2012 Inland and Purdy Reservoirs Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicators Section
Aquatic Assessment Unit
June 2015

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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
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Maximum Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
ONRW	Outstanding National Resource Water
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports
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

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INTRODUCTION

Inland Reservoir

Inland Reservoir's 1,095 acre water body was established in 1939. The reservoir is owned and operated by the Birmingham Water Works and Sewer Board of Birmingham, primarily for water supply. In 2004, the ADEM implemented a specific water quality criterion for nutrient management at one location on Inland Reservoir, which has been monitored by ADEM since 2002. This criterion represents the maximum growing season mean (April-October) chlorophyll *a* (chl *a*) concentration allowable while still fully supporting the reservoir's Public Water Supply and Swimming (PWS/S) use classifications.

Purdy Reservoir

Purdy Reservoir's 1,050 acre water body was established with the completion of the dam in 1929. The reservoir is also owned and operated by the Birmingham Water Works and Sewer Board of Birmingham. In 2010, the ADEM implemented specific water quality criteria for nutrient management at two locations on Purdy Reservoir. These criteria represent the maximum growing season mean chl *a* concentration allowable while still fully supporting the reservoir's Public Water Supply and Fish & Wildlife (PWS/F&W) use classifications.

Rivers & Reservoirs Monitoring Program

The Alabama Department of Environmental Management (ADEM) monitored Inland and Purdy Reservoirs as part of the 2012 assessment of the Black Warrior and Cahaba River Basins 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, 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 2012 Monitoring Strategy (ADEM 2012).

The purpose of this report is to summarize data collected at both Inland and Purdy Reservoirs during the 2012 growing season 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 (Fig. 1). Specific location information can be found in Table 1. Inland was sampled in the dam forebay. Purdy was sampled at the dam forebay, with one additional station in the upper reservoir.

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 2012), Surface Water Quality Assurance Project Plan (ADEM 2013), and Quality Management Plan (ADEM 2008).

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

Figure 1. Purdy Reservoir with 2012 sampling locations. A description of each sampling location is provided in Table 1.

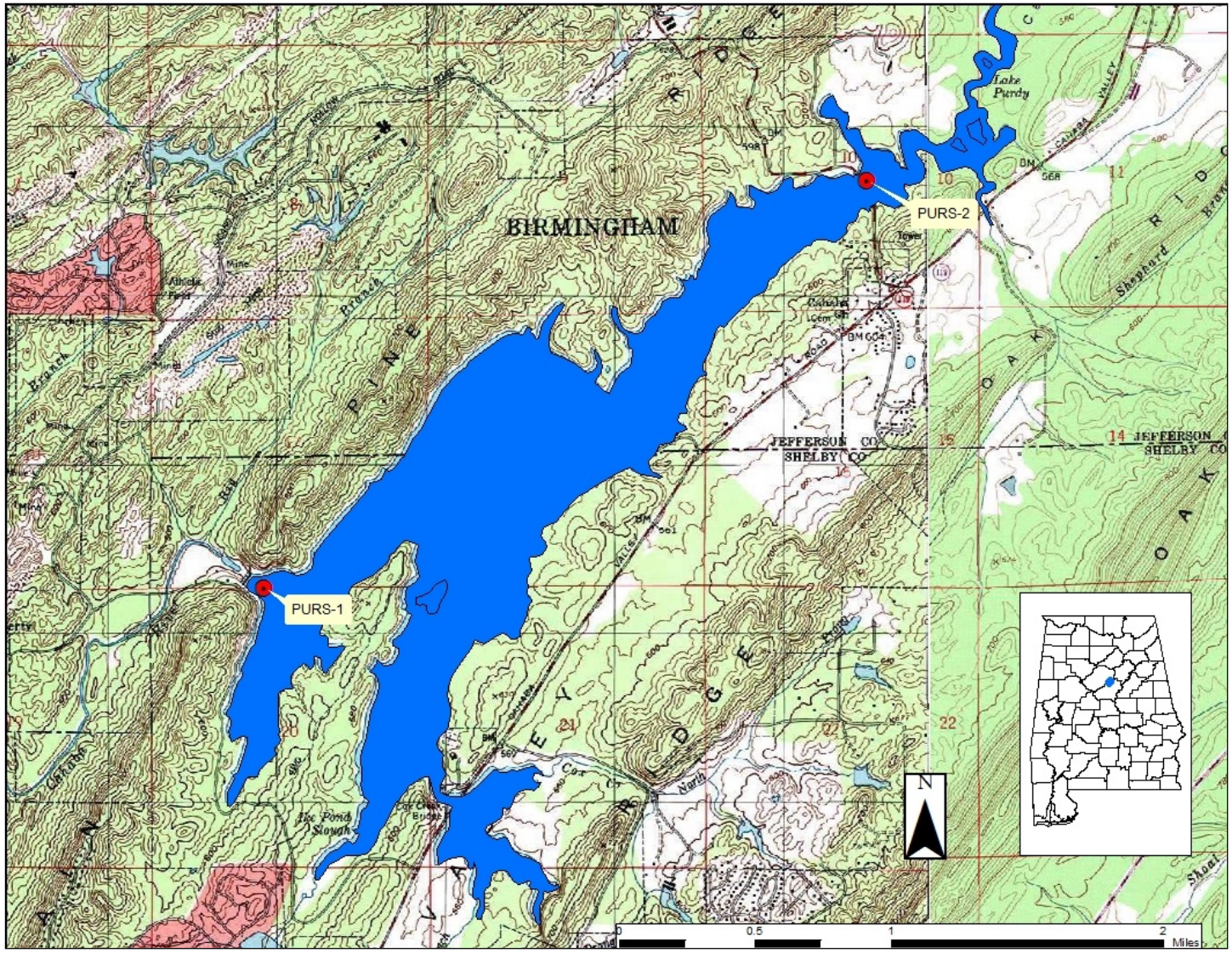

Figure 2. Inland Reservoir with its 2012 sampling location. A description of the sampling location is provided in Table 1.

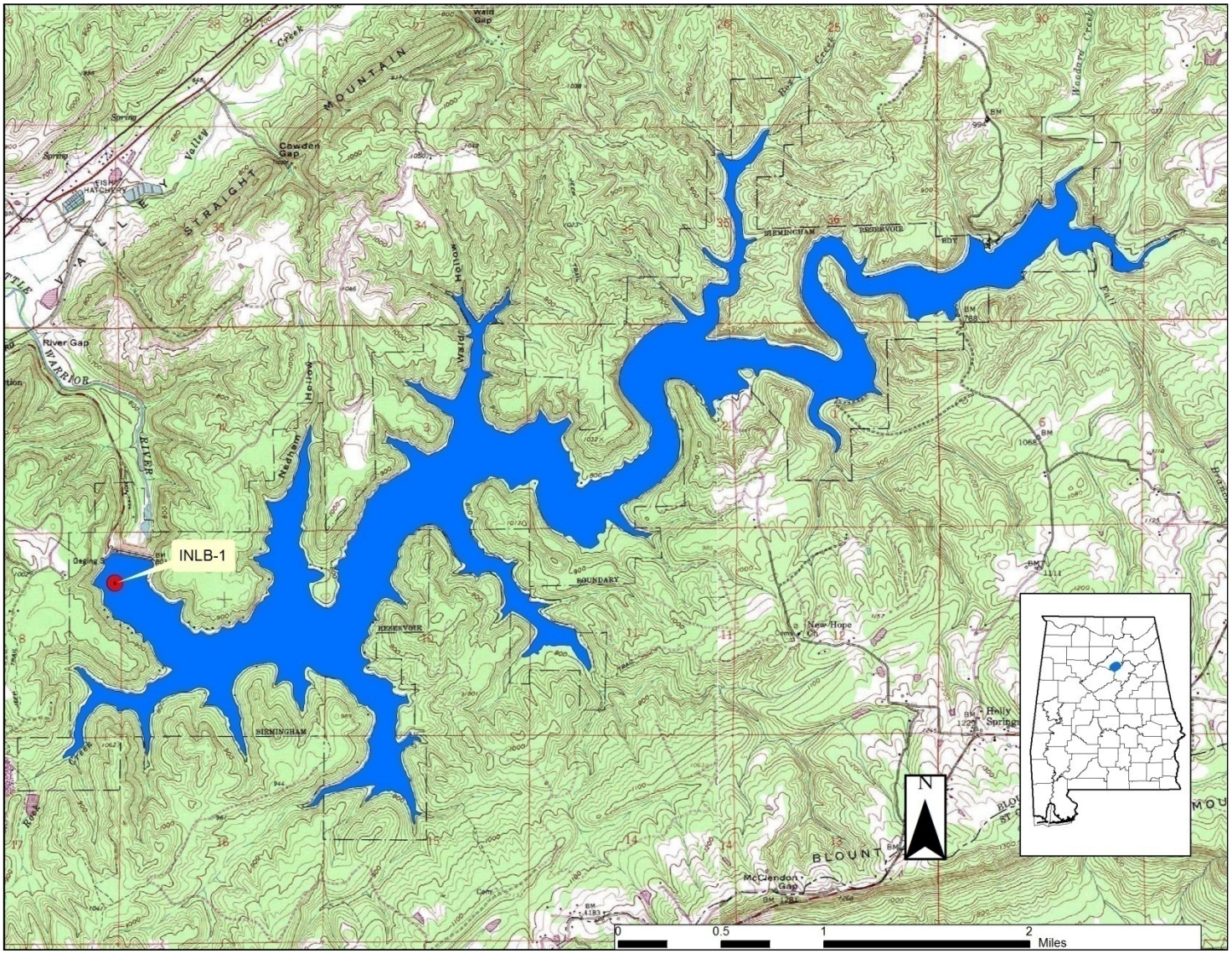

Table 1. Descriptions of the 2012 monitoring stations.

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
Inland Reservoir								
031601110204	Blount	INLB-1	Inland	Little Warrior R	Deepest point, main river channel, dam forebay.	6 µg/l	33.834688	-86.550942

*Growing season mean chl *a* criteria implemented at Inland in 2004 and Purdy in 2010.

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RESULTS

Growing season mean graphs for TN, TP, chl *a*, and TSS are provided in this section (Figs. 3 and 4). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figs. 5-9, 12). Algal growth potential test (AGPT) results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figs. 10-11. Summary statistics of all data collected during 2012 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

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

In 2012, growing season mean TN concentrations increased at both Purdy stations and the Inland station, compared to the previous year (Fig. 3). From 2002, concentrations have generally increased at lower Purdy, while concentrations at Inland have generally decreased. Monthly TN concentrations at both Purdy stations were above historic means in all months except October at the upper station (Fig. 5). Monthly TN concentrations at Inland were at or below historic means, April-October.

In 2012, growing season mean TP concentrations at lower Purdy and the Inland station were the lowest concentrations measured on record (Fig. 3). At upper Purdy, the growing season mean TP concentration was higher in 2012 than 2007. Monthly TP concentrations for lower Purdy and the Inland station were below historic means in most months, April-October (Fig. 6). Highest concentrations were measured in July for upper Purdy and Inland stations and July and October for lower Purdy.

In 2012, growing season mean chl *a* concentrations at both Purdy stations increased from the previous year but varied little from historic concentrations (Fig. 4). The growing season mean chl. *a* at the Inland station was the lowest ever measured. Specific water quality criteria for nutrient management were established at both Purdy stations in 2010 and on Inland in 2005. The 2012 growing season mean chl *a* concentration measured at lower Purdy was above the

criteria limit. The upper Purdy and Inland stations were in compliance with the established criteria. Monthly chl *a* concentrations at the Inland station were mostly below historic means (Fig. 7).

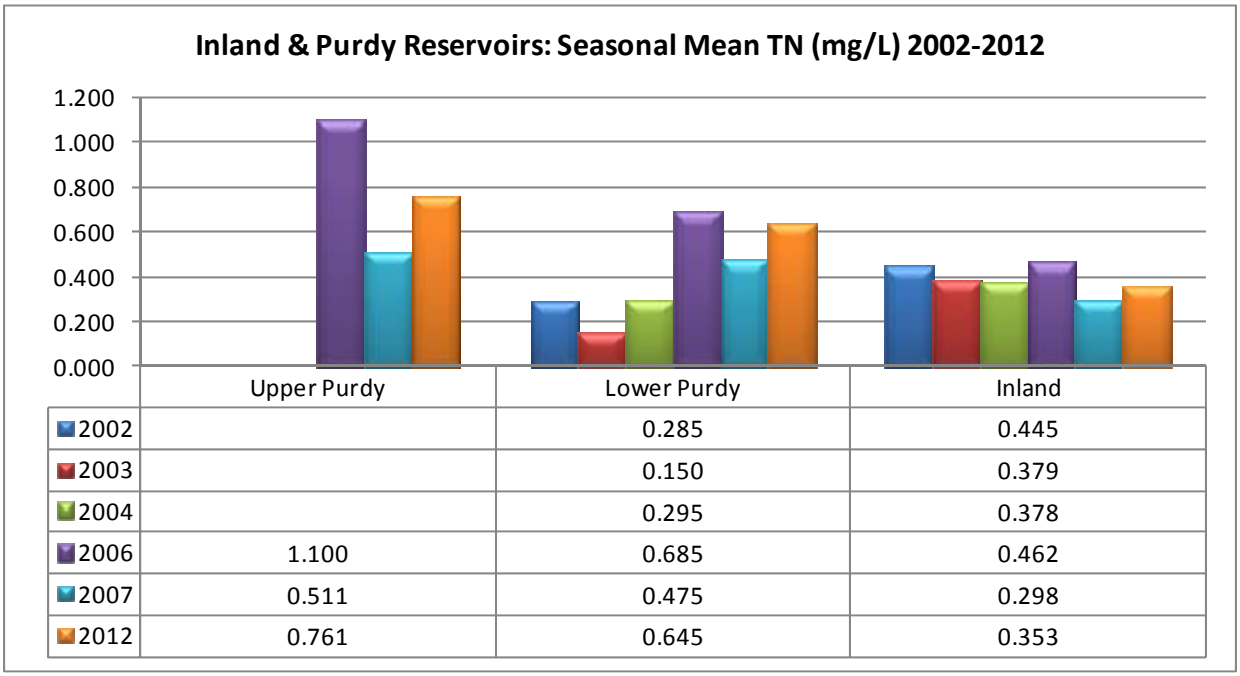
In 2012, the growing season mean TSS concentration in lower Purdy was the lowest on record and concentrations have decreased each year since 2003 (Fig. 4). The growing season mean TSS concentration for Inland in 2012, was also the lowest measured on record and concentrations have decreased each year since 2004. Monthly TSS concentrations at lower Purdy were below historic means in all months, with the highest concentration measured in October (Fig. 8). Concentrations in upper Purdy were more variable and lowest in October. Inland TSS concentrations were below historic means April-October.

In 2012, AGPT results indicated lower Purdy and the Inland station to be co-limited and the upper Purdy station to be phosphorus limited (Table 2). The MSC values were below 5 mg/L at all stations, the value defined as protective of reservoir and lake systems (Rashke and Schultz 1987).

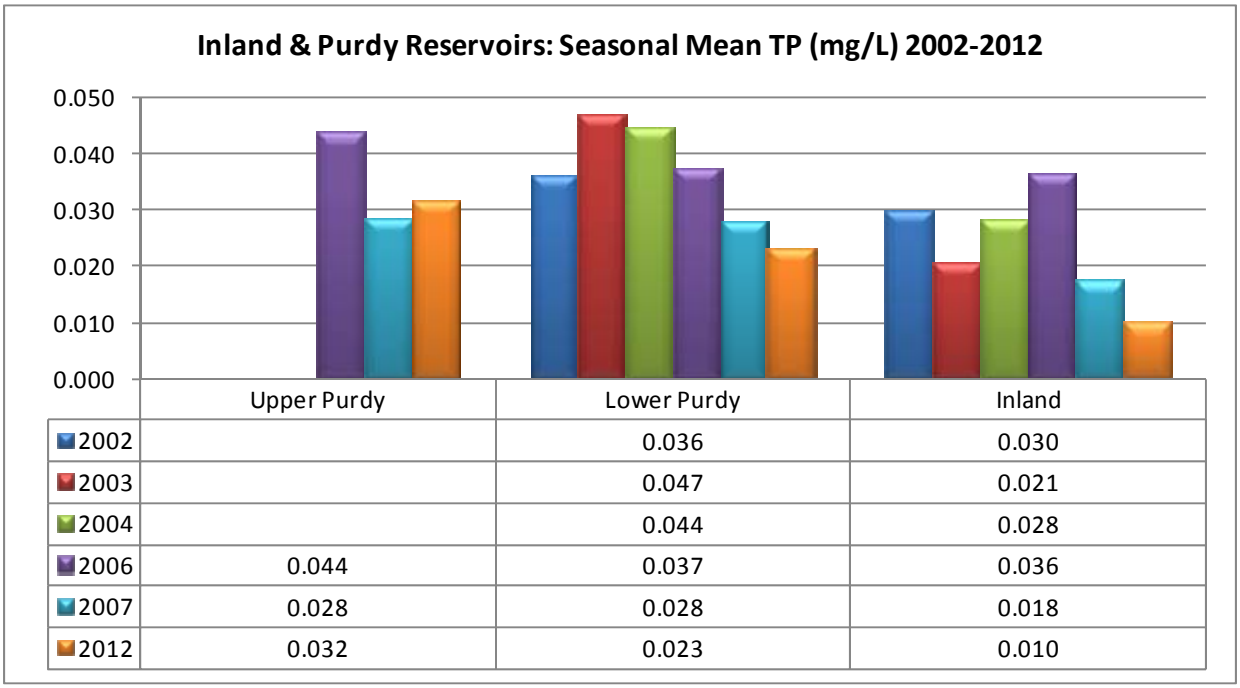
All measurements of DO at the Inland, upper Purdy and lower Purdy stations met the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m)(Fig. 9). Profiles of dissolved oxygen concentrations and temperature indicated that the water column was stratified at both lower Purdy and Inland, in all months, April-October (Figs. 10 & 11). Profiles of temperature at both stations show highest temperatures were reached in July.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. Both Purdy stations were eutrophic for the entire growing season (Fig. 12). The Inland station was oligotrophic July-October.

Figure 3. Growing season mean TN and TP measured in Inland and Purdy Reservoirs, April-October 2002-2012.

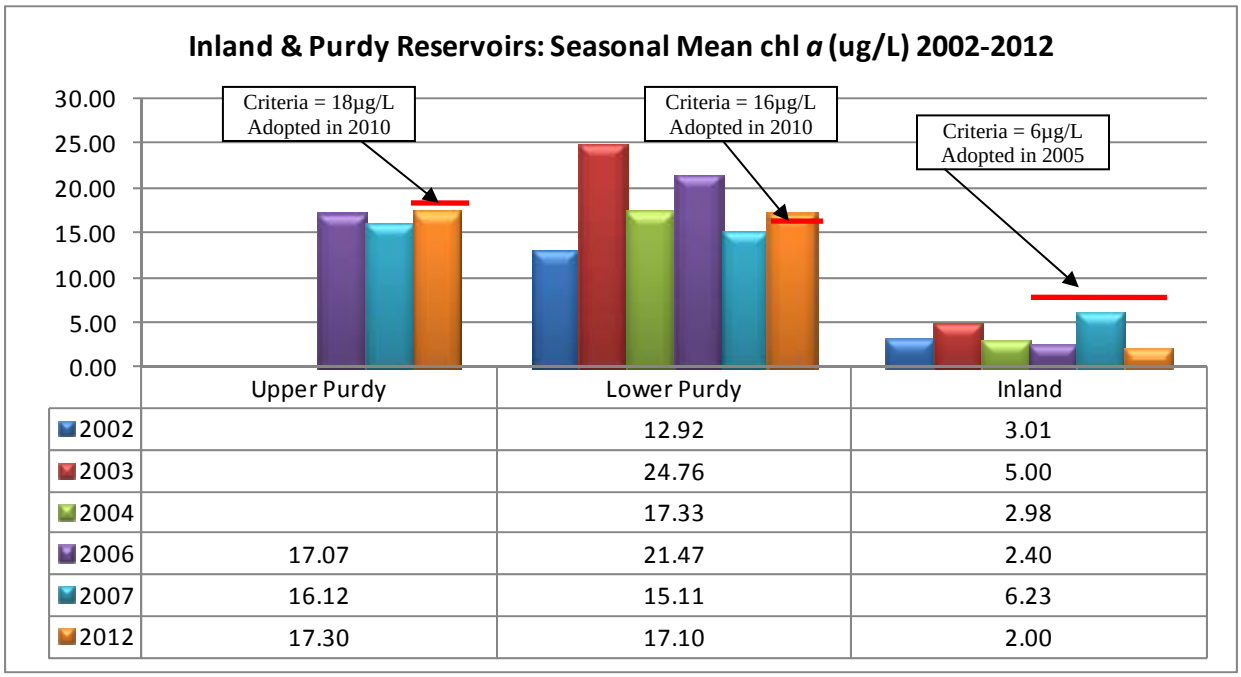


	Upper Purdy	Lower Purdy	Inland
2002		0.285	0.445
2003		0.150	0.379
2004		0.295	0.378
2006	1.100	0.685	0.462
2007	0.511	0.475	0.298
2012	0.761	0.645	0.353

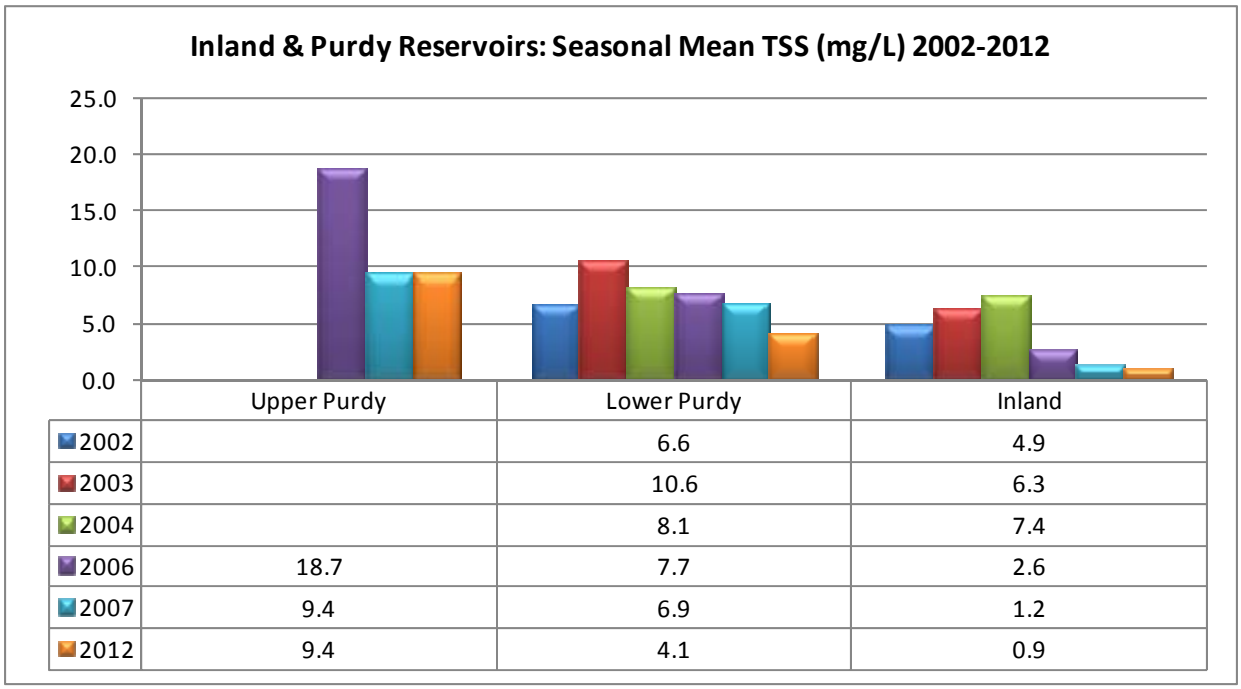


	Upper Purdy	Lower Purdy	Inland
2002		0.036	0.030
2003		0.047	0.021
2004		0.044	0.028
2006	0.044	0.037	0.036
2007	0.028	0.028	0.018
2012	0.032	0.023	0.010

Figure 4. Growing season mean chl *a* and TSS measured in Inland and Purdy Reservoirs, April-October 2002-2012.

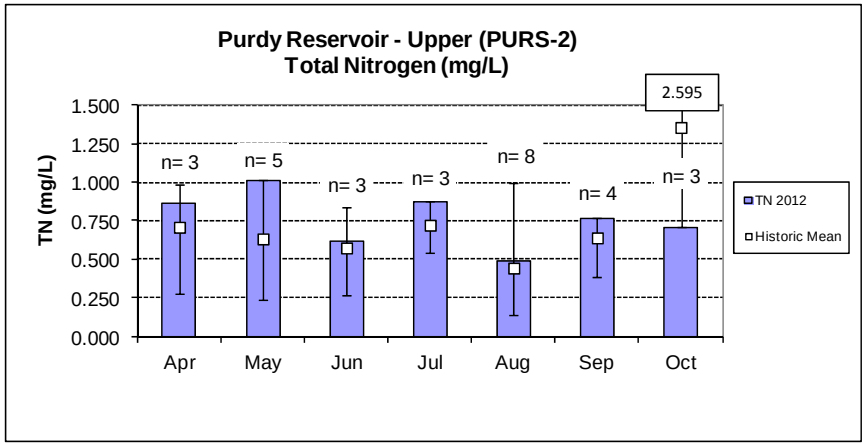


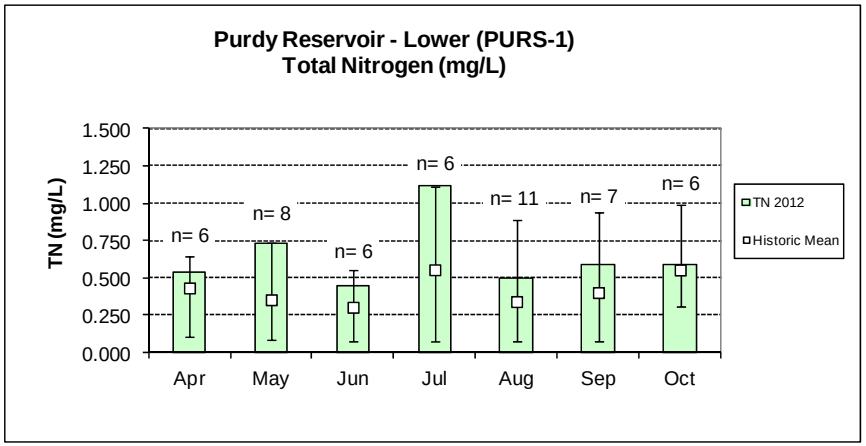
	Upper Purdy	Lower Purdy	Inland
2002		12.92	3.01
2003		24.76	5.00
2004		17.33	2.98
2006	17.07	21.47	2.40
2007	16.12	15.11	6.23
2012	17.30	17.10	2.00



	Upper Purdy	Lower Purdy	Inland
2002		6.6	4.9
2003		10.6	6.3
2004		8.1	7.4
2006	18.7	7.7	2.6
2007	9.4	6.9	1.2
2012	9.4	4.1	0.9

Figure 5. Monthly TN concentrations of the stations in Inland and Purdy Reservoirs, April-October 2012. 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 datapoints included in the monthly historic calculations.





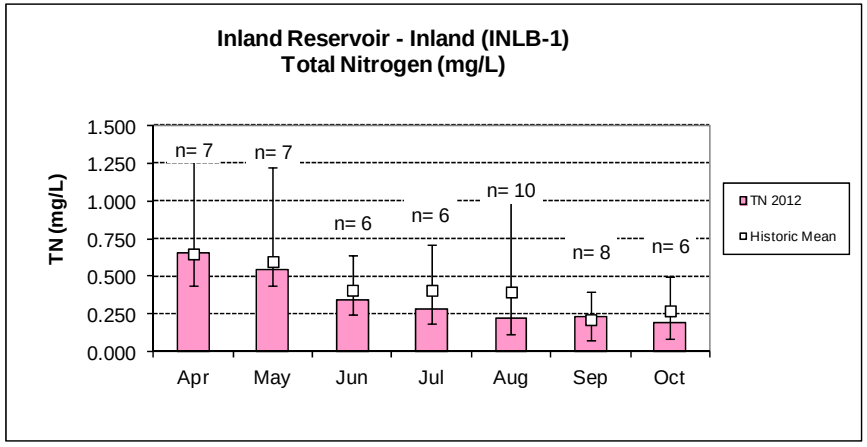
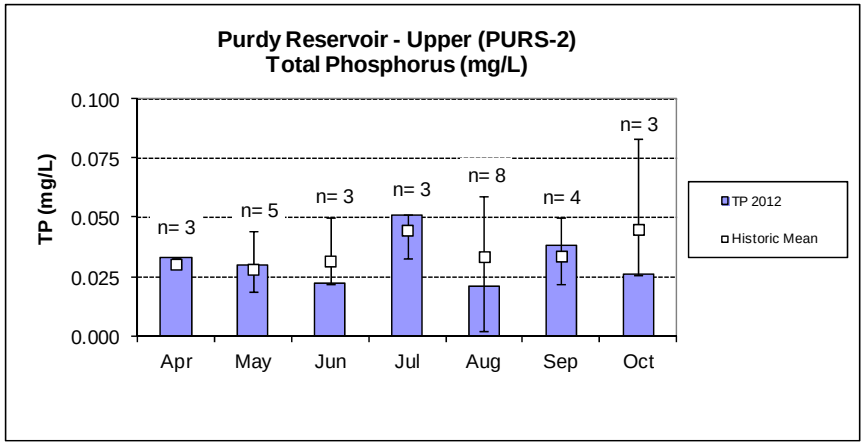
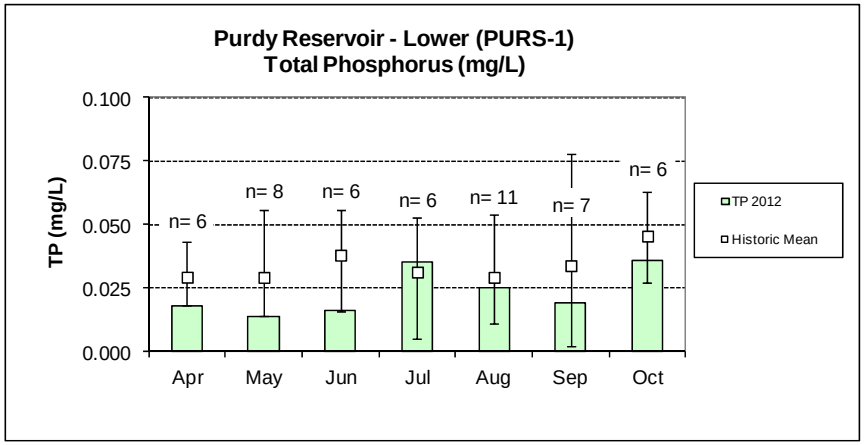


Figure 6. Monthly TP concentrations of the stations in Inland and Purdy Reservoirs, April-October 2012. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





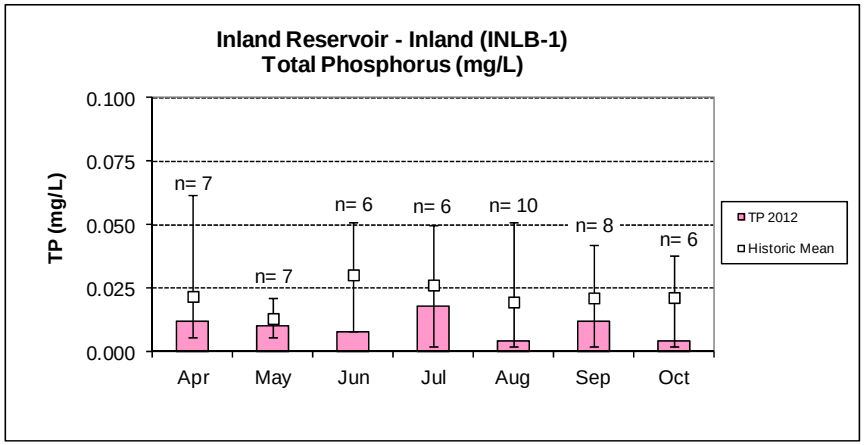
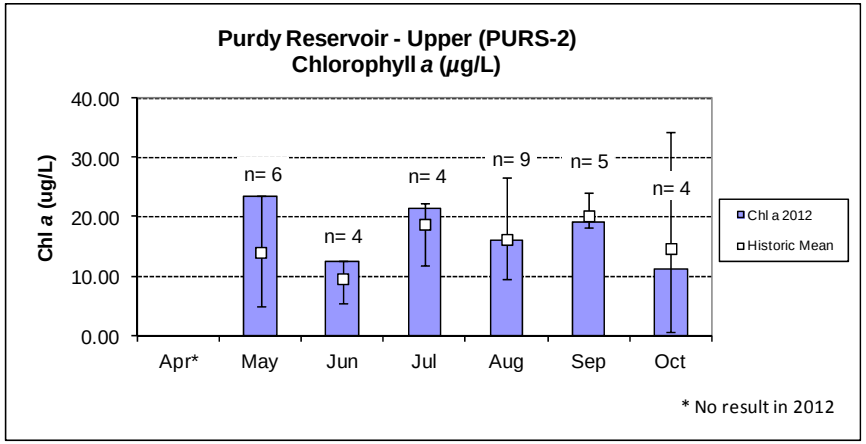
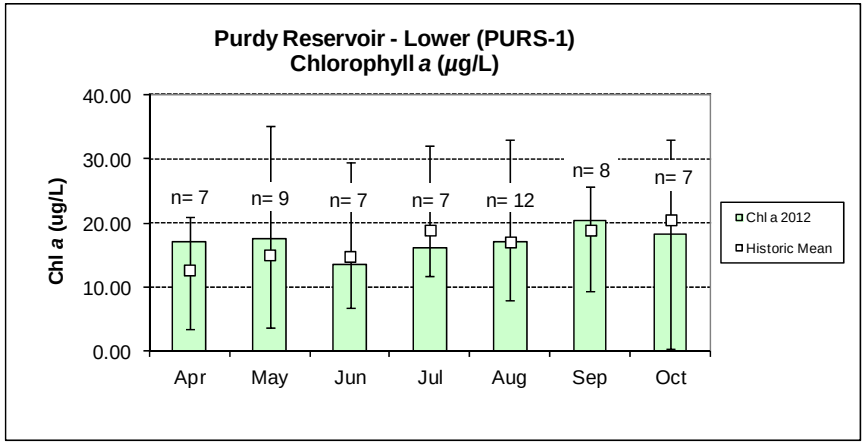


Figure 7. Monthly chl *a* concentrations of the stations in Inland and Purdy Reservoirs, April-October 2012. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





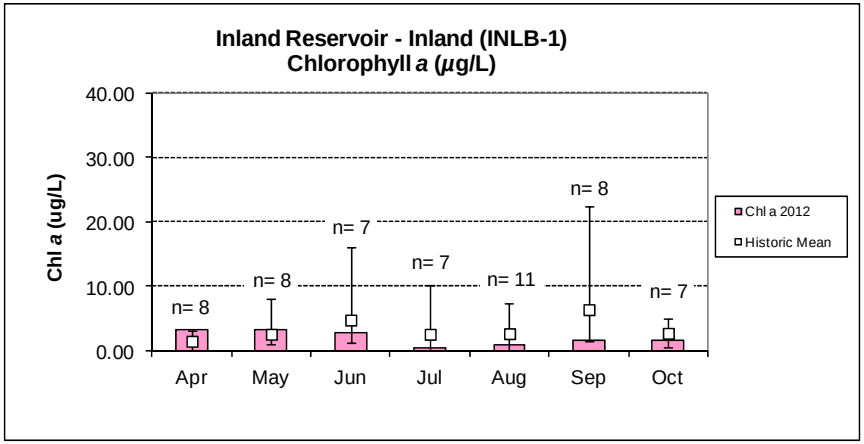
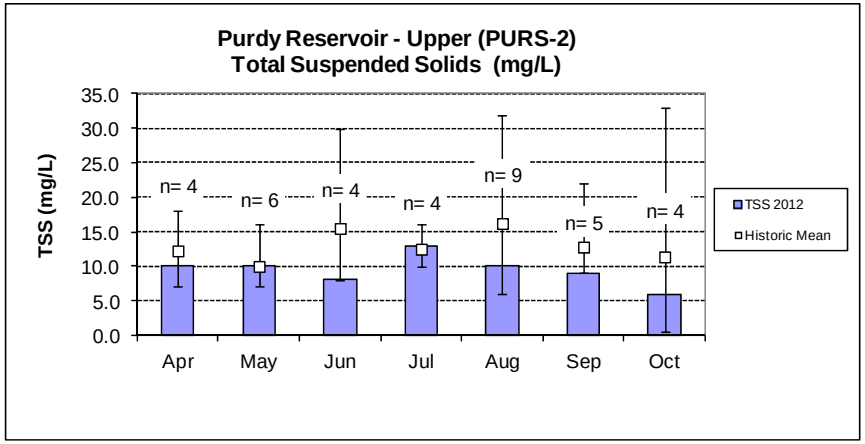
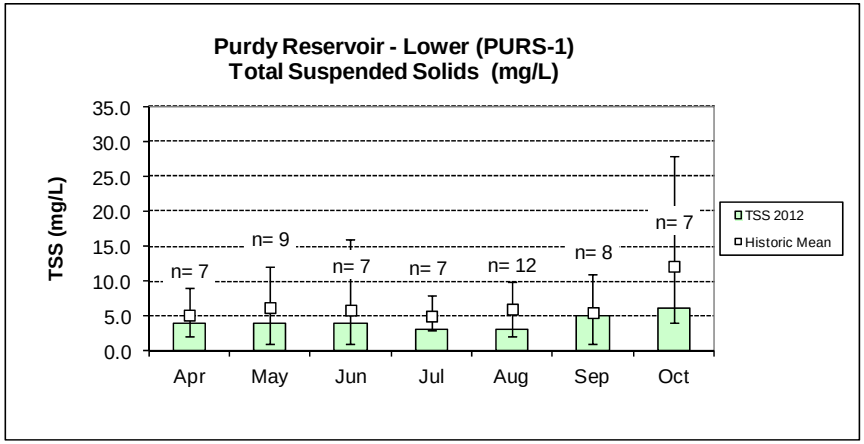


Figure 8. Monthly TSS concentrations of the stations in Inland and Purdy Reservoirs, April-October 2012. Each bar graph depicts monthly changes in each station. The historic mean and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





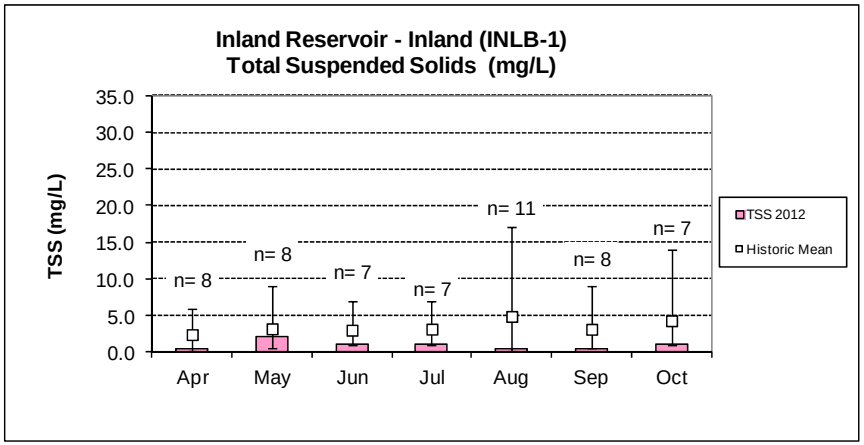


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective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

Station	Upper Purdy		Lower Purdy		Inland	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
August 2006	1.88	Phosphorus	1.58	Non-limiting	---	---
June 2007	1.41	Phosphorus	1.80	Phosphorus	1.56	Phosphorus
July 2007	1.21	Phosphorus	1.27	Phosphorus	1.25	Phosphorus
August 2007	2.22	Phosphorus	1.55	Phosphorus	1.41	Phosphorus
August 2012	2.82	Phosphorus	2.48	Co-limiting	2.28	Co-limiting

Figure 9. Monthly DO concentrations at 1.5 m (5 ft) for Inland and Purdy Reservoirs collected April-October 2012. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).

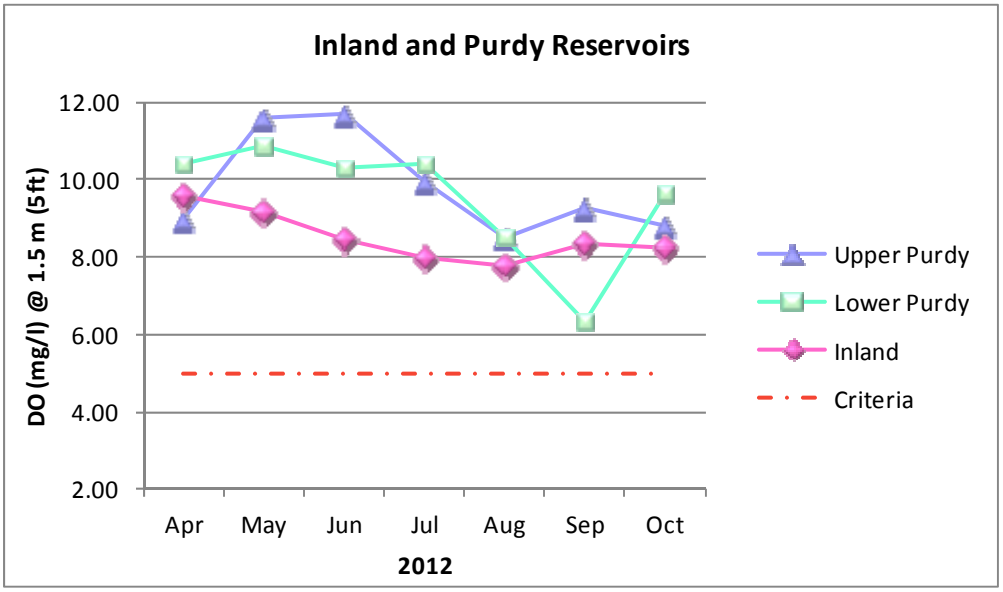


Figure 10. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in lower Purdy Reservoir, April-October 2012.

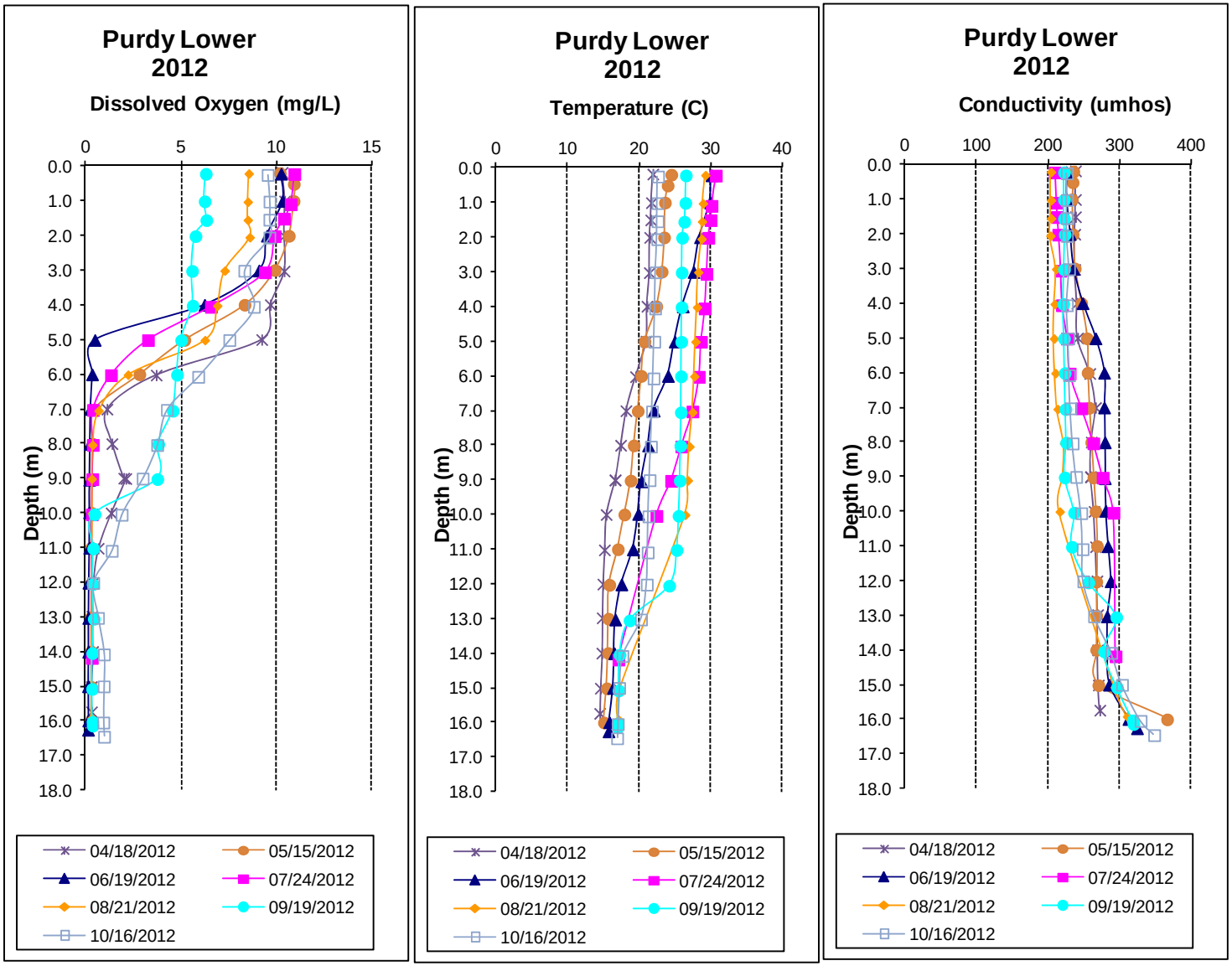


Figure 11. Monthly depth profiles of dissolved oxygen, temperature, and conductivity in Inland Reservoir, April-October 2012.

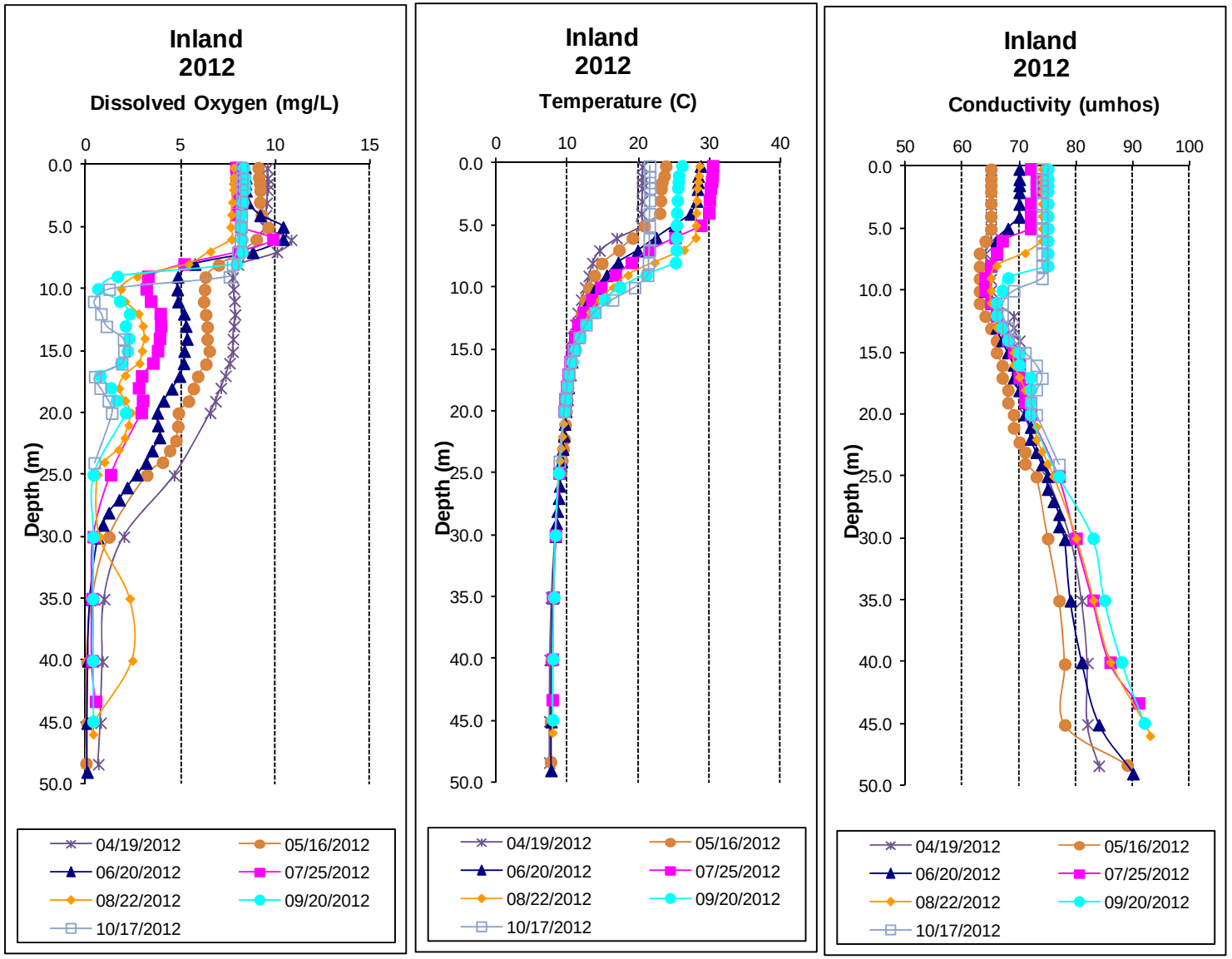
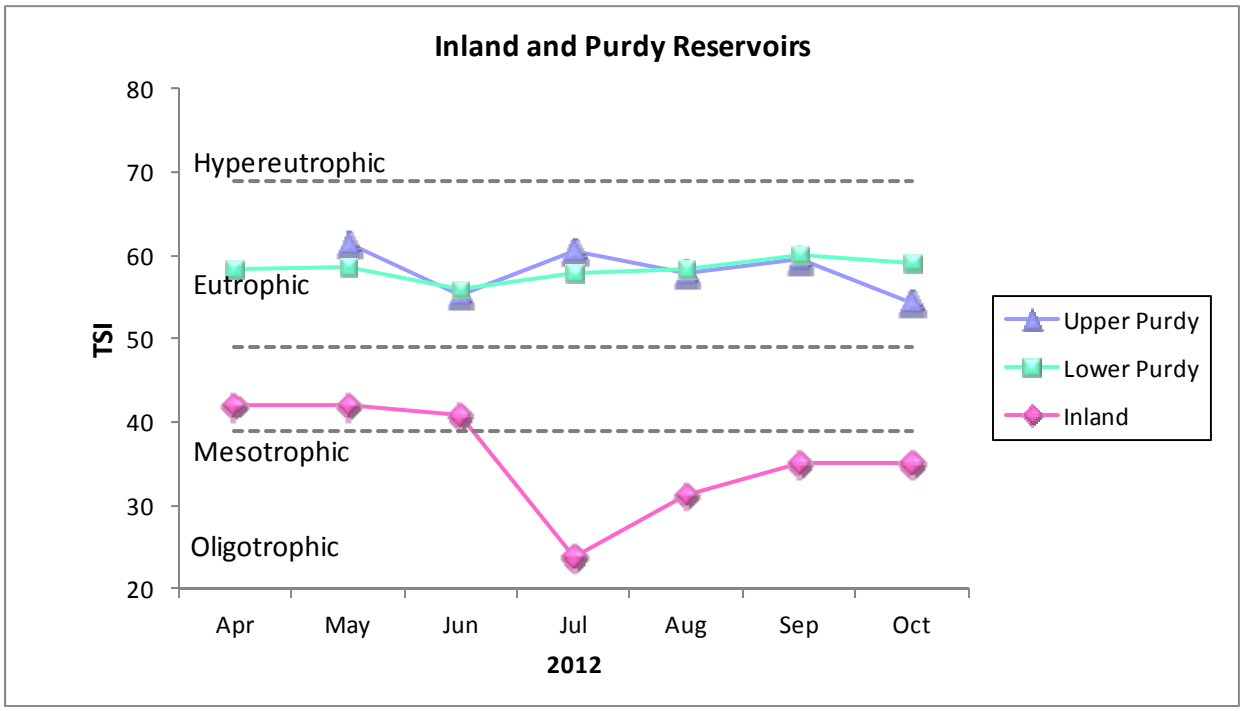


Figure 12. Monthly TSI values, April-Ocotber 2012, for Inland and Purdy Reservoirs using chl *a* concentrations and Carlson's Trophic State Index calculation.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2012. 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		3.1	4.0	3.6	3.6	0.3
	Total Dissolved Solids (mg/L) [J]	7		127.0	151.0	147.0	141.9	10.0
	Total Suspended Solids (mg/L) [J]	7		3.0	6.0	4.0	4.1	1.1
	Hardness (mg/L)	4		107.0	123.0	114.5	114.8	6.8
	Alkalinity (mg/L) [J]	7		57.5	88.4	74.6	74.1	9.4
	Photic Zone (m)	7		3.90	5.10	4.90	4.70	0.43
	Secchi (m)	7		1.13	1.50	1.35	1.33	0.16
	Chemical							
	Ammonia Nitrogen (mg/L) [J]	7	<	0.010	0.028	0.014	0.010	0.005
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	<	0.004	0.007	0.003	0.003	0.001
	Total Kjeldahl Nitrogen (mg/L) [J]	7		0.448	1.110	0.585	0.642	0.225
	Total Nitrogen (mg/L) [J]	7	<	0.450	1.113	0.588	0.645	0.225
	Dissolved Reactive Phosphorus (mg/L) [J]	7	<	0.004	0.008	0.005	0.005	0.003
	Total Phosphorus (mg/L)	7		0.014	0.036	0.019	0.023	0.009
	CBOD-5 (mg/L) [J]	7	<	1.0	2.0	1.0	0.9	0.2
	Chlorides (mg/L)	7		3.0	4.3	3.6	3.6	0.4
	Biological							
	Chlorophyll a (ug/L) [J]	7		13.40	20.30	17.10	17.10	2.11
	E. coli (mpn/DL)	3	<	1	2	1	1	1
PURS-2	**Physical**							
	Turbidity (NTU)	7		7.6	12.0	9.3	9.6	1.7
	Total Dissolved Solids (mg/L) [J]	7		135.0	166.0	146.0	146.1	10.3
	Total Suspended Solids (mg/L) [J]	7		6.0	13.0	10.0	9.4	2.2
	Hardness (mg/L)	4		110.0	136.0	113.5	118.2	12.1
	Alkalinity (mg/L) [J]	7		58.8	94.4	79.4	76.4	11.9
	Photic Zone (m)	7		2.63	3.32	3.28	3.09	0.32
	Secchi (m)	7		0.70	1.08	0.88	0.87	0.12
	Chemical							
	Ammonia Nitrogen (mg/L) [J]	7	<	0.010	0.028	0.014	0.010	0.005
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7		0.025	0.173	0.049	0.082	0.060
	Total Kjeldahl Nitrogen (mg/L)	7		0.463	0.922	0.690	0.679	0.144
	Total Nitrogen (mg/L) [J]	7		0.488	1.013	0.768	0.761	0.176
	Dissolved Reactive Phosphorus (mg/L) [J]	7	<	0.005	0.015	0.009	0.009	0.004
	Total Phosphorus (mg/L)	7		0.021	0.051	0.030	0.032	0.010
	CBOD-5 (mg/L) [J]	7	<	1.1	2.3	1.0	1.4	0.6
	Chlorides (mg/L) [J]	7		3.0	5.0	3.7	3.9	0.7
	Biological							
	Chlorophyll a (ug/L) [J]	6		11.20	23.50	17.60	17.30	4.92
	E. coli (mpn/DL)	3	<	1	214	2	72	123

Station	Parameter	N		Min	Max	Med	Mean	SD
INLB-1	**Physical**							
	Turbidity (NTU)	7		1.2	3.1	1.8	1.9	0.7
	Total Dissolved Solids (mg/L) [J]	7		37.0	105.0	57.0	61.6	22.7
	Total Suspended Solids (mg/L) [J]	7	<	1.0	2.0	1.0	0.9	0.5
	Hardness (mg/L)	4		21.9	28.8	25.4	25.4	3.3
	Alkalinity (mg/L)	7		2.4	12.0	10.5	9.6	3.4
	Photic Zone (m)	7		7.70	10.40	9.25	9.17	0.84
	Secchi (m)	7		3.19	4.59	4.39	4.07	0.56
	Chemical							
	Ammonia Nitrogen (mg/L) [J]	7	<	0.010	0.028	0.014	0.010	0.005
	Nitrate+Nitrite Nitrogen (mg/L) [J]	7	<	0.006	0.324	0.053	0.097	0.120
	Total Kjeldahl Nitrogen (mg/L)	7		0.193	0.365	0.227	0.256	0.065
	Total Nitrogen (mg/L) [J]	7	<	0.196	0.655	0.280	0.353	0.178
	Dissolved Reactive Phosphorus (mg/L) [J]	7	<	0.004	0.011	0.002	0.005	0.004
	Total Phosphorus (mg/L) [J]	7	<	0.008	0.018	0.010	0.010	0.005
	CBOD-5 (mg/L)	7	<	1.0	2.0	1.0	0.9	0.2
	Chlorides (mg/L) [J]	7		1.7	18.1	2.1	5.1	6.1
	Biological							
	Chlorophyll a (ug/L) [J]	7	<	1.00	3.20	1.60	2.00	1.08
	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