17 Stockton Lake

17.1 General Background

Stockton Lake was impounded in 1969 and multipurpose pool reached on 18 December 1971. The primary water quality threats to Stockton Lake are nutrients, bacterial contamination, and urban sprawl from the Springfield metro area. Stockton Lake serves as a drinking water source for the Springfield metropolitan area (City Utilities), with a water intake located on the Little Sac arm. Stockton and Truman dams are the only hydropower generation facilities within the district. Stockton contains a single turbine-generator unit, which is marketed by Southwest Power Administration for distribution.

17.1.1 Location

Stockton Lake is located approximately 82 km (51 miles) northwest of Springfield, Missouri in the rolling hills of the Ozarks. The dam is located 82 km (51 miles) above the confluence with the Little Osage River (Truman Lake). The watershed encompasses areas of Cedar, Polk, and Dade Counties. Historic water quality sample sites at Stockton Lake include 3 inflow, 3 lake, and 1 outflow (Figure 17.1).

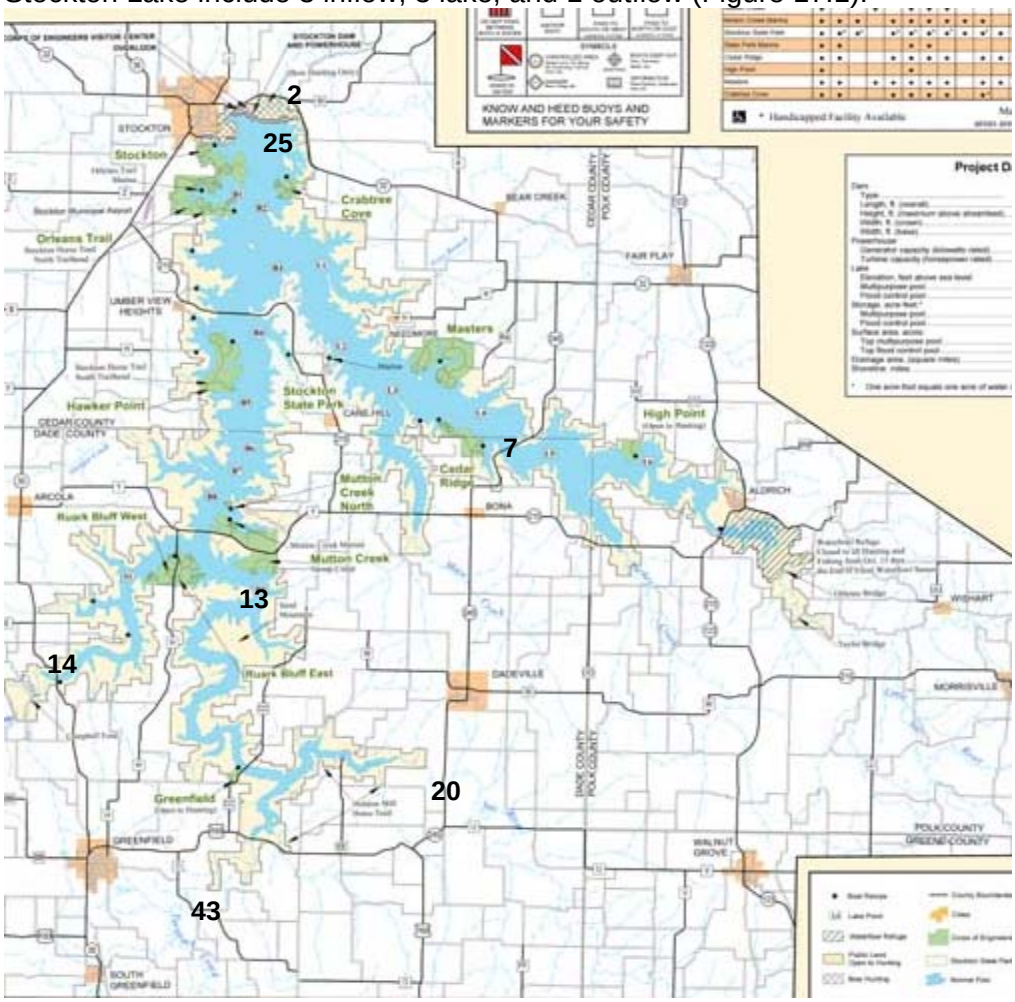


Figure 17.1. Stockton Lake area map with sample site locations.

17.1.2 Authorized Purposes: Flood control, water quality improvement, hydroelectric power generation, recreation, and fish and wildlife management.

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

17.1.4 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	892.0	779.4	38,200	
Multipurpose	867.0	878.3	24,900	300
Total		1,657.7		

Total watershed area: 1,160 sq miles (742,400 A)
Watershed ratio: 19.43 FC / 29.82 MP
Average Annual Inflow: 832,679 acre-feet
Average flushing rate: 1.01 years
Sediment inflow (measured): 8,953 acre-feet (1969 – 1987)
Water management Plan: Approved 21 August 1975
Historic stage hydrograph: 1996 – 2006 (Figure 17.2)

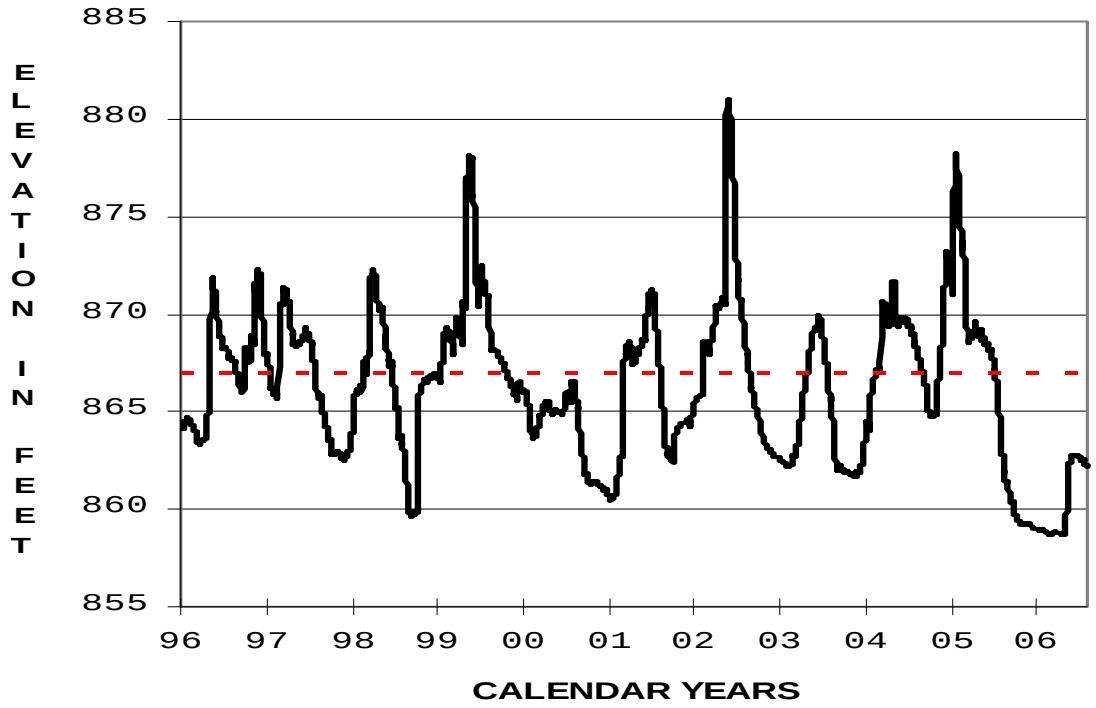


Figure 17.2. Pool elevation hydrograph from 1996 – 2006 (red-dashed line s the multipurpose pool elevation – 867.0 msl).

17.2 2006 Activities

Stockton Lake was categorized as an 'intensive' lake during 2006, thus inflow, lake (surface and bottom), and outflow sites were sampled (see Figure 17.1). Samples were collected from April through September 2006, while vertical profiles were recorded at the three lake sites during monthly trips. Stockton Lake staff (OF-ST) providing field sampling assistance during 2006 was Stanton Rains and Greg Thomas. Tom Long, OF-ST Operations Manager, provided insight and background regarding Stockton Lake.

17.3 2006 Data

Comparative historic data consists of single sample trips in 1999 (July) and 2002 (August) and monthly data from May through September 2005. Samples were collected at inflow, lake, and outflow sites from April through September, 2006.

17.3.1 Inflow

Inflow samples were collected at three sites – Turnback Creek, Sac River, Little Sac River --- in the Stockton Lake watershed during 2006. Please see comments for lake sites below on specific parameters.

17.3.2 Lake

Stockton Lake is considered a meso-trophic lake based on nutrients and chlorophyll data. Nitrogen is an essential nutrient to 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 (TN) median concentrations ranged from 0.52 – 0.72 mg/L (Figure 17.3), which exceeds EPA's proposed nutrient criteria value of 0.46 mg/L TN. Highest median concentrations are measured at the upper lake sites. These values are typical for other lakes within the district.

Phosphorus is another essential nutrient for aquatic life, and it limits algal growth. Median total phosphorus (TP) concentrations ranged from 0.01 – 0.02 mg/ (Figure 17.4), which are the lowest TP values within the district and typical for mesotrophic Ozark waters. EPA has proposed a nutrient criteria value of 0.008 mg/L TP for this ecoregions, and thus the lake would be in exceedence of such nutrient criteria. Watershed samples were collected during 2006, with significantly higher concentrations measured at both Site 20 (Sac River) and Site 43 (Turnback Creek). However, very elevated TP concentrations (median = 0.30 mg/l) were measured at Site 10 (Little Sac River). These TP concentrations are a concern for the overall water clarity, drinking water, and water quality concerns at Stockton Lake. Watershed efforts should be focused in this area to reduce nutrient inputs. It is important to determine possible sources – failing septic systems, WWTP inputs, animal waste.

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

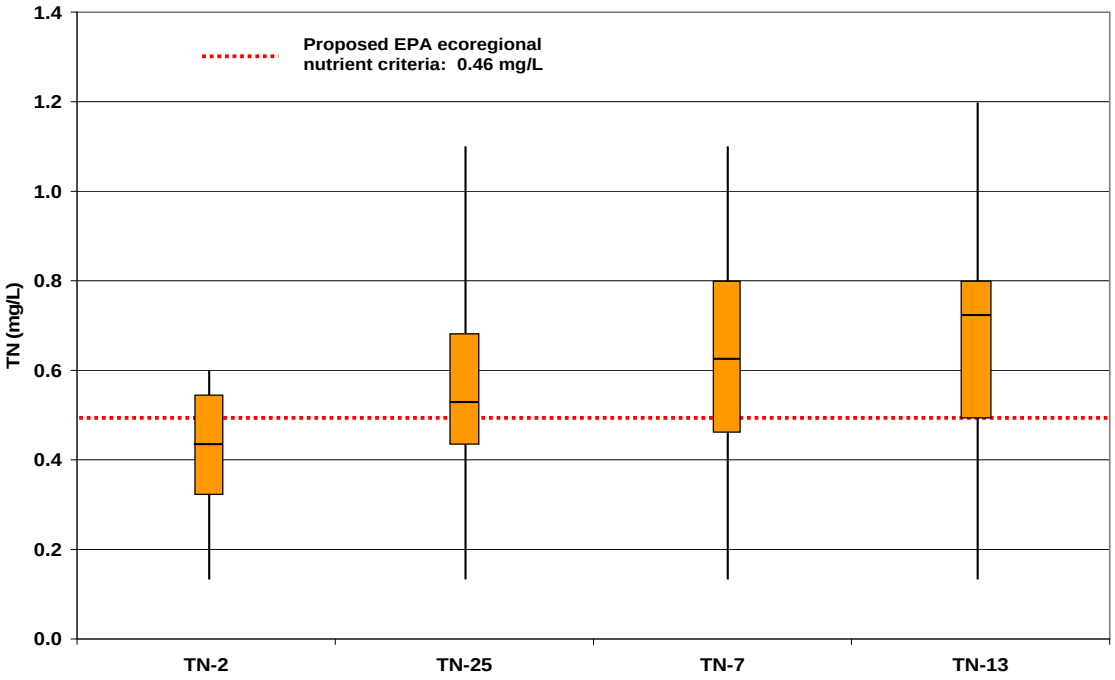


Figure 17.3. Box plots of surface water sample total nitrogen (TN) concentrations measured at lake sites from 1999, 2002, 2005, and 2005 in Stockton Lake.

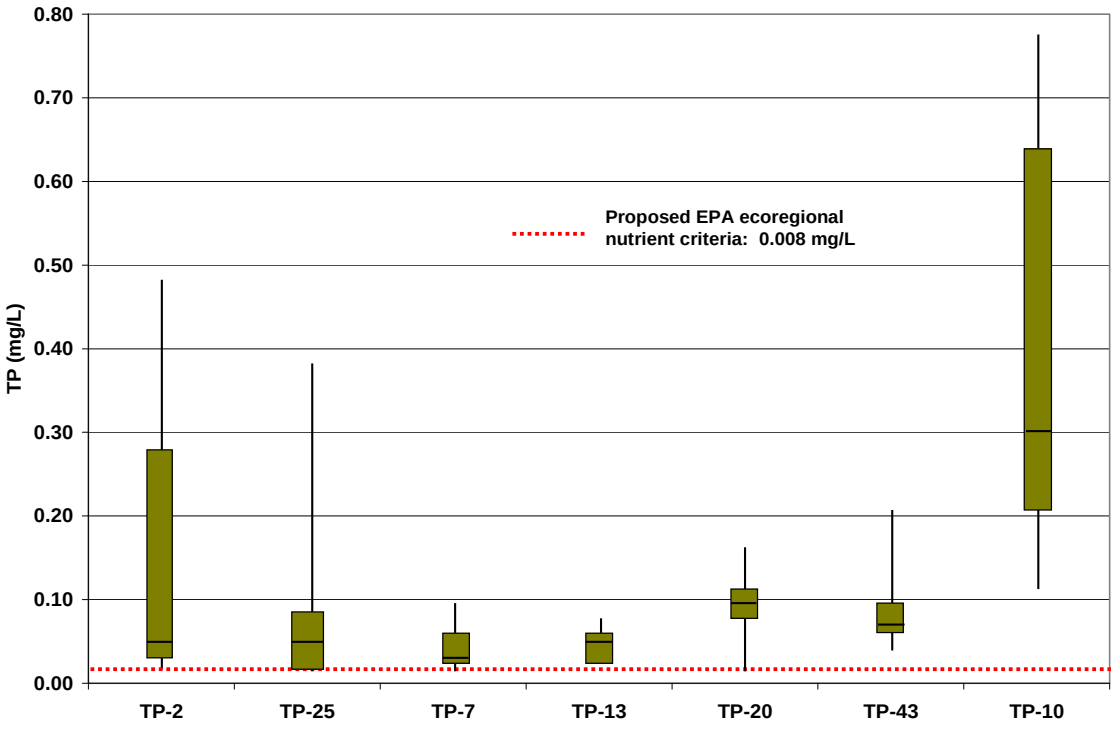


Figure 17.4. Box plots of surface water sample total phosphorus (TP) concentrations measured at lake sites from 1999, 2002, 2005 and 2006 at Stockton Lake.

communities, whereas ratios ≤ 12:1 are indicative of bloom-forming cyanobacteria (blue green algae). Median TN:TP concentrations range from 9.1 (Site 25) to 13.1 (Site 7), indicating all sites could be influenced by blue-green algae (Figure 17.5). As would be expected, there is high monthly variability in the TN:TP ratio at all sites, with lowest values recorded during late summer and early fall (Figure 17.6). Sites with TN:TP ratios < 12 are at risk for cyanobacteria blooms, however, no microcystin toxins were detected at Stockton Lake during sampling in 2000 (Dr. Jennifer Graham, USGS, personal communication). Cyanotoxins are a concern related to both drinking water and recreational use.

Median chlorophyll *a* concentrations ranged from 8 – 19 ug/L from lake sample sites collected during 1999, 2005 and 2006 (Figure 17.7). Lowest chlorophyll concentrations were measured at Site 25 (main lake – tower), while significantly higher concentrations are measured at both upper lake sites.

Secchi depth (water clarity) was measured monthly at all three lake sites. Differences in water clarity were detected between sites, as is evident in Figure 17.8. Water clarity is very high at Site 25 (mean = 2.99 m), while moderately clear water clarity is measured at both Sites 7 (mean = 1.8 m) and Site 13 (mean = 1.55 m).

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 17.9 depicts vertical distribution of phycocyanins measured at Site 25 (Tower) from June through September. Highest lake concentrations were measured during June at a depth of 9 – 11 m. Overall, concentrations in Stockton Lake were the lowest measured within the district.

Atrazine samples from surface water samples have only been collected 1x in 1999 and April – September 2006. The mean concentrations ranged from 0.03 – 0.06 ug/L from lake sites, and from 0.03 – 0.07 ug/L at inflow sites. These concentrations are the lowest measured within the district. None of the samples collected during 2006 exceeded the MCL (3 ug/L). It is also important to note that drought conditions may have some impact on concentrations measured this year.

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 all inflow sites (range = 386 – 3663 ug/L). The highest concentration was measured at Site 10. Total iron concentrations from bottom samples in the lake ranged from 3663 – 4571 ug/L, which reflects anoxic conditions throughout the lake. Elevated levels are directed at drinking water facilities related to taste and staining issues. In addition, surface samples collected during August exceeded EPA's SMCL for manganese (50 ug/L) at all inflow site (range = 70 - 1696 ug/L). Once again, the highest inflow concentrations was measured at Site 10 (Little Sac River). The SMCL for total manganese was exceeded in bottom samples from all lake sites (range = 1559 – 2074 ug/L). Implications are directed at drinking water facilities due to taste and stain issues.

Fecal bacteria (*E. coli*) samples were collected from all five beaches (Stockton, Orleans Trail, Ruark Bluff, Cedar Ridge, and Masters) prior to major recreational season holidays during 2006. Samples prior to July 4th exceeded single sample whole-body contact

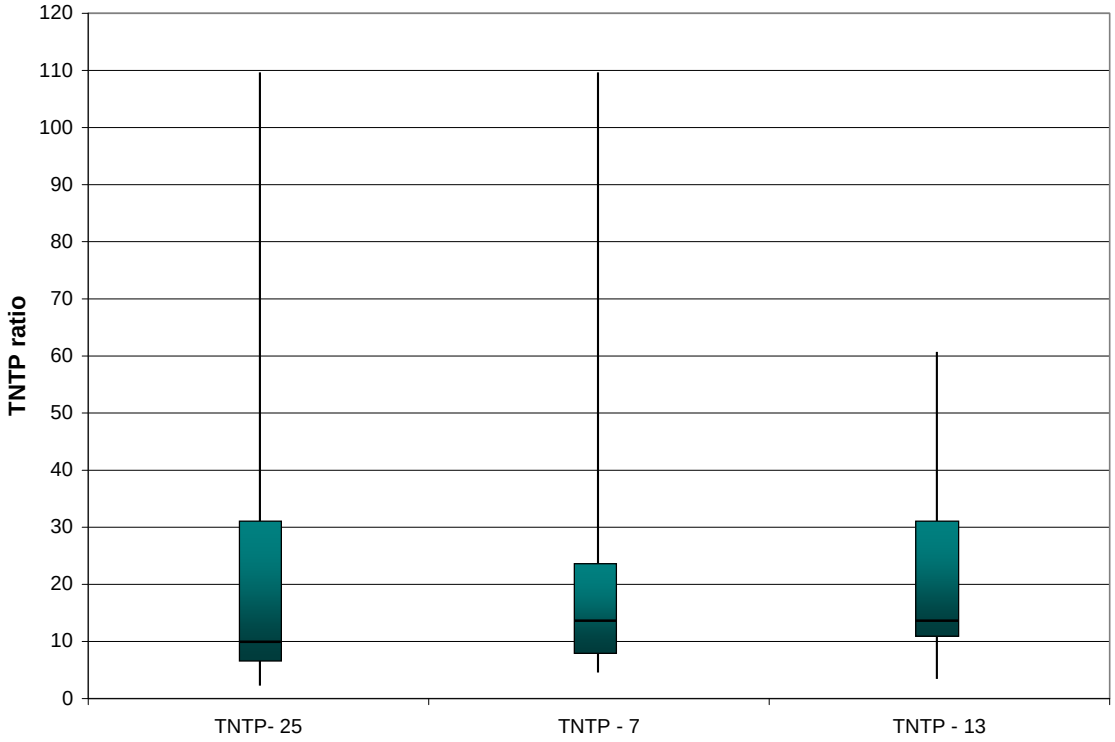


Figure 17.5 Box plots of total nitrogen : total phosphorus (TN : TP) ratio by site from 1996 through 2006 at Stockton Lake.

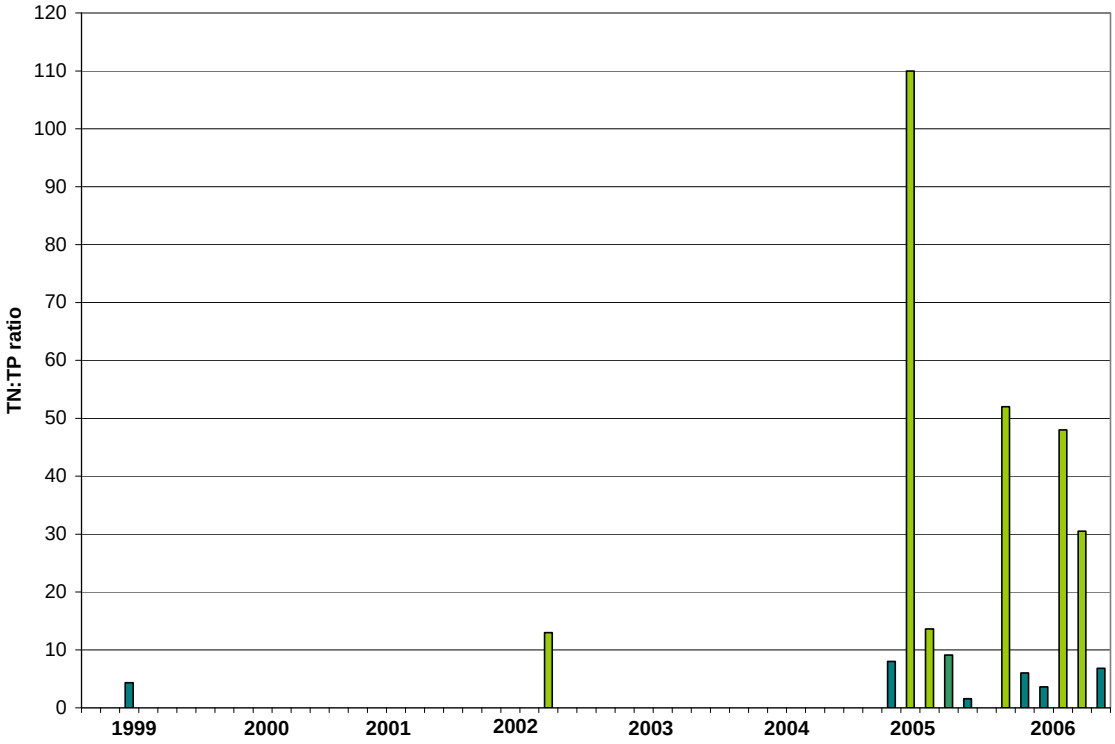


Figure 17.6. Total nitrogen : total phosphorus ratio variability by sample date and year from Site 25 in Stockton Lake from 1996 through 2006.

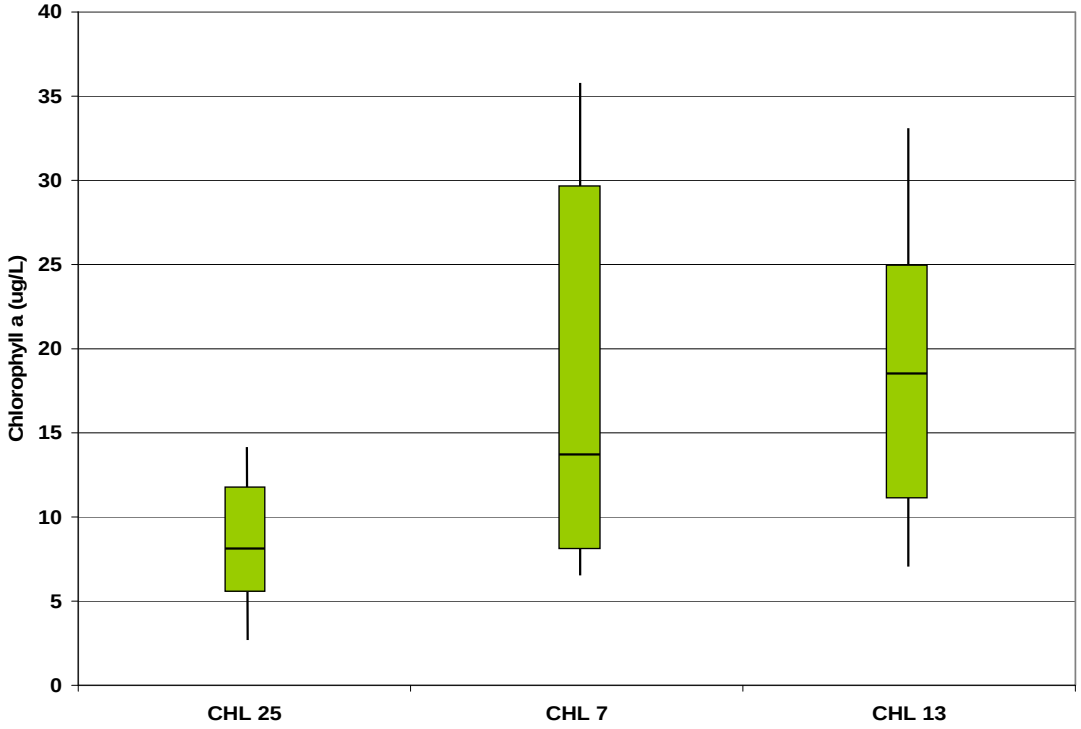


Figure 17.7. Box plots of chlorophyll a concentrations from samples collected by site during 1999 and 2005 at Stockton Lake.

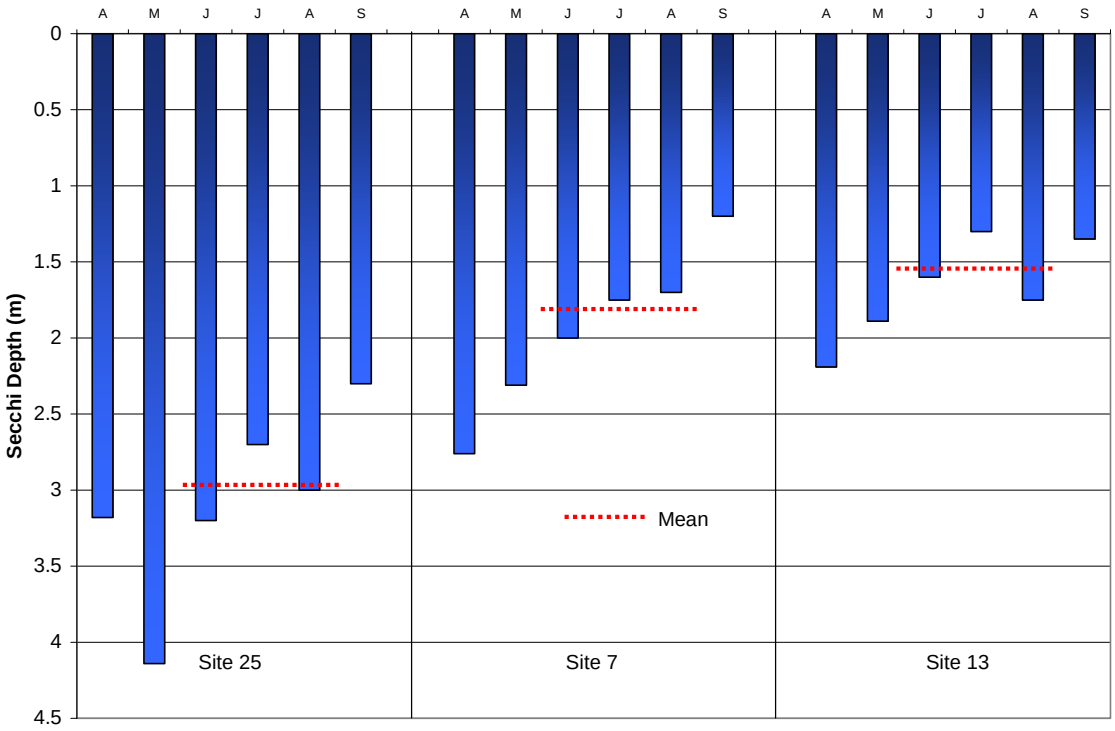


Figure 17.8. Plot of secchi depth (water clarity) measured by date and site during 2006 at Stockton Lake.

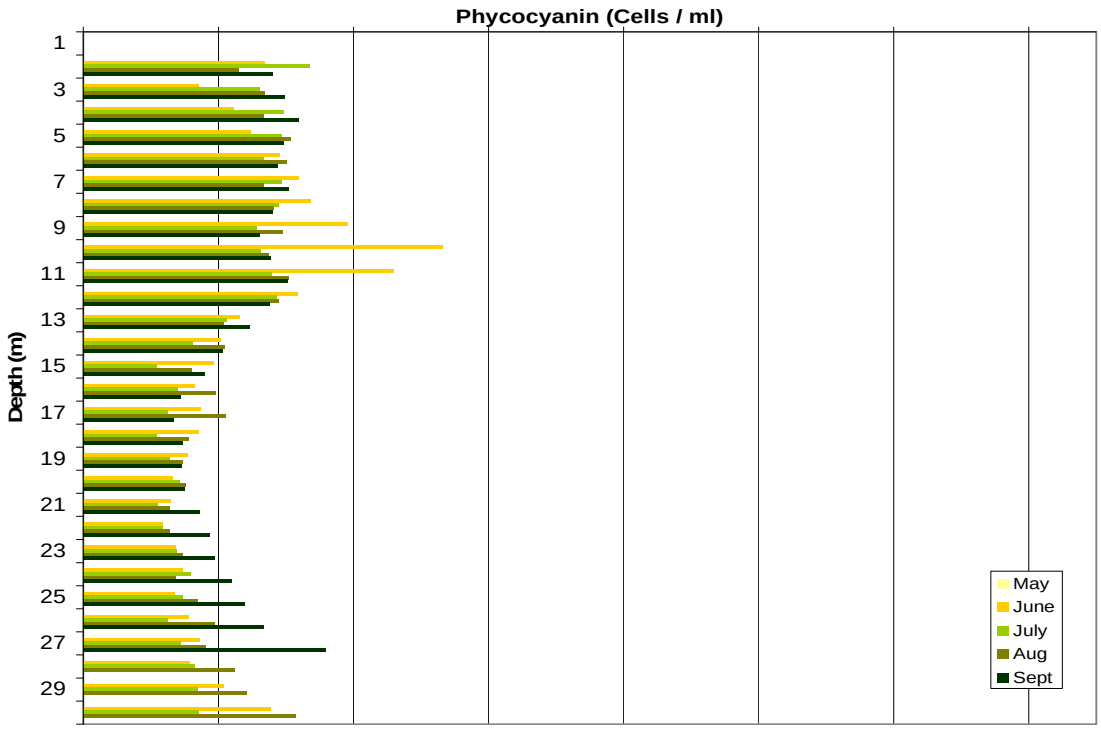


Figure 17.9. Relative concentrations of phycocyanin (bluegreen algae) (cells / ml) measured monthly by depth at Stockton Lake Site 25 (Tower) during 2006.

criteria (126 colonies / 100 ml) at Stockton, Orleans Trail, and Ruark Bluff beaches (Figure 17.10).

Vertical profiles were recorded at the three lake sites from April through September 2006. Parameters included temperature, dissolved oxygen, pH, conductivity, chlorophyll a, phycocyanins, and turbidity. Based on this information, the lake was strongly stratified both thermally and chemically. Stratification occurred between a depth of 7 – 9 m during June, and this increased to 11 – 14 m during August (Figure 5.10).

17.3.3 Outflow

Outflow samples were collected at Site 2 from Stockton Lake during 2006. Summarized data from Site 2 is included in discussions of lake sites listed above.

17.4 Future Activities and Recommendations

Sampling activities for 2007 will include transition to 'ambient' monitoring from May through September, as well as conducting a monthly 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

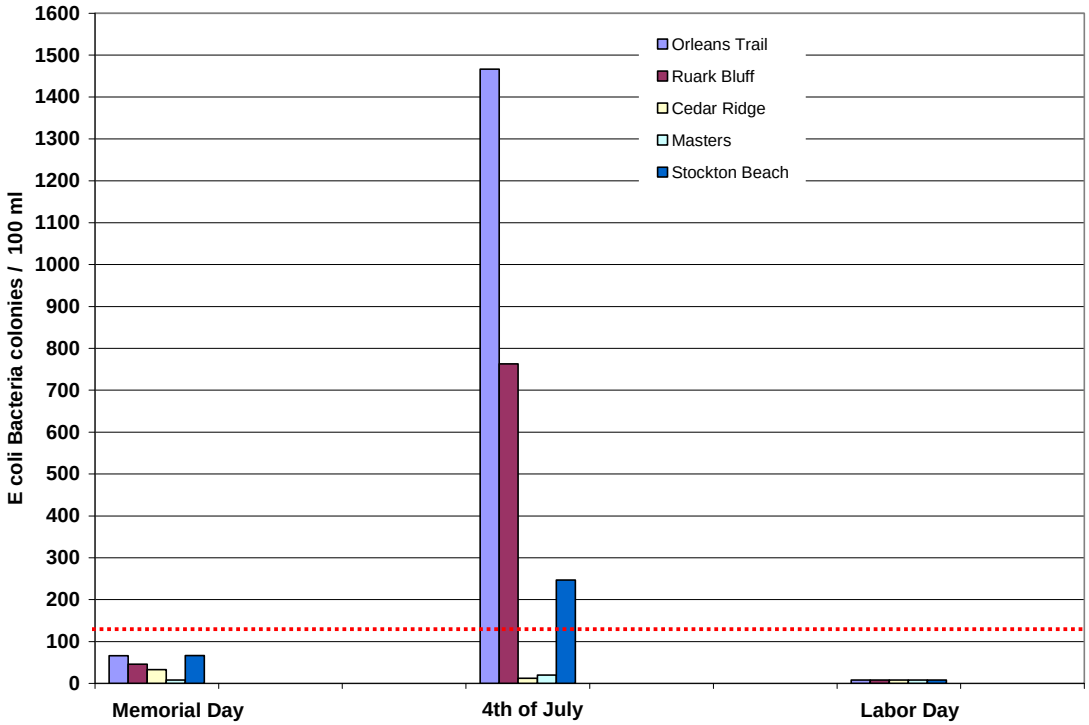
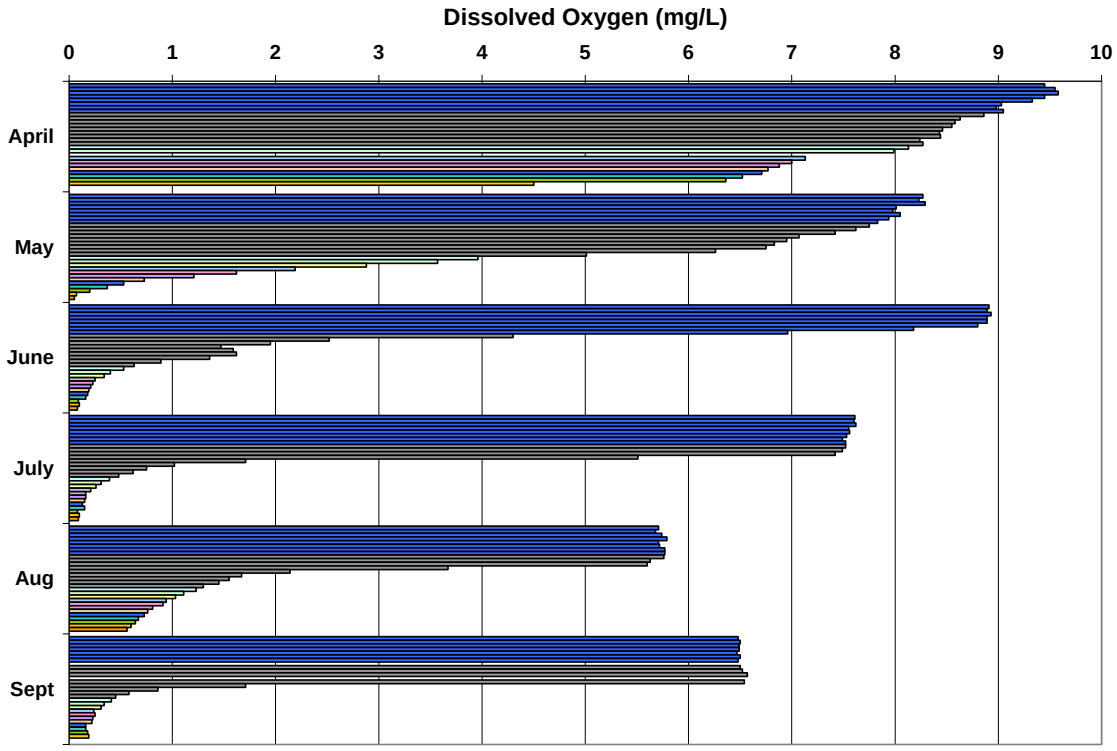


Figure 17.10. Fecal bacteria (E. coli) colonies per 100 ml samples from beach samples collected prior to major holidays at Stockton Lake during 2006.



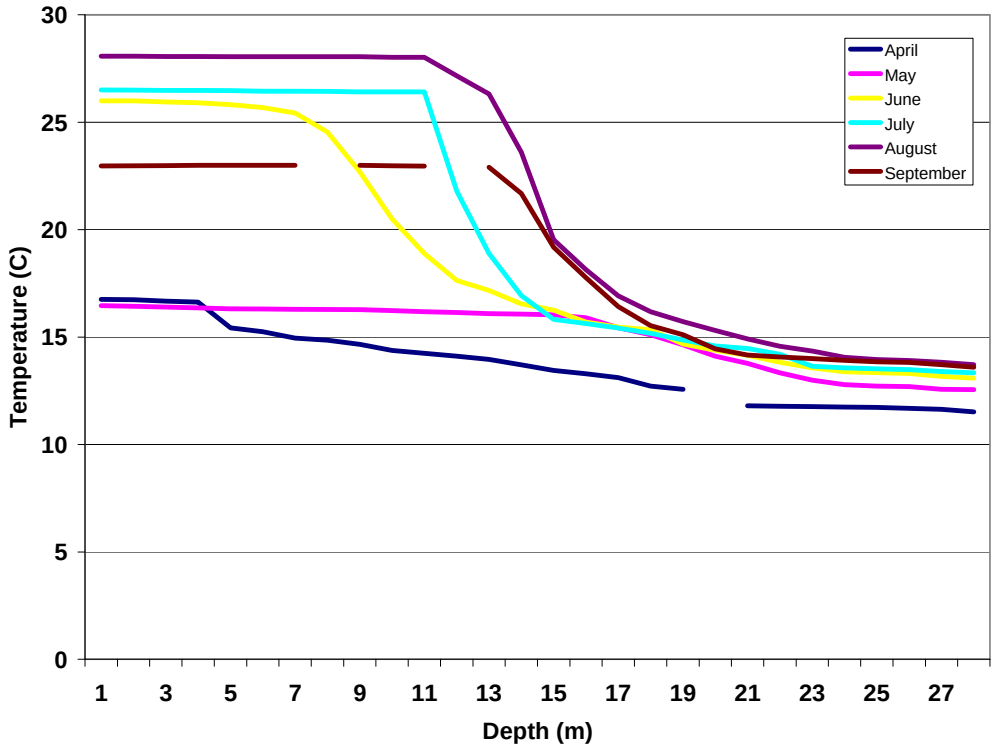


Figure 17.11. Dissolved oxygen concentration (mg/L) histogram and temperature (°C) plot from vertical profiles recorded at Stockton Lake Site 25 during 2006.

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. Two additional sites are proposed to provide additional lake and watershed information. Both sites are located in Sons Creek – an inflow site at the Hwy 39 bridge (Site 14), and a lake site (Site X) in the historic channel just west of the Ruark Bluff Recreation Area.