2012 Tuscaloosa Reservoir Report
Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit

July 2014

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2012

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Black Warrior River Basin

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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
BWC	Black Warrior and Cahaba Rivers
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

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INTRODUCTION

Lake Tuscaloosa is located 5 miles north of the cities of Tuscaloosa and Northport in west central Alabama. The 5,885 acre lake was impounded in 1971 to provide drinking and industrial water for the city of Tuscaloosa. The major waterbodies flowing into Lake Tuscaloosa include Binion Creek and the North River, while the tailrace empties into the Black Warrior River at Oliver Reservoir, east of Tuscaloosa.

The Alabama Department of Environmental Management (ADEM) monitored Tuscaloosa Reservoir as part of the 2012 assessment of the Black Warrior and Cahaba River (BWC) Basins under the Rivers and Reservoirs Monitoring Program (RRMP). ADEM began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program (now known as RRMP) was initiated by ADEM. The current objectives of this program are to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2012 Monitoring Strategy (ADEM 2012).

In 2004, the ADEM implemented a specific water quality criterion for nutrient management at the forebay of Tuscaloosa Reservoir, which has been monitored by ADEM since 1990. This criterion represents the maximum growing season mean (April-October) chlorophyll *a* (chl *a*) concentration allowable, while still fully supporting Tuscaloosa Reservoir's Public Water Supply, Swimming and Fish & Wildlife (PWS/S/F&W) use classifications.

In 2008, the Alabama Department of Public Health issued a consumption advisory for largemouth bass caught in Tuscaloosa Reservoir. Samples collected in 2007 contained mercury levels exceeding the EPA action level of 0.33 ppm. Consequently, Tuscaloosa Reservoir was added to Alabama's 2010 §303(d) list of impaired waters for not meeting its use classification. A draft mercury TMDL is scheduled for 2020.

The purpose of this report is to summarize data collected at five stations in Tuscaloosa Reservoir during the 2012 growing season, and to evaluate growing season 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

Sampling stations were selected using historical data and previous assessments (Fig. 1). Specific location information can be found in Table 1. Tuscaloosa Reservoir was sampled in the dam forebay, mid reservoir and upper reservoir. Two tributary embayment stations were also monitored, Binion Creek and the North River.

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 2012), Surface Water Quality Assurance Project Plan (ADEM 2012) 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. Monthly concentrations of these parameters were graphed with the closest available flow data and ADEM's previously collected data to help interpret the 2012 results.

Figure 1. Tuscaloosa Reservoir with 2012 sampling locations.

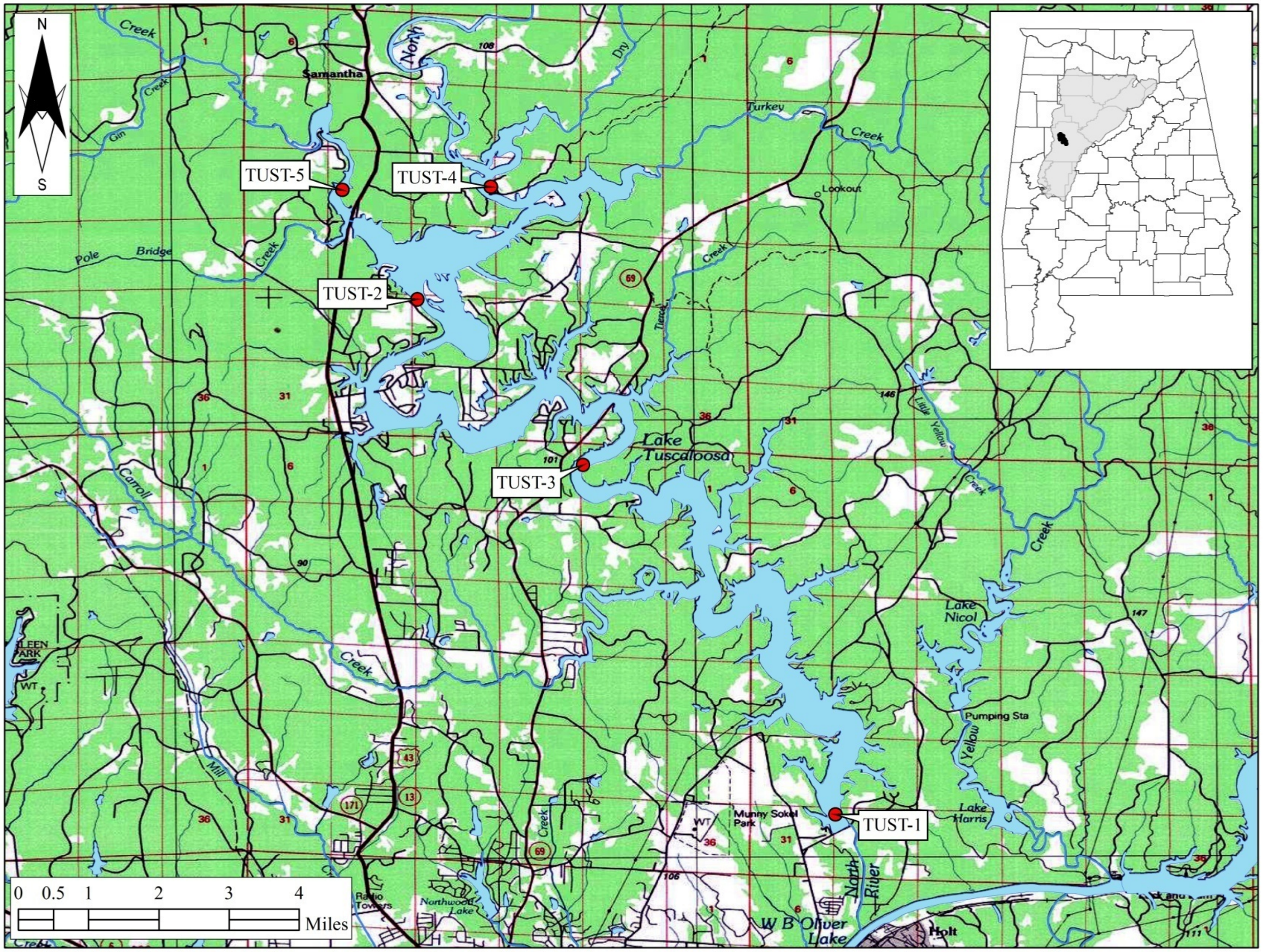


Table 1. Descriptions of the 2012 monitoring stations in Tuscaloosa Reservoir.

HUC	County	Station Number	Report Designation	Waterbody	Station Description	Chl *a* Criteria	Latitude	Longitude
031601120413	Tuscaloosa	TUST-1*	Lower	North R	Deepest point, main river channel, dam forebay.	8 µg/L	33.2685	-87.5084
031601120413	Tuscaloosa	TUST-2	Upper	North R	Deepest point, main river channel, immediately downstream of Binion Creek confluence.		33.3747	-87.5946
031601120413	Tuscaloosa	TUST-3	Mid	North R	Deepest point, main river channel, approximately one mile downstream of Alabama Hwy. 69 bridge.		33.3405	-87.5604
031601120411	Tuscaloosa	TUST-4	North R	North R	North River immediately upstream of Bull Slough Road crossing, deepest point, main channel		33.3979	-87.5795
031601120410	Tuscaloosa	TUST-5	Binion Ck	Binion Ck	Binion Creek, deepest point, main channel, immediately upstream of Hwy 43.		33.3972	-87.6101

*Growing season mean chl *a* criteria 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 and 3). Monthly graphs for TN, TP, chl *a*, TSS, dissolved oxygen (DO) and TSI are also provided (Figs. 4-8 and 12). Mean monthly discharge is included in monthly graphs for TN, TP, chl *a*, TSS and TSI as an indicator of flow and retention time in the months sampled. AGPT results are summarized in Table 2. Depth profile graphs of temperature, DO and conductivity are provided in Figs. 9-11. Summary statistics of all data collected during 2012 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 always be mentioned, review of the graphs will indicate stations that may be potential candidates for reference waterbodies and watersheds.

In 2012, the highest mean growing season TN value calculated among Tuscaloosa Reservoir mainstem stations was in the upper station (Fig. 2). The highest mean growing season TN value among tributary stations was in the North River station. Mean growing season TN values in the lower and mid stations were among the lowest since monitoring began, while values in the upper station were higher than all other years monitored, except 2006. Mean growing season TN values in the Binion Creek station have declined since 2002. For the lower and upper mainstem stations, the highest monthly TN concentration was measured in July, while the highest concentration measured in the mid station was in June (Fig. 4). A historic high TN concentration was measured in July in the upper station. Historic low TN concentrations were measured in the lower station in April, May, September and October. Historic low concentrations were also measured in the mid station in April, May and October, and in the upper station in May and October.

In 2012, the highest mean growing season TP value calculated among Tuscaloosa Reservoir mainstem stations was in the upper station (Fig. 2). The highest mean growing season TP value among tributary stations was in the North River station. Mean growing season TP values in all Tuscaloosa Reservoir mainstem and tributary stations were the lowest since monitoring began, and have declined overall in the years monitored. Monthly TP concentrations in all Tuscaloosa Reservoir mainstem stations were below historic means, April-October (Fig. 5). Historic low monthly TP concentrations were measured in the lower station, May-July, and in the mid station in May.

Specific water quality criterion for nutrient management has been established for the lower station in Tuscaloosa Reservoir. The growing season mean chl *a* value in the lower station during 2012 was in compliance with the criterion (Fig. 3). In 2012, the highest mean growing season chl *a* value calculated among Tuscaloosa Reservoir mainstem stations was in the upper station. The highest value calculated among tributary stations was in the North River. Mean growing season chl *a* values in all Tuscaloosa Reservoir mainstem and tributary stations were the lowest since monitoring began, and have declined overall in the years monitored. A historic high monthly chl *a* concentration was measured in the mid station in April (Fig. 6). All other monthly chl *a* concentrations measured in Tuscaloosa Reservoir mainstem stations were below historic means. Historic low monthly chl *a* concentrations were measured in the lower station in May, July and September, and in the mid station in May and October.

In 2012, mean growing season TSS values among Tuscaloosa Reservoir mainstem and tributary stations were similar, and have declined overall in the years monitored (Fig. 3). The 2012 monthly TSS concentrations were below historic means, often the lowest measurement on record, in all Tuscaloosa Reservoir mainstem stations (Fig. 7).

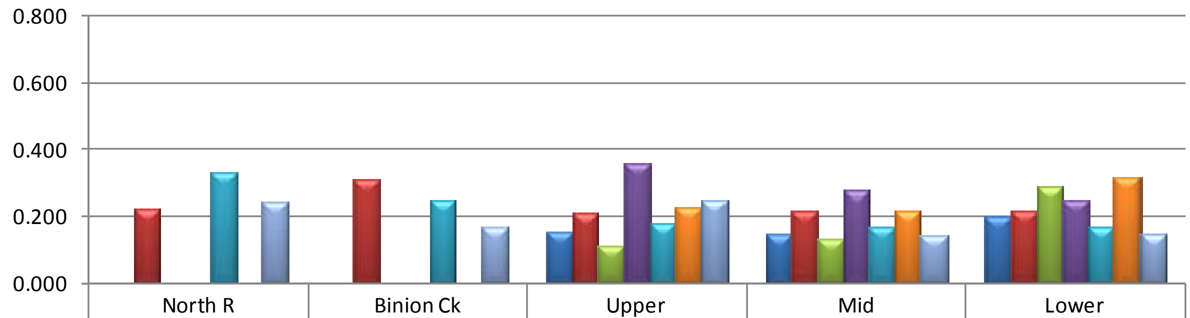
AGPT results for the mid and upper Tuscaloosa Reservoir stations have consistently changed between phosphorus limited, nitrogen limited, and co-limited since AGPT testing began in 1998 (Table 2). AGPT results in the lower station have been more consistent, indicating phosphorus limited conditions since 2002. AGPT results indicate all mainstem Tuscaloosa Reservoir stations remained below 5 mg/L MSC, the value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems.

All measurements of dissolved oxygen concentrations in Tuscaloosa Reservoir mainstem and tributary stations were above the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) (Fig. 8). Based on monthly DO profiles in the lower station, DO concentrations were below 5.0 mg/L at depths greater than 9m June-October (Fig. 9). In the mid and upper stations, monthly profiles indicate DO concentrations were below 5.0 mg/L in the majority of the water column all months monitored with the exception of the upper station in September (Fig. 10 and 11). Based on temperature profiles, all Tuscaloosa Reservoir mainstem stations were thermally stratified, April-October. Based on conductivity profiles, chemoclines were measured in the lower station all months monitored. Chemoclines were also measured in the mid station, June-October, and in the upper station, May-October.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. Among Tuscaloosa Reservoir mainstem stations, the upper station had the highest TSI value reaching near eutrophic conditions in April, August and October (Fig. 12). The lower station was oligotrophic all months monitored, while the mid station varied between oligotrophic and mesotrophic, April-October. Among tributaries, the North River station had the highest TSI values, reaching eutrophic conditions July through September, while the Binion Creek station was mesotrophic most months monitored.

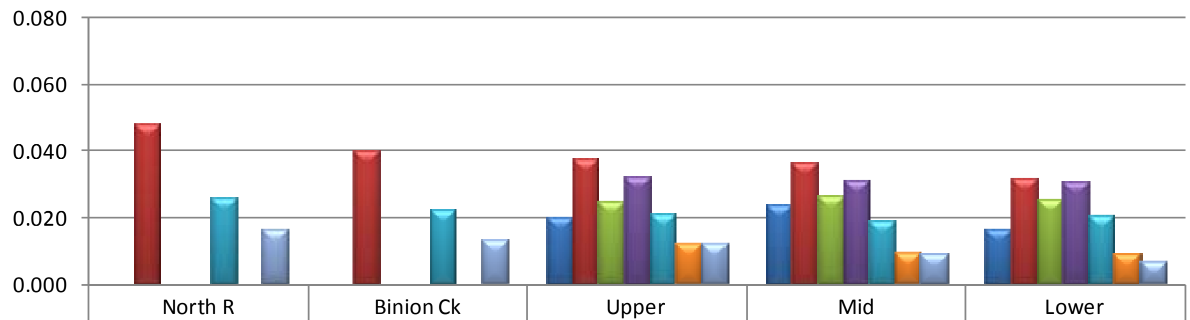
Figure 2. Mean growing season TN and TP measured in Tuscaloosa Reservoir, April-October, 1998-2012. Stations are illustrated from upstream to downstream as the graph is read from left to right.

Tuscaloosa Reservoir: Mean TN (mg/L) 1998-2012



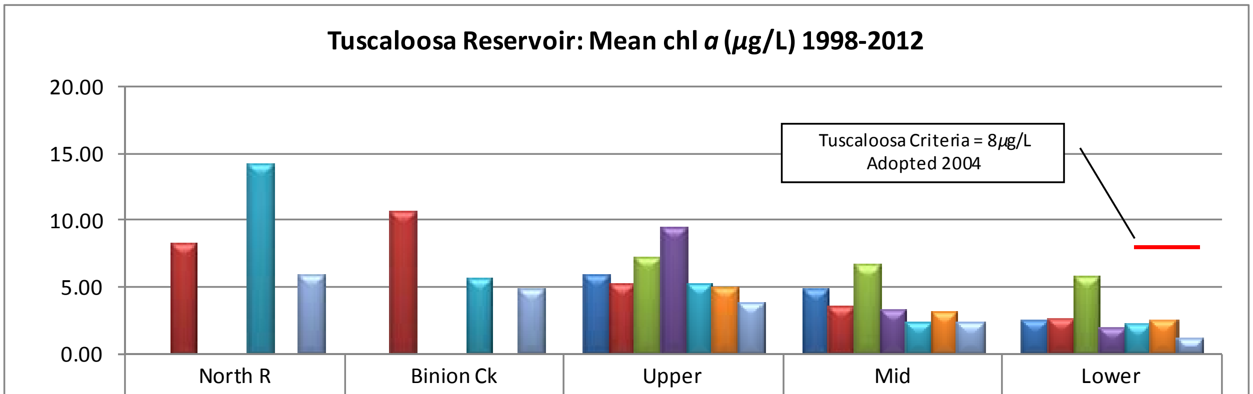
	North R	Binion Ck	Upper	Mid	Lower
1998			0.153	0.146	0.201
2002	0.225	0.309	0.211	0.217	0.218
2003			0.113	0.130	0.286
2006			0.358	0.278	0.252
2007	0.329	0.252	0.183	0.170	0.171
2011			0.227	0.219	0.315
2012	0.246	0.168	0.251	0.143	0.150

Tuscaloosa Reservoir: Mean TP (mg/L) 1998-2012

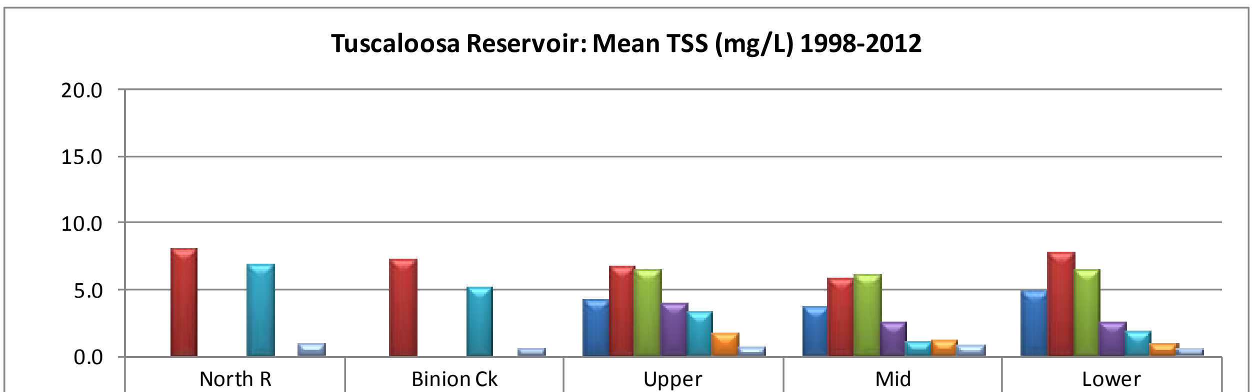


	North R	Binion Ck	Upper	Mid	Lower
1998			0.020	0.024	0.017
2002	0.049	0.040	0.038	0.037	0.032
2003			0.025	0.026	0.026
2006			0.032	0.031	0.031
2007	0.026	0.022	0.021	0.019	0.021
2011			0.012	0.009	0.009
2012	0.017	0.013	0.012	0.009	0.007

Figure 3. Mean growing season chl *a* and TSS measured in Tuscaloosa Reservoir, April-October, 1998-2012. Stations are illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criterion applies to the growing season mean of the lower station only.



	North R	Binion Ck	Upper	Mid	Lower
1998			5.93	4.87	2.52
2002	8.29	10.64	5.30	3.61	2.63
2003			7.13	6.70	5.80
2006			9.38	3.31	1.96
2007	14.22	5.67	5.35	2.44	2.25
2011			5.02	3.22	2.54
2012	5.94	4.88	3.89	2.44	1.18



	North R	Binion Ck	Upper	Mid	Lower
1998			4.3	3.7	4.9
2002	8.1	7.3	6.8	5.8	7.9
2003			6.5	6.1	6.6
2006			4.0	2.6	2.6
2007	6.9	5.2	3.3	1.1	1.9
2011			1.8	1.2	0.9
2012	0.9	0.6	0.7	0.9	0.5

Figure 4. Monthly TN concentrations measured in Tuscaloosa Reservoir, April-October, 2012, vs. average monthly discharge. Discharge calculated as the sum of USGS 02464000 North R near Samantha AL and 02464360 Binion Ck below Gin Ck near Samantha AL. Each bar graph depicts monthly changes in each station. The historic mean (1990-2012) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

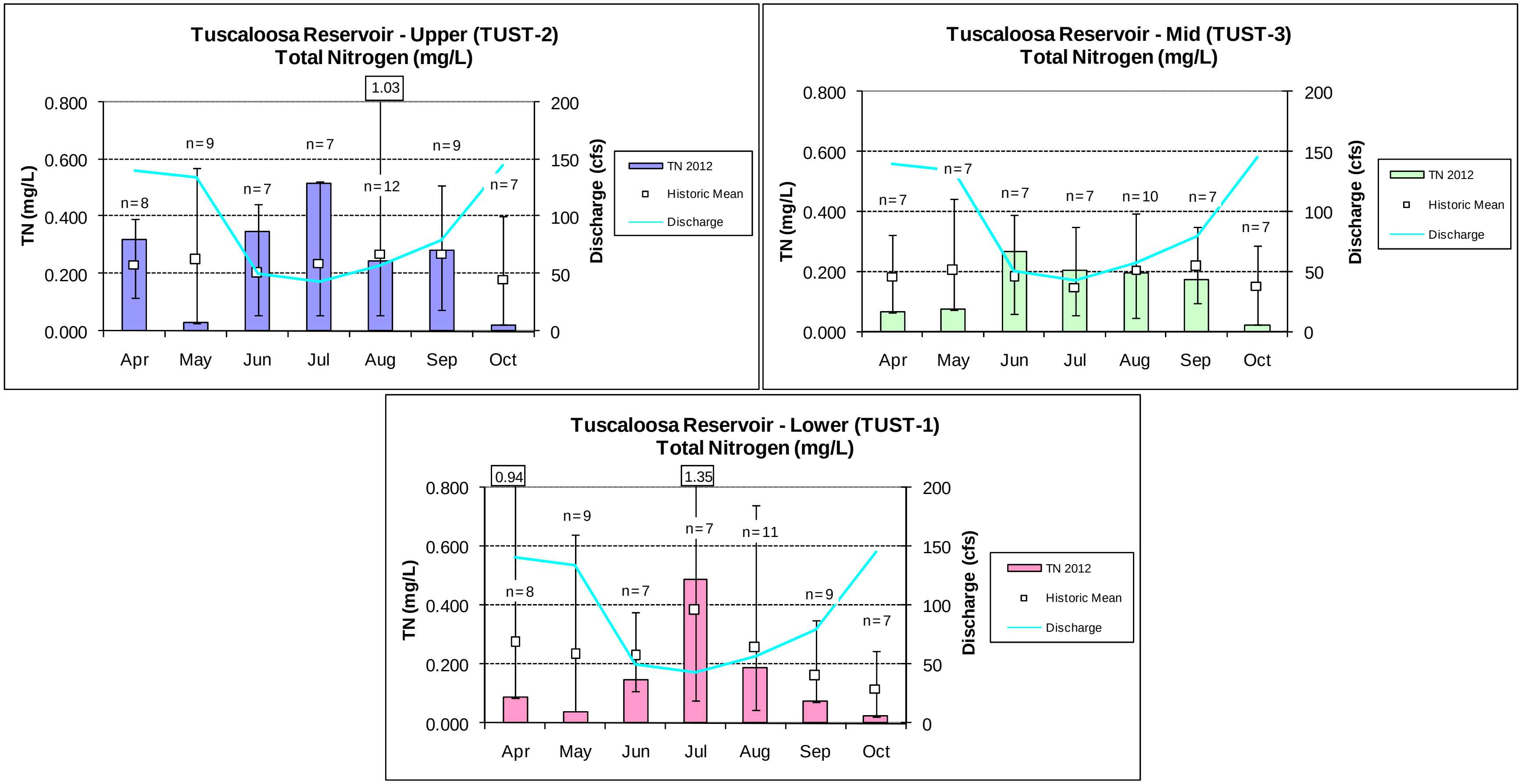


Figure 5. Monthly TP concentrations measured in Tuscaloosa Reservoir, April-October, 2012, vs. average monthly discharge. Discharge calculated as the sum of USGS 02464000 North R near Samantha AL and 02464360 Binion Ck below Gin Ck near Samantha AL. Each bar graph depicts monthly changes in each station. The historic mean (1990-2012) and min/max range are also displayed for comparison. The “n” value equals the number of datapoints included in the monthly historic calculations.

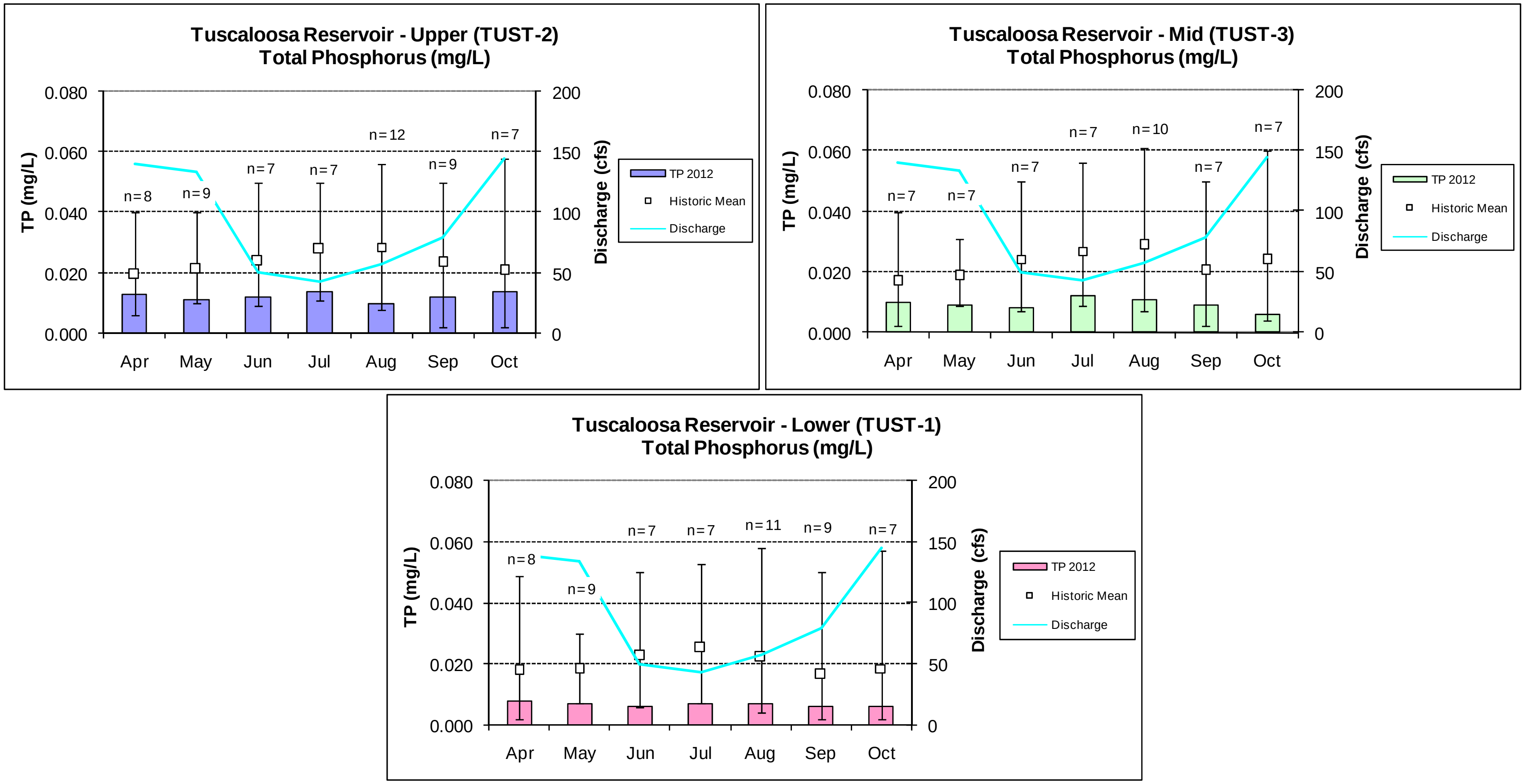
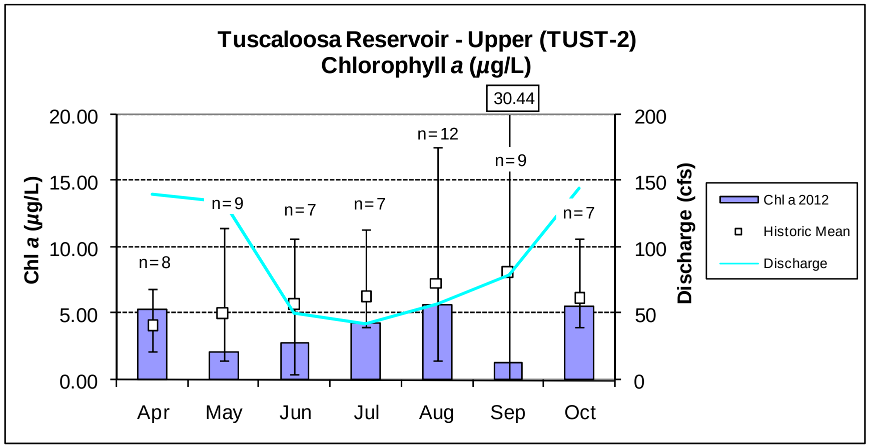
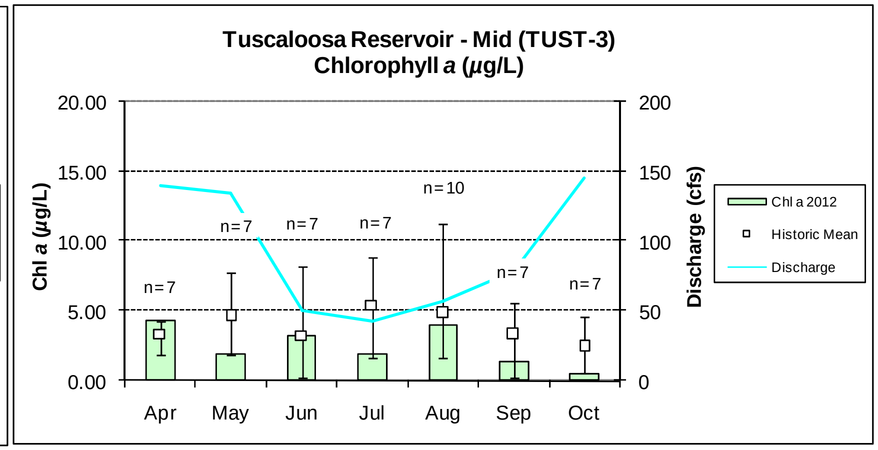


Figure 6. Monthly chl *a* concentrations measured in Tuscaloosa Reservoir, April-October, 2012, vs. average monthly discharge. Discharge calculated as the sum of USGS 02464000 North R near Samantha AL and 02464360 Binion Ck below Gin Ck near Samantha AL. Each bar graph depicts monthly changes in each station. The historic mean (1990-2012) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





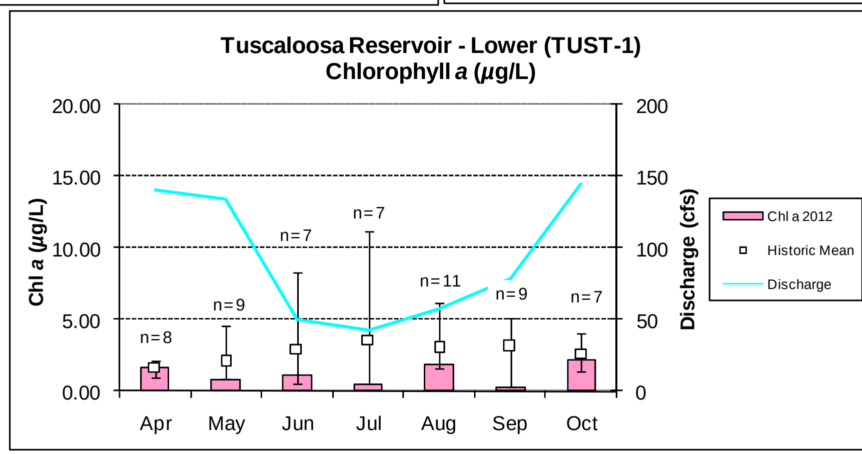


Figure 7. Monthly TSS concentrations measured in Tuscaloosa Reservoir, April-October, 2012, vs. average monthly discharge. Discharge calculated as the sum of USGS 02464000 North R near Samantha AL and 02464360 Binion Ck below Gin Ck near Samantha AL. Each bar graph depicts monthly changes in each station. The historic mean (1990-2012) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

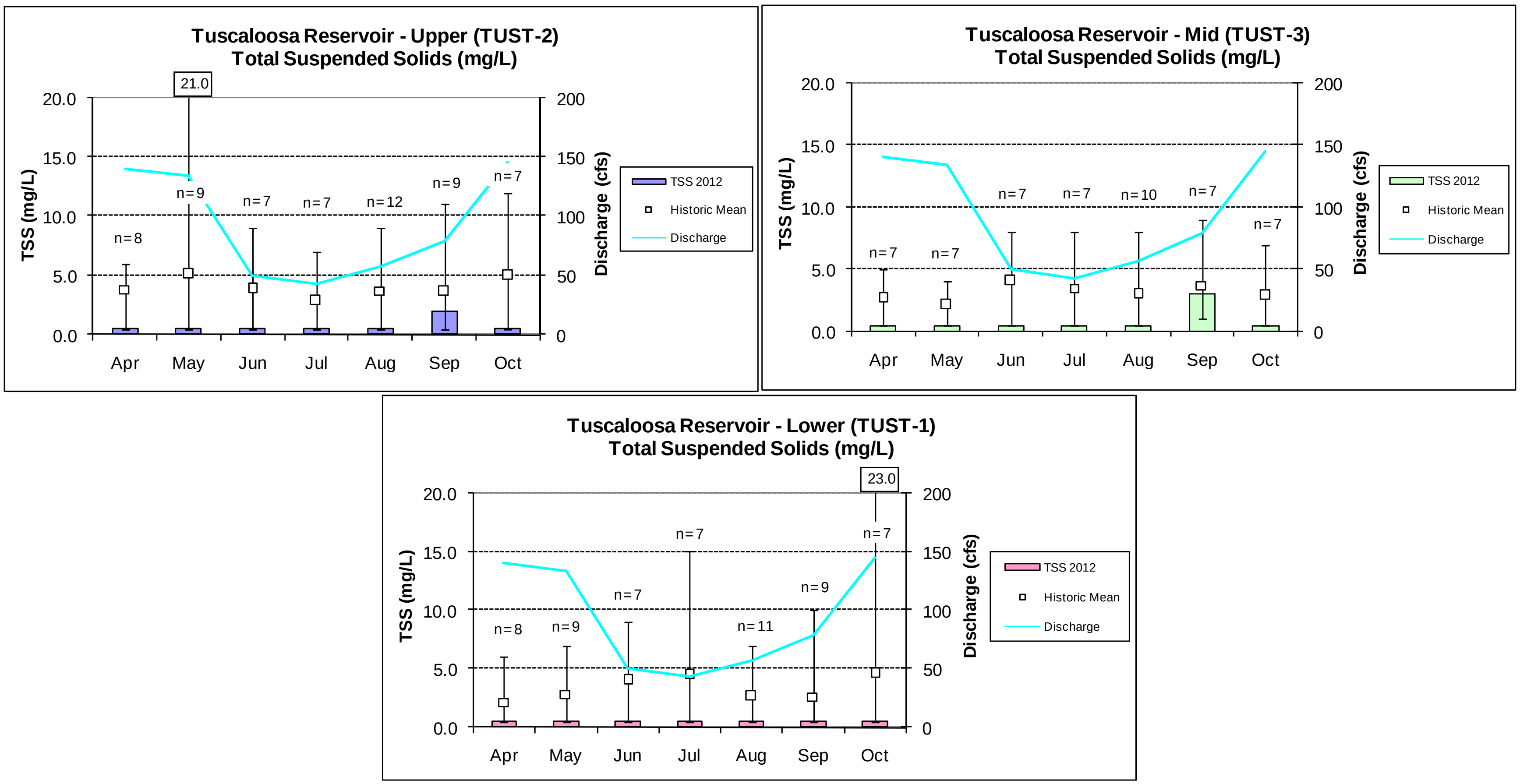
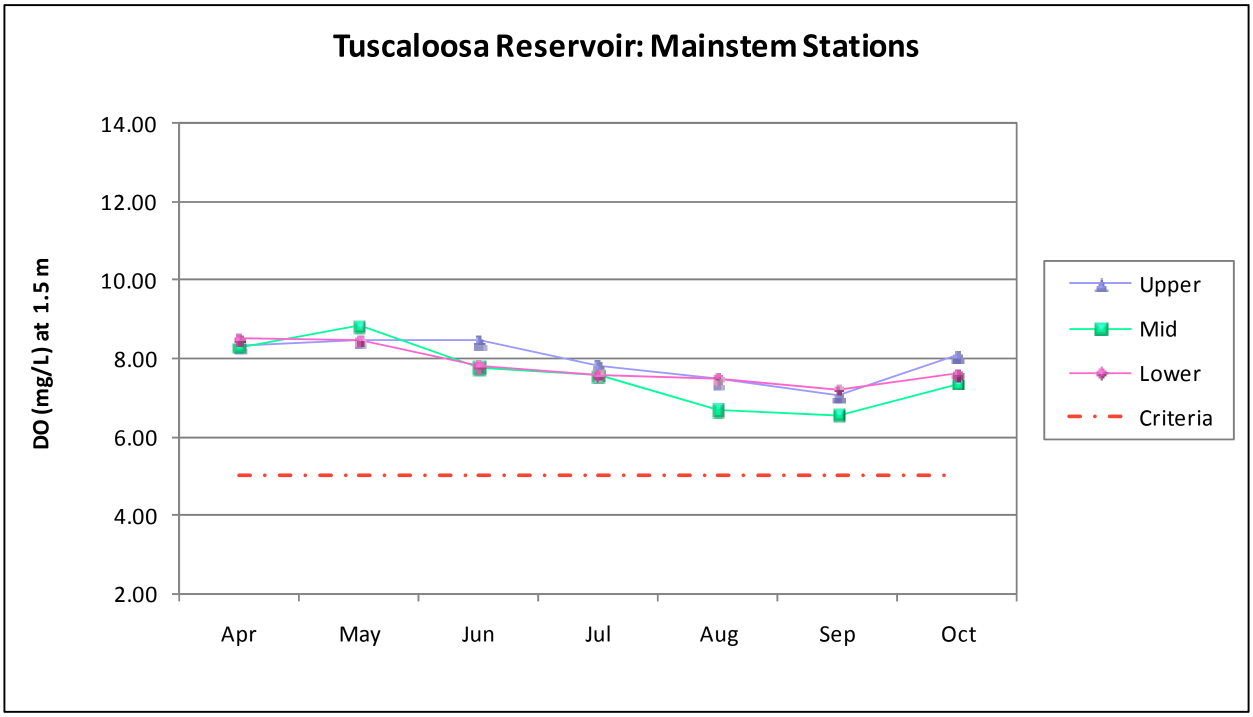


Table 2. Algal growth potential test results, Tuscaloosa Reservoir, 1998-2012, (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

Station	**Upper**		**Mid**		**Lower**	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
August 1998	2.49	Phosphorus	2.18	Phosphorus	2.31	Co-limiting
August 2002	1.80	Co-limiting	1.89	Nitrogen	1.82	Phosphorus
June 2007	2.05	Co-limiting	1.79	Phosphorus	2.13	Phosphorus
July 2007	1.80	Phosphorus	1.05	Co-limiting	1.28	Phosphorus
August 2007	2.21	Co-limiting	2.26	Phosphorus	2.32	Phosphorus
August 2012	1.93	Co-limiting	2.12	Co-limiting	1.51	Phosphorus

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Tuscaloosa Reservoir stations collected April-October, 2012. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).



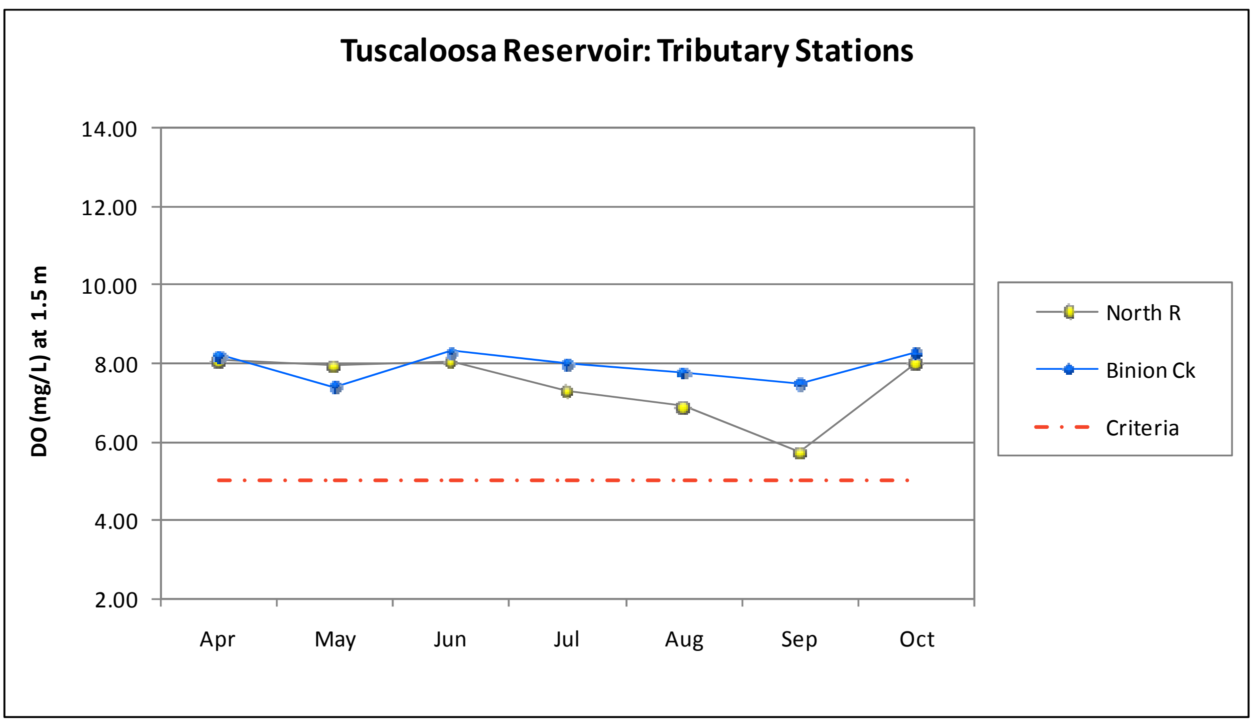


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the lower Tuscaloosa Reservoir station, April-October, 2012.

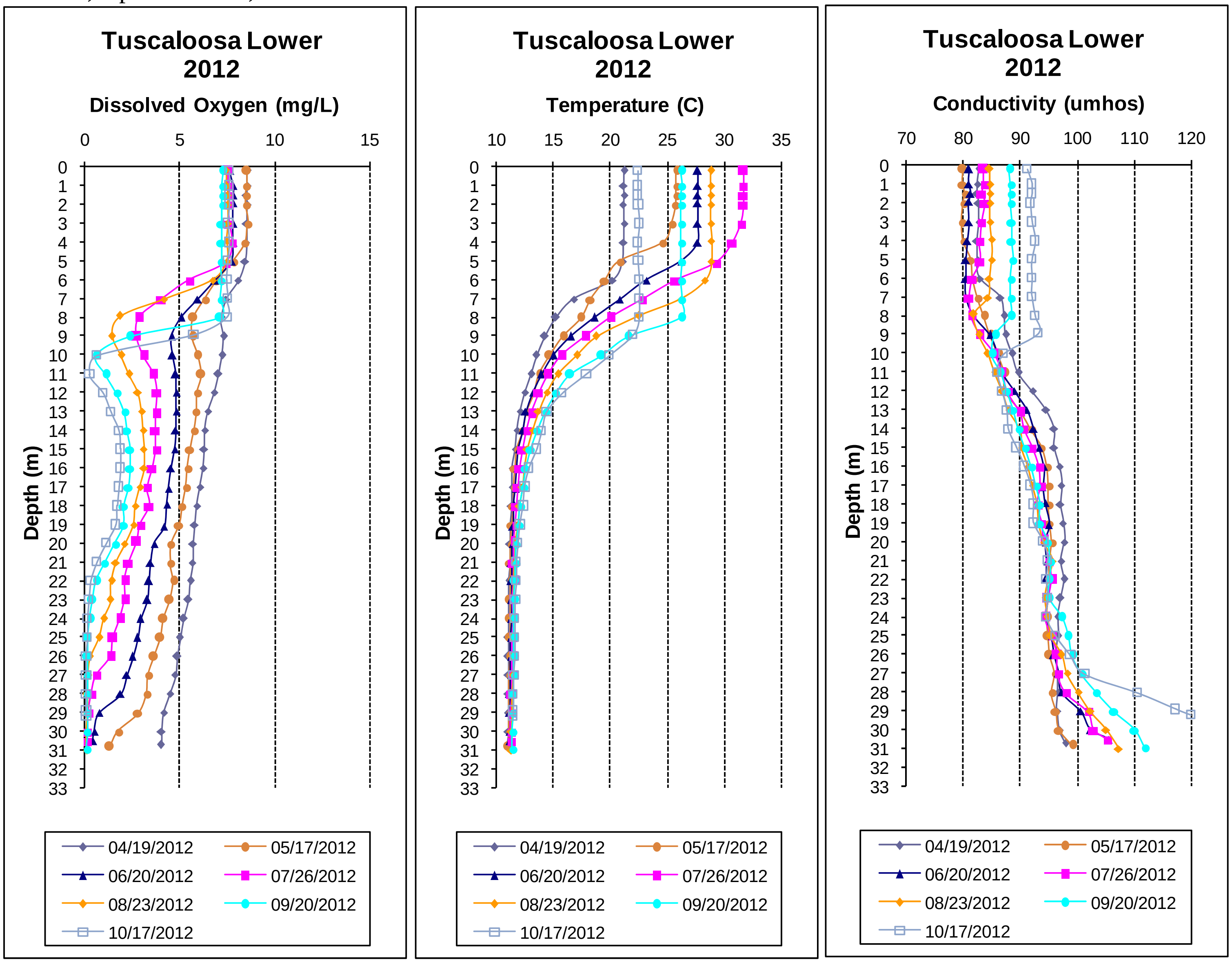


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the mid Tuscaloosa Reservoir station, April-October, 2012.

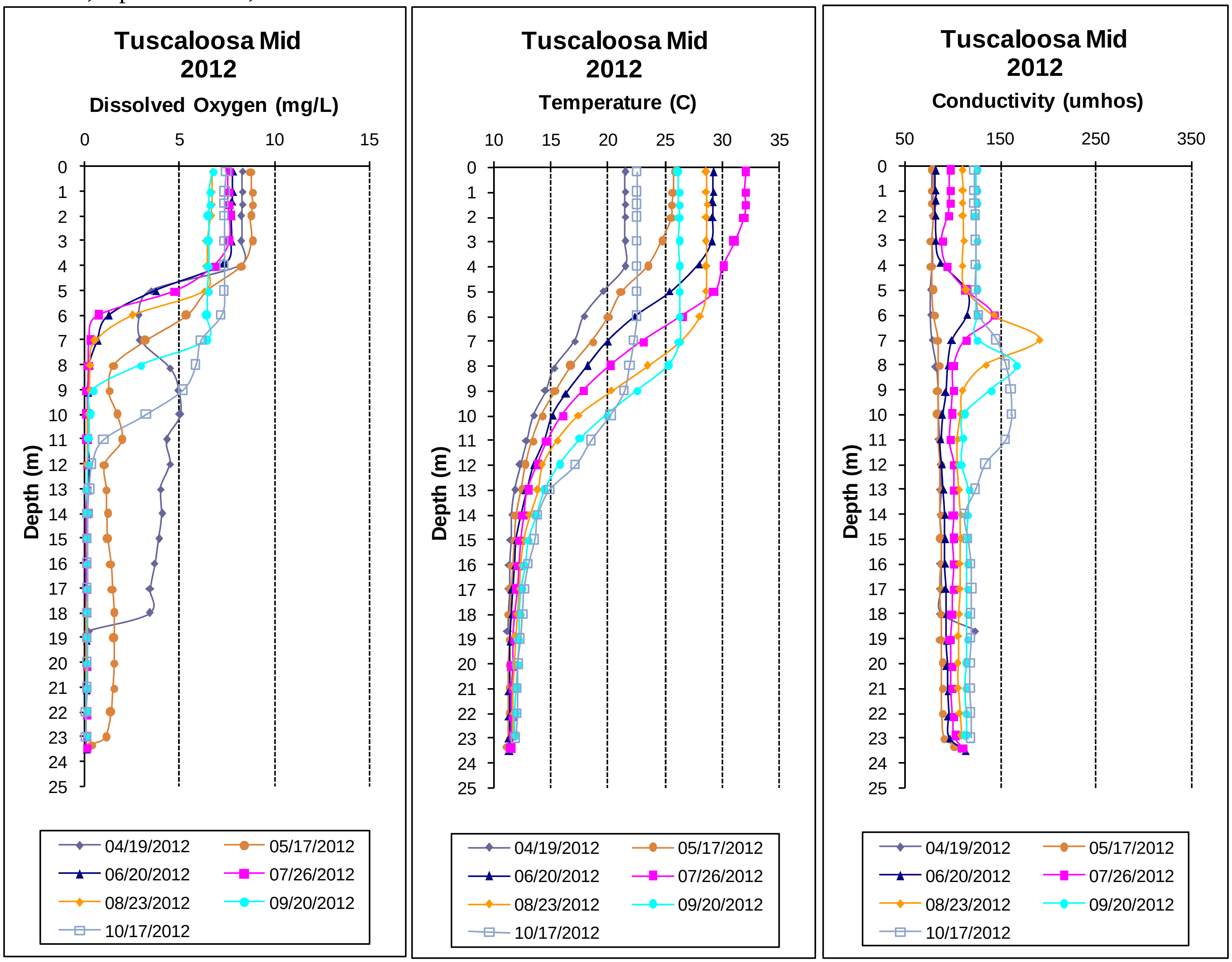


Figure 11. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the upper Tuscaloosa Reservoir station, April-October, 2012.

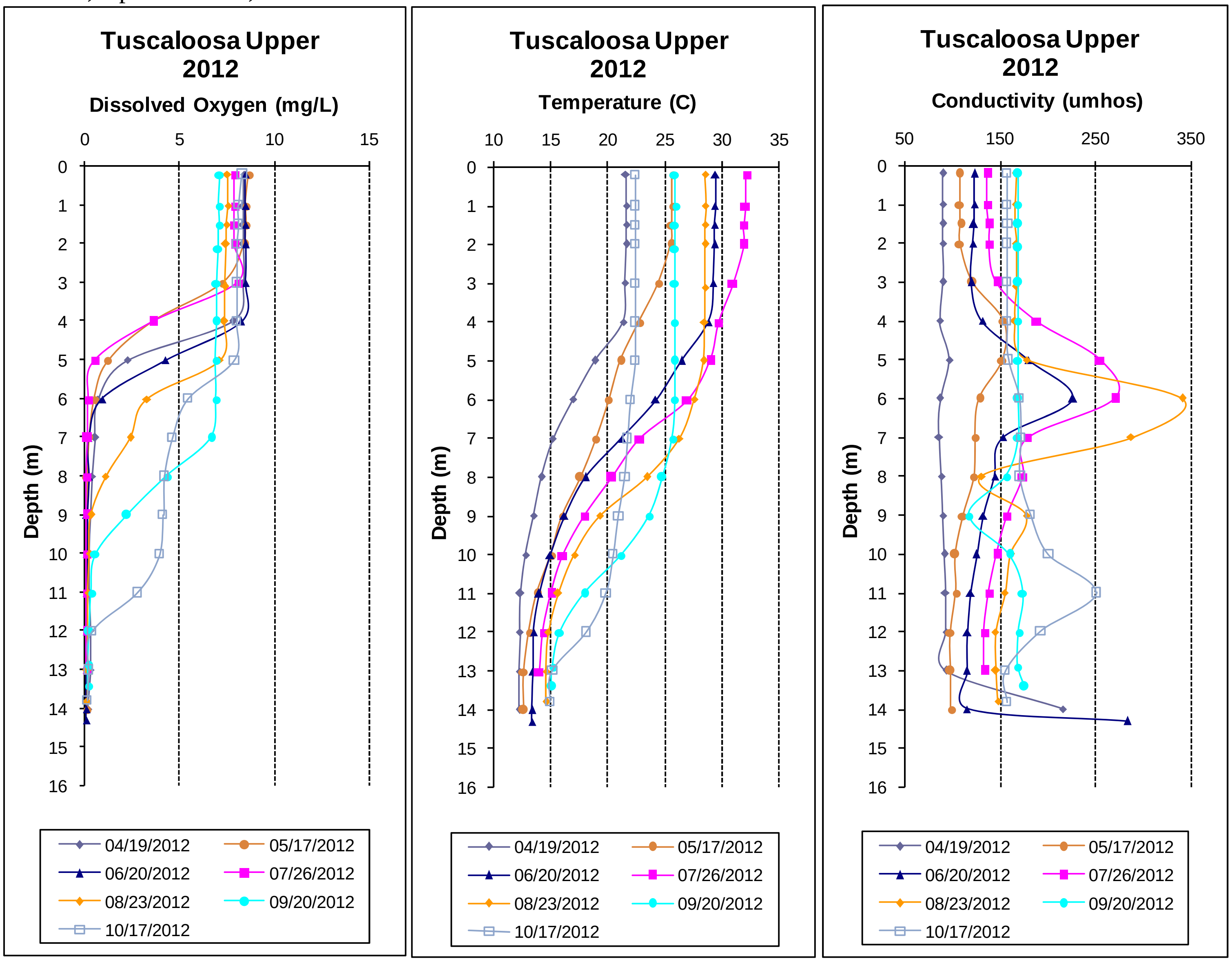
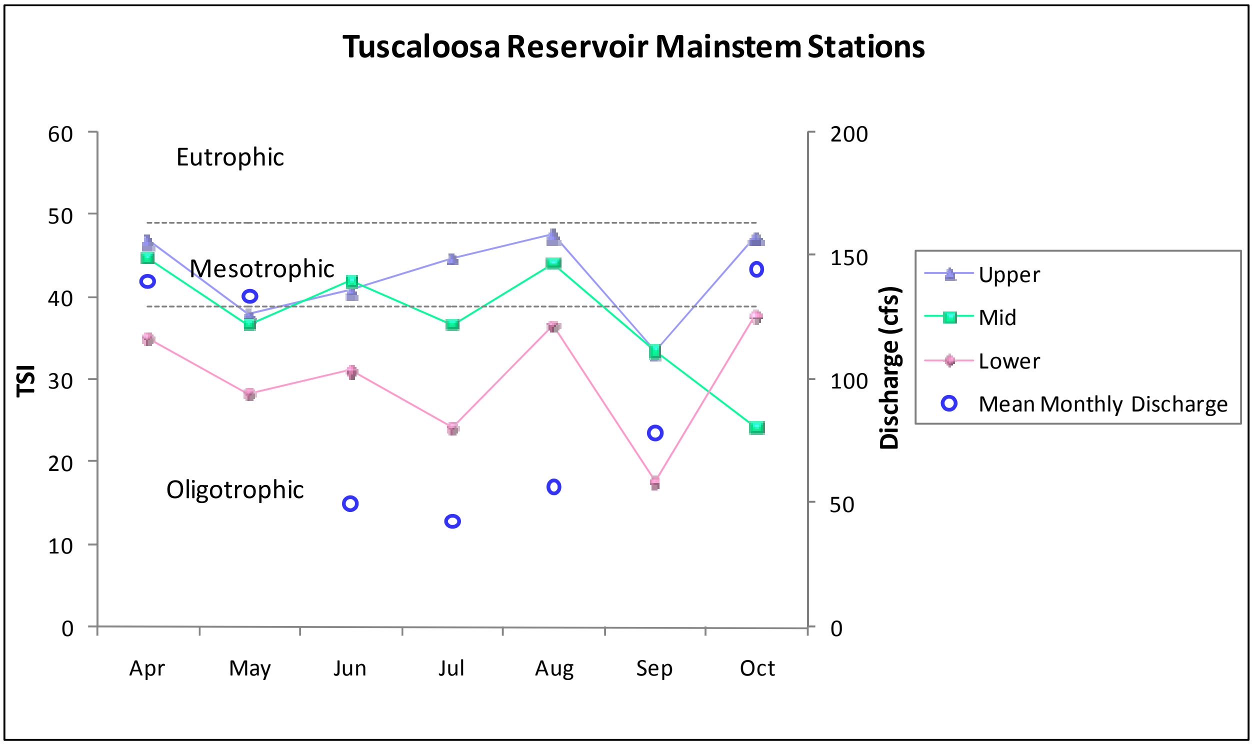
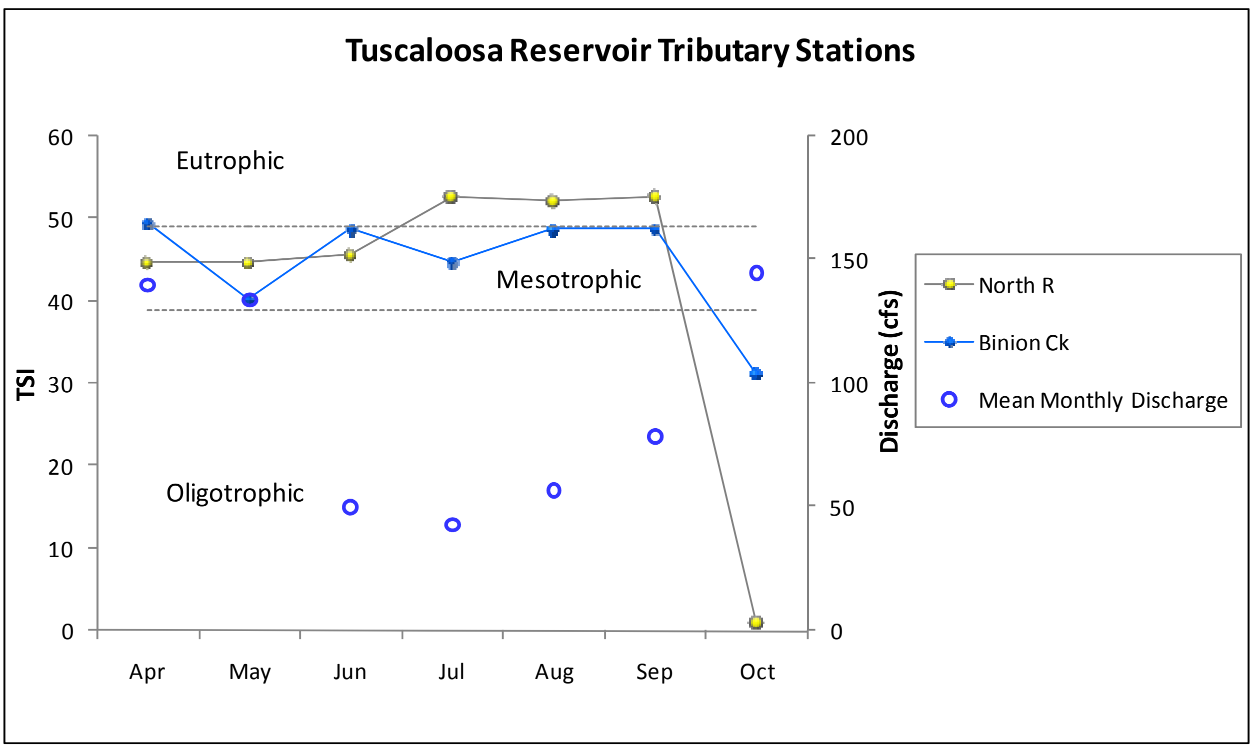


Figure 12. Monthly TSI values calculated for mainstem and tributary Tuscaloosa Reservoir stations, April-October, 2012, using chl *a* concentrations and Carlson's Trophic State Index calculation. Mean monthly discharge calculated as the sum of USGS 02464000 North R near Samantha AL and 02464360 Binion Ck below Gin Ck near Samantha AL.





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APPENDIX

Appendix Table 1. Summary of Tuscaloosa Reservoir water quality data collected April-October, 2012. 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
TUST-1	Physical							
	Turbidity (NTU)	7		0.8	1.3	1.1	1.1	0.2
	Total Dissolved Solids (mg/L)[J]	7		40.0	80.0	60.0	55.7	15.5
	Total Suspended Solids (mg/L)[J]	7	<	1.0	1.0	0.5	0.5	0.0
	Hardness (mg/L)	4		19.5	22.0	20.7	20.7	1.0
	Alkalinity (mg/L)	7		14.8	22.4	16.3	17.4	3.1
	Photic Zone (m)	7		6.93	8.43	7.61	7.70	0.57
	Secchi (m)	7		4.31	5.70	5.15	5.11	0.49
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.008	0.004	0.004	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.005	0.049	0.009	0.014	0.017
	Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.041	0.478	0.071	0.135	0.163
	Total Nitrogen (mg/L)[J]	7	<	0.023	0.487	0.087	0.150	0.160
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.005	0.006	0.002	0.003	0.001
	Total Phosphorus (mg/L)[J]	7		0.006	0.008	0.007	0.007	0.001
	CBOD-5 (mg/L)[J]	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.2	5.2	4.5	4.6	0.4
	Biological							
	Chlorophyll a (ug/L)	7		0.27	2.14	1.07	1.18	0.70
	E. coli (mpn/100mL)	3		1	1	1	1	0
TUST-2	Physical							
	Turbidity (NTU)	7		2.5	3.7	3.2	3.2	0.4
	Total Dissolved Solids (mg/L)[J]	7		72.0	114.0	86.0	92.3	15.2
	Total Suspended Solids (mg/L)[J]	7	<	1.0	2.0	0.5	0.7	0.6
	Hardness (mg/L)	4		23.7	27.4	24.8	25.2	1.7
	Alkalinity (mg/L)	7		17.2	40.1	37.2	32.1	8.6
	Photic Zone (m)	7		4.05	5.49	5.15	4.90	0.56
	Secchi (m)	7		1.79	2.60	2.27	2.25	0.31
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.008	0.004	0.004	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.008	0.002	0.003	0.002
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.041	0.514	0.279	0.249	0.178
	Total Nitrogen (mg/L)[J]	7	<	0.023	0.515	0.282	0.251	0.176
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.005	0.007	0.002	0.003	0.002
	Total Phosphorus (mg/L)	7		0.010	0.014	0.012	0.012	0.002
	CBOD-5 (mg/L)[J]	7	<	2.0	3.0	1.0	1.3	0.7
	Chlorides (mg/L)	7		4.6	11.8	10.7	9.2	2.7
	Biological							
	Chlorophyll a (ug/L)	7		1.34	5.70	4.27	3.89	1.78
	E. coli (mpn/100mL)	3	<	1	1	1	1	0

Station	Parameter	N		Min	Max	Med	Mean	SD
TUST-3	Physical							
	Turbidity (NTU)	7		1.4	2.7	1.9	1.9	0.4
	Total Dissolved Solids (mg/L)[J]	7		44.0	92.0	68.0	70.9	16.3
	Total Suspended Solids (mg/L)[J]	7	<	1.0	3.0	0.5	0.9	0.9
	Hardness (mg/L)	4		20.4	23.3	22.4	22.1	1.2
	Alkalinity (mg/L)	7		14.8	30.2	23.9	23.4	6.6
	Photic Zone (m)	7		5.05	6.74	6.00	5.91	0.54
	Secchi (m)	7		2.62	4.55	3.72	3.57	0.72
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.008	0.004	0.004	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.027	0.002	0.006	0.010
	Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.041	0.267	0.169	0.137	0.094
	Total Nitrogen (mg/L)[J]	7	<	0.023	0.268	0.172	0.143	0.090
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.005	0.007	0.002	0.003	0.002
	Total Phosphorus (mg/L)[J]	7		0.006	0.012	0.009	0.009	0.002
	CBOD-5 (mg/L)[J]	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.0	8.2	5.8	6.1	1.8
	Biological							
	Chlorophyll a (ug/L)	7		0.53	4.27	1.87	2.44	1.41
	E. coli (mpn/100mL)	3	<	1	4	1	2	2
TUST-4	Physical							
	Turbidity (NTU)	7		4.8	7.5	6.1	6.1	0.8
	Total Dissolved Solids (mg/L)[J]	7		88.0	180.0	128.0	136.3	34.0
	Total Suspended Solids (mg/L)[J]	7	<	1.0	3.0	0.5	0.9	0.9
	Hardness (mg/L)	4		27.9	36.0	31.3	31.6	3.3
	Alkalinity (mg/L)	7		32.6	76.8	44.7	50.3	16.6
	Photic Zone (m)	7		2.75	3.68	3.28	3.22	0.36
	Secchi (m)	7		1.13	1.50	1.36	1.32	0.14
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.008	0.004	0.004	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.026	0.014	0.013	0.009
	Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.076	0.436	0.293	0.234	0.143
	Total Nitrogen (mg/L)[J]	7	<	0.053	0.455	0.294	0.246	0.143
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.005	0.006	0.002	0.003	0.001
	Total Phosphorus (mg/L)	7		0.013	0.023	0.016	0.017	0.004
	CBOD-5 (mg/L)[J]	7	<	2.0	2.0	1.0	1.1	0.4
	Chlorides (mg/L)	7		9.8	24.1	14.2	15.5	5.0
	Biological							
	Chlorophyll a (ug/L)	7	<	0.10	9.61	4.67	5.94	3.62
	E. coli (mpn/100mL)	3		2	10	3	4	4

Station	Parameter	N		Min	Max	Med	Mean	SD
TUST-5	Physical							
	Turbidity (NTU)	7		3.9	5.2	4.8	4.6	0.5
	Total Dissolved Solids (mg/L)[J]	7		46.0	106.0	68.0	78.9	23.5
	Total Suspended Solids (mg/L)[J]	7	<	1.0	1.0	0.5	0.6	0.2
	Hardness (mg/L)	4		21.3	25.4	24.4	23.9	1.8
	Alkalinity (mg/L)	7		15.2	45.0	31.4	30.5	10.3
	Photic Zone (m)	7		3.22	4.72	4.09	4.11	0.52
	Secchi (m)	7		1.39	2.19	1.90	1.84	0.27
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.008	0.004	0.004	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.002	0.008	0.002	0.003	0.002
	Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.057	0.333	0.158	0.164	0.112
	Total Nitrogen (mg/L)[J]	7	<	0.040	0.334	0.166	0.168	0.111
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.005	0.006	0.002	0.003	0.001
	Total Phosphorus (mg/L)	7		0.011	0.018	0.013	0.013	0.002
	CBOD-5 (mg/L)[J]	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.9	11.0	8.3	8.1	2.8
	Biological							
	Chlorophyll a (ug/L)	7		1.07	6.94	6.41	4.88	2.27
	E. coli (mpn/100mL)	3	<	1	47	1	16	26

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