2016 Coffeeville Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Rivers & Reservoirs Unit
August 2020

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Tombigbee River Basin

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LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
ADPH	Alabama Department of Public Health
AGPT	Algal Growth Potential Test
APCo	Alabama Power Company
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
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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INTRODUCTION

Coffeeville Reservoir was constructed in the 1950s by the U.S. Army Corps of Engineers. Located near the town of Coffeeville in Clarke County, the 8,800 acre impoundment on the Tombigbee River system extends from Coffeeville Dam, located three miles from the town of that name, to Demopolis Dam, 97 miles upstream.

The Alabama Department of Environmental Management (ADEM) monitored Coffeeville Reservoir as part of the 2016 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, to 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 2017 Monitoring Strategy (ADEM 2017).

A consumption advisory was issued for Coffeeville Reservoir by the Alabama Department of Public Health (ADPH) in 2010 due to mercury found in fish tissue. As a result, Coffeeville Reservoir was placed on Alabama's 2012 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its Public Water Supply (PWS), Swimming (S), and Fish and Wildlife (F&W) water use classifications for mercury caused by atmospheric deposition.

Specific water quality criteria for nutrient management was implemented in 2005 at one location on Coffeeville Reservoir. This criterion represents the maximum growing season (April-October) mean chlorophyll *a* (chl *a*) concentration allowable, while still fully supporting the reservoir's Public Water Supply, Swimming, and Fish and Wildlife (PWS/S/F&W) use classifications.

The purpose of this report is to summarize data collected at twelve stations in Coffeeville Reservoir during the 2016 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 existing data and established criteria.

METHODS

Sampling stations were determined using historical data and previous assessments (Figures 1a and 1b). Specific location information is listed in Table 1. Coffeeville was sampled in the dam forebay, mid, and upper reservoir areas. Tributary embayment stations monitored include: Sucarnoochee Creek, Chickasaw Bogue Creek, Tuckabum Creek, Horse Creek, Wahalak Creek, Bashi Creek, Tallawampa Creek, Okatuppa Creek, and Turkey Creek.

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 2017), Surface Water Quality Assurance Project Plan (ADEM 2017) and Quality Management Plan (ADEM 2018).

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 2016 results.

Figure 1a. Coffeeville Reservoir with 2016 upper sampling locations.

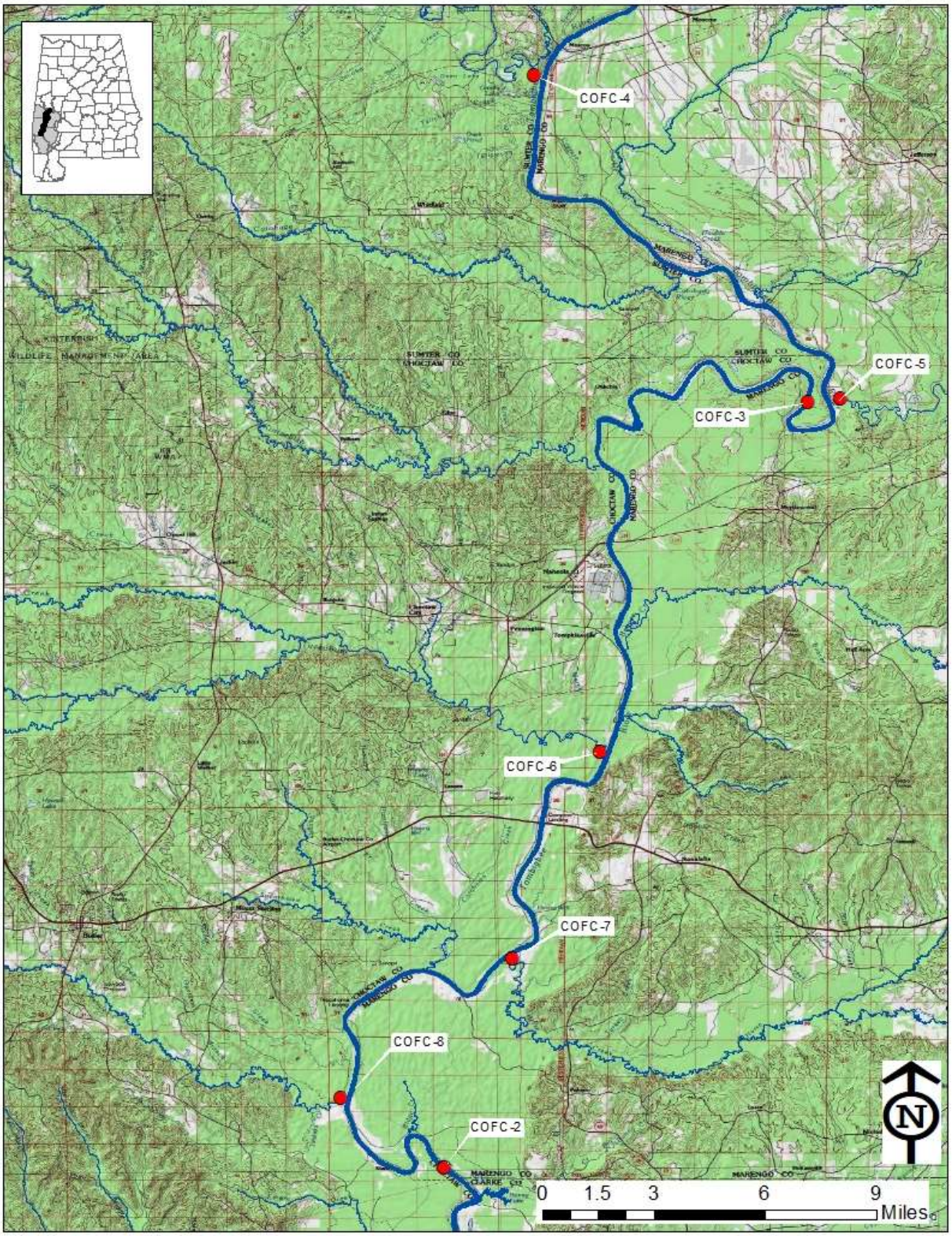


Figure 1b. Coffeeville Reservoir with 2016 lower sampling locations.

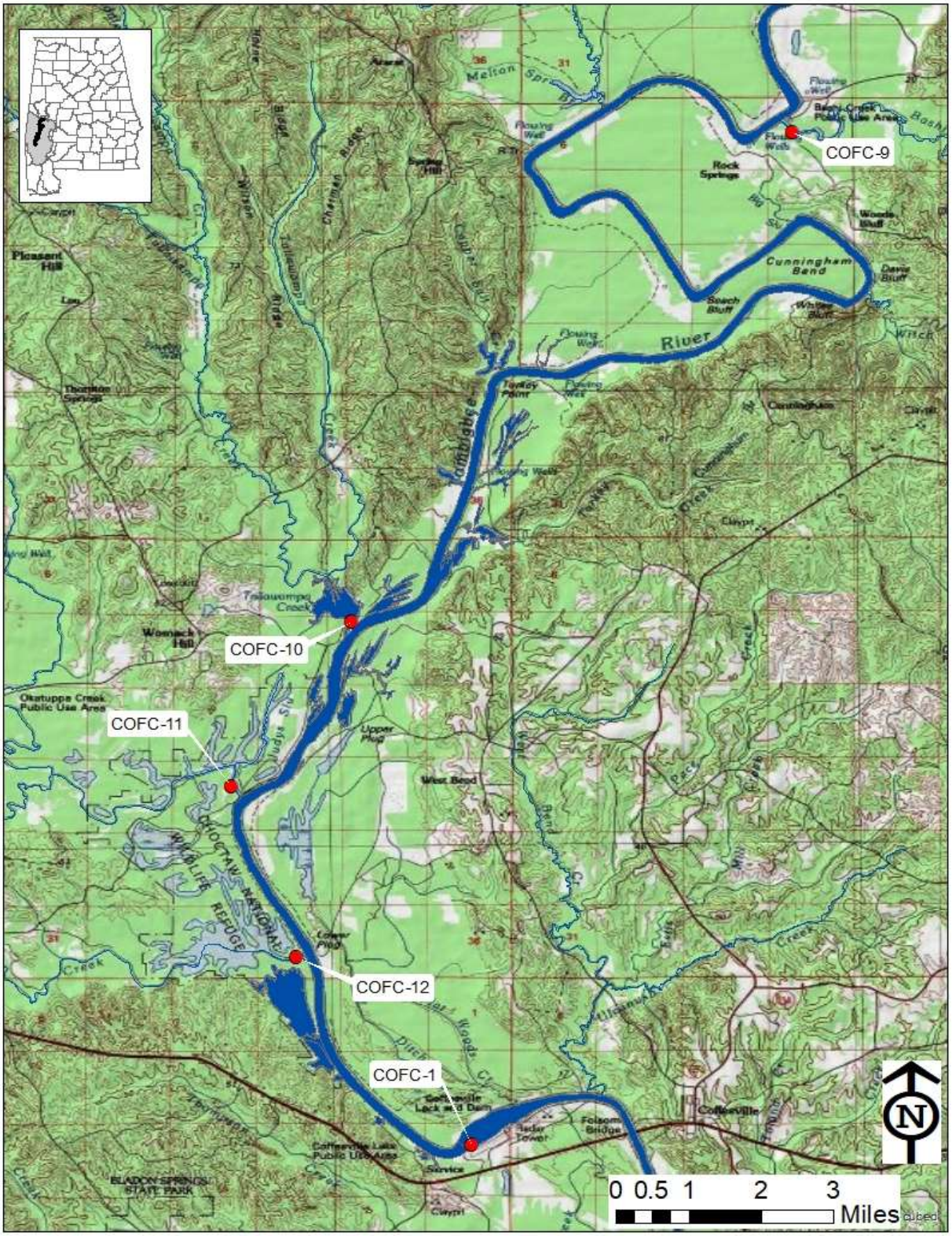


Table 1. Descriptions of the 2016 monitoring stations in Coffeeville Reservoir.

Coffeeville Reservoir								
HUC	**County**	**Station Number**	**Report Designation**	**Waterbody Name**	**Station Description**	**Chl *a* Criteria**	**Latitude**	**Longitude**
31602010909	Choctaw	COFC-1*	Lower	Coffeeville Res	Lower reservoir. Deepest point, main river channel, dam forebay .	10 ug/L	31.7529	-88.13382
31602010905	Choctaw	COFC-2	Mid	Coffeeville Res	Mid reservoir. Deepest point, main river channel, approx. 1.5 miles upstream of Big Bunny Creek confluence.		31.99463	-88.07962
31602010408	Choctaw	COFC-3	Upper	Coffeeville Res	Upper reservoir. Deepest point, main river channel, approx. two miles downstream of Chickasaw Bogue Creek confluence.		32.29236	-87.93796
31602020703	Sumter	COFC-4	Sucarnoochee Cr	Sucarnoochee Cr	Deepest point, main creek channel, Sucarnoochee River embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		32.41956	-88.04436
31602010109	Marengo	COFC-5	Chickasaw Bogue Cr	Chickasaw Bogue Cr	Deepest point, main creek channel, Chickasaw Bogue Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		32.29369	-87.92542
31602010506	Choctaw	COFC-6	Tuckabum Cr	Tuckabum Cr	Deepest point, main creek channel, Tuckabum Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		32.1565	-88.01891
31602010604	Marengo	COFC-7	Horse Cr	Horse Cr	Deepest point, main creek channel, Horse Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		32.07607	-88.05283
31602010904	Choctaw	COFC-8	Wahalak Cr	Wahalak Cr	Deepest point, main creek channel, Wahalak Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		32.02165	-88.12001
31602010704	Clarke	COFC-9	Bashi Cr	Bashi Cr	Deepest point, main creek channel, Bashi Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		31.95441	-88.07008
31602010906	Choctaw	COFC-10	Tallawampa Cr	Tallawampa Cr	Deepest point, main creek channel, Tallawampa Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		31.85692	-88.15773
31602010807	Choctaw	COFC-11	Okatuppa Cr	Okatuppa Cr	Deepest point, main creek channel, Okatuppa Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		31.82423	-88.18183
31602010908	Choctaw	COFC-12	Turkey Cr	Turkey Cr	Deepest point, main creek channel, Turkey Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		31.79016	-88.1689

*Growing season mean chl *a* criterion established at this station in 2005.

RESULTS

Growing season mean graphs for TN, TP, chl *a*, and TSS are provided in this section (Figures 2-5). Monthly graphs for TN, TP, chl *a*, TSS, dissolved oxygen (DO), and TSI are also provided (Figures 6-10, Figure 13), with 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 Figures 11-12. Summary statistics of all data collected during 2016 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, chl *a*, and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not be mentioned, review of the graphs will indicate stations that may be potential candidates for reference waterbodies and watersheds.

In 2016, the highest mean growing season TN value among mainstem stations was in the lower station, while the highest value among tributary stations was in Chickasaw Bogue Creek (Figure 2). Trends in mean TN concentrations seem to have increased at most stations 2001 through 2016. The highest monthly TN concentrations occurred during April, May, and August in the mid and upper stations and during April, May, and July in the lower station (Figure 6). Historic high monthly TN concentrations occurred at the upper station in August, at the mid station in April, May, and August, and at the lower station in April and July.

In 2016, the highest mean growing season TP value among mainstem stations was in the mid station while the highest value among tributary stations was in Wahalak Creek (Figure 3). Mean TP concentrations have declined at all stations since monitoring began. The highest monthly TP concentrations were measured during April and May in all mainstem stations, as well as in September in the mid station (Figure 7). Most monthly TP concentrations at mainstem stations were at or below historic mean values.

In 2016, the highest mean growing season chl *a* value among mainstem stations was in the upper station, while the highest value among tributary stations was in Chickasaw Bogue Creek (Figure 4). The mean chl *a* concentration in the lower Coffeeville station was below the established criterion of 10µg/L (ADEM Admin. Code R. 335-6-10-.11). Historic high

concentrations were measured in the upper and lower stations in both June and October (Figure 8).

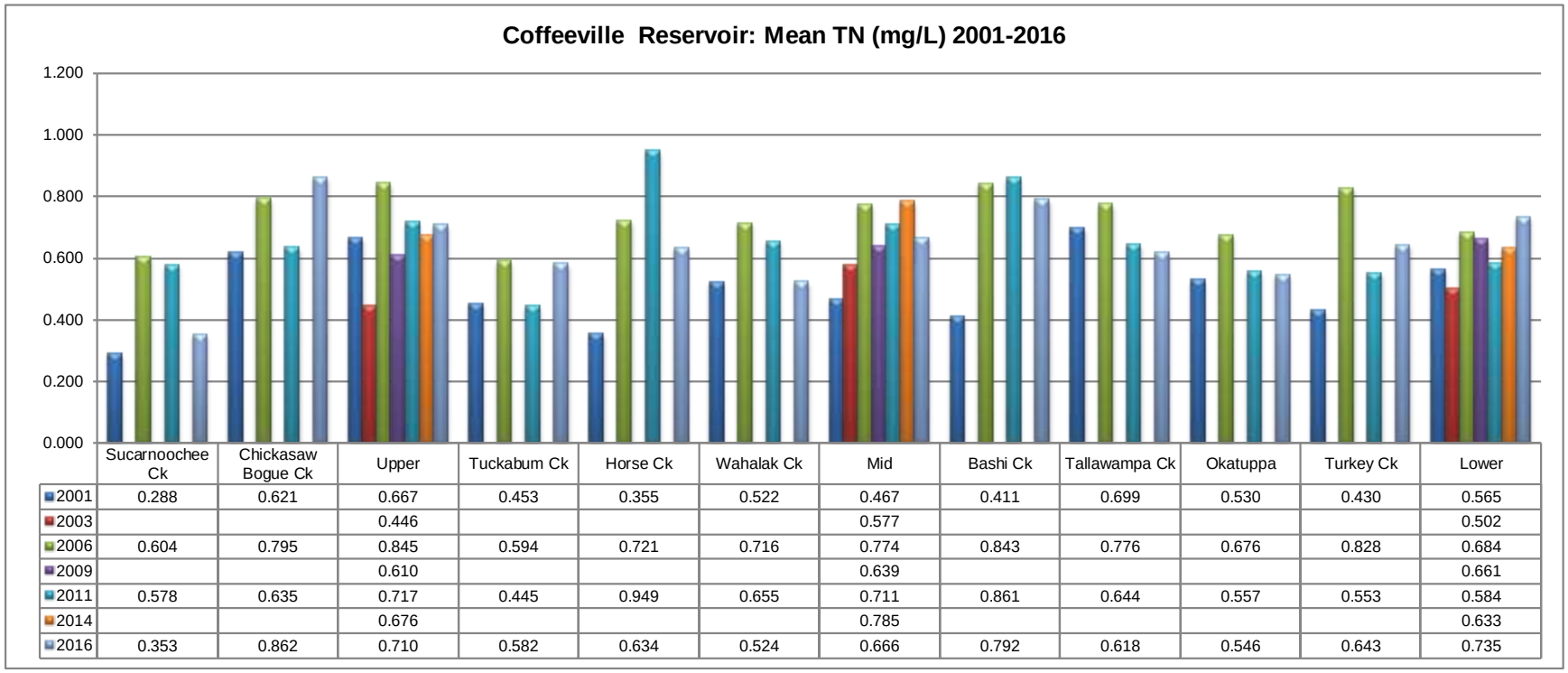
In 2016, the highest mean growing season TSS value among mainstem stations was in the upper station while the highest value among tributary stations was in Sucarnoochee Creek (Figure 5). Monthly TSS concentrations in the mainstem stations were highest in the spring and much lower throughout the summer and fall (Figure 9). With the exception of the upper station in April and May and the mid station in April, monthly concentrations were near or below historic means.

AGPT results for the upper station indicated a change from nitrogen-limited to phosphorus-limited conditions, while the lower station remained nitrogen-limited in 2016 (Table 2). In 2016, the MSC at the lower station was above 5.0 mg/L, the value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems. The more riverine upper station was above 5 mg/L MSC but below 20mg/L MSC, the value that Raschke et al. (1996) defined as protective of flowing stream and river systems.

Dissolved oxygen concentrations at Horse Creek were near or below the ADEM criterion of 5.0 mg/L at 5.0 ft (1.5m) June-October (ADEM Admin. Code R. 335-6-10-.09). Concentrations were also below criterion at Wahalak Creek in June, August, and Septmeber and at Bashi Creek in September (Figure 10). Dissolved oxygen concentrations at all mainstem Coffeeville stations met the dissolved oxygen criterion, April-October. With the exception of the lower station, which was stratified in July, profiles of the upper and lower mainstem stations were mixed throughout the sampling season. Highest temperatures were reached during July and August (Figures 11-12).

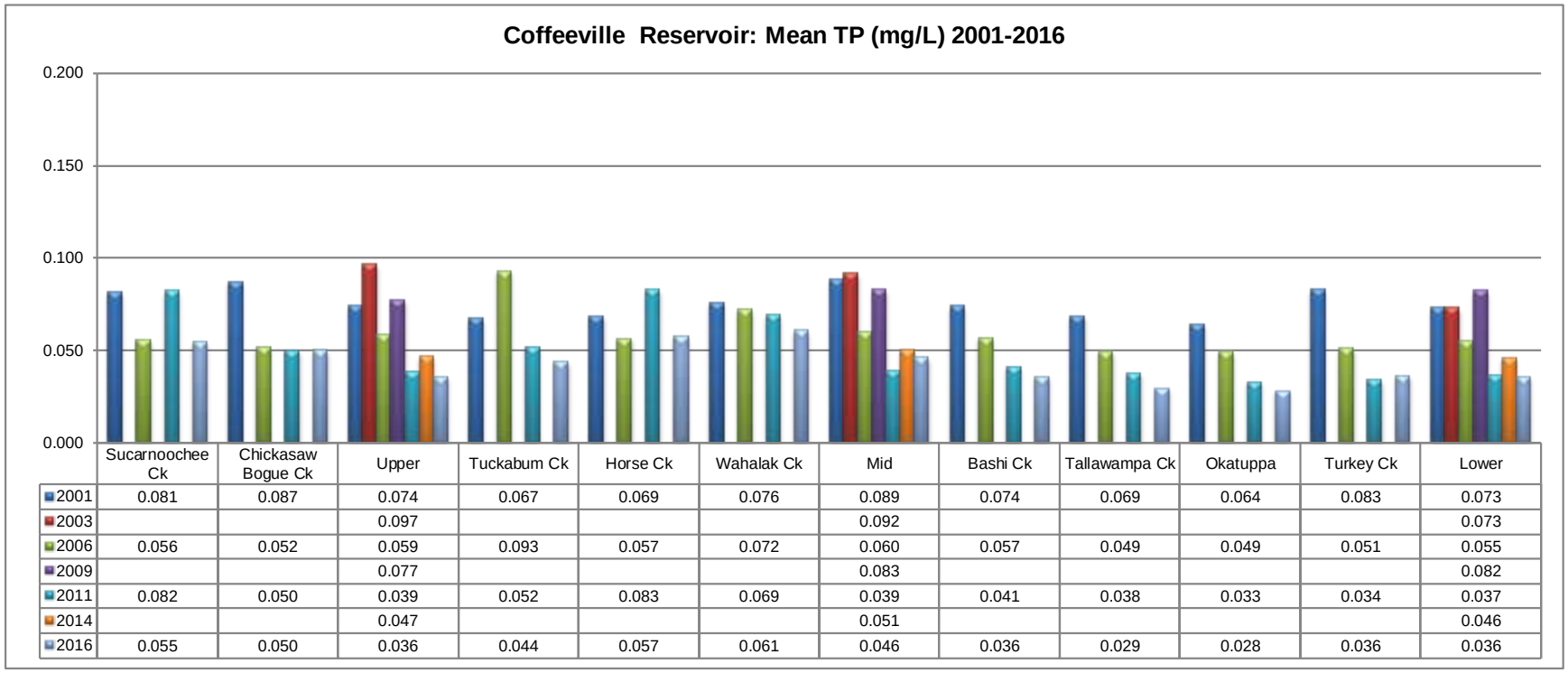
TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. The mainstem stations were eutrophic or near eutrophic June through October (Figure 13). Among tributary stations, Chickasaw Bogue and Tallawampa were eutrophic or near eutrophic April through October. Okatuppa and Turkey were eutrophic June through October, and Wahalak and Bashi were eutrophic June through August and October.

Figure 2. Mean growing season TN measured in Coffeeville Reservoir, April-October, 2001-2016. Stations are illustrated from upstream to downstream as the graph is read from left to right.



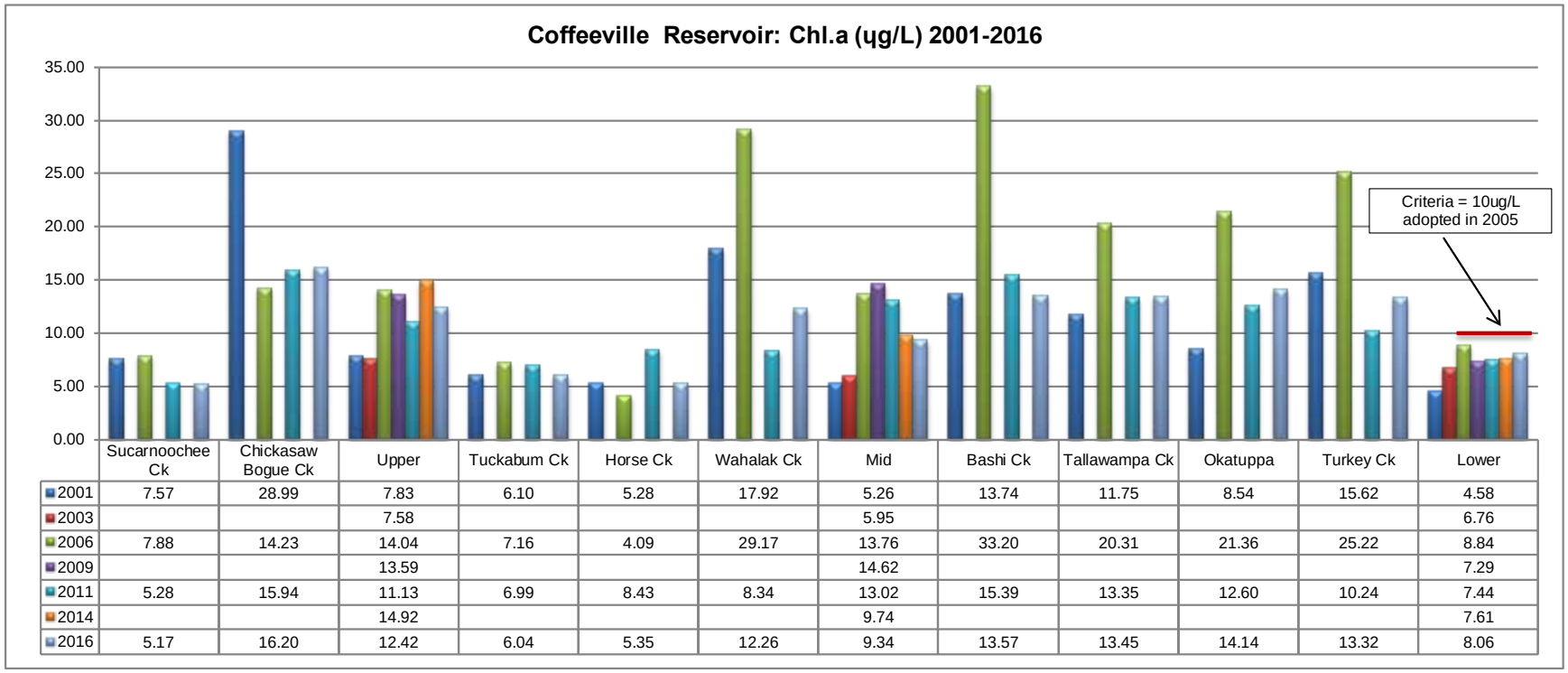
	Sucarnoochee Ck	Chickasaw Bogue Ck	Upper	Tuckabum Ck	Horse Ck	Wahalak Ck	Mid	Bashi Ck	Tallawampa Ck	Okatuppa	Turkey Ck	Lower
2001	0.288	0.621	0.667	0.453	0.355	0.522	0.467	0.411	0.699	0.530	0.430	0.565
2003			0.446				0.577					0.502
2006	0.604	0.795	0.845	0.594	0.721	0.716	0.774	0.843	0.776	0.676	0.828	0.684
2009			0.610				0.639					0.661
2011	0.578	0.635	0.717	0.445	0.949	0.655	0.711	0.861	0.644	0.557	0.553	0.584
2014			0.676				0.785					0.633
2016	0.353	0.862	0.710	0.582	0.634	0.524	0.666	0.792	0.618	0.546	0.643	0.735

Figure 3. Mean growing season TP measured in Coffeeville Reservoir, April-October, 2001-2016. Stations are illustrated from upstream to downstream as the graph is read from left to right.



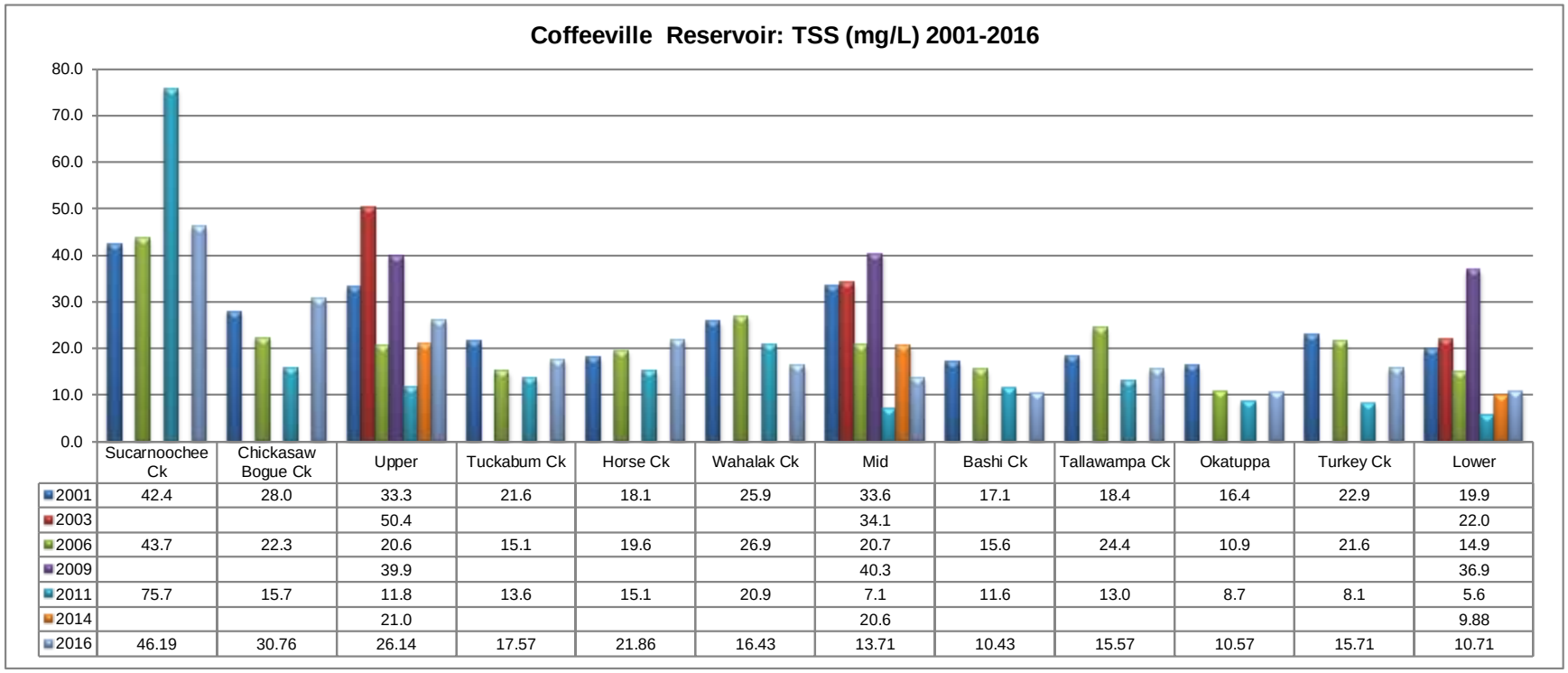
	Sucarnoochee Ck	Chickasaw Bogue Ck	Upper	Tuckabum Ck	Horse Ck	Wahalak Ck	Mid	Bashi Ck	Tallawampa Ck	Okatuppa	Turkey Ck	Lower
2001	0.081	0.087	0.074	0.067	0.069	0.076	0.089	0.074	0.069	0.064	0.083	0.073
2003			0.097				0.092					0.073
2006	0.056	0.052	0.059	0.093	0.057	0.072	0.060	0.057	0.049	0.049	0.051	0.055
2009			0.077				0.083					0.082
2011	0.082	0.050	0.039	0.052	0.083	0.069	0.039	0.041	0.038	0.033	0.034	0.037
2014			0.047				0.051					0.046
2016	0.055	0.050	0.036	0.044	0.057	0.061	0.046	0.036	0.029	0.028	0.036	0.036

Figure 4. Mean growing season chl *a* measured in Coffeeville Reservoir, April-October, 2001-2016. Stations are illustrated from upstream to downstream as the graph is read from left to right.



	Sucarnoochee Ck	Chickasaw Bogue Ck	Upper	Tuckabum Ck	Horse Ck	Wahalak Ck	Mid	Bashi Ck	Tallawampa Ck	Okatuppa	Turkey Ck	Lower
2001	7.57	28.99	7.83	6.10	5.28	17.92	5.26	13.74	11.75	8.54	15.62	4.58
2003			7.58				5.95					6.76
2006	7.88	14.23	14.04	7.16	4.09	29.17	13.76	33.20	20.31	21.36	25.22	8.84
2009			13.59				14.62					7.29
2011	5.28	15.94	11.13	6.99	8.43	8.34	13.02	15.39	13.35	12.60	10.24	7.44
2014			14.92				9.74					7.61
2016	5.17	16.20	12.42	6.04	5.35	12.26	9.34	13.57	13.45	14.14	13.32	8.06

Figure 5. Mean growing season TSS measured in Coffeeville Reservoir, April-October, 2001-2016. Stations are illustrated from upstream to downstream as the graph is read from left to right.



	Sucarnoochee Ck	Chickasaw Bogue Ck	Upper	Tuckabum Ck	Horse Ck	Wahalak Ck	Mid	Bashi Ck	Tallawampa Ck	Okatuppa	Turkey Ck	Lower
2001	42.4	28.0	33.3	21.6	18.1	25.9	33.6	17.1	18.4	16.4	22.9	19.9
2003			50.4				34.1					22.0
2006	43.7	22.3	20.6	15.1	19.6	26.9	20.7	15.6	24.4	10.9	21.6	14.9
2009			39.9				40.3					36.9
2011	75.7	15.7	11.8	13.6	15.1	20.9	7.1	11.6	13.0	8.7	8.1	5.6
2014			21.0				20.6					9.88
2016	46.19	30.76	26.14	17.57	21.86	16.43	13.71	10.43	15.57	10.57	15.71	10.71

Figure 6. Monthly TN concentrations measured at upper, mid, and lower stations in Coffeeville Reservoir, April-October 2016 vs. average monthly discharge. Monthly discharge acquired from USGS Tombigbee River gage 02469761 at Coffeeville Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.

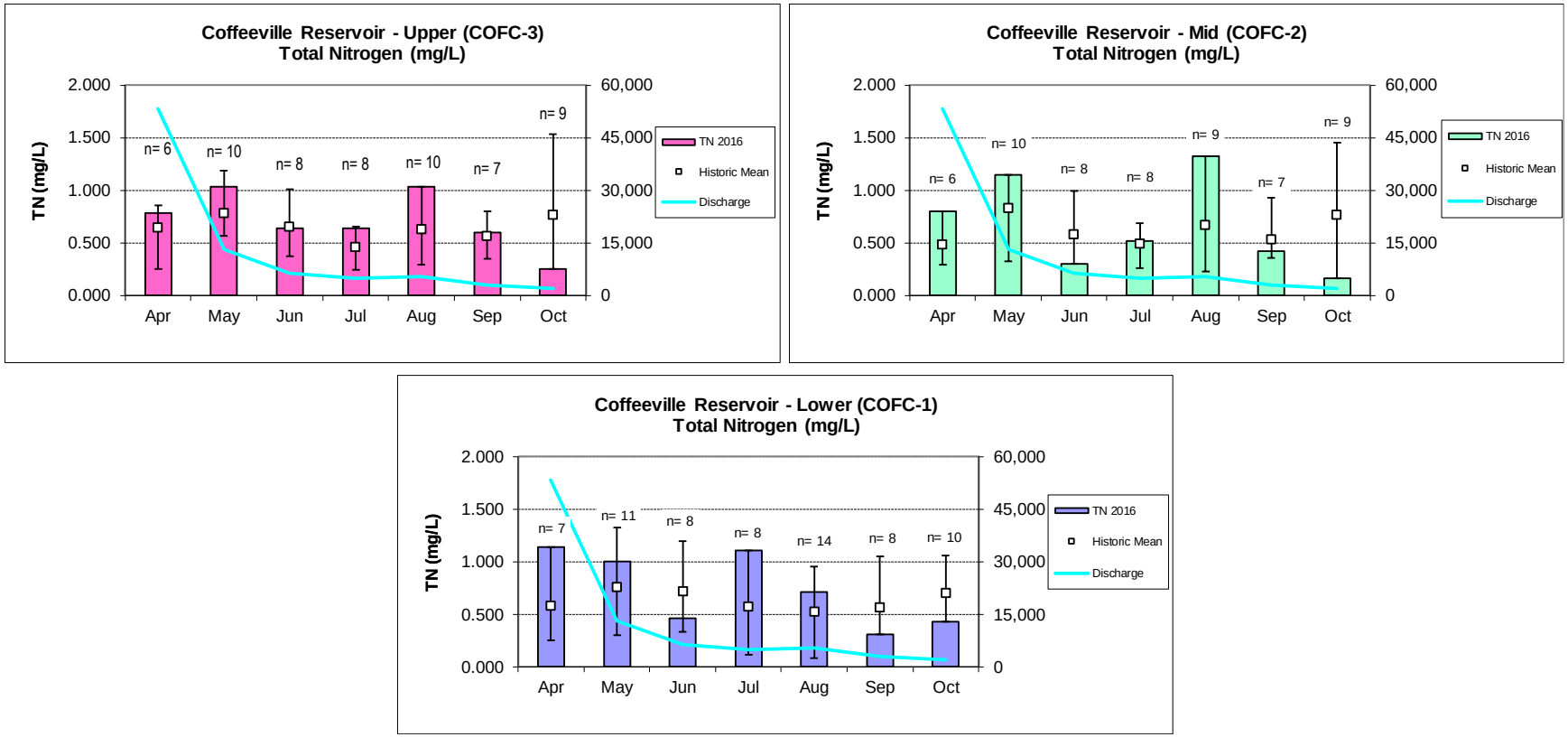
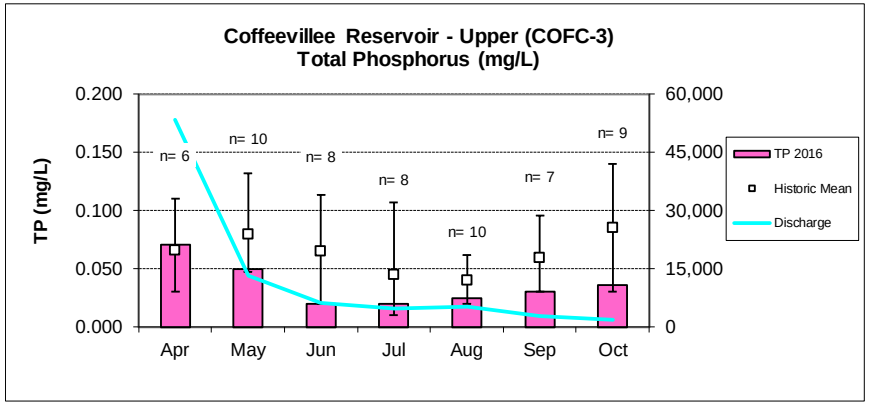
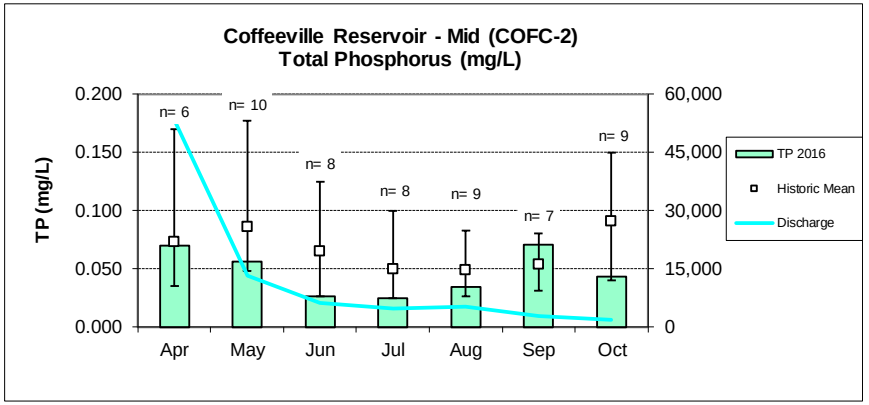


Figure 7. Monthly TP concentrations measured at upper, mid, and lower station in Coffeeville Reservoir, April-October 2016 vs. average monthly discharge. Monthly discharge acquired from USGS Tombigbee River gage 02469761 at Coffeeville Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.





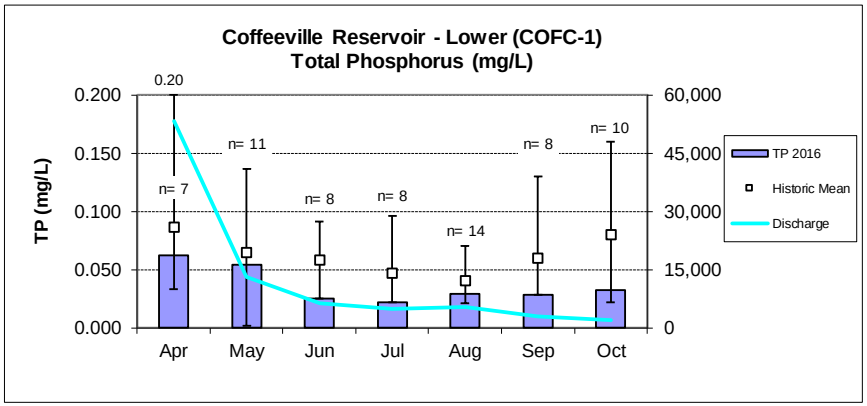
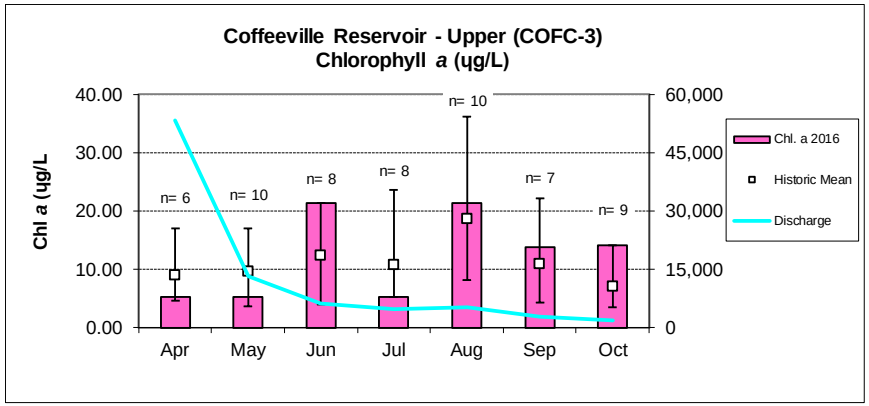
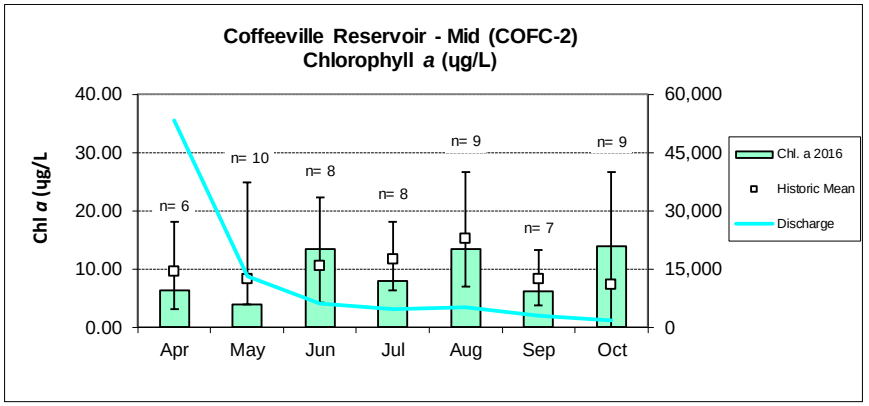


Figure 8. Monthly chl *a* concentrations measured at upper, mid, and lower station in Coffeeville Reservoir, April-October 2016 vs. average monthly discharge. Monthly discharge acquired from USGS Tombigbee River gage 02469761 at Coffeeville Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.





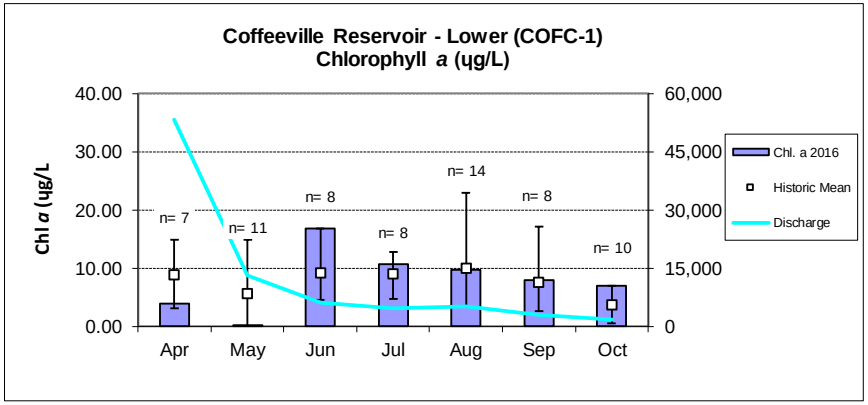
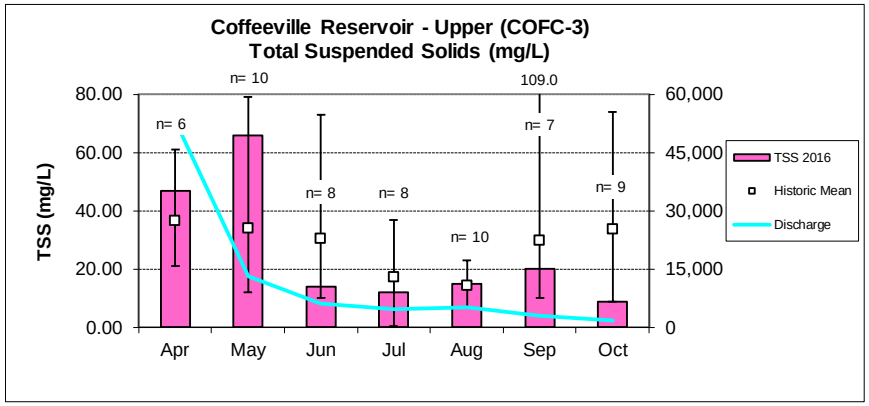
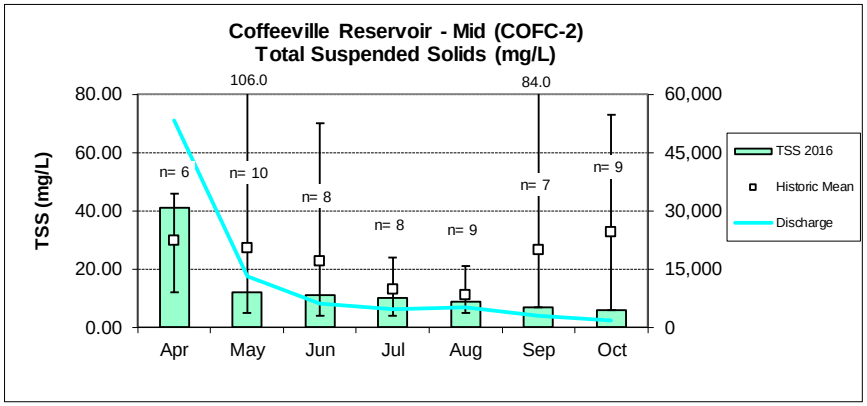


Figure 9. Monthly TSS concentrations measured at upper, mid, and lower station in Coffeeville Reservoir, April-October 2016 vs. average monthly discharge. Monthly discharge acquired from USGS Tombigbee River gage 02469761 at Coffeeville Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.





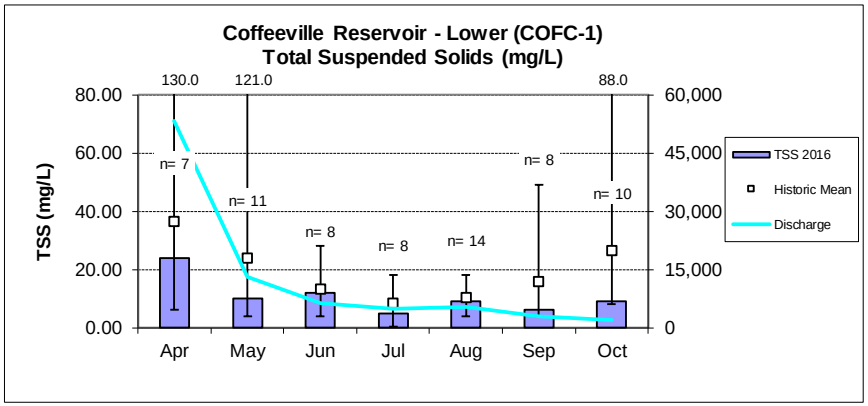


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/l are considered to be protective in reservoirs and lakes; MSC values below 20 mg/L are considered protective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

Station	Upper		Mid		Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
2001	7.63	Phosphorus	7.63	Nitrogen	13.58	Nitrogen
2006	5.16	Nitrogen	7.17	Nitrogen	4.19	Nitrogen
2011	4.13	Nitrogen	4.45	Nitrogen	7.98	Nitrogen
2016	9.92	Phosphorus	*	*	14.02	Nitrogen

*No AGPT sample collected at this location.

Figure 10. Monthly DO concentrations at 1.5 m (5 ft) for Coffeeville Reservoir stations collected April-October 2016. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2019).

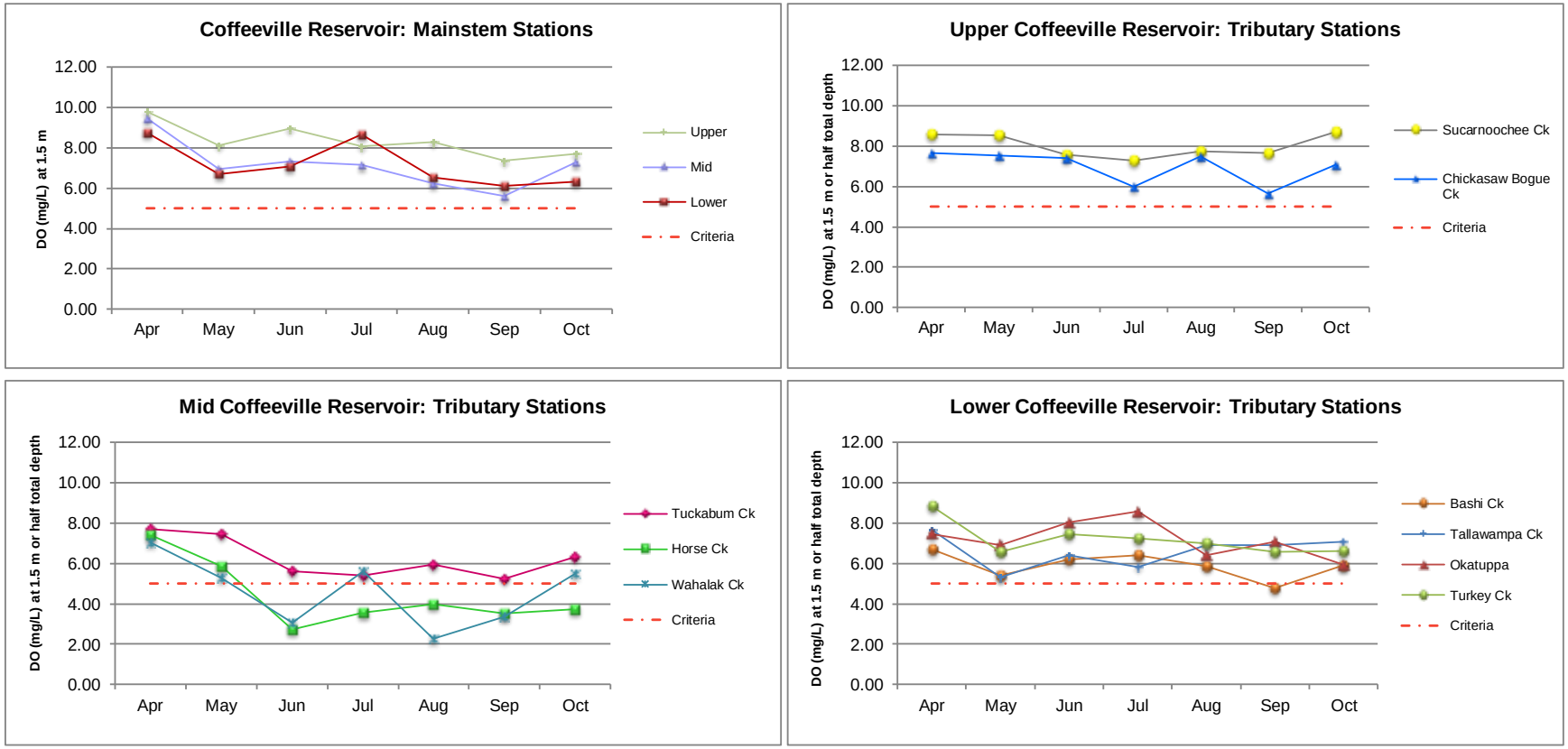


Figure 11. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the upper Coffeeville Reservoir station, April-October 2016.

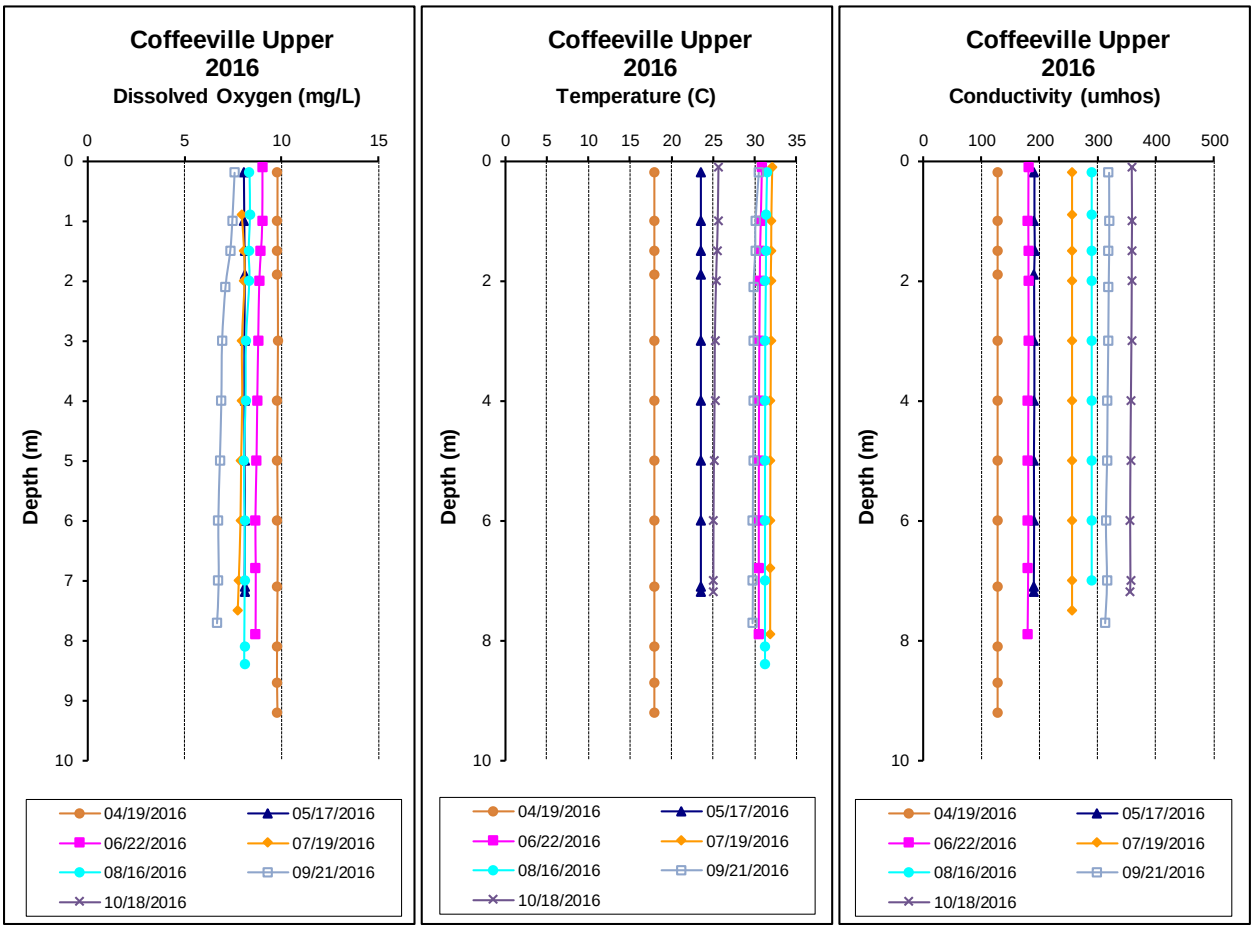


Figure 12. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the lower Coffeeville Reservoir station, April-October 2016.

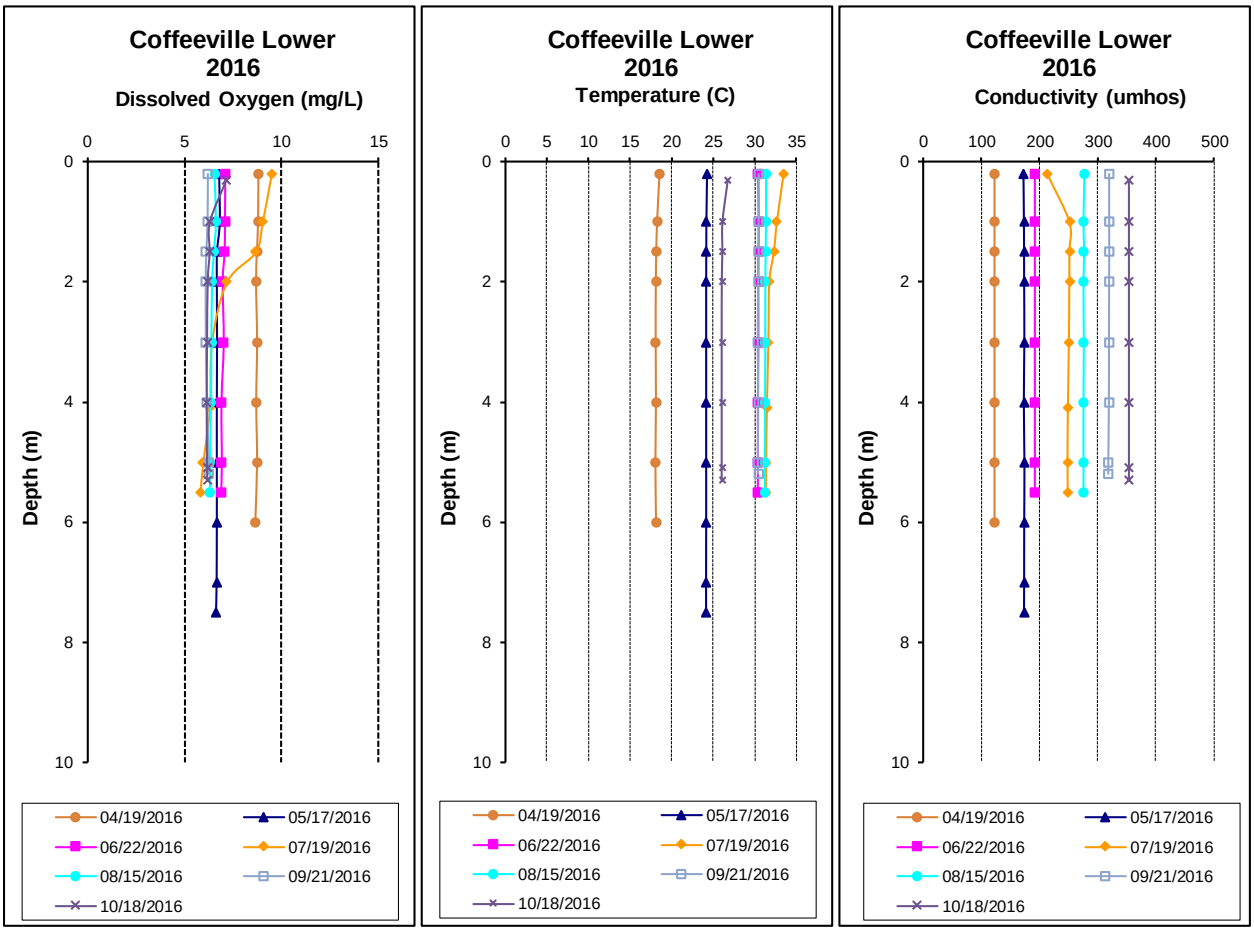
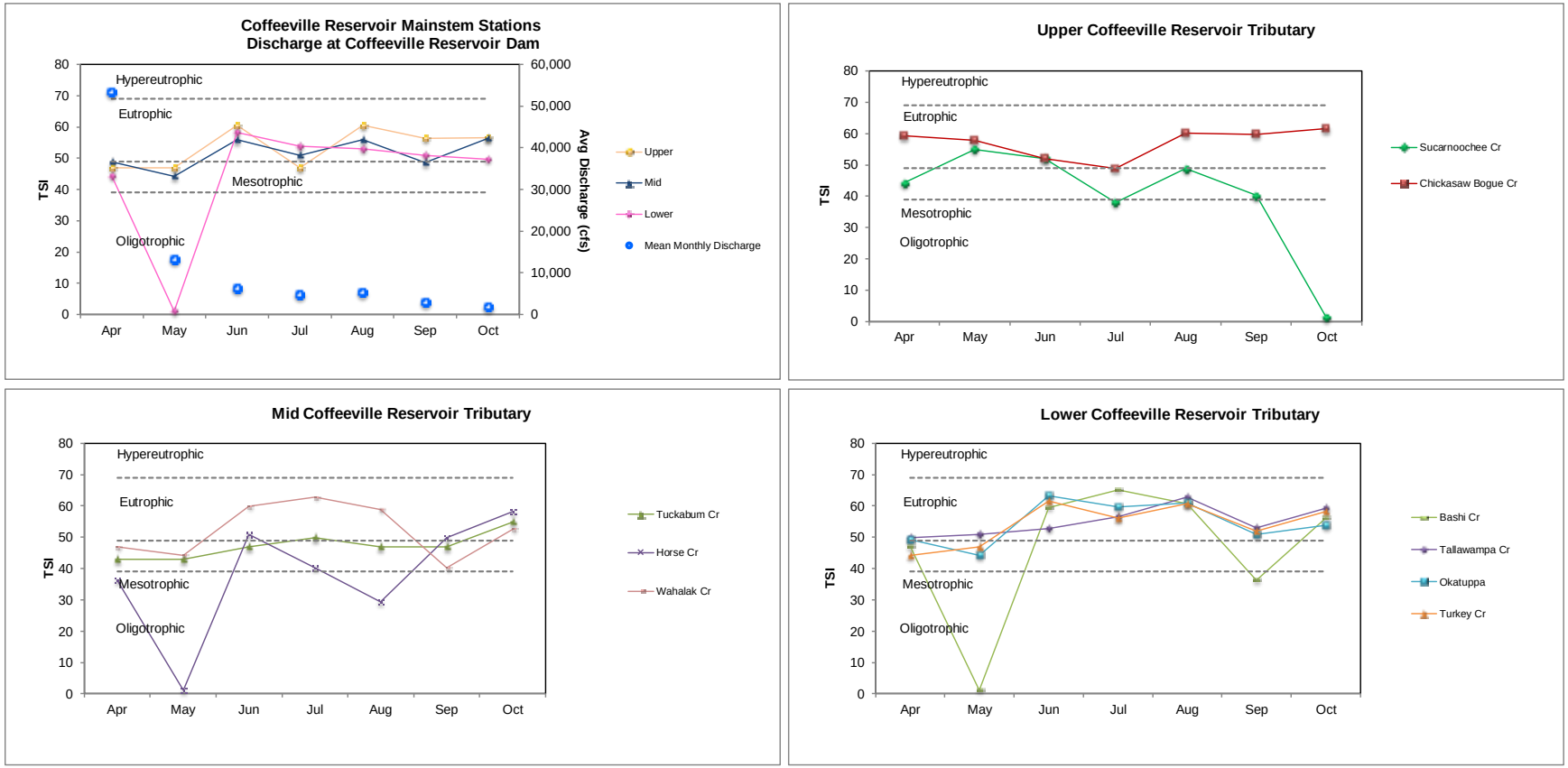


Figure 13. Monthly TSI values calculated for mainstem and tributary Coffeeville Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from USGS Tombigbee River gage station 02469761 at Coffeeville Dam.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2016. Minimum (Min) and maximum (Max) values calculated using minimum detection limits when results were less than this value. Median, 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
COFC-1	**Physical**							
	Turbidity (NTU)	7		6.4	35.8	10.0	15.1	10.9
	Total Dissolved Solids (mg/L)	7		99.0	213.0	135.0	147.9	48.1
	Total Suspended Solids (mg/L)	7		5.0	24.0	9.0	10.7	6.3
	Hardness (mg/L)	4		60.4	92.0	77.4	76.8	14.0
	Alkalinity (mg/L)	7		37.2	78.9	59.1	59.6	14.0
	Photic Zone (m)	7		1.22	3.88	2.44	2.49	1.02
	Secchi (m)	7		0.37	1.15	0.75	0.77	0.28
	Bottom Depth (m)	7		5.2	7.5	5.5	5.8	0.8
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.100	0.015	0.029	0.035
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.015	0.433	0.117	0.143	0.144
	Total Kjeldahl Nitrogen (mg/L)	7		0.295	0.960	0.570	0.592	0.265
	Total Nitrogen (mg/L)[J]	7		0.310	1.135	0.708	0.735	0.346
	Dis Reactive Phosphorus (mg/L)[J]	7		0.004	0.020	0.011	0.011	0.006
	Total Phosphorus (mg/L)	7		0.022	0.062	0.029	0.036	0.016
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.4	23.7	17.6	15.2	7.2
	Biological							
	Chlorophyll a (mg/m³)	7	<	0.10	16.90	8.01	8.06	5.32
	E. coli (MPN/DL)[J]	4		1	3	1	2	1
COFC-2	**Physical**							
	Turbidity (NTU)	7		6.2	45.5	11.8	16.7	14.1
	Total Dissolved Solids (mg/L)	7		90.0	221.0	171.0	156.0	53.0
	Total Suspended Solids (mg/L)[J]	7		6.0	41.0	10.0	13.7	12.2
	Hardness (mg/L)	4		62.1	97.3	79.8	79.8	15.6
	Alkalinity (mg/L)	7		41.0	84.5	58.0	60.9	15.7
	Photic Zone (m)	7		1.19	3.80	2.36	2.40	0.89
	Secchi (m)	7		0.33	1.22	0.66	0.71	0.30
	Bottom Depth (m)	7		9.7	11.5	10.6	10.6	0.7
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.077	0.004	0.020	0.027
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.002	0.365	0.113	0.140	0.119
	Total Kjeldahl Nitrogen (mg/L)	7		0.158	1.140	0.405	0.525	0.346
	Total Nitrogen (mg/L)	7	<	0.159	1.321	0.518	0.666	0.439
	Dis Reactive Phosphorus (mg/L)[J]	7		0.005	0.033	0.016	0.017	0.010
	Total Phosphorus (mg/L)	7		0.025	0.071	0.043	0.046	0.020
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		5.2	28.3	14.3	16.1	8.4
	Biological							
	Chlorophyll a (mg/m³)	7		4.00	13.90	8.01	9.34	4.13
	E. coli (MPN/DL)[J]	4	<	1	5	2	2	2

Appendix Table 1 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
COFC-3	**Physical**							
	Turbidity (NTU)	7		11.1	49.6	15.1	21.5	13.4
	Total Dissolved Solids (mg/L)	7		92.0	213.0	153.0	146.2	44.6
	Total Suspended Solids (mg/L)[J]	7		9.0	66.0	15.0	26.1	21.7
	Hardness (mg/L)	4		61.3	94.8	85.3	81.7	14.9
	Alkalinity (mg/L)	7		40.7	78.8	57.9	58.9	13.3
	Photic Zone (m)	7		1.01	2.63	2.20	2.00	0.53
	Secchi (m)	7		0.32	0.81	0.55	0.56	0.19
	Bottom Depth (m)	7		7.2	9.2	7.7	7.9	0.7
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.090	0.004	0.026	0.035
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.007	0.266	0.101	0.101	0.096
	Total Kjeldahl Nitrogen (mg/L)	7		0.242	0.921	0.602	0.610	0.210
	Total Nitrogen (mg/L)[J]	7		0.249	1.036	0.639	0.710	0.274
	Dis Reactive Phosphorus (mg/L)[J]	7		0.003	0.016	0.008	0.008	0.005
	Total Phosphorus (mg/L)	7		0.020	0.071	0.030	0.036	0.019
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		5.1	27.4	14.1	15.4	7.8
	Biological							
	Chlorophyll a (mg/m³)	7		5.34	21.40	13.90	12.42	7.27
	E. coli (MPN/DL)[J]	4		3	19	10	11	9
COFC-4	**Physical**							
	Turbidity (NTU)	7		18.3	69.4	38.7	39.9	15.4
	Total Dissolved Solids (mg/L)	7		26.0	76.0	68.0	60.0	18.0
	Total Suspended Solids (mg/L)	7		17.0	119.0	39.0	46.2	33.9
	Hardness (mg/L)	4		24.7	31.9	28.6	28.5	3.2
	Alkalinity (mg/L)	7		21.4	34.5	29.6	29.1	4.6
	Photic Zone (m)	7		0.40	1.00	0.60	0.69	0.27
	Secchi (m)	7		0.31	0.90	0.40	0.45	0.20
	Bottom Depth (m)	7		0.4	3.8	0.6	1.1	1.2
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.030	0.004	0.009	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.037	0.155	0.074	0.090	0.039
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.037	0.610	0.286	0.263	0.230
	Total Nitrogen (mg/L)	7	<	0.056	0.680	0.417	0.353	0.248
	Dis Reactive Phosphorus (mg/L)	7		0.010	0.021	0.017	0.016	0.004
	Total Phosphorus (mg/L)	7		0.044	0.070	0.055	0.055	0.008
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.2	6.6	4.2	4.5	1.0
	Biological							
	Chlorophyll a (mg/m³)	7	<	0.10	12.00	4.00	5.17	4.19
	E. coli (MPN/DL)[J]	4		36	199	77	97	73

Appendix Table 1 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
COFC-5	**Physical**							
	Turbidity (NTU)	7		16.8	49.1	29.2	31.9	11.4
	Total Dissolved Solids (mg/L)	7		112.0	169.0	140.0	139.3	21.9
	Total Suspended Solids (mg/L)	7		16.0	47.0	29.0	30.8	11.2
	Hardness (mg/L)	4		72.1	112.0	87.0	89.5	17.9
	Alkalinity (mg/L)	7		75.1	122.0	98.8	98.5	18.3
	Photic Zone (m)	7		0.99	2.50	1.60	1.61	0.50
	Secchi (m)	7		0.24	0.60	0.39	0.42	0.14
	Bottom Depth (m)	7		2.0	4.6	2.7	2.8	0.9
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.030	0.013	0.010	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.002	0.298	0.002	0.057	0.112
	Total Kjeldahl Nitrogen (mg/L)	7		0.420	1.520	0.589	0.805	0.456
	Total Nitrogen (mg/L)	7	<	0.422	1.521	0.680	0.862	0.431
	Dis Reactive Phosphorus (mg/L)[J]	7		0.003	0.032	0.010	0.013	0.009
	Total Phosphorus (mg/L)	7		0.028	0.087	0.041	0.050	0.022
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.5	15.1	8.1	9.2	3.5
	Biological							
	Chlorophyll a (mg/m³)	7		6.41	23.50	18.70	16.20	6.29
	E. coli (MPN/DL)[J]	4		5	179	12	52	85
COFC-6	**Physical**							
	Turbidity (NTU)	7		9.8	32.1	16.6	17.9	8.0
	Total Dissolved Solids (mg/L)	7		49.0	159.0	64.0	78.0	37.4
	Total Suspended Solids (mg/L)	7		8.0	43.0	11.0	17.6	13.3
	Hardness (mg/L)	4		19.6	27.4	21.4	22.4	3.4
	Alkalinity (mg/L)	7		20.7	72.0	33.7	38.8	16.2
	Photic Zone (m)	7		1.15	2.30	1.88	1.89	0.38
	Secchi (m)	7		0.42	0.90	0.65	0.63	0.16
	Bottom Depth (m)	7		1.8	3.0	2.2	2.2	0.4
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.071	0.015	0.024	0.025
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.019	0.220	0.039	0.078	0.074
	Total Kjeldahl Nitrogen (mg/L)	7		0.328	0.992	0.405	0.504	0.241
	Total Nitrogen (mg/L)[J]	7		0.364	1.055	0.464	0.582	0.260
	Dis Reactive Phosphorus (mg/L)[J]	7		0.005	0.016	0.009	0.010	0.004
	Total Phosphorus (mg/L)	7		0.036	0.050	0.047	0.044	0.005
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.6	18.6	4.9	6.7	5.3
	Biological							
	Chlorophyll a (mg/m³)	7		3.56	12.00	5.34	6.04	2.90
	E. coli (MPN/DL)	4		17	517	70	169	236

Appendix Table 1 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
COFC-7	**Physical**							
	Turbidity (NTU)	7		16.1	38.6	30.0	27.9	7.2
	Total Dissolved Solids (mg/L)	7		50.0	133.0	69.0	74.7	27.7
	Total Suspended Solids (mg/L)	7		9.0	42.0	17.0	21.9	11.2
	Hardness (mg/L)	4		16.5	23.5	21.2	20.6	3.1
	Alkalinity (mg/L)	7		17.6	57.6	26.1	30.3	13.0
	Photic Zone (m)	7		1.00	1.21	1.10	1.13	0.08
	Secchi (m)	7		0.28	0.72	0.41	0.42	0.14
	Bottom Depth (m)	7		1.0	1.8	1.1	1.2	0.3
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.009	0.080	0.071	0.057	0.030
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.038	0.134	0.066	0.074	0.034
	Total Kjeldahl Nitrogen (mg/L)	7		0.258	1.000	0.590	0.560	0.275
	Total Nitrogen (mg/L)	7		0.296	1.097	0.670	0.634	0.299
	Dis Reactive Phosphorus (mg/L)[J]	7		0.005	0.015	0.011	0.011	0.003
	Total Phosphorus (mg/L)	7		0.037	0.075	0.060	0.057	0.012
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.0	18.6	4.8	6.8	5.3
	Biological							
	Chlorophyll a (mg/m³)	7	<	0.10	16.90	2.67	5.35	5.94
	E. coli (MPN/DL)	4		48	194	105	112	67
COFC-8	**Physical**							
	Turbidity (NTU)	7		9.6	48.7	16.0	21.0	14.7
	Total Dissolved Solids (mg/L)	7		71.0	221.0	137.3	135.6	54.8
	Total Suspended Solids (mg/L)[J]	7		8.0	37.0	11.0	16.4	11.4
	Hardness (mg/L)	4		58.6	75.2	68.0	67.5	6.9
	Alkalinity (mg/L)	7		28.2	84.9	58.6	57.6	18.6
	Photic Zone (m)	7		0.90	1.50	1.00	1.11	0.22
	Secchi (m)	7		0.32	1.00	0.51	0.59	0.24
	Bottom Depth (m)	7		0.9	2.1	1.0	1.2	0.4
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.118	0.015	0.041	0.051
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.012	0.170	0.059	0.071	0.054
	Total Kjeldahl Nitrogen (mg/L)	7		0.316	0.660	0.382	0.453	0.143
	Total Nitrogen (mg/L)[J]	7		0.370	0.719	0.552	0.524	0.149
	Dis Reactive Phosphorus (mg/L)[J]	7		0.006	0.029	0.012	0.014	0.009
	Total Phosphorus (mg/L)	7		0.028	0.086	0.064	0.061	0.020
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.3	25.5	14.5	13.5	7.4
	Biological							
	Chlorophyll a (mg/m³)	7		2.67	26.70	9.34	12.26	9.27
	E. coli (MPN/DL)	4		7	35	21	21	11

Appendix Table 1 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
COFC-9	**Physical**							
	Turbidity (NTU)	7		7.8	33.4	11.0	15.0	9.6
	Total Dissolved Solids (mg/L)	7		77.0	222.0	188.0	155.6	62.9
	Total Suspended Solids (mg/L)	7		5.0	17.0	9.0	10.4	4.6
	Hardness (mg/L)	4		64.4	97.8	80.4	80.7	14.8
	Alkalinity (mg/L)	7		27.2	80.0	58.4	57.4	19.2
	Photic Zone (m)	7		1.52	3.00	1.90	2.11	0.55
	Secchi (m)	7		0.48	0.99	0.63	0.68	0.18
	Bottom Depth (m)	7		2.4	3.4	3.0	2.9	0.4
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.086	0.015	0.027	0.031
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.123	0.046	0.043	0.043
	Total Kjeldahl Nitrogen (mg/L)	7		0.329	2.200	0.480	0.749	0.652
	Total Nitrogen (mg/L)[J]	7	<	0.330	2.323	0.526	0.792	0.689
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.030	0.007	0.010	0.010
	Total Phosphorus (mg/L)	7		0.019	0.068	0.031	0.036	0.016
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.6	26.9	14.8	15.5	8.7
	Biological							
	Chlorophyll a (mg/m³)	7	<	0.10	33.80	13.40	13.57	12.19
	E. coli (MPN/DL)[J]	4		1	28	3	9	13
COFC-10	**Physical**							
	Turbidity (NTU)	7		9.3	32.1	14.9	17.2	7.8
	Total Dissolved Solids (mg/L)	7		73.0	205.0	88.0	121.0	53.8
	Total Suspended Solids (mg/L)	7		8.0	23.0	15.0	15.6	5.2
	Hardness (mg/L)	4		54.4	84.4	63.6	66.5	13.6
	Alkalinity (mg/L)	7		7.2	75.5	48.4	46.4	23.5
	Photic Zone (m)	7		1.24	3.04	1.75	1.97	0.61
	Secchi (m)	7		0.40	0.89	0.69	0.64	0.18
	Bottom Depth (m)	7		3.4	4.8	4.1	4.2	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.030	0.004	0.011	0.010
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.086	0.014	0.026	0.032
	Total Kjeldahl Nitrogen (mg/L)	7		0.329	1.080	0.560	0.592	0.253
	Total Nitrogen (mg/L)[J]	7	<	0.330	1.082	0.589	0.618	0.260
	Dis Reactive Phosphorus (mg/L)[J]	7		0.003	0.006	0.005	0.005	0.001
	Total Phosphorus (mg/L)	7		0.020	0.044	0.028	0.029	0.008
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.0	23.0	12.1	12.8	7.5
	Biological							
	Chlorophyll a (mg/m³)	7		7.12	26.70	9.79	13.45	7.09
	E. coli (MPN/DL)[J]	4		5	9	5	6	2

Appendix Table 1 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
COFC-11	**Physical**							
	Turbidity (NTU)	7		8.1	21.2	11.1	12.9	4.5
	Total Dissolved Solids (mg/L)	7		87.0	210.0	126.0	131.3	40.8
	Total Suspended Solids (mg/L)	7		8.0	16.0	10.0	10.6	2.6
	Hardness (mg/L)	4		61.1	71.4	66.0	66.2	4.7
	Alkalinity (mg/L)	7		39.0	77.4	52.5	55.4	11.8
	Photic Zone (m)	7		1.68	4.00	2.11	2.35	0.77
	Secchi (m)	7		0.50	1.00	0.92	0.78	0.22
	Bottom Depth (m)	7		6.0	7.2	6.5	6.5	0.4
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.059	0.011	0.016	0.020
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.002	0.279	0.040	0.070	0.094
	Total Kjeldahl Nitrogen (mg/L)	7		0.251	0.640	0.470	0.476	0.148
	Total Nitrogen (mg/L)	7	<	0.291	0.919	0.526	0.546	0.213
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.014	0.005	0.006	0.004
	Total Phosphorus (mg/L)	7		0.020	0.050	0.025	0.028	0.010
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		6.5	23.0	15.5	13.9	5.4
	Biological							
	Chlorophyll a (mg/m³)	7		4.00	27.80	10.70	14.14	9.03
	E. coli (MPN/DL)[J]	4		1	5	1	2	2
COFC-12	**Physical**							
	Turbidity (NTU)	7		8.4	46.7	10.9	18.2	14.2
	Total Dissolved Solids (mg/L)	7		95.0	204.0	124.0	144.7	46.4
	Total Suspended Solids (mg/L)	7		8.0	42.0	11.0	15.7	12.1
	Hardness (mg/L)	4		60.4	92.0	77.8	77.0	13.9
	Alkalinity (mg/L)	7		37.4	78.5	59.4	59.8	14.0
	Photic Zone (m)	7		0.76	3.64	2.18	2.07	1.00
	Secchi (m)	7		0.31	1.07	0.63	0.65	0.29
	Bottom Depth (m)	7		4.1	5.3	4.3	4.6	0.5
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.119	0.015	0.028	0.041
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.469	0.094	0.132	0.162
	Total Kjeldahl Nitrogen (mg/L)[J]	7		0.142	0.956	0.513	0.511	0.255
	Total Nitrogen (mg/L)[J]	7	<	0.143	1.149	0.607	0.643	0.372
	Dis Reactive Phosphorus (mg/L)[J]	7		0.003	0.021	0.008	0.010	0.007
	Total Phosphorus (mg/L)	7		0.021	0.067	0.029	0.036	0.018
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.5	23.5	16.6	15.0	7.1
	Biological							
	Chlorophyll a (mg/m³)	7		4.00	23.50	13.40	13.32	7.64
	E. coli (MPN/DL)[J]	4		2	14	6	7	6

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