Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Spring Creek Embayment
Pickwick Reservoir
Intensive Basin Survey 2018 & 2020

PICL-2: Spring Creek approx. 1 mile upstream of Pickwick Reservoir confluence (Colbert Co 34.73944/-87.73083)

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 Spring Creek (Pickwick 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 (Pickwick Lake) embayment (PICL-2) 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.

In 2014, Spring Creek (Pickwick Lake) from the confluence with the Tennessee River (Pickwick Lake) upstream to the end of the embayment was listed on ADEM's §303(d) list of impaired waterbodies for not meeting its designated use with respect to nutrients. In 2022, Spring Creek (Pickwick Lake) was also listed on ADEM's §303(d) list for not meeting the pathogen criteria applicable to its designated use.

Figure 1. Spring Creek (Pickwick Lake) at PICL-2.

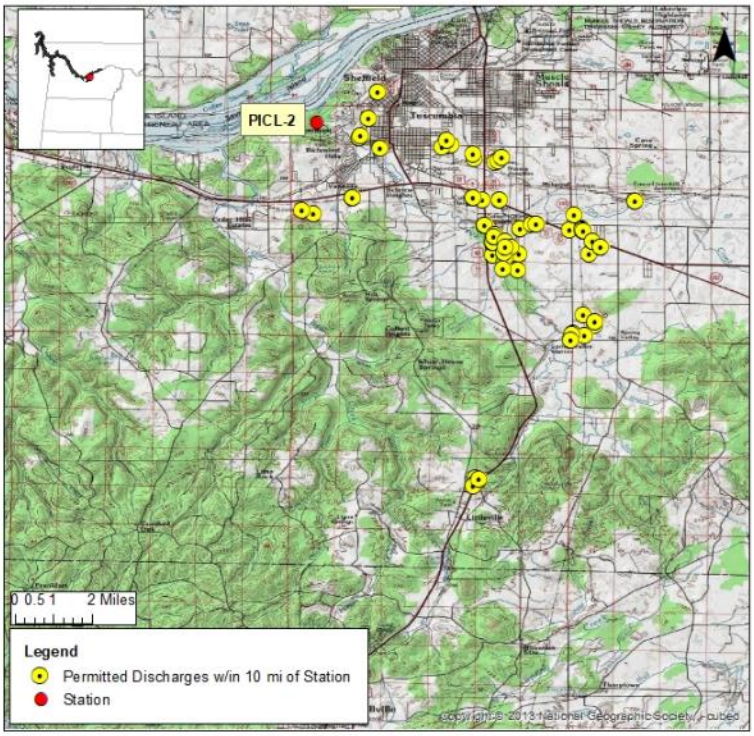


Figure 2. Map of the Spring Creek (Pickwick Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Spring Creek (Pickwick 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 107 mi^2 watershed is predominantly forest (33%), hay/pastureland, and cultivated crops (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 81 NPDES outfalls within the watershed. Several of those permits are located within 10 mi of the station (Figure 2).

Table 1. Summary of Watershed **PICL-2**

Basin		Tennessee R
Assessment Unit		AL06030005-0703-111
Drainage Area (mi^2)		107
Ecoregion[a]		71g
% Landuse		
Open Water		<1%
Developed	Open Space	6%
	Low Intensity	6%
	Medium Intensity	2%
	High Intensity	1%
Barren Land		<1%
Forest	Deciduous Forest	25%
	Evergreen Forest	4%
	Mixed Forest	4%
Shrub/Scrub		2%
Herbaceous		1%
Hay/Pasture		25%
Cultivated Crops		19%
Wetlands	Woody	5%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	81
Mining		4
Industrial General		61
Industrial Individual		11
Municipal		5
State Indirect Discharge		0

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

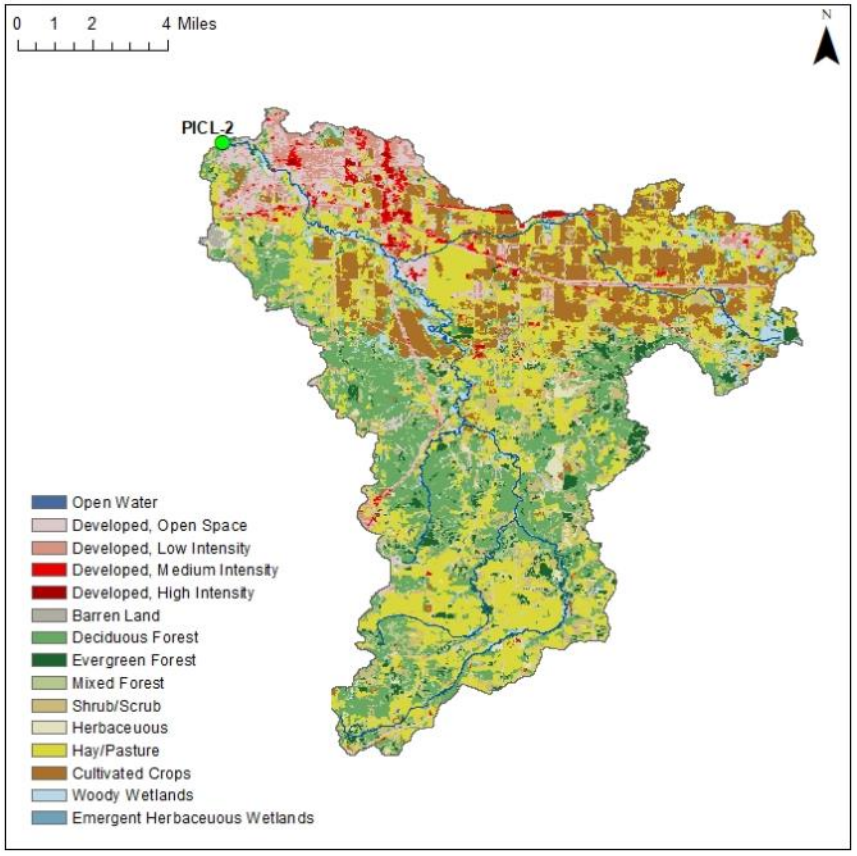


Figure 3. Land use within the Spring Creek (Pickwick Lake) watershed at PICL-2.

SITE DESCRIPTION

The Spring Creek (Pickwick Lake) embayment at PICL-2 is located just west of Sheffield/Tuscumbia, AL. It had a mean bottom depth of 3.6m in 2018 and 4.0m in 2020 (Table 2) at the sampling location and is dominated by filamentous algae in the spring and submerged vegetation, such as *Hydrilla sp.* and parrot's feather (*Myriophyllum aquaticum)* much of the summer.

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 May, and two samples were collected in the months of September and October to account for the missed sampling events early in the season. In 2020, the late September chl *a* sample was lost by the lab, so the 2020 mean is 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.

The mean growing season TN value measured in 2018 was the highest of all years sampled at PICL-2, but mean TN decreased in 2020 (Figure 4). Monthly TN concentrations were highest in June in 2018 and in early 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.

PICL-2 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	6	4.2	18.5	8.3	9.2	4.9
Total Dissolved Solids (mg/L)	7	154.0	219.0	182.0	183.9	26.1
Total Suspended Solids (mg/L)	7	5.0	14.0	9.0	9.1	3.1
Hardness (mg/L)	4	151.0	193.0	155.5	163.8	19.7
Alkalinity (mg/L)	7	117.0	186.0	147.0	149.3	27.3
Photic Zone (m)	7	2.10	3.96	3.20	3.11	0.64
Secchi (m)	7	0.53	1.82	0.75	0.88	0.44
Bottom Depth (m)	7	3.0	4.6	3.6	3.6	0.5
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.125	0.004	0.022	0.046
Nitrate+Nitrite Nitrogen (mg/L)	7	1.490	3.880	1.890	2.483	1.012
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.077	1.350	0.338	0.448	0.454
Total Nitrogen (mg/L)[J]	7	< 5.484	12.030	2.802	2.931	0.817
Dis Reactive Phosphorus (mg/L)[J]	7	0.009	0.089	0.023	0.029	0.027
Total Phosphorus (mg/L)	7	0.031	0.110	0.046	0.050	0.027
CBOD-5 (mg/L)[J]	7	< 2.0	8.0	1.0	2.2	2.6
Chlorides (mg/L)	7	4.5	9.7	6.3	7.2	1.9
Biological						
Chlorophyll a (mg/m³)	7	< 0.10	113.00	5.34	22.11	40.59
E. coli (MPN/DL)[J]	4	48	157	99	101	47
PICL-2 2020	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	5.7	10.4	8.0	8.0	1.9
Total Dissolved Solids (mg/L)	6	82.0	197.0	148.5	145.7	46.1
Total Suspended Solids (mg/L)	6	6.0	11.0	9.5	9.0	2.1
Hardness (mg/L)	4	75.1	157.0	104.6	110.3	39.5
Alkalinity (mg/L)	7	66.5	183.0	120.0	119.7	47.0
Photic Zone (m)	7	2.55	4.58	3.85	3.72	0.75
Secchi (m)	7	1.11	1.52	1.32	1.29	0.14
Bottom Depth (m)	7	2.6	4.7	4.3	4.0	0.7
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.044	0.044	0.022	0.022	0.000
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.197	3.660	2.520	1.975	1.361
Total Kjeldahl Nitrogen (mg/L)[J]	7	< 0.120	0.460	0.160	0.211	0.170
Total Nitrogen (mg/L)[J]	7	< 1.581	11.160	2.580	2.186	1.300
Total Phosphorus (mg/L)[J]	7	0.033	0.134	0.047	0.056	0.036
Chlorides (mg/L)	6	3.4	6.9	5.6	5.4	1.2
Biological						
Chlorophyll a (mg/m³)[J]	6	< 1.00	19.20	1.35	5.24	7.50
E. coli (MPN/DL)	4	41	411	76	151	175

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

RESULTS (con't)

The mean growing season TP concentration has been consistently near 0.05 mg/L since 2013 (Figure 4). In 2018, monthly TP concentrations were less than 0.05 mg/L all months sampled, except April (Figure 5). In 2020, the highest monthly TP concentration was observed in August.

Mean growing season chl *a* concentrations steadily increased from 2003-2018 (Figure 4). The growing season mean in 2020 was much lower, but spring monthly samples were not collected due to COVID protocols. Monthly chl *a* concentrations were highest in September of 2018, measuring 113 µg/L, and August 2020 (Figure 5).

The mean TSI indicates Spring Creek (Pickwick Lake) was eutrophic 2009-2018 and decreased to mesotrophic in 2020 (Figure 4). Monthly TSI calculations indicated the embayment reached hypereutrophic conditions in September of 2018 due to the high monthly chl a concentration measured that visit (Figure 5). In 2020, eutrophic conditions were reached in July and August.

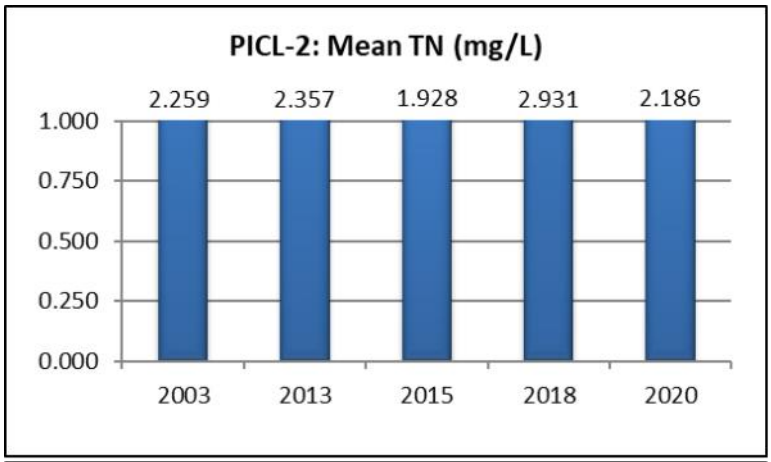
Mean growing season TSS concentrations decreased significantly since 2003 and 2009 and were <10 mg/L in 2018 and 2020 (Figure 4). In both 2018 and 2020, monthly TSS measurements were near or below 10 mg/L all months sampled (Figure 6).

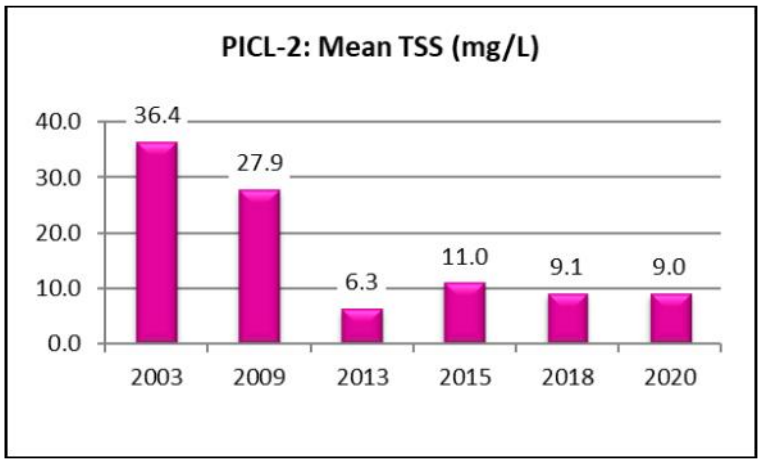
AGPT results show that Spring Creek (Pickwick Lake) was phosphorus-limited in all years that samples were collected (Table 3). While some samples were above the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems, samples were below 20.0 mg/L MSC, which they define as protective of flowing stream and river systems.

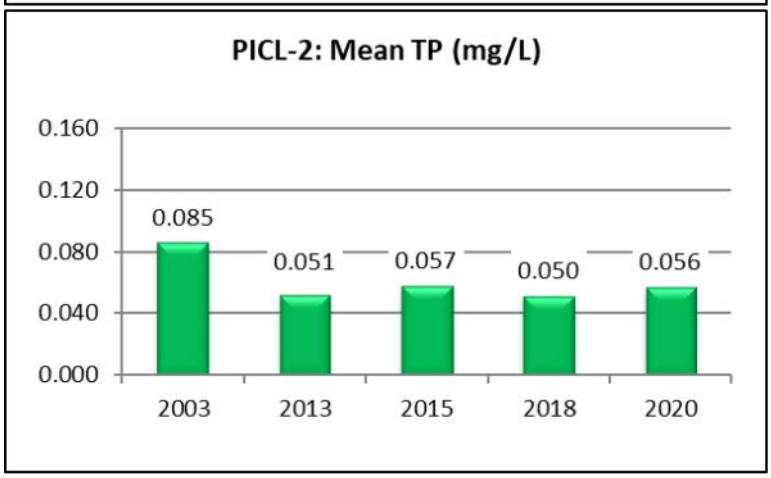
Dissolved oxygen (DO) concentrations at PICL-2 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2020 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

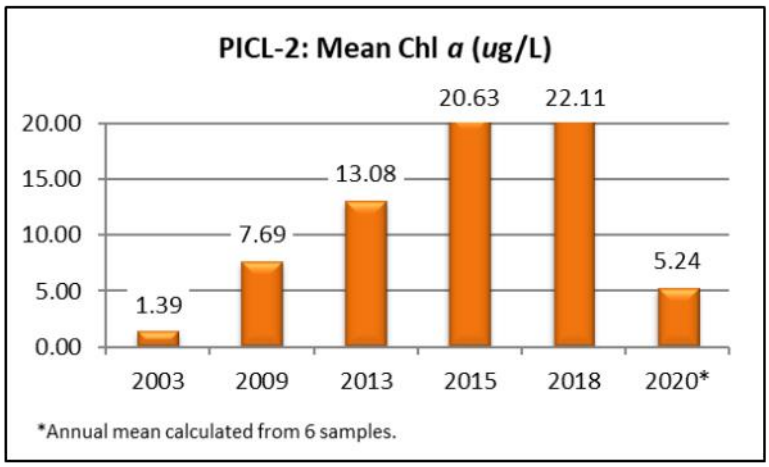
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	1.16	Phosphorus
2009	8.09	Phosphorus
2013	8.82	Phosphorus









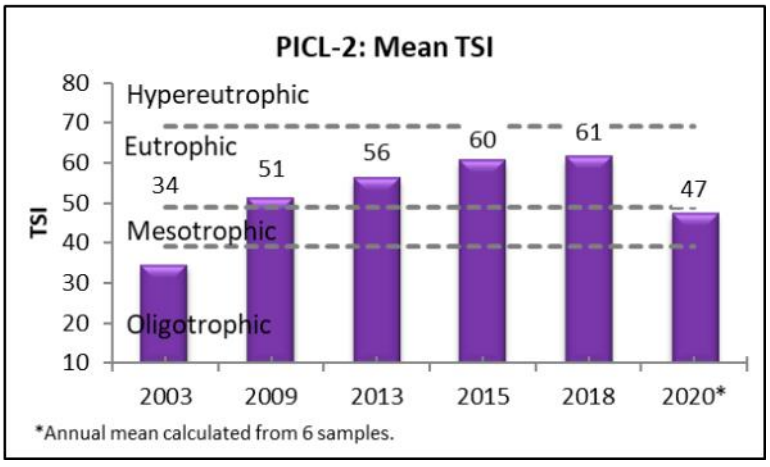
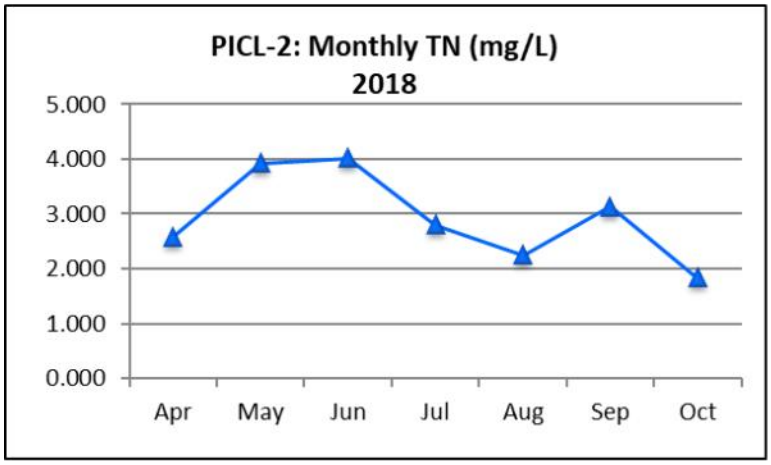
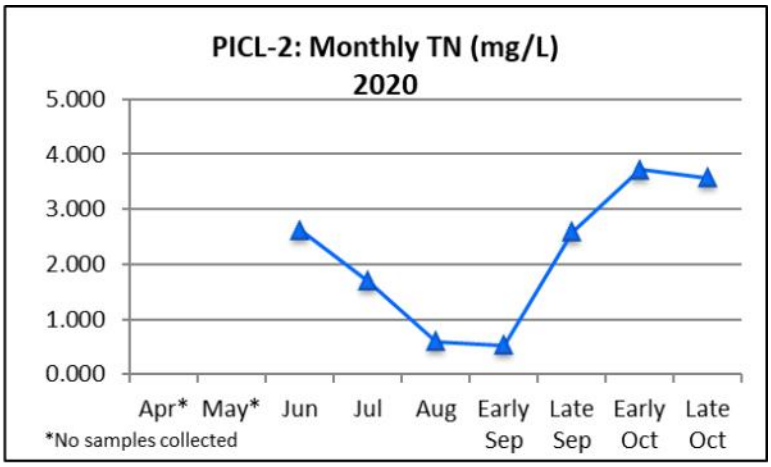
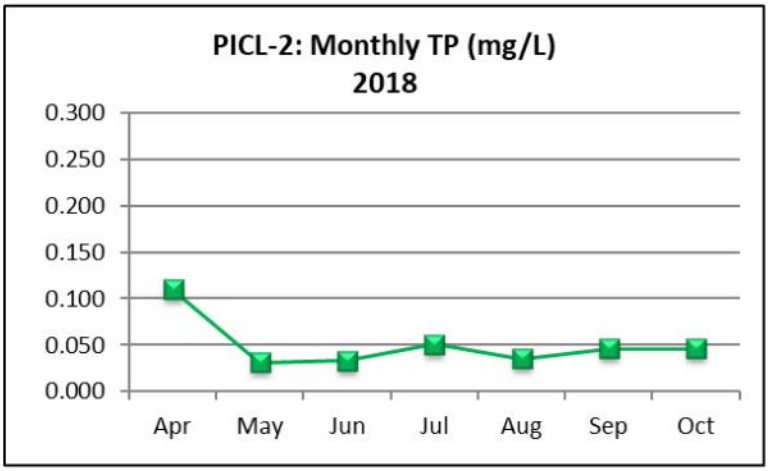
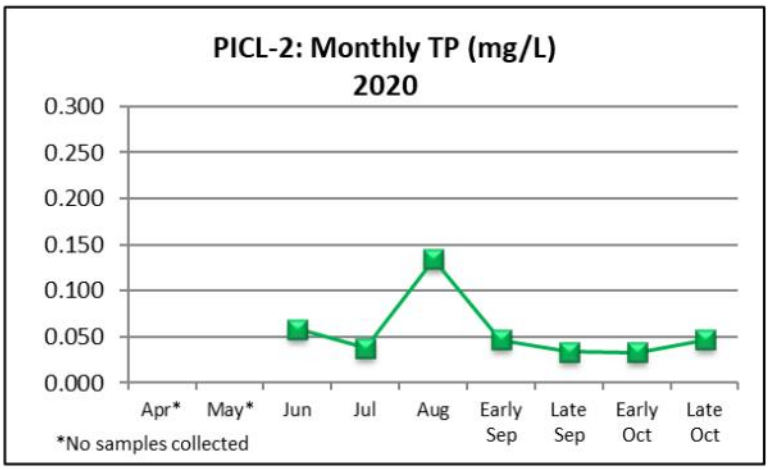


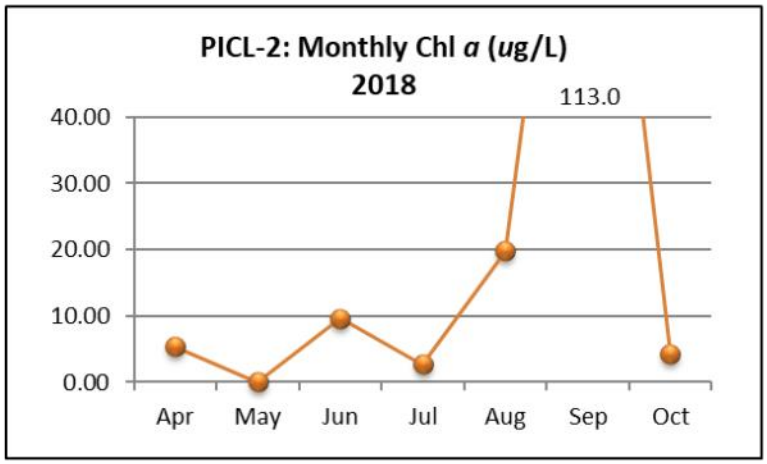
Figure 4. Mean growing season (2003-2020). TN, TP, chl *a,* and TSI measured in the Spring Creek (Pickwick Lake) embayment (PICL-2)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

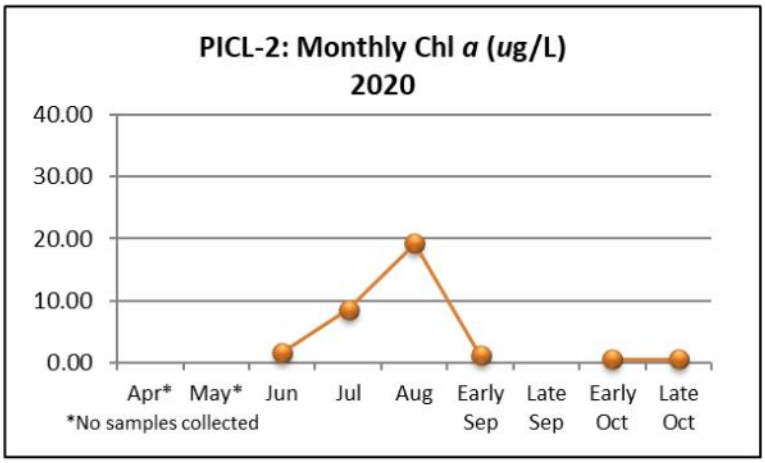


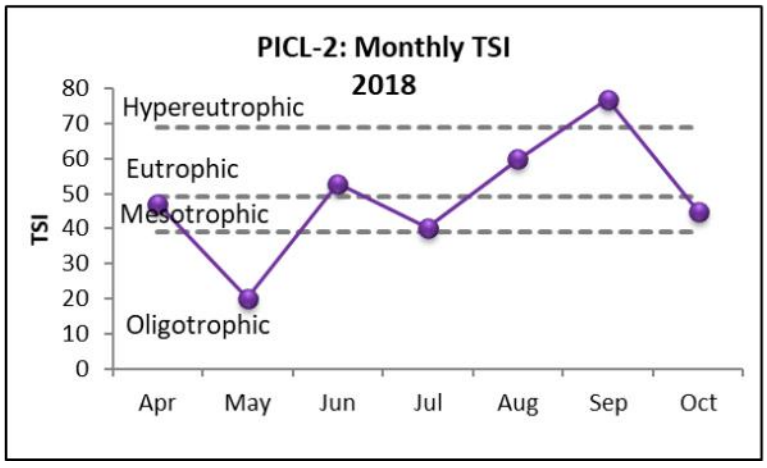












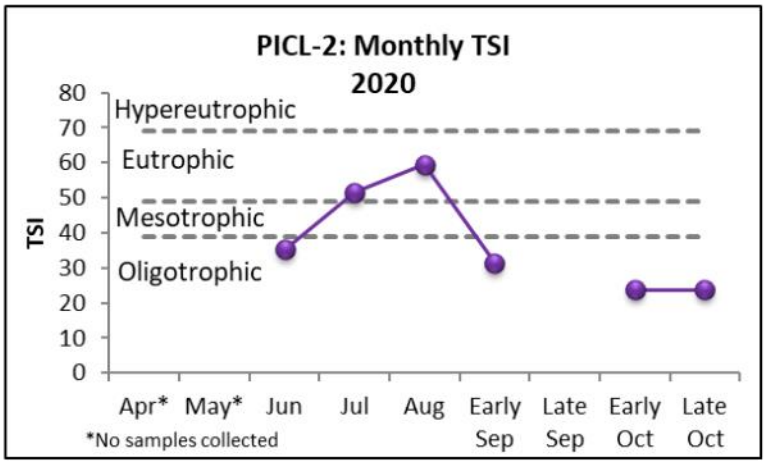


Figure 5. Monthly TN, TP, chl *a,* and TSI measured in the Spring Creek (Pickwick Lake) embayment (PICL-2). Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

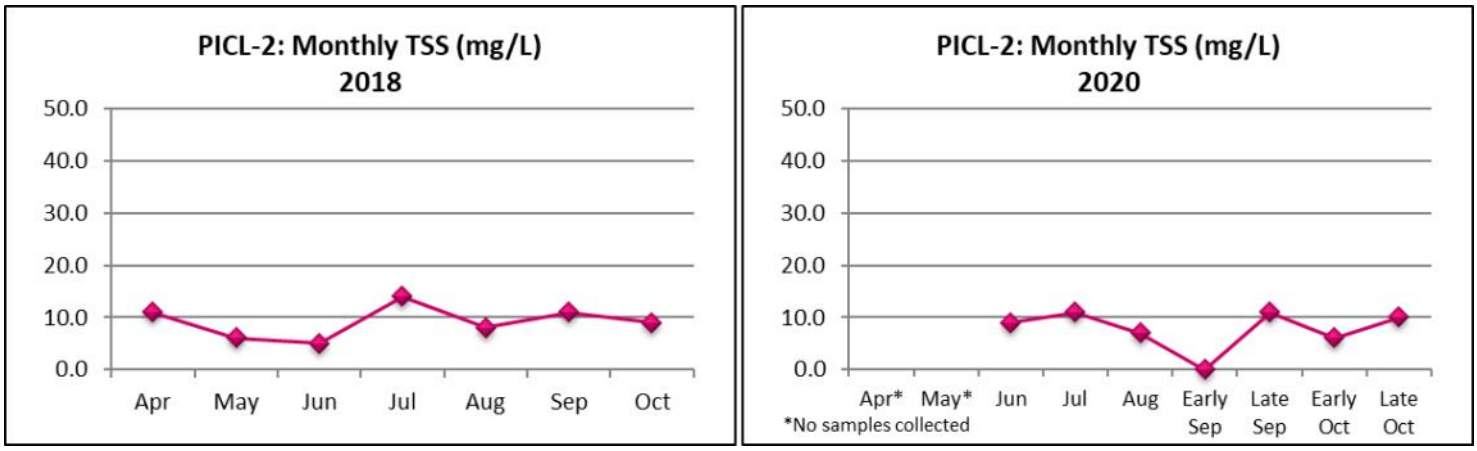


Figure 6. Monthly TSS measured in the Spring Creek (Pickwick Lake) embayment (PICL-2) in April-October 2018 and 2020**.**

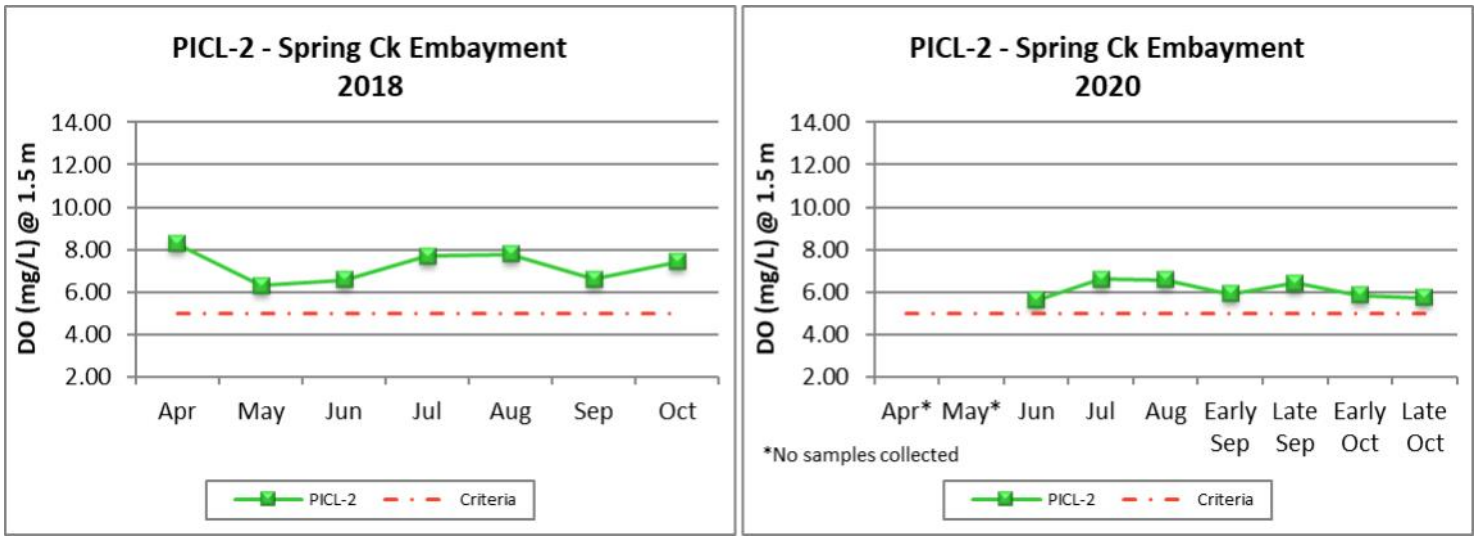


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Spring Creek (Pickwick Lake) embayment (PICL-2) collected in 2018 and 2020. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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