2008 Gantt/Point A/ Frank Jackson /Jackson Reservoirs Report

Rivers and Reservoirs Monitoring Program

Gantt Reservoir

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
November 2012

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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. Frank Jackson Reservoir is located north of the City of Opp along Hwy 331. The reservoir is fed by Lightwood Knot Creek and covers approximately 1,037 acres. Jackson Reservoir is located in the City of Florala directly on the Alabama-Florida line. The reservoir is a naturally formed water body and encompasses 350 acres.

The Alabama Department of Environmental Management (ADEM) monitored Gantt, Point A, Frank Jackson, and Jackson Reservoirs as part of the 2008 assessment of the Chattahoochee and Perdido-Escambia River Basins 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. In 2005, a specific water quality criterion for nutrient management was implemented at Jackson Reservoir, which has been monitored 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 four south Alabama reservoirs during the 2008 growing season and to evaluate growing season trends in mean lake trophic status and nutrient concentrations using ADEM's ten-year 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. 1-3). 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. Single sampling locations were established in the dam forebay of Frank Jackson and the center of the lake in Jackson Reservoir.

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 2007), Surface Water Quality Assurance Project Plan (ADEM 2005), and Quality Management Plan (ADEM 2003).

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 2008 results.

Figure 1. Gantt and Point A Reservoirs with 2008 sampling locations. A description of each sampling location is provided in Table 1.

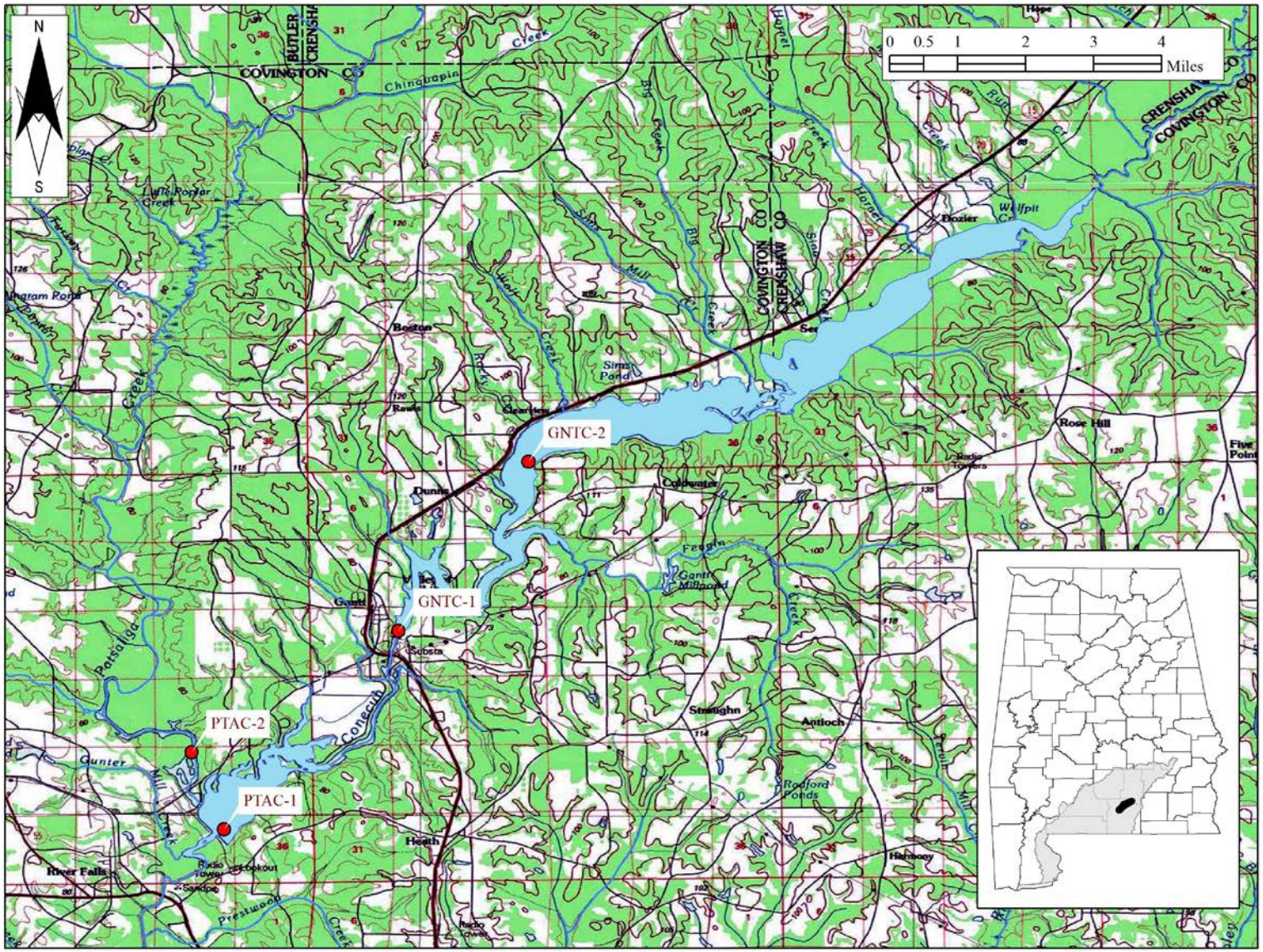


Figure 2. Frank Jackson Reservoir with the 2008 sampling location. A description of the sampling location is provided in Table 1.

Figure 3. Jackson Reservoir with the 2008 sampling location. A description of the sampling location is provided in Table 1.

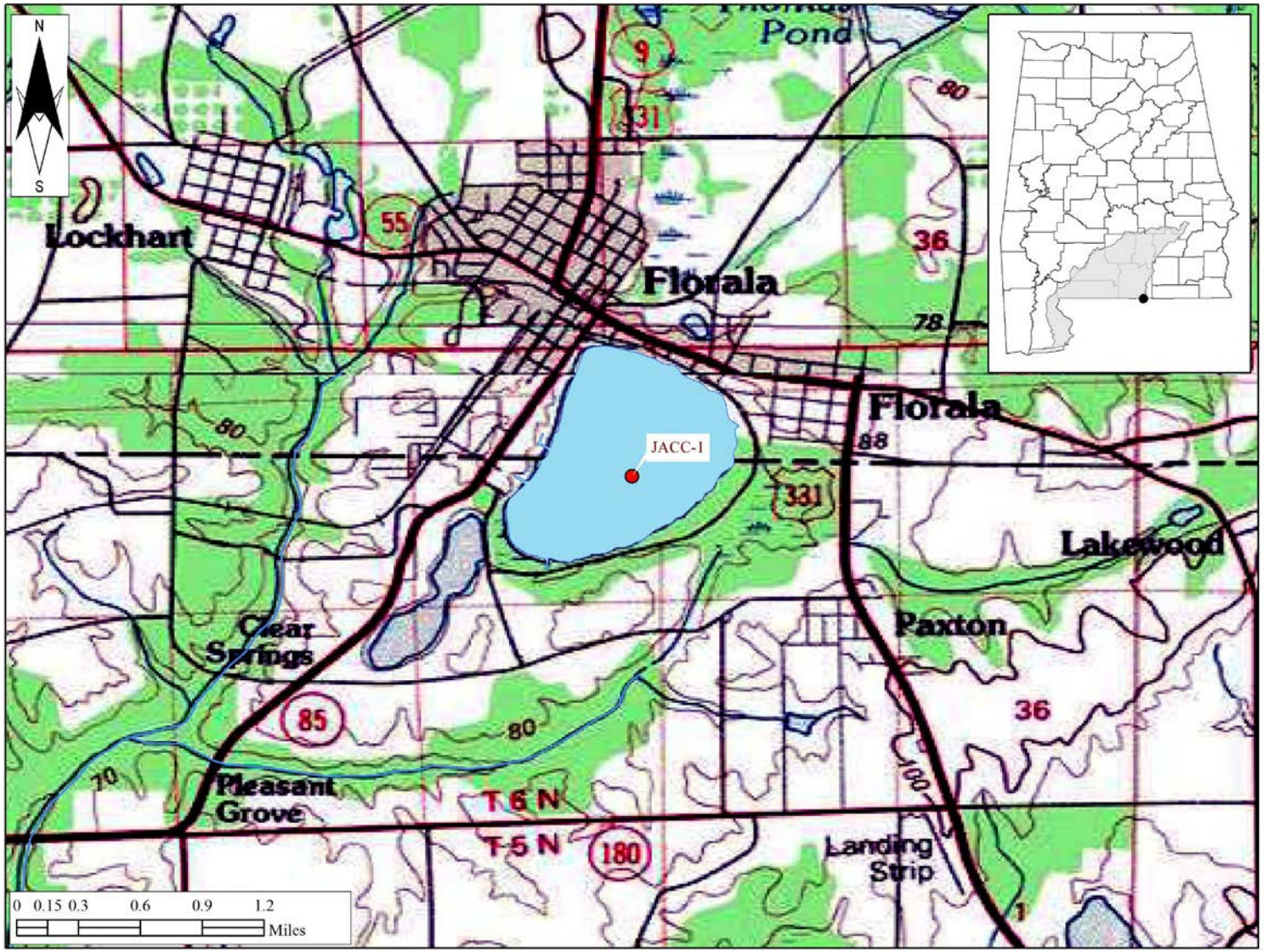


Table 1. Descriptions of the 2008 monitoring stations in Gantt, Point A, Frank Jackson, and Jackson Reservoirs.

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
Frank Jackson Reservoir								
031401030102	Covington	FJAC-1	Frank Jackson	Frank Jackson Reservoir	Deepest point, main creek channel, dam forebay.		31.30180	-86.28040
Jackson Reservoir								
031401030601	Covington	**JACC-1	Jackson	Jackson Reservoir	Florala, AL. Approximate center of lake.	7 µg/l	30.99290	-86.32470

*Growing season mean chl *a* criteria implemented in 2004.
**Growing season mean chl *a* criteria implemented in 2005.

RESULTS

Growing season mean graphs for TN, TP, chl *a*, and TSS are provided in this section (Figs. 4 and 5). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figs. 6-14 and 20). 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 and DO appear in Figs. 15-19. Summary statistics of all data collected during 2008 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

Stations with the highest concentrations of nutrients, chlorophyll, and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2008, mean TN concentrations at Gantt Reservoir were similar at both stations (Fig. 4). Growing season mean TN concentrations have increased overall at both stations 1999-2008 (Fig. 4). The highest monthly TN concentration at the lower station occurred in September (Fig. 6). Monthly TN concentrations at the lower station were above historic means each month sampled and concentrations were at historic highs June-September 2008 (Fig. 6). Monthly TN concentrations at the upper reservoir showed historic highs April-May and August-September 2008 (Fig. 6).

Mean 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 (Fig. 4). Monthly TN concentrations at the lower reservoir were above historic means each month sampled and concentrations were at historic highs April and September 2008 (Fig. 6). Mean TN concentrations at the Patsaliga Creek embayment were higher in 2007-2008 than in 2004 (Fig. 4).

Frank Jackson Reservoir showed little change in mean TN concentrations from 2007-2008 (Fig. 4). Monthly TN concentrations were highest in September (Fig. 7).

Growing season mean TN concentrations at Florala's Jackson Reservoir showed no obvious trend 1999-2008 (Fig. 4). Monthly TN concentrations were above historic mean a majority of months sampled on Jackson Reservoir with the highest monthly TN concentration occurring in May (Fig. 7).

Mean TP concentrations at the upper and lower locations on Gantt Reservoir were very similar in 2008 (Fig. 4). Mean TP concentrations in the upper reservoir were lower in 2008 than in 2004, while concentrations in the lower reservoir increased 1999-2003 then decreased since (Fig. 4). Monthly TP concentrations were highest in upper Gantt Reservoir in August and in April in lower Gantt Reservoir (Fig. 8). Both the upper and lower Gantt Reservoir stations were below historic means for most of the season with the exception of August (Fig. 8).

The highest mean TP concentration in lower Point A Reservoir occurred in 2003 and has decreased overall since (Fig. 4). Monthly TP concentrations at the lower reservoir were below historic means most months sampled with highest concentrations in April, August, and September (Fig. 8). Mean TP concentrations at the Patsaliga Creek embayment were variable in the years sampled, but were higher in 2008 than in 2007 (Fig. 4).

TP concentrations in Frank Jackson Reservoir were higher in 2008 than in 2007 (Fig. 4). Monthly TP concentrations were highest in September (Fig. 9).

Results of mean TP concentrations at Jackson Reservoir decreased overall 2002-2008 (Fig. 4). Monthly TP concentrations were highest in September at Jackson Reservoir (Fig. 9).

Mean chl *a* concentrations at lower Gantt Reservoir have decreased overall since 2002 while the upper location has decreased since 1999 (Fig. 5). The mean chl *a* concentration measured in 2008 was below the specific water quality criterion established for lower Gantt Reservoir (Fig. 5). Monthly chl *a* concentrations were highest in July at both lower and upper Gantt Reservoir in 2008 (Fig. 10).

The highest growing season mean chl *a* concentration in Point A Reservoir occurred in 2008 and has shown an increasing trend 2003-2008 (Fig. 5). Specific water quality criterion for nutrient management has also been established for lower Point A Reservoir. The mean chl *a*

concentration measured in 2008 was below the criteria limit (Fig. 5). Monthly chl *a* concentrations were highest in June and September with both of those concentrations resulting in historic highs (Fig. 10). The Patsaliga Creek embayment showed no clear trend in mean chl *a* concentrations, though concentrations were higher in 2007 and 2008 than those from 1999 and 2004 (Fig. 5).

Mean chl *a* concentrations in Frank Jackson Reservoir were higher in 2008 than in 2007 (Fig. 5). Highest monthly chl *a* concentrations for 2008 occurred in April (Fig. 11).

Mean chl *a* concentrations for Florala's Jackson Reservoir have increased 1999-2003 but decreased in 2007 and 2008 (Fig. 5). Specific water quality criterion for nutrient management has also been established for Jackson Reservoir. The mean chl *a* concentration measured in 2007 and 2008 was well below the criteria limit (Fig. 5). Highest monthly chl *a* concentrations occurred in September and concentrations were below historic means in most months sampled (Fig. 11).

Mean TSS concentrations at Gantt Reservoir were slightly higher in the lower reservoir in 2008 compared to the upper reservoir (Fig. 5). Mean TSS concentrations decreased 2004-2008 in the upper reservoir and decreased in the lower reservoir 2003-2008 (Fig. 5). Highest monthly TSS concentrations occurred in July in the lower station and August in the upper. Monthly TSS concentrations were below historic means for the entire 2008 sampling season at both Gantt Reservoir locations (Fig. 12).

Mean TSS concentrations at lower Point A Reservoir were highest in 2003 and have decreased since (Fig. 5). Highest monthly TSS concentrations for 2008 occurred at the lower station in May and August (Fig. 12). Lower Point A monthly TSS concentrations were below historic means every month with the exception of August (Fig. 12). The mean TSS concentration at the Patsaliga Creek embayment was highest in 2004 and much lower in 2007-2008 (Fig. 5).

Mean TSS concentrations at Frank Jackson Reservoir were similar from 2007-2008 (Fig. 5). The highest monthly concentrations occurred in June (Fig. 13).

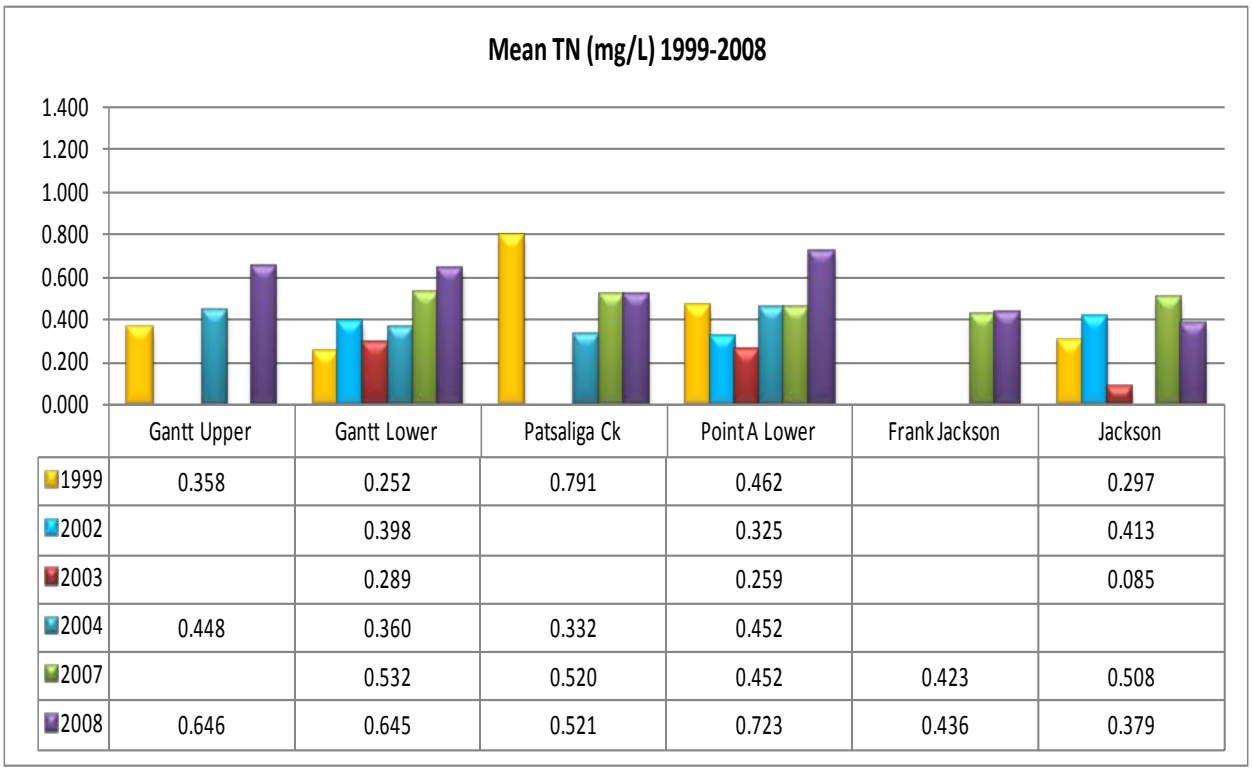
Mean TSS concentrations at Jackson Reservoir increased 1999-2003 and showed a considerable decrease in 2007 and 2008 (Fig. 5). Results were below historic mean concentrations in all months except June, reaching historic lows during those months (Fig. 13).

AGPT results for both the lower and upper Gantt Reservoir stations in 2008 indicated phosphorus limited conditions similar to previous results (Table 2). AGPT results for the lower Point A Reservoir station indicated phosphorus limited conditions June 1999-September 2008. Results for Patsaliga Creek indicated phosphorus limited conditions June 1999-August 2004 with no limiting nutrient in September 2008 (Table 2). Frank Jackson Reservoir was phosphorus limited in September 2008. Florala's Jackson Reservoir showed neither nitrogen nor phosphorus as a limiting nutrient, confirming the lake's low productivity (Table 2). The mean standing crop (MSC) value at the lower Point A Reservoir station was above 5 mg/L in September 2008, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems. All other stations were below 5 mg/L in 2008.

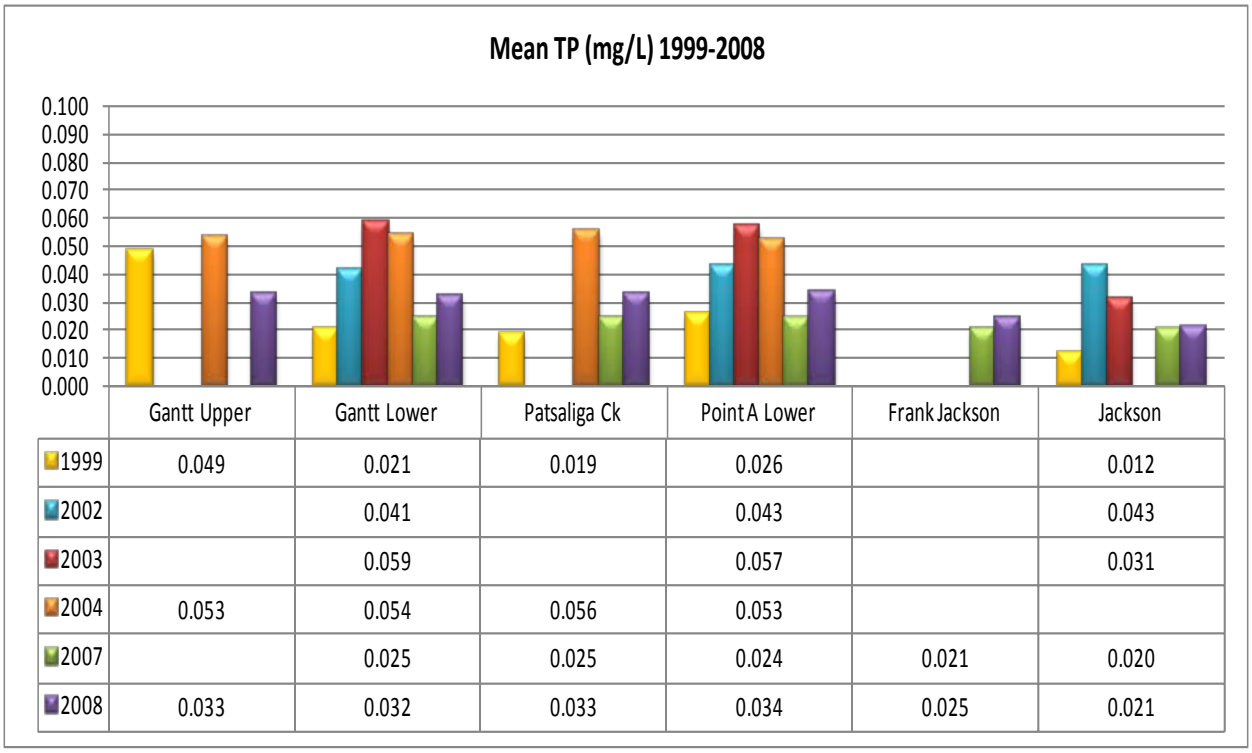
In September 2008 the dissolved oxygen concentration at the lower Gantt Reservoir station was below the ADEM criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) (ADEM Admin. Code R. 335-6-10-.09) (Fig. 14). Frank Jackson Reservoir was also below 5.0 mg/L in July (Fig. 18). All other measurements of dissolved oxygen at 5ft were above 5.0 mg/L in all reservoirs. Profiles of dissolved oxygen in lower Gantt showed deoxygenated conditions below four meters in June and July and stratification April-July at the upper station (Fig. 15 & 16). Point A also showed stratification in June and July (Fig. 17). Both Gantt and Point A water columns were mixed prior to the 9/2/2008 sampling event. A majority of the water column was deoxygenated in Frank Jackson in July (Fig. 18) while Florala's Jackson was well mixed April-October (Fig. 19). Highest temperatures were reached in July in all four reservoirs (Fig. 15, 16, 17, 18, & 19).

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 mesotrophic much of the growing season. In July values indicated the reservoir was eutrophic (Fig. 20). Lower Point A Reservoir and Patsaliga Creek varied month to month from oligotrophic to eutrophic (Fig. 20). Values indicated Frank Jackson Reservoir was mesotrophic for much of the growing season with the exceptions of eutrophic values in April and oligotrophic values in May (Fig. 20). Jackson Reservoir varied between mesotrophic and oligotrophic values throughout the growing season (Fig. 20).

Figure 4. Growing season mean TN and TP measured April-October 1999-2008. Bar graphs consist of mainstem and embayment stations.

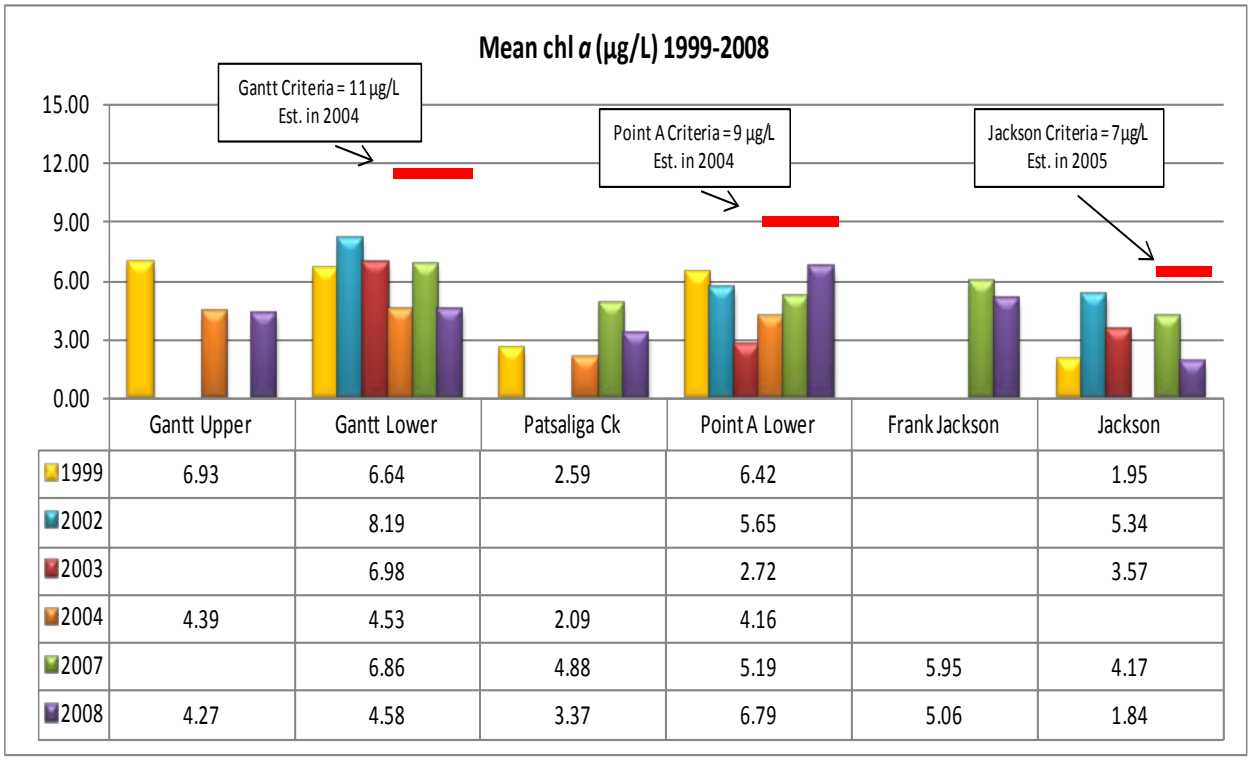


	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower	Frank Jackson	Jackson
1999	0.358	0.252	0.791	0.462		0.297
2002		0.398		0.325		0.413
2003		0.289		0.259		0.085
2004	0.448	0.360	0.332	0.452		
2007		0.532	0.520	0.452	0.423	0.508
2008	0.646	0.645	0.521	0.723	0.436	0.379

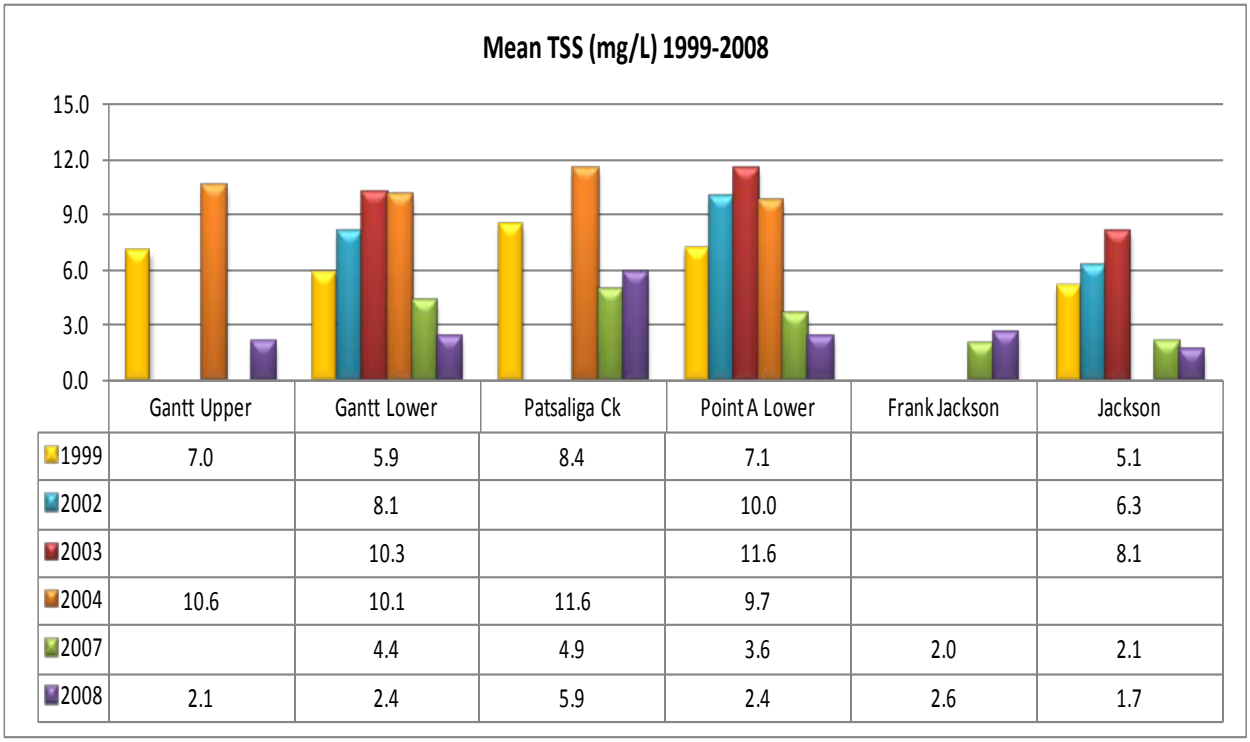


	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower	Frank Jackson	Jackson
1999	0.049	0.021	0.019	0.026		0.012
2002		0.041		0.043		0.043
2003		0.059		0.057		0.031
2004	0.053	0.054	0.056	0.053		
2007		0.025	0.025	0.024	0.021	0.020
2008	0.033	0.032	0.033	0.034	0.025	0.021

Figure 5. Growing season mean chl *a* and TSS measured in April-October 1999-2008. 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, and the Jackson station.



	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower	Frank Jackson	Jackson
1999	6.93	6.64	2.59	6.42		1.95
2002		8.19		5.65		5.34
2003		6.98		2.72		3.57
2004	4.39	4.53	2.09	4.16		
2007		6.86	4.88	5.19	5.95	4.17
2008	4.27	4.58	3.37	6.79	5.06	1.84



	Gantt Upper	Gantt Lower	Patsaliga Ck	Point A Lower	Frank Jackson	Jackson
1999	7.0	5.9	8.4	7.1		5.1
2002		8.1		10.0		6.3
2003		10.3		11.6		8.1
2004	10.6	10.1	11.6	9.7		
2007		4.4	4.9	3.6	2.0	2.1
2008	2.1	2.4	5.9	2.4	2.6	1.7

Figure 6. Monthly TN of the mainstem stations in Gantt and Point A Reservoirs, April-October 2008. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) 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 02372422 Conecuh River below Point A Dam).

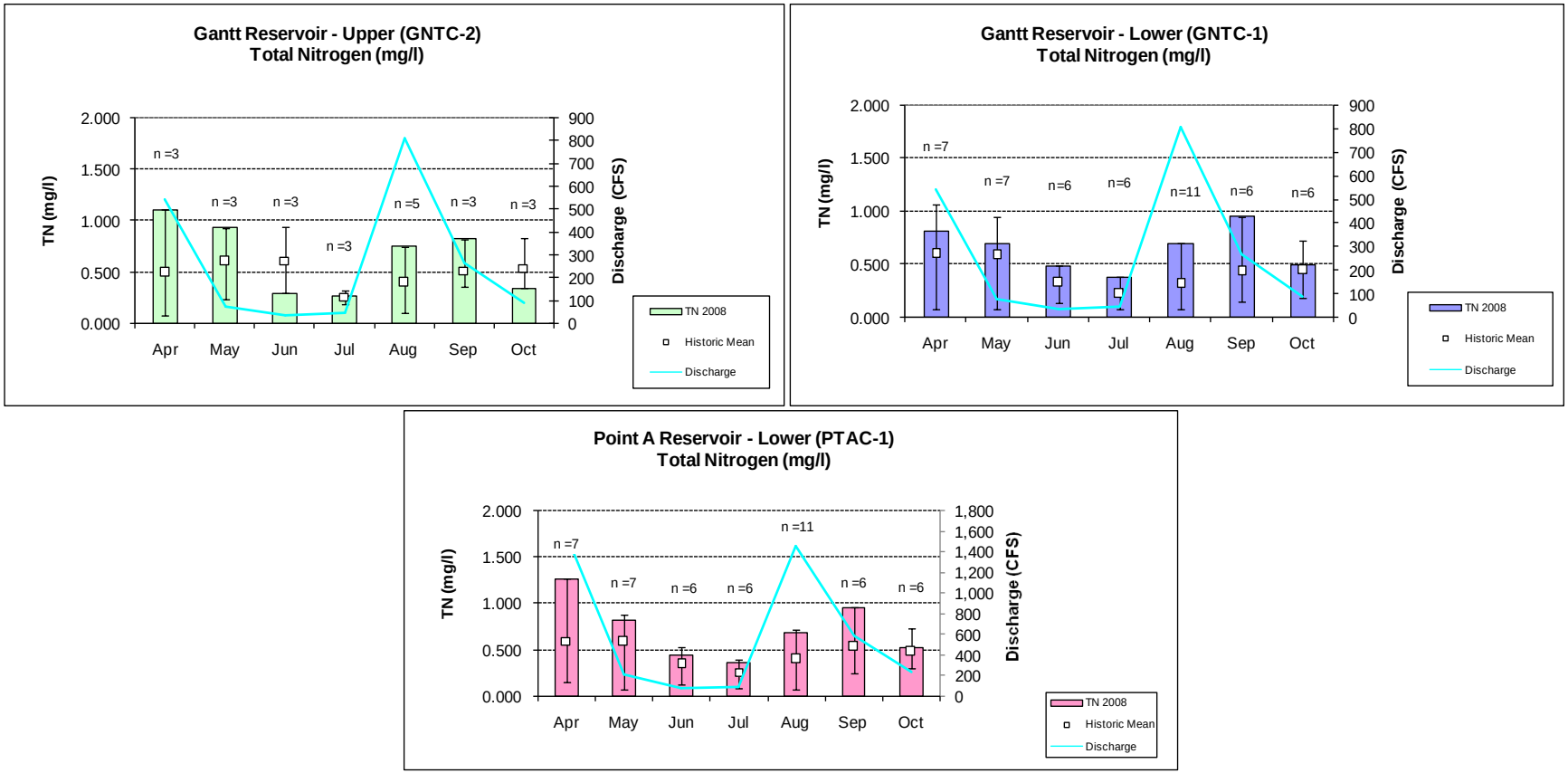
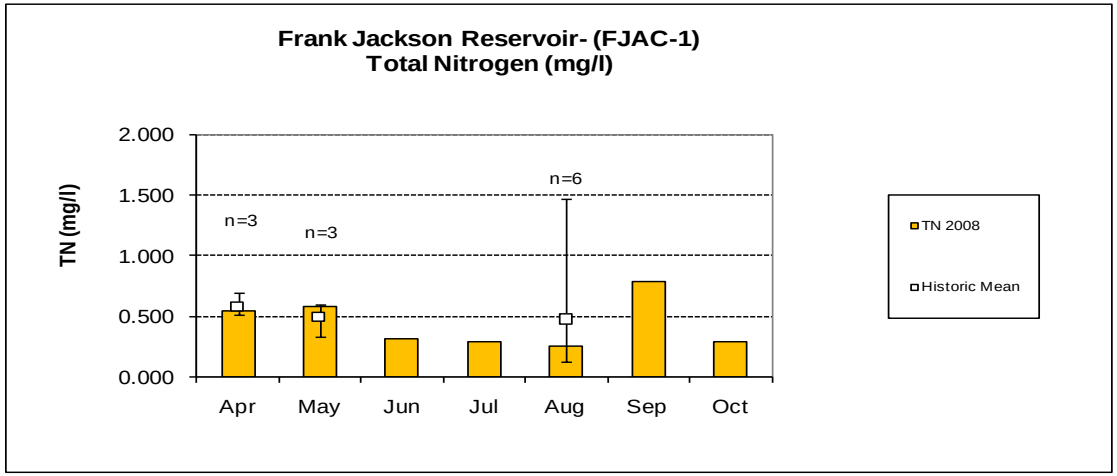


Figure 7. Monthly TN of Frank Jackson and Jackson Reservoirs, April-October 2008. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Historic comparisons were only graphed when three or more values existed.



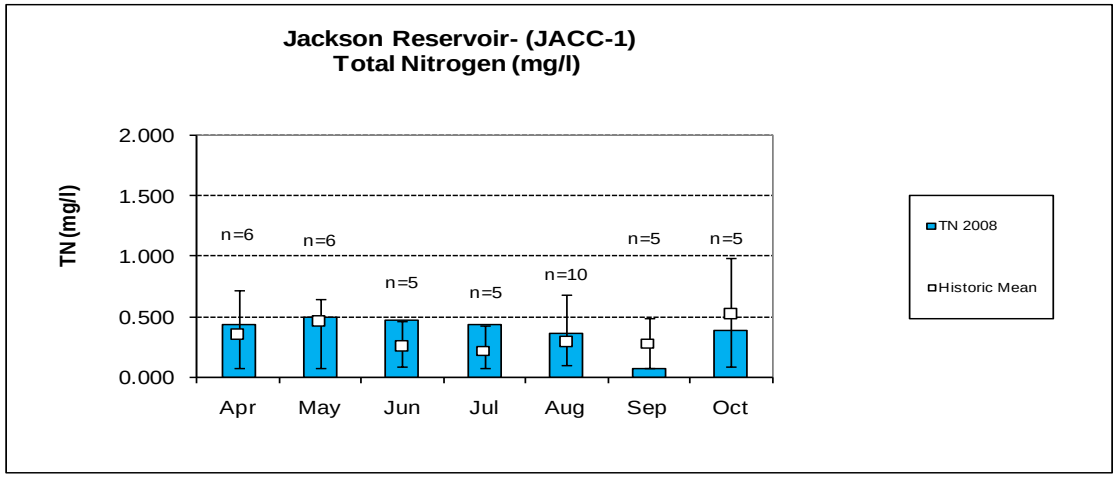


Figure 8. Monthly TP of the mainstem stations in Gantt and Point A Reservoir, April-October 2008**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in 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 02372422 Conecuh River below Point A Dam).

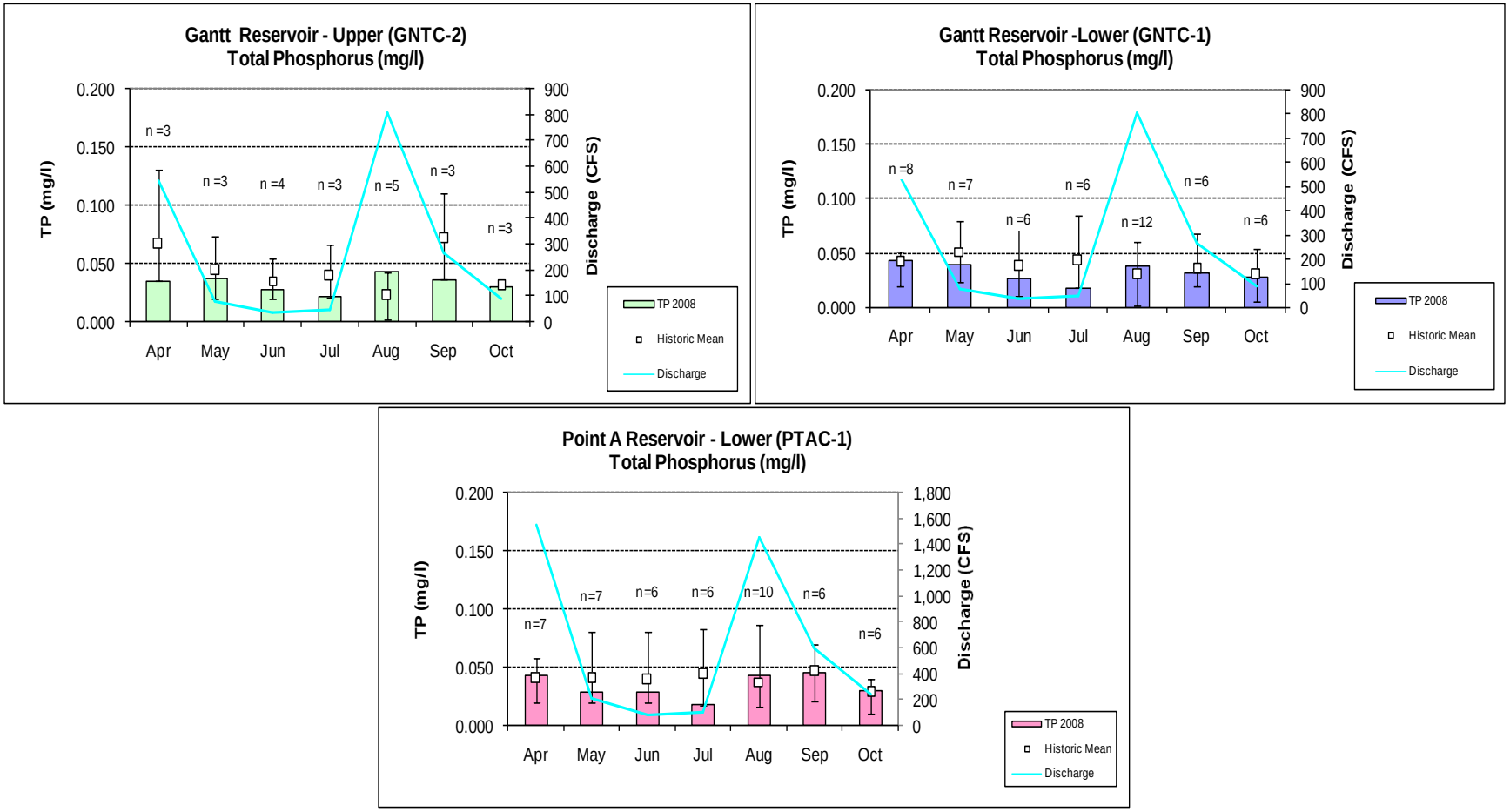


Figure 9. Monthly TP of Frank Jackson and Jackson Reservoir, April-October 2008**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Historic comparisons were only graphed when three or more values existed.

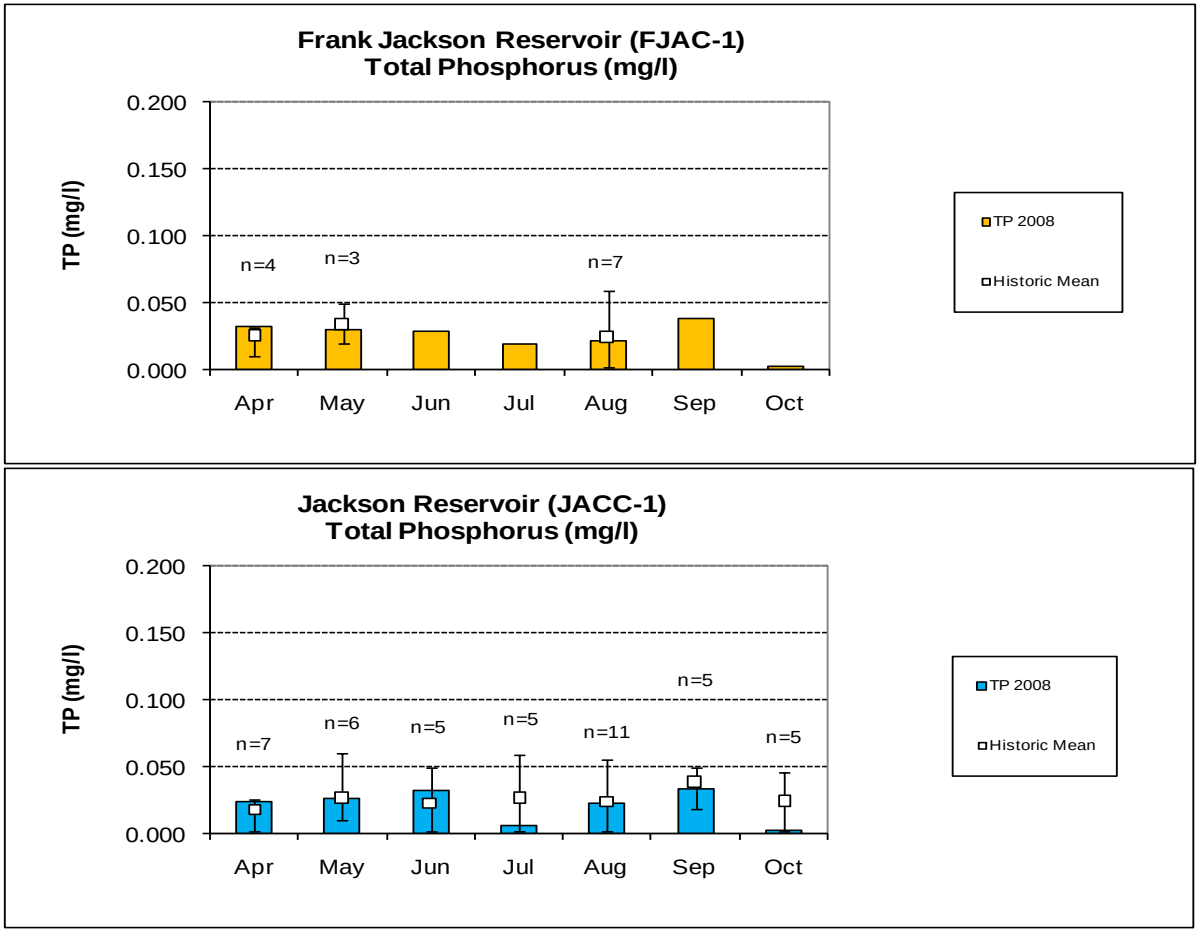


Figure 10. Monthly chl *a* of the mainstem stations in Gantt and Point A Reservoir, April-October 2008**.** Each bar graph depicts monthly changes in each station**.** The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included 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 02372422 Conecuh River below Point A Dam).

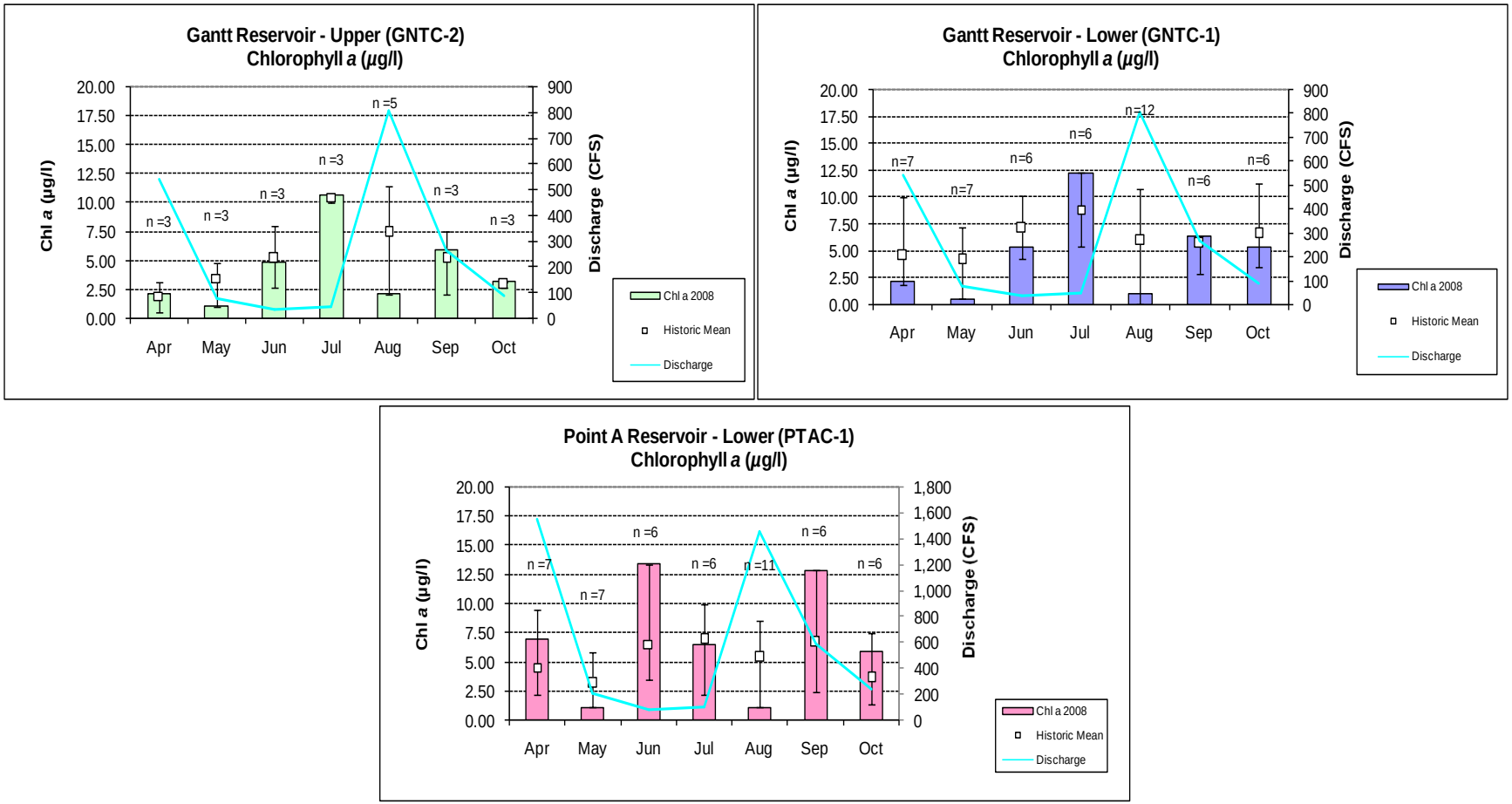


Figure 11. Monthly chl *a* of Frank Jackson and Jackson Reservoirs, April-October 2008**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Historic comparisons were only graphed when three or more values existed.

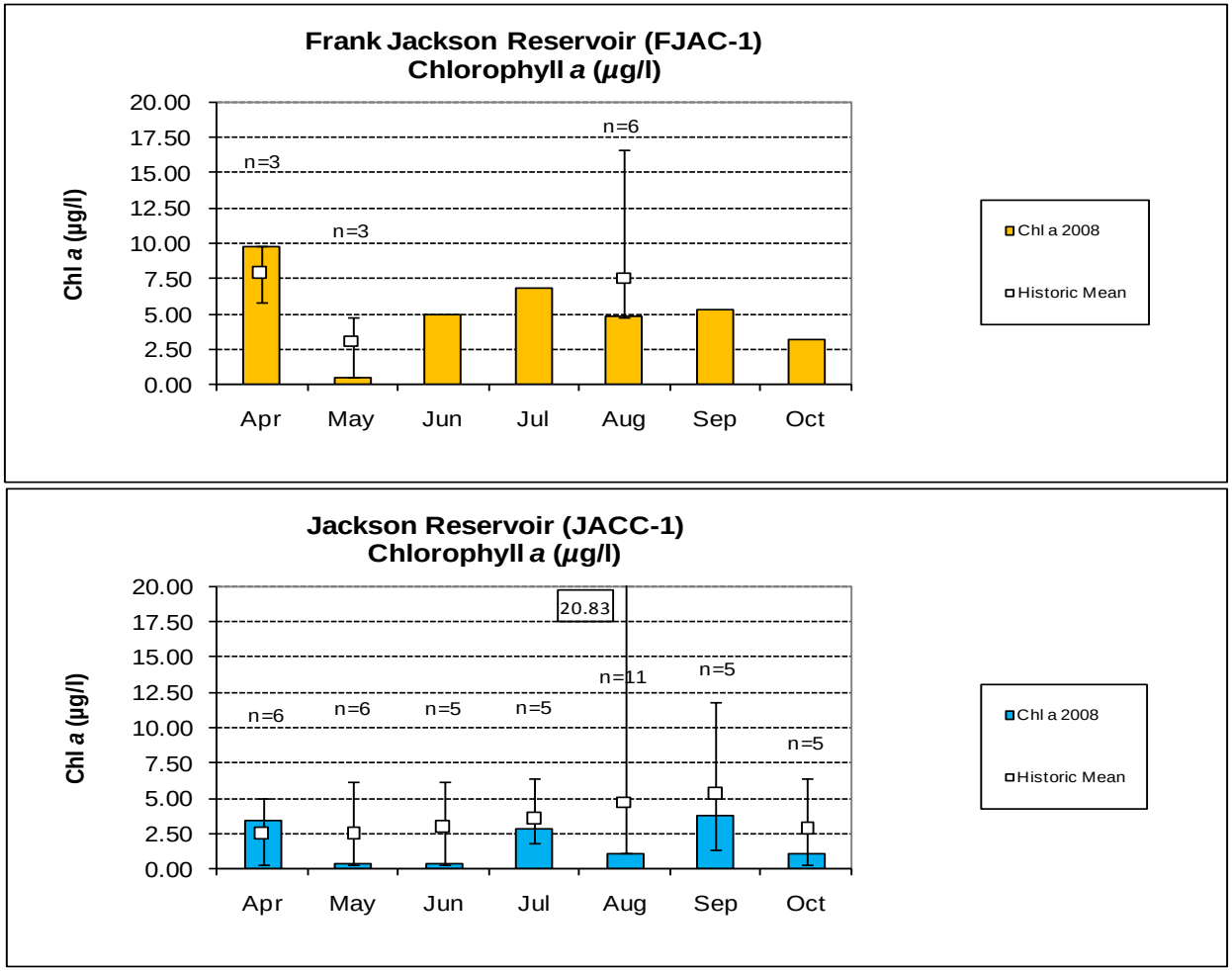


Figure 12. Monthly TSS of the mainstem stations in Gantt and Point A Reservoir, April-October 2008. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the 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 02372422 Conecuh River below Point A Dam).

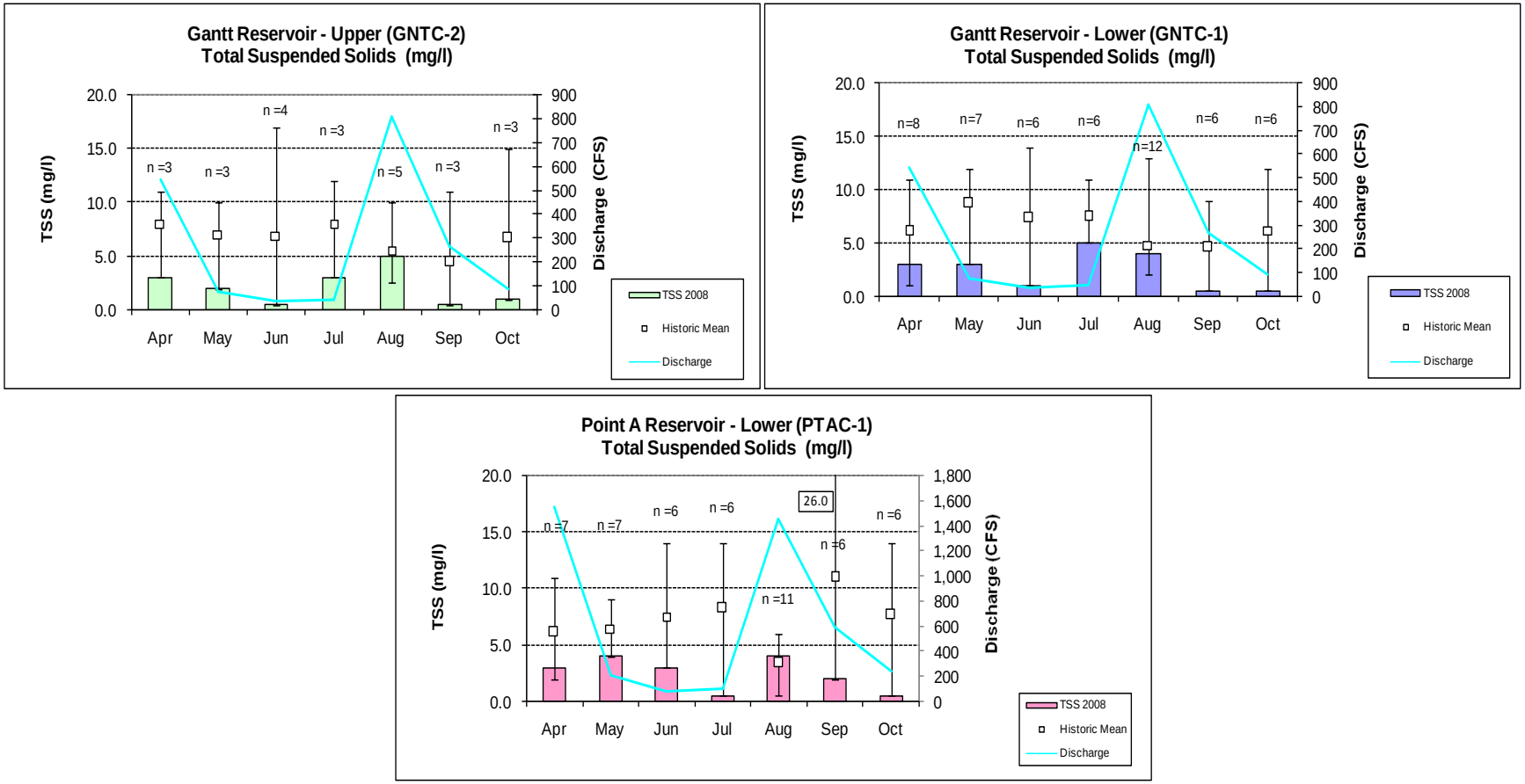


Figure 13. Monthly TSS of the mainstem stations in Frank Jackson and Jackson Reservoir, April-October 2008**.** Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Historic comparisons were only graphed when three or more values existed.

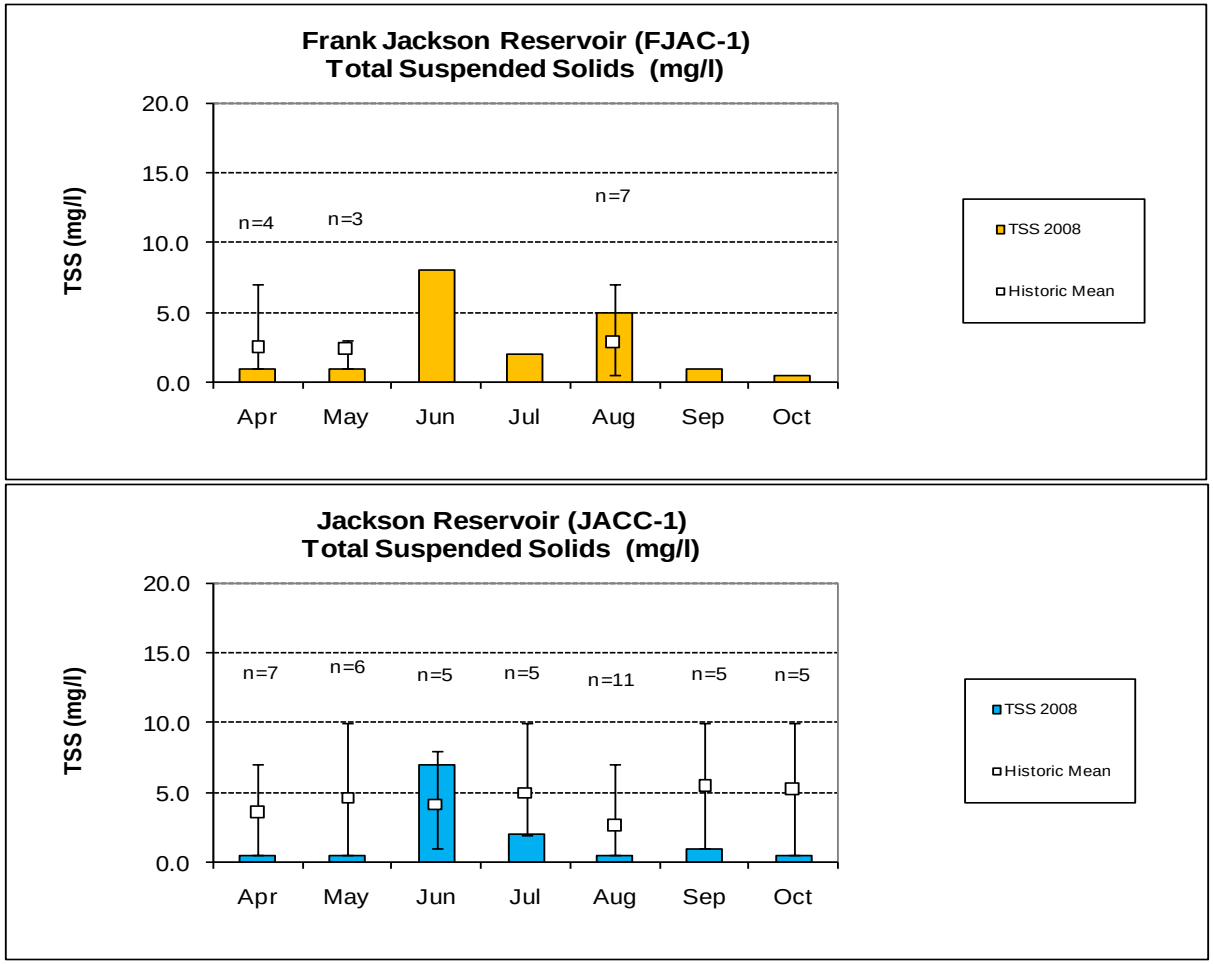


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective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

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

Station	FJAC-1		JACC-1	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient
June 1999	NA	NA	1.52	Phosphorus
July 1999	NA	NA	2.03	Phosphorus
August 1999	NA	NA	1.45	None
August 2004	NA	NA	NA	NA
September 2008	2.65	Phosphorus	2.49	None

Figure 14. Monthly DO concentrations at 1.5 m (5 ft) for Gantt, Point A, Frank Jackson, and Jackson Reservoir stations collected April-October 2008. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.

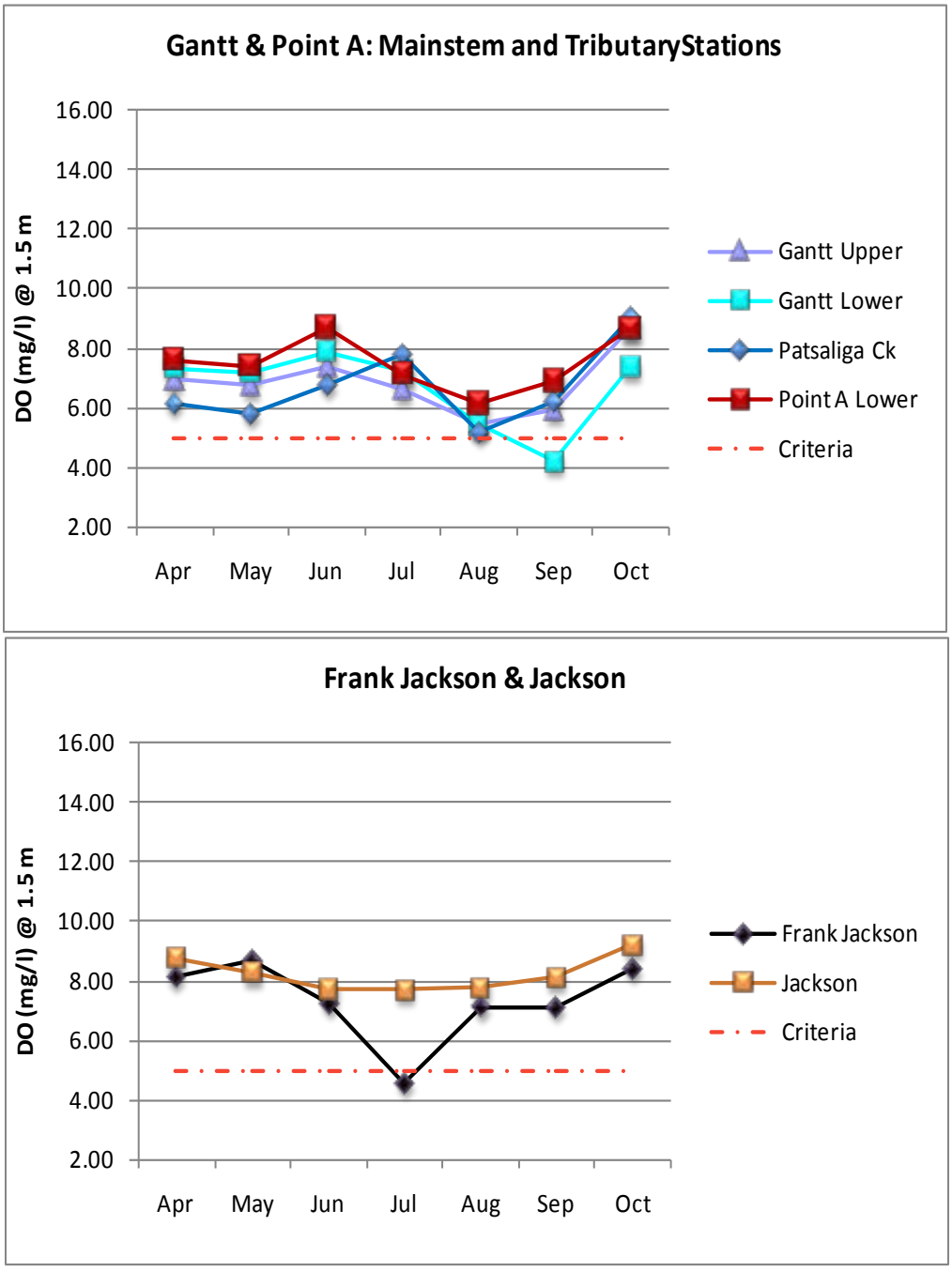


Figure 15. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in lower Gantt Reservoir, April-October 2008.

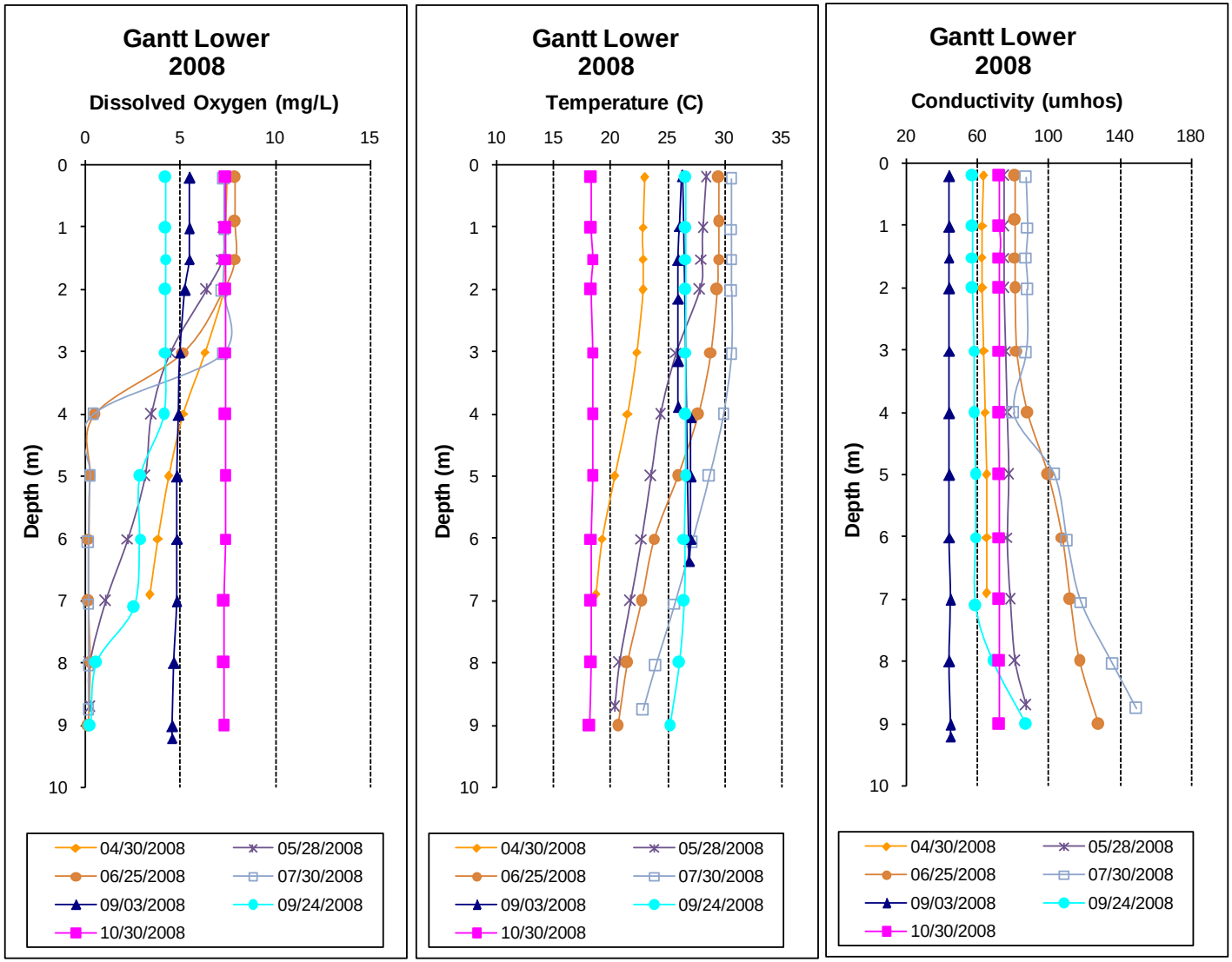


Figure 16. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in upper Gantt Reservoir, April-October 2008.

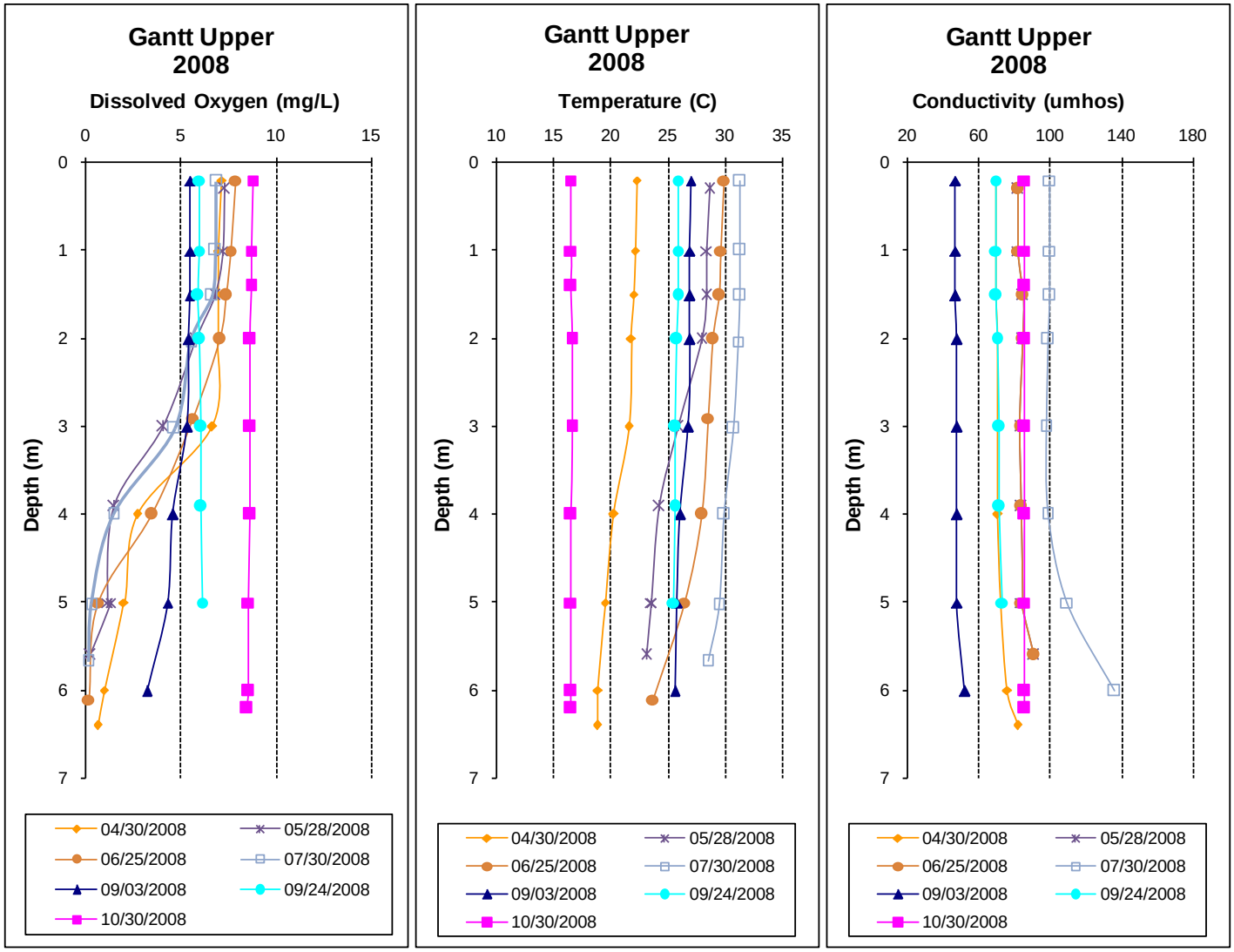


Figure 17. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in lower Point A Reservoir, April-October 2008.

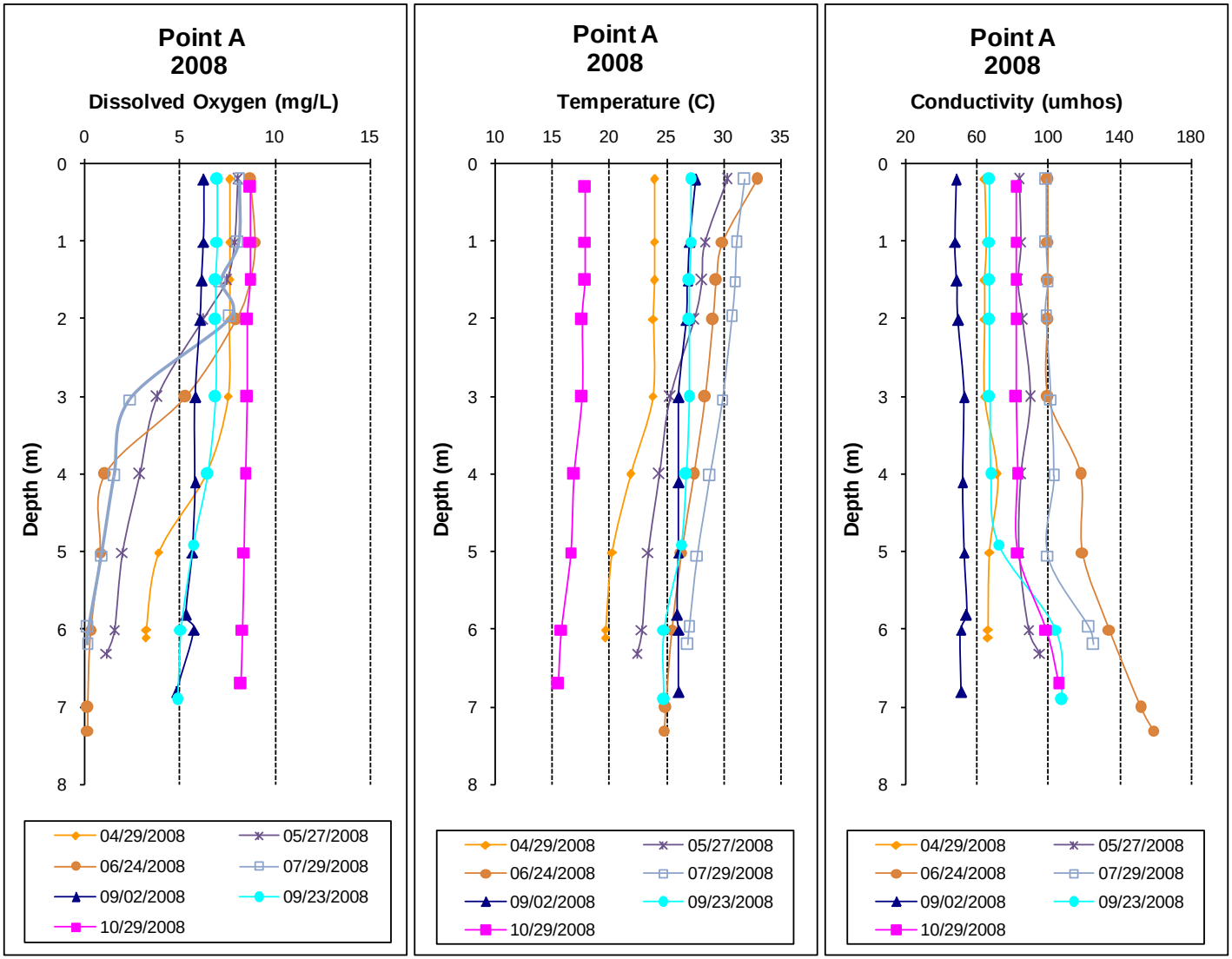


Figure 18. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in Frank Jackson Reservoir, April-October 2008.

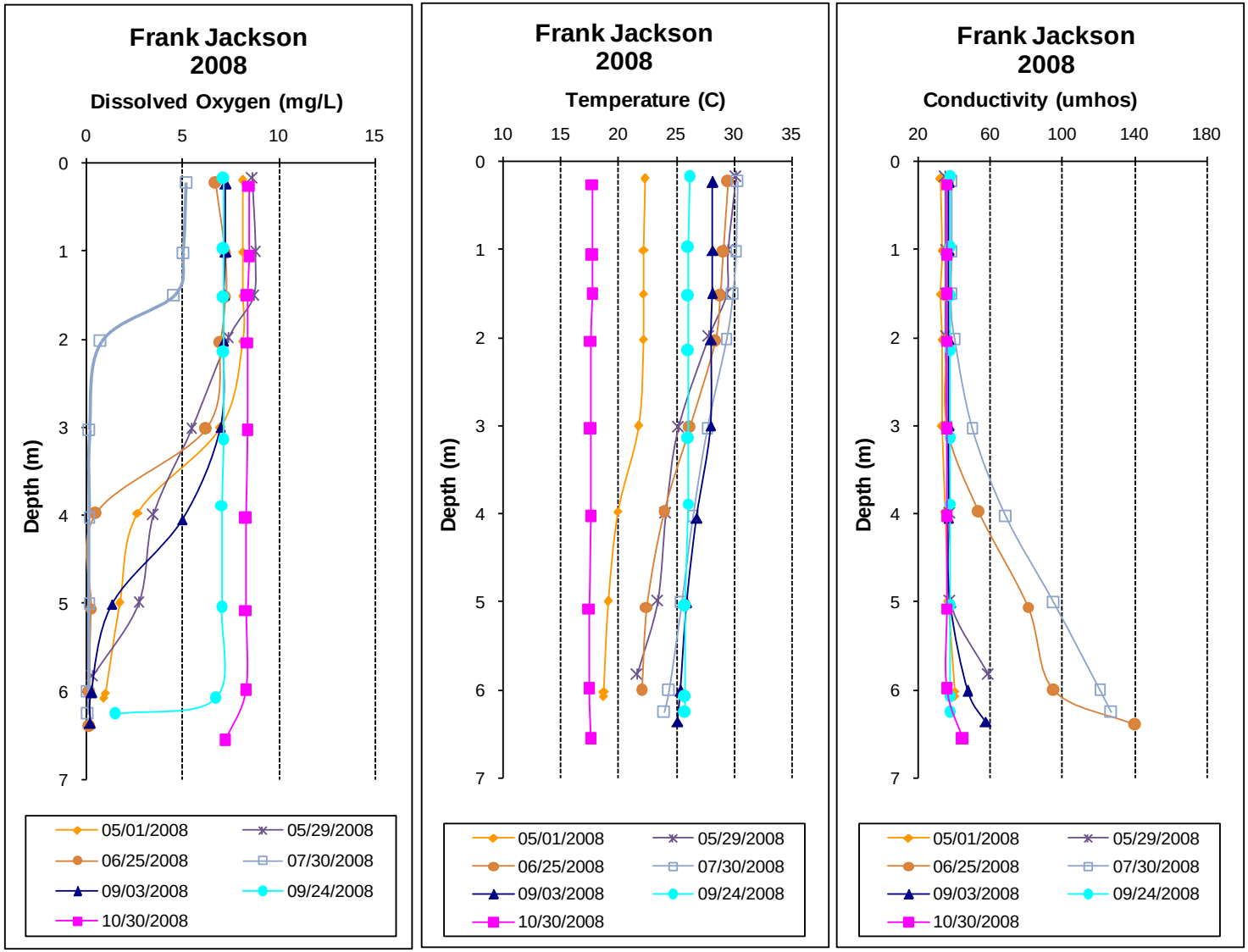


Figure 19. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (µmhos) in Jackson Reservoir, April-October 2008.

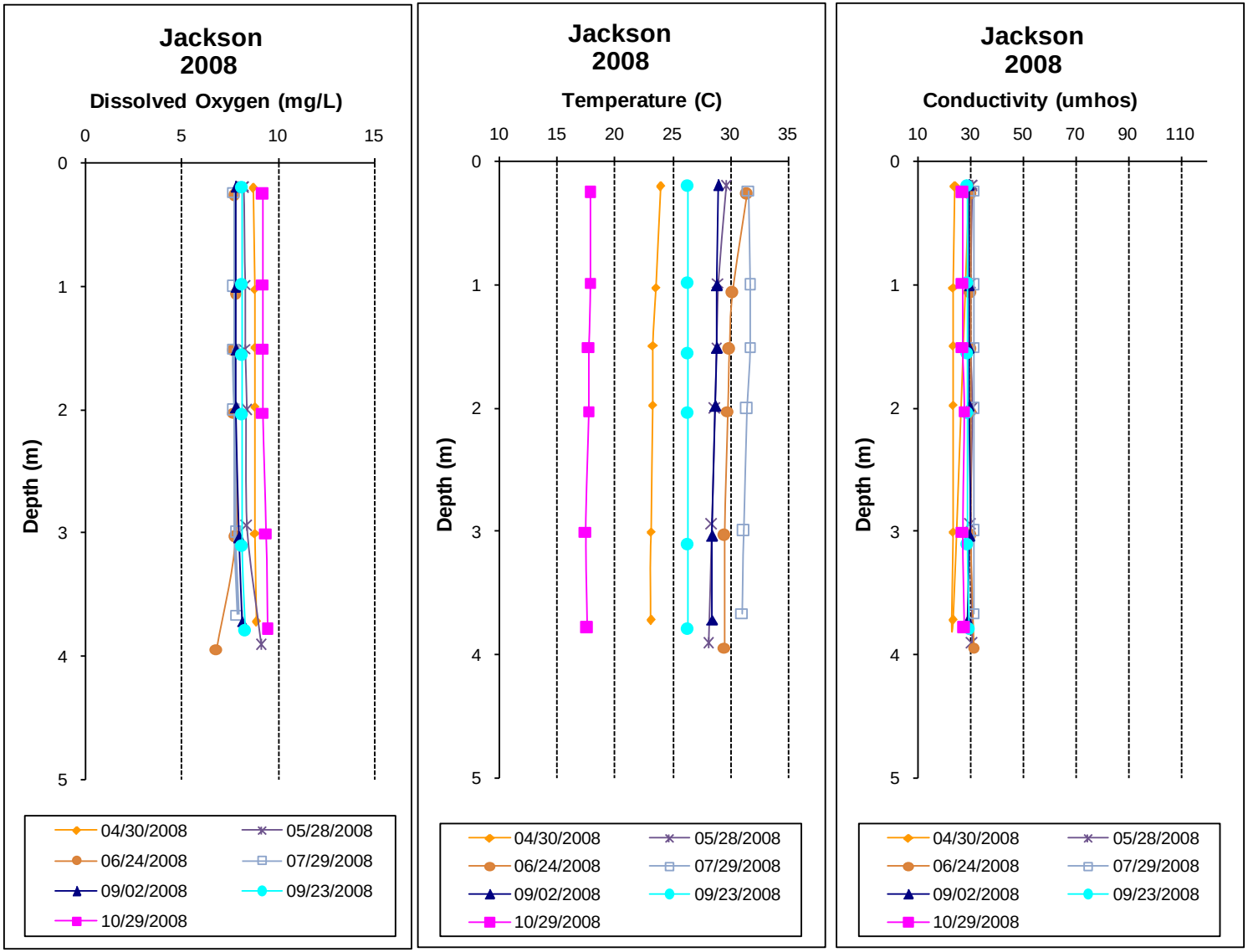
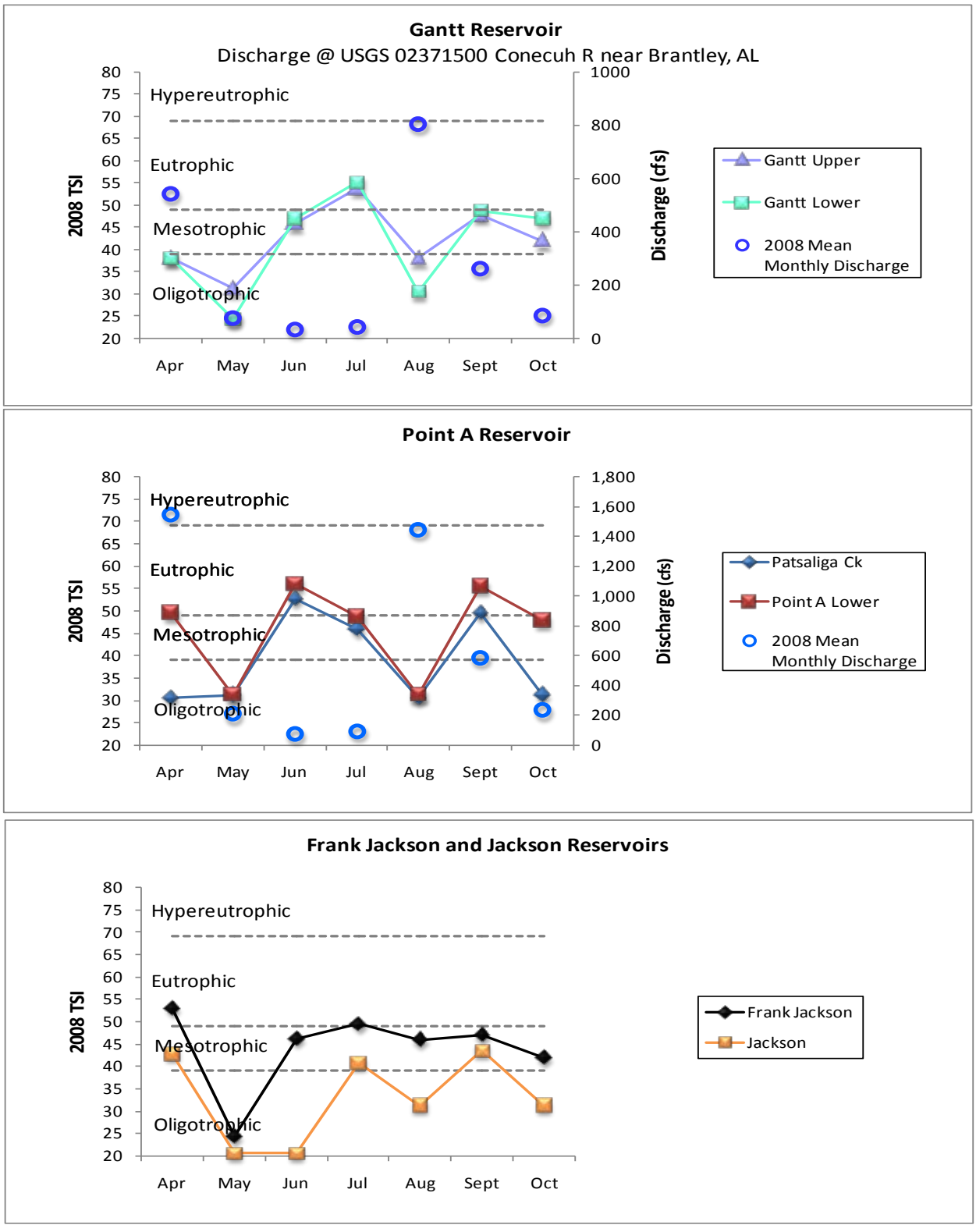


Figure 20. Monthly TSI values for Gantt, Point A, Frank Jackson, and Jackson Reservoir using chl *a* concentrations and Carlson's Trophic State Index calculation.



REFERENCES

ADEM. 2003. Quality Assurance Management Plan For The Alabama Department Of Environmental, Alabama Department of Environmental Management (ADEM), Montgomery, AL. 25 pp.

ADEM. 2005. Study Plan and Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring of Non-Wadeable Rivers, Reservoirs, Tributary Embayments, and Estuarine/Marine Waters in Alabama. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 110 pp.

ADEM. 2007 (as amended). Standard Operating Procedures #2041 *In Situ* Surface Water Quality Field Measurements-Temperature, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2042 *In Situ* Surface Water Quality Field Measurements-pH, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2043 *In Situ* Surface Water Quality Field Measurements–Conductivity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2044 *In Situ* Surface Water Quality Field Measurements–Turbidity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2045 *In Situ* Surface Water Quality Field Measurements–Dissolved Oxygen, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2046 Photic Zone Measurement and Visibility Determination, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2061 General Surface Water Sample Collection, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2062 Dissolved Reactive Phosphorus (DRP) Surface Water Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2007 (as amended). Standard Operating Procedures #2063 Water Column Chlorophyll *a* Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2005. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.11). 2005. Water Quality Criteria Applicable to Specific Lakes. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1998. Standard methods for the examination of water and wastewater. 20th edition. APHA, Washington, D.C.

Carlson, R.E. 1977. A trophic state index. Limnology and Oceanography. 22(2):361-369.

Lind, O.T. 1979. Handbook of common methods in limnology. The C.V. Mosby Co., St. Louis, Missouri. 199 pp.

Raschke, R.L. and D.A. Schultz. 1987. The use of the algal growth potential test for data assessment. Journal of Water Pollution Control Federation 59(4):222-227.

Raschke, R. L., H. S. Howard, J. R. Maudsley, and R. J. Lewis. 1996. The Ecological Condition of Small Streams in the Savannah River Basin: A REMAP Progress Report. EPA Region 4, Science and Ecosystem Support Division, Ecological Assessment Branch, Athens, GA.

U.S. Environmental Protection Agency. 1990. The lake and reservoir restoration guidance manual. 2nd edition. EPA-440/4-90-006. U.S.E.P.A. Office of Water. Washington, D.C. 326 pp.

Welch, E.B. 1992. Ecological Effects of Wastewater. 2nd edition. Chapman and Hall Publishers. London, England. 425 pp.

Wetzel, R.G. 1983. Limnology. 2nd edition. Saunders College Publishing. Philadelphia, Pennsylvania. 858 pp.

APPENDIX

Appendix Table 1. Summary water quality data collected April-October, 2008. 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
GNTC-1	**Physical**							
	Turbidity (NTU)	7		3.4	14.8	6.7	8.8	4.6
	Total Dissolved Solids (mg/L)	7		6.0	92.0	62.0	58.6	27.4
	Total Suspended Solids (mg/L)	7	<	1.0	5.0	3.0	2.4	1.8
	Hardness (mg/L)	4		11.7	30.4	25.5	23.3	8.1
	Alkalinity (mg/L)	7		7.3	30.7	24.2	20.6	8.1
	Photic Zone (m)	7		1.44	5.38	2.10	2.68	1.38
	Secchi (m)	7		0.57	2.40	0.85	1.12	0.64
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.015	0.087	0.008	0.031	0.036
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.131	0.017	0.056	0.063
	Total Kjeldahl Nitrogen (mg/L)	7		0.378	0.932	0.564	0.590	0.198
	Total Nitrogen (mg/L)	7	<	0.380	0.949	0.695	0.645	0.200
	Dissolved Reactive Phosphorus (mg/L)	7		0.006	0.013	0.011	0.010	0.003
	Total Phosphorus (mg/L)	7		0.018	0.043	0.032	0.032	0.009
	CBOD-5 (mg/L)	7	<	1.0	2.0	0.5	0.6	0.2
	Chlorides (mg/L)[J]	7		1.7	3.9	2.8	2.8	0.7
	Biological							
	Chlorophyll a (ug/L)	7	<	0.10	12.28	5.34	4.58	4.22
	Fecal Coliform (col/100 mL)	1					33	
GNTC-2	**Physical**							
	Turbidity (NTU)	7		5.8	15.8	8.7	10.5	3.9
	Total Dissolved Solids (mg/L)	7		22.0	106.0	58.0	63.4	27.3
	Total Suspended Solids (mg/L)	7	<	1.0	5.0	2.0	2.1	1.6
	Hardness (mg/L)	4		12.8	37.2	30.8	27.9	10.7
	Alkalinity (mg/L)	7		8.6	37.9	29.1	26.7	9.9
	Photic Zone (m)	7		1.56	3.57	2.21	2.36	0.69
	Secchi (m)	7		0.53	1.24	0.78	0.87	0.30
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.015	0.100	0.008	0.021	0.035
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.143	0.060	0.069	0.069
	Total Kjeldahl Nitrogen (mg/L)	7		0.203	0.970	0.748	0.577	0.311
	Total Nitrogen (mg/L)	7	<	0.268	1.108	0.750	0.646	0.340
	Dissolved Reactive Phosphorus (mg/L)	7		0.005	0.012	0.011	0.009	0.003
	Total Phosphorus (mg/L)	7		0.021	0.043	0.035	0.033	0.007
	CBOD-5 (mg/L)	7	<	1.0	2.0	0.5	0.6	0.2
	Chlorides (mg/L)[J]	7	<	1.0	3.8	3.1	2.6	1.1
	Biological							
	Chlorophyll a (ug/L)	7		1.07	10.68	3.20	4.27	3.28
	Fecal Coliform (col/100 mL)	1					32	

Station	Parameter	N		Min	Max	Med	Mean	SD
PTAC-1	**Physical**							
	Turbidity (NTU)	7		3.9	16.4	7.2	8.8	4.6
	Total Dissolved Solids (mg/L)	7		36.0	102.0	56.0	60.6	21.7
	Total Suspended Solids (mg/L)	7	<	1.0	4.0	3.0	2.4	1.5
	Hardness (mg/L)	4		12.8	34.7	30.5	27.1	10.3
	Alkalinity (mg/L)	7		8.6	36.1	29.4	25.6	10.0
	Photic Zone (m)	7		1.34	3.90	2.23	2.51	0.95
	Secchi (m)	7		0.45	1.91	0.92	0.99	0.48
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.015	0.056	0.008	0.021	0.020
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.116	0.047	0.046	0.048
	Total Kjeldahl Nitrogen (mg/L)	7		0.360	1.163	0.685	0.677	0.296
	Total Nitrogen (mg/L)	7	<	0.362	1.262	0.686	0.723	0.318
	Dissolved Reactive Phosphorus (mg/L)	7		0.006	0.012	0.010	0.010	0.002
	Total Phosphorus (mg/L)	7		0.018	0.046	0.030	0.034	0.010
	CBOD-5 (mg/L)	7	<	1.0	2.0	0.5	0.6	0.2
	Chlorides (mg/L) [J]	7	<	1.0	3.9	2.9	2.7	1.2
	Biological							
	Chlorophyll a (ug/L)	7		1.07	13.35	6.41	6.79	4.93
	Fecal Coliform (col/100 mL)[J]	1					36	
PTAC-2	**Physical**							
	Turbidity (NTU)	7		6.1	28.5	12.7	12.9	7.6
	Total Dissolved Solids (mg/L)	7		40.0	98.0	68.0	64.0	20.1
	Total Suspended Solids (mg/L)	7	<	1.0	14.0	4.0	5.9	4.3
	Hardness (mg/L)	4		23.7	54.1	40.7	39.8	12.5
	Alkalinity (mg/L)	7		23.2	49.4	37.1	35.9	8.9
	Photic Zone (m)	7		1.36	3.49	1.94	2.19	0.75
	Secchi (m)	7		0.43	1.71	0.87	0.90	0.42
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.015	0.049	0.008	0.017	0.017
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.194	0.059	0.075	0.082
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.150	0.767	0.477	0.446	0.227
	Total Nitrogen (mg/L)	7	<	0.269	0.778	0.590	0.521	0.207
	Dissolved Reactive Phosphorus (mg/L)	7		0.005	0.013	0.009	0.009	0.003
	Total Phosphorus (mg/L)	7		0.020	0.045	0.032	0.033	0.009
	CBOD-5 (mg/L)	7	<	1.0	2.0	0.5	0.7	0.4
	Chlorides (mg/L)[J]	7	<	1.0	4.6	2.8	2.9	1.3
	Biological							
	Chlorophyll a (ug/L)	7	<	0.10	9.61	1.07	3.37	3.79
	Fecal Coliform (col/100 mL)[J]	1					38	

Station	Parameter	N	Min	Max	Med	Mean	SD
FJAC-1	**Physical**						
	Turbidity (NTU)	7	2.6	5.0	4.0	3.9	0.9
	Total Dissolved Solids (mg/L)	7	< 1.0	52.0	16.0	21.2	18.4
	Total Suspended Solids (mg/L)	7	< 1.0	8.0	1.0	2.6	2.8
	Hardness (mg/L)	4	6.1	11.2	8.9	8.8	2.4
	Alkalinity (mg/L)	7	6.5	12.1	9.2	9.1	1.7
	Photic Zone (m)	7	2.72	3.85	3.16	3.21	0.40
	Secchi (m)	7	1.17	2.00	1.60	1.59	0.31
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.064	0.008	0.016	0.021
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.385	0.007	0.072	0.140
	Total Kjeldahl Nitrogen (mg/L)	7	0.255	0.572	0.308	0.364	0.123
	Total Nitrogen (mg/L)	7	< 0.256	0.787	0.312	0.436	0.202
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.010	0.007	0.007	0.003
	Total Phosphorus (mg/L) [J]	7	< 0.005	0.038	0.029	0.025	0.012
	CBOD-5 (mg/L)	7	< 1.0	2.0	0.5	0.6	0.2
	Chlorides (mg/L) [J]	7	2.9	3.9	3.6	3.4	0.4
	Biological						
	Chlorophyll a (ug/L)	7	0.53	9.79	4.90	5.06	2.88
	Fecal Coliform (col/100 mL)[J]	1				3	
JACC-1	**Physical**						
	Turbidity (NTU)	7	1.2	1.6	1.4	1.4	0.1
	Total Dissolved Solids (mg/L)	7	< 1.0	66.0	8.0	16.8	23.7
	Total Suspended Solids (mg/L)	7	< 1.0	7.0	0.5	1.7	2.4
	Hardness (mg/L)	4	3.9	7.5	5.8	5.8	1.7
	Alkalinity (mg/L)	7	2.5	3.2	2.7	2.8	0.3
	Photic Zone (m)	7	3.66	3.94	3.78	3.78	0.11
	Secchi (m)	7	3.08	3.78	3.41	3.40	0.26
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	0.000
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.003	0.002	0.002	0.000
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.487	0.430	0.377	0.140
	Total Nitrogen (mg/L)	7	< 0.076	0.488	0.432	0.378	0.140
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.007	0.004	0.005	0.002
	Total Phosphorus (mg/L) [J]	7	< 0.005	0.033	0.024	0.021	0.012
	CBOD-5 (mg/L)	7	< 1.0	2.0	0.5	0.6	0.2
	Chlorides (mg/L) [J]	7	2.5	4.6	3.2	3.3	0.6
	Biological						
	Chlorophyll a (ug/L)	7	0.36	3.74	1.07	1.84	1.46
	Fecal Coliform (col/100 mL)[J]	1				1	

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