2006 Big Creek Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
April 21, 2010

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2006

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Escatawpa River Basin

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INTRODUCTION

The Alabama Department of Environmental Management (ADEM) monitored Big Creek Reservoir as part of the 2006 assessment of the Escatawpa, Mobile, and Tombigbee (EMT) River basins under the [Rivers and Reservoirs Monitoring Program (RRMP)]. Implemented in 1990, the objectives of this program were to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria.

ADEM's RRMP has previously sampled five locations in Big Creek Reservoir as part of its [Intensive Basin Assessment Monitoring] in 2001, [Long-term Trend (Critical Period) Monitoring], and a special project to collect three years of consecutive data for [nutrient criteria development], 2001-2003. Descriptions of all monitoring activities are available in ADEM's [2005 Monitoring Strategy].

In 2007, the Alabama Department of Public Health issued a consumption advisory for largemouth bass caught in Big Creek Reservoir. Samples collected in 2006 contained mercury levels exceeding the EPA action level of 0.33 ppm. Consequently, Big Creek Reservoir was added to Alabama's 2008 §303(d) list of impaired waters for not meeting its Public Water Supply (PWS)/Fish & Wildlife (F&W) [water use classification].

The purpose of this report is to summarize data collected at five stations in Big Creek Reservoir during the 2006 growing season and to compare these results with data collected previously by ADEM. Monthly and mean concentrations of nutrients (total nitrogen (TN); total phosphorus (TP)), algal biomass/productivity (chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)), sediment (total suspended solids (TSS)), and trophic state (Carlson's trophic state index (TSI)) were compared to ADEM's historical data.

METHODS

Specific station location information is listed in Table 1. Big Creek Reservoir was sampled in the dam forebay, mid reservoir, and upper reservoir. Two tributary embayments were also monitored (Fig. 1).

Water quality assessments were conducted at monthly intervals April-October. All samples were collected, preserved, stored, and transported according to procedures in the [ADEM Field Operations Division Standard Operating Procedures (SOP)], [Surface Water Quality Assurance Project Plan (QAPP)], and [Quality Management Plan (QMP)].

Mean annual TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. For mainstem stations, monthly concentrations of these parameters were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2006 results. Data from the upper and mid-mainstem stations were compared to data collected April-October in 2001 as part of ADEM's [Intensive Basin Assessment Monitoring]. Historical trends were evaluated for the lower station, where data were collected April-October, 2001-2003 as part of the [Intensive Basin Assessment Monitoring] and a special project to collect data for [nutrient criteria development]. For all three mainstem stations, more data was graphed for August, the month during which ADEM generally conducts its [Long-term Trends (Critical Period) Monitoring].

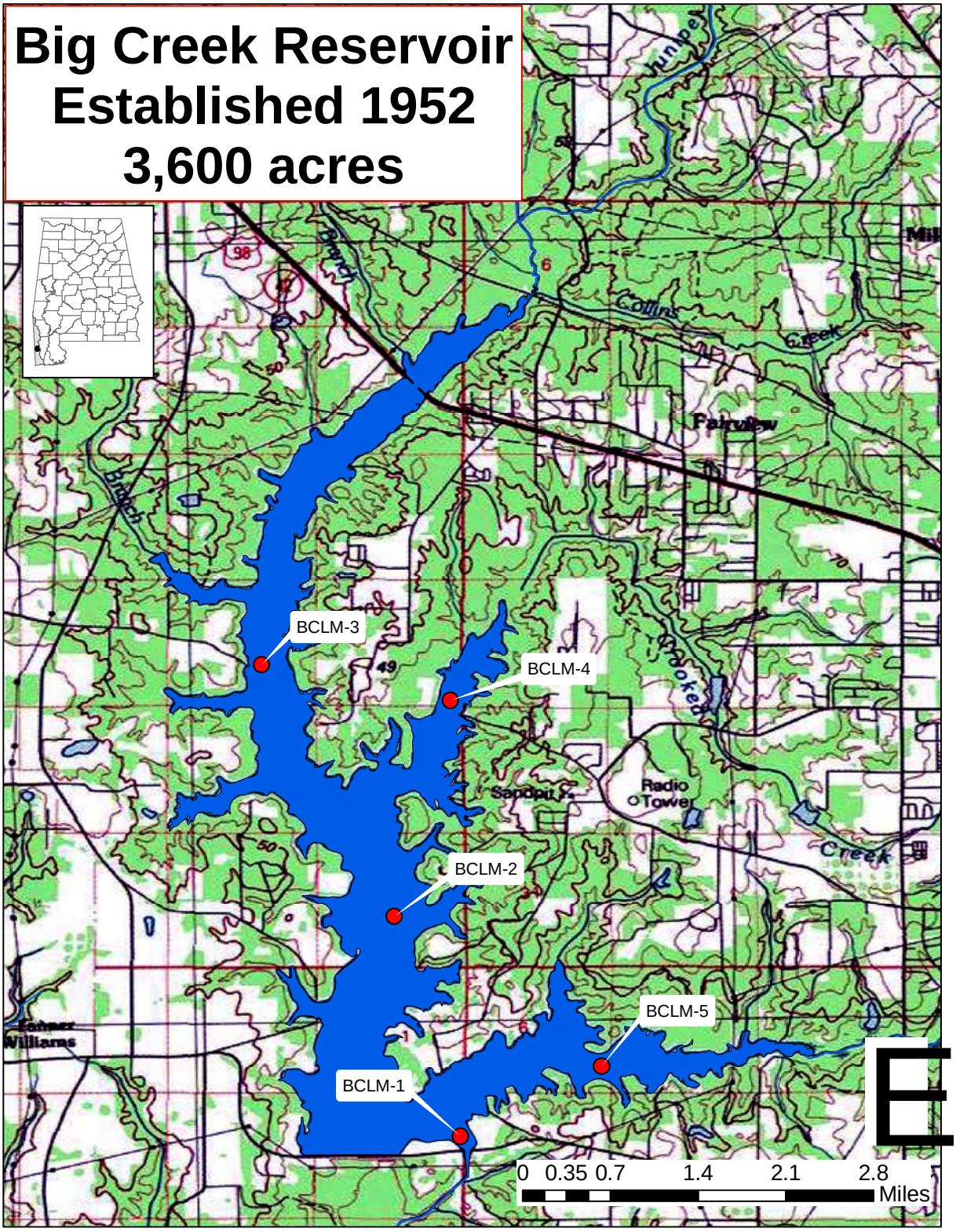


Figure 1. Big Creek Reservoir sampling locations, 2006.

Table 1. Descriptions for the monitoring stations in 2006 for Big Creek Reservoir.

Sub-watershed	County	Station Number	Report Designation	Waterbody Name	Station Description	Latitude	Longitude
Big Creek Reservoir							
Escatawpa (0317-0008)							
0402	Mobile	BCLM-1	Lower	Big Creek	Lower reservoir. Deepest point, Big Creek channel, dam forebay.	30.7146	-88.3275
0402	Mobile	BCLM-2	Mid	Big Creek	Mid reservoir. Deepest point, Big Creek channel, approximately 0.5 mile downstream of the Crooked Creek confluence.	30.7401	-88.3351
0402	Mobile	BCLM-3	Upper	Big Creek	Upper reservoir. Deepest point, Big Creek channel, approximately one mile downstream of US Hwy. 98.	30.7692	-88.3505
0402	Mobile	BCLM-4	Crooked Cr	Big Creek	Deepest point, main creek channel, Crooked Creek embayment, approximately one mile downstream of US Hwy. 98.	30.7650	-88.3286
0402	Mobile	BCLM-5	Hamilton Cr	Big Creek	Deepest point, main creek channel, Hamilton Creek embayment, approximately one mile upstream of confluence with Big Creek.	30.7227	-88.3112

RESULTS

Summary statistics of all data collected during 2006 are presented in Appendix Table 1. The table contains the min, max, median, average, and standard deviation of each parameter analyzed. Mean concentrations of TN, TP, chl *a*, and TSS are presented in Fig. 2. Monthly concentrations of these parameters are also presented for the Upper (Fig. 3), Mid (Fig. 4), and Lower (Fig 5) stations.

Mean TN concentrations measured at mainstem stations in 2006 ranged from 0.47 mg/l at the mid station to 0.61 mg/l at the upper station (Fig. 2). These concentrations are much higher than the 2001 mean concentrations at these locations, which ranged from 0.227 mg/l at the upper station to 0.271 mg/l at the mid-station (ADEM 2003). Mean TN concentrations measured at the two embayment locations were also higher in 2006 than in 2001 (Fig. 2; ADEM 2003). Monthly TN concentrations measured at mainstem stations were higher during the majority of the 2006 growing season than in 2001 (Fig. 3, 4, and 5).

Mean TP concentrations measured at mainstem stations increased from upstream to downstream (Fig. 2). Mean TP concentrations at all mainstem stations and at the Crooked Cr embayment were >0.025 mg/l, which can indicate eutrophic conditions within a lake or reservoir. However, mean TP concentrations at the upper and mid mainstem stations and Hamilton Ck were less than half of the concentrations measured at these locations in 2001 (ADEM 2003). At the lower mainstem and Crooked Ck stations, mean concentrations have increased slightly.

Monthly TP concentrations measured at the upper and mid stations generally declined through October, although concentrations were higher in September following increased flows (Fig. 3 & 4). Concentrations at the lower station also decreased through August, but increased in both September and October (Fig. 5). Monthly TP concentrations measured in 2006 at the lower station were generally higher than historic means (Fig. 5). Monthly TP concentrations at the upper station were generally similar to the 2001 results (Fig. 3) while the monthly concentrations at the mid-station were generally lower (Fig. 4).

Mean chl *a* concentrations measured at mainstem stations ranged from 8.81 ug/l at the mid station to 9.93 ug/l at the upper station (Fig. 2). The highest mean chl *a* concentration was

measured at the Crooked Cr embayment while the lowest was measured in the Hamilton Cr embayment. Mean chl a concentrations at the mid and lower mainstem stations have increased since ADEM began intensive surveys of Big Creek Reservoir in 2001 (Fig 6).

In 2006, monthly chl *a* concentrations measured at the upper and lower stations were generally highest in the fall (Figs. 3 and 5), with September and October values at the lower station higher than historic means. Conversely, monthly chl *a* concentrations measured at the mid station were higher in the spring (Fig. 4).

Mean TSS concentrations measured at Big Creek Reservoir mainstem stations increased from 4.07 mg/l at the upper station to 5.58 mg/l the lower station (Fig. 2). Mean TSS concentrations at the Crooked Cr embayment station were similar. The lowest TSS concentration was measured in the Hamilton Cr embayment. Mean TSS concentrations were higher in 2001, ranging from 6.29 mg/l at the mid station to 11.00 mg/l at the lower station (ADEM 2003).

Monthly TSS concentrations were relatively stable in the upper and mid stations (Fig. 3 & 4). Monthly TSS concentrations at the lower station were highest in April and May (Fig. 5). Comparison with ADEM's historic data set showed that these concentrations were unusually high for these months. Monthly TSS concentrations measured at the upper and mid stations were generally lower in 2006 than in 2001.

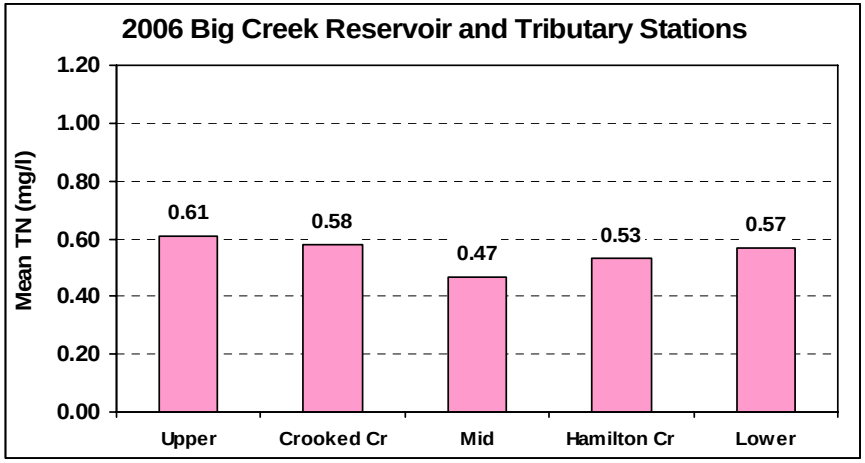
Algal Growth Potential Tests were conducted at mainstem stations in 2001 and 2006 (Table 2). Results from both years indicated phosphorus limited conditions at all three stations. Although mean standing crop (MSC) values at all mainstem stations were twice as high in 2006 than in 2001, 2006 values were still below the 5.0 mg/l level suggested as protective of reservoir and lake systems (Raschke and Schultz 1987).

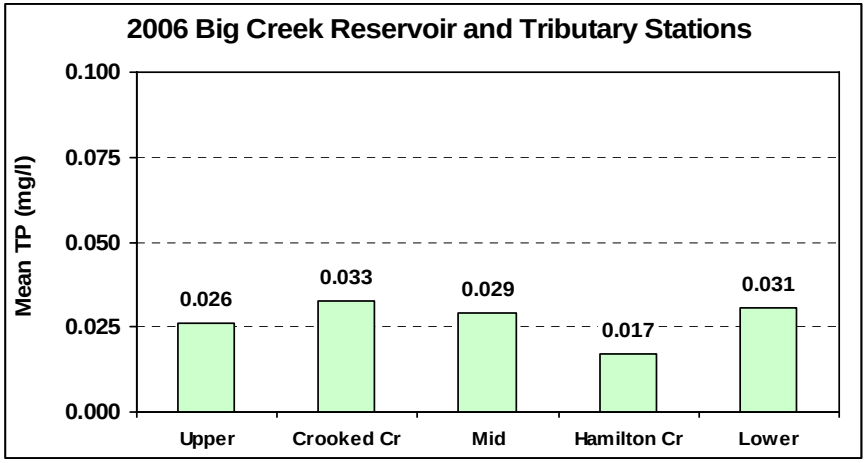
Dissolved oxygen concentrations were above the ADEM Criteria limit of 5.0 mg/l at 5 ft at all stations (ADEM Admin. Code R. 335-6-10-.09) (Fig. 7 & 8), April-October. The reservoir was stratified at the upper and mid stations, June-August, while the lower station was stratified June-September. Depth profiles also indicate >50% of the water column had dissolved oxygen levels < 5.0 mg/l June-August at the upper and mid stations (Fig. 7). Chemoclines were present at the mid and lower reservoir stations June-September and at the upper station June-August.

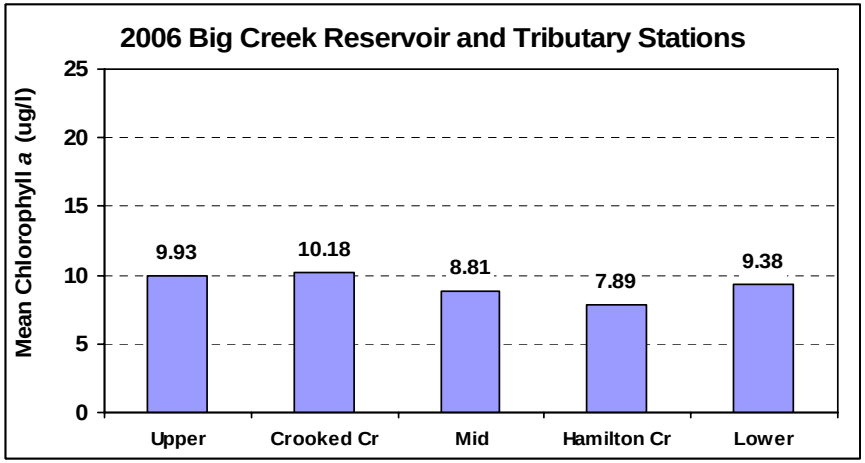
TSI values for all mainstem stations were mesotrophic in April, increasing to eutrophic or near eutrophic conditions May-October (Fig. 9). TSI values for the Crooked Cr embayment were eutrophic all months but August, when it declined to mesotrophic. TSI values for the Hamilton Cr embayment were much lower than the other stations in July and August.

August TSI values at the upper and mid stations have generally remained eutrophic since 2001 (Fig. 10). August TSI values at the lower mainstem station have ranged from oligotrophic to eutrophic throughout ADEM's historic dataset, 1985-2006.

Figure 2. Mean total nitrogen (TN), mean total phosphorus (TP), mean chlorophyll *a* (chl *a*), and mean total suspended solids (TSS) measured throughout Big Creek Reservoir, April-October 2006. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.







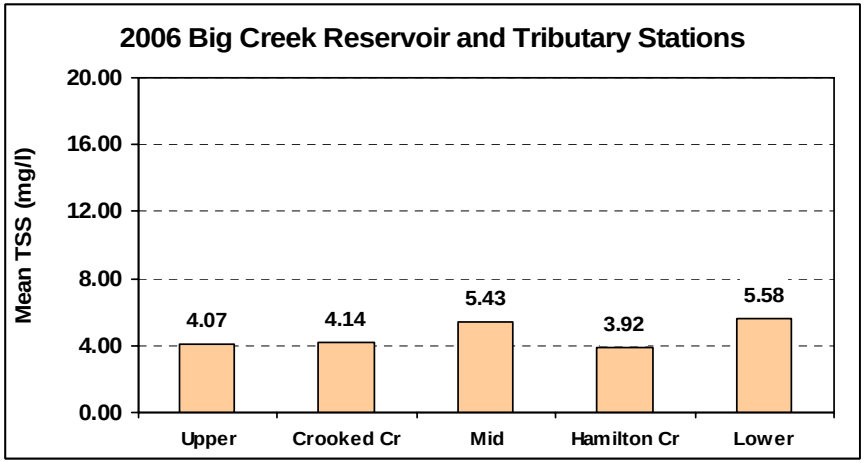
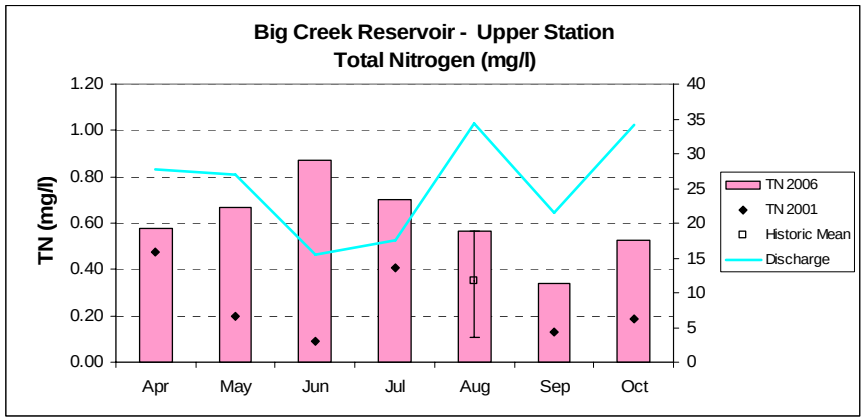
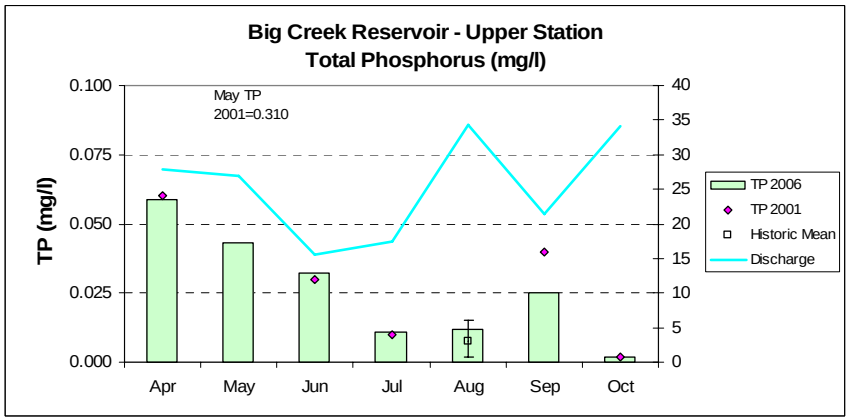
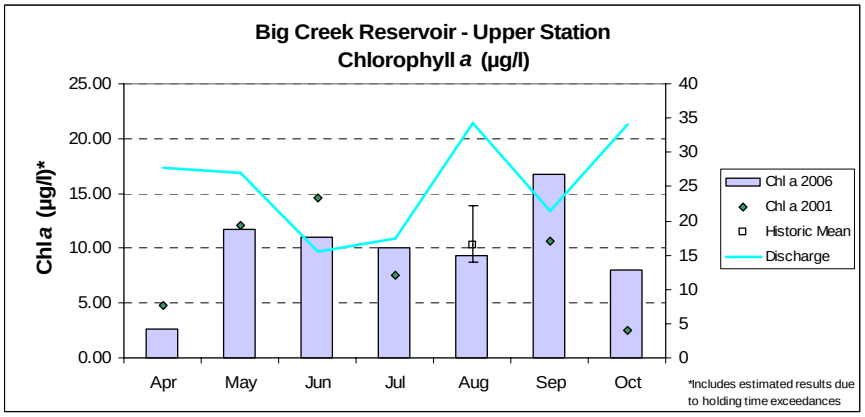


Figure 3. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the upper station in Big Creek Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the upper station. For August, the historic mean and min/max range are also displayed for comparison. Months with 2 years of data show values for both years, 2001 and 2006. Nutrients and TSS were plotted vs. discharge (USGS Big Creek gauge near Wilmer, AL).







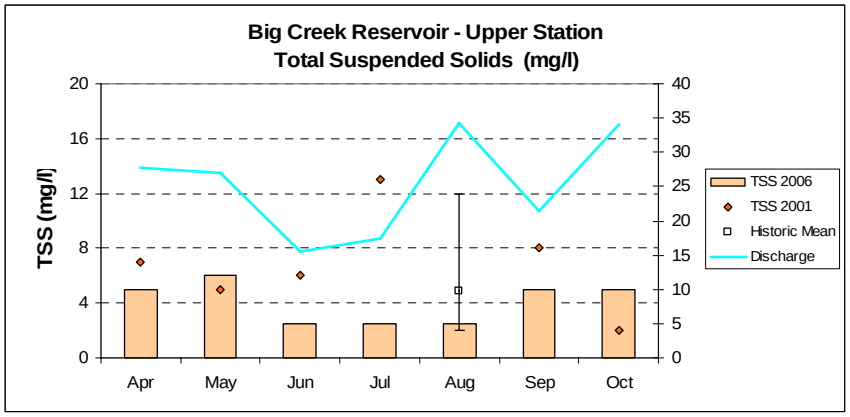


Figure 4. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the mid station in Big Creek Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the mid-reservoir station. For August, the historic mean and min/max range are also displayed for comparison. Months with 2 years of data show values for both years, 2001 and 2006. Nutrients and TSS were plotted vs. discharge (USGS Big Creek gauge near Wilmer, AL).

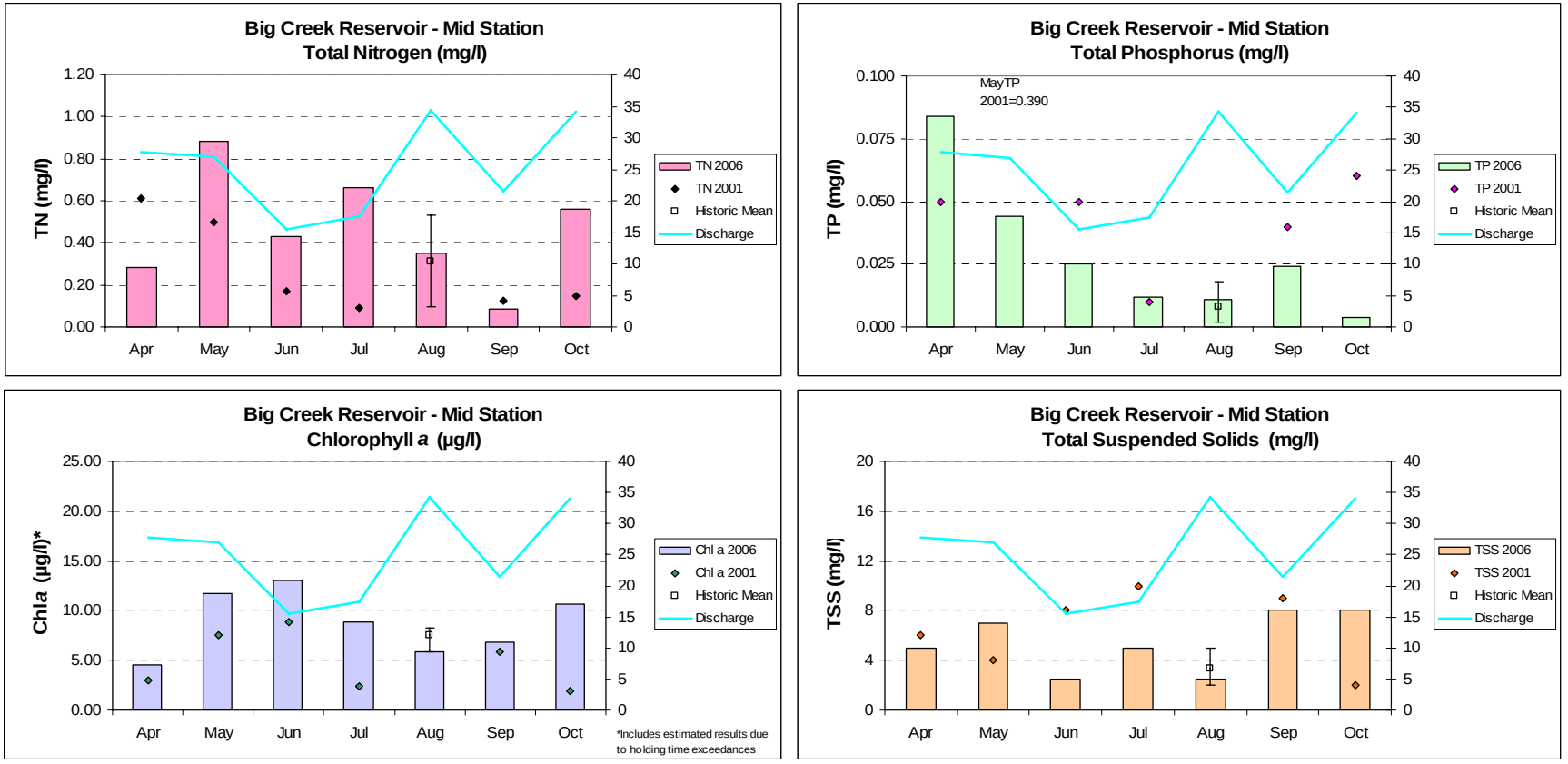


Figure 5. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the dam forebay station in Big Creek Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the lower reservoir station. The historic mean and min/max range are also displayed for comparison. Samples collected during April were collected upstream of Hamilton Cr influence and were not used in calculation of historic mean and min/max values. Nutrients and TSS were plotted vs. discharge (USGS Big Creek gauge near Wilmer, AL).

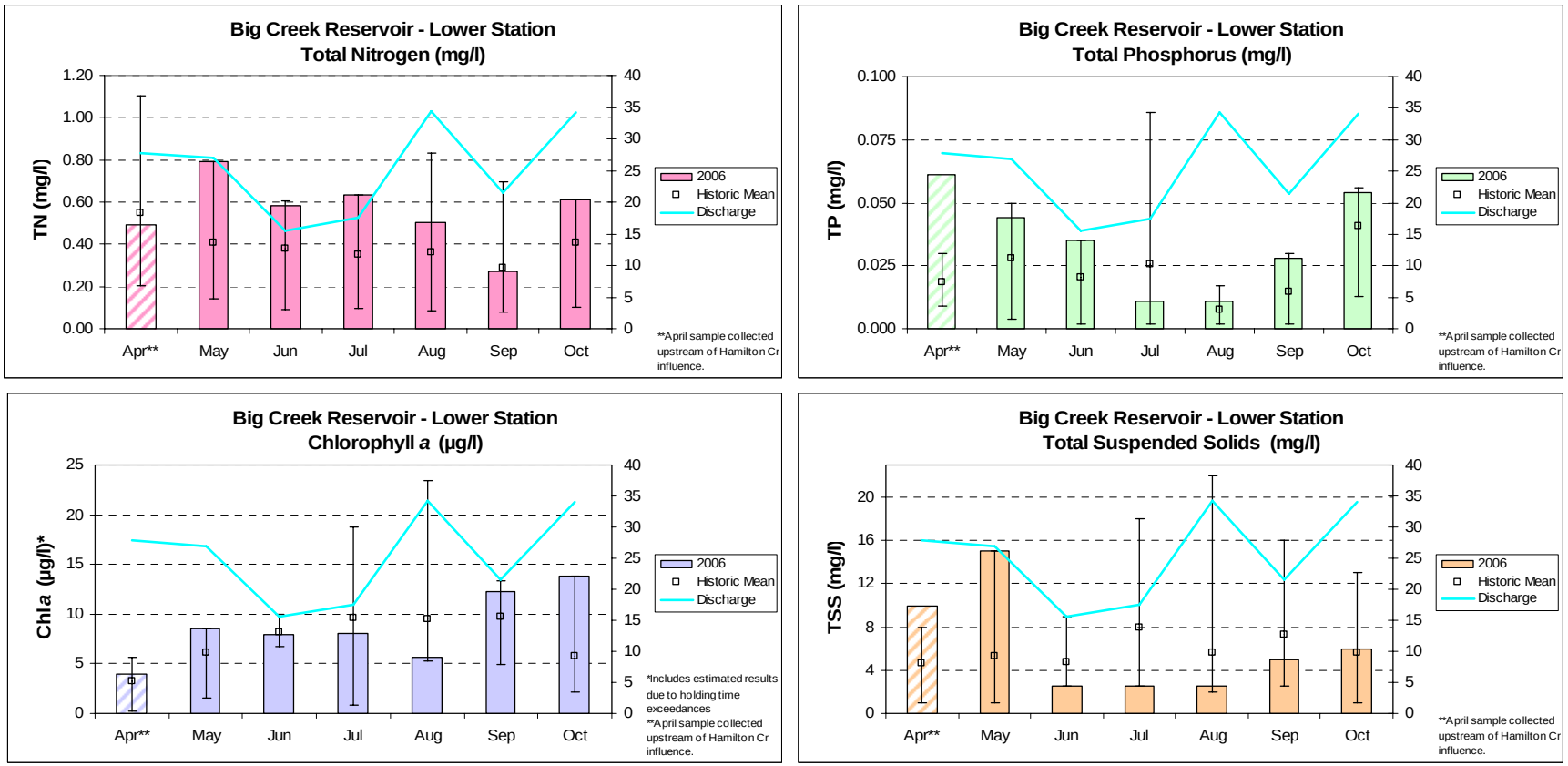


Figure 6. Mean chlorophyll *a* concentrations of mainstem Big Creek Reservoir stations, April-October, 2001-2006.

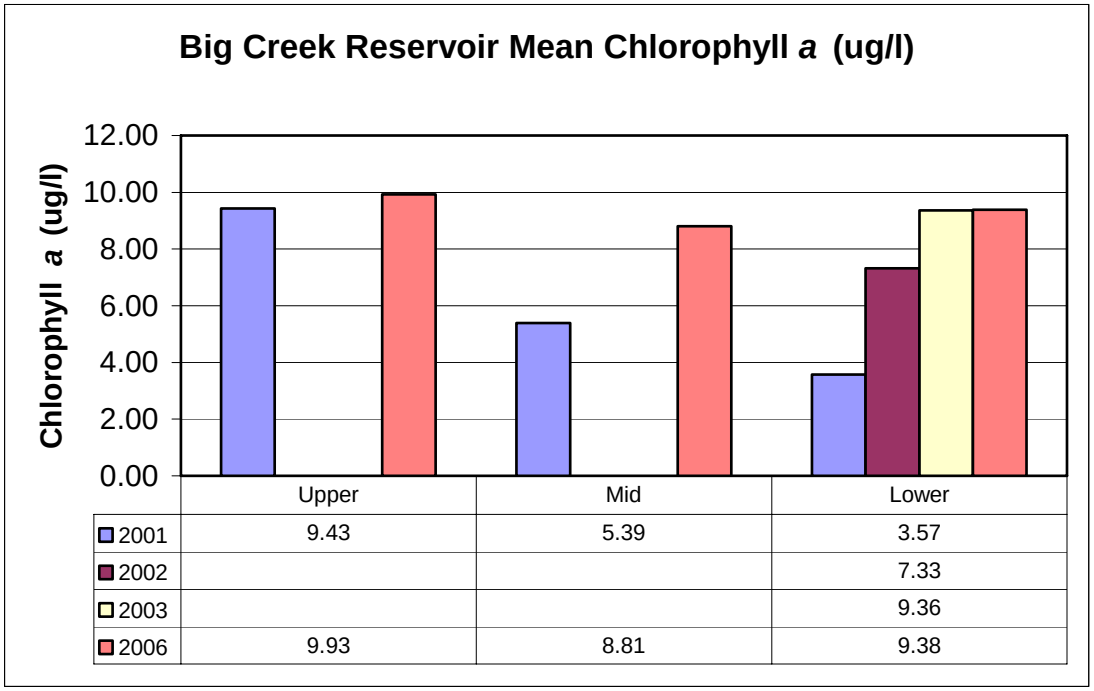


Table 2. Algal growth potential test results for mainstem Big Creek Reservoir stations, 2001 and 2006 (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status.

Station	2001 Control mean MSC	2001 Limiting Nutrient	2006 Control mean MSC	2006 Limiting Nutrient
Upper	1.80	Phosphorus	4.33	Phosphorus
Mid	1.77	Phosphorus	3.46	Phosphorus
Lower	1.46	Phosphorus	4.20	Phosphorus

Figure 7. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in Big Creek Reservoir, June-September 2006. Although profiles were measured April-October, these select months were chosen as they represent the warmest water temperatures and most stratified dissolved oxygen concentrations. ADEM Water Quality Criteria pertaining to non-wadeable river and reservoir waters require a DO concentration of 5.0 mg/l at 5.0 ft (1.5 m) (ADEM Admin. Code R. 335-6-10-.09). Under extreme natural conditions such as drought, the DO concentration may be as low as 4.0 mg/l.

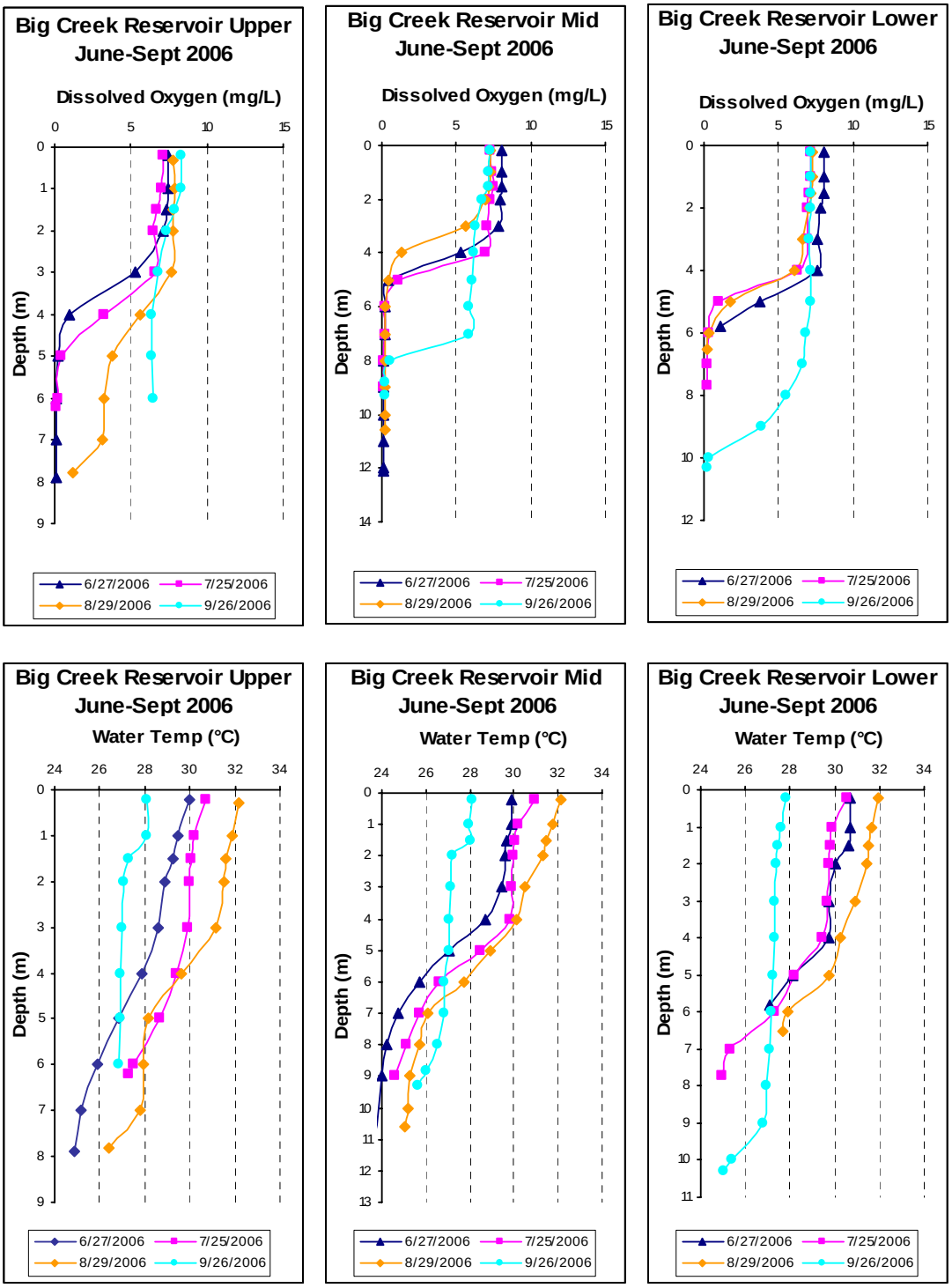


Figure 8. DO concentrations at 5 ft (1.5 m) for Big Creek Reservoir tributaries collected April-October 2006. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations at a depth of 5 ft (1.5 m) are graphed. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2005).

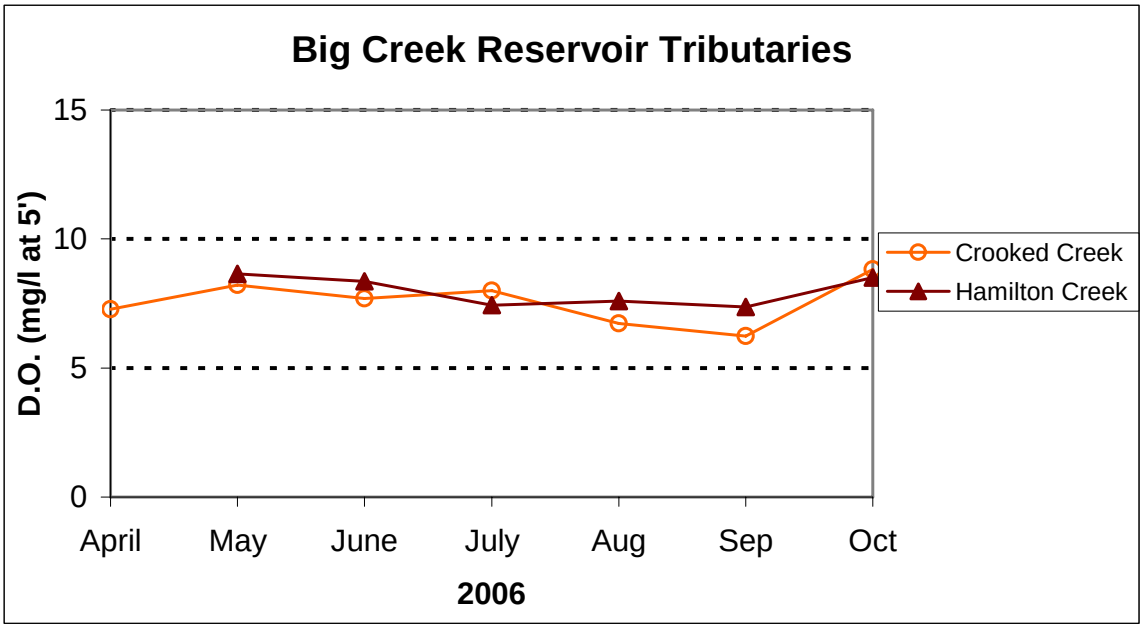


Figure 9. Monthly TSI values for Big Creek Reservoir mainstem and tributary stations using chlorophyll *a* concentrations and the Carlson's Trophic State Index calculation, April-October 2006.

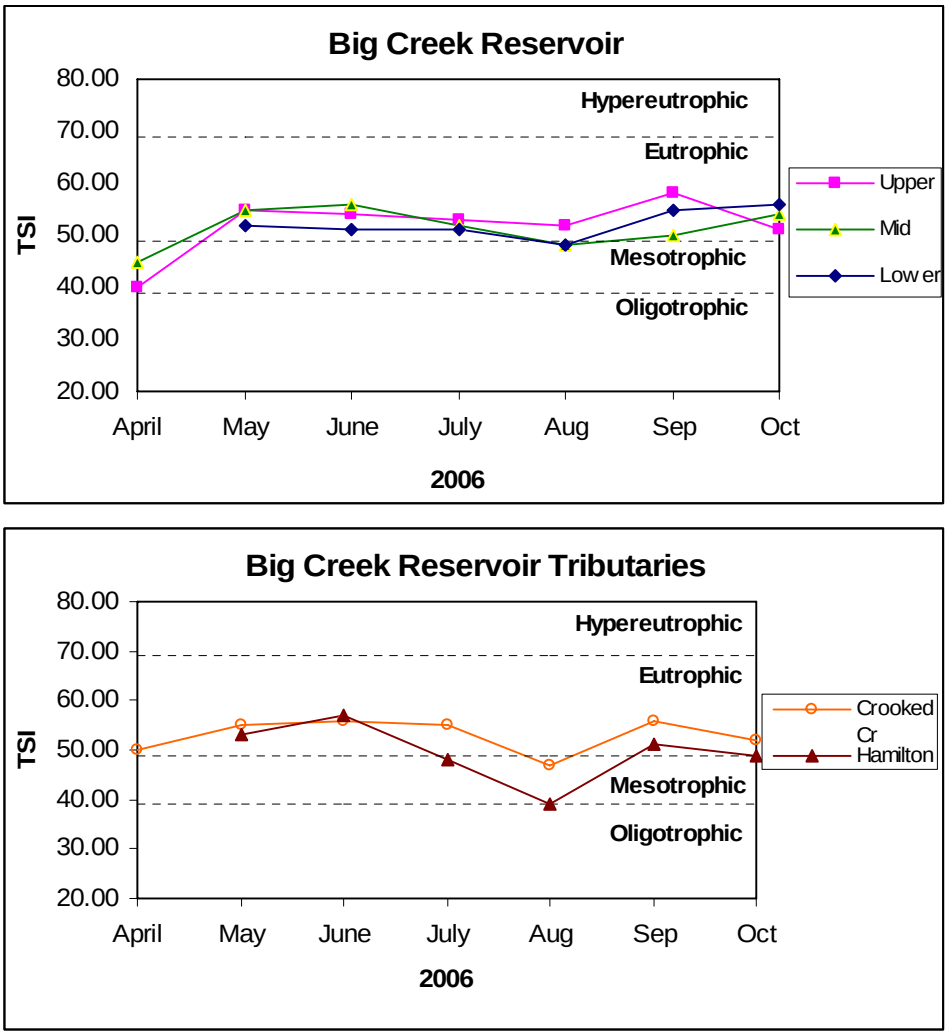
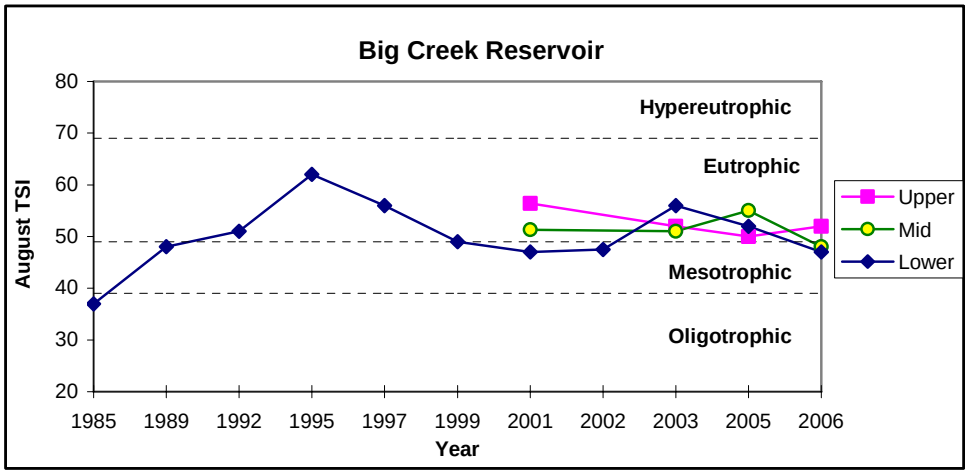


Figure 10. Trophic State Index values from critical period sampling of Big Creek Reservoir (August sampling only), 1985-2006.



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APPENDIX

Appendix Table 1. Summary of Big Creek Reservoir water quality data collected April-October, 2006. Minimum (Min) and maximum (Max) values calculated using minimum detection limits (MDL) when results were less than this value. Median (Med), average (Ave), and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Median	Avg	SD
BCLM-1	Alkalinity (mg/L)	6	4.4	10.0	7.2	7.3	1.8
	Hardness (mg/L)	0	---	---	---	---	---
	Total Dissolved Solids (mg/L)	6	16.0	90.0	28.5	37.0	26.6
	Total Suspended Solids (mg/L)	6	< 5.0	15.0	3.8	5.6	4.9
	Ammonia Nitrogen (mg/L)	6	< 0.010	0.037	0.008	0.015	0.014
	Nitrate+Nitrite Nitrogen (mg/L)	6	< 0.005	0.109	0.007	0.024	0.042
	Total Kjeldahl Nitrogen (mg/L)	6	0.263	0.685	0.589	0.543	0.150
	Total Nitrogen (mg/L)	6	0.270	0.790	0.600	0.568	0.173
	Total Phosphorus (mg/L)	6	0.011	0.054	0.032	0.031	0.017
	Dissolved Reactive Phosphorus (mg/L)	6	< 0.004	0.016	0.008	0.008	0.005
	Chlorophyll *a* (mg/L)[J]	6	5.60	13.88	8.32	9.38	3.08
	Turbidity (NTU)	6	3	4	3	3	1
	Secchi (m)	6	1.30	1.86	1.58	1.37	0.64
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	2	---
BCLM-2	Alkalinity (mg/L)	7	3.3	42.0	8.0	12.2	13.4
	Hardness (mg/L)	0	---	---	---	---	---
	Total Dissolved Solids (mg/L)	7	6.0	54.0	32.0	31.6	14.6
	Total Suspended Solids (mg/L)	7	< 5.0	8.0	5.0	5.4	2.4
	Ammonia Nitrogen (mg/L)	7	< 0.010	0.039	0.008	0.011	0.012
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.005	0.112	0.008	0.037	0.051
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.775	0.430	0.429	0.252
	Total Nitrogen (mg/L)	7	0.160	0.890	0.440	0.481	0.247
	Total Phosphorus (mg/L)	7	0.004	0.084	0.024	0.029	0.027
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.017	0.006	0.007	0.005
	Chlorophyll *a* (mg/L)[J]	7	4.54	13.00	8.90	8.81	3.17
	Turbidity (NTU)	7	2	4	3	3	1
	Secchi (m)	7	1.30	1.85	1.37	1.46	0.19
	Fecal Coliform (col/100 mL)	0	---	---	---	---	---
BCLM-3	Alkalinity (mg/L)	7	1.0	10.0	6.0	5.8	3.2
	Hardness (mg/L)	0	---	---	---	---	---
	Total Dissolved Solids (mg/L)	7	11.0	51.0	32.0	31.9	13.0
	Total Suspended Solids (mg/L)	7	< 5.0	6.0	5.0	4.1	1.5
	Ammonia Nitrogen (mg/L)	7	< 0.010	0.021	0.008	0.008	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.005	0.118	0.017	0.046	0.050
	Total Kjeldahl Nitrogen (mg/L)	7	0.321	0.870	0.550	0.561	0.179
	Total Nitrogen (mg/L)	7	0.340	0.880	0.580	0.611	0.167
	Total Phosphorus (mg/L)	7	< 0.004	0.059	0.025	0.026	0.020
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.015	0.006	0.006	0.004
	Chlorophyll *a* (mg/L)[J]	7	2.67	16.78	10.00	9.93	4.25
	Turbidity (NTU)	7	3	4	3	3	1
	Secchi (m)	7	0.98	1.79	1.33	1.38	0.29
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	1	---
BCLM-4	Alkalinity (mg/L)	7	1.0	59.0	7.0	13.5	20.3
	Hardness (mg/L)	0	---	---	---	---	---
	Total Dissolved Solids (mg/L)	7	19.0	54.0	32.0	34.3	11.9

Station	Parameter	N	Min	Max	Median	Avg	SD
	Total Suspended Solids (mg/L)	7	< 3.0	7.0	4.0	4.1	1.7
	Ammonia Nitrogen (mg/L)	7	< 0.010	0.049	0.008	0.015	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.005	0.116	0.012	0.045	0.051
	Total Kjeldahl Nitrogen (mg/L)	7	0.193	1.191	0.450	0.537	0.331
	Total Nitrogen (mg/L)	7	0.300	1.280	0.510	0.586	0.338
	Total Phosphorus (mg/L)	7	< 0.004	0.061	0.035	0.033	0.022
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.017	0.005	0.006	0.005
	Chlorophyll *a* (mg/L)[J]	7	5.10	13.73	11.75	10.18	3.27
	Turbidity (NTU)	7	4	6	4	4	1
	Secchi (m)	6	1.06	1.51	1.14	1.08	0.51
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	330	---
BCLM-5	Alkalinity (mg/L)	6	1.0	7.3	5.2	4.6	2.5
	Hardness (mg/L)	0	---	---	---	---	---
	Total Dissolved Solids (mg/L)	6	9.0	48.0	33.0	31.5	13.4
	Total Suspended Solids (mg/L)	6	< 3.0	9.0	2.8	3.9	2.6
	Ammonia Nitrogen (mg/L)	6	< 0.010	0.026	0.006	0.009	0.008
	Nitrate+Nitrite Nitrogen (mg/L)	6	< 0.005	0.114	0.007	0.029	0.044
	Total Kjeldahl Nitrogen (mg/L)	6	0.226	0.648	0.555	0.502	0.165
	Total Nitrogen (mg/L)	6	0.230	0.760	0.565	0.533	0.193
	Total Phosphorus (mg/L)	6	< 0.004	0.046	0.011	0.017	0.017
	Dissolved Reactive Phosphorus (mg/L)	6	< 0.004	0.006	0.004	0.004	0.002
	Chlorophyll *a* (mg/L)[J]	6	2.40	15.00	7.21	7.89	4.24
	Turbidity (NTU)	6	3	5	3	3	2
	Secchi (m)	6	1.26	1.64	1.40	1.22	0.55
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	<1	---

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit