Alabama Department of Environmental Management

Black Warrior River Basin

Rivers and Reservoirs Monitoring Program

Inland Reservoir Intensive Basin Survey 2017 & 2021

INLB-1: Inland Reservoir, deepest point, dam forebay (Blount Co 33.83469/-86.55094)

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 2017 and 2021, ADEM monitored Inland Reservoir as part of the intensive basin assessment of the Black Warrior 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 at the dam forebay of Inland Reservoir (INLB-1) during the 2017 and 2021 growing seasons (Apr-Oct). 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 consumption advisory was issued by the Alabama Department of Public Health in 2017 based on fish tissue data collected by ADEM at station INLB-1. Therefore, as an indication of an impaired use, Inland Reservoir from the dam forebay upstream to the extent of the reservoir was listed on Alabama's 2018 §303(d) list of impaired waterbodies.

Figure 1. Inland Reservoir, dam forebay at INLB-1.

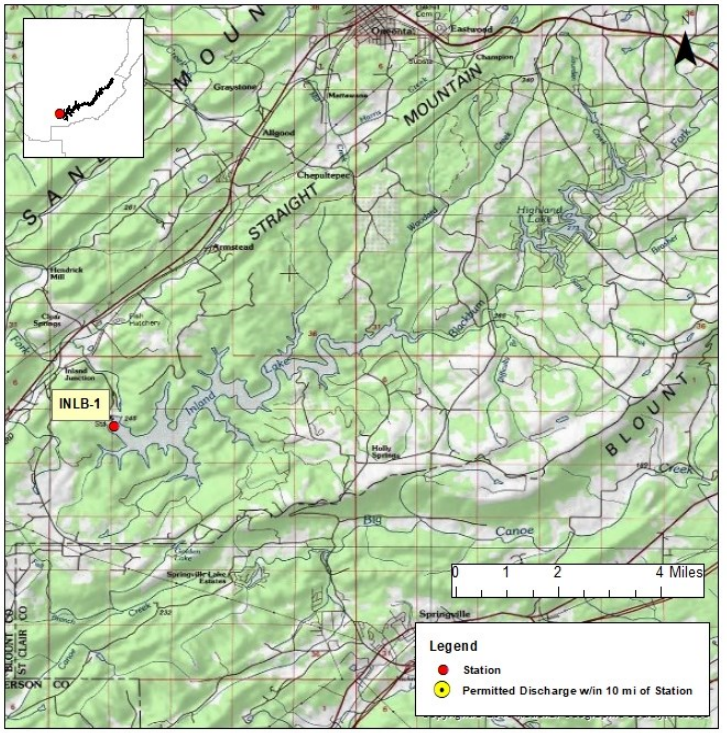


Figure 2. Map of Inland Reservoir. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Inland Reservoir is classified *Public Water Supply/Swimming (PWS/S)* and located in the Southern Table Plateaus ecoregion (68d). Based on the 2021 National Land Cover Dataset, land use within the 69 mi^2 watershed is predominantly forest (61%) (Figure 3). As of February 13, 2024, there were no active permitted outfalls issued by ADEM within the watershed (Figure 2).

Table 1: Summary of Watershed		**INLB-1**
Basin		Black Warrior R
Drainage Area (mi^2)		69
Ecoregion		68d
% Landuse		
Open Water		4%
Developed	Open Space	5%
	Low Intensity	1%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	36%
	Evergreen Forest	17%
	Mixed Forest	8%
Shrub/Scrub		3%
Herbaceous		2%
Hay/Pasture		22%
Cultivated Crops		<1%
Wetlands	Woody	<1%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	0

a. Southern Table Plateaus
b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Feb 13, 2024.

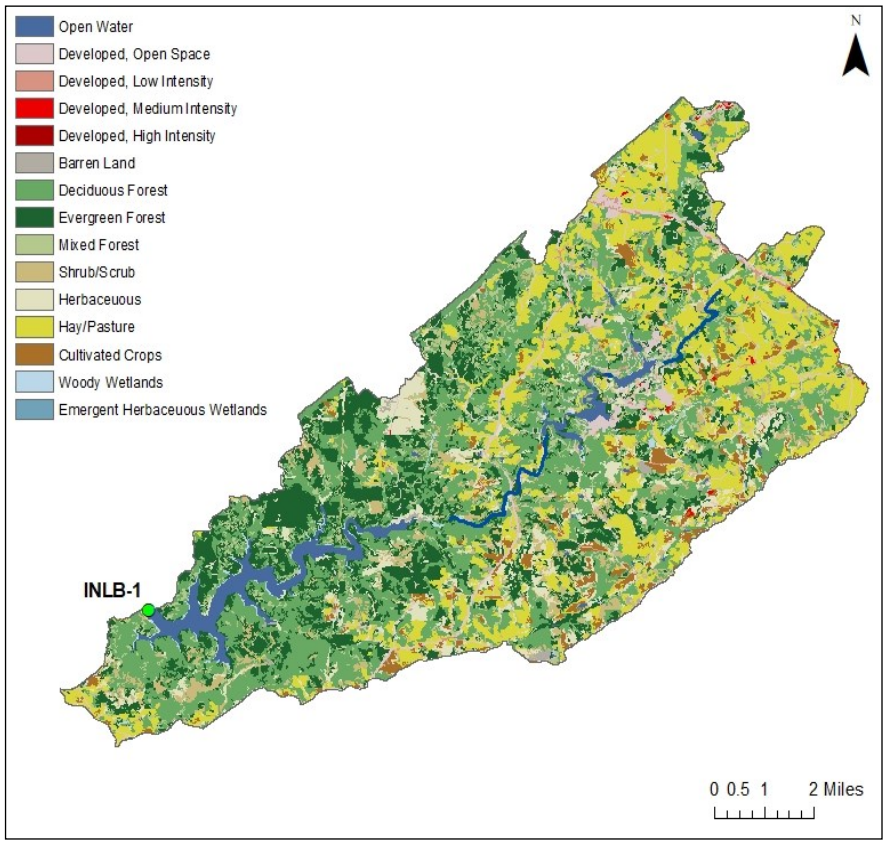


Figure 3. Land use within the Inland Reservoir watershed at INLB-1.

SITE DESCRIPTION

Inland Reservoir was established in 1939 as a water supply lake for the city of Birmingham. The reservoir is located on the Blackburn Fork of the Little Warrior River near the town of Oneonta. INLB-1, located at the dam forebay, had an average bottom depth of 47.4 m in 2017 and 45.5 m in 2021 (Table 2).

METHODS

Water quality sampling was conducted at monthly intervals, April-October in both 2017 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 2023), and Quality Management Plan (ADEM 2018).

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 2017 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 remained stable from 2002-2012, increased in 2017, and then decreased in 2021 (Figure 4). Monthly TN concentrations were highest in April in 2017 and in July in 2021 (Figure 5).

The mean growing season TP concentration decreased 2006 to 2017 but was slightly higher in 2021 (Figure 4). In both 2017 and 2021, monthly TP concentrations were below 0.05 mg/L all months sampled (Figure 5).

Table 2. Summary of water quality data collected April-October, 2017 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.

INLB-1 2017	N	Min	Max	Med	Mean	SD
Physical						
Turbidity (NTU)	7	0.6	2.8	1.7	1.7	0.7
Total Dissolved Solids (mg/L)	7	42.0	53.0	46.0	46.6	4.1
Total Suspended Solids (mg/L)	7	< 1.0	3.0	2.0	1.8	0.8
Hardness (mg/L)	4	22.8	24.8	23.7	23.8	0.8
Alkalinity (mg/L)	7	12.6	14.8	13.7	13.6	0.8
Photic Zone (m)	7	4.11	12.40	7.82	8.51	2.85
Secchi (m)	7	3.50	12.12	4.19	5.55	3.15
Bottom Depth (m)	7	42.0	50.8	48.0	47.4	3.3
Chemical						
Ammonia Nitrogen (mg/L)[J]	7	< 0.015	0.021	0.010	0.009	0.002
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.007	0.112	0.006	0.044	0.052
Total Kjeldahl Nitrogen (mg/L)[J]	7	0.244	2.120	0.403	0.642	0.660
Total Nitrogen (mg/L)[J]	7	< 0.936	6.696	0.406	0.686	0.693
Dis Reactive Phosphorus (mg/L)[J]	7	< 0.004	0.005	0.005	0.004	0.001
Total Phosphorus (mg/L)[J]	7	< 0.004	0.012	0.002	0.005	0.004
CBOD-5 (mg/L)	7	< 2.0	< 2.0	1.0	1.0	0.0
Chlorides (mg/L)[J]	7	1.0	1.9	1.5	1.5	0.3
Biological						
Chlorophyll a (mg/m³)	7	1.34	5.87	2.49	3.04	1.62
E. coli (MPN/DL)	4	2	21	2	7	10
INLB-1 2021	**N**	**Min**	**Max**	**Med**	**Mean**	**SD**
Physical						
Turbidity (NTU)	7	1.4	6.8	1.9	3.4	2.3
Total Dissolved Solids (mg/L)	7	28.0	48.0	40.0	40.3	7.2
Total Suspended Solids (mg/L)	7	1.0	3.0	2.0	2.0	1.0
Hardness (mg/L)	4	18.7	20.5	20.0	19.8	0.8
Alkalinity (mg/L)[J]	6	< 6.0	13.8	10.8	10.0	3.8
Photic Zone (m)	7	4.88	8.64	6.80	6.55	1.43
Secchi (m)	7	1.70	3.66	3.02	2.87	0.72
Bottom Depth (m)	7	41.2	49.6	47.4	45.5	3.4
Chemical						
Ammonia Nitrogen (mg/L)[J]	7	< 0.015	< 0.015	0.008	0.008	0.000
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	< 0.010	0.146	0.019	0.040	0.052
Total Kjeldahl Nitrogen (mg/L)	7	0.105	0.836	0.232	0.319	0.246
Total Nitrogen (mg/L)[J]	7	< 0.507	2.523	0.251	0.358	0.249
Dis Reactive Phosphorus (mg/L)	7	< 0.008	0.008	0.004	0.004	0.000
Total Phosphorus (mg/L)[J]	7	0.007	0.046	0.012	0.018	0.014
CBOD-5 (mg/L)[J]	7	< 2.0	< 2.0	1.0	1.0	0.0
Chlorides (mg/L)[J]	7	1.7	2.5	2.0	2.0	0.2
Biological						
Chlorophyll a (mg/m³)	7	1.87	10.10	3.92	4.93	2.93
E. coli (MPN/DL)[J]	4	2	10	6	6	4

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

RESULTS (con't)

The mean growing season chl *a* concentration measured in 2017 and 2021 were higher than the 2012 growing season mean, which was the lowest measured since sampling began in 2002 (Figure 4). However, both the 2017 and 2021 mean chl *a* values were below the criteria limit of 6 ug/L established for Inland Reservoir in 2005. In 2017 and 2021, monthly chl *a* concentrations were highest in July (Figure 5).

According to mean annual TSI, the Inland Reservoir has been mesotrophic in almost all years sampled (Figure 4). In 2017, monthly TSI calculations indicated oligotrophic conditions in April and May (Figure 5). In 2021, the site was eutrophic during May and July.

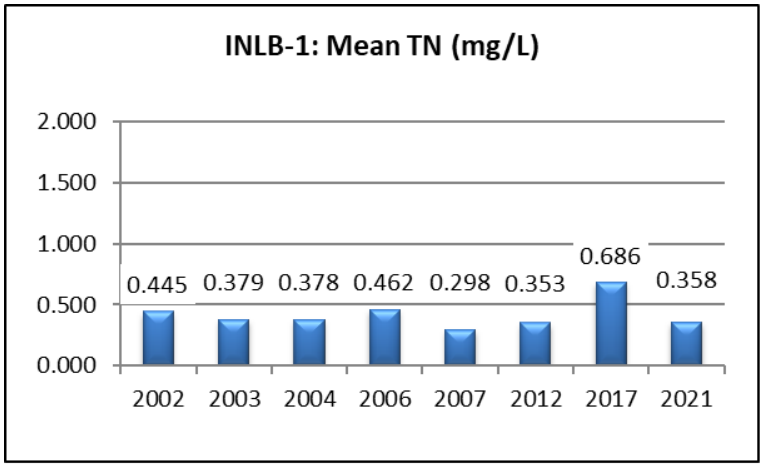
Mean growing season TSS concentrations have been below 3.0 mg/L since 2006 (Figure 4). In both 2017 and 2021, monthly TSS measurements were < 5 mg/L all months sampled (Figure 6).

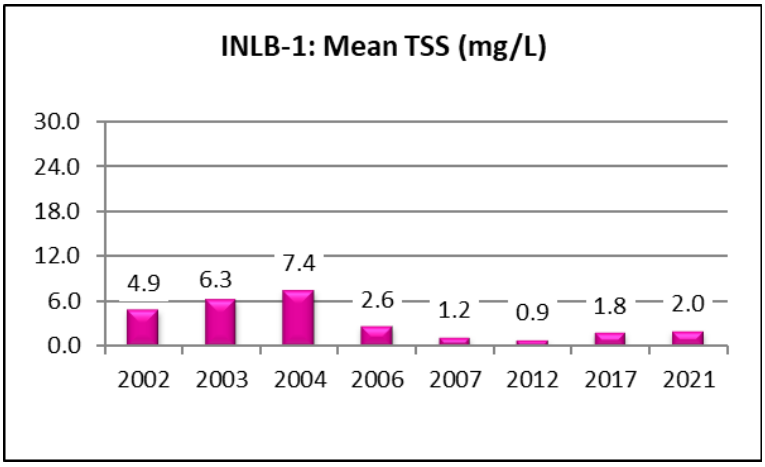
AGPT results show that Inland Reservoir was phosphorus-limited in 2007, co-limiting in 2012, and phosphorus-limited in 2017 (Table 3). All samples were below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

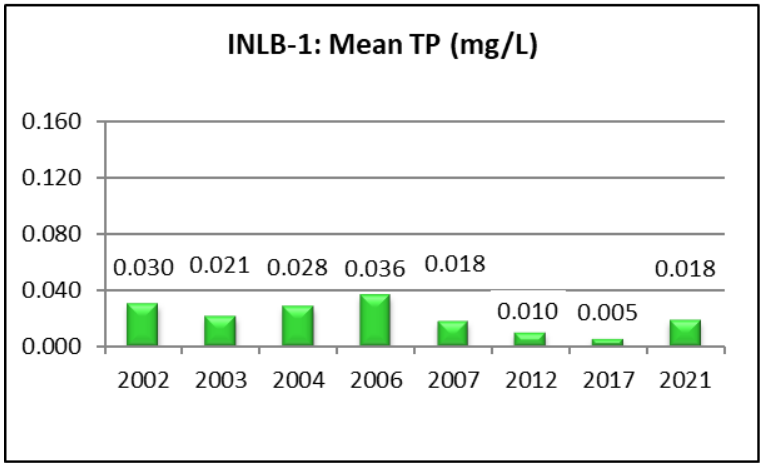
DO concentrations at INLB-1 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2017 and 2021 (ADEM Admin. Code R. 335-6-10-.09). (Figure 7).

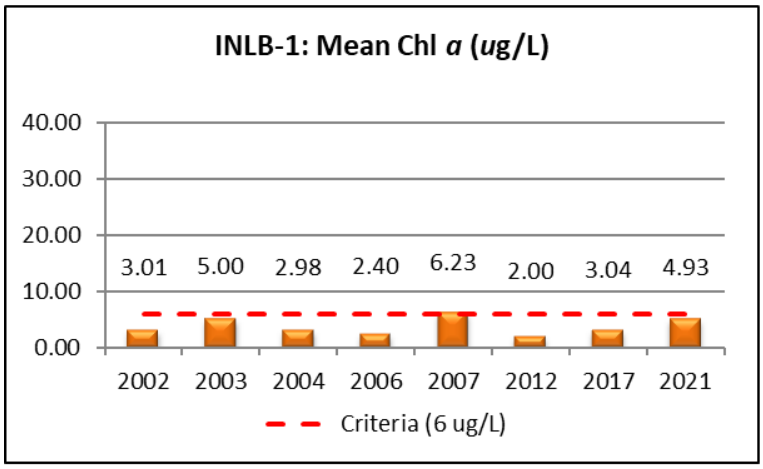
Table 3. Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
2007	1.41	Phosphorus
2012	2.28	Co-Limiting
2017	1.82	Phosphorus









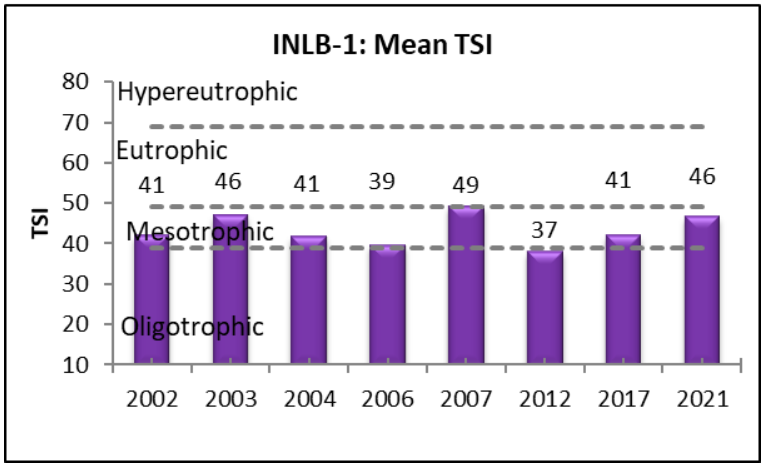
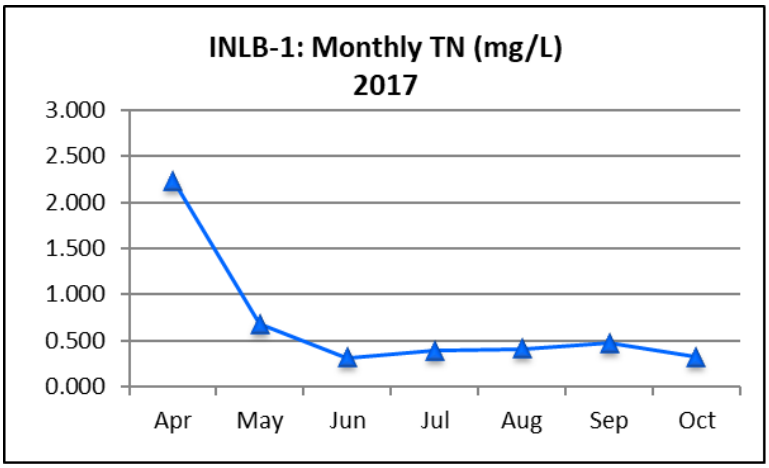
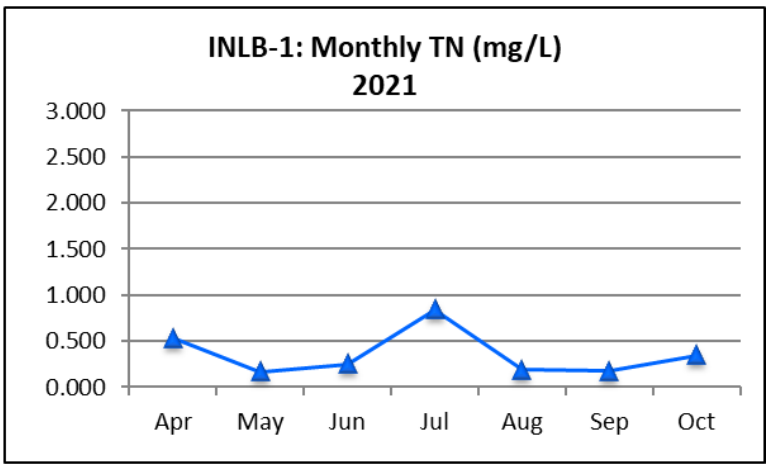
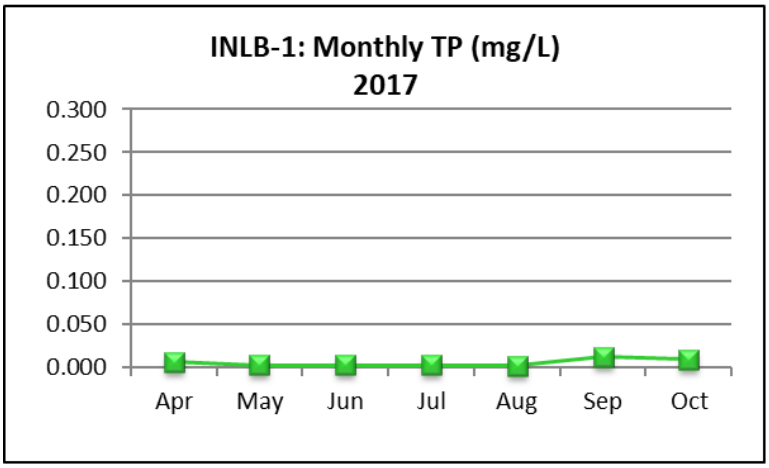
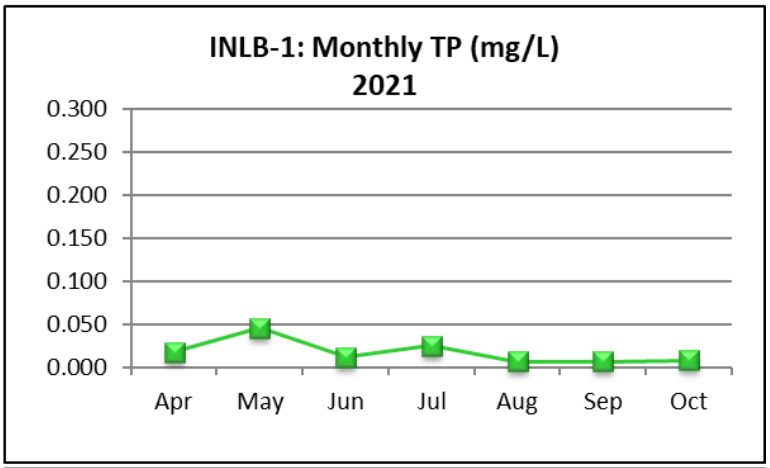


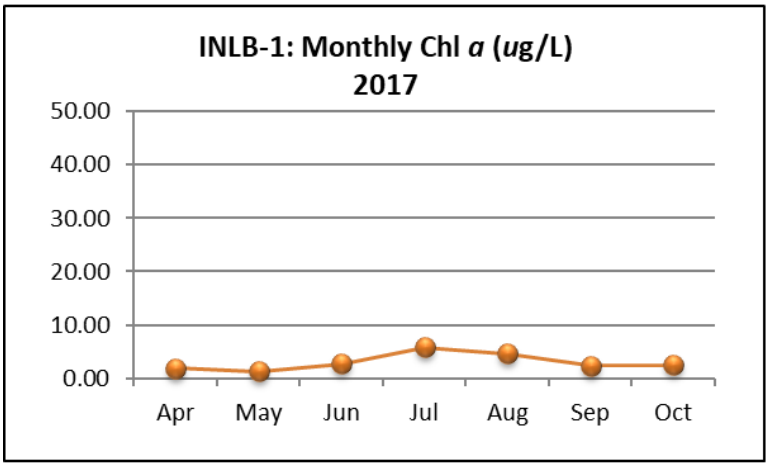
Figure 4. Mean growing season (2002-2021). TN, TP, chl *a,* and TSI measured in the Inland Reservoir forebay (INLB-1). Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

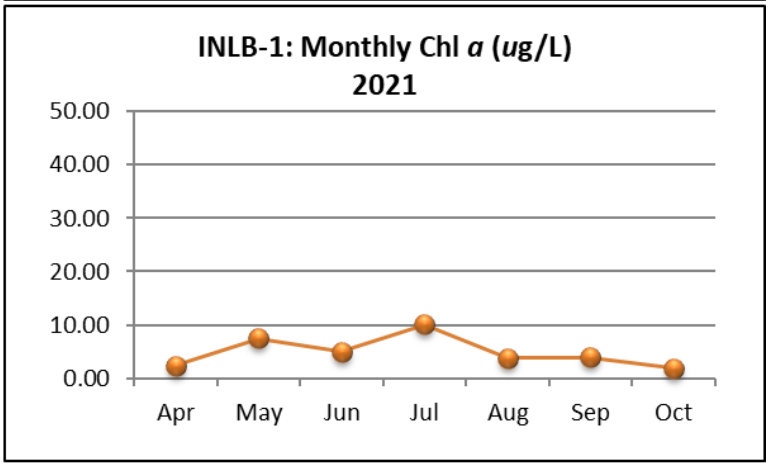


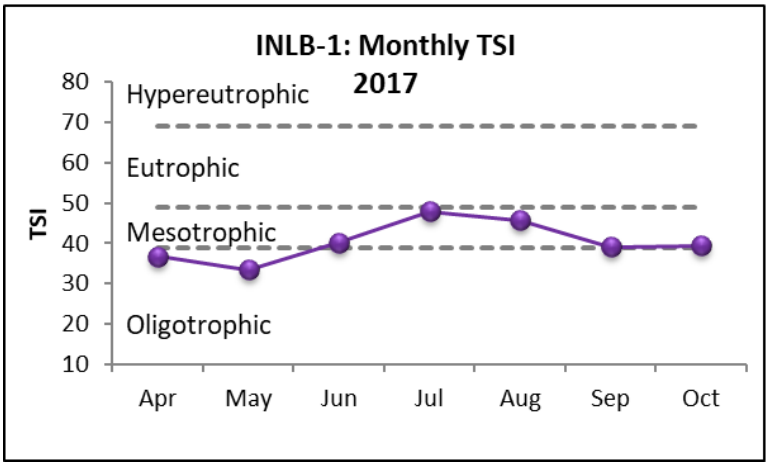












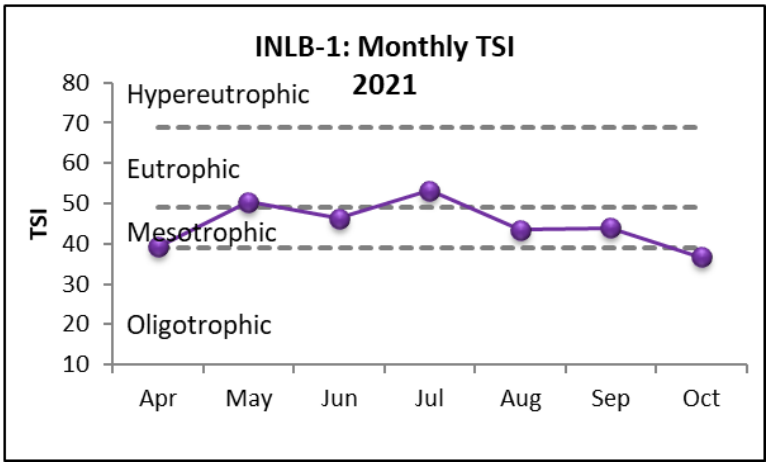
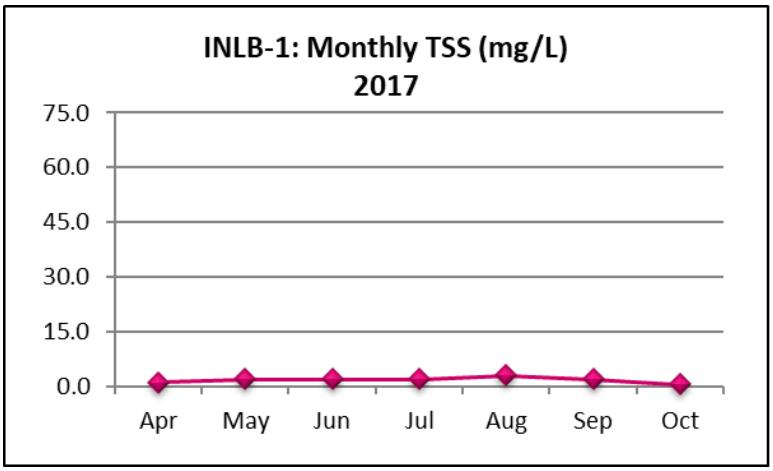


Figure 5. Monthly (April-October, 20157& 2021) TN, TP, chl *a,* and TSI measured in the Inland Reservoir forebay (INLB-1). Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



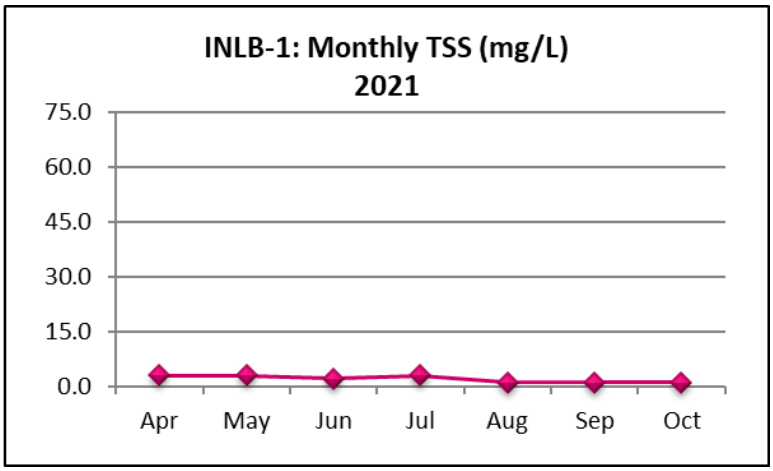
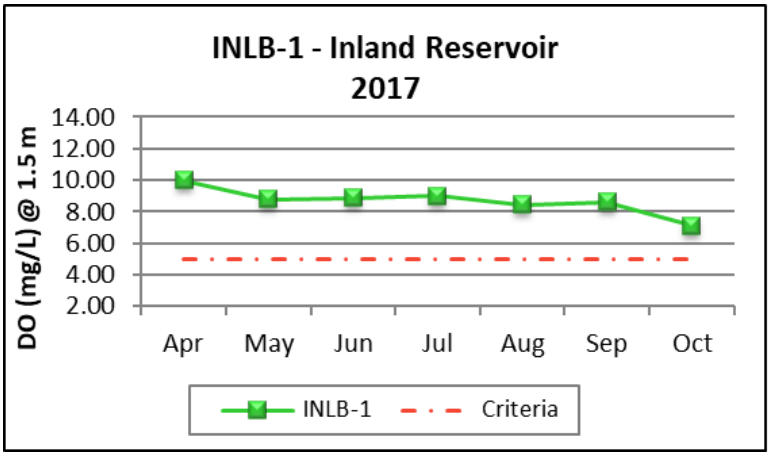


Figure 6. Monthly TSS measured at the Inland Reservoir forebay (INLB-1) in 2017 and 2020**.**



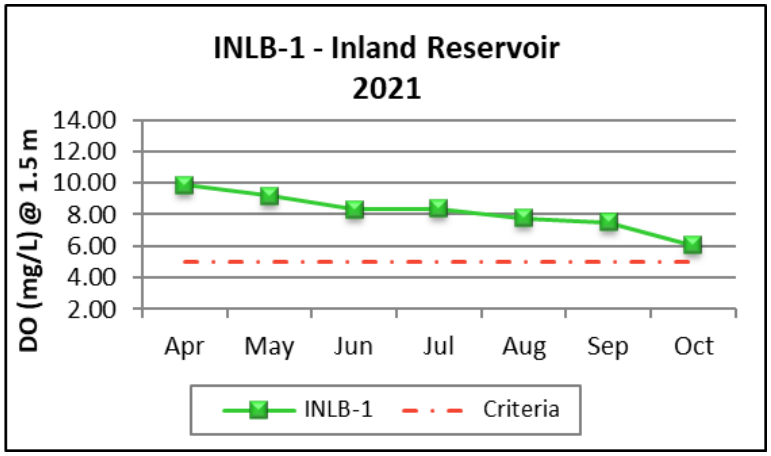


Figure 7. Monthly DO concentrations at 1.5 m (5 ft) for the Inland Reservoir forebay (INLB-1) collected April-October 2017 and June-Oct 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

REFERENCES

ADEM. 2017. State of Alabama Water Quality Monitoring Strategy. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 108 pp.

ADEM. 2021. Standard Operating Procedures Series #2000, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2023. Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring in Alabama Rev 2. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 176 pp.

ADEM. 2018. Quality Management Plan (QMP) for the Alabama Department of Environmental Management (ADEM) Rev 5.0, Montgomery, AL. 72 pp.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2021. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Carlson, R.E. 1977. A trophic state index. Limnology and Oceanography. 22(2):361-369.

Raschke, R.L. and D.A. Schultz. 1987. The use of the algal growth potential test for data assessment. Journal of Water Pollution Control Federation 59(4):222-227.

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