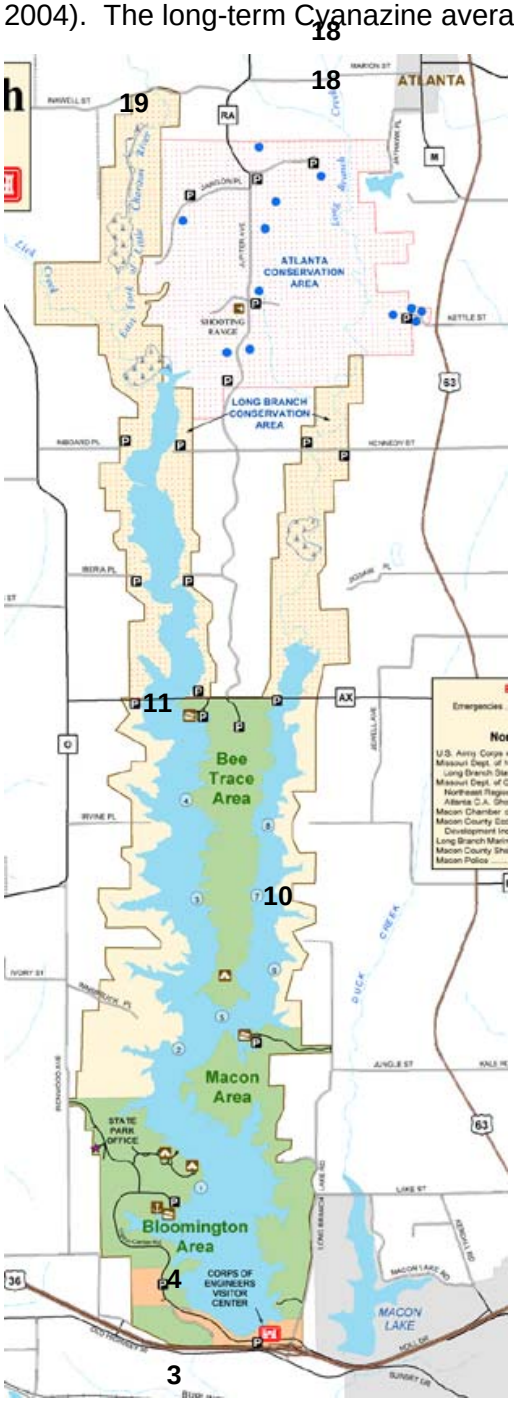
8 Long Branch Lake

8.1 General Background

Long Branch Lake was impounded in 1978 and reached full pool on 19 May 1981. The main threats to water quality at Long Branch Lake are nutrients, herbicides / pesticides, sedimentation, and bacterial contamination. The lake is currently listed on Missouri's 303(d) list of impaired waters due to atmospheric mercury deposition (MDNR 2004). Cyanazine was removed as a pollutant of concern at Long Branch Lake in 2002 (MDNR 2004). The long-term Cyanazine average (0.52 ug/L) dropped below the federal health standard of 1 ug/L. Cyanazine production ceased in 1999.



An AgNPS SALT Project was initiated in 2004 within the Long Branch Lake watershed. This project, designed to operate through 2010, is directed to improve agricultural BMPs and related water quality impairments.

The Corps had an 1135 project slated for Long Branch Lake, but funding limitations prevented development of the project. Another attempt was made with MODOT as part of a wetland mitigation project, but that fell through as well. The lake staff are currently coordinating with the local Army National Guard unit to construct berms in the upper reaches of both lake arms. The focus of in-lake projects are sediment control and bank erosion.

The NWK Water Quality Program was contacted in 2005 by MDNR regarding interest in re-writing the Long Branch Lake watershed management plan. Reassignment of MDNR staff caused this process to stop for the moment.

8.1.1 Location

The dam located on the East Fork of the Little Chariton River impounds Long Branch Lake. The dam is located 110 km (69 miles) upstream of the confluence of the Chariton River with the Missouri River. The lake is located 3.2 km (2 miles) west of Macon, in north-central Missouri. Historic water quality sample sites include 3 lake, 1 outflow, and 2 inflow (Figure 8.1).

Figure 8.1. Long Branch Lake area map with sample site locations and sample numbers.

8.1.2 Authorized Purposes: Flood control, water supply, fish and wildlife management, and downstream water quality improvement.

8.1.3 State Use Designations: Livestock and wildlife watering, warmwater aquatic life and human health / fish consumption, whole-body contact recreation, boating and canoeing, drinking water supply.

8.1.4 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	801.0	30.3	3,670	
Multipurpose	791.0	34.2	2,430	24
Total		64.5		

Total watershed area: 109 sq miles (69,700 A)

Watershed ratio: 19.0 FC / 28.7 MP

Average Annual Inflow: 81,780 acre-feet
Average Annual outflow: 000 acre-feet
Sediment inflow (measured): 483 acre-feet (1978 – 1988)
Flushing rate: 0.47 years
Water management Plan: Interim approved 21 November 1978
Historic stage hydrograph: 1996 – 2006 (Figure 8.2)

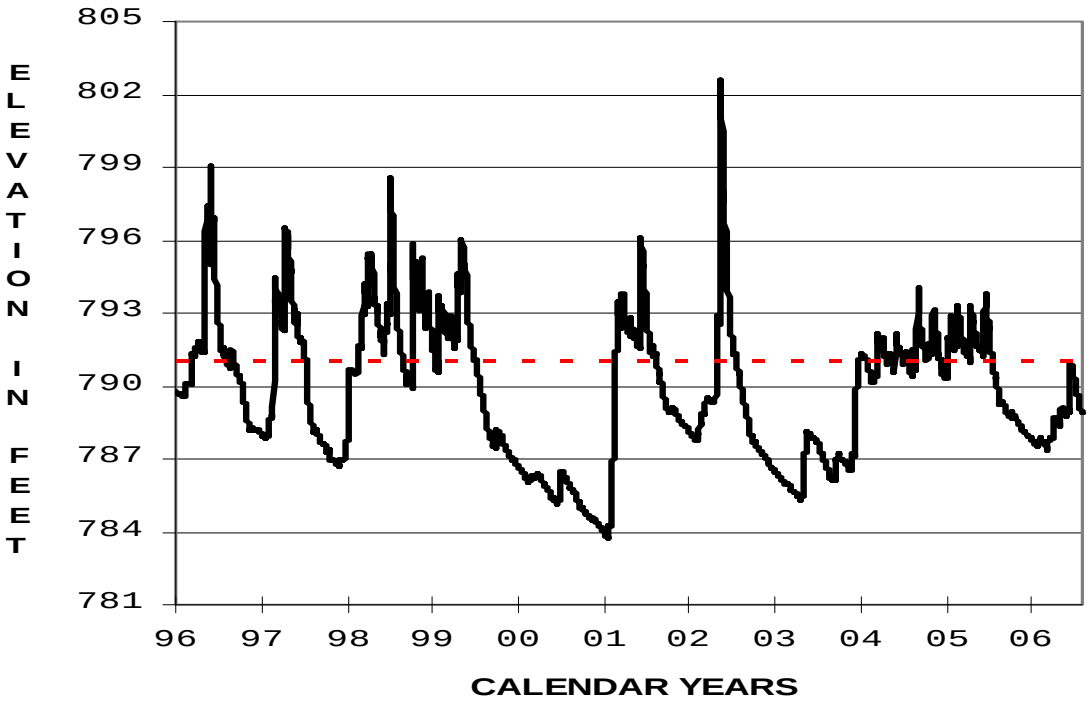


Figure 8.2. Pool elevation hydrograph from 1996 - 2006

8.2 2006 Activities

Long Branch Lake was categorized as an 'intensive' lake during 2006, thus samples were collected from 2 inflows, 3 lake sites, and the outflow (see Figure 8.1). Samples were collected monthly from April through September, and vertical profiles were recorded monthly. Long Branch Lake staff (OF-LB) providing field sampling assistance during 2006 included Mike Monda and Lucius Duerksen. Paul Sampson, OF-LB Operations Manager, provided insight and background regarding Long Branch Lake.

8.3 2006 Data

Comparative historic water quality data consists of monthly (April – September) data collected from 1995 through 2004 / 2005. Samples were collected from April though September during 2006.

8.3.1 Inflow

Long Branch Lake inflow samples were collected from two watershed sites (Sites 18 and 19) during 2006.

8.3.2 Lake

Long Branch Lake is a eutrophic waterbody based upon total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* measurements. Nitrogen is an essential nutrient for aquatic life. However, excessive concentrations can result in algal blooms, low DO levels, taste and odor issues in drinking water, and even fish kills. Total nitrogen mean concentrations for the three lake sites range from 0.96 – 1.27 mg/L, with the highest concentration at Site 11. When inflow sites are included, Site 18 exhibits a significantly higher median TN concentration than any other site (Figure 8.3). Elevated TN concentrations historically have been measured at Site 18 (Figure 8.4). This site is located on Long Branch Creek and is just outside of the City of Atlanta. With few exceptions, all TN measurements have exceeded EPA's proposed ecoregional nutrient criteria value of 0.36 mg/L.

Phosphorus is another essential nutrient for aquatic life, and it limits algal growth. Total phosphorus mean concentrations (0.08 – 0.14 mg/L) at lake sites are typical of Midwestern reservoirs. Similar to TN, significantly elevated TP concentrations exist at Site 18 – Long Branch Creek at Atlanta (Figure 8.5). For a comparative perspective of TP inputs from within the watershed, Figure 8.6 compares TP concentrations between inflow sites – Sites 18 (mean TP = 0.34 mg/L) and 19 (mean = 0.19 mg/L). From this data, efforts to control phosphorus inputs should be focused on Long Branch Creek sources.

The ratio of TN:TP can be used as a surrogate to determine the dominant algal community within a waterbody. Ratios $\geq$ 20:1 are indicative of desirable algal communities, whereas ratios $\leq$ 12:1 are indicative of bloom-forming cyanobacteria (blue green algae). As would be expected, there is high monthly and annual variability in the TN:TP ratio at all sites; see Figure 8.7 as an example at Site 4. Median TN:TP ratios at all three lake sites (Sites 11, 10 & 4) are < 10, indicating the lake is at risk for

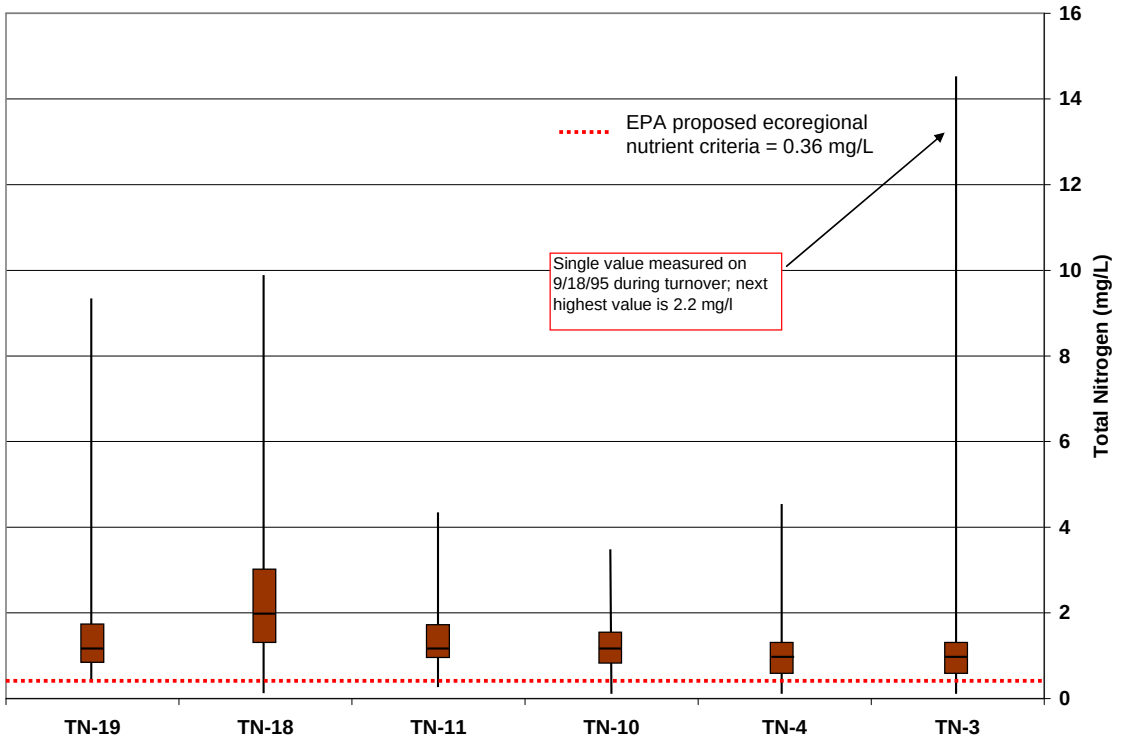


Figure 8.3. Box plots of surface water sample total nitrogen concentrations measured by site from 1996 through 2006 at Long Branch Lake.

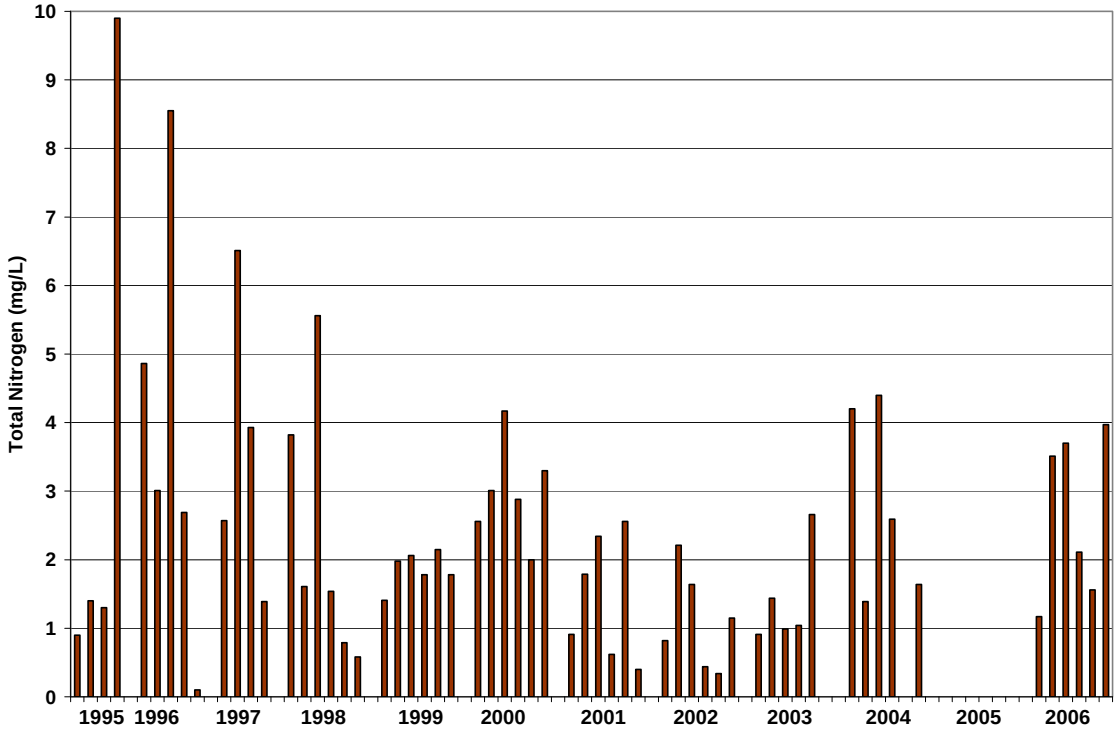


Figure 8.4. Total nitrogen concentrations by sample date at Site 18 (Long Branch Creek) within the Long Branch Lake watershed from 1995 through 2006.

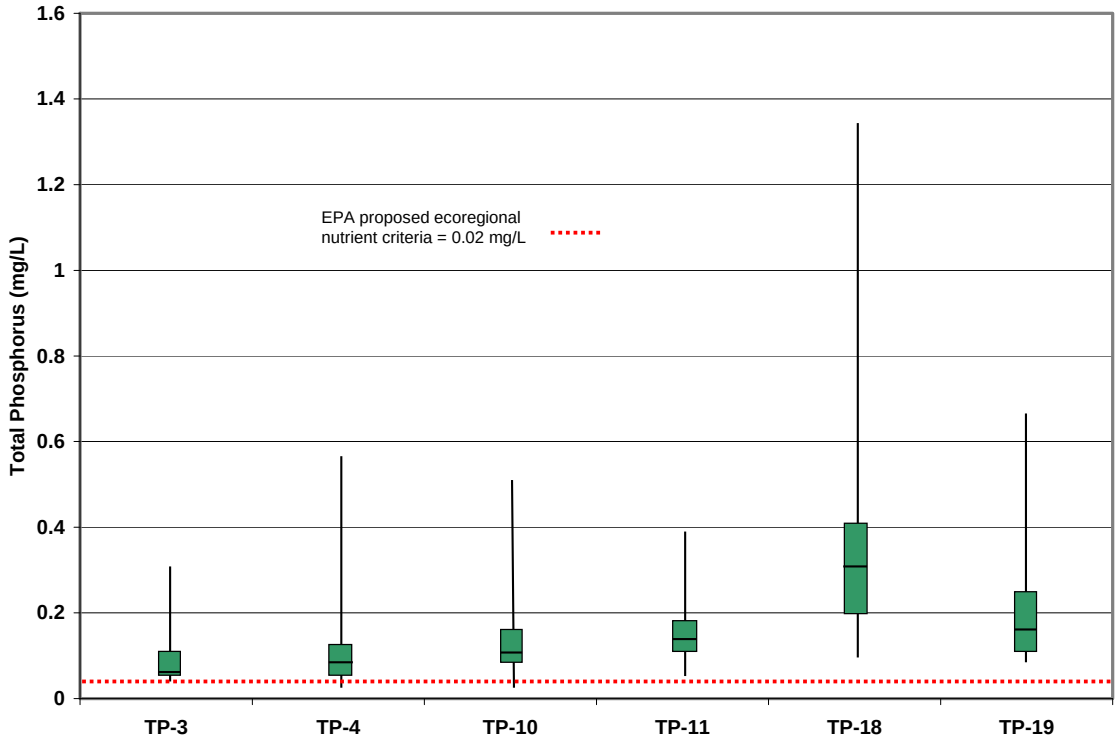


Figure 8.5. Box plot of surface water sample total phosphorus concentrations measured by site from 1996 through 2006 at Long Branch Lake.

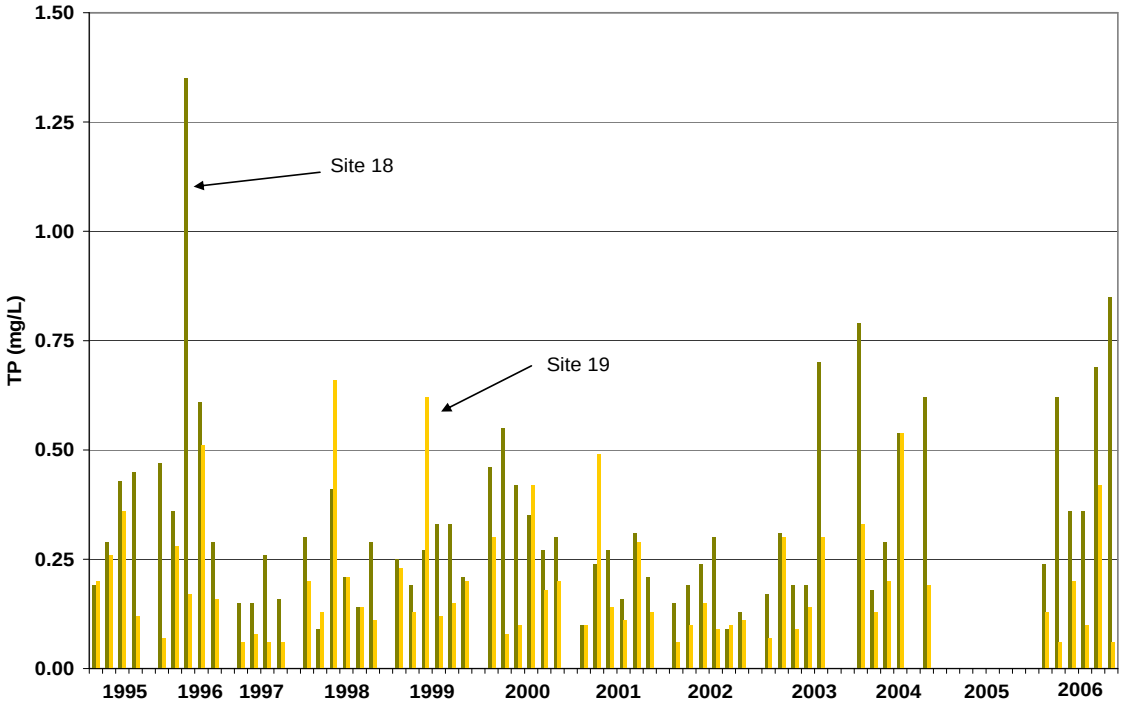


Figure 8.6. Comparison of total phosphorus concentrations by sample date at Site 18 (Long Branch Creek) and Site 19 (East Fork Little Chariton) within the Long Branch Lake watershed from 1995 through 2006.

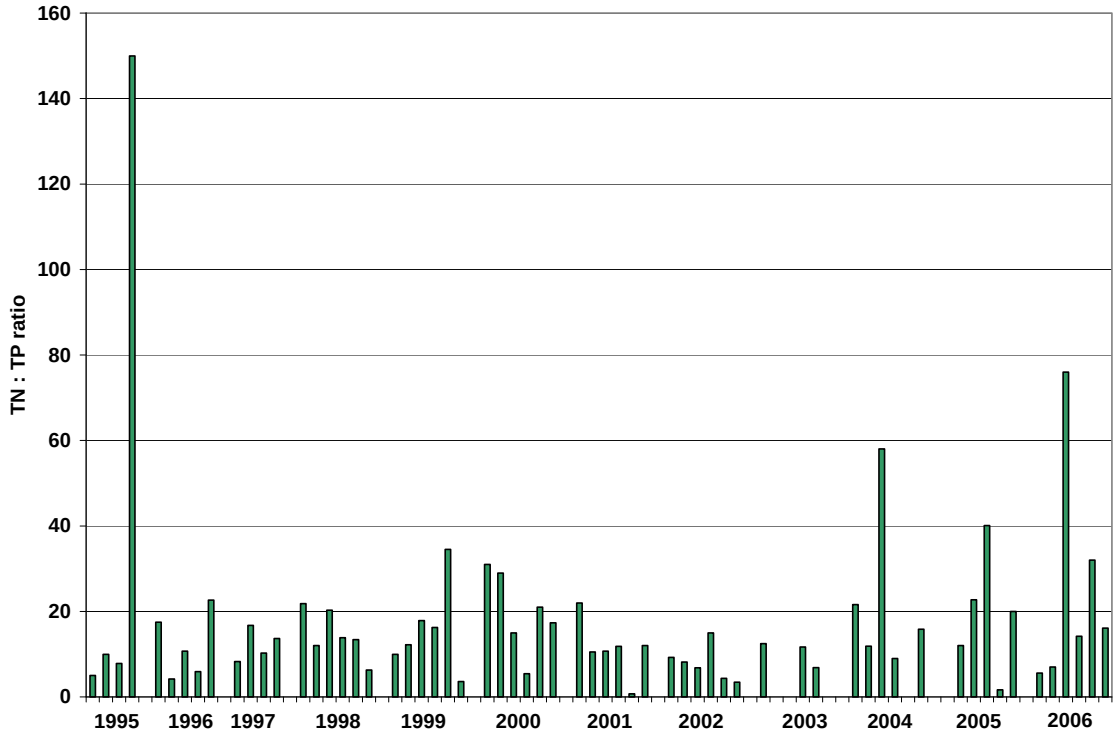


Figure 8.7. Graph of total nitrogen : total phosphorus ratio (TN:TP) by sample at Site 4 of Long Branch Lake from 1996 through 2006.

cyanobacteria blooms (Figure 8.8). The microcystin toxin has been collected from Long Branch Lake during 2000 (Dr. Jennifer Graham, USGS, personal communication).

Mean summer (June – August) chlorophyll *a* concentrations collected in 2006 range from 29.9 - 68 ug/L, with highest values measured at Site 11 (Little Chariton River arm) and lowest values near the dam. The longterm median chlorophyll values (18.0 – 30.3 ug/L; Figure 8.9) are among the highest measured within the district, and indicate the significant nutrient loading within the lake. This is expected due to sediment resuspension in the shallow upper arms and due to elevated TP inputs. Secchi depth ranged from 0.3 to 0.54 m at Site 4 during 2006, indicating limited water clarity within the lake. Figure 8.10 depicts secchi depth variability by month and site during 2006 in Long Branch Lake.

Relative concentrations of phycocyanins, or bluegreen algae, were measured vertically throughout the water column during each monthly sample trip. Such profiles provided information on monthly as well as within lake distribution changes. Figure 8.11 depicts vertical distribution of phycocyanins measured at Site 4 (Tower) from June through September. Concentrations increased significantly during August and September relative the previous months, and distributions were consistent throughout the water column during both months. The concentrations were among the highest measured within the district.

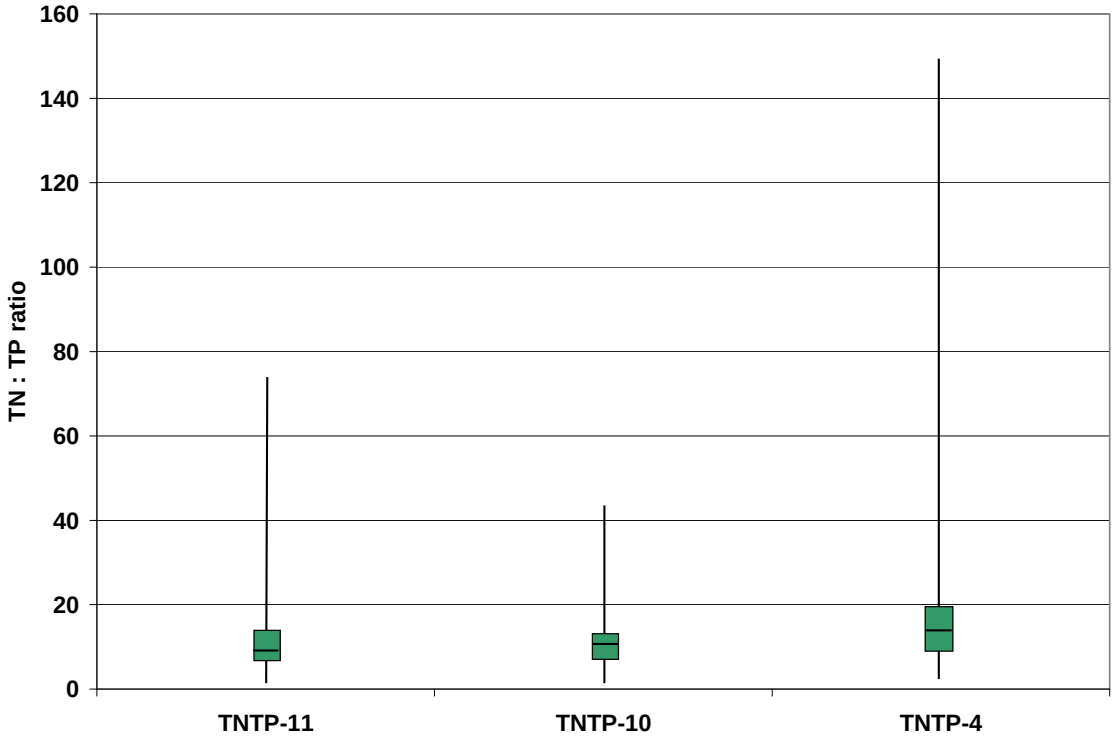


Figure 8.8. Box plots of total nitrogen : total phosphorus (TN : TP) ratio by site from 1996 through 2006 at Long Branch Lake.

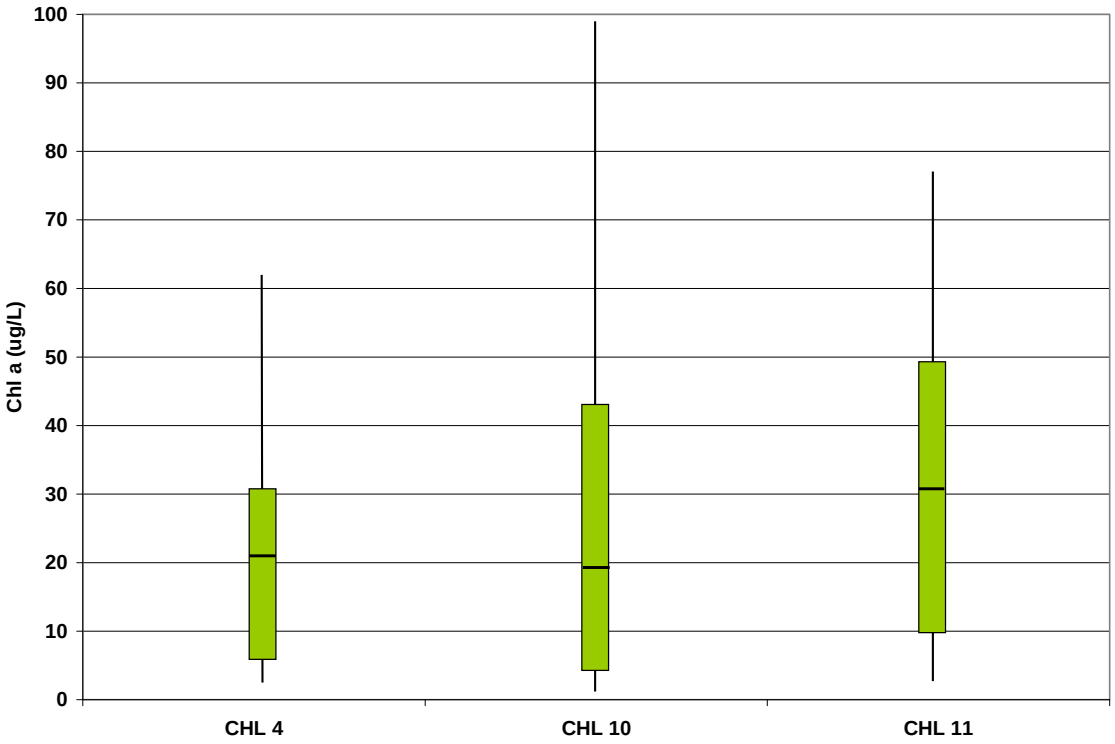


Figure 8.9. Box plots of chlorophyll a concentrations by site from measurements collected from 1996 - 1997 and 2005 - 2006 at Long Branch Lake.

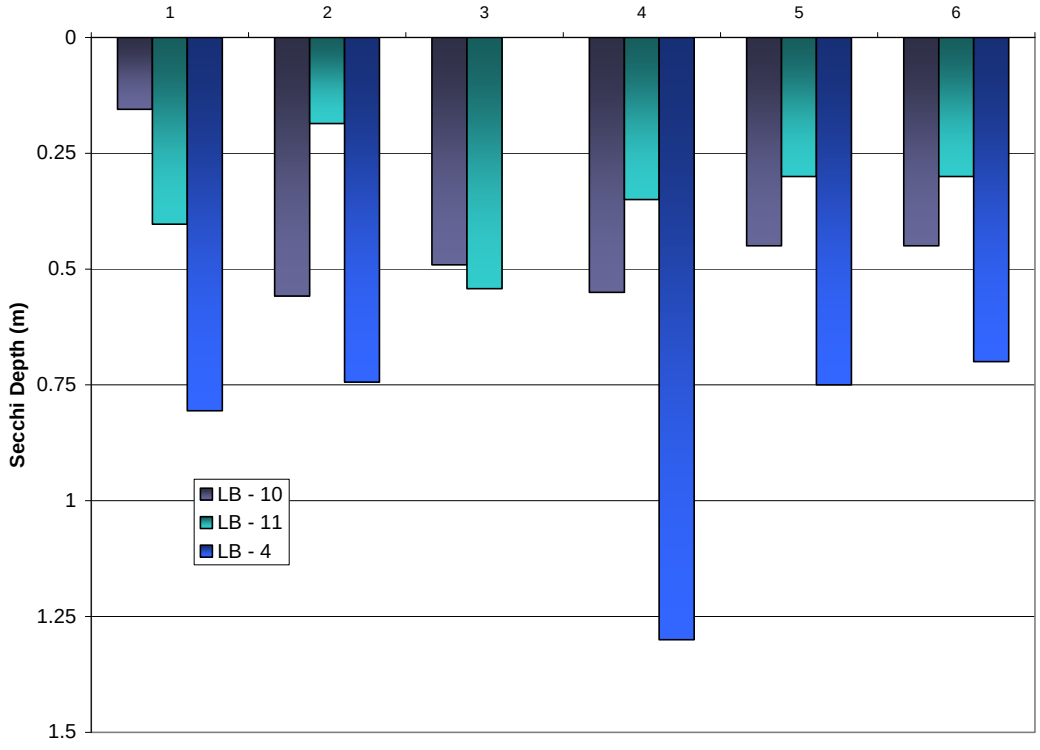


Figure 8.10. Comparison of secchi depth (water clarity) between lake sites from April through September 2006 in Long Branch Lake.

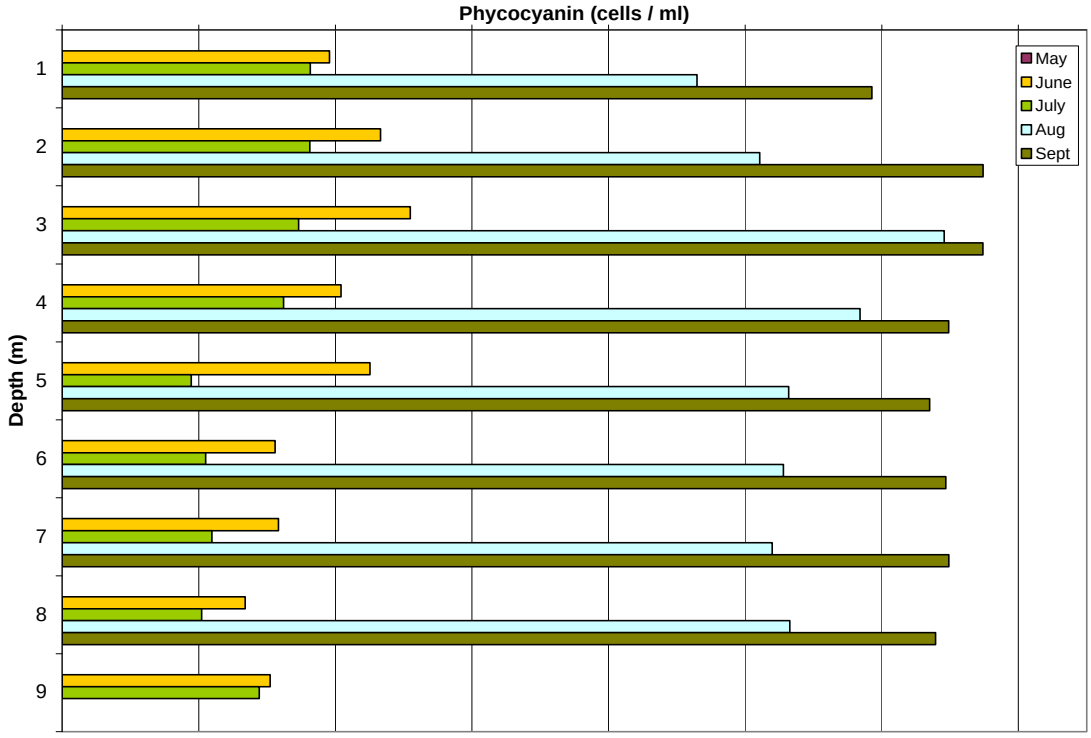


Figure 8.11. Relative concentrations of phycocyanin (bluegreen algae) (cells / ml) measured monthly by depth at Long Branch Lake Site 4 (Tower) during 2006.

The median atrazine concentrations from lake surface water samples collected between 1996 and 2006 (1.41 – 1.55 ug/L) were all below EPA's drinking water maximum contaminant level of 3 ug/L (Figure 8.12). Median inflow concentrations range from 0.67 (Site 19) to 1.65 (Site 18) are some of the lowest within the district. It should be noted that a samples exceeding the MCL were collected from Site 18 during May (3.32 ug/L) and June (15.0 ug/L), 2006 (Figure 8.13).

Median cyanazine concentrations ranged from 0.06 – 0.08 ug/L from lake sites, and 0.03 ug/L (Site 19) – 0.8 ug/L (Site 18) from inflows (Figure 8.14). Concentrations have declined dramatically following 1998 at all inflow, lake and outflow sample sites.

Total iron exceeded EPA's Drinking Water Standard of Secondary Maximum Contaminant Levels (SMCL) of 300 ug/L from surface samples collected during August at both inflow sites (Site 18 = 3122 ug/L; Site 19 = 4603 ug/L) and both upper lake sites (Site 10 = 530 ug/L; Site 11 = 1160 ug/L). Total iron concentrations ranged from 1115 to 11951 ug/L for bottom samples collected at Sites 4 and 10, respectively. These values are the highest recorded within the district. Elevated levels are directed at drinking water facilities related to taste and staining issues. In addition, the SMCL for manganese (50 ug/L) was exceeded in all surface samples (range = 103 – 460 ug/L) and lake bottom samples (338 – 661 ug/L) collected during August. Implications are directed at drinking water facilities due to taste and stain issues.

Vertical profiles were recorded during monthly sampling trips to Kanopolis Lake in 2006 (Figure 8.15). Parameters included temperature, dissolved oxygen, pH, conductivity, and turbidity. The lake was strongly stratified both chemically and thermally during July, and weakly stratified during both June and August.

Fecal bacteria (*E. coli*) samples were collected on a weekly basis from three locations at the State Park beach during the 2006 recreation season (May through August). The geometric mean of the samples never exceeded the state standard of 126 colonies / 100 ml sample for whole-body contact during the recreational season (Figure 8.16).

8.3.3 Outflow

Outflow samples were collected from Long Branch Lake during 2006. Summarized data on Site 3 is included in discussions of lakes sites listed above.

8.4 Future Activities and Recommendations

Sampling activities for 2007 will include transition to 'ambient' monitoring from May through September, as well as conducting a single vertical profile at each of the three lake sites during July or August. In an effort to gather baseline phycocyanin data, the lake will be monitored for the cyanotoxin microcystin during August and September. Geosmin, associated with taste and odor issues in drinking water, will be examined from samples collected near the tower from July through September. Caffeine will be measured at several sites around the lake as a surrogate for human impacts resulting from failing septic systems, WWTP's, illicit dumping from boats, etc. Interactions will continue with MDNR on efforts to re-write the watershed management plan.

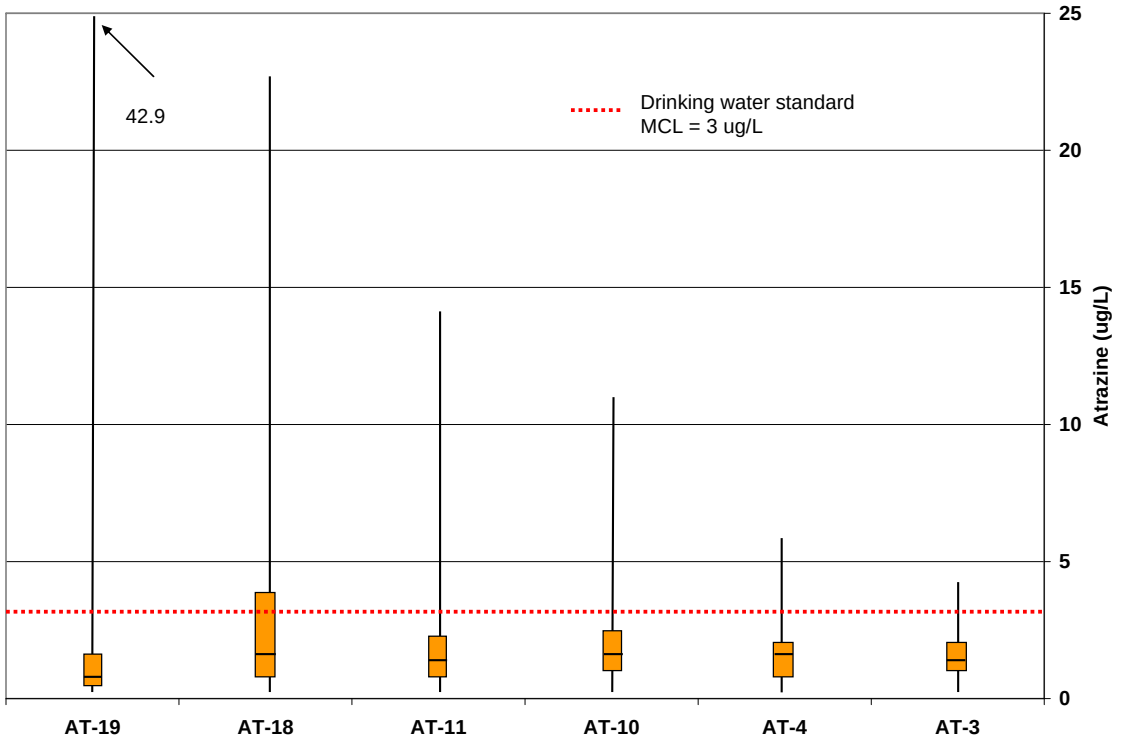


Figure 8.12. Box plot of surface water sample atrazine concentrations measured at lake sites from 1996 through 2005 at Long Branch Lake.

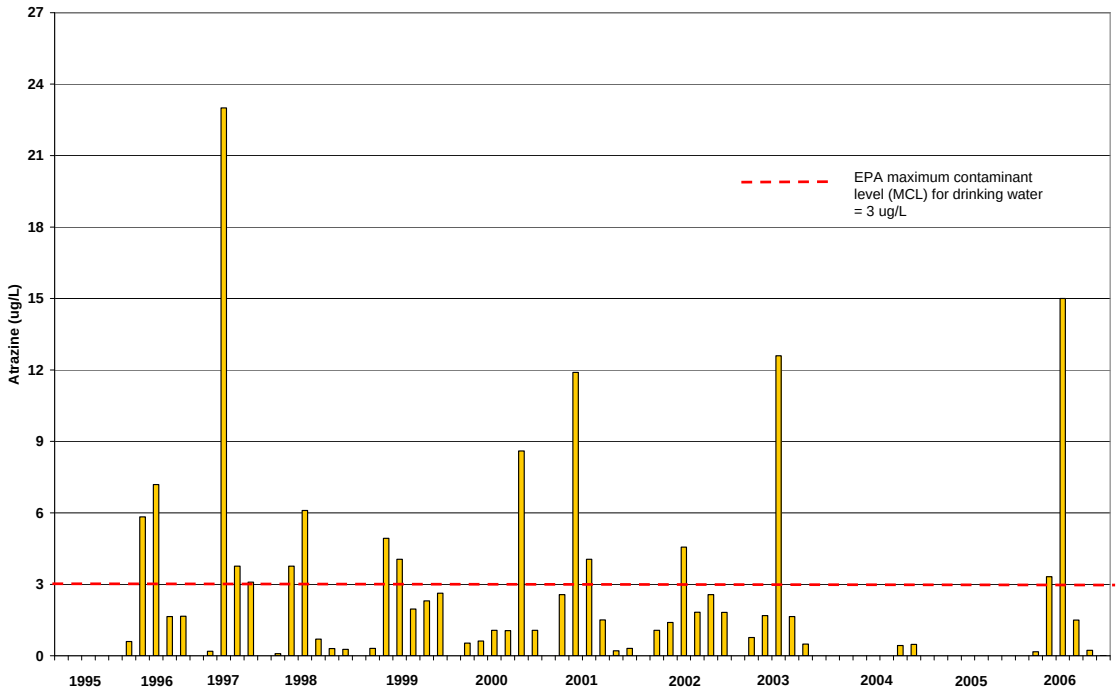


Figure 8.13. Atrazine concentrations by sample date collected at Site 18 (Long Branch Creek) inflow to Long Branch Lake from 1995 - 2006.

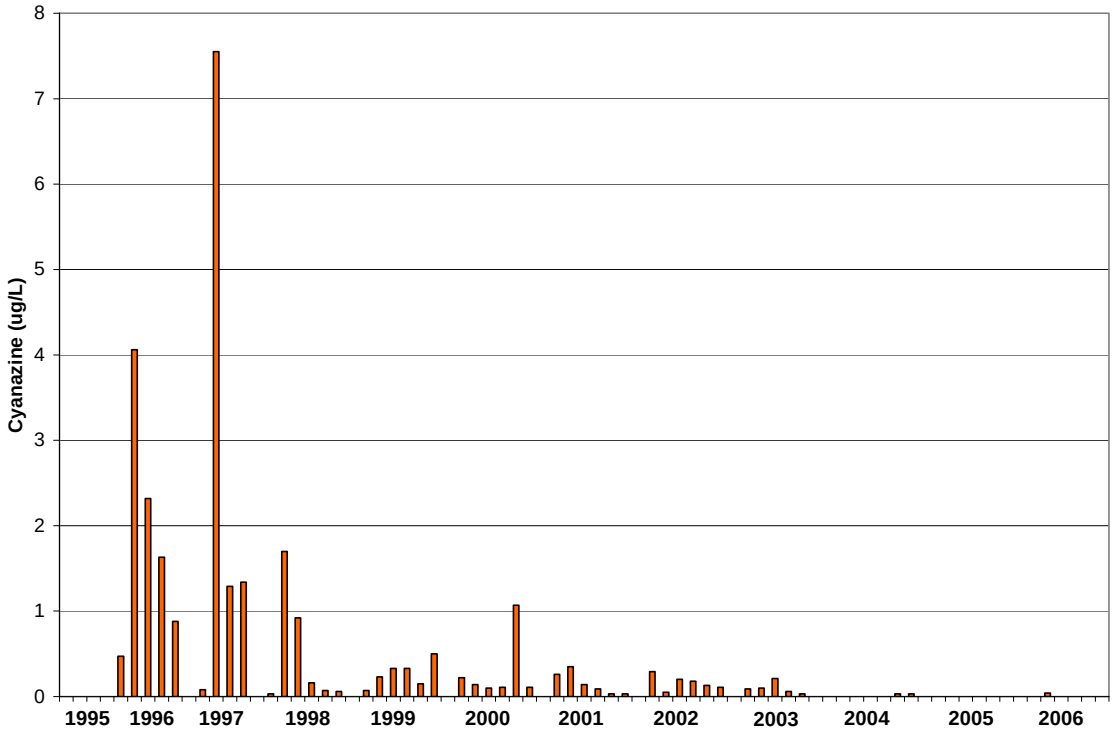
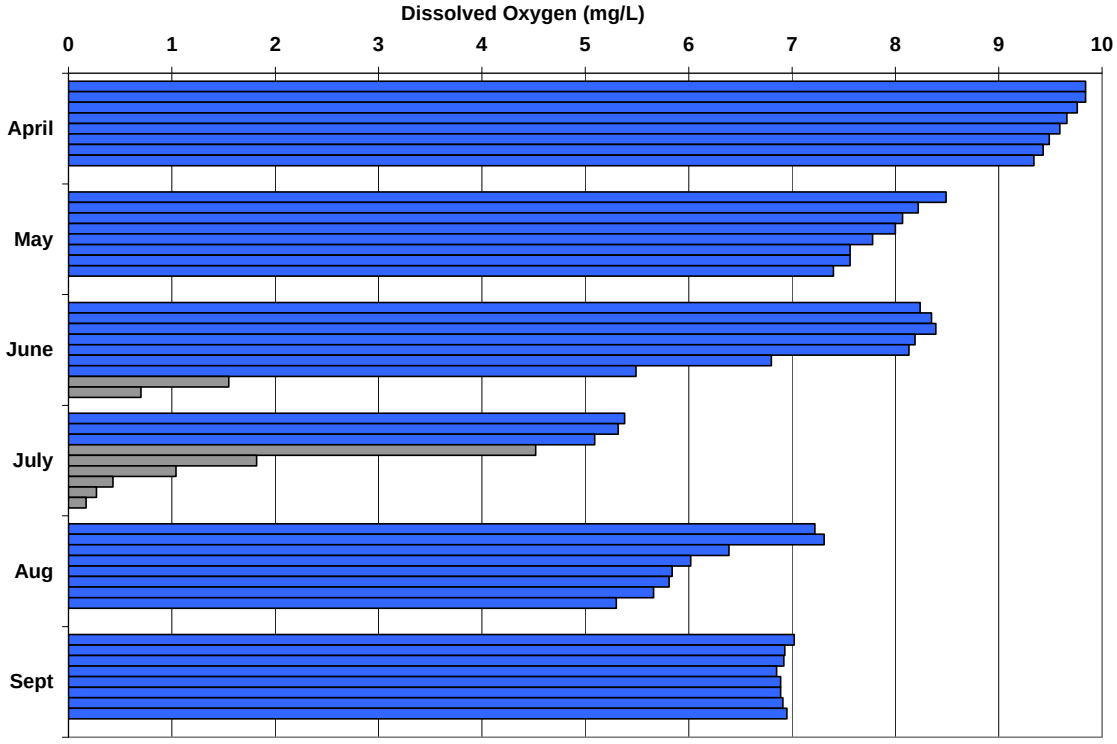


Figure 8.14. Cyanazine concentrations by sample date collected at Site 18 (Long Branch Creek) inflow to Long Branch Lake from 1995 - 2006.



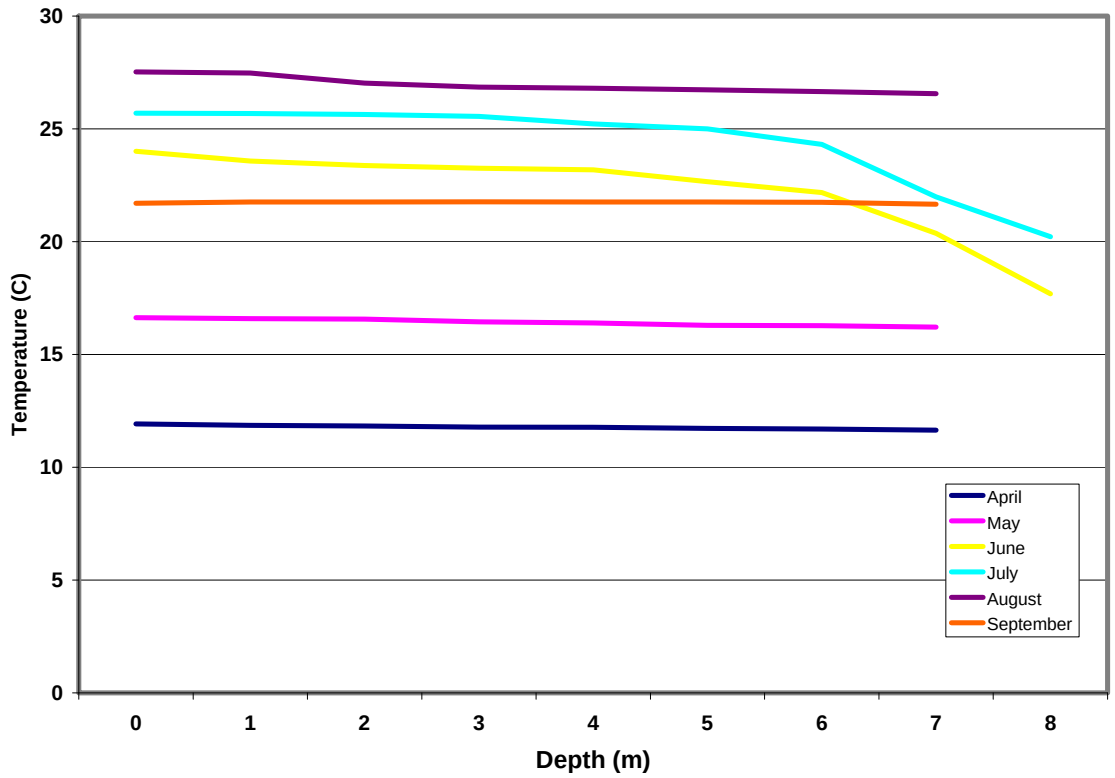


Figure 8.15. Dissolved oxygen concentration (mg/L) histogram and temperature (C) plot from vertical profiles recorded at Site 4 from April through September 2006 at Long Branch Lake.

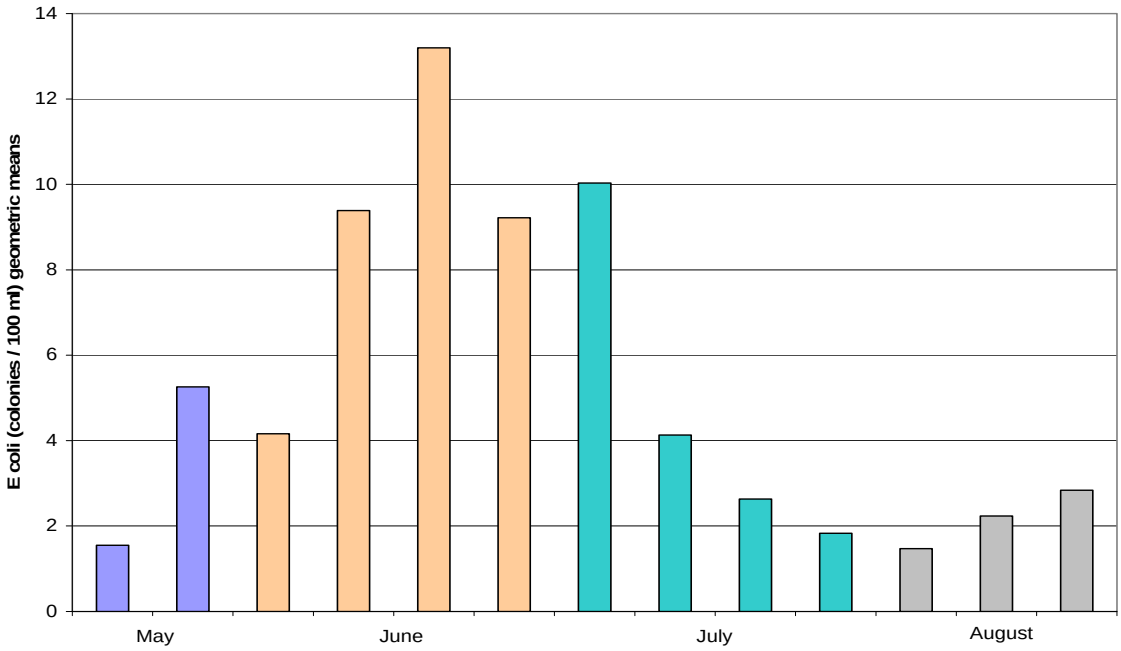


Figure 8.13. Geometric means of fecal bacteria (*E coli*) colonies per 100 ml samples from beach samples collected weekly at Long Branch Lake State Park during 2006.