

2012 Perdido Bay and Wolf Bay Watersheds Report

Coastal Waters Monitoring Program



Field Operations Division
Mobile Branch
Environmental Assessment Section
Water Unit
September 2014



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LIST OF ACRONYMS

A&I	Agricultural and Industrial Water Supply use classification
ADEM	Alabama Department of Environmental Management
CHL <i>a</i>	Chlorophyll <i>a</i>
CWA	Clean Water Act
CWMP	Coastal Waters Monitoring Program
DO	Dissolved Oxygen
F&W	Fish and Wildlife use classification
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Water use classification
OE	Organic Enrichment
PWS	Public Water Supply use classification
QAPP	Quality Assurance Project Plan
S	Swimming and Other Whole Body Water-Contact Sports use classification
SD	Standard Deviation
SH	Shellfish Harvesting use classification
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency

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INTRODUCTION

Wolf Bay, an estuary classified as an Outstanding Alabama Water (OAW), has a watershed of 70 mi². Tributaries to Wolf Bay include Miflin Creek, Sandy Creek, and Wolf Creek. Wolf Bay flows into the Intracoastal Waterway and, subsequently, Perdido Bay. The Perdido Bay watershed forms the southeastern boundary of coastal Alabama encompassing 1213 mi² along the Alabama/Florida state line. Major tributaries to Perdido Bay include the Perdido River, Styx River, Blackwater River, the Intracoastal Waterway, and Wolf Bay. Both of these watersheds provide valuable resources to the area including agriculture, spawning habitats for commercial fish and shellfish, and recreational activities such as boating, fishing, and swimming.

The Alabama Department of Environmental Management (ADEM) monitored stations within the Perdido and Wolf Bay watersheds as part of the 2012 assessment under the Coastal Waters Monitoring Program (CWMP). Implemented in 2011, the CWMP is designed to provide data to assess current water quality conditions, identify long-term trends in water quality conditions and to develop Total Maximum Daily Loads (TMDLs) and nutrient criteria. The program is also being used to update protocols and methodologies to more accurately assess water quality conditions for estuaries and coastal rivers and streams. Although the CWMP is relatively new, most sites within it have been sampled in other programs throughout ADEM's history, with many having been sampled since the 1970's. Descriptions of all CWMP monitoring activities are available in ADEM's 2012 Monitoring Strategy (ADEM 2012).

Surface waters within Alabama are categorized according to their designated use classification and the degree to which the water quality supports its use classification. As required by Section 303(d) of the Clean Water Act (CWA), surface waters that do not meet their use classification are placed on Alabama's 303(d) List of Impaired Waters. Once a waterbody is listed as impaired, a TMDL is implemented to take measures needed for the waterbody to meet or exceed its water quality standards. [Figure 1](#) shows a map of waterbodies within the Perdido Bay and Wolf Bay watersheds that are on the 2012 CWA 303(d) list as well as the 2010 approved TMDLs. [Table 1](#) shows a tabular listing of waterbodies in these watersheds with approved TMDLs as well as those that remain on the 303(d) list as impaired.

Figure 1. 2012 Perdido River and Wolf Bay stations, impaired waterbodies, and watershed areas.

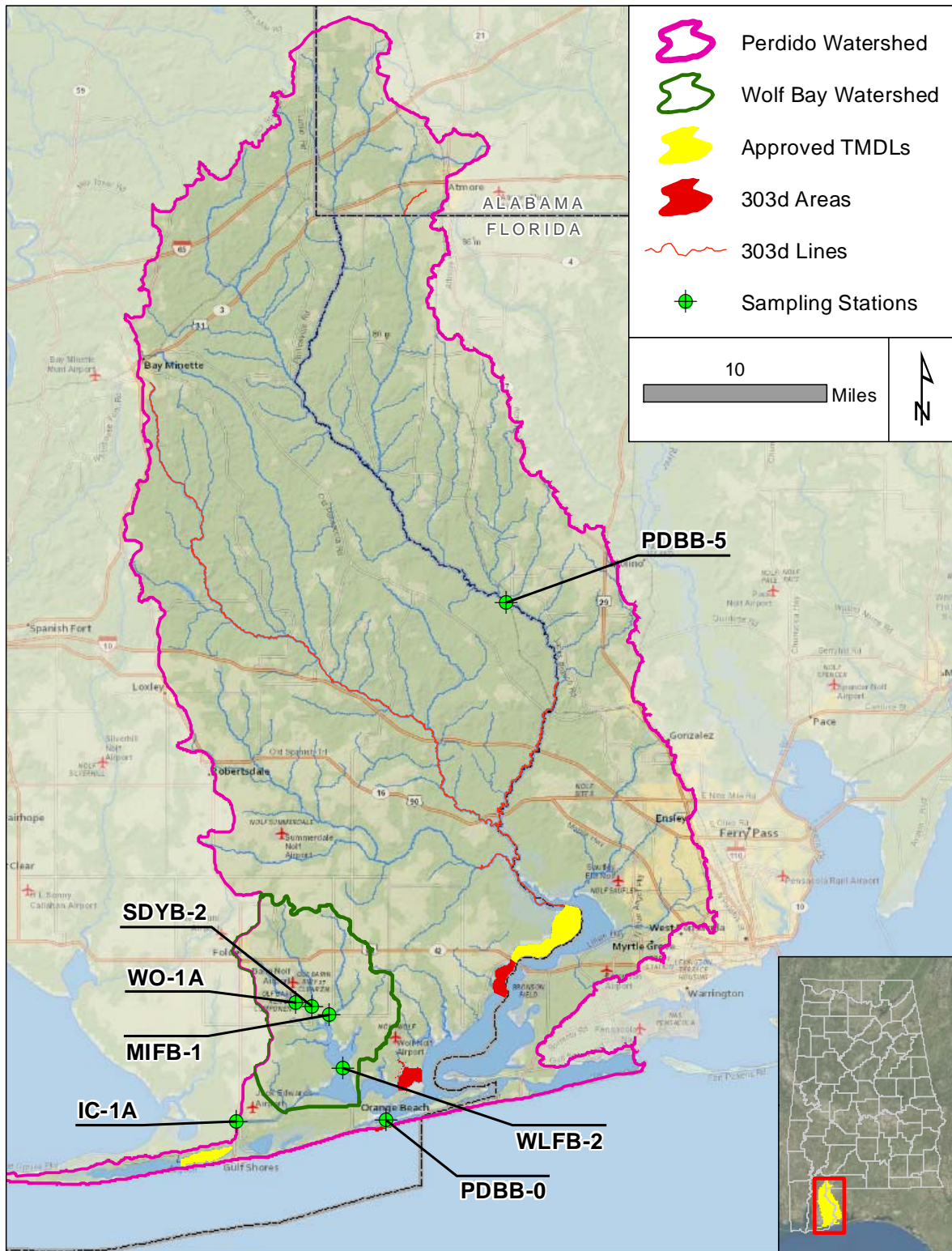


Table 1. 303(d) listed waterbodies in the Perdido Bay and Wolf Bay watersheds.

Waterbody ID	Name	County	Year Added	Designated Use	Causes	Year Removed	Justification for Removal	Estimated TMDL Date
AL/03140107-040_01	Intracoastal Waterway	Baldwin	1996	F&W	Nutrients, OE/DO	2004	No exceedances of the criteria for DO	N/A
AL/03140106-190-01	Blackwater River	Baldwin	1996	F&W	pH	1998	pH	N/A
AL/03140106-070_02	Brushy Creek	Escambia	2000	F&W	OE/DO			2015
AL/03140106-070_01	Boggy Branch	Escambia	2002	F&W	OE/DO, Metals (Hg, Zn), Chlorides			2015
AL/03140106-170_01	Styx River	Baldwin	2002	F&W	Metals (Hg)			2020
AL03140106-0603-101	Blackwater River	Baldwin	2004	F&W	Metals (Hg)			2020
AL03140104-0104-100	Blackwater River	Baldwin	2004	F&W	Metals (Hg)			2020
AL03140106-0302-101	Brushy Creek	Escambia	2006	F&W	Metals (Pb)			2015
AL03140106-0302-201	Boggy Branch	Escambia	2006	F&W	Pathogens, Metals (Pb, Cu)			2015
AL03140106-0302-202	Boggy Branch	Escambia	2006	F&W	Ammonia			2015
AL03140106-0703-100	Perdido River	Baldwin	2006	F&W	Metals (Hg)			2020
AL03140107-0204-300	Perdido Bay	Baldwin	2006	SH/S/F&W	Pathogens	2010	TMDL approved for area north of US Hwy 98	N/A
AL03140107-0205-100	Little Lagoon	Baldwin	2006	SH/S/F&W	Pathogens	2010	TMDL approved for eastern half, western half delisted due to subsequent data showing no impairment.	N/A
AL03140106-0302-201 AL03140106-0302-202	Boggy Branch	Escambia	2008	F&W	Metals (Hg)			
AL03140107-0204-400	Arnica Bay	Baldwin	2012	SH/S/F&W	Pathogens			2019
AL03140107-0204-302	Perdido Bay	Baldwin	2012	SH/S/F&W	Pathogens			2019

The purpose of this report is to summarize data collected at seven stations within the Perdido Bay and Wolf Bay watersheds during the 2012 growing season and to evaluate trends in nutrient concentrations using ADEM's historic dataset. Monthly and/or mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [Chl *a*], and sediment [total suspended solids (TSS)], were compared to ADEM's historical data.

METHODS

Sampling stations were selected using historical data and previous assessments ([Fig. 1](#)). Specific location information can be found in [Table 2](#). Wolf Bay, Perdido Bay and the Intracoastal Waterway were sampled within the Perdido Bay watershed. Tributary stations sampled include Wolf, Sandy, and Mifflin Creeks and the Perdido River.

Water quality assessments were conducted monthly, semi-monthly, or quarterly March-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operation Procedures (ADEM 2012), Surface Water Quality Assurance Project Plan (2008a), and Quality Management Plan (ADEM 2008b).

Mean growing season, March-October, TN, TP, chl *a*, and TSS were calculated for long-term trend stations to evaluate water quality conditions at each site. Monthly concentrations of these parameters were graphed with ADEM's previously collected data for all stations within the focus watersheds. Monthly growing season readings of dissolved oxygen (DO), salinity, and temperature were graphed for comparison with ADEM's water quality criteria level of 5.0 mg/L DO. Growing season profiles of DO, salinity, and temperature were also graphed to show stratification of each parameter. Chemical analysis also includes select total and dissolved metals. While summary statistics of metals analysis are presented in [Appendix Table 1](#), all metals analyses are available upon request.

Table 2. Descriptions for the monitoring stations in 2012 for the Perdido Bay and Wolf Bay Watersheds.

HUC8	County	Station Number	Use Classification	Waterbody	Station Description	Latitude	Longitude
3140107	Baldwin	IC-1A	F&W	Intracoastal Waterway	Deepest point, Intracoastal Waterway in Gulf Shores at Highway 59.	30.2793	-87.687
3140107	Baldwin	MIFB-1	S/F&W	Miflin Creek	Deepest point, Miflin Creek at County Road 20.	30.3637	-87.6027
3140107	Baldwin	PDBB-0	SH/S/F&W	Perdido Bay	Deepest point, Perdido Bay approximately 0.25 miles upstream of State Highway 182 bridge.	30.27968	-87.54948
3140106	Baldwin	PDBB-5	F&W	Perdido River	Deepest point, Perdido River at Duck Place Road, on AL/FL line off State Highway 112.	30.69047	-87.44026
3140107	Baldwin	SDYB-2	S/F&W	Sandy Creek	Deepest point, Sandy Creek approximately 50ft downstream of County Road 20/ Miflin Road.	30.3704	-87.6184
3140107	Baldwin	WLFB-2	OAW/SH/S/F&W	Wolf Bay	Deepest point, Wolf Bay at Mid-Bay off Mulberry Point.	30.32124	-87.58962
3140107	Baldwin	WO-1A	F&W	Wolf Creek	Deepest point, Wolf Creek at Baldwin County Road 12.	30.370278	-87.623407

RESULTS

Growing season mean graphs of TN, TP, chl *a*, and TSS for trend stations are provided in this section ([Figs. 2-5](#)). Monthly, semi-monthly, or quarterly graphs for TN, TP, chl *a*, TSS, DO, temperature, and salinity are also provided ([Figs. 6-10](#)). Depth profile graphs of DO, temperature, and salinity appear in [Figures 11-14](#). Station profiles presented in this report are representative of those stations not shown. 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 the 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.

Mean TN values in the Wolf Creek station were the lowest since 2005 but were the highest among stations monitored in 2012 ([Fig. 2](#)). Mean growing season TN values for Perdido River declined from 2010-2012 while values for Perdido Bay increased. Mean TN values for the Intracoastal Waterway declined overall 2005-2012. Monthly TN concentrations were near or less than historic means at all stations monitored ([Fig. 6](#)).

In all years sampled, the highest mean growing season TP values were for Wolf Creek ([Fig. 3](#)). From 2005-2008 the values for Wolf Creek increased, while from 2009-2012 concentrations were lower overall. The highest monthly TP concentrations measured during 2012 were also at Wolf Creek ([Fig. 7](#)). The lowest concentrations were measured in Perdido Bay and Perdido River.

In 2012, the highest mean growing season chl *a* value was calculated for the Intracoastal Waterway ([Fig. 4](#)). Overall, mean growing season chl *a* concentrations in all trend stations have declined since monitoring began. All monthly concentrations for the sampling season were variable and most were at or below historic means ([Fig. 8](#)).

In 2012, the highest mean growing season TSS value was calculated for the Intracoastal Waterway ([Fig. 5](#)). Mean TSS concentrations in Perdido Bay and the Intracoastal Waterway

were higher overall than that of the Perdido River and Wolf Creek from 2005-2012 and appear to be declining during this period. Monthly concentrations were variable in 2012 and most were at or below historic means ([Fig. 9](#)).

Dissolved oxygen concentrations in Miflin Creek were below the ADEM criteria limit of 5.0 mg/L at 5.0ft (1.5m) or mid-depth in June, August, and October (ADEM Admin. Code R. 335-6-10-09) ([Fig. 10](#)). DO concentrations in Wolf Bay were below the criteria in June and July, and the Intracoastal Waterway was below the limit in September. Sandy Creek was below the criteria limit for all months sampled. All measurements of DO concentrations in Perdido River, Perdido Bay, and Wolf Creek were above the ADEM criteria. Haloclines were present in Wolf Bay during June and in Sandy Creek most months sampled ([Fig. 11-14](#)).

Figure 2. Mean growing season TN measured for the trend stations in the Perdido Bay and Wolf Bay watersheds, 2005-2012.

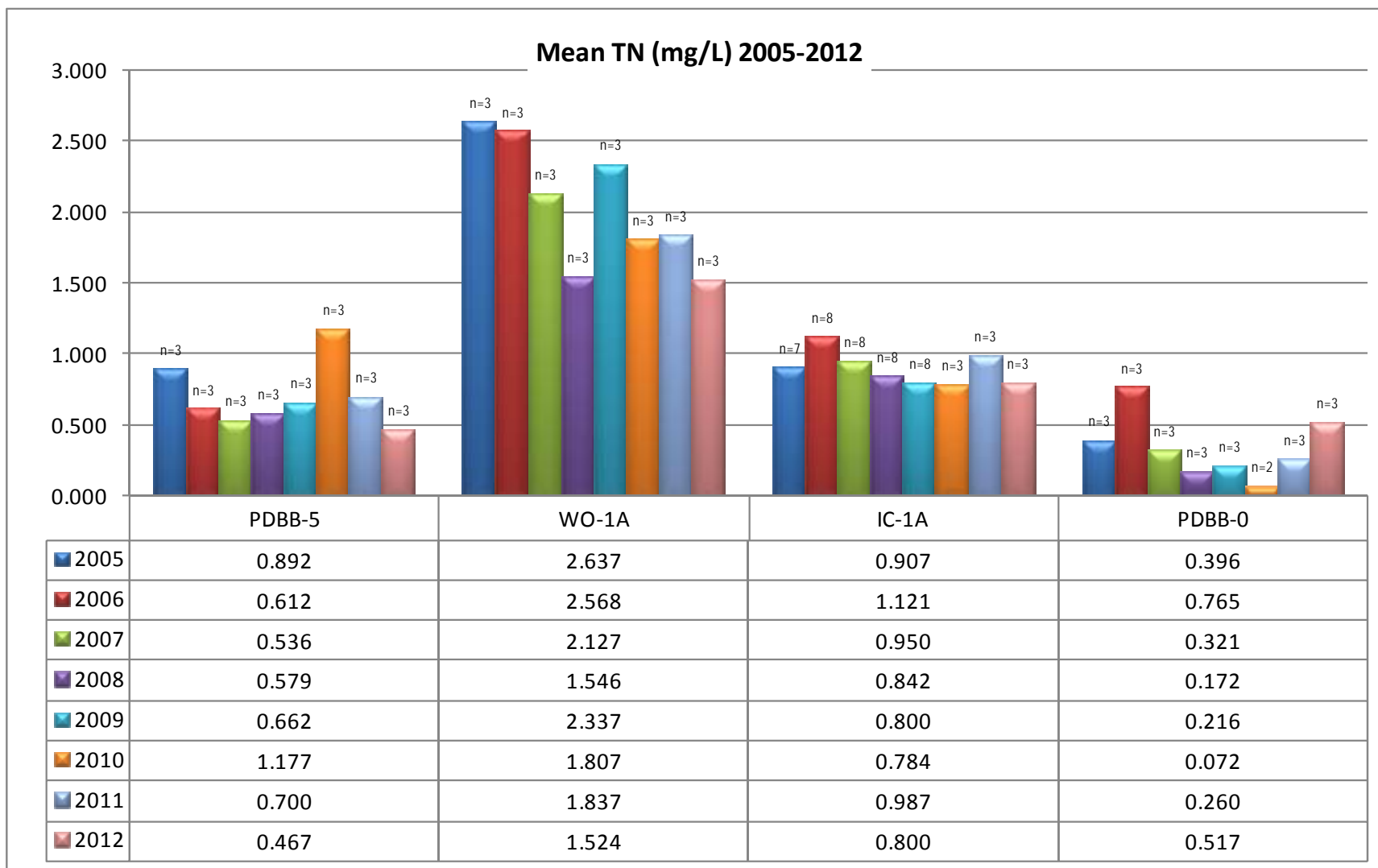


Figure 3. Mean growing season TP measured for the trend stations in the Perdido Bay and Wolf Bay watersheds, 2005-2012.

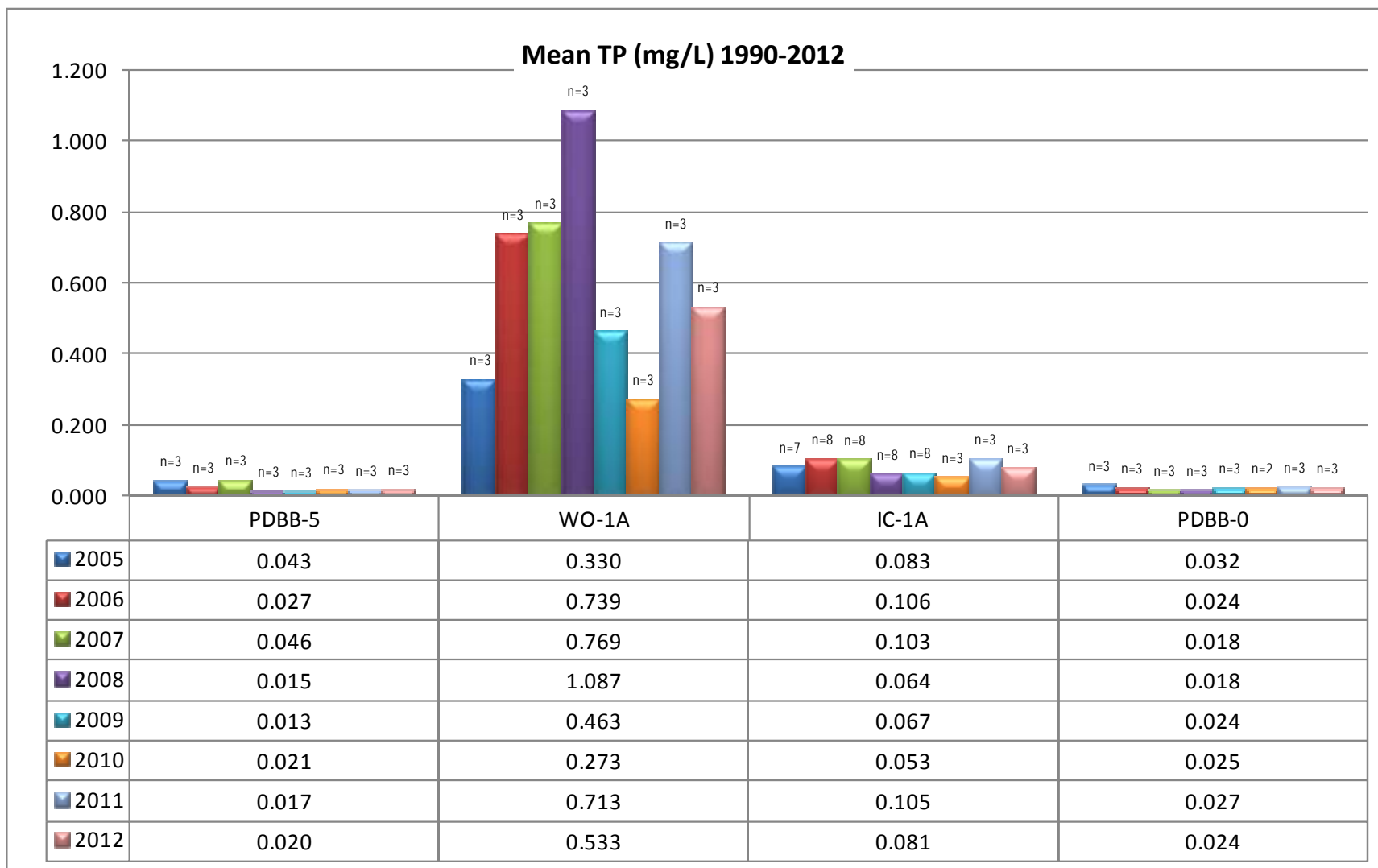


Figure 4. Mean growing season chl a measured for trend stations in the Perdido Bay and Wolf Bay watersheds, 2005-2012.

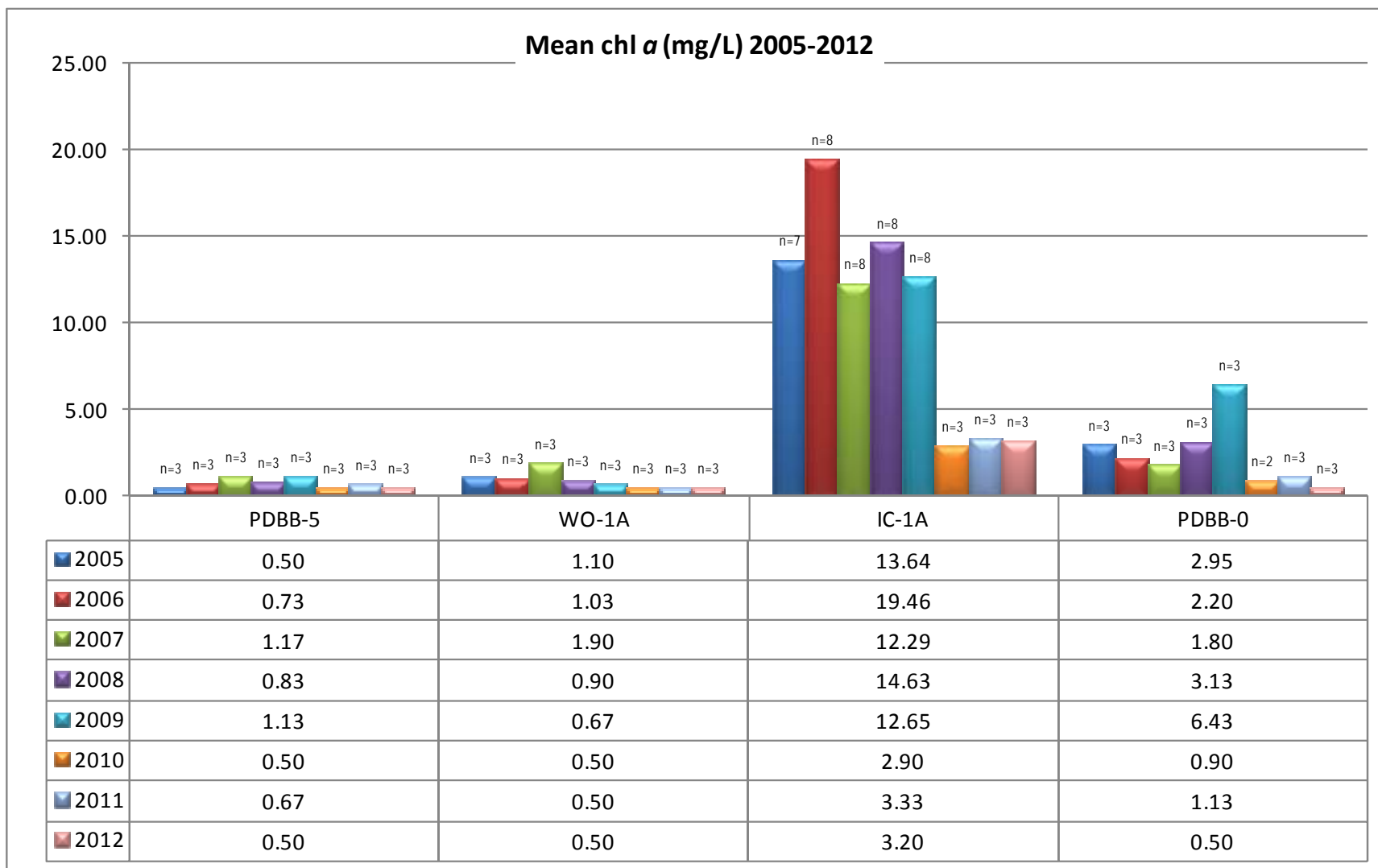


Figure 5. Mean growing season TSS measured for trend stations in the Perdido Bay and Wolf Bay watersheds, 2005-2012.

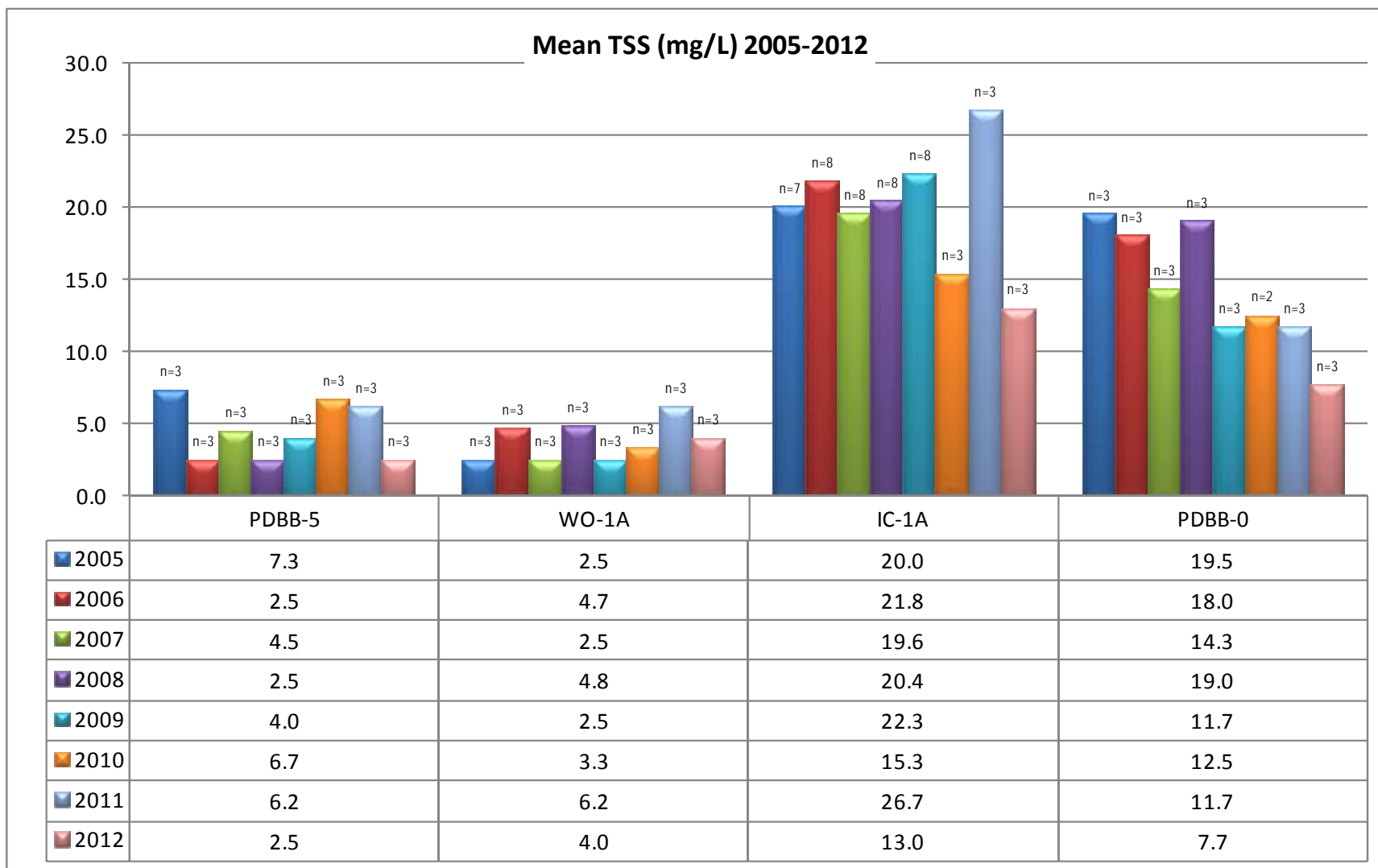


Figure 6. TN concentrations measured in the Perdido Bay and Wolf Bay watersheds, March or April-October, 2012. The historic mean (1990-2012) and min/max ranges are also displayed for comparison. When available, historic mean and min/max ranges are also displayed for months without 2012 data. The “n” value equals the number of data points included in the monthly historic calculations.

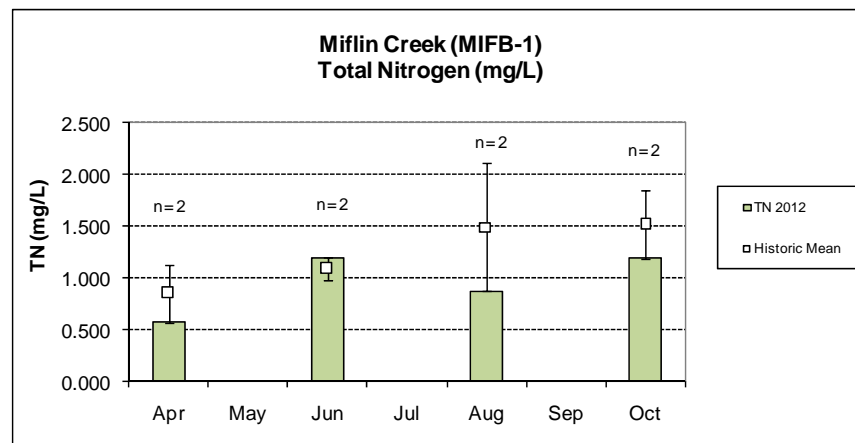
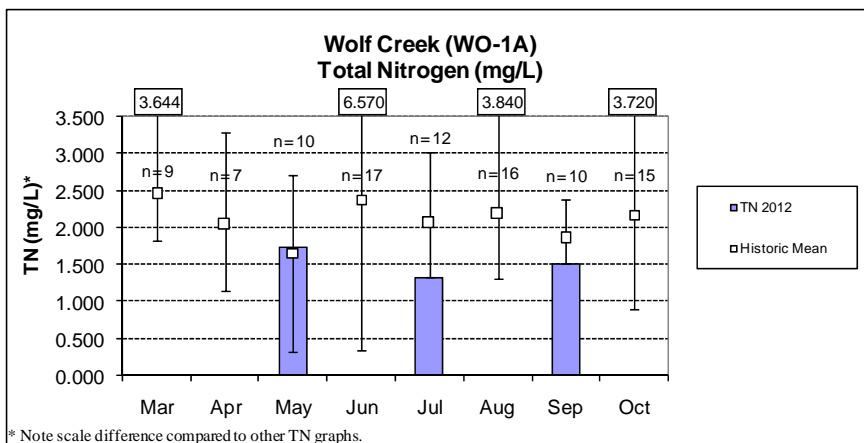
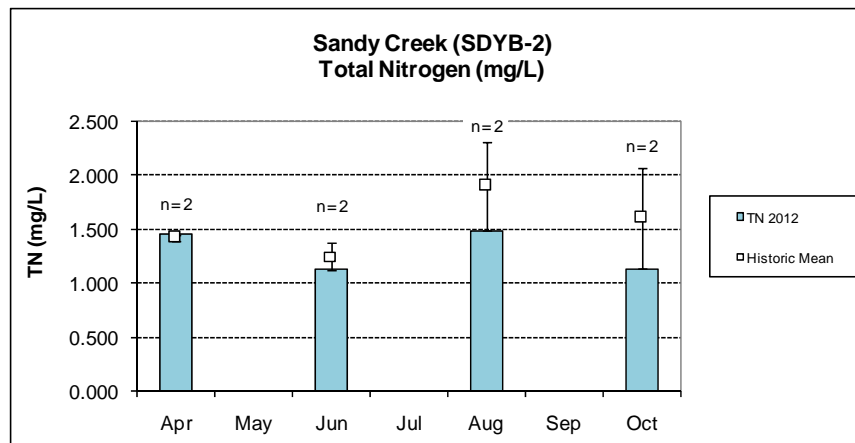
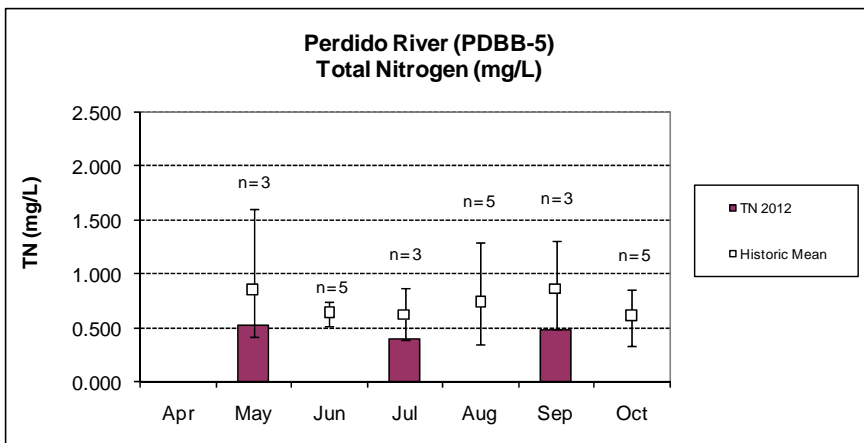


Figure 6. (continued)

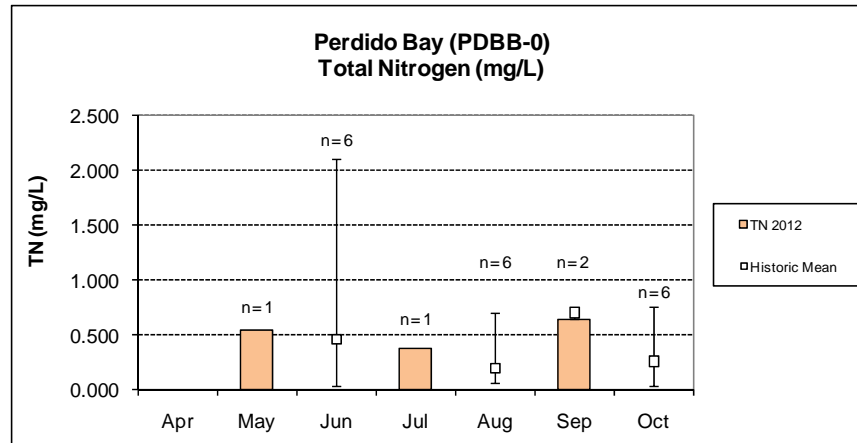
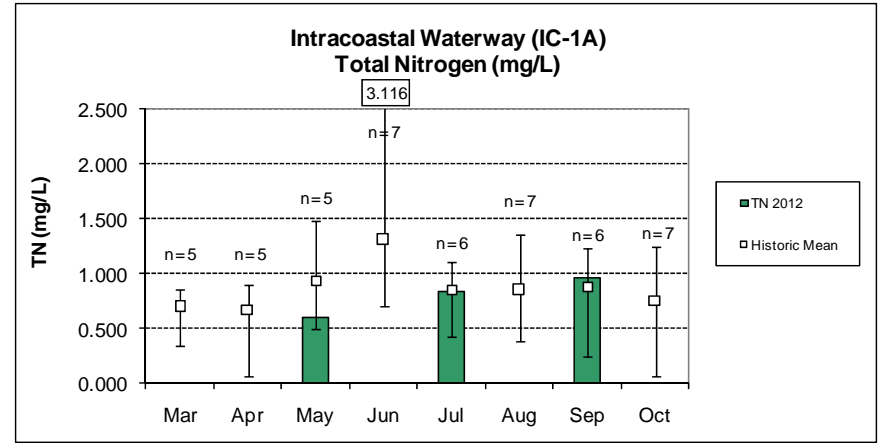
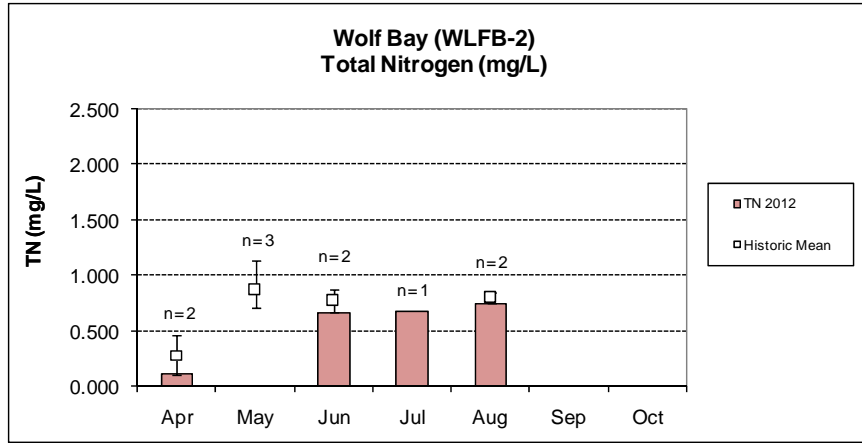


Figure 7. TP concentrations measured in the Perdido Bay and Wolf Bay watersheds, March or April-October, 2012. The historic mean (1990-2012) and min/max ranges are also displayed for comparison. When available, historic mean and min/max ranges are also displayed for months without 2012 data. The “n” value equals the number of data points included in the monthly historic calculations.

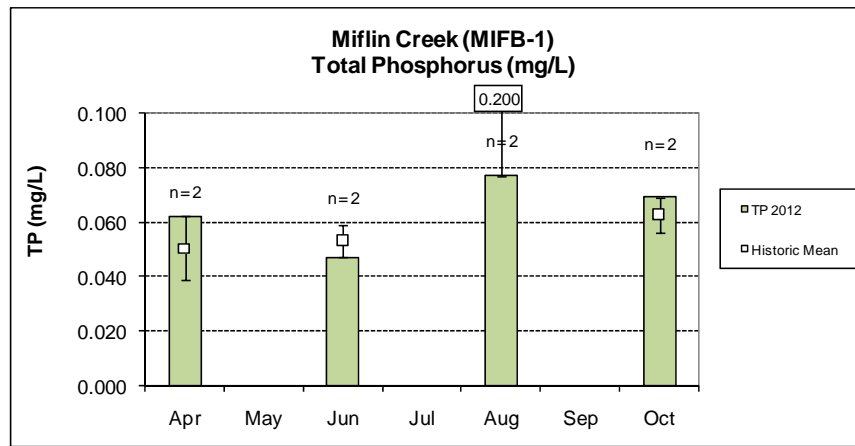
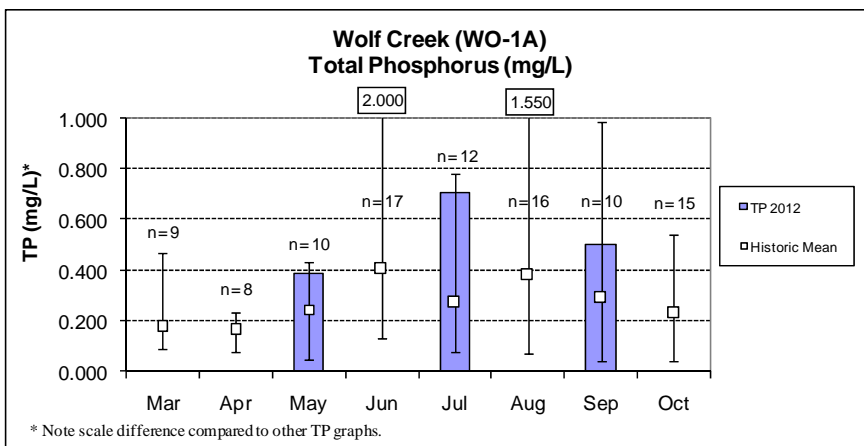
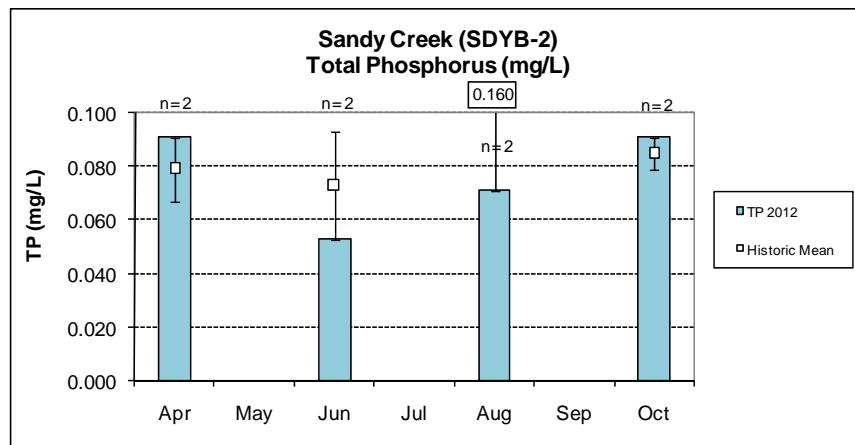
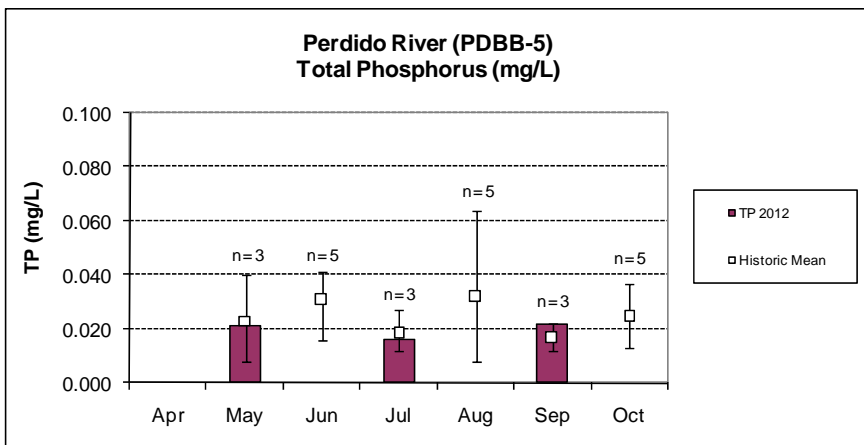


Figure 7. (continued)

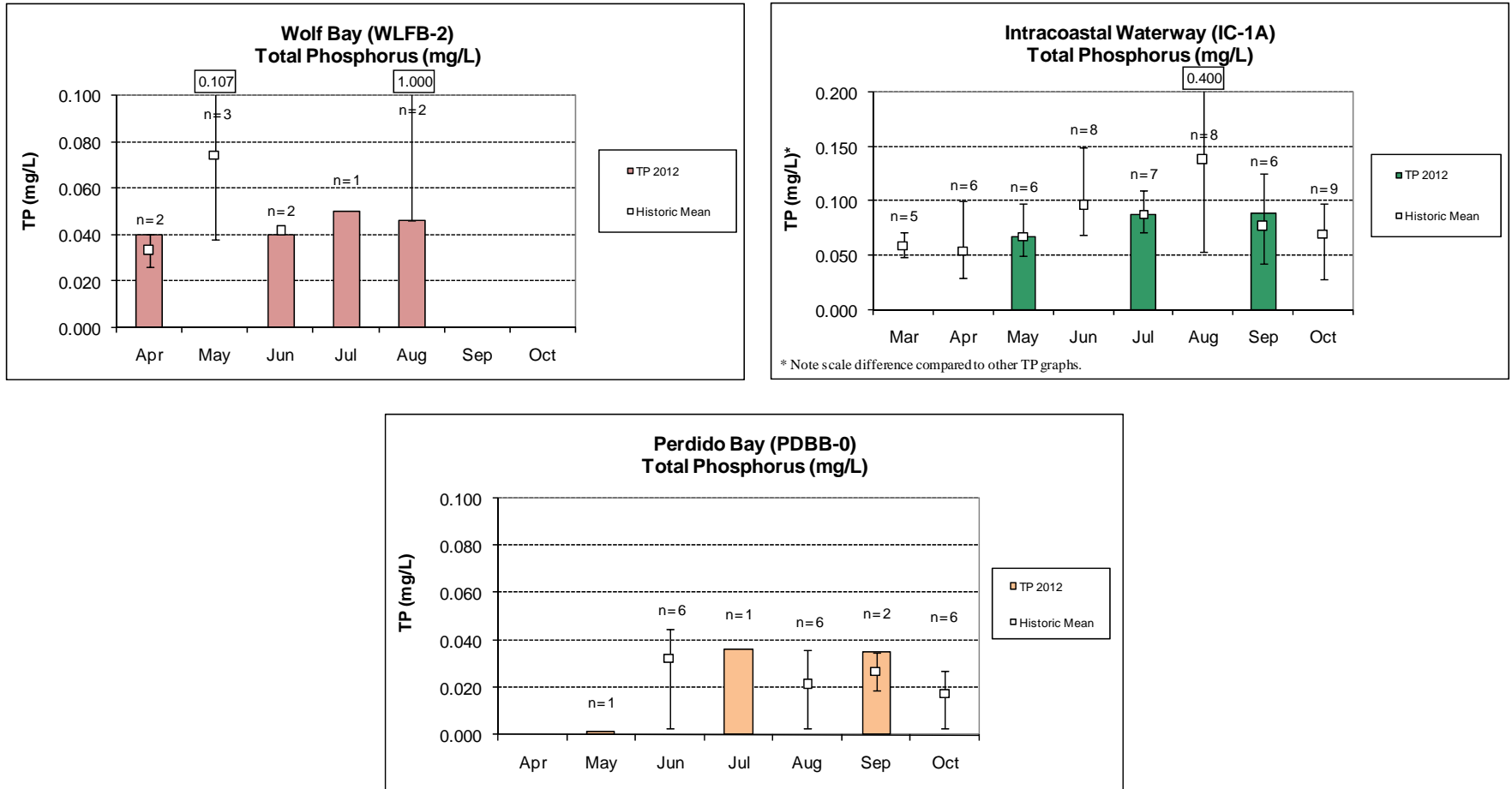


Figure 8. Chl *a* concentrations measured in the Perdido Bay and Wolf Bay watersheds, March or April-October, 2012. The historic mean (1990-2012) and min/max ranges are also displayed for comparison. When available, historic mean and min/max ranges are also displayed for months without 2012 data. The “n” value equals the number of data points included in the monthly historic calculations.

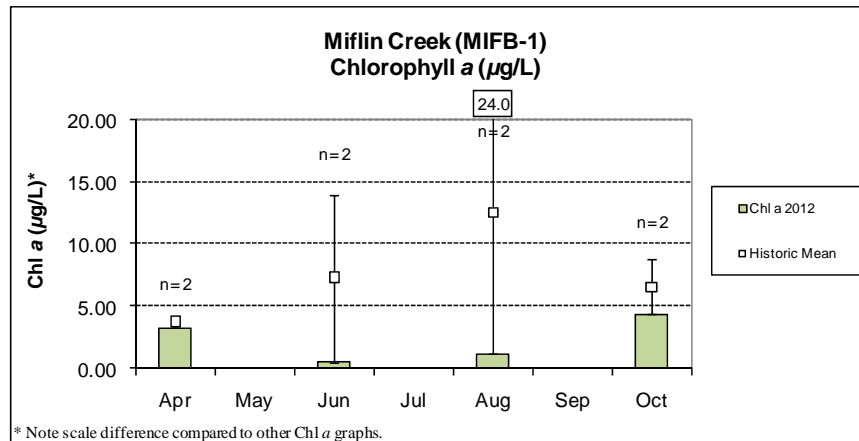
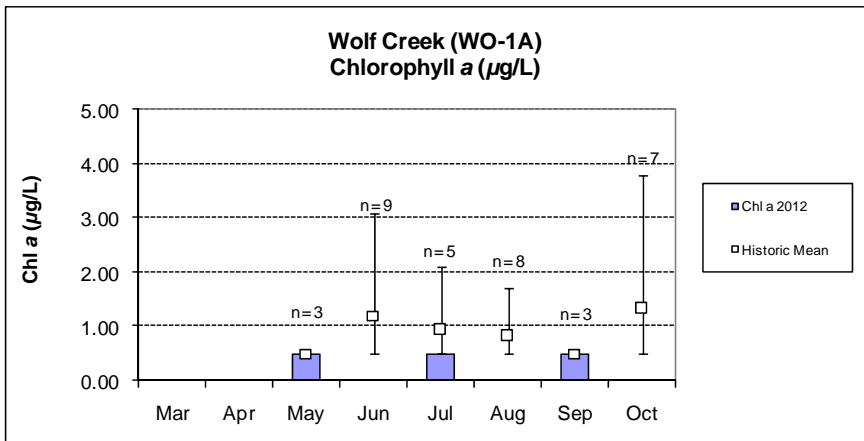
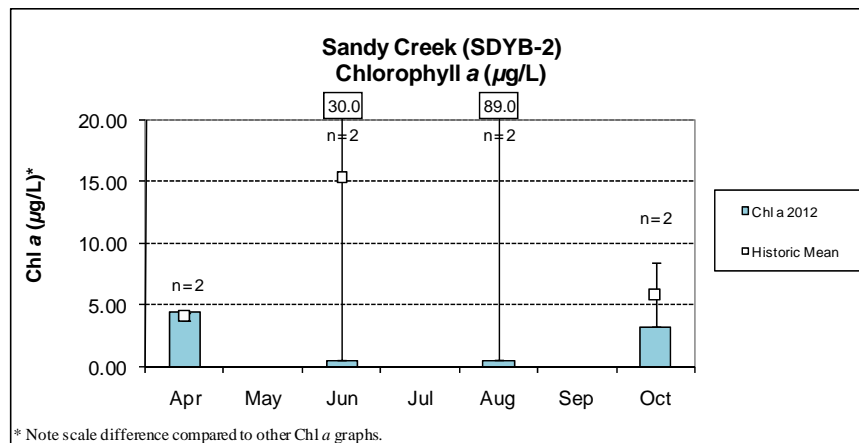
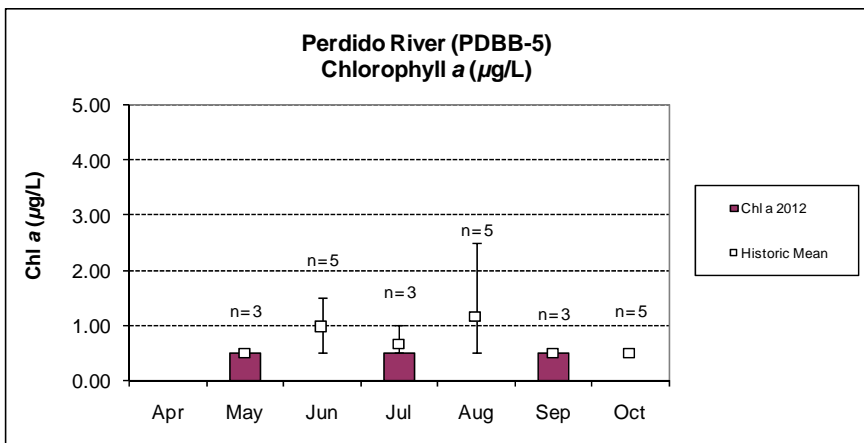


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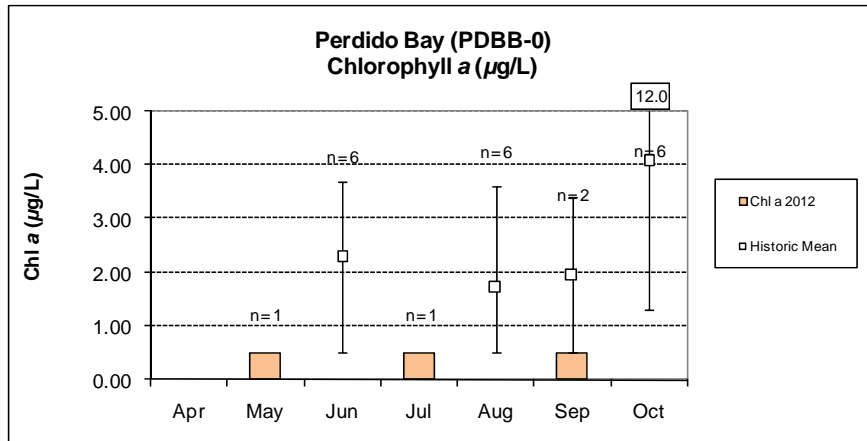
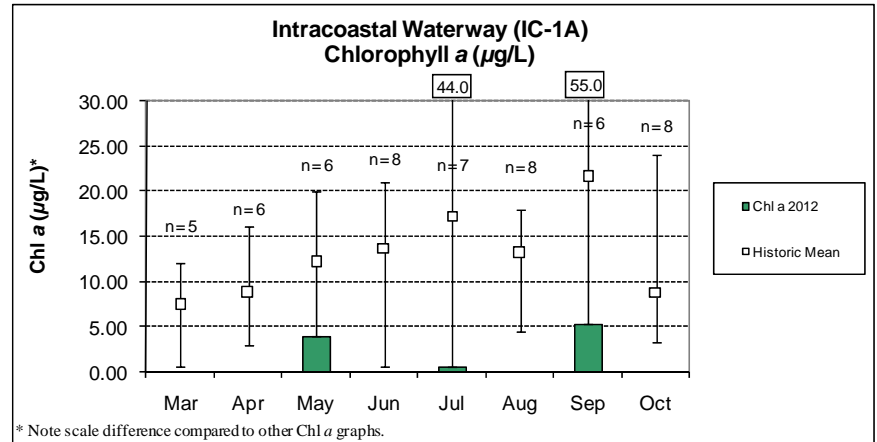
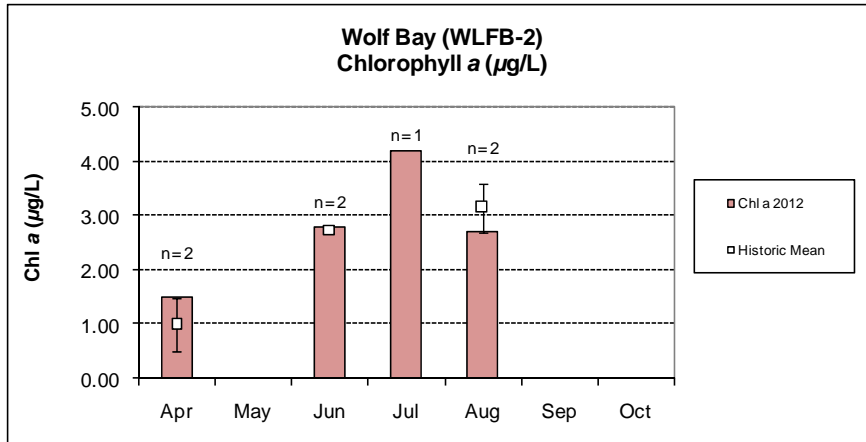


Figure 9. TSS concentrations measured in the Perdido Bay and Wolf Bay watersheds, March or April-October, 2012. The historic mean (1990-2012) and min/max ranges are also displayed for comparison. When available, historic mean and min/max ranges are also displayed for months without 2012 data. The “n” value equals the number of data points included in the monthly historic calculations.

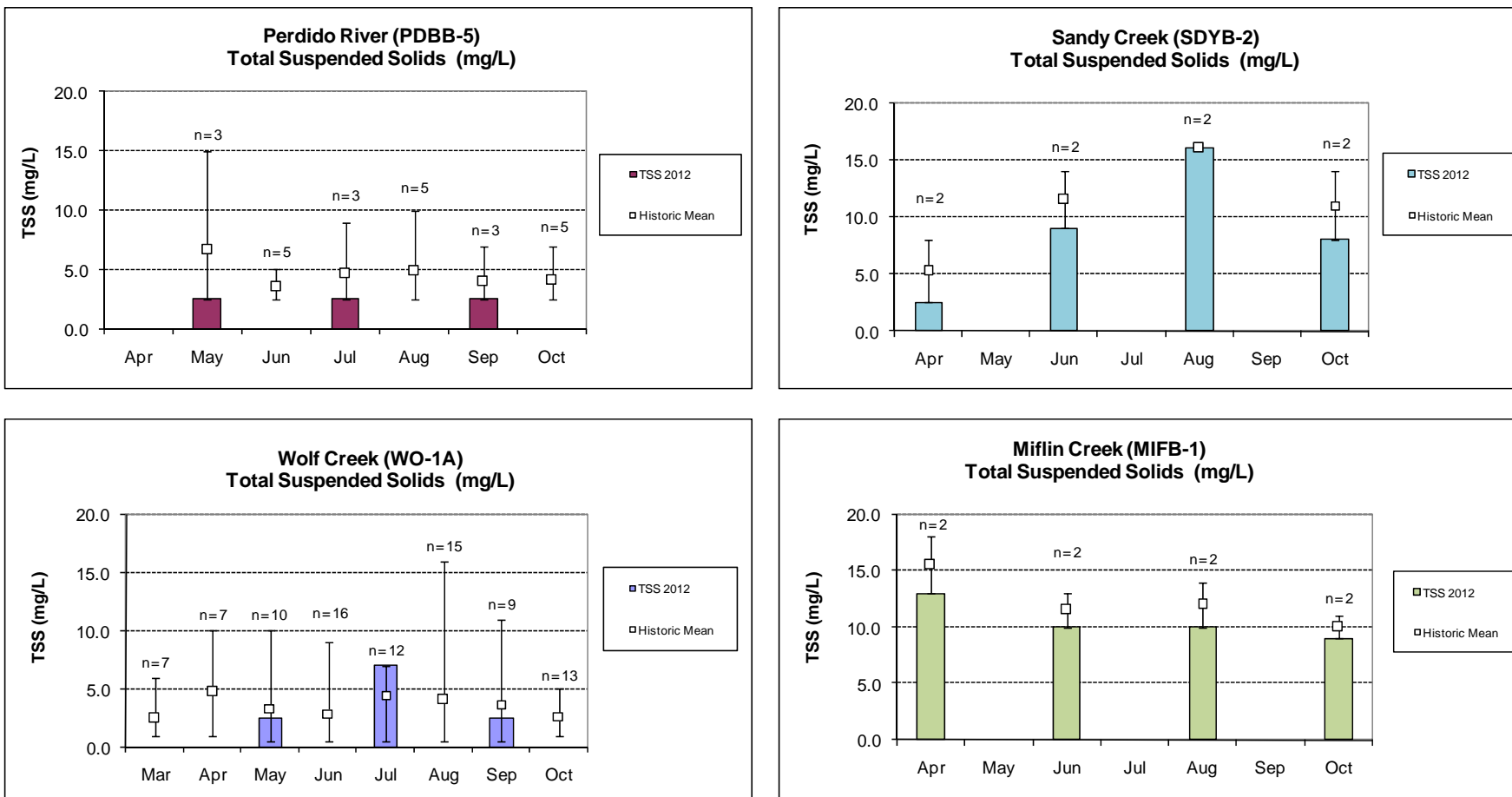


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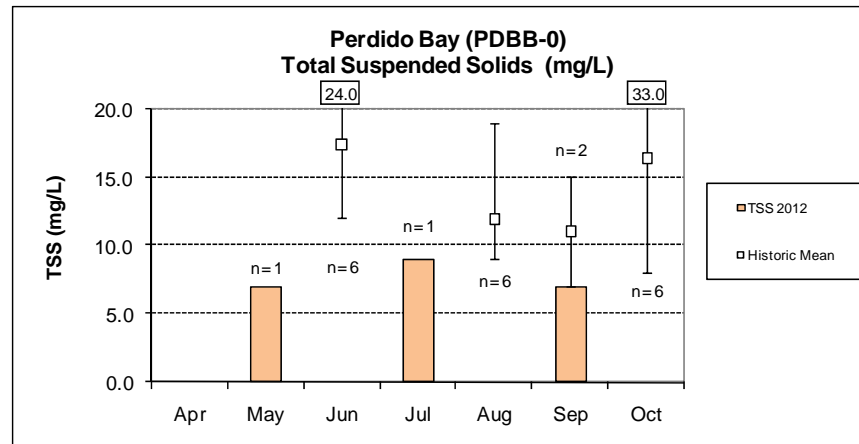
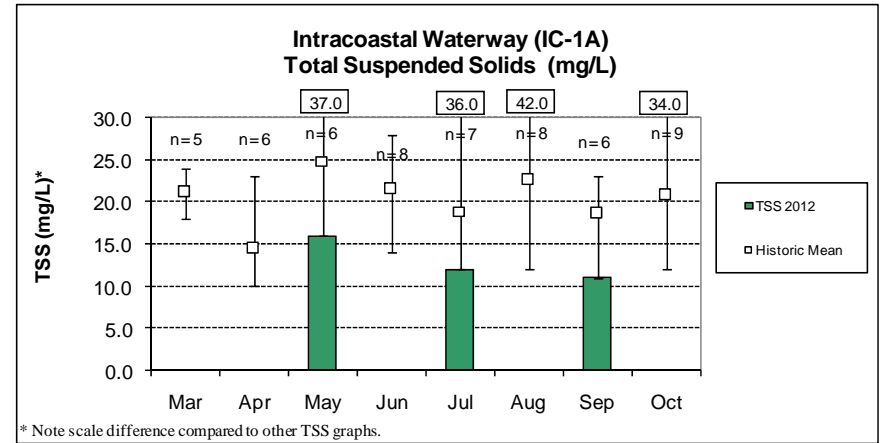
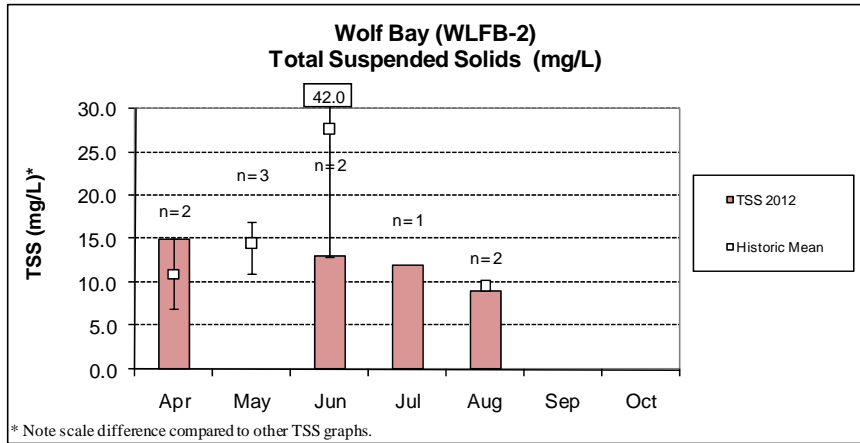


Figure 10. DO, temperature, and salinity concentrations at 1.5 m (5 ft) or mid-depth for Perdido Bay and Wolf Bay stations collected April-October 2012. ADEM Water Quality Criteria requires a DO concentration of 5.0 mg/L at this depth (ADEM 2012).

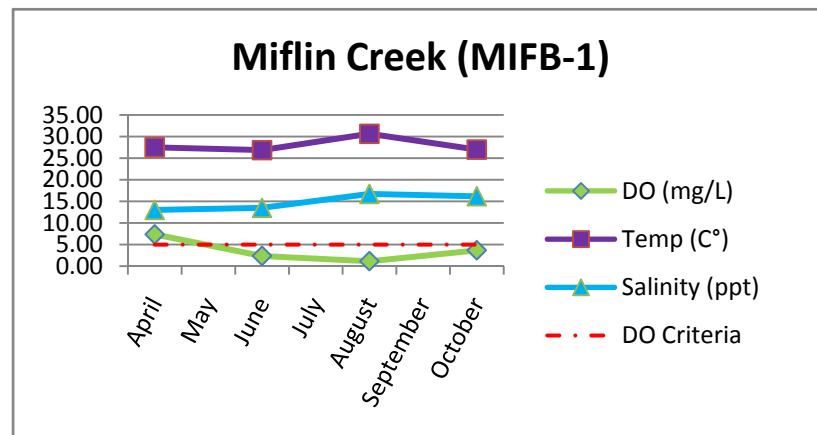
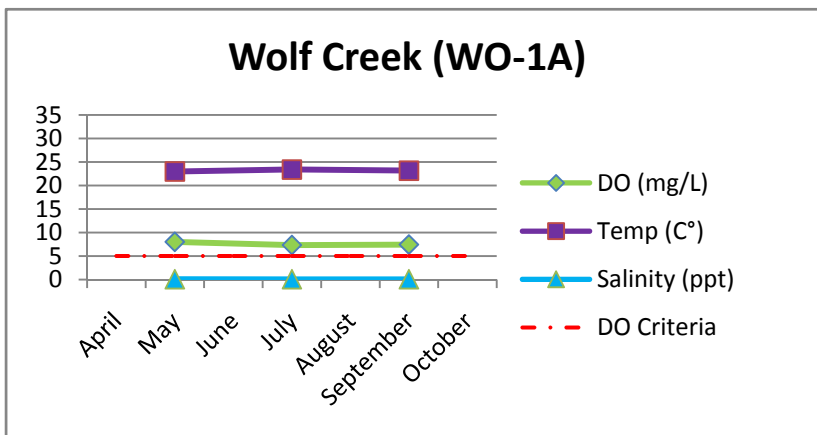
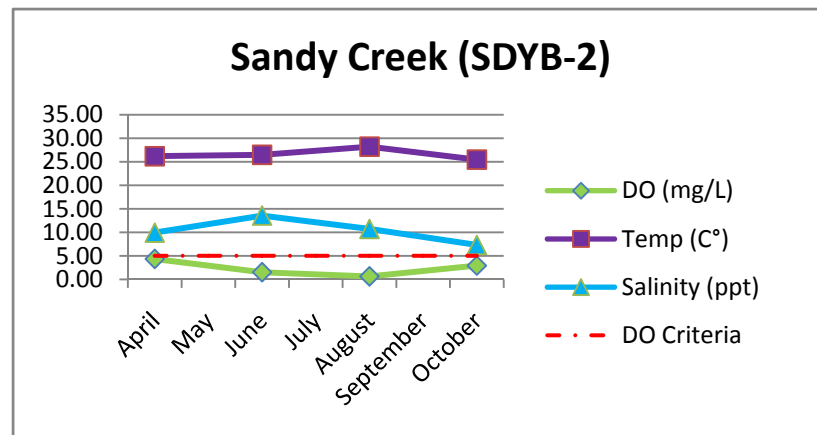
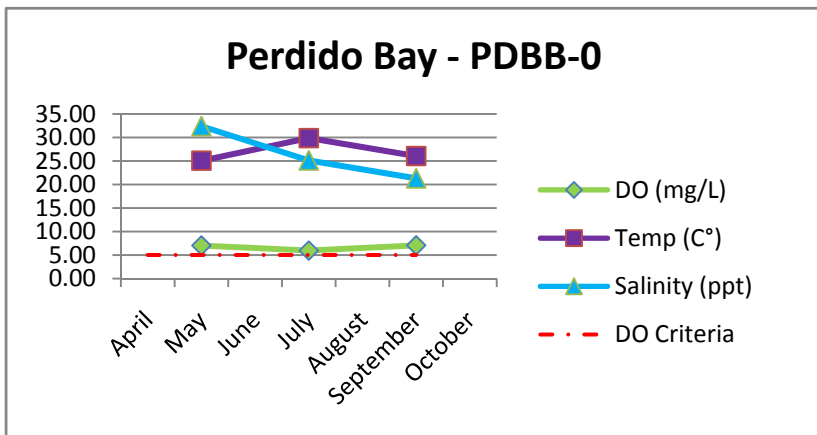


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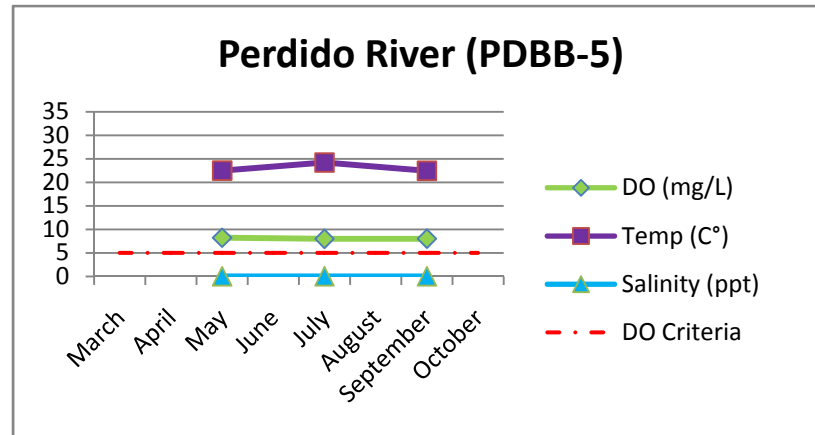
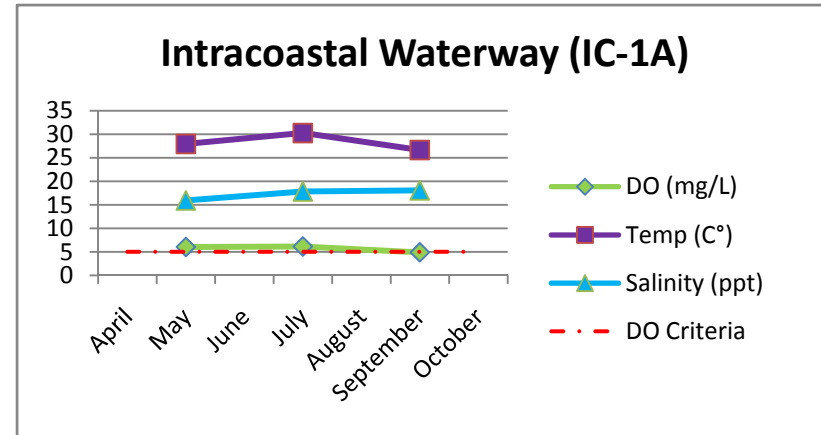
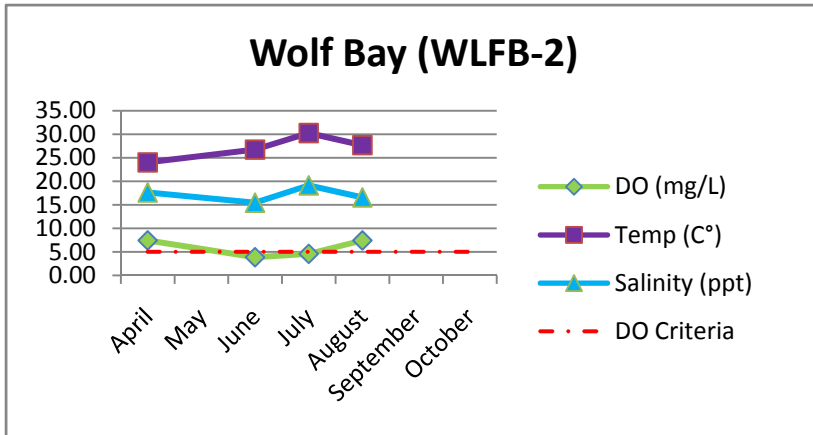


Figure 11. Semi-monthly depth profiles of dissolved oxygen, temperature, and salinity for Sandy Creek (SDYB-2), April-October, 2012.

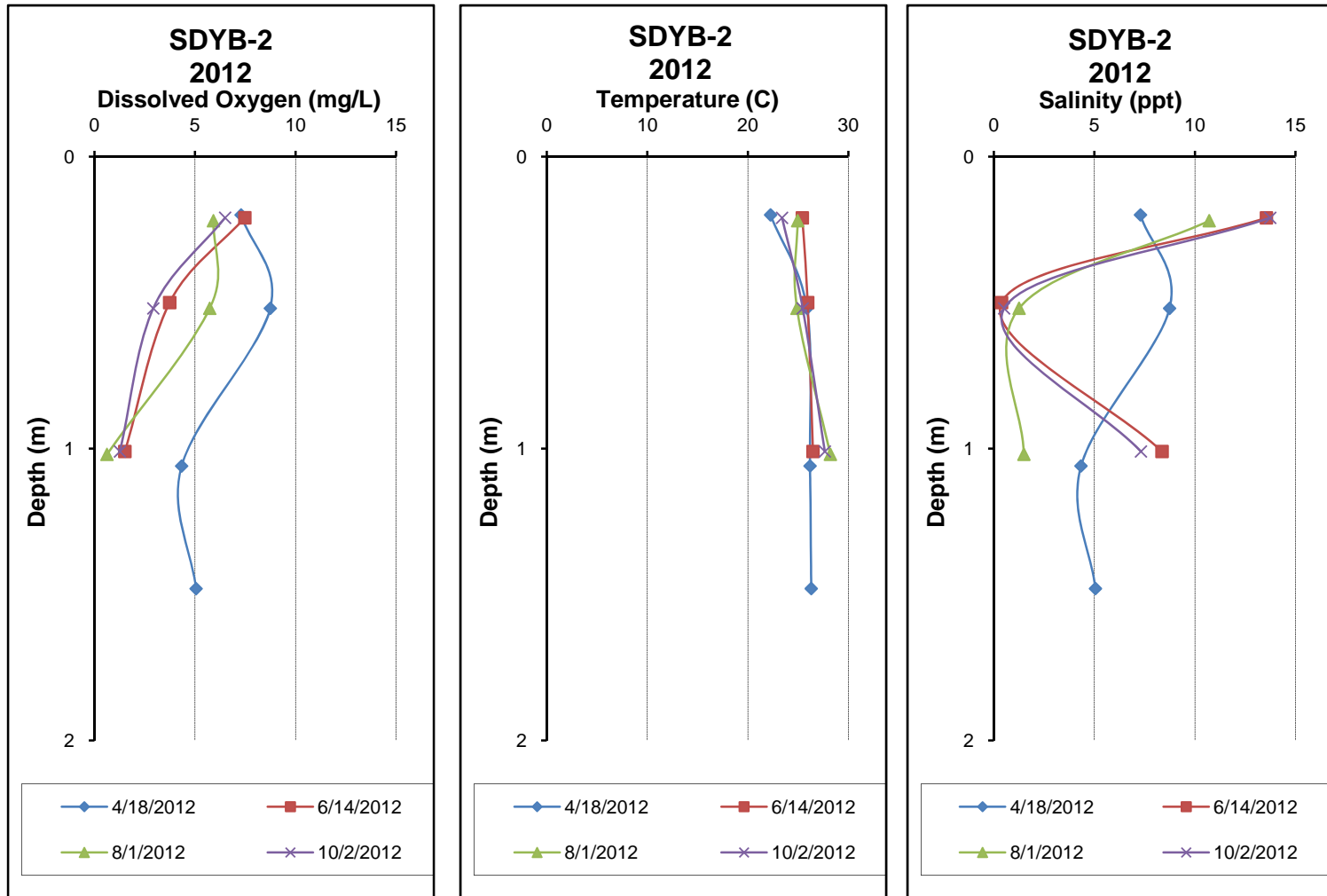


Figure 12. Semi-monthly depth profiles of dissolved oxygen, temperature, and salinity for Miflin Creek (MIFB-1), April-December, 2012.

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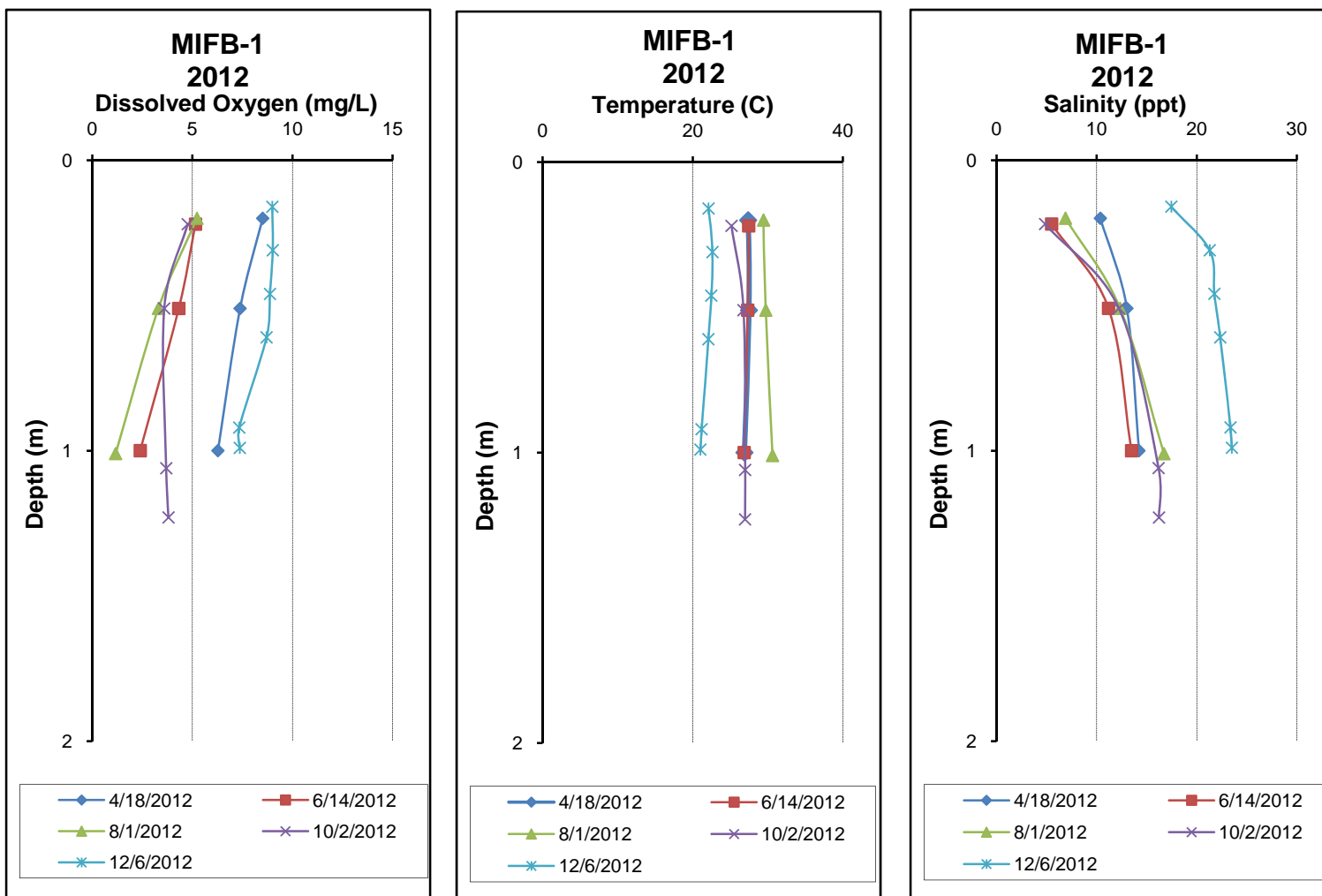


Figure 13. Semi-monthly depth profiles of dissolved oxygen, temperature, and salinity for Wolf Bay (WLFB-2), April-August, 2012.

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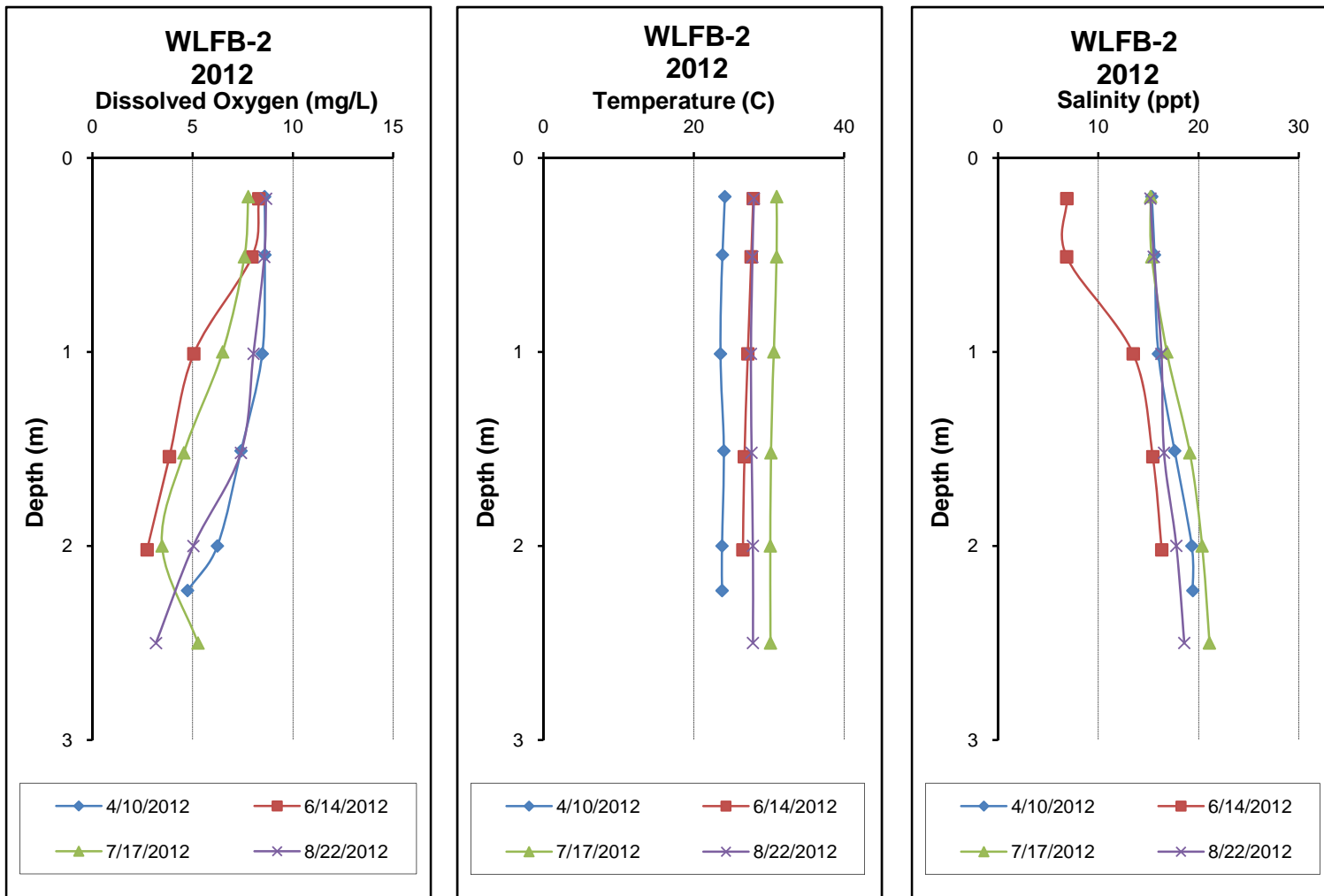
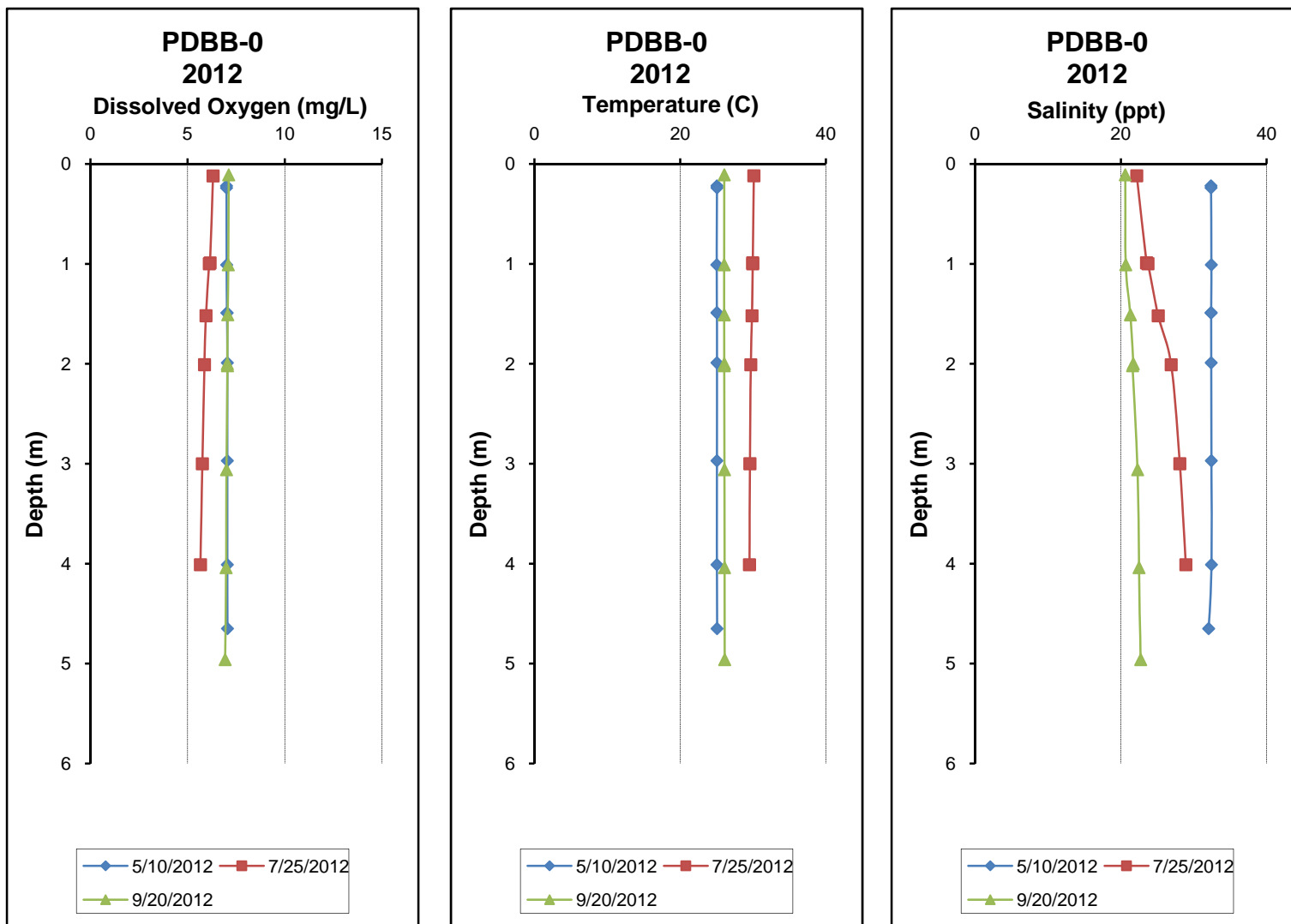


Figure 14. Semi-monthly depth profiles of dissolved oxygen, temperature, and salinity for Perdido Bay (PDBB-0), May-September, 2012.



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APPENDIX

Appendix Table 1. Summary of Perdido Bay Watershed and Wolf Bay Watershed 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
IC-1A	Physical						
	Turbidity (NTU)	3	7.5	10.0	9.0	8.8	1.3
	Total Dissolved Solids (mg/L)	3	10,400.0	14,600.0	13,300.0	12,766.7	2,150.2
	Total Suspended Solids (mg/L)	3	11.0	16.0	12.0	13.0	2.6
	Hardness (mg/L) ^J	1				2,300.0	
	Alkalinity (mg/L)	3	77.0	78.0	78.0	77.7	0.6
	Stream Flow (cfs) ^J	1				1,206.8	
	Photic Zone (m)	3	2.00	2.30	2.20	2.17	0.15
	Secchi (m)	3	0.55	0.82	0.66	0.68	0.14
	Bottom Depth (m)	3	4.90	7.80	4.80	5.77	1.76
	Chemical						
	Ammonia Nitrogen (mg/L)	3	< 0.005	0.210	0.130	0.114	0.105
	Nitrate+Nitrite Nitrogen (mg/L) ^J	3	< 0.004	0.049	0.008	0.020	0.026
	Total Kjeldahl Nitrogen (mg/L)	3	0.600	0.960	0.780	0.780	0.180
	Total Nitrogen (mg/L) ^J	3	< 0.602	0.968	0.829	0.800	0.184
	Dissolved Reactive Phosphorus (mg/L)	3	0.017	0.028	0.023	0.023	0.006
	Total Phosphorus (mg/L) ^J	3	0.067	0.089	0.087	0.081	0.012
	CBOD-5 (mg/L) ^J	3	< 2.0	3.4	3.1	2.5	1.3
	Chlorides (mg/L)	3	9,100.0	10,000.0	10,000.0	9,700.0	519.6
	Total Metals						
	Aluminum (mg/L) ^J	1				0.267	
	Iron (mg/L) ^J	1				0.207	
	Manganese (mg/L) ^J	1				0.092	
	Dissolved Metals						
	Aluminum (mg/L) ^J	1				0.087	
	Antimony (µg/L) ^J	1				< 1.4	
	Arsenic (µg/L) ^J	1				< 1.3	
	Cadmium (µg/L) ^J	1				< 0.022	
	Chromium (mg/L) ^J	1				< 0.006	
	Copper (mg/L) ^J	1				< 0.005	
	Iron (mg/L) ^J	1				< 0.036	
	Lead (µg/L) ^J	1				< 0.9	
Manganese (mg/L) ^J	1				0.019		
Mercury (µg/L) ^J	1				0.049		
Nickel (mg/L) ^J	1				< 0.045		
Selenium (µg/L) ^J	1				< 1.1		
Silver (µg/L) ^J	1				< 0.015		
Thallium (µg/L) ^J	1				1.7		
Zinc (mg/L) ^J	1				< 0.032		

Station	Parameter	N	Min	Max	Med	Mean	SD
IC-1A	Biological						
	Chlorophyll a (ug/L)	3	< 1.00	5.20	3.90	3.20	2.43
	Enterococci (col/100ml) ^J	3	< 2	38	1	13	21
MIFB-1	Physical						
	Turbidity (NTU)	5	6.8	10.3	8.0	8.4	1.6
	Total Dissolved Solids (mg/L)	4	7,120.0	12,300.0	11,100.0	10,405.0	2,404.7
	Total Suspended Solids (mg/L)	4	9.0	13.0	10.0	10.5	1.7
	Hardness (mg/L) ^J	2	839.0	3,400.0	2,119.5	2,119.5	1,810.9
	Alkalinity (mg/L)	4	26.0	58.0	40.0	41.0	13.3
	Stream Flow (cfs)	2	-18.3	17.9	0.1	0.1	25.2
	Photic Zone (m)	5	1.16	1.54	1.40	1.36	0.15
	Secchi (m)	5	0.60	0.72	0.62	0.64	0.05
	Bottom Depth (m)	5	1.00	1.54	1.40	1.36	0.15
	Chemical						
	Ammonia Nitrogen (mg/L) ^J	4	< 0.005	0.320	0.135	0.148	0.131
	Nitrate+Nitrite Nitrogen (mg/L) ^J	4	0.102	0.219	0.164	0.162	0.051
	Total Kjeldahl Nitrogen (mg/L)	4	0.430	1.000	0.875	0.795	0.265
	Total Nitrogen (mg/L) ^J	4	0.572	1.199	1.030	0.958	0.298
	Dissolved Reactive Phosphorus (mg/L)	4	< 0.002	0.016	0.008	0.008	0.008
	Total Phosphorus (mg/L)	4	0.047	0.077	0.066	0.064	0.013
	CBOD-5 (mg/L) ^J	4	< 2.0	2.8	2.6	2.2	0.8
	Chlorides (mg/L)	4	5,400.0	10,000.0	6,700.0	7,200.0	2,006.7
	Total Metals						
	Aluminum (mg/L)	2	0.290	0.338	0.314	0.314	0.034
	Iron (mg/L) ^J	2	0.102	0.302	0.202	0.202	0.141
	Manganese (mg/L) ^J	2	0.017	0.088	0.052	0.052	0.050
	Dissolved Metals						
	Aluminum (mg/L) ^J	2	0.100	0.136	0.118	0.118	0.026
	Antimony (µg/L)	2	< 3.6	3.6	1.8	1.8	0.0
	Arsenic (µg/L) ^J	2	< 1.8	1.8	0.9	0.9	0.0
	Cadmium (µg/L) ^J	2	< 0.031	0.046	0.019	0.019	0.005
	Chromium (mg/L) ^J	2	< 0.017	0.017	0.008	0.008	0.000
	Copper (mg/L)	2	< 0.005	0.011	0.004	0.004	0.002
	Iron (mg/L) ^J	2	< 0.036	0.123	0.070	0.070	0.074
	Lead (µg/L) ^J	2	< 0.4	1.3	0.8	0.8	0.8
	Manganese (mg/L) ^J	2	< 0.002	0.095	0.048	0.048	0.066
Mercury (µg/L)	2	< 0.035	0.351	0.184	0.184	0.236	
Nickel (mg/L)	2	< 0.045	0.045	0.022	0.022	0.000	
Selenium (µg/L) ^J	2	< 2.5	2.5	1.2	1.2	0.0	
Silver (µg/L) ^J	2	< 0.200	0.215	0.104	0.104	0.005	
Thallium (µg/L) ^J	2	< 1.4	7.7	4.2	4.2	5.0	
Zinc (mg/L)	2	< 0.032	0.032	0.016	0.016	0.000	
Biological							
Chlorophyll a (ug/L)	4	< 1.00	4.40	2.25	2.35	1.81	
Enterococci (col/100ml) ^J	3	16	600	38	218	331	

Station	Parameter	N	Min	Max	Med	Mean	SD
PDBB-0	Physical						
	Turbidity (NTU)	3	1.0	3.0	1.0	1.7	1.2
	Total Dissolved Solids (mg/L)	3	18,500.0	23,300.0	21,600.0	21,133.3	2,433.8
	Total Suspended Solids (mg/L)	3	7.0	9.0	7.0	7.7	1.2
	Hardness (mg/L) ^j	1				5,400.0	
	Alkalinity (mg/L)	3	76.0	106.0	94.0	92.0	15.1
	Photic Zone (m)	3	4.10	5.00	4.70	4.60	0.46
	Secchi (m)	2	1.25	1.50	1.38	1.38	0.18
	Bottom Depth (m)	3	4.00	5.00	4.70	4.60	0.46
	Chemical						
	Ammonia Nitrogen (mg/L)	3	0.040	0.240	0.240	0.173	0.116
	Nitrate+Nitrite Nitrogen (mg/L) ^j	3	< 0.004	0.015	0.002	0.004	0.003
	Total Kjeldahl Nitrogen (mg/L)	3	0.370	0.630	0.540	0.513	0.132
	Total Nitrogen (mg/L) ^j	3	< 0.372	0.638	0.542	0.517	0.134
	Dissolved Reactive Phosphorus (mg/L)	3	< 0.001	0.005	0.001	0.001	0.001
	Total Phosphorus (mg/L) ^j	3	< 0.003	0.036	0.035	0.024	0.020
	CBOD-5 (mg/L) ^j	3	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	3	12,000.0	19,000.0	16,000.0	15,666.7	3,511.9
	Total Metals						
	Aluminum (mg/L) ^j	1				< 0.040	
	Iron (mg/L) ^j	1				< 0.036	
	Manganese (mg/L) ^j	1				0.024	
	Dissolved Metals						
	Aluminum (mg/L) ^j	1				0.148	
	Antimony (µg/L) ^j	1				< 1.4	
	Arsenic (µg/L) ^j	1				< 1.3	
	Cadmium (µg/L) ^j	1				< 0.022	
	Chromium (mg/L) ^j	1				0.021	
	Copper (mg/L) ^j	1				< 0.005	
	Iron (mg/L) ^j	1				< 0.036	
	Lead (µg/L) ^j	1				52.1	
	Manganese (mg/L) ^j	1				0.020	
	Mercury (µg/L) ^j	1				0.330	
Nickel (mg/L) ^j	1				< 0.045		
Selenium (µg/L) ^j	1				< 1.1		
Silver (µg/L) ^j	1				< 0.015		
Thallium (µg/L) ^j	1				83.7		
Zinc (mg/L) ^j	1				< 0.032		
Biological							
Chlorophyll a (ug/L)	3	< 1.00	1.00	0.50	0.50	0.00	
Fecal Coliform (col/100 mL) ^j	3	< 2	4	2	2	2	
Enterococci (col/100ml) ^j	3	< 2	2	1	1	0	

Station	Parameter	N	Min	Max	Med	Mean	SD
PDBB-5	Physical						
	Turbidity (NTU)	3	2.0	3.0	2.1	2.4	0.6
	Total Dissolved Solids (mg/L)	3	39.0	49.0	49.0	45.7	5.8
	Total Suspended Solids (mg/L)	3	< 5.0	5.0	2.5	2.5	0.0
	Hardness (mg/L) ^J	1				6.3	
	Alkalinity (mg/L)	3	< 3.0	3.0	1.5	1.5	0.0
	Stream Flow (cfs)	3	218.0	297.0	243.0	252.7	40.4
	Bottom Depth (m)	3	1.0	1.5	1.5	1.5	0.1
	Chemical						
	Ammonia Nitrogen (mg/L) ^J	3	< 0.005	0.020	0.002	0.008	0.010
	Nitrate+Nitrite Nitrogen (mg/L) ^J	3	0.228	0.278	0.264	0.257	0.026
	Total Kjeldahl Nitrogen (mg/L) ^J	3	0.130	0.260	0.240	0.210	0.070
	Total Nitrogen (mg/L) ^J	3	0.394	0.518	0.488	0.467	0.065
	Dissolved Reactive Phosphorus (mg/L) ^J	3	0.004	0.007	0.004	0.005	0.002
	Total Phosphorus (mg/L) ^J	3	0.016	0.022	0.021	0.020	0.003
	CBOD-5 (mg/L) ^J	3	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L) ^J	3	4.0	4.2	4.2	4.1	0.1
	Total Metals						
	Aluminum (mg/L) ^J	1				< 0.040	
	Iron (mg/L) ^J	1				0.408	
	Manganese (mg/L) ^J	1				0.030	
	Dissolved Metals						
	Aluminum (mg/L) ^J	1				0.162	
	Antimony (µg/L) ^J	1				< 1.4	
	Arsenic (µg/L) ^J	1				2.1	
	Cadmium (µg/L) ^J	1				< 0.022	
	Chromium (mg/L) ^J	1				< 0.017	
	Copper (mg/L) ^J	1				< 0.005	
	Iron (mg/L) ^J	1				0.129	
	Lead (µg/L) ^J	1				< 0.9	
	Manganese (mg/L) ^J	1				0.027	
	Nickel (mg/L) ^J	1				< 0.045	
	Selenium (µg/L) ^J	1				< 1.1	
Silver (µg/L) ^J	1				< 0.015		
Thallium (µg/L) ^J	1				< 1.4		
Zinc (mg/L) ^J	1				< 0.032		
Biological							
Chlorophyll a (ug/L)	3	< 1.00	1.00	0.50	0.50	0.00	
E. coli (col/100mL) ^J	3	5	210	11	75	117	

Station	Parameter	N	Min	Max	Med	Mean	SD
SDYB-2	Physical						
	Turbidity (NTU)	4	6.9	18.5	7.6	10.2	5.6
	Total Dissolved Solids (mg/L)	4	4,540.0	8,610.0	6,490.0	6,532.5	1,780.1
	Total Suspended Solids (mg/L)	4	< 5.0	16.0	8.5	8.9	5.5
	Hardness (mg/L) ^J	1				1,500.0	
	Alkalinity (mg/L)	4	22.0	36.0	26.0	27.5	6.0
	Stream Flow (cfs) ^J	1				22.8	
	Photic Zone (m)	4	1.30	1.86	1.68	1.63	0.24
	Secchi (m)	4	0.98	1.13	1.02	1.04	0.07
	Bottom Depth (m)	4	1.00	1.86	1.68	1.63	0.24
	Chemical						
	Ammonia Nitrogen (mg/L) ^J	4	0.030	0.310	0.160	0.165	0.116
	Nitrate+Nitrite Nitrogen (mg/L) ^J	4	0.314	0.730	0.530	0.526	0.191
	Total Kjeldahl Nitrogen (mg/L)	4	0.700	0.850	0.770	0.772	0.074
	Total Nitrogen (mg/L) ^J	4	1.123	1.486	1.292	1.298	0.197
	Dissolved Reactive Phosphorus (mg/L) ^J	4	0.006	0.013	0.010	0.010	0.003
	Total Phosphorus (mg/L)	4	0.053	0.091	0.081	0.076	0.018
	CBOD-5 (mg/L) ^J	4	< 2.0	3.3	1.6	1.9	1.1
	Chlorides (mg/L)	4	3,100.0	5,100.0	4,100.0	4,100.0	879.4
	Total Metals						
	Aluminum (mg/L) ^J	1				0.332	
	Iron (mg/L) ^J	1				0.252	
	Manganese (mg/L) ^J	1				0.091	
	Dissolved Metals						
	Aluminum (mg/L) ^J	1				0.116	
	Antimony (µg/L) ^J	1				< 3.6	
	Arsenic (µg/L) ^J	1				< 1.8	
	Cadmium (µg/L) ^J	1				< 0.031	
	Chromium (mg/L) ^J	1				< 0.017	
	Copper (mg/L) ^J	1				< 0.005	
	Iron (mg/L) ^J	1				0.132	
	Lead (µg/L) ^J	1				0.5	
Manganese (mg/L) ^J	1				0.103		
Mercury (µg/L) ^J	1				0.442		
Nickel (mg/L) ^J	1				< 0.045		
Selenium (µg/L) ^J	1				< 2.5		
Silver (µg/L) ^J	1				< 0.200		
Thallium (µg/L) ^J	1				1.9		
Zinc (mg/L) ^J	1				< 0.032		
Biological							
Chlorophyll a (ug/L)	4	< 1.00	4.40	1.85	2.15	1.97	
Enterococci (col/100ml) ^J	5	2	600	40	138	259	

Station	Parameter	N	Min	Max	Med	Mean	SD
WLFB-2	Physical						
	Turbidity (NTU)	4	5.6	8.3	7.1	7.0	1.2
	Total Dissolved Solids (mg/L)	4	11,700.0	13,900.0	12,200.0	12,500.0	1,016.5
	Total Suspended Solids (mg/L)	4	9.0	15.0	12.5	12.2	2.5
	Hardness (mg/L) ^j	1					2,100.0
	Alkalinity (mg/L)	4	32.0	72.0	52.0	52.0	16.4
	Photic Zone (m)	4	2.30	2.73	2.42	2.46	0.19
	Secchi (m)	4	0.58	0.73	0.68	0.67	0.06
	Bottom Depth (m)	4	2.90	3.00	2.88	2.87	0.11
	Chemical						
	Ammonia Nitrogen (mg/L)	4	< 0.005	0.150	0.130	0.103	0.068
	Nitrate+Nitrite Nitrogen (mg/L) ^j	4	< 0.004	0.080	0.038	0.040	0.032
	Total Kjeldahl Nitrogen (mg/L)	4	< 0.120	0.710	0.625	0.505	0.302
	Total Nitrogen (mg/L) ^j	4	< 0.101	0.745	0.666	0.544	0.298
	Dissolved Reactive Phosphorus (mg/L)	4	< 0.001	0.005	0.001	0.001	0.001
	Total Phosphorus (mg/L)	4	0.040	0.050	0.043	0.044	0.005
	CBOD-5 (mg/L) ^j	4	< 2.0	2.1	1.5	1.5	0.6
	Chlorides (mg/L)	4	7,100.0	10,000.0	8,900.0	8,725.0	1,499.7
	Total Metals						
	Aluminum (mg/L) ^j	1					0.356
	Iron (mg/L) ^j	1					0.115
	Manganese (mg/L) ^j	1					0.045
	Dissolved Metals						
	Aluminum (mg/L) ^j	1					0.080
	Antimony (µg/L) ^j	1				< 3.6	
	Arsenic (µg/L) ^j	1				< 1.8	
	Cadmium (µg/L) ^j	1				< 0.031	
	Chromium (mg/L) ^j	1				< 0.017	
	Copper (mg/L) ^j	1				< 0.005	
	Iron (mg/L) ^j	1					0.052
	Lead (µg/L) ^j	1				< 0.4	
	Manganese (mg/L) ^j	1					0.039
	Mercury (µg/L) ^j	1					0.315
Nickel (mg/L) ^j	1				< 0.045		
Selenium (µg/L) ^j	1				< 2.5		
Silver (µg/L) ^j	1				< 0.200		
Thallium (µg/L) ^j	1				< 1.4		
Zinc (mg/L) ^j	1				< 0.032		
Biological							
Chlorophyll a (ug/L)	4	1.50	4.20	2.75	2.80	1.10	
Fecal Coliform (col/100 mL) ^j	4	< 2	16	2	5	7	
Enterococci (col/100ml) ^j	4	< 2	2	1	1	1	

Station	Parameter	N	Min	Max	Med	Mean	SD
WO-1A	Physical						
	Turbidity (NTU)	3	1.5	3.0	1.9	2.1	0.8
	Total Dissolved Solids (mg/L)	3	60.0	91.0	77.0	76.0	15.5
	Total Suspended Solids (mg/L)	3	< 5.0	7.0	2.5	4.0	2.6
	Hardness (mg/L) ^J	1				22.2	
	Alkalinity (mg/L)	3	< 3.0	15.0	13.0	9.8	7.3
	Stream Flow (cfs)	3	10.5	17.4	15.0	14.3	3.5
	Bottom Depth (m)	3	0.9	0.9	0.9	0.9	0.1
	Chemical						
	Ammonia Nitrogen (mg/L)	3	< 0.005	0.030	0.030	0.021	0.016
	Nitrate+Nitrite Nitrogen (mg/L) ^J	3	1.190	1.500	1.480	1.390	0.174
	Total Kjeldahl Nitrogen (mg/L) ^J	3	< 0.062	0.230	0.140	0.134	0.100
	Total Nitrogen (mg/L) ^J	3	< 1.330	1.730	1.511	1.524	0.200
	Dissolved Reactive Phosphorus (mg/L)	3	0.310	0.630	0.400	0.447	0.165
	Total Phosphorus (mg/L) ^J	3	0.390	0.710	0.500	0.533	0.163
	CBOD-5 (mg/L) ^J	3	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	3	14.0	15.0	14.0	14.3	0.6
	Total Metals						
	Aluminum (mg/L)	1				0.101	
	Iron (mg/L)	1				0.257	
	Manganese (mg/L)	1				0.039	
	Dissolved Metals						
	Aluminum (mg/L) ^J	1				0.118	
	Antimony (µg/L) ^J	1				< 1.4	
	Arsenic (µg/L) ^J	1				2.9	
	Cadmium (µg/L) ^J	1				< 0.022	
	Chromium (mg/L) ^J	1				< 0.017	
	Copper (mg/L) ^J	1				< 0.005	
	Iron (mg/L) ^J	1				0.102	
	Lead (µg/L) ^J	1				< 0.9	
	Manganese (mg/L) ^J	1				0.039	
	Nickel (mg/L) ^J	1				< 0.045	
	Selenium (µg/L) ^J	1				1.2	
Silver (µg/L) ^J	1				< 0.015		
Thallium (µg/L) ^J	1				< 1.4		
Zinc (mg/L) ^J	1				< 0.032		
Biological							
Chlorophyll a (ug/L)	3	< 1.00	1.00	0.50	0.50	0.00	
E. coli (col/100mL) ^J	3	< 1	100	96	66	56	

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