2010 Yates and Thurlow Reservoirs Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
April 2013

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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
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

Established in 1928 with the completion of Yates Dam, Yates Reservoir contains approximately 1,980 acres of surface water. It is the third reservoir on the Tallapoosa River system in Alabama, located downstream of Martin Reservoir. Thurlow Reservoir, completed in 1930, is located immediately downstream of Yates Reservoir and contains approximately 585 acres of surface water. The 2010 Yates and Thurlow Reservoirs monitoring information is presented together in this report due to the each reservoir's small size and close proximity to each other.

The Alabama Department of Environmental Management (ADEM) monitored Yates and Thurlow Reservoirs as part of the 2010 assessment of the Alabama, Coosa, and Tallapoosa (ACT) 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 the Field Operations Division of the 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 2002, the ADEM implemented specific water quality criteria for nutrient monitoring at the lower Yates and Thurlow locations. These criteria represent the maximum growing season mean (April-October) chlorophyll *a* (chl *a)* concentrations allowable while still fully supporting both 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 three stations in Yates and one station in Thurlow during the 2010 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's 14 year dataset. Monthly and/or 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 selected using historical data and previous assessments (Fig. 1). Specific location information can be found in Table 1. Yates and Thurlow Reservoirs were both sampled in the dam forebay. Two tributary embayment stations were sampled on Yates Reservoir, Channahatchee and Sougahatchee Creeks. Because Sougahatchee Creek has such a large watershed that contains a rapidly developing urban/suburban area, monthly graphs were prepared and included in the report along with those of mainstem sampling locations.

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 2010), Surface Water Quality Assurance Project Plan (ADEM 2008), 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 discharge data and ADEM's previously collected data to help interpret the 2010 results.

Figure 1. Yates and Thurlow Reservoirs with 2010 sampling locations. A description of each sampling location is provided in Table 1.

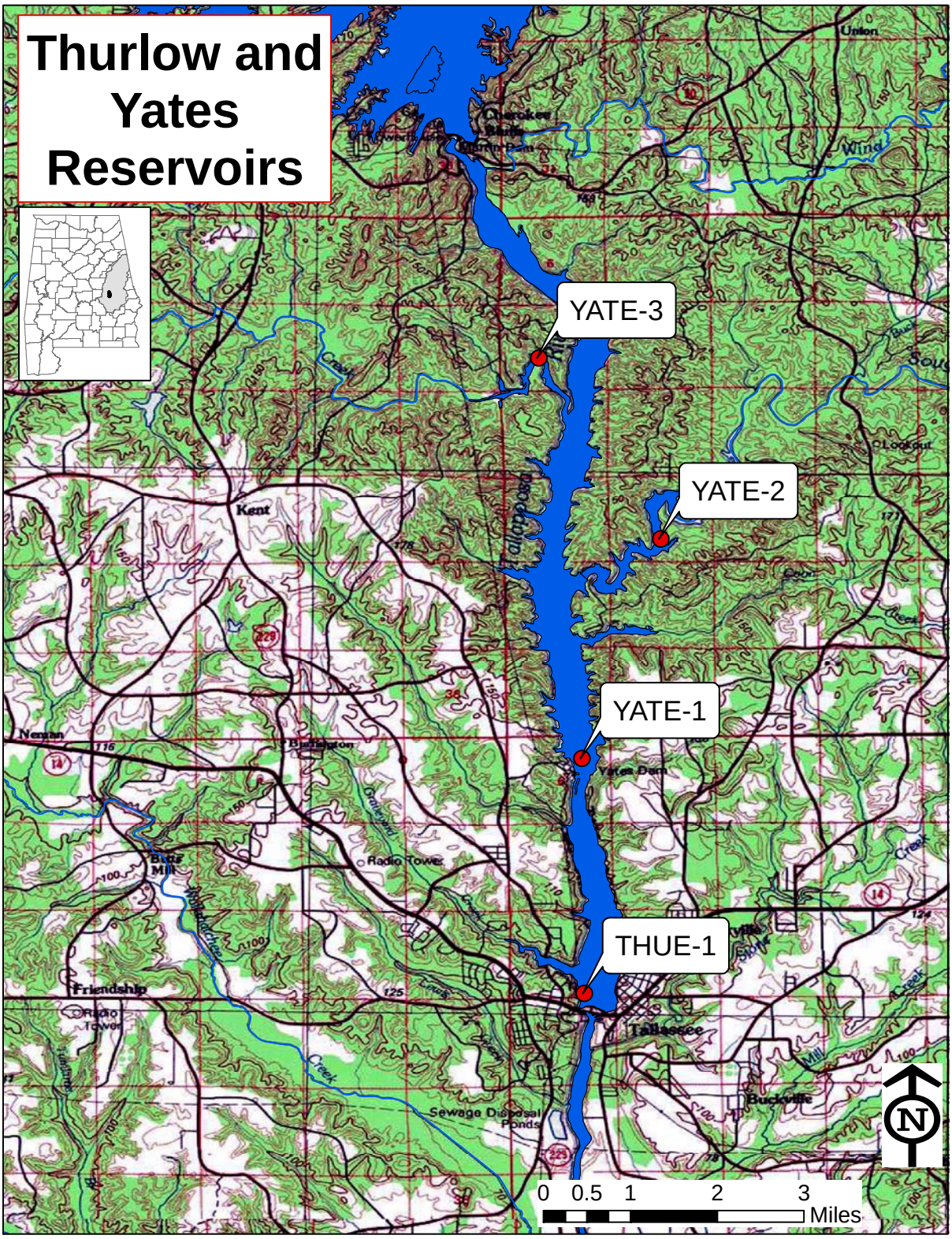


Table 1. Descriptions of the 2010 monitoring stations on Yates and Thurlow Reservoirs.

Thurlow and Yates Reservoirs								
HUC	**County**	**Station Number**	**Report Designation**	**Waterbody Name**	**Station Description**	**Chl *a* Criteria**	**Latitude**	**Longitude**
031501100406	Elmore	THUE-1*	Lower Thurlow	Tallapoosa R	Deepest point, main river channel, dam forebay .	5 μg/L	32.5376	-85.8893
031501100406	Tallapoosa	YATE-1*	Lower Yates	Tallapoosa R	Deepest point, main river channel, dam forebay.	5 μg/L	32.5766	-85.8896
031501100104	Tallapoosa	YATE-2	Sougahatchee Ck	Sougahatchee Cr	Deepest point, main creek channel, Sougahatchee Creek embayment. Approx. 1.6 miles upstream from the Tallapoosa River confluence.		32.6131	-85.8765
031501100402	Elmore	YATE-3	Channahatchee Ck	Channahatchee Cr	Deepest point, main creek channel, Channahatchee Creek embayment, approx. 0.5 miles upstream of lake confluence.		32.6432	-85.8969

*Growing season mean chl *a* criteria implemented at this station in 2002.

RESULTS

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figs. 2 & 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figs. 4-8, 11). 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 Figs. 9 & 10. Summary statistics of all data collected during 2010 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 2010, the highest mean growing season TN value was calculated for the Sougahatchee Ck station (Fig 2). Both the lower Yates and Thurlow stations saw a slight increase in growing season mean TN from 2008. Mean values in Sougahatchee Ck have increased since 2004, whereas the other three stations have remained relatively stable in concentration since 2000. The April and October monthly TN concentrations at lower Thurlow were the lowest of the season (Fig 4). While monthly concentrations were at or above historic means in Sougahatchee Ck, monthly TN concentrations were generally lower at the lower Yates station, below historic means four of seven months (Fig 4).

In 2010, the highest mean growing season TP value was calculated for the Sougahatchee Ck station (Fig 2). Growing season mean TP concentrations at both lower Yates and Thurlow were the lowest ever calculated (Fig 2). Both stations show a decreasing trend in mean values since 2002. All monthly TP values at lower Yates and Thurlow were below historic means each month sampled (Fig 5). The Sougahatchee Ck station had a record high value recorded in June.

In 2010, the highest mean growing season chl *a* value was calculated for the Sougahatchee Ck station (Fig 3). Mean concentrations at the other three stations were similar in

both reservoirs. Both lower Yates and Thurlow station values were below established criteria for chl *a*. Monthly chl *a* values were highest ever recorded at the Sougahatchee Ck and lower Yates station in July, and in July-October at the Thurlow lower station (Fig 6).

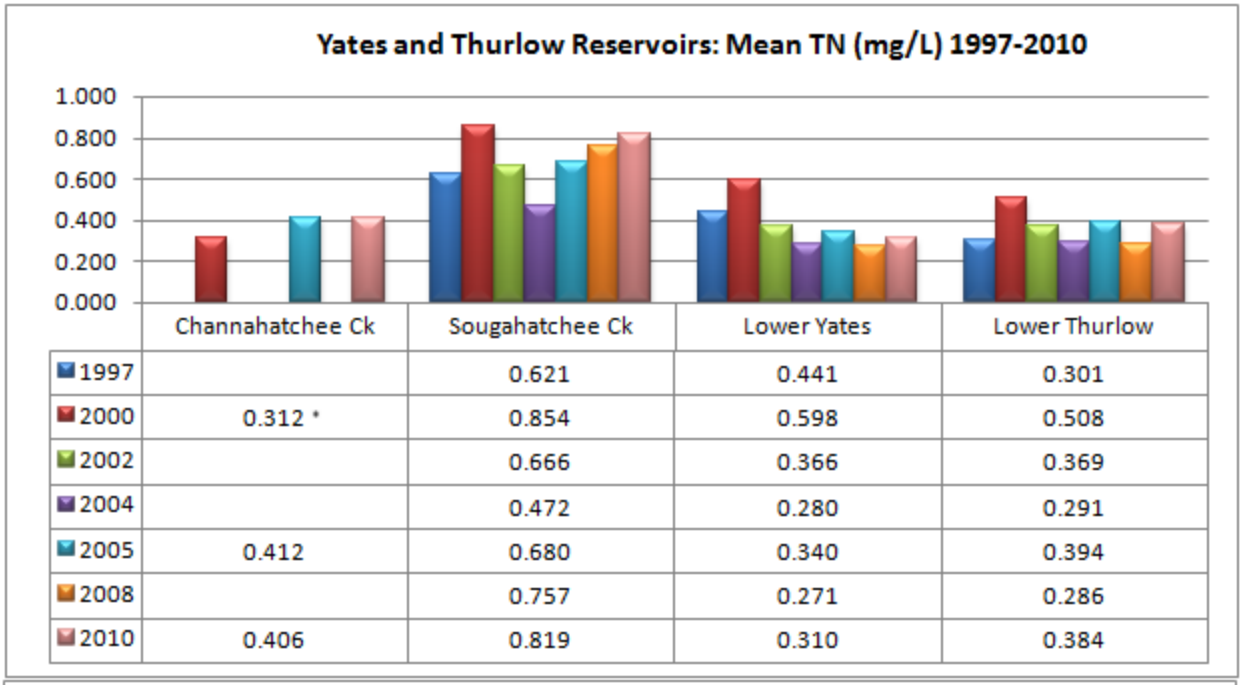
In 2010, the highest mean growing season TSS value was calculated for the Sougahatchee Ck station, the highest recorded at this station since 2000 (Fig 3). The growing season mean TSS values at the Channahatchee Ck and lower Yates and Thurlow stations, were the lowest values ever calculated at these stations (Fig 3). All monthly TSS concentrations were near or below historic mean values at the lower Yates and Thurlow stations, contrasting Sougahatchee Ck, which observed the highest value recorded for the month of August and above average values in June, July, and October (Fig 7).

AGPT results for the Channahatchee Ck, lower Yates, and lower Thurlow stations indicate it was phosphorus limited in all years monitored (Table 2). Due to resource constraints, AGPT samples were not collected at lower Yates station in August. The Sougahatchee Ck station was nitrogen limited in 1997 and 2000 and phosphorus limited in 2010. AGPT results from August 2010 indicate the Sougahatchee Ck exceeded 5mg/L, the value the Raschke et al. (1996) defined as protective of reservoir and lake systems.

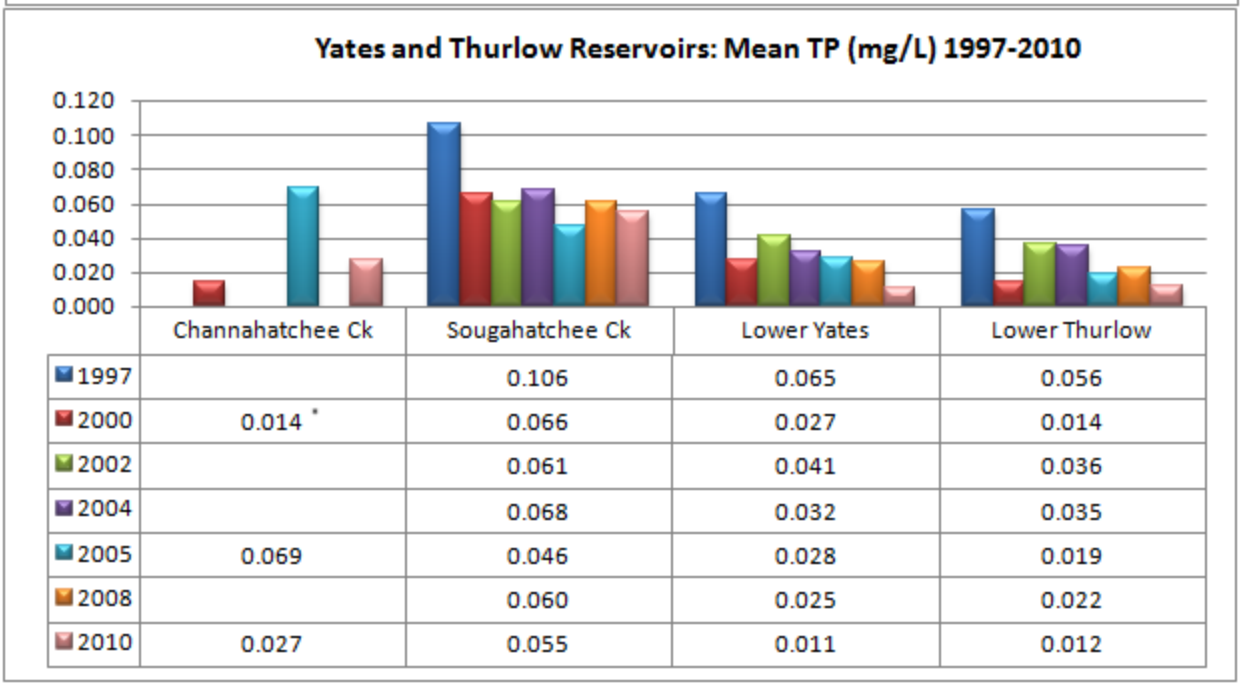
Sougahatchee Ck was below the DO criteria in August and September limit of 5.0 mg/L at 5.0 ft (1.5 m) (Fig 8) (ADEM Admin. Code R. 335-6-10-.09). DO concentrations at Channahatchee Ck were below the criteria in June, July, and August. All measurements of DO concentrations in both lower Yates and Thurlow stations met the ADEM criteria. Lower Yates and Thurlow stations were thermally stratified June-September (Figs 9 & 10).

Monthly TSI values were calculated using monthly chl *a* values and Carlson's Trophic State Index. Channahatchee Ck showed the largest variation of TSI starting oligotrophic in April and May, then climbing to eutrophic in July, August, and September (Fig 11). Sougahatchee Ck increased from oligotrophic conditions in April to highly eutrophic July-October. Lower Yates station was mesotrophic all sampling season with lower Thurlow station initially oligotrophic and increasing to eutrophic levels.

Figure 2. Mean growing season total nitrogen and total phosphurous of all stations in Yates and Thurlow Reservoirs, April-October 1997-2010**.** Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.



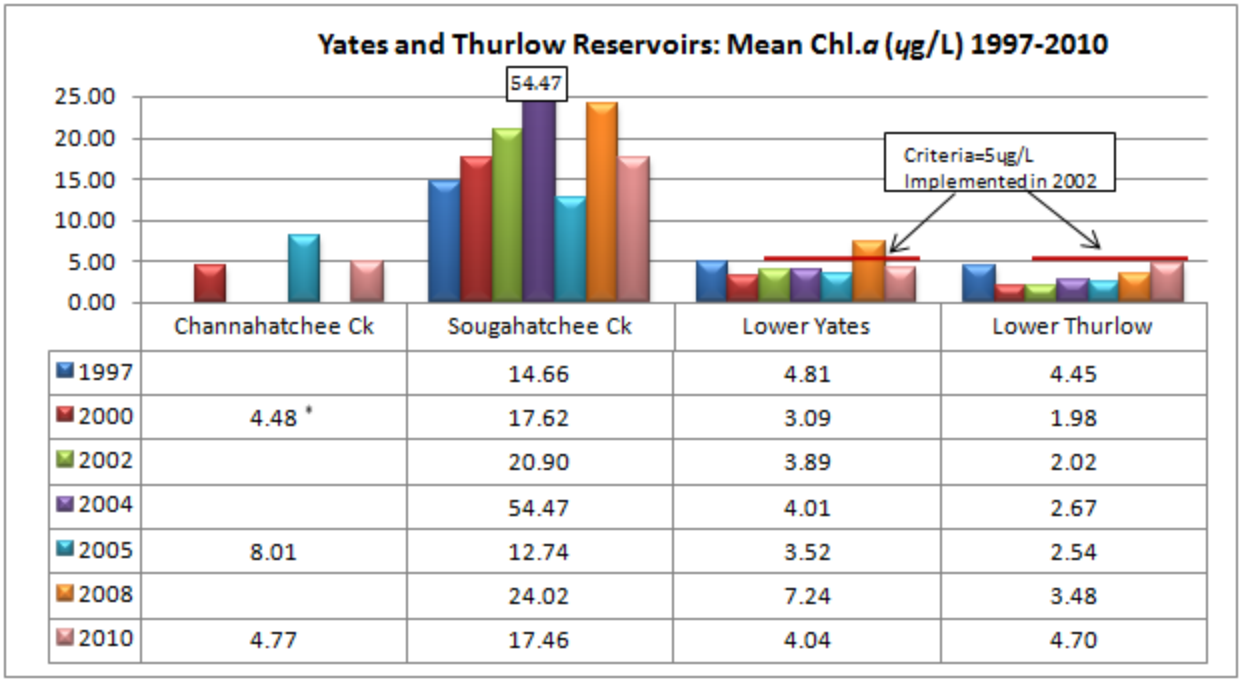
	Channahatchee Ck	Sougahatchee Ck	Lower Yates	Lower Thurlow
1997		0.621	0.441	0.301
2000	0.312 *	0.854	0.598	0.508
2002		0.666	0.366	0.369
2004		0.472	0.280	0.291
2005	0.412	0.680	0.340	0.394
2008		0.757	0.271	0.286
2010	0.406	0.819	0.310	0.384



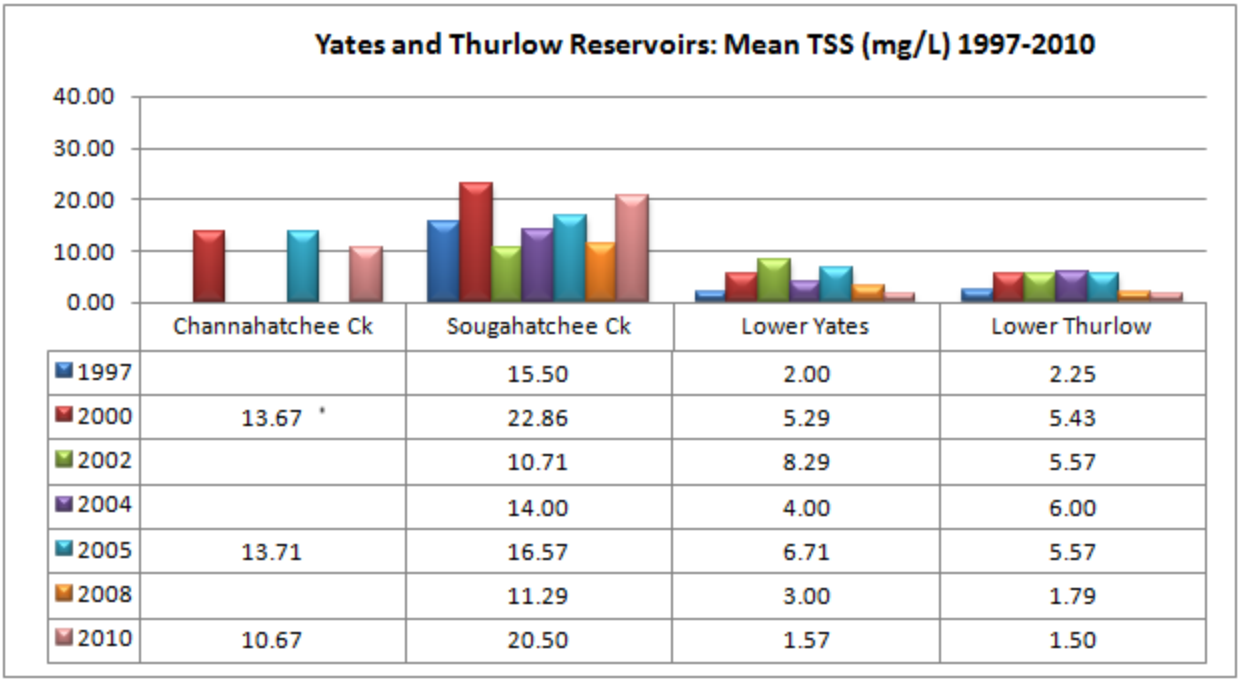
	Channahatchee Ck	Sougahatchee Ck	Lower Yates	Lower Thurlow
1997		0.106	0.065	0.056
2000	0.014 *	0.066	0.027	0.014
2002		0.061	0.041	0.036
2004		0.068	0.032	0.035
2005	0.069	0.046	0.028	0.019
2008		0.060	0.025	0.022
2010	0.027	0.055	0.011	0.012

*Mean of April/June/August only.

Figure 3. Mean growing season chlorophyll *a* and total suspended solids in all stations in Yates and Thurlow Reservoirs, April-October 1997-2010. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.



	Channahatchee Ck	Sougahatchee Ck	Lower Yates	Lower Thurlow
1997		14.66	4.81	4.45
2000	4.48 *	17.62	3.09	1.98
2002		20.90	3.89	2.02
2004		54.47	4.01	2.67
2005	8.01	12.74	3.52	2.54
2008		24.02	7.24	3.48
2010	4.77	17.46	4.04	4.70



	Channahatchee Ck	Sougahatchee Ck	Lower Yates	Lower Thurlow
1997		15.50	2.00	2.25
2000	13.67 *	22.86	5.29	5.43
2002		10.71	8.29	5.57
2004		14.00	4.00	6.00
2005	13.71	16.57	6.71	5.57
2008		11.29	3.00	1.79
2010	10.67	20.50	1.57	1.50

*Mean of April/June/August only.

Figure 4. Monthly TN concentrations measured in Yates and Thurlow Reservoirs, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Yates Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1994-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

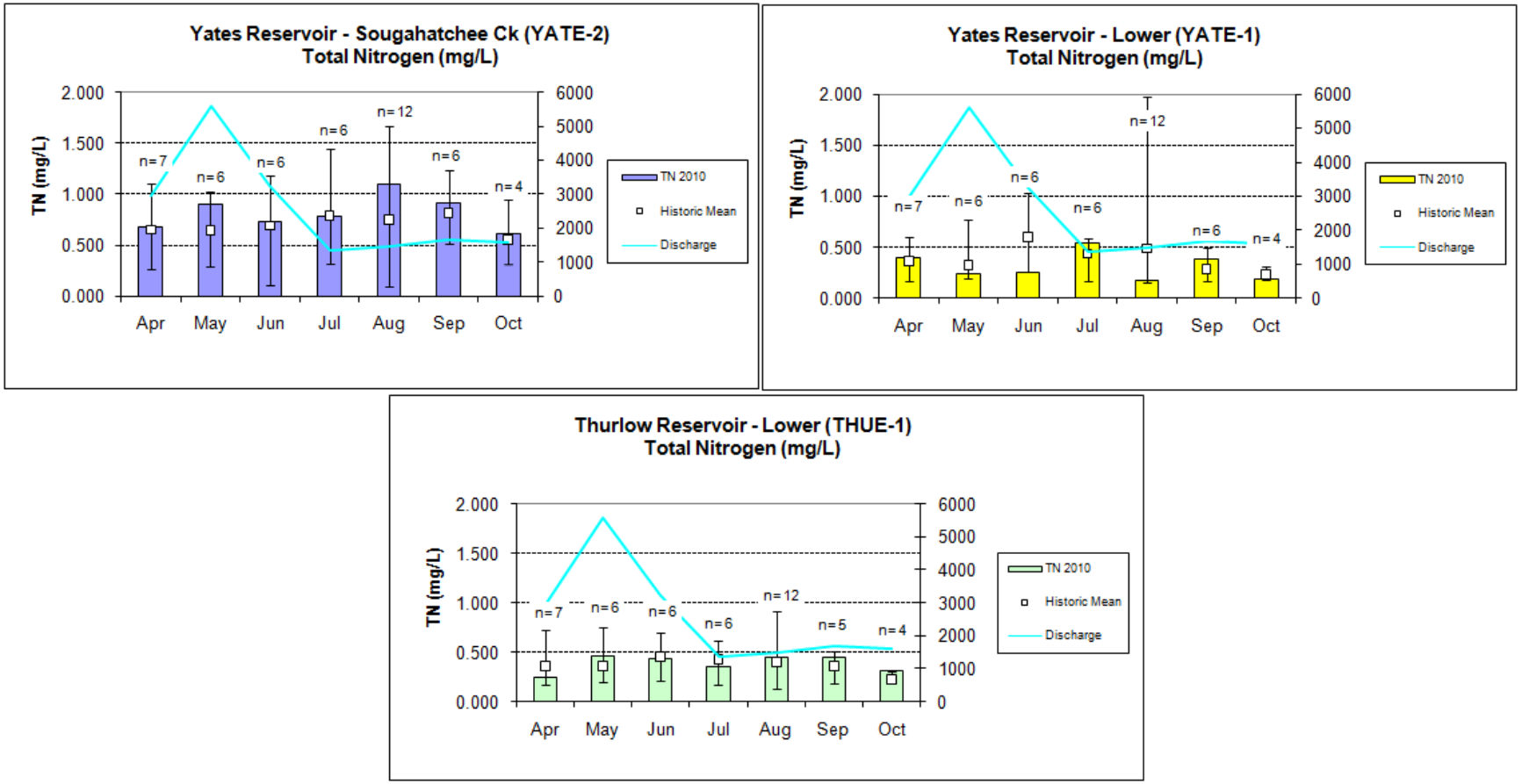


Figure 5. Monthly TP concentrations measured in Yates and Thurlow Reservoirs, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Yates Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1994-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

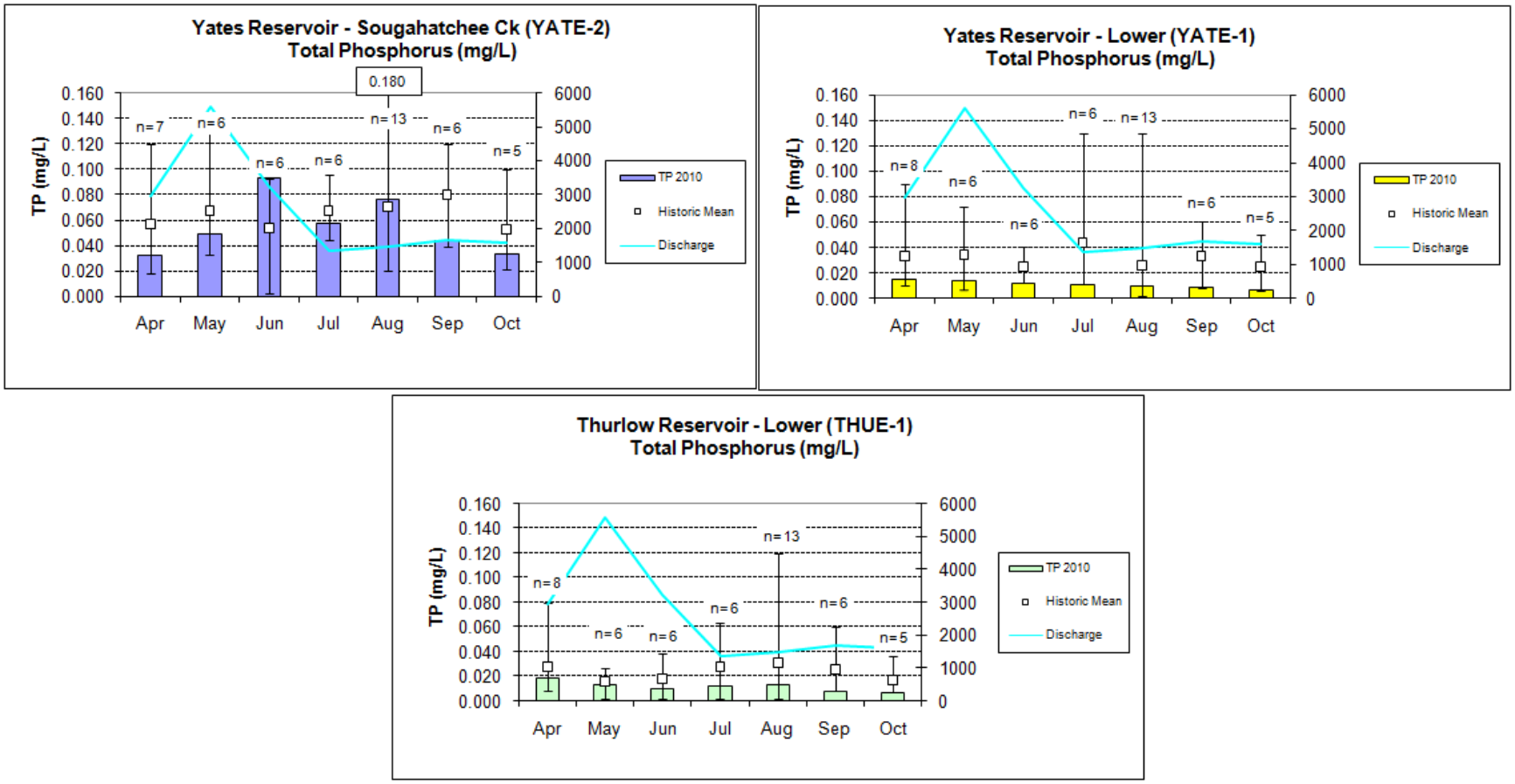


Figure 6. Monthly chl *a* concentrations measured in Yates and Thurlow Reservoirs, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Yates Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1994-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. Note the scale in the Sougahatchee station graph is different to better interpret the data.

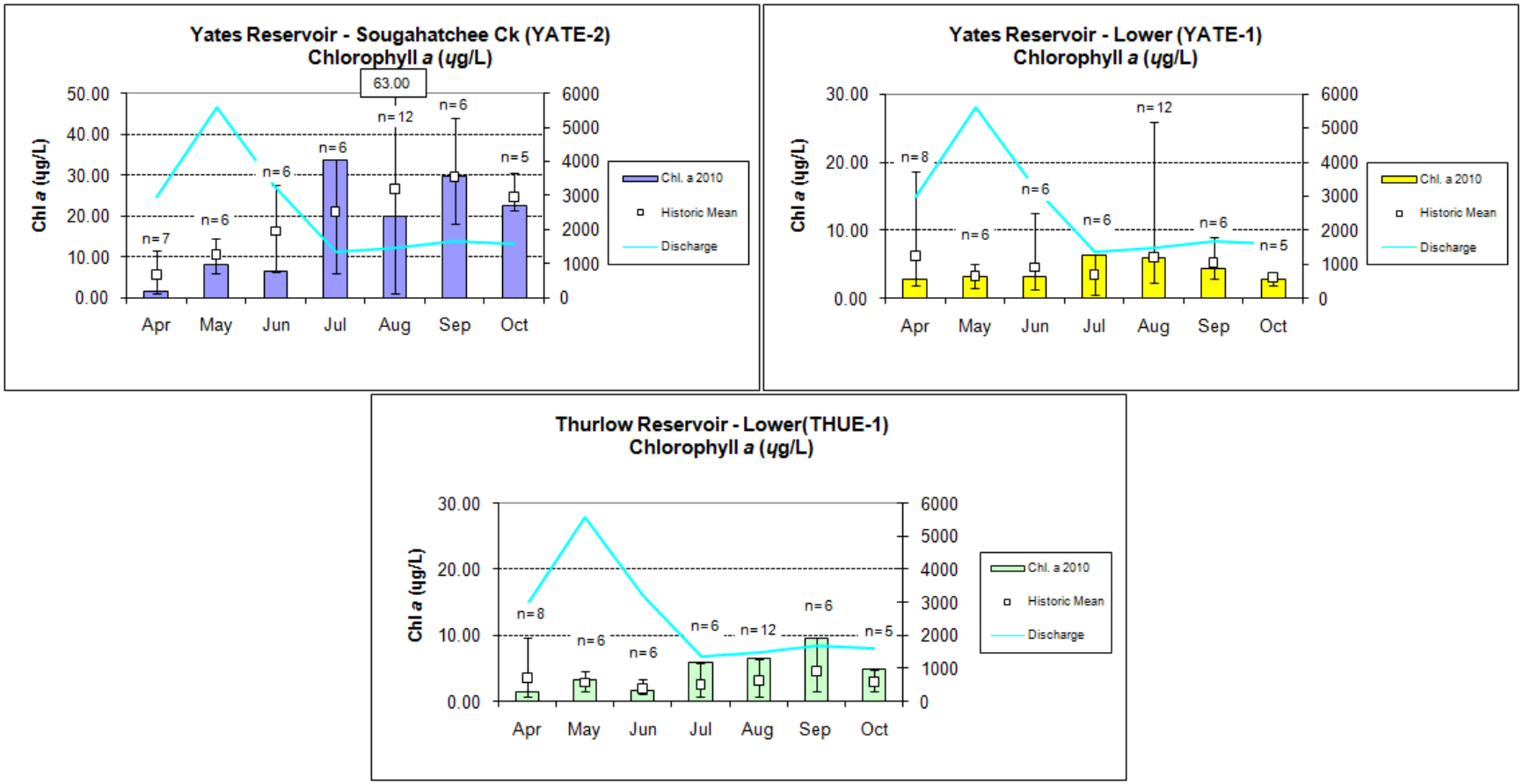


Figure 7. Monthly TSS concentrations measured in Yates and Thurlow Reservoirs, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Yates Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1994-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. Note the scale in the Sougahatchee station graph is different to better interpret the data.

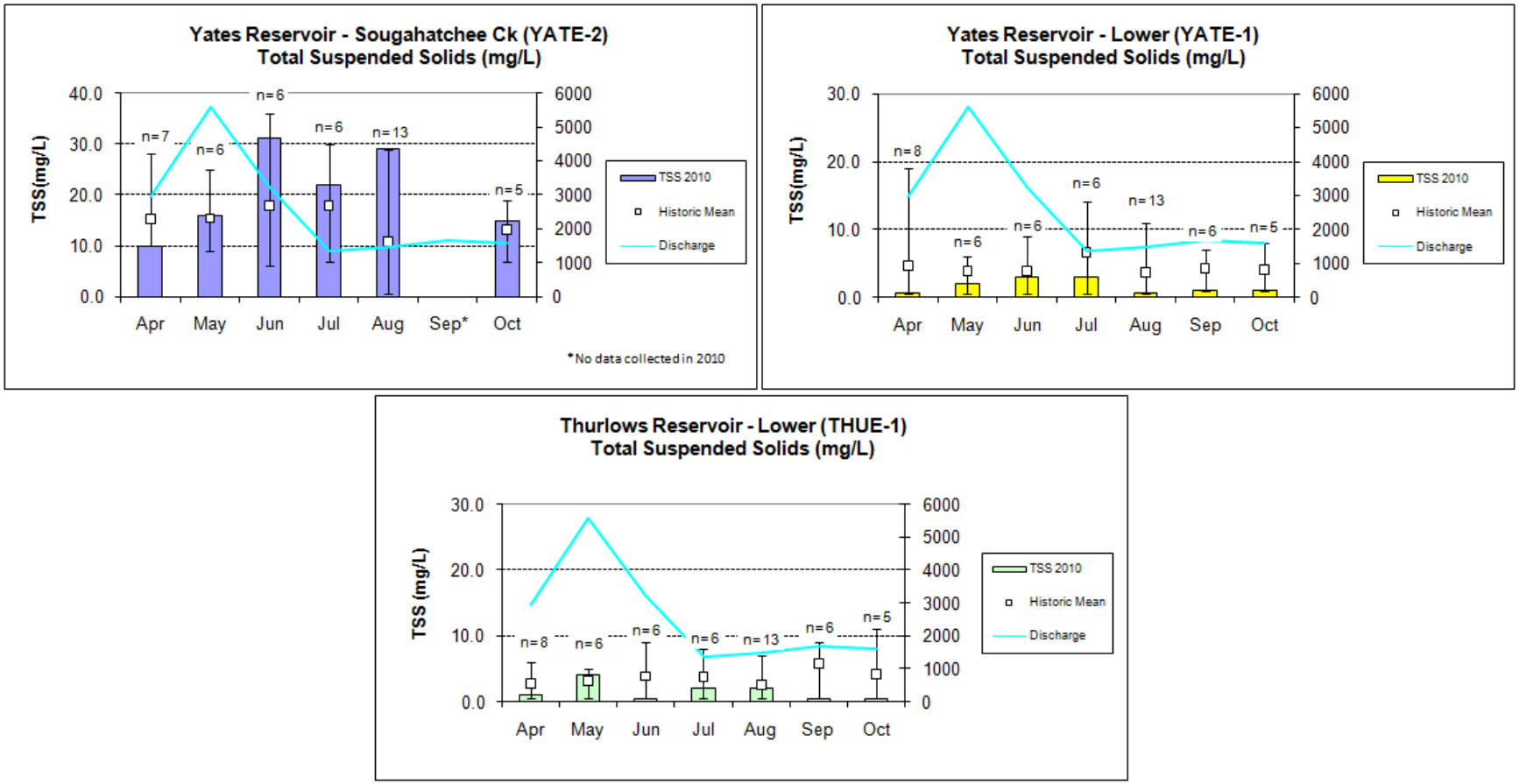


Table 2. Algal growth potential test results, Yates and Thurlow Reservoirs, (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in (mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz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

Station	Channahatchee Ck (YATE-3)		Sougahatchee Ck (YATE-2)		Lower Yates (YATE-1)	
	Control mean MSC	Limiting Nutrient	Control mean MSC	Limiting Nutrient	Control mean MSC	Limiting Nutrient
Aug-1997	---	---	36.92	NITROGEN	1.29	PHOSPHORUS
2000	---	---	7.14	NITROGEN	2.52	PHOSPHORUS
Aug-2005	---	---	---	---	3.35	PHOSPHORUS
2010	3.22	PHOSPHORUS	9.32	PHOSPHORUS	---	---

Station	Lower Thurlow (THUE-1)	
	Control mean MSC	Limiting Nutrient
1997	1.39	PHOSPHORUS
2000	2.53	PHOSPHORUS
2005	4.60	PHOSPHORUS
2010	1.52	PHOSPHORUS

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Yates and Thurlow Reservoirs stations collected April-October 2010. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2010).

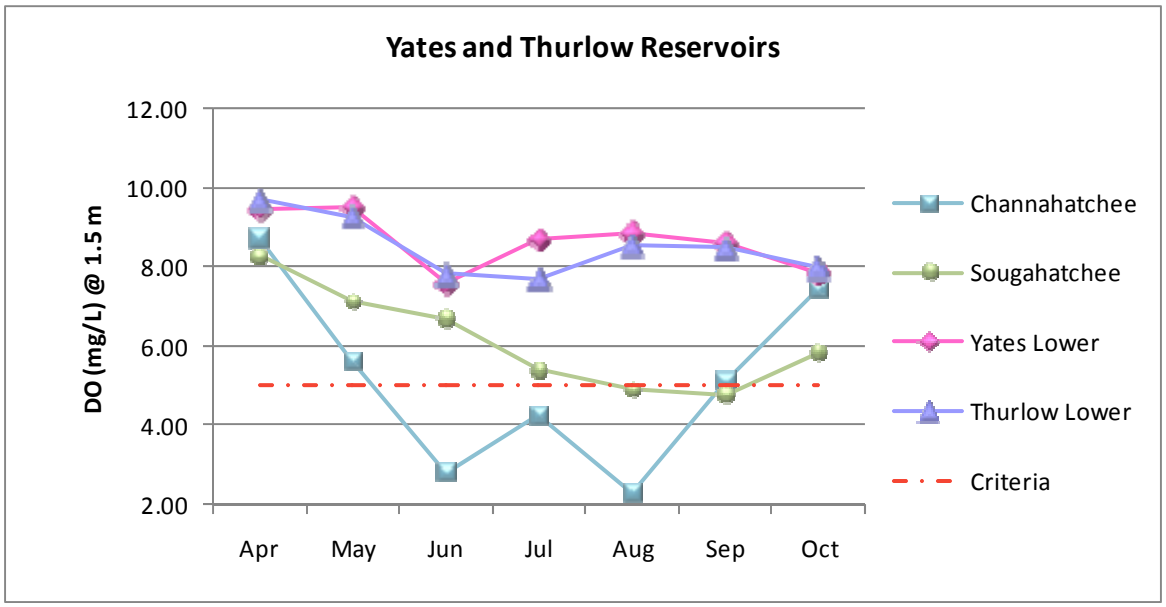


Figure 9. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the lower Yates Reservoir station, April-October 2010.

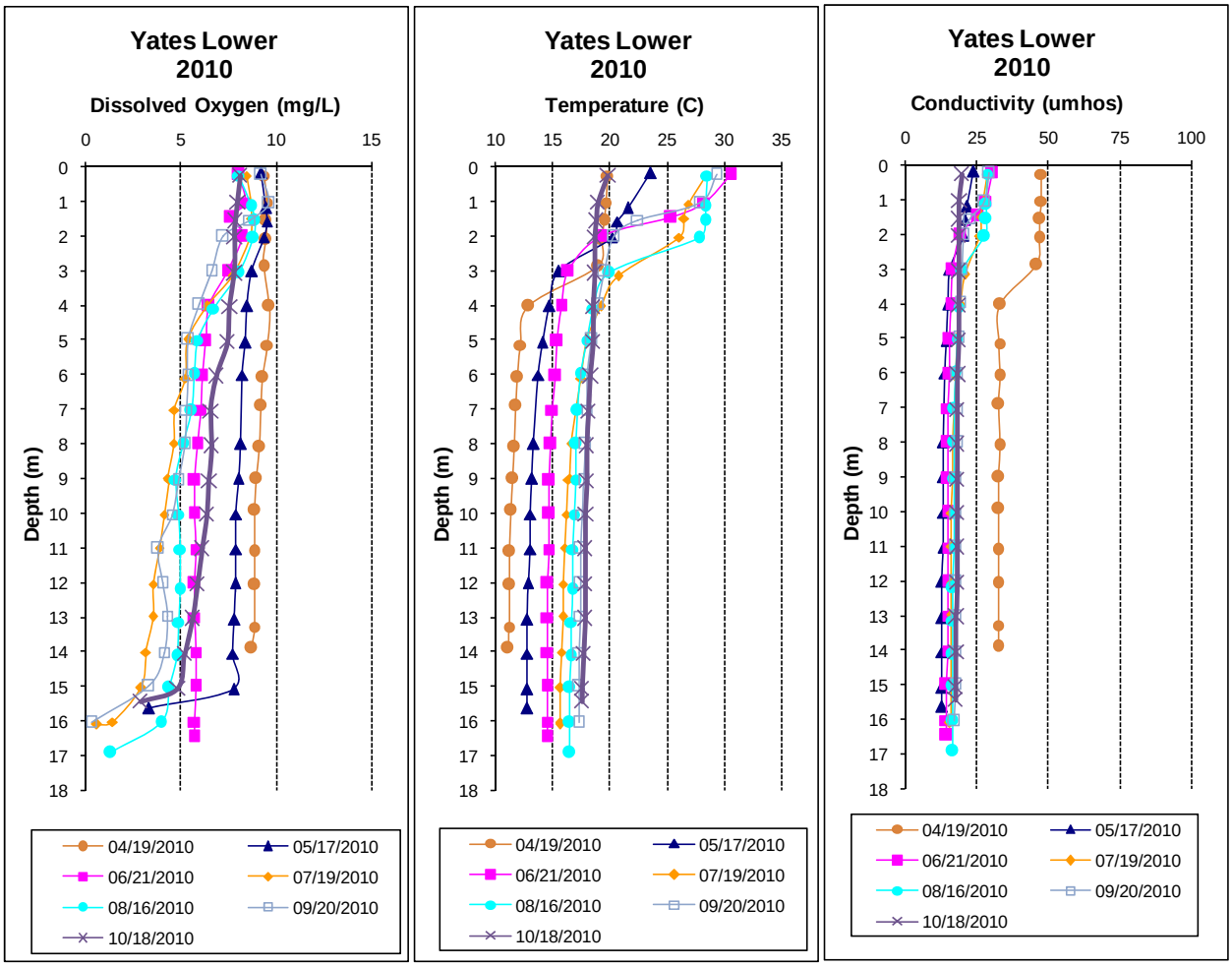


Figure 10. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the lower Thurlow Reservoir station, April-October 2010.

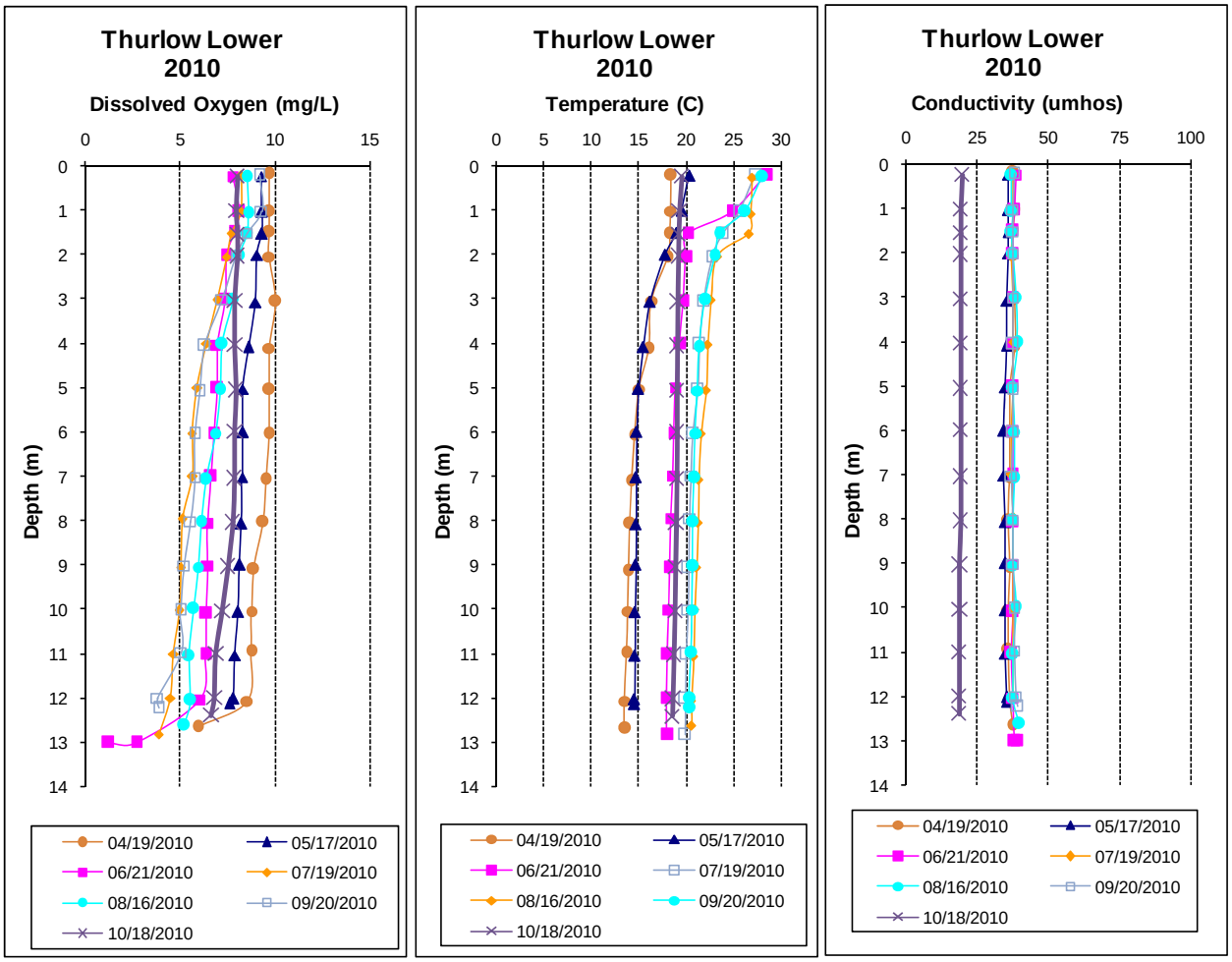
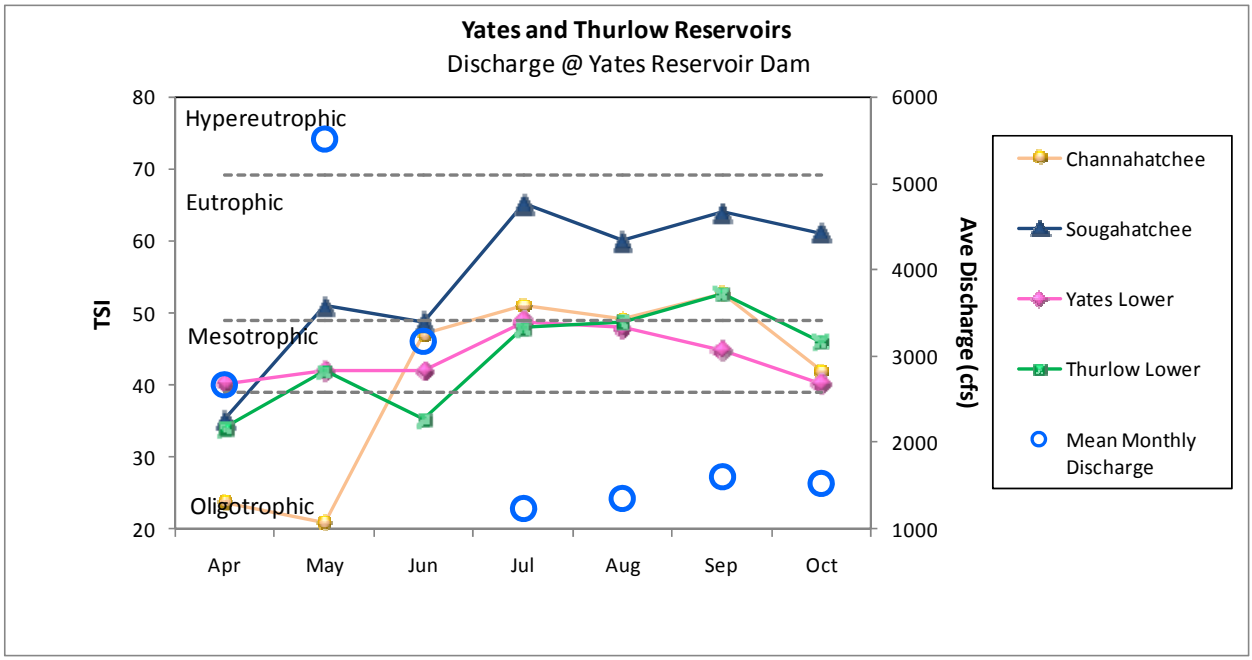


Figure 11. Monthly TSI values calculated for mainstem and tributary Yates and Thurlow Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from Alabama Power at Yates Dam.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2010. Minimum (Min) and maximum (Max) values calculated using minimum detection limits (MDL) when results were less than this value. Median (Med), average (Ave), and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Med	Avg	SD
THUE-1	**Physical**						
	Turbidity (NTU)	7	2.6	6.6	5.2	5.0	1.4
	Total Dissolved Solids (mg/L) [J]	7	22.0	42.0	36.0	34.6	7.2
	Total Suspended Solids (mg/L) [J]	7	< 1.0	4.0	1.0	1.5	1.3
	Hardness (mg/L)	4	8.5	10.6	9.7	9.6	0.9
	Alkalinity (mg/L)	7	9.4	20.6	11.3	13.0	4.0
	Photic Zone (m)	7	3.67	5.56	4.60	4.63	0.62
	Secchi (m)	7	1.41	2.43	2.00	2.02	0.34
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.117	0.220	0.175	0.173	0.040
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.325	0.208	0.212	0.098
	Total Nitrogen (mg/L)	7	< 0.245	0.462	0.428	0.384	0.084
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.005	0.014	0.010	0.009	0.004
	Total Phosphorus (mg/L) [J]	7	0.007	0.018	0.012	0.012	0.004
	CBOD-5 (mg/L) [J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.0	2.1	2.1	2.1	0.1
	Biological						
	Chlorophyll a (ug/L)	7	1.42	9.61	4.81	4.70	2.92
	E. coli (mpn/100mL) [J]	3	2	4	3	3	1
YATE-1	**Physical**						
	Turbidity (NTU)	7	2.8	7.0	6.4	5.6	1.7
	Total Dissolved Solids (mg/L)	7	28.0	42.0	36.0	36.3	5.1
	Total Suspended Solids (mg/L)	7	< 1.0	3.0	1.0	1.6	1.1
	Hardness (mg/L)	4	10.5	11.3	10.7	10.8	0.4
	Alkalinity (mg/L)	7	11.0	15.9	13.1	13.3	2.0
	Photic Zone (m)	7	4.25	7.41	5.00	5.12	1.06
	Secchi (m)	7	1.42	2.28	1.86	1.85	0.34
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.126	0.214	0.151	0.166	0.035
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.393	0.040	0.143	0.141
	Total Nitrogen (mg/L)	7	< 0.166	0.544	0.254	0.310	0.137
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.005	0.014	0.011	0.009	0.003
	Total Phosphorus (mg/L) [J]	7	0.006	0.015	0.011	0.011	0.003
	CBOD-5 (mg/L) [J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.0	2.3	2.1	2.2	0.1
	Biological						
	Chlorophyll a (ug/L)	7	2.67	6.41	3.20	4.04	1.54
	E. coli (mpn/100mL) [J]	3	< 1	1	1	1	0

Station	Parameter	N	Min	Max	Med	Avg	SD
YATE-2	**Physical**						
	Turbidity (NTU)	7	17.0	85.1	22.0	33.8	23.9
	Total Dissolved Solids (mg/L)	7	54.0	76.0	64.0	64.6	9.1
	Total Suspended Solids (mg/L)	6	10.0	31.0	19.0	20.5	8.3
	Hardness (mg/L)	4	20.0	24.7	22.6	22.5	2.3
	Alkalinity (mg/L)	7	27.2	38.1	32.2	32.2	4.7
	Photic Zone (m)	7	0.75	2.22	1.33	1.43	0.55
	Secchi (m)	7	0.28	0.93	0.59	0.57	0.20
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.091	0.010	0.022	0.030
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.020	0.525	0.360	0.322	0.181
	Total Kjeldahl Nitrogen (mg/L)	7	0.286	0.896	0.391	0.497	0.206
	Total Nitrogen (mg/L)	7	0.619	1.097	0.788	0.819	0.163
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.004	0.022	0.017	0.015	0.007
	Total Phosphorus (mg/L)	7	0.032	0.093	0.049	0.055	0.023
	CBOD-5 (mg/L) [J]	7	< 2.0	3.8	1.0	1.4	1.0
	Chlorides (mg/L)	7	3.1	7.4	5.6	5.1	1.6
	Biological						
	Chlorophyll a (ug/L)	7	1.60	33.82	20.03	17.46	12.36
	E. coli (mpn/100mL) [J]	3	2	46	12	20	23
YATE-3	**Physical**						
	Turbidity (NTU)	7	9.0	64.4	15.9	27.4	22.7
	Total Dissolved Solids (mg/L)	7	28.0	80.0	48.0	50.9	21.1
	Total Suspended Solids (mg/L)	6	6.0	21.0	9.0	10.7	5.5
	Hardness (mg/L)	4	9.2	13.4	10.5	10.9	1.8
	Alkalinity (mg/L)	7	11.2	25.7	16.7	18.3	5.8
	Photic Zone (m)	7	0.96	3.40	1.87	1.95	0.83
	Secchi (m)	7	0.34	1.44	0.87	0.83	0.39
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.175	0.010	0.047	0.060
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.029	0.099	0.050	0.059	0.024
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.610	0.369	0.347	0.176
	Total Nitrogen (mg/L)	7	< 0.085	0.639	0.430	0.406	0.172
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.005	0.024	0.017	0.015	0.006
	Total Phosphorus (mg/L)	7	0.012	0.040	0.026	0.027	0.010
	CBOD-5 (mg/L) [J]	7	< 2.0	2.5	1.0	1.4	0.6
	Chlorides (mg/L)	7	1.9	2.4	2.3	2.2	0.2
	Biological						
	Chlorophyll a (ug/L)	7	< 0.10	9.61	5.34	4.77	3.67
	E. coli (mpn/100mL) [J]	3	3	53	8	21	28

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