Appendix B

Atmospheric Deposition/Concentration Monitoring

Long Term Lakes

Currently there are six long-term lakes that are being monitored in the Wind River Mountains to determine if changes from atmospheric deposition are occurring. These lakes are Hobbs, Black Joe, Deep and Upper Frozen Lakes on the Bridger-Teton NF, and Ross and Lower Saddlebag lakes on the Shoshone NF. Recent funding has been allocated to do a detailed statistical analysis of the long-term lake chemistry for the lakes on the Bridger-Teton NF. This analyzed data for the Bridger-Teton NF will be the focus of this discussion, while the Shoshone NF long-term lakes will be analyzed in the future.

Lab analysis – Laboratory analysis has been completed by the USGS lab in Denver Colorado from 1984 to 1991, and the RMRS lab in Fort Collins, Colorado from 1991 to present.

Data analysis methods

- Data preparation

The original lab spreadsheets were manipulated to put them in a standardized format and data gaps such as elevation and geographic coordinates were filled in where possible. Blanks and data from areas outside the Wind River Range were removed. The data were then separated into Long-term and synoptic data sets. The Long-term data set was further separated by sampling location: epilimnion, hypolimnion, inlet and outlet. Analysis of synoptic lake data is not included in this report.

Missing data: no attempt was made to fill in missing analytical data.
Values below detection limit: in order to perform mathematical analysis of the data sets, values flagged as below the detection limit were assigned a value equal to one-half the detection limit provided by the analytical laboratory. Lab data from the Bridger-Teton NF for 1989, used a higher detection limit than was used for other sampling years, this data was discarded from the analysis.

◊ Analytes

The laboratories analyzed for a broad suite of analytes including major cations and anions, pH, and Acid Neutralizing Capacity (ANC) using comparable techniquesand standards.

◊ Seasonality

All data sets were analyzed for seasonality using the Kruskal-Wallis seasonality test. If the data sets showed seasonality (95% confidence level), the Seasonal Kendall test was run in addition to the Mann-Kendall test for trends.

◊ Outliers

Each data set was analyzed for outliers using the WQStatPlus outlier test. Statistical outliers were identified. If the values weren't explainable by the date of collection, or weren't part of a pattern shown in other samples, they were removed before trend analysis.

◊ Duplicates

For the Long-term data protocols, the Quality Assurance/Quality Checking (QA/QC) plans call for the collection and analysis of duplicate samples on a regular basis. In order to have a unique data record for a given location and date and time, these duplicates have to be combined into one sample. The duplicate records were reviewed, one by one, to make sure each of the duplicates met the QA/QC checks in the lab spreadsheet and to ensure that no other obvious contamination or other problem showed up in the data. Assuming both duplicates passed these criteria, each analyte of concern was averaged to provide a sample type of "dupavg" Where one sample did not pass the QA/QC checks or other screens for contamination (i.e. elevated sodium and chloride), the values for the remaining, good sample were used.

◊ Trend analysis

Trends in nitrate, sulfate, and ANC for the long term data sets were analyzed using the WQStatPlus statistical package. For lakes in which samples are collected at the epilimnion, hypolimnion, inlets and outlets, each lake location is analyzed separately. For non-seasonal data, the Mann-Kendall test was run to determine if there were significant temporal trends. Where data were seasonal, as indicated by the Kruskal Wallis statistic, both the Mann-Kendall and the Seasonal Kendall tests were run to determine if both tests provided essentially the same results. They did in all cases of this analysis. A minimum of eight data points are necessary to perform the non-parametric test. Upper Frozen Lake had exactly eight data points, but the first two were collected early in its season, while the later six samples were collected later. This could give the appearance of a false trend, so the data were plotted on a time-series plot, but no trend analysis is presented.

Regression analysis

In comparisons of two values for a data set such as elevation and acid neutralizing capacity (ANC), a simple linear regression using Microsoft Excel was run.

Lake chemistry and deposition comparison

For those lakes which have a collocated deposition collector (Hobbs Lake and Black Joe Lake), a comparison was made between lake inlet chemistry and deposition for average annual nitrate and sulfate concentrations. Deep Lake chemistry was also compared with the Black Joe Lake bulk deposition figures. All Long-term lake chemistry was also compared against average annual concentrations of nitrate and sulfate from the three National Atmospheric Deposition Program sites on the west side of the Wind River Mountains (Gypsum Creek, Pinedale, and South Pass).

<u>Presentation of Results</u>

For each lake, a table summarizing which locations and analytes from each lake are seasonal along with the seasons for that particular lake is presented first. The protocols call for collecting the first sample to be collected as soon as possible in the spring, the second sample at the height of the summer, and the fall sample as late as possible after turnover and before the lakes freeze. Based on this, an analysis was conducted determining the range of dates for each sampling period and these dates were assigned to "spring", "summer" and "fall". These dates were determined separately for each long-term lake and are presented at the beginning of the results for each lake.

A summary table is presented for each long-term lake, showing which, if any, analytes in each lake location show a significant trend, the slope of the trend (rate of increase or decrease in the analyte), and the corresponding confidence level. For each long-term lake, the results of the trend analysis are presented showing the actual outputs of the Mann-Kendall or Seasonal Kendall tests if the data showed a significant trend. If no trend is present, a time series plot is shown.

The results of the lake chemistry/deposition concentration analysis are presented as a line plots. Only significant trends are indicated by a trend line. For lakes with a collocated bulk collector or one located nearby (Deep Lake), the inlet nitrate and sulfate chemistry is plotted against the bulk deposition average annual concentration for the analyte. The next plot for each lake shows the lake inlet chemistry, plotted with the nearest bulk deposition chemistry and the average annual values for the three NADP sites on the west side of the Wind Rivers.

Statistically significant trends simple summary

	ANC Trend	**NO3 Trend**	**SO4 Trend**
Black Joe Lake Epilimnion	---	---	---
Black Joe Lake Hypolimnion	↑	↑	---
Black Joe Lake Inlet	↑	↑	---
Black Joe Lake Outlet	↑	↑	↑
Deep Lake Epilimnion	---	---	↓
Deep Lake Hypolimnion	---	---	↓
Deep Lake Inlet	---	↑	
Deep Lake Outlet	---	---	↓
Hobbs Lake Epilimnion	---	---	↓
Hobbs Lake Hypolimnion	---	---	↓
Hobbs Lake Inlet	---	↑	↓
Hobbs Lake Outlet	↓	---	---

Trends full output table

	ANC			**NO3 (since 1984)**			**SO4**		
	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level
Black Joe Lake Epilimnion	No	---------	-------	No	-------	--------	No	-------	-------
Black Joe Lake Hypolimnion	Yes	+.684 units/yr	90%	Yes	.007	90%	No	-------	-------
Black Joe Lake Inlet	Yes	+.5398	90%	Yes	.030	95%	No	-------	-------
Black Joe Lake Outlet	Yes	+.66	95%	Yes	.002	95%	Yes?	.011	80%
Deep Lake Epilimnion	No	---------	-------	No	-------	-------	Yes?	-.011	80%
Deep Lake Hypolimnion	No	---------	-------	No	-------	-------	Yes	-.018	95%
Deep Lake Inlet	No	---------	-------	Yes	.021	95%	No	-------	-------
Deep Lake Outlet	No	---------	-------	No	-------	-------	Yes	-.008	90%
Hobbs Lake Epilimnion	No	---------	-------	Yes	.000	95%	Yes?	-.006	80%
Hobbs Lake Hypolimnion	No	---------	-------	No	-------	-------	Yes	-.008	90%
Hobbs Lake Inlet	No	---------	-------	Yes	.002	95%	Yes	-.007	95%
Hobbs Lake Outlet	Yes?	-.342	80%	No	-------	-------	No	-------	-------

Black Joe Lake

◊ Seasonality:

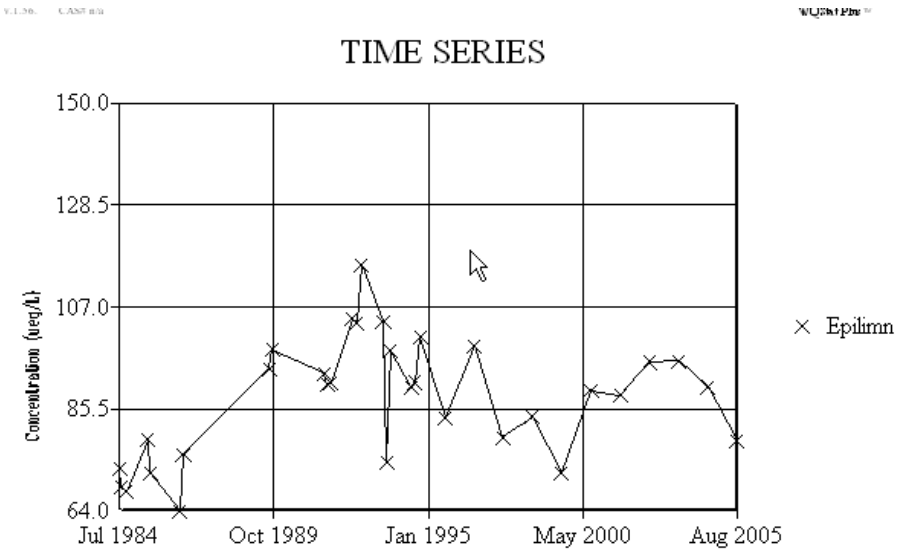
Spring =January 1 – July 20, Summer = July 21 – Aug 31, Fall = Sept 1 – December 31

	ANC	NO3	SO4
Epilimnion	No	No	No
Hypolimnion	too few obs.	No	No
Inlet	Yes	Yes	Yes
Outlet	No	Yes	No

Significant Trends

	ANC			**NO3 (since 1984)**			**SO4**		
	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level
Epilimnion	No	---------	-------	No	-------	--------	No	-------	-------
Hypolimnion	Yes	+.684 units/yr	90%	Yes	.007	90%	No	-------	-------
Inlet	Yes	+.5398	90%	Yes	.030	95%	No	-------	-------
Outlet	Yes	+.66	95%	Yes	.002	95%	Yes?	.011	80%

Black Joe Lake Acid Neutralizing Capacity Trend Analysis and Time Series Plots



Constituent: ANC (ueq/L) Facility: Black_Joe Data File: BJSTAT~1
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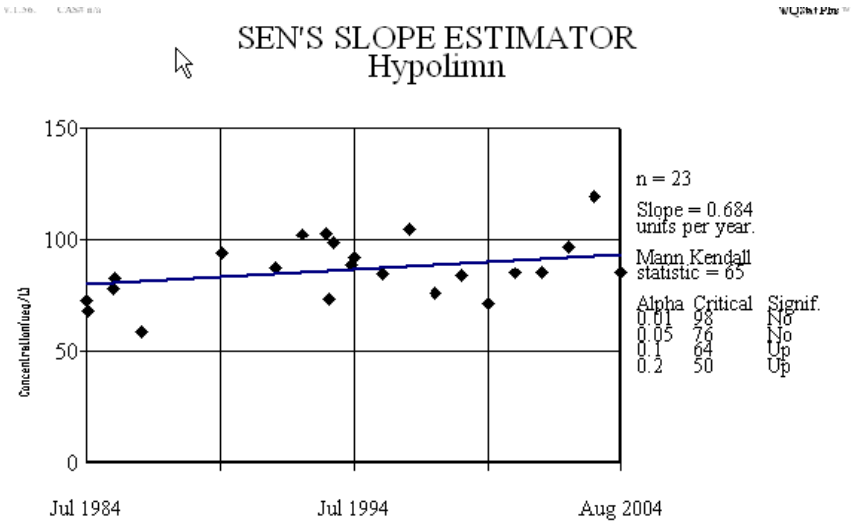

Constituent: ANC (ueq/L) Facility: Black_Joe Data File: BJSTAT~1
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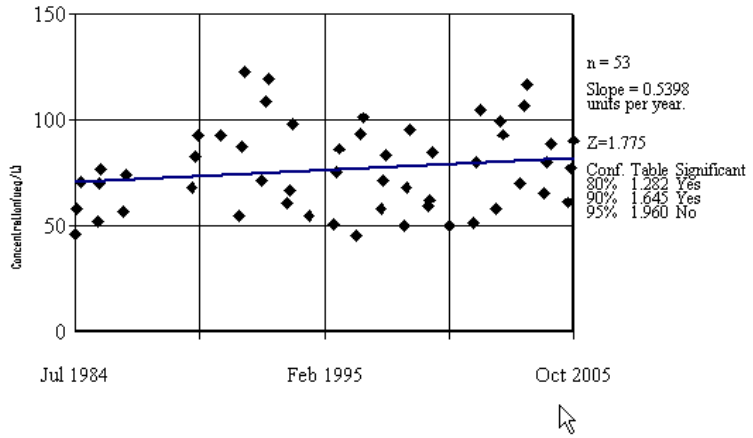
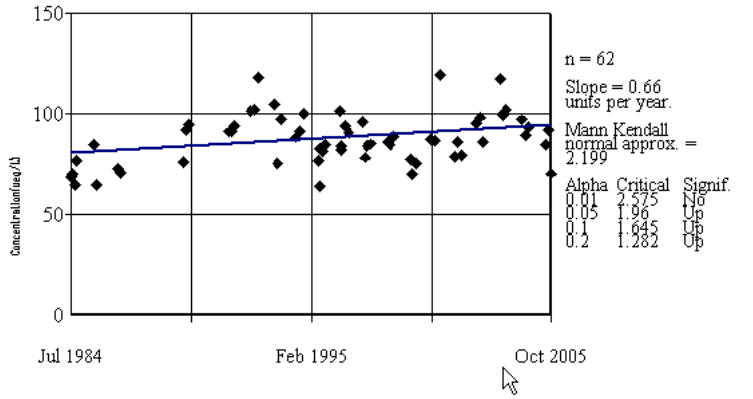
SEASONAL KENDALL SLOPE ESTIMATOR
Inlet



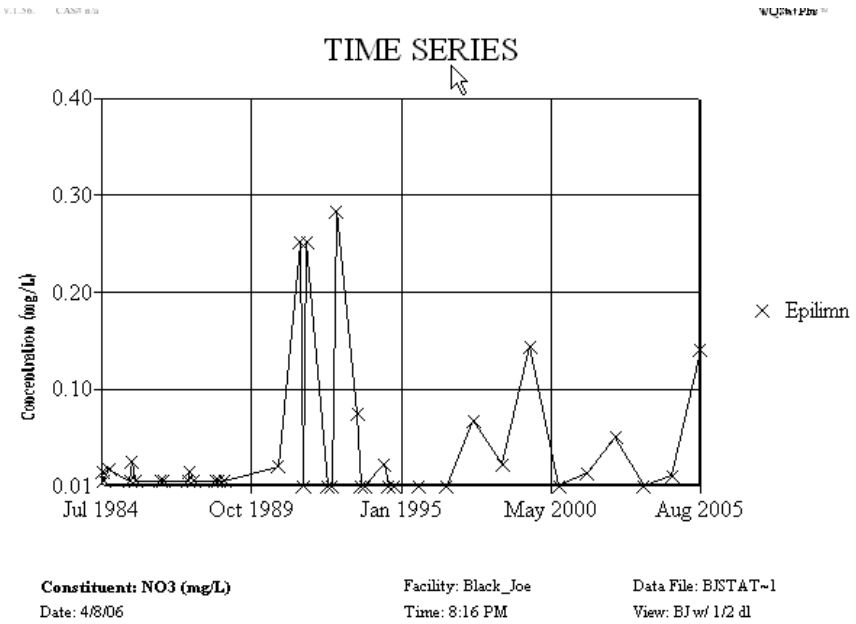
Constituent: ANC (ueq/L) Facility: Black_Joe Data File: BJSTAT~1
Date: 4/8/06 Time: 7:11 PM View: BJ w/ 1/2 dl

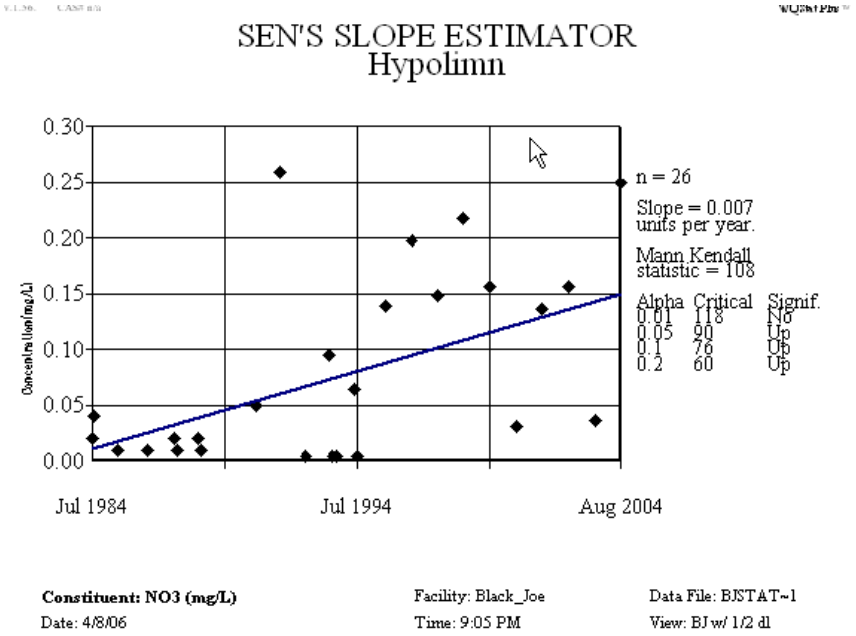
SEN'S SLOPE ESTIMATOR
Outlet



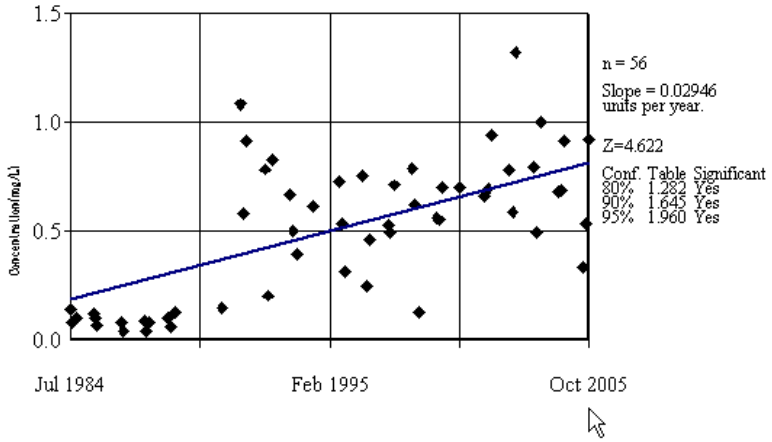
Constituent: ANC (ueq/L) Facility: Black_Joe Data File: BJSTAT~1
Date: 4/8/06 Time: 6:58 PM View: BJ w/ 1/2 dl

Black Joe Lake Nitrate Trend Analysis (since 1984) and Time Series Plots



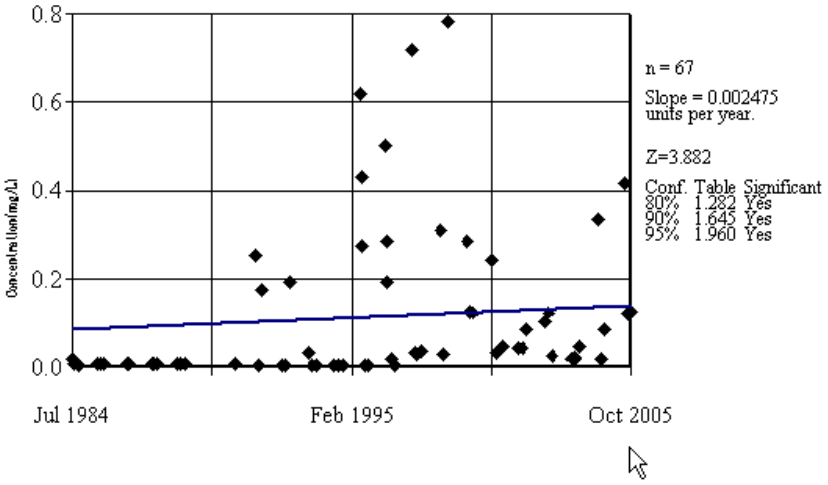


SEASONAL KENDALL SLOPE ESTIMATOR
Inlet



Constituent: NO3 (mg/L) Facility: Black_Joe Data File: BJSTAT~1
Date: 4/8/06 Time: 7:32 PM View: BJ w/ 1/2 dl

SEASONAL KENDALL SLOPE ESTIMATOR
Outlet



Constituent: NO3 (mg/L) Facility: Black_Joe Data File: BJSTAT~1
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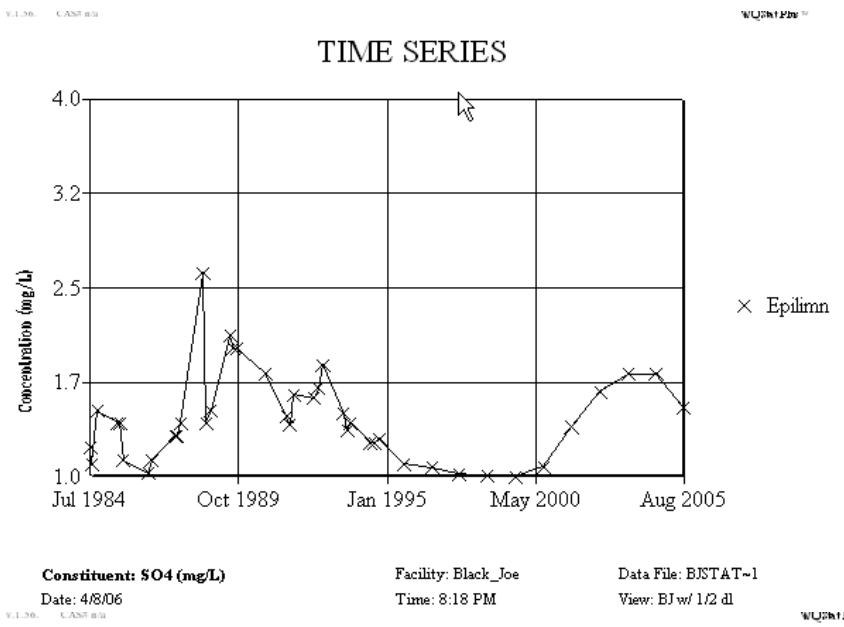
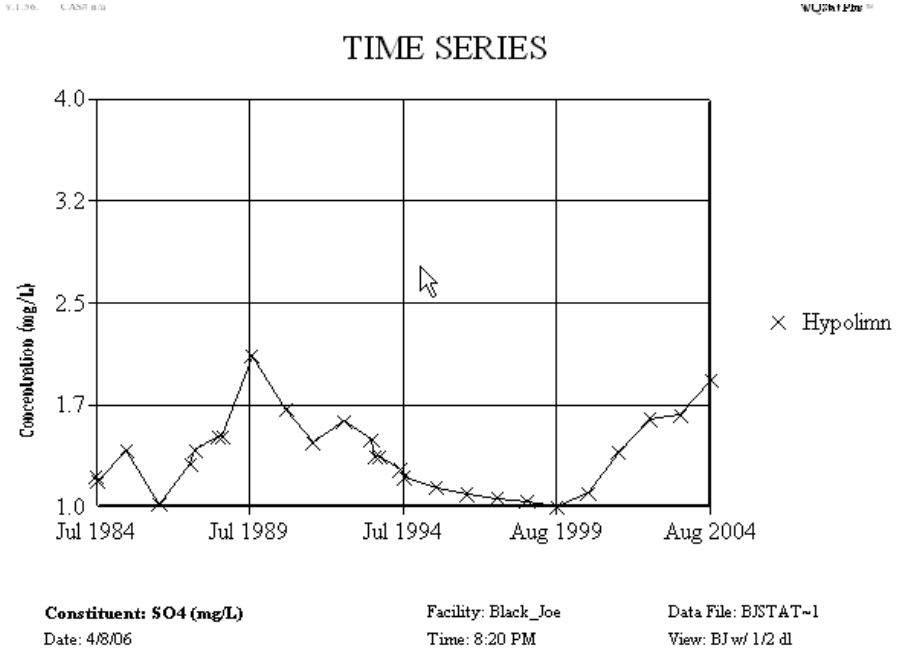
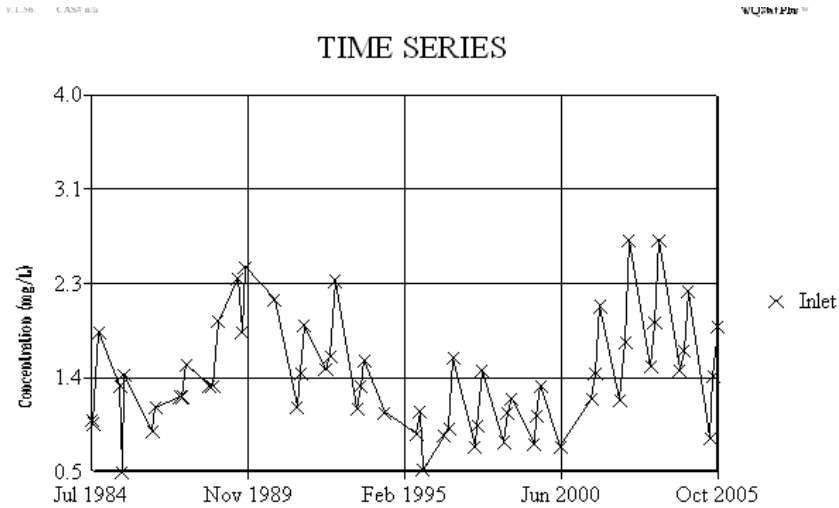
Black Joe Lake Sulfate Trend Analysis and Time Series Plots







Constituent: SO4 (mg/L) Facility: Black_Joe Data File: BJSTAT~1
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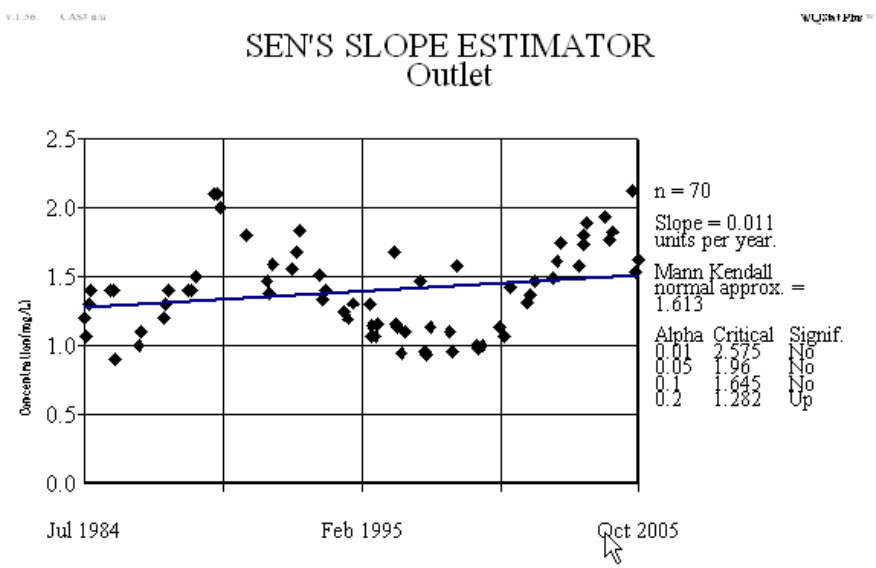
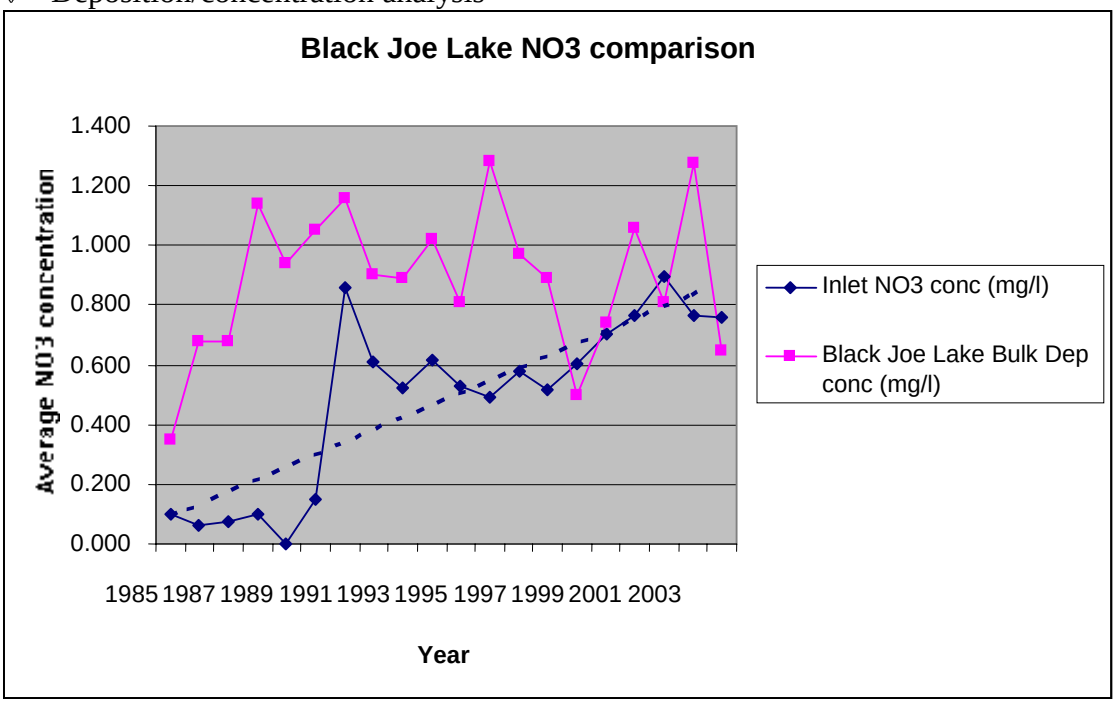
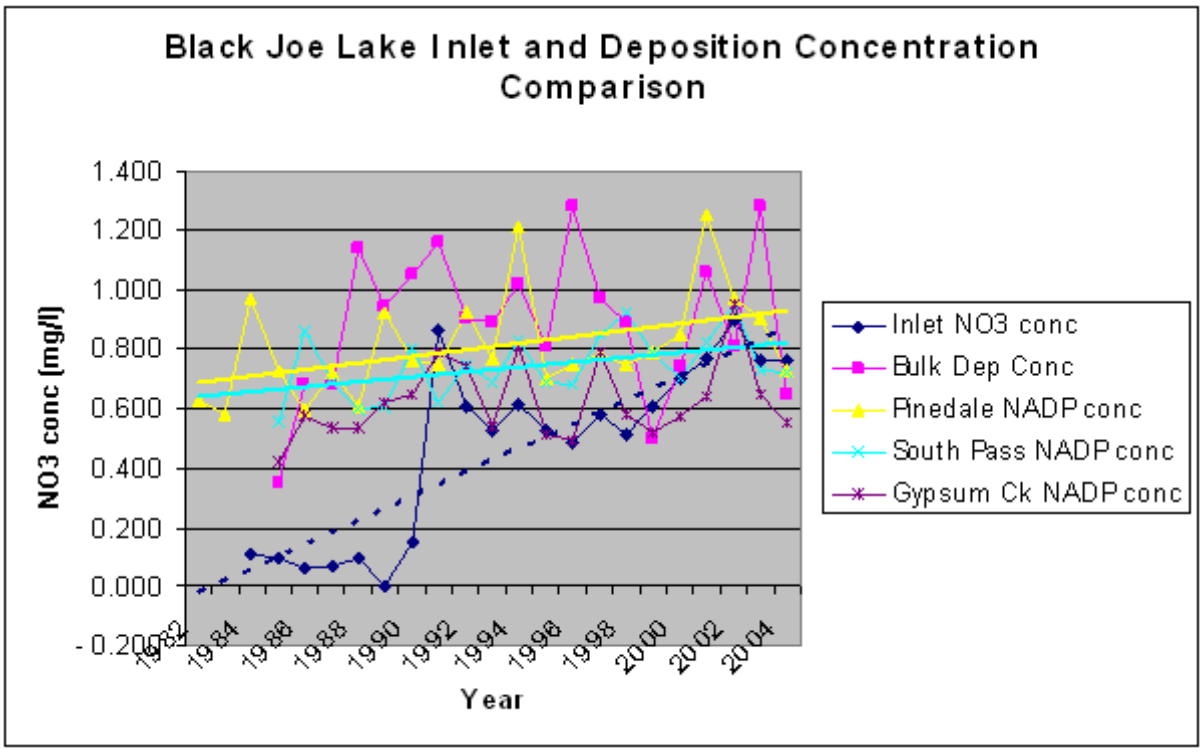
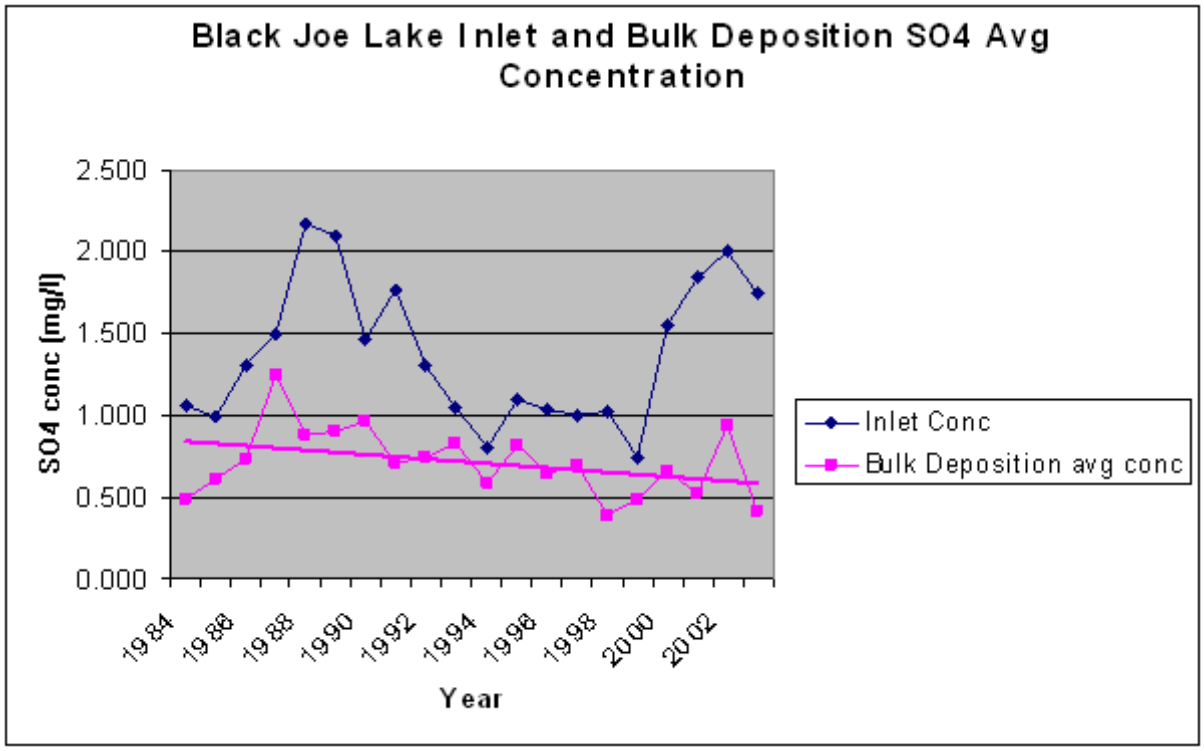


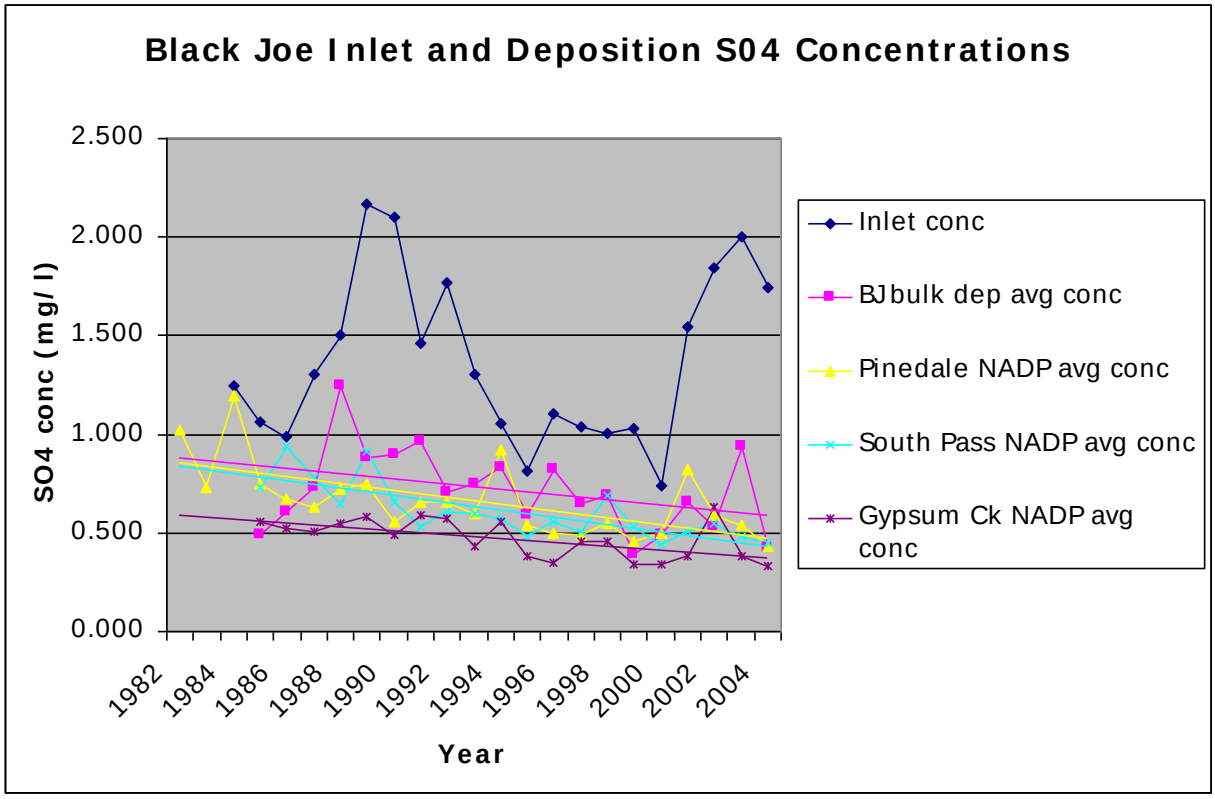
Constituent: SO4 (mg/L) Facility: Black_Joe Data File: BJSTAT~1
Date: 4/8/06 Time: 7:22 PM View: BJ w/ 1/2 dl

◊ Deposition/concentration analysis






Black Joe Lake Inlet and Bulk Deposition SO4 Avg Concentration
SO4 conc (mg/l)
2.500
2.000
1.500
1.000
0.500
0.000
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Year
Inlet Conc
Bulk Deposition avg conc


Black Joe Inlet and Deposition S04 Concentrations
SO4 conc (mg/l)
2.500
2.000
1.500
1.000
0.500
0.000
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year
Inlet conc
BJ bulk dep avg conc
Pinedale NADP avg conc
South Pass NADP avg conc
Gypsum Ck NADP avg conc

DeepLake

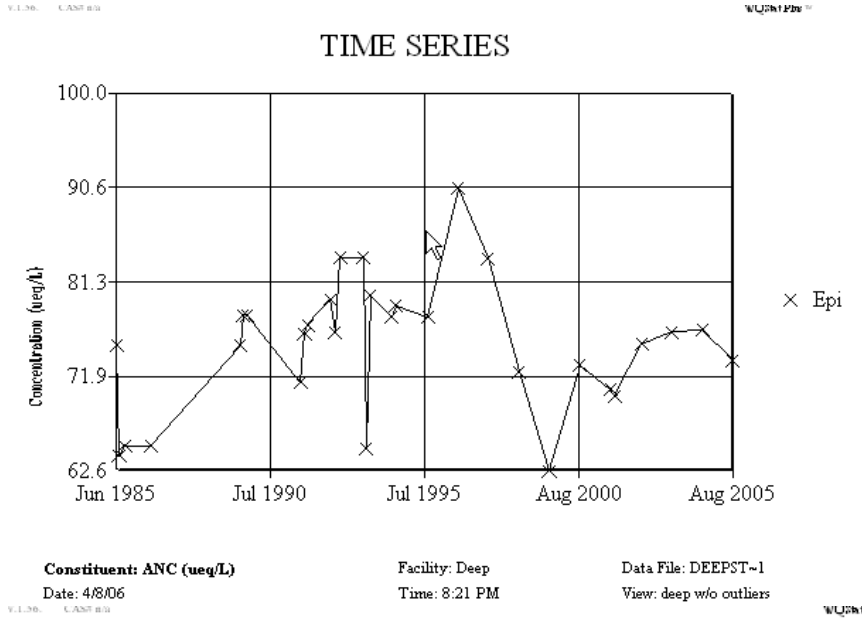
◊ Trends

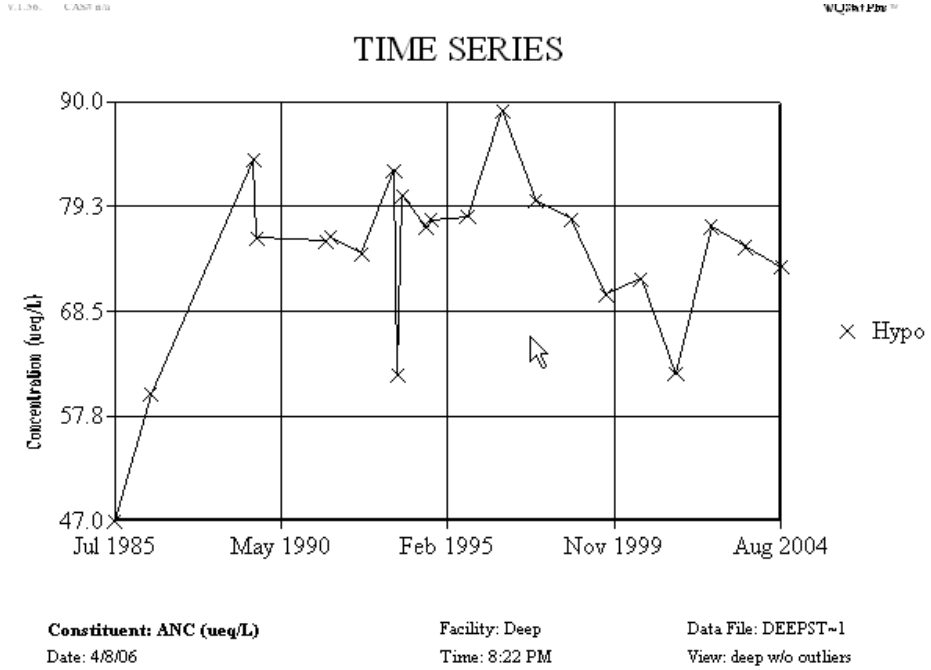
Seasons: Spring = Jan 1 – July 31, Summer = Aug. 1 – Sept 8, Fall = Sept 9 – Dec. 31

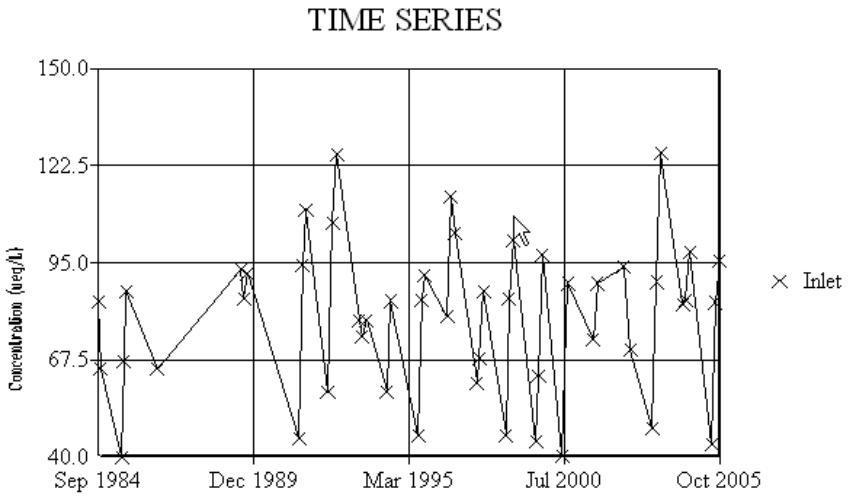
	ANC	**NO3**	**SO4**
Epilimnion	No	No	No
Hypolimnion	too few obs.	No	No
Inlet	Yes	Yes	Yes
Outlet	No	Yes	No

	ANC			**NO3 (since 1984)**			**SO4**		
	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level
Epilimnion	No	---------	-------	No	-------	-------	Yes?	-.011	80%
Hypolimnion	No	---------	-------	No	-------	-------	Yes	-.018	95%
Inlet	No	---------	-------	Yes	.021	95%	No	-------	-------
Outlet	No	---------	-------	No	-------	-------	Yes	-.008	90%

Deep Lake Acid Neutralizing Capacity Trend Analysis and Time Series Plots



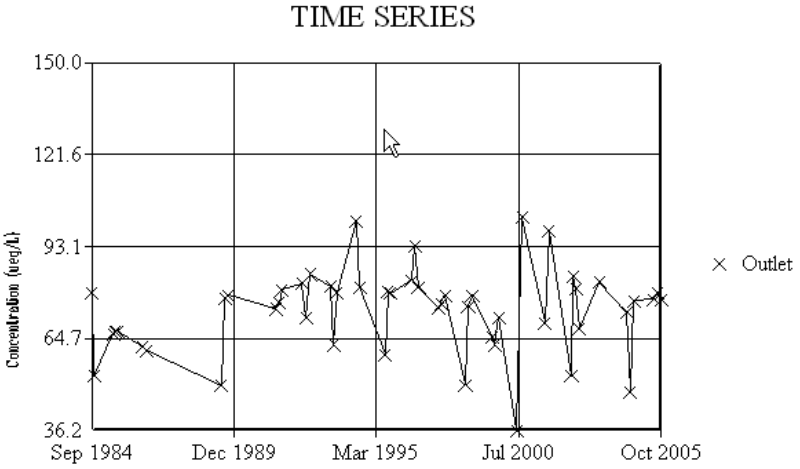




Constituent: ANC (ueq/L)
Date: 4/8/06

Facility: Deep
Time: 8:23 PM

Data File: DEEPST~1
View: deep w/o outliers

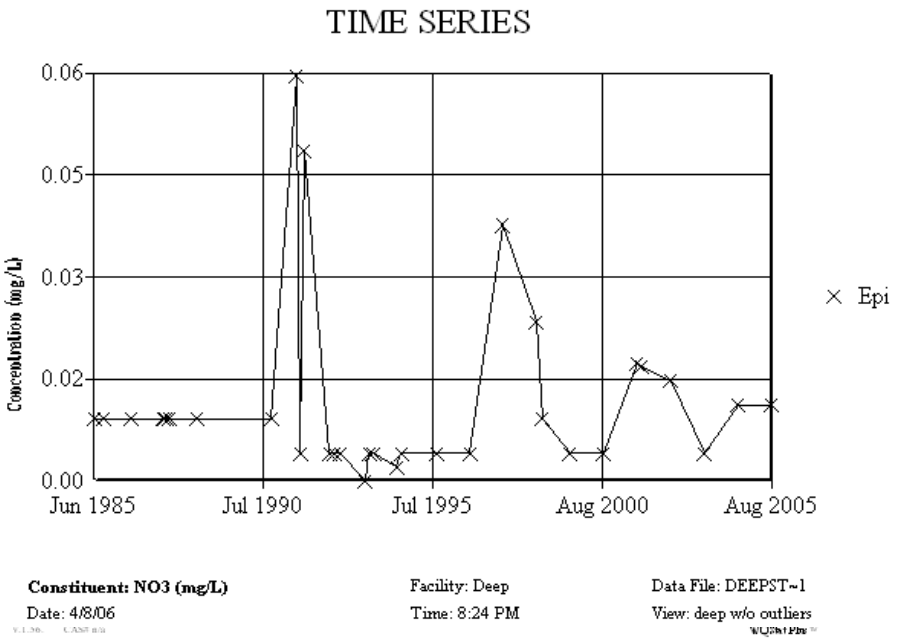


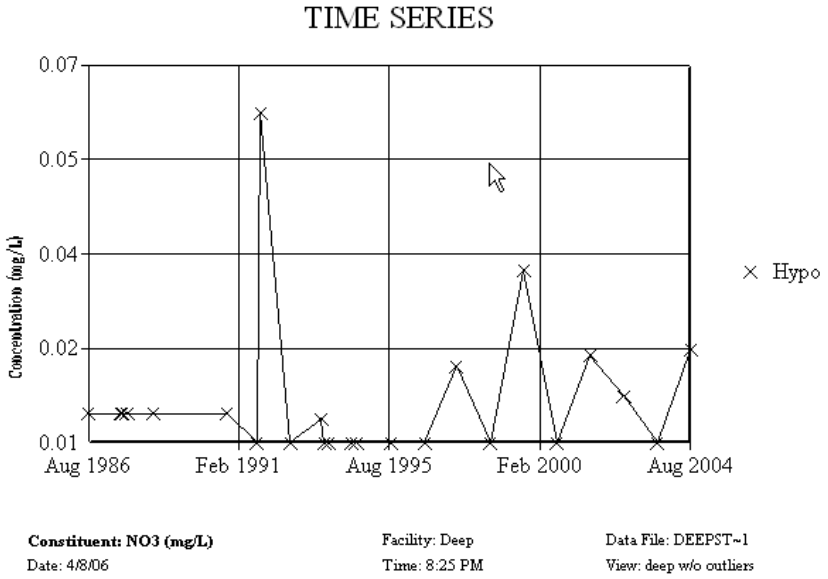
Constituent: ANC (ueq/L)
Date: 4/8/06

Facility: Deep
Time: 8:23 PM

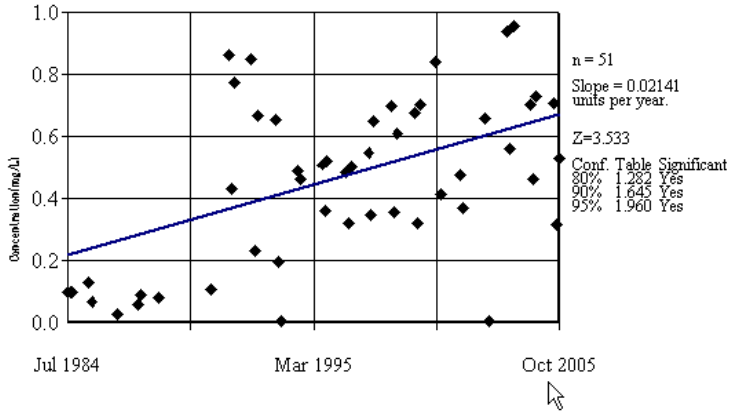
Data File: DEEPST~1
View: deep w/o outliers

Deep Lake Nitrate Trend (since 1984) Analysis and Time Series Plots



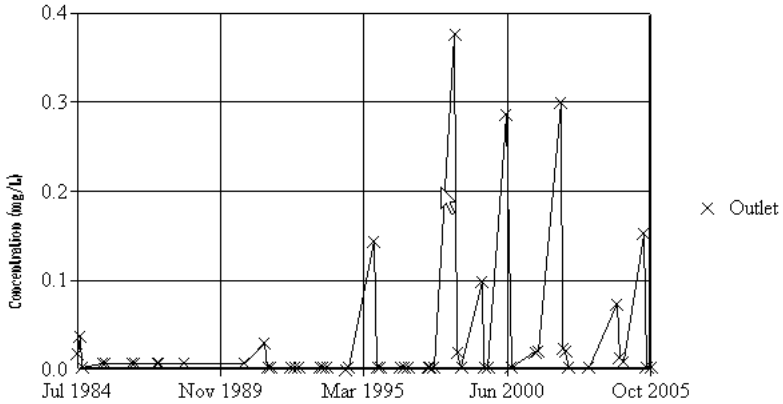


SEASONAL KENDALL SLOPE ESTIMATOR
Inlet



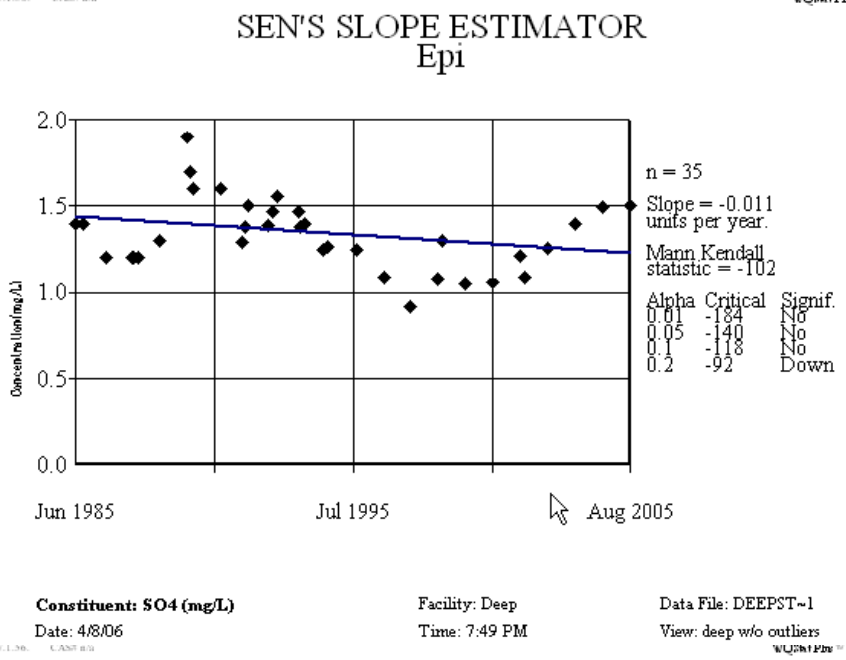
Constituent: NO3 (mg/L) Facility: Deep Data File: DEEPST~1
Date: 4/8/06 Time: 7:42 PM View: deep w/o outliers

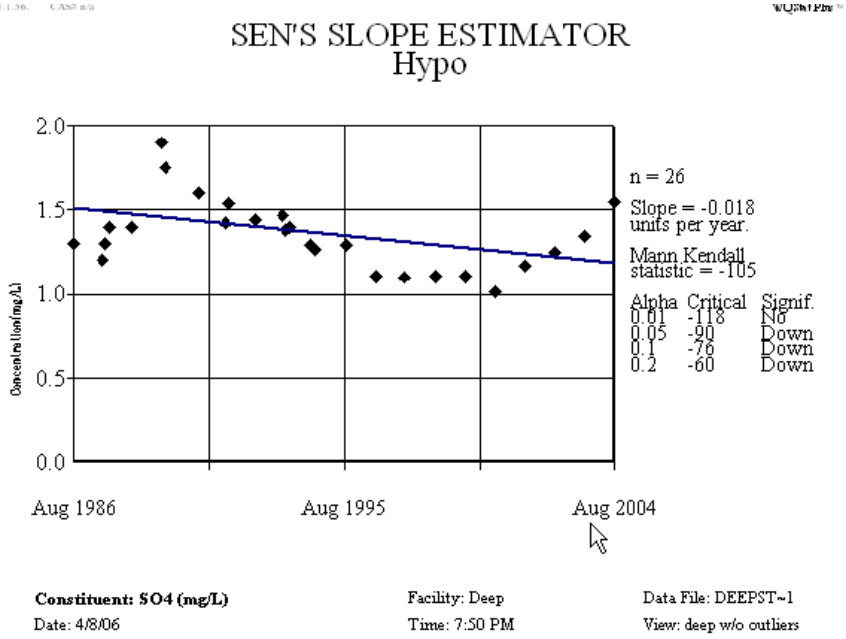
TIME SERIES



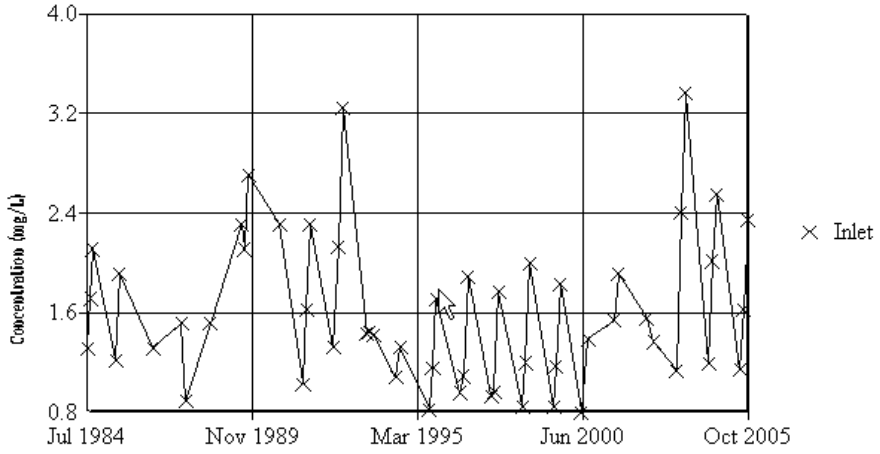
Constituent: NO3 (mg/L) Facility: Deep Data File: DEEPST~1
Date: 4/8/06 Time: 8:26 PM View: deep w/o outliers

Deep Lake Sulfate Trend Analysis and Time Series Plots





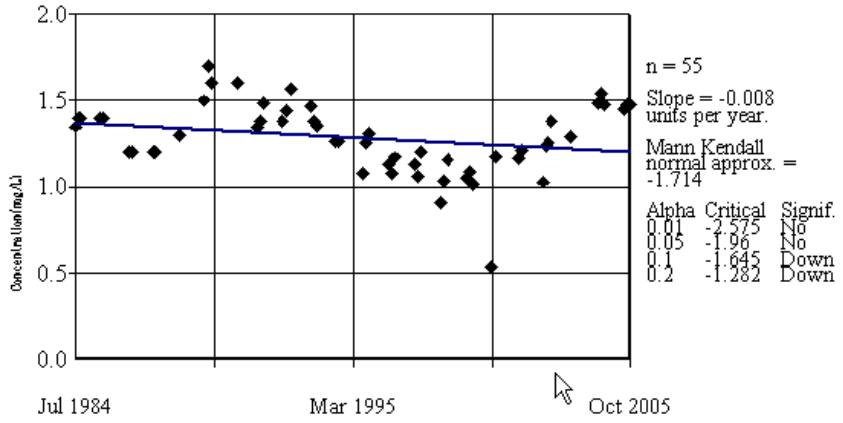
TIME SERIES



Constituent: SO4 (mg/L) Facility: Deep Data File: DEEPST~1

Date: 4/8/06 Time: 9:37 PM View: deep w/o outliers

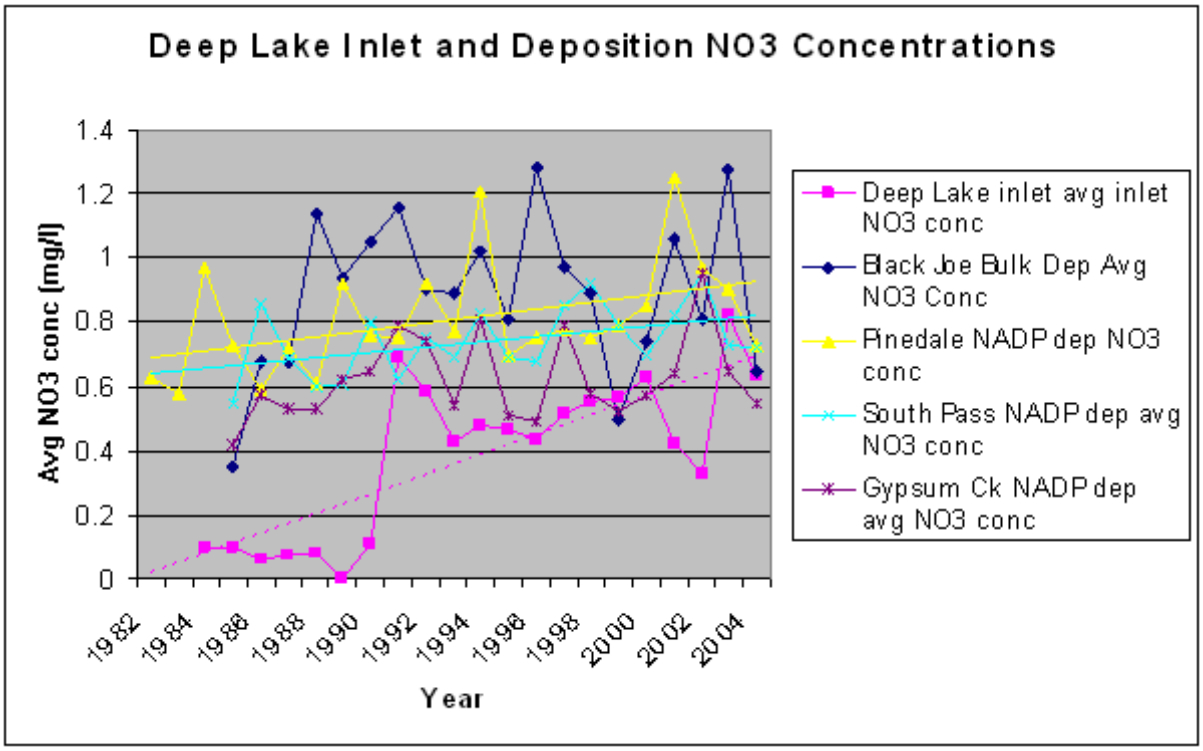
SEN'S SLOPE ESTIMATOR
Outlet

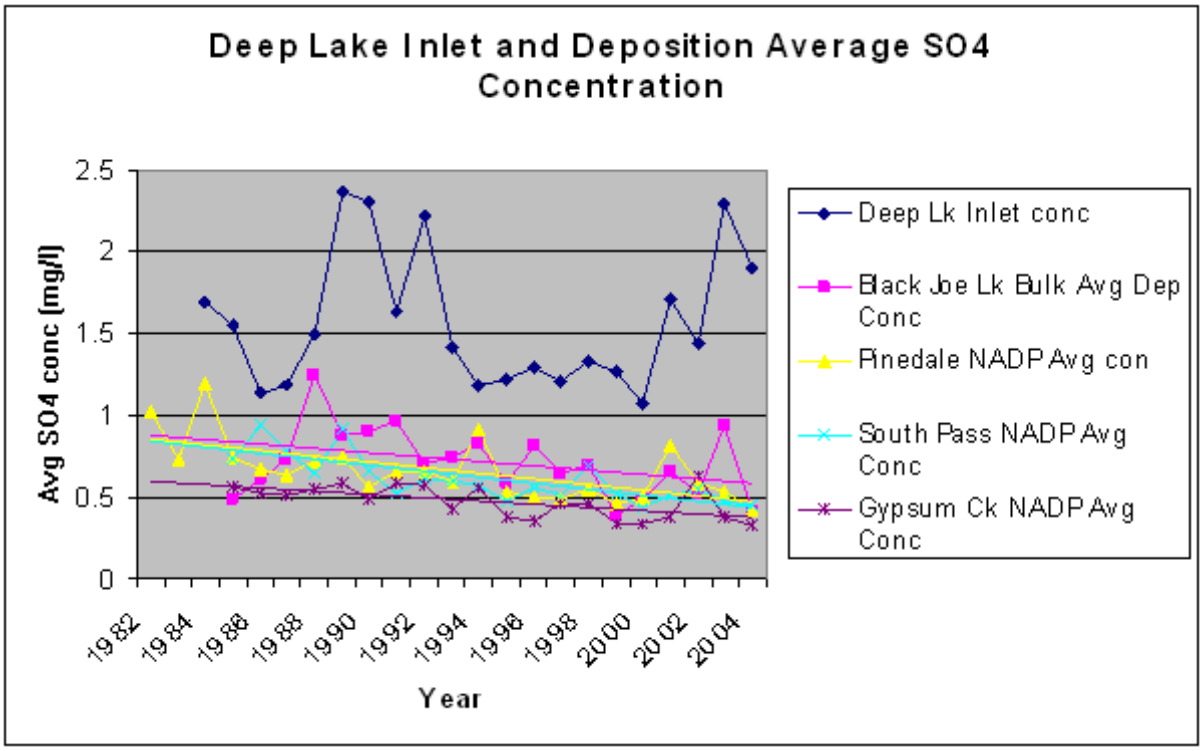


Constituent: SO4 (mg/L) Facility: Deep Data File: DEEPST~1

Date: 4/8/06 Time: 7:50 PM View: deep w/o outliers

◊ Deposition/concentration analysis





Hobbs Lake

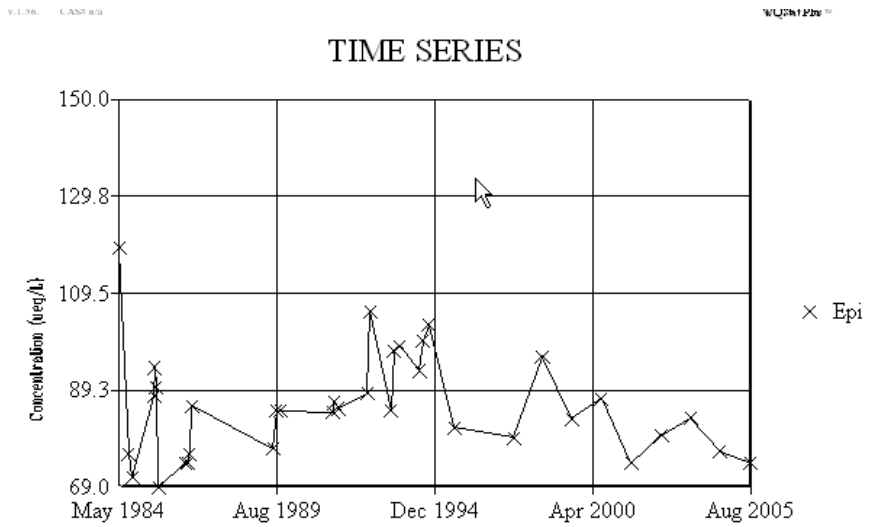
◊ Trends

Seasons: Spring = Jan 1 – July 31, Summer = Aug 1 – Sept. 10, Fall = Sept 11 - Dec. 31

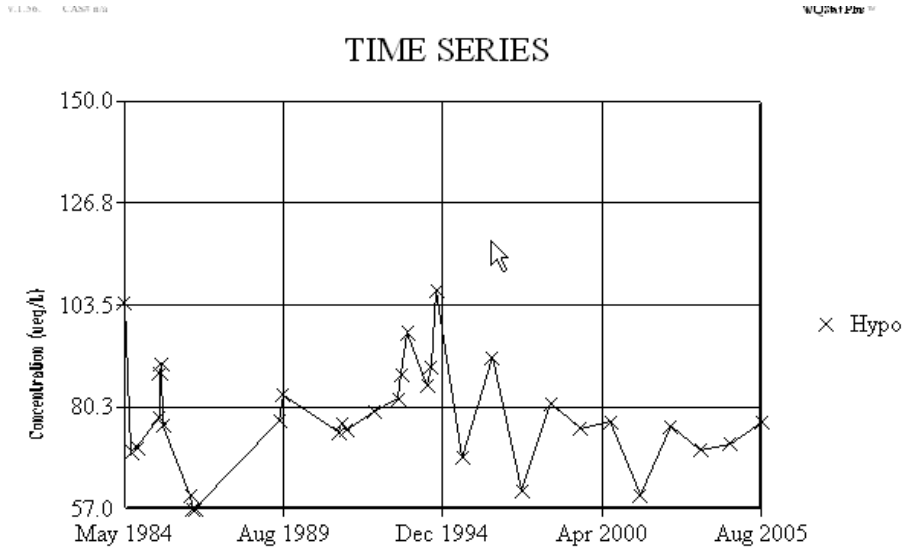
	ANC	**NO3**	**SO4**
Epilimnion	No	No	No
Hypolimnion	No	No	No
Inlet	Yes	Yes	Yes
Outlet	Yes	No	No

	ANC			**NO3 (since 1984)**			**SO4**		
	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level	Sig Trend?	Slope	Conf. Level
Epilimnion	No	---------	-------	Yes	-.189	95%	Yes?	-.006	80%
Hypolimnion	No	---------	-------	No	-------	-------	Yes	-.008	90%
Inlet	No	---------	-------	Yes	.002	95%	Yes	-.007	95%
Outlet	Yes?	-.342	80%	No	-------	-------	No	-------	-------

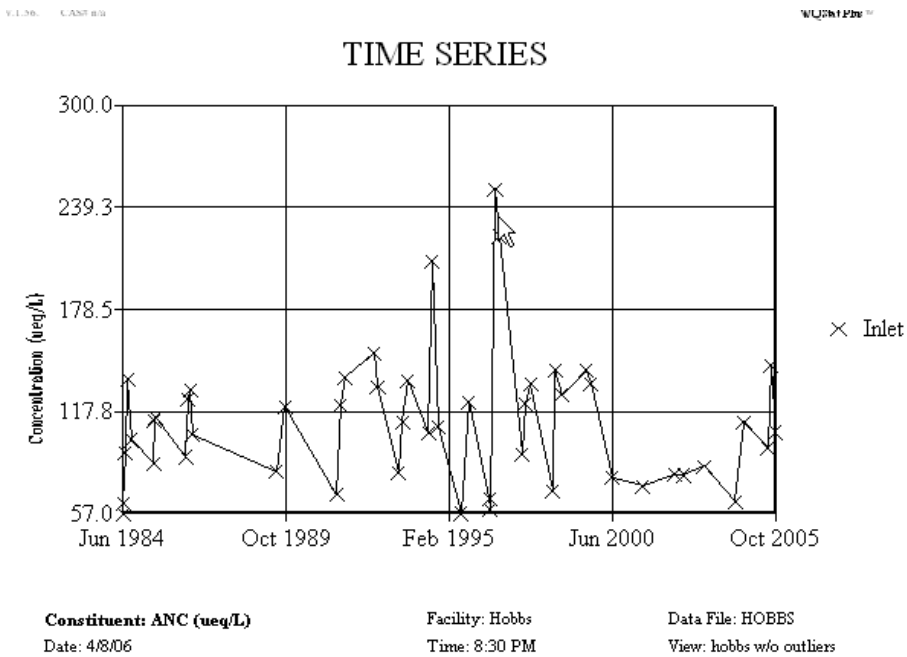
Hobbs Lake Acid Neutralizing Capacity Trend Analysis and Time Series Plots

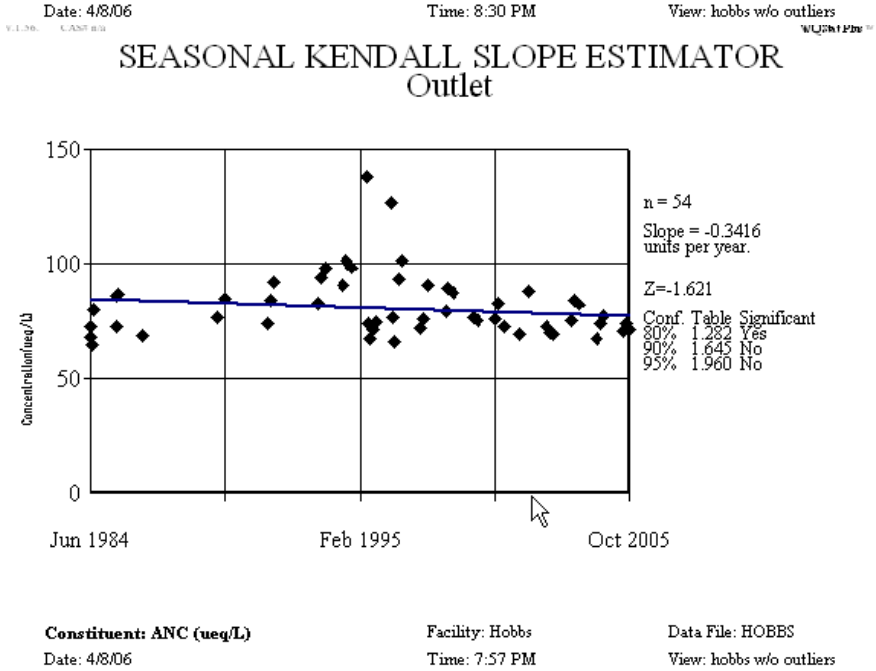


Constituent: ANC (ueq/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:29 PM View: hobbs w/o outliers

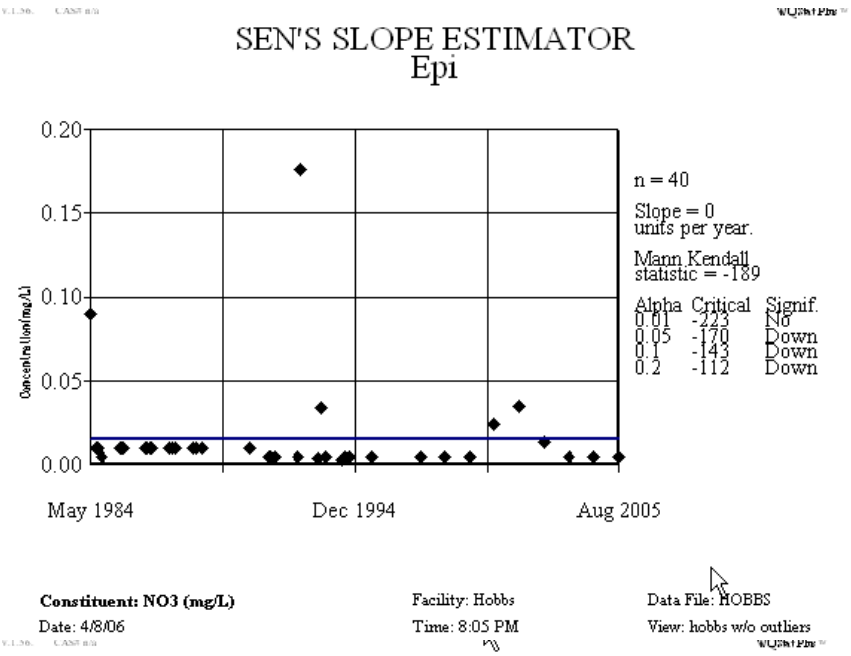


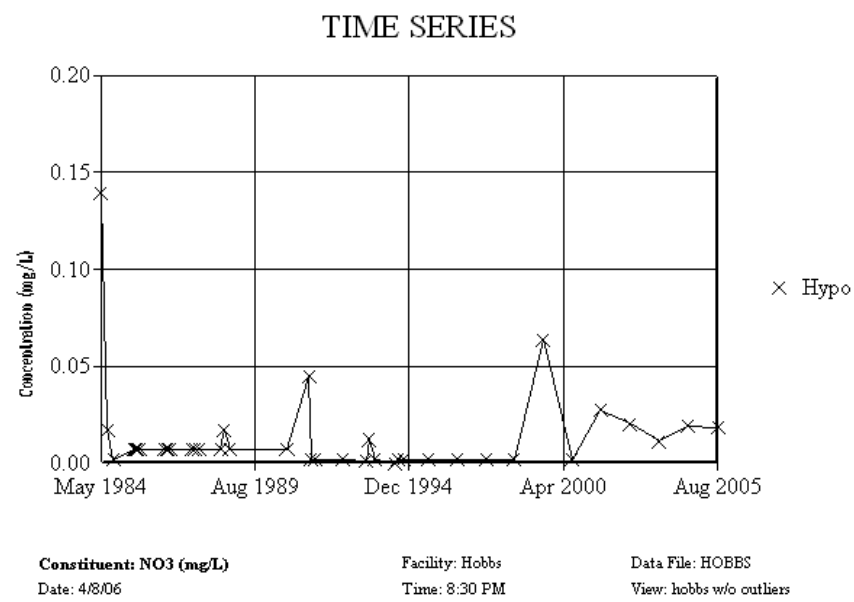
Constituent: ANC (ueq/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:29 PM View: hobbs w/o outliers


TIME SERIES
300.0
239.3
178.5
117.8
57.0
Concentration (ueq/L)
Jun 1984
Oct 1989
Feb 1995
Jun 2000
Oct 2005
Inlet
Constituent: ANC (ueq/L)
Date: 4/8/06
Facility: Hobbs
Time: 8:30 PM
Data File: HOBBS
View: hobbs w/o outliers

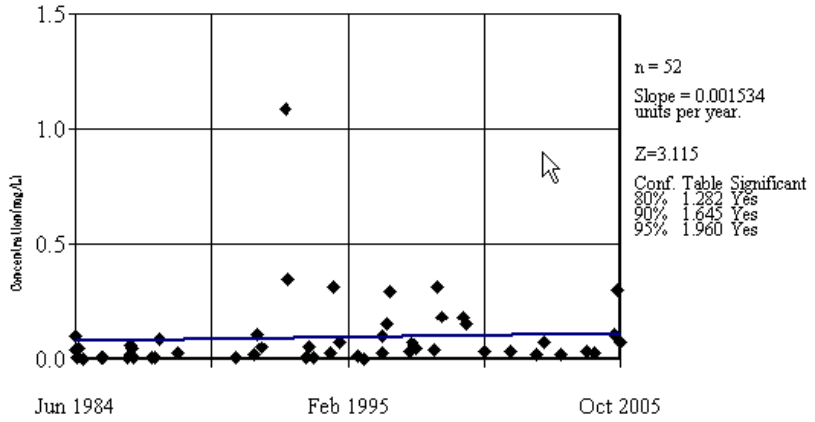

SEASONAL KENDALL SLOPE ESTIMATOR
Outlet
150
100
50
0
Concentration(ueq/L)
Jun 1984
Feb 1995
Oct 2005
n = 54
Slope = -0.3416
units per year.
Z=-1.621
Conf. Table Significant
80% 1.282 Yes
90% 1.645 No
95% 1.960 No
Constituent: ANC (ueq/L)
Date: 4/8/06
Facility: Hobbs
Time: 7:57 PM
Data File: HOBBS
View: hobbs w/o outliers

Hobbs Lake Nitrate Trend (since 1984) Analysis and Time Series Plots



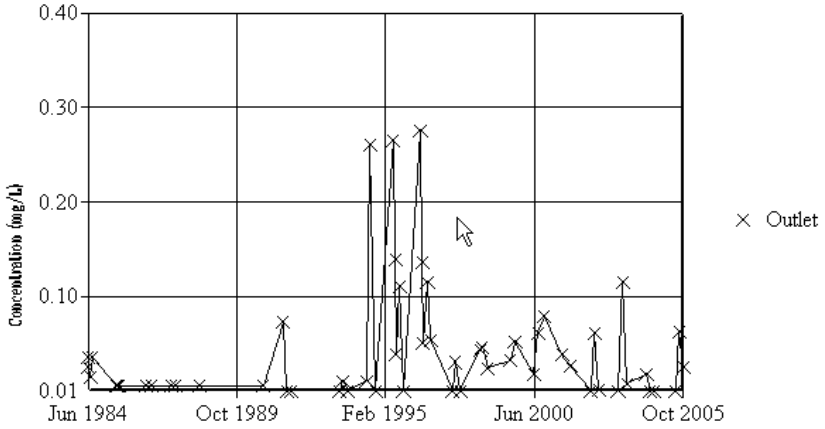


SEASONAL KENDALL SLOPE ESTIMATOR
Inlet



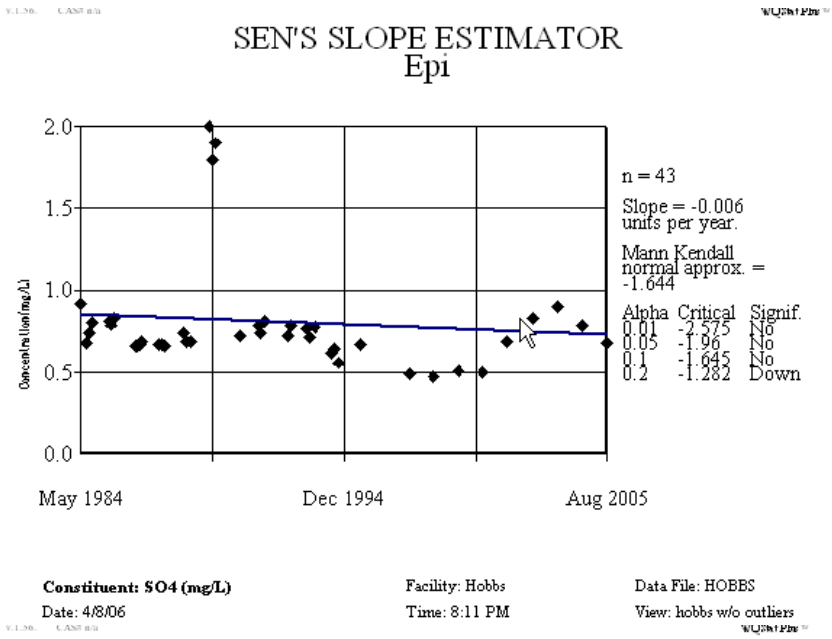
Constituent: NO3 (mg/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:05 PM View: hobbs w/o outliers

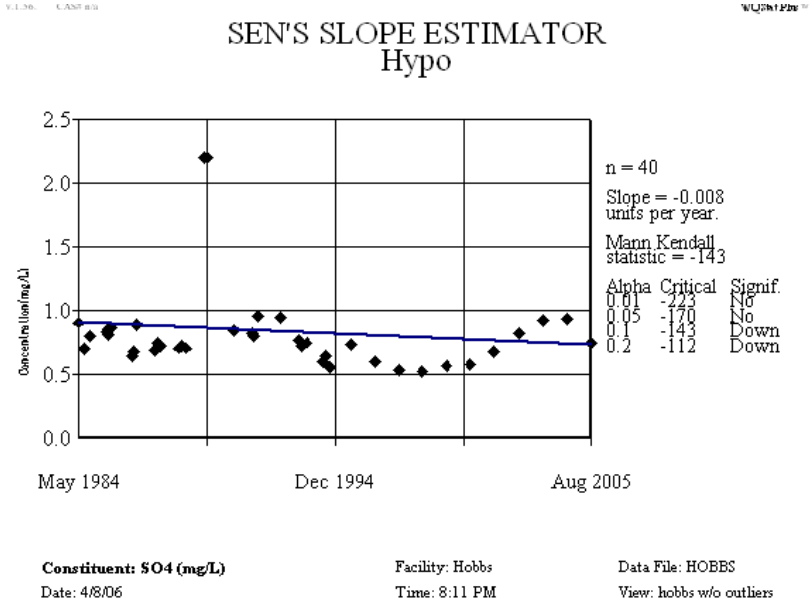
TIME SERIES



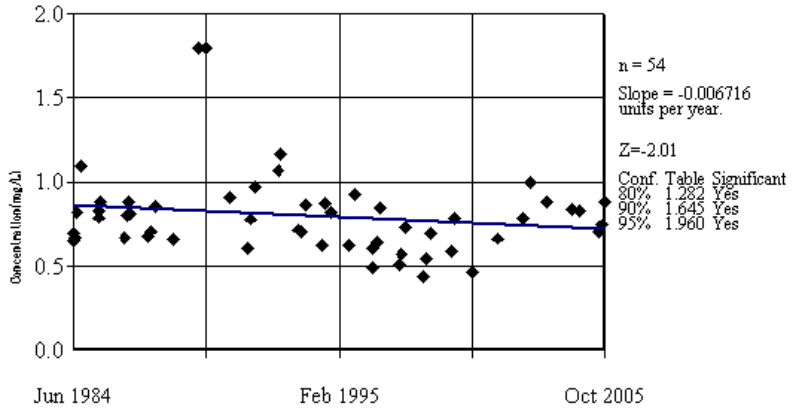
Constituent: NO3 (mg/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:32 PM View: hobbs w/o outliers

Hobbs Lake Sulfate Trend Analysis and Time Series Plots



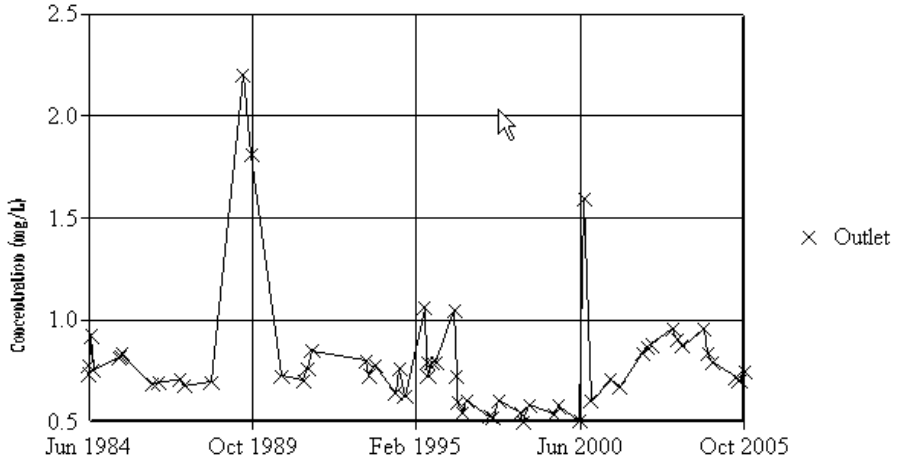


SEASONAL KENDALL SLOPE ESTIMATOR
Inlet



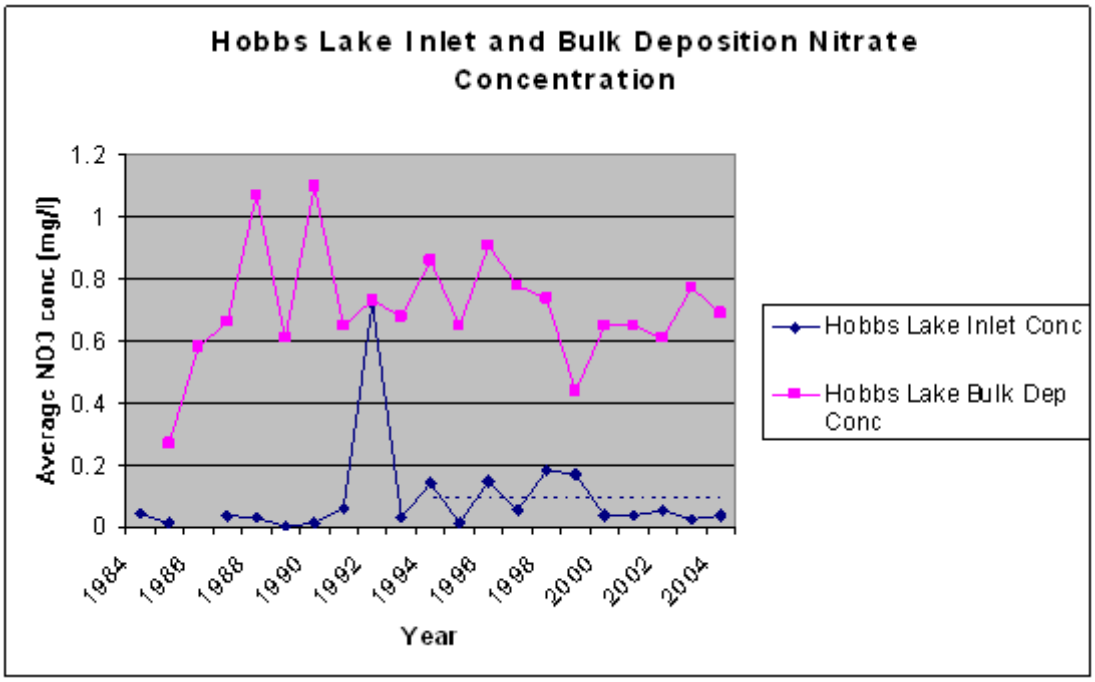
Constituent: SO4 (mg/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:12 PM View: hobbs w/o outliers

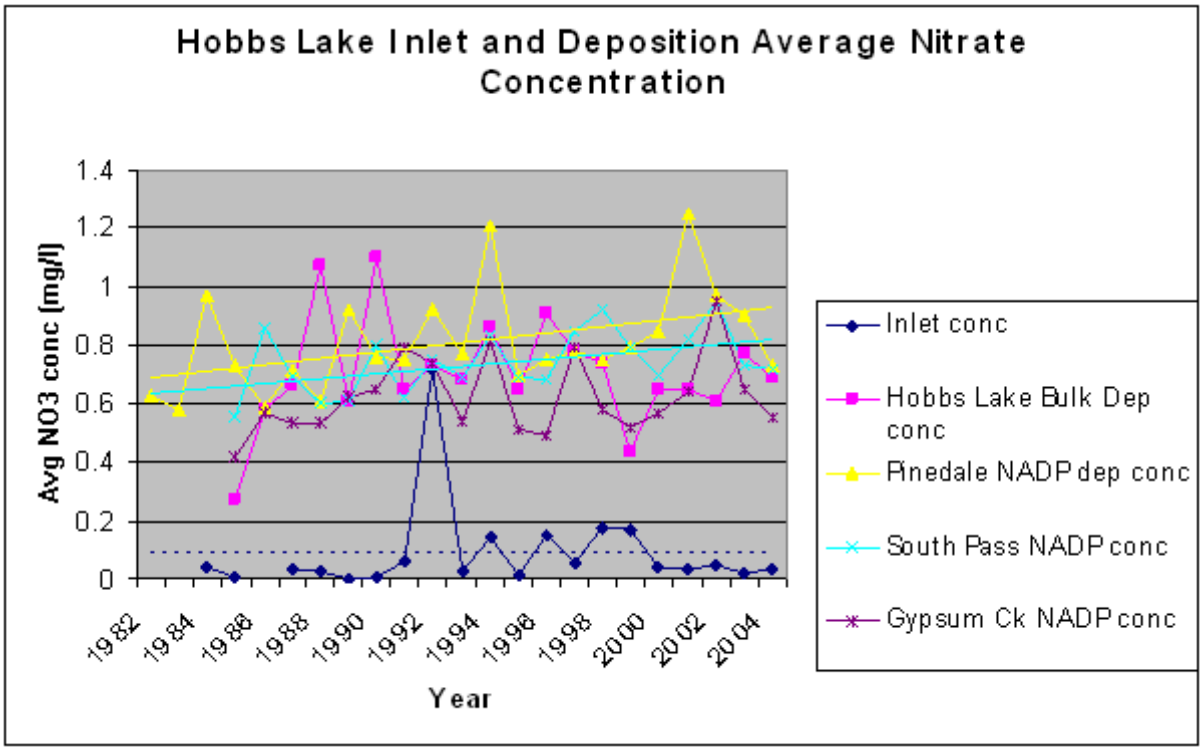
TIME SERIES

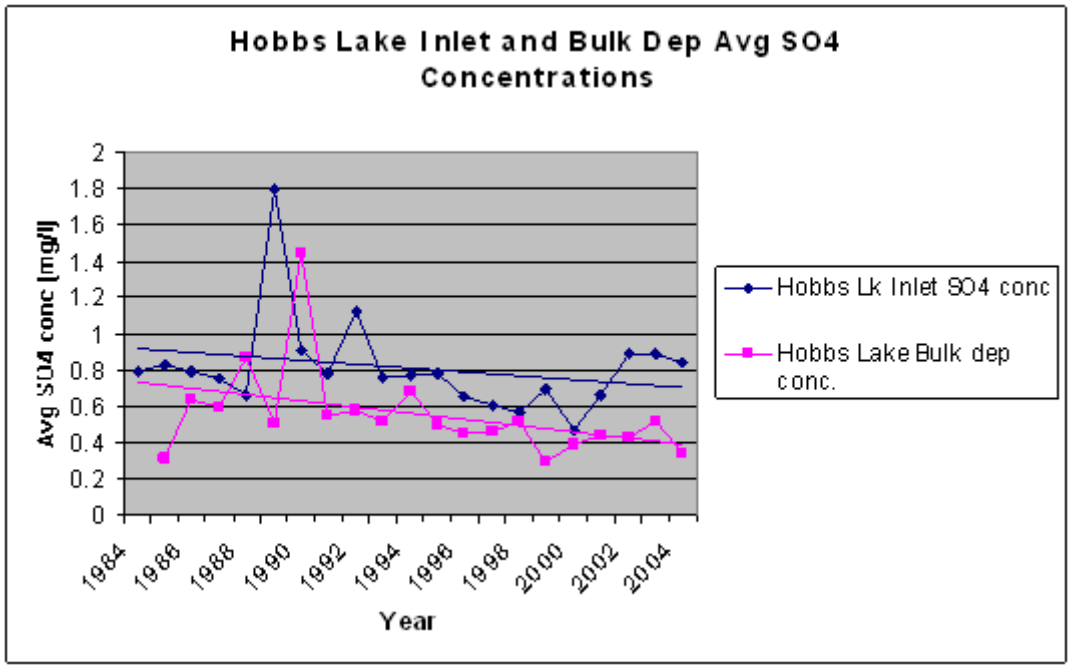


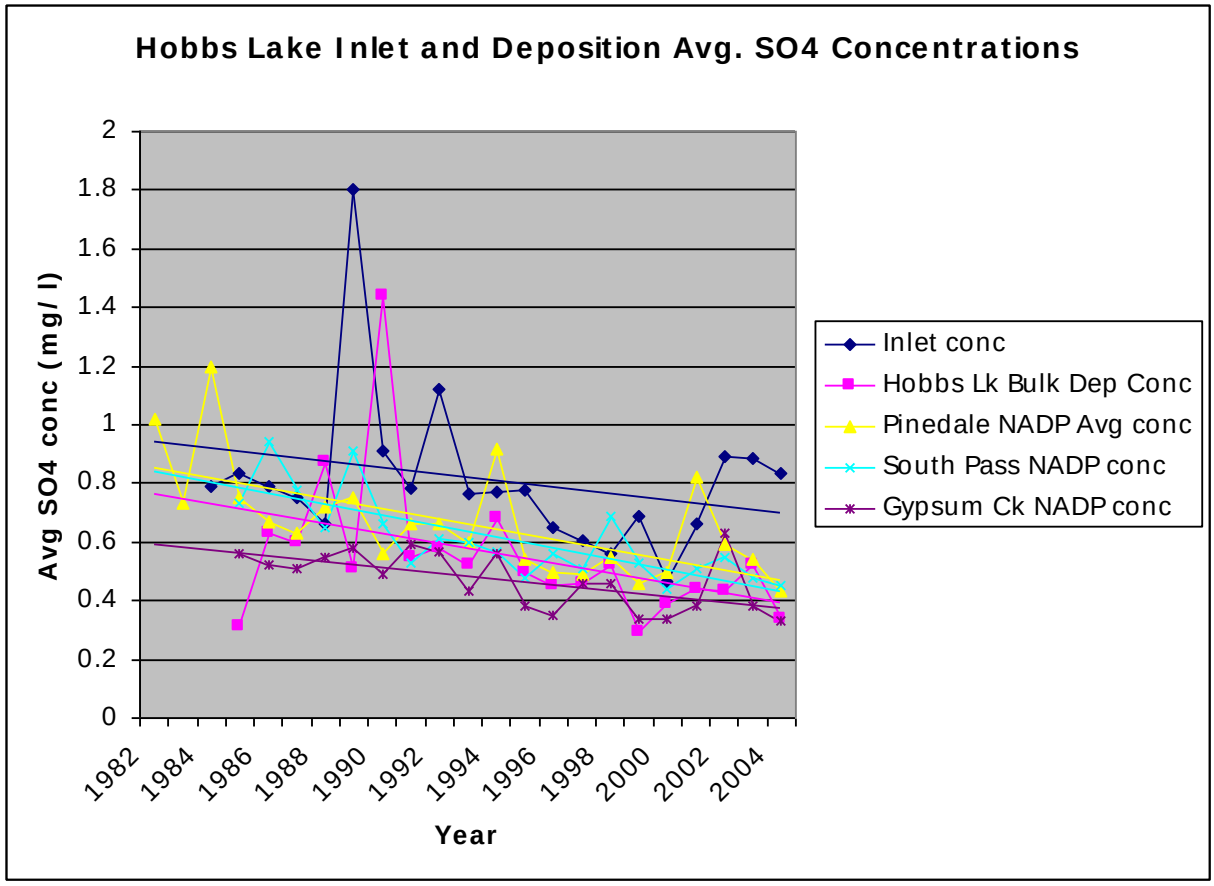
Constituent: SO4 (mg/L) Facility: Hobbs Data File: HOBBS
Date: 4/8/06 Time: 8:33 PM View: hobbs w/o outliers

◊ Deposition/concentration analysis





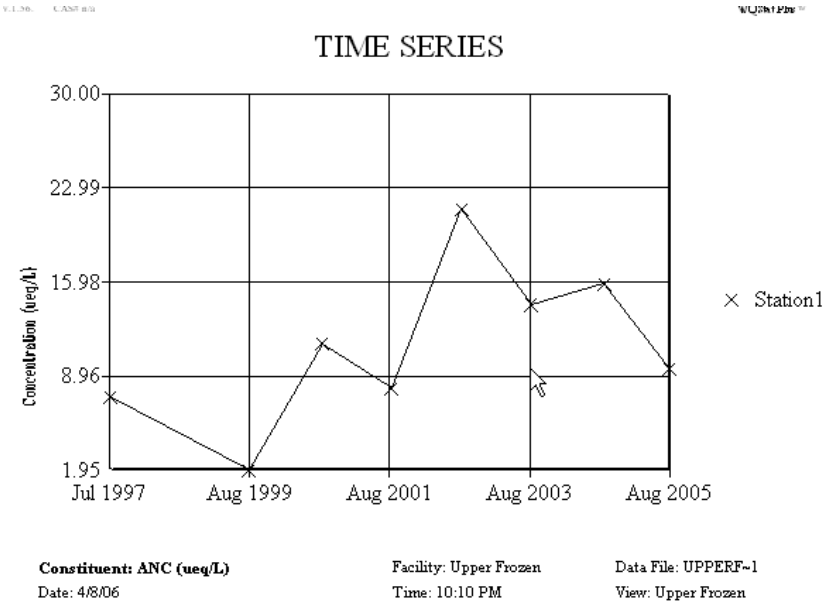

Hobbs Lake Inlet and Bulk Dep Avg SO4 Concentrations
Avg SO4 conc [mg/l]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year
Hobbs Lk Inlet SO4 conc
Hobbs Lake Bulk dep conc.

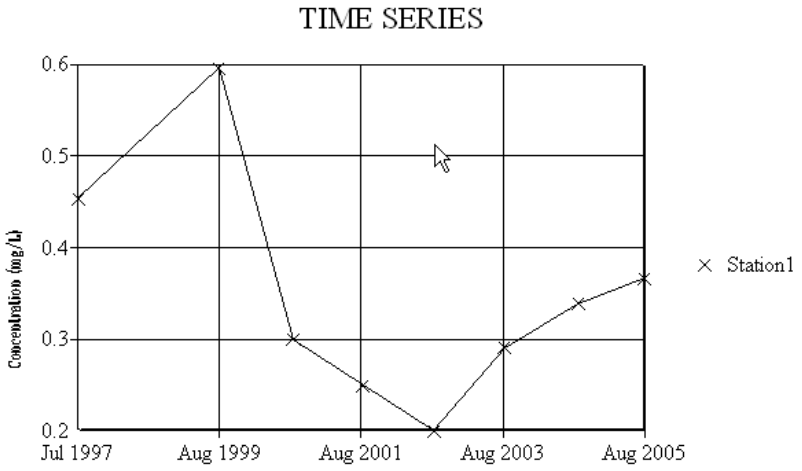

Hobbs Lake Inlet and Deposition Avg. SO4 Concentrations
Avg SO4 conc (mg/ l)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year
Inlet conc
Hobbs Lk Bulk Dep Conc
Pinedale NADP Avg conc
South Pass NADP conc
Gypsum Ck NADP conc

Upper Frozen Lake

◊ Trends

Upper Frozen Lake Acid Neutralizing Capacity Time Series Plots

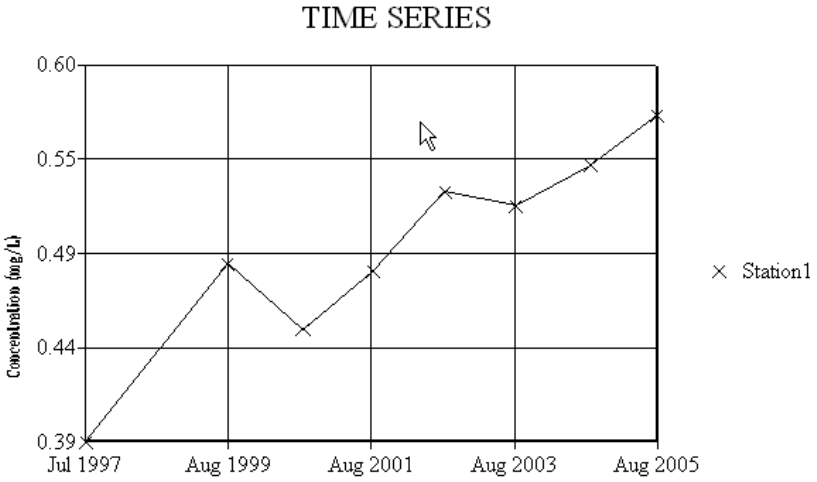




Constituent: NO3 (mg/L)
Date: 4/8/06

Facility: Upper Frozen
Time: 10:14 PM

Data File: UPPERF~1
View: Upper Frozen

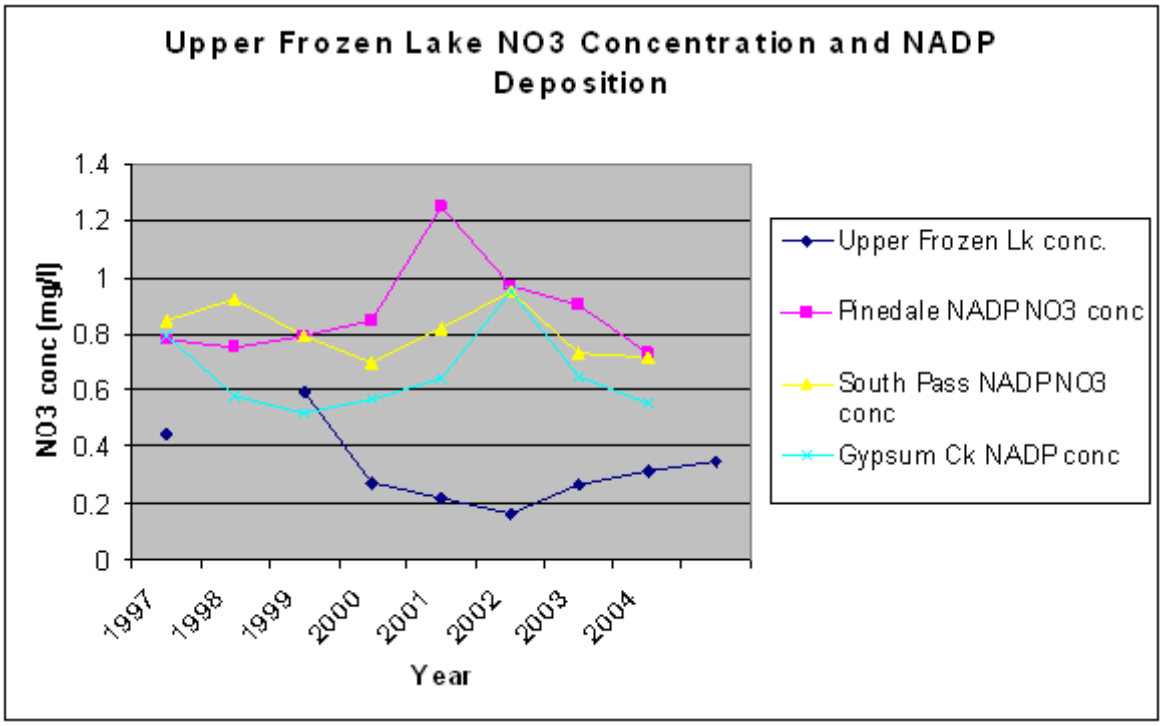


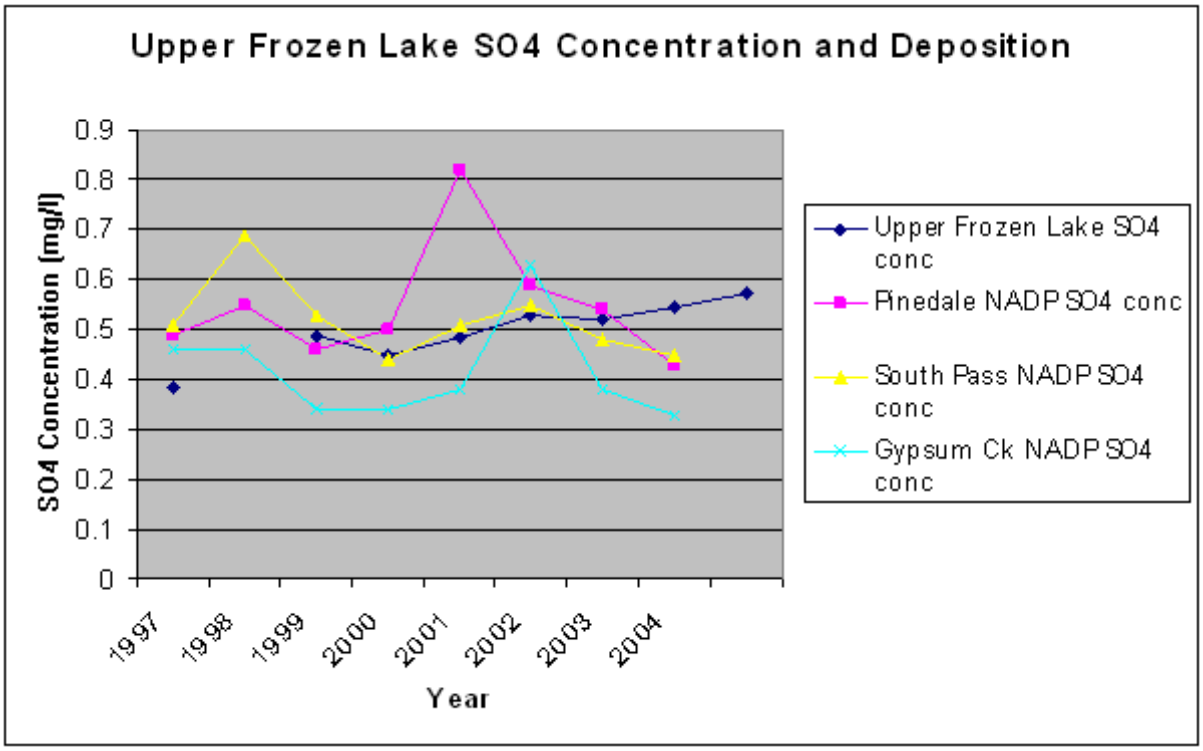
Constituent: SO4 (mg/L)
Date: 4/8/06

Facility: Upper Frozen
Time: 10:15 PM

Data File: UPPERF~1
View: Upper Frozen

◊ Deposition/concentration analysis





NADP Data – Deposition Values

The following tables correspond to Figures 3-7 to 3-10 in the body of the report.

WY 06:	Pinedale		**kg/ha**
	Deposition- Annual		
	NH_4	NO_3	SO_4
1982	0.4	2.17	3.51
1983	0.5	2.54	3.17
1984	0.48	3.18	3.95
1985	0.37	2.07	2.11
1986	0.18	1.66	1.89
1987	0.38	2.56	2.23
1988	0.13	0.83	0.98
1989	0.47	2.41	1.97
1990	0.49	2.47	1.82
1991	0.4	2.57	2.27
1992	0.44	2	1.45
1993	0.5	2.81	2.2
1994	0.48	2.87	2.17
1995	0.59	2.74	2.12
1996	0.35	1.8	1.19
1997	0.37	2.36	1.47
1998	0.44	0.24	0.05
1999	0.31	2.07	1.2
2000	0.4	2.35	1.39
2001	0.7	2.72	1.78
2002	0.64	1.87	1.14
2003	0.5	1.84	1.09
2004	0.59	2.65	1.57
2005			

WY 06	Deposition- Winter		
	NH_4	NO_3	SO_4
1982			
1983	0.02	0.23	0.24
1984	0.03	0.22	0.23
1985	0.01	0.21	0.2
1986			
1987	0.01	0.2	0.18
1988	0.01	0.13	0.09
1989	0.02	0.24	0.19
1990	0.11	0.33	0.16
1991	0.01	0.1	0.06
1992	0	0.05	0.02
1993	0.01	0.5	0.22
1994	0.04	0.24	0.1
1995	0.03	0.26	0.13
1996	0.01	0.11	0.04
1997	0.02	0.23	0.06
1998	0.02	0.24	0.05
1999	0.02	0.28	0.12
2000	0.04	0.36	0.18
2001	0.01	0.32	0.1
2002	0.02	0.14	0.02
2003	0.03	0.18	0.06
2004	0.01	0.19	0.05
2005	0.01	0.22	0.07

WY 06	Deposition- Spring		
	NH_4	NO_3	SO_4
1982	0.11	0.76	1.61
1983	0.14	0.61	0.81
1984	0.12	0.63	0.94
1985	0.19	0.78	0.87
1986	0.05	0.29	0.38
1987	0.2	1.02	1.17
1988	0.05	0.33	0.56
1989	0.08	0.52	0.49
1990	0.14	0.76	0.58
1991	0.15	0.83	0.97
1992	0.12	0.38	0.28
1993	0.17	0.73	0.67
1994	0.17	0.84	0.74
1995	0.16	0.71	0.69
1996	0.11	0.51	0.36
1997	0.08	0.38	0.24
1998	0.15	0.84	0.7
1999	0.06	0.42	0.3
2000	0.09	0.48	0.36
2001	0.15	0.57	0.45
2002	0.12	0.33	0.2
2003	0.11	0.33	0.26
2004	0.18	0.52	0.39
2005	0.39	1.31	1.11

WY 06	Deposition- Summer		
	NH_4	NO_3	SO_4
1982	0.19	0.91	1.03
1983	0.36	1.42	1.49
1984	0.15	1.1	1.26
1985	0.11	0.69	0.58
1986	0.07	0.79	0.93
1987	0.18	1.33	1.15
1988	0	0.56	0.37
1989	0.28	1.11	0.88
1990	0.13	0.73	0.55
1991	0.2	1.13	0.81
1992	0.37	1.32	0.9
1993	0.22	1.19	0.91
1994	0.15	0.78	0.54
1995	0.28	1.15	0.84
1996	0.16	0.78	0.54
1997	0.16	1.07	0.77
1998	0.19	1.35	0.98
1999	0.2	1.09	0.6
2000	0.19	0.88	0.49
2001	0.29	0.97	0.59
2002	0.39	0.88	0.47
2003	0.27	0.91	0.49
2004	0.25	1.06	0.64
2005			

WY 06	Deposition- Fall		
	NH_4	NO_3	SO_4
1982	0.07	0.31	0.62
1983	0.09	0.54	0.88
1984	0.17	1.15	1.36
1985	0.03	0.3	0.42
1986	0.04	0.51	0.51
1987	0.07	0.23	0.18
1988	0.06	0.28	0.24
1989	0.07	0.52	0.41
1990	0.1	0.61	0.5
1991	0.05	0.56	0.47
1992	0.08	0.44	0.4
1993	0.08	0.51	0.41
1994	0.13	0.98	0.8
1995	0.14	0.69	0.5
1996	0.07	0.35	0.23
1997	0.09	0.53	0.36
1998	0.08	0.61	0.43
1999			
2000	0.09	0.56	0.4
2001	0.22	0.76	0.57
2002	0.19	0.7	0.48
2003	0.12	0.49	0.32
2004	0.14	0.81	0.45
2005			

WY 98:	Gypsum Creek		kg/ha
	Deposition- Annual		
	NH_4	NO_3	SO_4
1985	0.24	1.38	1.82
1986	0.09	0.57	0.52
1987	0.08	0.53	0.51
1988	0.08	1.06	1.11
1989	0.38	1.61	1.5
1990	0.42	2.11	1.61
1991	0.36	2.32	1.72
1992	0.61	2.1	1.59
1993	0.36	2.41	1.91
1994	0.64	2.51	1.74
1995	0.67	2.92	2.18
1996	0.56	2.07	1.49
1997	0.65	3.61	2.1
1998	0.48	2.9	2.3
1999	0.35	2.05	1.33
2000	0.44	2.13	1.26
2001	0.49	1.72	1.03
2002	1	2.99	1.99
2003	0.73	2.28	1.33
2004	0.59	2.16	1.29
2005			

WY 98	Deposition- Winter		
	NH_4	NO_3	SO_4
1985	0.01	0.16	0.09
1986	0.01	0.27	0.26
1987	0.02	0.27	0.21
1988	0.02	0.18	0.22
1989	0.03	0.13	0.08
1990	0.01	0.16	0.09
1991	0.01	0.06	0.04
1992	0.02	0.17	0.11
1993	0.01	0.58	0.28
1994	0.04	0.26	0.08
1995	0.04	0.28	0.16
1996	0.07	0.34	0.23
1997	0.02	0.24	0.08
1998	0.02	0.34	0.08
1999	0.03	0.21	0.11
2000	0.03	0.31	0.11
2001	0.02	0.41	0.13
2002	0.03	0.23	0.12
2003	0.05	0.22	0.09
2004	0.03	0.27	0.07
2005			

WY 98	Deposition- Spring		
	NH_4	NO_3	SO_4
1985	0.16	0.63	0.66
1986	0.07	0.35	0.43
1987	0.17	0.88	0.93
1988	0.03	0.3	0.44
1989	0.07	0.3	0.41
1990	0.11	0.51	0.45
1991	0.09	0.65	0.5
1992	0.22	0.5	0.42
1993	0.14	0.69	0.7
1994	0.21	0.75	0.68
1995	0.19	0.89	0.69
1996	0.2	0.62	0.44
1997	0.16	0.53	0.29
1998	0.18	0.84	0.91
1999	0.12	0.68	0.49
2000	0.13	0.53	0.3
2001	0.11	0.45	0.33
2002	0.13	0.36	0.22
2003	0.13	0.44	0.26
2004	0.13	0.64	0.35
2005			

WY 98	Deposition- Summer		
	NH_4	NO_3	SO_4
1985	0.04	0.37	0.71
1986	0.18	0.89	0.64
1987	0.2	1.31	1.33
1988	0.02	0.36	0.27
1989	0.17	0.87	0.58
1990	0.2	0.88	0.62
1991	0.18	1.04	0.7
1992	0.24	0.94	0.71
1993	0.18	0.9	0.8
1994	0.28	0.87	0.52
1995	0.3	1.18	0.96
1996	0.25	0.85	0.81
1997	0.29	1.83	1.22
1998	0.17	1.13	0.78
1999	0.1	0.8	0.5
2000	0.2	0.64	0.44
2001	0.13	0.43	0.21
2002	0.53	1.41	0.99
2003	0.41	1.14	0.7
2004	0.26	0.89	0.54
2005			

WY 98	Deposition- Fall		
	NH_4	NO_3	SO_4
1985	0.03	0.29	0.52
1986	0.06	0.69	0.66
1987	0.01	0.23	0.19
1988	0.02	0.3	0.26
1989	0.13	0.54	0.49
1990	0.09	0.48	0.38
1991	0.1	0.64	0.54
1992	0.12	0.45	0.34
1993	0.05	0.29	0.06
1994	0.09	0.59	0.45
1995	0.13	0.52	0.3
1996	0.09	0.38	0.19
1997	0.17	1.05	0.53
1998	0.11	0.62	0.52
1999	0.1	0.34	0.23
2000	0.09	0.55	0.38
2001	0.22	0.57	0.4
2002	0.27	0.88	0.6
2003	0.13	0.42	0.27
2004	0.13	0.64	0.35
2005			

WY 97:	South Pass		kg/ha
	Deposition- Annual		
	NH_4	NO_3	SO_4
1985	0.24	1.38	1.82
1986	0.41	3.41	3.69
1987	0.46	2.94	3.34
1988	0.09	1.7	1.82
1989	0.55	2.63	3.91
1990	0.61	3.8	3.13
1991	0.38	2.86	2.47
1992	0.56	3.06	2.48
1993	0.65	3.78	3.31
1994	0.57	3.8	2.62
1995	0.62	4.21	2.91
1996	0.49	4.23	3.49
1997	0.39	3.59	2.15
1998	0.47	4.51	3.36
1999	0.54	3.67	2.46
2000	0.39	3.14	1.99
2001	0.43	2.67	1.66
2002	0.47	2.77	1.6
2003	0.75	3.41	2.25
2004	0.65	3.11	1.93
2005			

WY 97	Deposition- Winter		
	NH_4	NO_3	SO_4
1985			
1986			
1987	0.02	0.36	0.62
1988	0.01	0.46	0.46
1989	0.03	0.82	1.92
1990	0.08	0.61	0.39
1991	0.06	0.26	0.23
1992	0.02	0.19	0.15
1993	0.04	0.97	0.67
1994	0.12	0.93	0.61
1995	0.13	0.99	0.47
1996	0.07	0.8	0.68
1997	0.09	1.74	1.65
1998	0.04	0.64	0.37
1999	0.09	0.9	0.61
2000	0.06	0.76	0.49
2001	0.04	0.65	0.29
2002	0.04	0.58	0.42
2003	0.08	0.53	0.26
2004	0.08	0.8	0.42
2005			

WY 97	Deposition- Spring		
	NH_4	NO_3	SO_4
1985	0.16	0.63	0.66
1986	0.08	0.96	1.31
1987	0.16	0.88	0.98
1988	0.02	0.39	0.67
1989	0.14	0.77	0.99
1990	0.14	0.96	0.72
1991	0.19	1.47	1.33
1992	0.25	0.81	0.7
1993	0.36	1.11	1.3
1994	0.18	0.95	0.79
1995	0.24	1.41	0.98
1996	0.13	1.03	0.6
1997	0.14	0.84	0.52
1998	0.14	1.23	1.38
1999	0.18	1.11	0.74
2000	0.13	0.98	0.67
2001	0.1	0.83	0.58
2002	0.13	1.42	0.27
2003	0.21	0.75	0.68
2004	0.2	0.74	0.5
2005			

WY 97	Deposition- Summer		
	NH_4	NO_3	SO_4
1985	0.04	0.37	0.71
1986	0.12	0.88	0.69
1987	0.17	1.1	1.25
1988	0.01	0.44	0.45
1989	0.24	0.71	0.7
1990	0.21	1.09	0.91
1991	0.08	0.65	0.57
1992	0.2	1.11	0.9
1993	0.14	1.15	0.84
1994	0.11	0.73	0.42
1995	0.09	0.8	0.71
1996	0.27	1.09	0.94
1997	0.13	1.25	0.8
1998	0.18	1.28	0.82
1999	0.17	1.25	0.83
2000	0.14	0.56	0.3
2001	0.28	0.9	0.57
2002	0.26	1.08	0.69
2003	0.18	0.83	0.51
2004	0.2	0.89	0.58
2005			

WY 97	Deposition- Fall		
	NH_4	NO_3	SO_4
1985	0.03	0.29	0.52
1986	0.09	0.63	0.8
1987	0.07	0.27	0.24
1988	0.04	0.39	0.37
1989	0.12	0.57	0.57
1990	0.15	0.97	0.92
1991	0.08	0.7	0.52
1992	0.07	0.52	0.4
1993	0.1	0.78	0.74
1994	0.12	1.03	0.65
1995	0.17	1.13	0.71
1996	0.04	0.64	0.33
1997	0.07	0.68	0.45
1998	0.1	1.28	0.71
1999	0.09	0.49	0.3
2000	0.05	0.56	0.39
2001	0.07	0.52	0.31
2002	0.05	0.36	0.2
2003	0.15	0.76	0.43
2004	0.25	1.35	0.77
2005			

CASTNet Data presented in section 3.2.3 of the report is available from the BLM (Susan Caplan).

WARMS Data presented in Section 3.2.4 of the report is available from the BLM (Susan Caplan).

Bulk Deposition

The following are data tables for figures 3-18 to 3-24 in Section 3.2.5.

Data for Figure 3-18

Precipitation

Year	Hobbs Lake Precip (cm)	Black Joe Precip (cm)
1986	129.6	135.8
1987	66.0	60.7
1988	67.0	62.9
1989	101.0	84.1
1990	78.4	68.4
1991	95.8	93.9
1992	81.8	83.4
1993	109.4	100.1
1994	106.3	104.0
1995	140.9	138.1
1996	145.5	87.4
1997	125.4	94.8
1998	130.8	108.6
1999	106.5	131.5
2000	131.2	74.1
2001	112.6	52.9
2002	95.9	58.7
2003	112.5	72.9
2004	112.3	98.3
Average	**107.8**	**90.0**

Data for Figure 3-19

Nitrate Deposition (Kg/Ha/Yr)

Year	Hobbs Lake	Black Joe Lake
1986	5.91	6.34
1987	3.77	3.64
1988	4.23	4.08
1989	5.53	6.03
1990	5.21	5.60
1991	5.43	9.25
1992	5.59	7.24
1993	6.79	7.79
1994	8.25	9.28
1995	6.22	9.57
1996	7.50	8.29
1997	9.06	8.43
1998	8.48	9.82
1999	6.05	7.69
2000	8.40	6.15
2001	8.12	6.94
2002	6.83	6.67
2003	6.34	7.64
2004	5.667	6.498

Data for Figure 3-20

Sulfate Deposition (Kg/Ha/Yr)

Year	Hobbs Lake	Black Joe Lake
1986	5.84	6.52
1987	3.52	4.11
1988	3.90	4.73
1989	4.52	5.71
1990	4.12	4.52
1991	4.67	8.60
1992	4.42	5.91
1993	5.33	7.52
1994	6.30	7.19
1995	4.87	7.37
1996	4.69	5.58
1997	5.29	5.61
1998	6.35	7.23
1999	4.08	7.31
2000	5.74	4.62
2001	5.39	4.51
2002	5.24	4.87
2003	4.29	5.26
2004	3.09	4.113

Data for Figure 3-21

Annual Nitrate Concentrations
(Precipitation Weighted Monthly Averages)
(Mg/L)

	Hobbs Lake	Black Joe Lake
1985	0.27	0.35
1986	0.58	0.68
1987	0.66	0.68
1988	1.07	1.14
1989	0.61	0.94
1990	1.10	1.05
1991	0.65	1.16
1992	0.73	0.90
1993	0.68	0.89
1994	0.86	1.02
1995	0.65	0.81
1996	0.91	1.28
1997	0.78	0.97
1998	0.74	0.89
1999	0.44	0.50
2000	0.65	0.74
2001	0.65	1.06
2002	0.61	0.81
2003	0.77	1.277
2004	0.69	0.65

Data for Figure 3-22

Annual Sulfate Concentrations
(Precipitation Weighted Monthly Averages)
(Mg/L)

	Hobbs Lake	Black Joe Lake
1985	0.31	0.49
1986	0.63	0.61
1987	0.60	0.73
1988	0.87	1.25
1989	0.51	0.88
1990	1.44	0.90
1991	0.55	0.96
1992	0.58	0.71
1993	0.52	0.75
1994	0.68	0.83
1995	0.50	0.59
1996	0.45	0.82
1997	0.46	0.65
1998	0.52	0.69
1999	0.29	0.39
2000	0.39	0.49
2001	0.44	0.66
2002	0.43	0.53
2003	0.52	0.94
2004	0.34	0.42

Data for Figure 3-23

2004 Monthly Nitrate Concentrations of Precipitation (Mg/L)

Month	Hobbs Lake	Black Joe Lake
January	0.412	0.435
February	0.528	0.405
March	0.586	0.366
April	0.370	0.357
May	0.511	0.843
June	0.238	0.900
July	2.152	0.884
August	1.298	0.573
September	0.741	1.394
October	0.552	0.633
November	0.481	0.561
December	0.398	0.410
Average	**0.689**	**0.647**

Data for Figure 3-24

2004 Monthly Sulfate Concentrations of Precipitation (Mg/L)

Month	Hobbs Lake	Black Joe Lake
January	0.185	0.260
February	0.249	0.238
March	0.329	0.248
April	0.155	0.219
May	0.028	0.520
June	0.130	0.590
July	1.034	0.565
August	0.709	0.405
September	0.533	0.905
October	0.335	0.446
November	0.224	0.387
December	0.152	0.226
Average	**0.339**	**0.417**