16 Smithville Lake

16.1 General Background

Smithville Lake was impounded in 1979 and reached multipurpose pool elevation on 11 June 1982. The primary water quality threats in the Smithville Lake watershed include nutrients, herbicides, sedimentation, and bacterial contamination. The lake is listed on the state's 303(d) list for water quality impairment due to mercury contamination. The Smithville Lake Watershed Coalition (SLWC), formed in 1997, is a citizen-based watershed group active within the Smithville Lake watershed. The SLWC developed a Missouri DNR approved watershed management plan during 2005 to address water quality issues related to nutrients, contaminants, sediment, and bacterial contamination. The Missouri Department of Conservation has conducted aquatic vegetation introduction efforts at the lake to since 1998. The Corps of Engineers Waterways Experiment Station and the Missouri Department of Conservation have worked together to reduce shoreline erosion resulting from water level fluctuations and wave action. Techniques include planting willow wattling bundles and coyier rolls along the shoreline to dissipate wave energy. This not only reduces shoreline erosion but also protects newly planted aquatic vegetation. Additional benefits of the aquatic vegetation plantings include creating spawning and nursery habitat for fish, as well as uptake of excess nutrients in the water. Enclosures are used around the plantings to reduce wave action and reduce damage by foraging rough fish, namely carp. Woody plant species, primarily willow, will be planted at higher elevations in hopes of holding soil in place in times when the lake pool fluctuates above multipurpose pool. A variety of woody tree and shrub species will be experimented with to determine which species are best adapted to the lake shore environment. The effort expended will pay great dividends in the future to improved water quality, fishing habitat, and the aesthetic value for Smithville Lake.

16.1.1 Location

Smithville Lake is located approximately 32 km (20 miles) north of Kansas City, Missouri (Figure 16.1). The dam is located at river kilometer 20.6 (river mile 12.9) on the Little Platte River, a tributary of the Platte River. The watershed covers over 126,000 acres within the counties of Clay, Clinton, and Dekalb. Historic water quality sample sites include 1 inflow, 3 lake, and 1 outlfow.

16.1.2 Authorized Purposes: Water supply, flood control, water quality improvement, recreation, and fish and wildlife management.

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

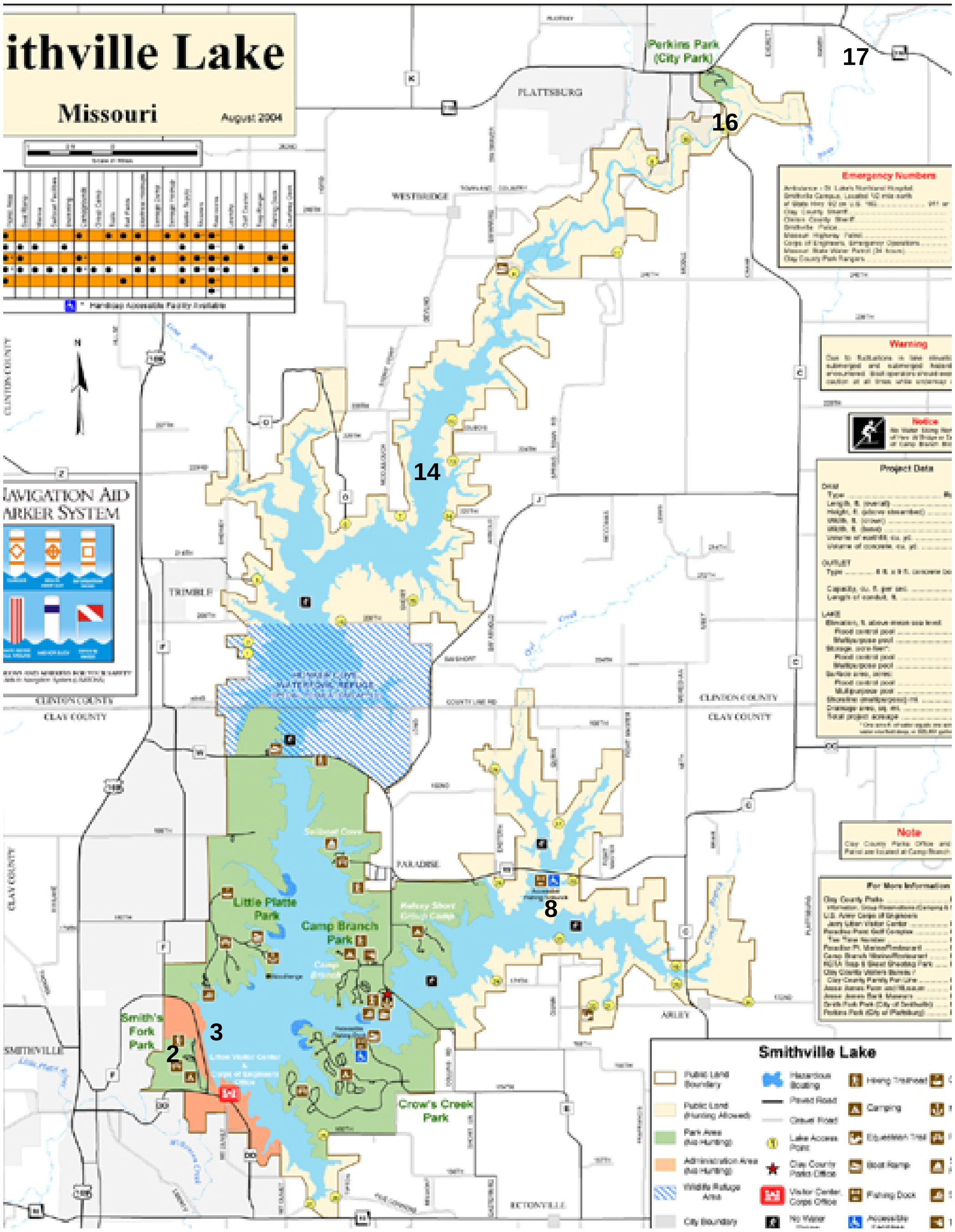


Figure 16.1. Smithville Lake area map with sample site locations.

16.1.4 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	876.2	101.7	10,000	
Multipurpose	864.2	139.8	7,190	175
Total		241.5		

Total watershed area:	213 sq miles (136,320 A)
Watershed ratio:	13.62 FC / 18.96 MP
Average Annual Inflow:	133,248 acre-feet
Average flushing rate:	1.18 yrs
Sediment inflow (measured):	4,987 acre-feet (1979 – 1993)
Water management Plan:	Approved 12 August 1979
Historic stage hydrograph:	1996 – 2006 (Figure 16.2)

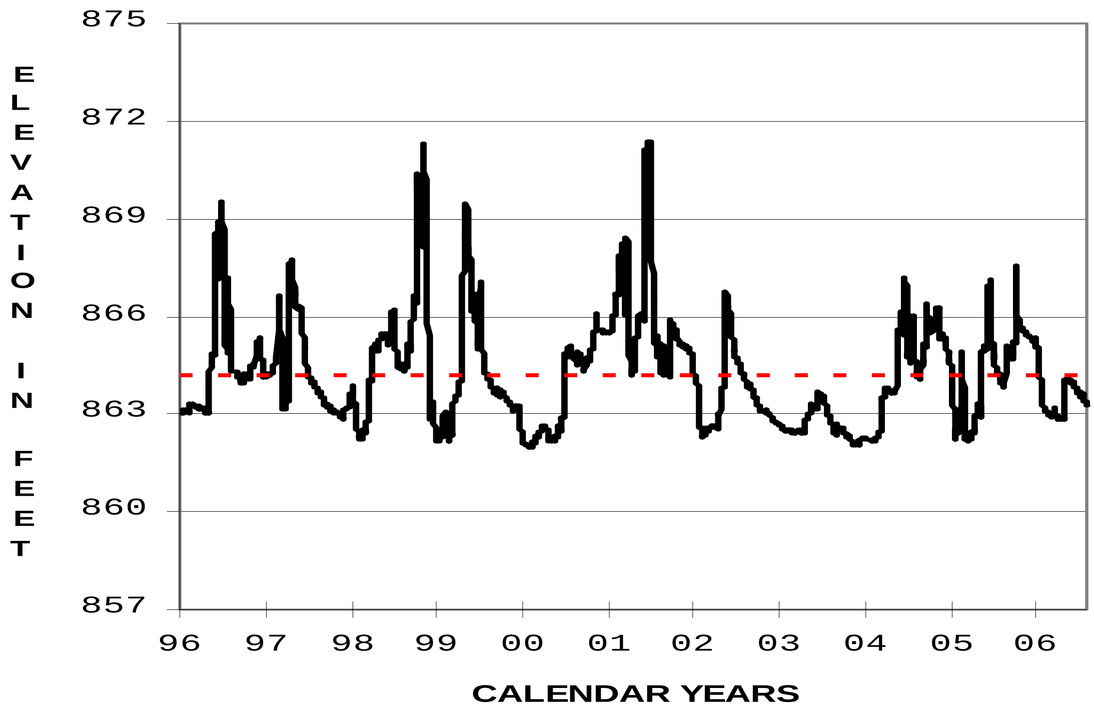


Figure 16.2. Pool elevation hydrograph from 1996 – 2006 (red-dashed line is the multipurpose pool elevation – 904.0 msl).

16.2 2006 Activities

Smithville Lake was categorized as an 'ambient' lake during 2006, thus lake and inflow sites were sampled (see Figure 11.1). An additional inflow site – Site 17 – was added during 2006 to provide additional data on water quality above Plattsburg. Samples were collected from April through September during 2006. Smithville Lake staff (OF-SM) providing field sampling assistance during 2006 was Derek Dorsey, Federal Park Ranger. Bruce Clark, OF-SM Operations Manager, provided insight and background regarding Smithville Lake.

16.3 2006 Data

Comparative historic data consists of monthly (April – September) data collected from 1997 through 2005. Samples were collected at inflow and lake sites from April through September, 2006.

16.3.1 Inflow

Inflow samples were collected from a two inflow sites -- Site 16 is located downstream from the city of Plattsburg, Missouri, while Site 17 is located just above Plattsburg. Data results will be discussed with lake specific data below.

16.3.2 Lake

Nitrogen is one of the most critical elements related to water quality. Sources of nitrogen within the watershed include: fertilizers, septic tanks / lagoons, and WWTP. Median total nitrogen (TN) concentrations from surface samples collected between 1997 and 2006 range from 0.74 – 0.91 mg/L (Figure 16.3). The highest median concentration and most variability are attributed to inflows from the upper watershed (Site 16). Although these median values are some of the lowest measured in the district, they do exceed EPA's proposed ecoregional nutrient criteria (0.36 mg/L). As expected, annual and monthly variability is very apparent for TN concentrations – see Figure 16.4 as an example from Site 14 (Little Platte arm).

Phosphorous is the other critical element related to water quality issues, especially related to algal communities. Phosphorous sources within the watershed include fertilizers (primarily bound to sediment), soaps / detergents, and waste byproducts. Median total phosphorus (TP) concentrations range from 0.05 – 0.1 mg/L from surface water samples collected from 1997 through 2006 (Figure 16.5). Similar to TN, the highest median concentrations and most variability are measured at the upper end of the lake (Site 16). All median TP concentrations exceed EPA's proposed ecoregional nutrient criteria value of 0.02 mg/L. Smithville Lake TP concentrations are typical of other large reservoirs in northern Missouri (LMVP 2004) and within the district.

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 TN:TP ratio at all sites; see Figure 16.6 as an example at Site 3 (Tower). Median TN:TP ratios are < 12 for Sites 14 (Little Platte arm) and 8 (Camp Branch arm), indicating the lake is at risk for cyanobacteria blooms (Figure 16.7). Microcystin toxins have been detected at Smithville Lake during 2000 and 2001 (Dr. Jennifer Graham, USGS, personal communication).

Mean summer chlorophyll *a* concentrations collected during 2006 ranged from 27 to 42 ug/L, with highest concentrations measured at Site 14. These values are much higher than the long-term median values (11.5 ug/L - 22.5 ug/L)(Figure 16.8).

Differences in water clarity, as measured my secchi depth, exist between lake sites (Figure 16.9). Longterm median secchi depths range from 1.1 m (Site 3; Tower) to 0.62 m (Site 14; Little Platte arm). Water clarity measured during 2006 was very similar to long-term means by site. The only difference occurred during April when secchi depth measurements were more than 2x greater than average, which was an indication of a dry spring.

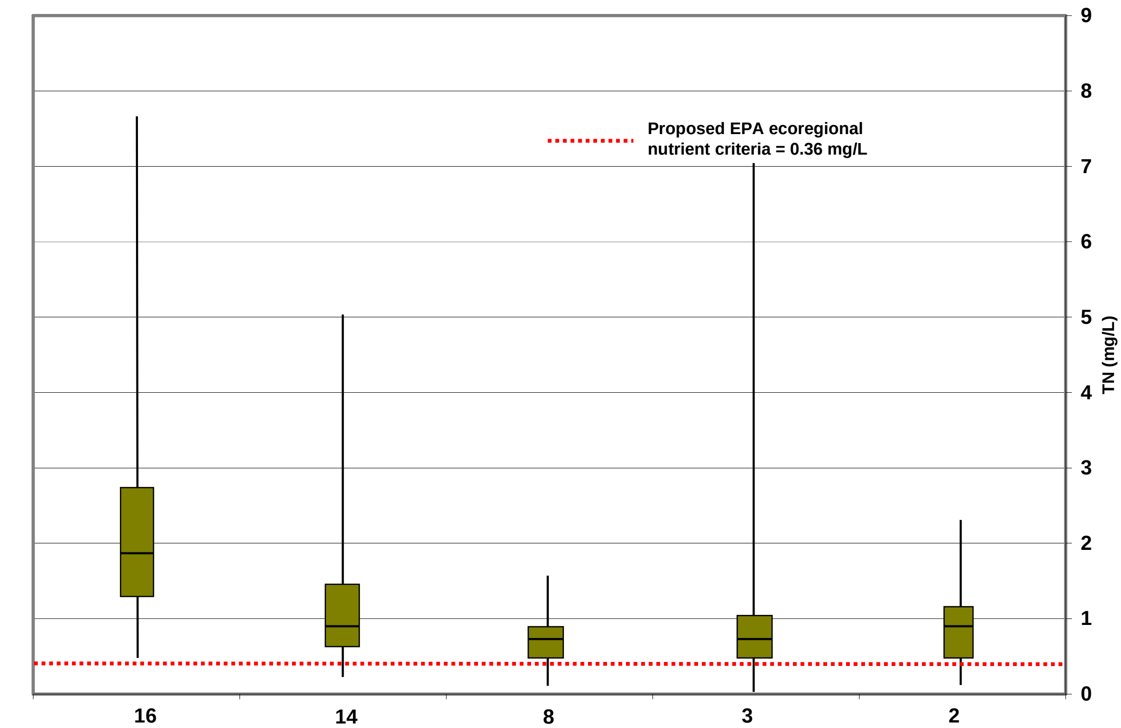


Figure 16.3. Box plots of surface water sample total nitrogen (TN) concentrations measured by site at Smithville Lake from 1997 through 2006.

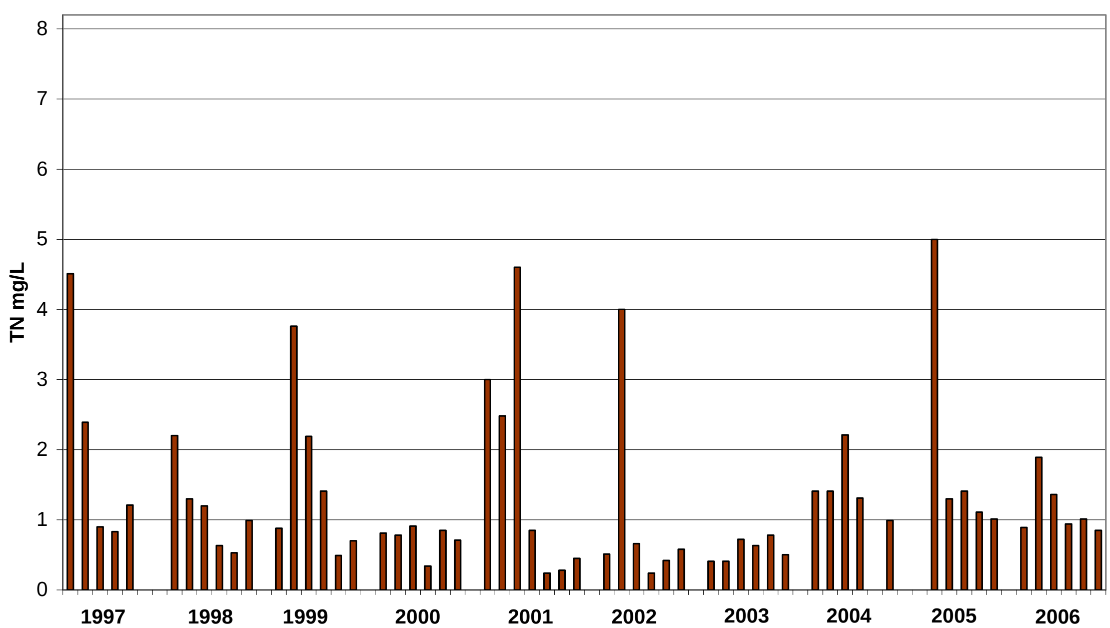


Figure 16.4. Total nitrogen (TN) concentrations from surface samples by date and year from Site 14 (Little Platte arm) in Smithville Lake from 1997 through 2006.

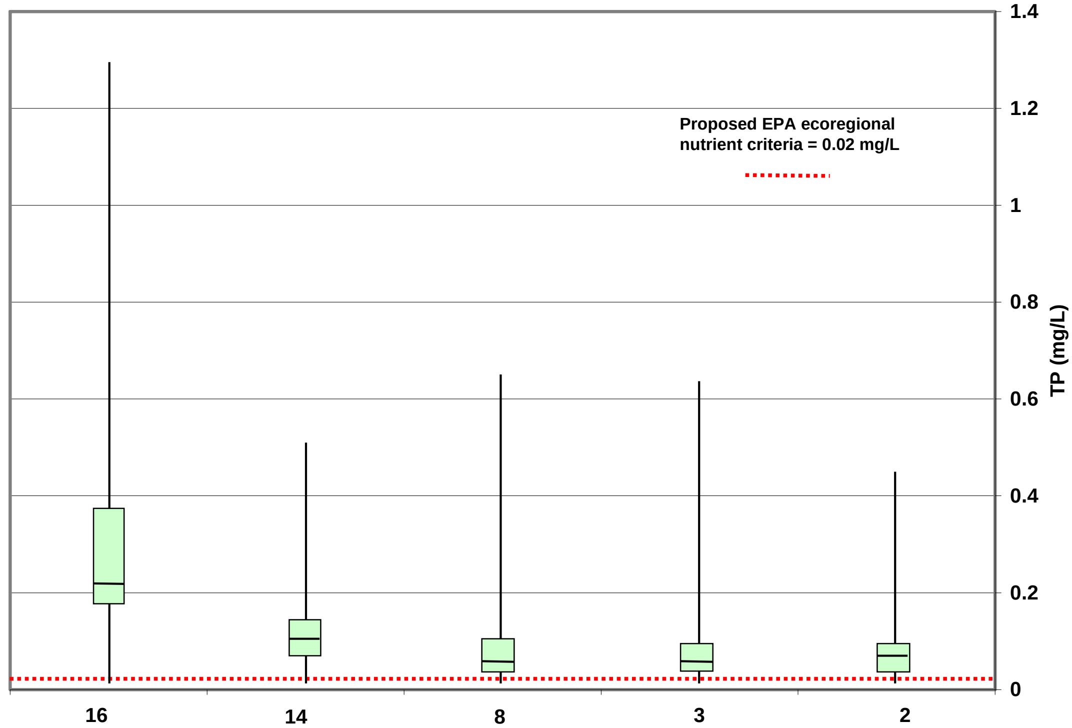


Figure 16.5. Box plots of surface water sample total phosphorus concentrations measured by site from 1997 through 2006 at Smithville Lake.

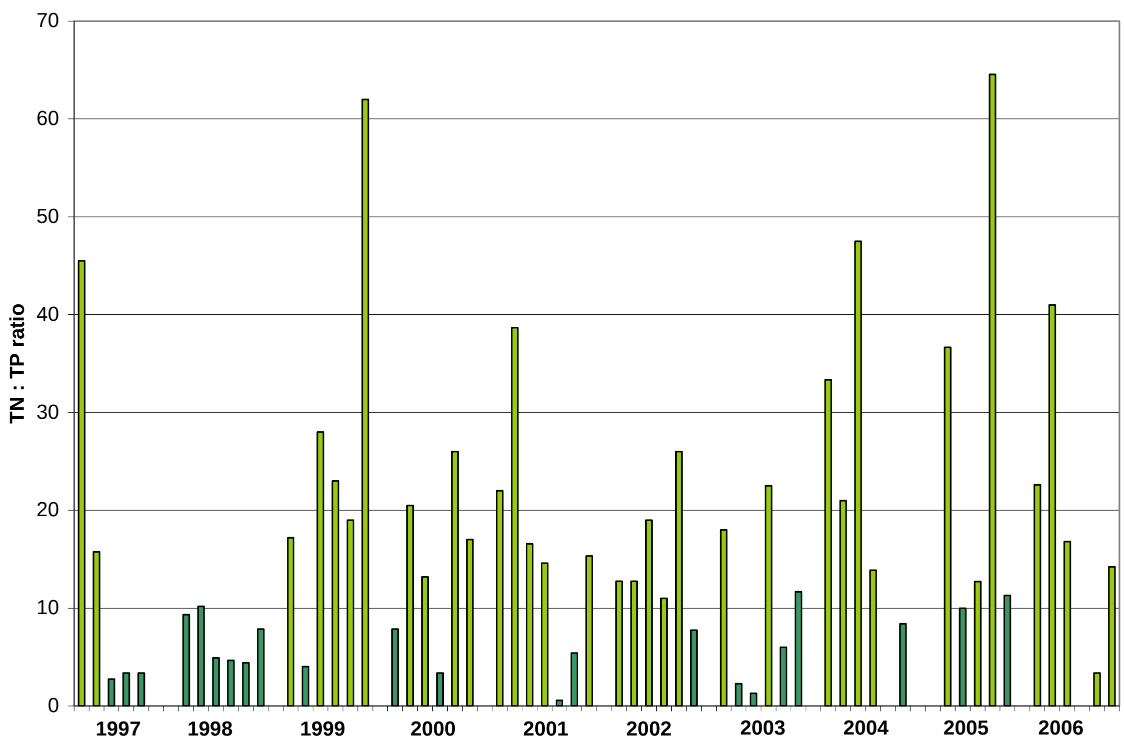


Figure 16.6. Graph of total nitrogen : total phosphorus (TN : TP) ratio by sample date from 1997 through 2006 at Site 3 (Tower) in Smithville Lake.

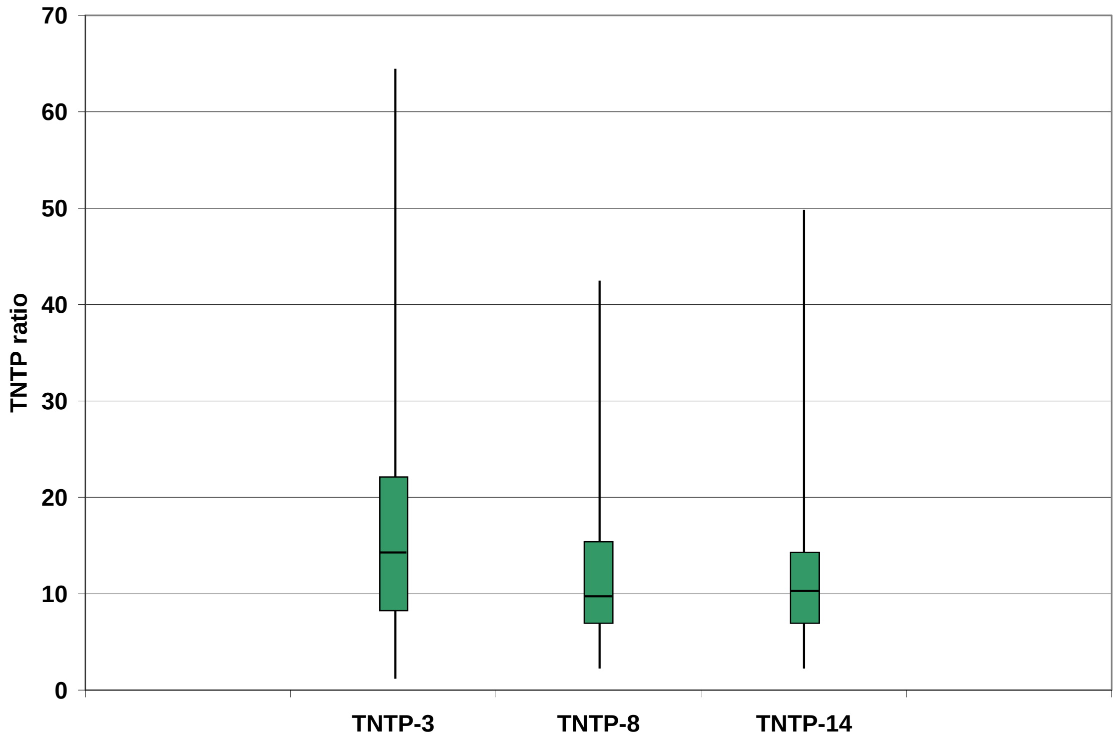


Figure 16.7. Box plots of total nitrogen : total phosphorus (TN : TP) concentrations by site from 1997 through 2006 at Smithville Lake.

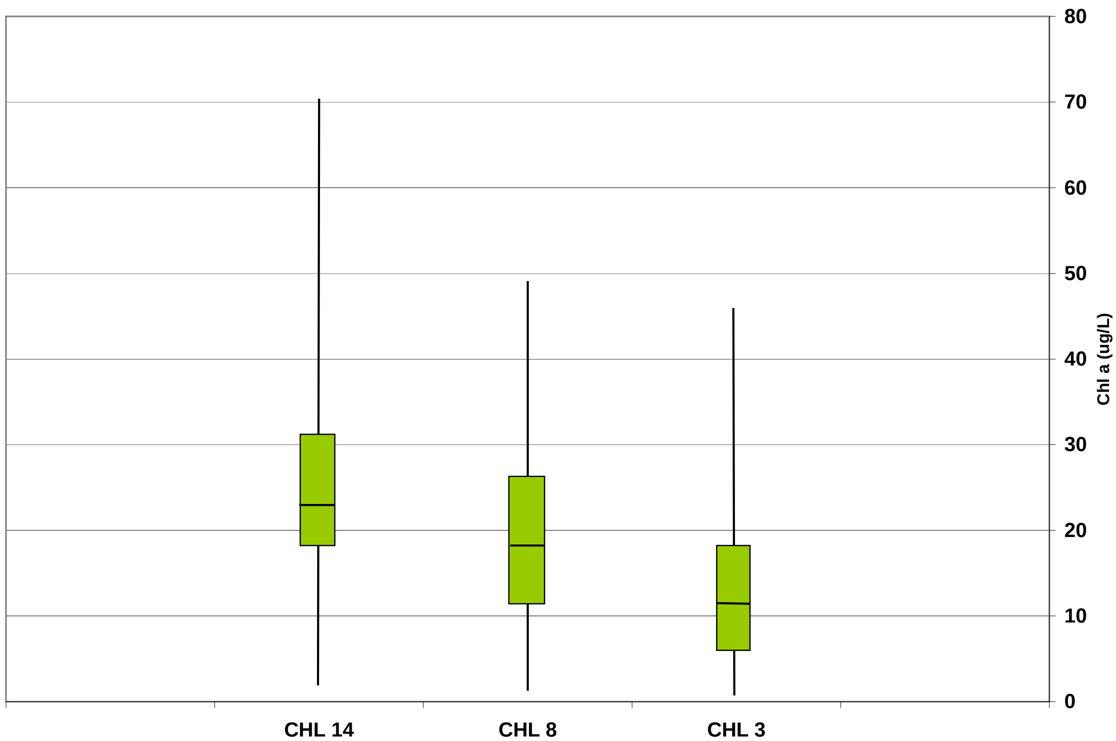


Figure 16.8. Box plots of chlorophyll a values measured by site at Smithville Lake from 1997 through 2006.

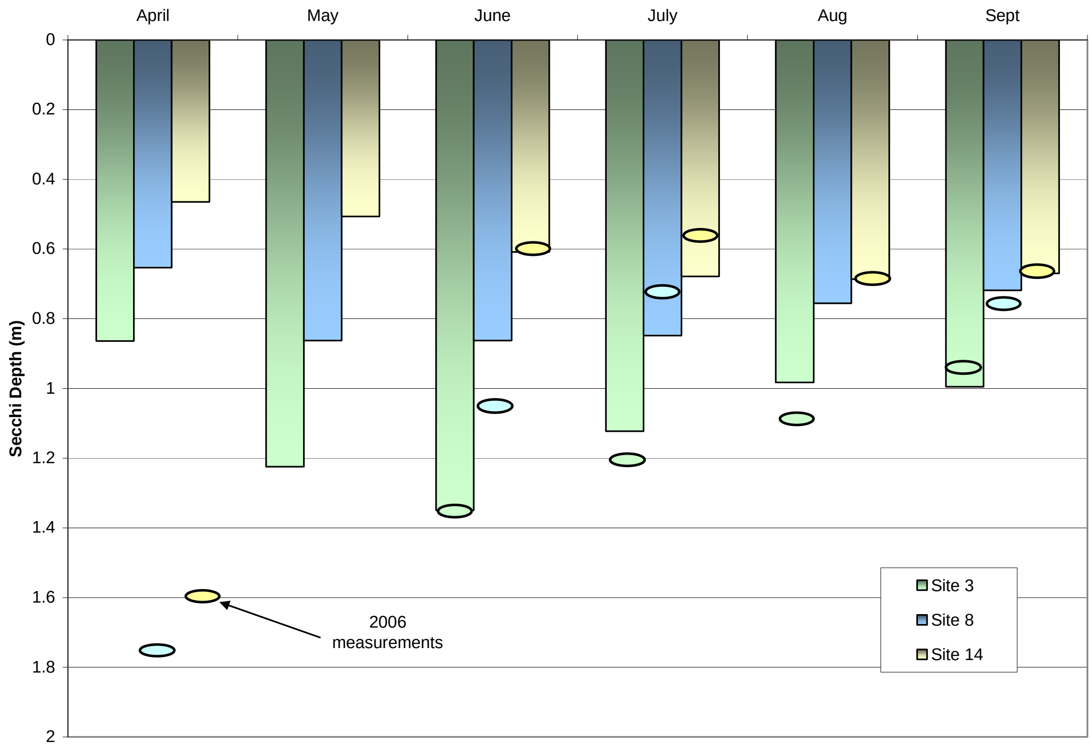


Figure 16.9. Plot of mean secchi depth measurements by site and month (bars 1997 - 2005) and 2006 measurements (circles) by site in Smithville Lake.

Relative concentrations of phycocyanins, or bluegreen algae, were measured vertically throughout the water column from May through September 2006. Such profiles provided information on monthly as well as within lake distribution changes. Figure 16.10 depicts vertical distribution of phycocyanins measured at Site 3 (Tower). Concentrations were highest in August, with higher concentrations above the thermocline. Concentrations in September were slightly lower, but distribution was more uniform throughtout the water column. These concentrations were some of the highest recorded within the district during 2006.

Major reductions in atrazine application rates (from 4.0 to 1.6 - 2.5 lbs active ingredient per acre), have resulted in improved water quality at Smithville Lake. The mean atrazine levels in Smithville Lake's raw water have declined from 2.37 ug/L in 1997 to 1.68 ug/L in 2004, which is less than EPA's drinking water maximum contaminant level (MCL) of 3 ug/L. Differences in median concentrations of atrazine from 1997 - 2006 are very noticeable between water quality monitoring sites at Smithville Lake (Figure 16.11). For reference, Site 2 is located just below the dam outflow, Site 3 is located within the lake near the dam (deep water site), Site 8 is located in the Camp Branch arm of the lake, Site 14 is located near Trimble, and Site 16 is located on the Little Platte River prior to the confluence of the lake. (Figure 16.1). The highest concentrations and most variability in data are from the Plattsburg site (Site 16), with median concentrations decreasing in a down-lake progression. When examined on a monthly basis during this time period, highest concentrations are measured during spring, which coincides with application, rainevents, and runoff. Figure 16.12 depicts monthly and annual

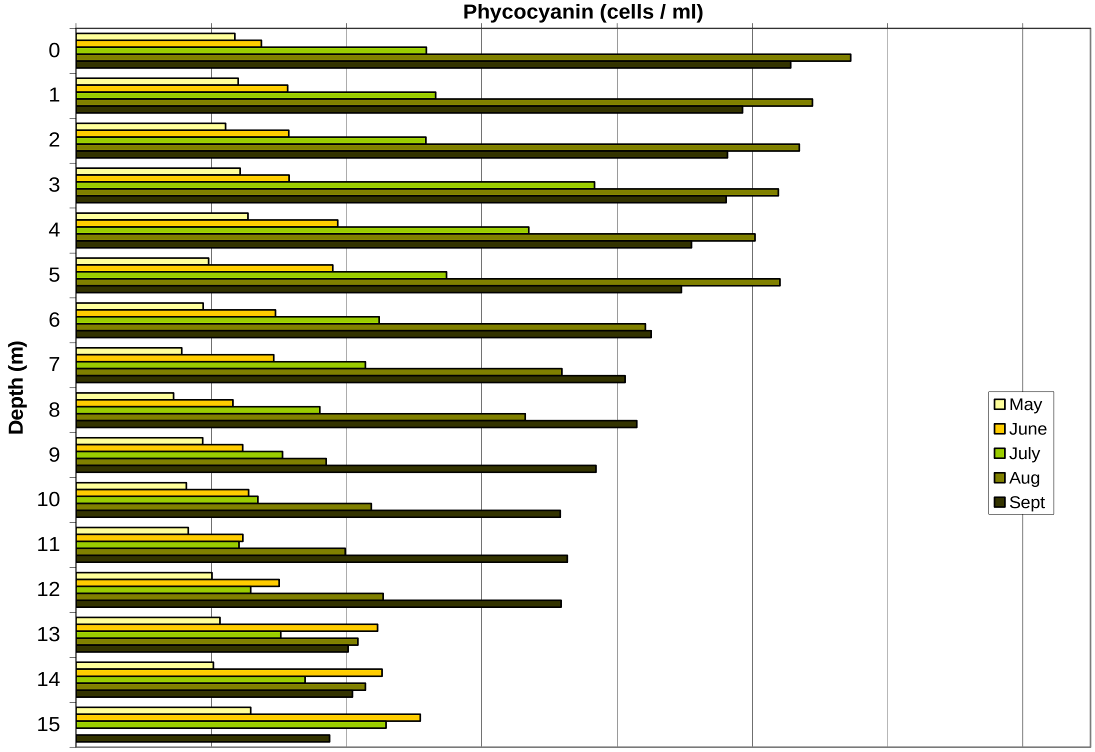


Figure 16.10. Relative concentrations of phycocyanin (bluegreen algae) (cells / ml) measured monthly by depth at Smithville Lake Site 3 (Tower) during 2006.

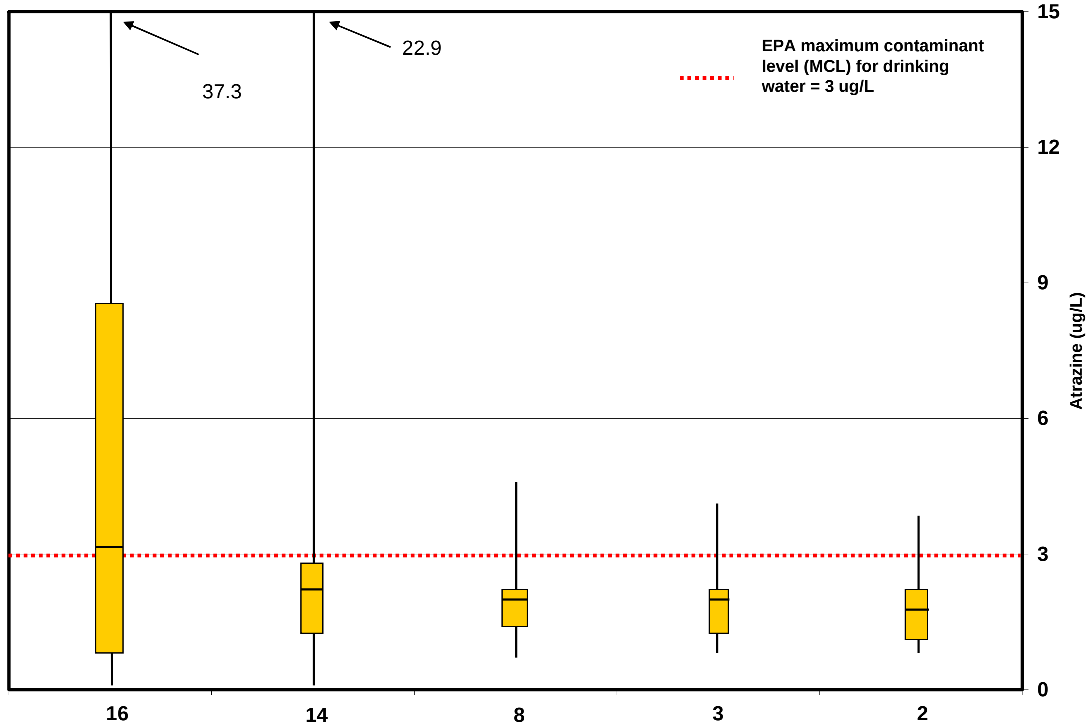


Figure 16.11. Box plots of surface water sample atrazine concentrations measured by site from 1997 through 2006 at Smithville Lake.

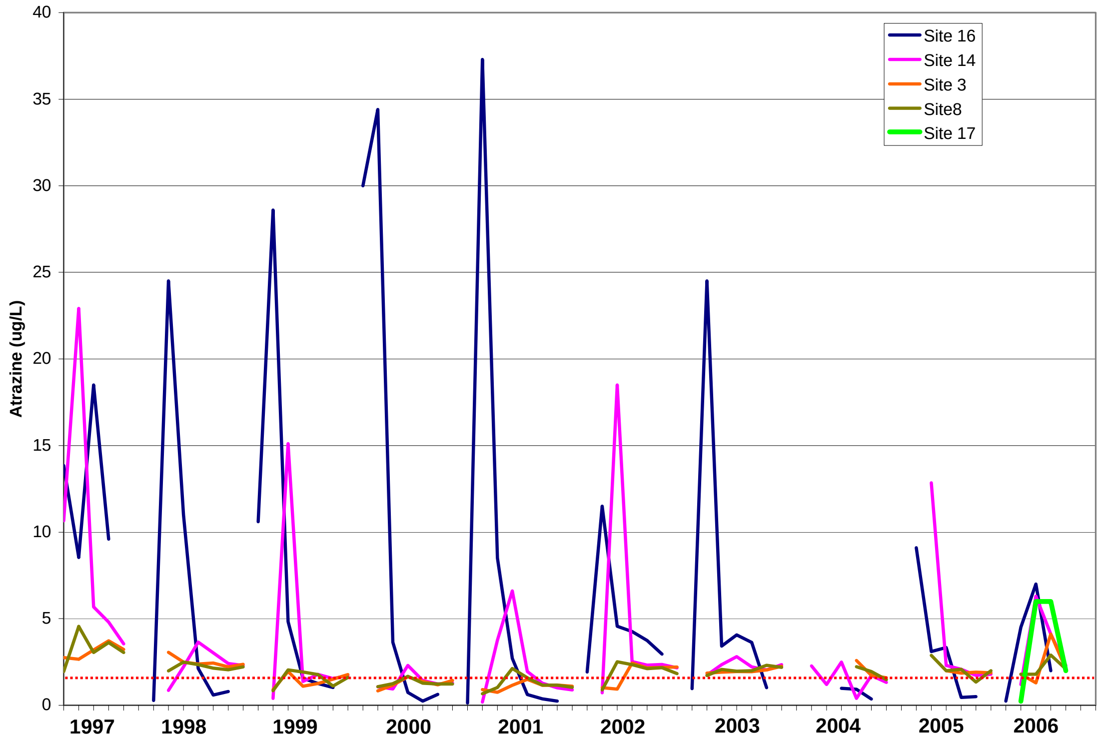
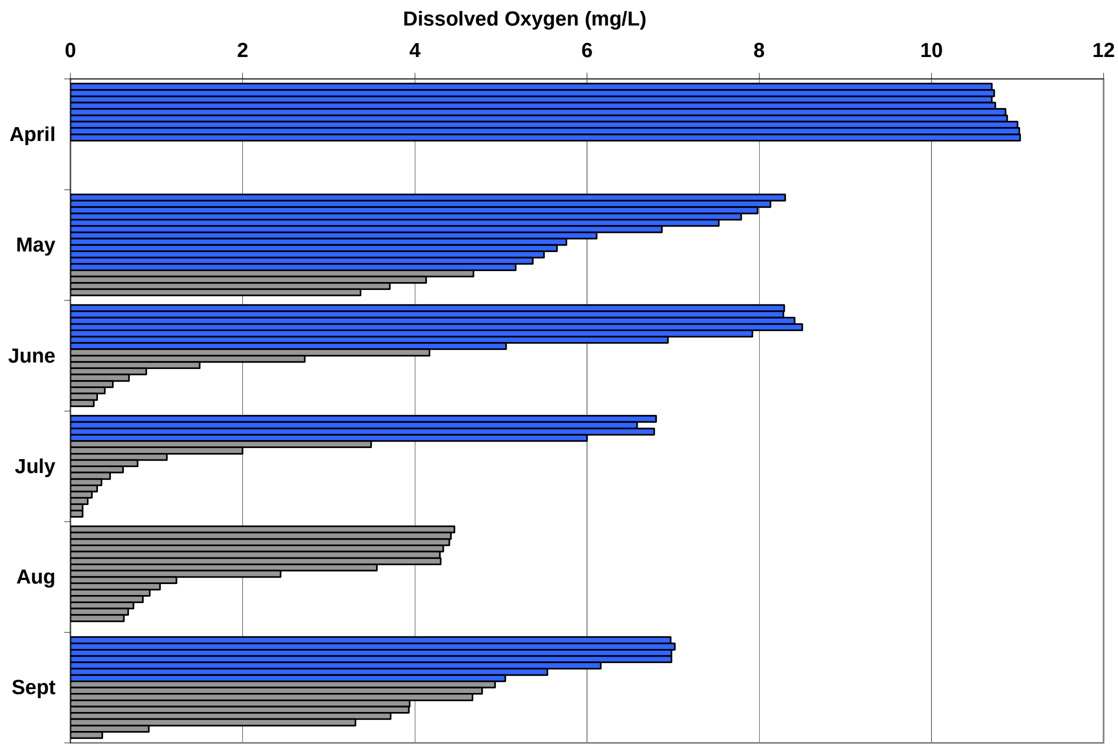


Figure 16.12. Atrazine concentrations by sample date collected by site (lake and inflows at Smithville Lake from 1997 through 2006.

differences in atrazine concentrations measured at all sites from 1997 through 2006. Spring rain events still produce concentrations that exceed the MCL, especially near the Plattsburg drinking water intake. This indicates that additional BMP's need to be installed in the upper watershed to reduce future herbicide runoff.

No metals data was collected during 2006. However, in 2005 total iron exceeded EPA's Drinking Water Standard of Secondary Maximum Contaminant Levels (SMCL) of 300 ug/L from surface samples collected during August from Sites 2 (outflow), 14 (Little Platte arm) and 16 (Little Platte inflow). Concentrations ranged from 222 (Site 8) to 3648 (Site 16), indicating possible inputs upstream of the lake in the Little Platte. Implications are directed at drinking water facilities related to taste and staining issues. In addition, all surface samples collected during August exceeded EPA's SMCL for manganese (50 ug/L). Sample concentrations ranged from 59 – 240 ug/L, with highest concentrations measured at Site 16 (Little Platte inflow). Implications are directed at drinking water facilities due to taste and stain issues.

A lake profile can provide insight into depth of lake stratification and mixing depending upon the time of year and location within the lake. Profile parameters include temperature, dissolved oxygen, pH, conductivity, and turbidity. Based on monthly profiles in 2006, stratification was prevalent from May through September (Figure 16.13). Both dissolved oxygen and temperature graphs indicate the lake was solidly stratified at a depth of 4m during both June and July. This transition from warm to cool waters is the thermocline – an area important to fishermen as well as water supply intakes! Within



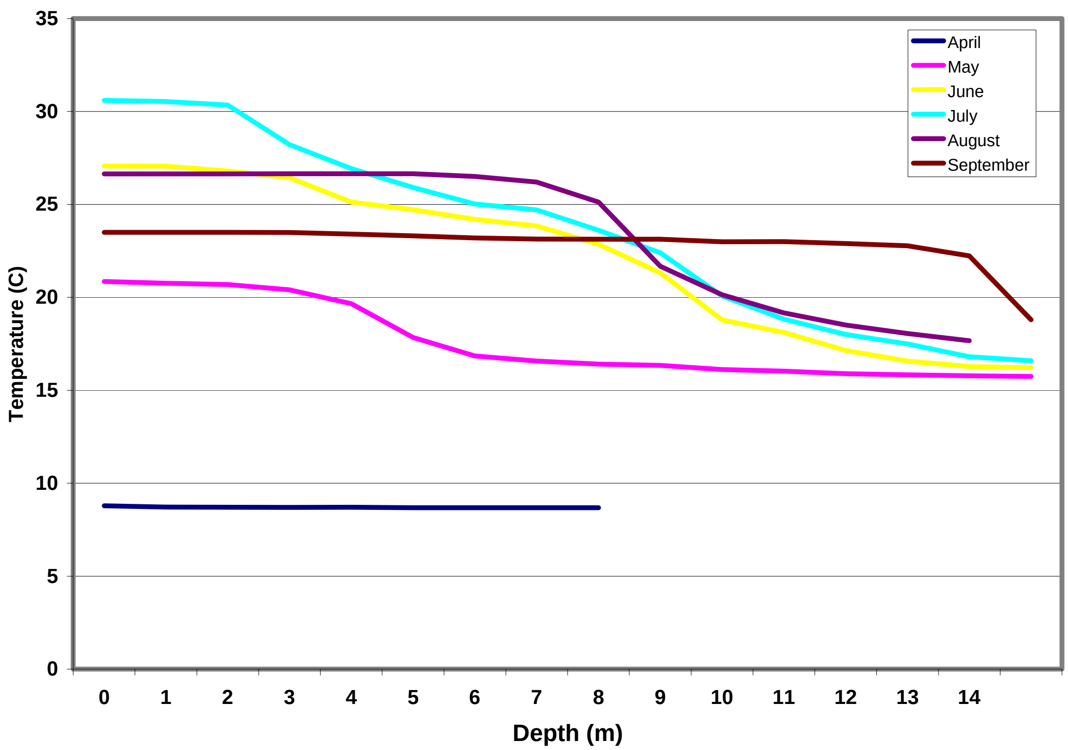


Figure 16.13. Dissolved oxygen concentration (mg/L) histogram and temperature (°C) plot from vertical profiles conducted during 2005 at Site 3 (Tower) in Smithville Lake.

this transition zone, available oxygen rapidly declines from 6-8 mg/L to nearly 0 mg/L. This anoxic layer (no oxygen) drives many water quality functions within the lake, including phosphorous release and ammonia buildup — these are released in fall when the lake undergoes 'turnover'. An increase in nutrients inputs into the lake ultimately reduces the depth at which the lake stratifies. This will impact depths at which fish can occupy (resulting in loss of habitat), and impacts quality of drinking water (ie, flavor, filtration, cyanobacteria).

16.3.3 Outflow

Outflow samples were not collected during 2006 (Site 2).

16.4 Future Activities and Recommendations

Sampling activities for 2007 will include continuation of 'ambient' monitoring from April through September, as well as conducting monthly vertical profile at each of the three lake sites. Due to concerns of potentially toxic bluegreen algae, phycocyanin concentrations 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. A contaminant group of interest is polyaromatic hydrocarbons (PAHs). These compounds are components of asphalt, fuels, oils, and greases. They enter receiving waters from stormwater runoff, industrial and wastewater treatment discharges, and through atmospheric deposition. They do not dissolve, but attach to particulate material and eventually settle out to the substrate. These compounds are highly toxic to aquatic biota, and thus baseline data is desired to track within district lakes. This is a high priority item when future funding becomes available. A Section 1135 aquatic habitat project will be initiated during 2007. This project is designed to provide bank stabilization and fish habitat structure along windswept, exposed banks in the Camp Branch area. Continue interactions with the Smithville Lake Watershed Coalition, NRCS, and Missouri Department of Conservation to improve water quality conditions within the lake and throughout the watershed.