975 to manage aquatic plants on Lake Noquebay. The management plan consisting of intensive harvesting, winter drawdown to dislodge plants in shallow water and spring harvesting of dislodged plant material. The LNRD currently operates two harvesters, each with a 10-foot cutting width and a five foot cutting depth. The harvesters operate five days a week from Memorial Day to Labor Day.

The current management strategy focuses on harvesting dense milfoil beds to open up the canopy. This practice has led to an improvement in species assemblage on the lake and reduced dominance by variable-leaf milfoil. The effectiveness of the current harvesting program is also evidenced by harvest records. These records show that during the first three years of the harvesting program almost 13 tons of aquatic plants were harvested per acre. Despite a maintenance of effort in acres harvested, the tonnage has dropped substantially. In the mid 80's, tonnage had fallen to 8.6 tons per acre. During the last five years of harvesting, only 5.7 tons of plants were harvested per acre. The reduced tonnage is due to changes in the aquatic plant community. Dense milfoil beds have been replaced with a better mix of pondweeds. Many of these plants are low growing and do not interfere with boating and other uses. Bushy pondweed has responded particularly well to the harvesting program. This low growing plant has expanded greatly in coverage and density since 1982.

Educational Video

An educational video has been produced which details the history of the LNRD's aquatic plant harvesting operation. The video also introduces the viewer to the aquatic plants of Lake Noquebay and stresses the importance of maintaining a healthy aquatic plant community.

Appendix A

Water Quality Monitoring Data

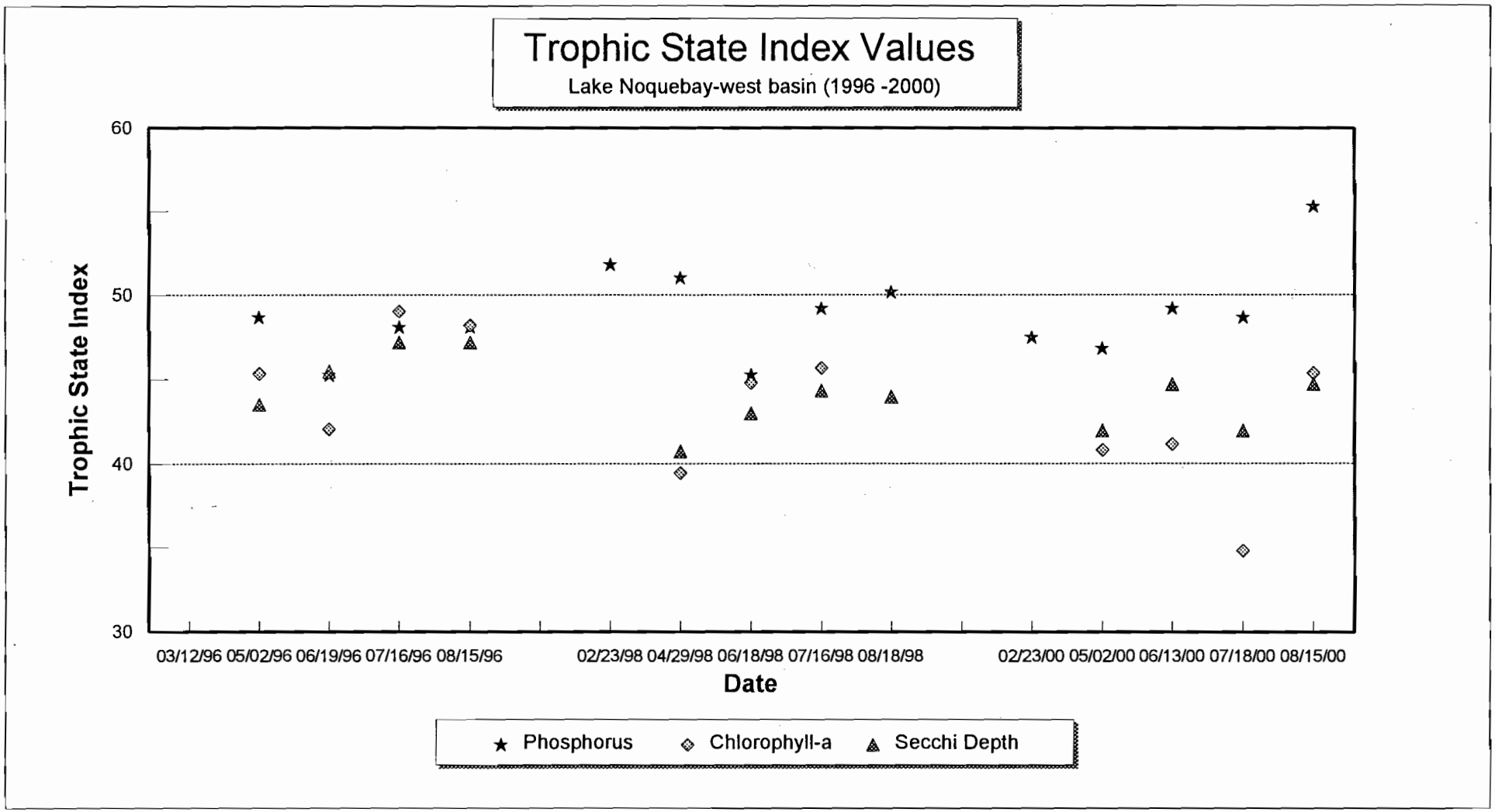
LAKE NOQUEBAY - West Basin
MARINETTE COUNTY, WI

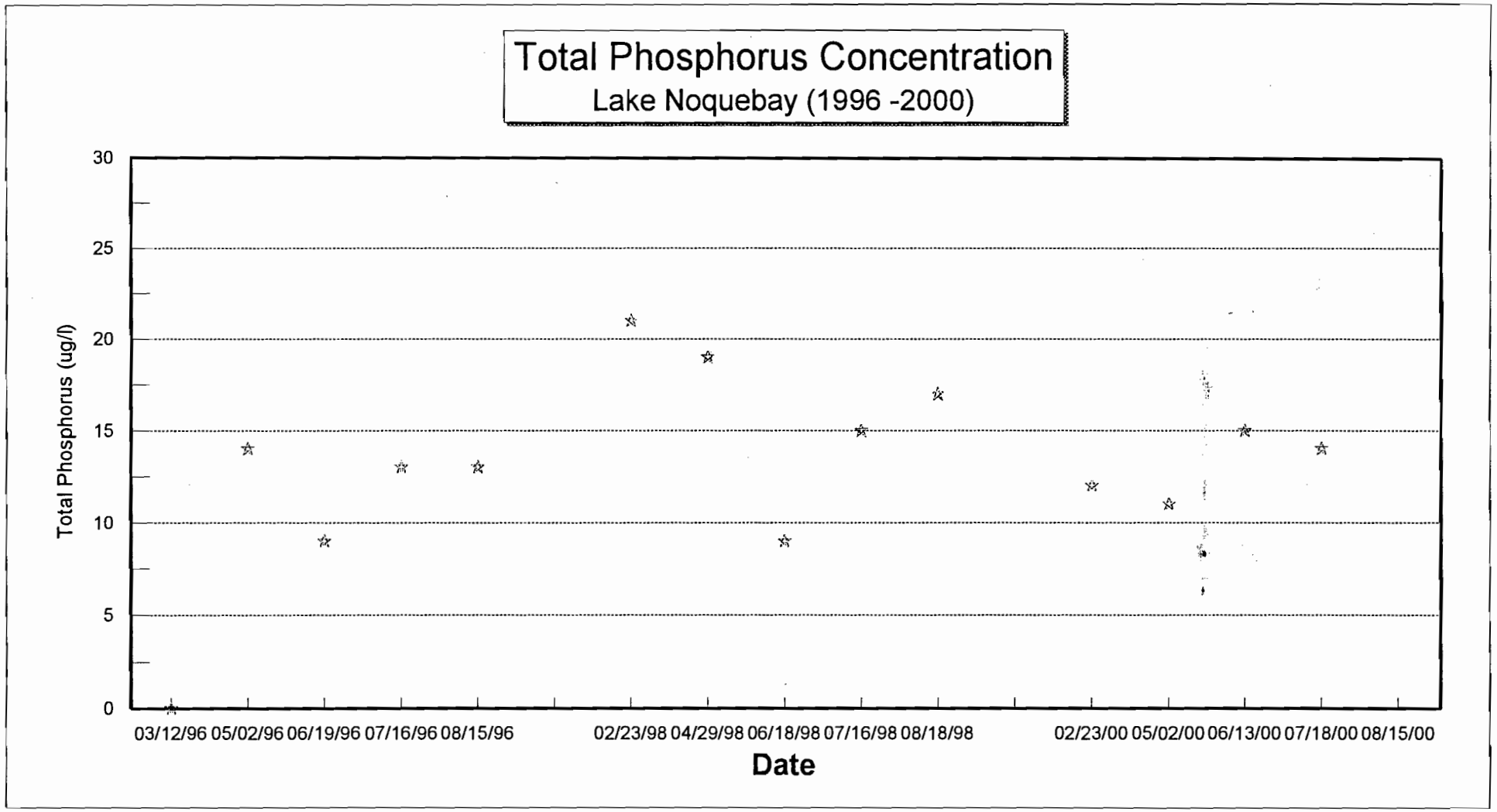
SURFACE WATER QUALITY SAMPLES

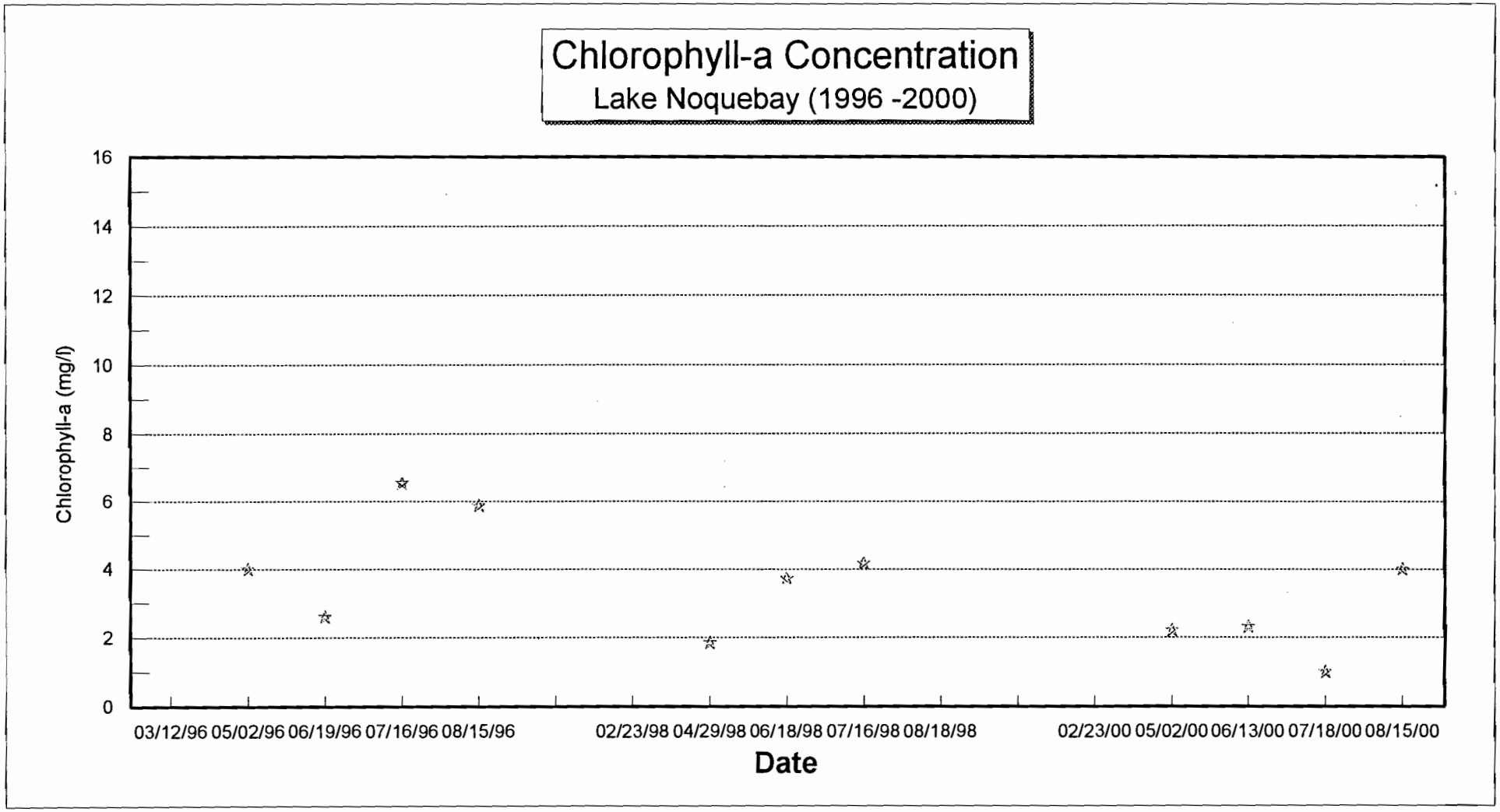
Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3 (ug/l)	NH3 (ug/l)	Chlor-a (UG/L)	Secchi (ft)	Phosporus TSI	Chlor-a TSI	Secchi TSI
03/12/96	ND	ND						ERR	ERR	ERR
05/02/96	14	ND	500	31	ND	4	10.3	48.6	45.3	43.5
06/19/96	9	ND				2.59	9	45.2	42.0	45.4
07/16/96	13	ND				6.53	8	48.1	49.0	47.1
08/15/96	13	ND				5.86	8	48.1	48.2	47.1
02/23/98	21	3						51.8	ERR	ERR
04/29/98	19	ND	380	71	ND	1.84	12.5	51.0	39.4	40.7
06/18/98	9	2				3.72	10.7	45.2	44.8	42.9
07/16/98	15	ND				4.17	9.75	49.2	45.6	44.3
08/18/98	17	ND					10	50.2	ERR	43.9
								ERR	ERR	ERR
02/23/00	12	ND						47.5	ERR	ERR
05/02/00	11	ND	590	22	19	2.2	11.5	46.8	40.8	41.9
06/13/00	15	ND	510	10	10	2.3	9.5	49.2	41.1	44.7
07/18/00	14	ND	560	ND	ND	1	11.5	48.6	34.8	41.9
08/15/00	33	ND	590	ND	ND	4	9.5	55.3	45.3	44.7
								ERR	ERR	ERR
								ERR	ERR	ERR

BOTTOM SAMPLES (0.5 m from bottom)

Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3 (ug/l)	NH3 (ug/l)
03/12/96	8	2			
05/02/96	12	ND	500	76	ND
06/19/96	13	4			
07/16/96	16	2			
08/15/96	27	10			
02/23/98	26	6			
04/29/98	22	ND	340	72	ND
06/18/98	17				
07/16/98	9	ND			
08/18/98	60	33			
02/23/00	13				
05/02/00	19	ND	580	70	36
06/13/00	22	ND	550	42	61
07/18/00	20	ND	580	73	85
08/15/00	29	8	730	ND	249


Trophic State Index Values
Lake Noquebay-west basin (1996 -2000)
Trophic State Index
60
50
40
30
03/12/96 05/02/96 06/19/96 07/16/96 08/15/96
02/23/98 04/29/98 06/18/98 07/16/98 08/18/98
02/23/00 05/02/00 06/13/00 07/18/00 08/15/00
Date
Phosphorus
Chlorophyll-a
Secchi Depth

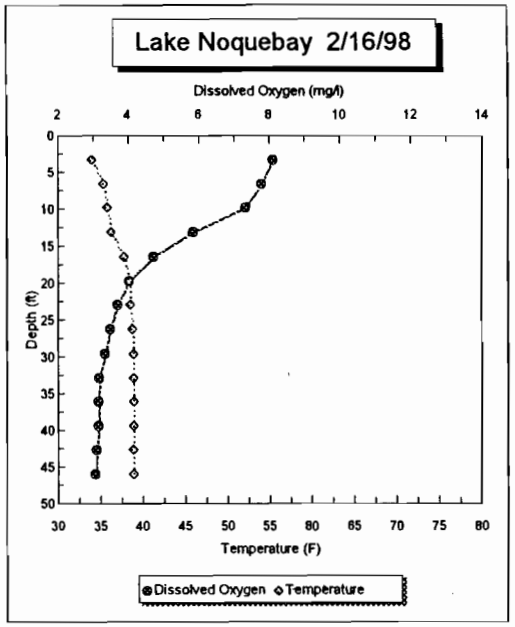

Total Phosphorus Concentration
Lake Noquebay (1996 -2000)
Total Phosphorus (ug/l)
30
25
20
15
10
5
0
03/12/96 05/02/96 06/19/96 07/16/96 08/15/96
02/23/98 04/29/98 06/18/98 07/16/98 08/18/98
02/23/00 05/02/00 06/13/00 07/18/00 08/15/00
Date


Chlorophyll-a Concentration
Lake Noquebay (1996 -2000)
Chlorophyll-a (mg/l)
16
14
12
10
8
6
4
2
0
03/12/96 05/02/96 06/19/96 07/16/96 08/15/96
02/23/98 04/29/98 06/18/98 07/16/98 08/18/98
02/23/00 05/02/00 06/13/00 07/18/00 08/15/00
Date

Hydrolab Monitoring Results

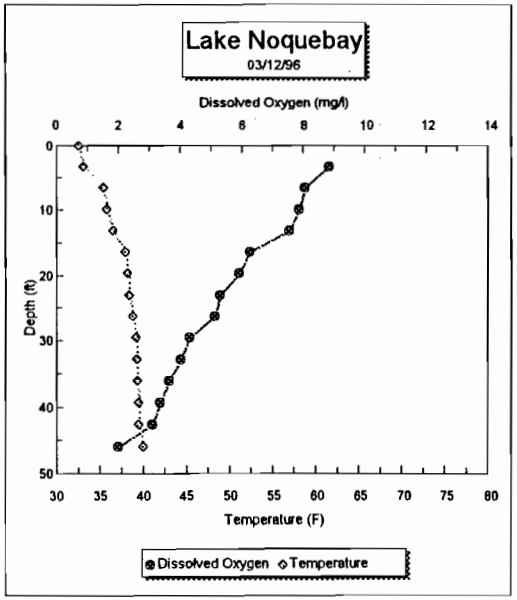
Lake Noquebay - West Basin
02/16/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0							
1.0	3.3	1.08	33.94	8.10	0.337	7.29	0.235	56.7
2.0	6.6	1.82	35.28	7.77	0.369	7.26	0.235	55.5
3.0	9.8	2.09	35.76	7.32	0.371	7.26	0.237	46.4
4.0	13.1	2.35	36.23	5.83	0.374	7.25	0.239	41.1
5.0	16.4	3.19	37.74	4.70	0.393	7.24	0.251	32.8
6.0	19.7	3.53	38.35	4.00	0.408	7.22	0.261	29.1
7.0	23.0	3.60	38.48	3.67	0.416	7.21	0.266	27.4
8.0	26.2	3.74	38.73	3.45	0.424	7.21	0.271	25.9
9.0	29.5	3.81	38.86	3.31	0.444	7.2	0.284	24.5
10.0	32.8	3.83	38.89	3.15	0.450	7.2	0.288	23.8
11.0	36.1	3.83	38.89	3.12	0.454	7.2	0.290	23.7
12.0	39.4	3.82	38.88	3.12	0.455	7.2	0.291	23.5
13.0	42.7	3.80	38.84	3.07	0.456	7.19	0.292	23.4
14.0	45.9	3.81	38.86	3.03	0.458	7.19	0.293	22.8



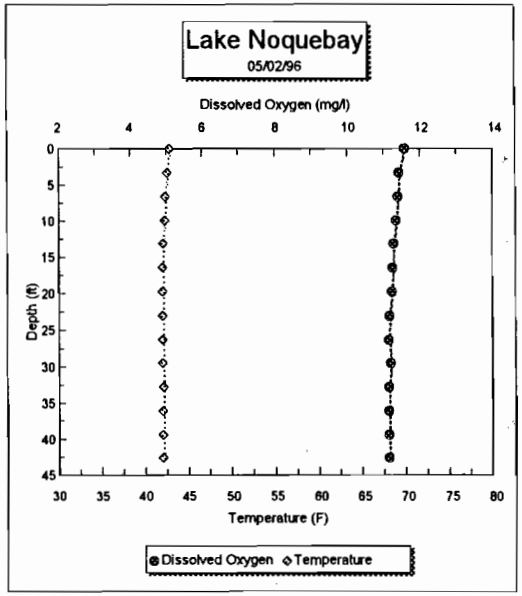
Lake Noquebay - West Basin
03/12/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	0.27	32.49					
1.0	3.3	0.56	33.01	8.84	0.378	7.4	0.243	61.1
2.0	6.6	1.85	35.33	8.04	0.387	7.33	0.247	56.9
3.0	9.8	2.08	35.74	7.85	0.391	7.32	0.250	56.2
4.0	13.1	2.49	36.48	7.54	0.410	7.32	0.263	54.3
5.0	16.4	3.27	37.89	6.26	0.420	7.32	0.269	46.7
6.0	19.7	3.43	38.17	5.90	0.424	7.3	0.271	43.8
7.0	23.0	3.52	38.34	5.27	0.428	7.27	0.274	42.8
8.0	26.2	3.74	38.73	5.10	0.446	7.24	0.285	35.2
9.0	29.5	3.96	39.13	4.29	0.459	7.24	0.294	31.7
10.0	32.8	4.01	39.22	4.00	0.462	7.24	0.296	30.0
11.0	36.1	4.06	39.31	3.63	0.463	7.23	0.296	27.4
12.0	39.4	4.15	39.47	3.33	0.464	7.23	0.296	24.7
13.0	42.7	4.15	39.47	3.09	0.464	7.23	0.297	23.8
14.0	45.9	4.43	39.97	1.97	0.469	7.24	0.300	14.6



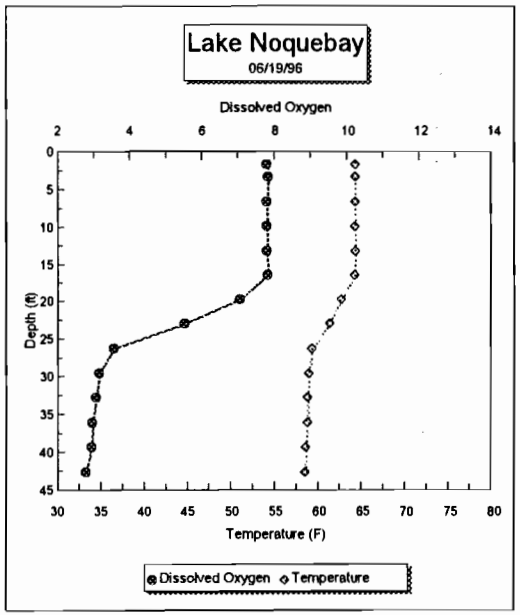
Lake Noquebay - West Basin
05/02/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	6.03	42.85	11.58	0.196	7.75	0.125	93.0
1.0	3.3	5.88	42.58	11.42	0.195	7.7	0.125	91.5
2.0	6.6	5.75	42.35	11.38	0.196	7.68	0.125	90.9
3.0	9.8	5.72	42.30	11.34	0.195	7.66	0.125	90.4
4.0	13.1	5.61	42.10	11.26	0.195	7.64	0.125	89.3
5.0	16.4	5.57	42.03	11.22	0.196	7.63	0.125	89.5
6.0	19.7	5.56	42.01	11.21	0.195	7.62	0.125	89.1
7.0	23.0	5.57	42.03	11.14	0.195	7.61	0.125	88.5
8.0	26.2	5.55	41.99	11.13	0.195	7.61	0.125	88.5
9.0	29.5	5.55	41.99	11.17	0.195	7.61	0.125	88.8
10.0	32.8	5.59	42.06	11.12	0.195	7.61	0.125	88.4
11.0	36.1	5.57	42.03	11.12	0.195	7.6	0.125	88.3
12.0	39.4	5.57	42.03	11.12	0.195	7.6	0.125	88.5
13.0	42.7	5.54	41.97	11.13	0.195	7.6	0.125	88.7



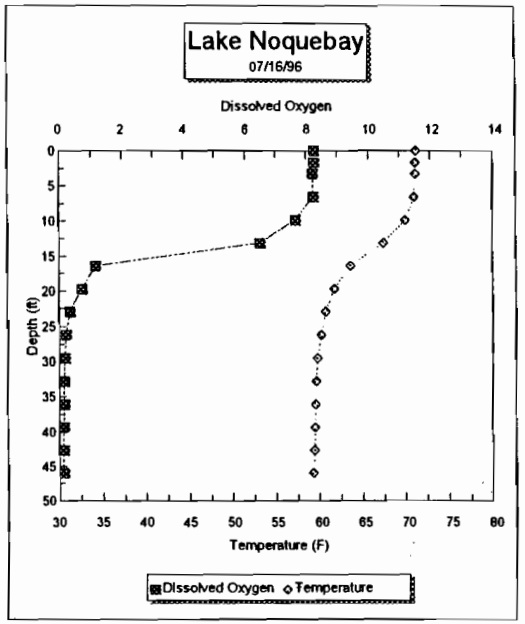
Lake Noquebay - West Basin
06/19/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0							
0.5	1.6	17.97	64.35	7.78	0.226	8.14	0.145	82.5
1.0	3.3	17.97	64.35	7.82	0.226	8.14	0.144	82.5
2.0	6.6	17.96	64.33	7.79	0.226	8.13	0.144	82.4
3.0	9.8	17.96	64.33	7.78	0.226	8.12	0.144	82.2
4.0	13.1	17.96	64.33	7.78	0.226	8.11	0.145	82.1
5.0	16.4	17.91	64.24	7.80	0.227	8.1	0.145	82.4
6.0	19.7	17.04	62.67	7.05	0.224	7.89	0.143	71.7
7.0	23.0	16.32	61.38	5.52	0.231	7.66	0.148	56.8
8.0	26.2	15.15	59.27	3.55	0.238	7.48	0.152	33.7
9.0	29.5	14.94	58.89	3.14	0.239	7.46	0.153	30.9
10.0	32.8	14.87	58.77	3.05	0.239	7.46	0.153	29.9
11.0	36.1	14.87	58.77	2.94	0.239	7.47	0.153	29.0
12.0	39.4	14.75	58.55	2.93	0.239	7.47	0.153	28.6
13.0	42.7	14.71	58.48	2.78	0.240	7.47	0.153	27.2



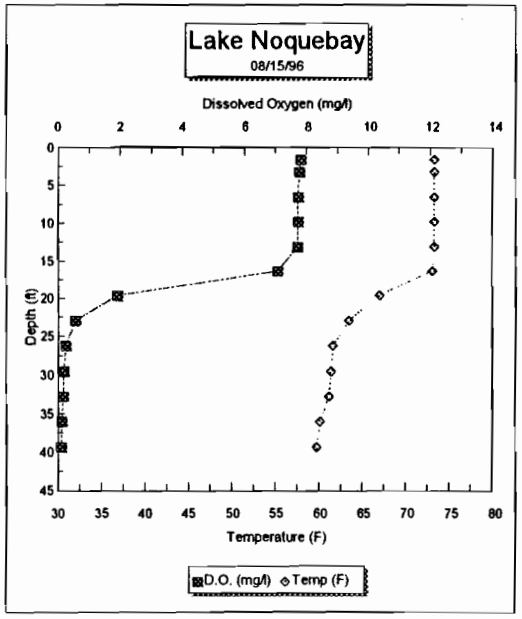
Lake Noquebay - West Basin
07/16/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	21.78	71.20	8.25	0.247	8.69	0.158	94.3
0.5	1.6	21.76	71.17	8.24	0.247	8.69	0.158	94.0
1.0	3.3	21.77	71.19	8.20	0.248	8.7	0.158	93.8
2.0	6.6	21.68	71.02	8.23	0.247	8.69	0.158	93.2
3.0	9.8	21.10	69.98	7.64	0.248	8.63	0.158	86.9
4.0	13.1	19.70	67.46	6.48	0.261	8.22	0.168	67.1
5.0	16.4	17.56	63.61	1.16	0.248	7.59	0.161	12.8
6.0	19.7	16.54	61.77	0.71	0.247	7.52	0.158	6.3
7.0	23.0	15.95	60.71	0.33	0.248	7.5	0.159	3.1
8.0	26.2	15.66	60.19	0.21	0.248	7.5	0.159	2.0
9.0	29.5	15.41	59.74	0.16	0.249	7.51	0.159	1.6
10.0	32.8	15.34	59.61	0.14	0.250	7.51	0.160	1.4
11.0	36.1	15.30	59.54	0.14	0.250	7.51	0.160	1.2
12.0	39.4	15.27	59.49	0.12	0.250	7.51	0.160	1.2
13.0	42.7	15.20	59.36	0.11	0.25	7.52	0.160	1.1
14.0	45.9	15.13	59.23	0.11	0.25	7.53	0.161	1.1



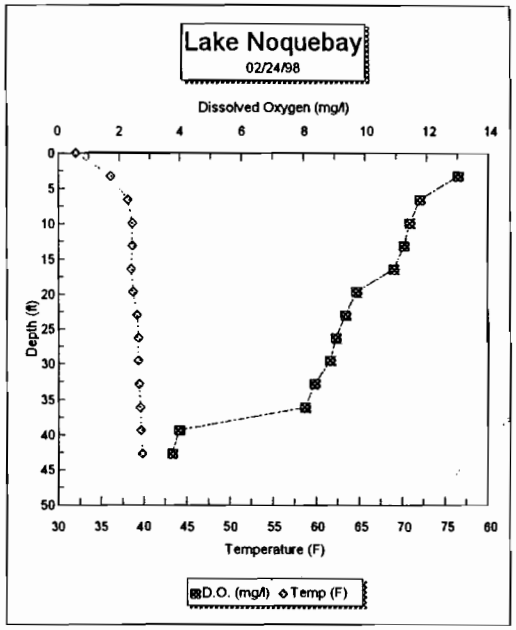
Lake Noquebay - West Basin
08/15/96

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0							
0.5	1.6	22.95	73.31	7.80	0.261	9.04	0.167	90.4
1.0	3.3	22.94	73.29	7.76	0.262	9.05	0.168	90.3
2.0	6.6	22.95	73.31	7.73	0.262	9.05	0.168	90.1
3.0	9.8	22.96	73.33	7.72	0.262	9.05	0.168	90.1
4.0	13.1	22.95	73.31	7.71	0.262	9.05	0.168	90.3
5.0	16.4	22.85	73.13	7.06	0.263	9	0.169	84.0
6.0	19.7	19.44	66.99	1.90	0.270	7.93	0.173	19.3
7.0	23.0	17.45	63.41	0.55	0.264	7.8	0.169	3.4
8.0	26.2	16.44	61.59	0.23	0.266	7.81	0.170	2.1
9.0	29.5	16.32	61.38	0.17	0.266	7.82	0.170	1.6
10.0	32.8	16.18	61.12	0.15	0.266	7.83	0.170	1.4
11.0	36.1	15.59	60.06	0.12	0.269	7.88	0.172	1.1
12.0	39.4	15.39	59.70	0.09	0.270	7.9	0.173	0.9
13.0	42.7							



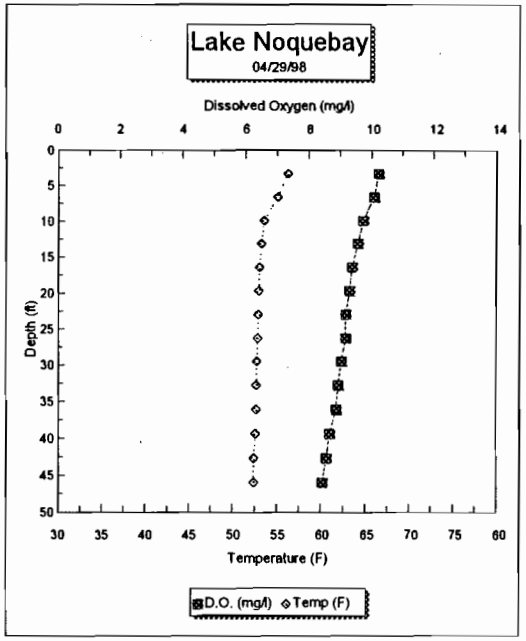
Lake Noquebay - West Basin
02/24/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0		32.00					
1.0	3.3	2.30	36.14	13.02	0.307	7.14	0.196	94.7
2.0	6.6	3.40	38.12	11.78	0.317	7.09	0.201	89.0
3.0	9.8	3.71	38.68	11.43	0.328	7.03	0.210	86.8
4.0	13.1	3.71	38.68	11.24	0.339	6.98	0.217	84.3
5.0	16.4	3.62	38.52	10.92	0.347	6.95	0.222	82.7
6.0	19.7	3.72	38.70	9.69	0.354	6.92	0.226	72.5
7.0	23.0	4.00	39.20	9.35	0.357	6.86	0.228	71.0
8.0	26.2	4.08	39.34	9.04	0.362	6.83	0.232	68.6
9.0	29.5	4.09	39.36	8.84	0.364	6.81	0.233	67.3
10.0	32.8	4.12	39.42	8.33	0.366	6.79	0.234	63.1
11.0	36.1	4.21	39.58	8.03	0.371	6.77	0.238	61.7
12.0	39.4	4.25	39.65	3.94	0.374	6.78	0.239	29.7
13.0	42.7	4.32	39.78	3.71	0.376	6.77	0.241	28.5
14.0	45.9							



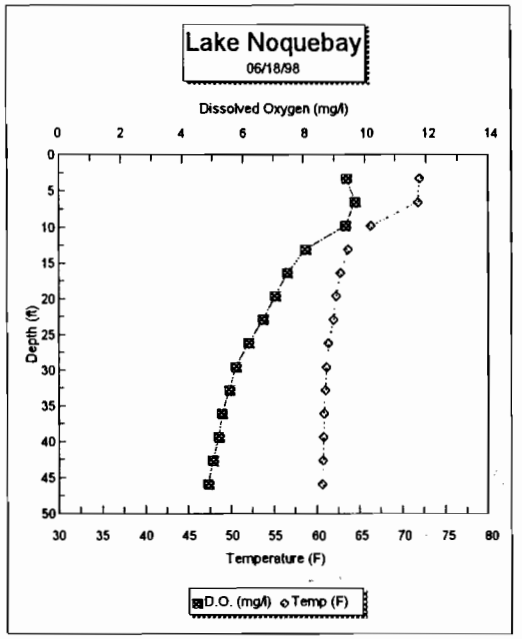
Lake Noquebay - West Basin
04/29/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0							
1.0	3.3	13.44	56.19	10.22	0.378	7.4	0.243	61.1
2.0	6.6	12.79	55.02	10.06	0.387	7.33	0.247	56.9
3.0	9.8	11.92	53.46	9.72	0.391	7.32	0.250	56.2
4.0	13.1	11.77	53.19	9.55	0.410	7.32	0.263	54.3
5.0	16.4	11.66	52.99	9.37	0.420	7.32	0.269	46.7
6.0	19.7	11.59	52.86	9.29	0.424	7.3	0.271	43.8
7.0	23.0	11.57	52.83	9.16	0.428	7.27	0.274	42.8
8.0	26.2	11.52	52.74	9.16	0.446	7.24	0.285	35.2
9.0	29.5	11.49	52.68	9.02	0.459	7.24	0.294	31.7
10.0	32.8	11.44	52.59	8.92	0.462	7.24	0.296	30.0
11.0	36.1	11.43	52.57	8.87	0.463	7.23	0.296	27.4
12.0	39.4	11.39	52.50	8.65	0.464	7.23	0.296	24.7
13.0	42.7	11.33	52.39	8.55	0.464	7.23	0.297	23.8
14.0	45.9	11.31	52.36	8.44	0.469	7.24	0.300	14.6



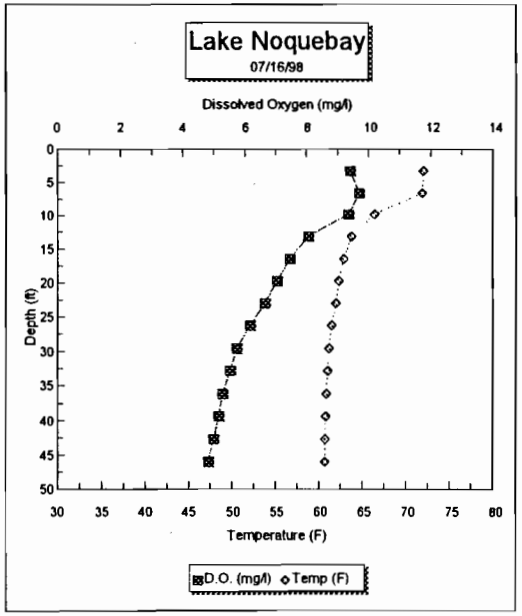
Lake Noquebay - West Basin
06/18/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	22.23						
1.0	3.3	22.22	72.00	9.40	0.292	8.84	0.187	108.0
2.0	6.6	22.14	71.85	9.68	0.293	8.84	0.187	110.5
3.0	9.8	19.10	66.38	9.35	0.297	8.65	0.191	106.5
4.0	13.1	17.63	63.73	8.05	0.299	8.39	0.192	83.0
5.0	16.4	17.12	62.82	7.45	0.300	8.35	0.192	78.0
6.0	19.7	16.82	62.28	7.04	0.300	8.30	0.192	72.4
7.0	23.0	16.64	61.95	6.65	0.300	8.22	0.192	67.9
8.0	26.2	16.34	61.41	6.17	0.300	8.16	0.192	62.5
9.0	29.5	16.20	61.16	5.74	0.301	8.11	0.193	56.8
10.0	32.8	16.12	61.02	5.54	0.302	8.06	0.194	53.3
11.0	36.1	16.02	60.84	5.29	0.303	8.03	0.194	52.6
12.0	39.4	15.99	60.78	5.17	0.303	8.03	0.194	51.9
13.0	42.7	15.95	60.71	5.00	0.304	8.02	0.195	49.8
14.0	45.9	15.91	60.64	4.84	0.305	8.00		



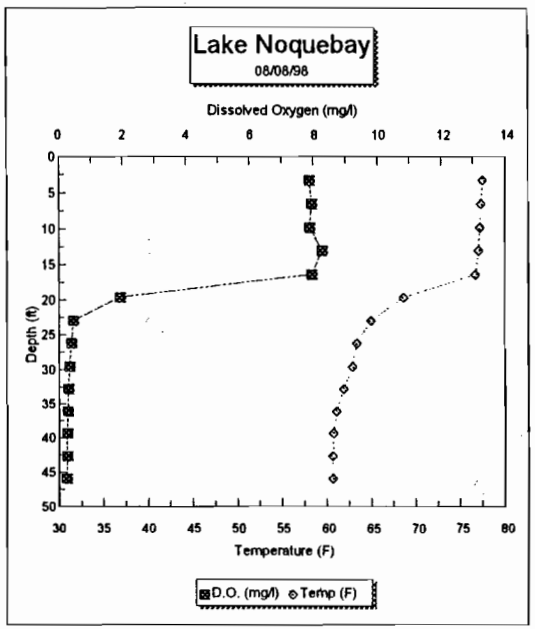
Lake Noquebay - West Basin
07/16/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	25.37						
1.0	3.3	25.25	77.45	7.87	0.294	9.00	0.188	96.7
2.0	6.6	25.19	77.34	7.92	0.294	9.01	0.188	94.1
3.0	9.8	25.12	77.22	7.87	0.294	9.02	0.188	95.2
4.0	13.1	25.04	77.07	8.26	0.294	9.02	0.188	100.3
5.0	16.4	24.83	76.69	7.93	0.295	8.99	0.188	95.2
6.0	19.7	20.34	68.61	1.92	0.309	7.96	0.197	16.4
7.0	23.0	18.29	64.92	0.45	0.310	7.71	0.198	4.5
8.0	26.2	17.43	63.37	0.38	0.312	7.72	0.199	3.9
9.0	29.5	17.12	62.82	0.32	0.312	7.72	0.200	3.2
10.0	32.8	16.58	61.84	0.28	0.313	7.72	0.200	2.8
11.0	36.1	16.16	61.09	0.26	0.315	7.74	0.202	2.7
12.0	39.4	15.96	60.73	0.25	0.317	7.76	0.203	2.6
13.0	42.7	15.92	60.66	0.24	0.318	7.77	0.203	2.4
14.0	45.9	15.9	60.62	0.22	0.318	7.77	0.203	2.2



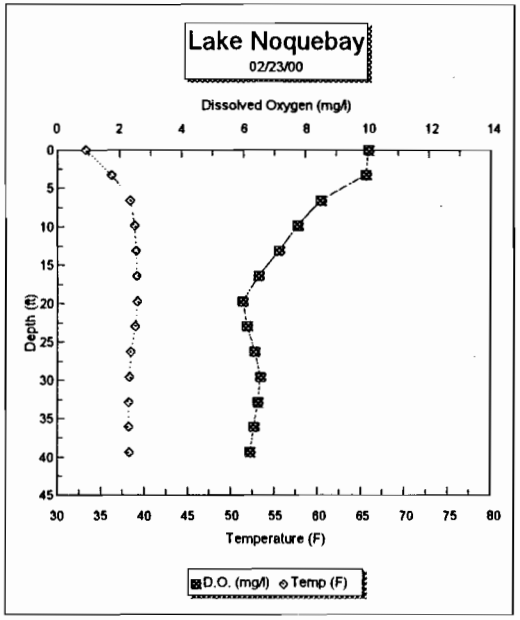
Lake Noquebay - West Basin
08/08/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	22.62	72.72	7.56	0.287	8.97	0.184	88.4
1.0	3.3	22.63	72.73	7.78	0.287	8.98	0.183	90.4
2.0	6.6	22.64	72.75	7.64	0.287	8.99	0.183	88.7
3.0	9.8	22.52	72.54	7.50	0.287	9.00	0.183	86.8
4.0	13.1	22.50	72.50	7.39	0.287	9.00	0.184	85.4
5.0	16.4	22.49	72.48	7.45	0.287	9.00	0.183	86.4
6.0	19.7	22.29	72.12	7.92	0.285	9.11	0.182	91.7
7.0	23.0	22.07	71.73	7.35	0.283	9.02	0.181	84.4
8.0	26.2	22.08	71.74	8.00	0.282	9.04	0.181	93.4
9.0	29.5	21.72	71.10	7.03	0.284	8.97	0.182	80.2
10.0	32.8	21.63	70.93	6.95	0.284	8.98	0.182	78.7
11.0	36.1	21.22	70.20	6.02	0.287	8.91	0.182	73.0
12.0	39.4	16.08	60.94	2.32	0.338	8.16	0.216	22.2
13.0	42.7	15.75	60.35	1.83	0.340	8.16	0.217	18.1
14.0	45.9	15.60	60.08	1.65	0.34	8.17	0.218	15.7



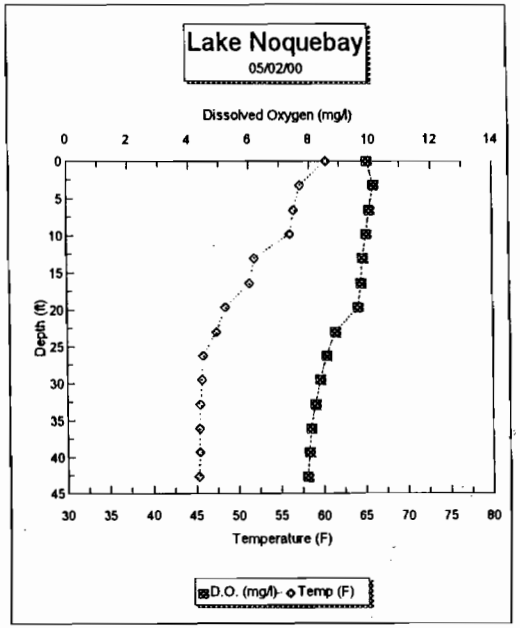
Lake Noquebay - West Basin
02/23/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.00	0.70	33.26	10.03	339	7.62	0.218	71.0
1.0	3.28	2.33	36.19	9.94	337	7.61	0.215	75.4
2.0	6.56	3.51	38.32	8.49	346	7.55	0.221	64.1
3.0	9.84	3.81	38.86	7.75	360	7.51	0.231	60.0
4.0	13.12	3.89	39.00	7.15	366	7.48	0.235	55.6
5.0	16.41	3.95	39.11	6.49	378	7.44	0.237	50.2
6.0	19.69	3.96	39.13	5.97	378	7.41	0.242	46.4
7.0	22.97	3.87	38.97	6.11	389	7.40	0.249	46.7
8.0	26.25	3.58	38.44	6.36	408	7.39	0.261	49.8
9.0	29.53	3.47	38.25	6.55	412	7.38	0.264	50.5
10.0	32.81	3.44	38.19	6.47	415	7.38	0.265	49.7
11.0	36.09	3.43	38.17	6.35	417	7.37	0.266	48.7
12.0	39.37	3.47	38.25	6.22	417	7.37	0.267	47.7
13.0	42.65							



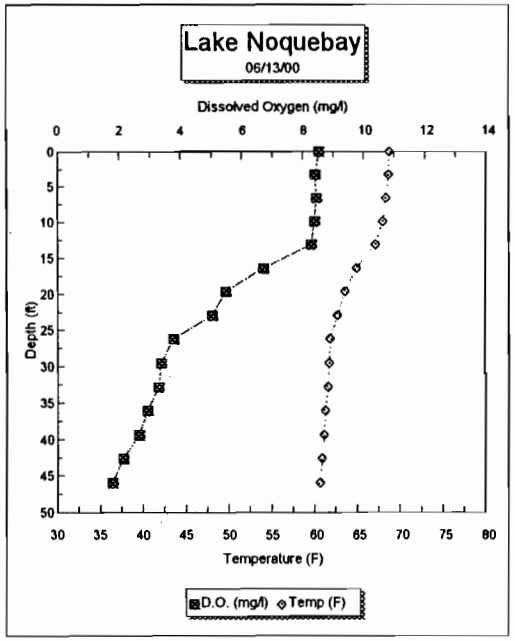
Lake Noquebay - West Basin
05/02/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	15.86	60.55	9.92	295	8.68	0.189	102.3
1.0	3.3	14.13	57.43	10.12	295	8.68	0.188	10.4
2.0	6.6	13.73	56.71	9.98	294	8.65	0.188	97.8
3.0	9.8	13.46	56.23	9.87	295	8.63	0.188	96.4
4.0	13.1	11.13	52.03	9.75	296	8.42	0.189	90.4
5.0	16.4	10.75	51.35	9.67	295	8.36	0.189	89.1
6.0	19.7	9.17	48.51	9.58	295	8.27	0.189	84.6
7.0	23.0	8.60	47.48	8.80	295	8.15	0.188	76.0
8.0	26.2	7.71	45.88	8.52	295	8.08	0.188	72.5
9.0	29.5	7.60	45.68	8.29	294	8.05	0.189	70.5
10.0	32.8	7.49	45.48	8.12	294	8.02	0.188	69.0
11.0	36.1	7.45	45.41	7.98	294	8.01	0.188	67.6
12.0	39.4	7.44	45.39	7.91	294	8.01	0.188	67.2
13.0	42.7	7.39	45.30	7.85	294	8.00	0.188	66.5



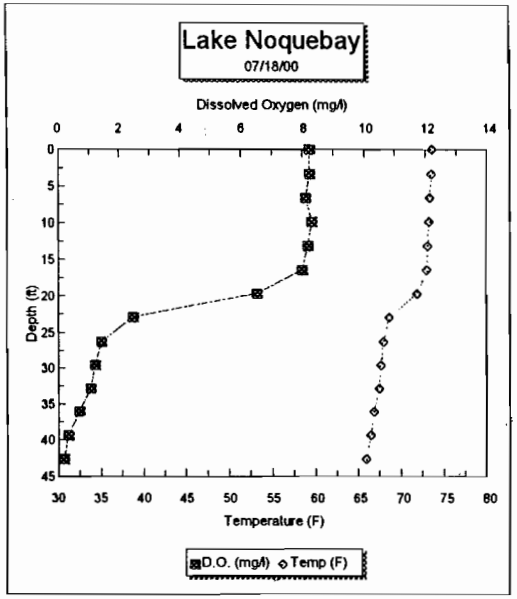
Lake Noquebay - West Basin
06/13/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	20.39	68.70	8.53	302	8.62	0.193	95.6
1.0	3.3	20.33	68.60	8.40	302	8.64	0.193	94.2
2.0	6.6	20.17	68.30	8.44	302	8.65	0.193	93.7
3.0	9.8	19.94	67.90	8.38	302	8.65	0.193	93.1
4.0	13.1	19.50	67.10	8.27	300	8.63	0.192	90.7
5.0	16.4	18.28	64.90	6.72	307	8.22	0.196	71.2
6.0	19.7	17.50	63.50	5.46	309	8.01	0.198	57.3
7.0	23.0	17.00	62.60	5.02	309	7.93	0.198	51.8
8.0	26.2	16.56	61.80	3.76	311	7.78	0.199	38.7
9.0	29.5	16.44	61.60	3.37	311	7.74	0.199	34.6
10.0	32.8	16.39	61.50	3.29	311	7.74	0.199	34.1
11.0	36.1	16.22	61.20	2.92	312	7.71	0.200	30.0
12.0	39.4	16.11	61.00	2.64	314	7.69	0.201	26.3
13.0	42.7	16.00	60.80	2.15	315	7.68	0.201	23.5
14.0	45.9	15.89	60.60	1.8	319	7.66	0.203	18.3



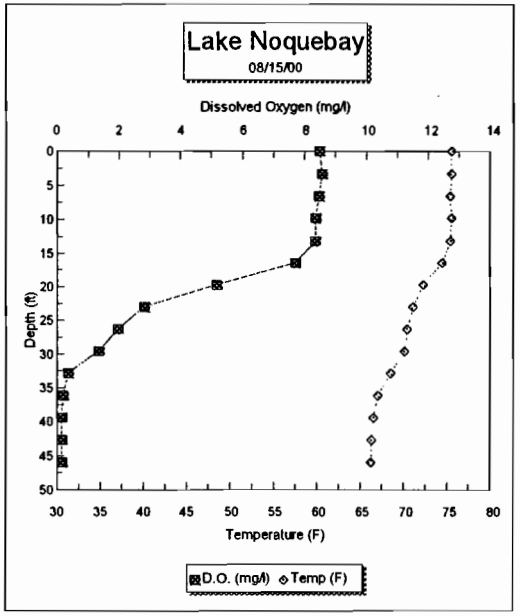
Lake Noquebay - West Basin
07/18/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	23.11	73.60	8.21	297	8.94	0.190	96.7
1.0	3.3	23.06	73.50	8.23	297	8.94	0.190	96.0
2.0	6.6	22.94	73.30	8.10	297	8.92	0.190	94.5
3.0	9.8	22.89	73.20	8.28	297	8.92	0.190	96.6
4.0	13.1	22.83	73.10	8.15	297	8.92	0.190	93.7
5.0	16.4	22.78	73.00	7.98	297	8.91	0.190	93.4
6.0	19.7	22.17	71.90	6.49	302	8.74	0.194	73.0
7.0	23.0	20.33	68.60	2.45	310	7.97	0.198	27.0
8.0	26.2	19.94	67.90	1.41	312	7.87	0.200	15.9
9.0	29.5	19.78	67.60	1.20	312	7.85	0.200	13.1
10.0	32.8	19.67	67.40	1.05	313	7.83	0.200	11.5
11.0	36.1	19.33	66.80	0.67	315	7.81	0.201	7.1
12.0	39.4	19.11	66.40	0.32	316	7.80	0.202	3.5
13.0	42.7	18.83	65.90	0.16	322	7.83	0.206	1.6



Lake Noquebay - West Basin
08/15/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	24.17	75.50	8.48	288	9.09	0.184	102.4
1.0	3.3	24.17	75.50	8.56	289	9.08	0.184	102.6
2.0	6.6	24.11	75.40	8.45	289	9.09	0.184	100.4
3.0	9.8	24.17	75.50	8.36	289	9.08	0.184	100.3
4.0	13.1	24.11	75.40	8.34	288	9.08	0.184	99.6
5.0	16.4	23.56	74.40	7.69	290	9.02	0.185	91.3
6.0	19.7	22.39	72.30	5.15	298	8.61	0.191	60.3
7.0	23.0	21.72	71.10	2.81	304	8.26	0.195	31.3
8.0	26.2	21.33	70.40	1.96	306	8.15	0.196	22.1
9.0	29.5	21.17	70.10	1.35	308	8.11	0.197	15.5
10.0	32.8	20.28	68.50	0.35	312	8.05	0.210	3.9
11.0	36.1	19.44	67.00	0.18	320	8.07	0.205	1.8
12.0	39.4	19.17	66.50	0.15	323	8.10	0.207	1.6
13.0	42.7	19.06	66.30	0.14	324	8.11	0.207	1.5
14.0	45.9	19.00	66.20	0.14	325	8.12	0.208	1.4

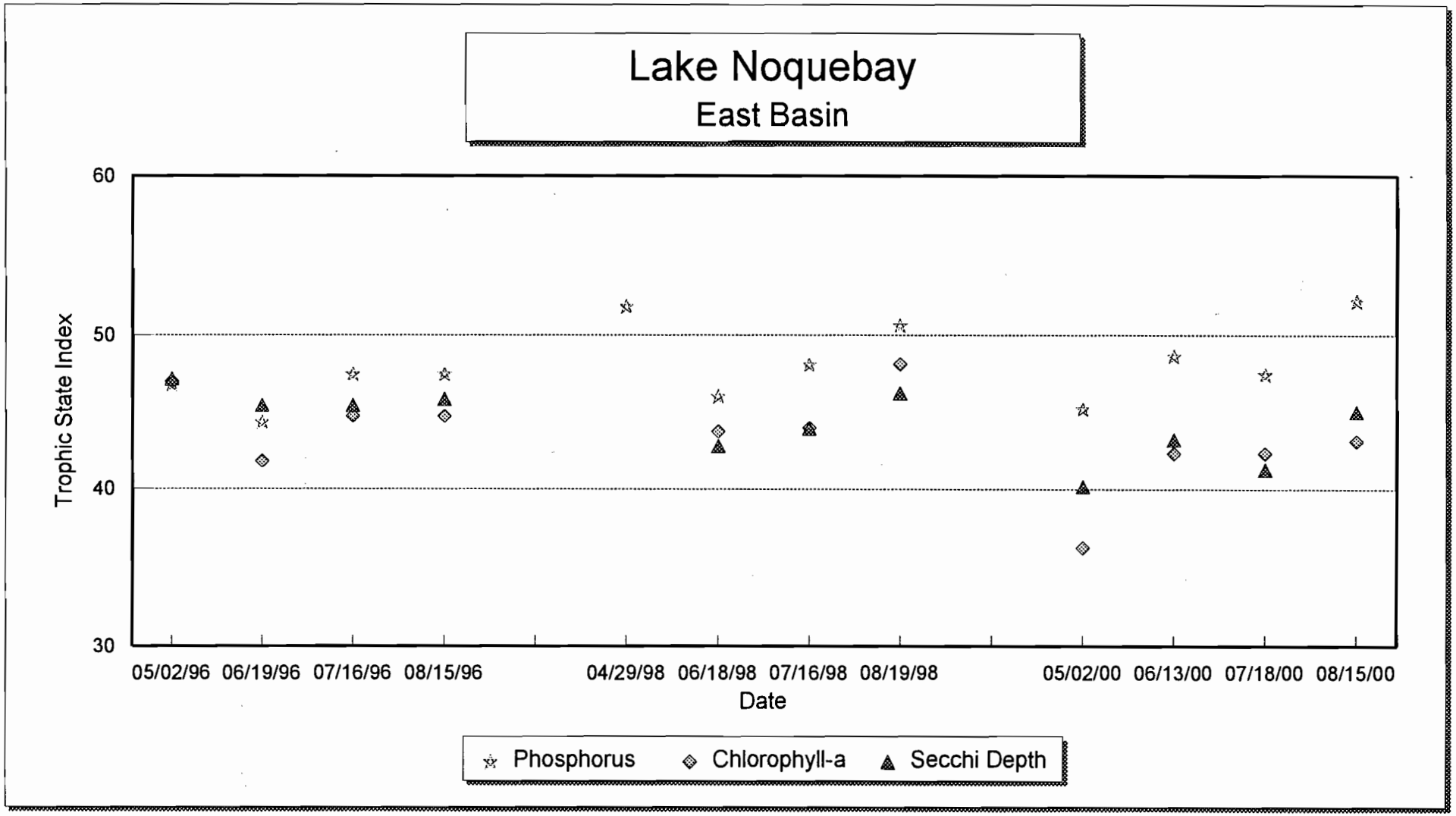


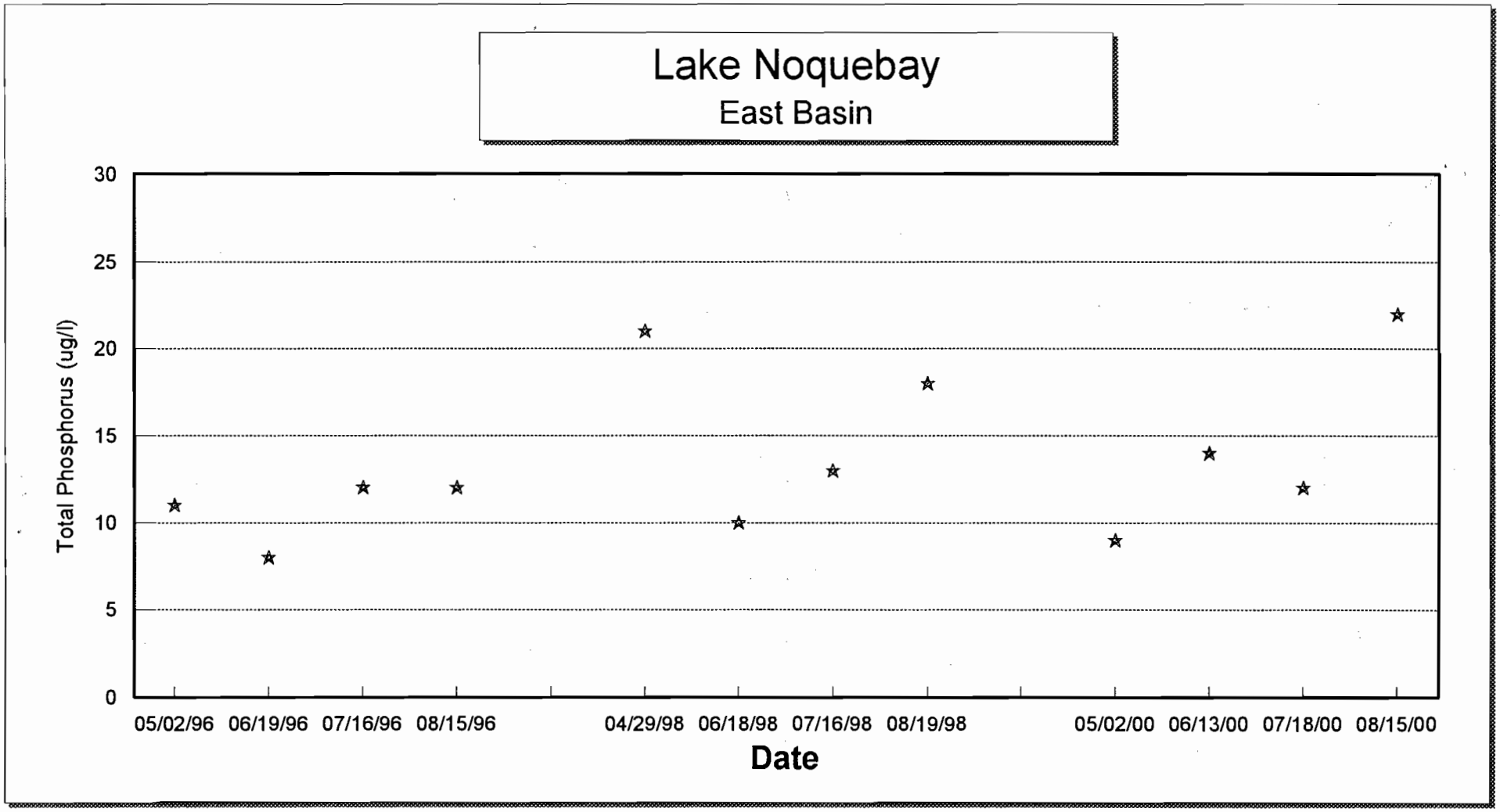
East Basin

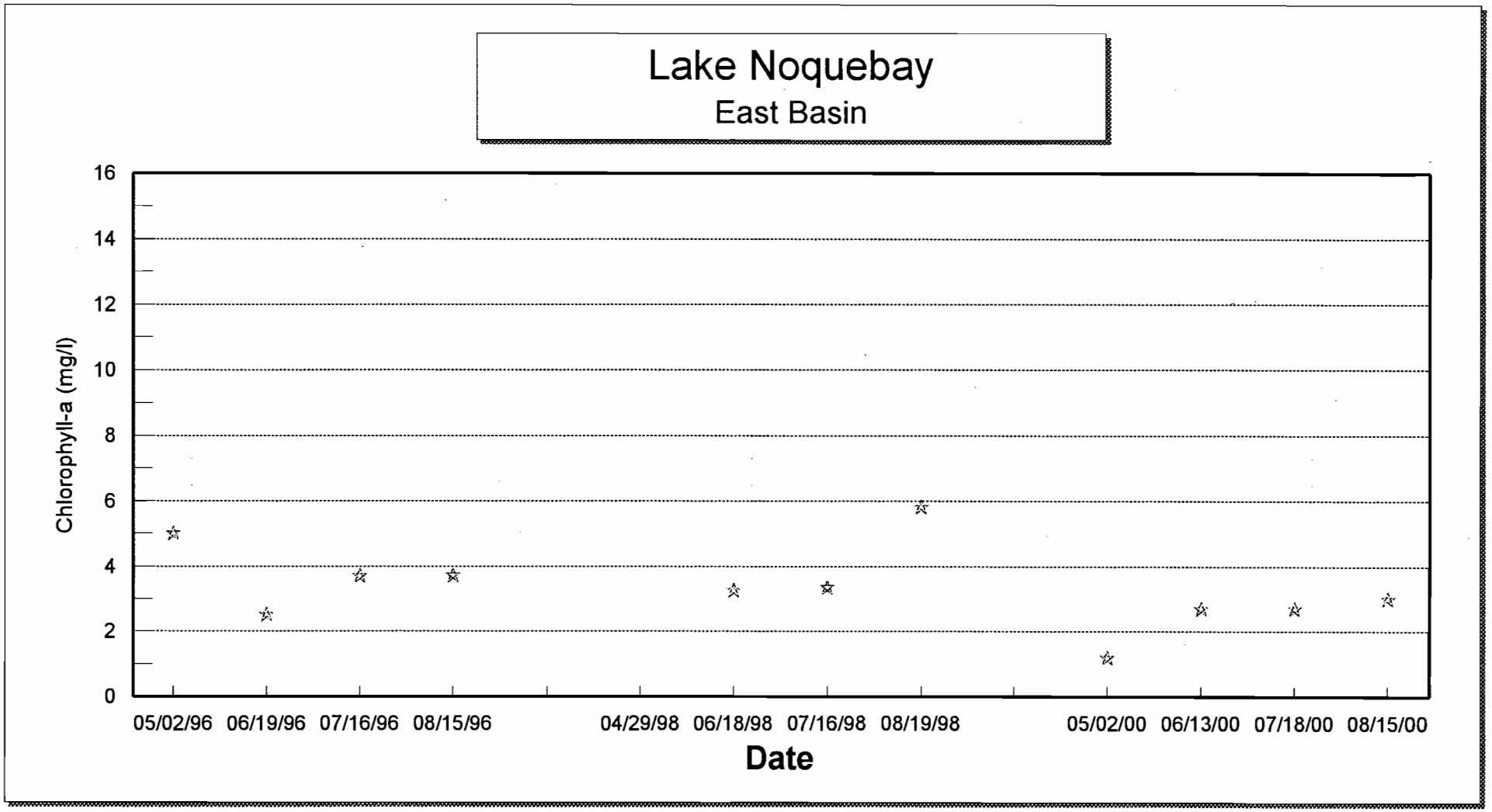
LAKE NOQUEBAY - East Basin
MARINETTE COUNTY, WI

SURFACE WATER QUALITY SAMPLES

Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3	NH3	Chlor-a (UG/L)	Secchi (ft)	Phosporus TSI	Chlor-a TSI	Secchi TSI
05/02/96	11					5	8	46.8	47.0	47.1
06/19/96	8					2.51	9	44.3	41.8	45.4
07/16/96	12					3.71	9	47.5	44.7	45.4
08/15/96	12					3.72	8.75	47.5	44.8	45.8
								ERR	ERR	ERR
04/29/98	21							51.8	ERR	ERR
06/18/98	10					3.26	10.82	46.0	43.8	42.8
07/16/98	13					3.35	10	48.1	44.0	43.9
08/19/98	18					5.81	8.5	50.6	48.1	46.3
								ERR	ERR	ERR
05/02/00	9	ND				1.2	13	45.2	36.2	40.1
06/13/00	14	2	520	11	14	2.7	10.5	48.6	42.3	43.2
07/18/00	12	ND	570	ND	ND	2.7	12	47.5	42.3	41.3
08/15/00	22	ND	540	ND	ND	3	9.25	52.1	43.1	45.0


Lake Noquebay
East Basin
Trophic State Index
60
50
40
30
05/02/96
06/19/96
07/16/96
08/15/96
04/29/98
06/18/98
07/16/98
08/19/98
05/02/00
06/13/00
07/18/00
08/15/00
Date
Phosphorus
Chlorophyll-a
Secchi Depth

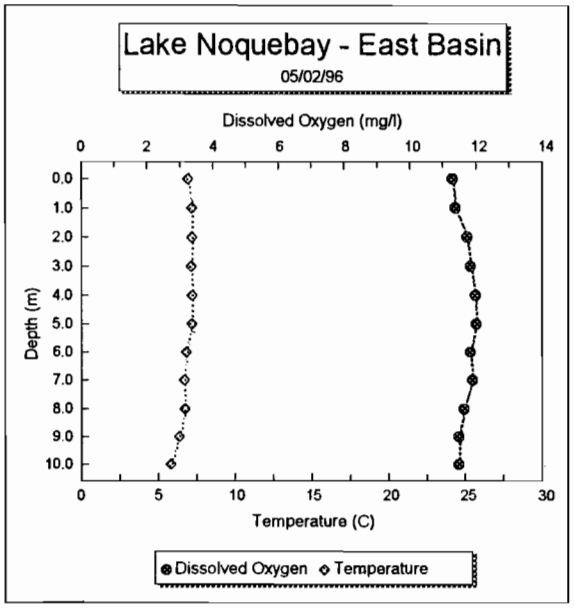

Lake Noquebay
East Basin
Total Phosphorus (ug/l)
30
25
20
15
10
5
0
05/02/96
06/19/96
07/16/96
08/15/96
04/29/98
06/18/98
07/16/98
08/19/98
05/02/00
06/13/00
07/18/00
08/15/00
Date


Lake Noquebay
East Basin
Chlorophyll-a (mg/l)
16
14
12
10
8
6
4
2
0
05/02/96
06/19/96
07/16/96
08/15/96
04/29/98
06/18/98
07/16/98
08/19/98
05/02/00
06/13/00
07/18/00
08/15/00
Date

Hydrolab Monitoring Results

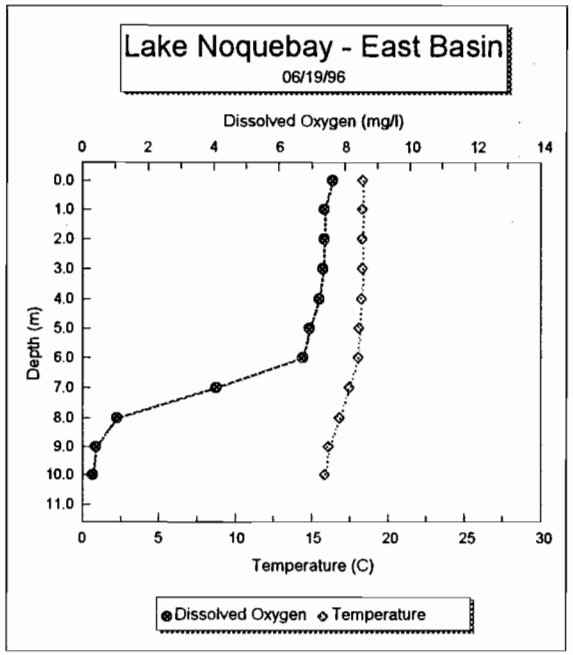
Lake Noquebay - East Basin
05/02/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	6.92	11.28	0.172	7.58	0.109	92.4
1.0	7.18	11.37	0.187	7.68	0.124	95.7
2.0	7.21	11.71	0.196	7.77	0.127	97.6
3.0	7.14	11.81	0.198	7.83	0.126	98.4
4.0	7.17	11.96	0.198	7.83	0.121	98.9
5.0	7.17	11.98	0.196	7.85	0.126	99.6
6.0	6.82	11.81	0.192	7.84	0.123	99.0
7.0	6.71	11.87	0.196	7.75	0.125	97.0
8.0	6.72	11.61	0.198	7.7	0.126	94.3
9.0	6.34	11.45	0.198	7.68	0.126	92.5
10.0	5.83	11.46	0.195	7.68	0.125	91.6
11.0						



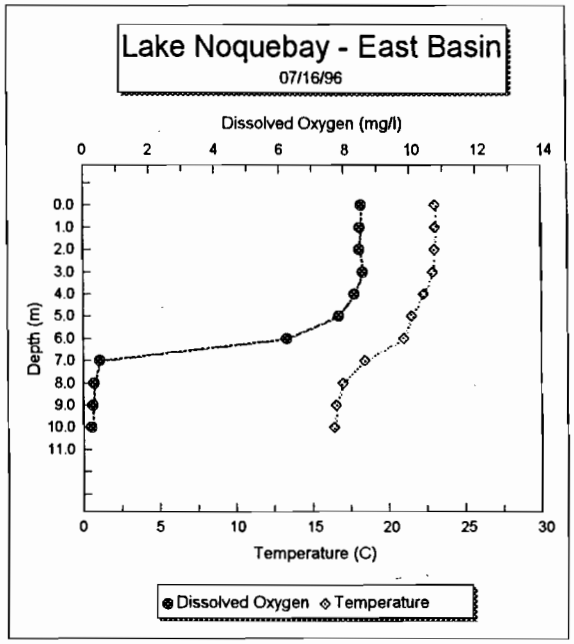
Lake Noquebay - East Basin
06/19/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	18.29	7.61	0.220	8.06	0.141	80.8
1.0	18.29	7.36	0.220	8.06	0.141	78.9
2.0	18.27	7.36	0.220	8.06	0.141	77.7
3.0	18.27	7.32	0.220	8.04	0.141	77.9
4.0	18.21	7.20	0.221	8.01	0.141	76.1
5.0	18.05	6.91	0.220	7.95	0.140	72.6
6.0	17.99	6.71	0.220	7.92	0.140	70.9
7.0	17.43	4.07	0.225	7.62	0.144	29.1
8.0	16.77	1.04	0.227	7.45	0.145	7.9
9.0	16.06	0.39	0.233	7.44	0.149	3.5
10.0	15.80	0.29	0.241	7.49	0.155	2.9
11.0						



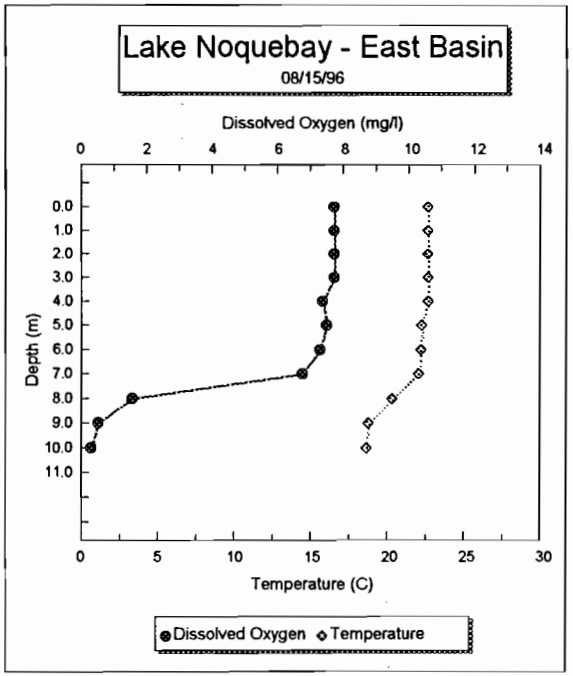
Lake Noquebay - East Basin
07/16/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	23.06	8.51	0.231	8.67	0.148	98.8
1.0	23.06	8.47	0.231	8.67	0.148	98.6
2.0	23.04	8.44	0.231	8.66	0.148	98.3
3.0	22.89	8.54	0.230	8.64	0.147	100.7
4.0	22.30	8.28	0.233	8.53	0.149	95.0
5.0	21.53	7.81	0.231	8.55	0.148	86.5
6.0	21.00	6.22	0.232	8.27	0.148	68.8
7.0	18.43	0.49	0.238	7.63	0.151	4.3
8.0	16.99	0.31	0.243	7.63	0.155	3.0
9.0	16.54	0.27	0.247	7.64	0.158	2.6
10.0	16.40	0.23	0.251	7.66	0.160	2.4
11.0						



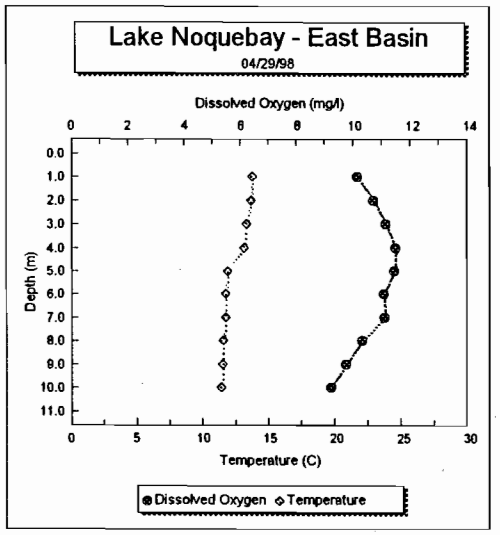
Lake Noquebay - East Basin
08/15/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	22.65	7.69	0.238	9.06	0.152	88.8
1.0	22.65	7.70	0.239	9.06	0.152	89.1
2.0	22.65	7.69	0.239	9.06	0.153	88.1
3.0	22.65	7.70	0.240	9.06	0.153	88.8
4.0	22.65	7.35	0.240	9.03	0.154	85.8
5.0	22.21	7.47	0.242	9.07	0.155	86.4
6.0	22.17	7.26	0.242	9.03	0.155	82.7
7.0	22.00	6.74	0.242	8.97	0.155	77.1
8.0	20.27	1.54	0.248	8.14	0.159	14.1
9.0	18.72	0.51	0.257	7.95	0.164	4.1
10.0	18.59	0.29	0.260	7.94	0.166	2.9
11.0						



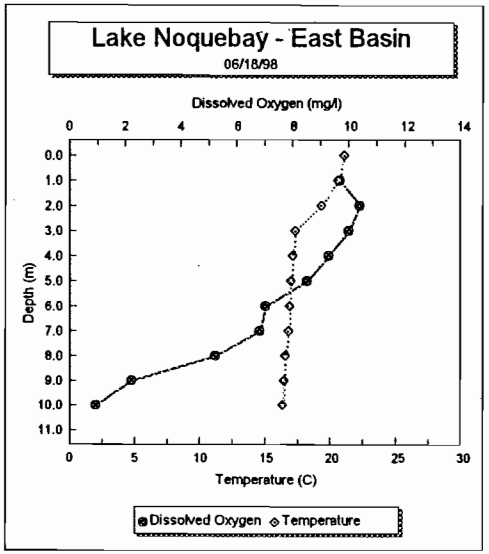
Lake Noquebay - East Basin
04/29/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0							
1.0	3.3	13.79	56.82	10.14	0.267	8.28	0.171	98.5
2.0	6.6	13.68	56.62	10.71	0.268	8.28	0.171	103.8
3.0	9.8	13.35	56.03	11.14	0.267	8.30	0.171	106.0
4.0	13.1	13.13	55.63	11.47	0.267	8.31	0.171	109.1
5.0	16.4	11.87	53.37	11.42	0.267	8.20	0.171	104.8
6.0	19.7	11.75	53.15	11.07	0.267	8.15	0.171	102.1
7.0	23.0	11.71	53.08	11.08	0.268	8.11	0.171	102.7
8.0	26.2	11.56	52.81	10.30	0.268	8.00	0.172	94.1
9.0	29.5	11.48	52.66	9.73	0.269	7.92	0.172	87.2
10.0	32.8	11.38	52.48	9.21	0.270	7.81	0.173	84.9
11.0	36.1							



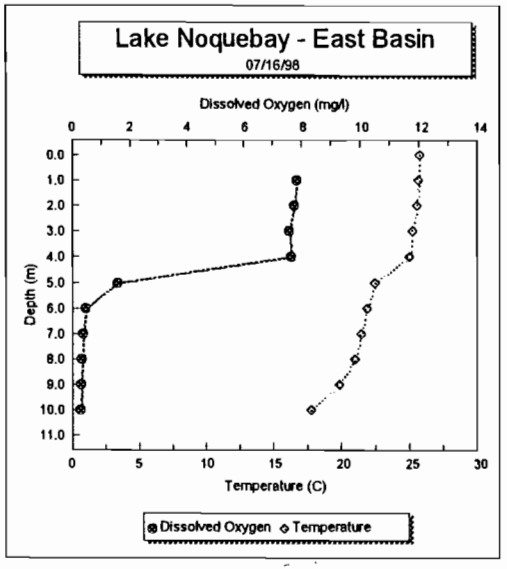
Lake Noquebay - East Basin
06/18/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	21.06	69.91					
1.0	3.3	20.64	69.15	9.66	0.286	8.66	0.183	105.0
2.0	6.6	19.34	66.81	10.37	0.286	8.58	0.183	107.6
3.0	9.8	17.33	63.19	10.00	0.288	8.18	0.184	106.0
4.0	13.1	17.12	62.82	9.27	0.290	8.08	0.185	95.8
5.0	16.4	16.97	62.55	8.50	0.290	8.01	0.186	89.9
6.0	19.7	16.87	62.37	7.00	0.291	7.94	0.186	62.0
7.0	23.0	16.78	62.20	6.80	0.291	7.91	0.186	56.0
8.0	26.2	16.54	61.77	5.20	0.291	7.81	0.187	42.2
9.0	29.5	16.45	61.61	2.20	0.293	7.66	0.187	19.3
10.0	32.8	16.33	61.39	0.90	0.296	7.58	0.189	4.8
11.0	36.1							



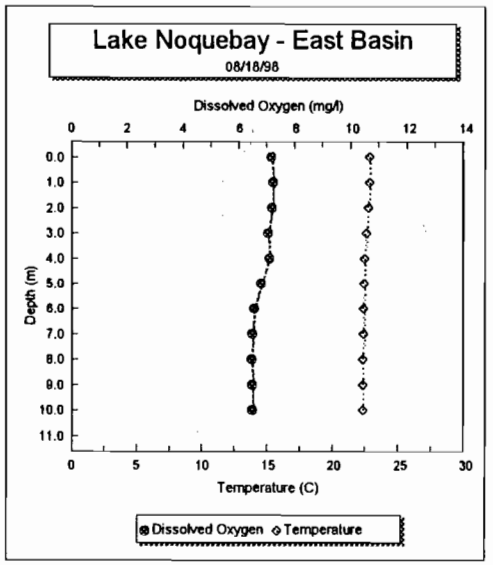
Lake Noquebay - East Basin
07/16/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	25.77	78.39					
1.0	3.3	25.66	78.19	7.81	0.282	8.96	0.180	95.9
2.0	6.6	25.55	77.99	7.72	0.281	8.97	0.180	94.2
3.0	9.8	25.24	77.43	7.56	0.281	8.96	0.180	92.7
4.0	13.1	24.97	76.95	7.61	0.282	8.94	0.180	92.2
5.0	16.4	22.48	72.46	1.56	0.296	7.95	0.189	17.3
6.0	19.7	21.88	71.38	0.46	0.298	7.86	0.191	4.7
7.0	23.0	21.49	70.68	0.36	0.303	7.87	0.194	3.9
8.0	26.2	20.98	69.76	0.32	0.308	7.87	0.197	3.5
9.0	29.5	19.83	67.69	0.30	0.321	7.87	0.205	3.1
10.0	32.8	17.74	63.93	0.28	0.340	7.84	0.218	2.9
11.0	36.1							



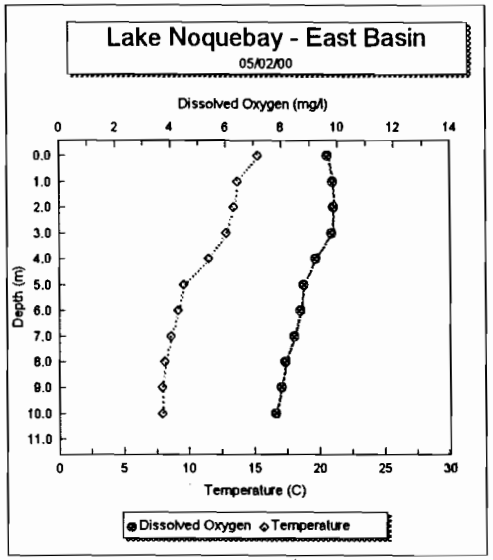
Lake Noquebay - East Basin
08/18/98

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	22.87	73.17	7.15	0.283	8.91	0.181	84.2
1.0	3.3	22.86	73.15	7.23	0.284	8.90	0.181	84.2
2.0	6.6	22.77	72.99	7.18	0.284	8.91	0.182	83.4
3.0	9.8	22.63	72.73	7.04	0.285	8.89	0.181	81.0
4.0	13.1	22.48	72.46	7.08	0.284	8.88	0.181	81.3
5.0	16.4	22.44	72.39	6.80	0.284	8.86	0.182	75.6
6.0	19.7	22.40	72.32	6.55	0.284	8.86	0.182	75.7
7.0	23.0	22.38	72.28	6.48	0.284	8.84	0.182	75.1
8.0	26.2	22.36	72.25	6.44	0.285	8.83	0.182	74.5
9.0	29.5	22.33	72.19	6.47	0.285	8.85	0.182	75.3
10.0	32.8	22.32	72.18	6.47	0.285	8.85	0.182	75.1
11.0	36.1							



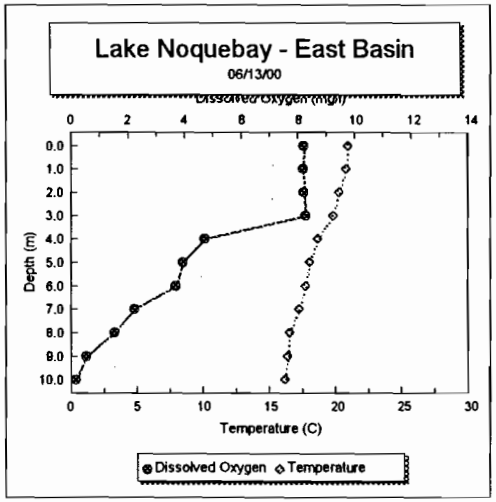
Lake Noquebay - East Basin
05/02/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	15.33	59.59	9.64	293	8.61	0.187	98.5
1.0	3.3	13.71	56.68	9.82	291	8.63	0.186	96.7
2.0	6.6	13.42	56.16	9.83	291	8.61	0.186	96.5
3.0	9.8	12.86	55.15	9.77	293	8.57	0.187	94.1
4.0	13.1	11.49	52.68	9.19	296	8.37	0.189	86.4
5.0	16.4	9.61	49.30	8.75	296	8.22	0.189	78.7
6.0	19.7	9.14	48.45	8.65	296	8.17	0.189	76.1
7.0	23.0	8.61	47.50	8.42	296	8.11	0.189	73.2
8.0	26.2	8.13	46.63	8.09	297	8.06	0.190	69.8
9.0	29.5	7.93	46.27	7.95	297	8.04	0.190	68.0
10.0	32.8	7.89	46.20	7.75	297	8.01	0.190	66.5
11.0	36.1							



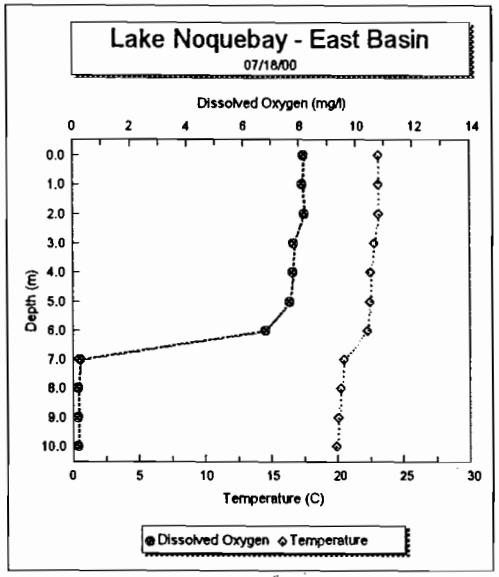
Lake Noquebay - East Basin
06/13/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	20.89	69.60	8.2	300	8.52	0.192	93.8
1.0	3.3	20.78	69.40	8.17	300	8.54	0.192	92.9
2.0	6.6	20.22	68.40	8.19	300	8.54	0.192	91.6
3.0	9.8	19.78	67.60	8.26	297	8.52	0.190	91.2
4.0	13.1	18.61	65.50	4.71	306	7.92	0.196	49.2
5.0	16.4	18.00	64.40	3.93	306	7.81	0.195	41.9
6.0	19.7	17.72	63.90	3.69	305	7.78	0.195	39.0
7.0	23.0	17.22	63.00	2.22	307	7.69	0.196	23.7
8.0	26.2	16.50	61.70	1.51	306	7.60	0.196	16.1
9.0	29.5	16.33	61.39	0.52	308	7.55	0.197	3.7
10.0	32.8	16.17	61.11	0.15	311	7.53	0.198	1.4
11.0	36.1							



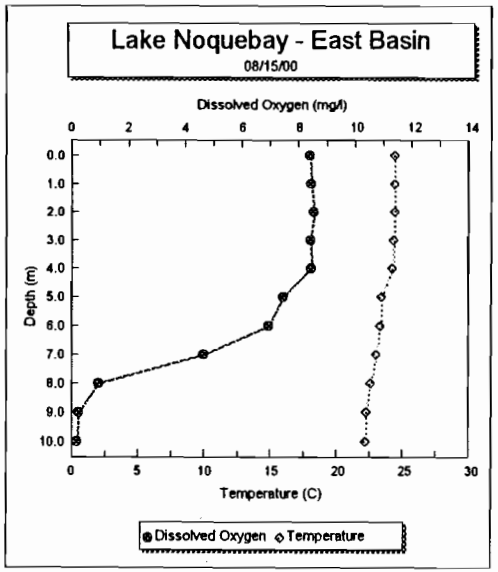
Lake Noquebay - East Basin
07/18/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	23.17	73.70	8.15	289	8.91	0.185	95.4
1.0	3.3	23.17	73.70	8.11	289	8.92	0.185	95.7
2.0	6.6	23.17	73.70	8.18	289	8.92	0.185	95.0
3.0	9.8	22.83	73.10	7.80	289	8.88	0.185	89.4
4.0	13.1	22.50	72.50	7.77	289	8.89	0.185	90.4
5.0	16.4	22.44	72.40	7.65	289	8.89	0.185	88.2
6.0	19.7	22.28	72.10	6.79	291	8.84	0.186	79.4
7.0	23.0	20.50	68.90	0.21	303	7.85	0.193	2.2
8.0	26.2	20.22	68.40	0.16	305	7.82	0.195	1.8
9.0	29.5	20.06	68.10	0.15	307	7.81	0.196	1.7
10.0	32.8	19.89	67.80	0.16	310	7.83	0.198	1.7
11.0	36.1							



Lake Noquebay -East Basin
08/15/00

Depth (m)	Depth (ft)	Temp (C)	Temp (F)	D.O. (mg/l)	Cond. (uS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	0.0	24.39	75.90	8.38	278	9.03	0.178	100.8
1.0	3.3	24.39	75.90	8.43	278	9.02	0.177	101.0
2.0	6.6	24.39	75.90	8.52	278	9.04	0.177	101.0
3.0	9.8	24.33	75.80	8.40	278	9.04	0.178	101.4
4.0	13.1	24.22	75.60	8.42	279	9.00	0.179	99.1
5.0	16.4	23.39	74.10	7.44	280	8.93	0.179	87.6
6.0	19.7	23.28	73.90	6.92	282	8.86	0.180	79.5
7.0	23.0	23.00	73.40	4.63	288	8.55	0.184	53.6
8.0	26.2	22.56	72.60	0.92	296	8.12	0.188	8.9
9.0	29.5	22.22	72.00	0.23	297	8.05	0.190	2.3
10.0	32.8	22.17	71.90	0.16	298	8.02	0.190	1.8
11.0	36.1							



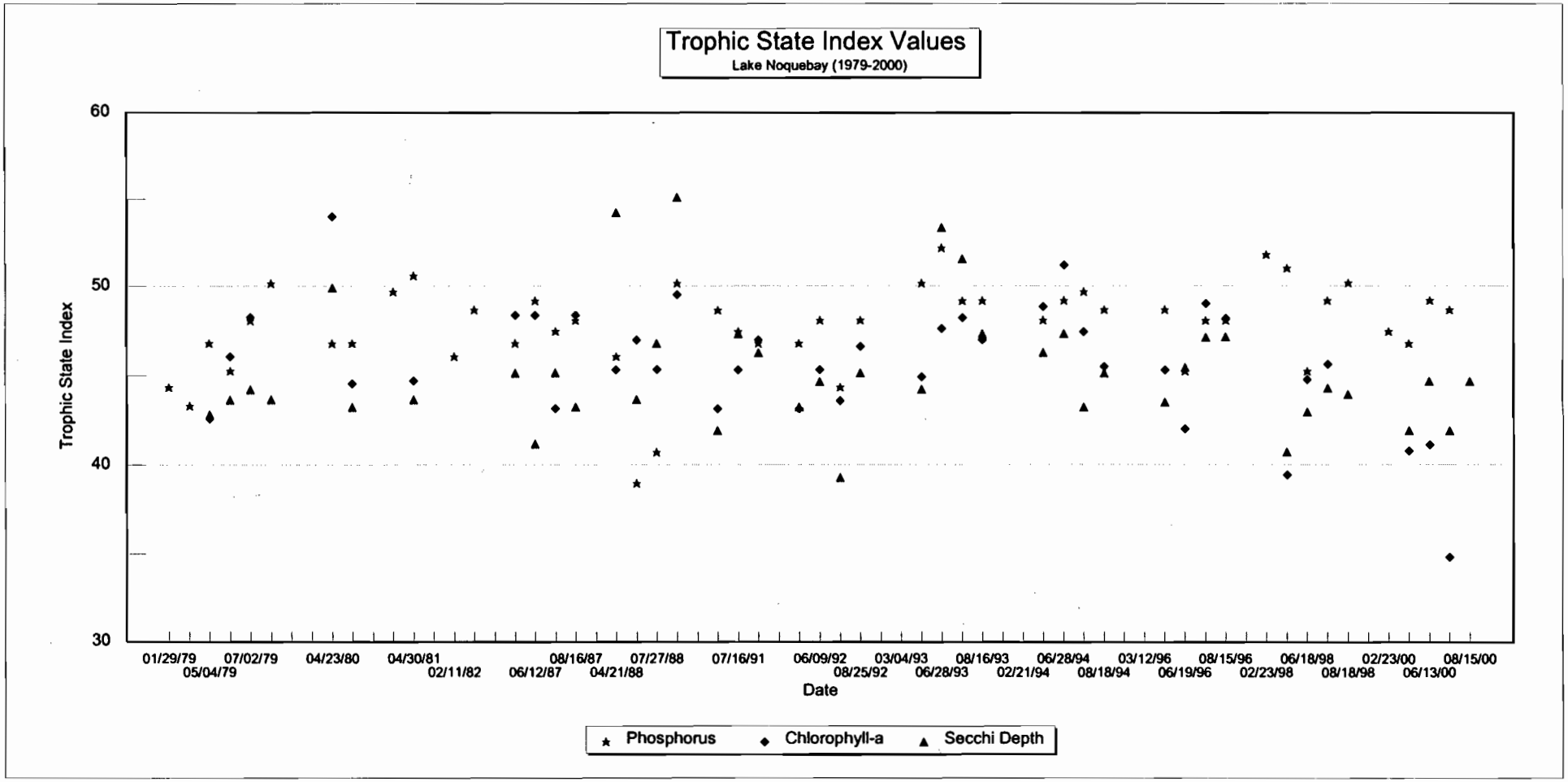
Water Quality Monitoring Results

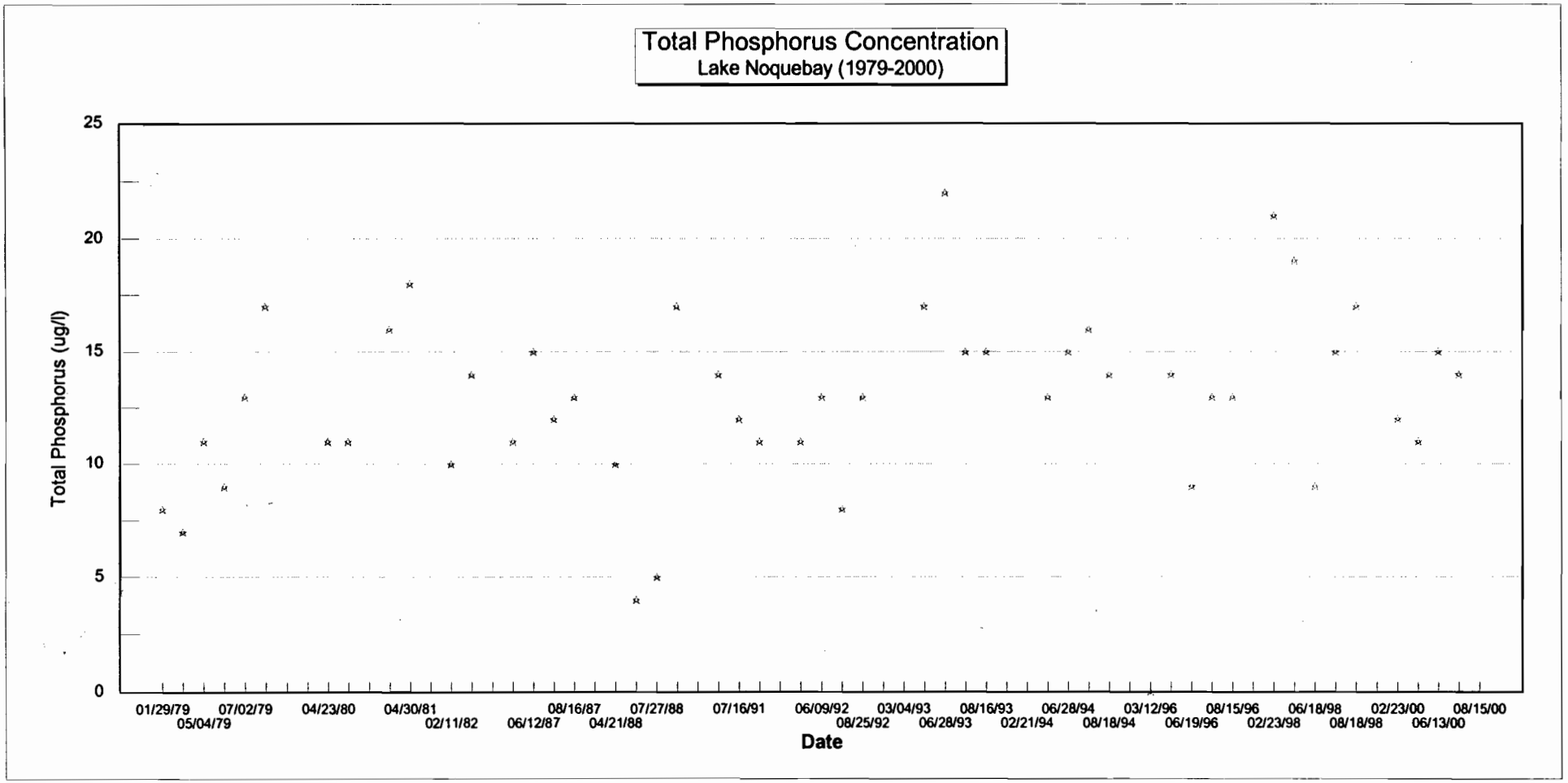
1979 - 2000

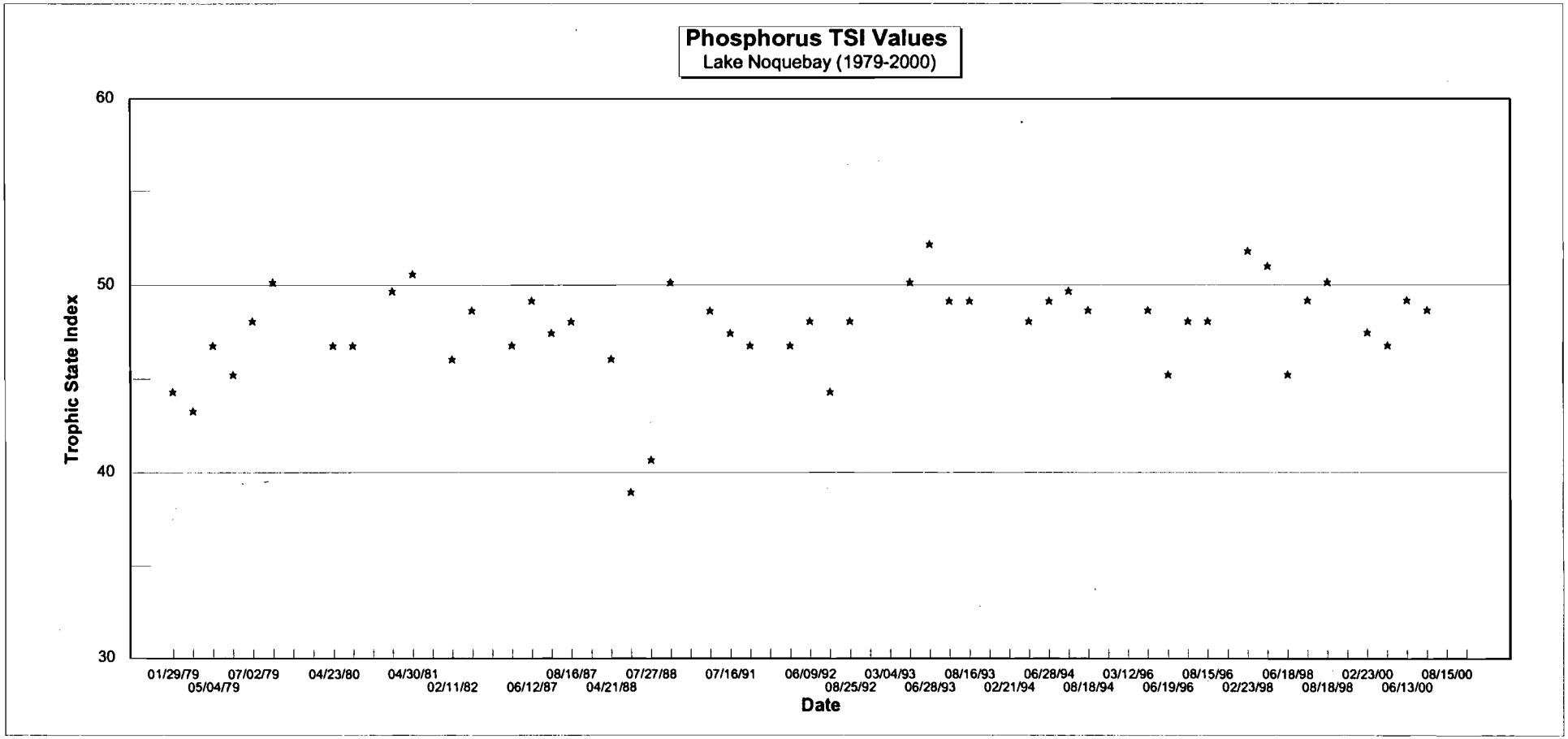
LAKE NOQUEBAY - West Basin
MARINETTE COUNTY, WI

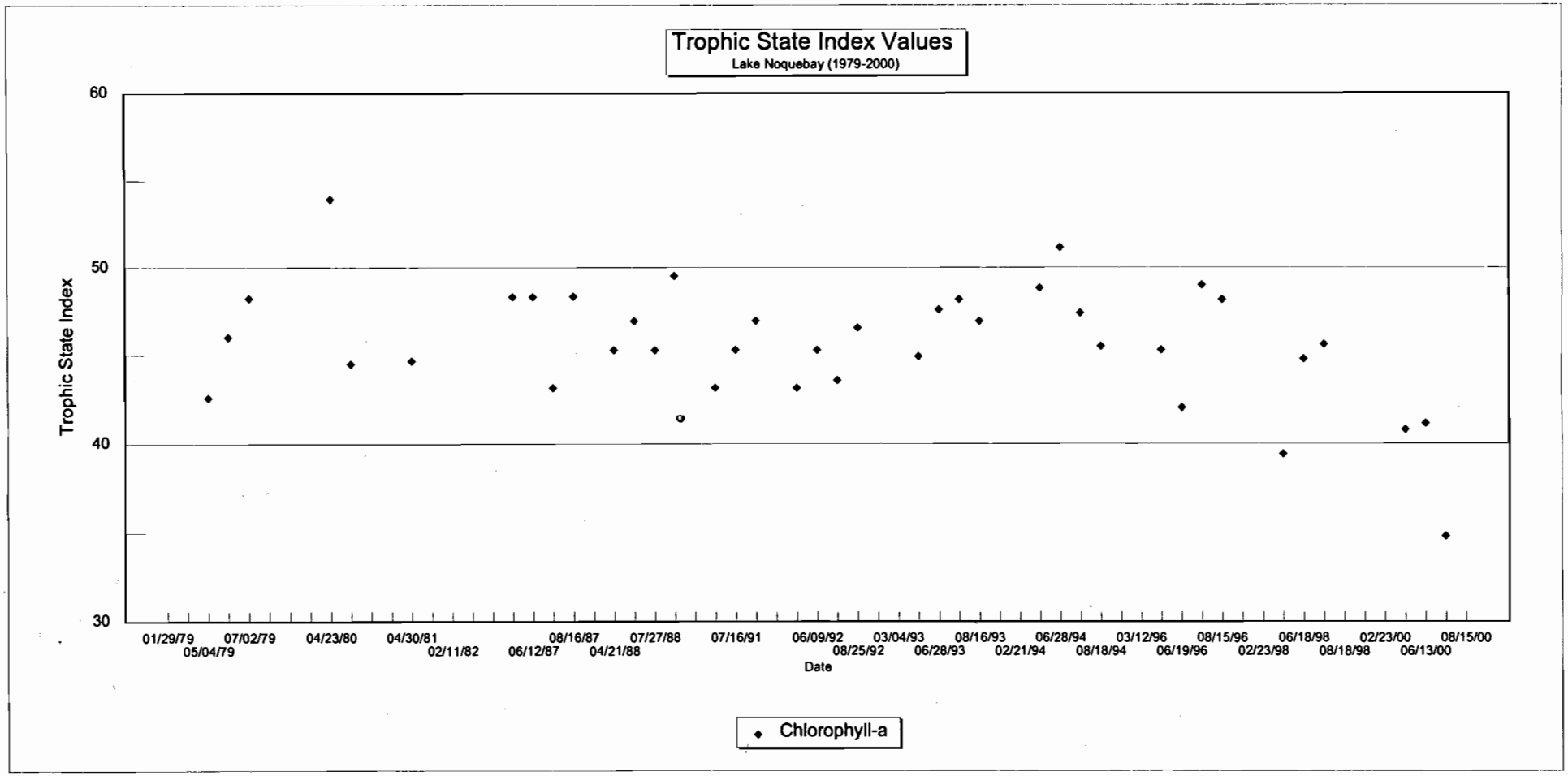
SURFACE WATER QUALITY SAMPLES

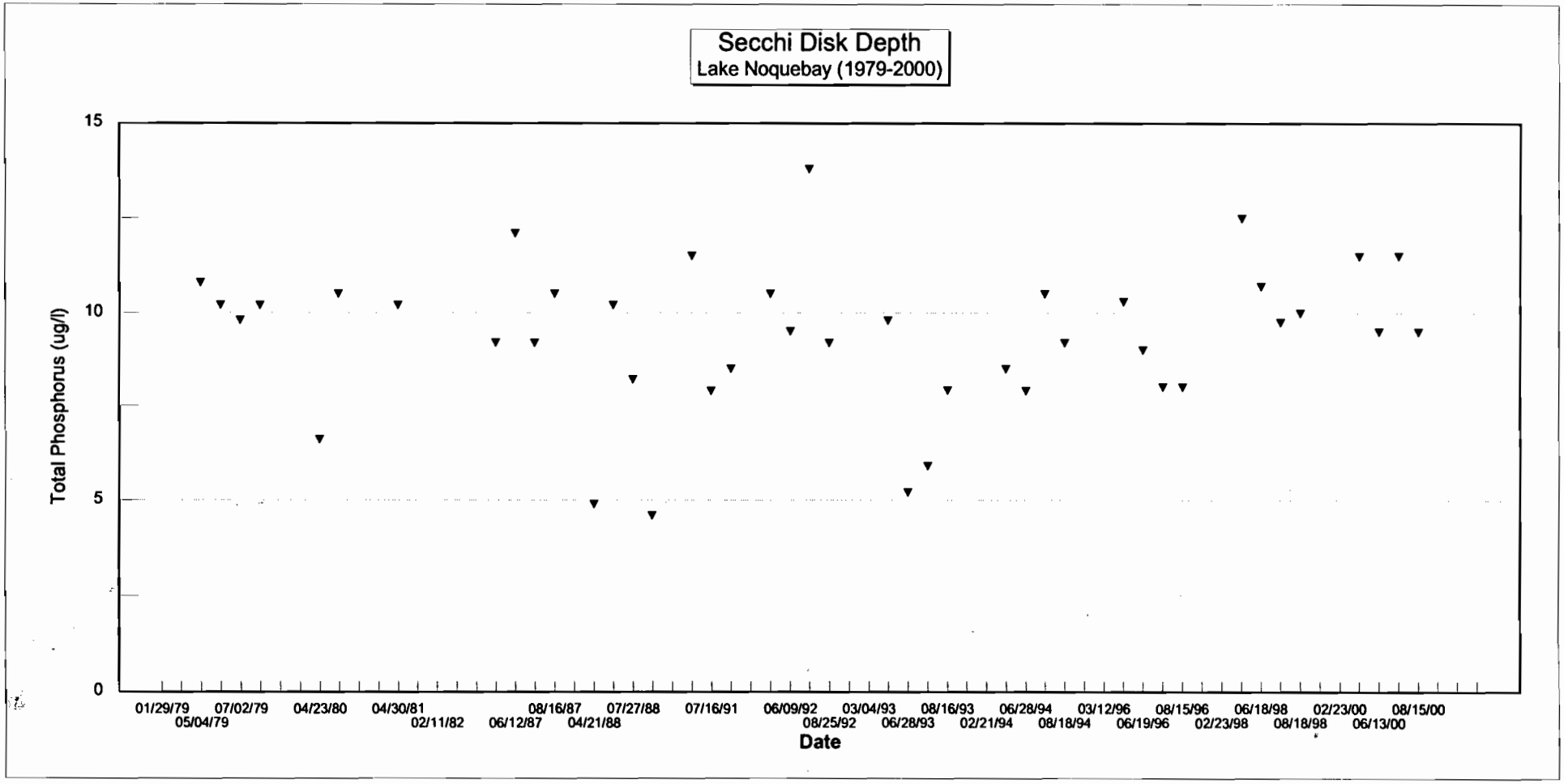
Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3 (ug/l)	NH3 (ug/l)	Chlor-a (UG/L)	Secchi (ft)	Phosporus TSI	Chlor-a TSI	Secchi TSI
01/29/79	8	2	300	200				44.3	ERR	ERR
02/26/79	7	4		220				43.3	ERR	ERR
05/04/79	11	5	520	60	10	2.79	10.8	46.8	42.6	42.8
05/29/79	9	4	700	30	30	4.42	10.2	45.2	46.1	43.6
07/02/79	13	3	560	10	20	5.91	9.8	48.1	48.3	44.2
07/31/79	17	3					10.2	50.2	ERR	43.6
								ERR	ERR	ERR
03/12/80		4	600	40	40			ERR	ERR	ERR
04/23/80	11	3	670	90		12.6	6.6	46.8	54.0	49.9
08/27/80	11	7	620	40	40	3.6	10.5	46.8	44.5	43.2
								ERR	ERR	ERR
02/25/81	16	5	810	280	250			49.7	ERR	ERR
04/30/81	18	16	450	110		3.68	10.2	50.6	44.7	43.6
								ERR	ERR	ERR
02/11/82	10	7						46.0	ERR	ERR
03/23/82	14	10	390	360				48.6	ERR	ERR
								ERR	ERR	ERR
04/23/87	11	8	600	90	10	6	9.2	46.8	48.4	45.1
06/12/87	15	8				6	12.1	49.2	48.4	41.2
07/16/87	12					3	9.2	47.5	43.1	45.1
08/16/87	13	8				6	10.5	48.1	48.4	43.2
								ERR	ERR	ERR
04/21/88	10	2				4	4.9	46.0	45.3	54.2
06/24/88	4					5	10.2	39.0	47.0	43.6
07/27/88	5					4	8.2	40.7	45.3	46.8
08/29/88	17					7	4.6	50.2	49.5	55.1
								ERR	ERR	ERR
04/15/91	14	4				3	11.5	48.6	43.1	41.9
07/16/91	12					4	7.9	47.5	45.3	47.3
08/27/91	11					5	8.5	46.8	47.0	46.3
								ERR	ERR	ERR
04/27/92	11	2				3	10.5	46.8	43.1	43.2
06/09/92	13					4	9.51	48.1	45.3	44.6
07/28/92	8					3.18	13.8	44.3	43.6	39.3
08/25/92	13					4.74	9.2	48.1	46.6	45.1
								ERR	ERR	ERR
03/04/93								ERR	ERR	ERR
04/28/93	17					3.8	9.8	50.2	44.9	44.2
06/28/93	22					5.43	5.2	52.1	47.6	53.4
07/26/93	15					5.88	5.9	49.2	48.2	51.5
08/16/93	15					4.99	7.9	49.2	47.0	47.3
								ERR	ERR	ERR
02/21/94								ERR	ERR	ERR
04/20/94	13					6.4	8.5	48.1	48.9	46.3
06/28/94	15					8.7	7.9	49.2	51.2	47.3
07/21/94	16					5.3	10.5	49.7	47.4	43.2
08/18/94	14					4.1	9.2	48.6	45.5	45.1
								ERR	ERR	ERR
03/12/96	ND	ND						ERR	ERR	ERR
05/02/96	14	ND	500	31	ND	4	10.3	48.6	45.3	43.5
06/19/96	9	ND				2.59	9	45.2	42.0	45.4
07/16/96	13	ND				6.53	8	48.1	49.0	47.1
08/15/96	13	ND				5.86	8	48.1	48.2	47.1
02/23/98	21	3						51.8	ERR	ERR
04/29/98	19	ND	380	71	ND	1.84	12.5	51.0	39.4	40.7
06/18/98	9	2				3.72	10.7	45.2	44.8	42.9
07/16/98	15	ND				4.17	9.75	49.2	45.6	44.3
08/18/98	17	ND					10	50.2	ERR	43.9
								ERR	ERR	ERR
02/23/00	12							47.5	ERR	ERR
05/02/00	11	ND	590	22	19	2.2	11.5	46.8	40.8	41.9
06/13/00	15	ND	510	10	10	2.3	9.5	49.2	41.1	44.7
07/18/00	14	ND	560			1	11.5	48.6	34.8	41.9
08/15/00							9.5	ERR	ERR	44.7
			508	33.5				ERR	ERR	ERR

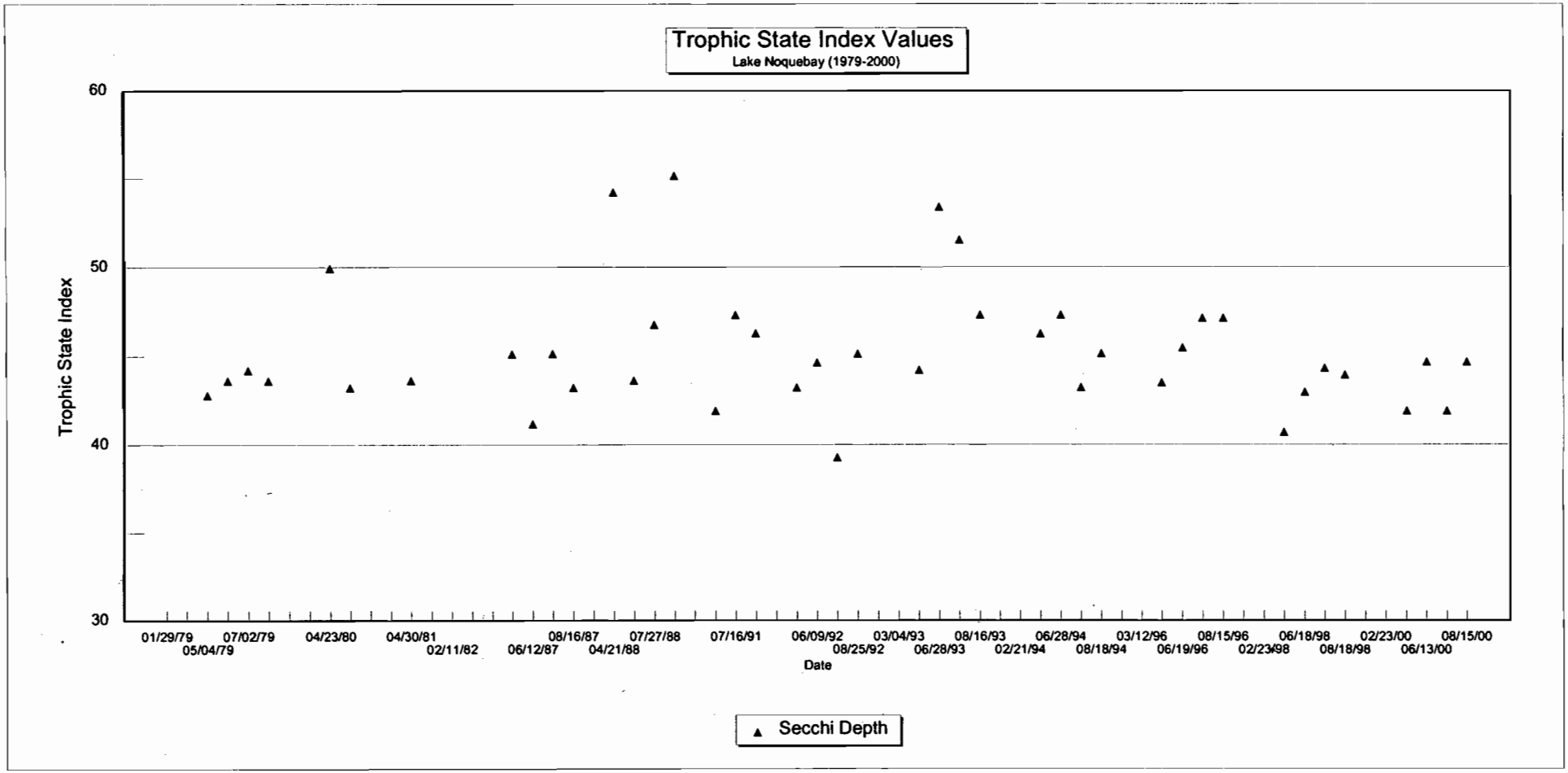

Trophic State Index Values
Lake Noquebay (1979-2000)
Trophic State Index
60
50
40
30
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
08/16/87
06/12/87
07/27/88
04/21/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date
Phosphorus
Chlorophyll-a
Secchi Depth


Total Phosphorus Concentration
Lake Noquebay (1979-2000)
Total Phosphorus (ug/l)
25
20
15
10
5
0
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
06/12/87
08/16/87
04/21/88
07/27/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date


Phosphorus TSI Values
Lake Noquebay (1979-2000)
Trophic State Index
60
50
40
30
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
08/16/87
06/12/87
07/27/88
04/21/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date

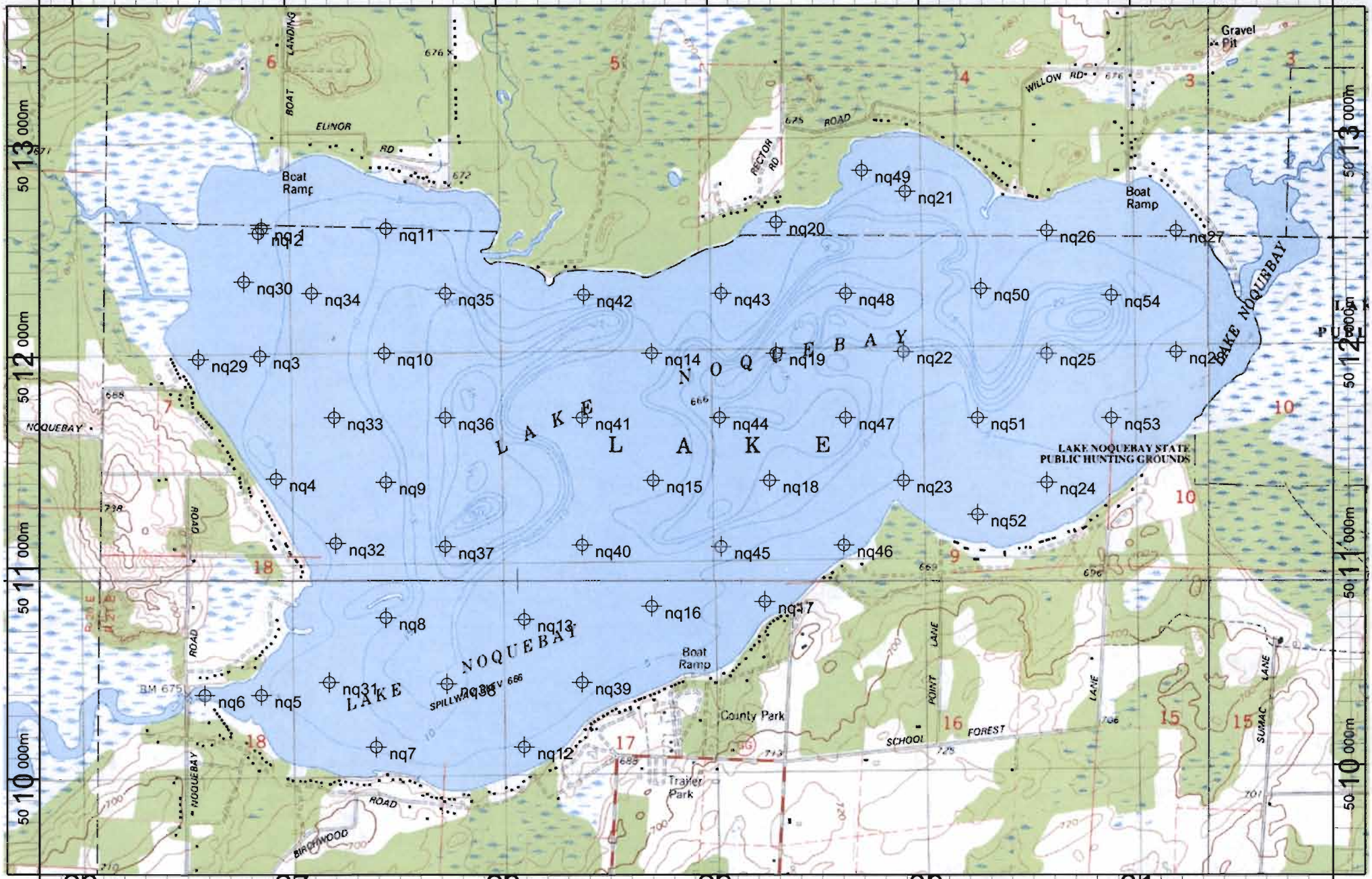

Trophic State Index Values
Lake Noquebay (1979-2000)
Trophic State Index
60
50
40
30
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
08/16/87
06/12/87
07/27/88
04/21/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date
Chlorophyll-a


Secchi Disk Depth
Lake Noquebay (1979-2000)
Total Phosphorus (ug/l)
15
10
5
0
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
06/12/87
08/16/87
04/21/88
07/27/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date


Trophic State Index Values
Lake Noquebay (1979-2000)
Trophic State Index
60
50
40
30
01/29/79
05/04/79
07/02/79
04/23/80
04/30/81
02/11/82
06/12/87
08/16/87
04/21/88
07/27/88
07/16/91
06/09/92
08/25/92
03/04/93
06/28/93
08/16/93
02/21/94
06/28/94
08/18/94
03/12/96
06/19/96
08/15/96
02/23/98
06/18/98
08/18/98
02/23/00
06/13/00
08/15/00
Date
Secchi Depth

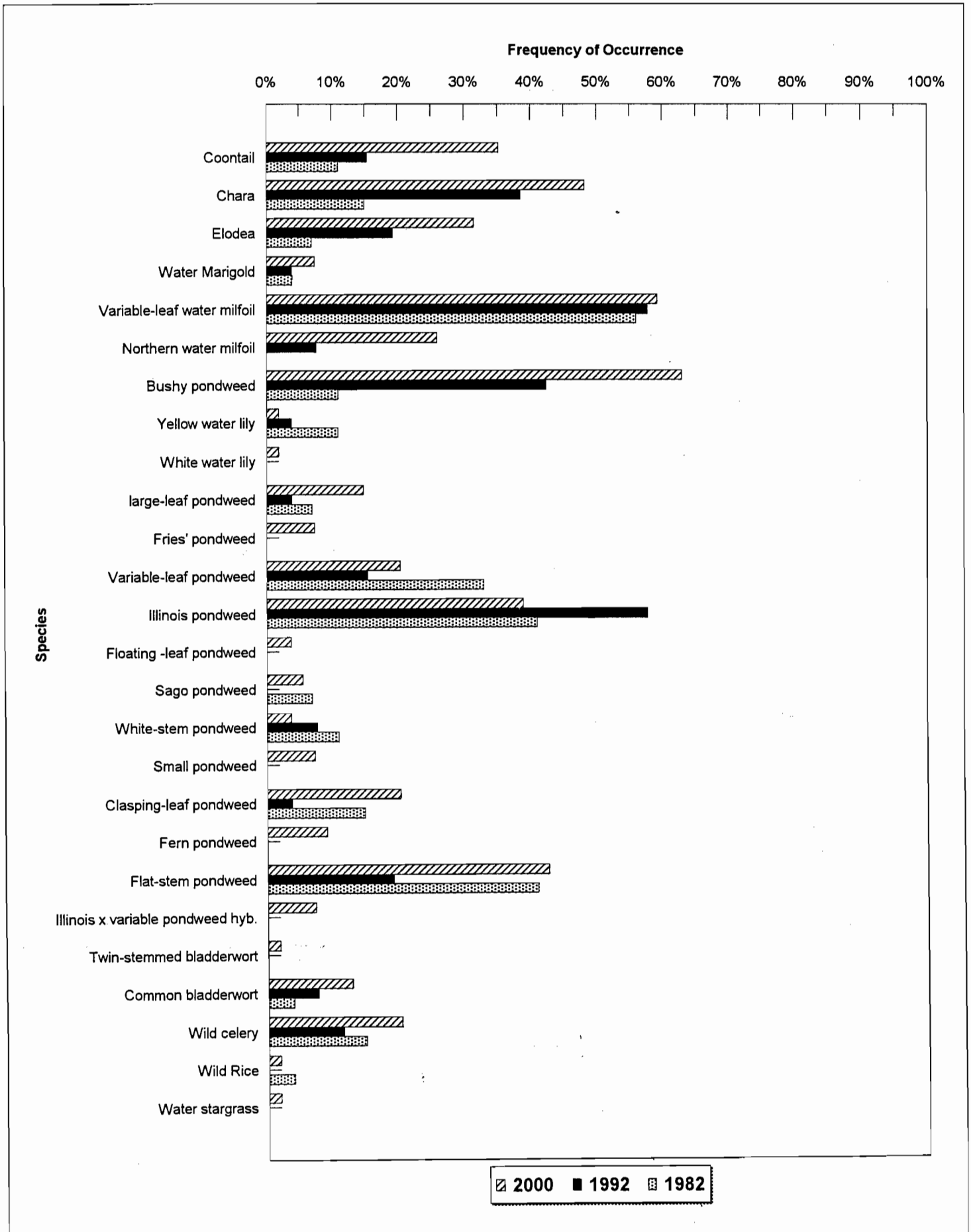
Appendix B

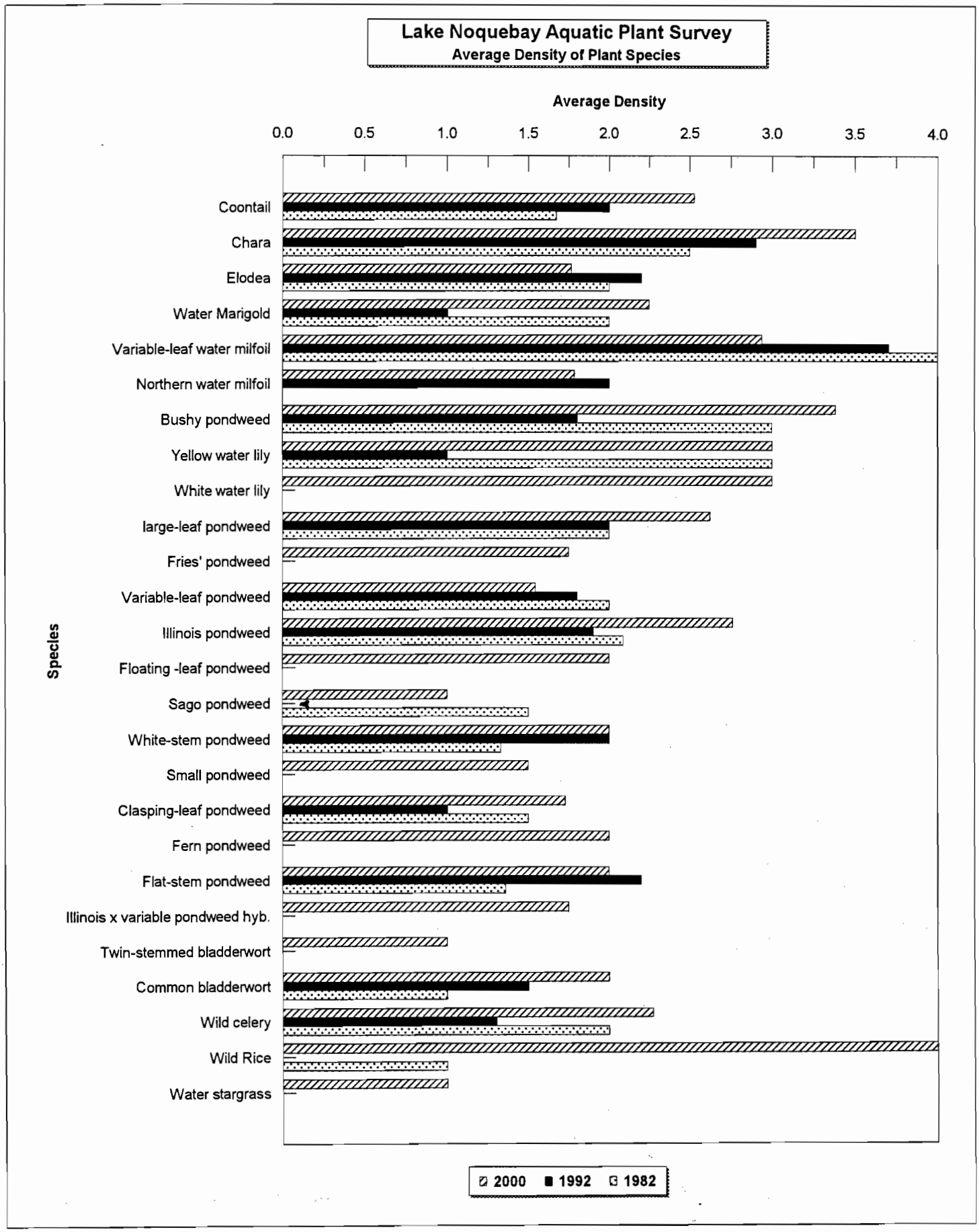
Aquatic Plant Survey Results



Name: WAUSAUKEE SOUTH
Date: 8/29/2002
Scale: 1 inch equals 2000 feet

Location: 16 428878 E 5011574 N
Caption:
Aquatic plant survey data points.


Frequency of Occurrence
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Species
Coontail
Chara
Elodea
Water Marigold
Variable-leaf water milfoil
Northern water milfoil
Bushy pondweed
Yellow water lily
White water lily
large-leaf pondweed
Fries' pondweed
Variable-leaf pondweed
Illinois pondweed
Floating -leaf pondweed
Sago pondweed
White-stem pondweed
Small pondweed
Clasping-leaf pondweed
Fern pondweed
Flat-stem pondweed
Illinois x variable pondweed hyb.
Twin-stemmed bladderwort
Common bladderwort
Wild celery
Wild Rice
Water stargrass
2000
1992
1982


Lake Noquebay Aquatic Plant Survey
Average Density of Plant Species
Average Density
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Species
Coontail
Chara
Elodea
Water Marigold
Variable-leaf water milfoil
Northern water milfoil
Bushy pondweed
Yellow water lily
White water lily
large-leaf pondweed
Fries' pondweed
Variable-leaf pondweed
Illinois pondweed
Floating -leaf pondweed
Sago pondweed
White-stem pondweed
Small pondweed
Clasping-leaf pondweed
Fern pondweed
Flat-stem pondweed
Illinois x variable pondweed hyb.
Twin-stemmed bladderwort
Common bladderwort
Wild celery
Wild Rice
Water stargrass
2000
1992
1982