2010 R.L .Harris Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
June 2013

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2010

R.L. Harris Reservoir

Tallapoosa 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
APCo	Alabama Power Company
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
USGS	United States Geological Survey

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INTRODUCTION

R. L. Harris dam was completed in 1983 by Alabama Power Company for hydropower generation. Harris Reservoir, also known as Lake Wedowee, encompasses 10,660 acres and has approximately 271 miles of shoreline in Clay and Randolph Counties.

The Alabama Department of Environmental Management (ADEM) monitored Harris 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).

Specific water quality criteria for nutrient management were implemented in 2001 at two locations on Harris (Table 1). These criteria represent the maximum growing season mean (April-October) chlorophyll *a* (chl *a)* concentrations allowable while still fully supporting the reservoir's Public Water Supply, Swimming and Fish and Wildlife [PWS/S/F&W] use classifications.

The purpose of this report is to summarize data collected at six stations in Harris 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 existing data and established criteria.

METHODS

Sampling stations were selected using historical data and previous assessments (Fig.. 1). Specific location information is provided in Table 1. Harris was sampled in the upper reservoir, mid reservoir (just upstream of its confluence with the Little Tallapoosa River), and dam forebay. Tributary embayment monitoring stations were L. Tallapoosa River, Mad Indian Creek, and Wedowee Creek.

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 2008), and Quality Management Plan (ADEM 2008).

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 Alabama Power flow data and ADEM's previously collected data to help interpret the 2010 results.

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

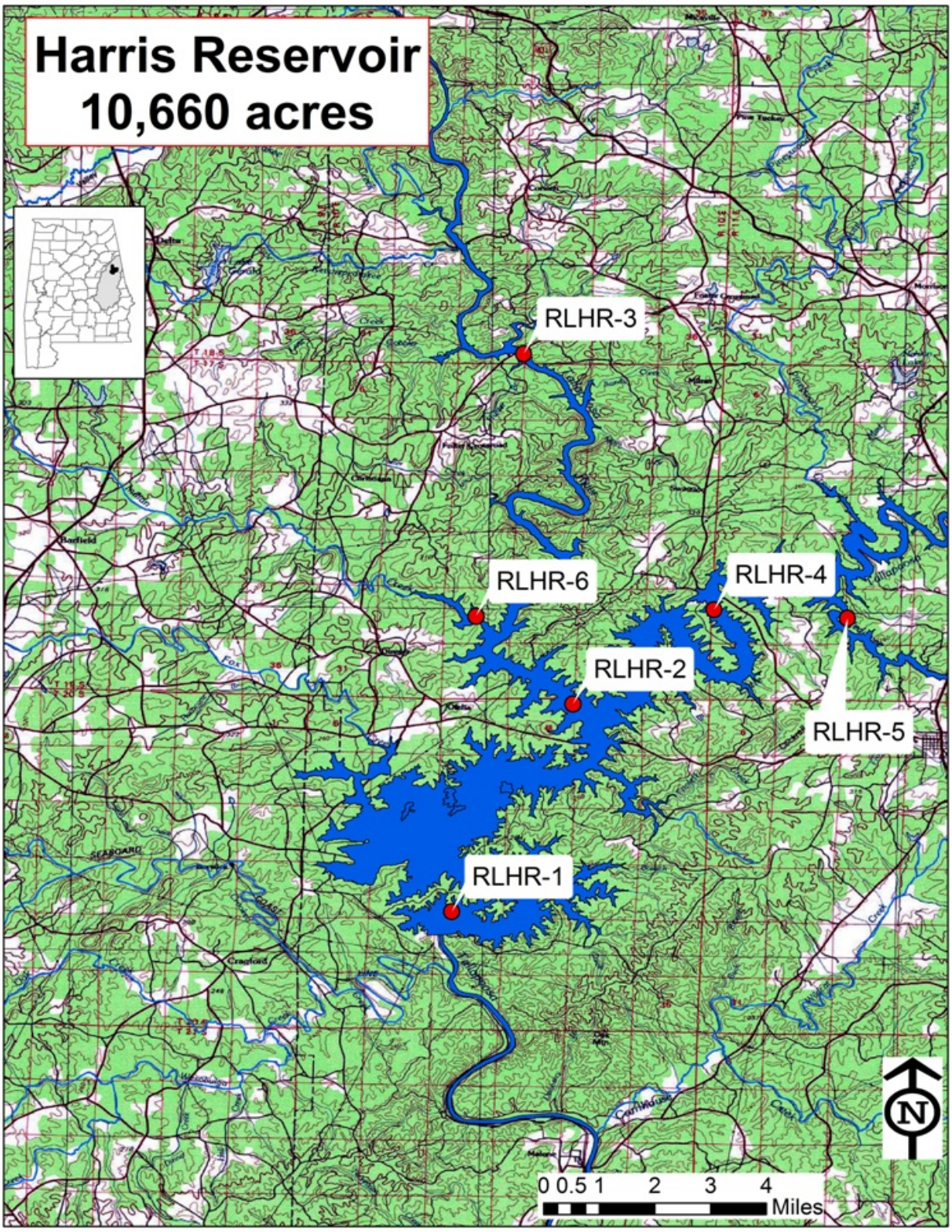


Table 1. Description of each 2010 monitoring station located in Harris Reservoir.

Station	Report Designation	12 digit HUC	County	Waterbody	Station Description	Chl *a* Criteria	Latitude	Longitude
RLHR-1*	Lower	0315-0109-0105	Randolph	Tallapoosa R	Deepest point, main river channel, dam forebay.	10 μg/L	33.2641	-85.6127
RLHR-2*	Mid	0315-0108-1006	Randolph	Tallapoosa R	Deepest point, main river channel, immediately upstream of Tallapoosa River/Little Tallapoosa River confluence.	12 μg/L	33.3184	-85.5811
RLHR-3	Upper	0315-0108-1006	Randolph	Tallapoosa R	Deepest point, main river channel, immediately downstream of Randolph Co. Hwy 82 bridge.		33.4100	-85.5939
RLHR-4	L. Tallapoosa	0315-0108-0906	Randolph	Little Tallapoosa R	Deepest point, Little Tallapoosa River channel, immediately downstream of Randolph Co. Hwy 29.		33.3431	-85.5444
RLHR-5	Wedowee	0315-0108-0904	Randolph	Wedowee Cr	Deepest point, main creek channel, Wedowee Creek embayment, approximately 0.5 miles upstream of lake confluence.		33.3408	-85.5097
RLHR-6	Mad Indian	0315-0108-1005	Randolph	Mad Indian Cr	Deepest point, main creek channel, Mad Indian Creek embayment, approximately 0.5 miles upstream of lake confluence.		33.3414	-85.6064

*Growing season mean chl *a* criteria implemented at this station in 2001

RESULTS

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figs. 2 & 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figs. 4-8 & 11), with mean monthly discharge included as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, conductivity and DO appear in Figs. 9 & 10. 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 be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2010, the highest mean growing season TN values were calculated for the Mad Indian, Wedowee and L. Tallapoosa stations (Fig. 2). The lower station increased from 2008 while all other stations decreased in concentrations from the previous sampling. Monthly TN concentrations were below historic means May-October in the upper station (Fig. 4). Historical lows were achieved in July, September and October at the L. Tallapoosa station, October for the upper station, May and October at the mid station, and September and October at the lower station.

In 2010, the highest growing season TP value was calculated for the upper station. Overall, growing season mean TP at mainstem stations are decreasing, with 2010 concentrations among the lowest measured (Fig. 2). Mean concentrations at Mad Indian, Wedowee and L. Tallapoosa stations were lower in 2010 than in 2005. All monthly TP values were below historic means (Fig. 5).

In 2010, the highest growing season mean chl *a* was calculated for the Wedowee station (Fig. 3). From 2005 to 2010, the mean chl. *a* concentration at all stations decreased. The upper station has generally decreased overall since 2000. Both the mid and lower stations, with

established criteria for nutrient mangement, were below criteria limits. Monthly chl *a* values were at or below historic means at all stations in most months with historic lows measured in April and/or May (Fig. 6). Historic lows were also measured in September and October in the mid station and October in the upper station.

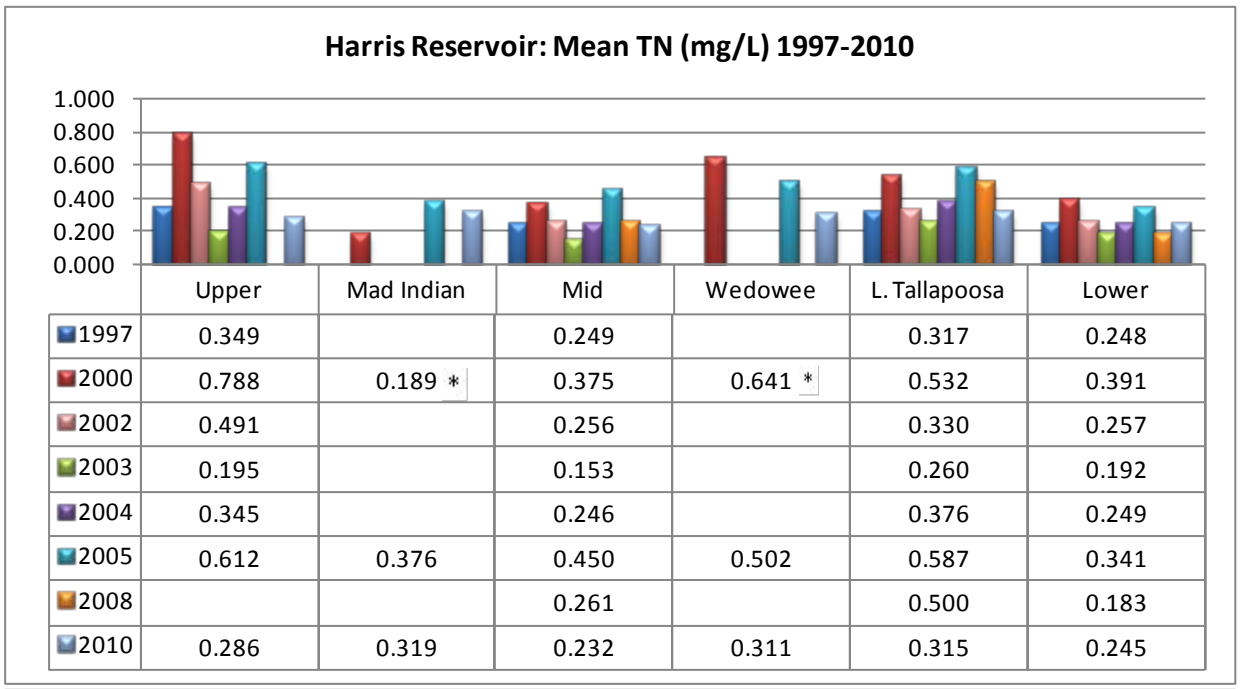
In 2010, the highest growing season mean TSS value was calculated for the upper station (Fig. 3). Growing season mean TSS concentrations have decreased overall at all mainstem stations since sampling began in 1997. Mean TSS concentrations at Mad Indian, Wedowee, and L. Tallapoosa stations were lower in 2010 than 2005. All monthly TSS concentrations were near or below historic means (Fig. 7). Historic lows occurred at the L. Tallapoosa and upper station in May, July and October, mid station in July, September and October, and the lower station in April, May, July, September, and October.

AGPT results show the Mad Indian station was phosphorus limited while the L. Tallapoosa station was co-limited (Table 2). Due to resource constraints, AGPT samples were not collected at the lower, mid, and upper stations in August. Both stations sampled in 2010 were below 5mg/L, the value the Raschke et al. (1996) defined as protective of reservoir and lake systems.

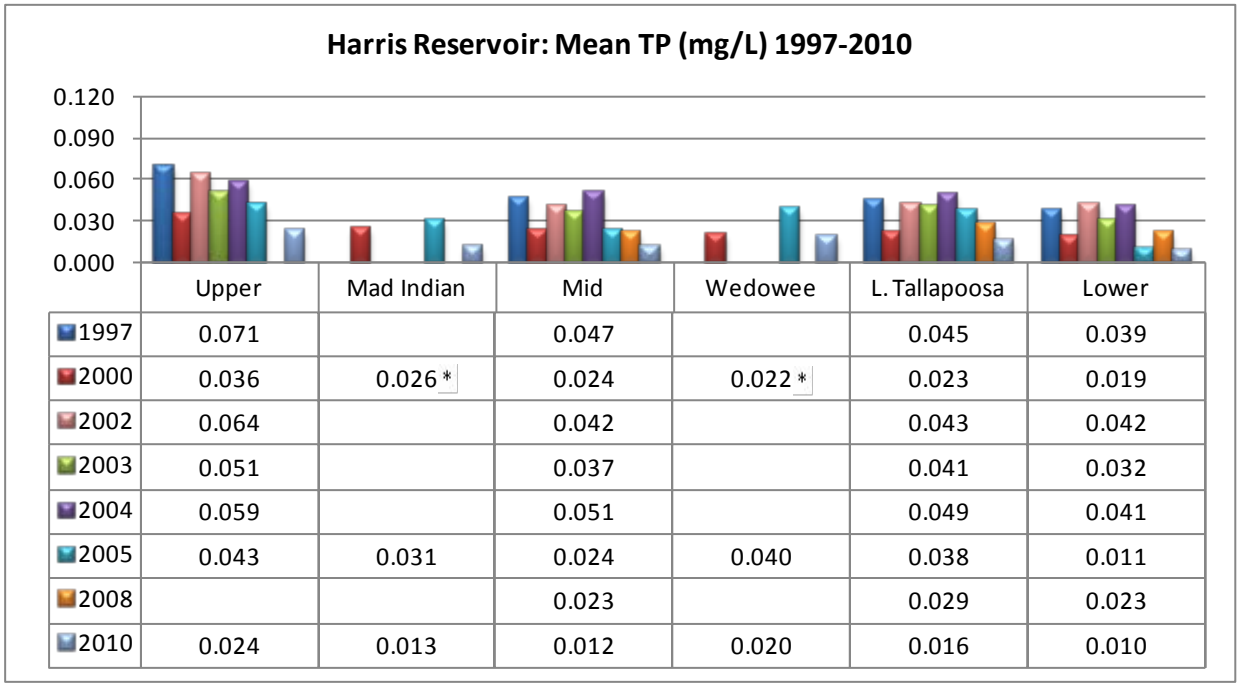
All measurements of dissolved oxygen concentrations in Harris Reservoir met the ADEM Criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) (ADEM Admin. Code R. 335-6-10-.09) (Fig. 8). Based on monthly profiles, DO and temperature stratification occurred at both the lower and mid stations April-October (Figs. 9 & 10). DO concentrations were generally much lower below the 5 m depth. Highest temperatures were measured in June. Conductivity values in the lower part of the water column of the mid station increased sharply during July, August, and October.

Monthly TSI values were calculated using chl *a* values and Carlson's Trophic State Index. TSI values at the lower station were oligotrophic in April, eutrophic from May-June, and mesotrophic July-October (Fig. 11). Mad Indian and the upper stations were oligotrophic in April and increased to eutrophic conditions May-October. All other stations showed little variation in TSI and ranged from high mesotrophic to low eutrophic.

Figure 2. Mean growing season total nitrogen and total phosphurous of all stations in Harris Reservoir, April-October 1997-2010. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.



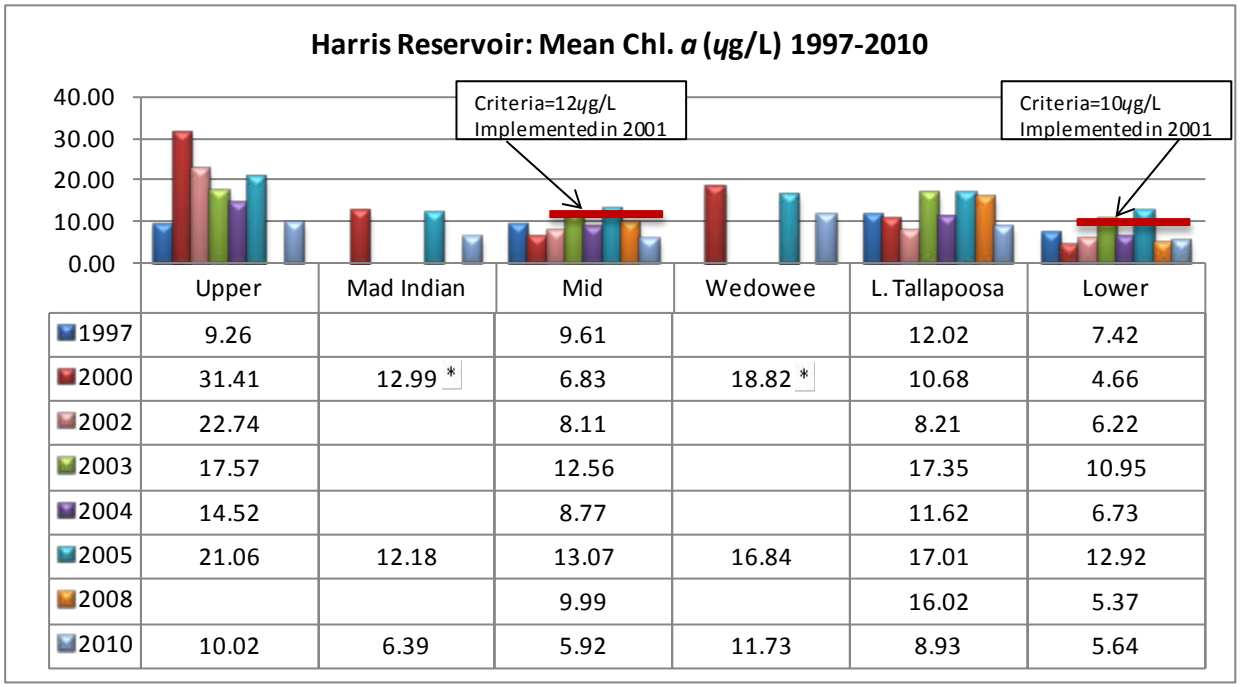
	Upper	Mad Indian	Mid	Wedowee	L. Tallapoosa	Lower
1997	0.349		0.249		0.317	0.248
2000	0.788	0.189 *	0.375	0.641 *	0.532	0.391
2002	0.491		0.256		0.330	0.257
2003	0.195		0.153		0.260	0.192
2004	0.345		0.246		0.376	0.249
2005	0.612	0.376	0.450	0.502	0.587	0.341
2008			0.261		0.500	0.183
2010	0.286	0.319	0.232	0.311	0.315	0.245



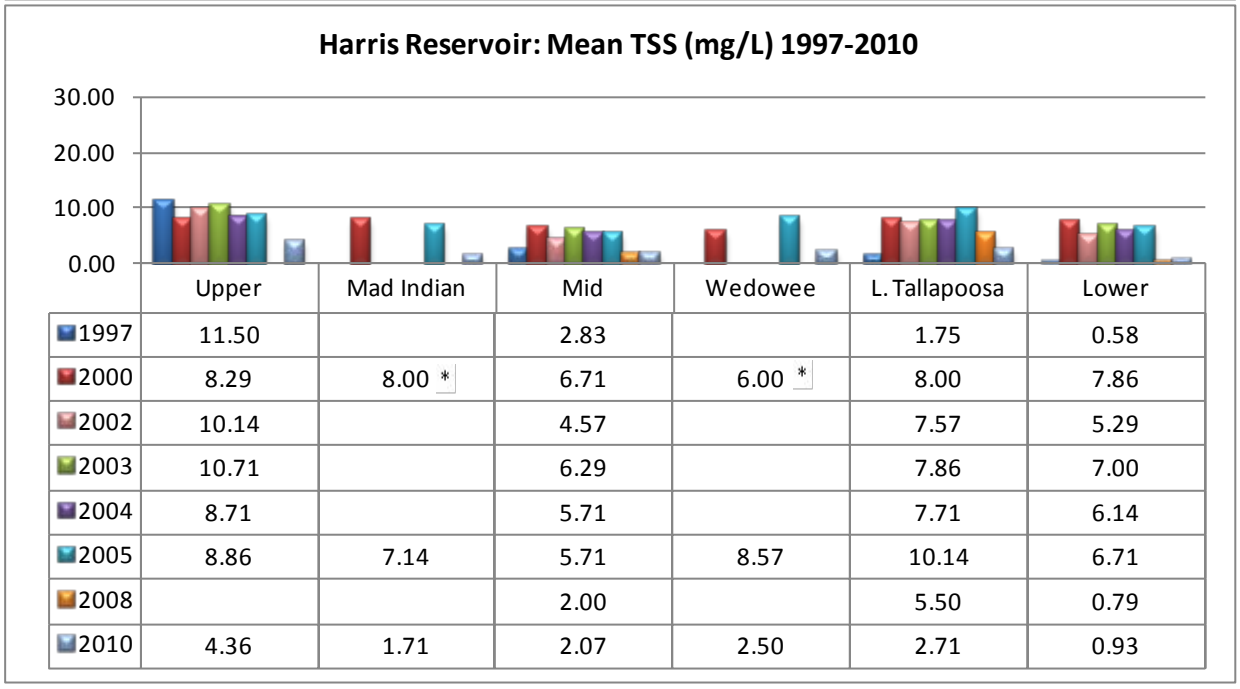
	Upper	Mad Indian	Mid	Wedowee	L. Tallapoosa	Lower
1997	0.071		0.047		0.045	0.039
2000	0.036	0.026 *	0.024	0.022 *	0.023	0.019
2002	0.064		0.042		0.043	0.042
2003	0.051		0.037		0.041	0.032
2004	0.059		0.051		0.049	0.041
2005	0.043	0.031	0.024	0.040	0.038	0.011
2008			0.023		0.029	0.023
2010	0.024	0.013	0.012	0.020	0.016	0.010

*Mean of April/June/August only.

Figure 3. Mean growing season chlorophyll *a* and total suspended solids total in all stations in Harris Reservoir, April-October 1997-2010. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right.



	Upper	Mad Indian	Mid	Wedowee	L. Tallapoosa	Lower
1997	9.26		9.61		12.02	7.42
2000	31.41	12.99 *	6.83	18.82 *	10.68	4.66
2002	22.74		8.11		8.21	6.22
2003	17.57		12.56		17.35	10.95
2004	14.52		8.77		11.62	6.73
2005	21.06	12.18	13.07	16.84	17.01	12.92
2008			9.99		16.02	5.37
2010	10.02	6.39	5.92	11.73	8.93	5.64



	Upper	Mad Indian	Mid	Wedowee	L. Tallapoosa	Lower
1997	11.50		2.83		1.75	0.58
2000	8.29	8.00 *	6.71	6.00 *	8.00	7.86
2002	10.14		4.57		7.57	5.29
2003	10.71		6.29		7.86	7.00
2004	8.71		5.71		7.71	6.14
2005	8.86	7.14	5.71	8.57	10.14	6.71
2008			2.00		5.50	0.79
2010	4.36	1.71	2.07	2.50	2.71	0.93

*Mean of April/June/August only.

Figure 4. Monthly TN concentrations measured in Harris Reservoir, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Harris Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

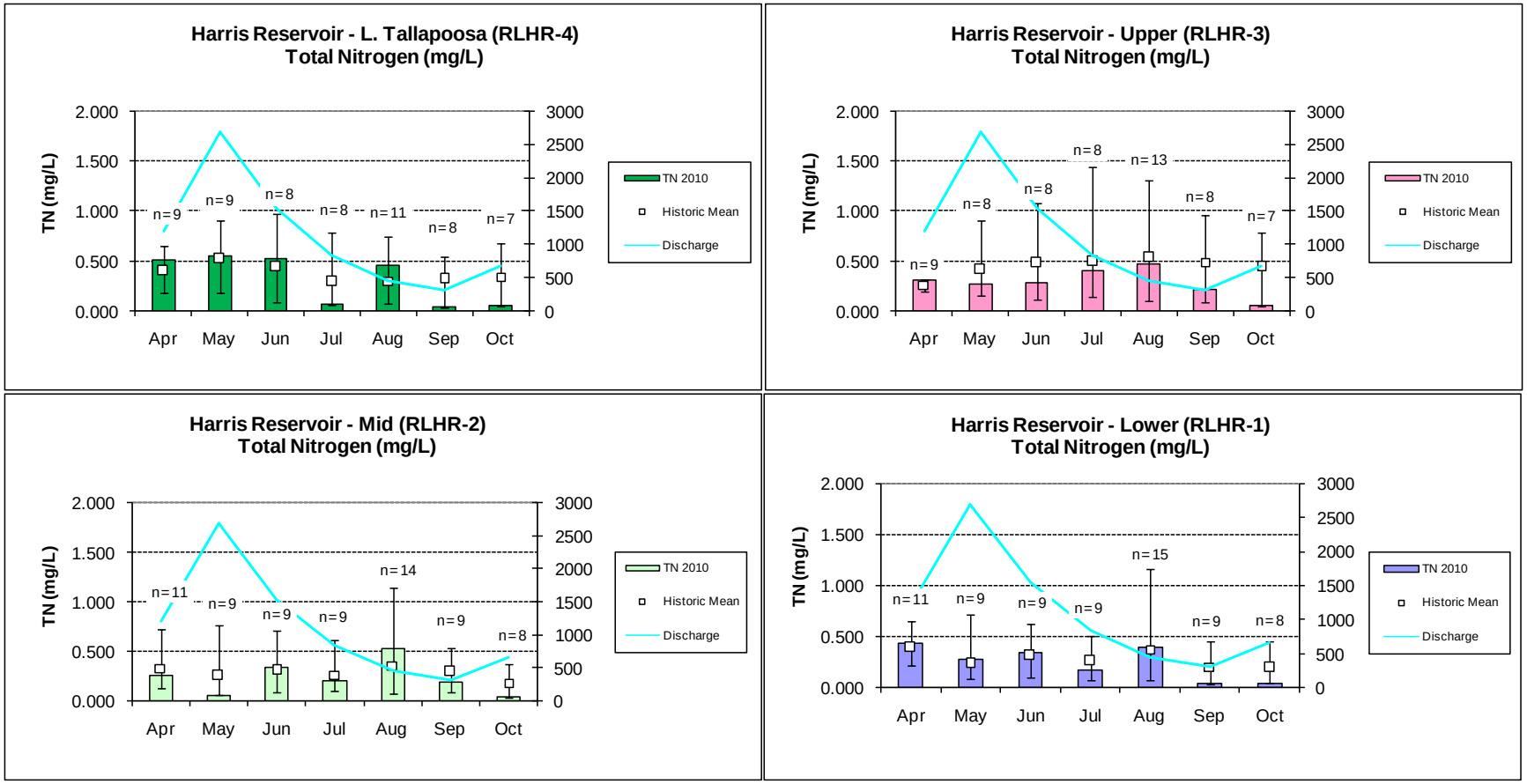


Figure 5. Monthly TP concentrations measured in Harris Reservoir, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Harris Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

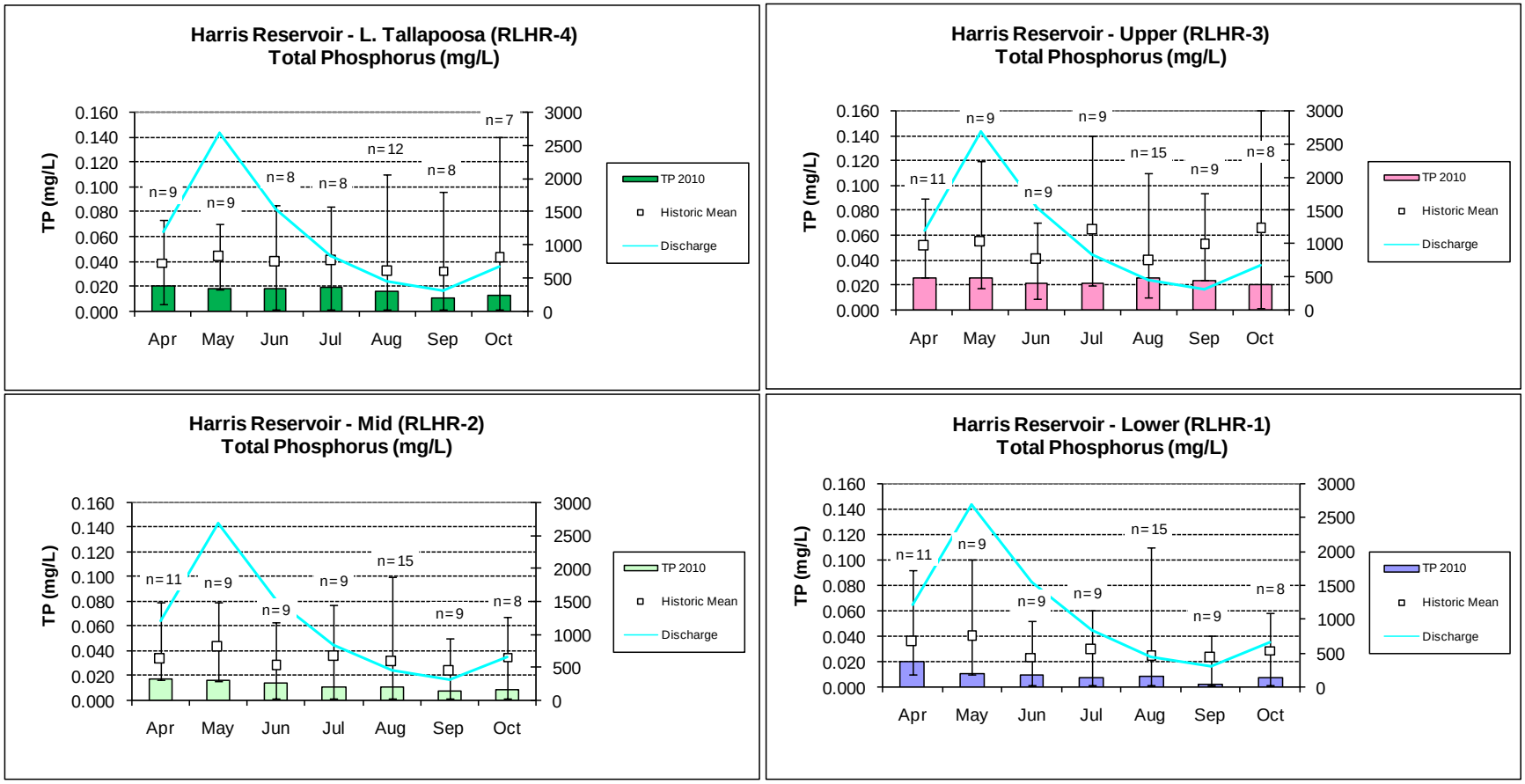


Figure 6. Monthly chl *a* concentrations measured in Harris Reservoir, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Harris Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

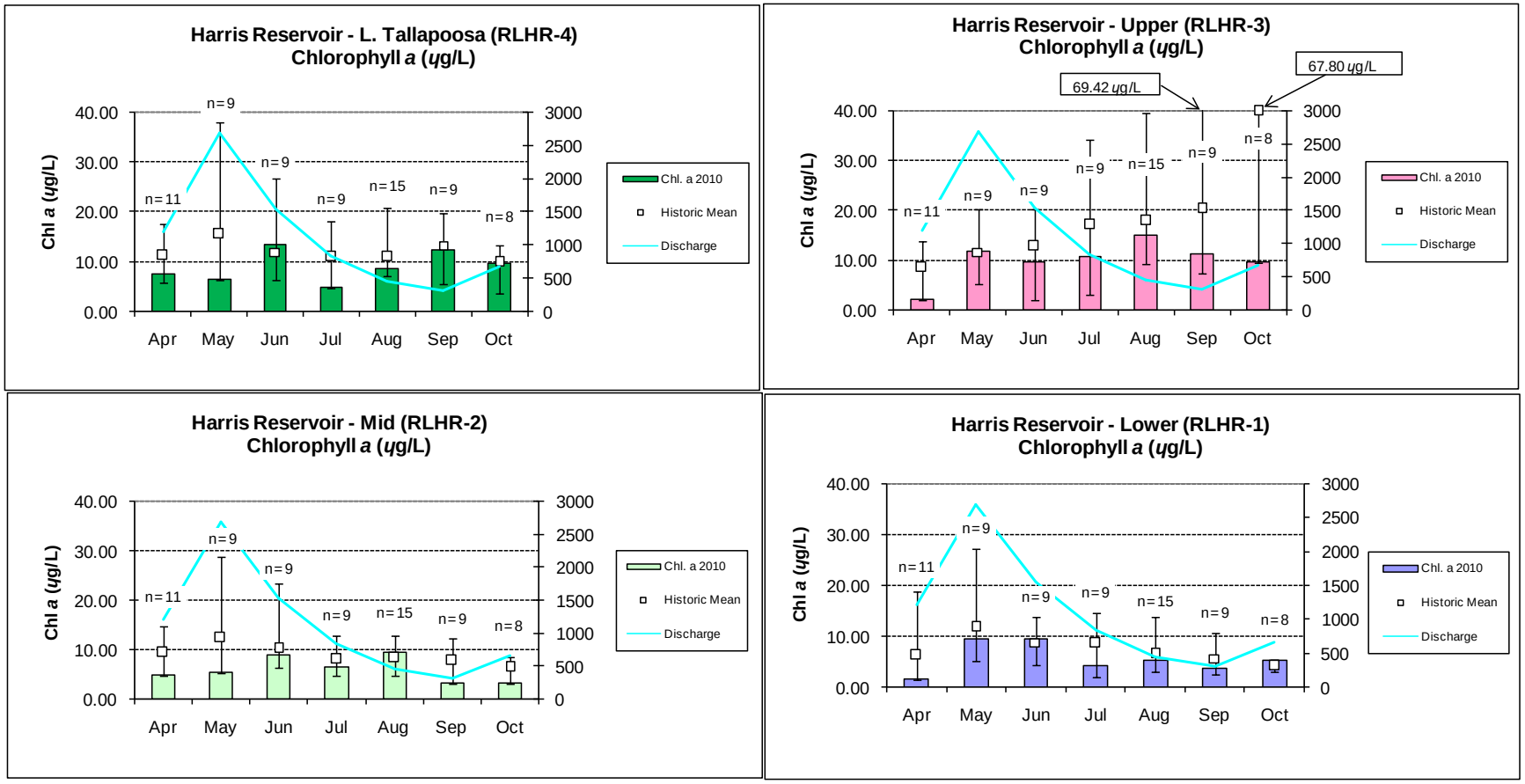


Figure 7. Monthly TSS concentrations measured in Harris Reservoir, April-October 2010 vs. average monthly discharge. Monthly discharge acquired from Alabama Power at Harris Reservoir Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2010) and min/max ranges are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

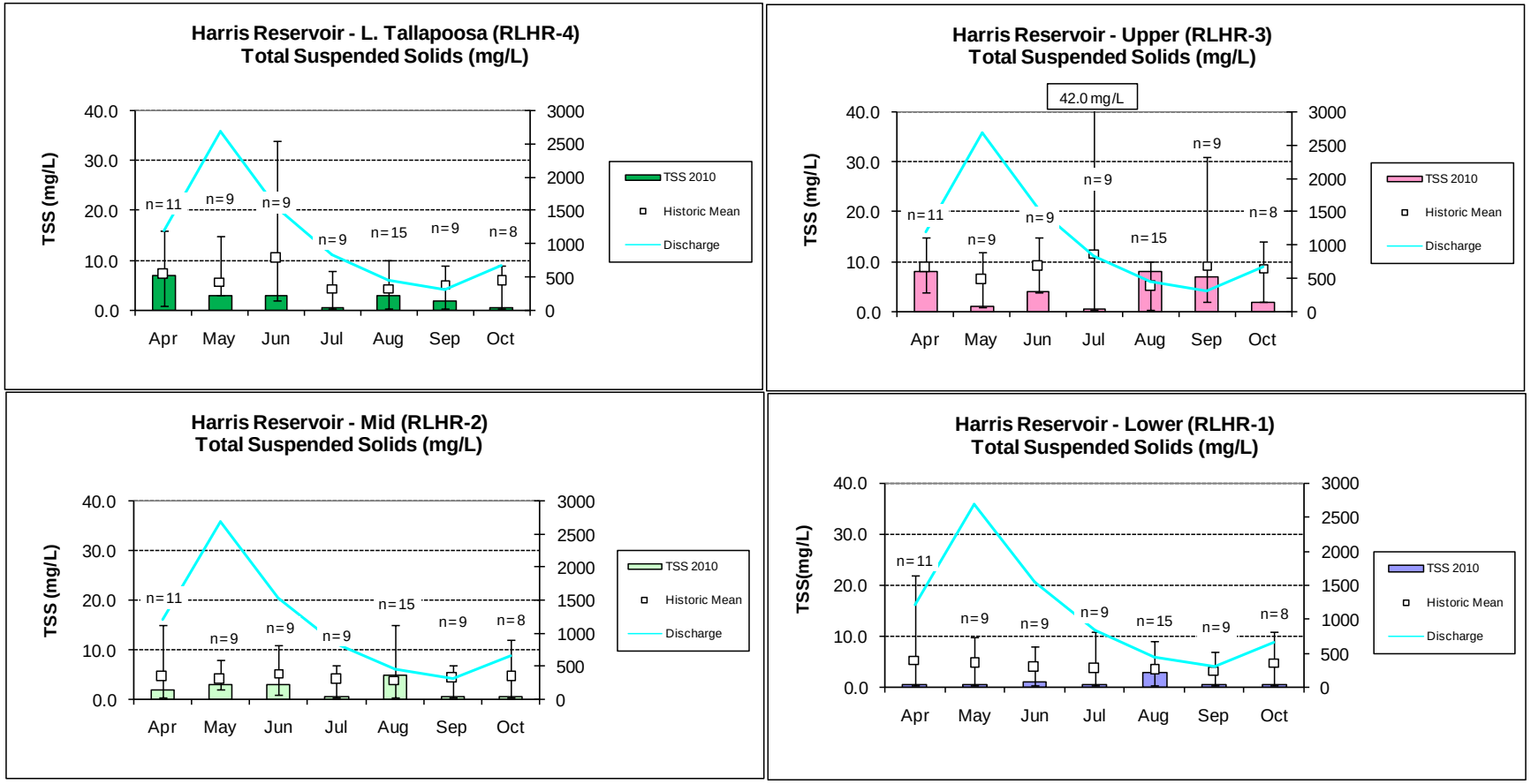


Table 2. Algal growth potential test results, Harris Reservoir, (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Station	Mad Indian (RLHR-6)		L.Tallapoosa (RLHR-4)		Upper (RLHR-3)	
	Control mean MSC	Limiting Nutrient	Control mean MSC	Limiting Nutrient	Control mean MSC	Limiting Nutrient
Aug-1997	---	---	3.55	PHOSPHORUS	4.55	PHOSPHORUS
2000	---	---	1.97	NONE	3.62	NITROGEN
April-04	---	---	3.75	PHOSPHORUS	5.73	PHOSPHORUS
May-04	---	---	2.60	PHOSPHORUS	3.49	PHOSPHORUS
Jun-04	---	---	3.91	PHOSPHORUS	8.21	PHOSPHORUS
Jul-04	---	---	3.74	PHOSPHORUS	5.48	PHOSPHORUS
Aug-04	---	---	1.10	PHOSPHORUS	1.83	PHOSPHORUS
Sep-04	---	---	4.72	PHOSPHORUS	7.33	CO-LIMITING
Oct-04	---	---	3.80	PHOSPHORUS	6.16	PHOSPHORUS
Aug-2005	---	---	5.46	PHOSPHORUS	7.46	PHOSPHORUS
2010	1.51	PHOSPHORUS	1.93	CO-LIMITING	---	---

Station	Mid (RLHR-2)		Lower (RLHR-1)	
	Control mean MSC	Limiting Nutrient	Control mean MSC	Limiting Nutrient
1997	1.82	PHOSPHORUS	1.59	PHOSPHORUS
2000	1.59	CO-LIMITING	1.74	NONE
April-04	3.16	PHOSPHORUS	2.27	PHOSPHORUS
May-04	2.80	PHOSPHORUS	2.33	PHOSPHORUS
Jun-04	2.99	PHOSPHORUS	2.91	PHOSPHORUS
Jul-04	3.61	PHOSPHORUS	2.61	PHOSPHORUS
Aug-04	0.96	PHOSPHORUS	0.99	PHOSPHORUS
Sep-04	3.31	PHOSPHORUS	1.32	PHOSPHORUS
Oct-04	3.03	PHOSPHORUS	2.65	PHOSPHORUS
2005	2.90	CO-LIMITING	2.91	PHOSPHORUS
2010	---	---	---	---

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Harris 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).

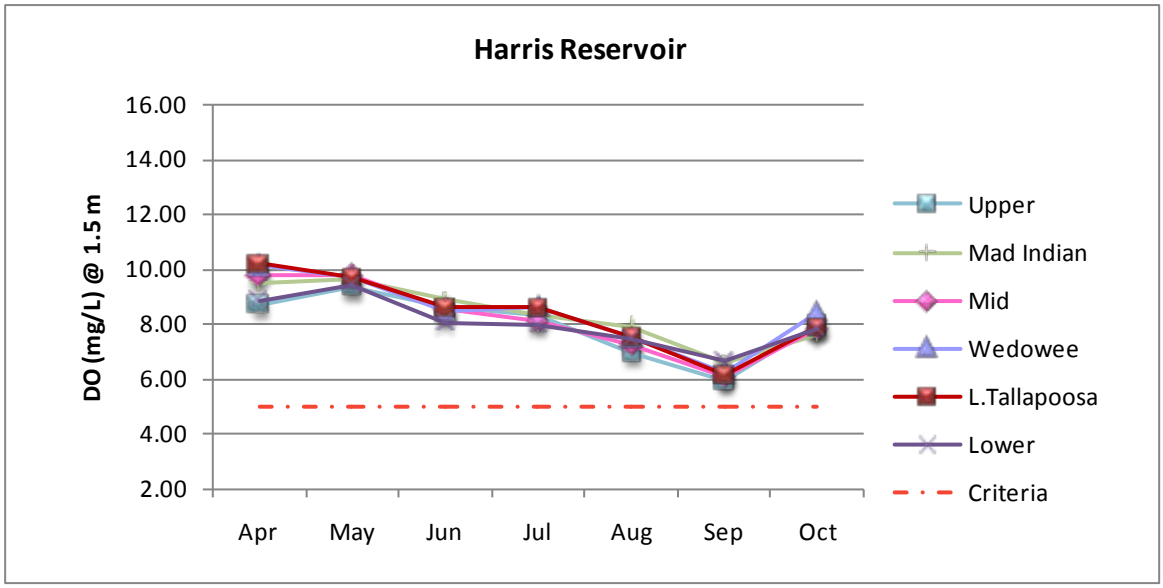


Figure 9. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the mid Harris Reservoir station, April-October 2010.

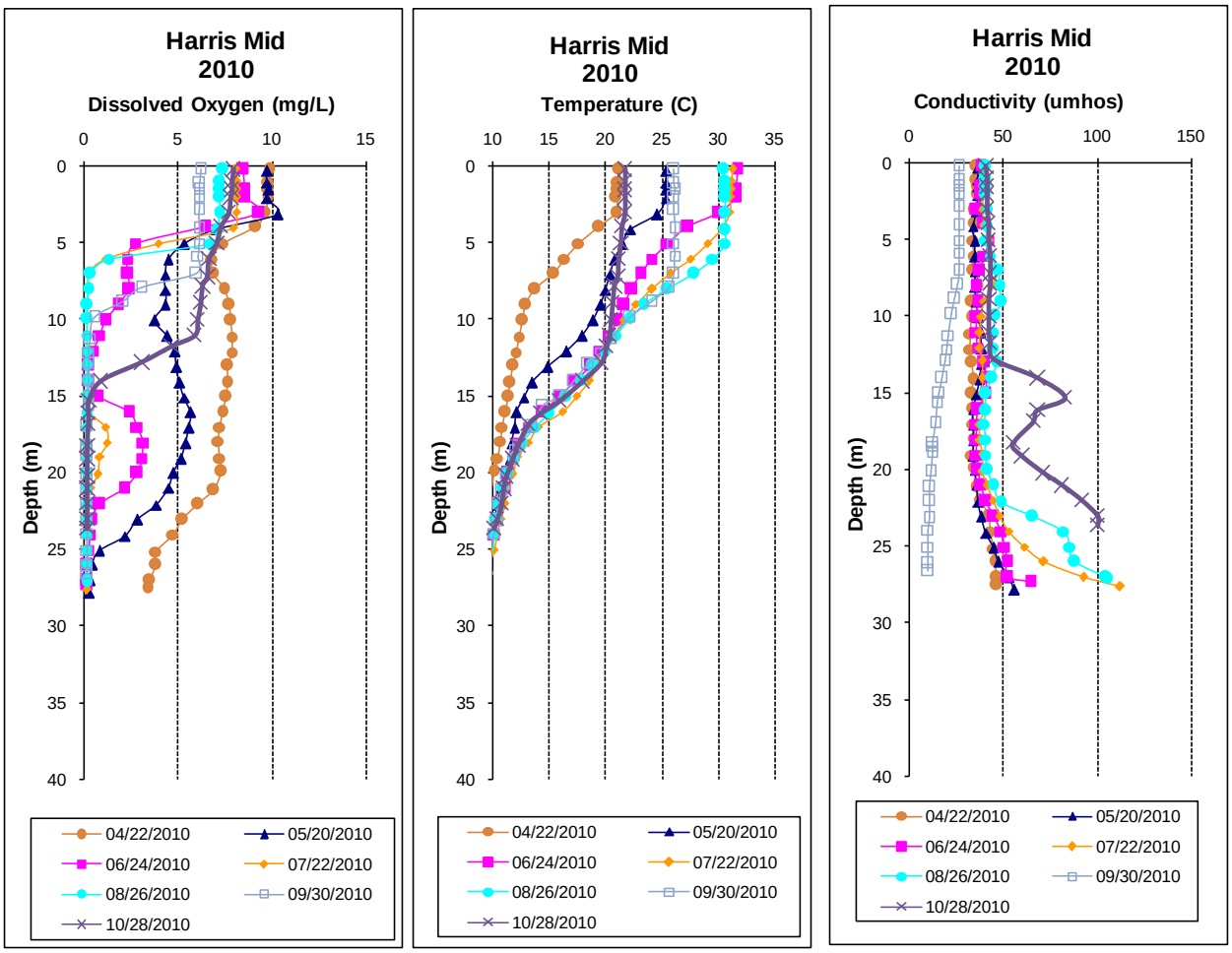


Figure 10. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in the lower Harris Reservoir station, April-October 2010.

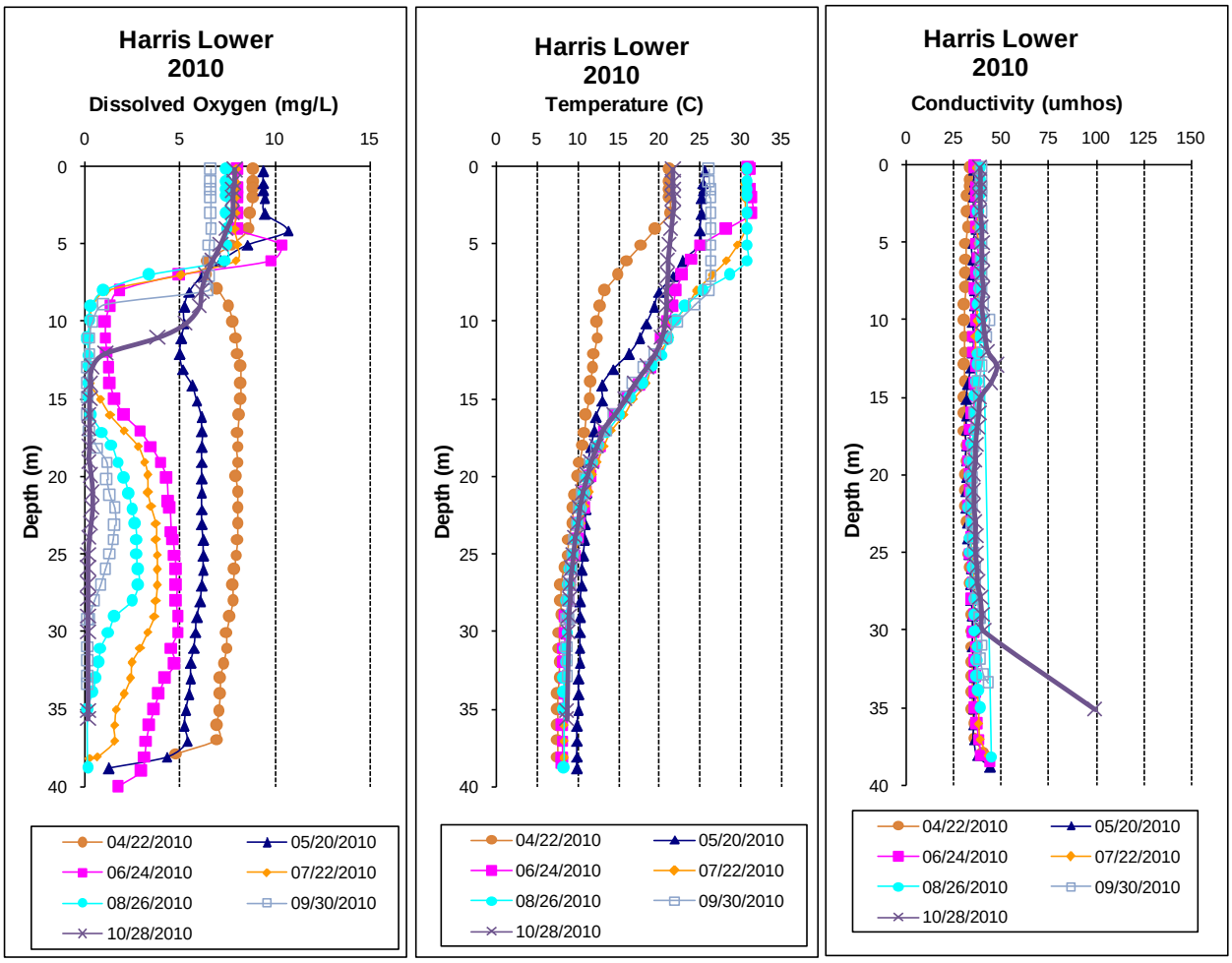
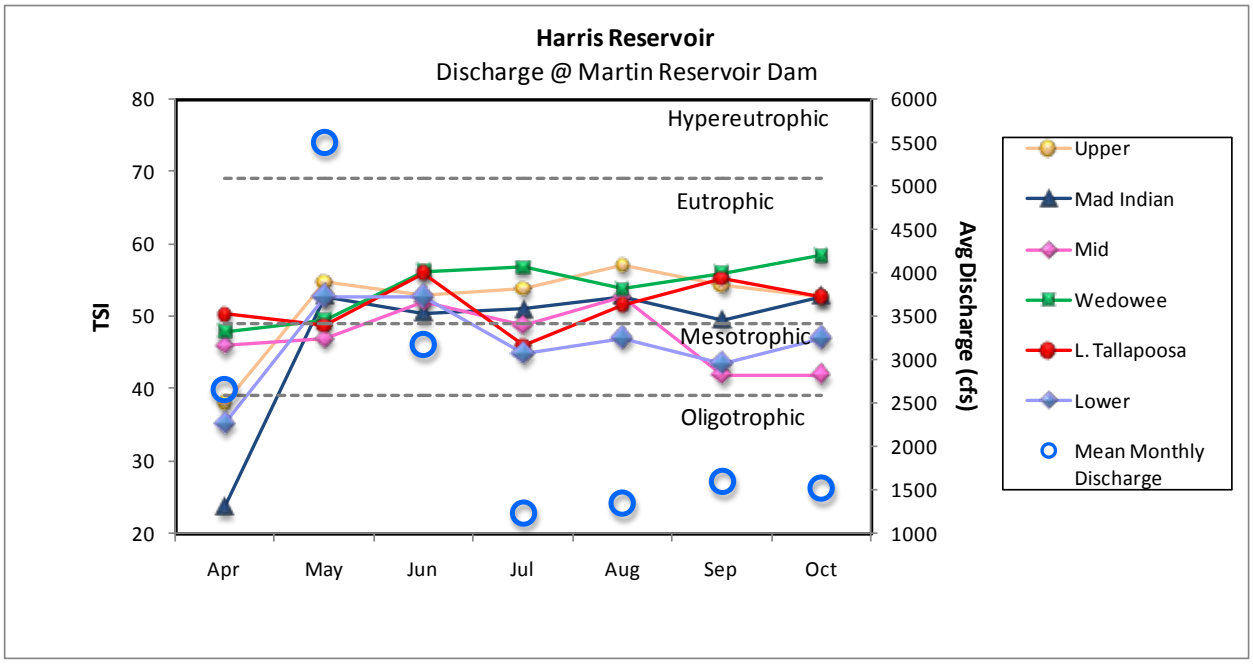


Figure 11. Monthly TSI values calculated for mainstem and tributary Harris Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from Alabama Power at Harris Dam.



REFERENCES

ADEM. 2008. Quality Management Plan For The Alabama Department Of Environmental, Alabama Department of Environmental Management (ADEM), Montgomery, AL. 58 pp.

ADEM. 2008. Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring in Alabama. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 78 pp.

ADEM. 2010 (as amended). Standard Operating Procedures #2041 *In Situ* Surface Water Quality Field Measurements-Temperature, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2010 (as amended). Standard Operating Procedures #2044 *In Situ* Surface Water Quality Field Measurements–Turbidity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2010 (as amended). Standard Operating Procedures #2046 Photic Zone Measurement and Visibility Determination, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2010 (as amended). Standard Operating Procedures #2047 *In Situ* Surface Water Quality Field Measurements–By Datasonde, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2010 (as amended). Standard Operating Procedures #2061 General Surface Water Sample Collection, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2010 (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. 2010 (as amended). Standard Operating Procedures #2063 Water Column Chlorophyll *a* Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2012 State of Alabama Water Quality Monitoring Strategy June 19, 2012. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 88 pp. http://www.adem.alabama.gov/programs/water/wqsurvey/2012WQMonitoringStrategy

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2010. 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). 2010. 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 water quality data collected April-October, 2010. Minimum (Min) and maximum (Max) values calculated using minimum detection limits (MDL) when results were less than this value. Median (Med), average (Ave), and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Med	Avg	SD
RLHR-1	**Physical**						
	Turbidity (NTU)	6	1.4	2.2	1.9	1.9	0.3
	Total Dissolved Solids (mg/L)	7	2.0	40.0	32.0	28.3	12.8
	Total Suspended Solids (mg/L)	7	< 1.0	3.0	0.5	0.9	0.9
	Hardness (mg/L)	4	9.4	11.3	10.3	10.3	0.9
	Alkalinity (mg/L)	7	8.4	20.7	12.8	13.0	3.9
	Photic Zone (m)	7	6.25	9.20	6.67	6.97	1.00
	Secchi (m)	7	2.00	3.74	2.84	2.91	0.64
	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	0.095	0.006	0.022	0.035
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.395	0.235	0.223	0.145
	Total Nitrogen (mg/L) [J]	7	< 0.042	0.431	0.275	0.245	0.161
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.003	0.009	0.008	0.007	0.003
	Total Phosphorus (mg/L) [J]	7	< 0.005	0.020	0.009	0.010	0.005
	CBOD-5 (mg/L)	7	< 2.0	2.1	1.0	1.2	0.4
	Chlorides (mg/L)	7	1.8	2.3	2.2	2.2	0.2
	Biological						
	Chlorophyll a (ug/L)	7	1.60	9.61	5.34	5.64	2.99
	E. coli (mpn/100mL) [J]	3	<1	10	1	4	4
RLHR-2	**Physical**						
	Turbidity (NTU)	6	2.7	4.1	3.2	3.3	0.5
	Total Dissolved Solids (mg/L) [J]	7	26.0	68.0	40.0	39.7	14.5
	Total Suspended Solids (mg/L) [J]	7	< 1.0	5.0	2.0	2.1	1.7
	Hardness (mg/L)	4	10.6	12.1	11.4	11.4	0.7
	Alkalinity (mg/L)	7	10.9	16.3	14.1	13.9	2.2
	Photic Zone (m)	7	5.09	6.55	5.70	5.74	0.56
	Secchi (m)	7	1.69	2.91	2.34	2.26	0.44
	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	0.048	0.009	0.018	0.020
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.528	0.193	0.214	0.168
	Total Nitrogen (mg/L) [J]	7	< 0.041	0.529	0.202	0.232	0.169
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.003	0.010	0.009	0.007	0.004
	Total Phosphorus (mg/L) [J]	7	0.008	0.017	0.011	0.012	0.004
	CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	1.9	2.5	2.2	2.2	0.2
	Biological						
	Chlorophyll a (ug/L)	7	3.20	9.61	5.34	5.92	2.55
	E. coli (mpn/100mL) [J]	2	<1	2	2	2	1
Station	**Parameter**	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**

RLHR-3	**Physical**						
	Turbidity (NTU)	6	4.1	12.9	7.1	8.1	3.9
	Total Dissolved Solids (mg/L)	7	< 1.0	50.0	32.0	29.8	16.7
	Total Suspended Solids (mg/L)	7	< 1.0	8.0	4.0	4.4	3.3
	Hardness (mg/L)	4	11.6	12.4	11.9	12.0	0.4
	Alkalinity (mg/L)	7	12.5	28.4	15.0	18.1	5.8
	Photic Zone (m)	7	2.64	4.18	3.13	3.38	0.57
	Secchi (m)	7	0.80	2.19	1.30	1.33	0.47
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	0.009	0.109	0.013	0.035	0.041
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.455	0.209	0.251	0.136
	Total Nitrogen (mg/L) [J]	7	< 0.053	0.466	0.280	0.286	0.132
	Dissolved Reactive Phosphorus (mg/L) [J]	7	0.003	0.012	0.010	0.008	0.004
	Total Phosphorus (mg/L)	7	0.021	0.026	0.024	0.024	0.002
	CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	1.8	2.2	1.9	1.1	0.1
	Biological						
	Chlorophyll a (ug/L)	7	2.14	14.95	10.68	10.02	3.90
	E. coli (mpn/100mL)	3	<1	47	3	17	26
RLHR-4	**Physical**						
	Turbidity (NTU)	6	2.7	5.0	3.8	3.7	0.9
	Total Dissolved Solids (mg/L)	7	< 1.0	48.0	32.0	27.2	18.4
	Total Suspended Solids (mg/L)	7	< 1.0	7.0	3.0	2.7	2.2
	Hardness (mg/L)	4	11.0	12.1	11.6	11.6	0.5
	Alkalinity (mg/L)	7	10.9	16.0	14.0	13.4	1.8
	Photic Zone (m)	7	4.09	6.57	5.68	5.45	0.84
	Secchi (m)	7	1.43	2.89	1.68	2.04	0.63
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.021	0.021	0.010	0.012	0.004
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	< 0.002	0.237	0.024	0.058	0.087
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.080	0.504	0.274	0.257	0.215
	Total Nitrogen (mg/L) [J]	7	< 0.041	0.557	0.452	0.315	0.248
	Dissolved Reactive Phosphorus (mg/L) [J]	7	< 0.003	0.009	0.006	0.006	0.003
	Total Phosphorus (mg/L)	7	0.011	0.020	0.018	0.016	0.003
	CBOD-5 (mg/L)	7	< 2.0	3.4	1.0	1.6	1.0
	Chlorides (mg/L)	7	2.8	3.6	3.2	3.2	0.3
	Biological						
	Chlorophyll a (ug/L)	7	4.81	13.35	8.54	8.93	3.08
	E. coli (mpn/100mL) [J]	3	<1	19	2	7	10

Station	Parameter	N		Min	Max	Med	Avg	SD
RLHR-5	**Physical**							
	Turbidity (NTU)	6		3.2	4.8	4.2	3.1	0.6
	Total Dissolved Solids (mg/L)	7	<	1.0	56.0	34.0	32.4	16.8
	Total Suspended Solids (mg/L)	7	<	1.0	4.0	3.0	2.5	1.1
	Hardness (mg/L)	4		10.2	11.9	11.1	11.1	0.9
	Alkalinity (mg/L)	7		10.0	15.6	12.0	12.4	2.2
	Photic Zone (m)	7		3.78	5.52	4.87	4.83	0.64
	Secchi (m)	7		1.27	2.51	1.59	1.86	0.50
	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	0.168	0.004	0.028	0.062
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.080	0.454	0.225	0.283	0.158
	Total Nitrogen (mg/L) [J]	7	<	0.043	0.611	0.230	0.311	0.193
	Dissolved Reactive Phosphorus (mg/L) [J]	7	<	0.003	0.009	0.005	0.006	0.003
	Total Phosphorus (mg/L)	7		0.016	0.027	0.019	0.020	0.004
	CBOD-5 (mg/L)	7	<	2.0	2.9	1.0	1.3	0.7
	Chlorides (mg/L)	7		2.6	3.5	3.1	3.2	0.3
	Biological							
	Chlorophyll a (ug/L)	7		5.87	17.09	13.35	11.73	4.10
	E. coli (mpn/100mL) [J]	3	<	1	19	1	6	10
RLHR-6	**Physical**							
	Turbidity (NTU)	6		3.4	4.7	4.1	4.0	0.6
	Total Dissolved Solids (mg/L)	7		14.0	5,852.0	36.0	864.9	2,199.2
	Total Suspended Solids (mg/L)	7	<	1.0	4.0	1.0	1.7	1.4
	Hardness (mg/L)	4		9.4	11.9	10.4	10.5	1.2
	Alkalinity (mg/L)	7		10.1	15.9	14.0	13.3	2.3
	Photic Zone (m)	7		4.21	6.51	4.91	5.14	0.88
	Secchi (m)	7		1.48	2.47	1.81	1.85	0.34
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.021	0.021	0.010	0.010	0.000
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7		0.003	0.070	0.014	0.020	0.024
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.080	0.595	0.276	0.299	0.218
	Total Nitrogen (mg/L) [J]	7	<	0.043	0.611	0.346	0.319	0.220
	Dissolved Reactive Phosphorus (mg/L) [J]	7	<	0.003	0.011	0.008	0.007	0.003
	Total Phosphorus (mg/L) [J]	7		0.009	0.016	0.014	0.013	0.003
	CBOD-5 (mg/L)	7	<	2.0	4.7	1.0	1.5	1.4
	Chlorides (mg/L)	7		1.7	2.4	2.0	2.1	0.3
	Biological							
	Chlorophyll a (ug/L)	7	<	0.10	12.82	6.94	6.39	4.20
	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;