2014 Gantt/Point A Reservoirs 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
AGPT	Algal Growth Potential Test
CHL *a*	Chlorophyll *a*
DO	Dissolved Oxygen
F&W	Fish and Wildlife
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Mean Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
ONRW	Outstanding National Resource Water
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports
SD	Standard Deviation
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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INTRODUCTION

Gantt and Point A Reservoirs were created in the early 1920s with the construction of two hydroelectric dams along the Conecuh River. Gantt (2,767 acres) was the first to be constructed and Point A (900 acres) soon followed. Both reservoirs are located just north of the City of Andalusia in Covington County.

The Alabama Department of Environmental Management (ADEM) monitored Gantt and Point A Reservoirs as part of the 2014 assessment of the Escambia River Basin under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the 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.

In 2004, the ADEM implemented specific water quality criteria for nutrient management at the forebay of Gantt and Point A Reservoirs, which have been monitored by ADEM since 1990. These criteria represent the maximum growing season mean (Apr-Oct) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting these reservoirs' Swimming (S) and Fish & Wildlife (F&W) use classifications.

The purpose of this report is to summarize data collected at two south Alabama reservoirs during the 2014 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. Gantt Reservoir was sampled in the dam forebay along with one additional mainstem station in the upper reservoir. Point A Reservoir was sampled in the dam forebay along with one additional station located in the Patsaliga Creek embayment.

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 2014), Surface Water Quality Assurance Project Plan (ADEM 2012), and Quality Management Plan (ADEM 2013).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Monthly concentrations of these parameters in Gantt and Point A were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2014 results.

Figure 1. Gantt and Point A Reservoirs with 2014 sampling locations. A description of each sampling location is provided in Table 1.

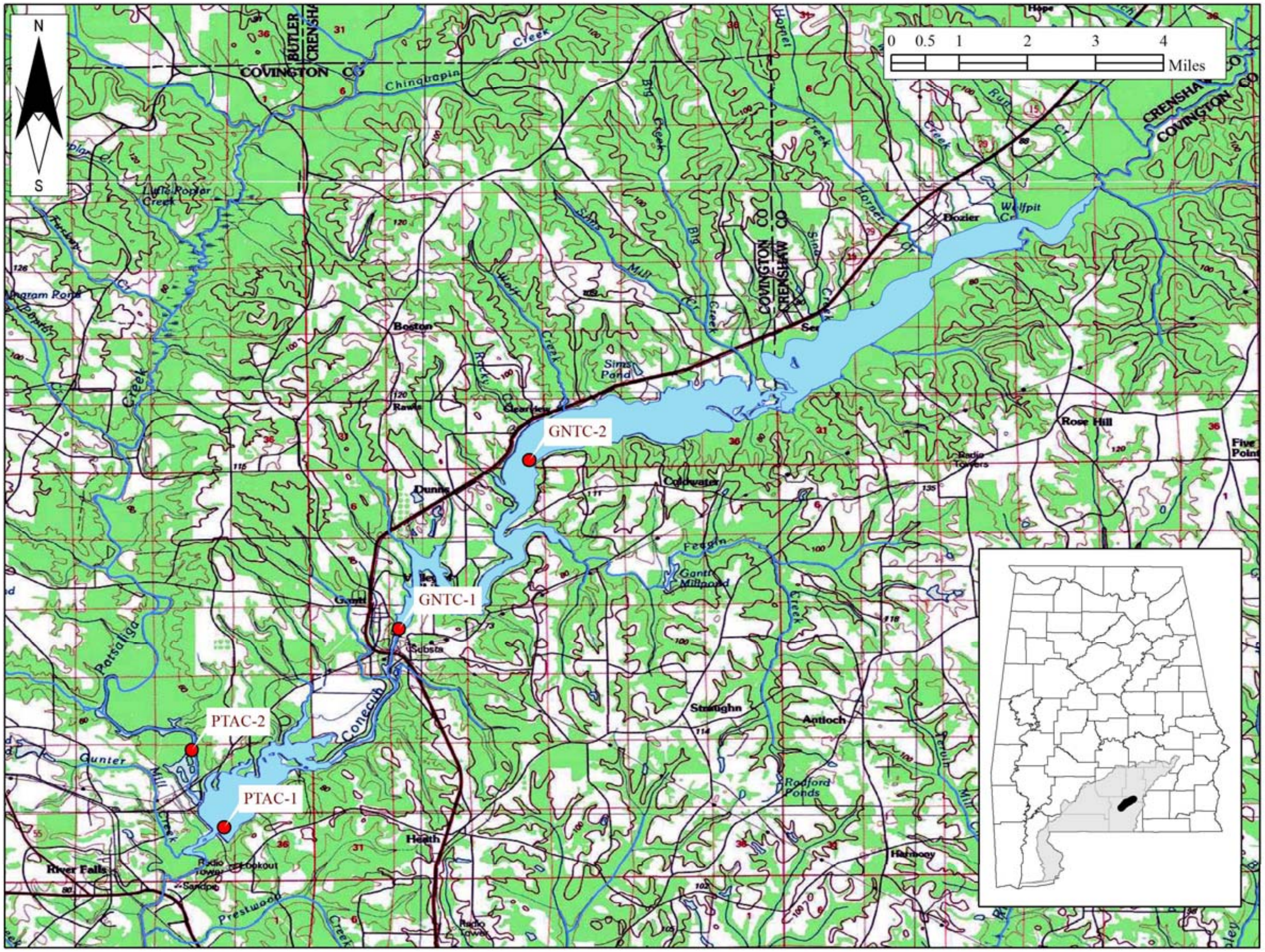


Table 1. Descriptions of the 2014 monitoring stations in Gantt and Point A Reservoirs.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria	Latitude	Longitude
Gantt Reservoir								
031403010404	Covington	*GNTC-1	Lower	Conecuh R	Deepest point, main river channel, dam forebay.	11 µg/l	31.40444	-86.47918
031403010404	Covington	GNTC-2	Upper	Conecuh R	Deepest point, main river channel, approx. one mi. upstream of Covington Co. 86 bridge.		31.44041	-86.45151
Point A Reservoir								
031403010405	Covington	*PTAC-1	Lower	Conecuh R	Deepest point, main river channel, dam forebay.	9 µg/l	31.36214	-86.51637
031403020506	Covington	PTAC-2	Patsaliga Ck	Patsaliga Ck	Deepest point, main creek channel, Patsaliga Cr. embayment.		31.37855	-86.52325

*Growing season mean chl *a* criteria implemented 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, DO, and TSI are also provided (Figs. 4-8 and 12). Mean monthly discharge for Gantt and Point A Reservoirs are included in monthly graphs as an indicator of flow and retention time in the months sampled. Algal growth potential test (AGPT) results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figs. 9-11. Summary statistics of all data collected during 2014 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 are not always mentioned, review of the graphs will indicate stations that may be potential candidates for reference waterbodies and watersheds.

In 2014, the highest mean growing season TN value at Gantt Reservoir was calculated for the lower station (Fig. 2). Mean growing season TN concentrations have increased overall since 1999 at the lower station. The mean concentration in the upper station declined 2008-2014 but has increased overall since 1999. Monthly TN concentrations were at historic highs in May and September 2014 at the lower station (Fig. 4). Monthly TN concentrations at the upper reservoir were at historic highs in April and July 2014.

The highest mean growing season TN value at Point A Reservoir was calculated for the Patsaliga Creek station (Fig. 2). Mean growing season TN concentrations have fluctuated in lower Point A Reservoir since 1999 but have shown an overall increase since 2003, reaching the highest concentration in 2008. Mean growing season TN concentrations at Patsaliga Creek have increased since 2004. Monthly TN concentrations were above historic means a majority of months sampled at the lower station (Fig. 4).

In 2014, mean growing season TP values at Gantt Reservoir were slightly higher in the lower station compared to the upper (Fig. 2). Mean TP concentrations decreased 2008-2014 at both the lower and upper stations. Monthly TP concentrations in the upper and lower Gantt Reservoir stations were below historic means April-October (Fig. 5).

Mean TP concentrations in Point A Reservoir were equal at both stations in 2014 and lower compared to 2008 (Fig. 2). Monthly TP concentrations at the lower reservoir were below historic means the entire season (Fig. 5).

In 2014, the highest mean growing season chl *a* concentration was calculated for the lower station in Gantt Reservoir (Fig. 3). The mean chl *a* concentration measured in 2014 was below the specific water quality criterion established for lower Gantt Reservoir. Monthly chl *a* concentrations were at historic highs in September and October in the lower station (Fig. 6). Historic high concentrations were also measured in July, September, and October in the upper station.

The highest growing season mean chl *a* concentration in Point A Reservoir was calculated for the Patsaliga Creek station (Fig. 3). Specific water quality criterion for nutrient management has also been established for lower Point A Reservoir. The mean chl *a* concentration measured in 2014 was below the criteria limit. Monthly chl *a* concentration was highest in July and concentrations were below historic means each month sampled except October (Fig. 6).

In 2014, the highest mean growing season TSS was calculated for the upper station of Gantt Reservoir (Fig. 3). Mean TSS concentrations increased 2008-2014 in both the upper and lower reservoir. Highest monthly TSS concentrations occurred in July at both Gantt Reservoir stations (Fig. 7). Monthly TSS concentrations were above historic means July-August at the upper station and in July at the lower station.

In 2014, the highest mean growing season TSS was calculated for the Patsaliga Creek station of Point A Reservoir (Fig. 3). The mean TSS concentration at the Patsaliga Creek embayment has increased 2007 through 2014. The highest monthly TSS concentrations for lower Point A Reservoir occurred in July (Fig. 7). Monthly TSS concentrations in the lower Point A station were below historic means most months with the exception of July and August, which were also historic highs.

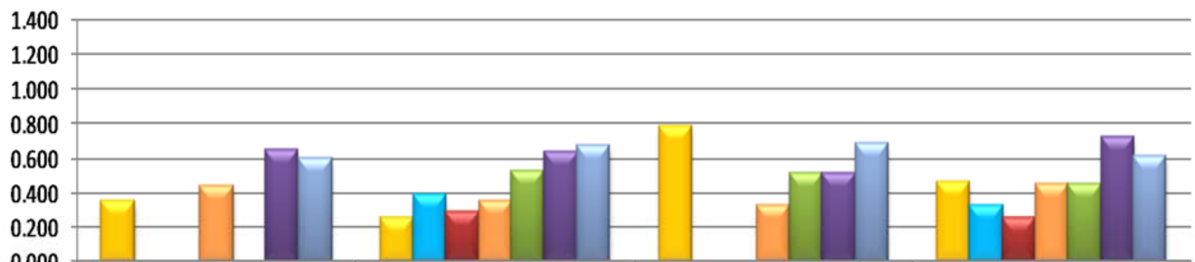
Results of AGPT samples collected in August 2014 indicated both phosphorus and nitrogen to be limiting nutrients (co-limiting) at the lower Gantt Reservoir station while results from the upper station indicated no limiting nutrient (Table 2). AGPT results for the lower Point A Reservoir station indicated nitrogen limited conditions in 2014 while Patsaliga Creek results indicated phosphorus and nitrogen both to be limiting nutrients. In 2014, the mean standing crop (MSC) values at each mainstem reservoir station were below 5 mg/L, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems. The mean standing crop (MSC) value at the Patsaliga Creek station was below 20mg/L, the value that Raschke et al. (1996) defined as protective of rivers and streams.

Measurements of dissolved oxygen concentrations were above the ADEM criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) (ADEM Admin. Code R. 335-6-10-.09) (Fig. 14) in each reservoir (Fig.-8). Profiles of dissolved oxygen in Gantt reservoir showed deoxygenated conditions at depths of four meters or greater in June, July, and August at both stations (Fig. 9 & 10). Anoxic conditions also existed in the lower Point A station in June, July, and August at depths greater than five meters (Fig. 11). Highest temperatures were reached in August in both reservoirs (Fig. 9, 10, & 11).

Monthly growing season TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. TSI values for Gantt mainstem locations varied between oligotrophic and eutrophic during the growing season (Fig. 12). Values indicated the upper reservoir was eutrophic July and September. The lower station also reached eutrophic conditions in July, September, and October. Lower Point A Reservoir and Patsaliga Creek varied month to month from oligotrophic to eutrophic as well. Values indicated the reservoir was eutrophic at the lower station in July and in October at the Patsaliga Creek station.

Figure 2. Growing season mean TN and TP measured in Gantt and Point A Reservoirs, April-October 2014. Bar graphs consist of mainstem and embayment stations.

Mean TN (mg/L) 1999-2014

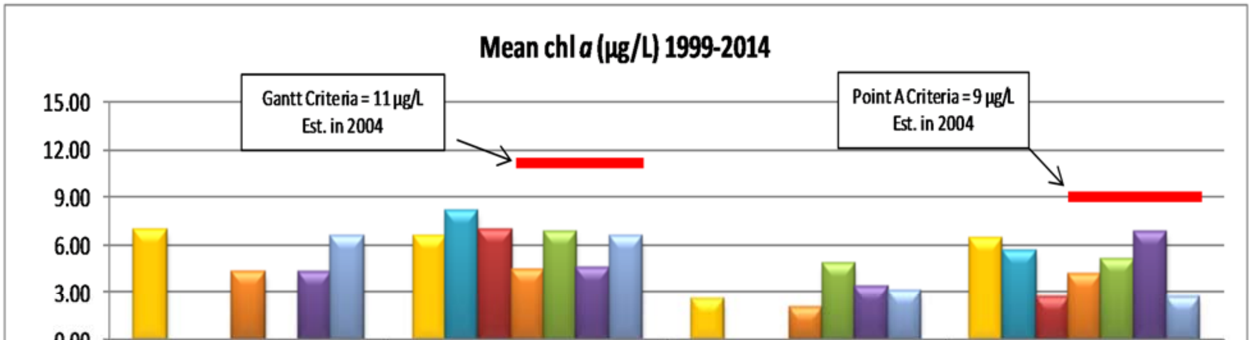


	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower
1999	0.358	0.252	0.791	0.462
2002		0.398		0.325
2003		0.289		0.259
2004	0.448	0.360	0.332	0.452
2007		0.532	0.520	0.452
2008	0.646	0.645	0.521	0.723
2014	0.599	0.678	0.693	0.615

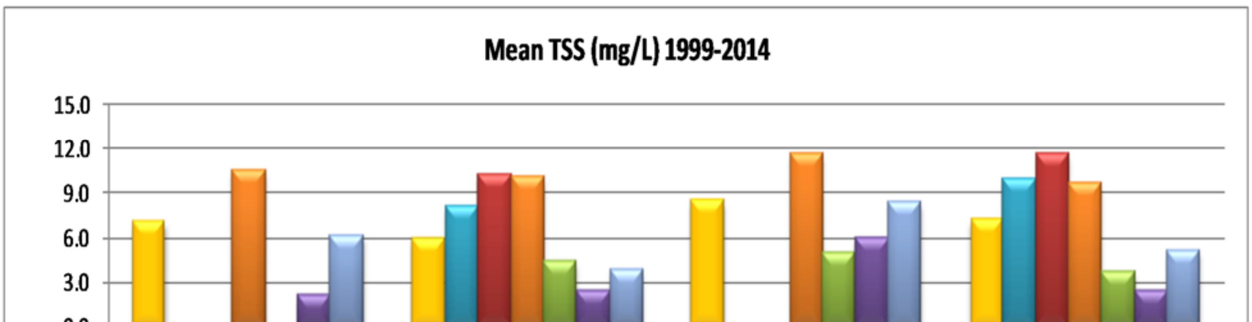
Mean TP (mg/L) 1999-2014

	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower
1999	0.049	0.021	0.019	0.026
2002		0.041		0.043
2003		0.059		0.057
2004	0.053	0.054	0.056	0.053
2007		0.025	0.025	0.024
2008	0.033	0.032	0.033	0.034
2014	0.023	0.025	0.023	0.023

Figure 3. Growing season mean chl *a* and TSS measured in Gantt and Point A Reservoirs, April-October 2014. Bar graphs consist of mainstem and embayment stations. Chl *a* criteria only applies to the growing season mean of the lower station of Gantt and Point A.



	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower
1999	6.93	6.64	2.59	6.42
2002		8.19		5.65
2003		6.98		2.72
2004	4.39	4.53	2.09	4.16
2007		6.86	4.88	5.19
2008	4.27	4.58	3.37	6.79
2014	6.59	6.64	3.17	2.72



	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower
1999	7.0	5.9	8.4	7.1
2002		8.1		10.0
2003		10.3		11.6
2004	10.6	10.1	11.6	9.7
2007		4.4	4.9	3.6
2008	2.1	2.4	5.9	2.4
2014	6.1	3.8	8.4	5.1

Figure 4. Monthly TN concentrations of the mainstem stations in Gantt and Point A Reservoirs, April-October 2014**.** Each bar graph depicts monthly changes in each station**.** The historic mean (1990-2014) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TN in Gantt and Point A Reservoirs were plotted vs. the closest discharge (**USGS 02371500 Conecuh River near Brantley, AL and USGS 02372430 Conecuh River at River Falls, AL).**

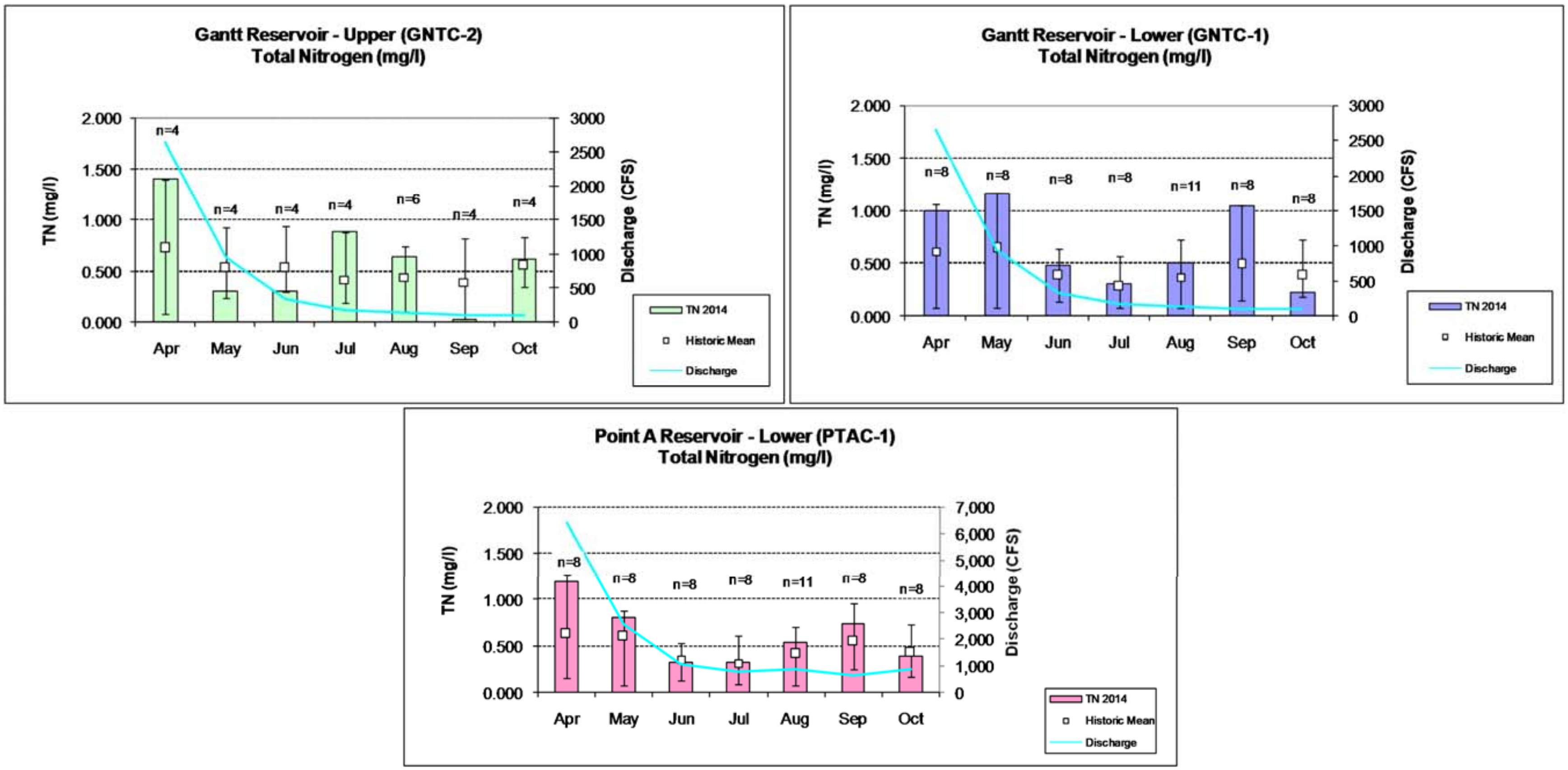
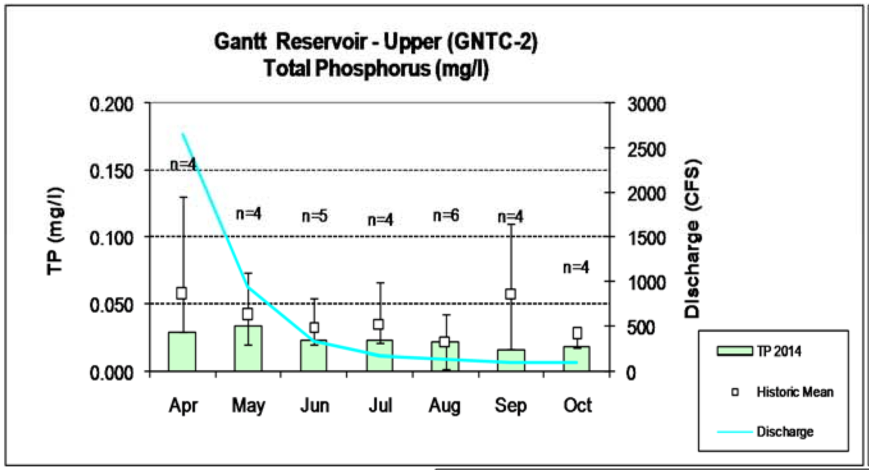
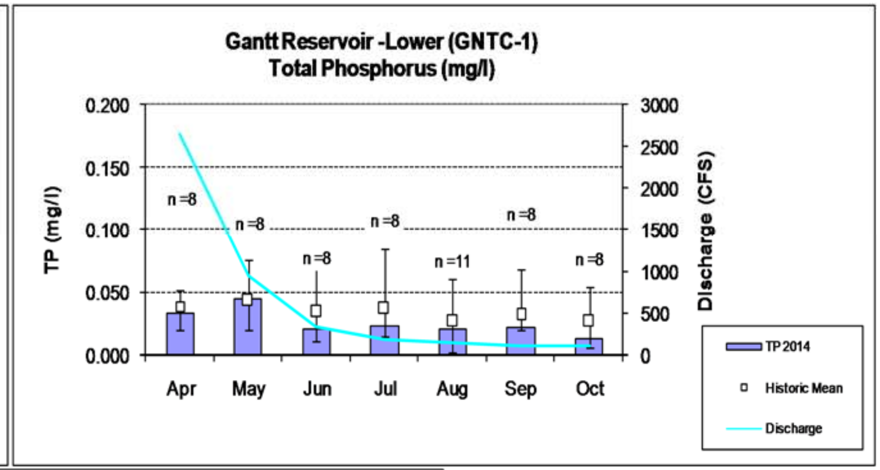


Figure 5. Monthly TP concentrations of the mainstem stations in Gantt and Point A Reservoir, April-October 2014**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2014) and min/max ranges are also displayed for comparison. The

"n" value equals the number of data points included in the monthly historic calculations. TP in Gantt and Point A Reservoirs were plotted vs. the closest discharge (USGS 02371500 Conecuh River near Brantley, AL and USGS 02372430 Conecuh River at River Falls, AL).





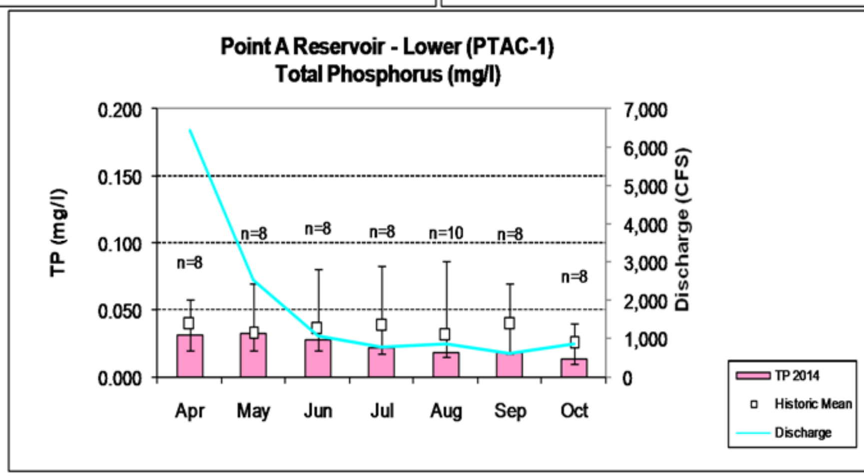


Figure 6. Monthly chl *a* concentrations of the mainstem stations in Gantt and Point A Reservoir, April-October 2014**.** Each bar graph depicts monthly changes in each station**.** The historic mean (1990-2014) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Chl *a* in Gantt and Point A Reservoirs were plotted vs. the closest discharge (USGS 02371500 Conecuh River near Brantley, AL and USGS 02372430 Conecuh River at River Falls, AL).

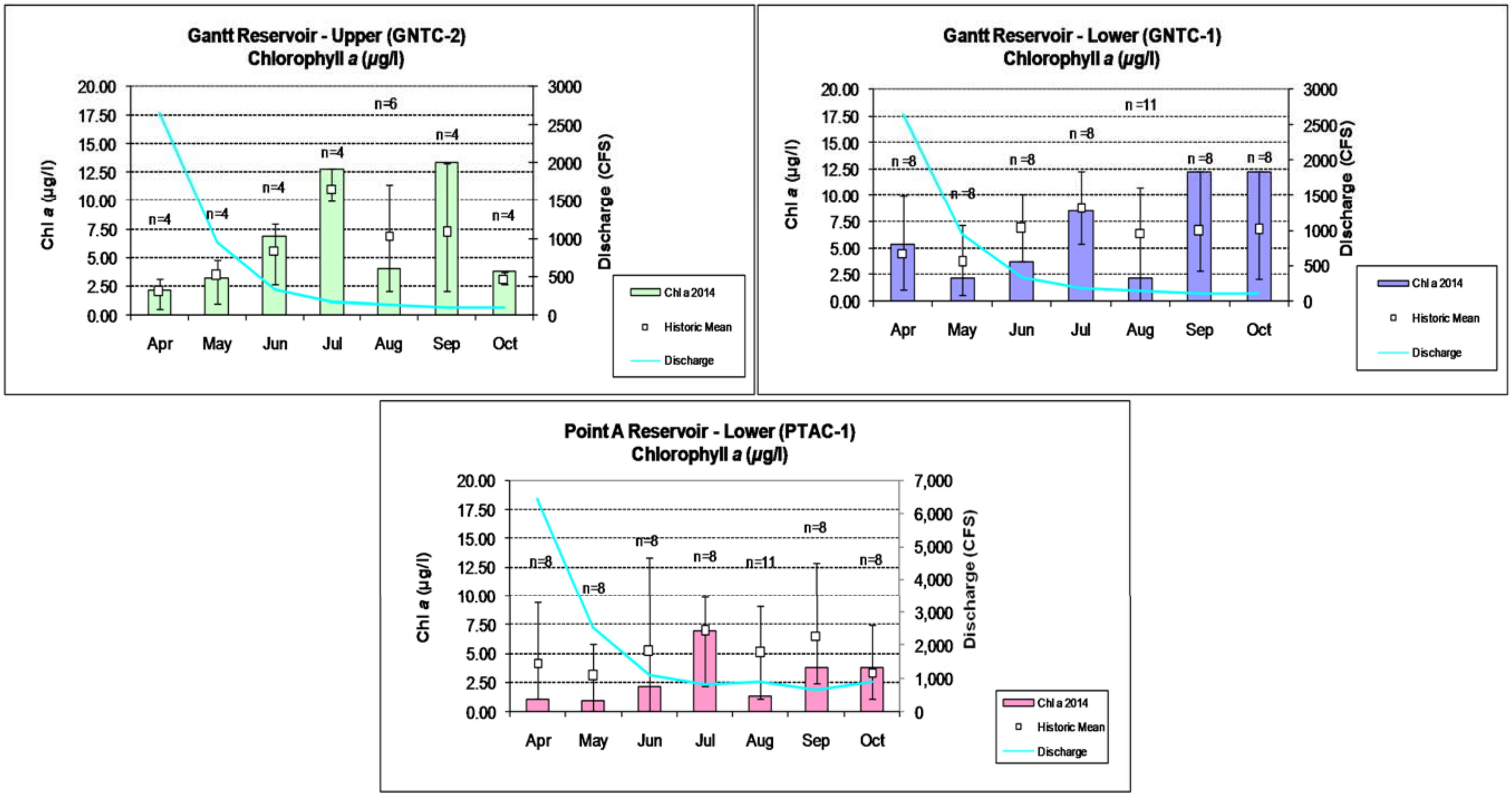


Figure 7. Monthly TSS concentrations of the mainstem stations in Gantt and Point A Reservoir, April-October 2014**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2014) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TSS in Gantt and Point A Reservoirs were plotted vs. the closest discharge (USGS 02371500 Conecuh River near Brantley, AL and USGS 02372430 Conecuh River at River Falls, AL).

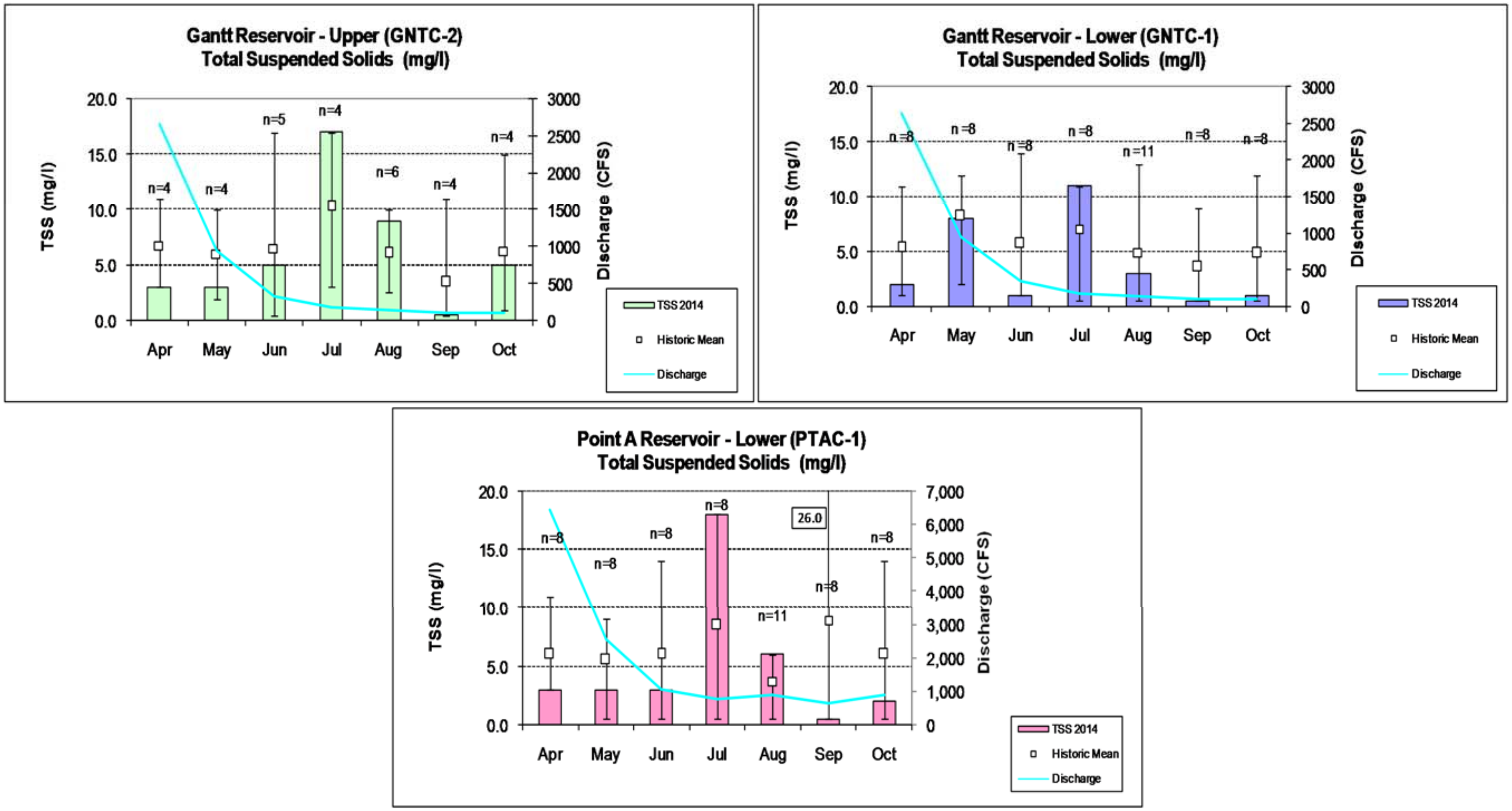
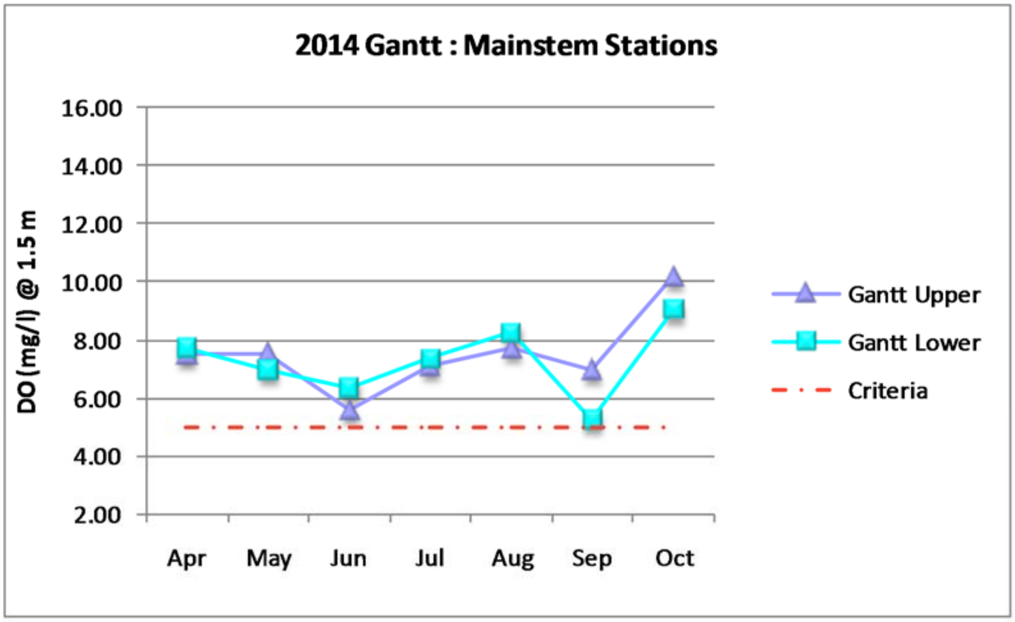


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective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

Station	GNTC-2 Upper		GNTC-1 Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient
June 1999	2.95	Phosphorus	2.71	Phosphorus
July 1999	2.82	Phosphorus	2.55	Phosphorus
August 1999	2.01	Phosphorus	1.95	Co-limiting
August 2004	2.44	Phosphorus	2.08	Co-limiting
September 2008	4.95	Phosphorus	4.62	Phosphorus
August 2014	3.24	None	2.51	Co-limiting

Station	PTAC-2 Patsaliga		PTAC-1 Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient
June 1999	3.24	Phosphorus	3.04	Phosphorus
July 1999	3.38	Phosphorus	2.21	Phosphorus
August 1999	2.43	Phosphorus	2.11	Phosphorus
August 2004	3.79	Phosphorus	2.96	Phosphorus
September 2008	4.36	None	5.67	Phosphorus
August 2014	7.52	Co-limiting	4.45	Nitrogen

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Gantt and Point A Reservoir stations collected April-October 2014. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).



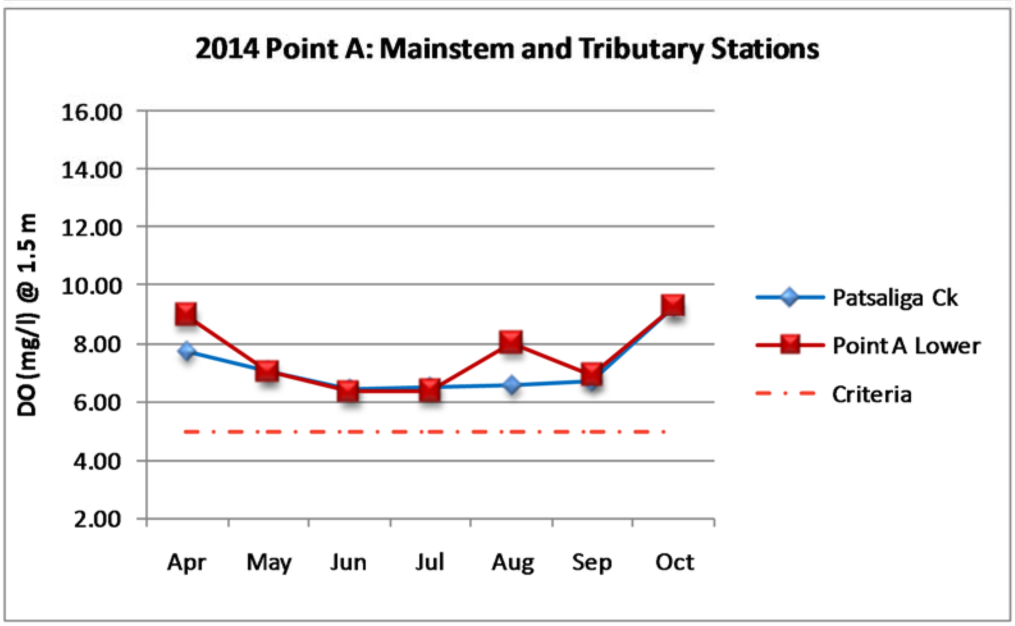


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in lower Gantt Reservoir, April-October 2014.

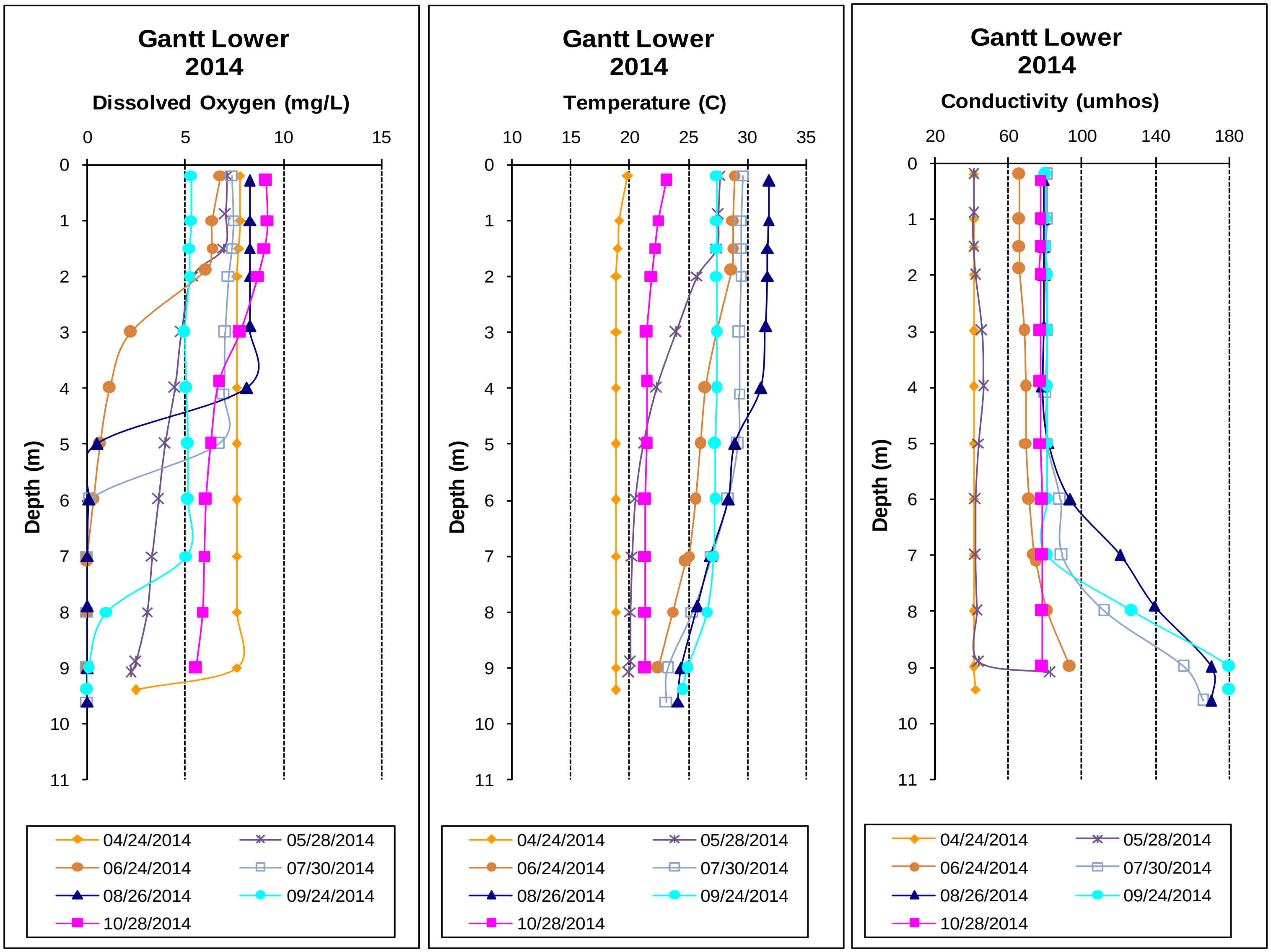


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (μmhos) in upper Gantt Reservoir, April-October 2014.

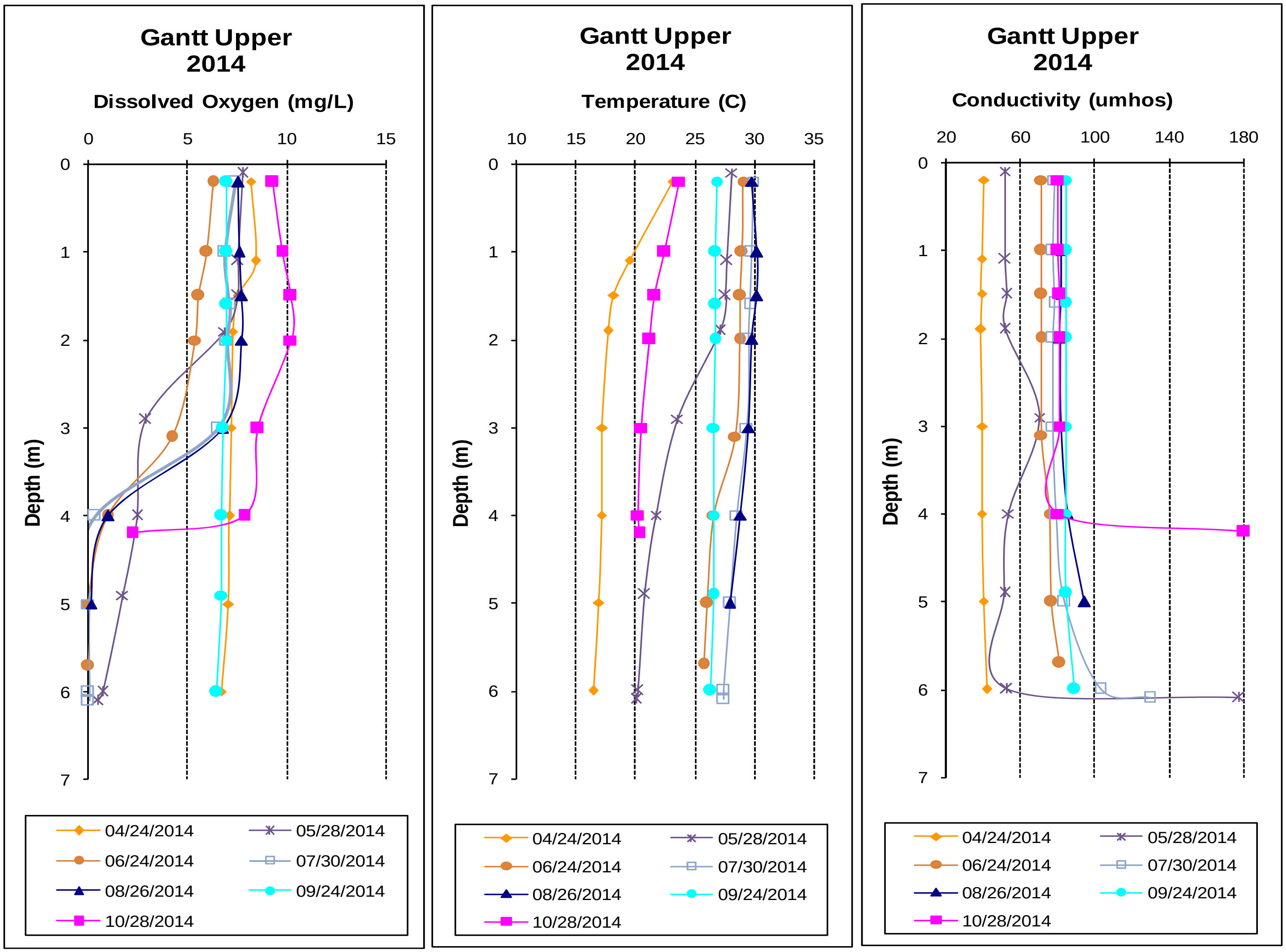


Figure 11. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in lower Point A Reservoir, April-October 2014**.**

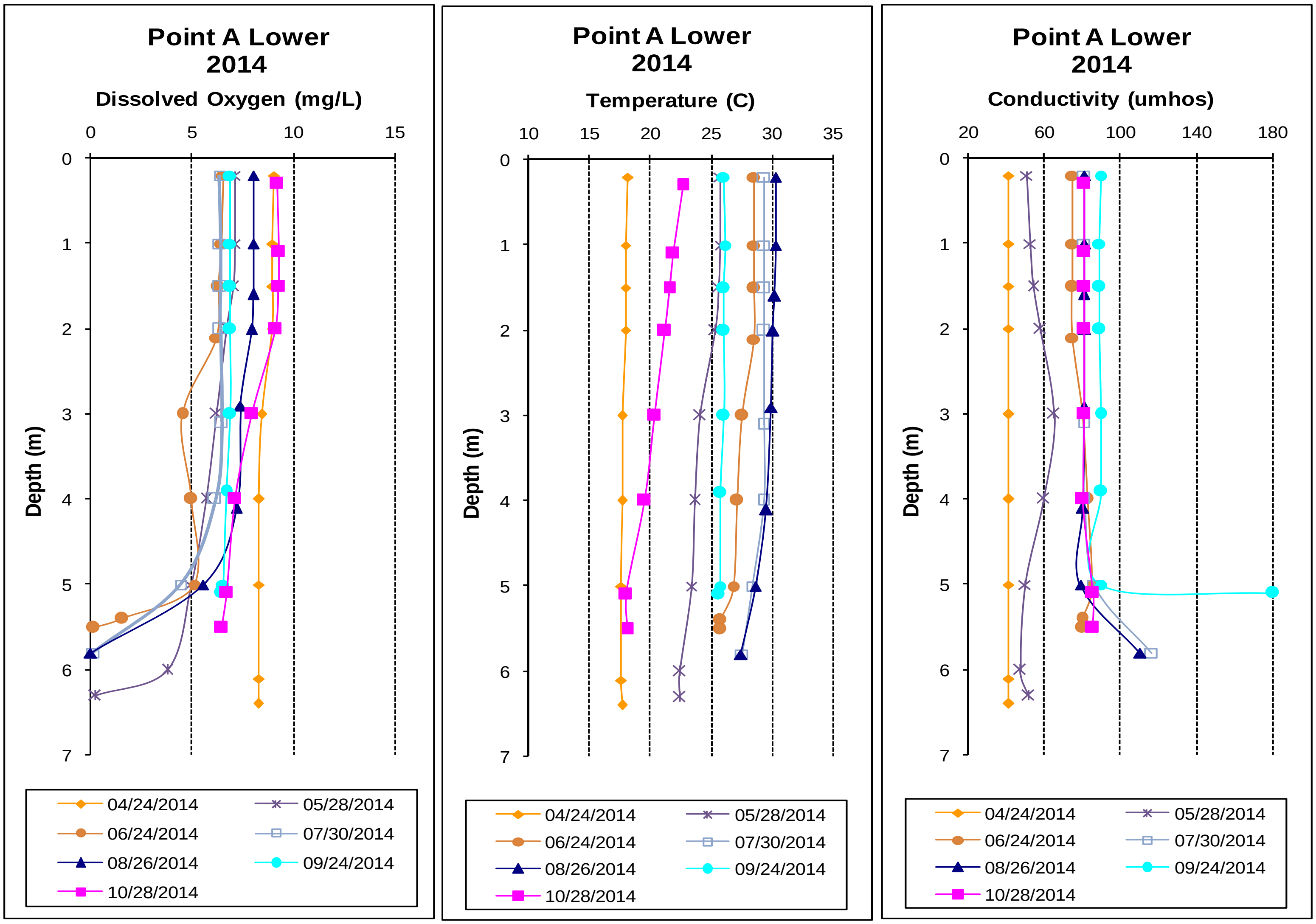
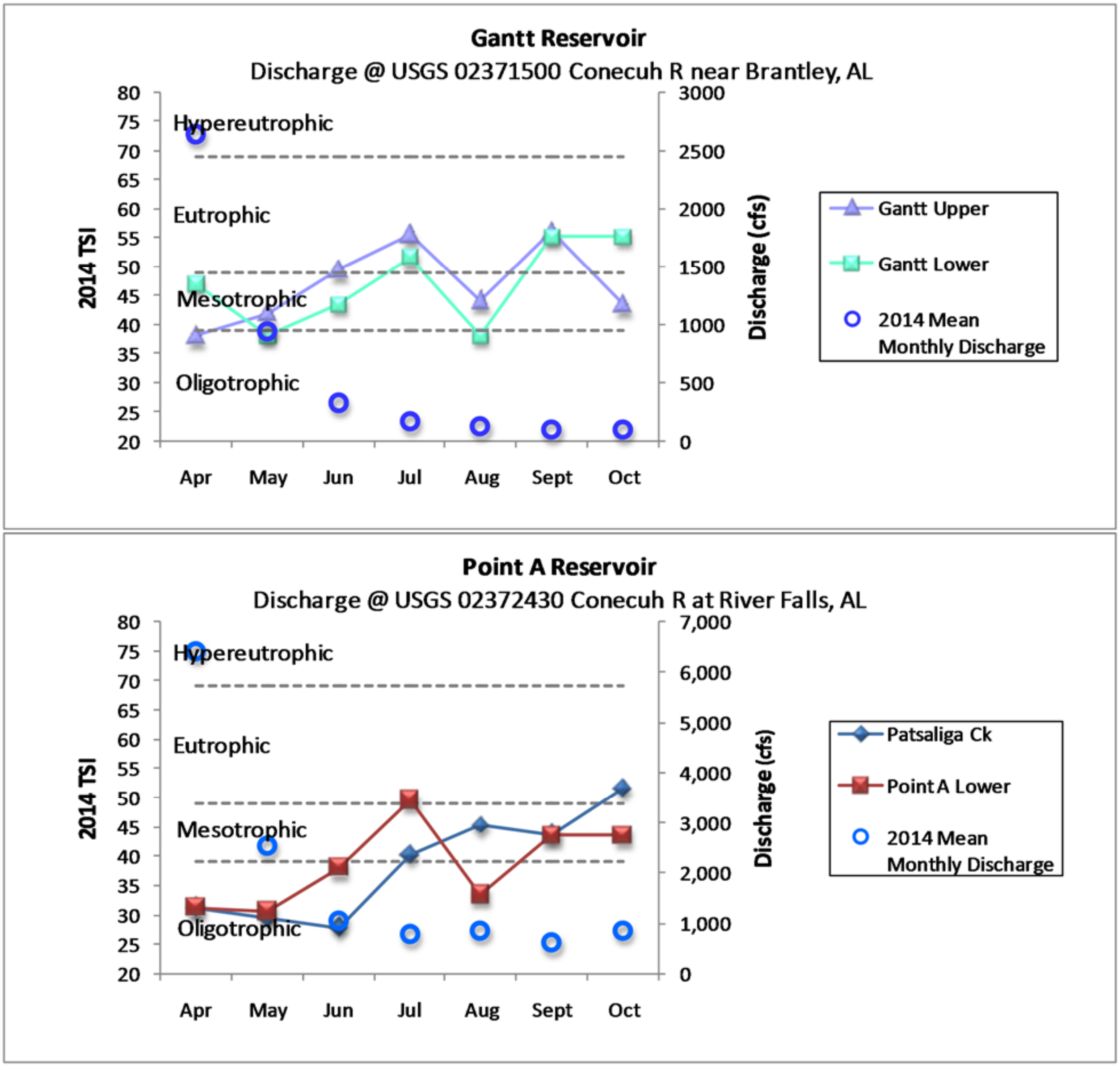


Figure 12. Monthly TSI values, April-October 2014, calculated for Gantt and Point A Reservoirs using chl *a* concentrations and Carlson's Trophic State Index calculation**.**



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APPENDIX

Appendix Table 1. Summary water quality data collected April-October, 2014. 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.

GNTC-1	N		Min	Max	Med	Avg	SD
Physical							
Hardness (mg/L)	4		13.1	31.5	26.8	24.5	8.6
Alkalinity (mg/L)	7		10.4	33.0	31.1	25.1	10.1
Photic Zone (m)	7		1.44	4.90	2.98	3.02	1.33
Secchi (m)	7		0.66	1.64	1.11	1.13	0.37
Bottom Depth (m)	8		9.0	9.6	9.2	9.3	0.3
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.006	0.081	0.003	0.015	0.029
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.001	0.098	0.002	0.032	0.042
Total Kjeldahl Nitrogen (mg/L)	7		0.224	1.130	0.507	0.646	0.376
Total Nitrogen (mg/L)[J]	7	<	0.226	1.170	0.508	0.678	0.384
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.008	0.004	0.004	0.002
Total Phosphorus (mg/L)	7		0.012	0.044	0.021	0.025	0.010
CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7		2.4	4.0	3.7	3.4	0.6
Biological							
Chlorophyll a (mg/m³)	7		2.14	12.28	5.34	6.64	4.43
E. coli (MPN/DL)	3		1	3	3	2	1

GNTC-2	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	8		3.9	25.7	7.5	10.3	7.5
Total Dissolved Solids (mg/L)	7		39.0	76.0	47.0	54.3	16.3
Total Suspended Solids (mg/L)	7	<	1.0	17.0	5.0	6.1	5.5
Hardness (mg/L)	4		13.9	33.7	28.1	26.0	8.8
Alkalinity (mg/L)	7		9.8	34.7	31.4	26.6	9.7
Photic Zone (m)	7		1.51	3.83	2.50	2.54	0.80
Secchi (m)	7		0.61	1.32	0.98	0.99	0.27
Bottom Depth (m)	8		4.2	6.1	5.9	5.7	0.6
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.006	0.042	0.003	0.011	0.015
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.001	0.093	0.006	0.032	0.038
Total Kjeldahl Nitrogen (mg/L)	7	<	0.054	1.340	0.616	0.567	0.451
Total Nitrogen (mg/L)[J]	7	<	0.028	1.403	0.618	0.599	0.452
Dis Reactive Phosphorus (mg/L)[J]	7		0.003	0.008	0.004	0.004	0.002
Total Phosphorus (mg/L)	7		0.016	0.034	0.023	0.023	0.006
CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7		2.5	4.0	3.6	3.4	0.6
Biological							
Chlorophyll a (mg/m³)	7		2.14	13.35	4.01	6.59	4.67
E. coli (MPN/DL)	3	<	1	4	1	2	1

PTAC-1	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	8		3.2	29.9	6.5	10.6	9.2
Total Dissolved Solids (mg/L)	7	<	1.0	71.0	61.0	48.4	26.5
Total Suspended Solids (mg/L)	7	<	1.0	18.0	3.0	5.1	5.9
Hardness (mg/L)	4		14.1	33.2	29.5	26.6	8.7
Alkalinity (mg/L)	7		10.4	36.3	32.1	27.1	9.7
Photic Zone (m)	7		1.44	4.15	3.09	2.81	1.04
Secchi (m)	7		0.58	1.81	1.12	1.16	0.47
Bottom Depth (m)	8		5.1	6.4	5.6	5.7	0.5
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.006	0.056	0.003	0.015	0.020
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.001	0.107	0.061	0.055	0.044
Total Kjeldahl Nitrogen (mg/L)	7		0.217	1.100	0.540	0.560	0.310
Total Nitrogen (mg/L)[J]	7	<	0.317	1.194	0.540	0.615	0.321
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.006	0.004	0.004	0.002
Total Phosphorus (mg/L)	7		0.013	0.032	0.022	0.023	0.007
CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7		2.6	4.3	3.8	3.6	0.6
Biological							
Chlorophyll a (mg/m^3)	7	<	0.10	6.94	2.14	2.72	2.31
E. coli (MPN/DL)	3		2	2	2	2	0

PTAC-2	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	8		5.9	33.7	12.1	14.1	8.7
Total Dissolved Solids (mg/L)	7		36.0	77.0	60.0	58.6	13.2
Total Suspended Solids (mg/L)	7	<	1.0	16.0	9.0	8.4	5.0
Hardness (mg/L)	4		16.3	35.4	30.5	28.2	8.4
Alkalinity (mg/L)	7		12.9	41.5	33.9	31.8	9.0
Photic Zone (m)	7		1.24	3.38	2.48	2.34	0.65
Secchi (m)	7		0.54	1.40	0.88	0.88	0.29
Bottom Depth (m)	8		3.4	5.0	3.6	3.8	0.5
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.006	0.027	0.003	0.007	0.009
Nitrate+Nitrite Nitrogen (mg/L)	7		0.052	0.261	0.192	0.185	0.066
Total Kjeldahl Nitrogen (mg/L)	7		0.213	1.250	0.437	0.507	0.356
Total Nitrogen (mg/L)	7		0.411	1.302	0.629	0.693	0.310
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.009	0.004	0.005	0.002
Total Phosphorus (mg/L)	7		0.017	0.034	0.023	0.023	0.006
CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7		2.2	4.2	3.6	3.5	0.6
Biological							
Chlorophyll a (mg/m^3)	7		0.76	8.54	2.67	3.17	2.78
E. coli (MPN/DL)	3		15	88	16	40	42

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