2005 Yates and Thurlow Reservoirs Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicator's Section
Aquatic Assessment Unit
May 2011

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INTRODUCTION

Established in 1928 with the completion of Yates Dam, Yates Reservoir contains approximately 1980 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 2005 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) intensively monitored Yates and Thurlow Reservoirs as part of the 2005 assessment of the Alabama, Coosa, and Tallapoosa (ACT) 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 condition, 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 2005 monitoring strategy.

Specific water quality criteria for nutrient monitoring were implemented in 2002 at the lower Yates and Thurlow locations, which have been monitored by ADEM since the late 1980's. 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 2005 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chl *a*; algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's existing data and established criteria.

METHODS

Specific location information can be found in Table 1, with a station map provided in Figure 1. The mainstems of 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. For mainstem stations, monthly concentrations of these parameters were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2005 results. 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 2003b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Mean growing season data were compared with similar data from the 2000 *Intensive Water Quality Survey of Coosa, Tallapoosa, and Alabama River Reservoirs* report. Although Sougahatchee was sampled monthly Apr-Oct in 2000, the Sougahatchee mean growing season concentrations in the 2000 report were based on Apr, Jun, and Aug data to compare these data to data collected from the other Tallapoosa River embayments, which were only sampled during these three months. Comparisons in this report are based on 2000 and 2005 Sougahatchee mean growing season concentrations calculated using the monthly Apr-Oct data.

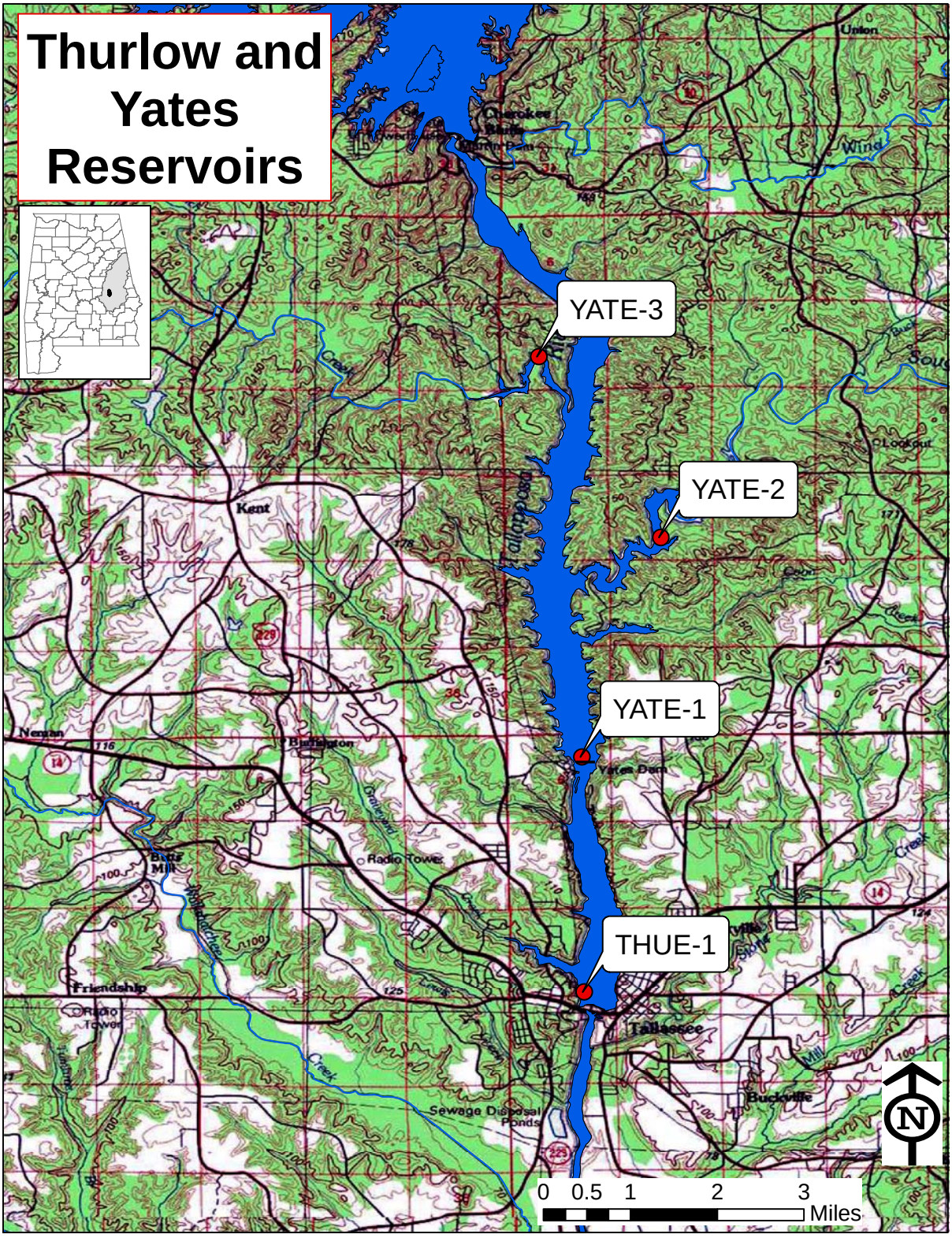


Figure 1. Yates and Thurlow Reservoirs with 2005 sampling locations A description of each sampling location is provided in Table 1.

Table 1. Descriptions of the 2005 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	Tallapoosa R	Lower reservoir. Deepest point, main river channel, dam forebay .	5 μg/L	32.5376	-85.8893
031501100406	Tallapoosa	YATE-1*	Lower	Tallapoosa R	Lower reservoir. Deepest point, main river channel, dam forebay.	5 μg/L	32.5766	-85.8896
031501100104	Tallapoosa	YATE-2	Sougahatchee	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	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

Summary statistics of the 2005 data are presented in Appendix Table 1. The table contains the min, max, median, average, and standard deviation of each parameter analyzed. Seasonal mean concentrations of TN, TP, chl *a*, and TSS are presented in Fig. 2.

Comparison of the 2000 and 2005 seasonal mean TN concentration showed values at the Sougahatchee (0.85 mg/L in 2000) and the lower Yates and Thurlow stations, to be lower in 2005 (Fig. 2, ADEM 2003a). Mean TN at Channahatchee was half the concentration of Sougahatchee, similar to the lower Yates station (Fig. 2). Monthly TN concentration in Sougahatchee increased and decreased every other month though concentrations usually fell within the historic range (Fig. 3). Monthly TN concentrations at the lower Yates and lower Thurlow stations were below the historic mean concentration with the exception of lower Thurlow in June, when the highest recorded concentration at this station was measured (Fig. 4 & 5).

The growing season mean TP concentration decreased at the Sougahatchee station from 0.066 mg/L in 2000 to 0.046 mg/L in 2005 (Fig. 2). Mean concentrations at the lower Yates and lower Thurlow stations were similar to those in 2000 (Fig. 2, ADEM 2003a). The highest mean TP of any station in Yates and Thurlow was found in Channahatchee (Fig. 2). Monthly TP concentrations were variable from month to month but were below historic means for all stations, Apr and Jul-Oct (Fig. 3, 4 & 5). Lowest monthly TP concentration on Sougahatchee was measured in Apr while it occurred in August for lower Yates and Thurlow (Fig. 3, 4 & 5).

Growing season mean chl *a* concentrations were similar to results in 2000 at both the Yates and Thurlow lower stations (Fig. 2, ADEM 2003a). The Sougahatchee station growing season mean chl *a* concentration dropped from 17.6 μg/L in 2000 to 12.7μg/L in 2005 (Fig. 2). Though the mean chl *a* concentration in Channahatchee was less than Sougahatchee, it was over two times higher than the lower Yates station (Fig. 2). The monthly concentrations were generally lower than historic means in Sougahatchee with the lowest concentrations in Apr and July, when discharge was greatest (Fig. 3). Monthly chl *a* concentrations were similar across the growing season for the lower stations of both Yates and Thurlow (Fig. 4 & 5). The 2005 chl *a*

growing season mean was below the 5 μg/L criteria implemented in 2002 at both the lower Yates and lower Thurlow stations (Fig. 6).

The mean TSS concentration at both embayment stations were around two times higher than the lower Yates station (Fig. 2). However, the growing season mean TSS concentrations did decrease at the Sougahatchee station from the 2000 mean (22.9 mg/L). Monthly TSS concentrations were the highest in July at both the lower Yates and Sougahatchee stations, when discharge was greatest (Fig. 3 & 4) while monthly TSS concentrations at lower Thurlow varied less throughout the season and were largely unaffected by discharge fluctuations (Fig. 5).

AGPT results indicated both reservoirs were phosphorus limited, similar to the 2000 results (Table 2). Mean standing crop (MCS) values for both stations were below 5mg/L, which is considered protective in reservoir and lakes (Raschke and Schultz 1987). Values were higher than those from the 2000 sampling season.

Profiles of dissolved oxygen concentrations in both lower Yates and Sougahatchee show a majority of the water column to be at or below 5.0 mg/L in Jun, Aug, and Sep (Fig 7). Thurlow profiles were generally well-mixed and oxygenated to the bottom (Fig. 7). Warmest water temperatures were reached in August and September (Fig. 7). Dissolved oxygen concentrations met the ADEM Water Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at a depth of 5 ft (1.5 m) for both mainstem reservoir stations (Fig. 8). Sougahatchee and Channahatchee were at or below the ADEM criteria from Aug-Sep and May-Sept, respectively (Fig. 8).

Monthly TSI values were calculated using chl *a* and Carlson's Trophic State Index. The lower Yates station was mostly mesotrophic while the tributary stations were more variable (Fig. 9). Channahatchee began the season oligotrophic and rose to eutrophic status by August (Fig. 9). Sougahatchee, on the other hand, fluctuated between borderline mesotrophic and eutrophic conditions all season (Fig. 9). With the exception of 1998, TSI values in August over the past 20 years indicate stable, mostly borderline oligotrophic to mesotrophic conditions for the lower Yates and Thurlow stations while Sougahatchee was more variable, with most values within the eutrophic range (Fig. 10).

Figure 2. Mean total nitrogen (TN), mean total phosphorus (TP), mean chlorophyll *a* (chl *a*), and mean total suspended solids (TSS) of all stations in Yates and Thurlow Reservoirs, April-October 2005. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right. The Yates mainstem station is shown in blue, the Yates tributary stations are in green and the Thurlow mainstem station is in purple.

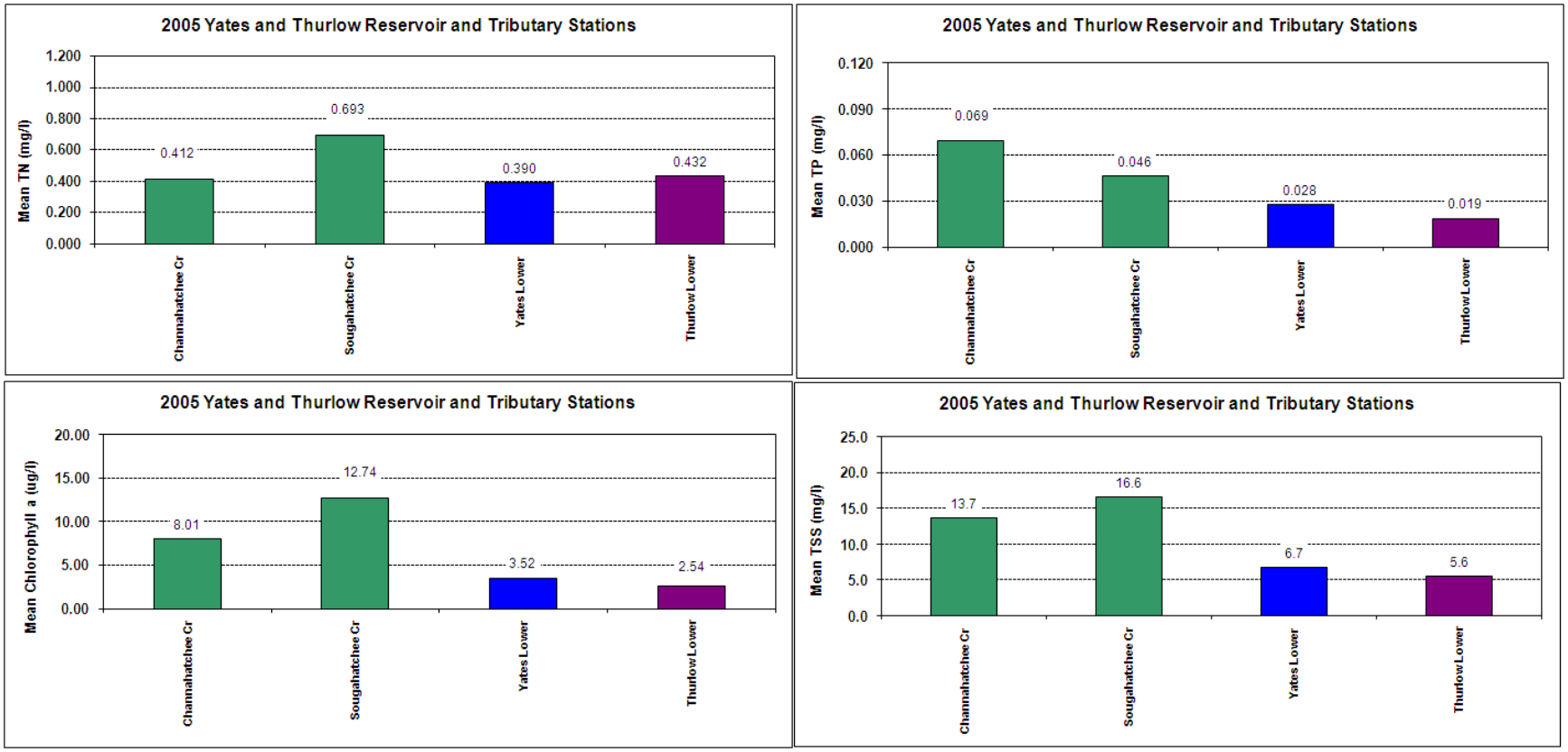


Figure 3. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the Sougahatchee Creek embayment station in Yates Reservoir, April-October 2005. Monthly bar graphs for the Sougahatchee station depict the monthly changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Gauge 02418230 Sougahatchee Ck discharge). The scale on this chl *a* graph is different than the other mainstem stations due to the larger range of historic values.

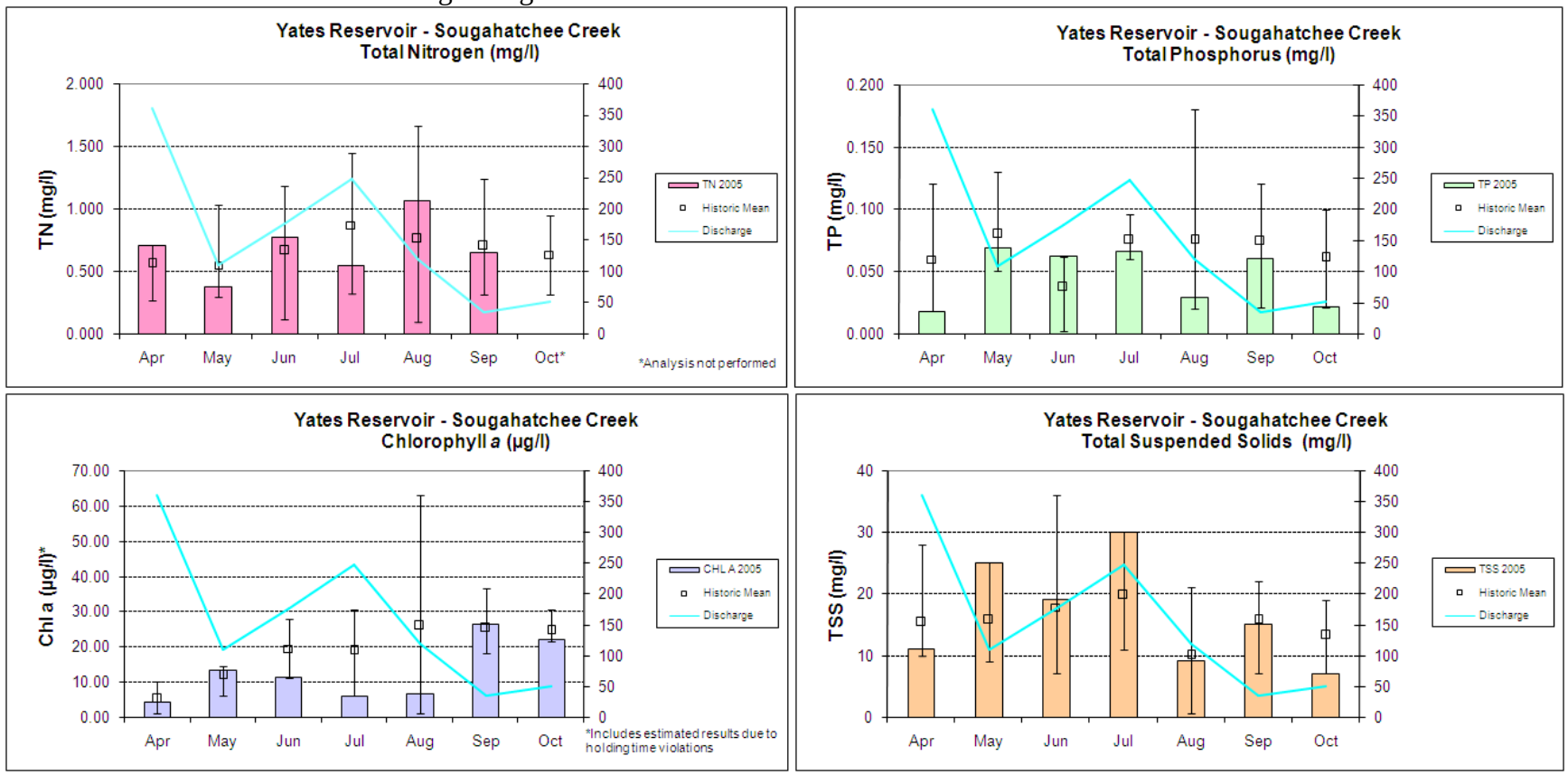


Figure 4. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the lower station in Yates Reservoir, April-October 2005. Monthly bar graphs for the lower Yates station depict the monthly changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).

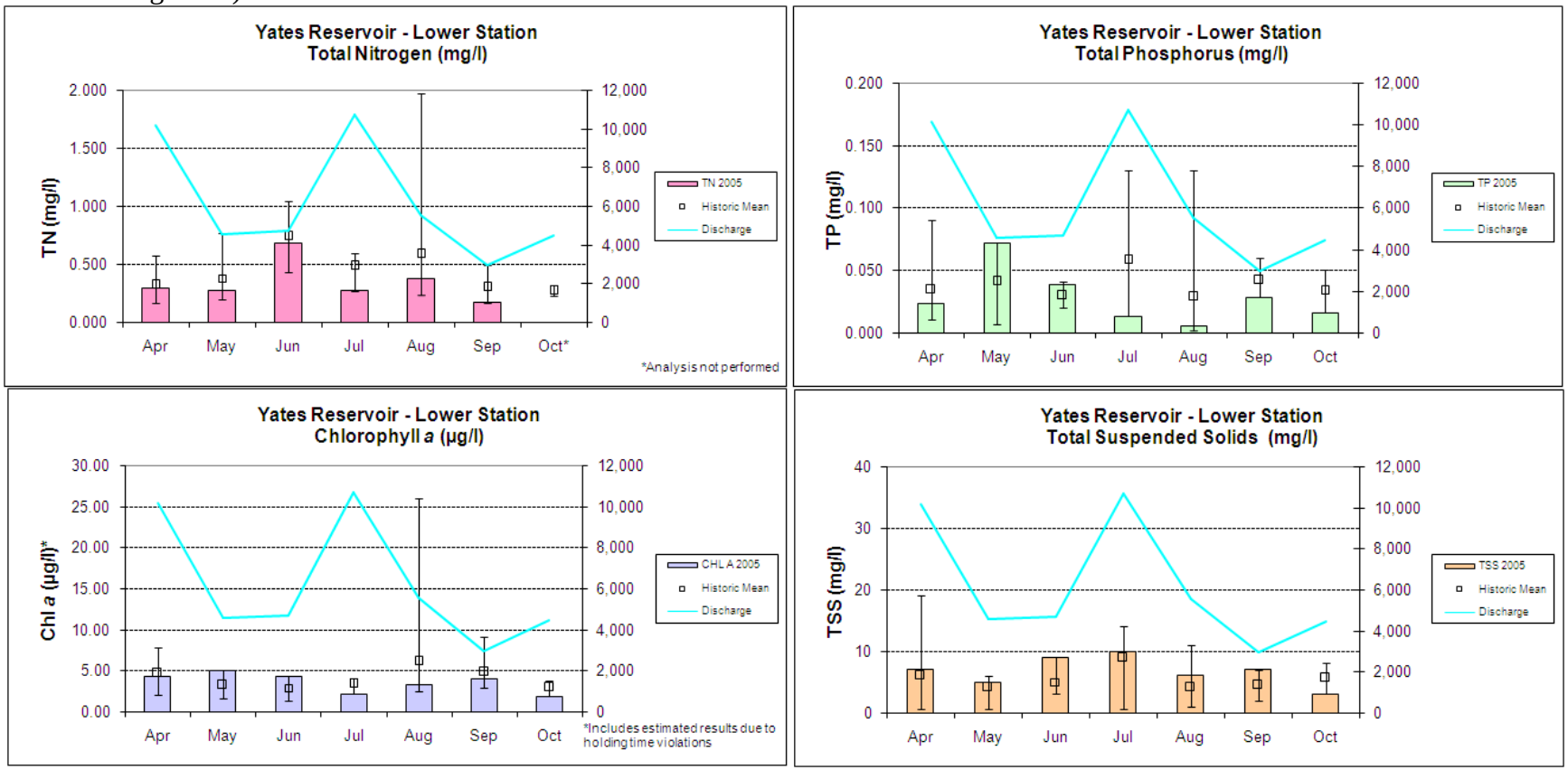


Figure 5. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the lower station in Thurlow Reservoir, April-October 2005. Monthly bar graphs for the lower Thurlow station depict the monthly changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).

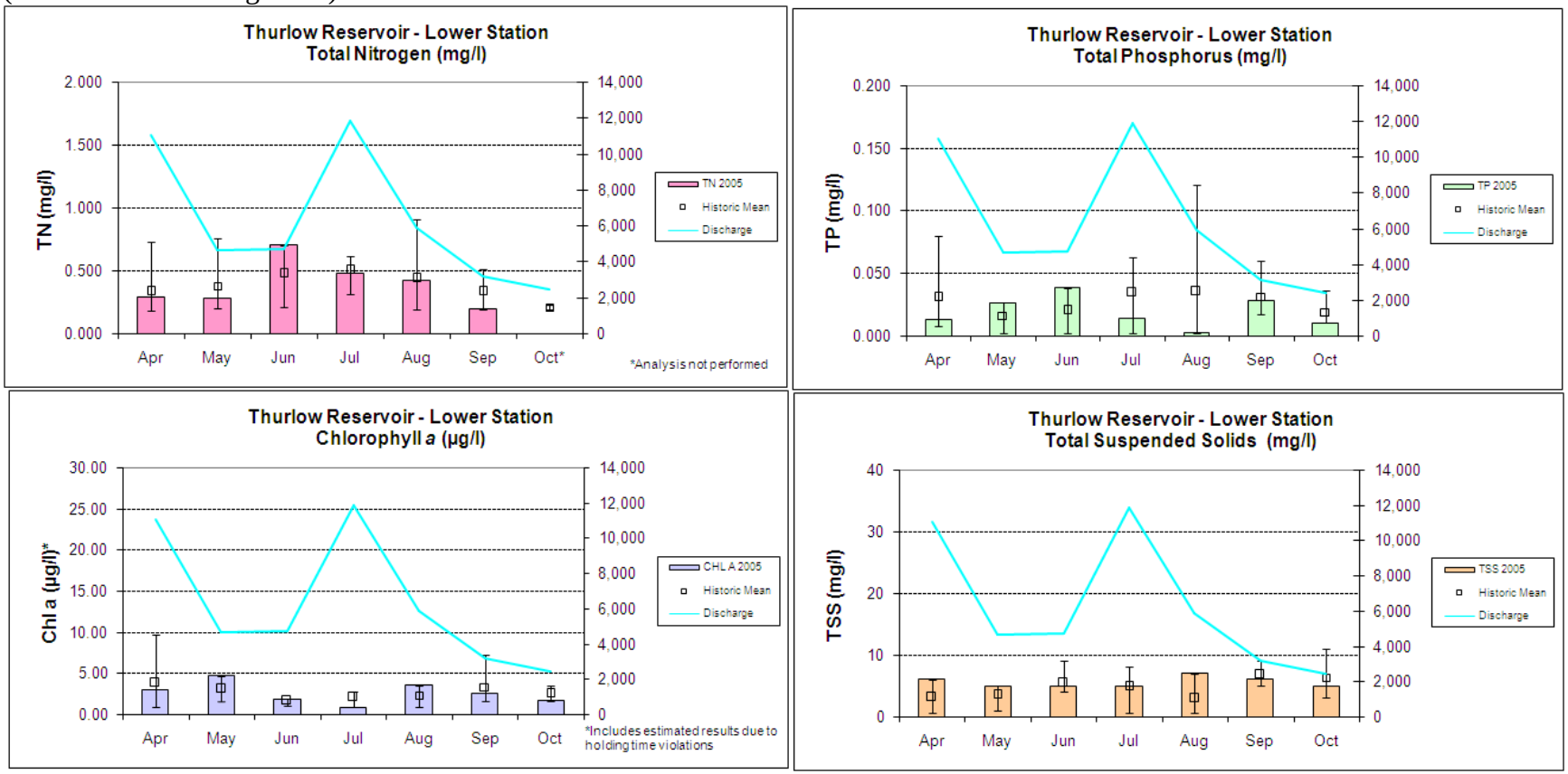
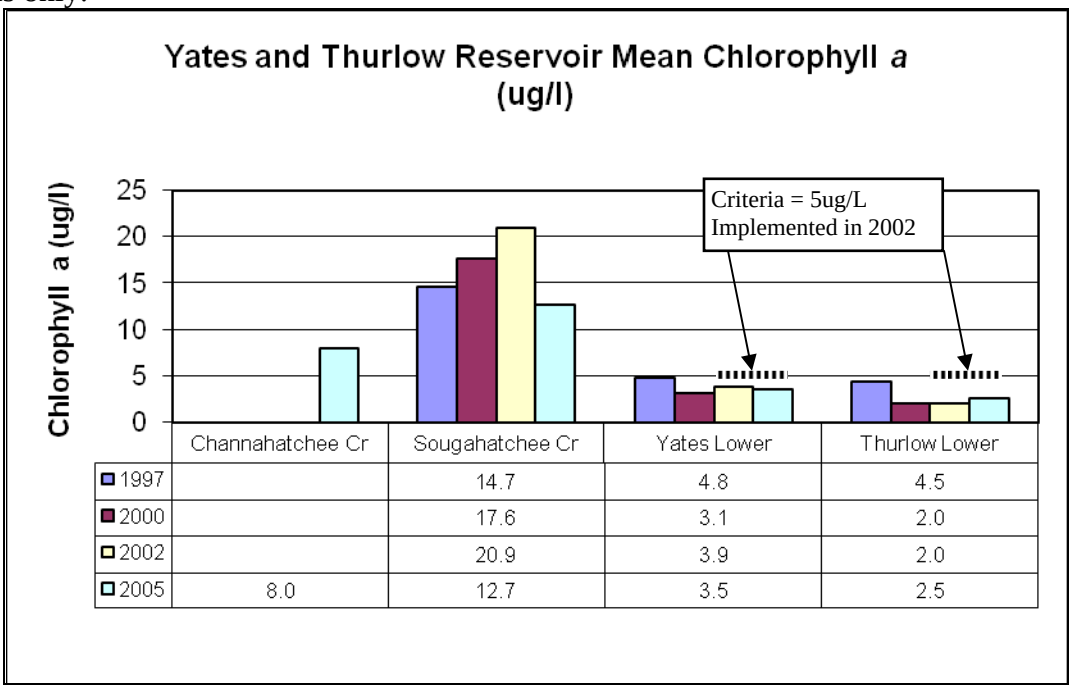


Figure 6. Mean chlorophyll *a* concentrations of Yates and Thurlow Reservoirs, 1997 through 2005. Chlorophyll *a* criteria applies to the growing season mean of lower Yates and Thurlow Stations only.



	Channahatchee Cr	Sougahatchee Cr	Yates Lower	Thurlow Lower
1997		14.7	4.8	4.5
2000		17.6	3.1	2.0
2002		20.9	3.9	2.0
2005	8.0	12.7	3.5	2.5

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. Mean standing crop (MSC) values below 5 mg/l are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Station	2000 Control mean MSC	2000 Limiting Nutrient	2005 Control mean MSC	2005 Limiting Nutrient
Yates Lower	2.52	Phosphorus	3.35	Phosphorus
Thurlow Lower	2.53	Phosphorus	4.60	Phosphorus

Figure 7. Monthly depth profiles of dissolved oxygen (DO) and temperature (temp) in Yates and Thurlow Reservoirs, June-September 2005. Although profiles were measured April-October, these select months were chosen as they represent the warmest water temperatures and most stratified dissolved oxygen concentrations. ADEM Water Quality Criteria pertaining to non-wadeable river and reservoir waters require a DO concentration of 5.0 mg/l at 5.0ft (1.5m)(ADEM Admin. Code R. 335-6-10-.09). Under extreme natural conditions such as drought, the DO concentration may be as low as 4.0 mg/l.

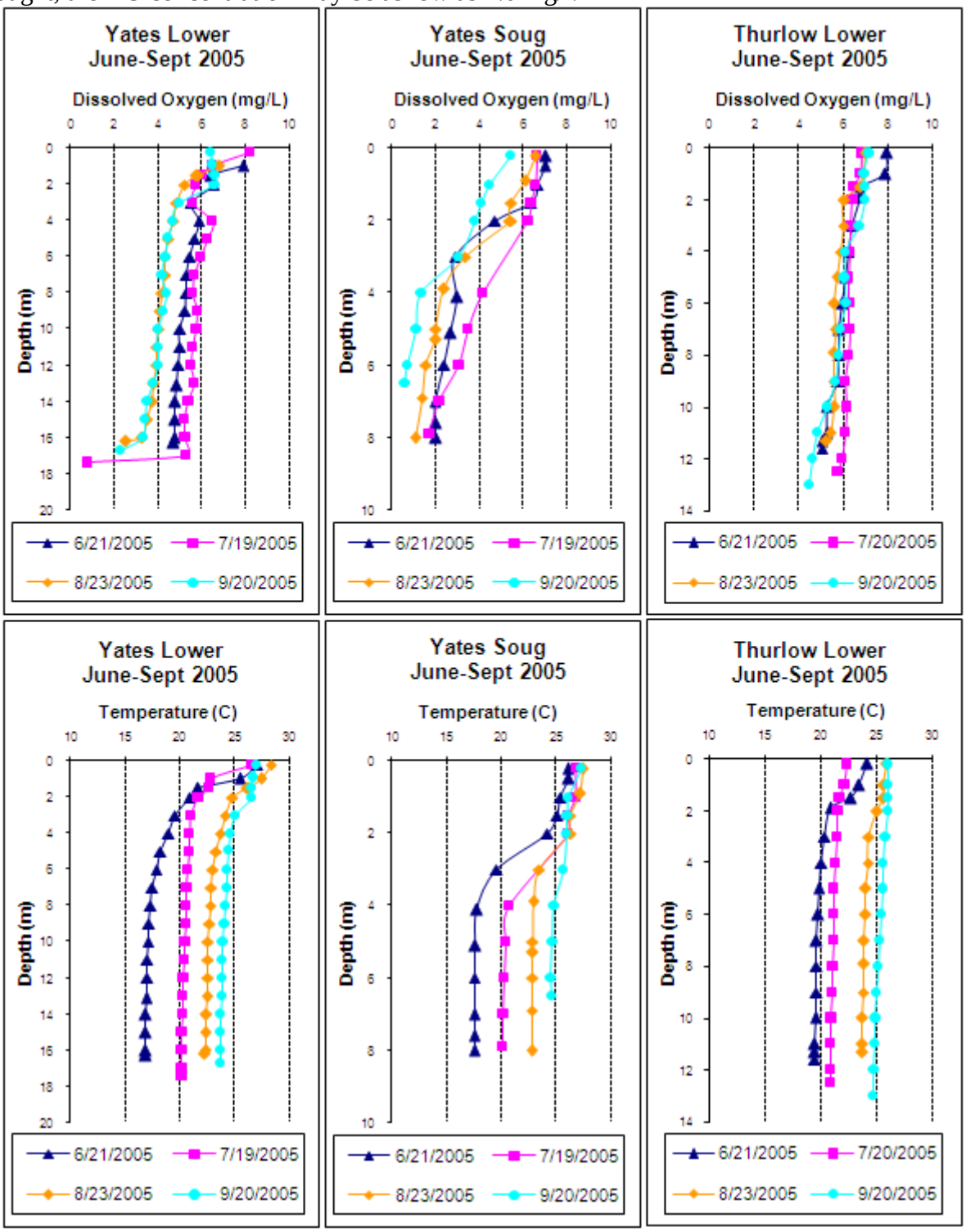


Figure 8. Monthly DO concentrations at 5 ft (1.5 m) for Yates and Thurlow Reservoirs mainstem and tributary stations collected April-October 2005. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations at a depth of 5 ft (1.5 m) are graphed. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEMWD 2005).

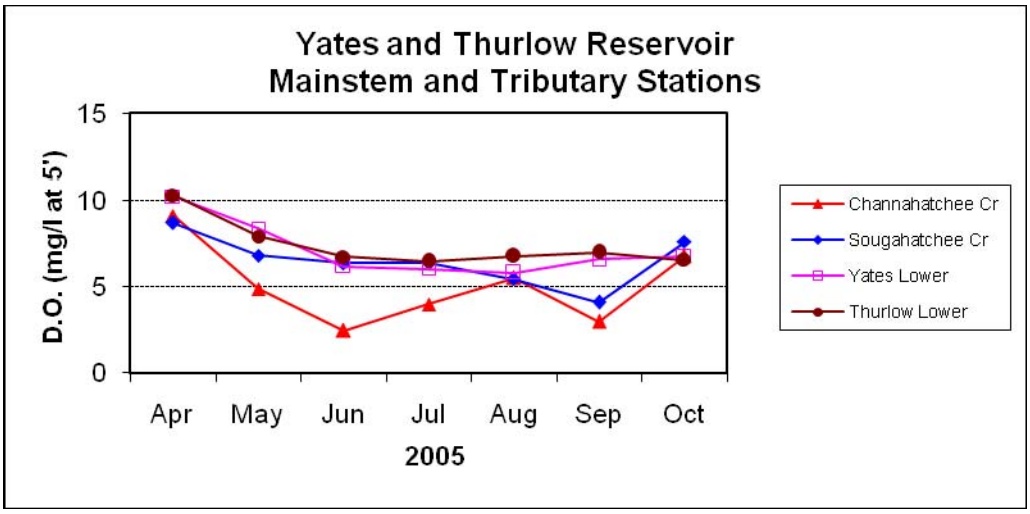


Figure 9. Monthly Trophic State Index (TSI) values for mainstem and tributary stations using chlorophyll *a* concentrations and Carlson's Trophic State Index calculation, April-October 2005.

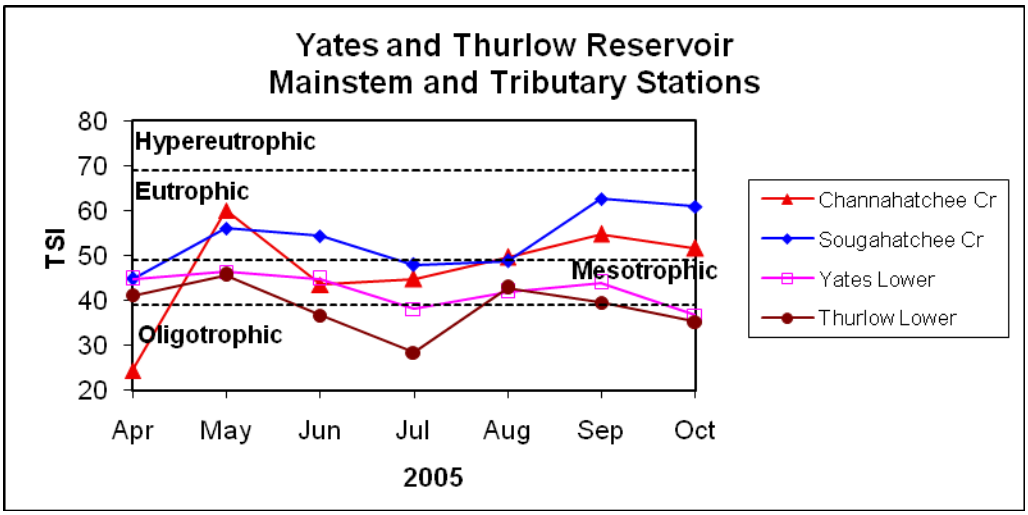
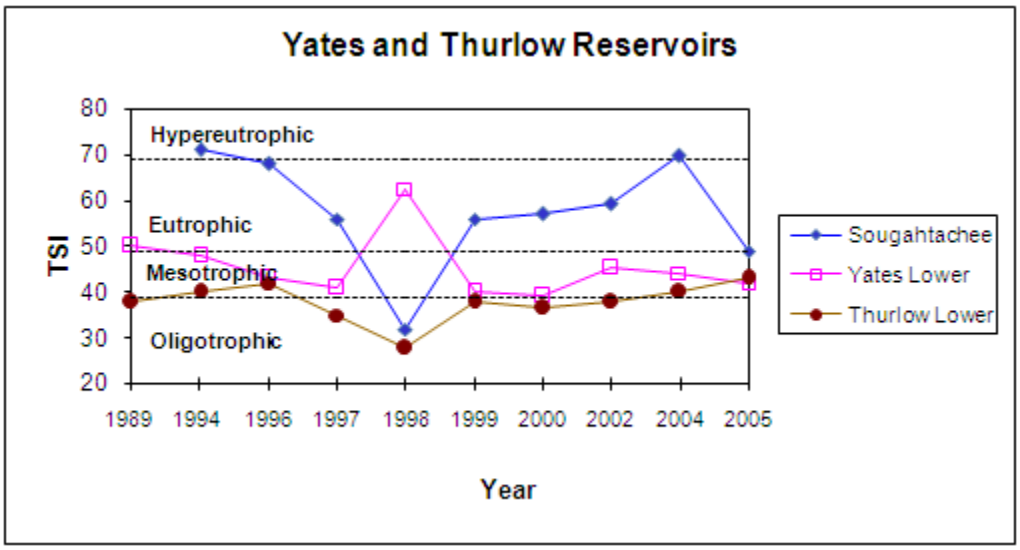


Figure 10. TSI values from critical period sampling (August sampling only) from 1989 to 2005.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2005. Minimum (min) and maximum (max) values calculated using minimum detection limits (MDL) when results were less than this value. Median, mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Median	Mean	SD
YATE-1	Alkalinity (mg/L)	7	13.5	15.2	13.9	14.1	0.6
	Hardness (mg/L)	4	11.5	13.8	12.5	12.6	0.9
	Total Dissolved Solids (mg/L)	7	36.0	92.0	51.0	54.7	18.7
	Total Suspended Solids (mg/L)	7	3.0	10.0	7.0	6.7	2.4
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.170	0.019	0.044	0.058
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.010	0.210	0.190	0.152	0.074
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.480	0.075	0.164	0.163
	Total Nitrogen (mg/L)	6	0.170	0.680	0.280	0.342	0.178
	Total Phosphorus (mg/L)	7	0.005	0.072	0.023	0.028	0.022
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.006	0.004	0.004	0.002
	Chlorophyll a (mg/L)[J]	7	1.87	4.98	3.92	3.52	1.17
	Turbidity (NTU)	7	3	8	5	6	2
	Secchi (m)	7	1.20	2.25	1.36	1.46	0.37
	Fecal Coliform (col/100 mL)	1	---	---	---	3	---
YATE-2	Alkalinity (mg/L)	7	21.9	44.7	32.2	33.3	7.6
	Hardness (mg/L)	4	16.2	27.2	23.0	22.4	5.1
	Total Dissolved Solids (mg/L)	7	50.0	130.0	72.0	76.0	26.1
	Total Suspended Solids (mg/L)	7	7.0	30.0	15.0	16.6	8.6
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.098	0.008	0.034	0.037
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.108	0.391	0.283	0.265	0.110
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.665	0.403	0.390	0.209
	Total Nitrogen (mg/L)	6	0.370	1.060	0.675	0.682	0.232
	Total Phosphorus (mg/L)	7	0.018	0.069	0.060	0.046	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.012	0.010	0.009	0.003
	Chlorophyll a (mg/L)[J]	7	4.27	26.17	11.21	12.74	8.42
	Turbidity (NTU)	7	16	34	24	26	6
	Secchi (m)	7	0.38	0.73	0.48	0.51	0.11
	Fecal Coliform (col/100 mL)	1	---	---	---	135	---
YATE-3	Alkalinity (mg/L)	7	13.2	21.1	15.9	16.8	3.0
	Hardness (mg/L)	4	9.7	15.3	11.9	12.2	2.3
	Total Dissolved Solids (mg/L)	7	30.0	65.0	56.0	53.6	12.2
	Total Suspended Solids (mg/L)	7	6.0	22.0	13.0	13.7	6.8
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.133	0.063	0.073	0.042
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.082	0.048	0.040	0.030
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.897	0.352	0.366	0.303
	Total Nitrogen (mg/L)	6	0.120	0.920	0.385	0.412	0.296
	Total Phosphorus (mg/L)	7	0.012	0.174	0.058	0.069	0.051
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.031	0.006	0.012	0.010
	Chlorophyll a (mg/L)[J]	7	0.53	20.29	6.94	8.01	6.51
	Turbidity (NTU)	7	12	23	18	17	3
	Secchi (m)	7	0.52	0.96	0.78	0.76	0.14
	Fecal Coliform (col/100 mL)	1	---	---	---	65	---

Station	Parameter	N	Min	Max	Median	Mean	SD
THUE-1	Alkalinity (mg/L)	7	11.4	23.4	13.8	14.9	4.0
	Hardness (mg/L)	4	9.8	12.8	10.8	11.1	1.5
	Total Dissolved Solids (mg/L)	7	23.0	62.0	45.0	44.1	13.5
	Total Suspended Solids (mg/L)	7	5.0	7.0	5.0	5.6	0.8
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.041	0.008	0.020	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.218	0.208	0.169	0.082
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.485	0.143	0.198	0.163
	Total Nitrogen (mg/L)	6	0.190	0.700	0.355	0.393	0.183
	Total Phosphorus (mg/L)	7	< 0.004	0.038	0.014	0.019	0.012
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.015	0.009	0.008	0.004
	Chlorophyll a (mg/L)[J]	7	0.80	4.63	2.49	2.54	1.28
	Turbidity (NTU)	7	3	6	4	4	1
	Secchi (m)	7	1.51	3.31	1.91	1.99	0.61
	Fecal Coliform (col/100 mL)	1	---	---	---	33	---

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