Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Flint River Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-2: Flint River approx. 1 mi upstream of confluence with Tennessee River (Madison Co 34.51073/-86.51411)

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 River (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 River (Wheeler Lake) embayment (WHEL-2) 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. Flint River (Wheeler Lake) at WHEL-2.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Flint River (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 568 mi^2 watershed is predominantly forest (31%) with some pastureland and cultivated crops (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 118 NPDES outfalls within the watershed (Figure 2).

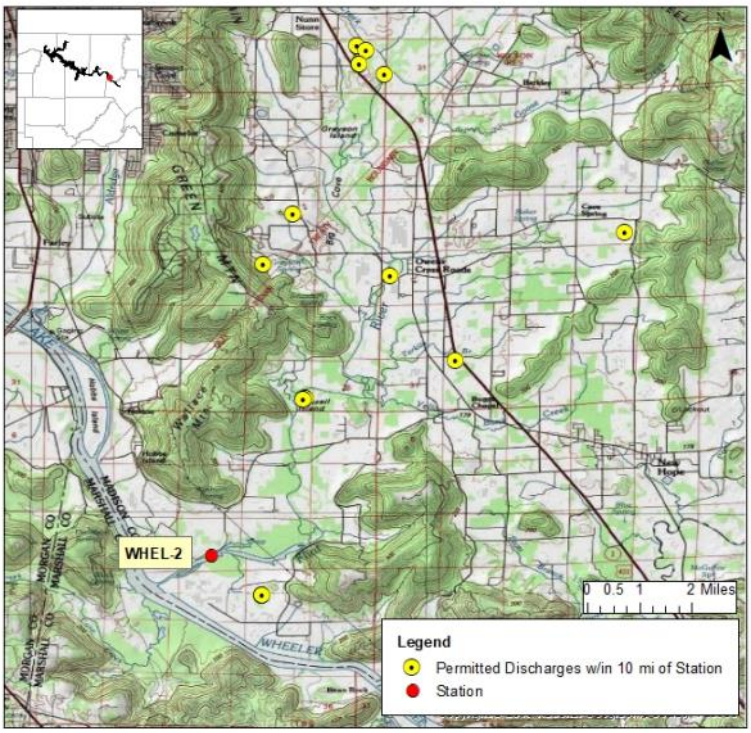


Figure 2. Map of the Flint River (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

Table 1. Summary of Watershed **WHEL-2**

Basin		Tennessee R
Assessment Unit		AL06030002-0405-111
Drainage Area (mi^2)		568
Ecoregion[a]		71g
% Landuse		
Open Water		<1%
Developed	Open Space	7%
	Low Intensity	4%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	28%
	Evergreen Forest	1%
	Mixed Forest	2%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		25%
Cultivated Crops		23%
Wetlands	Woody	6%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	118
Mining		12
Industrial General		72
Industrial Individual		6
Municipal		17
State Indirect Discharge		11

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

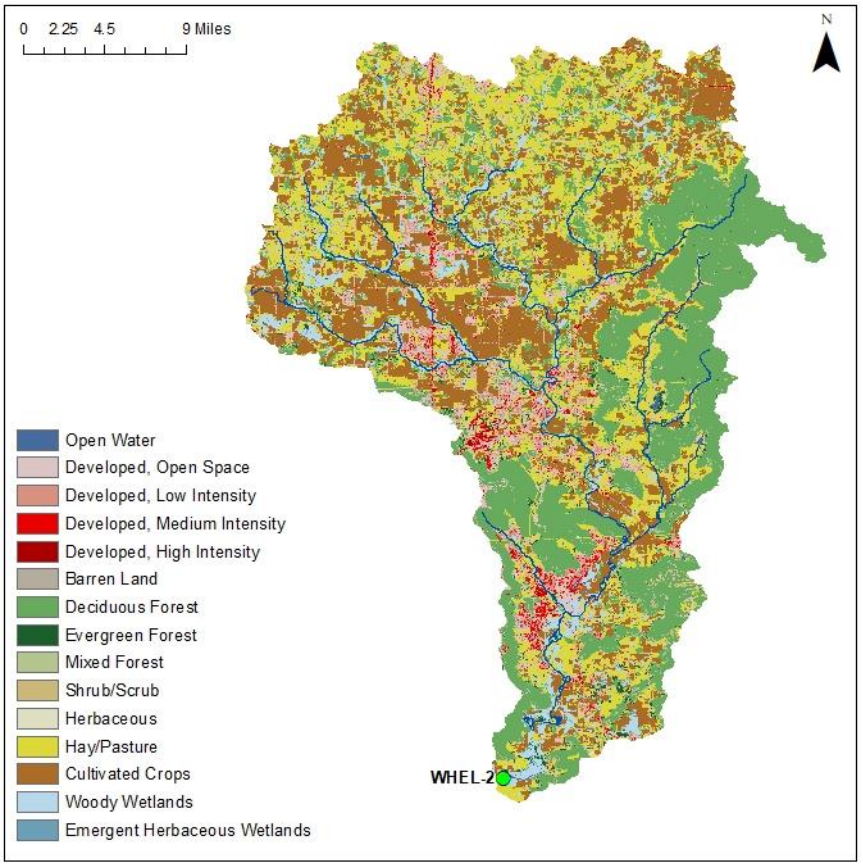


Figure 3. Land use within the Flint River (Wheeler Lake) watershed at WHEL-2.

SITE DESCRIPTION

The Flint River (Wheeler Lake) embayment at WHEL-2 is located south of Madison, AL. The upper portion of the watershed also includes parts of Huntsville. The riverine embayment flows into the Tennessee River near river mile 339. Flint River (Wheeler Lake) had a mean bottom depth of 4.9m in 2018 and 4.8m in 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 were >1.0 mg/L in all years sampled, with the 2018 mean being the highest observed overall (Figure 4). Monthly TN concentrations were highest in May in 2018 and in September 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-2 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	9.5	14.5	11.2	11.8	1.8
Total Dissolved Solids (mg/L)	7	79.0	140.0	109.0	110.1	19.3
Total Suspended Solids (mg/L)	7	9.0	13.0	10.0	10.4	1.4
Hardness (mg/L)	4	69.9	107.0	80.4	84.4	16.6
Alkalinity (mg/L)	7	68.6	132.0	79.2	87.9	22.5
Photic Zone (m)	7	2.46	3.69	2.73	2.86	0.45
Secchi (m)	7	0.70	1.52	0.78	0.90	0.29
Bottom Depth (m)	7	4.4	5.5	4.7	4.9	0.4
Chemical						
Ammonia Nitrogen (mg/L)[J]	7	< 0.007	0.016	0.004	0.005	0.003
Nitrate+Nitrite Nitrogen (mg/L)	7	0.230	2.270	0.970	1.082	0.641
Total Kjeldahl Nitrogen (mg/L)	7	0.352	1.070	0.734	0.683	0.239
Total Nitrogen (mg/L)	7	2.556	8.133	1.733	1.765	0.649
Dis Reactive Phosphorus (mg/L)[J]	7	0.006	0.047	0.020	0.023	0.014
Total Phosphorus (mg/L)	7	0.030	0.070	0.045	0.046	0.014
CBOD-5 (mg/L)	7	< 2.0	3.0	2.1	2.1	0.8
Chlorides (mg/L)	7	3.6	6.3	5.4	5.4	0.9
Biological						
Chlorophyll a (mg/m³)	7	2.14	26.70	15.00	13.95	8.44
E. coli (MPN/DL)[J]	4	3	14	7	8	4
WHEL-2 2021	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	7.2	18.5	12.0	11.6	3.7
Total Dissolved Solids (mg/L)[J]	7	92.0	131.0	114.0	112.0	14.7
Total Suspended Solids (mg/L)[J]	7	8.0	15.0	10.0	11.1	3.1
Hardness (mg/L)	4	98.4	103.0	99.0	99.8	2.1
Alkalinity (mg/L)	7	76.9	88.4	86.3	84.4	4.2
Photic Zone (m)	7	1.67	4.04	3.08	2.94	0.73
Secchi (m)	7	0.42	1.01	0.78	0.79	0.19
Bottom Depth (m)	7	4.2	5.4	4.6	4.8	0.5
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
Nitrate+Nitrite Nitrogen (mg/L)	7	1.030	1.670	1.490	1.389	0.248
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.339	0.162	0.187	0.067
Total Nitrogen (mg/L)[J]	7	< 3.576	5.496	1.652	1.576	0.217
Dis Reactive Phosphorus (mg/L)	7	0.015	0.030	0.021	0.022	0.006
Total Phosphorus (mg/L)	7	0.042	0.058	0.046	0.049	0.006
CBOD-5 (mg/L)[J]	7	< 2.0	2.5	1.0	1.2	0.6
Chlorides (mg/L)	7	4.5	5.9	5.1	5.2	0.5
Biological						
Chlorophyll a (mg/m³)	7	1.60	29.00	7.48	9.90	9.50
E. coli (MPN/DL)[J]	4	6	93	40	45	40

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

RESULTS (con't)

Mean growing season TP concentrations decreased 2003 to 2013 and have remained stable since then (Figure 4). In both 2018 and 2021, monthly TP values were <0.10 mg/L in all months sampled (Figure 5).

Mean growing season chl *a* concentrations increased 2013 to 2018, with the 2018 mean being the highest observed overall (Figure 4). Mean chl *a* decreased in 2021, but the value was still higher than previous years. In 2018, monthly chl *a* concentrations were highest in September (Figure 5). July was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Flint River (Wheeler Lake) embayment increased from oligotrophic to eutrophic from 2013 to 2018 and 2021 (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions from June through October (Figure 5). In 2021, the site was eutrophic from May to August.

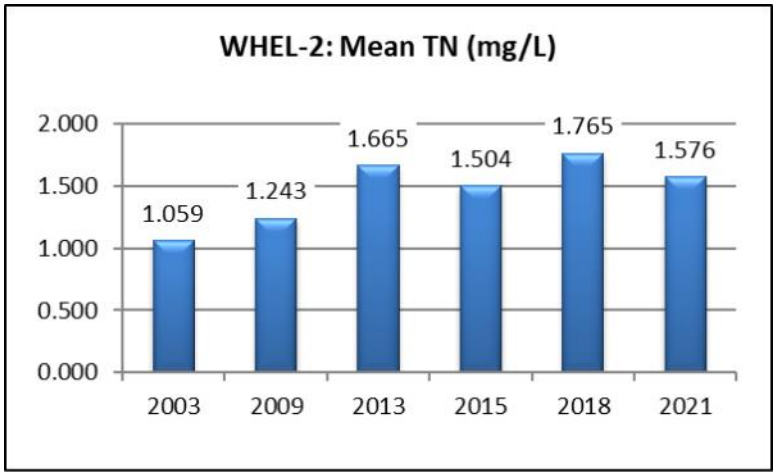
Mean growing season TSS concentrations remained stable 2009 to 2021 (Figure 4). Monthly TSS concentrations were at or below 15 mg/L in all months sampled during both 2018 and 2021 (Figure 6).

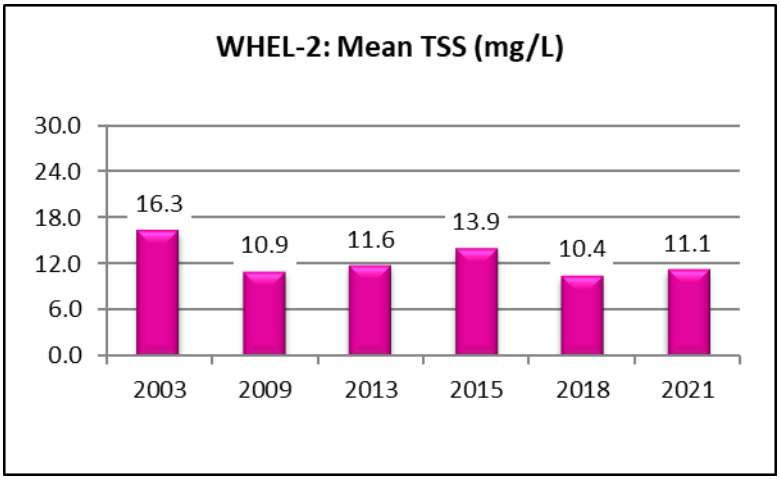
AGPT results show that Flint River (Wheeler Lake) was phosphorus-limited in all years sampled (Table 3). The 2009 sample was below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems. While the 2003 and 2013 samples were >5.0 mg/L, they were below 20.0 mg/L MSC, which Raschke and Schultz define as protective of flowing stream and river systems.

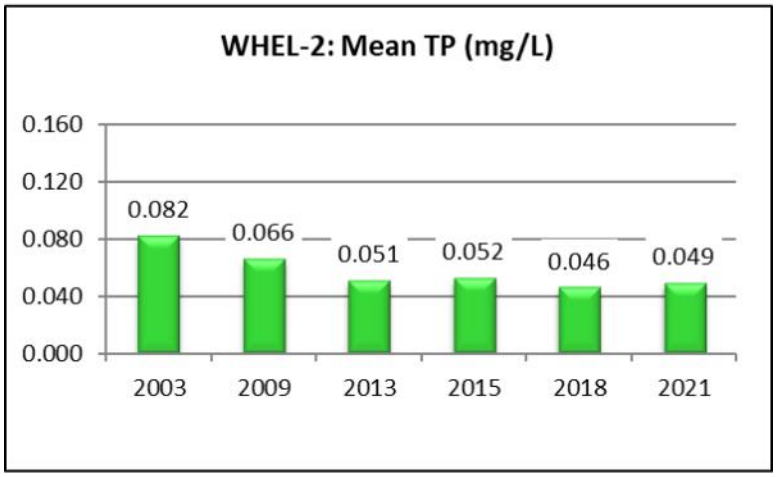
Dissolved oxygen (DO) concentrations at WHEL-2 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2021 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

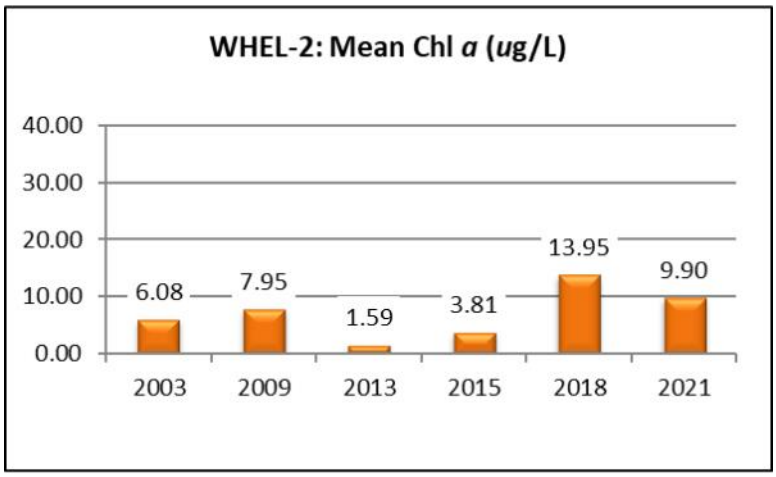
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	8.28	Phosphorus
2009	4.09	Phosphorus
2013	16.87	Phosphorus









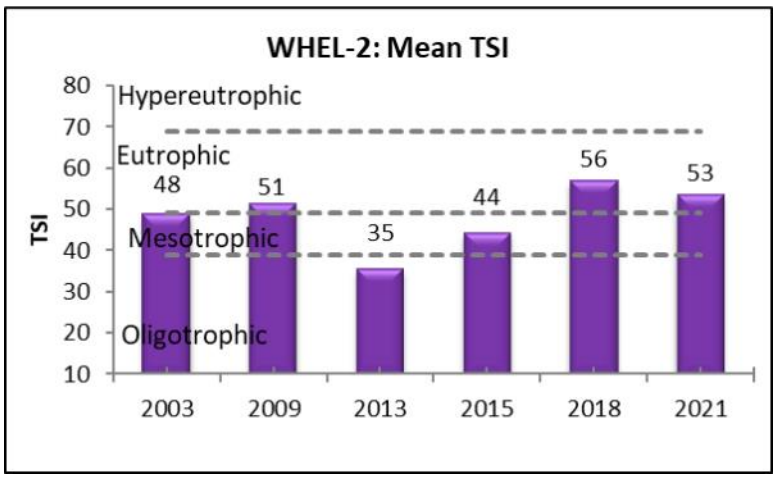
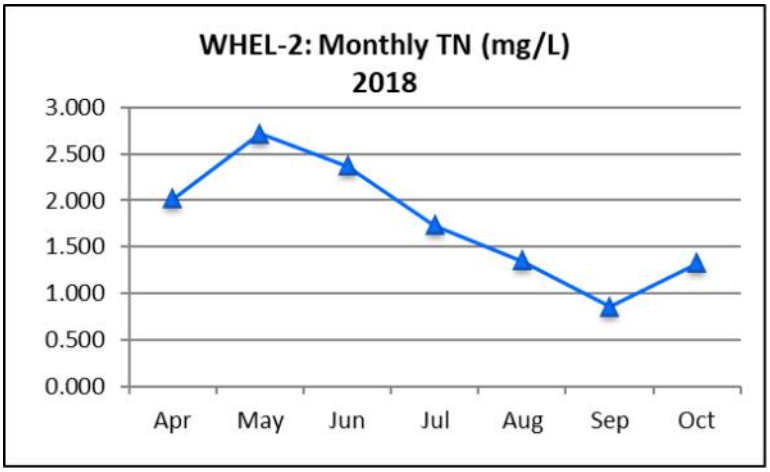
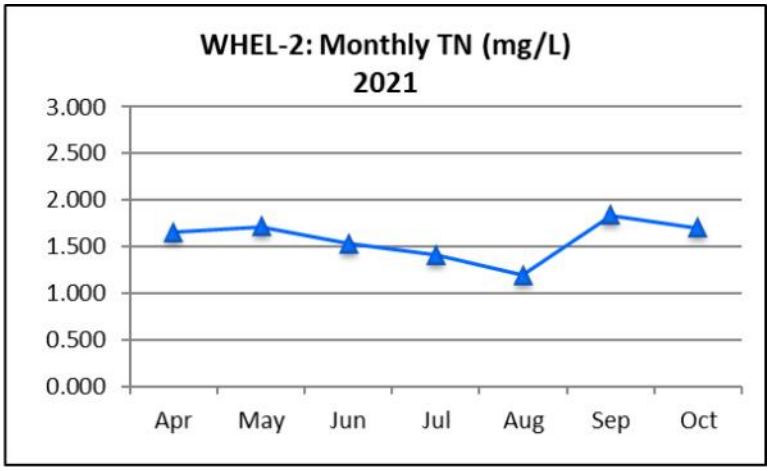
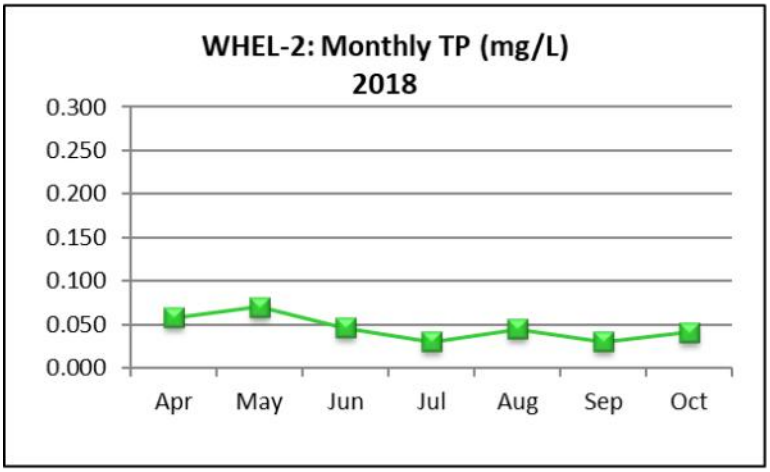
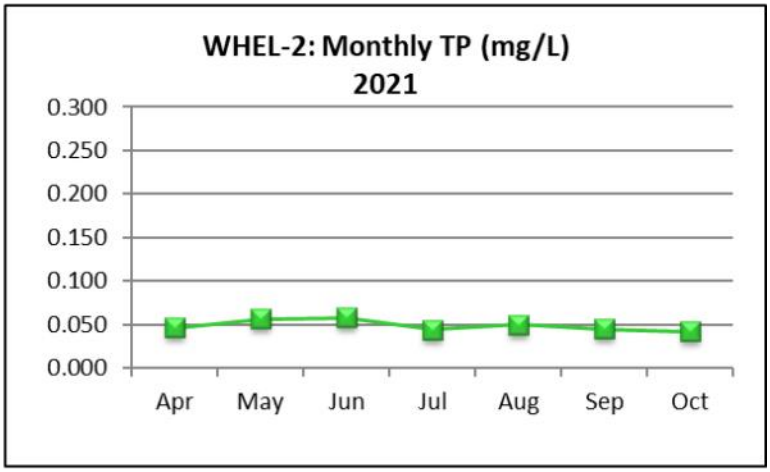


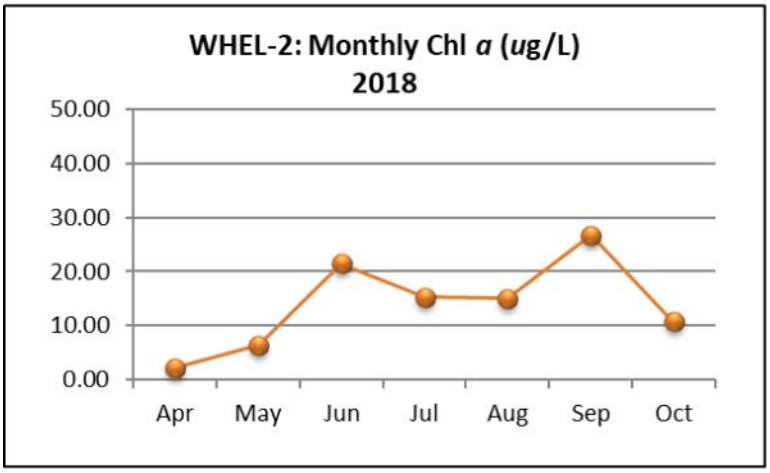
Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Flint River (Wheeler Lake) embayment (WHEL-2)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

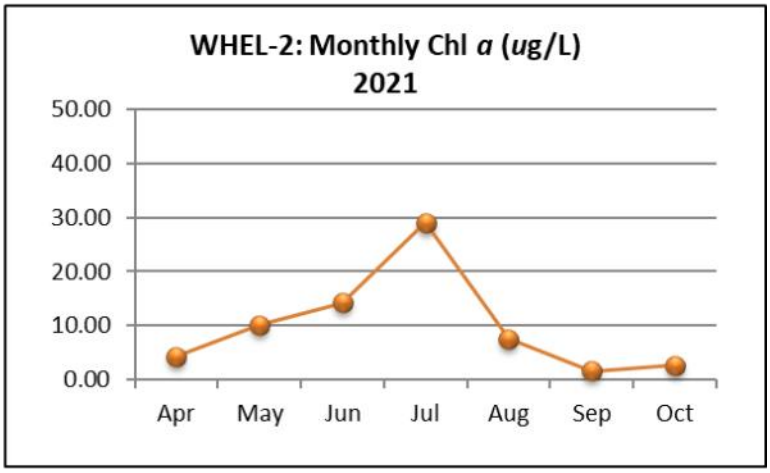


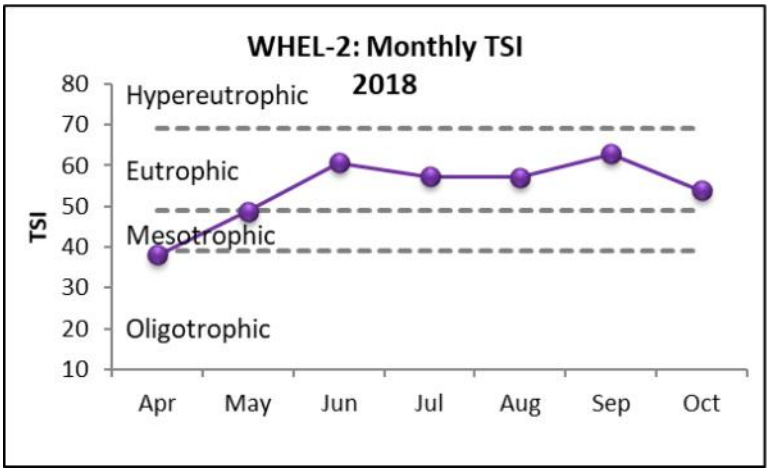












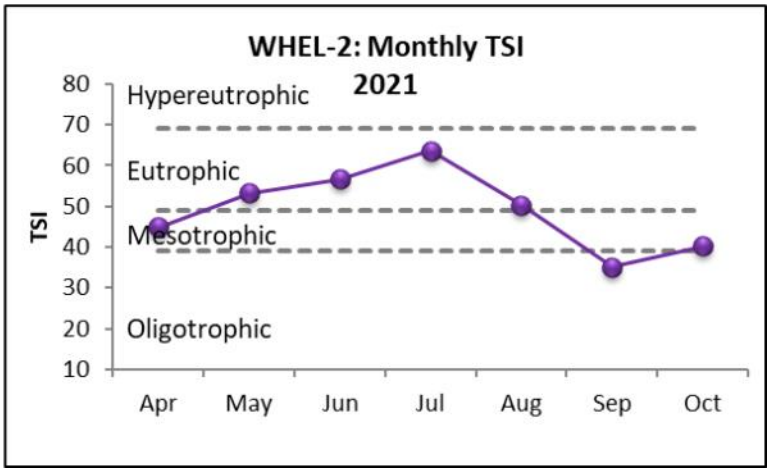


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Flint River (Wheeler Lake) embayment (WHEL-2)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

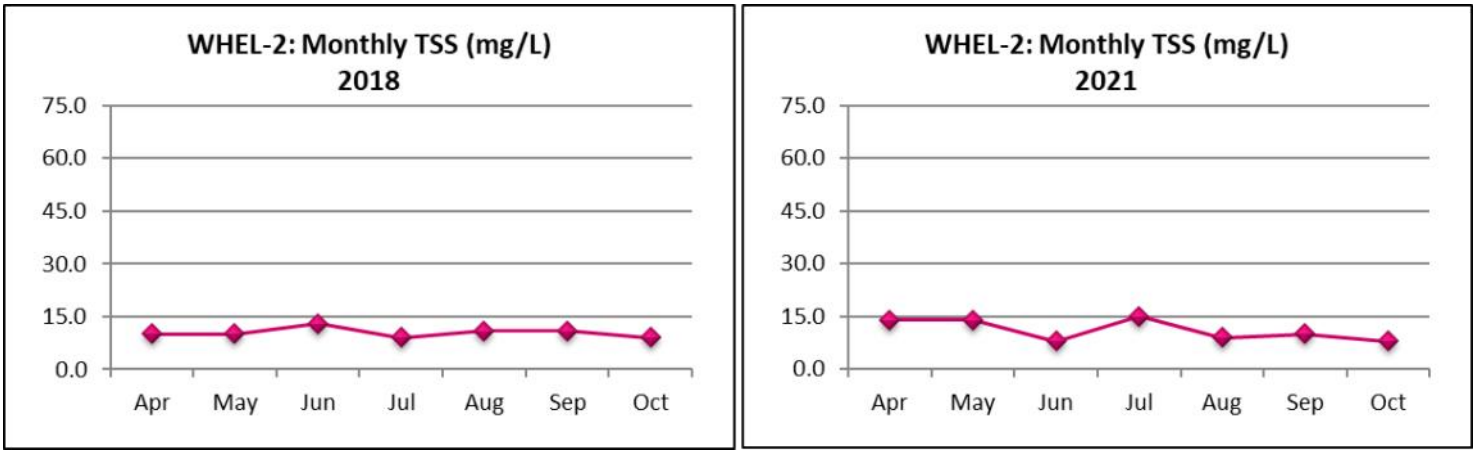


Figure 6. Monthly TSS measured in the Flint River (Wheeler Lake) embayment (WHEL-2) in 2018 and 2021.

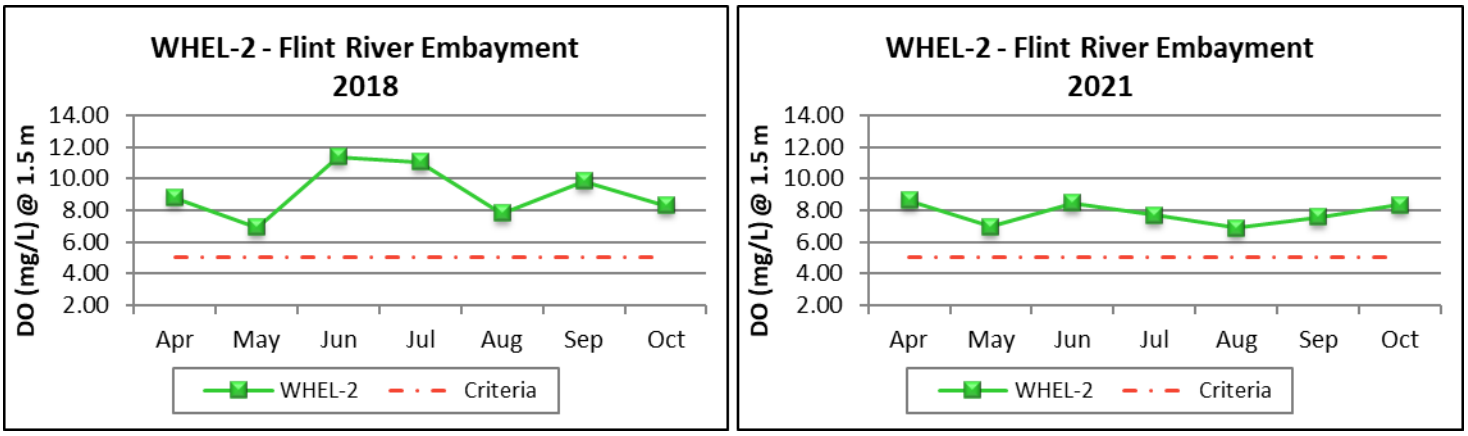


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Flint River (Wheeler Lake) embayment (WHEL-2) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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