Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Cane Creek Embayment
Pickwick Reservoir
Intensive Basin Survey 2018 & 2020

PICL-3: Cane Creek approx. 1 mile upstream of confluence with Tennessee River (Colbert Co 34.74694/-87.86389)

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 Cane 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 Cane Creek (Pickwick Lake) embayment (PICL-3) 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.

A fish consumption advisory for mercury was issued by the Alabama Department of Public Health (ADPH) in 2021 based on fish tissue data collected by ADEM at station PICL-3. Therefore, as an indication of an impaired use, Cane Creek (Pickwick Lake) from the confluence with the Tennessee River (Pickwick Lake) upstream to the end of the embayment was listed on ADEM's 2022 §303(d) list of impaired waterbodies.

Figure 1. Cane Creek (Pickwick Lake) at PICL-3.

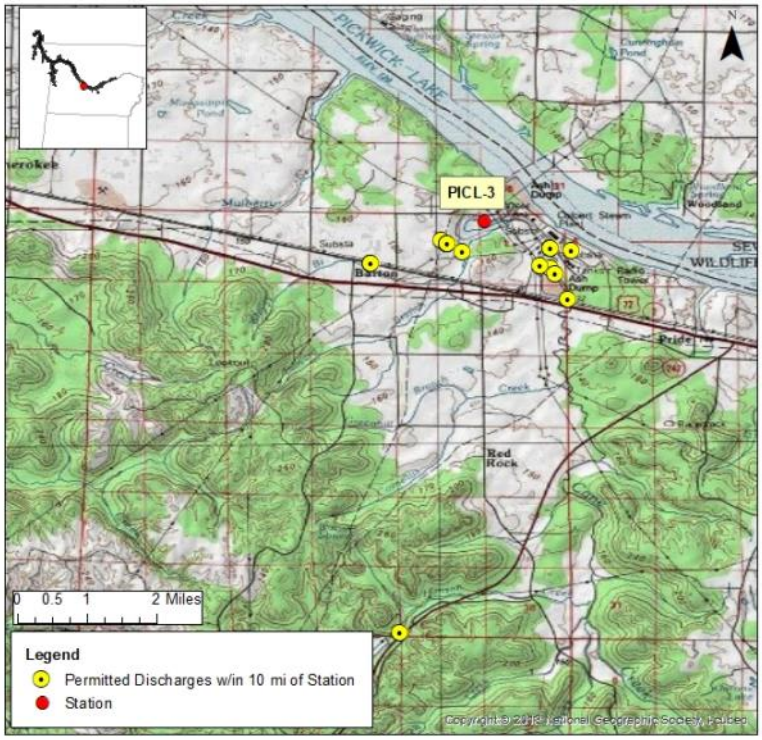


Figure 2. Map of the Cane Creek (Pickwick Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Cane Creek (Pickwick Lake) embayment is classified *Public Water Supply/ Swimming/Fish & Wildlife (PWS/S/F&W)* and located in the Eastern Highland Rim ecoregion (71g). Based on the 2021 National Land Cover Dataset, land use within the 59 mi^2 watershed is predominantly forest (70%) with some hay/pastureland (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 14 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-3**

Basin		Tennessee R
Assessment Unit		AL06030005-0807-111
Drainage Area (mi^2)		59
Ecoregion[a]		71g
% Landuse		
Open Water		<1%
Developed	Open Space	2%
	Low Intensity	1%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	50%
	Evergreen Forest	12%
	Mixed Forest	8%
Shrub/Scrub		4%
Herbaceous		1%
Hay/Pasture		15%
Cultivated Crops		2%
Wetlands	Woody	2%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	14
Mining		0
Industrial General		6
Industrial Individual		8
Municipal		0
State Indirect Discharge		0

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

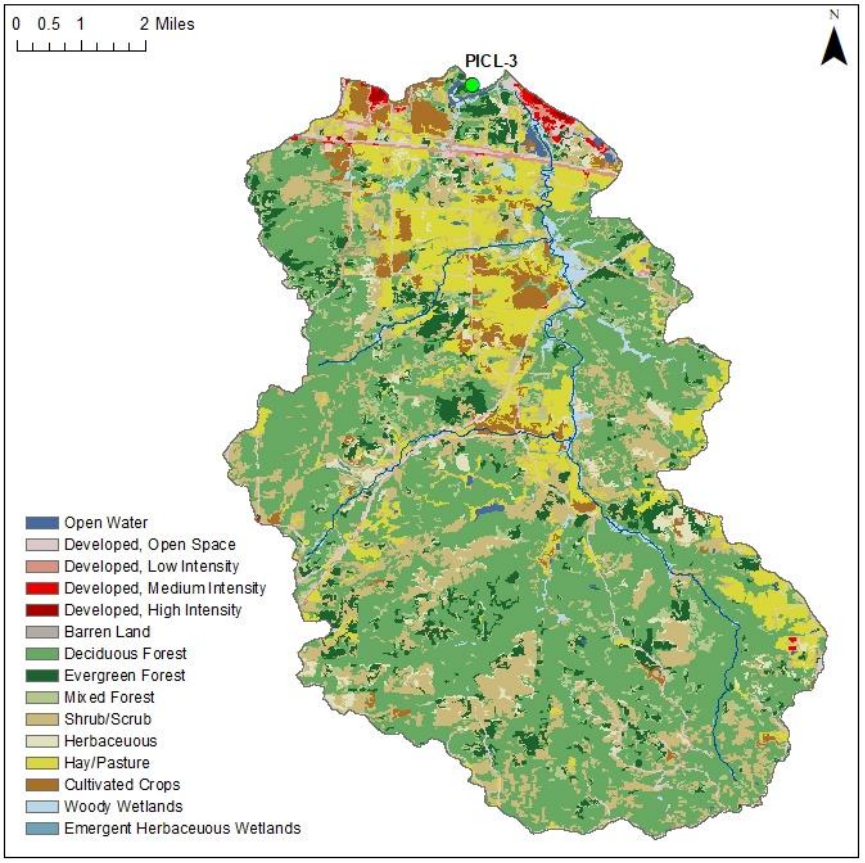


Figure 3. Land use within the Cane Creek (Pickwick Lake) watershed at PICL-3.

SITE DESCRIPTION

The Cane Creek (Pickwick Lake) embayment at PICL-3 is located just west of Colbert Steam Plant. It is a fairly shallow embayment with a mean bottom depth of 2.5m in 2018 and 2.6m in 2020 (Table 2) at the sampling location and has a moderate to swift flow for much of the sampling season.

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 were lower in 2018 and remained constant in 2020 (Figure 4). Monthly TN concentrations were highest in April in 2018 and in June 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-3 2018	N	Min	Max	Med	Avg	SD
Physical						
Turbidity (NTU)	6	3.9	9.8	7.4	7.2	2.1
Total Dissolved Solids (mg/L)	7	81.0	108.0	89.0	90.9	10.0
Total Suspended Solids (mg/L)	7	2.0	9.0	7.0	6.6	2.2
Hardness (mg/L)	4	60.4	72.5	64.6	65.5	5.4
Alkalinity (mg/L)	7	57.1	73.1	67.9	65.6	5.5
Photic Zone (m)	7	1.20	2.88	2.30	2.26	0.56
Secchi (m)	7	0.73	1.19	1.05	0.98	0.17
Bottom Depth (m)	7	2.1	3.2	2.4	2.5	0.4
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.007	0.016	0.004	0.004	0.002
Nitrate+Nitrite Nitrogen (mg/L)	7	0.130	0.360	0.247	0.248	0.081
Total Kjeldahl Nitrogen (mg/L)	7	0.220	0.379	0.248	0.262	0.057
Total Nitrogen (mg/L)	7	1.134	1.878	0.499	0.511	0.098
Dis Reactive Phosphorus (mg/L)	7	0.016	0.043	0.035	0.029	0.012
Total Phosphorus (mg/L)	7	0.025	0.058	0.049	0.044	0.013
CBOD-5 (mg/L)	7	< 2.0	2.2	1.0	1.2	0.4
Chlorides (mg/L)	7	3.8	7.5	6.2	6.0	1.3
Biological						
Chlorophyll a (mg/m³)	7	0.89	13.40	3.56	5.80	4.77
E. coli (MPN/DL)[J]	4	6	96	12	31	43
PICL-3 2020	**N**	**Min**	**Max**	**Med**	**Avg**	**SD**
Physical						
Turbidity (NTU)	7	5.2	11.0	7.0	7.6	2.0
Total Dissolved Solids (mg/L)	6	86.0	197.0	96.5	115.5	42.7
Total Suspended Solids (mg/L)	6	7.0	13.0	8.0	8.8	2.3
Hardness (mg/L)	4	73.1	162.0	80.2	98.9	42.4
Alkalinity (mg/L)	7	65.2	151.0	74.9	90.8	31.3
Photic Zone (m)	7	1.87	2.67	2.37	2.36	0.26
Secchi (m)	7	0.98	1.29	1.15	1.12	0.10
Bottom Depth (m)	7	1.9	2.7	2.4	2.4	0.3
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	0.206	0.037	0.066	0.071
Total Kjeldahl Nitrogen (mg/L)	7	0.260	0.660	0.480	0.449	0.147
Total Nitrogen (mg/L)[J]	7	< 0.824	2.598	0.494	0.515	0.204
Total Phosphorus (mg/L)[J]	7	0.029	0.094	0.042	0.049	0.023
Chlorides (mg/L)	6	3.1	5.8	4.4	4.4	1.1
Biological						
Chlorophyll a (mg/m³)[J]	6	1.10	29.90	12.85	14.34	10.83
E. coli (MPN/DL)[J]	4	< 1	16	3	6	7

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 near 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 calculated for 2020 was the highest since monitoring began in 2003 (Figure 4). However, monthly sampling in 2020 was atypical compared to previous sampling seasons. Monthly chl *a* concentrations were highest in June of 2018 and July of 2020 (Figure 5).

Mean TSI indicated that the Cane Creek (Pickwick Lake) embayment was mesotrophic in most years sampled, but conditions were eutrophic in 2020 (Figure 4). Monthly TSI calculations indicated the embayment reached eutrophic conditions in June, August, and September of 2018 (Figure 5). In 2020, Cane Creek was eutrophic in all months sampled except June and early September.

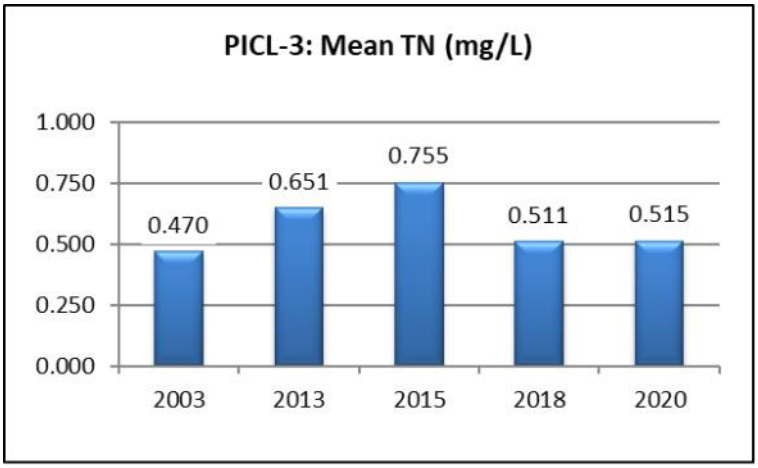
Mean growing season TSS concentrations decreased from 2003 to 2015, but increased slightly from 2015 to 2020 (Figure 4). In both 2018 and 2020, monthly TSS measurements were near or below 10 mg/L all months sampled (Figure 6).

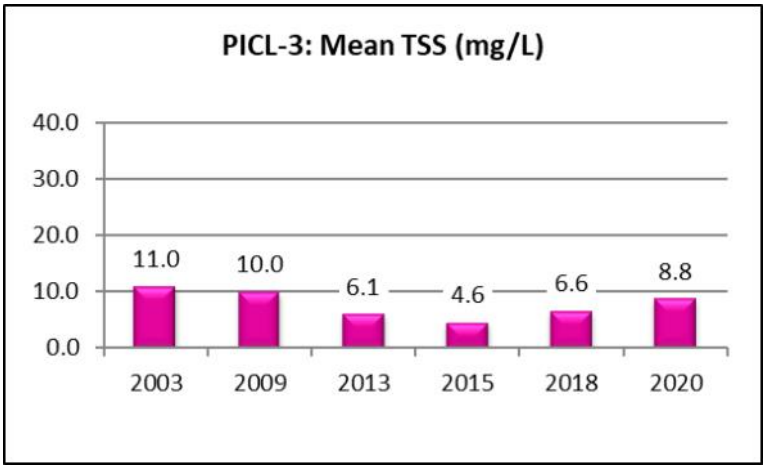
AGPT results show that Cane Creek (Pickwick Lake) was co-limiting in 2003, nitrogen-limited in 2009, and non-limiting in 2013(Table 3). While all samples were above the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems, samples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

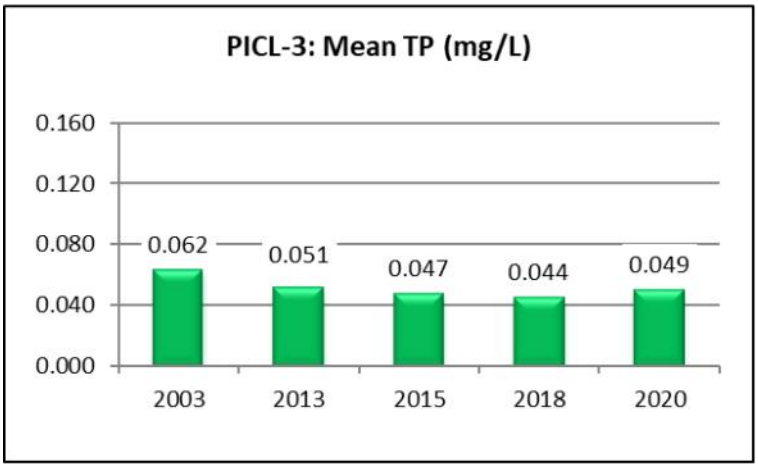
Dissolved oxygen (DO) concentrations at PICL-3 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2020 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

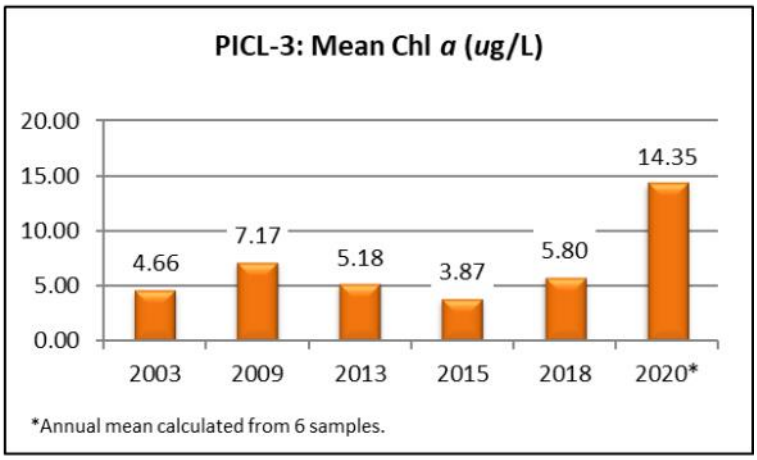
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2003	18.6	Co-limiting
2009	10.0	Nitrogen
2013	16.55	Non-limiting









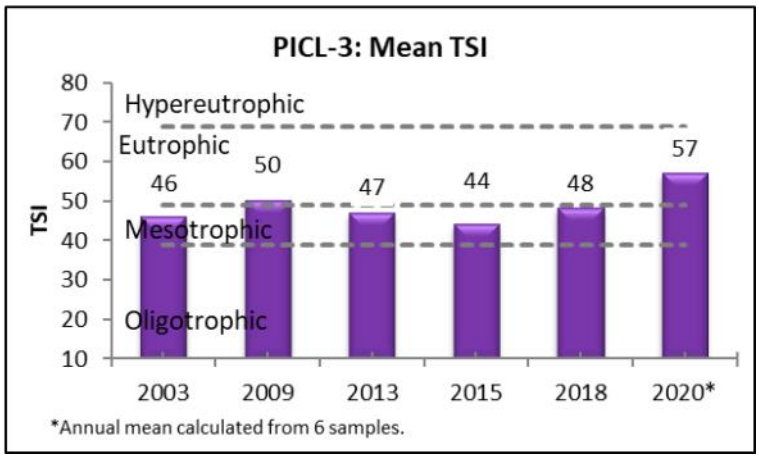
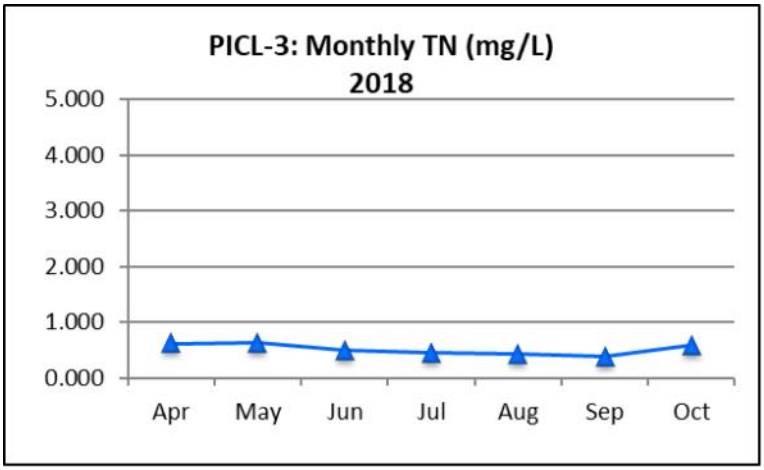
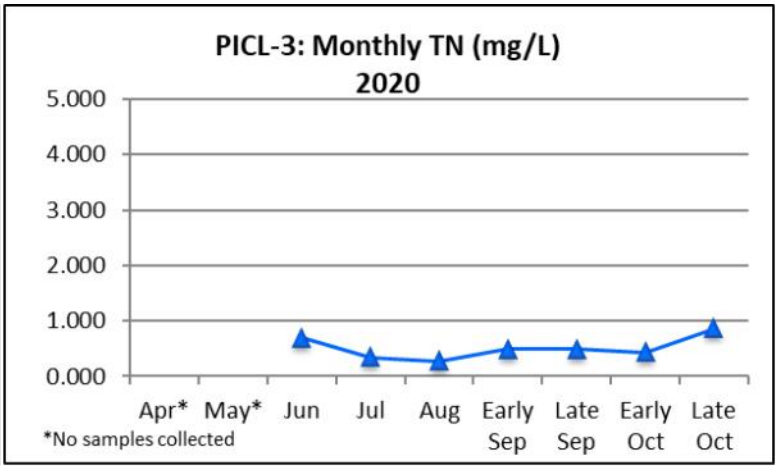
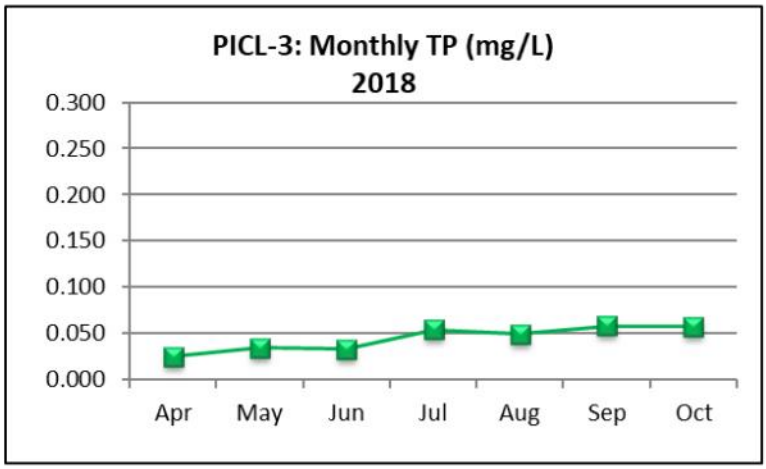
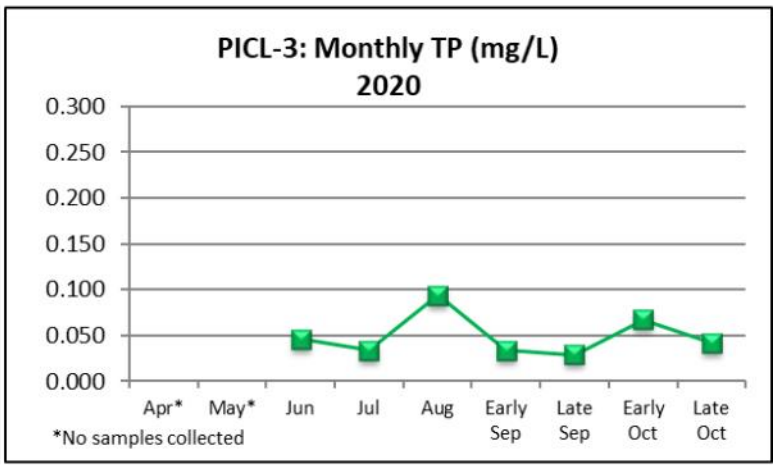


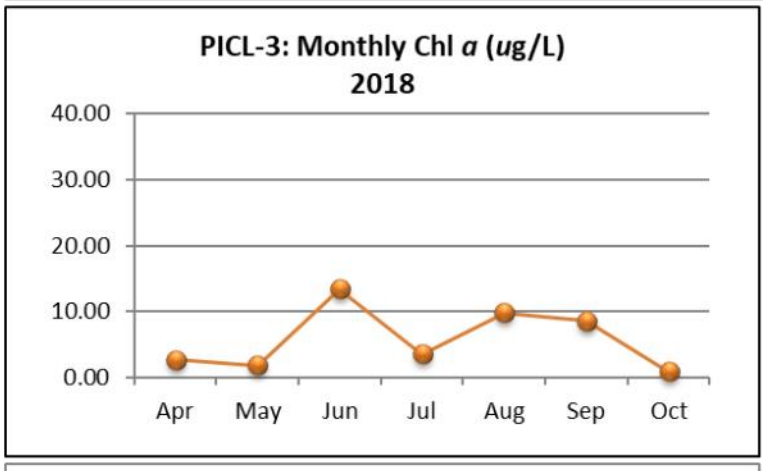
Figure 4. Mean growing season (2003-2020). TN, TP, chl *a,* and TSI measured in the Cane Creek (Pickwick Lake) embayment (PICL-3)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

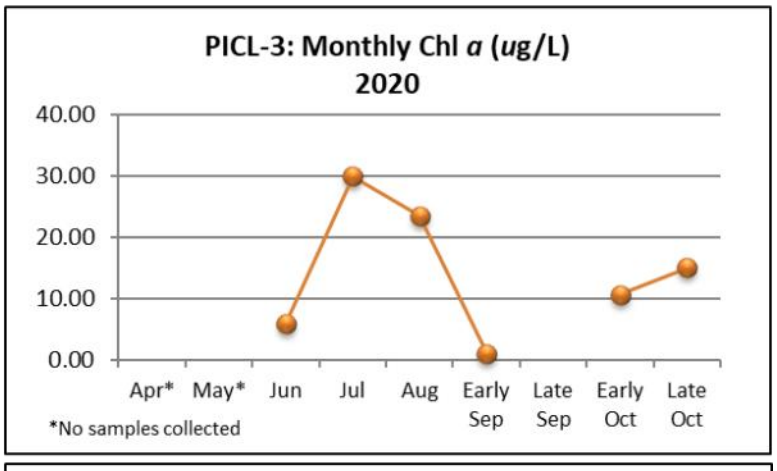


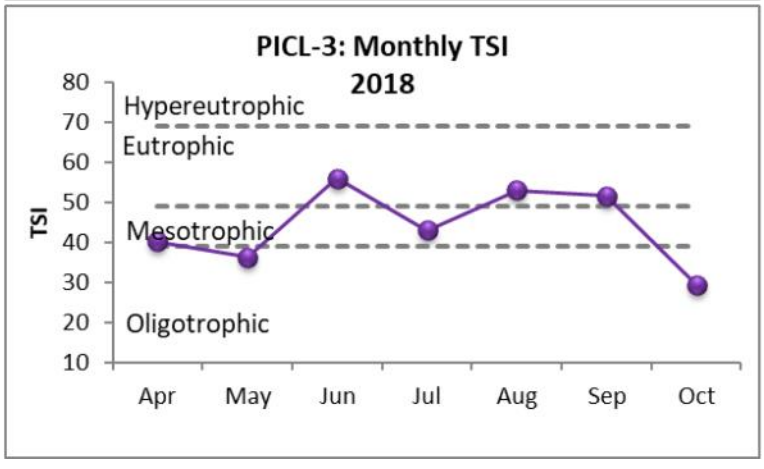












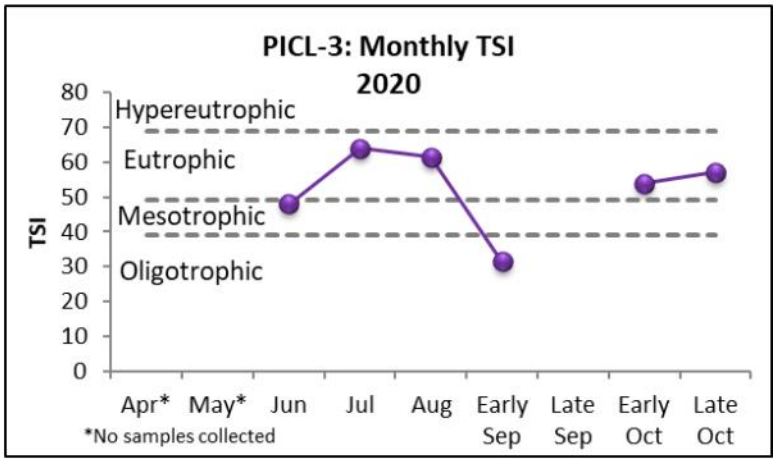


Figure 5. Monthly TN, TP, chl *a,* and TSI measured in the Cane Creek (Pickwick Lake) embayment (PICL-3)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

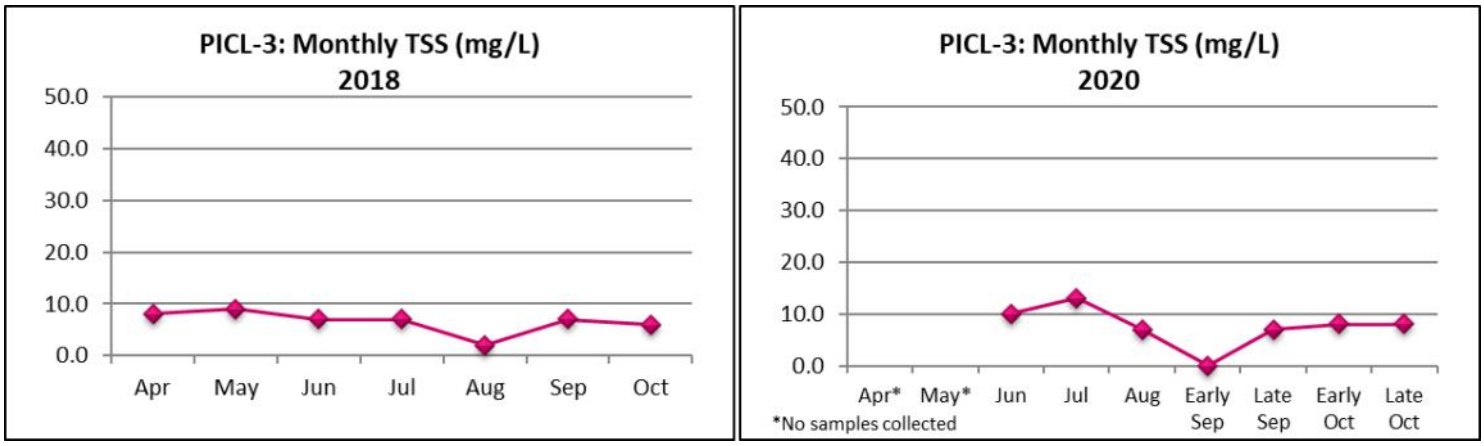


Figure 6. Monthly TSS measured in the Cane Creek (Pickwick Lake) embayment (PICL-3) in April-October 2018 and 2020**.**

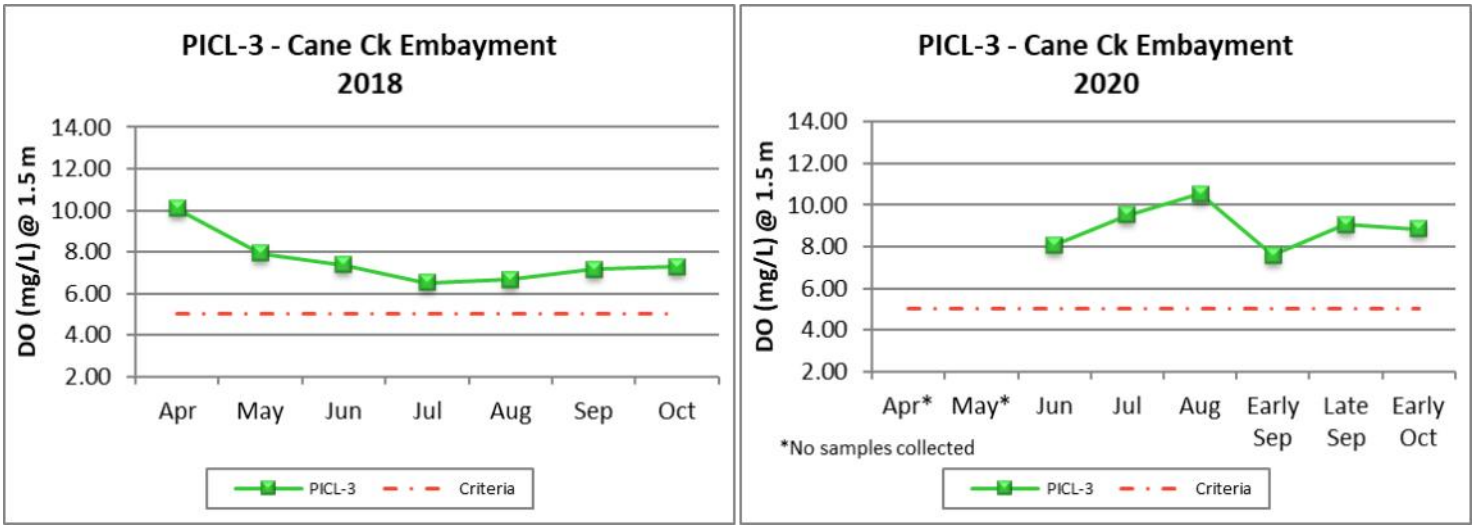


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for Cane Creek (Pickwick Lake) embayment (PICL-3) collected in 2018 and 2020. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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