Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Cotaco Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-4: Cotaco Creek immediately upstream of Sharps Ford Bridge (Morgan Co 34.54297/-86.72628)

BACKGROUND

The Alabama Department of Environmental Management (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 the Rivers and Reservoirs Monitoring Program (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 2017 Monitoring Strategy (ADEM 2017).

In 2018 and 2021, ADEM monitored the Cotaco Creek (Wheeler Lake) tributary embayment as part of the intensive basin assessment of the Tennessee River under the RRMP (Figure 1). This site was selected using historical data and previous assessments. The purpose of this report is to summarize data collected in the Cotaco Creek (Wheeler Lake) embayment (WHEL-4) during the 2018 and 2021 growing seasons (Apr-Oct). These are the fifth and sixth intensive basin assessments of the Tennessee River since ADEM began sampling on a basin rotation. 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.

Figure 1. Cotaco Creek (Wheeler Lake) at WHEL-4.

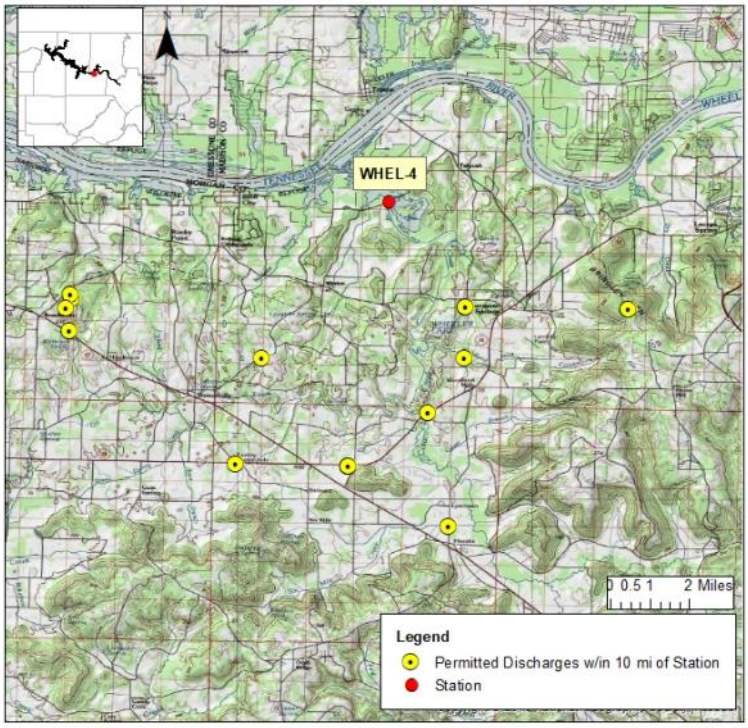


Figure 2. Map of the Cotaco Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Cotaco Creek (Wheeler Lake) embayment is classified *Swimming/Fish & Wildlife (S/F&W)* and located in the Eastern Highland Rim ecoregion (71g). Based on the 2021 National Land Cover Dataset, land use within the 189 mi^2 watershed is predominantly forest (51%) with some pastureland (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 39 NPDES outfalls within the watershed (Figure 2).

Table 1. Summary of Watershed **WHEL-4**

Basin		Tennessee R
Assessment Unit		AL06030002-0606-111
Drainage Area (mi^2)		228
Ecoregion[a]		71g
% Landuse		
Open Water		1%
Developed	Open Space	5%
	Low Intensity	3%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	39%
	Evergreen Forest	5%
	Mixed Forest	7%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		31%
Cultivated Crops		2%
Wetlands	Woody	3%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	39
Mining		4
Industrial General		22
Municipal		13

a. Eastern Highland Rim
b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Feb 13, 2024.

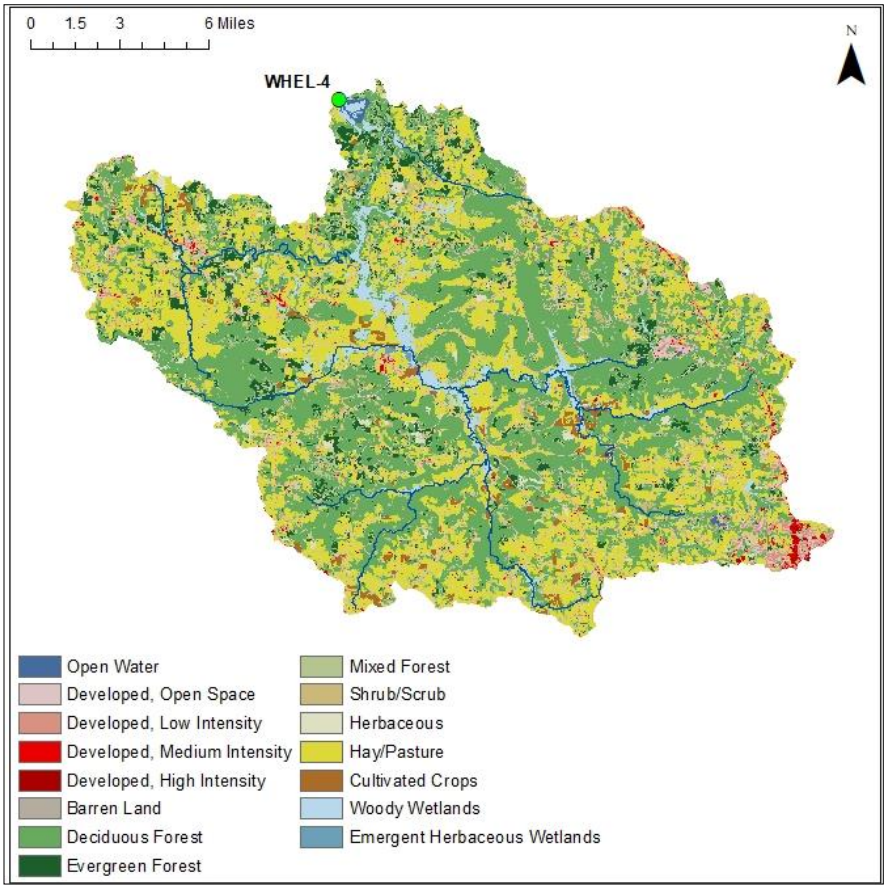


Figure 3. Land use within the Cotaco Creek (Wheeler Lake) watershed at WHEL-4.

SITE DESCRIPTION

The Cotaco Creek (Wheeler Lake) embayment at WHEL-4 is located southwest of Huntsville, near Valhermoso Springs, AL. It is a riverine embayment that flows into the Tennessee River near river mile 319. Cotaco Creek (Wheeler Lake) had a mean bottom depth of 4.4m in both 2018 and 2021 (Table 2) at the sampling location.

METHODS

Water quality samples were conducted at monthly intervals, April-October in 2018 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 2018a), and Quality Management Plan (ADEM 2018b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions. Monthly concentrations of these parameters were graphed with discharge data, if available, and ADEM's previously collected data to help interpret the 2018 and 2021 results. Carlson's TSI was calculated from the corrected chl *a* concentrations (Carlson 1977).

RESULTS

The following discussion of results is limited to those parameters which directly affect trophic status or parameters which have established criteria. A summary of all water chemistry analyses are presented in Table 2. The axis ranges of the graphs in Figures 4-7 were set to maximum values reservoir-wide so that all embayment reports on the same reservoir could be compared.

Mean growing season TN values increased 2003 to 2013, but they steadily decreased since then, with the 2021 mean TN value being the lowest overall (Figure 4). Monthly TN concentrations were highest in April in 2018 (Figure 5). In 2021, all monthly TN values were <1.0 mg/L.

Mean growing season TP concentrations decreased 2009 to 2013 and have remained stable since then (Figure 4). In both 2018 and 2021, the highest monthly TP value was observed in April (Figure 5).

Table 2. Summary of water quality data collected April-October, 2018 and 2021. Minimum (Min) and maximum (Max) values calculated using minimum detection limits. Median (Med), Mean, and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

WHEL-4 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	5.7	19.7	10.2	11.9	5.2
Total Dissolved Solids (mg/L)	7	6.0	143.0	93.0	84.1	42.1
Total Suspended Solids (mg/L)	7	6.0	20.0	8.0	9.6	4.9
Hardness (mg/L)	4	53.1	77.6	67.0	66.2	11.0
Alkalinity (mg/L)	7	53.2	88.6	65.1	68.5	11.5
Photic Zone (m)	7	1.95	3.93	2.60	2.69	0.67
Secchi (m)	7	0.53	1.27	0.79	0.85	0.30
Bottom Depth (m)	7	3.0	5.4	4.5	4.4	0.7
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.016	0.004	0.004	0.002
Nitrate+Nitrite Nitrogen (mg/L)	7	0.043	0.709	0.139	0.211	0.228
Total Kjeldahl Nitrogen (mg/L)	7	0.392	0.717	0.450	0.510	0.124
Total Nitrogen (mg/L)	7	1.311	4.278	0.617	0.720	0.322
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.029	0.007	0.011	0.011
Total Phosphorus (mg/L)	7	0.023	0.053	0.028	0.032	0.010
CBOD-5 (mg/L)	7	< 2.0	3.9	1.0	2.0	1.3
Chlorides (mg/L)	7	2.5	6.9	5.7	5.1	1.5
Biological						
Chlorophyll a (mg/m³)	7	0.53	22.90	8.54	10.64	8.00
E. coli (MPN/DL)[J]	4	1	6	3	3	2
WHEL-4 2021	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	10.4	20.5	15.3	15.2	3.8
Total Dissolved Solids (mg/L)[J]	7	62.0	99.0	90.0	87.1	12.3
Total Suspended Solids (mg/L)[J]	7	10.0	18.0	15.0	14.1	2.9
Hardness (mg/L)	4	71.1	83.2	82.2	79.7	5.8
Alkalinity (mg/L)	7	63.7	76.0	72.5	70.9	5.3
Photic Zone (m)	7	1.92	3.28	2.68	2.64	0.53
Secchi (m)	7	0.61	0.82	0.75	0.73	0.07
Bottom Depth (m)	7	3.8	5.4	4.3	4.4	0.6
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
Nitrate+Nitrite Nitrogen (mg/L)	7	0.042	0.350	0.134	0.178	0.105
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.689	0.162	0.311	0.254
Total Nitrogen (mg/L)[J]	7	< 0.807	2.427	0.424	0.489	0.210
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.010	0.004	0.005	0.003
Total Phosphorus (mg/L)	7	0.029	0.125	0.048	0.054	0.032
CBOD-5 (mg/L)[J]	7	< 2.0	2.9	2.3	2.0	0.7
Chlorides (mg/L)	7	2.6	4.9	3.8	3.7	0.9
Biological						
Chlorophyll a (mg/m³)	7	16.80	42.70	23.40	26.23	9.15
E. coli (MPN/DL)[J]	4	5	39	16	19	16

J= one or more of the values is an estimate; N= # samples.

RESULTS (con't)

Mean growing season chl *a* concentrations were stable 2009 to 2018 but increased in 2021 to the highest mean observed overall (Figure 4). In 2018, monthly chl *a* concentrations were highest in July (Figure 5). August was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Cotaco Creek (Wheeler Lake) embayment has been eutrophic in every sampling year (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in all months sampled except April and October (Figure 5). In 2021, the site was eutrophic throughout the growing season from April to October.

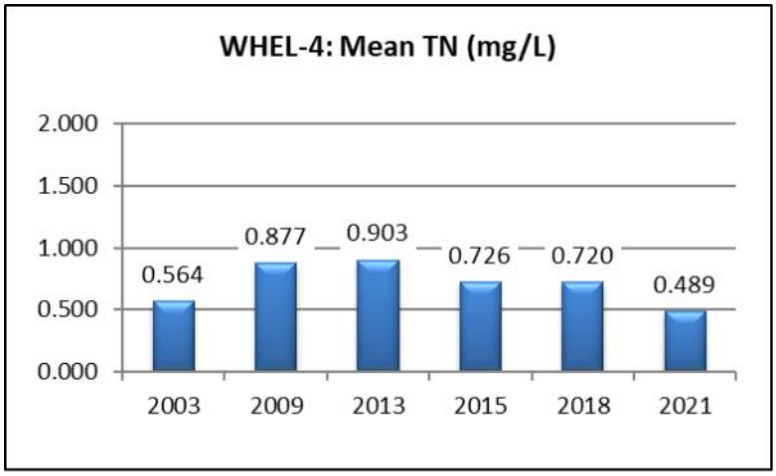
Mean growing season TSS concentrations decreased 2003 to 2013 but have fluctuated each year since then (Figure 4). Monthly TSS concentrations were highest in October of 2018 and in August of 2021 (Figure 6).

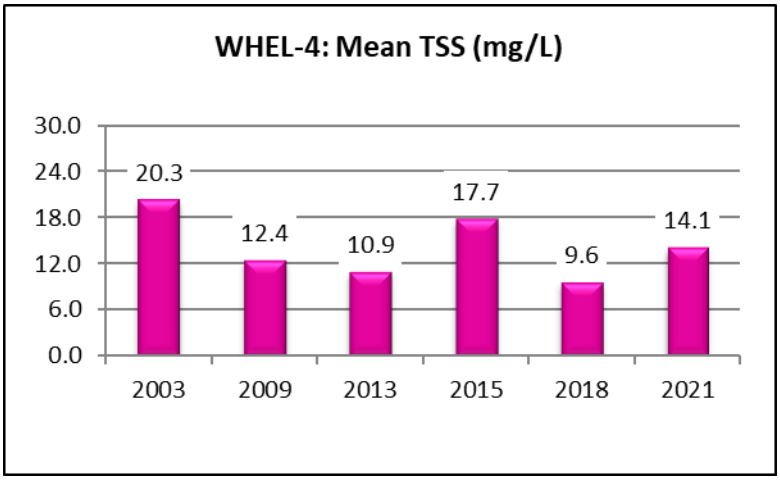
AGPT results show that Cotaco Creek (Wheeler Lake) was nitrogen-limited in 2003 and 2009 and co-limiting in 2013 (Table 3). The 2003 and 2009 samples were at or below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems. While the 2013 sample was >5.0 mg/L, it was below 20.0 mg/L MSC, which Raschke and Schultz define as protective of flowing stream and river systems.

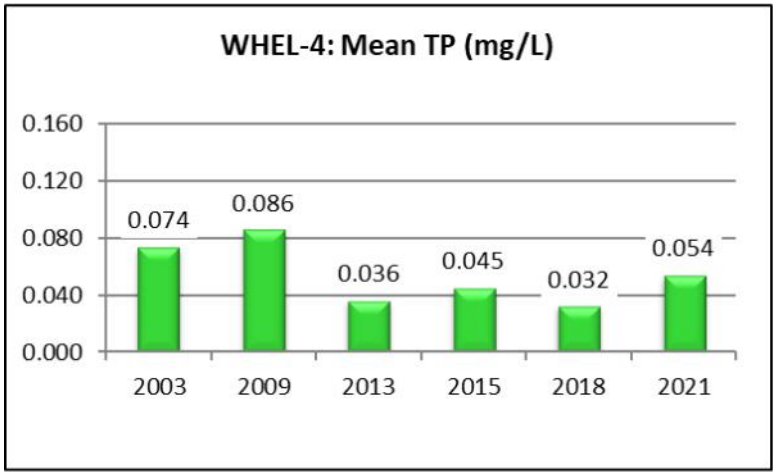
Dissolved oxygen (DO) concentrations at WHEL-4 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2021 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

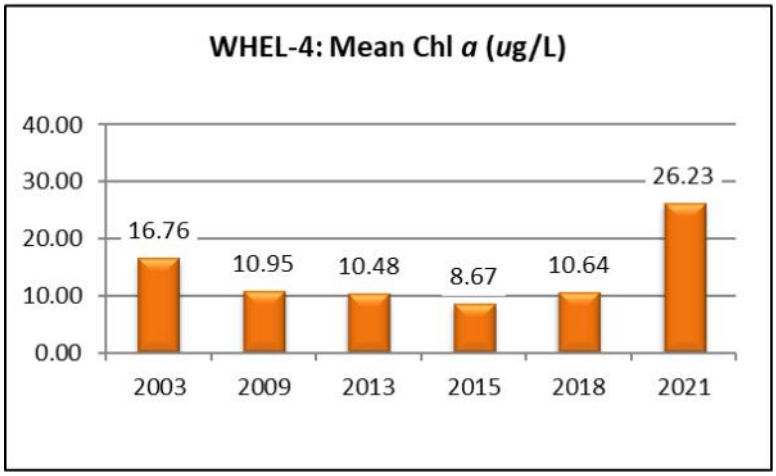
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	5.01	Nitrogen
2009	3.68	Nitrogen
2013	10.71	Co-limiting









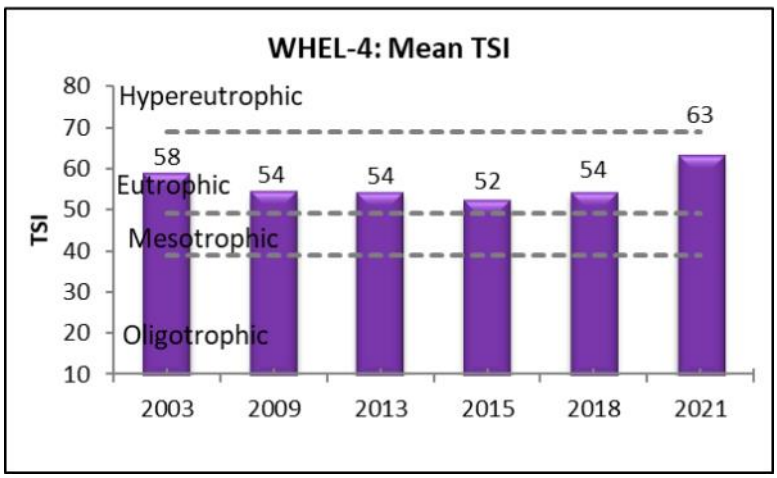
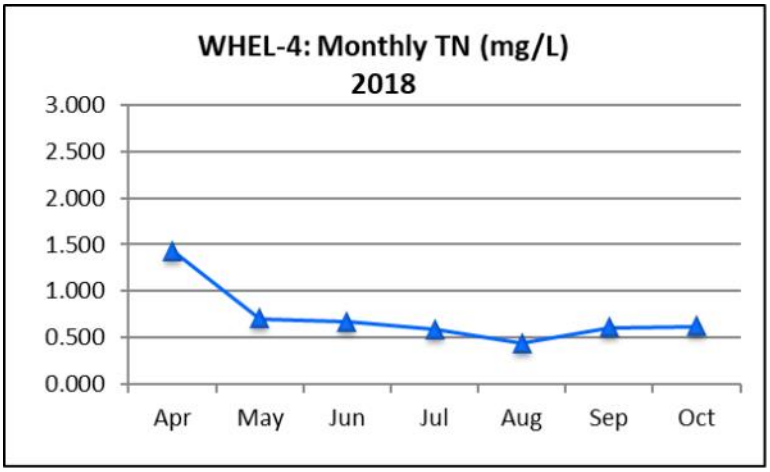
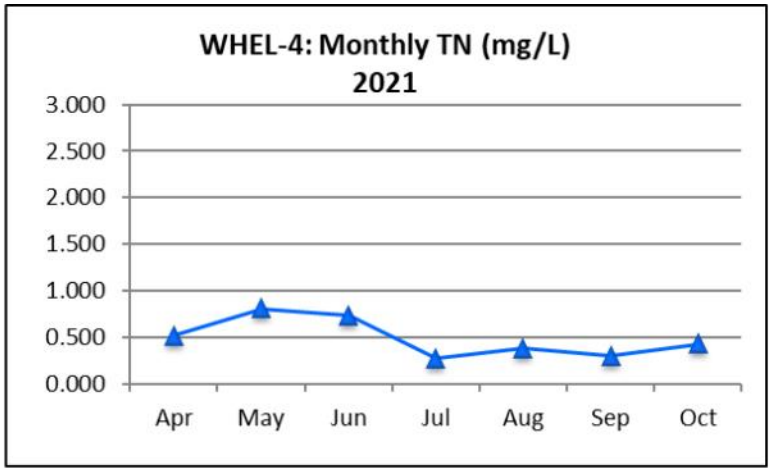
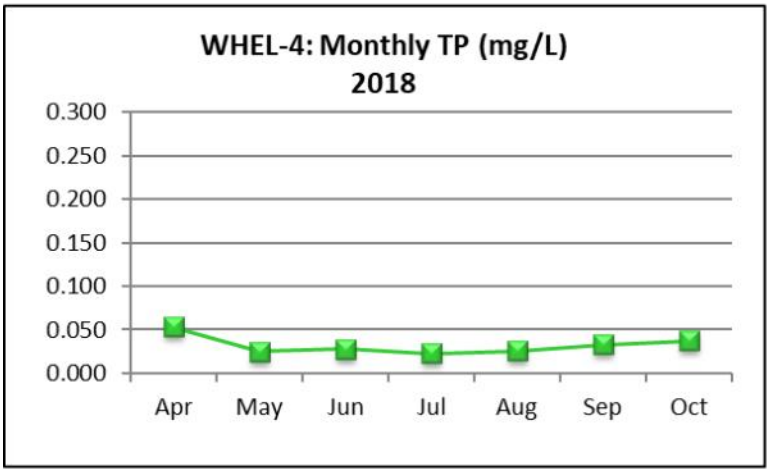
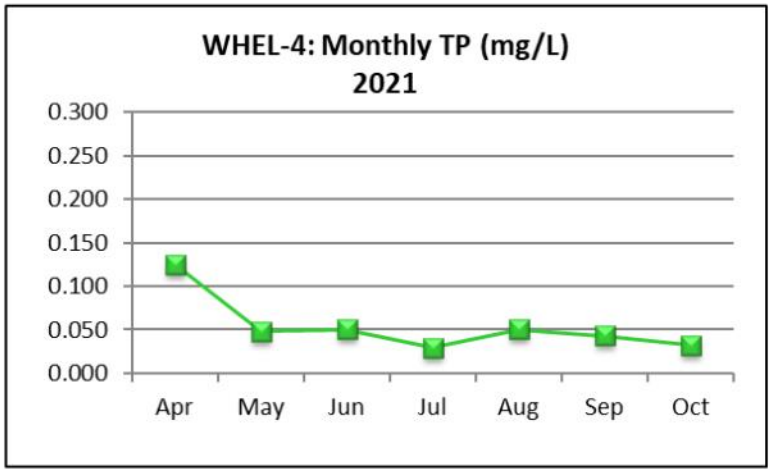


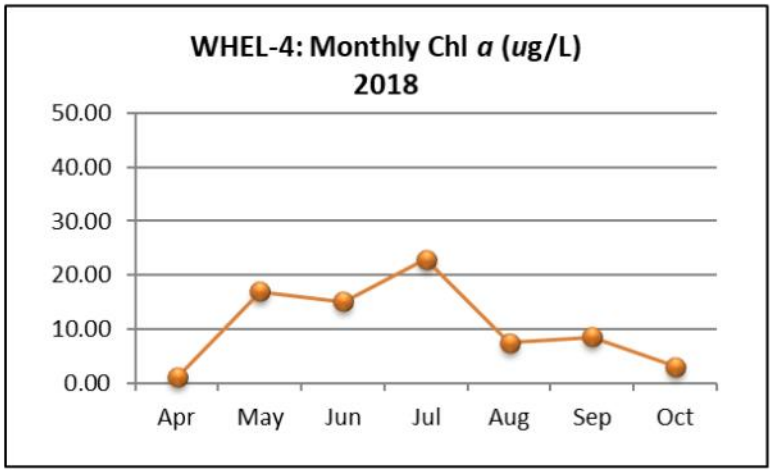
Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Cotaco Creek (Wheeler Lake) embayment (WHEL-4)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

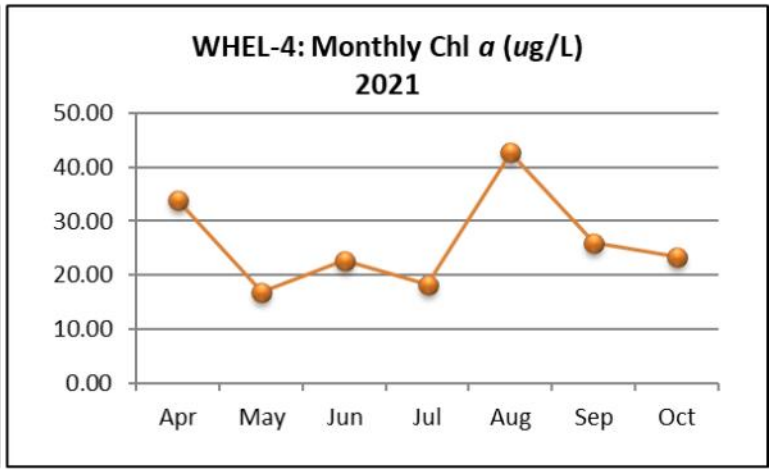


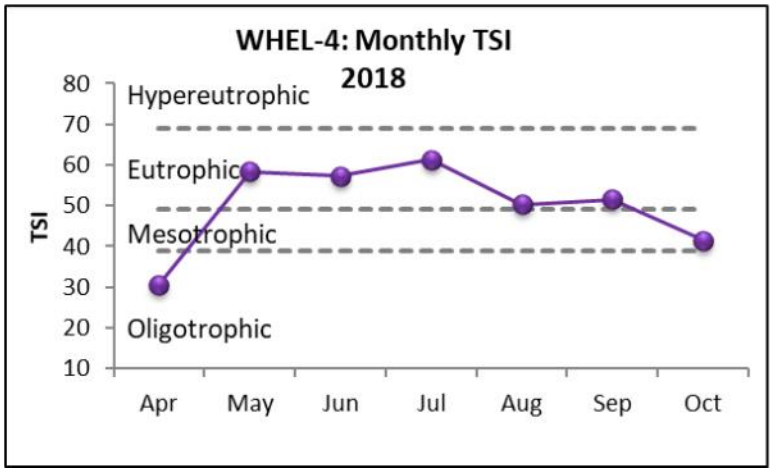












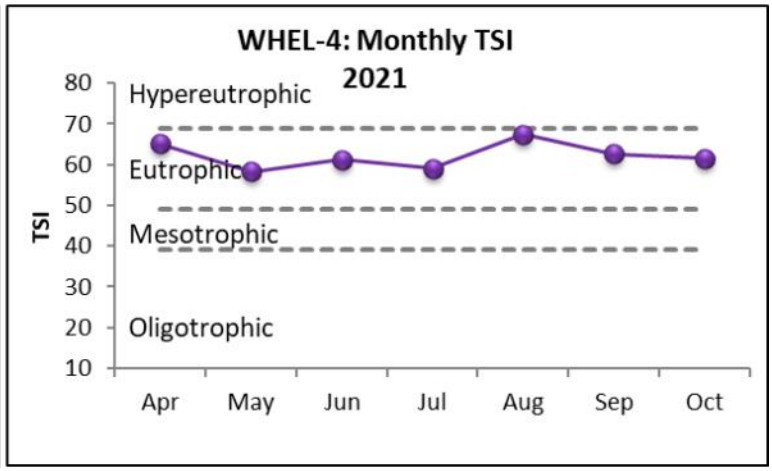


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Cotaco Creek (Wheeler Lake) embayment (WHEL-4)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

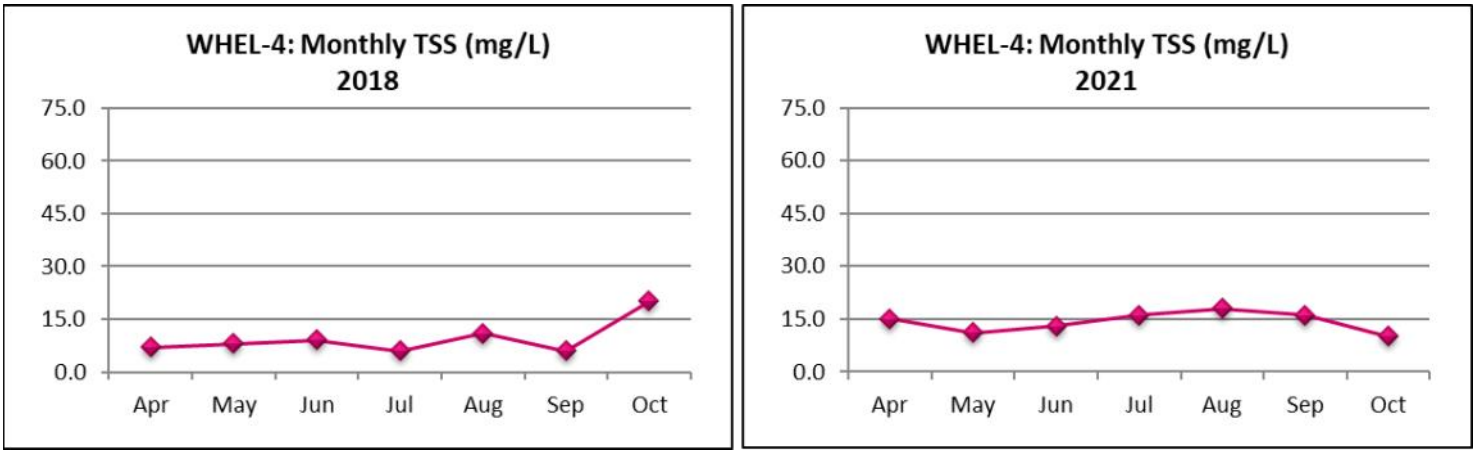


Figure 6. Monthly TSS measured in the Cotaco Creek (Wheeler Lake) embayment (WHEL-4) in 2018 and 2021.

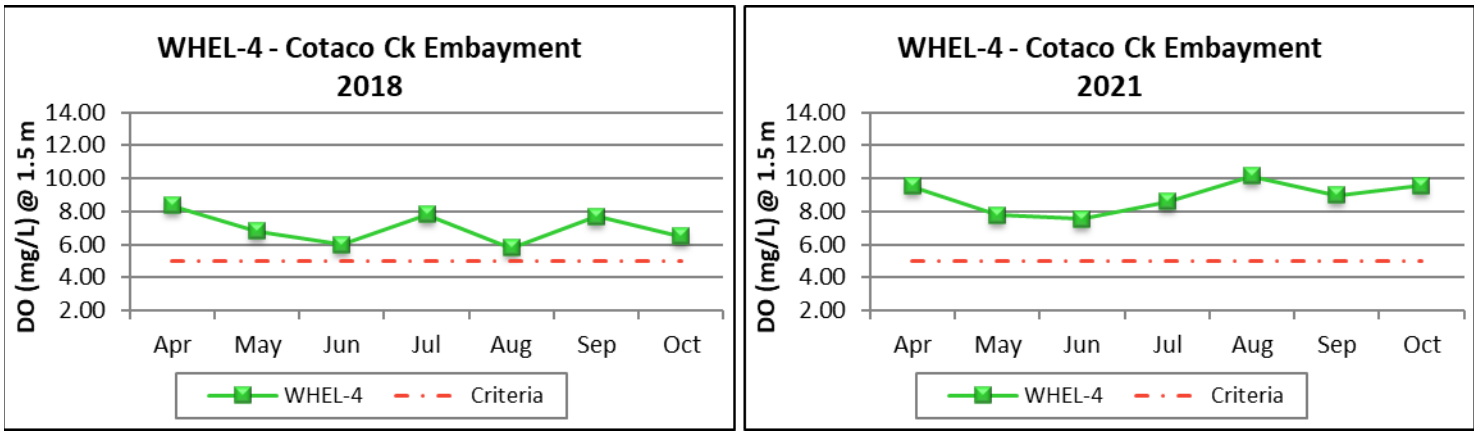


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Cotaco Creek (Wheeler Lake) embayment (WHEL-4) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

REFERENCES

ADEM. 2017. State of Alabama Water Quality Monitoring Strategy. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 108 pp.

ADEM. 2018a. Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring in Alabama Rev 2. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 176 pp.

ADEM. 2018b. Quality Management Plan (QMP) for the Alabama Department of Environmental Management (ADEM) Rev 5.0, Montgomery, AL. 72 pp.

ADEM. 2021. Standard Operating Procedures Series #2000, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2017. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

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

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.

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