Rivers and Reservoirs Monitoring Program

Tennessee River Basin

Bakers Creek Embayment Wheeler Reservoir Intensive Basin Survey 2018 & 2021

WHEL-11: Bakers Creek upstream of confluence with Tennessee River (Morgan Co 34.63767/-87.02961)

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 Bakers 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 Bakers Creek (Wheeler Lake) embayment (WHEL-11) 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.

A fish consumption advisory for PFOS was issued by the Alabama Department of Public Health (ADPH) in 2014 based on fish tissue data collected by ADEM at WHEL-11. Therefore, as an indication of an impaired use, Bakers Creek (Wheeler Lake) from the confluence with the Tennessee River (Wheeler Lake) upstream to the end of the embayment was listed on ADEM's 2016 §303(d) list of impaired waterbodies.

Figure 1. Bakers Creek (Wheeler Lake) at WHEL-11.

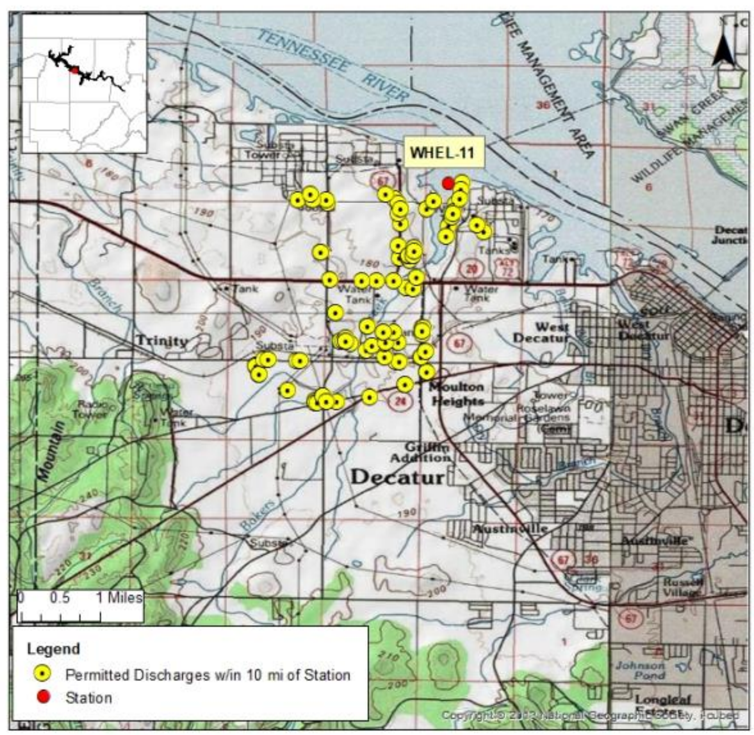


Figure 2. Map of the Bakers Creek (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Bakers Creek (Wheeler Lake) embayment is classified *Swimming/Fish & Wildlife (S/F&W)* and located in the Eastern Highland Rim ecoregion (71g). Based on the 2021 National Land Cover Dataset, land use within the 15 mi^2 watershed is predominantly developed (38%) with some pastureland (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 90 NPDES outfalls within the watershed (Figure 2).

Table 1. Summary of Watershed **WHEL-11**

Basin		Tennessee R
Assessment Unit		AL06030002-1102-211
Drainage Area (mi^2)		15
Ecoregion[a]		71g
% Landuse		
Open Water		2%
Developed	Open Space	10%
	Low Intensity	13%
	Medium Intensity	11%
	High Intensity	4%
Barren Land		<1%
Forest	Deciduous Forest	8%
	Evergreen Forest	3%
	Mixed Forest	2%
Shrub/Scrub		1%
Herbaceous		1%
Hay/Pasture		25%
Cultivated Crops		11%
Wetlands	Woody	9%
	Emergent Herb.	1%
# NPDES outfalls[b]	TOTAL	90
Industrial General		55
Industrial Individual		28
State Indirect Discharge		7

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

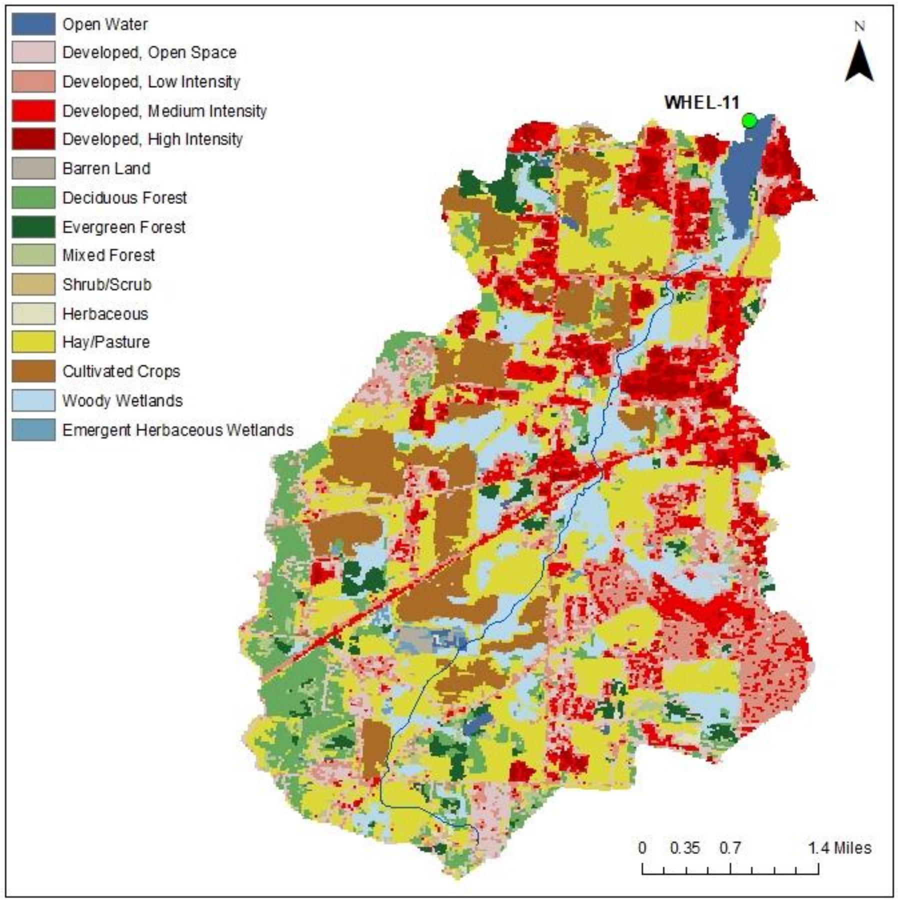


Figure 3. Land use within the Bakers Creek (Wheeler Lake) watershed at WHEL-11.

SITE DESCRIPTION

The Bakers Creek (Wheeler Lake) embayment at WHEL-11 is a small embayment, which flows into the south bank of the Tennessee River just downstream of Decatur, AL. Bakers Creek (Wheeler Lake) had a mean bottom depth of 1.7m in 2018 and 1.6m 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.

Mean growing season TN values increased 2009 to 2013, but they generally decreased since then (Figure 4). Monthly TN concentrations were highest in April in 2018 and in June in 2021 (Figure 5).

After very little variation from 2009 to 2018, mean growing season TP concentrations decreased to <0.10 mg/L for the first time in 2021 (Figure 4). The highest monthly TP value was observed in July 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-11 2018	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	7		9.8	22.5	14.0	14.9	4.3
Total Dissolved Solids (mg/L)	7		14.0	97.0	86.0	75.0	30.2
Total Suspended Solids (mg/L)[J]	7		10.0	15.0	11.0	11.9	1.7
Hardness (mg/L)	4		57.4	69.8	61.4	62.5	5.4
Alkalinity (mg/L)	7		54.7	68.3	59.9	60.8	4.8
Photic Zone (m)	7		1.40	1.80	1.80	1.72	0.15
Secchi (m)	7		0.55	0.95	0.84	0.79	0.14
Bottom Depth (m)	7		1.4	1.9	1.8	1.7	0.2
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.007	0.088	0.004	0.023	0.032
Nitrate+Nitrite Nitrogen (mg/L)	7		0.010	0.368	0.224	0.219	0.121
Total Kjeldahl Nitrogen (mg/L)	7	<	0.148	0.791	0.606	0.510	0.278
Total Nitrogen (mg/L)	7	<	0.951	3.261	0.705	0.729	0.285
Dis Reactive Phosphorus (mg/L)	7		0.047	0.201	0.104	0.115	0.049
Total Phosphorus (mg/L)	7		0.068	0.234	0.151	0.149	0.052
CBOD-5 (mg/L)	7	<	2.0	3.3	1.0	1.8	1.1
Chlorides (mg/L)	7		4.3	8.8	7.0	7.0	1.4
Biological							
Chlorophyll a (mg/m³)	7		1.53	20.30	8.54	9.10	7.44
E. coli (MPN/DL)	4		1	179	28	59	82
WHEL-11 2021	**N**		**Min**	**Max**	**Med**	**Avg**	**SD**
Physical							
Turbidity (NTU)	7		4.0	9.7	6.0	6.3	2.0
Total Dissolved Solids (mg/L)[J]	7		11.0	118.0	94.0	77.6	37.2
Total Suspended Solids (mg/L)[J]	7		4.0	12.0	8.0	7.0	3.1
Hardness (mg/L)	4		69.4	98.5	77.4	80.6	12.6
Alkalinity (mg/L)	7		57.8	89.6	66.2	69.4	10.0
Photic Zone (m)	7		1.02	1.81	1.65	1.55	0.26
Secchi (m)	7		0.55	1.81	1.02	1.05	0.42
Bottom Depth (m)	7		1.0	1.8	1.6	1.6	0.3
Chemical							
Ammonia Nitrogen (mg/L)	7	<	0.016	0.046	0.023	0.021	0.006
Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.308	0.041	0.102	0.123
Total Kjeldahl Nitrogen (mg/L)[J]	7	<	0.324	0.668	0.398	0.401	0.205
Total Nitrogen (mg/L)[J]	7	<	1.128	2.172	0.448	0.503	0.144
Dis Reactive Phosphorus (mg/L)[J]	7		0.007	0.118	0.031	0.055	0.044
Total Phosphorus (mg/L)	7		0.052	0.149	0.084	0.097	0.038
CBOD-5 (mg/L)[J]	7	<	2.0	2.9	1.0	1.5	0.8
Chlorides (mg/L)	7		5.4	8.1	5.7	6.2	1.0
Biological							
Chlorophyll a (mg/m³)	7	<	1.00	27.80	7.12	12.01	11.28
E. coli (MPN/DL)[J]	4		1	20	10	10	8

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

RESULTS (con't)

Mean growing season chl *a* concentrations increased 2003 to 2009 but decreased by nearly 1/3 in 2015 (Figure 4). Annual means have steadily increased since then. In 2018, monthly chl *a* concentrations were highest in June (Figure 5). August was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Bakers Creek (Wheeler Lake) embayment was eutrophic in every sampling year, except 2015, which was mesotrophic (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in the embayment from June-September (Figure 5). In 2021, the site fluctuated between eutrophic and mesotrophic conditions April-Setember but was oligotrophic in October.

Mean growing season TSS concentrations increased 2003 to 2009 but generally decreased since then (Figure 4). Monthly TSS concentrations were at or below 15 mg/L in all months sampled in both 2018 and 2021 (Figure 6).

AGPT results show that Bakers Creek (Wheeler Lake) was non-limiting in 2009 and nitrogen-limited in 2013 (Table 3). While both samples were above the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems, the 2013 value was below 20.0 mg/L MSC, which Raschke and Schultz define as protective of flowing stream and river systems. However, the 2009 sample was above that value also.

Dissolved oxygen (DO) concentrations at WHEL-11 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	21.18	Non-limiting
2013	14.69	Nitrogen

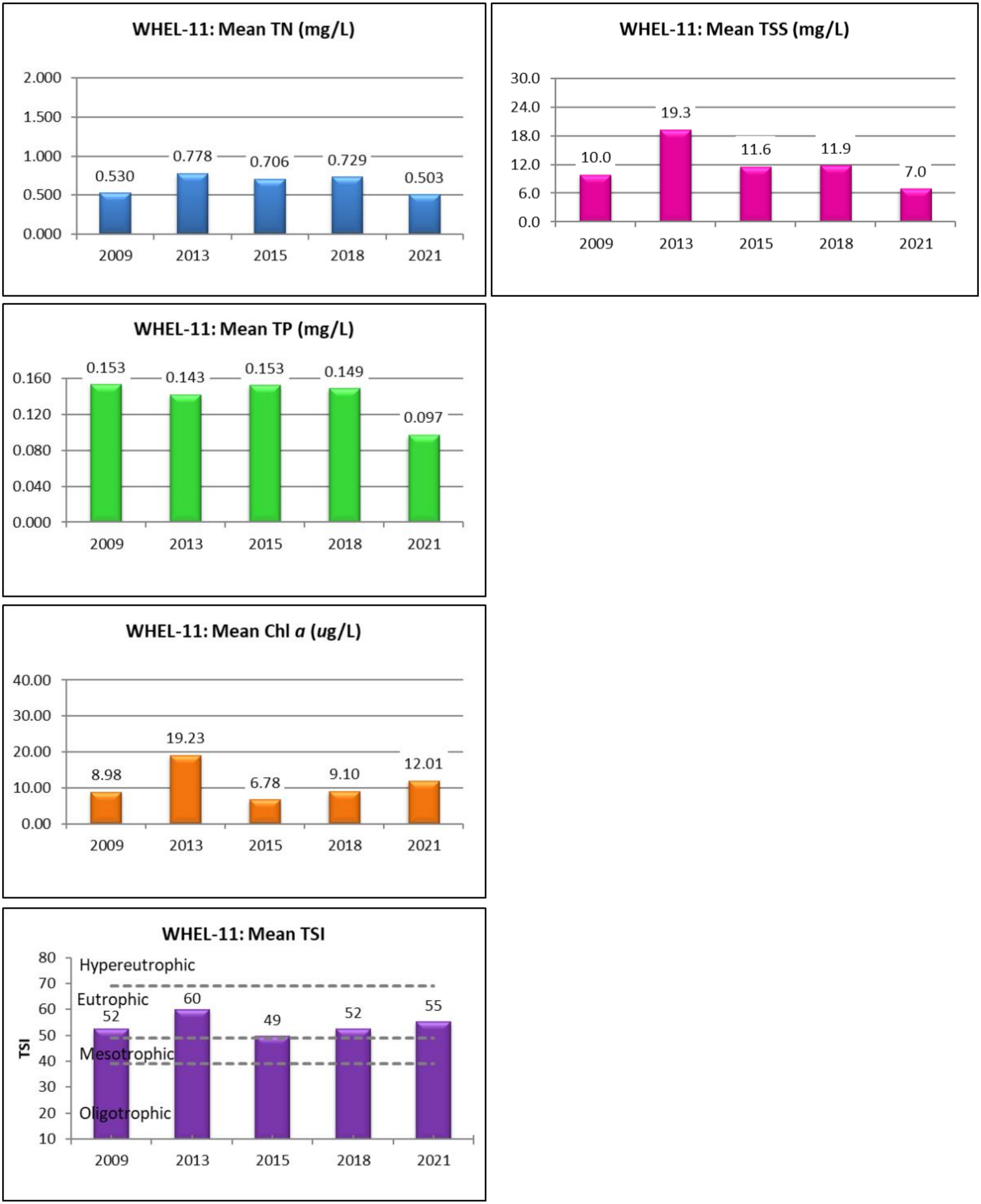


Figure 4. Mean growing season (2009-2021). TN, TP, chl *a,* and TSI measured in the Bakers Creek (Wheeler Lake) embayment (WHEL-11)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

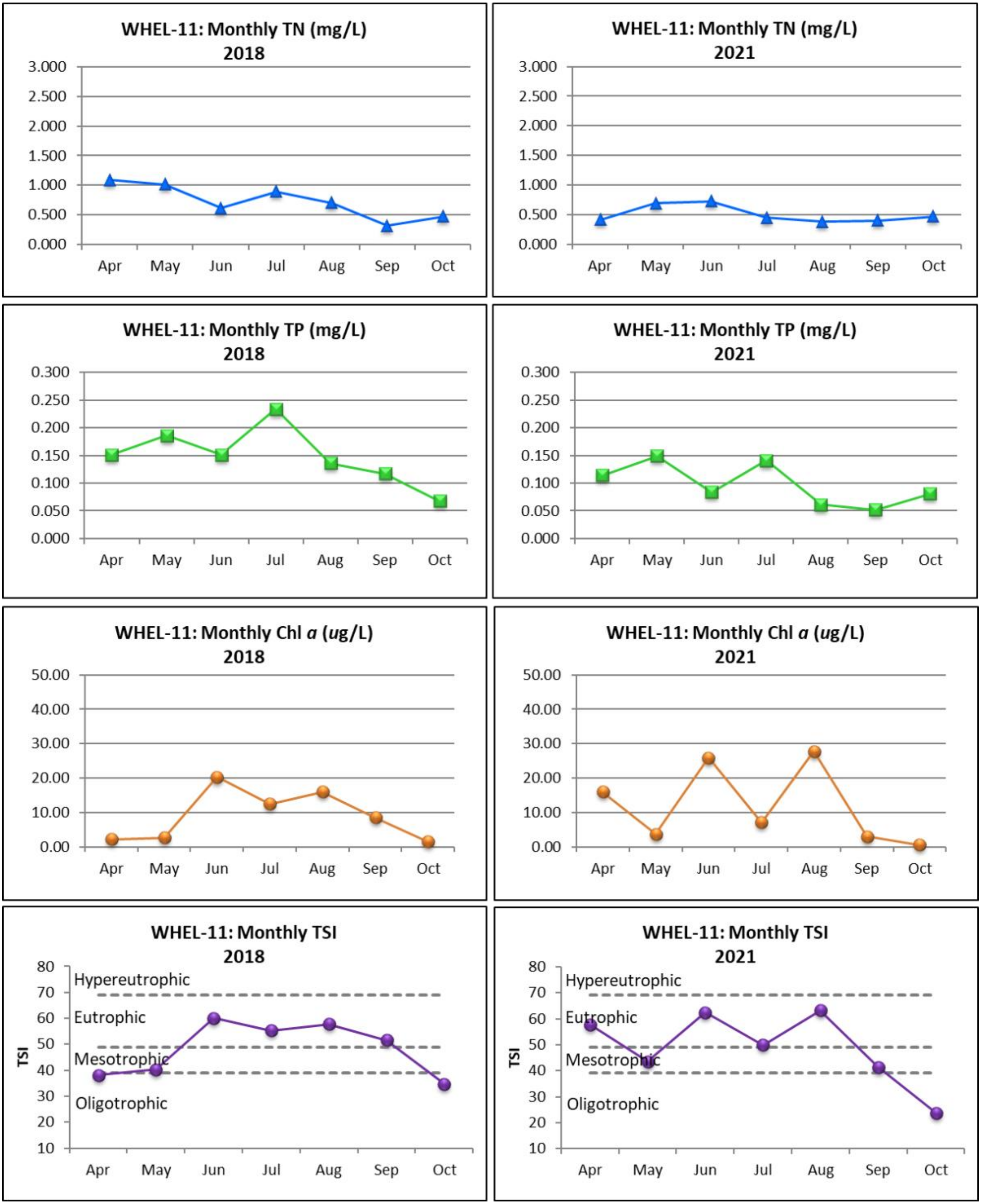
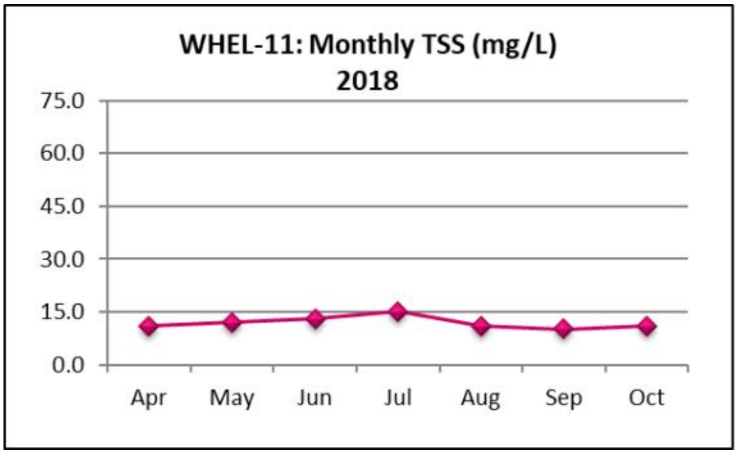


Figure 5. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Bakers Creek (Wheeler Lake) embayment (WHEL-11)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



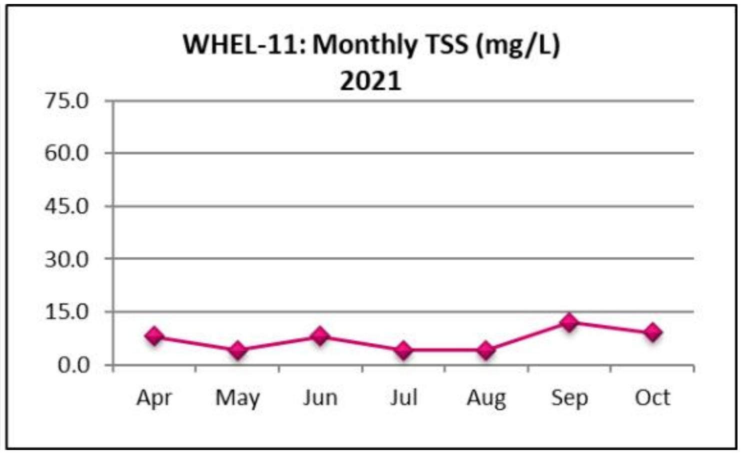
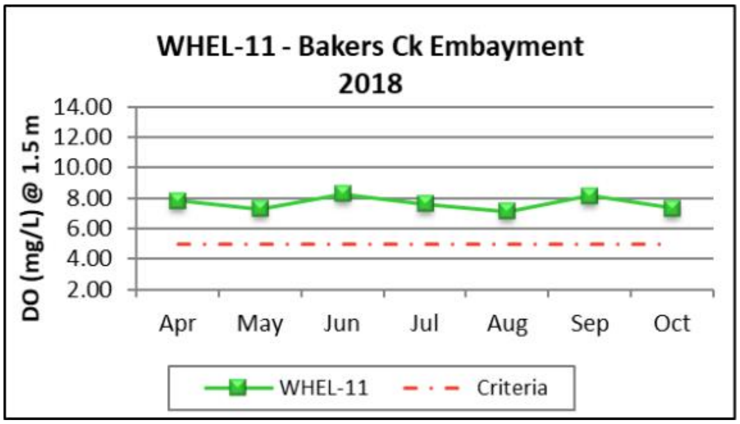


Figure 6. Monthly TSS measured in the Bakers Creek (Wheeler Lake) embayment (WHEL-11) in 2018 and 2021.



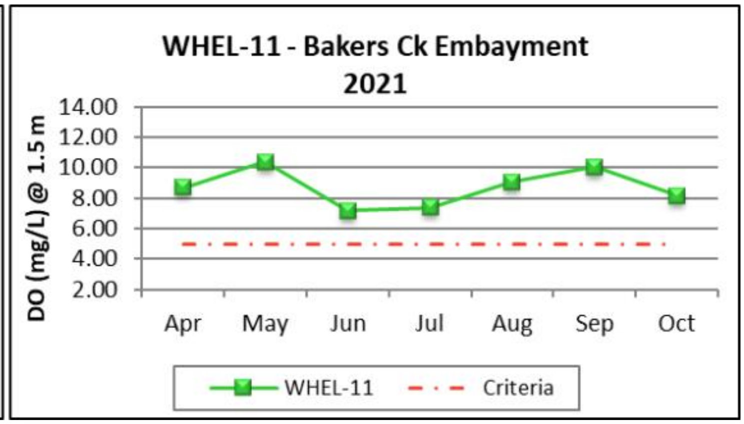


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Bakers Creek (Wheeler Lake) embayment (WHEL-11) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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