Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Paint Rock River Embayment
Wheeler Reservoir
Intensive Basin Survey 2018 & 2021

WHEL-1: Paint Rock River approx. 1 mi upstream of confluence with TN River (Madison Co 34.48325/-86.45508)

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 Paint Rock 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 Paint Rock River (Wheeler Lake) embayment (WHEL-1) 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. Paint Rock River (Wheeler Lake) at WHEL-1.

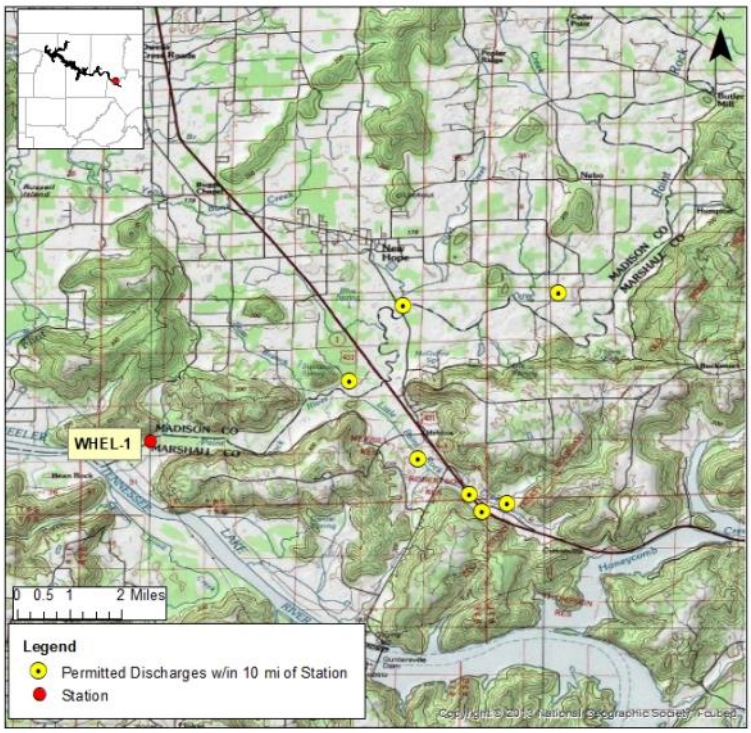


Figure 2. Map of the Paint Rock River (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Paint Rock River (Wheeler Lake) embayment is classified *Fish & Wildlife (F&W)* and located in the Plateau Escarpment ecoregion (68c). Based on the 2021 National Land Cover Dataset, land use within the 458 mi^2 watershed is predominantly forest (73%) with some pastureland (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 18 NPDES outfalls within the watershed (Figure 2).

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

Basin		Tennessee R
Assessment Unit		AL06030002-0204-111
Drainage Area (mi^2)		458
Ecoregion[a]		68c
% Landuse		
Open Water		<1%
Developed	Open Space	2%
	Low Intensity	1%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	69%
	Evergreen Forest	1%
	Mixed Forest	3%
Shrub/Scrub		2%
Herbaceous		1%
Hay/Pasture		12%
Cultivated Crops		6%
Wetlands	Woody	2%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	18
Mining		10
Industrial General		6
Municipal		2

a. Plateau Escarpment
b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Feb 13, 2024.

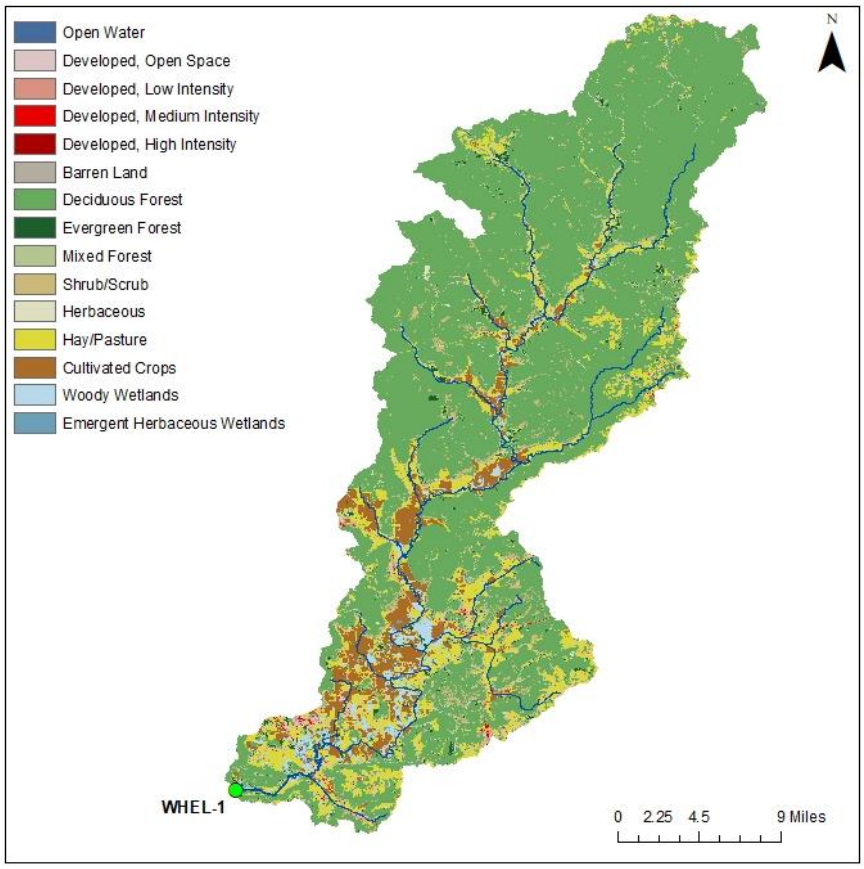


Figure 3. Land use within the Paint Rock River (Wheeler Lake) watershed at WHEL-1.

SITE DESCRIPTION

The Paint Rock River (Wheeler Lake) embayment of WHEL-1 is a fairly small, riverine embayment flowing into the Tennessee River near river mile 344. Paint Rock River (Wheeler Lake) had a mean bottom depth of 4.5m in 2018 and 4.4m 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 increased slightly 2015 to 2018 but 2018 and 2020 values were similar to the 2013 mean (Figure 4). Monthly TN concentrations were highest in June in 2018 and in July in 2021 (Figure 5).

The mean growing season TP concentration increased slightly 2015 to 2021 (Figure 4). In 2018, the highest monthly TP concentration was observed in October (Figure 5). In 2021, the highest monthly TP concentration was observed in July.

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-1 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	6.3	27.6	9.1	11.7	7.4
Total Dissolved Solids (mg/L)	7	85.0	150.0	131.0	128.6	21.7
Total Suspended Solids (mg/L)[J]	7	3.0	27.0	7.0	9.9	8.0
Hardness (mg/L)	4	84.2	134.0	101.4	105.2	23.6
Alkalinity (mg/L)[J]	7	81.2	128.0	105.0	107.7	18.7
Photic Zone (m)	7	2.54	3.83	3.01	3.11	0.42
Secchi (m)	7	0.94	1.13	1.04	1.04	0.08
Bottom Depth (m)	7	4.2	5.0	4.4	4.5	0.3
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.032	0.004	0.008	0.011
Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.004	0.673	0.233	0.305	0.251
Total Kjeldahl Nitrogen (mg/L)	7	0.250	0.698	0.344	0.404	0.153
Total Nitrogen (mg/L)	7	< 0.879	4.113	0.597	0.709	0.348
Dis Reactive Phosphorus (mg/L)[J]	7	0.004	0.018	0.008	0.010	0.005
Total Phosphorus (mg/L)	7	0.018	0.090	0.029	0.036	0.025
CBOD-5 (mg/L)	7	< 2.0	2.5	1.0	1.6	0.7
Chlorides (mg/L)	7	1.1	5.9	4.1	3.9	1.8
Biological						
Chlorophyll a (mg/m³)	7	2.14	18.20	10.10	11.42	5.86
E. coli (MPN/DL)[J]	4	3	12	7	7	4
WHEL-1 2021	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	7.8	21.4	11.1	12.1	5.0
Total Dissolved Solids (mg/L)[J]	7	101.0	140.0	127.0	122.6	13.9
Total Suspended Solids (mg/L)[J]	7	5.0	15.0	13.0	11.3	4.0
Hardness (mg/L)	4	85.8	129.0	121.5	114.4	19.4
Alkalinity (mg/L)	7	77.6	130.0	115.0	111.7	17.4
Photic Zone (m)	7	2.40	4.36	3.06	3.33	0.71
Secchi (m)	7	0.69	1.09	1.02	0.94	0.15
Bottom Depth (m)	7	4.0	4.6	4.4	4.4	0.2
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.016	0.046	0.023	0.021	0.006
Nitrate+Nitrite Nitrogen (mg/L)	7	0.437	0.640	0.482	0.510	0.071
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	0.498	0.162	0.249	0.150
Total Nitrogen (mg/L)[J]	7	< 1.929	2.892	0.737	0.759	0.126
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.070	0.014	0.019	0.023
Total Phosphorus (mg/L)	7	0.024	0.100	0.034	0.041	0.027
CBOD-5 (mg/L)[J]	7	< 2.0	< 2.0	1.0	1.0	0.0
Chlorides (mg/L)	7	2.0	4.6	2.3	2.7	0.9
Biological						
Chlorophyll a (mg/m³)	7	1.07	13.10	4.81	6.05	4.50
E. coli (MPN/DL)[J]	4	20	61	51	46	18

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

RESULTS (con't)

The mean growing season chl *a* concentration calculated for 2018 was the highest observed in all years of sampling (Figure 4). In 2018, monthly chl *a* concentrations were highest in April (Figure 5). May was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Paint Rock River (Wheeler Lake) embayment has varied over time, but the site reached eutrophic conditions in 2009 and 2018 (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in all months except May, which was oligotrophic (Figure 5). In 2021, the site was eutrophic during the months of May, June, and July.

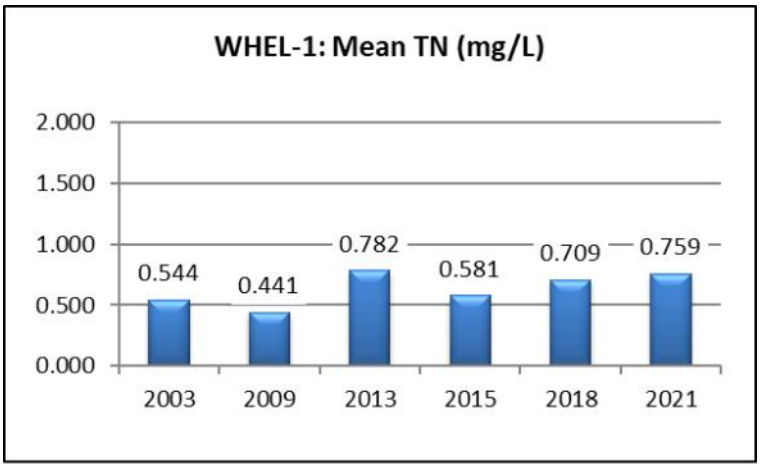
Mean growing season TSS concentrations decreased 2003 to 2009 but slightly increased 2009 to 2021 (Figure 4). In 2018, the highest monthly TSS value was measured in April (Figure 6). In 2021, monthly TSS concentrations were at or below 15 mg/L in all months sampled.

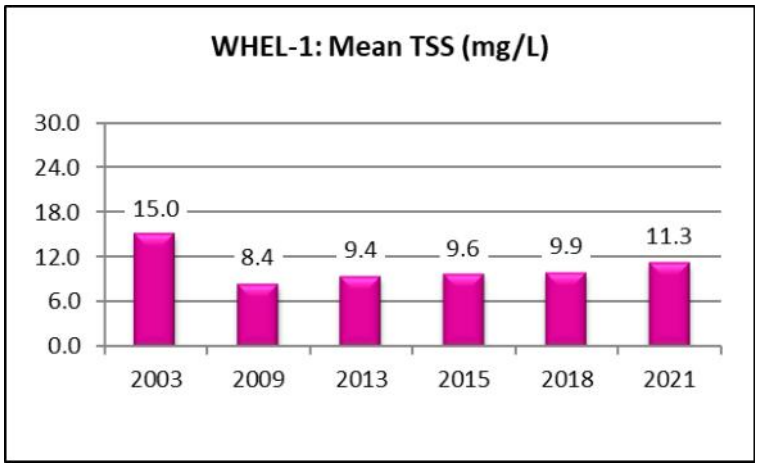
AGPT results show that Paint Rock River (Wheeler Lake) was phosphorus-limited in all years sampled (Table 3). All samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

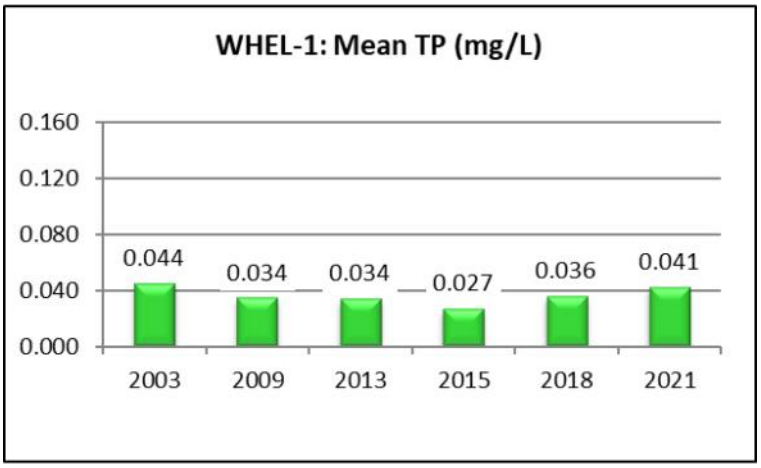
In 2018, all dissolved oxygen (DO) concentrations at WHEL-1 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled (ADEM Admin. Code R. 335-6-10-.09) (Figure 7). However, DO concentrations fell below the minimum criteria limit in July of 2021 measuring 3.88 mg/L at criteria depth.

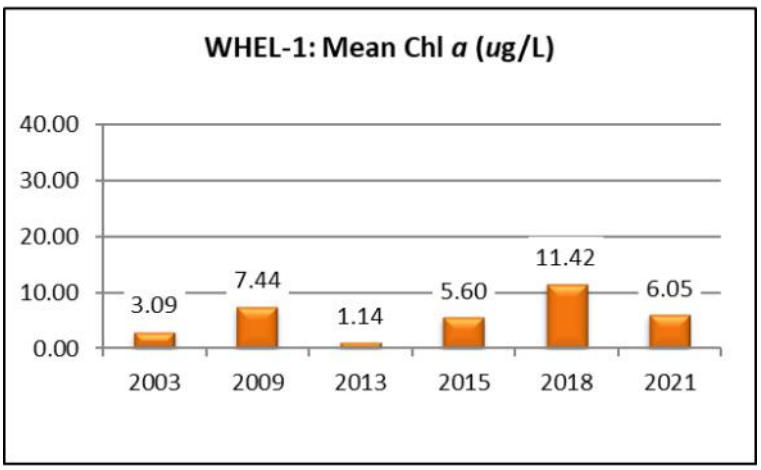
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	1.22	Phosphorus
2009	1.54	Phosphorus
2013	4.12	Phosphorus









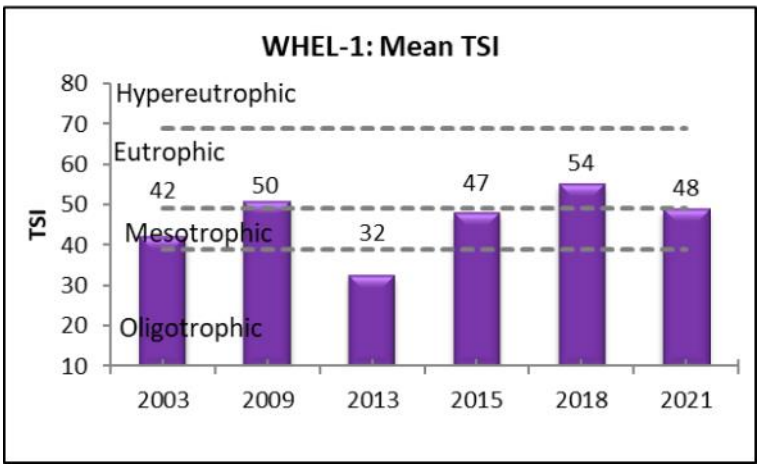
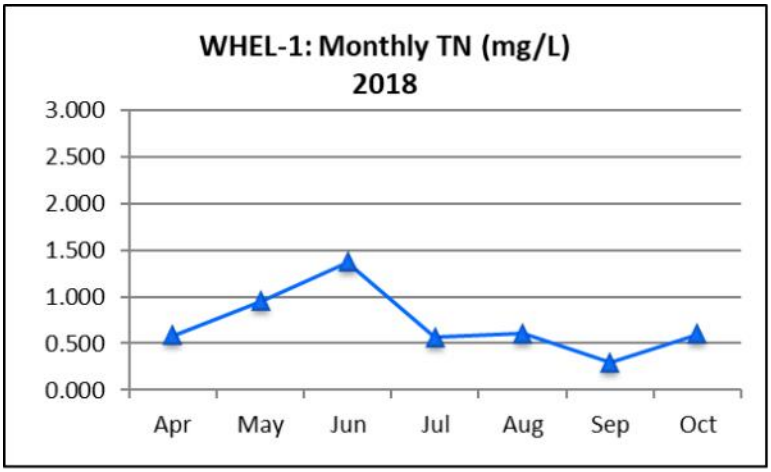
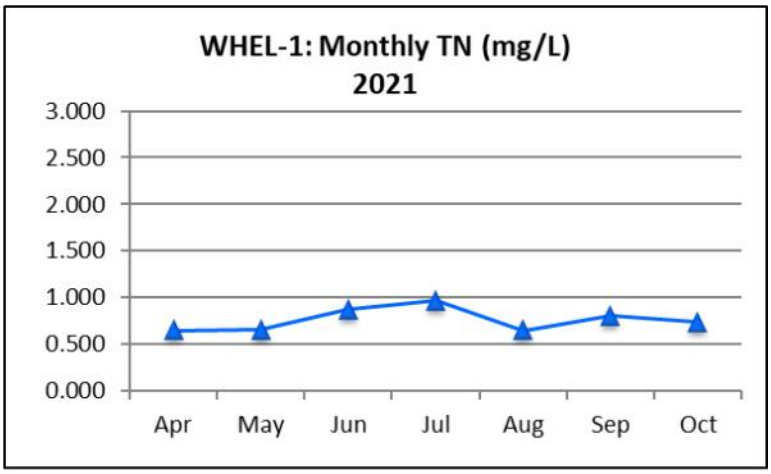
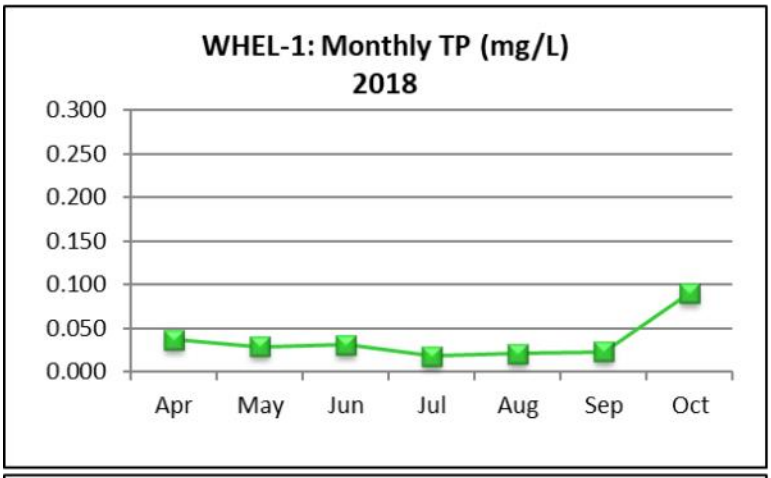
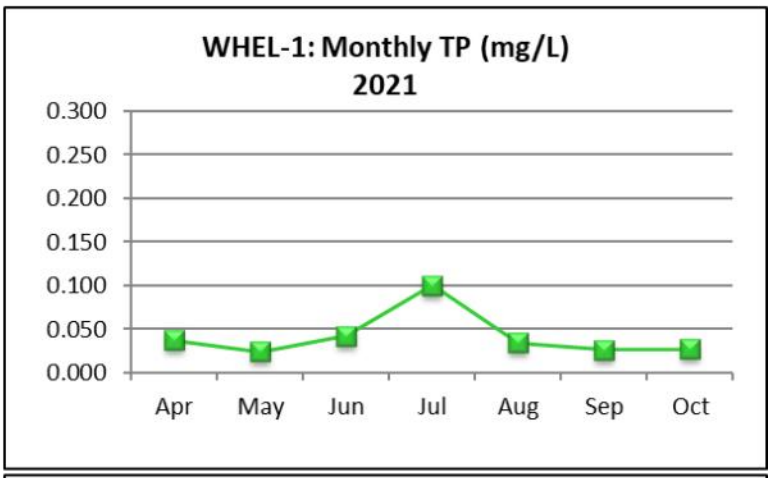


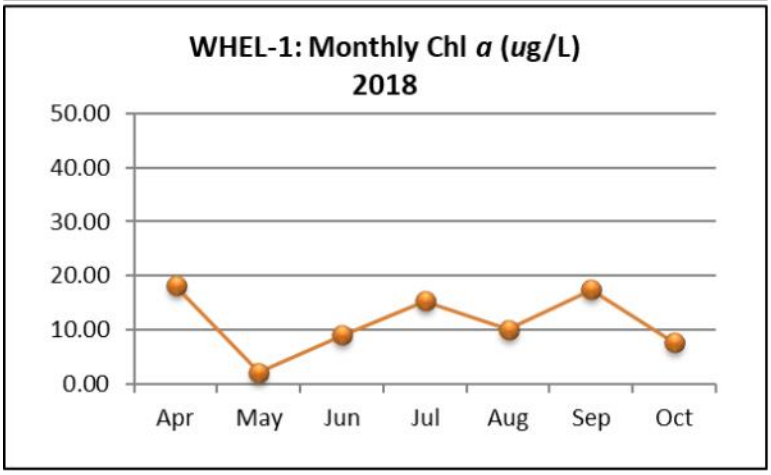
Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Paint Rock River (Wheeler Lake) embayment (WHEL-1)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

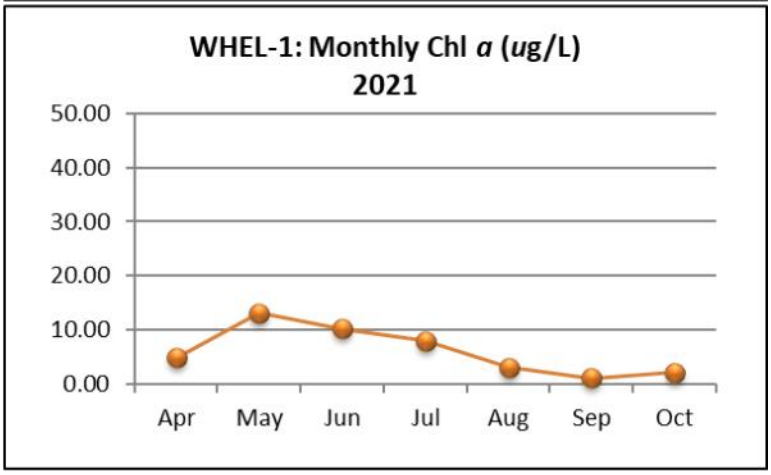


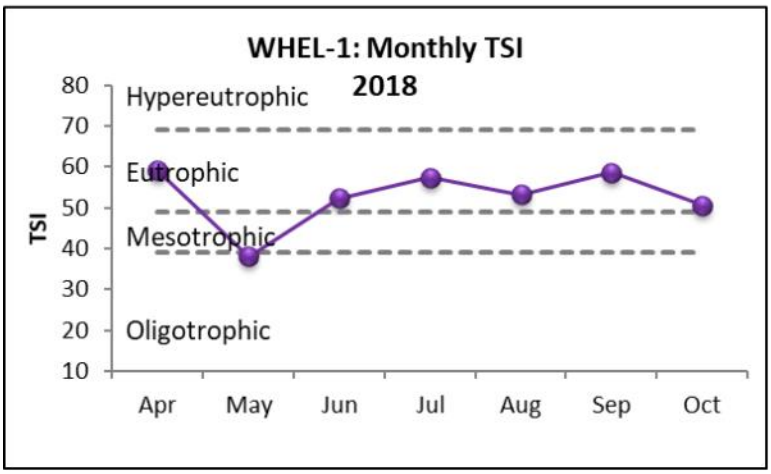












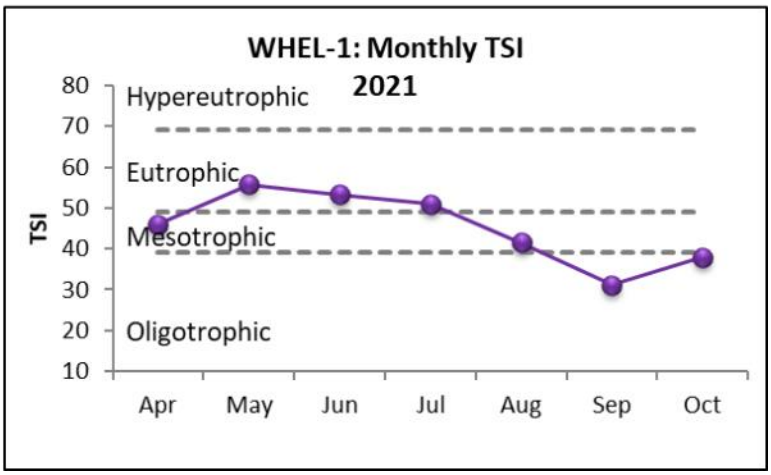


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Paint Rock River (Wheeler Lake) embayment (WHEL-1)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

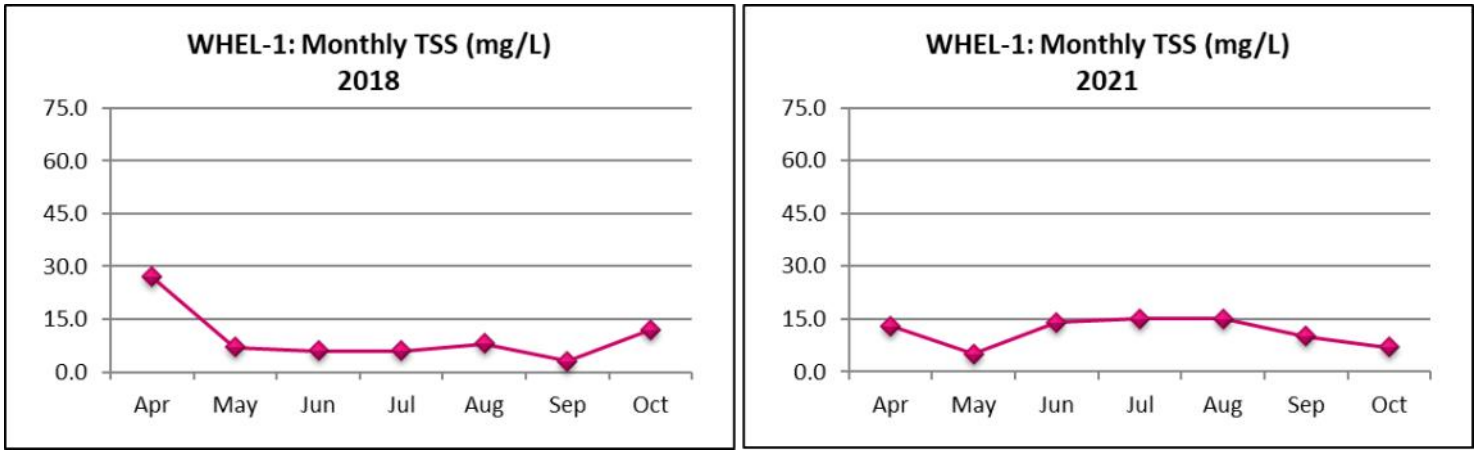


Figure 6. Monthly TSS measured in the Paint Rock River (Wheeler Lake) embayment (WHEL-1) in 2018 and 2021.

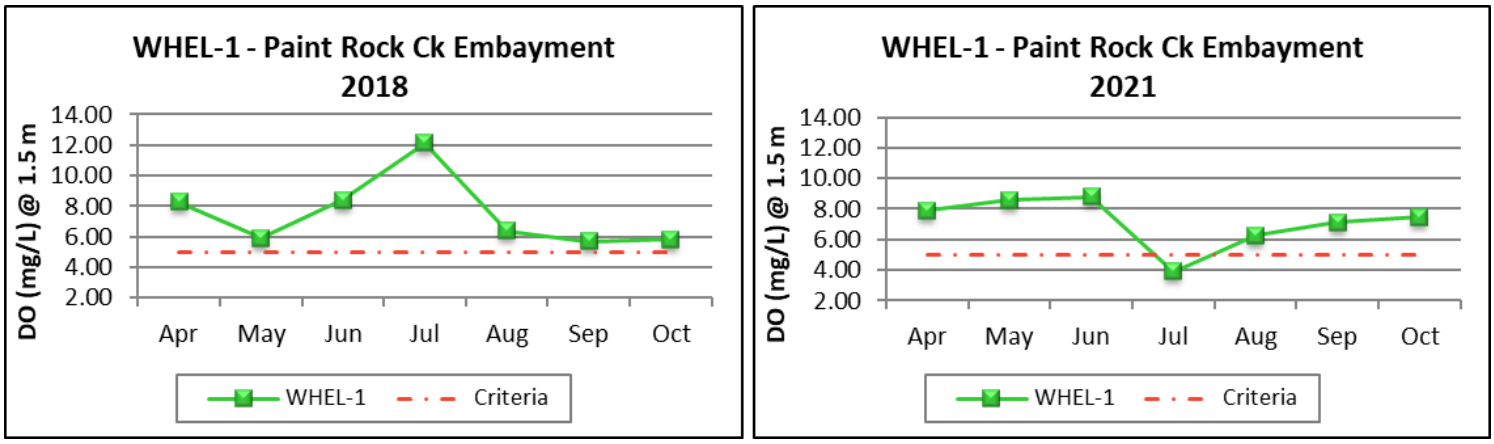


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Paint Rock River (Wheeler Lake) embayment (WHEL-1) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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