2010 Claiborne Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
May 2013

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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
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
COE	United States Army Corp of Engineers

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INTRODUCTION

Claiborne Reservoir was created with the construction of Claiborne Lock and Dam in 1971 by the United States Army Corps of Engineers (COE). The reservoir covers approximately 5,900 acres and stretches through three counties in southwest Alabama. Claiborne was primarily created for navigation, but the reservoir also provides a number of recreational opportunities such as camping, hiking, fishing, and hunting.

Claiborne Reservoir was placed on Alabama's 1998 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its Public Water Supply (PWS) water use classification. The reservoir was listed for impairments caused by organic enrichment/dissolved oxygen (OE/DO). In 2006, a consumption advisory was issued by the Alabama Department of Public Health for largemouth bass taken from Claiborne Reservoir due to mercury levels in fish tissue exceeding the EPA action level of 0.33 ppm. All waters within a consumption advisory are placed on Alabama's Clean Water Act (CWA) §303(d) list of impaired waters. In 2008, in addition to its impairments caused by OE/DO, Claiborne Reservoir was listed on Alabama's §303(d) list of impaired waters for not meeting its Swimming (S)/Fish & Wildlife (F&W) water use classification use classifications due to impairments caused by atmospheric deposition of metals (mercury). A draft TMDL for mercury is scheduled for 2017 for Claiborne Reservoir.

The Alabama Department of Environmental Management (ADEM) monitored Claiborne Reservoir as part of the 2010 assessment of the Alabama, Coosa, and Tallapoosa (ACT) 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 the Field Operations Division of the 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).

A specific water quality criterion for nutrient management was implemented in 2004 at one location on Claiborne Reservoir. This criterion represents the maximum growing season

mean (April-October) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting the reservoir's designated uses.

The purpose of this report is to summarize data collected at five stations in Claiborne reservoir during the 2010 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 [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 the established criteria.

METHODS

Sample sites were determined using historical data and previous assessments (Fig. 1). Claiborne was sampled in the dam forebay and upper reservoir. Three tributary embayments were also monitored. Specific station location information is listed in Table 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 (ADEM 2010), Surface Water Quality Assurance Project Plan (ADEM 2008), and Quality Management Plan (ADEM 2008).

Mean growing season 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 2010 results.

Figure 1. Claiborne Reservoir with 2010 sampling locations. A description of each sampling location is provided in Table 1.

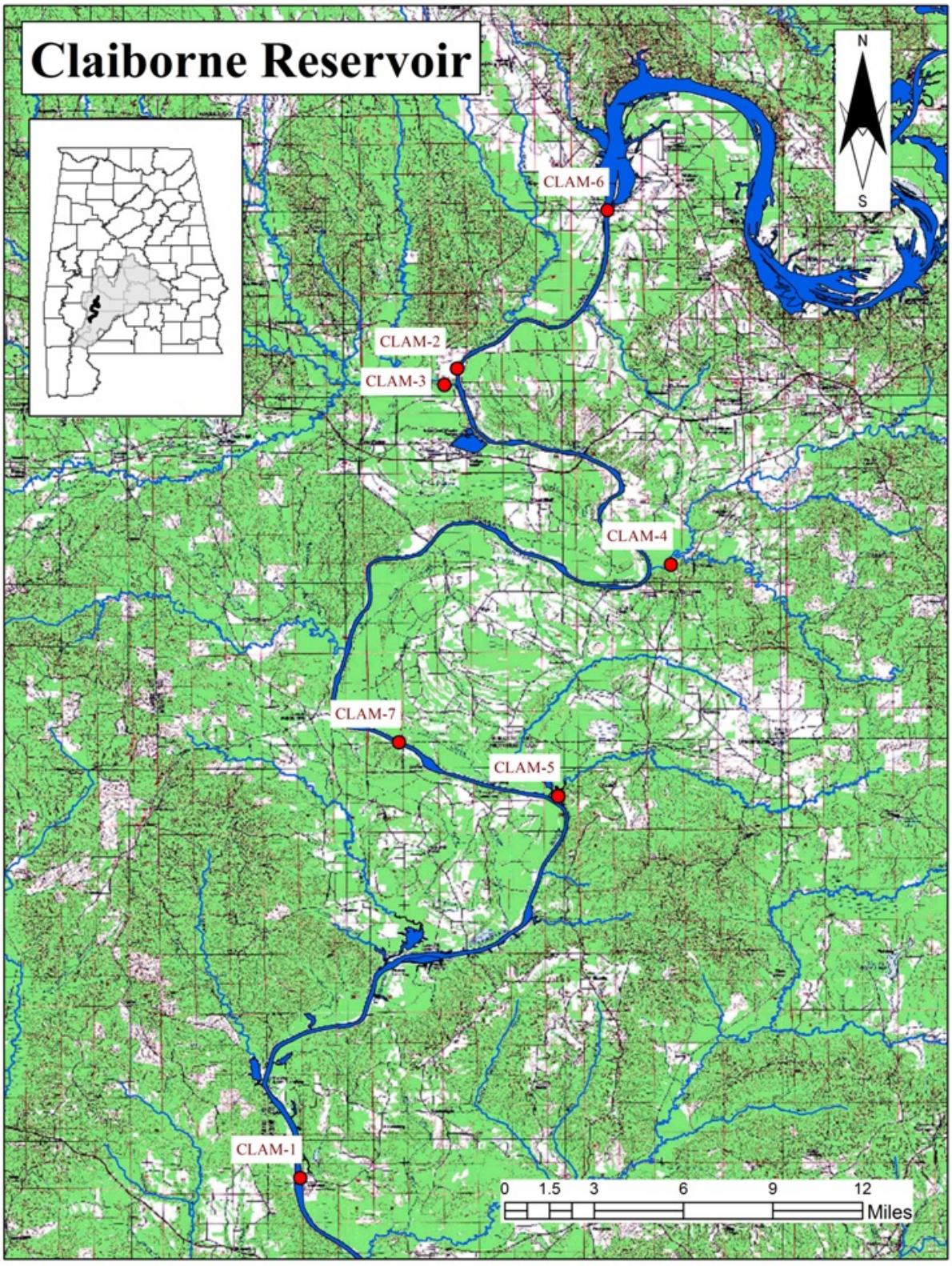


Table 1. Descriptions of the 2010 monitoring stations in Claiborne Reservoir.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criterion	Latitude	Longitude
Claiborne Reservoir								
031502030105	Monroe	CLAM-1**	Lower	Alabama R	Deepest point, main river channel, dam forebay.	15 µg/L	31.6174	-87.5506
031502030703	Wilcox	CLAM-2	Upper	Alabama R	Deepest point, main river channel, approximately 0.5 miles upstream of Beaver Creek confluence.		32.0106	-87.4744
031502030604	Wilcox	CLAM-3	Beaver Cr	Beaver Cr	Deepest point, main creek channel, Beaver Creek embayment, approximately 0.5 miles upstream of lake confluence.		32.0028	-87.4806
031502030802	Wilcox	CLAM-4	Pursley Cr	Pursley Cr	Deepest point, main creek channel, Pursley Creek embayment, approximately 0.5 miles upstream of lake confluence.		31.9155	-87.3705
031502040101	Monroe	CLAM-5	Tallatchee Cr	Tallatchee Cr	Deepest point, main creek channel, Tallatchee Creek embayment, approximately 0.5 miles upstream of lake confluence.		31.8029	-87.4253

**Growing season mean Chl a criterion implemented at this station in 2004

RESULTS

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figs. 2 & 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figs. 4-8, 11). Mean monthly discharge included as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, conductivity and DO appear in Figs. 9 & 10. Summary statistics of all data collected during 2010 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 and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2010, the highest mean growing season TN value was calculated for the Tallatchee Ck station (Fig. 2). The 2010 mean concentrations in both the upper and lower stations were the lowest since 2000. Mean TN concentrations in the lower reservoir decreased 2002-2010. All three tributaries showed a decrease in mean concentrations compared to 2005. With the exception of the lower station in April, monthly TN concentrations at both mainstem stations were below historic means April-October (Fig. 4).

In 2010, the highest mean growing season TP value was calculated for the Tallatchee Ck station (Fig. 2). Mean growing season TP concentrations were similar at the upper and lower stations, the lowest since 2000. Both stations show a decreasing trend in mean values since 2003. All three tributaries showed a decrease in mean concentrations compared to 2005. Monthly TP concentrations at the mainstem stations were below historic means the entire growing season (Fig. 5). Historic lows occurred at both mainstem locations in April and September.

In 2010, the highest mean growing season chl *a* value was calculated for the Tallatchee Ck station (Fig. 3). Growing season mean chl *a* concentrations at both the upper and lower stations were the lowest ever calculated. All three tributaries showed an increase in mean

concentrations compared to 2005. The mean chl *a* concentration in lower Claiborne station was below the established criterion, though the mean concentration was near the limit in 2008. With the exception of the upper station in October, monthly chl *a* concentrations for both mainstem stations were below historic means April-October and historically low in most months sampled (Fig. 6).

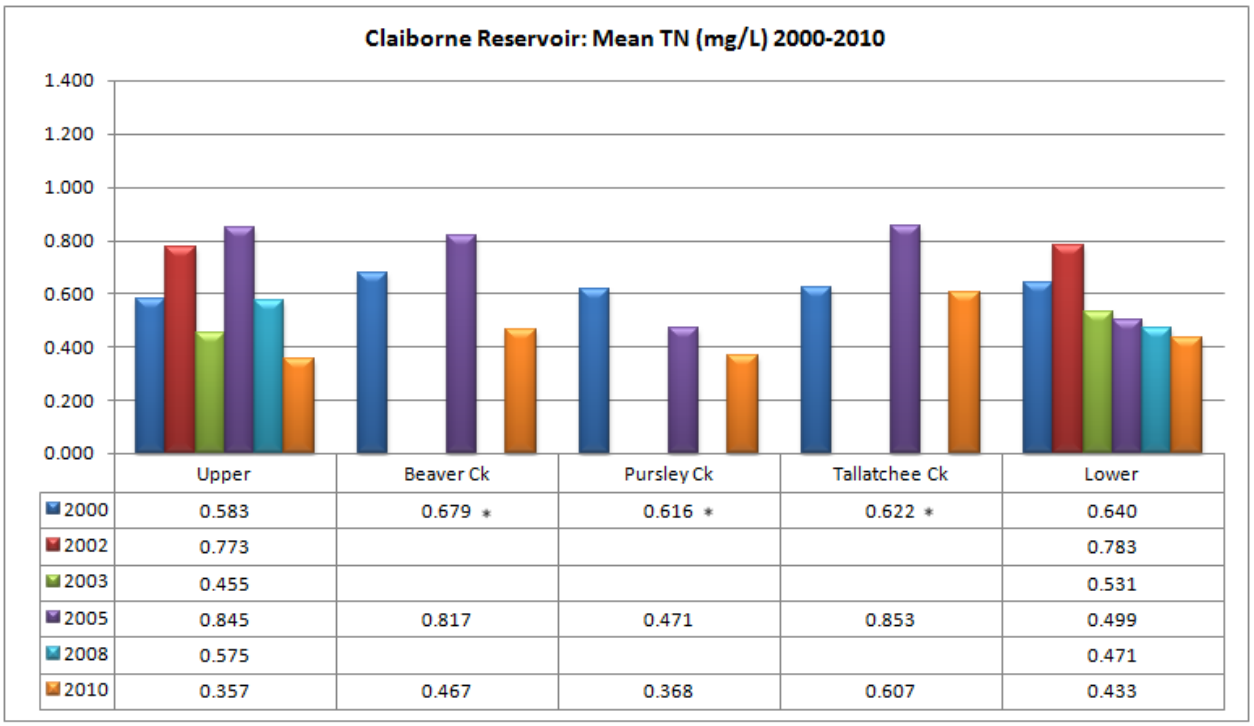
In 2010, the highest two mean growing season TSS values were calculated for Beaver and Tallatchee Ck stations (Fig. 3). Mean TSS concentrations were lower in 2010 than in 2005 at all three tributary stations while both mainstem stations showed an increase compared to 2008. All monthly TSS concentrations were near or below historic mean values at both the upper and lower stations (Fig. 7). Historic low monthly TSS concentrations were measured during May in the upper station and May and September in the lower station.

AGPT results for the upper station indicated phosphorus limited conditions in August 2010 and in 2000. Due to resource constraints, an AGPT sample was not collected at the lower station in August 2010. In 2010, mean standing crop at the upper station was 8.2 mg/L which is above 5 mg/L, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems (Table 2).

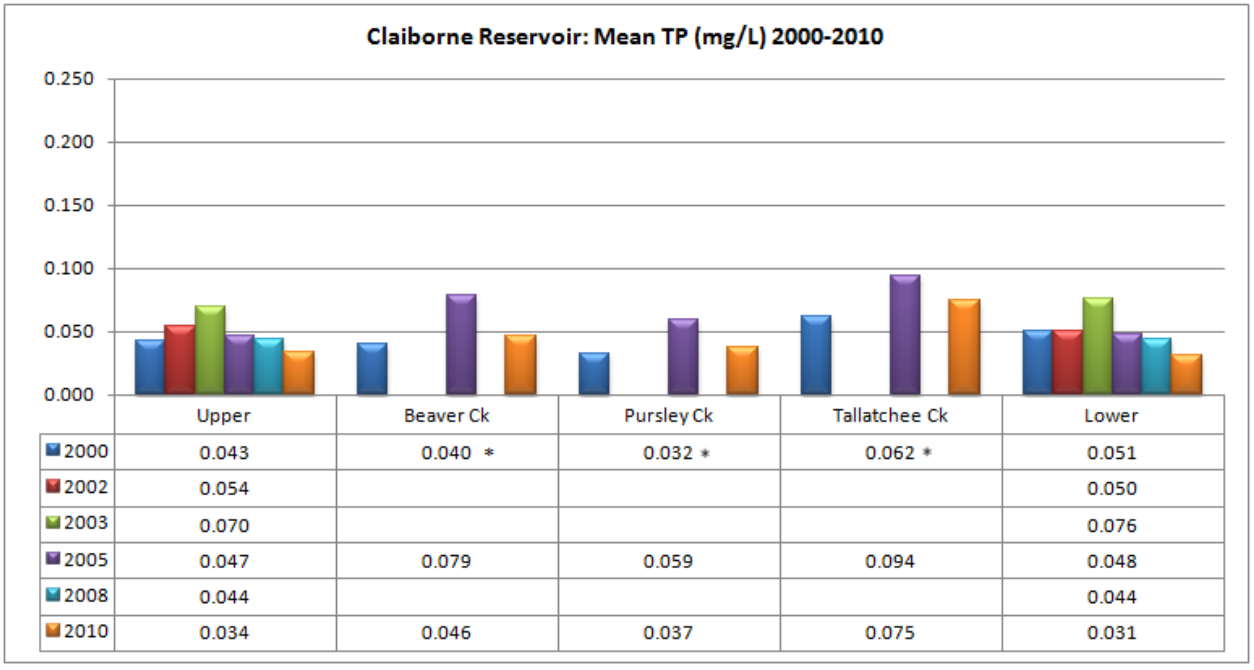
DO concentrations at the Tallatchee and Beaver Creek stations were below the ADEM criteria limit of 5.0 mg/l at 5.0 ft (1.5 m) May-September and June, respectively (ADEM Admin. Code R. 335-6-10-.09) (Fig. 8). All measurements of DO concentrations in the mainstem stations met the criteria limit, though the upper station was near the limit in July and August. Profiles of the mainstem stations show both locations were mixed throughout the sampling season and highest temperatures were reached in July and August (Figs. 9 & 10).

The highest TSI values came from Tallatchee Creek which reached hypereutrophic conditions in June, July, and September (Fig. 11). TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. TSI values in upper Claiborne indicated mesotrophic conditions April, June, and September and eutrophic conditions in May, July, August, and October. Lower Claiborne was oligotrophic in April and mesotrophic the remainder of the growing season. TSI results for Beaver Creek remained in the eutrophic range throughout the growing season with the exception of July. Pursley Creek was oligotrophic in April and increased to hypereutrophic conditions in October.

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



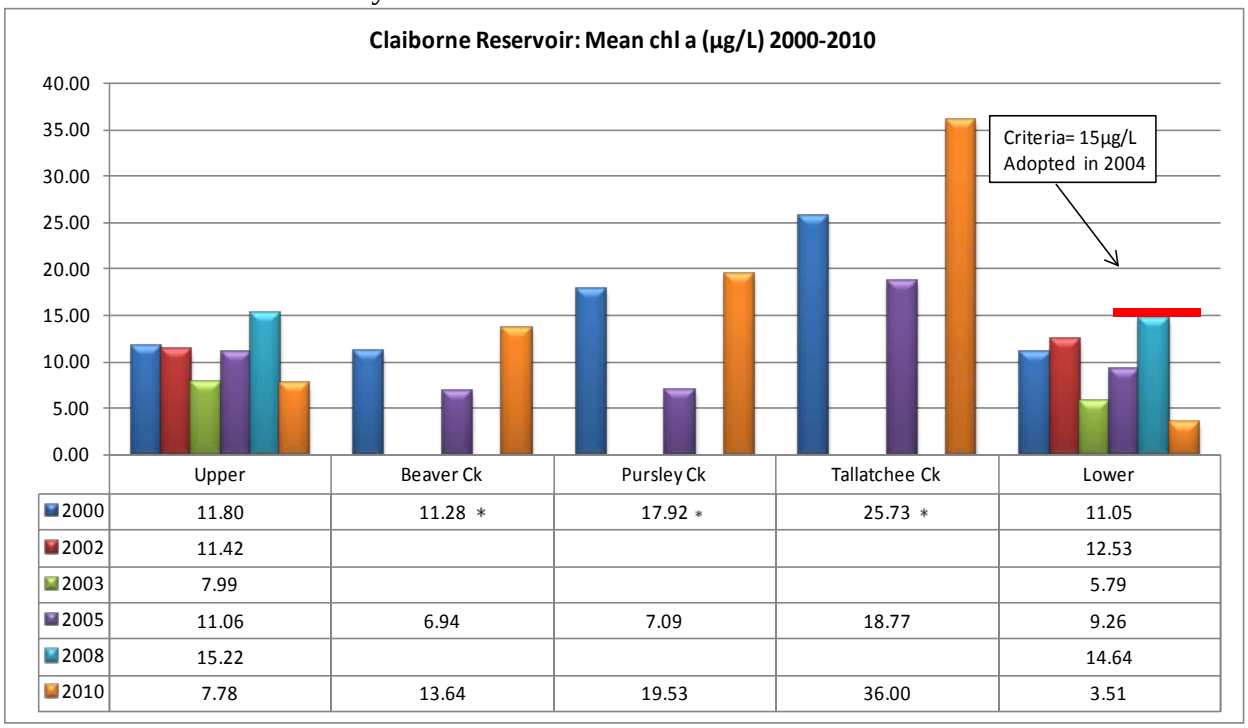
	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	0.583	0.679 *	0.616 *	0.622 *	0.640
2002	0.773				0.783
2003	0.455				0.531
2005	0.845	0.817	0.471	0.853	0.499
2008	0.575				0.471
2010	0.357	0.467	0.368	0.607	0.433



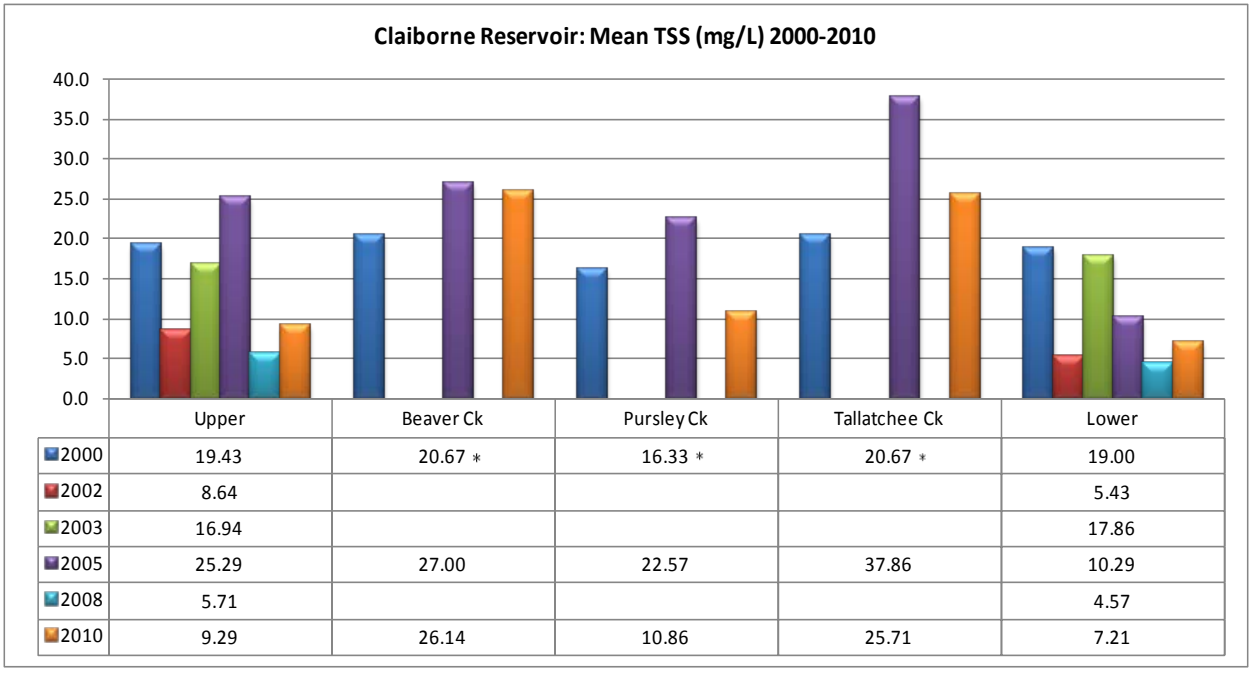
	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	0.043	0.040 *	0.032 *	0.062 *	0.051
2002	0.054				0.050
2003	0.070				0.076
2005	0.047	0.079	0.059	0.094	0.048
2008	0.044				0.044
2010	0.034	0.046	0.037	0.075	0.031

*Mean of April/June/August only.

Figure 3. Mean growing season chl *a* and TSS measured in Claiborne Reservoir, April-October. 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.



	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	11.80	11.28 *	17.92 *	25.73 *	11.05
2002	11.42				12.53
2003	7.99				5.79
2005	11.06	6.94	7.09	18.77	9.26
2008	15.22				14.64
2010	7.78	13.64	19.53	36.00	3.51



	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	19.43	20.67 *	16.33 *	20.67 *	19.00
2002	8.64				5.43
2003	16.94				17.86
2005	25.29	27.00	22.57	37.86	10.29
2008	5.71				4.57
2010	9.29	26.14	10.86	25.71	7.21

*Mean of April/June/August only.

Figure 4. Monthly TN concentrations measured in Claiborne Reservoir, April-October 2010**.** 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 02428400 Alabama River at Claiborne L&D near Monroeville, AL).

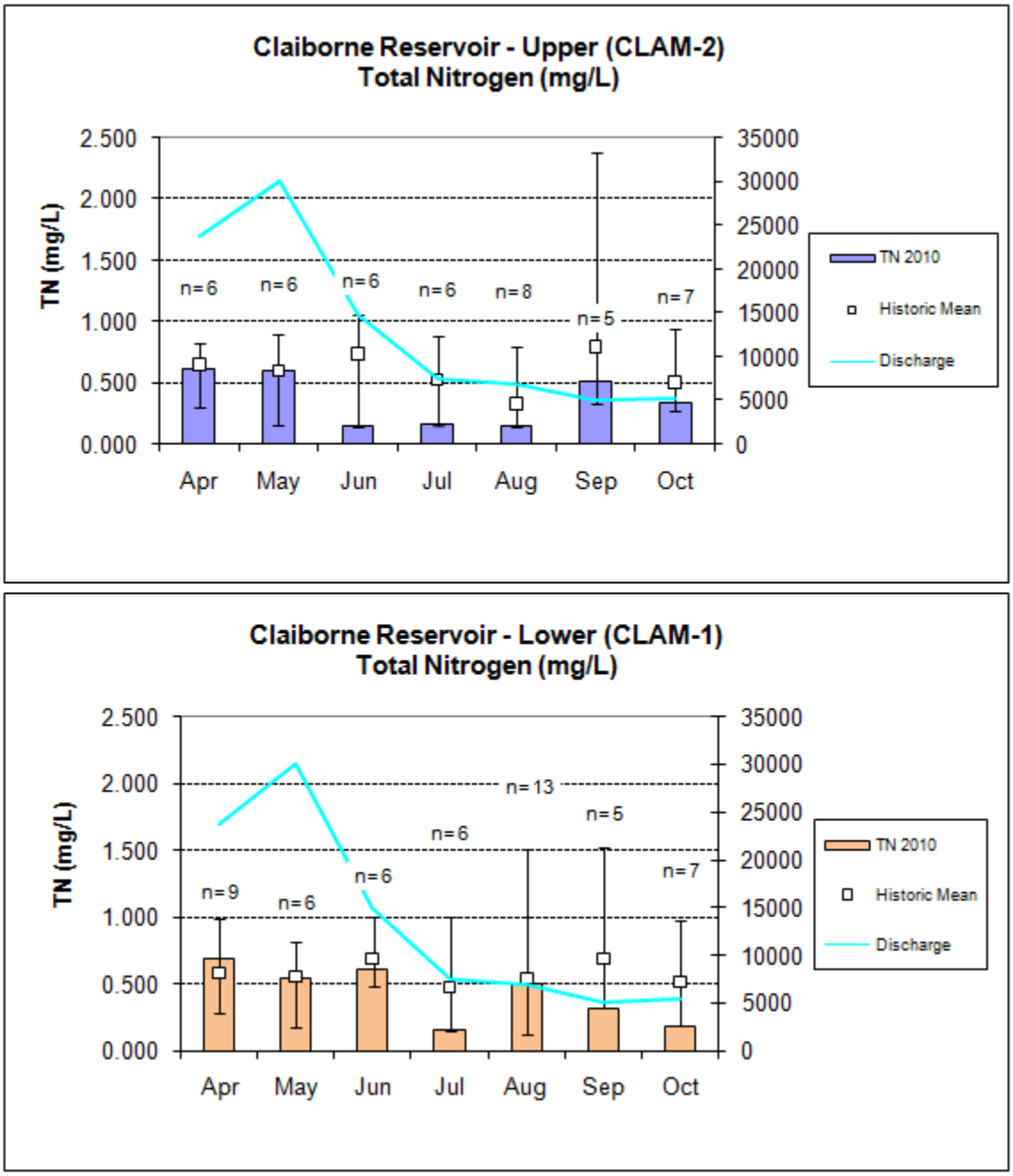


Figure 5. Monthly TP concentrations measured in Claiborne Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).

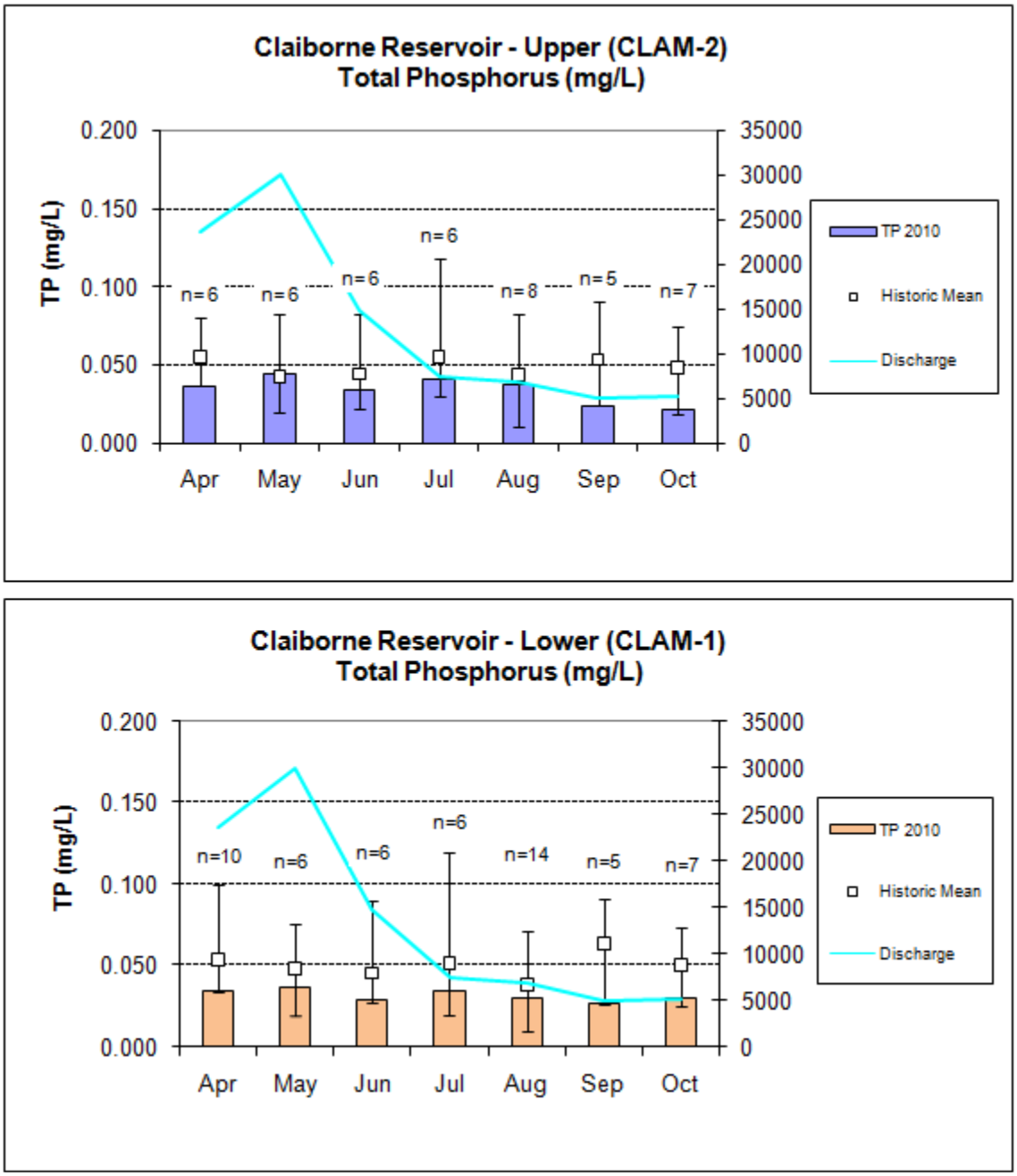
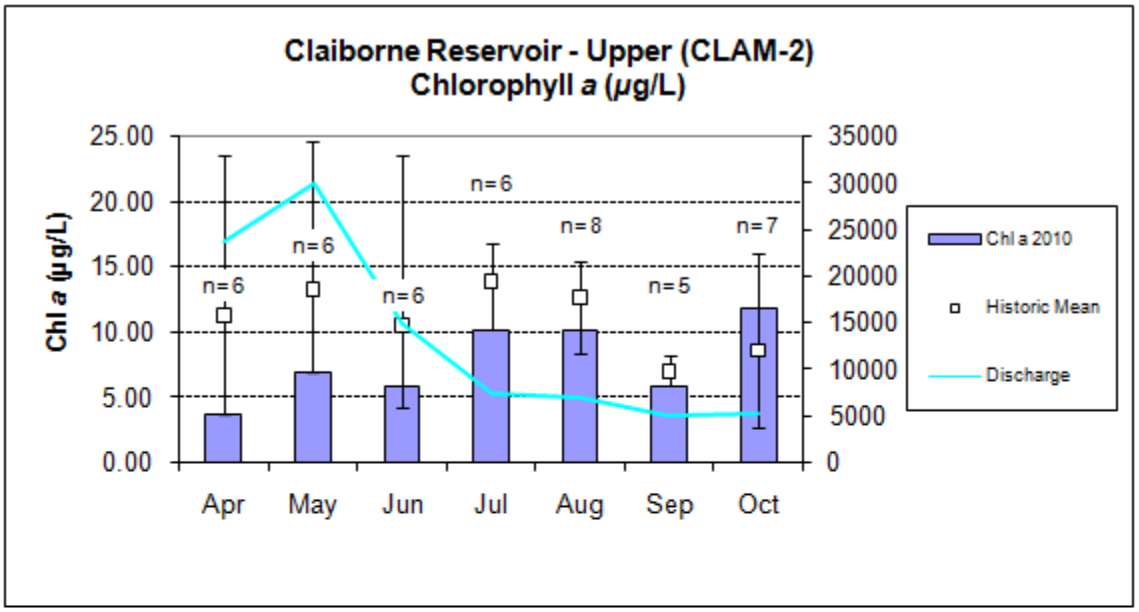


Figure 6. Monthly chl *a* concentrations measured in Claiborne Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Chl *a* was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).



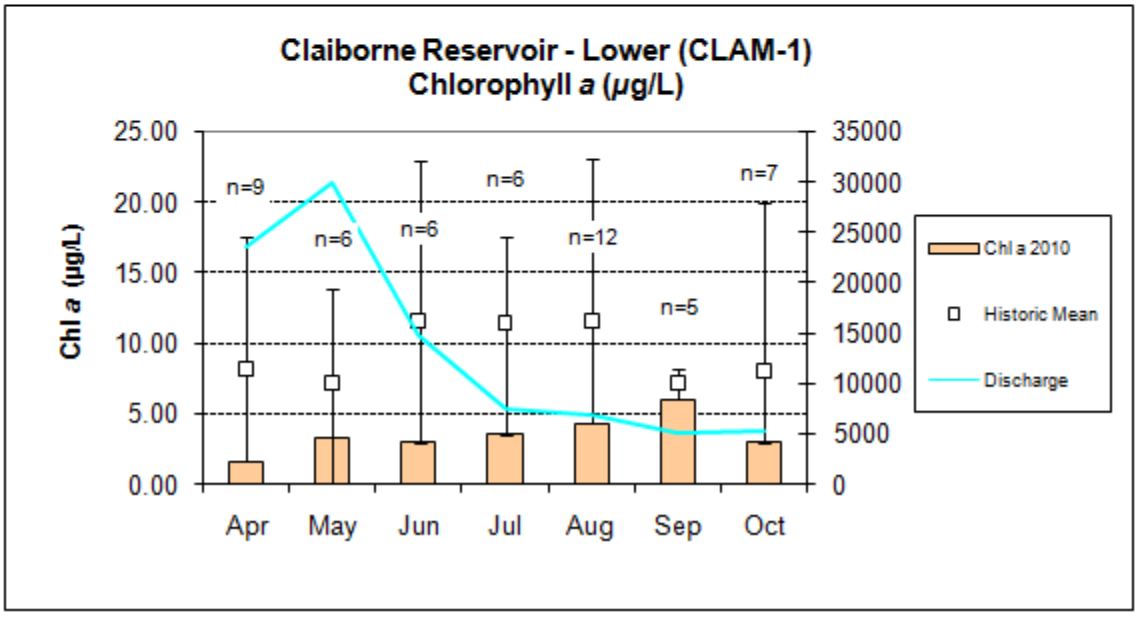


Figure 7. Monthly TSS concentrations measured in Claiborne Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TSS was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).

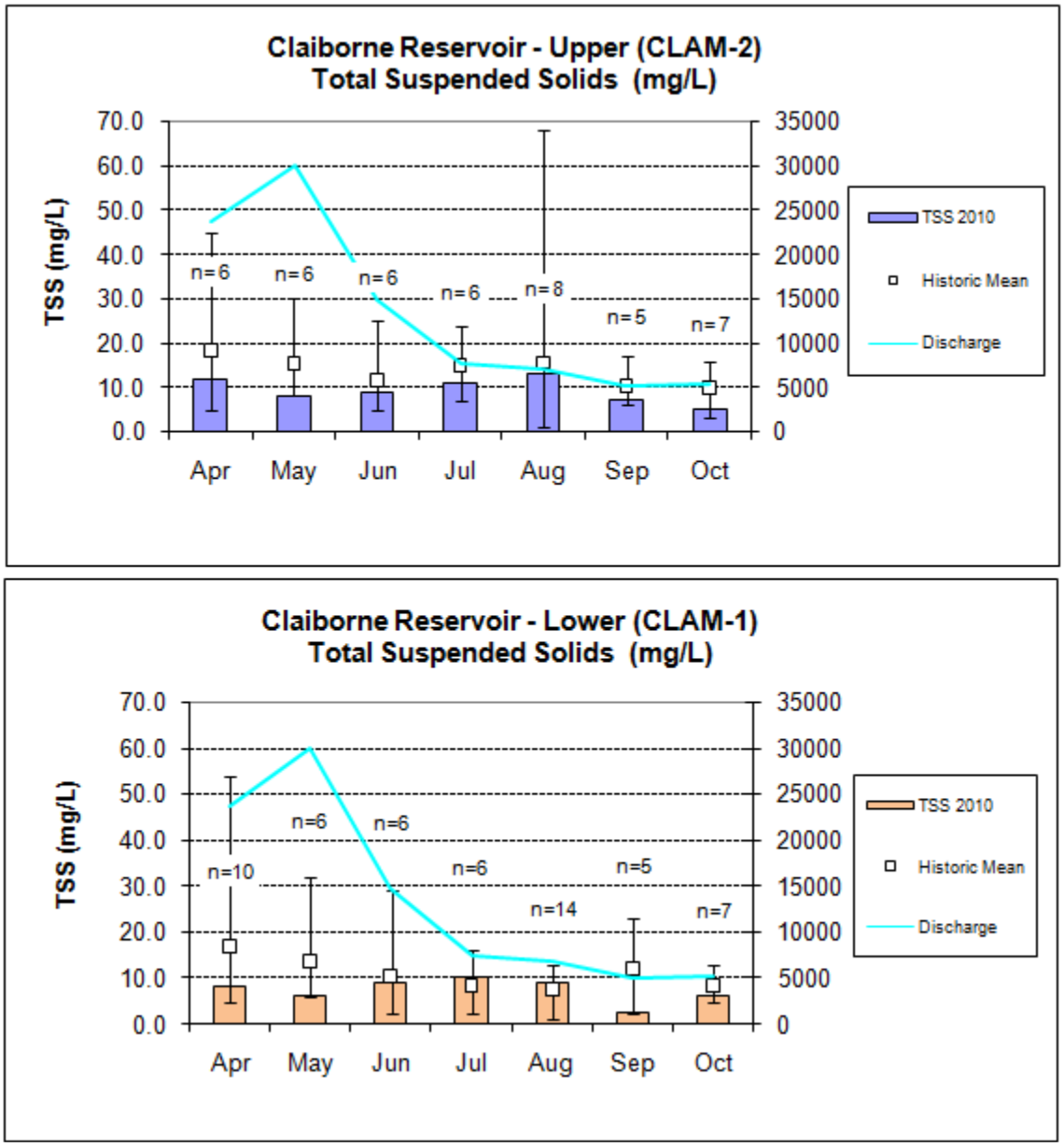


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/l are considered to be protective in reservoirs and lakes; values below 20 mg/l MSC are considered protective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

Station	Upper		Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient
2000	3.30	Phosphorus	2.81	Nitrogen
2005	4.73	Co-limiting	3.58	Phosphorus
2010	8.20	Phosphorus	---	---

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Claiborne Reservoir stations collected April-October 2010. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2010). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.

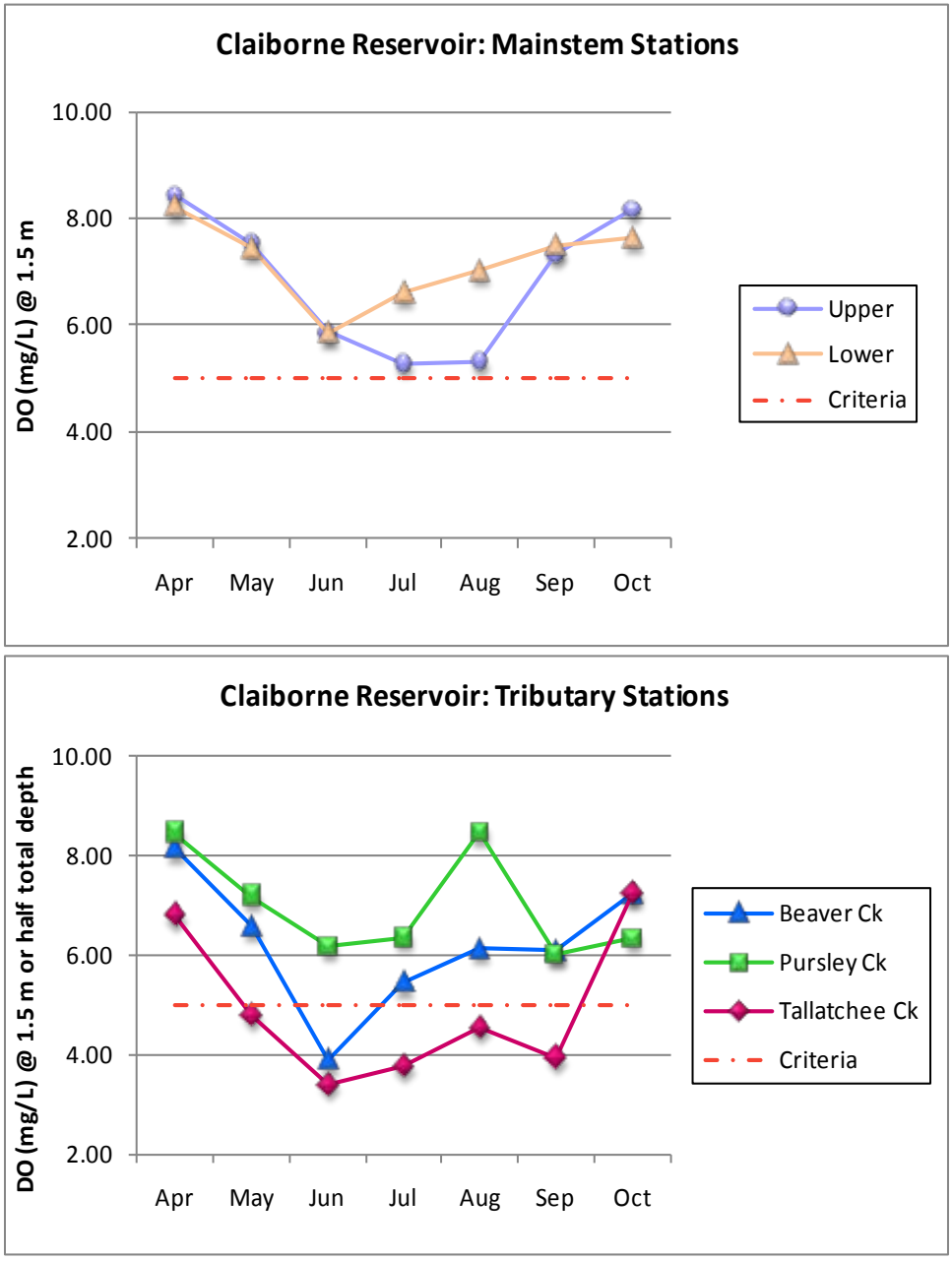


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the lower Claiborne Reservoir station, April-October 2010.

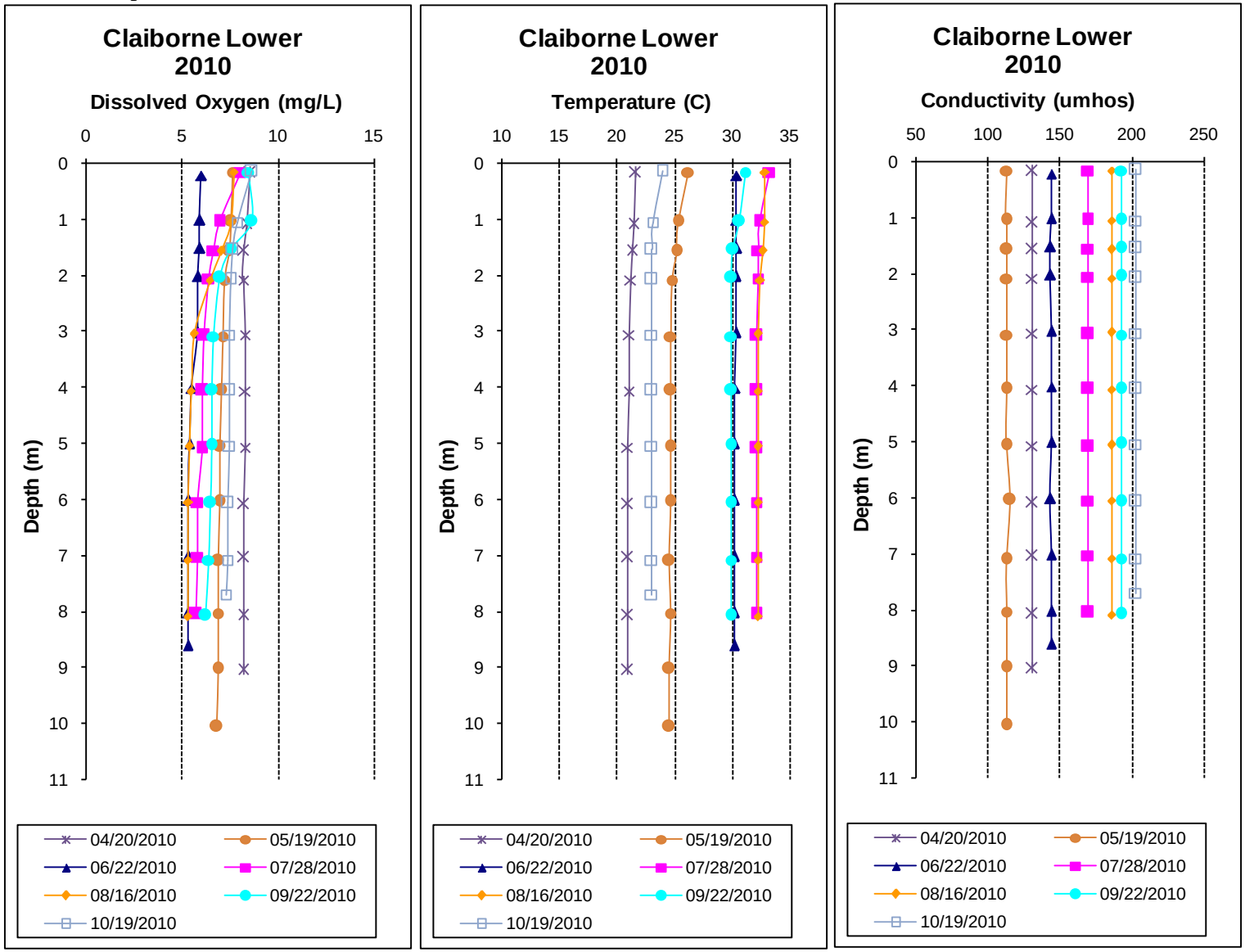


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the upper Claiborne Reservoir station, April-October 2010.

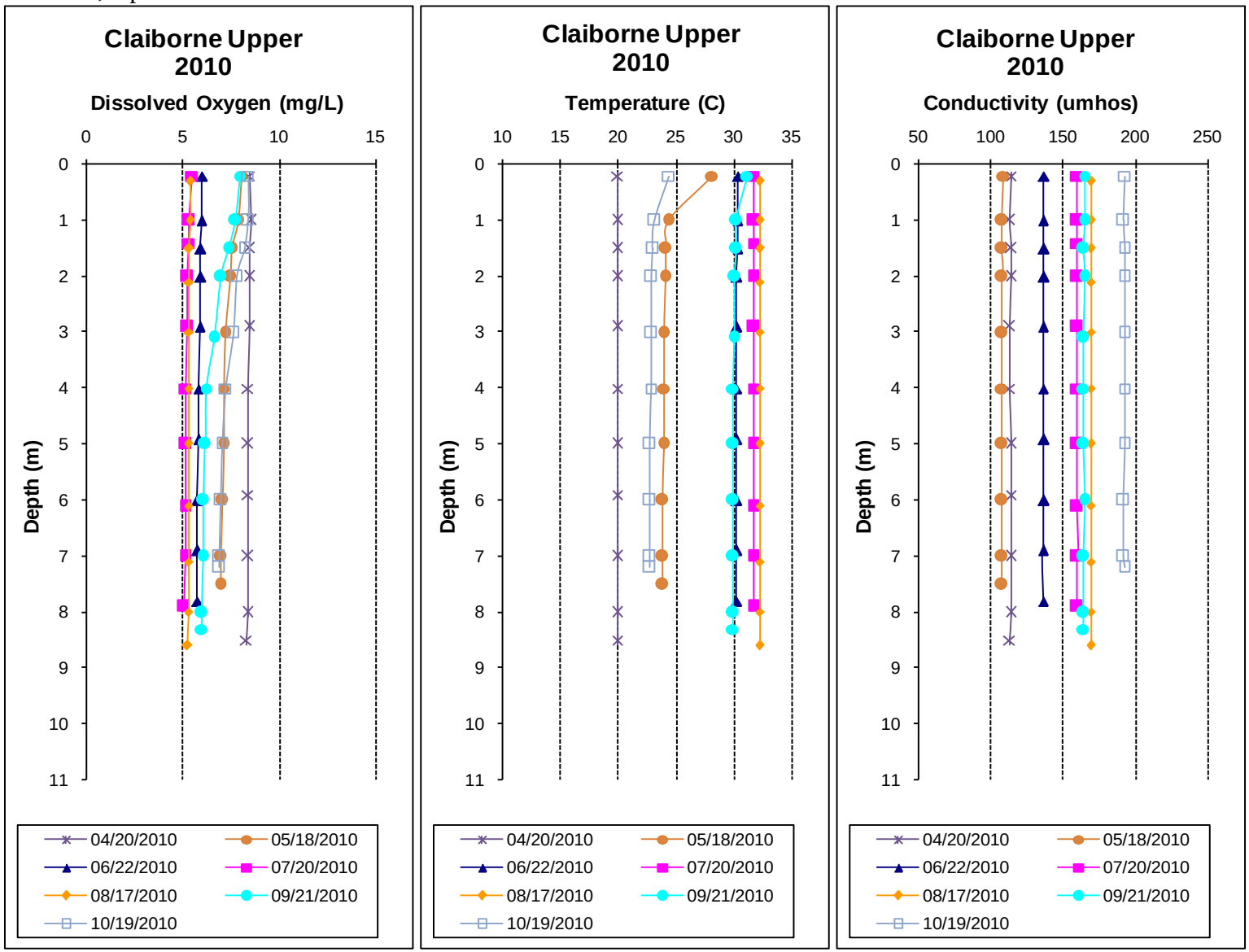
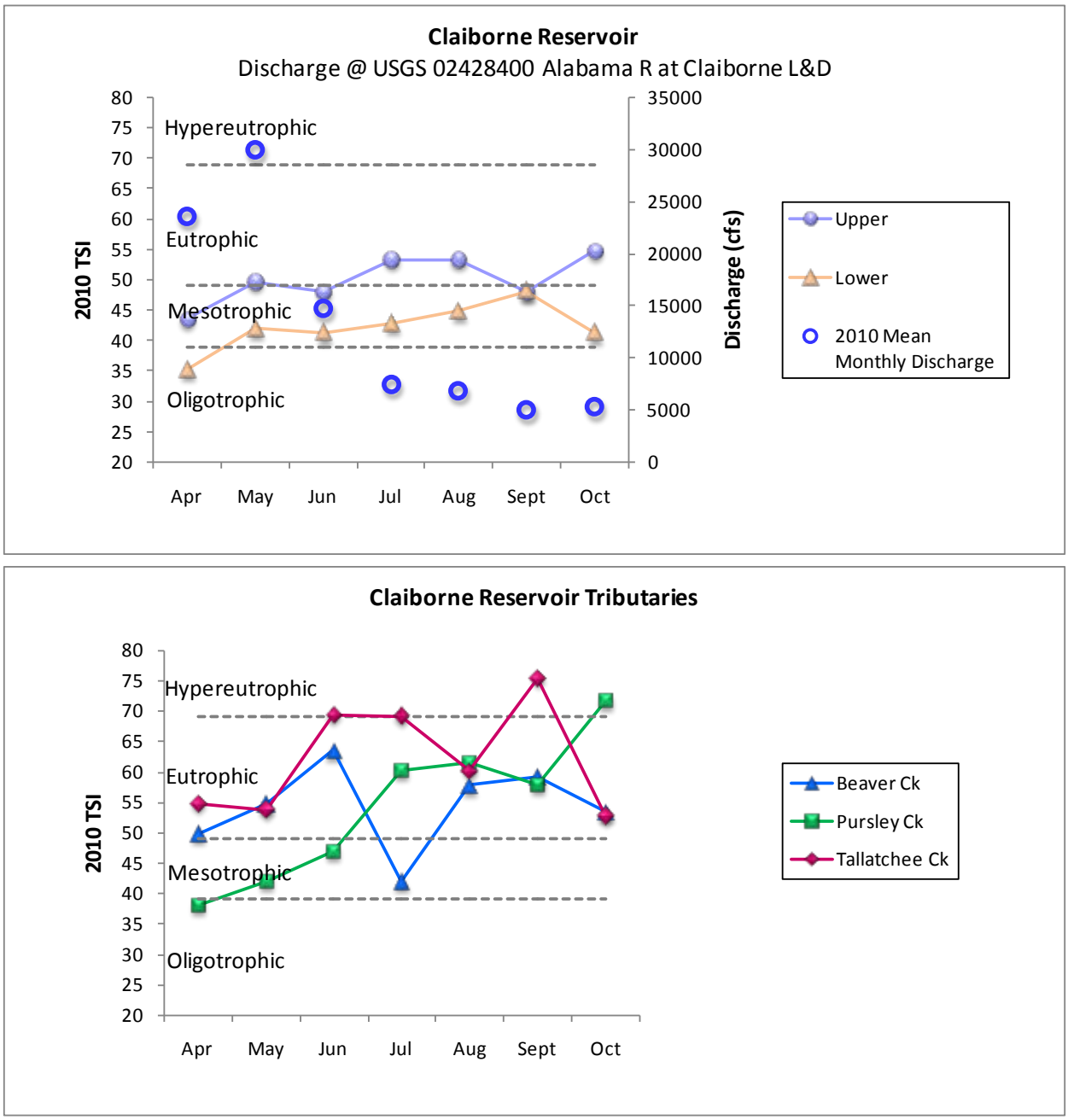


Figure 11. Monthly growing season TSI values for mainstem and tributary stations using chl *a* concentrations and Carlson's Trophic State Index calculation. TSI for mainstem stations were plotted vs. closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL)



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2010. 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
CLAM-1	**Physical**						
	Turbidity (NTU)	7	6.0	14.2	8.0	9.0	2.9
	Total Dissolved Solids (mg/L)	7	77.0	116.0	99.0	97.0	14.6
	Total Suspended Solids (mg/L)[J]	7	< 5.0	10.0	8.0	7.2	2.6
	Hardness (mg/L)	4	44.2	56.0	52.0	51.0	5.1
	Alkalinity (mg/L)	7	39.0	65.0	56.0	53.4	9.3
	Photic Zone (m)	7	2.53	3.50	2.83	2.91	0.35
	Secchi (m)	7	0.83	1.29	0.95	1.01	0.16
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.029	0.029	0.014	0.014	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.010	0.266	0.130	0.130	0.104
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.070	0.480	0.320	0.302	0.152
	Total Nitrogen (mg/L)[J]	7	< 0.154	0.686	0.510	0.433	0.212
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.012	0.006	0.007	0.004
	Total Phosphorus (mg/L)	7	0.026	0.036	0.030	0.031	0.004
	CBOD-5 (mg/L)[J]	7	< 1.0	1.1	0.5	0.6	0.2
	Chlorides (mg/L)	7	< 0.6	11.0	7.9	6.1	4.2
	Biological						
	Chlorophyll a (ug/L)	7	1.60	6.00	3.20	3.51	1.36
	E. coli (mpn/100mL)[J]	3	< 1	1	1	1	0
CLAM-2	**Physical**						
	Turbidity (NTU)	7	6.4	15.9	14.9	12.7	4.2
	Total Dissolved Solids (mg/L)[J]	7	68.0	122.0	94.0	92.9	17.5
	Total Suspended Solids (mg/L)[J]	7	5.0	13.0	9.0	9.3	2.9
	Hardness (mg/L)	4	41.5	56.6	48.6	48.8	6.5
	Alkalinity (mg/L)	7	41.2	66.7	57.1	53.9	9.3
	Photic Zone (m)	7	2.52	4.63	2.90	3.21	0.75
	Secchi (m)	7	0.76	1.78	0.91	1.07	0.39
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.018	0.222	0.105	0.108	0.073
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.029	0.484	0.320	0.249	0.206
	Total Nitrogen (mg/L)[J]	7	< 0.143	0.610	0.338	0.357	0.214
	Dissolved Reactive Phosphorus (mg/L)[J]	7	0.003	0.010	0.007	0.007	0.002
	Total Phosphorus (mg/L)	7	0.022	0.044	0.037	0.034	0.008
	CBOD-5 (mg/L)	7	< 2.0	2.5	1.0	1.4	0.7
	Chlorides (mg/L)	7	3.7	9.4	6.4	6.2	2.2
	Biological						
	Chlorophyll a (ug/L)	7	3.74	11.75	6.94	7.78	2.92
	E. coli (mpn/100mL)[J]	3	< 1	5	3	3	2

Station	Parameter	N	Min	Max	Med	Mean	SD
CLAM-3	**Physical**						
	Turbidity (NTU)	7	9.0	68.7	16.9	25.0	20.4
	Total Dissolved Solids (mg/L) [J]	7	88.0	124.0	106.0	102.0	13.0
	Total Suspended Solids (mg/L) [J]	7	6.0	104.0	15.0	26.1	34.6
	Hardness (mg/L)	4	42.1	51.6	48.6	47.7	4.2
	Alkalinity (mg/L)	7	40.2	59.9	53.4	50.6	8.3
	Photic Zone (m)	7	1.61	2.72	1.90	2.04	0.37
	Secchi (m)	7	0.57	0.94	0.73	0.75	0.16
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	< 0.002	0.104	0.037	0.045	0.037
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.854	0.373	0.423	0.264
	Total Nitrogen (mg/L)J	7	< 0.103	0.855	0.458	0.467	0.247
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.003	0.020	0.007	0.010	0.007
	Total Phosphorus (mg/L)	7	0.027	0.087	0.039	0.046	0.021
	CBOD-5 (mg/L)	7	< 2.0	4.5	1.0	2.0	1.4
	Chlorides (mg/L)	7	6.3	12.0	6.9	8.0	2.1
	Biological						
	Chlorophyll a (ug/L)	7	3.20	28.84	11.75	13.64	8.43
	E. coli (mpn/100mL) [J]	3	4	35	6	14	16
CLAM-4	**Physical**						
	Turbidity (NTU)	7	8.5	18.8	12.1	12.1	3.4
	Total Dissolved Solids (mg/L) [J]	7	118.0	180.0	138.0	144.0	26.0
	Total Suspended Solids (mg/L) [J]	7	7.0	16.0	11.0	10.9	3.4
	Hardness (mg/L)	4	55.6	107.0	94.2	87.7	23.0
	Alkalinity (mg/L)	7	61.7	97.6	71.7	77.0	13.2
	Photic Zone (m)	7	0.50	1.21	0.60	0.79	0.28
	Secchi (m)	7	0.32	0.93	0.60	0.63	0.21
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	0.003	0.036	0.011	0.017	0.014
	Total Kjeldahl Nitrogen (mg/L)	7	0.212	0.494	0.356	0.351	0.109
	Total Nitrogen (mg/L) [J]	7	0.219	0.497	0.392	0.368	0.109
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.004	0.020	0.010	0.011	0.007
	Total Phosphorus (mg/L)	7	0.029	0.042	0.037	0.037	0.004
	CBOD-5 (mg/L)	7	< 2.0	4.6	1.0	1.8	1.4
	Chlorides (mg/L)	7	6.0	8.8	7.2	7.3	1.0
	Biological						
	Chlorophyll a (ug/L)	7	2.14	66.22	16.02	19.53	22.28
	E. coli (mpn/100mL) [J]	3	9	162	41	70	81

Station	Parameter	N	Min	Max	Med	Mean	SD
CLAM-5	**Physical**						
	Turbidity (NTU)	7	21.9	44.0	34.7	32.3	7.4
	Total Dissolved Solids (mg/L) [J]	7	50.0	116.0	86.0	84.0	19.5
	Total Suspended Solids (mg/L)J	7	20.0	30.0	26.0	25.7	3.1
	Hardness (mg/L)	4	24.0	41.6	27.8	30.3	7.9
	Alkalinity (mg/L)	7	23.9	48.9	36.5	35.9	9.3
	Photic Zone (m)	7	0.98	1.75	1.30	1.29	0.24
	Secchi (m)	7	0.37	0.62	0.48	0.49	0.10
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.046	0.010	0.020	0.016
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	< 0.002	0.159	0.019	0.049	0.063
	Total Kjeldahl Nitrogen (mg/L)	7	0.279	0.782	0.608	0.558	0.175
	Total Nitrogen (mg/L) [J]	7	< 0.284	0.824	0.609	0.607	0.194
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.004	0.021	0.015	0.013	0.006
	Total Phosphorus (mg/L)	7	0.039	0.090	0.089	0.075	0.022
	CBOD-5 (mg/L)	7	< 2.0	5.6	2.7	2.9	1.4
	Chlorides (mg/L)	7	5.5	10.2	6.9	7.4	1.7
	Biological						
	Chlorophyll a (ug/L)	7	9.61	96.12	20.29	36.00	32.38
	E. coli (mpn/100mL) [J]	3	6	29	17	18	12

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