15 Rathbun Lake

15.1 General Background

Rathbun Lake was impounded in 1969 and reached multipurpose pool level on 10 October 1970. The main threats to water quality of Rathbun Lake are nutrients, sediment, bluegreen algae, bacterial contamination, and herbicides / pesticides. Rathbun Lake inflows are listed on Iowa's 303(d) impaired waters list due to low dissolved oxygen and nutrients. To address watershed landuse - water quality issues, the Rathbun Land and Water Alliance (RLWA, www.rlwa.org) was formed. Members include the Rathbun Rural Water Association, Soil and Water Conservation Districts and County Governments within the Rathbun Lake watershed. Partners include the Iowa Farm Bureau, Iowa Department of Natural Resources, Iowa Dept of Agriculture, Iowa State University, NRCS, FSA, and the Corps of Engineers. The mission of the Alliance is to 'foster a voluntary approach driven by landowners, water users, and public and private organizations to protect and enhance land, water, and economic resources in the Rathbun region'. The Corps and Iowa DNR are involved in a Section 1135 project at Rathbun Lake. The project, to begin during FY07, is designed to stabilize bank erosion at six sites identified around the lake.

15.1.1 Location

Rathbun Lake is located approximately 120 km (75 miles) southeast of Des Moines in south central Iowa. The dam is located on the Chariton River at river kilometer 227 (river mile 142). The watershed is located in Appanoose, Wayne, and Lucas Counties. Historic water quality sites at Rathbun Lake include 4 lake, 1 outflow, and 15 inflow (Figure 15.1).

15.1.2 Authorized Purposes: Flood damage reduction, water supply, water quality improvement, recreation, and fish and wildlife management.

15.1.3 State Use Designations: Primary contact recreation uses, significant warmwater resource for aquatic life uses, high quality resource water.

15.1.4 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	926.0	345.5	21,000	
Multipurpose	904.0	190.7	11,000	155
Total		536.2		

Total watershed area:	549 sq miles (351,360 A)
Watershed ratio:	16.73 FC / 31.94 MP
Average Annual Inflow:	355,704 acre-feet
Average Annual outflow:	000 acre-feet
Average flushing rate:	0.78 years
Sediment inflow (estimated):	240 AF/yr
Water management Plan:	Approved 18 October 1981; revisions September 2005

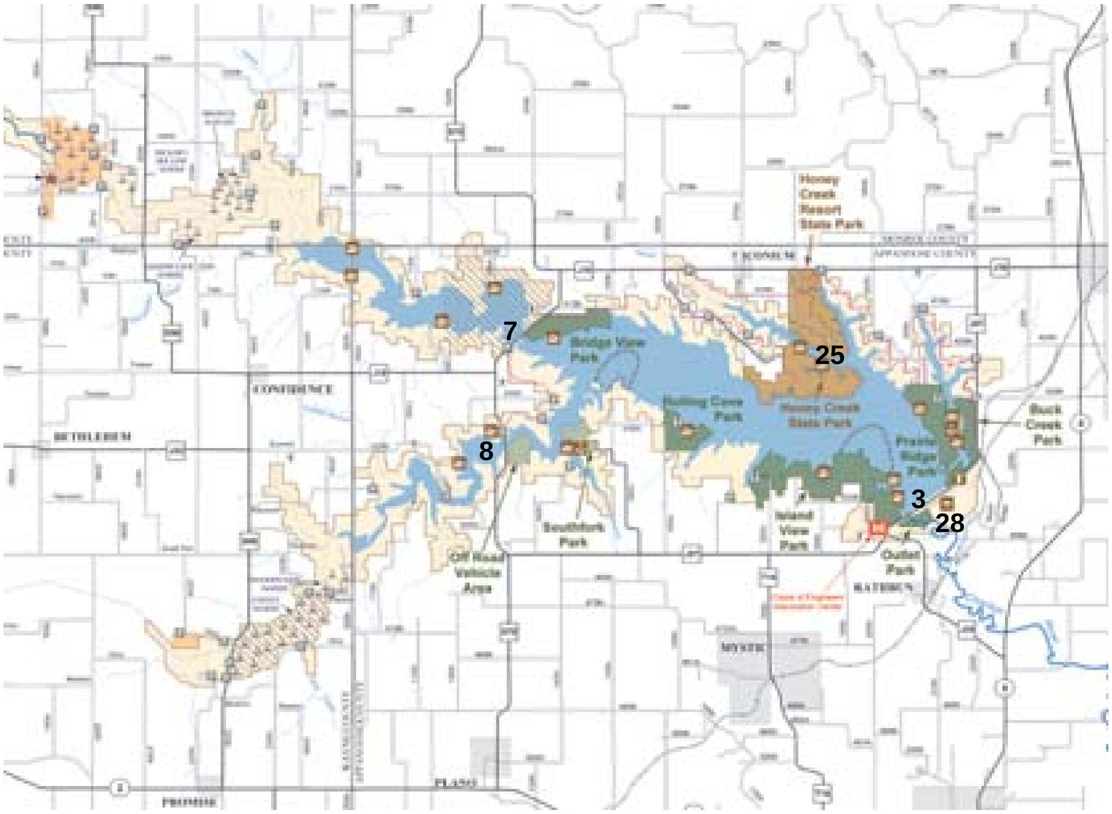


Figure 15.1.   Rathbun Lake area map with sample site locations.

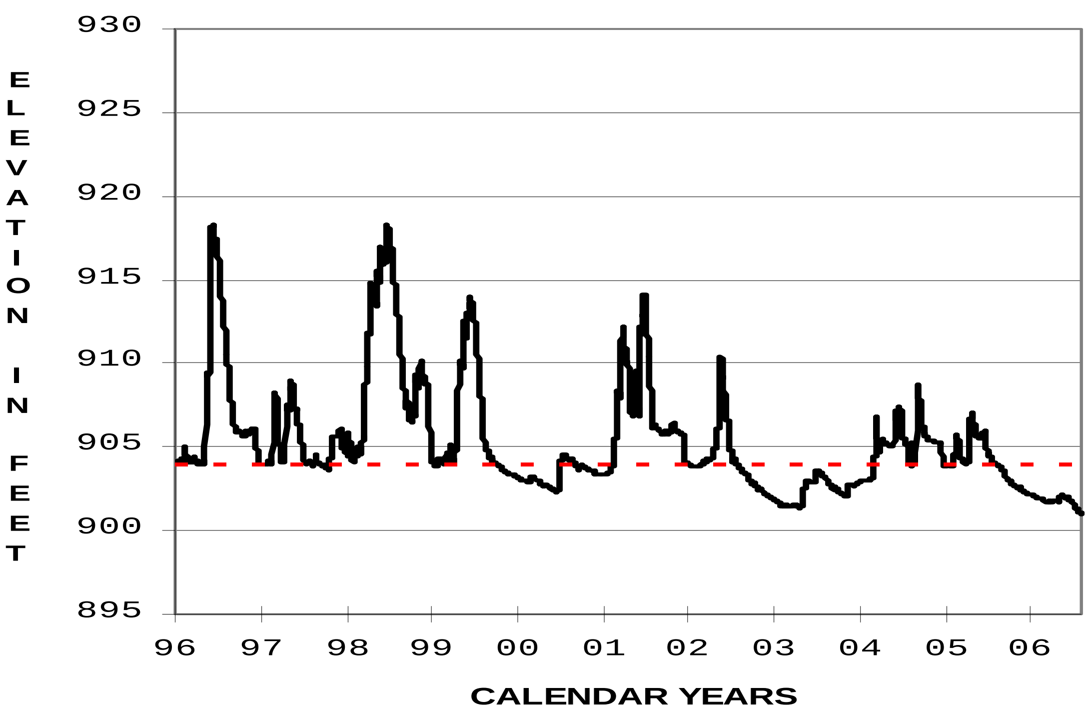


Figure 15.2.   Pool elevation hydrograph from 1996 – 2006 (red-dashed line is the multipurpose pool elevation – 904.0 msl).

15.2 2006 Activities

Rathbun Lake was categorized as an 'intensive' lake during 2006, thus surface and bottom samples were collected at the four lake sites and the outlfow. Sample collections occurred from April through September, with vertical profiles recorded at all four sites during each trip. Rathbun Lake staff (OF-RA) providing field sampling assistance during 2005 included Paul Egeland. Bill Duey, OF-RA Operations Manager, provided insight and background regarding Rathbun Lake. Data has been shared with the Rathbun Land and Water Alliance, Iowa State University, and Iowa Dept of Natural Resources. Input has been provided into proposed watershed monitoring efforts and proposed changes in the operations manual.

15.3 2006 Data

Comparative historic water quality data consists of monthly (April – September) samples collected from 1997 through 2006. Samples were collected at inflow, lake, and outflow sites from April through September, 2006.

15.3.1 Inflow

Inflow samples were collected by Iowa State University (Dr John Downing) and analyzed by both Iowa State University Limnology Lab as well as the USACE lab in Omaha. Historically, sediment, nutrient, and herbicide contaminants have been of major concern related to inflows into Rathbun Lake.

15.3.2 Lake

Total nitrogen (TN) median concentrations and chlorophyll a values indicate Rathbun Lake is eutrophic. 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. Monthly and annual variability in total nitrogen is evident at all sites (see Figure 15.3 for Site 8 as an example). Median concentrations range from 0.81 – 1.49 mg/L TN (Figure 15.4), with highest concentrations present in samples from the South Fork Chariton River arm (Site 8). All median values exceed EPA's proposed ecoregional nutrient criteria value of 0.36 mg/L TN. The measured values are typical for agricultural watersheds within the district.

Phosphorus is another essential nutrient for aquatic life, and it limits algal growth. Median total phosphorus concentrations ranged from 0.04 – 0.12 mg/L for surface samples collected between 1997 and 2005 at Rathbun Lake (Figure 15.5). These values do exceed EPA's proposed ecoregional nutrient criteria value of 0.02 mg/L. Monthly and annual variability in total phosphorus is evident at all sites, as is depicted in Figure 15.6 (Site 8). Mean TP concentrations from the lower lake sites are typical of clearer district lakes.

The ratio of TN:TP can be used as a surrogate to determine the dominant algal community within a waterbody. Ratios ≥ 20:1 are indicative of desirable algal communities, whereas ratios ≤ 12:1 are indicative of bloom-forming cyanobacteria (blue green algae). As would be expected, there is high monthly and annual variability in the

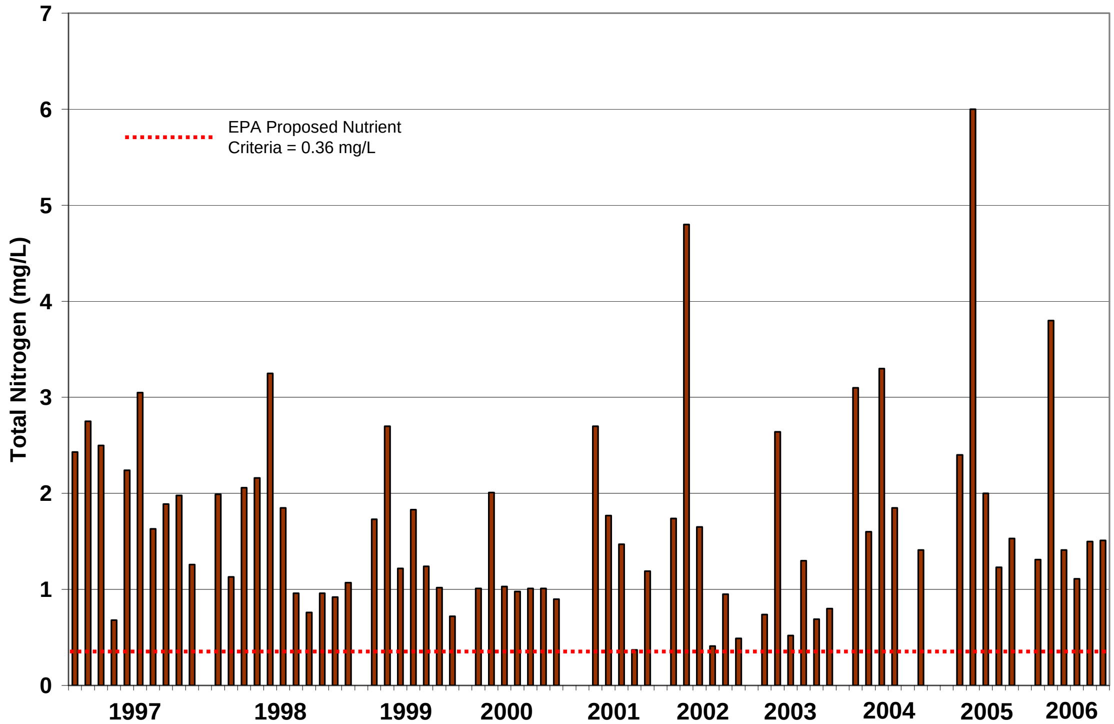


Figure 15.3 Total nitrogen concentrations by sample date collected from surface water samples at Site 8 (Southfork of Chariton River arm) in Rathbun Lake from 1997 through 2006.

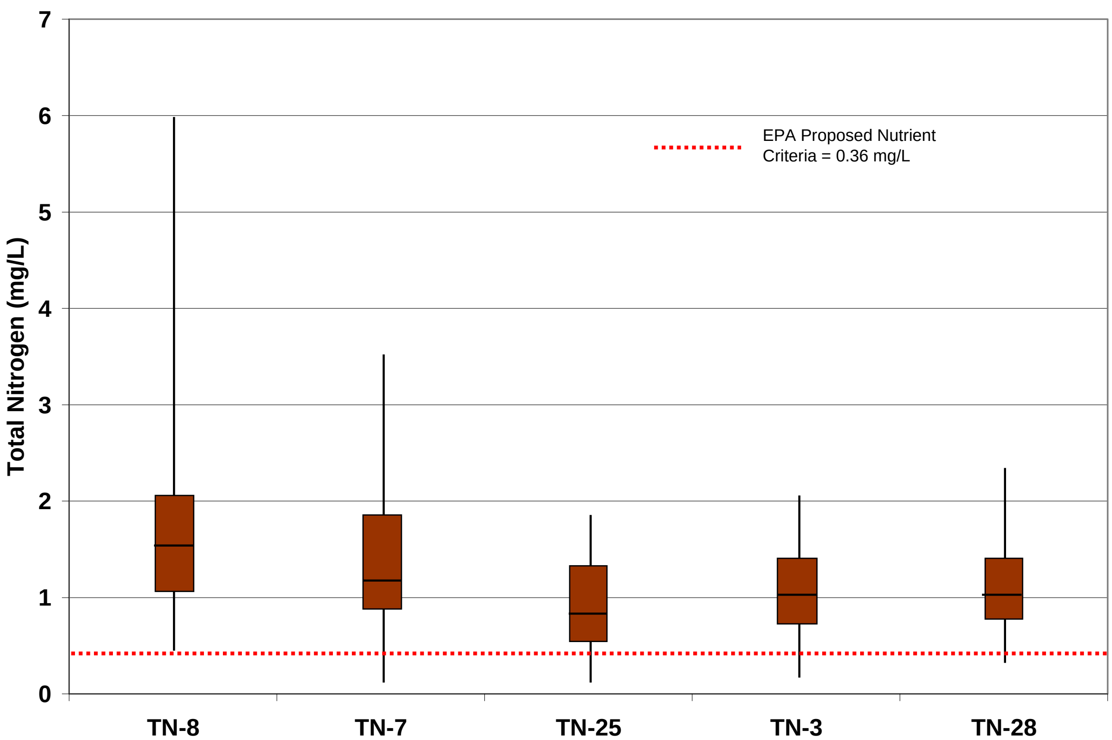


Figure 15.4. Box plots of surface water sample total nitrogen concentrations measured by site from 1997 through 2006 at Rathbun Lake.

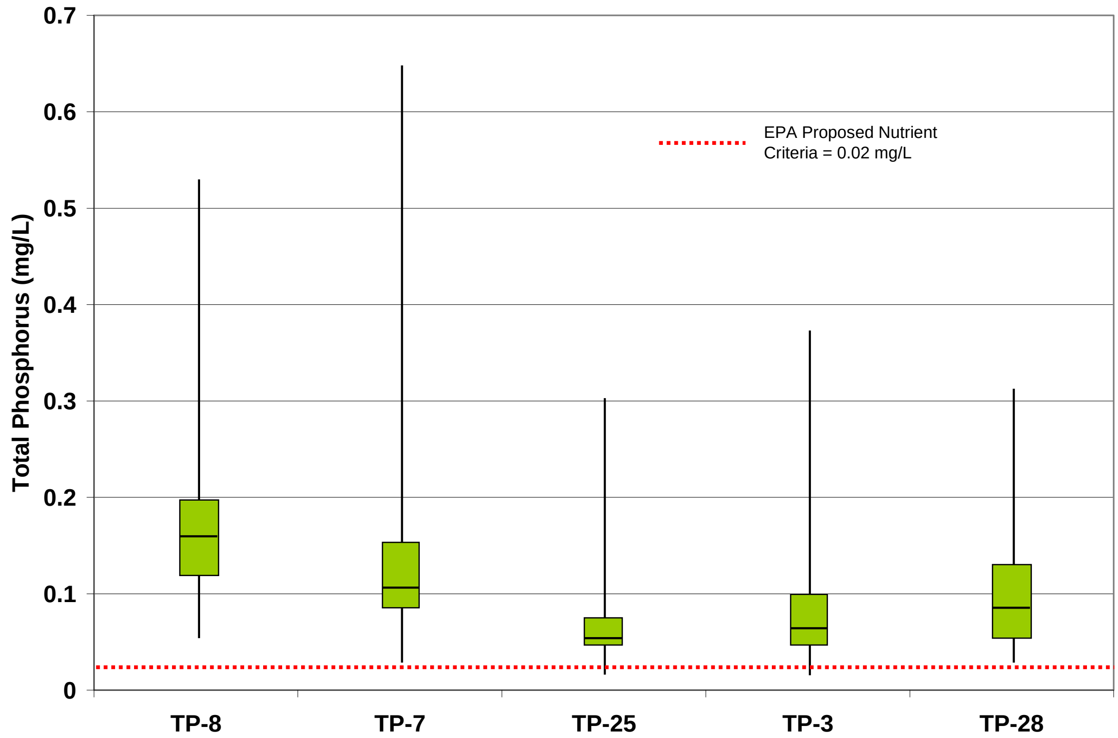


Figure 15.5. Box plots of surface water sample total phosphorus concentrations measured by site from 1997 through 2006 at Rathbun Lake.

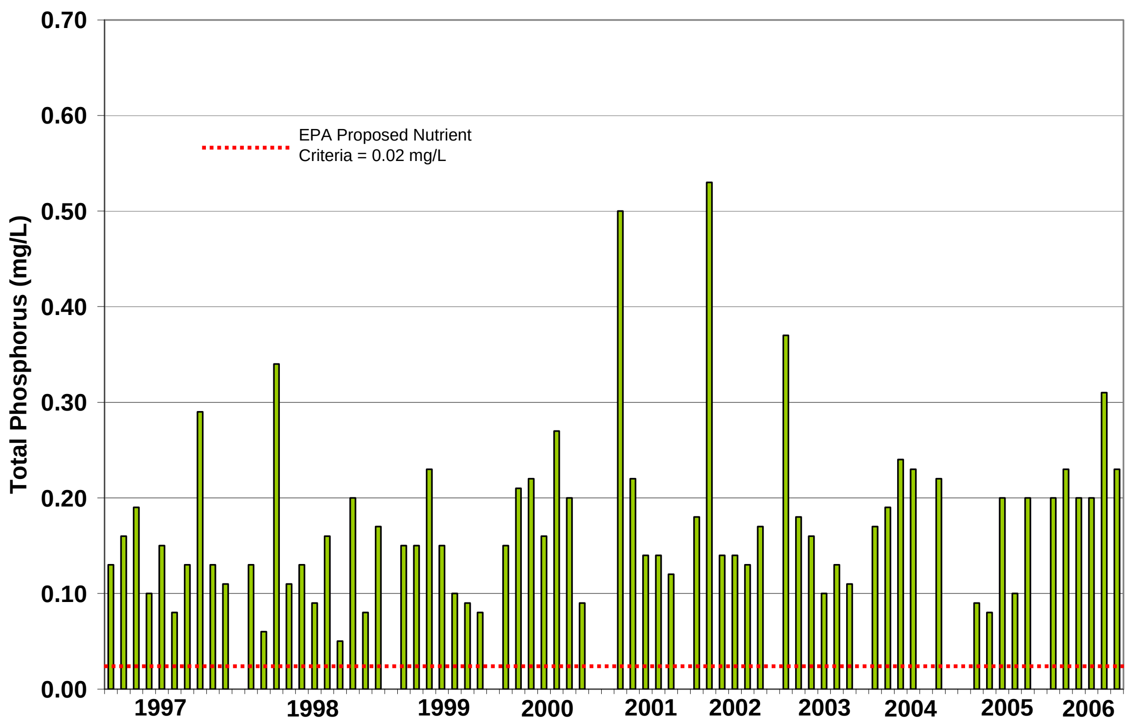


Figure 15.6 Total phosphorus concentrations by sample date collected from surface water samples at Site 8 (Southfork of Chariton River arm) in Rathbun Lake from 1997 through 2006.

TN:TP ratio at all sites; see Figure 15.7 as an example at Site 3. Median TN:TP ratios were < 12 at both upper lake sites (Sites 7 and 8) but slightly higher at lower lake sites (Figure 15.8). These values indicate the lake is at risk for cyanobacteria blooms. Microcystin toxins were detected at Rathbun Lake during 2000 and 2001 (Dr. Jennifer Graham, USGS, personal communication).

Rathbun Lake exhibited longitudinal differences in chlorophyll *a* concentrations by site from uplake to lower lake (Figure 15.9), which would be expected due to sediment and nutrient inflows. The highest chlorophyll *a* concentrations are consistently measured at Site 8 (median = 19.1 ug/L), while Site 7 and Site 25 are similar in median concentrations (median = 12.4 and 10.7 ug/L, respectively).

Secchi depth measurements (water clarity) also exhibited a longitudinal gradient from uplake to downlake (Figure 15.10). Significantly higher water clarity (0.78 m) was measured at Site 3 (Tower) and Site 25 (Honey Creek arm), whereas very limited clarity (0.24 – 0.37 m) was measured Site 8 (South Fork Chariton) and 7 (Chariton River arm), respectively.

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 15.11 depicts vertical distribution of phycocyanins measured at Site 3 (Tower) from June through September. Elevated concentrations were prevalent throughout the entire water column during June, and declined during July and September. The highest concentrations were typical of other lakes within the district.

Between 1997 and 2006, median atrazine concentrations (1.12 – 1.54 ug/L) were less than EPA's drinking water maximum contaminant level (MCL) of 3 ug/L (Figure 15.12). However, individual samples measured from surface samples during this period were significant enough to exceed the MCL. Figure 15.13 depicts sample concentrations measured by sample date at Site 8 (South Fork Chariton River) between 1997 and 2006. Concentrations exceed the MCL during most spring run-off events at Site 8; concentration of 24 ug/L was measured from Site 8 during 2006. The MCL has only been exceeded at Site 7 on limited occasions, while samples have never exceeded the MCL at Site 25.

Cyanazine exceeded EPA's drinking water maximum contaminant level (1 ug/L) at all sites during 1997 and up lake sites during 1998. No value has exceeded 1 ug/L at any site since 1998.

Glyphosate was monitored at all lake and outflow sites during 2006 to provide background data. Concentrations ranged from 0.13 – 0.23 ug/L, which well below EPA's drinking water MCL of 700 ug/L.

Total iron exceeded EPA's Drinking Water Standard of Secondary Maximum Contaminant Levels (SMCL) of 300 ug/L from surface samples collected during August 2006 at all lake sites (371 – 2475 ug/L) except Site 3 (299 ug/L); Site 28 (outfall) exceeded the SMCL (31 ug/L. Bottom samples exceeded the SMCL at all lake sites (311 – 2931), with highest concentrations measured at Sites 7 and 8. Implications are directed at drinking water facilities related to taste and staining issues. In addition,

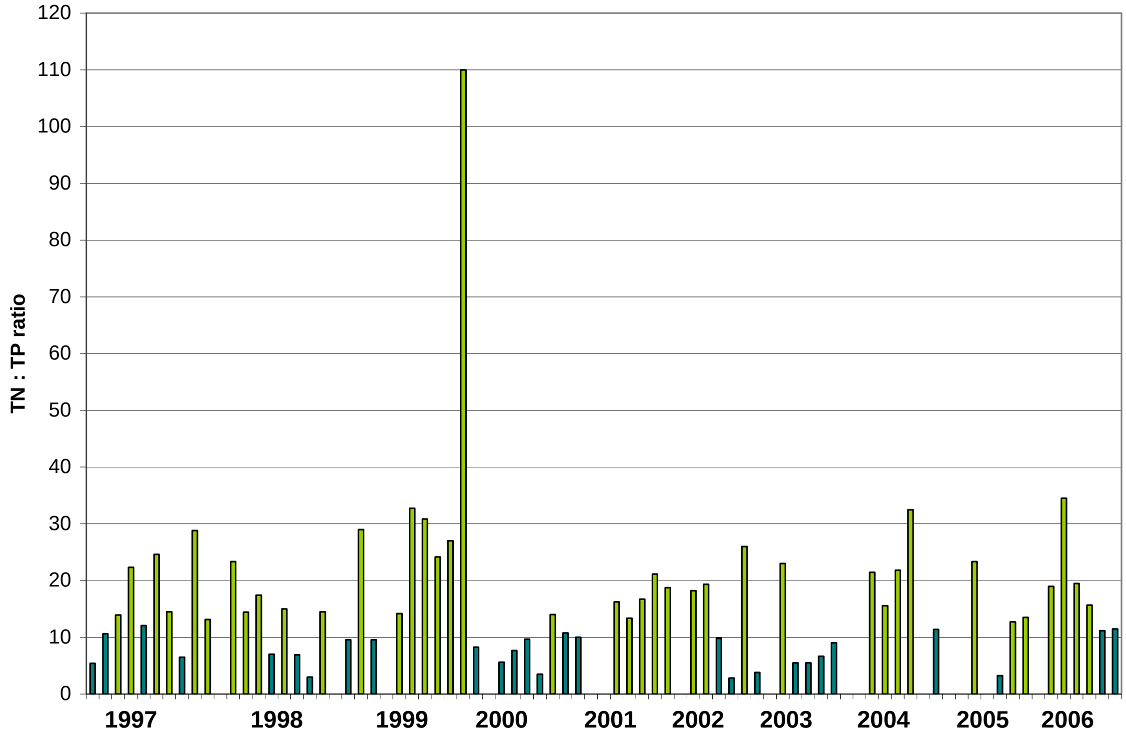


Figure 15.7. Graph of total nitrogen : total phosphorus ratio (TN : TP) by sample date from 1997 through 2006 at Site 3 (Tower) in Rathbun Lake.

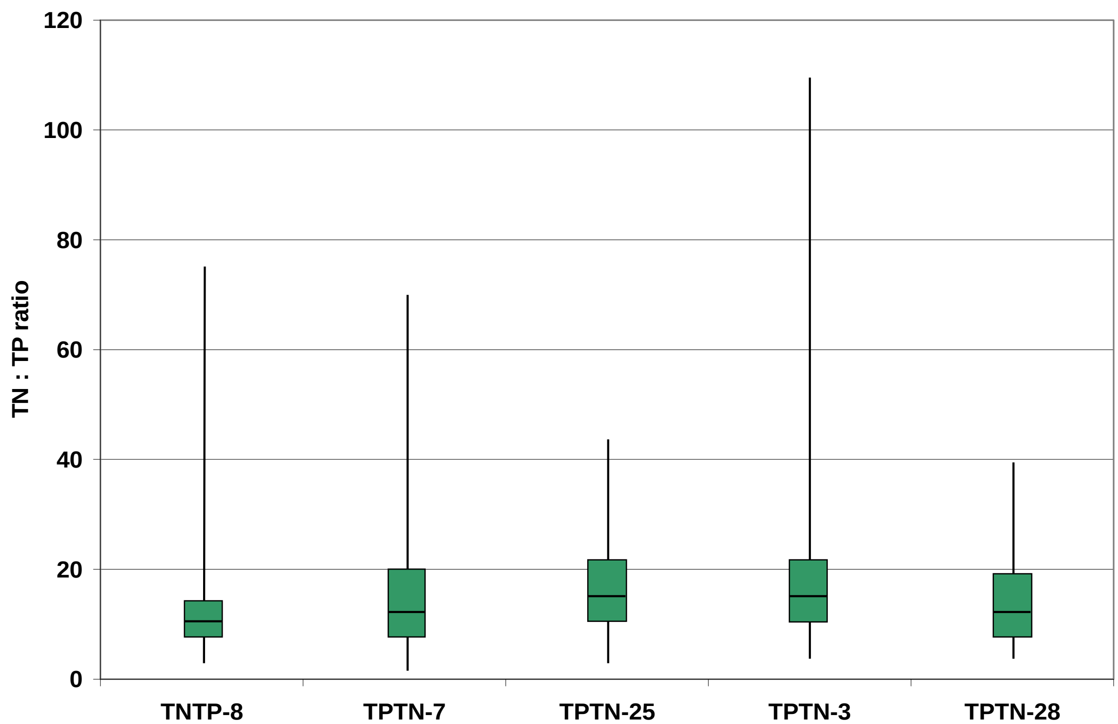


Figure 15.8. Box plots of total nitrogen : total phosphorus (TN : TP) ratio by site from 1997 through 2006 at Rathbun Lake.

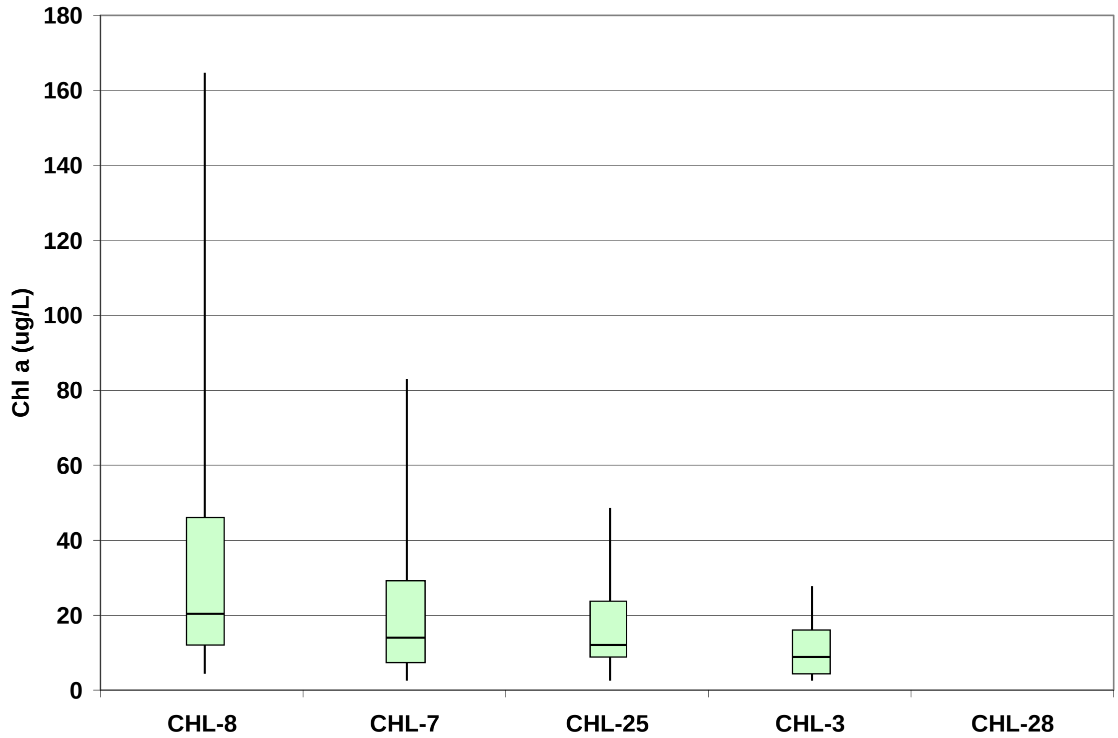


Figure 15.9. Box plots of chlorophyll a concentration measurements by site from 1997 through 2006 at Rathbun Lake.

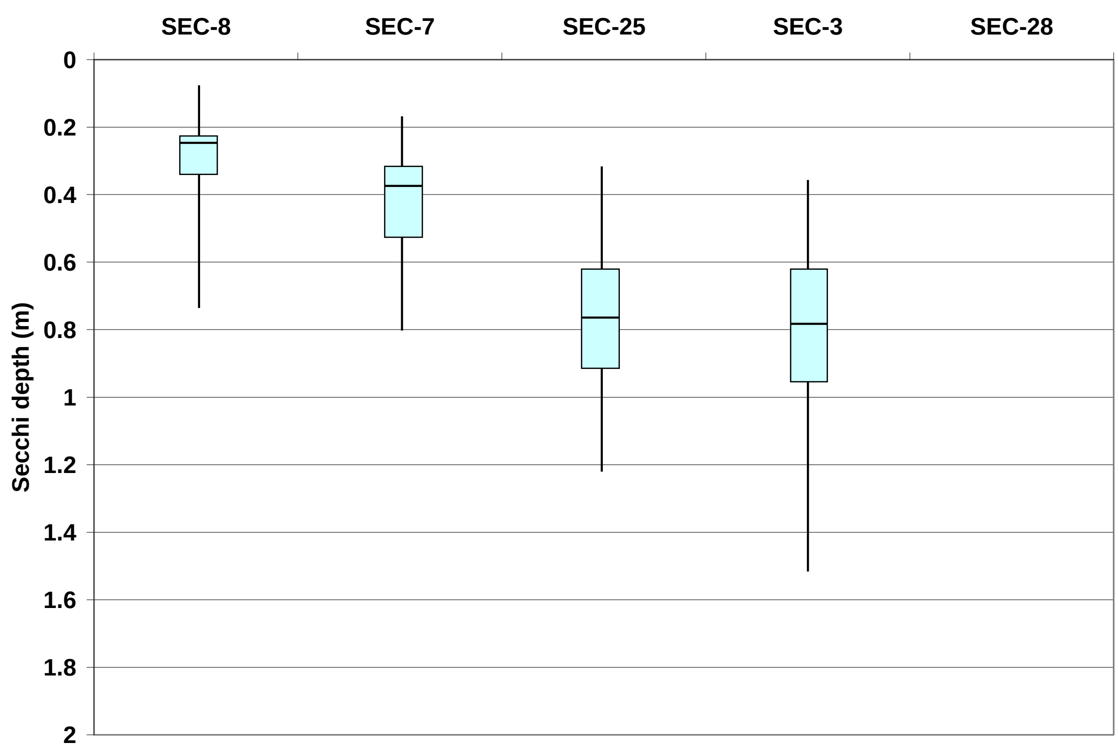


Figure 15.10. Box plot of secchi depth by site from 1997 through 2006 at Rathbun Lake.

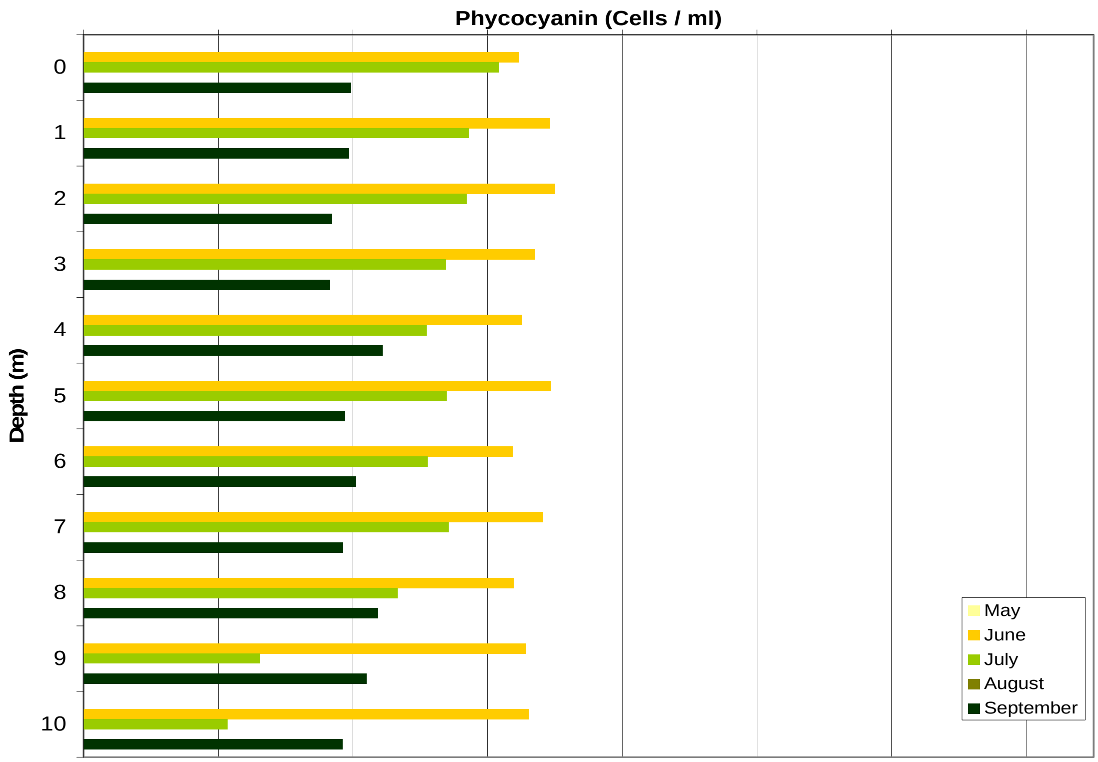


Figure 15.11. Relative concentrations of phycocyanin (bluegreen algae) (cells / ml) measured monthly by depth at Rathbun Lake Site 3 (Tower) during 2006.

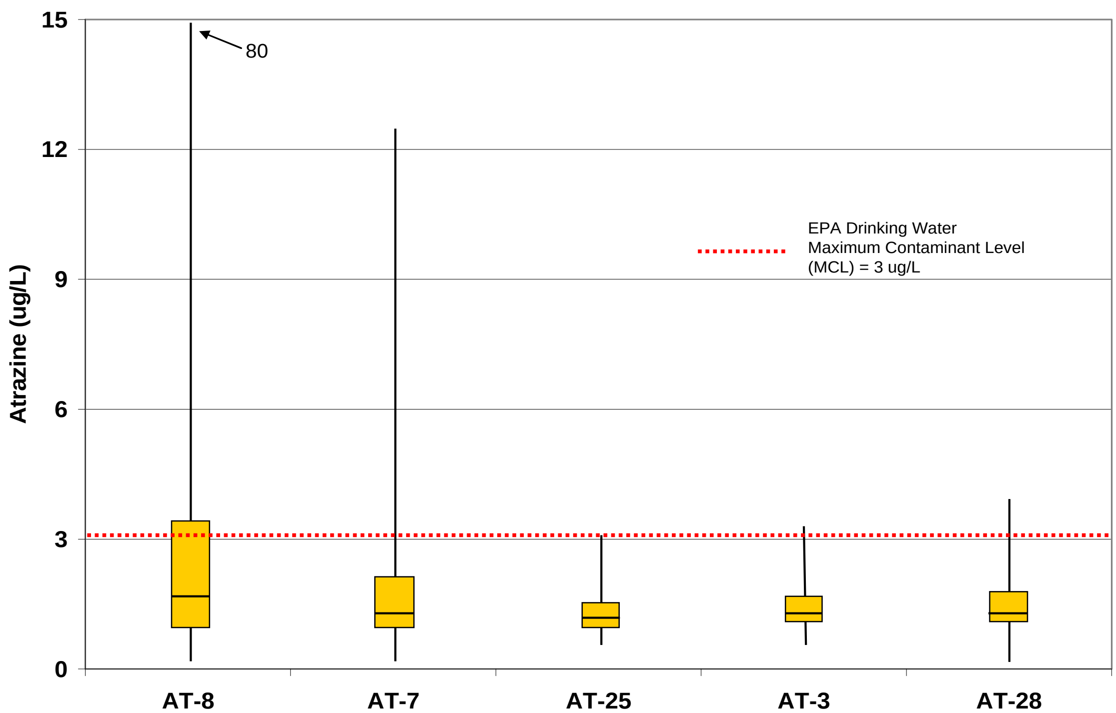


Figure 15.12. Box plots of atrazine concentrations from surface samples collected by site at Rathbun Lake from 1997 thorugh 2006.

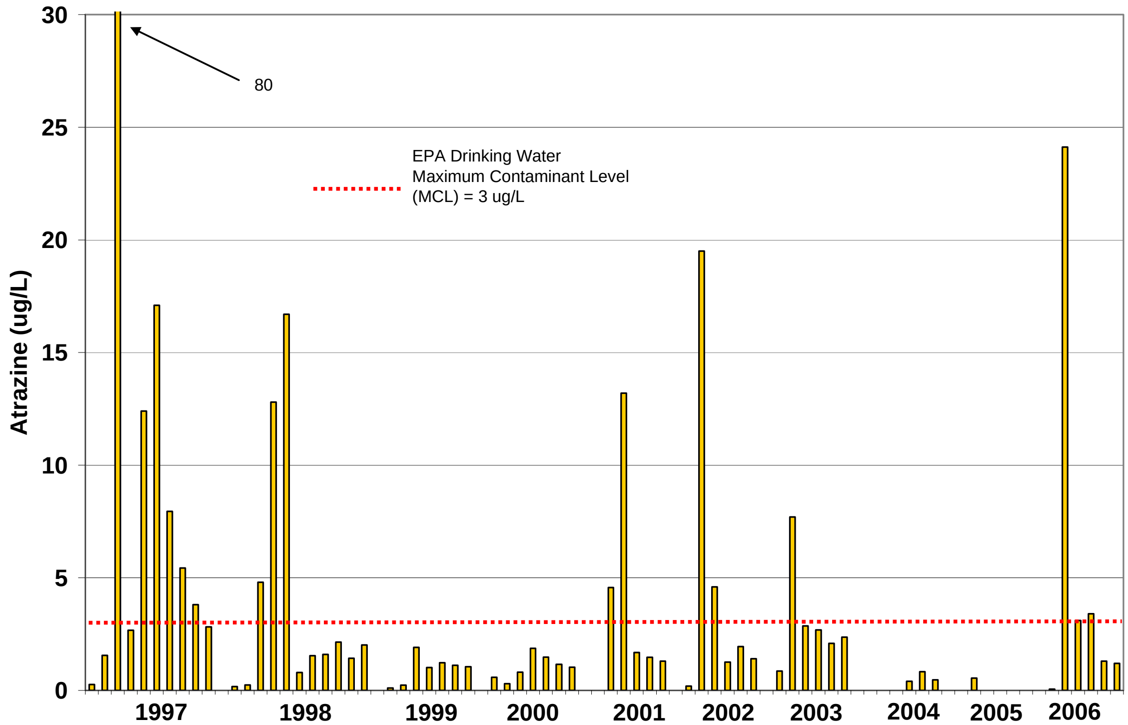


Figure 15.13 Atrazine concentrations from surface water samples by sample date at Site 8 (South Fork Chariton River arm) in Rathbun Lake from 1997 through 2006.

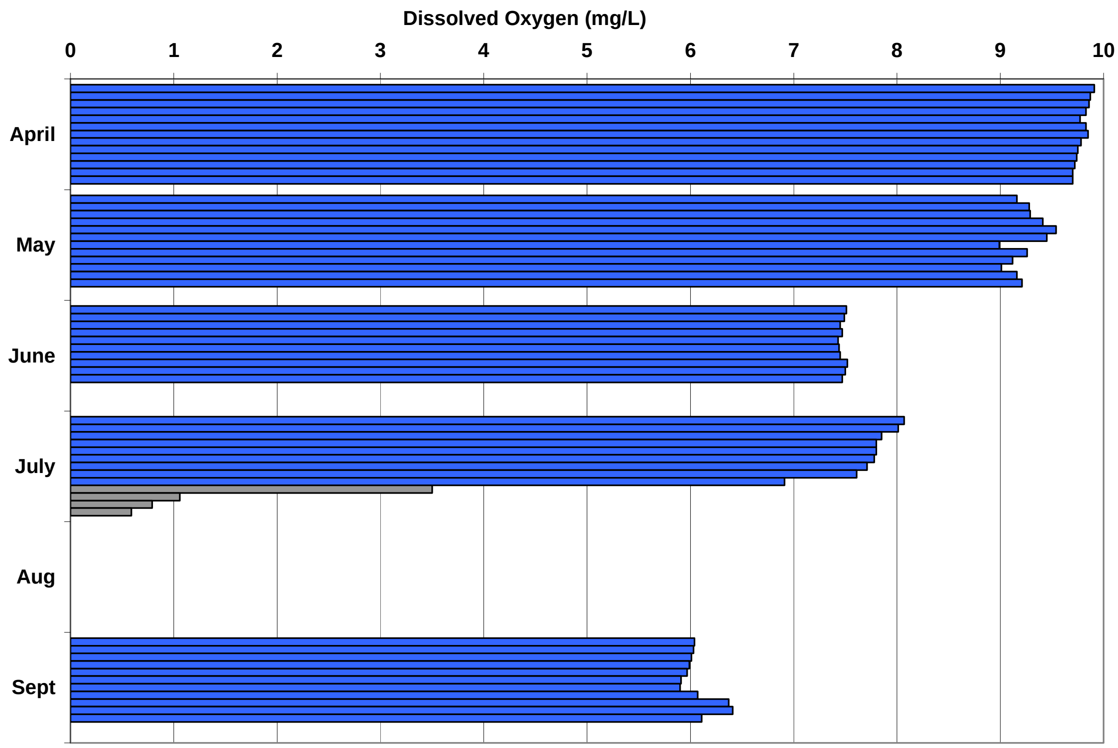
surface samples collected at lake sites and outflow during August 2006 exceeded EPA's SMCL for manganese (50 ug/L). Sample concentrations ranged from 81 – 564 ug/L, with highest concentrations measured at up lake sites. Implications are directed at drinking water facilities due to taste and stain issues. Bottom samples also exceeded the SMCL at all lake sites (86 – 605 ug/L).

Vertical profiles were recorded during sample trips in April through July and September 2006. Parameters included temperature, dissolved oxygen, pH, conductivity, and turbidity. Based on these profiles, the lake at Site 3 was weakly stratified both thermally and chemically during July (Figure 15.14). Lake stratification occurred between 8 – 10 m in depth. The lake was rather homogenous in terms of both temperature and dissolved oxygen during September.

Fecal bacteria (*E. coli*) samples were collected from all three beaches prior to major recreational season holidays during 2006. None of the mean samples exceeded the state standard for single sample whole-body contact (235 colonies / 100 ml)(Figure 15.15).

15.3.3 Outflow

Outflow samples were collected at Rathbun Lake from Site 28 during 2006. Summarized data from this site is included in discussions of lake sites listed above.



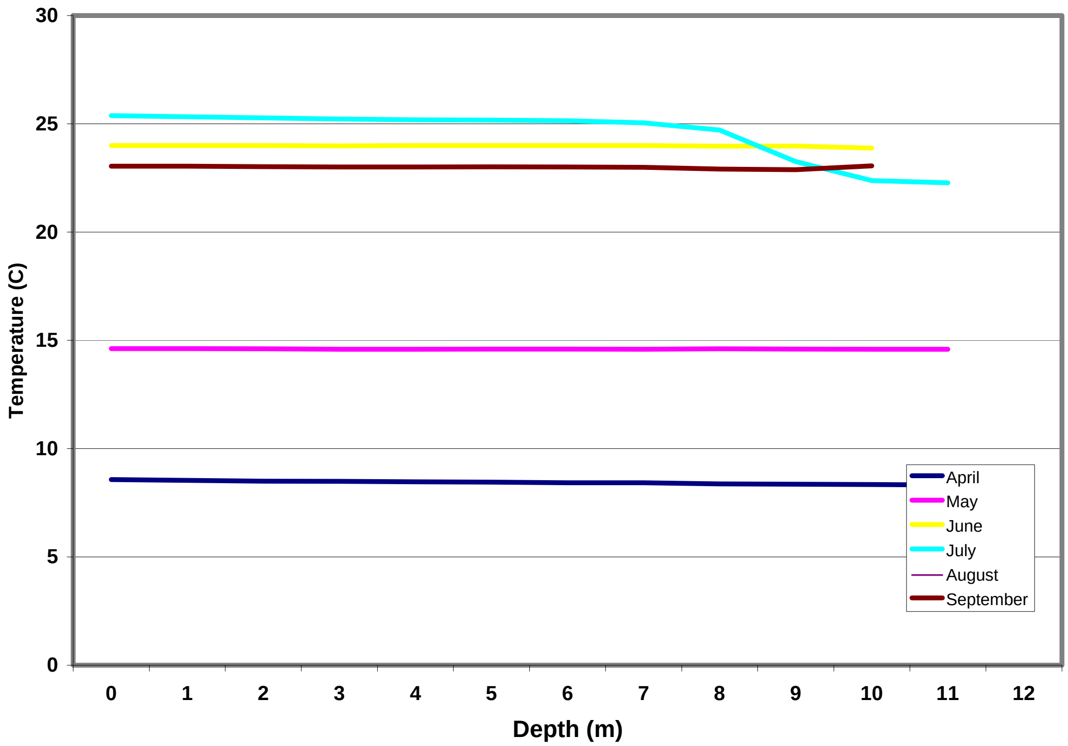


Figure 15.14. Dissolved oxygen concentration (mg/L) histogram and temperature (°C) plot from vertical profiles recorded at Site 3 (Tower) from June through September 2006.

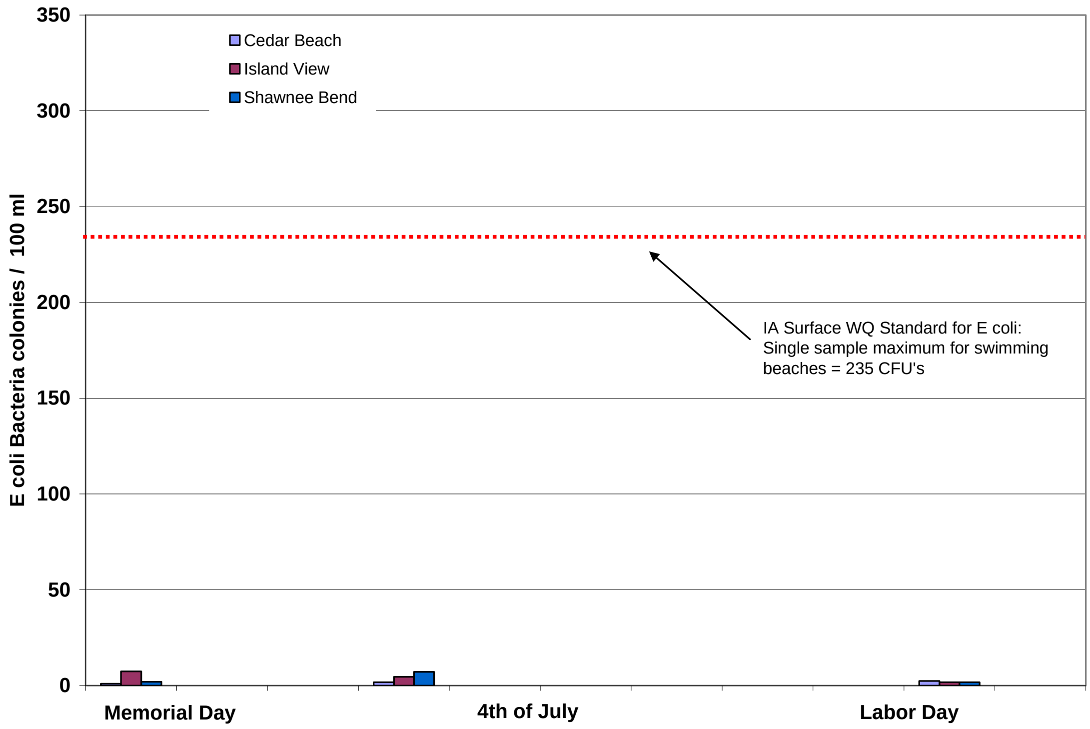


Figure 15.15. Mean fecal bacteria (E. coli) (colonies per 100 ml) results from samples at three swimming beaches collected from April through September during 2006 at Rathbun Lake.

15.4 Future Activities and Recommendations

Continue to cooperate with Iowa State University, Iowa DNR, and Rathbun Land and Water Alliance to monitor water quality parameters relative to BMP improvement programs within the watershed. Work with our partners to redesign the overall monitoring scheme for both lake and inflows to best capture ambient conditions present within the watershed. Sampling activities for 2007 will include transition to monthly ‘ambient’ monitoring from April through September, as well as conducting monthly vertical profiles at each of the four lake sites. 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. Beach monitoring will be conducted by the NWK Water Quality Program prior to main holidays during the recreational season. 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.