2015 Claiborne Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
December 2017

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LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
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).

The Alabama Department of Environmental Management (ADEM) monitored Claiborne Reservoir as part of the 2015 assessment of the Alabama River basin 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 2015 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*), 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 2015), 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 2015 results.

Figure 1. Claiborne Reservoir with 2015 sampling locations. A description of each sampling location is provided in Table 1.

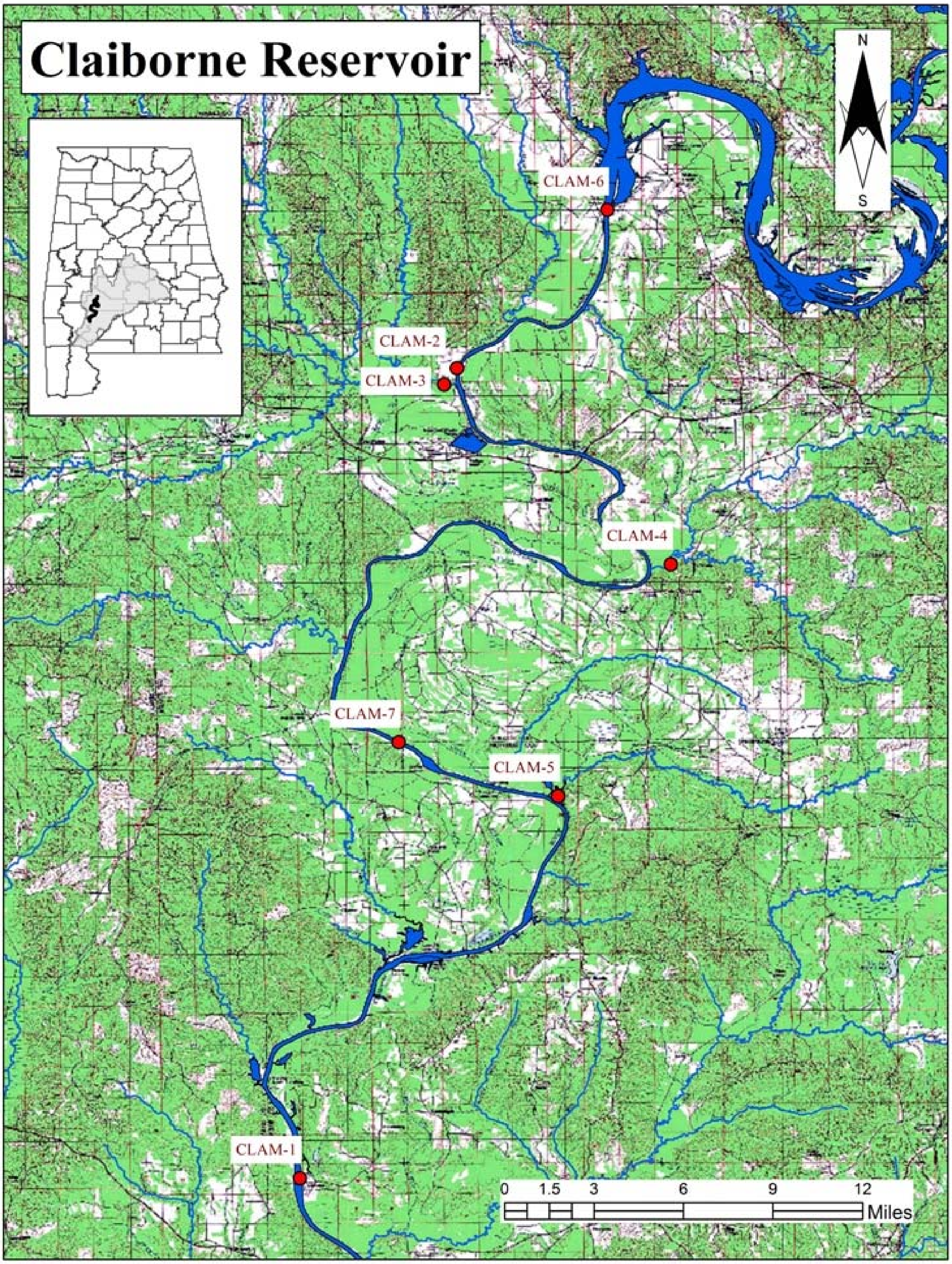


Table 1. Descriptions of the 2015 monitoring stations in Claiborne Reservoir.

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 fore bay.	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, & 10). Mean monthly discharge is included as an indicator of flow and retention time in the months sampled. Depth profile graphs of temperature, conductivity and DO appear in Fig. 9. Algal growth potential testing was not conducted on any sites on Claiborne Reservoir in 2015. Summary statistics of all data collected during 2015 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 2015, the highest mean growing season TN value was calculated for the upper reservoir station, although concentrations were similar reservoir-wide (Fig. 2). All stations showed an increase in mean concentrations compared to 2010. Monthly TN concentrations at the upper station were above historic means three of the seven months sampled and were at historic highs in April and July (Fig. 4). The lower station concentrations were above historic means four of the seven months sampled and at a historic high in April.

In 2015, the highest mean growing season TP value was calculated for the Tallatchee Creek station (Fig. 2). Mean growing season TP concentrations were similar at the upper and lower stations, the lowest ever measured. Both stations show a decreasing trend in mean values since 2003. All three tributaries showed a decrease in mean concentrations since 2005. Monthly TP concentrations at both mainstem stations were below historic means the entire growing season (Fig. 5). Historic lows occurred at the upper mainstem location in April and July. Concentrations in the lower station were at historic lows in April, June-July, and September.

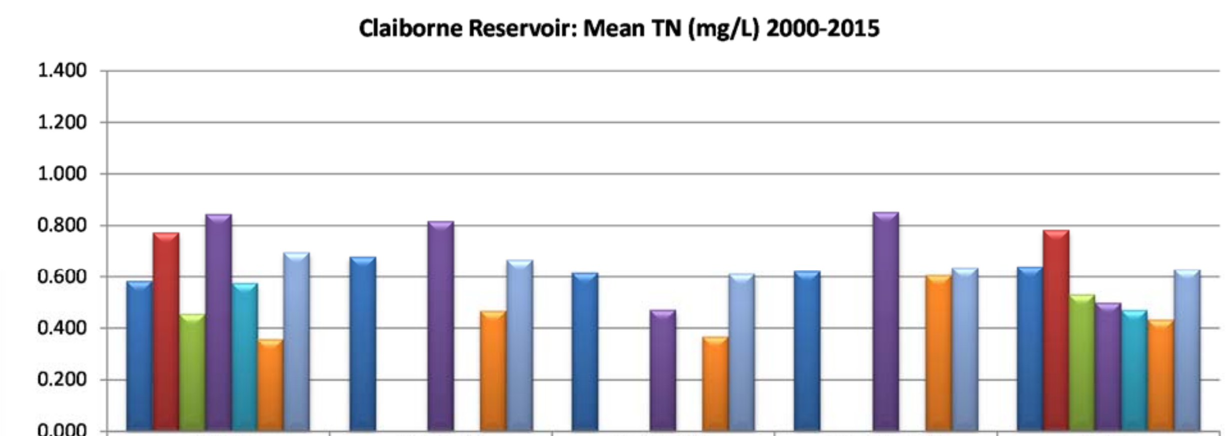
In 2015, the highest mean growing season chl *a* value was calculated for the Tallatchee Creek station (Fig. 3). Growing season mean chl *a* concentrations at both the upper and lower stations were among the lowest ever calculated. All three tributaries showed a decrease in mean concentrations compared to 2010. The mean chl *a* concentration in lower Claiborne station was below the established criterion, though the mean concentration was near the limit in 2008. Monthly chl *a* concentrations for both mainstem stations were below historic means April-October and historically low in several months sampled (Fig. 6).

In 2015, the highest mean growing season TSS value was calculated for the Tallatchee Creek station (Fig. 3). The mean TSS concentration was lower in 2015 than in 2010 at the Beaver Ck station while both mainstem stations, Pursley Ck, and Tallatchee Ck showed an increase compared to 2010. All monthly TSS concentrations were near or below historic mean values at both the upper and lower stations except for one October historic high in the lower station (Fig. 7).

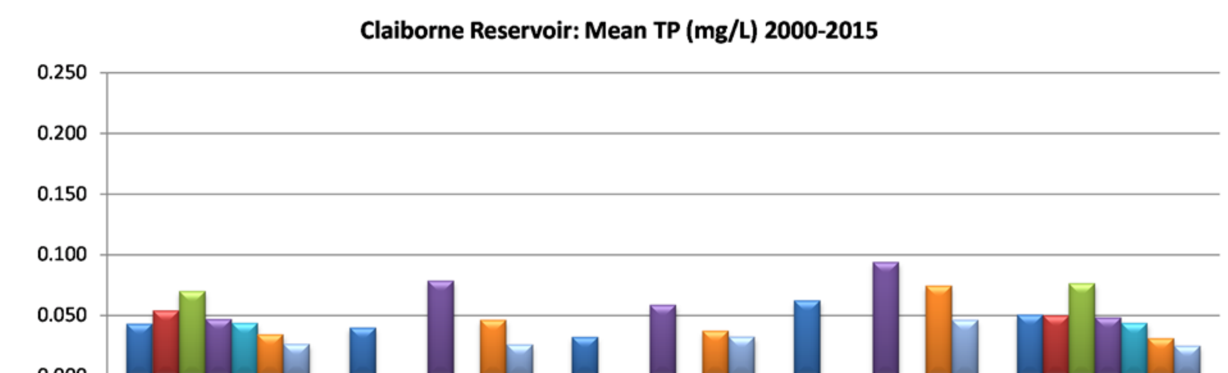
DO concentrations at the Tallatchee station were below the ADEM criteria limit of 5.0 mg/l at 5.0 ft (1.5 m) April and June-September (2010) (Fig. 8). All measurements of DO concentrations in the mainstem stations met the criteria limit, though the upper station was near the limit in June, July, and September. The DO profile of the lower station show the water column was mixed most of the sampling season with some surface stratification occurring in June, July, and August. Highest temperatures were reached in July (Figs. 9).

The highest TSI values came from Tallatchee Creek which reached upper eutrophic conditions in August, September, and October (Fig. 10). TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. TSI values at both mainstem stations generally varied between oligotrophic and mesotrophic status. When flows fell below 10,000 cfs, the reservoir tended to more eutrophic. Beaver Ck, Pursley Ck, and Tallatchee Ck stations increased from oligotrophic conditions in April to eutrophic conditions in August when the mainstem flows were lowest.

Figure 2. Growing season mean TN and TP concentrations measured in Claiborne Reservoir, April-October 2000-2015. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.



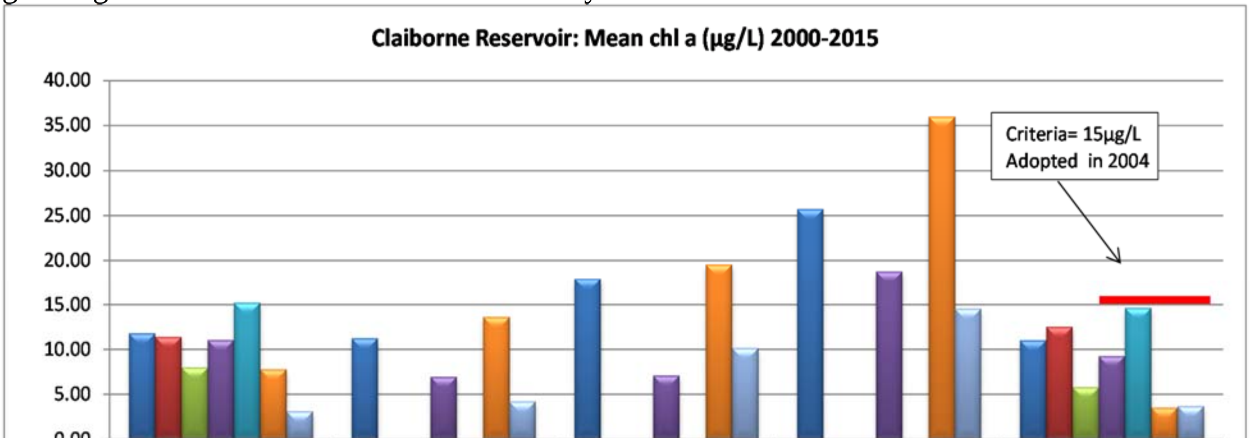
	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	0.583	0.679 *	0.616 *	0.622 *	0.640
2002	0.773				0.783
2003	0.455				0.531
2005	0.845	0.817	0.471	0.853	0.499
2008	0.575				0.471
2010	0.357	0.467	0.368	0.607	0.433
2015	0.697	0.667	0.612	0.635	0.629



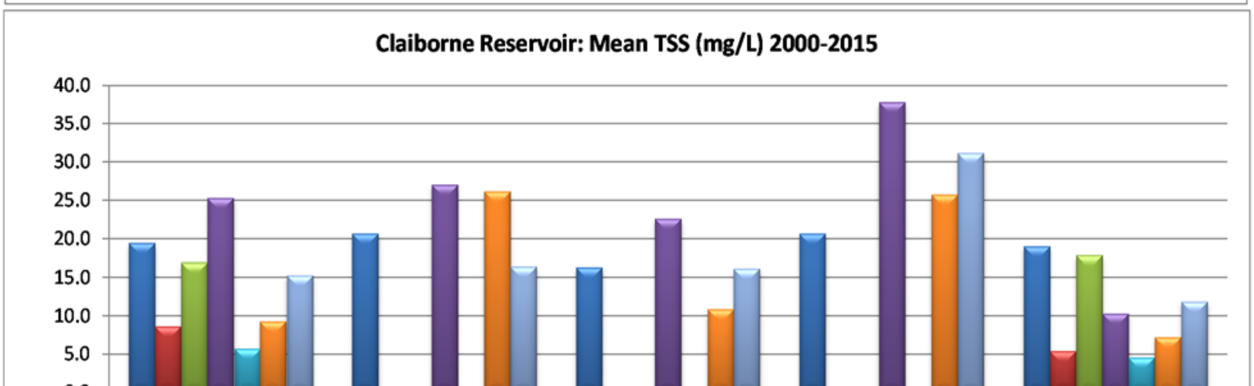
	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	0.043	0.040 *	0.032 *	0.062 *	0.051
2002	0.054				0.050
2003	0.070				0.076
2005	0.047	0.079	0.059	0.094	0.048
2008	0.044				0.044
2010	0.034	0.046	0.037	0.075	0.031
2015	0.026	0.026	0.032	0.046	0.025

*Mean of April/June/August only.

Figure 3. Growing season mean chl *a* and TSS concentrations measured in Claiborne Reservoir, April-October 2000-2015. 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.



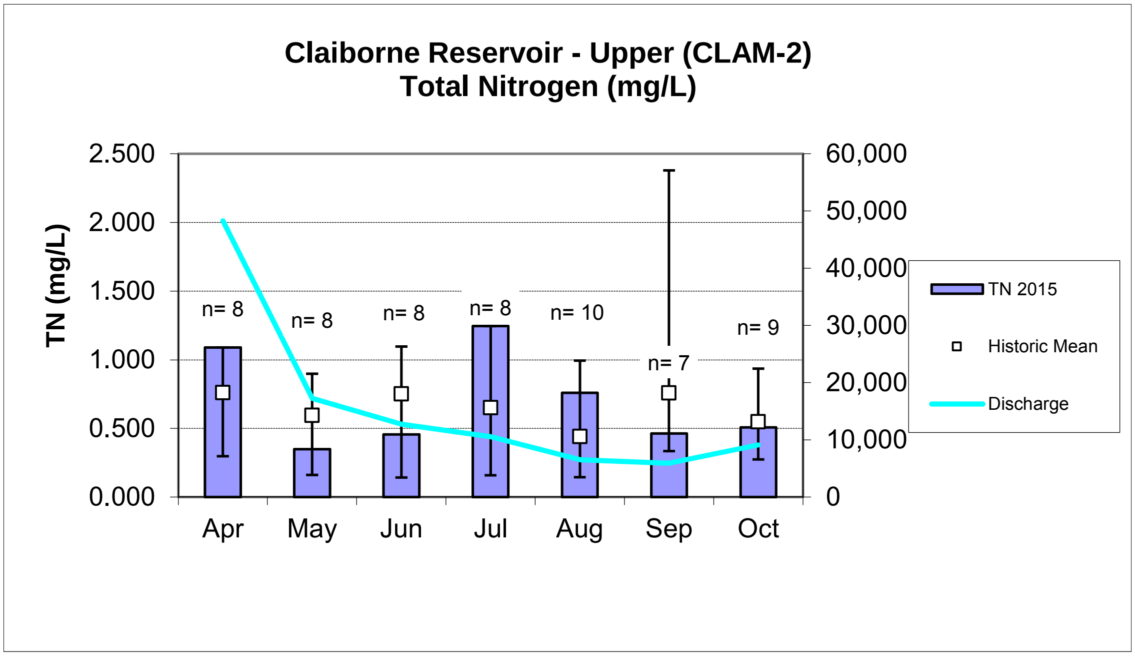
	Upper	Beaver Ck	Pursley Ck	Tallatchee Ck	Lower
2000	11.80	11.28 *	17.92 *	25.73 *	11.05
2002	11.42				12.53
2003	7.99				5.79
2005	11.06	6.94	7.09	18.77	9.26
2008	15.22				14.64
2010	7.78	13.64	19.53	36.00	3.51
2015	3.09	4.20	10.18	14.55	3.68



	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
2015	15.3	16.4	16.1	31.1	11.9

*Mean of April/June/August only.

Figure 4. Monthly TN concentrations of mainstem stations measured in Claiborne Reservoir, April-October 2015**.** 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).



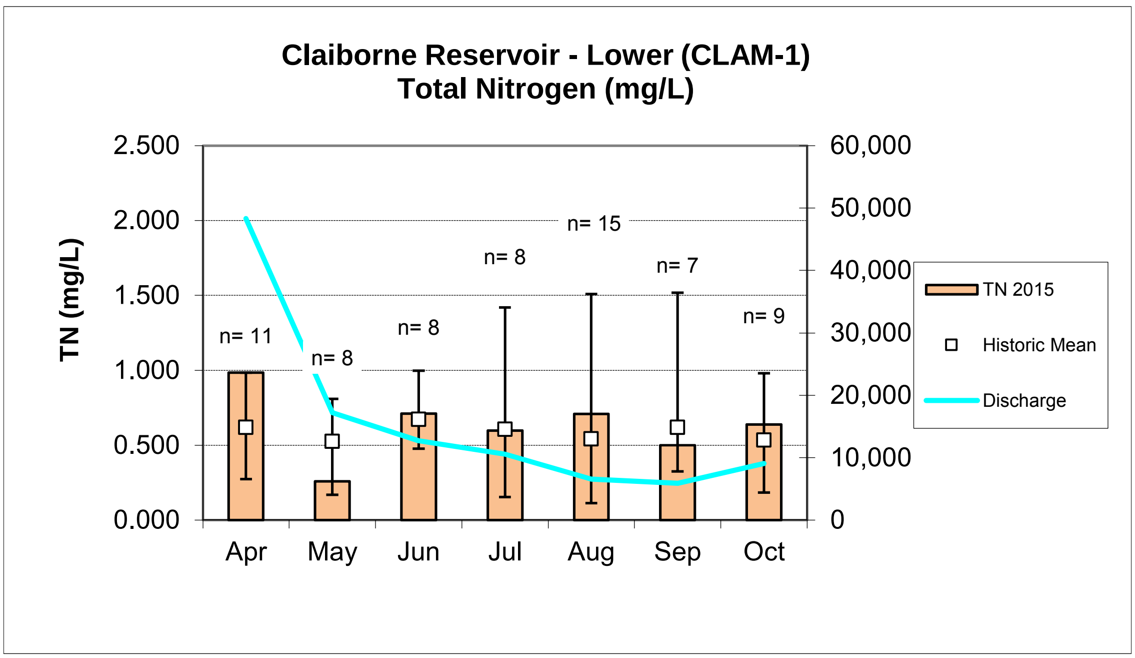
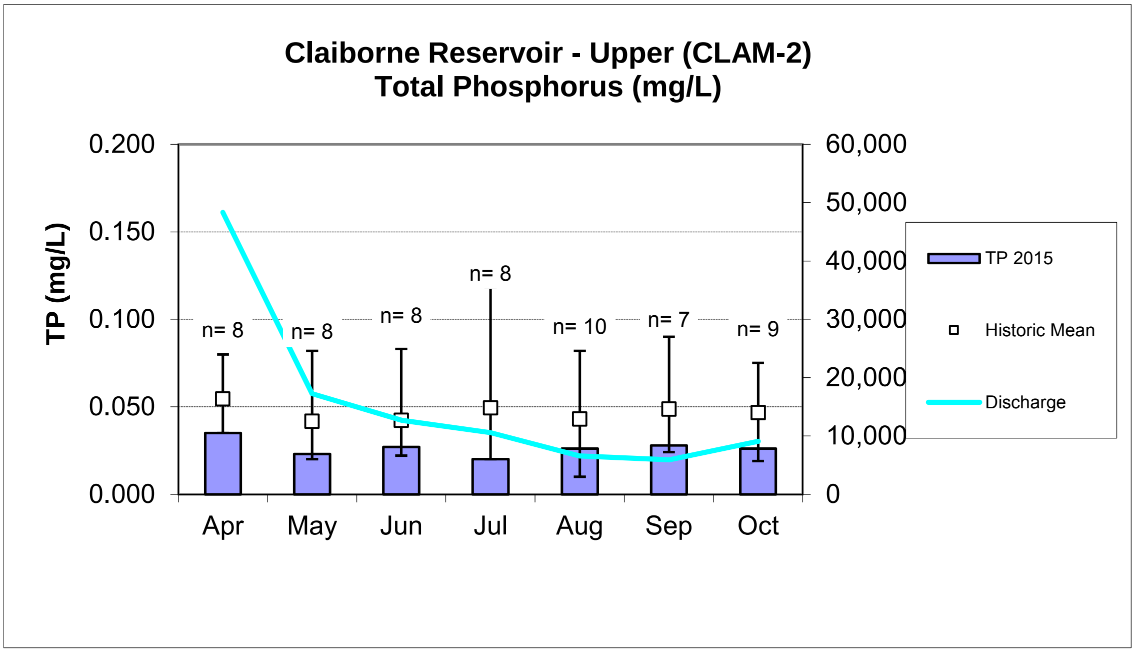


Figure 5. Monthly TP concentrations of mainstem stations measured in Claiborne Reservoir, April-October 2015. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).



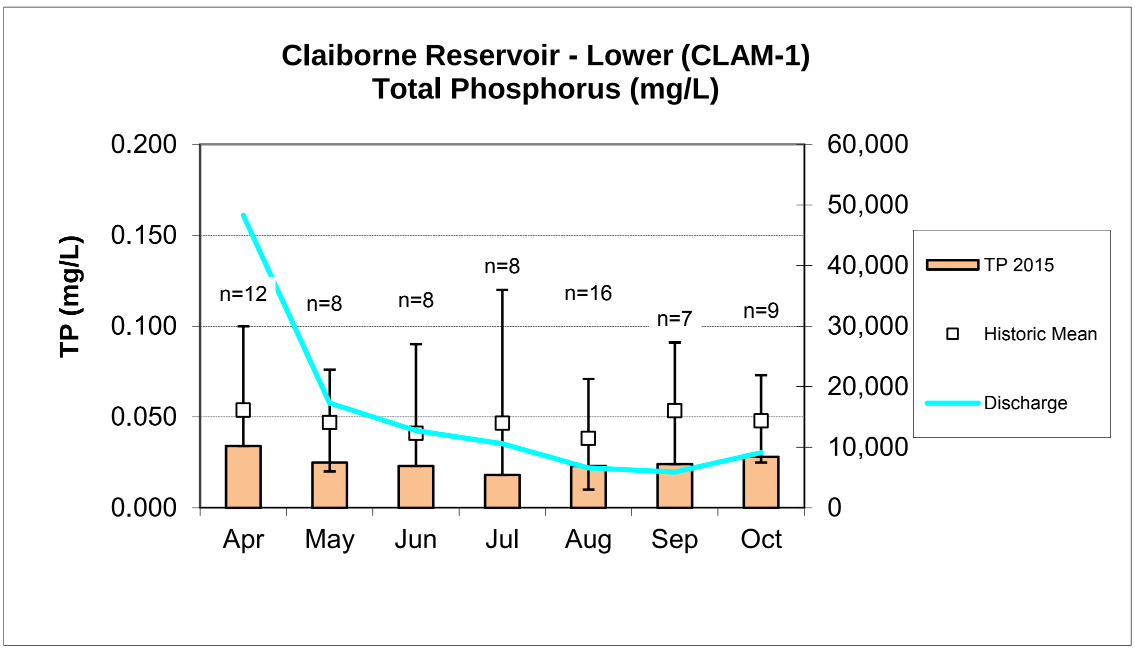
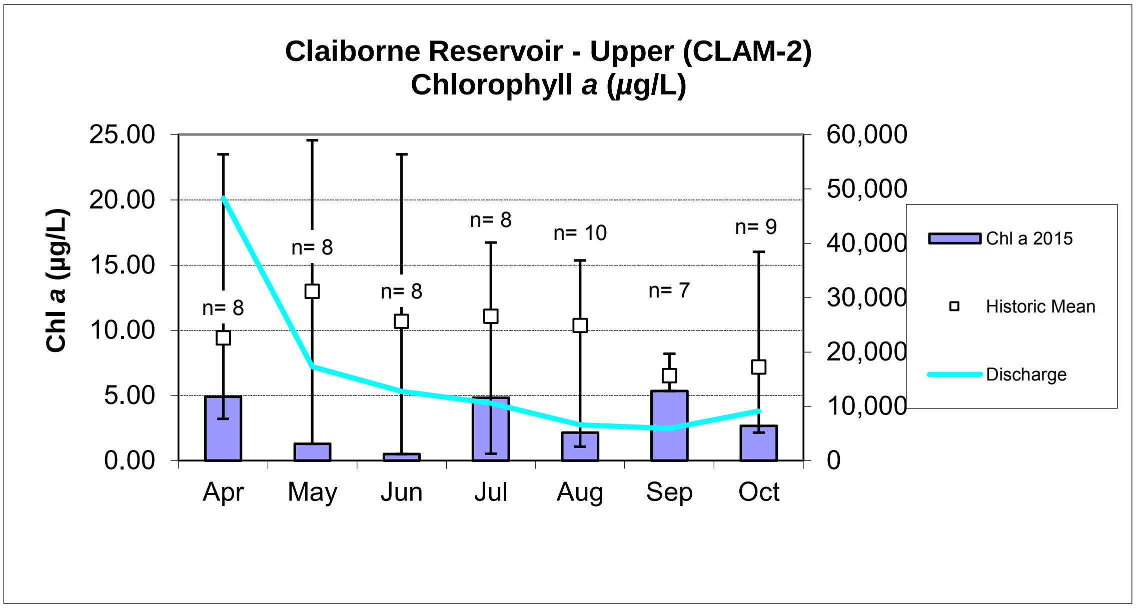


Figure 6. Monthly chl *a* concentrations of mainstem stations measured in Claiborne Reservoir, April-October 2015. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Chl *a* was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).



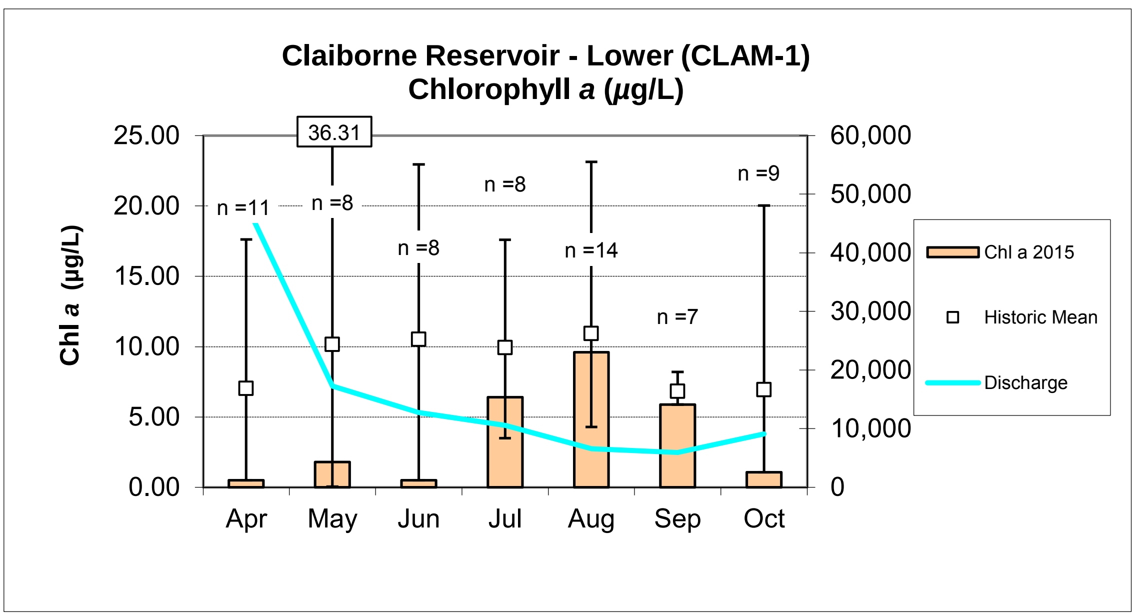
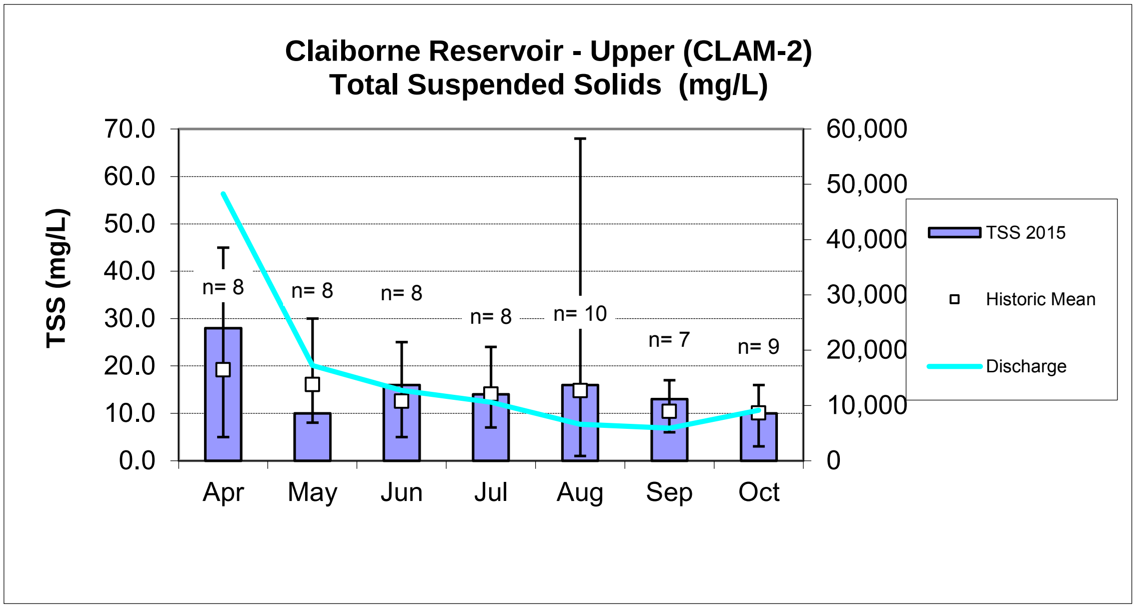


Figure 7. Monthly TSS concentrations of mainstem stations measured in Claiborne Reservoir, April-October 2015. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TSS was plotted vs. the closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL).



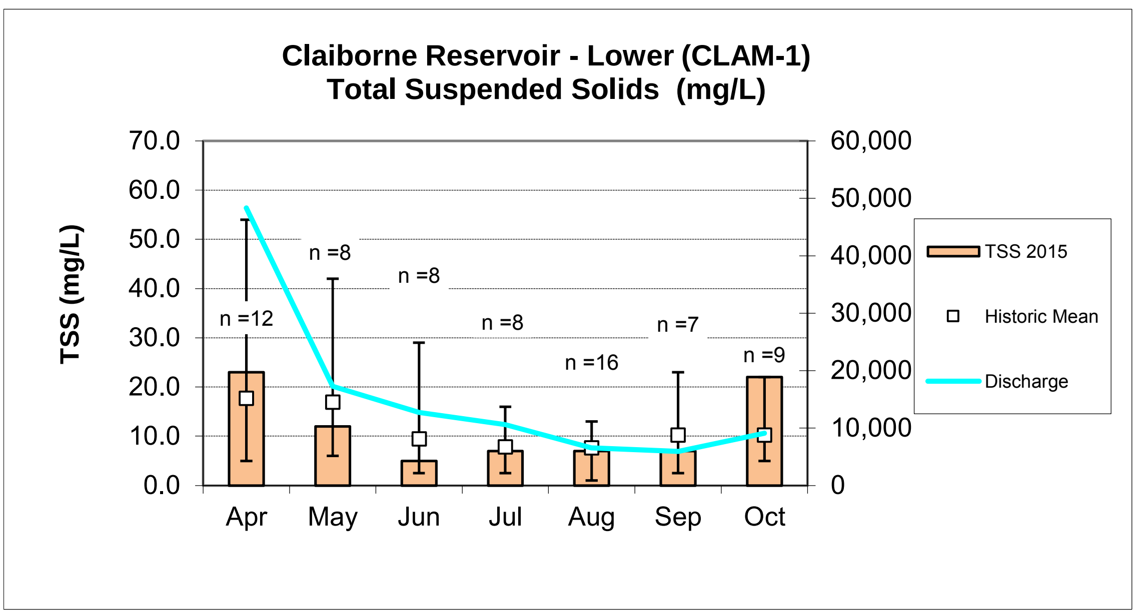
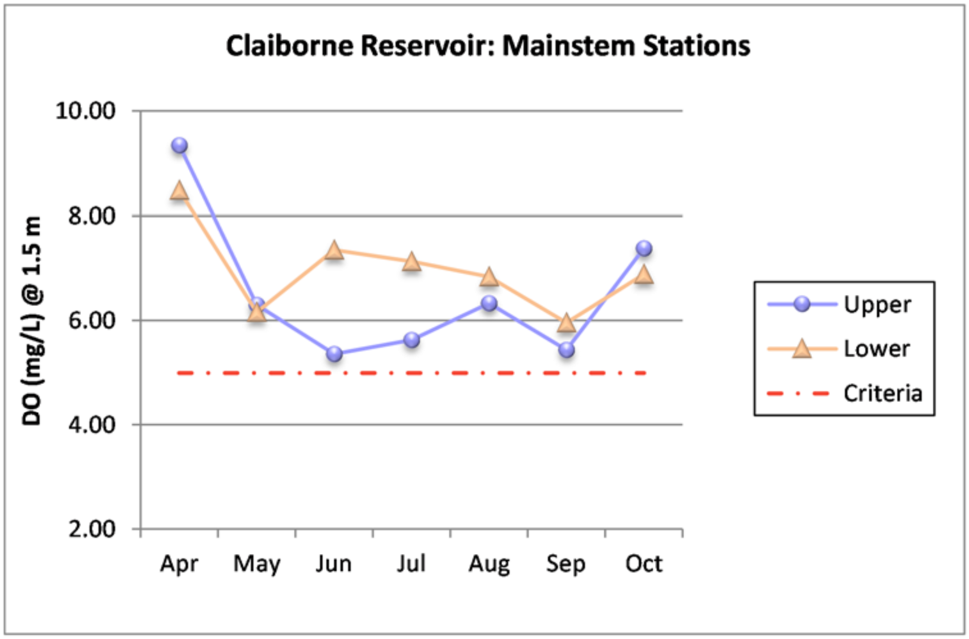


Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Claiborne Reservoir stations collected April-October 2015. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2010). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.



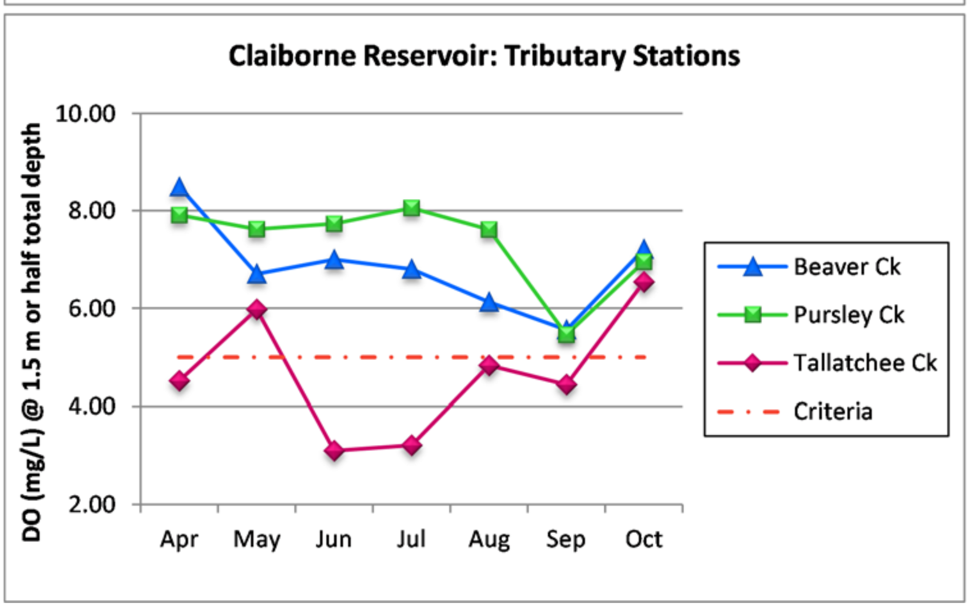


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in the lower Claiborne Reservoir station, April-October 2015.

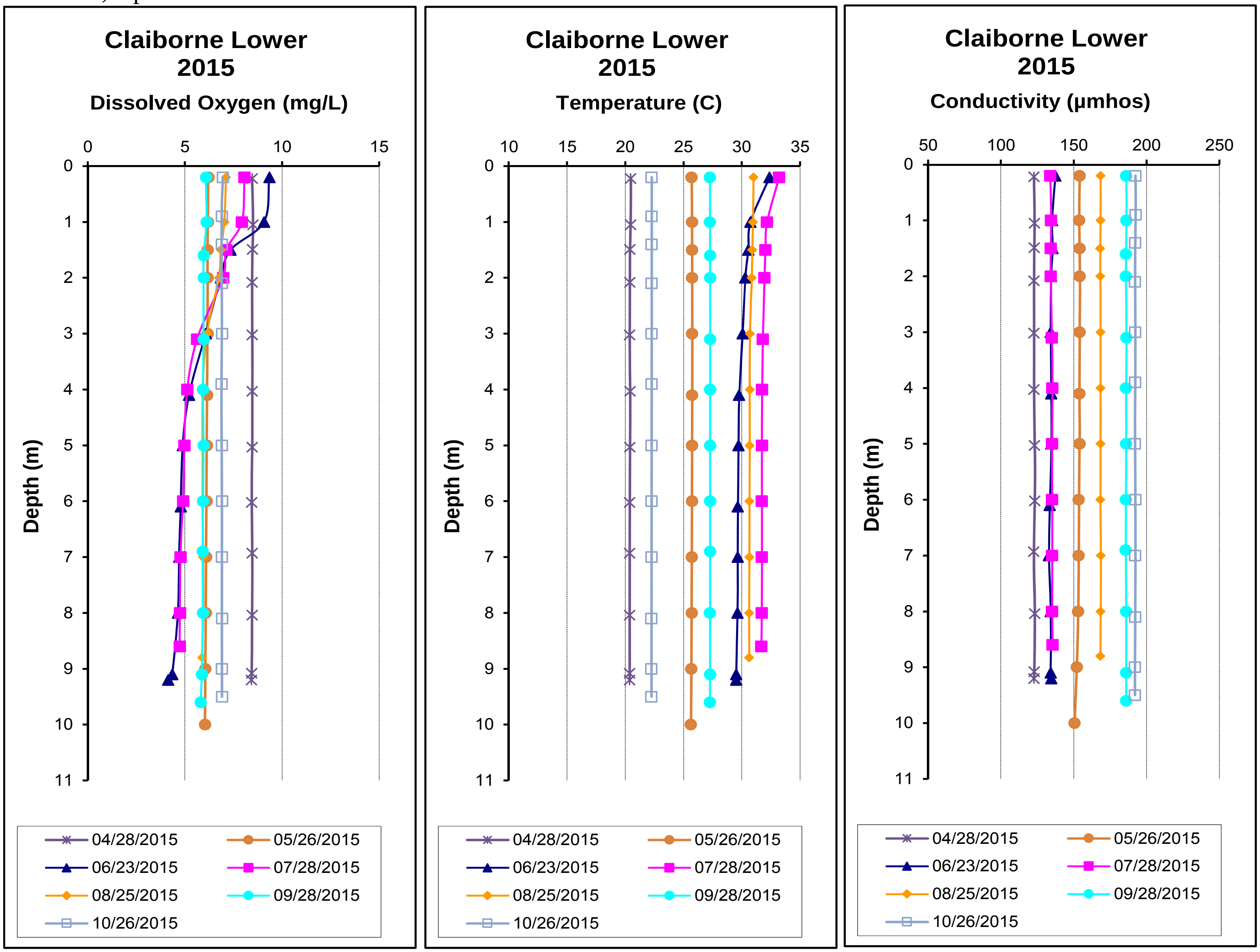
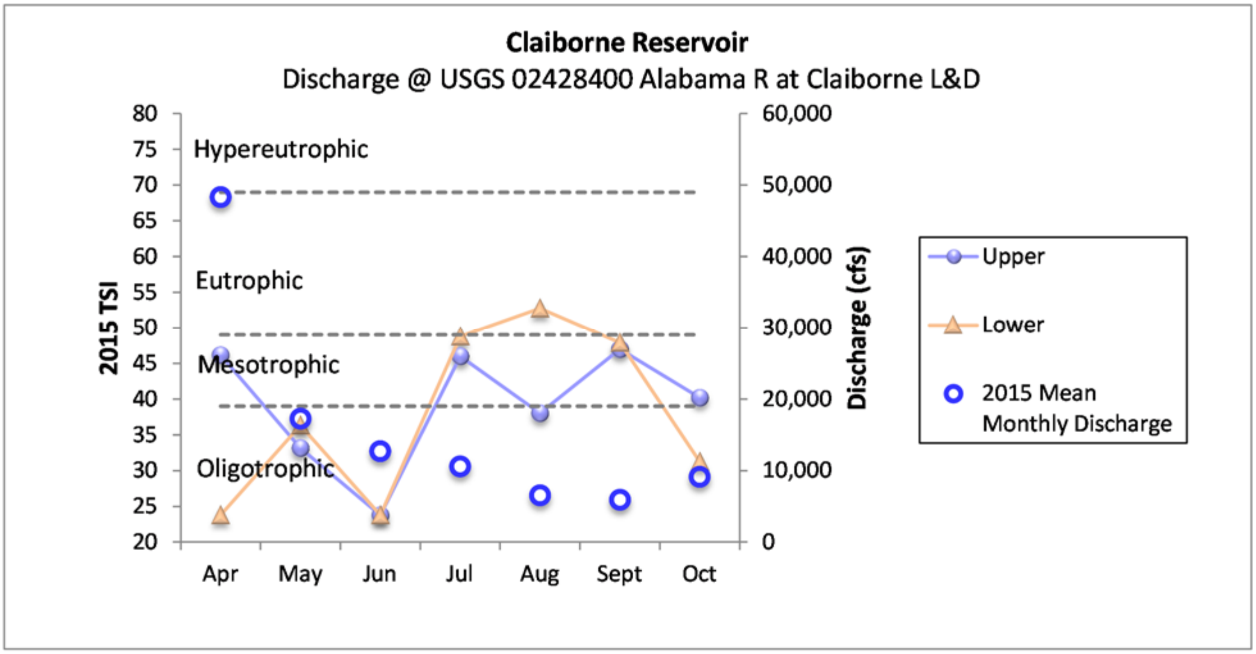
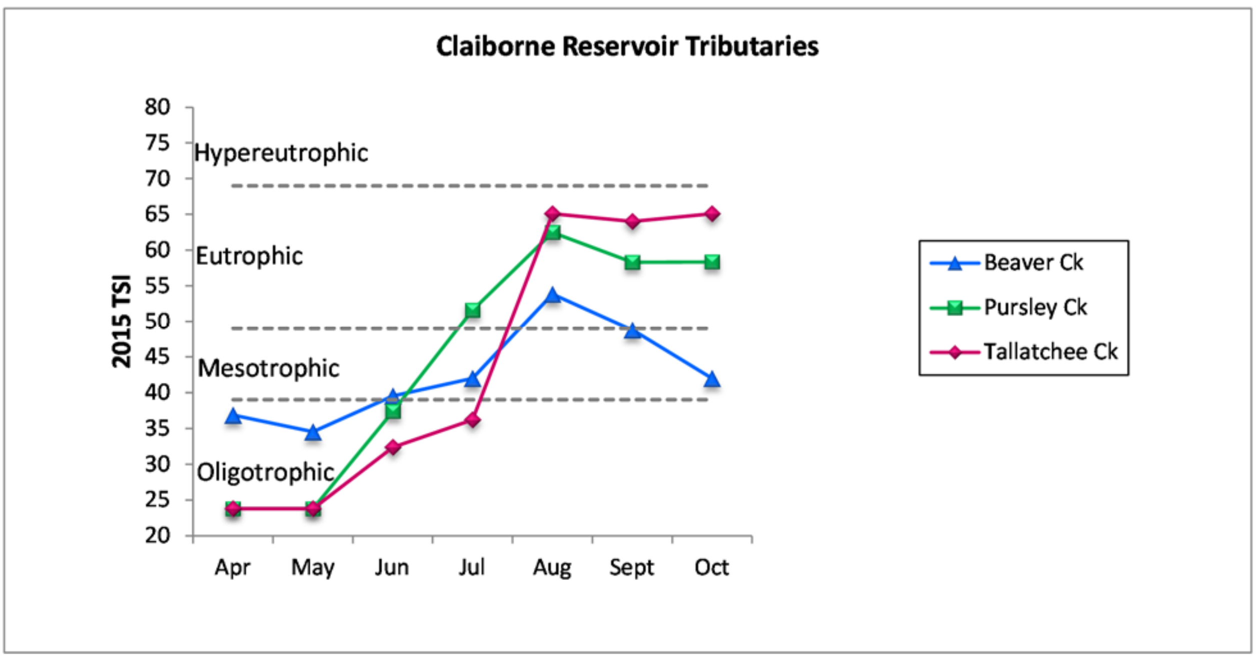


Figure 10. Monthly TSI values, April-October 2015 for mainstem and tributary stations using chl *a* concentrations and Carlson's Trophic State Index calculation. TSI for mainstem stations were plotted vs. closest discharge (USGS 02428400 Alabama River at Claiborne L&D near Monroeville, AL)





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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2015. 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		5.8	19.5	7.0	9.0	4.8
	Total Dissolved Solids (mg/L)	7		85.0	112.0	91.0	95.9	10.4
	Total Suspended Solids (mg/L)	7		5.0	23.0	7.0	11.9	7.6
	Hardness (mg/L)	4		46.4	61.2	56.2	55.0	7.0
	Alkalinity (mg/L)	7		45.7	64.5	54.8	55.2	7.2
	Photic Zone (m)	7		2.06	3.65	3.50	3.22	0.57
	Secchi (m)	7		0.88	1.80	1.22	1.23	0.30
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.010	0.113	0.017	0.031	0.039
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.018	0.158	0.039	0.072	0.058
	Total Kjeldahl Nitrogen (mg/L)	7		0.188	0.827	0.567	0.557	0.206
	Total Nitrogen (mg/L)[J]	7		0.259	0.985	0.639	0.629	0.222
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.004	0.013	0.009	0.007	0.004
	Total Phosphorus (mg/L)	7		0.018	0.034	0.024	0.025	0.005
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.3	9.9	5.9	6.8	1.9
	Biological							
	Chlorophyll a (mg/m^3)	7	<	1.00	9.61	1.80	3.68	3.60
	E. coli (MPN/DL)[J]	3	<	1	23	4	9	12
CLAM-2	Physical							
	Turbidity (NTU)	7		9.5	25.0	11.0	13.2	5.6
	Total Dissolved Solids (mg/L)	7		68.0	114.0	90.0	92.1	15.2
	Total Suspended Solids (mg/L)	7		10.0	28.0	14.0	15.3	6.1
	Hardness (mg/L)	4		51.0	66.3	58.6	58.6	7.3
	Alkalinity (mg/L)	7		45.2	67.1	57.7	57.4	7.6
	Photic Zone (m)	7		1.72	3.75	2.72	2.71	0.60
	Secchi (m)	7		0.59	1.20	0.93	0.93	0.25
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.010	0.105	0.031	0.046	0.041
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.057	0.147	0.091	0.093	0.031
	Total Kjeldahl Nitrogen (mg/L)	7		0.272	1.190	0.418	0.603	0.350
	Total Nitrogen (mg/L)	7		0.350	1.247	0.509	0.697	0.348
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.005	0.010	0.009	0.008	0.002
	Total Phosphorus (mg/L)	7		0.020	0.035	0.026	0.026	0.005
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.2	10.0	6.3	7.0	1.9
	Biological							
	Chlorophyll a (mg/m^3)	7	<	1.00	5.34	2.67	3.09	1.93
	E. coli (MPN/DL)[J]	3	<	1	4	3	3	2

Station	Parameter	N		Min	Max	Med	Mean	SD
CLAM-3	**Physical**							
	Turbidity (NTU)	7		6.6	69.3	9.9	18.3	22.7
	Total Dissolved Solids (mg/L)	7		80.0	111.0	98.0	96.1	10.7
	Total Suspended Solids (mg/L)	7		6.0	58.0	9.0	16.4	18.7
	Hardness (mg/L)	4		46.9	64.6	58.6	57.2	8.0
	Alkalinity (mg/L)	7		38.2	67.6	56.3	54.1	11.6
	Photic Zone (m)	7		1.09	3.78	2.83	2.68	0.97
	Secchi (m)	7		0.26	1.25	0.98	0.90	0.34
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.010	0.079	0.018	0.033	0.032
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.022	0.119	0.084	0.074	0.034
	Total Kjeldahl Nitrogen (mg/L)	7		0.446	0.880	0.561	0.593	0.140
	Total Nitrogen (mg/L)	7		0.533	0.902	0.657	0.667	0.125
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.003	0.012	0.008	0.007	0.003
	Total Phosphorus (mg/L)	7		0.017	0.047	0.025	0.026	0.010
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.4	10.2	6.3	7.1	1.9
	Biological							
	Chlorophyll a (mg/m^3)	7		1.50	10.70	3.20	4.20	3.28
	E. coli (MPN/DL)[J]	3		6	1,120	17	380	639
CLAM-4	**Physical**							
	Turbidity (NTU)	7		9.0	45.4	10.2	17.5	13.5
	Total Dissolved Solids (mg/L)	7		87.0	159.0	113.0	118.0	22.8
	Total Suspended Solids (mg/L)	7		8.0	46.0	12.0	16.1	13.5
	Hardness (mg/L)	4		64.2	73.8	70.5	69.8	4.4
	Alkalinity (mg/L)	7		48.3	92.8	62.0	66.3	14.3
	Photic Zone (m)	7		0.60	2.46	0.80	1.01	0.65
	Secchi (m)	7		0.36	0.98	0.70	0.67	0.23
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.079	0.023	0.032	0.032
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.132	0.045	0.051	0.046
	Total Kjeldahl Nitrogen (mg/L)	7		0.259	0.910	0.479	0.561	0.247
	Total Nitrogen (mg/L)[J]	7	<	0.344	0.924	0.549	0.612	0.215
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.004	0.015	0.007	0.008	0.004
	Total Phosphorus (mg/L)	7		0.020	0.049	0.029	0.032	0.010
	CBOD-5 (mg/L)	7	<	2.0	2.1	1.0	1.2	0.4
	Chlorides (mg/L)	7		4.8	9.7	6.8	7.1	1.6
	Biological							
	Chlorophyll a (mg/m^3)	7	<	1.00	25.80	8.54	10.18	9.94
	E. coli (MPN/DL)[J]	3		16	649	69	245	351

Station	Parameter	N		Min	Max	Med	Mean	SD
CLAM-5	Physical							
	Turbidity (NTU)	7		21.6	61.4	30.5	34.2	13.5
	Total Dissolved Solids (mg/L)	7		61.0	89.0	75.0	76.6	9.7
	Total Suspended Solids (mg/L)	7		16.0	55.0	29.0	31.1	12.9
	Hardness (mg/L)	4		21.6	37.2	30.0	29.7	7.1
	Alkalinity (mg/L)	7		17.5	37.9	31.8	29.6	7.5
	Photic Zone (m)	7		0.90	1.50	1.28	1.25	0.25
	Secchi (m)	7		0.24	0.56	0.42	0.41	0.11
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.010	0.074	0.069	0.045	0.033
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.001	0.178	0.001	0.041	0.066
	Total Kjeldahl Nitrogen (mg/L)	7		0.439	0.720	0.602	0.595	0.103
	Total Nitrogen (mg/L)	7	<	0.488	0.721	0.634	0.635	0.077
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.004	0.010	0.006	0.007	0.003
	Total Phosphorus (mg/L)	7		0.038	0.075	0.044	0.046	0.013
	CBOD-5 (mg/L)	7	<	2.0	4.8	1.0	1.7	1.4
	Chlorides (mg/L)	7		4.7	10.3	7.6	7.5	1.8
	Biological							
	Chlorophyll a (mg/m^3)	7	<	1.00	33.80	1.78	14.55	16.96
	E. coli (MPN/DL)[J]	3		47	308	51	135	149

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