Mary (Marie) Lake near Twin Lakes, Wisconsin
Water-Quality Data Summary

This summary covers the period October 1994 to September 1996, which is the period of water-quality monitoring of Mary Lake by the U.S. Geological Survey (USGS). Emphasis in this summary is on data collected during 1996. All data collected during 1996 is included. Data from 1995 is included in graphs to illustrate changes or trends.

In reviewing the data, it may be helpful to refer to the methods and explanations of physical and chemical characteristics sections in the USGS annual lake data report "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1996" and to Shaw and others (1994) "Understanding Lake Data."

Lake description and sampling locations:

Mary Lake is classified as a drained lake, with one outlet into Elizabeth lake. The average depth of Mary Lake is 9 feet, the surface area is 297 acres (0.464 square miles). The water-quality sampling site is located at the deepest point in the lake at a depth of about 33 feet. Lake stage was monitored near the boat landing on the north side of the lake. The locations of the monitoring sites are shown in Figure 1.

Hydrologic conditions during water year 1996:

Annual variability in lake condition often reflects variability in climatic and hydrologic conditions. Air temperature in southeastern Wisconsin was, on the average, 2.2 $^{\circ}$ F cooler than normal for the period December 1995 through March 1996; April and May was 4.0 $^{\circ}$ F cooler than normal; and the period June through August was 1.3 $^{\circ}$ F cooler than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1996 was 103 percent of normal precipitation for southeastern Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1996). Watershed runoff in the region of Mary Lake was between 100 and 120 percent of long-term average runoff (Holmstrom and others, 1997, "Water Resources Data--Wisconsin").

Lake Data for 1996:

The following summarizes some highlights of data given in the tables and shown in the figures.

Lake-stage fluctuations:

Lake stages were measured by the USGS on sampling dates. Stage values are shown in Table 4. Values that were published in the USGS annual lake data report, "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1996 " for Mary Lake were incorrect. Therefore, Table 4 lists correct values (to Mean Sea Level) for both 1995 and 1996 water years. The altitude of the local gage datum at Mary Lake (chiseled square at the boat landing) is 793.67 (+/- about 0.1 ft).

Lake-depth profiles:

Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance exhibit a pattern that is characteristic of thermally stratified lakes and are similar to those from 1995. These profiles, which were measured over the deepest point in the lake, are listed in Table 2 and shown in Figure 2. During the February through August sampling period, complete water-column mixing was observed on April 16. The lake became thermally stratified through the summer. No anoxic (devoid of oxygen) regions developed in June but by August the lower 8.5 feet were anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 7.3 and 8.5, is common for southeastern Wisconsin lakes and poses no problems for aquatic life.

Chemical constituents:

Analyses of water samples collected on April 16 for selected chemical constituents for chemical characterization of the lake are shown in Figure 2. Samples collected at 1.5 and 31-foot depths show similar constituent concentrations, as would be expected under mixed water column conditions. The constituent values for color, chlorophyll a, calcium, magnesium, pH, alkalinity, total nitrogen, and total phosphorus are within regional values for this area as described by Lillie and Mason in "Limnological Characteristics of Wisconsin Lakes," 1983, Technical Bulletin No. 138, Department of Natural Resources. The value for chloride was greater than typical values for the region.

The ratio of dissolved nitrogen to dissolved phosphorus was 45:1, based on the surface concentrations on April 16. This ratio suggests the lake is phosphorus limited, which means algal growth is dependent on the amount of available phosphorus rather than available nitrogen.

Three common measures of water quality used as indices are concentrations of near-surface total-phosphorus and chlorophyll a, and Secchi depth. Total phosphorus concentrations ranged from 0.010 mg/L on August 12 to 0.013 mg/L on April 16, June 10, and July 15, chlorophyll a ranged from 4.0 µg/L on August 12 to 7.1 µg/L on June 10, and Secchi depths ranged from 2.1 m on July 15 to 4.6 m on June

10. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for the 1995-96 period are shown on Figure 3. Values for 1996 are similar to those for 1995.

Total phosphorus concentration 1.5 feet above the lake bottom ranged from 0.011 mg/L on April 16 to 0.083 mg/L on July 15. The phosphorus concentrations observed during anoxic periods are indicative of minor phosphorus release from the bottom sediments.

Lake condition:

Water-quality index:

Lillie and Mason (1983) classified all Wisconsin lakes using a random data set collected in the summer (July and August). The index, shown on page 12 of "Water-Quality and Lake-Stage data for Wisconsin Lakes, Water Year 1996," is based on surface total phosphorus and chlorophyll a concentrations, and Secchi depths. According to the index, surface total phosphorus and Secchi depths in Mary Lake indicate "good" water quality, and surface chlorophyll a concentrations indicate "very good" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Mary Lake with other lakes in southeastern Wisconsin. The comparison in Table 3 shows the percentage distribution of southeastern Wisconsin lakes within each condition group and the relative position of Mary Lake.

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The 1996 TSI data is listed in Table 2. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Mary Lake during the 2 year study period. The data from 1996 show the lake to be mesotrophic, or a lake with moderate nutrient levels.

Table 1. Lake-depth profiles for Mary (Marie) Lake at Twin Lakes, Wisconsin, 1996 water year

WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
FEB 1996					
05...	3.00	2.0	715	7.9	14.5
05...	6.00	2.5	706	8.1	13.7
05...	9.00	3.0	698	8.3	13.0
05...	12.0	3.5	701	8.3	13.4
05...	15.0	4.0	718	8.3	13.2
05...	18.0	4.5	719	8.1	9.4
05...	21.0	4.5	714	8.0	8.6
05...	24.0	4.5	725	7.9	6.6
05...	27.0	5.0	733	7.9	5.9
05...	30.0	5.0	749	7.8	4.8
05...	31.0	5.0	743	7.8	4.6
05...	32.0	--	--	--	--
APR					
16...	1.50	7.5	643	8.5	11.5
16...	3.00	7.5	642	8.5	11.5
16...	6.00	7.5	643	8.5	11.5
16...	9.00	7.5	643	8.5	12.2
16...	12.0	7.5	644	8.5	13.0
16...	15.0	7.5	643	8.5	12.7
16...	18.0	7.5	644	8.5	12.0
16...	21.0	7.5	642	8.5	11.7
16...	24.0	7.5	642	8.5	11.6
16...	27.0	7.5	641	8.5	11.6
16...	30.0	7.5	642	8.5	11.7
16...	30.5	7.5	642	8.5	11.6
16...	32.0	--	--	--	--
JUN					
10...	1.50	17.0	609	8.4	9.1
10...	3.00	17.0	609	8.5	9.0
10...	6.00	17.0	610	8.5	9.1
10...	9.00	17.0	612	8.5	9.9
10...	12.0	17.0	612	8.5	10.3
10...	15.0	17.0	612	8.5	10.0
10...	18.0	16.5	614	8.4	9.0
10...	21.0	16.5	616	8.4	8.4
10...	24.0	16.0	622	8.3	8.0
10...	27.0	14.5	633	8.0	6.0
10...	30.0	14.5	636	8.0	5.3
10...	32.0	14.5	637	8.0	5.2
10...	33.5	--	--	--	--
JUL					
15...	1.50	24.0	611	8.5	8.3
15...	3.00	24.0	611	8.5	8.3
15...	6.00	24.0	610	8.5	8.6
15...	9.00	24.0	612	8.5	9.0
15...	12.0	24.0	613	8.5	9.4
15...	15.0	24.0	610	8.5	9.2
15...	18.0	23.0	618	8.2	6.0
15...	21.0	18.0	639	7.7	0.8
15...	24.0	17.0	647	7.7	0.4
15...	27.0	16.5	653	7.7	0.4
15...	30.0	15.5	654	7.6	0.2
15...	33.0	15.0	662	7.5	0.1
15...	36.0	14.5	665	7.5	0.1
15...	37.0	14.5	667	7.5	0.2
15...	38.5	--	--	--	--
AUG					
12...	1.50	25.0	608	8.3	7.5
12...	3.00	25.0	609	8.3	7.5
12...	6.00	25.0	609	8.3	7.7
12...	9.00	25.0	611	8.3	8.2
12...	12.0	25.0	611	8.3	8.5
12...	15.0	25.0	610	8.3	8.2
12...	18.0	23.0	619	7.8	2.4
12...	21.0	20.5	638	7.5	0.3
12...	24.0	18.5	655	7.4	0.4
12...	28.0	17.5	663	7.3	0.4
12...	29.5	--	--	--	--

Table 2.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Mary (Marie) Lake, 1996 water year

[- indicates not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus
	Depth (meters)	Depth (feet)	T.S.I.	Depth (feet)	Conc. (mg/L)	Conc. (µg/L)	T.S.I	Conc. (µg/L)	T.S.I.	Conc. (mg/L)
04/16/96	2.9	9.5	45	1.5	0.013	13	48	6.8	49	<0.002
	-	-	-	31	0.011	11	-	-	-	<0.002
06/10/96	4.6	15.1	38	1.5	0.013	13	48	7.1	50	--
	-	-	-	32	0.024	24	-	-	-	--
07/15/96	2.1	6.9	49	1.5	0.013	13	48	4.3	46	--
	-	-	-	37	0.083	83	-	-	-	--
08/12/96	3.0	9.8	44	1.5	0.010	10	46	4.0	45	--
	-	-	-	28	0.040	40	-	-	-	--

Table 3. Regional lake condition and percentage distribution of southeastern lakes

	Parameter		Percentage distribution of lakes in southeast Wisconsin within parameter ranges
	Total Phosphorus (mg/L)		
	<0.010	best condition	7
Mary Lake Values	0.010-0.020		21
	0.020-0.030		15
	0.030-0.050		21
	0.050-0.100		21
	0.100-0.150		3
	>0.150	worst condition	12
	Chlorophyll a (µg/L)		
Mary Lake Values	0-5	best condition	22
	5-10		31
	10-15		14
	15-30		12
	>30	worst condition	22
	Secchi depth (feet)		
	>19.7	best condition	1
	9.8-19.7		9
Mary Lake Values	6.6-9.8		26
	3.3-6.6		31
	<3.3	worst condition	33

Table 4. 1995 - 96 USGS lake stage values for Mary Lake at Twin Lakes, WI

1995	stage (ft)
Jun 26	793.56
Jul 13	793.53
Aug 16	793.57

1996	stage (ft)
Apr 16	793.82
Jun 10	794.12
Jul 15	793.87
Aug 12	793.87
Nov 20	793.76

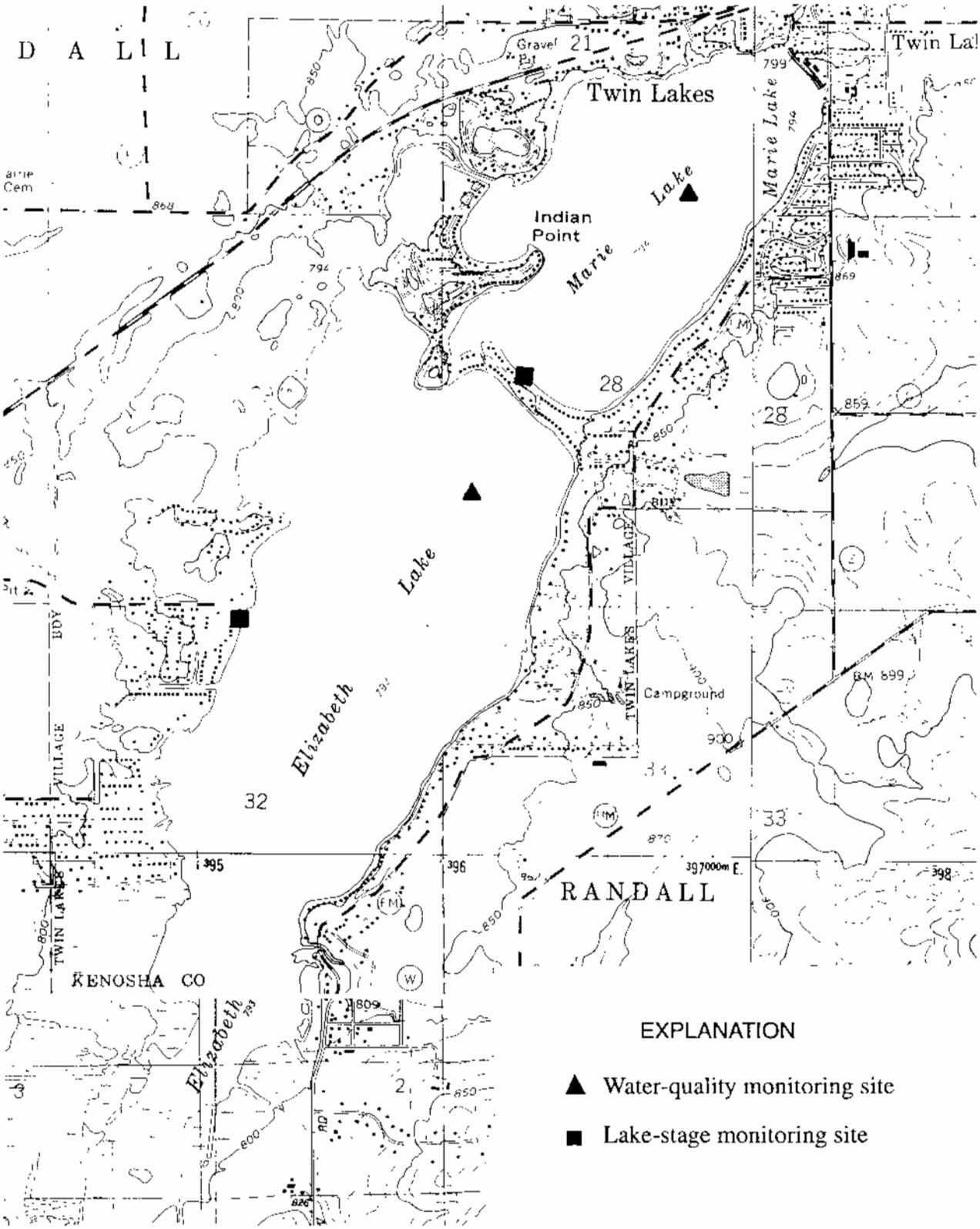

Figure 1. Locations of water-quality and lake-stage monitoring sites on Elizabeth and Marie Lakes at Twin Lakes, Wisconsin.

LOCATION.--Lat 42°31'28", long 88°15'12", in SW 1/4 SE 1/4 sec.21, T.1 N., R.19 E., Kenosha County, Hydrologic Unit 07120006, near Twin Lakes.

PERIOD OF RECORD.--February 1995 to current year.

REMARKS.--Lake sampled slightly north of center at the deep hole. Lake ice-covered during February measurements. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 05 TO AUGUST 12, 1996

(Milligrams per liter unless otherwise indicated)

	Feb. 05		Apr. 16		June 10		July 15		Aug. 12	
SDepth of sample (ft)	3.0	31	1.5	31	1.5	32	1.5	37	1.5	28
Lake stage (ft)										
Specific conductance (µS/cm)	715	743	643	642	609	637	611	667	608	663
pH (units)	7.9	7.8	8.5	8.5	8.4	8.0	8.5	7.5	8.3	7.3
Water temperature (°C)	2.0	5.0	7.5	7.5	17.0	14.5	24.0	14.5	25.0	17.5
Color (Pt-Co. scale)	---	---	5	5	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.90	0.90	---	---	---	---	---	---
Secchi-depth (meters)			2.9		4.6		2.1		3.0	
Dissolved oxygen	14.5	4.6	11.5	11.6	9.1	5.2	8.3	0.2	7.5	0.4
Hardness, as CaCO3	---	---	250	250	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	37	37	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	39	39	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	35	35	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	2	2	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	190	190	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	41	41	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	74	74	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	0.1	0.1	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	0.4	0.4	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	360	360	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.06	0.06	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	<0.03	<0.03	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.80	0.70	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.86	0.76	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.013	0.011	0.013	0.024	0.013	0.083	0.010	0.040
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	<0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<10	<10	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	<0.4	<0.4	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	6.8	---	7.1	---	4.3	---	4.0	---

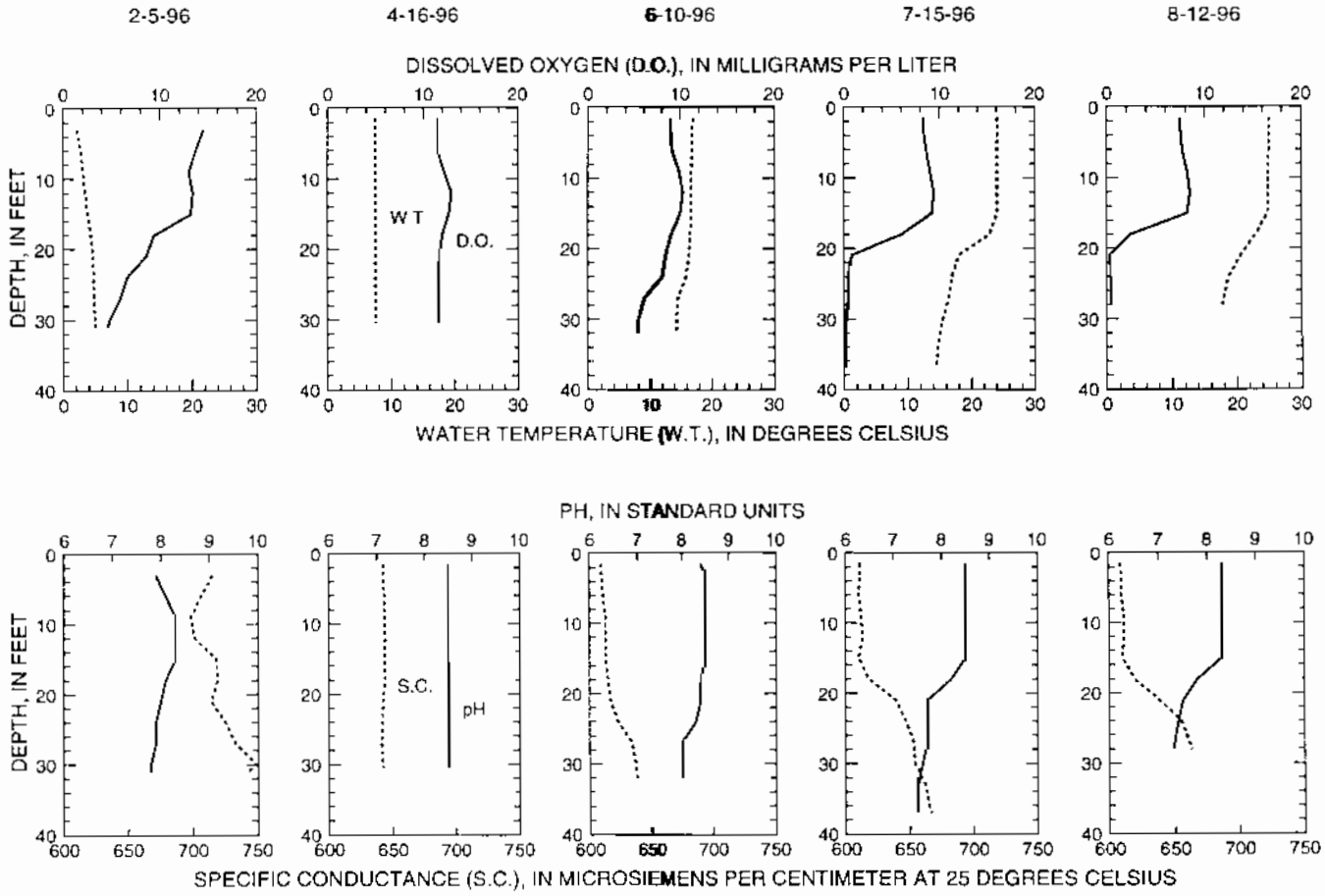

Figure 2. Water-quality data and depth profiles for Mary (Marie) Lake at Twin Lakes, Wisconsin, 1996 water year

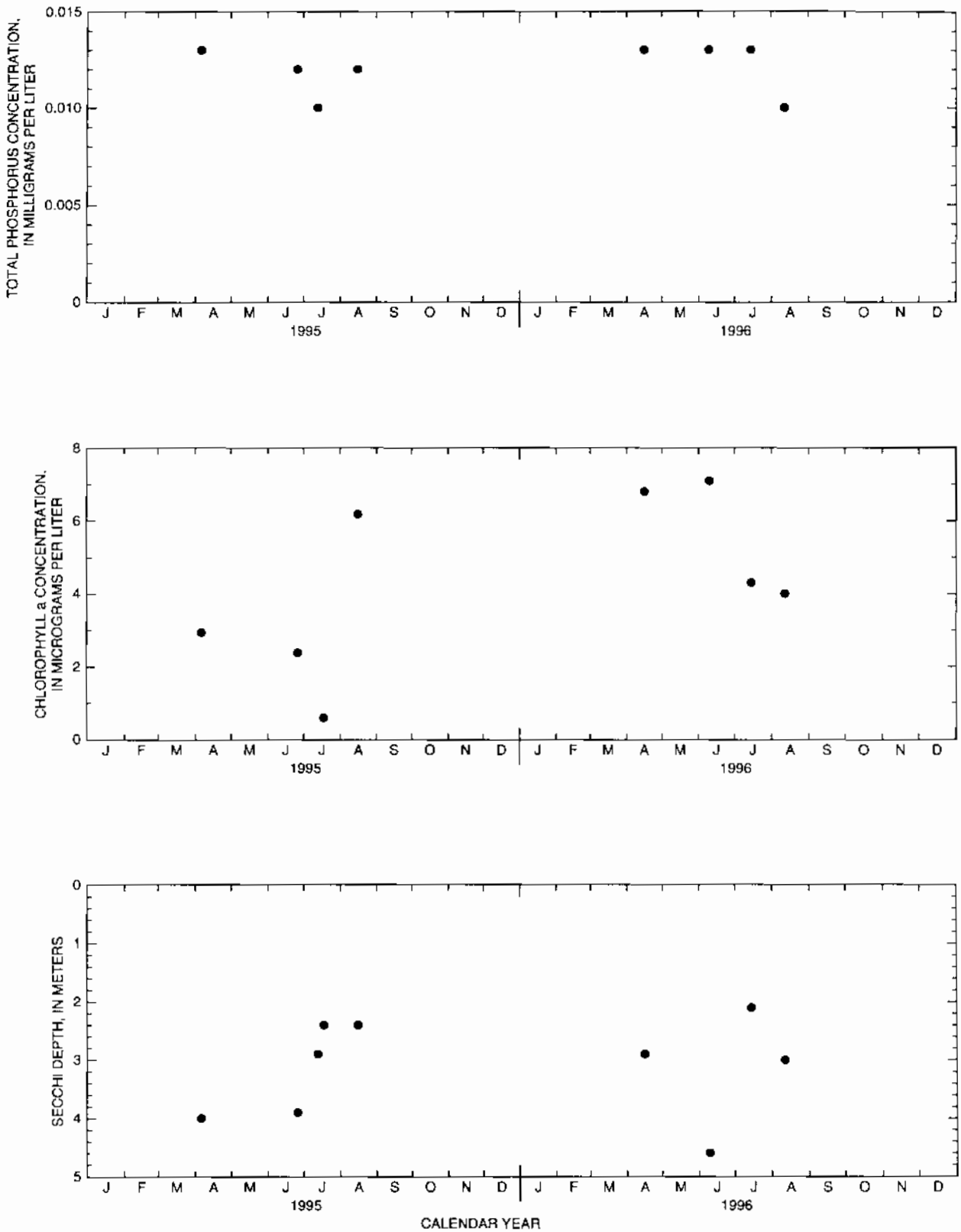

Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Mary (Marie) Lake at Twin Lakes, Wisconsin.

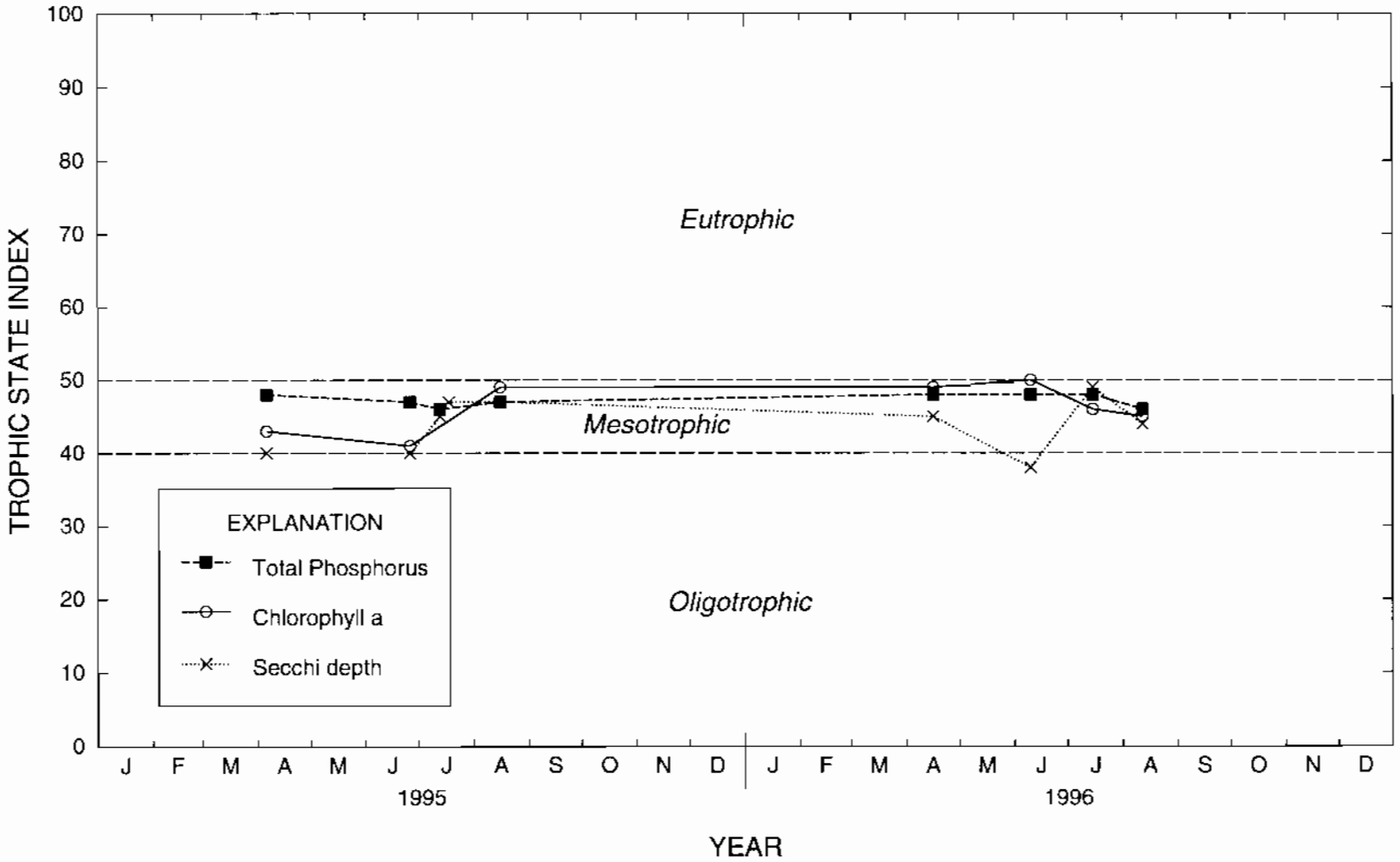

Figure 4. Trophic state indices for Mary (Marie) Lake at Twin Lakes, Wisconsin

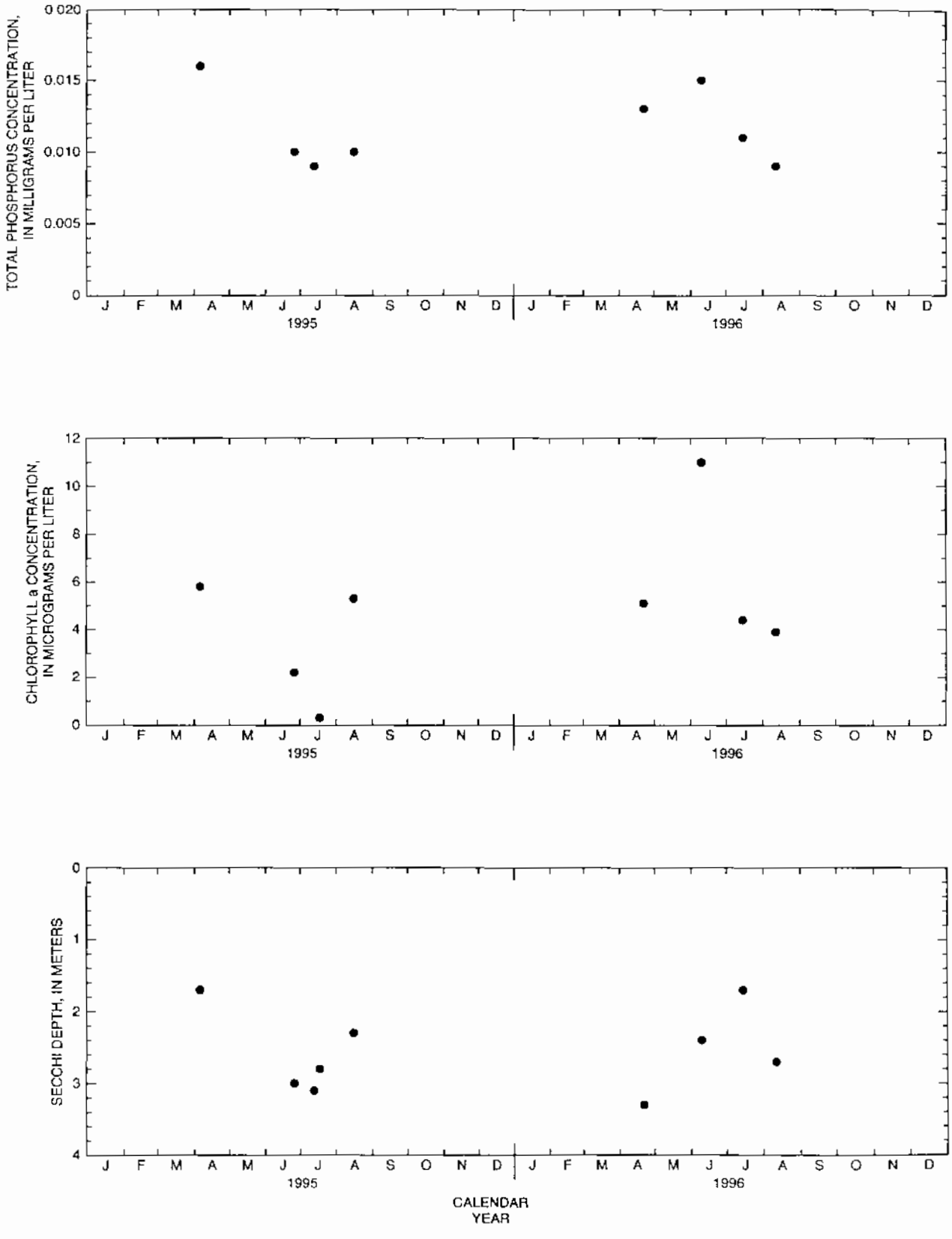

Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Elizabeth Lake near Twin Lakes, Wisconsin.

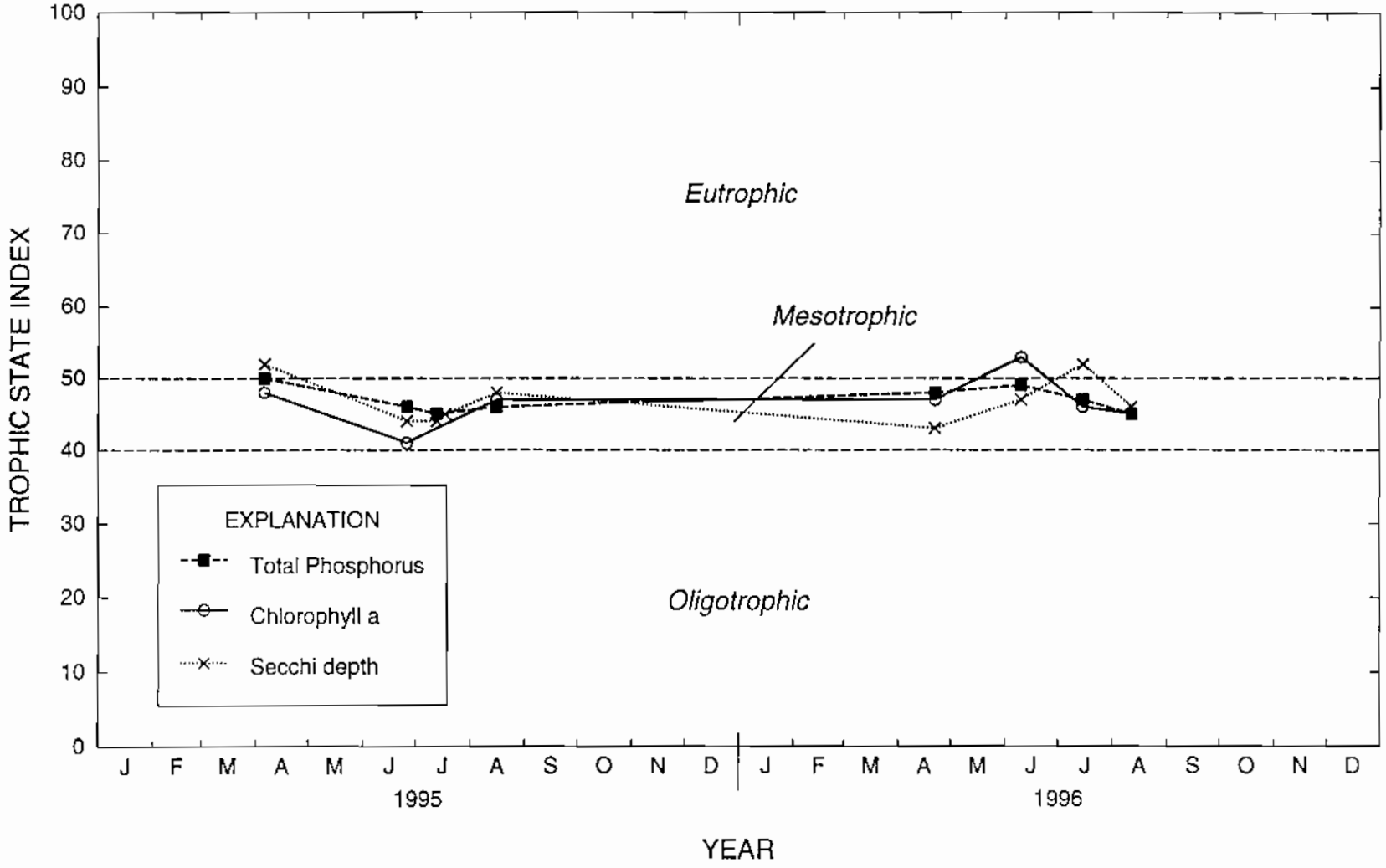

Figure 4. Trophic state indices for Elizabeth Lake near Twin Lakes, Wisconsin

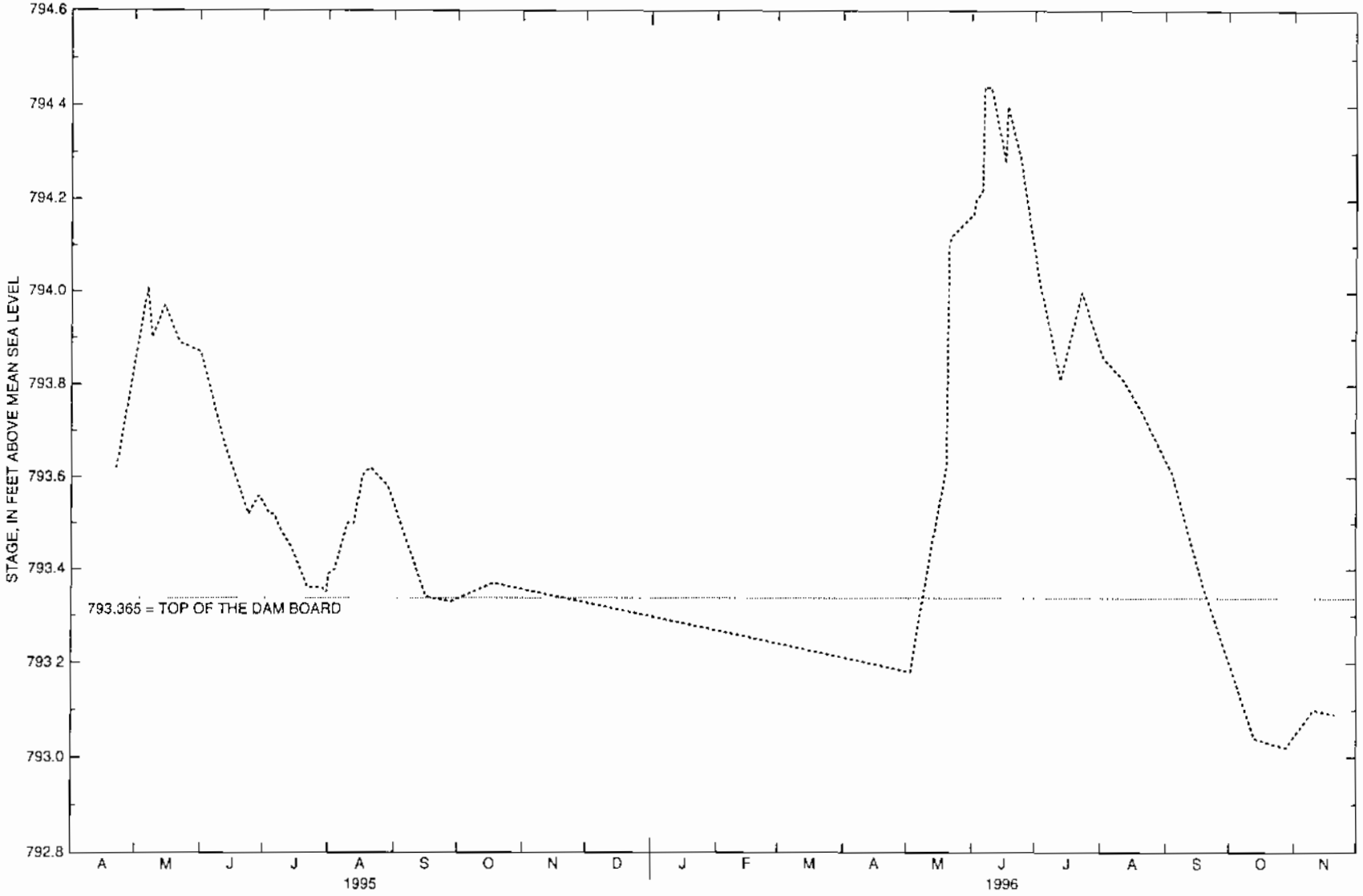

Figure 5. 1995 - 96 Observer lake stage plot for Elizabeth Lake, at Twin Lakes, WI