


**Chemical, Physical and Biological
Characterization of Devils Lake
1995 - 2001**

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Introduction

Devils Lake is a hypereutrophic saline lake comprising about 125,000 acres (51,020 hectares). It is located in southern Ramsey and northern Benson counties (Figure 1). The Devils Lake chain consists of several bays and East Devils Lake (Figure 2). The major inflows to Devils Lake are Big Coulee (Mauvais Coulee) and Channel A. Based on the dominant cations and anions in solution, water in Devils Lake is of the sodium-sulfate type.

The Devils Lake Basin is comprised of 2.4 million acres in northeastern North Dakota (Figure 1). The watershed is located in the northern glaciated plains and is an undulating mix of integrated and nonintegrated drainage patterns. Streams within the basin are intermittent. The two primary drainages are Channel A and Big Coulee (Mauvais Coulee). Channel A drains the Dry Lake, Edmore, Starkweather and Sweetwater areas, while Big Coulee drains Lake Irving, Lake Alice, Chain of Lakes and Mauvais Coulee.

Water levels for Devils Lake were first recorded in 1860. Since then there have been extreme fluctuations in the water level (Figure 3). Along with these water level changes have been corresponding changes in total dissolved solids (TDS). These changes have affected the aquatic community structure. Fluctuating water levels are primarily related to the closedbasin nature of the system. The absence of a surface outlet and the fact that annual evaporation frequently exceeds annual precipitation are important causes of the high TDS. Spring runoff, most of which enters the system through West Bay (naturally) and Six Mile Bay (Channel A), is the major source of water. According to the United States Geological Survey (USGS), about 80 percent of the water contributed to Devils Lake enters through these two sources (Greg Wiche pers. comm.). Groundwater also contributes to the hydrologic budget. As a result, Devils Lake is extremely vulnerable to widely fluctuating lake levels.

Nutrients and TDS are identified as the important variables affecting water quality in Devils Lake. High concentrations of nutrients in Devils Lake cause prolific algal blooms dominated by cyanophyta (blue-green algae). These algal blooms result in impaired water-based recreation. TDS affects fish reproduction, fish growth and algal blooms.

Methods

Ten sampling sites were identified from west to east across the Devils Lake chain of lakes. The 10 sites are: East Minnewaukan Flats (380251); West Minnewaukan Flats (380250); West Bay (380232); S.W. West Bay (384160); Six Mile Bay (380221); Creel Bay (380222); Main Bay (380233); East Bay (380234); East Bay near Black Tiger (380237); East Devils Lake (380235); and Pelican Lake (385029) (Figure 1).

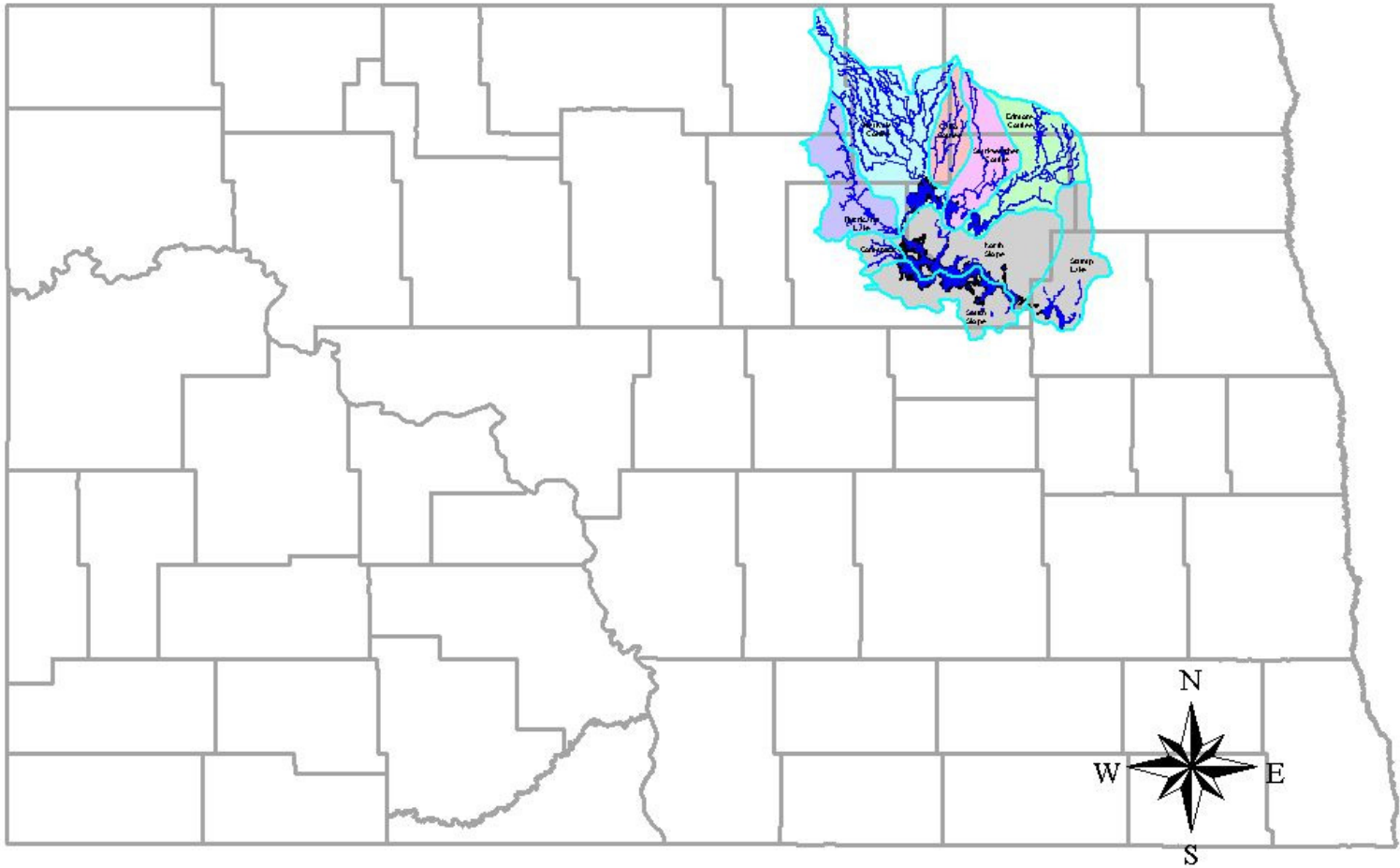
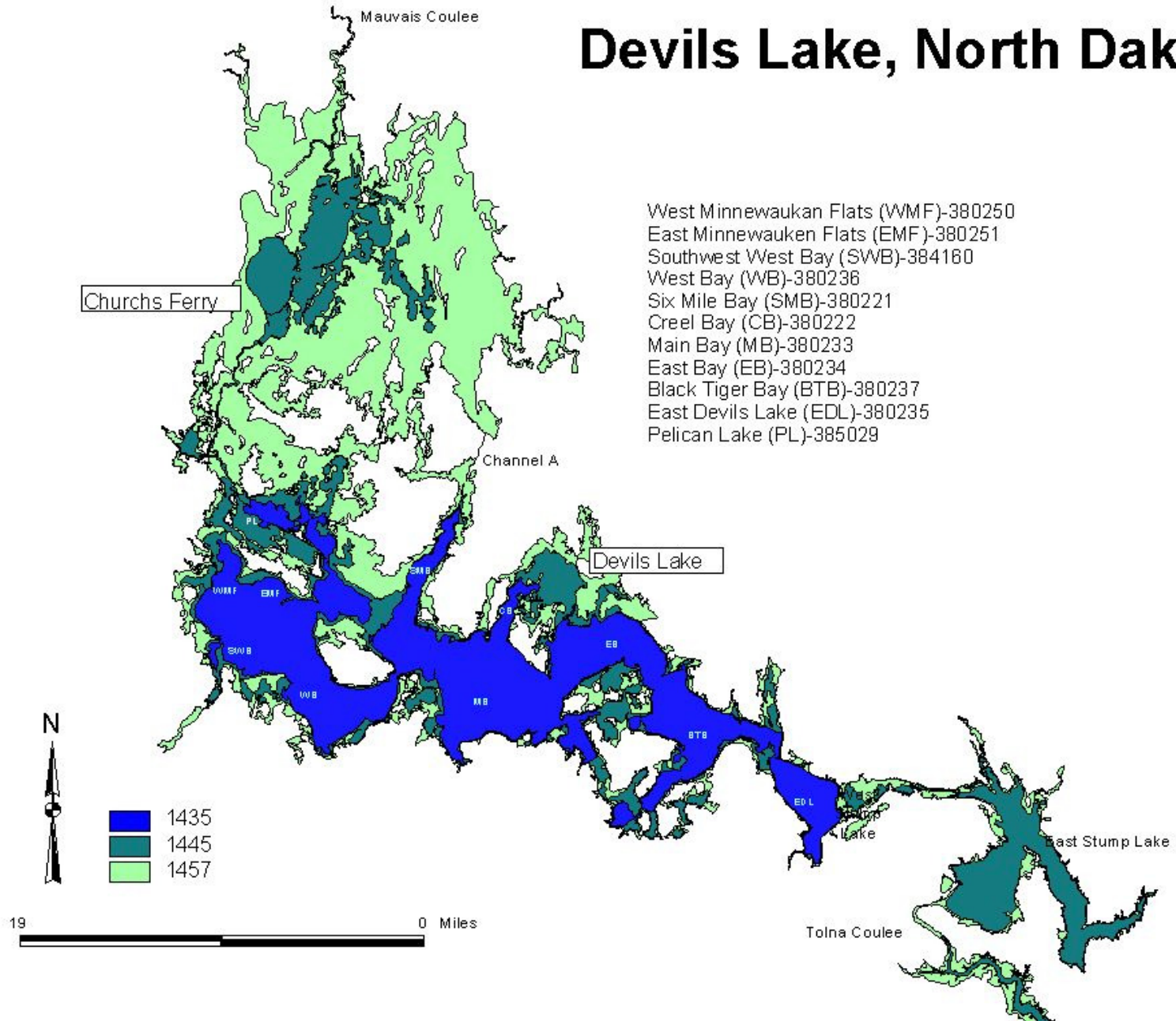


Figure 1. Devils Lake Watershed.



Devils Lake, North Dakota



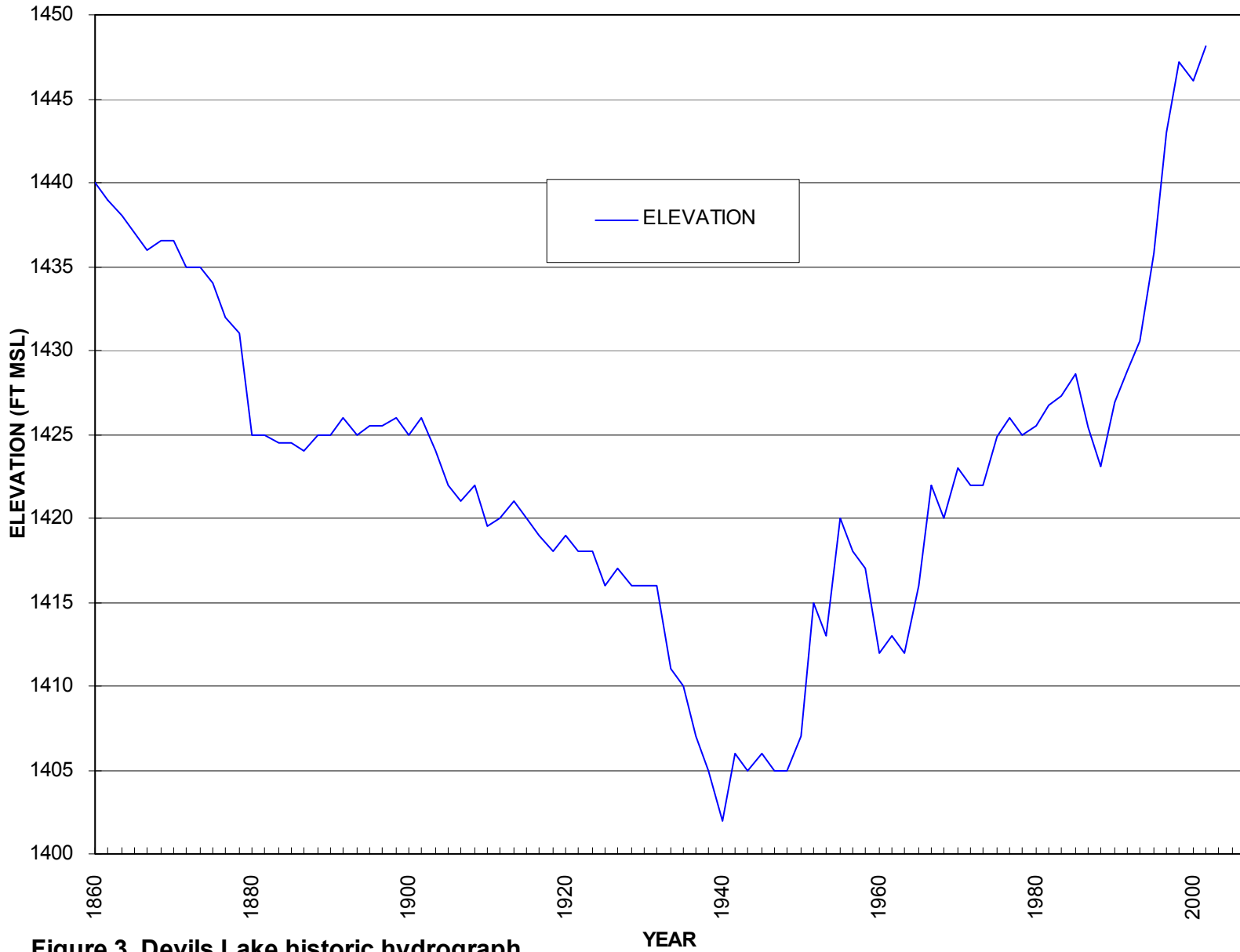


Figure 3. Devils Lake historic hydrograph.

Sampling occurred four times in 1995, 1999, 2000 and 2001, and six times each in 1996, 1997, and 1998. The first sample of each year was collected in late winter under icecover during February or March. The second sample was collected during the third week of May in 1996, 1997 and 1998 the remaining samples were collected during July, August, September and October. In 1995, 1999, 2000 and 2001, the third sample was collected in July (1995) or August (1999), while the fourth sample was collected in October.

Physical, chemical and biological variables that were sampled at each monitoring site consisted of the following: dissolved oxygen, pH, temperature and conductivity profiles; chlorophyll-*a*; phytoplankton; ammonia as N; total Kjeldahl nitrogen; nitrate + nitrite as N; total phosphate as P; dissolved phosphate as P; total dissolved solids; major cation/anions; and trace elements. Temperature, oxygen, pH and specific conductivity profiles were recorded at one-meter intervals. Chlorophyll-*a* and phytoplankton were collected as a composite sample of the top two meters of the water column. The remaining chemical variables were analyzed from two discrete samples collected at about one meter below the surface and one-half meter above the bottom. A mid-column sample also was collected at sites more than four meters deep. This sample was taken just below the thermocline, if present; otherwise it was taken at the center of the water column.

Water quality samples were collected, handled and tracked in accordance with standard procedures outlined in the North Dakota Department of Health, Division of Water Quality, Standard Operating Procedures for Field Samplers (NDS DHCL 1993). Quality assurance/quality control protocols are outlined in the Standard Operating Procedures for Field Samplers and in the Lake Water Quality Assessment (LWQA) Quality Assurance Project Plan (QAPP) (NDS DHCL 1991).

Analytical methods used for analysis of water quality samples are described in Section 9, 10 and 11 of the North Dakota Department of Health, Division of Chemistry Quality Assurance Manual, Volume 1. All methods used by the Division of Chemistry are approved Environmental Protection Agency (EPA) methods from 40 CFR 136 (NDS DHCL 1990). Quality control samples for the Division of Chemistry are described in the Division of Chemistry Quality Assurance Manual.

Field duplicate samples are checked to ensure sample integrity. Quality control charts are maintained by the Quality Assurance Representative (QAR) for all duplicate sample results collected. Quality control boundaries are established for all data collected by variable and are established based on the previous 100 duplicate sample results. Duplicate sample results, which exceed the mean percentage difference of the previous 100 results by more than one standard deviation, will be considered out-of-control margins. If field blank results exceed the quality control boundaries, corrective action is taken. Specific procedures for data review, validation and verification can be found in the North Dakota Department of Health, Division of Water Quality Standard Operating Procedures for Field Samplers (NDS DHCL 1993) and the LWQA QAPP (NDS DHCL 1991).

All field calibration procedures-including equipment calibration methods, equipment repair and calibration documentation-are described in the North Dakota Department of Health, Division of Water Quality Standard Operating Procedures for Field Samplers (NDS DHCL 1993). All results are available in the EPA's storage and retrieval database (STORET).

Results and Discussion

Annual evaporation and infiltration could not keep ahead of the tremendous amount of water being added to the Devils Lake basin during the past few years. Between 1993 and 2001, Devils Lake has increased in size from 50,000 surface acres to about 125,000 surface acres (Figure 2) and has risen 25 feet to a level of 1447.1 (Figure 3). Flow in Channel A and Big Coulee exceeded 1,000 cfs in August 1997 (Appendix B). With record spring runoff and numerous wet summers, Big Coulee has flowed all year long in some years.

With the increase in surface runoff since 1993, TDS concentrations have declined significantly when compared to data collected in 1990 and in 1991 (Elstad 1992). TDS concentrations have remained fairly constant from 1995 to 2001 (Figure 4), with the exception of East Devils Lake, where concentrations continue to decrease. Between 1995 and 2001 TDS concentrations in samples collected at the surface have ranged from 441 to 447 mg/L at Six Mile Bay and Pelican Lake to 8,200 mg/L at East Devils Lake. This is an increase from the western areas of the lake to the eastern areas. There are two significant changes in concentration that occur spatially in Devils Lake. TDS increases from Main Bay to East Bay and from Black Tiger Bay to East Devils Lake. Specific conductance follows the same pattern as TDS concentrations. Values measured at one meter below the surface ranged from 702 uS/cm at the Pelican Lake site to 9,650 at East Devils Lake (Figure 5). Median concentration levels have remained fairly constant throughout Devils Lake since 1995, with the exception of East Devils Lake, where the levels have dropped (Appendix A).

Temporal trends in sulfate (SO_4) concentrations are similar to the pattern shown for TDS. Sulfate concentrations decreased with the initial influx of water in 1993 and 1994, remaining fairly constant from 1995 through 2001 (Figure 6), with the exception of East Devils Lake, where concentrations dropped considerably. During 2001, the only area in Devils Lake that was less than the 450 mg/L state standard for Class IA streams was Pelican Lake. There, the sulfate concentrations remained from 282 mg/L to 354 mg/L. Median sulfate levels followed the same temporal pattern as TDS median levels, increasing from west to east (Appendix A).

Chlorophyll-*a* concentrations follow a temporal pattern that is typical for midwestern lakes and reservoirs. Concentrations in Devils Lake display cyclic highs and lows, with East Bay and East Devils Lake having the highest concentrations in 1995, East Devils Lake having the highest concentration in 1996 and West Bay and the Minnewaukan Flats displaying the highest levels in 1997 (Figure 7). In 1995 and 1996, chlorophyll-*a* concentrations generally were greatest in the eastern most areas of Devils Lake early in the year. During the summer of 1997, this began to change, with East Minnewaukan Flats, Southwest West Bay, West Bay and Main Bay all displaying consistently higher levels. This may be due to high nutrient loading in this area. During 1998, concentrations of chlorophyll remained higher in the west and southwest Minnewaukan Flats areas, with East Bay and East Devils Lake increasing. The eastern areas of Devils Lake once again displayed the highest concentrations in 1999. During 2000 and 2001, the highest concentrations of chlorophyll-*a* again were found in the western areas of Devils Lake, although in 2000 the two highest median concentrations were found at Pelican Lake and East Devils Lake. Median concentration levels did not follow a pattern and could be described as erratic. Much of this can be attributed to the cyclic boom to bust life cycle that blue-green algae exhibits.

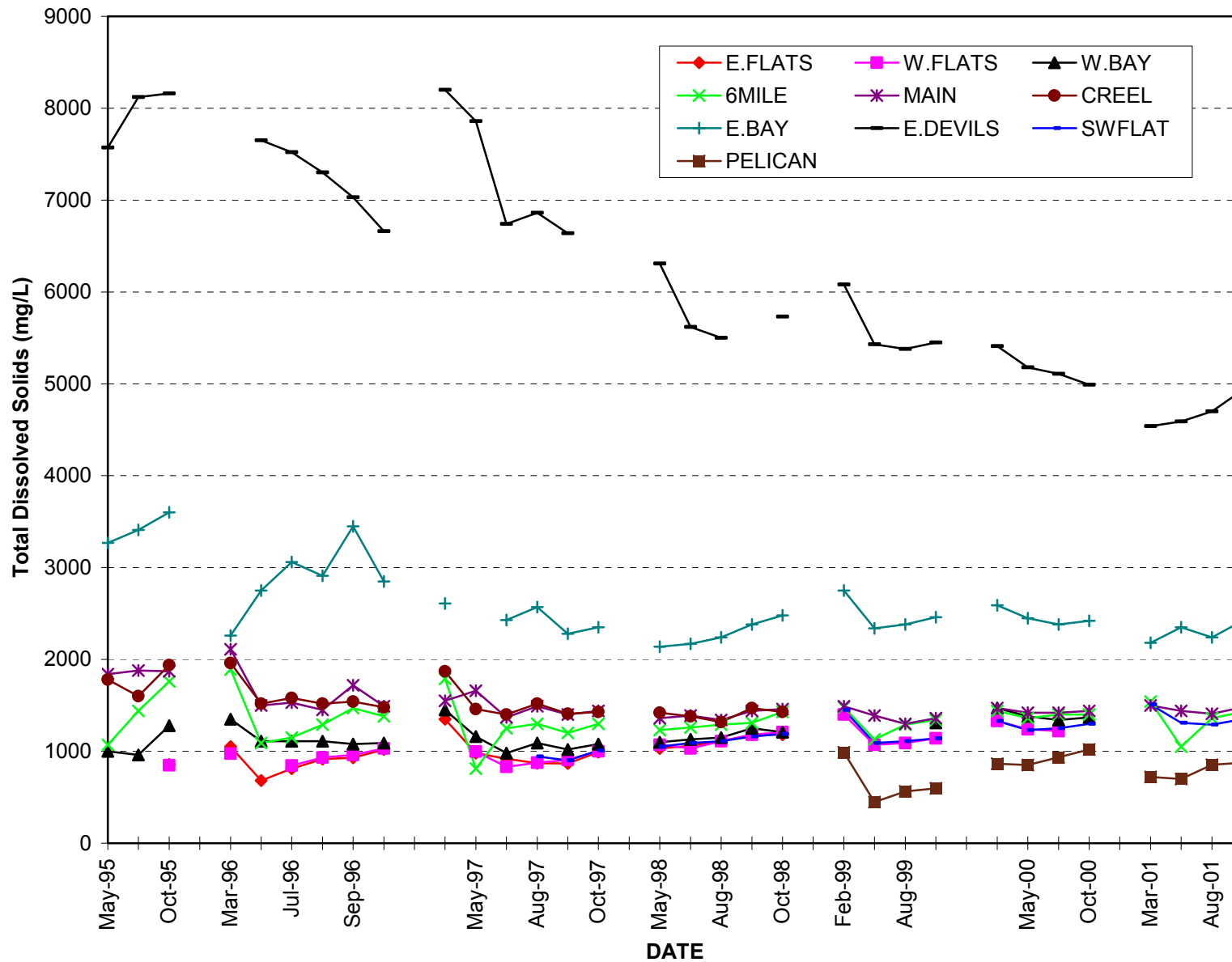


Figure 4. Devils Lake total dissolved solids (TDS) concentrations (mg/L) (samples collected at one meter)

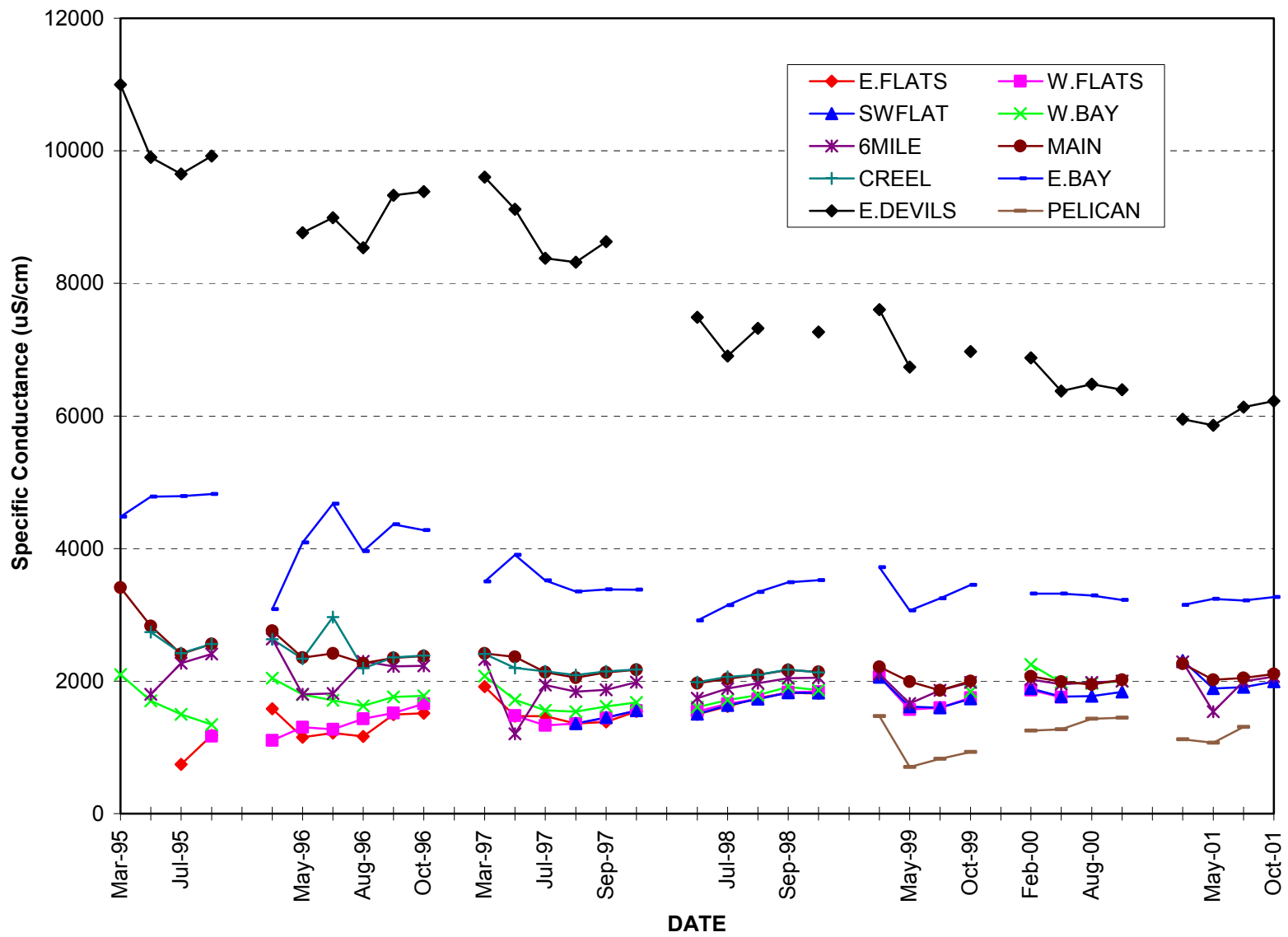


Figure 5. Devils Lake specific conductance levels ($\mu\text{S}/\text{cm}$) (samples collected at one meter)

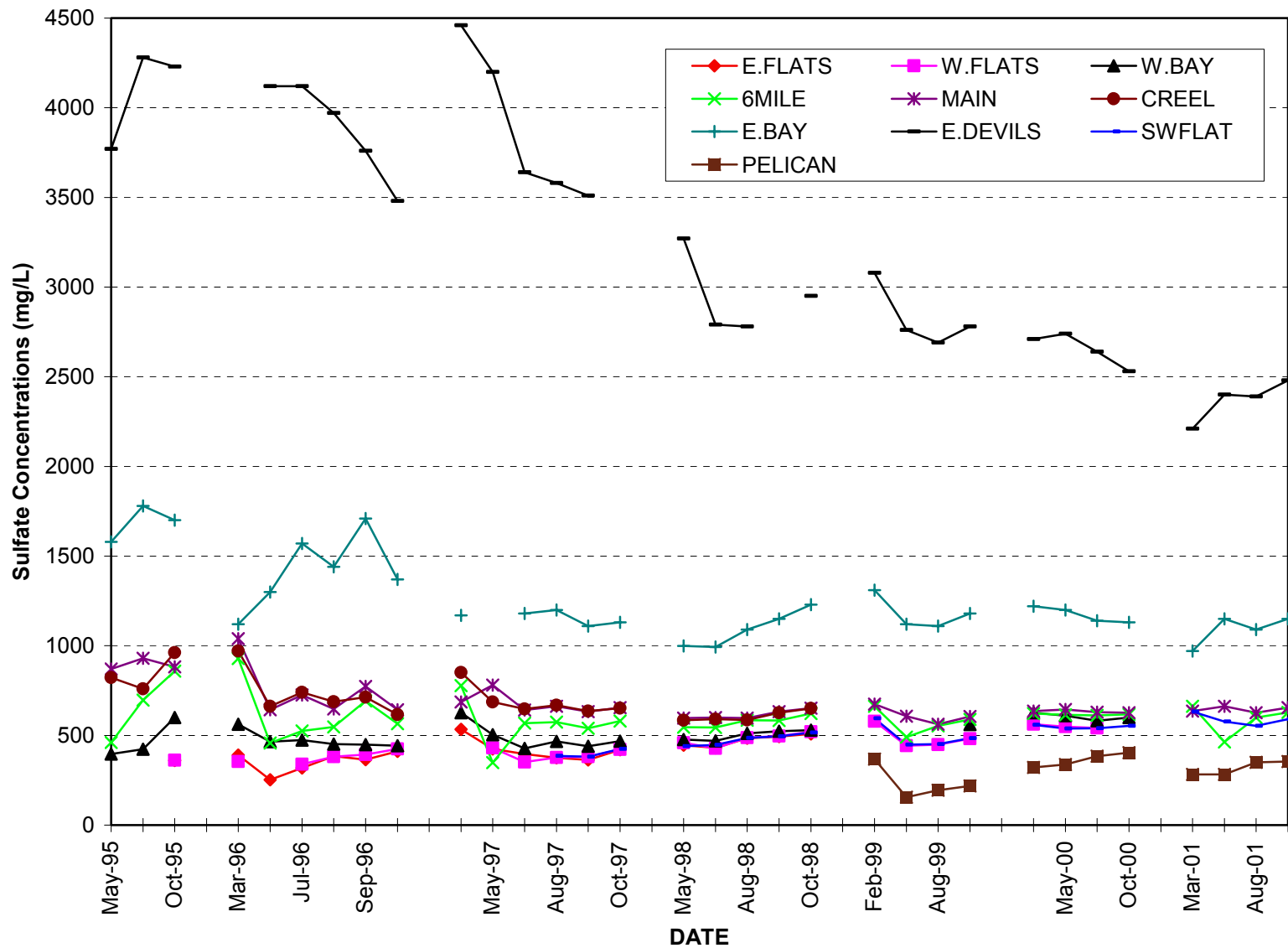


Figure 6. Devils Lake sulfate concentrations (mg/L)
(samples collected at one meter)

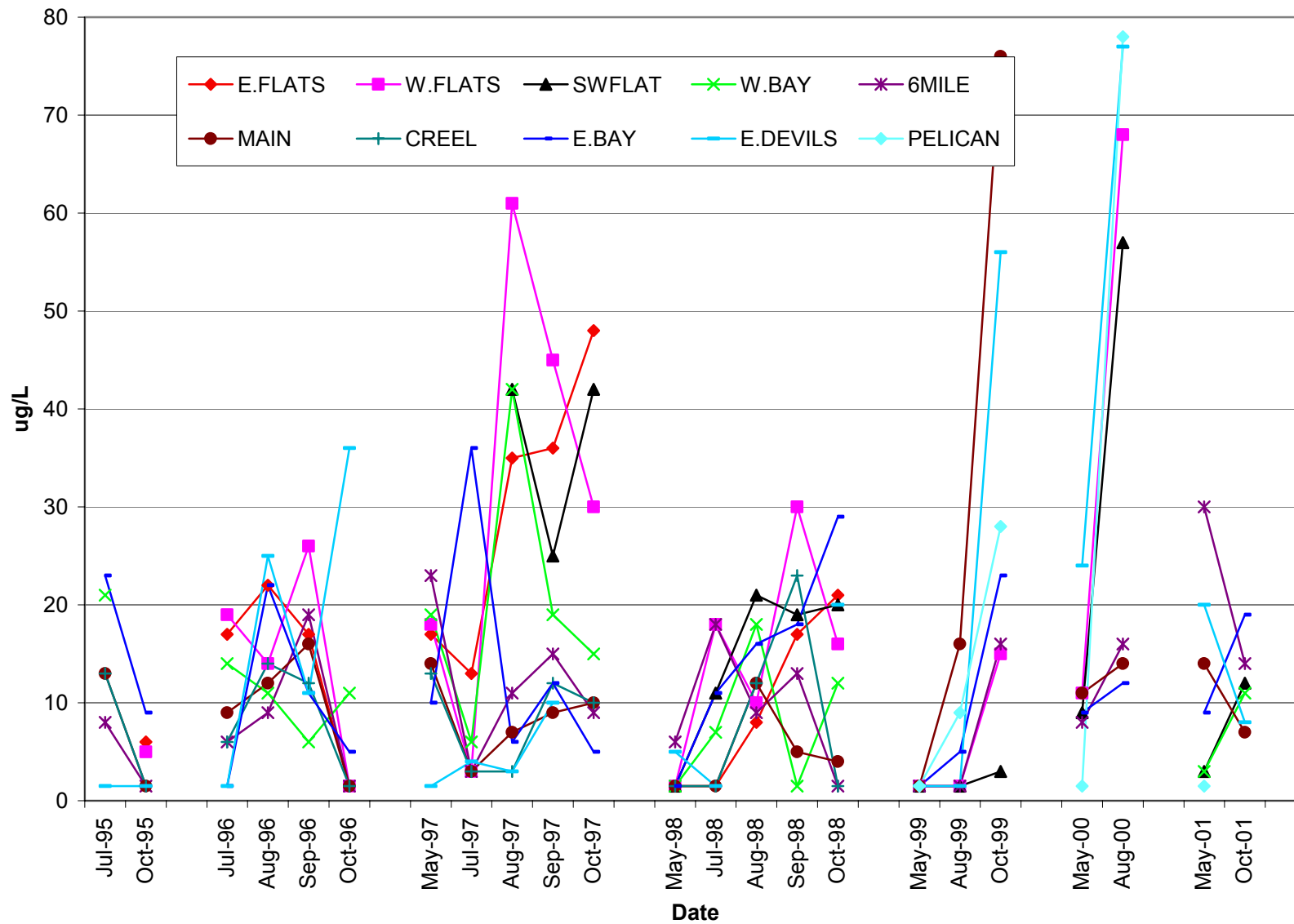


Figure 7. Devils Lake Chlorophyll-a Concentrations (ug/L) (0-2 meter composite sample).

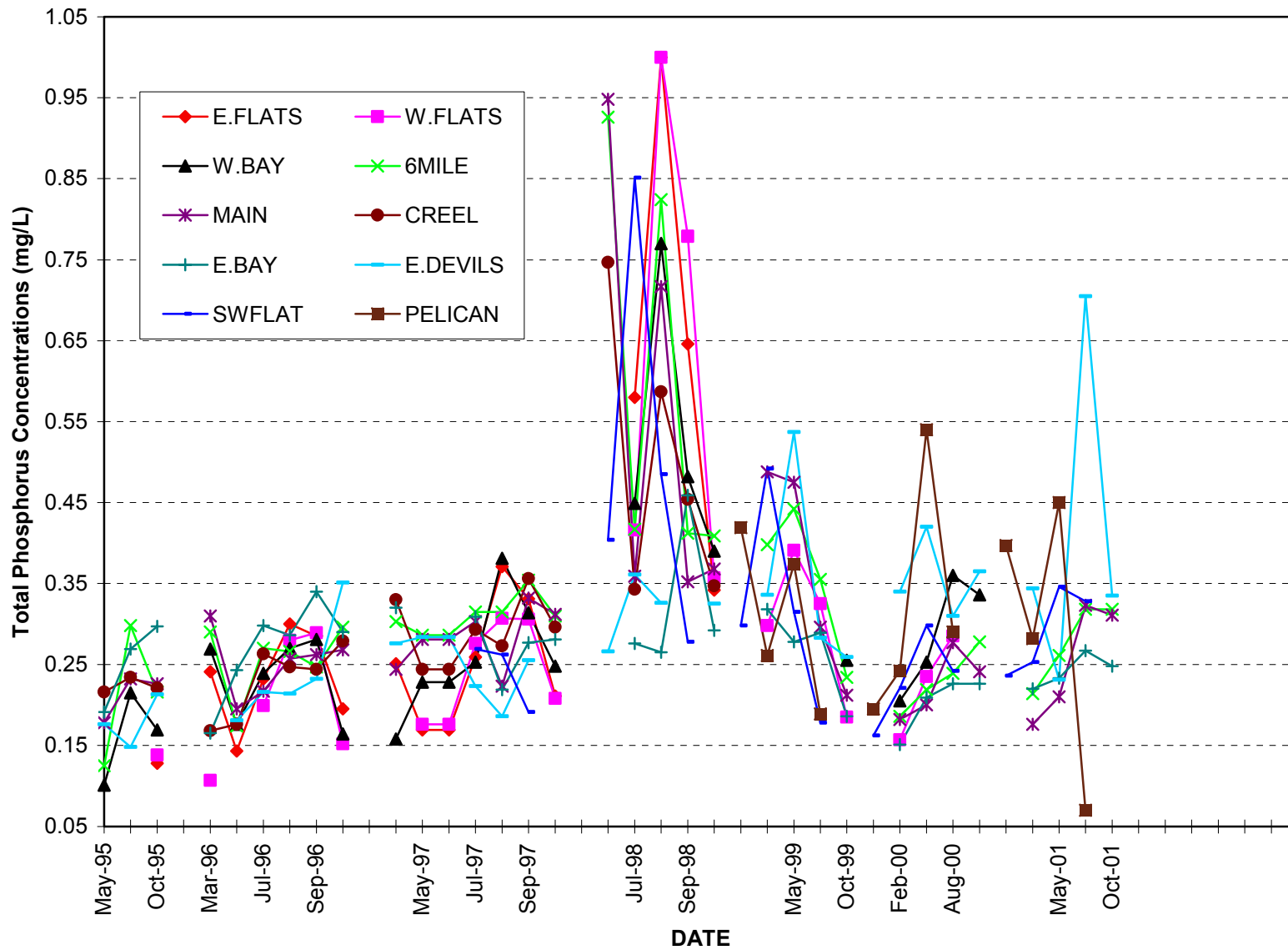


Figure 8. Devils Lake total phosphorus concentrations (mg/L) (samples collected at one meter).

Total phosphorus concentrations (TP) steadily increased from 1995 to 1998 and in 2001, decreasing in 1999 and 2000 (Figure 8). Total phosphorus concentrations closely follow those of chlorophyll-*a* concentrations. This could be due to the higher than normal runoff patterns and nonpoint loading from the Devils Lake watershed. TP is adsorbed on the sediments that are washed from fields during spring runoff and summer rainfall events and carried to the lake. Other possible sources are fertilizers, manure, point source discharges and internal loading from lake sediments. TP concentrations tend to be higher in the western most areas of the lake, with the exception of East Devils Lake, where median TP concentrations have been increasing steadily (Appendix A).

A comprehensive summary of the chemical and water quality data sampled and analyzed for this study can be found in Appendix A. Provisional USGS hydrographs of inflow into Devils Lake can be found in Appendix B.

Appendix C summarizes dissolved oxygen profile data from 1995 to 2001. While there have been periodic depletions in oxygen concentrations in the water column at most sites, oxygen concentrations, in general, have remained at or near saturation throughout the lake. Between 1995 and 1997, oxygen depletion generally occurred in the deepest areas of the Devils Lake chain (i.e., West Bay, Six Mile Bay, Creel Bay, Main Bay, East Bay and East Devils Lake) and was observed in late summer during stratification or in late winter during ice cover. A weak thermocline was also present in East Devils Lake during the summer of 1997 and 1998. Equipment problems prevented the documentation of stratification (if any) during the summer of 1999. Low dissolved oxygen levels were documented at all sites (except southwest West Bay) during August of 2000 and 2001.

Phytoplankton analyses were completed on all samples collected in July 1995; in May, July, August, September and October 1996, 1997, 1998; in May, August and October 1999, 2000 and 2001. Bluegreen (Cyanophyta) algae dominated the phytoplankton community for both volume and density (Tables 1-19). The only period in which bluegreen algae were not dominant was May 1996. During 1996, the highest densities of phytoplankton were found in the more eastern areas of the Devils Lake chain. During 1997, however, this changed somewhat, with phytoplankton densities becoming more uniform throughout the lake. In 1999, the highest densities of phytoplankton were found in East Devils Lake. The two sites nearest the Big Coulee inlet, West Minnewaukan Flats and East Minnewaukan Flats also had much higher densities beginning in July 1996. Lowest densities were found in Creel Bay. Diatom (Bacillariophyta) and green algae (Chlorophyta) densities were greatest in May 1996, 1997 and 1998. This is a natural phenomenon and is to be expected.

Table 1. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during July 1995.

Site	Taxon Group				Total
	<u>Bacillariophyta</u>	<u>Cyanophyta</u>	<u>Chlorophyta</u>	<u>Cryptophyta</u>	
WB	63	117,383	43,656	633	161,734
SMB	500	91,312	14,953	1,875	108,640
CB	766	163,390	9,859	1,000	175,016
MB	750	160,273	13,921	500	175,445
EB	375	216,675	563	125	217,688
EDL	2,320	59,781	656	812	63,570
Mean	796	134,802	13,935	824	150,349
Percent	<1	90	9	<1	

Table 2. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during May 1996.

Site	Taxon Group				Total
	<u>Bacillariophyta</u>	<u>Cyanophyta</u>	<u>Chlorophyta</u>	<u>Cryptophyta</u>	
WMF	226	4,215	78,838	6,730	90,291
EMF	190	245	37,739	2,230	40,403
WB	785	5,506	36,851	1,160	44,302
SMB	28,795	135,750	34,122	207	198,894
CB	1,707	4,000	83,900	1,482	90,590
MB	11,530	12,850	53,206	4,215	81,800
EB	24,835	7,480	72,826	3,250	108,396
BTB	59,633	18,015	155,383	4,000	238,530
EDL	51,144	4,961	114,773	750	211,691
Mean	19,871	21,447	74,182	2,669	118,170
Percent	17	18	63	2	

Table 3. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during July 1996.

Site	Taxon Group				Total
	Ballicariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	23	93,444	86,164	1,182	190,091
EMF	238	231,282	47,509	1,410	284,481
WB	102	137,064	51,962	3,185	196,312
SMB	58	10,055	39,963	877	50,994
CB	16	15,526	11,091	3,375	30,046
MB	160	18,223	20,816	1,405	40,683
EB	135	26,698	89,345	8	116,183
BTB	150	21,193	54,828	313	76,170
EDL	0	3,920	57,281	0	61,201
Mean	98	61,934	50,998	1,275	114,304
Percent	<1	54	45	1	

Table 4. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during August 1996.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	540	178,715	24,779	312	204,457
EMF	160	299,900	7,015	560	307,942
WB	45	76,265	24,805	380	101,495
SMB	1,960	70,690	7,410	267	80,330
CB	82	26,730	835	65	27,720
MB	270	30,386	7,440	205	38,912
EB	60	61,145	1,347	125	62,738
BTB	10	34,720	191	0	34,946
EDL	1,046	206,237	216	45	207,545
Mean	264	109,420	8,226	218	118,129
Percent	<1	93	7	<1	

Table 5. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during September 1996.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	2,084	177,580	1,663	636	181,913
EMF	1,577	140,893	3,372	108	146,040
WB	1,980	64,565	10,465	630	79,526
SMB	51	23,158	577	5	23,791
CB	143	35,410	85	323	35,966
MB	72	22,455	2,620	1,515	31,682
EB	20	29,985	95	0	30,101
BTB	0	22,625	88	0	22,723
EDL	2,684	60,843	1,727	0	63,256
Mean	957	64,168	2,299	357	67,782
Percent	1	95	3	<1	

Table 6. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during October 1996.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	485	92,085	727	563	94,365
EMF	1,050	175,595	1,193	255	178,092
WB	1,760	46,465	4,445	625	53,296
SMB	20	22,965	7,770	500	31,255
CB	113	38,348	6,595	250	45,007
MB	72	32,860	10,671	817	44,421
EB	17	42,285	1,438	188	43,928
BTB	45	33,545	850	8	34,448
EDL	175	92,445	7,530	0	100,150
Mean	415	64,065	4,580	356	69,417
Percent	<1	92	7	<1	

Table 7. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during May 1997.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	8,569	122,641	420	2,853	134,483
EMF	21,763	18,057	1,609	1,286	42,715
WB	14,013	4	1,341	1,725	17,083
SWWB	-	-	-	-	-
SMB	16,024	42,570	9,137	2,047	69,778
CB	11,772	811	405	1,632	14,620
MB	19,474	5,093	405	1,419	26,391
EB	12,173	9,730	608	816	23,328
EDL	202	24,326	811	811	26,728
Mean	12,999	27,904	1,842	1,574	44,391
Percent	29	63	4	4	

Table 8. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during July 1997.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	223	86,312	1,876	1,834	90,245
EMF	3,243	34,269	1,424	1,829	40,765
SWWB	-	-	-	-	-
WB	12	21,494	697	905	23,108
SMB	208	61,230	608	1,434	63,480
CB	1,059	9,953	405	1,627	13,044
MB	213	18,285	8,311	1,231	28,040
EB	208	30,002	608	203	31,021
EDL	5	57,187	0	609	57,801
Mean	646	39,842	1,741	1,209	43,438
Percent	1	92	4	3	

Table 9. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during August 1997.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	228	74,648	1,621	608	77,105
EMF	557	9,419	929	3,902	14,807
SWWB	2,783	34,612	1,660	2,239	41,294
WB	483	12,325	1,450	1,696	15,954
SMB	250	55,544	203	811	56,808
CB	215	4,831	186	13,751	18,983
MB	4,257	16,648	0	1,829	22,734
EB	99	3,815	324	568	4,806
EDL	213	43,671	203	405	44,492
Mean	1,009	28,390	731	2,868	32,998
Percent	3	86	2	9	

Table 10. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during September 1997.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	821	43,131	1,013	608	45,573
EMF	674	75,261	1,784	892	78,611
SWWB	378	72,301	536	890	74,105
WB	744	38,520	976	2,180	42,420
SMB	218	38,766	268	2,433	41,685
CB	445	75,189	1,221	1,419	78,274
MB	0	41,360	203	1,216	42,779
EB	0	68,315	405	203	68,923
EDL	0	21,084	81	405	21,570
Mean	364	52,659	721	1,138	54,882
Percent	<1	96	1	2	

Table 11. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during October 1997.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	1,261	68,289	0	1,839	71,389
EMF	445	27,406	1,216	811	29,879
SWWB	808	56,513	851	1,244	59,416
WB	480	84,800	953	2,122	88,355
SMB	1,424	4,317	208	2,042	7,991
CB	445	14,413	405	1,419	16,682
MB	1,236	4,257	1,014	1,419	7,926
EB	608	125	1,014	1,516	3,263
EDL	-	-	-	-	-
Mean	838	32,515	708	1,552	35,613
Percent	2	91	2	4	

Table 12. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during May 1998.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	12	901	47,241	407	48,561
EMF	16	0	49,726	1,131	50,873
SWWB	27	109	34,226	280	34,642
WB	19	8	23,712	110	23,863
SMB	120	176	16,576	1	16,873
CB	27	2,345	8,299	8	10,679
MB	8	90	7,602	2	7,702
EB	24	475	17,024	0	17,523
EDL	1	0	55,126	8	55,135
Mean	2.8	456	28,837	216	29,539
Percent	0.09	1.5	98	0.6	

Table 13. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during July 1998.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	18	32,725	53,445	1,116	87,304
EMF	240	19,428	45,453	2,140	67,261
SWWB	111	31,715	71,535	288	103,649
WB	219	18,988	33,175	728	53,110
SMB	3	49,706	11,564	360	61,633
CB	47	1,678	101,148	565	103,438
MB	7	2,786	42,311	421	45,525
EB	21	165,843	16,249	200	182,313
EDL	398	285,387	28,268	20	314,073
Mean	118	67,584	44,794	649	113,334
Percent	0.1	60	40	0.5	

Table 14. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during August 1998.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	21	132,162	21,308	366	153,857
EMF	46	100,440	25,081	562	126,129
SWWB	59	162,044	54,238	282	216,623
WB	102	129,650	12,049	245	142,046
SMB	50	47,688	9,753	1,459	58,950
CB	8	38,918	12,215	812	51,953
MB	36	18,023	4,866	210	23,135
EB	7	2,361,572	1,307	73	2,362,959
EDL	127	764,178	63	0	764,368
Mean	51	417,186	15,653	445	433,335
Percent	<0.1	96	4	0.4	

Table 15. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during September 1998.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	2,324	258,488	35,801	258	296,871
EMF	1,842	318,426	29,919	124	350,311
SWWB	1,231	285,634	56,068	7	342,940
WB	334	100,483	17,156	40	118,013
SMB	267	129,543	3,609	99	133,518
CB	54	52,761	38	79	52,932
MB	125	17,209	1,260	46	18,640
EB	250	338,784	1,411	79	340,524
Mean	794	187,666	18,167	91	206,709
Percent	0.4	91	9	<0.1	

Table 16. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during October 1998.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
WMF	2,053	63,982	31,159	377	97,571
EMF	6,054	57,673	37,598	527	101,852
SWWB	5,075	138,327	40,914	506	184,822
WB	2,076	191,997	50,615	141	244,829
SMB	458	39,383	20,158	1,100	42,959
CB	89	55,054	9,977	572	65,692
MB	143	7,863	7,923	446	16,375
EB	160	703,050	2,518	41	705,769
EDL	99	148,717	5,435	0	154,251
Mean	1,800	156,227	22,922	412	181,362
Percent	1.0	86	12.6	0.2	

Table 17. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during May 1999.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
PL	855	8,770	609	1,102	11,336
WMF	2,680	10,475	635	243	14,033
WB	1,218	56,427	974	122	58,741
SMB	2,316	9,500	1,827	2	13,645
MB	1,949	19,853	974	365	23,141
EB	3,654	12,436	998	609	17,697
EDL	2,256	33,860	503	243	36,862
Mean	2,133	21,617	931	384	25,065
Percent	8.5	86	3.7	1.5	

Table 18. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during August 1999.

Site	Taxon Group				Total
	Bacillariophyta	Cyanophyta	Chlorophyta	Cryptophyta	
PL	760	46,033	609	125	47,527
WMF	499	188,259	1,705	365	190,828
WB	3,365	162,895	7,264	1,218	174,742
SMB	3,532	17,464	487	122	21,605
MB	6,336	576,908	1,218	365	584,827
Mean	2,898	198,312	2,257	439	203,906
Percent	1.4	97.2	1.1	0.3	

Table 19. Density (cells/mL) of major phytoplankton taxon at selected sites in Devils Lake during October 1999.

<u>Site</u>	<u>Taxon Group</u>				<u>Total</u>
	<u>Bacillariophyta</u>	<u>Cyanophyta</u>	<u>Chlorophyta</u>	<u>Cryptophyta</u>	
PL	20,736	162,349	18,460	1,842	203,387
WMF	2,177	115,467	4,507	609	122,760
WB	7,039	142,399	7,942	730	158,110
SMB	2,829	43,970	625	250	47,674
MB	4,479	19,001	675	609	24,764
EB	3,676	27,300	2,071	609	33,656
EDL	10,353	317,492	4,947	305	333,097
Mean	7,327	118,283	5,604	708	131,921
Percent	5.6	89.7	4.2	0.5	

Literature Cited

Elstad, S., 1992. A comparison of the site-specific age structure, growth and diet of the walleye, *Stizostedion vitreum vitreum*, (Mitchell), in Devils Lake, North Dakota. M.S. Thesis, Univ. of North Dakota, Grand Forks, North Dakota.

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Wiche, G., 1997. Personal communication, U.S. Geological Survey, Bismarck, North Dakota.

Appendix A

Devils Lake

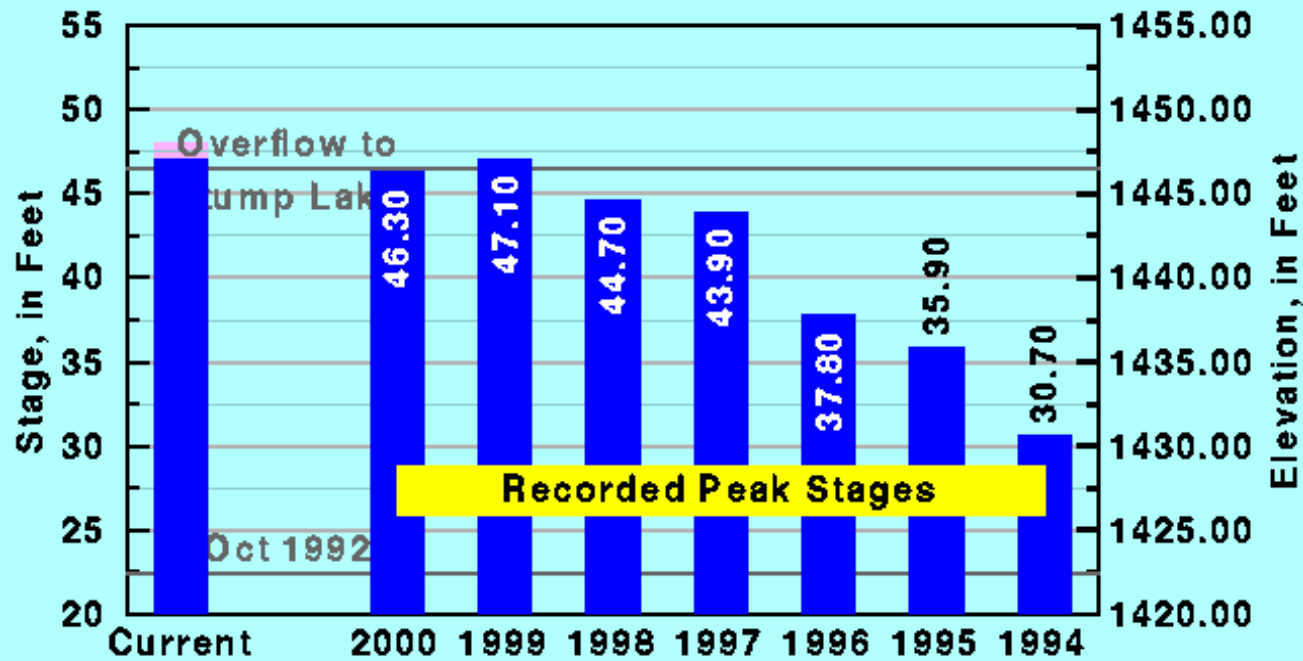
Water Chemistry Data

To Acquire, Contact the North Dakota Department of Health

Appendix B
Devils Lake Inflow
USGS Hydrographs
Provisional Data

05056500 DEVILS LAKE NEAR DEVILS LAKE, ND

(SLC = 1400.00)



Current Stage: 47.07 as of 2001.11.28 02:00:00

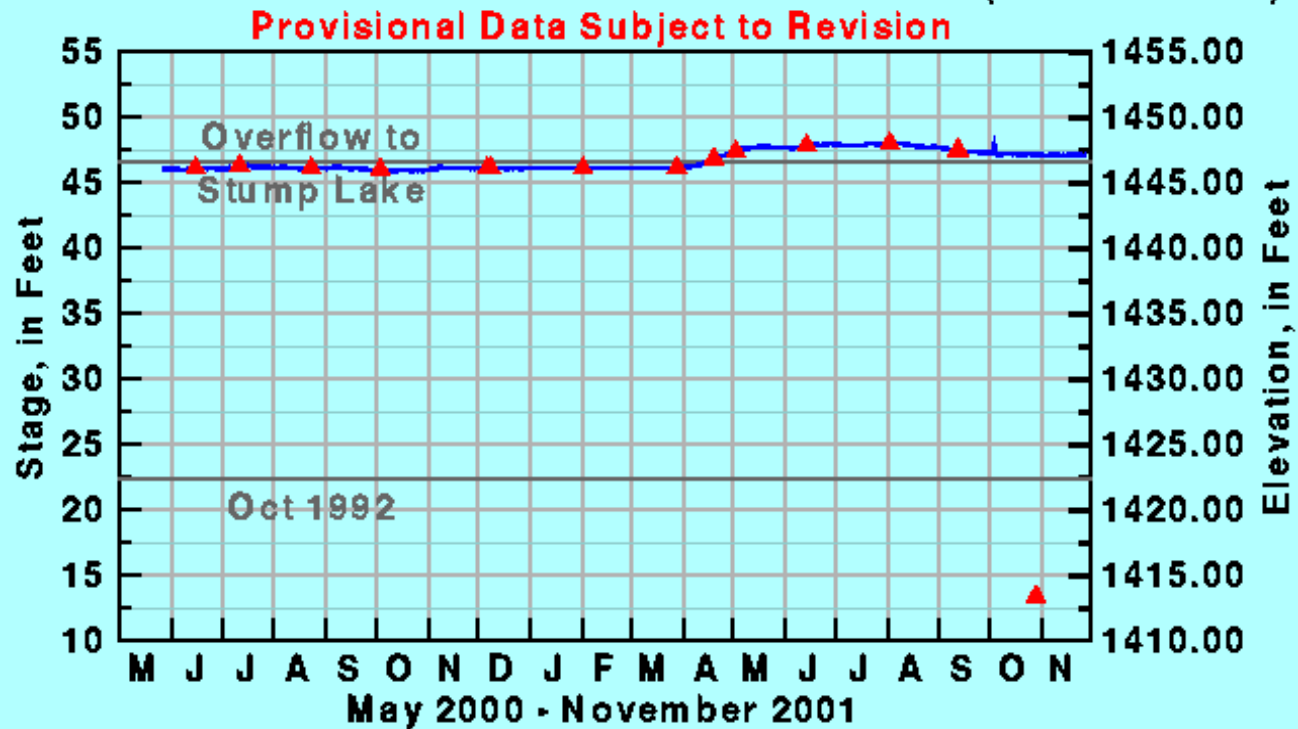


Recent Maximum Stage: 48.04 at 2001.08.09 02:00:00

Station Operated by the Grand Forks, ND Office

05056500 DEVILS LAKE NEAR DEVILS LAKE, ND

(SLC = 1400.00)



Daily Mean Stage: 47.07 as of 2001.11.27

▲ Measured Stage



Station Operated by the Grand Forks, ND Office

Appendix C

Dissolved Oxygen, Specific Conductance, Temperature and pH Data

To Acquire, Contact the North Dakota Department of Health