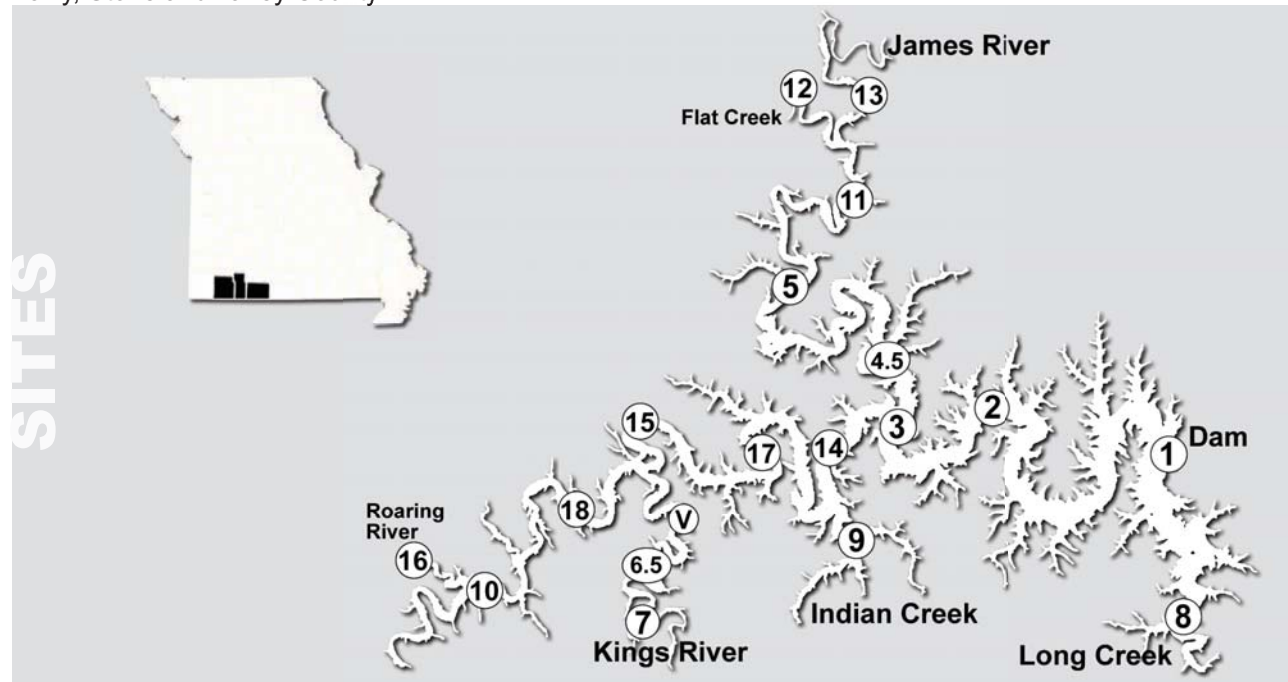


Table Rock Lake

Barry, Stone and Taney County



2006 SUMMARY

During 2006 there were 18 sites monitored on Table Rock Lake. Eight sites were located in the main lake channel, from the dam to the confluence with Roaring River. Four sites were located in the James River Arm, three sites in the Kings River Arm (only Secchi clarity was monitored at Viola Access), and one site each in the Indian Creek Arm, Roaring River and Flat Creek. Samples were not collected in the Long Creek Arm during 2006.

Water quality was similar at main lake sites, with small improvements as site location approached Table Rock Dam. Average phosphorus values in the main lake varied from 4 to 9 $\mu\text{g/L}$, with the highest average values occurring at up-lake sites. Average nitrogen ranged from 260 to 408 $\mu\text{g/L}$, with no identifiable spatial pattern among main lake sites. Chlorophyll concentrations at most main lake sites averaged between 4 to 5 $\mu\text{g/L}$, with Sites 1 and 2 having average chlorophyll levels $<3 \mu\text{g/L}$. Secchi transparency averaged between 112 and 140 inches in the main lake, with deeper transparency near the dam.

Site 4.5 in the lower James River Arm and Site 9 in Indian Creek both had water quality

that was comparable to main lake sites. The remaining sites varied considerably, with average phosphorus ranging up to 58 $\mu\text{g/L}$, average nitrogen ranging up to 1069 $\mu\text{g/L}$, and average chlorophyll up to 32.9 $\mu\text{g/L}$. The maximum averages for nutrients and chlorophyll were all measured at Site 13 in the upper James River Arm.

Gradients in water quality were obvious in both the James River and Kings River arms. Water clarity roughly doubled in each arm between upper most and down-lake sites. In the James River Arm, Site 13 (up-lake) had an average Secchi of 42 inches, while Site 4.5 (down-lake) averaged 77 inches of clarity. In the Kings River Arm clarity averaged 43 inches at Site 7 (up-lake) and increased to an average of 87 inches at Viola Access (down-lake). Nutrients and algal biomass also displayed a longitudinal gradient in the James River Arm. Average phosphorus, nitrogen and chlorophyll values at Site 4.5 were 14%, 35%, and 18% of average concentrations measured at Site 13, respectively. In the Kings River Arm there was about a 50% decrease in phosphorus between sites 7 and 6.5, while nitrogen and chlorophyll showed little change.

Summary Data Table

Table Rock Lake 2006

2006 Table Rock Summary Data

TP = Total Phosphorus;
 TN = Total Nitrogen;
 CHL = Chlorophyll

Main Lake Sites	10		18		15		17		14		3		2		1	
	# of samples	7	5	8	8	8	8	7	7	7	7	7	7	7	8	
Secchi (inches)	Mean	112	121	115	121	127	126	131	140	140	140	140	140	140	140	
	Min	89	92	59	69	89	89	89	87	87	87	87	87	87	87	
	Max	134	157	197	165	158	158	187	195	195	195	195	195	195	195	
TP (µg/L)	Mean	9	9	8	9	7	6	5	4	4	4	4	4	4	4	
	Min	6	6	5	4	4	4	4	2	2	2	2	2	2	2	
	Max	18	12	18	19	13	15	9	10	10	10	10	10	10	10	
TN (µg/L)	Mean	337	305	264	259	332	408	275	372	372	372	372	372	372	372	
	Min	240	230	170	180	260	310	190	300	300	300	300	300	300	300	
	Max	740	410	360	300	440	560	410	500	500	500	500	500	500	500	
CHL (µg/L)	Mean	4.4	4.8	5.5	4.2	4.0	4.5	2.5	2.8	2.8	2.8	2.8	2.8	2.8	2.8	
	Min	2.5	3.5	2.4	1.8	2.9	2.2	0.2	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
	Max	8.3	8.4	15.0	8.3	5.7	13.4	5.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	

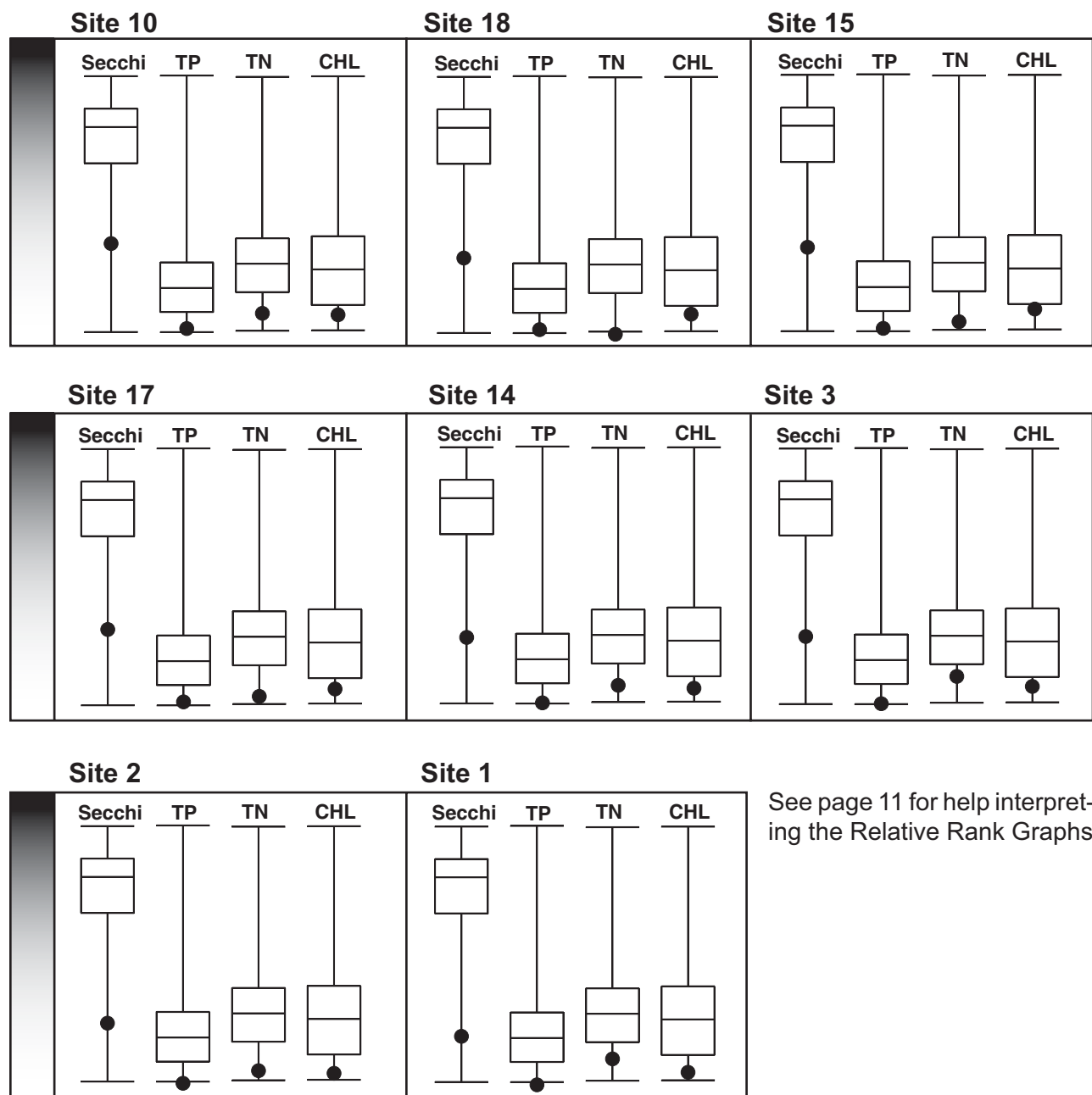
Tributary Sites	13		11		5		4.5		7		6.5		Viola		9		12		16	
	# of samples	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
Secchi (inches)	Mean	42	41	59	77	43	63	87	112	112	112	112	112	112	112	112	112	112	112	
	Min	35	34	42	59	30	54	50	84	84	84	84	84	84	84	84	84	84	84	
	Max	54	53	103	109	62	81	113	142	142	142	142	142	142	142	142	142	142	142	
TP (µg/L)	Mean	58	35	19	8	37	19	12	12	12	12	12	12	12	12	12	12	12	12	
	Min	40	22	11	4	21	10	8	8	8	8	8	8	8	8	8	8	8	8	
	Max	96	68	34	14	63	33	27	27	27	27	27	27	27	27	27	27	27	27	
TN (µg/L)	Mean	1069	691	623	371	436	390	332	332	332	332	332	332	332	332	332	332	332	332	
	Min	590	420	420	230	300	250	240	240	240	240	240	240	240	240	240	240	240	240	
	Max	1840	1250	1230	560	670	860	470	470	470	470	470	470	470	470	470	470	470	470	
CHL (µg/L)	Mean	32.9	31.4	14.1	5.8	14.9	14.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	
	Min	3.0	16.8	6.4	3.4	2.5	6.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	
	Max	93.6	81.1	22.6	12.1	43.9	31.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	

Main Lake Relative Rank Graphs

Table Rock Lake 2006

Nutrient and algal chlorophyll concentrations at main lake sites were low relative to the normal range found in Missouri lakes. In all cases the concentrations measured in 2006 were in the bottom 25th percentile, indicating that nutrient and chlorophyll levels in the main lake channel of Table Rock Lake were lower than those found in 75% of Missouri lakes.

Low algal biomass (as measured by chlorophyll) along with limited impacts from suspended soil materials, allows Secchi readings in the main lake to be some of the deepest in Missouri. The bottom of the relative ranking graphs corresponds with a Secchi depth of about 170 inches. Three main lake sites had individual Secchi measurements that exceeded this value in 2006 (sites 1, 2 and 15).



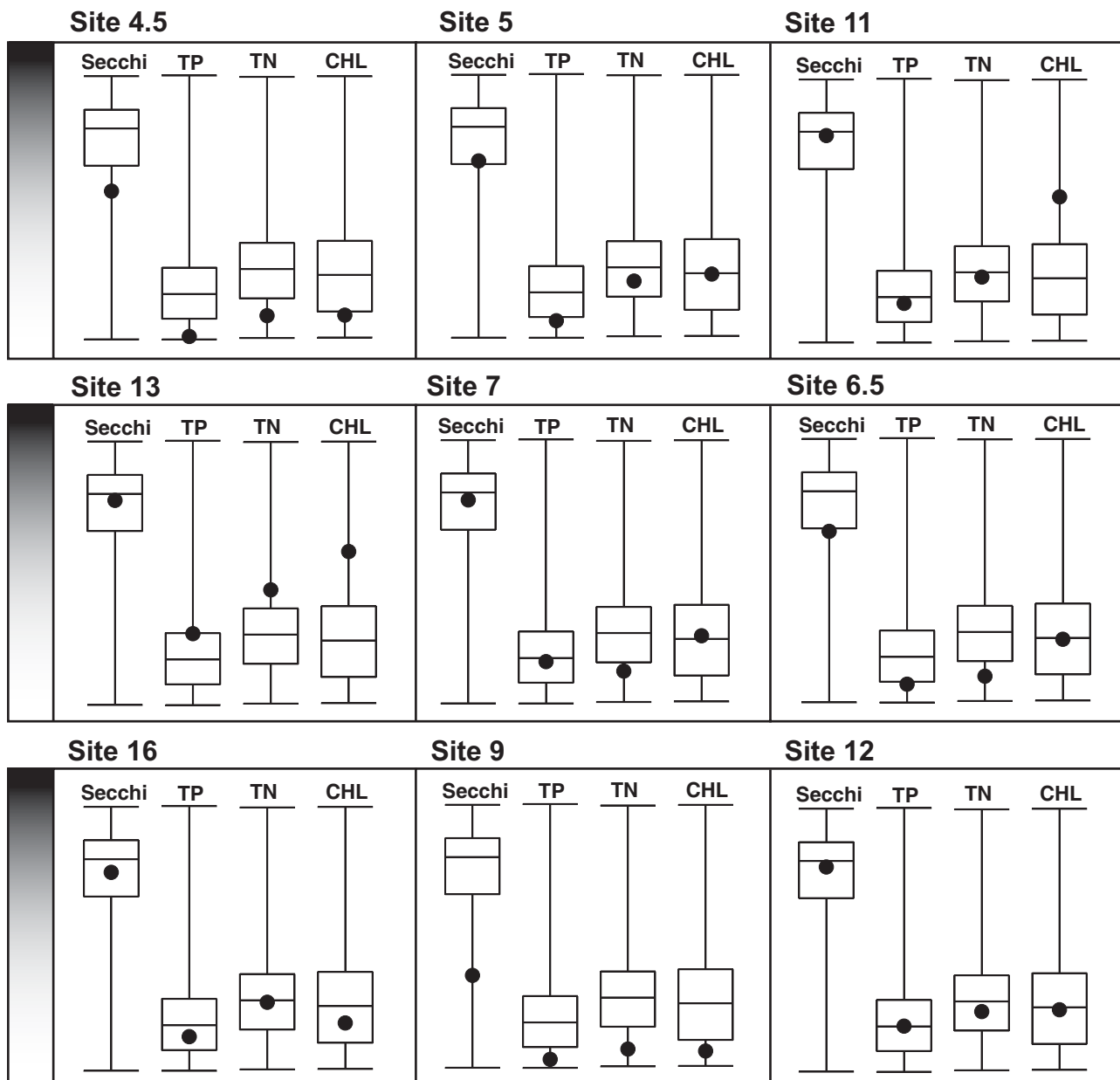
See page 11 for help interpreting the Relative Rank Graphs

Tributary Sites Relative Rank Graphs

Table Rock Lake 2006

Many of the tributary sites had water quality that would be considered normal for Missouri lakes, with average values from 2006 within the middle 50% of Missouri values. In many cases chlorophyll levels ranked higher than nutrients (relative to the median line). This is a result of more efficient algal growth in Table Rock Lake compared to other Missouri lakes. The increase in efficiency relates to the fact that suspended soil materials in Table Rock Lake are generally low. These materials block or absorb sunlight, reducing the potential for photosynthesis in many Missouri lakes.

Only Site 13 had water quality that was worse than the “average” Missouri lake, with nutrient and chlorophyll levels that were at or above the 75th percentile level. Even though algal chlorophyll at this site was higher than more than 75% of Missouri lakes, the water clarity as measured by the Secchi transparency was still below the median value (deeper Secchi readings than more than half the lakes in the state). The greater Secchi readings reflect the minimal impact of suspended soils on water clarity in Table Rock Lake.



Long Term Trends

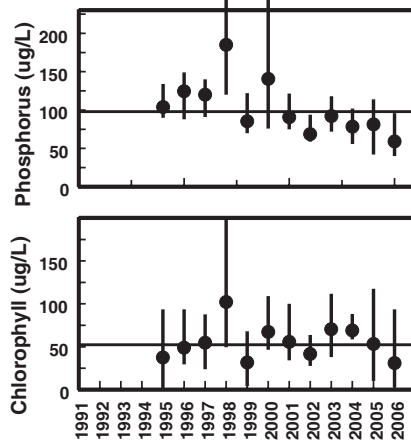
Table Rock Lake 2006

TABLE ROCK TRENDS

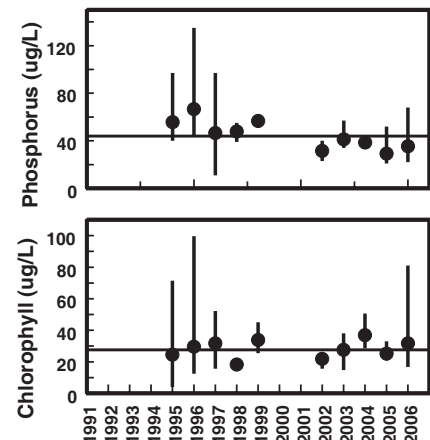
The most noticeable trend in Table Rock Lake is the reduction of phosphorus concentrations associated with upgrades to Springfield's Southwest Treatment Plant. In 2001 the plant started meeting regulated standards for phosphorus output. Since then, phosphorus levels in the James River Arm of the lake have decreased. Reductions have been greatest in the upper James River Arm (Site 13), where the highest concentrations occur. Sites 11 and 5 also display obvious reductions in phosphorus levels since 2001. The reductions in phosphorus are not as obvious at Site 4.5, located in the lower James River Arm at Aunts Creek. While some of the post-2001 annual geometric means at this site have been lower than those measured prior to 2001, there have been a few

years when phosphorus levels were comparable to pre-2001. Phosphorus values are much lower at this site than at other James River Arm sites (long-term mean of 11 µg/L at Site 4.5 as opposed to 24 µg/L at Site 5, 43 µg/L at Site 11 and 99 µg/L at Site 13). Because this site had relatively low levels of phosphorus prior to the treatment plant upgrade, we shouldn't expect the same degree of reduction after the upgrade. Also, the Aunts Creek watershed extends into the Branson West area. During the past few years this area has witnessed a fair amount of development, which could lead to nonpoint source inputs of nutrients into the lake. It is possible that localized nonpoint sources of nutrients could have enough impact to mask the slight decreases we would expect to observe at Site 4.5.

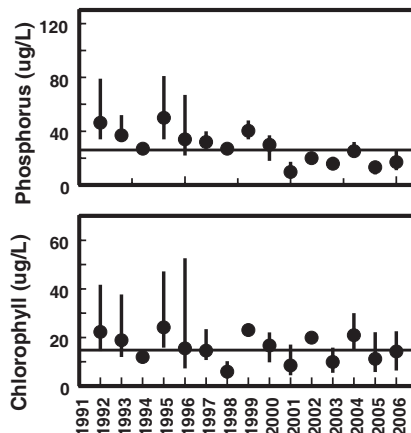
Site 13



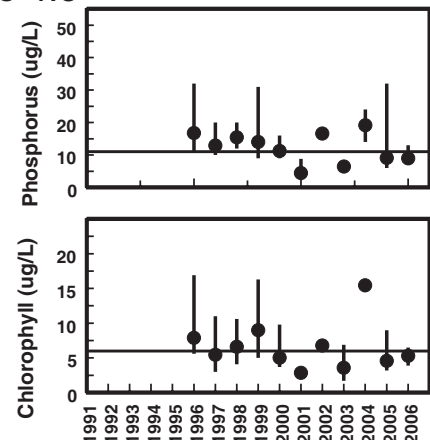
Site 11



Site 5



Site 4.5



Long Term Trends

Table Rock Lake 2006

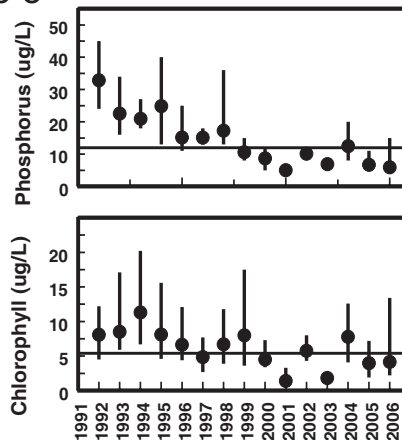
Phosphorus concentrations are decreasing at the main lake sites 3 and 2, down-lake from confluence of the James and the White River channels. Interestingly enough, the reduction began in 1996, prior to most point source reductions of phosphorus releases. The majority of sites located up-lake from Site 3 were not sampled before 1999, so it is impossible to tell if this reduction in phosphorus was occurring directly up-lake from Sites 2 and 3. Site 10 has been monitored since 1994, but shows no sign of decreasing phosphorus during the 1996 period. Site 1 (dam) does show a pattern of slight phosphorus decreases, similar to sites 2 and 3. The reduction in phosphorus at Site 1 is

not as obvious as it is at sites 2 and 3. This is probably due to lower initial phosphorus concentrations and potential influences from Long Creek.

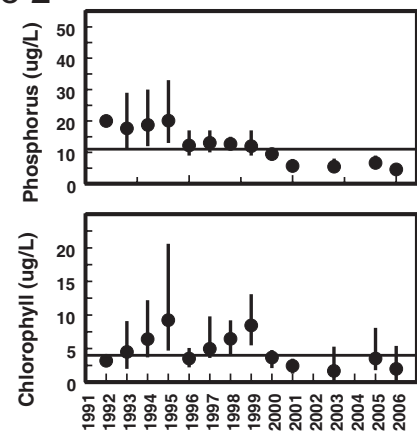
Site 7, located in the Kings River Arm, has also shown a decrease in the phosphorus levels. Median values from the last five years have all been below the long-term mean, averaging around 50 $\mu\text{g/L}$ compared to the 1998-2001 period when phosphorus averaged around 75 $\mu\text{g/L}$. The low phosphorus values from 1996 are misleading as only two samples were collected that summer, both of them during August when we often measure minimal nutrient levels in surface waters.

TABLE ROCK TRENDS

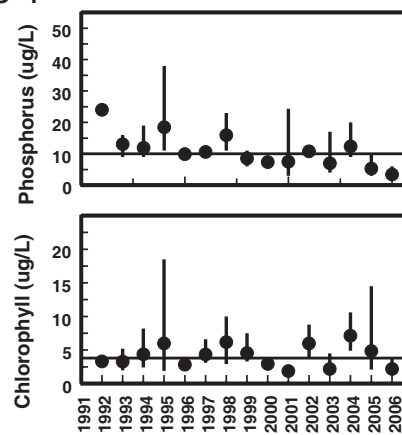
Site 3



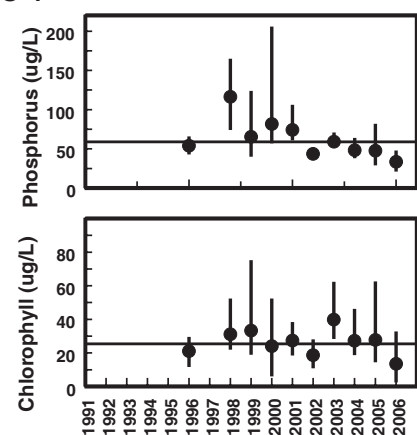
Site 2



Site 1



Site 7



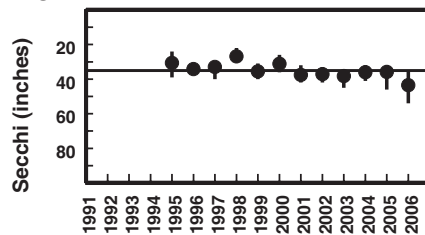
Secchi transparency has increased at Site 13, though the change has been an increase of only a few inches. Maximum Secchi readings at sites 5 and 4.5 have increased in recent years, though water clarity is variable enough at these sites to mask any trends. Water clarity at Site 3 in the main lake is substantially deeper in those years when chlorophyll levels are low, but similar to past values when algal chlorophyll does not respond to lower phosphorus levels. There does not seem to be any obvious trends in Secchi transparency at sites 1 and 2 in the main lake, or Site 7 in the Kings River.

Some concern has been expressed that the reduction in phosphorus in the James River Arm that has occurred since the 2001 improvements in Springfield's Southwest Treatment Plant may have had a negative impact on the fishery in Table Rock

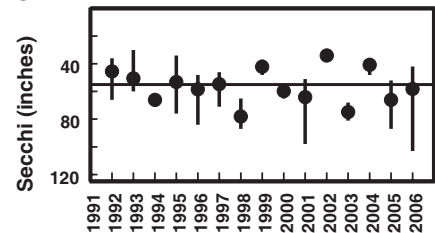
Lake. The worry is that lower nutrient levels have led to a decrease in algal biomass, which in turn would limit the food web that ultimately provides food for game fish such as bass.

While phosphorus has decreased throughout the James River Arm of the lake, algal chlorophyll has not shown an equal response. Chlorophyll levels in the upper James River Arm (Sites 11 and 13) are still relatively high, with median summer values near the long-term average for these sites. In the lower James River (Sites 4.5 and 5) there has been a slight decrease in algal chlorophyll. The main influence of phosphorus reductions at these sites has been to reduce the maximum chlorophyll levels measured during the summer. The changes that have occurred in phosphorus and chlorophyll concentrations are probably not enough to have a drastic effect on the lake's fishery.

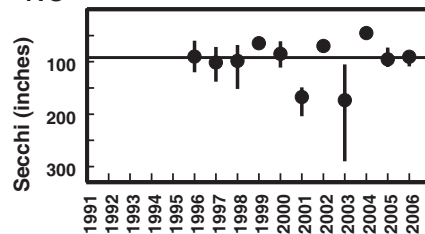
Site 13



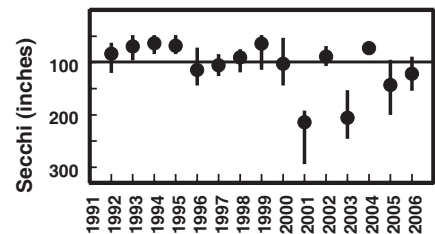
Site 5



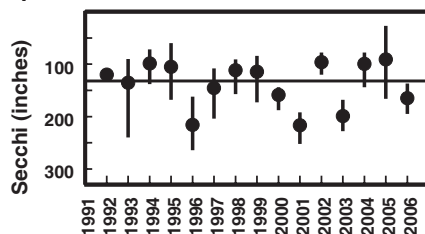
Site 4.5



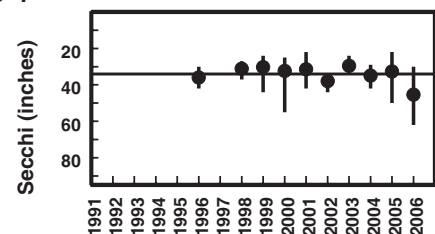
Site 3



Site 1



Site 7



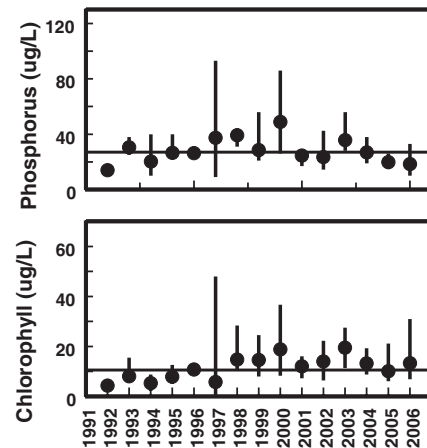
Nitrogen has not shown any trends of decreasing concentration in those sites where phosphorus reduction has occurred. The response of algal chlorophyll (see graphs on the three previous pages) to phosphorus reductions has been mixed. In the upper James River Arm (Sites 13 and 11) summertime chlorophyll has not decreased. In the lower James River (Sites 5 and 4.5), decreases in median chlorophyll values have been minimal, with the most obvious response at these sites being a decrease in the maximum value measured during individual summers. Chlorophyll

reductions at Site 3, in the main lake, have occurred though there are still years when chlorophyll concentrations are similar to those measured prior to the reduction in phosphorus. Reductions in chlorophyll seem more obvious at Site 2, but we are missing data from two years when other main lake sites had higher chlorophyll levels. Chlorophyll concentrations at Site 1 at the dam and Site 7 in the Kings River have not decreased in response to trends of lower phosphorus levels.

Potential Trends at Table Rock Lake

Site 6.5 in the Kings River Arm shows an increase in chlorophyll concentrations starting in 1998. This may be related to a slight shift in site location more than an actual change in the algal biomass within the lake. Because this site is located in a tributary arm, where water quality tends to show a longitudinal gradient, a small shift in site location could very well explain the change in chlorophyll concentrations. Phosphorus levels during the period 1992 – 2000 also show an increase that could relate to a shift in site location. The phosphorus has decreased slightly during the past few years, though all recent values are still near the overall mean.

Site 6.5



Long Term Trends

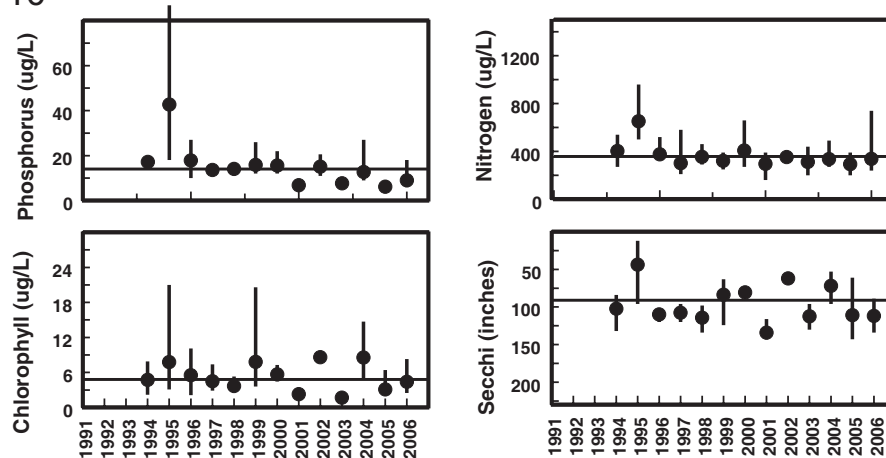
Table Rock Lake 2006

Site 10, the main channel site that is farthest from the dam, has had low phosphorus levels in four of the last six years. This may be a trend reflecting efforts both in the Table Rock Lake and Beaver Lake watersheds to reduce nutrient inputs. Continued sampling will help us identify if

this is a true trend or a not. Chlorophyll values during those four years were also low relative to the site's long-term mean. Secchi transparency readings were deeper than the long-term mean in those years, though not different from some previous years.

TABLE ROCK TRENDS

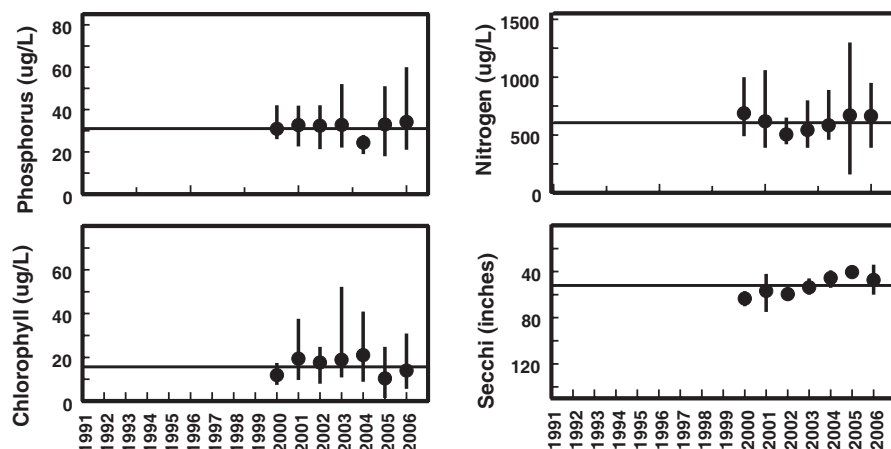
Site 10



Nutrients and algal chlorophyll have not displayed any trends at Site 16, but the Secchi transparency seems to be decreasing. Summer medians during 2000-02 were all greater than the long-term mean, averaging around 60 inches. During the past four years the median Secchi values have

been at or above the long-term mean, averaging around 45 inches. An increase in inorganic suspended sediments (soil materials) would not be measured with the chlorophyll analysis, and may account for changes in water clarity.

Site 16



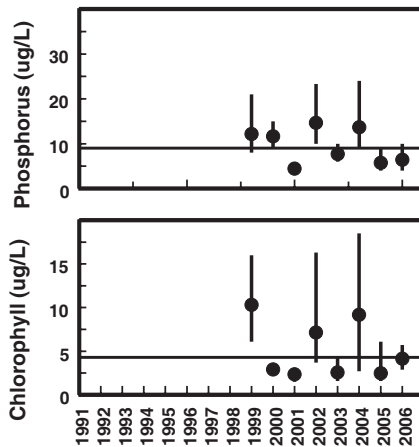
Long Term Trends

Table Rock Lake 2006

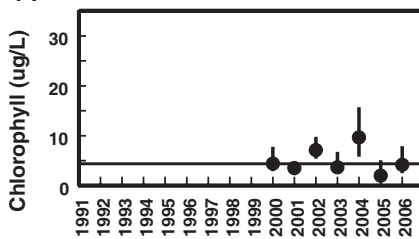
Six sites on Table Rock Lake do not show trends in any of the water quality parameters: Site 9 in Indian Creek, Site 12 in Flat Creek, and sites 14, 15, 17 and 18 in the main lake.

TABLE ROCK TRENDS

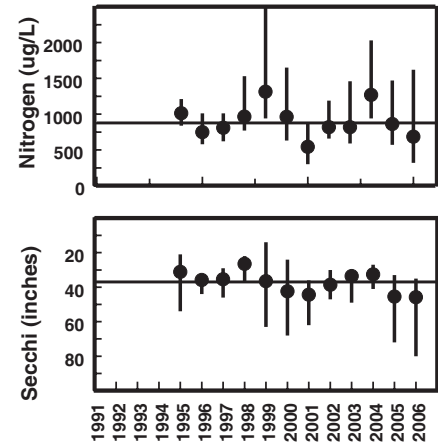
Site 14



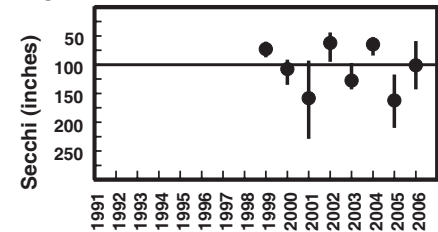
Site 17



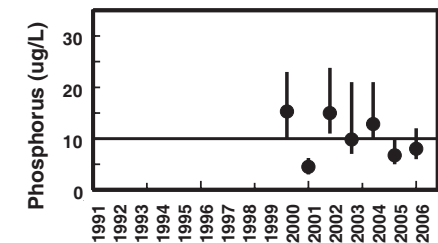
Site 12



Site 15



Site 18



At Site 9 the three lowest summer mean phosphorus concentrations have been measured during the last six years, suggesting that there may be a shift in water quality at this site. It is too early to call it a trend as the intervening years were similar to past years. Sites 14, 15, 17 and 18 have not been monitored for as long as some of the other sites, but no trends as of yet.

Site 9

