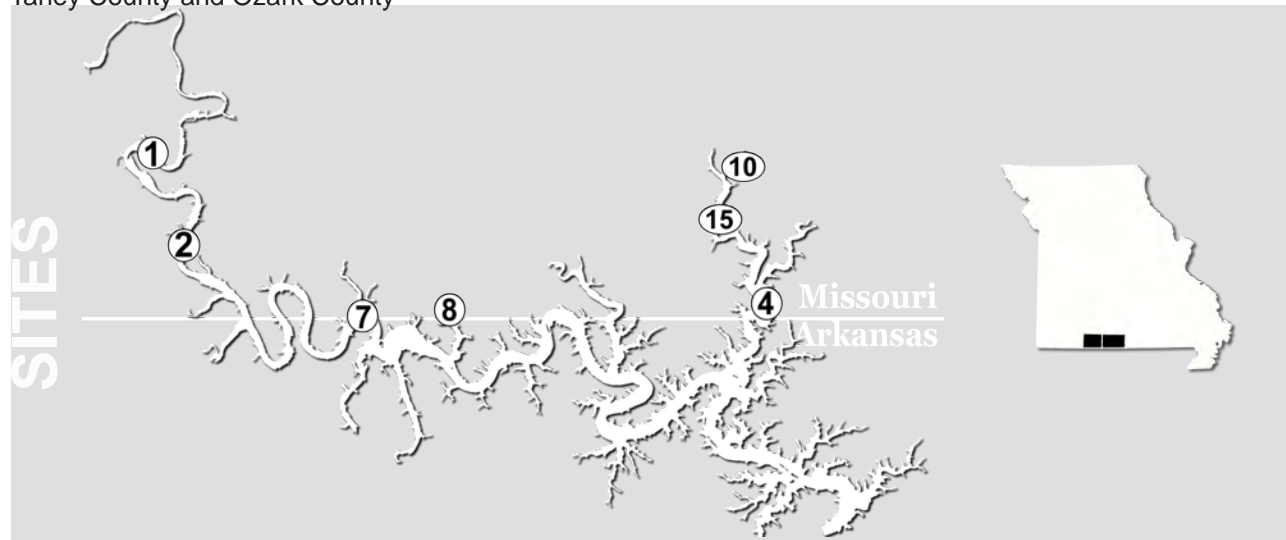


# Bull Shoals Lake

Taney County and Ozark County



Seven sites were monitored on Bull Shoals Lake in 2009, including three main lake sites (Sites 1, 2 and 7), three Little North Fork sites (Sites 10, 15 and 4) and one Shoal Creek Arm site (Site 8). Because the three main lake sites and the Shoal Creek site had similar water quality conditions in 2009, data will be reported together in the following review. With the exception of chlorophyll concentrations, the range of values observed in the Little North Fork sites was greater than the range found in the main lake.

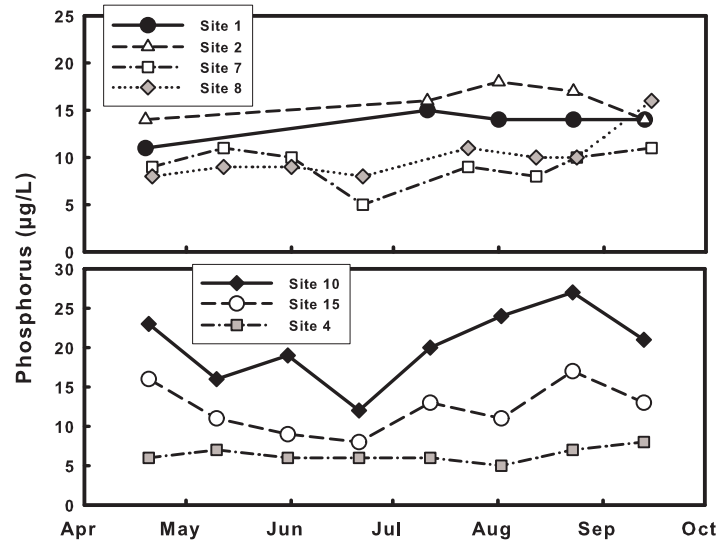
Overall, 2009 marked a return to normal for most sites following the extensive flooding of 2008. Site 2 was the exception to this, recording its highest seasonal mean concentrations of phosphorus, nitrogen and chlorophyll to date in 9 years of monitoring. Only the mean Secchi at Site 2 was near the long-term average. Water clarity (as measured by Secchi disk) was greatest during the third weekend in June at those sites reporting data. For sites 7 and 8 the water clarity was effectively double that observed during the remainder of the season.

		Main Channel			Shoal Creek	North Fork Arm		
<b>SITE</b>		<b>1</b>	<b>2</b>	<b>7</b>	<b>8</b>	<b>10</b>	<b>15</b>	<b>4</b>
SECCHI (inches)	Number of Samples	5	5	8	8	8	8	8
	Mean	80	84	88	90	70	88	163
	Minimum	68	62	60	63	31	66	113
	Maximum	95	96	184	160	145	160	240
TP (µg/L)	Mean	14	16	9	10	20	12	6
	Minimum	11	14	5	8	12	8	5
	Maximum	15	18	11	16	27	17	8
TN (µg/L)	Mean	600	404	314	341	627	436	414
	Minimum	280	320	200	240	420	300	280
	Maximum	760	620	640	510	1060	750	510
CHL (µg/L)	Mean	2.9	10.4	5.6	5.0	8.5	6.4	2.8
	Minimum	1.7	9.8	2.4	2.1	5.2	2.2	1.2
	Maximum	9.9	11.8	10.4	12.4	14.4	10.7	7.4

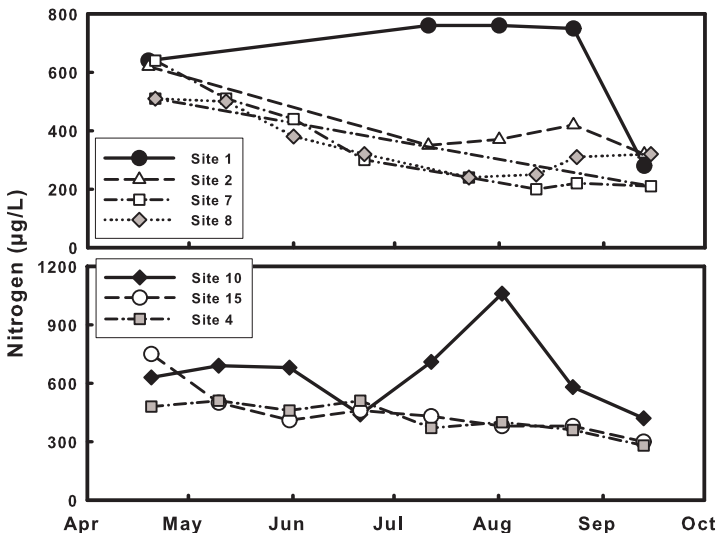
# Bull Shoals Lake

# 2009 Seasonal Data

Main lake and Shoal Creek phosphorus concentrations were stable throughout the season and comparable across sites. Site 2 had the highest concentrations of all main lake sites, marginally higher than at Site 1. Mean phosphorus concentrations varied by just 7  $\mu\text{g/L}$  across these 4 sites. Phosphorus concentrations in the Little North Fork Arm varied considerably more than in the main lake, both throughout the season and among the sites. Mean phosphorus values varied more than three-fold from the site farthest from the main lake (Site 10) to the site nearest the main lake (Site 4). Site 10 had considerably more variability across the season than any other site, with a 2009 maximum that is 15  $\mu\text{g/L}$  higher than the minimum. In contrast, the difference between the 2009 maximum and minimum at Site 4 was just 3  $\mu\text{g/L}$ .



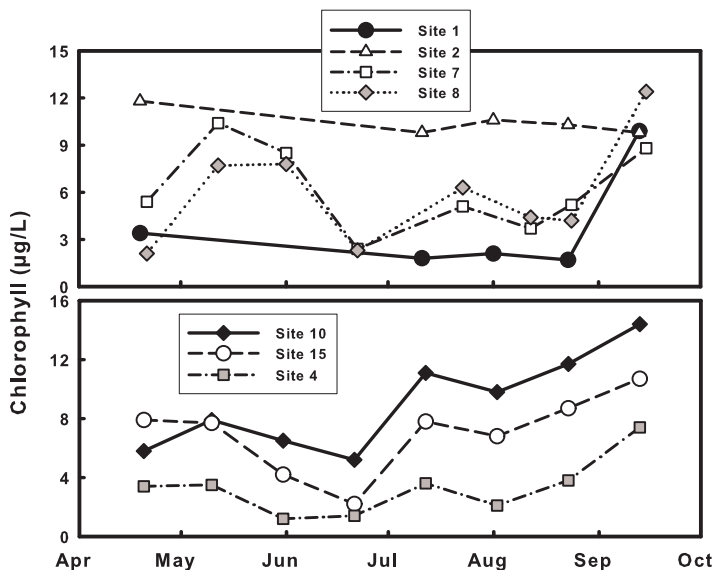
Mid-summer nitrogen concentrations at Site 1 were comparatively high, roughly double the values observed at the other main lake sites. However, early and late values at Site 1 were comparable to other sites and the resulting mean was only 50% greater than the mean of Site 2. All other main lake sites (and Shoal Creek) exhibited the same seasonal trend of decreasing nitrogen concentrations and had similar values throughout the season. Sites 4 and 15 on the Little North Fork Arm had nearly identical nitrogen concentrations during 2009, differing only in April. Site 10, the uppermost site in the arm, had the highest nitrogen values of any Bull Shoals site in 2009 with a seasonal maximum exceeding 1000  $\mu\text{g/L}$ .



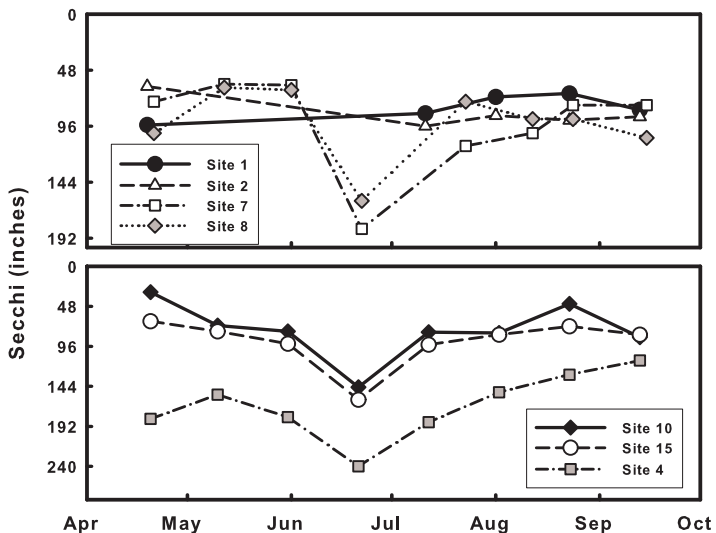
# Bull Shoals Lake

# 2009 Seasonal Data

Chlorophyll concentrations at three main lake sites peaked during September. For sites 1, 7 and 8 the end of season chlorophyll values were roughly three times higher than the previous sample (late August). Site 2 had chlorophyll concentrations higher than the other main lake sites, more than three times higher than the values observed at Site 1. Sites 7 and 8 had nearly identical chlorophyll concentrations and exhibited the same seasonal trend, with peak values in May and September. Chlorophyll concentrations and seasonal variability increased with distance up the Little North Fork Arm of Bull Shoals Lake, albeit only slightly. Site 4, nearest the main lake, varied by just 6 µg/L during 2009, while Site 10 varied by 9 µg/L. Sites 4, 7, 10 and 15 had their lowest chlorophyll concentrations of the season during June 21-23. This period coincides with lake-wide water clarity peaks (see Secchi graphs below).



Water clarity in Bull Shoals Lake is typically among the very best in Missouri. Mean Secchi values at the main lake sites were between 80 and 90 inches, with peak clarity occurring June 21-23. On these days the Secchi values were 13 and 15 feet for sites 8 and 7, respectively. Clarity was comparatively stable throughout the season otherwise. Water clarity in the upper Little North Fork Arm (sites 10 and 15) showed a trend similar to the main lake, with stable conditions throughout the year, save for a peak Secchi value in late June. Water clarity at Site 4 reached 20 feet on June 21, and Secchi values gradually decreased for the remainder of the season to a low of less than 10 feet.

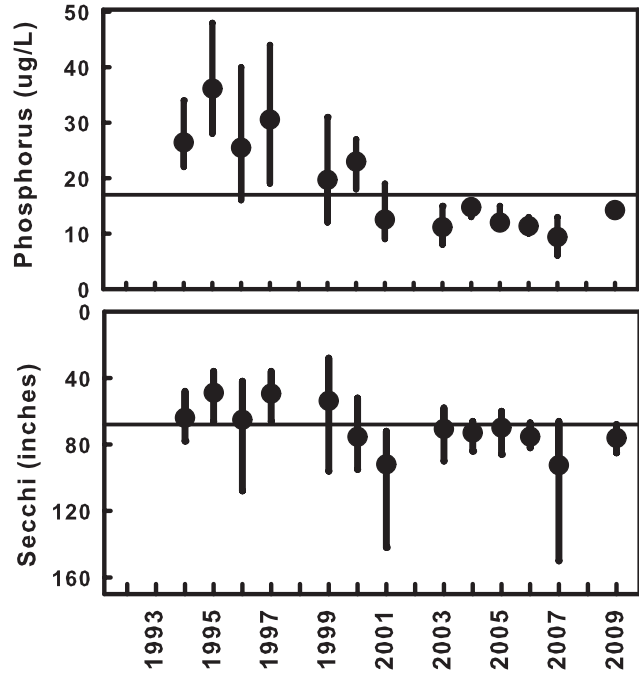


# Bull Shoals Lake

# Main Lake Trend Data

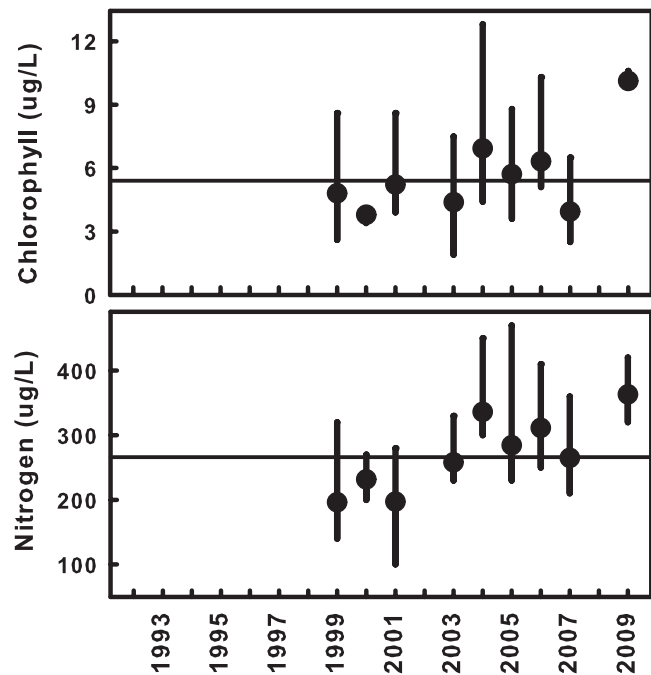
## Site 1

Phosphorus concentrations declined during the late 1990's at Site 1 and leveled out at around 12 µg/L by 2001. Since then, phosphorus concentrations have remained consistent, exhibiting comparatively little seasonal variation or year-to-year variation. This dramatic change is likely due to nonpoint source reduction efforts and phosphorus removal processes implemented at wastewater treatment plants throughout the White River basin. Secchi transparency values have increased by roughly 30% during the same period. All annual mean Secchi values prior to 2000 were shallower than the long-term mean of 68 inches. Since 2001, all seasonal mean Secchi values have been greater than the long-term mean. 2008 was a particularly wet year, with record flooding that eliminated access to both Site 1 and Site 2.



## Site 2

Mean 2009 concentrations of both nutrients and chlorophyll at Site 2 were the highest observed to date. Secchi transparency (not shown) was shallower than the long-term mean, but not atypical of this site. All 2009 chlorophyll values were comparatively high at roughly double the long-term mean, and varied little during the sampling season. High nutrient concentrations undoubtedly supported increased algal growth. Nitrogen concentrations appear to be trending upward, though are still among the lowest observed at Bull Shoals. Nevertheless, nitrogen concentrations should be closely monitored at this site.

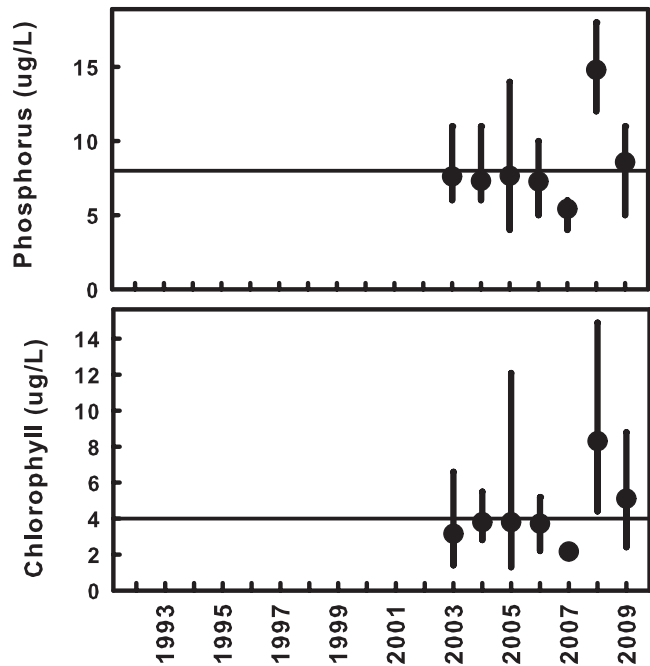


# Bull Shoals Lake

# Main Lake Trend Data

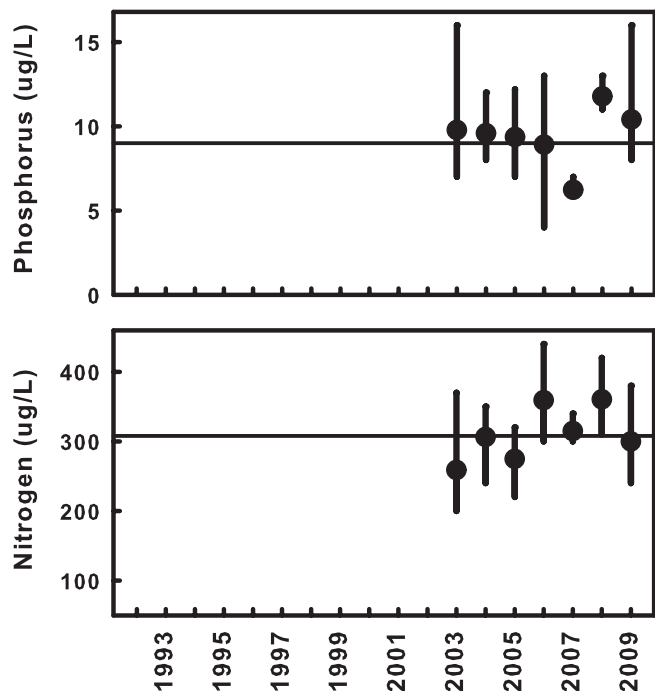
## Site 7

Sites 7 and 8 are in close proximity to one another and similar water quality characteristics. Site 7 is located at the confluence of the main channel and Elbow Creek. Phosphorus concentrations returned to normal in 2009, following the high values associated with the flooding of 2008. The 2009 seasonal mean chlorophyll concentration was the second highest measured to date (behind 2008), though no trend is apparent. Chlorophyll and phosphorus concentrations track one another closely across the years, with 2 units of phosphorus typical for every unit of chlorophyll (chlorophyll to phosphorus ratio of 0.5).



## Site 8

Site 8 is located in the Shoal Creek Arm, but its water quality conditions are similar to those found in the main channel. Phosphorus concentrations at Site 8 mirror those of Site 7 over the long term, but the high values associated with the flooding of 2008 were somewhat tempered by Site 8's separation from the main channel. The mean 2009 seasonal phosphorus concentration at Site 8 was greater than the long-term mean and seasonal variation was greater than the previous two years. The 2009 seasonal nitrogen mean was below the long-term mean and the lowest observed since 2005. Concerns of upward-trending nitrogen concentrations at this site are reduced, but not eliminated.



# Bull Shoals Lake

## Site 10

Bull Shoals Lake's largest arm is the Little North Fork. Site 10 is located at the upper end of the arm, above the town of Theodosia at the mouth of Barren Fork. Phosphorus concentrations at this site have been consistently near 20 µg/L for the last 6 years. The flooding of 2008 had no apparent effect on phosphorus concentrations. Nitrogen values have increased for the 5th consecutive year at Site 10, a phenomenon that appears to be occurring lakewide. The seasonal mean in 2005 was half of the 2009 seasonal mean.

## Site 15

Site 15 is located below the town of Theodosia. Phosphorus concentrations at this site are about 40% lower than found at Site 10, and seasonal means have varied little in the 7 years of monitoring this site. Water clarity as measured by Secchi disk varied by nearly 7 feet in 2009 and the clearest water observed in 7 years was recorded on June 21 (160 inches). The 2009 seasonal mean clarity was greater than the long-term mean for the third consecutive year. 2008 seasonal mean water clarity was the greatest to date, despite the flooding that increased turbidity throughout the main lake.

## Site 4

Site 4 is located at the mouth of Bratten Spring Creek on the Little North Fork Arm, near Pontiac, MO. This site, along with Site 7, have a long-term average phosphorus concentration of 8 µg/L which is the lowest value found at Bull Shoals. Phosphorus concentrations have been at or below the long-term mean for 6 consecutive years. This site has the lowest chlorophyll concentration of any Bull Shoals site monitored by the LMVP (graph not shown), and as a result has the greatest water clarity. Site 4 also has the clearest water of any site monitored by the LMVP, as indicated by long-term mean values. On June 21, 2009 this site had a Secchi reading of 240 inches, its second highest value since 1997.

# Little North Fork Trend Data

