Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Shoal Creek Embayment
Wilson Reservoir
Intensive Basin Survey 2018 & 2020

WILL-4: Shoal Creek immediately upstream of US Hwy 72 bridge (Lauderdale Co 34.85183/-87.56932)

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 2020, ADEM monitored the Shoal Creek (Wilson 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 Shoal Creek (Wilson Lake) embayment (WILL-4) during the 2018 and 2020 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. Shoal Creek (Wilson Lake) at WILL-4.

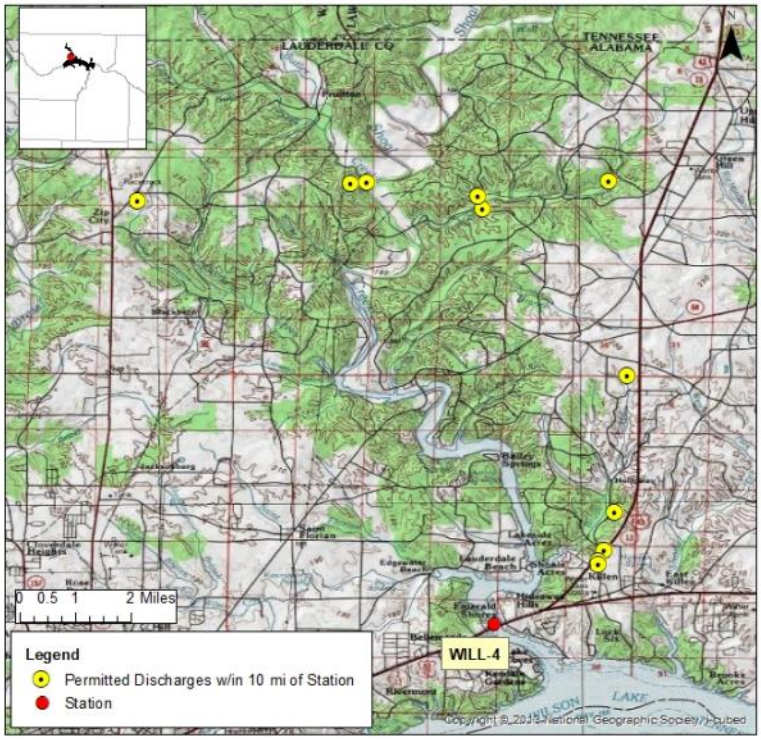


Figure 2. Map of the Shoal Creek (Wilson Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Shoal Creek (Wilson 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 490 mi^2 watershed is predominantly forest (55%) with some pastureland (Figure 3). As of February 13, 2024, ADEM has issued permits for ten NPDES outfalls within the watershed (Figure 2).

Table 1. Summary of Watershed **WILL-4**

Basin		Tennessee R
Assessment Unit		AL06030005-0509-101
Drainage Area (mi^2)		490
Ecoregion[a]		71f
% Landuse		
Open Water		<1%
Developed	Open Space	5%
	Low Intensity	2%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	44%
	Evergreen Forest	8%
	Mixed Forest	3%
Shrub/Scrub		3%
Herbaceous		2%
Hay/Pasture		25%
Cultivated Crops		7%
Wetlands	Woody	1%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	10
Mining		7
Industrial General		1
Municipal		2

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

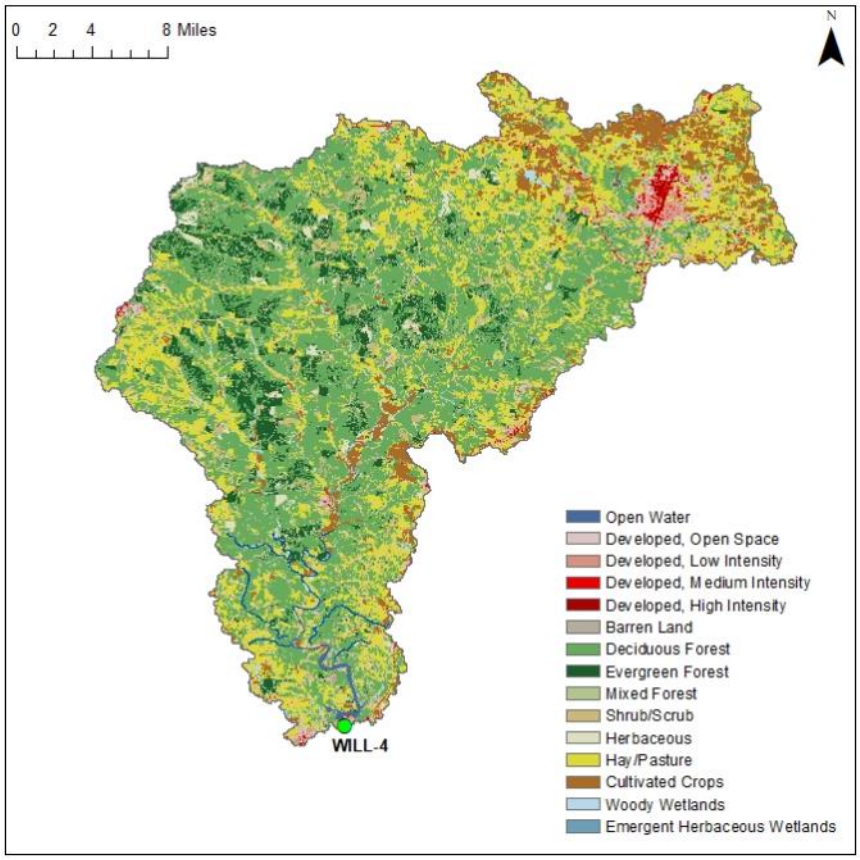


Figure 3. Land use within the Shoal Creek (Wilson Lake) watershed at WILL-4.

SITE DESCRIPTION

Shoal Creek (Wilson Lake) at WILL-4 is a deep, urbanized embayment located just east of Florence, AL. It had a mean bottom depth of 13.6m in 2018 and 2020 (Table 2) at the sampling location, which is located just upstream of US Highway 72. Residential houses and a marina surround the sampling site.

METHODS

Water quality assessments were conducted at monthly intervals, April-October in 2018. The 2020 sampling schedule was modified to accommodate Departmental precautions related to COVD-19 that occurred early in the sampling season. As a result, no water quality samples were collected in April and two samples were collected in October to account for the missed sampling event early in the season. In 2020, the early October chl *a* and TN samples were lost by the lab, so the 2020 means for these parameters are calculated from six monthly samples, not seven as is standard for all other growing season means. These modifications are noted in related graphs. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2020), 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 2020 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 have remained stable since 2003 (Figure 4). Monthly TN concentrations were highest in April in 2018 and in late October in 2020 (Figure 5).

Table 2. Summary of water quality data collected April-October, 2018 and 2020. 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.

WILL-4 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	6	2.5	6.7	5.9	5.2	1.8
Total Dissolved Solids (mg/L)	7	68.0	86.0	79.0	79.1	6.7
Total Suspended Solids (mg/L)	7	2.0	7.0	4.0	4.1	1.8
Hardness (mg/L)	4	57.8	69.8	63.3	63.6	5.0
Alkalinity (mg/L)	7	55.5	73.4	62.5	63.5	5.7
Photic Zone (m)	7	3.63	5.88	4.44	4.72	0.84
Secchi (m)	7	1.11	1.47	1.39	1.35	0.14
Bottom Depth (m)	7	13.4	13.9	13.6	13.6	0.2
Chemical						
Ammonia Nitrogen (mg/L)[J]	7	< 0.007	0.069	0.004	0.016	0.024
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.019	0.413	0.083	0.126	0.138
Total Kjeldahl Nitrogen (mg/L)[J]	7	0.133	0.561	0.310	0.333	0.151
Total Nitrogen (mg/L)[J]	7	0.456	2.355	0.496	0.460	0.213
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.037	0.017	0.017	0.012
Total Phosphorus (mg/L)	7	0.027	0.056	0.042	0.040	0.010
CBOD-5 (mg/L)	7	< 2.0	3.7	1.0	1.4	1.0
Chlorides (mg/L)	7	4.8	7.3	6.0	6.1	0.8
Biological						
Chlorophyll a (mg/m³)	7	0.53	15.00	7.48	8.63	5.33
E. coli (MPN/DL)[J]	4	1	62	3	17	30
WILL-4 2020	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	2.7	5.0	3.7	3.6	0.8
Total Dissolved Solids (mg/L)[J]	7	56.0	97.0	91.0	85.9	14.0
Total Suspended Solids (mg/L)[J]	7	3.0	93.0	4.0	17.0	33.5
Hardness (mg/L)	4	46.9	69.9	60.8	59.6	9.5
Alkalinity (mg/L)[J]	7	59.5	64.3	61.0	61.7	1.9
Photic Zone (m)	7	2.59	5.45	4.94	4.39	1.07
Secchi (m)	7	1.41	1.90	1.66	1.70	0.20
Bottom Depth (m)	7	12.9	14.4	13.4	13.6	0.6
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.044	< 0.044	0.022	0.022	0.000
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.029	0.250	0.066	0.102	0.090
Total Kjeldahl Nitrogen (mg/L)[J]	6	0.310	0.670	0.455	0.472	0.127
Total Nitrogen (mg/L)[J]	6	< 1.128	2.400	0.546	0.564	0.179
Total Phosphorus (mg/L)[J]	7	< 0.028	0.053	0.036	0.033	0.015
Chlorides (mg/L)[J]	7	4.3	6.8	5.2	5.5	1.0
Biological						
Chlorophyll a (mg/m³)[J]	6	3.20	21.40	15.65	14.19	7.37
E. coli (MPN/DL)[J]	4	< 1	12	1	4	6

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

RESULTS (con't)

Mean growing season TP concentrations decreased 2009 to 2015 and have remained stable since then (Figure 4). All monthly TP concentrations were <0.05 mg/L, except April in 2018 and early October in 2020 (Figure 5).

Mean growing season chl *a* concentrations decreased 2003 to 2018 but increased in 2020 (Figure 4). Monthly chl *a* concentrations were highest in May in 2018 and in May and July in 2020 (Figure 5).

According to mean annual TSI, the Shoal Creek (Wilson Lake) embayment was eutrophic in all years sampled (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in all months except April, which was oligotrophic, and July, which was mesotrophic (Figure 5). In 2020, the site was eutrophic in all months except late October, which was mesotrophic.

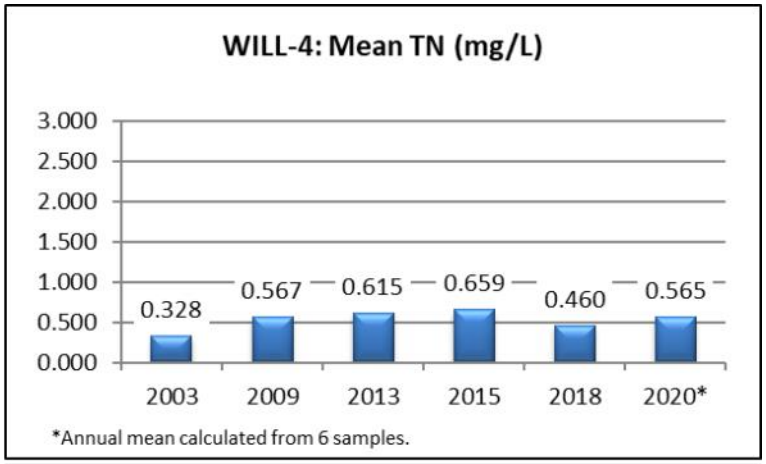
Mean growing season TSS concentrations decreased 2003 to 2015 but increased in 2018 and 2020 with the 2020 mean being the highest calculated for all sampling years (Figure 4). This elevated mean TSS value was due to a high monthly concentration observed at the site in September 2020. In 2018, all monthly TSS concentrations were <10 mg/L (Figure 6). In 2020, the highest monthly TSS value was measured in September. The September site visit was conducted after heavy precipitation in the area, which may have resulted in elevated TSS in the water column.

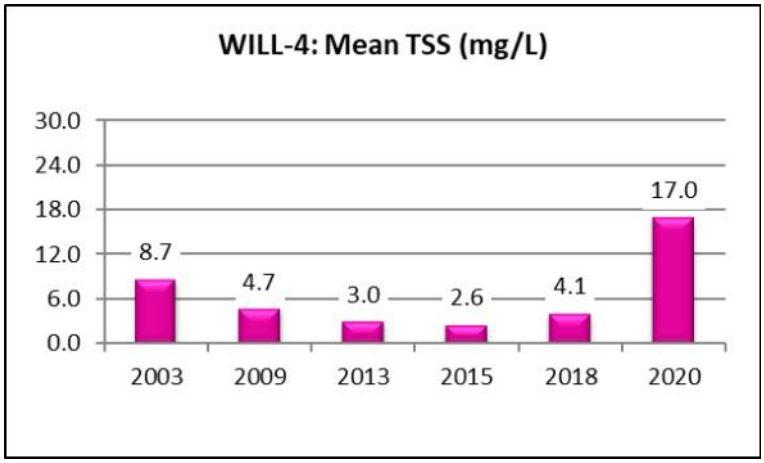
AGPT results show that Shoal Creek (Wilson Lake) was nitrogen-limited in all years sampled (Table 3). The 2003 and 2009 samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems. While the 2013 sample was above this 5.0 mg/L value, it was below 20.0 mg/L MSC, which they define as protective of flowing stream and river systems.

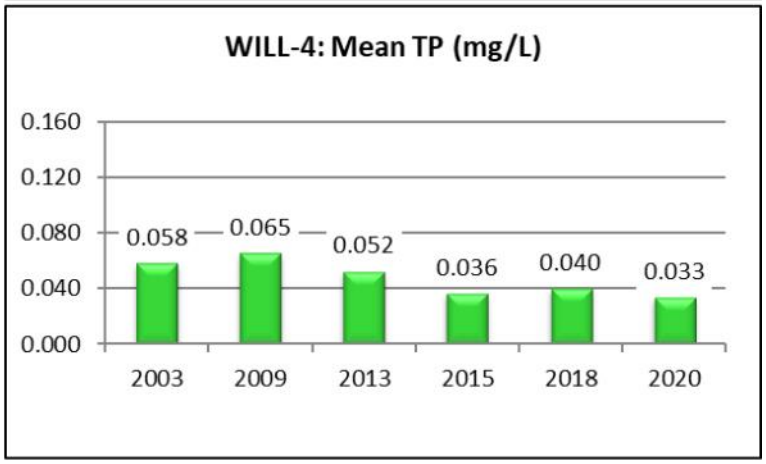
Dissolved oxygen (DO) concentrations at WILL-4 were at or above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2020 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

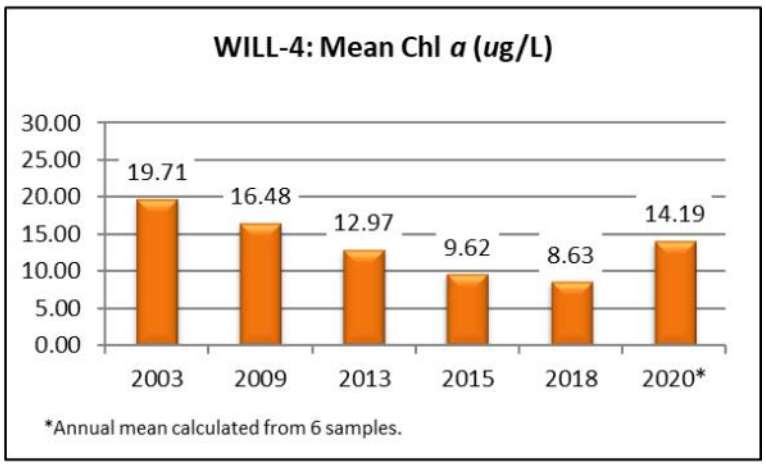
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	4.99	Nitrogen
2009	4.42	Nitrogen
2013	12.63	Nitrogen









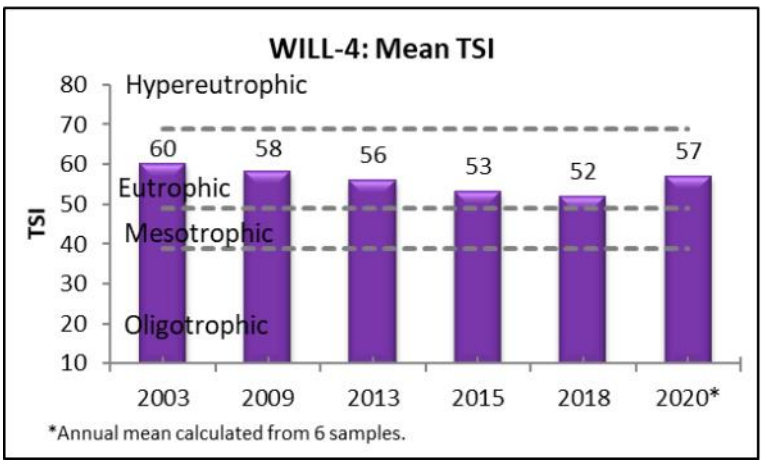
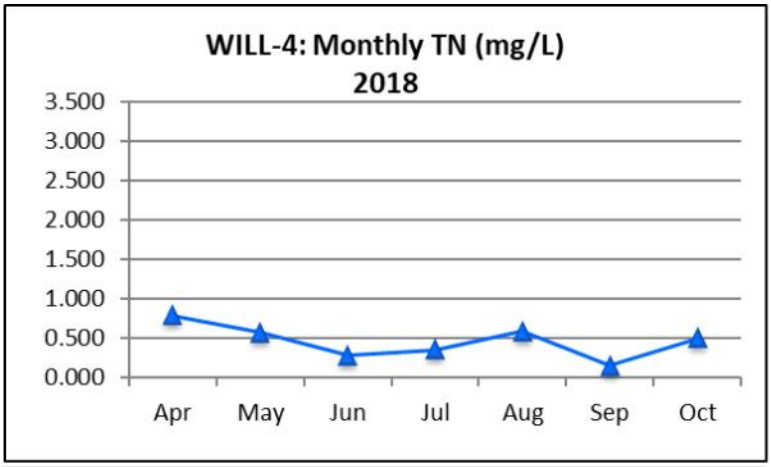
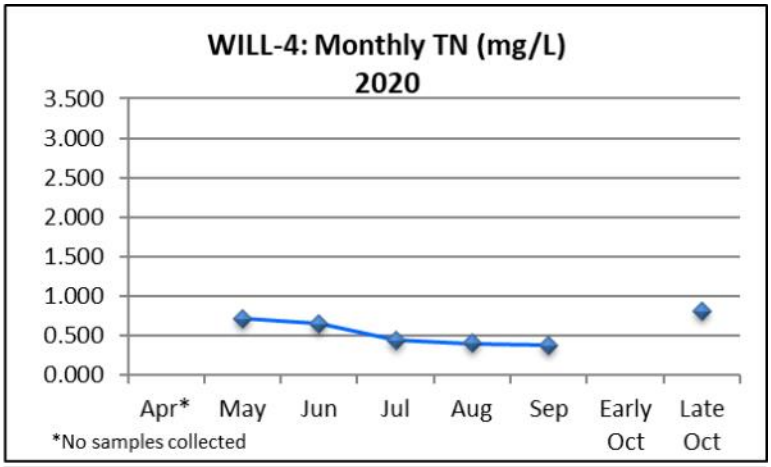
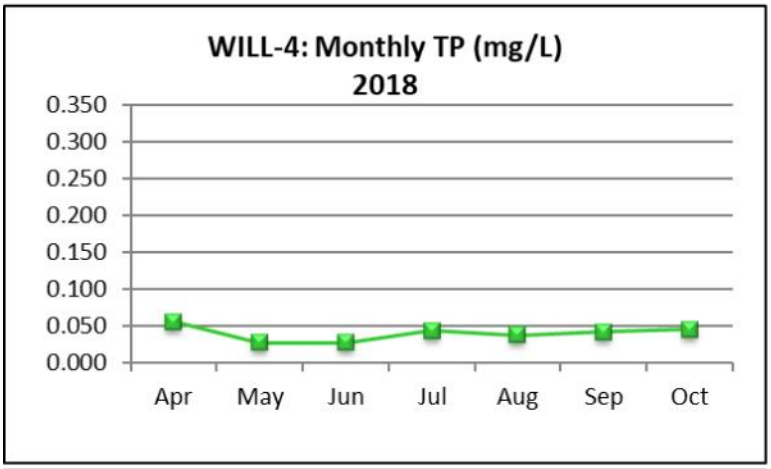
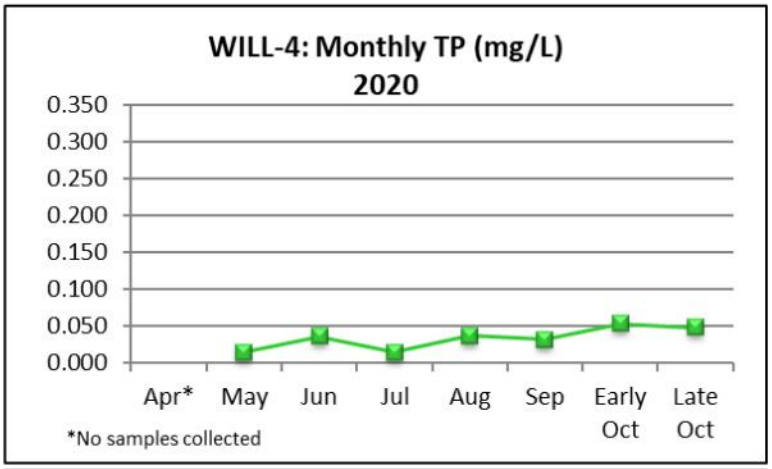


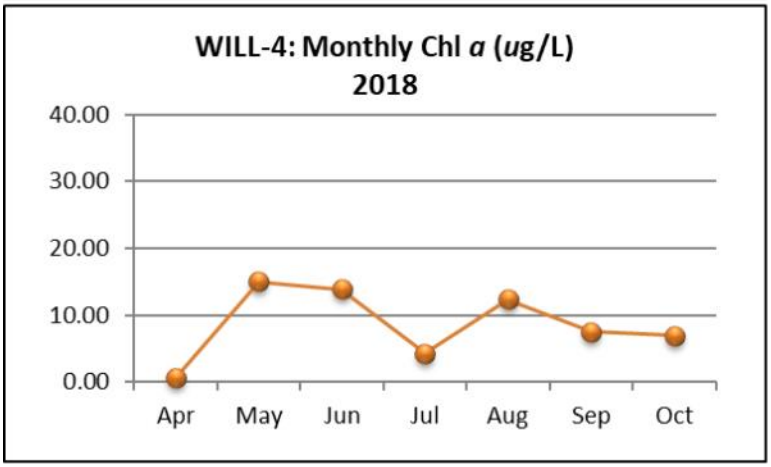
Figure 4. Mean growing season (2003-2020). TN, TP, chl *a,* and TSI measured in the Shoal Creek (Wilson Lake) embayment (WILL-4). Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

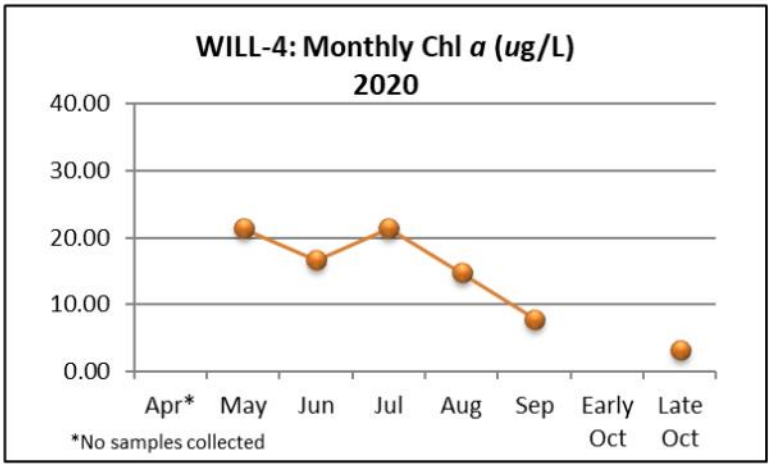


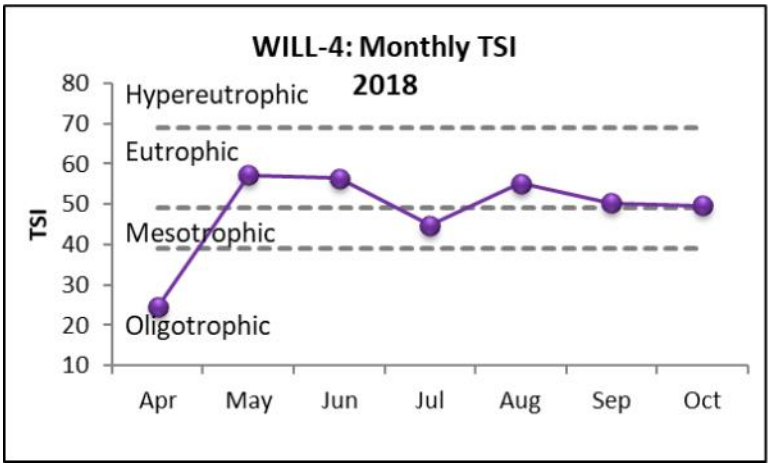












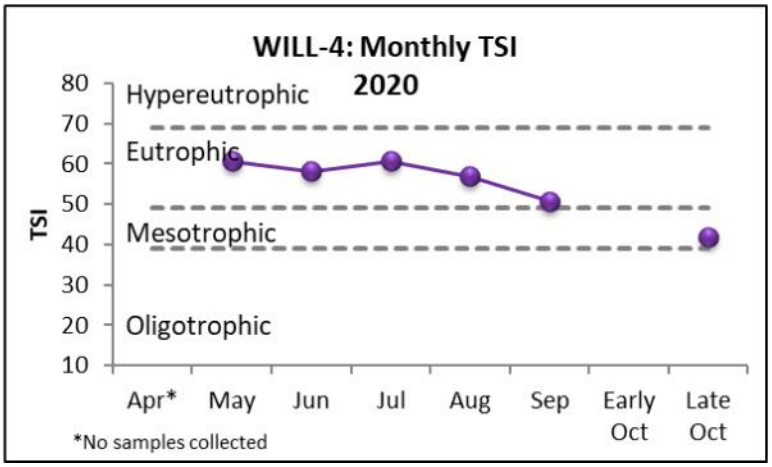


Figure 5. Monthly TN, TP, chl *a,* and TSI measured in the Shoal Creek (Wilson Lake) embayment (WILL-4)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

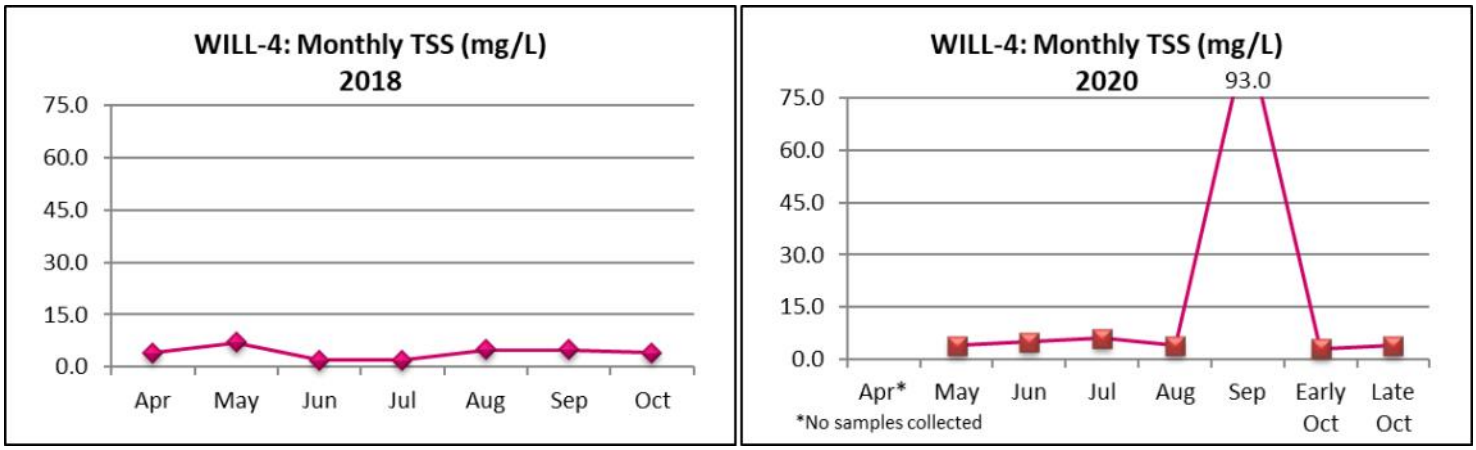


Figure 6. Monthly TSS measured in the Shoal Creek (Wilson Lake) embayment (WILL-4) in 2018 and 2020**.**

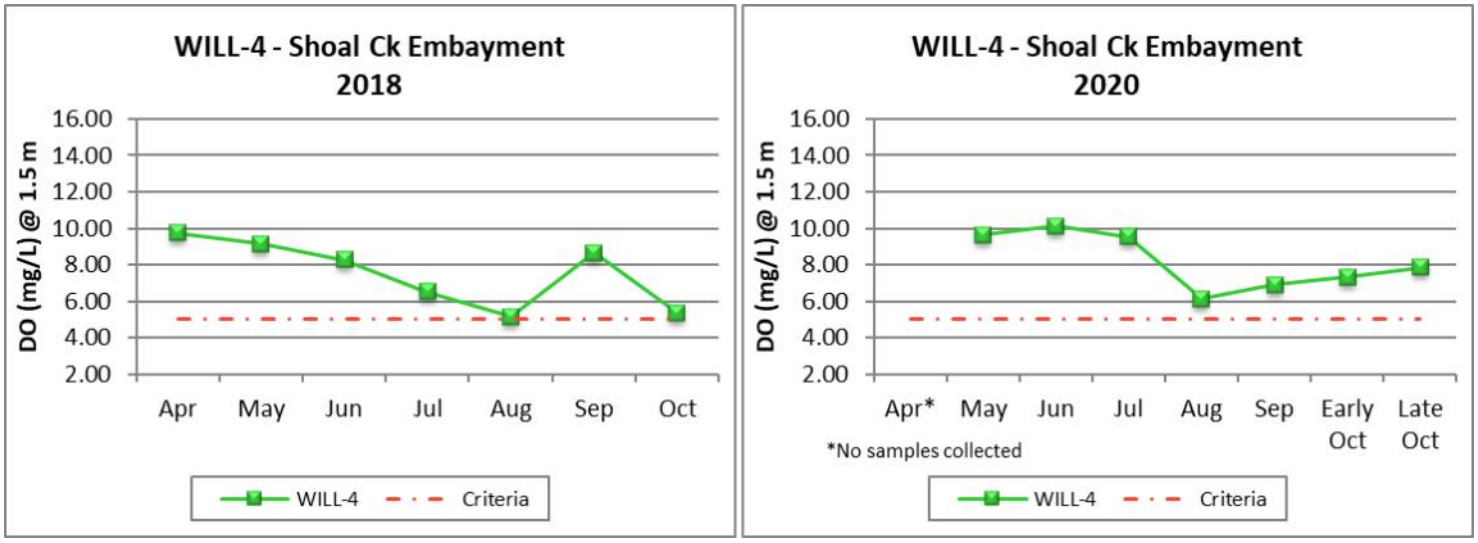


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Shoal Creek (Wilson Lake) embayment (WILL-4) collected in 2018 and 2020. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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