

Table Rock Lake

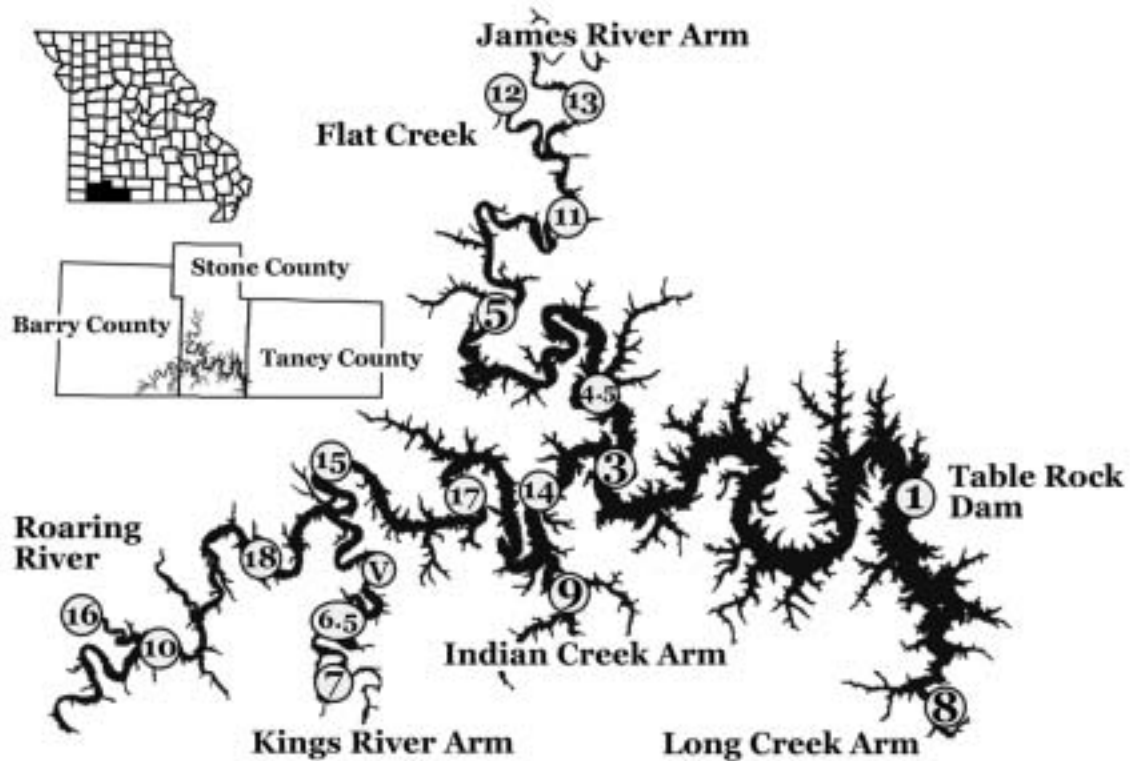


Figure 112. Location of Table Rock Lake and its sample sites

Table Rock Lake is a 43,100-acre Army Corps of Engineers reservoir located in southwest Missouri. This lake is in the White River System and is preceded upstream by Beaver Lake in northwest Arkansas. The lake consists of a long, winding main branch and three major arms. Kings River and Long Creek flow north out of Arkansas to enter Table Rock Lake while the James River flows south from the central Ozark Highlands Region. The majority of the lake's watershed is forested, but development around the lake and urban areas on the lake's tributaries threatens water quality.

The Chlorophyll – Secchi Relation in Table Rock Lake

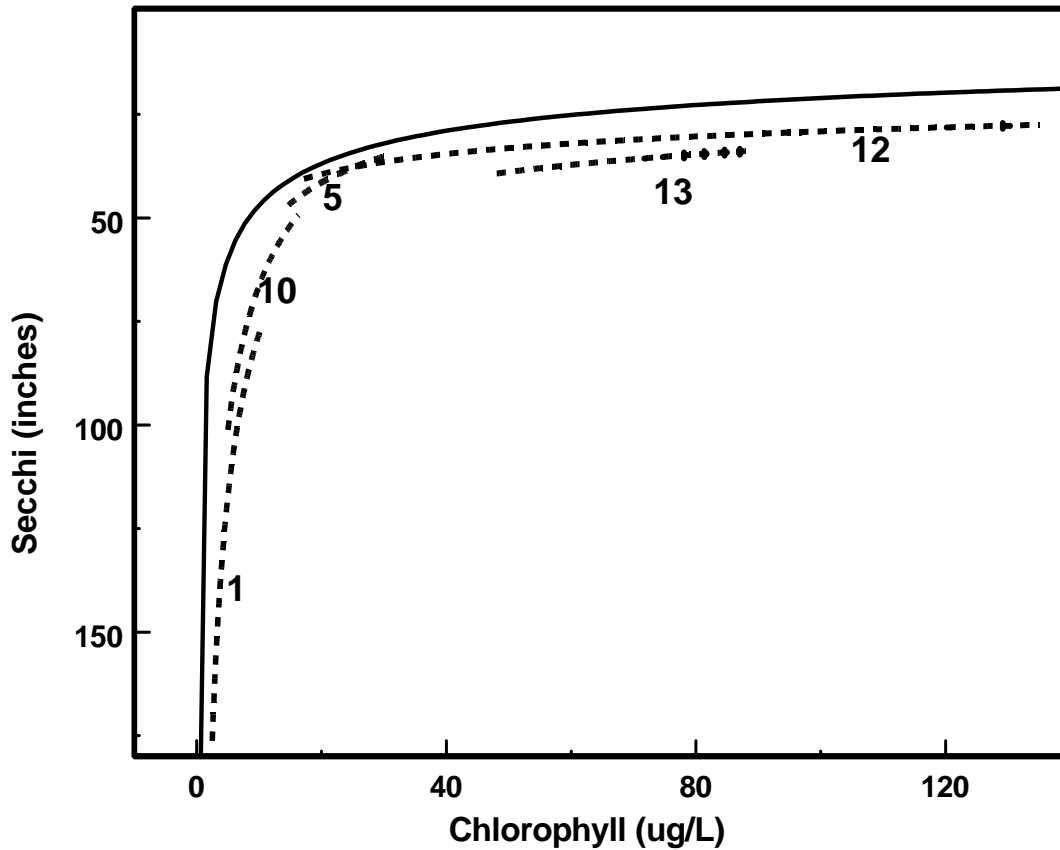


Figure 113. Chlorophyll Secchi relationship of selected Table Rock Lake sites. Solid line represents all 2004 LMVP data; dotted lines and numbers represent Table Rock Lake Sites.

For sites with low chlorophyll concentrations, a small increase in the amount of algae can dramatically reduce Secchi transparency.

For example, Site 1 chlorophyll concentrations only vary by 8.1 ug/L, while Secchi transparency values vary by 112 inches. In contrast, Site 12 chlorophyll concentrations vary by 118 ug/L, but Secchi values only vary by 14 inches.

Main Channel – Table Rock Lake

		Site	Site	Site	Site	Site	Site	Site
Parameters		10	18	15	17	14	3	1
Secchi Transparency (inches)	Mean	70	53	58	57	69	76	101
	Minimum	40	37	35	47	41	65	66
	Maximum	109	70	84	71	181	100	168
Phosphorus (ug/L)	Mean	13	13	14	16	12	13	12
	Minimum	9	10	10	11	9	8	8
	Maximum	27	21	26	47	24	22	20
Nitrogen (ug/L)	Mean	348	404	393	391	477	521	446
	Minimum	270	320	270	280	330	350	320
	Maximum	490	550	550	700	860	930	570
Chlorophyll (ug/L)	Mean	9.1	8.9	12.3	10.6	8.0	8.1	6.2
	Minimum	55.0	3.7	8.5	5.8	2.7	4.1	2.5
	Maximum	16.3	17.1	20.5	15.7	18.5	12.6	10.6

Table 46. Statistics from the main lake channel sites on Table Rock Lake – 2004

- Geometric mean Secchi transparency values ranged from 53 to 101 inches. Generally, transparency was higher at sites closer to the dam, and the dam had the greatest mean Secchi transparency value observed. Many volunteers observed a “green” lake this season. This is due to higher than average chlorophyll concentrations and at certain sites this resulted in a significant loss of clarity (see Figure 113).
- The geometric mean phosphorus values varied little among the main lake sites (from 12 to 16 ug/L). Minimum and Maximum values were also very comparable for the main lake sites, with the exception of site 17. This site had a maximum value (47 ug/L) that was nearly double that found at the other main lake sites. Overall, phosphorus levels were low throughout the main lake.
- Geometric mean nitrogen concentrations ranged from 348 to 521 ug/L and showed more (though still minor) spatial variability than phosphorus concentrations. The highest nitrogen concentrations were observed at sites 3 and 14. These sites were influenced by inflows from Indian Creek and the James River arms, which contained more nitrogen than the main lake.
- Geometric mean chlorophyll concentrations ranged from 6.2 to 12.3 ug/L across the main lake, with the lowest observed values at the dam. Interestingly, nutrient concentrations at the dam were comparable to the rest of the main lake.

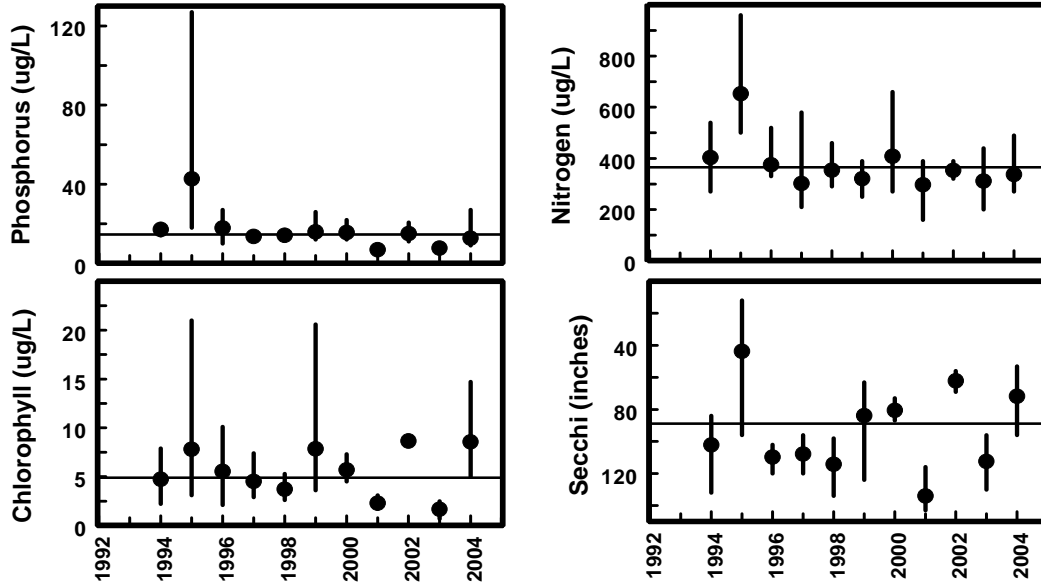


Figure 114. Multi year trends at Table Rock Lake, Site 10

Phosphorus is comparable from year to year, with the exception of 1995, when an extreme value elevated the geometric mean. Nitrogen shows the same pattern as phosphorus, but concentrations vary more within a given year. Chlorophyll concentrations over 10 ug/L have been observed in only 3 years (2004 included). Secchi reflects the amount of algae in the water, with clearer water during years with lower chlorophyll concentrations. There are no observable long-term trends at Site 10.

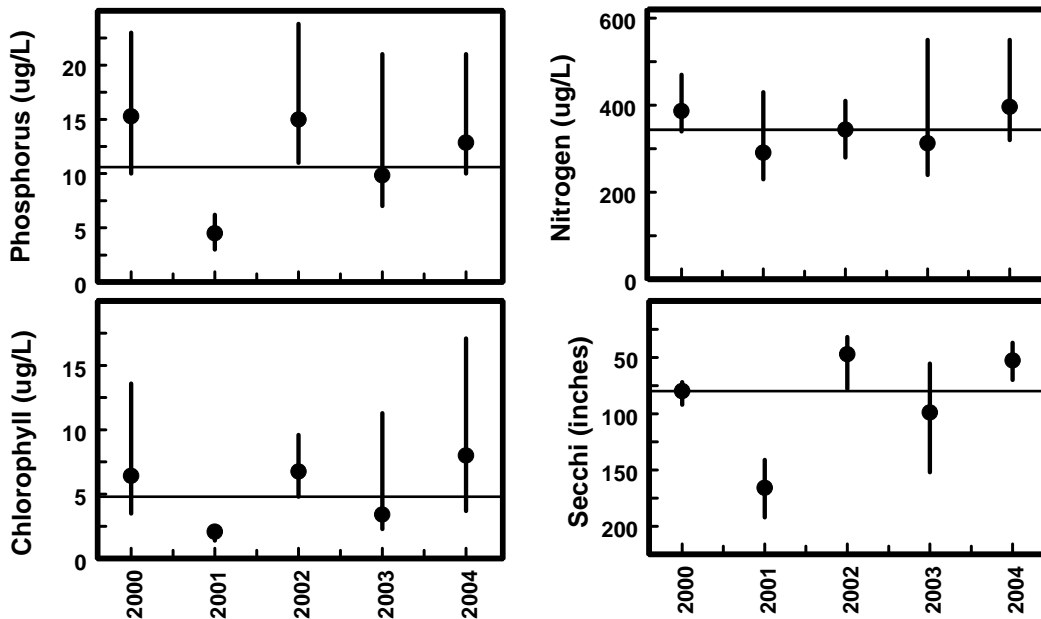


Figure 115. Multi year trends at Table Rock Lake, Site 18

This site has only been sampled for 5 years and shows no apparent long-term trends. The patterns shown by phosphorus, chlorophyll, and Secchi are nearly identical. 2001 had very low concentrations of phosphorus, thus low chlorophyll concentrations and deep Secchi transparency values.

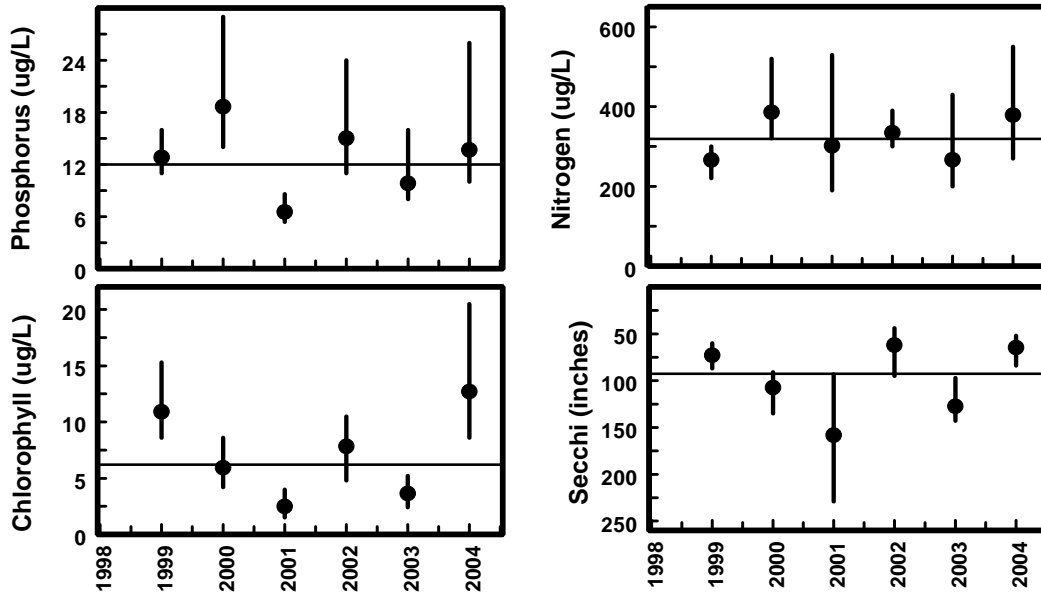


Figure 116. Multi year trends at Table Rock Lake, Site 15

This site does not show any long-term trends in water quality. Chlorophyll concentrations were higher this year than previously observed, though the geometric mean phosphorus concentration was lower than in either 2000 or 2002. Secchi values in 2004 were about half those of 2003, but very similar to 2002. Site 15 had low chlorophyll concentrations in 2000, considering phosphorus concentrations in that year were the highest observed.

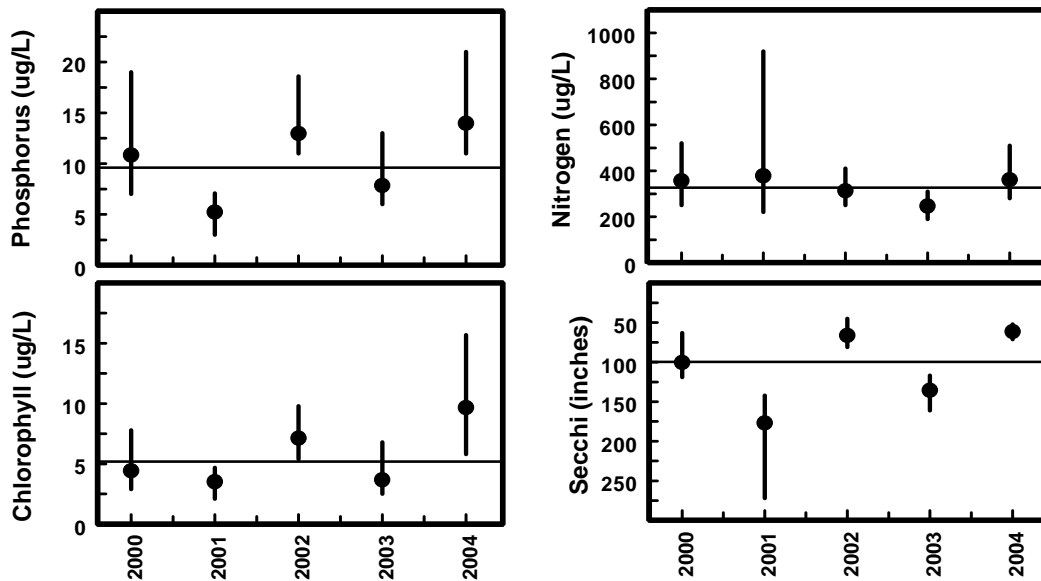


Figure 117. Multi year trends at Table Rock Lake, Site 17

Patterns of nutrients, chlorophyll and Secchi at Site 17 are nearly identical to those of Sites 10, 18 and 15. No detectable trends are apparent after 5 years of monitoring

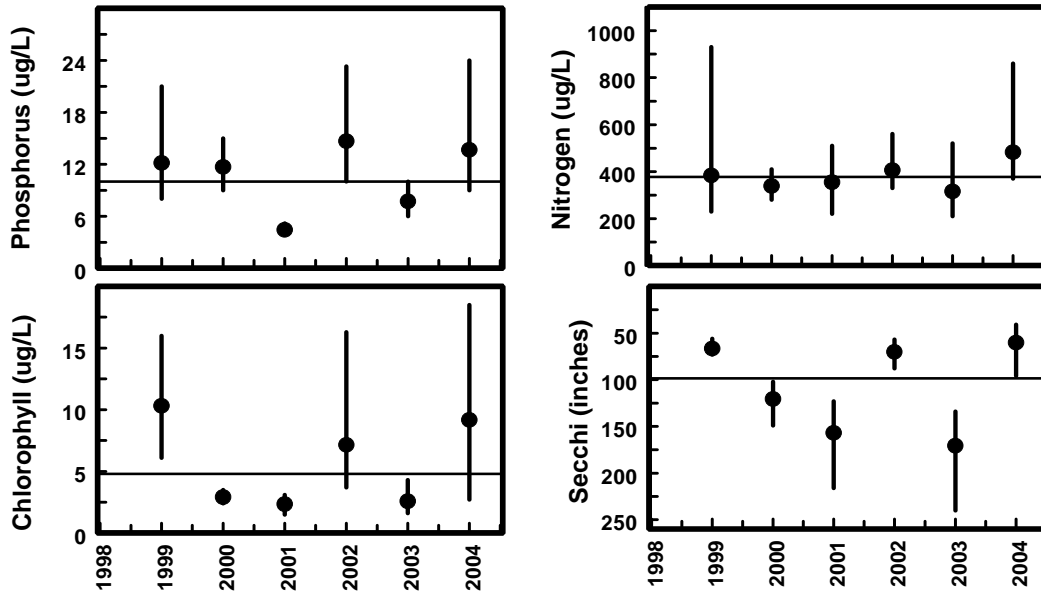


Figure 118. Multi year trends at Table Rock Lake, Site 14

The same patterns for nutrients, chlorophyll and Secchi are seen at Site 14 as at Sites 10, 18, 15 and 17. Site 14 had very low chlorophyll concentrations in 2000, relative to phosphorus concentrations.

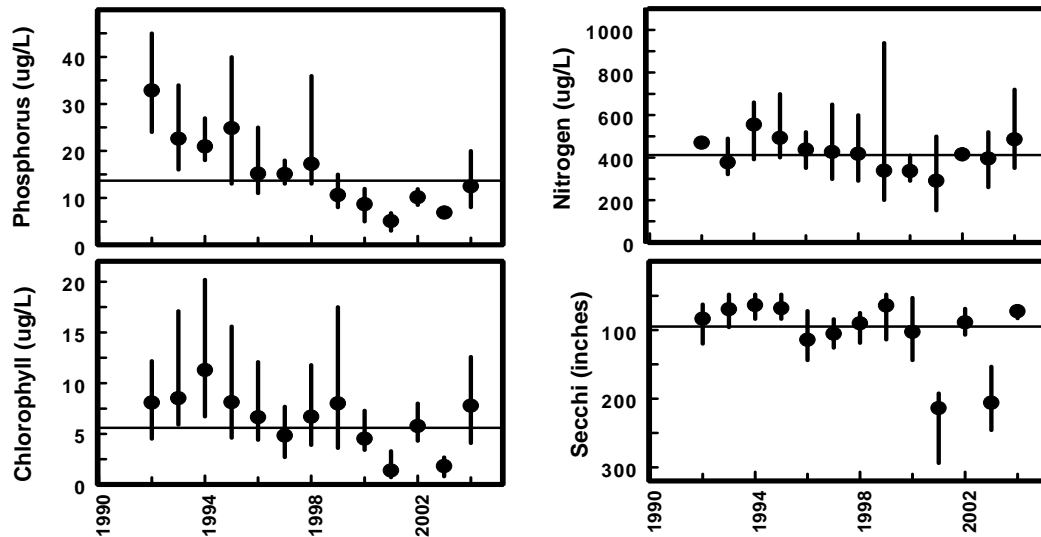


Figure 119. Multi year trends at Table Rock Lake, Site 3

Site 3 has been monitored each year since 1992. Long-term trends show decreasing phosphorus and chlorophyll concentrations. The average TP concentration for 1992 – 1996 was 26 ug/L, compared to an average for the last 4 years of 9 ug/L. Data from Site 5 suggests that decreasing phosphorus concentrations is a trend of the James River Arm rather than of the main lake. However, concentrations were higher in 2004 than they have been for several years. Nitrogen concentrations have changed relatively little in the last 13 years. 2001 and 2003 are standout years for Secchi transparency values, with geometric means during those years in excess of 200 inches. 2004 Secchi transparency was the lowest since 1999.

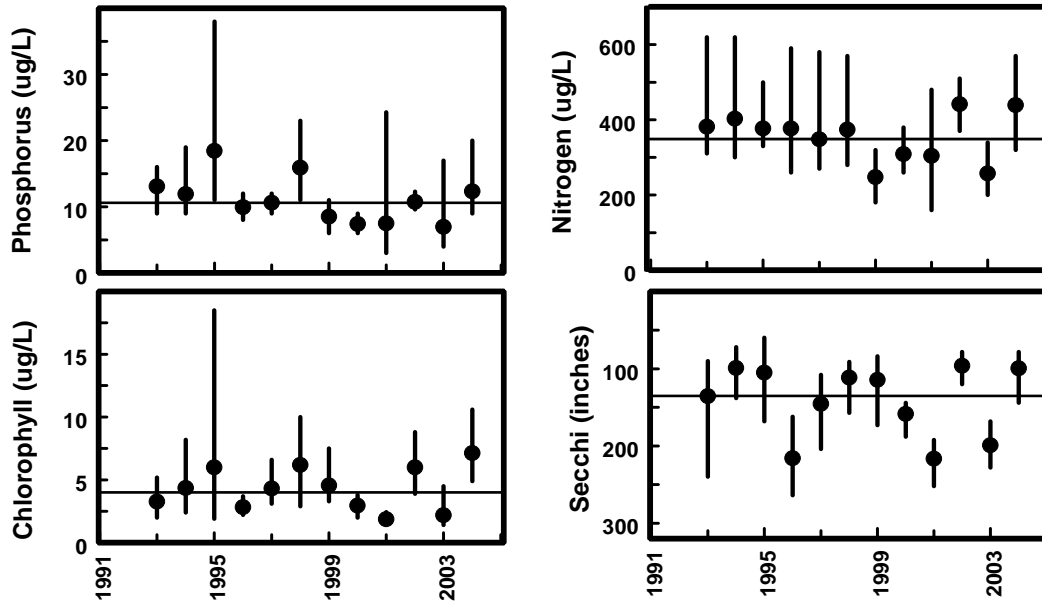


Figure 120. Multi year trends at Table Rock Lake, Site 1

Nutrient concentrations have been relatively stable at Site 1 since 1993. Yearly mean phosphorus has ranged from 7 – 13 ug/L and nitrogen has ranged from 250 – 440 ug/L. These among year ranges are less than the variability we find within some individual years. Chlorophyll levels generally mimic the phosphorus concentrations, which in turn dictate water clarity as measured by Secchi. There are no identifiable long-term trends.

Main Lake Summary

The only identifiable long-term trend in the main lake is the decreasing phosphorus concentrations at Site 3, which is likely related to changes in phosphorus concentrations in the James River Arm. We find that nutrient and chlorophyll concentrations are relatively stable across the main lake channel, changing little from one site to the next. During much of the 1990’s nutrient concentrations were higher at Site 3 than at Site 1 or Site 10, due to the influence of the James River. In reservoirs, it is typical for the water clarity (as measured by Secchi transparency) to increase with proximity to the dam. This “longitudinal” gradient is seen in Table Rock Lake.

James River Arm – Table Rock Lake

		Site	Site	Site	Site
Parameters		13	11	5	4.5
Secchi	Mean	36	38	41	54
Transparency (inches)	Minimum	32	25	36	41
	Maximum	41	45	48	93
Phosphorus (ug/L)	Mean	79	42	25	17
	Minimum	56	32	21	12
	Maximum	102	87	32	24
Nitrogen (ug/L)	Mean	1237	1009	934	694
	Minimum	950	580	720	420
	Maximum	1880	1860	1110	1200
Chlorophyll (ug/L)	Mean	65.5	26.4	21.0	11.7
	Minimum	48.1	3.3	14.7	5.1
	Maximum	88.2	50.6	30.0	16.2

Table 47. Statistics from the James River Arm of Table Rock Lake – 2004

Concentrations of nutrients and chlorophyll in the James River Arm of Table Rock Lake decrease at sites closer to the main lake. This predictable spatial trend is common and is due to the settling of algae (with their incorporated nutrients) and sediments to the bottom of the lake. Across the arm, Secchi transparency values increase as the chlorophyll concentrations decrease. The difference between maximum and minimum observed concentrations of nutrients or chlorophyll is lower at sites closer to the confluence of the James and White River (e.g. Sites 4.5 and 5) than at up-lake sites (Sites 13 and 11). The difference between maximum and minimum Secchi transparency values is greater at sites with the greatest water clarity (e.g. Site 4.5).

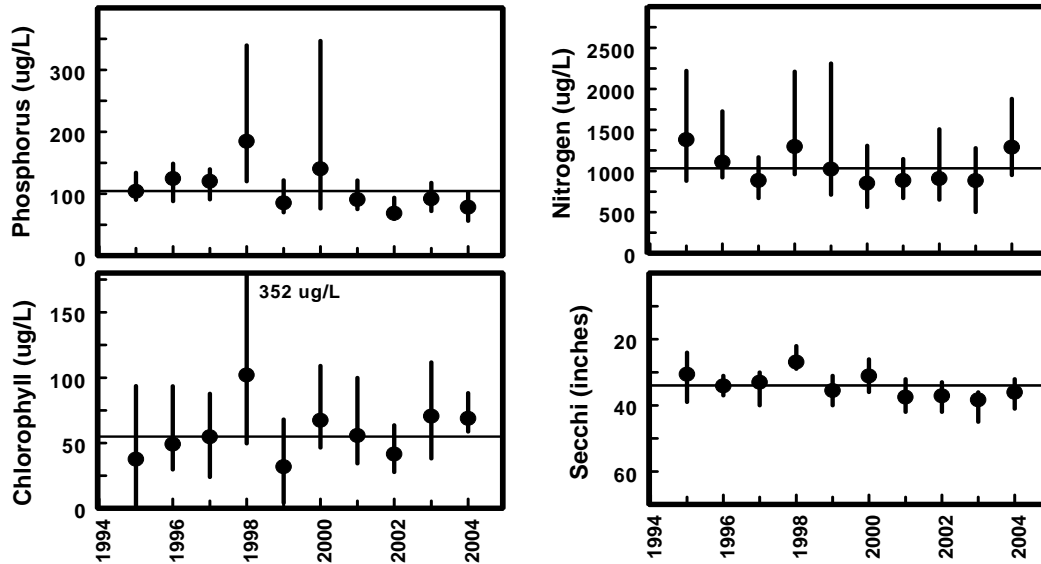


Figure 121. Multi year trends at Table Table Rock Lake, Site 13

Since 2001, Site 13 phosphorus concentrations have been lower than the overall site mean of 105 ug/L. By contrast, five of the six years prior to 2001 had phosphorus concentrations above the overall mean. 2001 is the year the city of Springfield began complying with the phosphorus reduction regulations imposed on its effluent that enters the James River. Chlorophyll concentrations have been variable, with means ranging from 32 – 102 ug/L. Recent chlorophyll concentrations have not reflected the phosphorus reductions. Secchi transparency values vary little from year to year; due to high concentrations of algal biomass (see Fig 113).

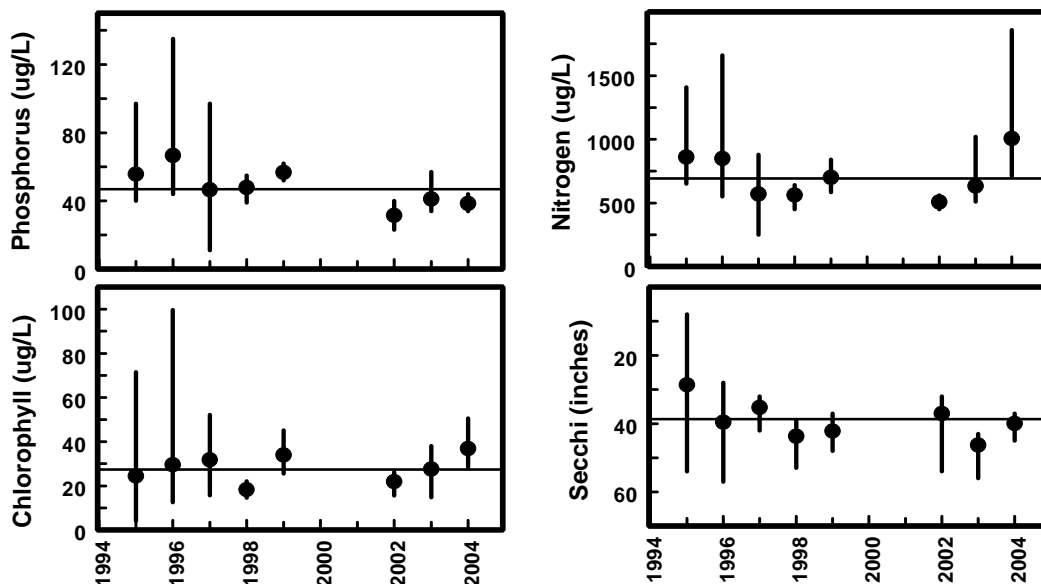


Figure 122. Multi year trends at Table Table Rock Lake, Site 11

Site 11 phosphorus concentrations are lower in the last three years than in previous years and are about half the magnitude of concentrations at Site 13. In contrast, nitrogen concentrations have increased each of the last three years (though they are still within the historic range).

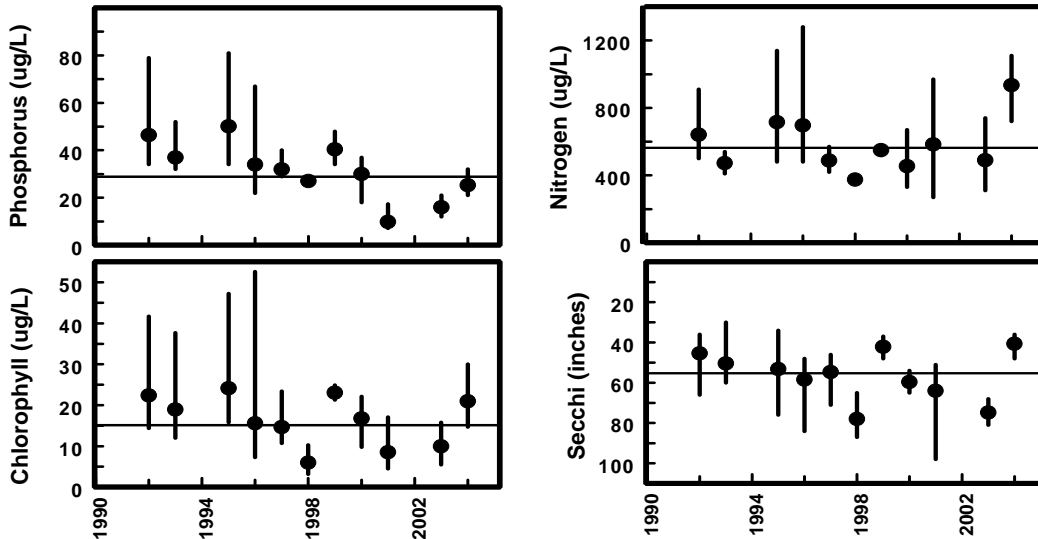


Figure 123. Multi year trends at Table Table Rock Lake, Site 5

Summer phosphorus concentrations have decreased at Site 5 since 2001. Prior to 2001, the mean phosphorus concentration ranged from 27 – 50 ug/L. Since 2001, the mean has not exceeded 25 ug/L. This has resulted in lower within-year variability for chlorophyll due to a reduction of extreme values. Secchi transparencies mimic chlorophyll concentrations.

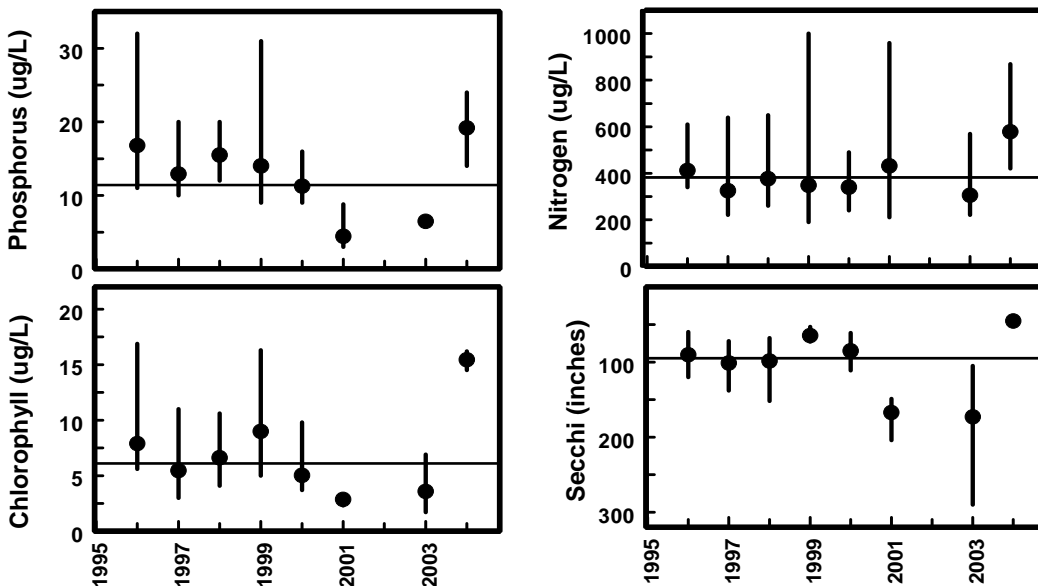


Figure 124. Multi year trends at Table Table Rock Lake, Site 4.5

Changes in phosphorus have not been as large at Site 4.5 as at other sites in the James River Arm of the lake. This is partly due to the fact that initial phosphorus levels (pre-2001) were much lower at Site 4.5 than at the sites farther up the James River (roughly half the magnitude of Site 5 phosphorus concentrations). 2004 mean nutrient and chlorophyll concentrations were higher than other years, likely due to the timing and number of samples. Only 3 samples were collected at Site 4.5 (and Site 5) and these were collected early in the season when nutrient and chlorophyll concentrations are usually greatest.

King's River Arm – Table Rock Lake

Parameters		King's River		
		7	6.5	Viola
Secchi Transparency (inches)	Mean	31	41	56
	Minimum	12	5	41
	Maximum	42	71	73
Phosphorus (ug/L)	Mean	54	32	
	Minimum	38	19	
	Maximum	113	124	
Nitrogen (ug/L)	Mean	628	494	
	Minimum	380	320	
	Maximum	1900	930	
Chlorophyll (ug/L)	Mean	16.5	9.8	
	Minimum	0.6	1.0	
	Maximum	46.2	19.3	

Table 48. Statistics from the King's sites on Table Rock Lake – 2004

All parameters display a longitudinal gradient along the King's River, from the up-lake Site 7 to the down-lake Site 6.5 (Viola for Secchi). Phosphorus and nitrogen decreased by 40% and 21% from Site 7 to Site 6.5, respectively. This decrease in nutrients led to a 41% decrease in mean algal chlorophyll concentrations between the sites. Water clarity as measured by Secchi transparency increased by 32% from Site 7 to Site 6.5, and 81% from Site 7 to Viola. Uptake of nutrients by algae, and the settling of algae cells to the bottom of the lake accounts for the decrease in concentrations of phosphorus, nitrogen and chlorophyll and the increase in Secchi transparency.

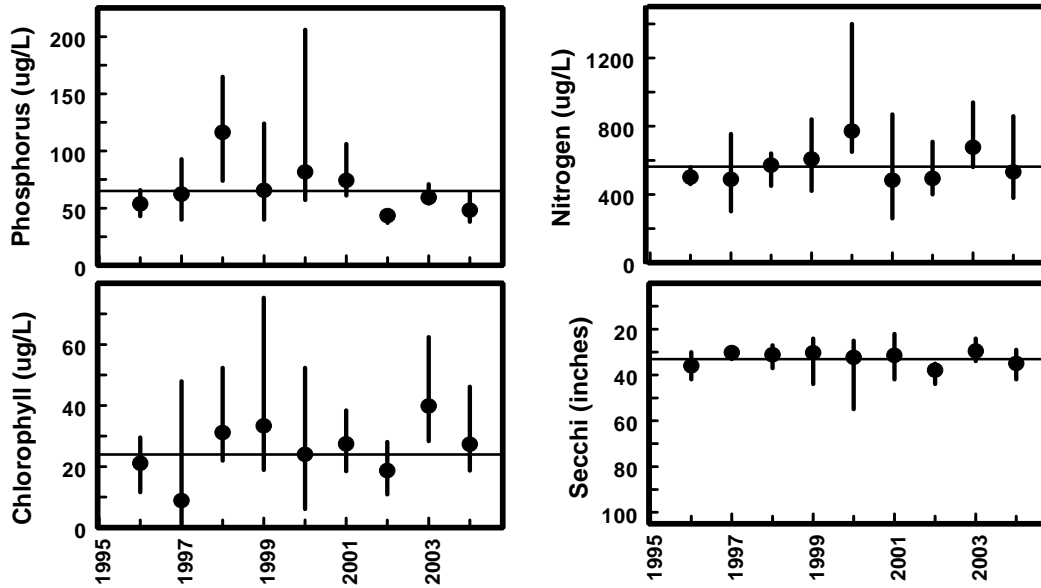


Figure 125. Multi year trends at Table Table Rock Lake, Site 7

Phosphorus concentrations have been relatively low and stable for the last three years. This does not represent a trend, though, as values were this low in 1996 and 1997. Aside from the high concentrations in 2000, nitrogen has been stable. Mean chlorophyll concentrations have varied from 9 to 40 ug/L. Mean Secchi transparency values vary by only 8 inches.

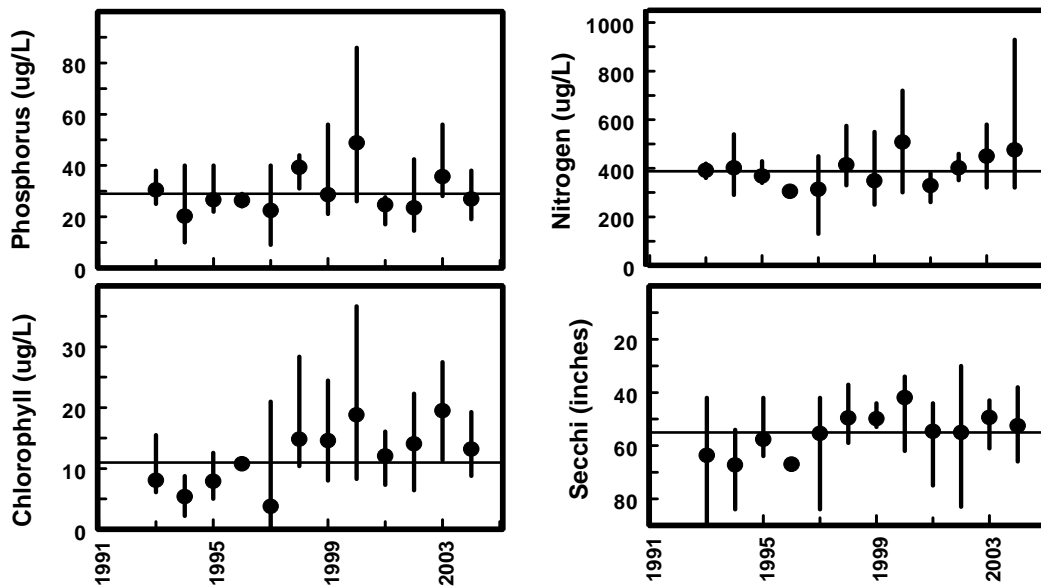


Figure 126. Multi year trends at Table Table Rock Lake, Site 6.5

This site moved approximately 3.5 miles upstream in 1997. This relatively minor difference in sampling location may account for the lower concentrations of chlorophyll observed prior to 1997, which would account for the greater Secchi transparency values in the same period. Nutrient concentrations do not show any change, however.

Tributary Sites – Table Rock Lake

Parameters		Indian Creek 9	Long Creek 8	Flat Creek 12	Roaring River 16
Secchi Transparency (inches)	Mean	67	68	32	42
	Minimum	42	18	27	29
	Maximum	147	96	41	54
Phosphorus (ug/L)	Mean	15	15.6	71	26
	Minimum	9	9	27	19
	Maximum	23	51	114	43
Nitrogen (ug/L)	Mean	519	437	1238	659
	Minimum	360	320	940	460
	Maximum	910	810	2030	1180
Chlorophyll (ug/L)	Mean	8.2	11.0	57	21.7
	Minimum	4.7	7.0	17	8.9
	Maximum	13.8	17.6	135	47.8

Table 49. Statistics from other tributary sites on Table Rock Lake – 2004

Water quality conditions, especially nutrient concentrations, are very similar in Indian Creek and Long Creek. There was slightly less algal chlorophyll in Indian Creek, which allowed greater maximum Secchi transparency readings. Roaring River had higher nutrient concentrations than either Indian or Long Creek. The higher nutrient concentrations accounted for twice as much algal biomass, measured as chlorophyll concentration. Flat Creek had nutrient and chlorophyll concentrations that were roughly double those of Roaring River.

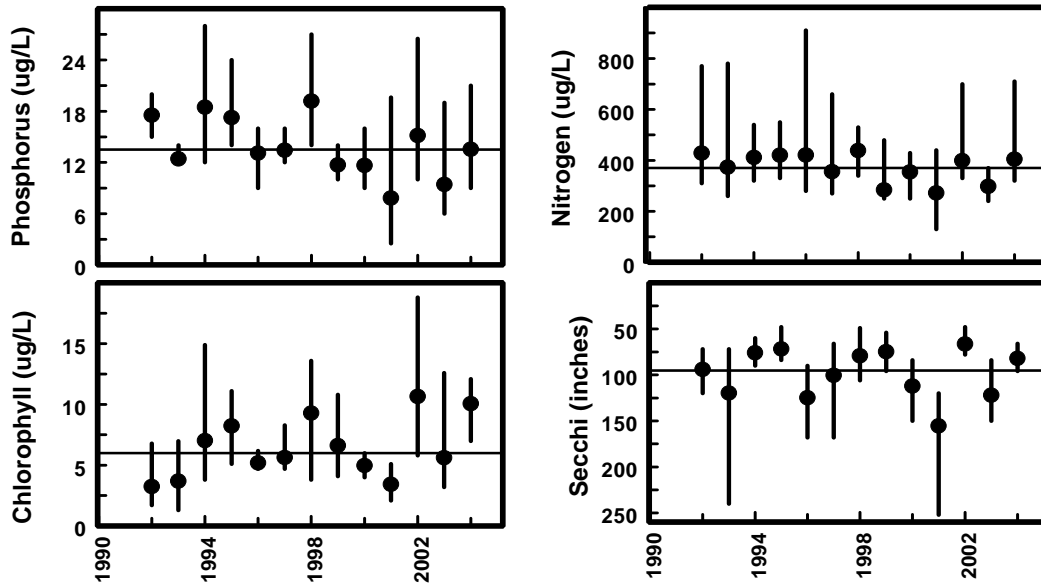


Figure 127. Multi year trends at Table Table Rock Lake, Site 8

The mean chlorophyll concentration at Site 8 was high in 2004, with only the mean for 2002 being higher. Mean Secchi transparency values in the Long Creek arm range from 66 inches to over 155 inches.

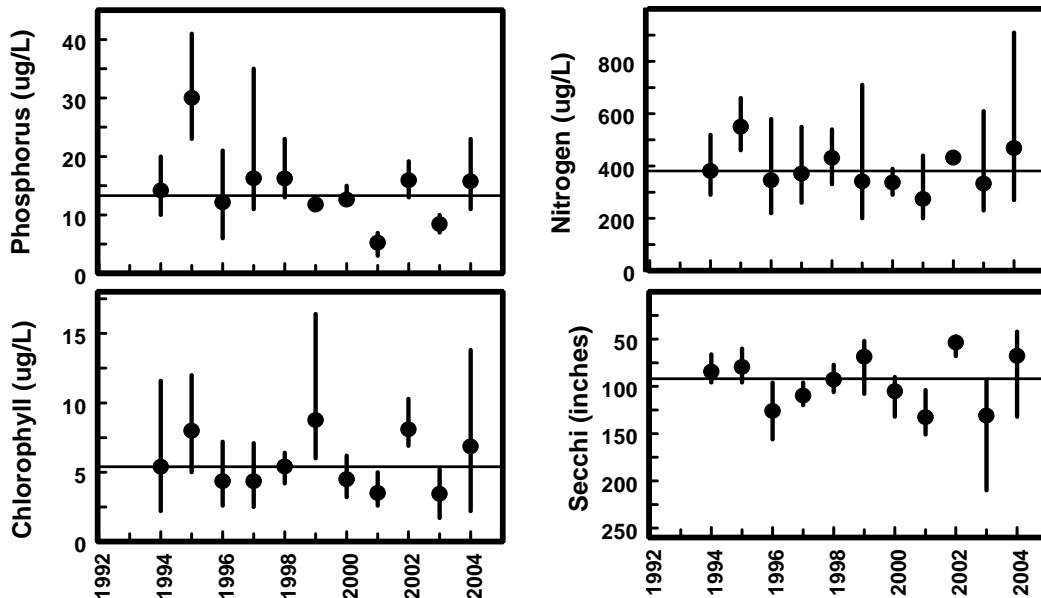


Figure 128. Multi year trends at Table Table Rock Lake, Site 9

The apparent high variability in Site 9 phosphorus concentrations is largely due to high concentrations in 1995 and low concentrations in 2001. Aside from these two years, concentrations of phosphorus have varied only from 8 – 15 ug/L. Nitrogen concentrations have been stable, averaging less than 400ug/L. Chlorophyll concentrations generally reflect the nutrients. Mean Secchi varies from year to year, and is dependant on the location of a given year’s data on the chlorophyll-Secchi relation curve (Figure 113, page 90).

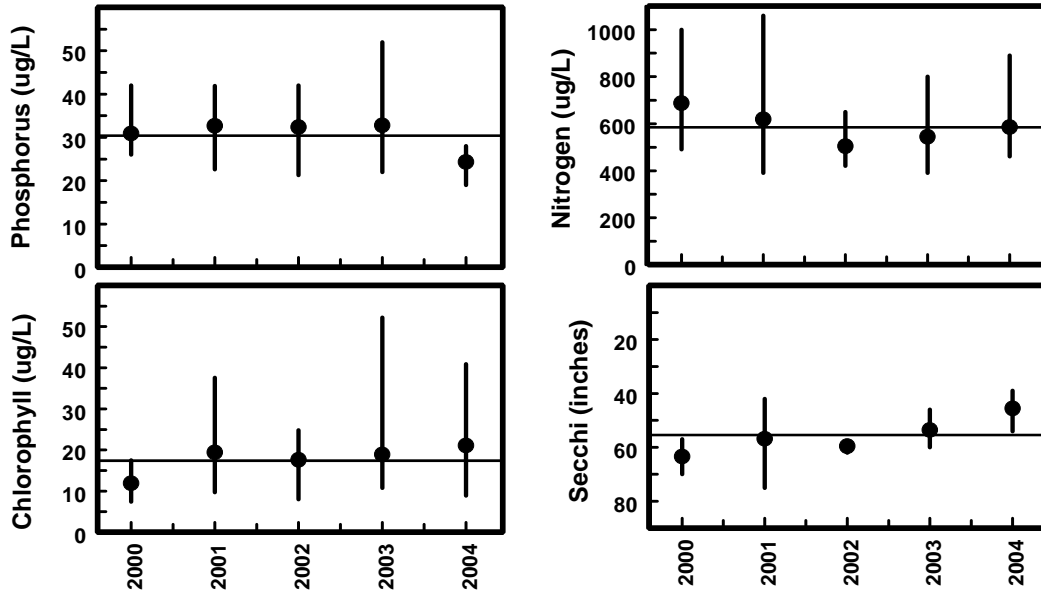


Figure 129. Multi year trends at Table Table Rock Lake, Site 16

There has been very little change in mean values at Site 16 since 2000. While phosphorus concentrations in 2004 were the lowest observed at this site to date, the chlorophyll concentrations were above the mean, indicating that the algae more efficiently consumed nutrients or that there was a shift in the algal community.

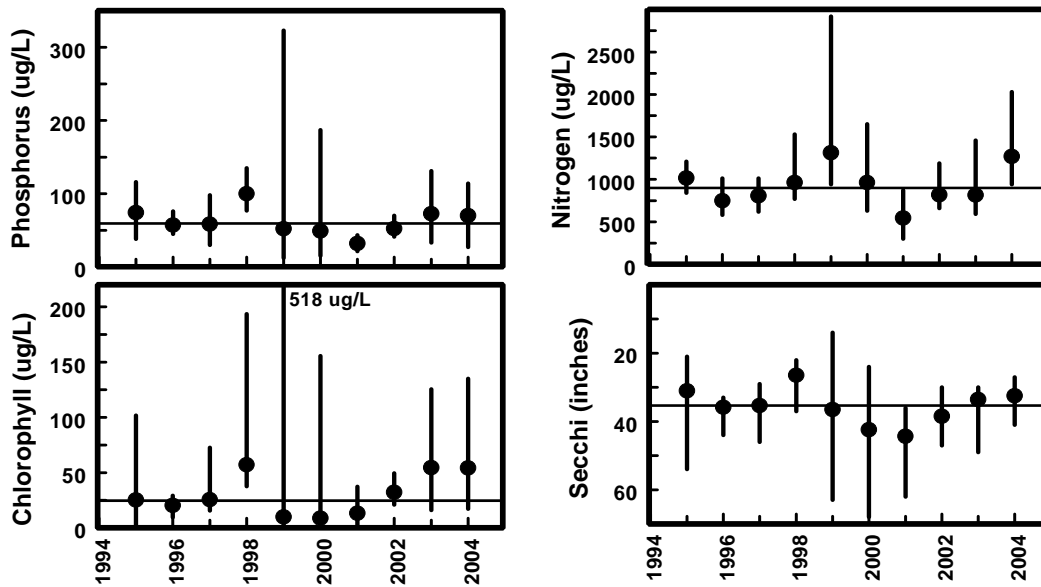


Figure 130. Multi year trends at Table Table Rock Lake, Site 12

Nutrients and chlorophyll at Site 12 vary considerably from year to year. Mean phosphorus concentrations have ranged more than three-fold since 1995. Mean chlorophyll concentrations have ranged six-fold. There are no apparent long-term trends, though chlorophyll concentrations follow phosphorus concentrations rather closely. Read more about Flat Creek on the following page.