2011 Aliceville Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
May 2014

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Upper Tombigbee River Basin

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Table of Contents

LIST OF ACRONYMS

A&I	Agricultural and Industrial Water Supply Use Classification
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
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

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

With the completion of the Tom Bevill Dam in 1980, Aliceville Reservoir joined the Tennessee-Tombigbee Waterway (Tenn-Tom) system that connects the Tennessee River with the Tombigbee River. Located in Pickens County, Aliceville Reservoir is the first Alabama reservoir on the Tenn-Tom system. The 234-mile waterway flows south from Pickwick Lake on the Tennessee River, down through northeast Mississippi and west Alabama to connect with the established Warrior-Tombigbee navigation system at Demopolis, Alabama. After 12 years of construction, the waterway opened to commercial traffic in January 1985.

The Alabama Department of Environmental Management (ADEM) monitored Aliceville Reservoir as part of the 2011 assessment of the Escatawpa, Mobile, and Tombigbee River basins under the Rivers and Reservoirs Monitoring Program (RRMP). ADEM began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program (now known as RRMP) was initiated by ADEM. The current 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 (ADEM 2012).

Aliceville Reservoir was placed on Alabama's 1996 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its Swimming (S)/Fish & Wildlife (F&W) water use classifications. The reservoir was listed for impairments caused by organic enrichment/dissolved oxygen (OE/DO). A total maximum daily load (TMDL), developed to address this impairment, was approved by the US EPA in 2008.

The purpose of this report is to summarize data collected at three stations in Aliceville Reservoir during the 2011 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. 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 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. Aliceville Reservoir was sampled in the dam forebay, the upper reservoir just upstream of the Lindsey Creek confluence near the state line, and in the Coal Fire Creek embayment.

Water quality assessments were conducted at monthly intervals, May-October. Assessments scheduled in April were postponed due to devastating tornadoes that affected most of the basin, resulting in two water quality assessments conducted in May. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2011), Surface Water Quality Assurance Project Plan (ADEM 2008a), and Quality Management Plan (ADEM 2008b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Monthly concentrations of these parameters were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2011 results.

Figure 1. Aliceville Reservoir with 2011 sampling locations. A description of each sampling location is provided in Table 1.

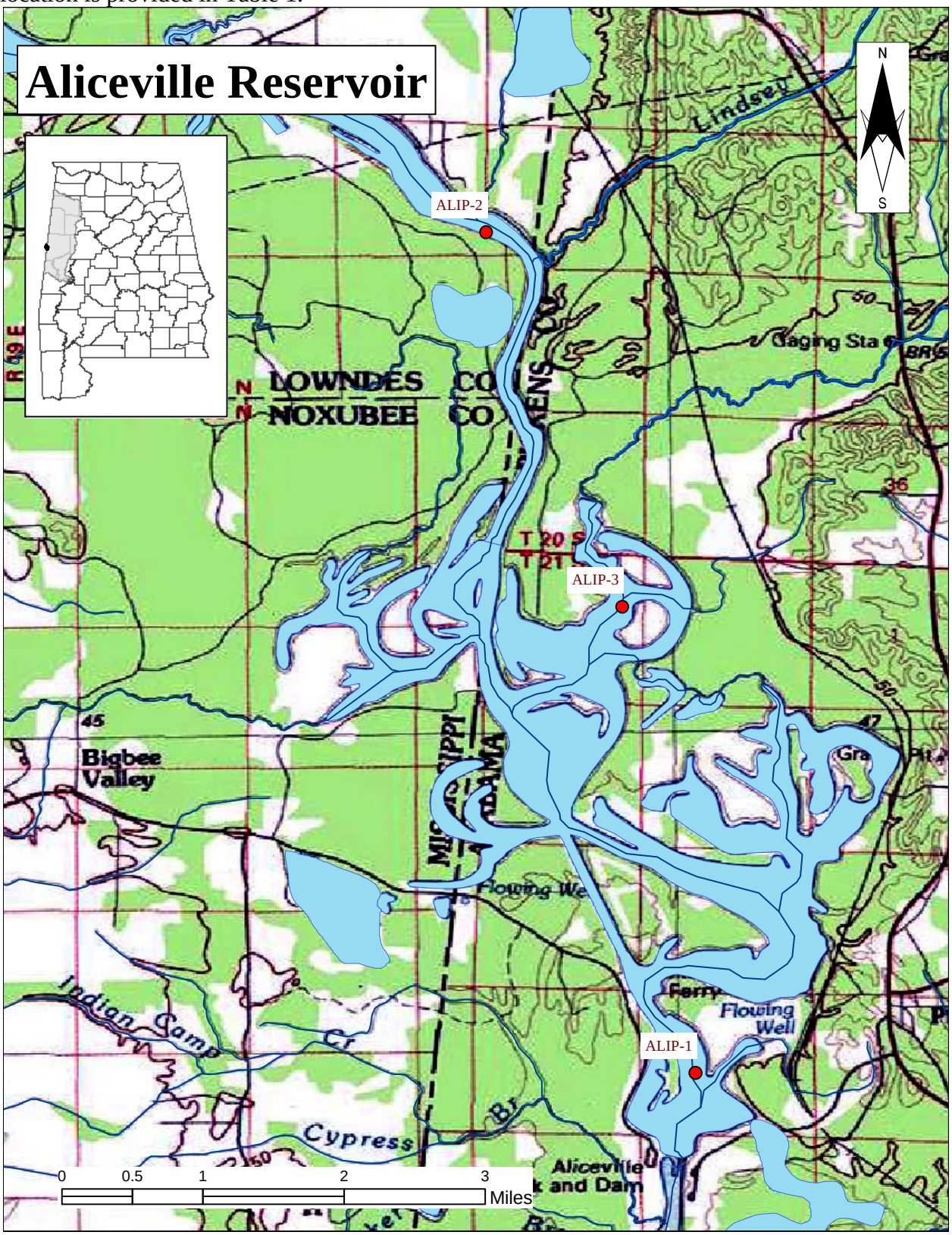


Table 1. Descriptions of the 2011 monitoring stations in Aliceville Reservoir.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criterion	Latitude	Longitude
Aliceville Reservoir								
031501050502	Pickens	**ALIP-1	Lower	Tombigbee R	Deepest point, main river channel, dam forebay.	18 µg/L	33.2191	-88.2861
031501050308	Pickens	ALIP-2	Upper	Tombigbee R	Deepest point, main river channel, immediately upstream of Lindsey Branch confluence.		33.3030	-88.3029
031501050203	Pickens	ALIP-3	Coal Fire	Coal Fire Ck	Deepest point, main creek channel, Coal Fire Creek embayment, approximately one mile upstream of confluence with Tombigbee River.		33.2669	-88.2936

** Growing season mean Chl a criterion implemented at this station in 2008

RESULTS

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figs. 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, DO and TSI are also provided (Figs. 4-8 and 11). Mean monthly discharge is included in monthly graphs for TN, TP, chl *a*, TSS and TSI as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, DO and conductivity appear in Figures 9 and 10. Summary statistics of all data collected during 2011 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean and standard deviation of each parameter analyzed.

Stations with the highest concentrations of nutrients, chlorophyll *a* and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs included in this report will indicate stations that may be potential candidates for reference waterbodies and watersheds.

In 2011, the highest mean growing season TN value was calculated for the upper station (Fig. 2). Mean growing season TN concentrations in 2011 and previous years were lower in the Coal Fire Creek embayment compared to both mainstem stations. Mean TN concentrations have generally increased at each station from 2001 through 2011. Highest monthly TN concentrations were measured in June at each station, with the upper station being the highest (Fig. 4). Monthly TN concentrations were near or above historic mean values a majority of the 2011 growing season at each station. Historic high TN concentrations were measured in the upper station in June and July, and in Coal Fire Creek, May and June. A historic high monthly TN concentration was also measured at the lower station in July. A historic low TN concentration was measured at the Coal Fire Ck station in October.

In 2011, the highest mean growing season TP value was calculated for the upper station, however values were similar to the lower station (Fig. 2). Although some variations in mean TP values were observed, concentrations have generally decreased 2001-2011. The highest monthly TP concentration was measured in the lower station during the second sampling event in May (Fig. 5). Monthly TP concentrations were below historic means the entire growing season at the

lower and Coal Fire Ck stations, while the upper station was above the historic mean in June only. Historic low monthly concentrations were measured during September in the lower station and during August and October in the upper station. Historic lows were also measured at the Coal Fire Ck station in June, September, and October.

In 2011, the highest growing season mean chl *a* was calculated for the upper station (Fig. 3). All three stations showed an increase in mean chl *a* concentrations from 2009-2011. The growing season mean chl *a* value calculated in the lower station during 2011 was in compliance with the established criterion limit (18µg/L). The highest monthly chl *a* concentration was measured in the upper station during October, which was also a historic high (Fig. 6). Monthly chl *a* concentrations in the upper and lower stations were near or above historic means most months.

In 2011, the highest mean growing season TSS value was calculated for the lower station (Fig. 3). Growing season mean TSS concentrations generally decreased 2003-2011 at all three stations. Monthly TSS concentrations were below historic means at all stations May-September (Fig. 7). Historic low concentrations were measured in May and September at each station.

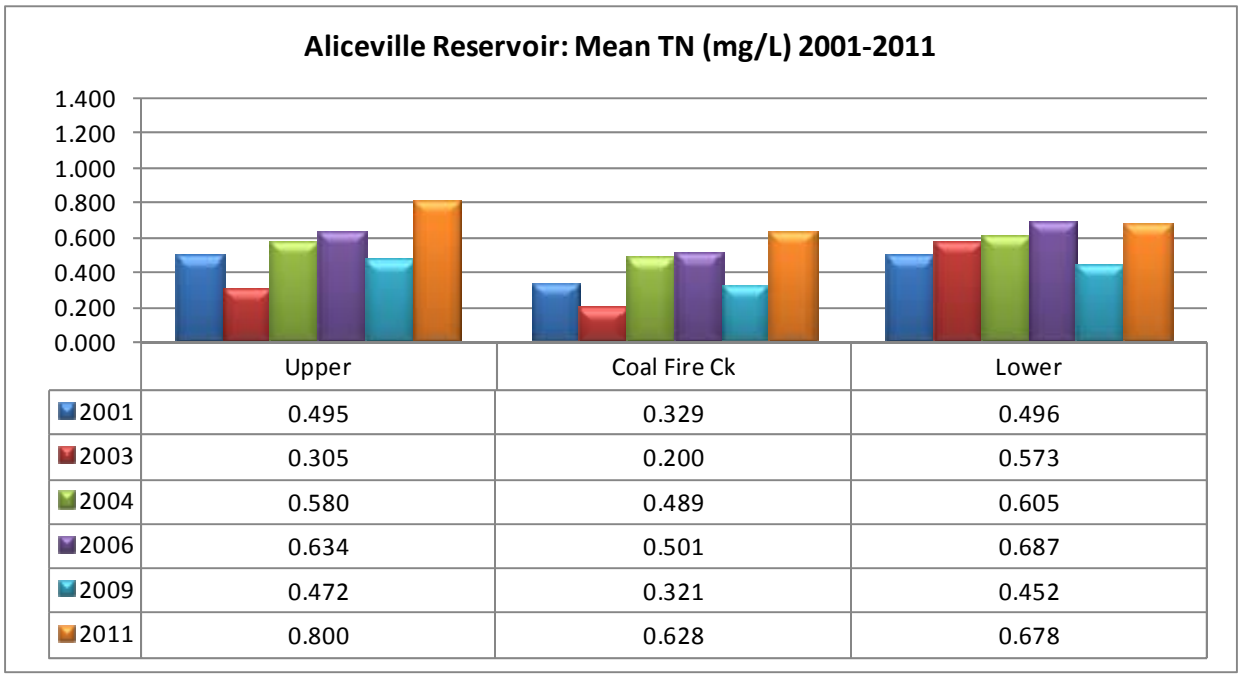
In 2011, AGPT results indicated the entire reservoir was nitrogen limited at both mainstem stations, which was similar to results obtained 2001 and 2006 (Table 2). The MSC value at the lower station was 9.95 mg/L, which is above 5 mg/L, the value defined as protective of reservoir and lake systems (Raschke and Schultz 1987). The mean MSC value at the upper station was above 20 mg/L, the value that Raschke et al. (1996) defined as protective of river systems. MSC values were over five times higher at the upper station and two times higher at the lower station compared to the previous assessment.

Dissolved oxygen (DO) concentration was below the ADEM Criterion (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) at the Coal Fire Ck station in July (Fig. 8). All other measurements of DO concentrations in the mainstem stations met the criterion limit, though the lower station was near the limit in July and August. Profiles of DO concentrations at the lower station indicate the water column was slightly stratified during the warmest months, June-August, while the upper station was generally mixed most months (Fig.

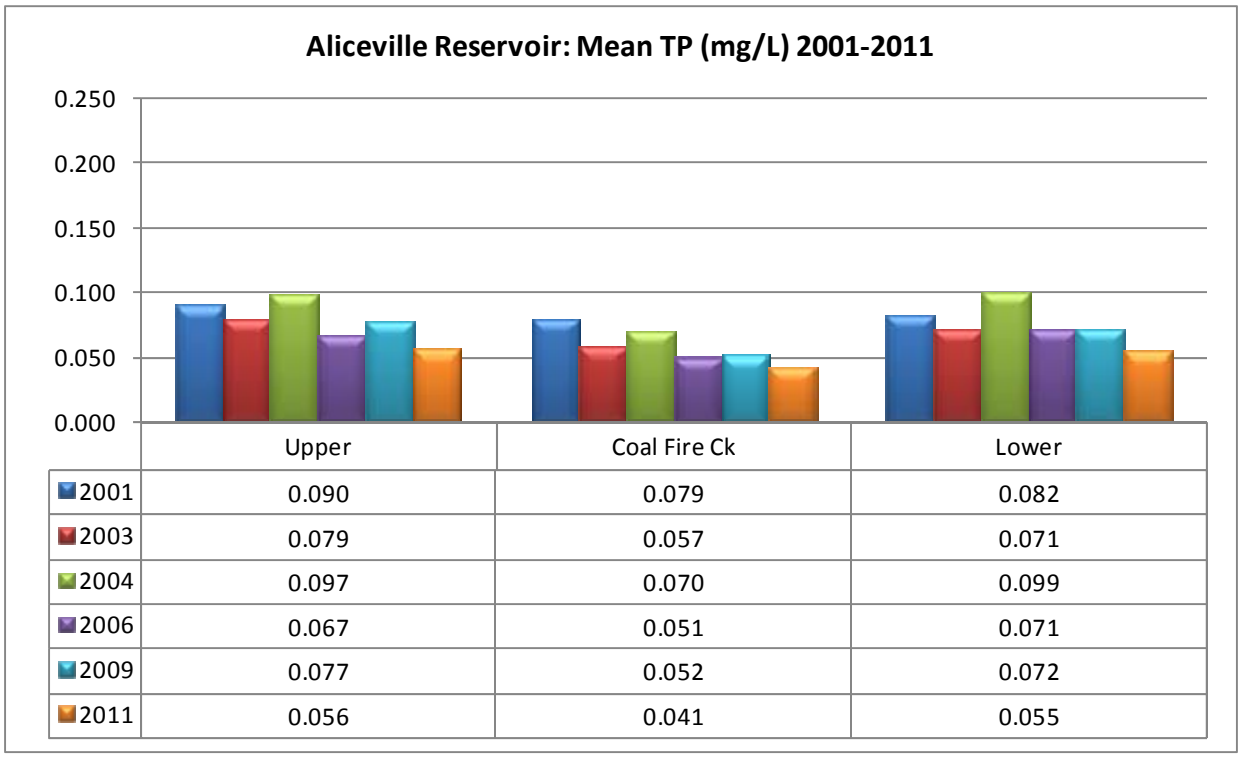
9&10). Profiles indicate highest water temperatures were reached in July and August at each station.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. TSI values in all stations indicated mostly eutrophic conditions May-October, with Coal Fire Ck reaching mesotrophic conditions in October (Fig. 11).

Figure 2. Mean growing season TN and TP measured in Aliceville Reservoir, April-October, 2001-2011. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.

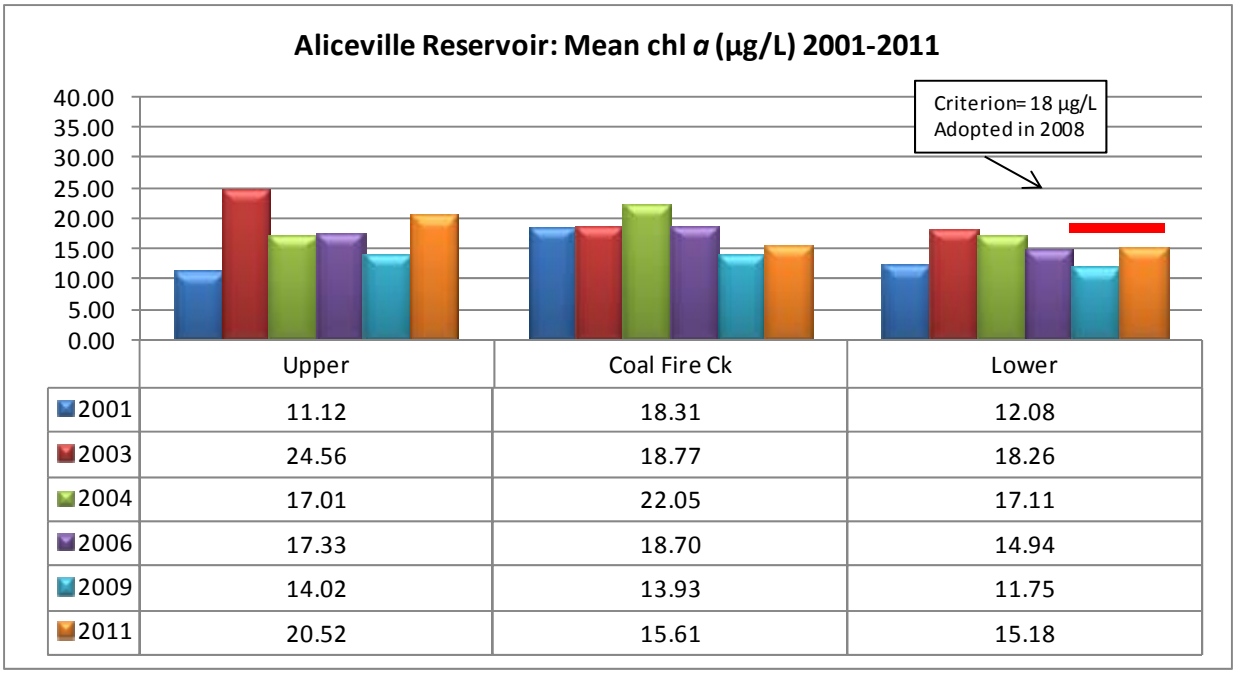


	Upper	Coal Fire Ck	Lower
2001	0.495	0.329	0.496
2003	0.305	0.200	0.573
2004	0.580	0.489	0.605
2006	0.634	0.501	0.687
2009	0.472	0.321	0.452
2011	0.800	0.628	0.678

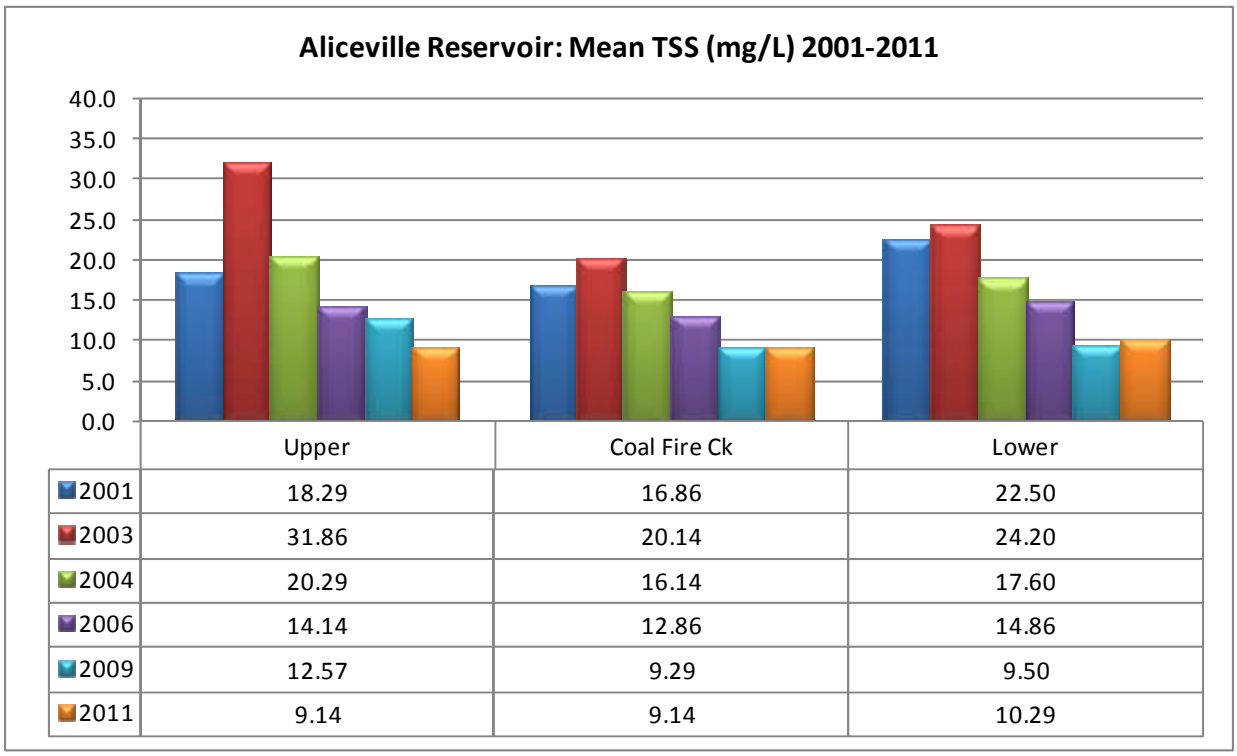


	Upper	Coal Fire Ck	Lower
2001	0.090	0.079	0.082
2003	0.079	0.057	0.071
2004	0.097	0.070	0.099
2006	0.067	0.051	0.071
2009	0.077	0.052	0.072
2011	0.056	0.041	0.055

Figure 3. Mean growing season chl *a* and TSS measured in Aliceville Reservoir, April-October, 2001-2011. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criterion applies to the growing season mean of the lower station only.



	Upper	Coal Fire Ck	Lower
2001	11.12	18.31	12.08
2003	24.56	18.77	18.26
2004	17.01	22.05	17.11
2006	17.33	18.70	14.94
2009	14.02	13.93	11.75
2011	20.52	15.61	15.18



	Upper	Coal Fire Ck	Lower
2001	18.29	16.86	22.50
2003	31.86	20.14	24.20
2004	20.29	16.14	17.60
2006	14.14	12.86	14.86
2009	12.57	9.29	9.50
2011	9.14	9.14	10.29

Figure 4. Monthly TN concentrations measured in Aliceville Reservoir, May-October 2011. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TN was plotted vs. the closest discharge (USGS 02444160 Tombigbee River at Bevill L&D near Pickensville, AL).

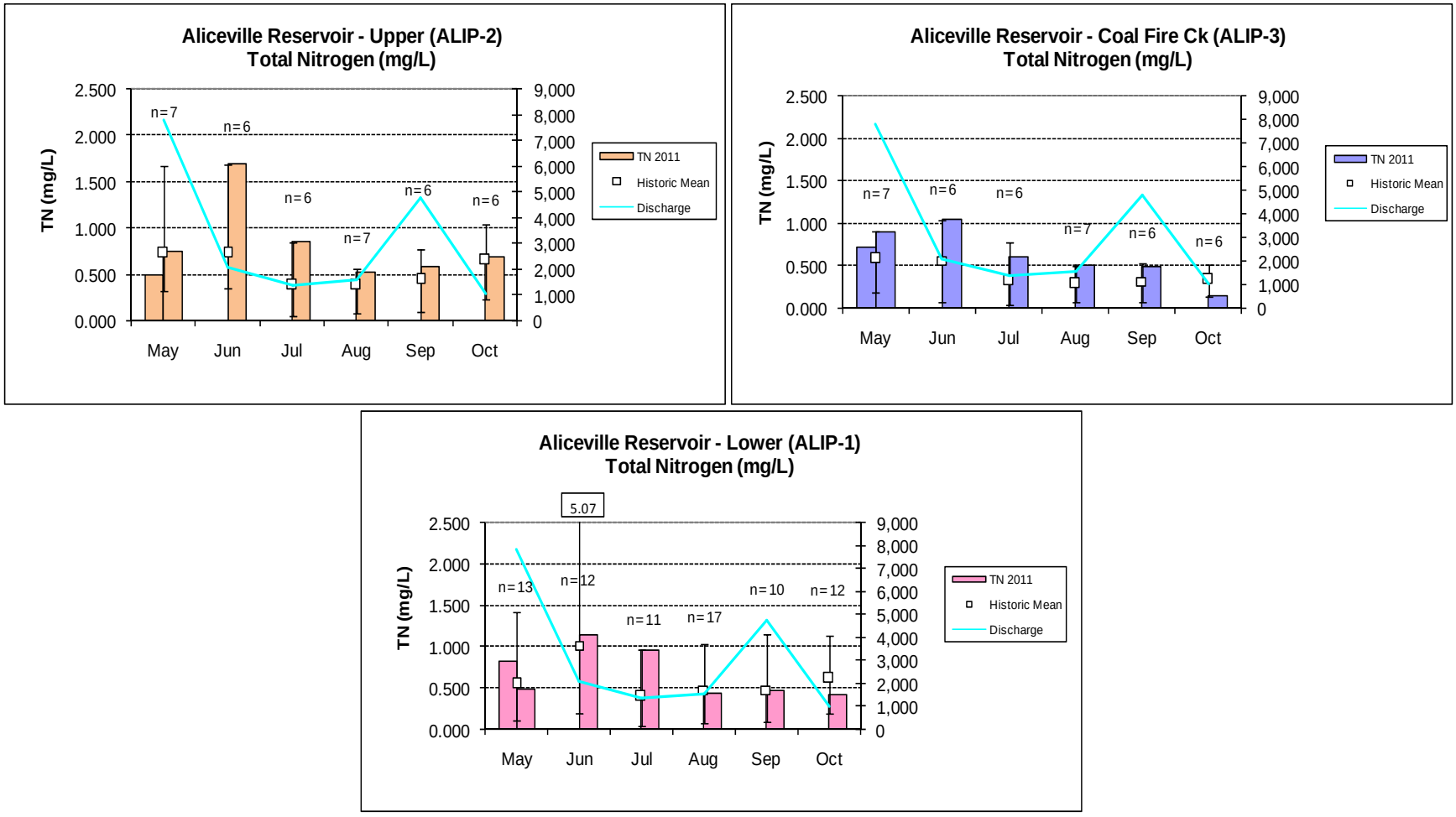


Figure 5. Monthly TP concentrations measured in Aliceville Reservoir, May-October 2011**.** Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (USGS 02444160 Tombigbee River at Bevill L&D near Pickensville, AL).

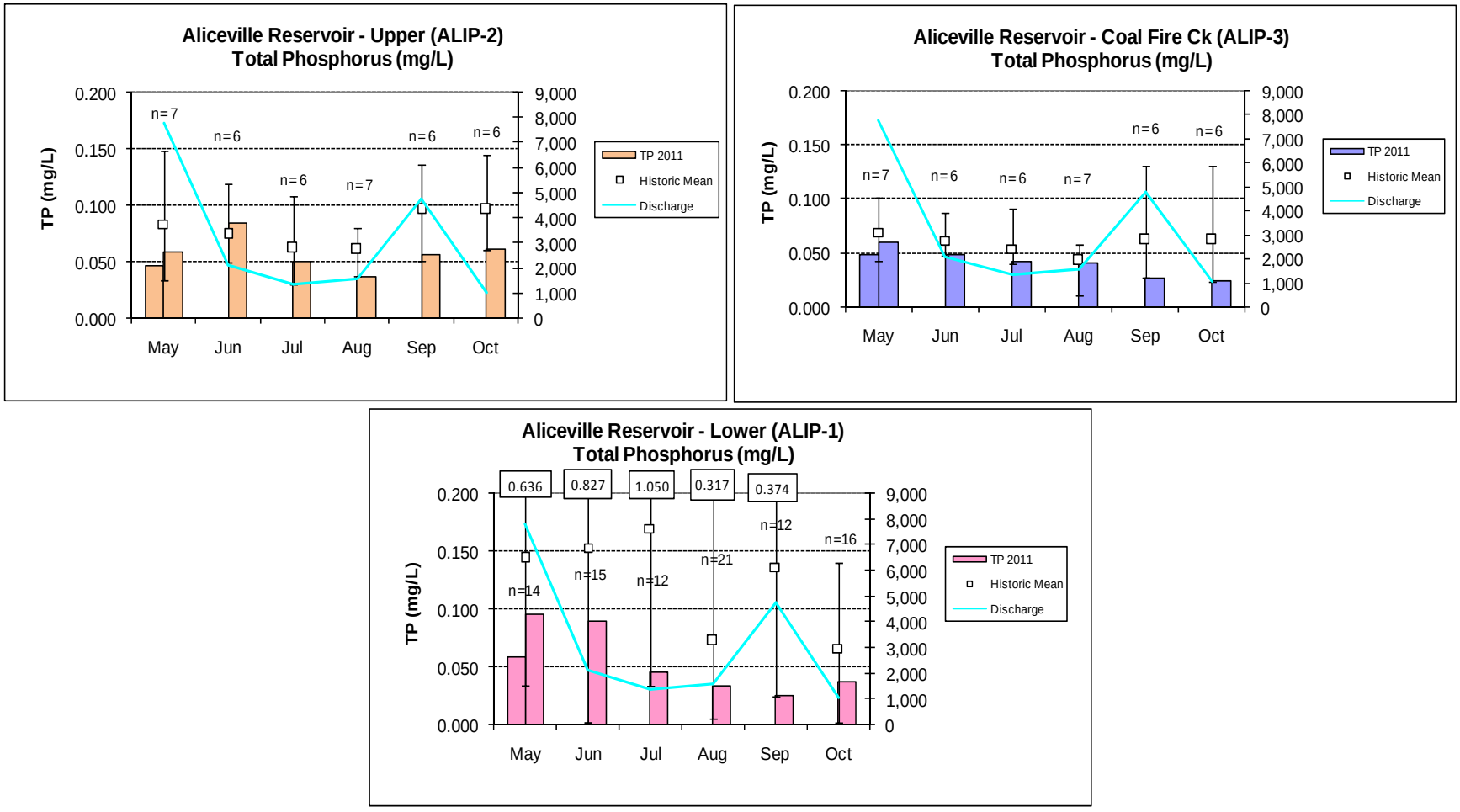


Figure 6. Monthly Chl *a* concentrations measured in Aliceville Reservoir, May-October 2011**.** Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TN was plotted vs. the closest discharge (USGS 02444160 Tombigbee River at Bevill L&D near Pickensville, AL).

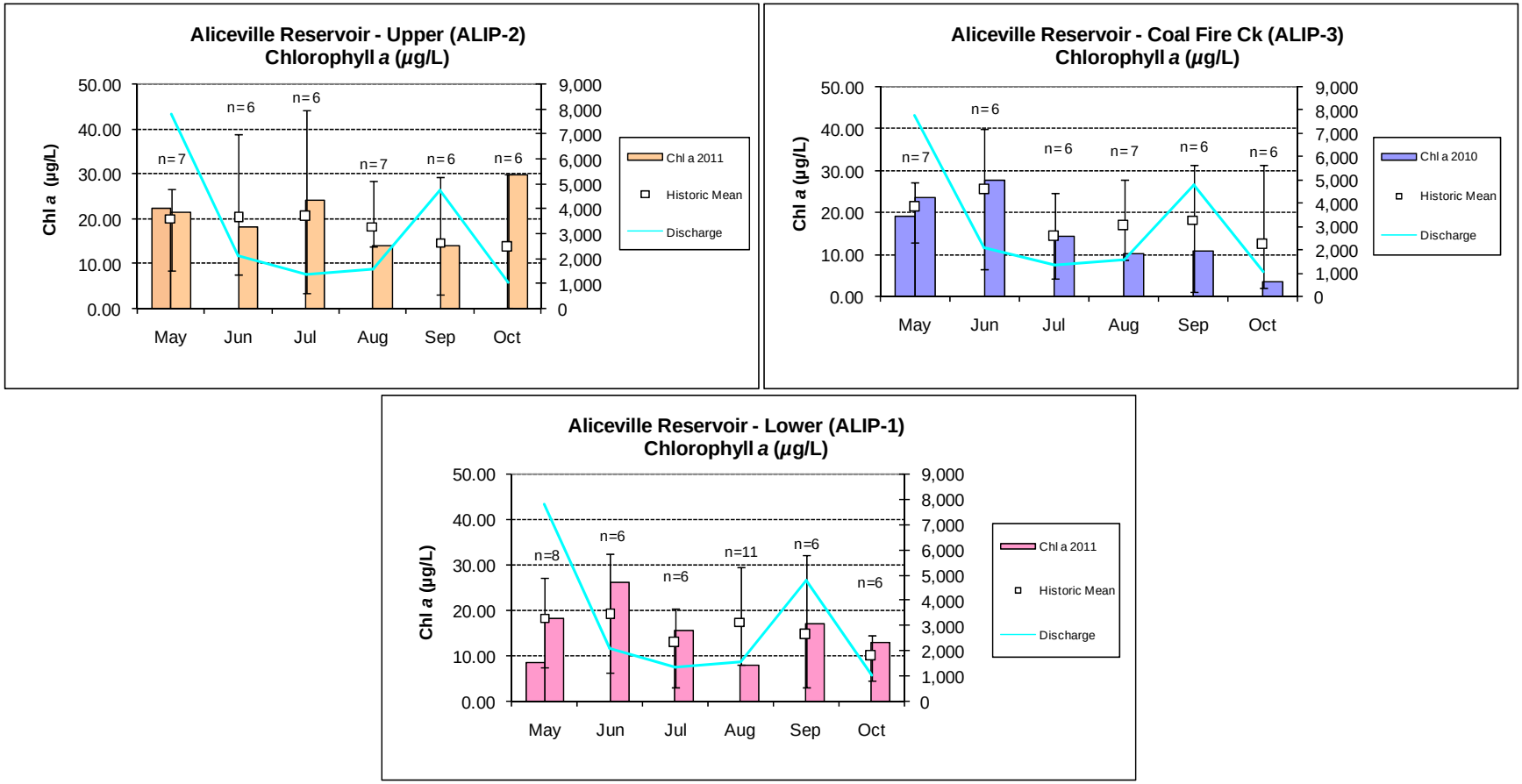


Figure 7. Monthly TSS concentrations measured in Aliceville Reservoir, May-October 2011. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (USGS 02444160 Tombigbee River at Bevill L&D near Pickensville, AL).

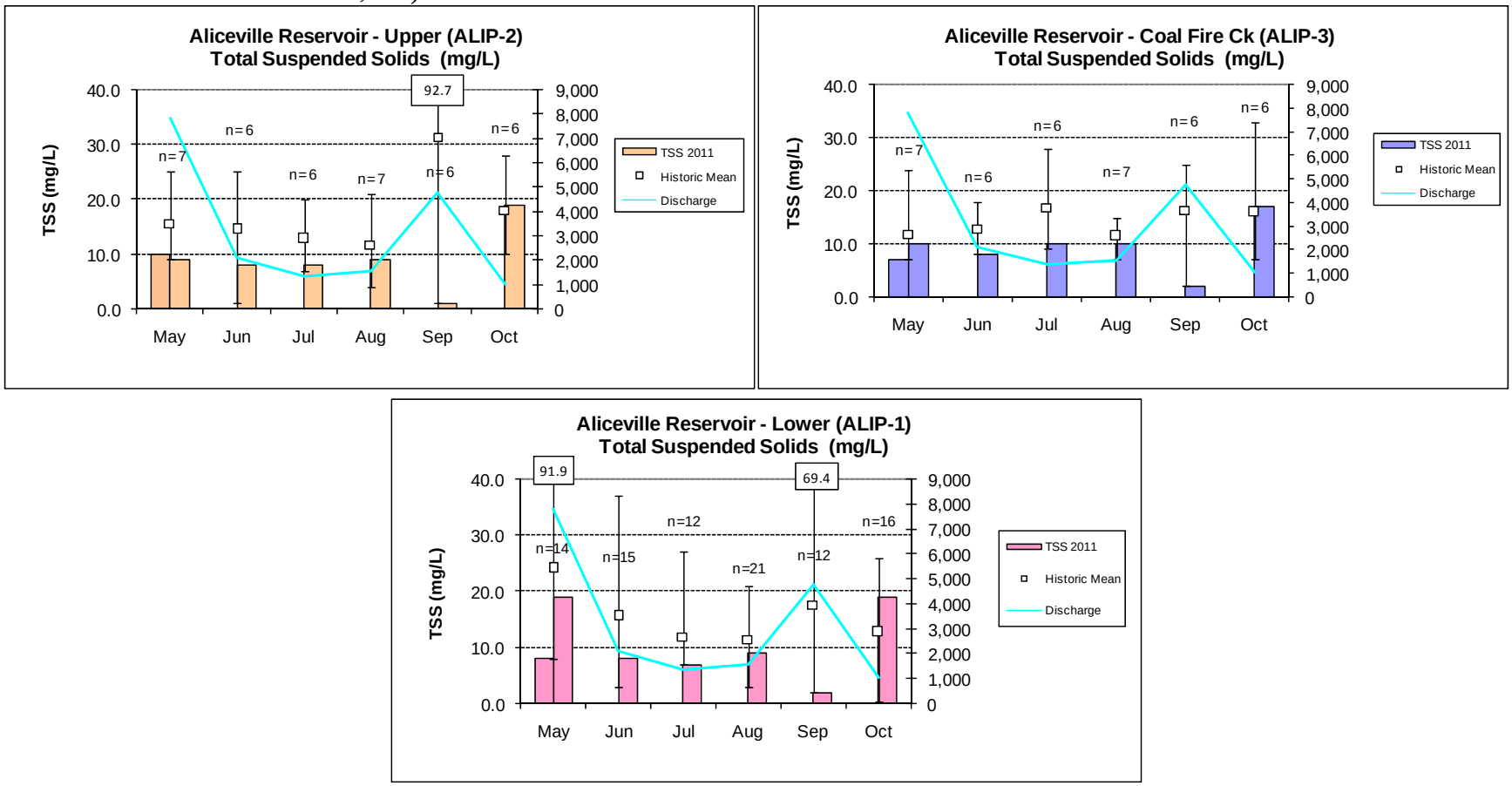


Figure 8. Monthly DO concentrations at 5 ft (1.5m) for Aliceville Reservoir stations collected May-October 2011. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2011). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.

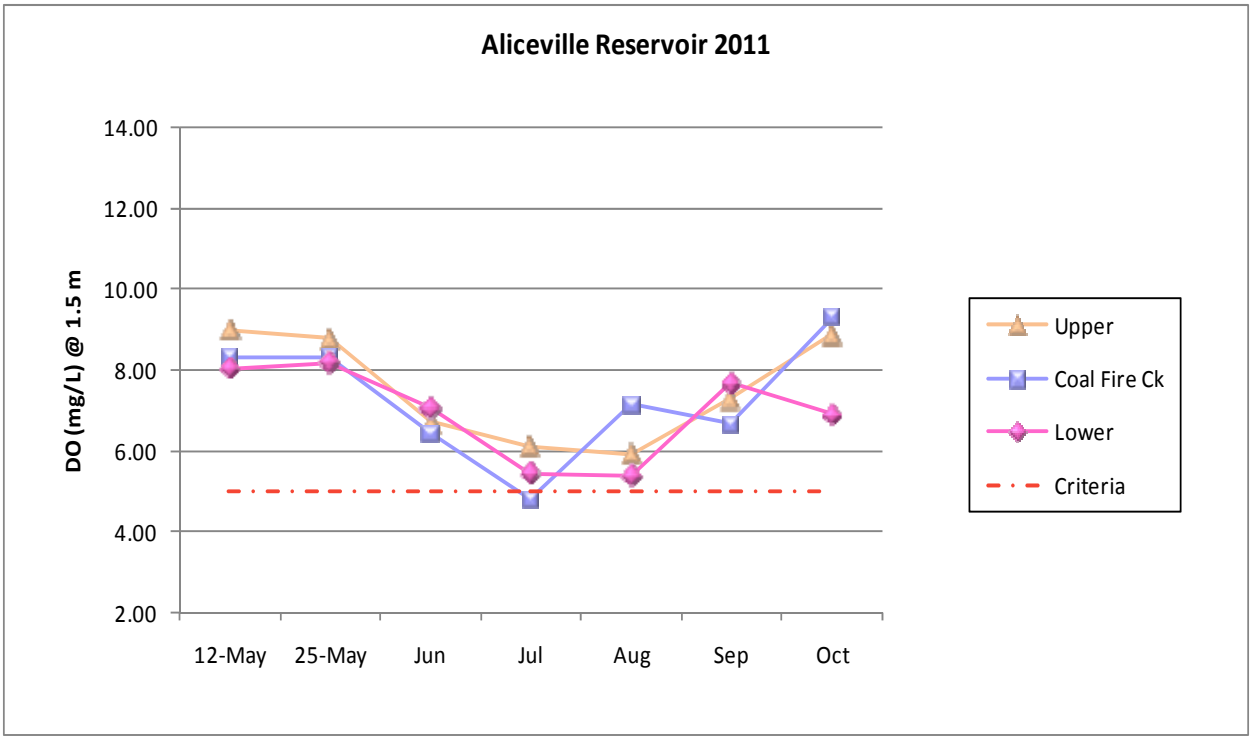


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective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

Station	Upper		Coal Fire Ck		Lower	
Year	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
2001	4.88	Nitrogen	NA*	NA*	1.79	Nitrogen
2006	4.61	Nitrogen	3.72	Nitrogen	5.14	Nitrogen
2011	25.43	Nitrogen	NA*	NA*	9.95	Nitrogen

***** The Coal Fire Ck station was not sampled for AGPT in 2001 or 2011**.**

Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the lower Aliceville Reservoir station, May-October 2011.

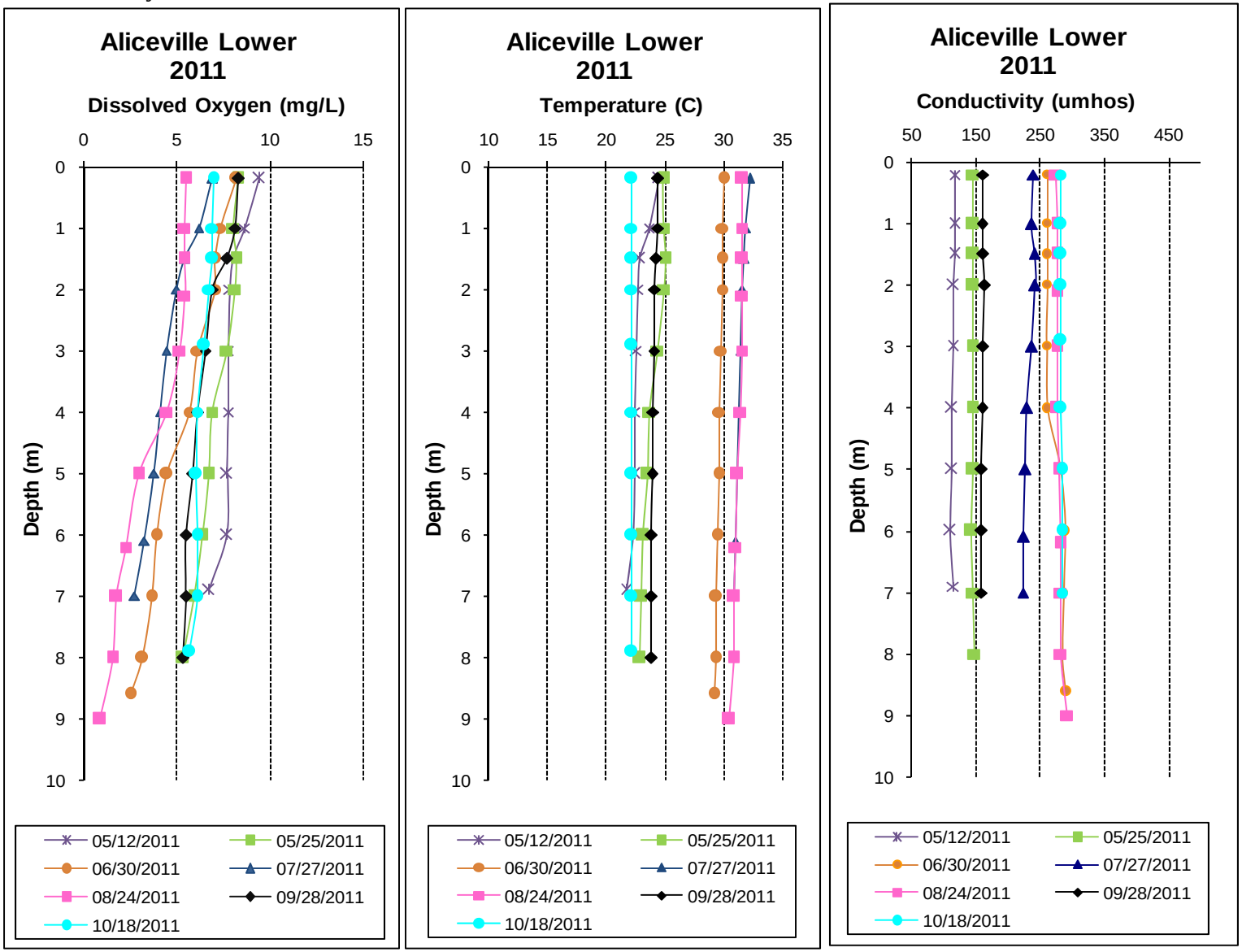


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the upper Aliceville Reservoir station, May-October 2011.

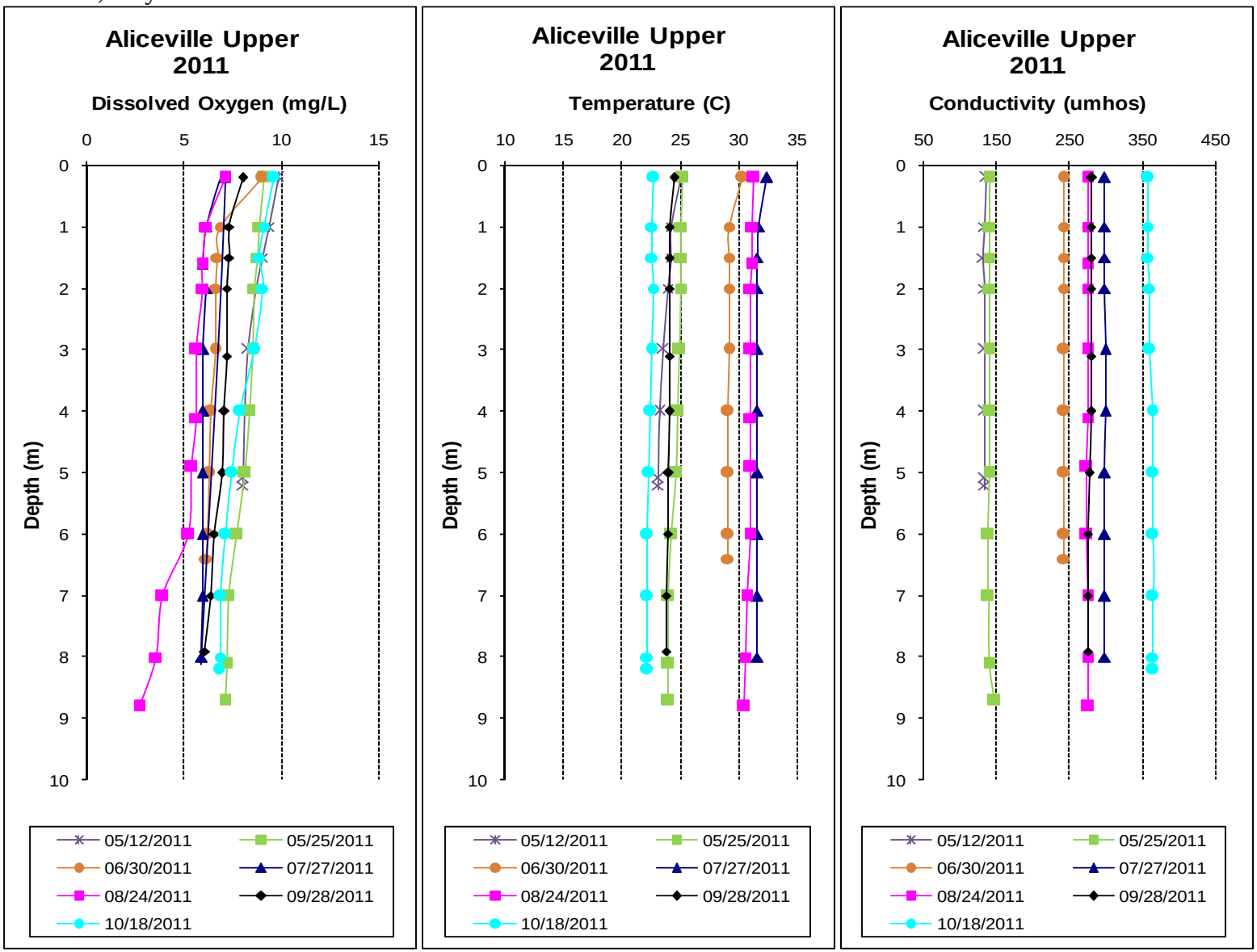
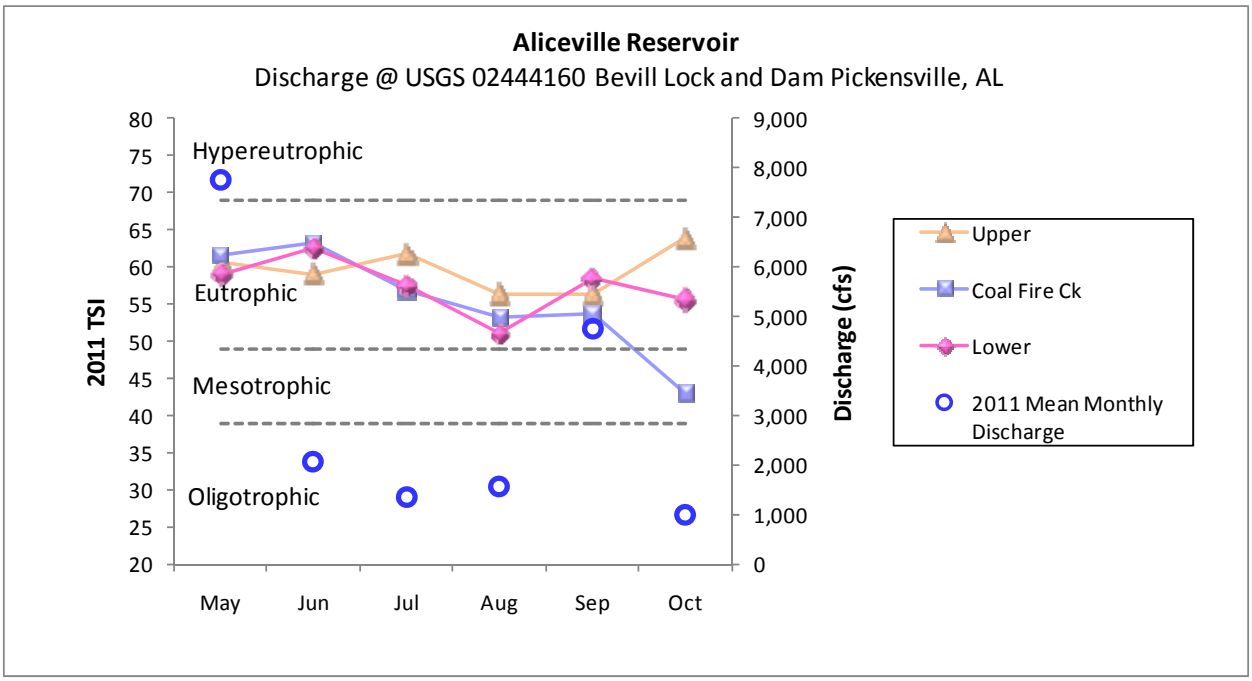


Figure 11. Monthly TSI values for Aliceville Reservoir stations using chlorophyll *a* concentrations and Carlson's Trophic State Index calculation, May-October 2011. TSI values for mainstem stations were plotted vs. closest discharge (USGS 02444160 Tombigbee River at Bevill L&D near Pickensville, AL).



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APPENDIX

Appendix Table 1. Summary of water quality data collected May-October, 2011. 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
ALIP-1	Physical							
	Turbidity (NTU)	7		10.2	27.1	11.8	16.2	7.1
	Total Dissolved Solids (mg/L)	7		112.0	228.0	162.0	159.4	42.4
	Total Suspended Solids (mg/L)[J]	7		2.0	19.0	8.0	10.3	6.4
	Hardness (mg/L)	4		38.2	75.1	64.2	60.4	16.7
	Alkalinity (mg/L)	7		31.7	57.2	44.2	42.6	8.8
	Photic Zone (m)	7		1.69	2.84	2.06	2.13	0.44
	Secchi (m)	7		0.52	1.02	0.83	0.74	0.19
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.005	0.007	0.002	0.003	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.176	0.043	0.048	0.060
	Total Kjeldahl Nitrogen (mg/L)	7		0.407	0.964	0.439	0.630	0.260
	Total Nitrogen (mg/L)[J]	7	<	0.416	1.140	0.486	0.678	0.293
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.003	0.007	0.006	0.006	0.001
	Total Phosphorus (mg/L)	7		0.025	0.095	0.046	0.055	0.028
	CBOD-5 (mg/L)	7	<	2.0	2.8	1.0	1.6	0.8
	Chlorides (mg/L)	7		9.0	37.6	27.6	24.4	11.0
	Biological							
	Chlorophyll a (ug/L)	7		8.01	26.17	15.49	15.18	6.25
	E. coli (mpn/100mL)	3		1	3	2	2	1
ALIP-2	Physical							
	Turbidity (NTU)	7		9.2	28.5	12.8	16.4	7.4
	Total Dissolved Solids (mg/L)	7		96.0	260.0	194.0	178.0	59.1
	Total Suspended Solids (mg/L)	7		1.0	19.0	9.0	9.1	5.3
	Hardness (mg/L)	4		40.4	66.6	65.4	59.4	12.7
	Alkalinity (mg/L)	7		35.0	54.1	45.8	44.8	7.4
	Photic Zone (m)	7		1.40	2.19	1.98	1.92	0.26
	Secchi (m)	7		0.42	1.00	0.57	0.65	0.22
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.005	0.007	0.002	0.003	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.004	0.546	0.043	0.113	0.193
	Total Kjeldahl Nitrogen (mg/L)	7		0.465	1.150	0.612	0.688	0.244
	Total Nitrogen (mg/L)[J]	7		0.499	1.696	0.690	0.800	0.415
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.005	0.018	0.009	0.011	0.006
	Total Phosphorus (mg/L)	7		0.037	0.084	0.056	0.056	0.015
	CBOD-5 (mg/L)	7	<	2.0	3.2	1.0	1.5	0.9
	Chlorides (mg/L)	7		11.6	47.9	33.2	29.9	14.0
	Biological							
	Chlorophyll a (ug/L)	7		13.88	29.90	21.36	20.52	5.75
	E. coli (mpn/100mL)	3		1	4	1	2	2

Station	Parameter	N		Min	Max	Med	Mean	SD
ALIP-3	**Physical**							
	Turbidity (NTU)	7		9.4	19.1	14.5	14.6	3.8
	Total Dissolved Solids (mg/L)[J]	7		76.0	184.0	146.0	131.4	41.6
	Total Suspended Solids (mg/L)	7		2.0	17.0	10.0	9.1	4.5
	Hardness (mg/L)	4		28.9	69.2	56.8	53.0	18.8
	Alkalinity (mg/L)	7		25.2	51.5	36.8	36.7	9.5
	Photic Zone (m)	7		1.74	2.76	2.25	2.22	0.42
	Secchi (m)	7		0.63	1.16	0.84	0.87	0.22
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.005	0.007	0.002	0.003	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.088	0.005	0.015	0.032
	Total Kjeldahl Nitrogen (mg/L)[J]	7		0.138	0.950	0.605	0.613	0.276
	Total Nitrogen (mg/L)[J]	7	<	0.139	1.038	0.611	0.628	0.296
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.004	0.005	0.005	0.005	0.000
	Total Phosphorus (mg/L)	7		0.024	0.060	0.042	0.041	0.012
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.1	0.4
	Chlorides (mg/L)	7		6.4	36.4	22.4	20.6	11.0
	Biological							
	Chlorophyll a (ug/L)	7		3.56	27.77	14.42	15.61	8.40
	E. coli (mpn/100mL)	3		1	6	1	3	3

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