2006 Gainesville Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
May 2011

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INTRODUCTION

Gainesville Reservoir's 6,400 acre water body was established in 1978 by the U.S. Army Corps of Engineers with the completion of Howell Heflin Lock and Dam. The lake's creation was part of the Tennessee Tombigbee Waterway project which started in 1972 and opened to commercial traffic in January 1985.

The Alabama Department of Environmental Management (ADEM) monitored Gainesville Reservoir as part of the 2006 assessment of the Escatawpa, Mobile, and Tombigbee River (EMT) 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 2005 Monitoring Strategy.

In 2005, the ADEM implemented a specific water quality criterion for nutrient management at one location on Gainesville Reservoir, which has been monitored by ADEM since the mid-80's. This criterion represents the maximum growing season mean (Apr-Oct) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting the reservoir's Swimming and Fish & Wildlife (S/F&W) use classifications.

The purpose of this report is to summarize data collected at six stations in Gainesville Reservoir during the 2006 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's 20 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). Specific location information can be found in Table 1. Gainesville was sampled in the dam forebay with additional stations in the mid reservoir and upper reservoir. Monitoring sites were also established in the Bogue Chitto Creek, Lubbub Creek, and the Sipsey River embayments.

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 2003b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. 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 2006 results.

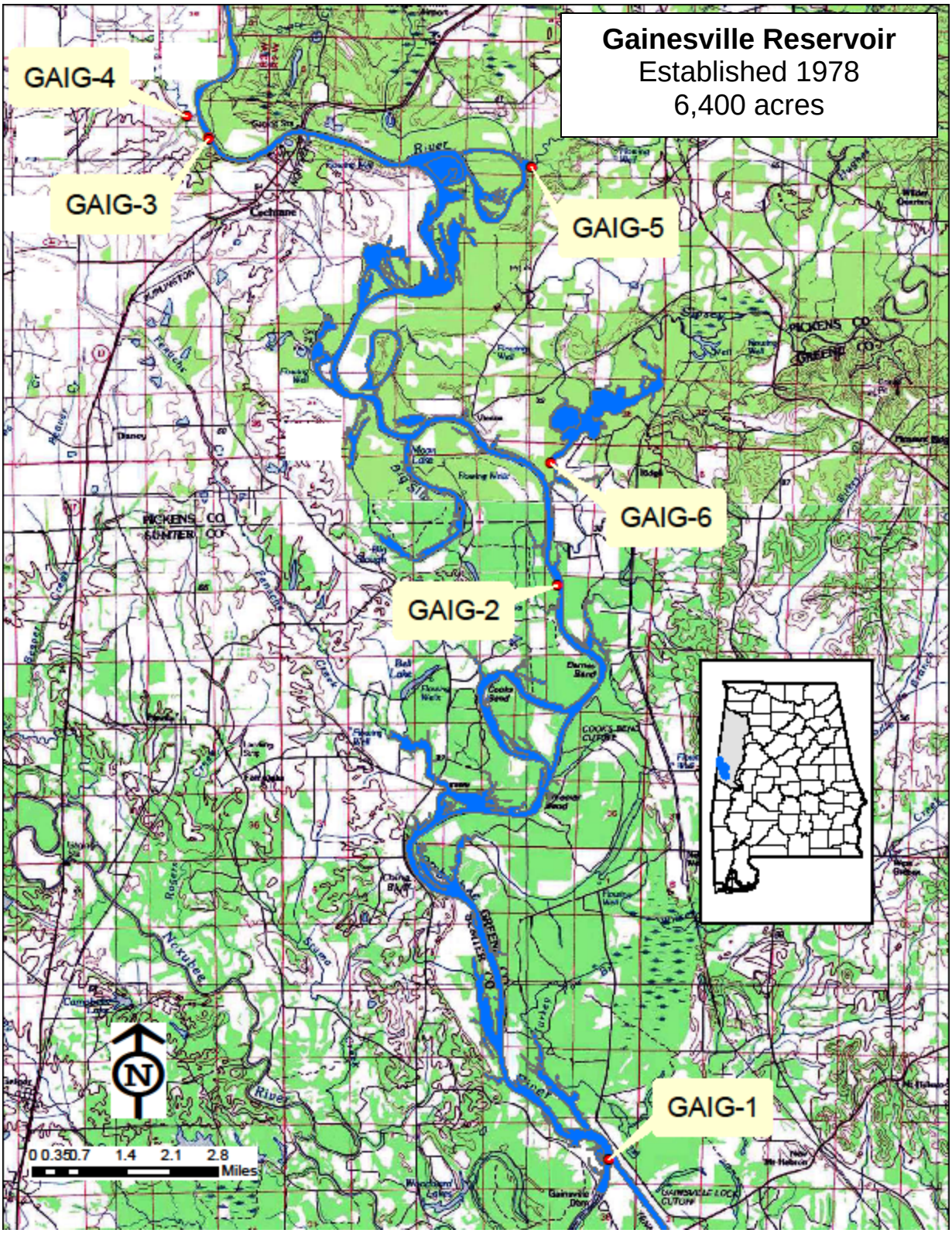


Figure 1. Gainesville Reservoir with 2006 sampling locations. A description of each sampling location is provided in Table 1.

Table 1. Descriptions of the 2006 monitoring stations in Gainesville Reservoir.

Sub-watershed	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria	Latitude	Longitude
Gainesville Reservoir								
Upper Tombigbee (0316-0106)								
0609	Greene	GAIG-1*	Lower	Tombigbee R	Lower reservoir. Deepest point, main river channel, upstream of lock canal/river channel split.	14 ug/L	32.8559	-88.1545
0603	Sumter	GAIG-2	Mid	Tombigbee R	Mid reservoir. Deepest point, main river channel, approximately 1.5 miles downstream of Sipsey River confluence.		32.9818	-88.1694
0505	Pickens	GAIG-3	Upper	Tombigbee R	Upper reservoir. Deepest point, main river channel, approx. 0.5 miles downstream of Bogue Chitto Creek confluence.		33.0789	-88.2618
0504	Pickens	GAIG-4	Bogue Chitto	Tombigbee R	Deepest point, main creek channel, Bogue Chitto Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		33.0837	-88.2676
0507	Pickens	GAIG-5	Lubbub	Tombigbee R	Deepest point, main creek channel, Lubbub Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		33.0734	-88.1774
0306	Greene	GAIG-6	Sipsey	Tombigbee R	Deepest point, main river channel, Sipsey River embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.		33.0086	-88.1716

*Growing season mean chl a criteria implemented at this station in 2005.

RESULTS

Summary statistics of all data collected during 2006 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

Mainstem Stations: The upper station was characterized by the highest mean TN, TP, chl *a* and TSS concentrations any of the mainstem reservoir stations (Fig. 2). The upper station's monthly TN concentrations were above historic means (n=4) during five of the seven sampling months (Fig. 3). Mean TN concentration at the mid station was lower in 2006 than in 2001 (ADEM 2003a). Monthly TN concentrations for all mainstem stations were highest in October, when the reservoir experienced a late surge in discharge (Fig. 3, 4, & 5).

The lowest mean TP concentration was measured at the mid station (Fig. 2). Mean TP concentrations at all three stations were lower in 2006 than in 2001 (ADEM 2003a). The highest monthly TP concentration for all mainstem stations occurred during October, which parallels a marked increase in discharge (Fig. 3, 4, & 5). Values measured in October were the highest on record (n=4).

Mainstem mean chl *a* concentrations in 2006 were higher overall than those measured in 2001 (Fig. 2, ADEM 2003a). Monthly chl *a* concentrations at the upper station varied month to month, while the mid and lower stations peaked in June and generally decreased to October (Fig. 3, 4, & 5). A specific water quality criterion for nutrient management has been established on Gainesville at the lower reservoir staiton. The 2006 mean chl *a* concentration measured at the lower station was in compliance with the criteria limit, although values from the past four growing seasons suggest an increasing trend similar to the mid station (Fig. 6). This trend differs from the upper station, which shows mean chl *a* concentrations to be decreasing (Fig. 6).

The highest mean growing season TSS concentration occurred at the upper station and decreased to the lower station (Fig. 2). Mean TSS concentrations in 2006 were lower than those measured in 2001 (ADEM 2003a). Monthly TSS concentrations were below historic means May-Sep and highest at all three mainstem stations in October (Fig. 3, 4, & 5).

As in 2001, AGPT results for 2006 indicated that Gainesville Reservoir was nitrogen limited at all mainstem stations (Table 2). The mean standing crop (MSC) values were well below 5 mg/L, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems.

Profiles of dissolved oxygen concentrations indicated that the water column was mixed at all mainstem stations, June-September (Fig. 7). While warmest water temperatures were reached in July and August, the entire water column at all three mainstem stations dropped almost six degrees in September (Fig. 7). All measurements of dissolved oxygen concentrations in the upper and mid reservoir stations met the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l at 5.0 ft (1.5 m)(Fig. 7). The dissolved oxygen concentration at the lower station was below ADEM criteria limits in August, and just above 5.0 mg/L in July (Fig. 7).

Monthly TSI values were calculated using chl *a* concentrations and Carlson's Trophic State Index. TSI values for all mainstem locations indicate mostly eutrophic conditions with a few exceptions (Fig. 9). Both the lower and mid station began the season mesotrophic, the mid station returned to mesotrophic status in September and ended the season Oligotrophic, while the lower station ended the season mesotrophic (Fig. 9). The upper station only dropped to mesotrophic conditions in October. August TSI values calculated from data collected at Gainesville stations, 1985-2006 are presented in Fig. 10. For the upper and mid stations, August TSI values were eutrophic 2001-2006. Values for the lower station were eutrophic with the exception of 2003 and 2004 when the reservoir was mesotrophic.

Tributary Stations: The highest mean TP, TN, chl *a*, and TSS of any tributary embayment in Gainesville Reservoir was measured at Bogue Chitto (Fig. 2). Lowest mean TN, TP and TSS concentrations were measured in the Sipsey R embayment station and lowest mean chl *a* in the Lubbub Cr embayment (Fig. 2).

All measurements of dissolved oxygen concentrations in all tributary embayments met the ADEM criteria (ADEM Admin. Code R. 335-6-10-.09) of 5.0 mg/l. (Fig. 8)

TSI values for all embayment stations were generally eutrophic April-October, with the exception of Lubbub Cr in April and Sipsey R in May and October. Both Lubbub Cr and Sipsey R dropped to oligotrophic status in April or May, respectively. Sipsey R changed status again in October, ending the sampling season in the mesotrophic range. During May, Bogue Chitto Cr was hypereutrophic. (Fig. 9)

Figure 2. Mean total nitrogen (TN), mean total phosphorus (TP), mean chlorophyll a (chl *a*) and mean total suspended solids (TSS) measured throughout Gainesville Reservoir, April-October 2006. Bar graphs consist of mainstem (green) and embayment (pink) stations, illustrated from upstream to downstream as the graph is read from left to right.

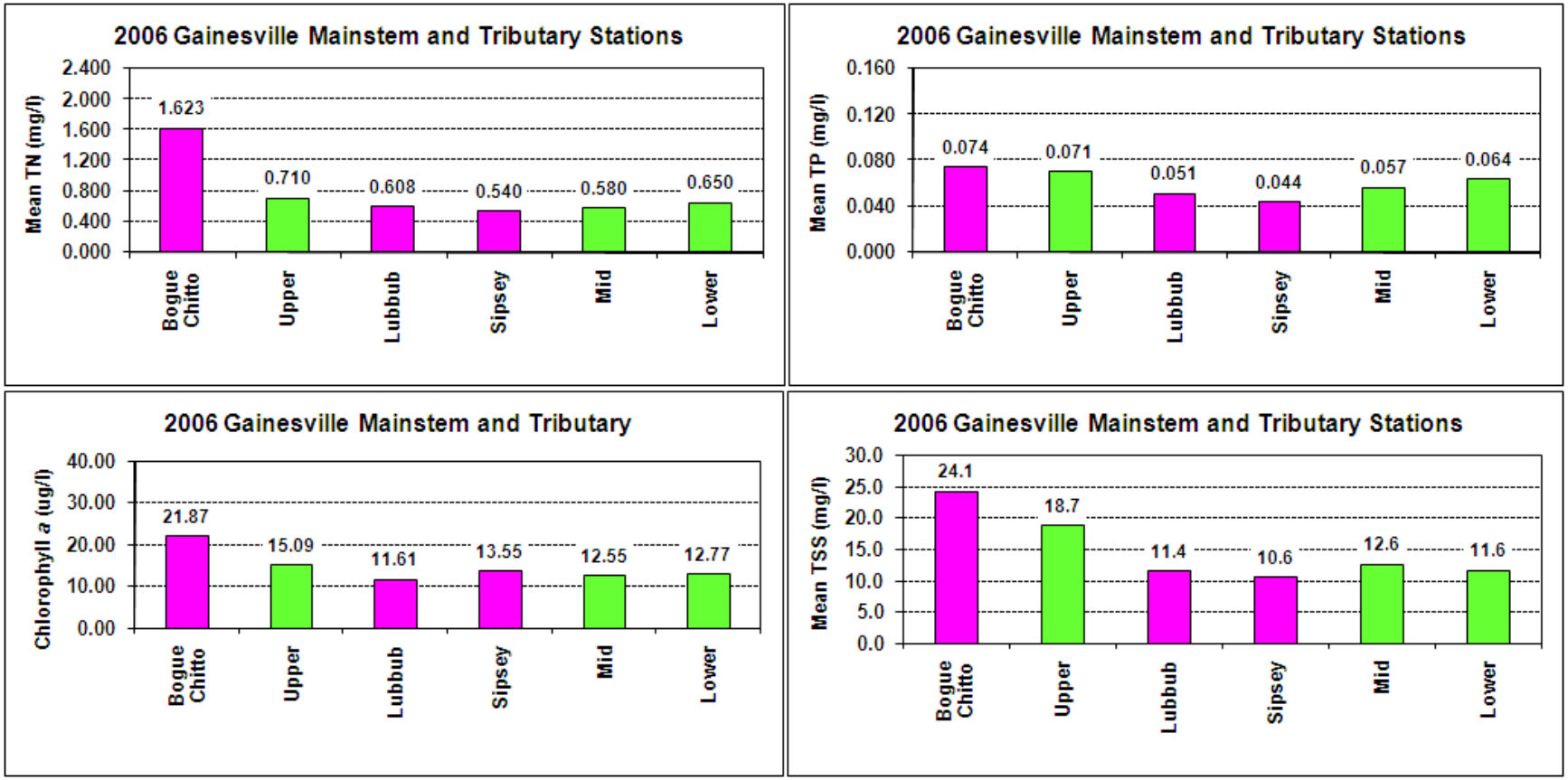


Figure 3. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll a (chl *a*) and total suspended solids (TSS) of the upper station in Gainesville Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the upper station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Tombigbee R gage at Heflin Lock and Dam near Gainesville, AL).

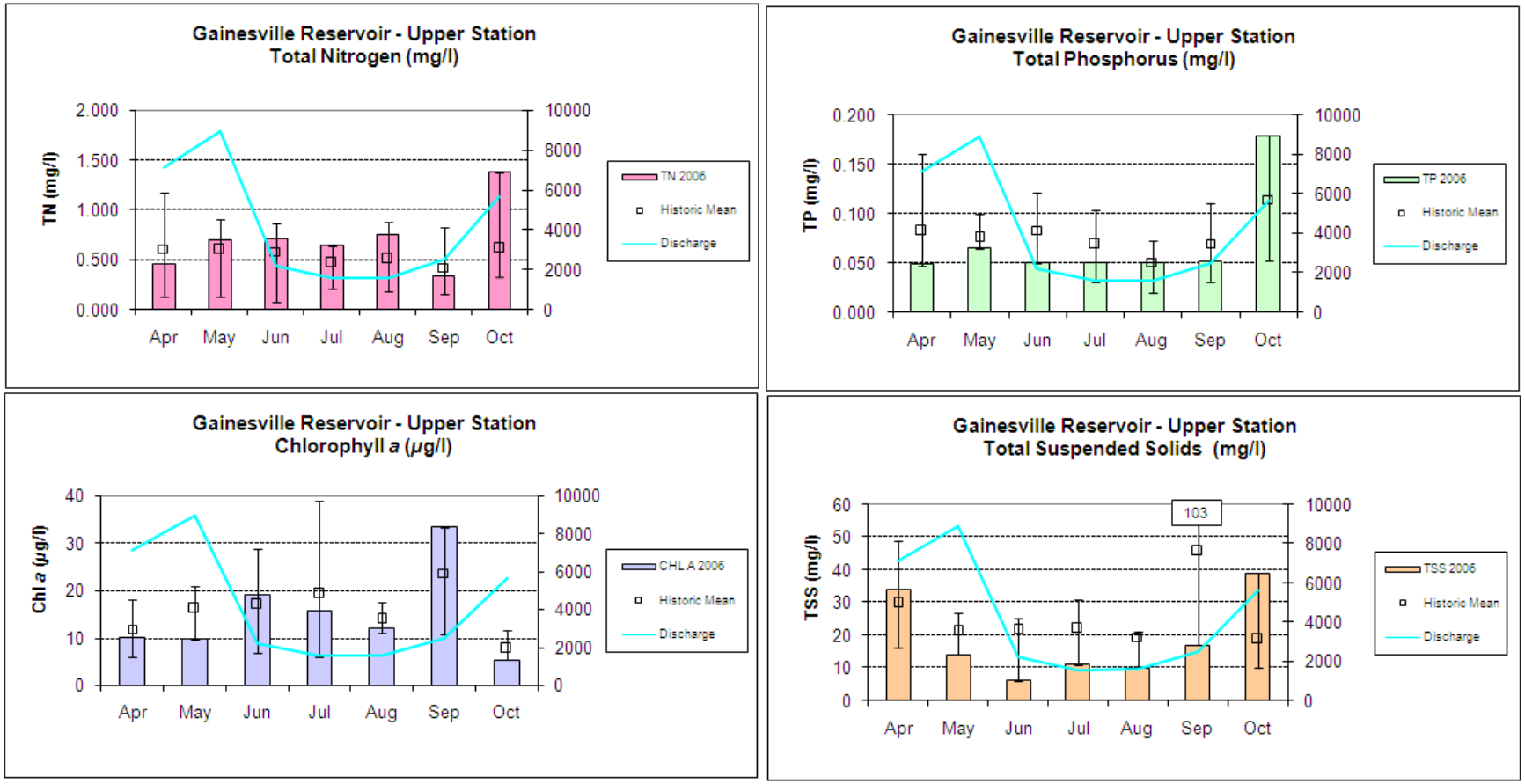


Figure 4. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll a (chl *a*) and total suspended solids (TSS) of the mid station in Gainesville Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the mid-reservoir station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Tombigbee R gage at Heflin Lock and Dam near Gainesville, AL).

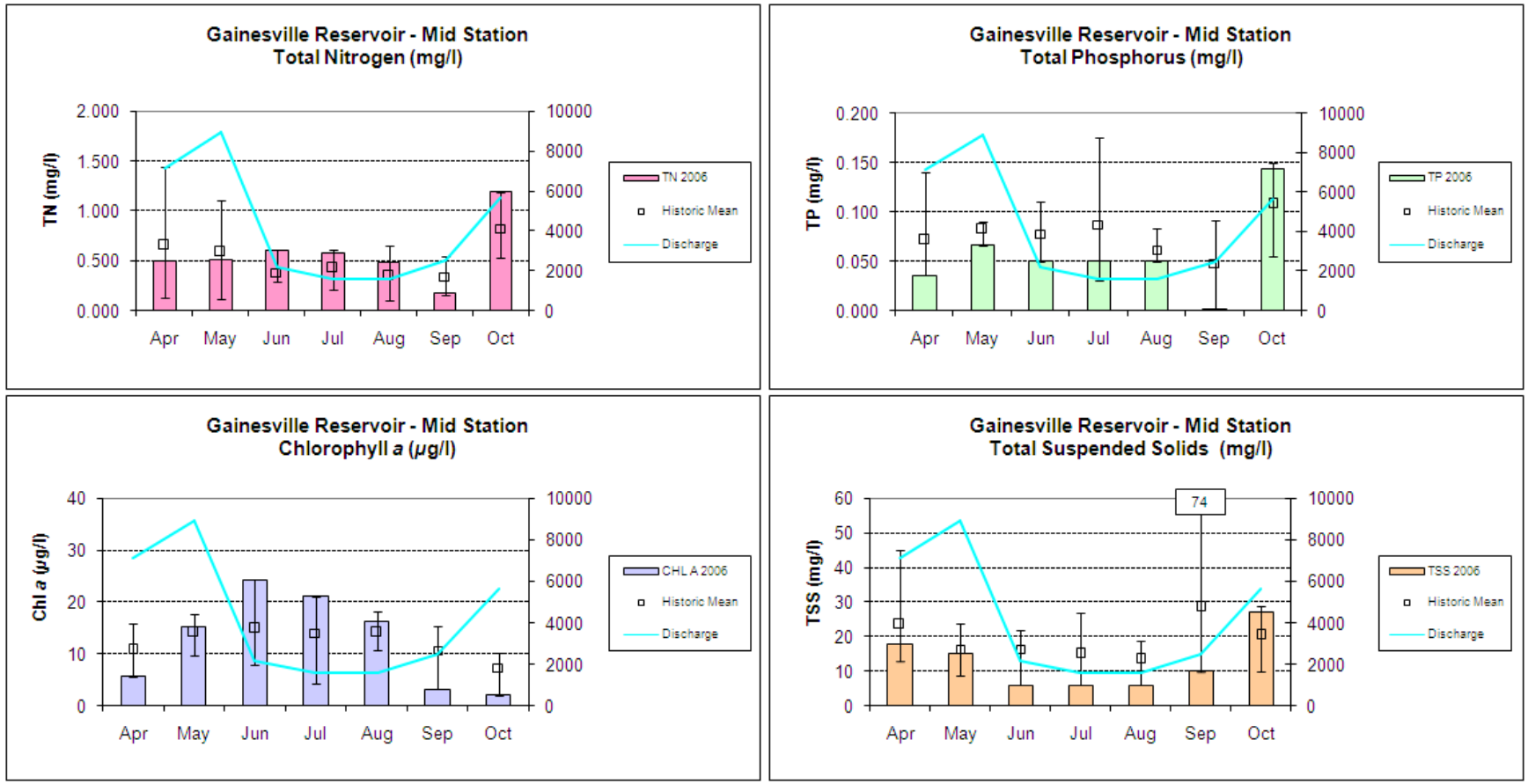


Figure 5. Monthly total nitrogen (TN), total phosphorus (TP), chlorophyll a (chl *a*) and total suspended solids (TSS) of the dam forebay station in Gainesville Reservoir, April-October 2006. Each bar graph depicts monthly changes in the variables at the lower reservoir station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS were plotted vs. discharge (USGS Tombigbee R gage at Heflin Lock and Dam near Gainesville, AL).

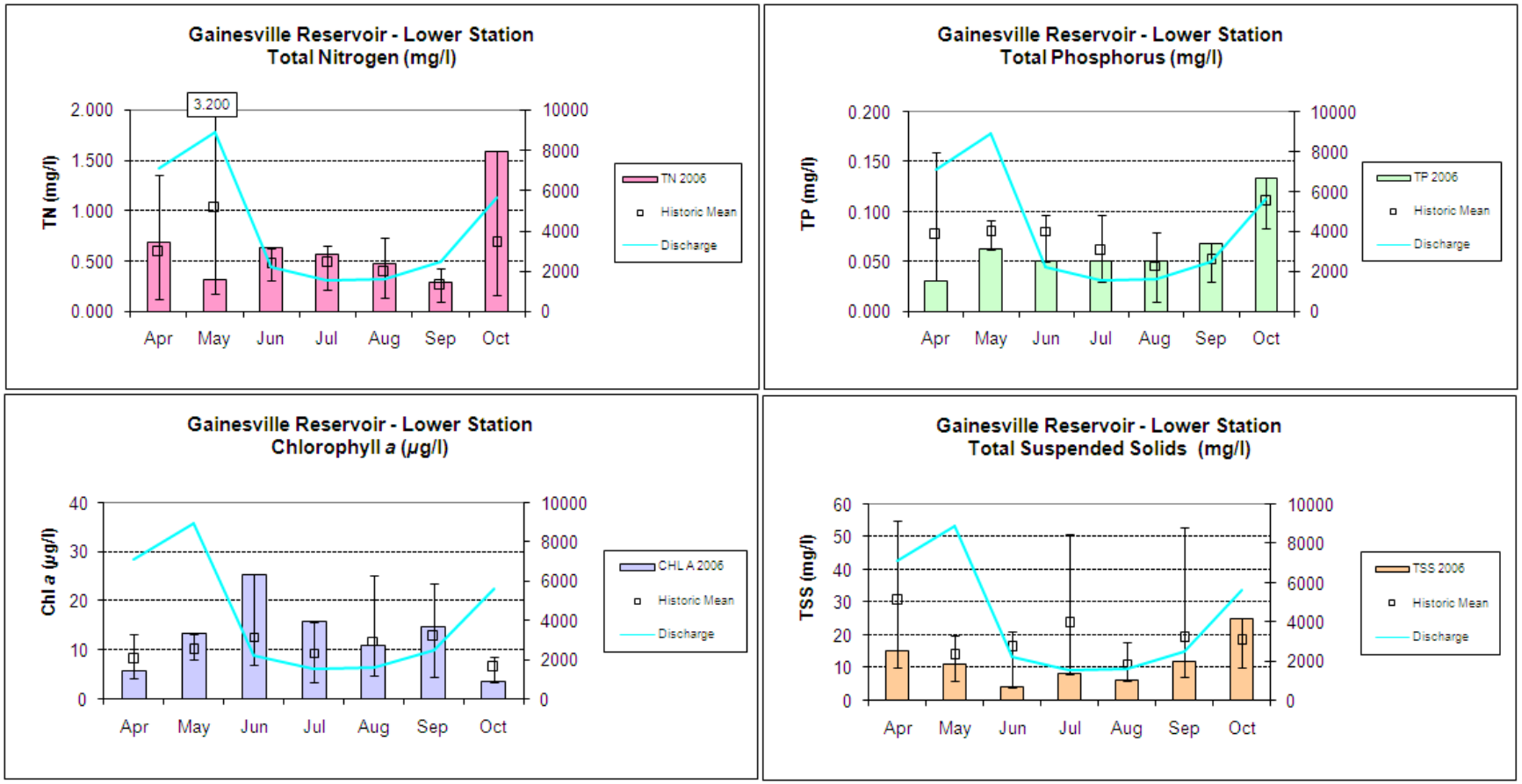


Figure 6. Mean chlorophyll a concentrations of mainstem Gainesville Reservoir, 2001 through 2006. Chl *a* criteria applies to the growing season mean of the lower station only.

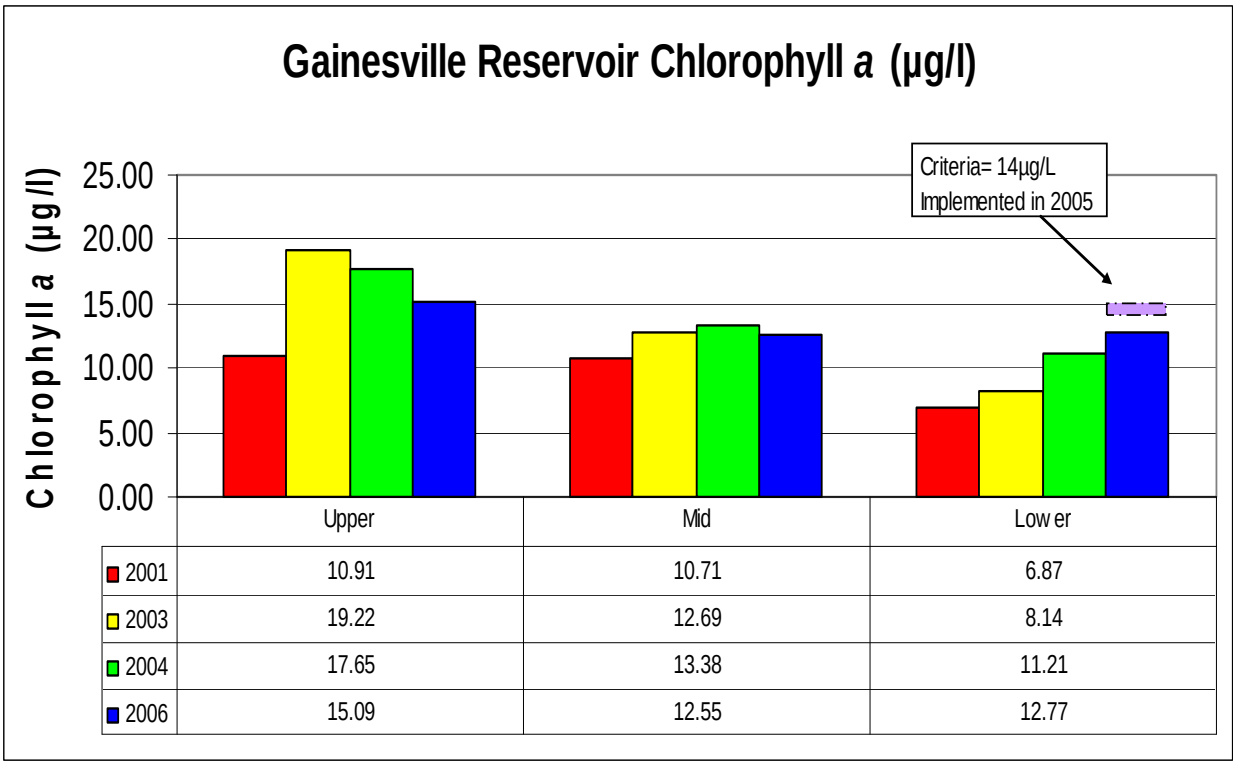


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. Mean standing crop (MSC) values below 5 mg/l are considered to be protective in reservoirs and lakes; MSC values below 20 mg/l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

Station	2001 Control mean MSC	2001 Limiting Nutrient	2006 Control mean MSC	2006 Limiting Nutrient
Upper	2.30	Nitrogen	1.55	Nitrogen
Mid	0.72	Nitrogen	1.41	Nitrogen
Lower	3.56	Nitrogen	1.63	Nitrogen

Figure 7. Monthly depth profiles of dissolved oxygen (DO) and temperature (temp) in Gainesville Reservoir, June-September 2006. 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.

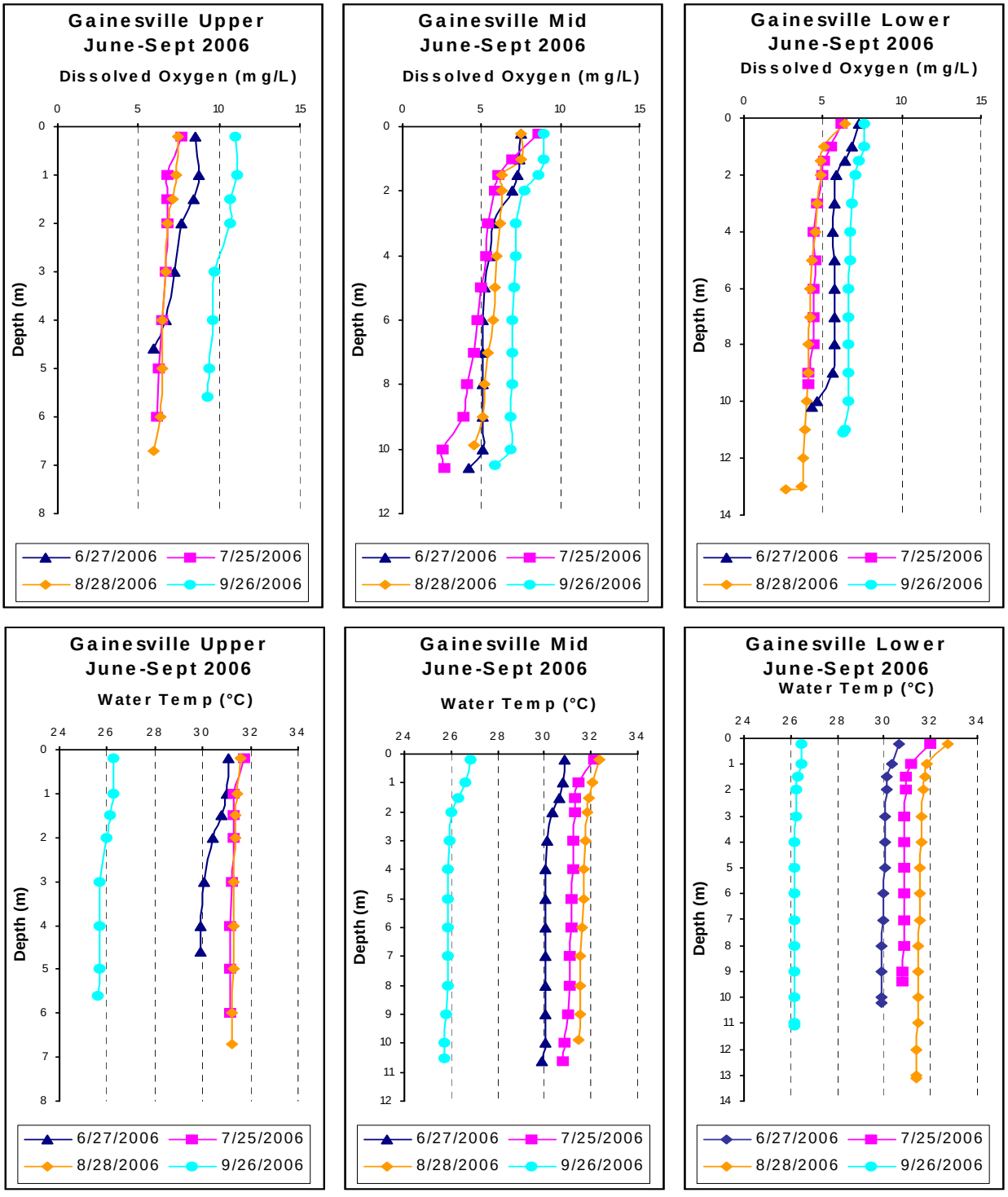


Figure 8. Monthly DO concentrations at 5 ft (1.5m) for Gainesville Reservoir tributaries collected April-October 2006. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations at a depth of 5ft (1.5m) or at half depth (<3m deep) are graphed. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2005).

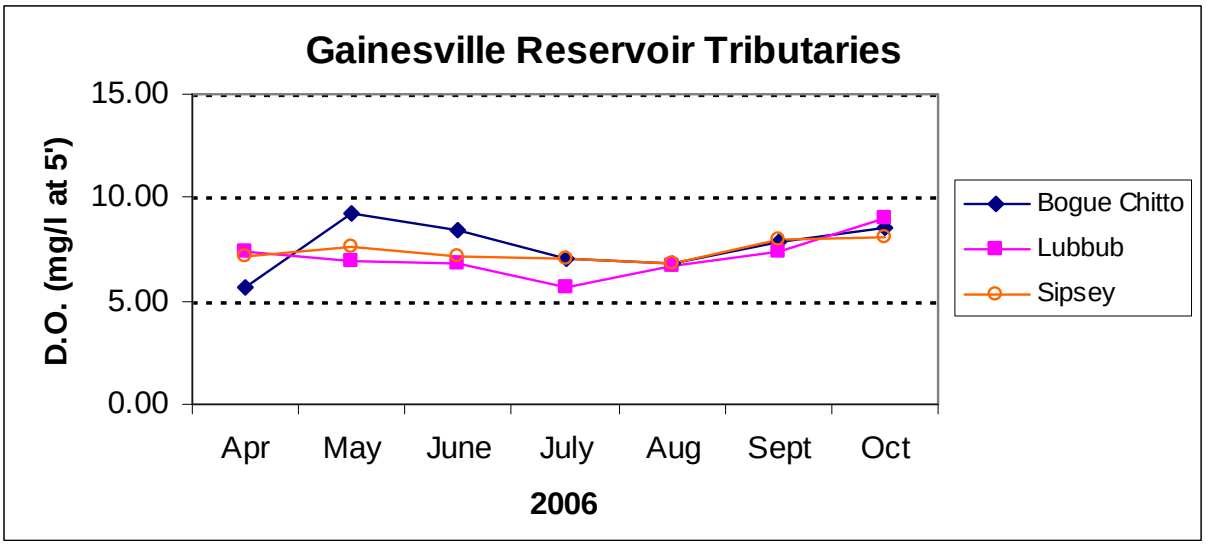


Figure 9. Monthly TSI values for mainstem and tributary stations using chlorophyll a concentrations and Carlson's Trophic State Index calculation, April-October 2006.

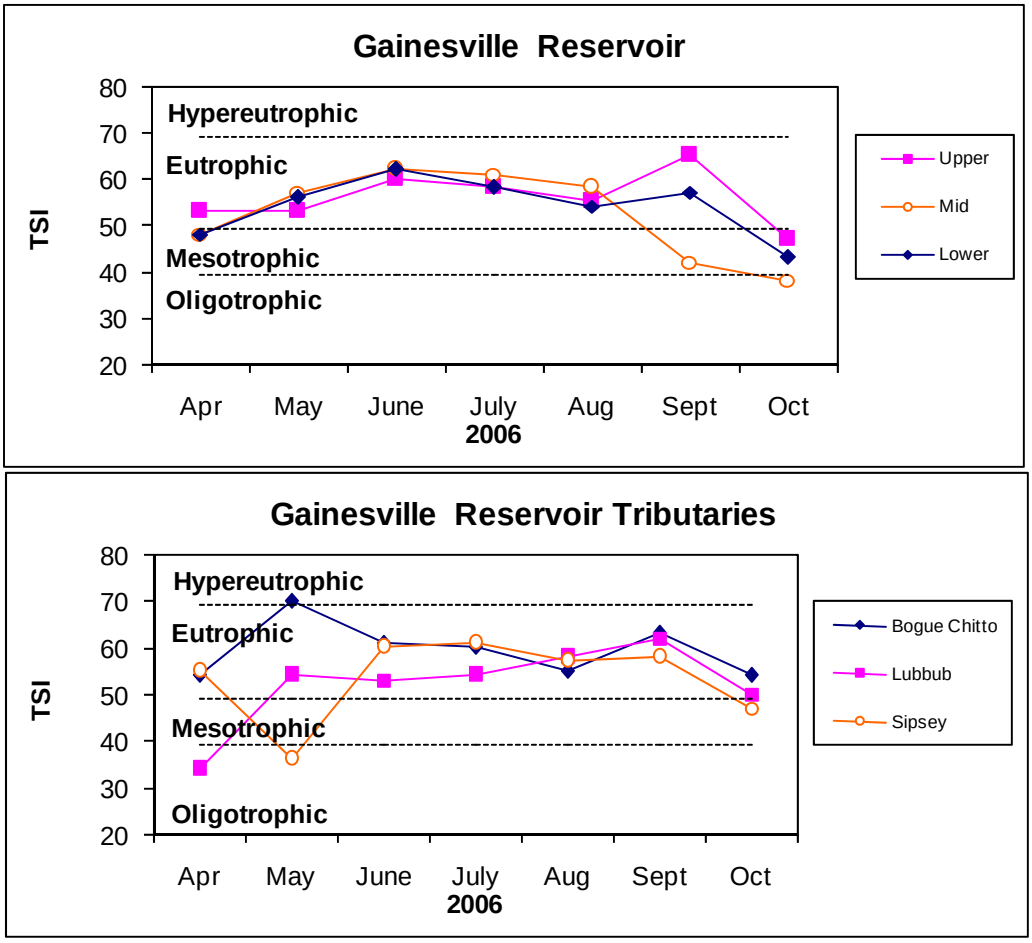
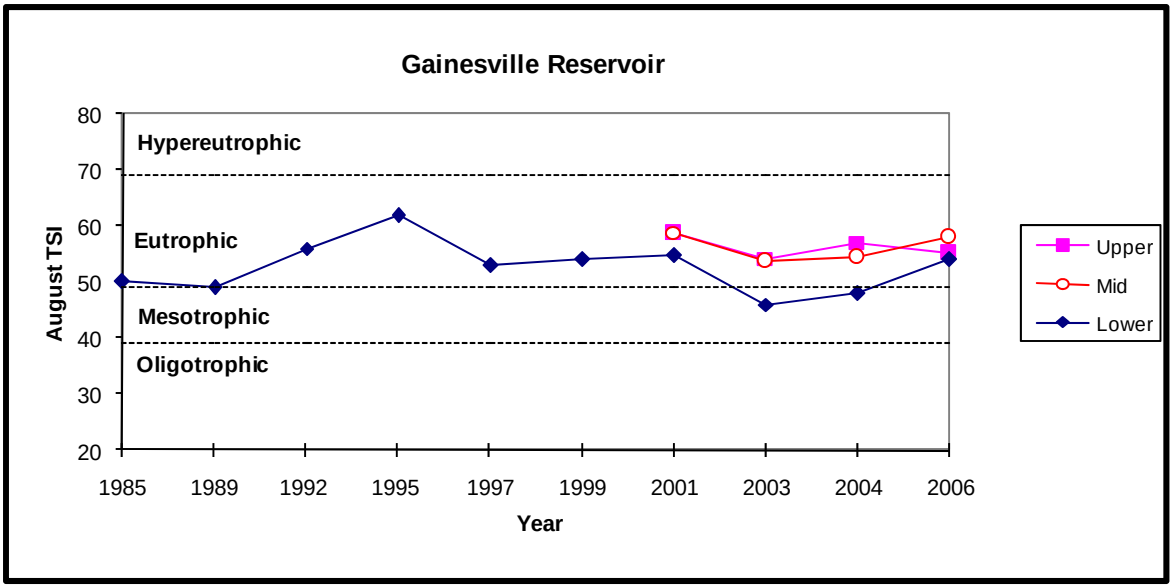


Figure 10. Trophic State Index values from critical period sampling (August sampling only) from 1985 to 2006.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2006. 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
GAIG-1	Alkalinity (mg/L)	7	30.2	52.4	39.9	40.8	7.7
	Total Dissolved Solids (mg/L)J	7	63.0	224.0	111.0	123.6	50.6
	Total Suspended Solids (mg/L)J	7	4.0	25.0	11.0	11.6	7.0
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.080	0.008	0.022	0.027
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.006	0.514	0.021	0.113	0.184
	Total Kjeldahl Nitrogen (mg/L)	7	0.190	1.077	0.546	0.538	0.287
	Total Nitrogen (mg/L)	7	0.290	1.590	0.570	0.650	0.442
	Total Phosphorus (mg/L)	7	0.031	0.134	0.050	0.064	0.033
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.044	0.002	0.011	0.016
	Chlorophyll a (mg/L)	7	3.56	25.40	13.35	12.77	7.20
	Turbidity (NTU)	7	6	32	8	13	9
	Secchi (m)	7	0.49	1.22	1.03	0.86	0.31
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	2	---
GAIG-2	Alkalinity (mg/L)	7	33.7	51.4	43.3	42.2	6.6
	Total Dissolved Solids (mg/L)J	7	59.0	254.0	113.0	134.6	61.7
	Total Suspended Solids (mg/L)J	7	6.0	27.0	10.0	12.6	8.0
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.050	0.008	0.015	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.490	0.008	0.096	0.178
	Total Kjeldahl Nitrogen (mg/L)	7	0.171	0.701	0.489	0.483	0.171
	Total Nitrogen (mg/L)	7	0.180	1.190	0.510	0.580	0.303
	Total Phosphorus (mg/L)	7	< 0.004	0.143	0.050	0.057	0.043
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.052	0.002	0.012	0.019
	Chlorophyll a (mg/L)	7	2.14	24.30	15.13	12.55	8.89
	Turbidity (NTU)	7	5	36	8	13	11
	Secchi (m)	7	0.43	1.45	0.90	0.86	0.36
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	1	---
GAIG-3	Alkalinity (mg/L)	7	31.0	54.7	47.4	45.8	8.4
	Total Dissolved Solids (mg/L)J	7	73.0	295.0	129.0	153.3	72.0
	Total Suspended Solids (mg/L)J	7	6.0	39.0	14.0	18.7	12.7
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.026	0.008	0.013	0.009
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.346	0.029	0.069	0.124
	Total Kjeldahl Nitrogen (mg/L)	7	0.306	1.030	0.645	0.640	0.235
	Total Nitrogen (mg/L)	7	0.340	1.380	0.710	0.713	0.331
	Total Phosphorus (mg/L)	7	0.049	0.179	0.050	0.071	0.048
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.067	0.002	0.012	0.024
	Chlorophyll a (mg/L)	7	5.34	33.38	12.10	15.09	9.20
	Turbidity (NTU)	7	8	42	12	17	13
	Secchi (m)	7	0.41	1.05	0.65	0.72	0.26
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	4	---

Station	Parameter	N	Min	Max	Median	Mean	SD
GAIG-4	Alkalinity (mg/L)	7	7.4	75.9	57.4	52.7	21.3
	Hardness (mg/L)	3	99.8	118.0	103.0	106.9	9.7
	Total Dissolved Solids (mg/L)J	7	131.0	280.0	159.0	174.6	52.9
	Total Suspended Solids (mg/L)J	7	7.0	50.0	19.0	24.1	15.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.311	0.008	0.051	0.115
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	1.950	0.009	0.792	0.984
	Total Kjeldahl Nitrogen (mg/L)	7	0.418	1.394	0.750	0.830	0.365
	Total Nitrogen (mg/L)	7	0.420	3.180	0.760	1.626	1.312
	Total Phosphorus (mg/L)	7	0.042	0.213	0.050	0.074	0.062
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.113	0.004	0.020	0.041
	Chlorophyll a (mg/L)	7	10.68	53.40	19.20	21.87	15.13
	Turbidity (NTU)	7	11	54	15	23	16
	Secchi (m)	7	0.30	1.05	0.64	0.62	0.25
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	8	---
GAIG-5	Alkalinity (mg/L)	7	1.3	16.6	10.9	10.2	4.9
	Total Dissolved Solids (mg/L)J	7	27.0	91.0	49.0	55.6	22.4
	Total Suspended Solids (mg/L)J	7	6.0	22.0	10.0	11.4	5.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.059	0.008	0.017	0.019
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.010	0.199	0.070	0.074	0.061
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.949	0.588	0.533	0.284
	Total Nitrogen (mg/L)	7	0.350	0.980	0.610	0.619	0.220
	Total Phosphorus (mg/L)	7	0.030	0.100	0.050	0.051	0.013
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.011	0.002	0.004	0.003
	Chlorophyll a (mg/L)	7	1.42	25.37	10.68	11.61	7.47
	Turbidity (NTU)	7	9	19	12	14	4
	Secchi (m)	5	0.79	0.96	0.80	0.61	0.42
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	26	---
GAIG-6	Alkalinity (mg/L)	7	5.5	43.2	27.7	27.3	13.5
	Total Dissolved Solids (mg/L)J	7	34.0	135.0	82.0	90.3	35.7
	Total Suspended Solids (mg/L)J	7	6.0	19.0	9.0	10.6	4.8
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.031	0.008	0.012	0.009
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.193	0.006	0.043	0.070
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.946	0.453	0.497	0.300
	Total Nitrogen (mg/L)	7	0.210	0.950	0.460	0.551	0.300
	Total Phosphorus (mg/L)	7	< 0.004	0.100	0.050	0.044	0.024
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.004	0.002	0.002	0.001
	Chlorophyll a (mg/L)	7	1.78	22.40	15.50	13.55	7.74
	Turbidity (NTU)	7	7	29	9	14	8
	Secchi (m)	6	0.47	1.28	0.60	0.70	0.42
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	4	---

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