2005 Lay Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
January 6, 2010

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INTRODUCTION

The Alabama Department of Environmental Management (ADEM) monitored Lay Reservoir 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 were to provide data that could 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.

Lay Reservoir was placed on Alabama's 1996 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its public water supply (PWS)/swimming (S)/fish & wildlife (F&W) water use classifications. The reservoir was listed in 1996 for impairments caused by priority organics (PCBs), nutrients and organic enrichment/dissolved oxygen (OE/DO). A TMDL developed to address the nutrient and OE/DO impairment in Lay, as well as the entire Coosa River reservoir chain, was approved by the USEPA in 2008.

The purpose of this report is to summarize data collected at nine stations in Lay Reservoir during the 2005 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 (chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)), sediment (total suspended solids (TSS)), and trophic state (Carlson's trophic state index (TSI)) are compared to ADEM's historical data.

METHODS

Sampling stations were determined using historical data and previous assessments (Fig. 1). Specific location information can be found in Table 1. Water quality assessments were conducted at monthly intervals April-October. Lay was sampled in the dam forebay with additional stations added at mid reservoir and near the upper reservoir, where the river first exhibits reservoir-like attributes. Six tributary embayment stations representing a range of landuses were also established.

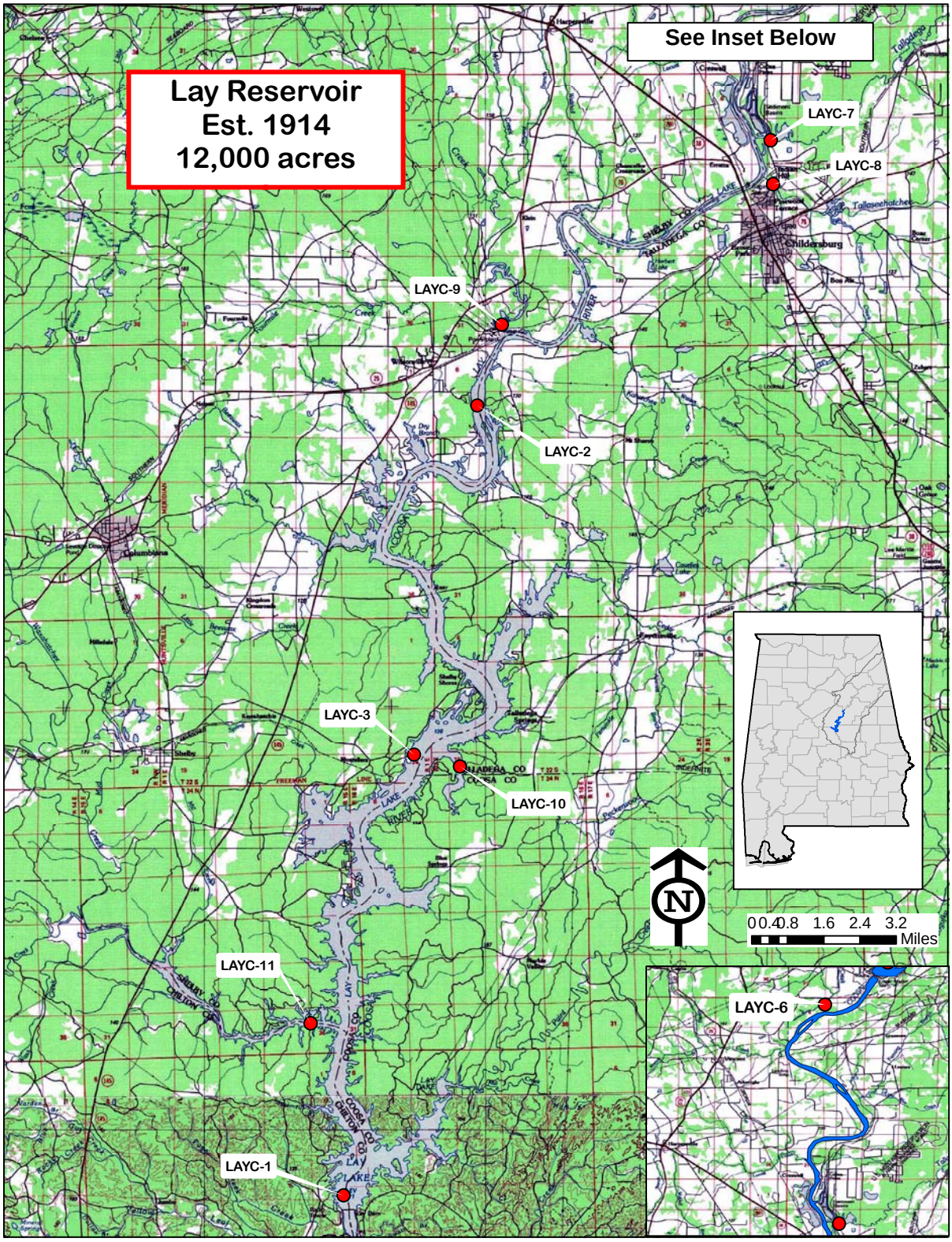


Figure 1. Lay Reservoir with 2005 sampling locations. A description of each sampling location is provided in Table 1.

Table 1. Descriptions for the monitoring stations in 2005 for Lay Reservoir.

Lay Reservoir							
Sub-watershed	**County**	**Station Number**	**Report Designation**	**Waterbody Name**	**Station Description**	**Latitude**	**Longitude**
Middle Coosa (0315-0106)							
0807	St. Clair	LAYC-6	Kelly Cr	Kelly Cr	Deepest point, main creek channel, Kelly Creek embayment, approximately 0.5 miles upstream of lake confluence.	33.4115	-86.3606
0703	Talladega	LAYC-7	Talladega Cr	Talladega Cr	Deepest point, main creek channel, Talladega Creek embayment, immediately upstream of AL Hwy. 235 bridge.	33.3064	-86.3537
Lower Coosa (0315-0107)							
0401	Chilton	LAYC-1**	Lower	Coosa R	Lower reservoir. Deepest point, main river channel, dam forebay .	32.9683	-86.5189
0102	Shelby	LAYC-2	Upper	Coosa R	Upper reservoir. Deepest point, main river channel, upstream of Bullock's Islands.	33.2217	-86.4665
0401	Shelby	LAYC-3**	Mid	Coosa R	Mid reservoir. Deepest point, main river channel, immed. downstream of Peckerwood Creek/Coosa River confluence.	33.1097	-86.4912
0204	Talladega	LAYC-8	Tallaseehatchee Cr	Tallasseehatche e Cr	Deepest point, main creek channel, Tallaseehatchee Creek embayment, immediately upstream of AL Hwy. 235 bridge.	33.2923	-86.3528
0305	Shelby	LAYC-9	Yellowleaf Cr	Yellowleaf Cr	Deepest point, main creek channel, Yellowleaf Creek embayment, upstream of Gaston Steam Plant discharge.	33.2476	-86.4570
0402	Talladega	LAYC-10	Peckerwood Cr	Peckerwood Cr	Deepest point, main creek channel, Peckerwood Creek embayment, approximately 0.5 miles upstream of lake confluence.	33.1058	-86.4738
0503	Chilton	LAYC-11	Waxahatchee Cr	Waxahatchee Cr	Deepest point, main creek channel, Waxahatchee Creek embayment, approximately 0.5 miles upstream of lake confluence.	33.0236	-86.5312

**Growing season mean Chl a criteria will be established at this station in 2010

All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (SOP), Surface Water Quality Assurance Project Plan (QAPP), and Quality Management Plan (QMP).

RESULTS

Summary statistics of all data collected in 2005 are presented in Appendix Table 1. The table contains the min, max, median, average, and standard deviation of each parameter analyzed.

The highest and lowest mean TN concentrations occurred in the upper tributaries, with mean TN concentrations highest in Tallaseehatchee Cr (0.865 mg/l) and lowest in Kelly Cr (0.488mg/l) (Fig. 2). Monthly TN concentrations for mainstem stations were generally higher than corresponding historic means. However, in August and October, monthly TN concentrations were lower than the historic means (Fig. 3, 4 & 5).

Mean TP concentrations ranged from 0.036 to 0.070 mg/l, indicating eutrophic conditions throughout the reservoir. Tallaseehatchee Cr, which had the highest mean TN concentration, also had the highest mean TP concentration. Kelly Cr, which had the lowest mean TN concentration, also had the lowest mean TP concentration (Fig. 2). The lowest monthly TN concentrations for the three mainstream stations occurred in August and October (Fig. 3, 4 & 5).

Mean chl *a* concentrations were lowest in Kelly and Talladega Creeks (6.18 and 6.15 ug/L) and highest at the mid-reservoir station (21.44 ug/L) (Fig. 2). Monthly concentrations were highest in July at the mid and lower mainstem reservoir stations and in October at the upper station (Fig. 3, 4 & 5). The ADEM monitored growing season mean chl *a* concentrations at mainstem reservoir stations in 1997, 2000, and 2005 (Fig. 6). Mean chl *a* was consistently higher at the mid-reservoir station. Results also suggest increasing concentrations at the upper reservoir station and decreasing concentrations at the lower reservoir station (Fig. 6).

Mean TSS concentrations in Lay were generally higher in the upper portions of the reservoir, with the highest mean concentration measured in Yellowleaf Cr (Fig. 2). Monthly TSS concentrations for the upper station generally correlated with flow (Fig. 3). Concentrations were

above historic means in six of the seven sampling months at the mid and lower mainstem stations (Fig. 4 & 5).

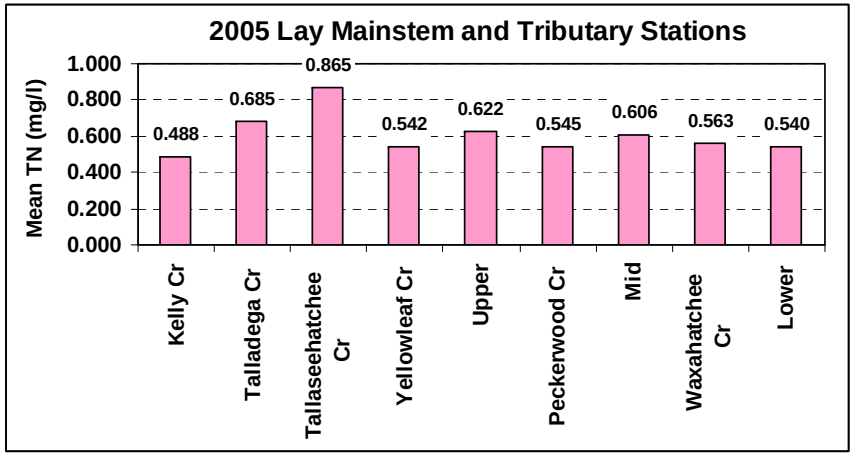
Algal growth potential testing (AGPT) results showed nitrogen limited conditions at the upper and mid reservoir stations. The lower station was found to have no limiting nutrient (Table 2). The mean standing crop (MSC) value at the upper station was above the 5 mg/l limit considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

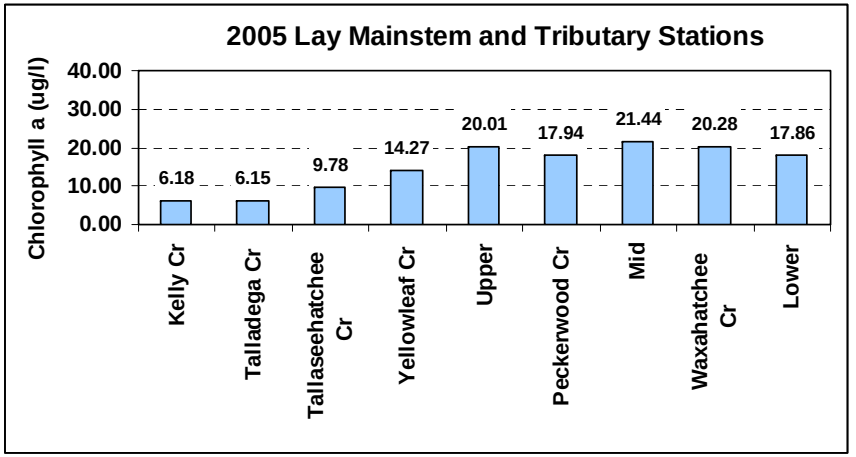
The dissolved oxygen concentrations at the Kelly Creek station was <5.0 mg/l at a depth of 5.0 ft. during August and September (Fig. 8). All other dissolved oxygen measurements met the ADEM Water Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l at a depth of 5.0 ft (Fig. 7 & 8). Profiles of the mainstem stations show the reservoir to be generally well oxygenated at the upper station and more stratified at the mid and lower reservoir stations (Fig. 7). Water temperatures were over 30°C in August at all stations.

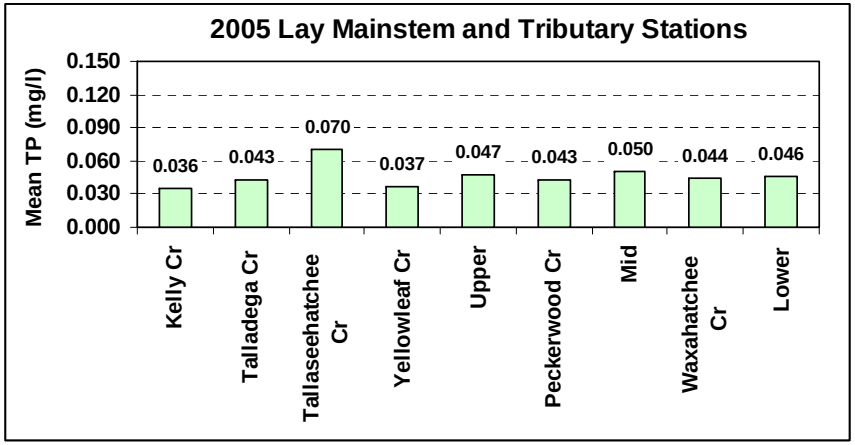
Carlson's TSI was calculated from the corrected chl *a* concentrations. TSI values of mainstem stations were in the mid-eutrophic range April-October (Fig.9). Trophic status of Waxahatchee, Tallaseehatchee, Yeallowleaf, and Peckerwood Creeks were eutrophic June-October.

August TSI values calculated from data collected at mainstem stations, 1985-2005, are presented in Fig. 10. August TSI values have remained eutrophic since 1985.

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 Lay Reservoir, April-October 2005. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.







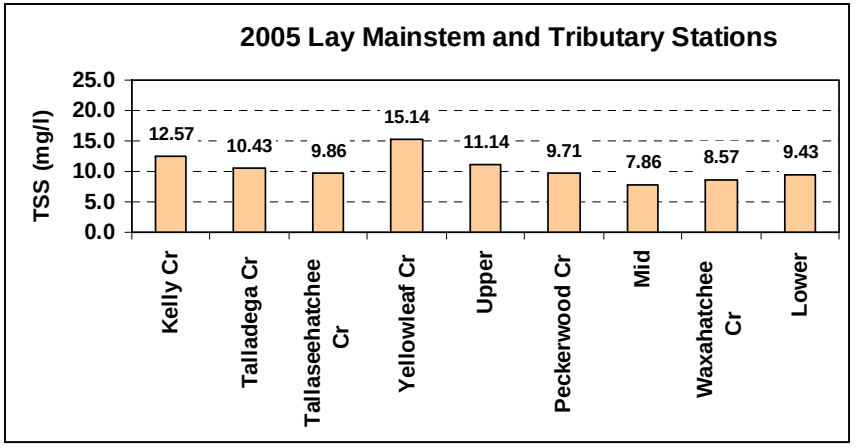
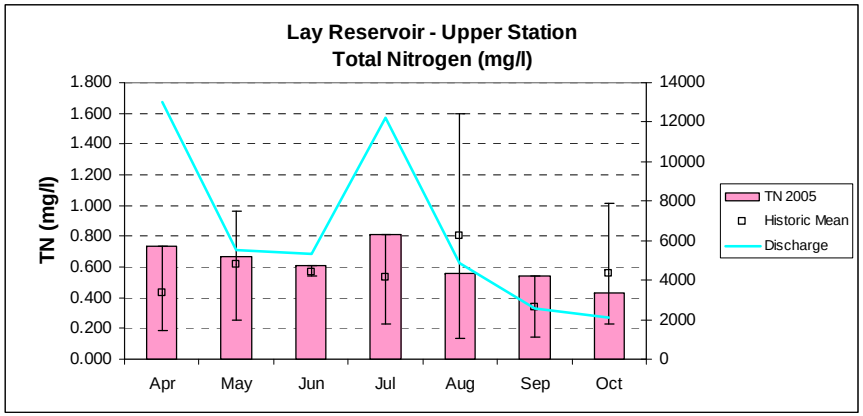
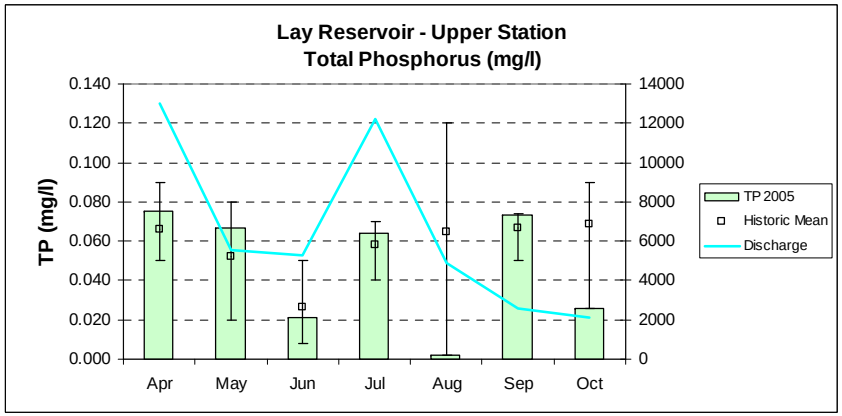
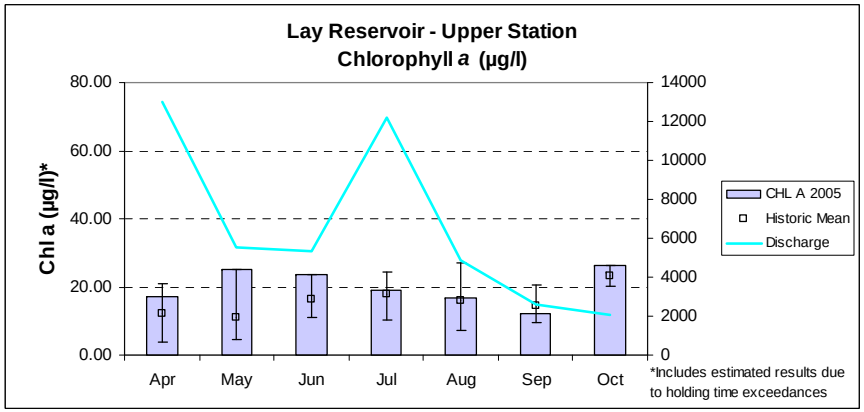


Figure 3. Total nitrogen (TN), total phosphorus (TP), chlorophyll a (Chl *a*) and total suspended solids (TSS) of the upper station in Lay Reservoir, April-October 2005. Each bar graph depicts monthly changes in the variables at the upper station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS are plotted vs. discharge (Coosa River near Rome, GA).







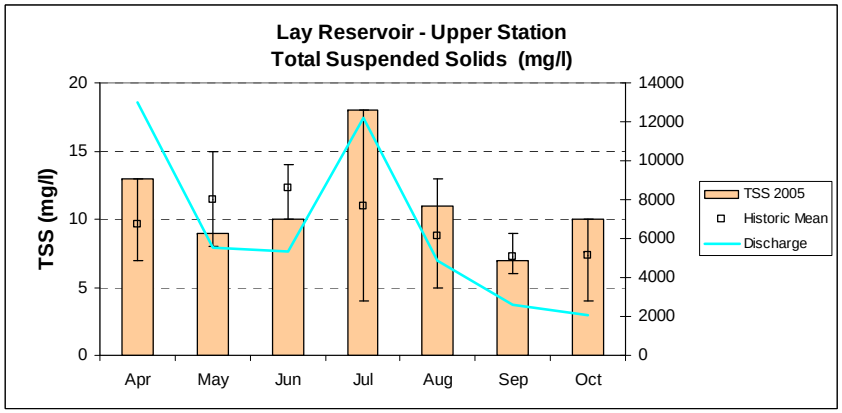
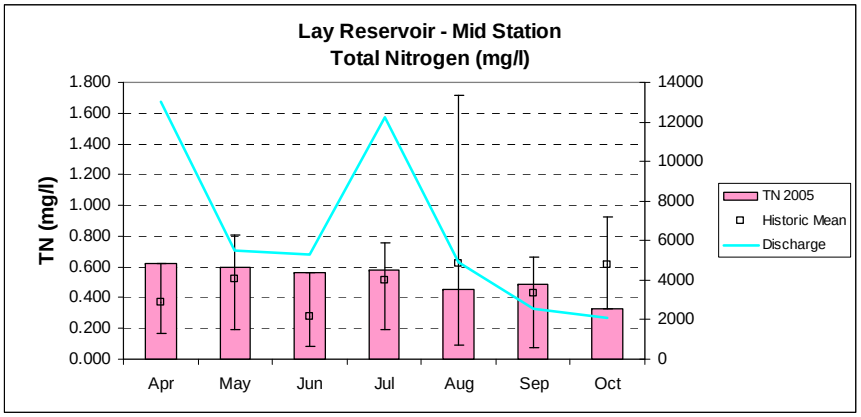
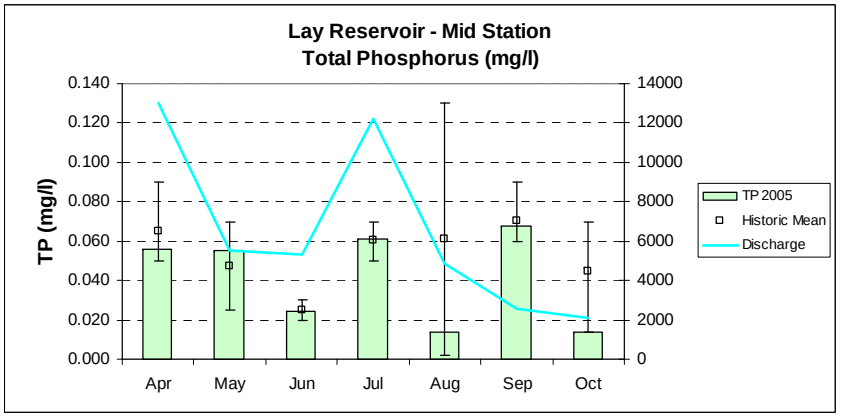
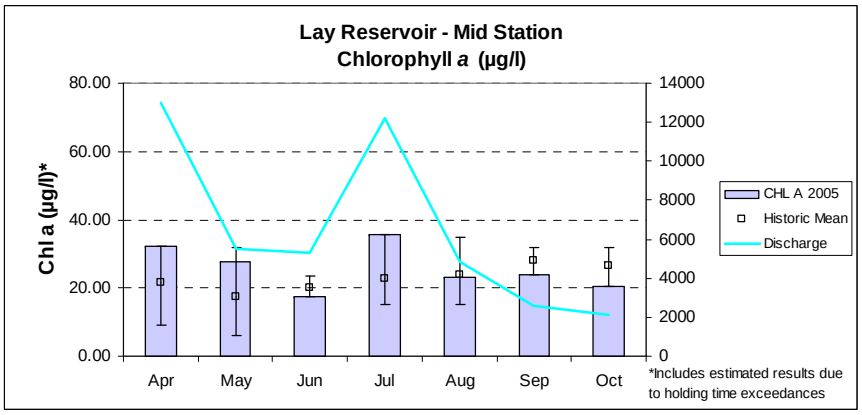


Figure 4. Total nitrogen (TN), total phosphorus (TP), chlorophyll a (Chl *a*) and total suspended solids (TSS), April-October 2005. Each bar graph depicts monthly changes in the variables at the mid-reservoir station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS are plotted vs. discharge (Coosa River near Rome, GA).







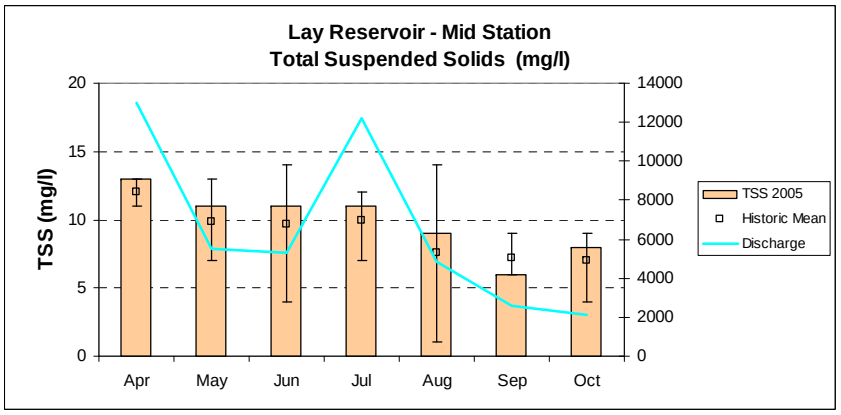


Figure 5. Total nitrogen (TN), total phosphorus (TP), chlorophyll a (Chl *a*) and total suspended solids (TSS), April-October 2005. Each bar graph depicts monthly changes in the variables at the lower reservoir station. The historic mean and min/max range are also displayed for comparison. Nutrients and TSS are plotted vs. discharge (Coosa River near Rome, GA).

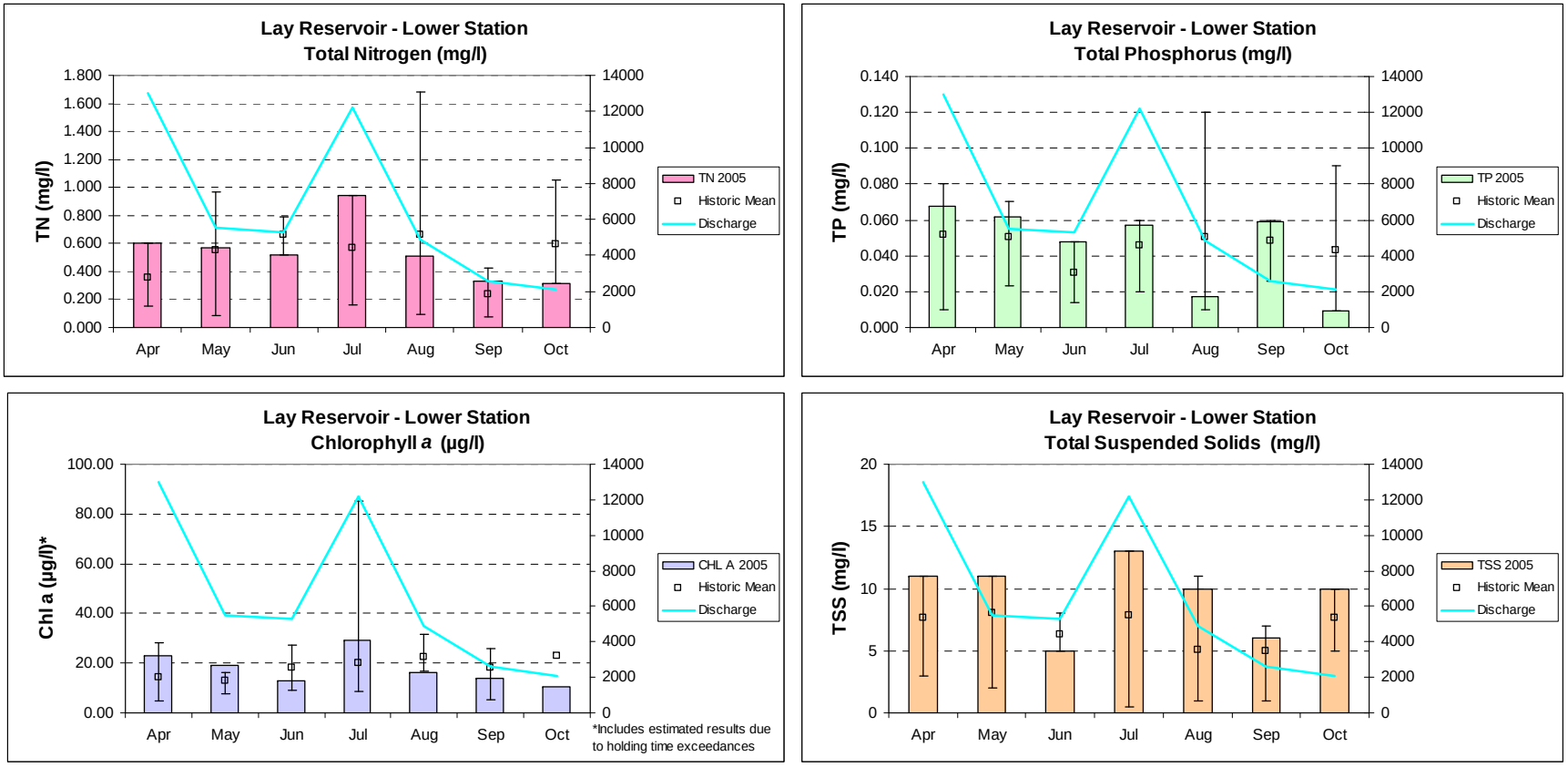


Figure 6. Growing season mean chlorophyll a concentrations of mainstem Lay Reservoir, 1997 through 2005.

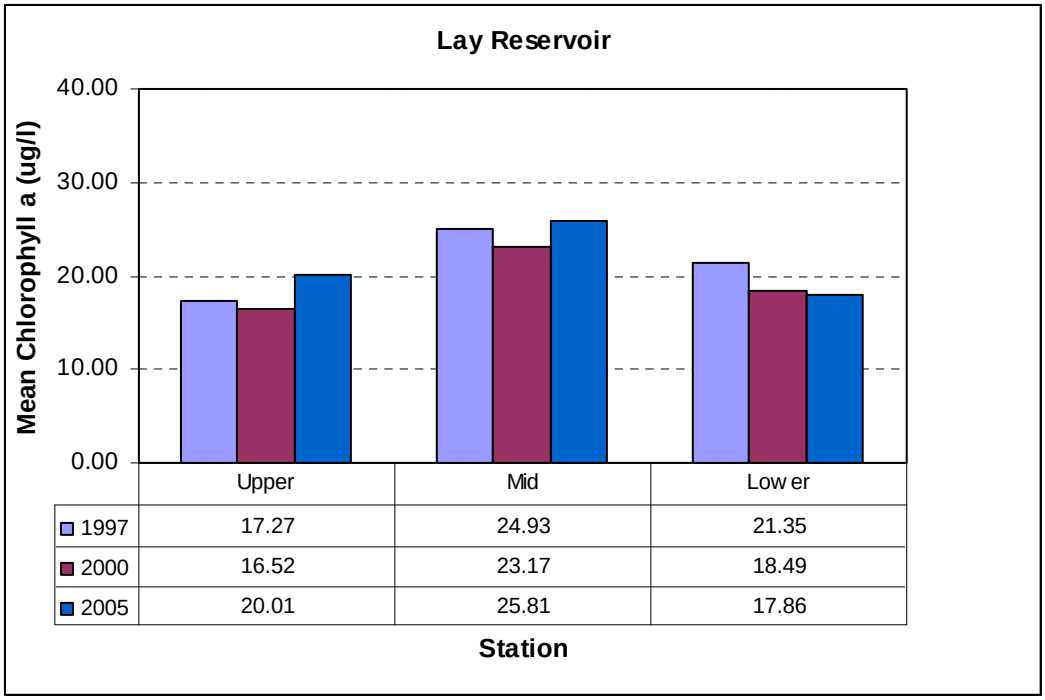


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) or dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status from 2000 and 2005. Mean standing crop (MSC) values below 5 mg/l are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Station	2000 Control mean MSC	2000 Limiting Nutrient	2005 Control mean MSC	2005 Limiting Nutrient
Upper	3.04	Co-Limiting	10.35	Nitrogen
Mid	5.55	Nitrogen	3.72	Nitrogen
Lower	2.67	Non Limiting	3.31	Non Limiting

Figure 7. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in Lay Reservoir, 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 5ft (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.

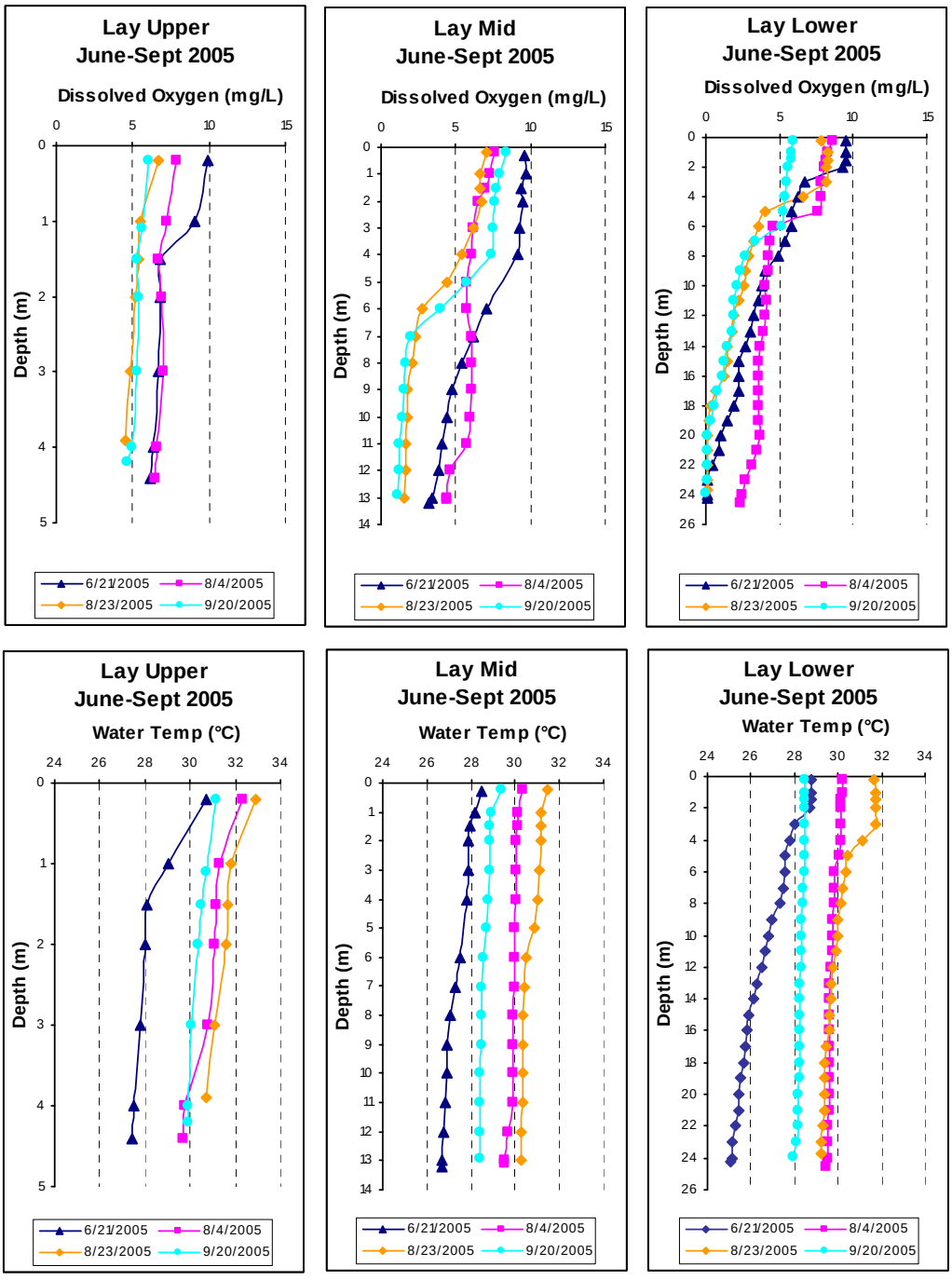
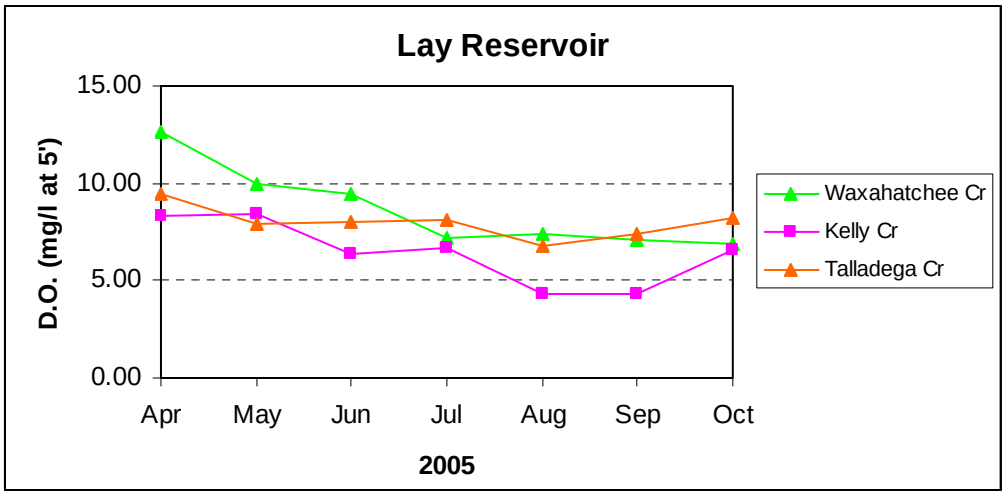


Figure 8. DO concentrations at 5 ft. for Lay Reservoir tributaries collected April-October 2005. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations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



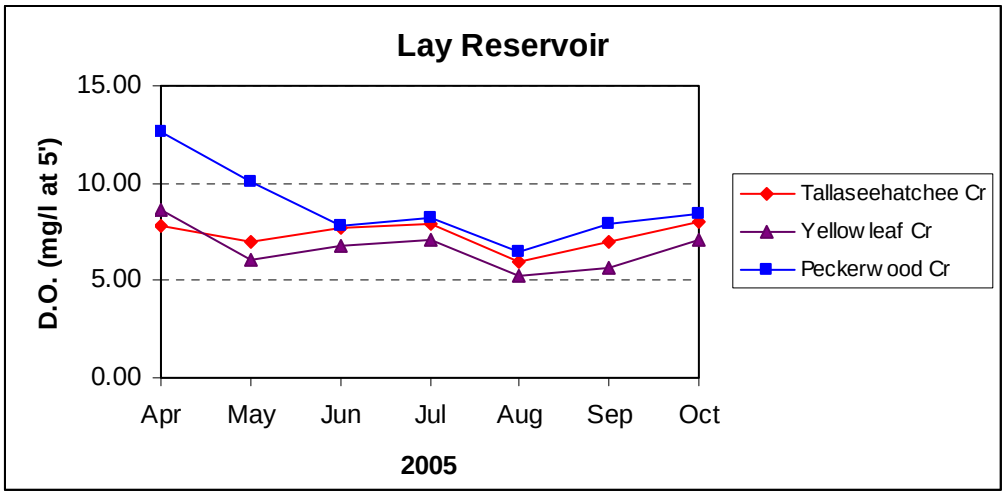
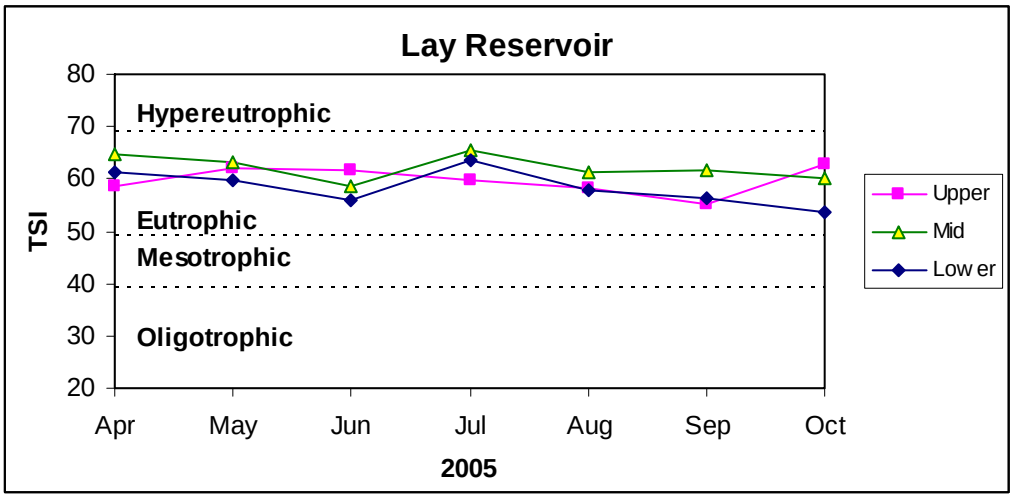
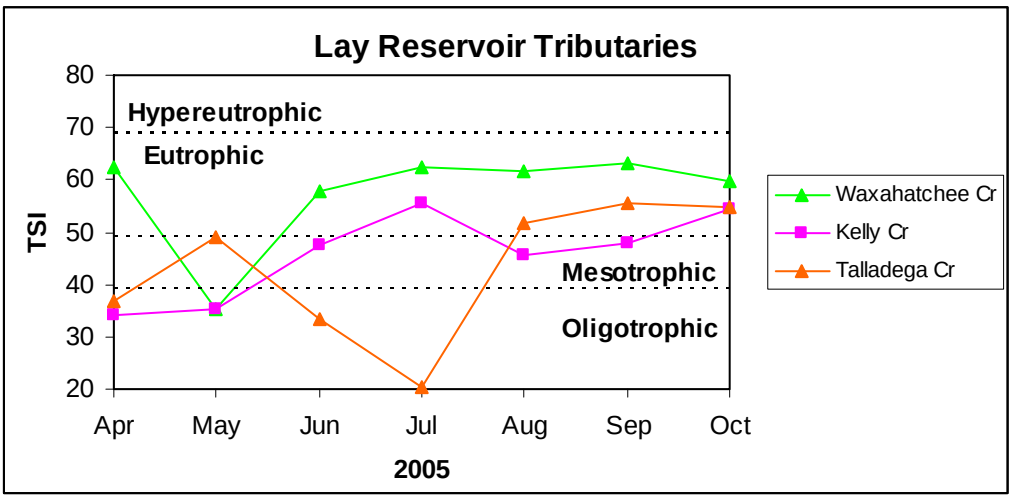


Figure 9. Monthly TSI values for mainstem and tributary stations using chlorophyll a concentrations and the Carlson's Trophic State Index calculation, April-October 2005.





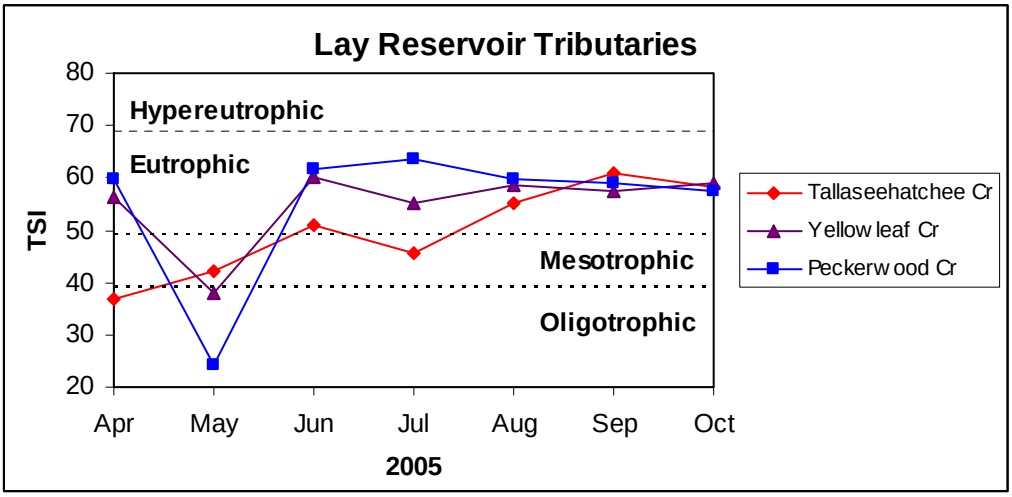
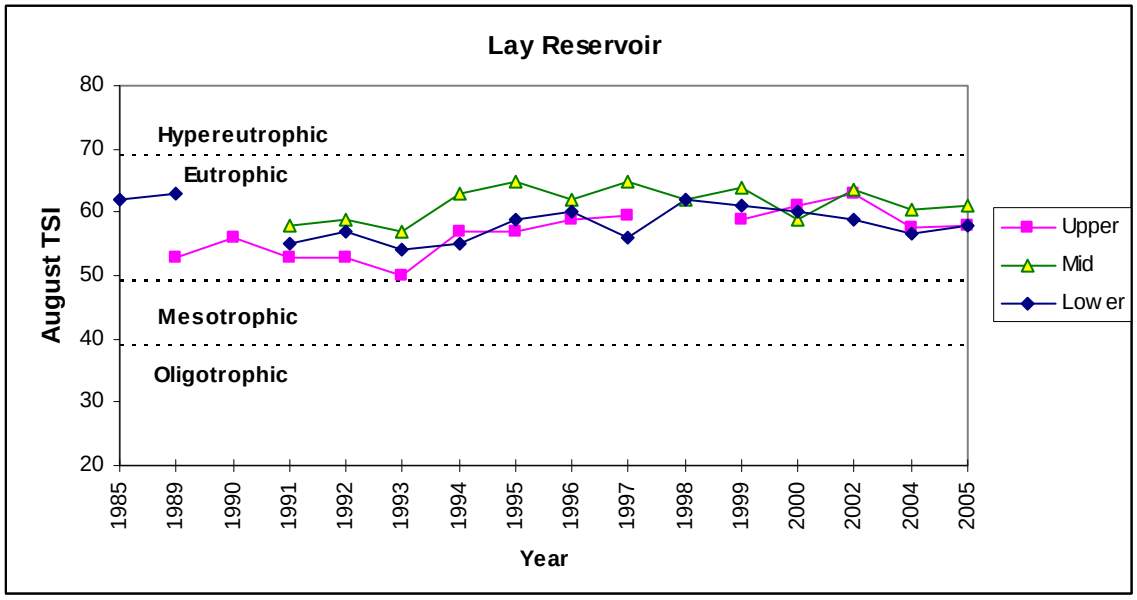


Figure 10. Trophic State Index values from critical period sampling (August sampling only) from 1985 to 2005.



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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 (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	Median	Avg	SD
LAYC-1	Alkalinity (mg/L)	7	46.9	66.5	57.5	57.2	6.7
	Hardness (mg/L)	4	51.6	67.8	53.0	56.4	7.7
	Total Dissolved Solids (mg/L)	7	43.0	129.0	72.0	82.9	30.3
	Total Suspended Solids (mg/L)	7	5.0	13.0	10.0	9.4	2.9
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.070	0.008	0.019	0.023
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.149	0.002	0.027	0.055
	Total Kjeldahl Nitrogen (mg/L)	7	0.308	0.912	0.503	0.513	0.200
	Total Nitrogen (mg/L)	7	0.310	0.940	0.510	0.539	0.210
	Total Phosphorus (mg/L)	7	0.009	0.068	0.057	0.046	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.010	0.007	0.007	0.003
	Chlorophyll a (mg/L)[J]	7	10.32	29.37	16.38	17.86	6.54
	Turbidity (NTU)	7	2	6	3	4	2
	Secchi (m)	7	0.85	2.22	1.29	1.44	0.49
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	1	---
LAYC-2	Alkalinity (mg/L)	7	53.7	75.9	59.9	62.5	7.8
	Hardness (mg/L)	4	57.1	66.5	61.0	61.4	4.1
	Total Dissolved Solids (mg/L)	7	74.0	109.0	94.0	95.0	12.1
	Total Suspended Solids (mg/L)	7	7.0	18.0	10.0	11.1	3.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.167	0.008	0.042	0.063
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.021	0.266	0.103	0.132	0.089
	Total Kjeldahl Nitrogen (mg/L)	7	0.325	0.640	0.465	0.489	0.109
	Total Nitrogen (mg/L)	7	0.430	0.810	0.610	0.620	0.128
	Total Phosphorus (mg/L)	7	< 0.004	0.075	0.064	0.047	0.030
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.018	0.008	0.010	0.005
	Chlorophyll a (mg/L)[J]	7	12.10	26.34	19.22	20.01	5.17
	Turbidity (NTU)	7	6	13	7	8	2
	Secchi (m)	7	0.69	0.99	0.78	0.84	0.13
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	2	---
LAYC-3	Alkalinity (mg/L)	7	49.0	70.9	56.4	60.4	8.6
	Hardness (mg/L)	4	51.9	68.8	55.4	57.9	7.5
	Total Dissolved Solids (mg/L)	7	70.0	105.0	84.0	86.4	11.8
	Total Suspended Solids (mg/L)	7	6.0	13.0	11.0	9.9	2.3
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.104	0.008	0.037	0.045
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.110	0.002	0.029	0.047
	Total Kjeldahl Nitrogen (mg/L)	7	0.328	0.598	0.501	0.491	0.087
	Total Nitrogen (mg/L)	7	0.330	0.620	0.560	0.519	0.103
	Total Phosphorus (mg/L)	7	0.014	0.068	0.055	0.042	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.016	0.008	0.008	0.005
	Chlorophyll a (mg/L)[J]	7	17.44	35.78	23.85	25.81	6.45
	Turbidity (NTU)	7	5	9	5	6	2
	Secchi (m)	7	0.71	1.06	0.98	0.96	0.12
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	10	---

Station	Parameter	N	Min	Max	Median	Avg	SD
LAYC-6	Alkalinity (mg/L)	7	43.5	70.9	57.3	57.6	9.4
	Hardness (mg/L)	4	48.2	67.9	53.5	55.8	9.2
	Total Dissolved Solids (mg/L)	7	37.0	139.0	86.0	83.1	33.6
	Total Suspended Solids (mg/L)	7	5.0	23.0	13.0	12.6	6.0
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.133	0.103	0.067	0.056
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.004	0.143	0.062	0.075	0.057
	Total Kjeldahl Nitrogen (mg/L)	7	0.210	0.797	0.393	0.413	0.205
	Total Nitrogen (mg/L)	7	0.270	0.810	0.520	0.487	0.189
	Total Phosphorus (mg/L)	7	< 0.004	0.069	0.036	0.036	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.018	0.010	0.011	0.006
	Chlorophyll a (mg/L)[J]	7	1.42	12.82	5.54	6.18	4.43
	Turbidity (NTU)	7	4	19	8	9	5
	Secchi (m)	7	0.64	1.65	1.11	1.14	0.37
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	5	---
LAYC-7	Alkalinity (mg/L)	7	79.1	106.9	89.9	91.4	9.8
	Hardness (mg/L)	4	92.1	98.2	94.8	95.0	2.9
	Total Dissolved Solids (mg/L)	7	67.0	138.0	100.0	99.4	27.0
	Total Suspended Solids (mg/L)	7	5.0	18.0	9.0	10.4	4.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.077	0.022	0.034	0.029
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.264	0.600	0.414	0.417	0.110
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.485	0.202	0.257	0.142
	Total Nitrogen (mg/L)	7	0.340	0.970	0.670	0.676	0.192
	Total Phosphorus (mg/L)	7	0.015	0.066	0.050	0.043	0.021
	Dissolved Reactive Phosphorus (mg/L)	7	0.005	0.023	0.018	0.017	0.006
	Chlorophyll a (mg/L)[J]	7	0.36	12.55	6.68	6.15	5.06
	Turbidity (NTU)	7	7	14	9	10	2
	Secchi (m)	7	0.80	1.22	0.99	1.01	0.13
	Fecal Coliform (col/100 mL)	1	---	---	---	> 82	---
LAYC-8	Alkalinity (mg/L)	7	72.4	99.3	82.7	85.3	10.5
	Hardness (mg/L)	4	74.5	100.0	87.0	87.1	11.3
	Total Dissolved Solids (mg/L)	7	58.0	199.0	110.0	112.1	43.6
	Total Suspended Solids (mg/L)	7	6.0	14.0	10.0	9.9	2.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.090	0.017	0.029	0.030
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.240	0.803	0.571	0.507	0.213
	Total Kjeldahl Nitrogen (mg/L)	7	0.286	0.420	0.357	0.358	0.048
	Total Nitrogen (mg/L)	7	0.550	1.220	0.920	0.864	0.229
	Total Phosphorus (mg/L)	7	< 0.004	0.103	0.078	0.070	0.033
	Dissolved Reactive Phosphorus (mg/L)	7	0.011	0.081	0.048	0.044	0.022
	Chlorophyll a (mg/L)[J]	7	1.87	21.89	8.01	9.78	7.48
	Turbidity (NTU)	7	5	11	8	8	2
	Secchi (m)	6	0.91	1.09	1.02	0.87	0.39
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	6	---

Station	Parameter	N	Min	Max	Median	Avg	SD
LAYC-9	Alkalinity (mg/L)	7	39.1	67.1	56.0	56.5	10.6
	Hardness (mg/L)	4	53.6	67.9	57.0	58.9	6.3
	Total Dissolved Solids (mg/L)	7	64.0	111.0	83.0	85.7	17.5
	Total Suspended Solids (mg/L)	7	8.0	22.0	16.0	15.1	4.7
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.091	0.008	0.024	0.032
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.186	0.090	0.095	0.058
	Total Kjeldahl Nitrogen (mg/L)	7	0.381	0.612	0.427	0.447	0.075
	Total Nitrogen (mg/L)	7	0.470	0.610	0.530	0.540	0.045
	Total Phosphorus (mg/L)	7	< 0.004	0.070	0.026	0.037	0.028
	Dissolved Reactive Phosphorus (mg/L)	7	0.005	0.012	0.006	0.008	0.003
	Chlorophyll a (mg/L)[J]	7	2.14	20.65	15.31	14.27	6.03
	Turbidity (NTU)	7	12	24	15	16	4
	Secchi (m)	7	0.49	0.84	0.63	0.67	0.13
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	6	---
LAYC-10	Alkalinity (mg/L)	7	46.7	68.3	54.5	57.1	8.0
	Hardness (mg/L)	4	49.7	69.8	55.2	57.5	8.6
	Total Dissolved Solids (mg/L)	7	61.0	106.0	89.0	84.9	16.9
	Total Suspended Solids (mg/L)	7	4.0	15.0	10.0	9.7	3.5
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.168	0.008	0.052	0.068
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.071	0.002	0.014	0.026
	Total Kjeldahl Nitrogen (mg/L)	7	0.342	0.836	0.478	0.530	0.169
	Total Nitrogen (mg/L)	7	0.340	0.860	0.510	0.544	0.175
	Total Phosphorus (mg/L)	7	< 0.004	0.070	0.051	0.043	0.024
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.012	0.008	0.007	0.003
	Chlorophyll a (mg/L)[J]	7	0.53	28.84	19.22	17.94	8.84
	Turbidity (NTU)	7	4	7	5	6	1
	Secchi (m)	7	0.78	1.42	1.18	1.14	0.19
	Fecal Coliform (col/100 mL)[J]	1	---	---	---	1	---
LAYC-11	Alkalinity (mg/L)	7	47.4	68.3	53.3	57.4	8.3
	Hardness (mg/L)	4	51.3	69.6	53.8	57.1	8.5
	Total Dissolved Solids (mg/L)	7	24.0	118.0	90.0	83.0	32.3
	Total Suspended Solids (mg/L)	7	5.0	13.0	6.0	8.6	3.6
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.168	0.019	0.051	0.065
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.102	0.002	0.022	0.039
	Total Kjeldahl Nitrogen (mg/L)	7	0.441	0.711	0.526	0.539	0.094
	Total Nitrogen (mg/L)	7	0.450	0.710	0.540	0.560	0.089
	Total Phosphorus (mg/L)	7	0.024	0.069	0.039	0.044	0.017
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.016	0.005	0.006	0.005
	Chlorophyll a (mg/L)[J]	7	1.60	28.30	23.85	20.28	9.19
	Turbidity (NTU)	7	3	7	4	5	2
	Secchi (m)	7	0.76	1.98	1.26	1.28	0.36
	Fecal Coliform (col/100 mL)	1	---	---	---	< 1	---

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