# *2010 Woodruff Reservoir Report*

*Rivers and Reservoirs Monitoring Program*

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Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
June 2013

# Rivers and Reservoirs Monitoring Program

# 2010

# Woodruff Reservoir

Alabama River Basin

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**June 2013**

# Table of Contents

# LIST OF ACRONYMS

| | |
|---|---|
| A&I | Agriculture and Industry water supply use classification |
| ADEM | Alabama Department of Environmental Management |
| AGPT | Algal growth Potential Test |
| CHL *a* | Chlorophyll *a* |
| DO | Dissolved Oxygen |
| F&W | Fish and Wildlife |
| MAX | Maximum |
| MDL | Method Detection Limit |
| MIN | Minimum |
| MSC | Mean Standing Crop |
| NTU | Nephelometric Turbidity Units |
| OAW | Outstanding Alabama Waters |
| ONRW | Outstanding National Resource Water |
| PWS | Public Water Supply |
| QAPP | Quality Assurance Project Plan |
| RRMP | Rivers and Reservoirs Monitoring Program |
| S | Swimming and Other Whole Body Water-Contact Sports |
| SD | Standard Deviation |
| SOP | Standard Operating Procedures |
| TEMP | Temperature |
| TN | Total Nitrogen |
| TMDL | Total Maximum Daily Load |
| TP | Total Phosphorus |
| TSI | Trophic State Index |
| TSS | Total Suspended Solids |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| COE | United States Army Corp of Engineers |
| | |

## LIST OF FIGURES

## LIST OF TABLES

## INTRODUCTION

Woodruff Reservoir was created with the construction of Robert F. Henry Lock and Dam in the early 1970s by the United States Army Corps of Engineers (COE). The reservoir covers approximately 12,500 acres and stretches from just north of Montgomery to Benton, Alabama. Woodruff serves a key role in hydroelectricity generation and also provides a number of recreational opportunities such as camping, hiking, fishing, and hunting.

The Alabama Department of Environmental Management (ADEM) monitored Woodruff Reservoir as part of the 2010 assessment of the Alabama, Coosa, and Tallapoosa (ACT) River basins under the Rivers and Reservoirs Monitoring Program (RRMP). ADEM began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program (now known as RRMP) was initiated by the Field Operations Division of the ADEM. The current objectives of this program are to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2012 Monitoring Strategy (ADEM 2012).

The purpose of this report is to summarize data collected at seven stations in Woodruff Reservoir during the 2010 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's historical data.

## METHODS

Sample sites were determined using historical data and previous assessments (Fig. 1). Woodruff Reservoir was sampled in the dam forebay, mid reservoir, and upper reservoir. Four tributary embayments representing a range of watershed conditions and landuse patterns were also monitored. Specific station location information is listed in Table 1.

Water quality assessments were conducted at monthly intervals, April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2010), Surface Water Quality Assurance Project Plan (ADEM 2008a), and Quality Management Plan (ADEM 2008b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. For mainstem stations, monthly concentrations of these parameters were graphed with the closest available COE flow data and ADEM's previously collected data to help interpret the 2010 results.

Figure 1. Woodruff Reservoir with 2010 sampling locations. A description of each sampling location is provided in Table 1.

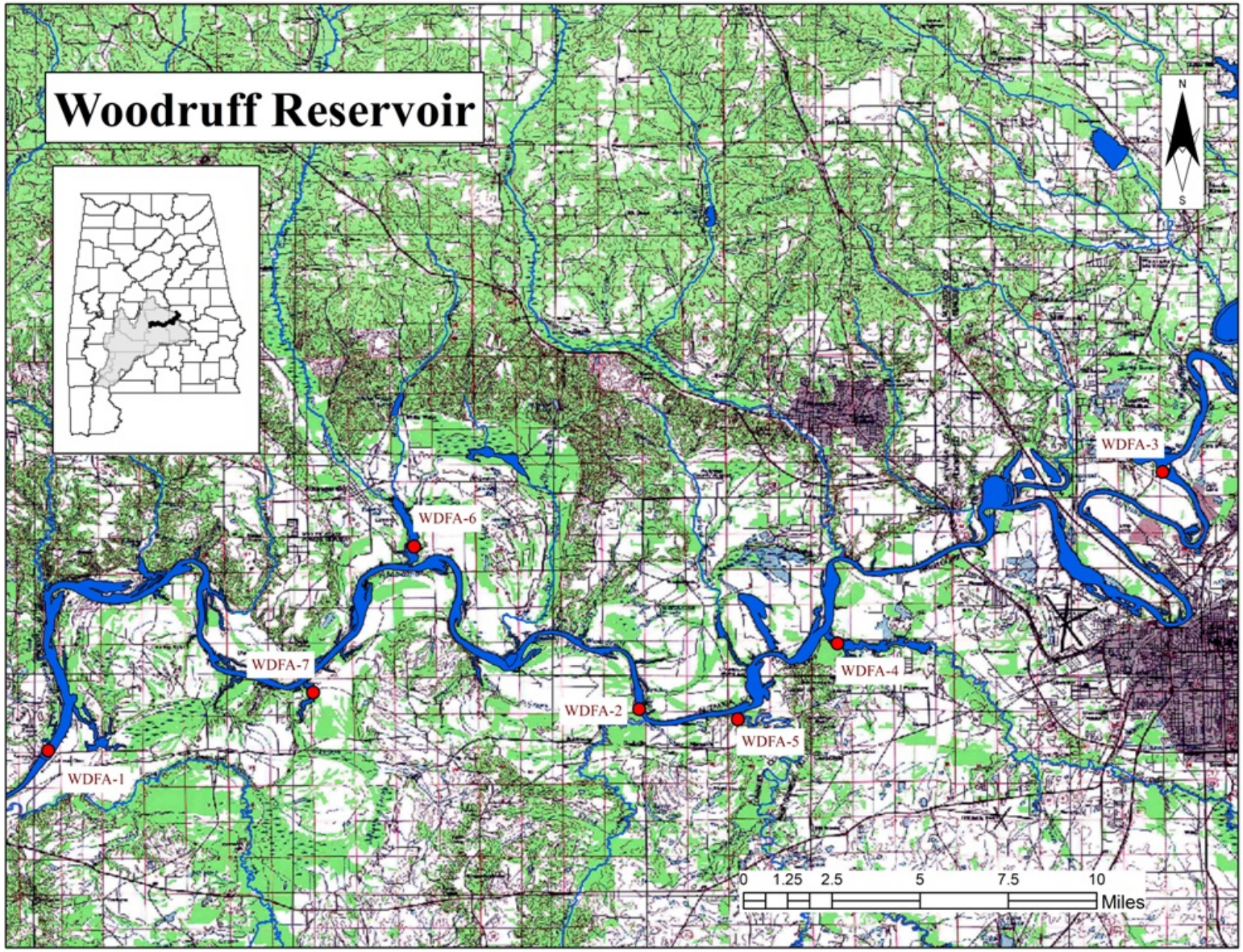


**Table 1.** Descriptions of the 2010 monitoring stations in Woodruff Reservoir.

| HUC | County | Station Number | Report Designation | Waterbody Name | Station Description | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| **Woodruff Reservoir** | | | | | | | |
| 031502010706 | Autauga | WDFA-1 | Lower | Alabama R | Deepest point, main river channel, dam forebay. | 32.3273 | -86.7820 |
| 031502010503 | Lowndes | WDFA-2 | Mid | Alabama R | Deepest point, main river channel, immediately downstream of Tallawassee Creek confluence. | 32.3443 | -86.5397 |
| 031502010106 | Montgomery | WDFA-3 | Upper | Alabama R | Deepest point, main river channel, immediately downstream of Jackson Lake. | 32.4414 | -86.3251 |
| 031502010309 | Montgomery | WDFA-4 | Catoma Cr | Catoma Cr | Deepest point, main creek channel, Catoma Creek embayment, approximately 0.5 miles upstream of lake confluence. | 32.3711 | -86.4584 |
| 031502010407 | Montgomery | WDFA-5 | Pintlalla Cr | Pintlalla Cr | Deepest point, main creek channel, Pintlalla Creek embayment, approximately 0.5 miles upstream of lake confluence. | 32.3402 | -86.4992 |
| 031502010603 | Autauga | WDFA-6 | Swift Cr | Swift Cr | Deepest point, main creek channel, Swift Creek embayment, approximately 0.5 miles upstream of lake confluence. | 32.4111 | -86.6321 |
| 031502010702 | Lowndes | WDFA-7 | Cypress Cr | Cypress Cr | Deepest point, main creek channel, Cypress Creek embayment, approximately 0.5 miles upstream of lake confluence. | 32.3521 | -86.6796 |

**RESULTS**

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figs. 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, DO and TSI are also provided (Figs. 4-8 and 12). Mean monthly discharge is included in monthly graphs for TN, TP, chl *a*, TSS and TSI as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, DO and conductivity appear in Figures 9-11. Summary statistics of all data collected during 2010 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean and standard deviation of each parameter analyzed

Stations with the highest concentrations of nutrients, chlorophyll and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2010, highest mean growing season TN values were calculated for the Cypress and Catoma Ck stations (Fig. 2). Mean growing season TN values at all mainstem stations have decreased overall from 2000-2010. Pintlalla and Cypress Ck stations showed an increase in mean TN concentrations compared to 2005. Monthly TN graphs show each mainstem station had a similar decrease in concentration June-August and were below historic means most months during the 2010 growing season (Fig. 4). Historic low concentrations were measured in the lower station in July and October, the mid station in May and July, and the upper station in August, along with a historical high in September at both the lower and upper stations.

In 2010, the highest mean growing season TP value was calculated for the Catoma Ck station (Fig. 2). Similar to mean TN concentration trends, growing season mean TP concentrations at all stations were lower in 2010 than previous years. The highest monthly TP concentration was measured in June at the mid station. Monthly concentrations at all three mainstem stations were equal to or below historic means throughout the growing season (Fig. 5). Historic lows occurred in June and September for both the mid and upper stations while a historic low occurred in September in the lower station.

In 2010, the highest mean growing season mean chl *a* value was calculated for the Catoma Ck station (Fig. 3). Mean concentrations were variable 2000-2010 at the mid and lower stations while the upper station increased 2005-2010. Mean chl *a* concentrations were similar 2000-2010 in Catoma Creek while all other tributaries decreased in mean concentrations in 2010 compared to previous years. Monthly chl *a* concentrations peaked in July at each mainstem location with the highest concentration occurring in the upper station (Fig. 6). Concentrations at the upper station were above historic means most months sampled and historic highs were measured in June and July. Historic highs were measured in July and October in the mid station and in July at the lower station. Monthly concentrations at the mid and lower stations were below historic means much of the growing season. Specific water quality criteria for nutrient management have not yet been established for the reservoir.

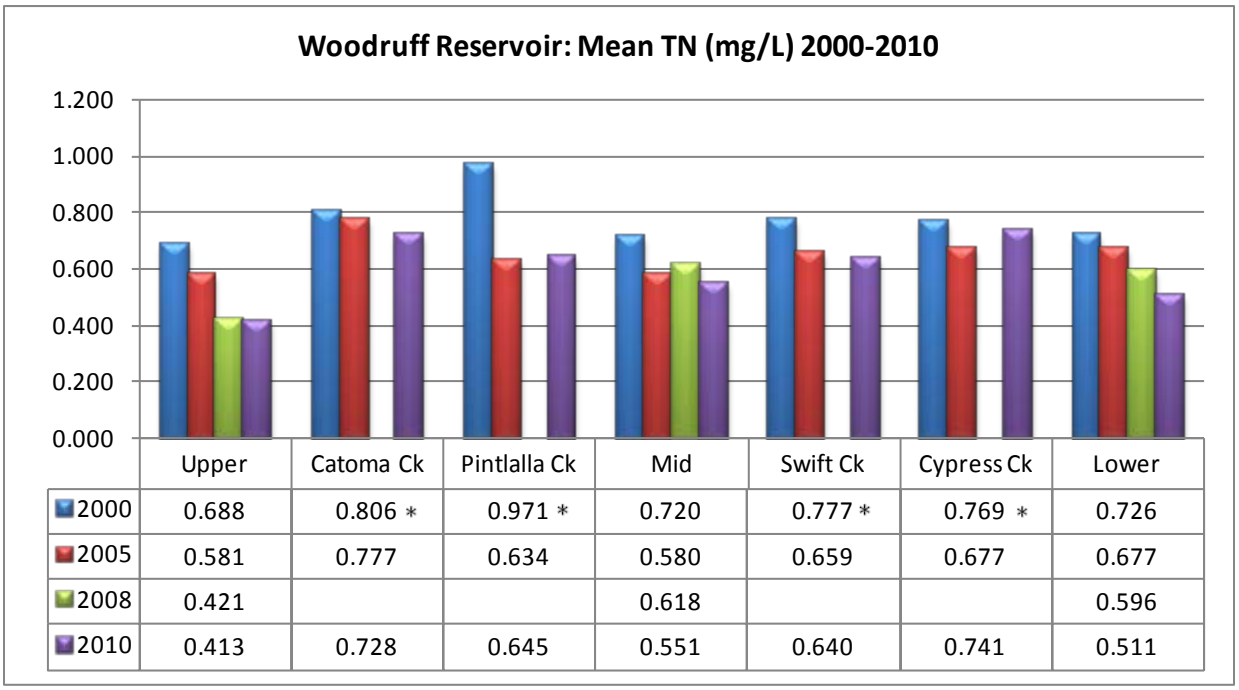
In 2010, the highest mean growing season TSS value was calculated for the Catoma Ck station (Fig. 3). Mean concentrations generally decreased at all stations 2000-2010. Monthly TSS concentrations were highest in May at each mainstem station as was reservoir discharge (Fig. 7). Historic lows were measured July, September, and October in the upper and mid stations. Historic lows were measured in September and October at the lower station.

AGPT results show the upper station was nitrogen limited in 2010 (Table 2). Due to resource constraints, AGPT samples were not collected at the mid and lower stations. Mean MSC value at the upper station was 3.29 mg/L, below the value that Raschke et al. (1996) defined as protective of reservoir and lake systems. Previous MSC values for the lower and mid stations were above 5 mg/L.

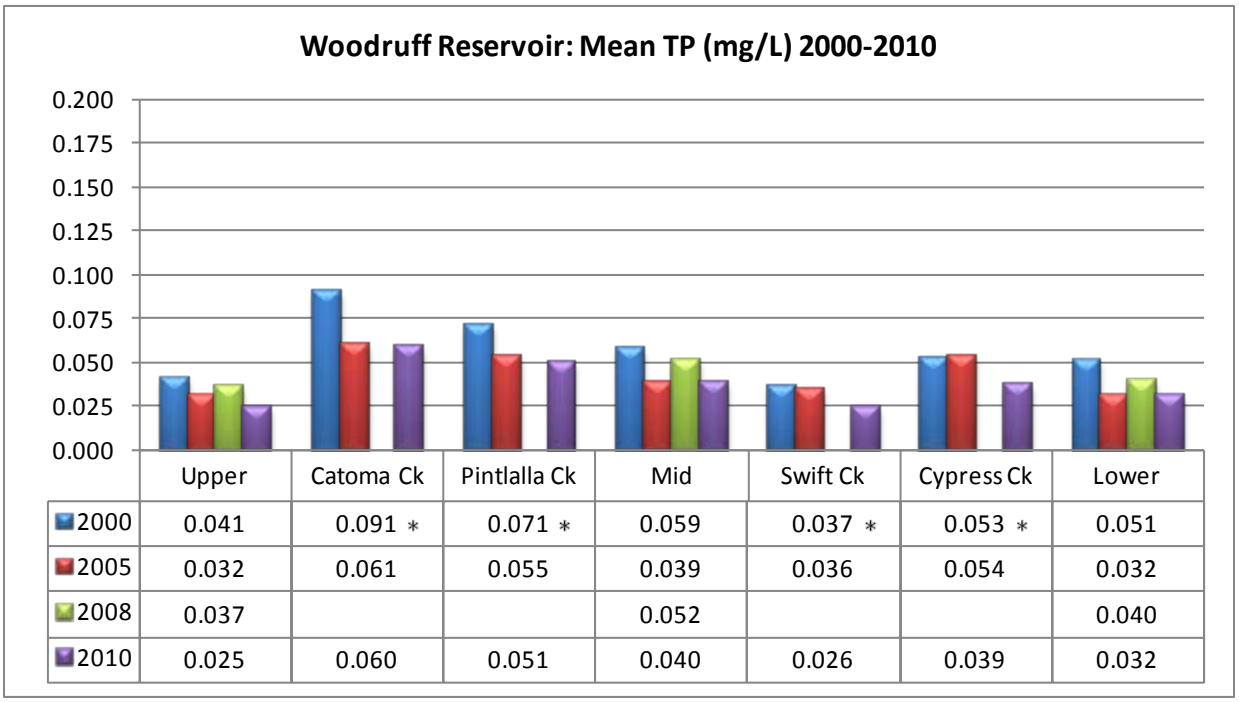
All measurements of DO concentrations in the mainstem and tributary stations met the ADEM criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) though Cypress Creek was near the limit in August (ADEM Admin. Code R. 335-6-10-.09) (Fig. 8). The reservoir's depth profiles of temperature and DO show the water column generally was mixed, though some chemical stratification occurred in the upper station in June and lower station in July (Fig. 9 & 10). Profiles show highest temperatures were reached in July and August. Conductivity values in the lower part of the water column of the mid station increased sharply during June, August, and September.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. The upper station was mostly eutrophic reaching near hypereutrophic levels in July (Fig. 11). TSI values for the mid and lower reservoir were mostly eutrophic. All tributaries were eutrophic from May-August, with Catoma Creek reaching near hypereutrophic levels in August.

Figure 2. Mean growing season TN and TP measured in Woodruff Reservoir, April-October, 2000-2010. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.



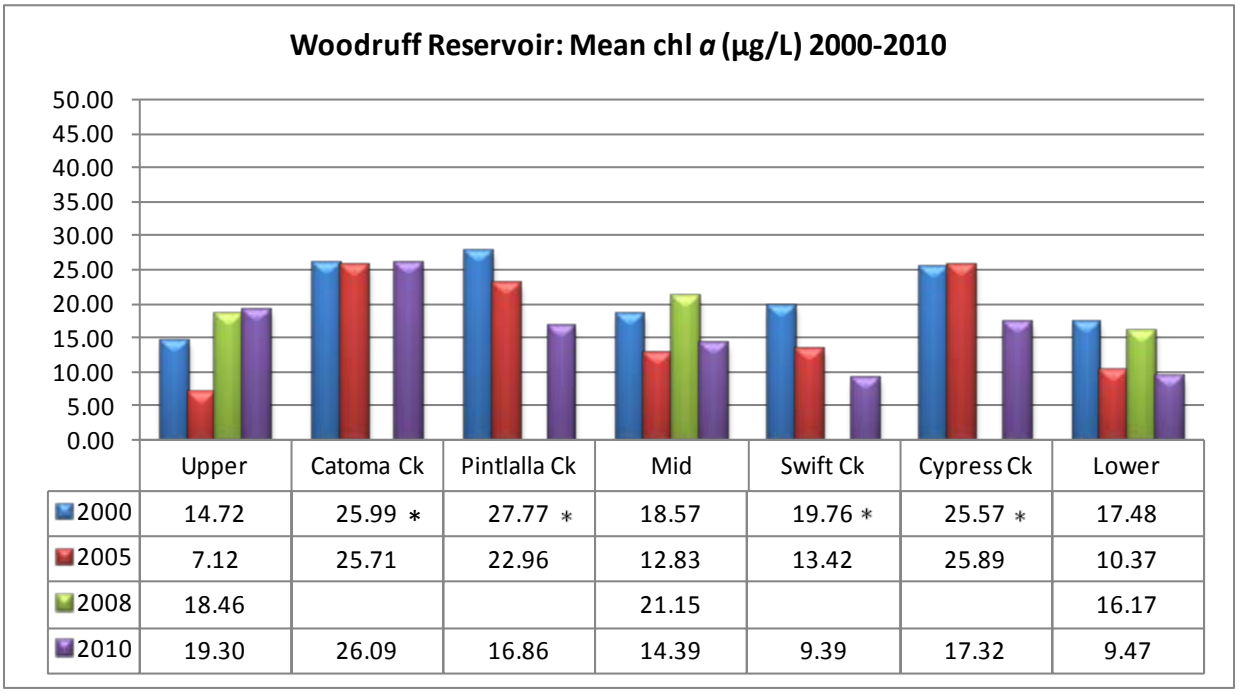

| | Upper | Catoma Ck | Pintlalla Ck | Mid | Swift Ck | Cypress Ck | Lower |
|---|---|---|---|---|---|---|---|
| 2000 | 0.688 | 0.806 * | 0.971 * | 0.720 | 0.777 * | 0.769 * | 0.726 |
| 2005 | 0.581 | 0.777 | 0.634 | 0.580 | 0.659 | 0.677 | 0.677 |
| 2008 | 0.421 | | | 0.618 | | | 0.596 |
| 2010 | 0.413 | 0.728 | 0.645 | 0.551 | 0.640 | 0.741 | 0.511 |



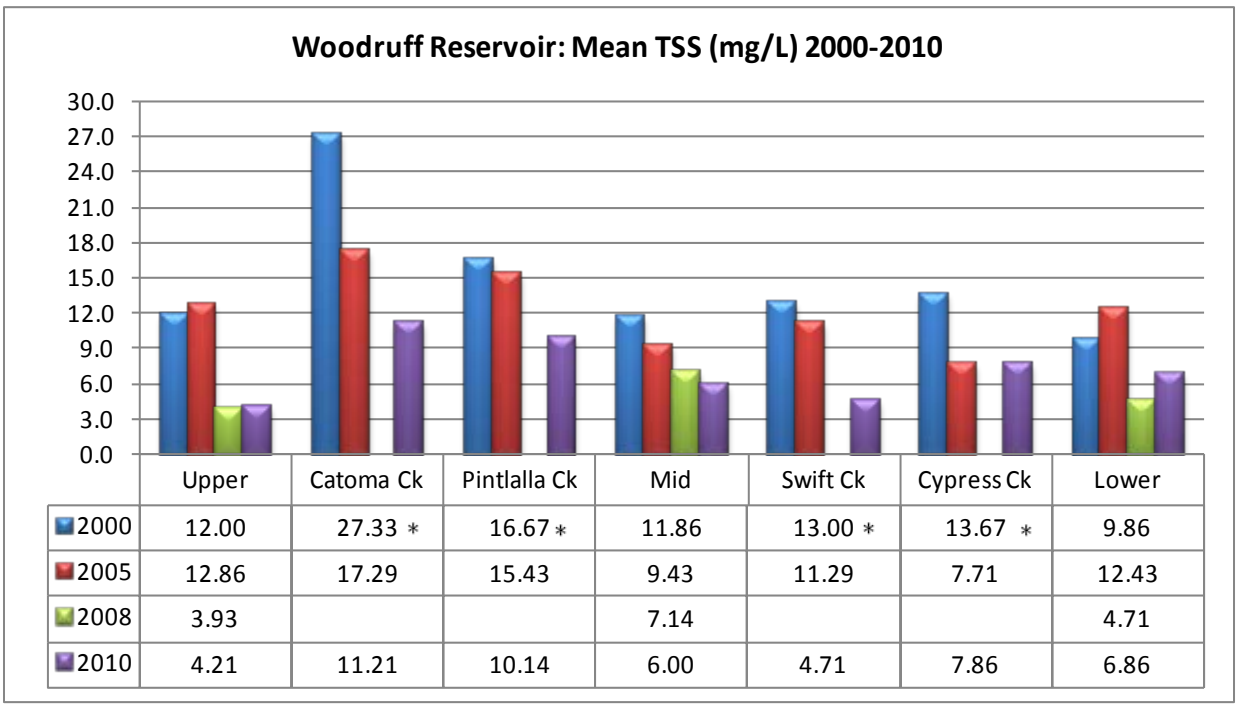

| | Upper | Catoma Ck | Pintlalla Ck | Mid | Swift Ck | Cypress Ck | Lower |
|---|---|---|---|---|---|---|---|
| 2000 | 0.041 | 0.091 * | 0.071 * | 0.059 | 0.037 * | 0.053 * | 0.051 |
| 2005 | 0.032 | 0.061 | 0.055 | 0.039 | 0.036 | 0.054 | 0.032 |
| 2008 | 0.037 | | | 0.052 | | | 0.040 |
| 2010 | 0.025 | 0.060 | 0.051 | 0.040 | 0.026 | 0.039 | 0.032 |

*Mean of April/June/August only.

Figure 3. Mean growing season chl *a* and TSS measured in Woodruff Reservoir, April-October, 2000-2010. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.




| | Upper | Catoma Ck | Pintlalla Ck | Mid | Swift Ck | Cypress Ck | Lower |
|---|---|---|---|---|---|---|---|
| 2000 | 14.72 | 25.99 * | 27.77 * | 18.57 | 19.76 * | 25.57 * | 17.48 |
| 2005 | 7.12 | 25.71 | 22.96 | 12.83 | 13.42 | 25.89 | 10.37 |
| 2008 | 18.46 | | | 21.15 | | | 16.17 |
| 2010 | 19.30 | 26.09 | 16.86 | 14.39 | 9.39 | 17.32 | 9.47 |




| | Upper | Catoma Ck | Pintlalla Ck | Mid | Swift Ck | Cypress Ck | Lower |
|---|---|---|---|---|---|---|---|
| 2000 | 12.00 | 27.33 * | 16.67 * | 11.86 | 13.00 * | 13.67 * | 9.86 |
| 2005 | 12.86 | 17.29 | 15.43 | 9.43 | 11.29 | 7.71 | 12.43 |
| 2008 | 3.93 | | | 7.14 | | | 4.71 |
| 2010 | 4.21 | 11.21 | 10.14 | 6.00 | 4.71 | 7.86 | 6.86 |

*Mean of April/June/August only.

Figure 4. Monthly TN of the mainstem stations in Woodruff Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TN was plotted vs. the closest discharge (COE Alabama River at Robert F. Henry L&D near Benton, AL).

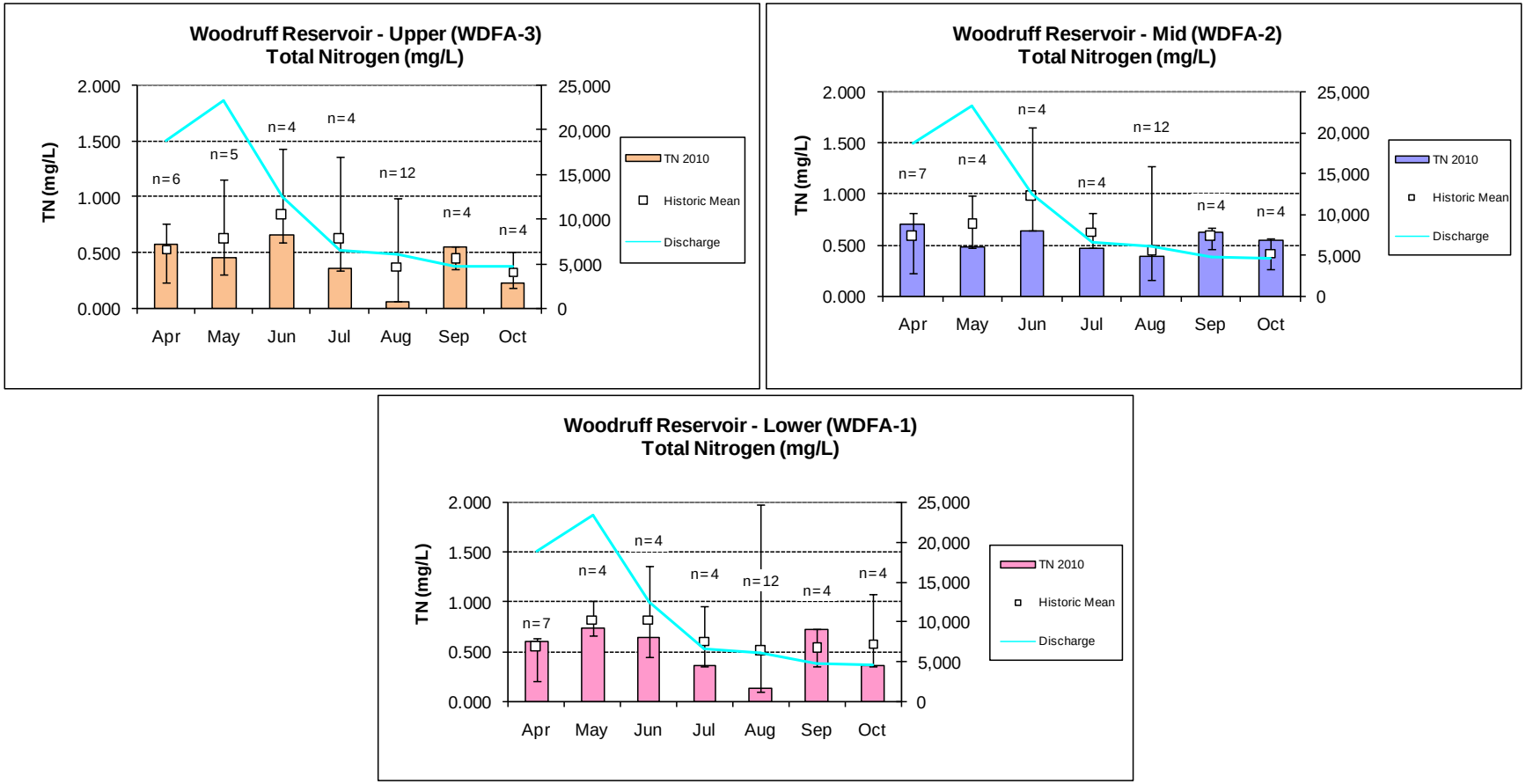


Figure 5. Monthly TP of the mainstem stations in Woodruff Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (COE Alabama River at Robert F. Henry L&D near Benton, AL).

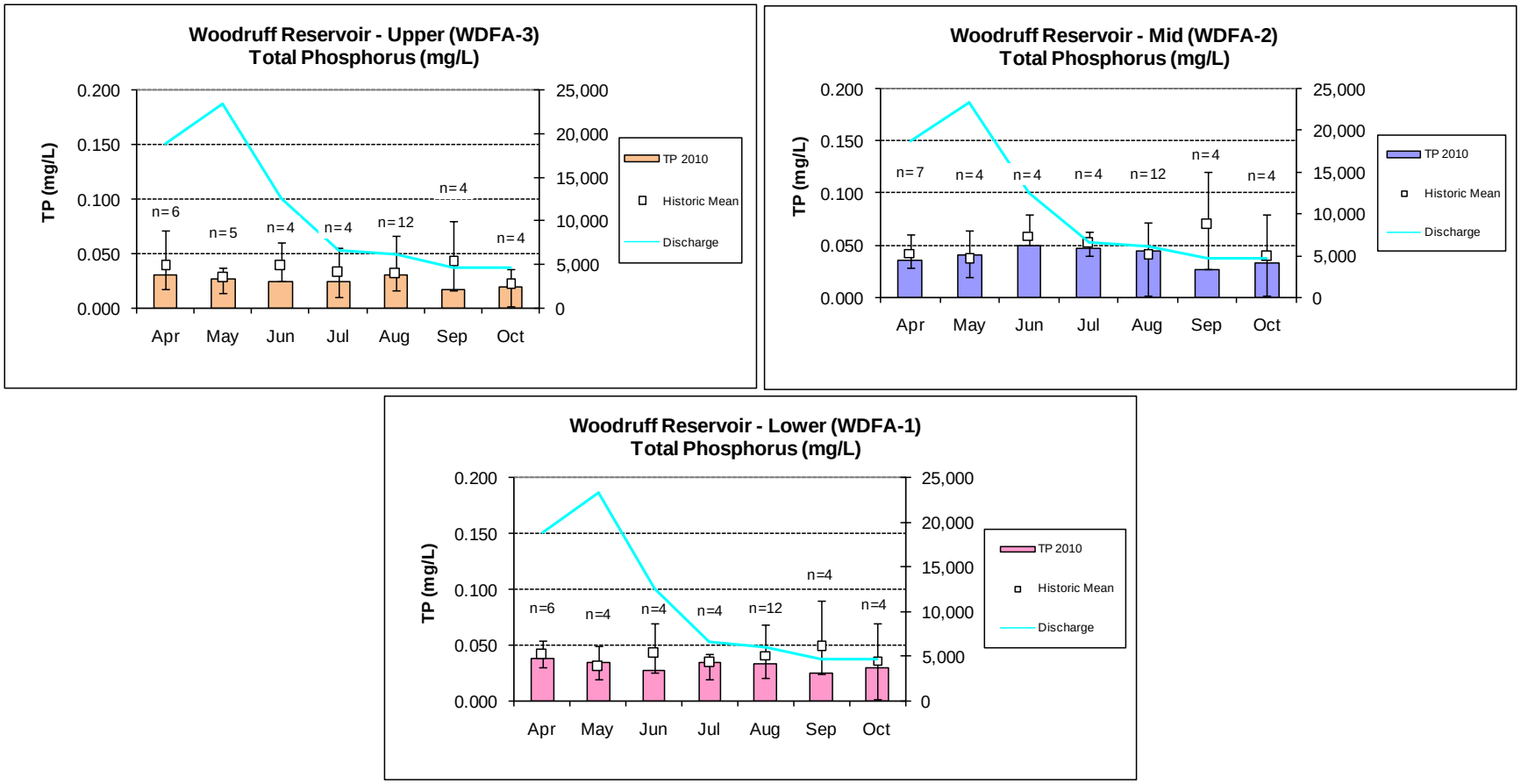


Figure 6. Monthly chl *a* of the mainstem stations in Woodruff Reservoir, April-October 2010**.** Each bar graph depicts monthly changes in each station**.** The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Chl *a* was plotted vs. the closest discharge (COE Alabama River at Robert F. Henry L&D near Benton, AL).

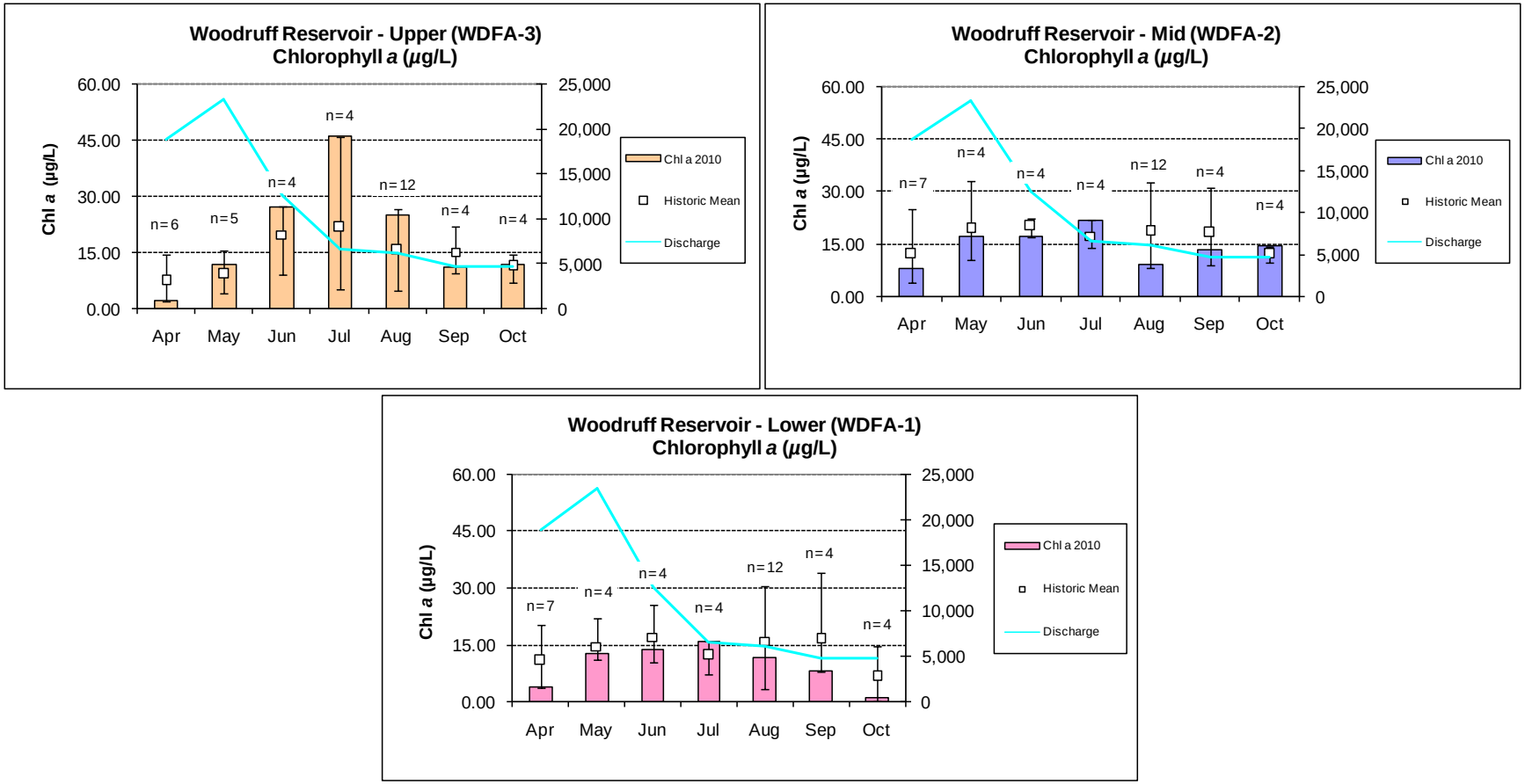


Figure 7. Monthly TSS of the mainstem stations in Woodruff Reservoir, April-October 2010. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TSS was plotted vs. the closest discharge (COE Alabama River at Robert F. Henry L&D near Benton, AL).

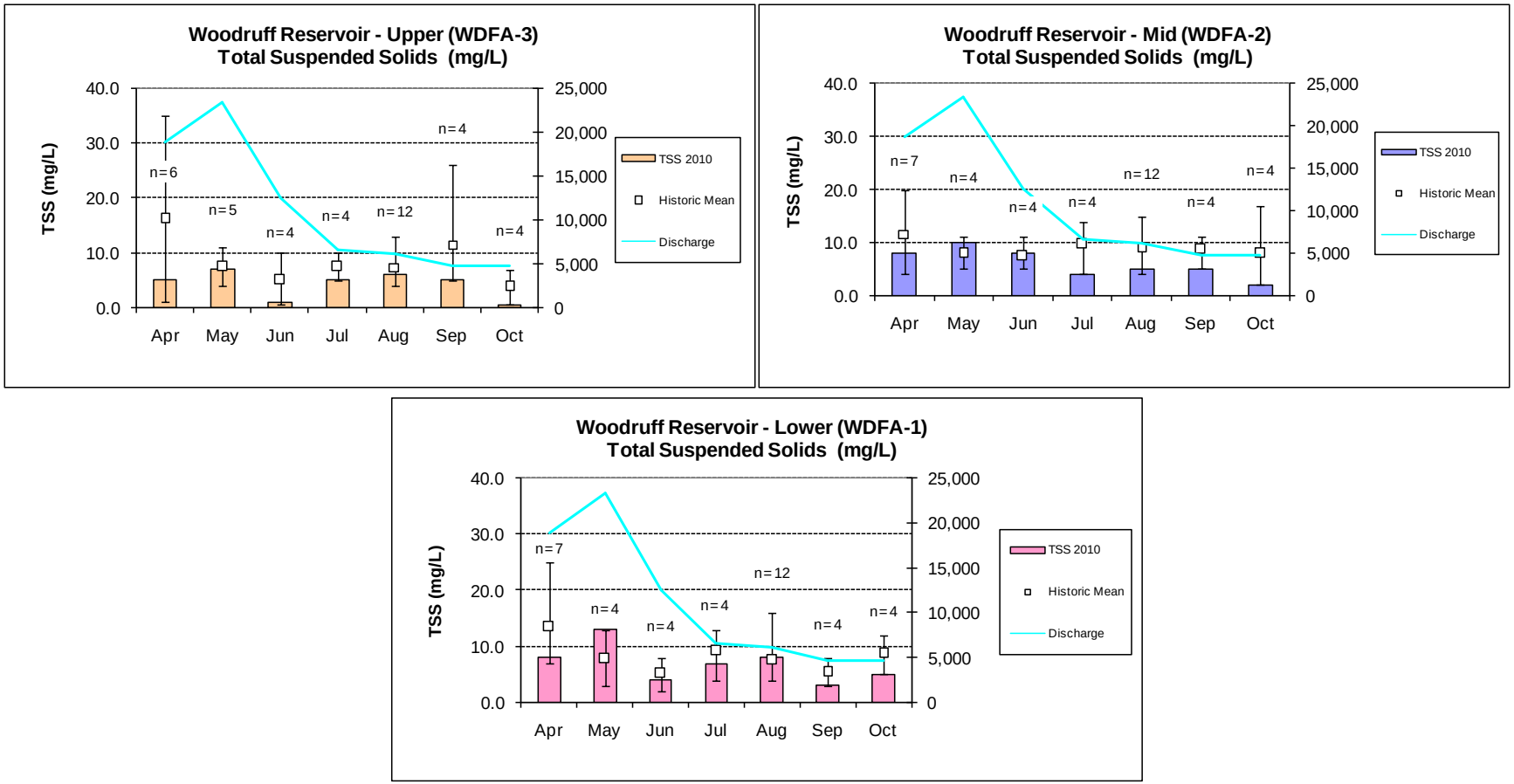


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective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

| Station | Upper | | Mid | | Lower | |
|---|---|---|---|---|---|---|
| | MSC | Limiting Nutrient | MSC | Limiting Nutrient | MSC | Limiting Nutrient |
| 2000 | 4.36 | Phosphorus | 6.79 | Nitrogen | 5.22 | Nitrogen |
| 2005 | 6.11 | Phosphorus | 8.63 | Co-limiting | 5.33 | Phosphorus |
| 2010 | 3.29 | Nitrogen | --- | --- | --- | --- |

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Woodruff Reservoir stations collected April-October 2010. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2010). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.

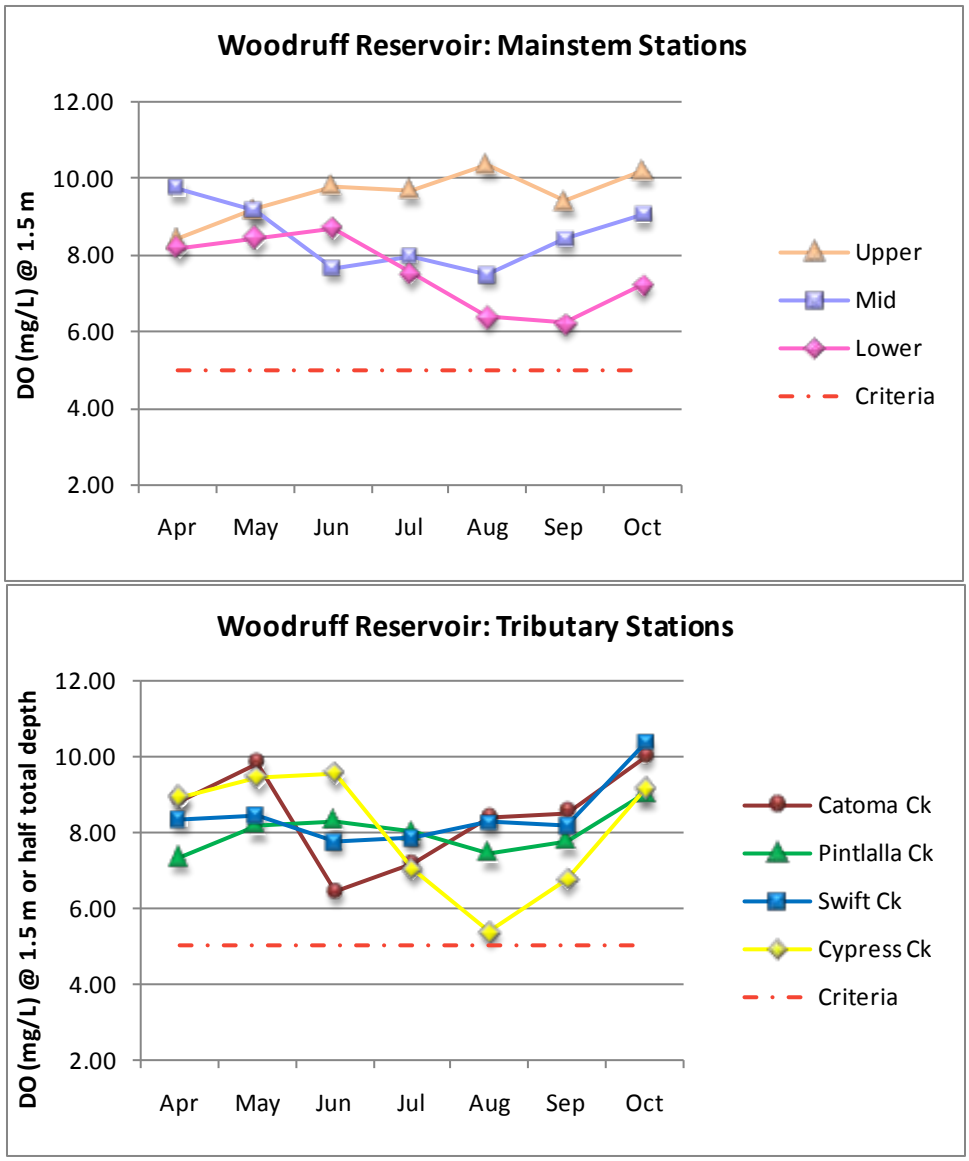


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in lower Woodruff Reservoir, April-October 2010.

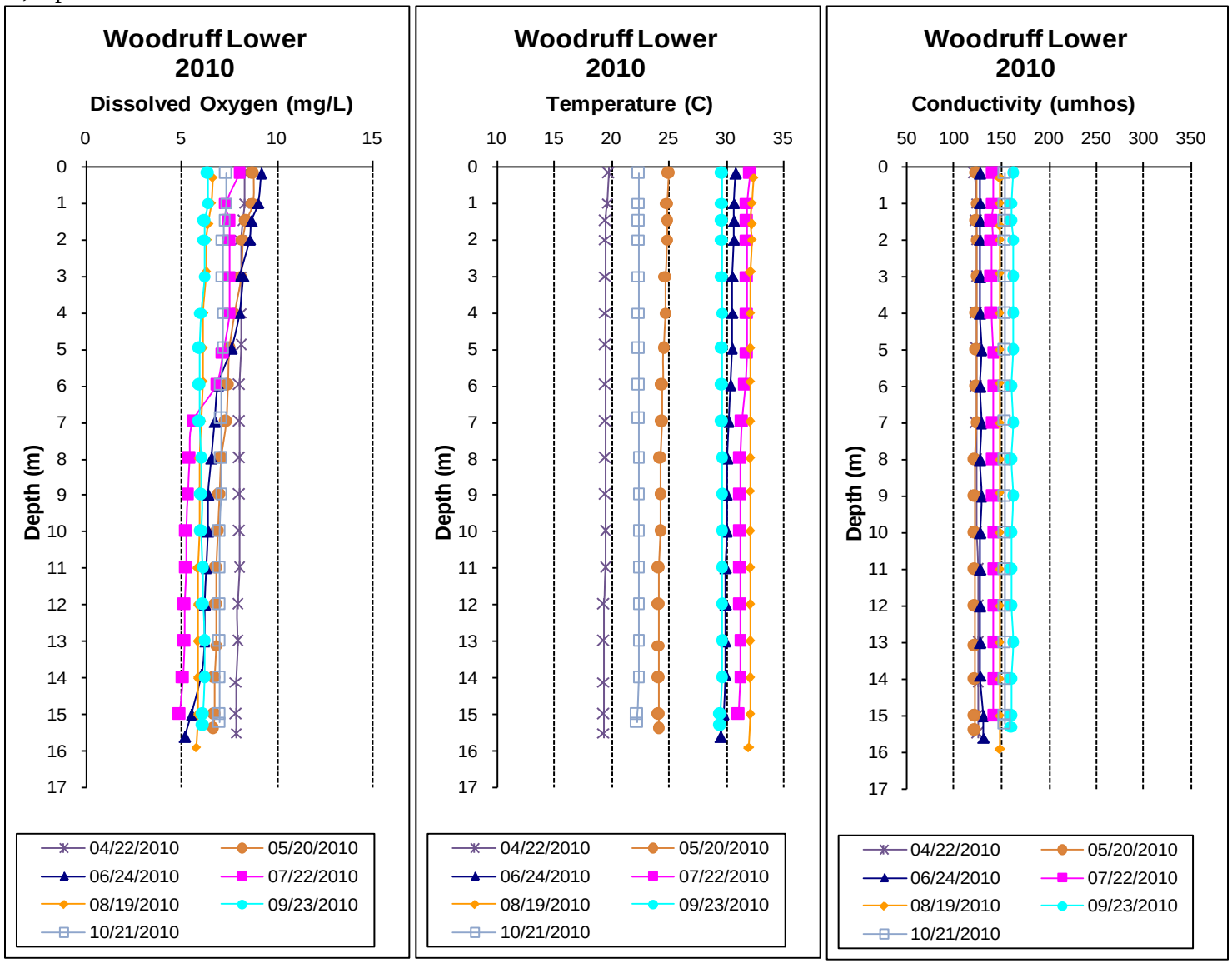


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in mid Woodruff Reservoir, April-October 2010.

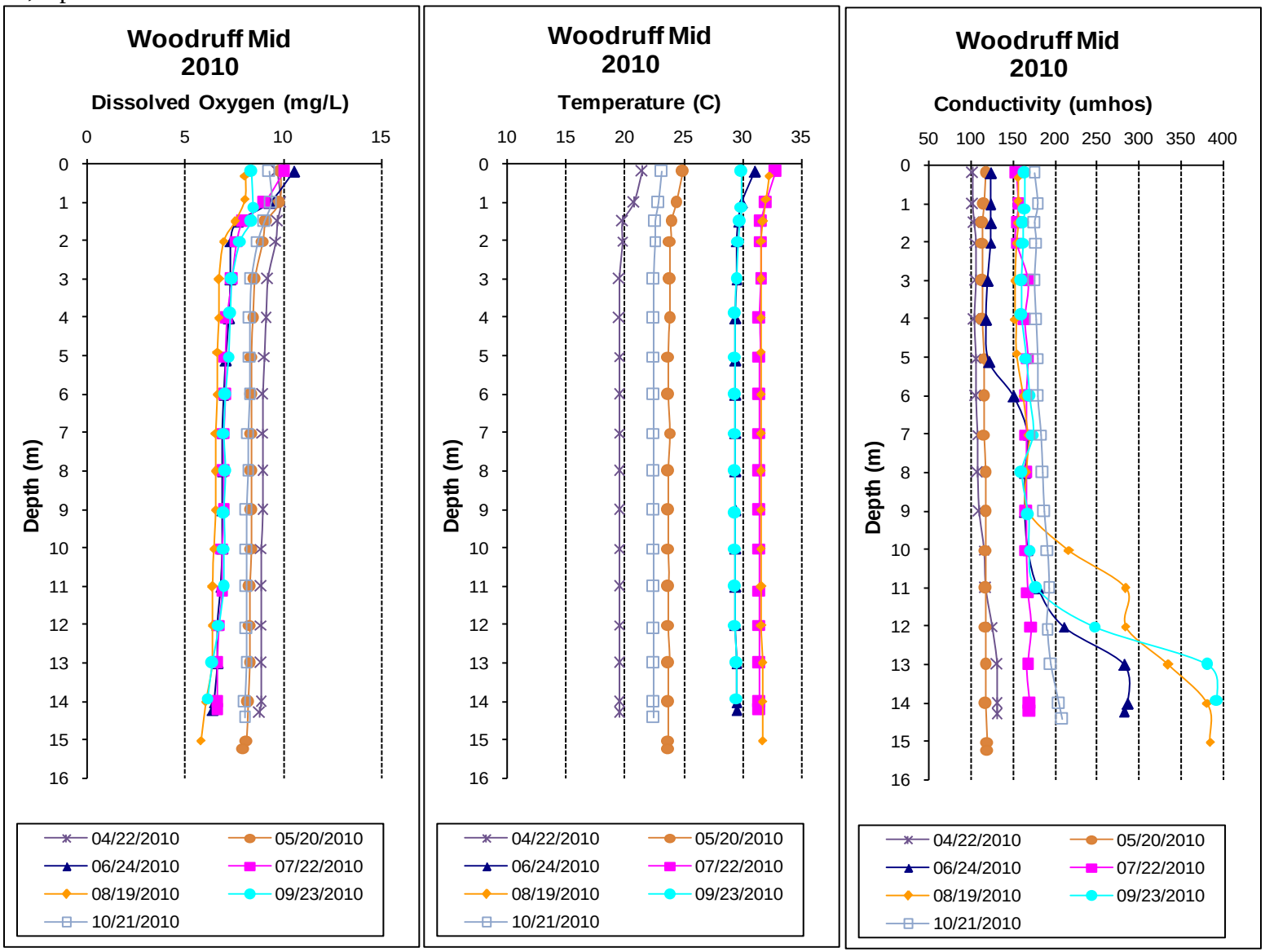


Figure 11. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in upper Woodruff Reservoir, April-October 2010.

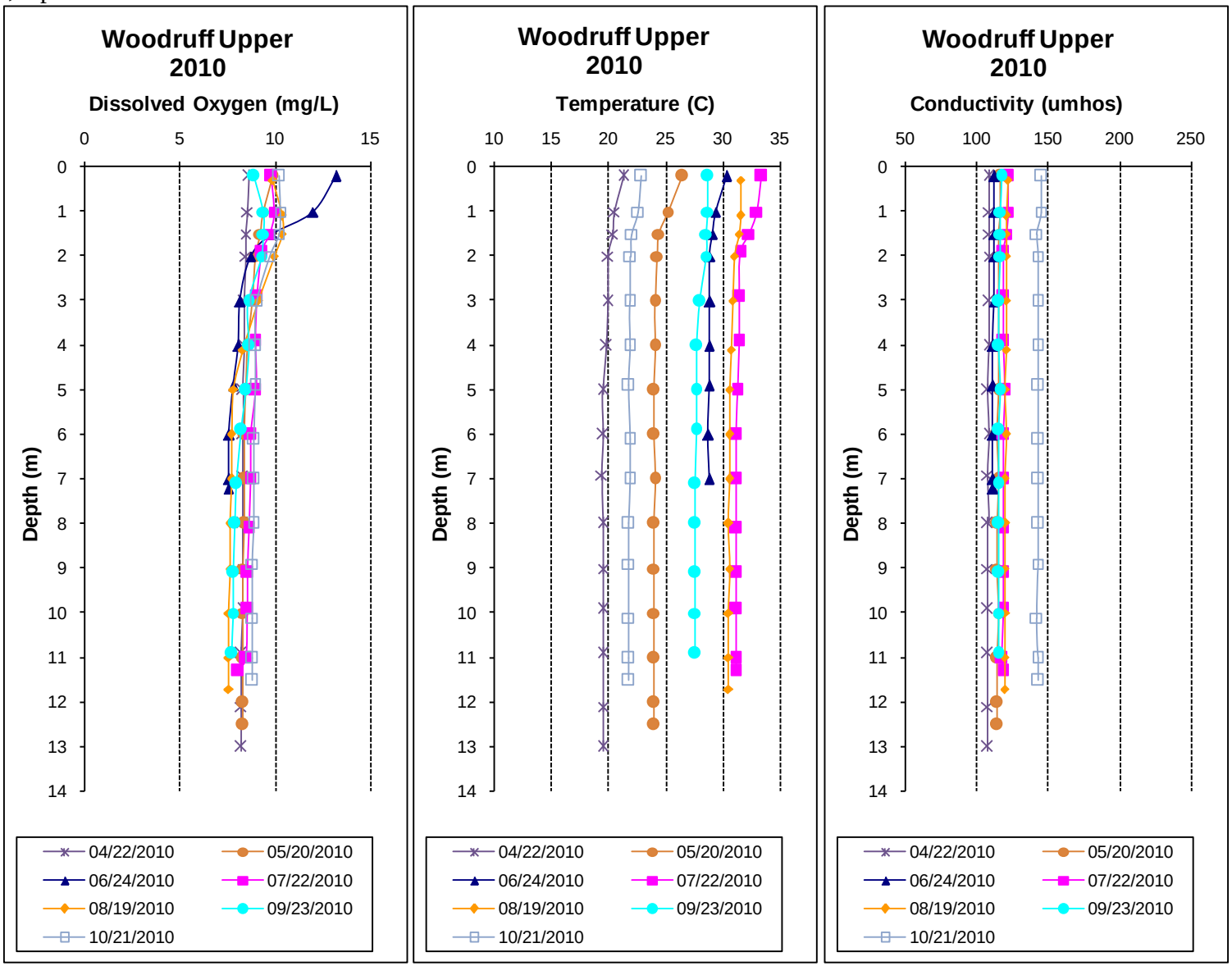
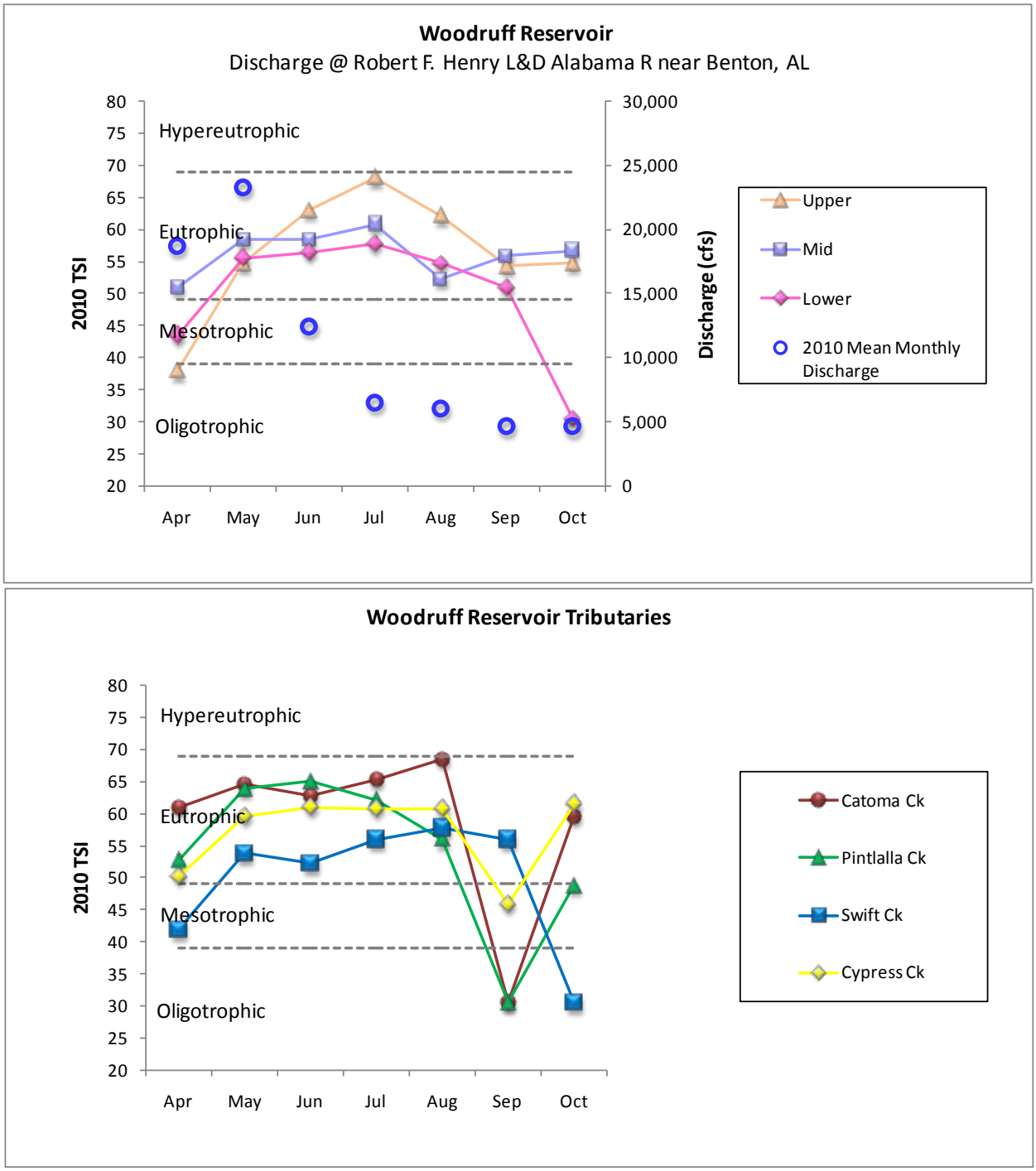


Figure 12. Monthly growing season TSI values for mainstem and tributary stations using chl *a* concentrations and Carlson's Trophic State Index calculation**.** TSI for mainstem stations were plotted vs. closest discharge (COE Alabama River at Robert F. Henry L&D near Benton, AL).



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# APPENDIX

**Appendix Table 1.** Summary of water quality data collected April-October, 2010. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

| Station | Parameter | N | Min | Max | Med | Mean | SD |
|---|---|---|---|---|---|---|---|
| **WDFA-1** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 5.9 | 10.4 | 6.8 | 7.6 | 1.8 |
| | Total Dissolved Solids (mg/L) | 7 | 72.0 | 96.0 | 88.0 | 84.9 | 10.7 |
| | Total Suspended Solids (mg/L) | 7 | 3.0 | 13.0 | 7.0 | 6.9 | 3.3 |
| | Hardness (mg/L) | 4 | 36.0 | 46.4 | 42.4 | 41.8 | 4.3 |
| | Alkalinity (mg/L) | 7 | 39.6 | 53.8 | 49.1 | 48.3 | 4.8 |
| | Photic Zone (m) | 7 | 2.88 | 4.61 | 3.53 | 3.57 | 0.60 |
| | Secchi (m) | 7 | 0.77 | 1.48 | 1.06 | 1.05 | 0.24 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.091 | 0.271 | 0.115 | 0.150 | 0.065 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | < 0.080 | 0.625 | 0.337 | 0.361 | 0.216 |
| | Total Nitrogen (mg/L) | 7 | < 0.131 | 0.742 | 0.608 | 0.511 | 0.231 |
| | Dissolved Reactive Phosphorus (mg/L) | 7 | 0.004 | 0.010 | 0.006 | 0.007 | 0.002 |
| | Total Phosphorus (mg/L) | 7 | 0.025 | 0.038 | 0.034 | 0.032 | 0.005 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 2.9 | 1.0 | 1.3 | 0.7 |
| | Chlorides (mg/L) | 7 | 5.3 | 7.9 | 7.1 | 6.8 | 0.1 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L)[J] | 7 | < 0.10 | 16.02 | 11.75 | 9.47 | 5.81 |
| | E. coli (mpn/100mL)[J] | 3 | < 1 | 2 | 1 | 1 | 1 |
| **WDFA-2** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 5.0 | 10.2 | 8.2 | 7.9 | 1.1 |
| | Total Dissolved Solids (mg/L) | 7 | 40.0 | 100.0 | 90.0 | 80.6 | 21.6 |
| | Total Suspended Solids (mg/L) | 7 | 2.0 | 10.0 | 5.0 | 6.0 | 2.8 |
| | Hardness (mg/L) | 4 | 33.3 | 47.9 | 42.4 | 41.5 | 6.7 |
| | Alkalinity (mg/L) | 7 | 38.8 | 59.2 | 51.2 | 49.9 | 7.3 |
| | Photic Zone (m) | 7 | 2.91 | 4.43 | 3.48 | 3.52 | 0.61 |
| | Secchi (m) | 7 | 0.64 | 1.54 | 0.98 | 0.99 | 0.30 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.094 | 0.280 | 0.153 | 0.166 | 0.068 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.239 | 0.519 | 0.421 | 0.385 | 0.106 |
| | Total Nitrogen (mg/L) | 7 | 0.392 | 0.701 | 0.544 | 0.551 | 0.110 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | 0.004 | 0.018 | 0.006 | 0.008 | 0.005 |
| | Total Phosphorus (mg/L) | 7 | 0.027 | 0.050 | 0.040 | 0.040 | 0.008 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 2.7 | 1.0 | 1.2 | 0.6 |
| | Chlorides (mg/L) | 7 | 3.8 | 11.5 | 7.0 | 6.9 | 2.7 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 8.01 | 21.89 | 14.42 | 14.39 | 4.85 |
| | E. coli (mpn/100mL)[J] | 3 | < 1 | 5 | 1 | 2 | 2 |

| Station | Parameter | N | Min | Max | Med | Mean | SD |
|---|---|---|---|---|---|---|---|
| **WDFA-3** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 4.7 | 7.3 | 6.8 | 6.3 | 0.1 |
| | Total Dissolved Solids (mg/L) | 7 | 42.0 | 84.0 | 72.0 | 67.1 | 16.3 |
| | Total Suspended Solids (mg/L) | 7 | < 1.0 | 7.0 | 5.0 | 4.2 | 2.5 |
| | Hardness (mg/L) | 4 | 39.9 | 50.6 | 42.4 | 43.8 | 4.8 |
| | Alkalinity (mg/L) | 7 | 42.2 | 57.8 | 46.8 | 47.4 | 5.2 |
| | Photic Zone (m) | 7 | 3.44 | 4.62 | 4.17 | 4.04 | 0.42 |
| | Secchi (m) | 7 | 0.73 | 1.80 | 1.22 | 1.29 | 0.34 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.023 | 0.203 | 0.082 | 0.103 | 0.072 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | < 0.080 | 0.516 | 0.324 | 0.310 | 0.168 |
| | Total Nitrogen (mg/L) | 7 | < 0.063 | 0.660 | 0.455 | 0.413 | 0.212 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | < 0.003 | 0.010 | 0.004 | 0.005 | 0.003 |
| | Total Phosphorus (mg/L) | 7 | 0.017 | 0.031 | 0.025 | 0.025 | 0.005 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 2.2 | 1.0 | 1.2 | 0.4 |
| | Chlorides (mg/L) | 7 | 3.2 | 5.2 | 3.6 | 3.9 | 0.7 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 2.14 | 45.92 | 11.75 | 19.30 | 14.60 |
| | E. coli (mpn/100mL) | 3 | 2 | 4 | 2 | 3 | 1 |
| **WDFA-4** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 10.1 | 17.6 | 13.5 | 13.8 | 2.9 |
| | Total Dissolved Solids (mg/L) | 7 | 16.0 | 108.0 | 78.0 | 77.1 | 29.6 |
| | Total Suspended Solids (mg/L) | 7 | < 1.0 | 16.0 | 12.0 | 11.2 | 5.5 |
| | Hardness (mg/L) | 4 | 46.2 | 55.2 | 49.2 | 50.0 | 3.8 |
| | Alkalinity (mg/L) | 7 | 53.5 | 64.5 | 56.1 | 57.8 | 3.8 |
| | Photic Zone (m) | 7 | 1.84 | 2.71 | 2.58 | 2.41 | 0.32 |
| | Secchi (m) | 7 | 0.58 | 0.75 | 0.69 | 0.68 | 0.06 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L)[J] | 7 | < 0.002 | 0.234 | 0.034 | 0.059 | 0.081 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.343 | 0.981 | 0.651 | 0.669 | 0.198 |
| | Total Nitrogen (mg/L)[J] | 7 | < 0.344 | 1.046 | 0.672 | 0.728 | 0.242 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | 0.004 | 0.007 | 0.006 | 0.006 | 0.001 |
| | Total Phosphorus (mg/L) | 7 | 0.047 | 0.078 | 0.052 | 0.060 | 0.013 |
| | CBOD-5 (mg/L) | 7 | 2.0 | 3.6 | 2.6 | 2.6 | 0.6 |
| | Chlorides (mg/L) | 7 | 4.0 | 5.2 | 4.5 | 4.6 | 0.4 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | < 0.10 | 48.06 | 26.70 | 26.09 | 14.85 |
| | E. coli (mpn/100mL)[J] | 3 | < 1 | 5 | 1 | 2 | 2 |

| Station | Parameter | N | Min | Max | Med | Mean | SD |
|---|---|---|---|---|---|---|---|
| **WDFA-5** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 7.5 | 19.5 | 10.9 | 12.6 | 5.2 |
| | Total Dissolved Solids (mg/L)[J] | 7 | 74.0 | 134.0 | 84.0 | 92.6 | 22.0 |
| | Total Suspended Solids (mg/L)[J] | 7 | 4.0 | 19.0 | 8.0 | 10.1 | 5.4 |
| | Hardness (mg/L) | 4 | 45.6 | 87.9 | 48.4 | 57.6 | 20.3 |
| | Alkalinity (mg/L) | 7 | 49.5 | 84.7 | 61.5 | 63.1 | 12.6 |
| | Photic Zone (m) | 7 | 1.91 | 3.25 | 2.58 | 2.61 | 0.50 |
| | Secchi (m) | 7 | 0.44 | 1.03 | 0.87 | 0.76 | 0.24 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.073 | 0.148 | 0.105 | 0.112 | 0.027 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | < 0.080 | 1.019 | 0.573 | 0.533 | 0.317 |
| | Total Nitrogen (mg/L) | 7 | < 0.145 | 1.143 | 0.663 | 0.645 | 0.324 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | 0.004 | 0.009 | 0.007 | 0.007 | 0.002 |
| | Total Phosphorus (mg/L) | 7 | 0.038 | 0.078 | 0.045 | 0.051 | 0.015 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 3.3 | 1.0 | 1.7 | 0.9 |
| | Chlorides (mg/L) | 7 | 3.8 | 5.6 | 4.2 | 4.5 | 0.8 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | < 0.10 | 33.57 | 13.35 | 16.86 | 12.74 |
| | E. coli (mpn/100mL) | 3 | < 1 | 7 | 5 | 5 | 3 |
| **WDFA-6** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 5.8 | 13.4 | 8.6 | 8.8 | 2.6 |
| | Total Dissolved Solids (mg/L) | 7 | 30.0 | 92.0 | 60.0 | 58.6 | 22.1 |
| | Total Suspended Solids (mg/L) | 7 | 2.0 | 6.0 | 5.0 | 4.7 | 1.6 |
| | Hardness (mg/L) | 4 | 12.7 | 37.8 | 34.2 | 29.8 | 11.6 |
| | Alkalinity (mg/L) | 7 | 14.1 | 48.7 | 38.7 | 34.9 | 14.2 |
| | Photic Zone (m) | 7 | 2.09 | 3.57 | 3.24 | 3.09 | 0.51 |
| | Secchi (m) | 7 | 0.74 | 1.32 | 1.15 | 1.07 | 0.20 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.021 | 0.010 | 0.010 | 0.000 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.021 | 0.264 | 0.068 | 0.103 | 0.087 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.367 | 0.711 | 0.567 | 0.537 | 0.111 |
| | Total Nitrogen (mg/L) | 7 | 0.515 | 0.739 | 0.635 | 0.640 | 0.078 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | 0.003 | 0.007 | 0.005 | 0.005 | 0.002 |
| | Total Phosphorus (mg/L) | 7 | 0.021 | 0.031 | 0.025 | 0.026 | 0.004 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 2.6 | 1.0 | 1.2 | 0.6 |
| | Chlorides (mg/L) | 7 | 3.2 | 7.4 | 5.7 | 5.5 | 1.7 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | < 0.10 | 16.02 | 10.68 | 9.39 | 5.81 |
| | E. coli (mpn/100mL)[J] | 3 | < 1 | 7 | 2 | 4 | 3 |

| Station | Parameter | N | Min | Max | Med | Mean | SD |
|---|---|---|---|---|---|---|---|
| **WDFA-7** | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 6.9 | 13.2 | 9.5 | 9.6 | 2.3 |
| | Total Dissolved Solids (mg/L)[J] | 7 | 72.0 | 102.0 | 84.0 | 84.6 | 10.0 |
| | Total Suspended Solids (mg/L) | 7 | 4.0 | 13.0 | 7.0 | 7.9 | 3.4 |
| | Hardness (mg/L) | 4 | 36.6 | 45.6 | 44.0 | 42.6 | 4.1 |
| | Alkalinity (mg/L) | 7 | 40.7 | 53.0 | 51.1 | 49.1 | 4.5 |
| | Photic Zone (m) | 7 | 2.20 | 3.99 | 3.25 | 3.16 | 0.63 |
| | Secchi (m) | 7 | 0.73 | 1.30 | 1.12 | 1.02 | 0.23 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.021 | 0.032 | 0.010 | 0.014 | 0.008 |
| | Nitrate+Nitrite Nitrogen (mg/L)[J] | 7 | 0.007 | 0.227 | 0.045 | 0.077 | 0.080 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.297 | 1.217 | 0.548 | 0.664 | 0.300 |
| | Total Nitrogen (mg/L)[J] | 7 | 0.324 | 1.360 | 0.699 | 0.741 | 0.330 |
| | Dissolved Reactive Phosphorus (mg/L)[J] | 7 | 0.003 | 0.006 | 0.004 | 0.004 | 0.001 |
| | Total Phosphorus (mg/L) | 7 | 0.032 | 0.050 | 0.037 | 0.039 | 0.006 |
| | CBOD-5 (mg/L) | 7 | < 2.0 | 2.6 | 1.0 | 1.6 | 0.8 |
| | Chlorides (mg/L) | 7 | 5.5 | 8.3 | 7.1 | 6.8 | 1.1 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 4.81 | 23.50 | 21.89 | 17.32 | 7.78 |
| | E. coli (mpn/100mL)[J] | 3 | < 1 | 2 | 1 | 1 | 1 |

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