Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Spring Creek Embayment Wheeler Reservoir Intensive Basin Survey 2018 & 2021

WHEL-9: Spring Creek approx. 0.5 mi upstream of County Road 400 bridge (Lawrence Co 34.72263-87.28049)

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 Spring 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 Spring Creek (Wheeler Lake) embayment (WHEL-9) 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.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Spring 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 17 mi^2 watershed is predominantly cultivated crops (Figure 3). As of February 13, 2024, ADEM has issued no permits for NPDES outfalls within the watershed (Figure 2).

Figure 1. Spring Creek (Wheeler Lake) at WHEL-9.

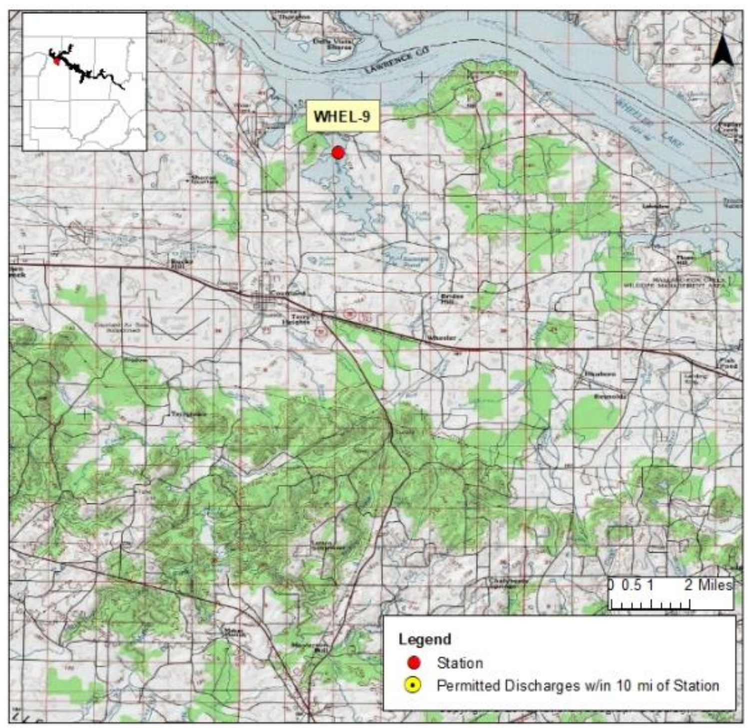

Figure 2. Map of the Spring Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

Table 1. Summary of Watershed		**WHEL-9**
Basin		Tennessee R
Assessment Unit		AL06030002-1201-111
Drainage Area (mi^2)		17
Ecoregion[a]		71g
% Landuse		
Open Water		8%
Developed	Open Space	2%
	Low Intensity	1%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	5%
	Evergreen Forest	3%
	Mixed Forest	2%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		6%
Cultivated Crops		58%
Wetlands	Woody	9%
	Emergent Herb.	1%
# NPDES outfalls[b]	TOTAL	0

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

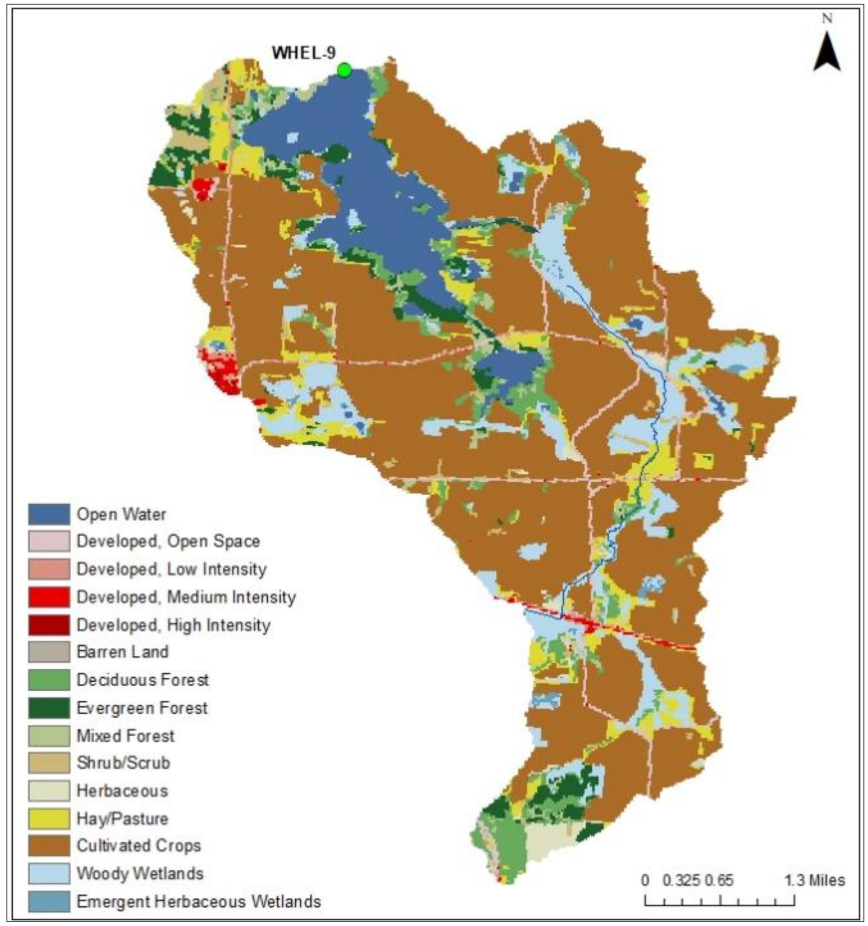

Figure 3. Land use within the Spring Creek (Wheeler Lake) watershed at WHEL-9.

SITE DESCRIPTION

The Spring Creek (Wheeler Lake) embayment at WHEL-9 is located near the community of Courtland, AL, halfway between Florence and Decatur. It is a narrow, deep embayment which flows into the Tennessee River near river mile 283. Spring Creek (Wheeler Lake) had a mean bottom depth of 8.4m in 2018 and 7.8m in 2021 at the sampling location (Table 2). The water column is fairly clear at this site most of the year.

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 2003 to 2013 but declined 2015 to 2021 (Figure 4). Monthly TN concentrations were highest in May in both 2018 and 2021 (Figure 5).

Mean growing season TP concentrations decreased 2003 to 2015, but the mean calculated for 2018 was almost three times that of 2015, similar to conditions observed in 2003 (Figure 4). The mean TP decreased slightly in 2021. The highest monthly TP value was observed in April in 2018 (Figure 5). In 2021, monthly TP concentrations were <0.05 mg/L throughout the growing seasons.

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-9 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	3.4	8.7	5.6	5.8	2.2
Total Dissolved Solids (mg/L)	7	56.0	99.0	84.0	82.0	13.7
Total Suspended Solids (mg/L)	7	2.0	8.0	6.0	5.3	2.1
Hardness (mg/L)	4	57.1	66.8	62.5	62.2	4.0
Alkalinity (mg/L)	7	54.3	75.2	61.2	62.7	6.8
Photic Zone (m)	7	2.86	5.45	3.89	4.04	1.01
Secchi (m)	7	0.92	1.93	1.16	1.30	0.35
Bottom Depth (m)	7	8.0	8.8	8.6	8.4	0.4
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.045	0.004	0.010	0.016
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.004	0.452	0.044	0.116	0.169
Total Kjeldahl Nitrogen (mg/L)	7	0.279	0.852	0.388	0.480	0.208
Total Nitrogen (mg/L)[J]	7	< 0.927	2.787	0.551	0.597	0.229
Dis Reactive Phosphorus (mg/L)	7	< 0.004	0.032	0.010	0.014	0.013
Total Phosphorus (mg/L)	7	0.016	0.074	0.046	0.041	0.021
CBOD-5 (mg/L)	7	< 2.0	4.0	2.1	2.3	1.1
Chlorides (mg/L)	7	6.1	7.9	6.4	6.7	0.7
Biological						
Chlorophyll a (mg/m³)	7	1.07	20.30	6.23	8.29	6.07
E. coli (MPN/DL)[J]	4	< 1	< 1	1	1	0

WHEL-9 2021	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	3.6	8.7	4.0	5.1	1.9
Total Dissolved Solids (mg/L)[J]	7	65.0	90.0	82.0	81.3	8.6
Total Suspended Solids (mg/L)[J]	7	3.0	9.0	5.0	5.3	2.2
Hardness (mg/L)	4	61.9	72.0	68.2	67.6	4.2
Alkalinity (mg/L)[J]	7	56.4	63.9	62.2	60.8	3.1
Photic Zone (m)	7	3.61	5.84	5.04	4.66	0.82
Secchi (m)	7	0.97	1.48	1.35	1.32	0.18
Bottom Depth (m)	7	7.0	8.4	8.1	7.8	0.5
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	0.331	0.005	0.097	0.148
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.324	1.220	0.162	0.380	0.387
Total Nitrogen (mg/L)[J]	7	< 0.495	3.669	0.438	0.477	0.352
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.026	0.005	0.007	0.008
Total Phosphorus (mg/L)	7	0.021	0.045	0.032	0.035	0.008
CBOD-5 (mg/L)[J]	7	< 2.0	2.8	1.0	1.7	0.8
Chlorides (mg/L)	7	4.7	6.6	5.5	5.6	0.7
Biological						
Chlorophyll a (mg/m³)	7	10.10	31.00	17.40	18.30	7.92
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 increased slightly from 2003 to 2013 but decreased by half in 2015 (Figure 4). The 2018 mean remained low, but mean chl *a* returned to pre-2015 conditions in 2021. In 2018, monthly chl *a* concentrations were highest in May (Figure 5). September was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Spring Creek (Wheeler Lake) embayment has been eutrophic every sampling year (Figure 4). In 2018, monthly TSI calculations indicated that the embayment fluctuated between eutrophic and mesotrophic conditions throughout the growing season (Figure 5). In 2021, the site was eutrophic in all months sampled.

Mean growing season TSS concentrations have been <10 mg/L in all years sampled, and the means calculated for 2018 and 2021 were the same (Figure 4). In both 2018 and 2021, monthly TSS concentrations were consistently low throughout the growing season (Figure 6). The highest monthly value was observed in August (8 mg/L) in 2018 and in May (9 mg/L) in 2021.

AGPT results show that Spring Creek (Wheeler Lake) was co-limiting in 2003 and 2009 and nitrogen-limited in 2013 (Table 3). The 2003 and 2009 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. While the 2013 sample was >5.0 mg/L, it was 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-9 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 showed super-saturated DO conditions with concentrations >13.0 mg/L (Figure 7). DO reached 13.23 mg/L in September 2018 and 15.08 mg/L in May 2021.

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	2.24	Co-limiting
2009	2.37	Co-limiting
2013	7.71	Nitrogen

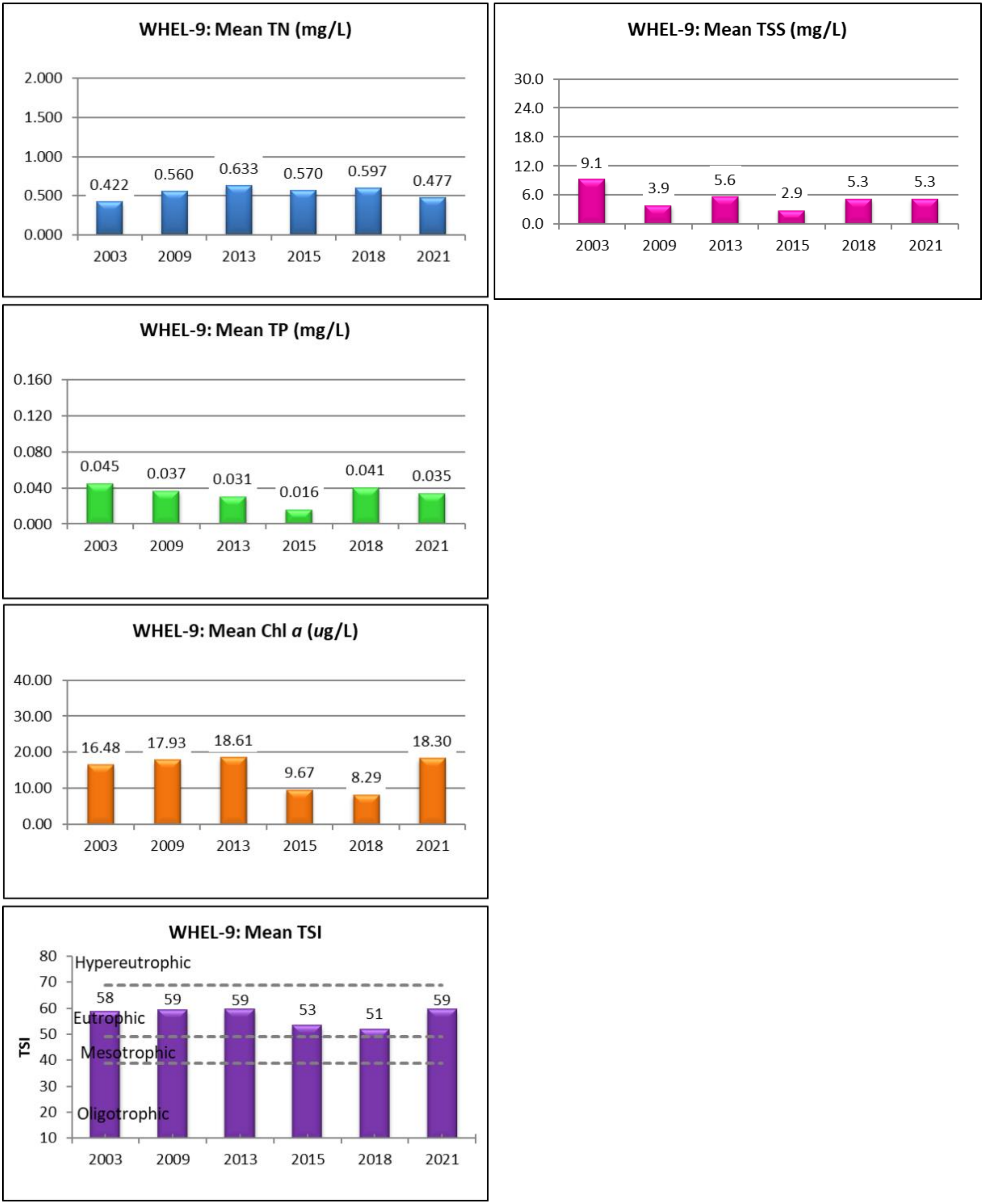

Figure 4. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Spring Creek (Wheeler Lake) embayment (WHEL-9)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Spring Creek (Wheeler Lake) embayment (WHEL-9)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

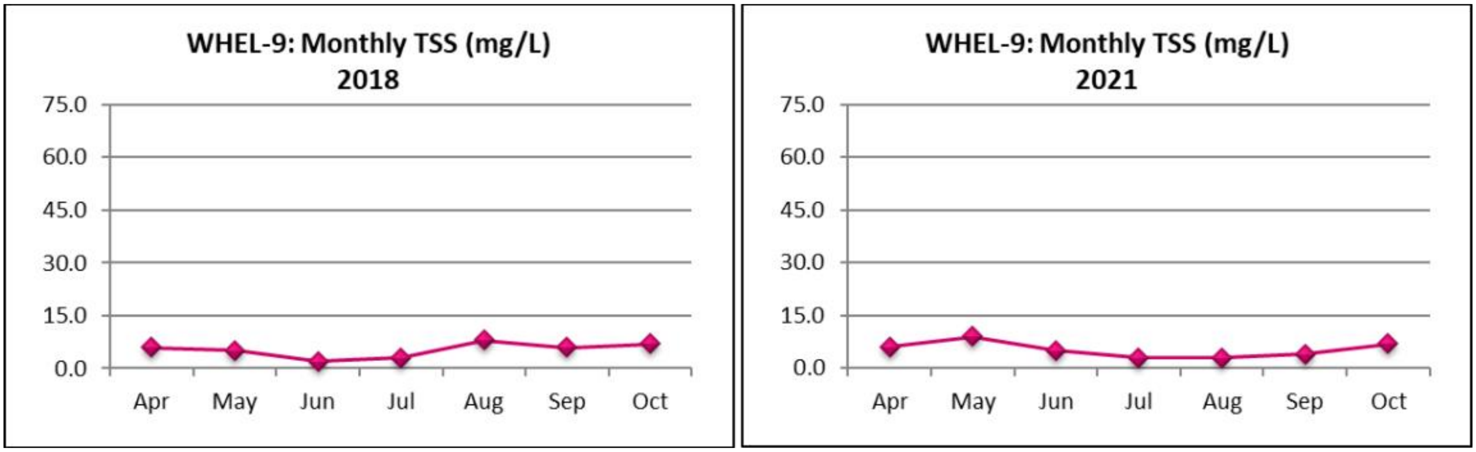

Figure 6. Monthly TSS measured in the Spring Creek (Wheeler Lake) embayment (WHEL-9) in 2018 and 2021**.**

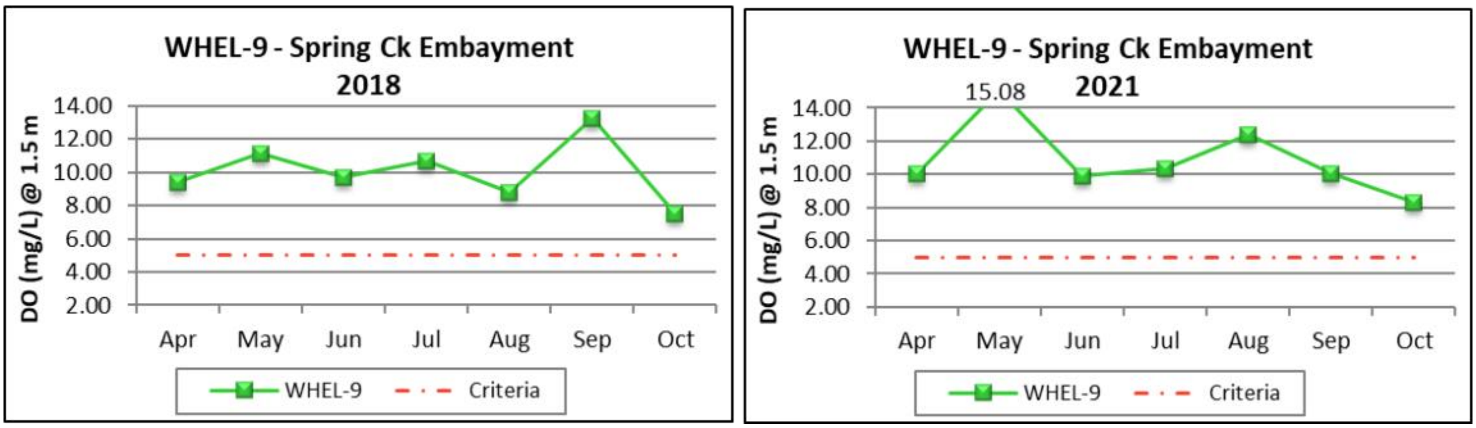

Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Spring Creek (Wheeler Lake) embayment (WHEL-9) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

REFERENCES

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