

The Lakes of Missouri Volunteer Program 2011 Data Report

LMVP.ORG

Featuring water quality monitoring data from 92 sites on 38 public lakes. All samples were collected and processed by trained volunteers, then analyzed by University of Missouri staff.



LAKES of
MISSOURI
VOLUNTEER
PROGRAM

Acknowledgements

This report is the result of a lot of work by many, many people.

Above all are the volunteers, without whom none of this would be possible. Their enthusiasm, energy and dedication are truly inspiring.

We extend a sincere thank you to Jim Stetson and the Ozark Lakes Country Senior Center in Kimberling City for hosting our data reviews for the last several years and for allowing us to store samples for pickup. Jim makes very good coffee.

We would also like to thank the Jackson County Parks Department, the Mark Twain Lake Sailing Association, the U.S. Army Corps of Engineers, the City of Lamar, the City of Bowling Green, the City of Moberly, the City of Unionville, the City of Cameron, the Missouri Department of Natural Resources and the United States Coast Guard Auxiliary Flotillas 55, 57 and 53 for donating their time and their employees' time to sampling.

Further thanks go to Baxter Marina, Jacomo Marina, and the Missouri Department of Conservation for loaning boats and gasoline to volunteer water samplers. Additional thanks to the Missouri Dept. of Conservation for allowing volunteers to drop samples off at their Camdenton office. Finally, thank you to the technicians in the University of Missouri's Limnology Laboratory for their exceptional work conducting the sample analyses.

Sincerely,



Tony Thorpe



Dan Obrecht

Coordinators of the Lakes of Missouri Volunteer Program

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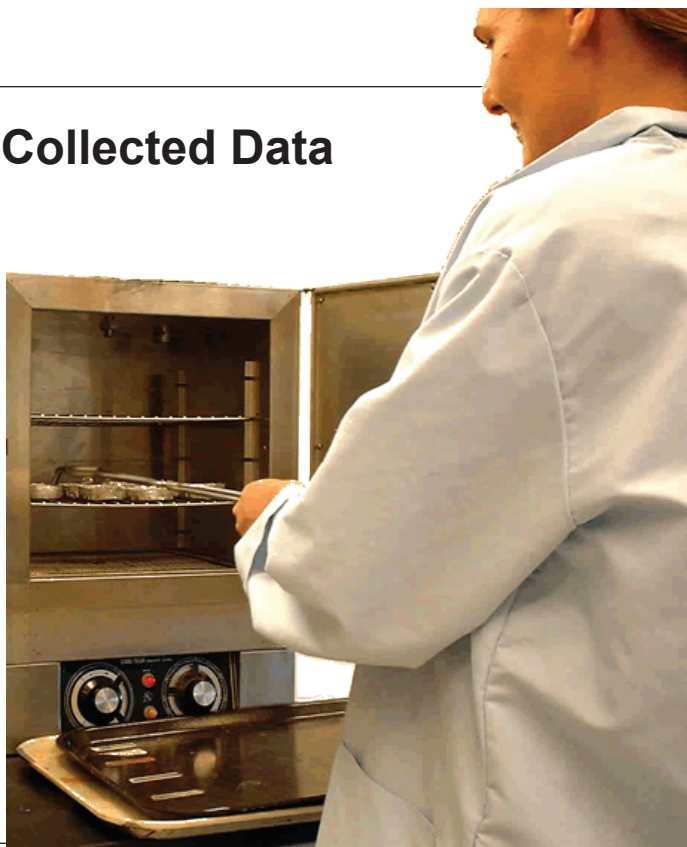
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The Quality of Volunteer Collected Data

Lakes of Missouri Volunteer Program (LMVP) volunteers monitor at 3-week intervals from late spring to early fall and process the samples in their homes. The processed samples are stored in volunteers' freezers until LMVP staff can pick them up. The samples are then analyzed at the University of Missouri's Limnology laboratory following accepted standard methods. LMVP data are "research quality", and have been used in several scientific journal articles. One study (Obrecht et al. 1998) shows LMVP data to be of comparable quality to data collected by employees of the University of Missouri.



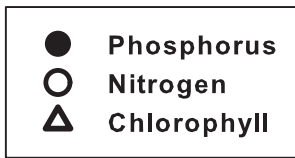
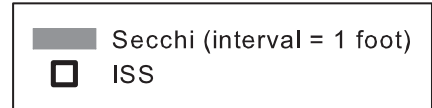
Parameter	Abbreviation	Unit of Measure
Water Clarity (using Secchi disk)	Secchi	Inches (“)
Total Phosphorus	TP	Micrograms per liter ($\mu\text{g/L}$) or parts per billion (ppb)
Total Nitrogen	TN	Micrograms per liter ($\mu\text{g/L}$) or parts per billion (ppb)
Chlorophyll	CHL	Micrograms per liter ($\mu\text{g/L}$) or parts per billion (ppb)
Inorganic Suspended Sediments	ISS	Milligrams per liter (mg/L) or parts per million (ppm)

This table shows the parameters measured by the Lakes of Missouri Volunteer Program, the abbreviations used in this document, and the units of measure that the numbers represent.

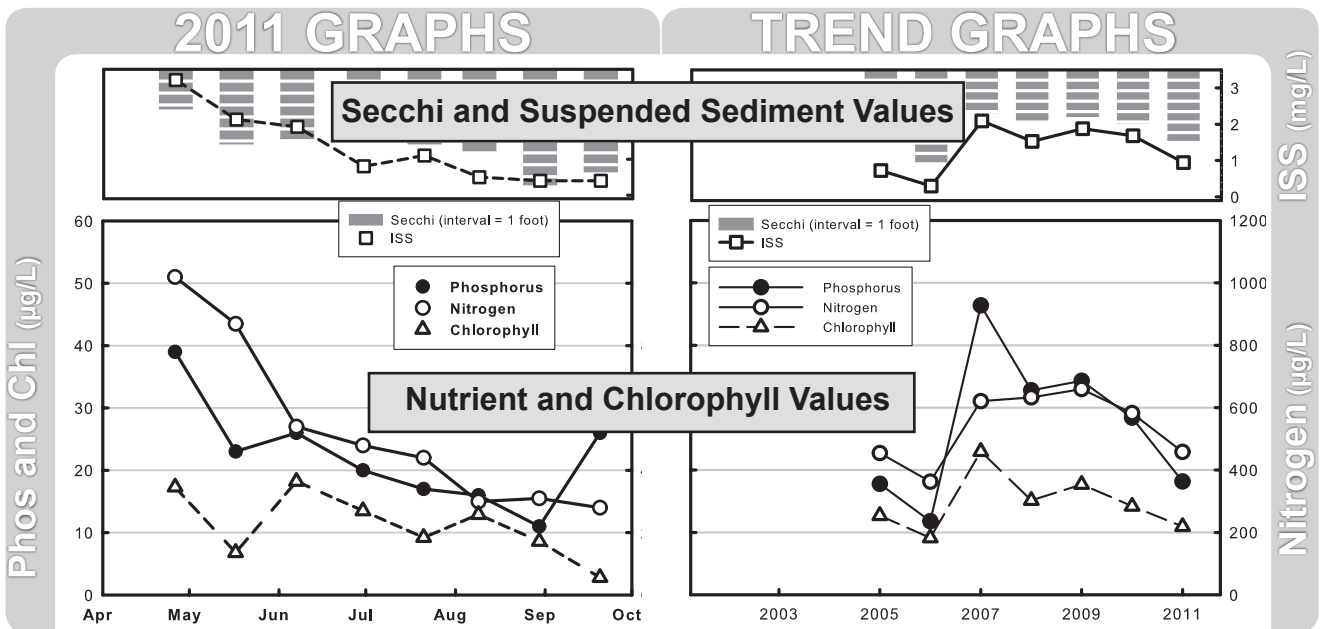
Understanding the Data Graphs

The data graphs for this year's report are slightly different from those of previous years. For each lake site the 2011 seasonal graphs (left) and the trend graphs (right) use the same symbols to represent parameters and share the same vertical scales. The scale of the horizontal axes (bottom) is by month in the 2011 graphs and by year in the trend graphs. Each graph is broken into two sections.

The top section shows water clarity (Secchi) and Inorganic Suspended Sediment (ISS) in mg/L. The bars represent Secchi and are divided into depth intervals, typically feet. Check the legend for the interval used in each graph. ISS values are shown as squares with values indicated on the right-most vertical axis.



The bottom section of each graph shows the concentrations of phosphorus, nitrogen and chlorophyll. Phosphorus is represented by a black circle and the left-most axis shows the scale. Nitrogen is represented by an open circle and the right-most axis shows the scale. The right and left axes are set to a nitrogen - phosphorus ratio of 20 to 1. Chlorophyll shares the same axis as phosphorus and is represented by an open triangle.



Seasonal graphs show individual values measured during the 2011 sampling season (April through September).

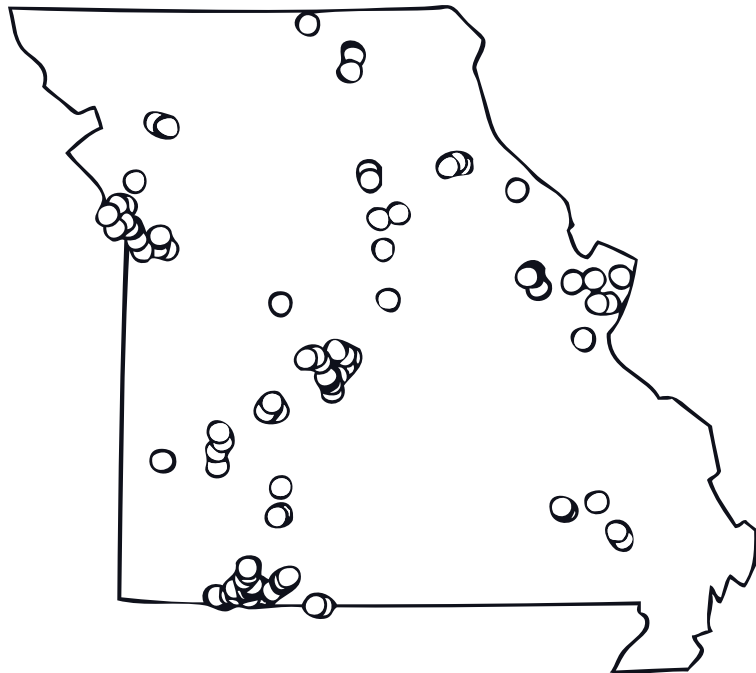
Trend graphs show geometric mean values, which measure the central tendency of the data and reduce the influence of extreme values. Data used to generate means are from May 15 through Sept 15.

2011 Lake Data

Lake by Lake Summary

In 2011, volunteers for the Lakes of Missouri Volunteer Program collected 837 samples from 123 sample sites on 61 Missouri lakes. To accomplish this, volunteers donated almost 1,700 hours and drove over 11,000 miles.

The following pages represent the data from the 92 sampling sites on 38 public lakes monitored in 2011. Data from private lakes are not shown.



Lake Sites monitored by LMVP volunteers in 2011.



Throughout the report are these squares, called QR Codes. These codes can be scanned with a smartphone to view the lake data on the LMVP website.

An app is required to scan the code. There are dozens of free apps available capable of scanning QR Codes. Just search for "QR Code Reader" in the phone's app store.

Binder Lake



2011 DATA

Cole County

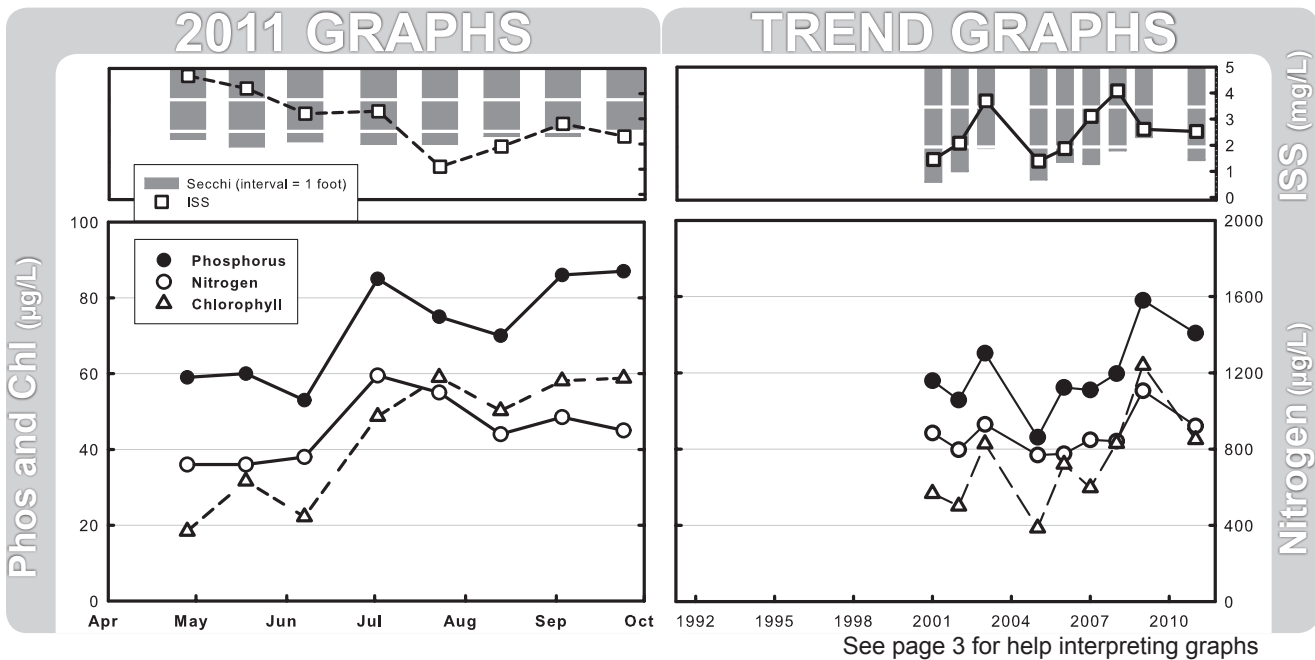
Latitude: 38.60028

Longitude: -92.3028

Date	4/28	5/18	6/7	7/2	7/23	8/13	9/3	9/24	Mean
Secchi (inches)	27	30	28	29	29	26	26	24	27
TP (µg/L)	59	60	53	85	75	70	86	87	71
TN (µg/L)	720	720	760	1190	1100	880	970	900	891
CHL (µg/L)	18.4	31.6	22.2	48.7	59.0	50.2	58.1	58.8	39.9
ISS (mg/L)	4.7	4.2	3.2	3.3	1.1	1.9	2.8	2.3	2.7

Suspended sediment concentrations decreased through the 2011 season in Binder Lake. In contrast, chlorophyll concentrations increased 3-fold from April to September. These contrasting patterns explain why Secchi transparency was stable in 2011, varying by only 6 inches. Nutrient concentrations also increased through the season but less dramatically than chlorophyll.

Long-term mean water clarity varies seasonally with the mean concentration of suspended sediment. While phosphorus was higher in 2009 and 2011 than in previous years, there are no apparent water quality trends at Binder Lake.



Blue Springs Lake



2011 DATA

Jackson County
Latitude: 39.0164

Longitude: -94.3375

Date	4/29	5/17	6/6	6/27	7/21	8/8	8/30	9/20	Mean
Secchi (inches)	36	52	64	36	32	51	40	40	43
TP (µg/L)	32	23	23	34	31	27	35	40	30
TN (µg/L)	680	520	390	490	560	480	540	570	523
CHL (µg/L)	5.2	5.9	8.5	22.6	26.8	20.6	28.9	32.5	15.3
ISS (mg/L)	6.7	2.7	2.4	2.7	3.4	1.2	6.8	3.4	3.2

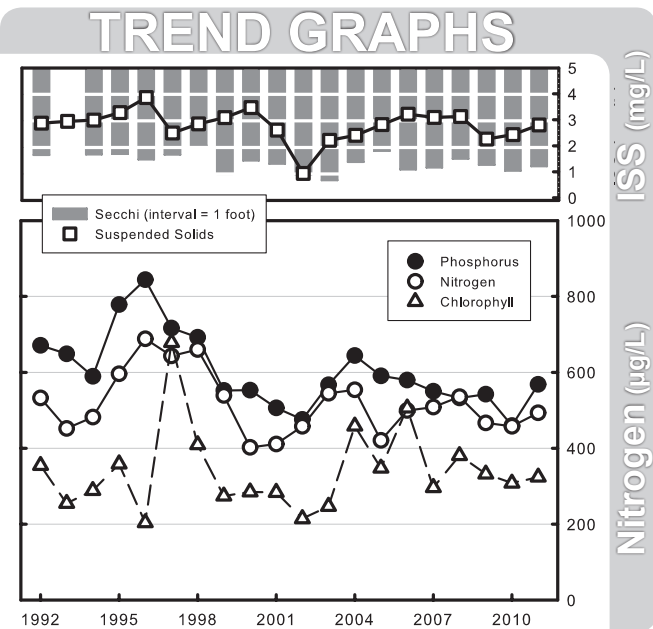
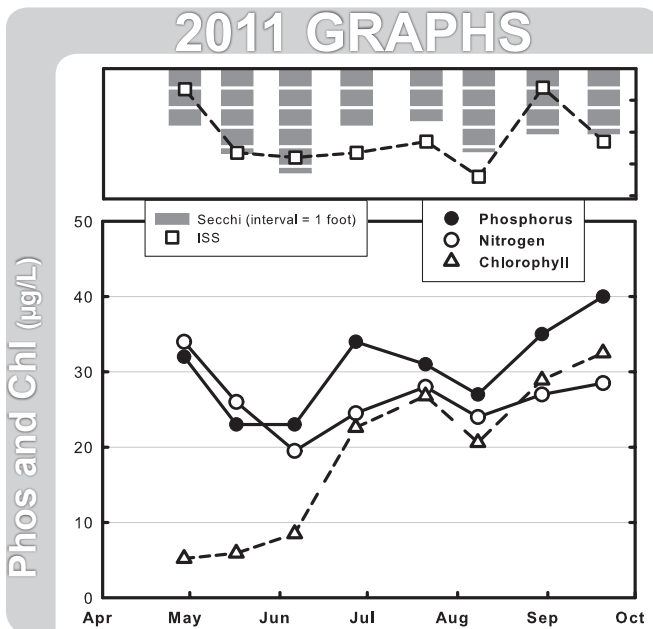
With 20 years of continuous monitoring, Blue Springs Lake is among the most sampled of LMVP lakes.

Water clarity consistently averages between 3 and 4 feet each season at Blue Springs Lake. Throughout the 2011 season, clarity ranged from nearly 3 feet to over 5 feet.

Nutrients (phosphorus and nitrogen) and sediment (ISS) were generally stable through the entire 2011 season, varying by less than a factor of 2. Chlorophyll, on the other hand, varied by more than a factor of 6 from an early season low of 5.2 ug/L to an end-of-season high of 32.5 ug/L.

Average summer phosphorus values have

been less than 30 ug/L for the past 5 years. Nitrogen values track phosphorus values at just under a 20:1 ratio. Chlorophyll concentrations have remained below 20 ug/L for 16 of the 20 monitored years.



See page 3 for help interpreting graphs

Bowling Green Lake #1



2011 DATA

Pike County

Latitude: 39.3417

Longitude: -91.1532

Date	5/11	5/18	6/29	7/22	8/9	8/29	9/20	Mean
Secchi (inches)								
TP (µg/L)	38	34	23	20	14	13	14	20
TN (µg/L)	610	470	500	430	370	360	340	432
CHL (µg/L)	6.5	3.1	13.1	6.3	2.6	1.1	4.6	4.2
ISS (mg/L)	6	2.8	0.6	0.5	0.5	0.4	1.5	1.1

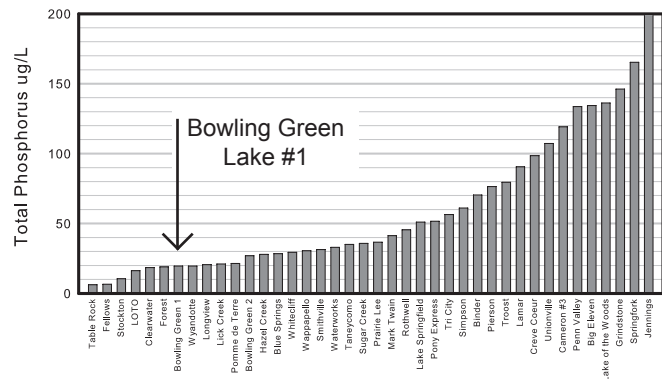
Water quality in Bowling Green Lake #1 followed a predictable pattern of higher nutrients and suspended sediment values early in the season, with a general decline in concentrations as the season progressed. This pattern reflects the influence of watershed runoff during spring and the subsequent settling of sediment and nutrients over the course of summer.

Algal chlorophyll showed moderate variability during the sample season, with no obvious pattern.

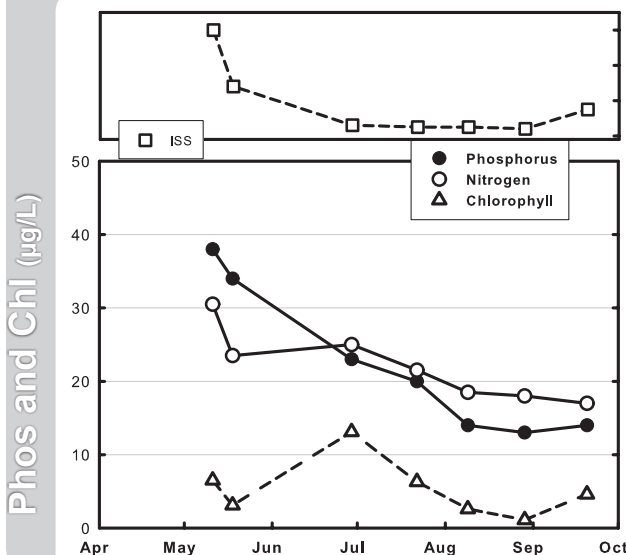
2011 was an average year for water quality at Bowling Green Lake #1. Concentrations of phosphorus and nitrogen were at or near the long-term mean values, while chlo-

rophyll and suspended solids were slightly below the long-term mean values. No trends were apparent.

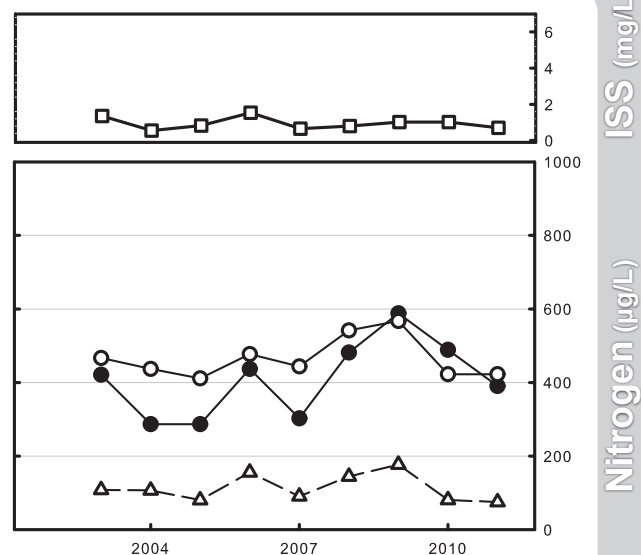
2011 Seasonal Mean Phosphorus Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Bowling Green Lake #2



2011 DATA

Pike County
Latitude: 39.3436 Longitude: -91.1615

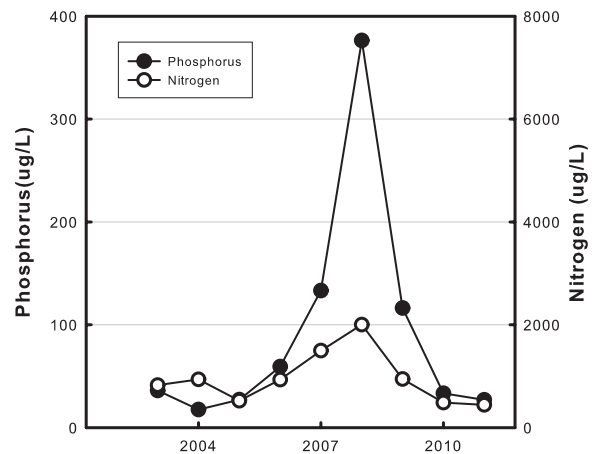
Date	5/11	5/18	6/29	7/22	8/9	8/29	9/20	Mean
Secchi (inches)								
TP (µg/L)	42	24	50	22	26	21	32	29
TN (µg/L)	800	480	370	430	500	450	420	479
CHL (µg/L)	6.5	3.1	1.4	4.9	6.4	9.2	9	5.0
ISS (mg/L)	6	2.5	3.3	1	2.2	0.9	2.5	2.2

During 2011, Bowling Green Lake #2 had water quality that was similar to Bowling Green Lake #1. Lake #2 had only slightly higher concentrations of nutrients, chlorophyll and sediment.

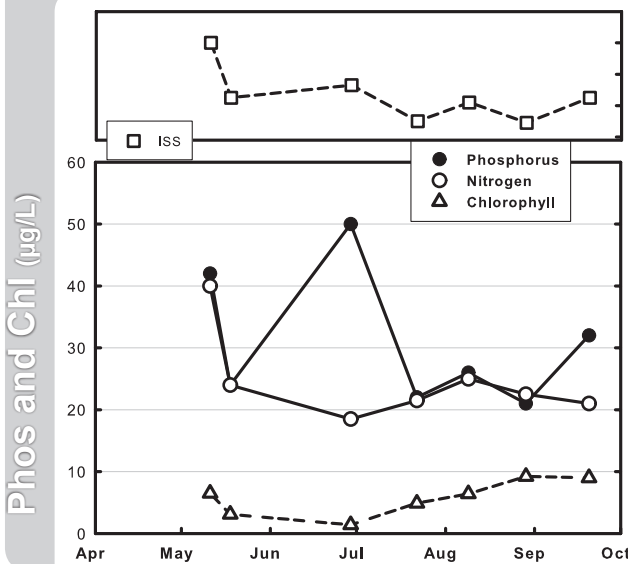
Long-term data show that Lake #2 appears to have returned to normal following an extremely dramatic phosphorus and nitrogen spike during the years 2007-2009. During 2008, the summer mean phosphorus concentration was 376 µg/L and the mean nitrogen concentration was 2004 µg/L.

The seasonal and trend graphs share the same scale and the trend graph below omits the high values to maintain a useful scale for the seasonal data. The graph to the right

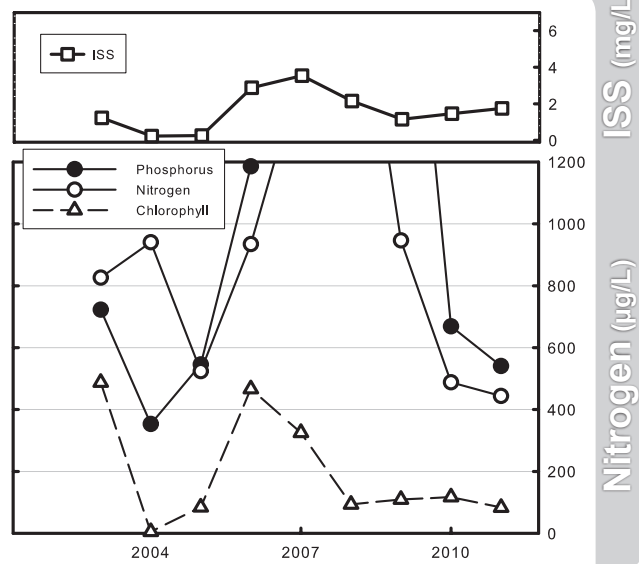
shows phosphorus and nitrogen values with the y-axes expanded to show the full data scale.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Bull Shoals Lake



Site 7



2011 DATA

Taney County and Ozark County
 Latitude: 36.5017 Longitude: -92.9300

Date	X	5/17	6/6	6/28	7/19	8/9	X	9/19	Mean
Secchi (inches)		104	144	133	174	108		119	128
TP (µg/L)		15	13	13	10	11		13	12
TN (µg/L)		520	240	290	250	120		320	265
CHL (µg/L)		7.9	4.5	4.9	3.7	6.6		9.6	5.9

Only 2 Bull Shoals Lake sites were monitored in 2011. Site 7 is in the main lake near Elbow Creek.

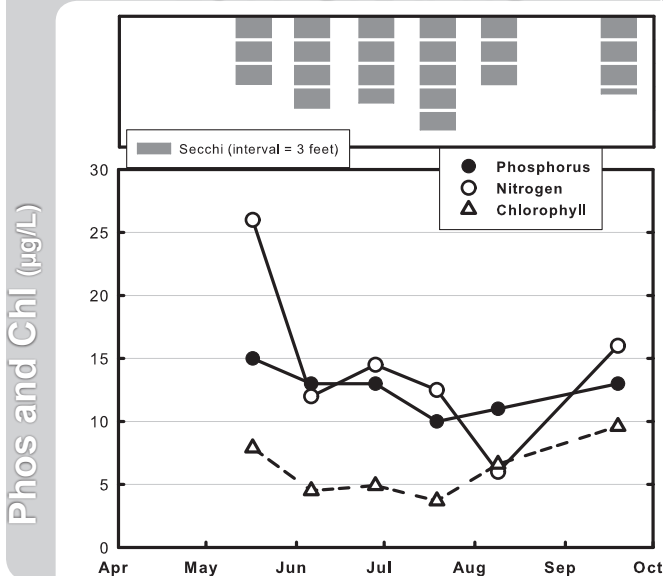
Water clarity was greater than 9 feet for most of the season and greater than 14 feet on one occasion. High water clarity can be attributed to the extremely low suspended sediment (ISS not measured at Bull Shoals) and chlorophyll concentrations. Phosphorus values were stable in 2011, varying by less than 5 µg/L during the sampling season. Nitrogen varied more than phosphorus, fluctuating more than 4-fold.

Average clarity at this site has historically been quite high, exceeding 10 feet during most years. Phosphorus values have been

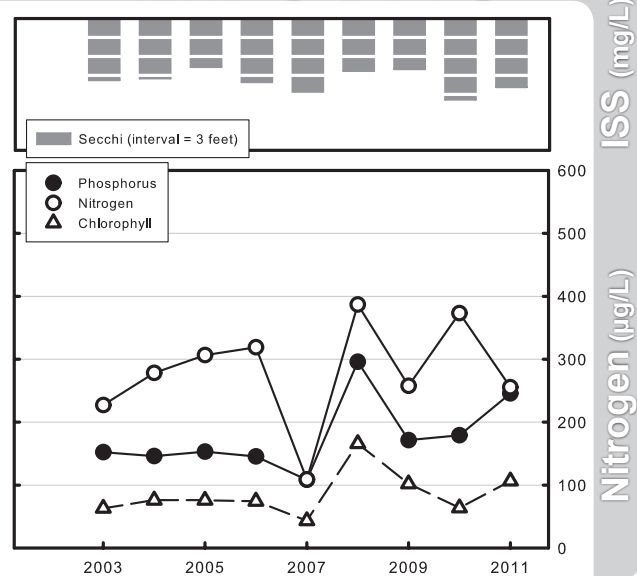
slightly higher during the past 4 years, and are the likely cause for the small increase in chlorophyll observed during that time. The seasonal average nitrogen value was surprisingly low in 2007.



2011 GRAPHS



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See page 3 for help interpreting graphs

Bull Shoals Lake



Site 8



Taney County and Ozark County
 Latitude: 36.4983 Longitude: -92.8667

2011 DATA

Date	X	5/17	6/6	6/28	7/19	8/9	X	9/19	Mean
Secchi (inches)		108	150	131	166	119		107	128
TP (µg/L)		17	11	11	11	11		12	12
TN (µg/L)		560	320	270	260	220		270	301
CHL (µg/L)		7.1	4.3	3.8	2.7	6.4		7.7	5.0

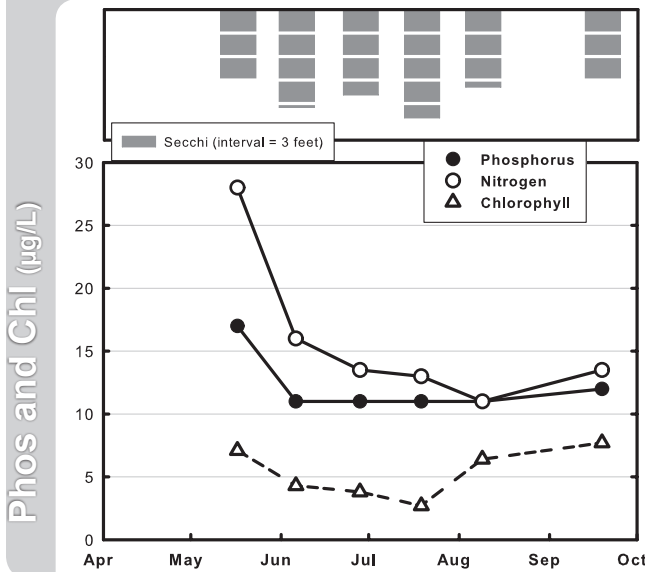
Site 8 is located in the Shoal Creek arm of Bull Shoals Lake, south of Protem, Missouri.

Water quality at Site 8 was nearly identical to Site 7. Aside from early season (comparatively) high values, nutrient and chlorophyll values were quite stable through the 2011 season. Water clarity was exceptional, at 9 feet or greater all season long.

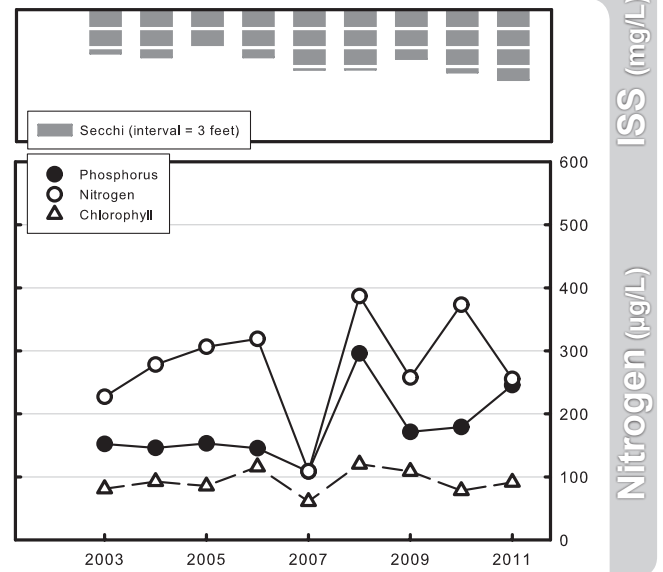
Long term values are quite similar to Site 7. Water clarity may be increasing at Site 8. Additional sampling is required to determine if this is truly a trend. As at Site 7, phosphorus concentrations seem to have increased slightly since 2007 and the nitrogen value from that year is surprisingly low.



2011 GRAPHS



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See page 3 for help interpreting graphs

Cameron City Lake #3



2011 DATA

Dekalb County
 Latitude: 39.7734 Longitude: -94.2717

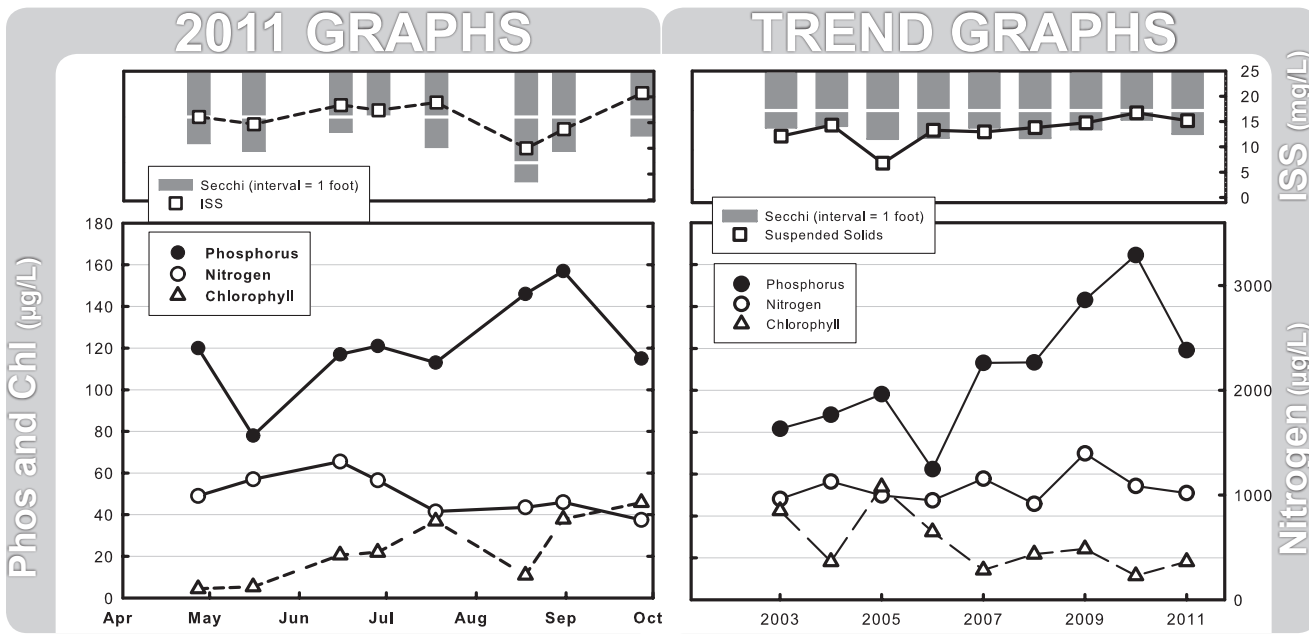
Date	4/27	5/16	6/15	6/28	7/18	8/18	8/31	9/27	Mean
Secchi (inches)	19	21	16	12	20	29	21	17	19
TP (µg/L)	120	78	117	121	113	146	157	115	119
TN (µg/L)	980	1140	1310	1130	830	870	920	750	976
CHL (µg/L)	4.4	5.3	20.6	21.9	36.9	10.9	37.8	45.8	20.8
ISS (mg/L)	16.1	14.7	18.4	17.4	18.9	10.0	13.7	20.7	15.9

Water clarity was low in Cameron City Lake #3 during the 2011 sampling season. Only once did clarity exceed 2 feet and the average was about 1.5 feet.

Suspended sediment and total phosphorus values were quite high during 2011. Total nitrogen values, while higher than the Missouri statewide mean, were lower than expected given the phosphorus values and remained stable throughout the season. Because of shading by suspended sediment algal chlorophyll concentrations were lower than expected from such a phosphorus-rich lake.

Over the last 9 years, water clarity and suspended sediment have varied little. Total phosphorus values appear to be trending

upward. The ratio of nitrogen to phosphorus appears to be decreasing as nitrogen values have remained stable for the past 9 years. Algal chlorophyll concentrations have not changed significantly in the last 9 years.



See page 3 for help interpreting graphs

Clearwater Lake Site 1



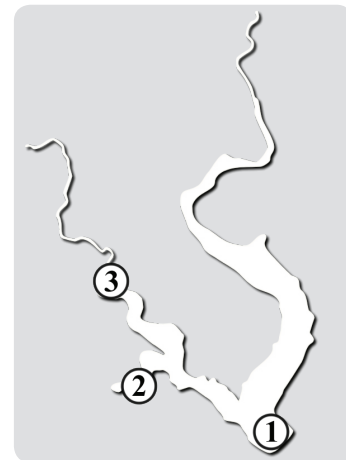
2011 DATA

Reynolds and Wayne County
 Latitude: 37.1376 Longitude: -90.7744

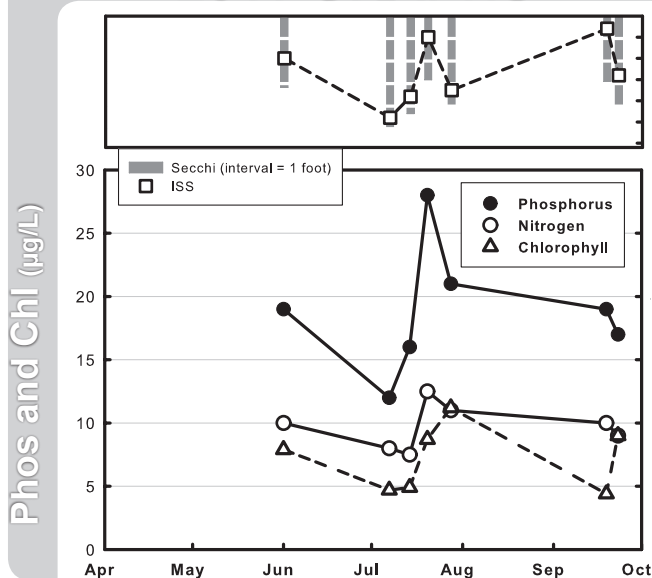
Date	X	6/1	7/7	7/14	7/20	7/28	9/19	9/23	Mean
Secchi (inches)		38	60	52	34	48	35	48	44
TP (µg/L)		19	12	16	28	21	19	17	18
TN (µg/L)		200	160	150	250	220	200	180	192
CHL (µg/L)		7.9	4.7	4.9	8.7	11.2	4.4	9.0	6.8
ISS (mg/L)		4.0	1.2	2.2	5.0	2.5	5.4	3.2	3.0

At all sites on Clearwater Lake during the 2011 sampling season, the data are biased toward the month of July. And at all sites, the variability observed during July was considerable, with maximum and minimum values for Secchi transparency, total phosphorus and total nitrogen occurring during the month. ISS values peaked on 9/19 at all Clearwater sites. As a result, it is difficult to draw any conclusions about the rest of the season, except to say that most of the remaining 2011 data fell between the highs and lows observed in July.

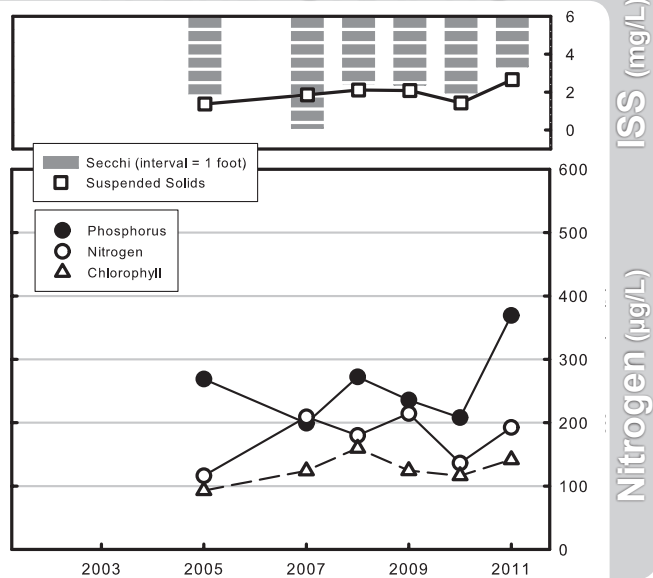
Average water clarity was lower and the average suspended sediment and total phosphorus concentrations were higher in 2011 than in any previously monitored year. Nonetheless, the long-term data do not indicate any water quality trends.



2011 GRAPHS



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See page 3 for help interpreting graphs

Clearwater Lake Site 2



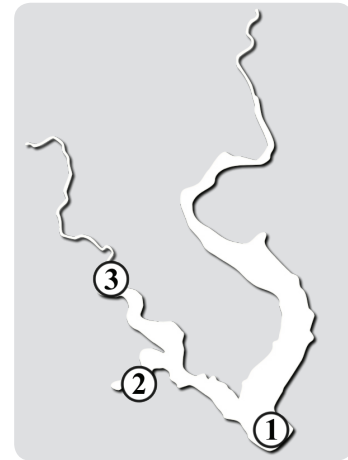
Reynolds and Wayne County
 Latitude: 37.1478 Longitude: -90.8069

2011 DATA

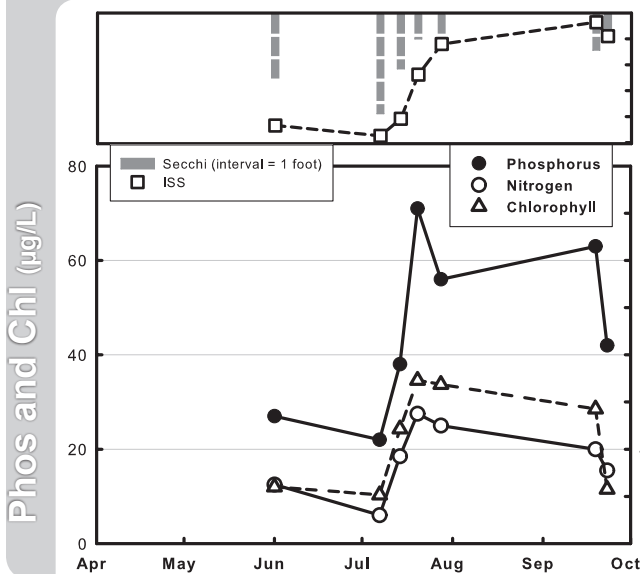
Date	X	6/1	7/7	7/14	7/20	7/28	9/19	9/23	Mean
Secchi (inches)		36	54	30	14	15	20	15	23
TP (µg/L)		27	22	38	71	56	63	42	42
TN (µg/L)		250	120	370	550	500	400	310	324
CHL (µg/L)		12.0	10.3	24.3	34.6	33.7	28.5	11.5	19.7
ISS (mg/L)		3.3	1.3	4.6	13.1	19.0	23.2	20.5	8.1

At all sites on Clearwater Lake during the 2011 sampling season, the data are biased toward the month of July. And at all sites, the variability observed during July was considerable, with maximum and minimum values for Secchi transparency, total phosphorus and total nitrogen occurring during the month. ISS values peaked on 9/19 at all Clearwater sites. As a result, it is difficult to draw any conclusions about the rest of the season, except to say that most of the remaining 2011 data fell between the highs and lows observed in July.

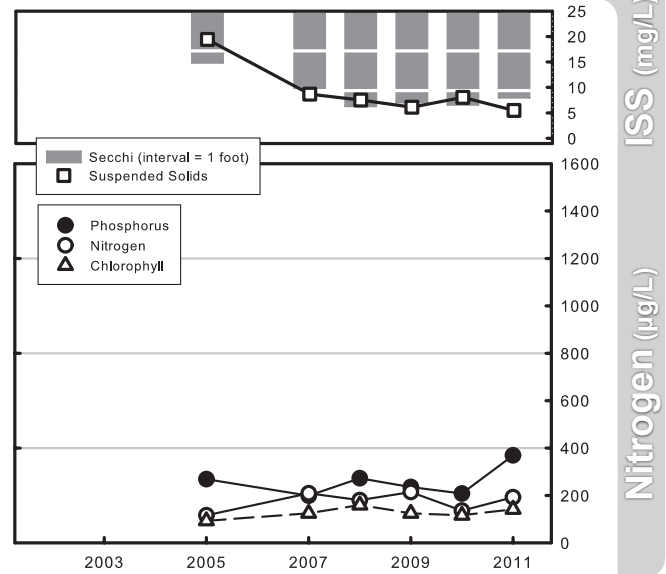
The long-term data do not indicate the presence of any trends,



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Clearwater Lake Site 3



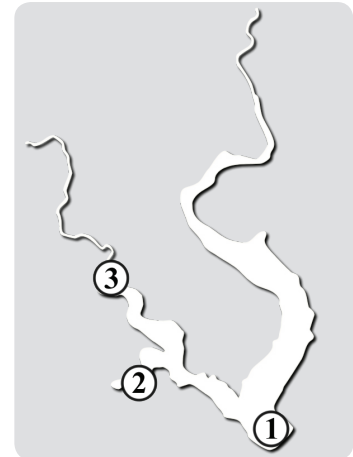
2011 DATA

Reynolds and Wayne County
 Latitude: 37.1664 Longitude: -90.8116

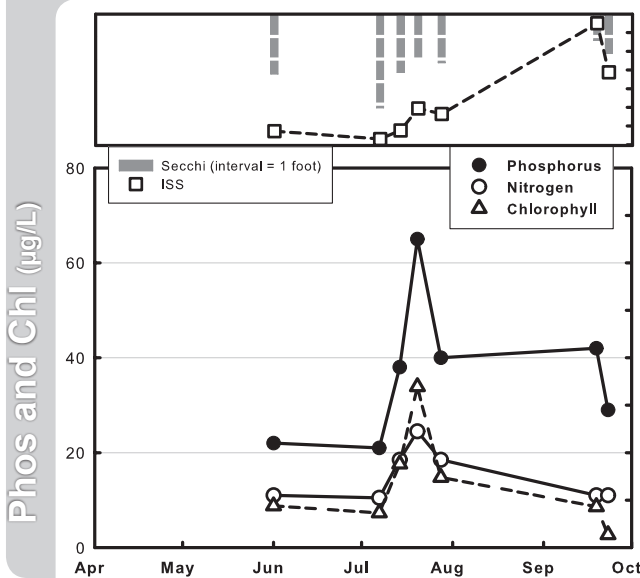
Date	X	6/1	7/7	7/14	7/20	7/28	9/19	9/23	Mean
Secchi (inches)		32	50	31	24	26	14	21	26
TP (µg/L)		22	21	38	65	40	42	29	34
TN (µg/L)		220	210	370	490	370	220	220	284
CHL (µg/L)		8.8	7.3	17.6	33.9	14.8	8.6	2.7	10.4
ISS (mg/L)		3.6	1.5	3.8	9.7	8.2	32.5	19.4	7.2

At all sites on Clearwater Lake during the 2011 sampling season, the data are biased toward the month of July. And at all sites, the variability observed during July was considerable, with maximum and minimum values for Secchi transparency, total phosphorus and total nitrogen occurring during the month. ISS values peaked on 9/19 at all Clearwater sites. As a result, it is difficult to draw any conclusions about the rest of the season, except to say that most of the remaining 2011 data fell between the highs and lows observed in July.

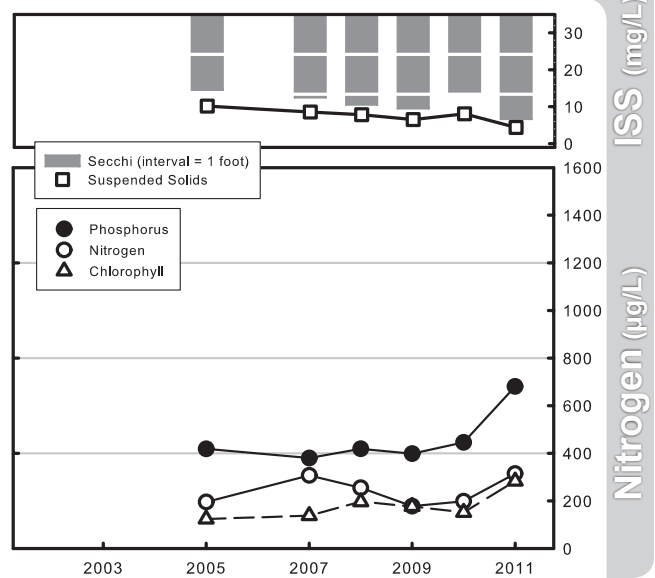
The long-term data do not indicate the presence of any trends.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Creve Coeur Lake



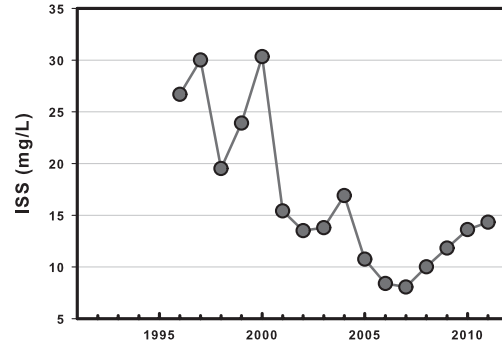
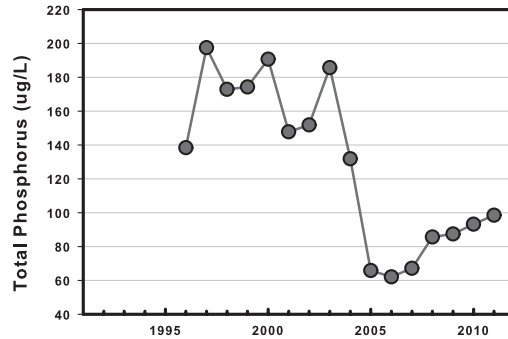
2011 DATA

Saint Louis County
Latitude: 38.7222 Longitude: -90.4911

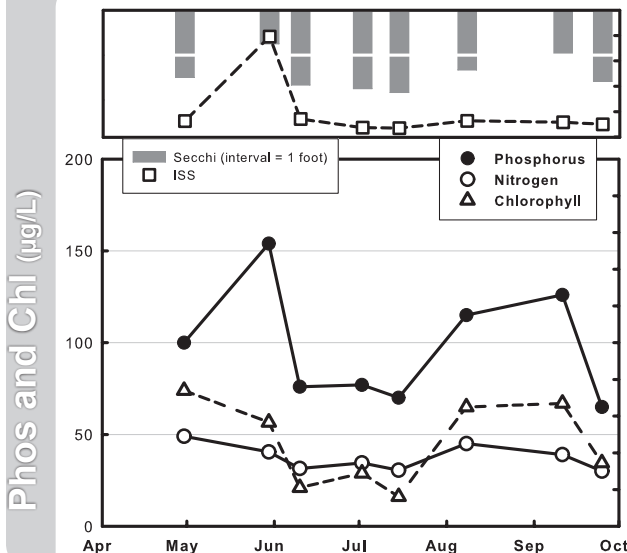
Date	4/30	5/30	6/10	7/2	7/15	8/8	9/11	9/25	Mean
Secchi (inches)	18	9	20	21	22	16	12	19	16
TP (µg/L)	100	154	76	77	70	115	126	65	94
TN (µg/L)	980	810	630	690	610	900	780	600	739
CHL (µg/L)	73.9	56.6	21.0	28.9	16.1	64.9	66.9	34.5	39.7
ISS (mg/L)	12.6	79.2	14.2	7.4	7.0	12.8	11.6	10.0	13.5

The concentration of suspended sediment (ISS) on 5/30/11 was the highest single ISS reading observed at Creve Coeur Lake to date. The average water clarity (Secchi) in 2011 was typical for Creve Coeur (16 inches), but quite low for a Missouri lake.

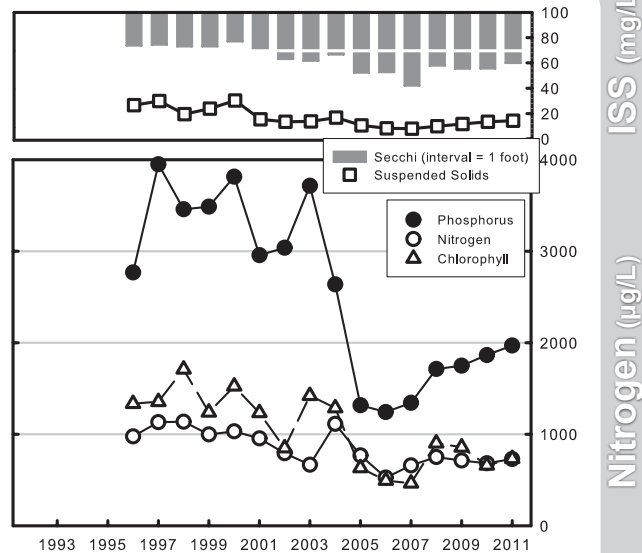
Lake improvement projects were completed in 2004. The lake was dredged and a new lake built to capture sediment that would otherwise flow into Creve Coeur Lake. The lake shows dramatically lower concentrations of both ISS and total phosphorus. However, concentrations of both are slowly trending back upward. The seasonal mean total phosphorus concentration was 50% higher in 2011 than in 2006; mean suspended sediment was 75% higher. Long-term graphs for each are shown enlarged to the right.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Fellows Lake



2011 DATA

Greene County
 Latitude: 37.3147 Longitude: -93.2280

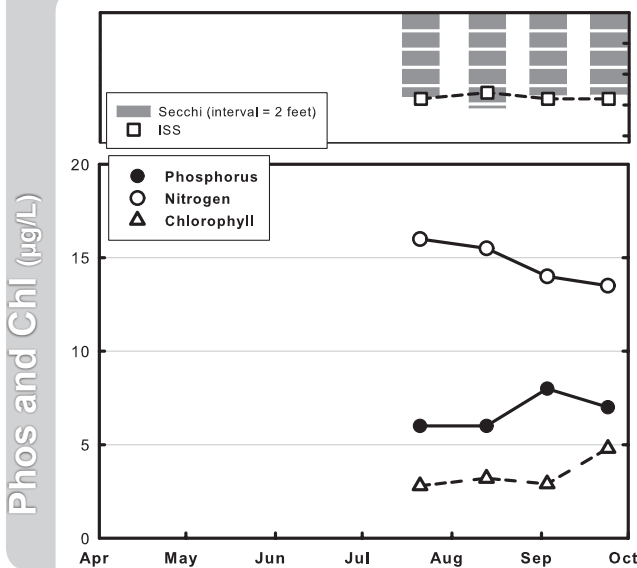
Date	X	X	X	X	7/21	8/13	9/3	9/24	Mean
Secchi (inches)					110	125	108	107	112
TP (µg/L)					6	6	8	7	7
TN (µg/L)					320	310	280	270	294
CHL (µg/L)					2.8	3.2	2.9	4.8	3.3
ISS (mg/L)					0.6	0.7	0.6	0.6	0.6

Fellows Lake was only sampled during the second half of the 2011 sampling season.

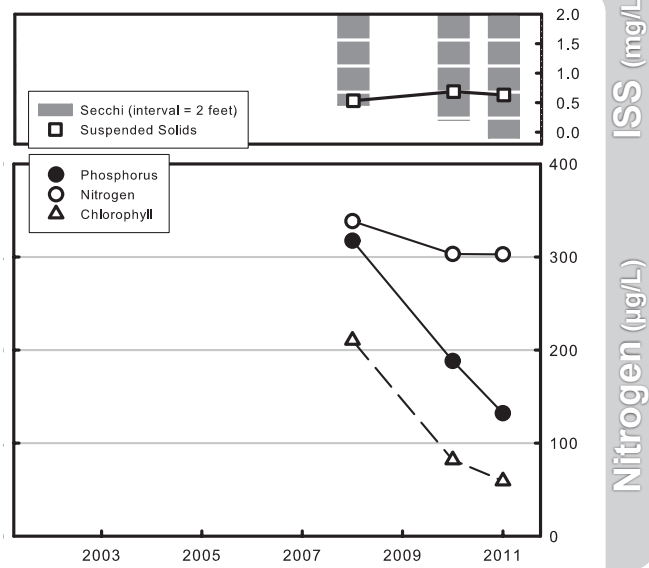
All parameters exhibited very little variation during 2011. The minimum Secchi value was only 10% lower than the maximum. Both phosphorus and chlorophyll varied by just 2 µg/L. Suspended sediment values never exceeded 1 mg/L.

At nearly 10 feet, 2011 mean water clarity was the highest observed in the 3 years that LMVP volunteers have monitored Fellows Lake. The increased clarity can be attributed to lower total phosphorus values and the subsequently reduced algal community (measured as chlorophyll concentration). Suspended sediment and total nitrogen values in 2011 were similar to other years.

2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Forest Lake



Site 1



2011 DATA

Adair County

Latitude: 40.1706

Longitude: -92.6556

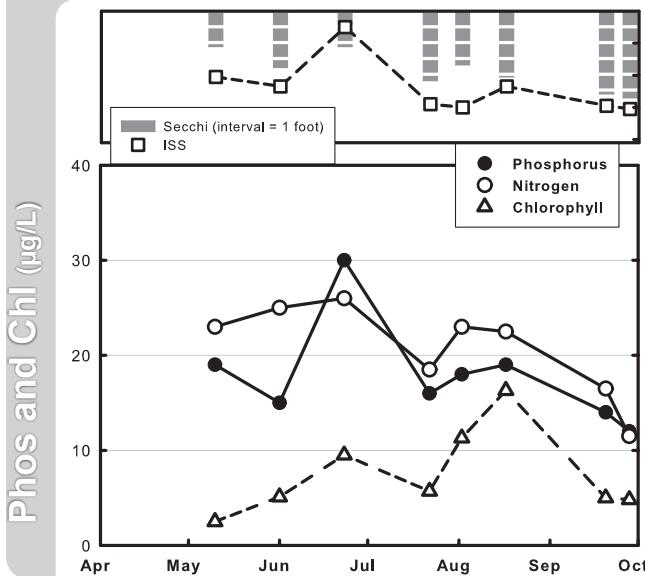
Date	5/10	6/1	6/23	7/22	8/2	8/17	9/20	9/28	Mean
Secchi (inches)	27	43	27	53	41	50	63	66	44
TP (µg/L)	19	15	30	16	18	19	14	12	17
TN (µg/L)	460	500	520	370	460	450	330	230	403
CHL (µg/L)	2.5	5.1	9.5	5.7	11.3	16.3	5.0	4.8	6.5
ISS (mg/L)	3.9	3.3	7.0	2.2	2.0	3.3	2.1	1.9	2.9

Water clarity at Forest Lake ranged from approximately 2 to 4 feet until September, when Secchi transparency exceeded 5 feet for the last 2 sample dates. A spike in the suspended sediment concentration (ISS) on June 23 coincided with a phosphorus peak and explains the comparatively low water clarity on that day (27 inches). Nutrient concentrations in 2011 were otherwise low for a northern Missouri lake. Chlorophyll concentrations were lowest in May and peaked in August, a typical seasonal pattern.

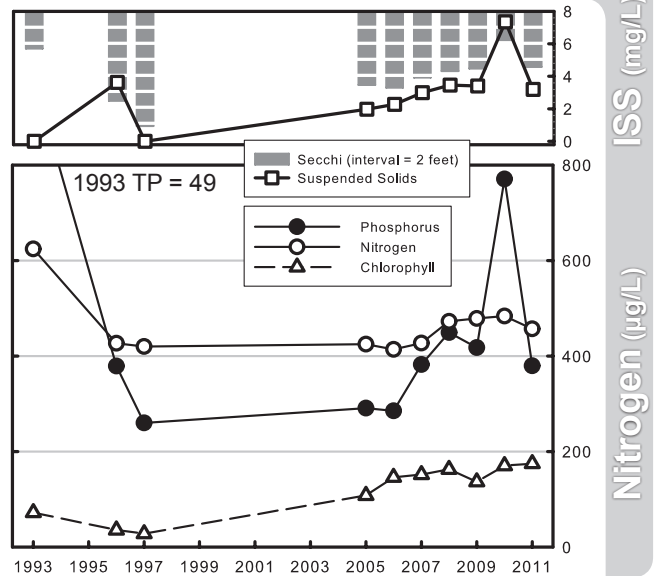
Concentrations of suspended sediment, phosphorus and chlorophyll have been trending upward since at least 2005. Water clarity has been trending downward across the same time frame.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Forest Lake



Site 2



2011 DATA

Adair County

Latitude: 40.1697

Longitude: -92.637

Date	5/10	6/1	6/23	7/22	8/2	8/17	9/20	9/28	Mean
Secchi (inches)	22	22	25	41	44	30	50	42	33
TP (µg/L)	19	23	52	37	35	36	24	20	29
TN (µg/L)	490	450	550	500	490	460	390	280	443
CHL (µg/L)	2.1	7.4	13.9	16.8	22.2	20.0	13.5	6.1	10.4
ISS (mg/L)	5.4	8.3	25.2	7.1	4.7	8.6	7.2	6.6	7.9

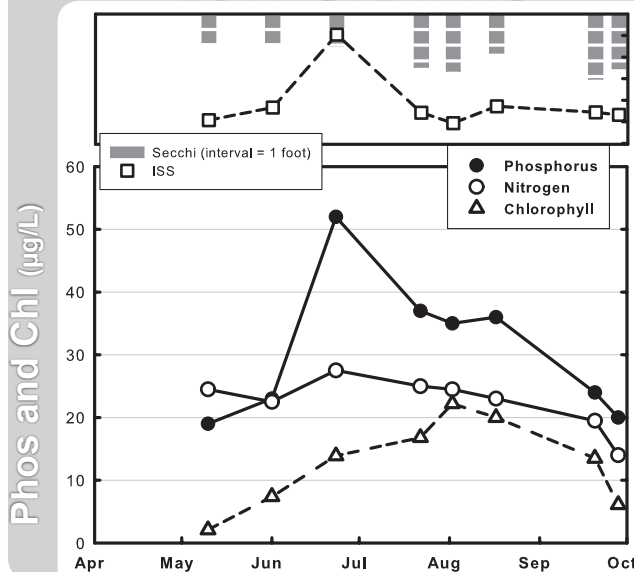
Site 2 is located in the Gill Branch arm of Forest Lake.

Compared to the dam site, water moves more quickly past Site 2 (shorter residence time). As a result, water clarity is typically lower here than at the dam. During the 2011 season, Site 2 had, on average, almost a foot less clarity than Site 1. Suspended sediment concentrations were considerably higher here than the dam, with one value exceeding 25 mg/L (6/23). Phosphorus concentrations were also higher at Site 2, though nitrogen concentrations were similar at both sites. Algal chlorophyll was higher at Site 2 than the dam, but not quite double. The highest seasonal chlorophyll value for each site occurred on different August sampling dates.

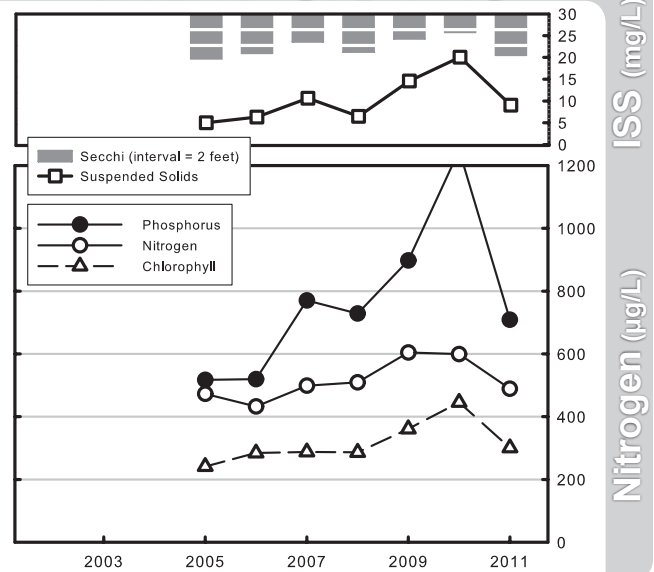
Site 2 has been monitored since 2005. Long-term trends mimic those observed at Site 1, but with higher concentrations of nutrients, chlorophyll and suspended sediment.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Grindstone Lake



2011 DATA

Dekalb County
Latitude: 39.7744 Longitude: -94.2952

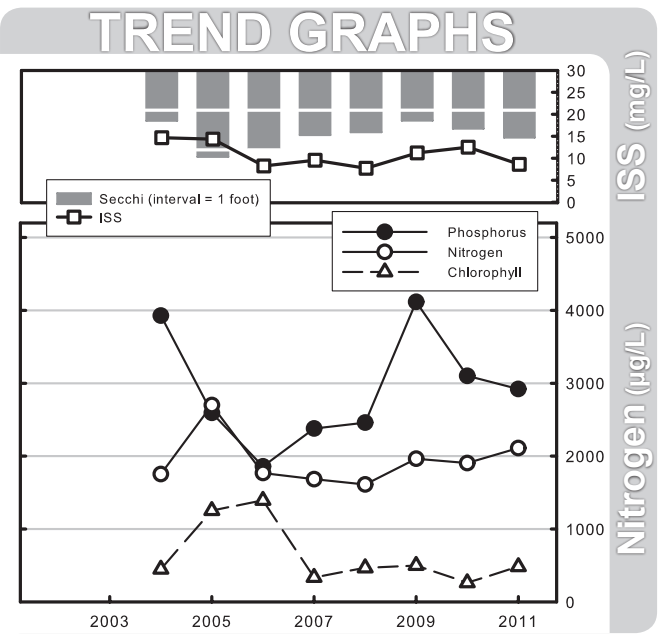
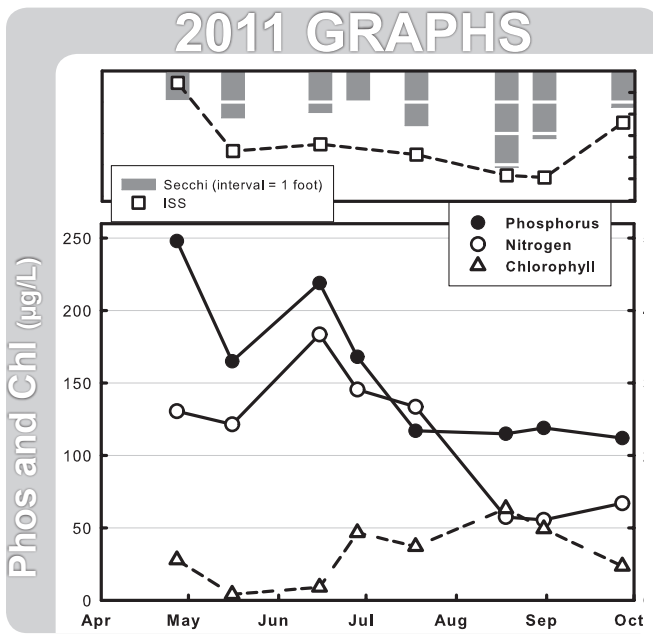
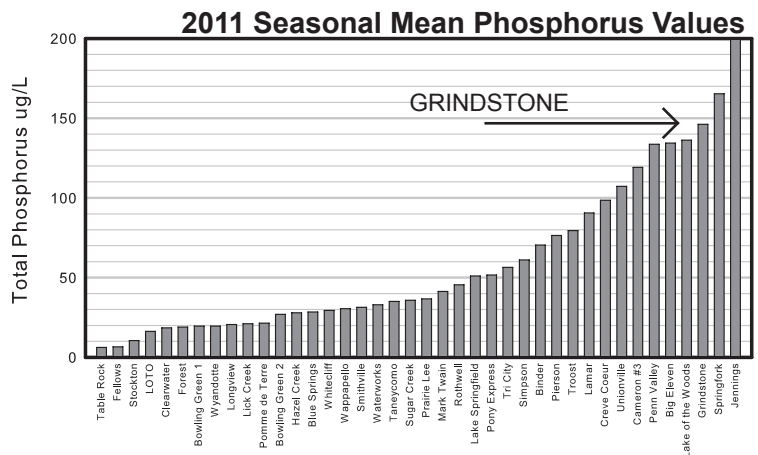
Date	4/27	5/16	6/15	6/28	7/18	8/18	8/31	9/27	Mean
Secchi (inches)	11	18	16	12	21	37	26	14	18
TP (µg/L)	248	165	219	168	117	115	119	112	151
TN (µg/L)	2610	2430	3670	2910	2670	1150	1110	1340	2048
CHL (µg/L)	27.9	4.1	9.0	46.7	37.1	63.3	49.4	23.6	24.5
ISS (mg/L)	27.2	11.4	13.0		10.6	5.8	5.3	18.0	11.3

Grindstone Reservoir is located about 4 miles northwest of Cameron. The very large watershed of this 180 acre reservoir covers 13,417 acres and is dominated by agricultural land use. The large ratio of watershed size to lake volume reduces the reservoir's ability to process the nonpoint source inputs associated with agriculture.

Water clarity averaged just 18 inches in 2011. This is typical of Grindstone, where seasonal average water clarity has been under 2 feet since 2005. Suspended sediment concentrations were high, but not atypical for this lake. While nutrient concentrations were among the highest measured in 2011 (see graph left), algal production was comparatively low because of

shading from sediment particles.

2011 was a typical year for Grindstone Reservoir water quality; there are no apparent trends.



See page 3 for help interpreting graphs

Hazel Creek Lake



Site 1



2011 DATA

Adair County
Latitude: 40.2985 Longitude: -92.628

Date	5/10	6/1	6/23	7/22	8/2	8/17	9/20	9/28	Mean
Secchi (inches)	27	66	48	65	44	38	46	49	46
TP (µg/L)	41	19	25	26	35	39	22		28
TN (µg/L)	970	780	750	560	740	890	790		773
CHL (µg/L)	21.4	3.4	15.8	9.2	27.2	43.4	13.1		14.9
ISS (mg/L)	4.5	1.3	3.0	1.4	1.8	2.5	3.7		2.4

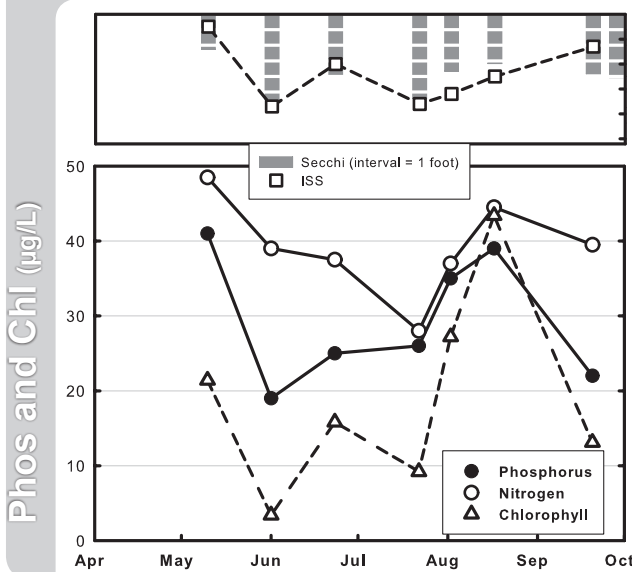
Water clarity in Hazel Creek Lake was pretty good in 2011, averaging nearly 4 feet, with a high of over 5 feet.

An algae bloom apparently was occurring during the August 17 sampling. Chlorophyll concentrations on that day were 3 times higher than the mean, and nearly double the previous maximum. The ratio of chlorophyll to phosphorus was 1.1, meaning there was more chlorophyll than phosphorus in the water. A more typical ratio is 0.5, or half as much chlorophyll as phosphorus in the water.

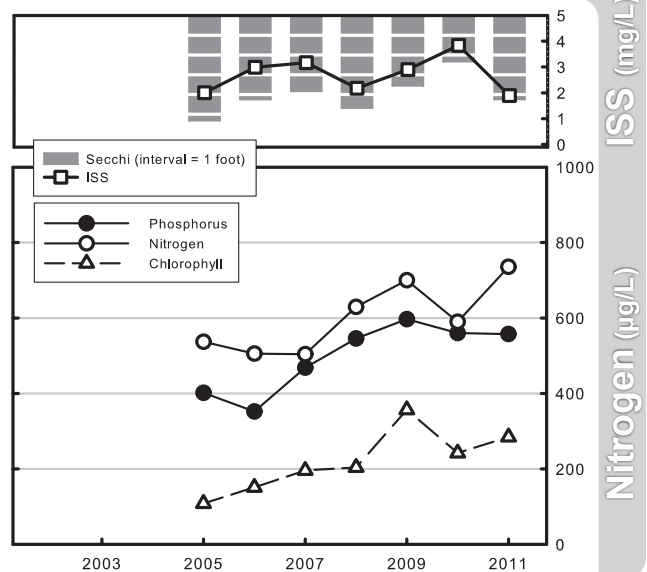
Over the long-term, nutrient and chlorophyll concentrations appear to be trending upward. Nitrogen and phosphorus have increased by about 50% and chlorophyll concentrations have nearly doubled since monitoring began in 2005.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Hazel Creek Lake



Site 2



2011 DATA

AdairCounty
Latitude: 40.2805 Longitude: -92.6045

Date	5/10	6/1	6/23	7/22	8/2	8/17	9/20	9/28	Mean
Secchi (inches)	14	42	28	37	26	18	27	24	26
TP (µg/L)	27	23	35	49	55	60	37		39
TN (µg/L)	840	800	710	720	870	1010	740		807
CHL (µg/L)	8.6	8.5	20.1	24.9	40.9	27.7	23.0		19.2
ISS (mg/L)	9.7	4.1	15.0	6.9	9.2	20.2	11.7		9.8

Site 2 is located in a cove near the inflow end of Hazel Creek Lake.

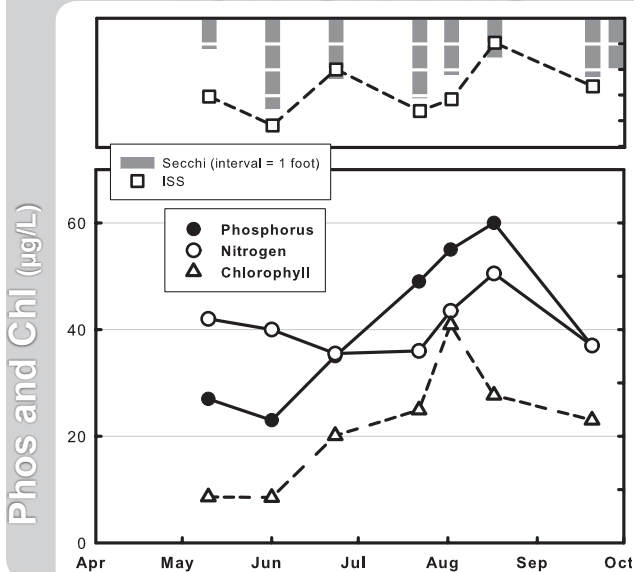
Water clarity (Secchi) at this site was roughly half that of Site 1 near the dam. Nutrient (TP and TN) and chlorophyll (CHL) concentrations were somewhat higher at Site 2, but sediment concentrations (ISS) were 4 times higher. This is not surprising, given the shallow water depth at this site and the site's proximity to the inflow. Sediment will wash in, off the watershed, during storm events and be resuspended from the bottom with wave action.

Long-term trend graphs are similar to the graphs from Site 1. Nutrient and chlorophyll concentrations are trending upward,

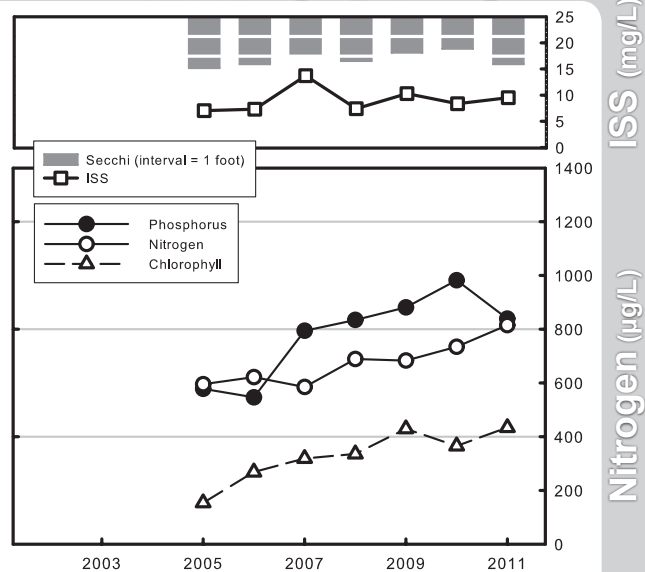
while water clarity and suspended sediment concentrations remain comparatively stable.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Hazel Creek Lake



Site 3



2011 DATA

Adair County
Latitude: 40.2772

Longitude: -92.6092

Date	5/10	6/1	X	7/22	8/2	8/17	9/20	9/28	Mean
Secchi (inches)	26	13		44	21	29	23	34	26
TP (µg/L)	39	107		103	117	47	98		78
TN (µg/L)	880	1520		1040	1210	650	780		974
CHL (µg/L)	20.1	18.1		51.8	78.1	30.2	62.6		55.0
ISS (mg/L)	8.2	17.4		9.6	8.5	8.2	19.1		11.1

Like Site 2, Site 3 is located in a cove on the inflowing end of Hazel Creek Lake. Site 3 differs in that a road separates the cove from the main lake, and all water exchange happens via culvert pipes. In effect, the road isolates Site 3 from the main lake, creating a small, shallow, sediment settling basin.

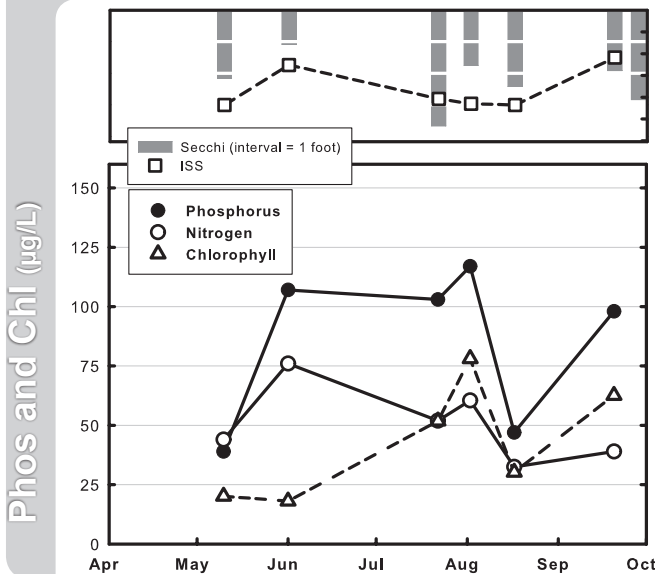
The water quality at Site 3 differs considerably from the main lake. Site 3 water clarity was, on average, identical to Site 2. This is odd, considering Site 3 had twice the phosphorus, nearly 3 times the chlorophyll, and slightly more suspended sediment.

Phosphorus and nitrogen concentrations were lower in 2011 than in the pre-

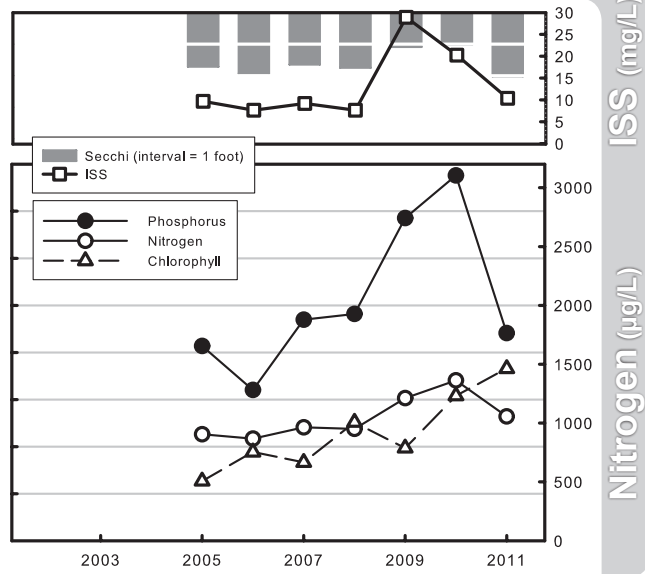
vious 2 years, possibly due to dry conditions. Nevertheless, while the scale differs, long-term data suggest the same trends at Site 3 as observed at Site 1 and Site 2.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Jennings Park Lake



(Koeneman Park)



2011 DATA

St. Louis County
Latitude: 38.7384

Longitude: -90.2583

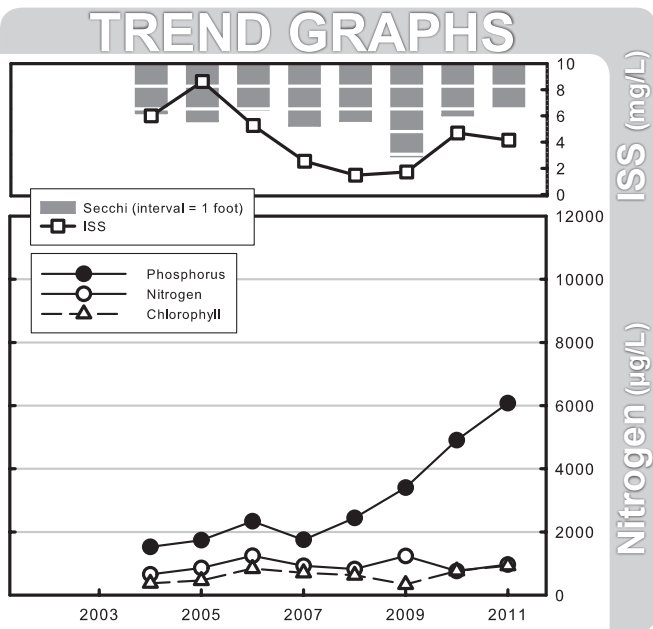
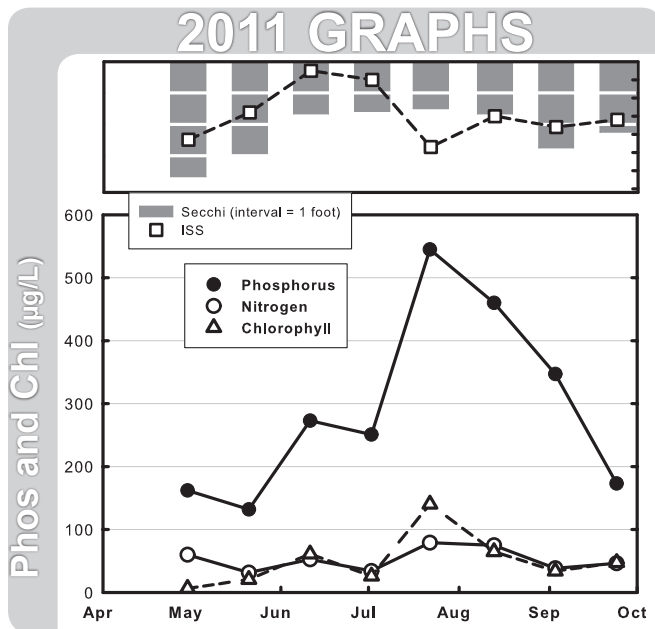
Date	4/30	5/21	6/11	7/2	7/22	8/13	9/3	9/24	Mean
Secchi (inches)	44	36	20	19	18	20	33	27	26
TP (µg/L)	162	132	273	251	545	460	347	173	262
TN (µg/L)	1200	630	1050	680	1580	1500	770	930	989
CHL (µg/L)	6.3	20.7	61.1	25.9	140.3	64.8	33.8	47.5	36.3
ISS (mg/L)	2.7	4.2	6.5	6	2.3	4	3.4	3.8	3.9

This small, shallow, lake is located in Koeneman Park in Jennings. The lake is young, and has been monitored since the year it first filled in with water. This lake is managed and stocked for fishing by MDC, including winter trout fishing.

Total phosphorus concentrations in this lake are remarkably high. The 2011 mean phosphorus in Koeneman Park Lake was 5 times greater than the statewide mean. On July 22 the phosphorus concentration reached 545 µg/L, more than 10 times greater than the long-term statewide mean. Nitrogen concentrations, while high, were comparatively lower at 50% greater than the statewide mean. As expected, there is abundant phosphorus in this lake. The nitrogen to phosphorus ratio was 3.8, compared to the statewide average

of 16.3. Aside from the very high phosphorus concentrations, this lake is similar to many Missouri lakes.

Seasonal mean phosphorus concentrations appear to be trending upward across the past 3 or 4 years. Sediment, nitrogen and chlorophyll values do not appear to be trending in any direction.



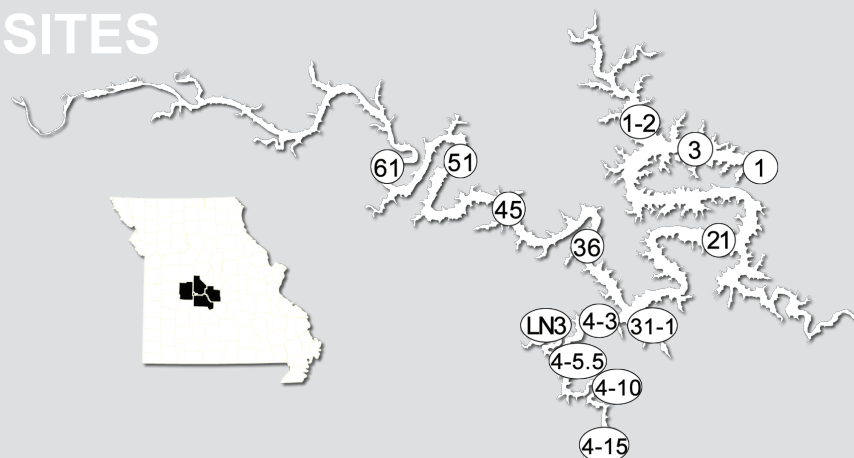
See page 3 for help interpreting graphs

Lake of the Ozarks

Benton, Camden, Miller and Morgan Counties



SITES



Many of the LMVP volunteers at the Lake of the Ozarks are also active in the Lake of the Ozarks Watershed Alliance (LOWA). Visit the LOWA website at www.soslowa.org.



Main Lake Sites

Site Number		1	3	21	45	51	61
(# of samples)		(8)	(8)	(8)	(5)	(8)	(8)
Secchi (inches)	Mean	72	76	60	36	31	18
	Range	50 – 108	40 – 116	39 – 108	22 – 49	18 – 61	13 – 24
Phosphorus (µg/L)	Mean	19	21	28	54	61	58
	Range	9 – 37	11 – 39	15 – 43	33 – 75	39 – 78	43 – 77
Nitrogen (µg/L)	Mean	456	476	575	696	711	625
	Range	280 – 910	280 – 1020	400 – 910	550 – 980	520 – 1060	380 – 1050
Chlorophyll (µg/L)	Mean	9.1	9.8	12.1	22.3	20.6	18.8
	Range	6.3 – 12.7	2.8 – 18.2	6.3 – 22.3	12.5 – 33.4	13.6 – 69.0	5.9 – 36.1
ISS (mg/L)	Mean	0.5	1	2	3.2	5.8	11.8
	Range	0.1 – 3.2	0.4 – 3.2	0.6 – 5.3	1.8 – 8.6	1.6 – 17.3	5.2 – 40.2

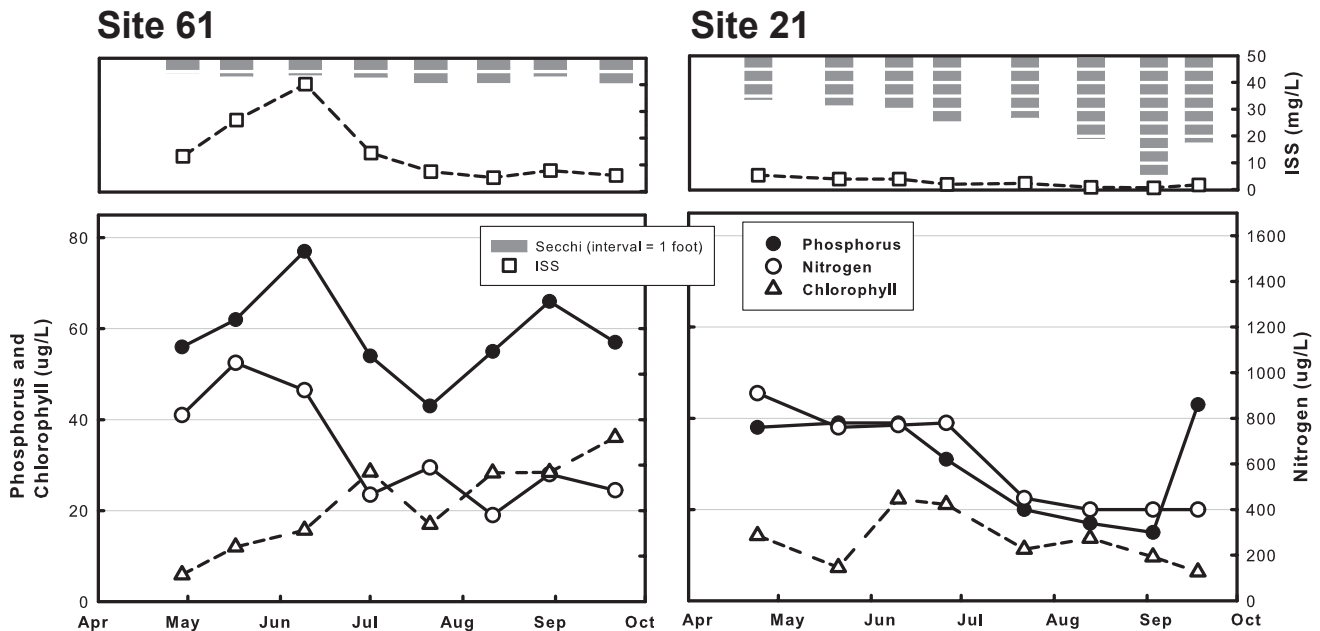
Tributary Sites

Site Number		1-2	31-1	4-3	4-5.5	4-10	4-15	LN3
(# of samples)		(8)	(7)	(7)	(9)	(7)	(5)	(6)
Secchi (inches)	Mean	76	46	43	43	34	29	41
	Range	50 – 108	30 – 57	34 – 48	11 – 64	6 – 60	24 – 31	34 – 51
Phosphorus (µg/L)	Mean	20	35	26	34	49	40	33
	Range	12 – 33	23 – 68	23 – 30	27 – 75	29 – 179	34 – 46	26 – 51
Nitrogen (µg/L)	Mean	460	537	660	456	532	619	453
	Range	300 – 800	340 – 910	360 – 1180	260 – 740	390 – 1010	410 – 850	360 – 760
Chlorophyll (µg/L)	Mean	10.4	18.7	9.2	17	20.6	34.3	17.7
	Range	4.8 – 16.7	10.1 – 74.3	6.5 – 12.7	7.0 – 28.3	3.5 – 45.7	25.9 – 45.9	13.2 – 26.7
ISS (mg/L)	Mean	1.1	2.2	0.5	3	3.8	7.3	2.4
	Range	0.5 – 2.8	1.1 – 6.0	0.2 – 0.9	1.0 – 22.0	1.8 – 65.0	5.9 – 10.7	1.2 – 3.7

Lake of the Ozarks - Main Lake 2011 Data

Six sites were monitored in the main lake channel of Lake of the Ozarks during 2011, with sites located at Bagnell Dam, the 3, 21, 45, 51 and 61 mile markers. Water quality in the main lake displayed the expected longitudinal gradient; with the highest average nutrient, sediment and chlorophyll concentrations up-lake and decreasing values as sites moved towards the dam. The most dramatic changes occurred with inorganic suspended sediment, which showed a 96% decrease in average concentration between the 61 mile marker and Bagnell Dam. As water moves through the main lake channel

the suspended soil particles settle out of the water column and become lake sediment. Phosphorus and chlorophyll also showed notable gradients, with a 68% and 50% decrease across the main lake, respectively. Nitrogen displayed the least change with the Bagnell Dam site having an average that was only about 30% lower than that measured at Site 61. Lower concentrations of inorganic suspended sediment and algal chlorophyll translated to improved water clarity down-lake. The average Secchi reading at Bagnell Dam was about 4-times deeper than that measured at Site 61.



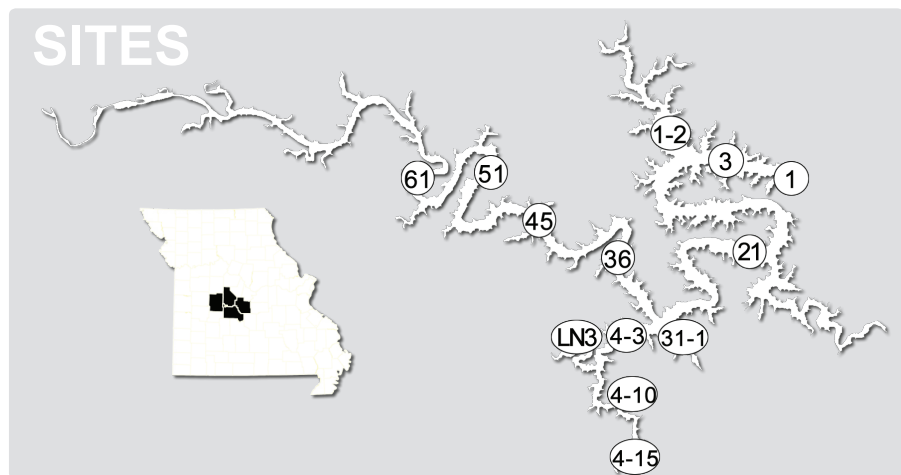
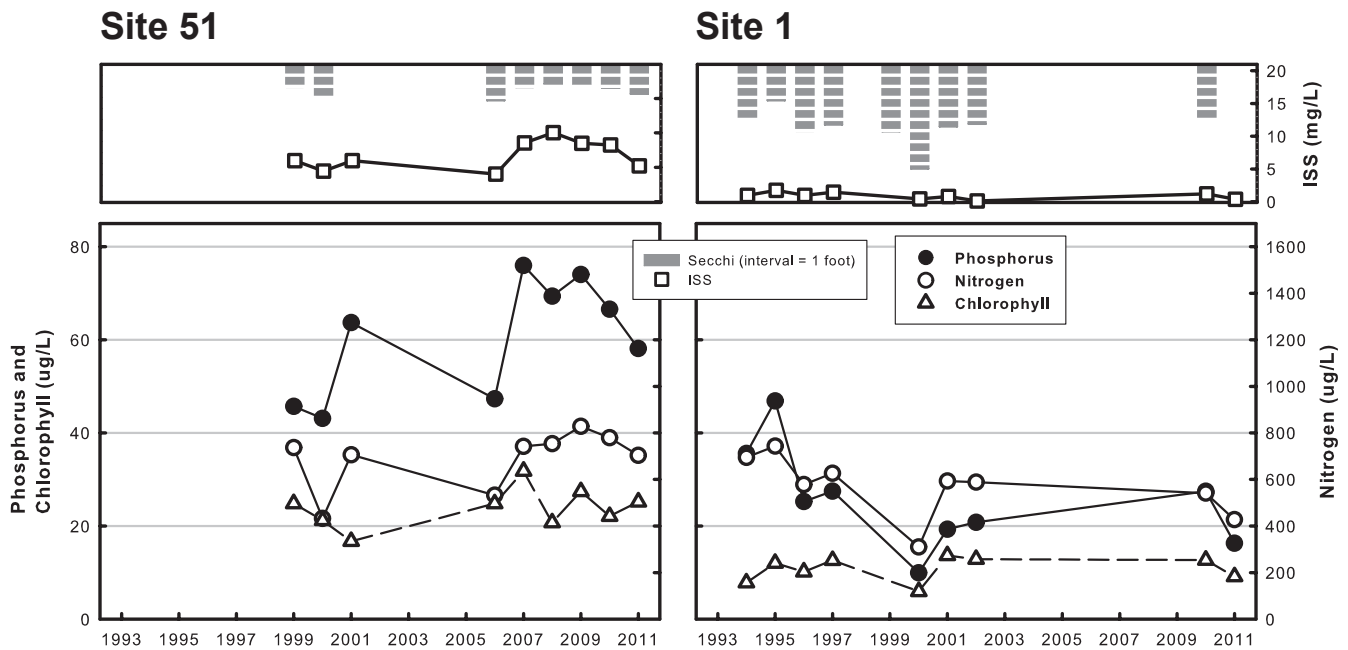
All main lake sites displayed a similar seasonal nitrogen pattern, high values in the spring with decreasing concentrations during summer and into fall. Phosphorus followed the same pattern in down-lake sites (1, 3 and 21), with the exception of the last sample date when concentrations spiked almost three-fold. Up-lake sites (51 and 61) had variable phosphorus levels with no obvious seasonal pattern. At five of the main lake sites chlorophyll concentrations fluctuated during the sample season with no obvious trend. Site 61 differed by displaying an in-

crease in chlorophyll across the season, with the September measurement being 6-times higher than the April value. This pattern of increasing chlorophyll is probably a result of decreasing suspended sediment concentrations during the season, which would lead to more available light for algal photosynthesis. The pattern of declining inorganic suspended sediment concentrations as the season progressed was observed at all main lake sites. In response to decreasing sediment levels, Secchi transparency readings generally improved during the season in the main lake.

Lake of the Ozarks - Main Lake Long-term Trends

None of the main lake sites display any obvious long-term trends in water quality, though two sites did display interesting fluctuations over time. At Bagnell Dam (Site 1) the geometric mean phosphorus concentrations were higher the first two years (1994-95) than the remainder of the monitored years. The average for the first two years was 42 $\mu\text{g/L}$ compared to an average of 21 $\mu\text{g/L}$ for the seven years of monitoring during 1996-2011. The lack of change in phosphorus levels over the last 16 years (1996-2011) keeps us from calling this a

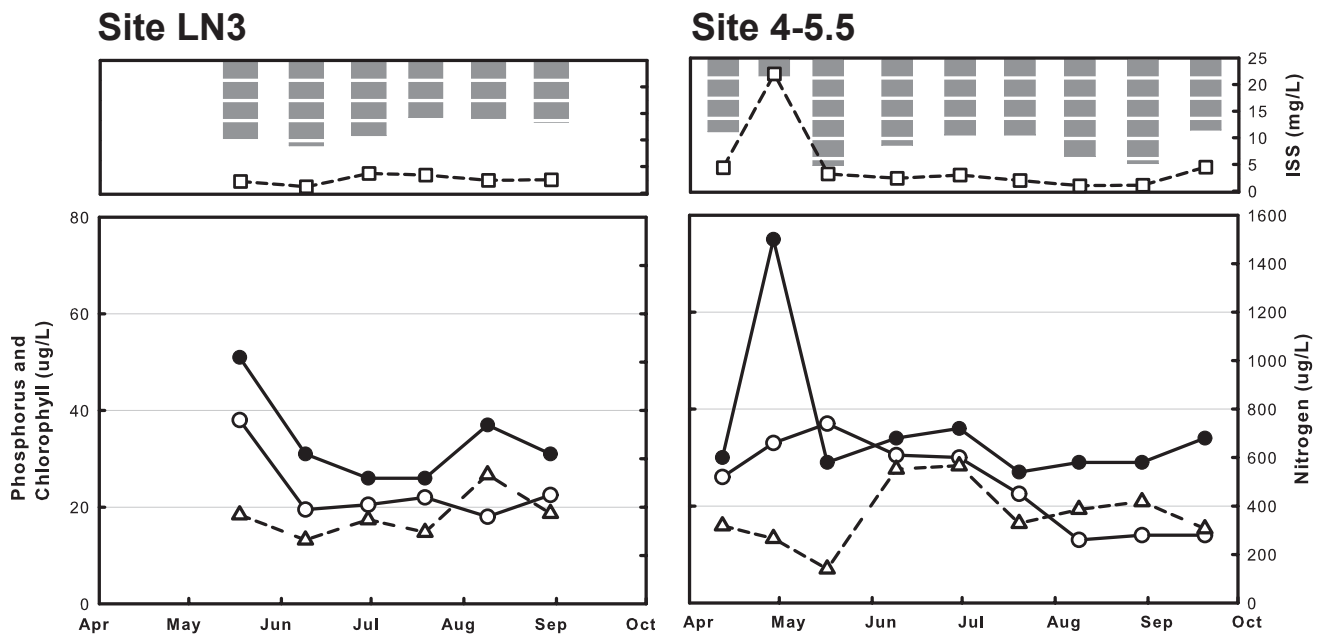
true trend. At Site 51 the four highest summertime mean phosphorus and suspended sediment values have been measured during the last five years. The overall average phosphorus value for 1999-2006 was 50 $\mu\text{g/L}$ compared to an average of 72 $\mu\text{g/L}$ for 2007-2010. Average inorganic suspended sediment values for the same periods were 5.1 mg/L and 8.8 mg/L. Lower phosphorus and suspended sediment values in 2011, along with no data from 2002-05, limit our ability to call these true trends.



Lake of the Ozarks - Tributary 2011 Data

Comparison of the Gravois Mill Arm (Site 1-2), Linn Creek Arm (Site 31-1) and the Niangua Arm (Site 4.3) show that water quality is marginally better in the Gravois Arm relative to the other tributaries. This site had lower average phosphorus and nitrogen concentrations than the other two arms. The

geometric mean chlorophyll concentration in the Gravois Mill Arm was 10.4 $\mu\text{g/L}$, a value similar the mean of 9.2 $\mu\text{g/L}$ at Site 4-3 in the Niangua Arm. These chlorophyll levels were notably lower than those measured in Linn Creek, which averaged 18.7 $\mu\text{g/L}$.



The Niangua Arm of the lake shows a longitudinal gradient similar to that observed in the main lake channel. This gradient was most obvious when comparing average suspended sediment and chlorophyll values, which decreased by 93% and 73% between sites at mile markers 15 and 3. Water quality in the Little Niangua Arm (LN3) was similar to that found at the Niangua-Little Niangua confluence (Site 4-5.5) when average values are compared. Interestingly, comparisons of data from individual sample days show difference at these two sites. For instance, the chlorophyll concentration in the Little Niangua was more than double that measured at the confluence site on May 18th. On the next sample date, June 9th, chlorophyll in at the Little Niangua site was half that found at the confluence site.

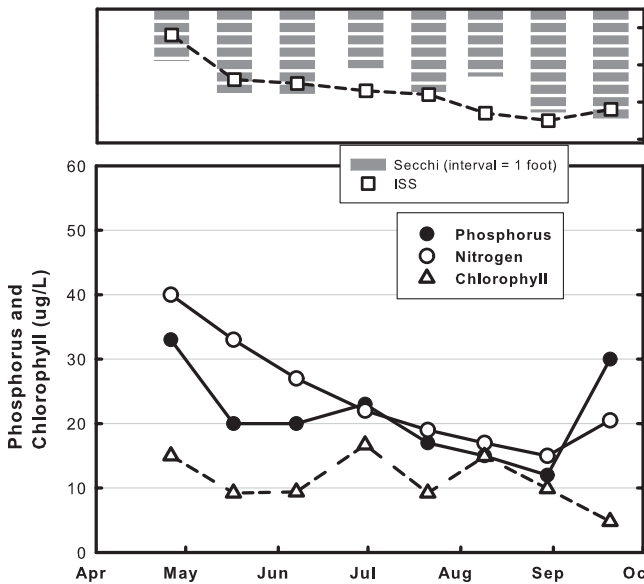
Seasonal patterns for 2011 in the three tributaries varied to some degree. The Gravois Mill Arm site mimicked Site 3 in the main lake, with higher values in the spring followed by a general decline in nutrient, chlorophyll and suspended sediment concentrations during the remainder of the sample season. The late season phosphorus spike observed in the lower-main lake was also measured in the Gravois Mill Arm. In the Linn Creek Arm nutrients, chlorophyll and suspended sediment spiked in mid-May, decreased by late June and remained fairly stable during the rest of the season. Site 4-3 in the Niangua Arm displayed very little variation in phosphorus, chlorophyll and suspended sediment concentrations, while nitrogen levels were low during the first three samples and then increased by almost three-fold during summer. The other sites in the Niangua Arm

Lake of the Ozarks - Tributary 2011 Data

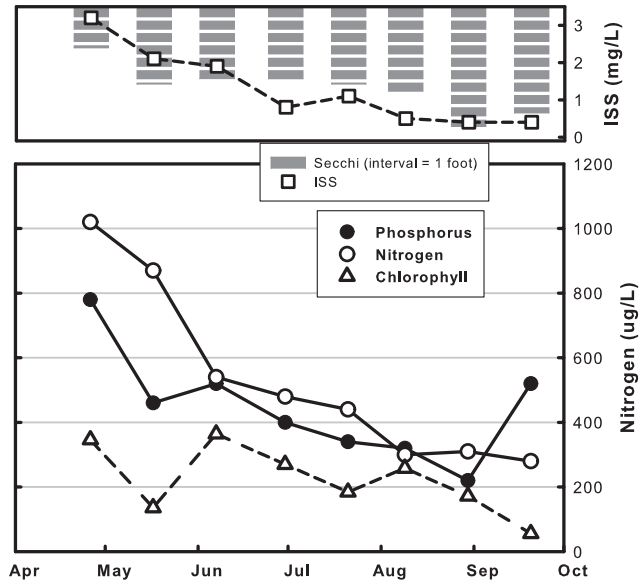
displayed seasonal patterns that differed from that seen at site 4-3. Early season spikes in phosphorus and inorganic suspended sediment were observed at Site 4-5.5 on the April 29th sample. On the same date Site 4-10 also had phosphorus and inorganic suspended sediment spikes, as well as a nitrogen spike. In the Little Niangua

Arm (Site LN-3) the highest measured phosphorus and nitrogen values were recorded on the first sample date (May 18th), while the maximum inorganic suspended sediment value was measured on June 30th.

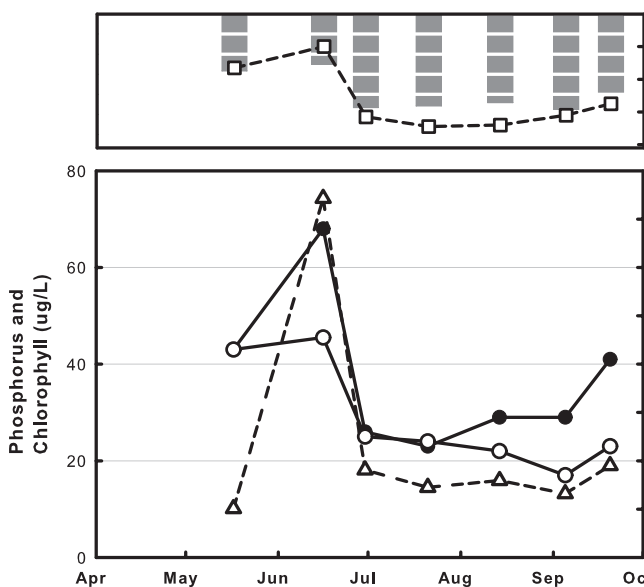
Site 1-2



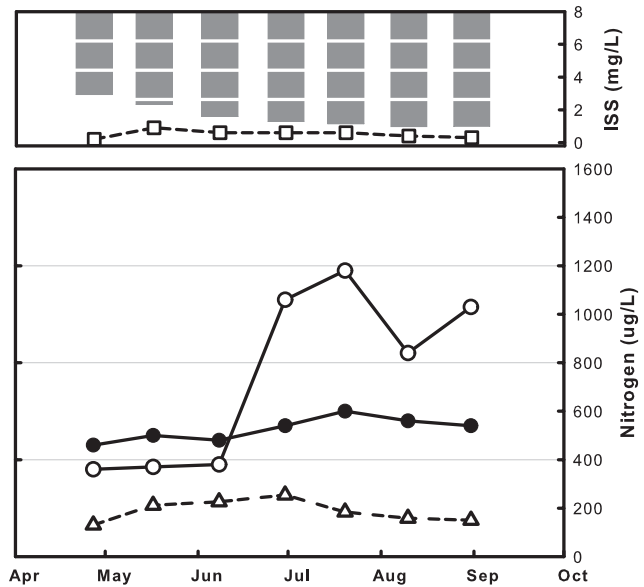
Site 3



Site 31-1



Site 4-3

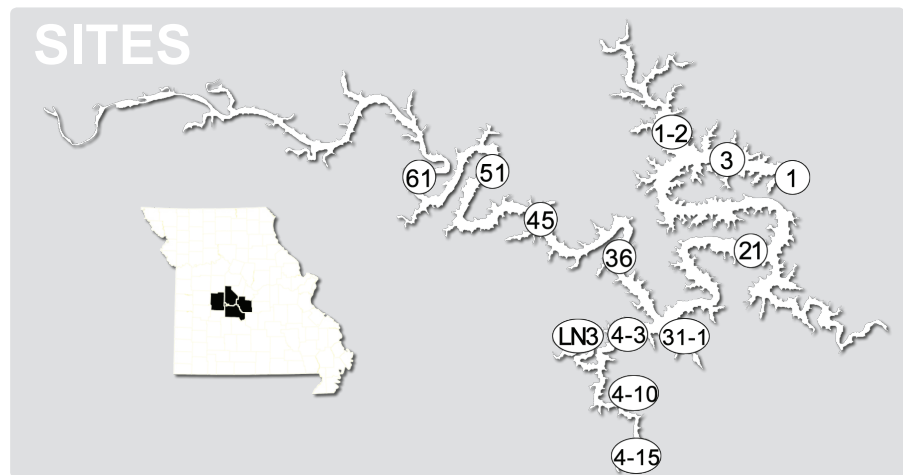
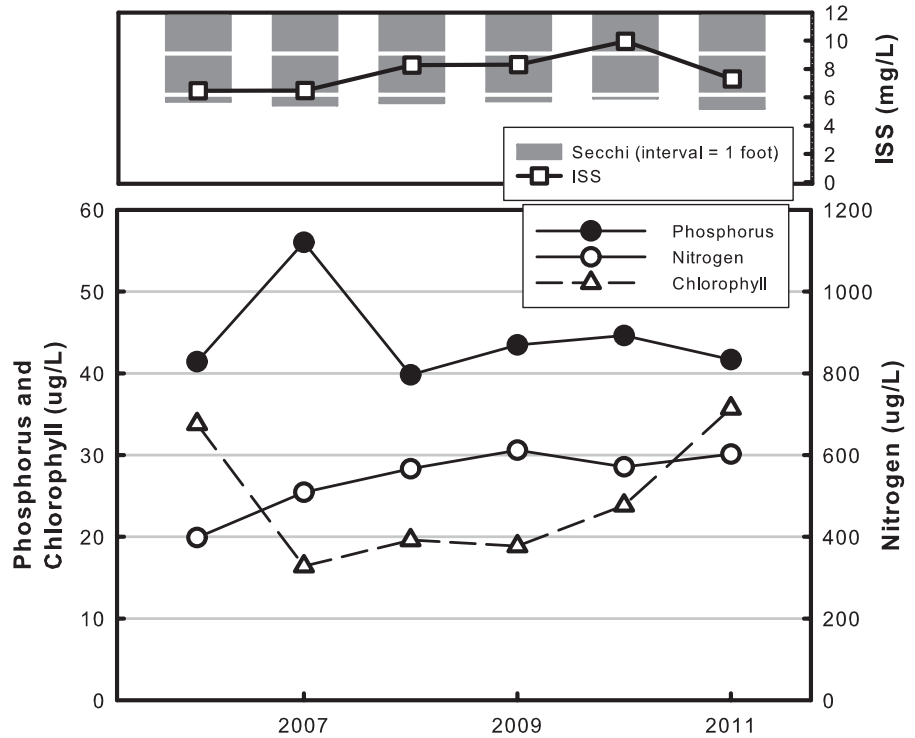


Lake of the Ozarks - Tributary Trends

Two of the tributary sites (4-5.5 and LN-3) have not been monitored long enough for trend analysis. At the other tributary sites none of the parameters display an obvious trend in water quality. Nitrogen levels at

Site 4-15 over the last six summers show a slight move upward, but care should be taken when interpreting these data as three of the summers had limited sample collection.

Site 4-15



Lake of the Woods

Swope Park



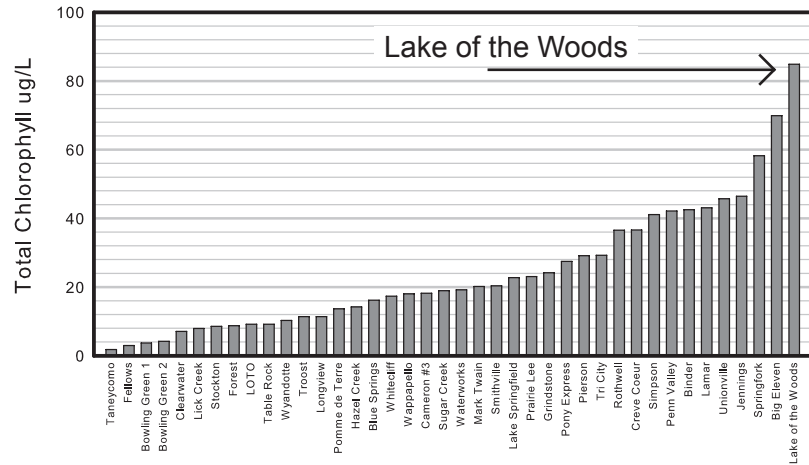
2011 DATA

Jackson County
Latitude: 38.9954 Longitude: -94.5206

Date	X	X	X	X	7/17	8/7	8/28	9/19	Mean
Secchi (inches)					28	18	28	29	25
TP (µg/L)					106	202	118	109	129
TN (µg/L)					760	1440	910	990	996
CHL (µg/L)					47.4	227.1	56.7	21.1	59.9
ISS (mg/L)					4.2	4.8	7.8	6.9	5.7

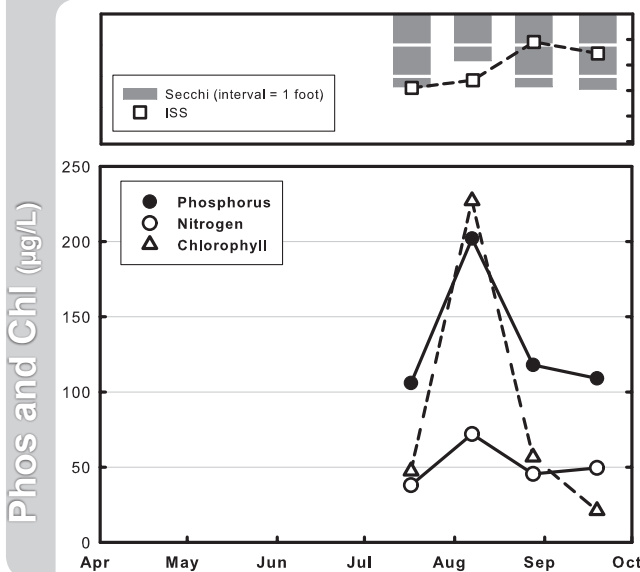
Lake of the Woods is located in Swope Park, in the metro Kansas City area. Lake of the Woods is approximately 7.7 acres and has a watershed size of approximately 800 acres. The watershed contains a considerable proportion of forested land, but also contains a golf course and residences.

Sampling at Lake of the Woods began on July 17, during the middle of the sampling season. 2011 water clarity was just over 2 feet, on average. Lowest water clarity measurement was on August 7, when an algae bloom was occurring. The chlorophyll concentration was 227 µg/L on that day, compared to the lake's 2011 geometric mean of 60 µg/L.



Lake of the Woods had the highest mean "summer" (May 15 - September 15) chlorophyll concentration of any LMVP lake in 2011. See figure above for reference.

2011 GRAPHS



TREND GRAPHS

Not enough data available to characterize a trend

ISS (mg/L)
Nitrogen (µg/L)

See page 3 for help interpreting graphs

Lamar City Lake



Site 1



2011 DATA

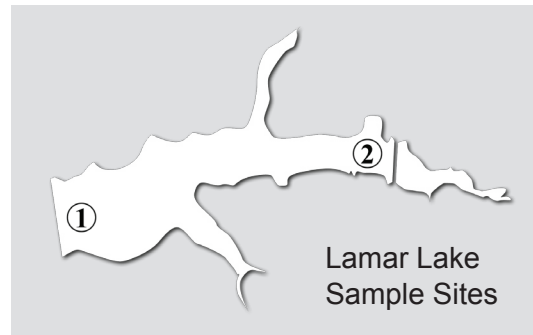
Barton County
 Latitude: 37.4801 Longitude: -94.2602

Date	4/28	5/17	6/10	7/1	7/12	X	8/16	9/13	Mean
Secchi (inches)	36	48	24	34	24		24	24	30
TP (µg/L)	113	73	85	83	110		103	94	93
TN (µg/L)	1110	1100	1780	1140	1180		1600	1480	1318
CHL (µg/L)	5.6	19.9	47.7	37.6	58.9		67.2	45.0	32.2
ISS (mg/L)	3.3	1.8	3.2	0.2	1.0		2.3	2.6	1.6

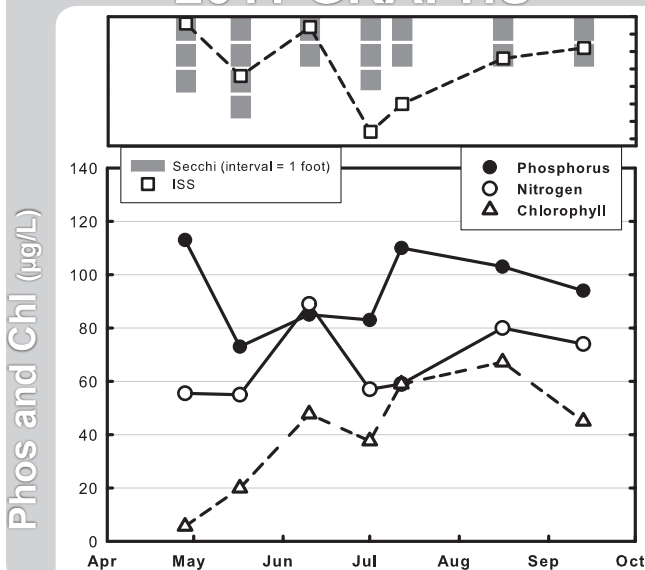
Water clarity was slightly lower at Lamar City Lake Site 1 than in the average Missouri lake. Suspended sediment concentrations were quite low, indicating that algae were likely responsible for low water clarity.

Chlorophyll values started quite low in April and increased considerably as the season progressed. The 2011 average chlorophyll value was 32.1 µg/L, roughly double the Missouri average. Nutrient concentrations at Site 1 in Lamar City Lake remained at approximately the same level throughout the 2011 sampling season. Nutrient concentrations were also high, roughly double the Missouri average.

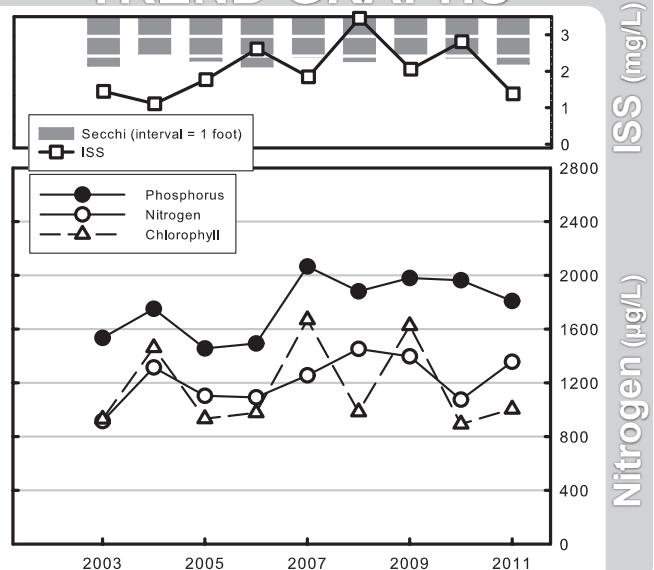
Long-term data suggest no water quality trends, though phosphorus concentrations were higher during the past 5 seasons than in the previous 4.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lamar City Lake



Site 2



2011 DATA

Barton County
Latitude: 37.483

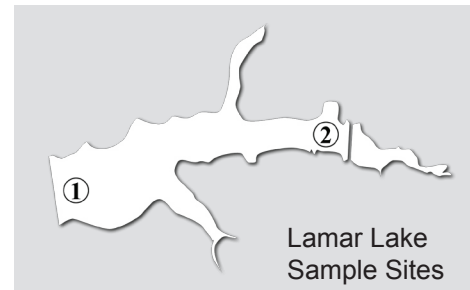
Longitude: -94.2451

Date	4/28	5/17	6/10	7/1	7/12	X	8/16	9/13	Mean
Secchi (inches)	36	54	30	32	24		24	18	29
TP (µg/L)	114	85	85	129	108		101	101	75
TN (µg/L)	1160	1110	1070	1830	1570		1100	1150	1259
CHL (µg/L)	5.2	27.6	53.1	91.2	73.8		43.4	43.9	37.2
ISS (mg/L)	1.6	1.5	1.8	0.9	1.9		11.7	46.3	3.3

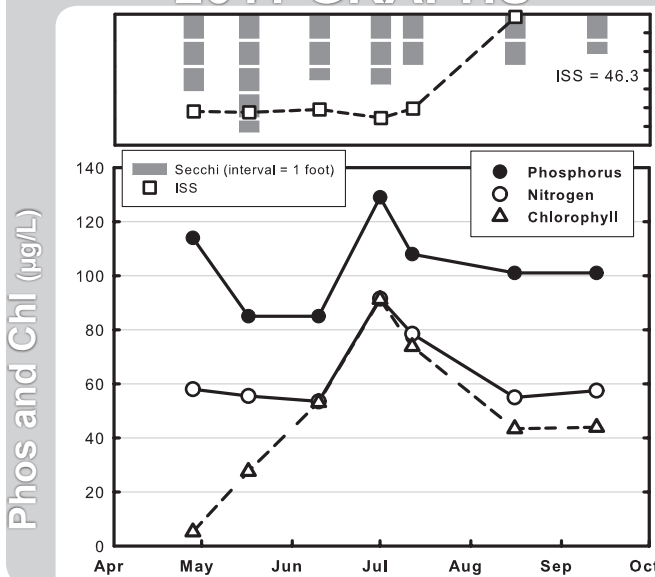
Water quality at Site 2 was not substantially different than at Site 1 (the dam). The average chlorophyll concentration was slightly higher at Site 2, and the average nutrient concentration was somewhat lower.

The geometric mean suspended sediment concentration was twice as high at Site 2 than at Site 1, but the value was still quite low. The only striking difference between the two sites was the extremely high suspended sediment value for September 13 (46.3 mg/L). The sample from the same date at Site 1 had a twentieth of the sediment measured at Site 2.

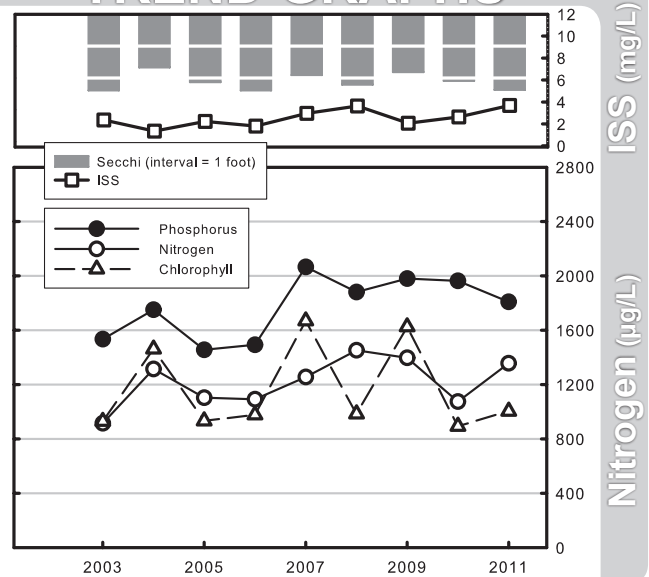
Long-term data from Site 2 are nearly identical to Site 1.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lick Creek Lake



2011 DATA

Boone County

Latitude: 39.1510

Longitude: -92.3852

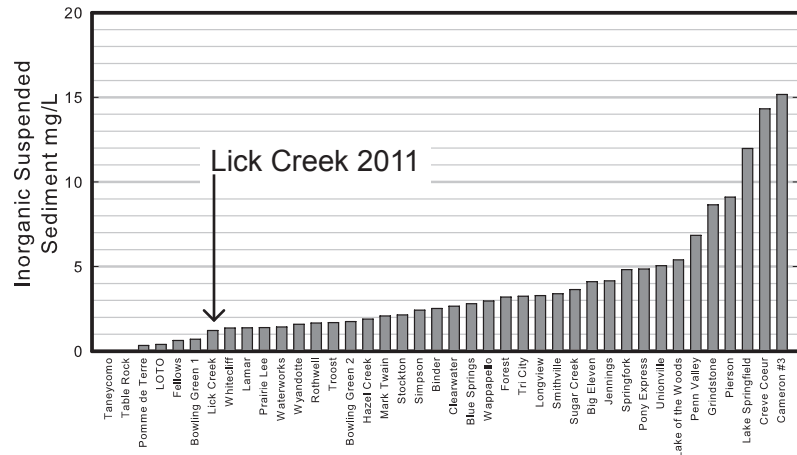
Date	4/29	5/18	X	7/2	7/23	8/13	9/3	9/23	Mean
Secchi (inches)	51	80		85	75	40	74	48	62
TP (µg/L)	28	17		16	18	28	30	33	23
TN (µg/L)	470	420		530	470	720	640	690	552
CHL (µg/L)	9.3	2.7		4.4	7.7	26.4	12.9	24.1	9.5
ISS (mg/L)	3.2	1.3		1.1	1.1	1.9	0.9	1.4	1.4

Water clarity at Lick Creek Lake averaged over 5 feet for the 2011 sampling season. This is well above the statewide average and quite good for a north Missouri lake, which tend to have low clarity. Suspended sediment concentrations were low (see graph, right), likely due to the largely forested watershed.

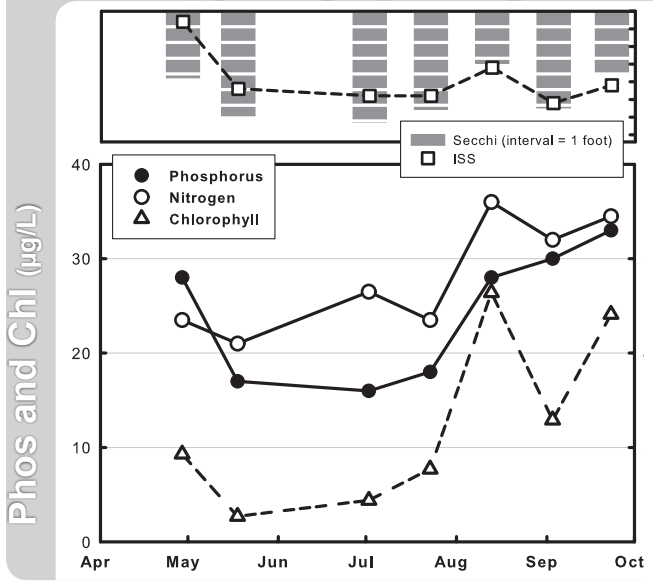
Concentrations of both nutrients and chlorophyll generally increased through the sample season. The chlorophyll concentration was unusually high on August, 23. According to the volunteer comments, this could be either blue-green algae or macrophyte (rooted plant) particles, both of which were present.

Long-term data show that 2011 was a typical year at Lick Creek Lake, unlike 2010 which had exceptionally high mean phosphorus and chlorophyll values.

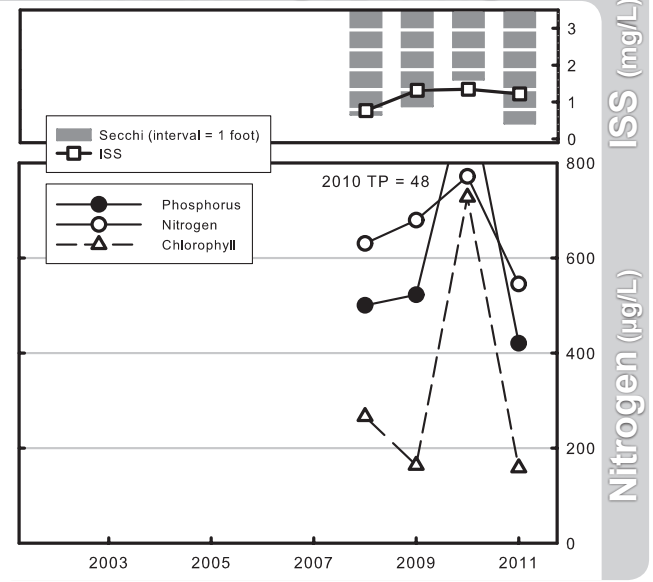
2011 Summer Mean ISS Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Longview Lake



2011 DATA

Jackson County
Latitude: 38.9210 Longitude: -94.4661

Date	4/29	X	5/27	6/20	7/8	7/28	8/17	9/15	Mean
Secchi (inches)	37		31	31	46	33	58	52	40
TP (µg/L)	27		22	23	22	23	17	17	21
TN (µg/L)	710		690	630	430	540	440	440	543
CHL (µg/L)	2.8		6.9	11.3	9.1	24.9	15.8	7.8	9.3
ISS (mg/L)	6.7		4.9	6.0	1.8	5.0	1.9	2.5	3.6

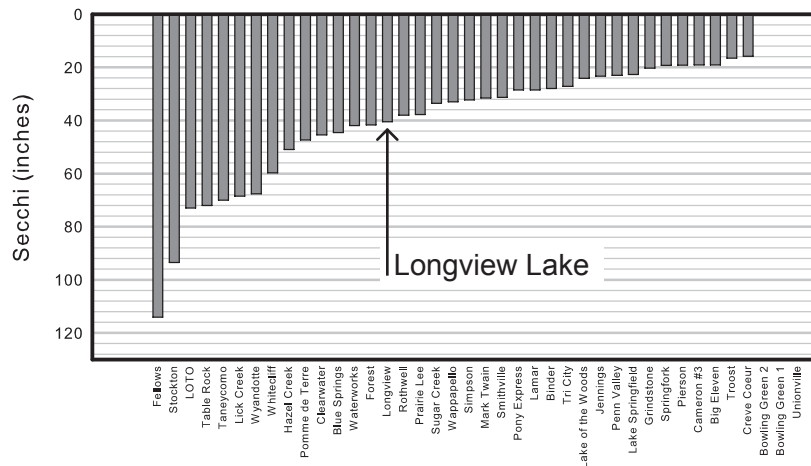
Longview Lake is one of the original LMVP lakes and has been monitored for 19 of the last 20 years. Water clarity and concentrations of suspended sediment are linked closely in Longview Lake. Both the seasonal 2011 data and the long-term mean data show this quite well. Secchi measurements are typically in the 3-4 foot range, about average for a Missouri lake (see graph, right). Suspended sediment values are variable, and slightly higher than found in most Missouri lakes.

Nutrient concentrations declined slightly as the 2011 sampling season progressed, but were generally stable all season long. The chlorophyll value peaked on July 28. The high chlorophyll to phosphorus ratio on that day (1.08, more chlorophyll than

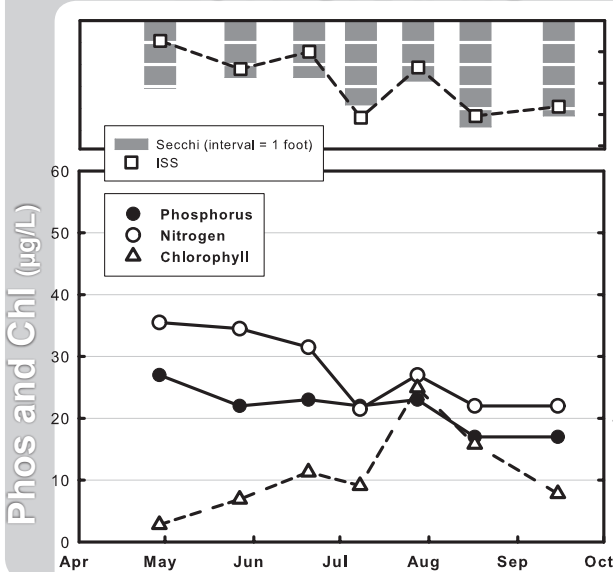
phosphorus) indicates a possible bloom event.

While flood years stand out from the rest (1993, 1995, 2008), long term data show Longview Lake to have stable water quality over the past 20 years.

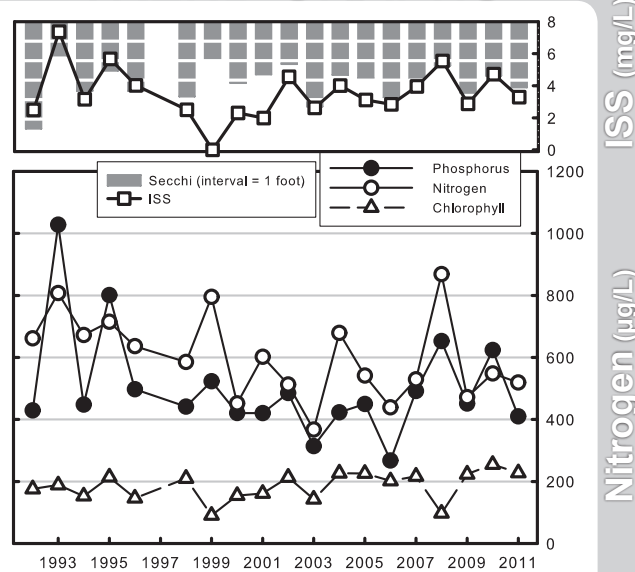
2011 Summer Mean Secchi Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Mahoney Lake



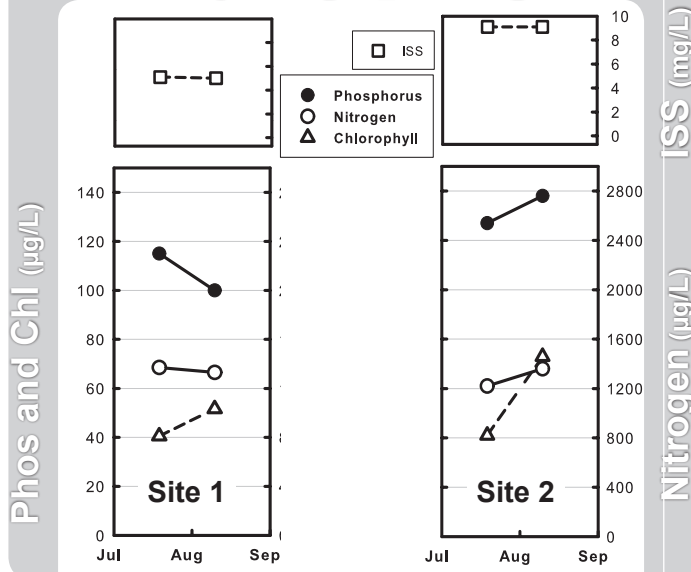
2011 DATA

Putnam County
Latitude: 40.4997

Longitude: -93.0244

Date	Site 1			Site 2		
	7/19	8/10	Mean	7/19	8/10	Mean
Secchi (inches)						
TP (µg/L)	115	100	107	127	138	132
TN (µg/L)	1370	1330	1350	1220	1360	1288
CHL (µg/L)	40.5	51.6	45.7	41.0	72.9	54.7
ISS (mg/L)	5.1	5.0	5.0	9.1	9.1	9.1

2011 GRAPHS



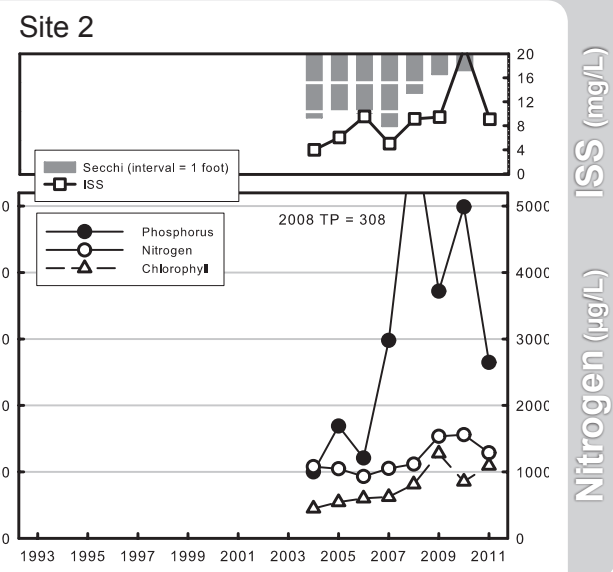
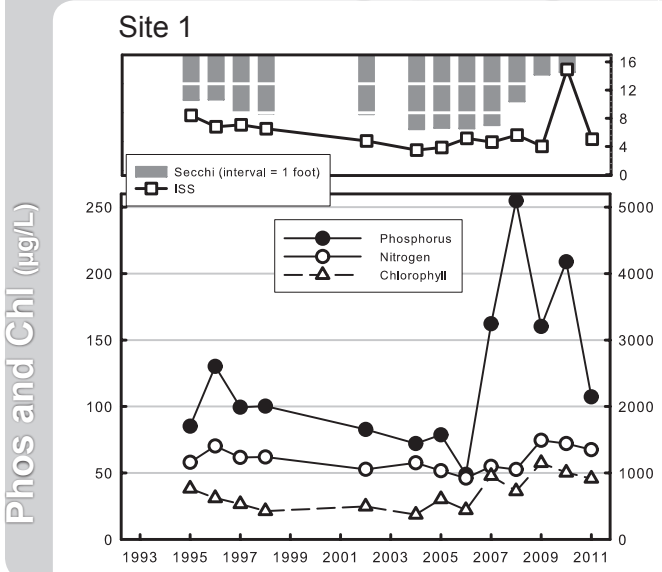
Only 2 samples were collected at the 2 sampling sites on Mahoney Lake (Unionville City Lake) in 2010. Secchi data are unavailable.

Seasonal data are to the left, trend data below. The low number of samples hinders our ability to describe seasonal data and potentially skews the long-term data.

Concentrations of phosphorus were particularly high at Mahoney Lake sampling sites during 2011, though not as high as measured in 2007-2010. Site 2 had an 82% higher concentration of suspended sediment (ISS) than Site 1, and 25% more phosphorus, otherwise the sites were comparable.



TREND GRAPHS



Mark Twain Lake Site 1



2011 DATA

Monroe and Ralls County

Latitude: 39.524

Longitude: -91.6478

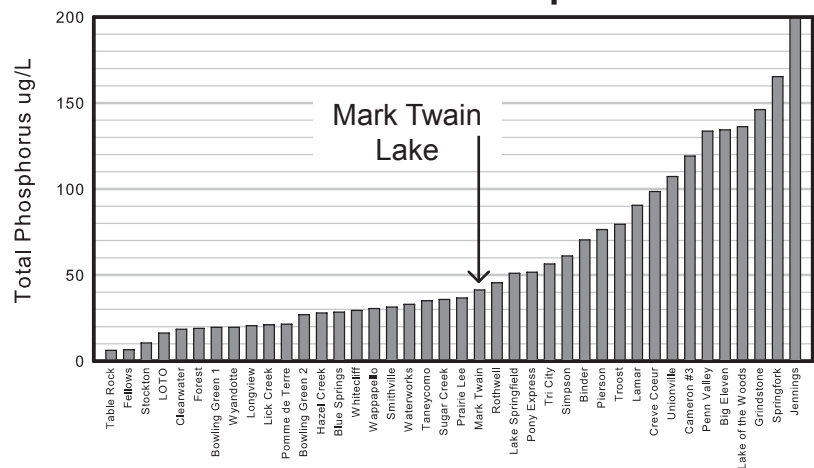
Date	4/23	5/14	6/5	6/26	7/16	8/6	8/28	9/17	Mean
Secchi (inches)	18	18	16	34	37	47	33	40	28
TP (µg/L)	132	109	84	62	41	27	21	20	49
TN (µg/L)	2290	2160	2130	2290	2000	1510	990	740	1644
CHL (µg/L)	8.2	6.4	14.6	20.2	19.0	18.7	31.8	27.3	16.2
ISS (mg/L)	7.6	6.3	6.0	3.5	2.4	0.6	1.3	0.7	2.5

Water clarity increased through the season at Mark Twain Lake dam (Site 1). Across the same period, concentrations of suspended sediment and both nutrients decreased by over 75 percent.

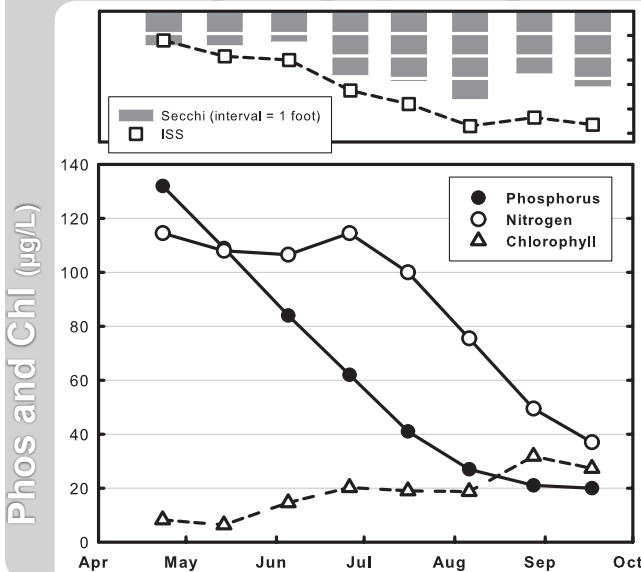
2011 was the 10th year of monitoring at Mark Twain Lake. There are no water quality trends apparent, though the mean phosphorus concentration of 2008 was uncharacteristically high.

Interestingly, chlorophyll concentrations increased through the season despite the declining nutrient availability. By the end of the season, there was more chlorophyll in the water than phosphorus. The algal abundance (as measured by chlorophyll) is inversely related to suspended sediment concentrations. As sediment particles settle out, light penetrated deeper in the water column and provided light for algal growth.

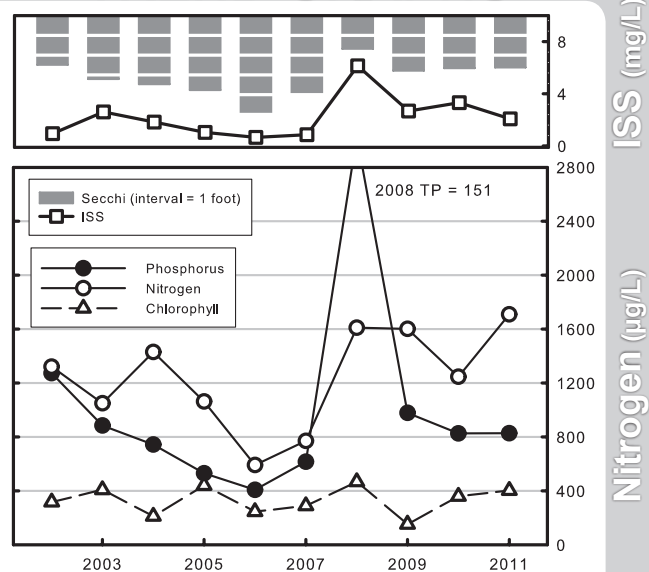
2011 Summer Mean Phosphorus Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Mark Twain Lake Site 2



2011 DATA

Latitude:39.5395

Longitude:-91.6972

Date	4/23	5/14	6/5	6/26	7/16	8/6	8/28	9/17	Mean
Secchi (inches)	16	18	20	36	36	44	33	39	28
TP (µg/L)	119	104	85	58	37	25	25	20	48
TN (µg/L)	1930	2080	1780	1930	2080	1430	900	840	1536
CHL (µg/L)	12.6	11.9	17.2	23.7	12.2	22.0	32.9	26.5	18.6
ISS (mg/L)	7.5	8.2	6.8	4.7	2.8	0.7	1.7	1.7	3.2

Mark Twain Lake sampling sites

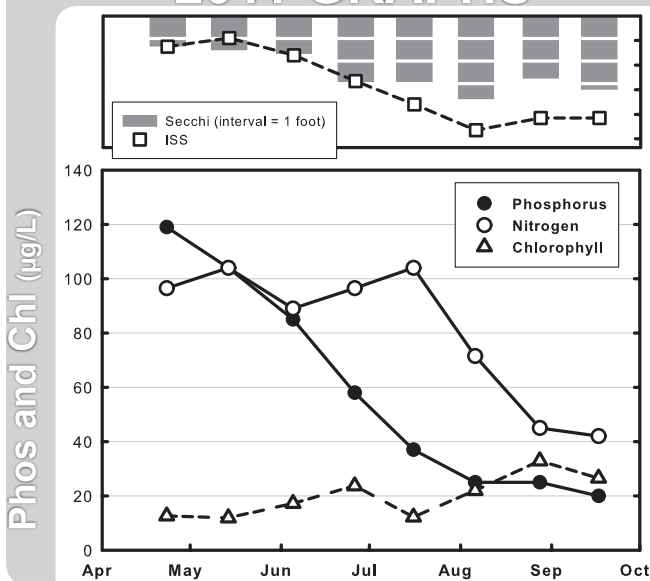
Water quality at Site 2 was very similar to that of Site 1.

Water clarity and chlorophyll concentrations increased during the 2011 sampling season while sediment and nutrient values decreased.

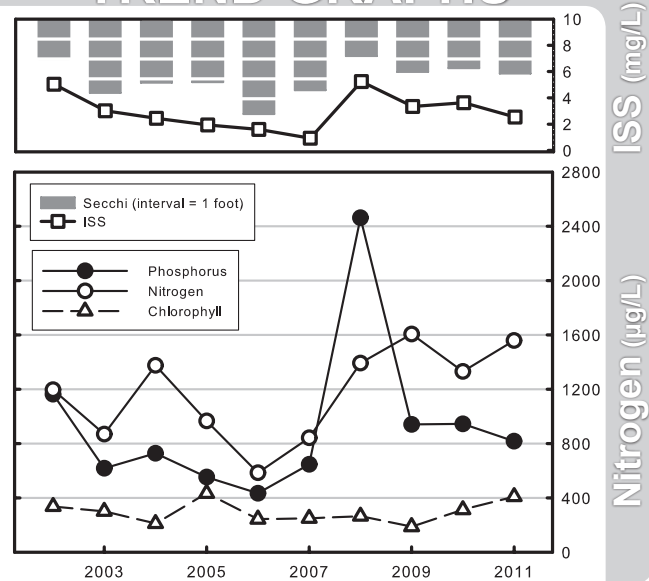
Long-term data are similar to Site 1 as well, though the 2008 phosphorus peak was not quite as high (123 at Site 2 vs 151 at Site 1).



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Mark Twain Lake Site 5



2011 DATA

Latitude: 39.5066

Longitude: -91.7679

Date	4/23	5/14	6/5	6/26	7/16	8/6	8/28	9/17	Mean
Secchi (inches)	12	14	16	32	31	46	31	39	25
TP (µg/L)	142	116	100	64	36	25	25	21	52
TN (µg/L)	2530	1870	2130	2280	1900	1230	970	710	1570
CHL (µg/L)	3.8	9.6	21.6	23.1	24.2	25.5	35.3	27.5	18.0
ISS (mg/L)	11.5	7.6	7.2	4.1	3.1	0.6	1.3	1.7	3.2

Water quality at Site 5 was very similar to that of Site 1 and Site 2.

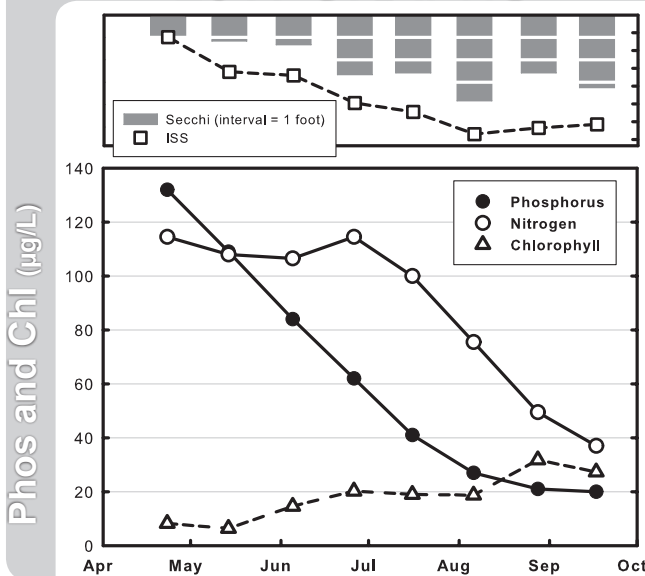
Water clarity and chlorophyll concentrations increased during the 2011 sampling season while sediment and nutrient values decreased.

Long-term data are similar to Site 1 and Site 2 as well.

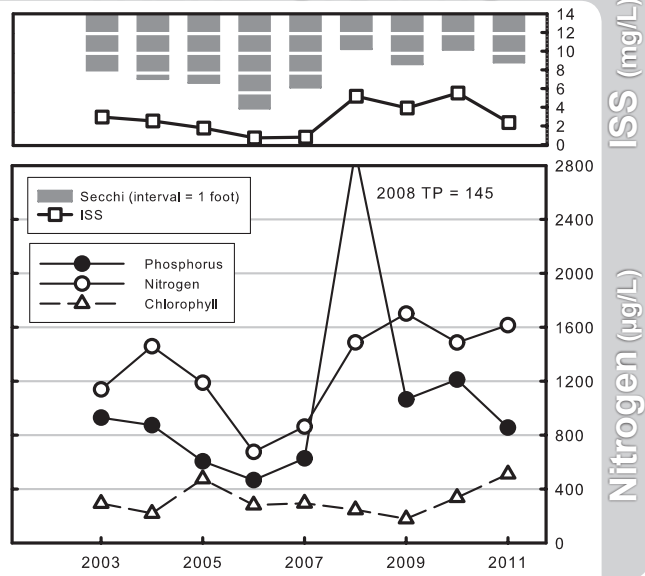
Mark Twain Lake sampling sites



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Penn Valley Lake



2011 DATA

Jackson County
 Latitude: 39.0783 Longitude: -94.5927

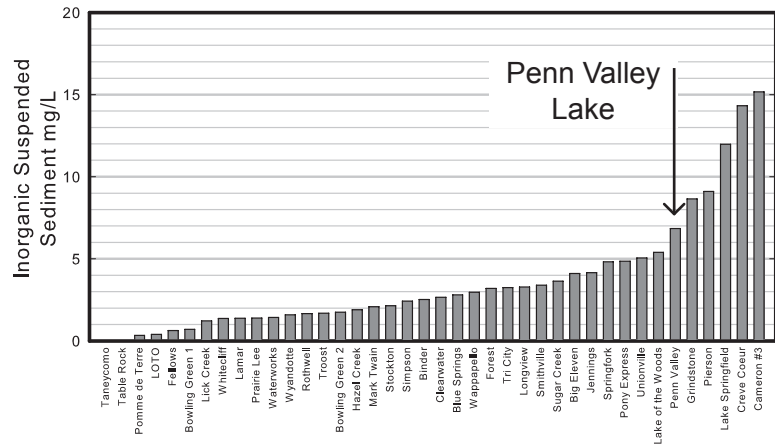
Date	X	X	X	X	7/19	8/24	9/14	9/22	Mean
Secchi (inches)					22	24	23	23	23
TP (µg/L)					173	145	95	125	131
TN (µg/L)					1200	1340	830	1210	1127
CHL (µg/L)					48.9	27.1	56.6	67.8	47.5
ISS (mg/L)					12.0	3.6	7.4	44.9	10.9

Penn Valley Lake is a 2 acre lake with a 170 acre urban-dominated watershed. This lake participates in the LMVP as part of the EPA's KC Urban Lakes monitoring effort.

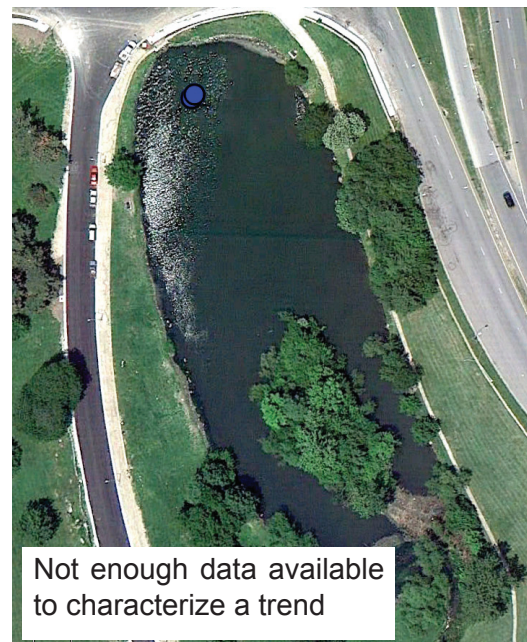
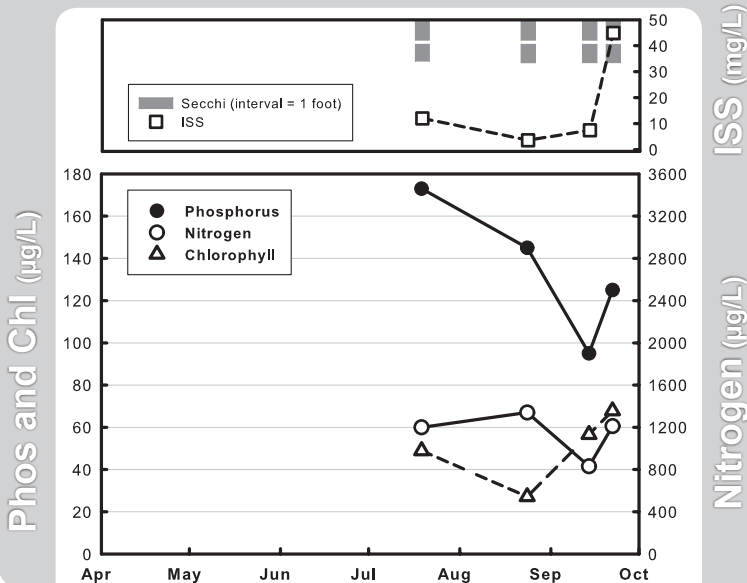
en the phosphorus concentrations could have been higher still.

Sampling at Penn Valley Lake was limited to the second half of the sampling season, starting July 19. During this part of the season, water clarity varied little, averaging 23 inches. Nutrient concentrations were high and phosphorus-rich, as indicated by the nitrogen to phosphorus ratio of 8.6. Suspended sediment particles varied considerably, ranging from 3.6 to 44.9 mg/L. Chlorophyll concentrations were high but, giv-

2011 Summer Mean ISS Values



2011 GRAPHS



Not enough data available to characterize a trend

See pages 10-11 for help interpreting graphs

Pomme de Terre Lake



Site 1



Hickory and Polk County
 Latitude: 37.892 Longitude: -93.3108

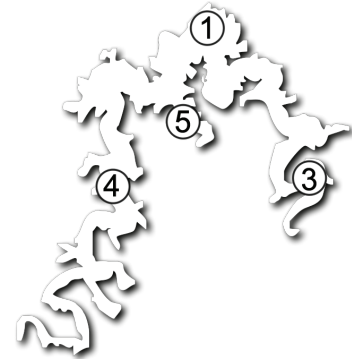
2011 DATA

Date	X	X	6/17	7/10	7/17	8/12	9/2	10/3	Mean
Secchi (inches)			48	36	50	60	46	46	47
TP (µg/L)			35	20	20	17	19	19	21
TN (µg/L)			530	490	460	490	620	480	509
CHL (µg/L)			19.5	9.7	10.2	13.6	18.3	17.3	14.2
ISS (mg/L)			0.4	0.6	0.5	0.1	0.4	0.7	0.4

Pomme de Terre Lake sampling sites

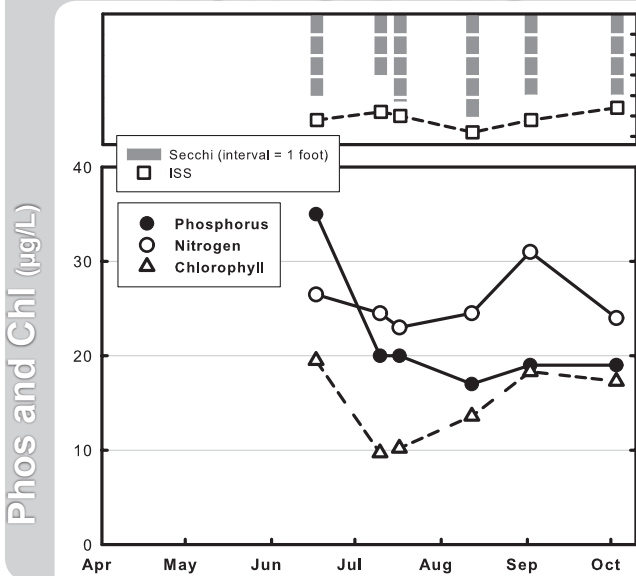
Site 1 is at the Pomme de Terre dam.

Because of the very low suspended sediment concentrations, water clarity averaged about 4 feet in 2011, clearer than most Missouri lakes. Phosphorus concentrations were roughly half those of the average Missouri lake in 2011, while nitrogen values were only slightly lower than average. Ratios of nitrogen to phosphorus were 24:1 on average, indicating that phosphorus is likely the limiting nutrient. Chlorophyll values were near the statewide average.

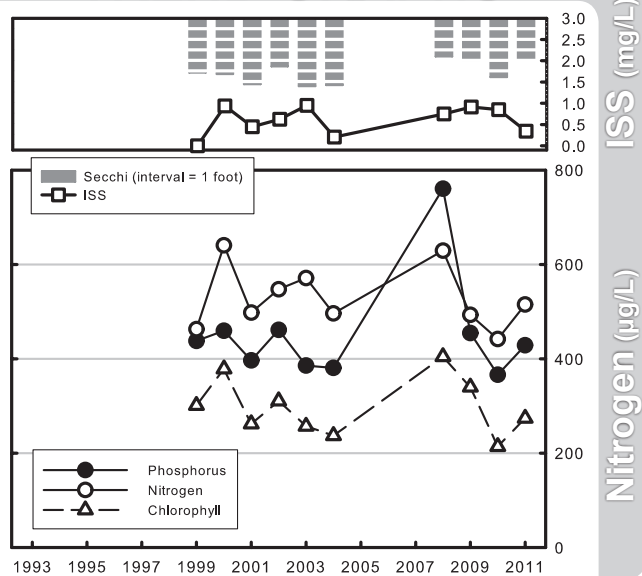


This site has been monitored for 10 summers since 1999. The data do not suggest any long-term trends. As a result of the rainfall and flooding, the 2008 seasonal mean phosphorus value was approximately double the typical seasonal mean.

2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Pomme de Terre Lake



Site 3



2011 DATA

Hickory and Polk County
 Latitude: 37.8357 Longitude: -93.2636

Date	X	X	6/17	7/10	7/17	8/12	9/2	10/3	Mean
Secchi (inches)			18	12	18	15	20	18	17
TP (µg/L)			77	120	110	77	99	70	90
TN (µg/L)			690	920	800	970	820	620	794
CHL (µg/L)			30.9	75.7	54.3	55.5	37.4	28.3	44.2
ISS (mg/L)			8.4	8.3	7.8	4.2	5.2	8.4	6.8

Site 3 is located in the upper end of the Lindley Creek arm near Pittsburg Park.

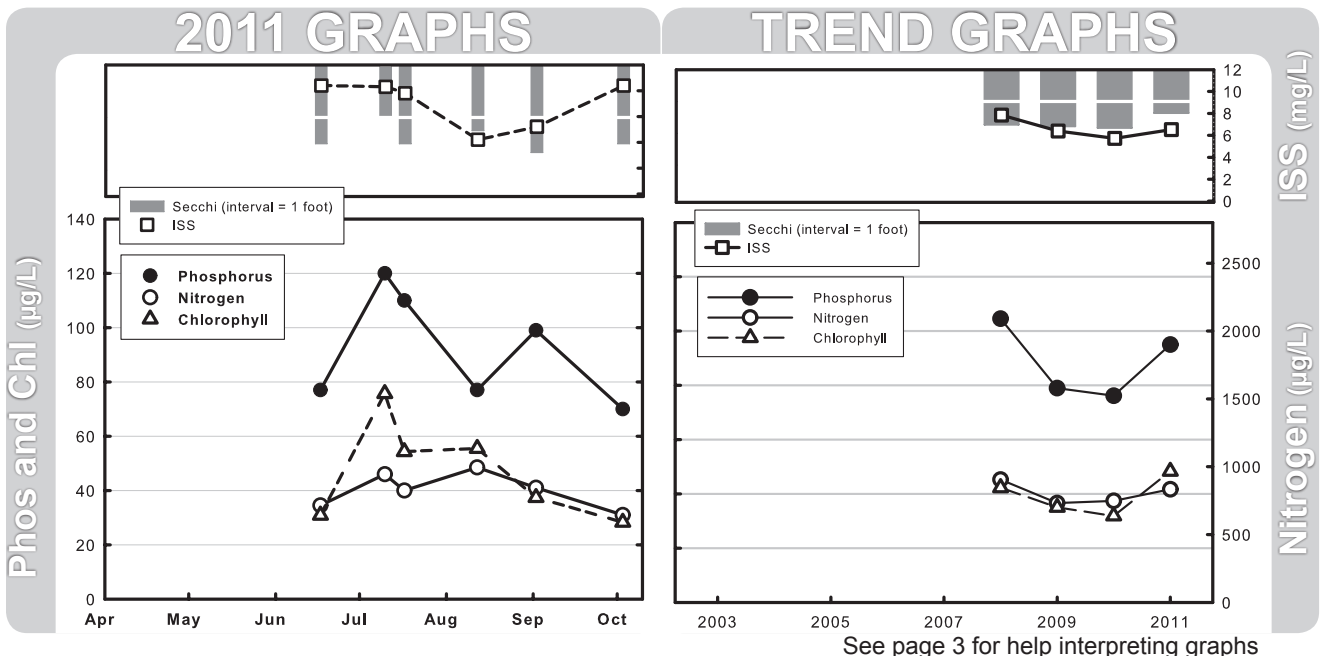
Pomme de Terre Lake sampling sites



Water quality at Site 3 differed considerably from Site 1. This is not unexpected, considering the longitudinal variation found in reservoirs. Water clarity never exceeded 2 feet, nutrient and chlorophyll concentrations were higher and there was significantly more suspended sediment.

Compared to Site 1, Site 3 has 4 times as much phosphorus for each unit of nitrogen measured. This can be explained by the higher suspended sediment concentrations observed at Site 3; phosphorus readily binds with sediment particles.

2011 marked the 4th year of sampling at Site 3. Average water clarity was lower in 2011 than in previous years and chlorophyll concentrations were higher. Other values were comparable with past years.



Pomme de Terre Lake



Site 4



2011 DATA

Hickory and Polk County
 Latitude: 37.892 Longitude: -93.3108

Date	X	X	6/17	7/10	7/16	8/12	9/2	10/3	Mean
Secchi (inches)			30	23	30	36	22	22	27
TP (µg/L)			40	33	26	30	43	36	34
TN (µg/L)			480	460	490	560	650	550	528
CHL (µg/L)			15.7	13.9	15.6	24.9	26.4	40.4	21.2
ISS (mg/L)			5.5	9.7	3.7	1.3	6.6	5.6	4.6

Pomme de Terre Lake sampling sites

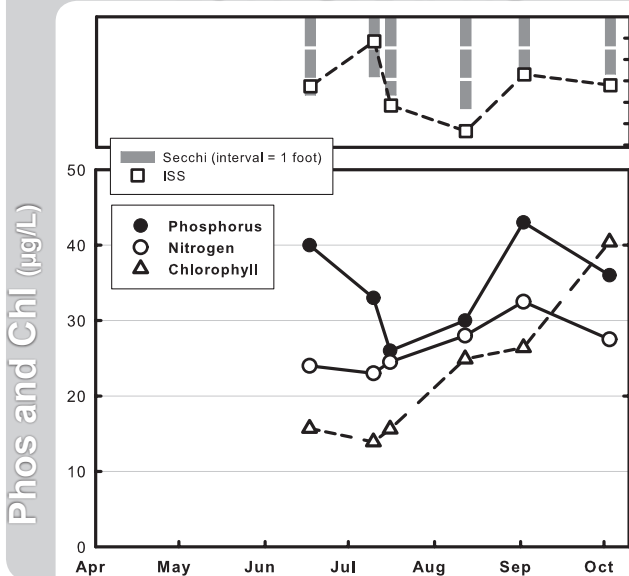
Site 4 is located near Lightfoot Park at the approximate halfway point of the Pomme de Terre arm.

Water clarity at Site 4 was approximately half that measured at the dam (Site 1). Phosphorus concentrations were slightly higher at Site 4 also, though nitrogen values were similar. In general, water quality at Site 4 fell between Site 1 and Site 3 in 2011.

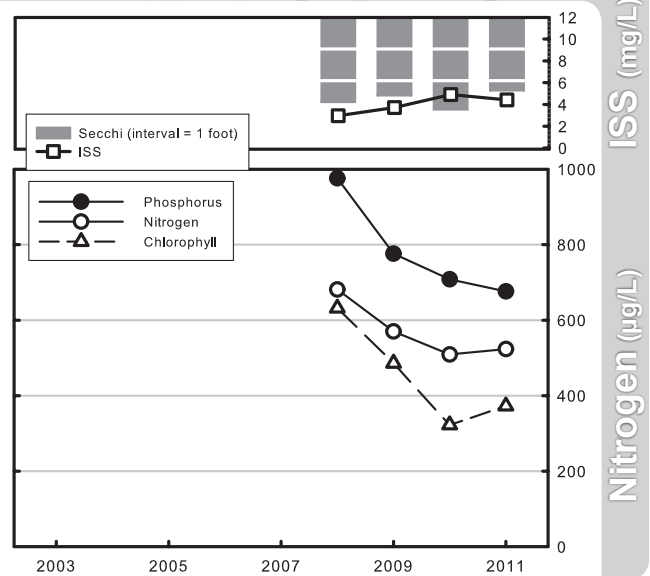
Site 4 was monitored for its 4th year in 2011. The data show that the 2011 nitrogen and chlorophyll seasonal values were slightly lower than the 4-year average. The 2011 seasonal mean phosphorus value was the lowest yet measured at Site 4. Seasonal mean values for water clarity and suspended sediment are comparable across all years.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Pomme de Terre Lake



Site 5



2011 DATA

Hickory and Polk County
 Latitude: 37.8573 Longitude: -93.3183

Date	4/24	X	6/13	6/27	7/22	8/7	8/28	9/18	Mean
Secchi (inches)	55		38	45	24	34	28	41	37
TP (µg/L)	46		49	27	28	24	24	27	31
TN (µg/L)	780		680	410	690	520	540	610	593
CHL (µg/L)	40.2		26.8	12.1	14.4	15.8	16.2	19.1	19.1
ISS (mg/L)	1.7		3.6	1.4	2.0	1.2	2.1	2.6	2.0

Site 5 is located in the Decker Branch cove on the Pomme de Terre arm.

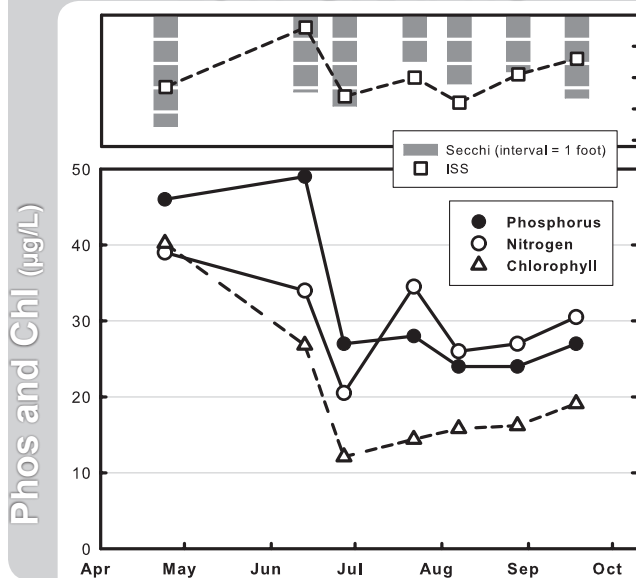
Water clarity averaged 3 feet during 2011, with the highest clarity observed in late April. Phosphorus and chlorophyll concentrations were highest early in the 2011 sampling season, but dropped significantly by the end of June and remained comparatively stable for the rest of the season. Suspended sediment values were moderate, averaging 2 mg/L.

2011 was the second year of monitoring at Site 5. 2011 suspended sediment values were comparable to 2010. 2011 water clarity was lower and nutrient and chlorophyll concentrations were higher than in 2010. There is not enough data available make any conclusions about trends.

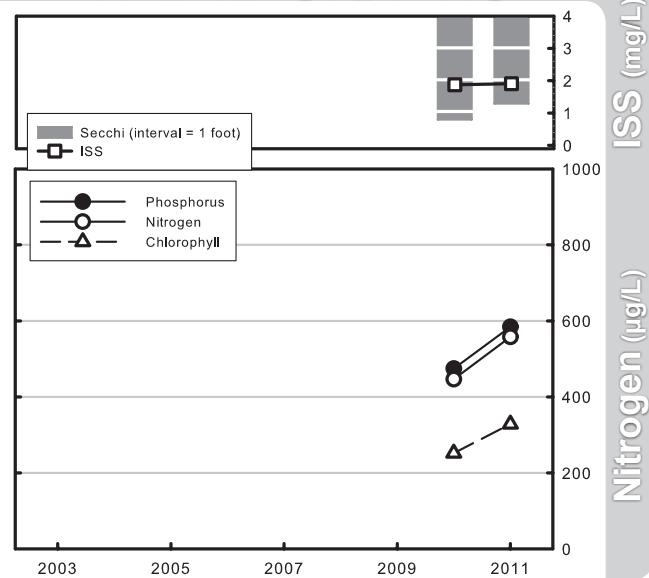
Pomme de Terre Lake sampling sites



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Pony Express Lake



2011 DATA

Dekalb County
Latitude: 39.8039 Longitude: -94.3804

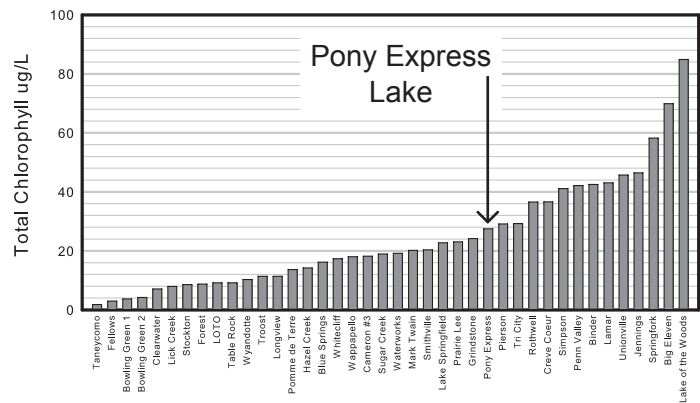
Date	5/7	5/22	6/5	6/26	X	X	X	X	Mean
Secchi (inches)	24	32	28	26					27
TP (µg/L)	60	47	49	60					54
TN (µg/L)	1240	1120	1210	920					1115
CHL (µg/L)	8.1	15.5	35.3	37.9					20.2
ISS (mg/L)	6.3	5.1	5.0	4.5					5.2

Pony Express Lake was monitored for the first half of the 2011 sampling season. This was the first year of LMVP monitoring on the lake.

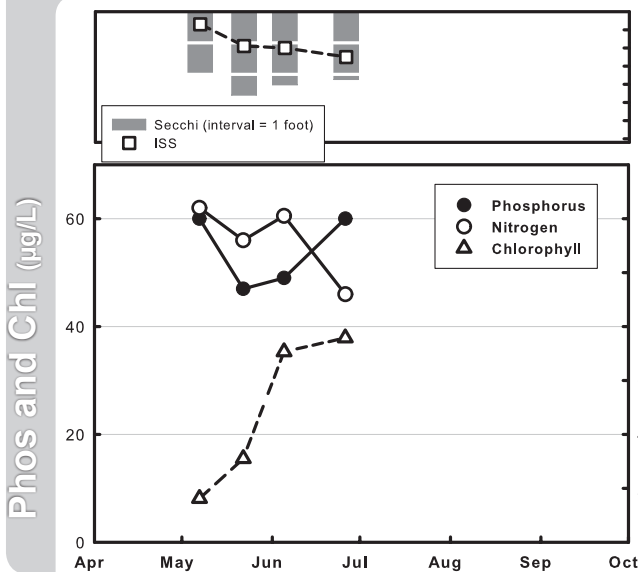
Water clarity was rather consistent throughout the first half of 2011, averaging just over 2 feet and varying by only 8 inches from maximum to minimum.

Nutrient concentrations were also consistent, varying little during May and June. Chlorophyll concentrations increased nearly 4-fold, possibly as suspended sediment particles settled to the bottom thereby increasing light penetration.

2011 Summer Mean Chlorophyll Values



2011 GRAPHS



TREND GRAPHS

Not enough data available to characterize a trend

ISS (mg/L)
Nitrogen (µg/L)

See page 3 for help interpreting graphs

Prairie Lee Lake



2011 DATA

Jackson County
Latitude: 38.9436 Longitude: -94.3294

Date	X	5/9	X	6/27	X	7/30	8/9	X	Mean
Secchi (inches)		43		37		34	43		39
TP (µg/L)		36		39		42	30		36
TN (µg/L)		1090		630		680	550		712
CHL (µg/L)		17.1		21.8		30.6	18.4		21.4
ISS (mg/L)		2.1		0.7		1.2	3.2		1.5

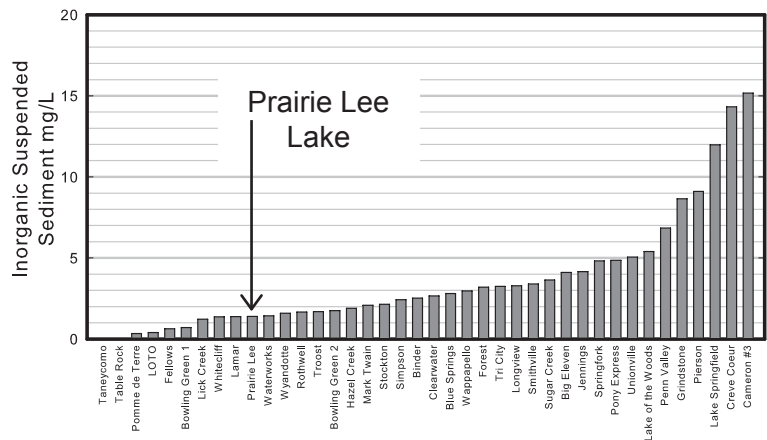
Prairie Lee Lake was sampled 4 times during 2011. While 2011 was not a full sampling season, data are distributed somewhat evenly across the season.

mean summer suspended sediment value was the lowest observed to date, while all other summer means were similar to past results.

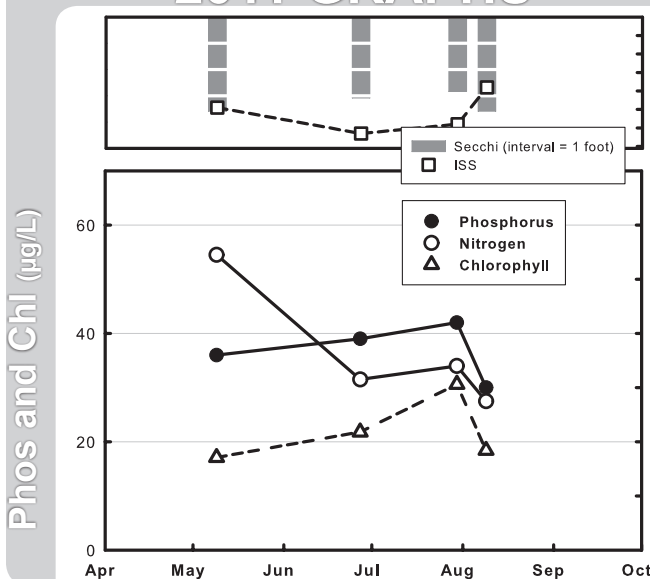
Water clarity varied little in 2011, averaging just over 3 feet. Nutrient and chlorophyll concentrations also varied little, with seasonal mean values very similar to the Missouri averages. The seasonal average suspended sediment value was about half of the maximum observed in 2011, and lower than found in most Missouri lakes where suspended sediment is measured.

Prairie Lee Lake was monitored for the 11th time in the 20 years of participation in the LMVP. The 2011

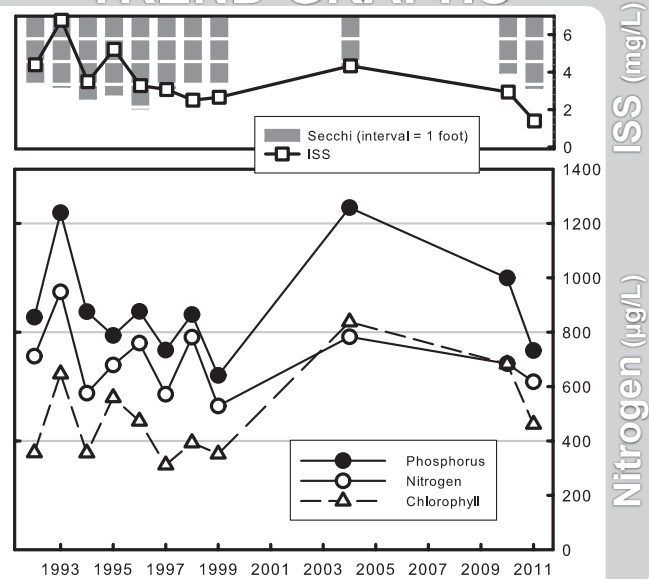
2011 Summer Mean ISS Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Rothwell Lake



2011 DATA

Randolph County
Latitude: 39.4184

Longitude: -92.4616

Date	4/29	5/17	6/14	6/28	7/18	8/10	8/29	9/21	Mean
Secchi (inches)	62	76	48	39	26	34	24	33	40
TP (µg/L)	36	29	42	48	53	52	55	55	45
TN (µg/L)	1130	630	730	1060	1210	1080	1620	1470	1070
CHL (µg/L)	3.9	8.9	29.3	50.4	57.5	37.7	84	37.5	27.7
ISS (mg/L)	2.8	2.0	4.2	1.3	1.0	1.1	1.8	1.5	1.8

Water clarity in Rothwell Lake in 2011 ranged from 5 feet in April to 2 feet in August.

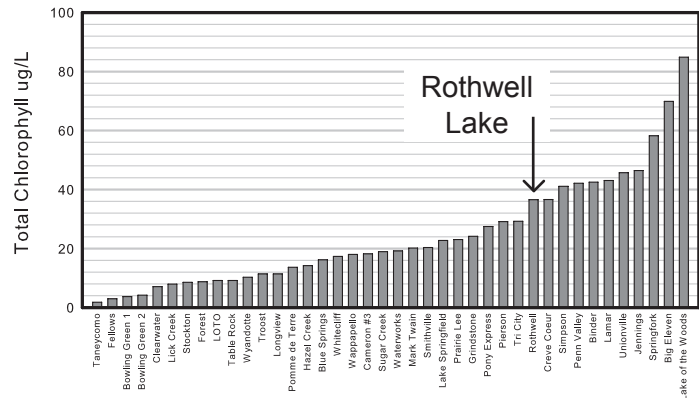
In a typical reservoir, there is approximately 2 to 3 times as much phosphorus as chlorophyll. Of the 8 samples collected in 2011, 3 had higher concentrations of chlorophyll than phosphorus. These data imply algae blooms dominated the summer and were responsible for the loss of water clarity.

Nutrient concentrations in Rothwell Lake during 2011 were greater than the Missouri average and generally increased during the sampling season. Suspended sediment values were at the low end of Missouri's range.

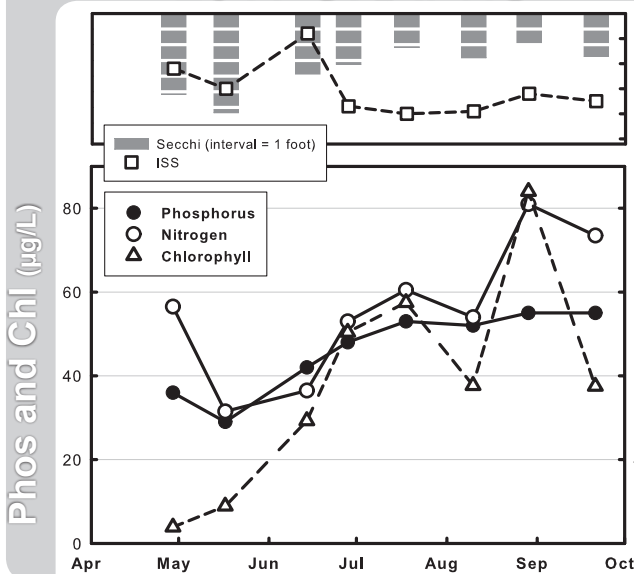
Rothwell Lake has been sampled

since 2003, and the data indicate no water quality trends across that period. Water clarity has been, on average, in the 3 to 4 foot range. Suspended sediment values have varied between 1 and 2 mg/L, somewhat low for Missouri reservoirs.

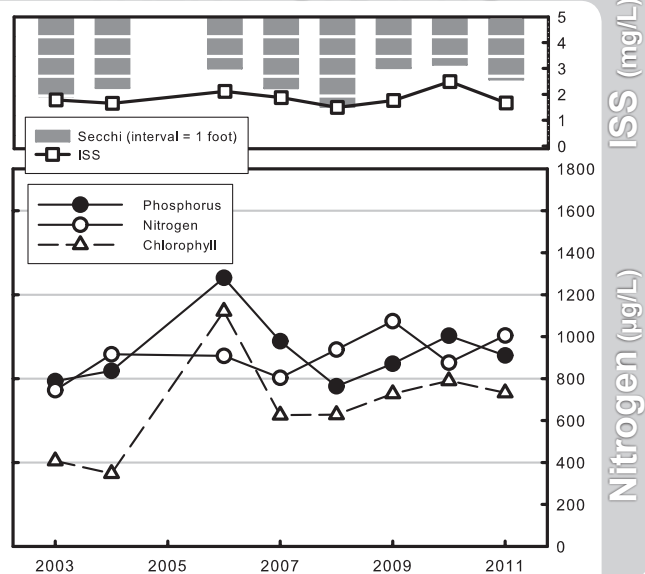
2011 Summer Mean Chlorophyll Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Simpson Lake



2011 DATA

St. Louis County
Latitude: 38.5571

Longitude: -90.4691

Date	5/9	X	6/5	X	7/17	8/7	X	9/19	Mean
Secchi (inches)	21		31		34	32		18	26
TP (µg/L)	85		60		56	68		98	72
TN (µg/L)	1040		790		680	710		980	828
CHL (µg/L)	94.3		45.2		25	61.3		66.6	53.4
ISS (mg/L)	3.6		2.8		2.1	2.4		7.0	3.2

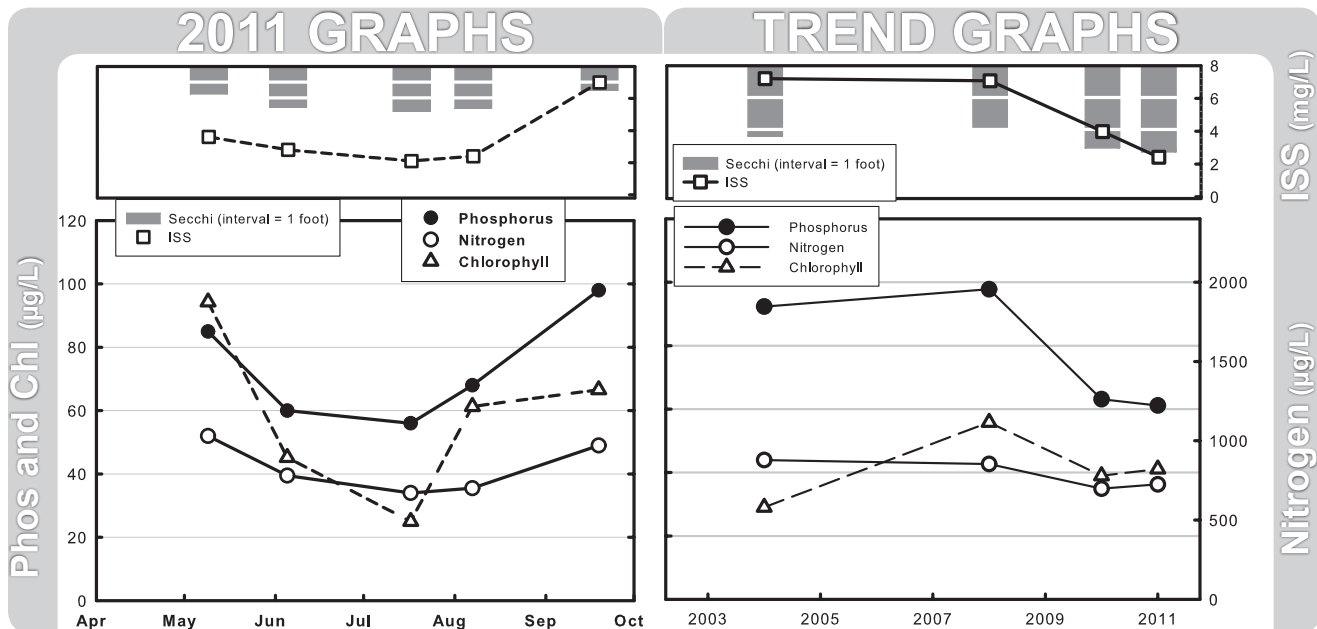
Simpson Lake was sampled on 5 occasions during 2011.

Abundant algal biomass characterized Simpson Lake in 2011. Chlorophyll concentrations were high throughout the season, with a maximum value of 94.3 µg/L observed on May 9. This maximum value was higher than found in 95% of 2011 LMVP samples.

Phosphorus concentrations were similarly high in Simpson Lake in 2011. The seasonal mean value was higher than most LMVP lakes in 2011. The seasonal mean nitrogen value was closer to Missouri's average value.

Due to the high algal biomass, water clarity was low, averaging just over 2 feet for the season.

Monitoring on Simpson Lake began in 2004, though the lake has not been sampled every year since. The St. Louis area experienced wet springs in both 2004 and 2008, likely contributing to the high concentrations of suspended sediment and phosphorus as well as the low water clarity in those years. Water quality was very similar in 2010 and 2011. No trends are apparent.



See page 3 for help interpreting graphs

Smithville Lake



2011 DATA

Latitude: 39.3953

Longitude: -94.5503

Date	4/29	5/19	6/11	7/3	7/17	8/7	8/28	9/18	Mean
Secchi (inches)	38	36	37	36	37	23	23	27	31
TP (µg/L)	37	32	30	38	31	28	30	40	33
TN (µg/L)	880	990	1100	650	640	740	770	780	805
CHL (µg/L)	3.0	5.5	25.4	25.6	17.9	33.9	32.8	27.1	16.6
ISS (mg/L)	6.9	7.9	3.2	6.7	2.3	1.4	2.8	4.7	3.9

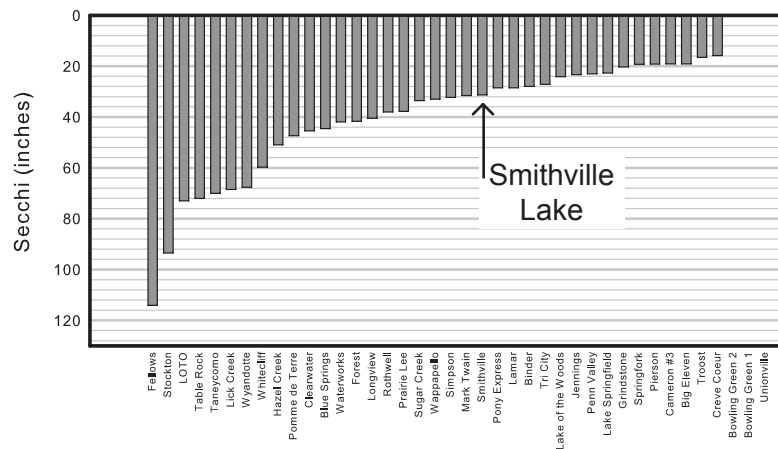
Water clarity varied across the sample season by 15 inches and averaged 31 inches, a foot less than the 2011 statewide mean. The low clarity can be attributed to both the sediment suspended in the water (ISS) and the algal biomass (CHL); each was somewhat higher than the 2011 statewide mean.

Chlorophyll concentrations increased sharply in June, and remained high through the end of the season. There was no significant change in nutrient concentrations during the season, so the change in algal abundance was due to other factors, possibly including grazing pressure and light limitation.

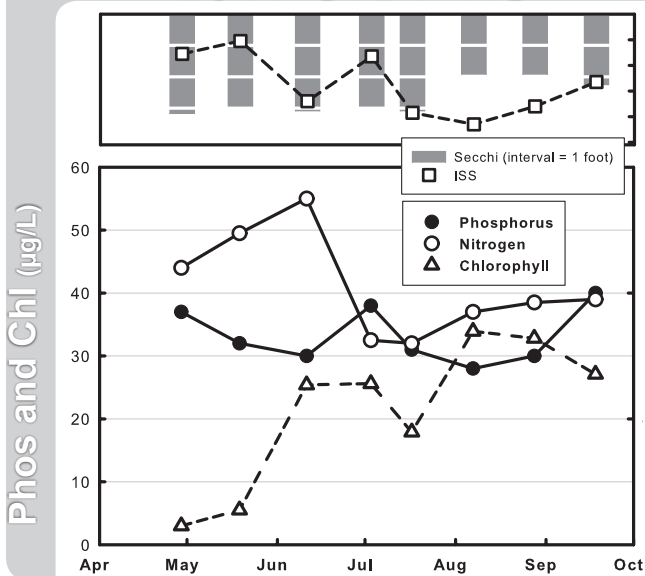
Smithville Lake has been monitored

at this site (near the dam) rather inconsistently since 1996. Data were collected in only 6 of the past 16 seasons, making trend detection impossible. Data from 2011 are comparable to previously collected data.

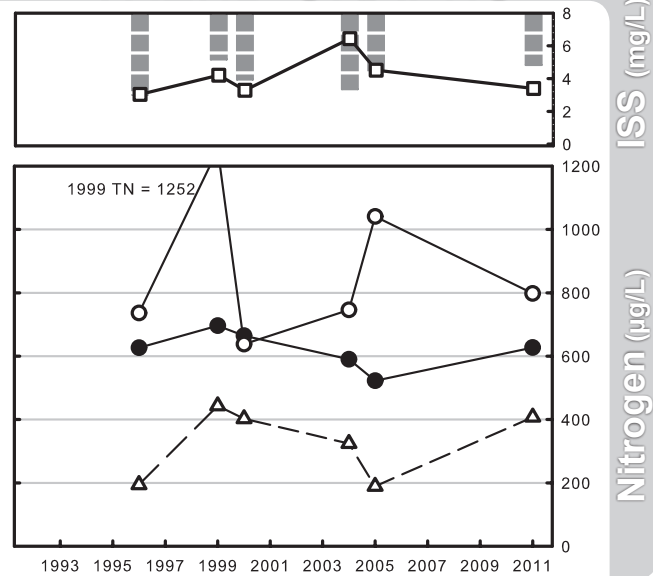
2011 Summer Mean Secchi Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lake Springfield



Site 1



2011 DATA

Greene County
Latitude: 37.1122 Longitude: -93.2608

Date	5/5	5/17	6/9	6/28	7/21	8/11	8/27	9/24	Mean
Secchi (inches)	32	30	28	25	20	18	18	22	24
TP (µg/L)	44	29	34	56	66	70	69	54	50
TN (µg/L)	1160	1210	960	630	630	680	590	780	800
CHL (µg/L)	1.6	6.9	16.4	32.7	26.8	35.3	39.5	37.0	17.3
ISS (mg/L)	7.0	8.2	11.5	10.0	11.6	17.0	15.9	13.3	11.3

With an average 2011 water clarity reading of just 2 feet, Lake Springfield is among the more turbid of Missouri lakes. Lake Springfield is used as a cooling water source for the James River Power Plant, so the water is warmer than ambient air temperatures would suggest. The warm water encourages algae growth and the flow can resuspend sediment from the bottom, both of which will reduce water clarity.

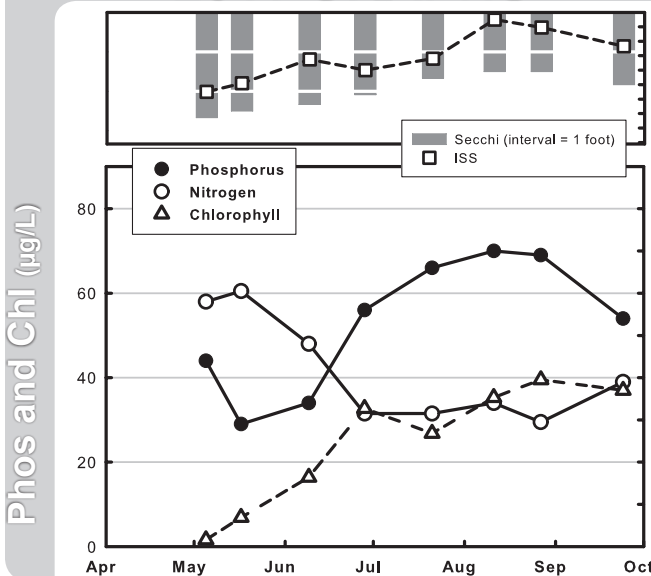
Long-term data suggest no changes in water clarity, suspended sediment or nutrients in the 9 seasons of monitoring. Concentrations of chlorophyll have been extremely consistent in the past 4 years, with values approximately half as high as measured in the previous 5 years.

Phosphorus concentrations are high for the region, partly due to the lake's location downstream of an urban area and partly due to the resuspension of sediment-bound phosphorus.

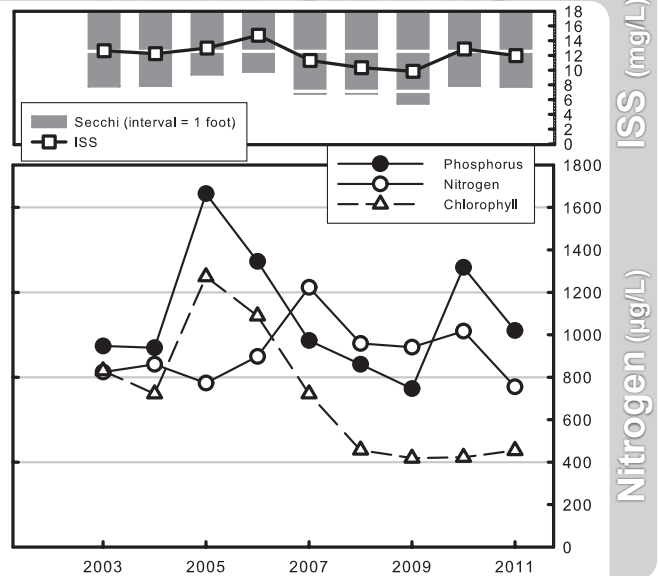
Lake Springfield Sites



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lake Springfield



Site 2



2011 DATA

Greene County
Latitude: 37.1263 Longitude: -93.2256

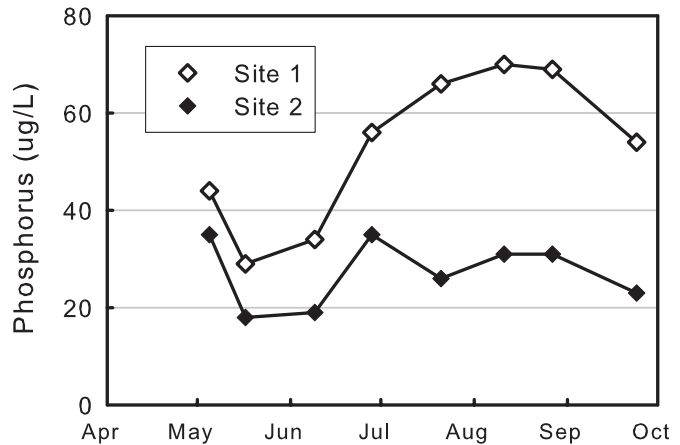
Date	5/5	5/17	6/9	6/28	7/21	8/11	8/27	9/24	Mean
Secchi (inches)	40	71	57	45	41	38	38	50	46
TP (µg/L)	35	18	19	35	26	31	31	23	26
TN (µg/L)	1550	1300	1210	970	690	770	570	1250	986
CHL (µg/L)	0.6	1.9	1.6	15.7	9.5	3.3	15.9	1.6	3.5
ISS (mg/L)	7.8	4.2	4.3	3.8	3.7	7.0	5.6	3.4	4.8

Lake Springfield Site 2 is located near the inflow from the James River, at the opposite end of the lake from Site 1. This site is unaffected by the warm water from the power plant that dominates the water quality of Site 1.

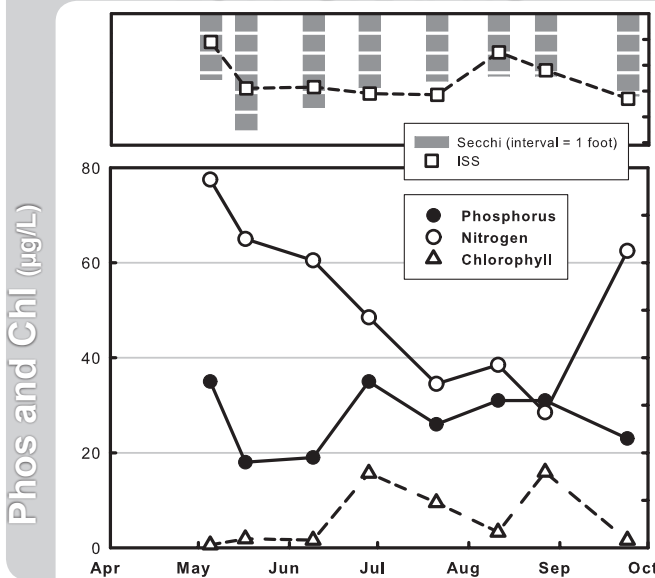
Water clarity at Site 2 is double that of Site 1, on average. The differences in Secchi readings can be attributed to differences in chlorophyll and suspended sediment concentrations, both of which are significantly lower at Site 2. Phosphorus concentrations were also lower at Site 2 than at Site 1 (see graph, right), though nitrogen concentrations were similar at both sites.

Long-term data suggest no changes in water clarity, suspended sediment

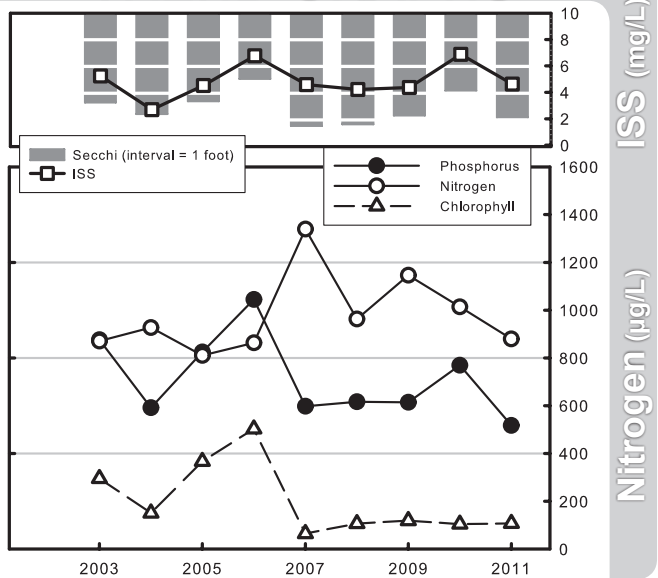
or nutrients in the 9 seasons of monitoring. Concentrations of chlorophyll have been extremely consistent in the past 5 years, with values approximately 1/3 as high as measured in the previous 4 years.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Spring Fork Lake



Site 1



2011 DATA

Pettis County
Latitude: 38.5678 Longitude: -93.2429

Date	4/29	5/16	6/7	6/28	X	8/16	8/29	9/25	Mean
Secchi (inches)	22	22	21	20		18	16	17	19
TP (µg/L)	138	93	138	237		210	193	128	155
TN (µg/L)	1580	1110	2030	1890		1610	1790	1460	1612
CHL (µg/L)	10.9	11.5	62.4	55.0		92.3	183.4	63.3	46.4
ISS (mg/L)	8.7	5.7	6.0	3.3		5.2	4.4	5.4	5.3

Water clarity was consistently low in Spring Fork Lake during 2011, never exceeding 2 feet. Nutrient concentrations were quite high. The seasonal mean phosphorus value was more than four times higher than the 2011 statewide mean and the seasonal mean nitrogen was almost three times higher.

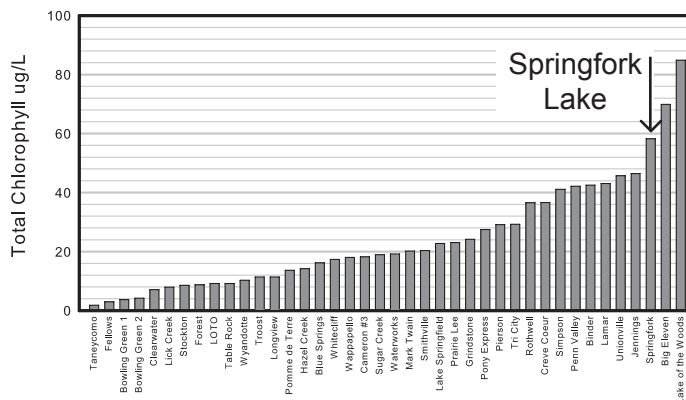
Abundant nutrients led to abundant algal biomass; the chlorophyll concentrations were more than triple the statewide mean and the third highest of LMVP's public lakes in 2011. Among the 805 chlorophyll samples analyzed in 2011, the August 29 sample from Spring Fork Site 1 was third highest. Spring Fork Lake has a lot of algae.

Suspended sediment concentrations are somewhat high, roughly double the 2011 statewide average. Without the shading

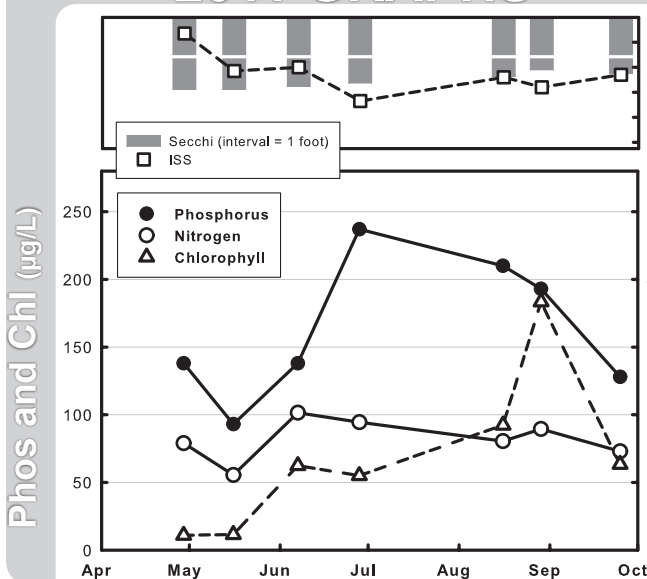
provided by the sediment, the concentrations of algal chlorophyll would likely be much higher.

Long-term data suggest a possible increase of nitrogen concentrations over time. Data otherwise suggest no trends.

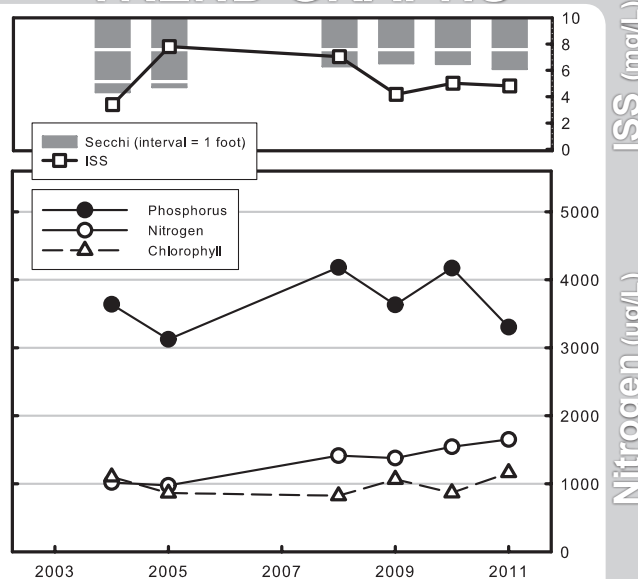
2011 Summer Mean Chlorophyll Values



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Spring Fork Lake



Site 2



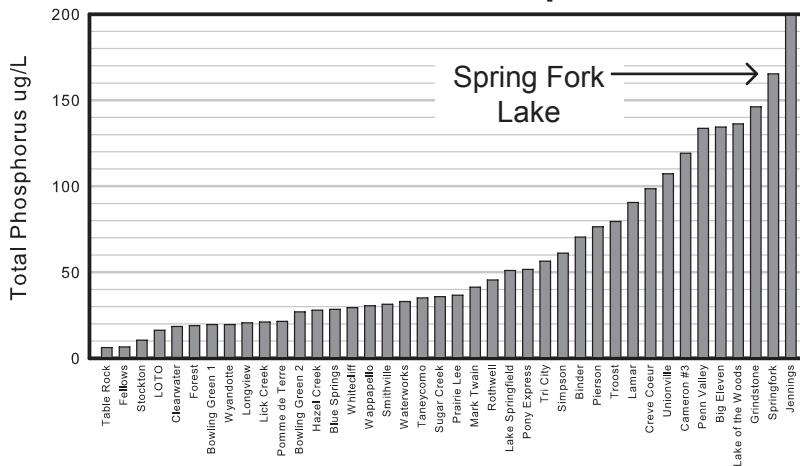
2011 DATA

Pettis County
Latitude: 38.5605 Longitude: -93.2440

Date	4/29	5/16	6/7	6/28	X	8/16	8/29	9/25	Mean
Secchi (inches)	21	22	21	20		17	20	12	19
TP (µg/L)	137	99	120	124		227	179	146	143
TN (µg/L)	1560	1210	1890	1220		1410	1410	1620	1458
CHL (µg/L)	11.8	7.6	38.5	46.9		78.6	67.8	83.7	35.6
ISS (mg/L)	6.1	9.0	6.7	3.4		8.3	6.6	10.6	6.9

Conditions at Site 2 are very similar to Site 1. Trend data are also very similar to Site 1. Site 2 had slightly more suspended sediment, and lower concentrations of chlorophyll and nutrients. Water clarity was, on average, identical.

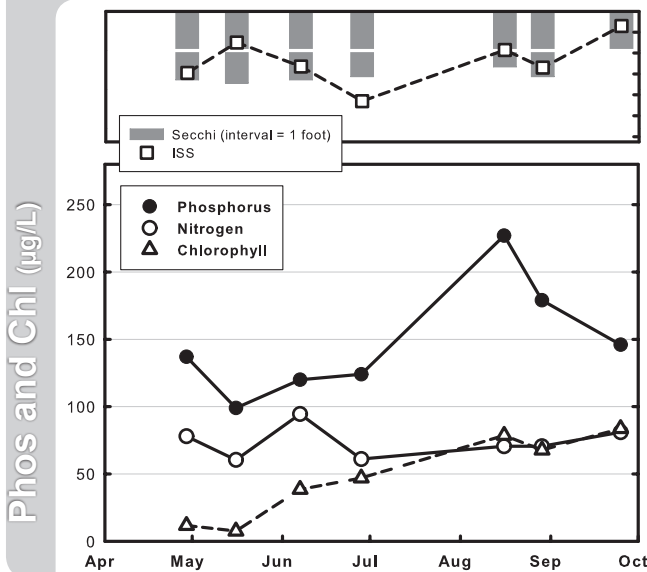
2011 Summer Mean Phosphorus Values



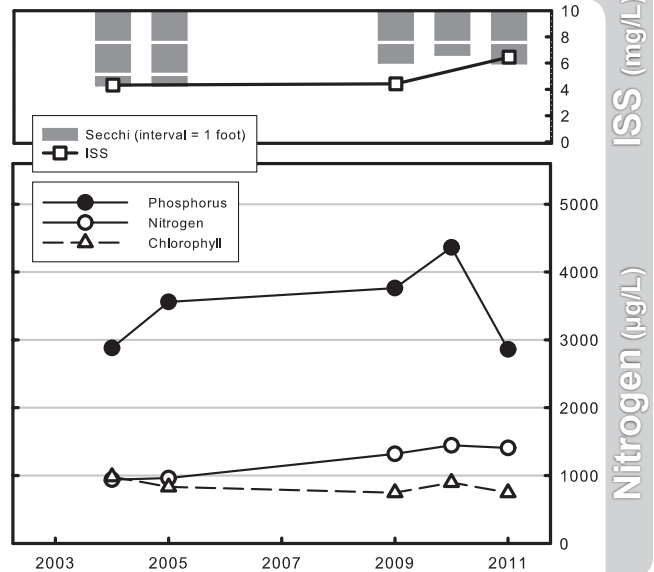
Spring Fork Lake Sites



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Stockton Lake



Site #		1	2	3	5
(# of samples)		(6)	(6)	(4)	(8)
Secchi	Mean	90	102	49	27
(inches)	Range	74 - 125	92 - 120	39 - 55	12 - 67
TP	Mean	10	13	23	79
(µg/L)	Range	9 - 14	9 - 17	16 - 62	22 - 163
TN	Mean	362	380	416	1101
(µg/L)	Range	180 - 680	220 - 710	220 - 1050	730 - 1570
CHL	Mean	9.4	10.0	13.1	27.3
(µg/L)	Range	4.8 - 15.2	6.8 - 18.6	10.4 - 17.0	2.5 - 90.2
ISS	Mean	2	1.5	2.4	10.6
(mg/L)	Range	1.2 - 4.2	0.9 - 2.6	1.6 - 3.8	3.7 - 39.6



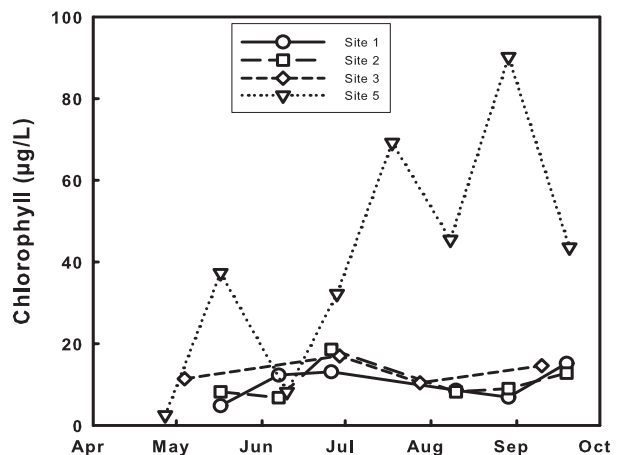
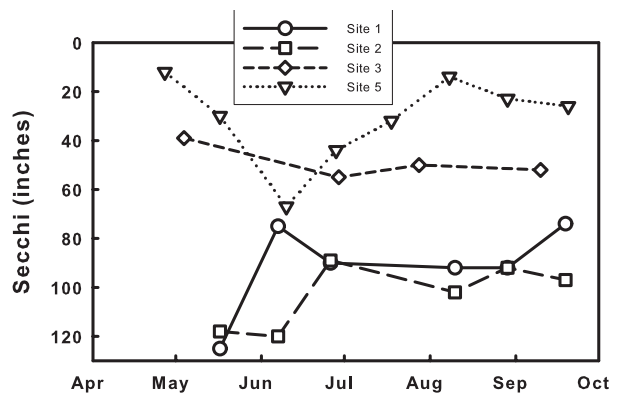
2011 Stockton Lake Sample Sites

Stockton Lake was monitored at 4 locations in 2011. **Site 1** is near the dam. **Site 2** is near the State Park Marina on the Little Sac River Arm. **Site 3** is near the Mutton Creek Public Use Area on the Sac River arm of Stockton Lake, just below the Highway Y bridge. **Site 5** is at the Greenfield Public Access on the Sac River Arm.

The data table above summarizes water quality at all 4 sites.

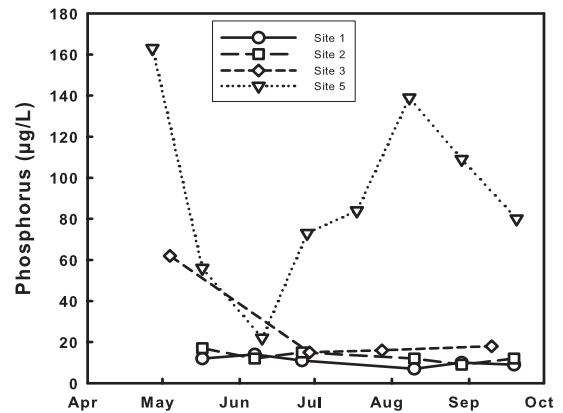
At the dam (Site 1) Stockton Lake had the second highest clarity of any public lake monitored by the LMVP in 2011. Both sites had mean Secchi values of about 8 feet, with the highest clarity of the season occurring early in the season. Reservoir data typically show that the greatest clarity is found near the dam and that clarity decreases with distance up-lake from the dam. Consistent with this, Sites 3 and 5, located considerably farther from the dam than Site 2, had half to one third the clarity found at either Site 1 or Site 2.

Chlorophyll concentrations were low at Sites 1 and 2, slightly higher at Site 3, and quite high at Site 5.

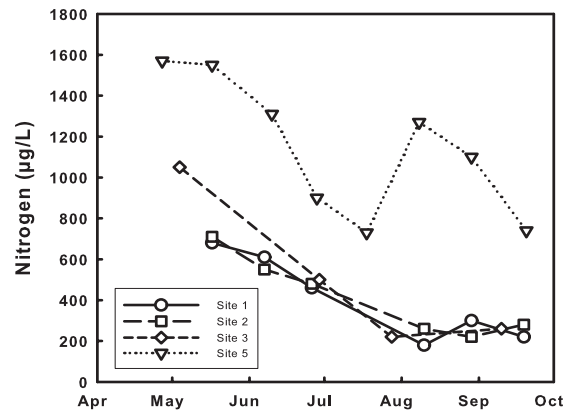


Stockton Lake 2011 Data

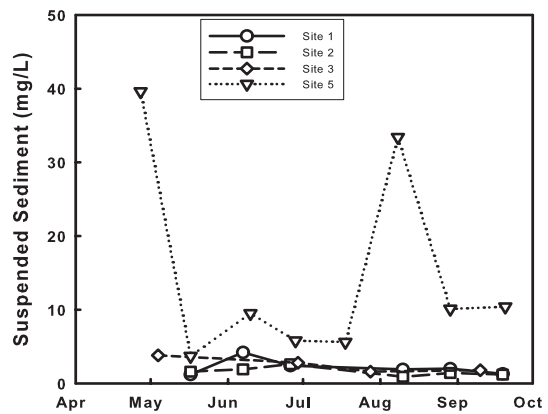
Phosphorus concentrations were considerably higher at Site 5 than at the other sites. While Site 3 had a particularly high phosphorus concentration on May 4, values for the remainder of the season were only double those measured at Sites 1 and 2. Phosphorus at Sites 1 and 2 varied little through the season, and never exceeded 20 µg/L.



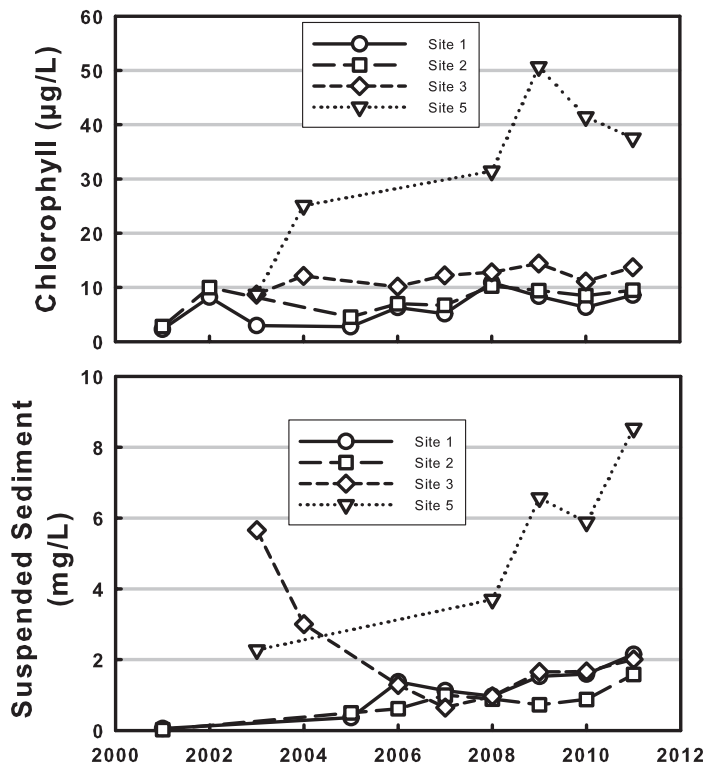
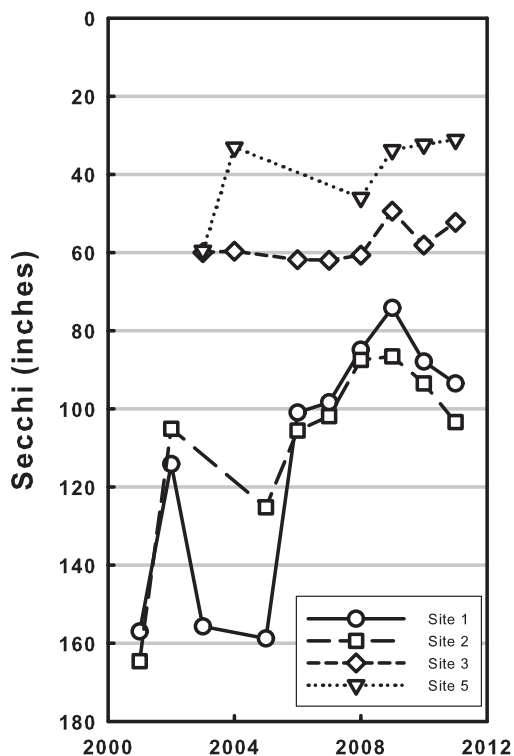
Nitrogen concentrations were similar at Sites 1, 2 and 3 during 2011. Site 5 had roughly double the nitrogen found at the other sites. While nitrogen concentrations generally decreased with time through the 2011 sample season at all sites, 2 values in August at Site 5 did not conform to this trend.



Suspended sediment concentrations at Sites 1, 2 and 3, were lower than found in most Missouri lakes, though somewhat high for Stockton Lake. Site 5 had considerably more suspended sediment than found at the other sites. The suspended sediment values of April 27 and August 8 at Site 5 were among the highest measured in any LMVP lake during 2011.



Stockton Lake Long-Term Trends

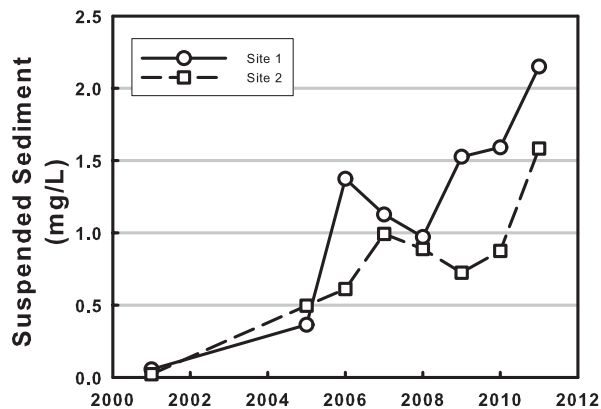


Monitoring at Sites 1 and 2 in Stockton Lake began in 2001. Sites 3 and 5 were added in 2003. In that time, water clarity at both Site 1 and Site 2 has decreased by almost half. This may not be a trend, but bears careful watching. Climate plays a large role in reservoir water clarity and the range of values observed may be related to rainfall rather than changes in the reservoir. Sites 3 and 5 show no similar decrease in water clarity.

Chlorophyll concentrations have increased at all sites since 2003. At Sites 1 and 2, measured chlorophyll has nearly tripled, though the 2002 and 2011 values are nearly identical. Site 3 had more algae in 2011 than in 2003, though the change was much less dramatic than at Sites 1 and 2. Site 5 experienced the greatest chlorophyll increase by far. The 2003 concentration was 8.7 and it increased to 37.5 in 2011, a more than four-fold increase.

At Sites 1, 2 and 5 concentrations of suspended sediment were higher in 2011 than

in any previous year and an upward trend is indicated. This is concerning and further monitoring will determine if suspended sediments are truly trending upward in Stockton Lake or if weather extremes and sample timing are responsible.



Suspended Sediment at Stockton Lake Site 1 and Site 2

Stockton Lake Long-Term Trends

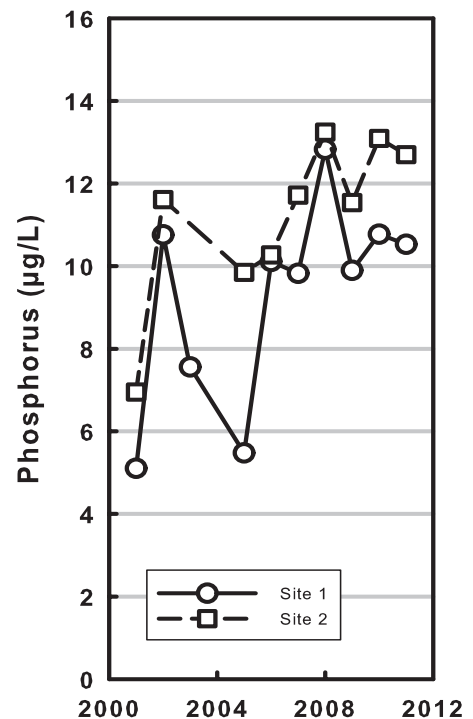
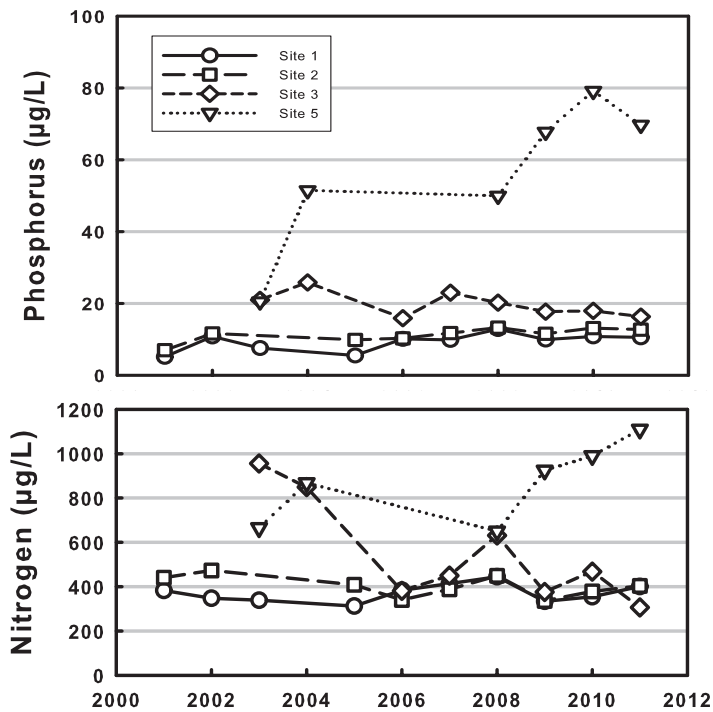
Concentrations of phosphorus in Stockton Lake have increased since 2001. Sites 1 and 2 have experienced almost a doubling of total phosphorus since the first year of monitoring. Phosphorus concentrations at Site 5 have more than tripled since 2003.

Precipitation data correlate somewhat with the phosphorus data. Phosphorus molecules bind readily with soil particles, which will wash into the lake during storm events. Further monitoring will determine if the phosphorus increase at Sites 1, 2 and 5 are the result of human influence.

Interestingly, Site 3 showed no increase in phosphorus concentrations.

The far right graph shows only Site 1 and Site 2, with the scale manipulated to exaggerate the phosphorus increases at these sites.

Nitrogen concentrations have not changed at either Site 1 or Site 2. There is some variability at Sites 3 and 5, but there are no trends apparent.



Sugar Creek Lake



Site 1



2011 DATA

Randolph County
Latitude: 39.4740

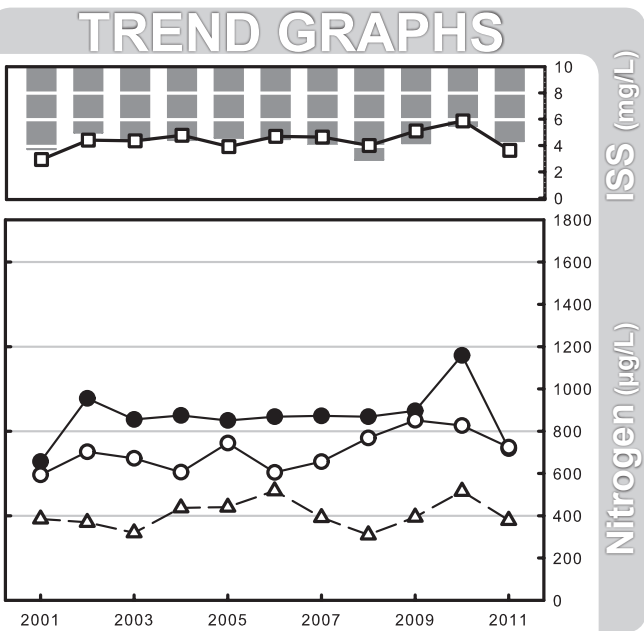
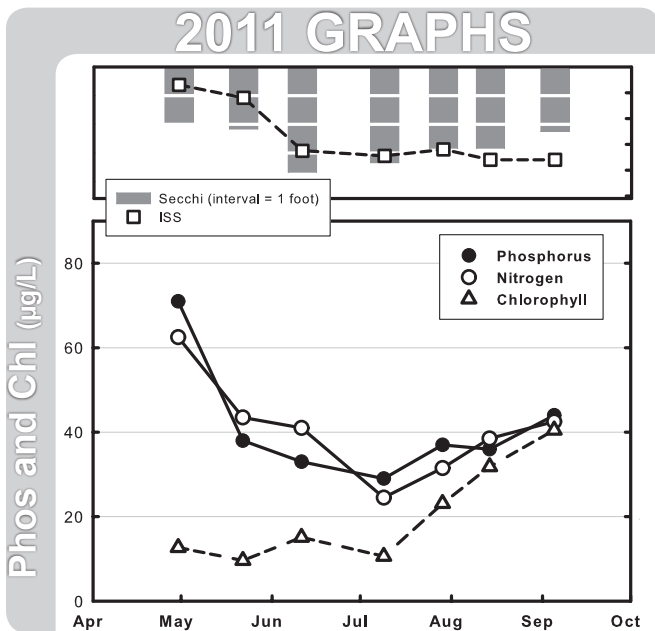
Longitude: -92.4783

Date	4/30	5/22	6/11	7/9	7/29	8/14	9/5	X	Mean
Secchi (inches)	24	26	44	40	34	34	27		32
TP (µg/L)	71	38	33	29	37	36	44		40
TN (µg/L)	1250	870	820	490	630	770	850		783
CHL (µg/L)	12.7	9.6	15.1	10.6	23.1	31.8	40.5		17.9
ISS (mg/L)	8.6	7.6	3.5	3.1	3.6	2.8	2.8		4.1

The two sites in Sugar Creek Lake displayed the same general seasonal trends: maximum nutrient levels early in the season with decreasing concentrations into summer and a slight increase moving into fall. Inorganic suspended sediment levels were also high on the first sample date followed by decreases, while algal chlorophyll was generally low early in the season and increased across the summer and into the fall. Water quality at the two sites differed on July 9th; with phosphorus, chlorophyll and suspended sediment values at Site 2 being 80%, 100% and 248% higher than at Site 1, respectively. Increased algal levels and suspended sediment concentrations lead to Site 2 having a Secchi transparency depth that was half of that measured at Site 1 on the same

day. By the next sampling event on July 29th water quality at the two sites was for all nearly identical.

Long-term data for the two sites on Sugar Creek Lake display a normal amount of year-to-year variation. While none of the parameters show an obvious trend of increasing or decreasing concentrations, the three highest nitrogen values at both sites have been measured during the last four summers. Average nitrogen levels during 2008-2011 have been about 130µg/L higher than the averages for 2001-2007. Continued sampling will determine if there is truly a trend of increasing nitrogen concentrations in Sugar Lake.



See page 3 for help interpreting graphs

Sugar Creek Lake



Site 2



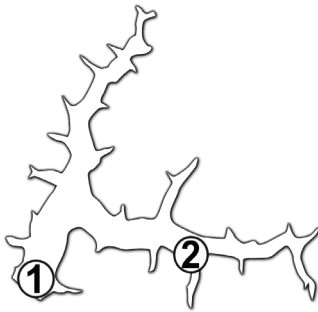
2011 DATA

Randolph County
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Longitude: -92.4619

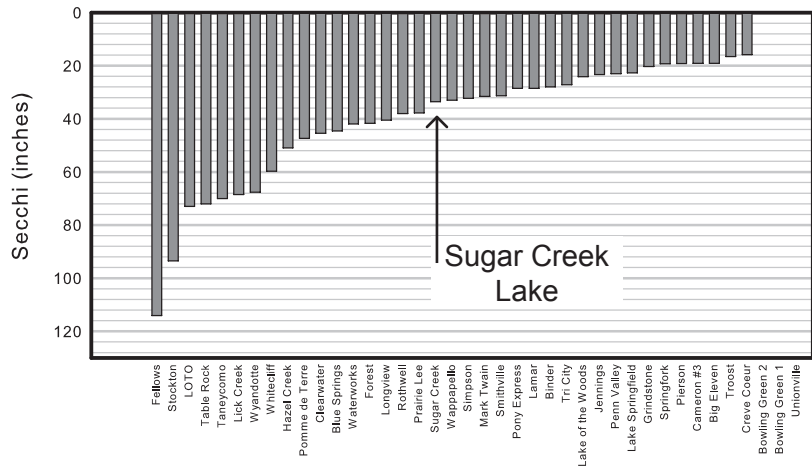
Date	4/30	5/22	6/11	7/9	7/29	8/14	9/5	X	Mean
Secchi (inches)	20	28	34	21	34	29	26		27
TP (µg/L)	82	45	43	52	38	53	63		52
TN (µg/L)	1400	930	850	620	680	960	820		867
CHL (µg/L)	15.1	13.2	22.4	21.1	25.4	37.9	53.9		24.2
ISS (mg/L)	11.2	7.7	5.2	10.8	3.5	6.2	7.1		6.9

See text on previous page.

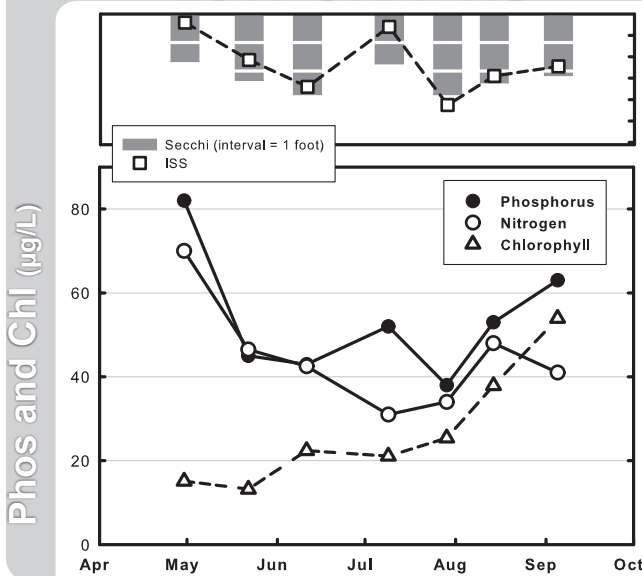


Sampling sites at Sugar Creek Lake

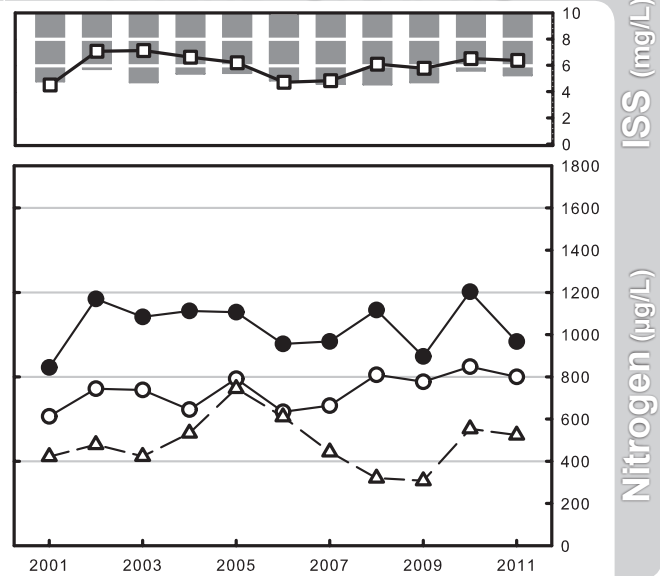
2011 Summer Mean Secchi Values



2011 GRAPHS



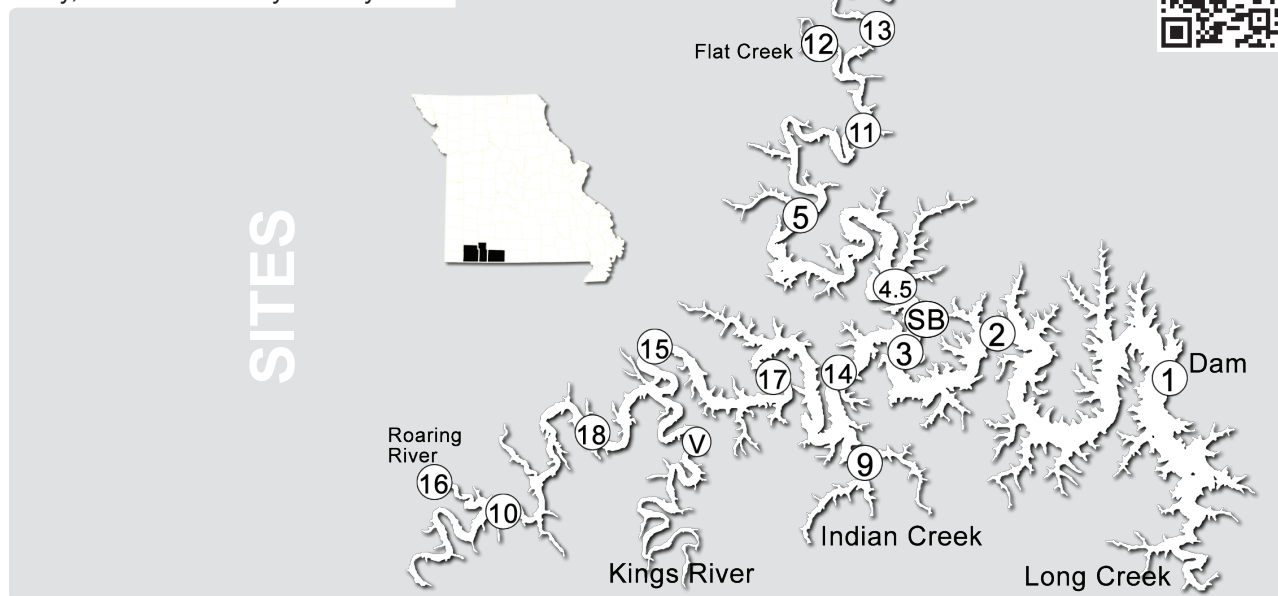
TREND GRAPHS



See page 3 for help interpreting graphs

Table Rock Lake

Barry, Stone and Taney County



Main Lake Sites

Site Number	10	18	15	17	14	3	2	1
(# of Samples)	(6)	(7)	(8)	(8)	(7)	(9)	(6)	(5)
Secchi	87	71	49	58	91	86	77	77
(inches) Range	76 - 101	24 - 107	10 - 96	21 - 94	60 - 114	36 - 168	57 - 107	56 - 101
TP	12	19	20	20	17	15	15	6
(µg/L) Range	9 - 16	8 - 53	7 - 106	8 - 65	9 - 45	9 - 73	8 - 38	4 - 8
TN	389	564	366	366	349	539	385	305
(µg/L) Range	270-560	260-1600	210-1100	200-760	230-760	300-1300	220-870	250-440
CHL	6	4.5	6.2	7.1	8.3	7	8.5	9
(µg/L) Range	3.4-10.9	0.8-11.9	2.2-35.6	3.8-28.6	4.4-13.0	2.1-4.4	4.9-5.2	5.0-18.5

Tributary Arms Sites

Site Number	13	11	5	4.5	9	Viola	16	12	SB Cove
(# of samples)	(8)	(8)	(6)	(7)	(7)	(7)	(8)	(7)	(8)
Secchi	40	49	56	69	91	67	37	39	76
(inches) Range	29 - 79	41 - 82	48 - 86	36 - 135	58 - 120	44 - 88	30 - 42	31 - 54	41 - 121
TP	64	46	21	15	19	19	33	47	18
(µg/L) Range	34 - 112	37 - 62	16 - 35	8 - 34	10 - 53	12 - 35	17 - 64	32 - 67	9 - 73
TN	1057	791	512	320	366	672	716	985	546
(µg/L) Range	570-2060	420-2010	270-980	220-480	210-660	340-1220	430-2180	570-2830	250-1610
CHL	39.0	26.1	15.5	13.1	8.1	8.4	11.2	32.0	11.7
(µg/L) Range	14.7-87.7	18.9-46.2	7.8-35.6	6.6-45.4	4.5-13.5	5.7-19.8	1.2-61.1	19.2-55.1	Single value

Table Rock Lake - 2011 Secchi Data

Water clarity as measured by the Secchi disk varied both within individual sites as well as among sites in the main lake channel during 2011. Site 15, located at the Highway 39 Bridge, had Secchi readings that varied nearly 10-fold, ranging from 10 to 96 inches. The shallowest value occurred on May 10th when nutrients and algal chlorophyll levels were at their maximum. Water quality improved with time at this site, with the 96 inch reading occurring on the last sample date (September 19). Three other main lake sites (18, 17 and 3) had Secchi readings that varied by 4-fold or more. Among sites the average Secchi readings ranged from 40 inches at Site 15 to 91 inches at Site 14. These two sites are only 14.5 miles apart, a small distance given the size of Table Rock Lake. While Site 14 was not sampled on May 10th, the date in which the shallowest reading at Site 15 was taken, differences in sample number or timing do not totally account for the differences in water clarity at these two sites. On four sample occasions when the sites were visited within a couple of days of each other the clarity at Site 14 was at least 30 inches deeper than that measured at Site 15.

The average Secchi transparency values in tributary sites ranged from a low of 37 inches in Roaring River to a high of 91 inches in Indian Creek. Sites located near the main lake channel (4.5 and SB Cove in the lower James River, 9 in Indian Creek and Viola in the King's River) tended to have deeper transparency readings while sites located farther away from the main channel (13 in upper James River and 12 in Flat Creek) had shallower readings. This follows the pattern we normally see in the James River with improving clarity as sites move down-lake.

Note: Graphs displaying Secchi values are “upside down” with zero at the top.

Imagine lowering a Secchi disk when viewing the graph. The clearer the water, the closer the data point is to the bottom of the graph.


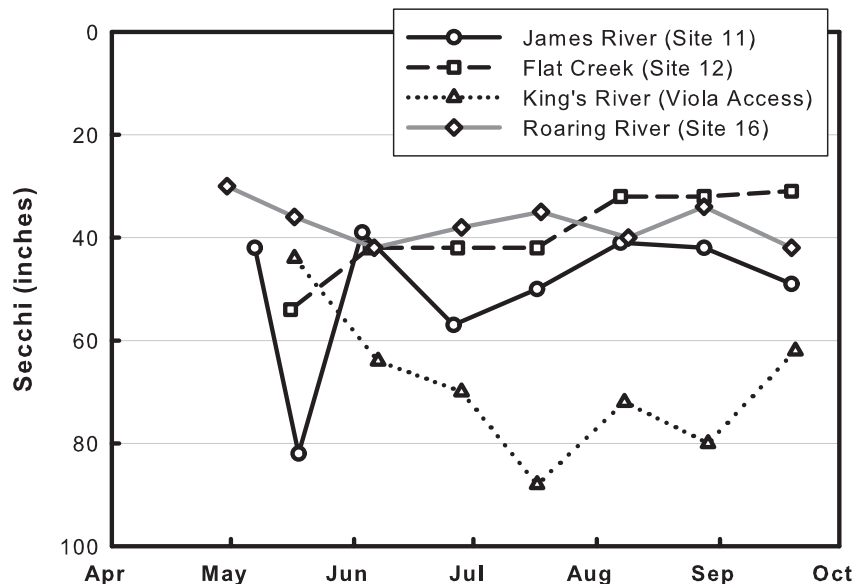
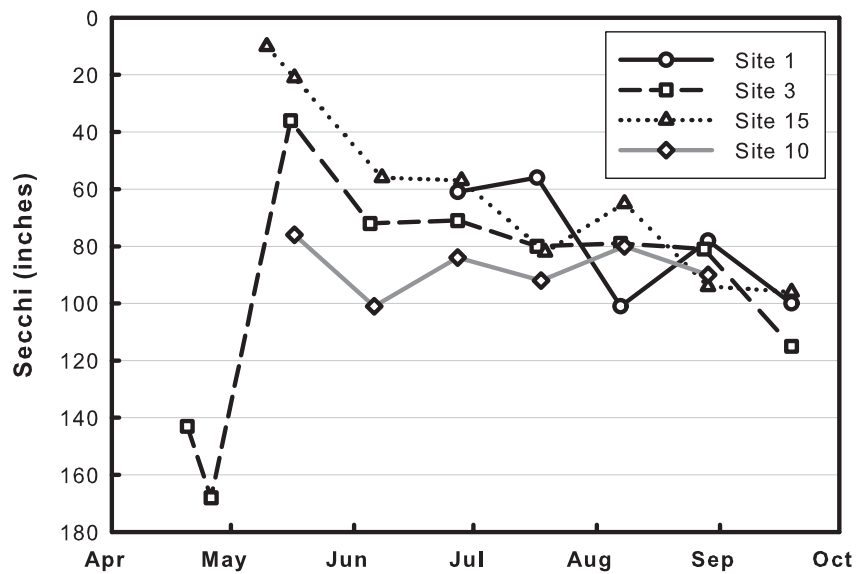
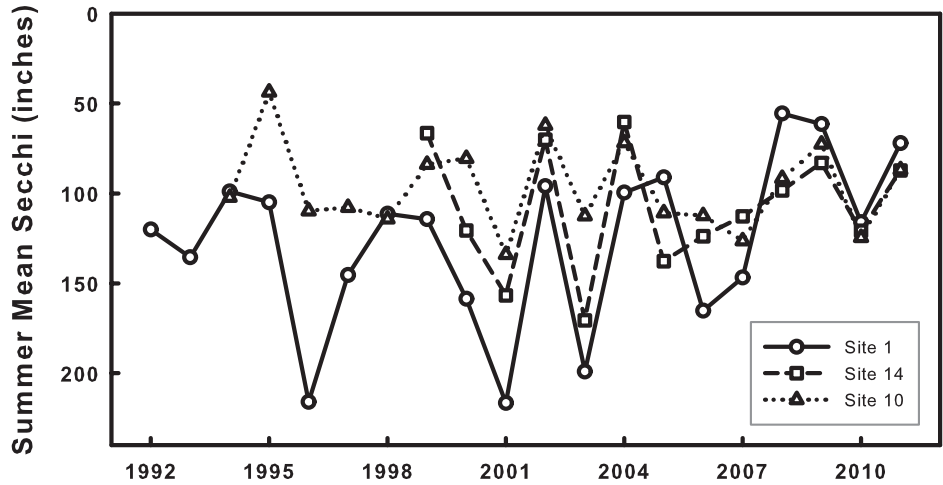



Table Rock Lake - Long-term Secchi Data

Across the lake during 2011, the Secchi values were lower than the long-term means for all sites except those in the upper end of the James River Arm. Water clarity at each of the main lake sites was, on average, over 2 feet lower than the long-term mean.



2011 summer mean water clarity in the tributary sites was near each site's long-term mean in all cases except Site 4.5, in the lower James River Arm, near the main lake. Water clarity at this site was, like the main lake sites, over 2 feet lower than the long-term mean. The only apparent long-term trend is that of decreasing water clarity at Site 16 in the Roaring River Arm. Continued monitoring will determine if Site 16 is experiencing water quality degradation.

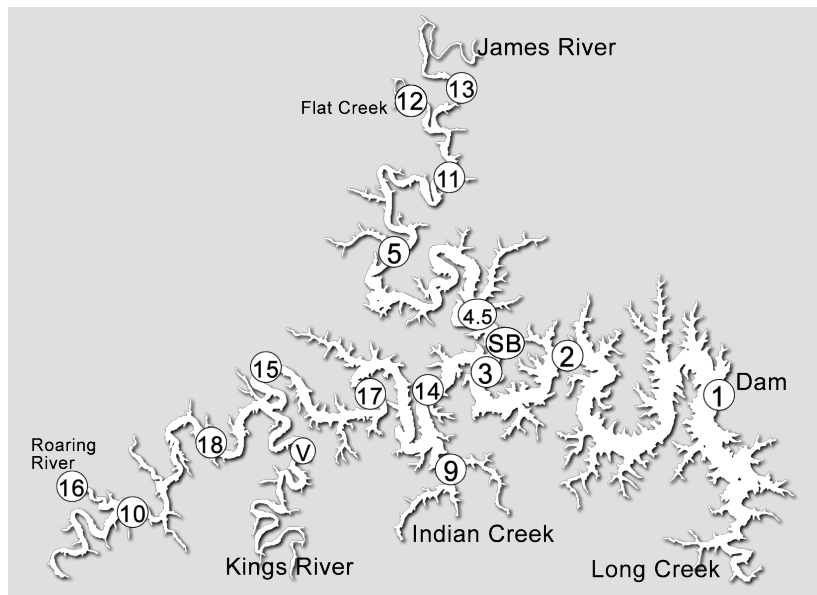
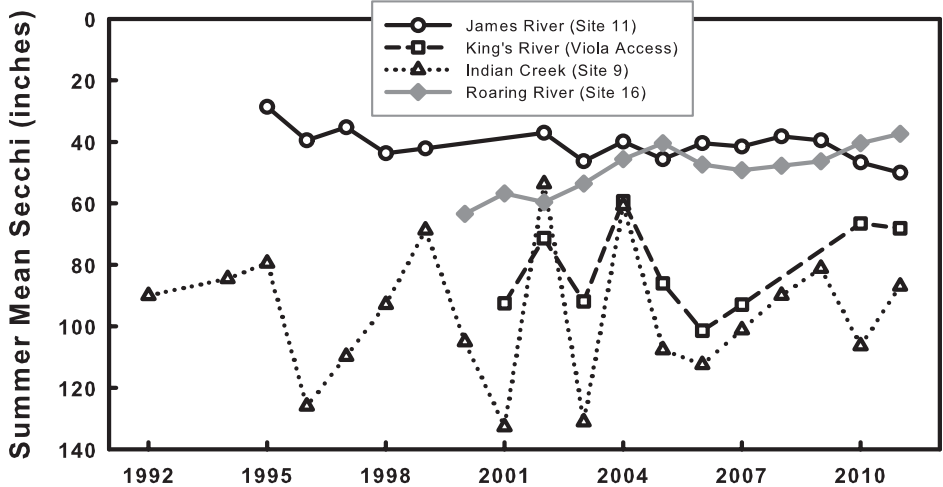
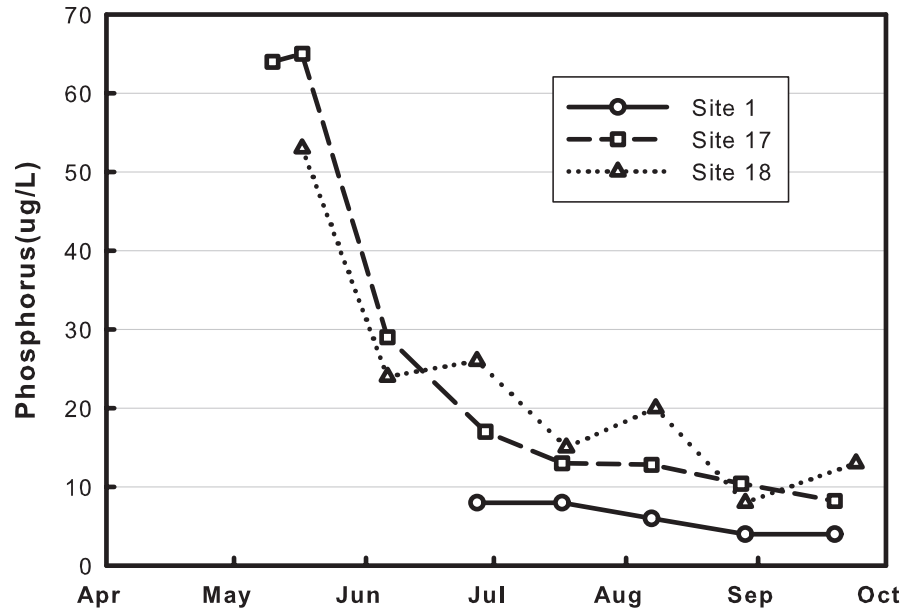


Table Rock Lake - 2011 Total Phosphorus Data

Average phosphorus values for the eight main lake sites ranged from 6 µg/L at the dam to 20 µg/L at Sites 15 and 17. Site 15 displayed the most variation with phosphorus values ranging from 7 to 106 µg/L. In contrast, Sites 10 and 1 both showed minimal variation in phosphorus levels with ranges of 9 to 16 µg/L and 4 to 8 µg/L, respectively. A partial explanation for the low variation at Site 1 is that this site was not sampled until late June, missing out on early season inputs.



Five of the nine tributary sites had average phosphorus values <21 µg/L, levels similar to the main lake sites. Interestingly, some of these sites showed the highest range of phosphorus values during the season. SB Cove, located in the lower James River Arm, had individual phosphorus values that ranged 9 to 73 µg/L, more than an 8-fold difference. In contrast, sites with higher average phosphorus values (sites 12, 11 and 16) tended to display lower variation among individual values.

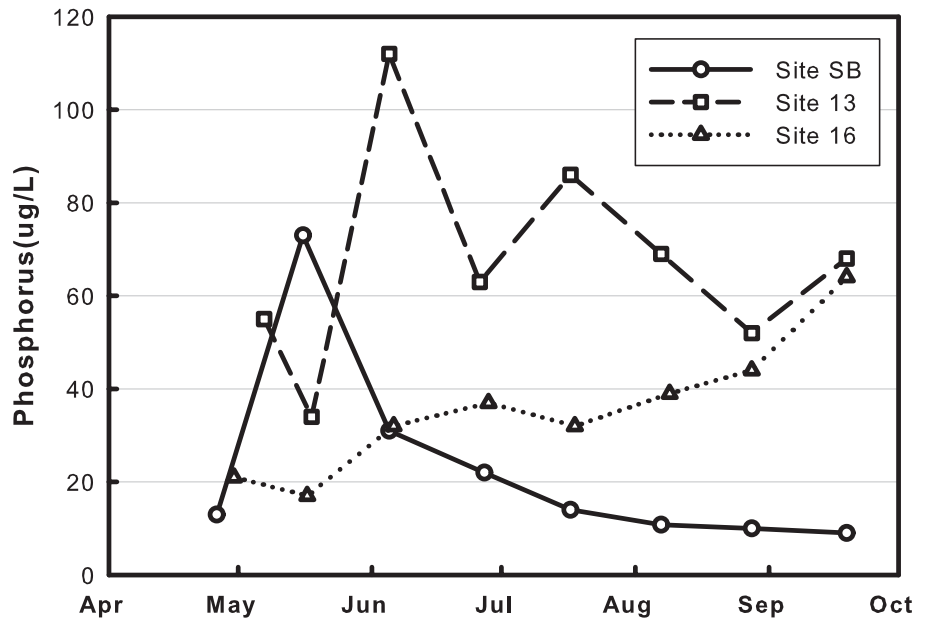
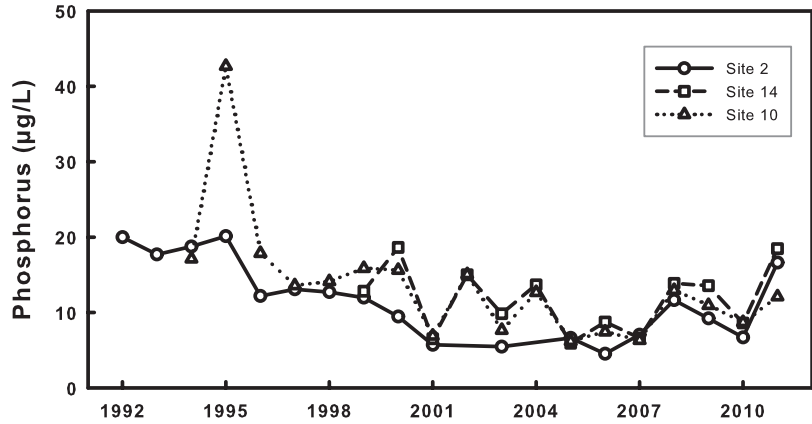
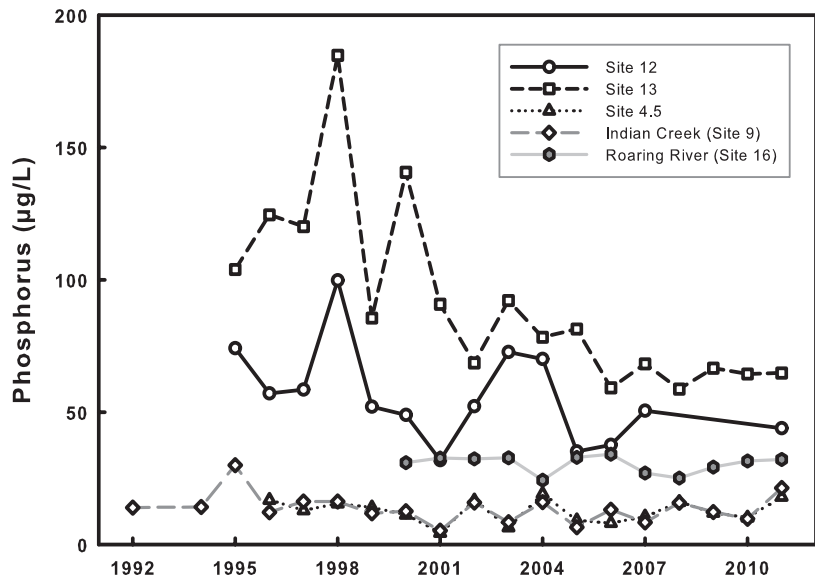


Table Rock Lake - Long-term Total Phosphorus Data

Long-term phosphorus data from the main lake show similar trends among the sites. The 2011 summer phosphorus value was higher than average for nearly all main lake sites. Only Site 1 had less phosphorus than average, certainly due to the lack of spring samples at this site. The 2011 mean phosphorus concentration at Site 10 was exactly average.



Sites in the upper James River Arm had significantly less phosphorus than average in 2011. At Site 13, for example, the 2011 summer mean phosphorus value was about 25% lower than the average of all the years the site has been monitored. Site 12 in Flat Creek, a tributary to the upper James River Arm, had approximately 20% less phosphorus in 2011 than average.



Sites nearer to the main lake have water quality similar to the main lake. Phosphorus concentrations at Site 4.5, on the lower James River Arm, are virtually indistinguishable from Site 9 on Indian Creek. Mean summer phosphorus concentrations at Site 14, roughly between the two sites on the main lake, show a pattern very similar to that of Sites 4.5 and 9.

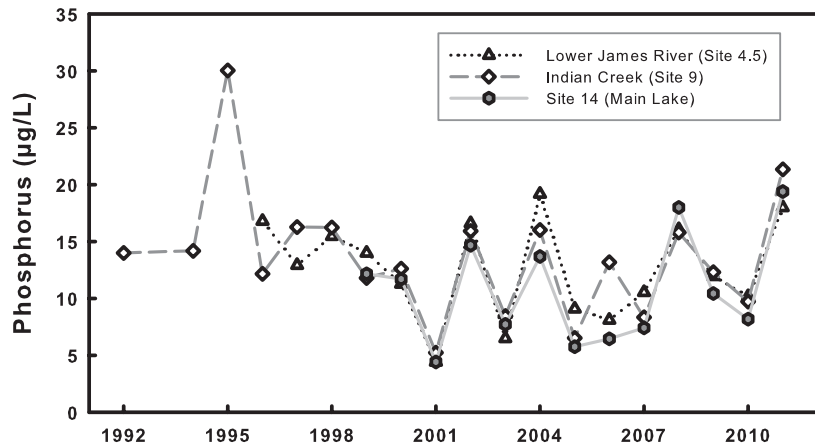


Table Rock Lake - 2011 Total Nitrogen Data

Nitrogen was less variable than phosphorus both within and among main lake sites. The range of average values across the main channel was 305 µg/L at the dam to 564 µg/L at Site 18. Six of the eight main lake sites had average nitrogen values between 300 - 400 µg/L, with the other two sites averaging 540-560 µg/L. Both of these sites with the higher nitrogen average had two individual nitrogen measurements that exceeded 1000 µg/L. Site 18 was the most variable, with a maximum nitrogen value that was 6.2 times higher than the minimum measurement. As with phosphorus, Sites 10 and 1 had the least amount of variation among individual nitrogen values.

The average nitrogen concentration at the tributary sites ranged from a low of 320 µg/L at Site 4.5 in the lower James River Arm to a high of 1057 µg/L at Site 13 in the upper James River Arm. This longitudinal gradient of decreasing values within the arm is expected and consistent from one year to the next. Along with having the lowest average nitrogen value among the tributary sites, Site 4.5 also showed the least variation with individual values ranging between 220 - 480 µg/L. In contrast, SB Cove in the lower James River Arm had values that ranged between 250 - 1610 µg/L, more than a 6-fold difference.

When compared to other lakes in the state of Missouri, nitrogen concentrations have historically been low at Table Rock Lake. At the dam in 2011, Table Rock had the third lowest nitrogen concentration of any LMVP lake.

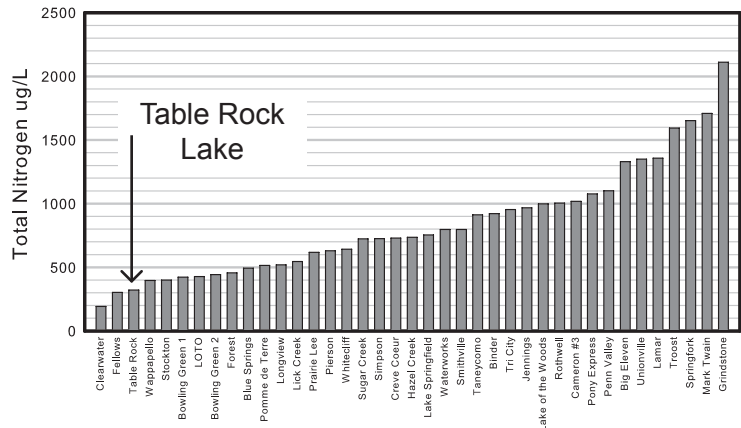
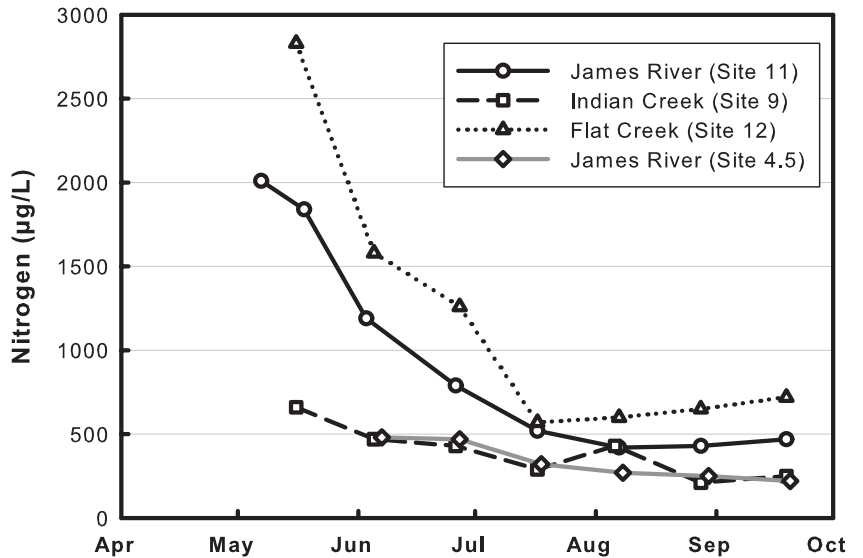
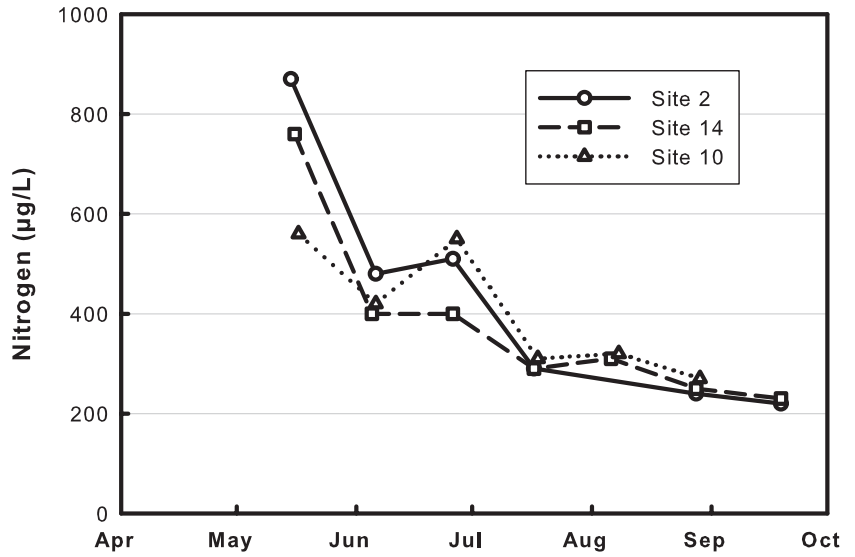
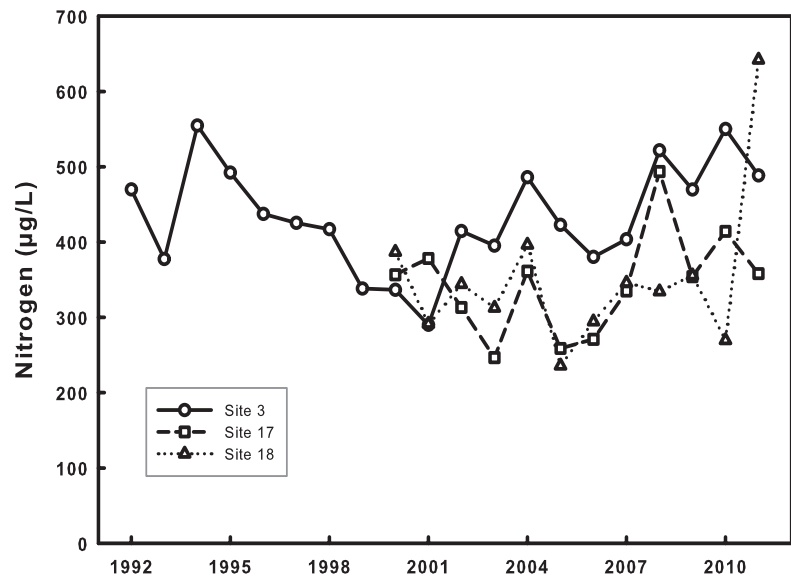


Table Rock Lake - Long-term Total Nitrogen Data

Since 2001, the summer mean nitrogen values appear to be trending upward at Site 3, the confluence of the James and White Rivers. This trend is not apparent at other main lake sites. For most main lake sites, summer mean nitrogen concentrations have remained within the 300 to 500 µg/L range. Two particularly high nitrogen values were measured at Site 18 during the “summer” (May 15 - Sept. 15) of 2011, both over 1000 µg/L. As a result, the 2011 summer mean nitrogen concentration for Site 18 was the highest measured to date, nearly double the site’s long-term mean.



Mean summer nitrogen concentrations in 2011 tended to be higher than average at the sites in the James River Arm, with Site 13 being the exception. Like Site 13, Indian Creek (Site 9) and Roaring River (Site 16) had lower 2011 mean nitrogen values than their sites’ respective long-term means. No long term trends were apparent at any site.

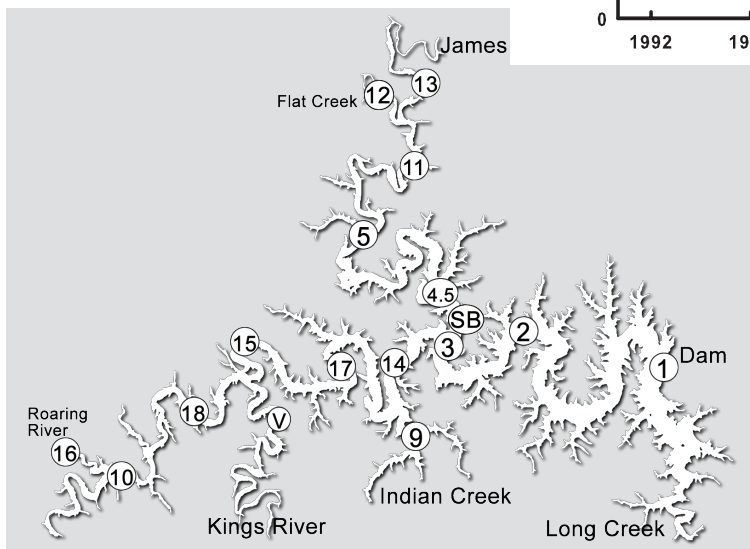
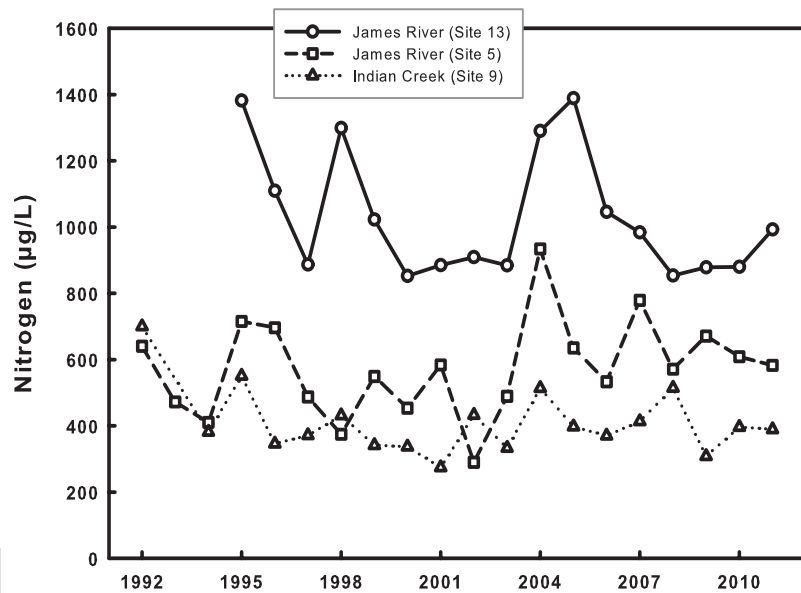
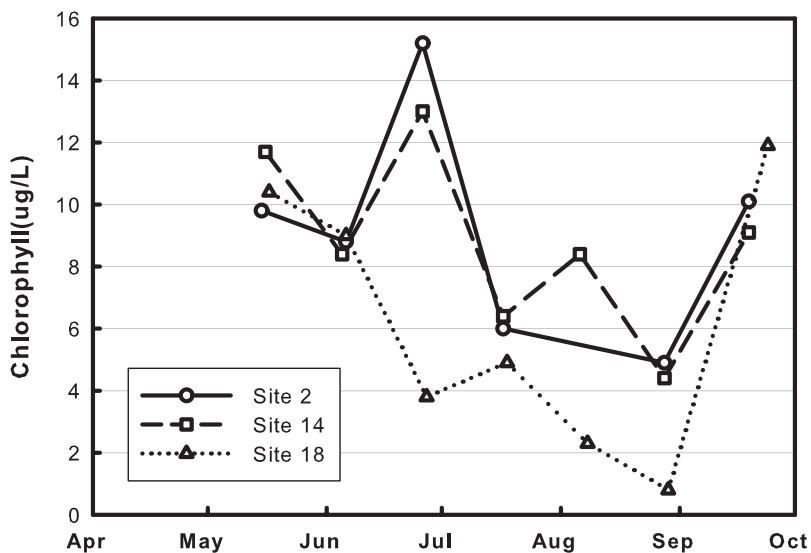


Table Rock Lake - 2011 Total Chlorophyll Data

All eight main lake sites had comparable average chlorophyll values, ranging from 4.5 $\mu\text{g/L}$ at Site 18 to 9.0 $\mu\text{g/L}$ at Site 1 at the dam. Interestingly Site 1 had the highest mean chlorophyll value while also having the lowest nutrient levels. The most variable site in terms of chlorophyll was Site 15, with a 16-fold difference between minimum and maximum chlorophyll values. The maximum value of 35.6 $\mu\text{g/L}$ was measured on May 10th and the minimum concentration of 2.2 $\mu\text{g/L}$ was collected a month later on June 8th. This dramatic shift in algal chlorophyll was accompanied by a 62% decrease in nitrogen and a 73% decline in phosphorus.



Only two tributary sites (Indian Creek #9 and Viola) had average chlorophyll concentrations $<10 \mu\text{g/L}$, indicating more algal growth in the tributary sites than in the main lake where none of the sites exceeded an average chlorophyll of $10 \mu\text{g/L}$. Predictably, the highest average chlorophyll value was measured at Site 13 in the upper James River Arm where the highest nutrient concentrations were found. Individual chlorophyll values varied the most at Site 16 in Roaring River, where a minimum value of 1.2 $\mu\text{g/L}$ was measured on May 17th and a maximum value of 61.1 $\mu\text{g/L}$ was collected on September 19th.

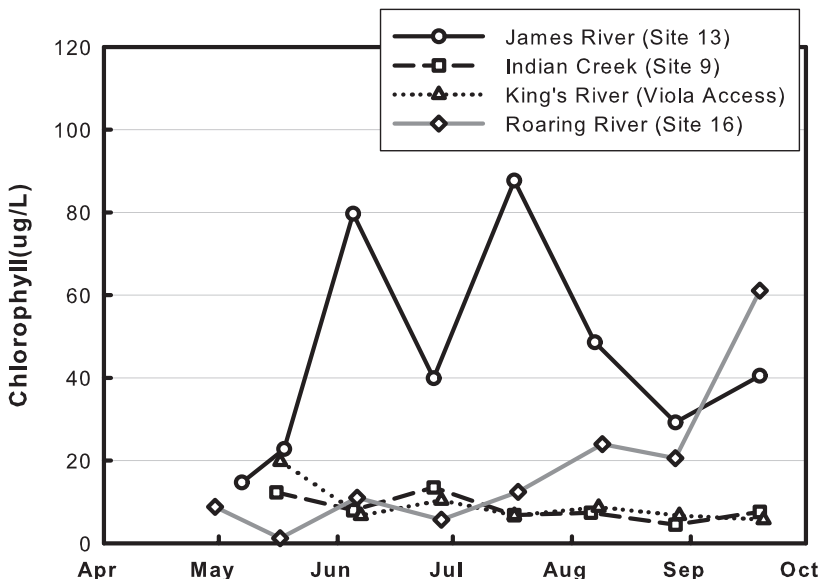
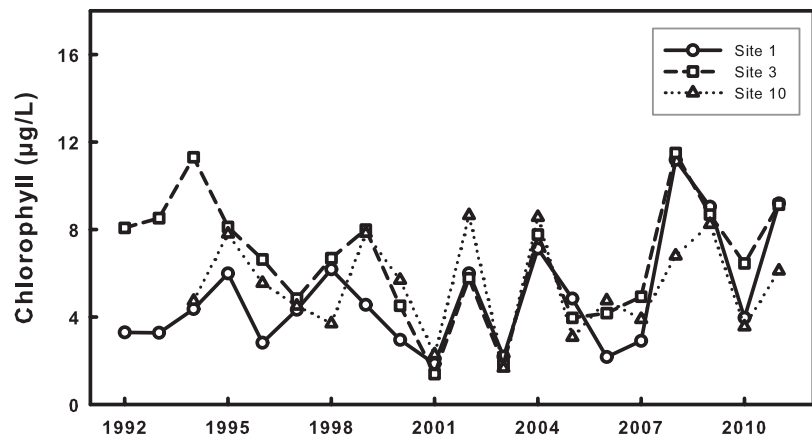
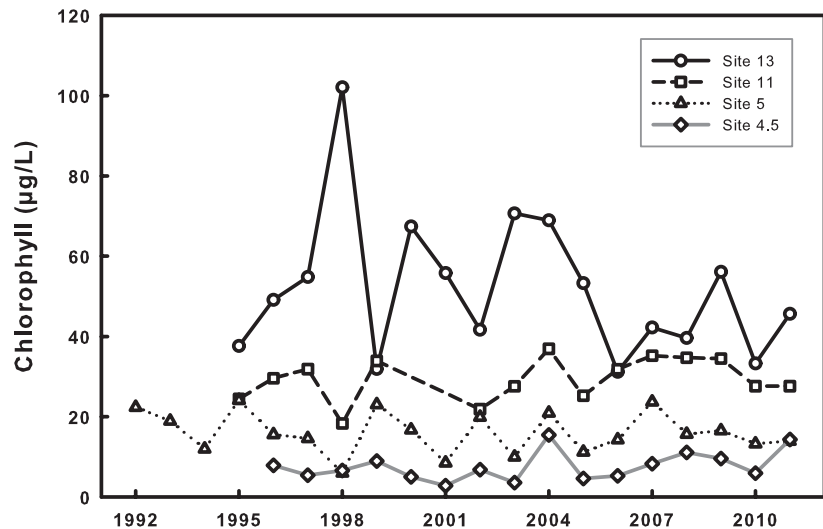


Table Rock Lake - Long-term Total Chlorophyll Data

Summer mean chlorophyll values in the main lake have typically varied with one another. There is surprisingly little variability across sites, though year-to-year mean values at a given site sometimes vary 3-fold.



James River chlorophyll concentrations vary considerably from site to site. Values are lowest near the main lake and increase with distance from the main lake up the James River. Year-to-year variability is quite high at Site 13, as are the individual values when compared to the rest of the James River and Table Rock Lake. Sites 5 and 4.5 have considerably lower values, and year-to-year patterns that resemble those of the main lake.



Summer mean chlorophyll concentrations can be quite high at Site 12 in Flat Creek, a tributary to the upper James River Arm of Table Rock Lake. Other years, however, those values can be quite low, similar to those of the Indian Creek or Roaring River Arms. Indian Creek summer mean chlorophyll values have always been lower than 10 µg/L and Roaring River values have been less than 20 µg/L for all but 1 summer.

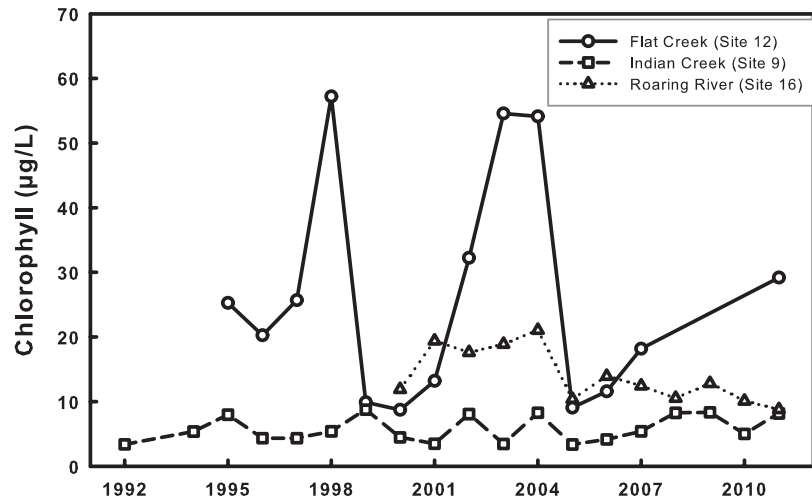
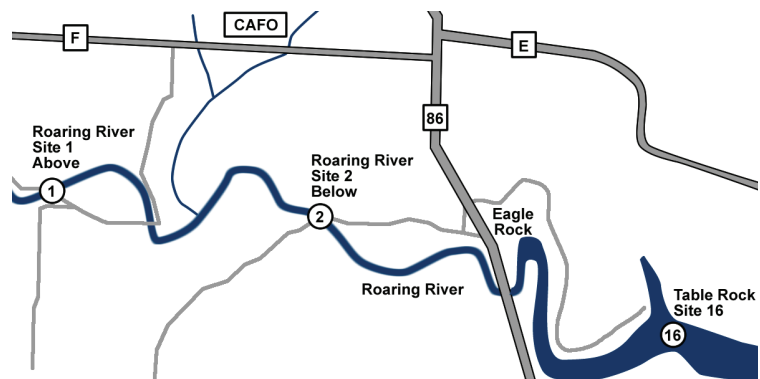


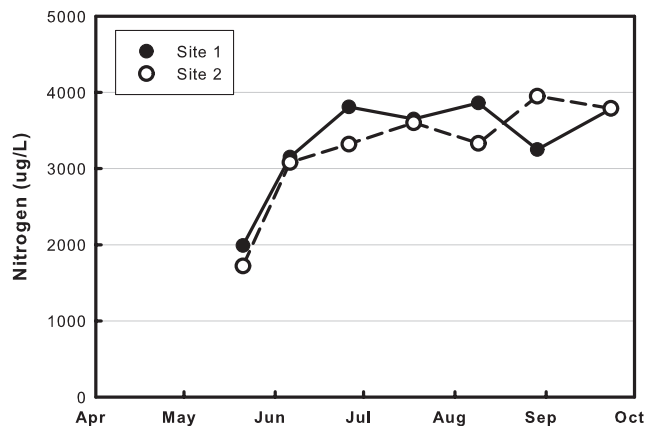
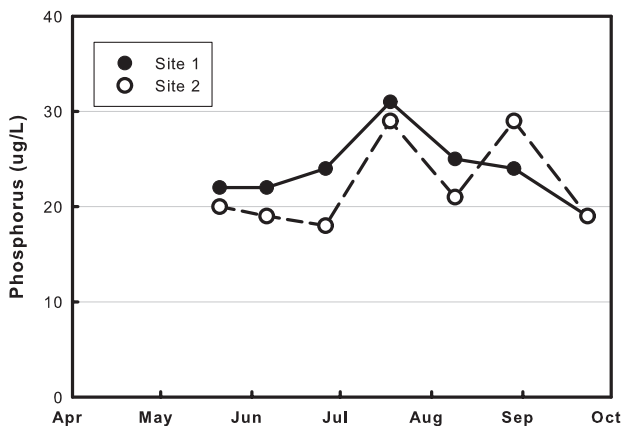
Table Rock Lake Roaring River Sampling – Above and Below



Supplemental nutrient sampling at two sites in Roaring River showed minor differences in nutrient concentrations between the two sites on any given sample day, but the same general patterns over the course of the season.

Phosphorus fluctuated but did not display a true seasonal pattern, while nitrogen levels were notably lower on the first sample date in May, increased by the beginning of June and then leveled off for the rest of the season.

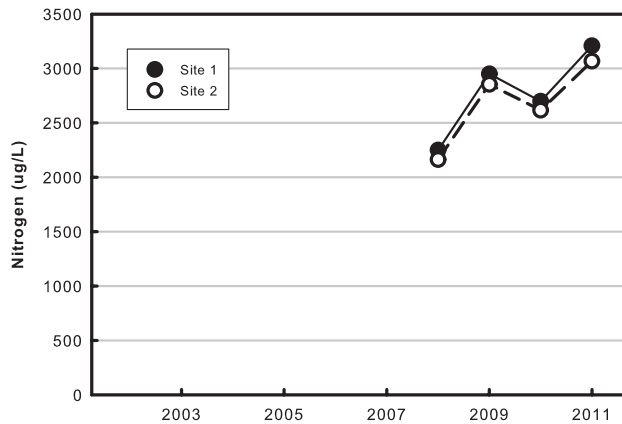
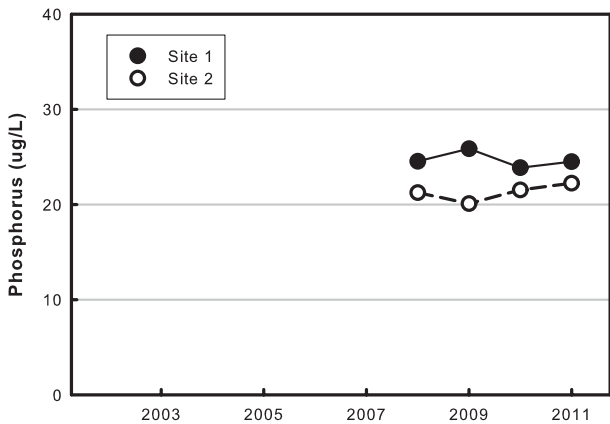
2011 Roaring River Data



These two sites have been monitored since 2008 and summertime averages indicate no trends for phosphorus. Nitrogen has been more variable from one summer to the next, with the lowest values ($\approx 2300\mu\text{g/L}$) measured

in 2008 and the highest measured in 2011 ($\approx 3100\mu\text{g/L}$). With only four years of data it is difficult to know if this is truly a trend or the normal year-to-year fluctuations that we might expect.

Roaring River 2008 - 2011



Lake Taneycomo Site 3.5

Taney County



2011 DATA

Latitude: 36.6934

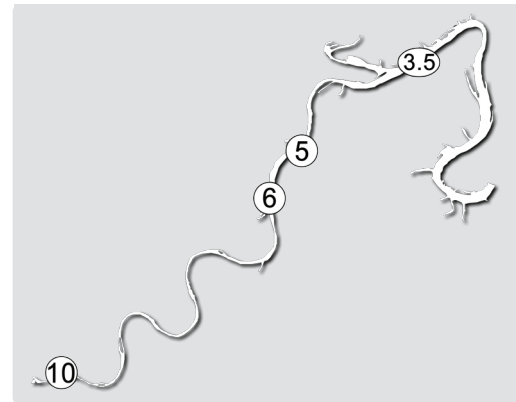
Longitude: -93.1583

Date	X	5/17	6/7	6/27	7/27	8/9	8/24	9/28	Mean
Secchi (inches)		99	72	67	104	54	44	78	71
TP (µg/L)		19		46	41	27	58	32	35
TN (µg/L)		810		890	970	950	950	1060	935
CHL (µg/L)		0.4	0.8	0.6	0.9	6.0	35.2	3.0	2.0

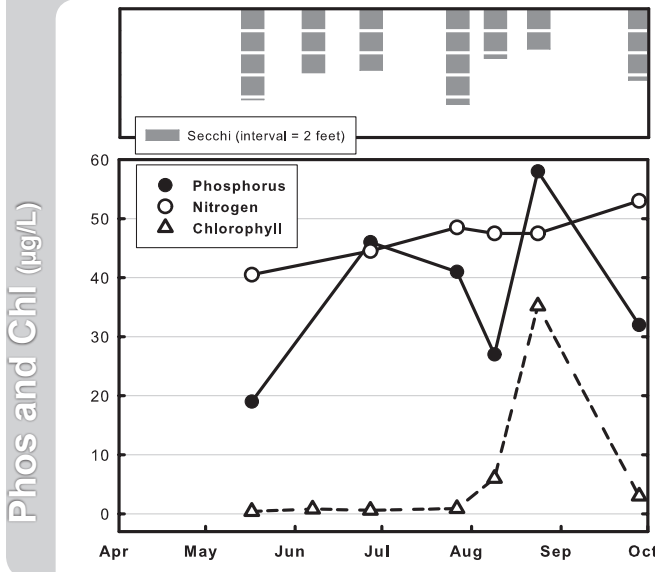
Phosphorus levels at Site 3.5 fluctuated during the sample season, with the maximum concentration being 3-fold higher than the minimum. In contrast, nitrogen values were fairly stable and display a slight trend of increasing concentrations over the course of the season. Chlorophyll values were generally low and stable with the exception of an extreme reading in late August. This maximum chlorophyll value of 35.2 was almost 6-times higher than the next highest value measured in 2011.

in the year. While not as dramatic, the annual nitrogen mean in 2011 was also high (second only to the 2010 value). Even with an extreme value, the annual mean chlorophyll concentration was comparable to previous values.

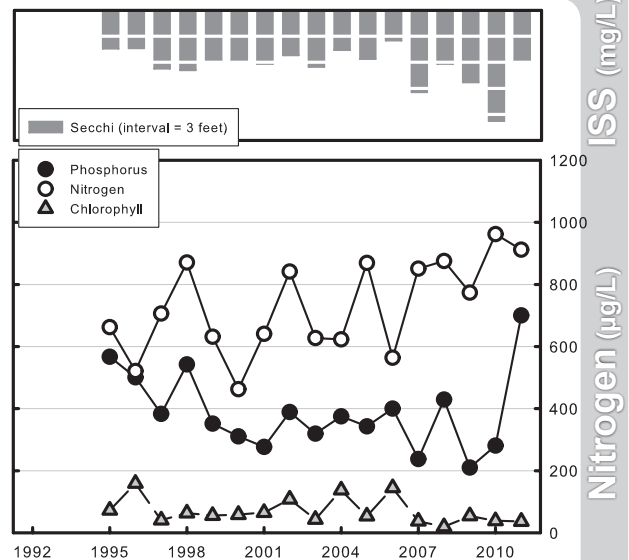
The 2011 annual summertime phosphorus mean exceeds all previous annual means for Site 3.5. It is very likely that the intense flooding that occurred in the Table Rock Lake watershed in spring of 2011 was a large source of the phosphorus measured at Site 3.5 later



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lake Taneycomo Site 5

Taney County

2011 DATA

Latitude: 36.6722

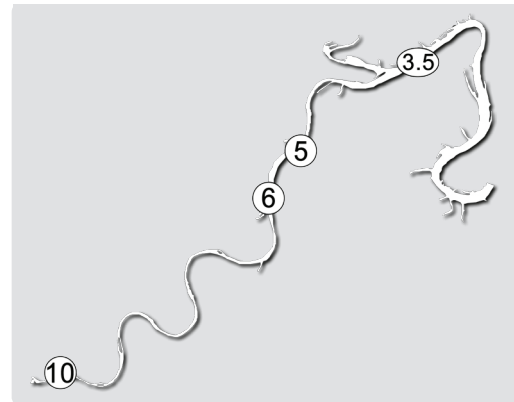
Longitude: -93.1986

Date	X	5/17	6/7	6/27	7/27	8/9	8/24	9/28	Mean
Secchi (inches)		116	73	84	96	92	114	129	99
TP (µg/L)		19		54		51	40	41	39
TN (µg/L)		840		820		1160	1160	910	967
CHL (µg/L)		0.1	0.3	1.1	1.1	0.6	0.8	0.6	0.5

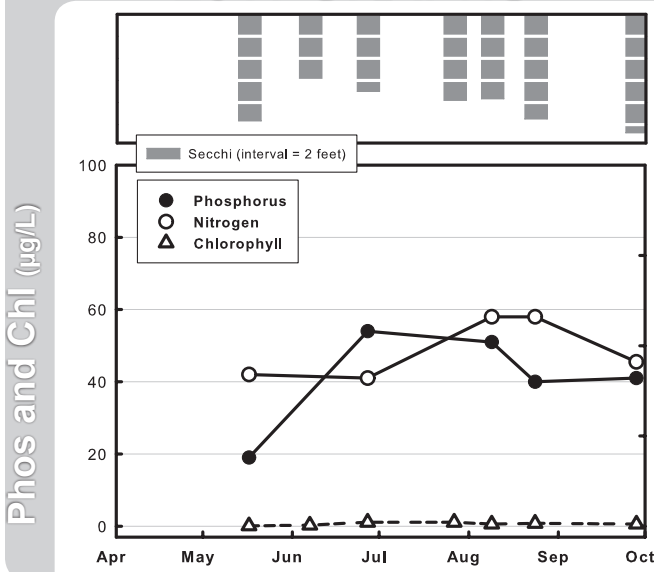
The range of phosphorus values at Site 5 was almost identical to that measured at Site 3.5, though fluctuations between individual values at Site 5 displayed less variability. As seen down-lake, nitrogen concentrations at Site 5 were quite stable across the sample season. Site 5 chlorophyll values differed from Site 3.5 in that all the measurements were low (<1.1 µg/L).

The long-term trends graphs show that the 2011 summertime mean phosphorus value was higher than it has been in a decade. This phosphorus spike is probably a result of the intense rains and flooding that occurred in the White River system during the spring 2011. Secchi transparency was low in 2011 compared to recent summers. Minimal algal chlorophyll concentrations suggest that algae were not the cause of the reduced clarity. It

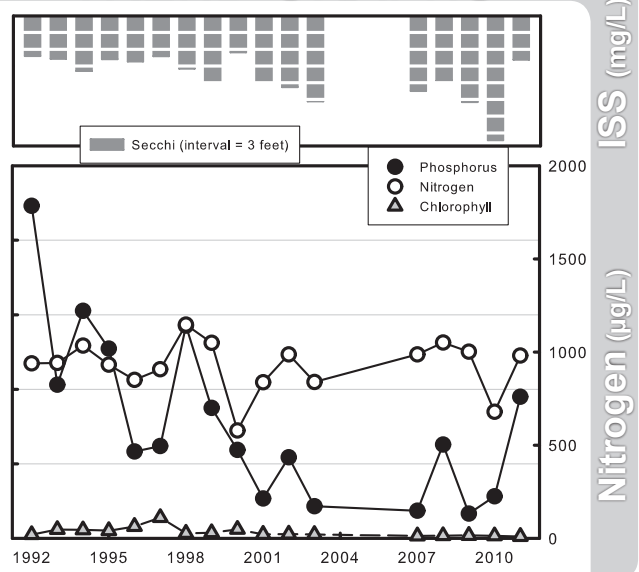
is most likely that the springtime floods also brought increased levels of suspended sediment into the system, which reduced Secchi readings.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lake Taneycomo Site 6

Taney County

2011 DATA

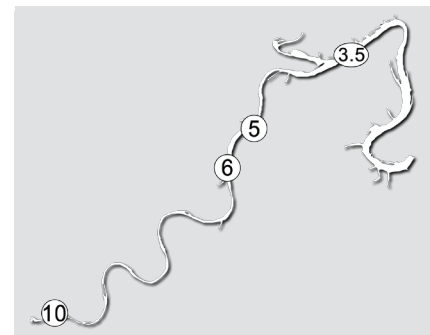
Latitude: 36.6519 Longitude: -93.2133

Date	X	5/17	6/7	6/27	7/27	8/9	8/24	9/28	Mean
Secchi (inches)		105	71	87	99	74	101	122	93
TP (µg/L)		23		93	47	41	36	33	41
TN (µg/L)		720		1220	1090	1270	900	1030	1020
CHL (µg/L)		0.3	0.4	1.0	1.4	0.6	1.5	0.8	0.7

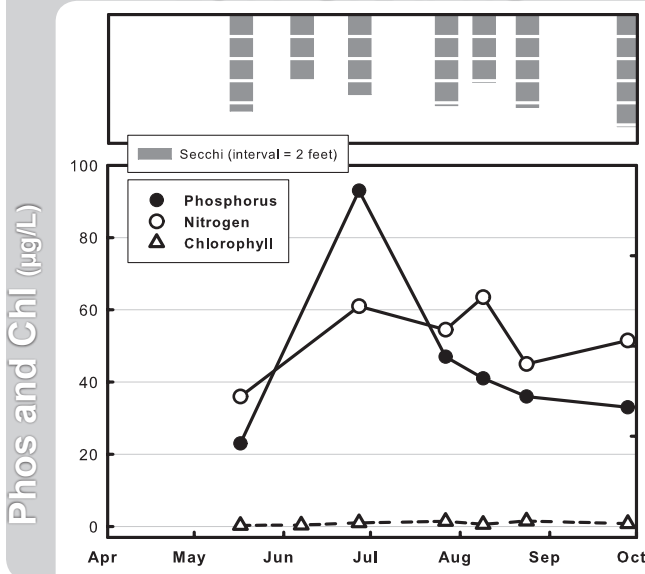
Phosphorus concentrations at Site 6 were more variable than at Site 5 during 2011 due to a spike in phosphorus measured in late June. This value of 93 µg/L was four-times higher than the minimum value measured in May at Site 6 (and was about twice as high as the maximum value measured at Site 5). The minimum nitrogen value was also measured in May, with nitrogen displaying much lower variability over the season than phosphorus. While nutrients fluctuated during the sample season, chlorophyll levels remained stable, never changing by more than 0.8 µg/L from one sample to the next.

The annual mean phosphorus value at Site 6 was the highest it has been since 1998. This is notable given the higher phosphorus levels in the early and mid-1990s occurred prior to the efforts to reduce point-source phosphorus inputs entering the system in the Table Rock

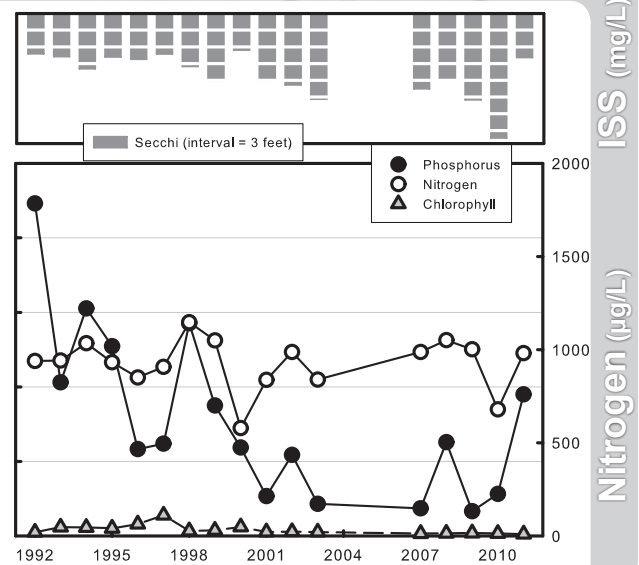
Lake watershed. Higher phosphorus at Site 6 probably reflects flooding that occurred in the spring of 2011 in Table Rock Lake. Secchi transparency during summer 2011 was low at Site 6 relative to readings from the last decade. Shallower Secchi readings did not seem to be the result of increased algal levels given the low chlorophyll values measured in 2011. Elevated amounts of suspended sediment in the water would account for a decline in transparency.



2011 GRAPHS



TREND GRAPHS



See page 3 for help interpreting graphs

Lake Taneycomo Site 10

Taney County

2011 DATA

Latitude: 36.5967

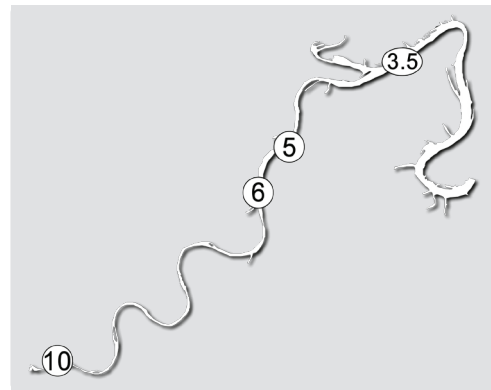
Longitude: -93.2950

Date	X	X	6/10	6/29	7/28	8/9	X	X	Mean
Secchi (inches)									
TP (µg/L)			50	43	62	97			60
TN (µg/L)			710	750	990	1410			929
CHL (µg/L)			0.6	0.5	6.2	7.7			1.9

Phosphorus and nitrogen both displayed a 2-fold difference in concentrations during the 2011 season, which is notable given sample collection was limited to a two month period during the summer. This amount of variation in the nutrient data is not unusual for a Missouri lake, but usually includes either samples from springtime when inflows into the lake are the greatest or samples from fall when the lake is starting to de-stratify.

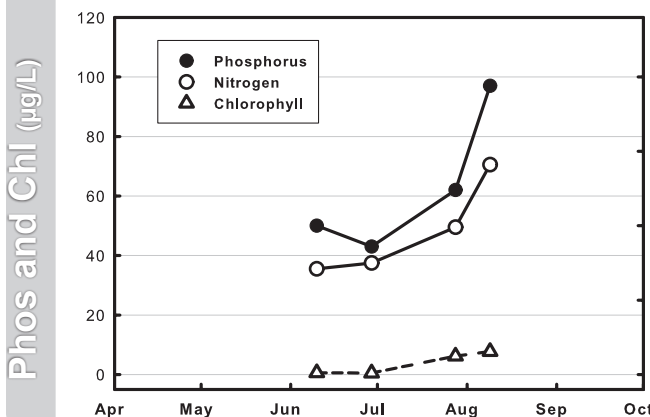
The summertime phosphorus mean at Site 10 was higher in 2011 than in any other summer of the last 20 years. This was not a function of one or two extreme values as the minimum concentration measured in 2011 (43 µg/L) exceeded all of the previous annual values. Springtime flooding in Table Rock Lake could account for the increase in phosphorus con-

centrations at Site 10 as this site represents the water coming into Taneycomo from Table Rock. In contrast, nitrogen and chlorophyll levels in 2011 were similar to previous data.



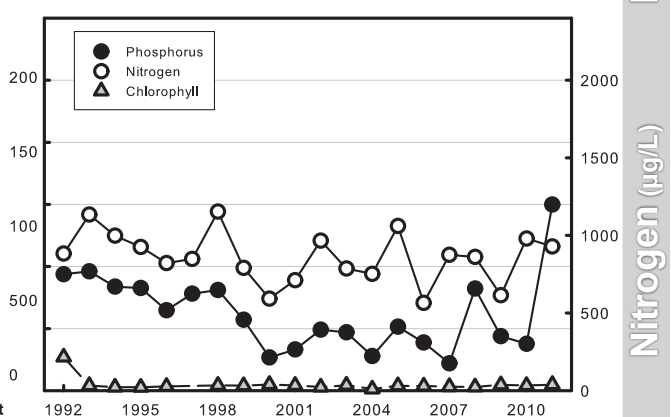
2011 GRAPHS

Secchi disk hits bottom at Site 10



TREND GRAPHS

Secchi disk hits bottom at Site 10



See page 3 for help interpreting graphs

Tri City Lake



2011 DATA

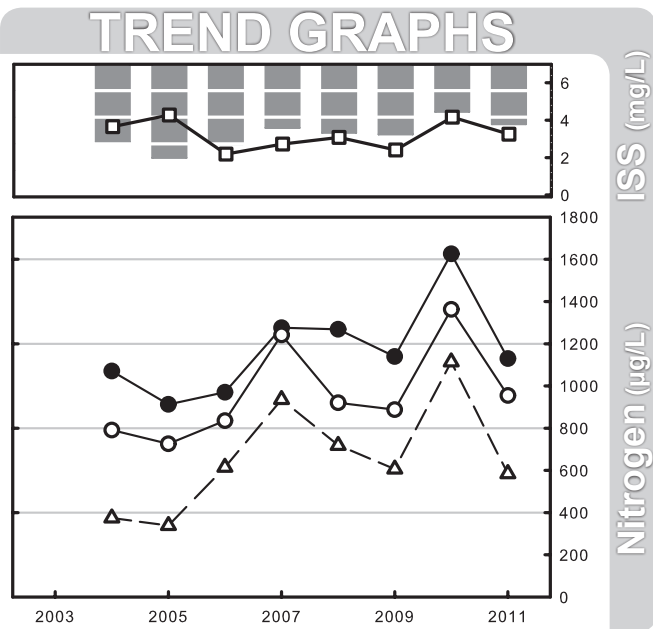
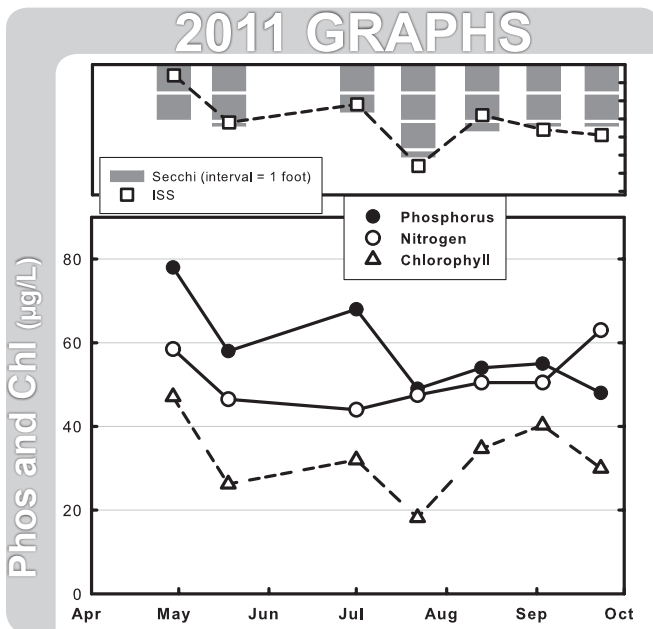
Boone County
Latitude: 39.1904 Longitude: -92.2085

Date	4/29	5/18	X	7/1	7/22	8/13	9/3	9/23	Mean
Secchi (inches)	24	26		20	39	28	26	26	27
TP (µg/L)	78	58		68	49	54	55	48	58
TN (µg/L)	1170	930		880	950	1010	1010	1260	1023
CHL (µg/L)	47.1	26.2		32.0	18.2	34.7	40.3	30	31.4
ISS (mg/L)	6.4	3.8		4.8	1.4	4.2	3.4	3.1	3.6

Water quality in Tri City Lake showed moderate levels of variation during the 2011 season, with no strong seasonal patterns. Chlorophyll to phosphorus ratios indicate that algae in Tri City Lake were fairly efficient at using the available nutrients, with the ratio averaging 0.56 for the season (median value for Missouri lakes is 0.31 with an inter-quartile range of 0.22 -0.44).

Long-term phosphorus and nitrogen data show that these two nutrients have followed the same pattern of variation since sampling began in 2004. The maximum annual value for each nutrient has been about 1.8 times higher than the minimum annual value, representing a considerable amount of year-to-year variability. Algal chlorophyll concentra-

tions have mimicked the nutrients since 2004, with the maximum annual value being about 3 times higher than the minimum.



See page 3 for help interpreting graphs

Troost Lake



2011 DATA

Jackson County
Latitude: 39.0755

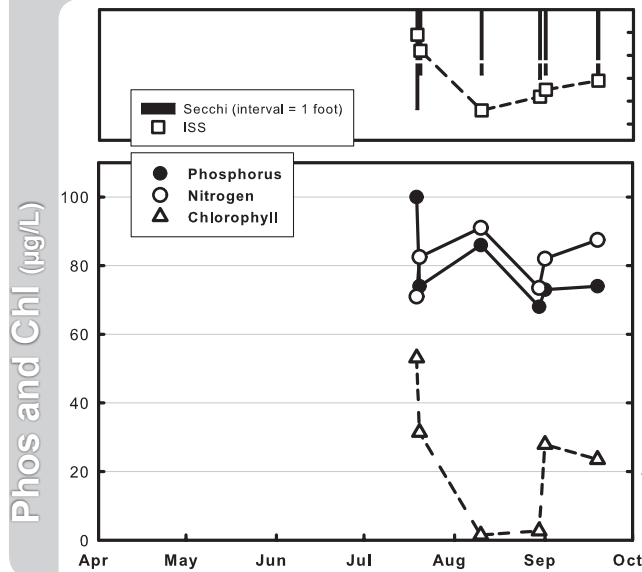
Longitude: -94.5647

Date	X	X	7/19	7/20	8/10	8/30	9/1	9/19	Mean
Secchi (inches)			23	15	15	16	15	16	16
TP (µg/L)			100	74	86	68	73	74	78
TN (µg/L)			1420	1650	1820	1470	1640	1750	1619
CHL (µg/L)			53.1	31.4	1.5	2.7	27.9	23.5	12.8
ISS (mg/L)			3.9	3.2	0.6	1.2	1.5	1.9	1.7

Nutrient levels in Troost Lake were fairly stable during the sample season with maximum values being about 1.4 times higher than minimum concentrations (it is common for phosphorus to vary 3-fold during a sample season in Missouri). While nutrients were stable they were high compared to the 2011 LMVP phosphorus and nitrogen averages. Chlorophyll concentrations in July and September were typical given the nutrient levels, while August chlorophyll values were extremely low. These low chlorophyll values were not the result of increased suspended sediment (ISS) levels which can cause light limitation. Also, decreased algal levels did not result in improved water clarity.

Some of the samples from Troost Lake were collected very close in time to one another (July 19 and 20; August 30 and September 1). Comparison of water quality results within the pairs of samples indicated notable differences. The July 20th sample had 41% less chlorophyll than the sample from the previous day, while the September 1st sample had a chlorophyll concentration that was 10 times that measured two days previously. It is quite likely that these differences are a result of wind accumulating the algae on one side of the lake. High values occur when the wind blows across the lake towards the near shore sample site and low values are measured when the wind blows away from the sample site.

2011 GRAPHS



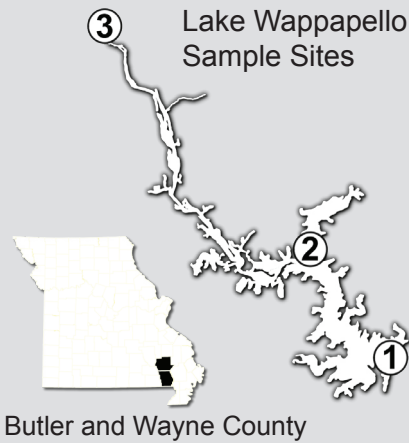
TREND GRAPHS

Not enough data available to characterize a trend

ISS (mg/L)
Nitrogen (µg/L)

See page 3 for help interpreting graphs

Lake Wappapello



Water quality at sites 1 and 2 showed similar patterns, with lower nutrient, chlorophyll and suspended sediment values during the first few samples and higher values as the season progressed. As expected, increased suspended sediment and algal levels led to shallower Secchi transparency readings during the second half of the season. Normally higher suspended sediment concentrations lead to decreased chlorophyll as the sediment limits available light for photosynthesis. At sites 1 and 2 the September chlorophyll values were more than 10 times higher than the June values even though the suspended sediment concentrations were 4 to 5 times greater in September.

Site 1

Latitude: 36.9337 Longitude: -90.2833

Date	X	X	6/8	7/1	7/22	8/9	9/1	X	Mean
Secchi (inches)			66	48	36	19	18		33
TP (µg/L)			16	24	23	49	61		31
TN (µg/L)			200	200	330	760	990		398
CHL (µg/L)			5.5	7.7	13.5	44.4	74.3		18.0
ISS (mg/L)			1.2	1.8	3.0	7.4	4.8		3.0

Site 2

Latitude: 36.9888 Longitude: -90.3351

Date	X	X	6/8	7/1	7/22	8/9	9/1	X	Mean
Secchi (inches)			66	40	36	19	13		30
TP (µg/L)			25	28	47	64	77		44
TN (µg/L)			280	240	360	610	930		424
CHL (µg/L)			5.9	11.2	23.2	48.3	62.9		21.6
ISS (mg/L)			1.6	4.5	9.4	12.6	7.8		5.8

Site 3

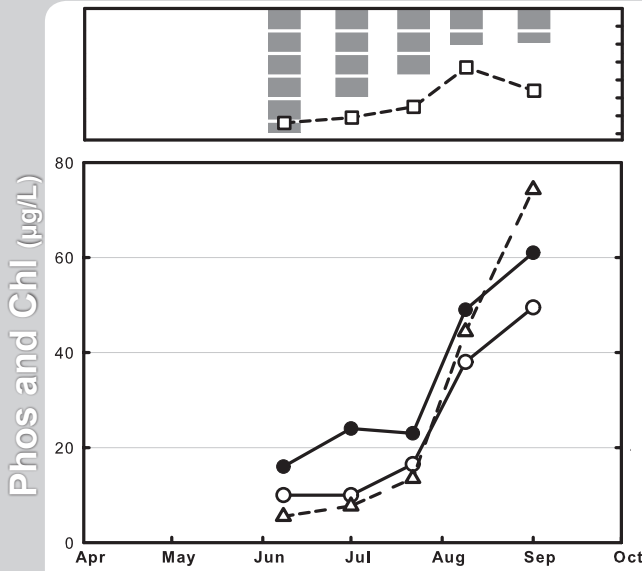
Latitude: 37.1945 Longitude: -90.5037

Date	X	X	6/8	7/1	7/22	8/9	9/1	X	Mean
Secchi (inches)			27		30		24		27
TP (µg/L)			24	30	17	18	16		20
TN (µg/L)			220	130	180	190	240		188
CHL (µg/L)			11.4	10.7	5.4	6.0	5.7		7.4
ISS (mg/L)			6.2	3.7	5.8	3.0	3.8		4.3

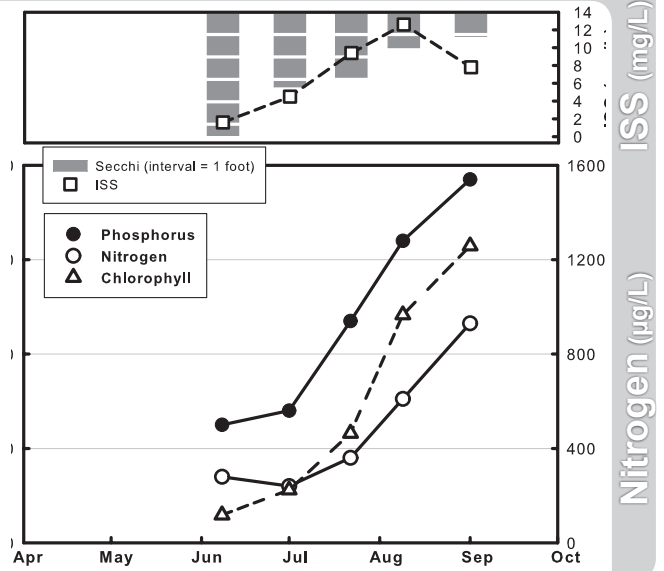
Lake Wappapello - Sites 1 and 2

2011 GRAPHS

Site 1 - 2011 Data



Site 2 - 2011 Data

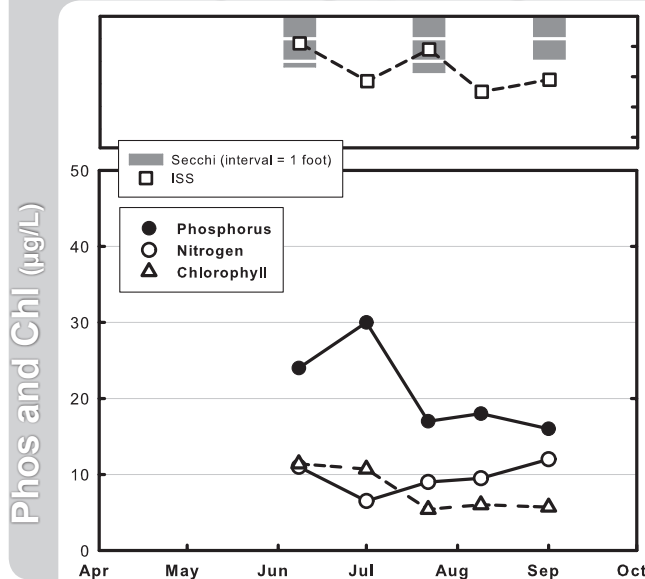


Lake Wappapello Site 3

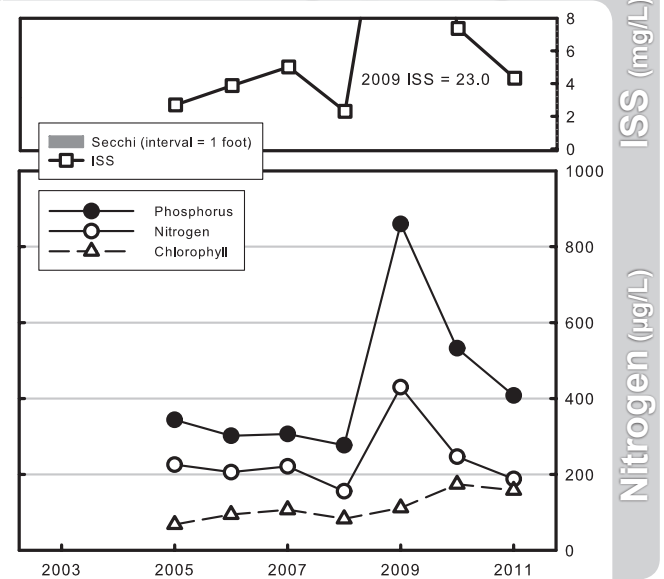
Site 3 differed from the other two sites in that there was not a distinct seasonal pattern of change in water quality. This site is located far enough upstream that water quality reflects

inputs coming into Lake Wappapello, while sites 1 and 2 are truly lake sites that react to in-lake processes such as internal loading and frequent mixing.

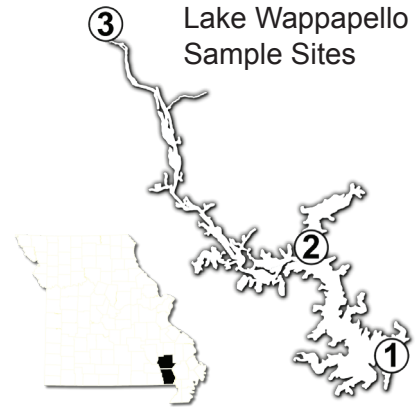
2011 GRAPHS



TREND GRAPHS



Lake Wappapello - Trend Discussion

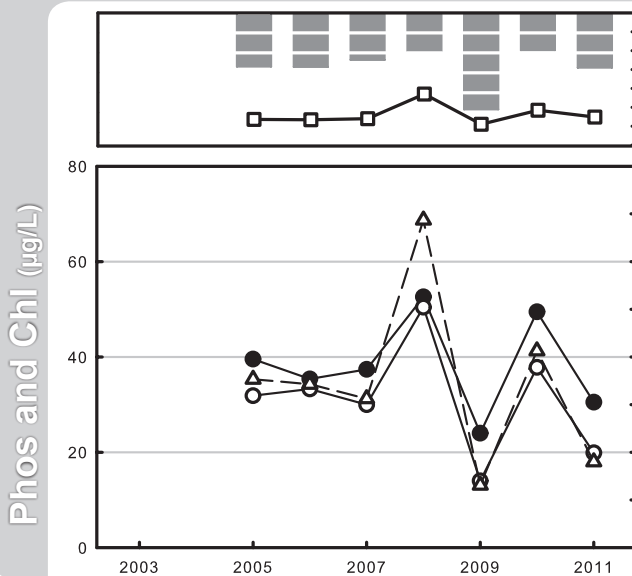


Water quality at Sites 1 and 2 was stable during the first three years of monitoring (2005-07) with only minor differences in summertime mean values from one year to the next. In contrast, the last four summers have exhibited much more year-to-year variation in water quality. These recent fluctuations are normal for Missouri reservoirs. None of the parameters display a trend of increasing or decreasing values at the current time.

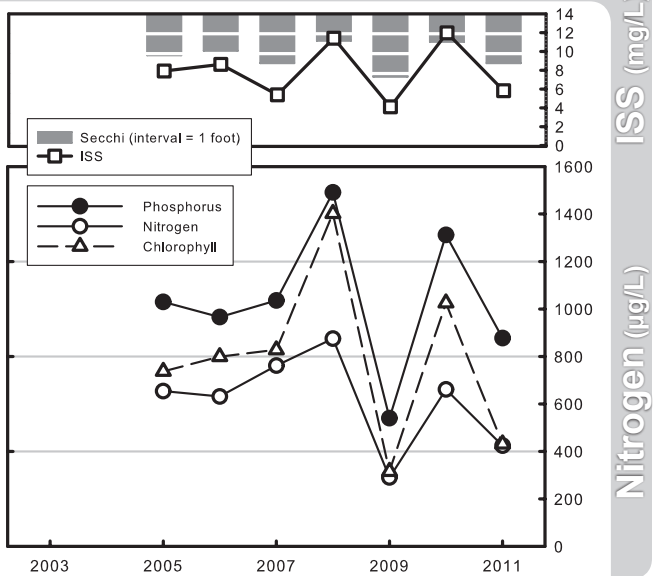
The long term trends in water quality at Site 3 show the last three summers have had higher phosphorus levels that the first four summers of sampling. Increased phosphorus resulted in slightly higher chlorophyll values. While nitrogen was notably higher in 2009, the last two summers have not differed from previous values. Because Site 3 is located fairly far up the St. Francois River Arm, sample results are very dependent on the timing of sample collections relative to rain events in the watershed. Because of the expected variability at this site, it is hard to know if phosphorus is truly trending up or if the results are a function of sample timing.

TREND GRAPHS

Site 1 - Long-Term Trends



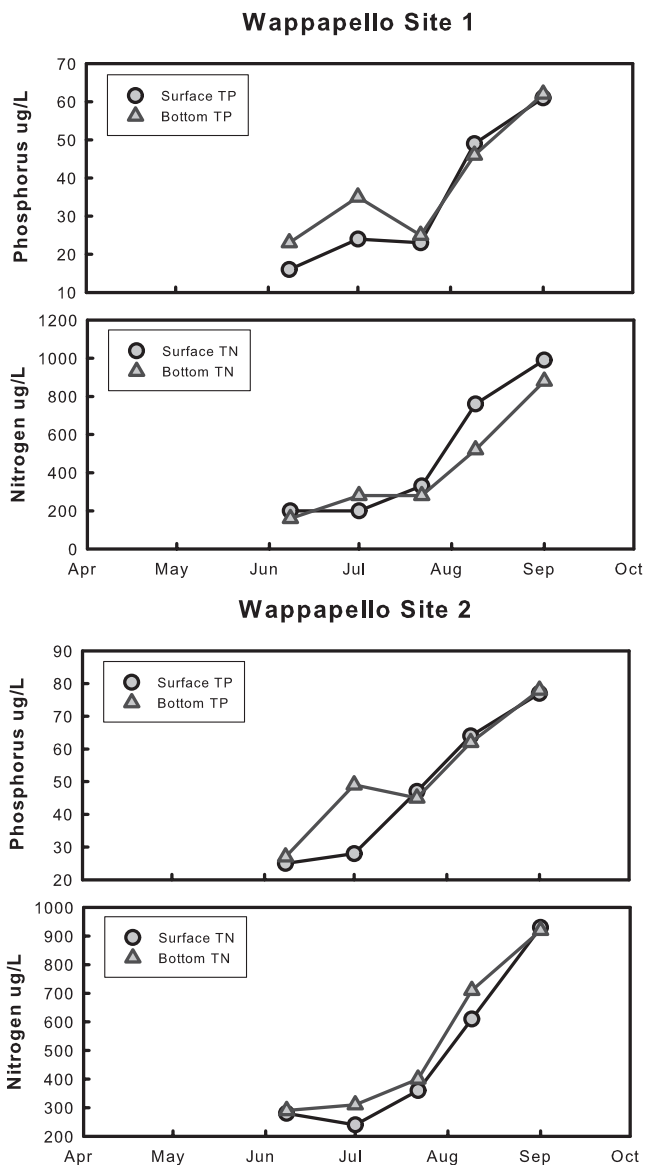
Site 2 - Long-Term Trends



Lake Wappapello Bottom to surface comparison

During the 2011 season samples were also collect near the bottom of the lake at sites 1 and 2 in order to gauge the influence of internal loading in Lake Wappapello. Comparisons of surface and bottom water quality varied from one sample to the next. During the first and second samples the bottom water generally had more phosphorus, chlorophyll and inorganic suspended sediment than the surface water (nitrogen showed minimal differences). This changed by late July when water quality at both sites was virtually the same in top and bottom waters. Samples collected in August and September had mixed results, with phosphorus remaining equal top to bottom at both sites, while chlorophyll was slightly higher in the bottom samples at both sites. Nitrogen was puzzling with the surface value being higher than the bottom value at site 1 in August, while Site 2 had higher nitrogen values in the bottom sample on the same date.

The results of the surface-bottom comparisons suggest that during the first part of the season there was thermal stratification with differences in water quality between the top and bottom layer of the lake. The third sample would seemed to have been collected while the lake water was actively mixing, thus the similarity in water quality top to bottom. The last two samples did show some differences between surface and bottom samples for some parameters. These samples may have been collected long enough after a mixing event that differences between surface and bottom waters were starting to develop.



Site 1 - Bottom Sample

Date	X	X	6/8	7/1	7/22	8/9	9/1	X	Mean
TP (µg/L)			23	35	25	46	62		36
TN (µg/L)			160	280	280	520	880		356
CHL (µg/L)			10.6	17.4	14	52.1	78.1		25.4
ISS (mg/L)			2.4	7.2	3.6	7.2	9.6		5.3

Site 2 - Bottom Sample

Date	X	X	6/8	7/1	7/22	8/9	9/1	X	Mean
TP (µg/L)			27	49	45	62	78		49
TN (µg/L)			290	310	400	710	920		472
CHL (µg/L)			13.1	20.7	24.1	57.1	78.5		31.1
ISS (mg/L)			2.4	14	8.8	11.6	10		8.1

Waterworks Lake



2011 DATA

Randolph County
Latitude: 39.4162

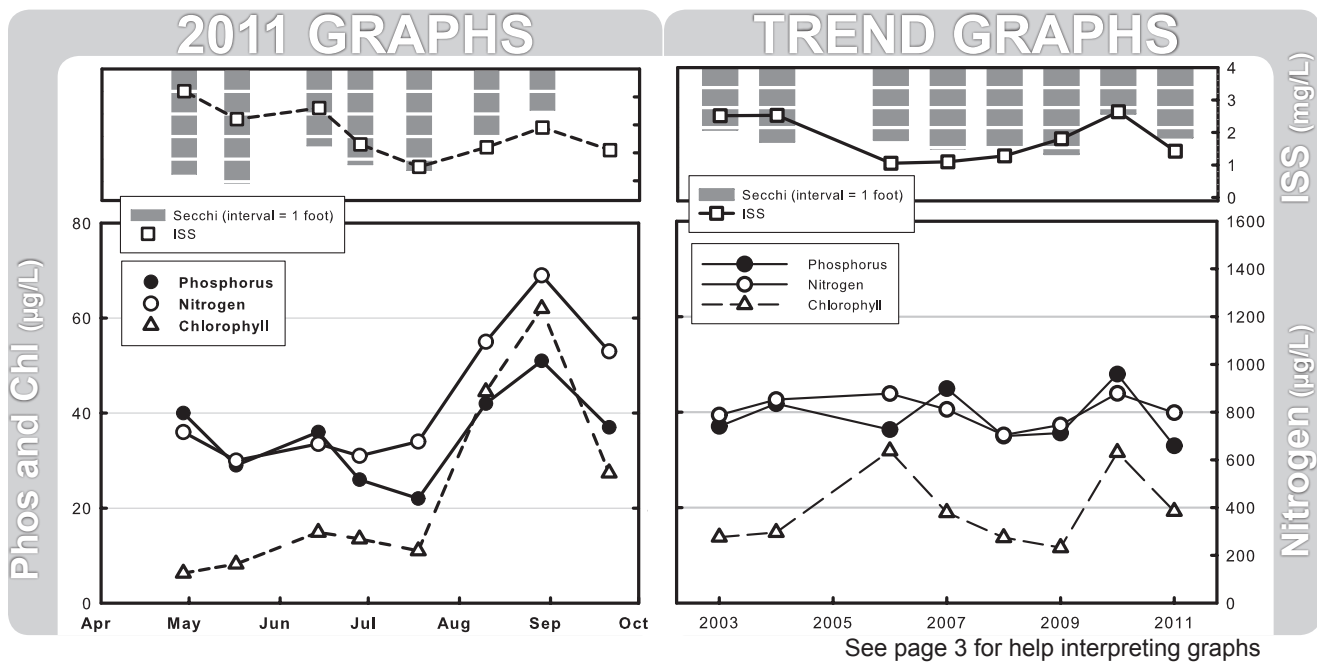
Longitude: -92.4646

Date	4/29	5/17	6/14	6/28	7/18	8/10	8/29	9/21	Mean
Secchi (inches)	56	61	41	51	54	36	22		44
TP (µg/L)	40	29	36	26	22	42	51	37	34
TN (µg/L)	720	600	670	620	680	1100	1380	1060	816
CHL (µg/L)	6.3	8.2	14.9	13.5	11.0	44.5	62.0	27.4	17.5
ISS (mg/L)	3.2	2.2	2.6	1.3	0.5	1.2	1.9	1.1	1.5

During the 2011 season nutrient and chlorophyll concentrations were relatively stable May through July, while samples collected in August and September showed elevated values (especially nitrogen and chlorophyll). Increases in algal chlorophyll were not simply a function of elevated nutrient levels as the ratio of chlorophyll to phosphorus (a way of gauging how effective algae are at using nutrients) was much higher during the last three samples. The average chlorophyll-phosphorus ratio for this period was 1.01, a value that represents extremely efficient use of nutrients by the algae. In contrast, the ratio for the first five samples averaged 0.37, a value that is normal for Missouri lakes.

ies from one year to the next, there are no identifiable trends observed in Waterworks Lake.

Waterworks Lake has been sampled in eight of the last nine years. While water quality var-



Whitecliff Park Lake



2011 DATA

St. Louis County
Latitude: 38.5561

Longitude: -90.3688

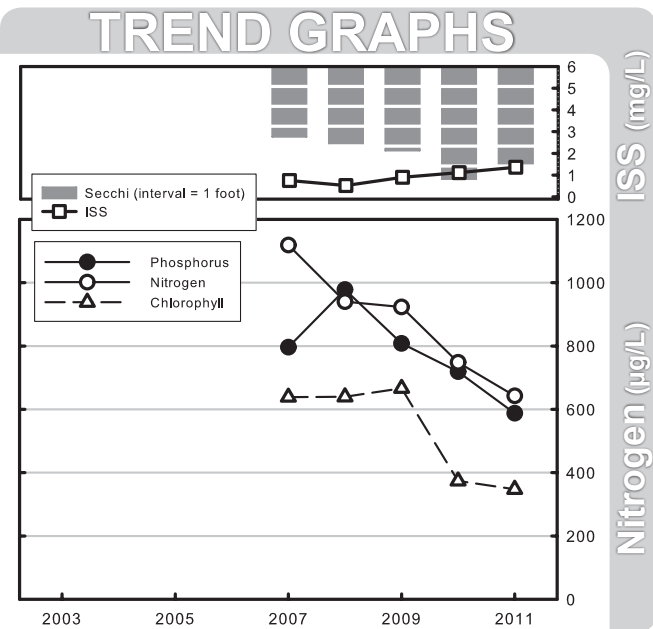
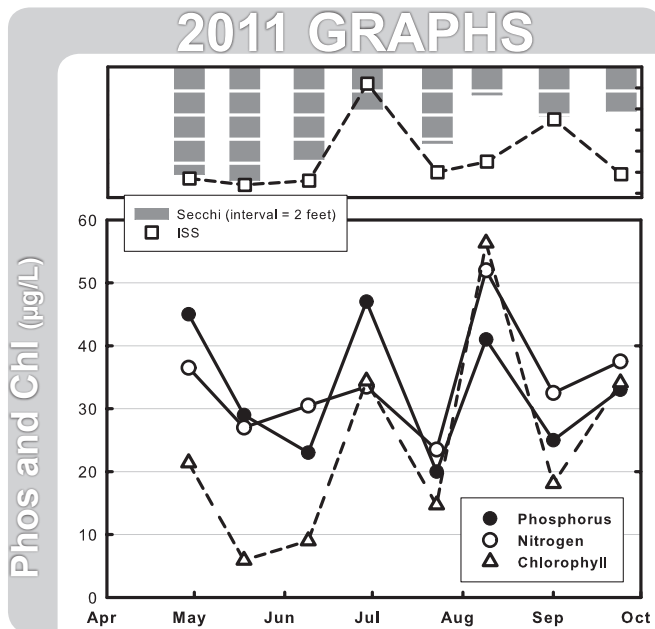
Date	4/29	5/18	6/9	6/29	7/23	8/9	9/1	9/24	Mean
Secchi (inches)	107	113	92	42	76	28	49	44	62
TP (µg/L)	45	29	23	47	20	41	25	33	31
TN (µg/L)	730	540	610	670	470	1040	650	750	665
CHL (µg/L)	21.4	5.9	9.0	34.4	14.7	56.3	18.1	34.1	19.4
ISS (mg/L)	0.7	0.4	0.6	5.2	1.0	1.5	3.5	0.9	1.2

Water quality parameters in Whitecliff Park Lake did not display the predictable seasonal pattern of decreasing nutrients and suspended sediment that is common in Missouri lakes. The variable nature of water quality in this lake may relate to it being in an urban setting (most monitored lakes in the state have more rural watersheds). Differences in the land use within the watershed would affect the timing and amounts of inputs entering the lake.

Algal chlorophyll concentrations tended to track fluctuations in nutrients, though the amount of chlorophyll being produced relative to available nutrients changed during the season. During the first three samples the chlorophyll-phosphorus ratio (a way of gauging how efficient the algae use phosphorus) averaged 0.36, a value that is within the normal range for Missouri lakes. During the remainder of

the season the ratio averaged 0.92, a value that represents very efficient use of nutrients by the algae.

Over the five years in which Whitecliff Park Lake has been monitored the total nitrogen values during the summer have declined. In 2007 the summer geometric mean total nitrogen value was 1119 µg/L, while the 2011 mean was 642 µg/L. This represents a decline of 43%. The maximum summer mean phosphorus value occurred in the second year of monitoring, but has also declined over the last four summers by about 39% (49 µg/L in 2008 and 29 µg/L in 2011).



See page 3 for help interpreting graphs

