2007 Bankhead Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
May 2012

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LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
BW	Black Warrior
CHL *a*	Chlorophyll *a*
DO	Dissolved Oxygen
F&W	Fish and Wildlife
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Mean Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
ONRW	Outstanding National Resource Water
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports
SD	Standard Deviation
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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INTRODUCTION

Bankhead Reservoir's 9,200 acre water body was established in 1915 by the US Army Corp of Engineers (COE) with the completion of John Hollis Bankhead Dam and is the second largest reservoir in the Black Warrior system. While the COE maintains dam operations, Alabama Power owns and operates the generating plant. This allows Bankhead to fulfill multiple purposes like fishing, recreation, and power supply.

The Alabama Department of Environmental Management (ADEM) monitored Bankhead Reservoir as part of the 2007 assessment of the Black Warrior and Cahaba River (BWC) Basins under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the objectives of this program are 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. Descriptions of all RRMP monitoring activities are available in ADEM's 2012 Monitoring Strategy.

In 2004, the ADEM implemented a specific water quality criterion for nutrient management at one location on Bankhead Reservoir, which has been intensively monitored by ADEM since the mid 1980's. This criterion represents the maximum growing season mean (April-October) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting the reservoir's Public Water Supply, Swimming, and Fish & Wildlife (PWS/S/F&W) use classifications.

The purpose of this report is to summarize data collected at eight stations in Bankhead Reservoir during the 2007 growing season and to evaluate growing season trends in mean lake trophic status and nutrient concentrations using ADEM's nine-year dataset. Monthly and growing season mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [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 and established criteria.

METHODS

Sampling stations were selected using historical data and previous assessments (Fig. 1). Specific location information can be found in Table 1. Bankhead was sampled in the dam forebay, mid reservoir and in both Mulberry and Locusts Forks of the upper reservoir. Monitoring sites were also established in the Lost Creek, Village Creek, Valley Creek, and Big Yellow Creek embayments.

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 (ADEM 2007), Surface Water Quality Assurance Project Plan (ADEM 2005), and Quality Management Plan (ADEM 2003).

Growing season mean 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 2007 results.

Figure 1. Bankhead Reservoir with 2007 sampling locations. A description of each sampling location is provided in Table 1.

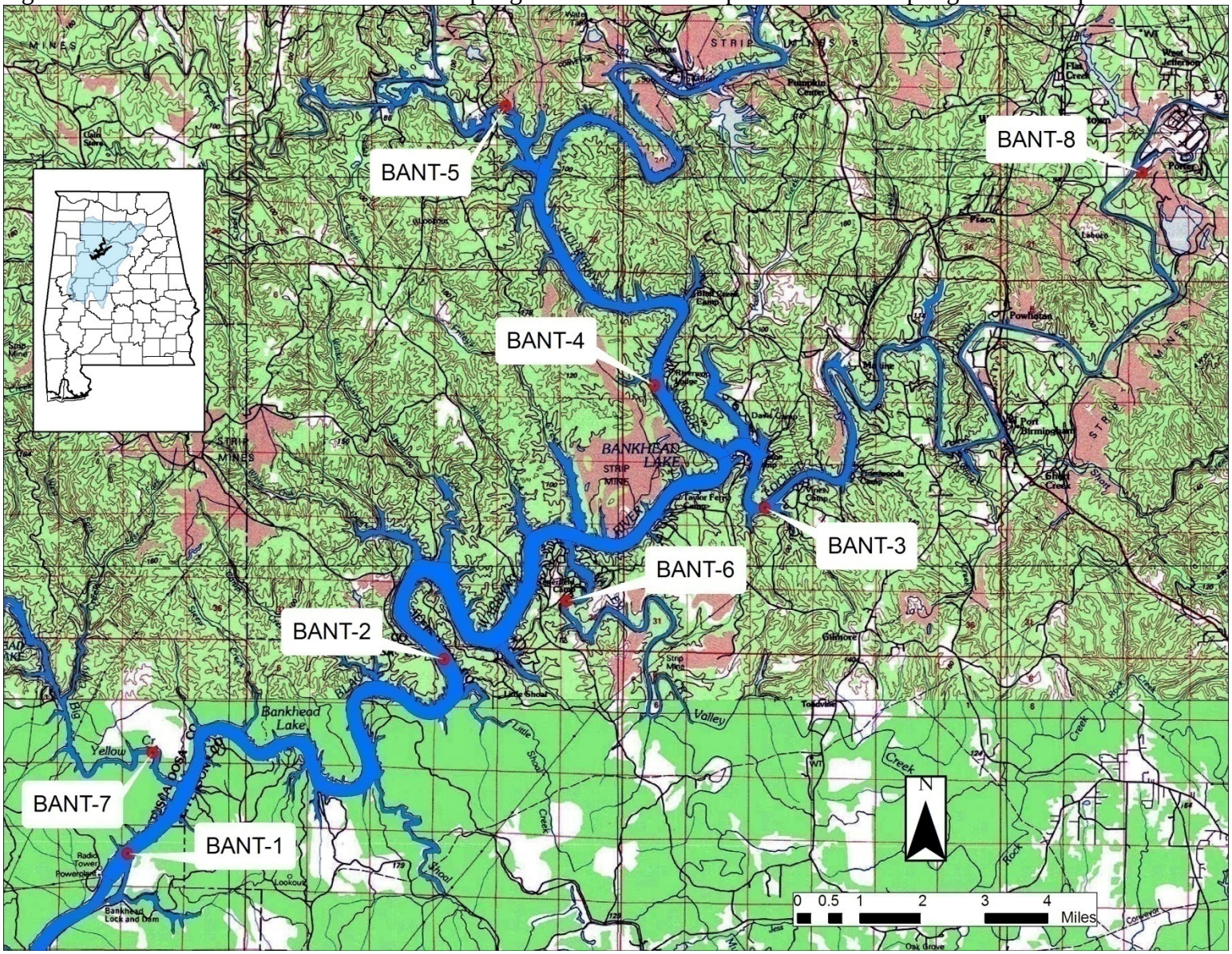


Table 1. Descriptions of the 2007 monitoring stations in Bankhead Reservoir.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria	Latitude	Longitude
Bankhead Reservoir								
031601120203	Tuscaloosa	BANT-1	Lower	Black Warrior R	Deepest point, main river channel, dam forebay.	16 µg/l	33.4642	-87.3511
031601120203	Jefferson	BANT-2	Mid	Black Warrior R	Deepest point, main river channel, mid-reservoir. Approx. 0.5 mi. upstream of Little Shoal Creek confluence.		33.5095	-87.2637
031601110413	Jefferson	BANT-3	Locust Fk	Black Warrior R	Deepest point, main river channel, Locust Fork. Approx. 1.5 mi. upstream of Mulberry, Locust confluence.		33.5448	-87.1750
031601090604	Walker	BANT-4	Mulberry Fk	Black Warrior R	Deepest point, main river channel, Mulberry Fork. Approx. 1.5 mi. upstream of Mulberry, Locust confluence.		33.5732	-87.2055
031601090604	Walker	BANT-5	Lost Ck	Lost Ck	Deepest point, main creek channel, Lost Creek embayment. Approx. 0.5 mi. downstream of Walker Co. Rd. 53 bridge.		33.6380	-87.2470
031601120106	Jefferson	BANT-6	Valley Ck	Valley Ck	Deepest point, main creek channel, Valley Creek embayment. Approx. 1 mile upstream of confluence with Warrior River.		33.5231	-87.2299
031601120202	Tuscaloosa	BANT-7	Big Yellow Ck	Big Yellow Ck	Deepest point, main creek channel, Big Yellow Creek embayment. Approx. 1 mile upstream of confluence with Warrior River.		33.4876	-87.3443
031601110409	Jefferson	BANT-8	Village Ck	Village Ck	Deepest point, main creek channel, Village Creek embayment. Approx. 0.5 mile upstream of confluence with Black Warrior River.		33.6228	-87.0706

*Growing season mean chl *a* criteria implemented at this station in 2004.

RESULTS

According to the National Weather Service's Weather Forecast Office, during 2007 Alabama recorded its driest January through August period in the past 100 years. The drought was intensified by a drier than normal preceding winter and spring. Though difficult to quantify, drought of this magnitude will affect water quality in a number of ways and is a likely factor in many of the results to follow. Stations with the highest concentrations of nutrients, chlorophyll, and TSS are noted in the paragraphs to follow. Though not mentioned in the paragraphs below, review of the graphs that follow will also indicate those stations with lowest concentrations for these parameters. These stations may be potential candidates for reference waterbodies and watersheds.

Summary statistics of all data collected during 2007 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

While the mainstem stations did not exhibit any clear long-term trends, two of the embayment stations, Village and Valley Creeks, show increased seasonal mean TN concentrations in each of the two or three growing seasons sampled (Fig. 2). The highest mainstem seasonal mean TN concentrations were measured in Locust Fk while the highest tributary seasonal mean TN concentrations were measured in the Village Ck embayment. Seasonal mean TN concentrations at all but the Locust Fk, Valley and Village Ck stations were historically low in 2007 (Fig. 2). Monthly TN concentrations were highest in April and below historic means, June-August, at all stations (Fig. 4).

Similar to seasonal mean TN concentration trends, seasonal mean TP concentrations were variable each year sampled in the mainstem stations, but showed an increasing trend at both Village and Valley Ck embayment stations (Fig. 2). The highest mainstem yearly mean TP concentration was observed in Locust Fk (Fig. 2). Monthly TP concentrations varied little across the growing season and were at or below historic means in most months (Fig. 5).

Highest mainstem seasonal mean chl *a* concentration was observed in Locust Fk while the highest tributary seasonal mean was observed in Village Ck (Fig. 3). A specific water quality

criterion for nutrient management has been established on Bankhead at the lower reservoir station. The 2007 mean chl *a* concentration measured at the lower station was in compliance with the criteria limit (Fig. 3). The mid and lower stations reached highest concentrations in July and lowest concentrations in August (Fig. 6). Locust Fk had a similar trend to both mainstem stations, while Mulberry Fk monthly values declined from May-September (Fig. 6).

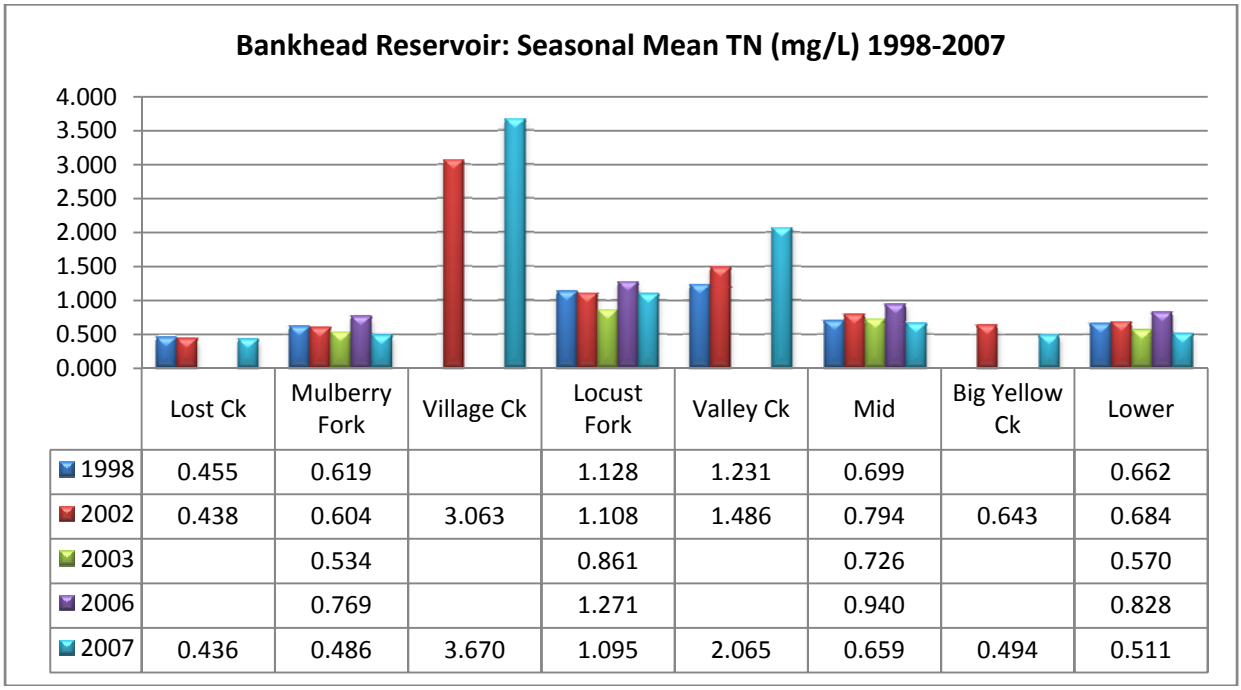
Seasonal mean TSS has been generally decreasing at all mainstem stations since 2002 (Fig. 3). With the exception of Village Ck, the remaining embayments also showed a decrease in seasonal mean TSS in 2007 from the concentrations in 2002 (Fig. 3). Monthly TSS concentrations were variable April-October, independent of discharge (Fig. 7).

While Mulberry Fk has remained phosphorus limited since testing was initiated in 1998, the other three mainstem stations were nitrogen limited conditions during August 2007 (Table 2). Of all the 2007 mean standing crop (MSC) values, only Locust Fk was above 5 mg/L, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems.

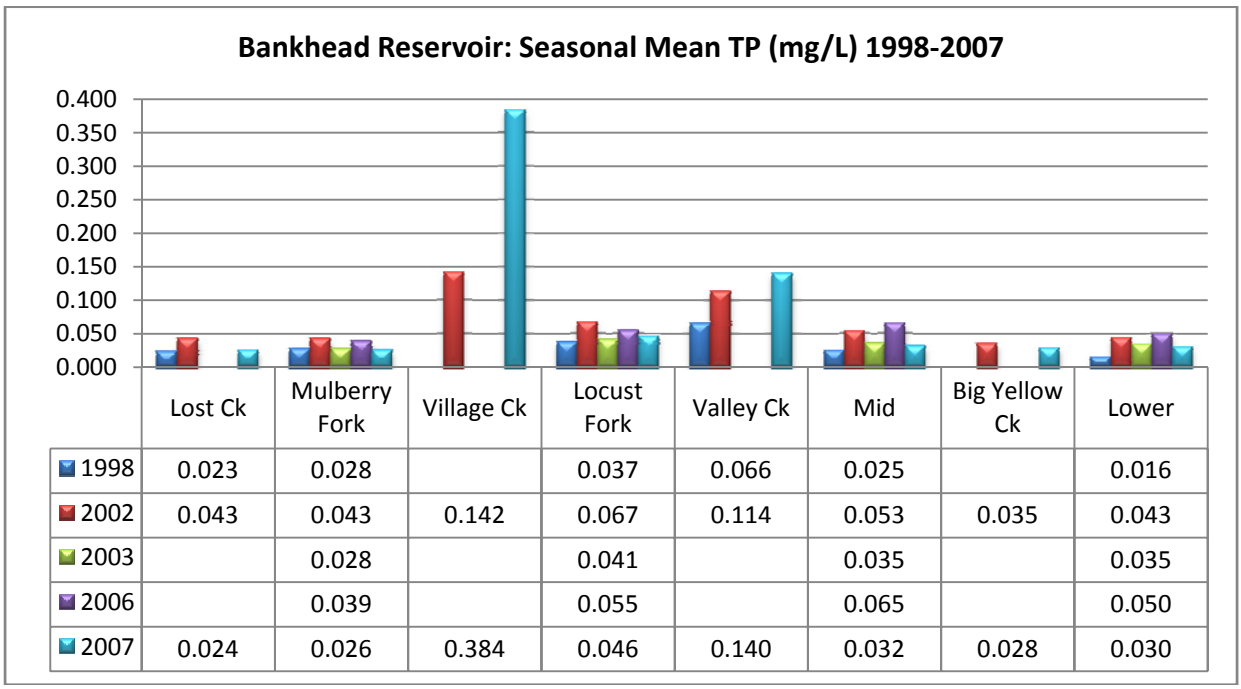
All measurements of dissolved oxygen concentrations in the Mulberry Fk and Locust Fk stations met the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l at 5.0 ft (1.5 m)(Fig. 8). The dissolved oxygen concentrations at the mid station were below ADEM criteria limits in September and just above 5.0 mg/L in Oct (Fig. 8). In October, profiles of dissolved oxygen concentrations at the lower station were <3.0 mg/l from surface to bottom. (Fig. 8 & 9). Profiles of temperature at both the lower and mid stations show highest temperatures were reached in August (Fig. 9 & 10). The lower reservoir showed stratification May-September (Fig. 9). The DO concentration at Big Yellow Ck was below the ADEM criteria limit in October while all other tributaries remained above the ADEM criteria in all months (Fig. 8).

Mean growing season TSI values were calculated using season mean chl *a* concentrations and Carlson's Trophic State Index. TSI values for all mainstem locations indicate the reservoir is eutrophic. Since 2003, annual discharge has decreased each year, while TSI at each mainstem stations increased, from lower eutrophic to mid eutrophic conditions. (Fig. 11)

Figure 2. Growing season mean TN and TP measured in Bankhead Reservoir, April-October 1998-2007. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.

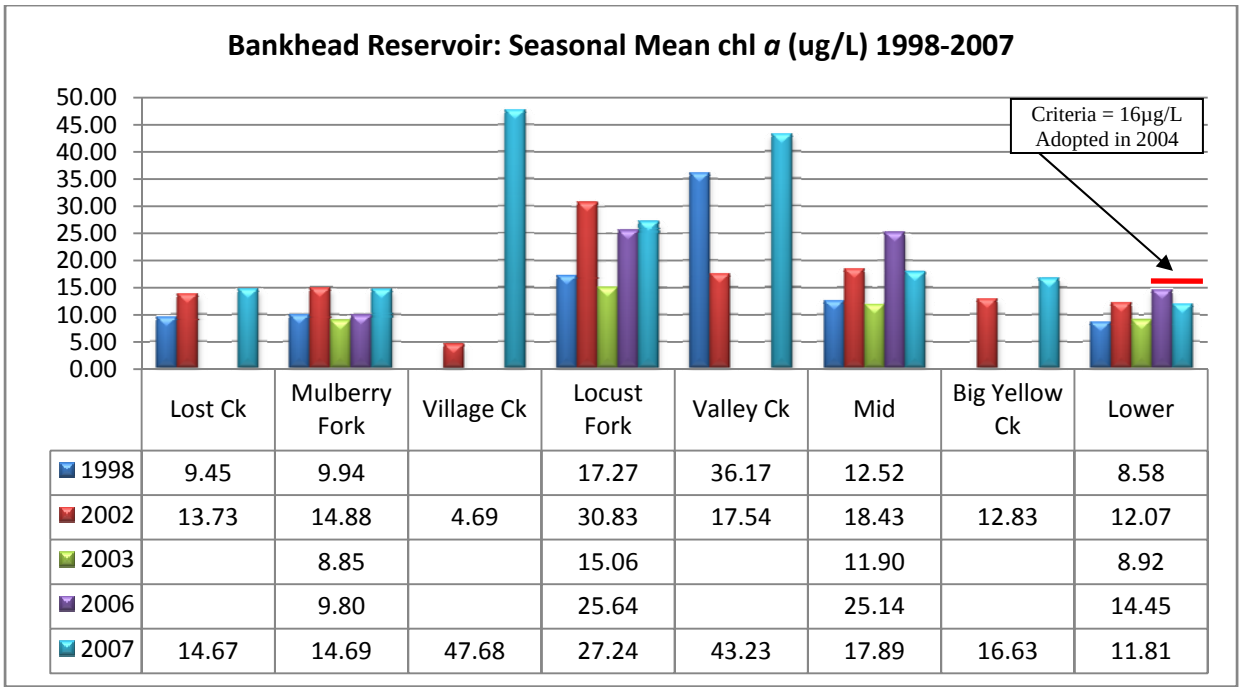


	Lost Ck	Mulberry Fork	Village Ck	Locust Fork	Valley Ck	Mid	Big Yellow Ck	Lower
1998	0.455	0.619		1.128	1.231	0.699		0.662
2002	0.438	0.604	3.063	1.108	1.486	0.794	0.643	0.684
2003		0.534		0.861		0.726		0.570
2006		0.769		1.271		0.940		0.828
2007	0.436	0.486	3.670	1.095	2.065	0.659	0.494	0.511

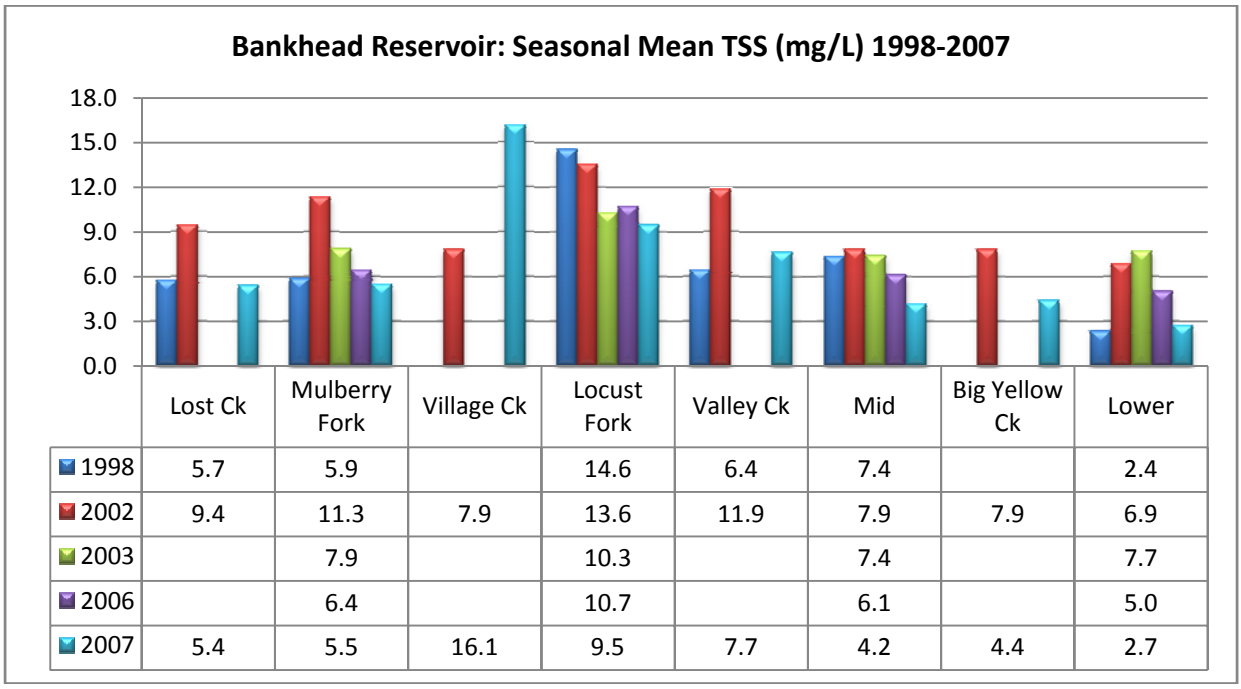


	Lost Ck	Mulberry Fork	Village Ck	Locust Fork	Valley Ck	Mid	Big Yellow Ck	Lower
1998	0.023	0.028		0.037	0.066	0.025		0.016
2002	0.043	0.043	0.142	0.067	0.114	0.053	0.035	0.043
2003		0.028		0.041		0.035		0.035
2006		0.039		0.055		0.065		0.050
2007	0.024	0.026	0.384	0.046	0.140	0.032	0.028	0.030

Figure 3. Growing season mean chl *a* and TSS measured in Bankhead Reservoir, April-October 1998-2007. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criteria applies to the growing season mean of the lower station only.



	Lost Ck	Mulberry Fork	Village Ck	Locust Fork	Valley Ck	Mid	Big Yellow Ck	Lower
1998	9.45	9.94		17.27	36.17	12.52		8.58
2002	13.73	14.88	4.69	30.83	17.54	18.43	12.83	12.07
2003		8.85		15.06		11.90		8.92
2006		9.80		25.64		25.14		14.45
2007	14.67	14.69	47.68	27.24	43.23	17.89	16.63	11.81



	Lost Ck	Mulberry Fork	Village Ck	Locust Fork	Valley Ck	Mid	Big Yellow Ck	Lower
1998	5.7	5.9		14.6	6.4	7.4		2.4
2002	9.4	11.3	7.9	13.6	11.9	7.9	7.9	6.9
2003		7.9		10.3		7.4		7.7
2006		6.4		10.7		6.1		5.0
2007	5.4	5.5	16.1	9.5	7.7	4.2	4.4	2.7

Figure 4. Monthly TN of the mainstem stations in Bankhead Reservoir, April-October 2007. Each bar graph depicts monthly changes in each station. The historic mean (1992-2007) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. TN was plotted vs. the closest discharge (lower and mid stations: USGS 02462500 Black Warrior R at Bankhead L&D near Bessemer AL; Locust Fork: USGS 02456500 Locust Fork at Sayre, AL; Mulberry Fork: USGS 02450180 Mulberry Fork near Arkadelphia, AL).

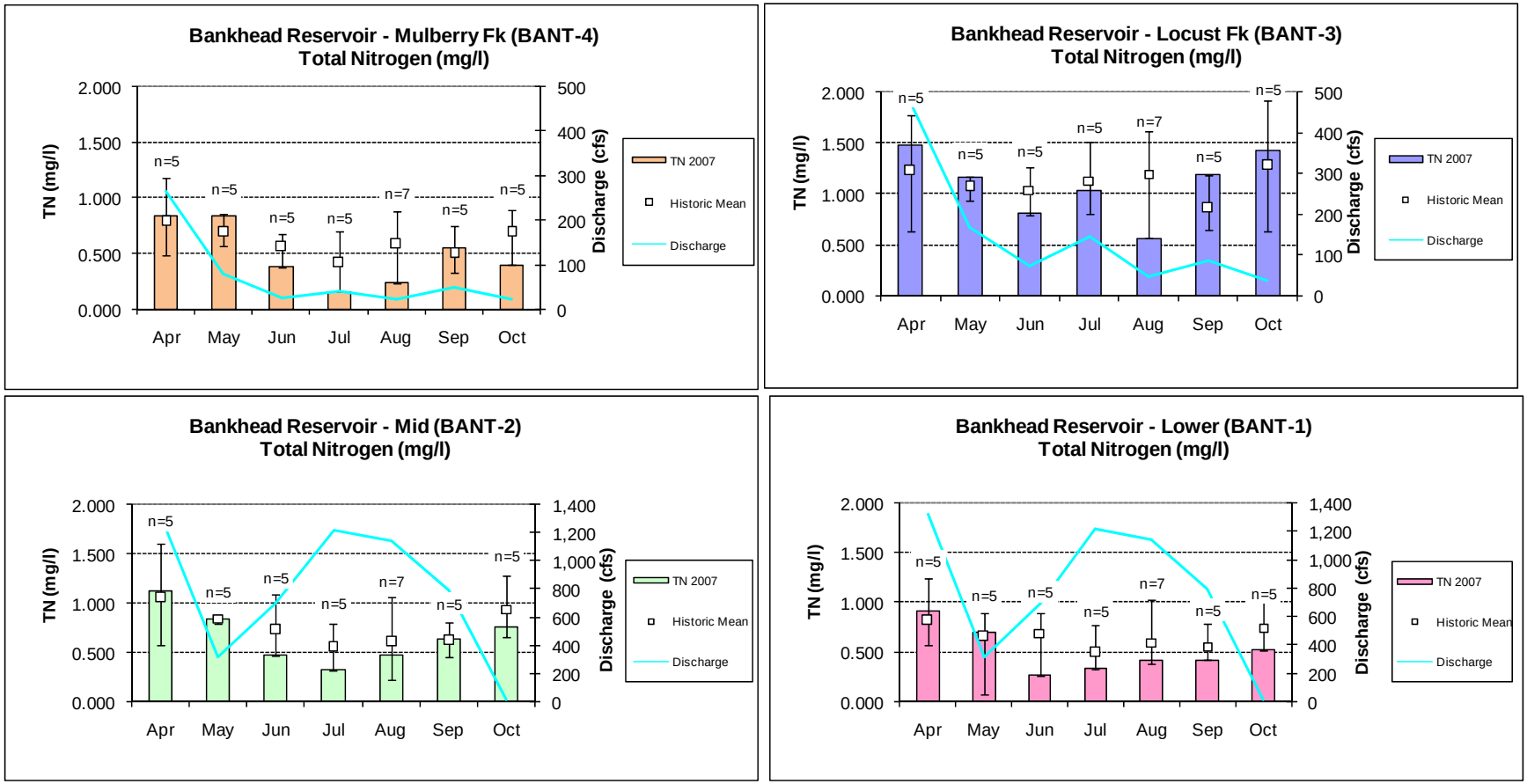


Figure 5. Monthly TP of the mainstem stations in Bankhead Reservoir, April-October 2007. Each bar graph depicts monthly changes in each station. The historic mean (1992-2007) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. TP was plotted vs. the closest discharge (lower and mid stations: USGS 02462500 Black Warrior R at Bankhead L&D near Bessemer AL; Locust Fork: USGS 02456500 Locust Fork at Sayre, AL; Mulberry Fork: USGS 02450180 Mulberry Fork near Arkadelphia, AL).

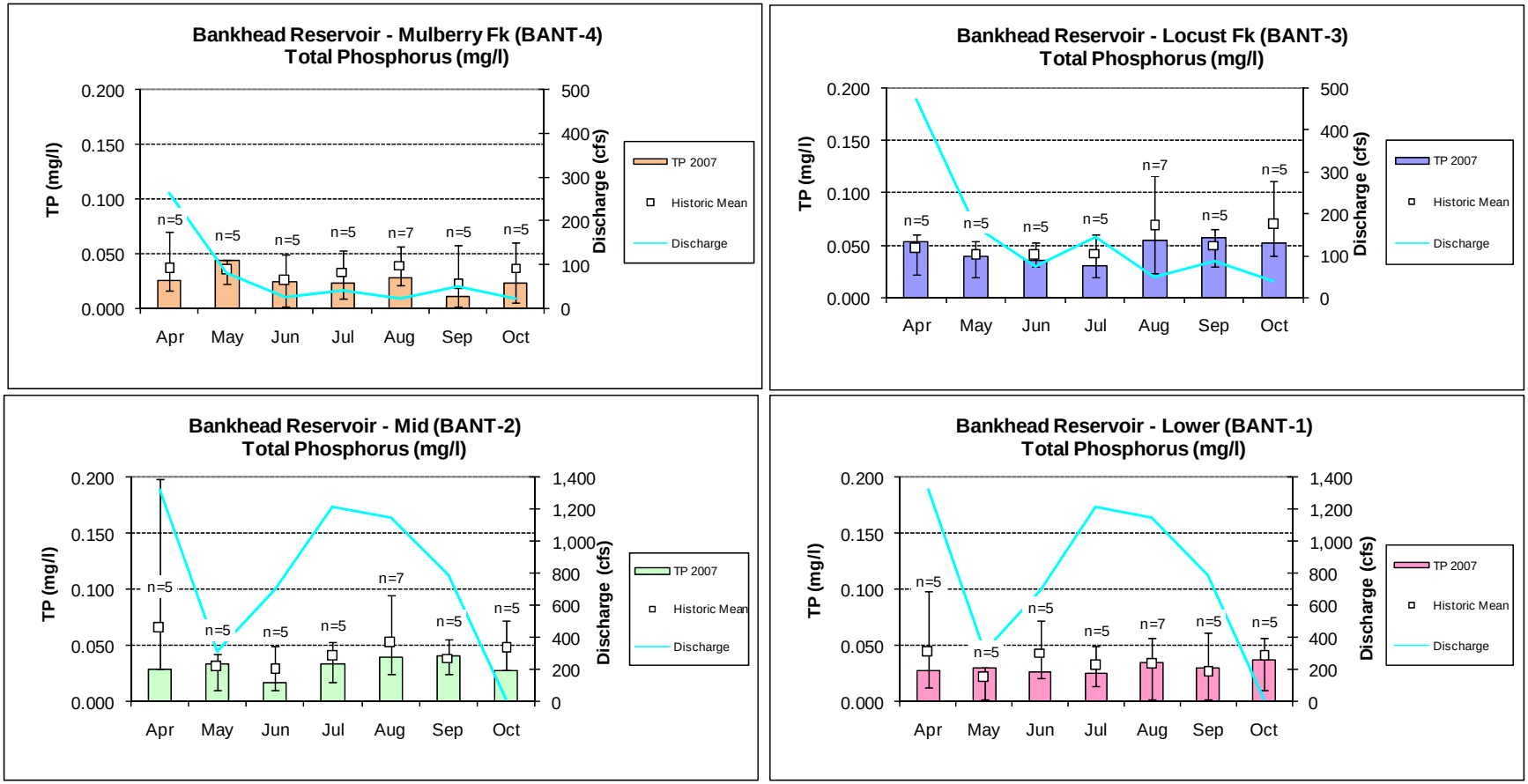


Figure 6. Monthly chl *a* of the mainstem stations in Bankhead Reservoir, April-October 2007. Each bar graph depicts monthly changes in each station. The historic mean (1992-2007) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. Chl *a* was plotted vs. the closest discharge (lower and mid stations: USGS 02462500 Black Warrior R at Bankhead L&D near Bessemer AL; Locust Fork: USGS 02456500 Locust Fork at Sayre, AL; Mulberry Fork: USGS 02450180 Mulberry Fork near Arkadelphia, AL).

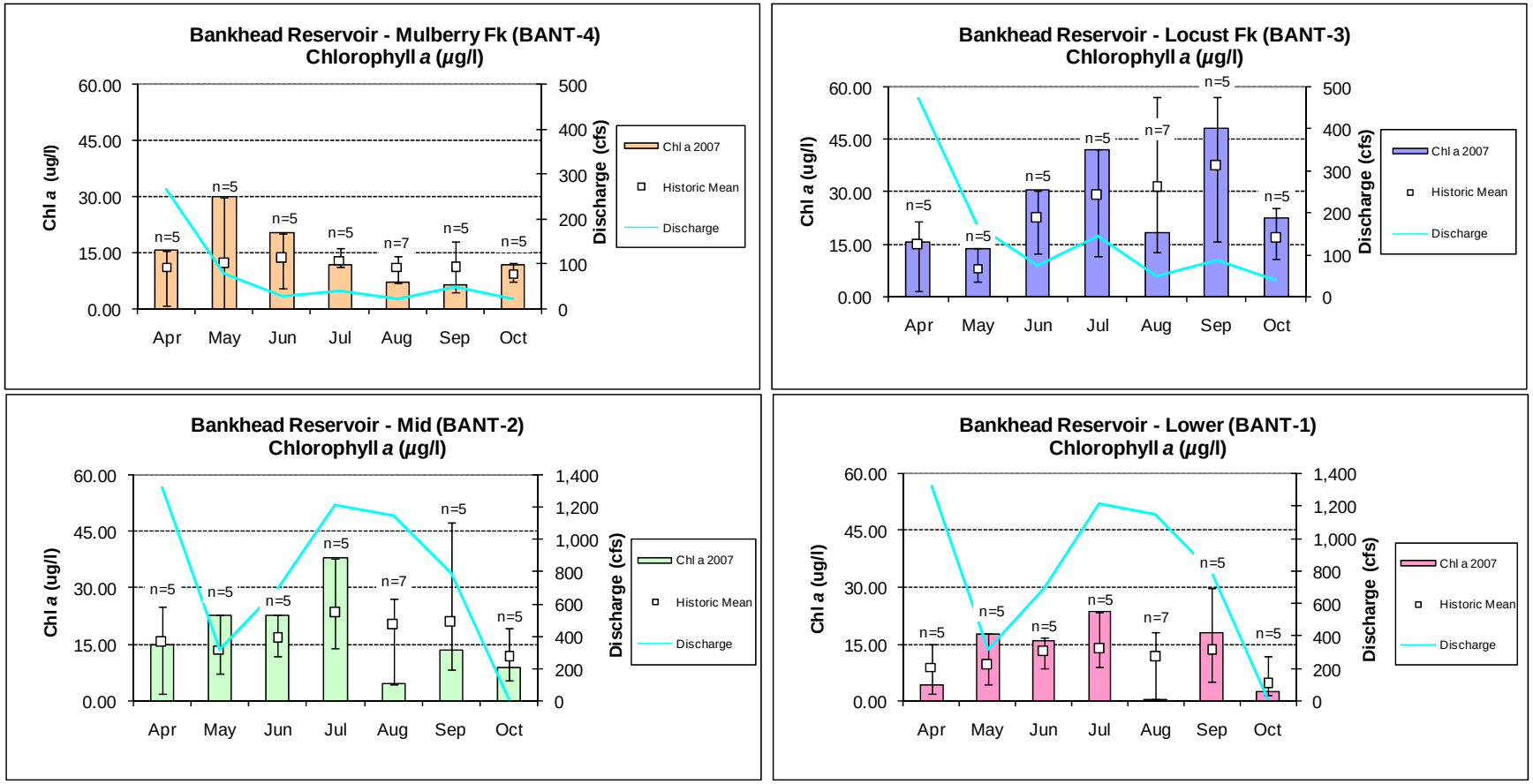


Figure 7. Monthly TSS of the mainstem stations in Bankhead Reservoir, April-October 2007. Each bar graph depicts monthly changes in each station. The historic mean (1992-2007) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. TSS was plotted vs. the closest discharge (lower and mid stations: USGS 02462500 Black Warrior R at Bankhead L&D near Bessemer AL; Locust Fork: USGS 02456500 Locust Fork at Sayre, AL; Mulberry Fork: USGS 02450180 Mulberry Fork near Arkadelphia, AL).

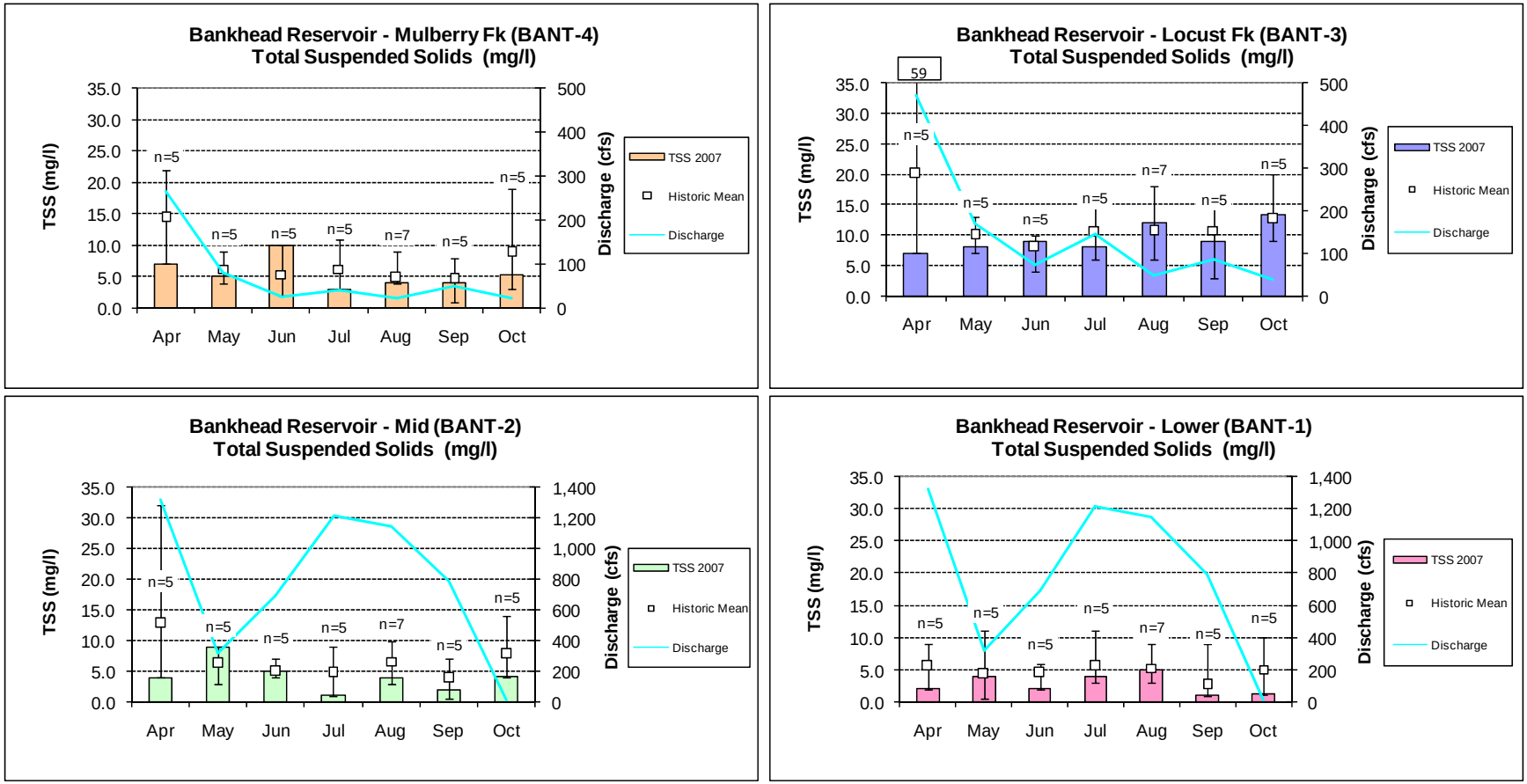
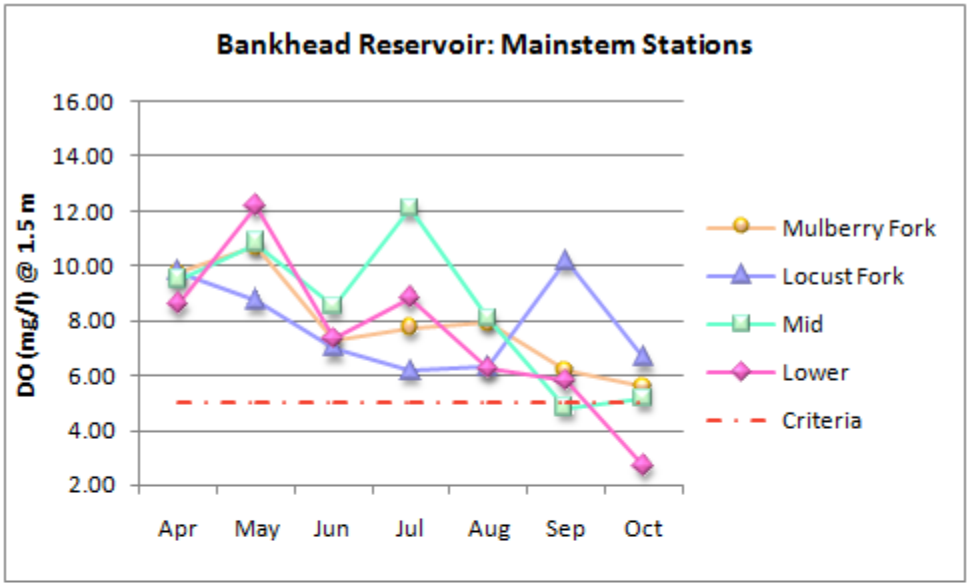


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/l are considered to be protective in reservoirs and lakes; values below 20 mg/l MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

Station	Mulberry Fork		Locust Fork		Mid		Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
August 1998	2.31	Phosphorus	24.74	Phosphorus	4.52	Phosphorus	2.65	Phosphorus
August 2002	6.95	Phosphorus	15.91	Phosphorus	9.61	Co-limiting	3.56	Co-limiting
June 2007	2.05	Phosphorus	2.34	Phosphorus	2.11	Phosphorus	2.23	Phosphorus
July 2007	2.91	Phosphorus	3.44	Phosphorus	3.42	Nitrogen	2.29	Nitrogen
August 2007	2.91	Phosphorus	9.53	Nitrogen	2.41	Nitrogen	2.40	Nitrogen

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Bankhead Reservoir stations collected April-October 2007. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2005). In tributaries, when total depth was less than 3 m, criteria applies to the mid-depth reading.



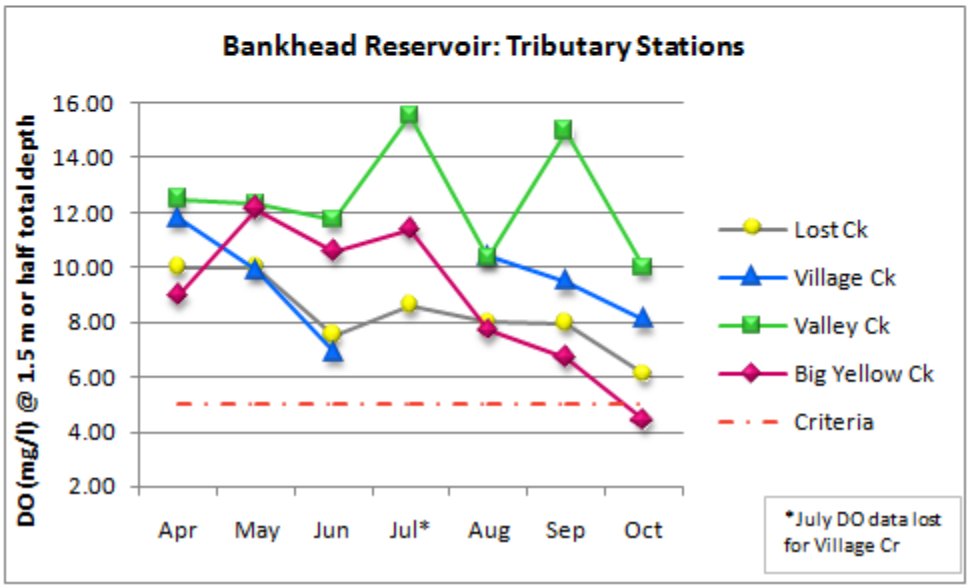


Figure 9. Monthly depth profiles of dissolved oxygen, temperature and conductivity in lower Bankhead Reservoir, April-October 2007.

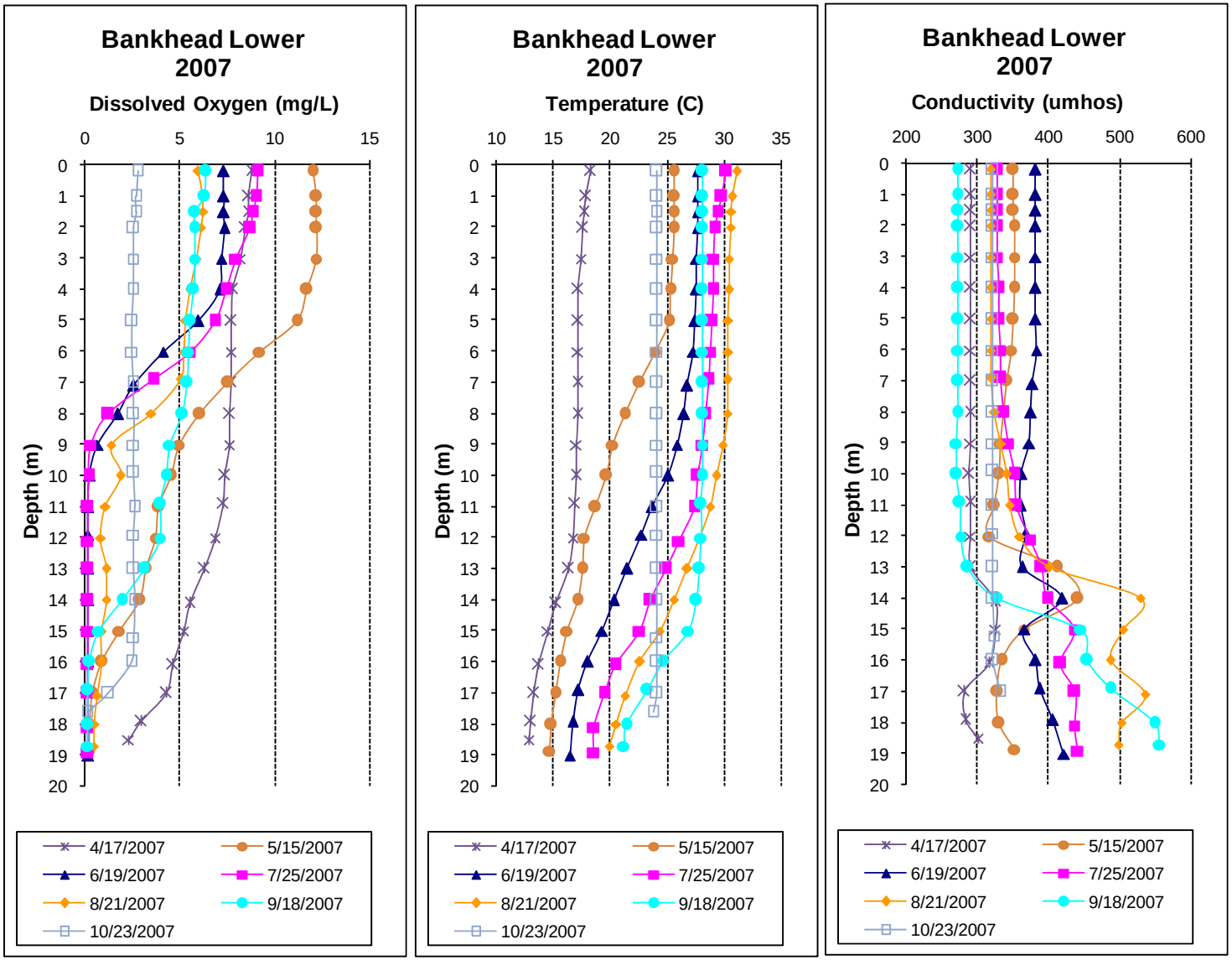


Figure 10. Monthly depth profiles of dissolved oxygen, temperature and conductivity in mid Bankhead Reservoir, April-October 2007.

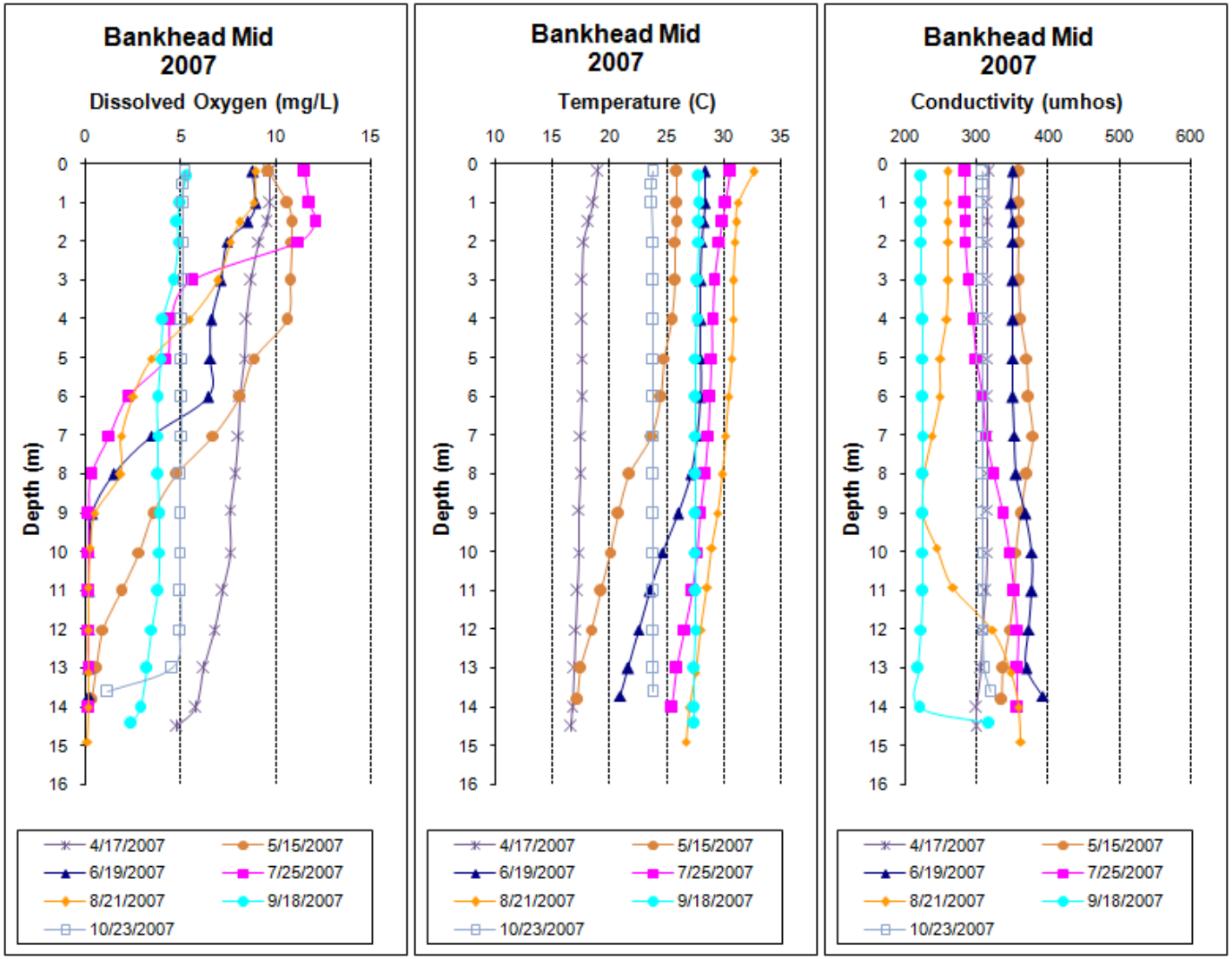
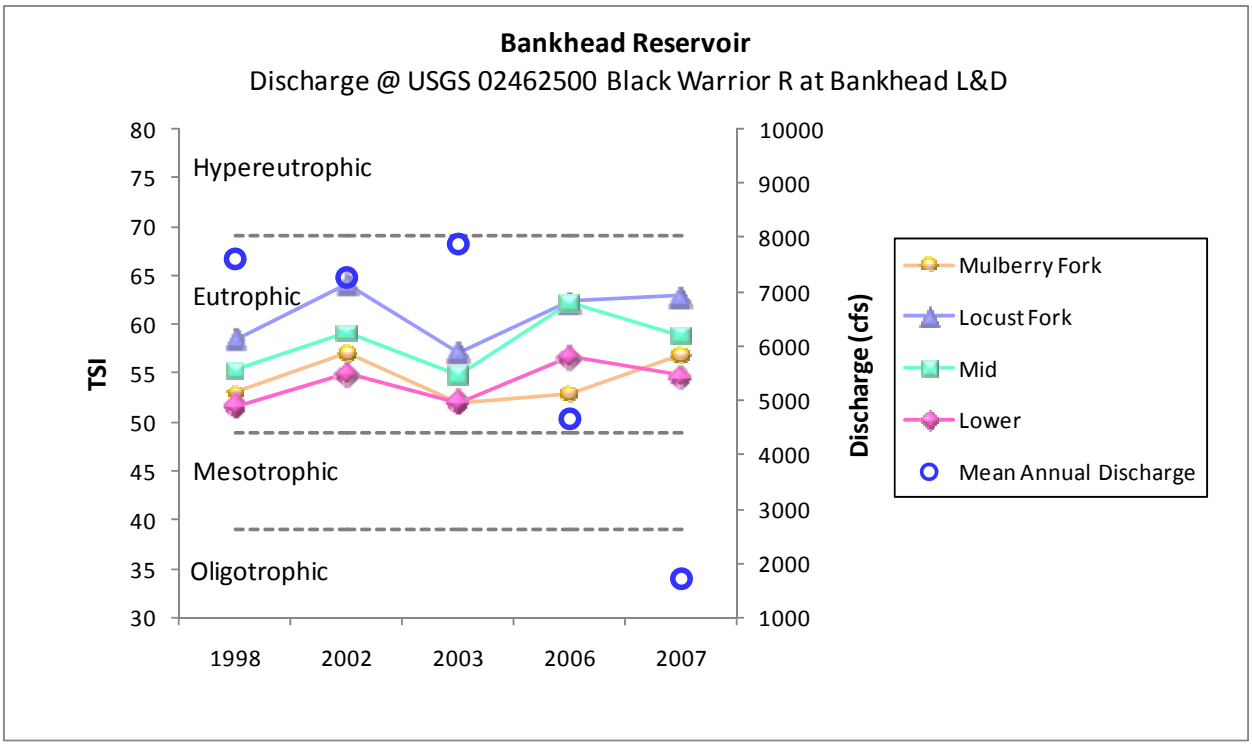


Figure 11. Mean growing season TSI values for mainstem stations using chl *a* concentrations and Carlson's Trophic State Index calculation.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2007. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Med	Mean	SD
BANT-1	**Physical**						
	Turbidity (NTU)	7	2.0	2.8	2.3	2.3	0.3
	Total Dissolved Solids (mg/L)	7	120.0	221.0	176.0	175.1	38.5
	Total Suspended Solids (mg/L)	7	1.0	5.0	2.0	2.7	1.6
	Hardness (mg/L)	4	50.3	96.0	62.7	67.9	19.9
	Alkalinity (mg/L)	7	61.7	89.3	71.7	73.9	9.2
	Photic Zone (m)	7	3.60	6.05	5.38	5.29	0.85
	Secchi (m)	7	1.28	2.03	1.56	1.59	0.25
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.049	0.008	0.013	0.016
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.003	0.523	0.080	0.176	0.201
	Total Kjeldahl Nitrogen (mg/L)	7	0.184	0.440	0.392	0.335	0.107
	Total Nitrogen (mg/L)[J]	7	< 0.264	0.919	0.420	0.511	0.228
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.027	0.008	0.010	0.008
	Total Phosphorus (mg/L)	7	0.025	0.037	0.030	0.030	0.004
	CBOD-5 (mg/L)	7	< 1.0	2.6	1.9	1.7	0.8
	Chlorides (mg/L)[J]	7	9.9	45.3	11.8	17.3	12.7
	Biological						
	Chlorophyll a (ug/L)[J]	7	0.53	23.50	16.02	11.81	9.08
	Fecal Coliform (col/100 mL)[J]	1				< 1	
BANT-2	**Physical**						
	Turbidity (NTU)	7	2.6	3.9	3.5	3.4	0.4
	Total Dissolved Solids (mg/L)	7	115.0	211.0	182.0	173.4	38.0
	Total Suspended Solids (mg/L)	7	1.0	9.0	4.0	4.2	2.5
	Hardness (mg/L)	4	44.2	113.0	78.3	78.4	30.4
	Alkalinity (mg/L)	7	48.1	83.6	65.6	67.1	12.1
	Photic Zone (m)	7	3.42	4.91	4.39	4.20	0.58
	Secchi (m)	7	0.97	1.55	1.21	1.28	0.21
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.065	0.008	0.016	0.022
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.610	0.228	0.229	0.218
	Total Kjeldahl Nitrogen (mg/L)	7	0.299	0.522	0.406	0.429	0.078
	Total Nitrogen (mg/L)	7	< 0.319	1.122	0.634	0.659	0.272
	Dissolved Reactive Phosphorus (mg/L)[J]	7	0.005	0.015	0.008	0.009	0.003
	Total Phosphorus (mg/L)	7	0.017	0.041	0.033	0.032	0.008
	CBOD-5 (mg/L)	7	< 1.0	3.4	2.0	1.8	1.3
	Chlorides (mg/L)[J]	7	7.9	52.9	8.9	15.5	16.6
	Biological						
	Chlorophyll a (ug/L)[J]	7	4.63	37.91	14.95	17.89	11.08
	Fecal Coliform (col/100 mL)[J]	1				< 1	

Station	Parameter	N	Min	Max	Med	Mean	SD
BANT-3	**Physical**						
	Turbidity (NTU)	7	5.9	10.3	7.7	7.7	1.6
	Total Dissolved Solids (mg/L)	7	200.0	364.0	300.0	280.4	64.1
	Total Suspended Solids (mg/L)	7	7.0	13.4	9.0	9.5	2.3
	Hardness (mg/L)	4	89.8	189.0	116.0	127.7	44.0
	Alkalinity (mg/L)	7	70.3	115.2	103.9	97.5	18.5
	Photic Zone (m)	7	2.11	3.05	2.41	2.49	0.37
	Secchi (m)	7	0.67	1.21	0.83	0.89	0.19
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.061	0.020	0.026	0.021
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.053	0.919	0.515	0.433	0.304
	Total Kjeldahl Nitrogen (mg/L)	7	0.513	0.906	0.657	0.661	0.133
	Total Nitrogen (mg/L)	7	0.566	1.480	1.168	1.095	0.325
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.004	0.016	0.009	0.010	0.005
	Total Phosphorus (mg/L)	7	0.030	0.057	0.052	0.046	0.011
	CBOD-5 (mg/L)	7	< 1.0	2.7	2.0	1.7	1.0
	Chlorides (mg/L) [J]	7	7.9	55.9	17.1	21.5	15.9
	Biological						
	Chlorophyll a (ug/L) [J]	7	13.88	48.06	22.43	27.24	13.47
	Fecal Coliform (col/100 mL) [J]	1				3	
BANT-4	**Physical**						
	Turbidity (NTU)	7	3.0	5.9	4.8	4.5	1.0
	Total Dissolved Solids (mg/L)	7	76.0	213.0	118.0	132.0	57.8
	Total Suspended Solids (mg/L)	7	3.0	10.0	5.0	5.5	2.4
	Hardness (mg/L)	4	20.3	115.0	67.9	67.8	45.6
	Alkalinity (mg/L)	7	27.3	75.4	51.5	51.7	19.4
	Photic Zone (m)	7	3.03	5.23	3.91	3.87	0.73
	Secchi (m)	7	0.95	1.63	1.22	1.23	0.25
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.032	0.008	0.014	0.011
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.076	0.499	0.140	0.209	0.156
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.496	0.240	0.277	0.150
	Total Nitrogen (mg/L)	7	< 0.161	0.837	0.402	0.486	0.270
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.004	0.010	0.008	0.008	0.002
	Total Phosphorus (mg/L) [J]	7	0.011	0.044	0.025	0.026	0.010
	CBOD-5 (mg/L)	7	< 1.0	4.9	1.6	1.8	1.6
	Chlorides (mg/L) [J]	7	3.9	58.6	5.4	13.2	20.1
	Biological						
	Chlorophyll a (ug/L) [J]	7	6.41	29.90	11.75	14.69	8.24
	Fecal Coliform (col/100 mL) [J]	1				< 1	

Station	Parameter	N	Min	Max	Med	Mean	SD
BANT-5	**Physical**						
	Turbidity (NTU)	7	3.6	5.9	4.2	4.4	0.8
	Total Dissolved Solids (mg/L)	7	104.0	283.0	144.0	164.9	60.1
	Total Suspended Solids (mg/L)	7	< 1.0	12.0	4.0	5.4	3.6
	Hardness (mg/L)	4	27.4	154.0	58.8	74.8	59.9
	Alkalinity (mg/L)	7	41.2	104.2	58.9	63.3	21.3
	Photic Zone (m)	7	3.04	4.12	3.82	3.70	0.35
	Secchi (m)	7	0.95	1.43	1.27	1.22	0.18
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	0.000
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.301	0.057	0.114	0.114
	Total Kjeldahl Nitrogen (mg/L)	7	0.199	0.445	0.332	0.322	0.088
	Total Nitrogen (mg/L)	7	< 0.221	0.675	0.467	0.436	0.181
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.004	0.009	0.007	0.006	0.003
	Total Phosphorus (mg/L) [J]	7	0.016	0.035	0.025	0.024	0.007
	CBOD-5 (mg/L)	7	< 1.0	4.2	0.5	1.5	1.4
	Chlorides (mg/L) [J]	7	3.0	89.6	4.1	16.6	32.2
	Biological						
	Chlorophyll a (ug/L) [J]	7	7.12	24.23	13.53	14.67	5.62
	Fecal Coliform (col/100 mL) [J]	1				59	
BANT-6	**Physical**						
	Turbidity (NTU)	7	3.7	6.6	4.5	4.8	1.1
	Total Dissolved Solids (mg/L)	7	166.0	335.0	275.0	265.4	55.8
	Total Suspended Solids (mg/L)	7	4.6	11.0	8.0	7.7	2.5
	Hardness (mg/L)	4	70.5	140.0	108.5	106.9	38.3
	Alkalinity (mg/L)	7	69.1	123.6	101.3	100.0	17.8
	Photic Zone (m)	7	1.48	3.75	2.88	2.86	0.79
	Secchi (m)	7	0.48	1.22	0.93	0.93	0.26
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.065	0.008	0.020	0.023
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.560	2.670	0.938	1.276	0.770
	Total Kjeldahl Nitrogen (mg/L)	7	0.451	1.329	0.768	0.788	0.293
	Total Nitrogen (mg/L)	7	1.390	3.999	1.862	2.065	0.927
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.029	0.181	0.064	0.086	0.053
	Total Phosphorus (mg/L)	7	0.065	0.214	0.137	0.140	0.051
	CBOD-5 (mg/L)	7	< 1.0	4.6	2.4	2.1	1.6
	Chlorides (mg/L) [J]	7	12.0	69.7	20.6	27.2	19.3
	Biological						
	Chlorophyll a (ug/L) [J]	7	14.42	101.46	26.70	43.23	30.97
	Fecal Coliform (col/100 mL) [J]	1				< 1	

Station	Parameter	N	Min	Max	Med	Mean	SD
BANT-7	**Physical**						
	Turbidity (NTU)	7	1.9	3.4	2.4	2.5	0.5
	Total Dissolved Solids (mg/L)	7	128.0	239.0	160.0	184.3	44.8
	Total Suspended Solids (mg/L)	7	2.0	6.0	4.0	4.4	1.6
	Hardness (mg/L)	4	50.5	88.0	73.8	71.5	16.6
	Alkalinity (mg/L)	7	55.5	89.8	72.3	72.6	10.9
	Photic Zone (m)	7	4.67	5.89	5.63	5.36	0.52
	Secchi (m)	7	1.17	2.05	1.51	1.57	0.34
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	0.000
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.002	0.430	0.037	0.140	0.172
	Total Kjeldahl Nitrogen (mg/L)	7	0.197	0.437	0.381	0.355	0.078
	Total Nitrogen (mg/L)	7	< 0.198	0.817	0.418	0.494	0.213
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.004	0.017	0.008	0.008	0.005
	Total Phosphorus (mg/L) [J]	7	0.024	0.034	0.028	0.028	0.003
	CBOD-5 (mg/L)	7	< 1.0	3.1	1.0	1.6	1.2
	Chlorides (mg/L) [J]	7	7.0	16.2	11.3	11.3	2.6
	Biological						
	Chlorophyll a (ug/L) [J]	7	0.27	39.52	18.51	16.63	12.95
	Fecal Coliform (col/100 mL) [J]	1				< 1	
BANT-8	**Physical**						
	Turbidity (NTU)	7	5.1	31.6	6.5	10.6	9.5
	Total Dissolved Solids (mg/L)	7	76.2	419.0	300.0	286.7	118.9
	Total Suspended Solids (mg/L)	7	5.0	39.0	14.0	16.1	11.1
	Hardness (mg/L)	3	158.0	330.0	176.0	221.3	94.5
	Alkalinity (mg/L)	7	87.1	144.9	116.4	116.9	24.0
	Photic Zone (m)	7	0.84	1.82	1.40	1.33	0.39
	Secchi (m)	7	0.40	1.34	0.75	0.73	0.32
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	0.000
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	1.010	2.987	2.220	2.208	0.760
	Total Kjeldahl Nitrogen (mg/L)	7	0.764	2.582	1.291	1.462	0.674
	Total Nitrogen (mg/L) [J]	7	2.244	5.542	3.331	3.670	1.201
	Dissolved Reactive Phosphorus (mg/L)	7	0.155	0.416	0.312	0.284	0.090
	Total Phosphorus (mg/L)	7	0.227	0.519	0.395	0.384	0.088
	CBOD-5 (mg/L)	7	< 1.0	2.9	0.5	1.3	1.0
	Chlorides (mg/L) [J]	7	13.9	23.7	19.1	19.2	3.9
	Biological						
	Chlorophyll a (ug/L) [J]	7	13.88	124.96	38.45	47.68	37.27
	Fecal Coliform (col/100 mL)	1				54	

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