

Water Quality Monitoring Results
Of Beaver Creek and Bull Shoals Lake
September 2003 through July 2004

Prepared by

Janice Schnake Greene
Director, Bull Shoals Field Station

Celeste Prussia
Manager, Bull Shoals Field Station

Damien Misquith
Graduate Student

Southwest Missouri State University
August 31, 2004

TABLE OF CONTENTS

Introduction.....	3
Methods.....	3
Results.....	4
Discussion.....	7
Resources.....	8
Figures.....	9
Appendix I: Raw Data.....	23

INTRODUCTION

Southwest Missouri and northern Arkansas is an area of forested hills with many creeks, and a chain of four reservoirs in the White River Basin that start in Arkansas, move into Missouri, and then back into Arkansas. The two middle reservoirs, Table Rock Lake and Lake Taneycomo, have declined in water clarity due to increased nutrient levels from agriculture runoff, septic tank leakage, municipal wastewater treatment systems, and other sources. Bull Shoals Lake is currently the cleanest lake of the four but is in threatened by development in upstream reservoirs (Havel and Pattinson, 2004). Monitoring of Bull Shoals Lake will provide a picture on how up-stream reservoirs can affect downstream reservoirs in addition to the effects of nutrients brought in by tributaries.

Bradleyville, Missouri, is located on Beaver Creek. In 2002, Bradleyville decided to incorporate which will allow the town to qualify for funding to address its aging septic tanks and their effect on local water quality (Buckstaff, 2002). In partnering with the Upper White River Basin Foundation and the Missouri Department of Natural Resources, Bradleyville is taking a hard look at the issue. In addition, karst topography in the Ozarks contains many sinkholes, caves, and springs which allow nutrients to flow underground and surface in other places. This complicates the issue of water quality in the Ozarks. Monitoring above, within, and below Bradleyville can give a picture of the effects of the town on water quality levels in Beaver Creek.

METHODS

Three sites on Beaver Creek were sampled once during September, January, February, and July and sampled weekly during October, November, March, April, May,

and June. August, 2003, was not sampled due to the timing of receiving the final contract. Sites included one above Bradleyville (BA), one at the bridge in Bradleyville (BB), and one downstream of Bradleyville (BD; Fig. 1). Total nitrogen (TN), total phosphorus (TP), and *E. coli* were examined for each site. Additional data collected included temperature, pH, and dissolved oxygen (DO).

Two sites were examined on Bull Shoals Lake with the same sampling regime as Beaver Creek (Fig. 2). The site near K-Dock Marina (BK) is in the upper part of Bull Shoals Lake and has characteristics more similar to a river (Havel and Pattinson, 2004). Buck Creek (BC) is near the Arkansas State Line and has characteristics more closely resembling a lake (Havel and Pattinson, 2004).

Field procedures followed the Quality Assurance Project Plan submitted to the U.S. Environmental Protection Agency.

Analysis

Data from the Beaver Creek sites were analyzed separately from the Bull Shoals Lake sites. Mean and standard deviation values for DO, TN, TP, and *E. coli* colony forming units (CFU) were calculated for each site.

The mean values for the three creek sites and for the two lake sites were compared using a one-way analysis of variance to determine if the sites were significantly different from each other. Sites were considered significantly different if the *p* values were greater than 0.05.

RESULTS

Twenty-nine samples were collected. Every month was sampled according to the schedule except August, 2003, which was missed because of the timing of the signing of

the final contract. However, we realize now that when we had two months together, where sampling occurred every week, we needed to sample an extra time due to the two partial weeks at the end of one month and the beginning of the other. Missed data points were due to equipment breakdowns e.g., the DO meter did not work or the boat would not start.

Beaver Creek

In general, there were very small differences between the three creek sites for temperature and pH (Figs. 3 and 4). All pH values were in the basic range (8.0 to 8.8 with most values between 8.1 and 8.4).

Dissolved oxygen (DO) values were also similar between sites (Fig. 5). The mean DO values for the three sites were 13.13 mg/L for BA (Standard Deviation = 15.74), 13.13 mg/L for BB (SD = 15.39), and 10.32 mg/L (SD = 1.95) for BD. The differences were not significantly different ($p = 0.659$). However on many sampling dates, the lowest DO values were at the downstream (BD) site.

E. coli, also, did not vary significantly between the three sites ($p = 0.887$) although the mean values did show some qualitative differences (BA = 90.5 CFU, SD = 192.9; BB = 138.3 CFU, SD = 333.8; BD = 184.3 CFU, SD = 488.0) with the downstream site (BD) having the highest mean. If you examine the trends (Fig. 6), you will notice trends where sites BB and BD are generally higher than the above Bradleyville (BA) site. Specifically on sampling days after a rain event, the trend is more noticeable with each successive downstream site having a higher value. For example, the November 19 sample followed an extensive amount of rain on November 17 and 18. The BA site had *E. coli* had 461 CFU; the BB site had 1553 CFU, while the BD site had >

2419 CFU (Appendix 1). Other sampling dates occurring after rain events showed similar trends (e.g., May 6, 2004).

Mean total phosphorus (TP) values for the three sites, upstream to downstream, were 0.014 ppm (SD = 0.014), 0.016 ppm (SD = 0.015), and 0.015 ppm (SD = 0.013), BA, BB, and BD, respectively. There was not a significant difference between sites ($p = 0.599$). Total nitrogen (TN) mean values were 0.438 ppm (SD = 0.251), 0.505 ppm (SD = 0.331), and 0.551 ppm (SD = 0.317; BA, BB, and BD, respectively). There was not a statistical difference between the three sites ($p = 0.335$). Again, the trend lines do show somewhat higher values as you move downstream, especially after rain events e.g., November 19 (Figs.7 and 8).

Bull Shoals Lake

Temperature ranged from a low of 5.3°C in February to a high of 29.5°C in July (Fig. 9). Only slight differences were found between the two sites. Values for pH ranged from slightly lower than 8.0 to 9.0 with little variation between sites and most values were between 8.3 to 8.8 (Fig. 10). Generally, there were slightly higher values at the down-reservoir site.

Mean DO values were nearly identical between sites (Fig. 11). DO for BK was 10.16 ppm (SD = 1.29) and was 9.85 ppm (SD = 1.85) for BC. There was no significant difference ($p = 0.996$).

The mean *E. coli* CFU value for BK was 10 CFU (SD = 19.8) and was 2.16 CFU (SD = 3.86) for BC (Fig. 12). These values were very low. The two sites were not significantly different ($p = 0.789$).

Values for TP and TN were both larger at the BK site (Figs. 13 and 14). Mean TP values for BK and BC were 0.022 ppm (SD = 0.019) and 0.016 ppm (SD = 0.012), respectively. TP values were not significantly different ($p = 0.537$). Mean TN for BK was 0.476 ppm (SD = 0.167) while the mean TN for BC was 0.333 ppm (SD = 0.096). Again, the two sites were not significantly different ($p = 0.749$).

DISCUSSION

The three Beaver Creek sites did not show any statistically significant differences for any of the variables. However, this could be due to the variability of values throughout the study. Values changed, sometimes dramatically, after rain events.

The mean value for *E. coli*, in the Beaver Creek BA site, was below the standard of 126 CFU; both BB and BD means were above this level. *E. coli* was above this standard on six (21 %) sampling days, mostly following rain events. There was usually a pattern after rain events: values increased as you move downstream.

Beaver Creek did show some pattern on TN and TP readings after rain events where the two downstream sites were higher. Mean TP values did increase as you move from upstream to downstream.

Bull Shoals Lake values for *E. coli*, TP, and TN were slightly greater at the up-reservoir site. The higher values could be due to the greater development in the up-reservoir areas (i.e., more leaking septic tanks, etc.) or could be from contamination from up-stream reservoirs. However, it is important to note that the sites were not statistically different.

Recommendations

1. A sampling period will be added in December and the 5th week will be sampled in months where samples are collected each week.
2. The Buck Creek site on Bull Shoals Lake may need to be changed. It may give a better picture of how Beaver Creek is affecting Bull Shoals Lake to sample where the creek enters the lake. One suggestion from the field collection coordinator is to move the fifth sampling site from Buck Creek (near Protem, MO) to the outlet of Beaver Creek at Bull Shoals Lake near the end of Hwy M south of Kissee Mills, MO. This is, of course, up to UWRBF.

RESOURCES

Buckstaff, K. 2002. Bradleyville's incorporation pays off. Springfield News-Leader. September 9, 2002.

Havel, J. E., and K. R. Pattinson. 2004. Spatial distribution and seasonal dynamics of plankton in a terminal multiple-series reservoir. *Lake and Reservoir Management*. 20(1):14-26.

ACKNOWLEDGEMENTS

The Bull Shoals Field Station is indebted to a number of people who assisted in the execution of this project in a variety of ways. Thanks to Mike and Kay Lanham who provided the use of their boat, "Basser One," to collect samples from the main channel of Bull Shoals Lake near their Buck Creek Boat Dock. Anita and Bill Curry of K-Dock Marina repeatedly came to the rescue providing a boat for sampling when the BSFS pontoon boat engine failed to run and Bill readily shared his knowledge of watercraft to the benefit of the project staff. Don Prussia was a frequent volunteer for the water collection days providing his watercraft expertise and affording a measure of safety when a second team member was needed. Beaver Creek access was granted by Buddy and Madeline Albright (farm downstream of Bradleyville bridge) and Gerry Yearly (gravel mine upstream from Bradleyville School and bridge) whose permission to enter their private properties made it possible to collect water samples from some most

advantageous points in Bradleyville. We express our most sincere thanks to all of the above cooperators.

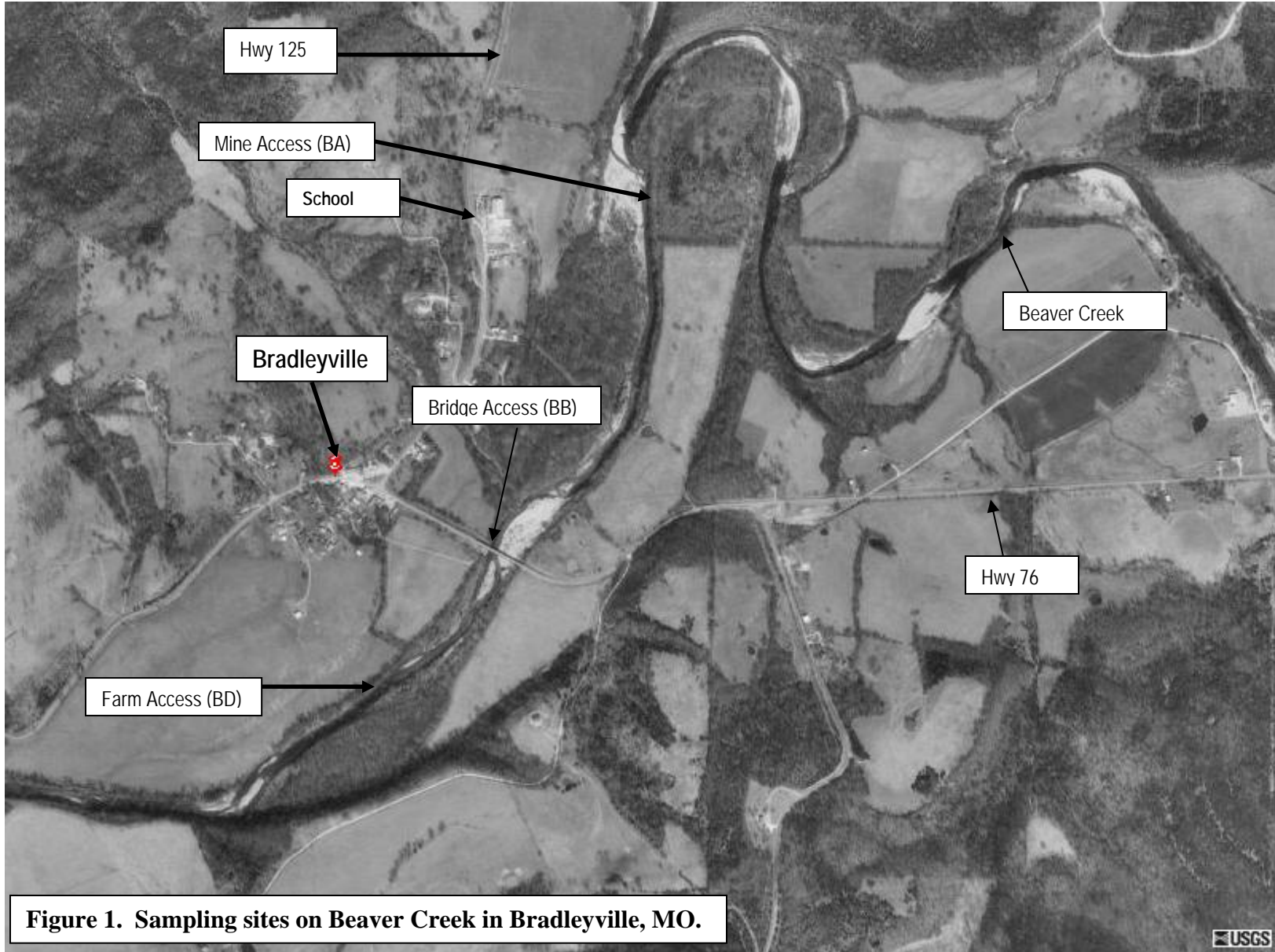


Figure 1. Sampling sites on Beaver Creek in Bradleyville, MO.

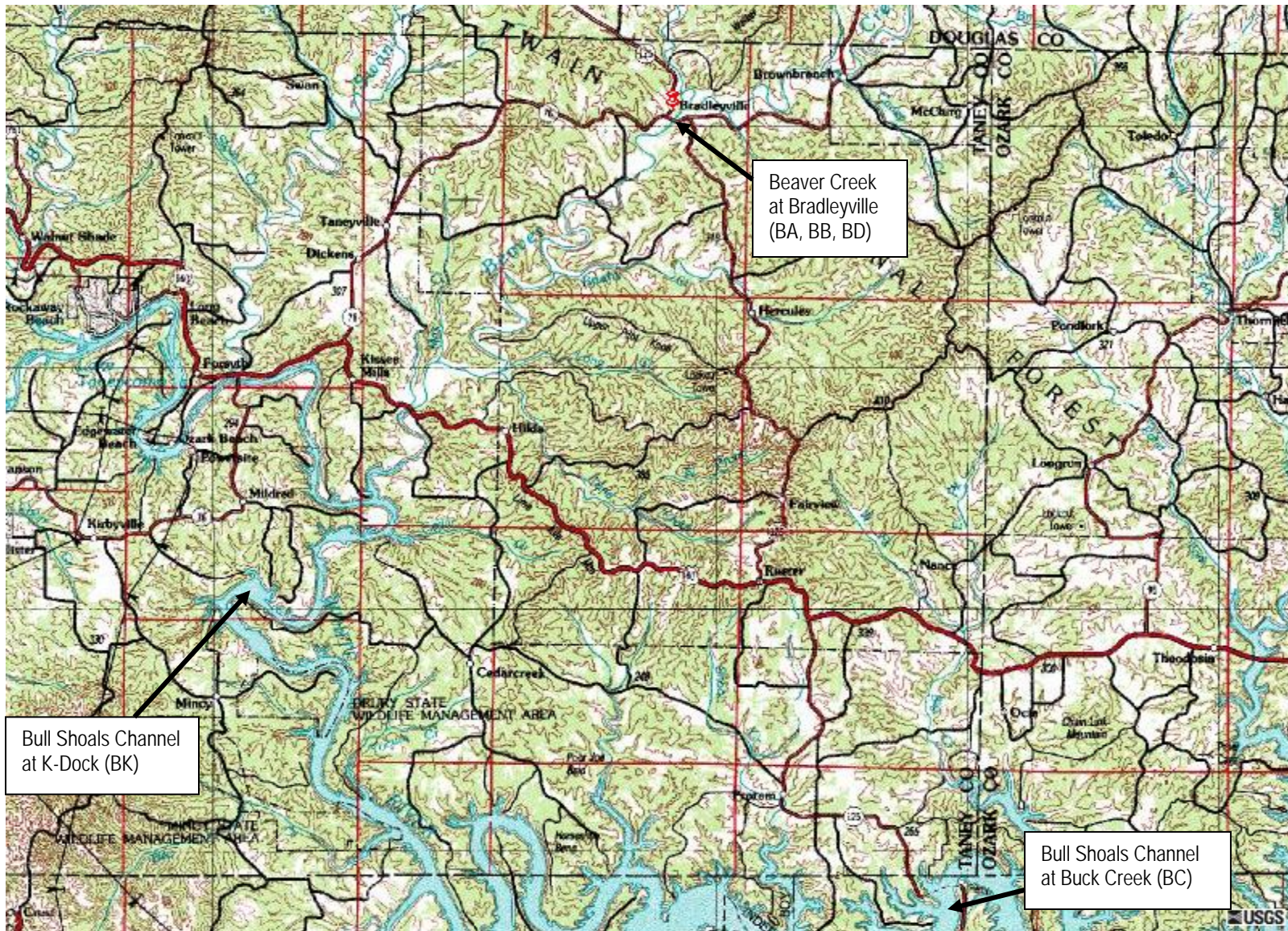


Figure 2. Sampling sites on Beaver Creek and in Bull Shoals Lake.

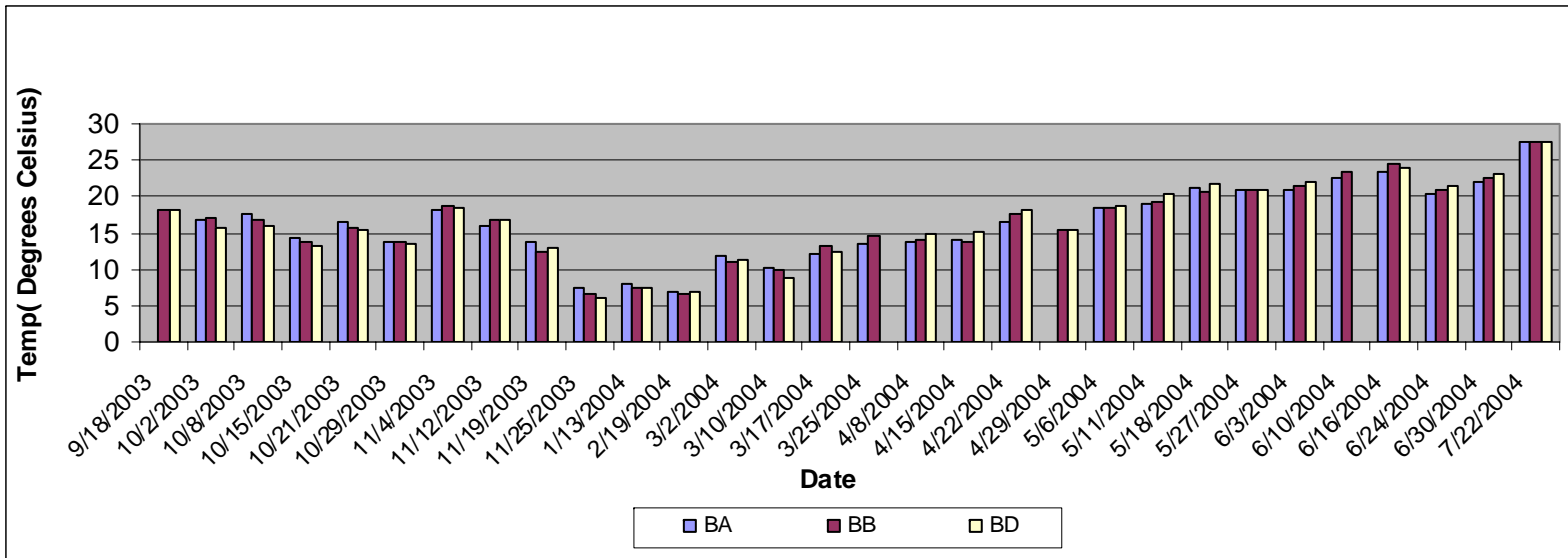


Figure 3. Temperature for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD).

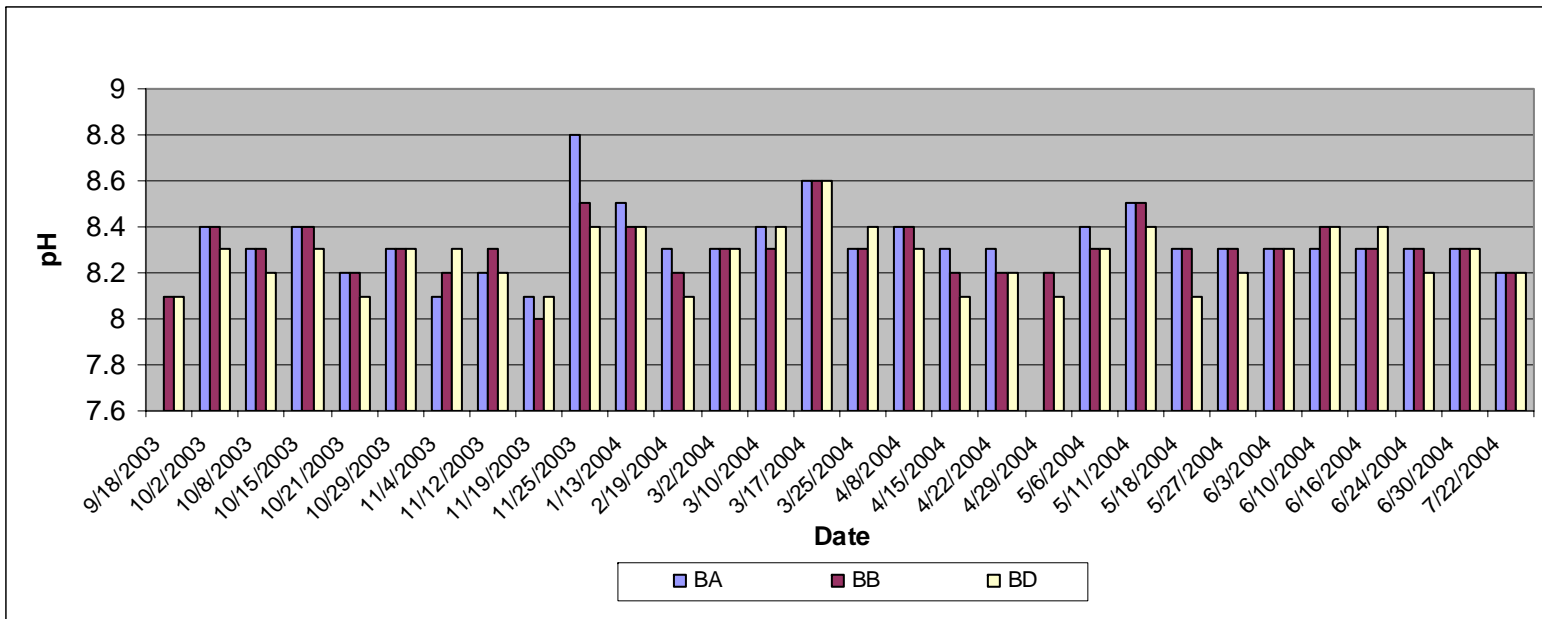


Figure 4. pH readings for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD).

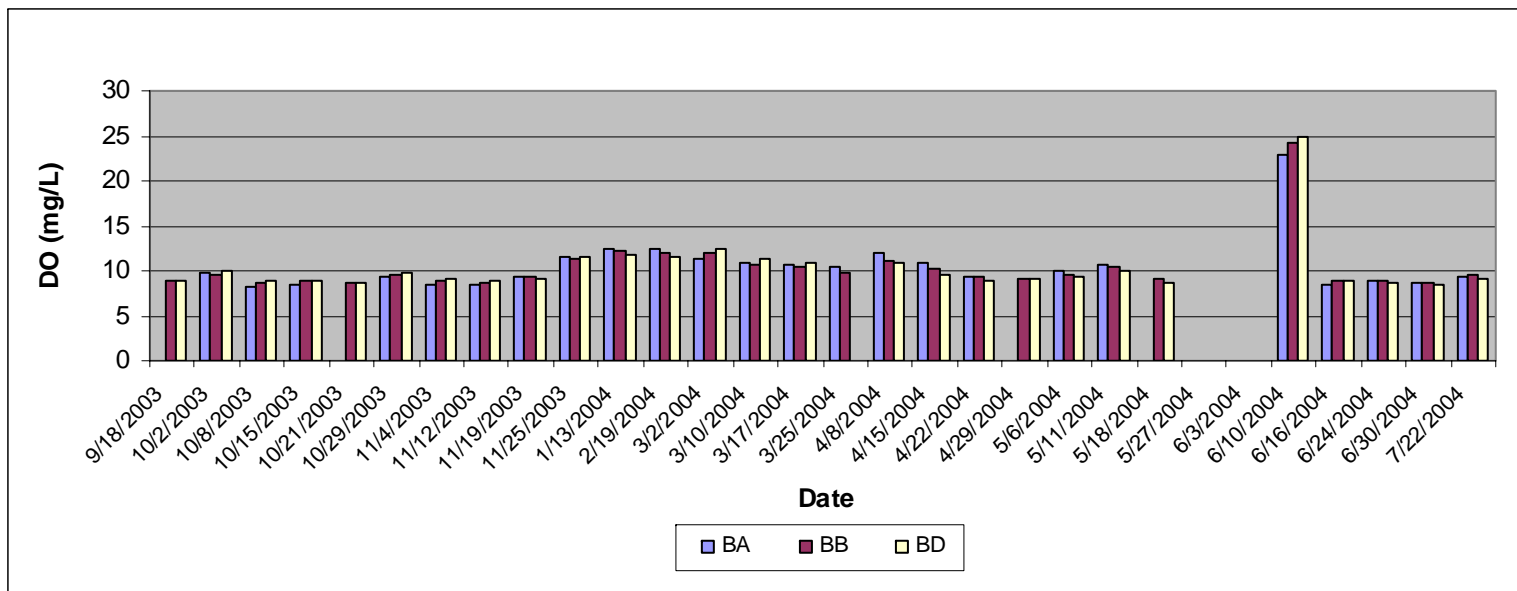
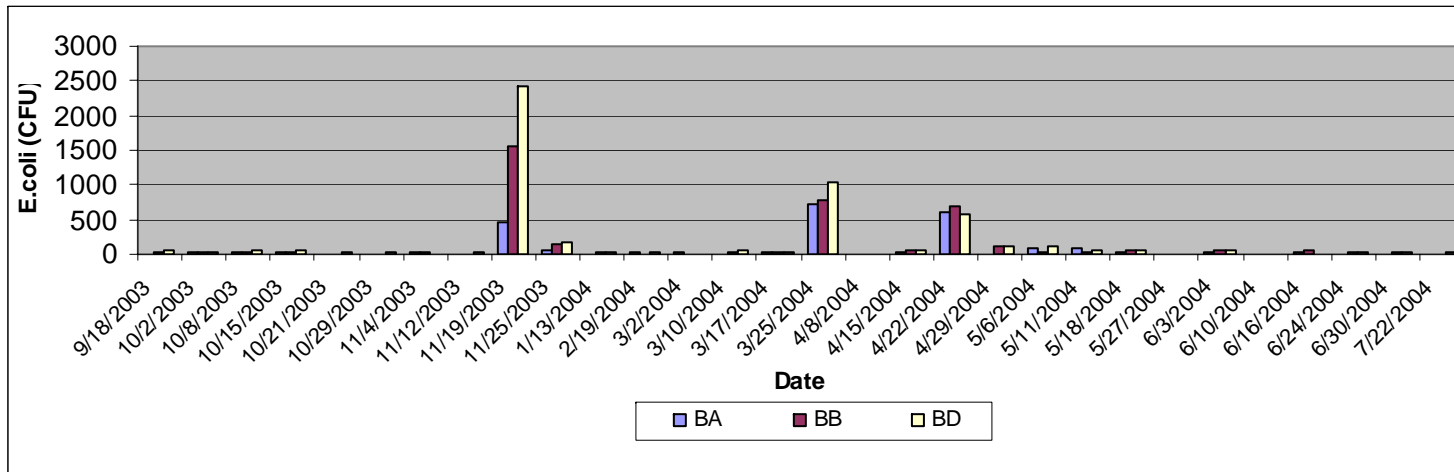


Figure 5. Dissolved oxygen readings for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD).

(a)



(b)

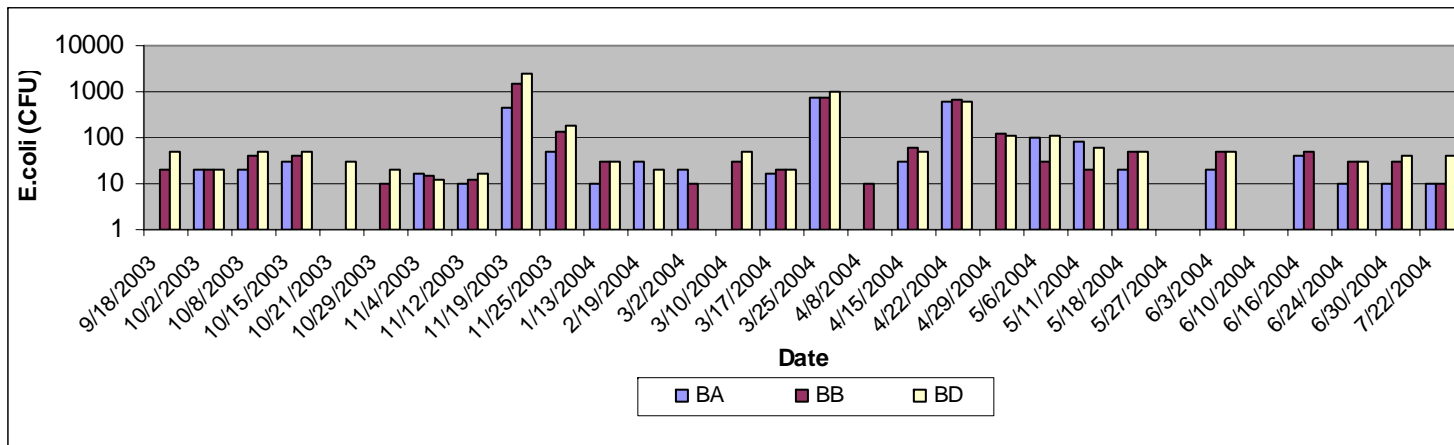


Figure 6. *E. coli* colony forming units (CFU) for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD). Graph (a) is in a linear scale; graph (b) is in a logarithmic scale.

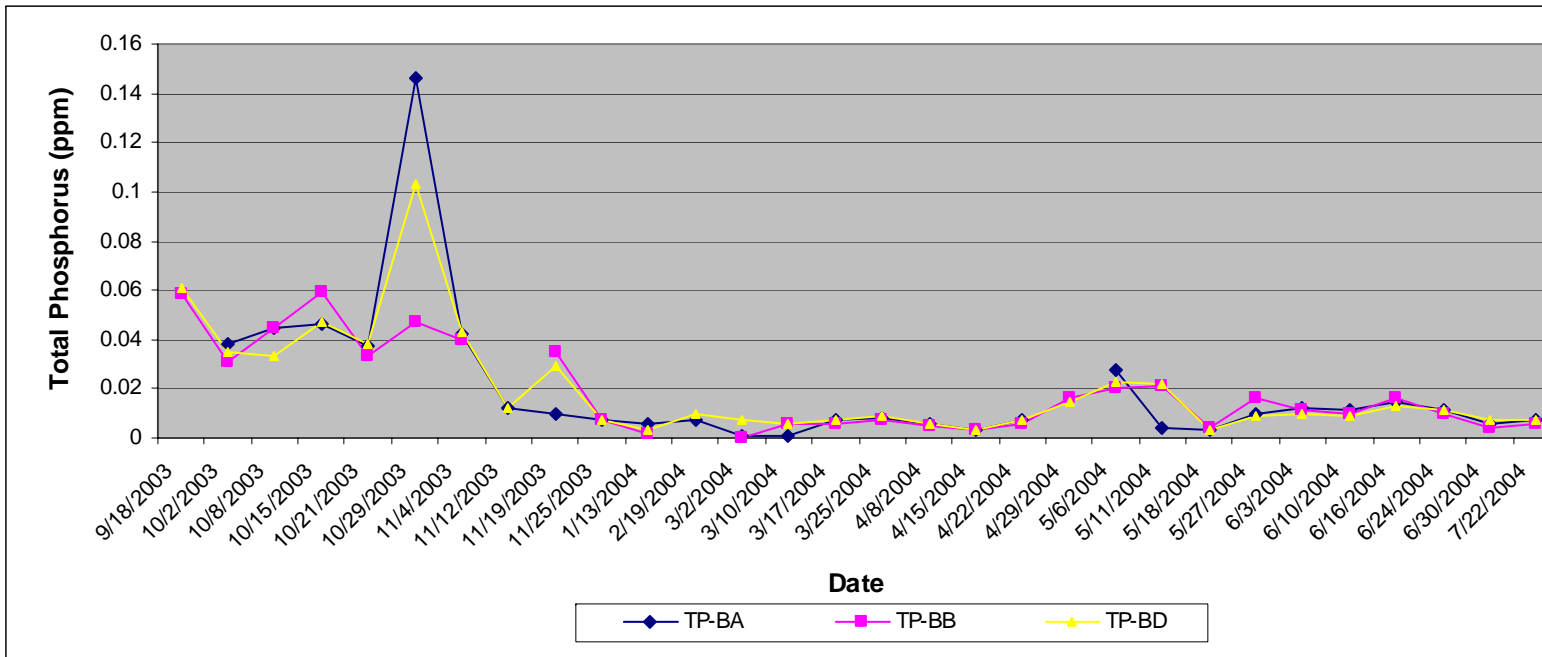


Figure 7. Total phosphorus readings for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD). Data for samples on 10/29/03 is unreliable due to the use of glass sampling bottles in place of high density polypropylene (HDPE) bottles.

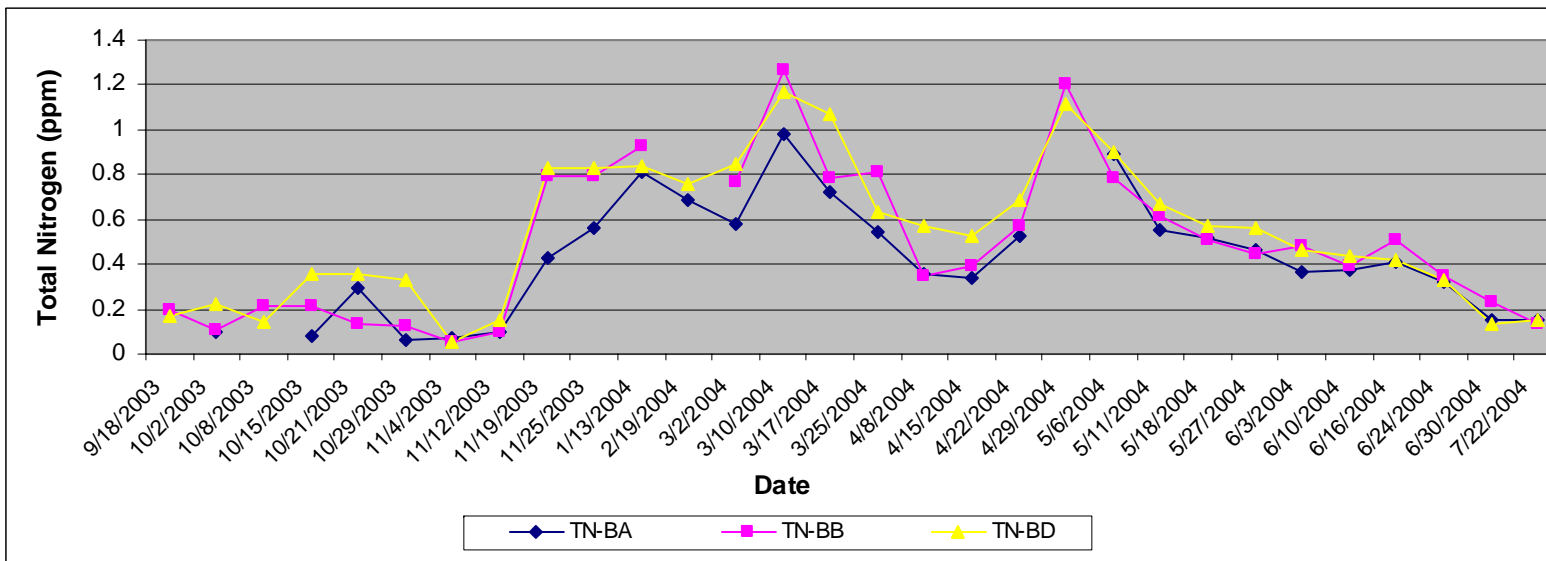


Figure 8. Total nitrogen values for sites above Bradleyville (BA), at the Bradleyville bridge (BB), and downstream of Bradleyville (BD). Data for samples on 10/29/03 is unreliable due to the use of glass sampling bottles in place of high density polypropylene (HDPE) bottles.

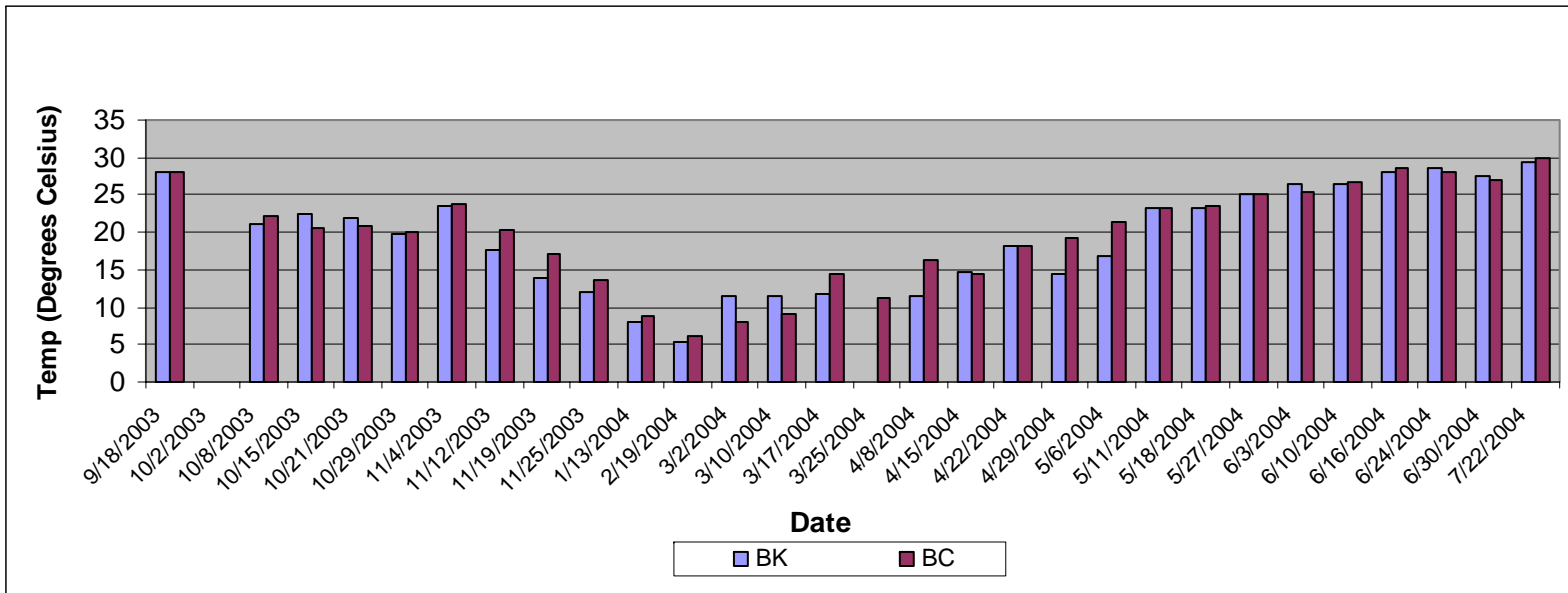


Figure 9. Temperature values for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC).

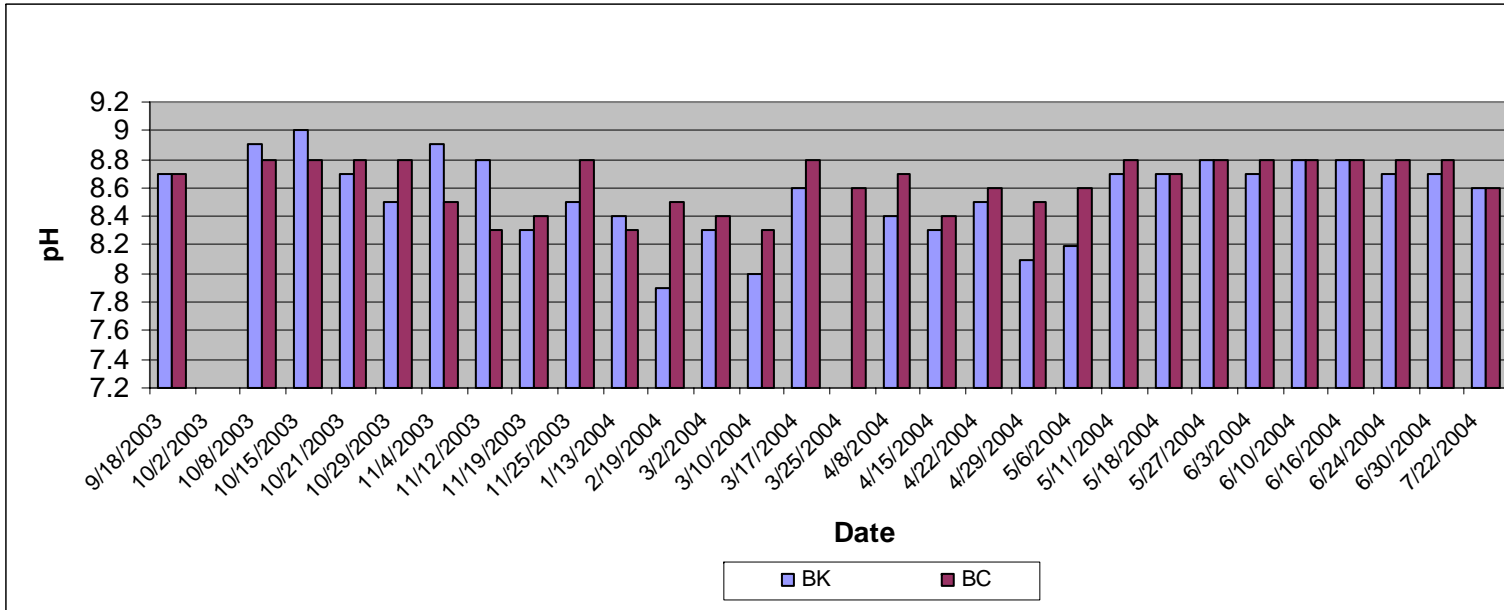


Figure 10. pH values for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC).

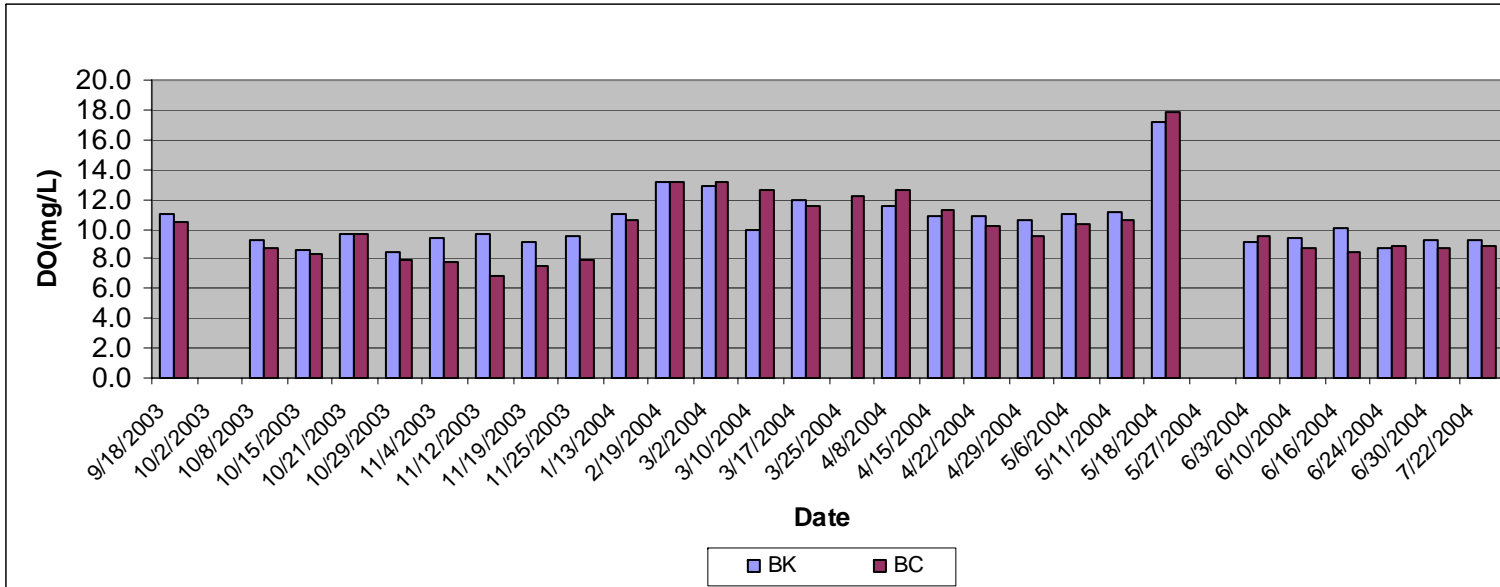


Figure 11. Dissolved oxygen (DO) values for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC).

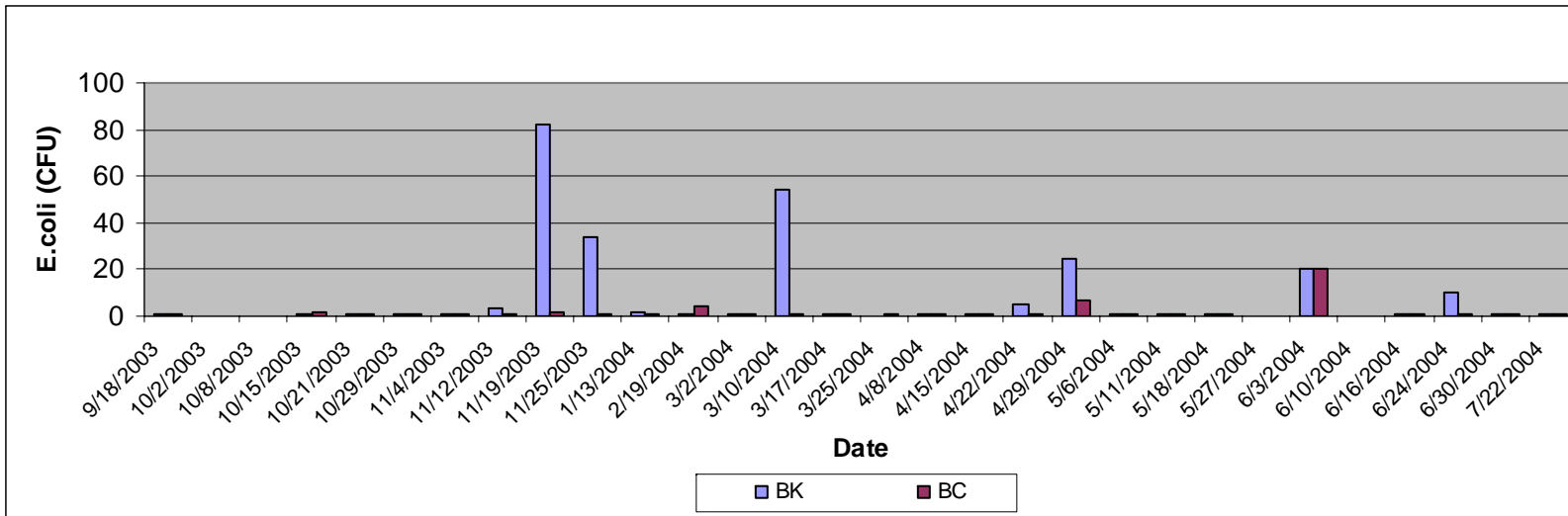


Figure 12. *E. coli* colony forming units (CFU) for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC).

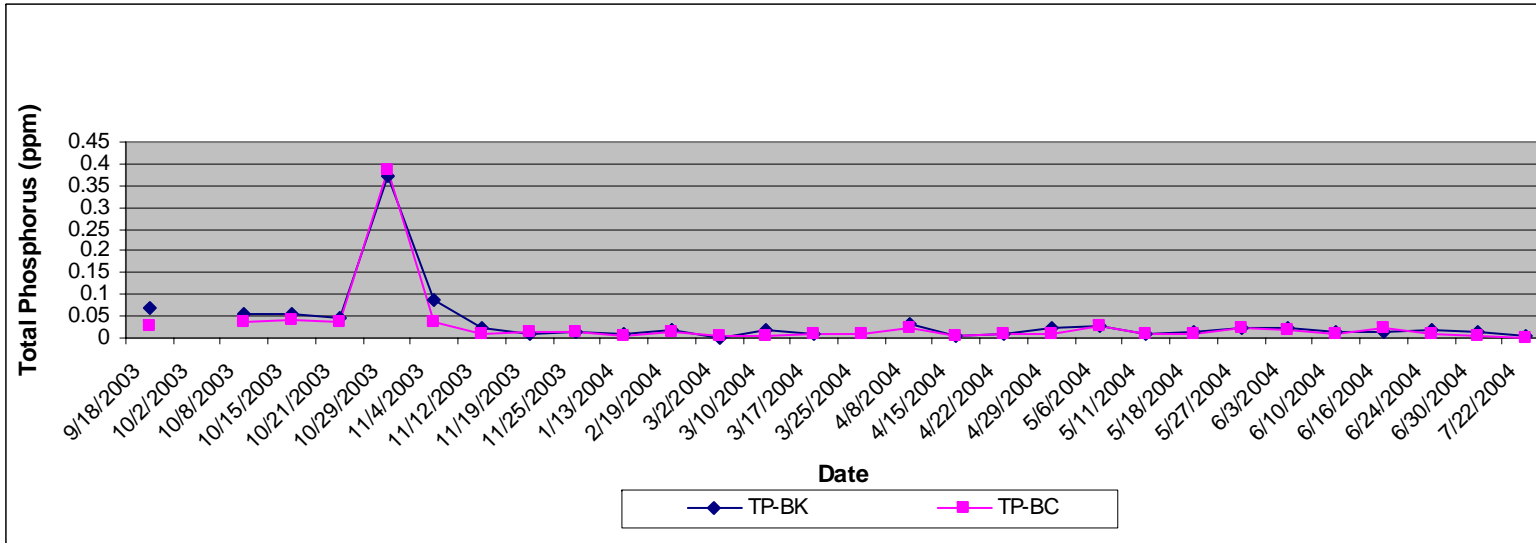


Figure 13. Total phosphorus readings for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC). Data for samples on 10/29/03 is unreliable due to the use of glass sampling bottles in place of high density polypropylene (HDPE) bottles.

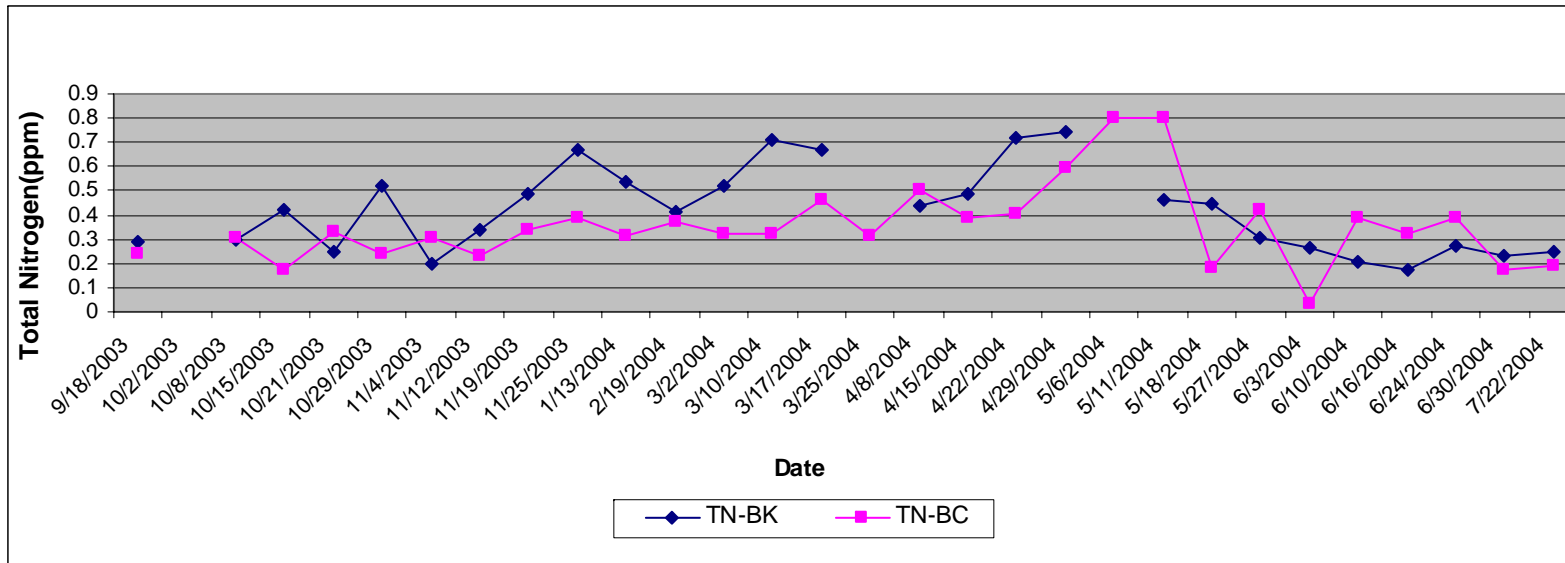


Figure 14. Total nitrogen values for Bull Shoals Lake near K-Dock Marina (BK) and at Buck Creek (BC). Data for samples on 10/29/03 is unreliable due to the use of glass sampling bottles in place of high density polypropylene (HDPE) bottles.

Appendix 1. Raw Data Collected From August, 2003, through July, 2004.