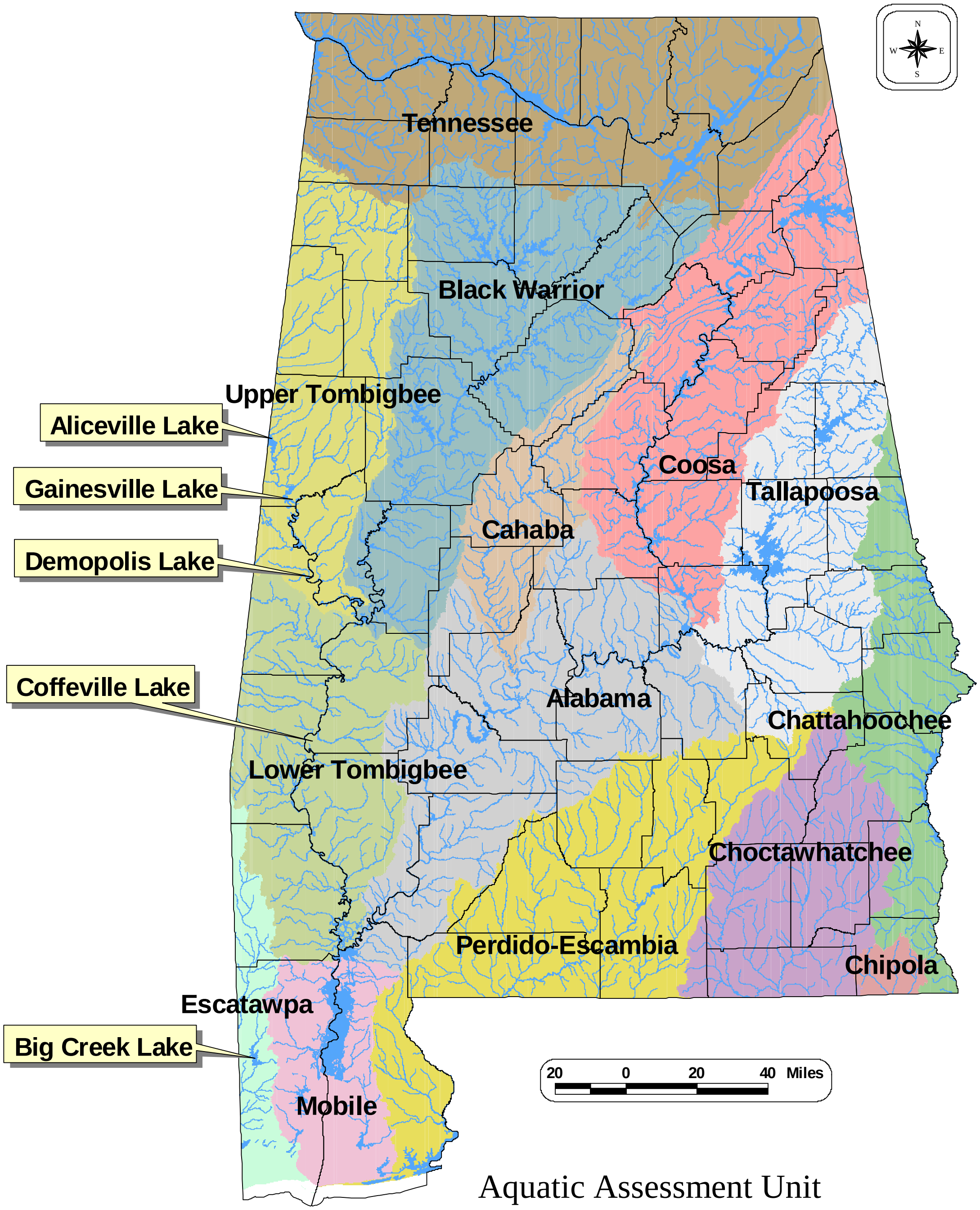
Intensive Water Quality Survey of Tombigbee and Escatawpa River Reservoirs
2001



Aquatic Assessment Unit
Field Operations Division
Alabama Department of Environmental Management

Intensive Water Quality Survey of Tombigbee and Escatawpa River Reservoirs 2001

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Environmental Indicators Section
Field Operations Division
Alabama Department of Environmental Management

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FINAL REPORT

Preface

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Comments or questions related to this report should be addressed to:

Alabama Department of Environmental Management

Field Operations Division

Aquatic Assessment Unit

P.O. Box 301463

Montgomery, AL 36130-1463

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INTRODUCTION

ADEM Reservoir Water Quality Monitoring Program

Section 314(a)(1) of the Water Quality Act of 1987 requires states to conduct assessments of the water quality of publicly-owned lakes and report the findings as part of their biennial 305(b) Water Quality Report To Congress. Prior to 1997, funding for the assessments was provided by Lake Water Quality Assessment (LWQA) grants administered through the Clean Lakes Program of the United States Environmental Protection Agency (EPA). Submittal to the EPA of approved lakes assessment information from states ensured continued eligibility for financial assistance under the Clean Lakes Program. With the discontinuance of Clean Lakes Program funding, water quality assessments are currently conducted using funding from a variety of sources, including Clean Water Act Section 319 funds.

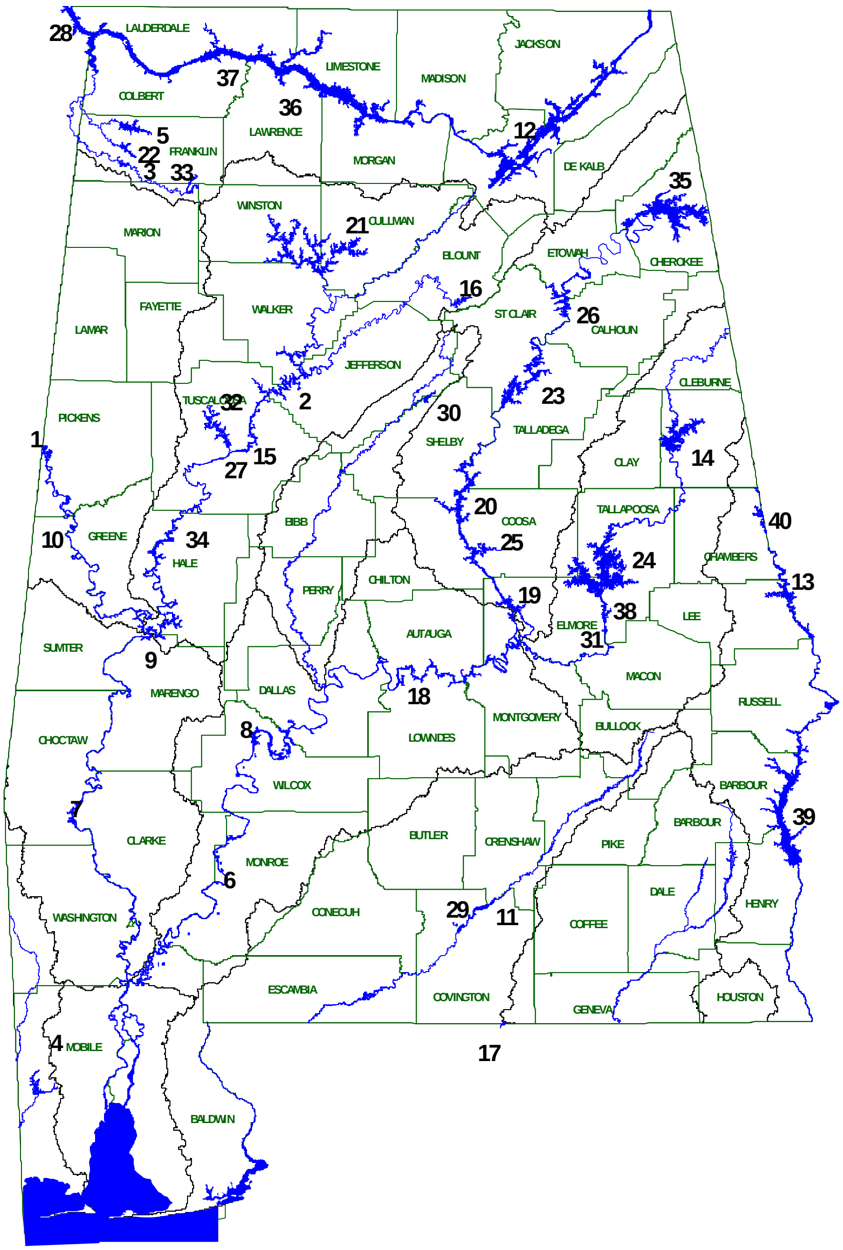
The Alabama Department of Environmental Management (ADEM) has defined publicly-owned lakes/reservoirs as those that are of a multiple-use nature, publicly-accessible, and exhibit physical/chemical characteristics typical of impounded waters. Lakes designated strictly for water supply, privately owned lakes, or lakes managed by the Alabama Department of Conservation and Natural Resources (ADCNR) strictly for fish production are not included in this definition. Lakes or reservoirs meeting the publicly-owned requirements defined above are listed in Figure 1.

In 1985, the need for information on the trophic state of Alabama's publicly-owned lakes led to an initial survey conducted by ADEM with the assistance of the Environmental Protection Agency (EPA), Region IV. The survey established limited baseline information on the lakes and was used to rank them according to trophic condition.

In 1989, LWQA funds enabled the ADEM to conduct required water quality assessments of thirty-four publicly-owned lakes in the state and submit the collected

Figure 1.

Alabama Publicly Accessible Reservoirs



1) Aliceville
2) Bankhead
3) Bear Creek
4) Big Creek
5) Cedar Creek
6) Claiborne
7) Coffeeville
8) Dannelly
9) Demopolis
10) Gainesville
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33) Upper Bear Creek
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35) Weiss
36) Wheeler
37) Wilson
38) Yates
39) W. F. George
40) West Point

information as part of the 1990 305(b) Water Quality Report to Congress (ADEM 1989). Trophic state index (TSI) values calculated from data gathered for the water quality assessments indicated potentially significant increases when compared to TSI values from the study conducted in 1985.

In 1990, the Reservoir Water Quality Monitoring (RWQM) Program was initiated by the Special Studies Section of the Field Operations Division of ADEM. Objectives of the program are as follows:

a) to develop an adequate water quality database for all publicly-owned lakes in the state;

b) to establish trends in lake trophic status that can only be established through long-term monitoring efforts; and,

c) to satisfy the requirement of Section 314(a)(1) of the Water Quality Act of 1987 that states conduct assessments of the water quality of publicly-owned lakes and report the findings as part of their biennial Water Quality Report to Congress.

Acquiring this information enables the ADEM to determine lake water quality and identify those in which water quality may be deteriorating. Should deterioration in lake water quality be indicated by collected data, more intensive study of the lake can be instituted to establish causes and extent of the deterioration.

Thirty-one publicly-owned lakes in the state were monitored at least once during the three-year period 1990-1992. In 1991, additional funding received through the Clean Lakes Program enabled the expansion of the RWQM Program to include all of the 31 publicly-owned lakes in the state, with the exception of those in the Tennessee River system. Expansion of the program allowed more extensive monitoring of certain lakes for which water quality concerns were greatest and the inclusion of Alabama/Georgia border lakes that were not included in earlier water quality assessments.

Beginning in 1994, the frequency of reservoir monitoring in the RWQM Program was increased to a minimum of once every two years so that the water quality database and trends in trophic status could be developed more rapidly. Lakes indicated to be use-threatened or impaired from previously collected data continued to be monitored annually. Realignment of the reservoir sampling schedule was also begun in 1994 so that reservoir sampling by basin could be instituted by 1996.

During 1997, intensive monitoring of reservoirs by basin was initiated with Coosa and Tallapoosa reservoirs sampled to gather water quality data prior to proposed water diversions in Georgia (ADEM 2002). Intensive monitoring consists of monthly sampling of mainstem and tributary embayment sites through the algal growing season (April through October). Basins sampled to date are as follows:

a) 1997 - Coosa and Tallapoosa basins;
b) 1998 - Warrior basin;
c) 1999 - Chattahoochee and Conecuh basins;
d) 2000 - Coosa, Tallapoosa, Alabama basins; and,
e) 2001 - Escatawpa, Tombigbee basins.

MATERIALS AND METHODS

Sampling Locations. Reservoirs sampled during 2001 appear in Table 1. Locations of sampling sites appear in Table 2. All reservoirs were sampled at the dam forebay. Multiple mainstem and tributary embayment sites were sampled at each reservoir. Water quality measurements and water sample collections were conducted from boats positioned at the deepest point of the channel at each sampling site.

Sample Collection. Intensive monitoring of reservoirs consisted of monthly sampling of all stations from April through October in the Tombigbee and Escatawpa basins. Reservoirs within each basin were sampled within a one-week period to reduce weather-related variability in water quality conditions.

Monitoring and analyses were conducted in accordance with appropriate standard operating procedures. Water quality variables measured during 2001 appear in Table 3.

At each sampling site temperature, dissolved oxygen, specific conductance, and pH were measured *in situ* at multiple depths in the water column with Hydrolab instruments.

A standard, 20 cm diameter Secchi disk with alternating black and white quadrants was used to measure visibility. Photic zone depth determinations were made by measuring the vertical illumination of the water column using an underwater photometer. The depth at which one percent of the surface illumination was measured by the photometer was considered the photic zone depth. A composite water sample of approximately twenty liters was collected from the photic zone. The sample was collected by raising and lowering a plastic submersible pump and hose apparatus repeatedly through the photic zone while collecting the sample in a plastic container. Withdrawal of individual samples from the composite water sample occurred in the order presented in the following paragraphs.

Chlorophyll *a* samples were collected by filtering a minimum of 500 ml of the composite photic zone sample through glass fiber filters immediately after collection of

Table 1. Reservoirs sampled during the Intensive Water Quality Survey of Tombigbee and Escatawpa River Reservoirs, 2001.

River Basin	Reservoir	Surface Area (acres)	Drainage Area (square miles)
Tombigbee			
	Aliceville	8,300	5,785
	Gainesville	6,400	7,142
	Demopolis	10,000	15,385
	Coffeeville	8,800	18,417
Escatawpa			
	Big Creek	3,600	105

Table 2. Monitoring sites for the Intensive Water Quality Survey of Tombigbee and Escatawpa River Reservoirs, 2001.

Basin	Reservoir	Station #	Latitude	Longitude	Description
Tombigbee					
	Aliceville	1	33.21905954	-88.28606321	Deepest point, main river channel, dam forebay .
		2	33.30533388	-88.30754479	Deepest point, main river channel, immed. upstream of Lindsey Creek confluence .
		3	33.26687169	-88.29357099	Deepest point, main creek channel, Coal Fire Creek embayment, approx. one mile upstream of confluence with Tombigbee River.
	Gainesville	1	32.85588295	-88.15445638	Deepest point, main river channel, dam forebay .
		2	32.9817556	-88.16940881	Deepest point, main river channel, approx. 1.5 miles downstream of Sipsey River confluence.
		3	33.07893013	-88.26180478	Deepest point, main river channel, approx. 0.5 miles downstream of Bogue Chitto Creek confluence.
		4	33.0837084	-88.26756936	Deepest point, main creek channel, Bogue Chitto Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		5	33.07344	-88.17740928	Deepest point, main creek channel, Lubbub Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		6	33.00858345	-88.17158894	Deepest point, main river channel, Sipsey River embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
	Demopolis	1	32.52011903	-87.8747804	Deepest point, main river channel, dam forebay .
		2	32.59942588	-88.0281156	Deepest point, main river channel, immed. downstream of Cobb Creek confluence.
		3	32.8035595	-88.10780698	Deepest point, main river channel, approx. two miles downstream of Tubbs Creek confluence.
		4	32.82742347	-88.1815549	Deepest point, Noxubee River channel, approx. one mile upstream of Tombigbee River confluence.

Basin	Reservoir	Station #	Latitude	Longitude	Description
	Demopolis	5	32.80704696	-88.08066982	Deepest point, main creek channel, Trussels Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		6	32.79536437	-88.06461889	Deepest point, main creek channel, Brush Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		7	32.70402497	-88.11221357	Deepest point, main creek channel, Factory Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
	Coffeeville	1	31.75290519	-88.13382153	Deepest point, main river channel, dam forebay .
		2	31.99463504	-88.07962793	Deepest point, main river channel, approx. 1.5 miles upstream of Big Bunny Creek confluence.
		3	32.29236849	-87.93796722	Deepest point, main river channel, approx. two miles downstream of Chickasaw Bogue Creek confluence.
		4	32.41956599	-88.04436386	Deepest point, main creek channel, Sucarnoochee Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		5	32.29369786	-87.92542835	Deepest point, main creek channel, Chickasaw Bogue Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		6	32.15650883	-88.01890989	Deepest point, main creek channel, Tuckabum Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		7	32.07607569	-88.05282993	Deepest point, main creek channel, Horse Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		8	32.0216573	-88.12000793	Deepest point, main creek channel, Wahalak Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.

Basin	Reservoir	Station #	Latitude	Longitude	Description
	Coffeeville	9	31.95441516	-88.07007965	Deepest point, main creek channel, Bashi Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		10	31.85692229	-88.15773659	Deepest point, main creek channel, Tallawampa Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		11	31.82423314	-88.18183739	Deepest point, main creek channel, Okatuppa Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
		12	31.79016798	-88.1689028	Deepest point, main creek channel, Turkey Creek embayment, approx. 0.5 miles upstream of confluence with Tombigbee River.
Escatawpa					
	Big Creek	1	30.714613	-88.327467	Deepest point, Big Creek channel, dam forebay .
		2	30.74005181	-88.33514222	Deepest point, Big Creek channel, approx. one mile downstream of the Crooked Creek confluence.
		3	30.76917424	-88.35045404	Deepest point, Big Creek channel, approx. one mile downstream of US Hwy. 98.
		4	30.76504751	-88.32860981	Deepest point, main creek channel, Crooked Creek embayment, approx. one mile downstream of US Hwy. 98.
		5	30.722719	-88.311215	Deepest point, main creek channel, Hamilton Creek embayment, approx. one mile upstream of confluence with Big Creek.

Table 3. Water quality variables measured during the Intensive Water Quality Survey of Tombigbee and Escatawpa River Reservoirs, 2001.

Variable	Method	Reference	Detection Limit
Physical			
Vertical illumination	Photometer, Secchi disk	Lind, 1979	---
Temperature	Thermistor	APHA et al. 1992	---
Turbidity	Nephelometer	APHA et al. 1992	---
Total dissolved solids	Filtration, drying	EPA-600/4-79-020	1 mg/l
Total suspended solids	Filtration, drying	EPA-600/4-79-020	1 mg/l
Specific conductance	Wheatstone bridge	APHA et al. 1992	---
Hardness	Titrametric, EDTA	EPA-600/4-79-020	1 mg/l
Alkalinity	Potentiometric titration	EPA-600/4-79-020	1 mg/l
Chemical			
Dissolved oxygen	Membrane electrode	APHA et al. 1992	---
pH	Glass electrode	APHA et al. 1992	---
Ammonia	Automated phenate	EPA-600/4-79-020	0.015 mg/l
Nitrate + Nitrite	Cadmium reduction	EPA-600/4-79-020	0.003 mg/l
Total Kjeldahl Nitrogen	Automated colorimetric	EPA-600/4-79-020	0.15 mg/l
Dissolved reactive phosphorus	Automated single reagent	EPA-600/4-79-020	0.004 mg/l
Total phosphorus	Persulfate digestion	EPA-600/4-79-020	0.004 mg/l
Total organic carbon	Persulfate-ultraviolet	EPA-600/4-79-020	0.50 mg/l
Biological			
Chlorophyll a	Spectrophotometeric	APHA et al. 1992	0.1 µg/l
Fecal coliform	Membrane filter	APHA et al. 1992	---
Algal growth potential test*	Printz Algal Assay Test	ADEM 1993	---

* Intensive Survey mainstem reservoir locations, August only.

the composite sample. Immediately after filtering, each filter was folded once and placed in a 50 mm petri dish. Each petri dish was wrapped in aluminum foil, sealed in a ziploc bag, and placed on ice for shipment to the Field Operations Division to be frozen until analyzed. Corrected chlorophyll *a* concentrations were used in calculating Carlson's trophic state index (TSI) for lakes. A more detailed discussion of Carlson's TSI appears later in this section.

Dissolved reactive phosphorus (formerly termed orthophosphate) samples were collected by vacuum-filtering 200 ml of the composite sample through 0.45 micron Millipore membrane filters and collecting the filtrate in acid-washed 250 ml Nalgene containers.

Finally, two half-gallon portions of the composite sample were collected in plastic containers and properly preserved for laboratory analysis of water quality variables. Subsurface grab samples were collected in properly prepared containers at each sampling site for fecal coliform analysis.

During August, samples for Algal Growth Potential Tests (AGPT) were collected from the composite photic zone sample of mainstem reservoir sampling locations by filling a properly prepared plastic container and preserving on ice. A more detailed discussion of AGPT appears later in this section.

All samples were preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures and Quality Control Assurance Manual Volume I Physical/Chemical (1992).

Quality Control / Quality Assurance. For quality control/quality assurance purposes, field duplicates of each sample type were collected at ten percent of the sampling sites. Field duplicates were true duplicates of the complete collection process. Blanks were collected at the same frequency as duplicates by processing distilled water through the collection and filtration equipment in the same manner as regular samples. Measurements of water temperature, dissolved oxygen, specific conductance, and pH were replicated at sampling sites where duplicate samples were collected.

Trophic State Index. Corrected chlorophyll *a* concentrations were used in calculating Carlson's trophic state index (TSI) for lakes (Carlson 1977). Carlson's TSI provides limnologists and the public with a single number that serves as an indicator of a lake's trophic status. Corrected chlorophyll *a* is the parameter used in the RWQM Program to calculate TSI because it is considered to give the best estimate of the biotic response of lakes to nutrient enrichment when algae are the dominant plant community. The trophic state classification scale used is as follows:

Oligotrophic:	TSI < 40
Mesotrophic:	TSI 40 - 49
Eutrophic:	TSI 50 - 69
Hypereutrophic:	TSI ≥ 70

Algal Growth Potential Tests. The Algal Growth Potential Test (AGPT) determines the total quantity of algal biomass supportable by the test waters and provides a reliable estimate of the bioavailable and limiting nutrients (Raschke and Schultz 1987). In control samples, maximum algal standing crop (MSC) dry weights below 5.0 mg/l are thought to assure protection from nuisance algal blooms and fish-kills in southeastern lakes, with the exception of lakes in Florida (Raschke and Schultz 1987). In most freshwater lakes, phosphorus is the essential plant nutrient that limits growth and productivity of plankton algae (Wetzel 1983). Nitrogen usually becomes the limiting nutrient when bioavailable phosphorus increases relative to nitrogen, as in the case of waters receiving quantities of treated municipal waste (Raschke and Schultz 1987). The AGPT is helpful in identifying these common growth limiting nutrients.

RESULTS AND DISCUSSION

Data Selection. Material in this section is divided by basin and reservoir. Water quality data presented for further discussion consist of the following:

a) total nitrogen (TN) and total phosphorus (TP), used as indicators of nutrient content in the waterbody;
b) algal growth potential tests (AGPT), used as a determinant of the total quantity of algal biomass supportable by test waters and of the limiting nutrient;
c) corrected chlorophyll a (chl. a), used as an indicator of algal biomass;
d) Carlson Trophic State Index (TSI), calculated from corrected chlorophyll a concentrations as a means of trophic state classification of the reservoir ;
e) Total suspended solids (TSS) concentrations, used as an indicator of water clarity; and,
f) dissolved oxygen (DO) concentrations, used as a more direct indicator of water quality because severe depletion can damage aquatic vertebrate and macroinvertebrate communities and interfere with water supply and recreational uses;

These data were selected because of their relationship to the process of eutrophication and their interest to the regulatory and scientific communities that stems from this relationship. The process of eutrophication and the effects on water quality will be discussed more fully in following paragraphs. Data not selected for further discussion in this report were done so in the interests of time, space, or data availability.

Graphs. Bar graphs consist of means of the variables for all months depicted in the line graphs. Bar graphs with multiple reservoirs and mainstem reservoir stations are illustrated from upstream to downstream as the graph is read from left to right. Line graphs for each reservoir depict the monthly changes in the variables. Unless otherwise specified, reservoir location is referred to in the legends of graphs as **upper**, for the upper portion of each reservoir; **mid**, for the middle portion of the reservoir; and **lower,** for the dam forebay of each reservoir.

Line graphs of DO concentrations consist of measurements conducted at a depth of five feet because ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 1997). Under extreme natural conditions such as drought the DO concentration may be as low as 4.0 mg/l.

Eutrophication. Eutrophication is the process by which water bodies become more productive through increased input of nutrients, primarily nitrogen and phosphorus (Welch 1992). Normally, increased plant (algae and/or macrophyte) productivity and biomass are considered part of the eutrophication process though nutrients can increase without an increase in plant growth if available light in the water column is limited by high concentrations of suspended solids.

The classical trophic succession sequence that occurs in natural lakes is as follows:

Oligotrophy: nutrient-poor, biologically unproductive;
Mesotrophy: intermediate nutrient availability and productivity;
Eutrophy: nutrient-rich, highly productive;
Hypereutrophy: the extreme end of the eutrophic stage.

Depending on the nature of the watershed however, eutrophication of natural lakes may take thousands of years or they may never become eutrophic.

All waterbodies monitored during the intensive survey are reservoirs rather than natural lakes. Trophic succession in reservoirs does not occur in the classical form as in natural lakes. Typically, after filling of the reservoir basin, trophic upsurge occurs, resulting in high productivity of algae and fish. The trophic upsurge is fueled by nutrient inputs from the watershed, leaching of nutrients from the flooded soils of the basin, and decomposition of terrestrial vegetation and litter. Eventually a trophic depression takes place with a decline in the productivity of algae and fish as these initially available nutrient sources decline. In time, a less productive but more stable trophic state is established. The trophic state that the reservoir eventually settles into (oligotrophic, mesotrophic, or eutrophic) is determined by the combination of the natural fertility of the watershed and the effects of the point and non-point sources of pollution within the watershed.

The concern about eutrophication from a water quality standpoint is more likely due to cultural eutrophication. Cultural eutrophication is eutrophication resulting from an increase of nutrient, soil, and/or organic matter loads to a lake or reservoir as a result of anthropogenic activities (EPA 1990). Activities that contribute to cultural eutrophication include wastewater treatment discharges, agricultural and silvicultural activities, residential and urban development, and road building. Increased eutrophication in a waterbody occurring over a period of 10 to 50 years usually indicates cultural eutrophication (Welch 1992).

The effects of cultural eutrophication to a reservoir that is highly productive, or eutrophic, can lead to hypereutrophic conditions. Hypereutrophic conditions are characterized by the following:

a) dense algal populations;

b) low dissolved oxygen concentrations;

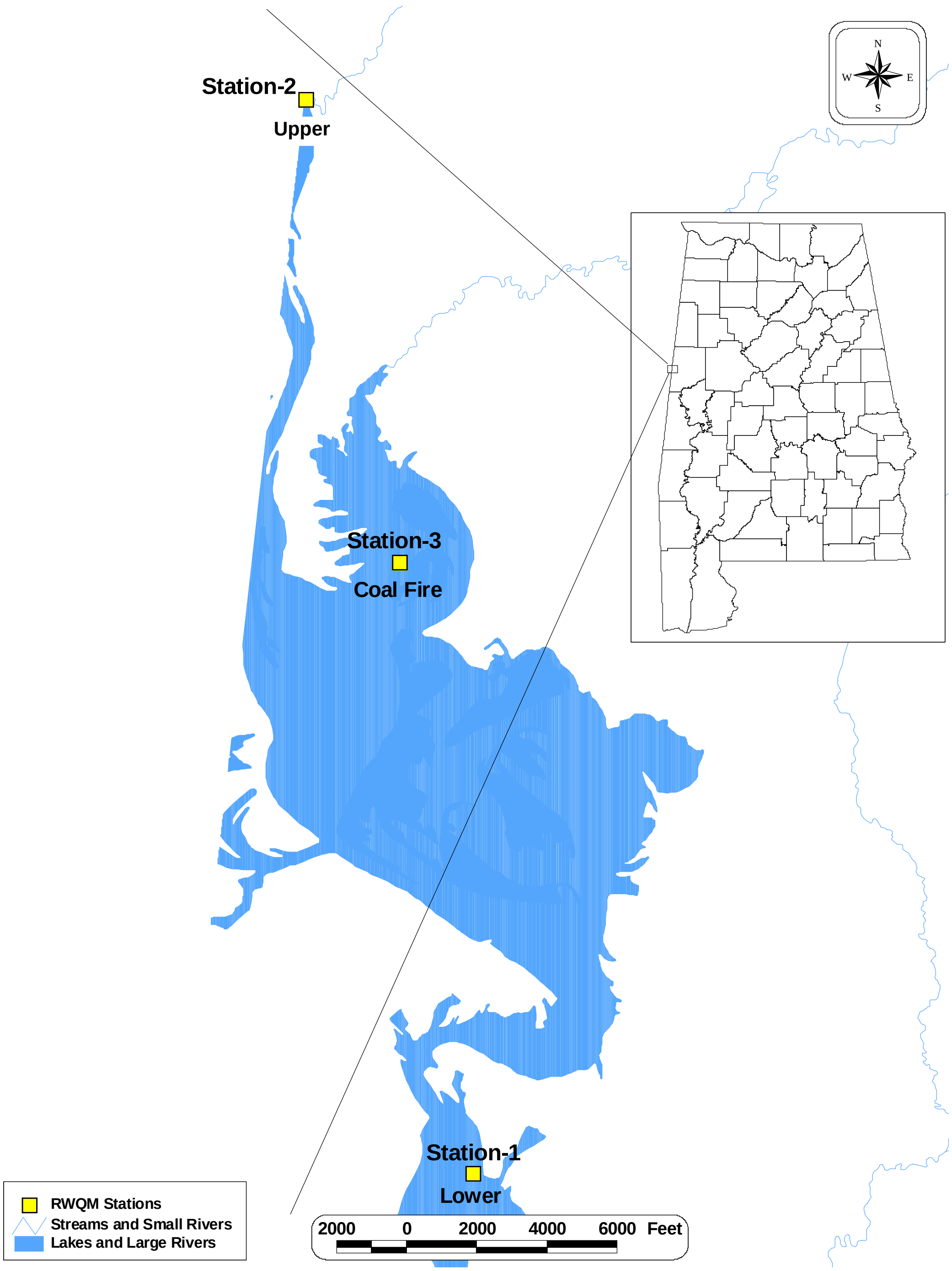
c) increased likelihood of fish kills; and,

d) interference with public water supply and recreational uses.

Regardless of whether a reservoir is oligotrophic, mesotrophic, or eutrophic, however, cultural eutrophication negatively affects biological communities of these waterbodies through sedimentation and changes in water quality variables such as dissolved oxygen, pH, water temperature, and light availability.

I. Tombigbee Basin Reservoirs

Figure I.1. Aliceville Reservoir with 2001 sampling locations.



Aliceville Reservoir

Nitrogen/Mainstem. Mean total nitrogen (TN) concentrations were below Gainesville Reservoir concentrations (Figure I.5).

Monthly TN concentrations decreased steadily April – July and increased at a similar rate July – October (Figure I.9). Highest TN concentrations occurred during April and October for both Aliceville locations. TN concentration was slightly higher at the dam forebay during the first and last two months of the sampling period.

Lake mean TN concentration decreased steadily April – July and increased at a similar rate July – October (Figure I.9). Mean discharge at Aliceville Reservoir decreased from 16,000 cfs (cubic feet per second) in April to 4,000 cfs in May. Mean discharge increased in June and fell once again in July. Mean discharge was lowest in July and August and remained relatively low through September. Between September to October, mean discharge increased sharply to approximately 12,000 cfs in October. Lake mean TN concentration and mean discharge followed a similar pattern in all months except June. In June, lake mean TN continued to decrease as mean discharge increased.

Nitrogen/Tributary. Mean TN concentration for Coal Fire Creek embayment was third lowest of the seventeen Tombigbee tributaries (Figure I.5). TN concentration at Coal Fire Creek embayment was highest during April and lowest in June (Figure I.12).

Phosphorus/Mainstem. Mean total phosphorus (TP) concentrations at mainstem Aliceville Reservoir locations were higher than any other Tombigbee mainstem location (Figure I.6). Mean TP concentration was only slightly higher at the lower reservoir location.

Monthly TP concentrations were similar throughout Aliceville reservoir except during June. For June, TP at the dam forebay was more than twice the upper reservoir location concentration (Figure I.9). TP concentration was higher at upper reservoir during August and September.

Lake mean total phosphorus concentration declined gradually between April – July, and increased similarly July – October (Figure I.9). Discharge declined sharply April to May, increased in June and was lowest in July. Mean discharge increased steadily August to October. With exception of June, monthly changes in lake mean total phosphorus concentration followed a pattern similar to that of discharge.

Phosphorus/Tributary. For Coal Fire Creek embayment, total phosphorus concentration decreased steadily from May to August, peaked sharply in September and remained relatively high through October (Figure I.12).

Algal Growth Potential Tests. Nitrogen was indicated to be the limiting nutrient for both Aliceville Reservoir locations (Table 4). The mean MSC for upper Aliceville was 4.88 mg/l, slightly lower than the maximum of 5.0 mg/l suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes. The mean MSC for lower Aliceville was lower at 1.79 mg/l.

Chlorophyll a/Mainstem. Mean chlorophyll *a* concentrations were higher at Aliceville Reservoir locations than any other Tombigbee locations (Figure I.7). Mean chlorophyll *a* was only slightly higher at the dam forebay than the upper reservoir location.

Monthly chlorophyll *a* concentrations peaked at both locations in May and August (Figure I.10). Both mainstem locations followed similar patterns during the growing season. Lake mean chlorophyll *a* increased from April to May, decreased steadily through July, and peaked once again in August. Lake mean chlorophyll *a* concentration remained steady for September and October. Mean discharge decreased April to May, increased for June and decreased once again in July. Mean discharge increased steadily July – October. There was no apparent relationship between lake mean chlorophyll *a* and mean discharge.

Chlorophyll a/Tributary. Mean chlorophyll *a* concentration for Coal Fire Creek embayment was lower than Bogue Chitto Creek embayment on Gainesville Reservoir, but higher than any other Gainesville tributaries (Figure I.7). Chlorophyll *a* concentration for Coal Fire Creek was highest (approximately 30 µg/l) in May and August – October (Figure I.12).

Trophic state. TSI values were from mesotrophic range to above mid-eutrophic range during the growing season (Figure I.10). Monthly TSI values were similar for both Aliceville locations.

Total Suspended Solids/Mainstem. Mean total suspended solids concentration (TSS) for lower Aliceville was higher than upper Aliceville (Figure I.8). Mean TSS for the lower Aliceville site was higher than any Gainesville reservoir mainstem location.

Concentrations of TSS were similar at the upper and lower Aliceville locations with the exception of May concentrations (Figure I.11). TSS concentration for lower Aliceville increased sharply from April to May. Lake mean TSS concentration was highest in April and May, followed by a decline in June. Lake mean TSS increased slightly in July and gradually decreased July – October. Mean discharge decreased from 16,000 cfs to 4,000 cfs from April to May, increased in June, and fell to the lowest value in July. Discharge increased steadily July – October. For the most of the sampling period, there appears to be an inverse relationship between TSS and discharge.

Total Suspended Solids/Tributary. Mean TSS for Coal Fire Creek embayment was fourth lowest of all seventeen Tombigbee tributaries (Figure I.8).

TSS concentration for Coal Fire Creek ranged from 4.3 to 31.5 mg/l. TSS concentration was near 5 mg/L in April, June and July. Alternately, May, August, September and October had concentrations near 30 mg/L (Figure I.13). Coal Fire Creek TSS decreased sharply between May and June and increased similarly July to August.

Dissolved oxygen/Temperature/Mainstem. Dissolved oxygen concentrations at both reservoir locations were similar each month (Figures I.14 & I.15). Highest DO concentrations existed during April and October and lowest concentrations occurred during July and September. DO concentrations were above the criterion limit of 5.0 mg/l at a depth of 5 feet for all dates sampled except the lower reservoir location during September (4.9 mg/l).

Depth profiles of temperature at the dam forebay and upper reservoir indicated little to no thermal stratification April – October. Highest water column temperatures occurred during July (Figure I.14, I.15). A moderate chemocline existed at both mainstem locations in July with dissolved oxygen concentrations falling below 5.0 mg/l for the majority of the water column. DO concentration for the lower reservoir location in September was at or below 5.0 mg/l for the entire water column.

Dissolved oxygen/Temperature/Tributary. Dissolved oxygen concentrations at Coal Fire Creek embayment remained above the criterion limit of 5.0 mg/l at a depth of 5 feet throughout the sampling period (Figure I.12). The lowest DO concentrations existed from July to September.

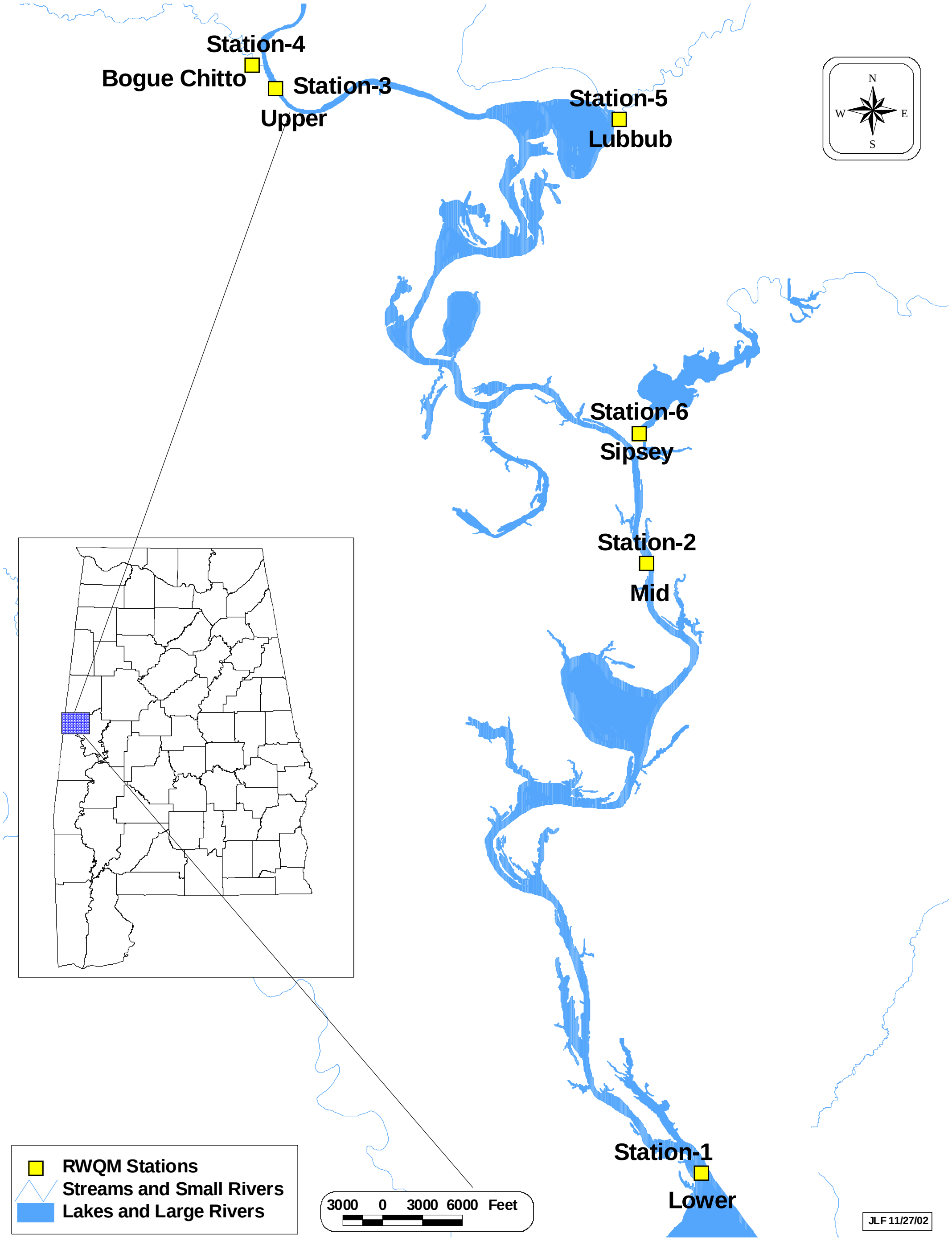
Discussion. Mean total phosphorus concentration at both Aliceville Reservoir mainstem locations was higher than at any other Tombigbee mainstem reservoir location and nitrogen was indicated to be the limiting nutrient for both Aliceville Reservoir locations. Mean chlorophyll *a* concentrations were higher at Aliceville Reservoir locations than any other Tombigbee location. Coal Fire Creek, a major tributary in the Aliceville watershed, exhibited relatively low mean nutrient concentrations. Therefore, it is likely that higher mean chlorophyll *a* concentrations for mainstem Aliceville locations were due to nutrient loading from sources other than Coal Fire Creek. TSI values at mainstem locations ranged from mesotrophic to mid-eutrophic during the growing season. Given the elevated trophic status of Aliceville locations during months of lowest flow, dissolved oxygen concentrations most likely fell below 5.0 mg/l for the majority of the water column due to biochemical oxygen demand from decaying organic material and relatively high water temperatures.

Coal Fire Creek was the only tributary embayment monitored on Aliceville Reservoir during the 2001 Intensive Survey. The Coal Fire Creek subwatershed encompasses 134 square miles in Fayette, Lamar, and Pickens Counties. One industrial process wastewater treatment facility is located in the Coal Fire Creek subwatershed. Landcover of the subwatershed was 93% forest with row crops and pasture accounting for the majority of other land use (ASWCC 1998). Primary NPS concerns within the sub-watershed were estimated to be aquaculture and sedimentation. In addition, there was *moderate* potential for impairment from septic tank failure. The overall potential for non-point source impairment was estimated as *low* (ADEM 2003).

No locally specific discharge data were available for Coal Fire Creek, so loadings from this tributary could not be calculated. Concentrations of TN and TP were generally lowest in June, July and August at both the mainstem and tributary locations. However, in June the lower Aliceville site had a TP concentration greater than 1.0 mg/l, while the

Coal Fire Creek concentration was near 0.04 mg/l. Although the overall potential for NPS impairment was estimated to be *low*, the elevated TP and TSS concentrations for Coal Fire Creek in September and October may have been due to NPS runoff since precipitation was higher than average in August, September and October, and phosphorous and TSS typically increase with greater streamflow. The most probable sources of NPS nutrient loading in the Coal Fire Creek subwatershed were listed as aquaculture, row crops and pasture.

Figure I.2. Gainesville Reservoir with 2001 sampling locations.



Gainesville Reservoir

Nitrogen/Mainstem. Mean total nitrogen concentration at mid Gainesville Reservoir was higher than any other Tombigbee River mainstem sampling location (Figure I.5). Mean TN concentration for lower Gainesville Reservoir was third highest of Tombigbee mainstem locations.

Trends in monthly TN concentration were similar at each location April – September (Figure I.16). Mid-reservoir values were much higher in October. Total nitrogen concentrations fell sharply April – June, increased slightly for July, and fell once again in August. TN concentration at mid reservoir increased to more than two times that of other Gainesville locations from August to October. TN concentrations were highest at all Gainesville locations in April.

Lake mean total nitrogen concentration decreased substantially April – June, increased slightly in July, and fell once again in August (Figure I.16). Lake mean TN increased slowly August to October. Discharge at the Gainesville dam fell dramatically from April to May, increased sharply in June, and was lowest in July. A relatively slow increase in lake mean discharge occurred July – October. No apparent relationship existed between TN and discharge at Gainesville Reservoir.

Nitrogen/Tributary. Mean total nitrogen concentration for Bogue Chitto Creek embayment was higher than any other Tombigbee tributary embayment (Figure I.5).

Total nitrogen concentrations decreased April – June at each of the three Gainesville tributary embayment locations (Figure I.19). A moderate increase in TN occurred June – July at Lubbub Creek and Sipsey River embayments as TN continued to decline for Bogue Chitto Creek through August. Total nitrogen concentrations were highest for Bogue Chitto Creek embayment 4 of the 7 months samples were collected. A possible relationship existed between TN and discharge for Bogue Chitto Creek.

Phosphorus. Mean total phosphorus (TP) concentrations for mainstem Gainesville Reservoir locations were lower than Aliceville, slightly higher than Demopolis, and similar to Coffeeville mainstem sites (Figure I.6). Highest mean TP concentration in the mainstem occurred at mid reservoir.

Monthly total phosphorus concentrations changed similarly for each of the Gainesville locations throughout the sampling season (Figure I.16). Monthly TP concentrations generally declined April – August, increased slightly for September, and increased sharply in October back to initial concentrations. Lake mean TP concentration followed a pattern similar to mean discharge most months of the sampling period.

Phosphorus/Tributary. Mean TP for Bogue Chitto Creek embayment was higher than Lubbub or Sipsey. TP values for Gainesville tributaries were generally lower than Demopolis Reservoir tributaries (Figure I.6).

TP concentrations for Gainesville tributary embayments fell moderately May – July and increased at a similar rate July – October (Figure I.20). TP concentration was highest at Bogue Chitto Creek embayment April, May, and October. Changes in discharge rates were similar for Bogue Chitto and Sipsey embayments. The seasonal dip in TP concentrations generally corresponded with discharge for both locations.

Algal Growth Potential Tests Algal Growth Potential Tests (AGPT) conducted in August indicated nitrogen to be the limiting nutrient throughout Gainesville Reservoir (Table 4). The mean Maximum Standing Crop (MSC) concentration for Gainesville ranged from 0.72 mg/l at mid reservoir to 3.56 mg/l at the dam forebay. These concentrations were well below the maximum 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes.

Chlorophyll a/Mainstem. Mean chlorophyll *a* concentrations at mid and upper Gainesville reservoir locations were approximately 4 µg/l higher than at lower reservoir (Figure I.7). Mean chlorophyll *a* concentrations for mid and upper Gainesville were lower than Aliceville Reservoir, but higher than all other Tombigbee reservoir sampling locations.

Monthly chlorophyll *a* concentrations at mid-reservoir and upper reservoir were highest during May, August and September (Figure I.17). Chlorophyll *a* concentration at mid reservoir was approximately two times higher than at the dam forebay during May, August, and September. Chlorophyll *a* was highest at the upper reservoir location in September.

Lake mean chlorophyll *a* concentrations were highest for May, August, and September, and lowest in April, July, and October (Figure I.17). Lake mean discharge in May was approximately one fourth of April mean discharge, then more than doubled in June. Mean discharge was lowest in July. Lake mean discharge then steadily increased from August – October. There was no apparent relationship between lake mean chlorophyll *a* concentration and lake mean discharge.

Chlorophyll a/Tributary. Mean chlorophyll *a* concentration for Bogue Chitto Creek embayment was highest of all seventeen Tombigbee tributaries (Figure I.7). Mean chlorophyll *a* for Bogue Chitto was more than 4 times that of Lubbub and more than two times that of Sipsey River.

Chlorophyll *a* concentrations at Bogue Chitto Creek embayment were more than ten times those of Lubbub and Sipsey embayments in April, June and July (Figure I.21). Chlorophyll *a* concentrations at Lubbub Creek and Sipsey River embayments were highest during May and August. Changes in chlorophyll *a* concentration for Bogue Chitto Creek embayment were similar to discharge. Changes in chlorophyll *a* for Sipsey River embayment appeared to be inversely related to discharge.

Trophic state. Trophic State Index (TSI) values at Gainesville reservoir were near eutrophic status most of the growing season (Figure I.17). TSI values were similar at reservoir locations most months. TSI values fell into the mesotrophic range for at least one station in April, July, September and October.

Total Suspended Solids/Mainstem. Mean total suspended solids concentration (TSS) for upper Gainesville (22.7 mg/l) was highest of the Gainesville mainstem locations and concentrations decreased successively at the mid (19.4 mg/l) and lower (18.0 mg/l) downstream sites. Overall, mean Gainesville TSS concentrations were less than that of the upper Demopolis site (Figure I.8).

TSS concentrations at all reservoir locations followed similar patterns April – October (Figure I.18). TSS were highest April and May, then generally declined afterward. TSS for Aliceville dam forebay was generally lower than the other locations. Lake mean TSS concentrations declined sharply April – July, then were similar through October. Mean discharge was highest in April and fell sharply in May. Discharge increased sharply in June and fell once again for July. Mean discharge increased slowly July – October. There was no apparent relationship between mean TSS and discharge.

Total Suspended Solids/Tributary. Mean TSS for Bogue Chitto Creek was more than two times the other Gainesville tributaries (Figure I.8).

Monthly TSS for Bogue Chitto Creek was higher than the other Gainesville Reservoir tributaries (Figure I.22). TSS concentrations for Lubbub Creek and Sipsey River embayments were similar most months except August, when TSS concentration for Lubbub Creek increased slightly. TSS concentration for Bogue Chitto Creek embayment fell steadily August – October as discharge increased (Figure I.22). Despite moderate fluctuations in discharge at Sipsey River, TSS concentration remained relatively stable April – October.

Dissolved oxygen/Temperature/Mainstem. Dissolved oxygen concentrations were above the EPA standard of 5.0 mg/l for all dates and locations sampled with the exception of September (Figure I.17). A dissolved oxygen concentration of 4.9 mg/l was recorded at the dam forebay during September. The lowest concentrations for other locations occurred during July.

Depth profiles of temperature and dissolved oxygen indicated thermal and chemical stratification near the surface during June and July at the dam forebay location and June – September at mid reservoir. Water temperatures remained near or above 30° C for the entire reservoir in July and August (Figures I.23-25).

Dissolved Oxygen/Temperature/Tributary. Dissolved oxygen concentrations for Gainesville Reservoir tributary embayments remained above the criterion limit of 5.0 mg/l except for Lubbub Creek in July (Figure I.21). DO for Lubbub Creek was lowest of Gainesville tributaries 4 of 7 months in 2001.

Discussion. Mean TN concentration at mid Gainesville Reservoir were higher than any other Tombigbee River sampling location, likely due in part to nutrient loading from three major tributaries located upstream to include Bogue Chitto Creek. Algal Growth Potential Tests (AGPT) conducted in August indicated nitrogen to be the limiting nutrient throughout Gainesville Reservoir. Higher mean chlorophyll *a* concentrations at mid and upper Gainesville reservoir locations were likely influenced by close proximity to Bogue Chitto and Lubbub Creek embayments. A dissolved oxygen concentration just below the EPA standard of 5.0 mg/l was recorded at the dam forebay for the majority of the water column during September. Low dissolved oxygen concentrations most likely occurred due to biochemical oxygen demand related to high algal densities.

The three tributary embayments on Gainesville monitored in 2001 included Bogue Chitto Creek, Lubbub Creek, and Sipsey River. The Bogue Chitto Creek sub-watershed encompasses approximately 54 square miles in Pickens and Sumter Counties. The subwatershed is covered by an estimated 52% forest, 19% pasture, 16% row crop, 2% urban and 11% open water and other (ASWCC 1998). NPS concerns within the watershed include animal husbandry, aquaculture, crop land, pastures, and sedimentation. Two current stormwater/construction authorizations, 2 non-coal mining stormwater authorizations (< 5 acres), 1 semi-public/private NPDES permit, and 1 CAFO registration have been issued in the Bogue Chitto sub-watershed (ADEM 2003).

Total nitrogen and total phosphorus concentrations for Bogue Chitto Creek may have been elevated due to non-point source nutrient loading. Nutrient concentrations were generally highest during months of greater flow except June. Chlorophyll *a* concentration may have been highest during June and July because of lower flows, longer photoperiod, and increased nutrient loading during previous months. Animal husbandry, aquaculture, crop land and pastures are listed as non-point source concerns for the Bogue Chitto Creek watershed. TSS levels remained relatively high despite changes in discharge suggesting TSS concentrations may have been influenced by other sources.

The Lower-Lubbub Creek sub-watershed includes approximately 59 square miles that is covered by 53% forest, 17% pasture, 11% row crop, 11% urban, and 9% open water and other (ASWCC 1998). The local SWCD estimated there was a *high* potential for impairment from aquaculture and sedimentation and *moderate* potential from runoff. Two current construction stormwater authorizations and 1 non-coal mining stormwater authorization (<5 acres), and 2 municipal NPDES permits have been issued in the Lower Lubbub sub-watershed (ADEM 2003).

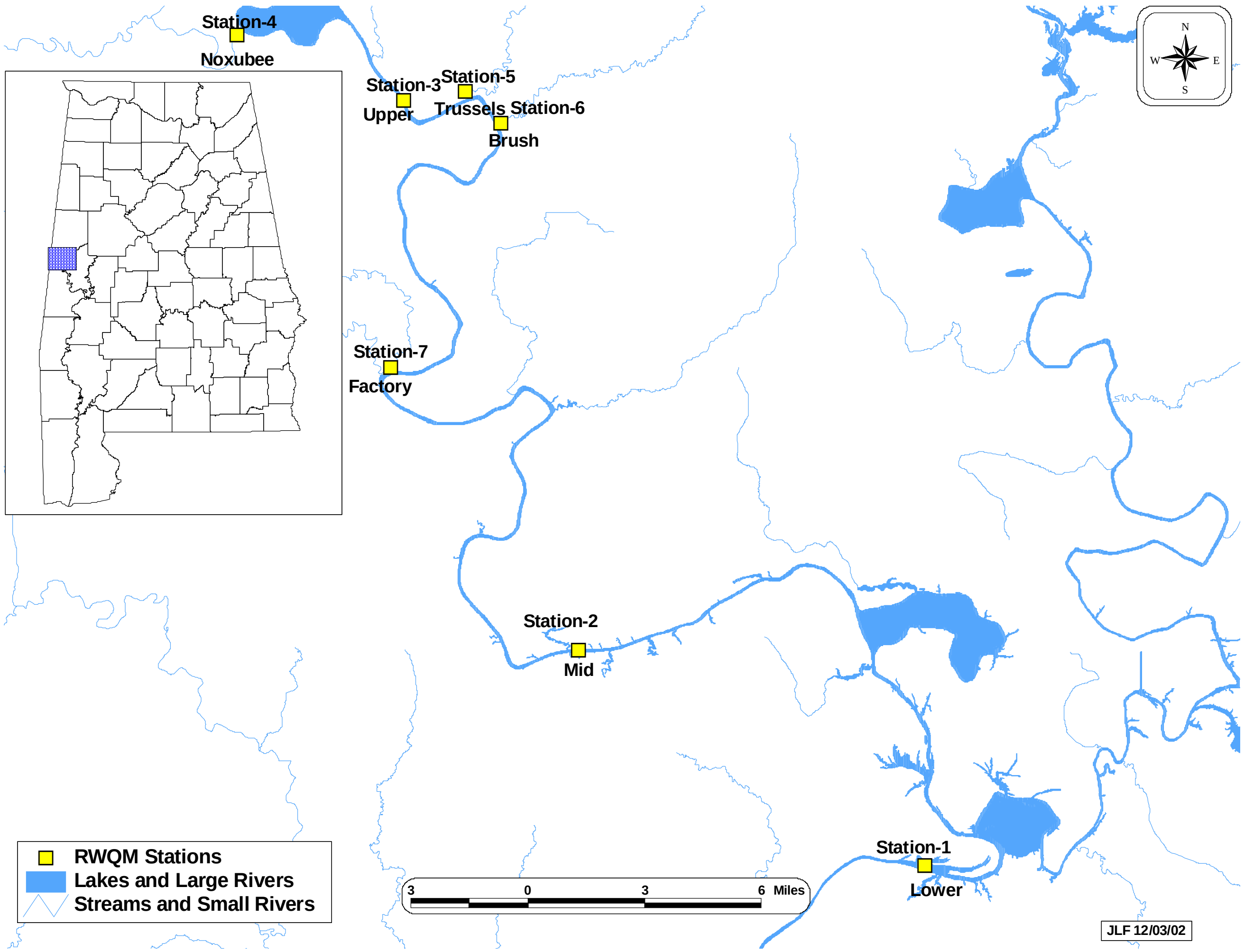
Total nitrogen concentrations may have been higher April – June due to non-point source nutrient loading. Although locally specific discharge data for Lubbub Creek were unavailable, the assumption can be made that discharge was higher during the first and last months of the sampling period based on data from surrounding waterbodies. Seasonal activities associated with agriculture and aquaculture, or natural seasonal variation, may have accounted for higher levels of nutrients during April and May since TN did not increase during other months of increased discharge. Although TN concentrations at Lubbub Creek increased between June and July, chlorophyll *a* remained very low. The peak in chlorophyll *a* in August may be related to the increased TN measured in July.

Monthly total phosphorus concentration for Lubbub Creek was most likely influenced by non-point source nutrient loading. Total phosphorus concentrations followed similar patterns related to discharge levels of other nearby waterbodies. The potential for impairment from aquaculture was estimated as high. In addition, total phosphorus levels may have been elevated during September and October due to stormwater runoff given the close proximity to the town of Aliceville. Chlorophyll *a* concentration was most likely highest during months of least flow due to greater amount of light exposure and nutrient uptake.

The Sipsey River drains approximately 789 square miles in 7 counties including Fayette, Marion, Walker, Winston, Pickens, Tuscaloosa, and Greene (USDA 1995). Two construction/stormwater authorizations, three non-coal mining authorizations, and one CAFO registration have been issued in the Sipsey River subwatershed.

Monthly total nitrogen concentrations were relatively low for Sipsey River. Monthly total phosphorus concentrations were possibly influenced by non-point sources, especially August – October since TP increased sharply similar to discharge. Animal husbandry, pasture and crop-land, and stormwater runoff most likely represent major NPS concerns for the Sipsey River watershed. Similar to Lubbub Creek, chlorophyll *a* concentrations were the lowest in June and July. TN increased slightly in July, followed by a peak in chlorophyll *a* in August. Chlorophyll *a* concentrations were highest during months of least flow (May and August) possibly due to greater amount of light exposure and nutrient uptake that occurred during more stagnant conditions.

Figure I.3. Demopolis Reservoir with 2001 sampling locations.



Demopolis Reservoir

Nitrogen/Mainstem. Mean total nitrogen concentrations for lower and mid Demopolis Reservoir locations were lower than any other Tombigbee reservoir location (Figure I.5). Mean TN concentration for upper Demopolis was highest of Demopolis mainstem locations.

TN concentration at upper Demopolis in April was more than four times higher than mid or lower reservoir concentrations (Figure I.26). Highest TN concentrations occurred at upper reservoir during April and October and the lower reservoir location in July.

Lake mean TN concentration remained relatively low April – October. Lake mean TN at Demopolis Reservoir was highest in April and October (Figure I.26). Mean discharge decreased from approximately 45,000 cfs in April to less than 10,000 cfs in May. Mean discharge increased slightly for June, decreased again in July and remained low July – August. Mean discharge increased to approximately 20,000 cfs for September and October. TN decreased in May along with discharge, and appeared to increase along with discharge in September.

Nitrogen/Tributary. Overall, mean TN concentrations for Brush Creek and Noxubee River were highest of Demopolis tributaries (Figure I.5). TN concentrations for Demopolis tributary embayments were highest during April, September and October (Figure I.29). Noxubee River discharge rates were highest in April and October. Highest TN concentrations occurred at Brush Creek embayment April – June. TN concentrations were highest at the Noxubee River embayment July and October.

Phosphorus/Mainstem. Mean TP concentration at lower Demopolis was below that of any other mainstem Tombigbee location (Figure I.6). Mean TP at upper and mid-reservoir locations were among the lowest of Tombigbee mainstem locations.

TP concentrations at mainstem locations generally declined through August and increased September – October (Figure I.26). Highest concentrations occurred in April and October. Discharge sharply declined April – May and June – July, then slowly increased through October. A relationship appears to exist between lake mean TP and discharge.

Phosphorus/Tributary. Mean TP concentrations for Noxubee River, Brush Creek and Factory Creek were higher than any other Tombigbee tributary embayment (Figure I.6). Typically, TP concentrations in Trussels Creek, Brush Creek, Factory Creek and Noxubee River increased and decreased simultaneously. However, Trussels Creek peaked in September and declined to the lowest value in October. Mean TP concentrations increased and decreased with discharge for most Demopolis tributary embayments sampled (Figure I.29). TP concentrations increased for most Demopolis tributaries May – June and August – September (Figure I.29).

Algal Growth Potential Tests. Algal Growth Potential Tests (AGPT) conducted in August indicated nitrogen to be the limiting nutrient for the upper reservoir and the mid and lower reservoir locations were phosphorus limited (Table 4). The mean MSC of the Demopolis locations ranged from 3.53 – 3.91 mg/l, below the maximum 5.0 mg/l level suggested to avoid nuisance algal blooms and fish-kills in southeastern lakes.

Chlorophyll a/Mainstem. Mean chlorophyll *a* concentrations for Demopolis Reservoir were below those of all mainstem reservoir stations located upstream, with exception of lower Gainesville (Figure I.7).

Monthly chlorophyll *a* concentrations were highest during May and August (Figure I.27). Chlorophyll *a* concentrations fluctuated at all locations throughout the growing season.

Lake mean chlorophyll *a* concentration increased in May, fell slowly through July and then peaked in August (Figure I.27). Mean discharge was highest in April followed by a substantial decline in May. Discharge increased in June and fell once again in July. Mean discharge increased August – October. In general, discharge and lake mean chlorophyll *a* appear to be inversely related, especially in May and August when higher chlorophyll *a* corresponds with low discharge.

Chlorophyll a/Tributary. Mean chlorophyll *a* for Factory Creek was more than two times any other Demopolis tributary and third highest of all Tombigbee tributary embayments (Figure I.7). Chlorophyll *a* concentration fluctuated between approximately 10 µg/l and 45 µg/l at Factory Creek from April to October (Figure I.29). For May and August, chlorophyll *a* concentration at Factory Creek embayment was approximately four times that of any other Demopolis tributary. There was no apparent relationship between chlorophyll *a* concentrations and Noxubee River discharge.

Trophic state. TSI values for Demopolis Reservoir locations ranged from mesotrophic status to near mid eutrophic status (Figure I.27). TSI values at mid and upper reservoir reached near mid eutrophic status for May and August. The lower site was more consistently mesotrophic.

Total Suspended Solids/Mainstem. Mean total suspended solids concentration (TSS) was third highest for upper Demopolis when compared to other Tombigbee mainstem locations (Figure I.8). Like Gainesville, concentrations were highest at upper reservoir and decreased as sampling moved downstream.

During April, total suspended solids concentration at upper Demopolis was 2 - 3 times that of the other mainstem location (Figure I.28). Lake mean TSS concentration fell sharply April to May and remained relatively stable May – October. Discharge fell sharply April to May and fluctuated May to October. TSS and discharge exhibited a similar decline between April and May. With the exception of April-May, lake mean TSS did not appear to fluctuate with discharge.

Total Suspended Solids/Tributary. Mean TSS for Trussels Creek and Brush Creek were the two highest of all Tombigbee tributaries (Figure I.8). Mean TSS for Factory Creek was fourth highest of Tombigbee tributaries.

Highest total suspended solids concentration for Trussels Creek embayment in September was approximately two times that of any other Demopolis Reservoir tributary embayment (Figure I.30). TSS concentrations for Brush Creek embayment were highest of Demopolis tributaries June – August and October. Despite moderate fluctuations in discharge, TSS concentration for Noxubee River remained relatively stable throughout the sampling season.

Dissolved oxygen/Temperature/Mainstem. Dissolved oxygen concentrations at Demopolis remained above the criterion limit of 5.0 mg/l on all dates sampled (Figure I.27). Lowest dissolved oxygen concentrations occurred at lower reservoir July –August.

Depth profiles of temperature and dissolved oxygen indicated little to no thermal or chemical stratification lake-wide April – October (Figure I.31-33). Lowest dissolved oxygen concentrations occurred during September at lower Demopolis. Dissolved oxygen concentrations were lowest during July at mid reservoir. Highest water column temperatures occurred during June at the dam forebay and July at mid and upper reservoir.

Dissolved oxygen/Temperature/Tributary. Dissolved oxygen concentrations fell below the criterion limit of 5.0 mg/l at Brush Creek and Factory Creek locations during June and July, and again at Factory Creek embayment September and October (Figure I.29).

Discussion. Similar patterns occurred between nutrient concentrations and discharge indicating that non-point sources may be impacting the water quality of Demopolis Reservoir. Major non-point sources of concern for the Demopolis watershed include animal husbandry, aquaculture, and runoff from pasture and row crops. Mean chlorophyll *a* concentration for Demopolis Reservoir was lowest at the dam forebay and increased at upstream locations. This is possibly due to the number of major tributaries located upstream and influences from the cities of Gainesville and Eutaw. With exception of June, increases in lake mean chlorophyll *a* occurred during months of lesser discharge as retention time increased.

Demopolis tributary embayments monitored in 2001 included the Noxubee River, Trussels Creek, Brush Creek and Factory Creek. The Noxubee River sub-watershed drains approximately 47 square miles in Sumter County and has a variety of land uses, including pasture, forest, and crop land (ASWCC 1998). The sub-watershed was assigned the highest possible rating for potential impairment. In addition, it received the highest sedimentation rating caused by erosion from gullies. NPS concerns were attributed to animal husbandry, aquaculture, runoff from pasture and row crops, and forestry activities. Two current construction/stormwater authorizations and 2 non-coal mining/stormwater authorizations (< 5 acres) have been issued in the Noxubee sub-watershed (ADEM 2003). There were little to no areas of concern for the Noxubee River water quality with exception of higher nitrogen levels July and October. A similar pattern occurred between nutrient concentrations and discharge from August to October.

Therefore, nutrient loading in the Noxubee River watershed is most likely influenced by non-point sources listed earlier.

The Trussels Creek sub-watershed encompasses approximately 144 square miles in Greene County and consists mainly of pasture and forest. Ten percent of the land use is attributed to row crops (ASWCC 1998). A *high* potential for impairment from aquaculture and pasture runoff was assigned. The potential for impairment from cropland runoff and sedimentation was *moderate*. Four current construction/stormwater authorizations and 3 non-coal mining stormwater authorizations have been issued in the Trussels Creek sub-watershed (ADEM 2003).

Nutrient concentrations for Trussels Creek embayment were higher during months of greater discharge in nearby Noxubee River. Therefore, nutrient loading in the Trussels Creek watershed may be most influenced by non-point sources listed earlier. Chlorophyll *a* concentrations for Trussels Creek were low when compared to other tributaries in the Demopolis Reservoir basin. Higher total suspended solids concentrations may have affected light availability and contributed to lower algal densities.

The Brush Creek sub-watershed is located in Greene County. Habitat quality was assessed as *excellent* during the 2001 NPS screening assessment for the Southeastern Floodplains and Low Terraces subecoregion (ADEM 2003). Macroinvertabrate and fish communities were indicated to be in *fair* condition (ADEM 2003). A similar pattern existed between total nitrogen concentration for Brush Creek and discharge for the Noxubee River located nearby. This indicates that nitrogen loading can most likely be attributed to non-point sources located within the Brush Creek sub-watershed.

The Factory Creek sub-watershed drains approximately 88 square miles in Sumter County. Land cover is composed of 57% pasture, 17% cropland, 10% forest, 10% open water, and 7% urban and other (ASWCC 1998). The potential for NPS impairment was *high* due to animal husbandry, cattle and swine, aquaculture, runoff from crop and pasture land, and sedimentation. Eleven current authorizations including one NPDES permit, 3 CAFO registrations, 3 non-coal mining authorizations, and 4 construction/stormwater authorizations have been issued in the Factory Creek sub-watershed (ADEM 2003).

Factory Creek has been monitored at three stations under the ADEM’s Factory and Bodka Creek Arsenic Monitoring Project.

Nutrient concentrations for Factory Creek were similar to other Demopolis tributaries. However, mean chlorophyll *a* concentration was much higher than any other Demopolis tributary and was highest during months of least discharge from the nearby Noxubee River.

Figure I.4a. Coffeeville Reservoir with 2001upper reservoir sampling locations.

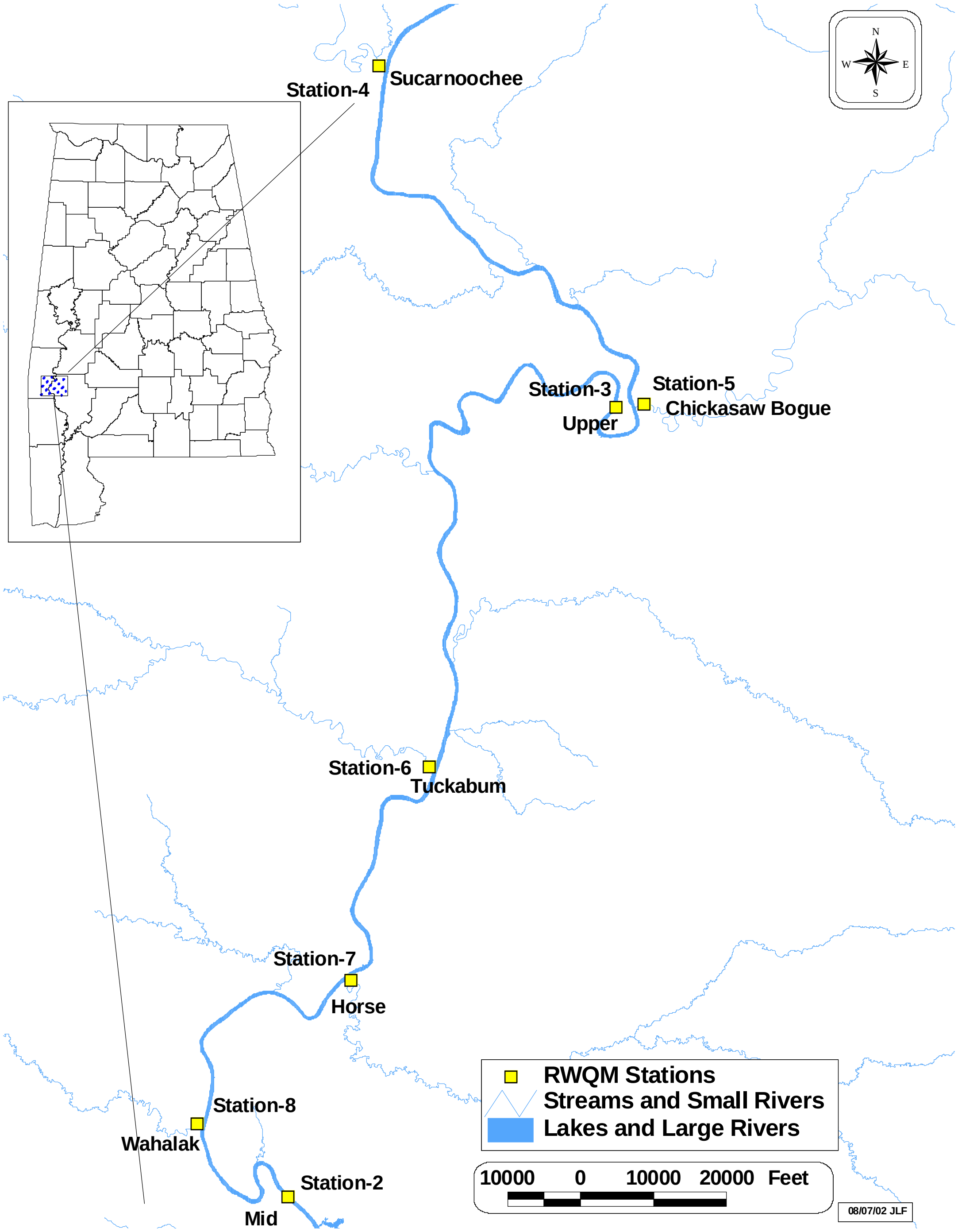
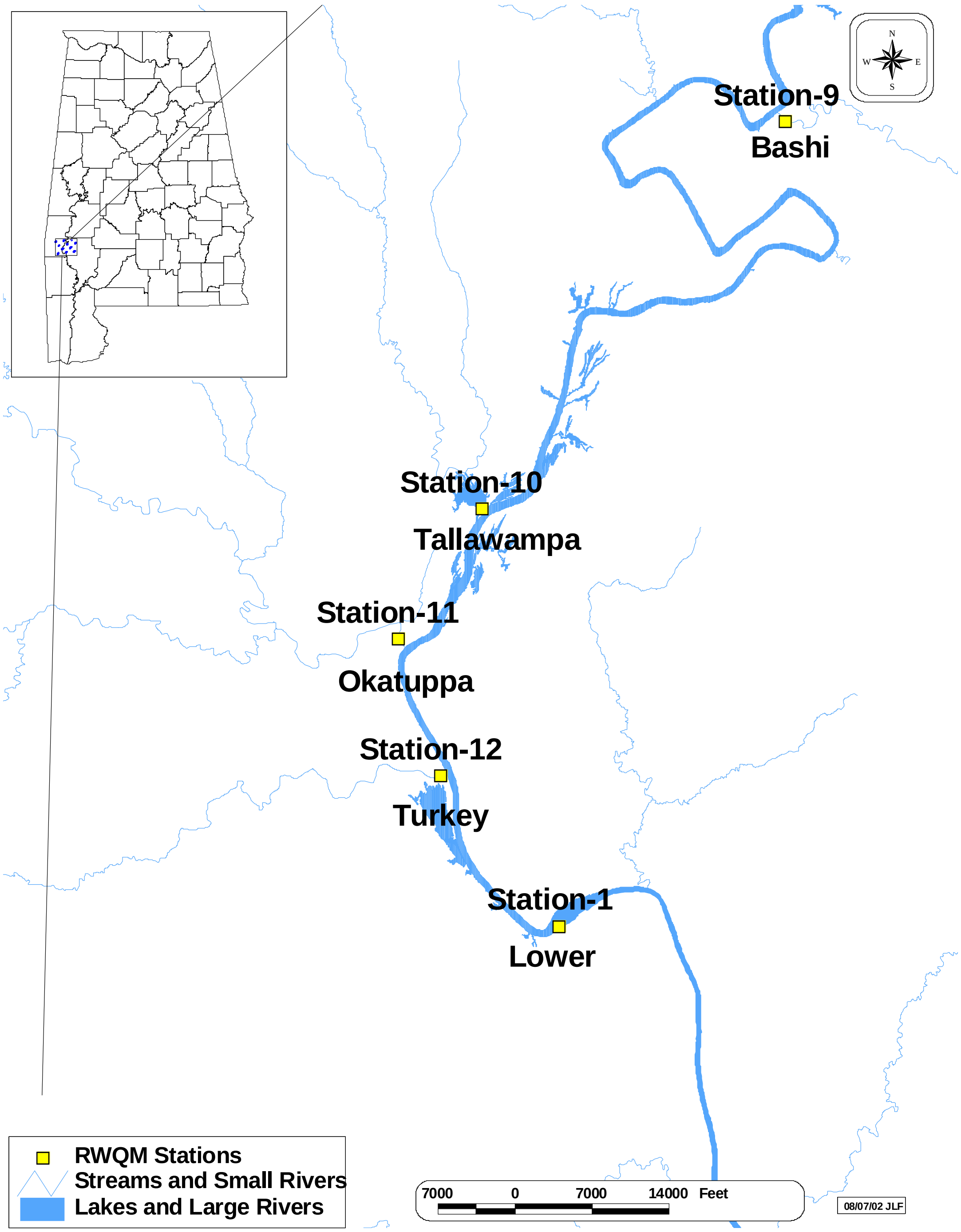


Figure I.4b. Coffeeville Reservoir continued with 2001 lower reservoir sampling locations.



Coffeeville Reservoir

Nitrogen/Mainstem. Mean total nitrogen concentration at upper Coffeeville Reservoir was second highest of all Tombigbee mainstem locations (Figure I.5). Mean TN concentration was slightly higher at lower reservoir than at mid reservoir.

Changes in TN concentration were similar lake-wide for each month of sampling (Figure I.34). TN concentrations were highest April and October at upper reservoir locations; April, July, October in mid-reservoir; and July and October in lower reservoir.

Lake mean TN concentrations were variable April - October (Figure I.34). Mean discharge was highest in April followed by a substantial decline for May. Discharge increased in June, fell once again in July and slowly increased July – October. No apparent relationship existed between lake mean TN and mean discharge.

Nitrogen/Tributary. Mean total nitrogen concentration at Wahalak Creek embayment was highest of nine Coffeeville Reservoir tributary embayments sampled (Figure I.5). Of the four uppermost Coffeeville tributaries, TN concentration for Chickasaw Bogue Creek was highest 4 of 7 months (Figure I.37). There was no apparent relationship between Sucarnoochee River TN concentration and Sucarnoochee River discharge.

TN concentrations for Tallawampa Creek and Okatuppa Creek were much higher than any other Coffeeville tributary in April (Figure I.38). Concentrations for Turkey Creek were relatively low April – September but increased sharply September - October.

Phosphorus/Mainstem. Lake mean total phosphorus concentrations were similar to those of Gainesville and higher than Demopolis Reservoir mainstem means (Figure I.6).

TP concentrations for Coffeeville mainstem locations fluctuated April – July and steadily increased August – October. Highest mainstem TP concentrations occurred April and October (Figure I.34).

Lake mean TP appeared to be related to discharge since months of greatest total phosphorus concentration were months of greatest discharge (Figure I.34).

Phosphorus/Tributary. Mean TP concentrations for Chickasaw Bogue Creek and Wahalak Creek were highest of Coffeeville tributary embayments (Figure I.6). TP concentrations for upper Coffeeville tributaries were elevated during April, September, and October (Figure I.37). TP concentrations for the Sucarnoochee River embayment increased steadily July – October. Rate of discharge for the Sucarnoochee River was higher each month July – October.

TP concentrations were relatively high for all locations in April (Figure I.38). TP concentrations were highest in October for Bashi, Tallawampa, and Okatuppa embayments.

Algal Growth Potential Tests. Algal growth potential tests conducted in August indicated that the upper and lower reservoir locations were phosphorus limited, and nitrogen was the limiting nutrient for mid reservoir (Table 4). The mean MSC for the dam forebay was nearly two times higher than mid and upper reservoir, and all MSC concentrations for Coffeeville Reservoir were well above the maximum 5.0 mg/l level suggested to avoid nuisance algal blooms and fish-kills in southeastern lakes.

Chlorophyll a/Mainstem. Mean chlorophyll *a* concentrations were lowest at the dam forebay and increased upstream (Figure I.7). Mean chlorophyll *a* concentrations at the dam forebay and mid reservoir were lower than any other Tombigbee location.

Chlorophyll *a* concentration at upper reservoir was higher for each month of sampling with the exception of July (Figure I.35). Highest chlorophyll *a* concentrations occurred during May, August, and September. Chlorophyll *a* levels fell sharply at all locations in October.

Lake mean chlorophyll *a* concentration increased slightly from April to May, remained relatively stable through September, and declined slightly in October (Figure I.35). Mean discharge was highest in April followed by a substantial decline in May. Discharge increased in June, fell once again in July and slowly increased July – October. There was no apparent relationship between lake mean chlorophyll *a* concentration and discharge.

Chlorophyll a/Tributary. Mean chlorophyll *a* concentrations for Coffeeville tributaries were highest at Chickasaw Bogue Creek, Wahalak Creek, and Turkey Creek, respectively (Figure I.7). Of the four uppermost Coffeeville Reservoir tributaries monitored in 2001, highest chlorophyll *a* concentrations were observed at Chickasaw Bogue Creek embayment 5 of 7 months (Figure I.37). Chlorophyll *a* concentrations at other upper Coffeeville tributaries remained below 20 µg/l throughout the sampling period. Highest chlorophyll *a* concentrations occurred at the Sucarnoochee embayment May and August. Rate of discharge for the Sucarnoochee River was highest in April and October and lowest for May, July, and August.

Chlorophyll *a* concentration for Wahalak Creek embayment was much higher than any other lower Coffeeville tributary during May and August (Figure I.38). Chlorophyll *a* concentrations were relatively low for all lower Coffeeville tributaries, including Wahalak Creek, in October.

Trophic state. TSI levels for Coffeeville locations remained between mesotrophic and mid eutrophic ranges throughout the growing season (Figure I.35).

Total Suspended Solids/Mainstem. Mean total suspended solids concentrations for upper and mid Coffeeville were much higher than any other Tombigbee mainstem location (Figure I.8).

Lake mean TSS was highest in April and September (Figure I.36). Total suspended solids concentrations for mainstem Coffeeville locations were highest for upper reservoir each month except September (Figure I.36). For September, TSS at mid reservoir was approximately four times greater than any other location. Overall there appeared to be a relationship between TSS and discharge.

Total Suspended Solids/Tributary. Mean TSS for Sucarnoochee Creek was third highest of Tombigbee tributaries and much higher than most other Coffeeville tributaries (Figure I.8). Mean TSS concentrations for Chickasaw Bogue and Wahalak were also relatively high when compared with other Coffeeville tributaries.

Total suspended solids concentration for Sucarnoochee Creek embayment was highest of any other upper Coffeeville Reservoir tributary for each month of the sampling period except July (Figure I.39). For July, TSS concentration was highest at Chickasaw Bogue Creek embayment. TSS concentration for Sucarnoochee Creek was possibly related to discharge with exception of May and August. During May and August, TSS concentration for Sucarnoochee embayment increased as discharge decreased.

TSS concentrations for Wahalak and Turkey Creek embayments were generally higher than other lower Coffeeville Reservoir tributaries (Figure I.39). Wahalak Creek embayment TSS concentration was highest of lower Coffeeville tributaries during May and September.

Dissolved oxygen/Temperature/Mainstem. Dissolved oxygen concentrations were above the criterion limit of 5.0 mg/l on all dates sampled (Figure I.35). Lowest dissolved oxygen concentrations occurred in July at lower and mid reservoir.

Depth profiles of temperature and dissolved oxygen indicated little to no thermal or chemical stratification lake-wide April – October (Figure I.40-42). Highest water column temperatures occurred during July and August lake-wide. Dissolved oxygen concentrations were lowest June – August, with DO barely above 5.0 mg/l in mid and lower reservoir in July. Dissolved oxygen concentrations were slightly higher at upper reservoir when compared to mid and lower reservoir.

Dissolved oxygen/Temperature/Tributary. Dissolved oxygen concentrations for upper Coffeeville tributary embayments were above the criterion limit of 5.0 mg/l with the exception of Horse Creek (Figure I.37). DO concentration for Horse Creek embayment was consistently near or below 5.0 mg/l with lowest DO concentrations occurring in July.

Dissolved oxygen concentrations for lower Coffeeville tributaries were near or below 5.0 mg/l during the majority of the sampling period (Figure I.38). Lowest dissolved oxygen concentrations occurred at Turkey Creek in August and September.

Discussion. Mean chlorophyll *a* concentration for upper reservoir was highest of Coffeeville locations but lower than upper or mid Demopolis. Mean total nitrogen concentration at upper Coffeeville Reservoir was second highest of all Tombigbee mainstem locations. Since chlorophyll *a* concentration increased from lower Demopolis to upper Coffeeville, elevated chlorophyll *a* concentration for upper Coffeeville may be influenced by nutrient loading from area point and nonpoint sources.

Nine tributary embayment locations were sampled at Coffeeville Reservoir for 2001 reservoir monitoring and include the following: Sucarnoochee River, Chickasaw Bogue Creek, Tuckabum Creek, Horse Creek, Wahalak Creek, Bashi Creek, Tallawampa Creek, Okatuppa Creek, and Turkey Creek. The Sucarnoochee River sub-watershed drains approximately 140 square miles in Sumter County (USDA 1995). Two construction/stormwater authorizations and 7 non-coal mining authorizations have been issued in the Sucarnoochee sub-watershed (ADEM 2003).

Mean total suspended solids for Sucarnoochee were among the highest of Coffeeville tributaries. Lower mean chlorophyll *a* concentration for Sucarnoochee could be in part due to reduced light availability from high TSS.

The Chickasaw Bogue Creek sub-watershed includes approximately 94 square miles in Marengo County. Approximately ¾ of the land cover is forested with an additional 20% pastureland. Urban, row crop, open water and other accounted for less than 7% (ASWCC 1998). *Moderate* potential for NPS impairment exists primarily due to aquaculture, pasture runoff, and sedimentation. Potential impairment from septic tank failure posed a *moderate* risk. One construction/stormwater authorization, 1 non-coal mining/stormwater authorization (<5 acres), and 1 municipal NPDES permit have been issued in the Chickasaw Bogue Creek sub-watershed (ADEM 2003).

Chlorophyll *a* concentrations for Chickasaw Bogue were second highest of all Coffeeville tributaries. Flow data for Chickasaw Bogue Creek were unavailable.

The Tuckabum Creek sub-watershed encompasses 47 square miles of Choctaw County and is covered almost completely by forest (ASWCC 1998). Although the overall potential for NPS impairment was estimated as *low*, potential impairment from sedimentation was *high*. Erosion from gullies was primarily responsible for the elevated sediment loading. Three construction/stormwater and 5 non-coal mining/stormwater (<5 acres) authorizations have been issued in the sub-watershed (ADEM 2003).

Few areas of concern existed for the Tuckabum Creek sub-watershed with exception of low dissolved oxygen during June. Flow data for Tuckabum Creek was unavailable.

The Horse Creek sub-watershed is approximately 149 square miles in Clarke and Marengo Counties. Land use within the sub-watershed was almost exclusively forest (ASWCC 1998). The overall estimate for potential impairment from non-point sources was *low* despite moderate potential from mining and urban development. Three current construction/stormwater authorizations, 3 non-coal mining/stormwater authorizations, and one semi-public/private NPDES permit have been issued in the sub-watershed (ADEM 2003).

Mean total phosphorus concentration for Horse Creek was higher than any other Coffeeville tributary. Dissolved oxygen concentrations for Horse Creek were generally much lower than other Coffeeville tributaries and remained near or below 5.0 mg/l April – October. Flow data was unavailable for Horse Creek. Chlorophyll *a* concentrations were relatively low for Horse Creek when compared to other Coffeeville tributaries.

The Wahalak Creek sub-watershed encompasses approximately 150 square miles in Choctaw County. The land cover within the sub-watershed is more than 90 % forest (ASWCC 1998). Other land use includes cropland, pastureland, and urban areas. The overall potential for non-point source impairment was *low* despite a high potential for impairment from sedimentation due to gully erosion. A total of 7 stormwater authorizations, one municipal NPDES permit and one semi-public/private NPDES permit have been issued in the Wahalak Creek sub-watershed (ADEM 2003).

Mean total nitrogen concentration at Wahalak Creek embayment was highest of nine Coffeeville Reservoir tributary embayments sampled. Chlorophyll *a* concentration for Wahalak Creek embayment was much higher than any other lower Coffeeville tributary during May and August. Wahalak Creek embayment TSS concentration was the highest of lower Coffeeville tributaries in May and September. Flow data for Wahalak Creek were unavailable. Flow data from Sucarnoochee River and Coffeeville Dam suggested that May – August was a period of relatively low flow. Therefore, increased nutrient and algal concentrations and lower dissolved oxygen concentrations during drier periods may be related to point sources listed earlier or non-point sources associated with isolated precipitation events.

The Bashi Creek sub-watershed drains approximately 127 square miles in Clarke and Marengo Counties. Ninety five percent of the land cover is forest with 4% pasture (ASWCC 1998). The overall potential for impairment from non-point sources was estimated to be low. Four current construction/stormwater and 3 non-coal mining/stormwater authorizations have been issued in the Bashi Creek watershed (ADEM 2003).

Few areas of concern existed for Bashi Creek with exception of low dissolved oxygen during May and September. Flow data for Bashi Creek were unavailable.

The Tallawampa Creek embayment is in Choctaw County and covers nearly 67 square miles. Land cover is approximately 96% forest and 4% is pasture (ASWCC 1998). Potential impairment from sedimentation was listed as high. One non-coal mining/stormwater authorization has been issued in the Tallawampa Creek sub-watershed (ADEM 2003).

Few areas of concern existed for Tallawampa Creek. Flow data for Tallawampa Creek was unavailable. Nutrient concentrations generally increased during months of greater discharge for other Coffeeville locations indicating that non-point sources listed earlier represent the greatest potential for impairment in the Tallawampa sub-watershed.

The sub-watershed of Okatuppa Creek drains approximately 169 square miles in Choctaw County (USDA 1995). Little to no areas of concern existed for Okatuppa Creek. Flow data for Okatuppa Creek was unavailable. Nutrient concentrations generally increased during months of greater discharge for other Coffeeville locations indicating that non-point sources most likely represent the greatest potential for impairment in the Okatuppa sub-watershed.

The Turkey Creek sub-watershed drains approximately 63 square miles in Choctaw County and is primarily covered by forest with minor areas of pastureland, cropland, and urban land use (ASWCC 1998). The overall potential for non-point source impairment was listed as *low* despite a high rating for potential impairment from sedimentation. Three construction/stormwater authorizations, 2 non-coal mining/stormwater authorizations (<5 acres), and 1 semi-public/private NPDES permit have been issued in the Turkey Creek sub-watershed (ADEM 2003).

Dissolved oxygen concentrations for Turkey Creek were well below the standard of 5.0 mg/l during August and September. No flow data were available for Turkey Creek.

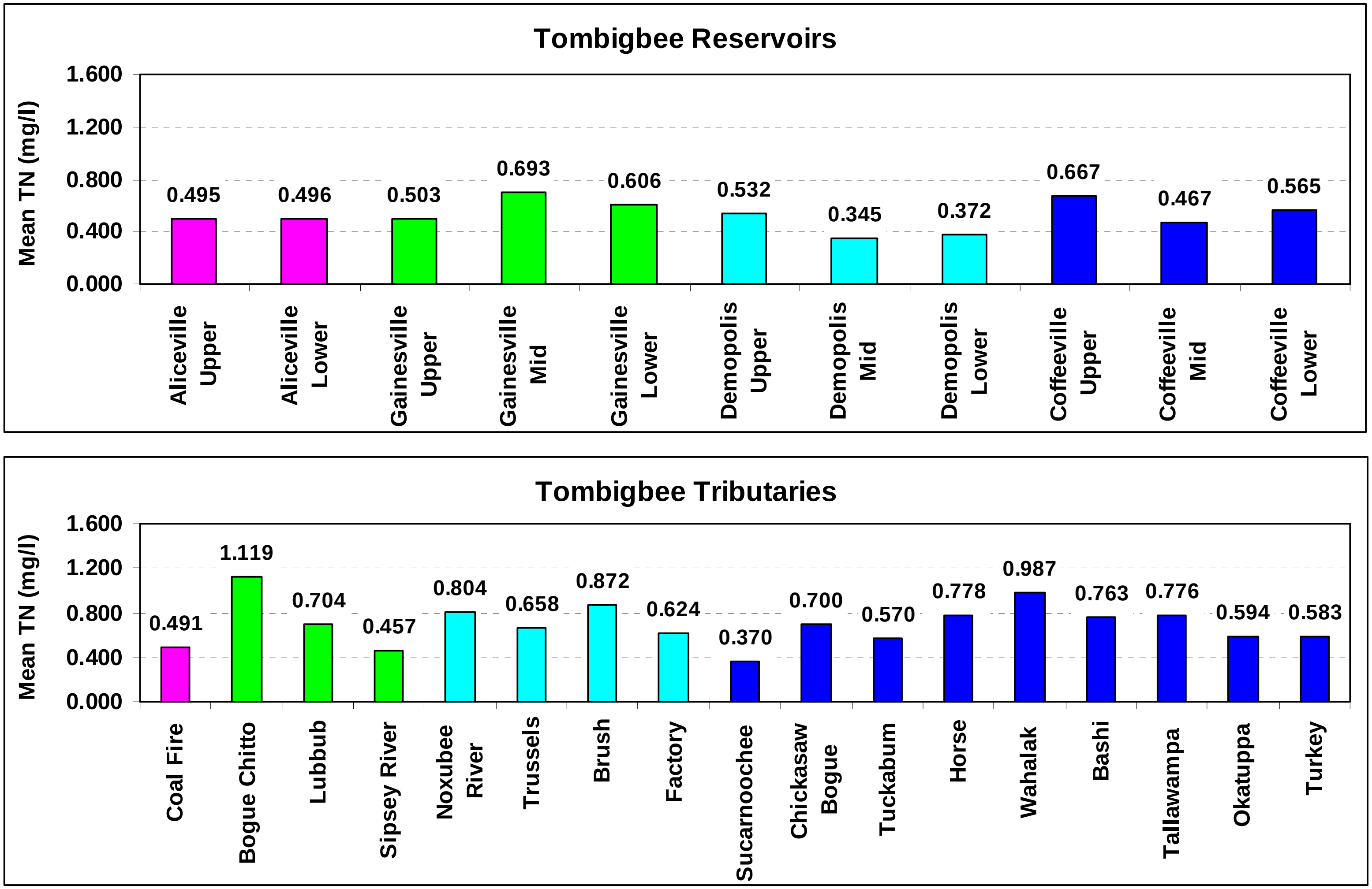


Figure I.5. Mean total nitrogen (TN) concentrations of Tombigbee reservoir locations, April-October 2001.

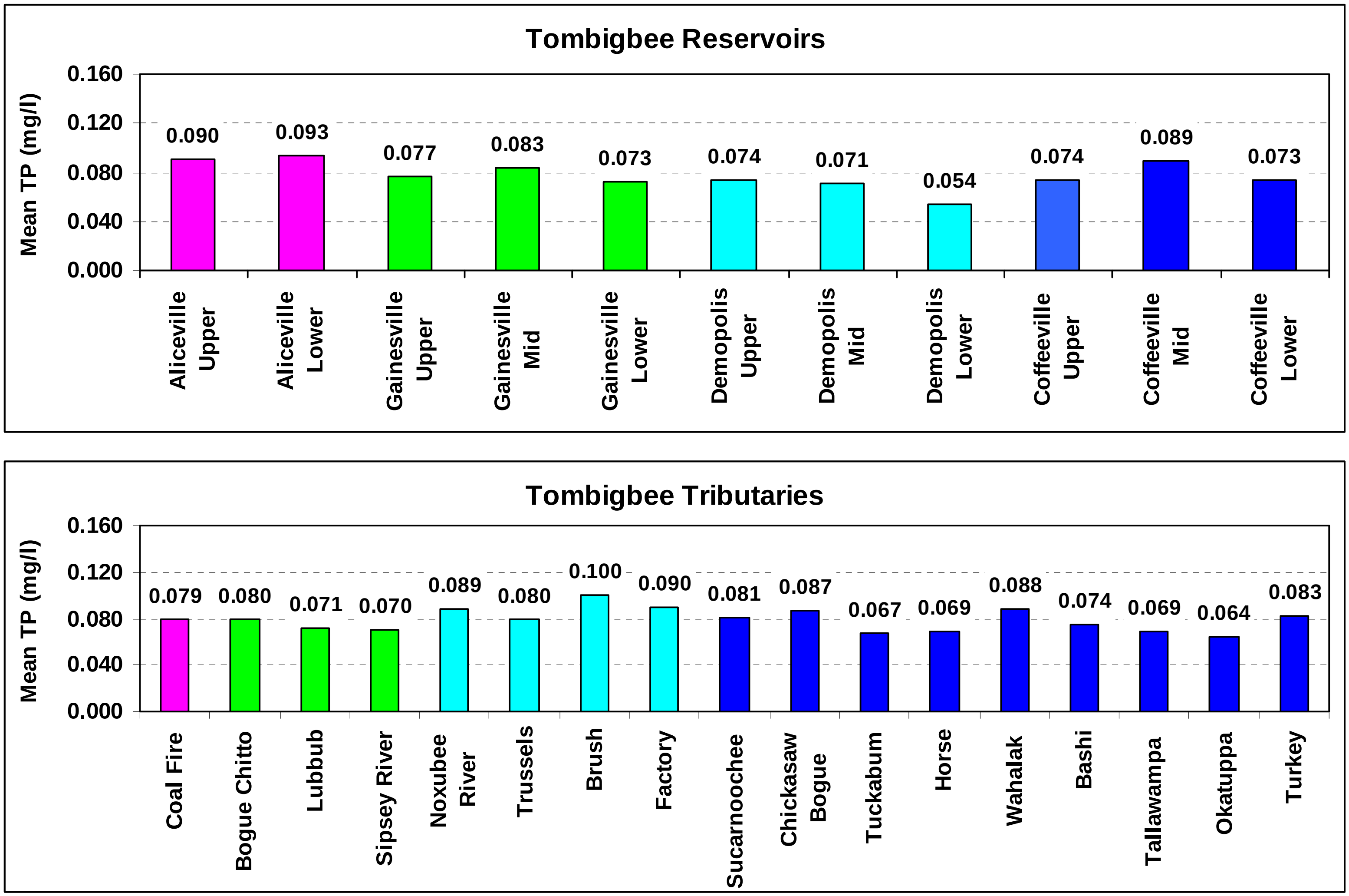


Figure I.6. Mean total phosphorus (TP) concentrations of Tombigbee reservoir locations April-October 2001.

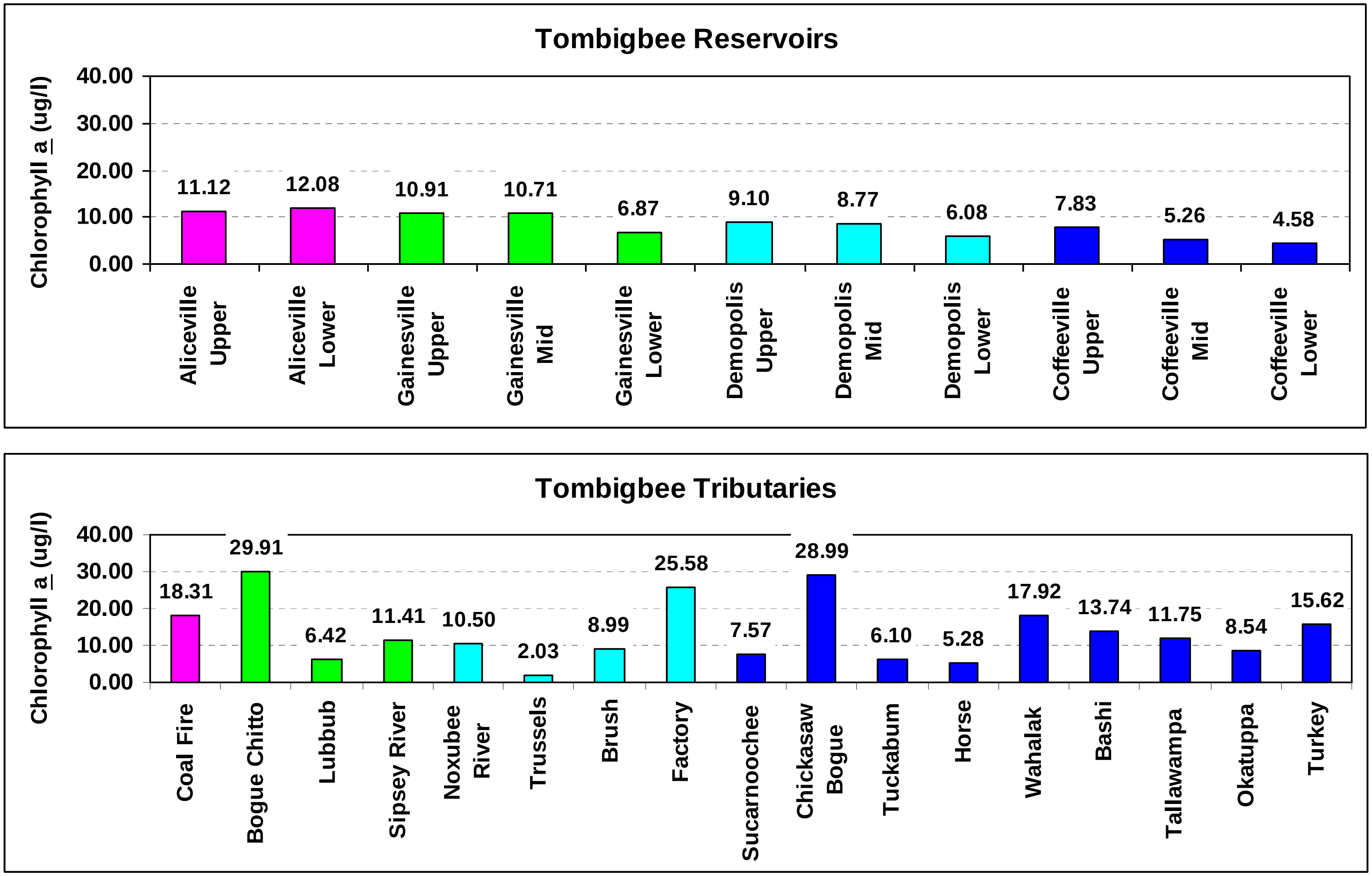


Figure I.7. Mean chlorophyll *a* concentrations of Tombigbee reservoir locations April-October 2001.

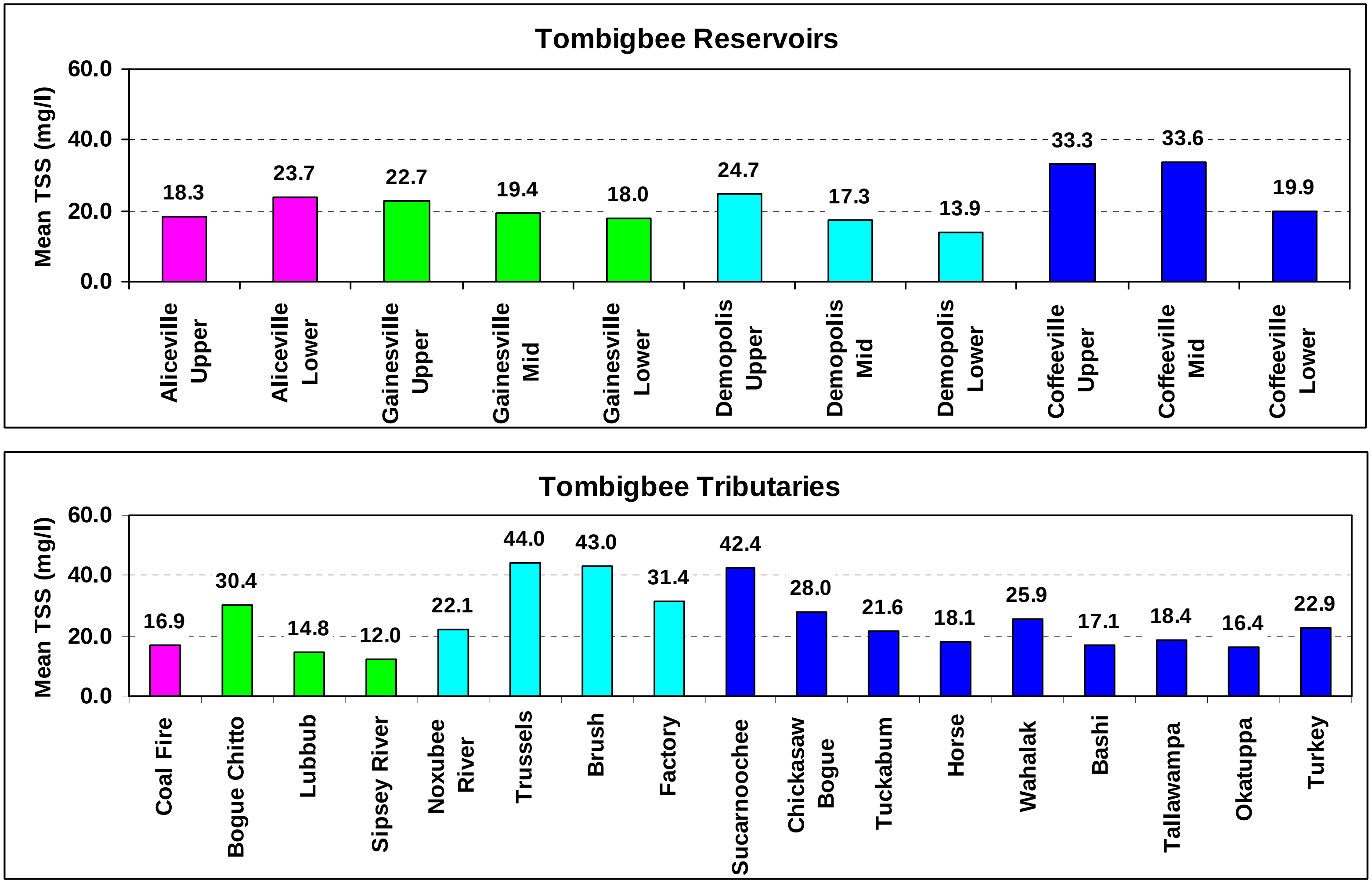


Figure I.8. Mean total suspended solids concentrations of Tombigbee reservoir locations April – October 2001.

Table 4. Algal growth potential testing (AGPT) of Tombigbee River reservoirs, August 2001.

Reservoir	Location	Collection Date	Mean MSC (mg/l) C	C+N	C+P	Limiting Nutrient
Coffeeville	Upper	8/14/01	7.63	**7.52**	11.97	Phosphorus
	Mid	8/14/01	7.63	10.79	6.72	Nitrogen
	Lower	8/14/01	13.58	**21.21**	**14.50**	Nitrogen
Demopolis	Upper	8/13/01	3.53	**9.31**	**2.84**	Nitrogen
	Mid	8/13/01	3.57	**3.29**	4.74	Phosphorus
	Lower	8/13/01	3.91	**4.16**	6.96	Phosphorus
Gainesville	Upper	8/13/01	2.30	**13.83**	1.45	Nitrogen
	Mid	8/13/01	0.72	**19.90**	**0.77**	Nitrogen
	Lower	8/21/01	3.56	**10.46**	**3.09**	Nitrogen
Aliceville	Upper	8/14/01	4.88	**21.87**	1.76	Nitrogen
	Lower	8/14/01	1.79	**21.87**	1.76	Nitrogen

MSC = Maximum Standing Crop
C = Control
C+N = Control + Nitrogen
C+P = Control + Phosphorus

Values in **bold** print are significantly different from control.

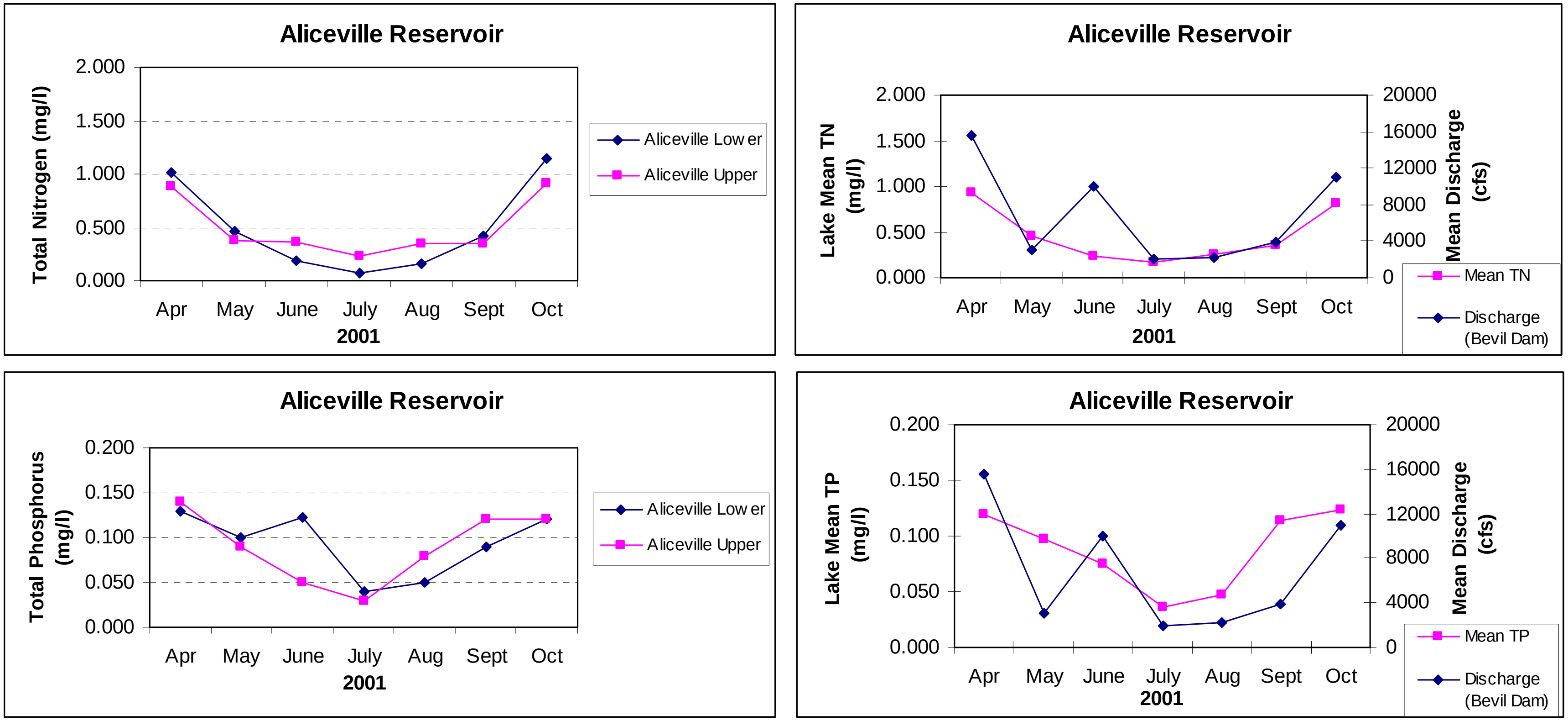


Figure I.9. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Aliceville Reservoir, April-October 2001.

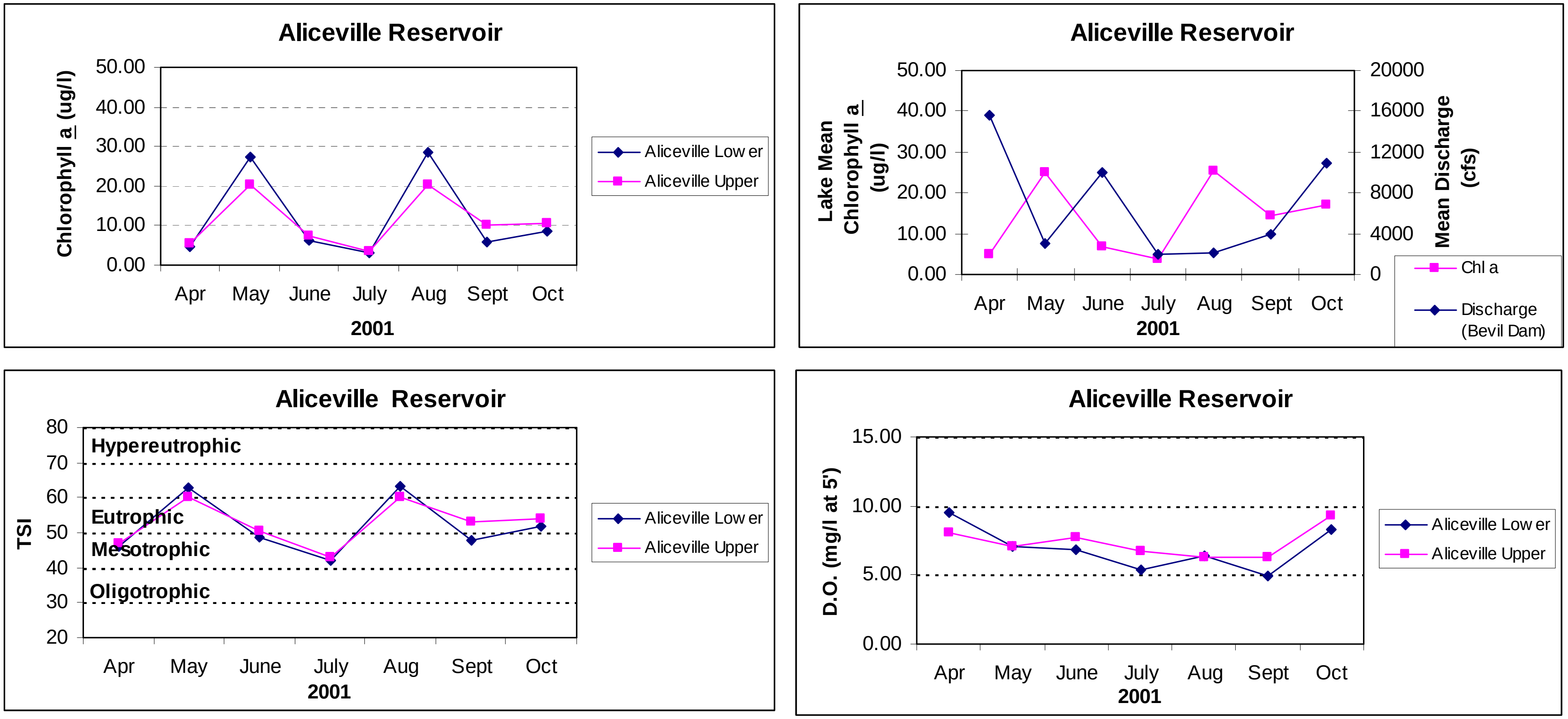


Figure I.10. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, trophic state index (TSI), and dissolved oxygen (DO) of Aliceville Reservoir, April-October 2001.

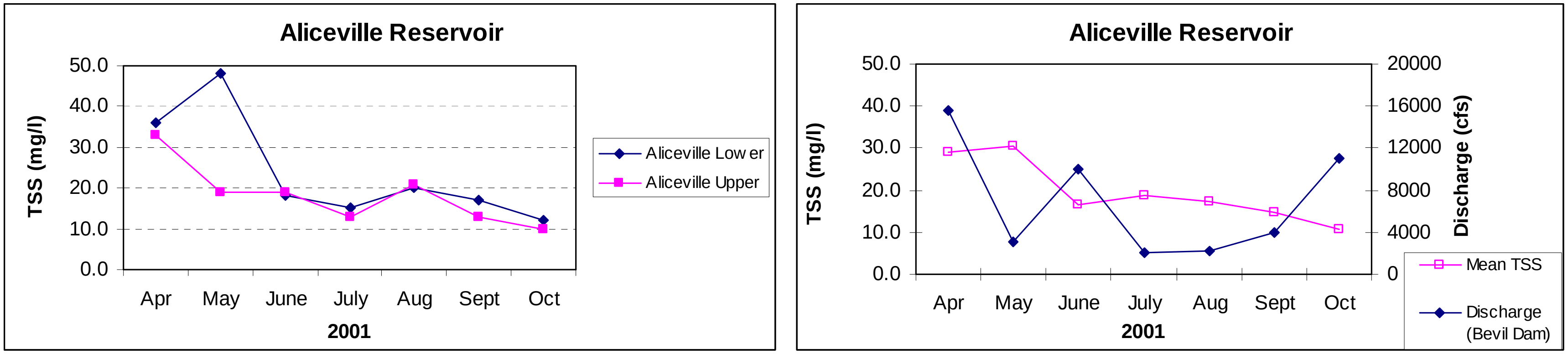


Figure I.11. Total suspended solids (TSS) and TSS vs. discharge for Aliceville Reservoir, April – October 2001.

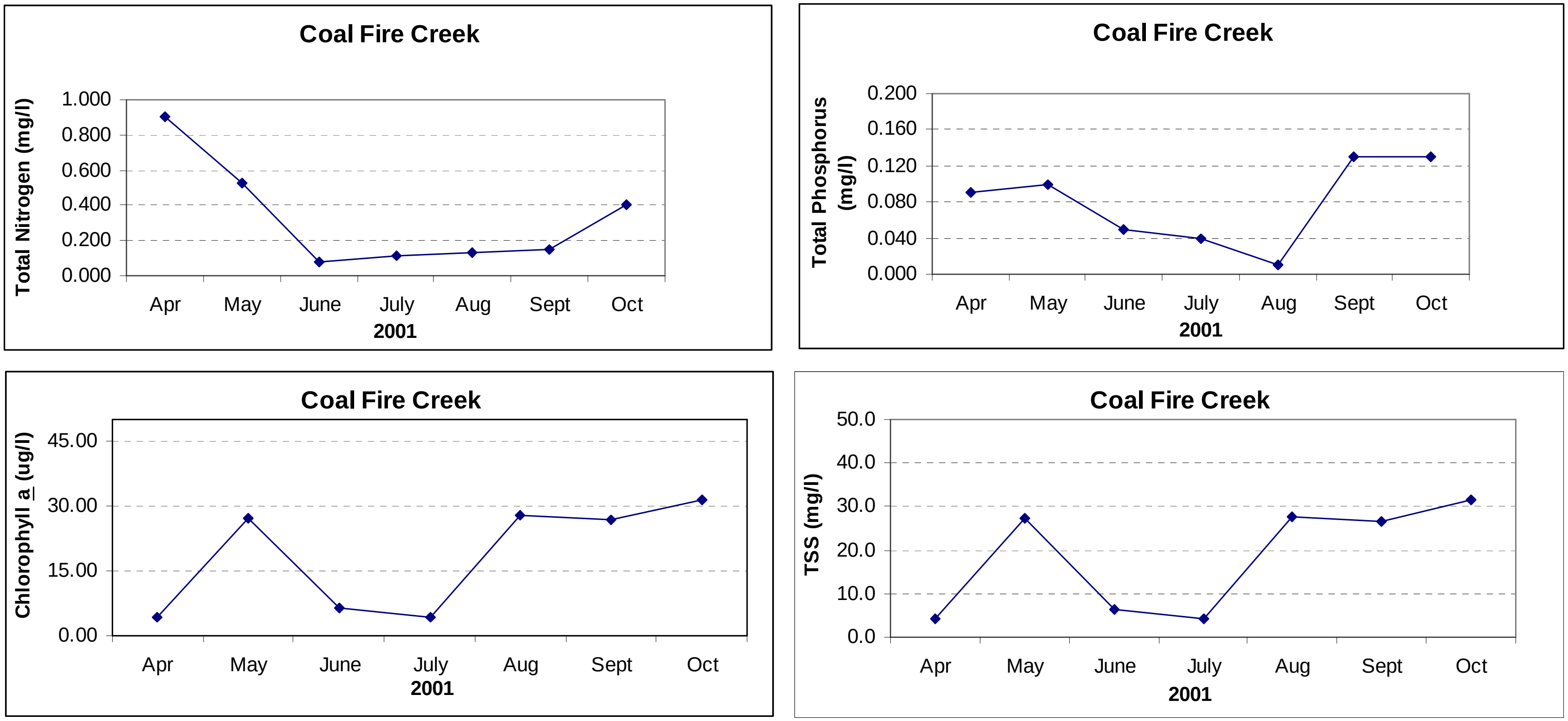


Figure I.12. Total nitrogen (TN), total phosphorus (TP), chlorophyll a and dissolved oxygen for Aliceville Reservoir, Coal Fire Creek embayment, April – October 2001.

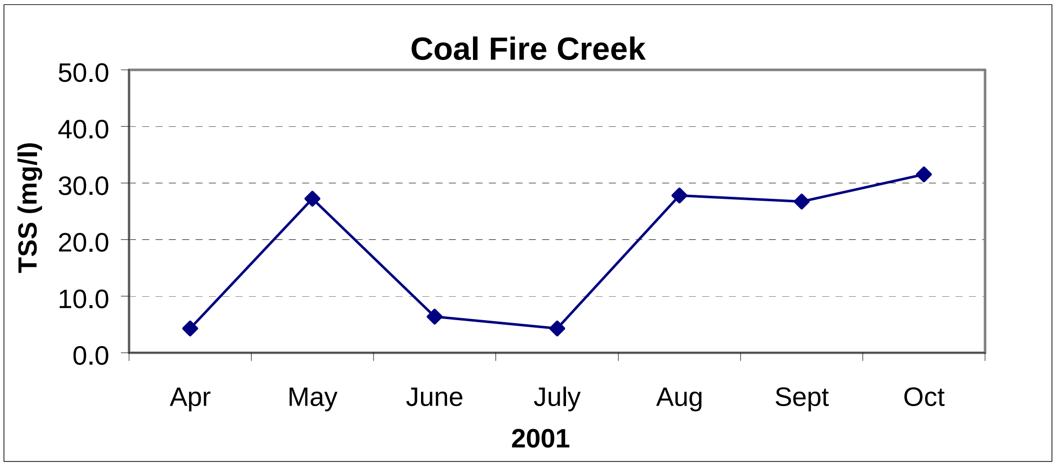


Figure I.13. Total suspended solids (TSS) for Coal Fire Creek embayment, April – October 2001.

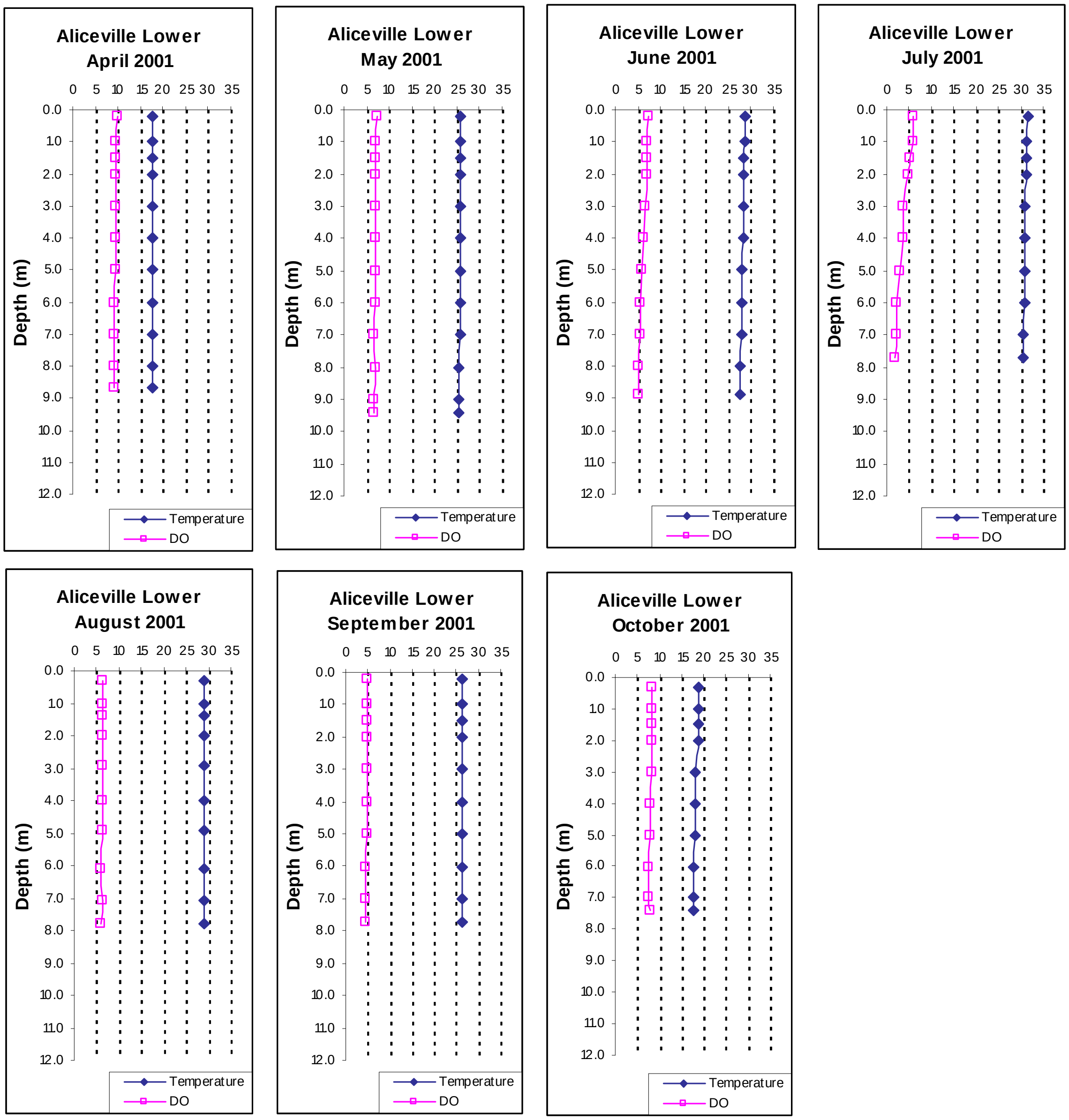


Figure I.14. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the dam forebay of Aliceville Reservoir, April-October 2001.

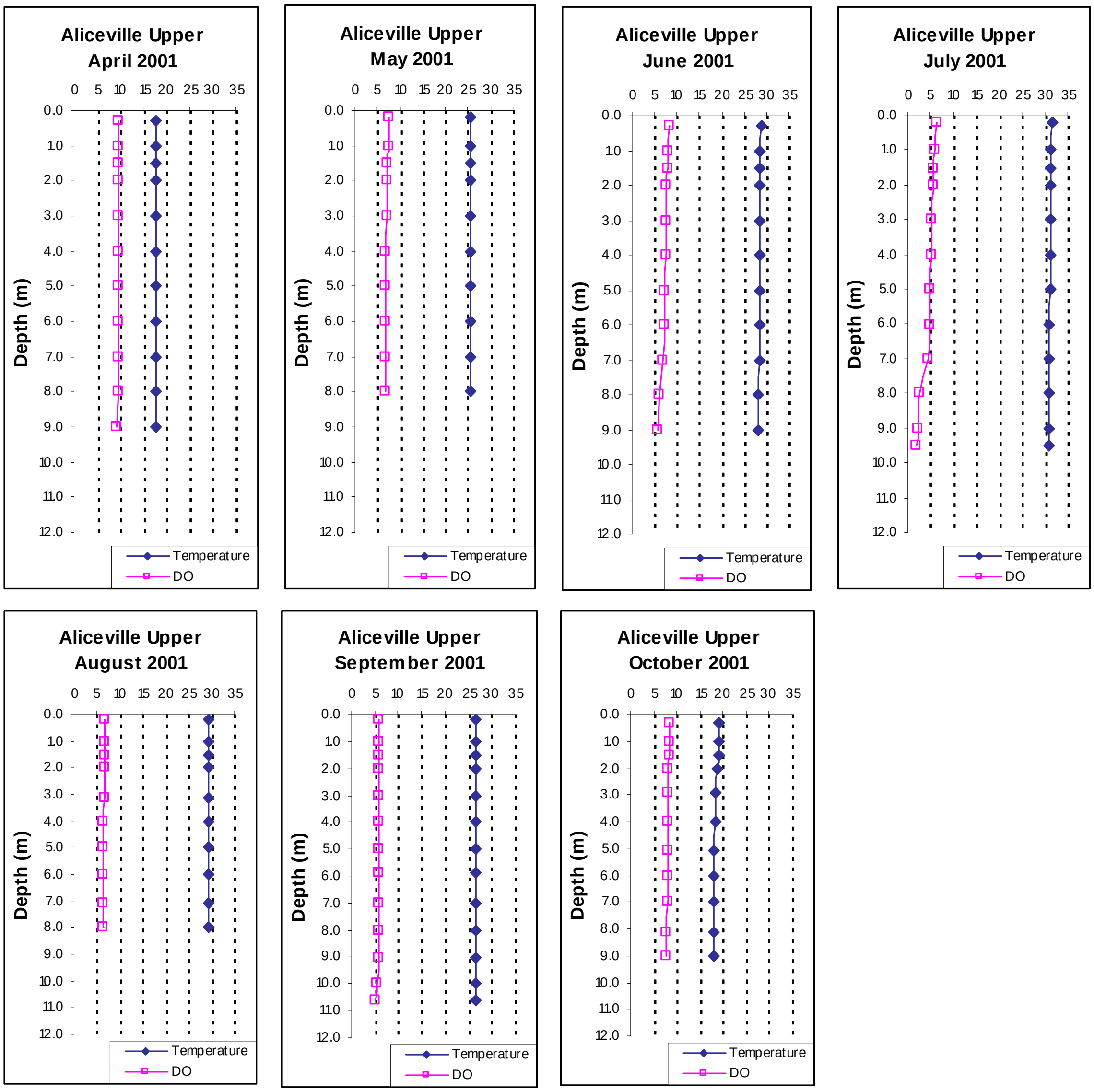


Figure I.15. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for upper Aliceville Reservoir, April – October 2001.

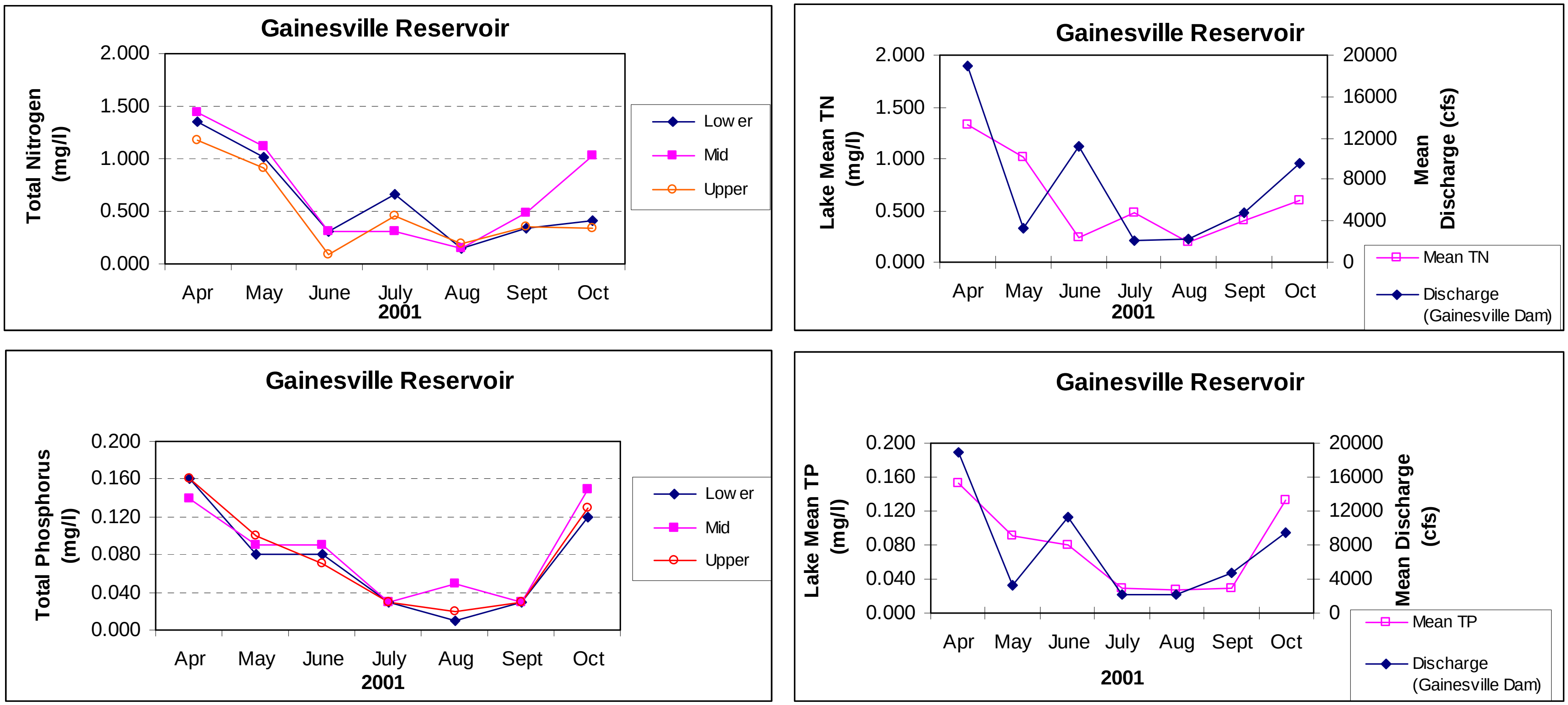


Figure I.16. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge for Gainesville Reservoir, April-October 2001.

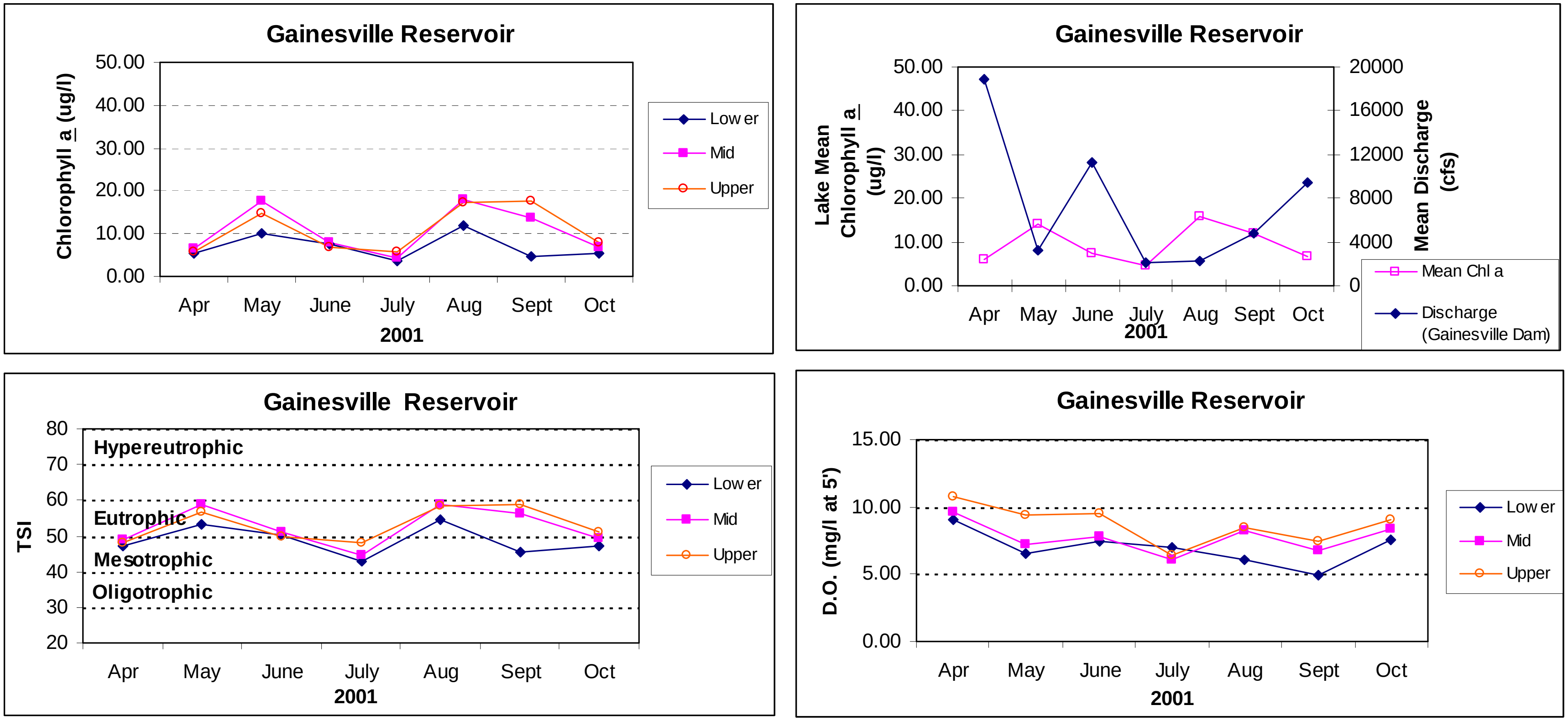
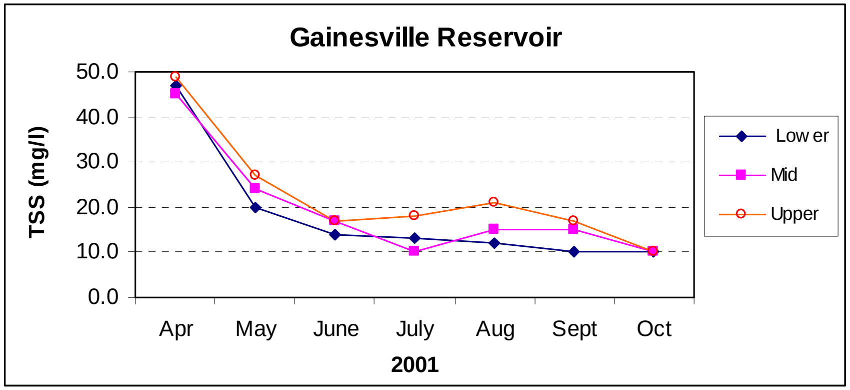


Figure I.17. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, trophic state index (TSI) and dissolved oxygen (DO) for Gainesville Reservoir, April-October 2001.



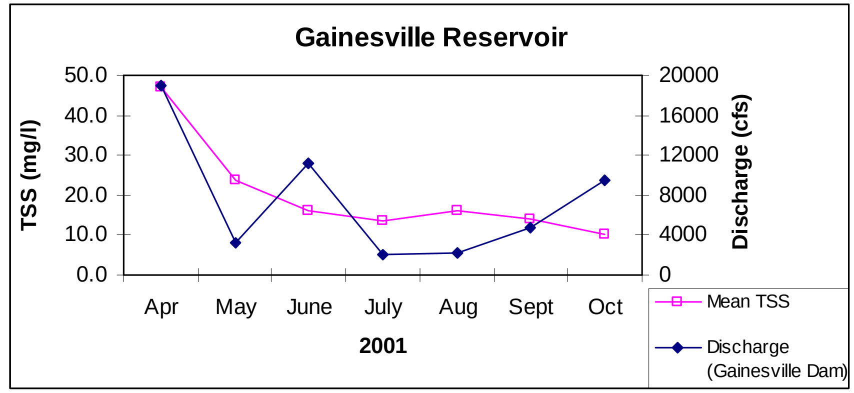


Figure I.18. Total suspended solids (TSS) and TSS vs. discharge of Gainesville Reservoir, April – October 2001.

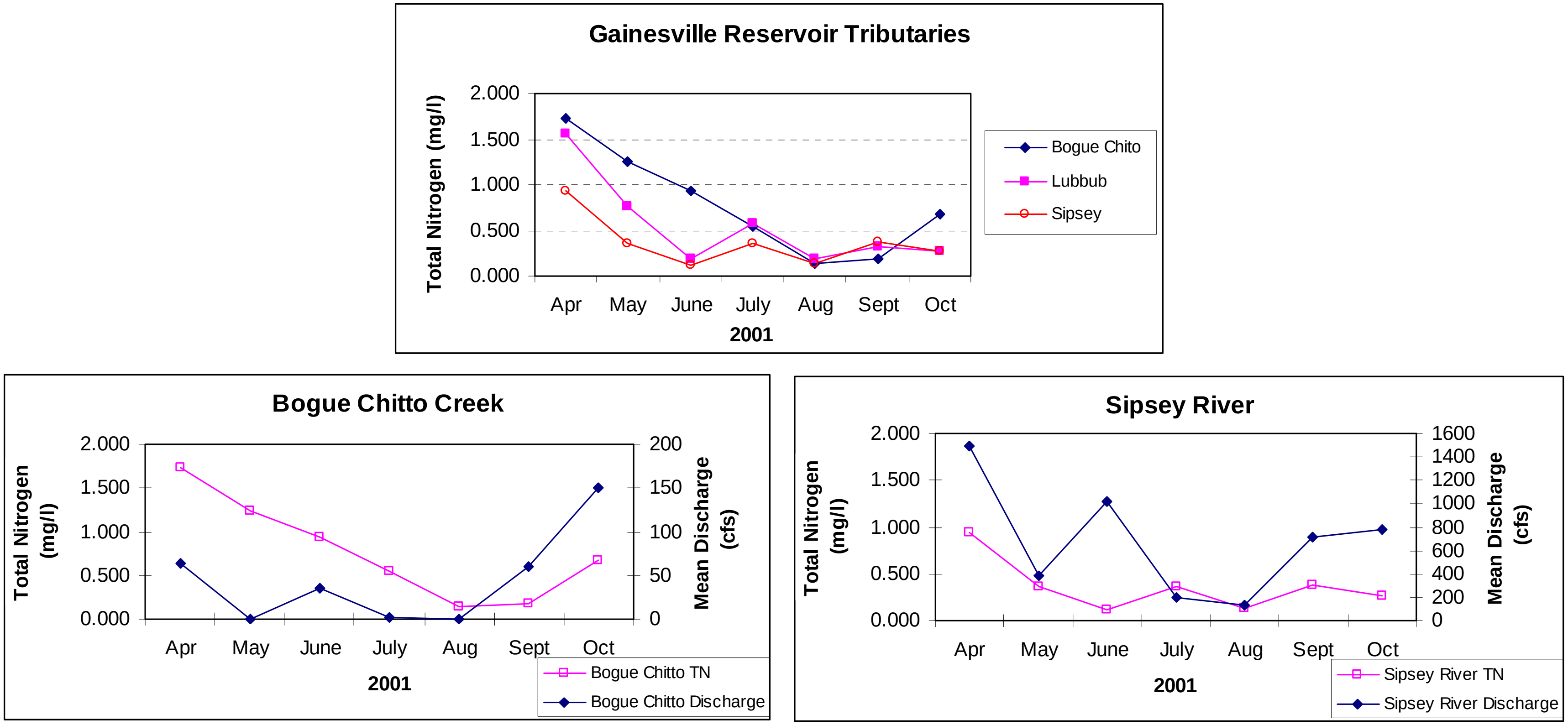


Figure I.19. Total nitrogen for Gainesville Reservoir tributaries, Bogue Chitto Creek TN vs. discharge, and Sipsey River TN vs. discharge, April – October 2001.

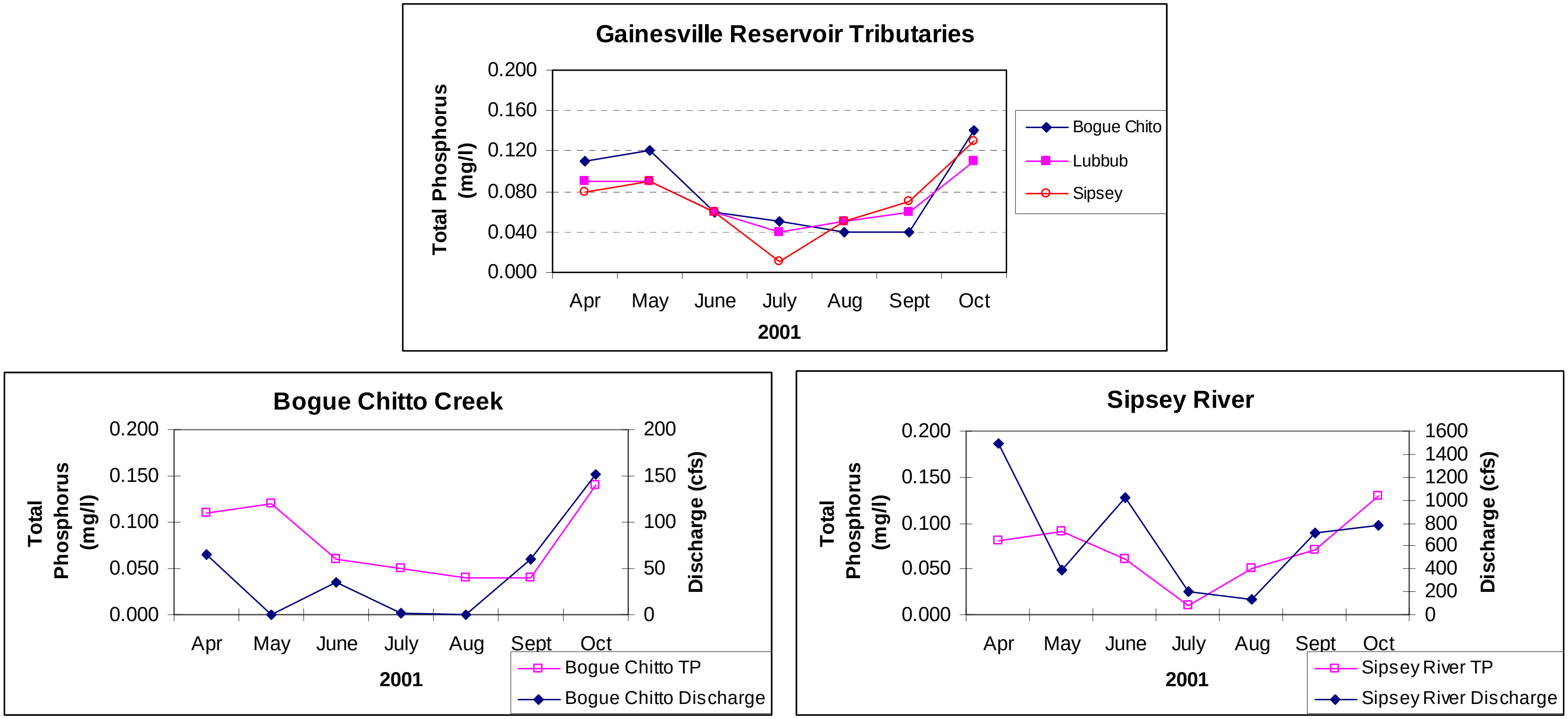


Figure I.20. Total phosphorus for Gainesville Reservoir tributaries, TP vs. Bogue Chitto Creek discharge, and TP vs. Sipsey River discharge, April – October 2001.

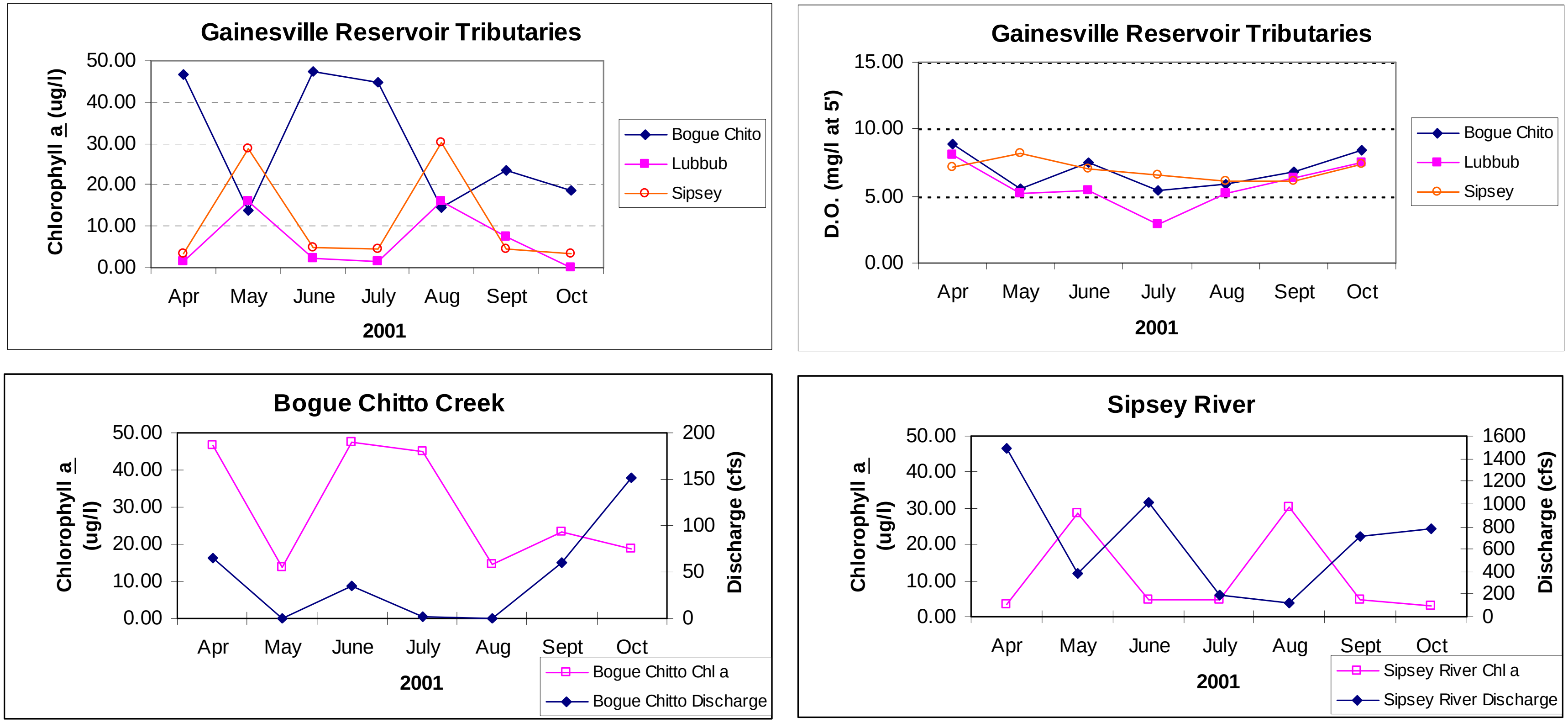


Figure I.21. Chlorophyll *a* for Gainesville Reservoir tributaries, dissolved oxygen (DO) for Gainesville tributaries, chlorophyll *a* vs. Bogue Chitto Creek discharge, and chlorophyll *a* vs. Sipsey River discharge, April – October 2001.

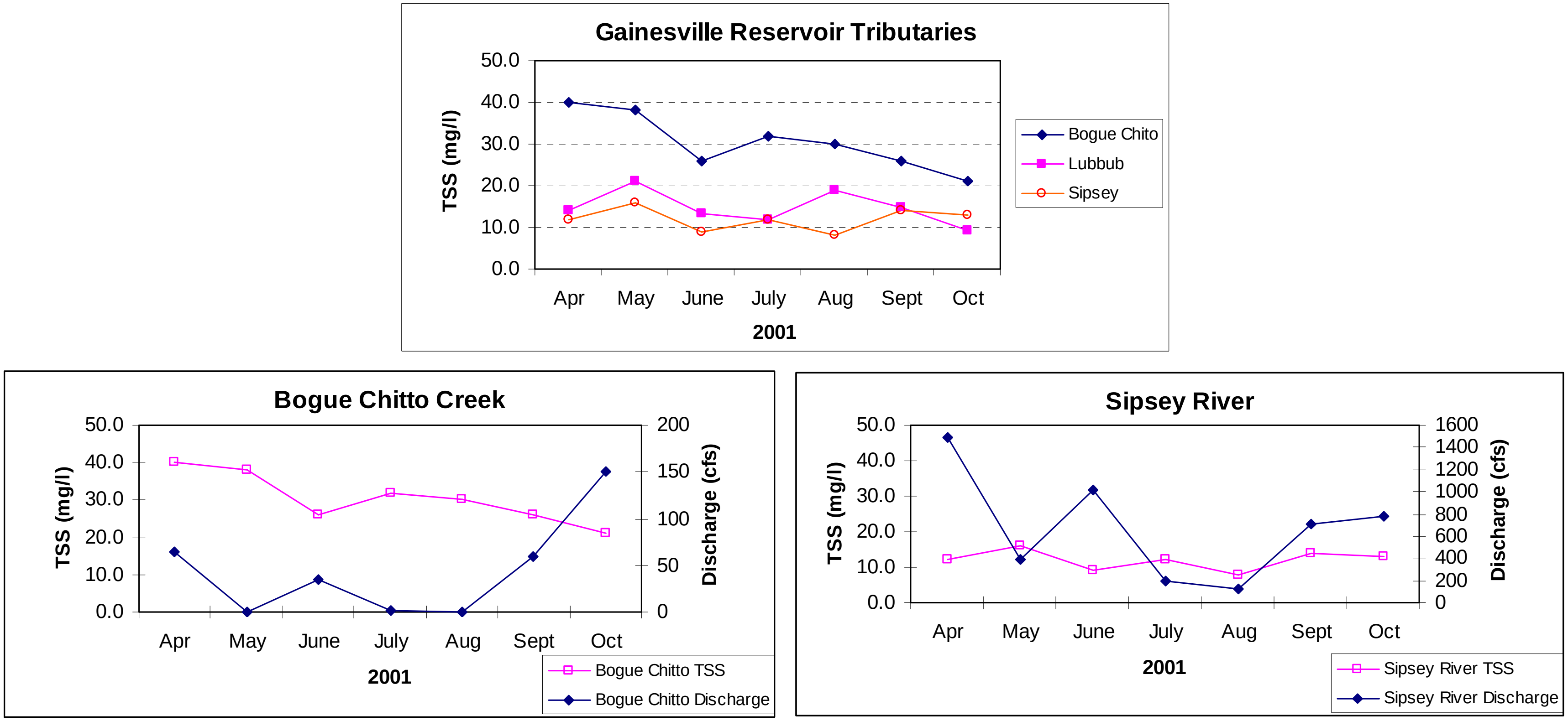


Figure I.22. Total suspended solids (TSS) for Gainesville Reservoir tributaries, TSS vs. Bogue Chitto discharge, and TSS vs. Sipsey River discharge, April – October 2001.

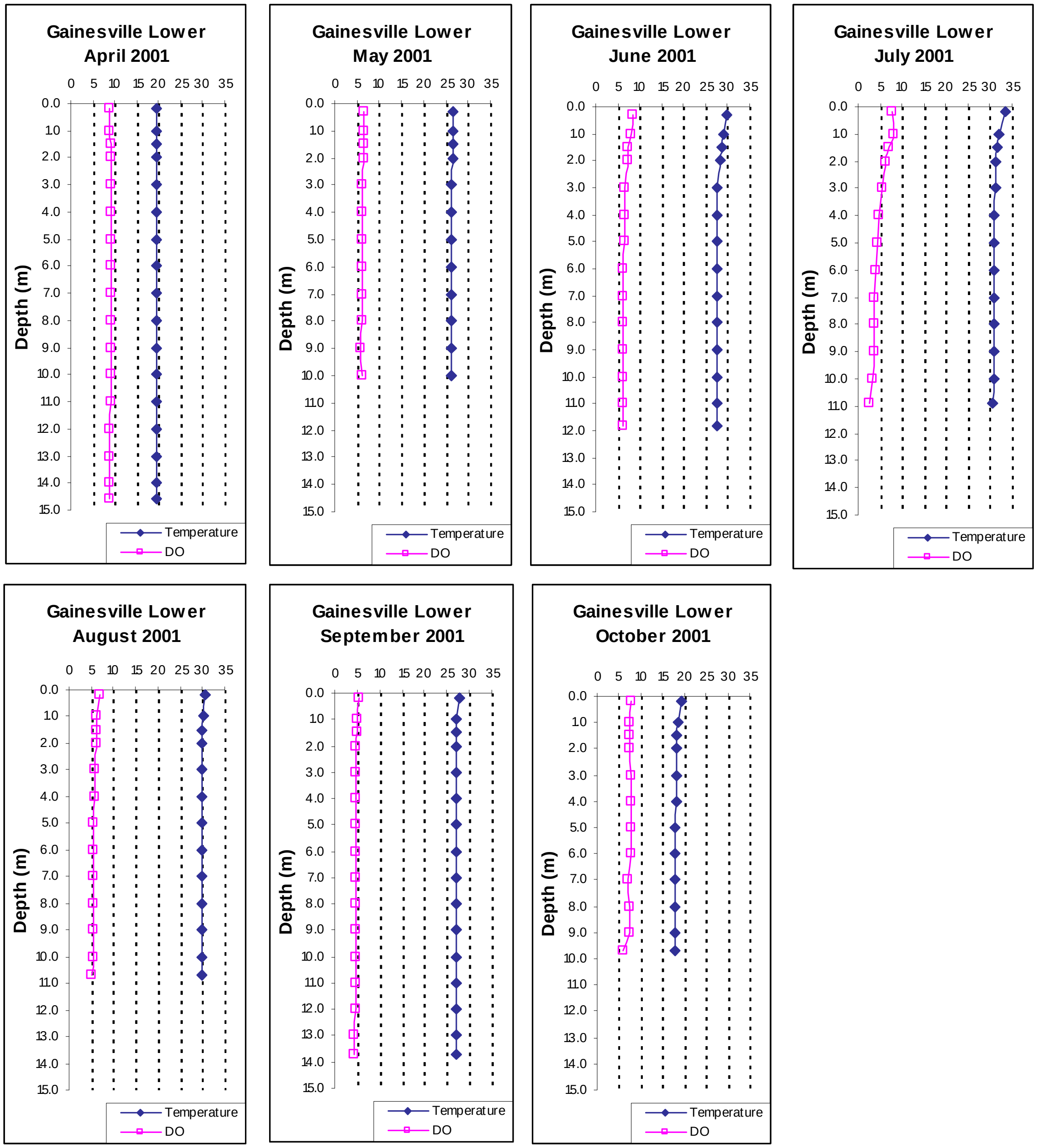


Figure I.23. Depth profiles of dissolved oxygen (DO) and temperature (Temp) of the dam forebay of Gainesville Reservoir, April-October 2001.

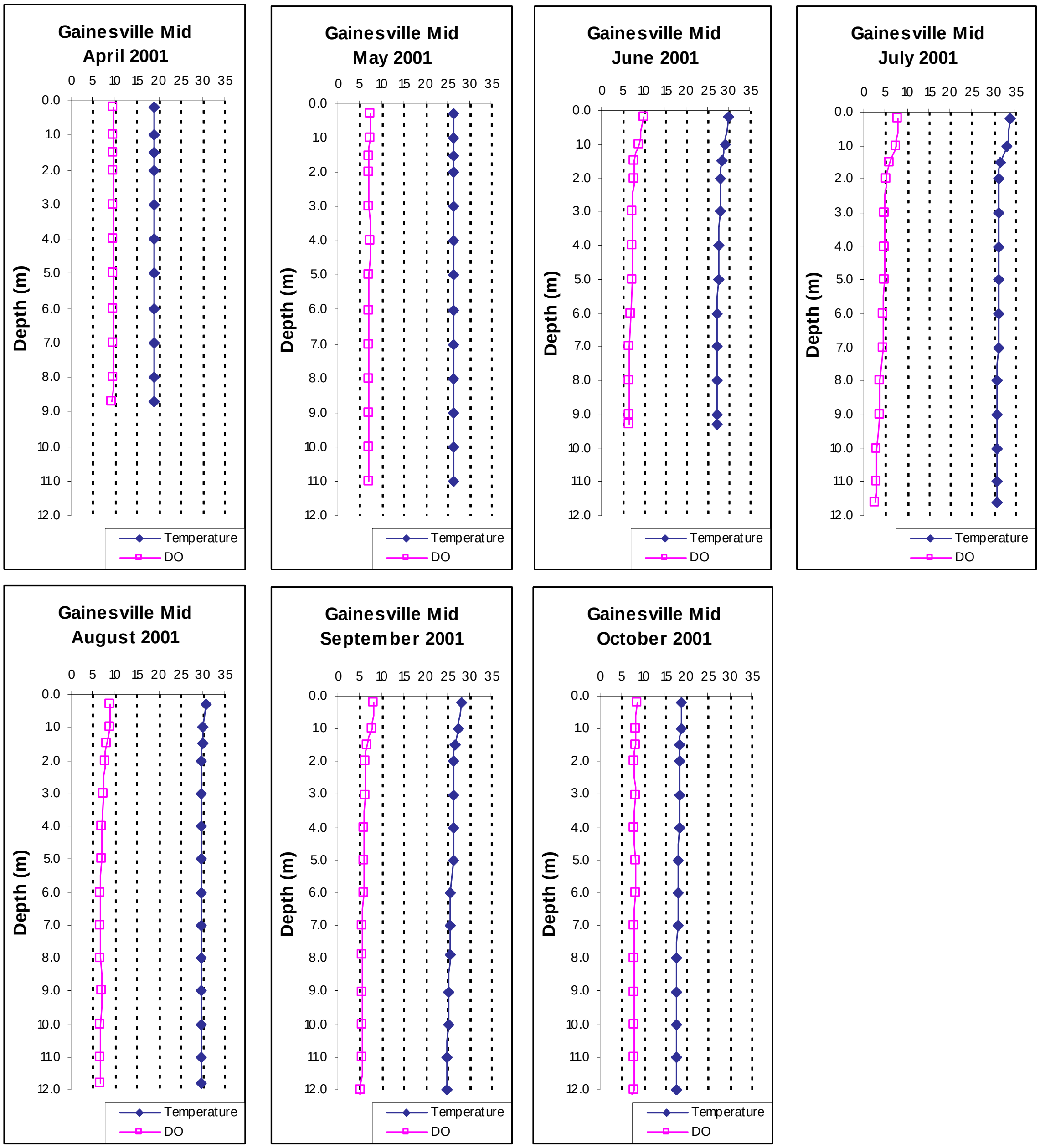


Figure I.24. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for middle Gainesville Reservoir, April – October 2001.

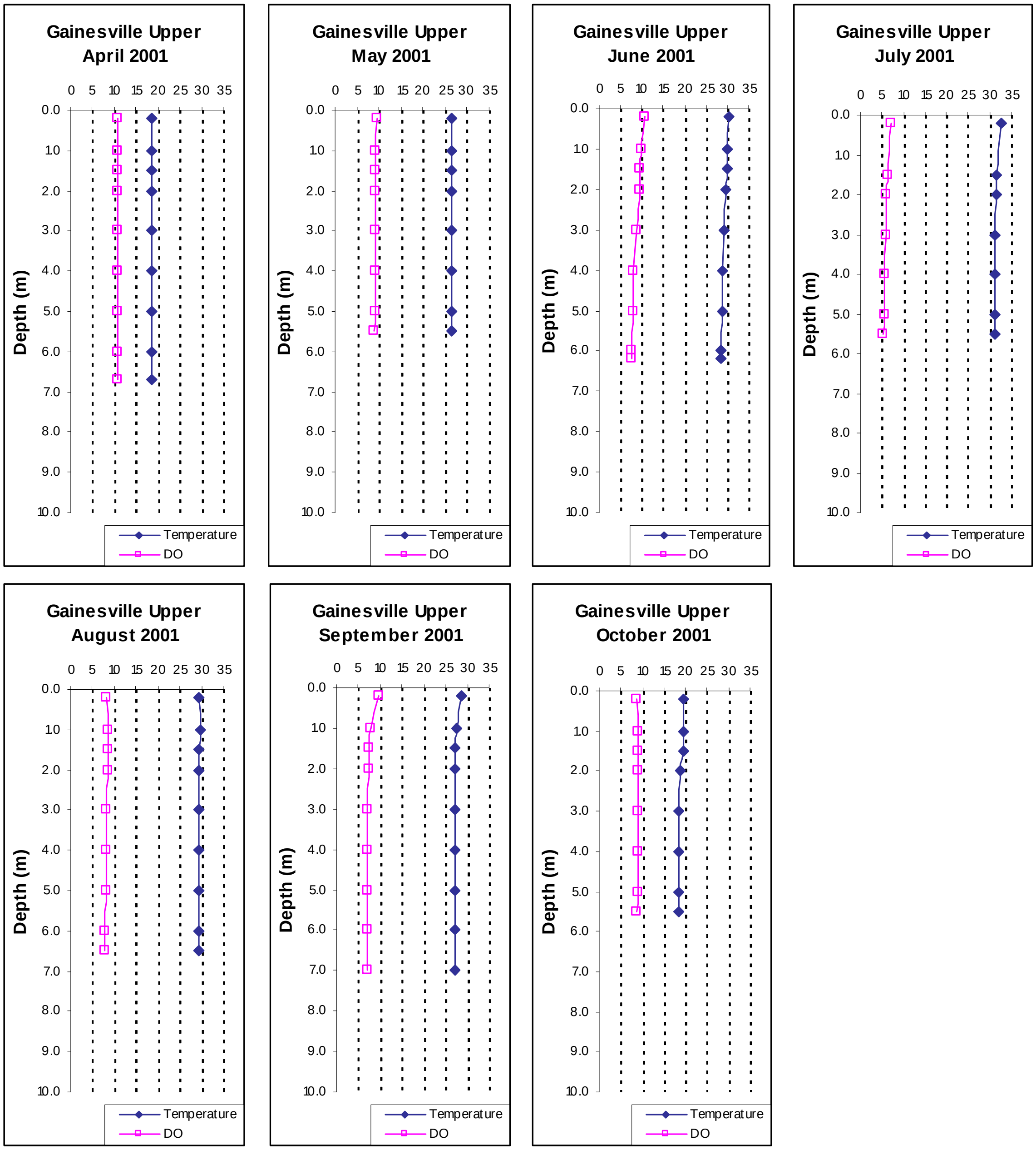


Figure I.25. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for upper Gainesville Reservoir, April – October 2001.

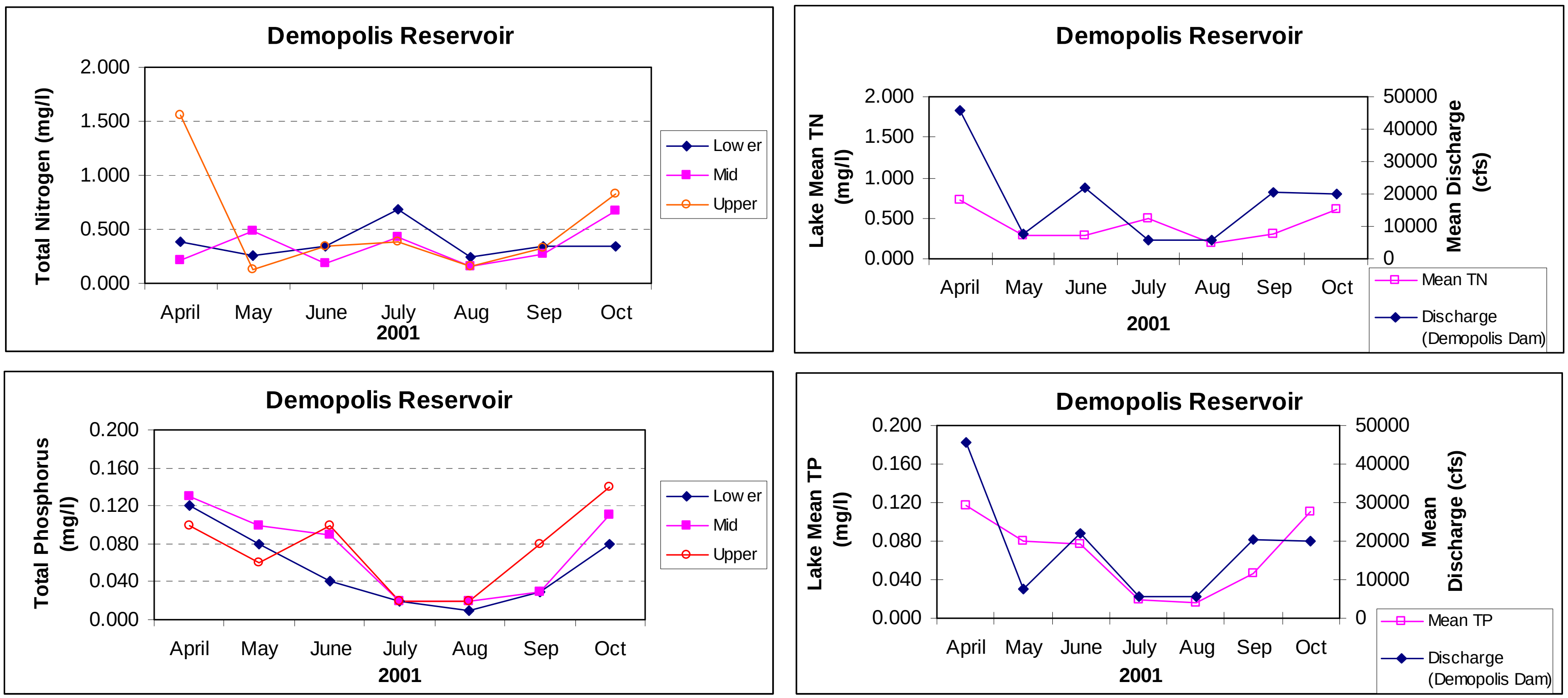


Figure I.26. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Demopolis Reservoir, April-October 2001.

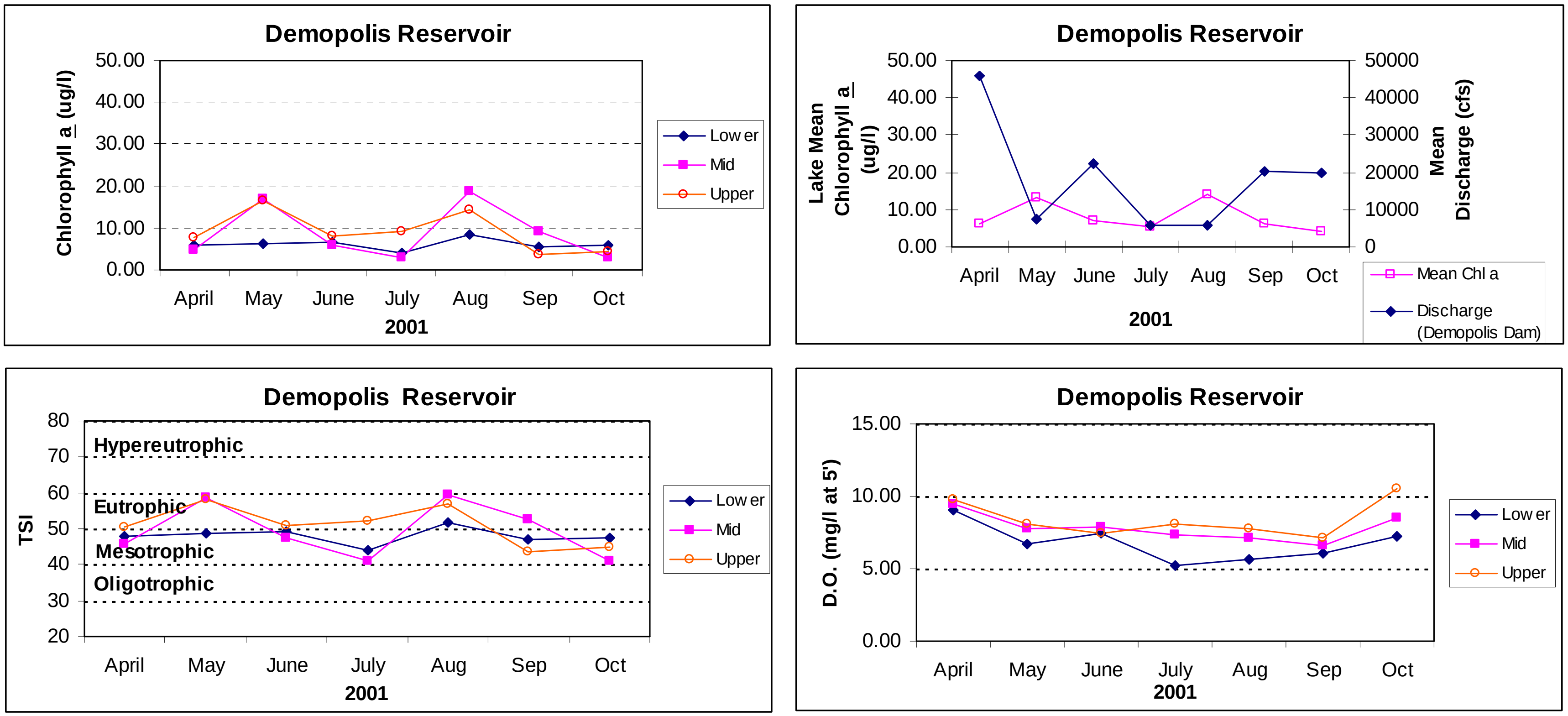


Figure I.27. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, trophic state index (TSI), and dissolved oxygen (DO) of Demopolis Reservoir, April-October 2001.

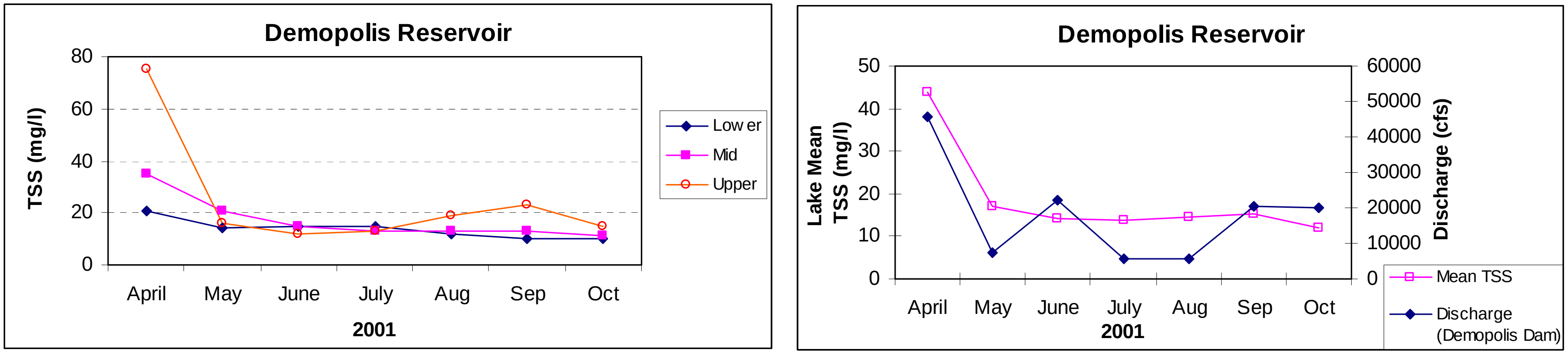


Figure I.28. Total suspended solids (TSS) and TSS vs. discharge of Demopolis Reservoir, April – October 2001.

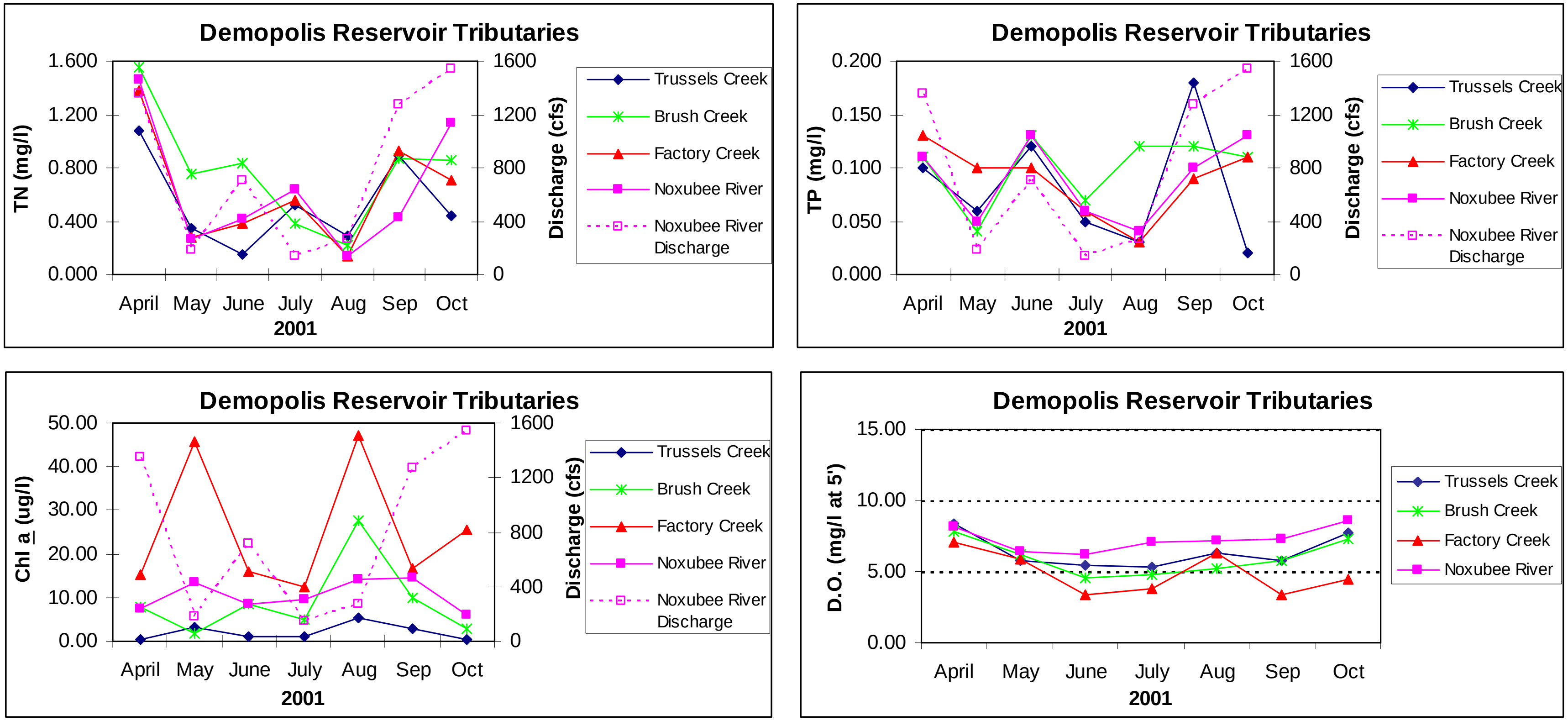


Figure I.29. Total nitrogen **(**TN) vs. Noxubee River discharge, total phosphorus (TP) vs. Noxubee River discharge, chlorophyll *a* (chl a) vs. Noxubee River discharge, and dissolved oxygen (DO) for Demopolis Reservoir tributaries, April – October 2001.

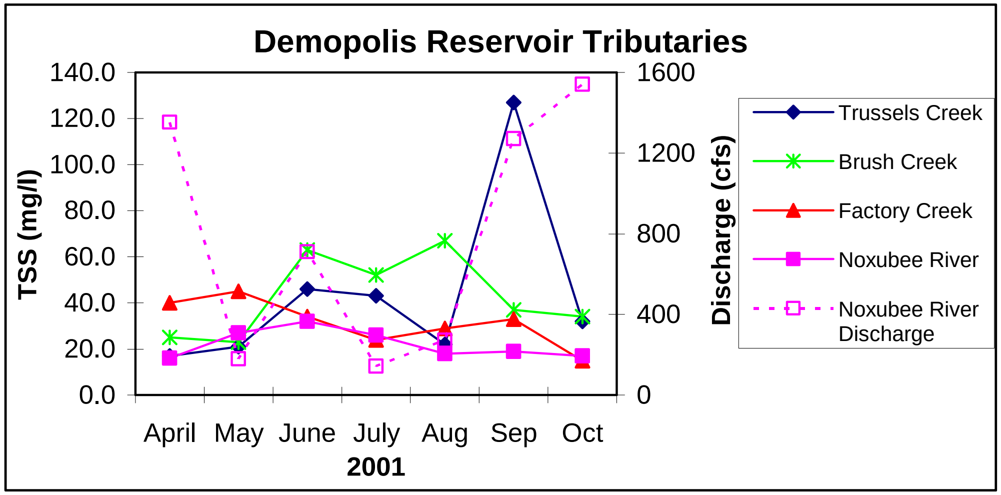


Figure I.30. Total suspended solids (TSS) for Demopolis Reservoir tributaries and Noxubee River discharge, April – October 2001.

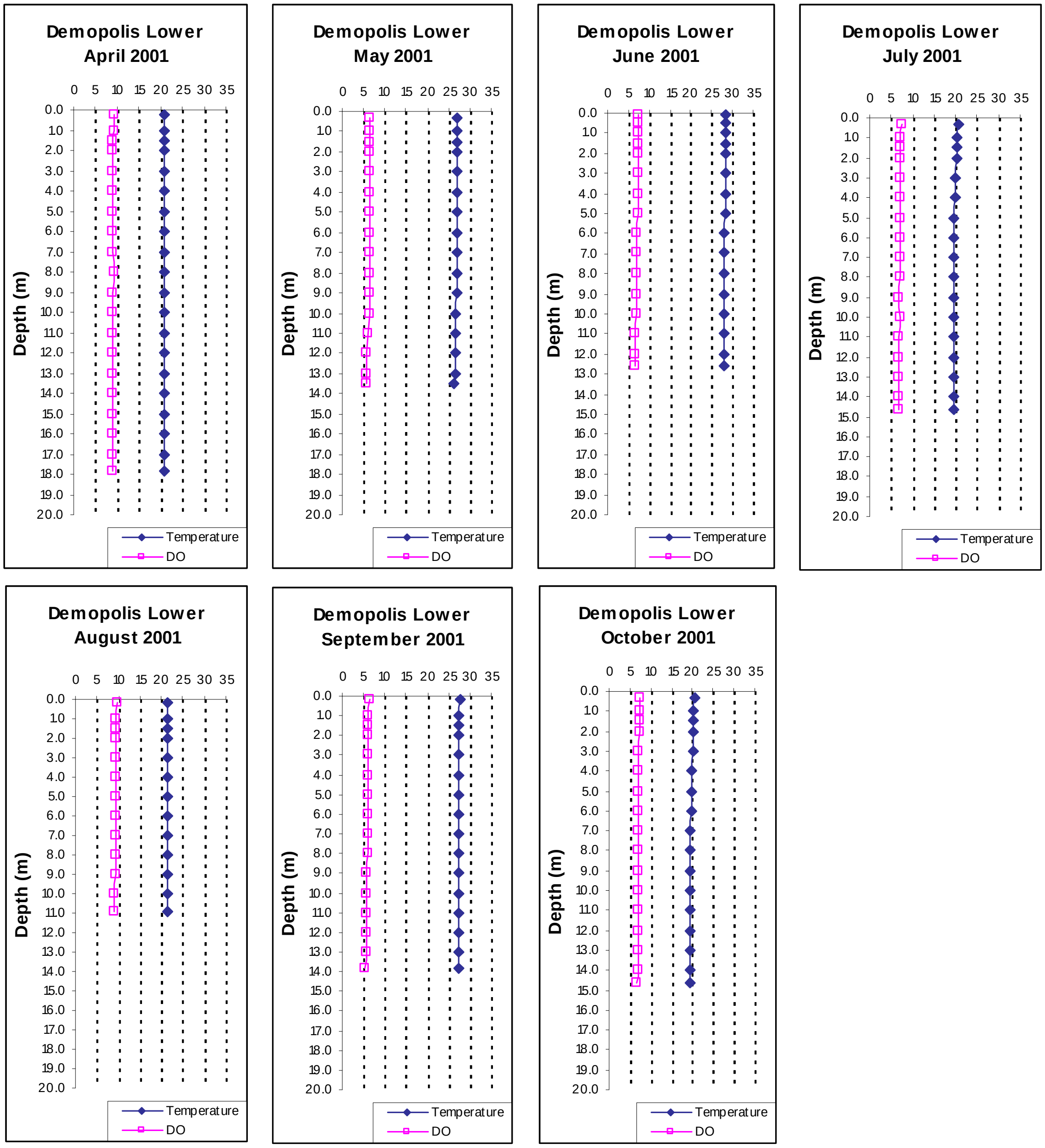


Figure I.31. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the dam forebay of Demopolis Reservoir, April-October 2001.

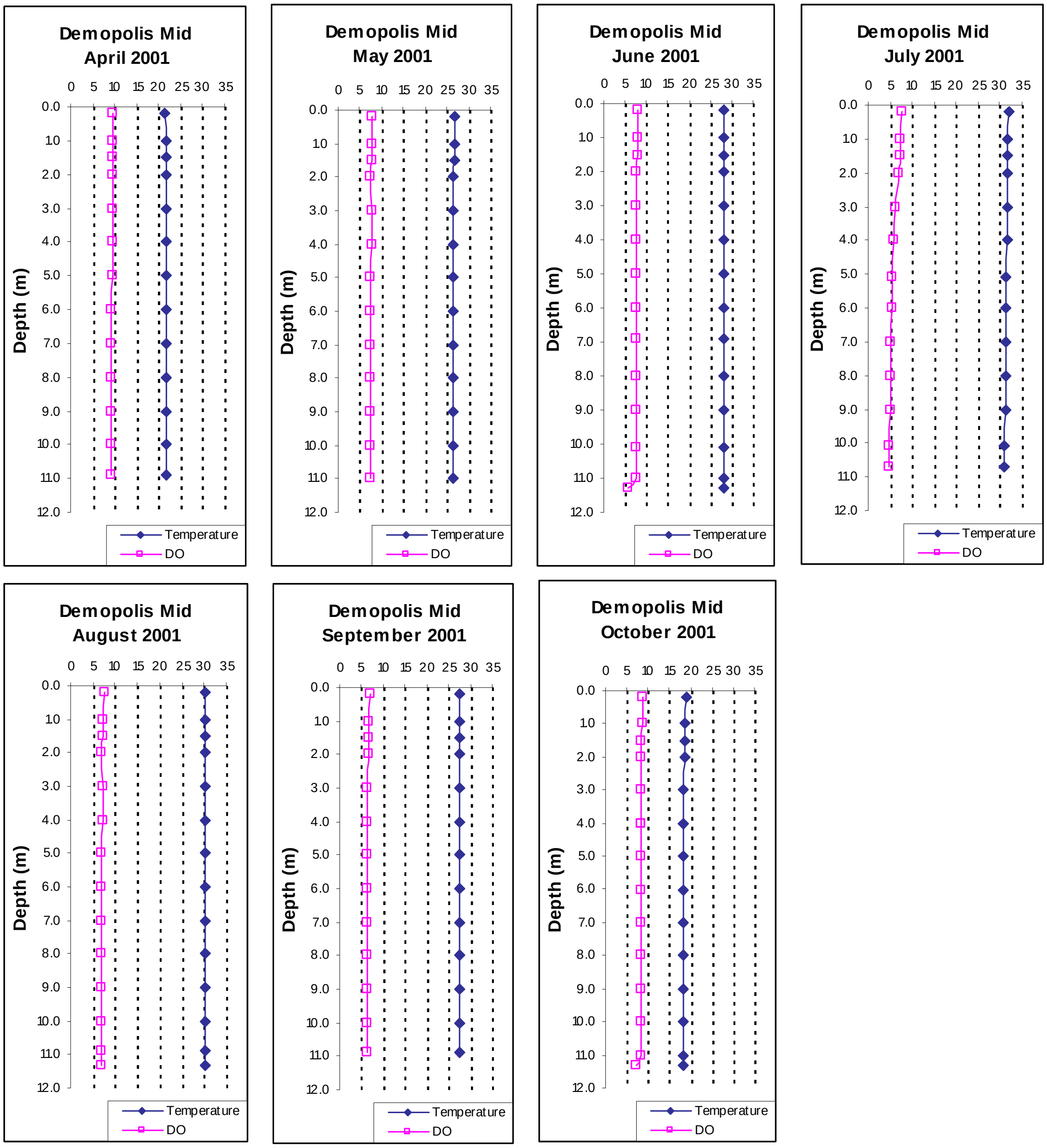


Figure I.32. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for middle Demopolis Reservoir, April - October 2001.

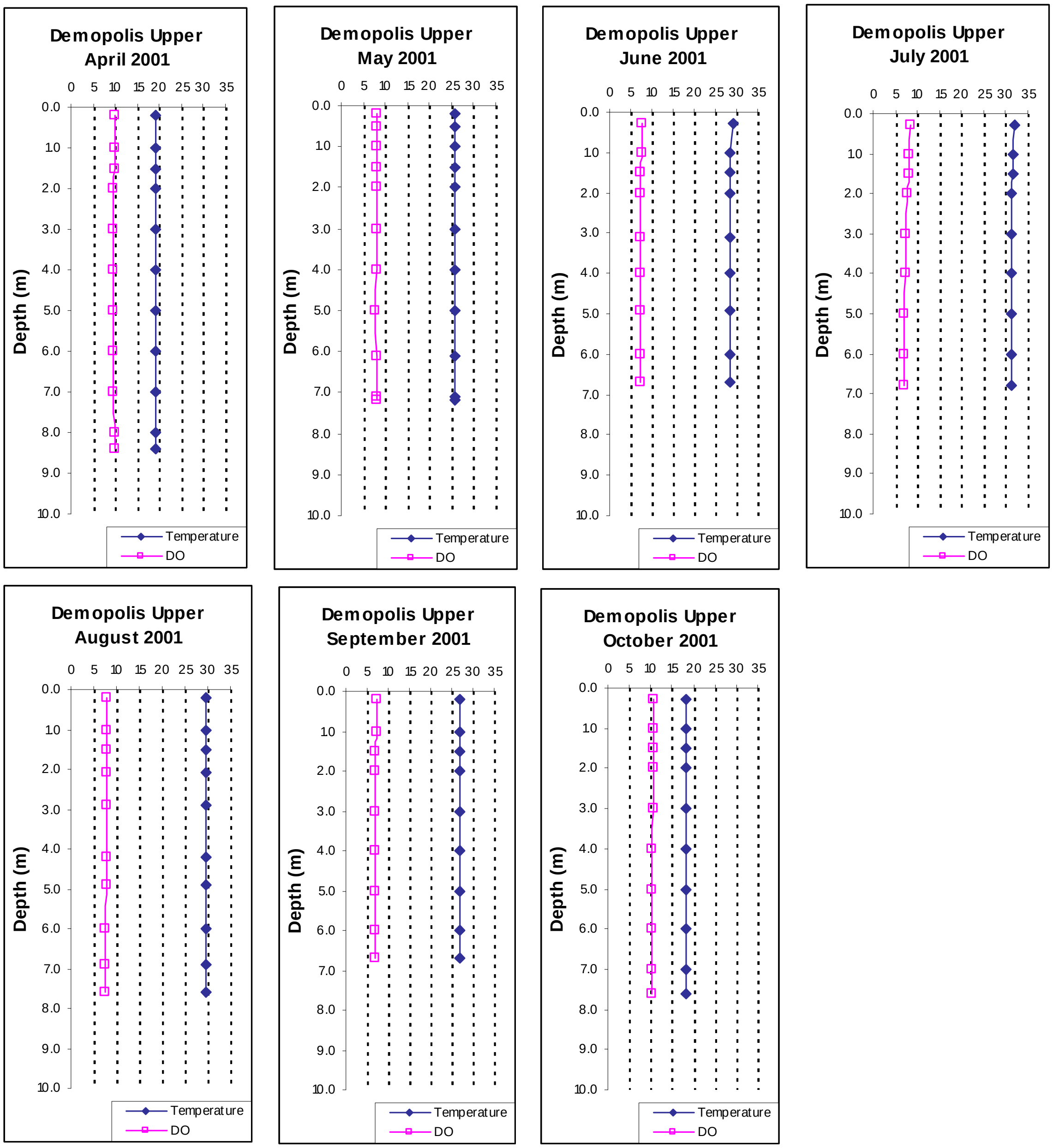


Figure I.33. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for upper Demopolis Reservoir, April – October 2001.

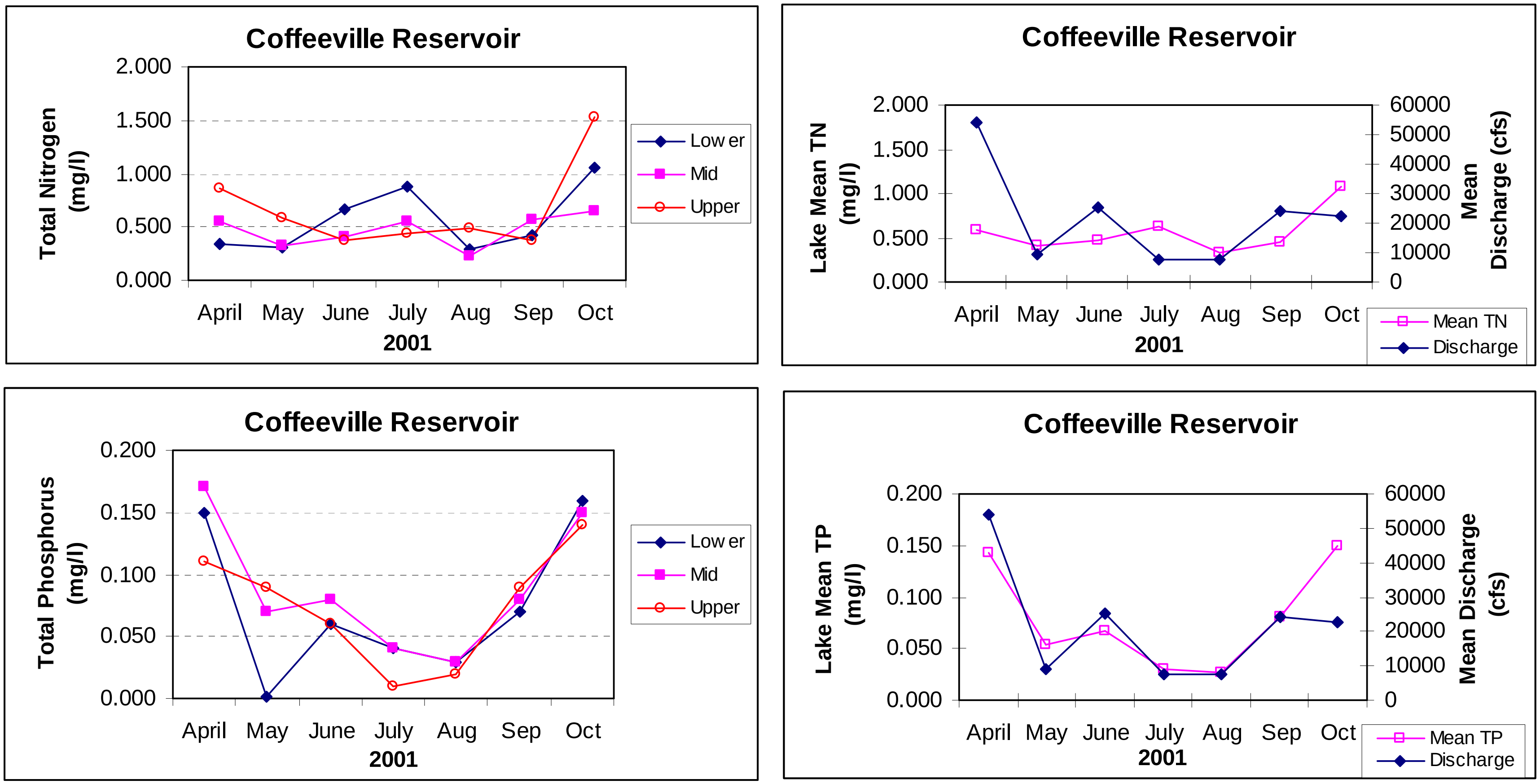


Figure I.34. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Coffeeville Reservoir, April – October 2001.

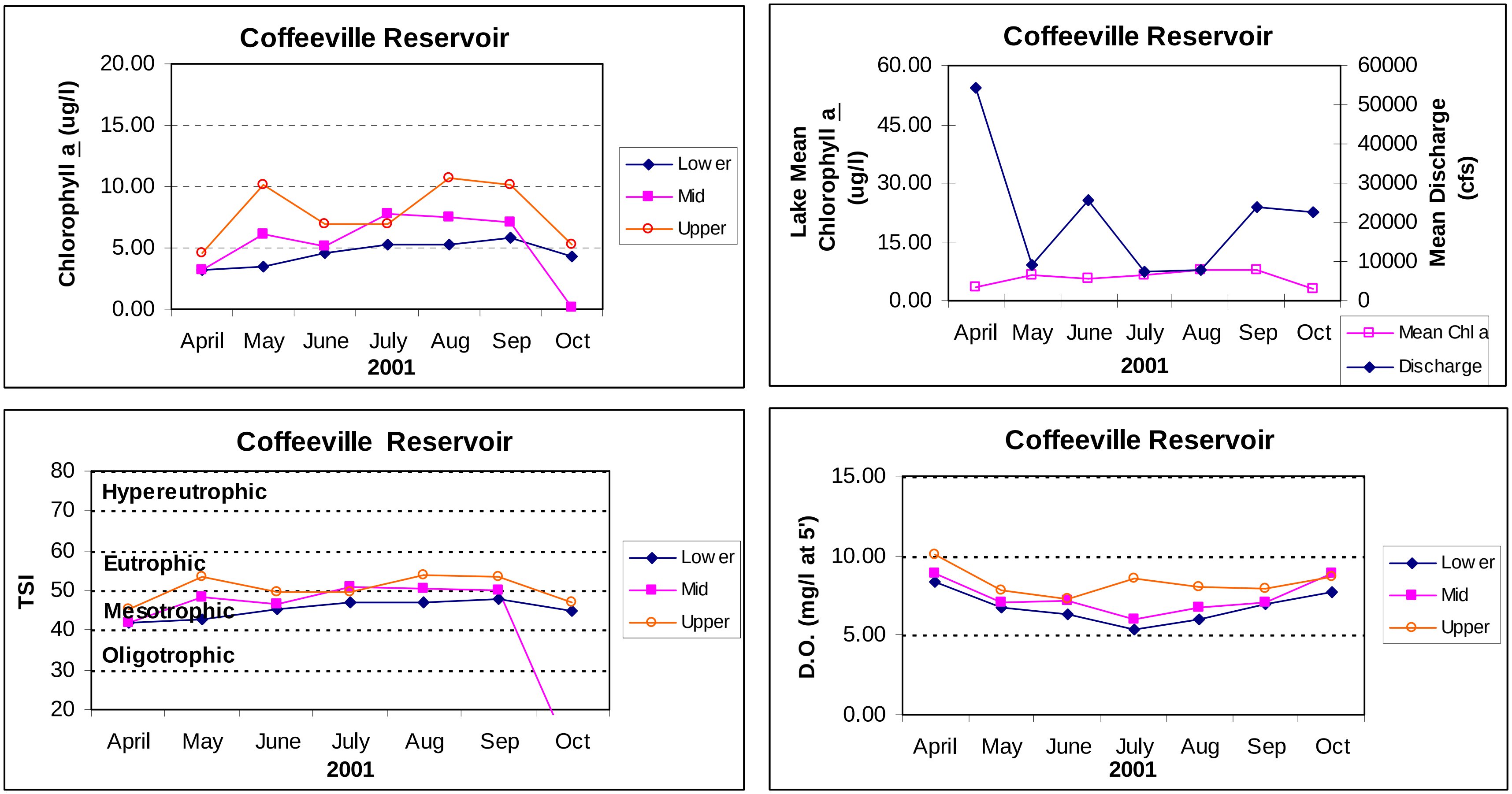
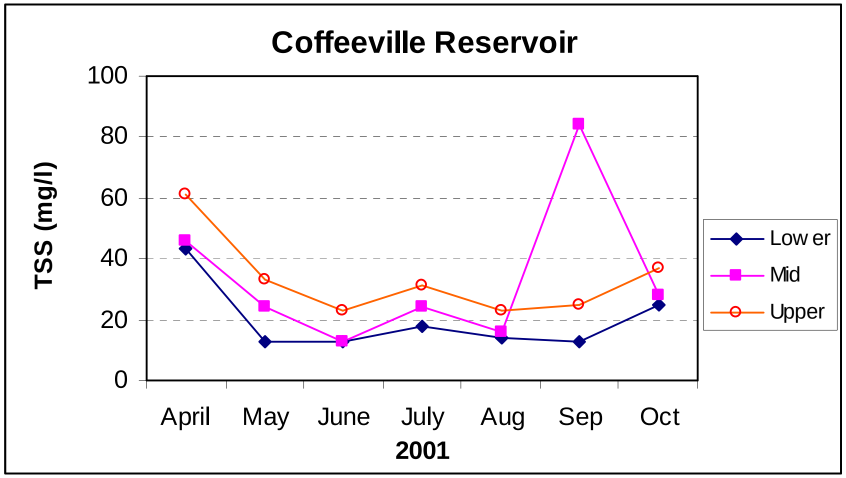


Figure I.35. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, trophic state index (TSI) and dissolved oxygen (DO) of Coffeeville Reservoir, April – October 2001.



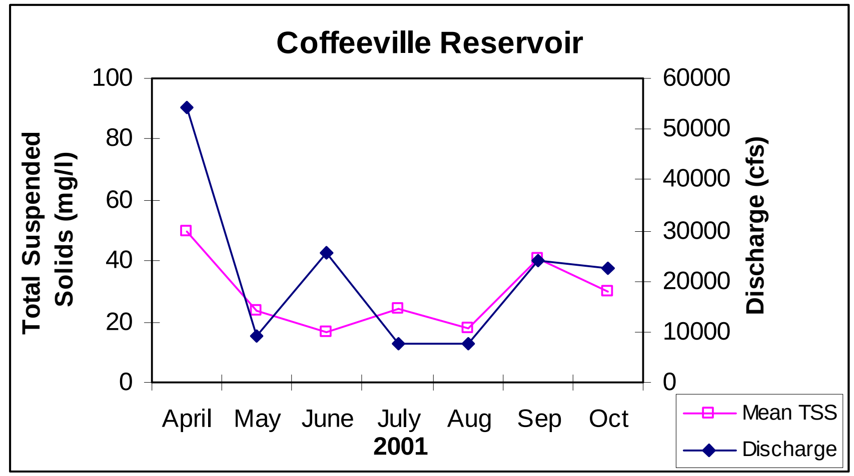


Figure I.36. Total suspended solids (TSS) and TSS vs. discharge of Coffeeville Reservoir, April – October 2001.

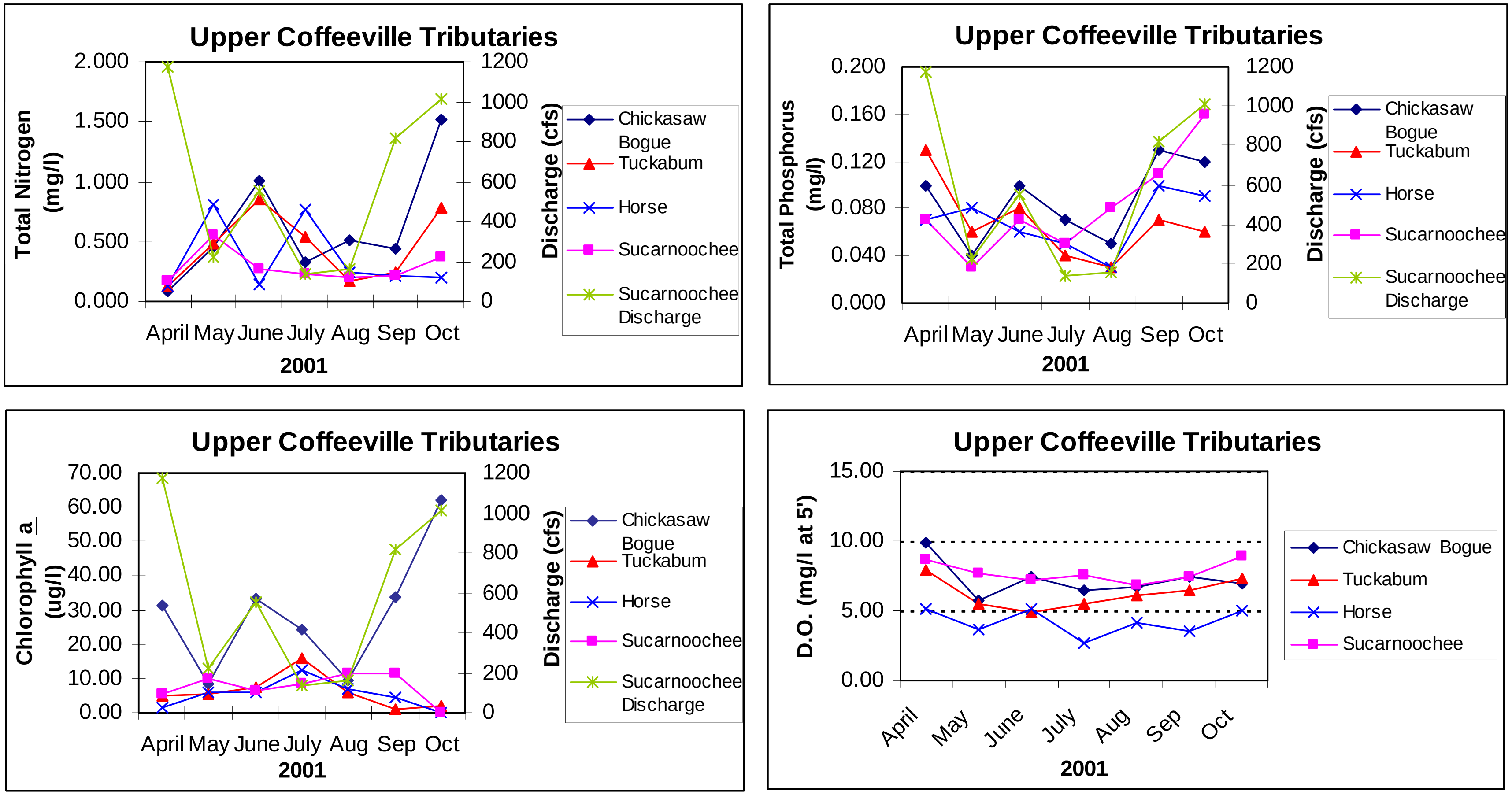


Figure I.37. Total nitrogen, total phosphorus, and chlorophyll *a* vs. Sucarnoochee River discharge, and dissolved oxygen for upper Coffeeville Reservoir tributaries, April – October 2001.

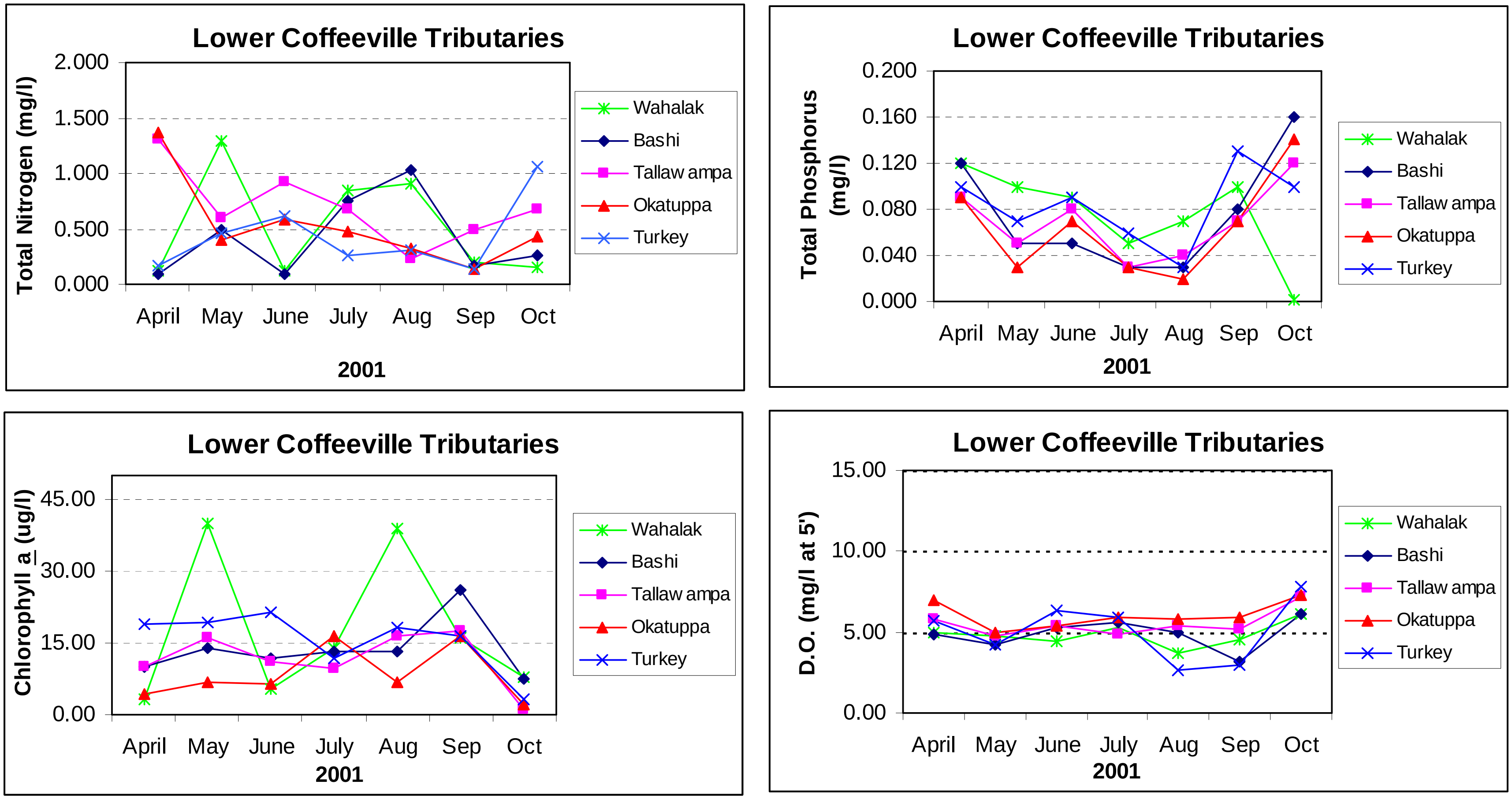


Figure I.38. Total nitrogen, total phosphorus, and chlorophyll *a*, and dissolved oxygen for lower Coffeeville Reservoir tributaries, April – October 2001.

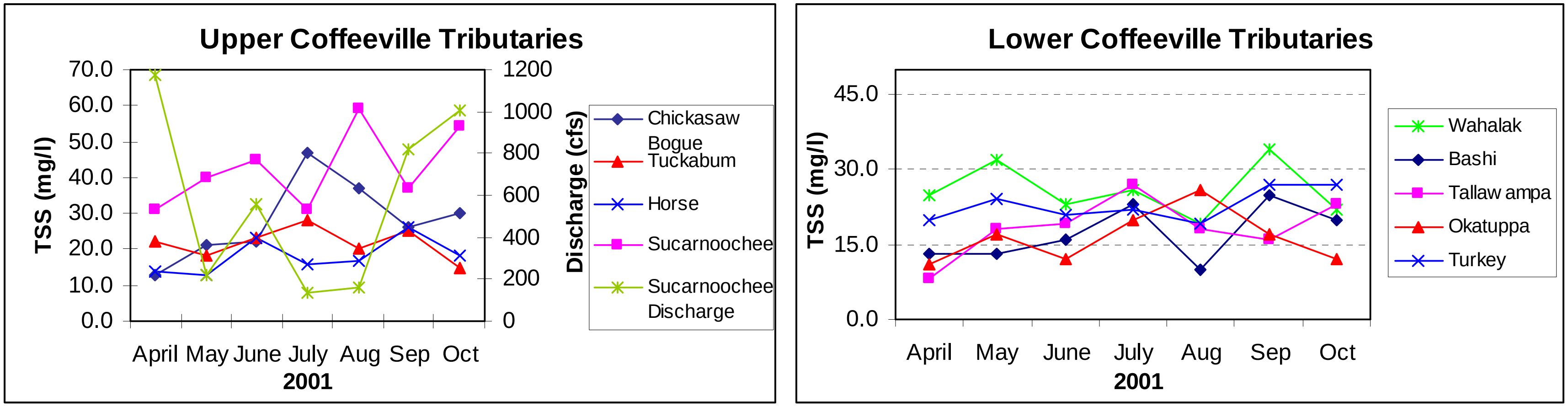


Figure I.39. Total suspended Solids (TSS) for Upper and Lower Coffeeville tributary embayment locations, April – October 2001.

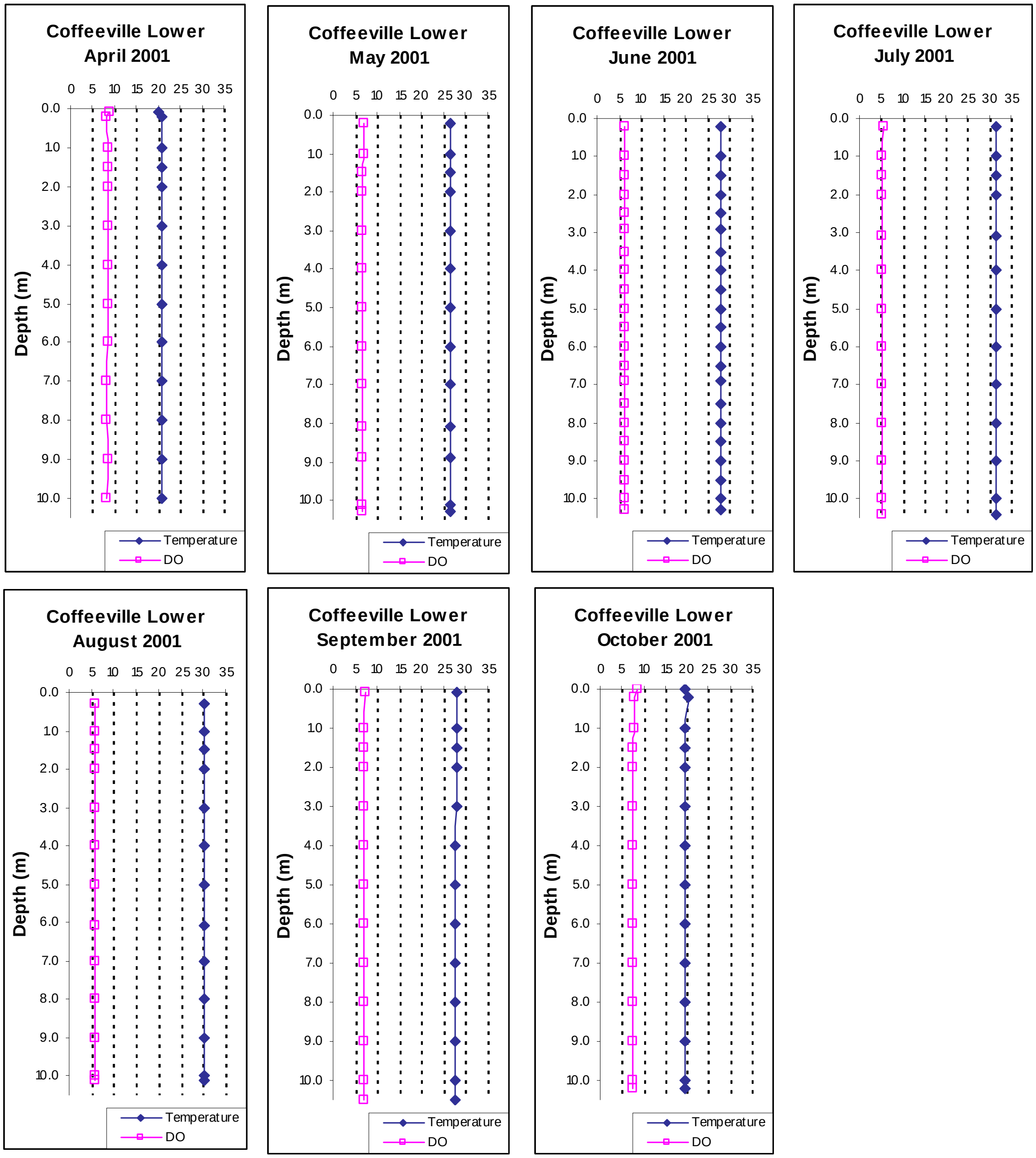


Figure I.40. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the dam forebay of Coffeeville Reservoir, April – October 2001.

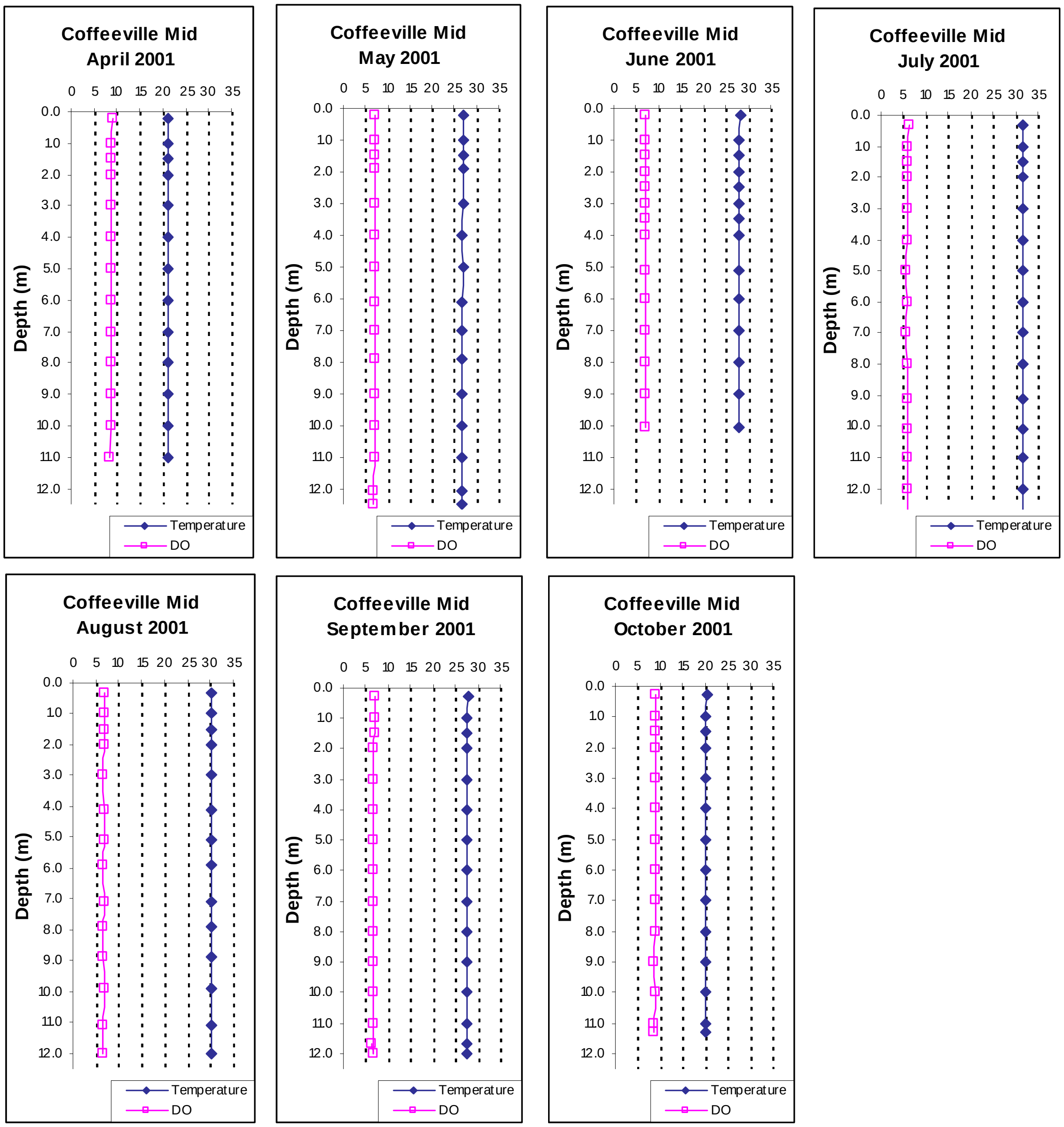


Figure I.41. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at middle Coffeeville Reservoir, April – October 2001.

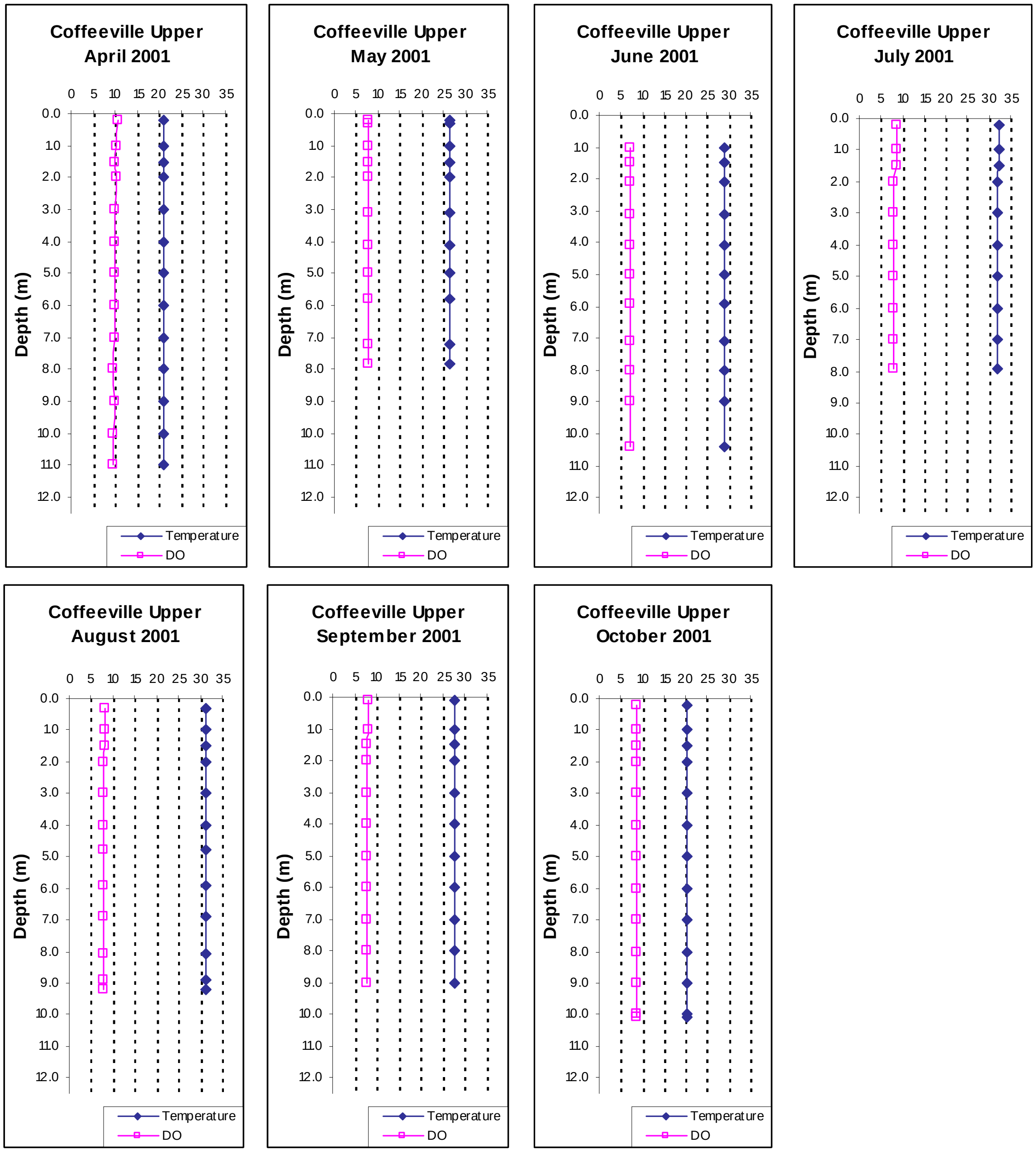
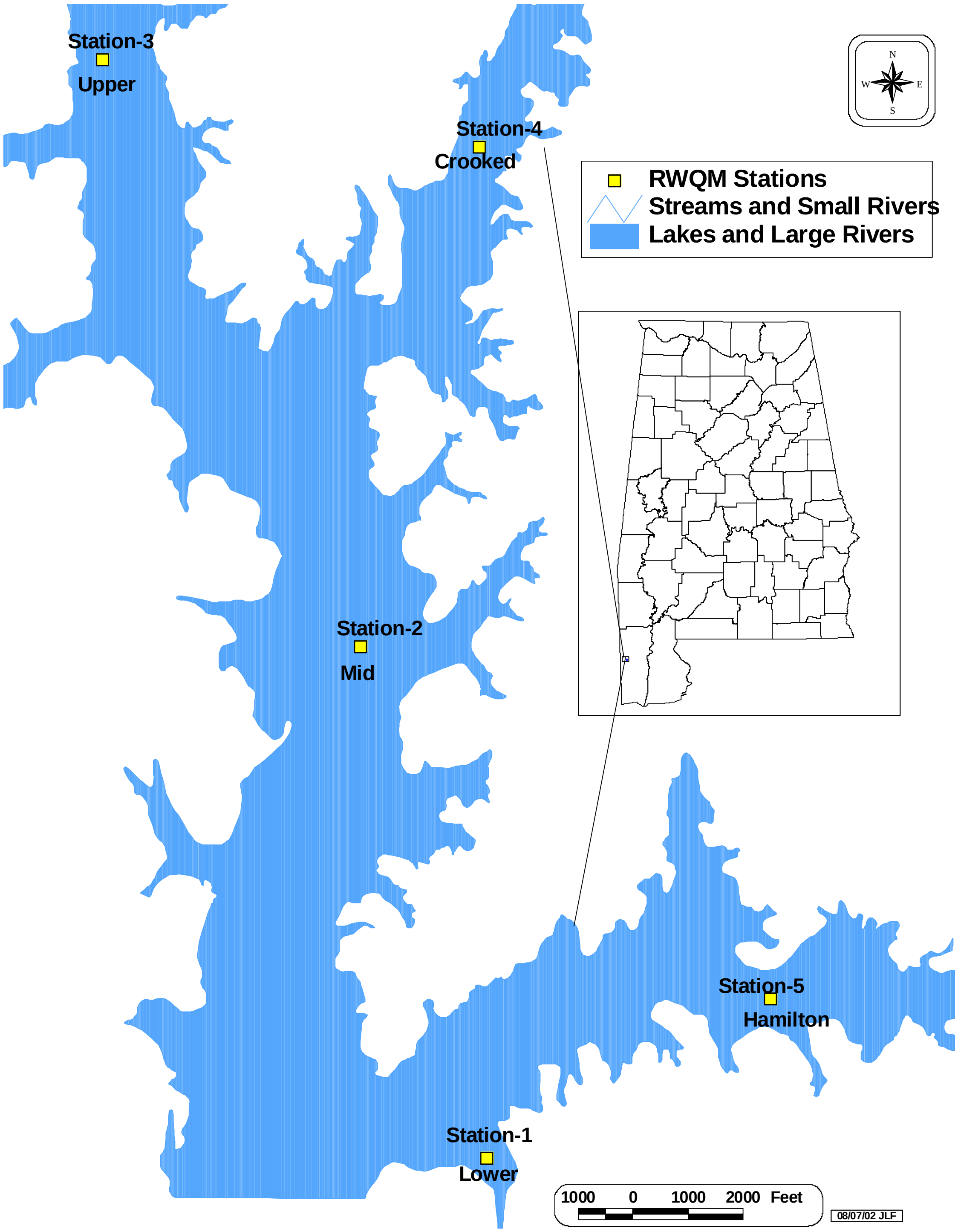


Figure I.42. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for upper Coffeeville Reservoir, April – October 2001.

II. Escatawpa Basin Reservoirs

Figure II.1. Big Creek Reservoir with 2001 sampling locations.



Big Creek Reservoir

Nitrogen/Mainstem. Mean total nitrogen concentration for Big Creek Reservoir ranged from 0.161 to 0.271 mg/l and was highest at mid reservoir followed by lower reservoir and upper reservoir, respectively (Figure II.2).

TN concentrations were highest in April and declined sharply through June. For May and June, TN concentration was noticeably higher at mid reservoir (Figure II.4). A substantial increase in total nitrogen occurred at upper Big Creek in July. TN concentration at lower Big Creek increased from August to September contrasting the decline that occurred at other mainstem locations.

Lake mean TN concentration declined April to June, increased for July and remained relatively stable through October (Figure II.4). Highest mean TN concentration occurred in April. Mean discharge for Big Creek fluctuated monthly April – August, and fell steadily August through October. Mean discharge was relatively low for April and May followed by a sharp peak in June. Another peak in monthly mean discharge occurred in August. Lake mean TN concentration was slightly lower during months of greater flow and higher during months of lesser discharge.

Nitrogen/Tributary. TN concentrations at Big Creek tributary embayments were highest during April and July (Figure II.6). TN concentrations were relatively stable during other months of the sampling period. The rate of discharge for Crooked Creek increased in June and August. Overall, TN concentration appeared to be inversely related to discharge.

Phosphorus/Mainstem. Mean total phosphorus concentration at mid reservoir location was nearly two times higher than any other Big Creek location (Figure II.2). Lowest mean TP concentrations were at lower reservoir and the Crooked Creek embayment.

For May, TP concentrations for mid and upper reservoir increased more than six times the concentrations for mid and upper reservoir the previous month (Figure II.4). TP concentrations for main-stem locations fell to similarly low levels by June, and remained relatively stable through October.

Lake mean total phosphorus concentration increased drastically April to May, fell more sharply for June and continued to decline slowly through August (Figure II.4). A slight increase in lake mean total phosphorus occurred August – October. Mean discharge for Big Creek fluctuated monthly April – August, and fell steadily August through October. There was no apparent relationship between lake mean total phosphorus and discharge over the full sampling period, but it should be noted that the dramatic increase in lake mean total phosphorus occurred during the month of least flow.

Phosphorus/Tributary. Total phosphorus concentrations for Big Creek embayments were similar April – June (Figure II.6). During July and October, TP concentration for Hamilton Creek increased sharply in contrast to a decline in total phosphorus for Crooked Creek. There was no apparent relationship between total phosphorus concentration for Crooked Creek embayment and discharge.

Algal Growth Potential Tests. Algal growth potential tests conducted in August indicated that phosphorus was the limiting nutrient for all three main-stem locations at Big Creek Reservoir (Table 5). The mean MSC for Big Creek locations ranged from 1.46mg/l to 1.80 mg/l, well below the suggested maximum of 5.0 mg/l to assure protection from nuisance algal blooms and fish kills in southeastern lakes.

Chlorophyll a/Mainstem. Mean chlorophyll *a* concentration was higher at upper reservoir than any other Big Creek location (Figure II.3). Mean chlorophyll *a* concentration was lowest at the dam forebay and increased at more upstream locations.

Monthly chlorophyll *a* concentration was higher at upper reservoir location for each month of the sampling period (Figure II.5). Chlorophyll *a* concentrations increased at all locations April – June. For July, chlorophyll *a* levels declined sharply lake wide. Chlorophyll *a* concentrations increased again in August followed by lake wide decline August – October.

Lake mean chlorophyll *a* concentrations peaked in June and August (Figure II.5). Mean discharge for Big Creek fluctuated monthly April – August, and fell steadily August through October. Lake mean chlorophyll *a* concentrations appeared to be related to discharge.

Chlorophyll a/Tributary. Similar trends in chlorophyll *a* concentrations occurred for Big Creek tributary embayments from April – October (Figure II.6). Highest chlorophyll *a* concentrations occurred during June. Chlorophyll *a* concentration for Crooked Creek appeared to be related to discharge.

Trophic state. Trophic State Index (TSI) values ranged from Oligotrophic status to just above eutrophic status (Figure II.5). TSI values were highest May - June and August – September.

Dissolved oxygen/Temperature/Mainstem. Dissolved oxygen concentrations at Big Creek locations remained near or above 6 mg/l throughout the sampling period (Figure II.5). Dissolved oxygen concentrations were highest during May, June, and October and lowest during April, August and September.

Temperature and dissolved oxygen profiles conducted at the dam forebay indicated little to no thermal or chemical stratification near the surface at Big Creek throughout the sampling period (Figure II.8). A moderate decline in temperature and DO occurred just off the lake bottom May – July. Highest water column temperatures occurred during June and July. Lowest dissolved oxygen concentrations occurred during August. Chemical and/or thermal stratification occurred at mid and upper reservoir during most months, April – October (Figure II.9,10).

Dissolved Oxygen/Temperature/Tributary. Dissolved oxygen concentrations were essentially identical for Crooked Creek and Hamilton Creek embayments (Figure II.6). Lowest DO concentrations for both tributaries occurred during April and September. DO concentrations for both locations remained above the criterion limit of 5.0 mg/l, April - October.

Total Suspended Solids/Mainstem. Mean total suspended solids concentration for lower Big Creek were much higher than mid or upper reservoir (Figure II.3).

TSS concentrations were similar for Big Creek mainstem locations from April – June (Figure II.7). TSS concentration for lower reservoir continued to increase July – August unlike other mainstem locations. During August, TSS concentration at lower Big Creek was approximately four times higher than mid reservoir. TSS concentrations were lowest for all locations in October. Mean TSS concentration decreased sharply April to

May similar to discharge. Lake mean TSS peaked in July despite a drop in rate of discharge. Mean TSS and discharge decreased steadily August – October. Mean TSS and discharge appeared to be closely related all months except July.

Total Suspended Solids/Tributary. Mean TSS concentration for Crooked Creek was higher than Hamilton Creek (Figure II.3). TSS concentrations for Crooked Creek and Hamilton Creek increased sharply April – June (Figure II.7). TSS at Crooked Creek in July was much lower than Hamilton Creek. TSS for both tributaries decreased steadily August – October. Highest TSS concentrations occurred during June for both tributaries. Overall, there appeared to be a relationship between Crooked Creek TSS and Crooked Creek discharge.

Discussion. Mean TN concentration was slightly lower during months of greater flow and higher during months of lesser discharge. Mean total phosphorus concentration at mid reservoir location was nearly two times higher than any other Big Creek location. There was a substantial increase in lake mean total phosphorus in May, the month of least discharge. Total phosphorus for upper reservoir was also very high during May. TP for Crooked Creek was relatively low during May indicating that sources of phosphorus loading may be located upstream in the Big Creek watershed. Mean chlorophyll *a* concentration was higher at upper reservoir than any other Big Creek location. Lake mean chlorophyll *a* concentrations peaked during months of greatest discharge. Lowest dissolved oxygen concentrations occurred at Big Creek dam forebay during August.

The upper Big Creek sub-watershed drains approximately 105 square miles in Mobile County. Land cover is approximately 75% Forest, 12% Urban, 4% Cropland, 5% pasture, and 6% open water and other (ASWCC 1998). The primary concern for potential impairment from non-point sources was sedimentation. Major contributors to sediment loading in the sub-watershed include runoff from roads and roadbanks and sand and gravel pits (ADEM 2003). Boggy Branch, Juniper Creek, and Collins Creek, each located within the sub-watershed, are currently on the ADEM’s draft 2000 CWA 303(d) list of impaired water bodies. Juniper and Collins Creeks are listed for pathogens associated with pasture grazing and Boggy Branch is listed for impairment from high metals concentrations from natural sources (ADEM 2001b). Twelve current construction/stormwater and 13 non-coal mining/stormwater (<5 acres) authorizations have been issued in the upper Big Creek sub-watershed (ADEM 2003).

The lower Big Creek sub-watershed is approximately 106 square miles of Mobile County. Land cover was approximately 40% forest, 32% cropland, 18%pasture and 10% urban (ASWCC 1998). Primary non-point source concerns included runoff from crop and pasture lands, animal husbandry, and sedimentation. In addition, there was a *high* potential for impairment from urban development (ADEM 2003). Twenty-four current construction/stormwater and 30 non-coal mining/stormwater (<5 acres) authorizations have been issued in the lower Big Creek sub-watershed (ADEM 2003).

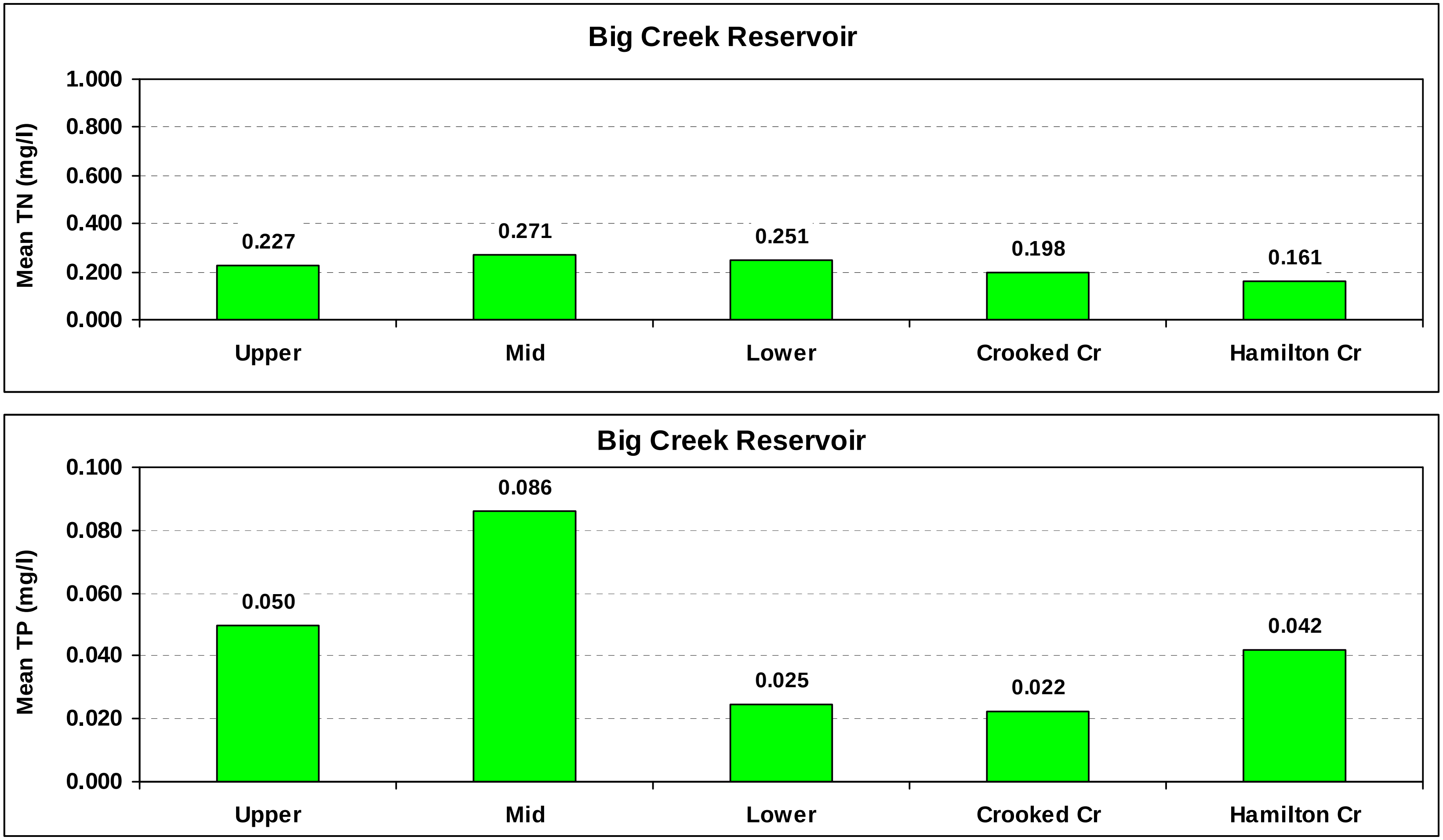


Figure II.2. Mean total nitrogen (TN) and mean total phosphorus (TP) concentrations of Big Creek reservoir locations, April-October 2001.

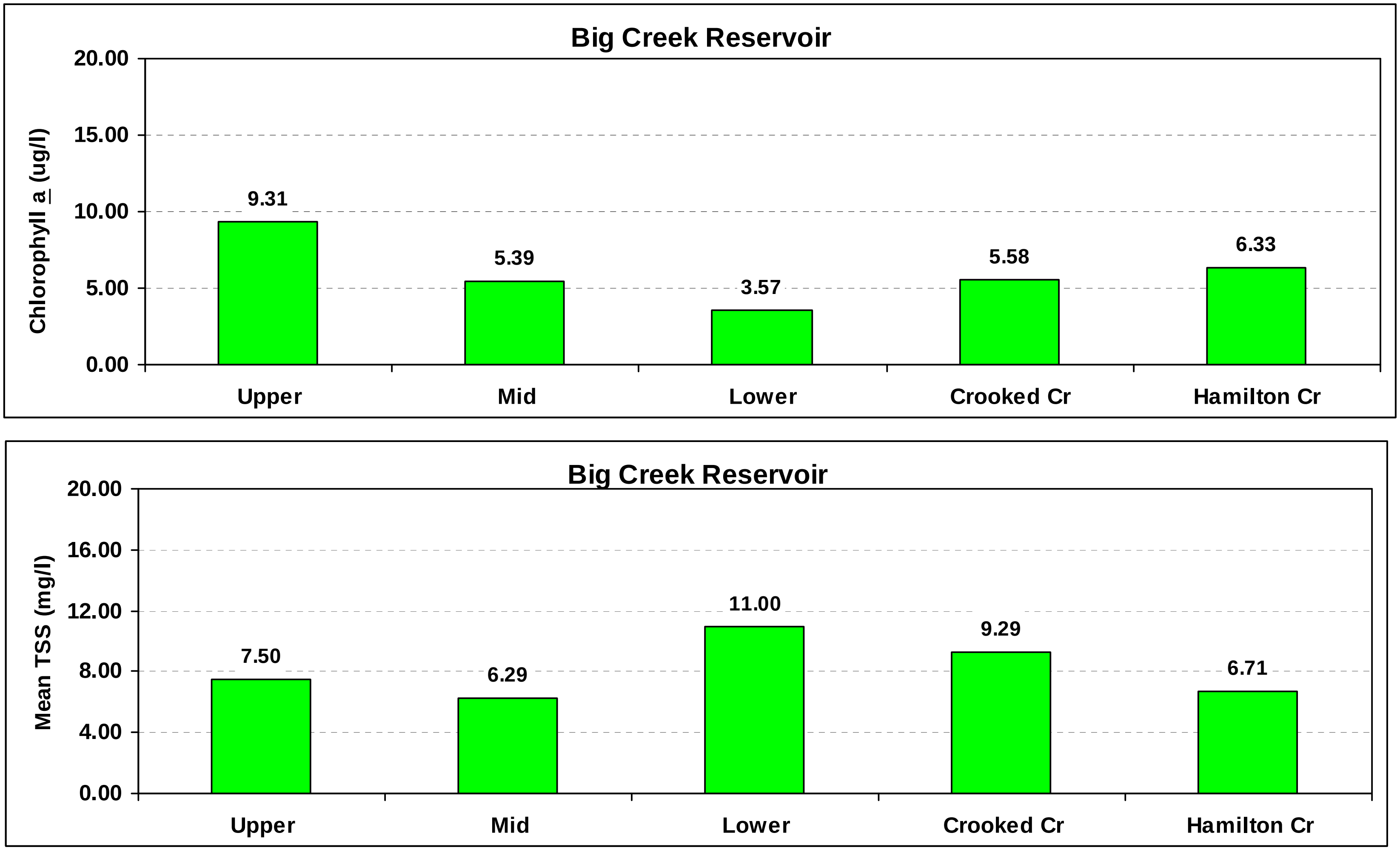


Figure II.3. Mean chlorophyll *a* (Chl a) and mean total suspended solids (TSS) concentrations of Big Creek reservoir locations, April – October 2001.

Table 5. Algal growth potential testing (AGPT) of Big Creek Reservoir, August 2001.

Reservoir	Location	Collection Date	Mean MSC (mg/l) C	C+N	C+P	Limiting Nutrient
Big Creek	Upper	8/13/01	1.80	**1.85**	7.17	Phosphorus
	Mid	8/13/01	1.77	**1.91**	4.04	Phosphorus
	Lower	8/13/01	1.46	**1.39**	2.96	Phosphorus

MSC = Maximum Standing Crop
C = Control
C+N = Control + Nitrogen
C+P = Control + Phosphorus

Values in **bold** print are significantly different from control.

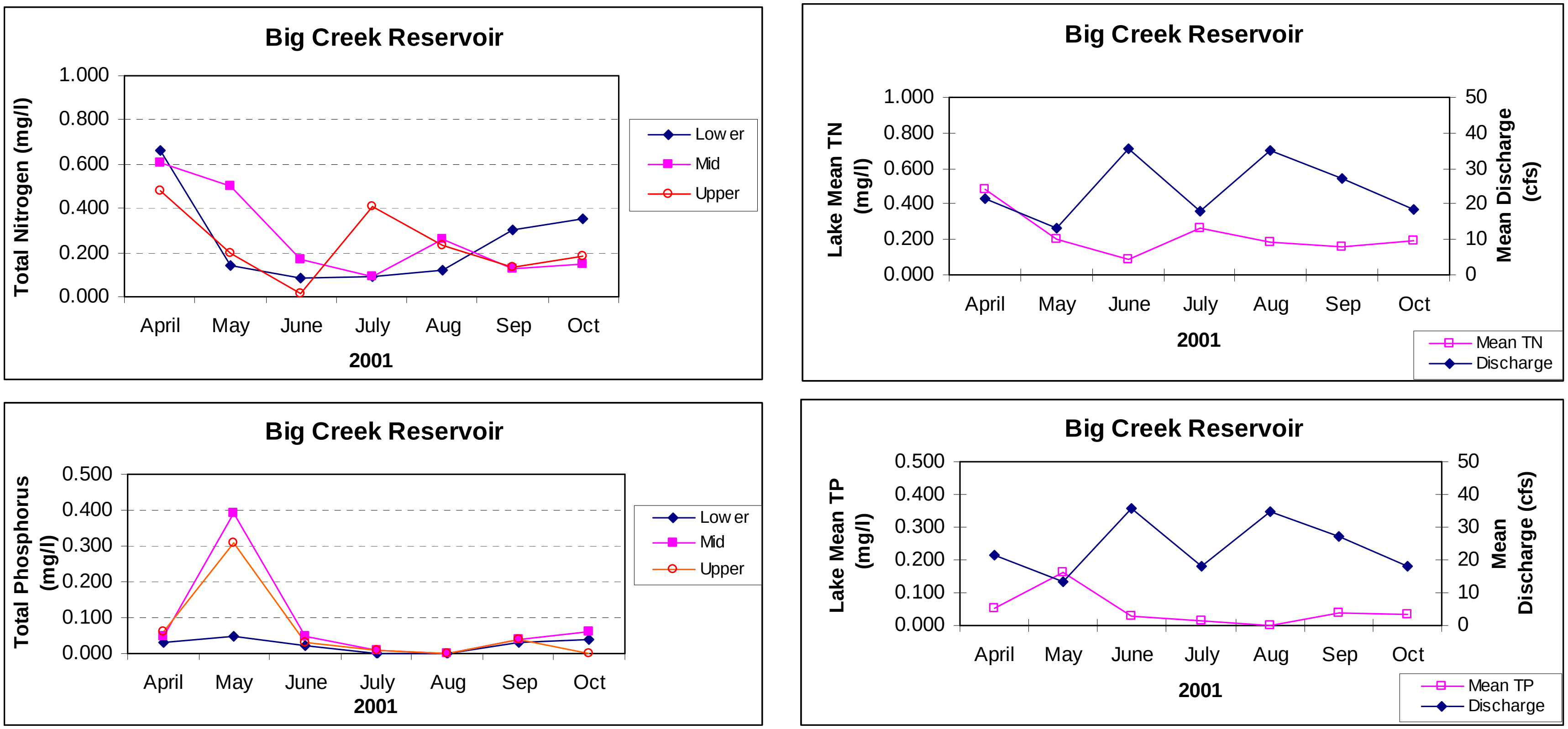


Figure II.4. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Big Creek Reservoir, April-October 2001.

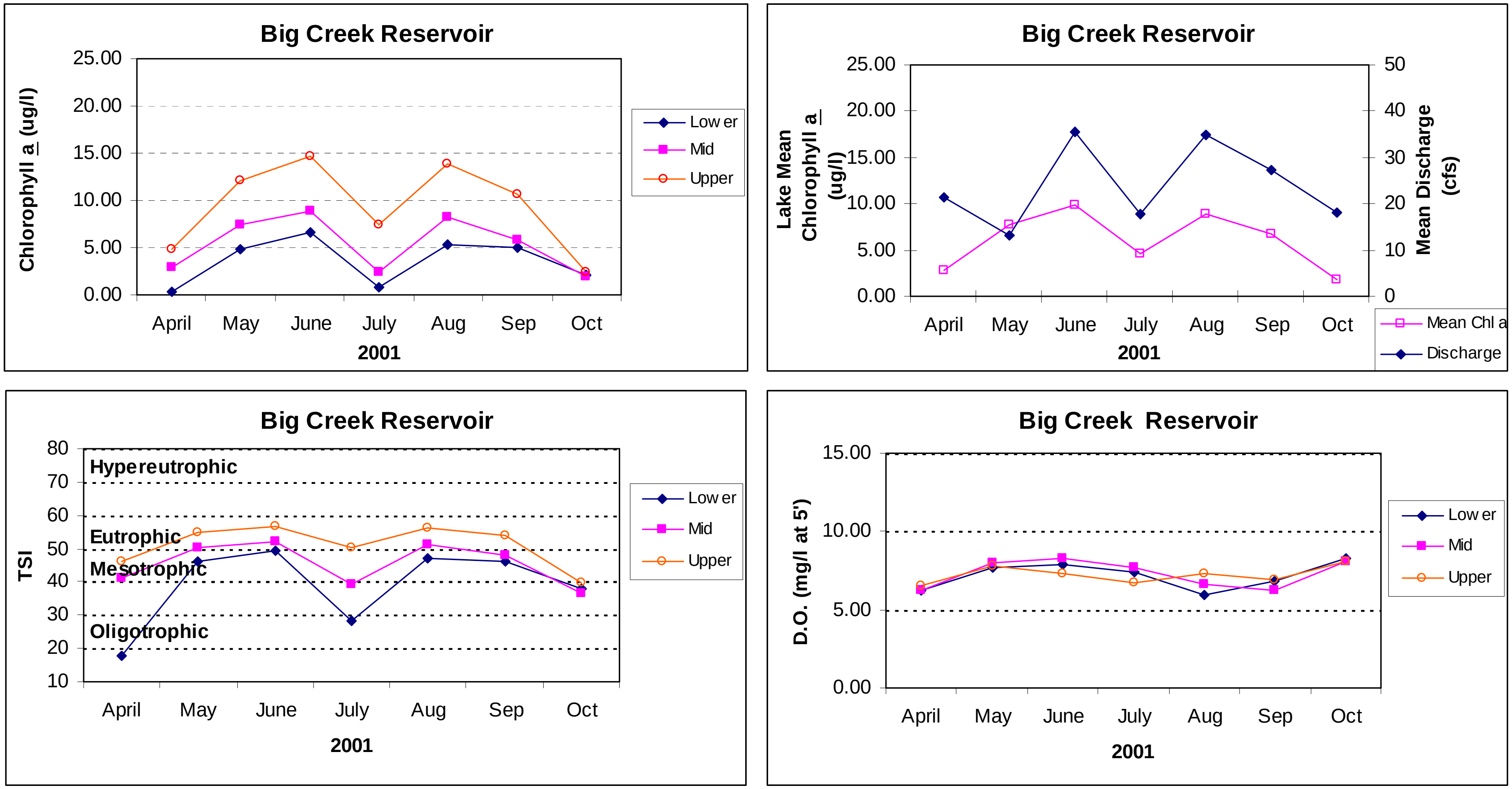


Figure II.5. Chlorophyll *a* and Chlorophyll *a* vs. discharge, trophic state index (TSI), and dissolved oxygen (DO) of Big Creek Reservoir, April-October 2001.

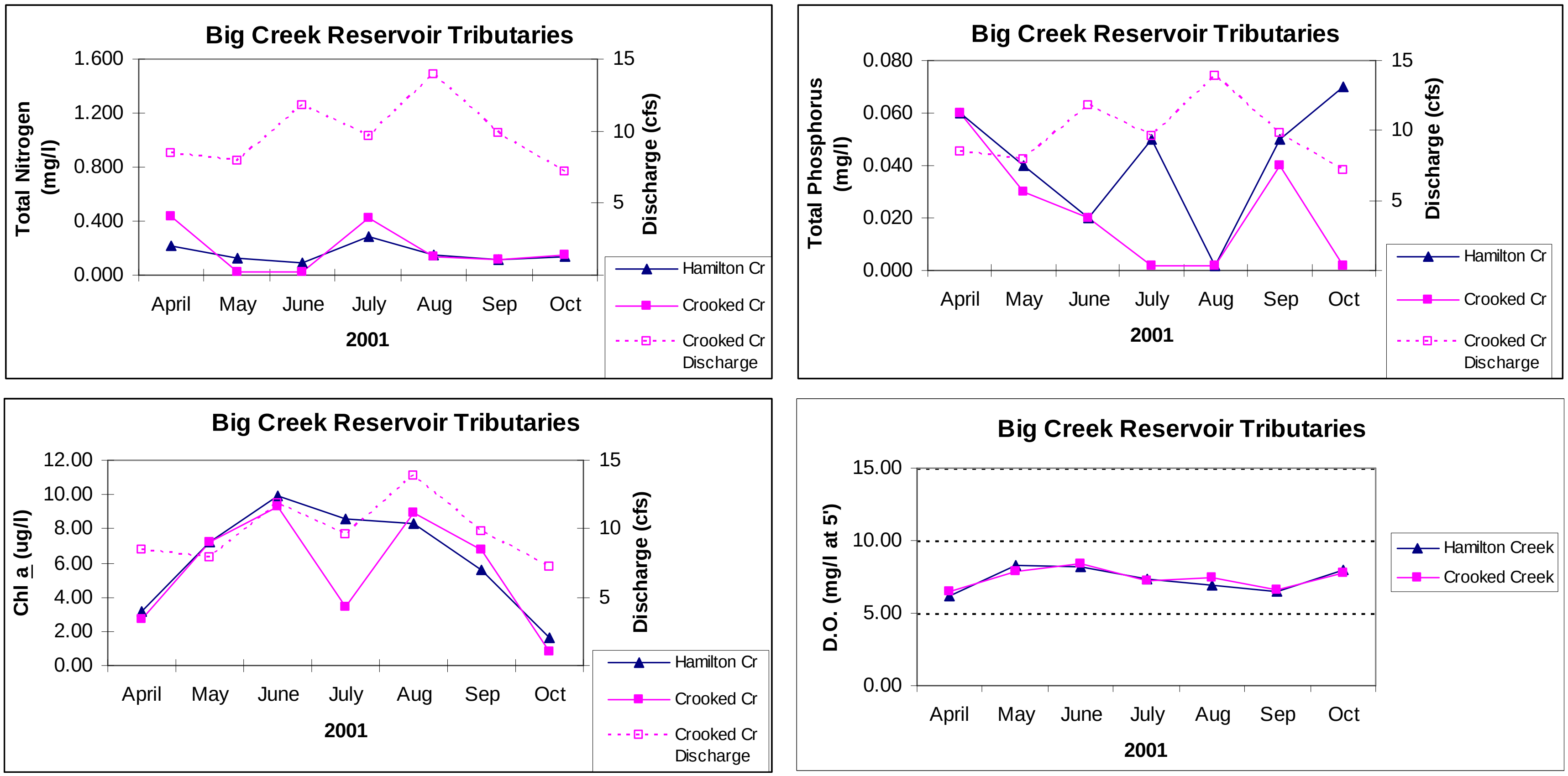


Figure II.6. Total nitrogen, total phosphorus, and chlorophyll *a* vs. Crooked Creek discharge and dissolved oxygen for Big Creek Reservoir tributaries, April – October 2001.

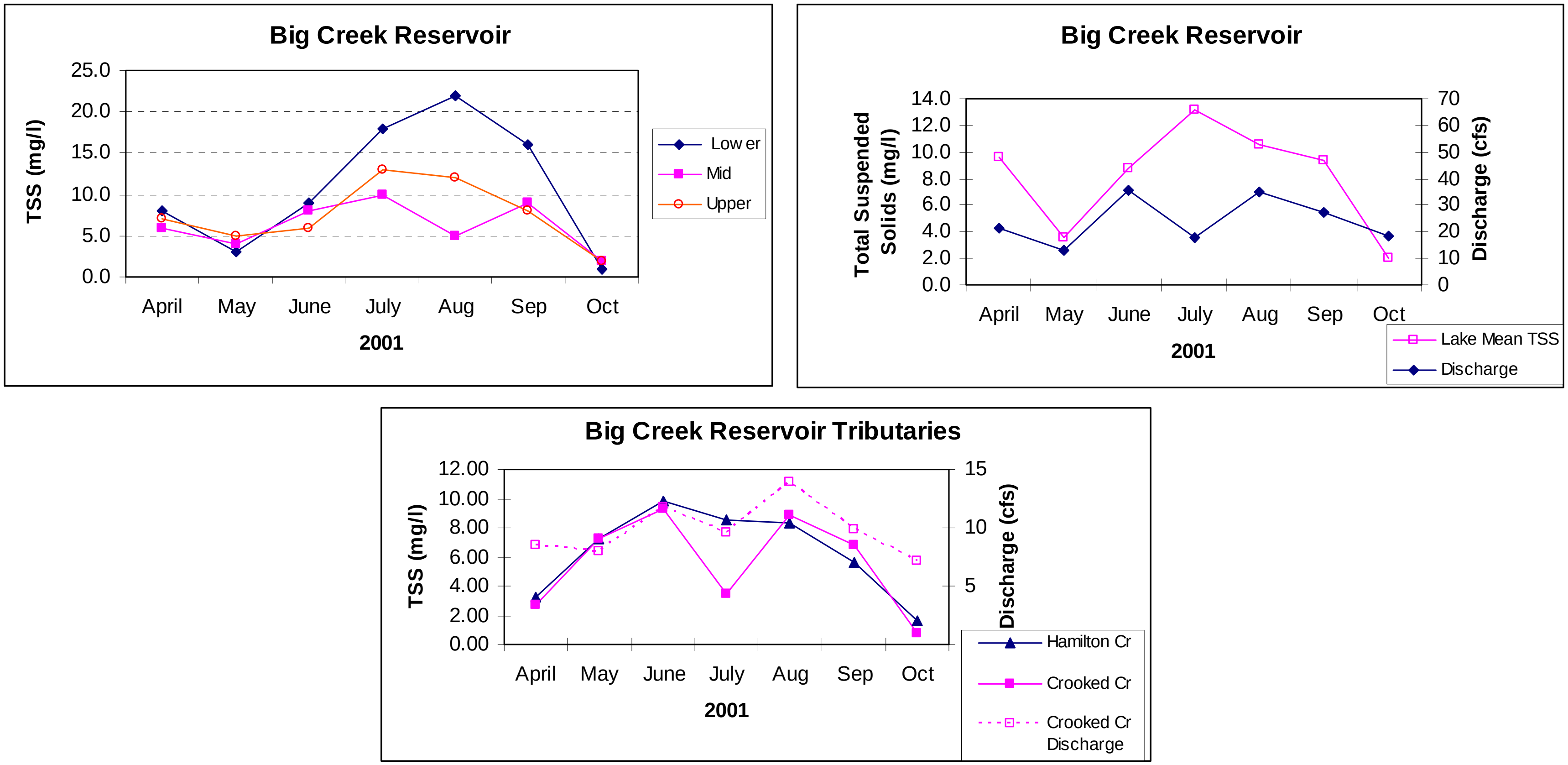


Figure II.7. Total suspended solids (TSS), TSS vs. lake mean discharge for Big Creek Reservoir mainstem locations, and TSS and TSS vs. Crooked Creek discharge for Big Creek tributaries, April – October 2001.

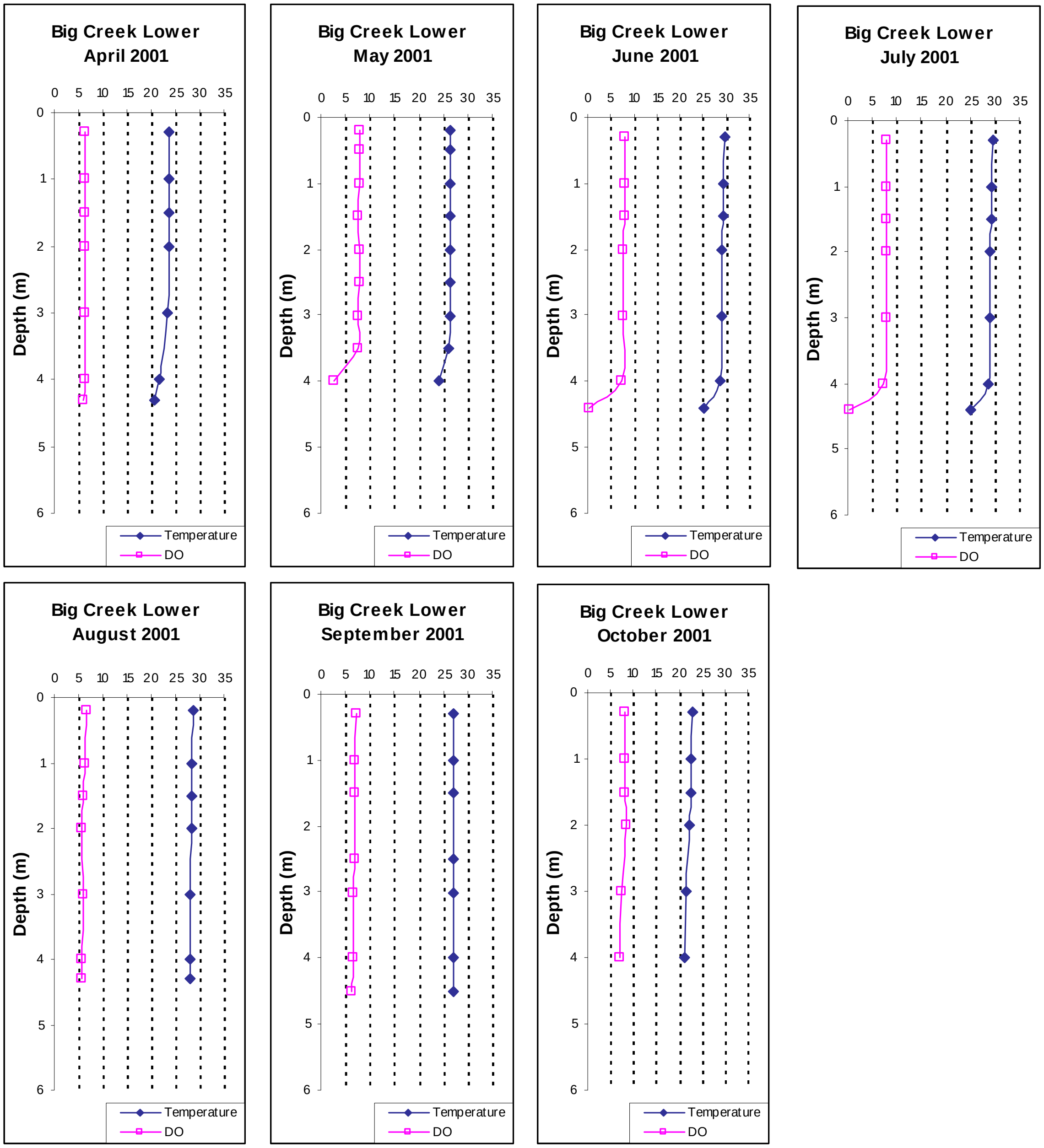


Figure II.8. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the dam forebay of Big Creek Reservoir, April-October 2001.

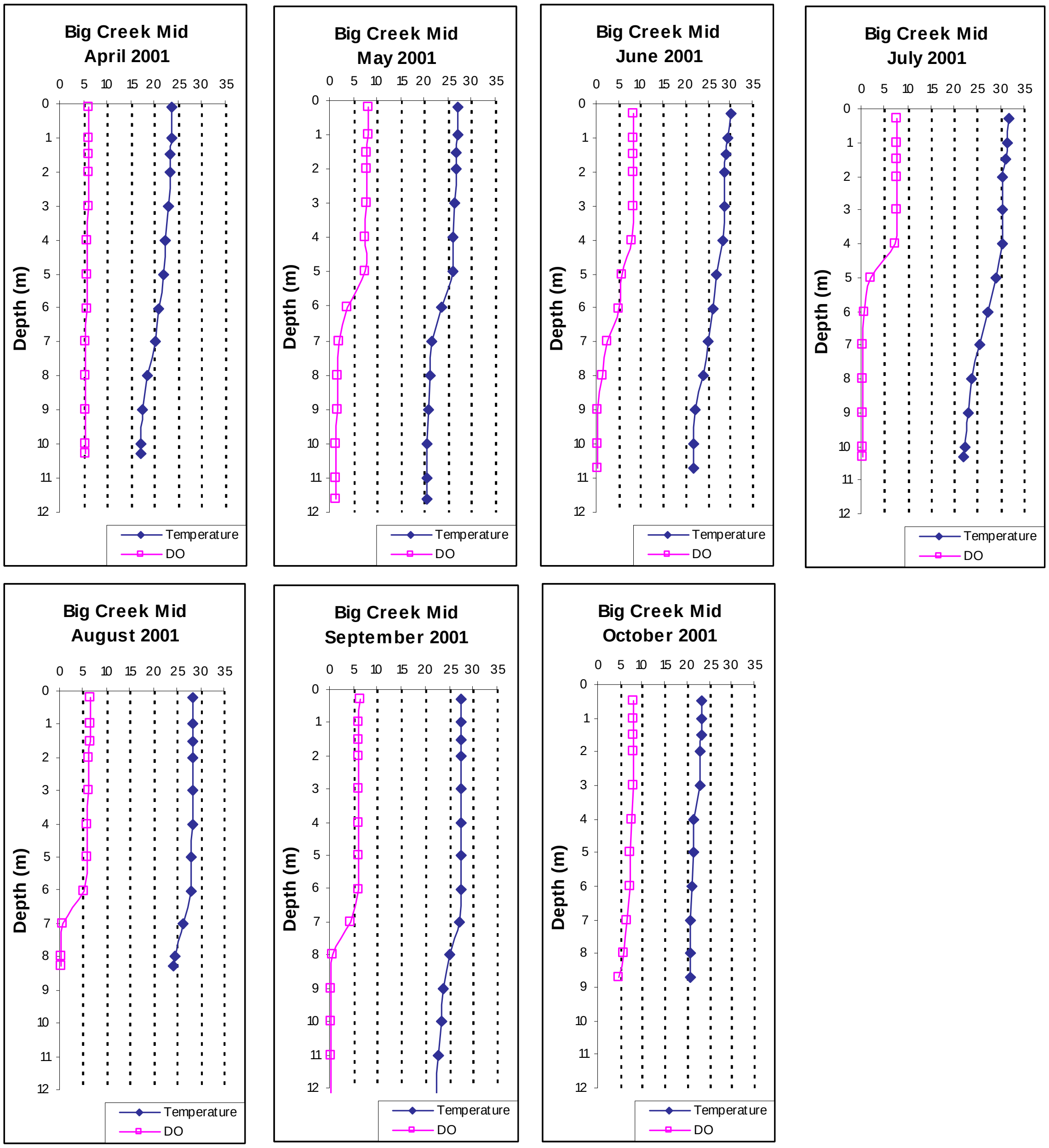


Figure II.9. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for middle Big Creek Reservoir, April – October 2001.

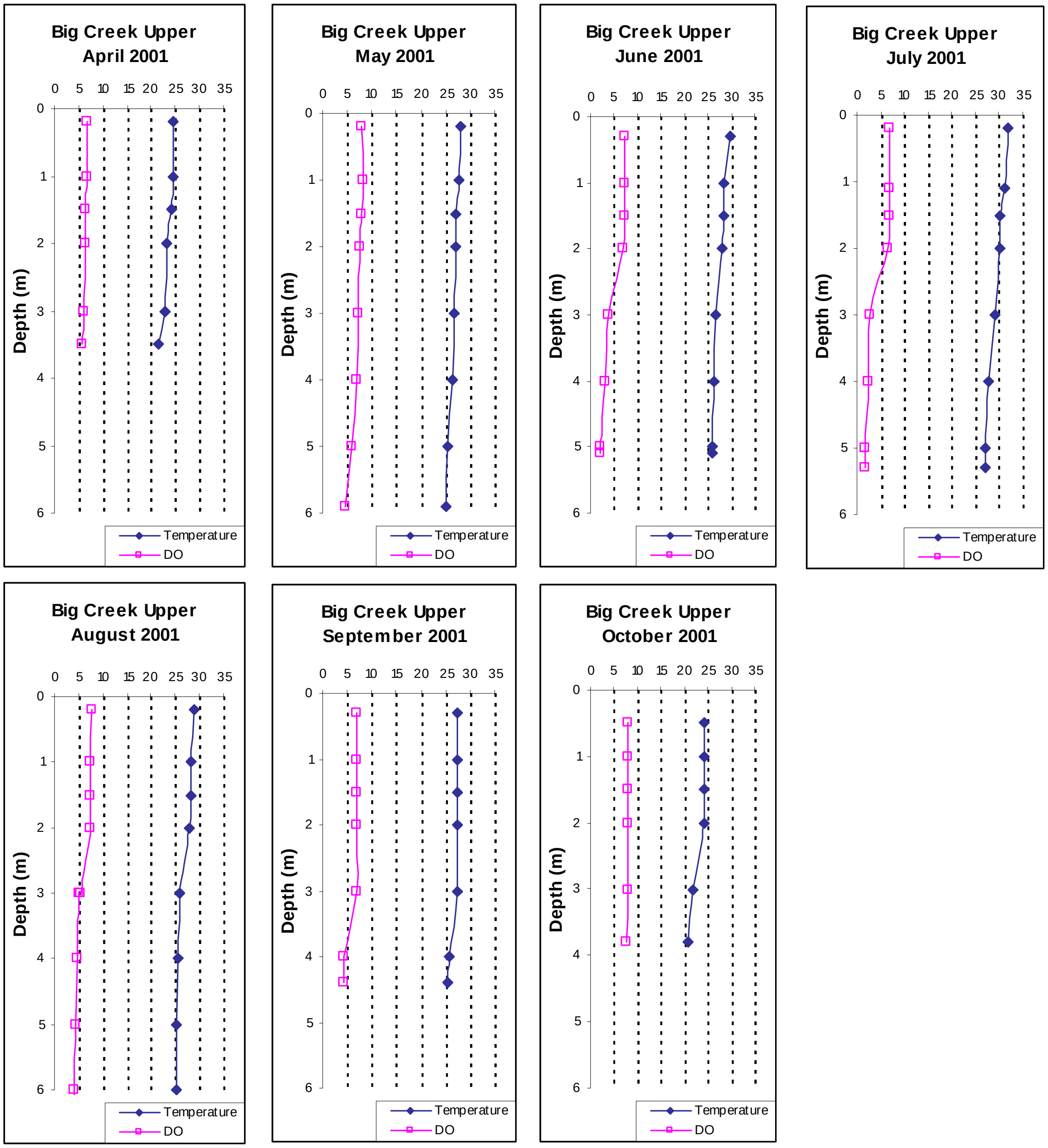


Figure II.10. Depth profiles of dissolved oxygen (DO) and temperature (Temp) for upper Big Creek Reservoir, April – October 2001.

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