Whitefish Lake near Gordon, WI
Water-Quality Data Summary

This summary covers the second two years, 2000 and 2001, of the four years of water-quality monitoring of Whitefish Lake by the U.S. Geological Survey (USGS). All data that were collected are given in the attached tables and shown in accompanying figures. Data collected in 1998 and 1999 are included in graphs to show 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 2001" and to Shaw and others (1994) "Understanding Lake Data."

Lake description and sampling locations:

Whitefish Lake is classified as a seepage lake, a lake with no perennially flowing inlets or outlets. The average depth of the lake is 9.1 meters, maximum depth is 31 meters, and the surface area is 832 acres (1.30 square miles). The main water-quality sampling site is located at the deepest point in the south basin of the lake. An auxiliary sampling site is located in the north basin where depth is about 17 meters. Lake stage was monitored on the south side of the lake near the public launch. The locations of the monitoring sites are shown in Figure 1.

Lake Data:

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. The stages ranged from 4.74 feet on June 8, 2000 to 5.39 feet on June 13, 2001. Owing to the infrequency of measurements, actual range of fluctuation during the two-year period may have been greater than observed. Stage values are shown in the table on the top half of Figure 2a,b. Observed stages for the entire four-year monitoring period are shown in figure 2c.

Lake-depth profiles:

Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance exhibit a pattern typical of lakes that develop strong thermal stratification. These profiles, which were measured over the deepest points in each of the basins of the lake, are listed in Tables 1a and 1b and shown in Figures 2a and 2b. During the February through August sampling periods, complete water-column mixing was observed in both basins during spring turnover at the April sampling visits. The lake becomes thermally stratified through the summer. Anoxic regions developed only in the deepest waters (1 – 3 meters) in July and August. The anoxic zone is unable to support fish. The pH, which ranged between 6.5 and 8.1, is common for northwestern Wisconsin lakes and poses no problem for aquatic life.

Chemical constituents:

Analyses of water samples collected in April during spring turnover for selected chemical constituents for chemical characterization of the lake are shown in Figures 2a and 2b. The constituent values for color, chlorophyll a, chloride, 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 ratio of dissolved nitrogen to dissolved phosphorus (N:P) was greater than 27:1 in April at spring turnover, based on the surface concentrations. The N:P ratios for July averaged less than 10:1. Ratios greater than 15:1 indicate algal growth is limited by available phosphorus, and ratios less than 10:1 indicate that growth is limited by available nitrogen. Ratios between 10:1 and 15:1 are regarded as transitional between indicating nitrogen limited and phosphorus limited conditions. Relatively phosphorus-rich waters that are nitrogen limited have a propensity to experience blue-green algal blooms. However, in Whitefish Lake phosphorus concentrations are so low that algal blooms are unlikely.

Three common measures of water quality used as indices are concentrations of near-surface total-phosphorus and chlorophyll a, and Secchi depth. At the Deep Hole (South Basin) sampling site, total phosphorus concentrations ranged from <0.005 mg/L on many sampling dates to 0.010 mg/L; chlorophyll a ranged from <1 µg/L on many sampling dates to 1.8 µg/L on May 3, 2001; and Secchi depths ranged from 3.7 m on May 3, 2001 to 11.6 m on June 13, 2001. At the North sampling site, total phosphorus concentrations were ranged from <0.005 mg/L to 0.008 mg/L, chlorophyll a ranged from <1 µg/L on several sampling dates to 3.3 µg/L on May 3, 2001, and Secchi depths ranged from 3.7 m on May 3, 2001 to 10.9 m on June 13, 2001. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for the 1998-2001 period are shown on Figure 3a and 3b.

Total phosphorus concentration 0.5 meters above the lake bottom at the south sampling site ranged from 0.009 mg/L on April 12, 2000 to 0.206 mg/L on Mar. 2, 2001. These relatively low total phosphorus

concentrations in deep anoxic waters are indicative of minimal phosphorus release from the bottom sediments.

Lake condition:

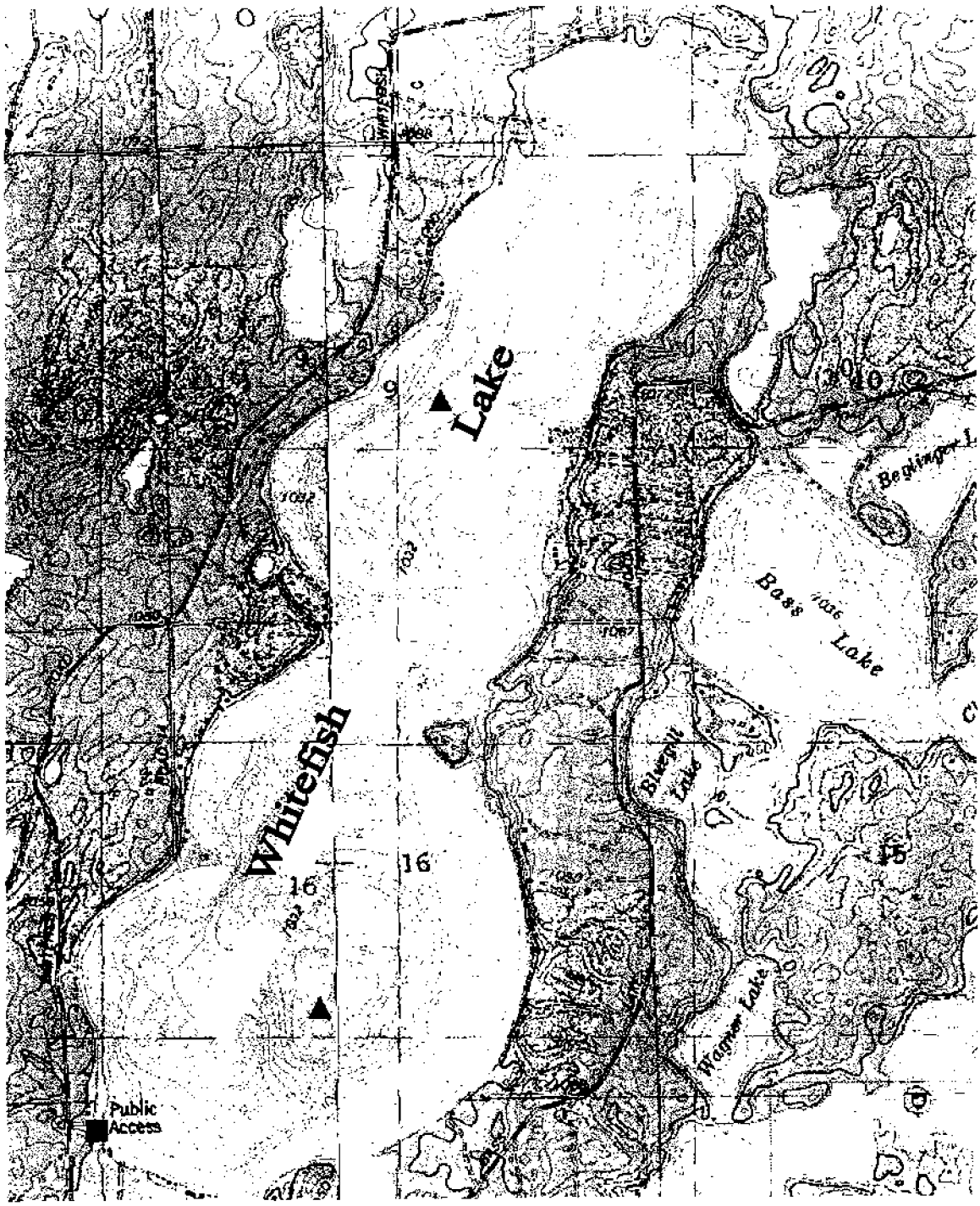
Water-quality index:

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 14 of "Water-Quality and Lake-Stage data for Wisconsin Lakes, Water Year 2001," is based on surface total-phosphorus and chlorophyll a concentrations, and Secchi depths. According to the index, surface total-phosphorus, chlorophyll a concentrations and Secchi depths in Whitefish Lake indicate "excellent" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Whitefish Lake with other lakes in northwestern Wisconsin. The comparison in Table 3 shows the percentage distribution of northwestern Wisconsin lakes within each condition group and the relative position of Whitefish Lake. Clearly, Whitefish Lake is one of the least nutrient-enriched lakes in northwestern Wisconsin and all of Wisconsin.

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The 1999 TSI data is listed in Tables 2a and 2b. The bottom plot on Figures 3a and 3b is a graphical illustration of the variation in Trophic State Indices for Whitefish Lake during the 4-year study period. The data show the lake to be oligotrophic, or a lake with low nutrient levels.



EXPLANATION

▲ Water-quality monitoring site

■ Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Whitefish Lake near Gordon, Douglas County, Wisconsin

461212091523200 WHITEFISH LAKE, SOUTH BASIN, NEAR GORDON, WI

LOCATION.--Lat 46°12'12", long 91°52'32", in SE 1/4 SW 1/4 sec.16, T.43 N., R.12 W., Douglas County, Hydrologic Unit 07030002, near Gordon

PERIOD OF RECORD.--March 1998 to current year.

REMARKS.--Lake sampled at deepest part of southern basin. Lake ice-covered during March sampling. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 03 TO AUGUST 10, 2000
(Milligrams per liter unless otherwise indicated)

	Mar-3		Apr-12		Jun-8		Jul-13		Aug-10	
Lake stage (ft)	---		4.82		4.74		4.88		4.79	
Secchi depth (m)	---		6.4		8.6		8.3		7.90	
Chlorophyll a, phytoplankton (ug/L)	---		<1.00		<1.00		<1.00		1.7	
Depth of sample (m)	0.5	27.0	0.5	27.0	0.5	28.0	0.5	27.0	0.5	28.0
Water temperature (°C)	2.3	3.8	5.4	5.2	18.1	5.5	22.5	5.8	23.4	5.8
Specific conductance (uS/cm)	39	46	37	37	38	40	39	42	37	43
pH (units)	7.3	6.7	6.8	7.1	8.0	6.2	7.9	7.0	8.1	6.5
Dissolved oxygen (mg/L)	13.6	1.2	12.7	12.4	9.9	6.4	9.2	2.8	8.3	0.2
Phosphorus, total (as P)	0.007	0.163	0.010	0.009	<0.005	0.035	0.006	0.065	---	0.044
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	---	---	---	<0.002	---	<0.002	0.003
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.041	---	---	---	0.013	---	0.011	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.015	---	---	---	0.038	---	<0.013	---
Nitrogen, amm. + org., total (as N)	---	---	0.41	---	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.45	---	---	---	---	---	---	
Color (Pt-Co. scale)	---	---	15	---	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.7	---	---	---	---	---	---	---
Hardness, (as CaCO3)	---	---	35	---	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	12	---	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	1.3	---	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	0.9	---	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	0.4	---	---	---	---	---	---	---
Alkalinity, (as CaCO3)	---	---	26	---	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	<4.5	---	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	0.6	---	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	0.2	---	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	26	---	---	---	---	---	---	---
Iron, dissolved (Fe) ug/L	---	---	30	---	---	---	---	---	---	---
Manganese, dissolved (Mn) ug/L	---	---	4	---	---	---	---	---	---	---

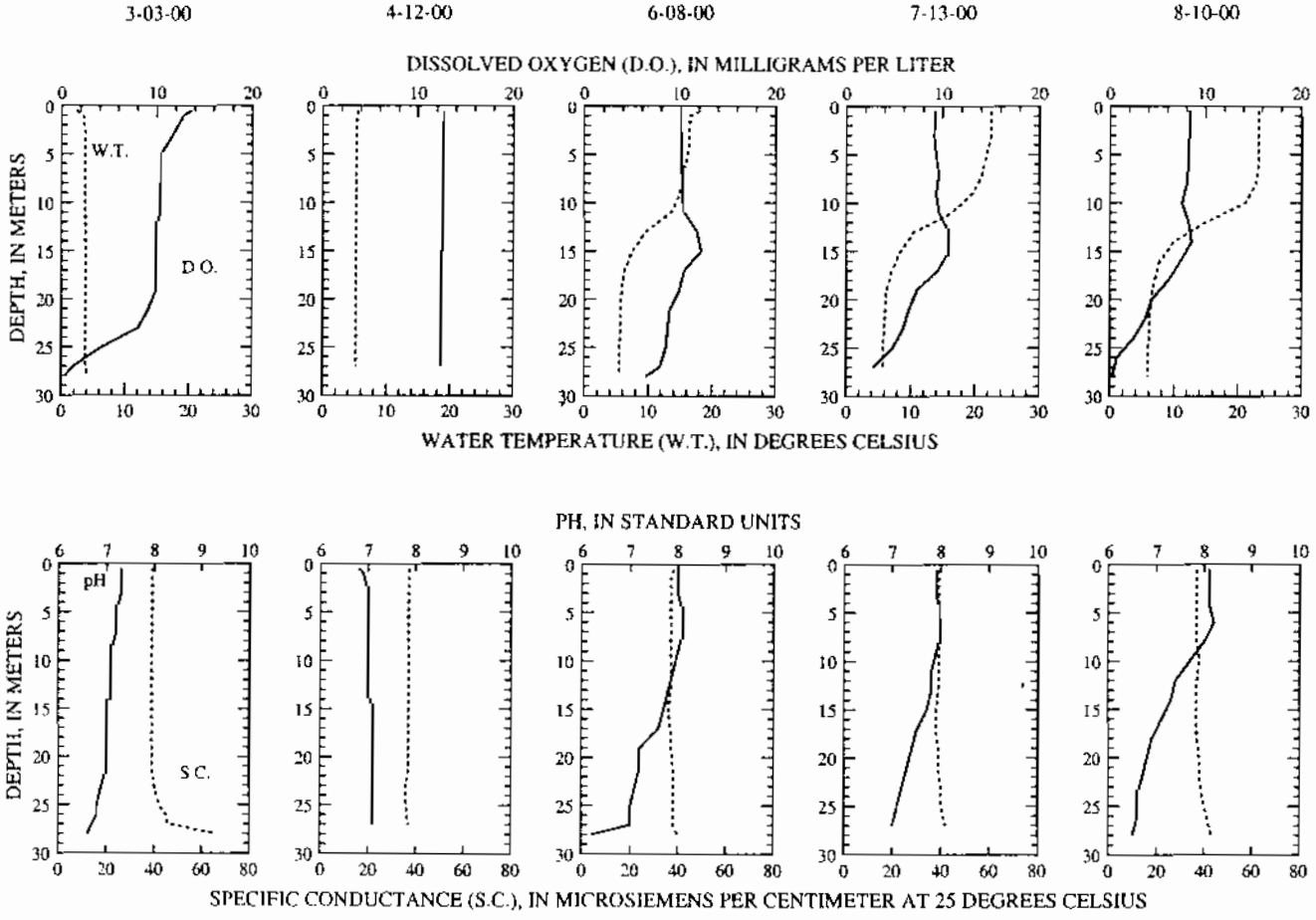


Figure 2a. Water quality and depth profiles for Whitefish Lake's south basin near Gordon, Wisconsin for year 2000.

461212091523200 WHITEFISH LAKE, SOUTH BASIN, NEAR GORDON, WI

LOCATION.--Lat 46°12'12", long 91°52'32", in SE 1/4 SW 1/4 sec.16, T.43 N., R.12 W., Douglas County, Hydrologic Unit 07030002, near Gordon.

PERIOD OF RECORD.--March 1998 to current year.

REMARKS.--Lake sampled at deepest part of southern basin. Lake ice-covered during March sampling. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 02 TO AUGUST 14, 2001
(Milligrams per liter unless otherwise indicated)

	Mar-2		May-3	Jun-13		Jul-12		Aug-14		
Lake stage (ft)	---		5.27	5.39		5.10		5.09		
Secchi-depth (m)	---		3.7	11.6		9.5		6.90		
Chlorophyll a, phytoplankton (µg/L)	---		1.8	<1		<1		<1		
Depth of sample (m)	0.5	27.0	0.5	0.5	28.0	0.5	27.0	0.5	11.0	27.0
Water temperature (°C)	0.5	4.1	9.2	19.5	6.2	23.2	6.6	24.2	15.4	6.6
Specific conductance (µS/cm)	50	59	35	38	37	38	38	38	37	40
pH (units)	7.5	6.5	8.1	7.4	7.0	8.0	6.7	8.1	7.6	6.6
Dissolved oxygen (mg/L)	12.1	0.8	12.1	9.4	7.9	8.3	5.6	9.0	10.8	1.4
Phosphorus, total (as P)	<0.005	0.206	0.006	0.006	0.013	<.005	0.010	0.007	0.009	0.041
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	---	---	0.003	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.039	---	---	0.010	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.014	---	---	0.013	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.24	---	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.279	---	---	---	---	---	---	---
Color (Pt-Co. scale)	---	---	20	---	---	---	---	---	---	---
Turbidity (NTU)	---	---	2.1	---	---	---	---	---	---	---
Hardness, (as $CaCO_3$)	---	---	17.6	---	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	4.9	---	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	1.3	---	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	0.9	---	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	0.4	---	---	---	---	---	---	---
Alkalinity, (as $CaCO_3$)	---	---	17	---	---	---	---	---	---	---
Sulfate, dissolved (SO_4)	---	---	<4.5	---	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	0.9	---	---	---	---	---	---	---
Silica, dissolved (SiO_2)	---	---	0.5	---	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	26	---	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<10	---	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	0.8	---	---	---	---	---	---	---

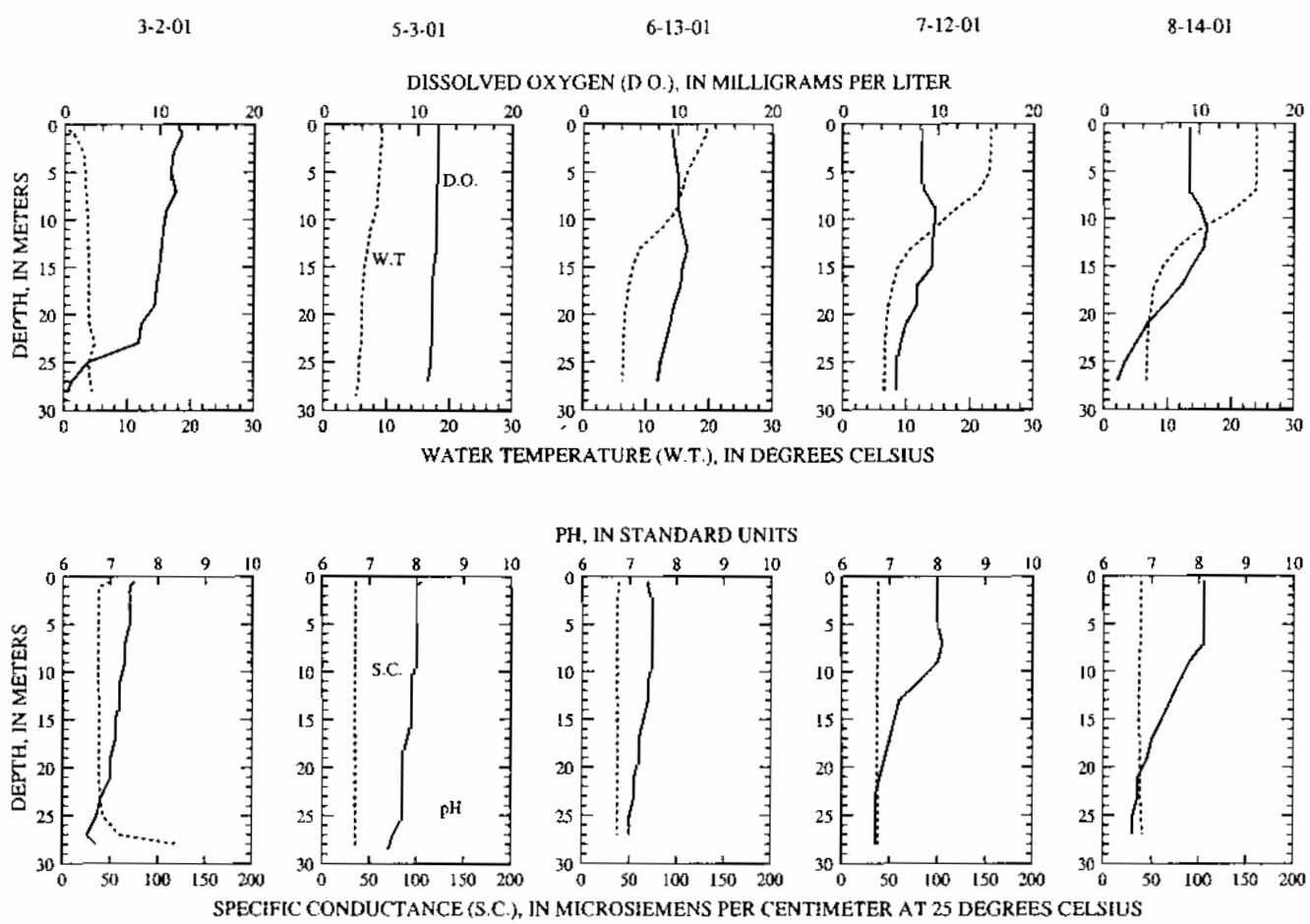


Figure 2a (continued). Water quality and depth profiles for Whitefish Lake's south basin near Gordon, Wisconsin for year 2001.

461321091520900 WHITEFISH LAKE, NORTH SITE, NEAR GORDON, WI

LOCATION.--Lat 46°13'21", long 91°52'09", in NW 1/4 SE 1/4 sec.9, T.43 N., R.12 W., Douglas County, Hydrologic Unit 07030002, near Gordon.

PERIOD OF RECORD.--March 1998 to current year.

REMARKS.--Lake sampled at deepest part of northern basin. Lake ice-covered during March sampling. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 03 TO AUGUST 10, 2000
(Milligrams per liter unless otherwise indicated)

	Mar-3	Apr-12	Jun-8	Jul-13		Aug-10	
Lake stage (ft)	---	4.82	4.74	4.88		4.79	
Secchi-depth (m)	---	6.6	8.0	6.6		7.5	
Chlorophyll a, phytoplankton (ug/L)	---	1.07	<1.00	1.07		1.5	
Depth of sample (m)	0.5	0.5	0.5	0.5	15.0	0.5	16.0
Water temperature (°C)	3.2	5.8	19.1	22.7	12.8	23.8	12.7
Specific conductance (uS/cm)	41	37	38	39	52	37	79
pH (units)	7.4	7.3	7.9	8.0	6.8	8.0	7.0
Dissolved oxygen (mg/L)	14.6	12.7	9.7	9.6	0.2	8.7	0.1
Phosphorus, total (as P)	0.006	0.008	<0.005	0.006	0.026	<0.005	0.044

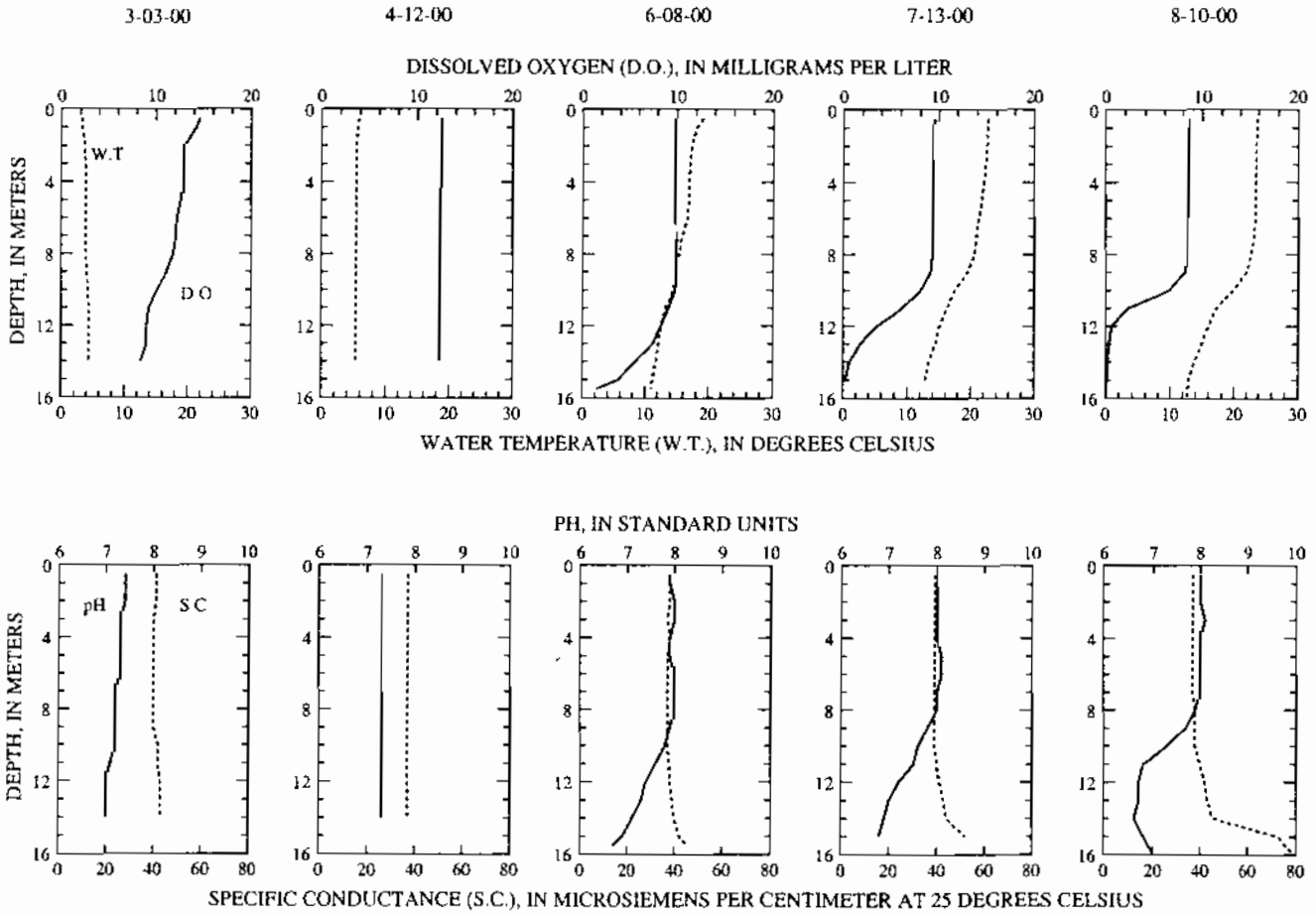


Figure 2b. Water quality and depth profiles for Whitefish Lake's north basin near Gordon, Wisconsin for year 2000.

461321091520900 WHITEFISH LAKE, NORTH BASIN, NEAR GORDON, WI

LOCATION.--Lat 46°13'21", long 91°52'09", in NW 1/4 SE 1/4 sec.9, T.43 N., R.12 W., Douglas County, Hydrologic Unit 07030002, near Gordon.

PERIOD OF RECORD.--March 1998 to current year.

REMARKS.--Lake sampled at deepest part of northern basin. Lake ice-covered during March sampling. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 02 TO AUGUST 14, 2001
(Milligrams per liter unless otherwise indicated)

	Mar-2		May-3	Jun-13	Jul-12	Aug-14	
Lake stage (ft)	---		5.27	5.39	5.10	5.09	
Secchi-depth (m)	---		3.7	10.9	9.1	6.5	
Chlorophyll a, phytoplankton (µg/L)	---		3.3	1.1	<1	1.2	
Depth of sample (m)	0.5	15.0	0.5	0.5	0.5	0.5	15.0
Water temperature (°C)	0.1	4.5	10.1	19.8	23.2	24.4	12.8
Specific conductance (µS/cm)	9	44	35	37	38	38	63
pH (units)	7.9	6.7	7.6	7.4	8.0	8.1	6.7
Dissolved oxygen (mg/L)	9.7	3.4	11.8	9.0	8.5	8.9	0.4
Phosphorus, total (as P)	0.050	0.153	<0.005	0.006	<0.005	0.006	0.040

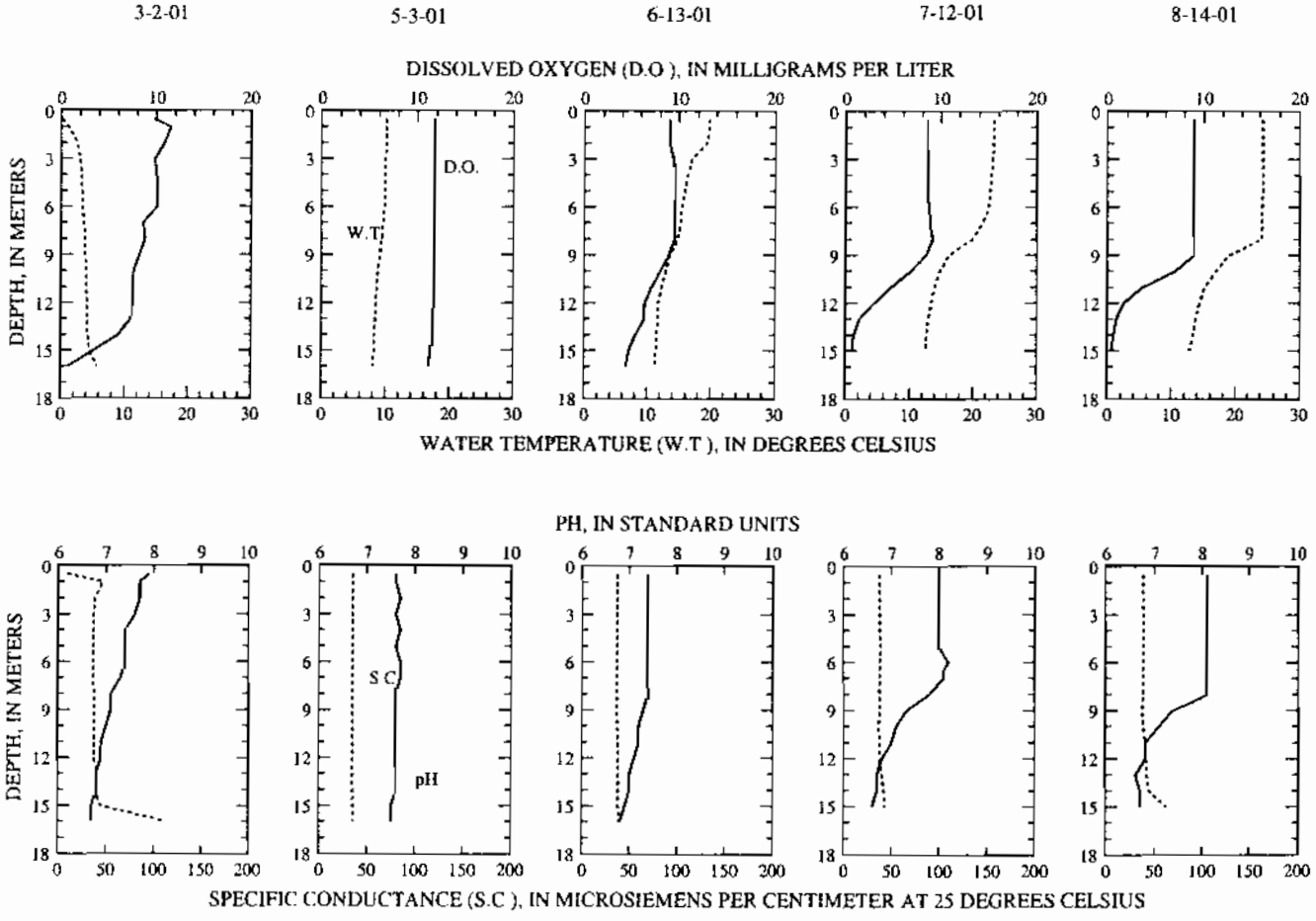


Figure 2b (continued). Water quality and depth profiles for Whitefish Lake's north basin near Gordon, Wisconsin for year 2001.

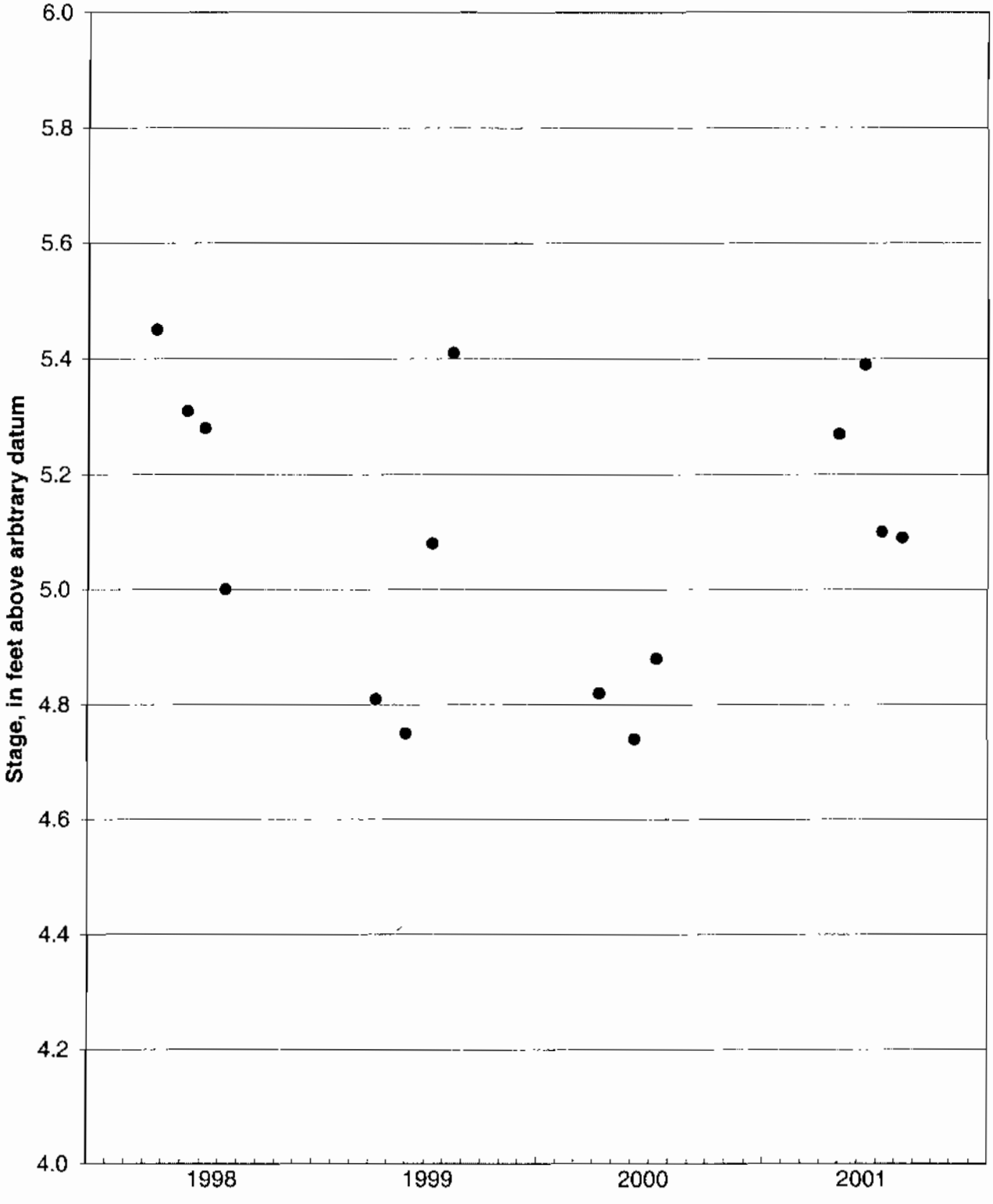


Figure 2c. Observed stages (water levels) in Whitefish Lake near Gordon, Wiscosin, 1998 - 2001.

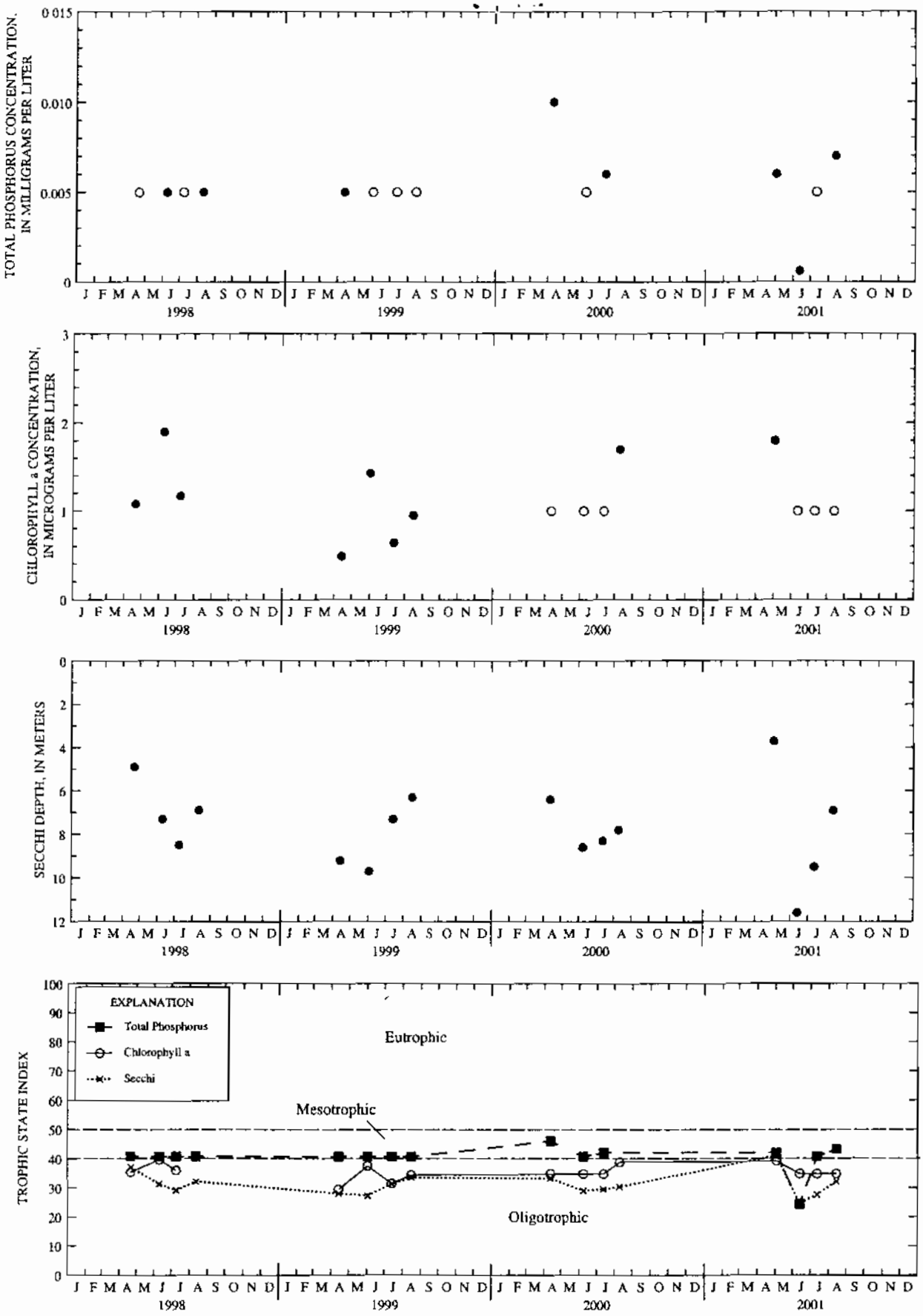


Figure 3a. Surface total phosphorus, chlorophyll a concentrations, Secchi depth, and TSI data for Whitefish Lake, South Basin, near Gordon, Wisconsin, 1998 – 2001.

(Circles on the first three plots indicate laboratory detection limit for selected analyses. Actual concentrations for these particular analyses are less than the plotted circles.)

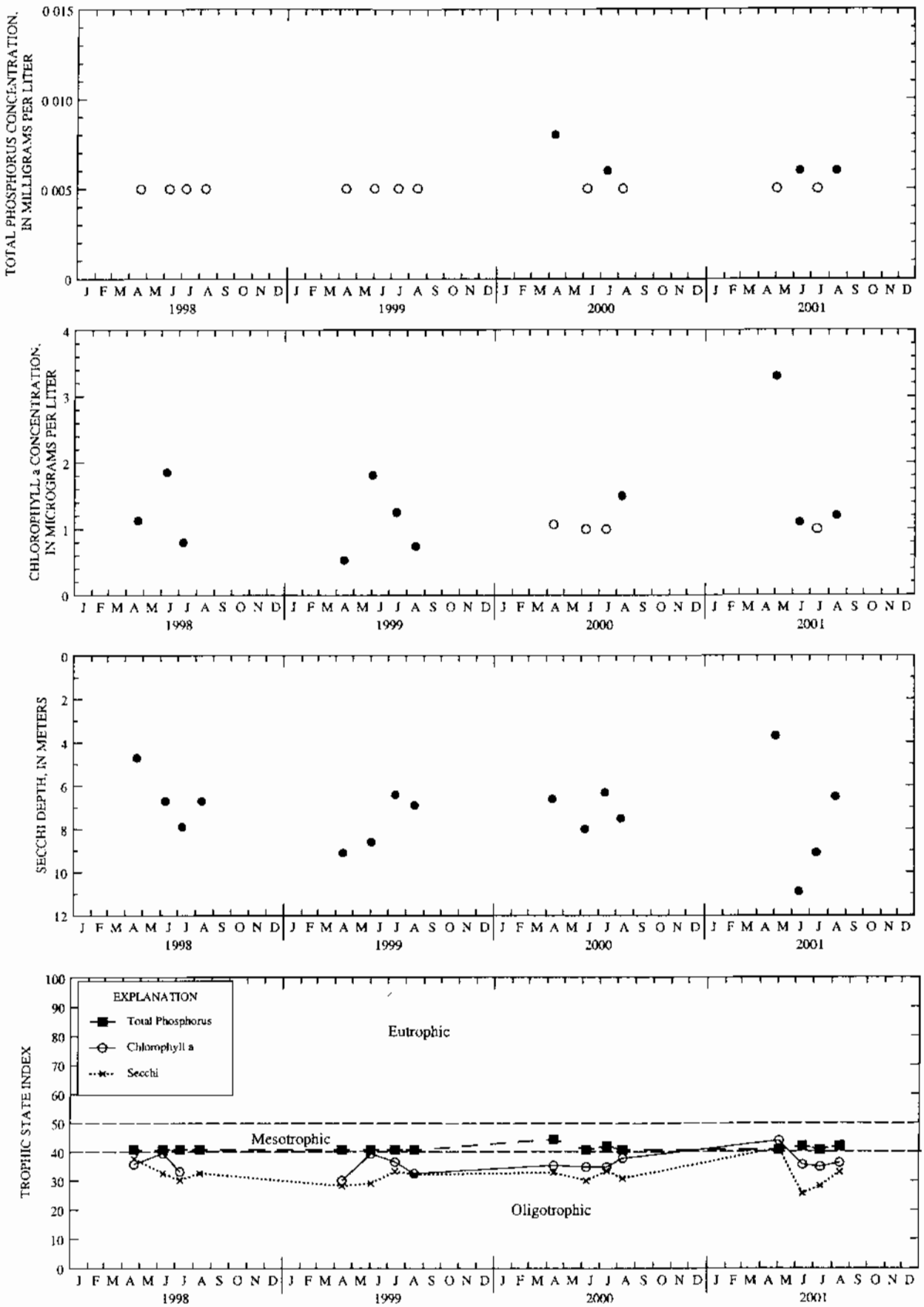


Figure 3b. Surface total phosphorus, chlorophyll a concentrations, Secchi depth, and TSI data for Whitefish Lake, North Basin, near Gordon, Wisconsin, 1998 – 2001.

(Circles on the first three plots indicate laboratory detection limit for selected analyses. Actual concentrations for these particular analyses are less than the plotted circles.)

Table 3. Late summer condition of Whitefish Lake relative to other northwestern Wisconsin Lakes

[Average July and August values for 1998-2001]
[mg/L, milligrams per liter; µg/L; Micrograms per liter]

	Parameter (late Summer values)		Percentage distribution of lakes in southeastern Wisconsin within parameter ranges [1]
	Total Phosphorus (mg/L)		
Whitefish Lake	<0.010	best condition	12
	0.010-0.020		35
	.020-0.030		23
	0.030-0.050		18
	0.050-0.100		8
	0.100-0.150		3
	>0.150	worst condition	1
	Chlorophyll a (µg/L)		
Whitefish Lake	0 - 5	best condition	29
	5 - 10		36
	10 - 15		14
	15 - 30		14
	>30	worst condition	9
	Secchi depth (meters)		
Whitefish Lake	>6	best condition	
	3 - 6		22
	2 - 3		29
	1 - 2		30
	0 - 1	worst condition	19

[1] Percentages for each range are rounded to nearest whole unit. Hence, the sum may not equal 100 percent.

Data in this table are from Lillie, R.A. and Mason, J.W., 1983, *Limnological characteristics of Wisconsin Lakes:* Wisconsin Department of Natural Resources Tech. Bull. 138, 116 p.