Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Browns Creek Embayment Guntersville Reservoir Intensive Basin Survey 2015 & 2018

GUNM-10: Browns Creek approximately 1 mi upstream of AL Hwy 69 bridge (Marshall Co 34.3446/-86.3306)

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 2015 and 2018, ADEM monitored the Browns Creek tributary embayment of Guntersville Reservoir 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 Browns Creek embayment (GUNM-10) during the 2015 and 2018 growing seasons (Apr-Oct). These are the fourth and fifth 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.

Browns Creek from the end of the embayment to the Tennessee River was listed on Alabama's 2012 Clean Water Act (CWA) §303 (d) list of impaired waters for not meeting its water use classifications. The entire waterbody is listed for elevated nutrients from agriculture activities. Further upstream, Browns Creek is also listed for nutrients from mining operations and pathogens due to animal feeding operations and pasture grazing.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Browns Creek is classified as a *Public Water Supply/Swimming/Fish & Wildlife (PWS/S/F&W)* stream located in the Sequatchie Valley ecoregion (68b). Based on the 2016 National Land Cover Dataset, land use within the 58 mi^2 watershed is predominantly forest (38%) and pasture/hay (Figure 3). As of January 28, 2016, ADEM has issued a total of 15 NPDES permits within the watershed. Three of those permits are located within 10 mi of the station (Figure 2).

Figure 1. Browns Creek at GUNM-10.

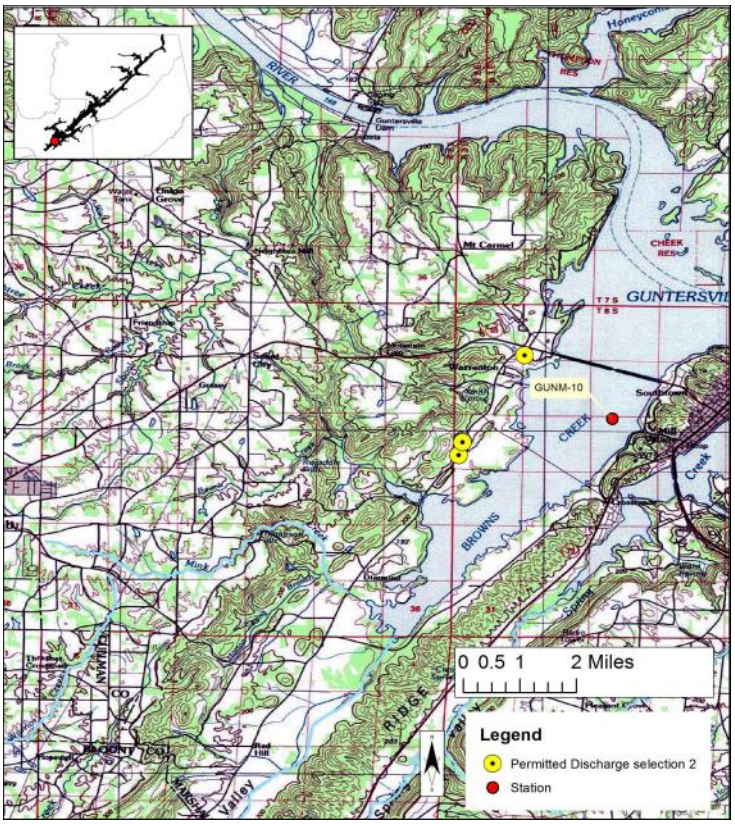


Figure 2. Map of Browns Creek embayment of Guntersville Reservoir. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles upstream of the station are displayed on the map.

SITE DESCRIPTION

Browns Creek is a large embayment located west of Guntersville, AL. Mean bottom depth at the sampling location is approximately 7.0 meters (Table 2). Like much of Lake Guntersville, submerged aquatic vegetation is present with floating mats of vegetation present in the shallower areas of the embayment.

METHODS

Water quality assessments were conducted at monthly intervals, April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2018a), Surface Water Quality Assurance Project Plan (ADEM 2018b), and Quality Management Plan (ADEM 2018c).

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 results. Carlson's TSI was calculated from the corrected chl *a* concentrations (1977).

Table 1. Summary of Watershed **GUNM-10**

Basin		Tennessee R
Drainage Area (mi^2)		58
Ecoregion[a]		68b
Assessment Unit		AL06030001-0904-101
% Landuse		
Open Water		13%
Developed	Open Space	4%
	Low Intensity	<1%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	29%
	Evergreen Forest	4%
	Mixed Forest	5%
Shrub/Scrub		5%
Herbaceous		3%
Hay/Pasture		30%
Cultivated Crops		4%
Wetlands	Woody	1%
	Emergent Herb.	<1%
# NPDES outfalls[b]	TOTAL	15
Construction Stormwater		4
Mining		1
Industrial General		10
Industrial Individual		0
No Exposure		0
Municipal		0
Underground Injection Control		0

a. Sequatchie Valley
b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Jan 28, 2016.

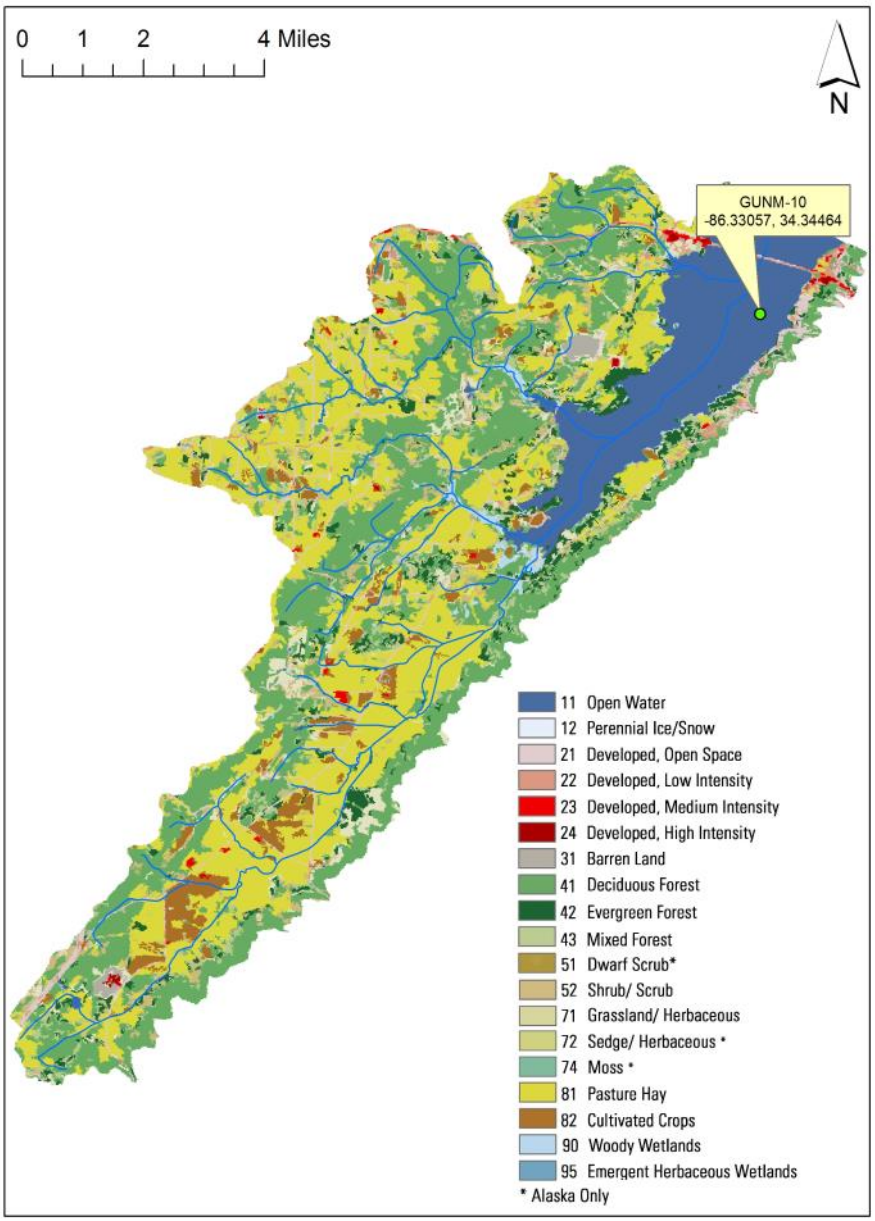


Figure 3. Land use within the Browns Creek watershed at GUNM-10.

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 4-6 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 increased 2003-2013 then declined in 2015 (Figure 4). Monthly TN concentrations were highest in August of 2015 and in June of 2018.

The mean growing season TP concentration decreased from 2009-2015 (Figure 5). The highest monthly TP concentration was measured in September of 2015 and in June of 2018.

The mean growing season chl *a* value decreased 2009-2015, but then increased again in 2018 (Figure 5). The highest monthly chl *a* concentration was measured in August of 2015 and in June of 2018.

The lowest mean TSI measured at Browns Creek was in 2015. However, conditions have remained eutrophic since monitoring began in 2003 (Figure 5). In 2015, monthly TSI in Browns Creek was oligotrophic April-June, increasing to eutrophic the rest of the growing season. In 2018, conditions remained eutrophic for the duration of the sampling season.

Table 2. Summary of water quality data collected (April-October, 2015 and 2018). 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.

GUNM-10 2015	N		Min	Max	Med	Avg	SD
Physical							
Turbidity (NTU)	7		2.7	7.3	5.3	4.8	2.0
Total Dissolved Solids (mg/L)	7		84.0	114.0	104.0	101.9	9.1
Total Suspended Solids (mg/L)	7	<	1.0	9.0	3.0	4.2	3.2
Hardness (mg/L)	4		66.9	82.7	79.6	77.2	7.0
Alkalinity (mg/L)	7		63.3	75.0	71.4	69.8	4.5
Photic Zone (m)	7		2.35	6.13	3.66	4.15	1.60
Secchi (m)	7		0.88	3.35	1.54	1.91	1.02
Bottom Depth (m)	7		7.0	7.2	7.0	7.1	0.1
Chemical							
Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.037	0.005	0.014	0.014
Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.001	0.099	0.007	0.020	0.035
Total Kjeldahl Nitrogen (mg/L)[J]	7		0.072	1.230	0.572	0.520	0.398
Total Nitrogen (mg/L)[J]	7		0.237	3.714	0.573	0.540	0.392
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.005	0.003	0.003	0.002
Total Phosphorus (mg/L)	7		0.014	0.036	0.021	0.021	0.008
CBOD-5 (mg/L)[J]	7	<	2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7		6.0	8.5	7.5	7.2	1.0
Biological							
Chlorophyll a (mg/m³)	7	<	1.00	39.40	14.00	13.71	14.72
E. coli (MPN/DL)[J]	3	<	1	1	1	1	0
GUNM-10 2018	**N**		**Min**	**Max**	**Med**	**Avg**	**SD**
Physical							
Turbidity (NTU)	7		3.1	8.0	3.9	4.7	1.9
Total Dissolved Solids (mg/L)	7		90.0	105.0	102.0	100.1	5.3
Total Suspended Solids (mg/L)	7		1.0	9.0	5.0	4.7	2.9
Hardness (mg/L)	4		58.0	70.3	65.6	64.9	5.1
Alkalinity (mg/L)	7		55.5	72.0	65.5	65.8	5.2
Photic Zone (m)	7		2.45	5.30	4.40	4.18	1.21
Secchi (m)	7		0.53	2.43	1.21	1.23	0.61
Bottom Depth (m)	7		3.9	7.7	7.2	6.7	1.3
Chemical							
Ammonia Nitrogen (mg/L)[J]	7	<	0.015	0.019	0.008	0.009	0.004
Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.007	0.076	0.004	0.014	0.027
Total Kjeldahl Nitrogen (mg/L)	7		0.299	0.727	0.610	0.572	0.152
Total Nitrogen (mg/L)[J]	7	<	0.908	2.262	0.614	0.586	0.163
Dis Reactive Phosphorus (mg/L)[J]	7	<	0.004	0.005	0.002	0.003	0.001
Total Phosphorus (mg/L)	7		0.011	0.046	0.018	0.021	0.012
CBOD-5 (mg/L)	7	<	2.0	3.1	1.0	1.3	0.8
Chlorides (mg/L)[J]	7		4.3	7.9	5.4	5.7	1.2
Biological							
Chlorophyll a (mg/m³)	7		11.00	45.40	17.10	21.66	11.52
E. coli (MPN/DL)	4	<	1	1	1	1	0

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

RESULTS (con't)

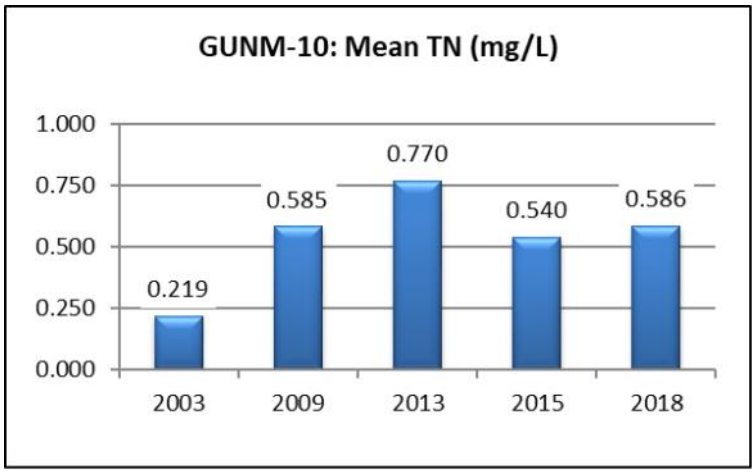
The mean growing season TSS concentration was highest in 2003, but it appears to have stabilized since then (Figure 5). Monthly TSS concentrations were highest in August of 2015 and in October of 2018.

AGPT results show that Browns Creek was nitrogen limited in 2013 (Table 3). Raschke and Schultz (1987) found that maximum standing crop (MSC) values below 5.0 mg/L are considered to be protective of reservoir and lake systems. In 2013, the mean MSC was 2.67 mg/L. MSC values from all previous samples have also been less than 5.0 mg/L. AGPT samples were not collected at Browns Creek during the 2015 or 2018 sampling seasons.

The DO concentration at the Browns Creek station was above the ADEM criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) for all monthly sampling dates in both 2015 and 2018. (ADEM Admin. Code R. 335-6-10-.09) (Figure 6).

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	3.75	PHOSPHORUS
2009	2.97	NITROGEN
2013	2.67	NITROGEN



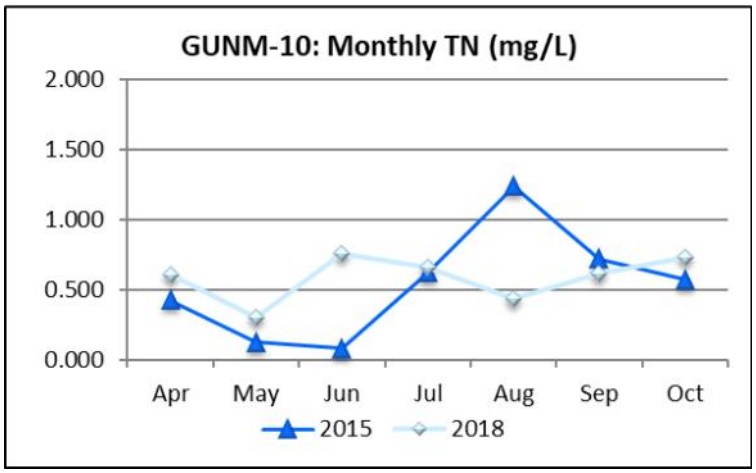
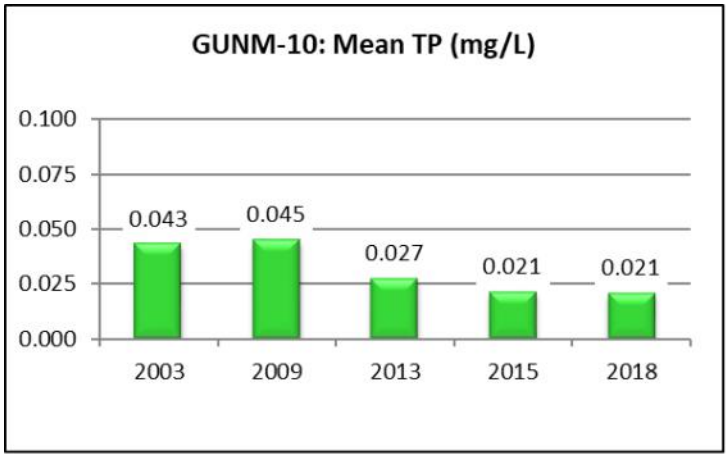
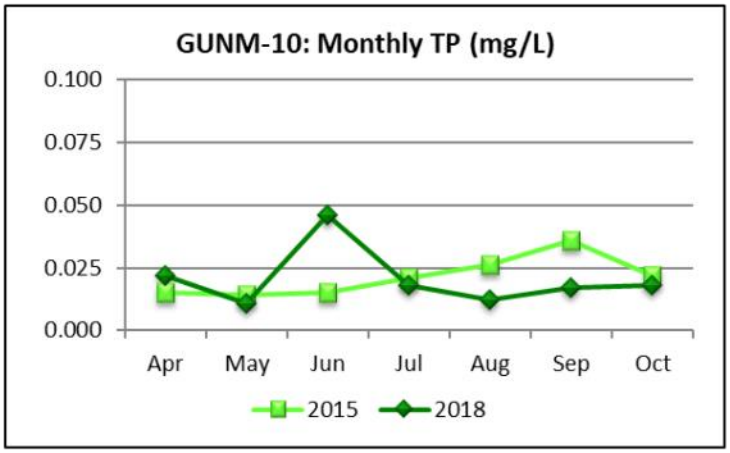
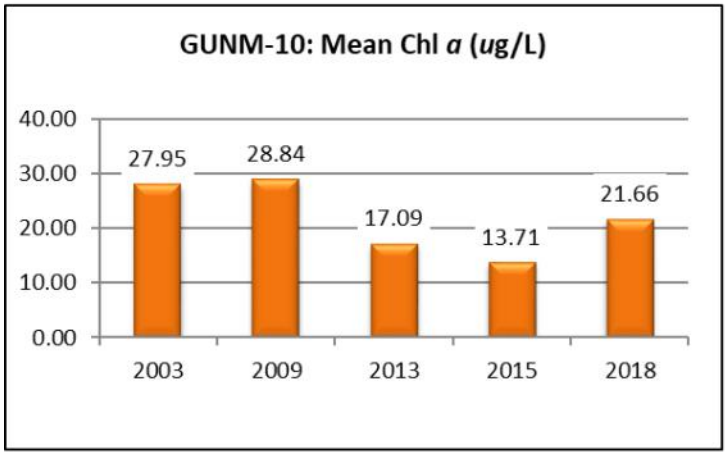
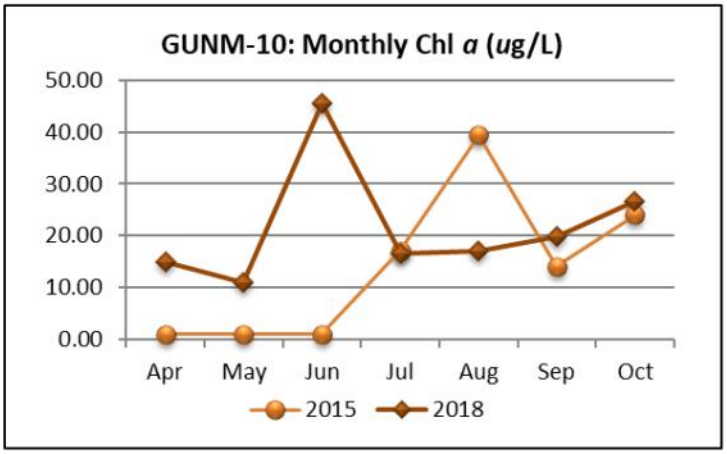


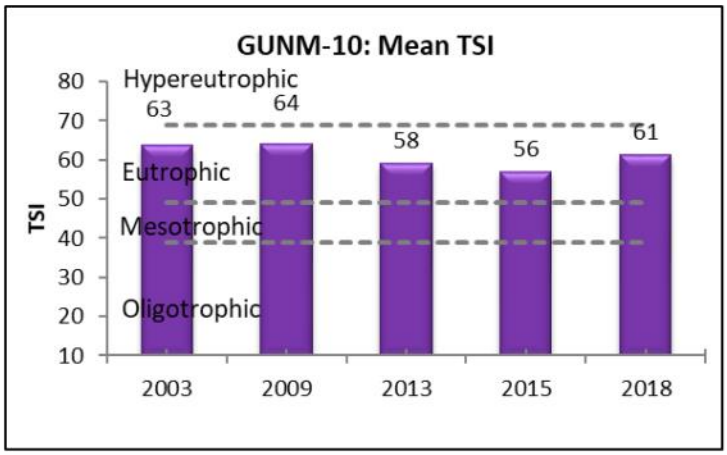
Figure 4. Mean growing season (2003-2018) and monthly (April-October, 2015 and 2018) TN measured in the Browns Creek embayment (GUNM-10) of Guntersville Reservoir. Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

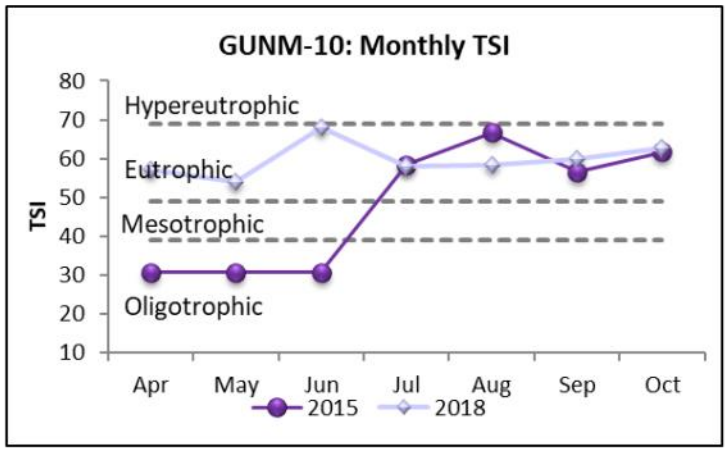


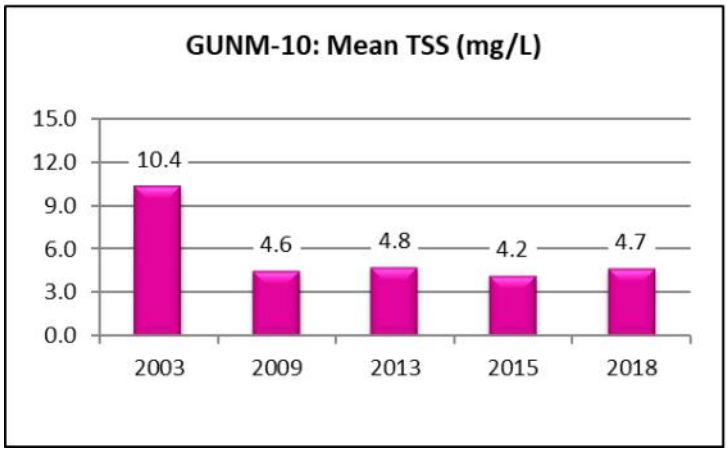












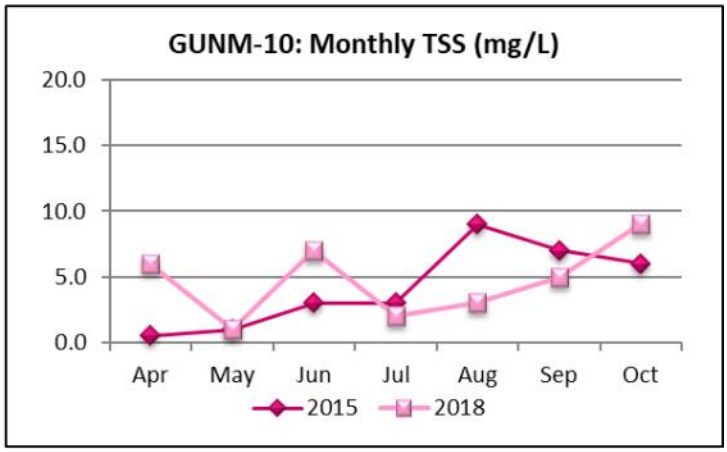


Figure 5. Mean growing season (2003-2018) and monthly (April-October, 2015 and 2018) TP, chl *a,* TSI, and TSS measured in the Browns Creek embayment (GUNM-10) of Guntersville Reservoir**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

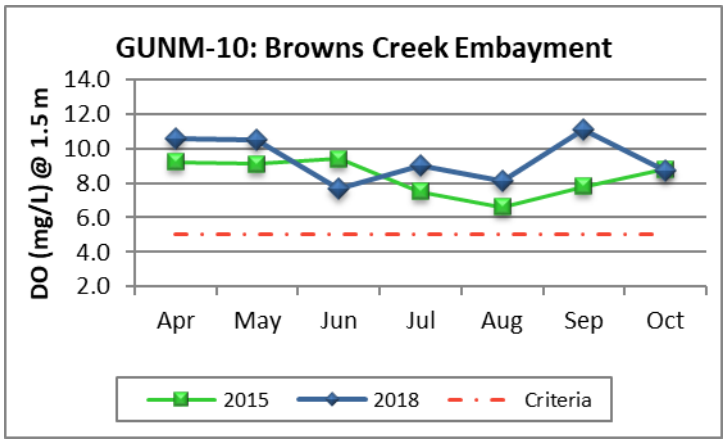


Figure 6. Monthly DO concentrations at 1.5 m (5 ft) for Browns Creek embayment station (GUNM-10) of Guntersville Reservoir collected (April-October, 2015 and 2018). ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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FOR MORE INFORMATION, CONTACT:
Ben Darby, ADEM Rivers and Reservoirs Unit
1350 Coliseum Boulevard, Montgomery, AL 36110
(334) 260-2708, bedarby@adem.alabama.gov