Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Flint Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-6: Flint Creek approx. 1 mile downstream of AL Hwy 67 bridge (Morgan Co 34.55889/-86.94806)

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 Flint 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 Flint Creek (Wheeler Lake) embayment (WHEL-6) 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.

A fish consumption advisory for mercury was issued by the Alabama Department of Public Health (ADPH) in 2021 based on fish tissue data collected by ADEM at WHEL-6. Therefore, as an indication of an impaired use, Flint Creek (Wheeler Lake) from the confluence with the Tennessee River (Wheeler Lake) upstream to the end of the embayment was listed on ADEM's 2022 §303(d) list of impaired waterbodies.

Figure 1. Flint Creek (Wheeler Lake) at WHEL-6.

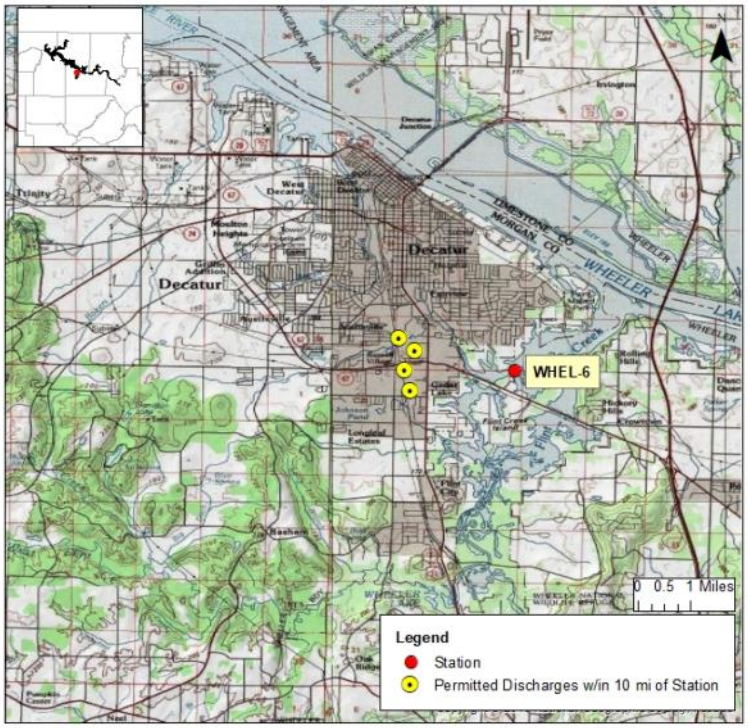


Figure 2. Map of the Flint Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Flint Creek (Wheeler Lake) embayment is classified *Fish & Wildlife (F&W)* and located in the Eastern Highland Rim ecoregion (71g). Based on the 2021 National Land Cover Dataset, land use within the 444 mi^2 watershed is predominantly developed (67%) (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of four NPDES outfalls within the watershed (Figure 2).

Table 1. Summary of Watershed **WHEL-6**

Basin		Tennessee R
Assessment Unit		AL06030002-1014-101
Drainage Area (mi^2)		444
Ecoregion[a]		71g
% Landuse		
Open Water		4%
Developed	Open Space	15%
	Low Intensity	26%
	Medium Intensity	17%
	High Intensity	9%
Barren Land		<1%
Forest	Deciduous Forest	7%
	Evergreen Forest	4%
	Mixed Forest	3%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		7%
Cultivated Crops		3%
Wetlands	Woody	3%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	4
Industrial General		3
Industrial Individual		1

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

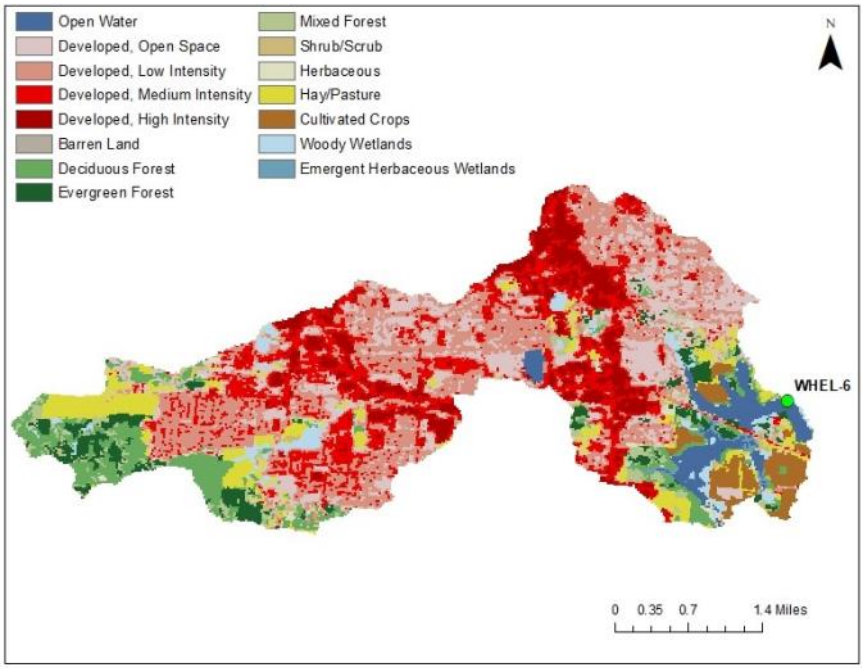


Figure 3. Land use within the Flint Creek (Wheeler Lake) watershed at WHEL-6.

SITE DESCRIPTION

The Flint Creek (Wheeler Lake) embayment at WHEL-6 is located approximately one mile upstream from Point Mallard Water Park, flowing into the Tennessee River at river mile 308. The station is at the confluence of Flint Creek (Wheeler Lake) and Branch Creek. The Flint Creek (Wheeler Lake) embayment is generally shallow. It had a mean bottom depth of 3.8m in 2018 and 4.4m in 2021 (Table 2).

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 then steadily decreased each year since then (Figure 4). Monthly TN concentrations were highest in August in 2018 and in July in 2021 (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-6 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	11.7	35.9	15.1	19.7	9.1
Total Dissolved Solids (mg/L)[J]	7	75.0	132.0	123.0	117.1	19.7
Total Suspended Solids (mg/L)[J]	7	16.0	51.0	26.0	28.1	12.7
Hardness (mg/L)	4	79.0	112.0	93.2	94.4	13.7
Alkalinity (mg/L)	7	37.8	112.0	86.9	84.6	24.2
Photic Zone (m)	7	1.19	2.01	1.74	1.61	0.30
Secchi (m)	7	0.52	0.78	0.72	0.67	0.09
Bottom Depth (m)	7	3.1	4.2	3.7	3.8	0.4
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.015	0.046	0.008	0.013	0.015
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.007	0.192	0.004	0.032	0.071
Total Kjeldahl Nitrogen (mg/L)	7	0.464	1.150	0.766	0.794	0.216
Total Nitrogen (mg/L)[J]	7	< 1.402	3.460	0.786	0.826	0.221
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.047	0.006	0.012	0.016
Total Phosphorus (mg/L)	7	0.019	0.123	0.041	0.048	0.035
CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
Chlorides (mg/L)[J]	7	2.3	5.1	4.0	3.8	1.0
Biological						
Chlorophyll a (mg/m³)	7	2.14	33.40	24.60	20.79	10.46
E. coli (MPN/DL)[J]	4	1	8	3	4	3

WHEL-6 2021	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	12.2	19.2	13.3	14.5	2.9
Total Dissolved Solids (mg/L)[J]	7	78.0	118.0	107.0	103.4	15.8
Total Suspended Solids (mg/L)[J]	7	12.0	19.0	15.0	14.9	2.5
Hardness (mg/L)	4	65.3	97.9	81.2	81.4	15.6
Alkalinity (mg/L)	7	58.1	114.0	82.1	81.3	18.1
Photic Zone (m)	7	1.65	3.32	2.37	2.30	0.59
Secchi (m)	7	0.43	0.85	0.68	0.70	0.15
Bottom Depth (m)	7	3.6	4.8	4.5	4.4	0.4
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	0.359	0.217	0.180	0.139
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.628	0.393	0.338	0.182
Total Nitrogen (mg/L)[J]	7	< 0.504	2.145	0.610	0.519	0.208
Dis Reactive Phosphorus (mg/L)[J]	7	0.004	0.079	0.010	0.026	0.031
Total Phosphorus (mg/L)	7	0.034	0.127	0.076	0.078	0.033
CBOD-5 (mg/L)[J]	7	< 2.0	3.2	2.2	1.9	0.9
Chlorides (mg/L)	7	2.6	4.2	3.6	3.4	0.6
Biological						
Chlorophyll a (mg/m³)	7	7.12	34.00	22.10	21.68	10.83
E. coli (MPN/DL)[J]	4	1	26	17	16	11

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

RESULTS (con't)

Mean growing season TP concentrations decreased 2009 to 2013 and appeared stable since then, though the 2021 mean was slightly higher than previous years (Figure 4). In 2018, the highest monthly TP value was observed in April (Figure 5). August was the highest monthly concentration recorded in 2021.

Mean growing season chl *a* concentrations appeared to remain stable since 2015 (Figure 4). In 2018, monthly chl *a* concentrations were highest in August (Figure 5). June was the highest monthly concentration recorded in 2021.

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

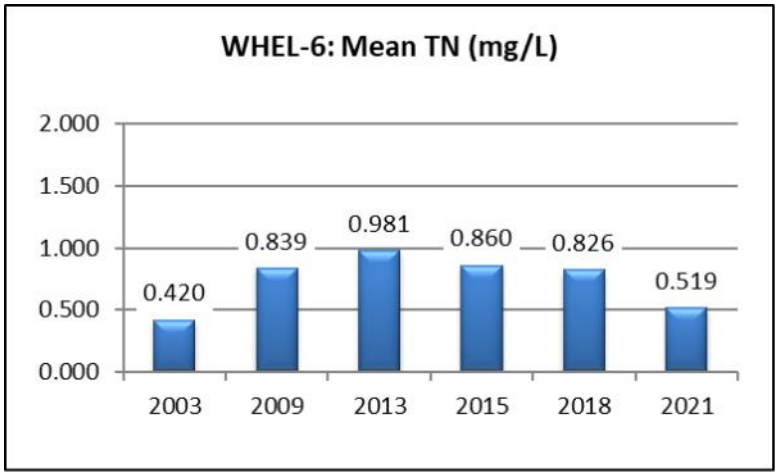
Mean growing season TSS concentrations have shown little fluctuation since 2009, though the 2018 mean was higher than other sampling years (Figure 4). Monthly TSS concentrations were highest in April in 2018, reaching 51 mg/L (Figure 6). The April sample was collected after a rain event in the area. In 2021, the highest monthly concentration was recorded in July.

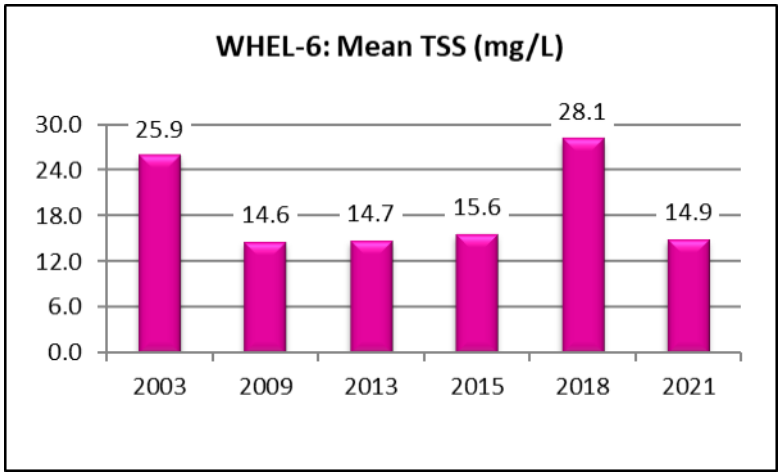
AGPT results show that Flint Creek (Wheeler Lake) was nitrogen-limited all years sampled (Table 3). Additionally, all samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

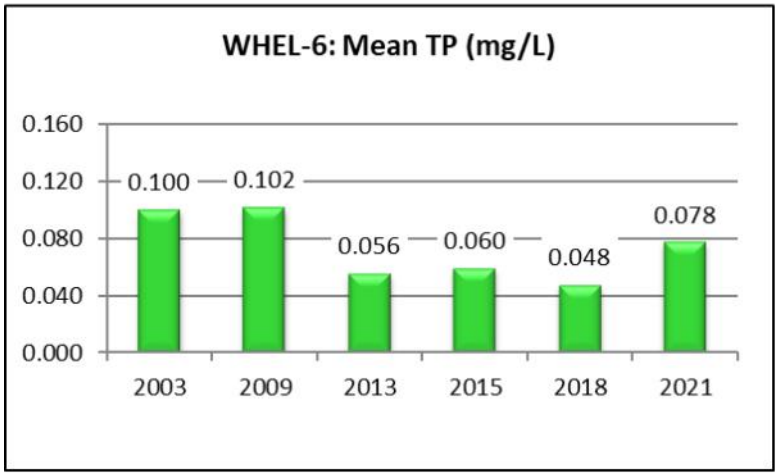
Dissolved oxygen (DO) concentrations at WHEL-6 were at or above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during 2018 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7). In 2021, DO concentrations at criteria depth fell below the minimum criteria limit in June. All other months sampled were at or above 5.0 mg/L. at 5.0 ft (1.5 m).

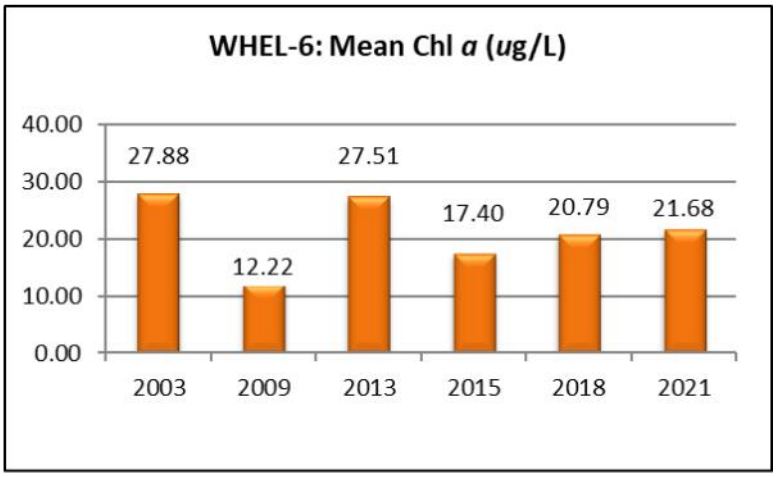
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	3.09	Nitrogen
2009	3.84	Nitrogen
2013	3.65	Nitrogen









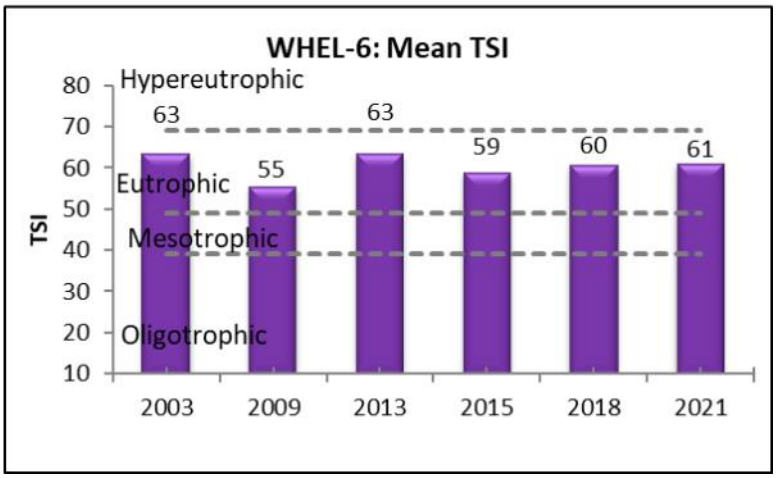
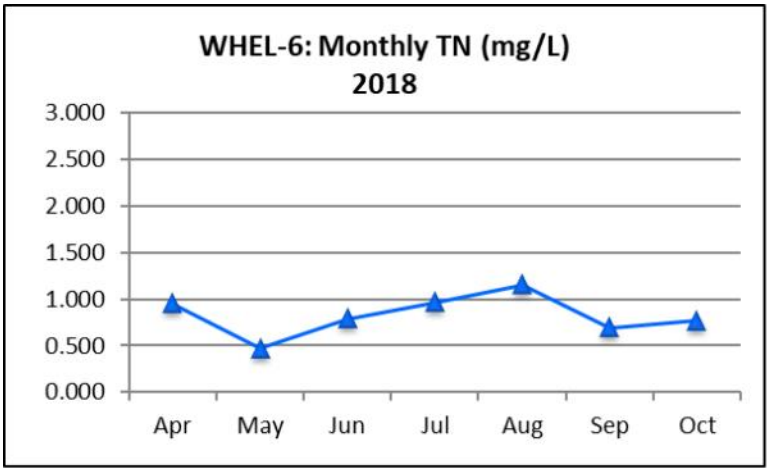
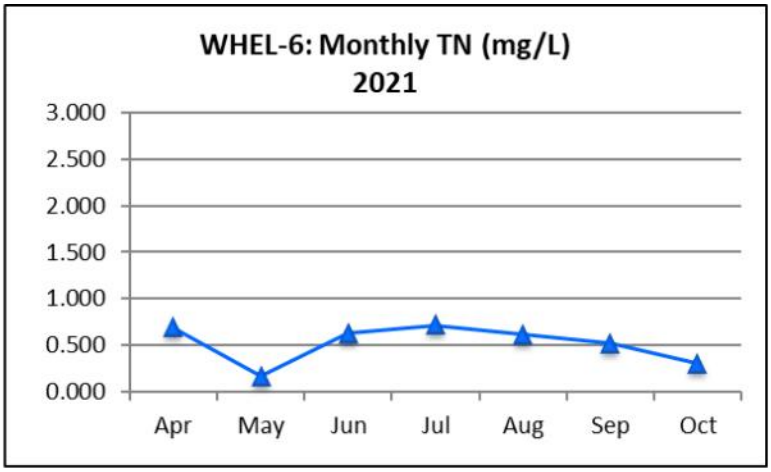
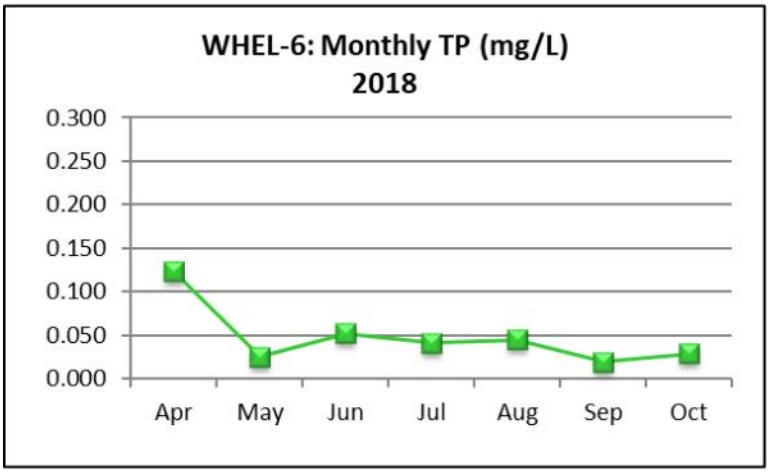
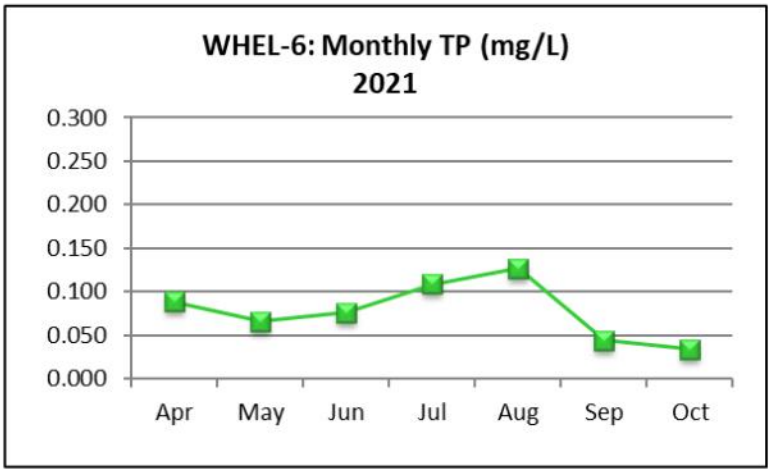


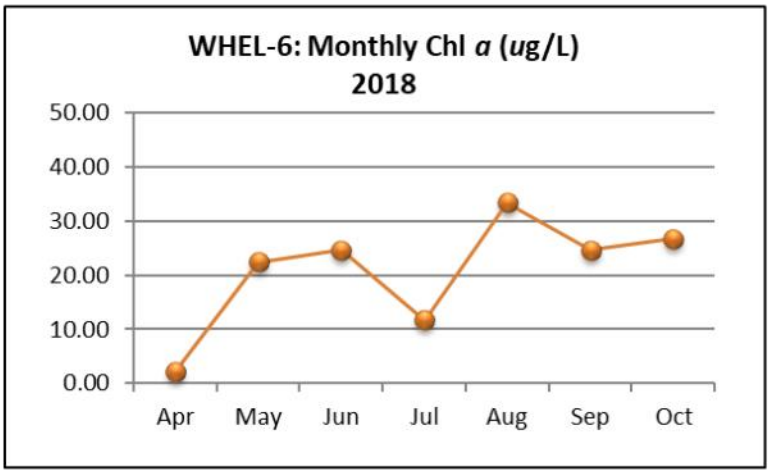
Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Flint Creek (Wheeler Lake) embayment (WHEL-6)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

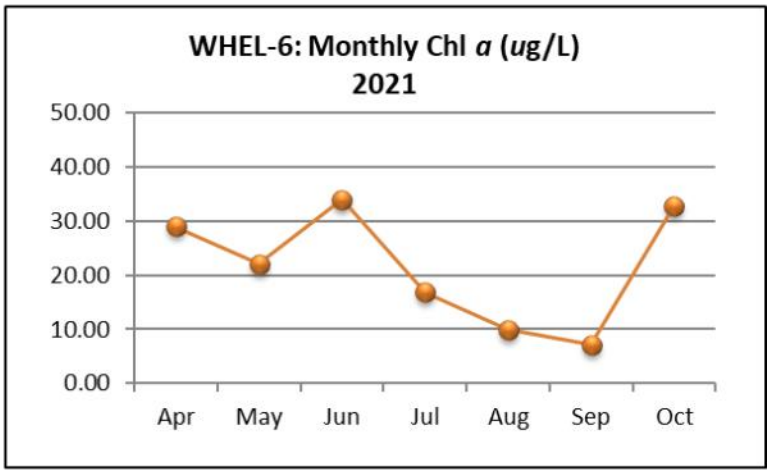


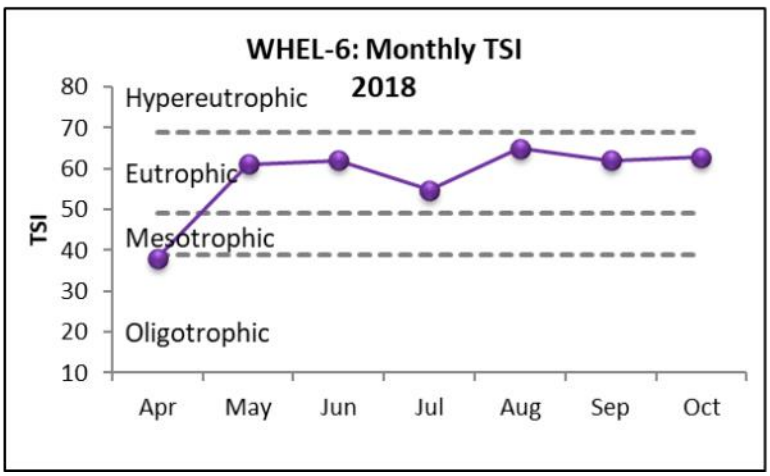












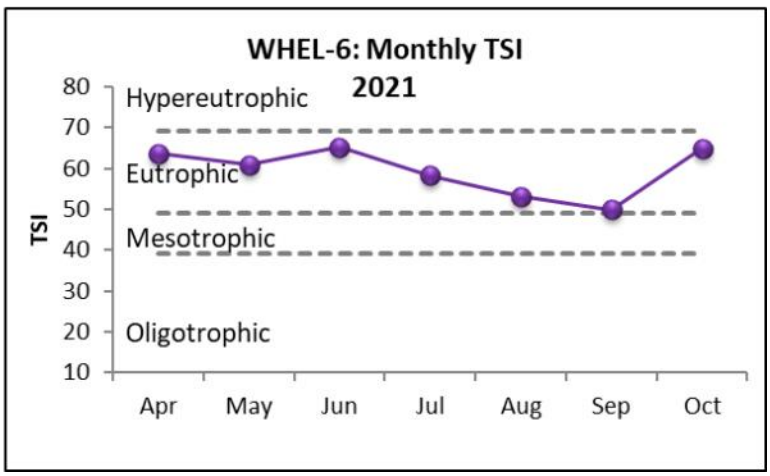


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Flint Creek (Wheeler Lake) embayment (WHEL-6)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

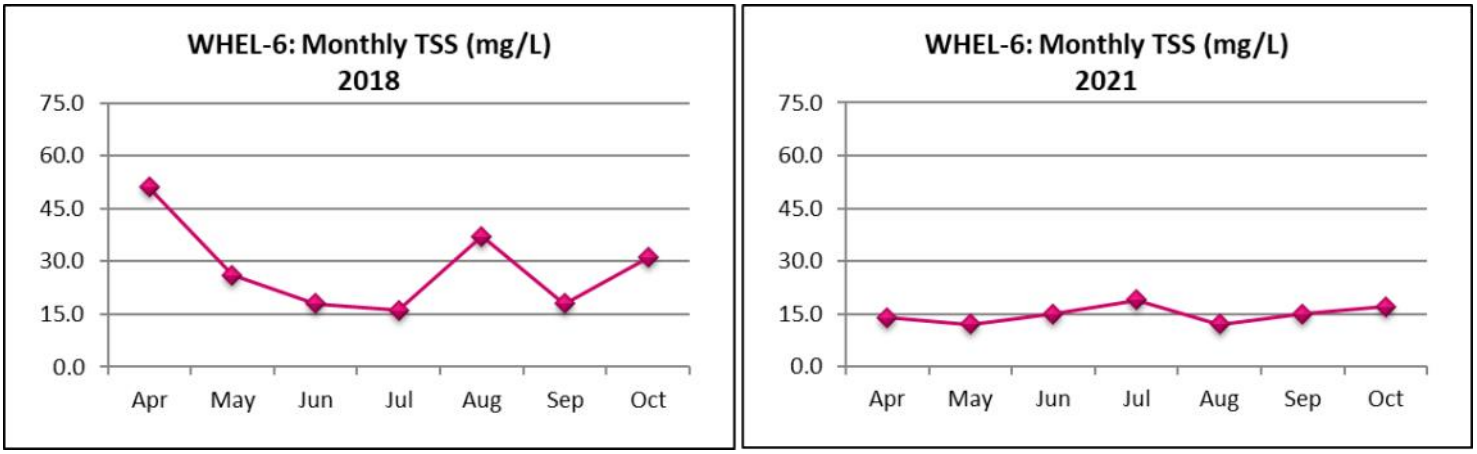


Figure 6. Monthly TSS measured in the Flint Creek (Wheeler Lake) embayment (WHEL-6) in 2018 and 2021.

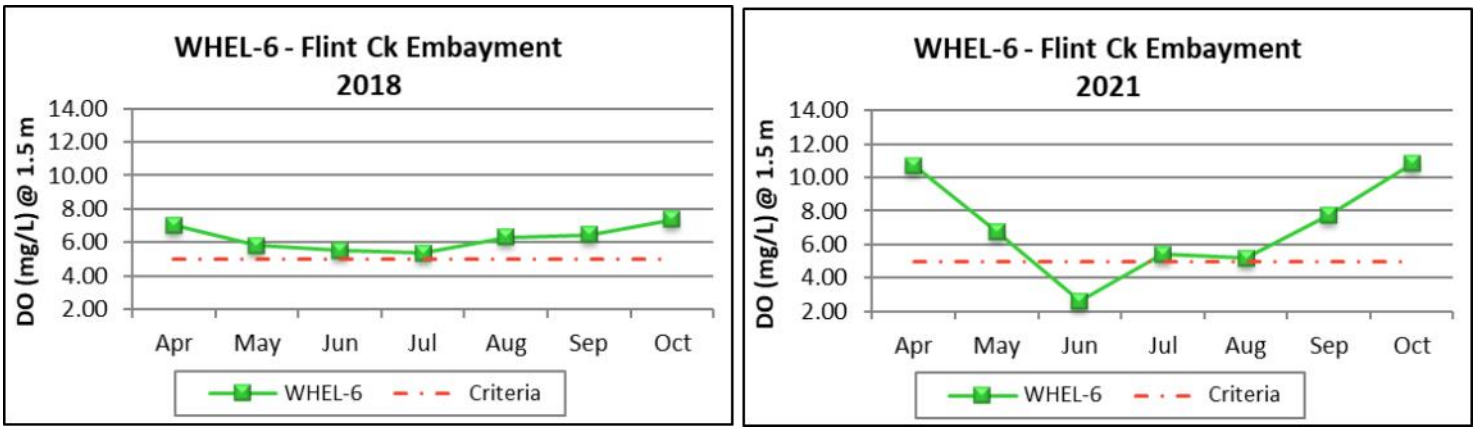


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Flint Creek (Wheeler Lake) embayment (WHEL-6) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

REFERENCES

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