2017 & 2021 Warrior Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Rivers and Reservoirs Unit
August 2025

Rivers and Reservoirs Monitoring Program

2021

Warrior Reservoir

Black Warrior River Basin

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LIST OF ACRONYMS

A&I	Agricultural and Industrial Water Supply
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
BW	Black Warrior
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

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INTRODUCTION

Warrior Reservoir was established in 1962 by the US Army Corps of Engineers (USACOE) with the completion of Armistead Selden Lock and Dam. The reservoir stretches seventy-seven miles from Oliver Dam in Tuscaloosa to just south of Eutaw, AL, and encompasses 7,800 acres of waterway. The construction of the dam replaced locks seven, eight, and nine of an old lock system that consisted of seventeen locks along the river's course. The locks were created by the US Federal government beginning in the 1880s as a means of making the entire river navigable from Birmingham to Mobile. Warrior Reservoir, along with other impoundments in the chain, provides a significant amount of commerce and recreation to the State of Alabama.

In 2022, the Alabama Department of Public Health (ADPH) issued a fish consumption advisory due to mercury found in fish tissue. As a result, Warrior Reservoir was placed on Alabama's 2024 CWA §303(d) list of impaired waters for not meeting its Fish & Wildlife (F&W) water use classification for mercury caused by atmospheric deposition. The Big Sandy Creek embayment of Warrior Reservoir was also listed on the 2024 CWA §303(d) list for not meeting its Fish & Wildlife (F&W) water use classification for pathogens (*E. coli*) from agricultural sources.

The Alabama Department of Environmental Management (ADEM) monitored Warrior Reservoir as part of the 2017 and 2021 assessments of the Black Warrior (BW) River basin 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 ADEM. The current objectives of this program are to provide data that can be used to assess current water quality conditions, to 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 2015 Monitoring Strategy (ADEM 2017).

A specific water quality criterion for nutrient management was implemented in 2004 at the dam forebay, or lower end sampling location (WARG-1) on Oliver Reservoir. This criterion represents a growing season mean (April-October) chlorophyll *a* (chl *a*) concentration that is protective of Warrior Reservoir's Fish & Wildlife (F&W) use classification.

The purpose of this report is to summarize data collected at seven stations in Warrior Reservoir during the 2017 and 2021 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and/or 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 and established criteria.

METHODS

Sampling stations were selected using historical data and previous assessments (Figure 1). Specific location information can be found in Table 1. Warrior Reservoir was sampled in the dam forebay, mid reservoir, upper reservoir, and above I-59. Monitoring sites were also established in the Big Brush Creek, Five Mile Creek, and Big Sandy Creek embayments.

Water quality sampling was conducted at monthly intervals, April-October in both 2017 and 2021. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2021), Surface Water Quality Assurance Project Plan (ADEM 2023), and Quality Management Plan (ADEM 2018).

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 USGS flow data and ADEM's previously collected data to help interpret the 2017 and 2021 results.

Figure 1. Warrior Reservoir with 2017 and 2021 sampling locations. A description of each sampling location is provided in Table 1.

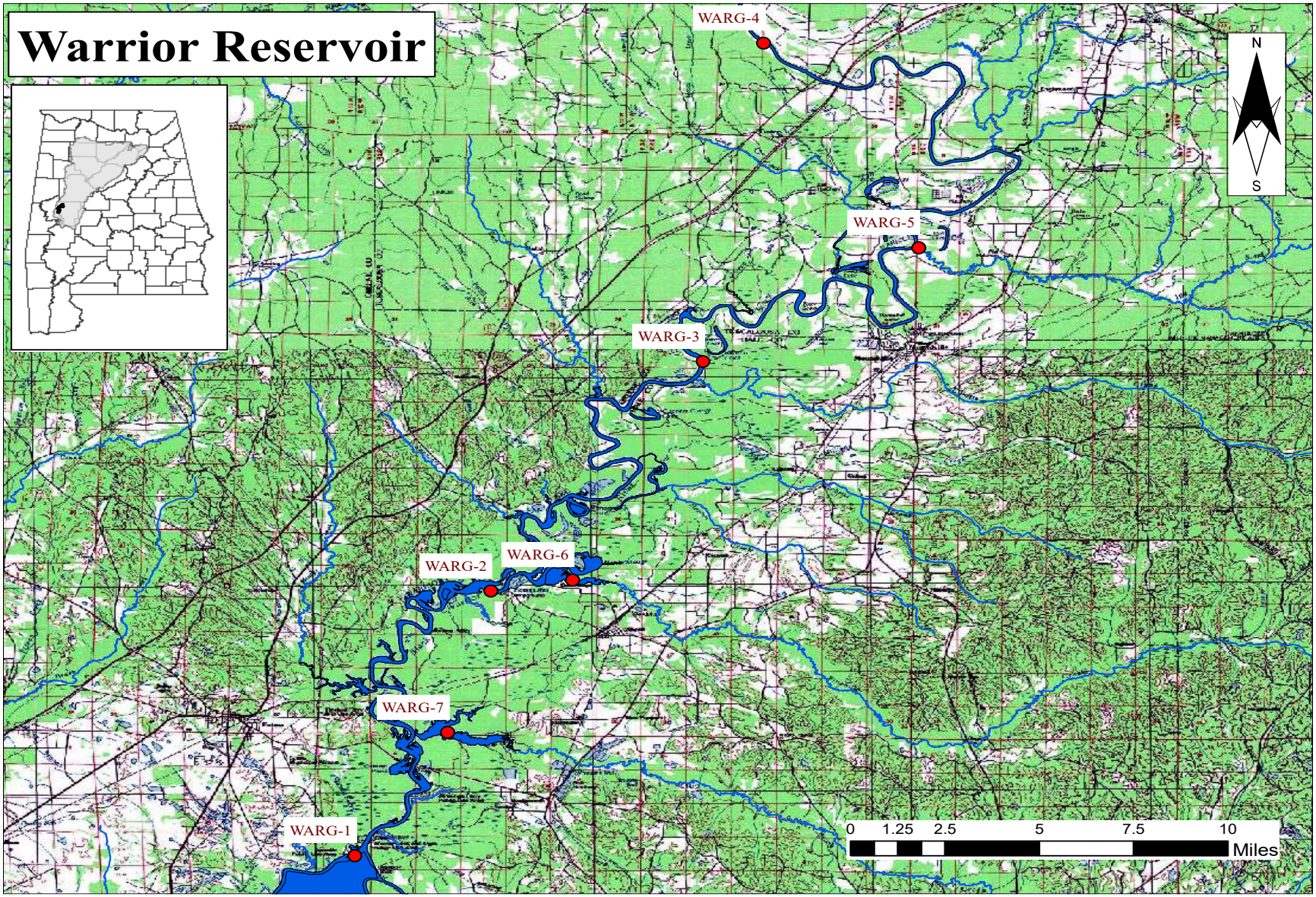


Table 1. Descriptions of the 2017 and 2021 monitoring stations in Warrior Reservoir.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria	Latitude	Longitude
Warrior Reservoir								
031601130607	Greene	*WARG-1	Lower	Black Warrior R	Deepest point, main river channel, dam forebay.	12 µg/l	32.77967	-87.83922
031601130607	Greene	WARG-2	Mid	Black Warrior R	Deepest point, main river channel, immediately downstream of Lock 8 Public Use Area.		32.89492	-87.78727
031601130602	Greene	WARG-3	Upper	Black Warrior R	Deepest point, main river channel, at Lock 9 Public Use Area.		32.99508	-87.70566
031601130204	Tuscaloosa	WARG-4	Above I-59	Black Warrior R	Deepest point, main river channel, approximately 3.5 miles upstream of I-59 crossing.		33.13381	-87.68262
031601130105	Tuscaloosa	WARG-5	Big Sandy Ck	Big Sandy Ck	Main creek channel, Big Sandy Creek 0.5 miles upstream of confluence with Black Warrior River.		33.04478	-87.62318
031601130402	Hale	WARG-6	Five Mile Ck	Five Mile Ck	Main creek channel, Five Mile Creek, 0.5 miles upstream of confluence with Black Warrior River.		32.89998	-87.75597
031601130507	Hale	WARG-7	Big Brush Ck	Big Brush Ck	Main creek channel, Big Brush Creek 0.5 miles upstream of confluence with Black Warrior River.		32.83340	-87.80384

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

RESULTS

Growing season mean graphs for TN, TP, chl *a*, TSS, and TSI are provided in this section (Figures 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figures 4-9 and 16-17). Mean monthly discharge is included in monthly graphs as an indicator of flow and retention time in the months sampled. Algal growth potential test (AGPT) results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figures 10-15. Summary statistics of all data collected during 2017 and 2021 are presented in Appendix Table 1 and Appendix Table 2. The tables contain the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

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

The highest mean growing season TN concentration was calculated for the mid reservoir station in 2017 and the lower station in 2021 (Figure 2). Mean growing season TN concentrations have been variable since sampling began in 1998, but concentrations decreased at all stations from 2017 to 2021. Mean TN concentrations decreased at all embayment stations from 2017 to 2021. Monthly TN graphs are available in Figure 4.

In 2017, the highest mean growing season TP value was calculated for Five Mile Creek (Figure 2). In 2021, Big Brush Creek had the highest mean TP concentration. Mean growing season TP concentrations have been variable since the start of sampling, but, in general, they have trended downward since 2002. Monthly TP graphs are available in Figure 5.

The growing season mean chl *a* concentration in the lower Warrior Reservoir station (WARG-1) exceeded the established criterion in 2017. The highest growing season mean chl *a* concentrations were calculated for Big Brush Creek in both 2017 and 2021 (Figure 3). Mean chl *a* values have been variable at all stations over the years, but concentrations at Big Sandy Creek are consistently lower than those observed at other locations in the reservoir. Monthly chl *a* graphs are available in Figure 6.

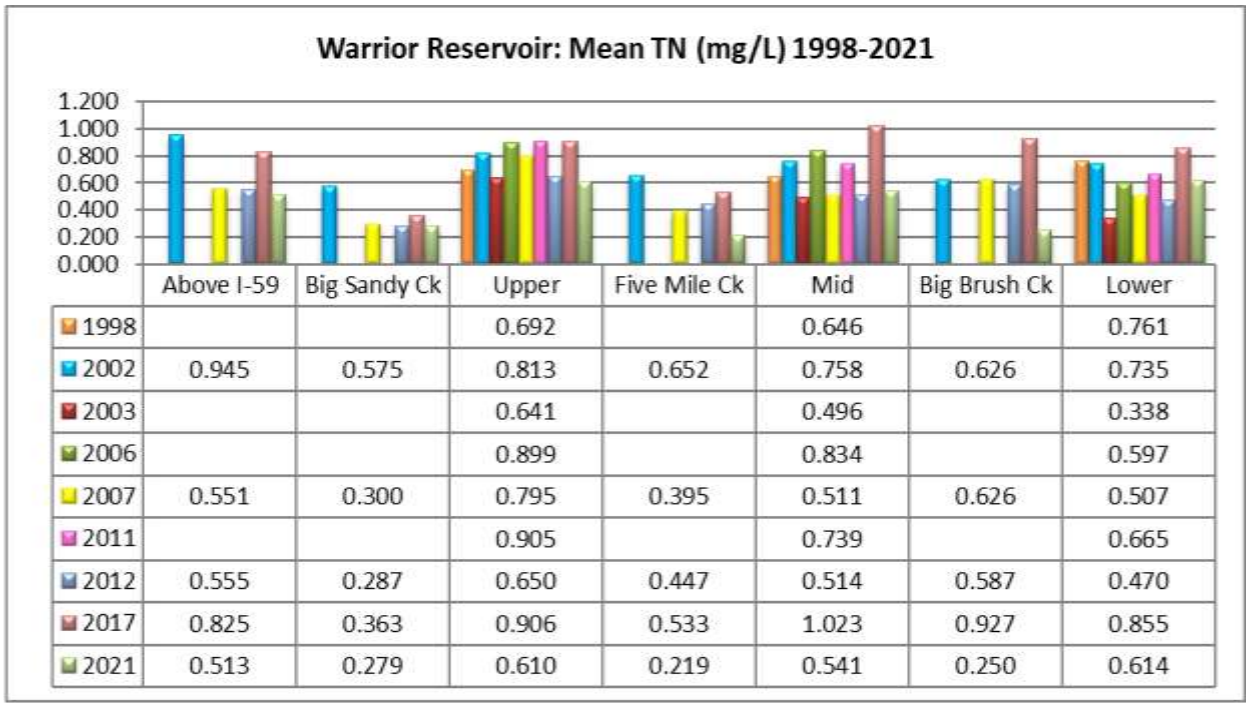
In 2017, the highest mean growing season TSS value was calculated for the mainstem station above I-59 (WARG-4). The highest mean growing season TSS measured in 2021 occurred at the lower station (Figure 3). Mean TSS values at the upper, mid, and lower stations decreased 2006-2012 but increased 2017-2021. The concentrations calculated for 2021 at Big Sandy Creek, the upper station, the mid station, Big Brush Creek, and the lower station were the highest observed since the start of sampling. Monthly TSS graphs are available in Figure 7.

In 2012, AGPT results indicated co-limiting nutrients at the upper and lower stations and nitrogen-limited conditions at the mid station (Table 2). The mean standing crop (MSC) values for all three stations were below 5 mg/L, the value defined by Rashke and Schultz (1987) as protective of reservoir and lake systems. AGPT was not collected during the 2017 or 2021 sampling seasons.

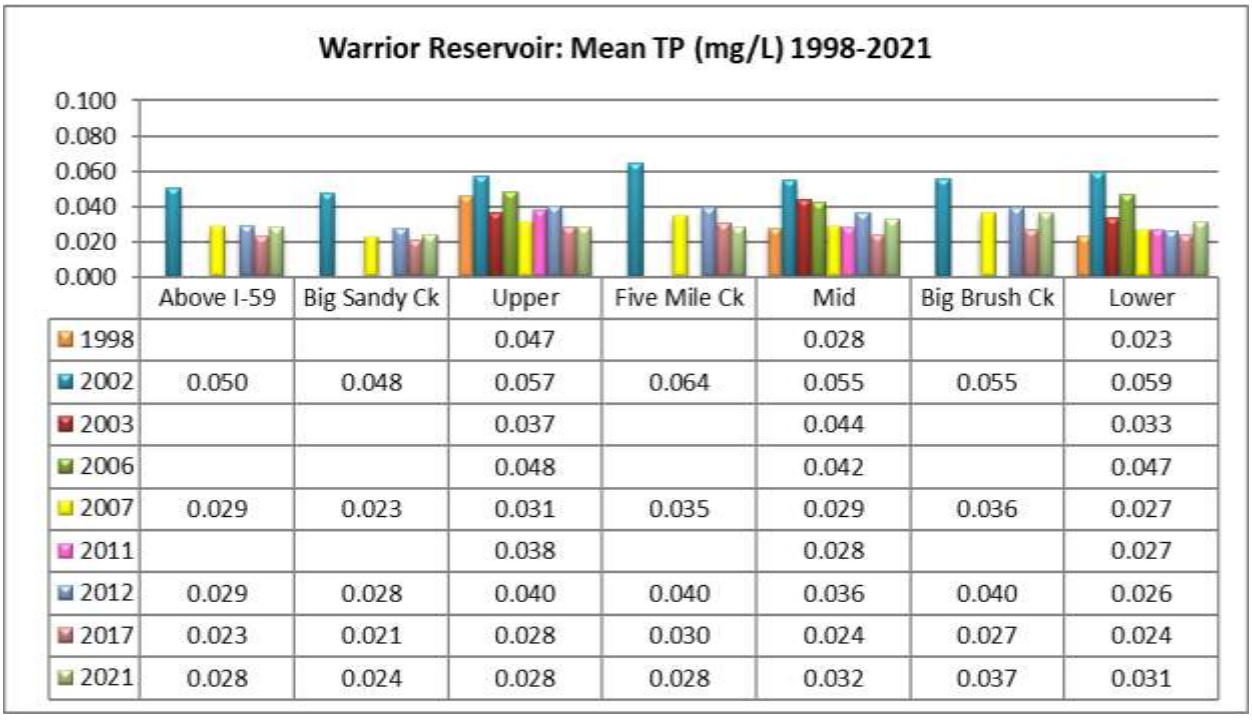
Dissolved oxygen concentrations at all Warrior Reservoir stations were above the ADEM criteria limit of 5.0 mg/L at 5 ft (1.5m) throughout the April-October growing season in both 2017 and 2021 (ADEM Admin. Code R. 335-6-10-.09) (Figures 8-9). Profiles of DO concentrations show each mainstem station was well-mixed and remained above 5 mg/L top to bottom in both 2017 and 2021 (Figures 10-15). Profiles of temperature show the highest temperatures were reached in August at all stations in both sampling years.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. In 2017, mainstem stations were eutrophic all months of the growing season, except the mid station in October, which was oligotrophic (Figure 16). Mainstem stations showed more variability during the 2021 sampling season, reaching mesotrophic and oligotrophic conditions some months (Figure 17). Big Brush Creek and Five Mile Creek were eutrophic most months sampled in both 2017 and 2021. Big Sandy Creek was oligotrophic to mesotrophic both sampling years.

Figure 2. Mean growing season TN and TP measured in Warrior Reservoir, April-October 1998-2021. Stations are illustrated from upstream to downstream as the graph is read from left to right.



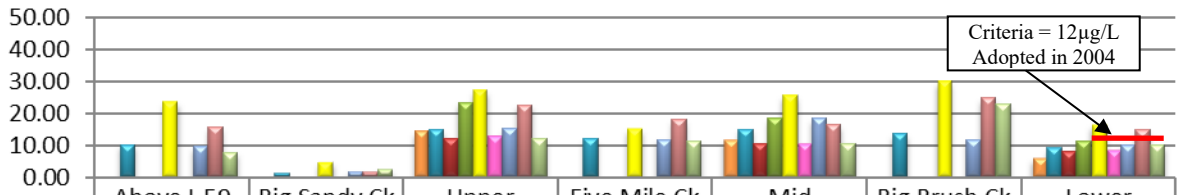
	Above I-59	Big Sandy Ck	Upper	Five Mile Ck	Mid	Big Brush Ck	Lower
1998			0.692		0.646		0.761
2002	0.945	0.575	0.813	0.652	0.758	0.626	0.735
2003			0.641		0.496		0.338
2006			0.899		0.834		0.597
2007	0.551	0.300	0.795	0.395	0.511	0.626	0.507
2011			0.905		0.739		0.665
2012	0.555	0.287	0.650	0.447	0.514	0.587	0.470
2017	0.825	0.363	0.906	0.533	1.023	0.927	0.855
2021	0.513	0.279	0.610	0.219	0.541	0.250	0.614



	Above I-59	Big Sandy Ck	Upper	Five Mile Ck	Mid	Big Brush Ck	Lower
1998			0.047		0.028		0.023
2002	0.050	0.048	0.057	0.064	0.055	0.055	0.059
2003			0.037		0.044		0.033
2006			0.048		0.042		0.047
2007	0.029	0.023	0.031	0.035	0.029	0.036	0.027
2011			0.038		0.028		0.027
2012	0.029	0.028	0.040	0.040	0.036	0.040	0.026
2017	0.023	0.021	0.028	0.030	0.024	0.027	0.024
2021	0.028	0.024	0.028	0.028	0.032	0.037	0.031

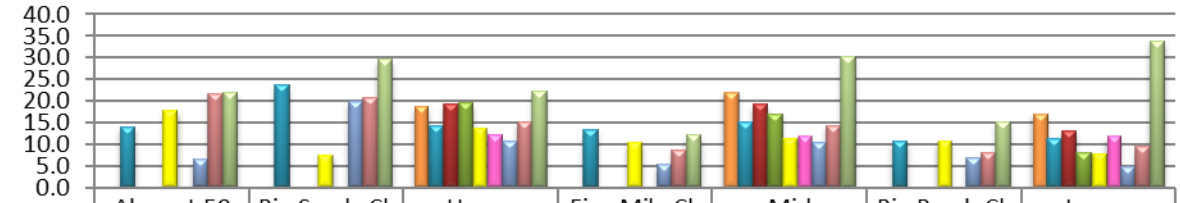
Figure 3. Mean growing season chl *a* and TSS measured in Warrior Reservoir, April-October 1998-2021. Stations are illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criteria applies to the growing season mean of the lower station only.

Warrior Reservoir: Mean chl *a* (µg/L) 1998-2021



	Above I-59	Big Sandy Ck	Upper	Five Mile Ck	Mid	Big Brush Ck	Lower
1998			14.55		11.73		5.86
2002	10.30	1.21	14.95	12.11	15.10	13.73	9.18
2003			12.17		10.75		8.09
2006			23.56		18.43		11.30
2007	23.44	4.64	27.27	15.03	25.49	30.09	16.54
2011			12.66		10.22		8.51
2012	9.71	1.87	15.18	11.84	18.54	11.75	10.07
2017	15.76	1.60	22.74	18.15	16.47	24.83	14.82
2021	7.83	2.42	12.11	11.33	10.63	22.84	10.13

Warrior Reservoir: Mean TSS (mg/L) 1998-2021



	Above I-59	Big Sandy Ck	Upper	Five Mile Ck	Mid	Big Brush Ck	Lower
1998			18.71		22.14		17.14
2002	14.00	23.71	14.29	13.29	15.00	10.71	11.29
2003			19.14		19.29		13.14
2006			19.57		17.00		8.07
2007	17.97	7.50	13.74	10.54	11.57	10.80	7.86
2011			12.14		11.86		11.86
2012	6.43	19.79	10.71	5.29	10.29	6.86	4.79
2017	21.7	20.7	15.3	8.7	14.3	8.1	9.4
2021	21.9	29.6	22.1	12.1	30.3	15.3	33.9

Figure 4. Monthly TN concentrations measured in Warrior Reservoir mainstem stations, April-October 2017 and 2021. Each bar graph depicts monthly changes in each station. The historic mean (1992-2021) and min/max ranges 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 (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).

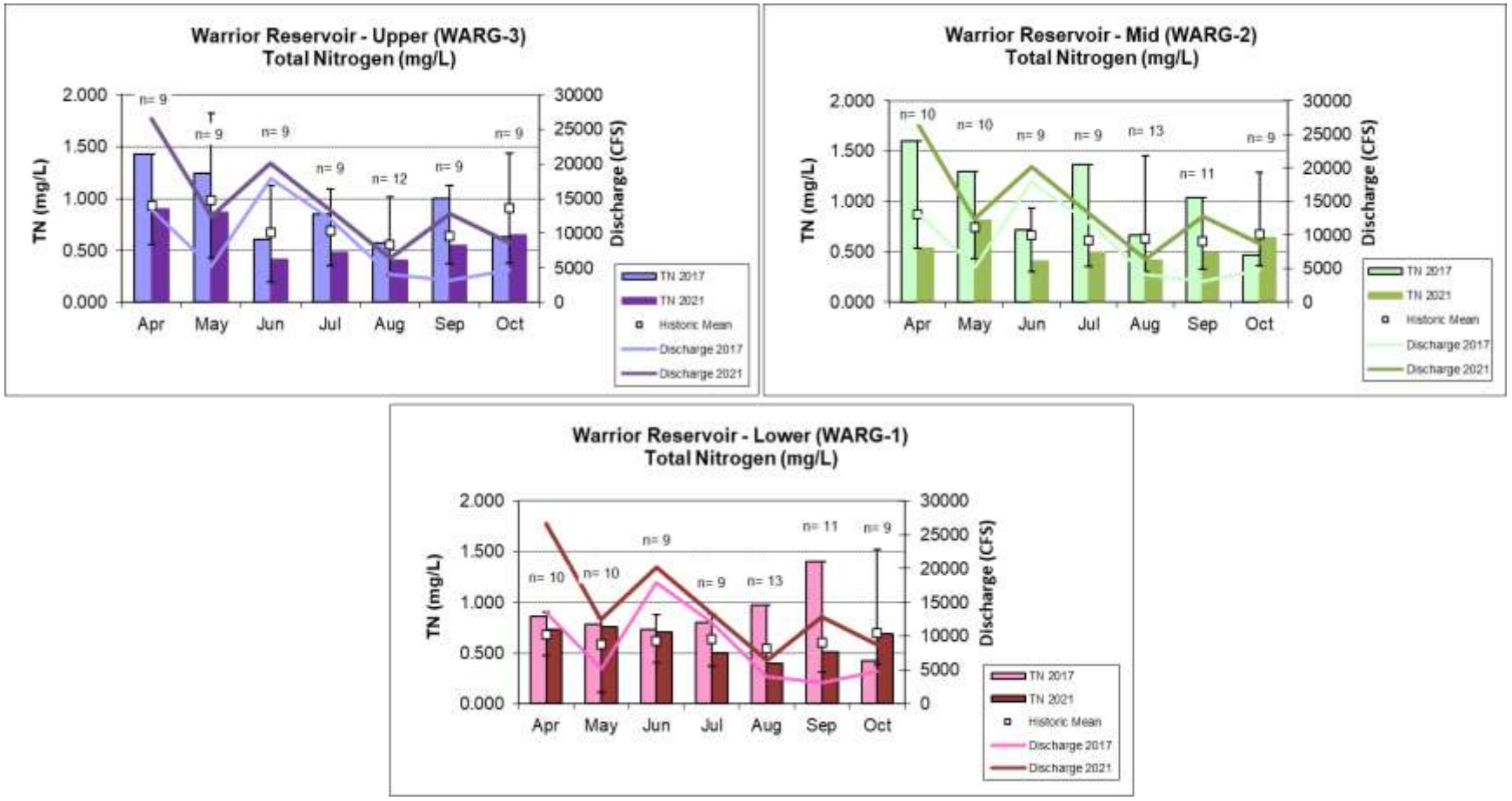


Figure 5. Monthly TP concentrations measured in Warrior Reservoir mainstem stations, April-October 2017 and 2021. Each bar graph depicts monthly changes in each station. The historic mean (1992-2021) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TP was plotted vs. the closest discharge (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).

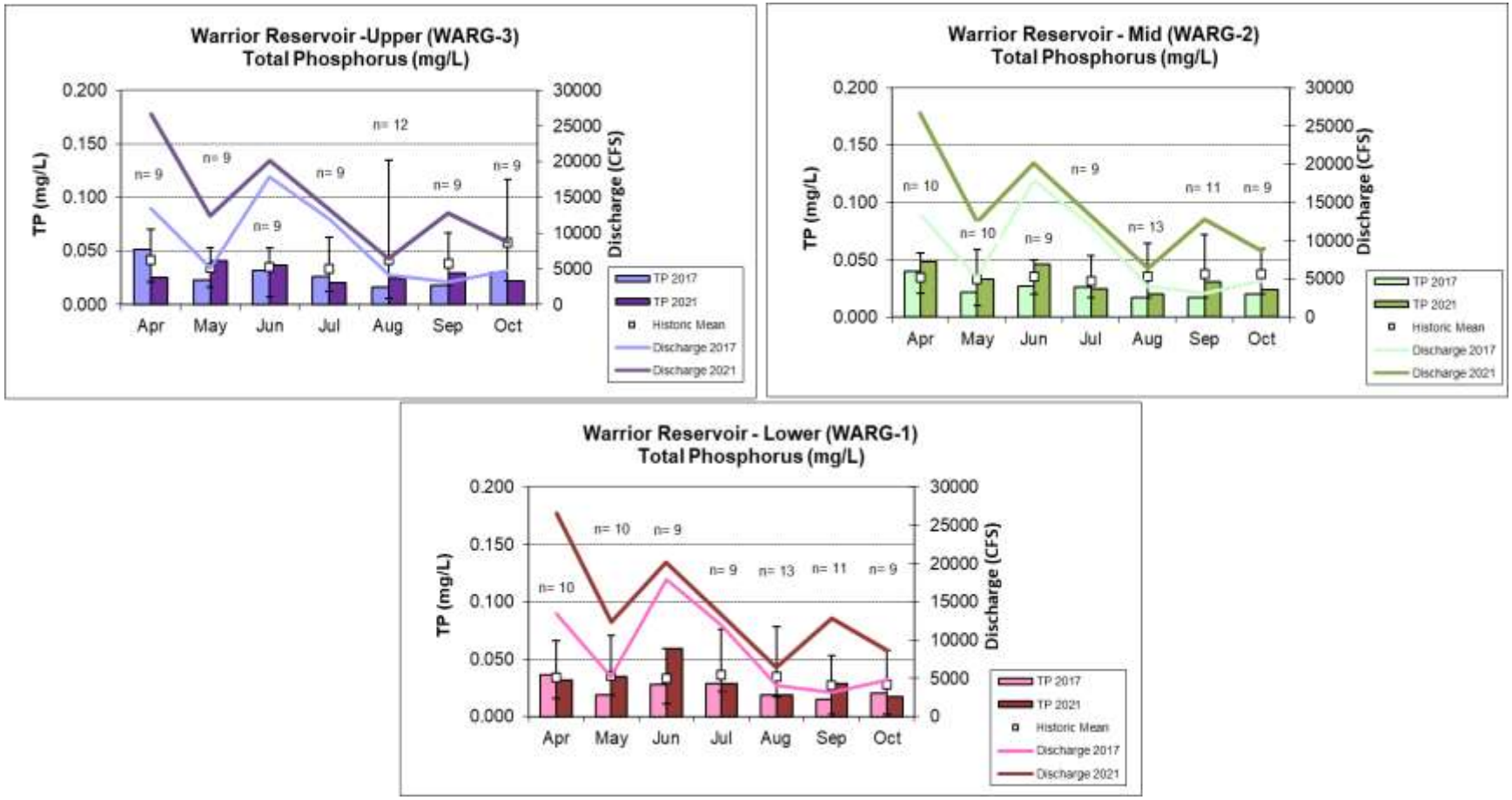


Figure 6. Monthly chl *a* concentrations measured in Warrior Reservoir mainstem stations, April-October 2017 and 2021. Each bar graph depicts monthly changes in each station. The historic mean (1992-2021) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Chl *a* was plotted vs. the closest discharge (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).

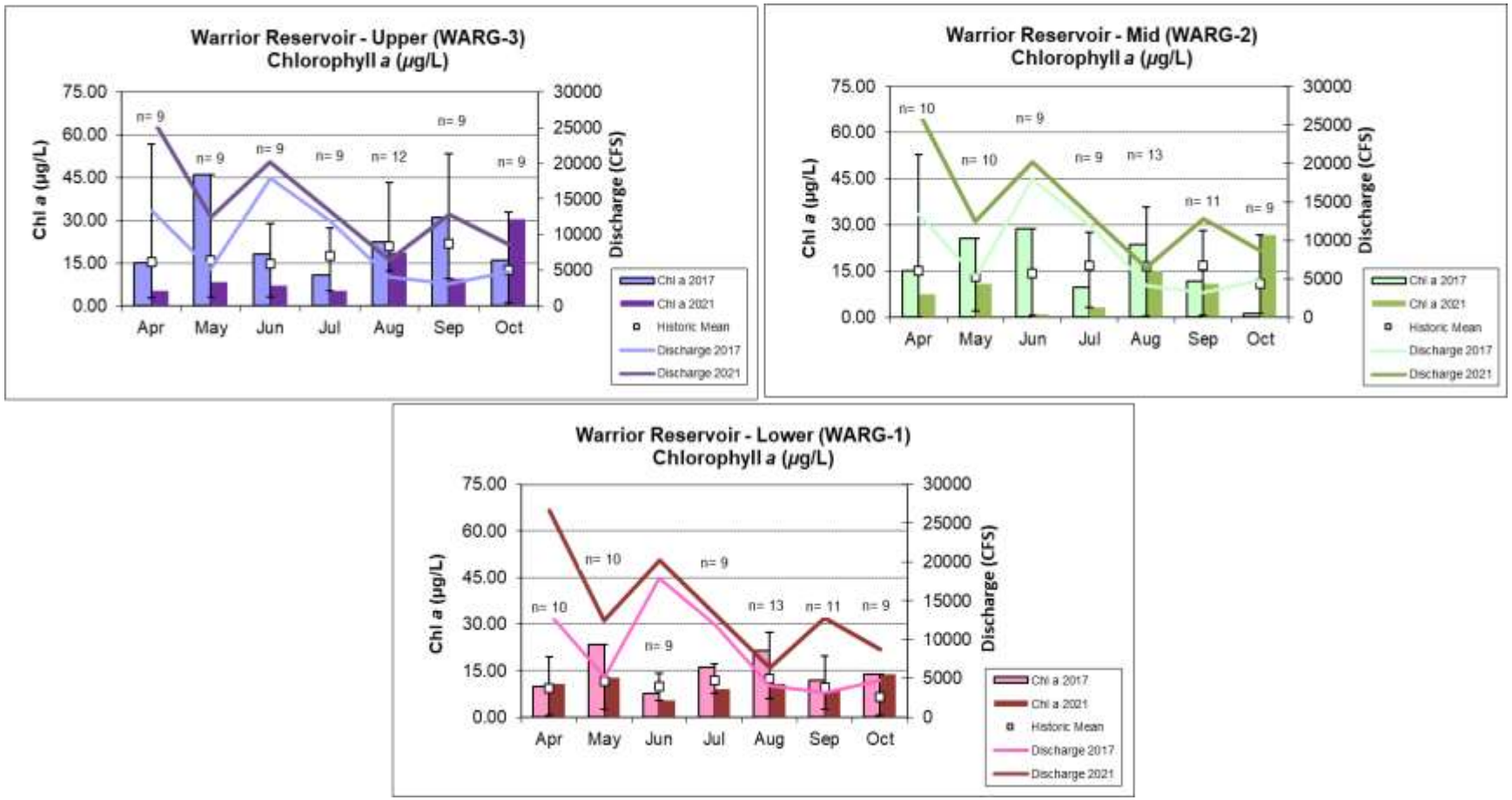


Figure 7. Monthly TSS concentrations measured in Warrior Reservoir mainstem stations, April-October 2017 and 2021. Each bar graph depicts monthly changes in each station. The historic mean (1992-2021) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. TSS was plotted vs. the closest discharge (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).

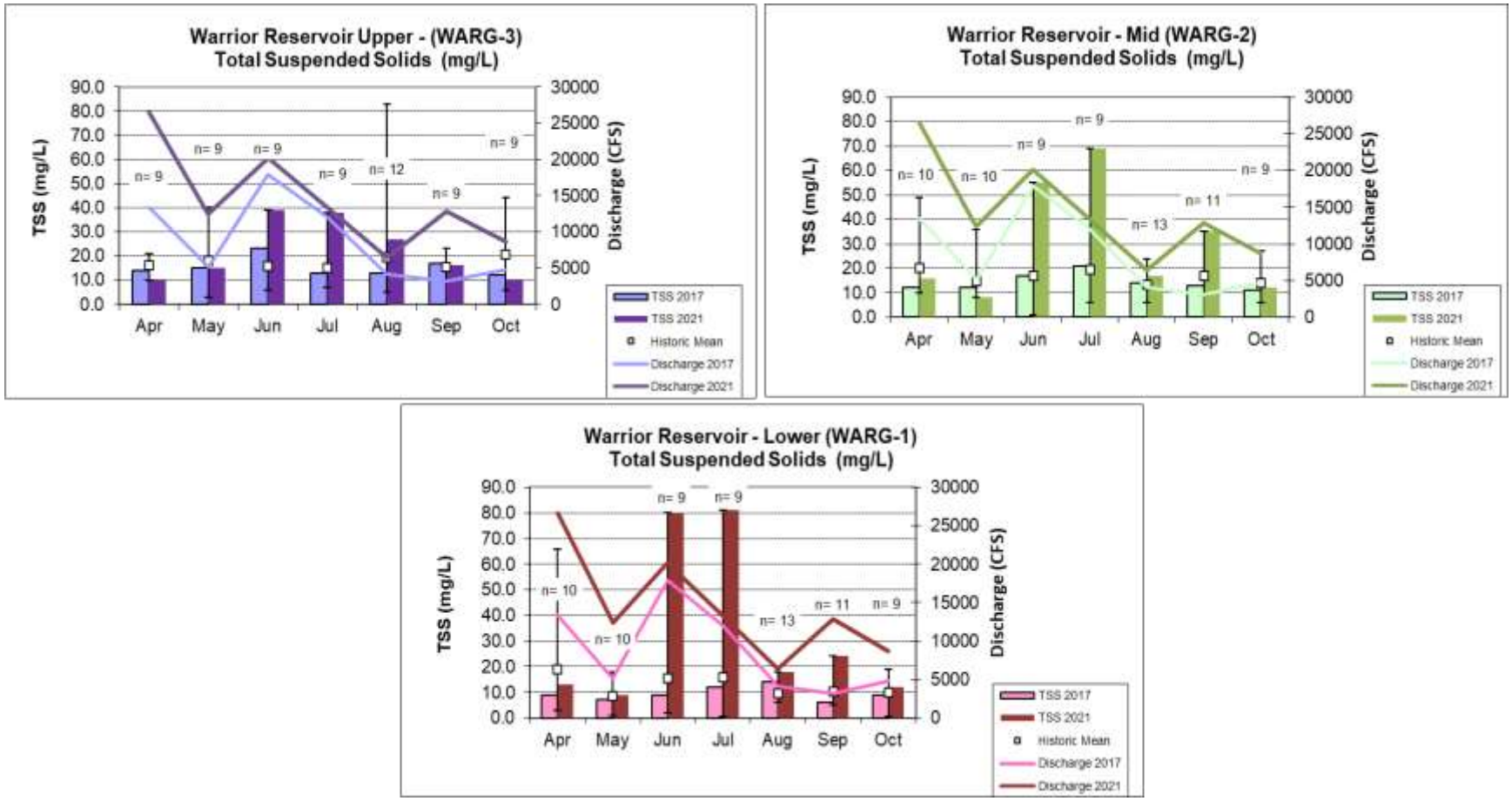


Table 2. Algal growth potential test results, Warrior Reservoir, 1998-2021, (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 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
August 1998	3.12	Phosphorus	3.57	Phosphorus	2.90	Phosphorus
August 2002	5.56	Phosphorus	5.11	Phosphorus	3.69	Phosphorus
June 2007	4.93	Phosphorus	5.09	Phosphorus	3.77	Phosphorus
July 2007	2.18	Co-limiting	2.36	Nitrogen	3.23	Phosphorus
August 2007	2.62	Nitrogen	2.87	Co-limiting	4.30	Phosphorus
August 2012	4.27	Co-limiting	4.26	Nitrogen	4.18	Co-limiting

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Warrior Reservoir stations collected April-October 2017. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM Admin. Code R. 335-6-10-.09).

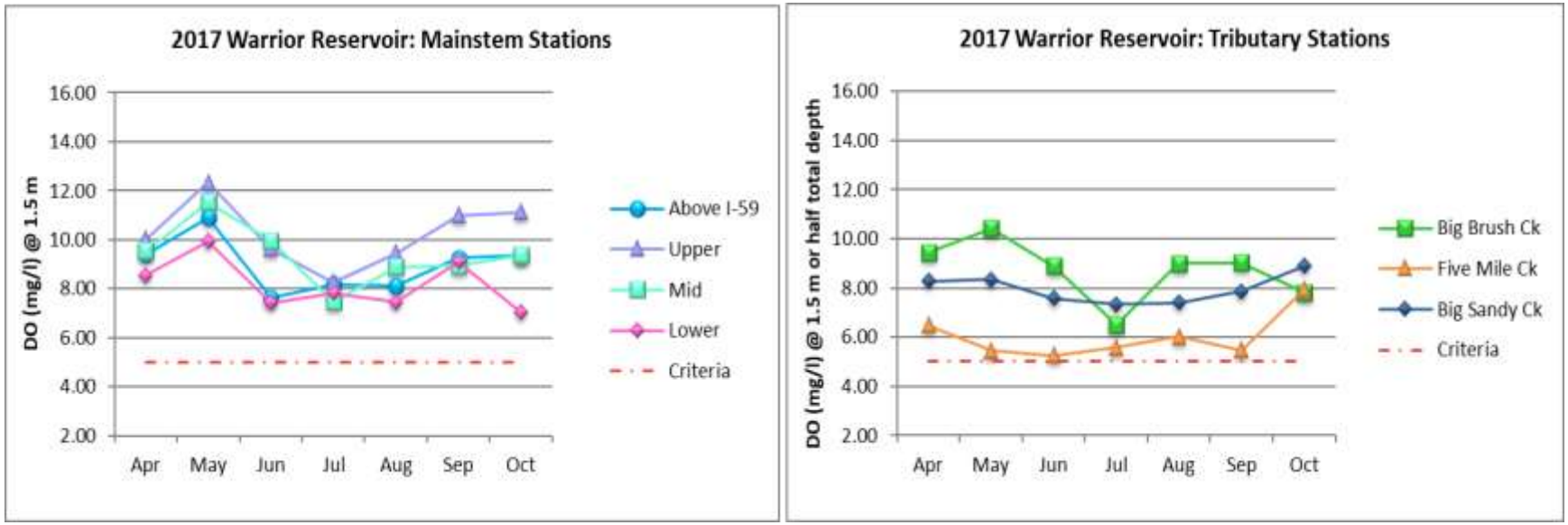


Figure 9. Monthly DO concentrations at 1.5 m (5 ft) for Warrior Reservoir stations collected April-October 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM Admin. Code R. 335-6-10-.09).

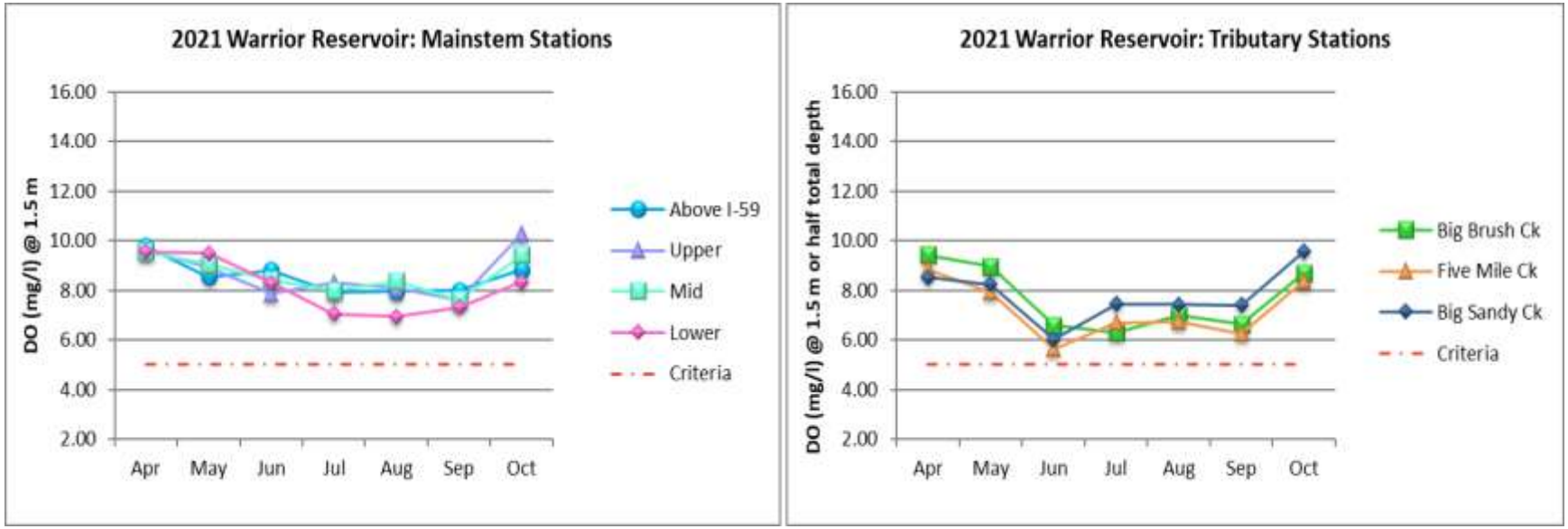


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in lower Warrior Reservoir, April-October 2017.

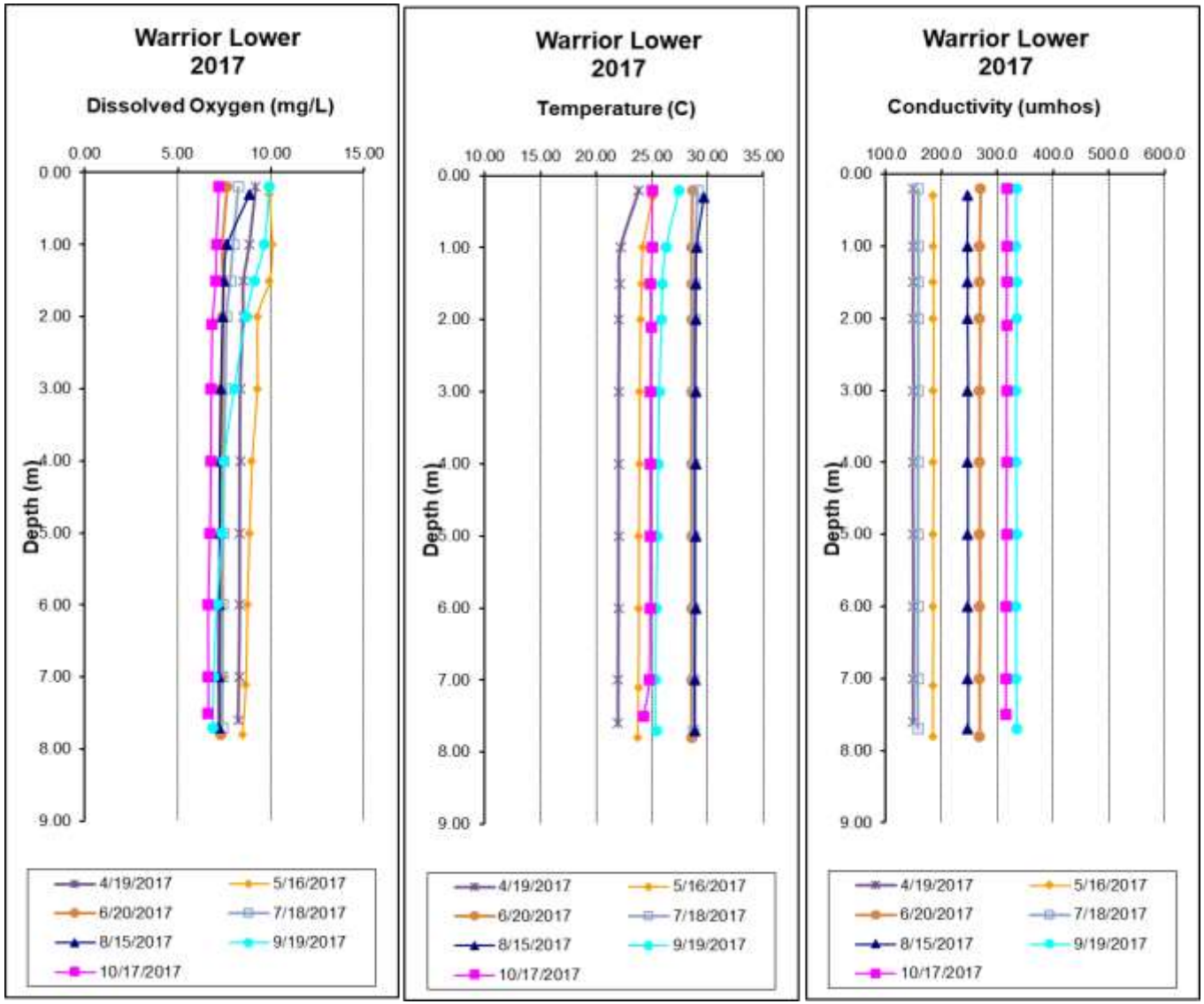


Figure 11. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in mid Warrior Reservoir, April-October 2017.

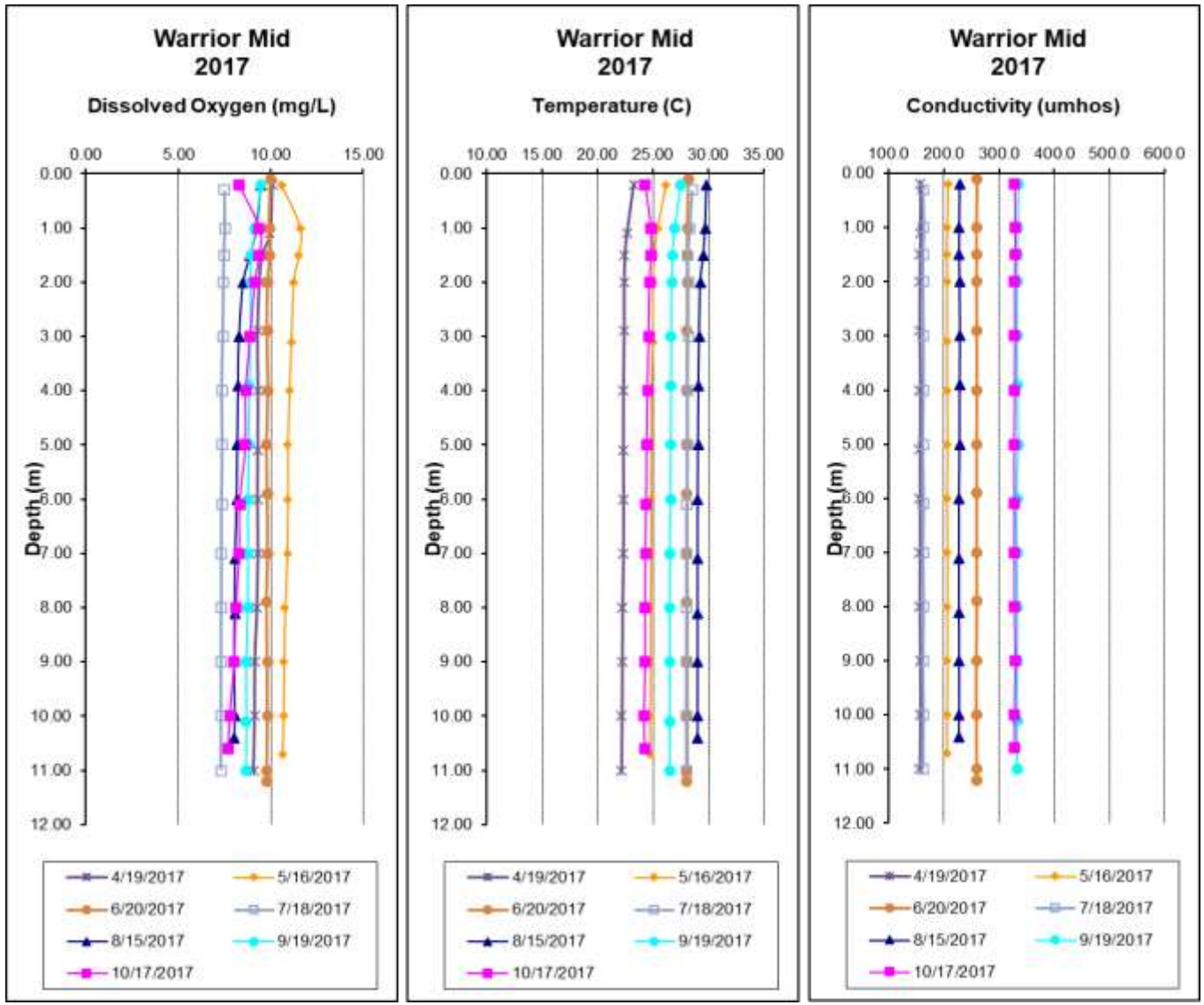


Figure 12. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in upper Warrior Reservoir, April-October 2017.

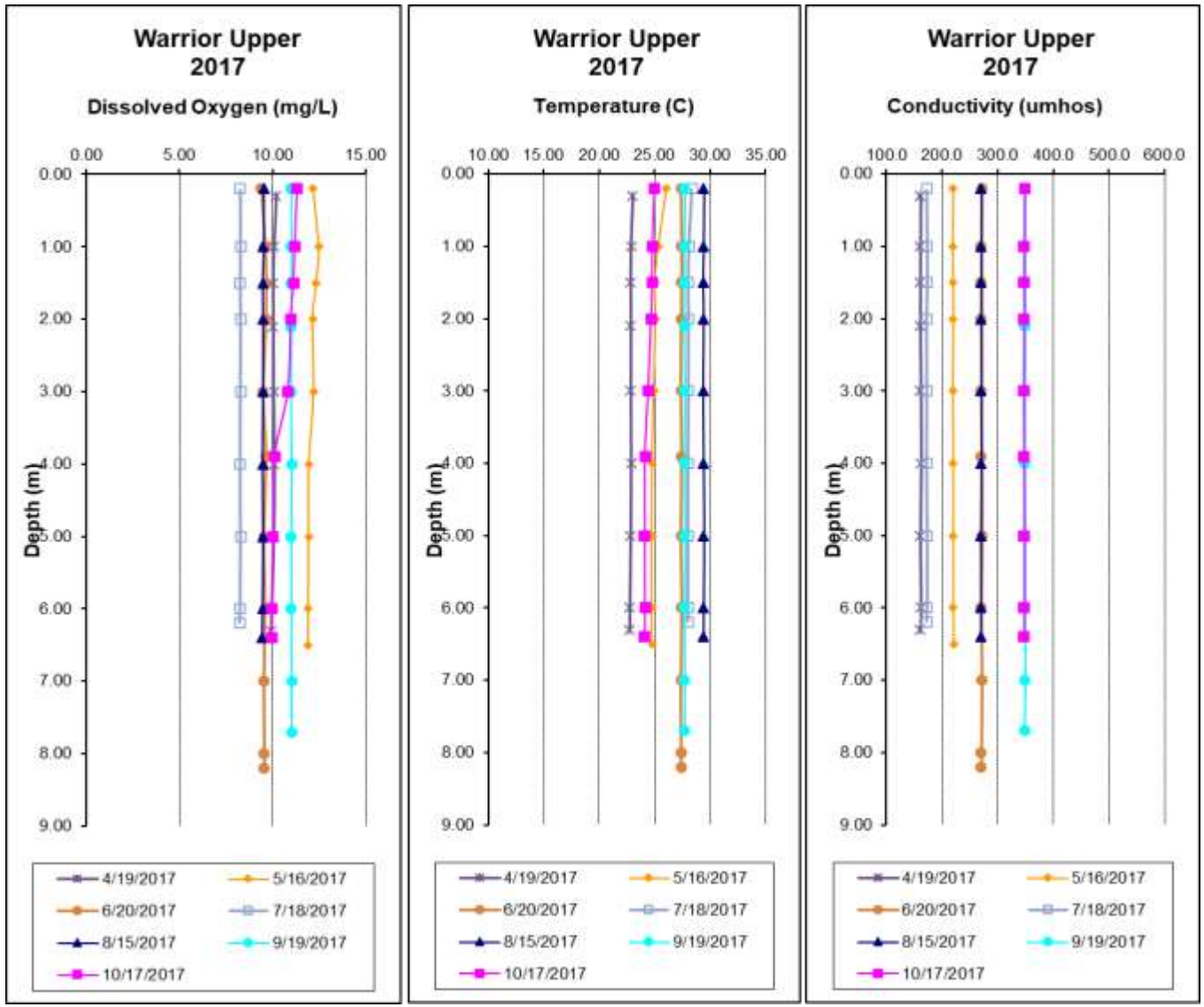


Figure 13. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in lower Warrior Reservoir, April-October 2021.

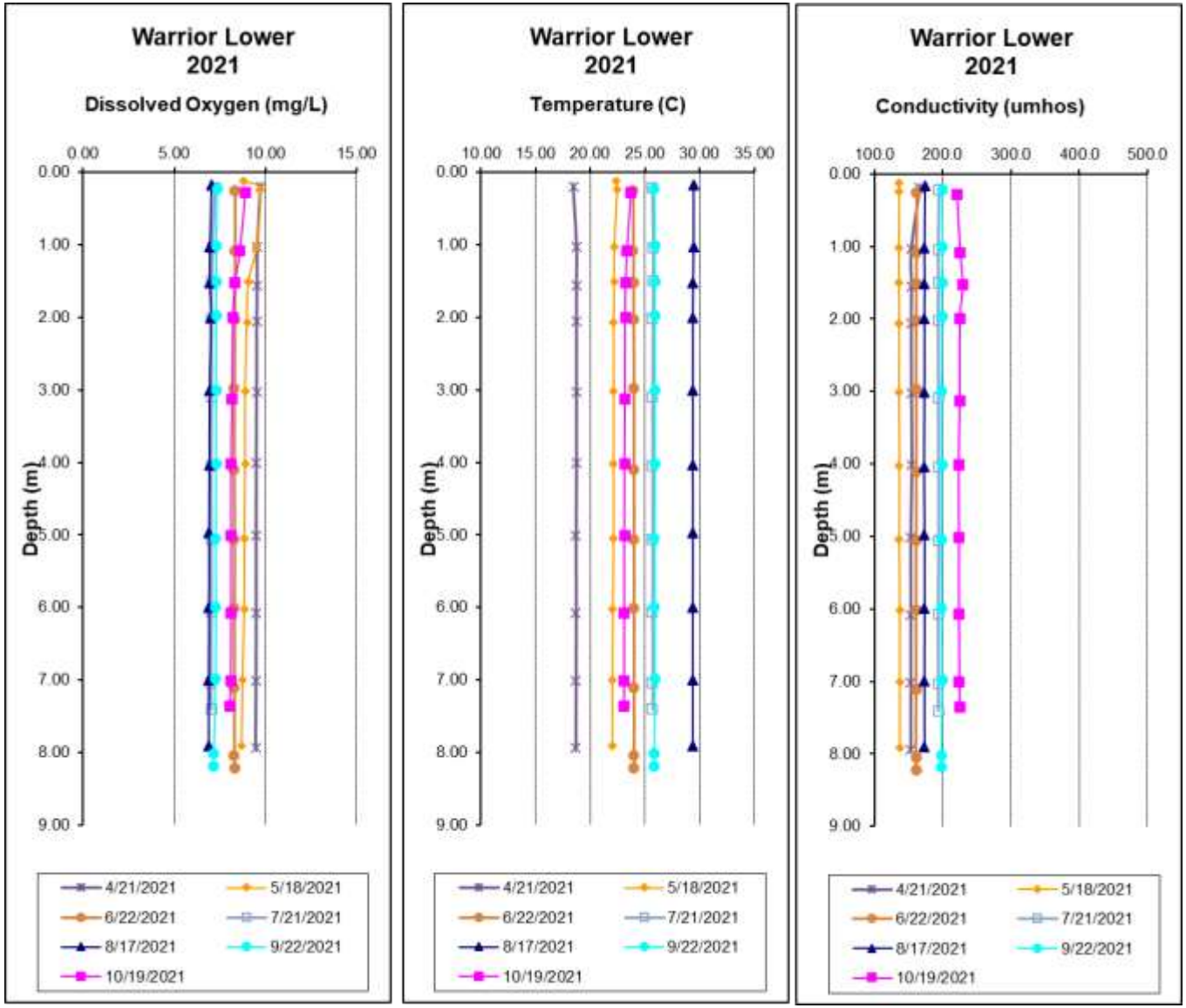


Figure 14. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in mid Warrior Reservoir, April-October 2021.

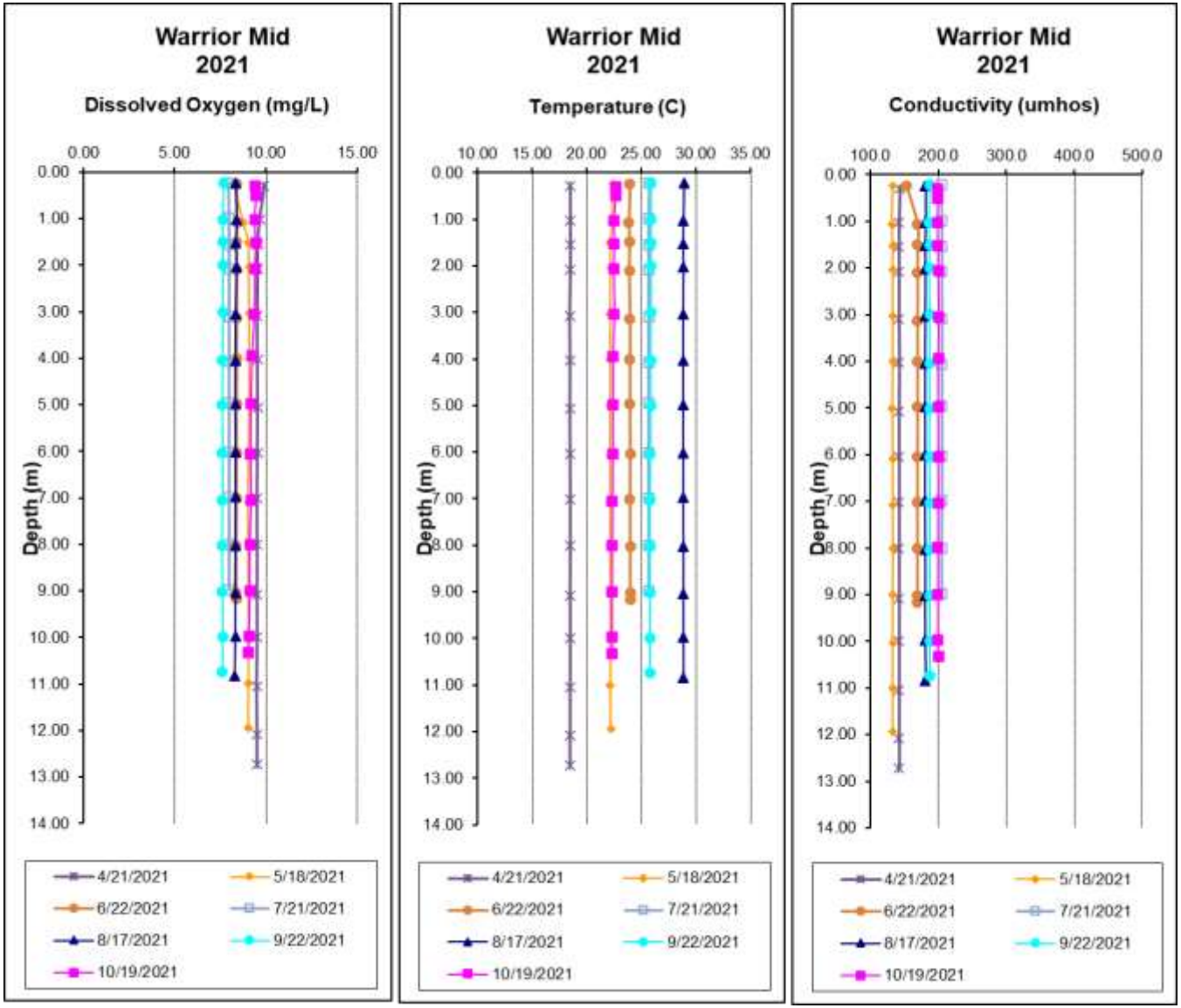


Figure 15. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (µmhos) in upper Warrior Reservoir, April-October 2021.

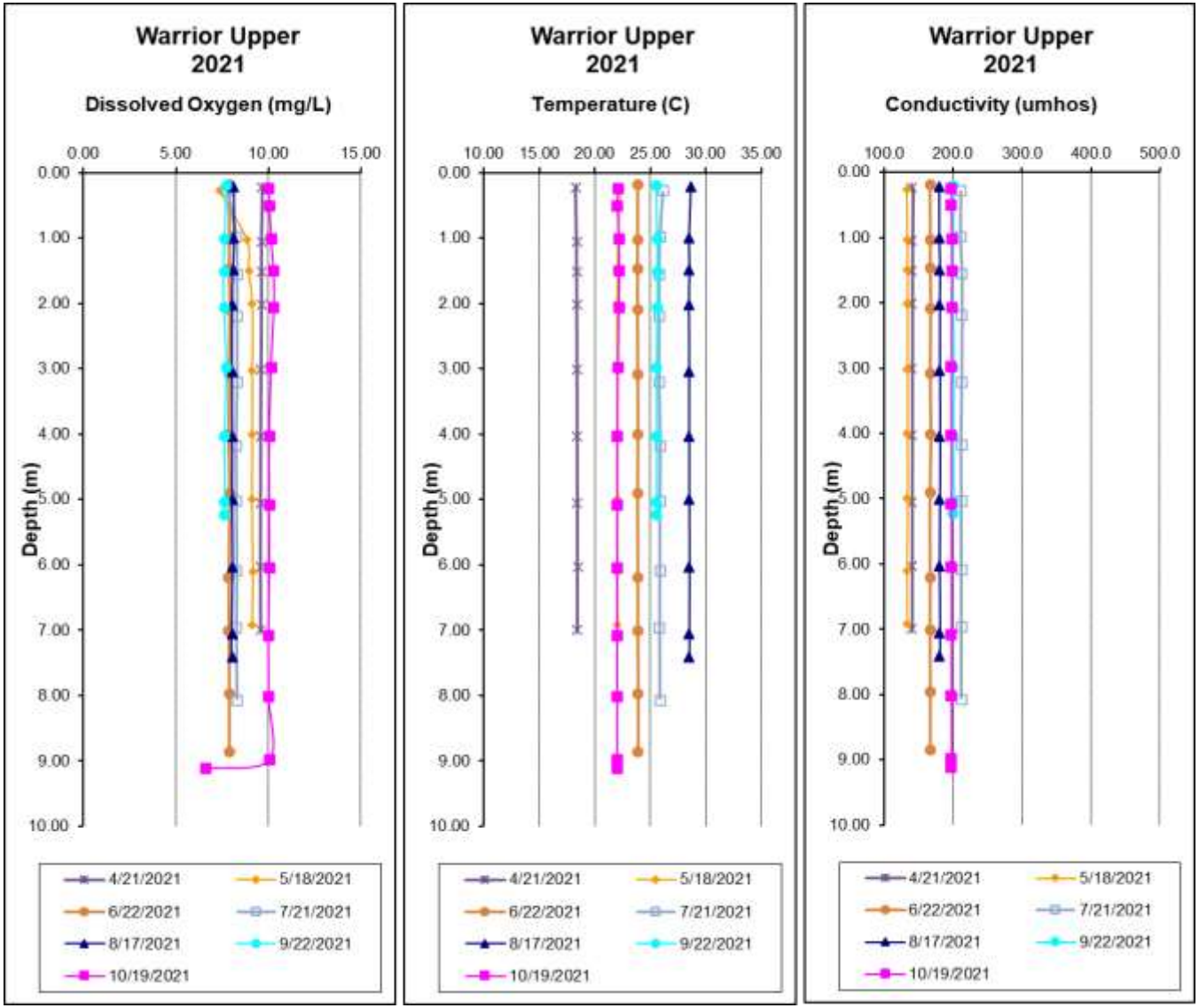


Figure 16. Monthly TSI values calculated for mainstem and tributary Warrior Reservoir stations, April-October 2017 using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly TSI was plotted vs. the closest mean monthly discharge (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).

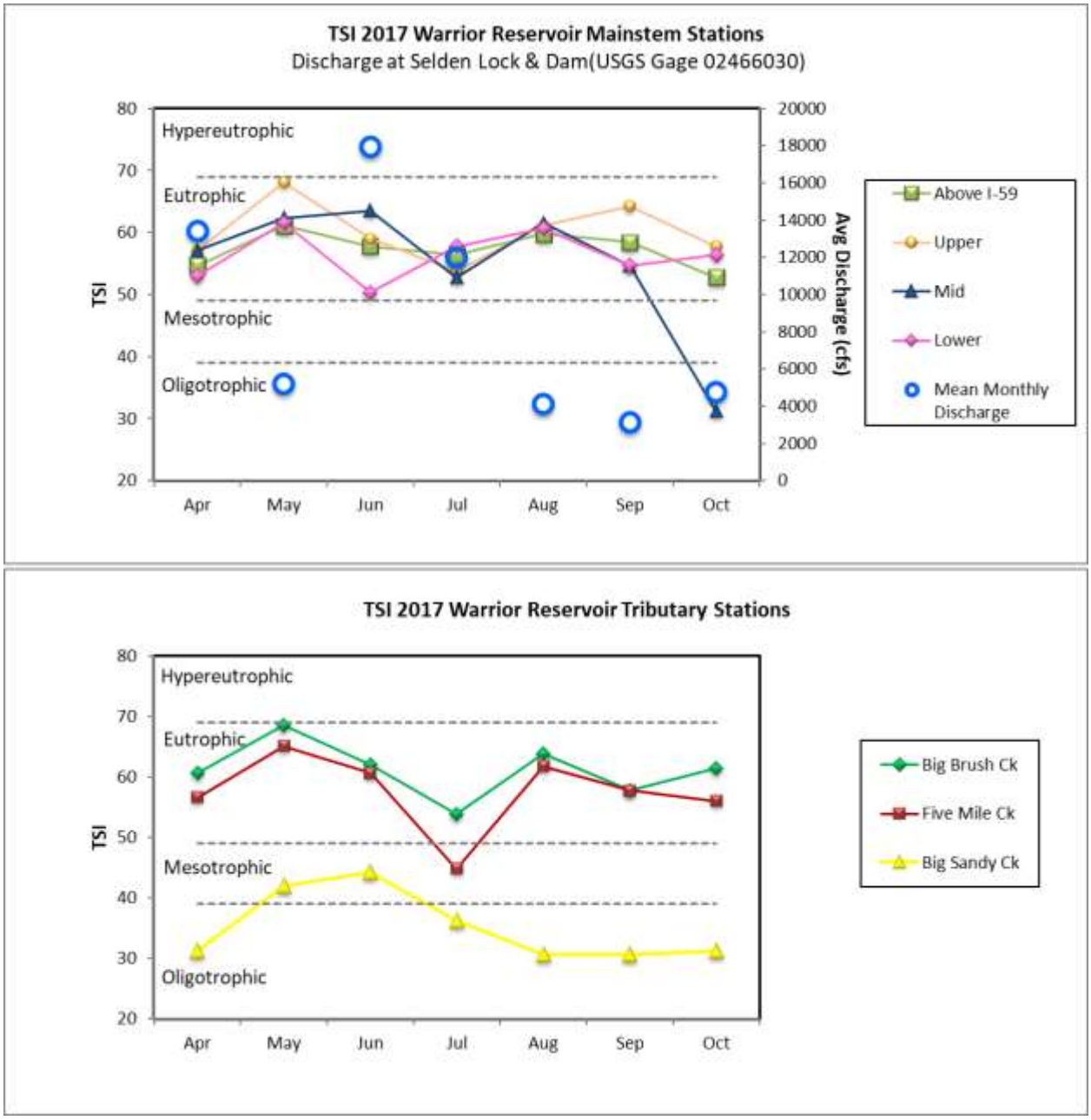
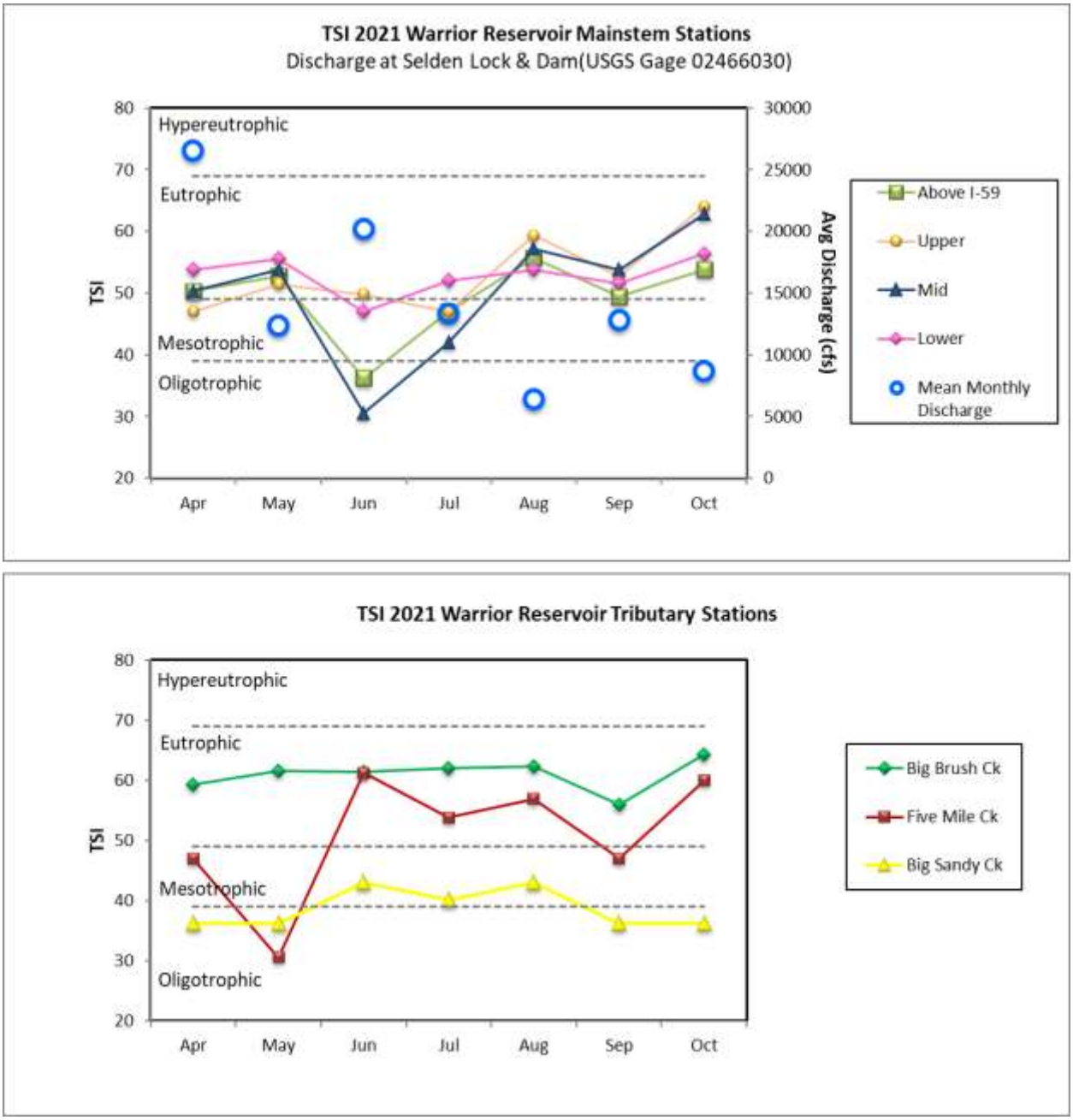


Figure 17. Monthly TSI values calculated for mainstem and tributary Warrior Reservoir stations, April-October 2021 using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly TSI was plotted vs. the closest mean monthly discharge (USGS 02466030 Black Warrior River at Selden L&D near Eutaw, AL).



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APPENDIX

Appendix Table 1. Summary of Warrior Reservoir water quality data collected April-October 2017. 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	Parameters	N	Min	Max	Med	Avg	SD
WARG-1	**Physical**						
	Turbidity (NTU)	7	7.0	18.3	11.4	12.3	3.8
	Total Dissolved Solids (mg/L)	7	89.0	209.0	142.0	137.4	41.6
	Total Suspended Solids (mg/L)	7	6.0	14.0	9.0	9.4	2.8
	Hardness (mg/L)	4	51.4	109.0	87.4	83.8	23.9
	Alkalinity (mg/L)	7	31.4	70.7	51.2	50.5	16.2
	Photic Zone (m)	7	2.00	3.62	2.75	2.65	0.54
	Secchi (m)	7	0.50	1.02	0.72	0.76	0.19
	Bottom Depth (m)	7	7.5	7.8	7.7	7.7	0.1
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.004	0.171	0.004	0.035	0.064
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.191	0.469	0.256	0.284	0.100
	Total Kjeldahl Nitrogen (mg/L)	7	0.211	1.180	0.523	0.571	0.309
	Total Nitrogen (mg/L)	7	1.281	4.215	0.805	0.855	0.295
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.002	0.005	0.003	0.003	0.002
	Total Phosphorus (mg/L)	7	0.015	0.036	0.020	0.024	0.007
	CBOD-5 (mg/L)[J]	6	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	6.0	12.0	9.0	9.1	2.4
	Biological						
	Chlorophyll a (mg/m³)	7	7.48	23.50	13.90	14.82	5.91
	E. coli (MPN/DL)[J]	4	2	9	5	4	3
WARG-2	**Physical**						
	Turbidity (NTU)	7	12.7	25.4	14.6	16.6	4.6
	Total Dissolved Solids (mg/L)	7	78.0	209.0	136.0	141.4	40.9
	Total Suspended Solids (mg/L)	7	11.0	21.0	13.0	14.3	3.6
	Hardness (mg/L)	4	54.8	107.0	86.0	83.4	21.8
	Alkalinity (mg/L)	7	33.0	71.3	48.1	51.1	15.9
	Photic Zone (m)	7	1.82	2.71	2.35	2.29	0.33
	Secchi (m)	7	0.38	0.84	0.52	0.60	0.17
	Bottom Depth (m)	7	10.4	11.2	11.0	10.9	0.3
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.004	0.012	0.004	0.004	0.004
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.168	0.533	0.254	0.291	0.142
	Total Kjeldahl Nitrogen (mg/L)	7	0.301	1.070	0.787	0.731	0.296
	Total Nitrogen (mg/L)	7	1.407	4.809	1.041	1.023	0.419
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.002	0.006	0.003	0.003	0.002
	Total Phosphorus (mg/L)	7	0.017	0.040	0.022	0.024	0.008
	CBOD-5 (mg/L)[J]	6	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	5.1	12.4	8.7	8.6	2.6
	Biological						
	Chlorophyll a (mg/m³)	7	1.07	28.80	15.00	16.47	9.95
	E. coli (MPN/DL)[J]	4	2	36	16	18	17

Station	Parameters	N	Min	Max	Med	Avg	SD
WARG-3	**Physical**						
	Turbidity (NTU)	7	11.4	37.1	15.2	18.7	8.6
	Total Dissolved Solids (mg/L)	7	89.0	222.0	165.0	152.6	43.6
	Total Suspended Solids (mg/L)	7	12.0	23.0	14.0	15.3	3.8
	Hardness (mg/L)	4	59.4	115.0	94.8	91.0	23.2
	Alkalinity (mg/L)	7	33.5	74.6	57.8	54.4	16.7
	Photic Zone (m)	7	1.94	2.39	2.12	2.17	0.17
	Secchi (m)	7	0.49	0.72	0.60	0.60	0.08
	Bottom Depth (m)	7	6.2	8.2	6.4	6.8	0.8
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.004	0.045	0.004	0.009	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.147	0.620	0.243	0.307	0.166
	Total Kjeldahl Nitrogen (mg/L)	7	0.343	0.974	0.489	0.599	0.256
	Total Nitrogen (mg/L)	7	1.719	4.287	0.850	0.906	0.335
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.002	0.018	0.002	0.004	0.006
	Total Phosphorus (mg/L)	7	0.016	0.051	0.026	0.028	0.012
	CBOD-5 (mg/L)[J]	6	< 2.0	2.2	1.5	1.5	0.6
	Chlorides (mg/L)	7	4.6	12.8	9.8	9.1	2.8
	Biological						
	Chlorophyll a (mg/m³)	7	10.70	45.90	18.20	22.74	12.08
	E. coli (MPN/DL)[J]	4	13	27	15	18	7
WARG-4	**Physical**						
	Turbidity (NTU)	7	9.1	75.5	13.8	23.8	23.8
	Total Dissolved Solids (mg/L)	7	78.0	209.0	139.0	140.6	45.9
	Total Suspended Solids (mg/L)	7	8.0	71.0	13.0	21.7	22.3
	Hardness (mg/L)	4	61.4	121.0	91.4	91.3	24.5
	Alkalinity (mg/L)	7	32.2	78.0	56.2	54.8	17.6
	Photic Zone (m)	7	1.00	3.10	2.65	2.36	0.72
	Secchi (m)	7	0.28	1.03	0.72	0.70	0.27
	Bottom Depth (m)	7	4.5	7.8	5.4	5.5	1.1
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.004	0.007	0.002	0.003	0.001
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.182	0.608	0.386	0.379	0.136
	Total Kjeldahl Nitrogen (mg/L)	7	0.235	0.846	0.377	0.445	0.214
	Total Nitrogen (mg/L)	7	1.317	3.507	0.763	0.825	0.270
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.002	0.007	0.003	0.004	0.002
	Total Phosphorus (mg/L)	7	0.016	0.031	0.022	0.023	0.006
	CBOD-5 (mg/L)[J]	6	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	5.1	11.0	8.2	8.0	2.2
	Biological						
	Chlorophyll a (mg/m³)	7	9.61	22.40	16.00	15.76	4.44
	E. coli (MPN/DL)[J]	4	12	579	55	176	272

Station	Parameter	N	Min	Max	Med	Avg	SD
WARG-5	**Physical**						
	Turbidity (NTU)	7	10.5	87.5	24.6	31.9	26.8
	Total Dissolved Solids (mg/L)	7	55.0	119.0	76.0	83.3	22.1
	Total Suspended Solids (mg/L)	7	6.0	54.0	13.0	20.7	17.1
	Hardness (mg/L)	4	26.1	49.2	40.9	39.3	11.1
	Alkalinity (mg/L)	7	25.7	43.2	40.0	35.8	7.2
	Photic Zone (m)	7	1.03	2.80	1.94	1.98	0.64
	Secchi (m)	7	0.31	1.00	0.66	0.64	0.24
	Bottom Depth (m)	7	1.4	3.3	2.6	2.5	0.6
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.007	0.074	0.011	0.017	0.025
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.066	0.111	0.079	0.084	0.018
	Total Kjeldahl Nitrogen (mg/L)[J]	7	0.099	0.500	0.288	0.279	0.137
	Total Nitrogen (mg/L)[J]	7	0.501	1.788	0.355	0.363	0.140
	Dis Reactive Phosphorus (mg/L)[J]	7	0.002	0.004	0.003	0.003	0.001
	Total Phosphorus (mg/L)	7	0.012	0.036	0.020	0.021	0.008
	CBOD-5 (mg/L)[J]	6	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	14.2	36.7	28.6	26.2	8.4
	Biological						
	Chlorophyll a (mg/m³)	7	< 0.10	4.00	1.07	1.60	1.51
	E. coli (MPN/DL)[J]	4	114	579	318	332	213
WARG-6	**Physical**						
	Turbidity (NTU)	7	11.1	26.0	14.0	15.2	4.9
	Total Dissolved Solids (mg/L)	7	35.0	71.0	54.0	54.0	10.5
	Total Suspended Solids (mg/L)	7	6.0	12.0	7.0	8.7	2.5
	Hardness (mg/L)	4	17.3	31.1	19.2	21.7	6.4
	Alkalinity (mg/L)	7	6.8	23.3	11.8	12.2	5.4
	Photic Zone (m)	7	1.33	2.06	1.68	1.67	0.26
	Secchi (m)	7	0.42	0.88	0.59	0.62	0.16
	Bottom Depth (m)	7	2.7	3.6	2.9	3.1	0.4
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.004	0.109	0.004	0.025	0.041
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.004	0.056	0.022	0.023	0.017
	Total Kjeldahl Nitrogen (mg/L)	7	0.270	0.740	0.590	0.509	0.181
	Total Nitrogen (mg/L)[J]	7	< 0.858	2.388	0.592	0.533	0.192
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.002	0.004	0.003	0.003	0.001
	Total Phosphorus (mg/L)	7	0.021	0.040	0.029	0.030	0.007
	CBOD-5 (mg/L)[J]	6	< 2.0	2.5	1.0	1.3	0.6
	Chlorides (mg/L)	7	2.6	5.2	3.3	3.5	0.9
	Biological						
	Chlorophyll a (mg/m³)	7	4.27	33.80	16.00	18.15	9.36
	E. coli (MPN/DL)[J]	4	11	67	13	26	28

Station	Parameter	N	Min	Max	Med	Avg	SD
WARG-7	**Physical**						
	Turbidity (NTU)	7	7.1	18.5	10.0	11.0	3.8
	Total Dissolved Solids (mg/L)	7	59.0	203.0	90.0	100.9	46.6
	Total Suspended Solids (mg/L)	7	6.0	13.0	7.0	8.1	2.8
	Hardness (mg/L)	4	19.2	98.8	43.8	51.4	33.9
	Alkalinity (mg/L)	7	15.3	65.2	30.4	33.4	16.3
	Photic Zone (m)	7	1.68	2.72	2.05	2.17	0.33
	Secchi (m)	7	0.52	1.12	0.82	0.77	0.21
	Bottom Depth (m)	7	3.4	4.4	3.9	4.0	0.4
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.004	0.048	0.004	0.009	0.017
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.004	0.143	0.011	0.061	0.069
	Total Kjeldahl Nitrogen (mg/L)	7	0.311	1.510	0.857	0.867	0.424
	Total Nitrogen (mg/L)[J]	7	< 0.939	4.551	0.977	0.927	0.458
	Dis Reactive Phosphorus (mg/L)[J]	7	0.002	< 0.003	0.003	0.003	0.000
	Total Phosphorus (mg/L)	7	0.019	0.037	0.026	0.027	0.008
	CBOD-5 (mg/L)[J]	6	< 2.0	2.2	1.0	1.4	0.6
	Chlorides (mg/L)	7	4.1	12.3	7.7	8.3	3.1
	Biological						
	Chlorophyll a (mg/m³)	7	10.70	48.10	23.10	24.83	11.97
	E. coli (MPN/DL)[J]	4	1	8	4	4	2

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

Appendix Table 2. Summary of Warrior Reservoir water quality data collected April-October 2021. 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	Avg	SD
WARG-1	**Physical**						
	Turbidity (NTU)	7	9.3	75.0	20.8	31.8	28.3
	Total Dissolved Solids (mg/L)[J]	7	73.0	114.0	102.0	98.1	14.4
	Total Suspended Solids (mg/L)[J]	7	9.0	81.0	18.0	33.9	32.2
	Hardness (mg/L)	4	61.1	71.6	68.8	67.6	5.0
	Alkalinity (mg/L)	7	29.1	49.7	37.2	38.3	6.8
	Photic Zone (m)	7	0.70	2.97	2.04	1.89	0.90
	Secchi (m)	7	0.20	0.80	0.62	0.55	0.22
	Bottom Depth (m)	7	7.4	8.2	7.9	7.8	0.3
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.232	0.527	0.343	0.345	0.096
	Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.455	0.162	0.270	0.138
	Total Nitrogen (mg/L)[J]	7	< 1.182	2.286	0.689	0.614	0.143
	Dis Reactive Phosphorus (mg/L)[J]	7	0.004	0.006	0.004	0.005	0.001
	Total Phosphorus (mg/L)	7	0.017	0.059	0.029	0.031	0.014
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.8	6.2	4.2	4.8	1.0
	Biological						
	Chlorophyll a (mg/m³)	7	5.34	13.90	10.70	10.13	2.86
	E. coli (MPN/DL)[J]	4	11	102	76	67	41
WARG-2	**Physical**						
	Turbidity (NTU)	7	11.0	60.2	16.2	26.4	19.2
	Total Dissolved Solids (mg/L)[J]	7	77.0	140.0	107.0	106.0	24.2
	Total Suspended Solids (mg/L)[J]	7	8.0	69.0	17.0	30.3	23.6
	Hardness (mg/L)	4	62.8	76.3	65.2	67.4	6.2
	Alkalinity (mg/L)	7	28.4	45.6	39.0	37.4	6.6
	Photic Zone (m)	7	1.14	2.86	2.12	2.04	0.56
	Secchi (m)	7	0.33	0.97	0.64	0.60	0.22
	Bottom Depth (m)	7	9.0	12.7	10.7	10.7	1.4
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.248	0.481	0.328	0.334	0.078
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.324	0.477	0.162	0.207	0.119
	Total Nitrogen (mg/L)	7	< 1.230	2.427	0.490	0.541	0.142
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.006	0.005	0.004	0.002
	Total Phosphorus (mg/L)	7	0.020	0.048	0.031	0.032	0.011
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.5	6.2	4.3	4.8	1.1
	Biological						
	Chlorophyll a (mg/m³)	7	< 1.00	26.70	10.70	10.63	8.62
	E. coli (MPN/DL)[J]	4	19	150	61	73	56

Station	Parameter	N	Min	Max	Med	Avg	SD
WARG-3	**Physical**						
	Turbidity (NTU)	7	10.6	44.2	23.6	22.8	12.2
	Total Dissolved Solids (mg/L)[J]	7	84.0	126.0	101.0	101.0	17.0
	Total Suspended Solids (mg/L)[J]	7	10.0	39.0	16.0	22.1	12.5
	Hardness (mg/L)	4	60.7	80.8	67.4	69.1	9.1
	Alkalinity (mg/L)	7	28.8	45.2	37.7	37.7	7.0
	Photic Zone (m)	7	1.21	2.61	1.96	2.00	0.55
	Secchi (m)	7	0.33	0.89	0.55	0.59	0.18
	Bottom Depth (m)	7	5.2	9.1	7.4	7.5	1.3
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.241	0.485	0.363	0.346	0.084
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.324	0.539	0.162	0.264	0.175
	Total Nitrogen (mg/L)	7	< 1.209	2.706	0.546	0.610	0.206
	Dis Reactive Phosphorus (mg/L)[J]	7	0.004	0.008	0.005	0.006	0.002
	Total Phosphorus (mg/L)	7	0.020	0.041	0.025	0.028	0.008
	CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.9	7.1	4.5	5.0	1.3
	Biological						
	Chlorophyll a (mg/m³)	7	5.34	30.30	8.39	12.11	9.23
	E. coli (MPN/DL)[J]	4	45	185	70	92	63
WARG-4	**Physical**						
	Turbidity (NTU)	7	9.1	47.4	13.5	20.0	14.3
	Total Dissolved Solids (mg/L)[J]	7	71.0	129.0	100.0	97.4	21.7
	Total Suspended Solids (mg/L)[J]	7	10.0	40.0	19.0	21.9	10.8
	Hardness (mg/L)	4	61.6	77.1	68.2	68.8	6.7
	Alkalinity (mg/L)	7	29.1	44.2	39.8	37.8	6.6
	Photic Zone (m)	7	1.41	2.98	2.10	2.08	0.55
	Secchi (m)	7	0.37	0.98	0.72	0.66	0.24
	Bottom Depth (m)	7	5.1	11.9	6.5	7.4	2.5
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.272	0.533	0.350	0.351	0.093
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.324	< 0.324	0.162	0.162	0.000
	Total Nitrogen (mg/L)	7	< 1.302	2.085	0.512	0.513	0.093
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.012	0.006	0.007	0.004
	Total Phosphorus (mg/L)	7	0.017	0.049	0.027	0.028	0.012
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.2	5.1	3.9	4.1	0.8
	Biological						
	Chlorophyll a (mg/m³)	7	1.78	13.00	7.48	7.83	3.70
	E. coli (MPN/DL)[J]	4	81	248	161	163	71

Station	Parameter	N	Min	Max	Med	Avg	SD
WARG-5	**Physical**						
	Turbidity (NTU)	7	10.6	70.8	37.2	37.0	19.6
	Total Dissolved Solids (mg/L)[J]	7	33.0	71.0	59.0	57.1	11.6
	Total Suspended Solids (mg/L)[J]	7	9.0	50.0	33.0	29.6	13.4
	Hardness (mg/L)	4	16.1	34.9	21.6	23.6	8.1
	Alkalinity (mg/L)	7	9.5	37.1	24.4	22.5	9.5
	Photic Zone (m)	7	1.04	3.03	1.23	1.51	0.72
	Secchi (m)	7	0.21	1.50	0.34	0.56	0.46
	Bottom Depth (m)	7	1.8	5.0	3.0	3.2	1.0
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.012	0.112	0.023	0.034	0.035
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.058	0.098	0.080	0.076	0.016
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.324	0.450	0.162	0.203	0.109
	Total Nitrogen (mg/L)	7	< 0.669	1.524	0.244	0.279	0.102
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.013	0.004	0.005	0.004
	Total Phosphorus (mg/L)	7	0.013	0.040	0.021	0.024	0.010
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	6.3	15.1	9.0	9.4	3.2
	Biological						
	Chlorophyll a (mg/m³)	7	1.78	3.56	1.78	2.42	0.85
	E. coli (MPN/DL)[J]	4	194	1,300	639	693	478
WARG-6	**Physical**						
	Turbidity (NTU)	7	9.5	30.2	17.2	19.0	8.1
	Total Dissolved Solids (mg/L)[J]	7	20.0	79.0	44.0	49.6	21.0
	Total Suspended Solids (mg/L)[J]	7	5.0	18.0	11.0	12.1	4.7
	Hardness (mg/L)	4	14.6	26.1	17.6	19.0	5.0
	Alkalinity (mg/L)[J]	7	4.1	15.9	9.6	10.4	4.1
	Photic Zone (m)	7	1.03	1.88	1.61	1.50	0.31
	Secchi (m)	7	0.38	0.65	0.55	0.52	0.10
	Bottom Depth (m)	7	3.0	3.8	3.4	3.4	0.3
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.026	0.097	0.055	0.057	0.028
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.324	< 0.324	0.162	0.162	0.000
	Total Nitrogen (mg/L)[J]	7	< 0.564	0.777	0.217	0.219	0.028
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.006	0.004	0.004	0.002
	Total Phosphorus (mg/L)	7	0.020	0.044	0.028	0.028	0.009
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.2	4.5	3.1	3.3	0.9
	Biological						
	Chlorophyll a (mg/m³)	7	< 1.00	22.70	10.70	11.33	8.22
	E. coli (MPN/DL)[J]	4	30	185	121	114	70

Station	Parameter	N	Min	Max	Med	Avg	SD
WARG-7	**Physical**						
	Turbidity (NTU)	7	11.2	33.5	17.9	18.1	7.7
	Total Dissolved Solids (mg/L)[J]	7	32.0	78.0	45.0	51.1	15.5
	Total Suspended Solids (mg/L)[J]	7	8.0	22.0	13.0	15.3	5.3
	Hardness (mg/L)	4	10.2	39.2	16.7	20.7	13.0
	Alkalinity (mg/L)	7	6.6	29.7	11.1	15.6	9.3
	Photic Zone (m)	7	0.97	2.31	1.53	1.61	0.45
	Secchi (m)	7	0.32	0.68	0.57	0.53	0.12
	Bottom Depth (m)	7	3.3	4.2	4.0	3.9	0.3
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.003	0.057	0.031	0.026	0.021
	Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.414	0.162	0.224	0.108
	Total Nitrogen (mg/L)[J]	7	< 0.490	1.413	0.194	0.250	0.117
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.006	0.004	0.004	0.001
	Total Phosphorus (mg/L)	7	0.019	0.060	0.037	0.037	0.016
	CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.4	6.2	4.6	4.7	1.1
	Biological						
	Chlorophyll a (mg/m³)	7	13.40	31.00	23.50	22.84	5.54
	E. coli (MPN/DL)[J]	4	2	93	41	45	39

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