# 2008 Harding 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
December 2012

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# 2008

# Harding Reservoir

Chattahoochee River Basin

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# 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 |
| USACE | United States Army Corp of Engineers |
| USEPA | United States Environmental Protection Agency |
| USACE | United States Geological Survey |

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## INTRODUCTION

Originally constructed by Columbus Electric and Power Company in 1926, Harding Reservoir, also known as Bartlett's Ferry, was acquired by Georgia Power in 1930 and operated for hydropower ever since. The reservoir stretches from just north of Columbus, GA to Valley, AL and covers 5,850 acres along the Alabama/Georgia state line. Most of Harding's flow comes from upstream West Point Reservoir and three large tributaries, two in Alabama (Osanippa and Halawakee Creeks) and one in Georgia (Mountain Oak Creek).

The Alabama Department of Environmental Management (ADEM) monitored Harding Reservoir as part of the 2008 assessment of the Chattahoochee and Perdido-Escambia River Basins under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the objectives of this program are to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs), and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2012 Monitoring Strategy.

In 2004, the ADEM implemented a specific water quality criterion for nutrient management at the forebay station of Harding Reservoir, which has been monitored by ADEM since 1990. This criterion represent the maximum growing season mean (April-October) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting Harding Reservoir's Public Water Supply, Swimming, and Fish & Wildlife (PWS/S/F&W) use classifications.

The purpose of this report is to summarize data collected at four stations in Harding Reservoir during the 2008 growing season and to evaluate growing season trends in lake trophic status and nutrient concentrations using ADEM's ten-year dataset. Monthly and/or mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chl *a*; algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's historical data and established criteria.

## METHODS

Sampling stations were selected using historical data and previous assessments (Fig. 1). Specific location information can be found in Table 1. Harding Reservoir was sampled in the dam forebay and upper reservoir along with two tributary stations; Halawakee and Osanippa Creeks.

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 2008), Surface Water Quality Assurance Project Plan (ADEM 2005), and Quality Management Plan (ADEM 2003).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Monthly concentrations of these parameters were graphed with the closest available USACE flow data and ADEM's previously collected data to help interpret the 2008 results.

Figure 1. Harding Reservoir with 2008 sampling locations.

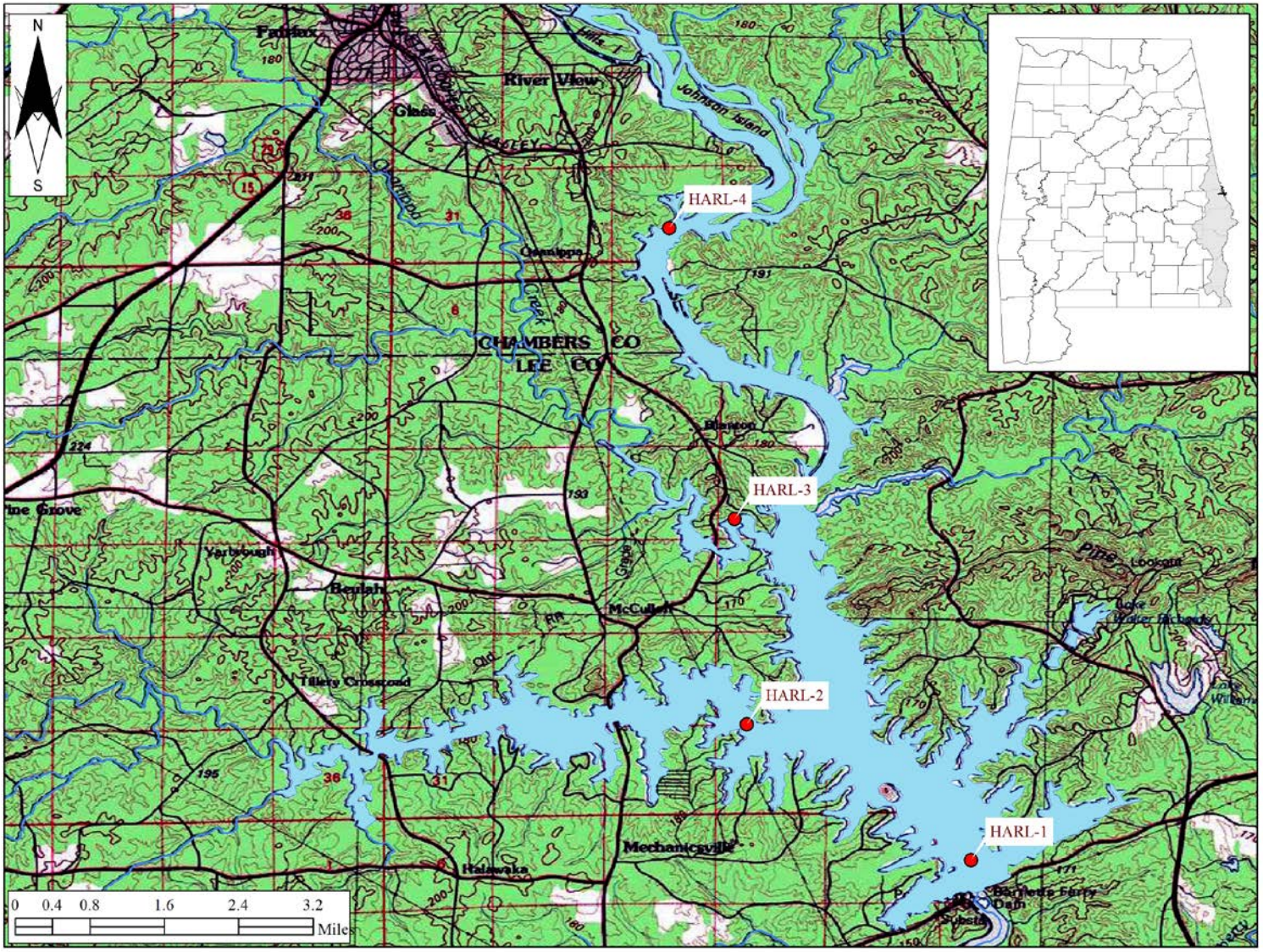


Table 1. Descriptions of the 2008 monitoring stations in Harding Reservoir.

| HUC | County | Station Number | Report Designation | Waterbody Name | Station Description | Chl *a* Criteria | Latitude | Longitude |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 031300021109 | Lee | HARL-1* | Lower | Chattahoochee R | Deepest point, main river channel, dam forebay. | 15 µg/l | 32.66763 | -85.09190 |
| 031300021108 | Lee | HARL-2 | Halawakee Ck | Halawakee Ck | Deepest point, main channel, Halawakee Ck embayment. | | 32.68878 | -85.12679 |
| 031300021105 | Lee | HARL-3 | Osanippa Ck | Osanippa Ck | Deepest point, main channel, Osanippa Ck embayment | | 32.72072 | -85.12866 |
| 031300021109 | Chambers | HARL-4 | Upper | Chattahoochee R | Deepest point, main river channel, immediately downstream of Johnson Island. | | 32.76599 | -85.13879 |

*Growing season mean chl *a* criteria implemented at this station in 2004.

## 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 11). 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 Figs. 9-10. Summary statistics of all data collected during 2008 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 2008 the highest mean growing season TN value calculated among Harding Reservoir stations was in the upper station which is consistent with 1999 and 2004 (Fig. 2). Mean growing season TN values in the Halawakee Ck and lower stations increased 2003-2007 but decreased in 2008, while Osanippa Ck increased 1999-2008. Monthly TN concentrations decreased through the growing season until August or September in all Harding stations (Fig. 4). The upper and Osanippa Ck stations measured record highs in April and/or August while both the lower and Halawakee Ck stations were below historic means August-October.

Mean growing season TP values in 2008 were similar between the Halawakee Ck and the lower stations, while the highest mean TP value was in Osanippa Ck (Fig. 2). Mean growing season values at all stations decreased 2004 through 2008 (Fig. 2). Monthly TP concentrations in the upper, Halawakee Ck and lower stations were similar April-September, and were at or below historic means in almost all months (Fig. 5). Concentrations in Osanippa Ck were nearly double the other stations in August and September (Fig. 5).

A specific water quality criterion for nutrient management has been established for the lower station in Harding Reservoir. The growing season mean chl *a* concentration measured in

2008 was in compliance with the criteria limit (Fig. 3). The growing season mean chl *a* value in all but the Osanippa Ck stations in 2008 were the lowest of all seasons sampled (1999-2008). Both the Halawakee Ck and the lower station have decreased concentrations overall since 2002 while the upper and Osanippa Ck stations were similar to previous years sampled (Fig. 3). Monthly chl *a* concentrations in the riverine upper station were very low (<2.0 µg/l) April-October (Fig. 6). Halawakee Ck and the lower station were below historic means May-September, reaching historic low concentrations in May and/or July. Monthly concentrations in August and September in Osanippa Ck were over double the other stations and the highest on record (Fig. 6).

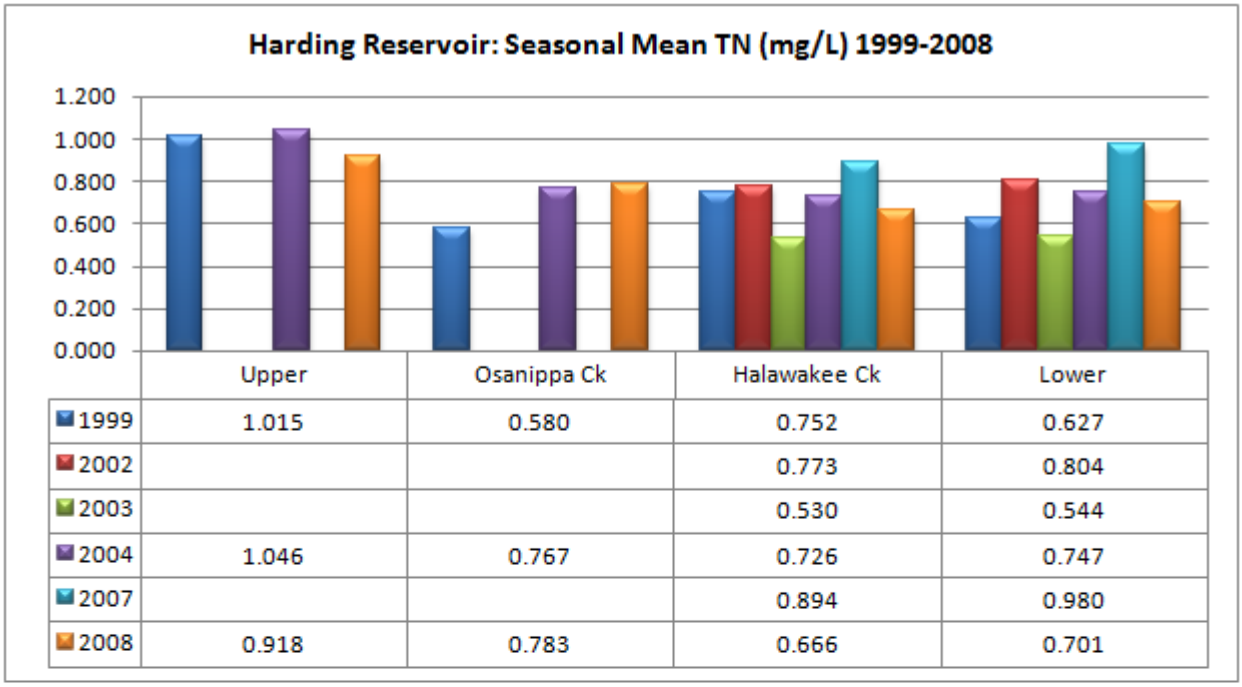
The mean growing season TSS values calculated in 2008 in all Harding Reservoir stations were the lowest of all years sampled (Fig. 3). This continues the trend, since growing season mean TSS concentrations have decreased since 2003. Monthly TSS concentrations measured in all stations were at or below historic means April or May through October (Fig. 7).

AGPT results at all stations in Harding have remained phosphorus limited since testing began in 1999 (Table 2). MSC results in the lower and Halawakee Ck stations have remained below 5 mg/L MSC all months monitored, the value that Raschke et al. (1996) defined as protective of reservoir and lake systems. The MSC for Osanipp Ck was >5 mg/L when sampled in June 1999. MSC results in the upper station are below 20 mg/L MSC, the value that Raschke et al. (1996) defined as protective of flowing stream and river systems.

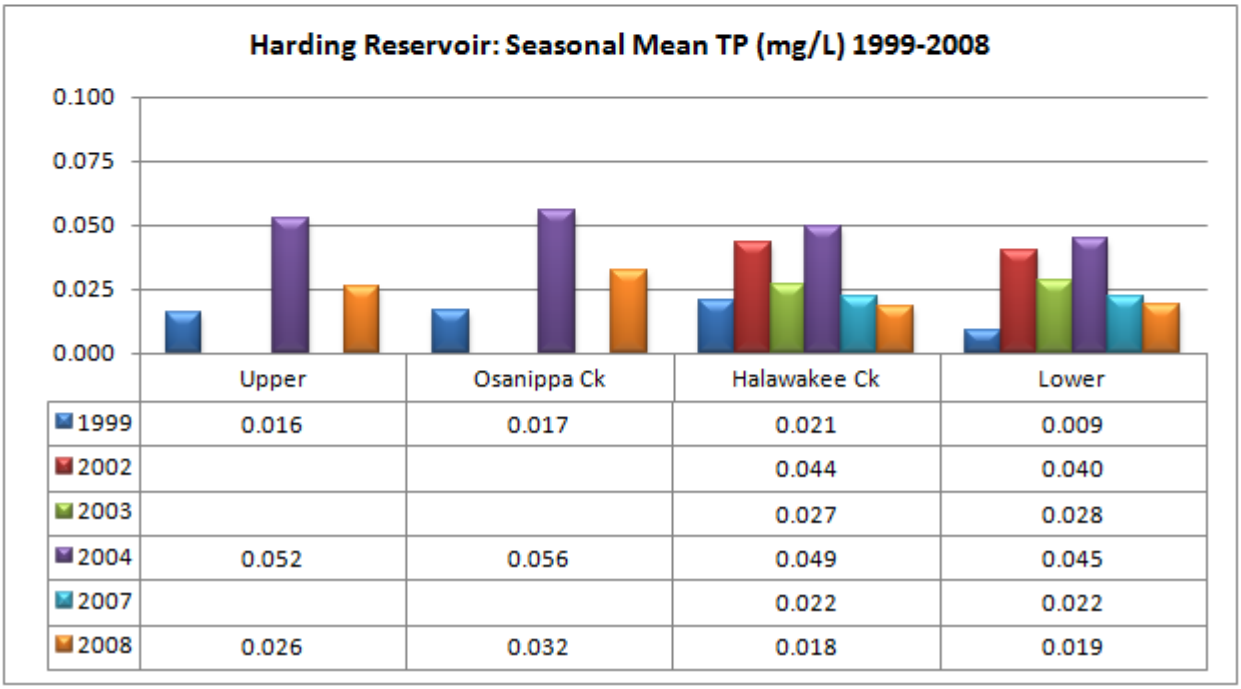
Measurements of dissolved oxygen (DO) at all stations met the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) (Fig. 8) though concentrations at the lower, Halawakee Ck, and Osanippa Ck stations were below 6 mg/l in September. Based on monthly DO profiles, anoxic conditions existed during June and July in both the lower and Halawakee Ck stations at depths greater than 9.0m, as well as below 20.0 m in the lower station in May and September (Figs. 9 & 10). Highest temperatures were measured in July.

Monthly TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. TSI values calculated for the lower Harding Reservoir station were mostly mesotrophic while the upper station was oligotrophic in all months monitored (Fig. 11). Halawakee and Osanippa fluctuated between mesotrophic and eutrophic conditions with a drop to oligotrophic conditions in May (Fig. 11). Osanippa Ck TSI was highly eutrophic in August.

Figure 2. Mean growing season TN and TP measured in Harding Reservoir, April-October, 1999-2008. Stations are illustrated from upstream to downstream as the graph is read from left to right.

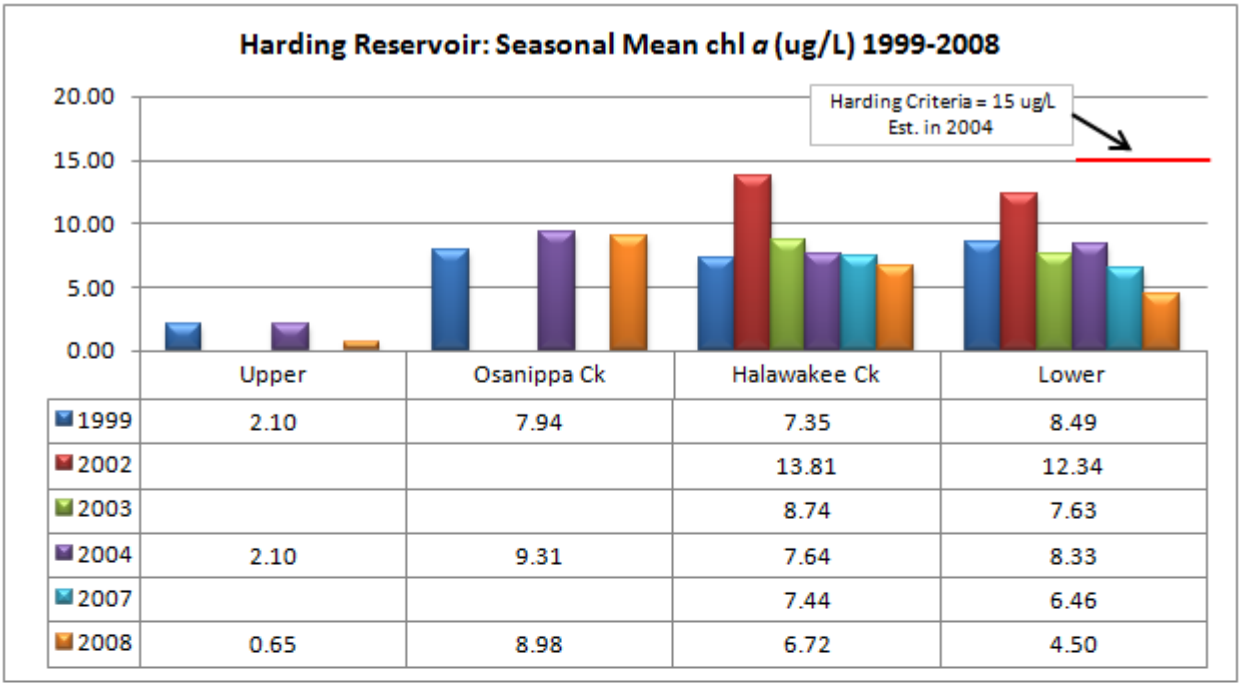



| | Upper | Osanippa Ck | Halawakee Ck | Lower |
|---|---|---|---|---|
| 1999 | 1.015 | 0.580 | 0.752 | 0.627 |
| 2002 | | | 0.773 | 0.804 |
| 2003 | | | 0.530 | 0.544 |
| 2004 | 1.046 | 0.767 | 0.726 | 0.747 |
| 2007 | | | 0.894 | 0.980 |
| 2008 | 0.918 | 0.783 | 0.666 | 0.701 |

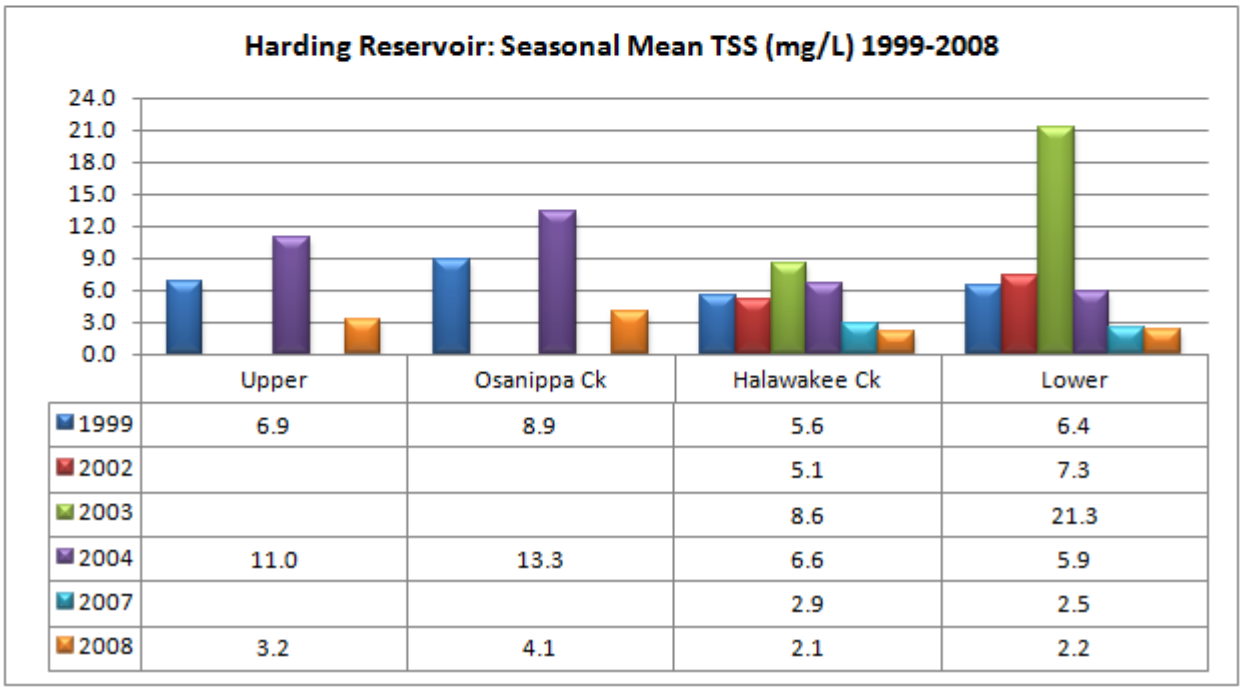



| | Upper | Osanippa Ck | Halawakee Ck | Lower |
|---|---|---|---|---|
| 1999 | 0.016 | 0.017 | 0.021 | 0.009 |
| 2002 | | | 0.044 | 0.040 |
| 2003 | | | 0.027 | 0.028 |
| 2004 | 0.052 | 0.056 | 0.049 | 0.045 |
| 2007 | | | 0.022 | 0.022 |
| 2008 | 0.026 | 0.032 | 0.018 | 0.019 |

Figure 3. Mean growing season chl *a* and TSS measured in Harding Reservoir, April-October, 1999-2008. Stations are illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criteria applies to the growing season mean of the lower station only.




| | Upper | Osanippa Ck | Halawakee Ck | Lower |
|---|---|---|---|---|
| 1999 | 2.10 | 7.94 | 7.35 | 8.49 |
| 2002 | | | 13.81 | 12.34 |
| 2003 | | | 8.74 | 7.63 |
| 2004 | 2.10 | 9.31 | 7.64 | 8.33 |
| 2007 | | | 7.44 | 6.46 |
| 2008 | 0.65 | 8.98 | 6.72 | 4.50 |




| | Upper | Osanippa Ck | Halawakee Ck | Lower |
|---|---|---|---|---|
| 1999 | 6.9 | 8.9 | 5.6 | 6.4 |
| 2002 | | | 5.1 | 7.3 |
| 2003 | | | 8.6 | 21.3 |
| 2004 | 11.0 | 13.3 | 6.6 | 5.9 |
| 2007 | | | 2.9 | 2.5 |
| 2008 | 3.2 | 4.1 | 2.1 | 2.2 |

Figure 4. Monthly TN concentrations measured in Harding Reservoir, April-October 2008 vs. average monthly discharge. Monthly discharge acquired from USACE at West Point Dam. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

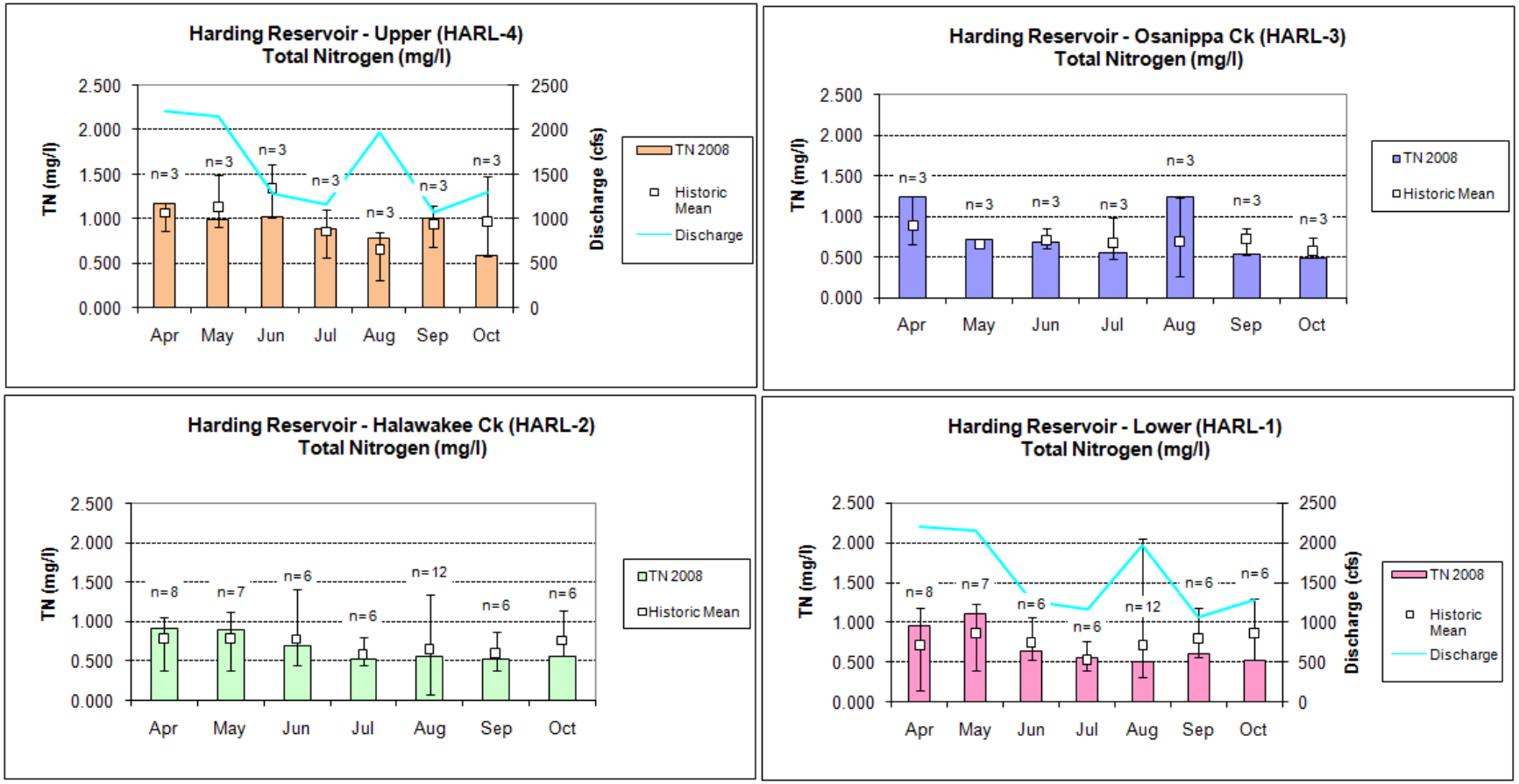


Figure 5. Monthly TP concentrations measured in Harding Reservoir, April-October 2008 vs. average monthly discharge. Monthly discharge acquired from USACE at West Point Dam. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

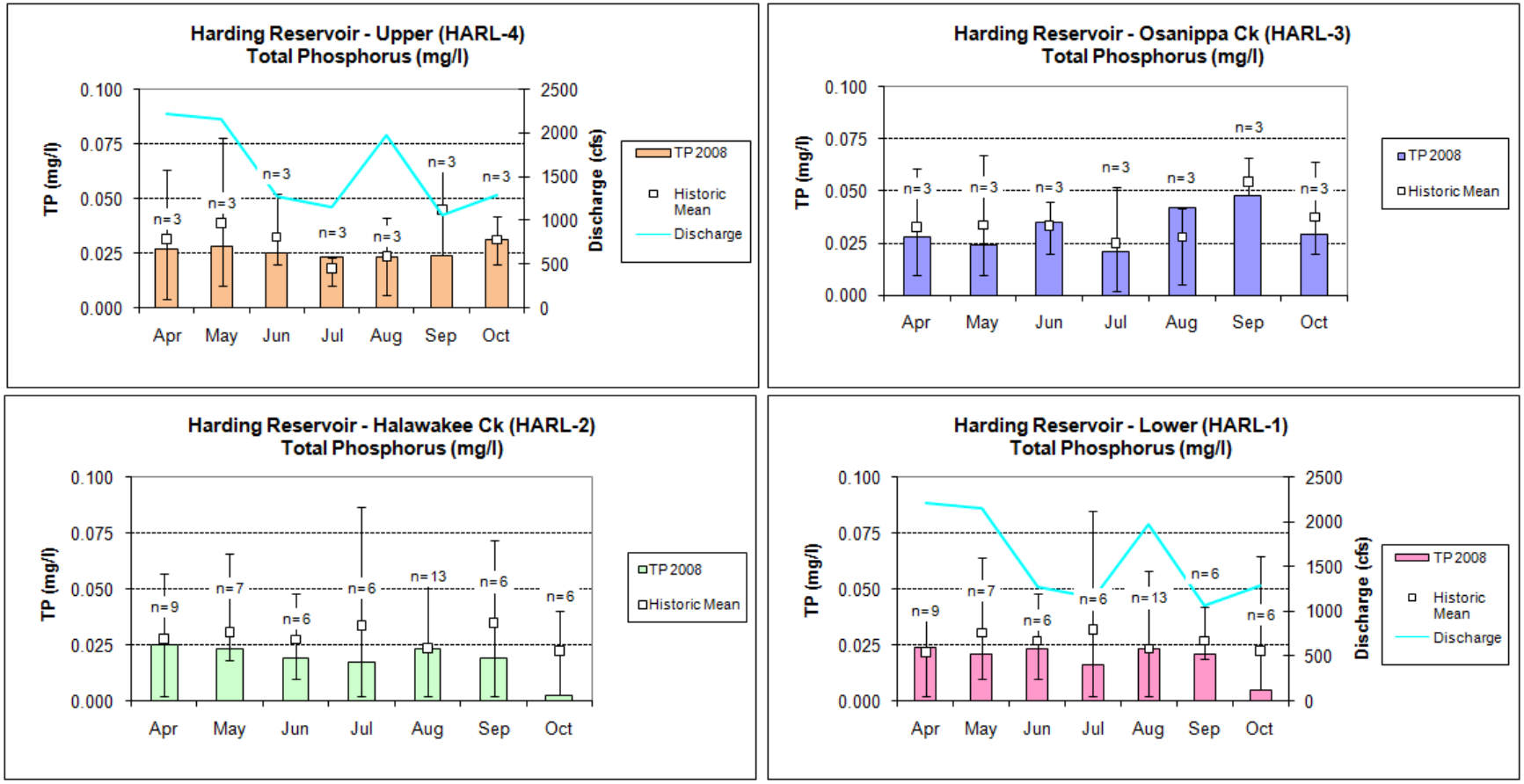


Figure 6. Monthly chl *a* concentrations measured in Harding Reservoir, April-October 2008 vs. average monthly discharge. Monthly discharge acquired from USACE at West Point Dam. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations. The scale of the vertical axis of the upper station is smaller than the other two stations to allow visibility of the results.

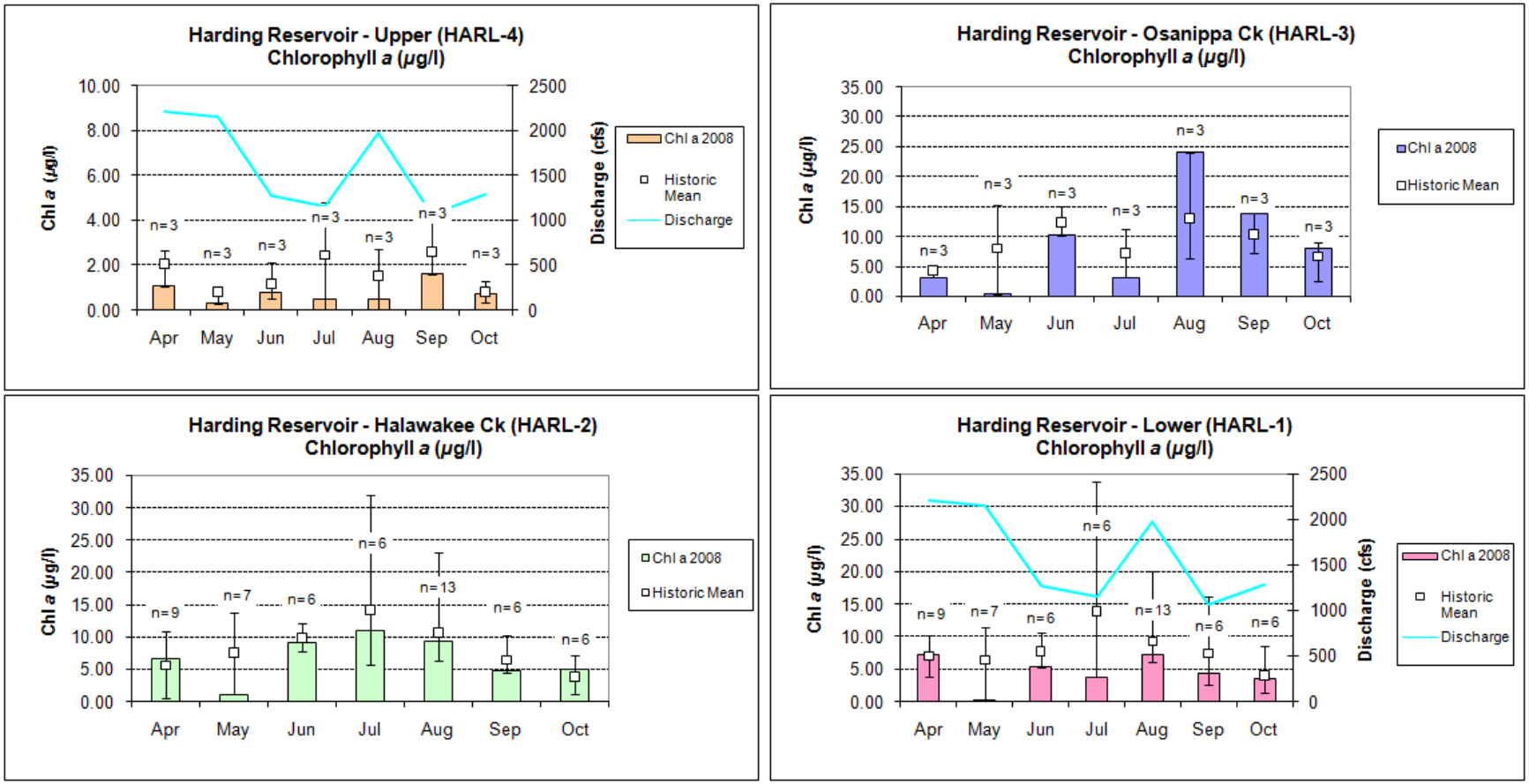


Figure 7. Monthly TSS concentrations measured in Harding Reservoir, April-October 2008 vs. average monthly discharge. Monthly discharge acquired from USACE at West Point Dam. Each bar graph depicts monthly changes in each station. The historic mean (1990-2008) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

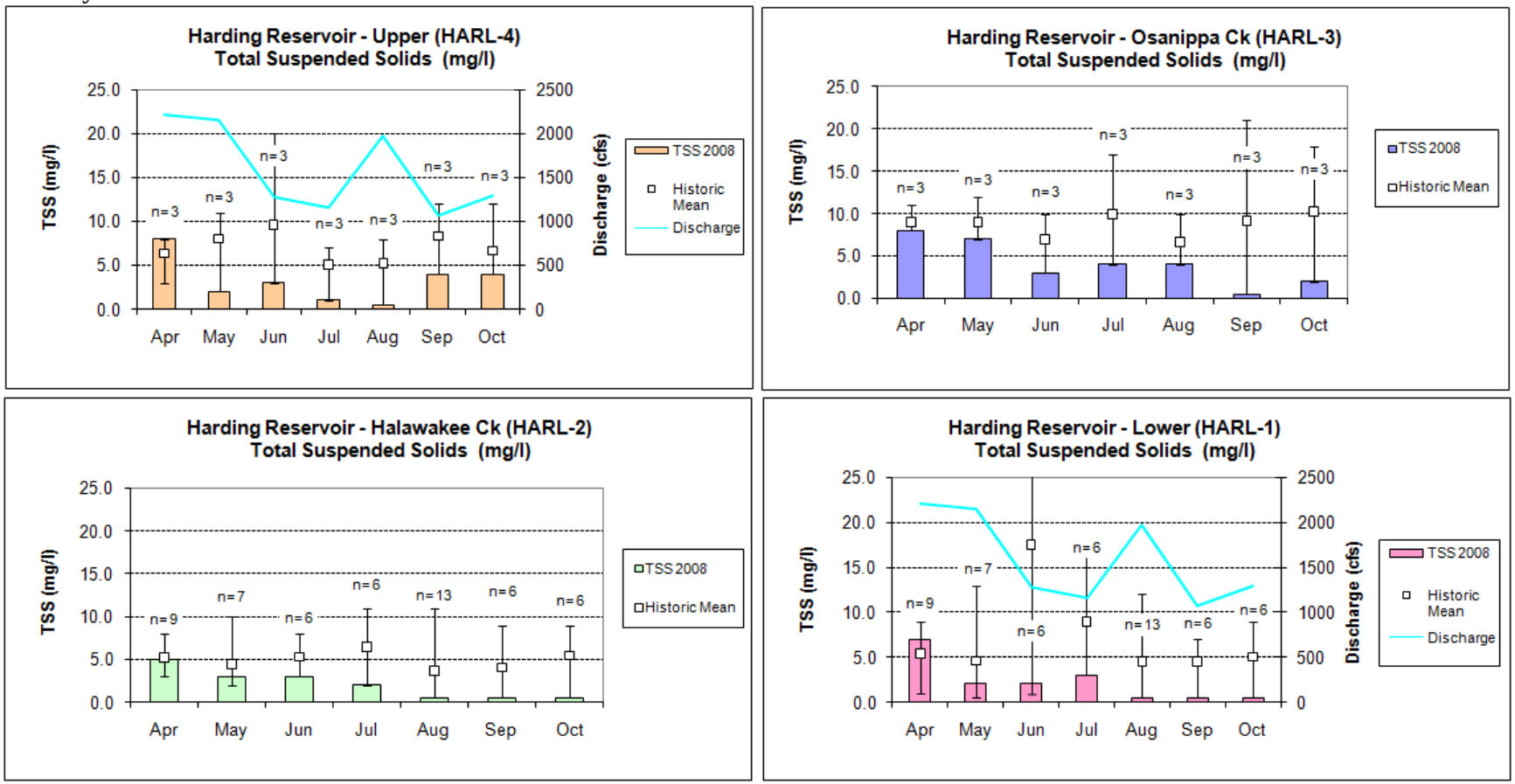


Table 2. Algal growth potential test results, Harding Reservoir, 1999-2008 (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

| | **Upper** | | **Osanippa Ck** | | **Halawakee Cr** | | **Lower** | |
|---|---|---|---|---|---|---|---|---|
| June 1999 | 5.18 | Phosphorus | 6.99 | Phosphorus | 1.57 | Phosphorus | 1.34 | Phosphorus |
| July 1999 | 6.14 | Phosphorus | 2.74 | Phosphorus | 3.43 | Phosphorus | 2.48 | Phosphorus |
| August 1999 | 2.62 | Phosphorus | 1.74 | Phosphorus | 1.51 | Phosphorus | 1.84 | Phosphorus |
| August 2004 | 5.27 | Phosphorus | --- | --- | 2.47 | Phosphorus | 2.36 | Phosphorus |
| August 2008 | --- | --- | --- | --- | 3.93 | Phosphorus | 3.59 | Phosphorus |

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Harding Reservoir stations collected April-October 2008. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).

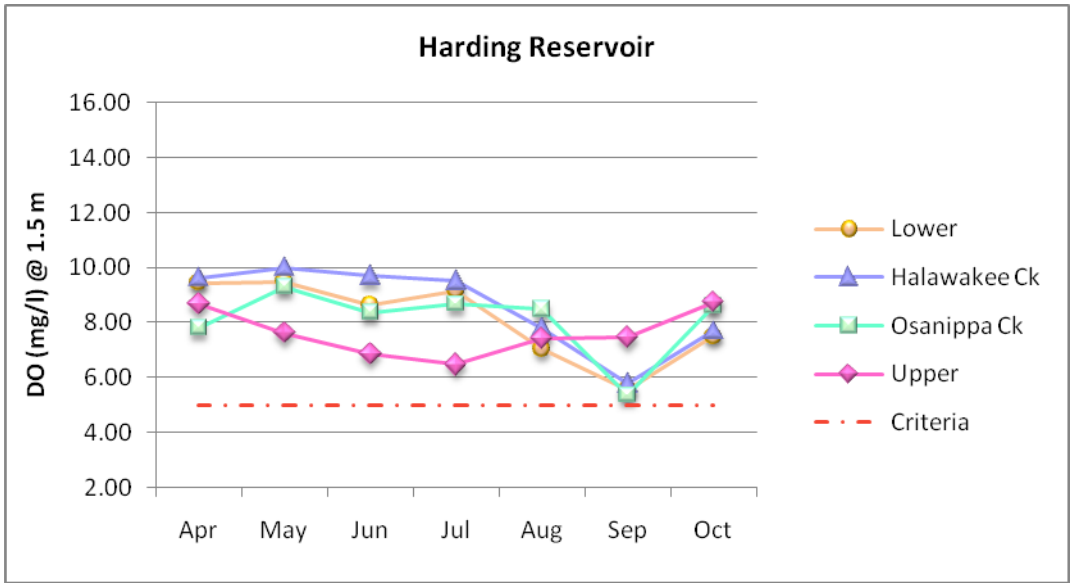


Figure 9. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the lower Harding Reservoir station, April-October 2008.

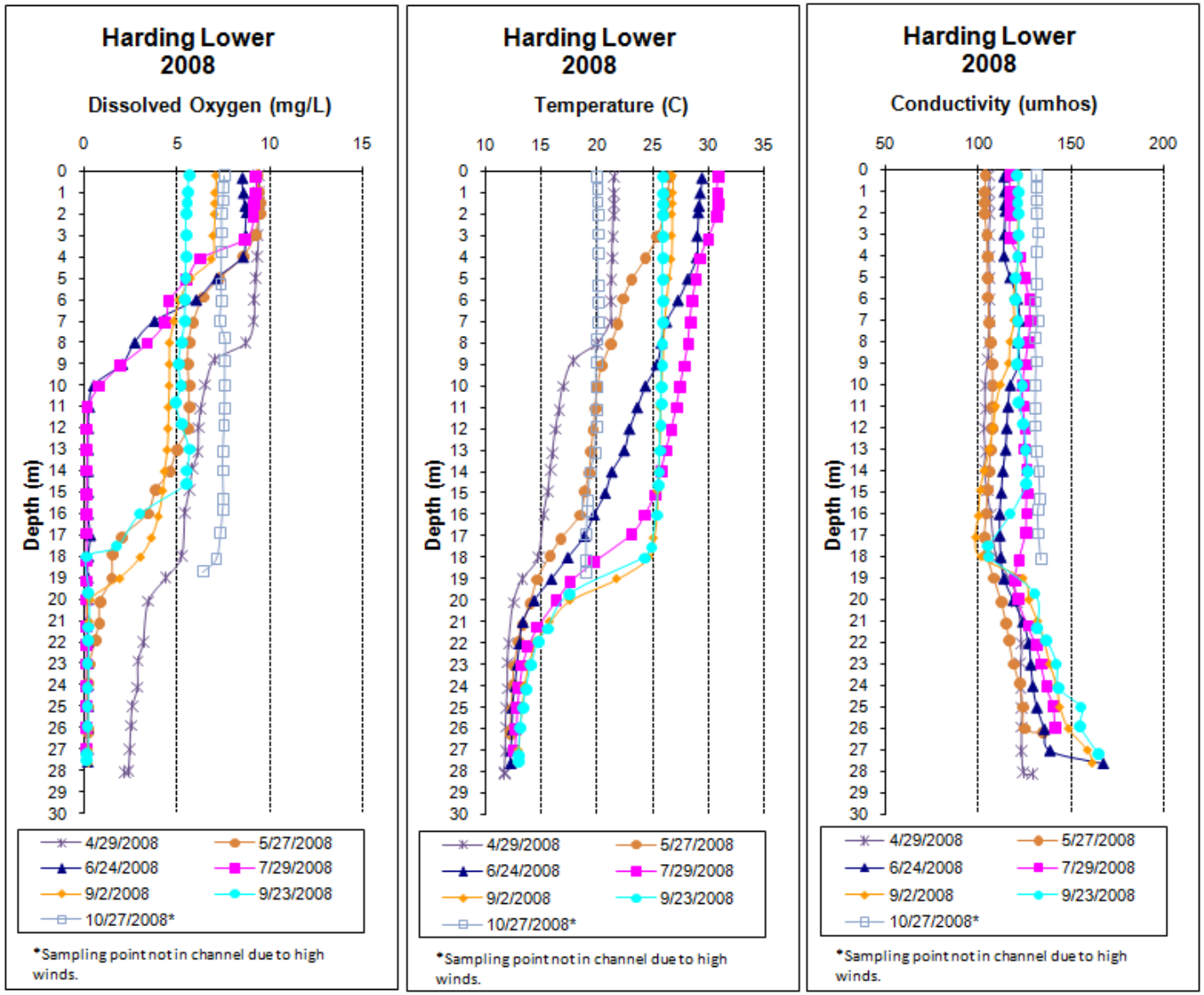


Figure 10. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the Halawakee Ck station, April-October 2008.

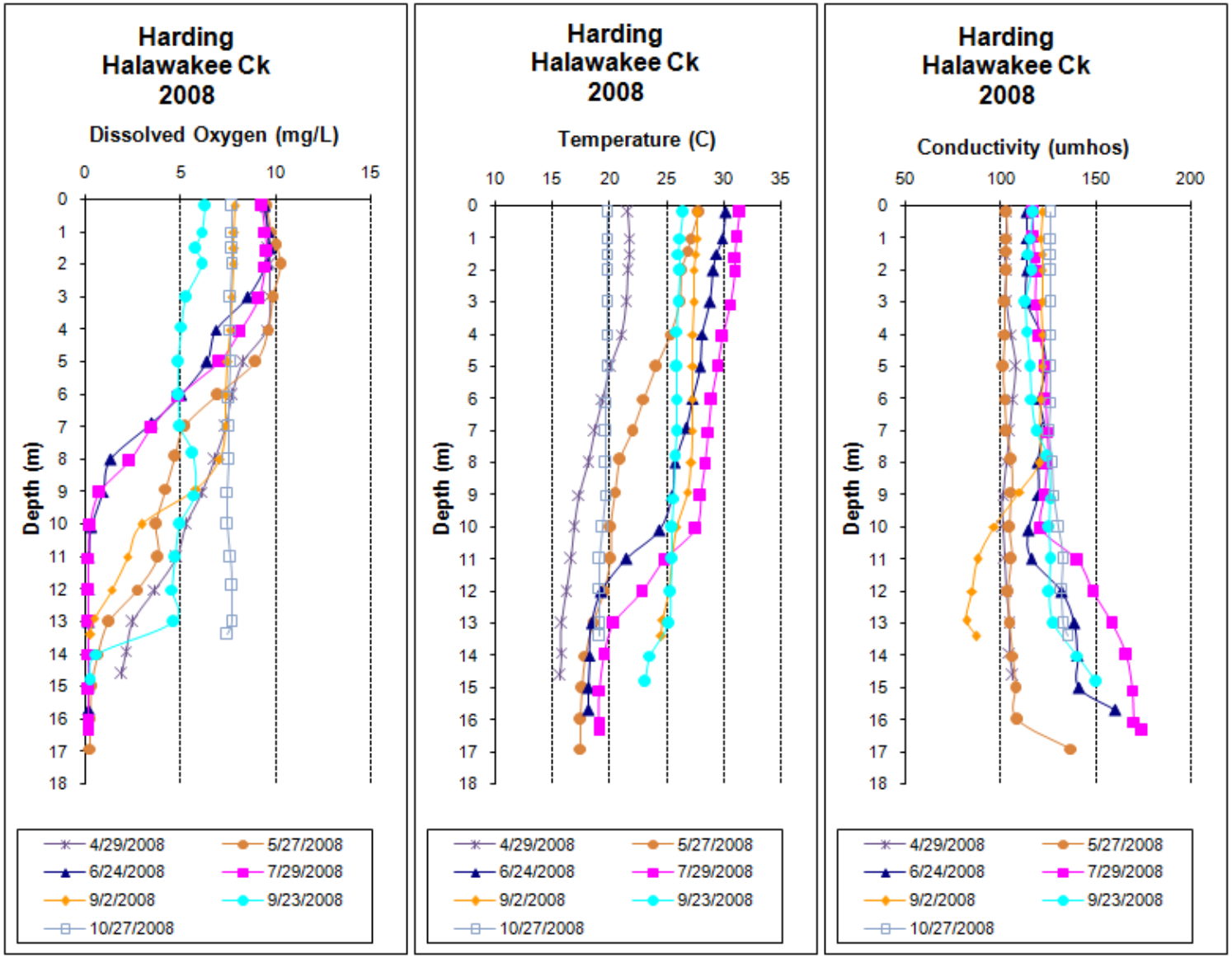
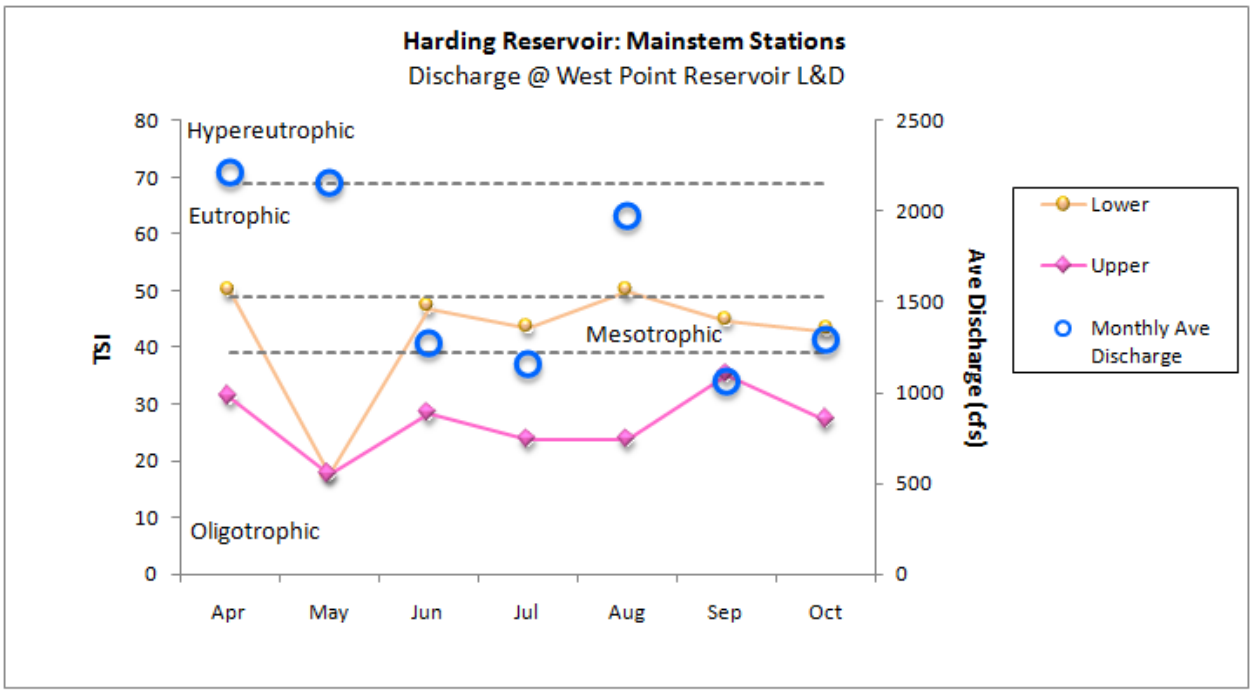
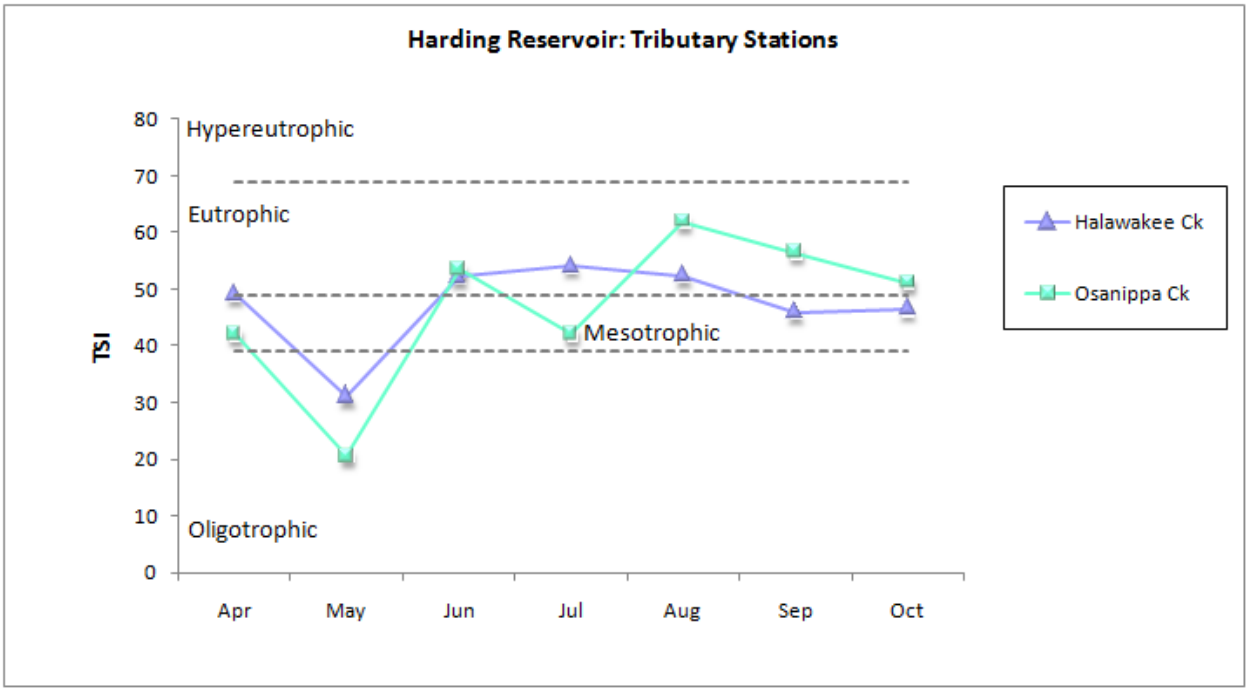


Figure 11. Monthly TSI values calculated for mainstem and tributary Harding Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from USACE at West Point Lock and Dam.



## REFERENCES


ADEM. 2003. Quality Assurance Management Plan For The Alabama Department Of Environmental, Alabama Department of Environmental Management (ADEM), Montgomery, AL. 25 pp.

ADEM. 2005. Study Plan and Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring of Non-Wadeable Rivers, Reservoirs, Tributary Embayments, and Estuarine/Marine Waters in Alabama. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 110 pp.

ADEM. 2008 (as amended). Standard Operating Procedures #2041 *In Situ* Surface Water Quality Field Measurements-Temperature, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2042 *In Situ* Surface Water Quality Field Measurements-pH, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2043 *In Situ* Surface Water Quality Field Measurements–Conductivity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2044 *In Situ* Surface Water Quality Field Measurements–Turbidity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2045 *In Situ* Surface Water Quality Field Measurements–Dissolved Oxygen, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2046 Photic Zone Measurement and Visibility Determination, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2061 General Surface Water Sample Collection, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2062 Dissolved Reactive Phosphorus (DRP) Surface Water Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2008 (as amended). Standard Operating Procedures #2063 Water Column Chlorophyll *a* Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2005. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.11). 2005. Water Quality Criteria Applicable to Specific Lakes. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1998. Standard methods for the examination of water and wastewater. 20th edition. APHA, Washington, D.C.

Carlson, R.E. 1977. A trophic state index. Limnology and Oceanography. 22(2):361-369.

Lind, O.T. 1979. Handbook of common methods in limnology. The C.V. Mosby Co., St. Louis, Missouri. 199 pp.

Raschke, R.L. and D.A. Schultz. 1987. The use of the algal growth potential test for data assessment. Journal of Water Pollution Control Federation 59(4):222-227.

Raschke, R. L., H. S. Howard, J. R. Maudsley, and R. J. Lewis. 1996. The Ecological Condition of Small Streams in the Savannah River Basin: A REMAP Progress Report. EPA Region 4, Science and Ecosystem Support Division, Ecological Assessment Branch, Athens, GA.

U.S. Environmental Protection Agency. 1990. The lake and reservoir restoration guidance manual. 2nd edition. EPA-440/4-90-006. U.S.E.P.A. Office of Water. Washington, D.C. 326 pp.

Welch, E.B. 1992. Ecological Effects of Wastewater. 2nd edition. Chapman and Hall Publishers. London, England. 425 pp.

Wetzel, R.G. 1983. Limnology. 2nd edition. Saunders College Publishing. Philadelphia, Pennsylvania. 858 pp.

# APPENDIX

Appendix Table 1. Summary of Harding Reservoir water quality data collected April-October, 2008. 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 |
|---|---|---|---|---|---|---|---|
| HARL-1 | Physical | | | | | | |
| | Turbidity (NTU) | 7 | 1.9 | 4.3 | 2.4 | 2.7 | 0.8 |
| | Total Dissolved Solids (mg/L) | 7 | 52.0 | 88.0 | 62.0 | 62.9 | 13.1 |
| | Total Suspended Solids (mg/L) | 7 | < 1.0 | 7.0 | 2.0 | 2.2 | 2.3 |
| | Hardness (mg/L) | 4 | 17.6 | 26.2 | 21.6 | 21.8 | 4.6 |
| | Alkalinity (mg/L) | 7 | 20.1 | 30.4 | 25.9 | 26.0 | 4.0 |
| | Photic Zone (m) | 7 | 3.65 | 6.86 | 6.25 | 5.84 | 1.11 |
| | Secchi (m) | 7 | 1.80 | 2.26 | 2.02 | 2.03 | 0.20 |
| | Chemical | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.015 | 0.055 | 0.008 | 0.014 | 0.018 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.276 | 0.693 | 0.453 | 0.459 | 0.156 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | < 0.150 | 0.487 | 0.230 | 0.242 | 0.128 |
| | Total Nitrogen (mg/L) | 7 | < 0.506 | 1.113 | 0.611 | 0.701 | 0.239 |
| | Dissolved Reactive Phosphorus (mg/L) | 7 | 0.006 | 0.011 | 0.008 | 0.009 | 0.002 |
| | Total Phosphorus (mg/L) [J] | 7 | 0.005 | 0.024 | 0.021 | 0.019 | 0.007 |
| | CBOD-5 (mg/L) | 7 | < 1.0 | 2.0 | 0.5 | 0.6 | 0.2 |
| | Chlorides (mg/L) | 7 | 2.4 | 11.6 | 9.1 | 8.5 | 2.9 |
| | Biological | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 0.27 | 7.21 | 4.27 | 4.50 | 2.39 |
| | Fecal Coliform (col/100 mL)[J] | 1 | | | | 5 | |
| | | | | | | | |
| HARL-2 | Physical | | | | | | |
| | Turbidity (NTU) | 7 | 2.5 | 8.2 | 3.2 | 3.9 | 2.0 |
| | Total Dissolved Solids (mg/L) | 7 | 38.0 | 76.0 | 48.0 | 53.7 | 14.7 |
| | Total Suspended Solids (mg/L) | 7 | < 1.0 | 5.0 | 2.0 | 2.1 | 1.7 |
| | Hardness (mg/L) | 4 | 17.8 | 25.8 | 21.0 | 21.4 | 4.1 |
| | Alkalinity (mg/L) | 7 | 20.1 | 29.1 | 25.6 | 25.5 | 3.5 |
| | Photic Zone (m) | 7 | 4.15 | 6.35 | 5.35 | 5.36 | 0.80 |
| | Secchi (m) | 7 | 1.49 | 2.18 | 1.73 | 1.79 | 0.21 |
| | Chemical | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.015 | 0.045 | 0.008 | 0.015 | 0.014 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.235 | 0.605 | 0.380 | 0.388 | 0.149 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.162 | 0.329 | 0.307 | 0.278 | 0.062 |
| | Total Nitrogen (mg/L) | 7 | 0.516 | 0.912 | 0.561 | 0.666 | 0.173 |
| | Dissolved Reactive Phosphorus (mg/L) | 7 | 0.006 | 0.011 | 0.008 | 0.008 | 0.002 |
| | Total Phosphorus (mg/L) [J] | 7 | < 0.005 | 0.025 | 0.019 | 0.018 | 0.008 |
| | CBOD-5 (mg/L) | 7 | < 1.0 | 2.0 | 0.5 | 0.6 | 0.2 |
| | Chlorides (mg/L)[J] | 7 | 7.2 | 12.2 | 9.0 | 9.1 | 1.6 |
| | Biological | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 1.07 | 11.04 | 6.68 | 6.72 | 3.39 |
| | Fecal Coliform (col/100 mL)[J] | 1 | | | | 3 | |

| Station | Parameter | N | Min | Max | Med | Avg | SD |
|---|---|---|---|---|---|---|---|
| HARL-3 | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 5.4 | 10.3 | 8.1 | 7.8 | 2.1 |
| | Total Dissolved Solids (mg/L) | 7 | 26.0 | 86.0 | 68.0 | 59.7 | 25.2 |
| | Total Suspended Solids (mg/L) | 7 | < 1.0 | 8.0 | 4.0 | 4.1 | 2.6 |
| | Hardness (mg/L) | 4 | 15.5 | 26.2 | 22.6 | 21.7 | 5.3 |
| | Alkalinity (mg/L) | 7 | 21.9 | 29.2 | 27.4 | 26.4 | 2.9 |
| | Photic Zone (m) | 7 | 1.86 | 3.68 | 2.91 | 2.73 | 0.61 |
| | Secchi (m) | 7 | 0.78 | 1.42 | 1.05 | 1.10 | 0.22 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.015 | 0.026 | 0.008 | 0.010 | 0.007 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.184 | 0.643 | 0.325 | 0.319 | 0.159 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | 0.173 | 1.056 | 0.348 | 0.465 | 0.290 |
| | Total Nitrogen (mg/L) | 7 | 0.498 | 1.249 | 0.683 | 0.783 | 0.325 |
| | Dissolved Reactive Phosphorus (mg/L) | 7 | 0.008 | 0.011 | 0.011 | 0.010 | 0.001 |
| | Total Phosphorus (mg/L) | 7 | 0.021 | 0.048 | 0.029 | 0.032 | 0.010 |
| | CBOD-5 (mg/L) | 7 | < 1.0 | 2.0 | 0.5 | 0.6 | 0.2 |
| | Chlorides (mg/L)[J] | 7 | 6.2 | 9.9 | 7.2 | 7.5 | 1.4 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | 0.36 | 24.03 | 8.01 | 8.98 | 8.10 |
| | Fecal Coliform (col/100 mL)[J] | 1 | | | | 20 | |
| HARL-4 | **Physical** | | | | | | |
| | Turbidity (NTU) | 7 | 3.2 | 8.9 | 3.9 | 4.6 | 2.0 |
| | Total Dissolved Solids (mg/L) | 7 | 40.0 | 90.0 | 66.0 | 62.9 | 17.4 |
| | Total Suspended Solids (mg/L) [J] | 7 | < 1.0 | 8.0 | 3.0 | 3.2 | 2.5 |
| | Hardness (mg/L) | 4 | 21.0 | 28.4 | 24.5 | 24.6 | 4.0 |
| | Alkalinity (mg/L) | 7 | 22.6 | 34.1 | 29.0 | 28.5 | 4.3 |
| | Photic Zone (m) | 7 | 3.00 | 4.40 | 3.70 | 3.68 | 0.44 |
| | Secchi (m) | 6 | 1.15 | 2.61 | 1.88 | 1.86 | 0.48 |
| | **Chemical** | | | | | | |
| | Ammonia Nitrogen (mg/L) | 7 | < 0.015 | 0.155 | 0.008 | 0.034 | 0.054 |
| | Nitrate+Nitrite Nitrogen (mg/L) | 7 | 0.430 | 0.832 | 0.629 | 0.602 | 0.136 |
| | Total Kjeldahl Nitrogen (mg/L) | 7 | < 0.150 | 0.392 | 0.343 | 0.316 | 0.110 |
| | Total Nitrogen (mg/L) | 7 | < 0.579 | 1.174 | 0.993 | 0.918 | 0.194 |
| | Dissolved Reactive Phosphorus (mg/L) | 7 | 0.010 | 0.013 | 0.012 | 0.012 | 0.001 |
| | Total Phosphorus (mg/L) [J] | 7 | 0.023 | 0.031 | 0.025 | 0.026 | 0.003 |
| | CBOD-5 (mg/L) | 7 | < 1.0 | 2.0 | 0.5 | 0.6 | 0.2 |
| | Chlorides (mg/L)[J] | 7 | 2.4 | 12.6 | 10.3 | 9.3 | 3.3 |
| | **Biological** | | | | | | |
| | Chlorophyll a (ug/L) | 7 | < 0.10 | 1.60 | 0.71 | 0.65 | 0.57 |
| | Fecal Coliform (col/100 mL)[J] | 1 | | | | 46 | |

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