Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Swan Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-13: Swan Creek approx. 1 mi downstream of County Road 45 bridge (Limestone Co 34.66969/-87.00228)

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 Swan 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 Swan Creek (Wheeler Lake) embayment (WHEL-13) 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. Swan Creek (Wheeler Lake) at WHEL-13.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Swan 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 57 mi^2 watershed is predominantly developed (25%), pastureland, and cultivated crops (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 66 NPDES outfalls within the watershed (Figure 2).

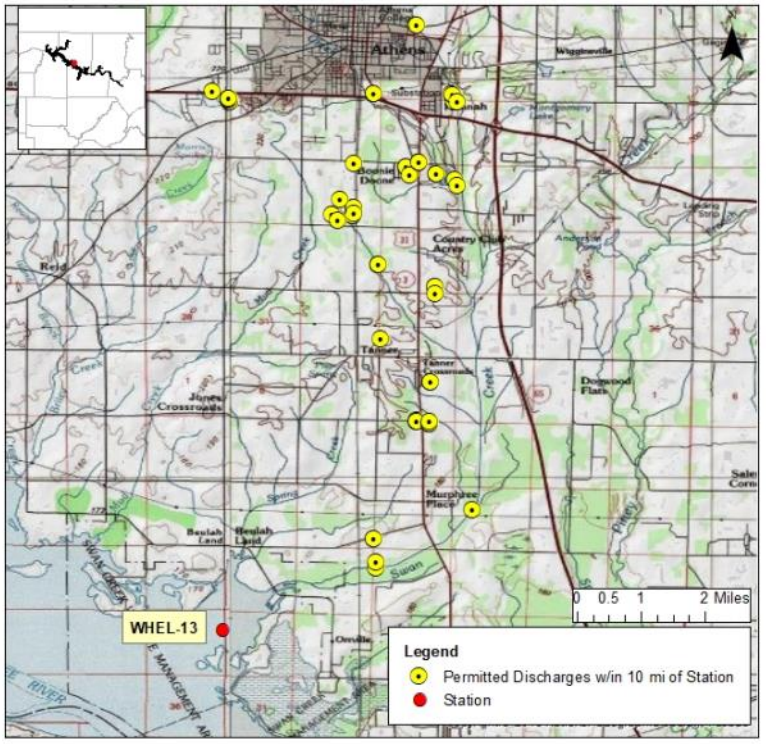


Figure 2. Map of the Swan Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

Table 1. Summary of Watershed **WHEL-13**

Basin		Tennessee R
Assessment Unit		AL06030002-1101-111
Drainage Area (mi^2)		57
Ecoregion[a]		71g
% Landuse		
Open Water		1%
Developed	Open Space	9%
	Low Intensity	9%
	Medium Intensity	5%
	High Intensity	2%
Barren Land		<1%
Forest	Deciduous Forest	10%
	Evergreen Forest	3%
	Mixed Forest	3%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		25%
Cultivated Crops		24%
Wetlands	Woody	8%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	66
Mining		2
Industrial General		49
Industrial Individual		2
Municipal		4
State Indirect Discharge		5

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

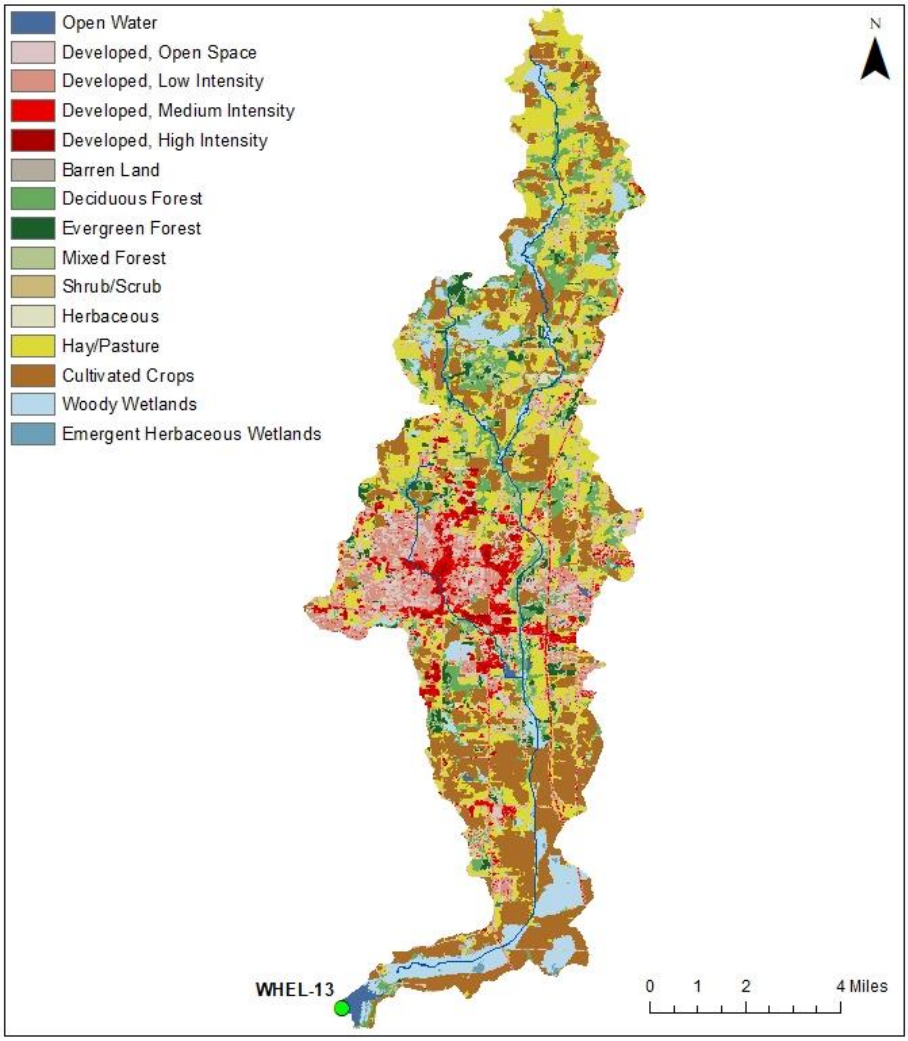


Figure 3. Land use within the Swan Creek (Wheeler Lake) watershed at WHEL-13.

SITE DESCRIPTION

The Swan Creek (Wheeler Lake) embayment at WHEL-13 is a shallow embayment that flows into the north bank of the Tennessee River at approximately river mile 300 near Decatur, AL. Swan Creek (Wheeler Lake) had a mean bottom depth of 1.8m in 2018 and 1.4m in 2021 at the sampling location (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.

In general, mean growing season TN values decreased 2009 to 2021, with the 2021 mean being the lowest calculated overall (Figure 4). Monthly TN concentrations were highest in April in 2018 and in May 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-13 2018	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	7		9.6	25.8	19.8	18.4	5.7
Total Dissolved Solids (mg/L)	7		84.0	100.0	90.0	90.9	5.1
Total Suspended Solids (mg/L)[J]	7		9.0	21.0	14.0	14.7	5.0
Hardness (mg/L)	4		52.8	68.6	58.8	59.8	7.0
Alkalinity (mg/L)	7		53.8	65.7	58.5	59.1	4.6
Photic Zone (m)	7		1.30	2.00	1.70	1.66	0.24
Secchi (m)	7		0.43	0.82	0.61	0.63	0.13
Bottom Depth (m)	7		1.3	2.3	1.8	1.8	0.4
Chemical							
Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.069	0.004	0.015	0.024
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.004	0.474	0.002	0.111	0.190
Total Kjeldahl Nitrogen (mg/L)[J]	7		0.241	0.786	0.663	0.611	0.180
Total Nitrogen (mg/L)[J]	7	<	1.560	3.186	0.693	0.723	0.176
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.004	0.029	0.005	0.011	0.010
Total Phosphorus (mg/L)	7		0.019	0.054	0.032	0.034	0.011
CBOD-5 (mg/L)	7	<	2.0	3.9	2.1	2.0	1.1
Chlorides (mg/L)	7		4.8	7.4	6.2	6.2	0.8
Biological							
Chlorophyll a (mg/m³)	7		2.14	17.10	9.79	10.12	6.02
E. coli (MPN/DL)[J]	4	<	1	9	1	3	4
WHEL-13 2021	**N**		**Min**	**Max**	**Med**	**Avg**	**SD**
Physical							
Turbidity (NTU)	7		4.4	26.9	11.1	14.3	9.7
Total Dissolved Solids (mg/L)[J]	7		61.0	92.0	80.0	79.7	11.6
Total Suspended Solids (mg/L)[J]	7		4.0	28.0	11.0	15.7	10.5
Hardness (mg/L)	4		59.9	67.0	62.8	63.2	2.9
Alkalinity (mg/L)	7		53.8	60.6	56.9	57.4	2.5
Photic Zone (m)	7		1.10	1.69	1.35	1.41	0.21
Secchi (m)	7		0.47	1.24	0.65	0.75	0.31
Bottom Depth (m)	7		1.1	1.7	1.4	1.4	0.2
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.016	0.046	0.023	0.021	0.006
Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.312	0.126	0.138	0.131
Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.324	1.020	0.162	0.371	0.326
Total Nitrogen (mg/L)[J]	7	<	0.864	3.159	0.412	0.509	0.257
Dis Reactive Phosphorus (mg/L)[J]	7		0.004	0.020	0.007	0.011	0.007
Total Phosphorus (mg/L)	7		0.030	0.086	0.034	0.044	0.020
CBOD-5 (mg/L)[J]	7	<	2.0	2.2	1.0	1.2	0.4
Chlorides (mg/L)	7		4.1	6.1	5.5	5.3	0.7
Biological							
Chlorophyll a (mg/m³)	7		3.74	31.00	11.30	13.27	9.60
E. coli (MPN/DL)[J]	4		1	89	10	28	42

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

RESULTS (con't)

Mean growing season TP concentrations decreased significantly from 2009 to 2013 (Figure 4). However, the 2021 mean was slightly higher than that of previous years. The highest monthly TP value was observed in April in both 2018 and 2021 (Figure 5).

Mean growing season chl *a* concentrations decreased 2009 to 2015, but annual means have incrementally increased since then (Figure 4). In 2018, monthly chl *a* concentrations were highest in September (Figure 5). April was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Swan Creek (Wheeler Lake) embayment was eutrophic in all sampling years (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in the embayment in May and July to September (Figure 5). In 2021, the site was eutrophic April to July and then decreased to mesotrophic for the remainder of the sampling season.

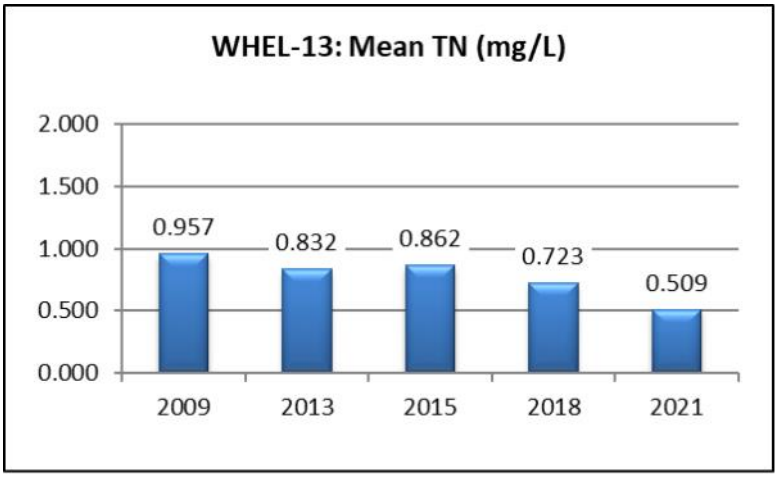
Mean growing season TSS concentrations decreased 2009 to 2018, but the 2021 annual mean was slightly higher (Figure 4). Monthly TSS concentrations were highest in August in 2018 and in April in 2021 (Figure 6).

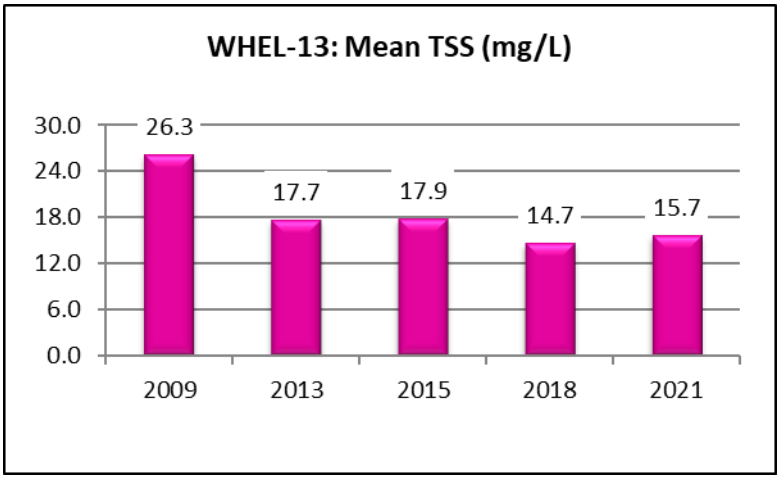
AGPT results show that Swan Creek (Wheeler Lake) was nitrogen-limited in both sampling years (Table 3). Both the 2009 and 2013 samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

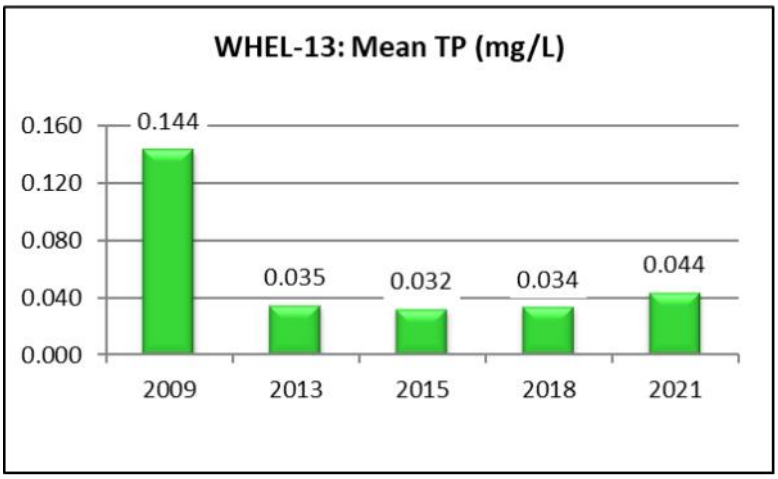
Dissolved oxygen (DO) concentrations at WHEL-13 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2021 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

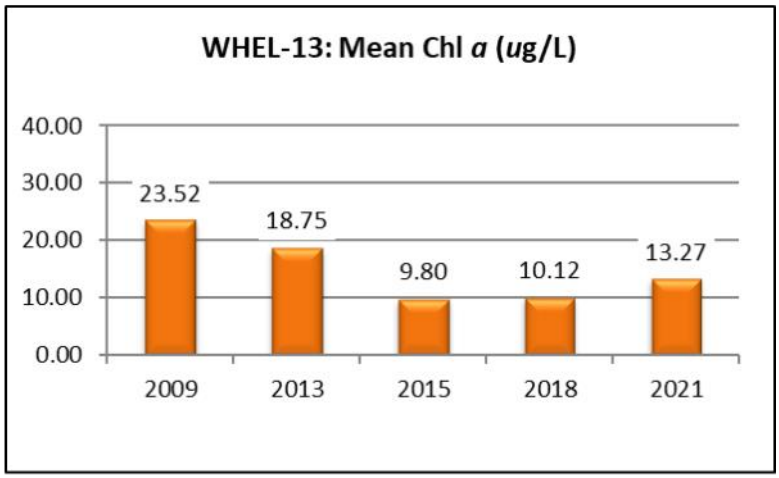
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2009	2.07	Nitrogen
2013	3.17	Nitrogen









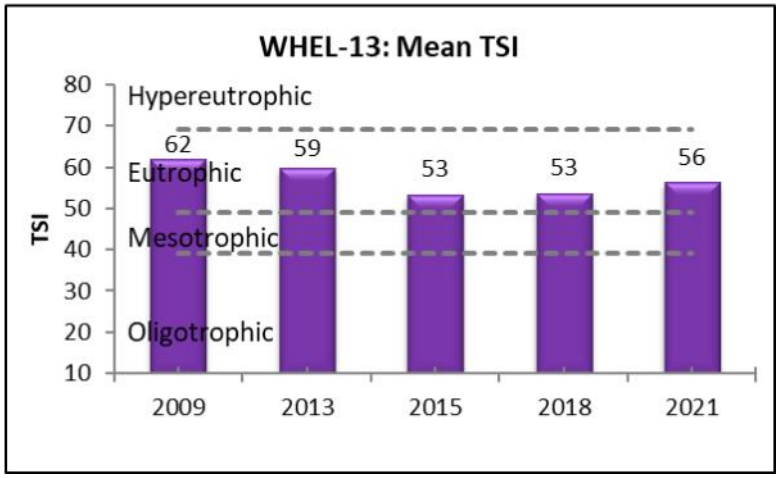
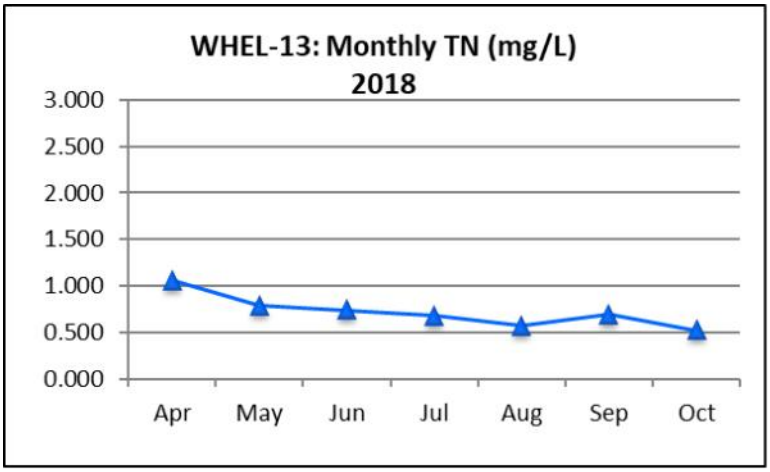
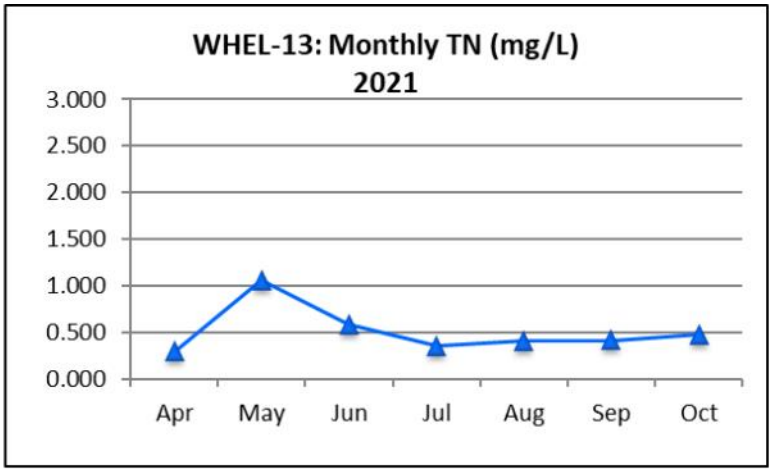
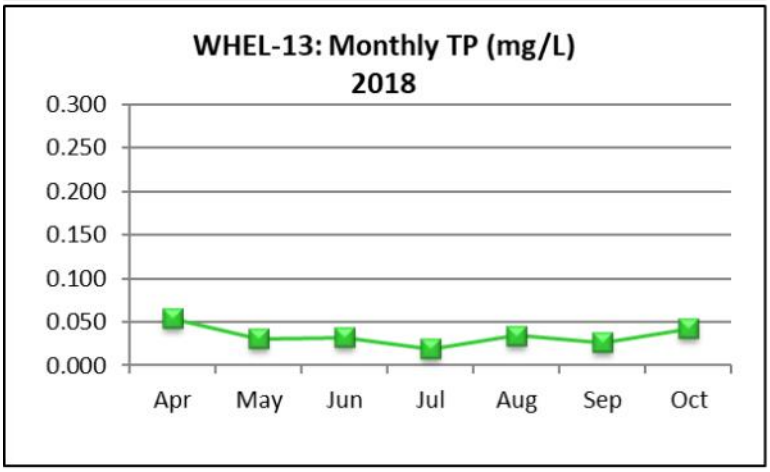
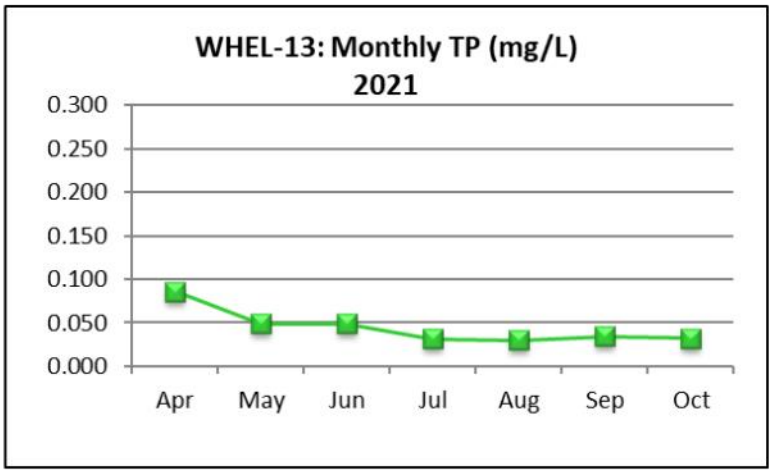


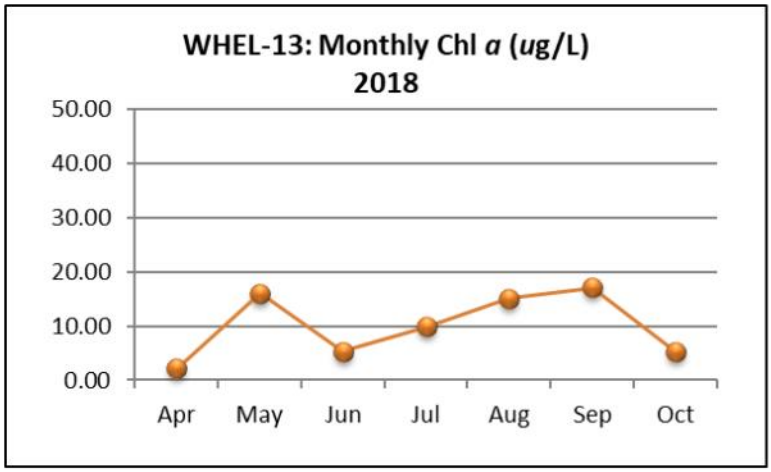
Figure 4. Mean growing season (2009-2021). TN, TP, chl *a,* and TSI measured in the Swan Creek (Wheeler Lake) embayment (WHEL-13)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

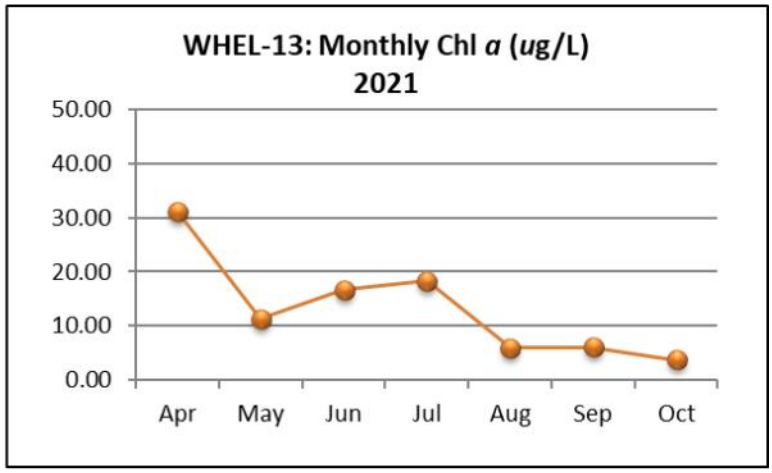


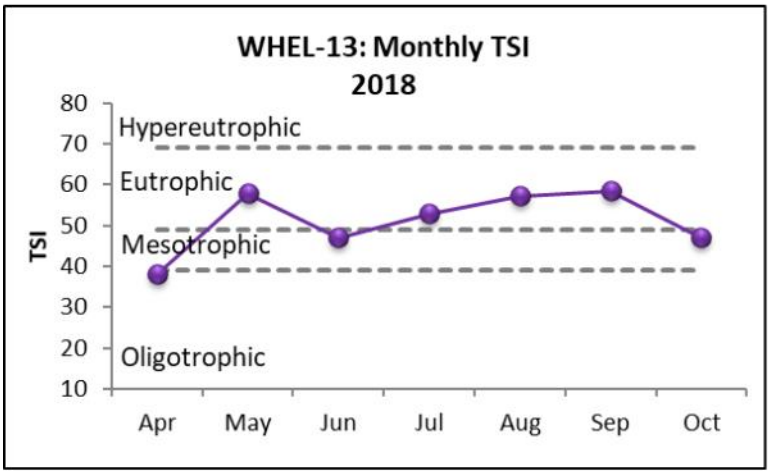












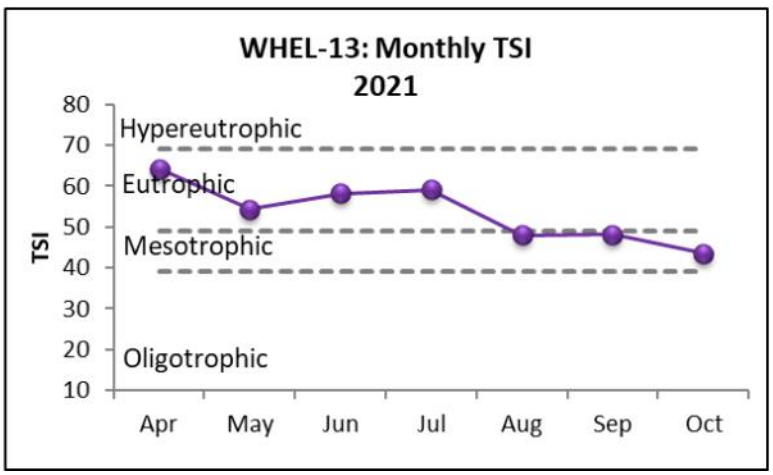


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Swan Creek (Wheeler Lake) embayment (WHEL-13)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

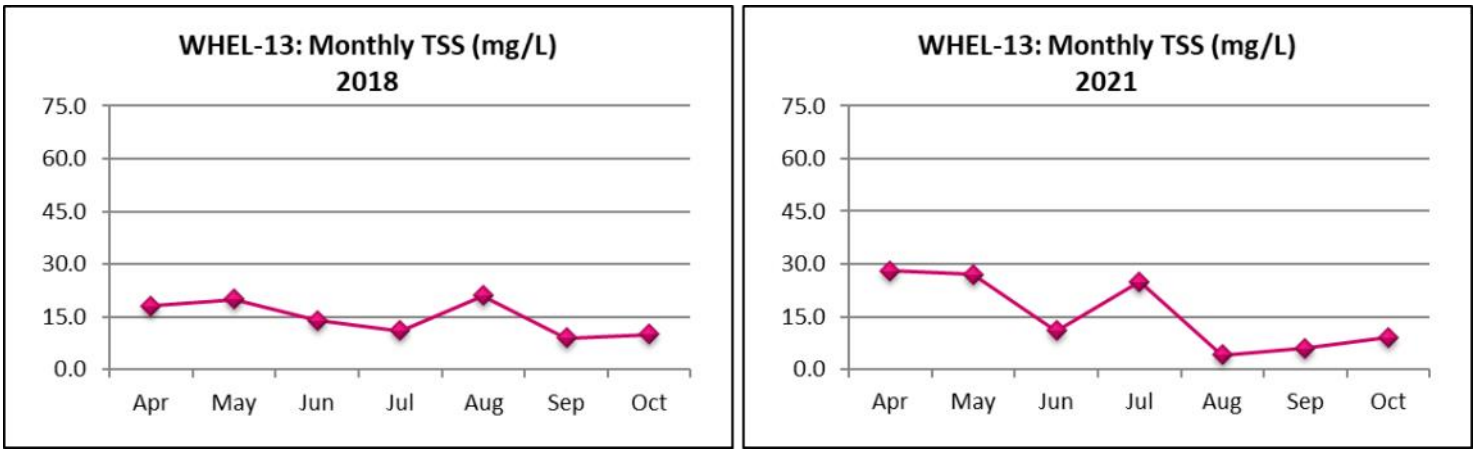


Figure 6. Monthly TSS measured in the Swan Creek (Wheeler Lake) embayment (WHEL-13) in 2018 and 2021.

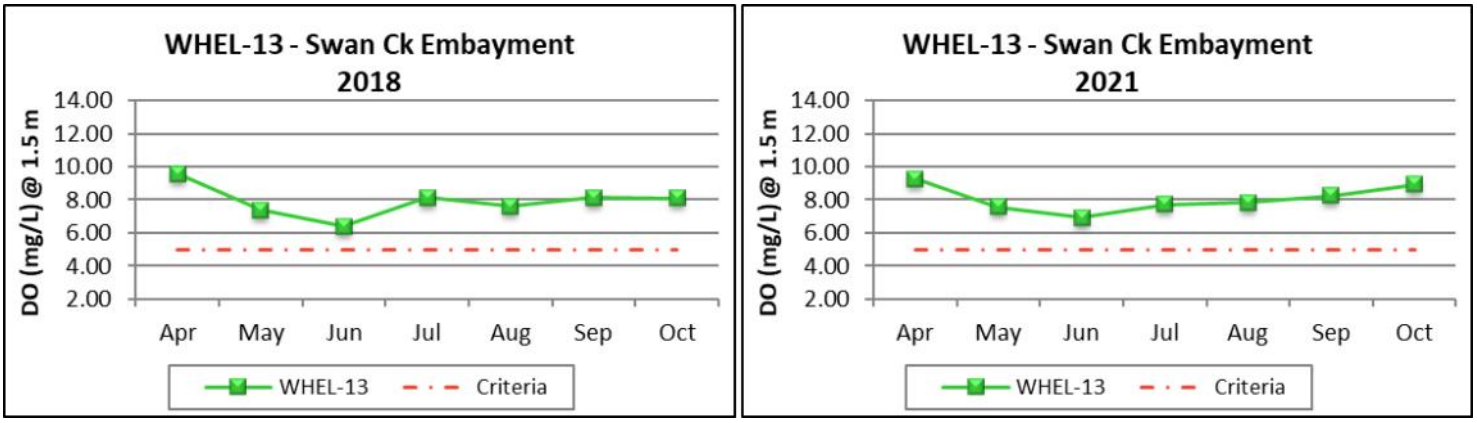


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Swan Creek (Wheeler Lake) embayment (WHEL-13) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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