Druid Lake Near Hartford, Wisconsin
Water-Quality Data Summary

This summary covers the period October 1991 to September 1996, which is the period of water-quality monitoring of Druid Lake by the U.S. Geological Survey (USGS). Emphasis in this summary is on data collected during 1996. All data collected during 1996 are included. Data from previous years are 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:

Druid Lake is classified as a drainage lake, with one inlet and one outlet. The average depth of Druid Lake is 25 feet, the surface area is 121 acres (0.19 square miles). The water-quality sampling site is located at the deepest point in the lake at a depth of about 51 feet. Lake stage was monitored at Bill Noennig's residence along the southwest shoreline. The locations of these 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 °F colder than normal for the period December 1995 through March 1996; April and May was 4.0 °F colder than normal; and the period June through August was 1.3 °F colder than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1996 was about normal (103 percent of normal precipitation) for southeastern Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1996); however, watershed runoff in the region of Druid Lake was between 160 and 180 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 Bill Noennig intermittently, and by the USGS on sampling dates. Observed stages ranged from 10.71 feet on September 21 to 13.22 feet on June 19. This range of fluctuation is much greater than the previous 5 years of monitoring. Stage values are listed in table 1 and in the table on the top half of Figure 2.

Lake-depth profiles:

Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance exhibit no abnormalities and are similar to those from the previous years. 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 only on April 24. The lake became thermally stratified through the summer. In June the lower 13 feet of water were anoxic (devoid of oxygen), and by August the lower 27 feet were anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 7.5 and 8.4, is common for southeast Wisconsin lakes and poses no problems for aquatic life. The lake was also weakly stratified during winter under the ice.

Chemical constituents:

Analyses of water samples collected on April 24 for selected chemical constituents for chemical characterization of the lake are listed in Figure 2. Samples collected at 1.5 and 53-foot depths show similar constituent concentrations, as would be expected under mixed water column conditions. The constituent values for color, chlorophyll a, chloride, calcium, magnesium, pH, alkalinity, total-nitrogen, and total phosphorus are within the 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 was at least 405:1, based on the surface concentrations on April 24. 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 0.019 mg/L on July 23 and August 9 to 0.027 mg/L on June 13 and April 24, chlorophyll a ranged from 5.1 µg/L on April 24 to 15 µg/L on August 9, and Secchi depths ranged from 1.4 m on August 9 to 4.1 m on April

24. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for the 1991-96 period are shown on Figure 3. The data exhibit no consistent change from year to year. There is a general seasonal pattern of highest total phosphorus concentration occurring in spring turnover, which is followed by decreasing concentration through the summer.

Total phosphorus concentration 1.5 feet above the lake bottom at the center site ranged from 0.034 mg/L on April 24 to 0.517 mg/L on July 24. The large total phosphorus concentrations observed during anoxic periods are indicative of a major phosphorus release from the bottom sediments.

Lake condition:

Water-quality index:

Lillie and Mason (1983) classified all Wisconsin lakes using an extensive 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 concentrations in Druid Lake indicate "good" water quality, chlorophyll a concentrations indicate "fair/good" water quality and Secchi depths indicate "fair" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Druid Lake with other lakes in southeastern Wisconsin. The comparison in Table 4 shows the percentage distribution of southeast Wisconsin lakes within each condition group and the relative position of Druid 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 are listed in Table 3. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Druid Lake during the 6-year study period. The data from 1996 show the lake to be in general meso-eutrophic, or a lake with medium to high nutrient levels.

Table 1. Lake stages for Druid Lake near Hartford, Wisconsin, 1996 water year

LOCATION.--Lat 43°16'43" long 88°24'33", in NW 1/4 NE 1/4 sec.6, T.9 N., R.18 E., Washington County, Hydrologic Unit 07090001, 3.2 mi southwest of Hartford.

LAKE-STAGE RECORDS

PERIOD OF RECORD.--June 1991 to current year.

GAGE.--Staff gage read by Bill Noennig at his residence.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 13.22 ft, June 19, 1996; minimum observed, 10.71 ft, Sept. 21, 1996.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 13.22 ft, June 19; minimum observed, 10.71 ft, Sept. 21.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1995 TO SEPTEMBER 1996

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	10.93	---	---	---
2	---	---	---	---	---	---	---	---	---	11.57	---	---
3	10.87	---	---	---	---	---	---	---	---	---	---	10.87
4	---	---	---	---	---	---	---	---	---	---	---	---
5	---	---	---	---	---	---	---	---	---	---	11.03	---
6	---	---	---	---	---	---	---	---	---	---	---	---
7	11.13	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	12.12	11.37	---	---
9	---	---	---	---	---	---	---	---	12.43	---	11.07	---
10	---	---	---	---	---	---	---	---	12.43	---	---	10.82
11	---	---	---	---	---	---	---	---	---	---	---	---
12	---	---	---	---	---	---	---	---	12.01	---	---	---
13	---	---	---	---	---	---	---	---	11.92	11.31	---	---
14	---	---	---	---	---	---	---	---	11.71	---	10.97	---
15	---	---	---	---	---	---	---	---	---	---	---	---
16	---	---	---	---	---	---	---	---	11.47	---	---	---
17	10.93	---	---	---	---	---	---	---	12.15	---	---	---
18	---	---	---	---	---	---	---	11.41	12.91	---	---	---
19	---	---	---	---	---	---	---	---	13.22	11.62	---	---
20	---	---	---	---	---	---	---	---	13.04	---	11.17	---
21	---	---	---	---	---	---	---	---	12.81	---	---	10.71
22	---	---	---	---	---	---	---	---	12.61	---	---	---
23	---	---	---	---	---	---	---	---	12.41	11.45	---	---
24	---	---	---	---	---	---	---	---	12.21	---	---	---
25	---	---	---	---	---	---	---	11.13	12.03	---	---	---
26	---	---	---	---	---	---	---	---	---	---	---	---
27	---	---	---	---	---	---	---	---	---	---	---	---
28	---	---	---	---	---	---	---	---	---	---	10.97	---
29	---	---	---	---	---	---	---	---	11.77	11.25	---	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	10.93	---	---	---	---

Table 2. Lake-depth profiles for Druid Lake near Hartford, 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					
09...	3.00	3.0	601	8.4	14.0
09...	6.00	3.0	614	8.4	14.0
09...	9.00	3.0	620	8.5	13.9
09...	12.0	3.0	620	8.5	14.9
09...	15.0	3.0	625	8.5	15.1
09...	18.0	3.0	626	8.4	13.7
09...	21.0	3.0	628	8.4	12.3
09...	24.0	3.0	632	8.3	11.5
09...	27.0	3.0	638	8.2	10.3
09...	30.0	3.0	642	8.2	10.2
09...	33.0	3.0	652	8.0	7.5
09...	36.0	3.0	658	7.9	6.0
09...	39.0	3.0	659	7.8	3.1
09...	42.0	3.0	673	7.7	2.3
09...	45.0	3.0	681	7.6	1.6
09...	48.0	3.0	707	7.5	1.1
09...	51.0	3.5	723	7.5	2.6
09...	53.0	--	--	--	--
APR					
24...	1.50	10.0	622	8.1	10.9
24...	3.00	10.0	620	8.1	10.7
24...	6.00	10.0	619	8.1	10.7
24...	9.00	10.0	620	8.1	11.7
24...	12.0	9.5	618	8.1	12.1
24...	15.0	9.5	620	8.1	11.7
24...	18.0	9.5	617	8.1	11.1
24...	21.0	9.0	618	8.1	10.7
24...	24.0	8.5	616	8.1	10.4
24...	27.0	8.0	614	8.1	10.4
24...	30.0	8.0	618	8.1	10.4
24...	33.0	7.5	617	8.1	10.3
24...	36.0	7.5	619	8.1	10.3
24...	39.0	7.0	621	8.1	10.2
24...	42.0	7.0	622	8.0	9.9
24...	45.0	6.5	625	8.0	9.8
24...	48.0	6.5	626	8.0	9.7
24...	51.0	6.5	626	8.0	9.5
24...	52.5	6.5	627	8.0	9.5
24...	54.0	--	--	--	--
JUN					
13...	1.50	22.5	589	8.4	11.0
13...	3.00	22.0	581	8.4	11.3
13...	6.00	19.5	582	8.4	11.9
13...	9.00	17.0	585	8.5	12.2
13...	12.0	15.5	568	8.2	8.9
13...	15.0	14.5	568	8.1	8.4
13...	18.0	13.5	622	8.3	8.5
13...	21.0	12.5	621	8.2	7.3
13...	24.0	11.5	623	8.1	6.1
13...	27.0	10.5	621	8.0	5.9
13...	30.0	10.0	626	8.0	5.8
13...	33.0	9.5	627	7.9	3.6
13...	36.0	9.5	630	7.9	2.8
13...	39.0	9.0	630	7.8	0.5
13...	42.0	9.0	634	7.7	0.4
13...	45.0	9.0	640	7.7	0.4
13...	48.0	9.0	637	7.7	0.3
13...	50.5	8.5	640	7.7	0.4
13...	52.0	--	--	--	--

Table 2. Lake-depth profiles for Druid Lake near Hartford, Wisconsin, 1996 water year--continued

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)
JUL 1996					
24...	1.50	22.5	554	8.2	8.3
24...	3.00	22.5	553	8.2	8.3
24...	6.00	22.5	554	8.2	8.5
24...	9.00	22.0	561	8.2	8.2
24...	12.0	20.5	570	8.1	6.2
24...	15.0	17.0	589	7.7	1.2
24...	18.0	13.5	620	7.9	2.3
24...	21.0	12.0	628	7.9	1.4
24...	24.0	11.0	630	7.8	0.7
24...	27.0	10.5	630	7.8	0
24...	30.0	10.0	630	7.8	0
24...	33.0	9.5	636	7.7	0
24...	36.0	9.0	637	7.7	0
24...	39.0	9.0	644	7.7	0
24...	42.0	9.0	647	7.6	0
24...	45.0	8.5	648	7.6	0
24...	48.5	8.5	651	7.6	0
24...	50.0	--	--	--	--
AUG					
09...	1.50	25.0	559	8.4	9.0
09...	3.00	25.0	560	8.4	8.9
09...	6.00	25.0	559	8.4	9.0
09...	9.00	24.5	567	8.3	9.2
09...	12.0	20.5	573	8.1	6.4
09...	15.0	17.5	590	7.7	1.6
09...	18.0	14.5	618	7.7	0.7
09...	21.0	12.0	623	7.7	0.2
09...	24.0	11.0	627	7.7	0.2
09...	27.0	10.5	628	7.7	0.2
09...	30.0	10.0	631	7.7	0.2
09...	33.0	9.5	633	7.7	0.2
09...	36.0	9.5	637	7.6	0.1
09...	39.0	9.0	643	7.6	0.1
09...	42.0	9.0	644	7.6	0.1
09...	45.0	9.0	645	7.6	0.2
09...	46.5	9.0	646	7.6	0.2
09...	48.0	--	--	--	--

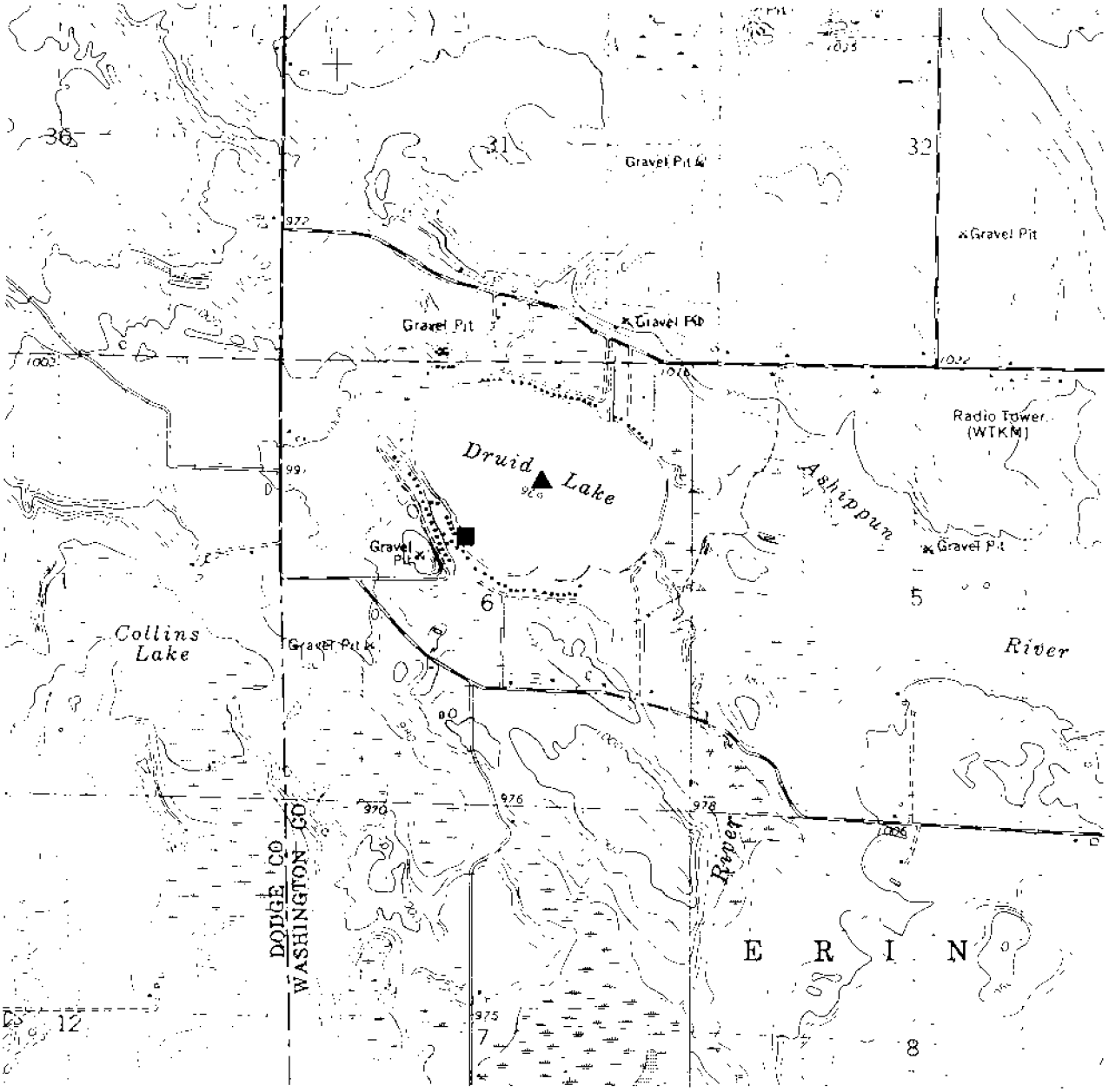
Table 3.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Druid Lake, 1996 water year

[- 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)
04/24/96	4.1	13.5	40	1.5	0.027	27	54	5.1	47	<0.002
	-	-	-	53	0.036	36	-	-	-	0.004
06/13/96	2.1	6.9	49	1.5	0.027	27	54	8.5	51	--
	-	-	-	51	0.241	241	-	-	-	--
07/24/96	2.1	6.9	49	1.5	0.019	19	51	8.3	51	--
	-	-	-	49	0.517	517	-	-	-	--
08/09/96	1.4	4.6	55	1.5	0.019	19	51	15.0	55	--
	-	-	-	47	0.493	493	-	-	-	--

Table 4. 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
Druid 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)		
	0-5	best condition	22
	5-10		31
Druid Lake Values	10-15		14
	15-30		12
	>30	worst condition	22
	Secchi depth (feet)		
	>19.7	best condition	1
	9.8-19.7		9
	6.6-9.8		26
Druid Lake Values	3.3-6.6		31
	<3.3	worst condition	33



EXPLANATION

▲ Water-quality monitoring site

■ Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Druid Lake near Hartford, Wisconsin.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--February 1991 to current year.

REMARKS.--Lake sampled near 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 09 TO AUGUST 09, 1996

(Milligrams per liter unless otherwise indicated)

	Feb 09		Apr. 24		June 13		July 24		Aug. 09	
Depth of sample (ft)	3.0	51	1.5	53	1.5	51	1.5	49	1.5	47
Lake stage (ft)	---		---		11.87		11.37		11.09	
Specific conductance (µS/cm)	601	723	622	627	589	640	554	651	559	646
pH (units)	8.4	7.5	8.1	8.0	8.4	7.7	8.2	7.6	8.4	7.6
Water temperature (°C)	3.0	3.5	10.0	6.5	22.5	8.5	22.5	8.5	25.0	9.0
Color (Pt-Co. scale)	---	---	35	---	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.60	---	---	---	---	---	---	---
Secchi-depth (meters)	---		4.1		2.1		2.1		1.4	
Dissolved oxygen	14.0	2.6	10.9	9.5	11.0	0.4	8.3	0.0	9.0	0.2
Hardness, as CaCO3	---	---	310	320	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	68	68	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	35	36	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	10	9.8	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	2	2	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	270	280	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	30	30	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	27	27	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	0.1	---	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	4.7	4.9	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	374	376	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.64	0.62	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.17	0.31	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	---	0.69	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.10	1.0	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.74	1.6	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.027	0.036	0.027	0.241	0.019	0.517	0.019	0.493
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	0.004	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<10	---	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	15	---	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	5.1	---	8.5	---	8.3	---	15	---

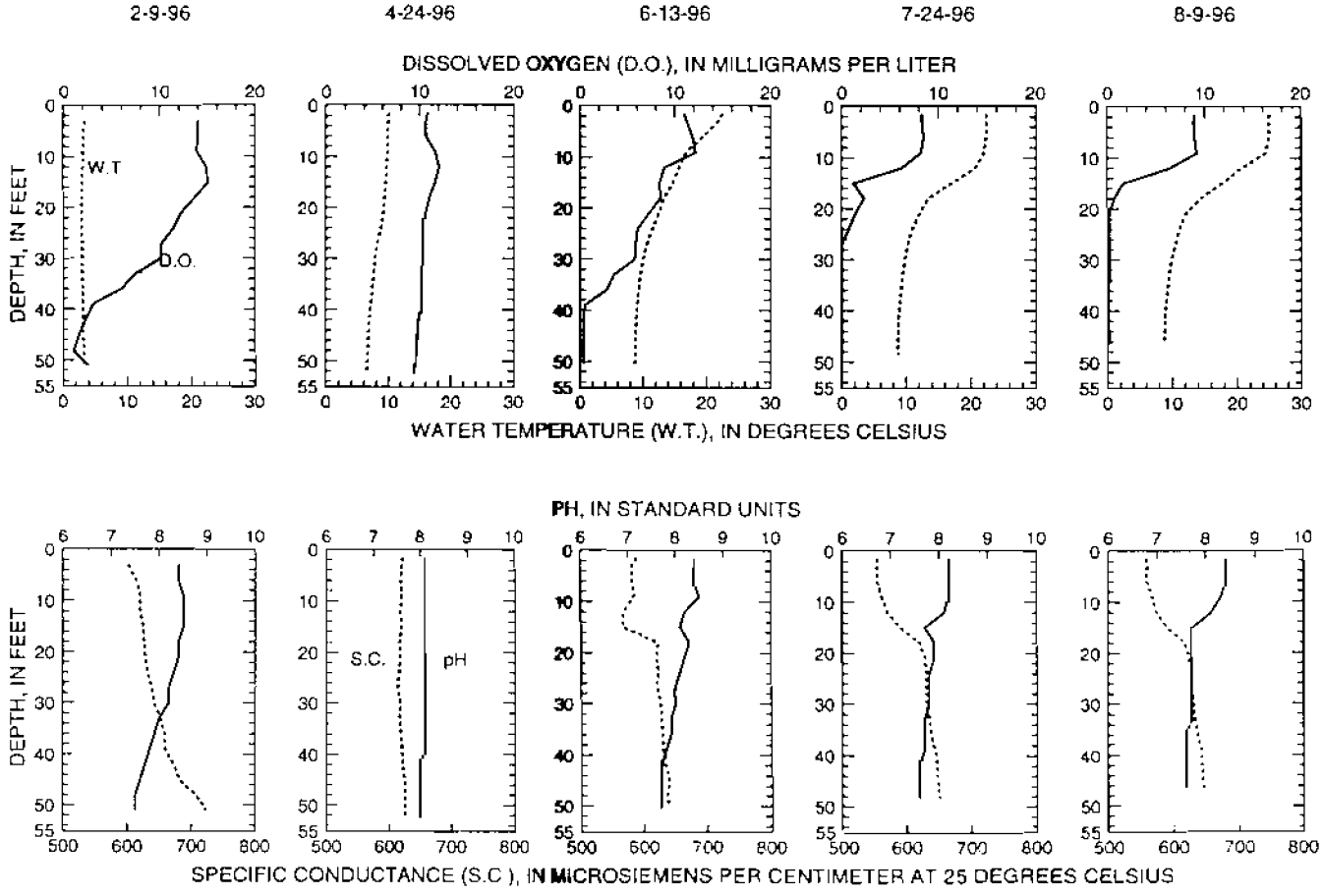


Figure 2. Water-quality data and depth profiles for Druid Lake near Hartford, Wisconsin, 1996 water year

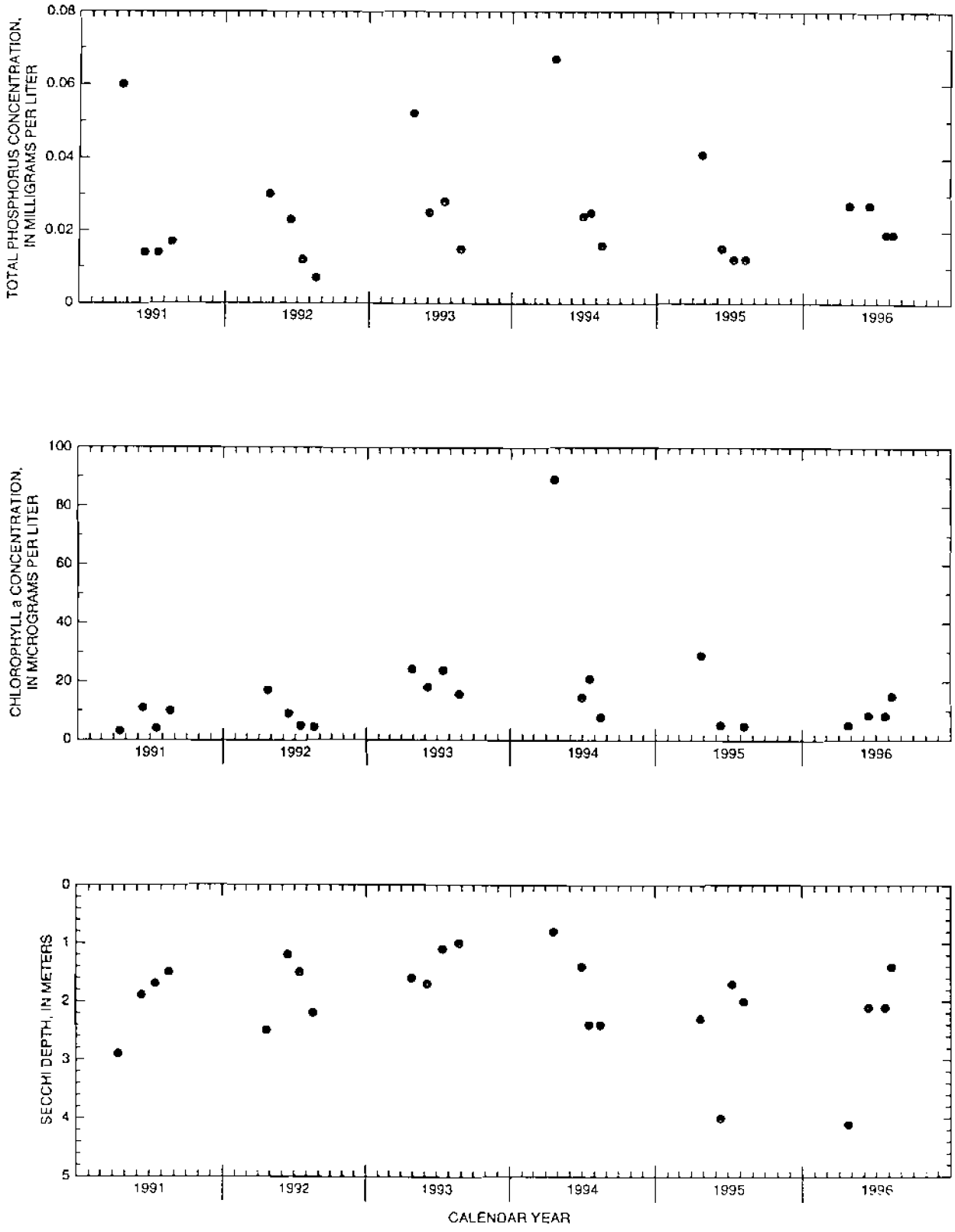


Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Druid Lake near Hartford, Wisconsin.

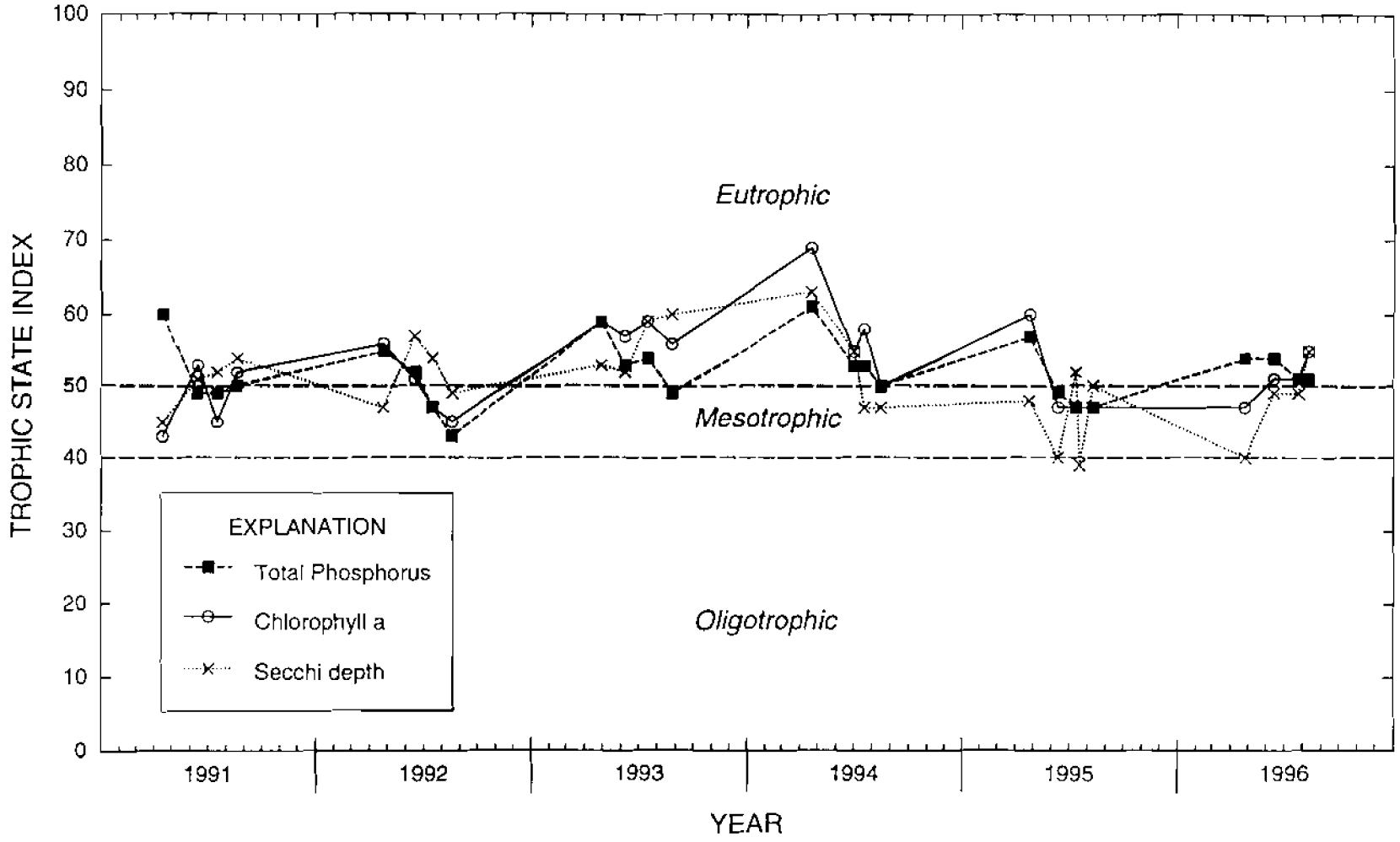


Figure 4. Trophic state indices for Druid Lake, near Hartford, Wisconsin