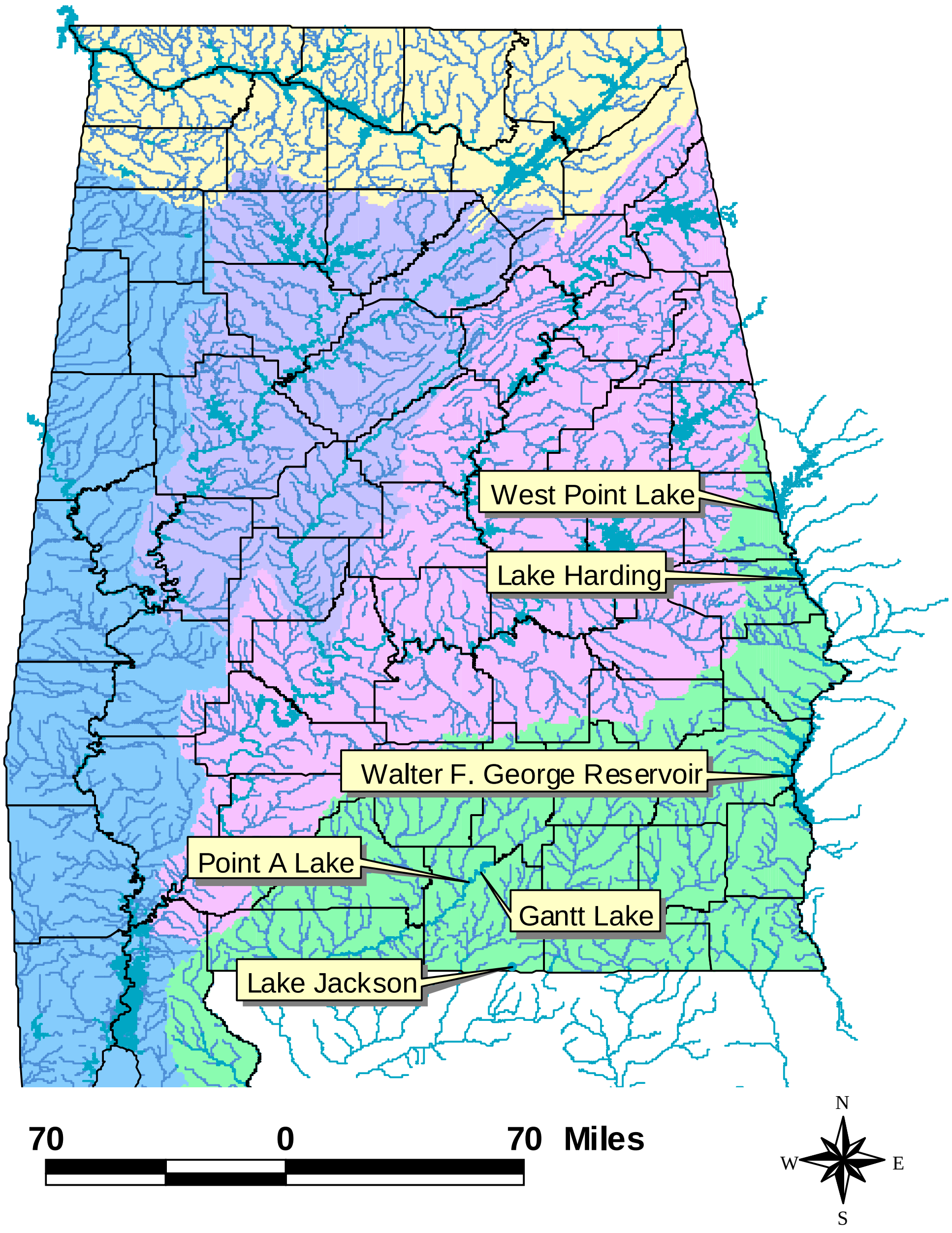
Intensive Water Quality Survey of Chattahoochee and Conecuh River Basin Reservoirs 1999



Environmental Indicators Section
Field Operations Division
Alabama Department of Environmental Management

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June 6, 2001

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Executive Summary

In 1999, intensive monitoring of reservoirs in the Chattahoochee and Conecuh basins and Lake Jackson was conducted to align reservoir monitoring with the ADEM nonpoint source basin schedule. Objectives of the intensive survey were to:

a) assess water quality and trophic state of reservoir and tributary embayment locations in the Chattahoochee and Conecuh River Basins;
b) identify tributary embayments most impacted by point and nonpoint source (NPS) pollution;
c) assist the Nonpoint Source Unit of ADEM in prioritization of subwatersheds by determining the water quality of tributary embayments.

Tributary embayment locations were targeted because embayments usually exhibit water quality characteristics that are more indicative of the tributary than of the mainstem reservoir. Selecting mainstem reservoir stations allows a determination of the effects of the tributary inflows on the main body of the reservoir.

Sampling stations (Table 2) were determined using historical data and preliminary results of the Chattahoochee and Conecuh River basins screening assessment conducted in 1998. A maximum of 18 mainstem and tributary embayment sampling locations were determined by available funding. Water quality assessments were conducted at locations throughout the Chattahoochee and Conecuh basins and Lake Jackson at monthly intervals April-October.

Chemical, physical, and biological variables were measured at each location to determine water quality and trophic state (Table 3). Water quality data selected for further discussion consists 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 a reservoir or embayment;

e) dissolved oxygen (DO) concentrations, used as a more direct indicator of water quality;

f) total suspended solids (TSS), used as an indicator of sediment inflow.

These variables 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.

West Point Reservoir: Mean TN values were among the highest of Chattahoochee basin locations (Figure I. 1). Mean TP, TSS and chlorophyll *a* values were similar to the other Chattahoochee reservoirs monitored (Figures I. 1. and I. 2). AGPT results indicated that phosphorus was the limiting nutrient at all West Point sample locations and mean Maximum Standing Crop (MSC) values were below the maximum 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table I. 1). All locations had TSI values within the eutrophic range April through September (Figure I. 6). In October however, Hwy 109 remained eutrophic while the trophic status of the lower reservoir station and the Wehadkee Creek embayment station dropped to borderline oligotrophic / mesotrophic.

During the August sampling event at Hwy 109 DO levels were below the criteria level of 5.0 mg/l at a depth of 1.5m's and remained below 5.0 mg/l throughout the water column.

Harding Reservoir. Mean TN values were generally lower than West Point and higher than Walter F. George (Figure I. 1). However mean TN levels at the upper Harding Reservoir station were second highest among sampled locations, the highest mean TN level was at West Point Reservoir, Hwy. 109 (Figure I. 1). Mean TP, TSS and chlorophyll *a* values were comparable to the other Chattahoochee reservoirs (Figures I. 1. and I. 2). AGPT results indicate phosphorus as the limiting nutrient at all stations (Table I. 1). The suggested MSC level of 5.0 mg/l was exceeded by the upper location in June and July and by Osanippa Creek embayment in July (Table I. 1).

TSI values varied between mesotrophic and eutrophic levels at all stations with periods of oligotrophy at the upper reservoir station and the Halawakee Creek embayment station in October and at the upper reservoir station in May, June and July (Figure I. 14).

Walter F. George Reservoir. Mean TN values were among the lowest monitored in the Chattahoochee basin and showed little variation between stations (Figure I. 1). TP means were also comparable to other Chattahoochee River reservoirs except the upper Walter F. George Reservoir station which was two times any other reservoir value (Figure I. 1).

Mean TSS values, although higher, were not greatly different than those measured at other Chattahoochee River locations (Figure I. 2). Mean chlorophyll *a* values were the highest measured within the Chattahoochee River basin with the highest station mean at the Cowikee Creek embayment (Figure I. 2).

AGPT results indicated the upper station was phosphorus limited during June and July and nitrogen limited during August (Table I. 1). All three months at the upper station MSC values exceeded the maximum 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table I. 1). The mid reservoir station also exceeded the maximum suggested MSC value of 5.0 mg/l in June and August and was phosphorus limited.

TSI values indicated all stations were within the eutrophic range during the course of the study (Figure I. 24).

Gantt Reservoir. Both mean TN and TP at the mid Gantt station were the highest measured in the Conecuh basin during this study (Figure II. 1). Further study will be required to determine the trend of this data. Mean TSS and chlorophyll *a* values were similar to those of most other main stem Conecuh Basin stations (Figure II. 2). AGPT results indicated phosphorus as the limiting nutrient at both locations with MSC values well below the maximum 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table II. 1). Nutrient, chlorophyll *a* and TSS concentrations at the lower Gantt station were all similar to those of other Conecuh basin monitoring stations (Figures II. 2 and II. 1).

DO levels in July were just above the 5.0 mg/l criteria at a depth of 5 ft (Figure II. 6). Below 5 ft both stations fell below 5.0 mg/l DO. Mean TSI values at both stations indicate high mesotrophic conditions (Figure II. 5).

Point A Reservoir. All mean nutrient, TSS and chlorophyll *a* concentrations were similar to those measured at other Conecuh basin locations (Figures II. 1. and II. 2). The lowest mean chlorophyll *a* concentration measured within the Conecuh basin was at the Patsaliga Creek embayment of Point A Reservoir (Figure II. 2). Patsaliga Creek also had the highest mean TSS (Figure II. 2). Algal Growth Potential Tests indicated phosphorus as the limiting nutrient and MSC levels below 5.0 mg/l, the level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table II. 1).

TSI values indicate oligotrophic conditions at Patasliga Creek and mesotrophic conditions at the lower station (Figure II. 10). Further monitoring is needed to determine trophic state trends.

DO concentrations remained above 5.0 mg/l throughout the sample period at both sample locations (Figure II. 11).

Lake Jackson: Mean nutrient, TSS and chlorophyll *a* concentrations were below those of other Conecuh Basin reservoirs monitored (Figures II. 1. and II. 2). Phosphorus was indicated as the limiting nutrient with MSC values well below the maximum 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table II. 1). TSI values were within the oligotrophic range (Figure II. 5) and DO concentrations remained above 5.0 mg/l during all sampling events and at all depths (Figure II. 5).

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INTRODUCTION

Section 314(a) 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. Funding for the assessments is 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 ensures continued eligibility for financial assistance under the Clean Lakes Program.

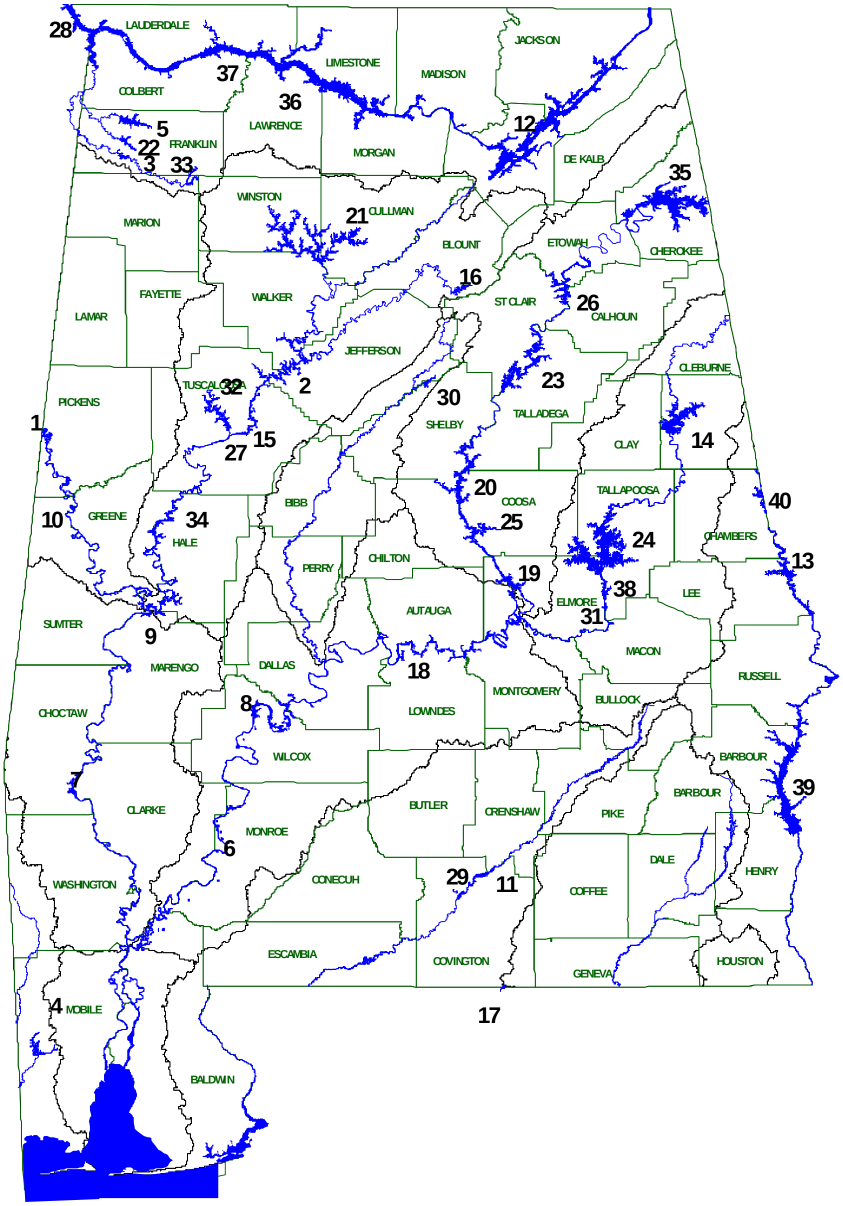
The Alabama Department of Environmental Management (ADEM) has defined publicly-owned lakes/reservoirs as those that are of a multiple-use nature, publicly-accessible, and exhibit physical/chemical characteristics typical of impounded waters. Lakes designated strictly for water supply, privately owned 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 meeting the above definition are shown 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 the 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 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.

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
11) Gantt
12) Guntersville
13) Harding
14) Harris
15) Holt
16) Inland
17) Jackson
18) Jones Bluff
19) Jordan
20) Lay
21) Lewis Smith
22) Little Bear Creek
23) Logan-Martin
24) Martin
25) Mitchell
26) Neely Henry
27) Oliver
28) Pickwick
29) Point A
30) Purdy
31) Thurlow
32) Tuscaloosa
33) Upper Bear Creek
34) Warrior
35) Weiss
36) Wheeler
37) Wilson
38) Yates
39) W. F. George
40) West Point

In 1990, the Reservoir Water Quality Monitoring (RWQM) Program was initiated by the Special Studies Section of the Field Operations Division of the 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) 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 (see TVA Program). 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 more rapidly developed. 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.

In 1997, intensive monitoring of reservoirs of the Coosa and Tallapoosa River basins was conducted to gather water quality data prior to proposed water diversions in Georgia. Intensive monitoring consisted of monthly sampling, April through October in the Coosa basin and April through September in the Tallapoosa basin, at multiple locations in reservoirs of each basin.

In 1998, intensive monitoring of reservoirs in the Warrior basin was conducted to align reservoir monitoring with the ADEM nonpoint source basin schedule. Location of sampling stations was determined in part by using results of the Black Warrior River basin screening assessment conducted in 1997. Intensive monitoring consisted of monthly water quality sampling, April-October, at multiple locations of Smith, Tuscaloosa, Holt, Bankhead, Oliver, and Warrior Reservoirs. Fish were also collected from each reservoir for tissue analysis of priority pollutant content during October and November 1998.

Intensive monitoring of reservoirs in the Chattahoochee and Conecuh River basins was conducted during 1999 in accordance with the nonpoint source basin schedule. Lake Jackson on the Alabama / Florida border was also intensively monitored.

MATERIALS AND METHODS

RWQM Sampling Locations

Reservoirs sampled during the 1999 intensive survey appear in Table 1. Locations of sampling sites appear in Table 2 and Figures 2 - 7. All reservoirs were sampled in the dam forebay. Multiple sites were sampled on larger reservoirs. Water quality measurements and water sample collections were conducted from boats positioned at the deepest point of the channel at each sampling site.

Water Quality Assessment

Intensive monitoring of Chattahoochee reservoirs, Conecuh reservoirs, and Lake Jackson were conducted monthly, April-October 1999. 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 1999 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 Surveyor III instruments.

A standard, 20 cm diameter Secchi disk with attenuating 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 remained as measured by a submersible photometer was considered the photic zone depth.

Table 1. Reservoirs sampled during the Intensive Water Quality Survey of the Chattahoochee and Conecuh River Basins 1999.

Year	River Basin	Reservoir	Surface Area (acres)	Drainage Area (mi^2)
1999				
	Chattahoochee			
		West Point	25,299	5,440
		Harding	5,850	4,240
		W. F. George	45,200	7,460
	Conecuh			
		Gantt	2,767	658
		Point A	900	1,277
	Yellow			
		Jackson	350	----

Table 2. Monitoring sites for the Intensive Water Quality Survey of Chattahoochee and Conecuh River Basin Reservoirs 1999.

Year	Basin	Reservoir	Site	Station Description
1999				
	Chattahoochee			
		West Point	Sta. 1	Deepest point, main river channel, dam forebay .
			Sta. 2	Deepest point, main creek channel, immediately downstream of Wehadkee / Veasey / Stroud Creeks confluence.
			Sta. 3	Deepest point, main river channel, at GA Hwy. 109 bridge
		Harding	Sta. 1	Deepest point, main river channel, dam forebay .
			Sta. 2	Deepest point, main creek channel, Halawakee Creek embayment.
			Sta. 3	Deepest point, main channel, Osanippa Cr. embayment
			Sta. 4	Deepest point, main river channel, immed. downstream of Johnson Island.
		W. F. George	Sta. 1	Deepest point, main river channel, dam forebay .
			Sta. 4	Deepest point, main river channel, approximately 0.25 miles upstream of U.S. Highway 82 causeway.
			Sta. 6	Deepest point, main river channel, immediately downstream of Florence Marina State Park.
			Sta. 10	Deepest point, main channel, Cowikee Cr. embayment
			Sta. 12	Deepest point, main channel, Barbour Cr. embayment
			Sta. 13	Deepest point, main channel Cheneyhatchee Cr. embayment
	Conecuh			
		Gantt	Sta. 1	Deepest point, main river channel, dam forebay .
			Sta. 2	Deepest point, main river channel, approx. 1 mi. upstream of Covington Cty. Rd. 86 bridge.
		Point A	Sta. 1	Deepest point, main river channel, dam forebay .
			Sta. 2	Deepest point, main channel, Patsaliga Cr. embayment.
	Yellow			
		Jackson	Sta. 1	Approximate center of lake.

Figure 2. West Point Reservoir with 1999 sampling stations.

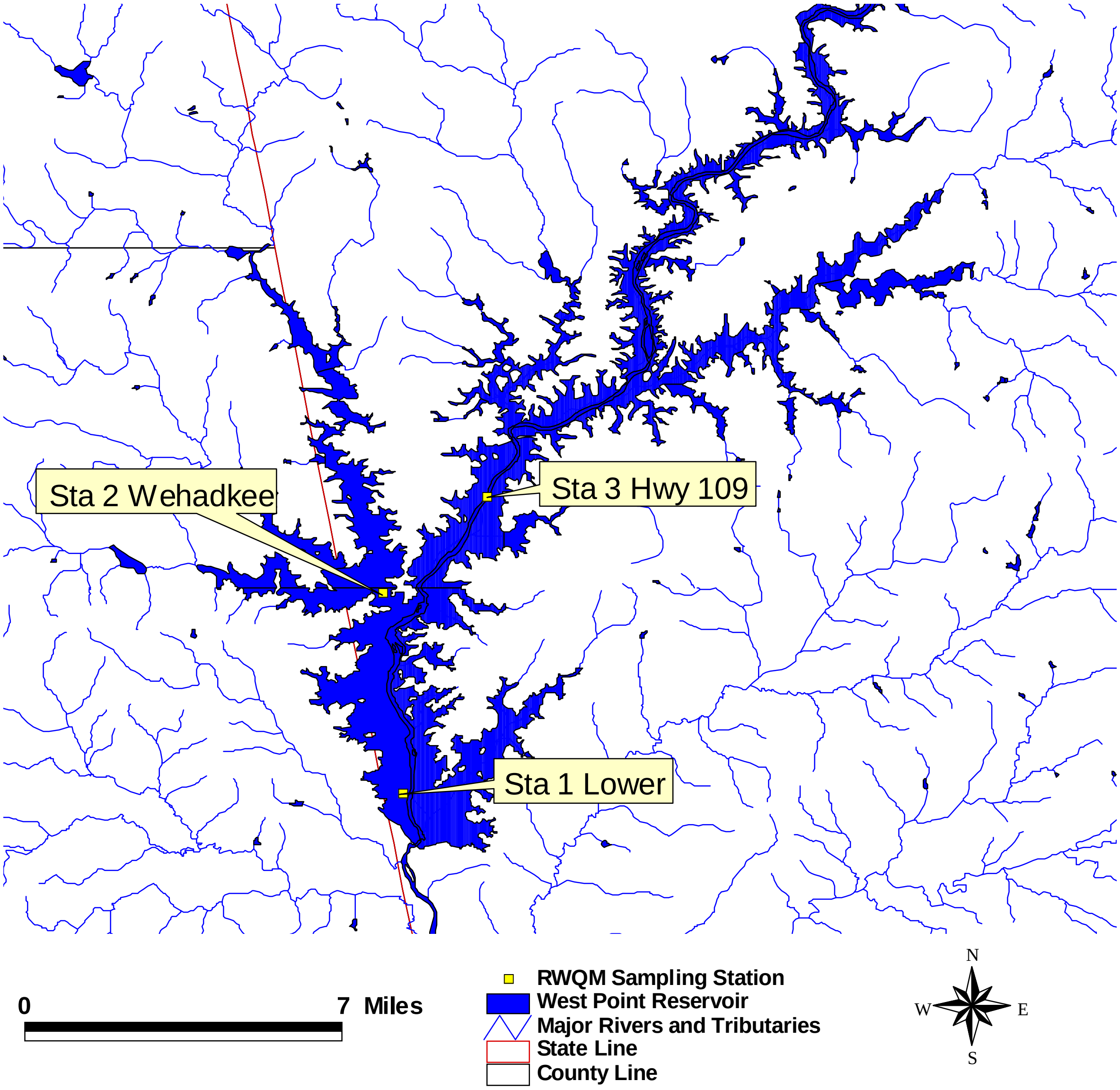


Figure 3. Harding Reservoir with 1999 sampling stations.

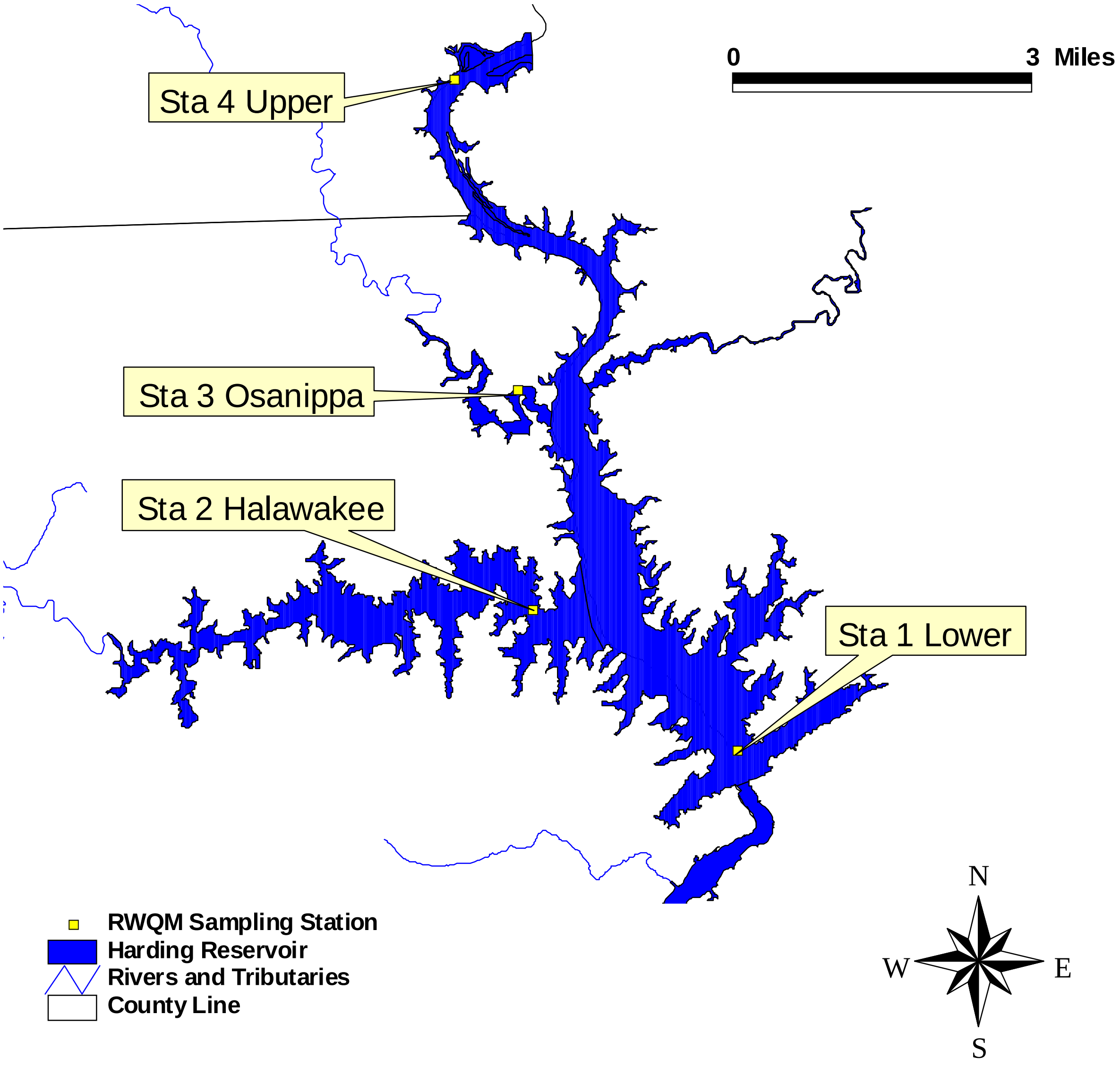


Figure 4. Walter F. George Reservoir with 1999 sampling stations.

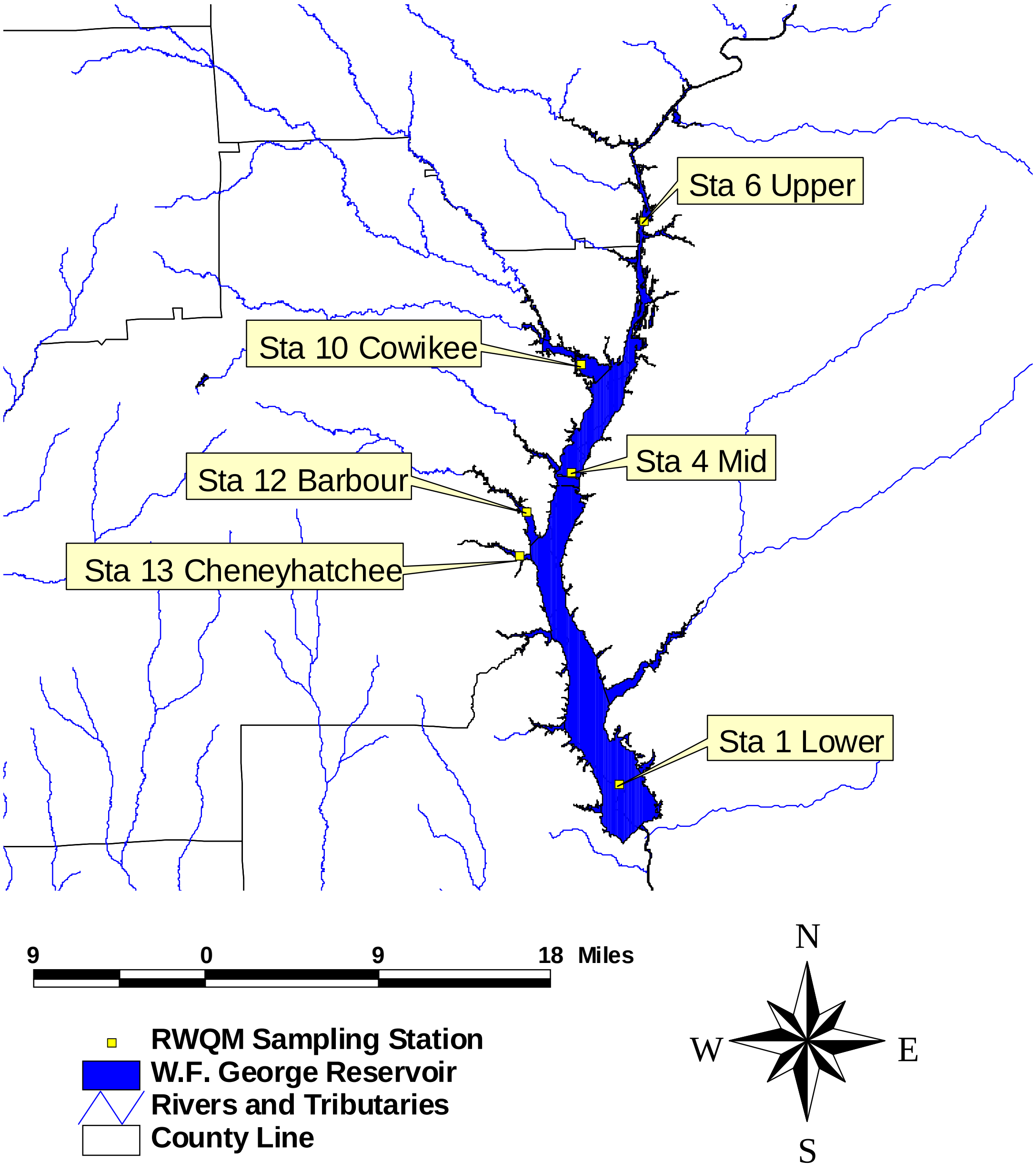


Figure 5. Gantt Reservoir with 1999 sampling stations.

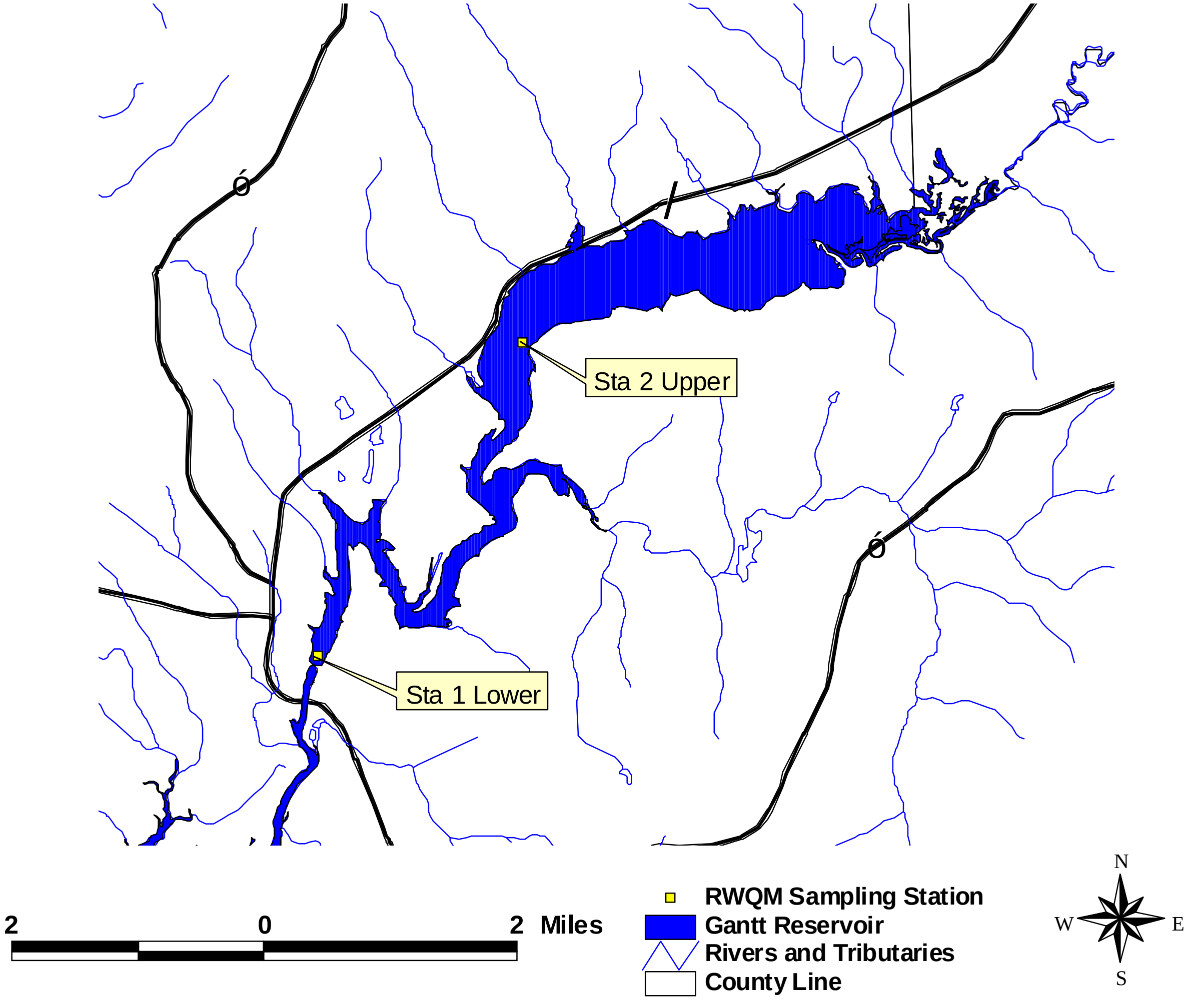


Figure 6. Point A Reservoir with 1999 sampling stations.

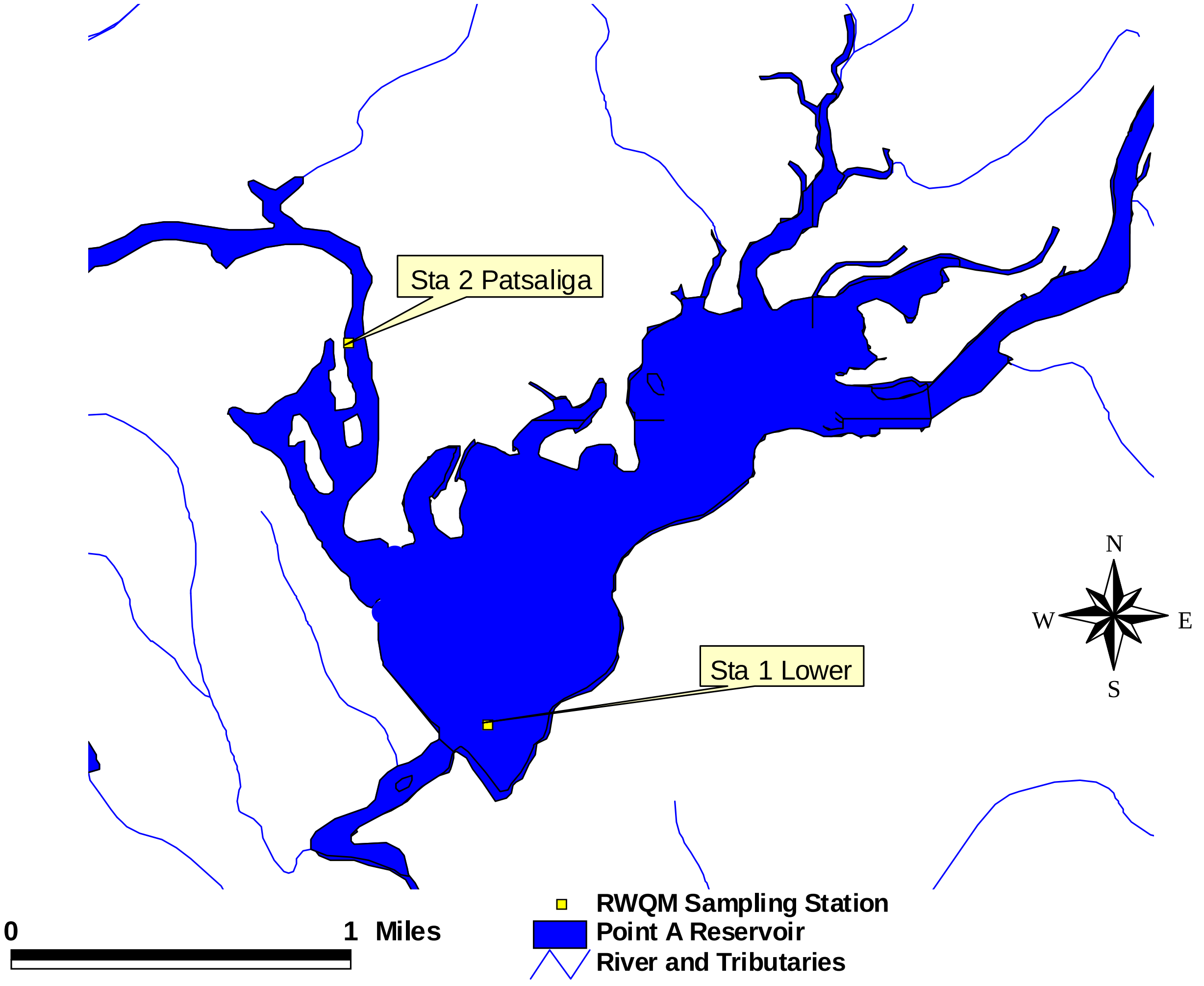


Figure 7. Lake Jackson with 1999 sampling stations.

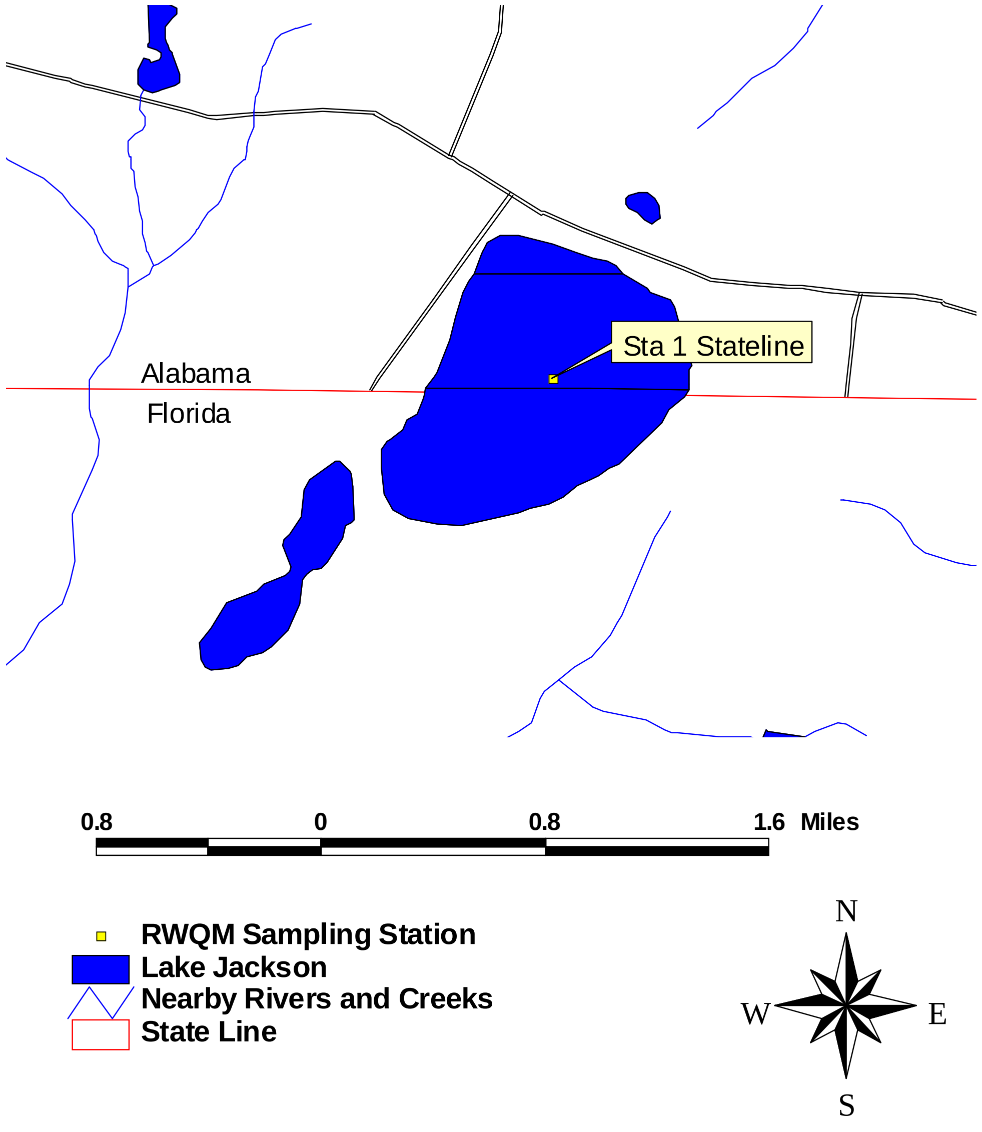


Table 3. Water quality variables measured during the Intensive Water Quality Survey of Chattahoochee and Conecuh River Basin Reservoirs 1999.

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			
BOD_5 (Point A Sta. 1, Gantt Sta. 2, and WFG Sta. 12)	Modified Azide Method	EPA-600/4-79-020	0.1 mg/l
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
Soluble 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
Fecal coliform	Membrane filter	APHA et al. 1992	---
Algal growth potential test	Printz Algal Assay Test	ADEM 1993	---

A composited water sample of 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 composited water sample occurred in the order presented in the following paragraph.

Chlorophyll *a* samples were collected by filtering a minimum of 500 ml of the composited photic zone sample through glass fiber filters immediately after collection of the composited sample. Immediately after filtering, each filter pad 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 concentrations were used in calculating Carlson's trophic state index (TSI) for lakes.

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

From June-August, samples for Algal Growth Potential Tests (AGPT) were collected from the composite photic zone sample of each station by filling a properly prepared plastic container and preserving on ice.

Finally, two half-gallon portions of the composited sample will be 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.

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).

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 is 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.

Quality Control / Quality Assurances

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 are collected.

Data Management and Reporting

All water quality data collected from reservoirs will be compiled and stored in a departmental database.

Results and Discussion

Data selection. Material in this section is divided by reservoir. Water quality data selected 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) 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;
f) total suspended solids (TSS), used as an indicator of sediment inflow.

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. However, all data collected during the intensive survey are available upon request.

Graphs. Bar graphs consist of means of the variables for all months depicted in the line graphs. Bar graphs with multiple reservoirs and 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. For those unfamiliar with the process of eutrophication, it may be useful to discuss the relationship of the data to the process and how the process affects the water quality of lakes and reservoirs. Eutrophication is the process by which waterbodies 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. 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, other than Lake Jackson, 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. 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 nonpoint sources of pollution within the watershed.

The concern about eutrophication from a water quality standpoint is more likely due to cultural eutrophication. Cultural eutrophication can be defined as eutrophication brought about by the 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. Nutrients introduced through these activities can prevent the trophic depression stage in reservoirs, leading to a continuation of the trophic upsurge. However, increased eutrophication in any 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.

For the fishery, the long-term effect of eutrophication will be one of changed species composition, a result largely of the changed DO status (Welch 1992). However, an increased food supply, in the form of more detritus, would tend to favor detritus/bottom-feeding fish such as suckers and carp. As eutrophication increases, DO concentrations will continue to decrease and the incidence of low DO concentrations will occur earlier in the year. Fish activity and growth will decrease progressively with decreasing DO. Fish will evacuate the epilimnion when temperatures exceed their preferred level. If adequate DO exists in the hypolimnion, it can be a healthy refuge during the warm summer period. If there is inadequate DO, the fish will be subjected to either stressful DO in the hypolimnion or, if excluded from the cooler deoxygenated hypolimnion, to stressful temperature in the epilimnion.

I. Chattahoochee Basin Reservoirs

West Point Reservoir

Nitrogen. Mean TN concentration in the Hwy 109 West Point Reservoir was higher than any other Chattahoochee River location (Figure I. 1). Within the reservoir, the mean concentration at Hwy 109 was approximately 0.3 mg/l higher than the lower reservoir location.

Monthly TN concentrations for Hwy 109 were higher than all other West Point stations each month of the sampling period (Figure I. 3). For all three locations, TN concentration was higher from April to June, declined through September, and increased again in October.

The lake mean TN concentration at West Point Reservoir was higher during April and May, declined June to August and increased through September and October (Figure I. 3). In general, months of lower discharge were accompanied by higher lake mean TN concentrations (Figure I. 3).

Phosphorus. Mean TP concentrations in West Point Reservoir were similar at all three locations sampled (Figure I. 1).

Monthly TP concentrations varied by less than 0.030 mg/l among the three locations (Figure I. 3). Concentrations were lower from April-August and then peaked in September. The lake mean TP concentration also increased greatly in September. Mean lake discharge varied between 1000 and 4000 cfs (Figure I. 3).

Algal Growth Potential Tests. All West Point Reservoir stations were phosphorus limited during the course of this study. All MSC values remained below the 5.0 mg/l level suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Table I. 1). Hwy 109 had the highest mean MSC of all West Point stations with a value of 3.87 mg/l in June (Table I. 1).

Chlorophyll a. Mean chlorophyll *a* concentrations varied little at the three locations during the growing season and were more than 4 ug/l higher than concentrations at Harding reservoir (Figure I. 2).

Monthly chlorophyll *a* concentrations were generally 15ug/l or less from April to September with a decline between September and October (Figure I. 4).

As discharge fluctuated at West Point Reservoir, lake mean chlorophyll *a* concentrations remained relatively constant (Figure I. 4). Lake mean concentrations remained just below 15ug/l until a decline in October.

Total Suspended Solids. Mean TSS concentrations of all three West Point locations were similar to other Chattahoochee basin locations (Figure I. 2). Concentration was highest at the lower station.

Monthly TSS concentrations at lower reservoir were approximately 4 times higher than other stations during April (Figure I. 4). From May through September monthly TSS concentrations were similar between all West Point stations, approximately 10 mg/l during May and near 5 mg/l the remainder of the sampling season. In October the TSS concentration at the Hwy 109 location was approximately twice as high as other stations. Lake mean TSS concentration was at its highest concentration during April and steadily declined until June (Figure I. 4). As lake mean discharge increased, TSS concentration decreased.

Trophic State. TSI values for each of the three locations remained in the eutrophic range during April – September (Figure I. 6). Trophic levels decreased from September to October. During October, the Hwy 109 station was borderline eutrophic/mesotrophic, while other locations were on the lower end of mesotrophic status.

Dissolved Oxygen/Temperature. Dissolved oxygen concentrations at the three locations were very similar with the highest concentrations occurring during April and lowest concentrations occurring during August (Figure I. 6). DO concentration at Hwy 109 location (4.93 mg/l) failed to meet the criterion limit of 5.0 mg/l during August. DO concentrations were above the criterion limit at all other locations and dates sampled.

Depth profiles indicated a thermocline from May – August (Figure I. 7) and chemical stratification during the months of April – September with half of the water column having a dissolved oxygen concentration of less than 5mg/l.. Highest water column temperatures occurred in July and August.

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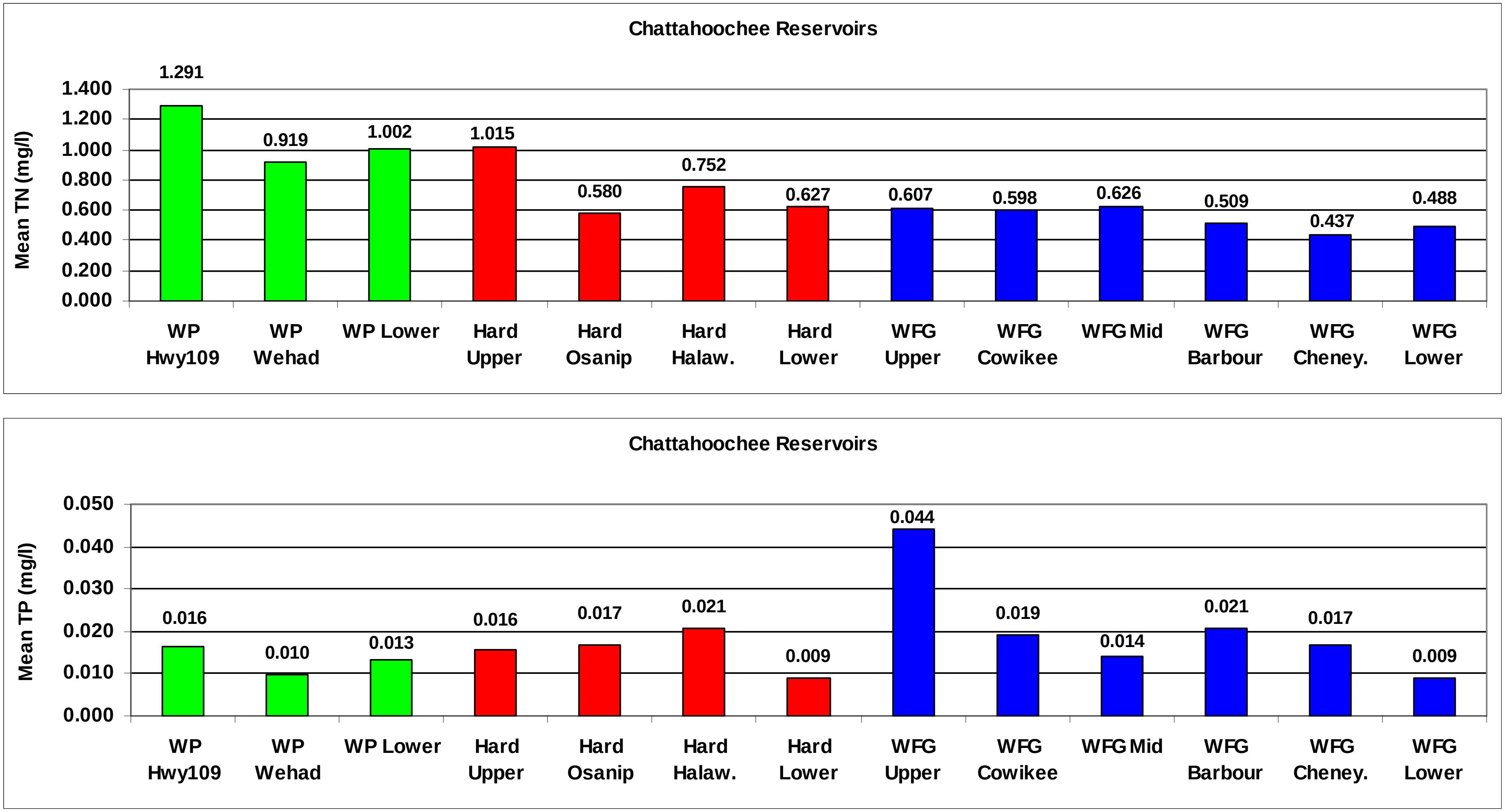


Figure I. 1. Mean total nitrogen (TN) and total phosphorus (TP) concentrations of Chattahoochee basin reservoirs, April-October 1999.

Table I. 1. Algal Growth Potential Tests (AGPT) of Chattahoochee River reservoirs, June-August 1999.

Reservoir	Location	Collection Date					
		Jun-99		Jul-99		Aug-99	
		Mean MSC (mg/l)	Limiting Nutrient	Mean MSC (mg/l)	Limiting Nutrient	Mean MSC (mg/l)	Limiting Nutrient
West Point	Hwy. 109	3.87	Phosphorus	1.68	Phosphorus	1.74	Phosphorus
	Wehadkee Creek	1.74	Phosphorus	1.33	Phosphorus	1.24	Phosphorus
	Lower	1.78	Phosphorus	1.57	Phosphorus	1.11	Phosphorus
Harding	Upper	5.18	Phosphorus	6.14	Phosphorus	2.62	Phosphorus
	Osanippa Creek	6.99	Phosphorus	2.74	Phosphorus	1.74	Phosphorus
	Halawakee Creek	1.57	Phosphorus	3.43	Phosphorus	1.51	Phosphorus
	Lower	1.34	Phosphorus	2.48	Phosphorus	1.84	Phosphorus
Walter F. George	Upper	7.24	Phosphorus	12.06	Phosphorus	31.67	Nitrogen
	Cowikee	4.6	Nitrogen	4.36	Phosphorus	4.68	Nitrogen
	Mid	5.69	Phosphorus	2.5	Phosphorus	8.04	Phosphorus
	Barbour Creek	4.05	Phosphorus	3.17	Phosphorus	2.56	Phosphorus
	Cheneyhatchee Creek	1.38	Phosphorus	3.07	Phosphorus	1.38	Phosphorus
	Lower	2.08	Co-Limit	1.38	Co-Limit	2.19	Phosphorus

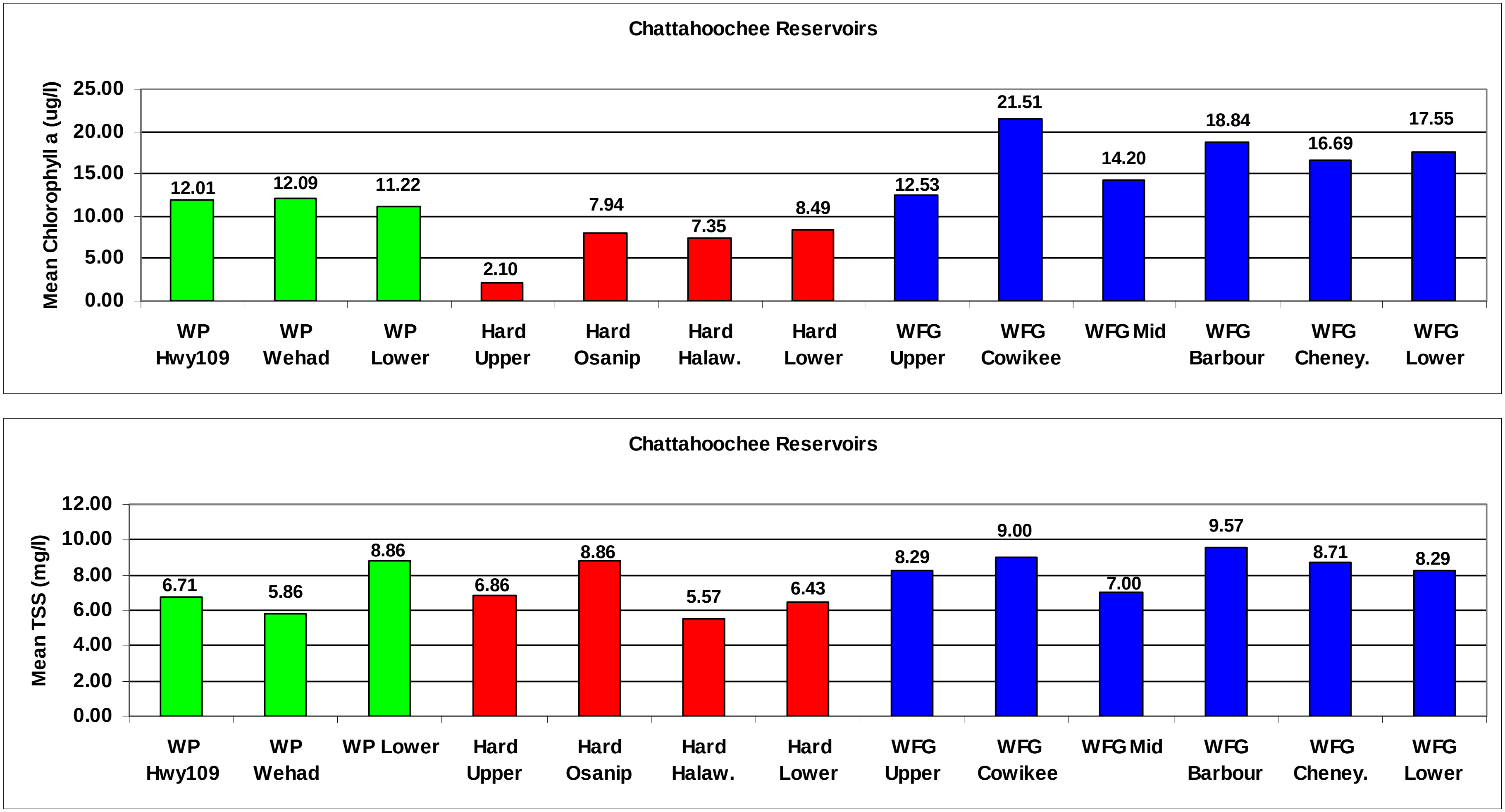


Figure I. 2. Mean chlorophyll *a* and total suspended solids (TSS) concentrations of Chattahoochee basin reservoirs, April-October 1999.

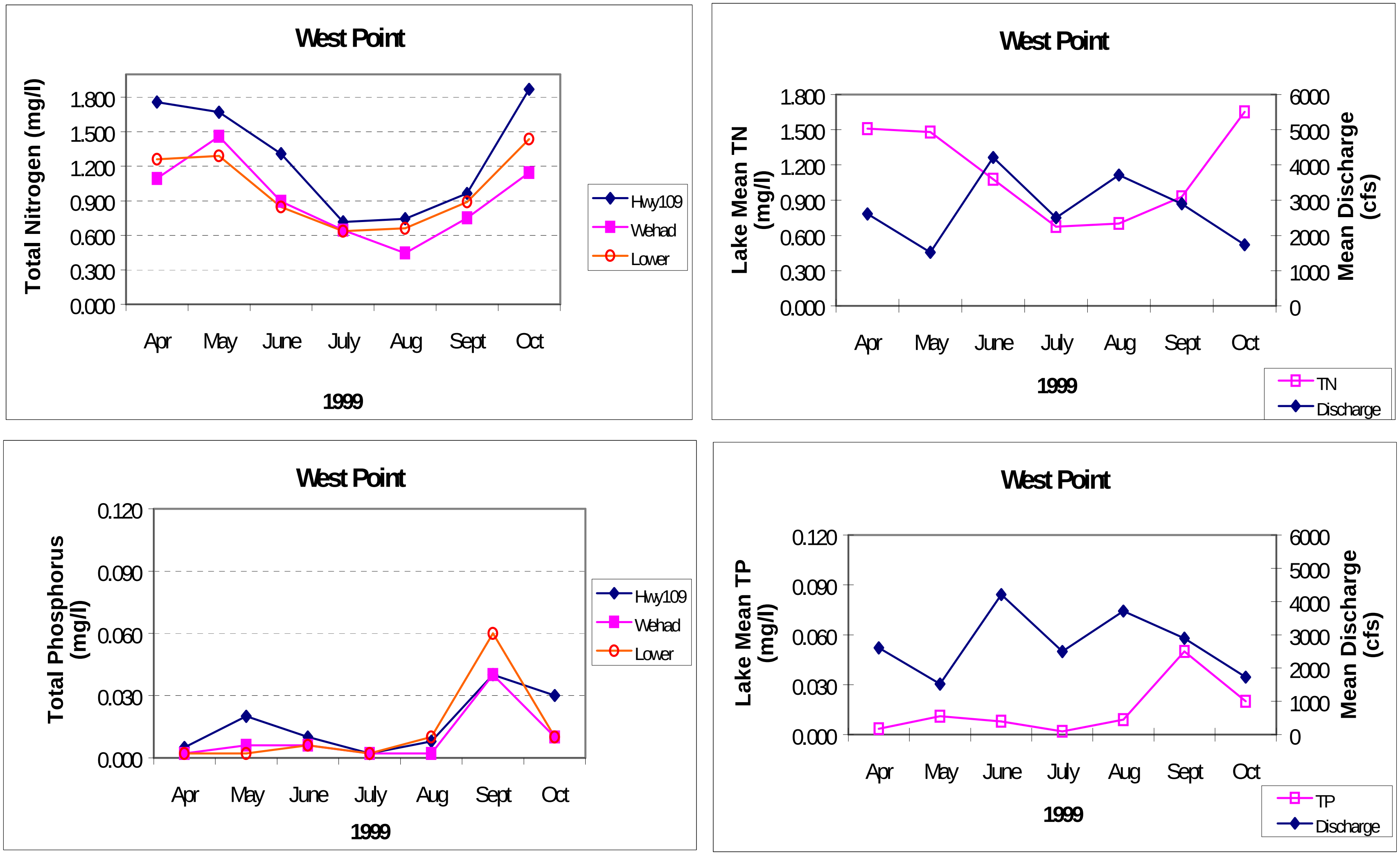


Figure I. 3. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of West Point Reservoir, April-October 1999.

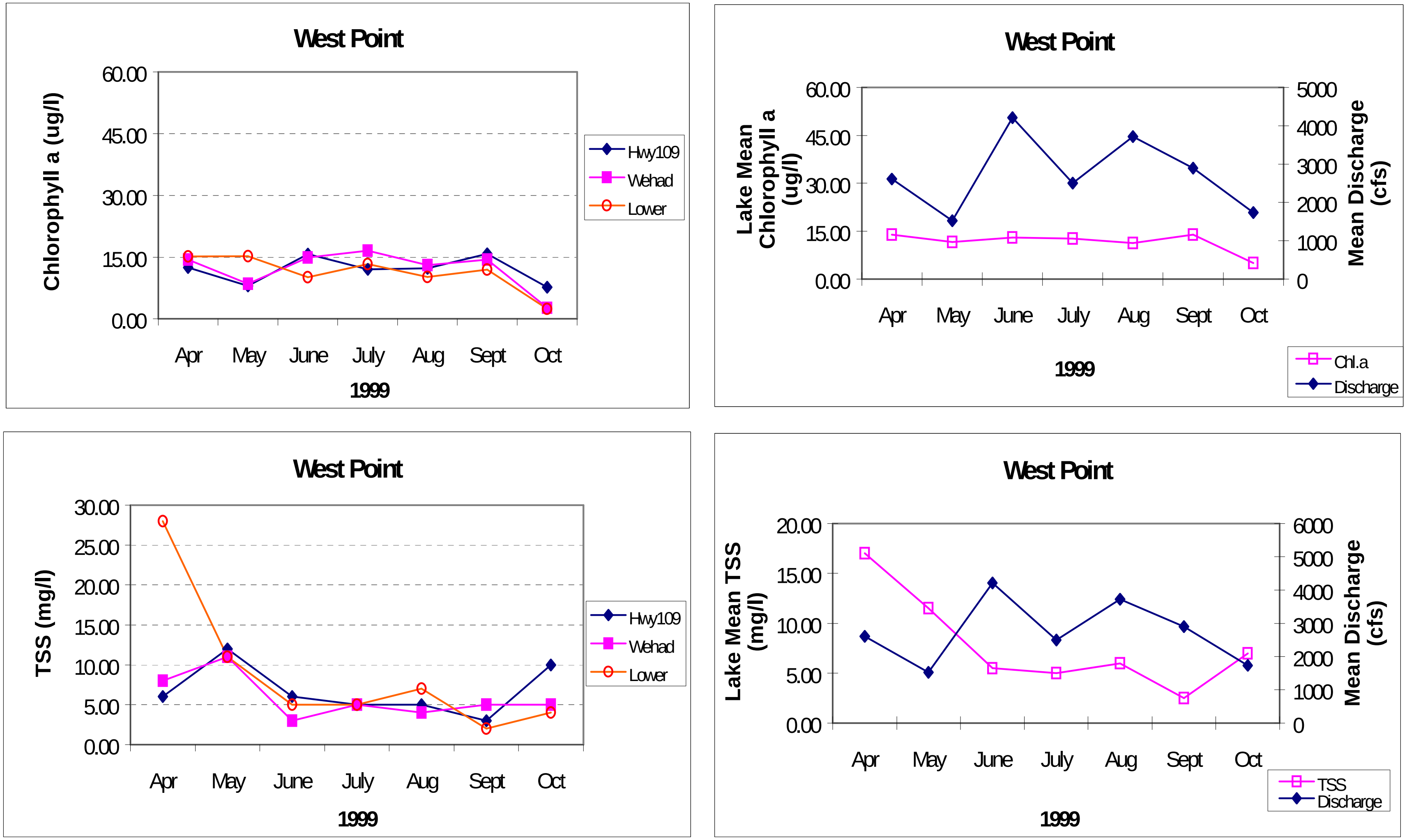


Figure I. 4. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, total suspended solids (TSS), and TSS vs. discharge of West Point Reservoir, April-October 1999.

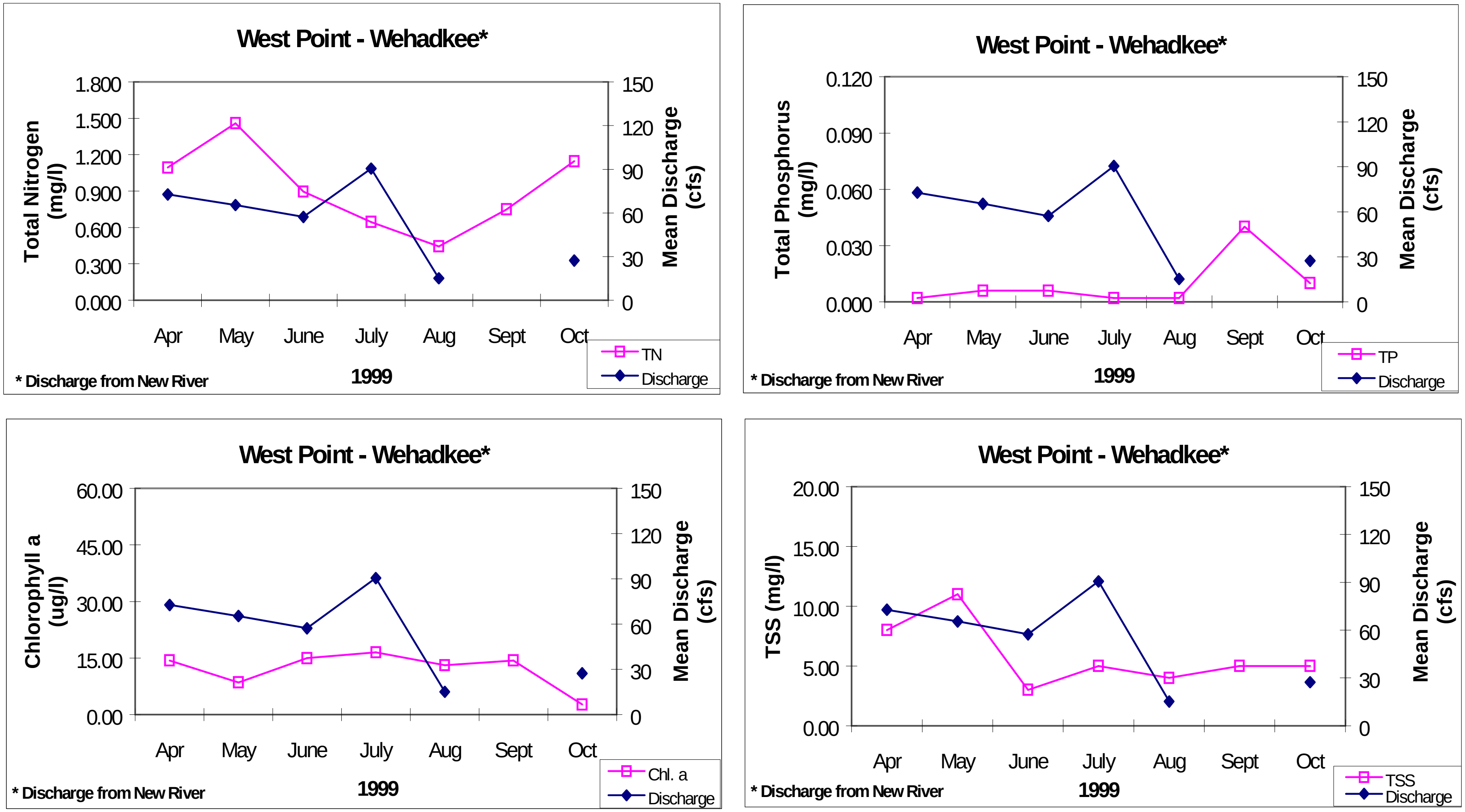


Figure I. 5. Total nitrogen (TN) vs. discharge, total phosphorus (TP) vs. discharge, chlorophyll *a* vs. discharge, and total suspended solids (TSS) vs. discharge of the Wehadkee Creek embayment of West Point Reservoir, April-October 1999.

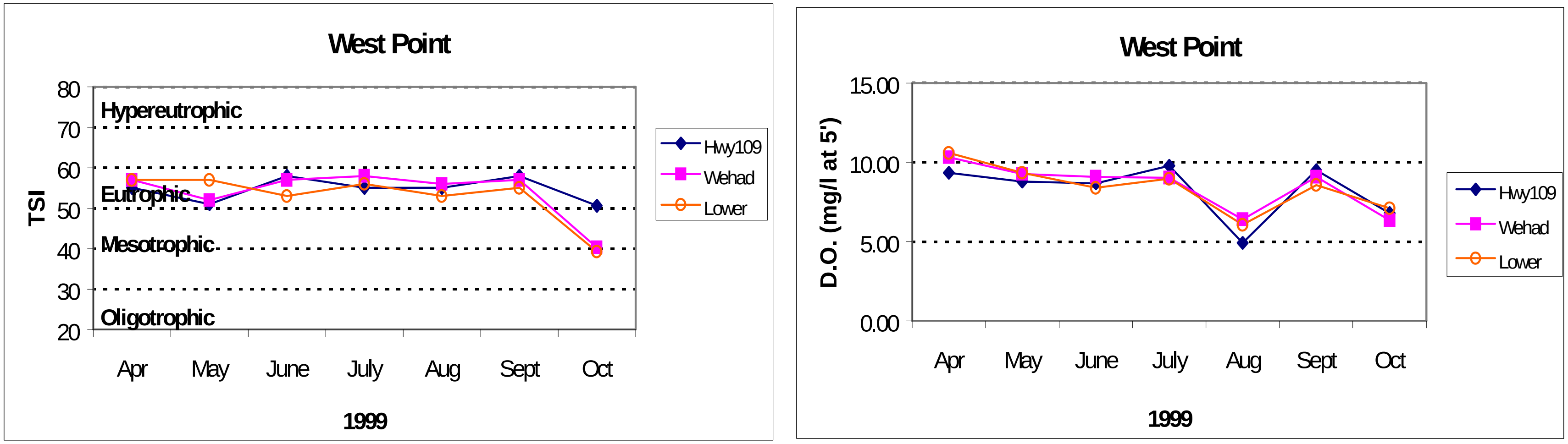
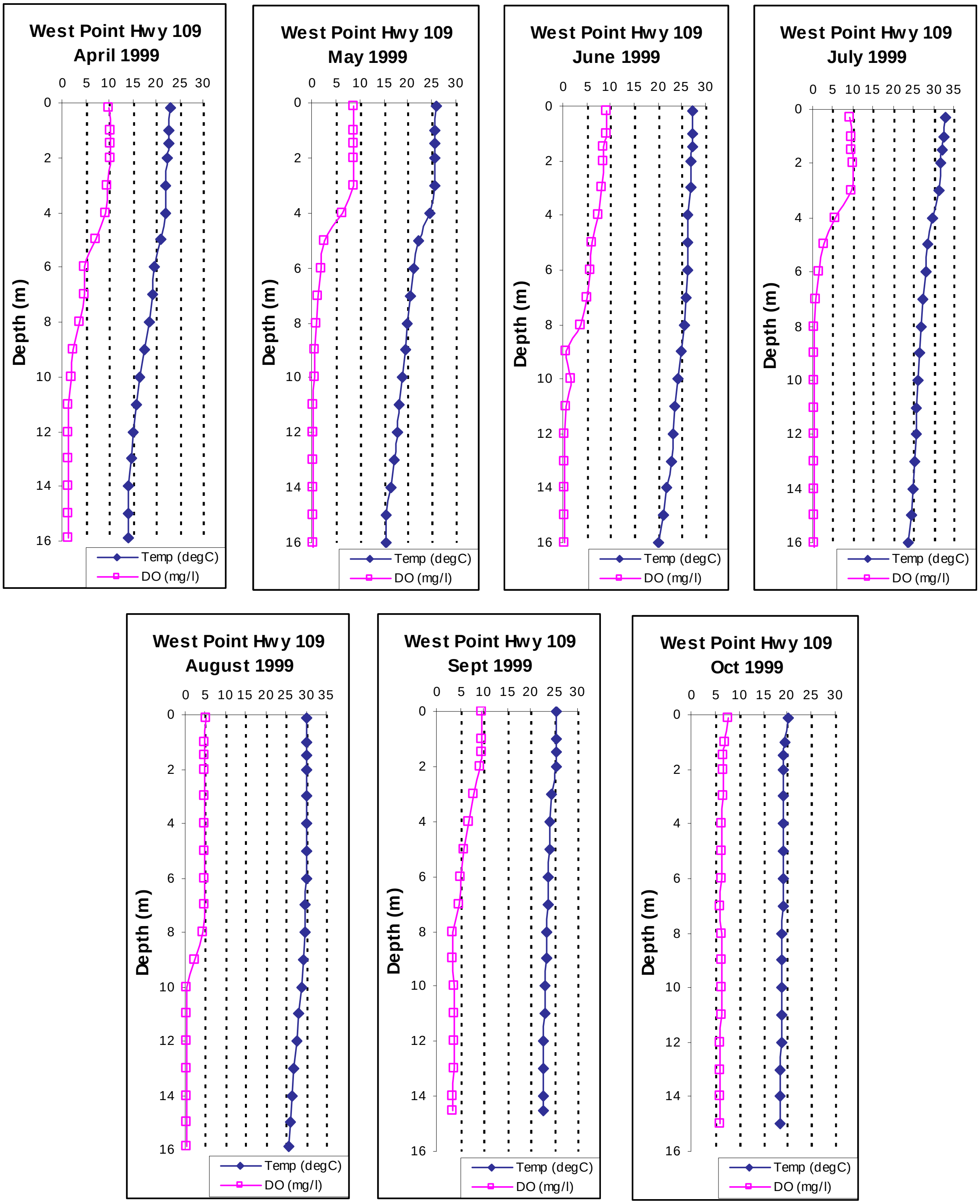


Figure I. 6. Trophic state index (TSI), and dissolved oxygen (DO) of West Point Reservoir, April-October 1999.



West Point Hwy 109 April 1999

West Point Hwy 109 May 1999

West Point Hwy 109 June 1999

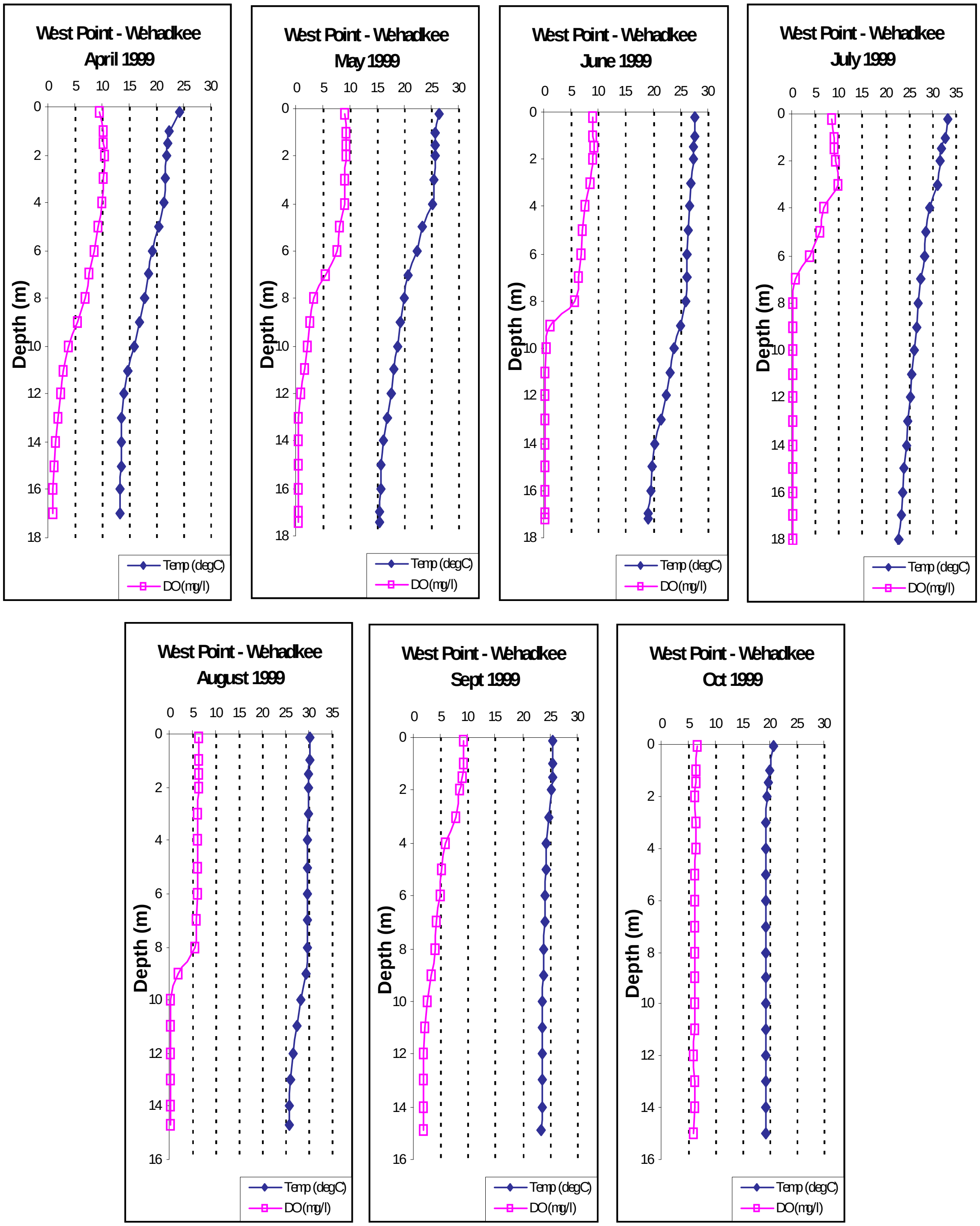
West Point Hwy 109 July 1999

West Point Hwy 109 August 1999

West Point Hwy 109 Sept 1999

West Point Hwy 109 Oct 1999

Figure I. 7. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at Hwy 109 West Point Reservoir, April-October 1999.


West Point - Wehadkee April 1999

West Point - Wehadkee May 1999

West Point - Wehadkee June 1999

West Point - Wehadkee July 1999

West Point - Wehadkee August 1999

West Point - Wehadkee Sept 1999

West Point - Wehadkee Oct 1999

Figure I. 8. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the Wehadkee Creek embayment of West Point Reservoir, April-October 1999.

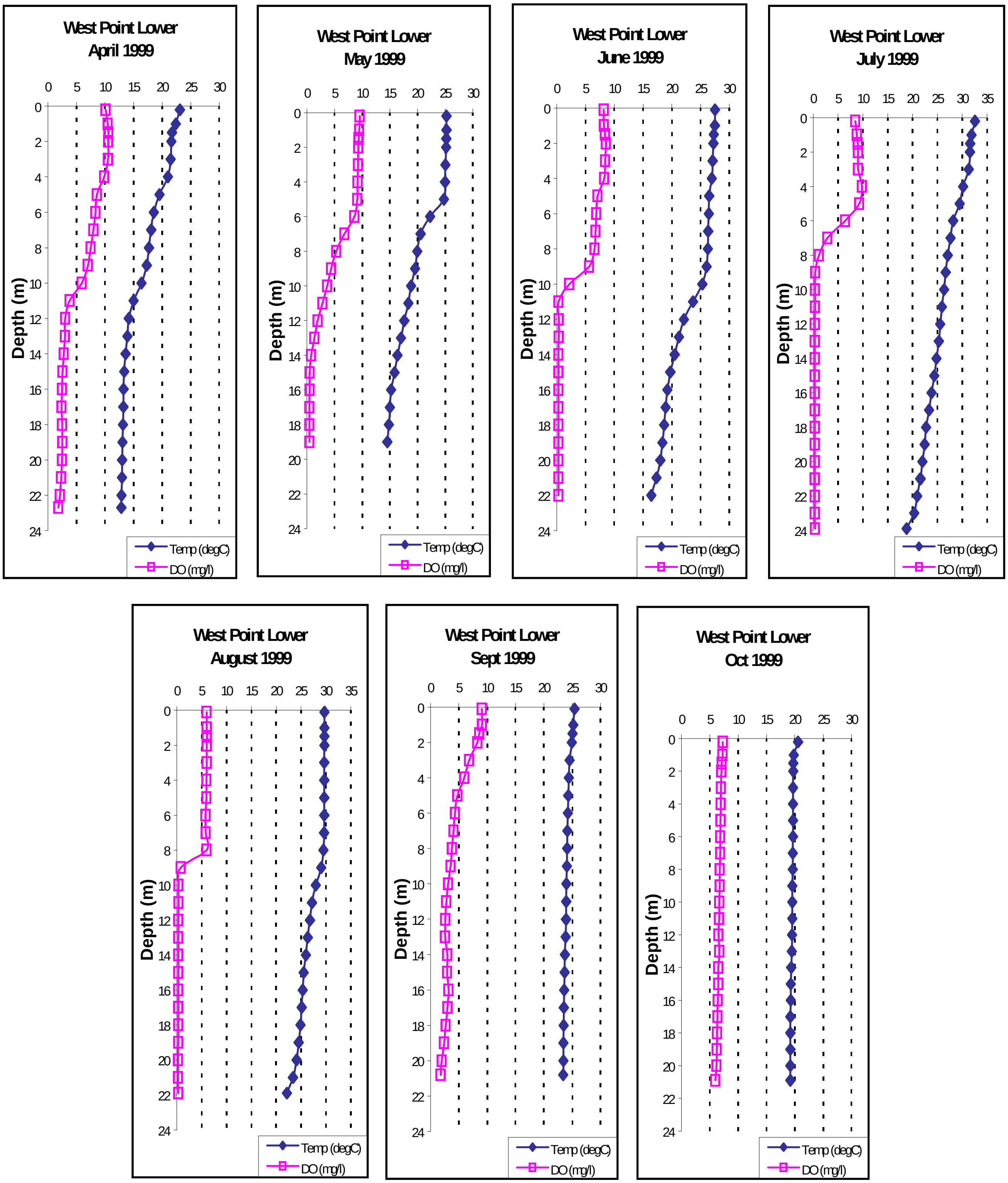


Figure I. 9. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in lower West Point Reservoir, April-October 1999.

Harding Reservoir

Nitrogen. Mean TN concentration was highest in the upper Harding Reservoir location (Figure I. 1). In general, mean TN concentrations of Harding Reservoir were lower than West Point Reservoir and greater than Walter F. George Reservoir.

During the sampling season, lake mean TN concentration increased in May, decreased until August and then peaked in October (Figure I. 10)**.** Meanwhile, discharge decreased April – May, increased greatly May- June, and slowly declined June-October**.** There was no apparent relationship between lake mean TN and discharge.

Phosphorus. Mean TP concentration at Halawakee Creek was the highest of Harding Reservoir locations (Figure I. 1).

Total phosphorus levels remained below 0.030 mg/l through August, increased sharply in September, and fell in October (Figure I. 10)**.** During September concentrations at Halawakee Creek were highest of Harding Reservoir stations with concentrations exceeding 0**.**060 mg/l.

Lake Mean TP remained low April – August, increased in September and fell in October (Figure I. 10). Mean discharge was lowest during May, peaked in June and slowly declined July – October.

Algal Growth Potential Tests. All Harding reservoir stations were phosphorus limited during the course of this study. Mean MSC values exceeded the maximum 5.0 mg/l suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes at Harding Upper in June and July and at Osanippa Creek in June (Table I. 1). Mean MSC values declined to below the maximum 5.0 mg/l at the upper station in August and Osanippa Creek during July and August. AGPT values at Halawakee Creek and the Lower station remained below the 5.0 mg/l level during the study.

Chlorophyll *a*. Mean chlorophyll *a* concentrations at Harding Reservoir were lower than any other Chattahoochee River reservoir. The mean chlorophyll *a* concentration at upper Harding Reservoir was the lowest of any Chattahoochee River station. Mean chlorophyll *a* concentrations were similar among Osanippa and Halawakee Creeks and lower Harding Reservoir (Figure I. 2).

Monthly chlorophyll *a* concentrations were at or below 15 mg/l throughout the growing season (Figure I. 11). The highest monthly chlorophyll *a* concentrations were observed during June at Osanippa Creek embayment and September at the lower Harding station.

Mean discharge peaked in June and declined through the remainder of the sampling season. Lake mean chlorophyll *a* remained relatively low with a slight increase during September (Figure I. 11). Chlorophyll *a* concentrations did not exhibit any relationship with discharge.

Total Suspended Solids. The highest mean TSS concentrations in Harding Reservoir were observed at the Osanippa Creek embayment location (Figure I. 2).

Monthly TSS concentrations were highest at Osanippa Creek location during May and October (Figure I. 11). TSS peaked at lower Harding reservoir during July and at upper reservoir, Osanippa Creek, and Halawakee Creek during May.

Lake mean TSS concentrations were lowest in April and highest during May and July (Figure I. 11). Mean discharge was highest in June and lowest during May and October.

Trophic State. Monthly TSI values at upper Harding Reservoir were lower than any other Harding Reservoir station reaching oligotrophic status during June (Figure I. 14). Other stations alternated between eutrophy and mesotrophy throughout the growing season with June – September being the highest months. Osanippa Creek during June and lower Harding during September were highest in trophic status.

Dissolved Oxygen/Temperature. Dissolved oxygen concentrations were similar among Harding Reservoir locations except during July (Figure I. 14). For July, DO concentrations at Halawakee Creek and lower Harding Reservoir increased while concentrations at Upper Reservoir and Osanippa Creek decreased. DO concentrations were above the criterion limit of 5.0 mg/L on all dates sampled.

Depth profiles of upper reservoir indicated no apparent thermal stratification during the sampling season (Figures I. 15). Weak thermal and chemical stratification was observed May – July, September, and October at Osanippa Creek location (Figure I. 16). At Halawakee Creek, more defined thermal and chemical stratification occurred April –

August (Figure I. 17)**.** Finally, lower Harding station was stratified each month, April – August but depths of stratification varied (Figure I. 18). Water temperature was highest during July for each of the four Harding Reservoir locations.

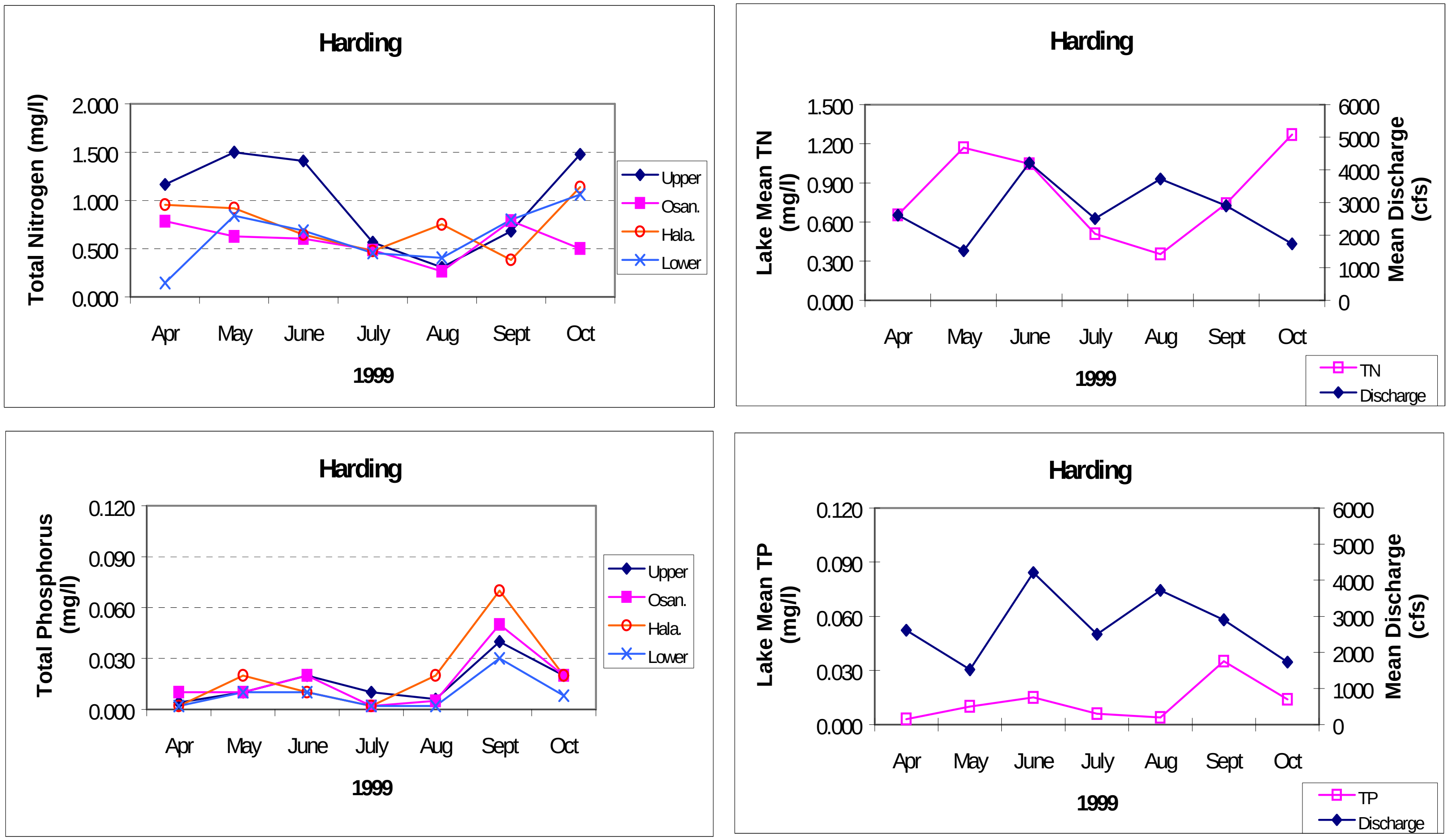


Figure I. 10. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Harding Reservoir, April-October 1999.

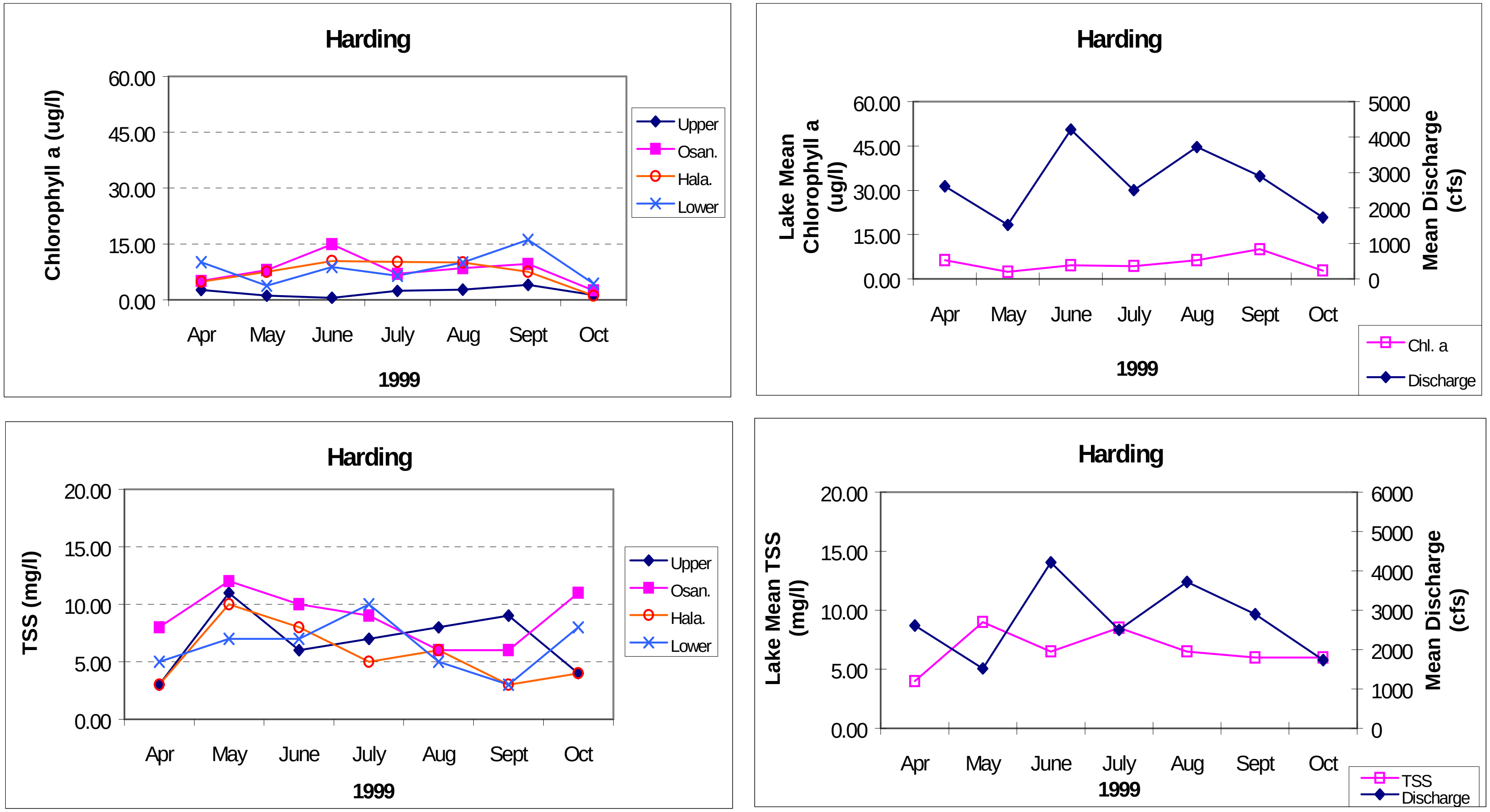


Figure I. 11. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, total suspended solids (TSS), and TSS vs. discharge of Harding Reservoir, April-October 1999.

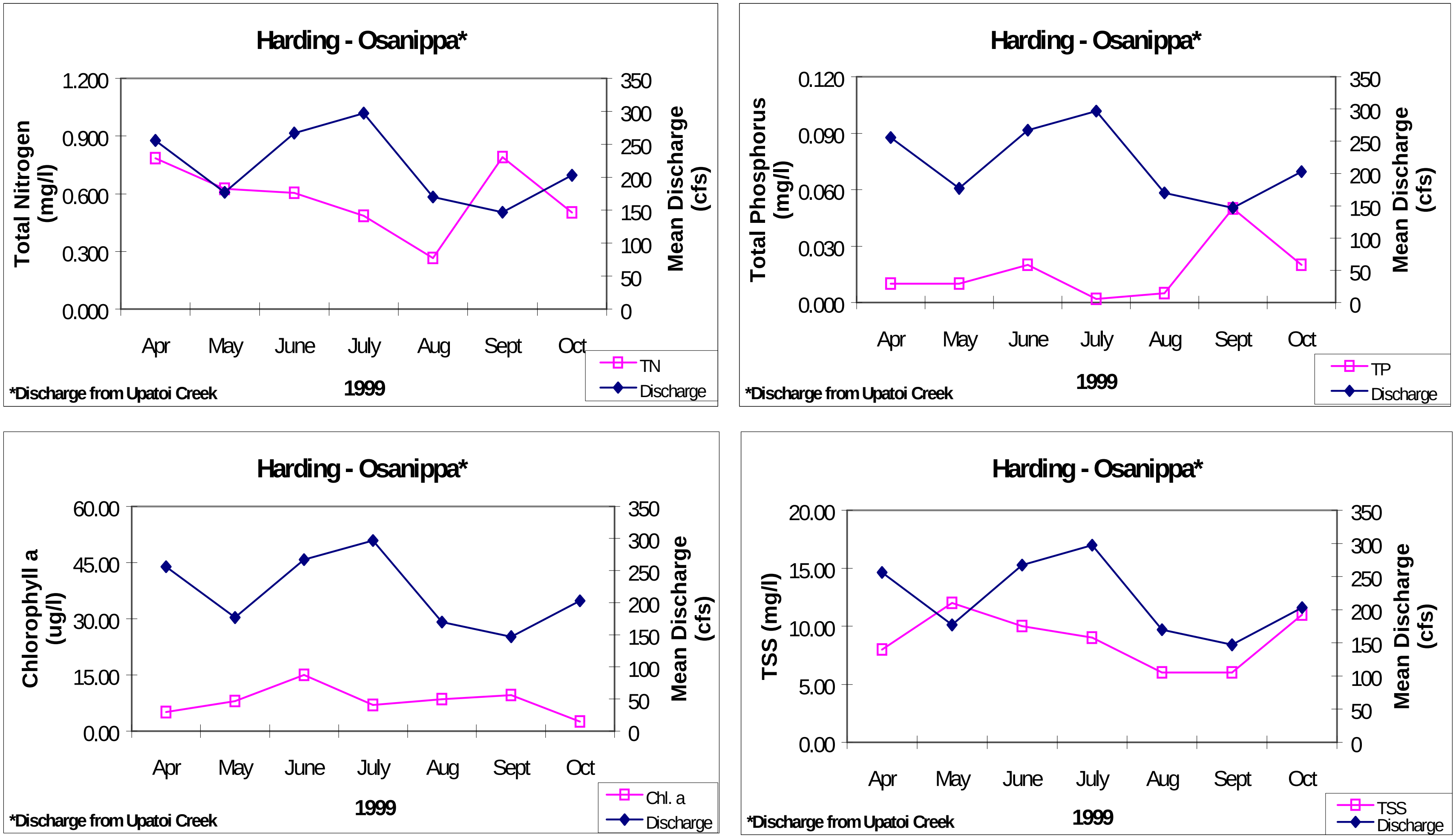


Figure I. 12. Total nitrogen (TN) vs. discharge, total phosphorus (TP) vs. discharge, chlorophyll *a* vs. discharge, and total suspended solids (TSS) vs. discharge of the Osanippa Creek embayment of Harding Reservoir, April-October 1999.

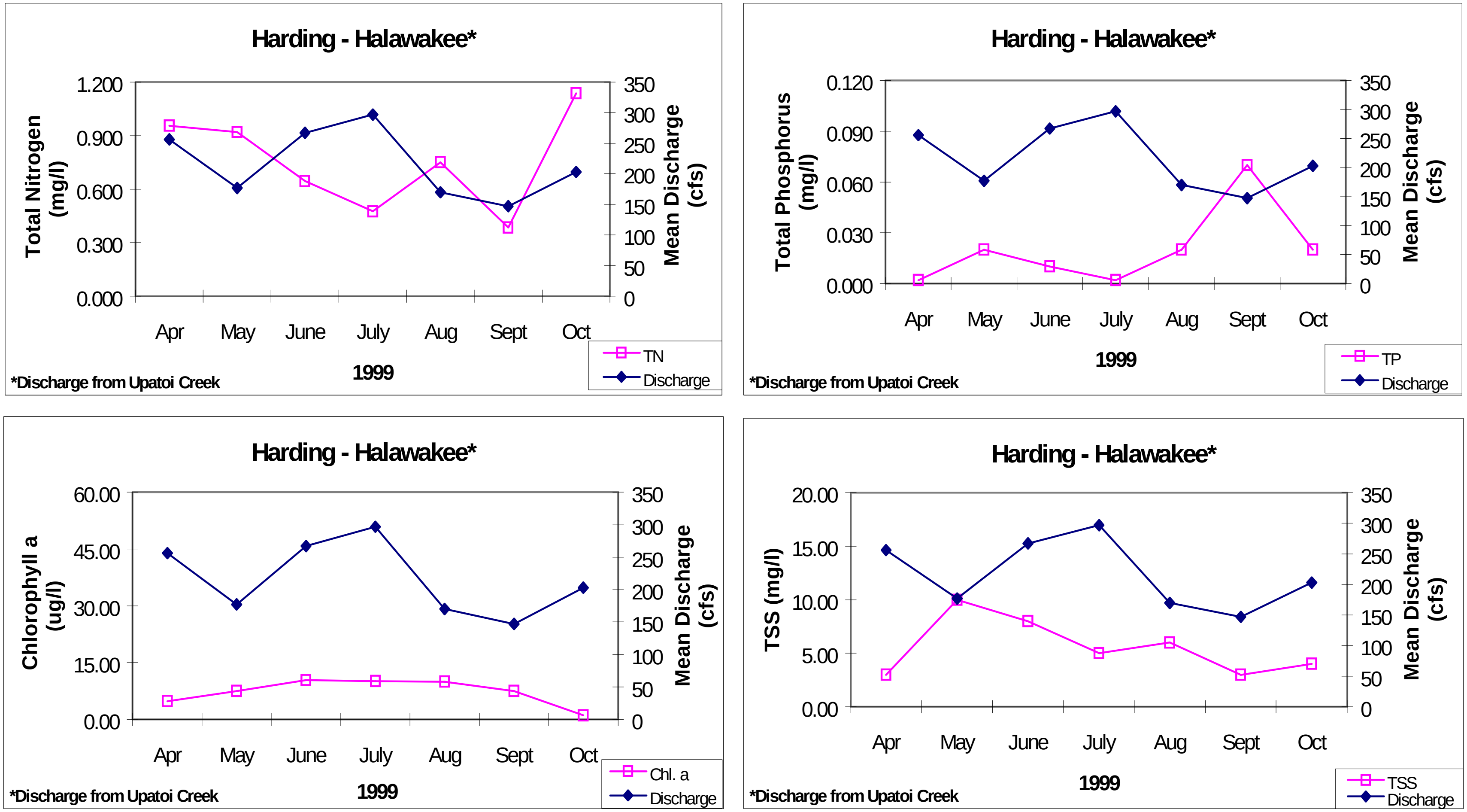


Figure I. 13. Total nitrogen (TN) vs. discharge, total phosphorus (TP) vs. discharge, chlorophyll *a* vs. discharge, and total suspended solids (TSS) vs. discharge of the Halawakee Creek embayment of Harding Reservoir, April-October 1999.

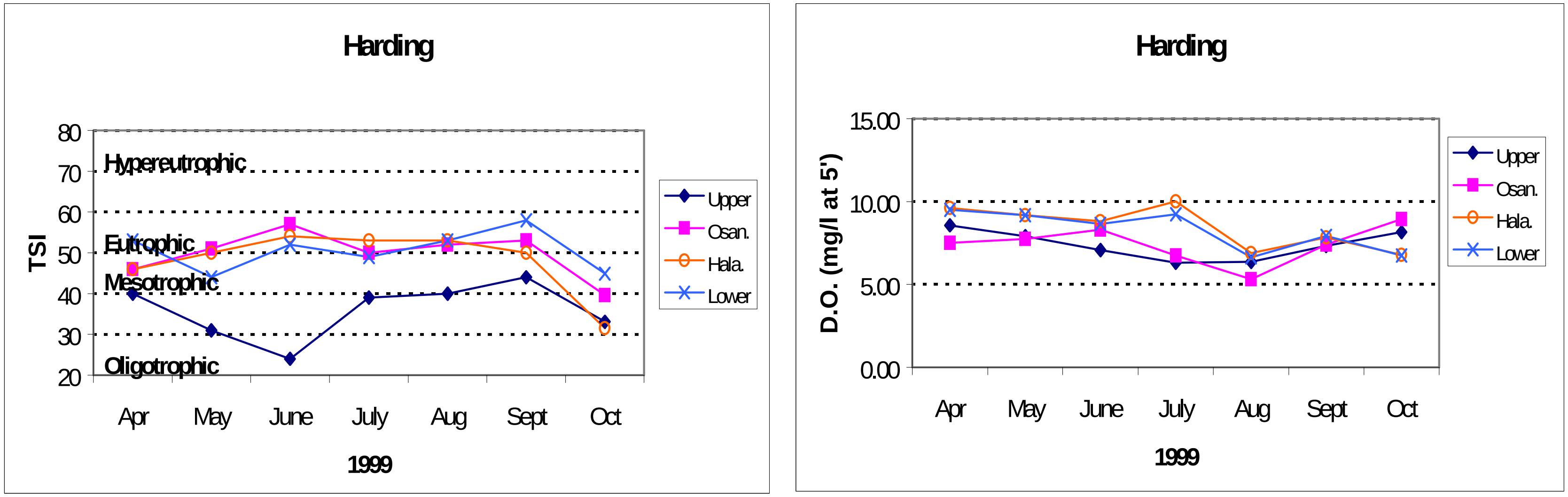


Figure I. 14. Trophic state index (TSI), and dissolved oxygen (DO) of Harding Reservoir, April-October 1999.

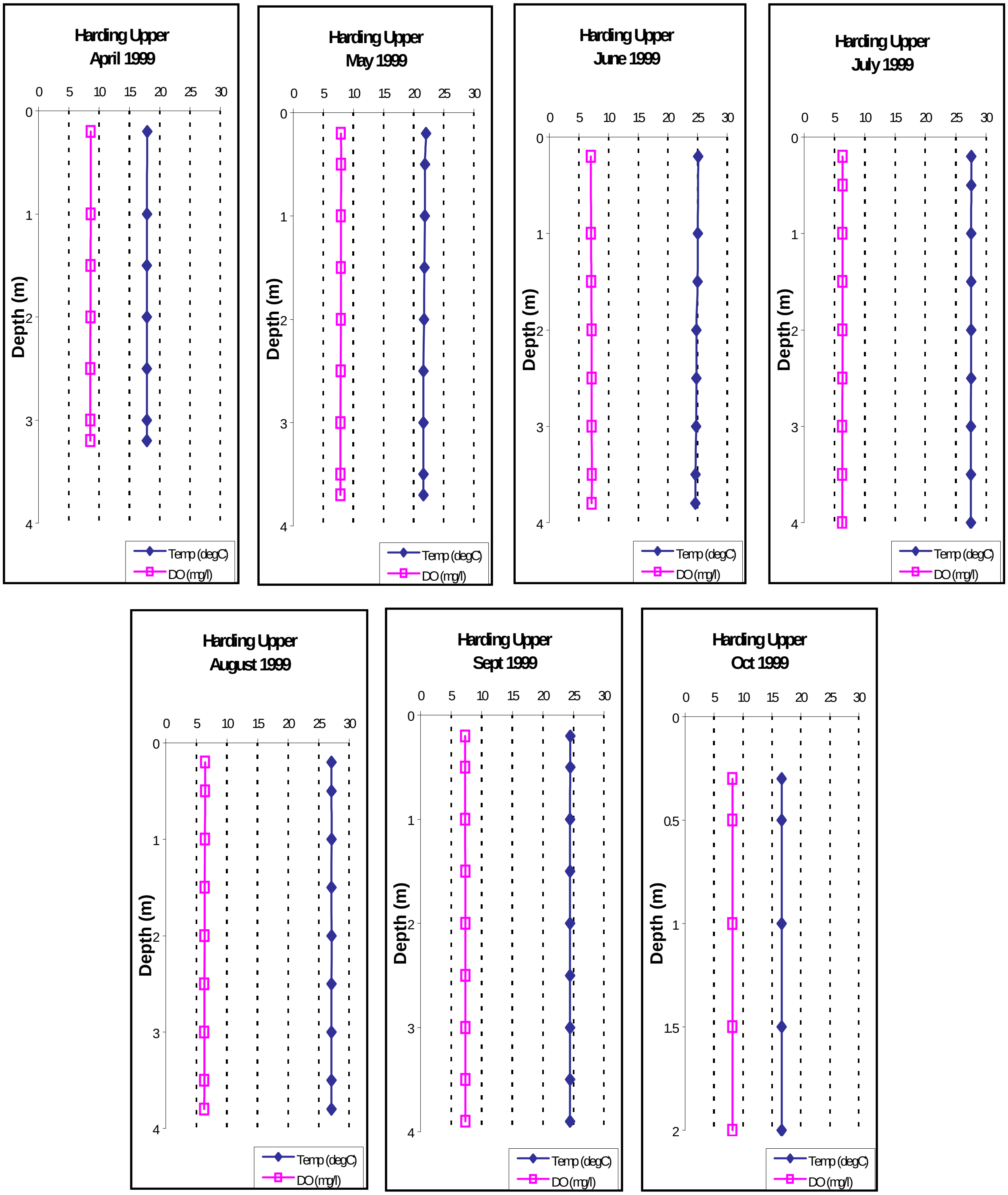


Figure I. 15. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in upper Harding Reservoir, April-October 1999.

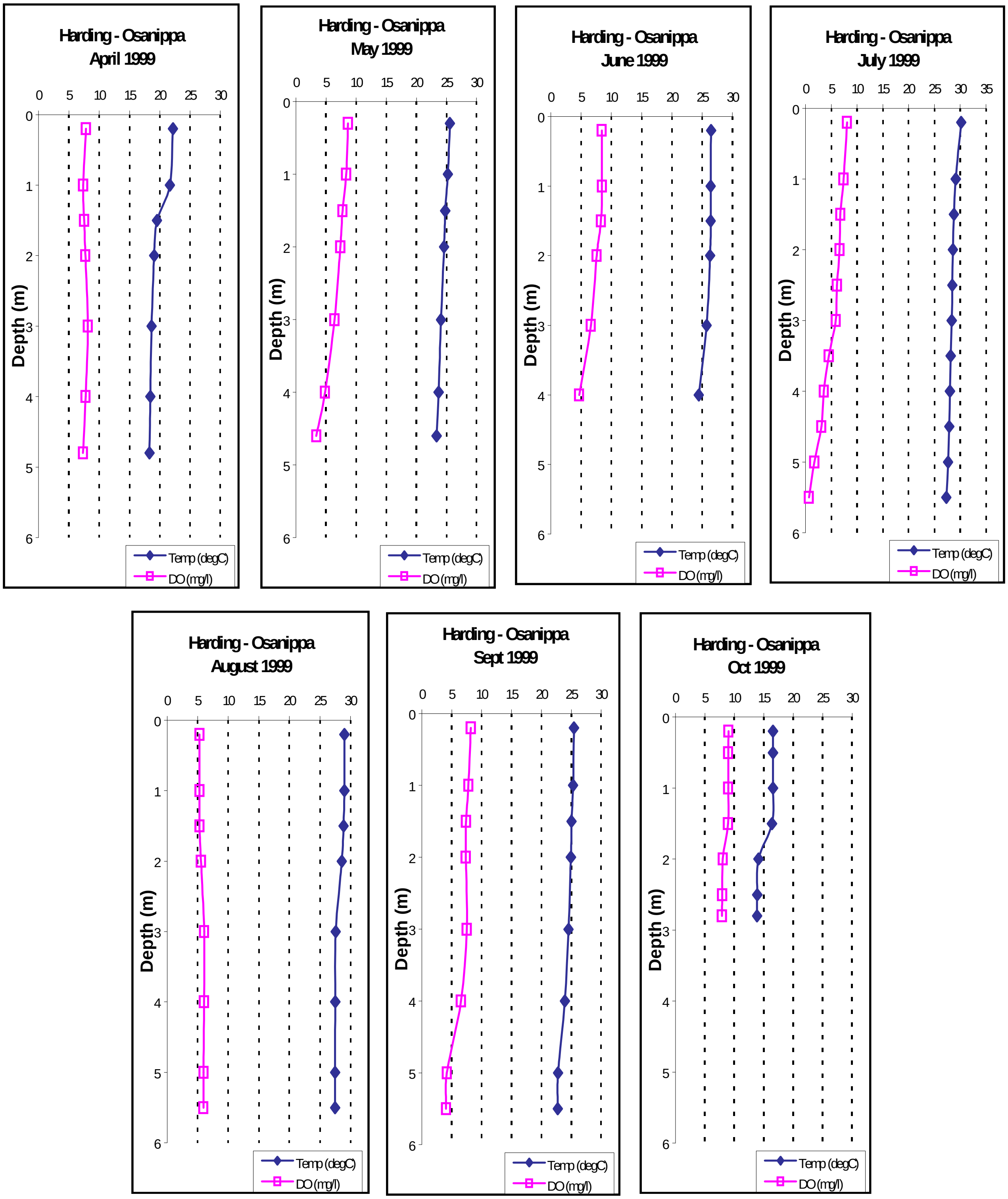


Figure I. 16. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the Osanippa Creek embayment of Harding Reservoir, April-October 1999.

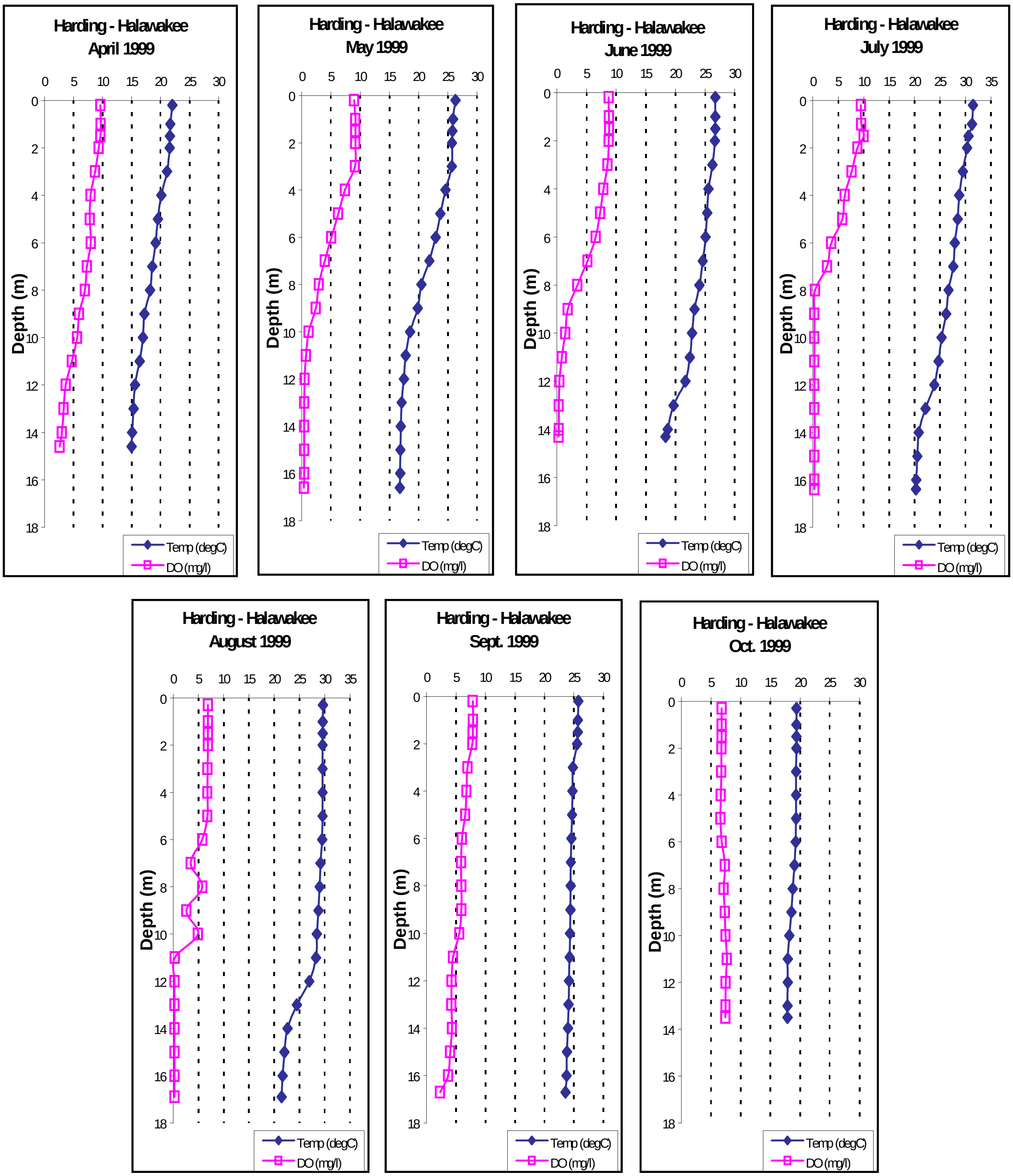


Figure I. 17. Depth profiles of dissolved oxygen (DO) and temperature (Temp) in the Halawakee Creek embayment of Harding Reservoir, April-October 1999.

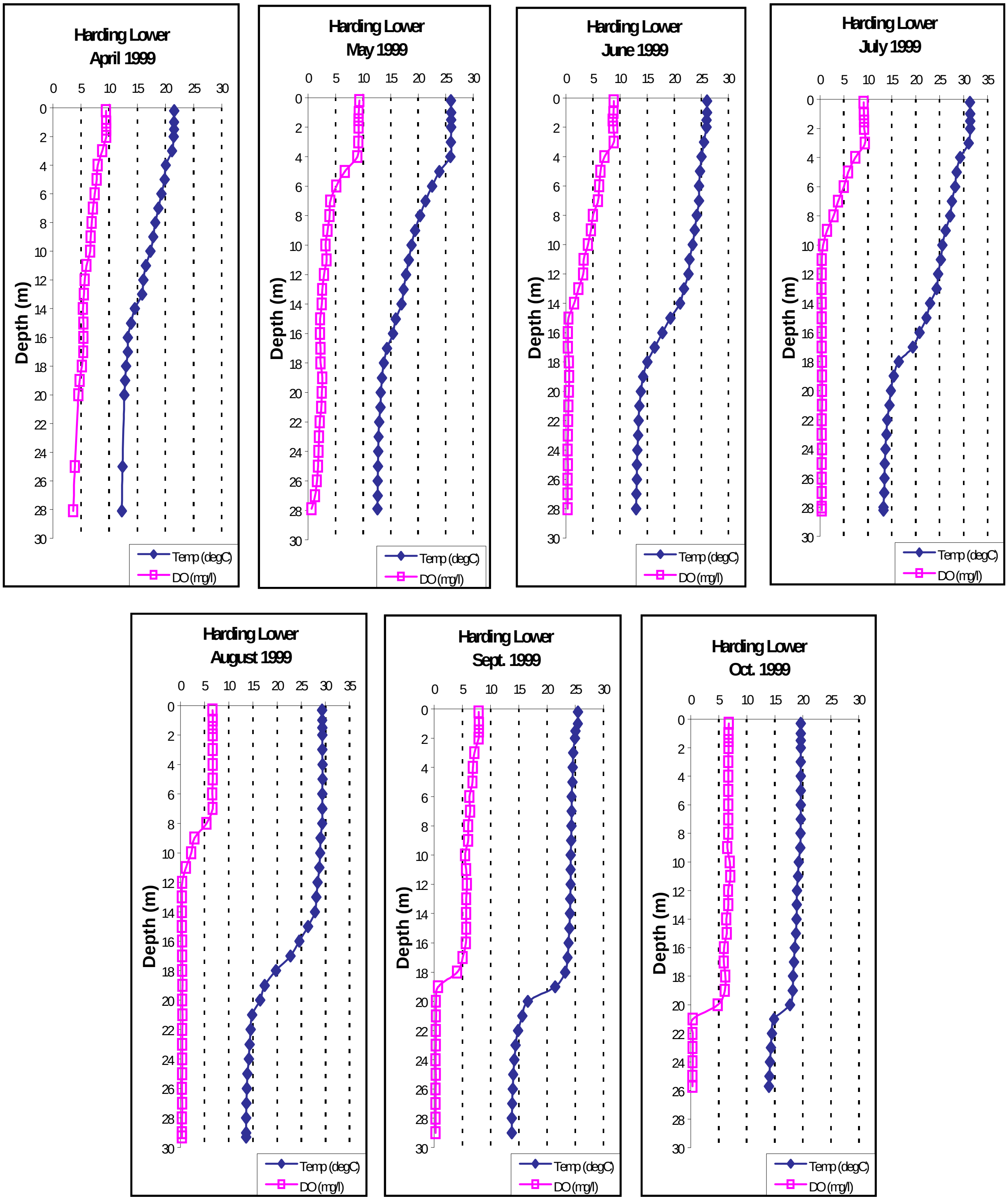


Figure I. 18. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the lower Harding Reservoir station, April-October 1999.

Walter F. George Reservoir

Nitrogen. Mean TN concentrations in Walter F. George Reservoir were generally lower than other Chattahoochee River impoundments sampled (Figure I. 1). Mid reservoir had the highest mean TN concentration. Barbour Creek and Cheneyhatchee Creek stations had the lowest in mean TN of all Chattahoochee River locations.

During June, TN concentrations at Cowikee Creek were approximately ten times greater than lower Walter F. George Reservoir. TN levels at lower reservoir were more than three times higher than Cowikee Creek during August. Three locations exceeded 1.0mg/l during the sampling season: Cowikee Creek in June (the highest TN concentration observed during the sampling season), lower reservoir during August, and Barbour Creek during October.

The lake mean TN concentration in Walter F. George Reservoir was highest in August and October (Figure I. 19). Mean lake discharge was highest in June and lowest in October. June, the month of highest discharge, was followed in July by a sharp decrease in lake mean TN. From July through October discharge tended to decline and lake mean TN tended to increase (Figure I. 19).

Phosphorus. Mean TP concentrations at upper reservoir were more than two times higher than any other Chattahoochee basin sampling location (Figure I. 1). In addition, mean TP concentration at Cowikee Creek and Barbour Creek were higher than most sampling locations.

Monthly TP concentrations were similar among Walter F. George locations with the exception of upper reservoir in April (Figure I. 19). TP concentration at upper reservoir during April was high compared to all other locations within the reservoir. TP concentrations for most locations were below the detectable limit during April compared to 0.110mg/l at upper reservoir. Each of six locations on Walter F. George Reservoir increased in TP concentration during September.

Lake mean TP concentration was relatively stable April – October (Figure I. 19). A slightly higher lake mean TP concentration occurred during April due to high levels at upper reservoir. Mean TP concentration increased slightly during September. Mean discharge decreased steadily from August as lake mean TP comparatively increased.

Algal Growth Potential Tests. AGPT results indicated that Mid, Barbour Creek and Cheneyhatchee Creek stations were all phosphorus limited throughout the study (Table I. 1). The Upper station was phosphorus limited June and July and nitrogen limited in August. Cowikee Creek was nitrogen limited in June and August and phosphorus limited in July. Phosphorus was the limiting nutrient at the Lower station in August and phosphorus and nitrogen were co-limiting at the Lower station during June and July.

Mean MSC values were highest at the Upper station with concentrations exceeding the 5.0 mg/l recommended level during June, July and August with values of 7.24 mg/l, 12.06 mg/l and 31.67 mg/l respectively. The Mid station also exceeded the 5.0 mg/l level during June and August with values of 5.69 mg/l and 8.04 mg/l respectively. AGPT values for all other stations and months monitored remained below the maximum 5.0 mg/l suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes

Chlorophyll *a*. Mean chlorophyll *a* concentrations were relatively high at all Walter F. George sites compared to other Chattahoochee basin locations (Figure I. 2)**.**

During April, the monthly chlorophyll *a* concentration exceeded 30ug/l at lower reservoir (Figure I. 20). Chlorophyll *a* remained near 15ug/l for other locations with the exception of Cowikee Creek in June which was two times higher than any other station.

Lake mean chlorophyll *a* concentration changed little for W.F. George Reservoir (Figure I. 20)**.** Mean discharge was highest in June and slowly declined for the remainder of the sampling season**.** There was no apparent relation between mean discharge and lake mean chlorophyll *a* concentration.

Total Suspended Solids. Mean TSS concentrations for Walter F. George reservoir were slightly higher than other Chattahoochee basin reservoirs (Figure I. 2). Concentrations ranged between 8 – 10 mg/l for all stations except mid reservoir.

Monthly TSS concentrations were similar for most locations on W.F. George reservoir (Figure I. 20). A sharp decline was observed for mid reservoir during June. Highest TSS concentrations were observed at upper reservoir during July. Higher concentrations were also exhibited at Barbour Creek for September and October.

Lake mean TSS concentration was approximately 10 mg/l for April – May and decreased sharply during June (Figure I. 20). In August, TSS returned to approximately 10 mg/l and declined slowly the remainder of the sampling season. Mean discharge was highest in June and slowly declined for the remainder of the sampling season. In general, lake mean TSS concentration decreased during months of higher discharge, and TSS increased as discharge decreased.

Trophic State. Monthly TSI values for Walter F. George reservoir remained in the eutrophic range with the exception of lower reservoir during October (Figure I. 24). TSI values at lower reservoir dropped to the mesotrophic range for October. The highest TSI value was observed at Cowikee Creek location during June.

Dissolved Oxygen/Temperature. Similar trends for dissolved oxygen concentrations were observed for W. F. George stations April – October (Figure I. 24). DO remained stable April – July, decreased in August, and recovered September – October. DO concentrations were above the criterion limit of 5.0 mg/L on all dates sampled. However, values measured in August in the lower and mid reservoir were only slightly above 5.0 mg/l.

Depth profiles of temperature at upper W.F. George indicated weak thermal stratification near the surface May – October (Figure I. 25). Highest water column temperatures were observed during July and August. Depth profiles of oxygen also indicated weak chemoclines near the surface for May – October.

Depth profiles of temperature at Cowikee Creek location indicated weak thermoclines near the surface for each month of the sampling season (Figure I. 26). Highest water temperatures were observed during August. Depth profiles of oxygen also indicated weak chemoclines near the surface April – October. Deoxygenation occurred beneath the hypolimneon May – August.

Depth profiles of temperature at mid reservoir indicated weak thermoclines near the surface April – July (Figure I. 27). Highest water temperatures were observed during August. Depth profiles of dissolved oxygen indicated chemical stratification April – July. Essentially isothermal and isochemical conditions existed August – October.

Depth profiles of temperature at Barbour Creek location indicated weak thermoclines in the first half of the water column for April – October (Figure I. 28). Highest water temperatures were observed during August. Depth profiles of dissolved oxygen indicated chemical stratification also in the first half of the water column during April – October.

The Chaneyhatchee Creek location showed weak thermoclines near the surface April –September (Figure I. 29) and the highest water temperatures during August. Depth profiles of dissolved oxygen also indicated chemical stratification near the surface April –September.

Temperature and DO profiles at lower reservoir indicated thermal stratification above 10 meters for April – July (Figure I. 30) and chemical stratification above 10 meters for April – September. Highest water temperatures were observed during August.

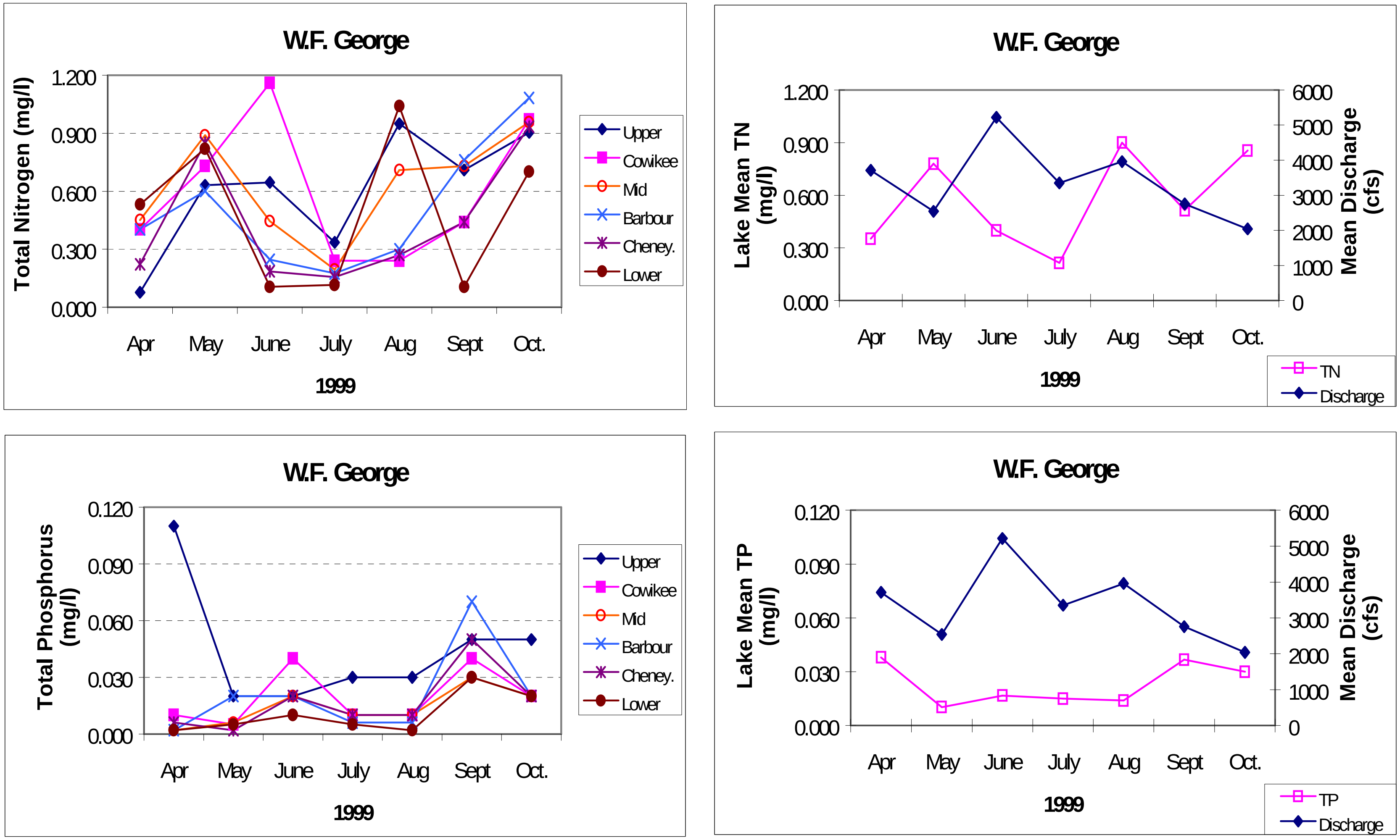


Figure I. 19. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of W.F. George Reservoir, April-October 1999.

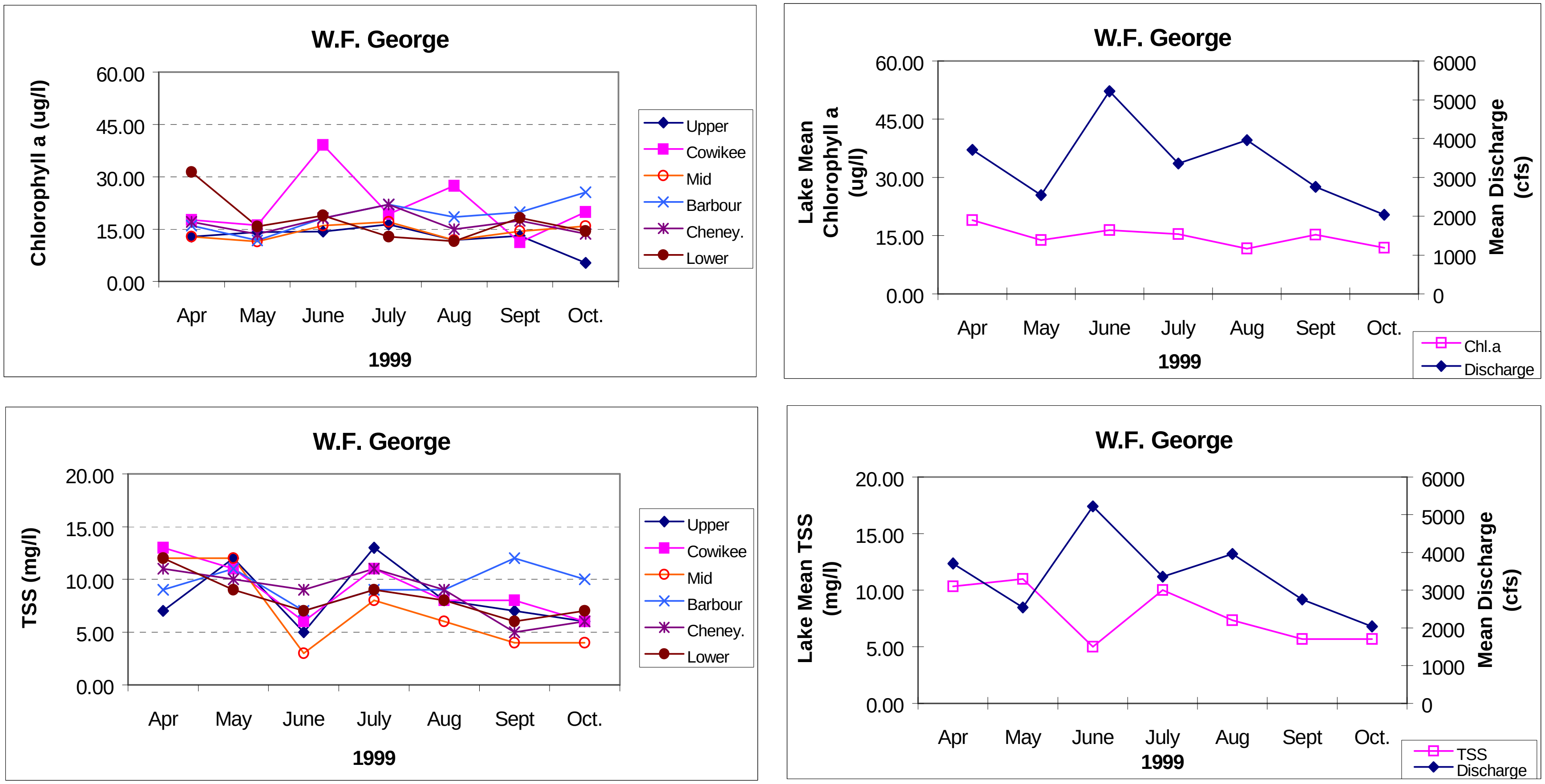


Figure I. 20. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, total suspended solids (TSS), and TSS vs. discharge of W.F. George Reservoir, April-October 1999.

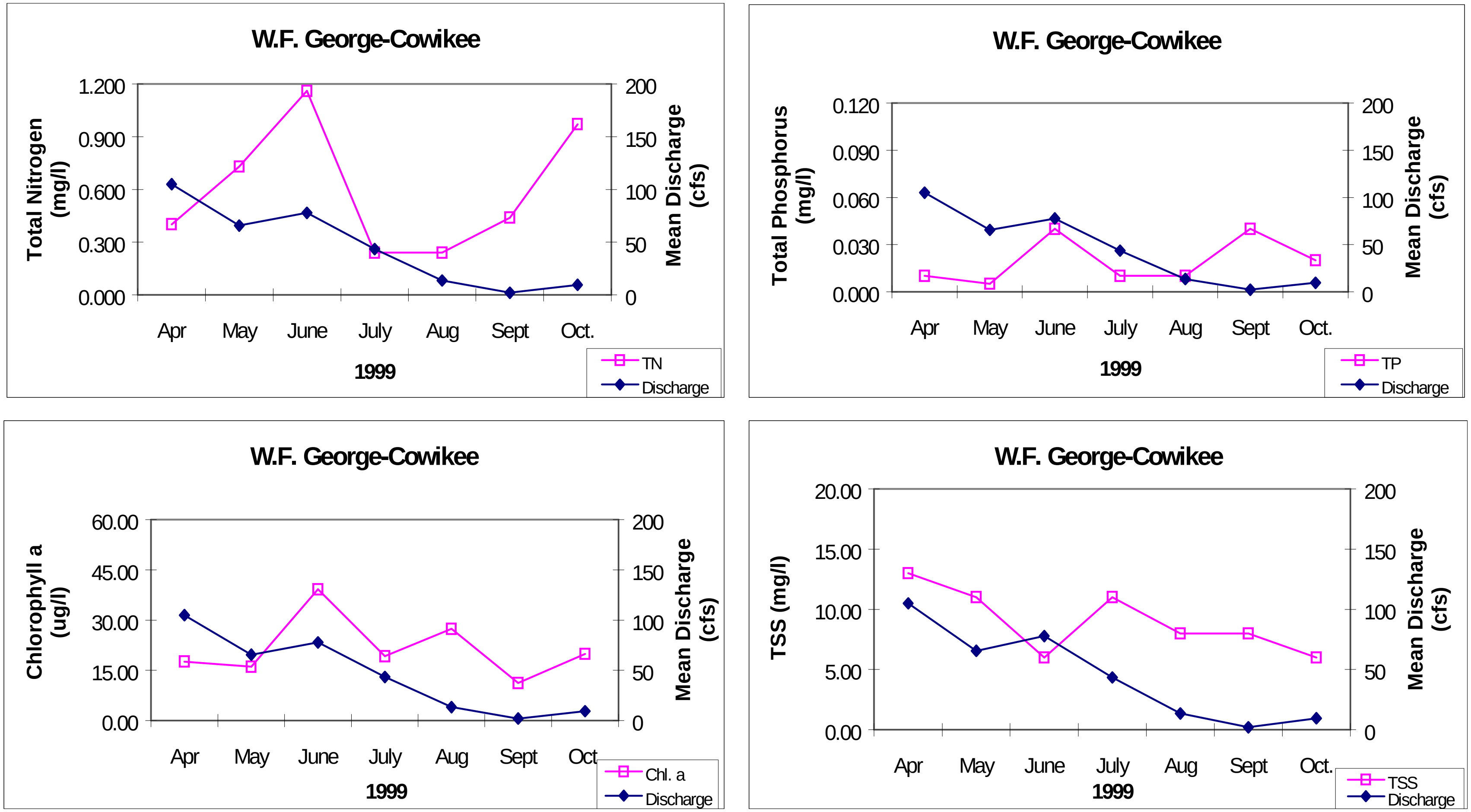


Figure I. 21. Total nitrogen (TN) vs. discharge, total phosphorus (TP) vs. discharge, chlorophyll *a* vs. discharge, and total suspended solids (TSS) vs. discharge of the Cowikee Creek embayment of W.F. George Reservoir, April-October 1999.

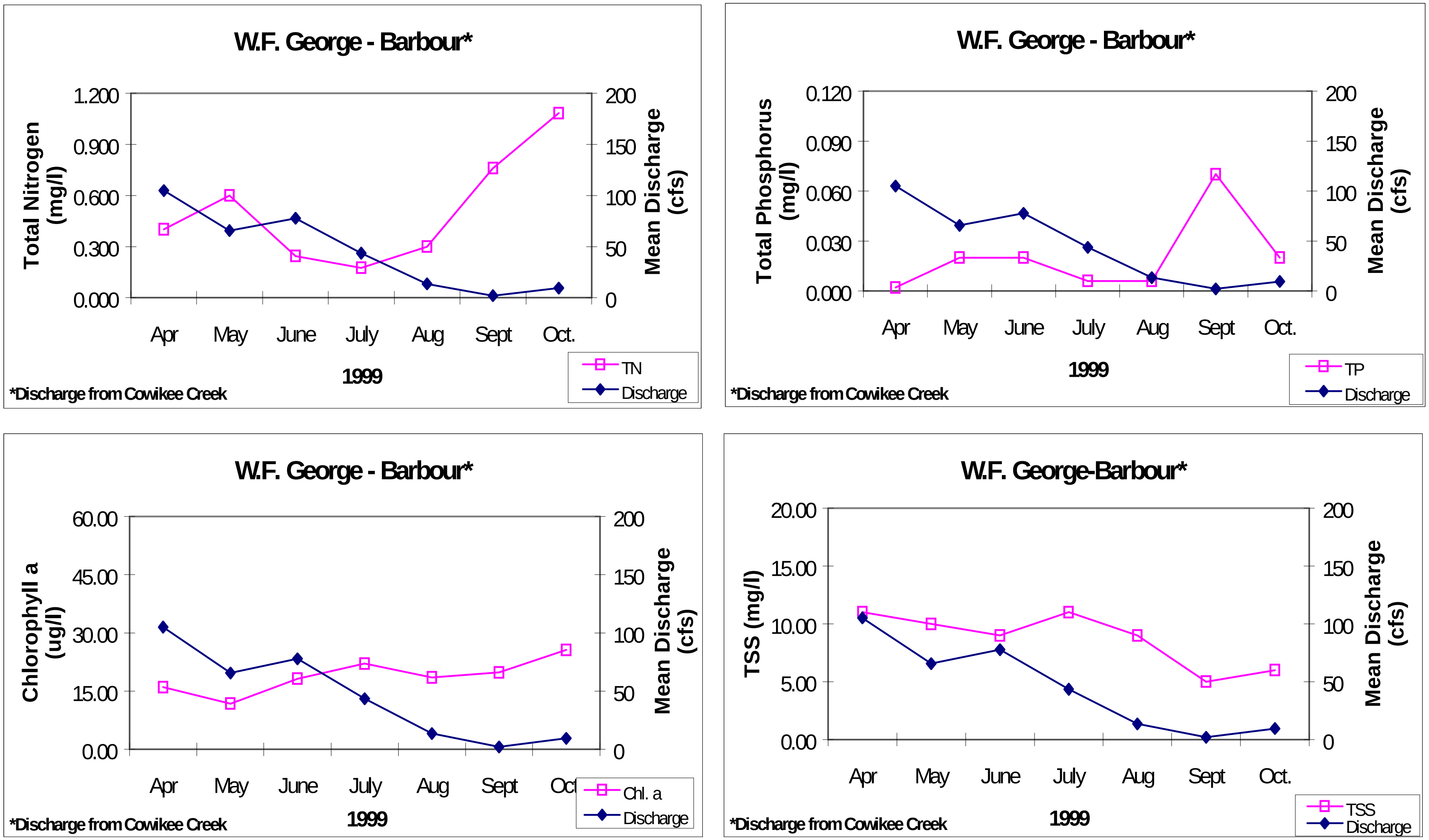


Figure I. 22. Total nitrogen (TN) vs. discharge, total phosphorus (TP) vs. discharge, chlorophyll *a* vs. discharge, and total suspended solids (TSS) vs. discharge of the Barbour Creek embayment of W.F. George Reservoir, April-October 1999.

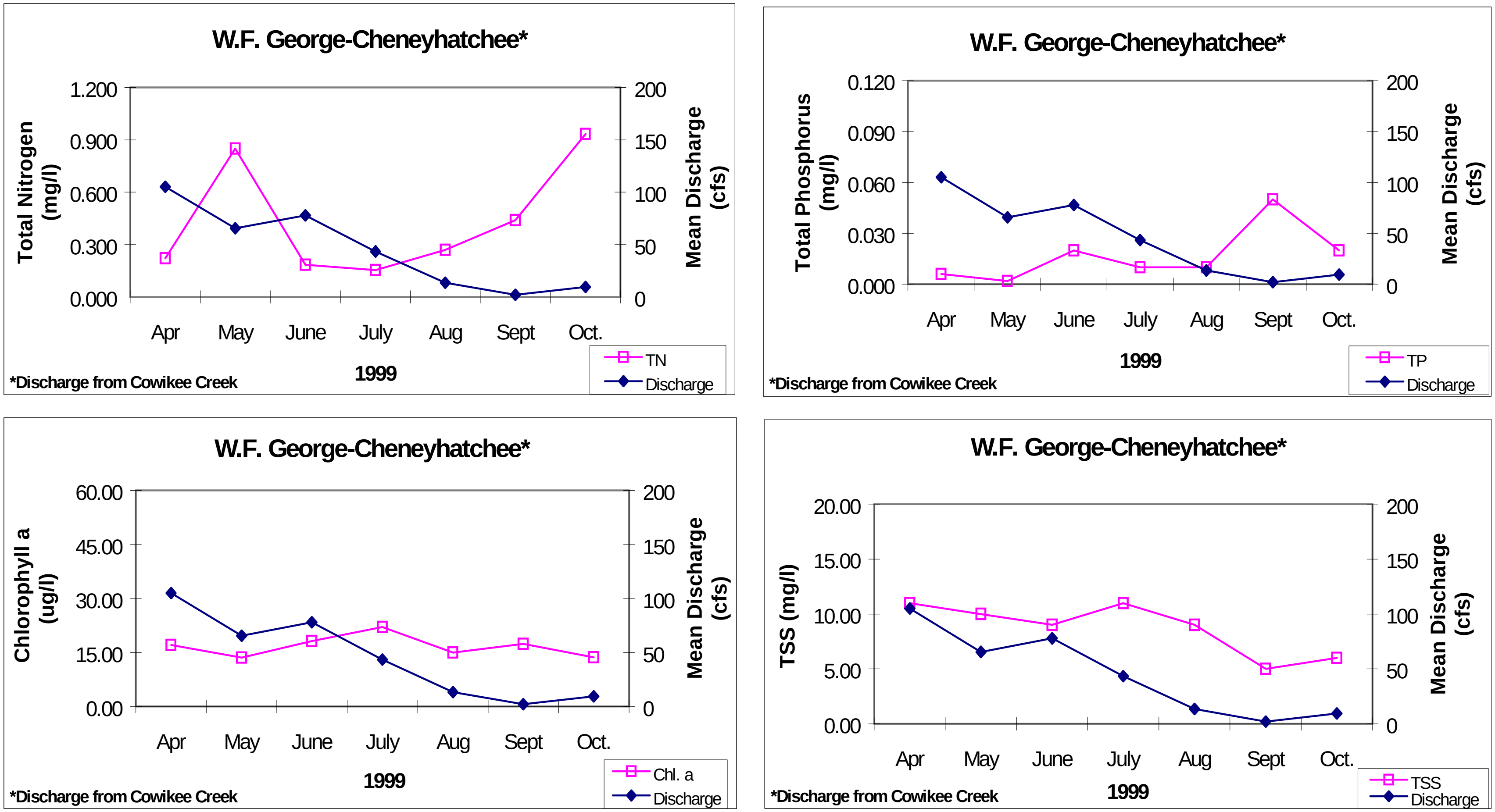


Figure I. 23. Total nitrogen vs. discharge, total phosphorus vs. discharge, chlorophyll *a* vs. discharge and TSS vs. discharge of the Cheneyhatchee Creek embayment of W.F. George Reservoir, April-October 1999.

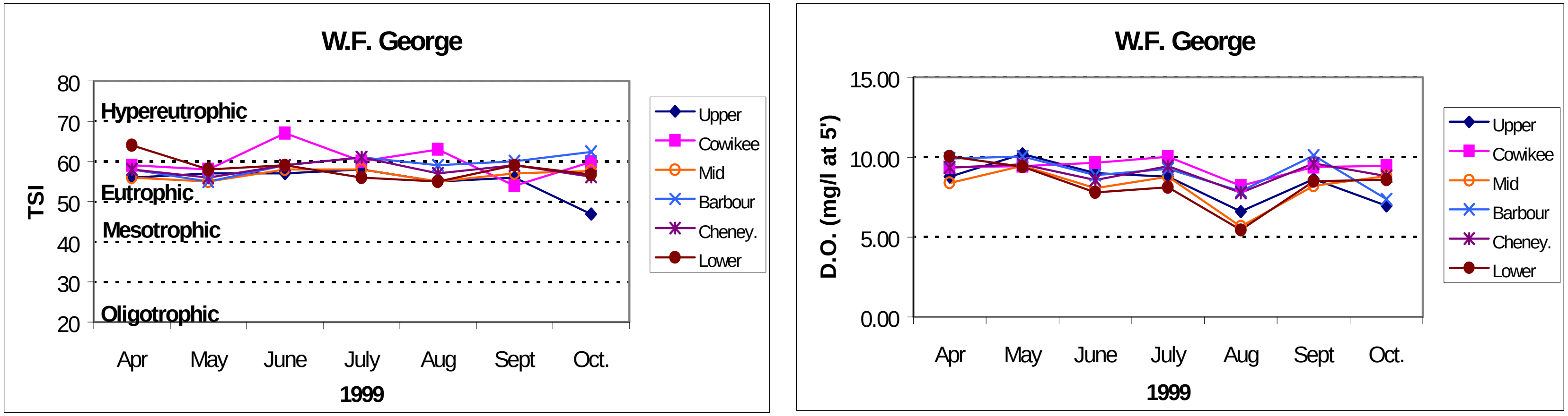


Figure I. 24. Trophic state index (TSI), and dissolved oxygen (DO) of W. F. George Reservoir, April-October 1999.

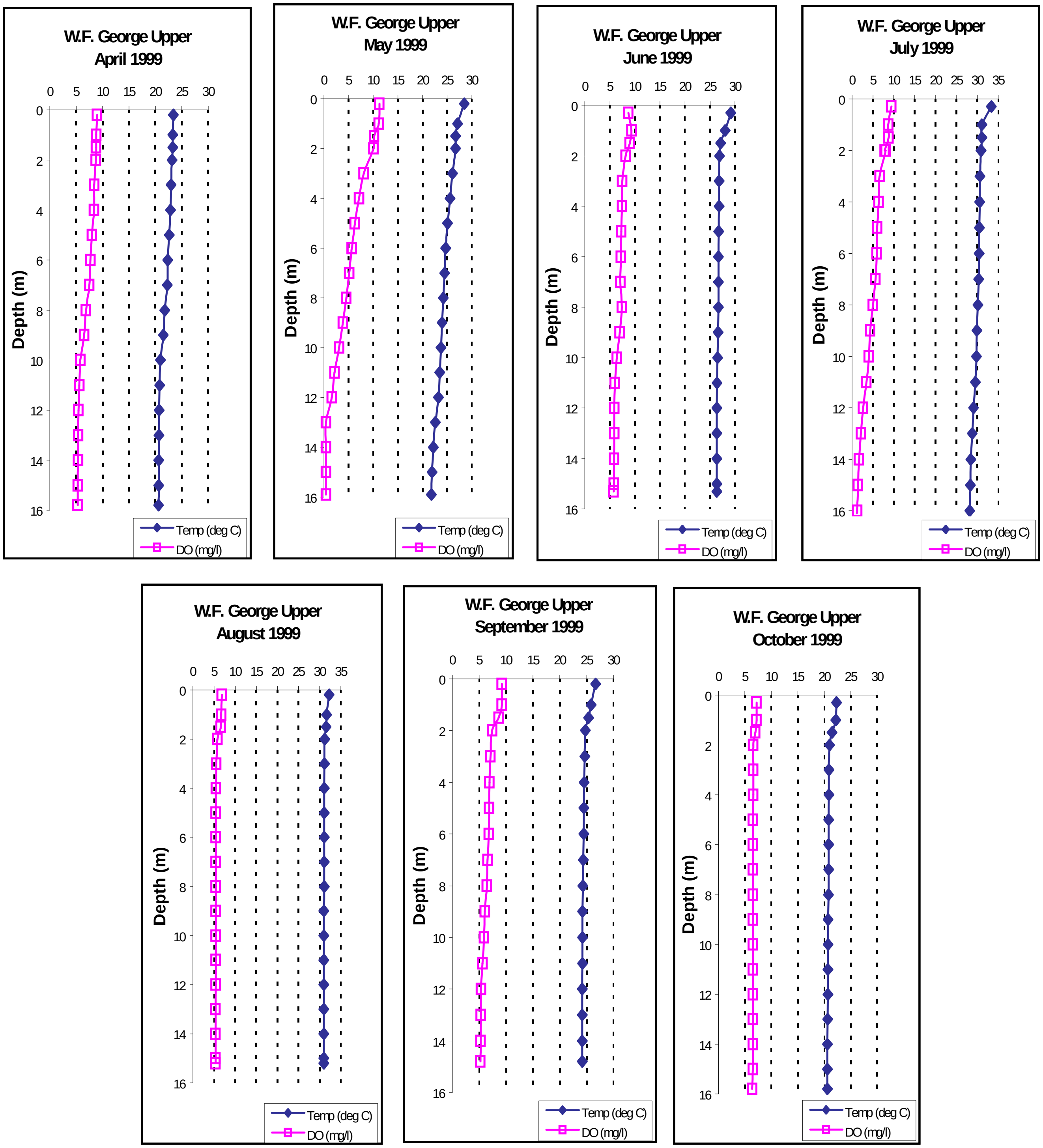


Figure I. 25. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at upper W.F. George Reservoir, April-October 1999.

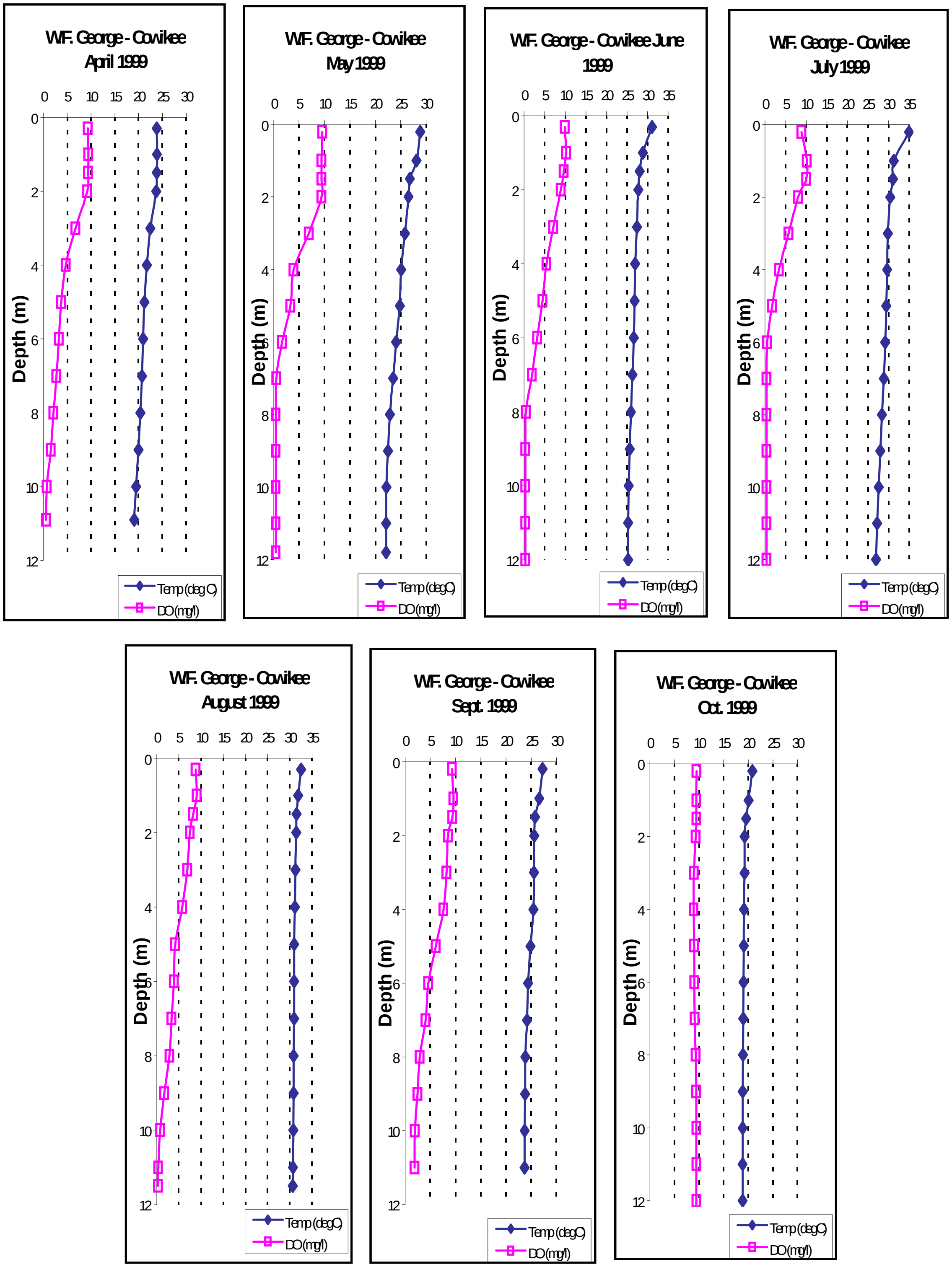


Figure I. 26. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the Cowikee Creek embayment of W.F. George Reservoir, April-October 1999.

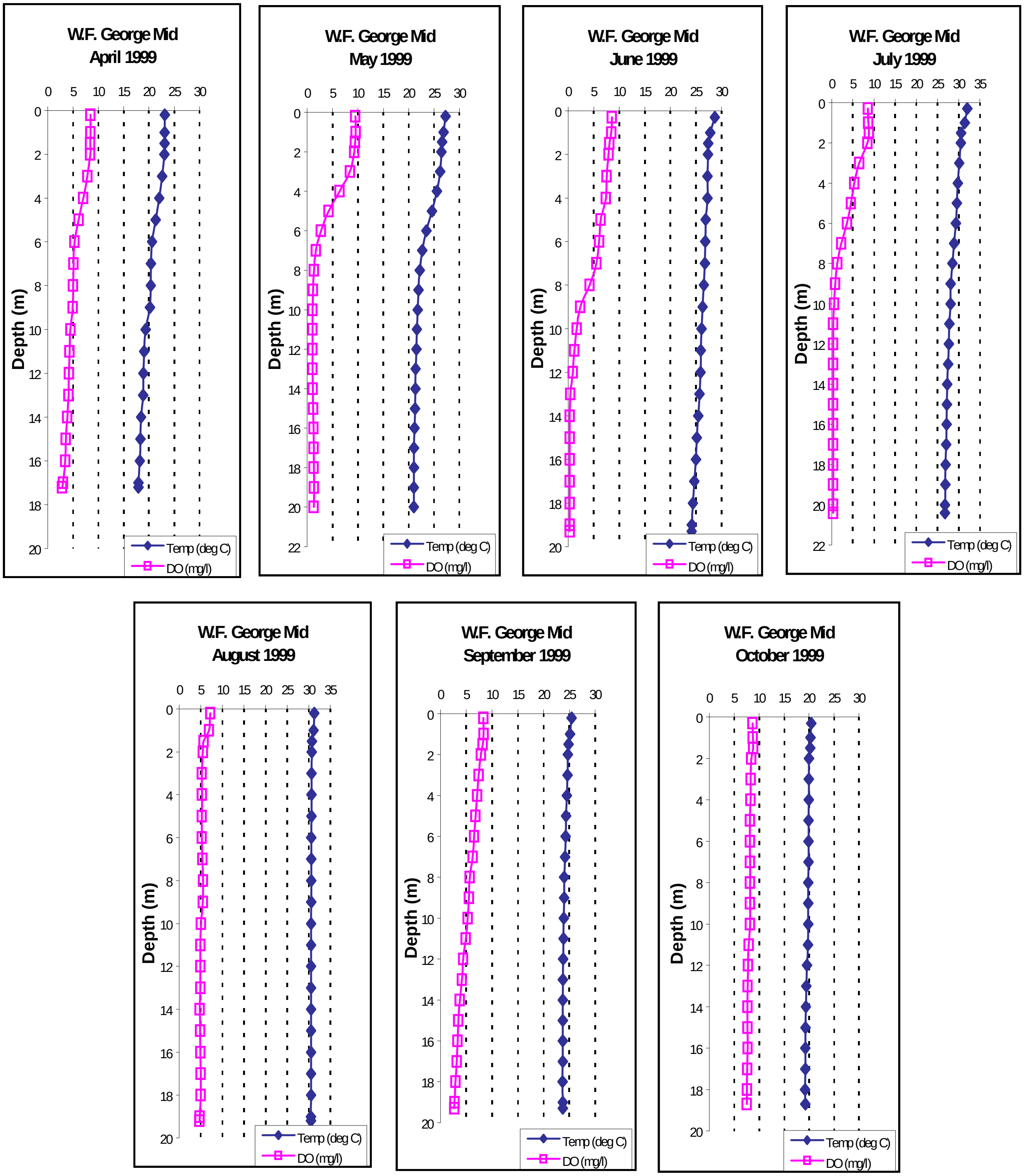


Figure I. 27. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at mid W.F. George Reservoir, April-October 1999.

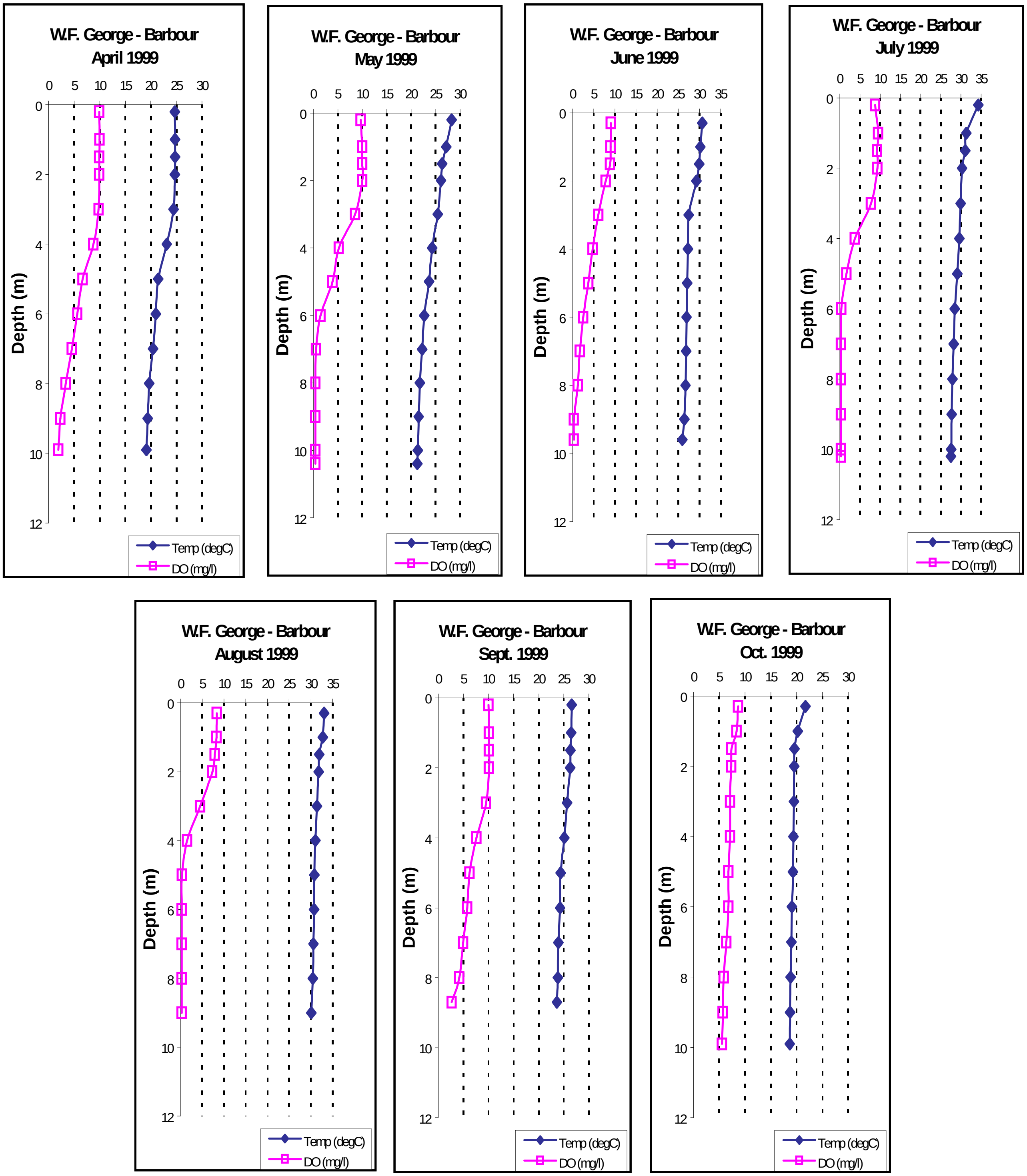


Figure I. 28. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the Barbour Creek embayment of W.F. George Reservoir, April-October 1999.

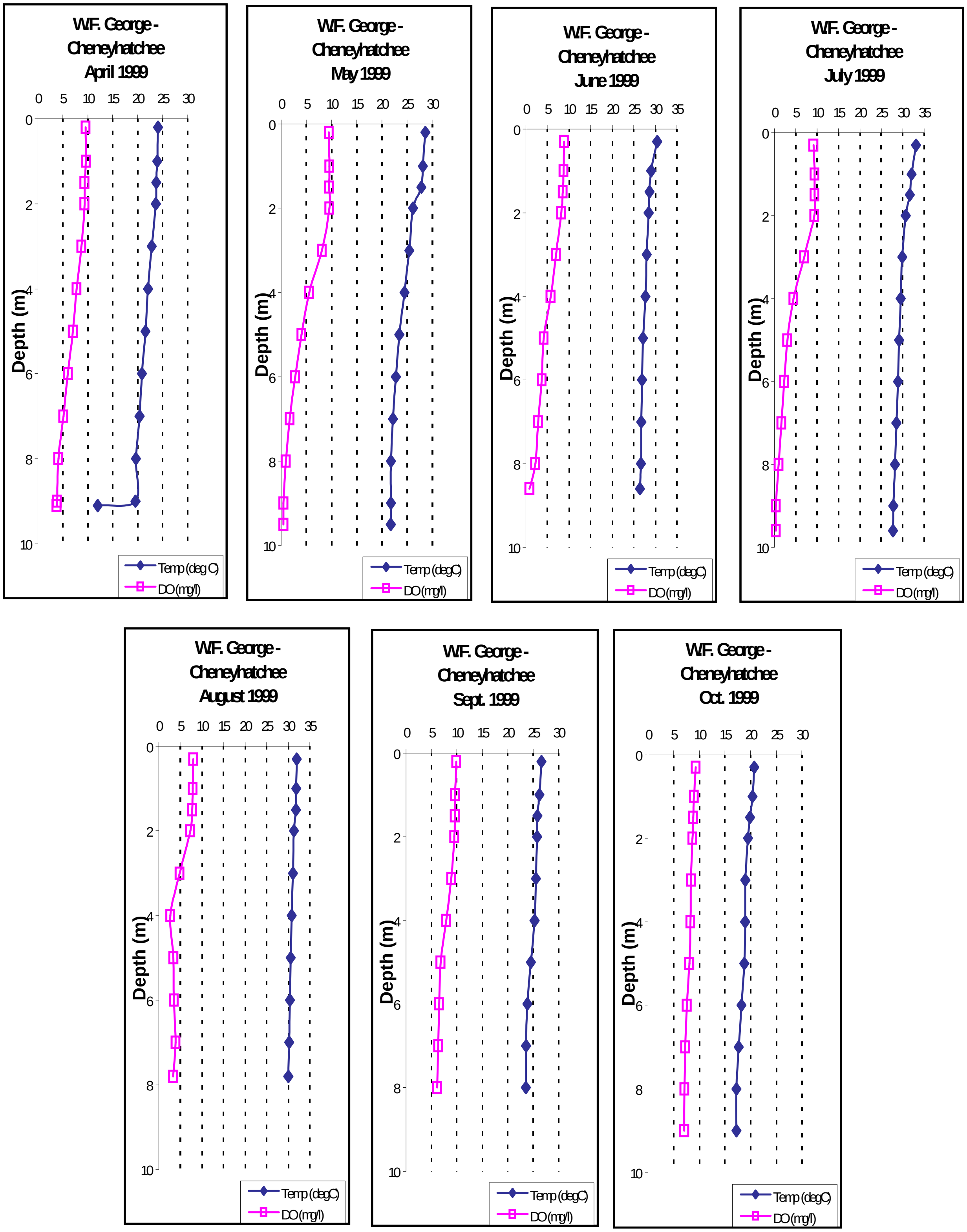


Figure I. 29. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the Cheneyhatchee Creek embayment of W.F. George Reservoir, April-October 1999.

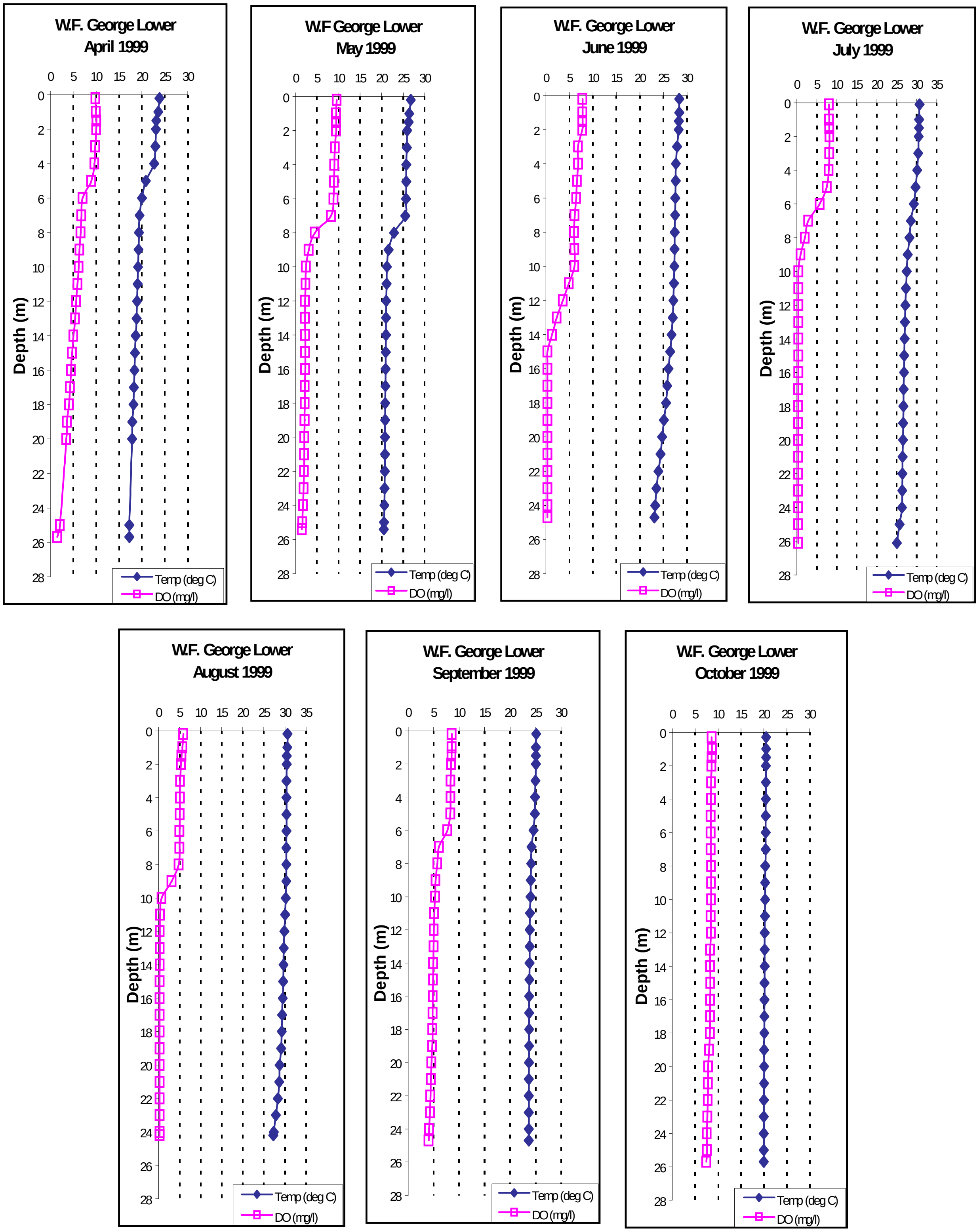


Figure I. 30. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at the lower W.F. George Reservoir station, April-October 1999.

II. Conecuh Basin Reservoirs and Lake Jackson

Gantt Reservoir

Nitrogen. Mean TN concentration in mid Gantt Reservoir was higher than any other Conecuh Reservoir location (Figure II. 1).

Monthly TN concentrations were similar in both the mid and lower reservoir locations except June (Figure II. 3). In the mid reservoir, mean TN concentration increased sharply in June and declined in July. Mean TN concentrations in the lower reservoir remained relatively constant throughout the sampling period.

The lake mean TN concentration in Gantt Reservoir also peaked during the month of June (Figure II. 3). Mean lake discharge approximately doubled from June to July and decreased sharply in August.

Phosphorus. Mean TP concentrations were highest in the mid reservoir of any Conecuh basin locations (Figure II. 1).

Monthly TP concentrations varied little April – October, except in the mid reservoir (Figure II. 3). During April and September mean TP was approximately 4 times higher in mid reservoir.

Lake mean TP concentrations generally declined April-August as mean discharge increased April- June (Figure II. 3). Mean TP increased September – October while mean discharge decreased August – October with the exception of the lower reservoir in August.

Algal Growth Potential Tests. Phosphorus was the limiting nutrient in the reservoir during the months sampled (Table II. 1). When sampled in August the lower reservoir was co-limiting. The mean MSC of the mid and lower reservoir locations ranged from 1.95 to 2.95 mg/l, 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*. Mean chlorophyll *a* concentrations were similar to those measured at the lower site on Point A reservoir (Figure II. 2) which were lower than mean chlorophyll *a* concentrations at Lake Jackson and more than 50 % greater than concentrations in Patsaliga Creek. Mean chlorophyll *a* concentrations were slightly higher in the mid reservoir than the lower reservoir.

Monthly chlorophyll *a* concentrations were similar between the mid and lower reservoir locations (Figure II. 4). Monthly concentrations increased April-August and then declined through October.

Lake mean chlorophyll *a* increased April-August, while mean discharge also increased April-July (Figure II. 4). Mean discharge declined sharply from July to August and similarly lake mean chlorophyll *a* declined August-October.

Total Suspended Solids. Mean TSS concentrations in Gantt Reservoir were lower than any other Conecuh Reservoir location (Figure II. 2). Within the reservoir, mean concentrations were slightly higher in the mid reservoir than in the lower reservoir.

Monthly TSS concentrations in the mid reservoir were variable with the highest concentrations occurring in May and July and lowest concentrations occurring in June and September (Figure II. 4). In the lower reservoir monthly TSS concentrations were variable with the highest concentrations occurring in May and July and lowest concentrations occurring in April and September.

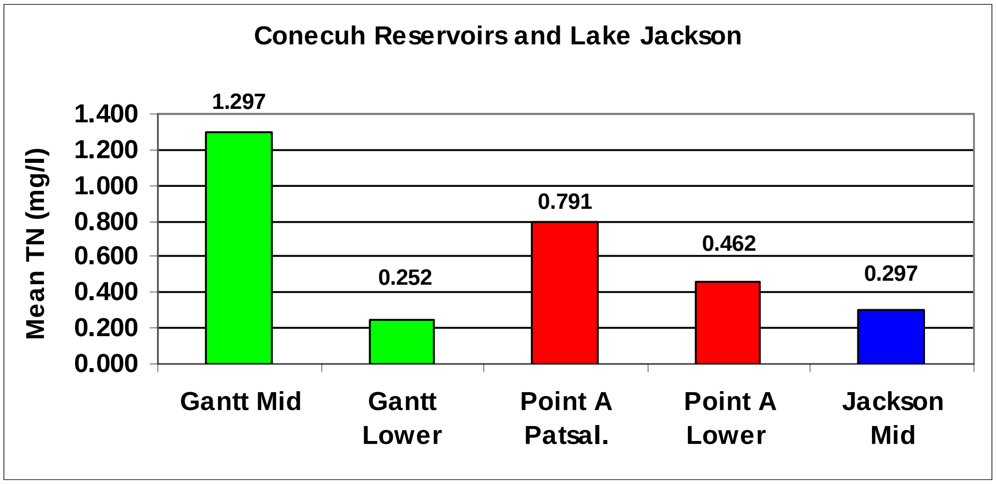
Mean discharge increased April-July, declined drastically from July to August and remained steady August-October (Figure II. 4). Generally, lake mean TSS concentration fluctuated similar to fluctuations in discharge.

Trophic State. TSI values for both reservoir locations were in the mesotrophic range during April-May and September-October (Figure II. 5). During June-August, TSI values increased into the eutrophic range.

Dissolved Oxygen/Temperature. Dissolved oxygen concentrations at both reservoir locations were very similar with the lowest concentrations occurring in July and highest in September (Figure II. 5). DO concentrations were above the criterion limit of 5.0 mg/L on all dates sampled though only slightly above the limit in July.

Depth profiles at the upper station indicated thermal stratification near the surface April-July. Highest water column temperatures occurred in June-August (Figure II. 6). A moderate chemocline existed in May and August, with the remaining months being essentially isochemical. Deoxygenation did not occur.

Depth profiles at the lower station indicated thermoclines near the surface April-July. The highest water column temperatures occurred in July (Figure II. 7). Chemical stratification existed during the months of May - June and August with half of the water column having a dissolved oxygen concentration less than 5 mg/L.



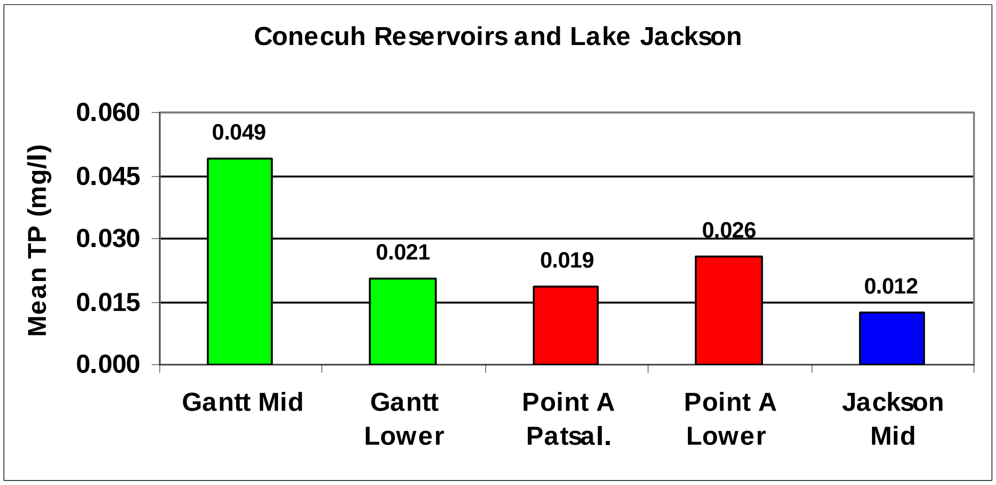
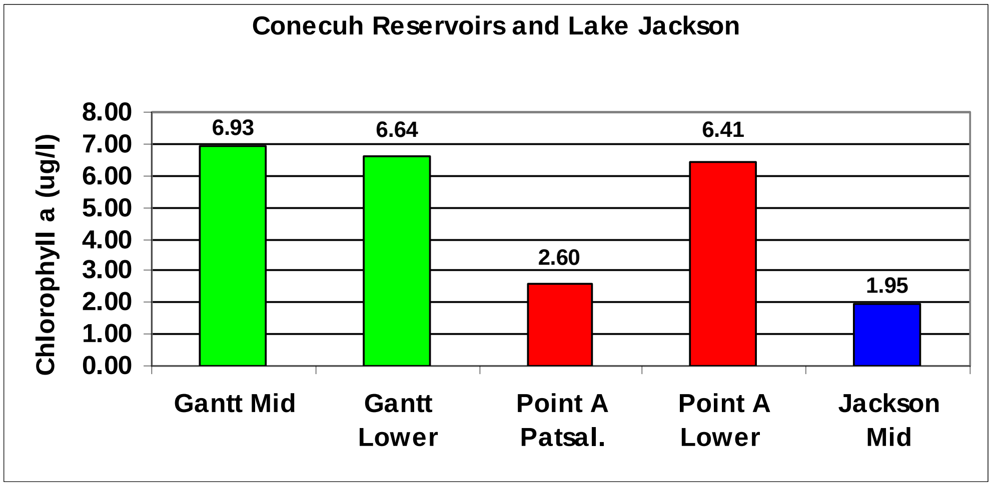


Figure II. 1. Mean total nitrogen (TN) and total phosphorus (TP) concentrations of Conecuh basin reservoirs, April-October 1999.

Table II. 1. Algal Growth Potential Tests (AGPT) of Conecuh River Reservoirs and Lake Jackson, June-August 1999.

Reservoir	Location	Collection Date					
		Jun-99		Jul-99		Aug-99	
		Mean MSC (mg/l)	Limiting Nutrient	Mean MSC (mg/l)	Limiting Nutrient	Mean MSC (mg/l)	Limiting Nutrient
Jackson	Mid-lake	1.52	Phosphorus	2.03	Phosphorus	1.45	None
Point A	Lower	3.04	Phosphorus	2.21	Phosphorus	2.11	Phosphorus
Point A	Patsaliga Creek	3.24	Phosphorus	3.38	Phosphorus	2.43	Phosphorus
Gantt	Lower	2.71	Phosphorus	2.55	Phosphorus	1.95	Co-Limit
Gantt	Mid	2.95	Phosphorus	2.82	Phosphorus	2.01	Phosphorus



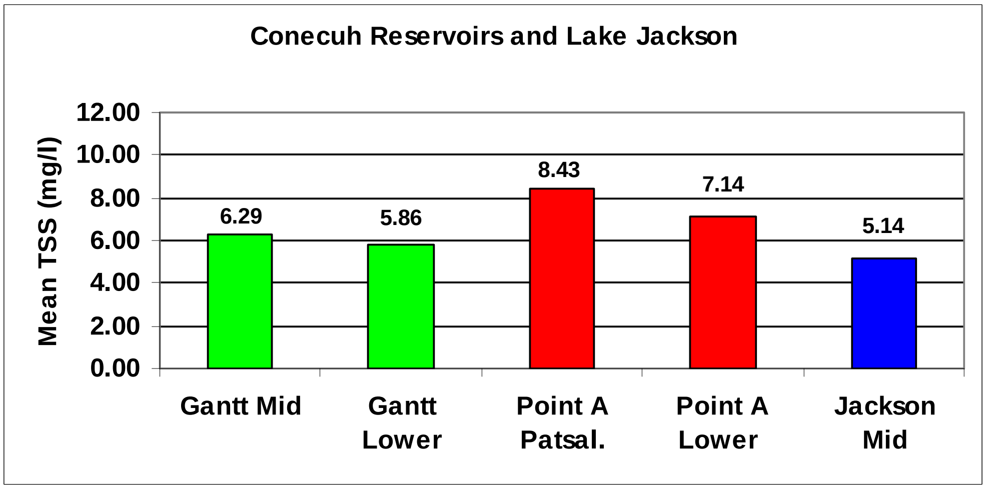


Figure II. 2. Mean chlorophyll *a* and total suspended solids (TSS) concentrations of Conecuh basin reservoirs, April-October 1999.

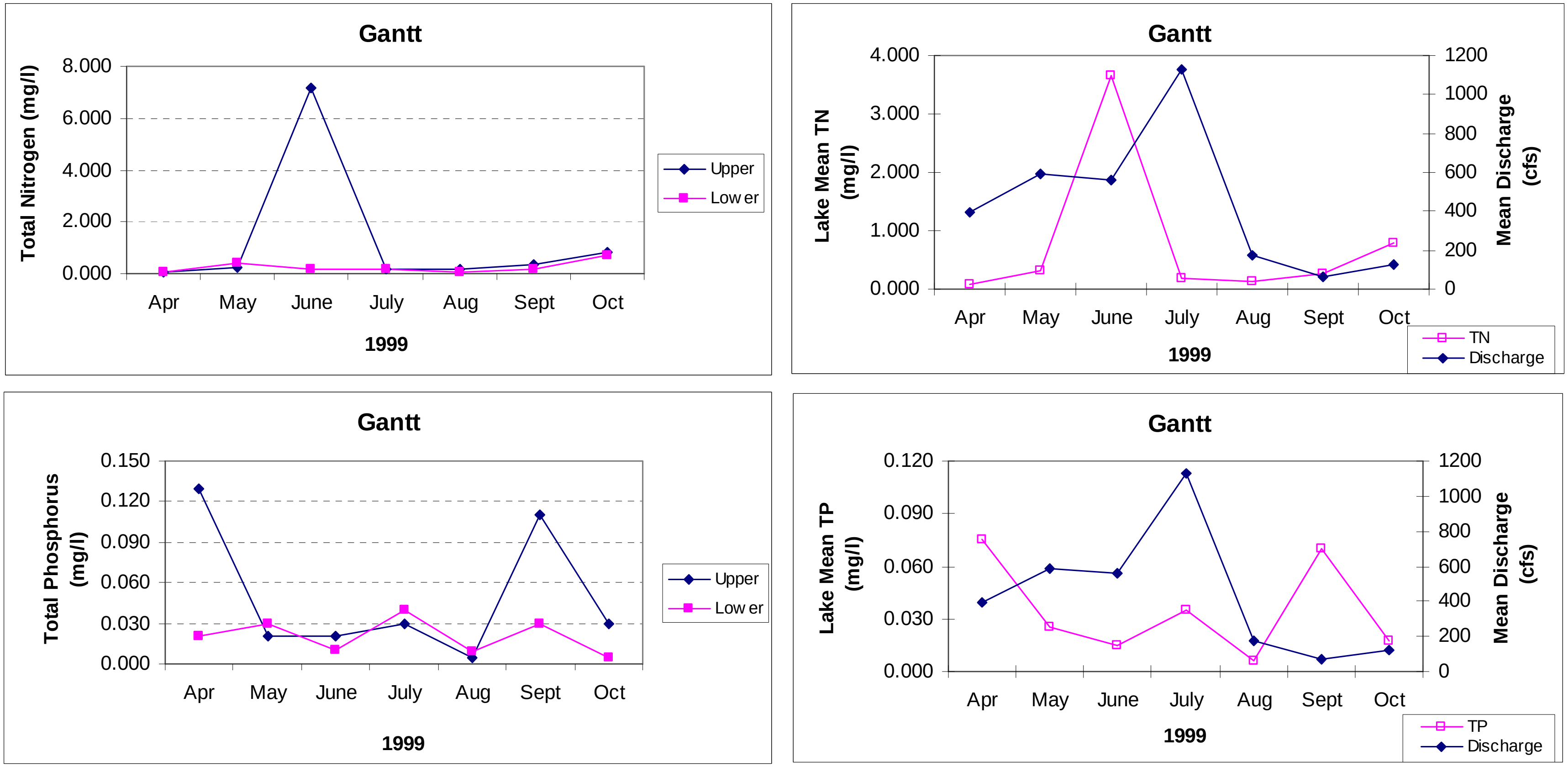


Figure II. 3. Total nitrogen (TN), lake mean TN vs. discharge, total phosphorus (TP), and lake mean TP vs. discharge of Gantt Reservoir, April-October 1999.

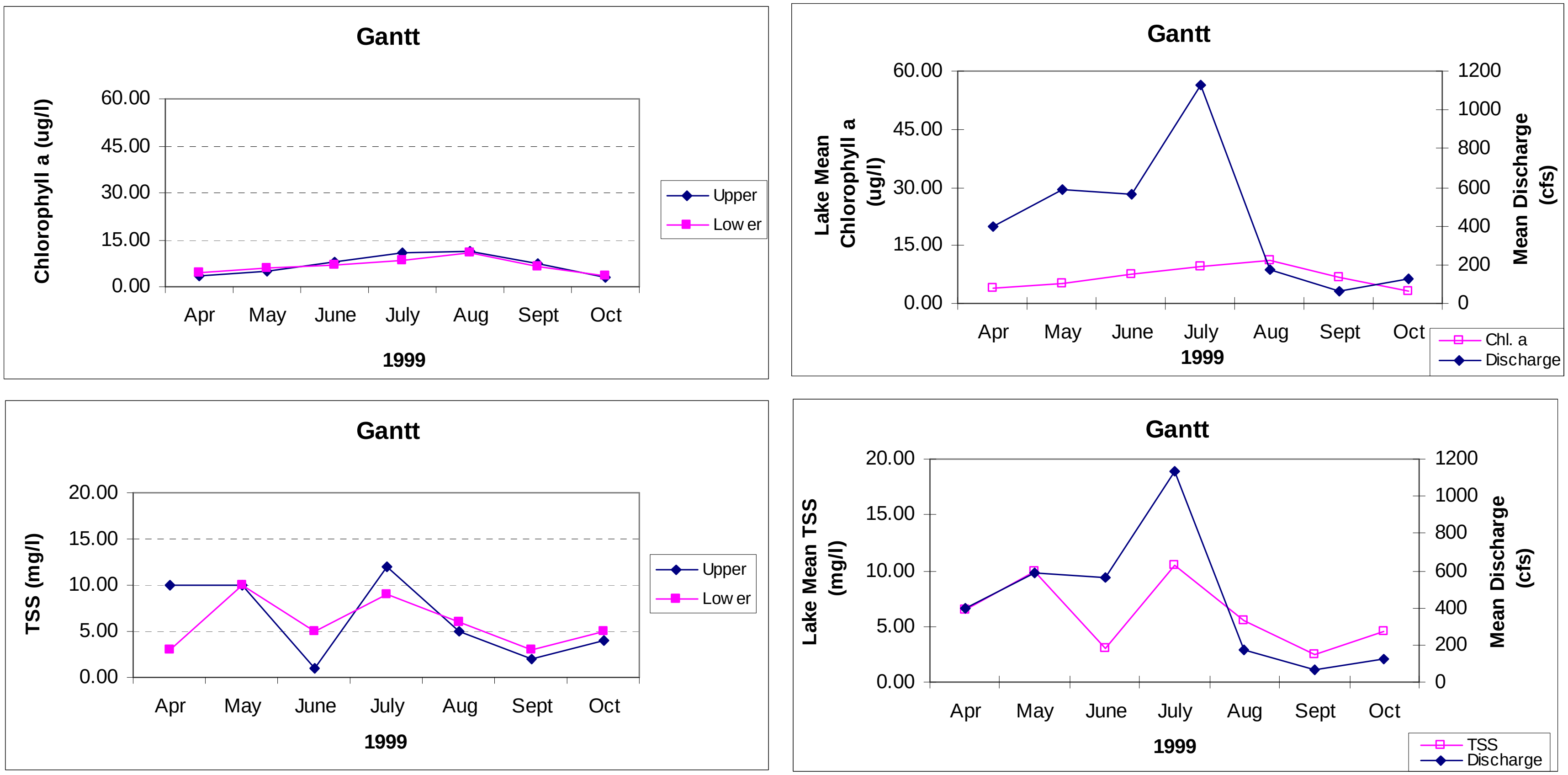


Figure II. 4. Chlorophyll *a*, lake mean chlorophyll *a* vs. discharge, total suspended solids (TSS), and TSS vs. discharge of Gantt Reservoir, April-October 1999.

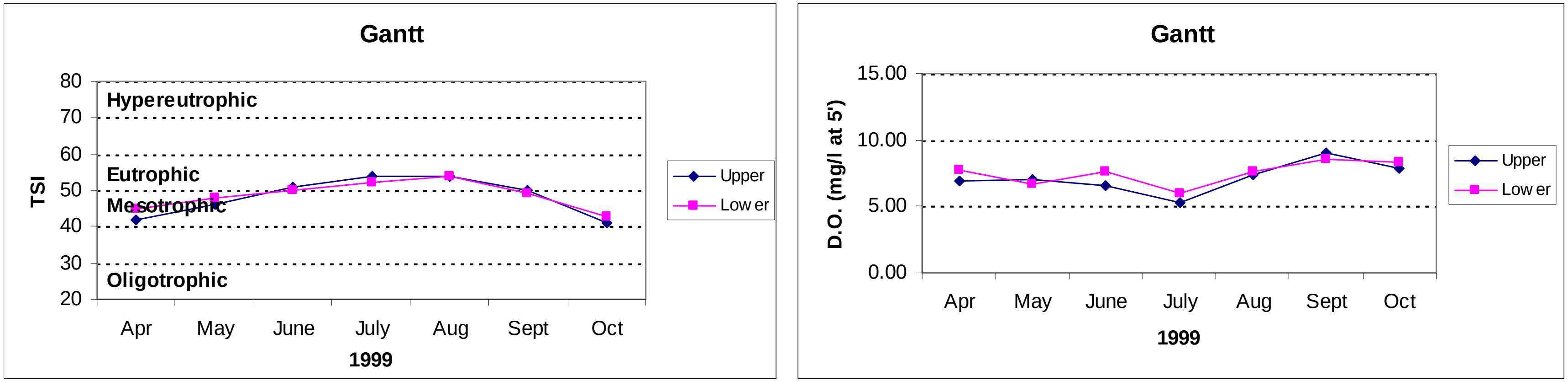


Figure II. 5. Trophic state index (TSI), and dissolved oxygen (DO) of Gantt Reservoir, April-October 1999.

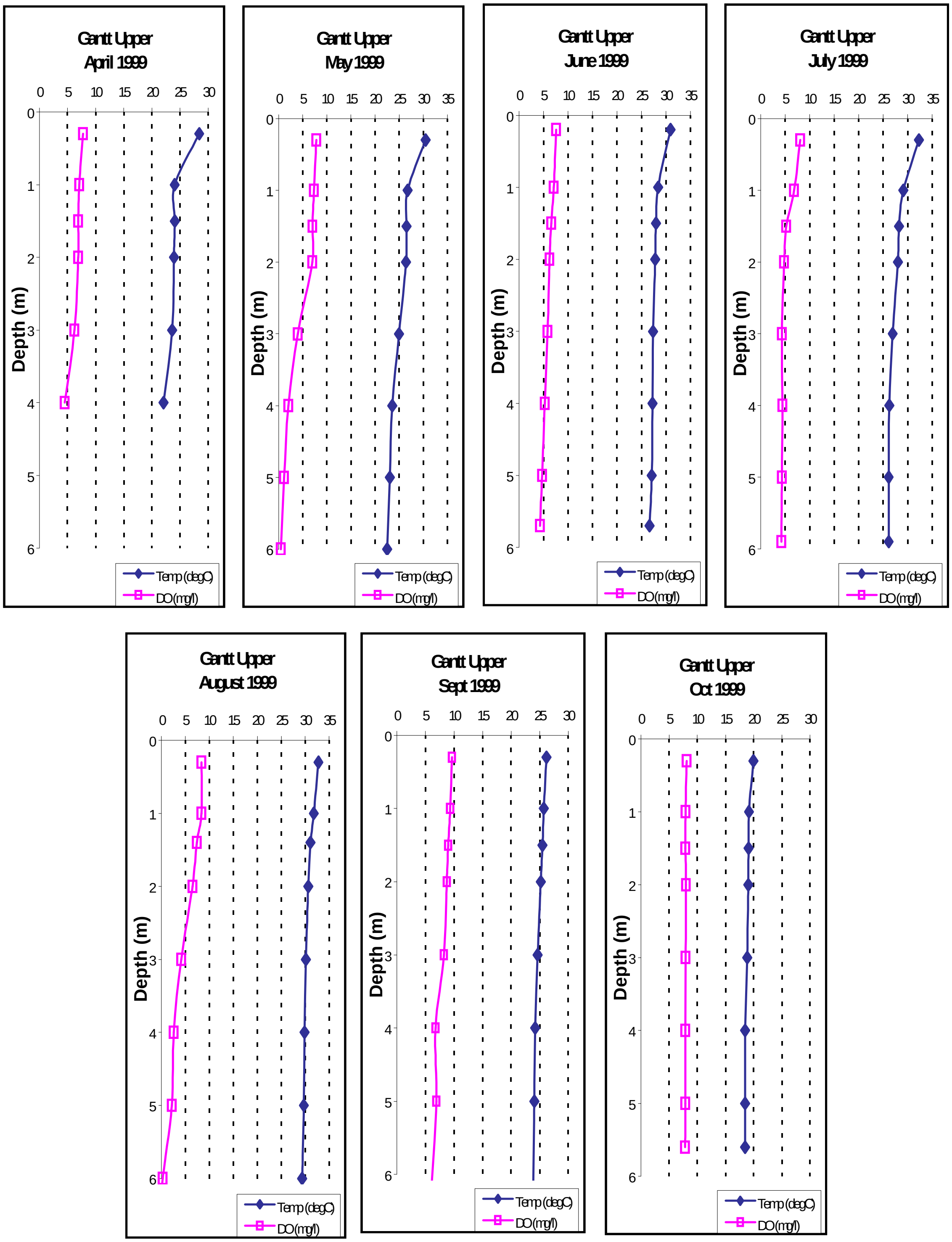


Figure II. 6. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at upper Gantt Reservoir, April-October 1999.

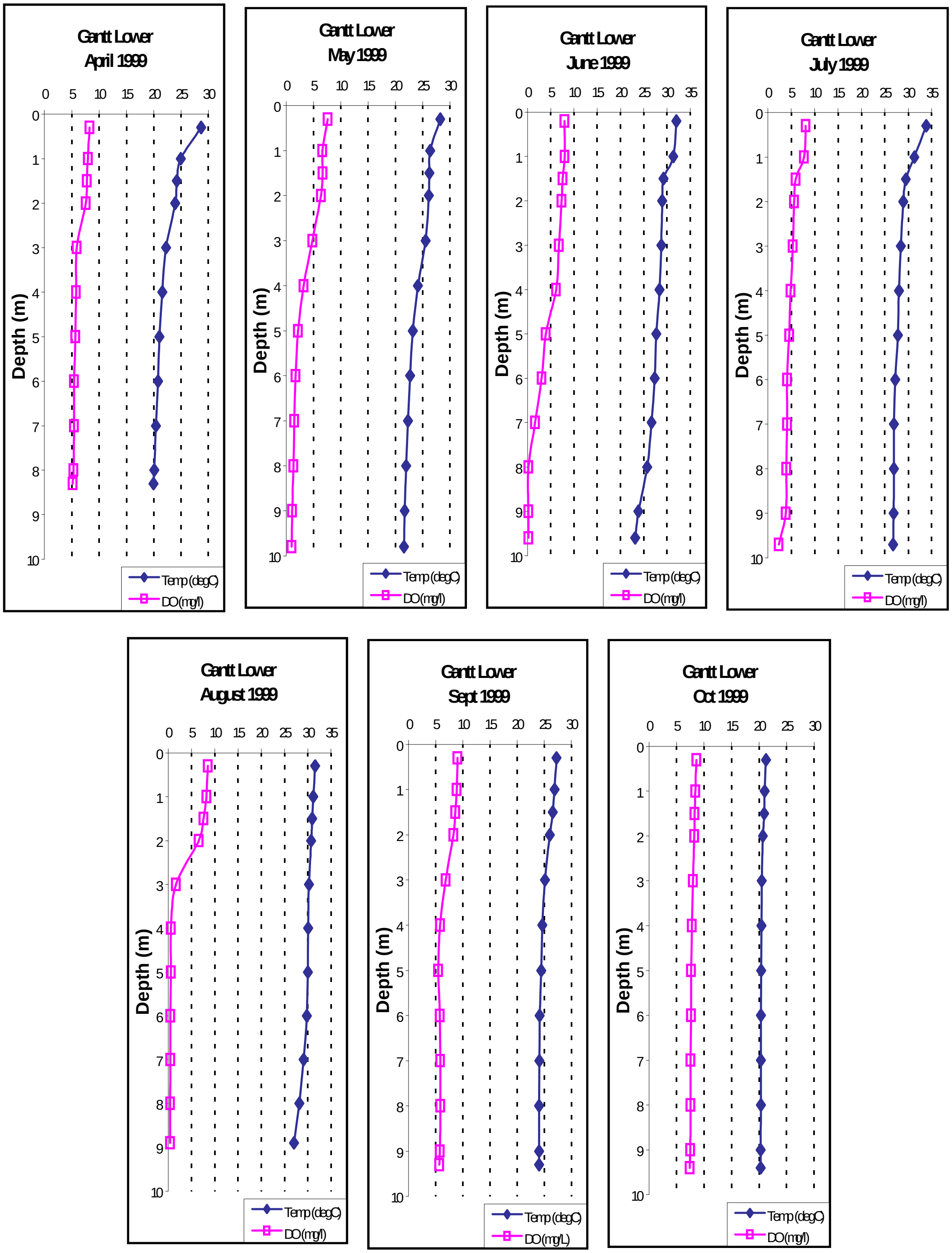


Figure II. 7. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at lower Gantt Reservoir, April-October 1999.

Point A Reservoir

Nitrogen. Mean TN concentration at the lower station on Point A Reservoir was the second lowest of the Conecuh basin locations (Figure II. 1). However, mean TN concentration measured at the location on Patsaliga Creek was the second highest of the Conecuh basin locations.

Monthly TN concentrations were similar in both the lower reservoir and Patsaliga Creek sites, with the exception of a sharp increase in total nitrogen in June at the Patsaliga Creek location (Figure II. 8). There was no evident relationship between discharge and total nitrogen at either of the lower or Patsaliga Creek sites. Mean discharge at both sites increased April-July, declined sharply in August and remained relatively constant September-October.

Phosphorus. Mean TP concentration at Patsaliga Creek was the lowest of all Conecuh basin locations (Figure II. 1). However, the mean TP concentration at the lower Point A site was the second highest of Conecuh basin locations.

Monthly TP concentrations at the lower reservoir site were slightly higher June-September than TP concentrations measured at Patsaliga Creek (Figure II. 9). Total phosphorus concentrations more than doubled during September at both locations. TP concentration and mean lake discharge did not exhibit any relationship.

Algal Growth Potential Tests. Phosphorus was the limiting nutrient June-August at the lower and Patsaliga Creek locations (Table II. 1). The mean MSC ranged from 2.11 to 3.38 mg/l, the highest of any Conecuh basin location but well below the maximum 5.0 mg/l suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes.

Chlorophyll *a*. Mean chlorophyll *a* concentration at Patsaliga Creek was less than half the concentration measured at the lower sampling site on Point A as well as other Conecuh basin locations (Figure II. 2).

Monthly chlorophyll *a* concentrations were slightly higher at the lower Point A location than the Patsaliga Creek location (Figure II. 10). Chlorophyll *a* concentration fluctuated monthly at both locations with the highest monthly chlorophyll *a* concentration being measured in July at the lower Point A location. Mean discharge increased from April-July at both locations, then declined sharply to October. Chlorophyll *a* concentration fluctuated very little monthly with no apparent relationship between mean lake discharge and mean chlorophyll *a* concentrations.

Total Suspended Solids. Mean TSS concentration at Patsaliga Creek location was higher than any other Conecuh Reservoir location (Figure II. 2), with lower Point A mean TSS concentration slightly lower.

Monthly TSS concentrations in Patsaliga Creek were variable with the highest concentrations occurring in May and July and lowest concentration occurring in June (Figure II. 11). Lower Point A monthly TSS concentrations were variable with the highest concentrations occurring in July and lowest concentrations occurring in August. Mean discharge increased April-July declined drastically from July to August and remained similar August-October. The highest mean discharge and mean TSS concentration occurred during the month of July.

Trophic State. Monthly TSI values for Patsaliga Creek were in the oligotrophic range during April, May, July and October (Figure II. 12). TSI values increased the to mesotrophic range during June, August and September. TSI values in Lower Point A were higher every month with values in the eutrophic range in April, July and August. Monthly TSI values in lower Point A Reservoir were in the mesotrophic range during May - June and September – October.

Dissolved Oxygen/Temperature. Dissolved oxygen concentrations at both reservoir locations were very similar with the lowest concentrations occurring in August (Figure II. 12). DO concentrations were above the criterion limit of 5.0 mg/l on all dates sampled.

Depth profiles of temperature at Patsaliga Creek indicated weak thermal stratification near the surface April-September. Highest water column temperatures occurred in June-August (Figure II. 13). Depth profiles of oxygen indicate that the water column was essentially isochemical April-July and October. During August and September a weak chemocline developed throughout the water column.

Depth profiles of temperature indicated weak thermoclines April-September in lower Point A. The highest water column temperatures occurred in June-August (Figure II. 14). Weak chemical stratification existed during the months of April-September.

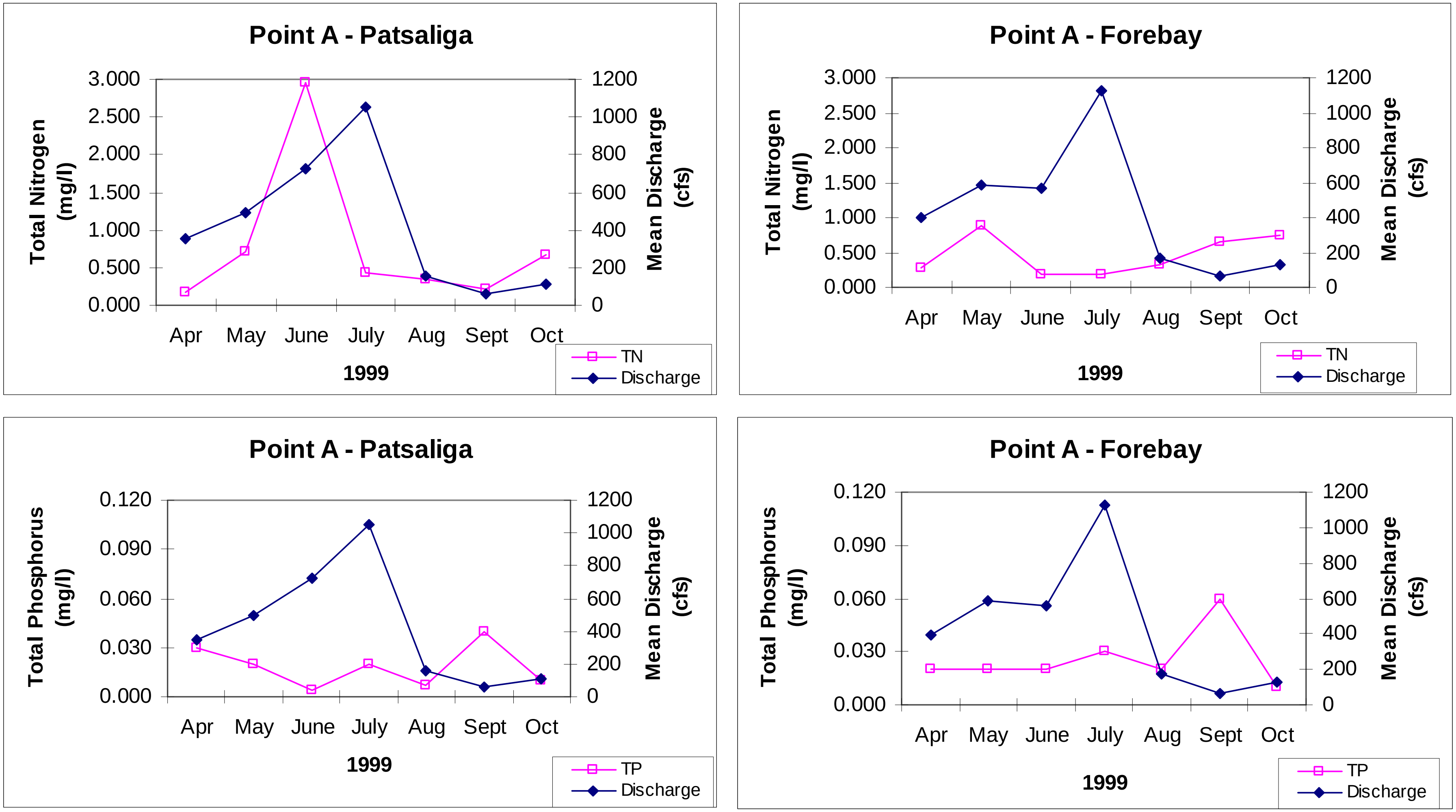


Figure II. 8. Lower Point A TN vs. discharge, Patsaliga Creek embayment TN vs. discharge, lower Point A TP vs. discharge, and Patsaliga Creek embayment TP vs. discharge of Point A Reservoir, April-October 1999.

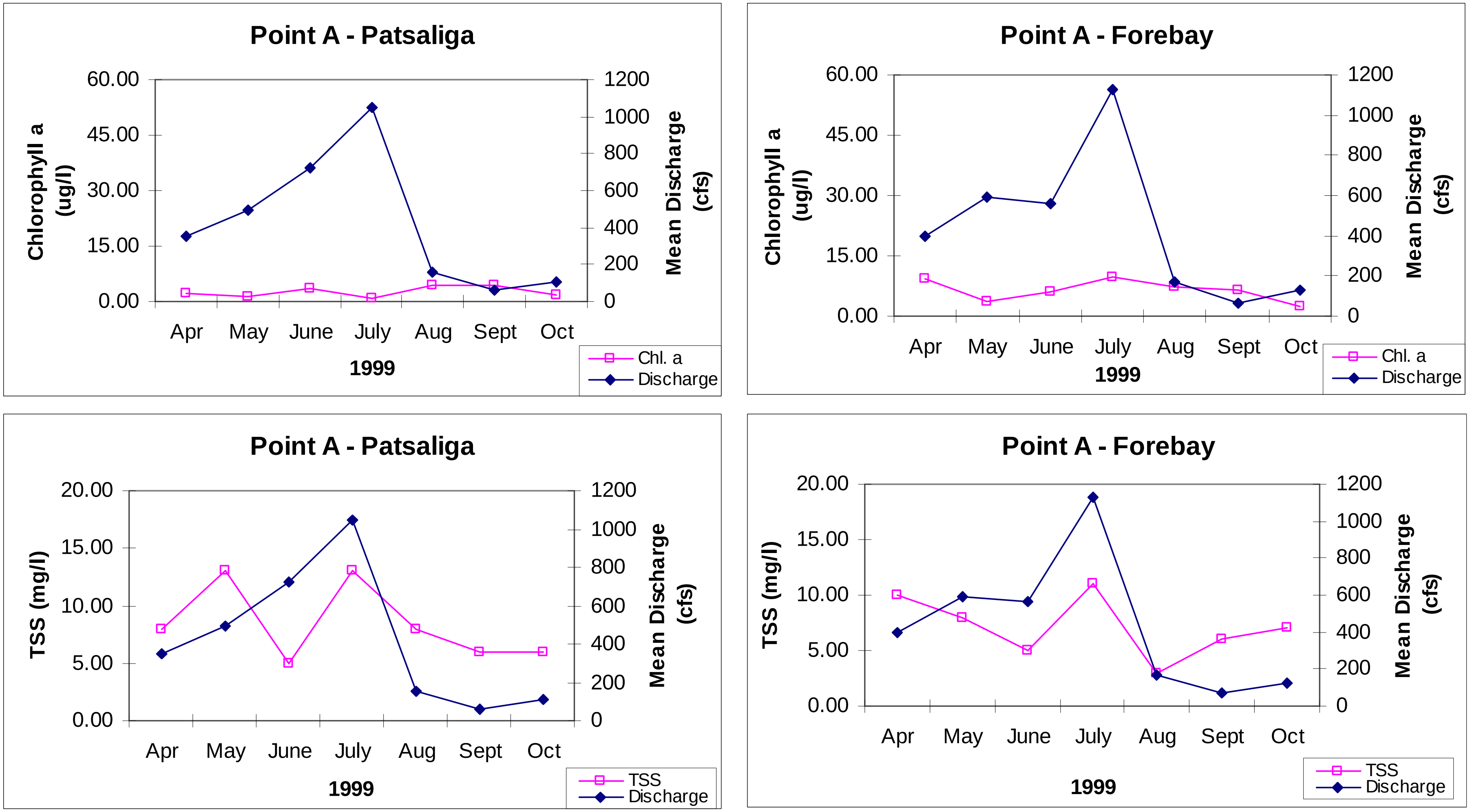


Figure II. 9. Lower Point A chlorophyll *a* vs. discharge, Patsaliga Creek embayment chlorophyll *a* vs. discharge, lower Point A TSS vs. discharge and Patsaliga Creek embayment TSS vs. discharge of Point A Reservoir, April-October 1999.

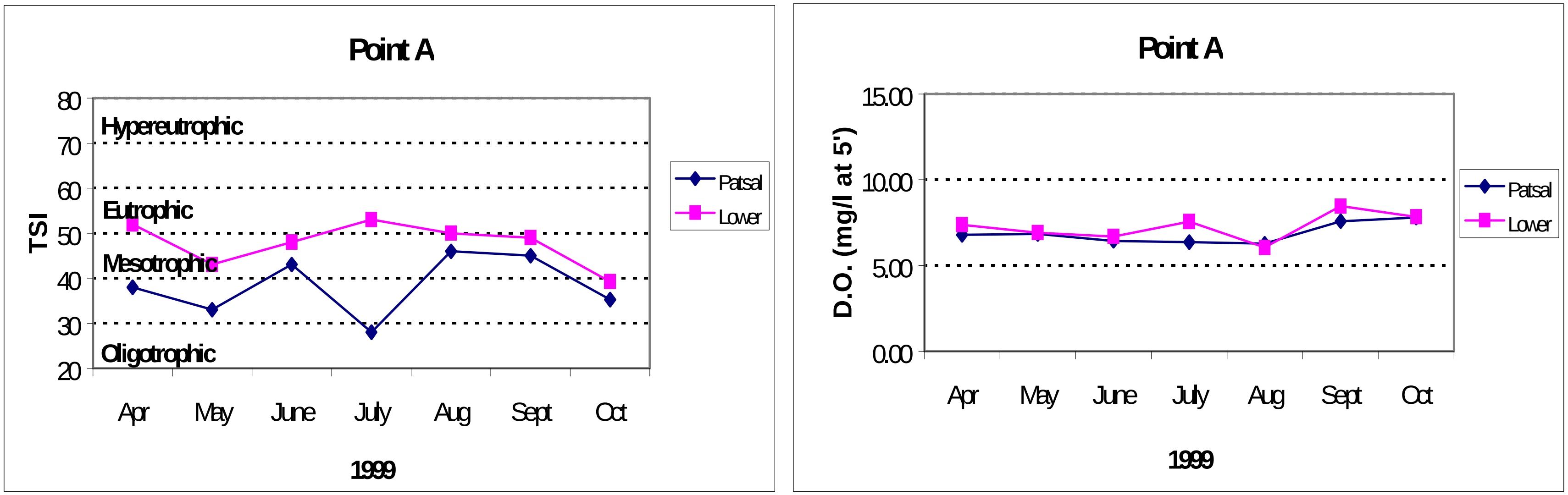


Figure II. 10. Trophic state index (TSI), and dissolved oxygen (DO) of Point A Reservoir, April-October 1999.

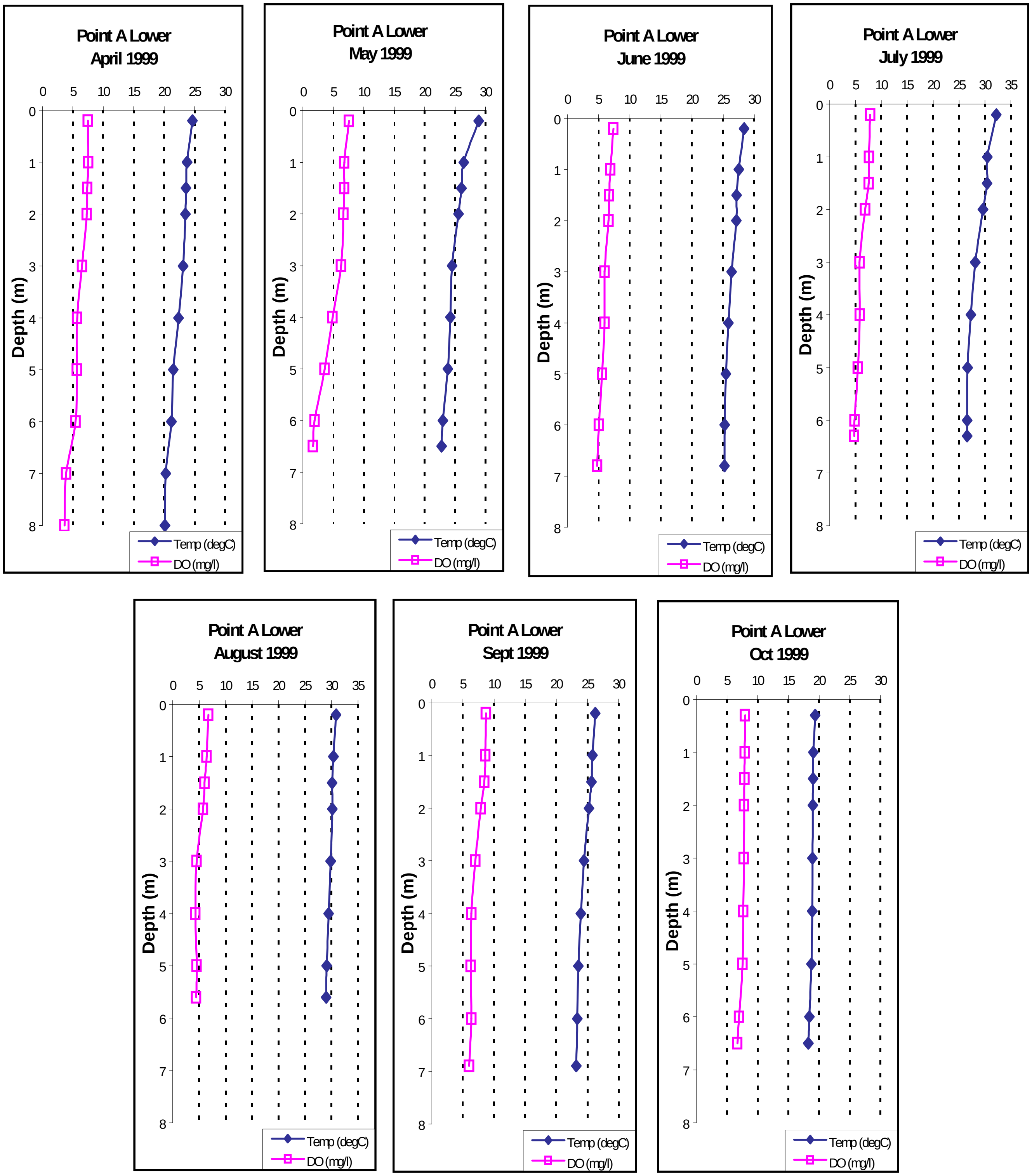


Figure II. 11. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at Lower Point A Reservoir, April-October 1999.

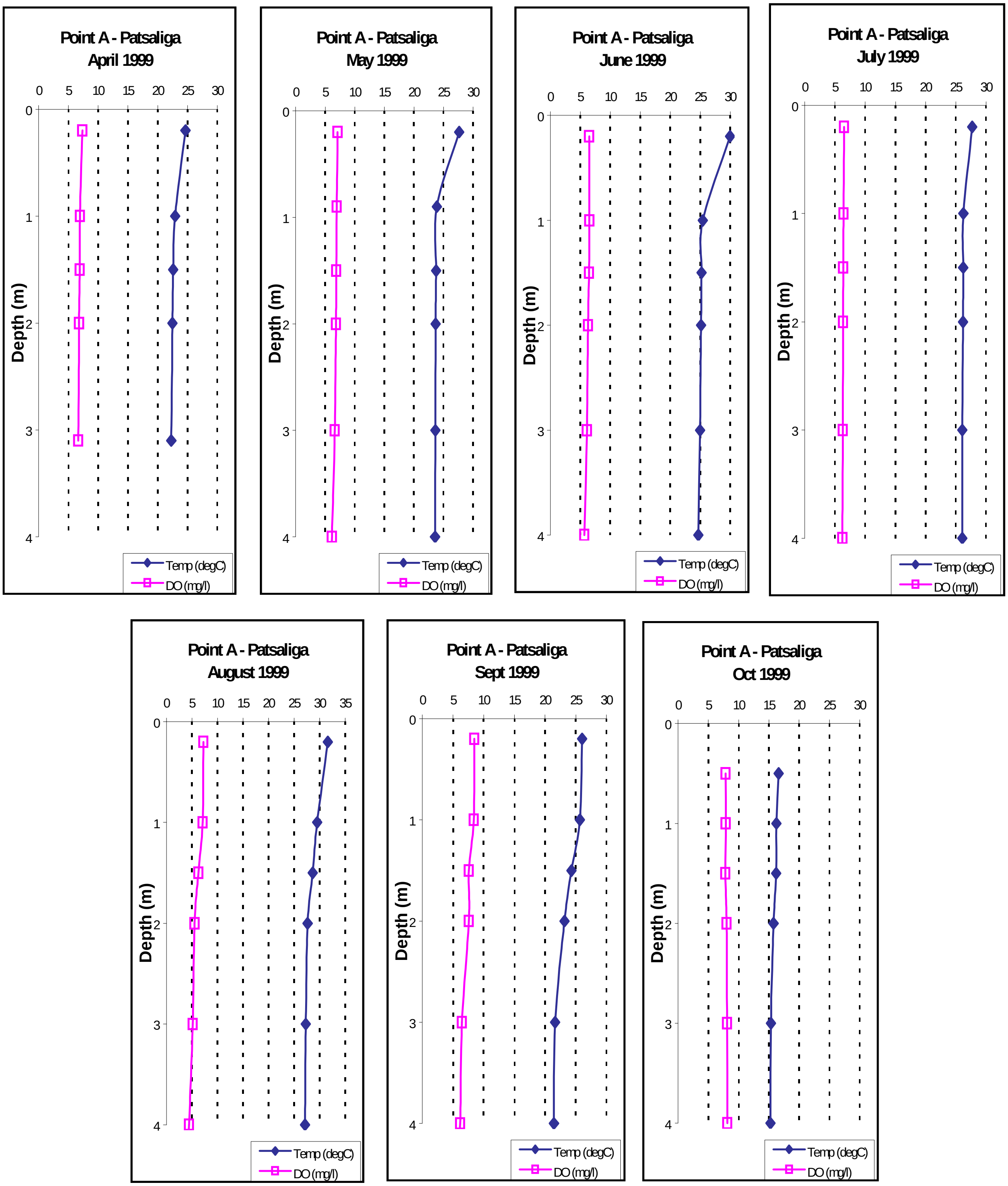


Figure II. 12. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at Patsaliga Creek embayment of Point A Reservoir, April-October 1999.

Lake Jackson

Nitrogen. Mean TN concentration in Lake Jackson was similar to that of lower Gantt (Figure II. 1).

The highest monthly TN concentration was measured in May followed by a decline in concentration in June-August and an increase in September and October (Figure II. 13).

Phosphorus. Mean TP concentration in Lake Jackson was lower than that of Conecuh basin sites (Figure II. 1).

Monthly TP concentration was similar April-October with the exception of September. During September, monthly TP concentration approximately doubled (Figure II. 13).

Algal Growth Potential Tests. Phosphorus was indicated to be the limiting nutrient June-August at Lake Jackson (Table II. 1). The mean MSC ranged from 1.45 to 2.03 mg/l, which was lower than any other Conecuh basin location. The mean MSC was below the maximum 5.0 mg/l suggested to assure protection from nuisance algal blooms and fish-kills in southeastern lakes.

Chlorophyll *a.* Mean chlorophyll *a* concentration in Lake Jackson was lower than any Conecuh basin location measured (Figure II. 2).

Monthly chlorophyll *a* concentration varied little throughout the monitoring period (Figure II. 13).

Total Suspended Solids. Mean TSS concentration in Lake Jackson was lower than those of Conecuh basin monitoring locations (Figure II. 2).

Monthly TSS concentration peaked in May and declined sharply in June (Figure II. 13). In July, TSS concentration increased slightly and remained relatively unchanged through September.

Trophic State. Monthly TSI values for Lake Jackson were in the oligotrophic range during April, May, August and September (Figure 45). TSI values increased to a low mesotrophic condition during June, July and October.

Dissolved Oxygen/Temperature. Dissolved oxygen concentrations changed little April-October (Figure 45). In general, concentrations were highest in October and lowest in June. DO concentrations were above the criterion limit of 5.0 mg/l on all dates sampled. Depth profiles indicate no thermal or chemical stratification at Lake Jackson during the sampling period.

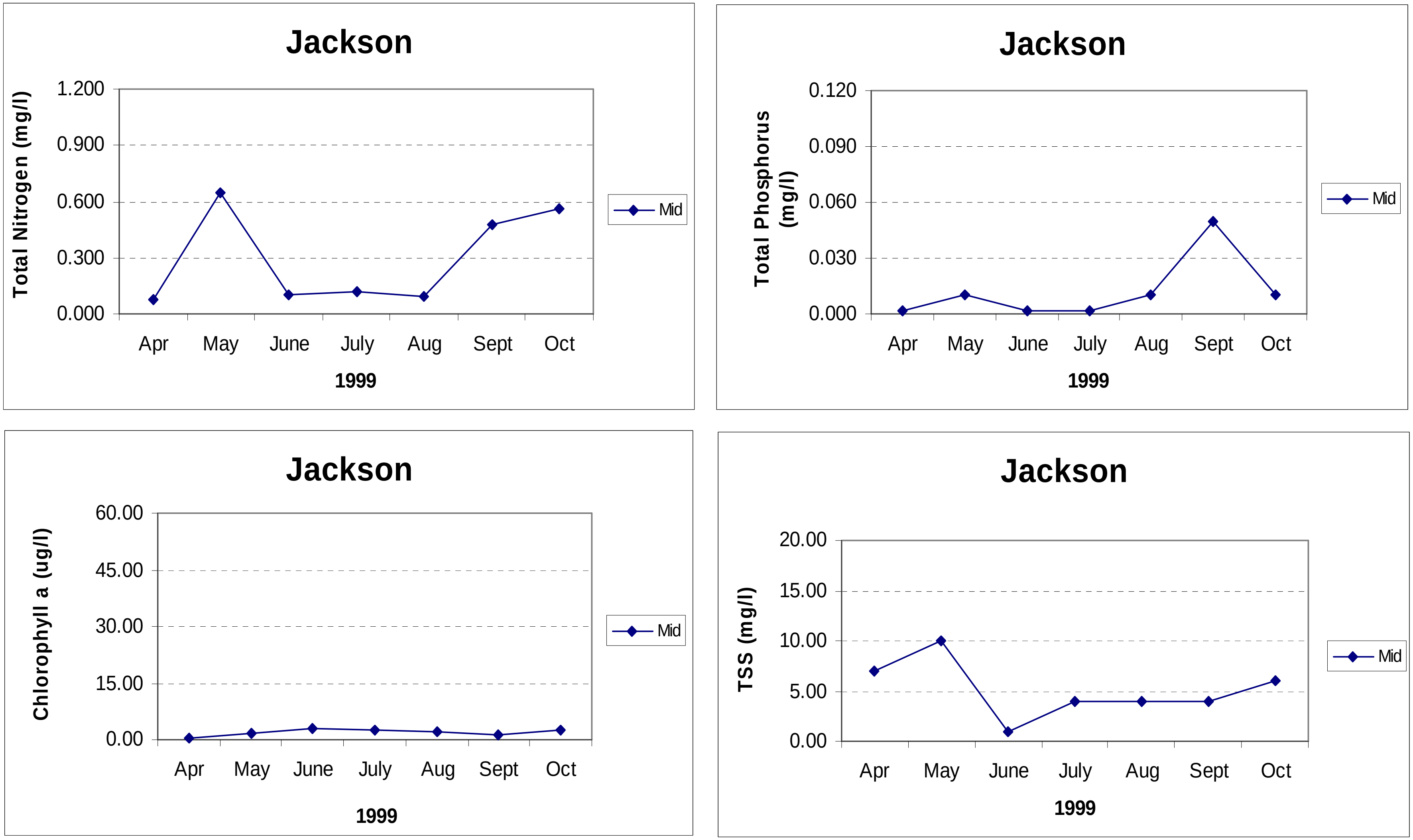


Figure II. 13. Total nitrogen, total phosphorus, chlorophyll a, and total suspended solids (TSS) concentrations of Lake Jackson (TP), April-October 1999.

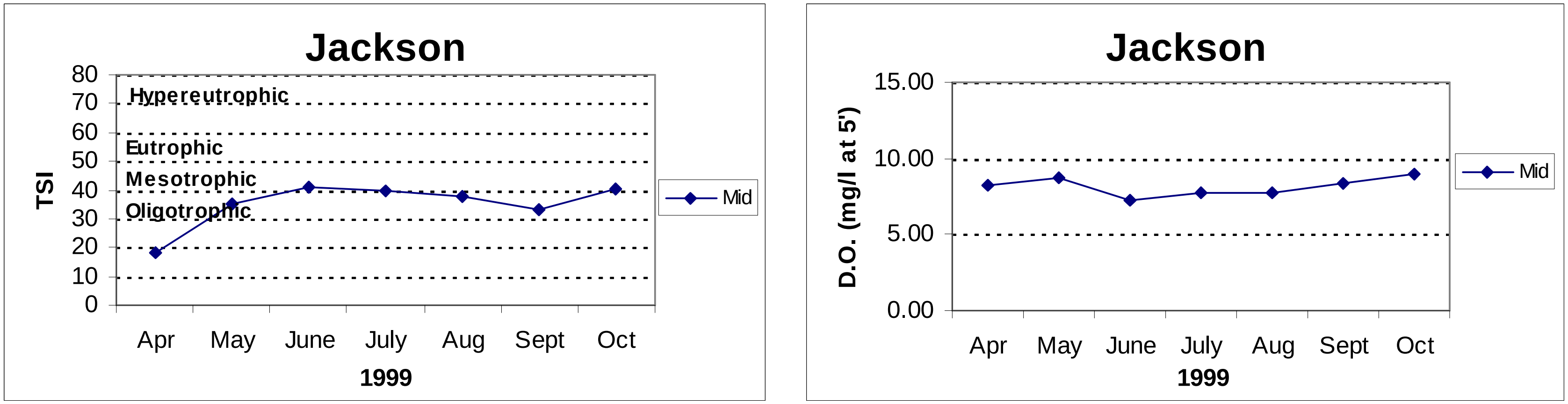
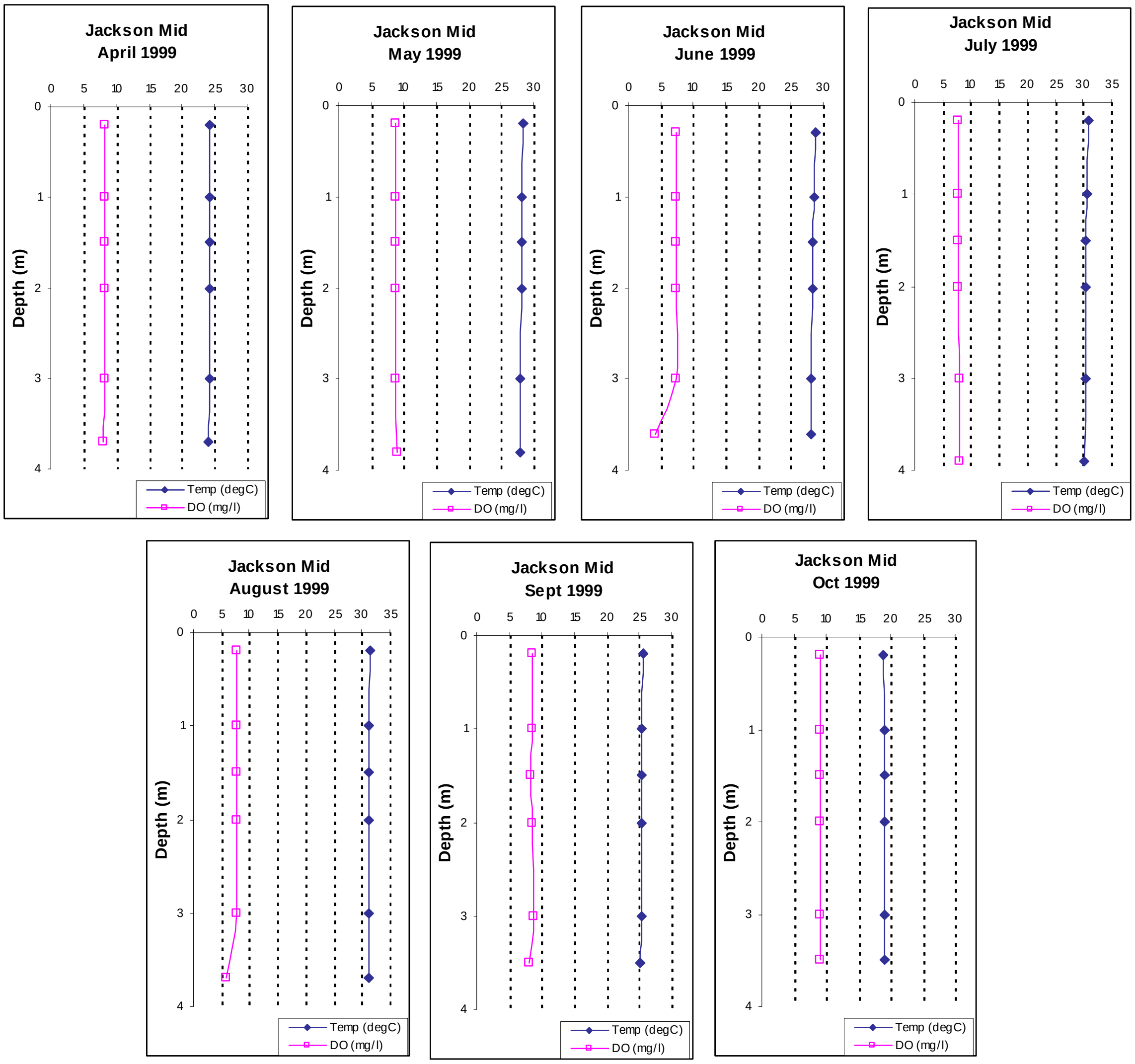


Figure II. 14. Trophic state index (TSI), and dissolved oxygen (DO) of Lake Jackson, April-October 1999


Jackson Mid April 1999

Jackson Mid May 1999

Jackson Mid June 1999

Jackson Mid July 1999

Jackson Mid August 1999

Jackson Mid Sept 1999

Jackson Mid Oct 1999

Figure II. 15. Depth profiles of dissolved oxygen (DO) and temperature (Temp) at Lake Jackson, April-October 1999