2018 Purdy Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
River and Reservoirs Unit
June 2022

Rivers and Reservoirs Monitoring Program

2018

Purdy Reservoir

Cahaba River Basin

Alabama Department of Environmental Management
Field Operations Division
Rivers and Reservoirs Unit

June 2022

Table of Contents

LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
CHL *a*	Chlorophyll *a*
DO	Dissolved Oxygen
F&W	Fish and Wildlife water supply use classification
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Maximum Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters water supply use classification
ONRW	Outstanding National Resource Water
PWS	Public Water Supply water supply use classification
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports water supply use classification
SD	Standard Deviation
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Purdy Reservoir is located in Jefferson and Shelby Counties near the city of Birmingham. The 1,050 acre water body was established with the completion of the dam in 1929. The reservoir is owned and operated by the Birmingham Water Works and Sewer Board of Birmingham.

The Alabama Department of Environmental Management (ADEM) monitored Purdy Reservoir as part of the 2015 and 2018 assessments of the Cahaba River Basin under the Rivers and Reservoirs Monitoring Program (RRMP). 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 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, a consumption advisory was issued by the Alabama Department of Public Health (ADPH) due to mercury found in fish tissue. As a result, all waters from Purdy Dam upstream to the top of the reservoir were placed on Alabama's 2018 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its Public Water Supply and Fish & Wildlife (PWS/F&W) water use classifications due to impairments caused by atmospheric deposition of metals (mercury).

Specific water quality criteria for nutrient management were implemented at two locations on Purdy Reservoir in 2010 (Table 1). These criteria represent growing season mean chl *a* concentrations that are protective of the reservoir's Public Water Supply and Fish & Wildlife (PWS/F&W) use classifications.

The purpose of this report is to summarize data collected at Purdy Reservoir during the 2015 and 2018 growing seasons and to evaluate growing season trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and growing season

mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [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.

METHODS

Sampling stations were selected using historical data and previous assessments (Figure 1). Specific location information can be found in Table 1. Purdy was sampled at the dam forebay and at one additional station in the upper reservoir.

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

Growing season mean TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site.

Figure 1. Purdy Reservoir with 2015 and 2018 sampling locations. A description of each sampling location is provided in Table 1.

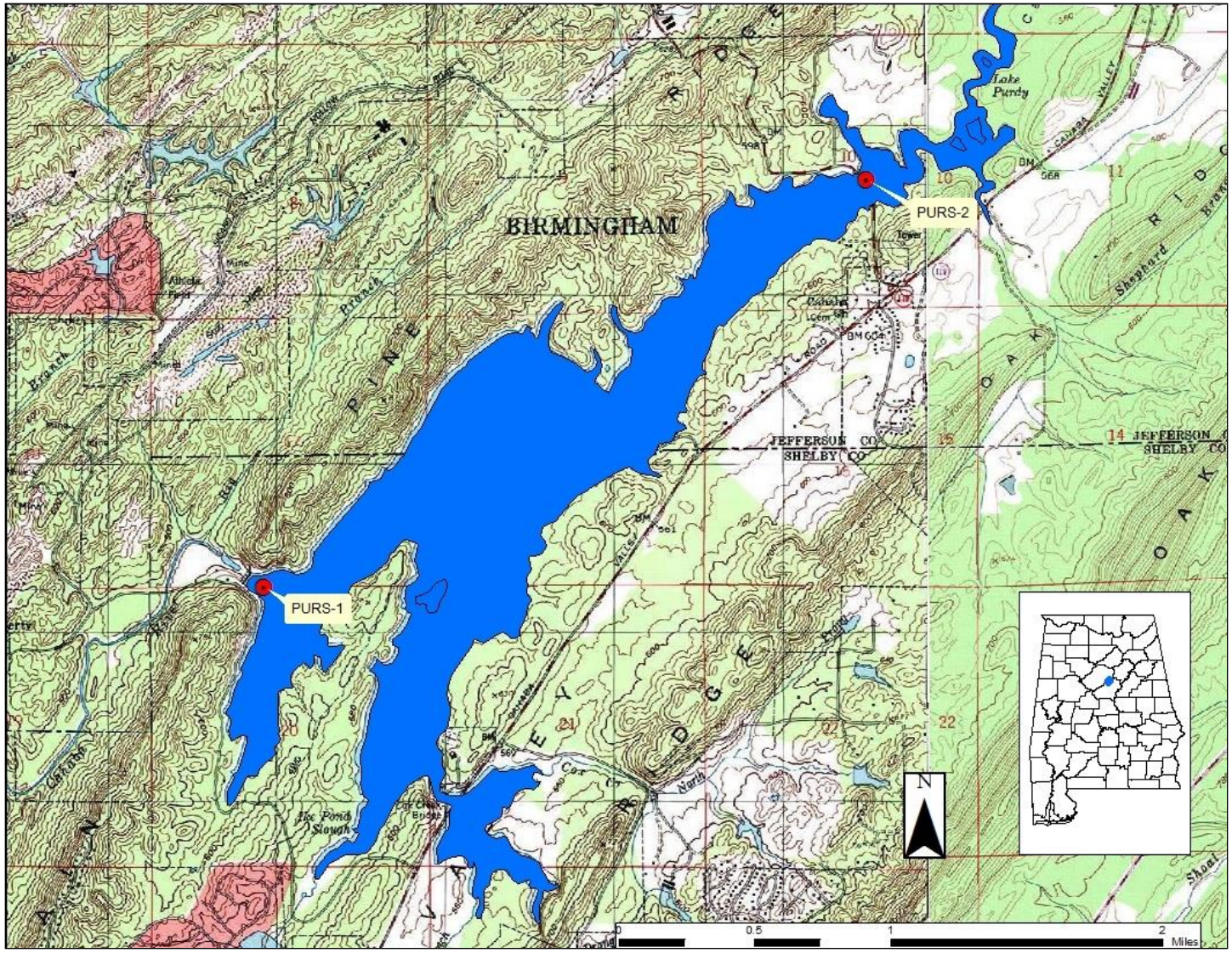


Table 1. Descriptions of the 2015 and 2018 monitoring stations.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criteria*	Latitude	Longitude
Purdy Reservoir								
031502020103	Shelby	PURS-1	Lower Purdy	Little Cahaba R	Deepest point, main river channel, dam forebay.	16 µg/l	33.459449	-86.667274
031502020103	Jefferson	PURS-2	Upper Purdy	Little Cahaba R	Deepest point, main river channel, immed. downstream of Irondale Bridge.	18 µg/l	33.481067	-86.628783

*Growing season mean chl *a* criteria implemented at Purdy in 2010.

RESULTS

Growing season mean graphs for TN, TP, chl *a*, and TSS are provided in this section (Figures 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figures 4-8 & 11). Algal growth potential test (AGPT) results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figures 9-10. Summary statistics of all data collected during 2015 and 2018 are presented in Appendix Table 1 and Appendix Table 2. These tables contain the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

Stations with the highest concentrations of nutrients, chlorophyll *a*, and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2015 and 2018, growing season mean TN concentrations were higher at the upper Purdy station (Figure 2). Mean TN concentrations at the lower Purdy station increased from 2003 to 2006, but values appear to have stabilized since 2012. Mean TN concentrations at the upper station increased 2007-2015, but decreased in 2018. In 2015, monthly TN concentrations were at or above historic means in all months except October at the upper station and July at the lower station (Figure 4). In 2018, monthly TN concentrations at the upper station were at or below historic means in all months except August. However, monthly concentrations at the lower station were above historic means in all months except June. Historic monthly highs were observed in 2015 at the upper station in September and the lower station in April.

In general, mean growing season TP concentrations at the lower station have decreased steadily since 2003 (Figure 2). In 2018, concentrations at both Purdy stations were the lowest values recorded since monitoring of the reservoir began in 2002. In 2015, monthly TP concentrations in the upper station were at or below historic means in all months except June, August, and September, which was a historic high value (Figure 5). All monthly concentrations recorded in the lower station were at or below historic means in all months sampled in both 2015 and 2018. Historical low concentrations were observed four times at the upper station in 2018—

June, July, September, and October. The lower station reached historical low concentrations in June and August of 2018.

Growing season mean chl *a* concentrations were the lowest on record at both stations during the 2015 sampling season (Figure 3). Record high mean chl *a* concentrations were observed in the upper station in 2018. Mean concentrations in the lower station were lower in 2015 and 2018 compared to those observed in previous sampling years. Specific water quality criteria for nutrient management were established at both Purdy stations in 2010. The seasonal mean chl *a* concentrations measured on Purdy Reservoir were below the criteria limit at both stations in 2015. However, mean concentrations in the upper station exceeded criteria for the first time in 2018. Monthly chl *a* concentrations at both Purdy stations were below historic means for most of the 2015 sampling season; July and October at the lower station were the only exceptions (Figure 6). In 2018, monthly chl *a* concentrations at the upper station were higher than those observed in 2015, with values reaching historic highs in April and October. The lower station remained below the historic means in all months except August.

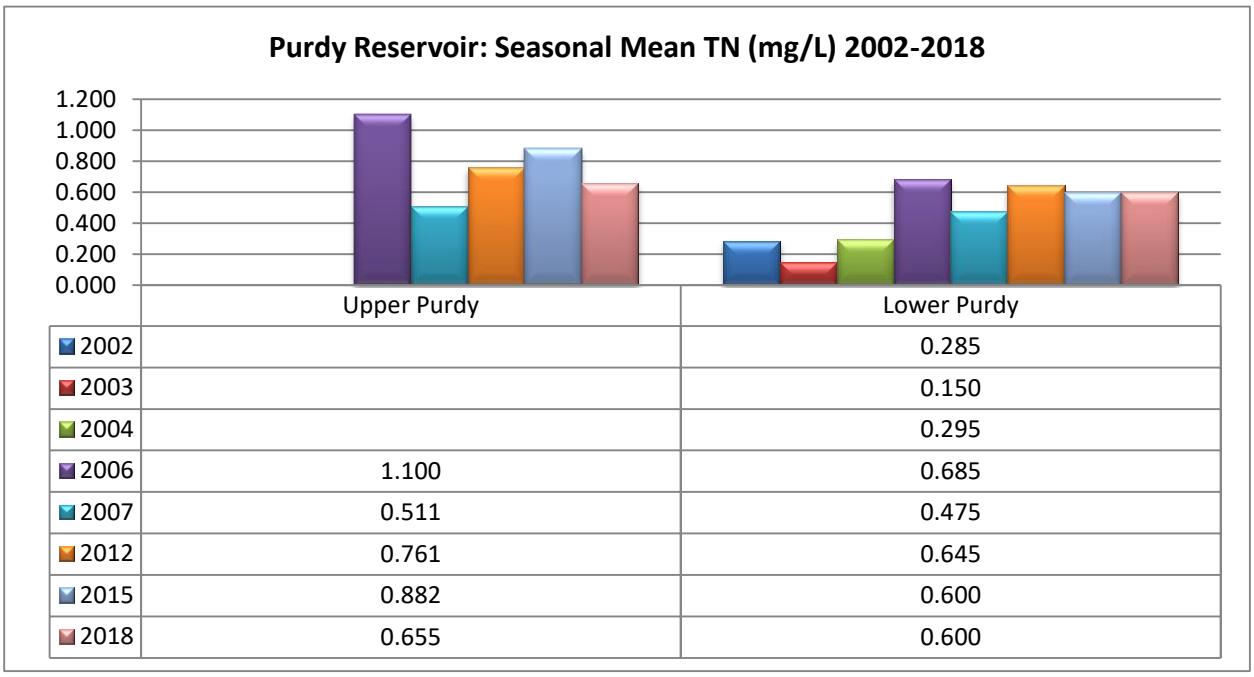
Growing season mean TSS concentrations were the lowest on record at both stations during the 2015 sampling season (Figure 3). In general, mean TSS concentrations appeared to decrease in Purdy Reservoir from 2003 to 2015. However, concentrations slightly increased at both stations in 2018. Monthly TSS concentrations at both Purdy stations were below historic means in 2015, with the highest concentration measured in May at the upper station (Figure 7). During the 2018 sampling season, most monthly TSS concentrations were higher than those observed in 2015. A historic high TSS concentration was measured in April at the upper station in 2018.

No AGPT samples were collected in Purdy Reservoir during the 2015 or 2018 sampling seasons. However, results indicated that the upper Purdy station was phosphorus-limited and the lower station was co-limiting in 2012 (Table 2). Raschke and Schultz (1987) defined a mean standing crop (MSC) value of 5.0 mg/L as protective of reservoir and lake systems. All samples collected at Purdy Reservoir have had MSC values less than 5.0 mg/L.

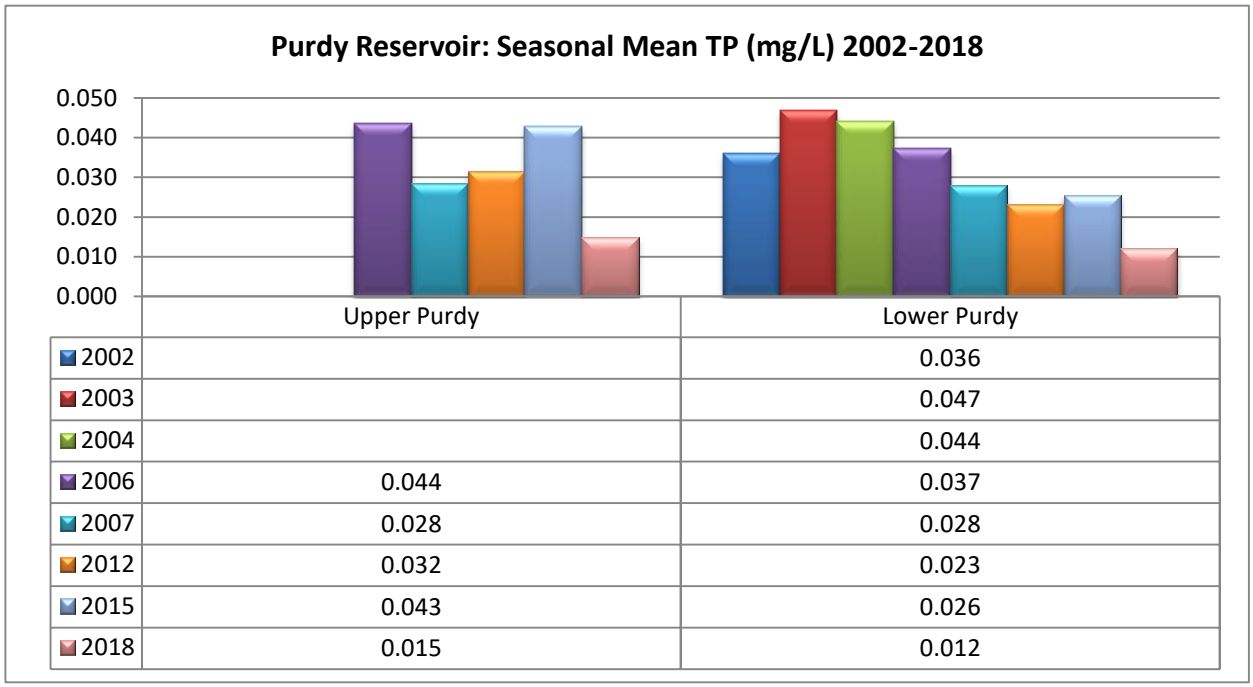
All dissolved oxygen readings were above the ADEM criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) throughout the growing season in both 2015 and 2018 (Figure 8). Based on monthly profiles collected at the lower station, the water column was stratified in all months, April-October in both 2015 and 2018 (Figures 9 & 10). In 2015, anoxic conditions were observed in the water column at depths below 5.0 meters from May-July, and at least half of the water column recorded DO concentrations less than 5.0 mg/L in all months sampled. In 2018, DO concentrations reached anoxic conditions by 13.0 meters during all months sampled. Temperature profiles indicated that thermoclines were present during several months of sampling. The highest water temperatures were recorded June-August in 2015 and 2018.

Monthly TSI values were calculated using chl *a* concentrations and Carlson's Trophic State Index (Figure 11). In 2015, eutrophic, or borderline eutrophic, conditions were observed at both the upper and lower stations in July, September, and October. In 2018, monthly TSI values indicated eutrophic conditions during all months sampled at both stations, except in October at the lower station, which was mesotrophic.

Figure 2. Growing season mean TN and TP measured in Purdy Reservoir, April-October 2002-2018.

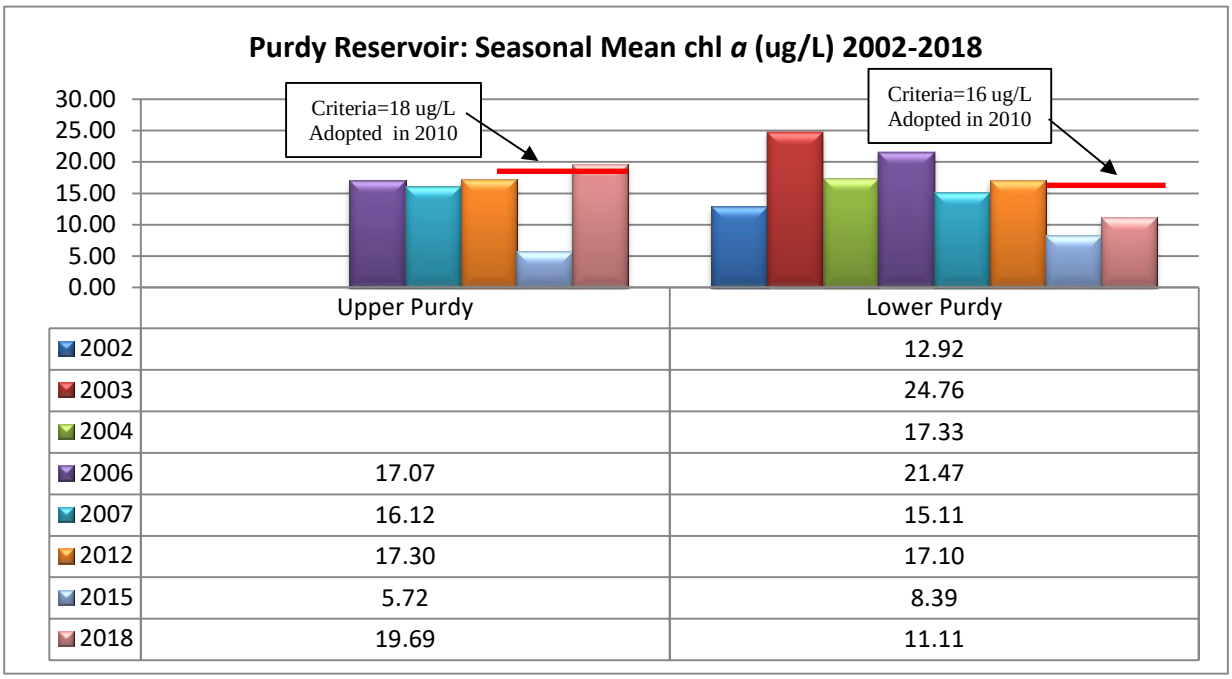


	Upper Purdy	Lower Purdy
2002		0.285
2003		0.150
2004		0.295
2006	1.100	0.685
2007	0.511	0.475
2012	0.761	0.645
2015	0.882	0.600
2018	0.655	0.600

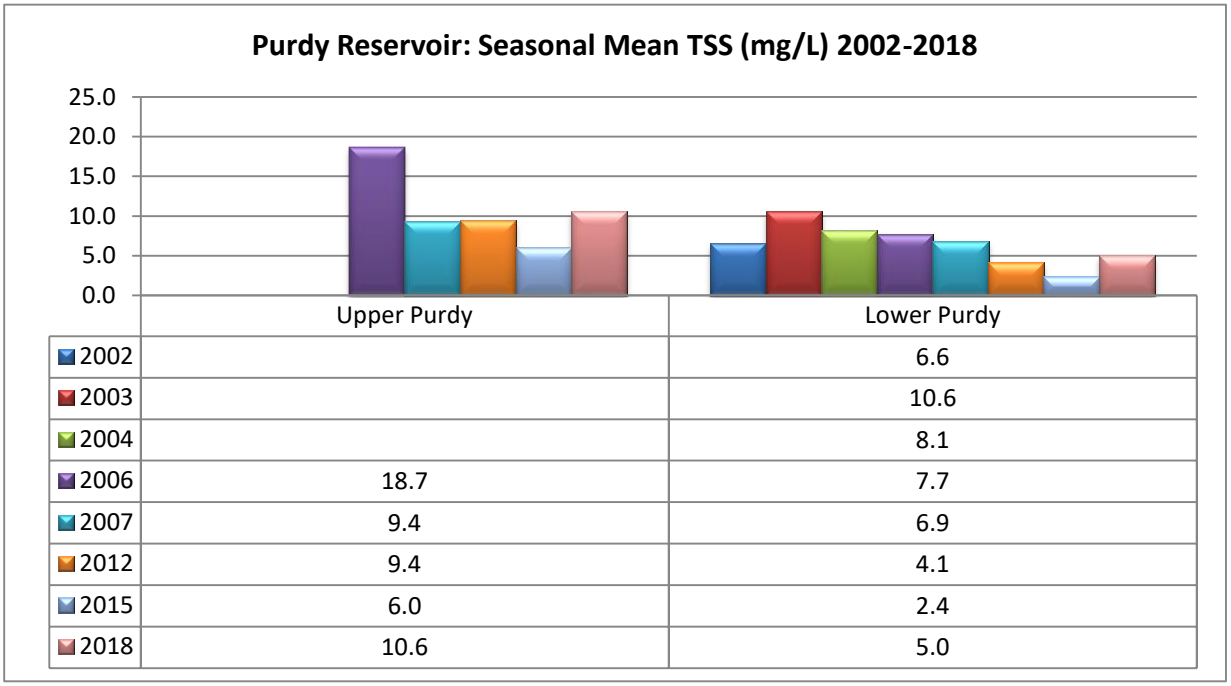


	Upper Purdy	Lower Purdy
2002		0.036
2003		0.047
2004		0.044
2006	0.044	0.037
2007	0.028	0.028
2012	0.032	0.023
2015	0.043	0.026
2018	0.015	0.012

Figure 3. Growing season mean chl *a* and TSS measured in Purdy Reservoir, April-October 2002-2018.

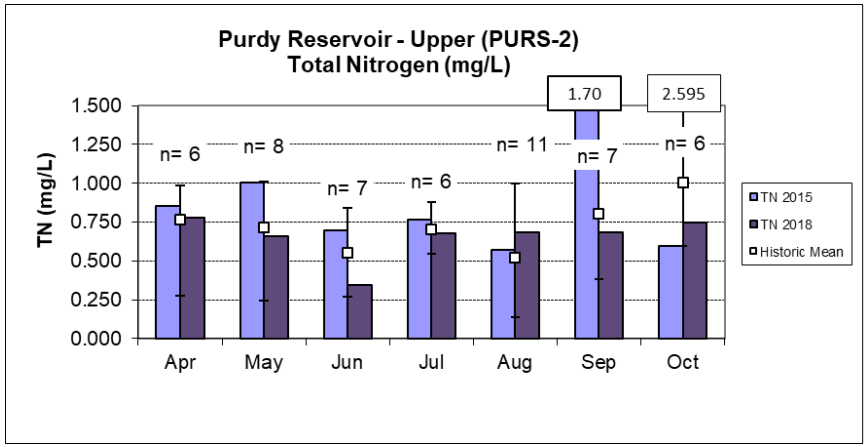


	Upper Purdy	Lower Purdy
2002		12.92
2003		24.76
2004		17.33
2006	17.07	21.47
2007	16.12	15.11
2012	17.30	17.10
2015	5.72	8.39
2018	19.69	11.11



	Upper Purdy	Lower Purdy
2002		6.6
2003		10.6
2004		8.1
2006	18.7	7.7
2007	9.4	6.9
2012	9.4	4.1
2015	6.0	2.4
2018	10.6	5.0

Figure 4. Monthly TN concentrations of the stations in Purdy Reservoir, April-October 2015 and 2018. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.



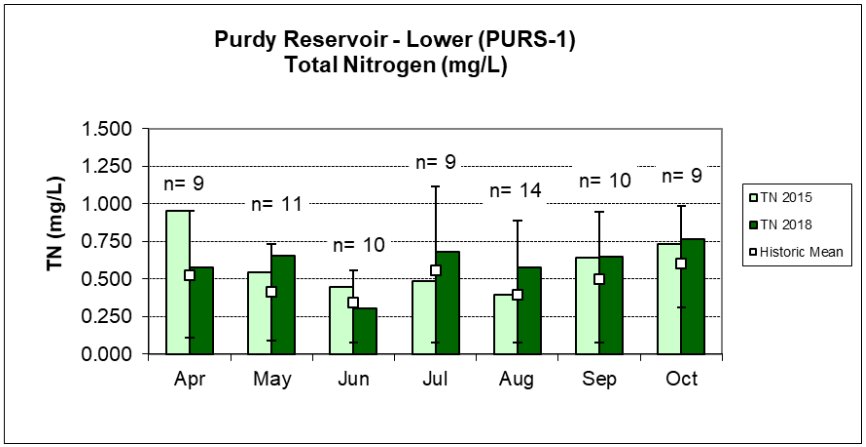
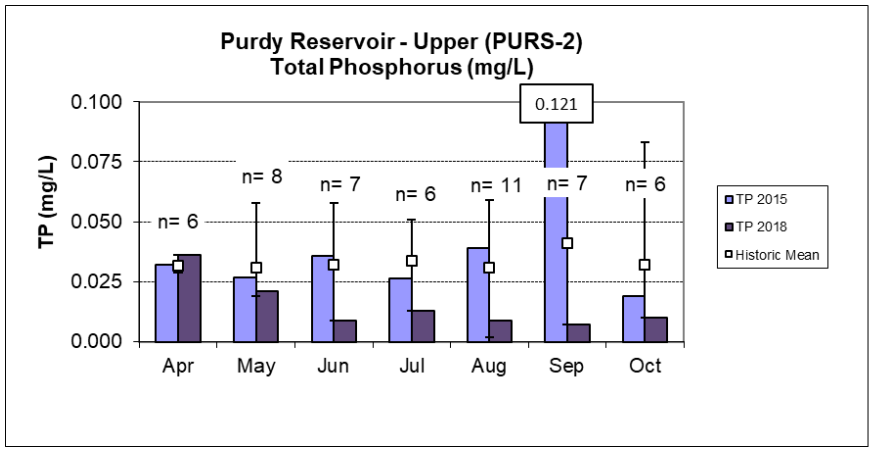


Figure 5. Monthly TP concentrations of the stations in Purdy Reservoir, April-October 2015 and 2018. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.



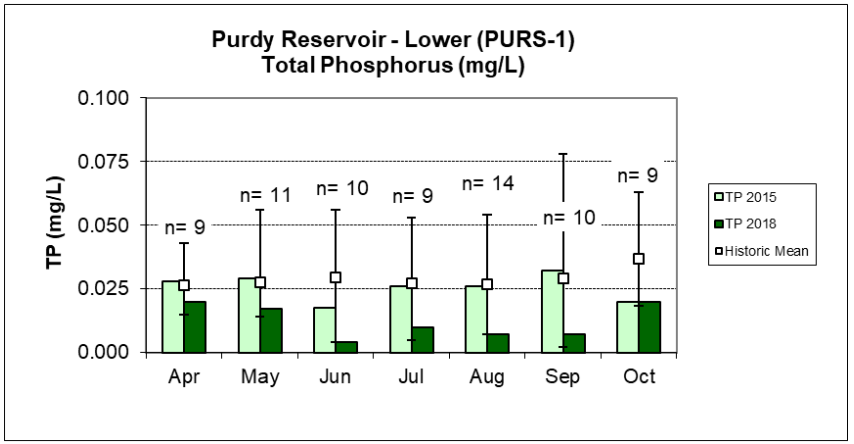
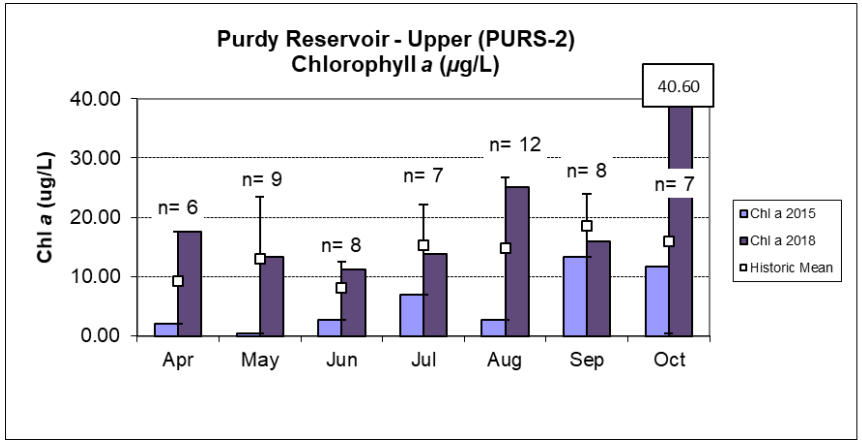


Figure 6. Monthly chl *a* concentrations of the stations in Purdy Reservoir, April-October 2015 and 2018. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.



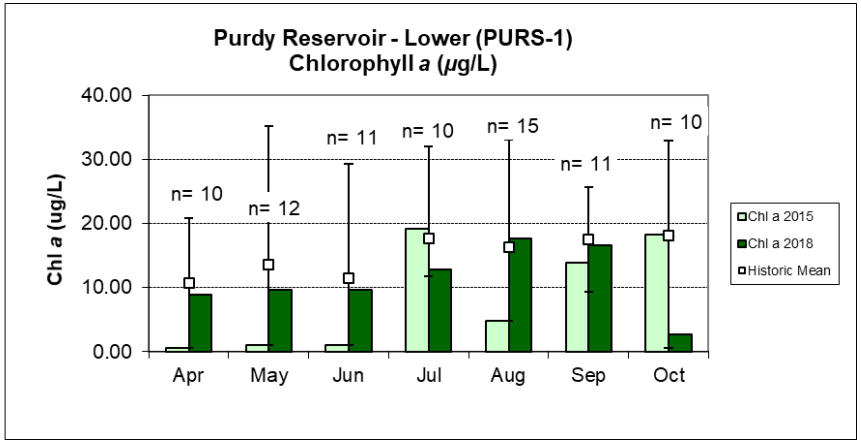
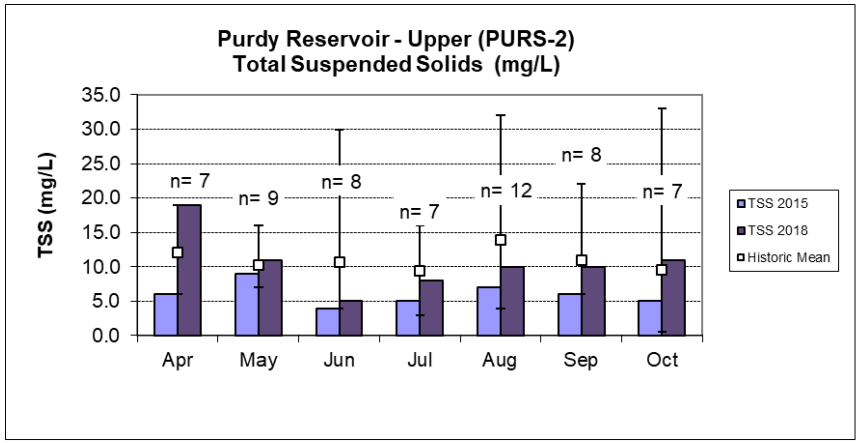


Figure 7. Monthly TSS concentrations of the stations in Purdy Reservoir, April-October 2015 and 2018. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.



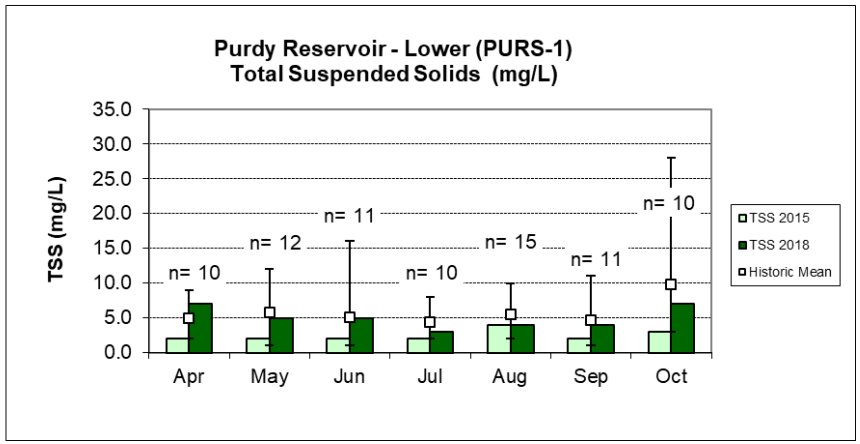
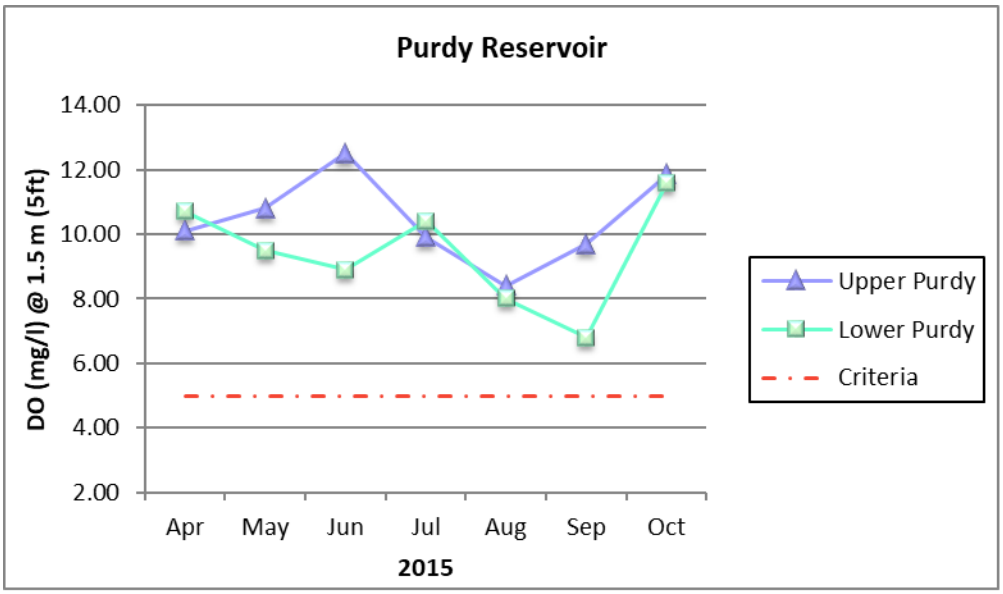


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

Station	Upper Purdy (PURS-2)		Lower Purdy (PURS-1)	
	MSC	**Limiting Nutrient**	**MSC**	**Limiting Nutrient**
August 2006	1.88	Phosphorus	1.58	Non-limiting
June 2007	1.41	Phosphorus	1.80	Phosphorus
July 2007	1.21	Phosphorus	1.27	Phosphorus
August 2007	2.22	Phosphorus	1.55	Phosphorus
August 2012	2.82	Phosphorus	2.48	Co-limiting

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Purdy Reservoir collected April-October 2015 and 2018. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).



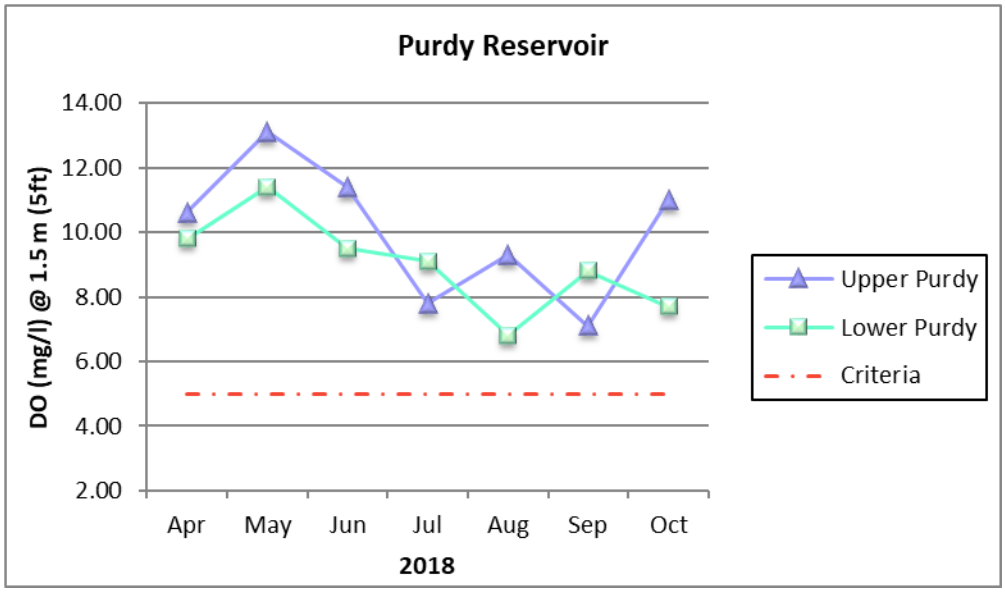


Figure 9. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in Lower Purdy Reservoir, April-October 2015.

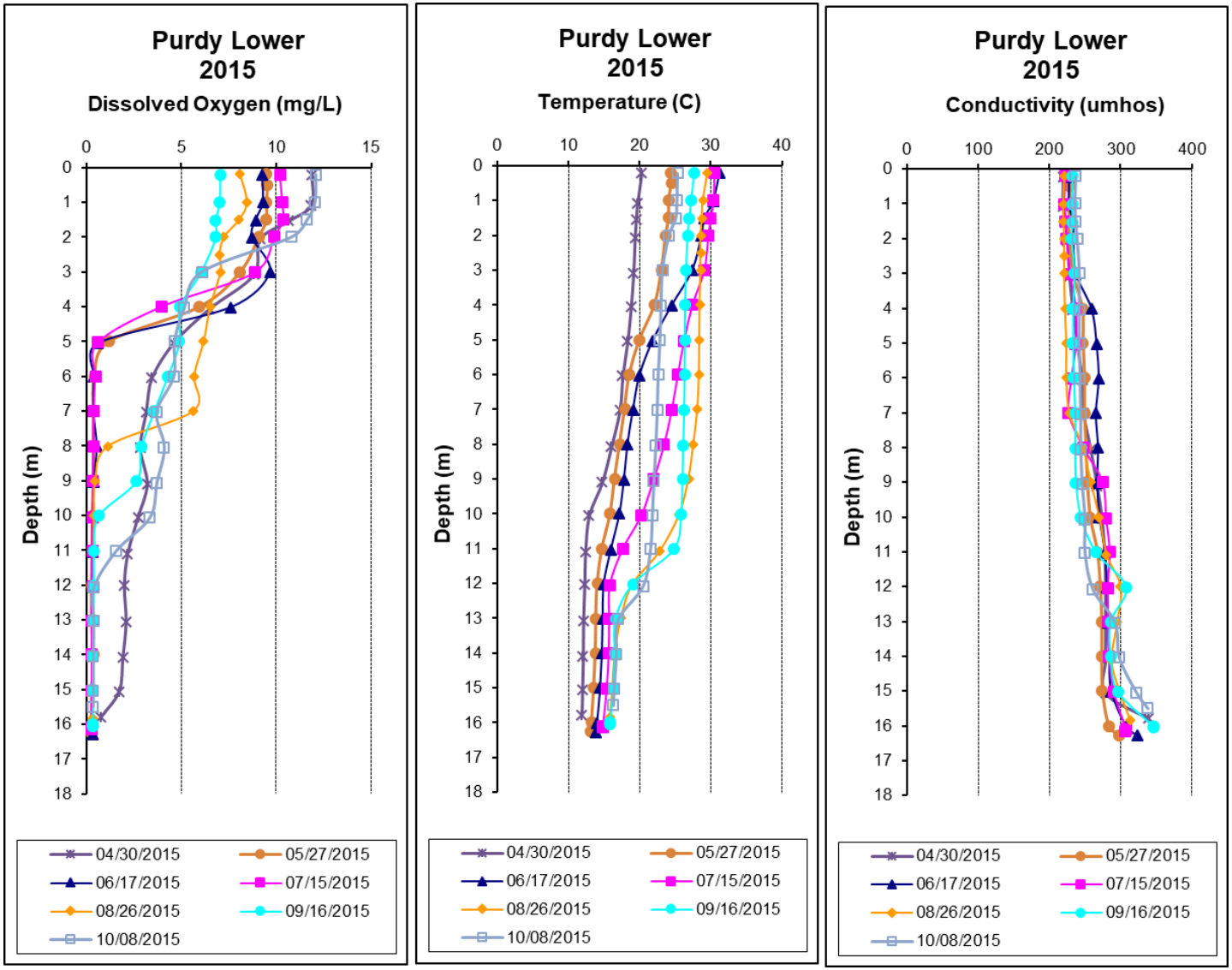


Figure 10. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in Lower Purdy Reservoir, April-October 2018.

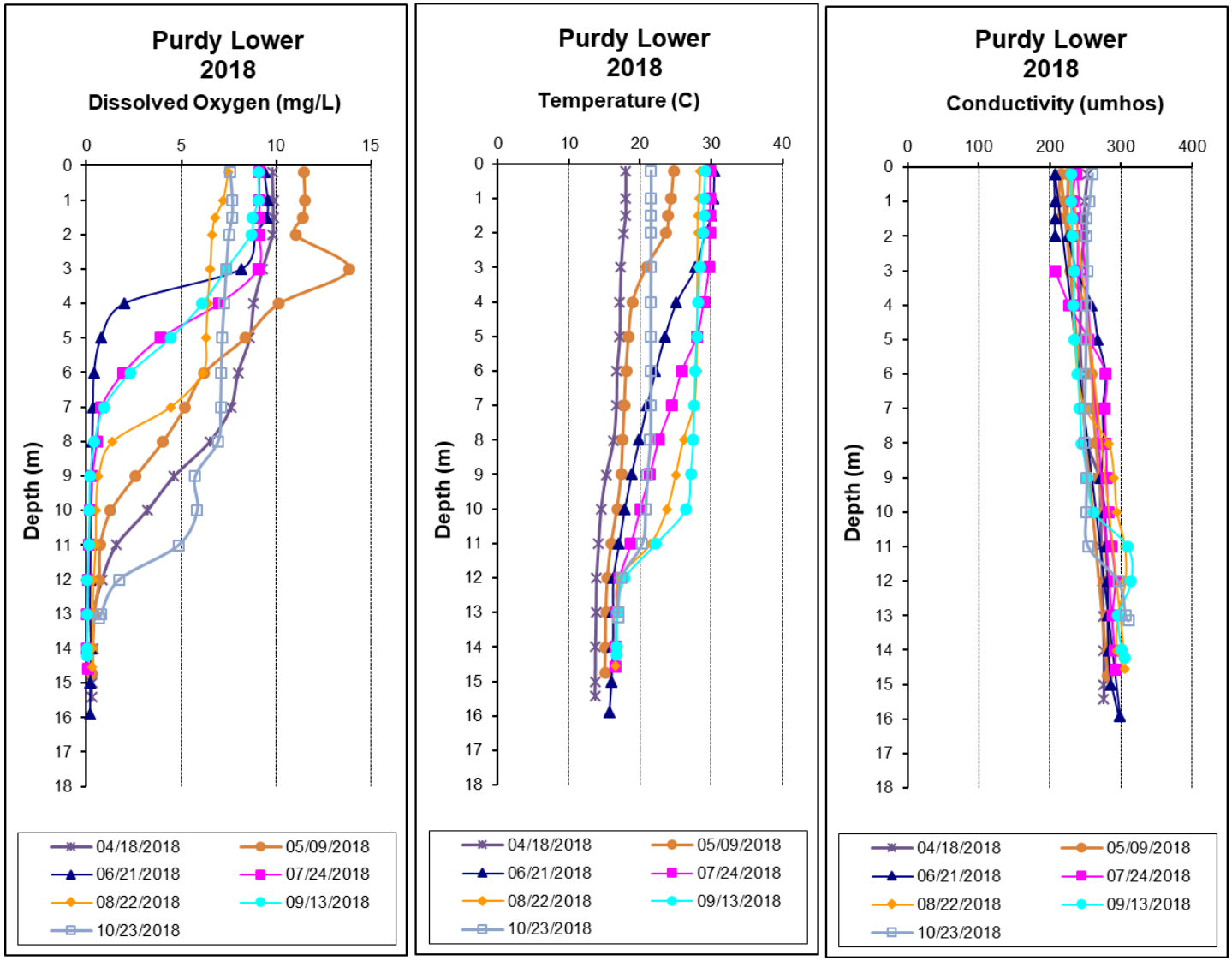
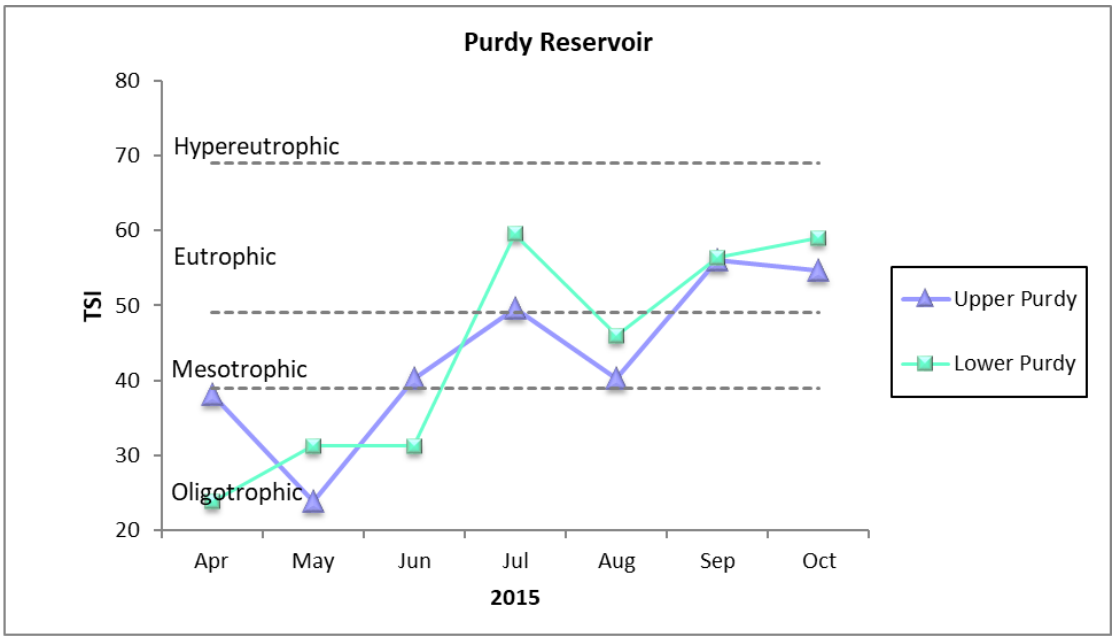
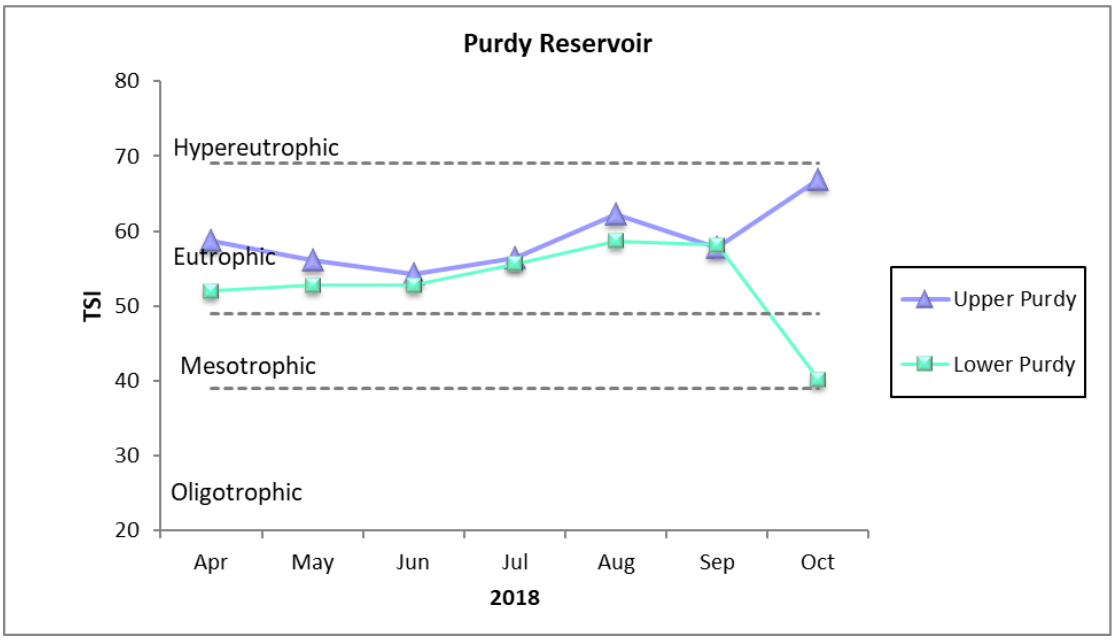


Figure 11. Monthly TSI values, April-October 2015 and 2018, for Purdy Reservoir using chl *a* concentrations and Carlson's Trophic State Index calculation.





REFERENCES

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

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

ADEM. 2018c. Standard Operating Procedures Series #2000, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2017. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.11). 2017. Water Quality Criteria Applicable to Specific Lakes. 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.

APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2015. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N		Min	Max	Med	Mean	SD
PURS-1	**Physical**							
	Turbidity (NTU)	7		3.0	4.3	3.2	3.4	0.5
	Total Dissolved Solids (mg/L)	7		132.0	144.0	140.0	139.4	4.4
	Total Suspended Solids (mg/L)	7		2.0	4.0	2.0	2.4	0.8
	Hardness (mg/L)	4		40.9	123.0	120.0	101.0	40.0
	Alkalinity (mg/L)	7		84.3	97.2	88.3	89.1	4.5
	Photic Zone (m)	7		3.70	5.20	4.45	4.50	0.47
	Secchi (m)	7		0.97	1.93	1.37	1.38	0.31
	Bottom Depth (m)	7		15.5	16.3	16.0	16.0	0.3
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.060	0.004	0.014	0.021
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.006	0.055	0.004	0.013	0.020
	Total Kjeldahl Nitrogen (mg/L)	7		0.390	0.896	0.543	0.586	0.177
	Total Nitrogen (mg/L)[J]	7	<	0.393	0.951	0.546	0.600	0.193
	Dis Reactive Phosphorus (mg/L)	7	<	0.003	0.007	0.004	0.003	0.001
	Total Phosphorus (mg/L)	7		0.018	0.032	0.026	0.026	0.005
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)[J]	7		2.3	3.6	3.3	3.1	0.5
	Biological							
	Chlorophyll a (mg/m³)	7	<	1.00	19.20	4.81	8.39	8.42
	E. coli (MPN/DL)	3	<	1	1	1	1	0
PURS-2	**Physical**							
	Turbidity (NTU)	7		5.3	12.5	7.4	8.1	2.5
	Total Dissolved Solids (mg/L)	7		143.0	164.0	150.0	150.7	8.0
	Total Suspended Solids (mg/L)	7		4.0	9.0	6.0	6.0	1.6
	Hardness (mg/L)	4		50.2	133.0	121.5	106.6	38.1
	Alkalinity (mg/L)	7		81.9	102.0	94.0	91.9	8.0
	Photic Zone (m)	7		2.70	3.70	3.25	3.26	0.34
	Secchi (m)	7		0.85	1.64	1.10	1.12	0.27
	Bottom Depth (m)	7		2.6	4.2	4.0	3.8	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.007	0.070	0.011	0.024	0.029
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.007	0.958	0.255	0.304	0.335
	Total Kjeldahl Nitrogen (mg/L)	7		0.357	0.947	0.500	0.578	0.203
	Total Nitrogen (mg/L)[J]	7	<	0.571	1.698	0.764	0.882	0.389
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.003	0.007	0.004	0.004	0.002
	Total Phosphorus (mg/L)	7		0.019	0.121	0.032	0.043	0.035
	CBOD-5 (mg/L)	7	<	2.0	2.3	1.0	1.5	0.7
	Chlorides (mg/L)[J]	7		2.4	4.9	3.8	3.7	0.8
	Biological							
	Chlorophyll a (mg/m³)	7	<	1.00	13.40	2.67	5.72	5.08
	E. coli (MPN/DL)	3	<	1	2	1	1	1

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit.

Appendix Table 2. Summary of water quality data collected April-October, 2018. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N		Min	Max	Med	Mean	SD
PURS-1	**Physical**							
	Turbidity (NTU)	7		2.9	6.7	3.9	4.5	1.6
	Total Dissolved Solids (mg/L)	7		119.0	140.0	130.0	130.9	7.1
	Total Suspended Solids (mg/L)	7		3.0	7.0	5.0	5.0	1.5
	Hardness (mg/L)	4		95.4	106.0	100.8	100.8	4.7
	Alkalinity (mg/L)	7		92.6	114.0	101.0	102.0	6.5
	Photic Zone (m)	7		3.30	5.35	4.47	4.43	0.64
	Secchi (m)	7		0.92	1.92	1.15	1.24	0.32
	Bottom Depth (m)	7		13.1	15.9	14.6	14.6	0.9
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.015	0.033	0.008	0.013	0.010
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.007	0.199	0.004	0.031	0.074
	Total Kjeldahl Nitrogen (mg/L)	7		0.300	0.759	0.642	0.569	0.168
	Total Nitrogen (mg/L)[J]	7	<	0.304	0.762	0.646	0.600	0.145
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.004	0.008	0.002	0.003	0.002
	Total Phosphorus (mg/L)[J]	7		0.004	0.020	0.010	0.012	0.007
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.2	6.2	3.8	4.2	1.0
	Biological							
	Chlorophyll a (mg/m^3)	7		2.67	17.60	9.61	11.11	5.10
	E. coli (MPN/DL)	4	<	1	2	1	1	1
PURS-2	**Physical**							
	Turbidity (NTU)	7		4.1	12.3	8.0	8.0	2.4
	Total Dissolved Solids (mg/L)[J]	7		110.0	149.0	132.0	128.9	13.4
	Total Suspended Solids (mg/L)[J]	7		5.0	19.0	10.0	10.6	4.3
	Hardness (mg/L)	4		83.8	100.0	99.0	95.4	7.8
	Alkalinity (mg/L)	7		78.7	109.0	99.3	98.7	11.2
	Photic Zone (m)	7		1.98	3.15	2.66	2.64	0.35
	Secchi (m)	7		0.17	1.00	0.80	0.75	0.28
	Bottom Depth (m)	7		2.0	4.3	2.7	2.9	0.7
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.015	0.015	0.008	0.008	0.000
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.007	0.290	0.013	0.058	0.104
	Total Kjeldahl Nitrogen (mg/L)	7		0.343	0.731	0.655	0.597	0.136
	Total Nitrogen (mg/L)[J]	7	<	0.346	0.781	0.686	0.655	0.142
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.004	0.005	0.002	0.003	0.002
	Total Phosphorus (mg/L)[J]	7		0.007	0.036	0.010	0.015	0.010
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		3.2	5.1	3.9	4.0	0.6
	Biological							
	Chlorophyll a (mg/m^3)	7		11.20	40.60	16.00	19.69	10.24
	E. coli (MPN/DL)	4		1	3	2	2	1

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit.