Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Second Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-10: Second Creek approx. 0.5 mile downstream of Highway 72 bridge (Lauderdale Co 34.83745/-87.37147)

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 Second 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 Second Creek (Wheeler Lake) embayment (WHEL-10) 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. Second Creek (Wheeler Lake) at WHEL-10.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Second Creek (Wheeler Lake) embayment is classified *Swimming/Fish & Wildlife (S/F&W)* and located in the Western Highland Rim ecoregion (71f). Based on the 2021 National Land Cover Dataset, land use within the 56 mi^2 watershed is predominantly pasture with some forest (30%) (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of five NPDES outfalls within the watershed (Figure 2).

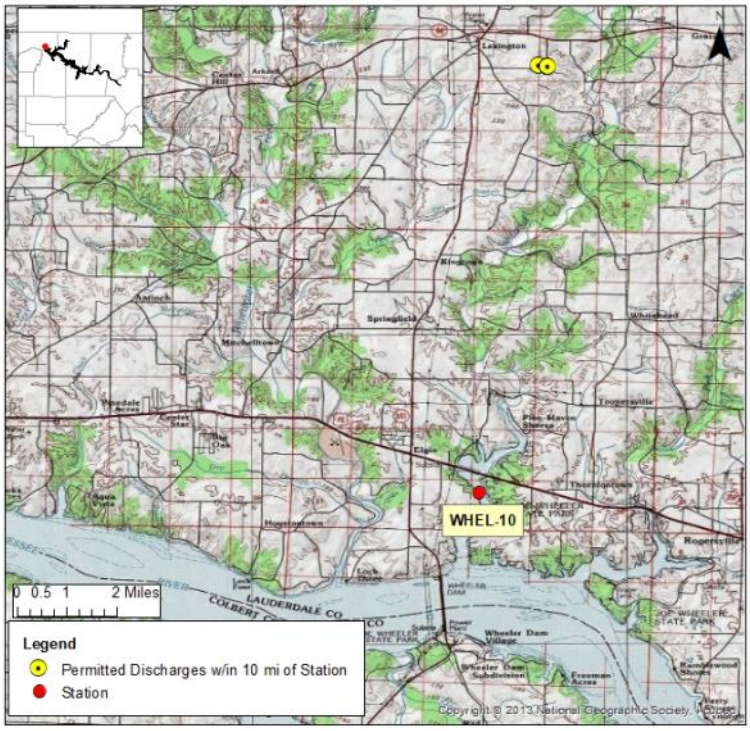


Figure 2. Map of the Second Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

Table 1. Summary of Watershed **WHEL-10**

Basin		Tennessee R
Assessment Unit		AL06030002-1204-101
Drainage Area (mi^2)		56
Ecoregion[a]		71f
% Landuse		
Open Water		1%
Developed	Open Space	6%
	Low Intensity	1%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	26%
	Evergreen Forest	2%
	Mixed Forest	2%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		46%
Cultivated Crops		11%
Wetlands	Woody	3%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	5
Municipal		5

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

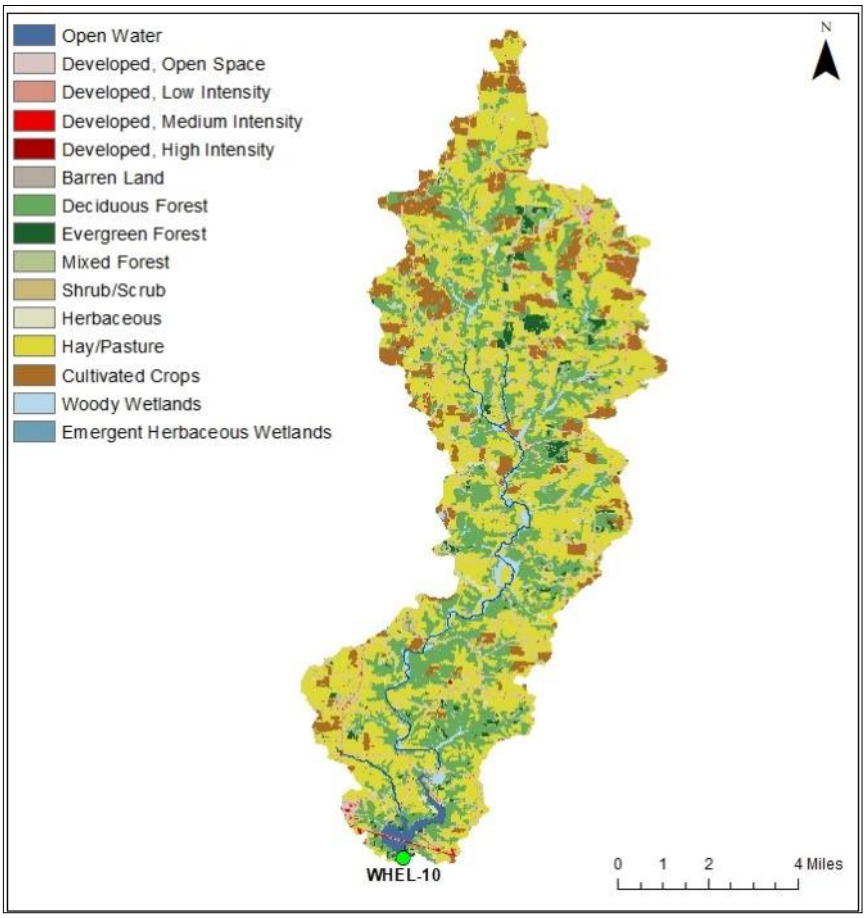


Figure 3. Land use within the Second Creek (Wheeler Lake) watershed at WHEL-10.

SITE DESCRIPTION

The Second Creek (Wheeler Lake) embayment at WHEL-10 is a clear, fairly deep embayment which flows into the Tennessee River just upstream of the Wheeler Dam. Second Creek (Wheeler Lake) had a mean bottom depth of 9.4m in 2018 and 9.1m 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.

In general, mean growing season TN values increased 2003 to 2013, but they have decreased each year since then (Figure 4). Monthly TN concentrations were highest in April in 2018 and in May in 2021 (Figure 5).

Mean growing season TP concentrations decreased 2009 to 2013 and have fluctuated very little since then (Figure 4). The mean TP value calculated for 2018 was the lowest measured in all years sampled. In 2018, the highest monthly TP value was observed in April (Figure 5). In 2021 the highest monthly TP value was observed in May.

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-10 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	2.9	10.0	5.5	5.4	2.6
Total Dissolved Solids (mg/L)	7	64.0	94.0	85.0	82.6	10.1
Total Suspended Solids (mg/L)	7	3.0	6.0	5.0	4.3	1.2
Hardness (mg/L)	4	56.7	67.4	60.8	61.4	4.8
Alkalinity (mg/L)[J]	7	54.7	66.4	60.3	61.2	3.8
Photic Zone (m)	7	3.62	5.80	4.04	4.44	0.76
Secchi (m)	7	1.07	1.91	1.34	1.40	0.29
Bottom Depth (m)	7	8.9	9.6	9.5	9.4	0.2
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.060	0.004	0.015	0.021
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.004	0.393	0.029	0.095	0.148
Total Kjeldahl Nitrogen (mg/L)	7	0.250	0.733	0.450	0.468	0.170
Total Nitrogen (mg/L)[J]	7	< 1.005	3.048	0.454	0.564	0.237
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.031	0.009	0.012	0.011
Total Phosphorus (mg/L)	7	0.022	0.062	0.029	0.033	0.014
CBOD-5 (mg/L)	7	< 2.0	3.0	1.0	1.5	0.8
Chlorides (mg/L)	7	5.4	7.4	6.2	6.4	0.7
Biological						
Chlorophyll a (mg/m³)	7	< 0.10	17.60	4.27	6.71	7.09
E. coli (MPN/DL)[J]	4	< 1	4	1	2	2
WHEL-10 2021	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	3.6	6.8	4.0	4.6	1.2
Total Dissolved Solids (mg/L)[J]	7	43.0	94.0	72.0	70.9	15.5
Total Suspended Solids (mg/L)[J]	7	3.0	8.0	6.0	5.6	2.1
Hardness (mg/L)	4	59.9	68.1	63.8	63.9	3.6
Alkalinity (mg/L)	7	54.3	59.7	57.4	57.1	2.0
Photic Zone (m)	7	3.02	6.48	5.02	4.67	1.18
Secchi (m)	7	0.90	1.62	1.37	1.30	0.29
Bottom Depth (m)	7	8.0	9.6	9.3	9.1	0.6
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	0.226	0.008	0.066	0.102
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	1.180	0.413	0.432	0.362
Total Nitrogen (mg/L)[J]	7	< 0.510	3.544	0.417	0.498	0.348
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.011	0.006	0.007	0.003
Total Phosphorus (mg/L)	7	0.027	0.074	0.031	0.043	0.020
CBOD-5 (mg/L)[J]	7	< 2.0	3.5	2.3	2.1	1.1
Chlorides (mg/L)	7	4.5	6.9	5.4	5.5	1.0
Biological						
Chlorophyll a (mg/m³)	7	4.27	58.70	25.10	27.67	18.23
E. coli (MPN/DL)[J]	4	< 1	< 1	1	1	0

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

RESULTS (con't)

Mean growing season chl *a* concentrations decreased by half from 2003 to 2009 (Figure 4). While the 2013 mean was slightly higher, it decreased by half again in 2015, and the 2018 mean was the lowest of all years sampled. However, mean chl *a* concentrations increased four-fold in 2021. Monthly chl *a* concentrations were highest in September in 2018 and in July of 2021, reaching a value of 58.70 (Figure 5).

According to mean annual TSI, the productivity of the Second Creek (Wheeler Lake) embayment was eutrophic every sampling year, except 2018, which was mesotrophic (Figure 4). In 2018, monthly TSI calculations indicated the embayment did not reach eutrophic conditions until August-October (Figure 5). In 2021, the site was eutrophic in all months sampled, except April, which was mesotrophic and July, which was hypereutrophic.

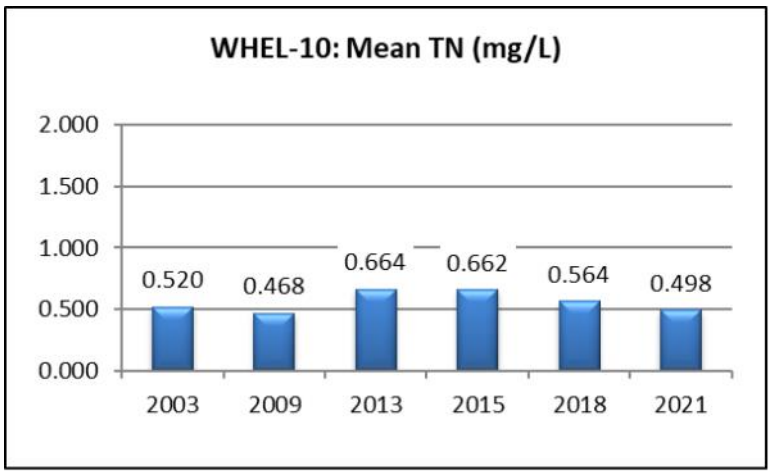
Mean growing season TSS concentrations decreased 2003 to 2015 but increased slightly in 2018 and 2021 (Figure 4). In 2018, monthly TSS concentrations were all low, ranging from 3-6 mg/L (Figure 6). Monthly TSS was similar in 2021, with concentrations ranging from 3-8 mg/L throughout the growing season.

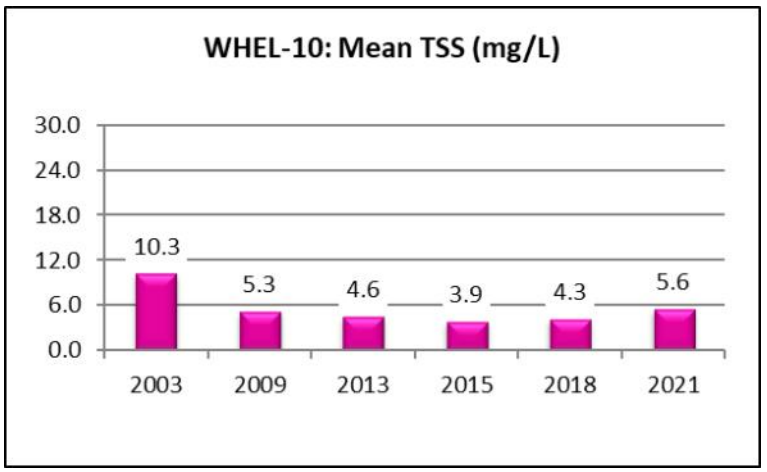
AGPT results show that Second Creek (Wheeler Lake) was co-limiting in 2003 and nitrogen-limited in 2009 and 2013 (Table 3). The 2009 sample was below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems. While the 2003 and 2013 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.

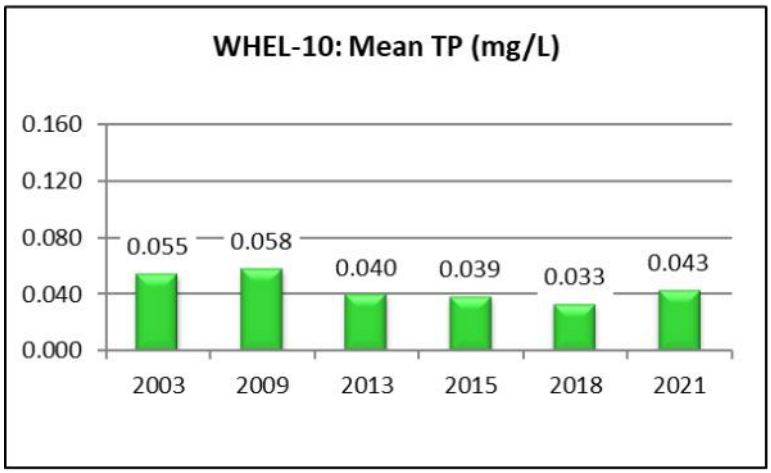
While dissolved oxygen (DO) concentrations at WHEL-10 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2021 (ADEM Admin. Code R. 335-6-10-.09), some monthly readings in 2021 showed super-saturated DO conditions (Figure 7). DO was >10.0 mg/L at criteria depth in all months sampled except October. In May 2021, DO concentrations reached 17.32 mg/L, and in September, the reached 15.0 mg/L.

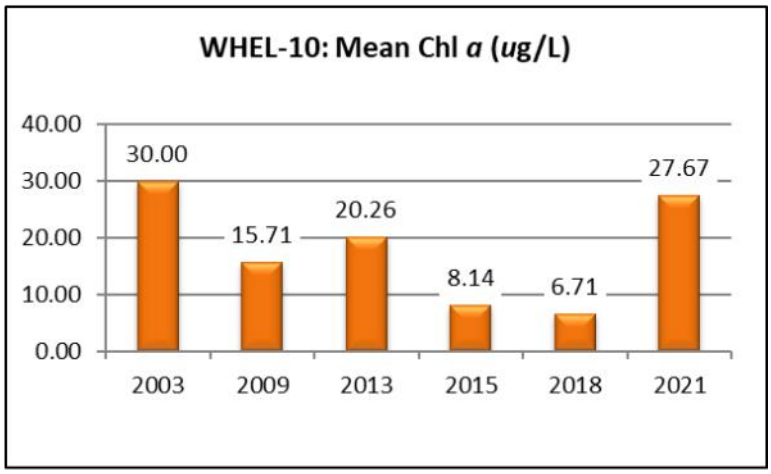
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	5.86	Co-limiting
2009	3.36	Nitrogen
2013	7.56	Nitrogen









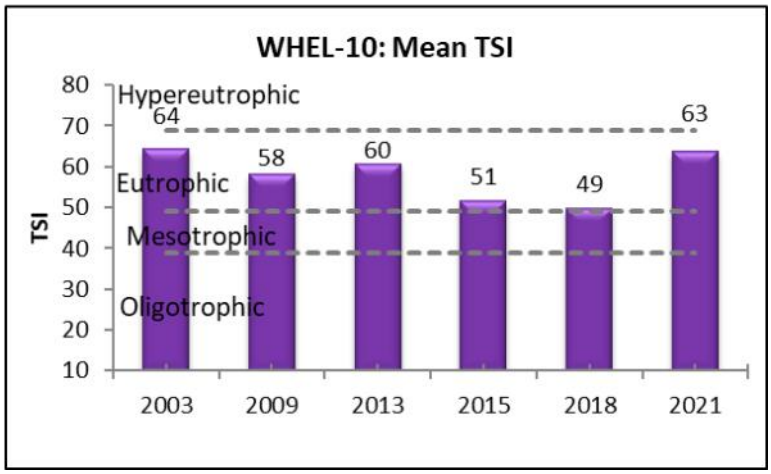
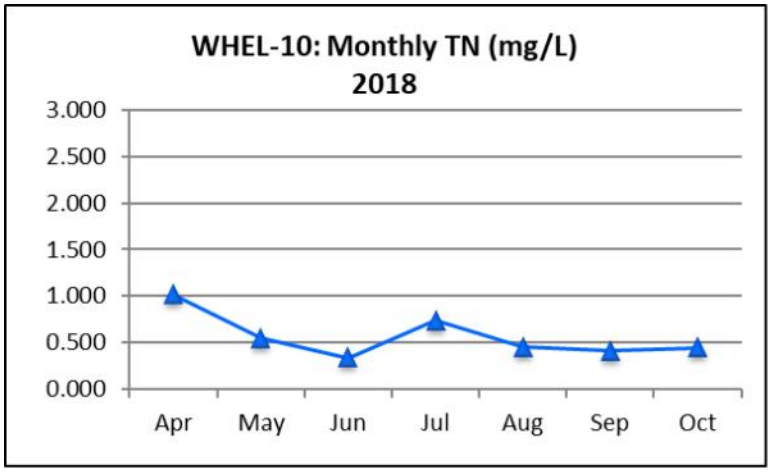
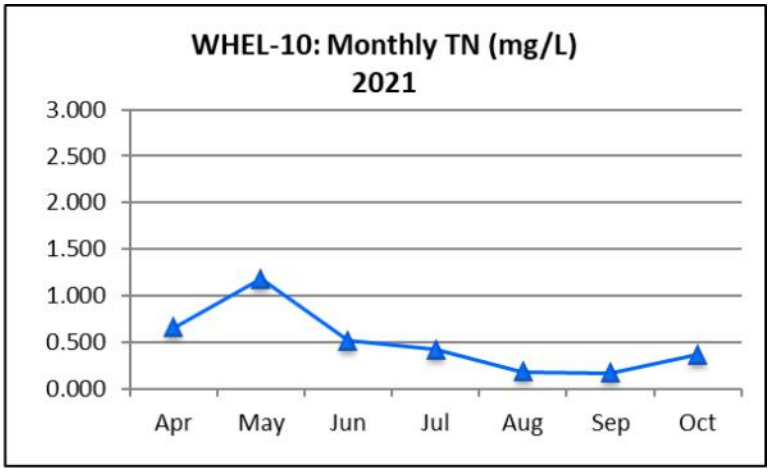
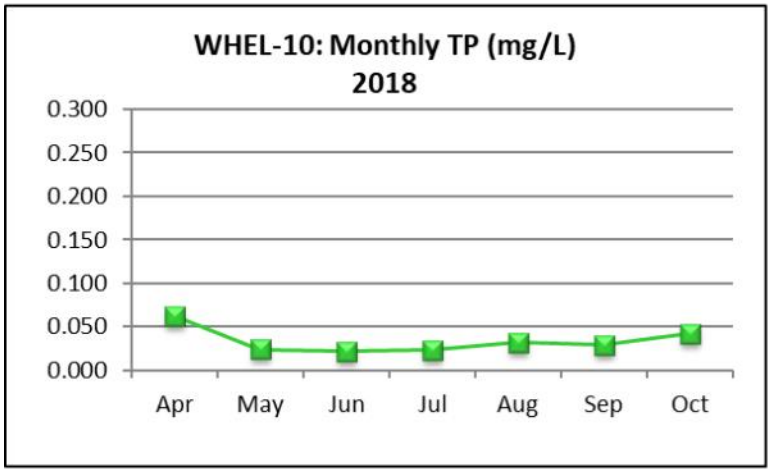
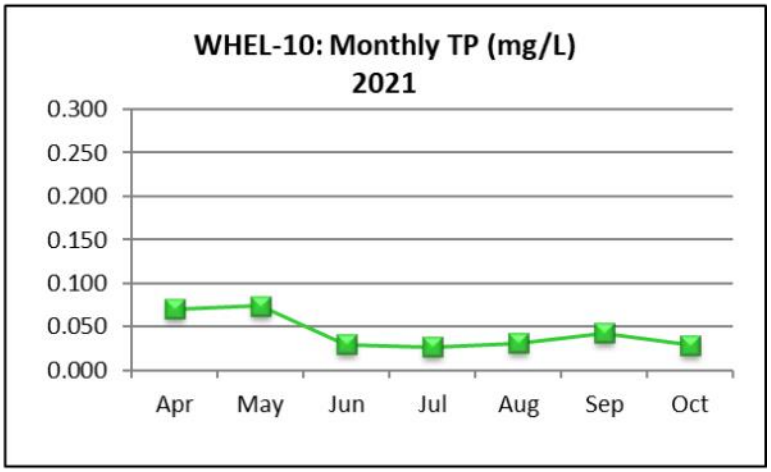


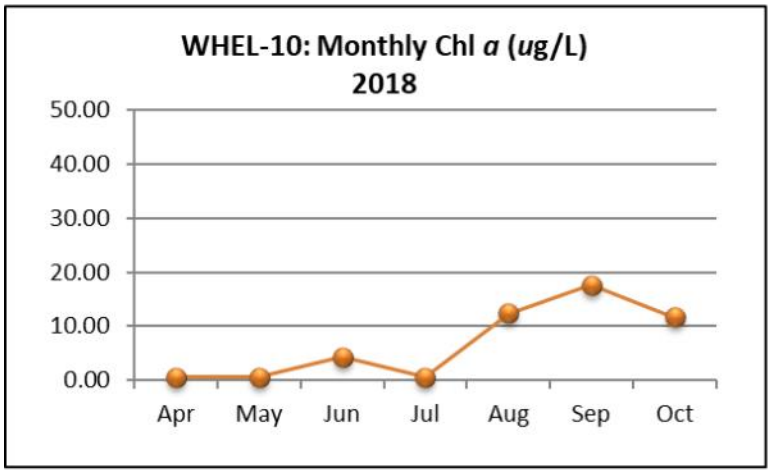
Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Second Creek (Wheeler Lake) embayment (WHEL-10)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

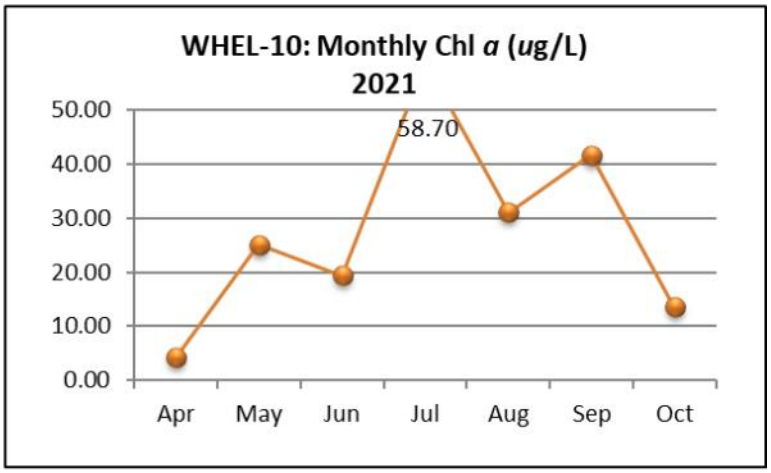


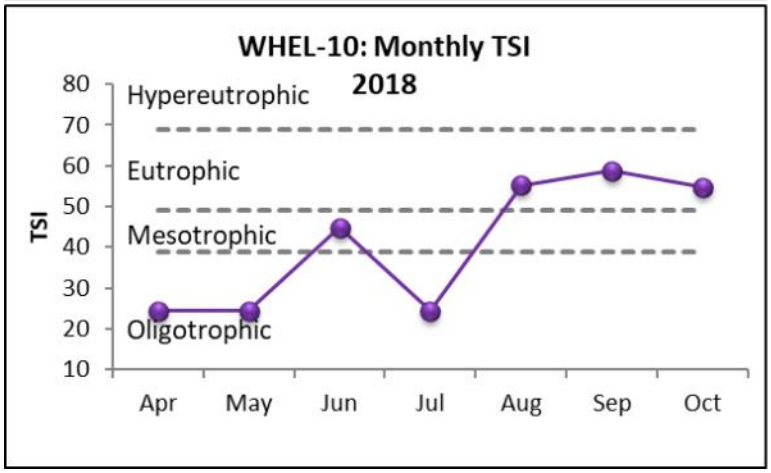












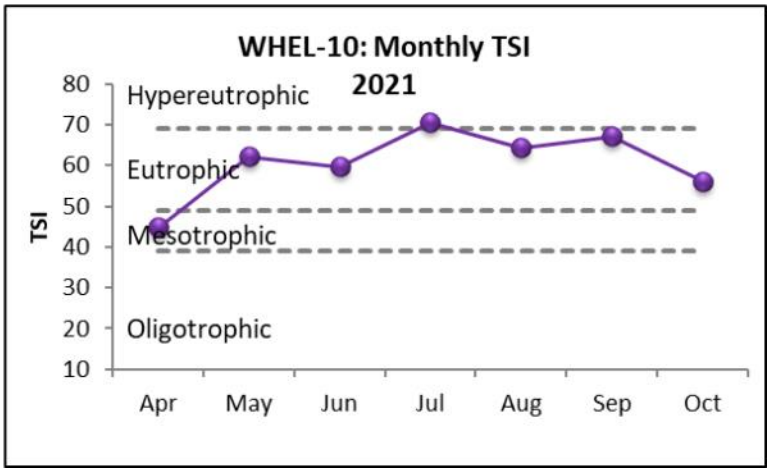


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Second Creek (Wheeler Lake) embayment (WHEL-10)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

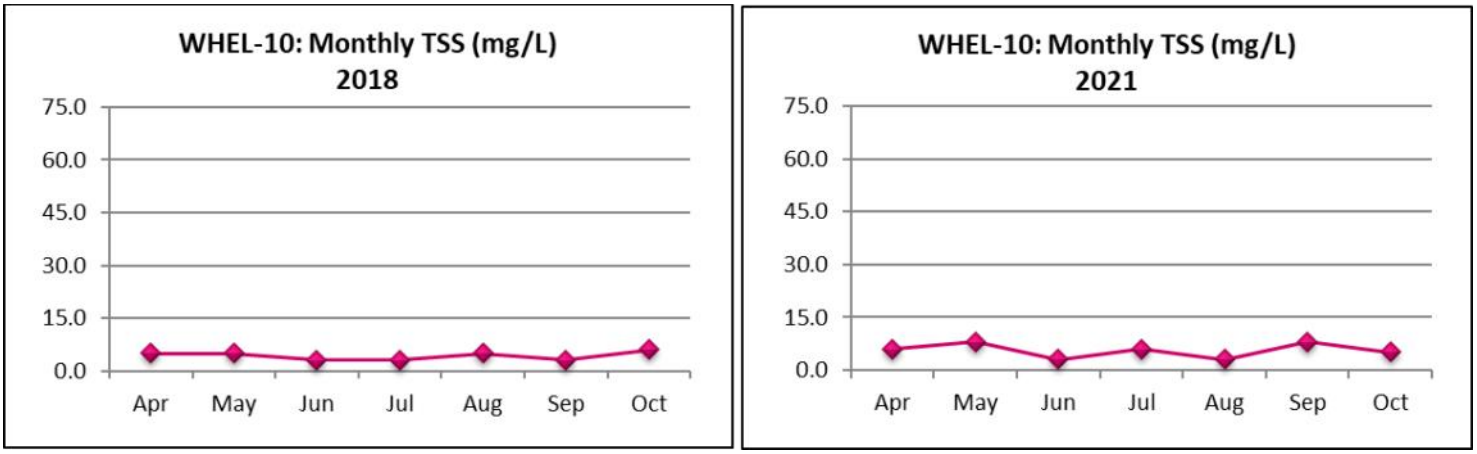


Figure 6. Monthly TSS measured in the Second Creek (Wheeler Lake) embayment (WHEL-10) in 2018 and 2021.

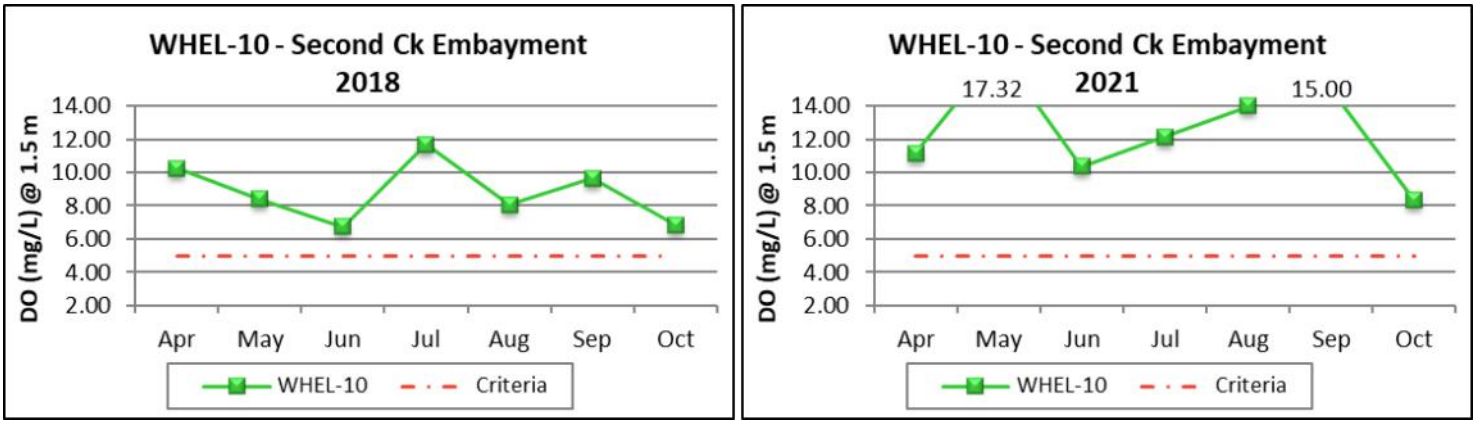


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Second Creek (Wheeler Lake) embayment (WHEL-10) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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