2005 Claiborne Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
January 15, 2010

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INTRODUCTION

The Alabama Department of Environmental Management (ADEM) monitored Claiborne Reservoir as part of the 2005 assessment of the Alabama, Coosa, and Tallapoosa (ACT) River basins under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the objectives of this program were to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria.

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 classifications. 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.

Specific water quality criteria for nutrient management were implemented in 2004 at one location on Claiborne Reservoir (Table 1). These criteria represent 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 2005 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 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 (SOP), Surface Water Quality Assurance Project Plan (QAPP), and Quality Management Plan (QMP).

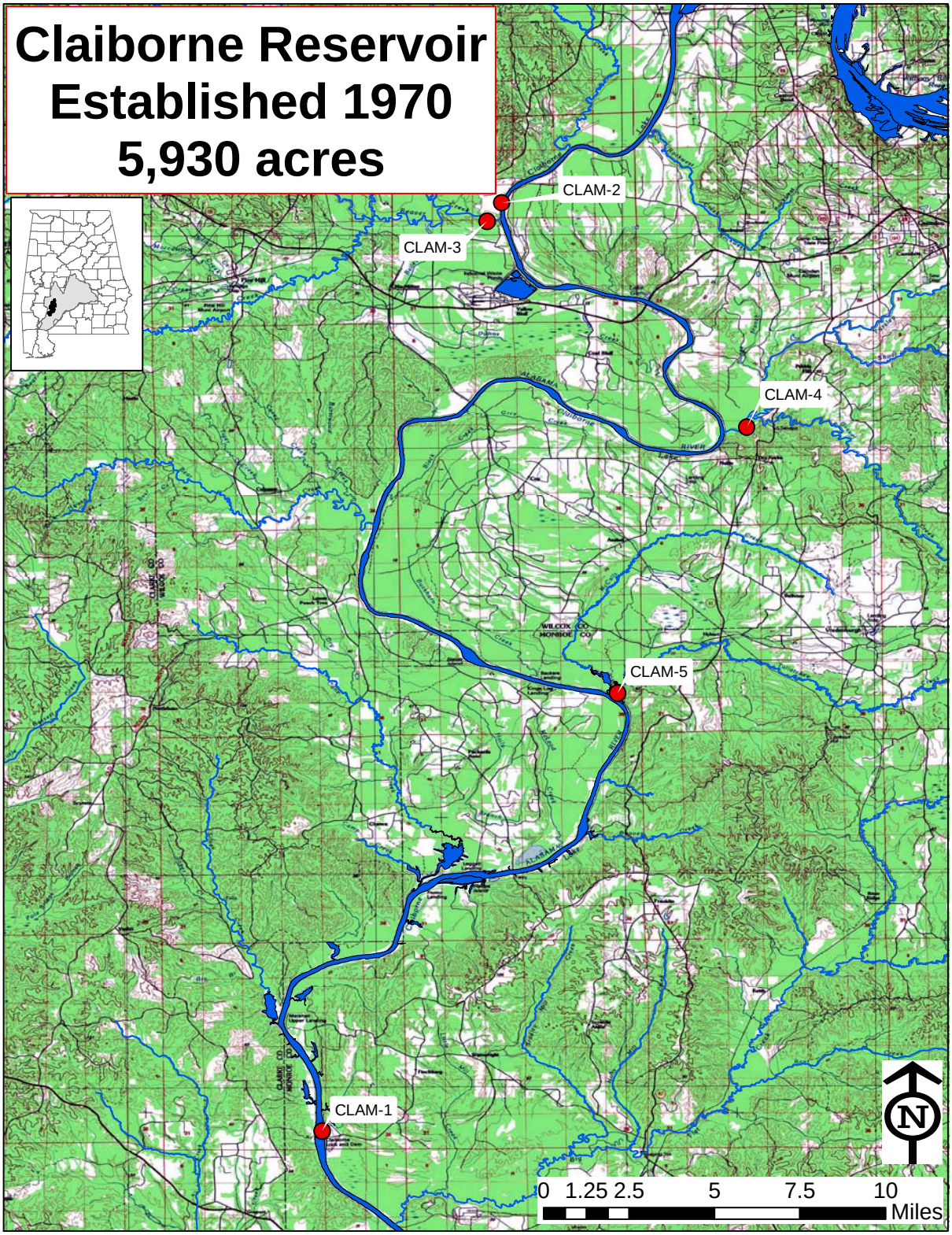


Figure 1. Claiborne Reservoir sampling locations, 2005.

Table 1. Descriptions for the monitoring stations in 2005 for Claiborne Reservoir.

Sub-watershed	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria	Latitude	Longitude
Claiborne Reservoir								
Middle Alabama (0315-0203)								
0703	Wilcox	CLAM-2	Upper	Alabama R	Upper reservoir. Deepest point, main river channel, approximately 0.5 miles upstream of Beaver Creek confluence.		32.0106	-87.4744
0604	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
0802	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
Lower Alabama (0315-0204)								
0105	Monroe	CLAM-1**	Lower	Alabama R	Lower reservoir. Deepest point, main river channel, dam forebay.	15 ug/L	31.6174	-87.5506
0101	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 criteria implemented at this station in 2004

RESULTS

Summary statistics of all data collected during 2005 are presented in Appendix Table 1. The table contains the min, max, median, average, and standard deviation of each parameter analyzed.

The mean TN concentrations in Claiborne Reservoir embayment stations ranged from 0.47 mg/l in the Pursley Cr embayment to 0.85 mg/l in the Tallatchee Cr embayment (Fig. 2). Mean TN concentrations at Claiborne Reservoir mainstem stations ranged from 0.52 mg/l at the lower station to 0.86 mg/l at the upper station. Monthly TN concentrations measured at the upper mainstem reservoir station ranged from 0.16 mg/l in May to 2.38 mg/l in September (Fig. 3). Monthly TN concentrations measured at the lower mainstem reservoir station ranged from 0.17 mg/l in May to 0.74 mg/l in September (Fig. 4). Monthly TN concentrations measured in May at the upper station, and May and October at the lower station, were the lowest in ADEM's dataset at these stations. Monthly TN concentrations measured in September at the upper station were the highest in ADEM's dataset at the upper station.

Mean TP concentrations ranged from 0.059 mg/l to 0.094 mg/l in Claiborne Reservoir embayment stations, with the highest concentrations occurring at the Tallatchee Creek embayment station and the lowest at the Pursley Cr embayment station (Fig. 2). Mean TP concentrations at Claiborne Reservoir mainstem stations were 0.047 mg/l at the upper station and 0.048 mg/l at the lower station. TP concentrations over 0.025 mg/l can indicate eutrophic conditions within a lake or reservoir. Monthly TP concentrations measured at the upper mainstem reservoir station ranged from 0.019 mg/l in October to 0.082 mg/l in August (Fig. 3). Monthly TP concentrations measured at the lower mainstem reservoir station ranged from 0.025 mg/l in October to 0.069 mg/l in May (Fig. 4). Monthly TP concentrations at the upper and lower mainstem stations were below historic means for those stations most months. However, TP concentrations for the months of May at the lower station and August at the upper station were the highest recorded for these stations in ADEM's complete dataset.

The lowest mean chl *a* concentration measured within an embayment was 6.94 ug/l in Beaver Cr, and the highest was 18.77 ug/l in Tallatchee Creek (Fig. 2). The two mainstem stations had

similar mean chl *a* concentrations of 11.06 ug/l at the upper station and 9.26 ug/l at the lower station. Monthly chl *a* concentrations measured at the upper mainstem station ranged from 2.67 ug/l in October to 24.56 ug/l in May (Fig. 3). The monthly chl *a* concentrations at the lower station ranged from 5.34 ug/l in October to 13.17 ug/l in August (Fig. 4). Chl *a* concentrations > 20 ug/l can indicate eutrophic conditions. Specific water quality criteria for nutrient management have been established for Claiborne Reservoir at the lower reservoir. These criteria were not exceeded during 2005 (Fig. 5).

Mean TSS concentrations at Claiborne Reservoir embayment stations ranged from 22.57 mg/l at the Pursley Cr embayment to 37.86 mg/l at the Tallatchee Creek embayment station (Fig. 2). Mean TSS concentrations at mainstem Claiborne Reservoir stations ranged from 10.29 mg/l at the lower station to 25.29 mg/l at the upper station. Monthly TSS concentrations at the upper station ranged from 14 mg/l in September and October to 68 mg/l in August, while the lower station ranged from 6 mg/l in July to 16 mg/l in April (Fig. 3 & 4). Monthly TSS concentrations for the months of May and August at the upper station were the highest recorded in ADEM's dataset at this station. By contrast, the TSS concentration recorded in July at this station was the lowest recorded in ADEM's dataset at this station. TSS concentrations at the lower Claiborne Reservoir station were below historic mean concentrations for this station for all months monitored except August.

AGPT results indicated the upper station to be nitrogen/phosphorus co-limited and the lower station to be phosphorus limited, differing from results obtained in 2000 when the upper station was phosphorus limited and the lower station was nitrogen limited (Table 2). Mean standing crop (MSC) values ranged from 4.73 mg/l at the upper station to 3.58 mg/l at the lower station, with concentrations decreasing from the riverine sections of the reservoir upstream to the more lacustrine areas downstream. Five mg/l MSC has been defined as protective of reservoir and lake systems (Raschke and Schultz 1987), 20 mg/l MSC has been defined as protective of flowing streams and rivers (Raschke et al. 1996).

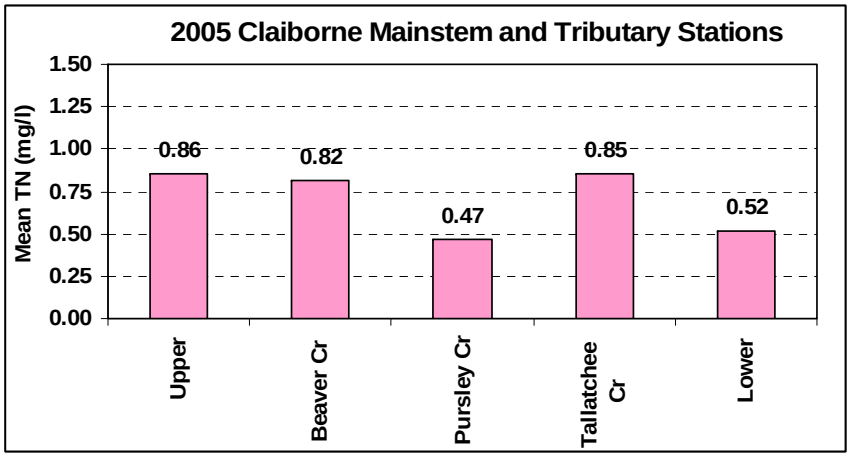
The dissolved oxygen concentration in the Tallatchee Creek embayment of Claiborne Reservoir was <5.0 mg/l at a depth of 5.0 ft during June, July, and September (Fig. 7). The dissolved oxygen concentration in the Beaver Cr embayment station was near 5.0 mg/l at a depth of 5.0 ft

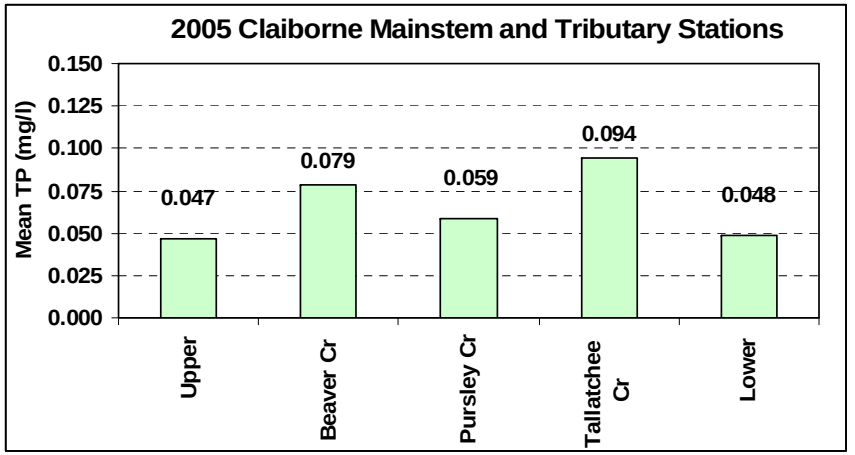
in July and August. All other measurements of dissolved oxygen concentrations were above the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l (Fig. 6 & 7) at this depth. Dissolved oxygen profiles of the mainstem stations show little thermal stratification at the upper or lower stations during June-September (Fig. 6). Warmest water temperatures were reached in August at both the upper and lower stations.

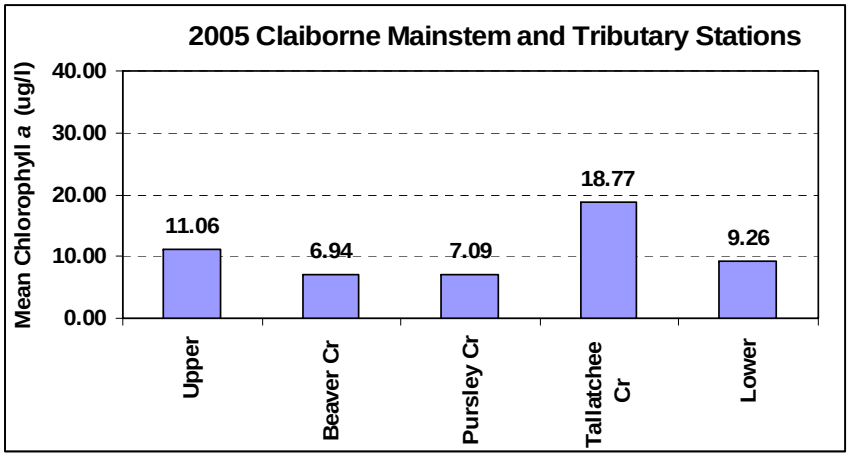
Carlson's TSI was calculated from the corrected chl *a* concentrations. TSI values for the upper station generally declined from eutrophic to mesotrophic through the growing season (Fig. 8). The TSI values for the lower station were eutrophic April-August, declined in September, and mesotrophic by October. Of the three embayment's, Tallatchee Creek had the highest TSI values with all months except August being eutrophic. Pursley Creek embayment varied between mesotrophic and eutrophic each month of the growing season. Beaver Creek embayment TSI values varied from oligotrophic in April, July, and August to eutrophic in May and September and mesotrophic in October.

Except for mesotrophic conditions at the lower station in 1991, August TSI values calculated at the mid and lower mainstem stations were eutrophic through the entire historic record, 1989-2005 (Fig. 9).

Figure 2. Mean total nitrogen (TN), mean total phosphorus (TP), mean chlorophyll *a* (Chl *a*), and mean total suspended solids (TSS) measured throughout Claiborne Reservoir, April-October 2005. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.







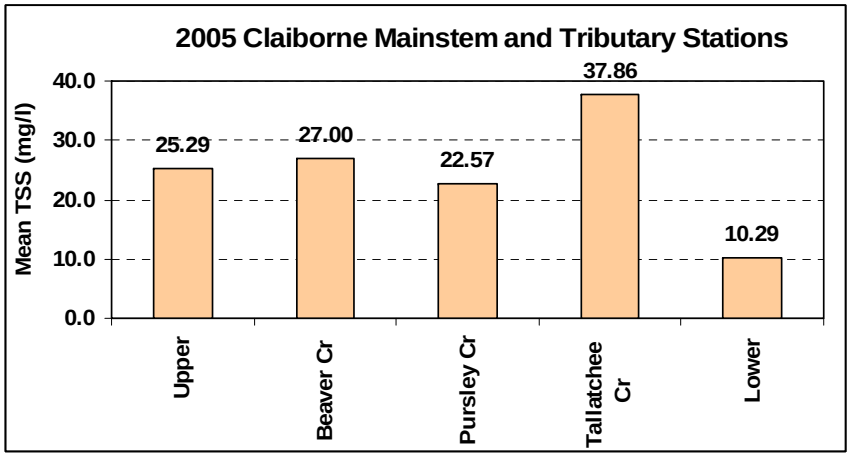
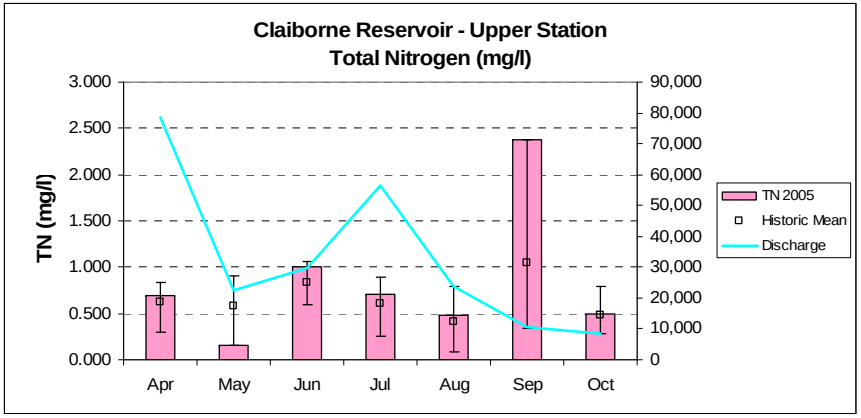
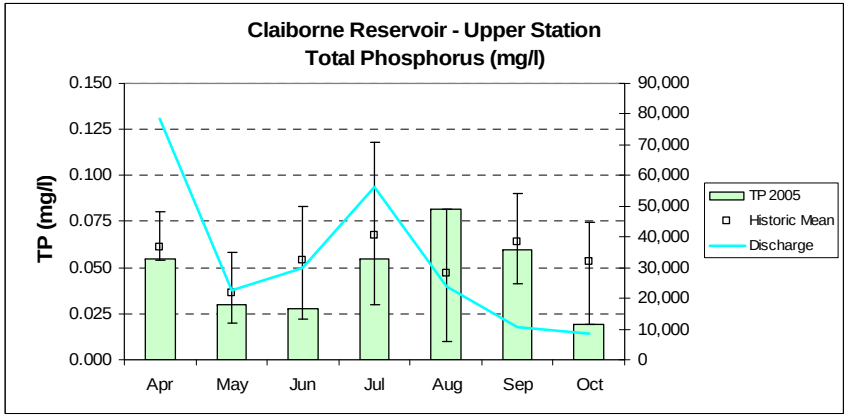
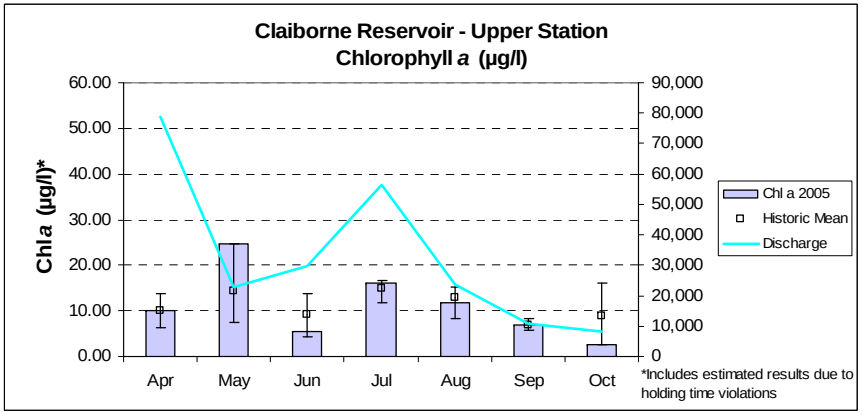


Figure 3. Total nitrogen (TN), total phosphorus (TP), chlorophyll a (Chl *a*), and total suspended solids (TSS) of the upper station in Claiborne Reservoir, April-October 2005. Each bar graph depicts monthly changes in the variables at the upper station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Claiborne L&D gauge near Monroeville, AL).







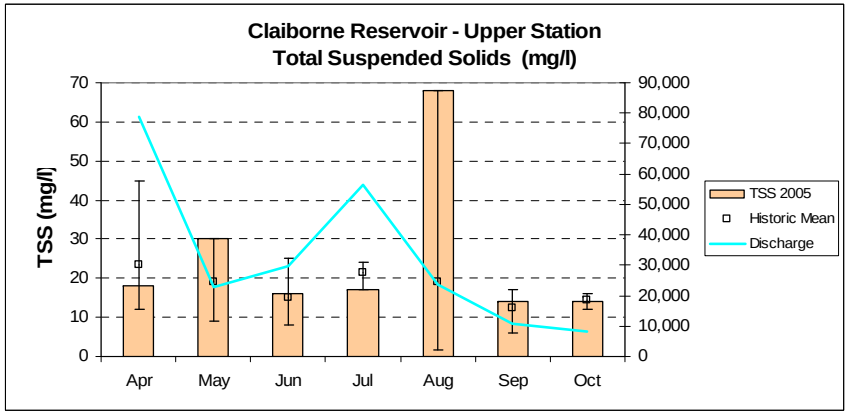
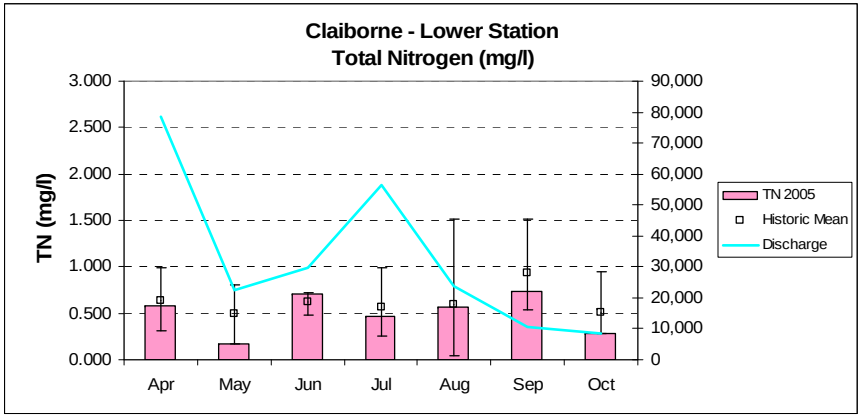
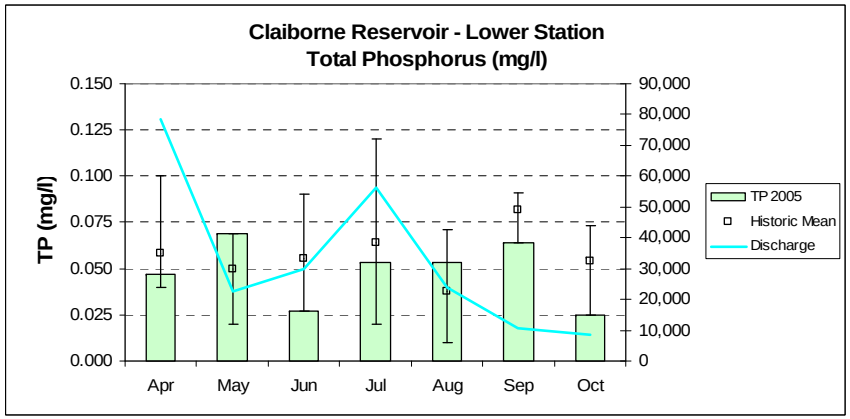
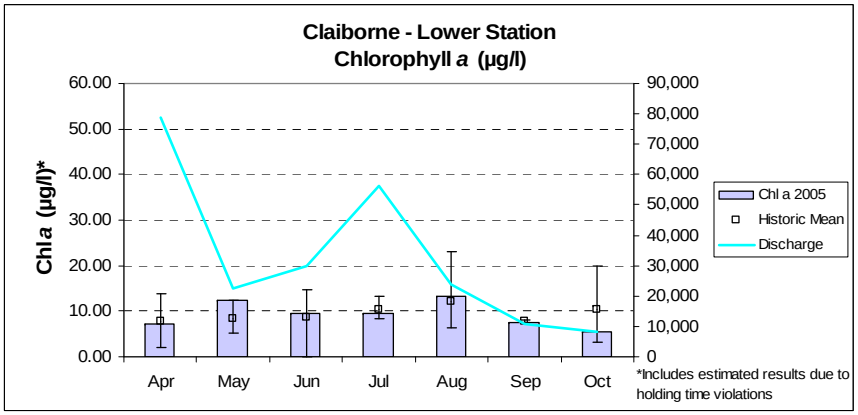


Figure 4. Total nitrogen (TN), total phosphorus (TP), chlorophyll a (Chl *a*), and total suspended solids (TSS) of the lower station in Claiborne Reservoir, April-October 2005. Each bar graph depicts monthly changes in the variables at the lower station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Claiborne L&D gauge near Monroeville, AL).







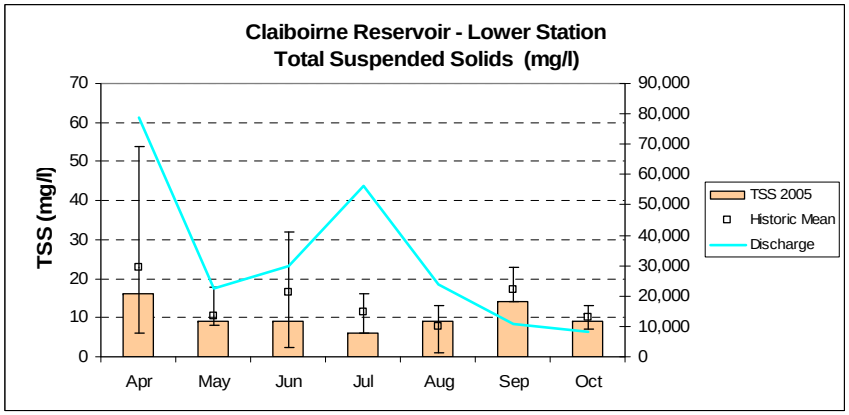


Figure 5. Mean chlorophyll *a* concentrations of mainstem Claiborne Reservoir stations, 2000-2005. Chlorophyll *a* criteria applies to the growing season mean of the lower station.

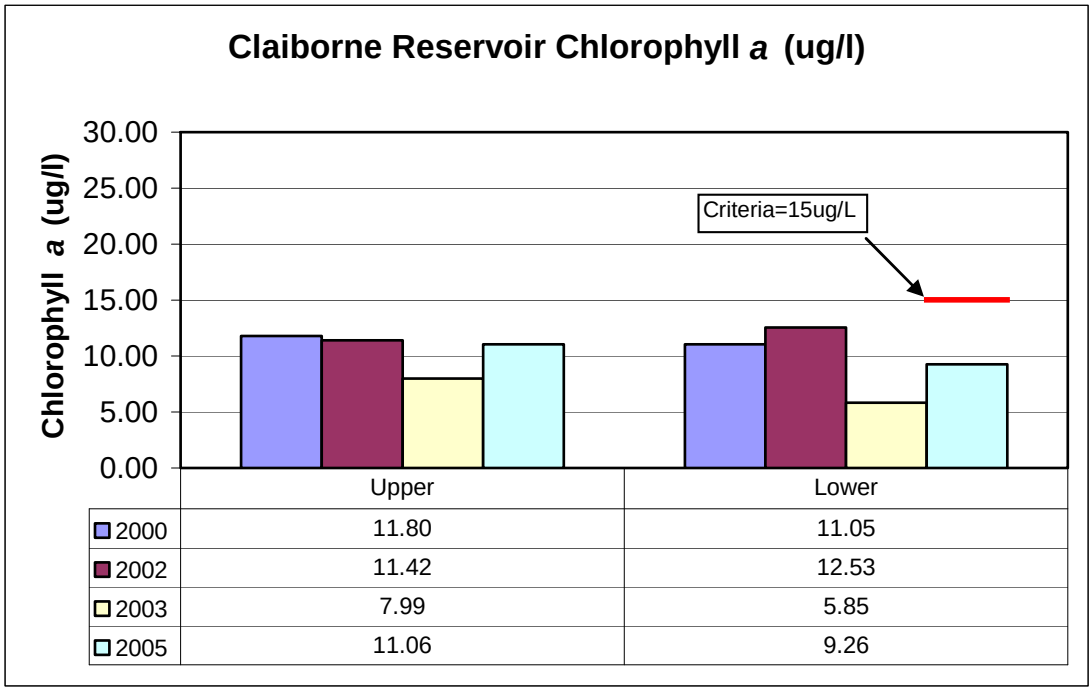


Table 2. Algal growth potential test results for mainstem Claiborne Reservoir stations, 2000 and 2005 (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status.

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

Figure 6. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in Claiborne Reservoir, June-September 2005. Although profiles were measured April-October, these select months were chosen as they represent the warmest water temperatures and most stratified dissolved oxygen concentrations. ADEM Water Quality Criteria pertaining to non-wadeable river and reservoir waters require a DO concentration of 5.0 mg/l at 5.0 ft (1.5 m) (ADEM Admin. Code R. 335-6-10-.09). Under extreme natural conditions such as drought, the DO concentration may be as low as 4.0 mg/l.

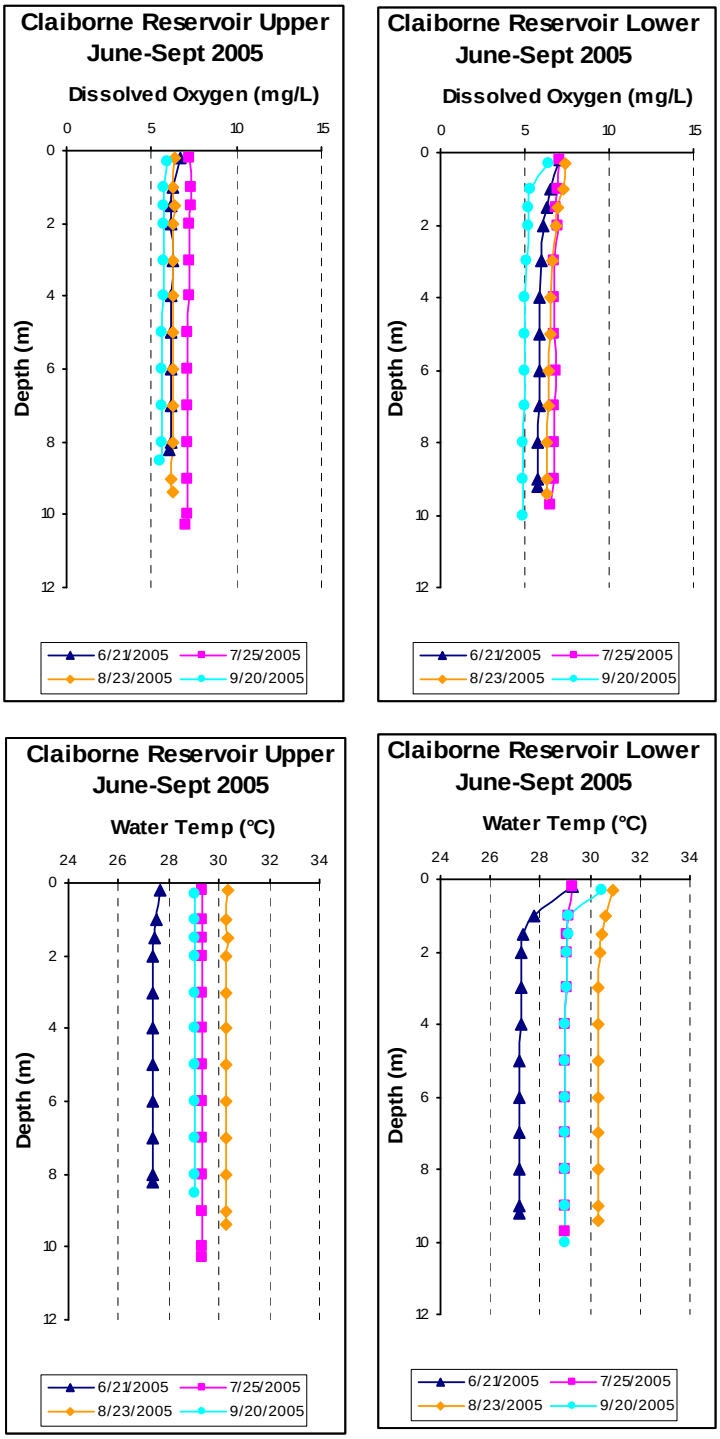


Figure 7. DO concentrations at 5 ft (1.5 m) for Claiborne Reservoir tributaries, April-October 2005. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations at a depth of 5 ft (1.5 m) are graphed. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2005).

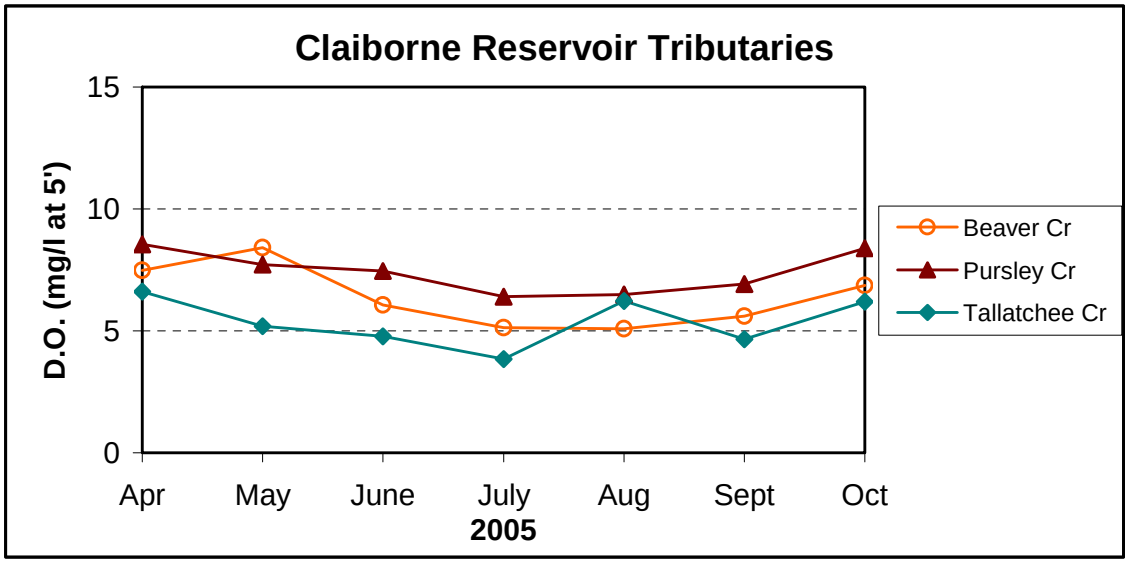


Figure 8. Monthly TSI values for Claiborne Reservoir mainstem and tributary stations using chlorophyll *a* concentrations and the Carlson's Trophic State Index calculation, April-October 2005.

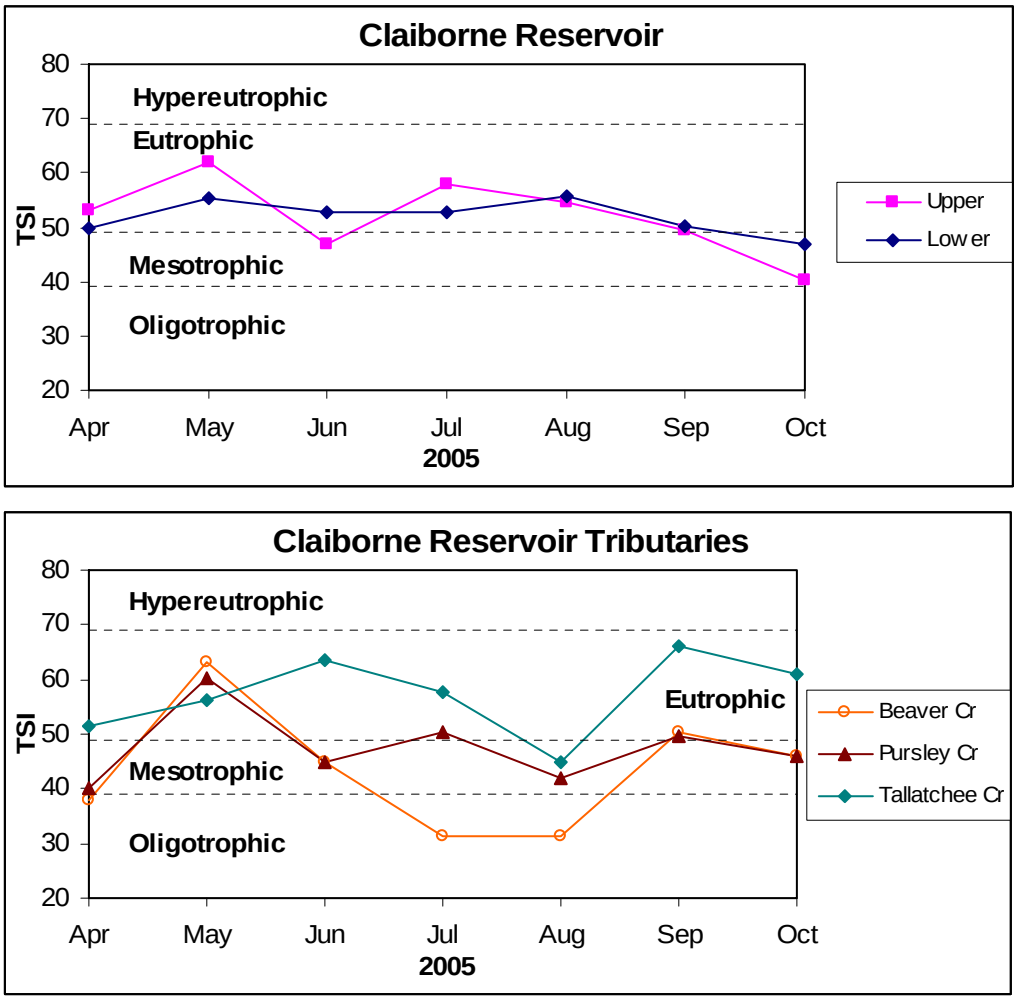
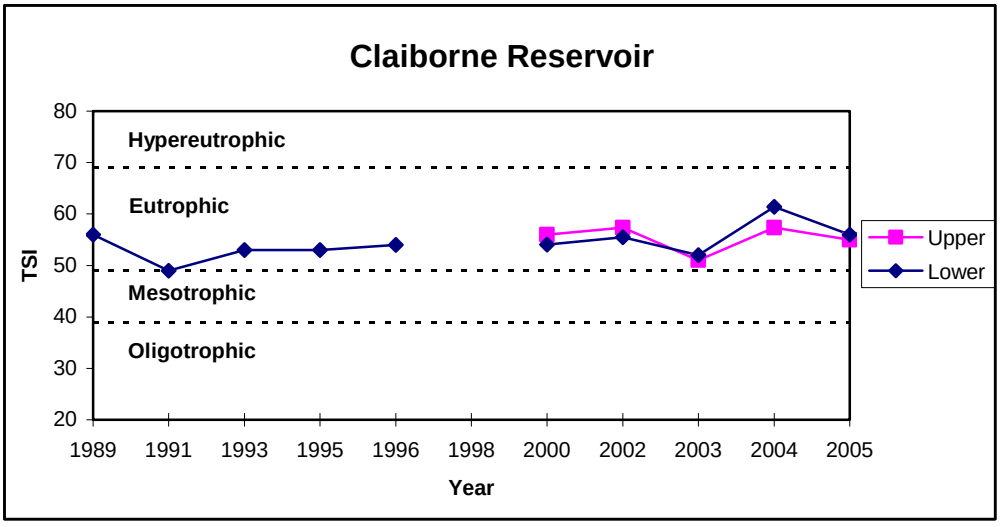


Figure 9. Trophic State Index values from critical period sampling of Claiborne Reservoir (August sampling only), 1989-2005.



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APPENDIX

Appendix Table 1. Summary of Claiborne Reservoir water quality data, April-October, 2005. Minimum (Min) and maximum (Max) values calculated using minimum detection limits (MDL) when results were less than this value. Median (Med), average (Ave), and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Median	Avg	SD
CLAM-1	Alkalinity (mg/L)	7	37.3	43.7	42.5	41.0	2.8
	Hardness (mg/L)	4	35.3	42.6	41.1	40.0	3.2
	Total Dissolved Solids (mg/L)	7	18.0	106.0	81.0	72.6	31.2
	Total Suspended Solids (mg/L)	7	6.0	16.0	9.0	10.3	3.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.042	0.008	0.014	0.013
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.095	0.212	0.145	0.162	0.044
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.562	0.368	0.337	0.198
	Total Nitrogen (mg/L)	7	0.170	0.740	0.560	0.501	0.211
	Total Phosphorus (mg/L)	7	0.025	0.069	0.053	0.048	0.017
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.018	0.016	0.014	0.006
	Chlorophyll a (mg/L)[J]	7	5.34	13.17	9.61	9.26	2.85
	Turbidity (NTU)	7	10	17	14	13	3
	Secchi (m)	7	0.52	0.88	0.78	0.74	0.13
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	3	---
CLAM-2	Alkalinity (mg/L)	7	39.1	48.5	41.9	42.3	3.1
	Hardness (mg/L)	4	36.8	44.2	42.4	41.4	3.3
	Total Dissolved Solids (mg/L)	7	29.0	129.0	89.0	82.1	34.5
	Total Suspended Solids (mg/L)	7	14.0	68.0	17.0	25.3	19.6
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.051	0.015	0.020	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.087	0.240	0.166	0.163	0.055
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	2.140	0.496	0.682	0.686
	Total Nitrogen (mg/L)	7	0.160	2.380	0.690	0.846	0.724
	Total Phosphorus (mg/L)	7	0.019	0.082	0.055	0.047	0.022
	Dissolved Reactive Phosphorus (mg/L)	7	0.006	0.017	0.011	0.011	0.004
	Chlorophyll a (mg/L)[J]	7	2.67	24.56	10.15	11.06	7.40
	Turbidity (NTU)	7	13	21	16	16	3
	Secchi (m)	7	0.31	0.89	0.73	0.68	0.20
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	17	---
CLAM-3	Alkalinity (mg/L)	7	14.4	42.1	40.1	34.4	10.3
	Hardness (mg/L)	4	21.4	43.2	38.9	35.6	9.9
	Total Dissolved Solids (mg/L)	7	49.0	114.0	96.0	88.9	22.5
	Total Suspended Solids (mg/L)	7	10.0	68.0	18.0	27.0	20.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.069	0.031	0.030	0.024
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.046	0.231	0.171	0.143	0.073
	Total Kjeldahl Nitrogen (mg/L)	7	0.209	1.570	0.444	0.675	0.487
	Total Nitrogen (mg/L)	7	0.300	1.800	0.620	0.819	0.520
	Total Phosphorus (mg/L)	7	0.026	0.235	0.053	0.079	0.073
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.019	0.010	0.010	0.006
	Chlorophyll a (mg/L)[J]	7	1.07	27.77	4.27	6.94	9.47
	Turbidity (NTU)	7	12	119	16	35	38
	Secchi (m)	7	0.13	0.81	0.53	0.54	0.24
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	5200	---
CLAM-4	Alkalinity (mg/L)	7	36.9	68.6	54.6	55.6	11.2
	Hardness (mg/L)	4	51.4	74.1	61.9	62.3	9.3
	Total Dissolved Solids (mg/L)	7	38.0	161.0	79.0	98.7	43.6
	Total Suspended Solids (mg/L)	7	2.0	40.0	26.0	22.6	13.9
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.103	0.023	0.033	0.033

Station	Parameter	N	Min	Max	Median	Avg	SD
CLAM-4	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.143	0.056	0.059	0.046
	Total Kjeldahl Nitrogen (mg/L)	7	0.240	0.590	0.372	0.412	0.129
	Total Nitrogen (mg/L)	7	0.380	0.650	0.420	0.470	0.103
	Total Phosphorus (mg/L)	7	0.037	0.072	0.065	0.059	0.013
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.018	0.011	0.010	0.006
	Chlorophyll a (mg/L)[J]	7	2.67	20.29	4.81	7.09	6.09
	Turbidity (NTU)	7	10	50	18	22	14
	Secchi (m)	7	0.21	0.81	0.57	0.55	0.19
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	5700	---
CLAM-5	Alkalinity (mg/L)	6	8.1	32.3	19.2	20.0	8.4
	Hardness (mg/L)	4	13.8	26.8	22.5	21.4	5.5
	Total Dissolved Solids (mg/L)	6	43.0	148.0	81.5	85.7	35.0
	Total Suspended Solids (mg/L)	6	25.0	85.0	30.5	39.7	23.0
	Ammonia Nitrogen (mg/L)	6	< 0.015	0.104	0.033	0.039	0.034
	Nitrate+Nitrite Nitrogen (mg/L)	6	0.053	0.145	0.102	0.102	0.034
	Total Kjeldahl Nitrogen (mg/L)	6	0.299	1.239	0.683	0.716	0.345
	Total Nitrogen (mg/L)	6	0.350	1.320	0.800	0.817	0.347
	Total Phosphorus (mg/L)	6	0.009	0.222	0.070	0.094	0.073
	Dissolved Reactive Phosphorus (mg/L)	6	< 0.004	0.016	0.007	0.007	0.005
	Chlorophyll a (mg/L)[J]	6	4.27	28.84	14.95	15.66	8.98
	Turbidity (NTU)	6	24	128	37	43	40
	Secchi (m)	6	0.12	0.38	0.32	0.26	0.14
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	4000	---

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