Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Second Creek Embayment
Pickwick Reservoir
Intensive Basin Survey 2018 & 2020

PICL-4: Second Creek approx. 1 mile upstream of County Road 14 bridge (Lauderdale Co 34.92624/-88.04680)

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 Second 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 Second Creek (Pickwick Lake) embayment (PICL-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. Second Creek (Pickwick Lake) at PICL-4.

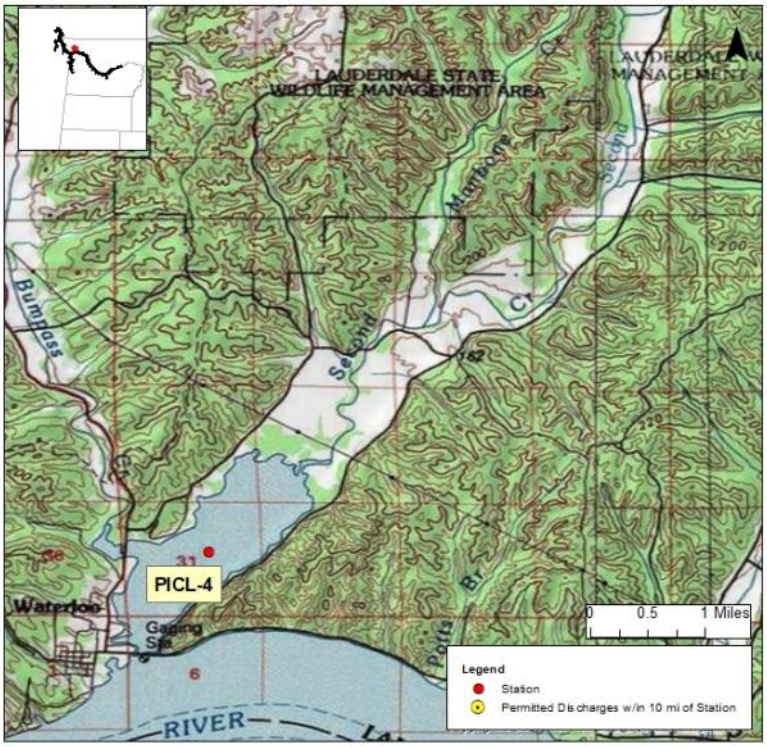


Figure 2. Map of the Second Creek (Pickwick Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Second Creek (Pickwick Lake) embayment is classified *Public Water Supply/Swimming/Fish & Wildlife (PWS/S/F&W)* and located in the Transition Hills ecoregion (65j). Based on the 2021 National Land Cover Dataset, land use within the 71 mi^2 watershed is predominantly forest (75%) (Figure 3). As of February 13, 2024, there were no active permits issued by ADEM within the watershed (Figure 2).

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

Basin		Tennessee R
Assessment Unit		AL06030005-0902-111
Drainage Area (mi^2)		71
Ecoregion[a]		65j
% Landuse		
Open Water		1%
Developed	Open Space	3%
	Low Intensity	<1%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	52%
	Evergreen Forest	19%
	Mixed Forest	4%
Shrub/Scrub		5%
Herbaceous		5%
Hay/Pasture		9%
Cultivated Crops		<1%
Wetlands	Woody	2%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	0

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

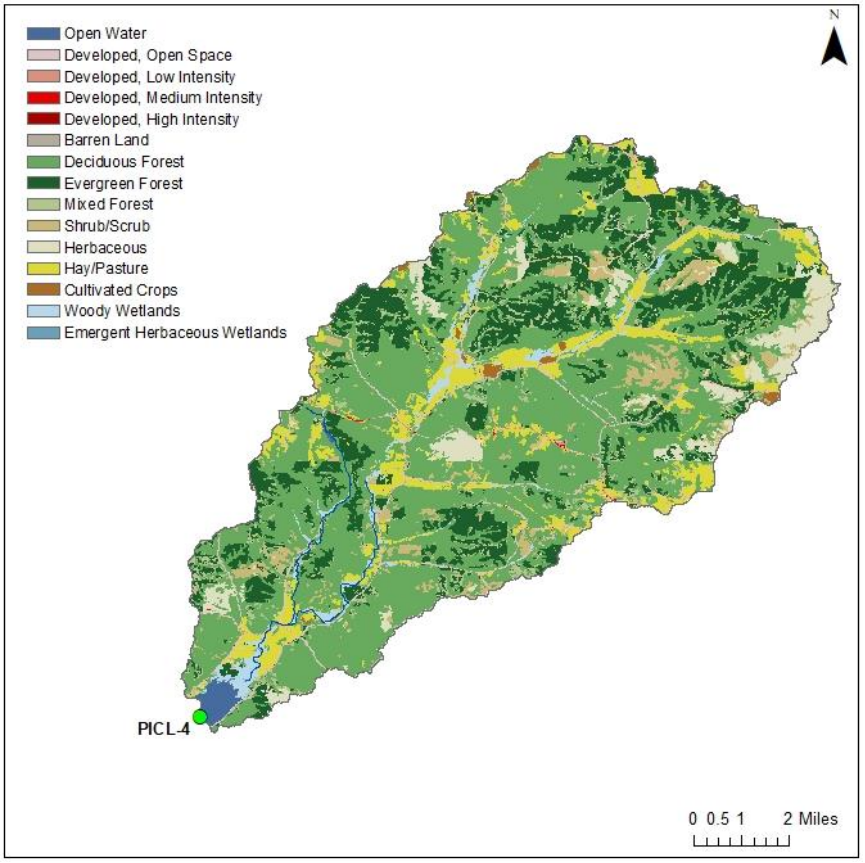


Figure 3. Land use within the Second Creek (Pickwick Lake) watershed at PICL-4.

SITE DESCRIPTION

The Second Creek (Pickwick Lake) embayment at PICL-4 is a fairly wide embayment surrounded by residential houses to the west and a park to the east. It is located near the community of Waterloo, AL. The embayment had a mean bottom depth of 4.7m in 2018 and 5.0m in 2020 (Table 2) at the sampling location. Second Creek flows into the main channel of the Tennessee River near river mile 227.

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.

Mean growing season TN values increased 2003-2015 but decreased in 2018 and remained stable in 2020 (Figure 4). Monthly TN concentrations were highest in May 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.

PICL-4 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	6	4.2	7.6	6.7	6.3	1.3
Total Dissolved Solids (mg/L)	7	26.0	83.0	73.0	61.4	22.0
Total Suspended Solids (mg/L)	7	5.0	9.0	7.0	6.9	1.4
Hardness (mg/L)	4	50.9	59.5	55.1	55.2	3.6
Alkalinity (mg/L)	7	16.8	56.0	51.9	47.1	13.5
Photic Zone (m)	7	3.04	4.63	4.00	3.96	0.52
Secchi (m)	7	0.88	1.65	1.05	1.16	0.30
Bottom Depth (m)	7	4.3	5.4	4.7	4.7	0.4
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.016	0.004	0.004	0.002
Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.004	0.101	0.002	0.031	0.042
Total Kjeldahl Nitrogen (mg/L)	7	0.244	0.616	0.389	0.378	0.129
Total Nitrogen (mg/L)	7	< 0.738	2.151	0.406	0.409	0.155
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.008	0.002	0.004	0.002
Total Phosphorus (mg/L)	7	0.013	0.038	0.027	0.026	0.008
CBOD-5 (mg/L)	7	< 2.0	3.0	2.6	2.2	0.9
Chlorides (mg/L)	7	2.0	7.1	5.4	5.2	1.8
Biological						
Chlorophyll a (mg/m³)	7	< 0.10	34.70	7.48	13.52	12.59
E. coli (MPN/DL)[J]	4	1	1	1	1	0

PICL-4 2020	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	7	3.5	6.9	4.2	4.7	1.2
Total Dissolved Solids (mg/L)[J]	6	52.0	69.0	61.0	60.5	7.1
Total Suspended Solids (mg/L)[J]	6	4.0	10.0	6.0	6.3	2.2
Hardness (mg/L)	4	57.3	127.0	58.4	75.2	34.5
Alkalinity (mg/L)	7	45.1	55.0	53.4	51.8	3.5
Photic Zone (m)	7	3.28	4.74	4.17	4.12	0.49
Secchi (m)	7	1.17	2.31	1.39	1.45	0.40
Bottom Depth (m)	7	4.4	5.6	4.9	5.0	0.5
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	0.065	0.014	0.022	0.019
Total Kjeldahl Nitrogen (mg/L)	7	0.250	0.810	0.370	0.401	0.190
Total Nitrogen (mg/L)[J]	7	< 0.794	2.474	0.384	0.423	0.186
Total Phosphorus (mg/L)[J]	7	< 0.028	0.083	0.038	0.043	0.024
Chlorides (mg/L)[J]	6	3.3	5.8	5.4	4.9	0.1
Biological						
Chlorophyll a (mg/m³)[J]	6	< 1.00	29.90	10.16	10.95	10.82
E. coli (MPN/DL)[J]	4	< 1	3	1	1	1

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

RESULTS (con't)

The mean growing season TP concentration decreased 2003 to 2018 but was slightly higher in 2020 (Figure 4). In 2018, monthly TP concentrations were below 0.05 mg/L all months sampled (Figure 5). In 2020, the highest monthly TP concentration was observed in August.

The mean growing season chl *a* concentration measured in 2018 was higher than that of the previous two growing seasons, but the 2020 mean was the lowest observed since sampling began in 2003 (Figure 4). In 2018, monthly chl *a* concentrations were highest in April and October (Figure 5). Late October was the highest monthly concentration recorded in 2020.

According to mean annual TSI, the Second Creek (Pickwick Lake) embayment has been eutrophic in all years sampled (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in all months except July and August (Figure 5). In 2020, the site was eutrophic during June, August, and both October sampling events.

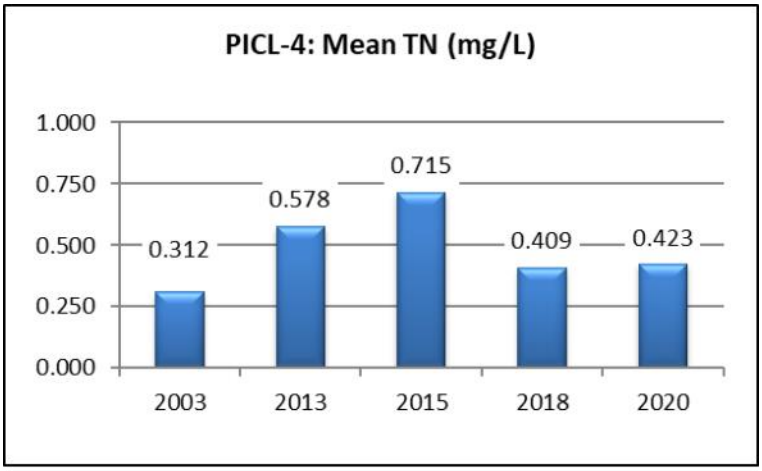
Mean growing season TSS concentrations have remained stable since 2009 (Figure 4). In both 2018 and 2020, monthly TSS measurements were at or below 10 mg/L all months sampled (Figure 6).

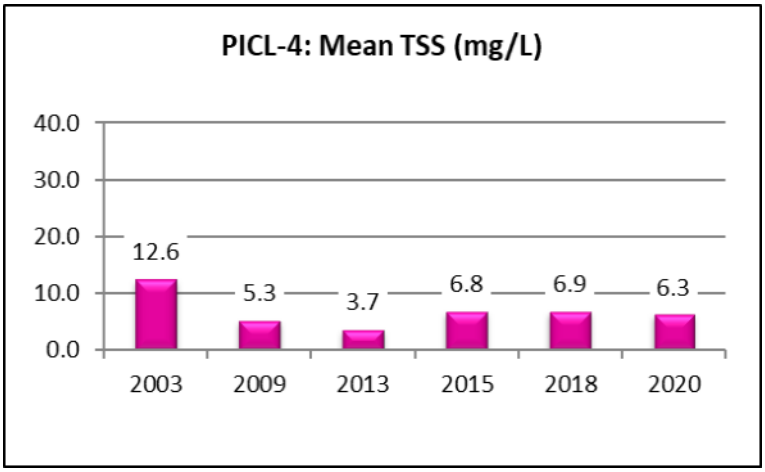
AGPT results show that Second Creek (Pickwick Lake) was phosphorus-limited in 2003 and nitrogen-limited in 2009 and 2013 (Table 3). All samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

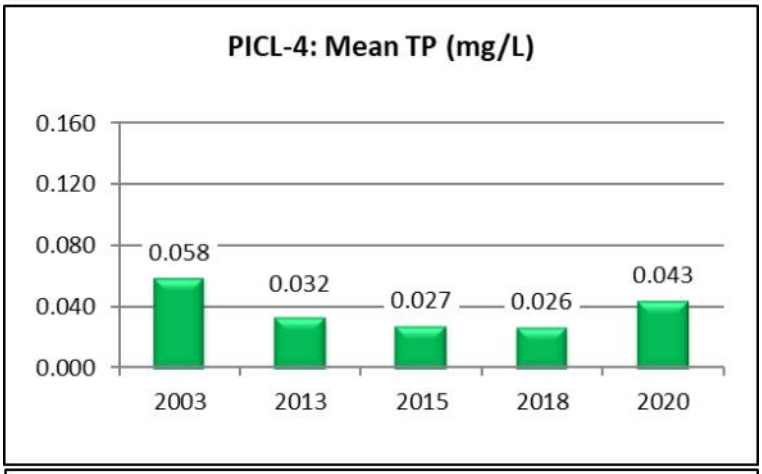
While dissolved oxygen (DO) concentrations at PICL-4 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2020 (ADEM Admin. Code R. 335-6-10-.09), many monthly readings showed super-saturated DO conditions with concentrations >10.0 mg/L (Figure 7). DO was above 10.0 mg/L in April-June of 2018 and in July and early and late October in 2020.

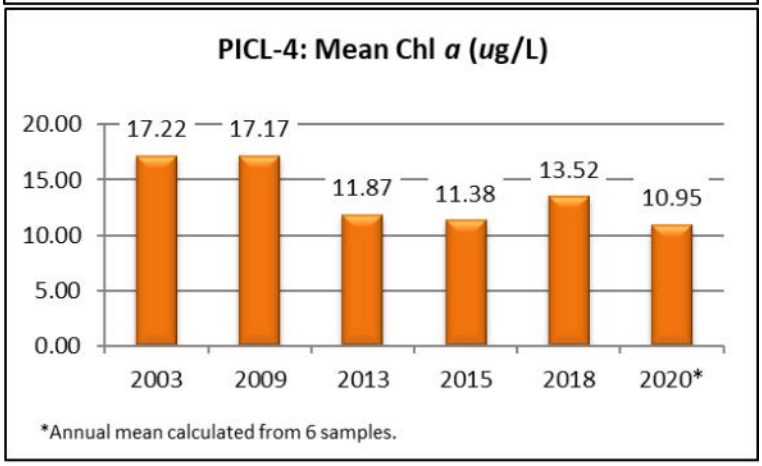
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	3.31	Phosphorus
2009	3.06	Nitrogen
2013	2.62	Nitrogen









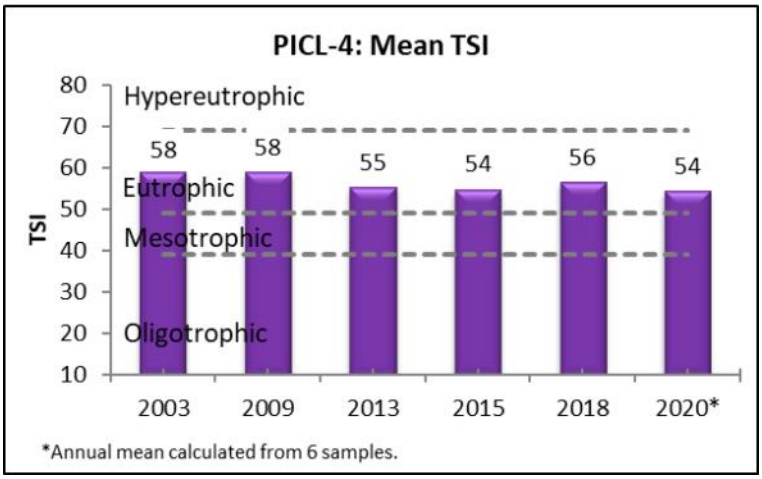
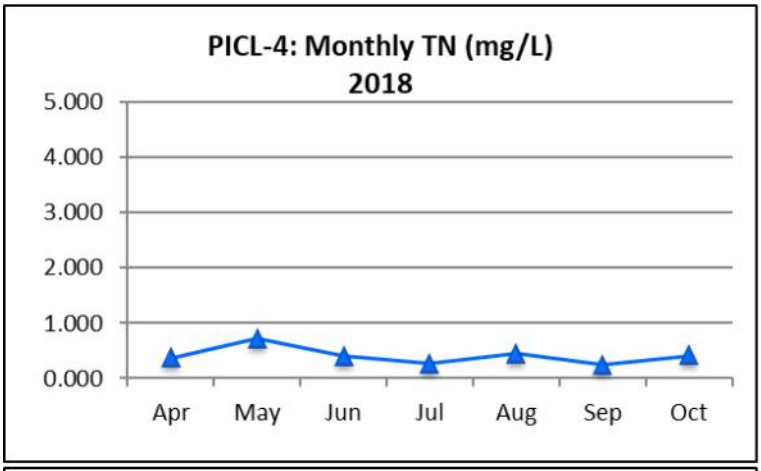
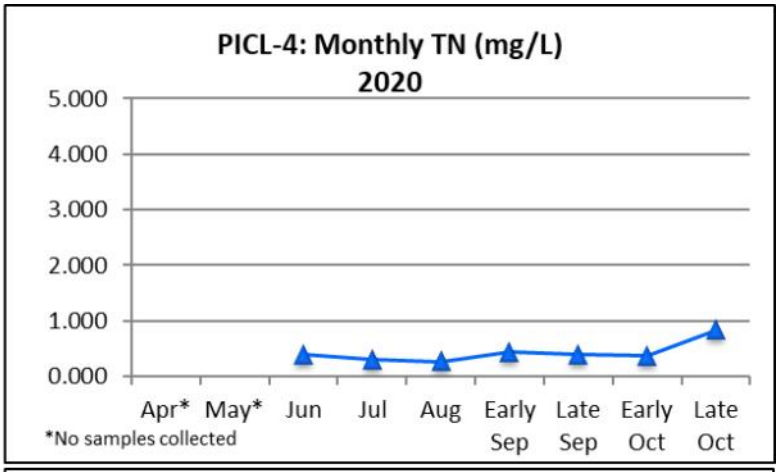
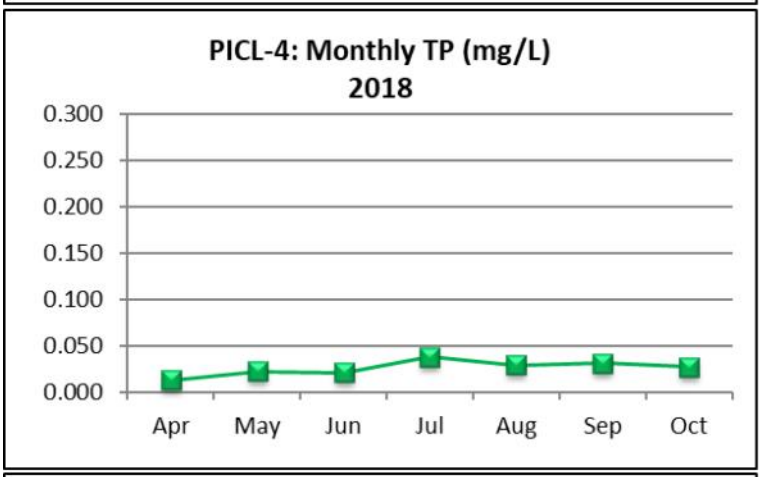
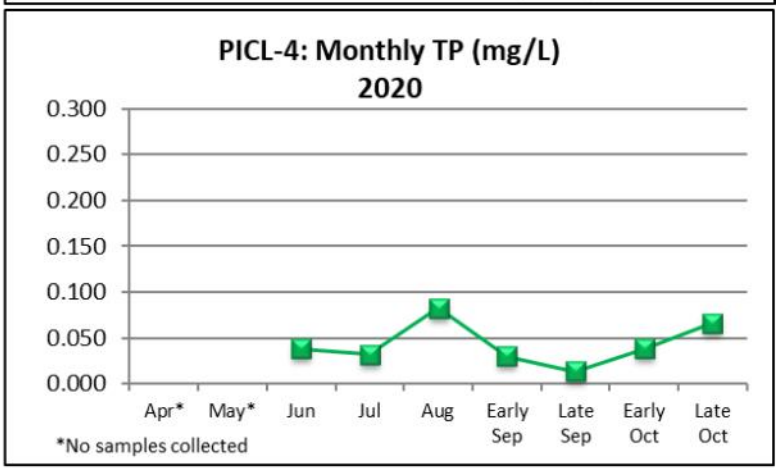


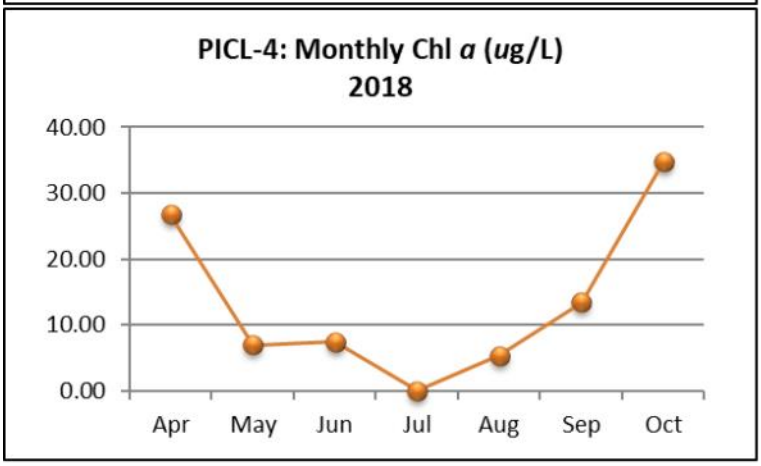
Figure 4. Mean growing season (2003-2020). TN, TP, chl *a,* and TSI measured in the Second Creek (Pickwick Lake) embayment (PICL-4). Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

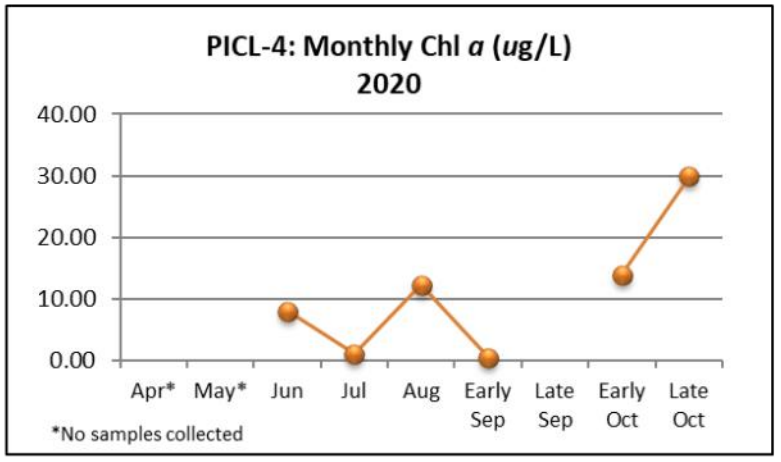


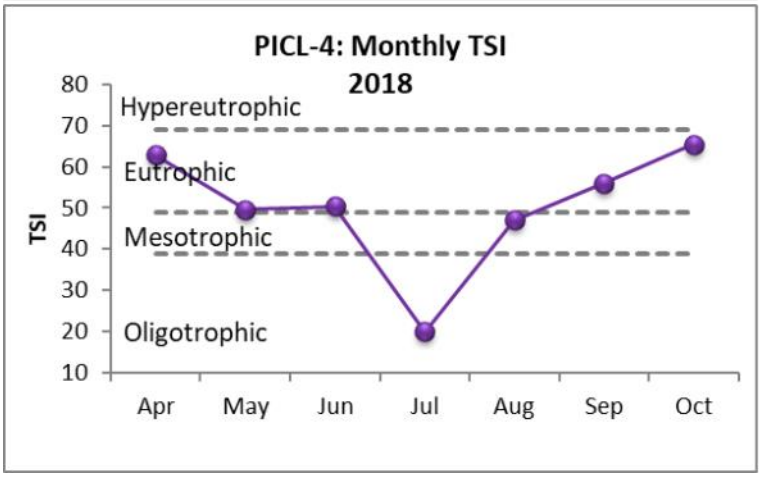












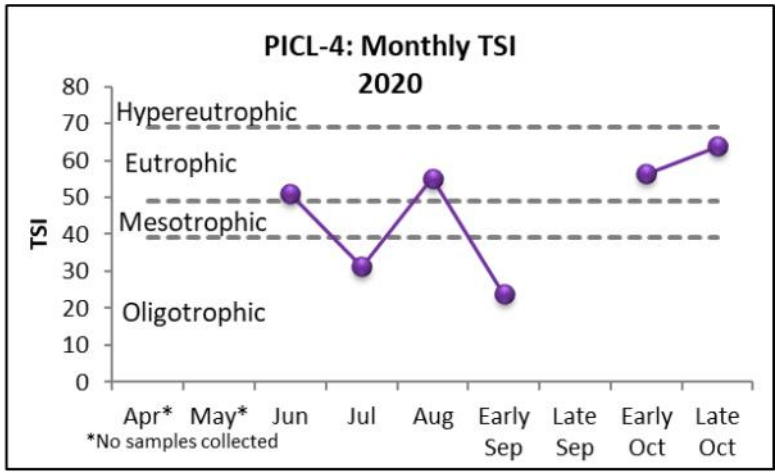


Figure 5. Monthly TN, TP, chl *a,* and TSI measured in the Second Creek (Pickwick Lake) embayment (PICL-4)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

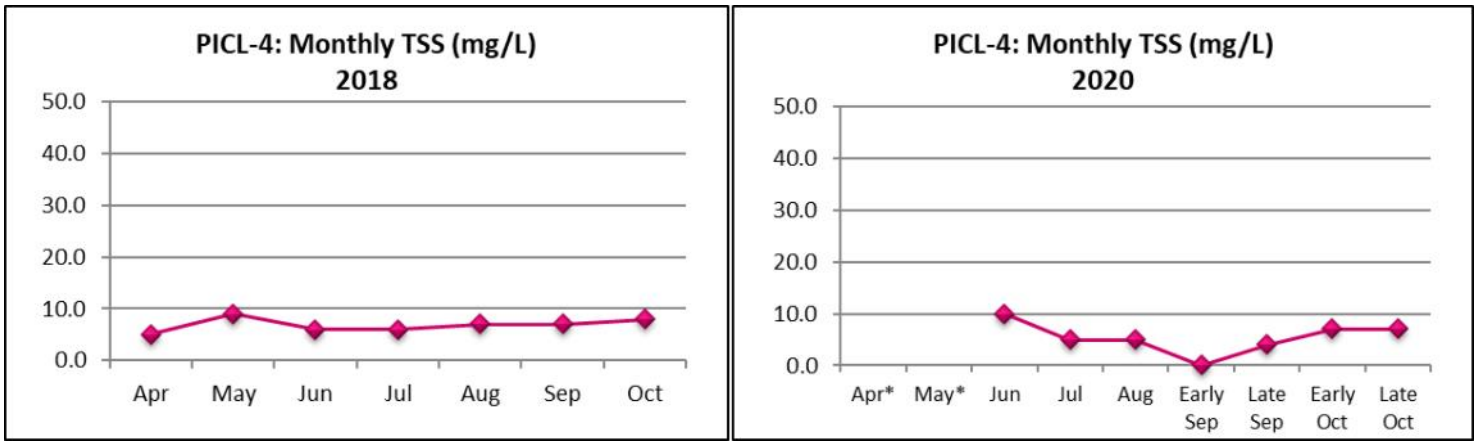


Figure 6. Monthly TSS measured in the Second Creek (Pickwick Lake) embayment (PICL-4) in April-October 2018 and 2020**.**

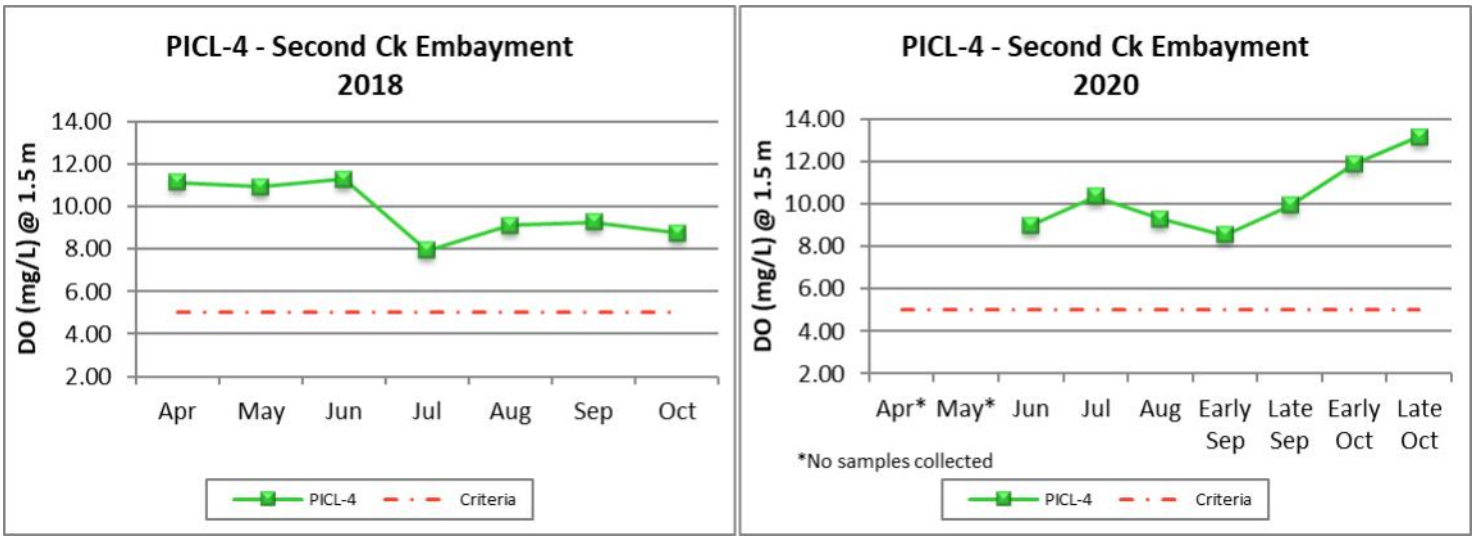


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Second Creek (Pickwick Lake) embayment (PICL-4) collected in 2018 and 2020. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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