2016 Mississippi Sound Sub-Estuary Report

Alabama Department of Environmental Management

Field Operations Division
Environmental Assessment Section
Water Unit
August 2020

Coastal Waters Monitoring Program

2016

Mississippi Sound Sub-Estuary Report

Alabama Department of Environmental Management
Environmental Assessment Section
Water Unit

August 2020

Table of Contents

LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
CHL *a*	Chlorophyll *a*
CWA	Clean Water Act
CWMP	Coastal Waters Monitoring Program
DO	Dissolved Oxygen
F&W	Fish and Wildlife
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
S	Swimming and Other Whole Body Water-Contact Sports
SD	Standard Deviation
SH	Shellfish Harvesting
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

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Mississippi Sound watershed forms the southwestern boundary of coastal Alabama and Mississippi and empties into the Gulf of Mexico. Major tributaries to the Mississippi Sound include West Fowl River, Fowl River, Bayou La Batre River, Grand Bay, Portersville Bay, and Heron Bay. This watershed provides valuable resources to the area including spawning habitats for commercial and recreational fish and shellfish, and recreational activities such as boating, fishing, and swimming.

The Alabama Department of Environmental Management (ADEM) monitored stations within the Mississippi Sound watershed as part of the 2016 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, Table 1. 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 2017 Monitoring Strategy (ADEM 2017).

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 1972 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. Table 1 shows a tabular listing of waterbodies that remain on the 303(d) list as impaired. Figure 1 shows a map of 2016 monitoring locations as well as waterbodies within the Mississippi Sound watershed that are on the 2016 CWA 303(d) list.

The purpose of this report is to summarize data collected at seventeen stations within the Mississippi Sound watershed during the 2016 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. Deer River, Fowl River, Bayou La Batre, West Fowl River, Fowl River Bay, Grand Bay, Portersville Bay, Heron Bay, Mississippi Sound, and the Gulf of Mexico were sampled within the Mississippi Sound watershed.

Water quality assessments were conducted monthly March-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operation Procedures (ADEM 2016), Surface Water Quality Assurance Project Plan (2015), and Quality Management Plan (ADEM 2012).

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 using data from 2006 through 2016. Monthly concentrations of these parameters were graphed with ADEM's previously collected data for all stations within the focus watershed. Monthly growing season readings of dissolved oxygen (DO), salinity, and temperature were graphed at 1.5m (5ft), or mid-depth if less than 10ft deep, 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 through the National Water Quality Monitoring Council Water Quality Data Portal, https://www.waterqualitydata.us/. As Alabama's state environmental regulatory agency, the ADEM submits all possible surface water quality monitoring data to the EPA.

Table 1. 303(d) listed water bodies in the Mississippi Sound Sub-Estuary.

Assessment Unit ID	Waterbody Name	River Basin	County	Uses	Causes	Sources	Size	Unit Type	Downstream / Upstream Locations	Year Listed
AL03170009-0201-100	Mississippi Sound	Escatawpa	Mobile	Shellfish Harvesting Swimming Fish & Wildlife	Metals (Thallium)	Industrial	94.62	sq. mi.	Segment classified for shellfish harvesting	2010
AL03170009-0201-100	Mississippi Sound	Escatawpa	Mobile	Shellfish Harvesting Swimming Fish & Wildlife	Pathogens (Enterococcus)	Urban runoff/storm sewers	94.62	sq. mi.	Segment classified for shellfish harvesting	1998
AL03170009-0201-200	Portersville Bay	Escatawpa	Mobile	Shellfish Harvesting Swimming Fish & Wildlife	Pathogens (Enterococcus)	Municipal	18.81	sq. mi.	Portersville Bay	1998
AL03170009-0201-300	Grand Bay	Escatawpa	Mobile	Shellfish Harvesting Swimming Fish & Wildlife	Pathogens (Enterococcus)	On-site wastewater systems	30.73	sq. mi.	Grand Bay	2006
AL03160205-0105-100	Deer River	Mobile	Mobile	Fish & Wildlife	Organic enrichment (CBOD, NBOD)	Collection system failure Urban runoff/storm sewers	1.02	miles	Mobile Bay / its source	2006
AL03160205-0105-300	Middle Fork Deer River	Mobile	Mobile	Fish & Wildlife	Organic enrichment (CBOD, NBOD)	Collection system failure Urban runoff/storm sewers	2.47	miles	Deer River / its source	2006
AL03160205-0104-110	Fowl River	Mobile	Mobile	Swimming Fish & Wildlife	Metals (Mercury)	Atmospheric deposition	20.56	miles	Mobile Bay / its source	2000
AL-Gulf-of-Mexico	Gulf of Mexico	Mobile	Baldwin Mobile	Shellfish Harvesting Swimming Fish & Wildlife	Metals (Mercury)	Atmospheric deposition	201.02	sq. mi.	Mississippi / Florida	1998
AL03160205-0300-501	Mobile Bay	Mobile	Baldwin	Shellfish Harvesting Fish & Wildlife	Pathogens (Enterococcus)	Urban runoff/storm sewers	168.29	sq. mi.	All except out to 1000 feet offshore from Mullet Point to Ragged Point	1998

Figure 1. 2016 Mississippi Sound stations with 303d listed waters and approved TMDLs.

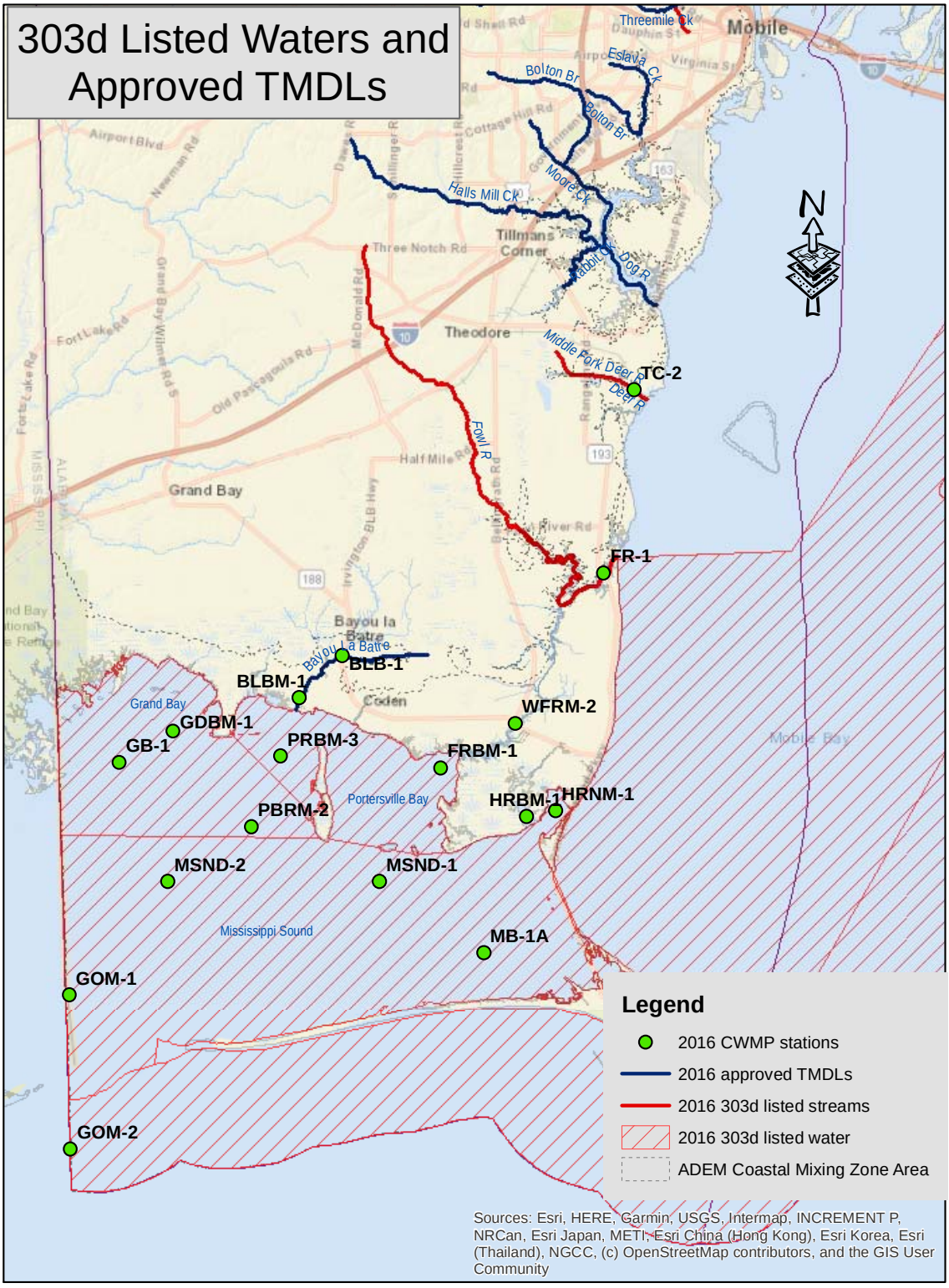


Table 2. Descriptions for the monitoring stations in 2016 for the Mississippi Sound Sub-Watershed.

HUC8	County	Station Number	Use Classification	Waterbody Name	Station Description	Latitude	Longitude
3160205	Mobile	TC-2	F&W	Deer River	At mouth of canal	30.526495	-88.098243
3160205	Mobile	FR-1	F&W, S	Fowl River	Fowl River at AL Hwy 193 at Dauphin Island Parkway Bridge	30.44416618	-88.113056
3170009	Mobile	BLB-1	F&W	Bayou la Batre	Bayou La Batre at AL Hwy 188 crossing	30.4059	-88.2481
3170009	Mobile	BLBM-1	F&W	Bayou la Batre	Bayou La Batre in channel next to light approx. 0.4 mile upstream from mouth	30.3867	-88.27
3170009	Mobile	WFRM-2	F&W, S	West Fowl River	West Fowl River at CR188	30.376186	-88.158137
3170009	Mobile	FRBM-1	F&W, S, SH	Fowl River Bay	Middle of Fowl River Bay	30.3559	-88.1965
3170009	Mobile	GDBM-1	F&W, S, SH	Grand Bay	Middle of Grand Bay	30.3709	-88.335
3170009	Mobile	GB-1	F&W, S, SH	Grand Bay	Grand Bay	30.356667	-88.362833
3170009	Mobile	PRBM-3	F&W, S, SH	Portersville Bay	0.5 miles south of the most northern point of Isle aux Herbes and 1.25 miles west of Isle aux Herbes	30.36046	-88.279224
3170009	Mobile	PBRM-2	F&W, S, SH	Portersville Bay	Portersville Bay just west of the southern tip of the Isle aux Herbes in the main navigation channel	30.328467	-88.29403
3170009	Mobile	HRNM-1	F&W, S, SH	Heron Bay	Heron Bay	30.337194	-88.136889

Table 3 (Continued).

HUC8	County	Station Number	Use Classification	Waterbody Name	Station Description	Latitude	Longitude
3170009	Mobile	HRBM-1	F&W, S, SH	Heron Bay	Middle of Heron Bayou	30.33445	-88.15178
3170009	Mobile	MSND-1	F&W, S, SH	Mississippi Sound	One mile south of the most western tip of Marsh Island	30.304615	-88.22746
3170009	Mobile	MSND-2	F&W, S, SH	Mississippi Sound	5.25 mi NNW of the western tip of Dauphin Island	30.303542	-88.33695
3170009	Mobile	MB-1A	F&W, S, SH	Mississippi Sound	Intracoastal Waterway on east side of Portersville Bay at bouy 25	30.27308	-88.17317
	Open Ocean	GOM-1	F&W, S, SH	Mississippi Sound	Gulf of Mexico-Mississippi Sound on state line	30.25208	-88.38714
	Open Ocean	GOM-2	F&W, S, SH	Gulf of Mexico	Alabama/Mississippi State Line, 3 miles south of Petit Bois Pass in the Gulf of Mexico	30.18303	-88.38559

RESULTS

Growing season mean graphs of TN, TP, chl *a*, and TSS for trend stations are provided in this section (Figs. 2-5). Monthly 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 Figure 11. Summary statistics of all data collected during 2016 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.

In 2016, the highest mean growing season mean TN value was in the Gulf of Mexico at GOM-2 (Fig. 2). While mean TN values were not the highest on record, they appear to be increasing at all stations with a historic dataset. With the exception of Fowl River Bay at FRBM-1 and Heron Bay at HRNM-1 and HRBM-1, monthly TN concentrations tended to be lower in the spring and increase through the fall. Most monthly TN concentrations were similar to or above historic means (Fig. 6).

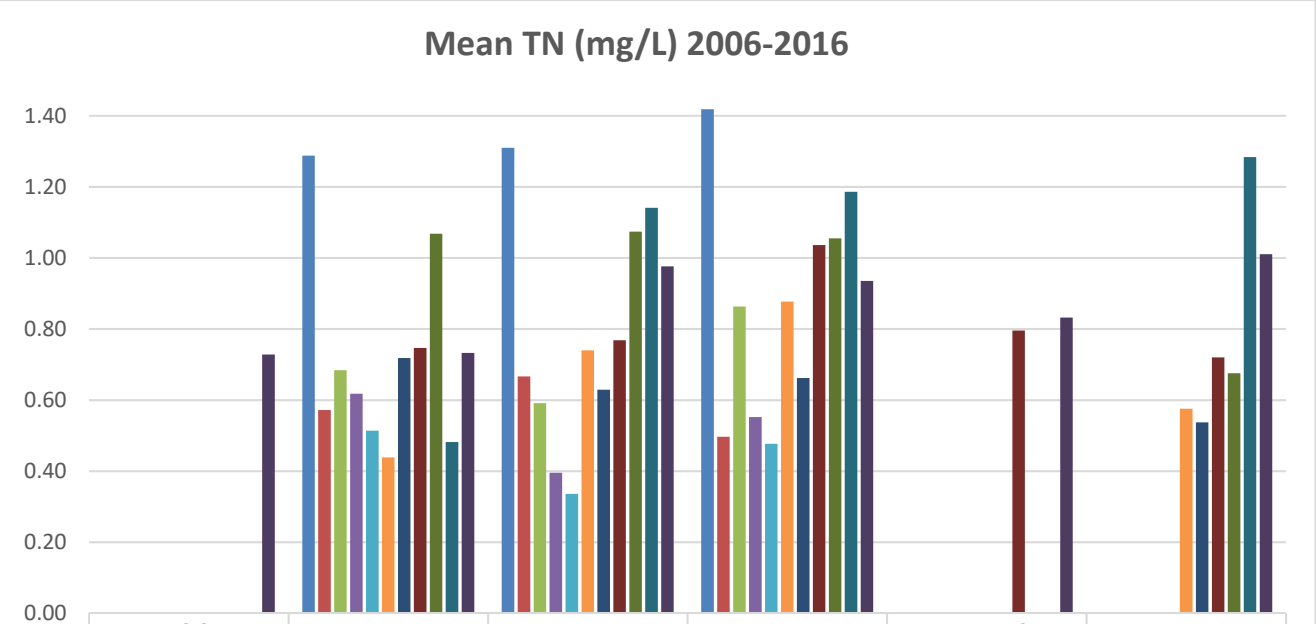
In 2016, the highest mean growing season TP value was in Bayou la Batre (BLB-1) (Fig. 3). The highest mean value on record was in Grand Bay (GB-1) in 2012. The highest monthly TP concentrations for 2016 were in Bayou la Batre (BLB-1) in July, August, September, and October (Fig. 7). With the exception of BLB-1, most stations were near the historic mean in most months sampled.

In 2016, the highest mean growing season chl *a* value was in Portersville Bay at PRBM-3 (Fig. 4). With the exception of West Fowl River (WFRM-2) and Portersville Bay (PRBM-3), mean chl *a* values have declined in all stations since monitoring began. The highest monthly chl *a* concentrations were measured in March in Portersville Bay (PRBM-3) (Fig. 8). Most monthly concentrations were near or less than historic means.

In 2016 the highest mean growing season TSS values were in Heron Bay at HRNM-1 and HRBM-1 (Fig. 5). Mean TSS values in most stations have declined since 2011. Monthly concentrations were highest in August 2016 at Heron Bay (HRBM-1) and lowest overall in the Gulf of Mexico at GOM-2 for all months sampled (Fig. 9). Most monthly TSS concentrations were near or less than historic means.

Dissolved oxygen concentrations were below or near the ADEM criteria limit of 5.0 mg/L at 5.0ft (1.5m) or mid-depth in Bayou la Batre at BLB-1 all months monitored and at BLBM-1 all months except April and May (Fig. 10) (ADEM Admin. Code R. 335-6-10-09). Dissolved oxygen concentrations in Deer River (TC-2) were below the ADEM criteria in September. Dissolved Oxygen concentrations were also below ADEM criteria in Fowl River (FR-1) in July and September, West Fowl River (WFRM-2) in July, August, September, and October; and Portersville Bay (PRBM-3) in March. All measurements of DO concentrations in Fowl River Bay (FRBM-1), Grand Bay (GDBM-1 and GB-1), Heron Bay (HRNM-1 and HRBM-1), Portersville Bay (PBRM-2), Mississippi Sound (MSND-1, MSND-2, MB-1A, and GOM-1), and the Gulf of Mexico (GOM-2) were above the ADEM criteria. Monthly depth profiles of dissolved oxygen, temperature, and salinity for Mississippi Sound sub-watershed stations are provided in Figure 11.

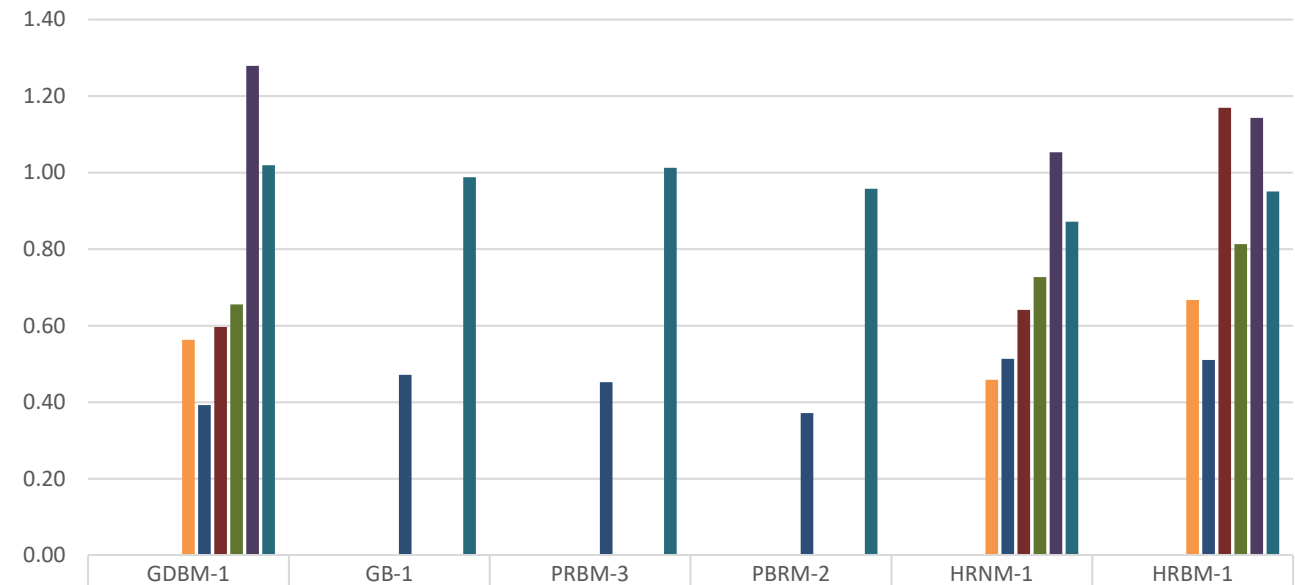
Figure 2. Mean growing season TN measured for the trend stations in the Mississippi Sound Sub-Watershed, 2006-2016.



	TC-2	FR-1	BLB-1	BLBM-1	WFRM-2	FRBM-1
2006		1.288	1.310	1.418		
2007		0.572	0.667	0.497		
2008		0.684	0.592	0.863		
2009		0.618	0.396	0.552		
2010		0.514	0.336	0.477		
2011		0.439	0.740	0.877		0.576
2012		0.719	0.629	0.662		0.537
2013		0.746	0.768	1.036	0.796	0.720
2014		1.068	1.074	1.055		0.676
2015		0.482	1.141	1.186		1.284
2016	0.728	0.733	0.976	0.935	0.832	1.011

Blank cells indicate station was not sampled during that particular year.

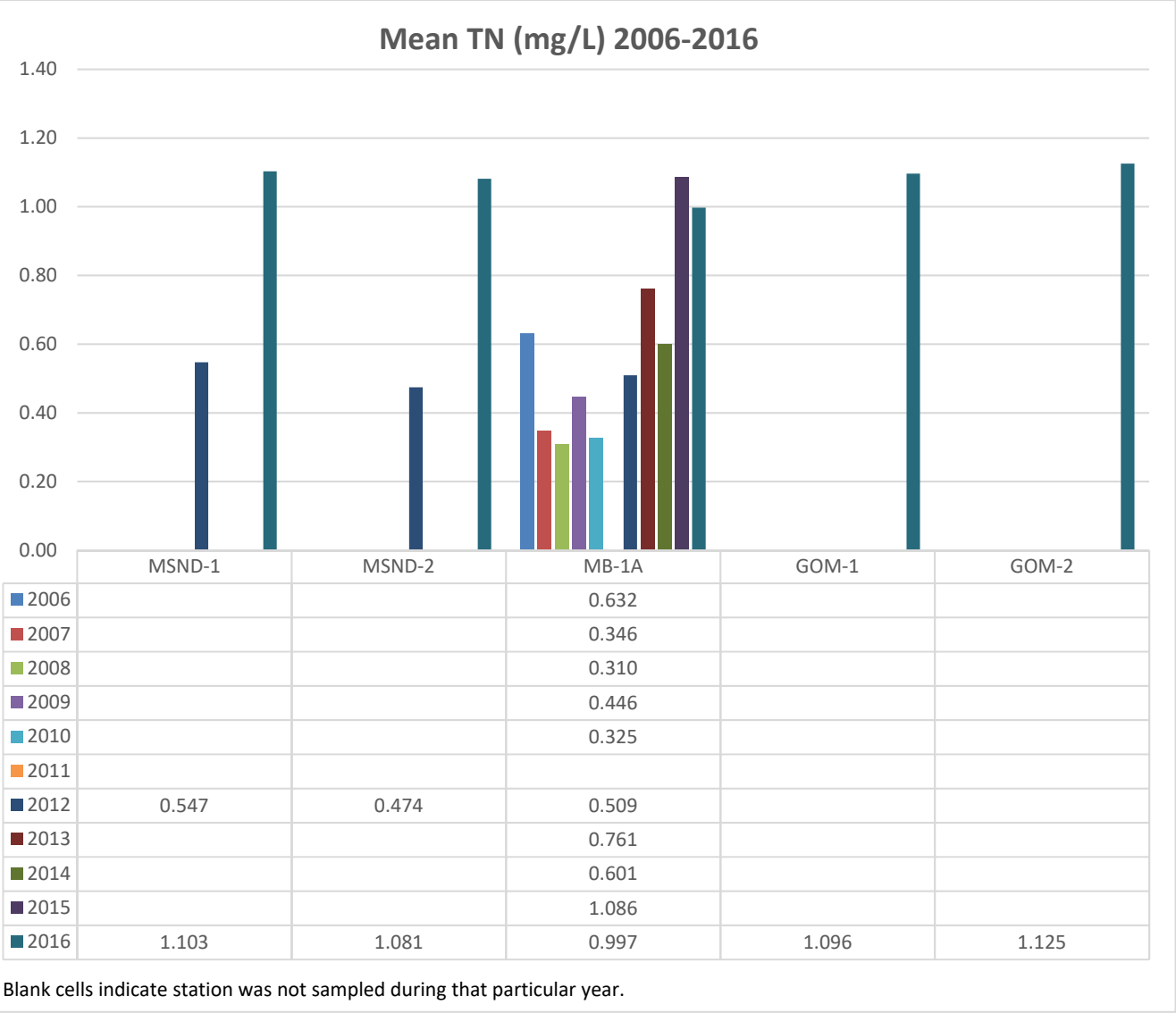
Figure 2. (Continued)



	GDBM-1	GB-1	PRBM-3	PBRM-2	HRNM-1	HRBM-1
2006						
2007						
2008						
2009						
2010						
2011	0.563				0.459	0.667
2012	0.392	0.471	0.452	0.372	0.513	0.510
2013	0.596				0.641	1.169
2014	0.656				0.727	0.813
2015	1.279				1.053	1.143
2016	1.019	0.988	1.012	0.958	0.871	0.951

Blank cells indicate station was not sampled during that particular year.

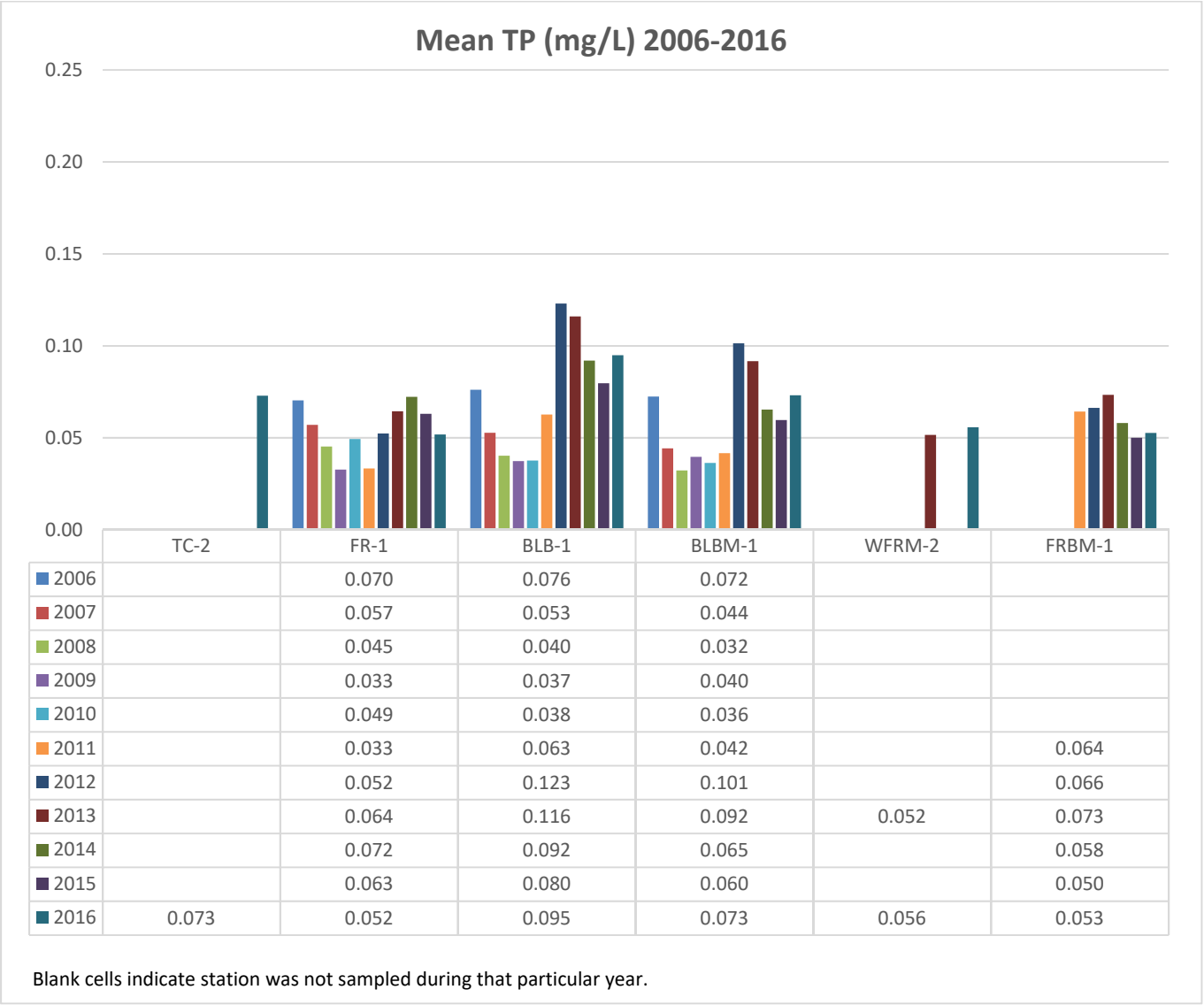
Figure 2. (Continued)



	MSND-1	MSND-2	MB-1A	GOM-1	GOM-2
2006			0.632		
2007			0.346		
2008			0.310		
2009			0.446		
2010			0.325		
2011					
2012	0.547	0.474	0.509		
2013			0.761		
2014			0.601		
2015			1.086		
2016	1.103	1.081	0.997	1.096	1.125

Blank cells indicate station was not sampled during that particular year.

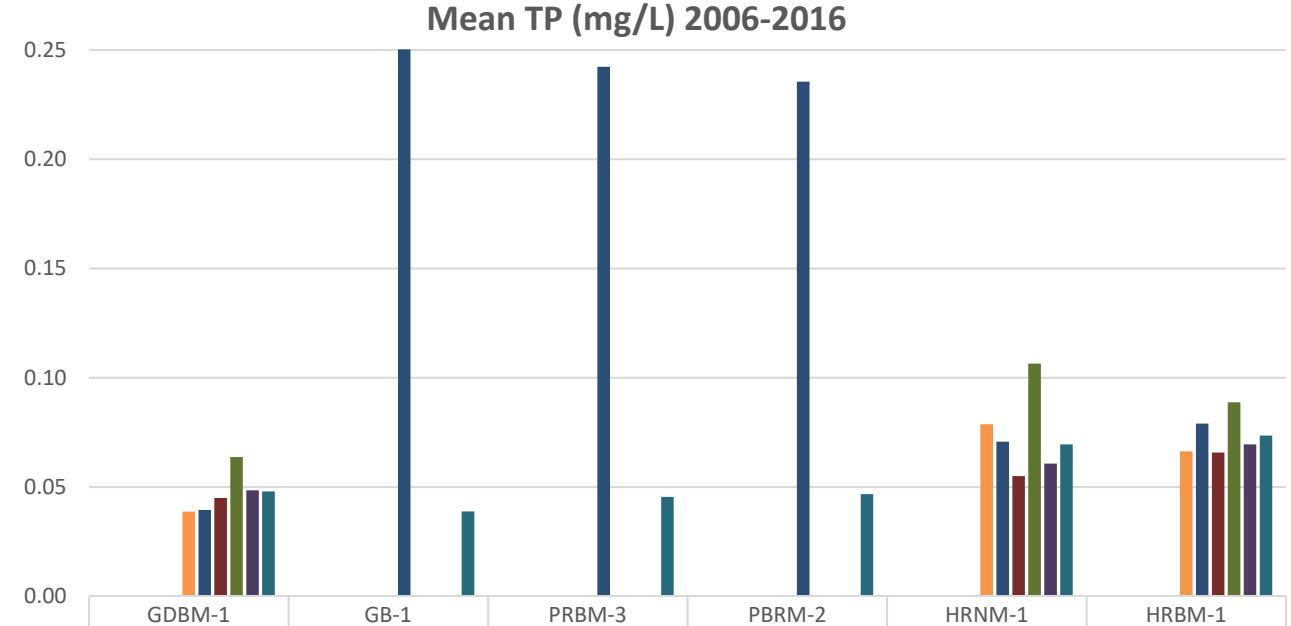
Figure 3. Mean growing season TP measured for the trend stations in the Mississippi Sound Sub-Watershed, 2006-2016.



	TC-2	FR-1	BLB-1	BLBM-1	WFRM-2	FRBM-1
2006		0.070	0.076	0.072		
2007		0.057	0.053	0.044		
2008		0.045	0.040	0.032		
2009		0.033	0.037	0.040		
2010		0.049	0.038	0.036		
2011		0.033	0.063	0.042		0.064
2012		0.052	0.123	0.101		0.066
2013		0.064	0.116	0.092	0.052	0.073
2014		0.072	0.092	0.065		0.058
2015		0.063	0.080	0.060		0.050
2016	0.073	0.052	0.095	0.073	0.056	0.053

Blank cells indicate station was not sampled during that particular year.

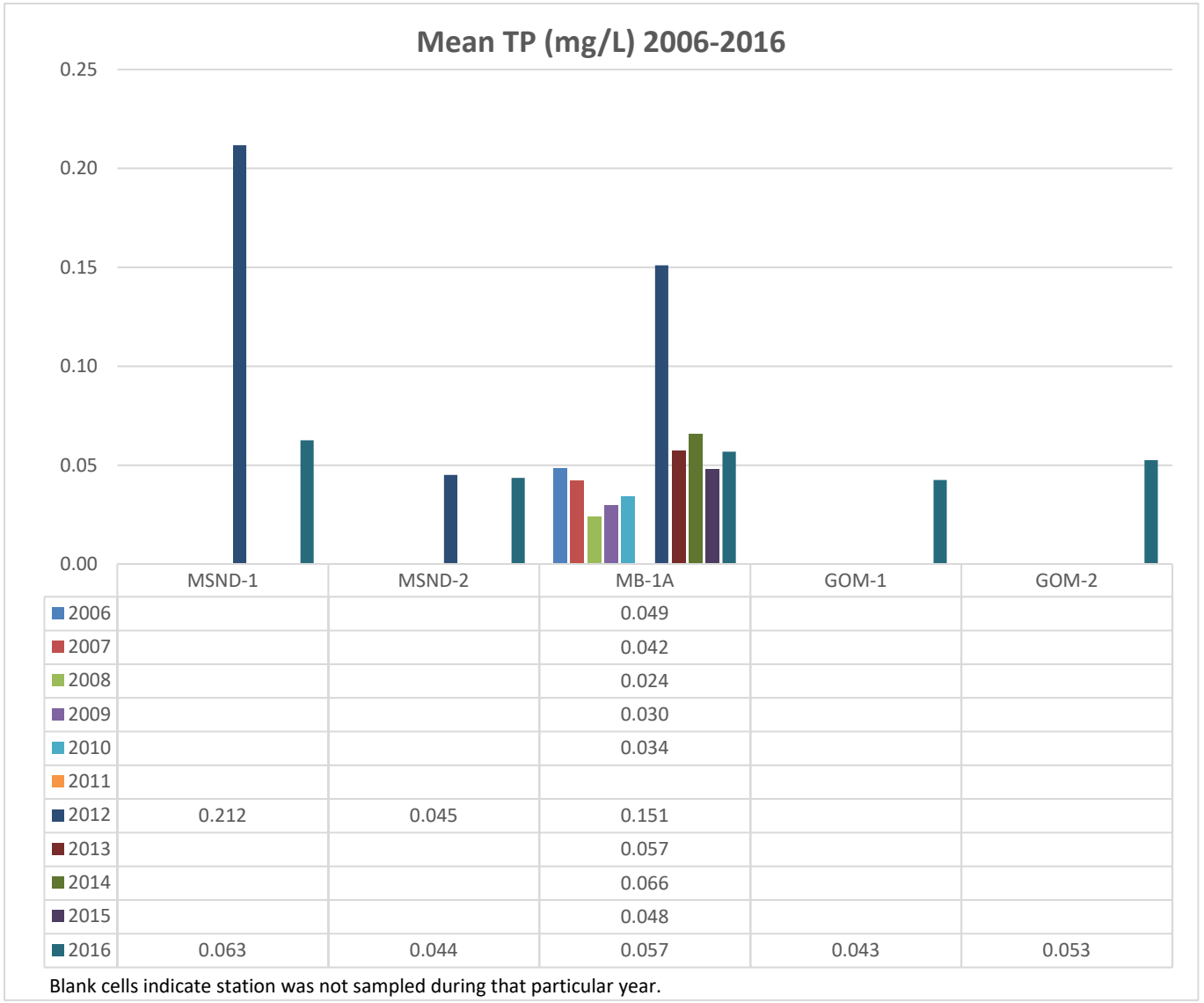
Figure 3. (Continued)



	GDBM-1	GB-1	PRBM-3	PBRM-2	HRNM-1	HRBM-1
2006						
2007						
2008						
2009						
2010						
2011	0.039				0.079	0.066
2012	0.040	0.250	0.242	0.235	0.071	0.079
2013	0.045				0.055	0.066
2014	0.064				0.107	0.089
2015	0.049				0.061	0.070
2016	0.048	0.039	0.046	0.047	0.070	0.074

Blank cells indicate station was not sampled during that particular year.

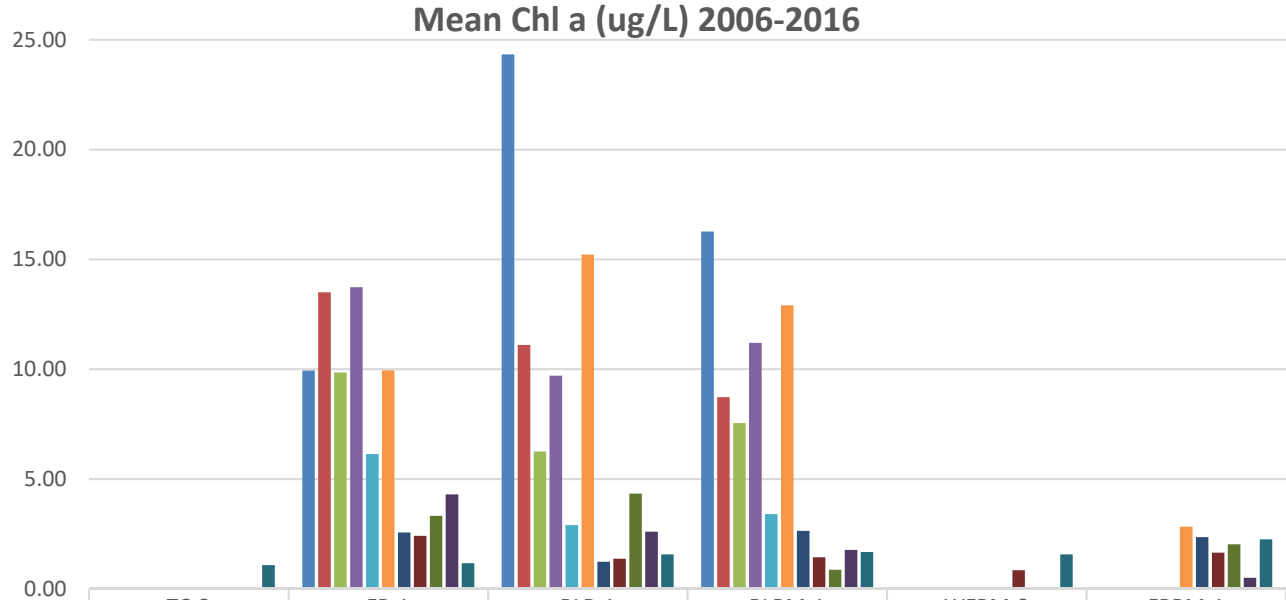
Figure 3. (Continued)



	MSND-1	MSND-2	MB-1A	GOM-1	GOM-2
2006			0.049		
2007			0.042		
2008			0.024		
2009			0.030		
2010			0.034		
2011					
2012	0.212	0.045	0.151		
2013			0.057		
2014			0.066		
2015			0.048		
2016	0.063	0.044	0.057	0.043	0.053

Blank cells indicate station was not sampled during that particular year.

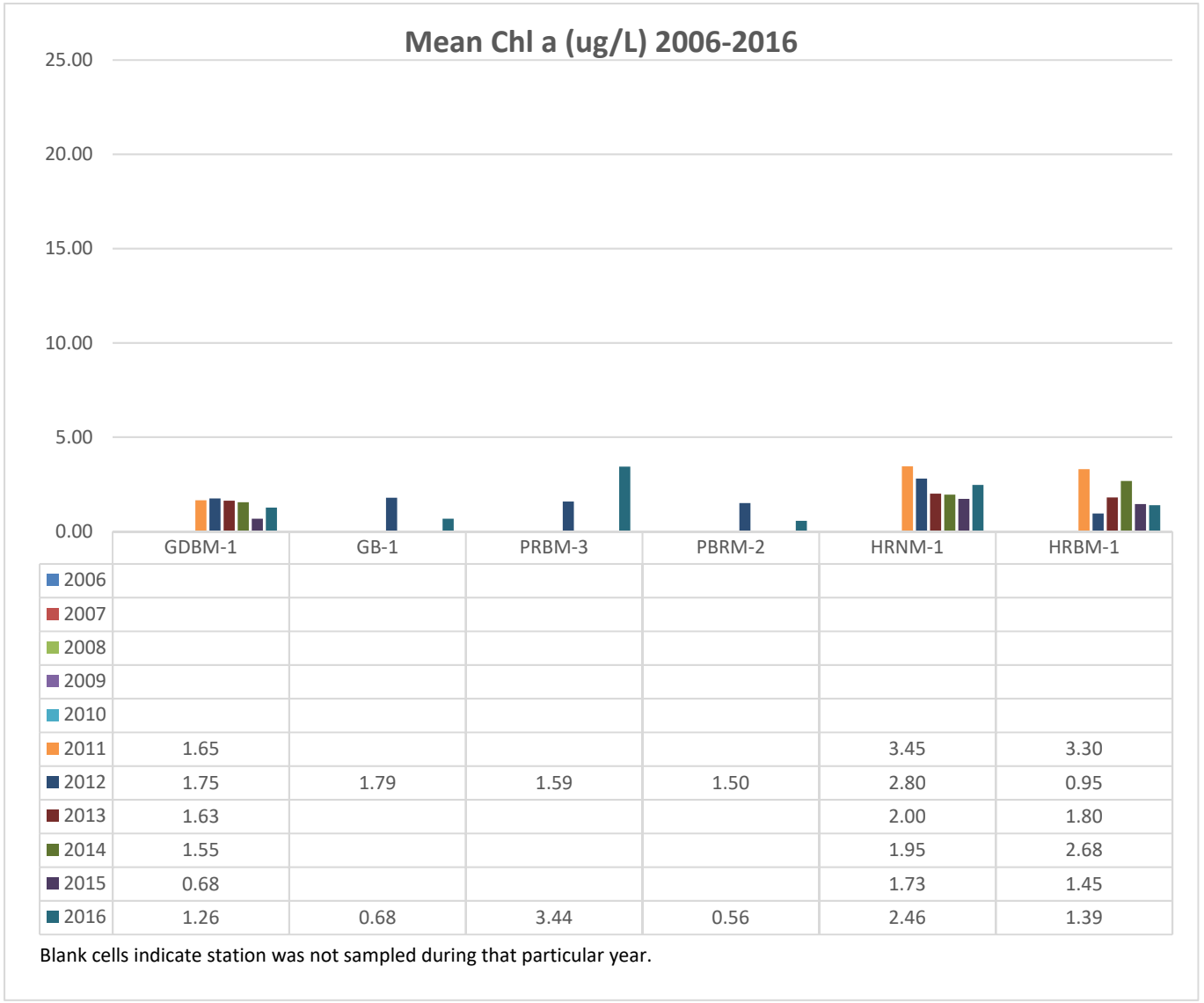
Figure 4. Mean growing season chl *a* measured for the trend stations in the Mississippi Sound Sub-Watershed, 2006-2016.



	TC-2	FR-1	BLB-1	BLBM-1	WFRM-2	FRBM-1
2006		9.93	24.33	16.27		
2007		13.50	11.10	8.73		
2008		9.85	6.25	7.55		
2009		13.73	9.70	11.20		
2010		6.13	2.90	3.40		
2011		9.95	15.22	12.91		2.83
2012		2.57	1.23	2.63		2.35
2013		2.41	1.37	1.43	0.84	1.64
2014		3.33	4.33	0.87		2.03
2015		4.30	2.60	1.77		0.50
2016	1.08	1.16	1.56	1.68	1.56	2.25

Blank cells indicate station was not sampled during that particular year.

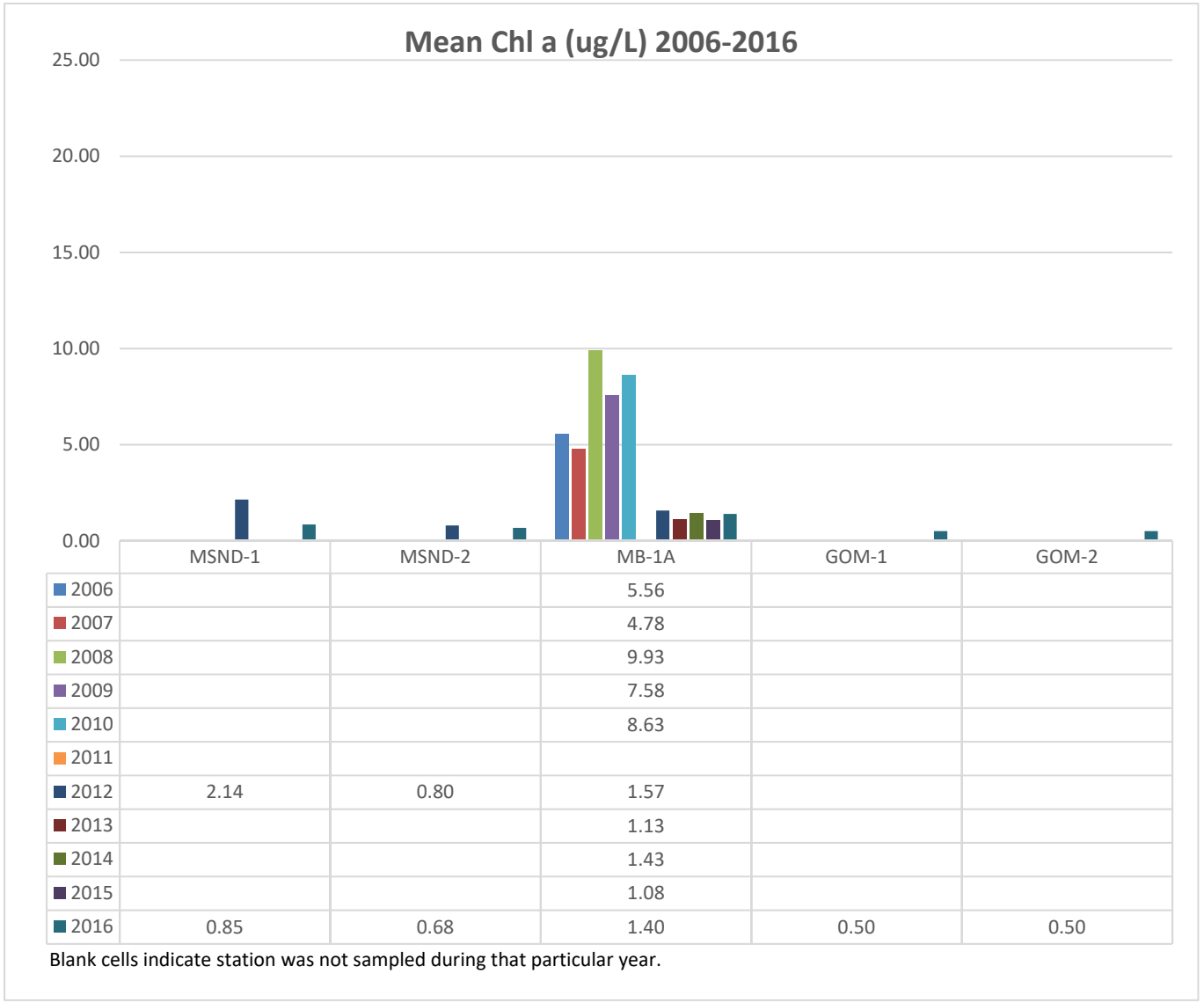
Figure 4. (Continued)



	GDBM-1	GB-1	PRBM-3	PBRM-2	HRNM-1	HRBM-1
2006						
2007						
2008						
2009						
2010						
2011	1.65				3.45	3.30
2012	1.75	1.79	1.59	1.50	2.80	0.95
2013	1.63				2.00	1.80
2014	1.55				1.95	2.68
2015	0.68				1.73	1.45
2016	1.26	0.68	3.44	0.56	2.46	1.39

Blank cells indicate station was not sampled during that particular year.

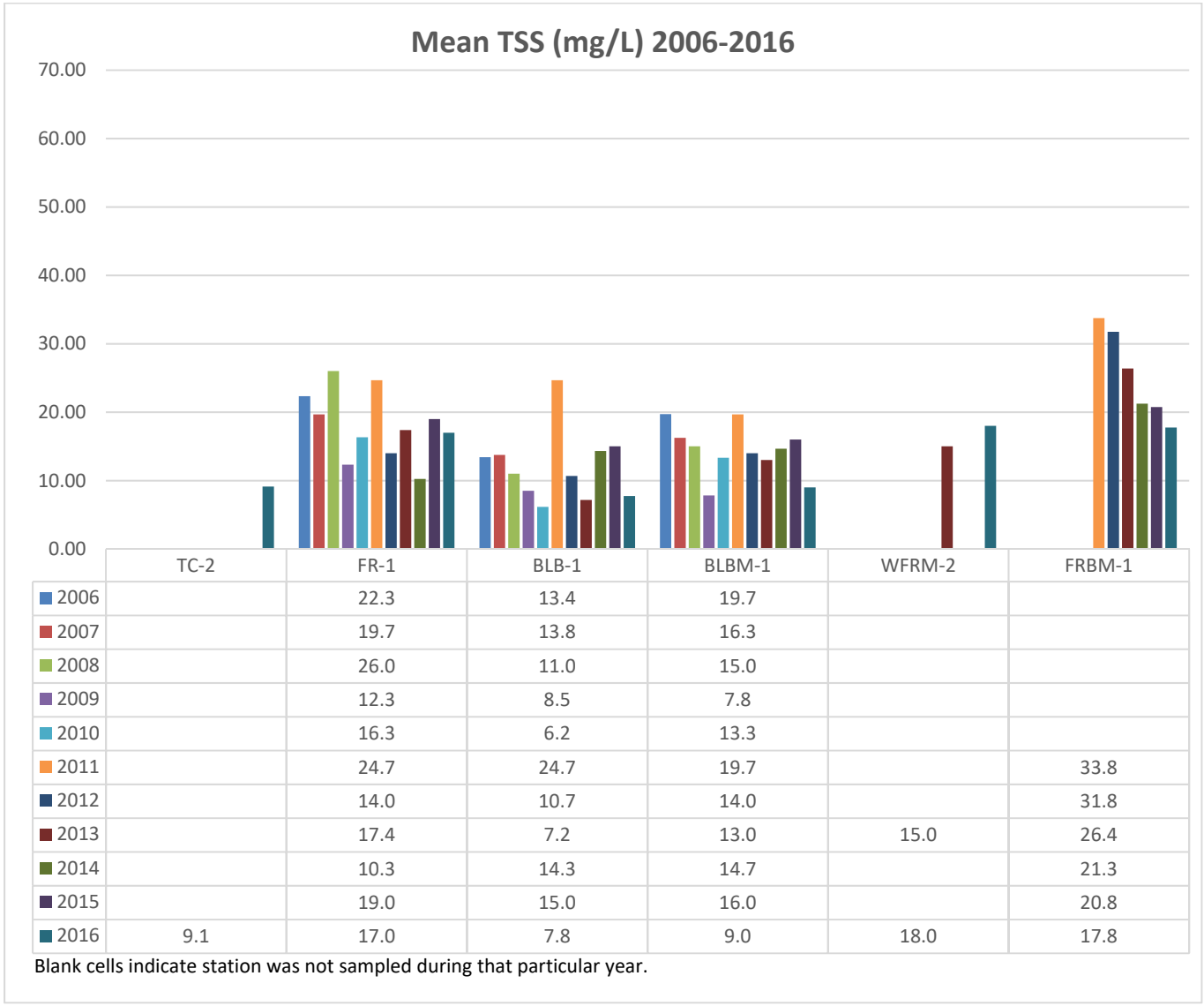
Figure 4. (Continued)



	MSND-1	MSND-2	MB-1A	GOM-1	GOM-2
2006			5.56		
2007			4.78		
2008			9.93		
2009			7.58		
2010			8.63		
2011					
2012	2.14	0.80	1.57		
2013			1.13		
2014			1.43		
2015			1.08		
2016	0.85	0.68	1.40	0.50	0.50

Blank cells indicate station was not sampled during that particular year.

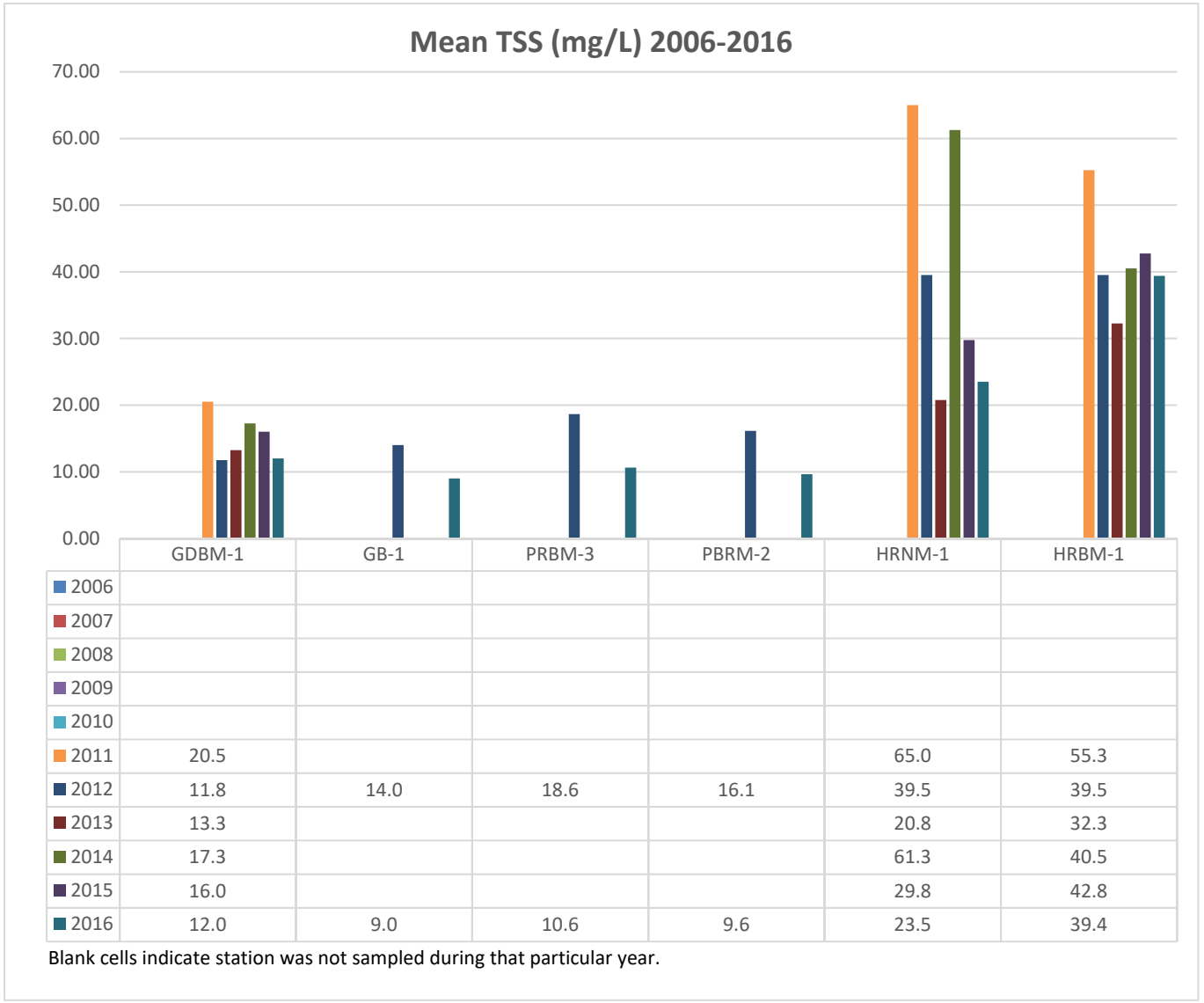
Figure 5. Mean growing season TSS measured for the trend stations in the Mississippi Sound Sub-Watershed, 2006-2016.



	TC-2	FR-1	BLB-1	BLBM-1	WFRM-2	FRBM-1
2006		22.3	13.4	19.7		
2007		19.7	13.8	16.3		
2008		26.0	11.0	15.0		
2009		12.3	8.5	7.8		
2010		16.3	6.2	13.3		
2011		24.7	24.7	19.7		33.8
2012		14.0	10.7	14.0		31.8
2013		17.4	7.2	13.0	15.0	26.4
2014		10.3	14.3	14.7		21.3
2015		19.0	15.0	16.0		20.8
2016	9.1	17.0	7.8	9.0	18.0	17.8

Blank cells indicate station was not sampled during that particular year.

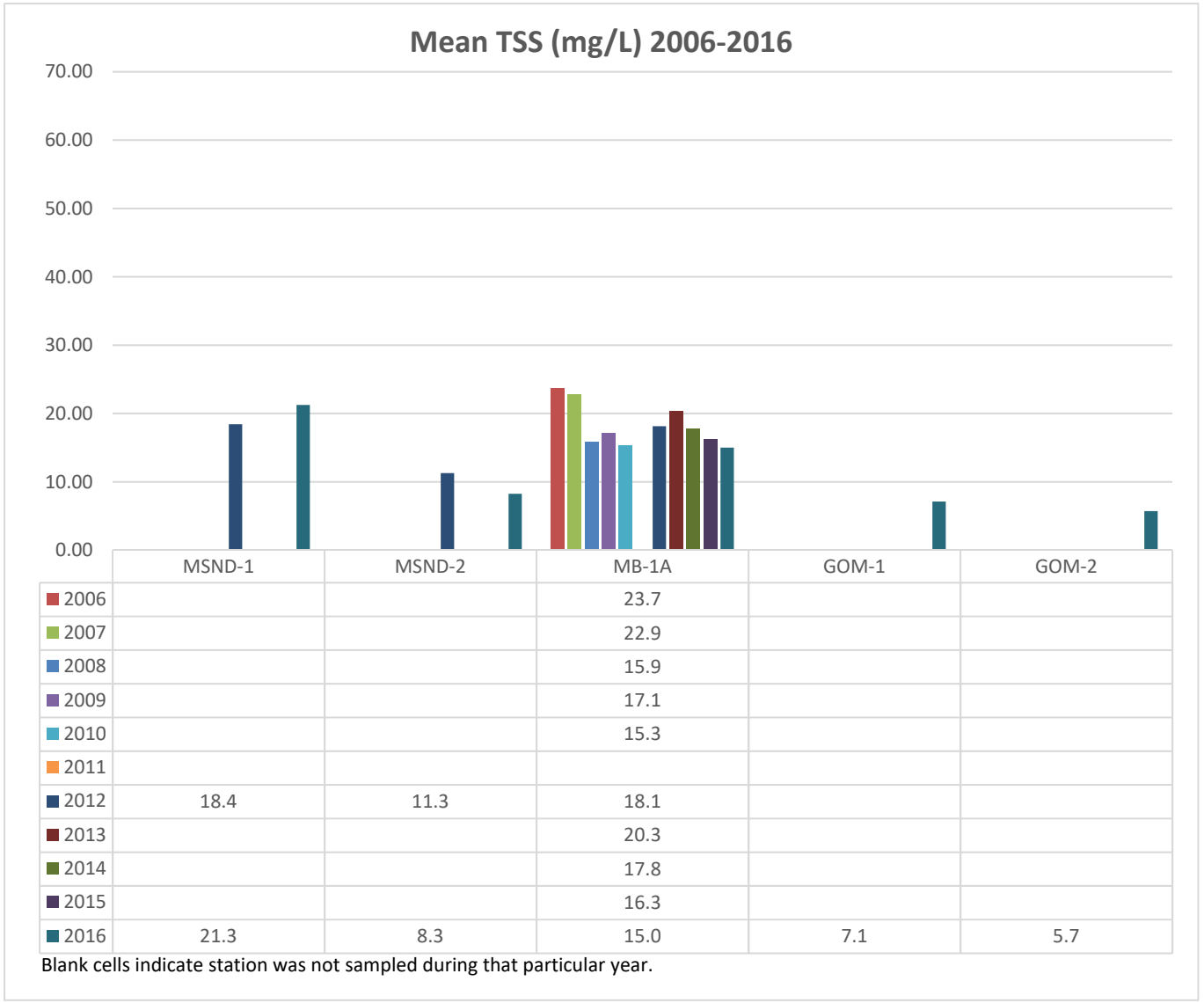
Figure 5. (Continued)



	GDBM-1	GB-1	PRBM-3	PBRM-2	HRNM-1	HRBM-1
2006						
2007						
2008						
2009						
2010						
2011	20.5				65.0	55.3
2012	11.8	14.0	18.6	16.1	39.5	39.5
2013	13.3				20.8	32.3
2014	17.3				61.3	40.5
2015	16.0				29.8	42.8
2016	12.0	9.0	10.6	9.6	23.5	39.4

Blank cells indicate station was not sampled during that particular year.

Figure 5. (Continued)



	MSND-1	MSND-2	MB-1A	GOM-1	GOM-2
2006			23.7		
2007			22.9		
2008			15.9		
2009			17.1		
2010			15.3		
2011					
2012	18.4	11.3	18.1		
2013			20.3		
2014			17.8		
2015			16.3		
2016	21.3	8.3	15.0	7.1	5.7

Blank cells indicate station was not sampled during that particular year.

Figure 6. Monthly TN concentrations measured in the Mississippi Sound Sub-Watershed, March-October 2016. Each bar graph depicts changes in each station. The historic mean (1990-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Flow is as measured at several stations.

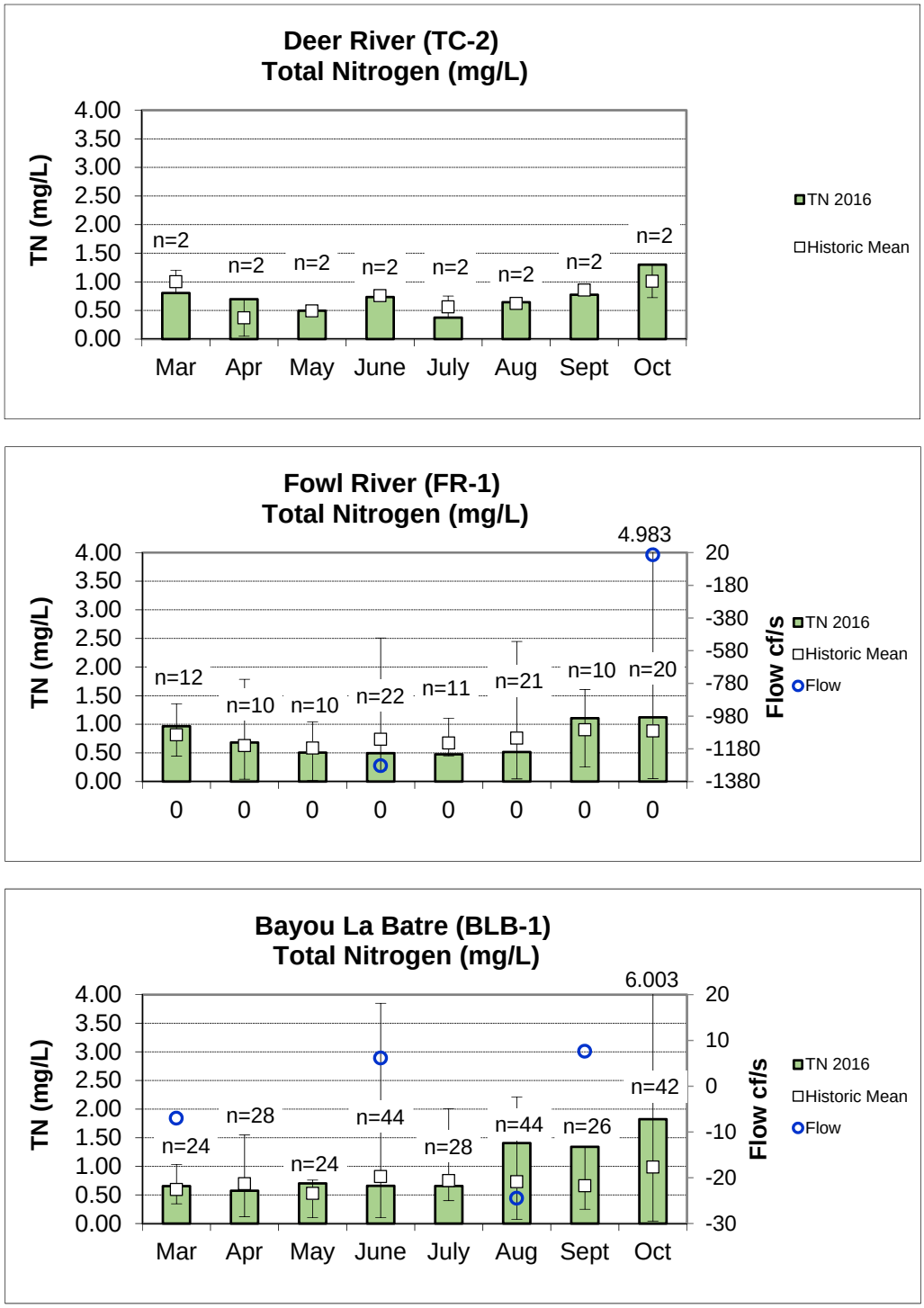
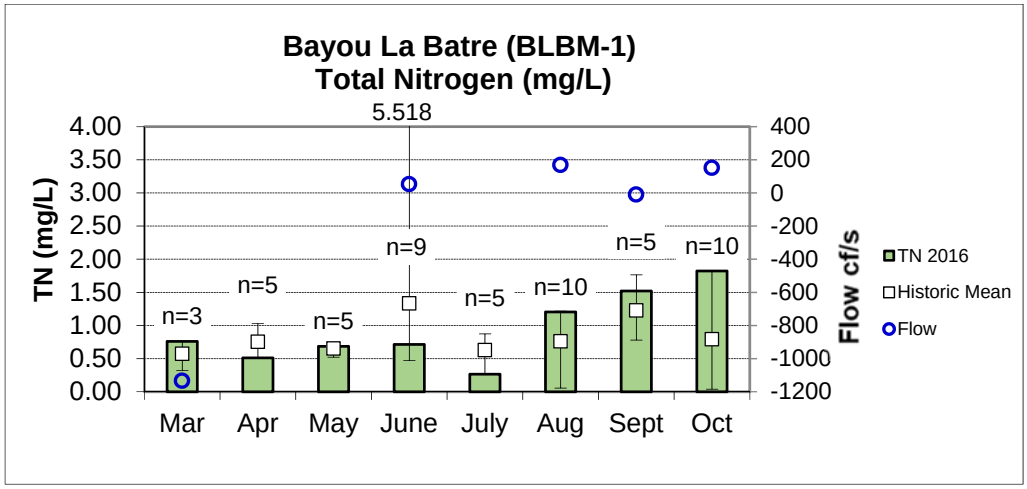
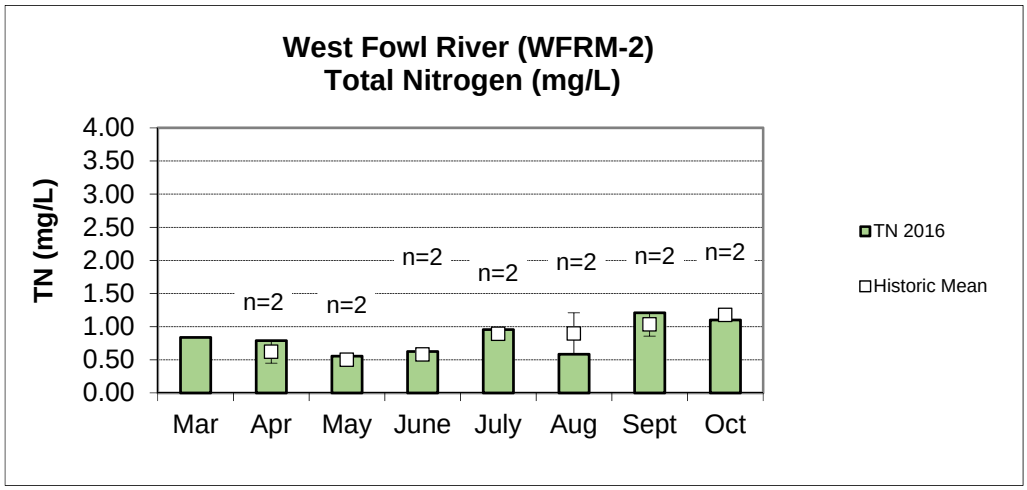


Figure 6. (continued)





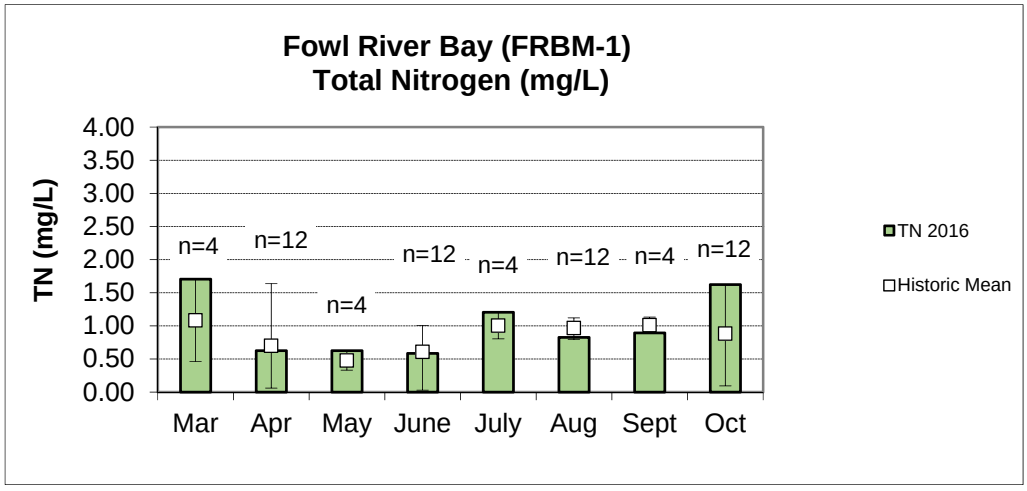
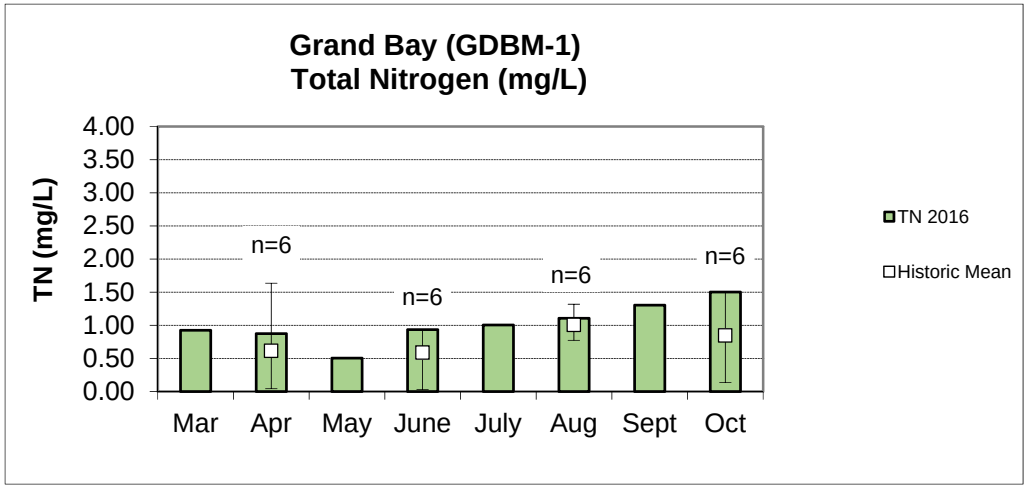
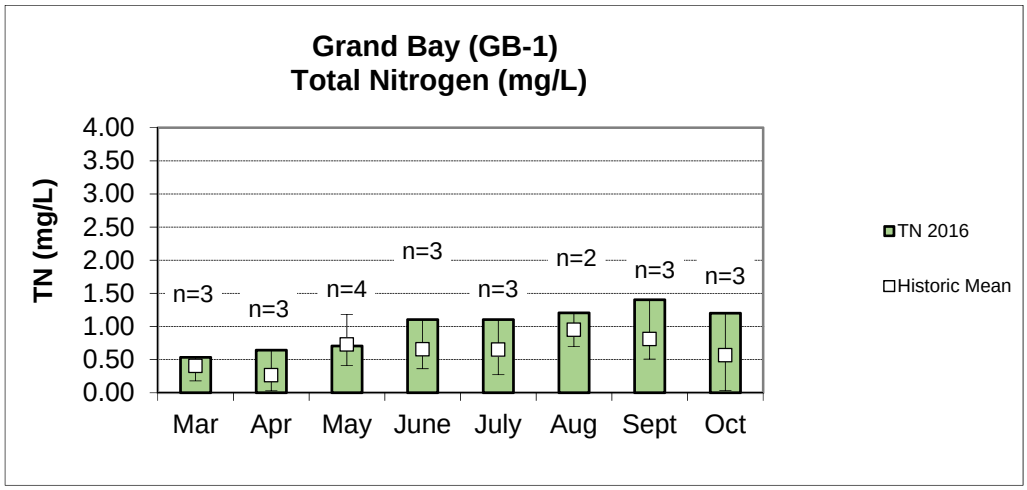


Figure 6. (continued)





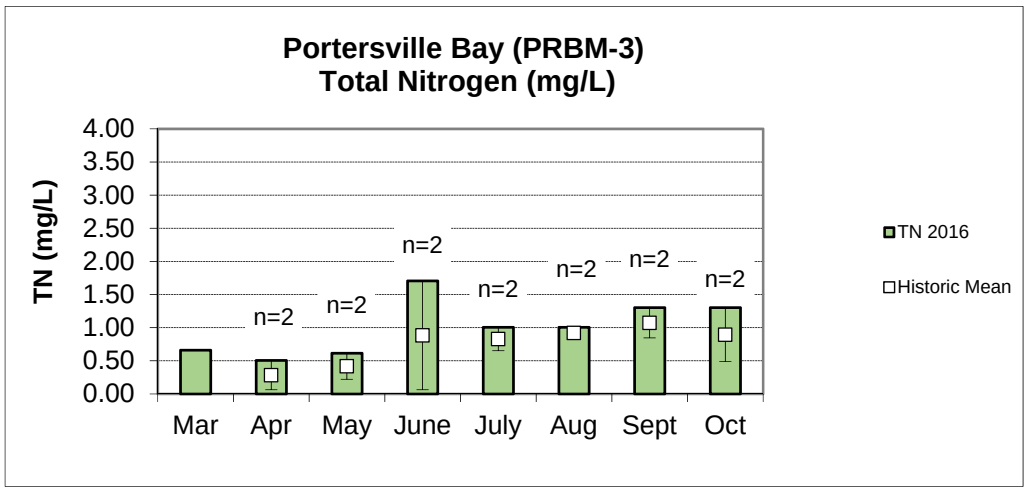
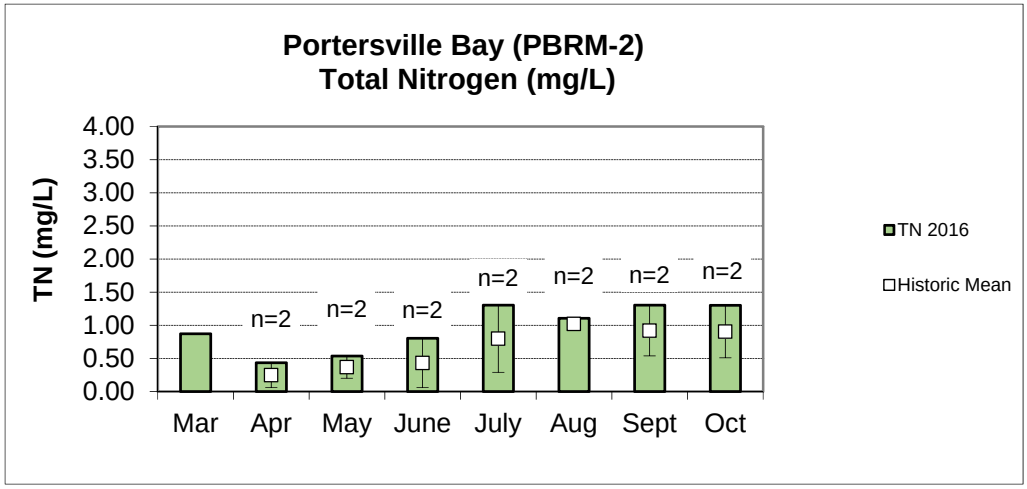
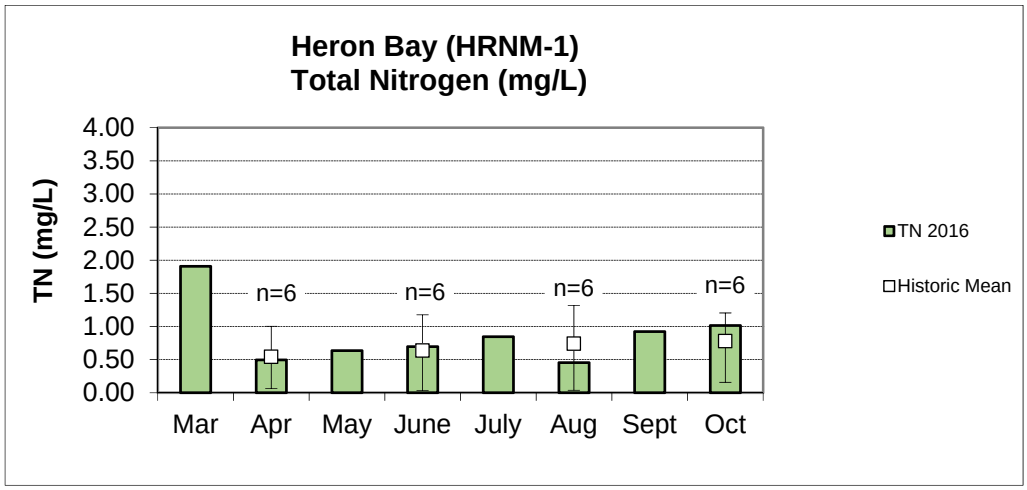


Figure 6. (continued)





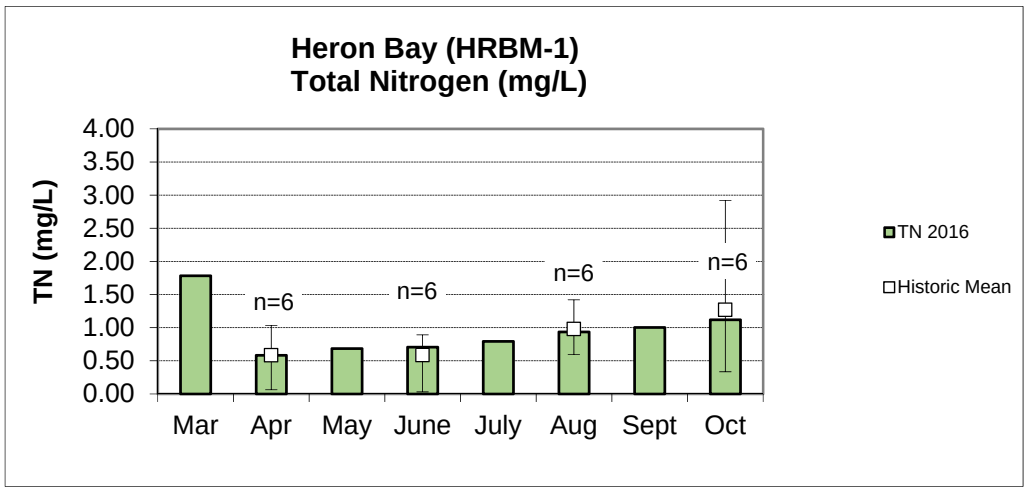
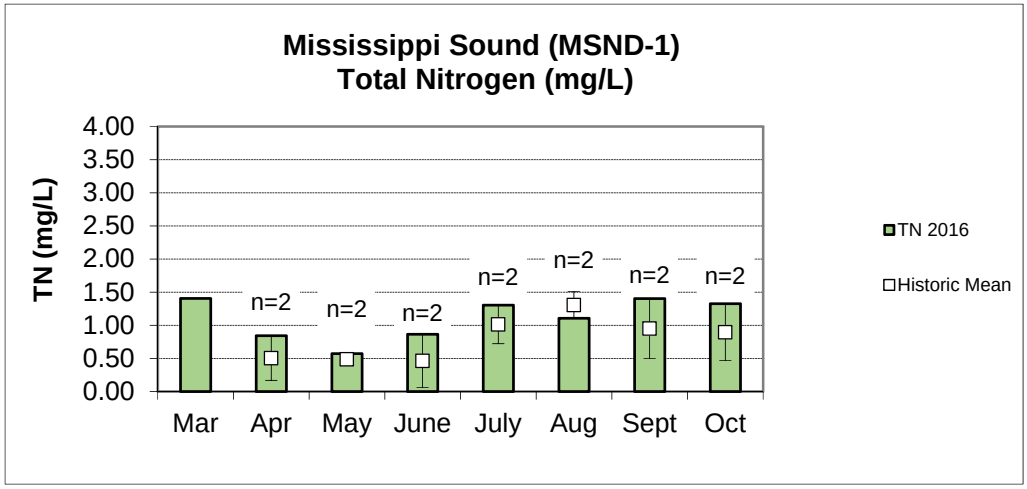
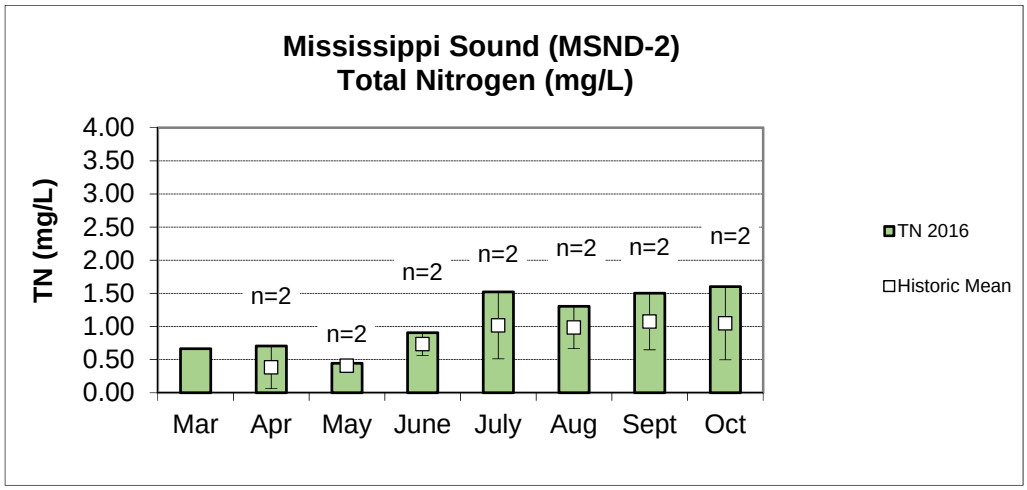


Figure 6. (continued)





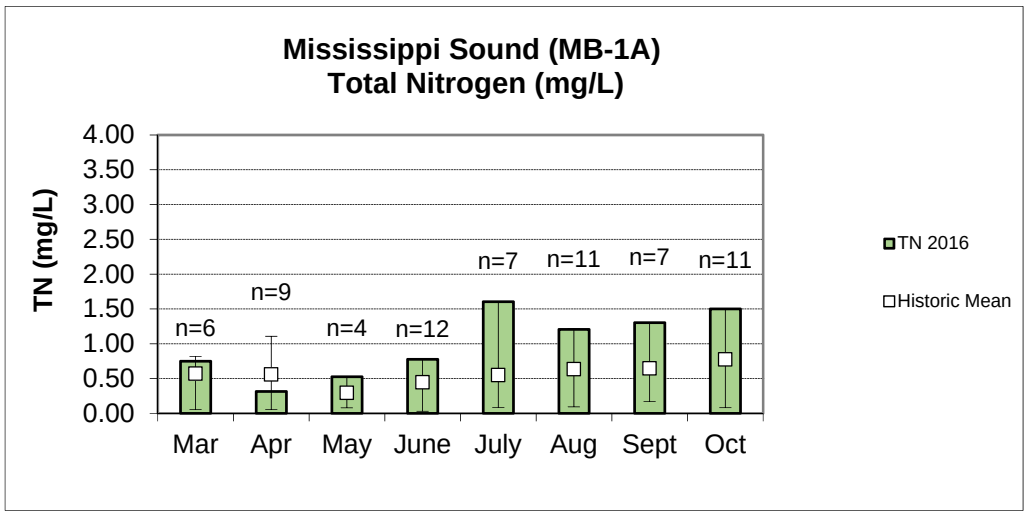
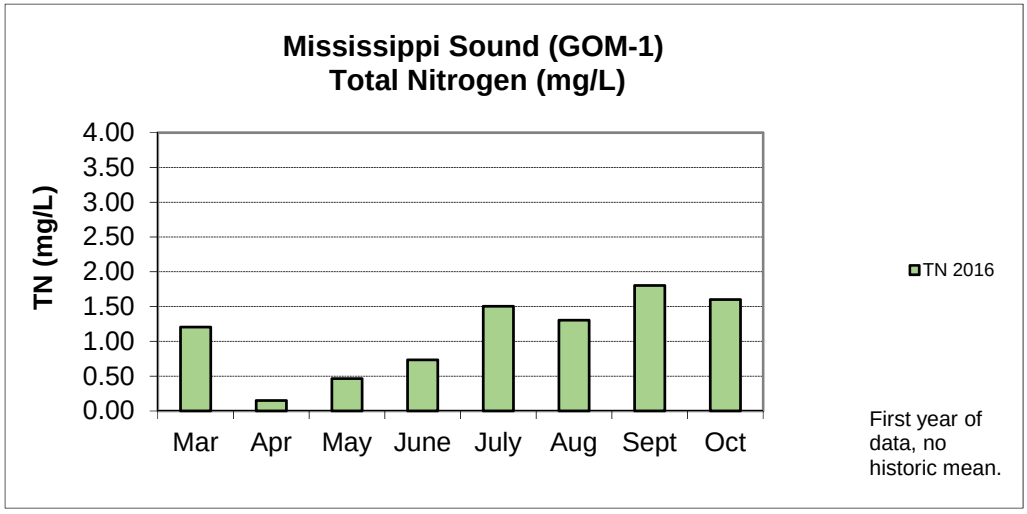


Figure 6. (continued)



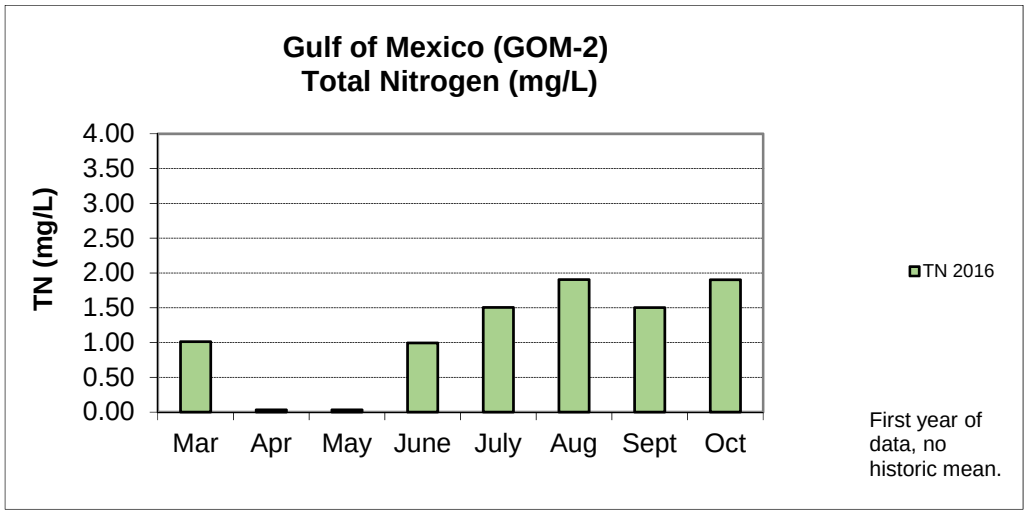


Figure 7. Monthly TP concentrations measured in the Mississippi Sound-Watershed, March-October 2016. Each bar graph depicts changes in each station. The historic mean (1990-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Flow is as measured at several stations.

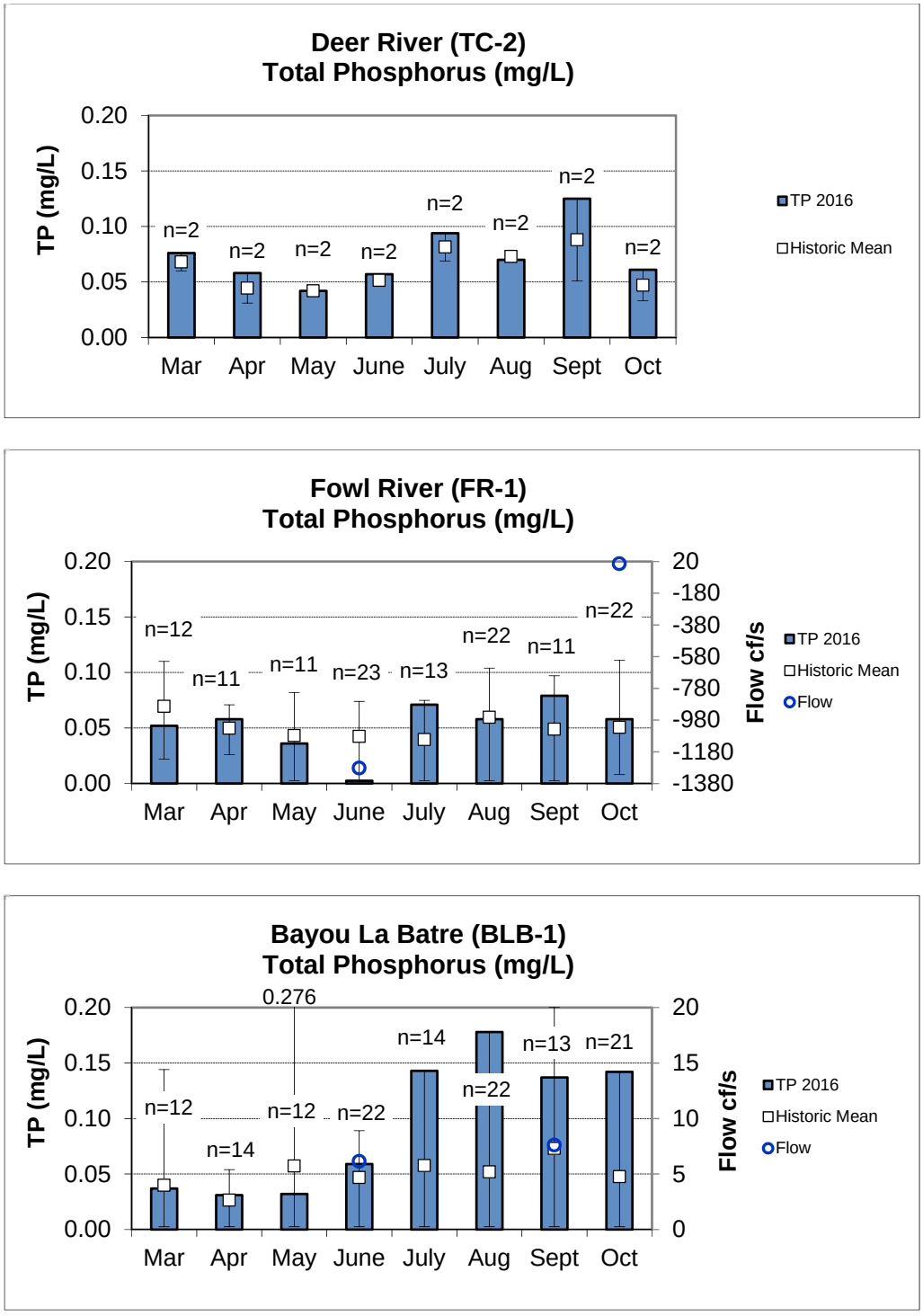
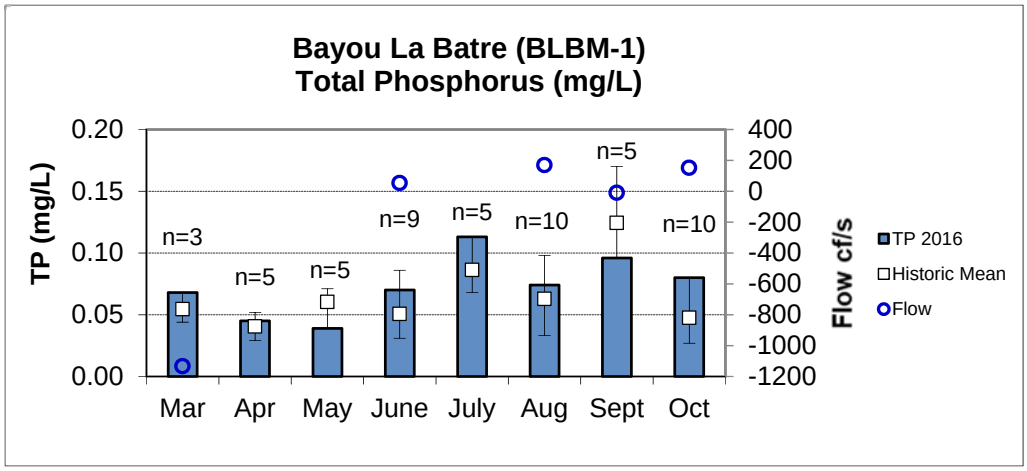
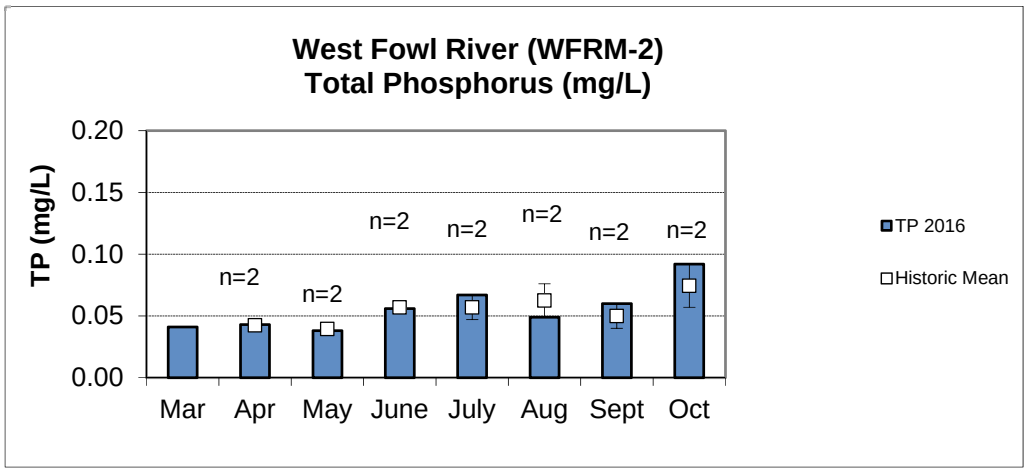


Figure 7. (continued)





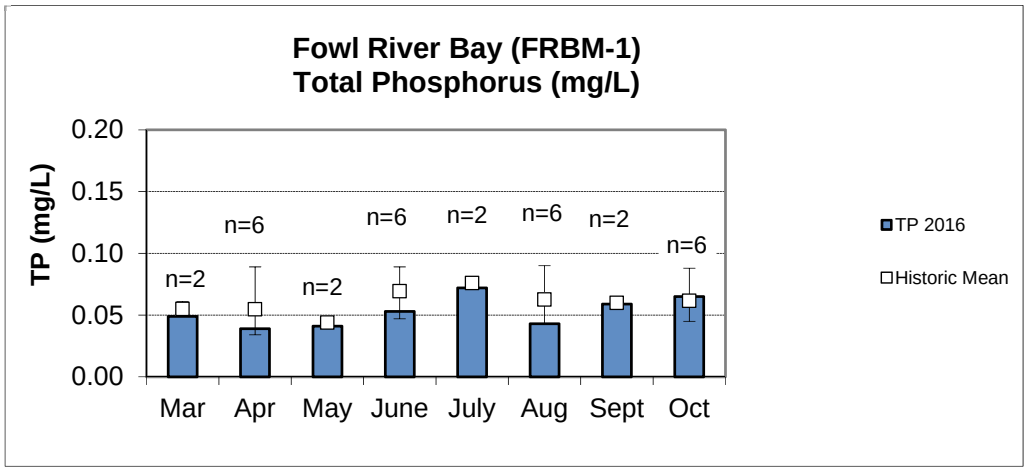
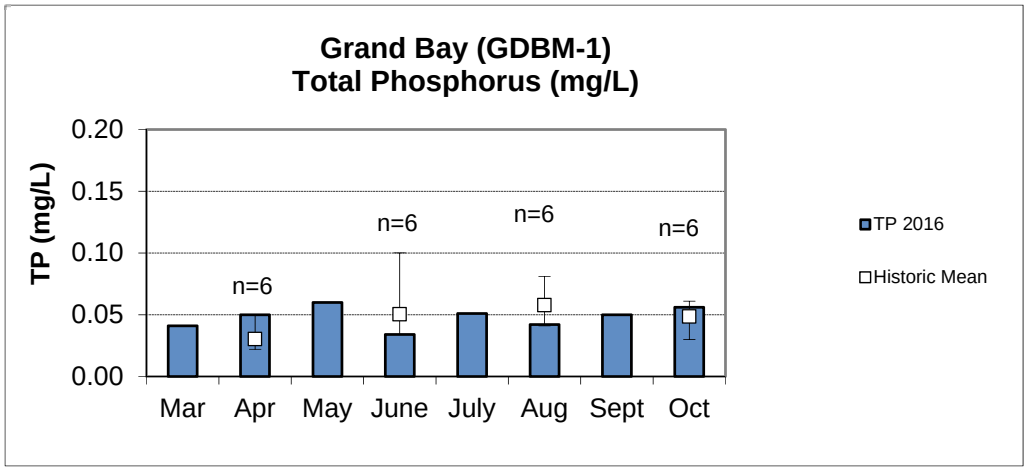
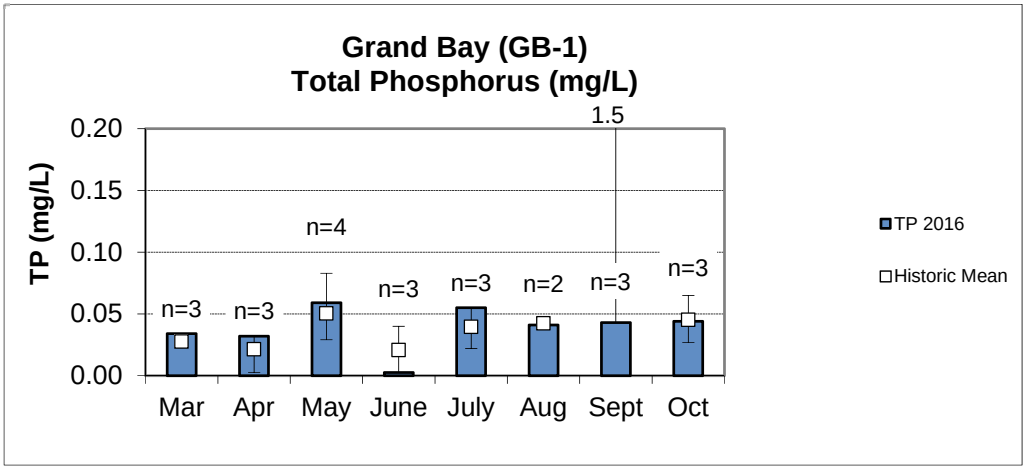


Figure 7. (continued)





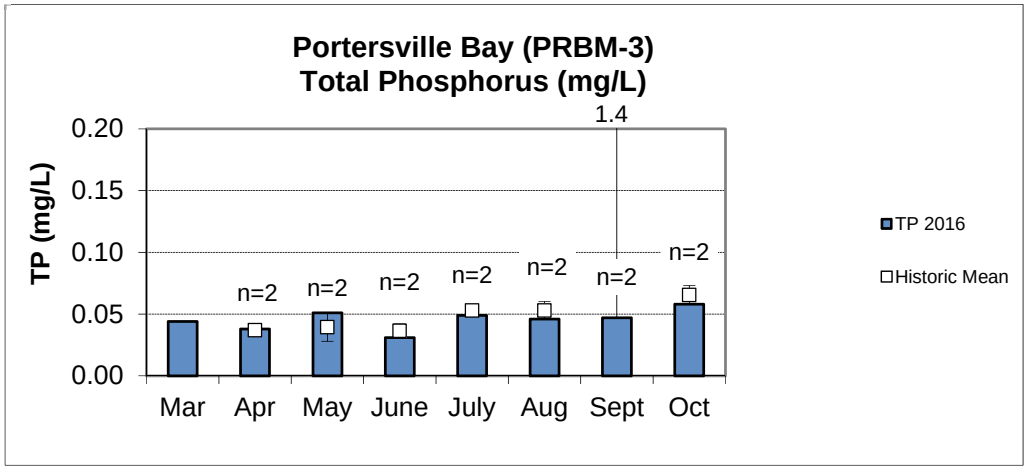
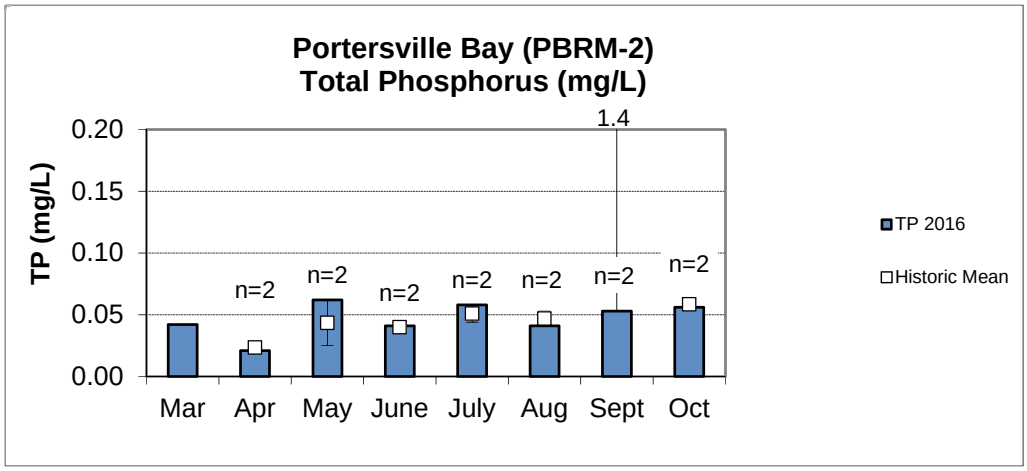
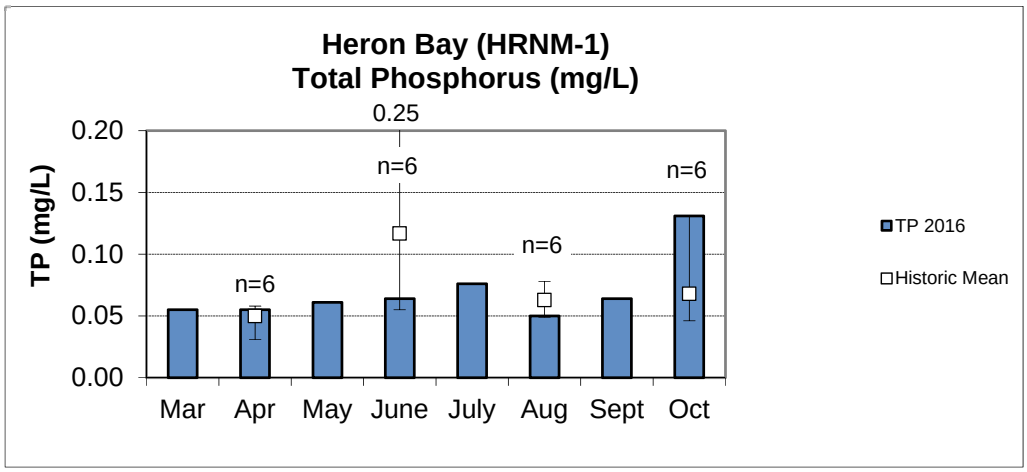


Figure 7. (continued)





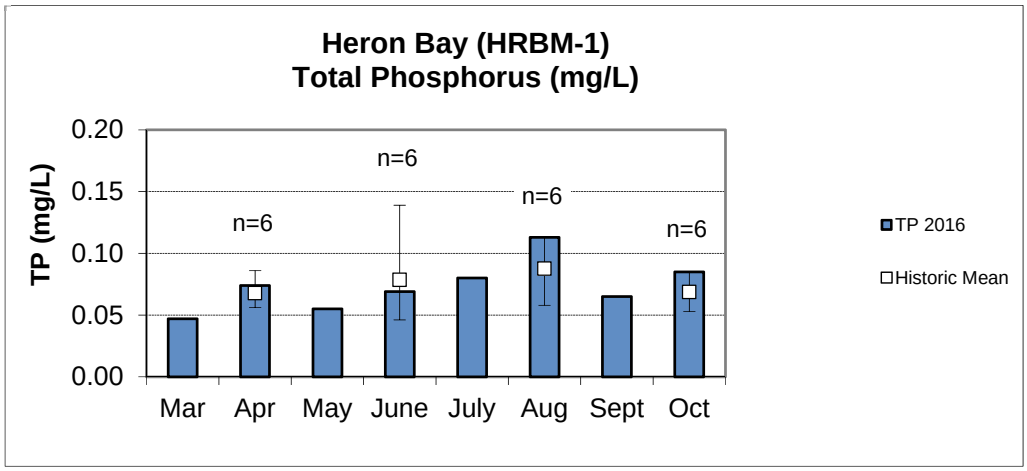
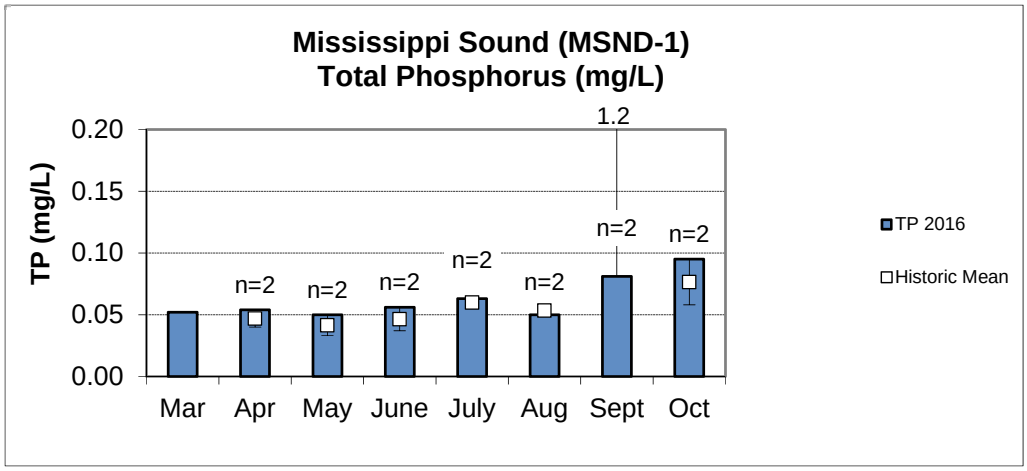
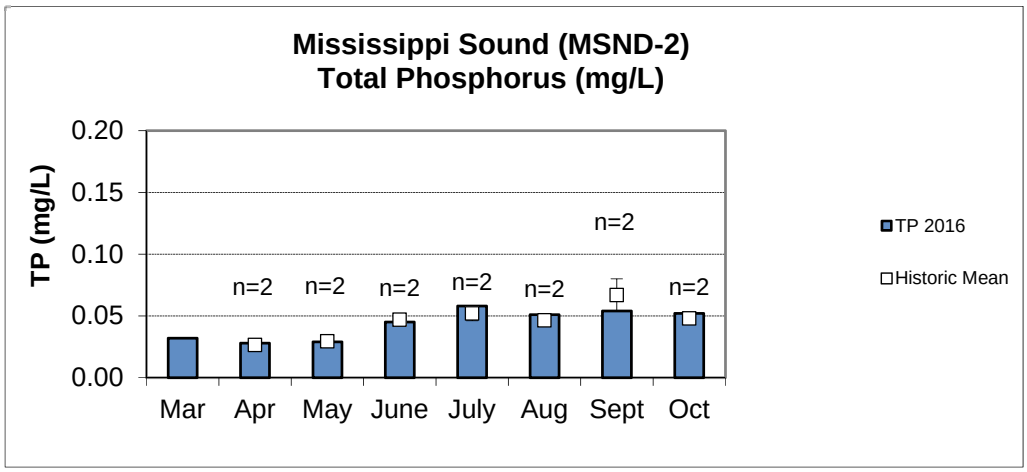


Figure 7. (continued)





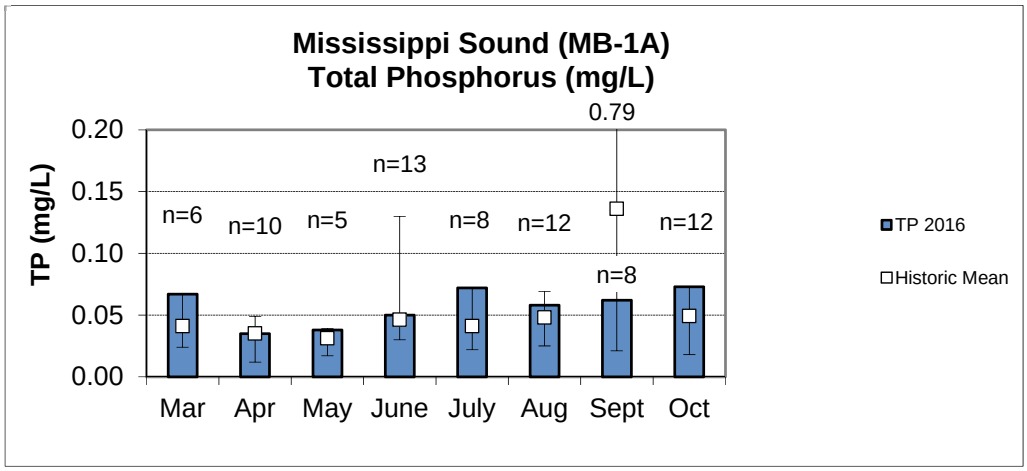
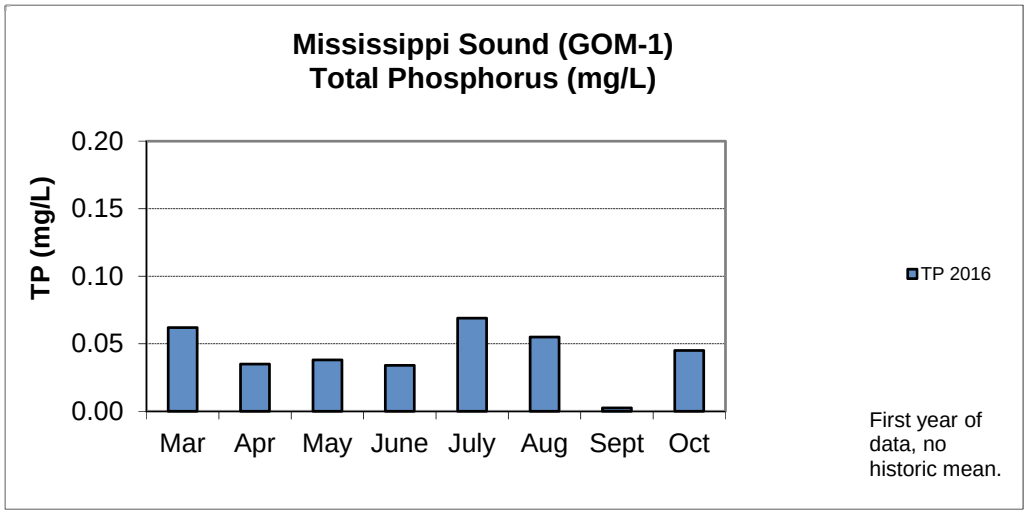


Figure 7. (continued)



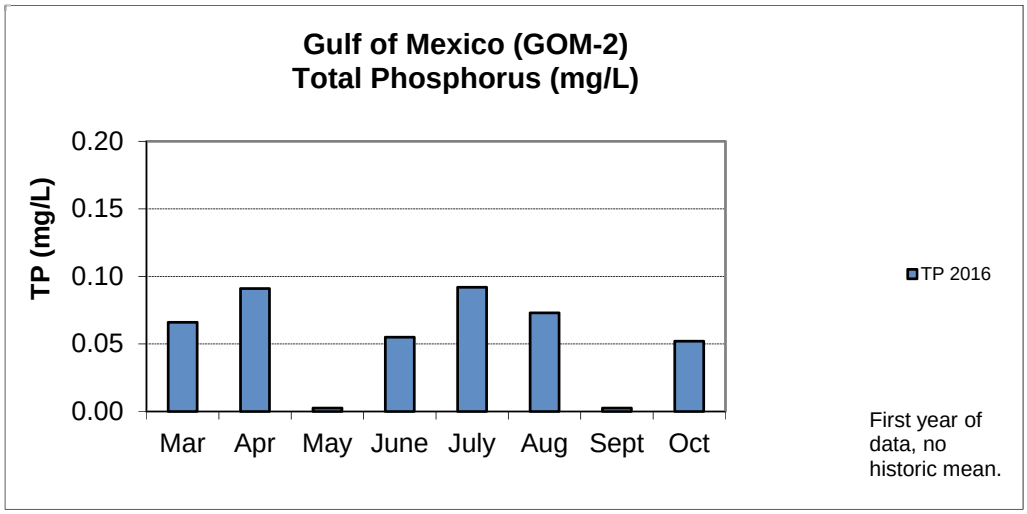


Figure 8. Monthly chl a concentrations measured in the Mississippi Sound-Watershed, March-October 2016. Each bar graph depicts changes in each station. The historic mean (1990-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Flow is as measured at several stations.

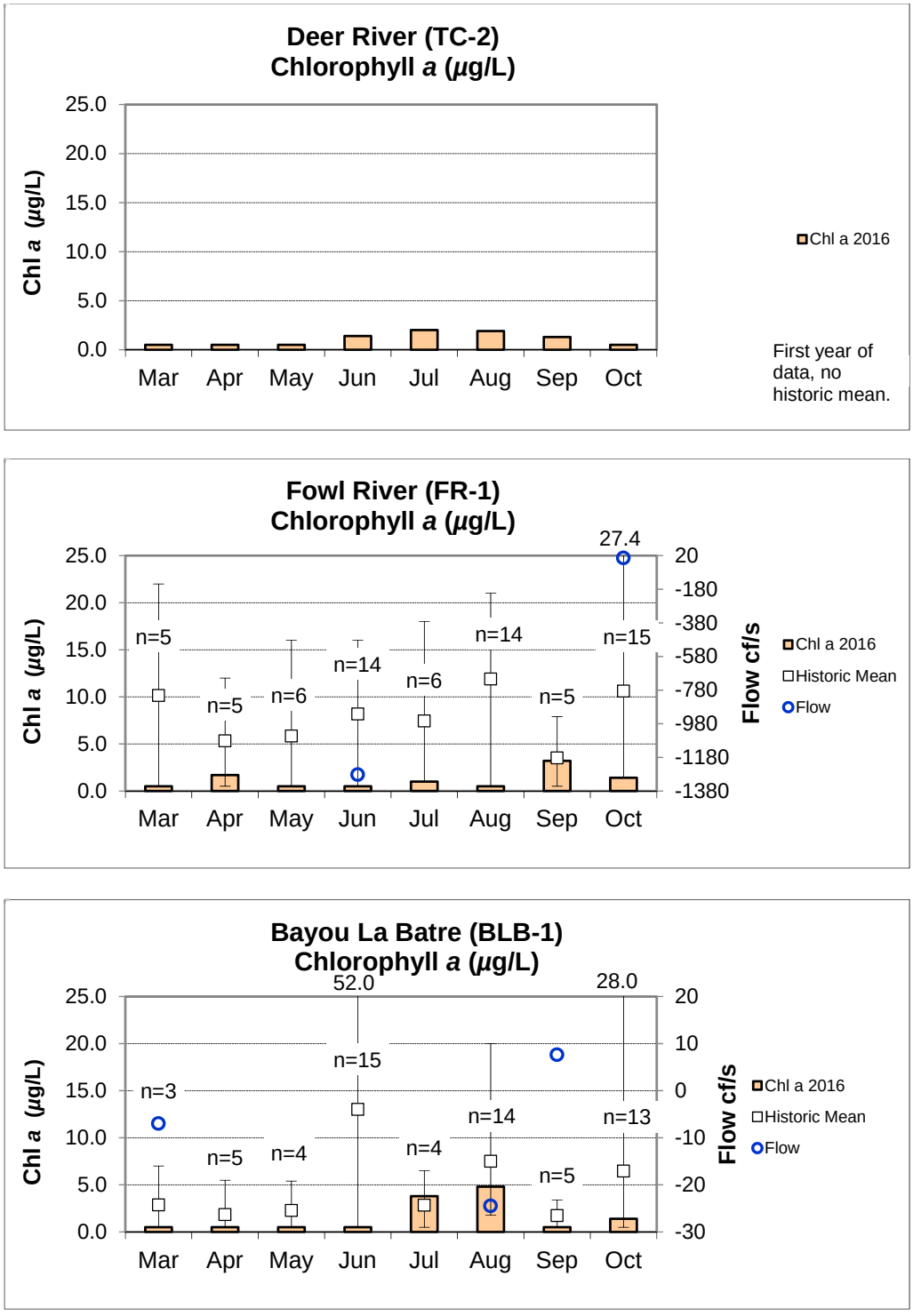
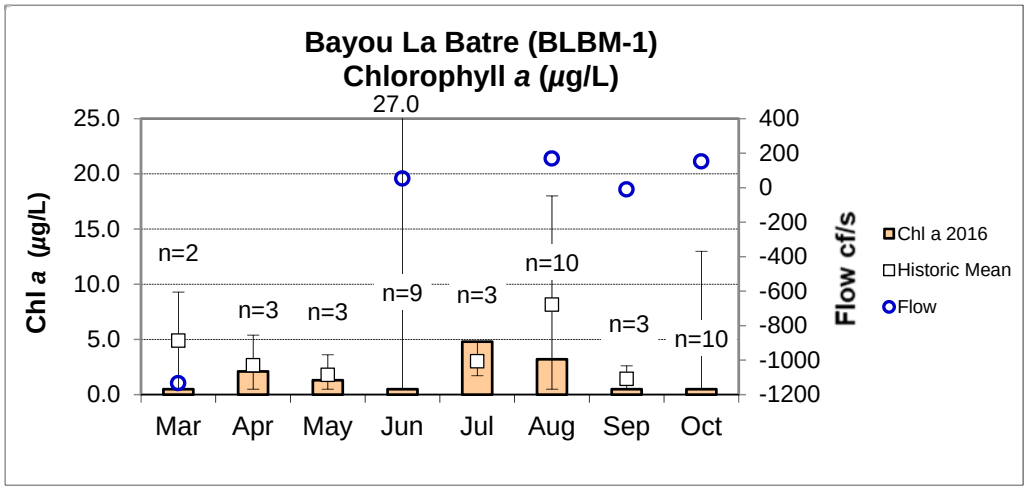
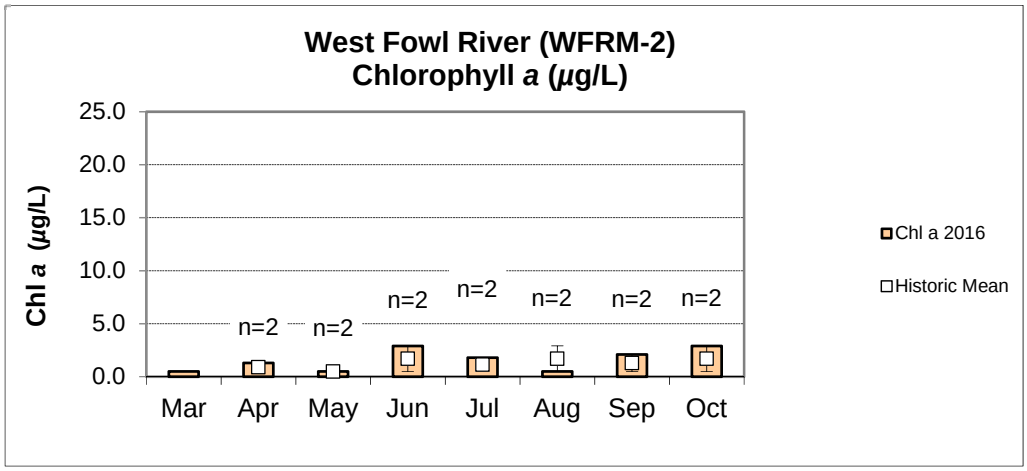


Figure 8. (continued)





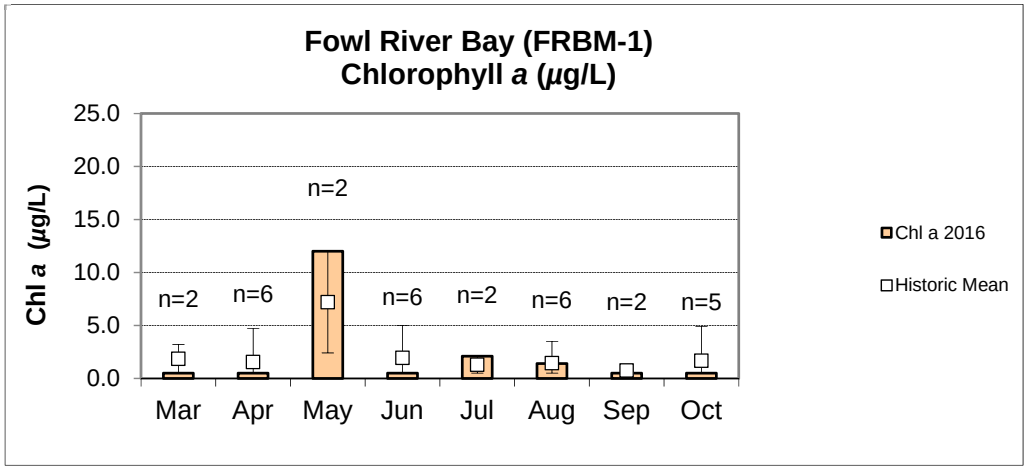
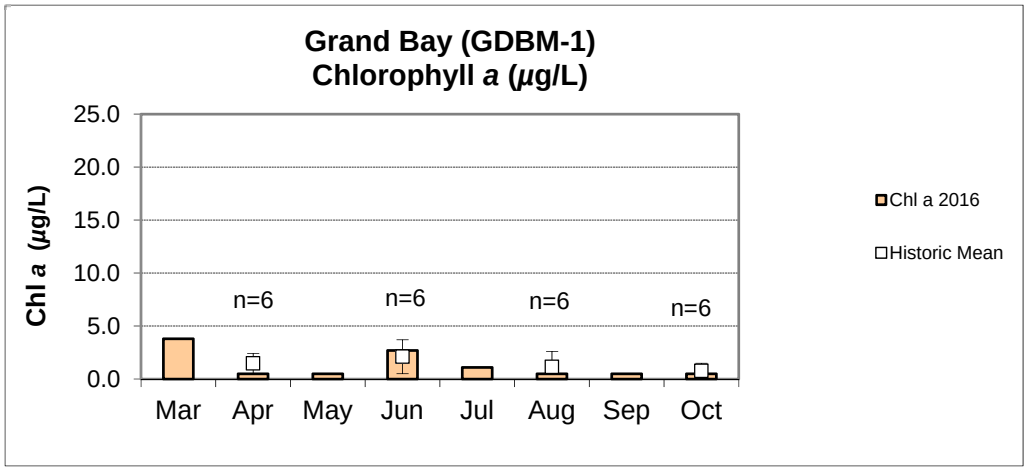
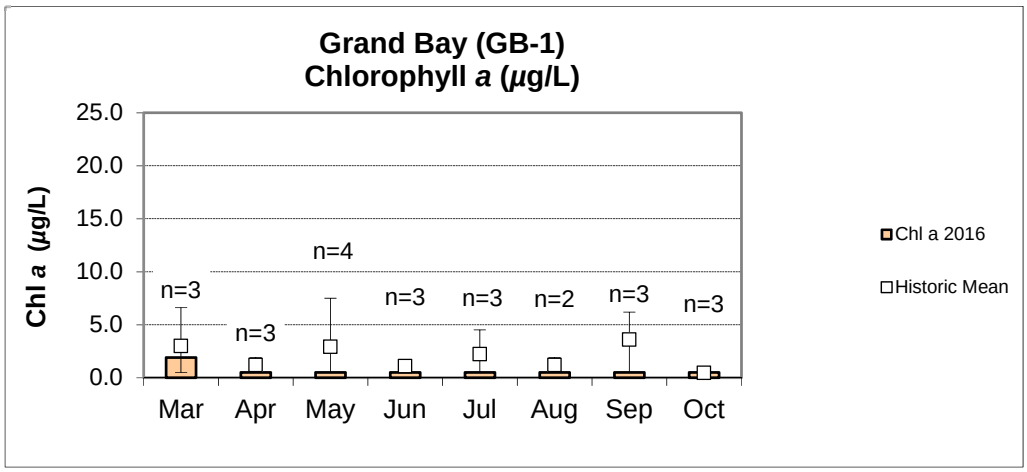


Figure 8. (continued)





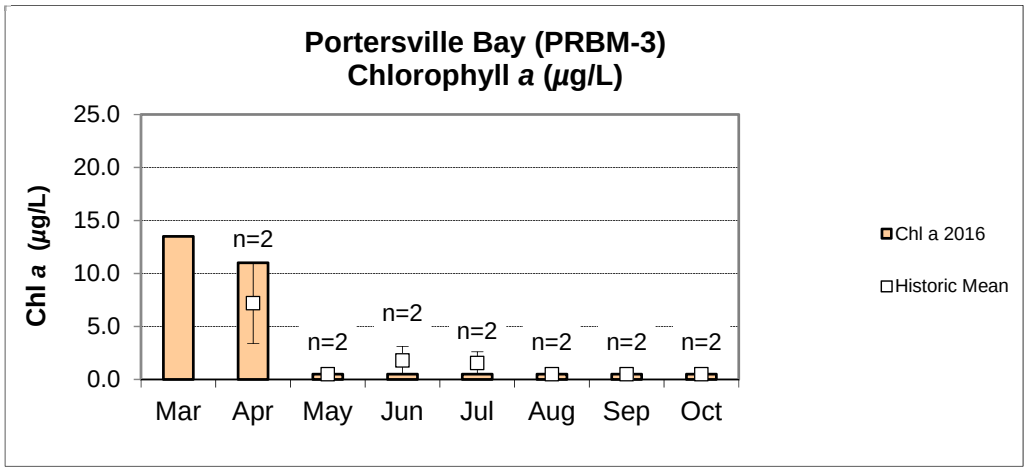
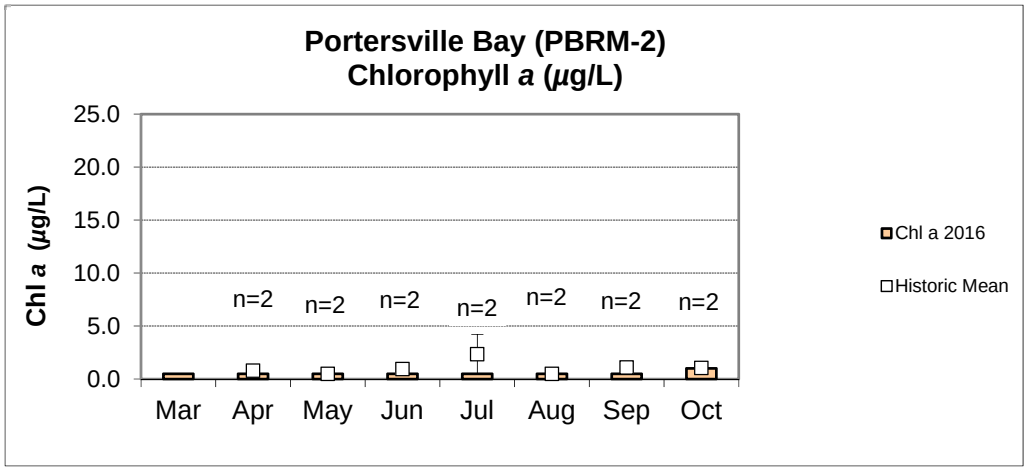
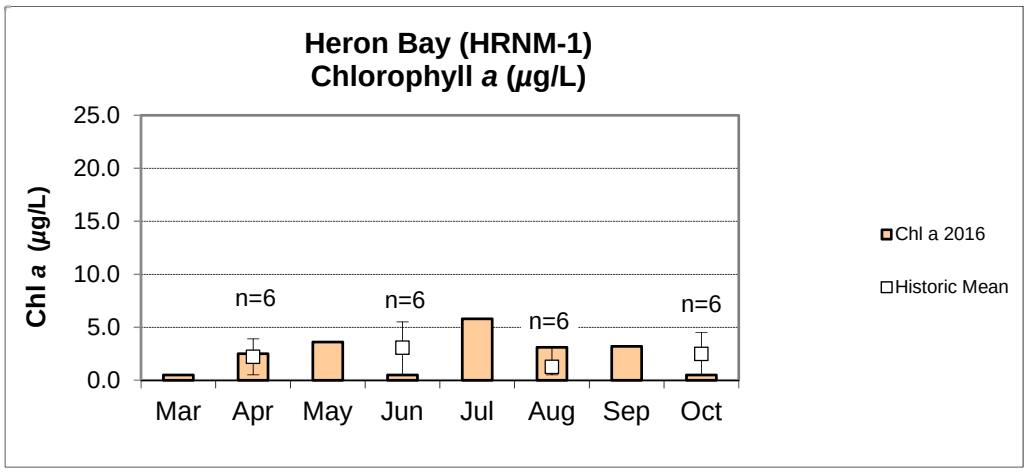


Figure 8. (continued)





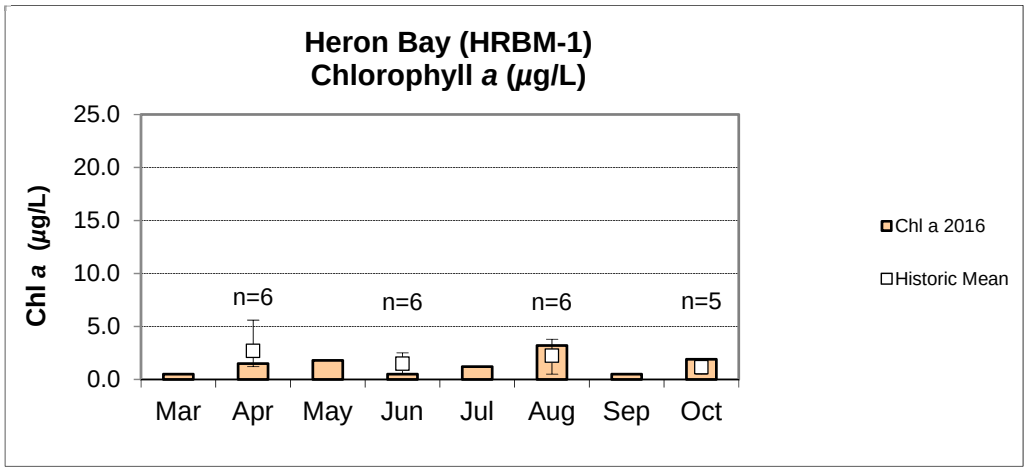
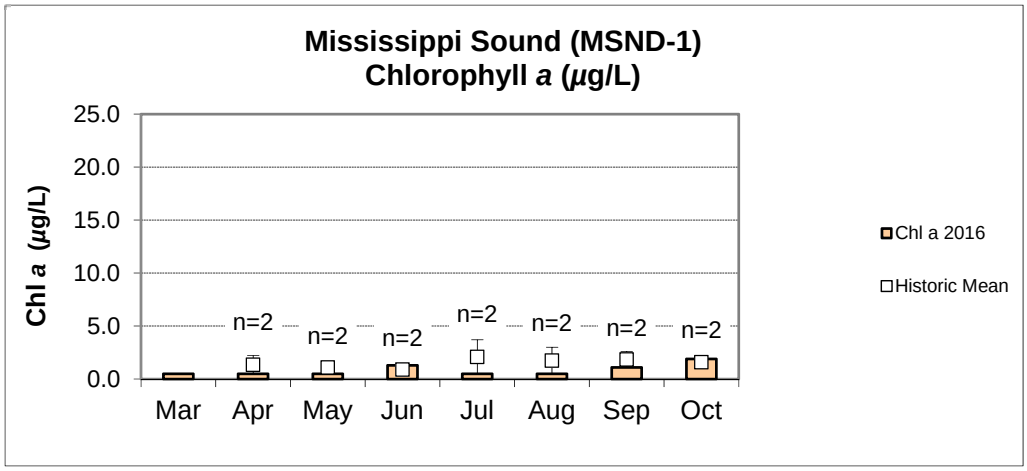
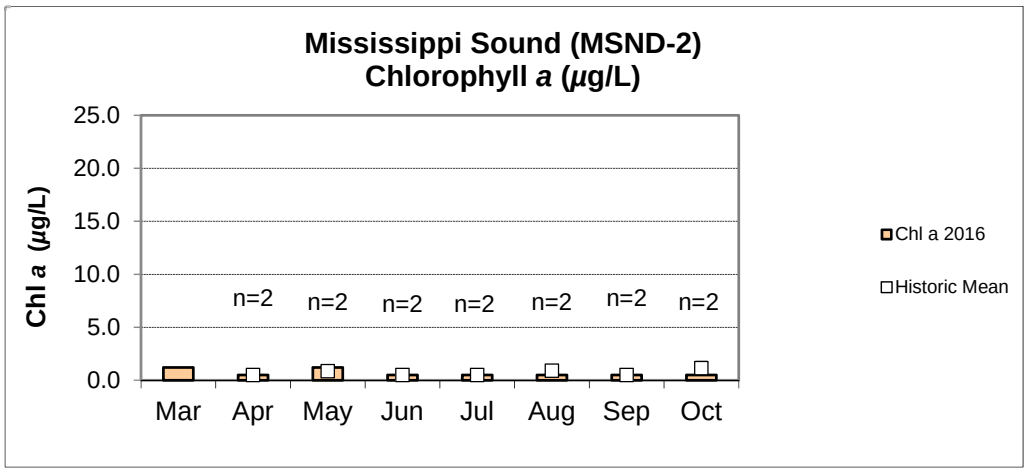


Figure 8. (continued)





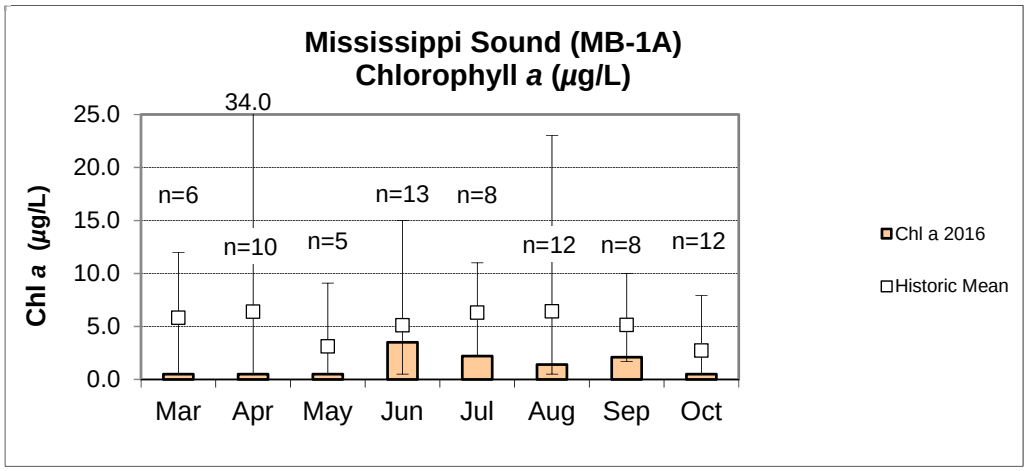
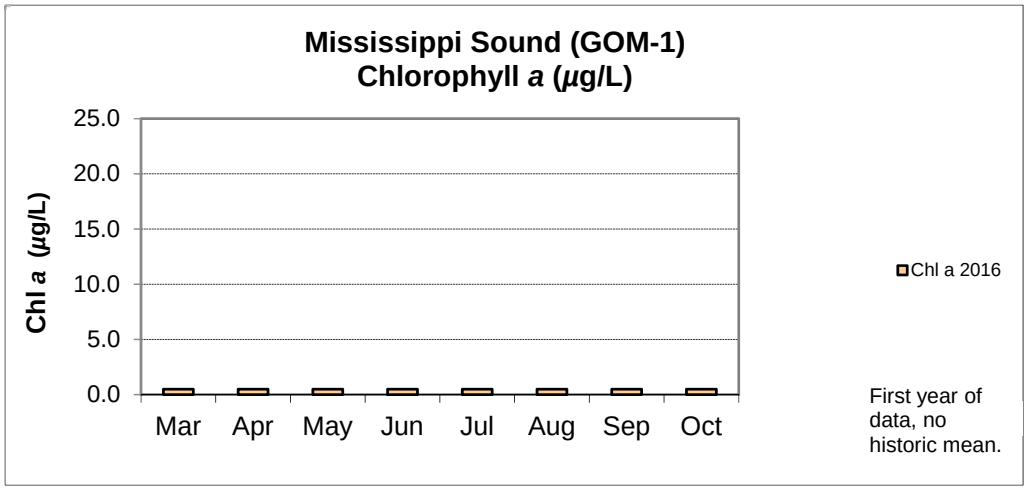


Figure 8. (continued)



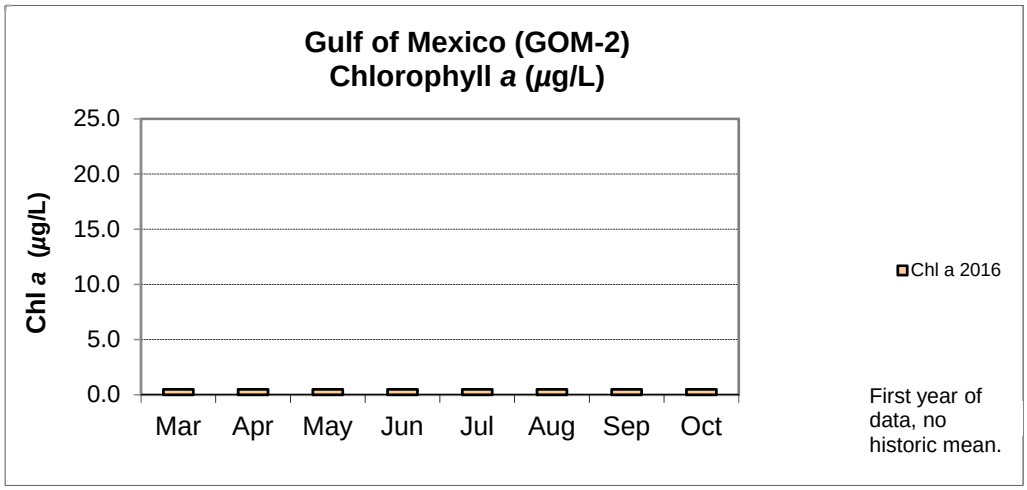


Figure 9. Monthly TSS concentrations measured in the Mississippi Sound Sub-Watershed, March-October 2016. Each bar graph depicts changes in each station. The historic mean (1990-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations. Flow is as measured at several stations.

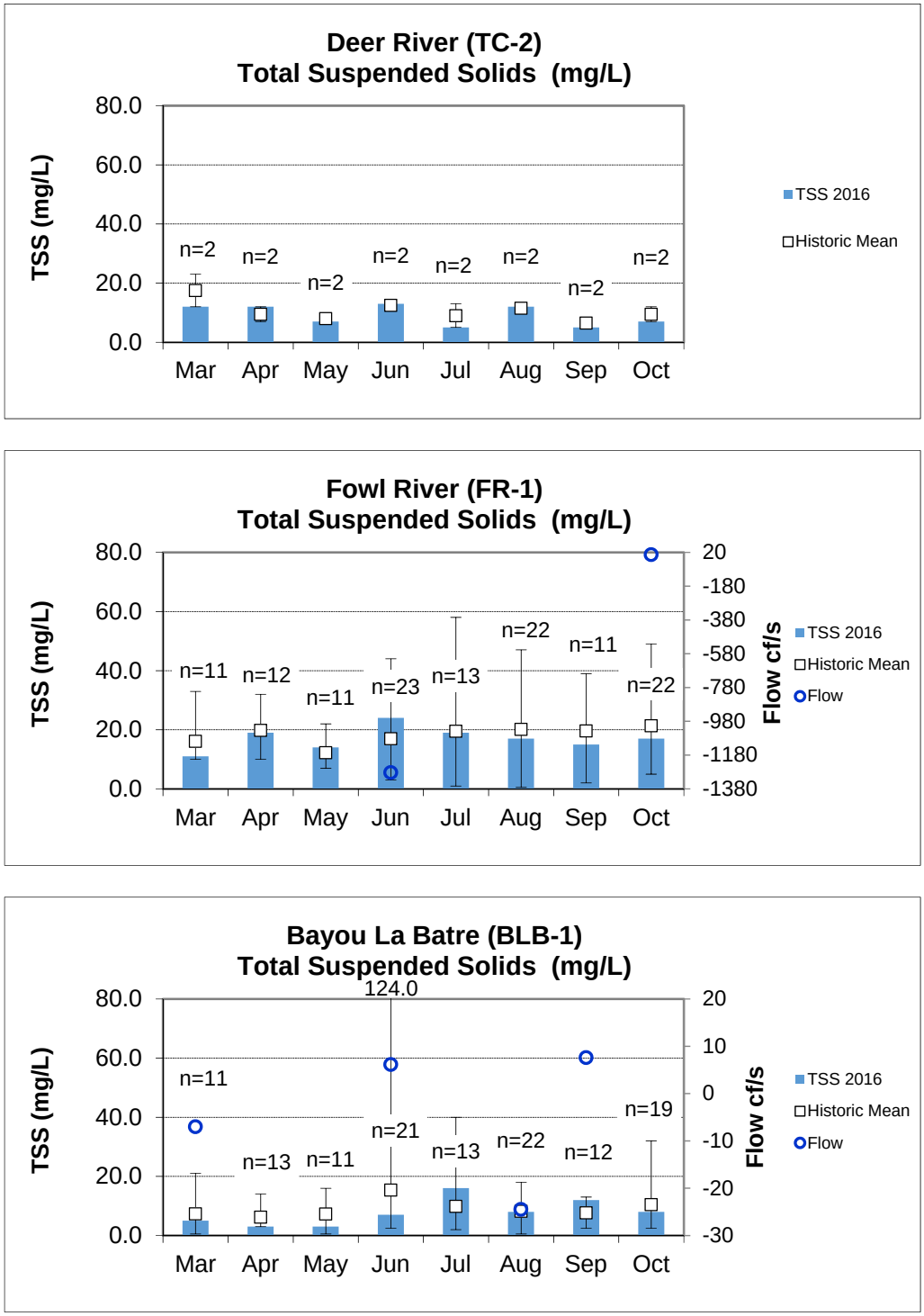
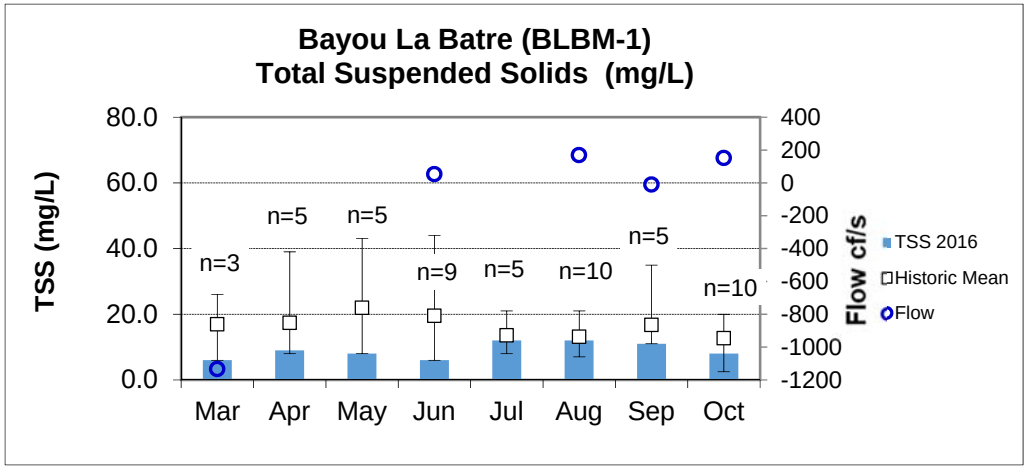
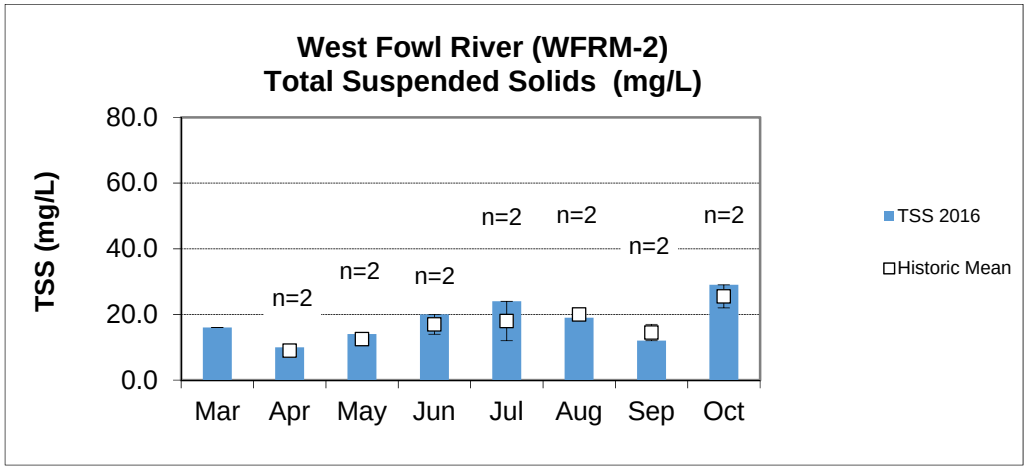


Figure 9. (continued)





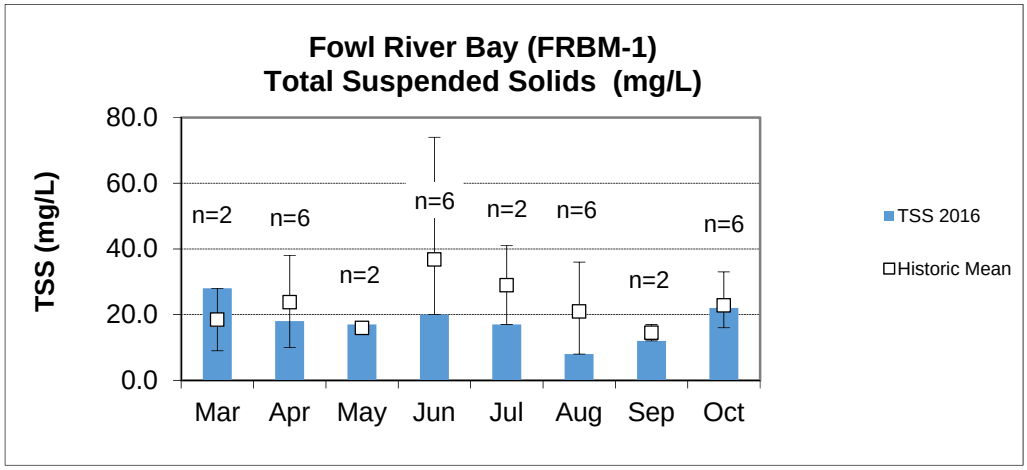
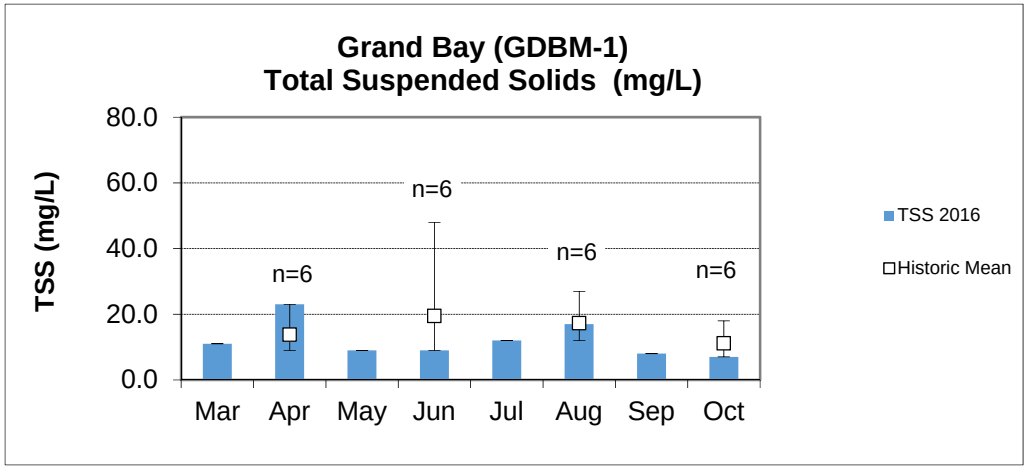
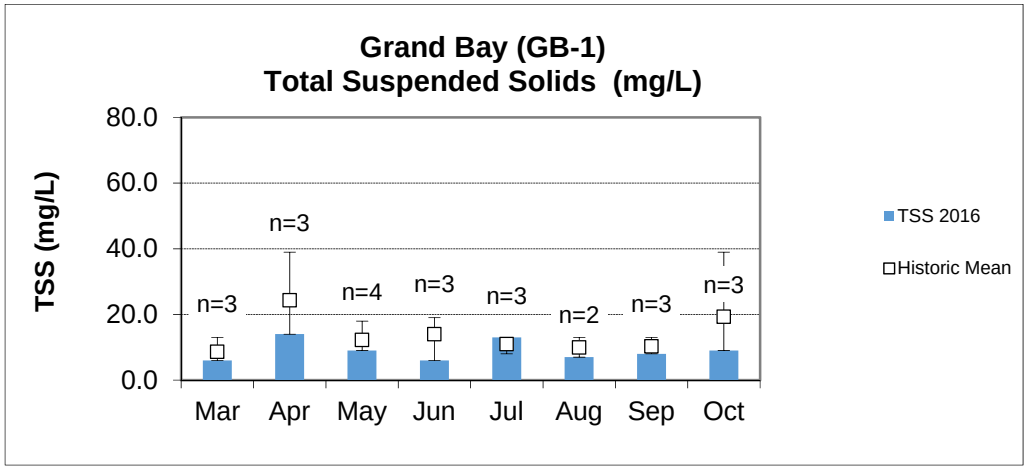


Figure 9. (continued)





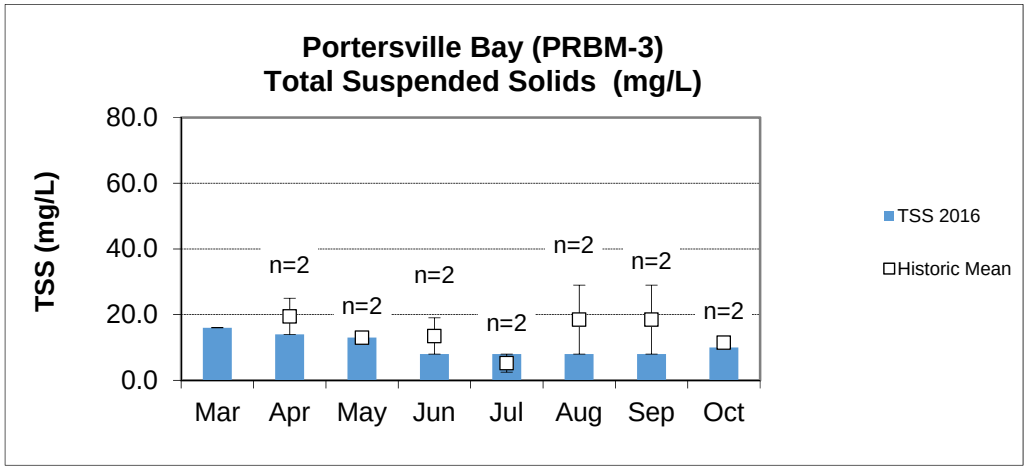
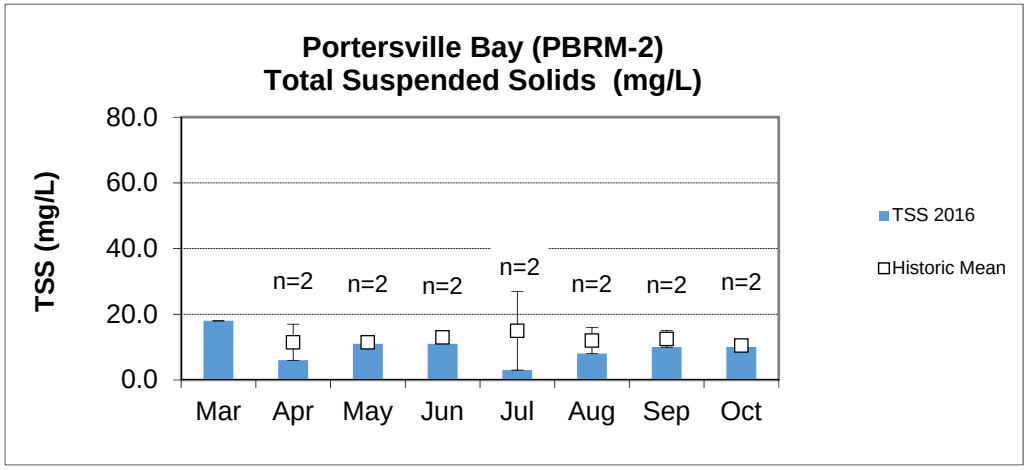
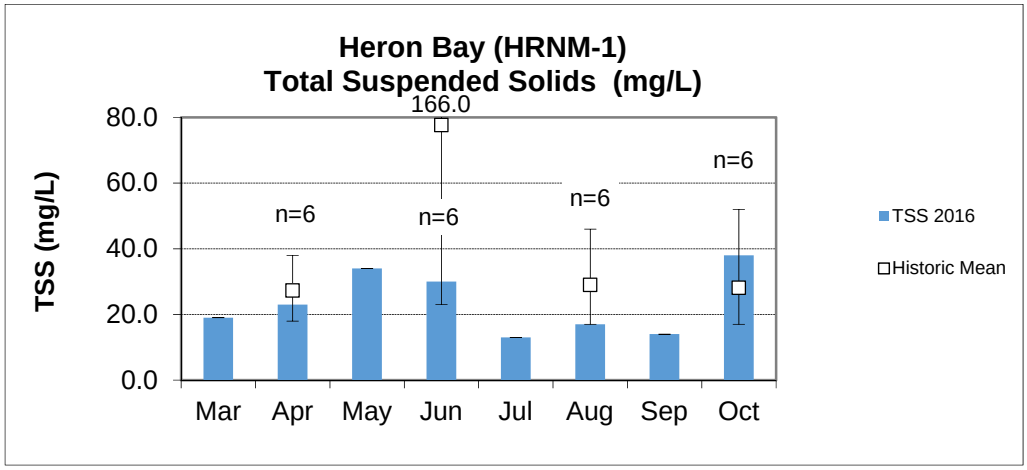


Figure 9. (continued)





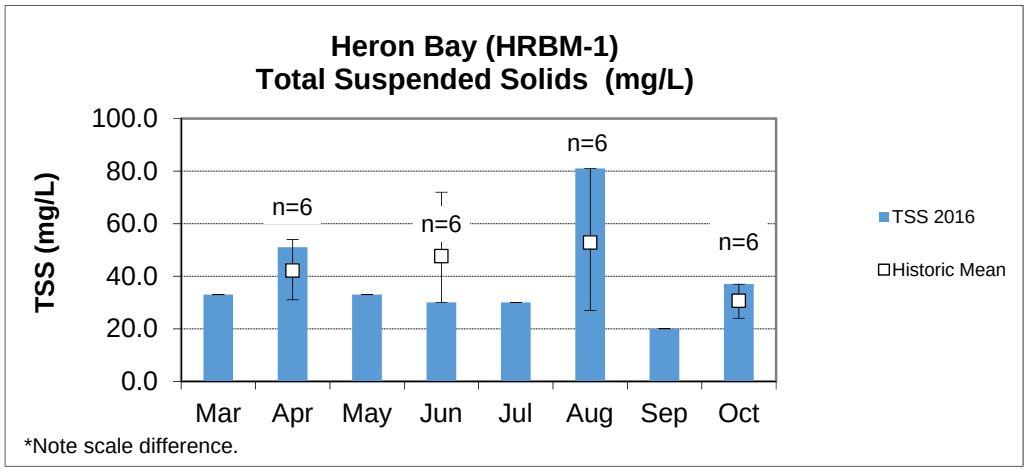
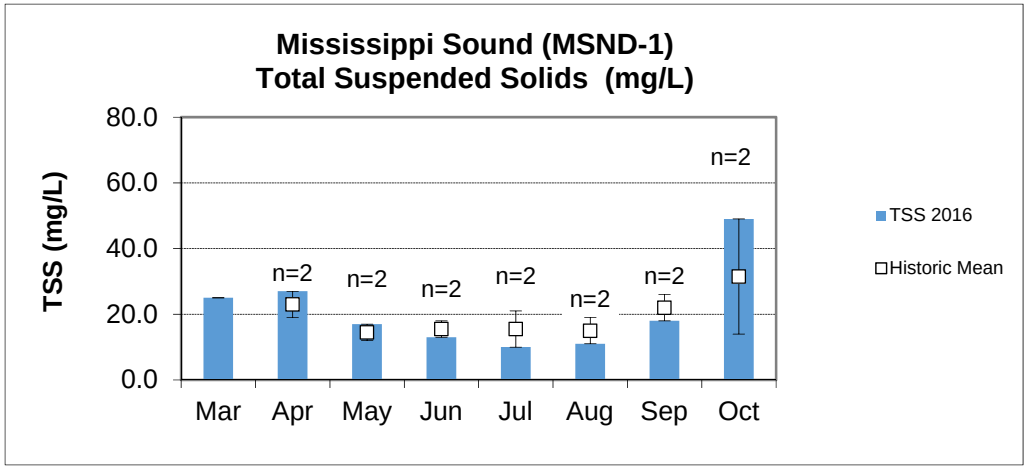
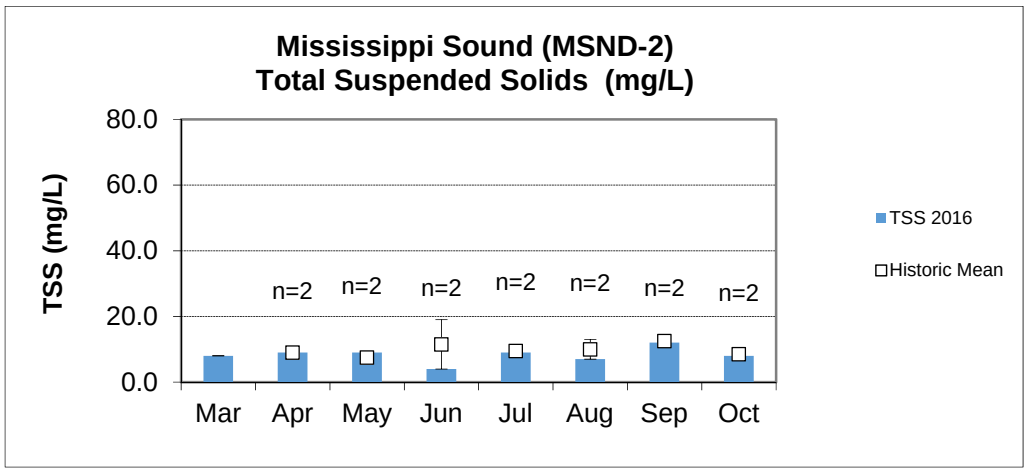


Figure 9. (continued)





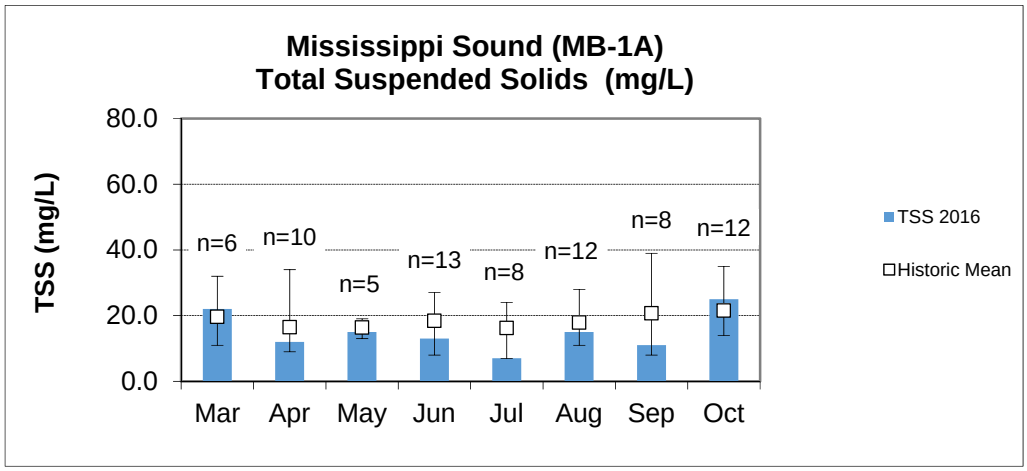
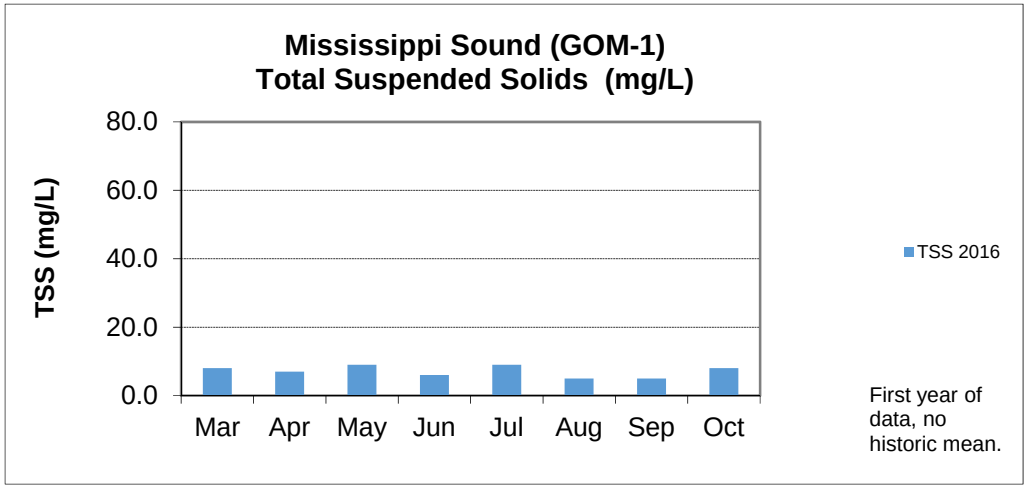


Figure 9. (continued)



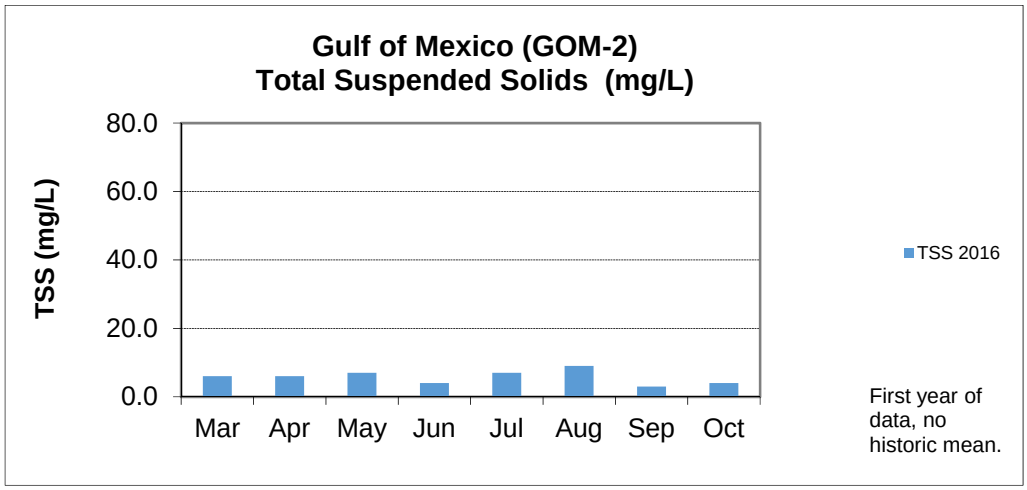


Figure 10. Monthly DO, Temperature, and Salinity concentrations at 1.5 m (5 ft), or mid-depth, for the Mississippi Sound Sub-Watershed stations collected March-October 2016. ADEM Water Quality Criteria requires a DO concentration of 5.0 mg/L at this depth (ADEM 2012). Flow is also measured at some stations.

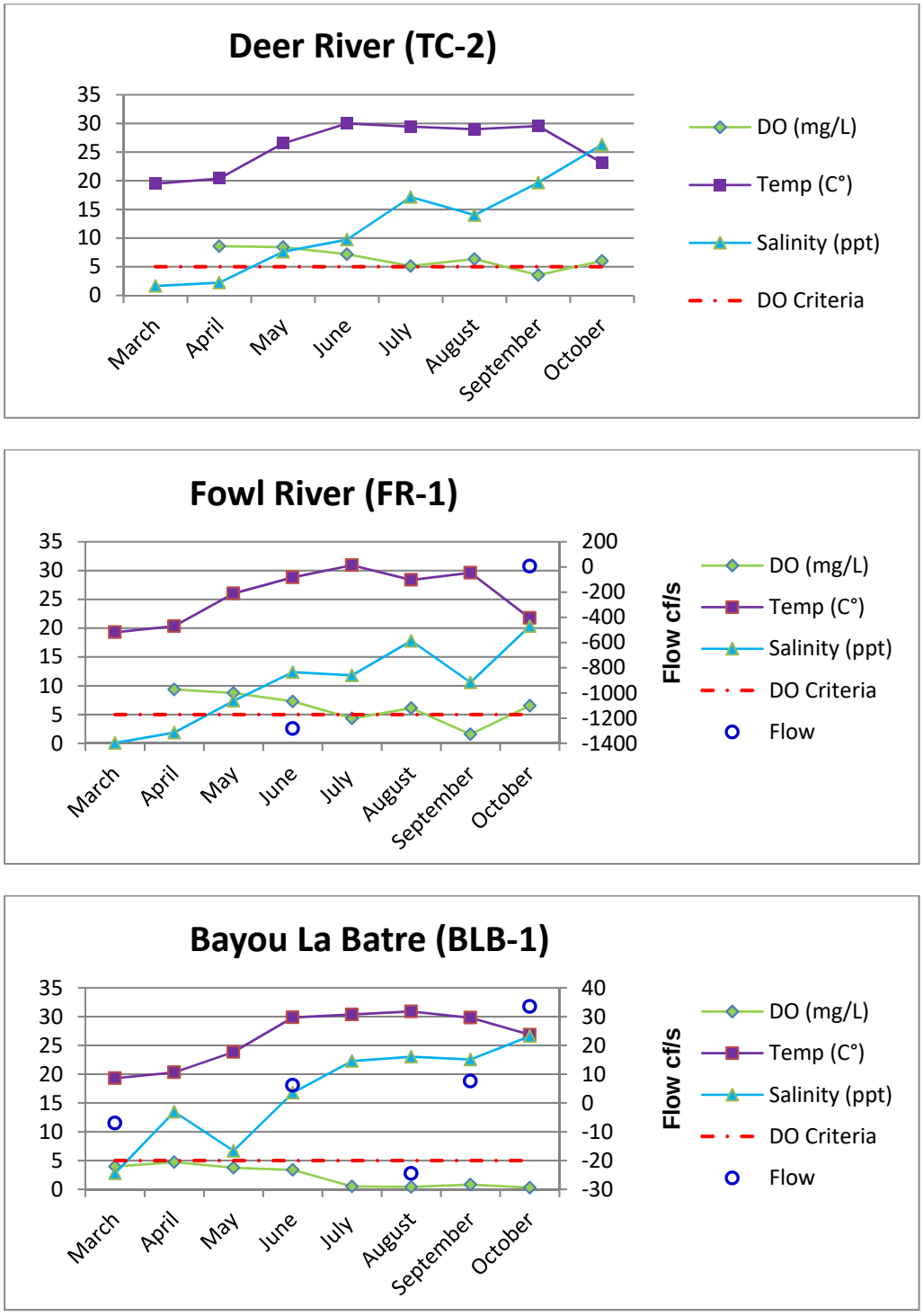


Figure 10. (continued)

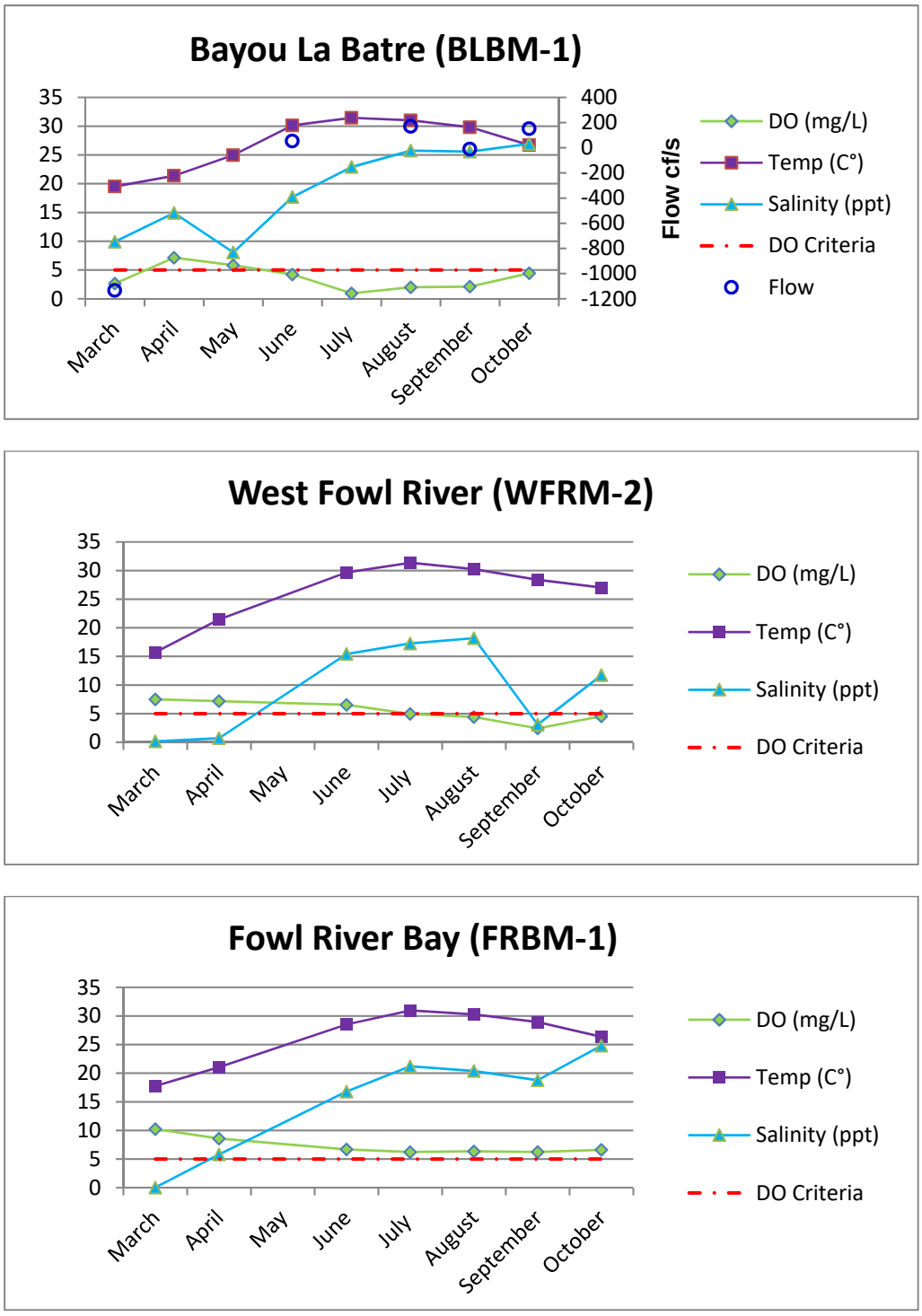


Figure 10. (continued)

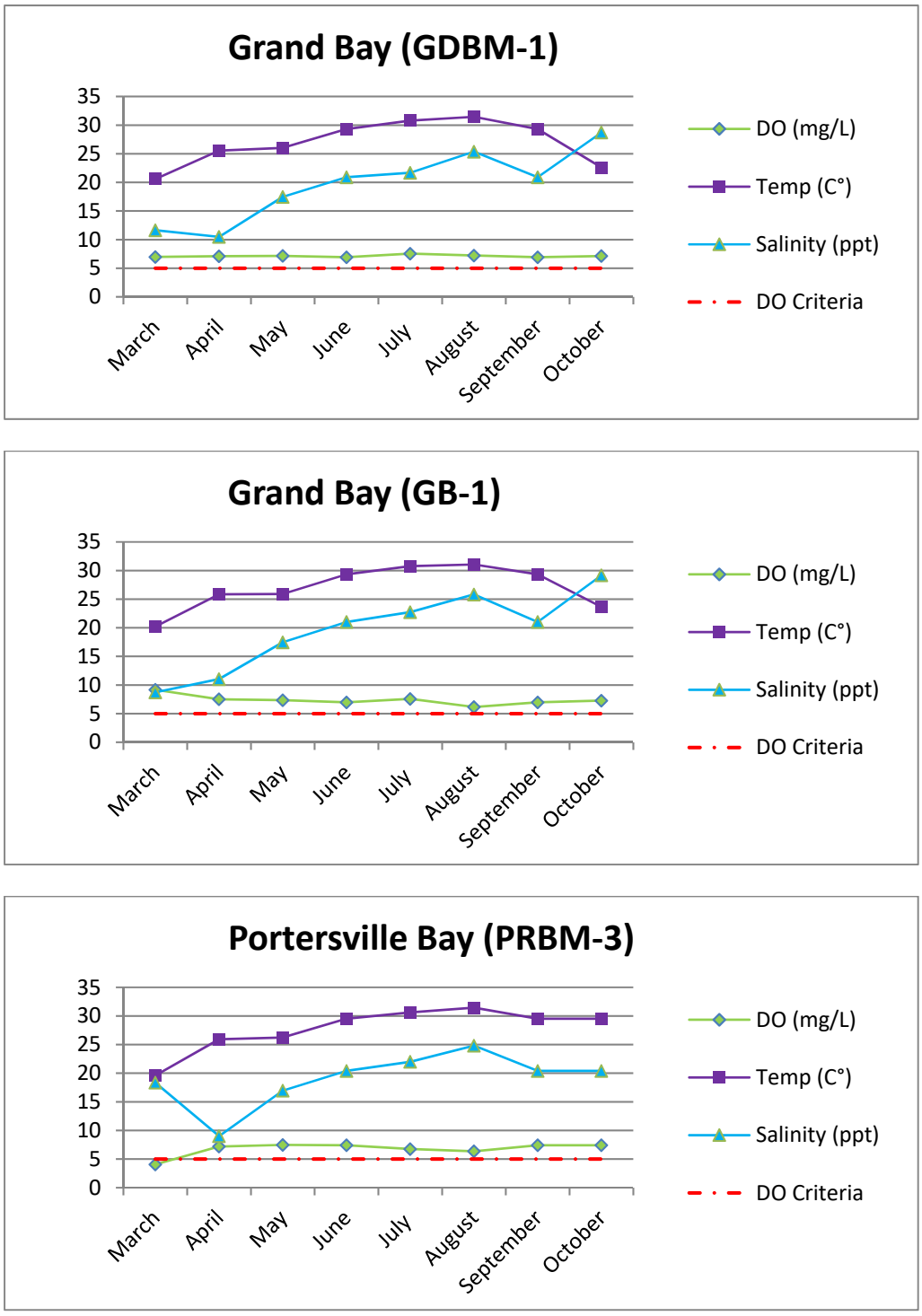


Figure 10. (continued)

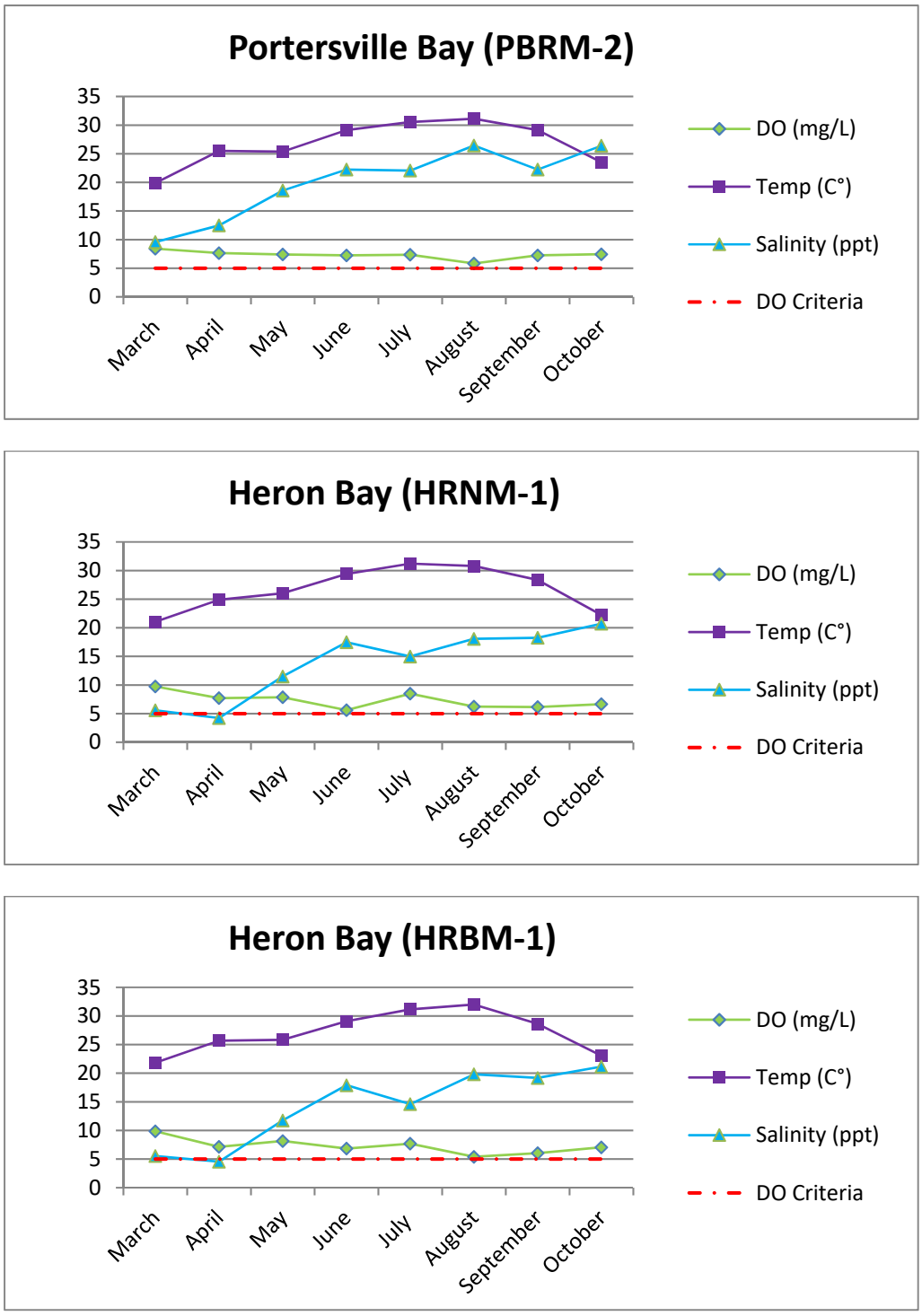


Figure 10. (continued)

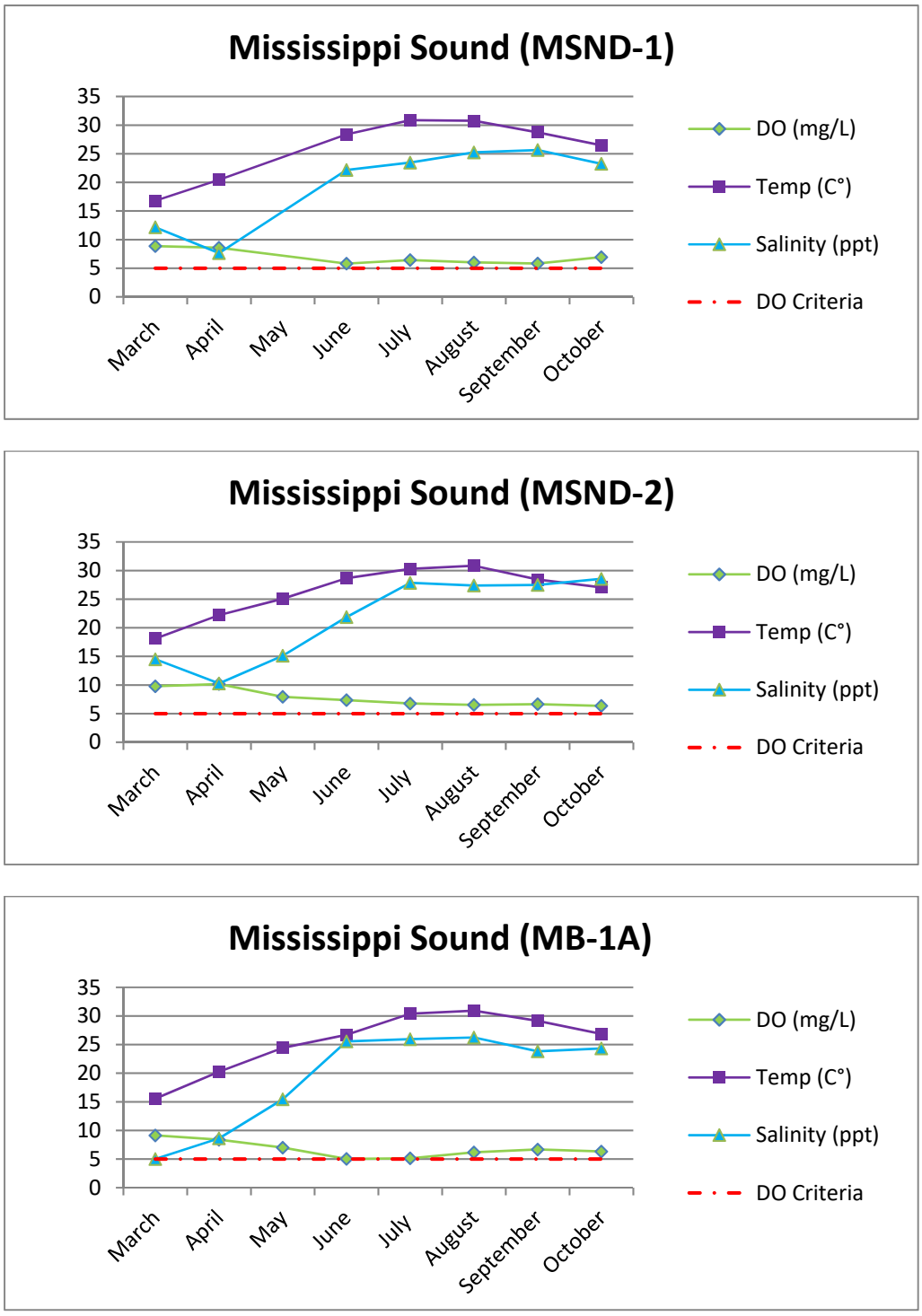


Figure 10. (continued)

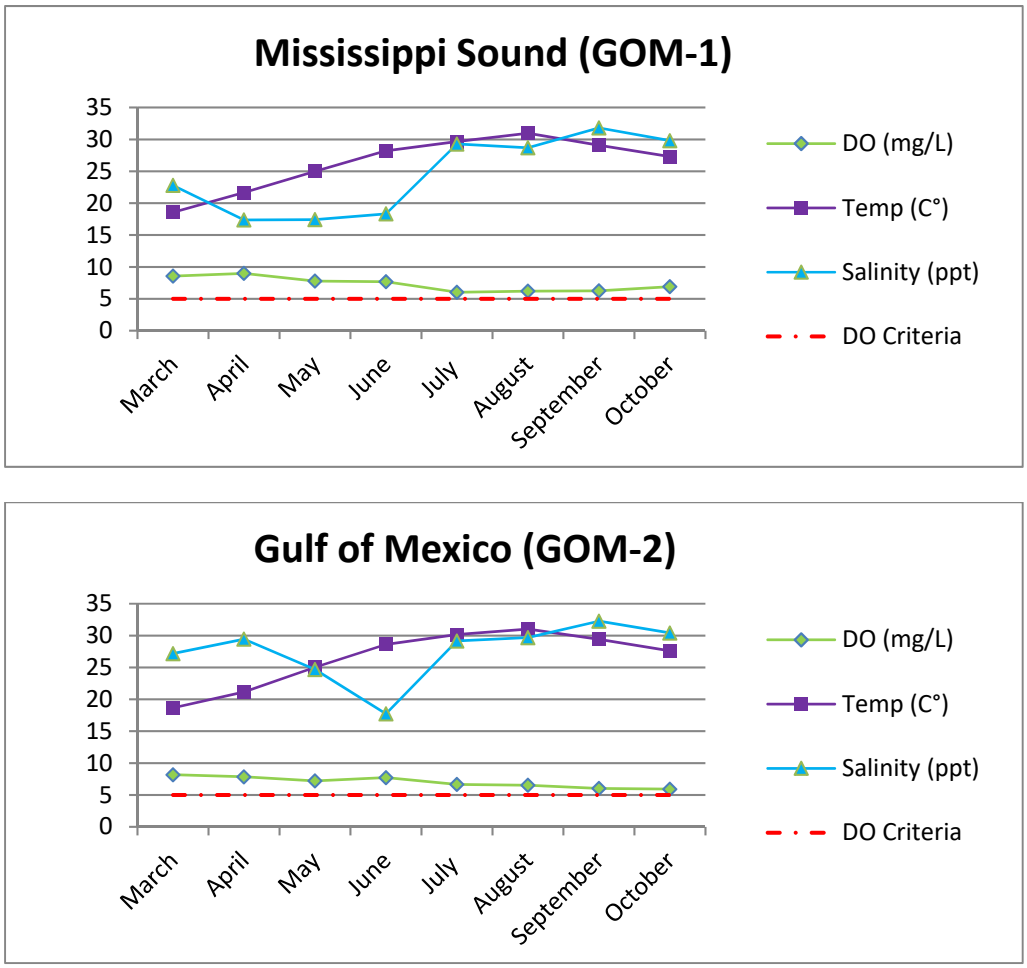


Figure 11. Monthly depth profiles of Dissolved Oxygen, Temperature, and Salinity for Mississippi Sound Sub-Watershed, March-October 2016.

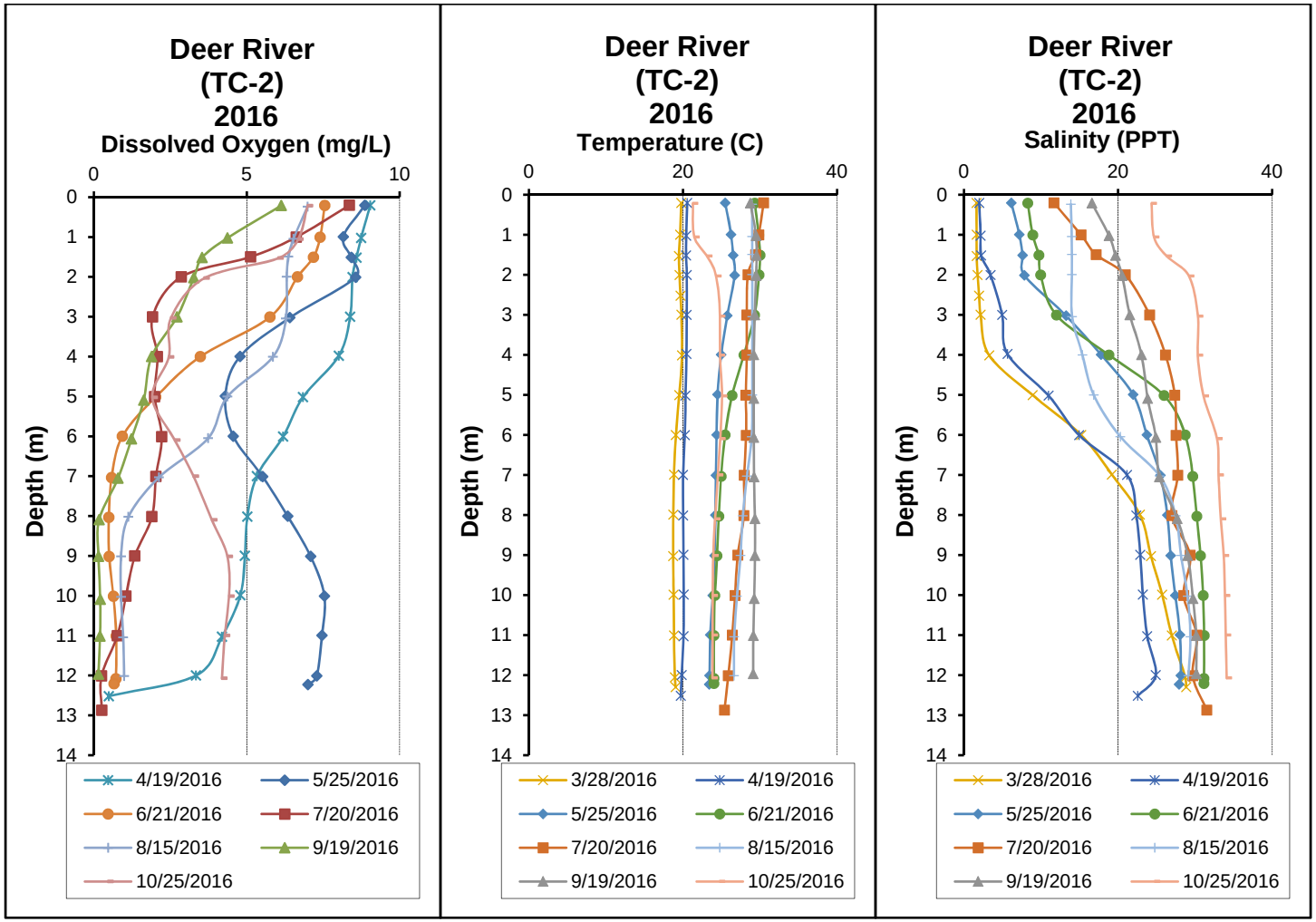


Figure 11. (continued)

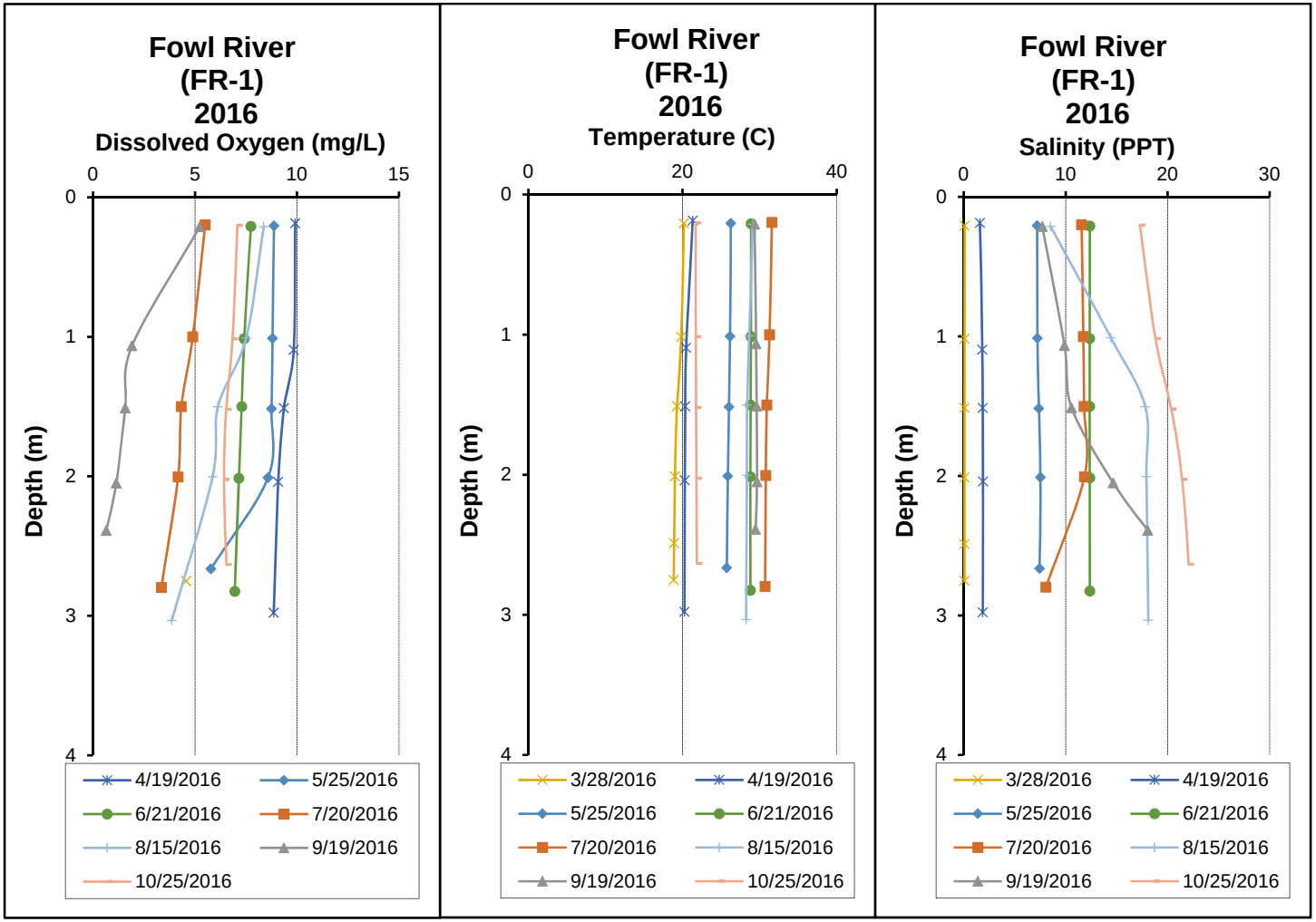


Figure 11. (continued)

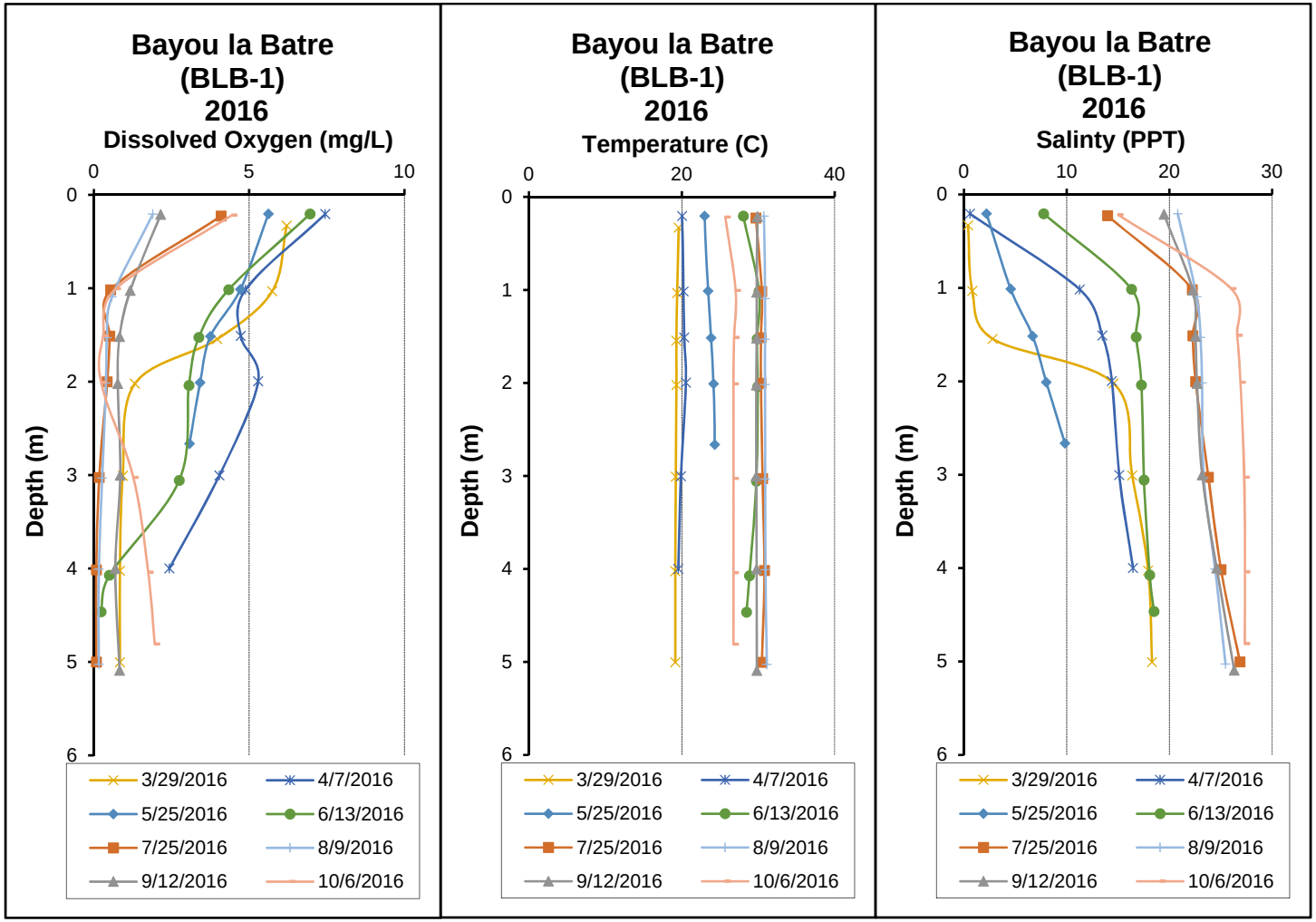


Figure 11. (continued)

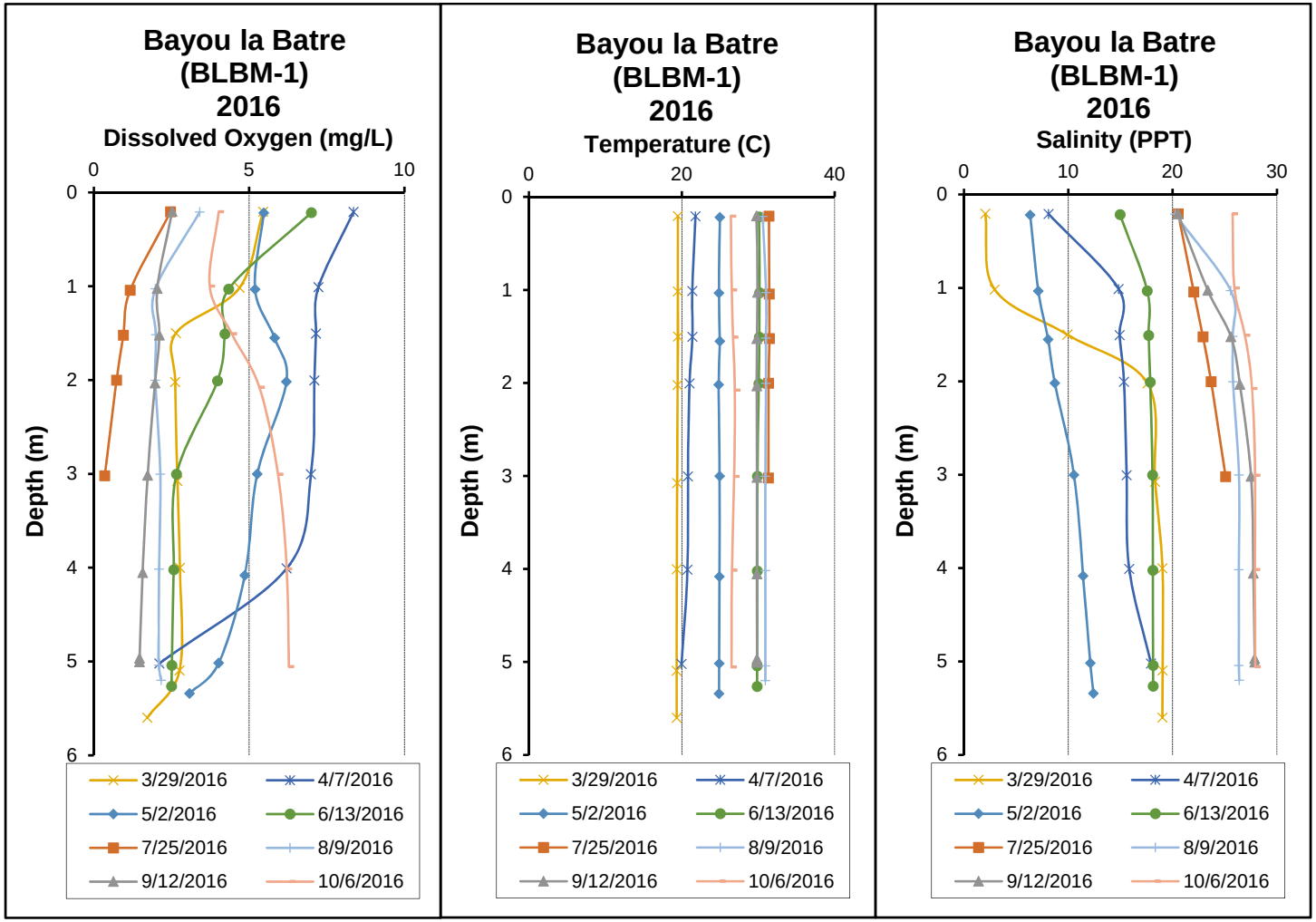


Figure 11. (continued)

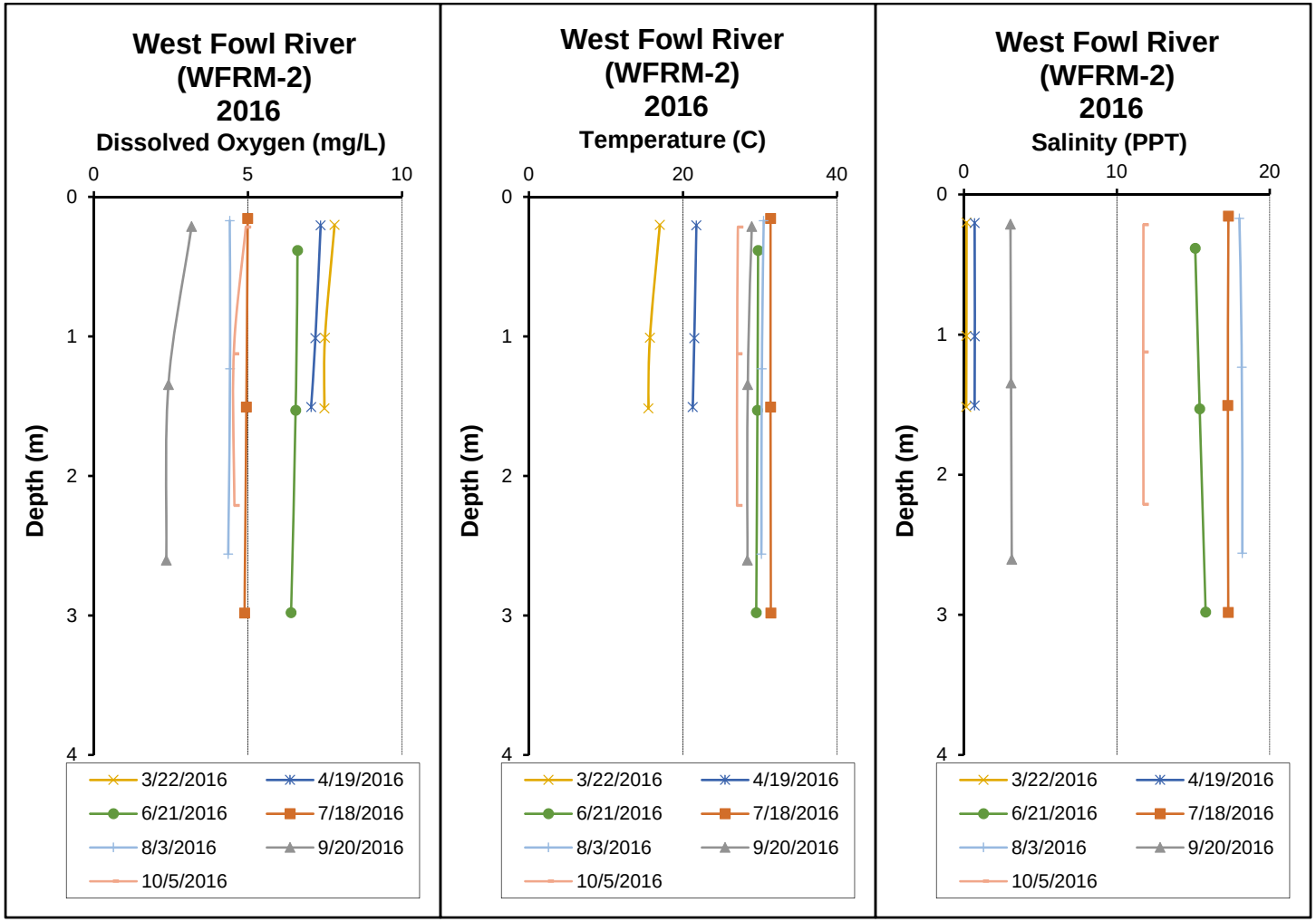


Figure 11. (continued)

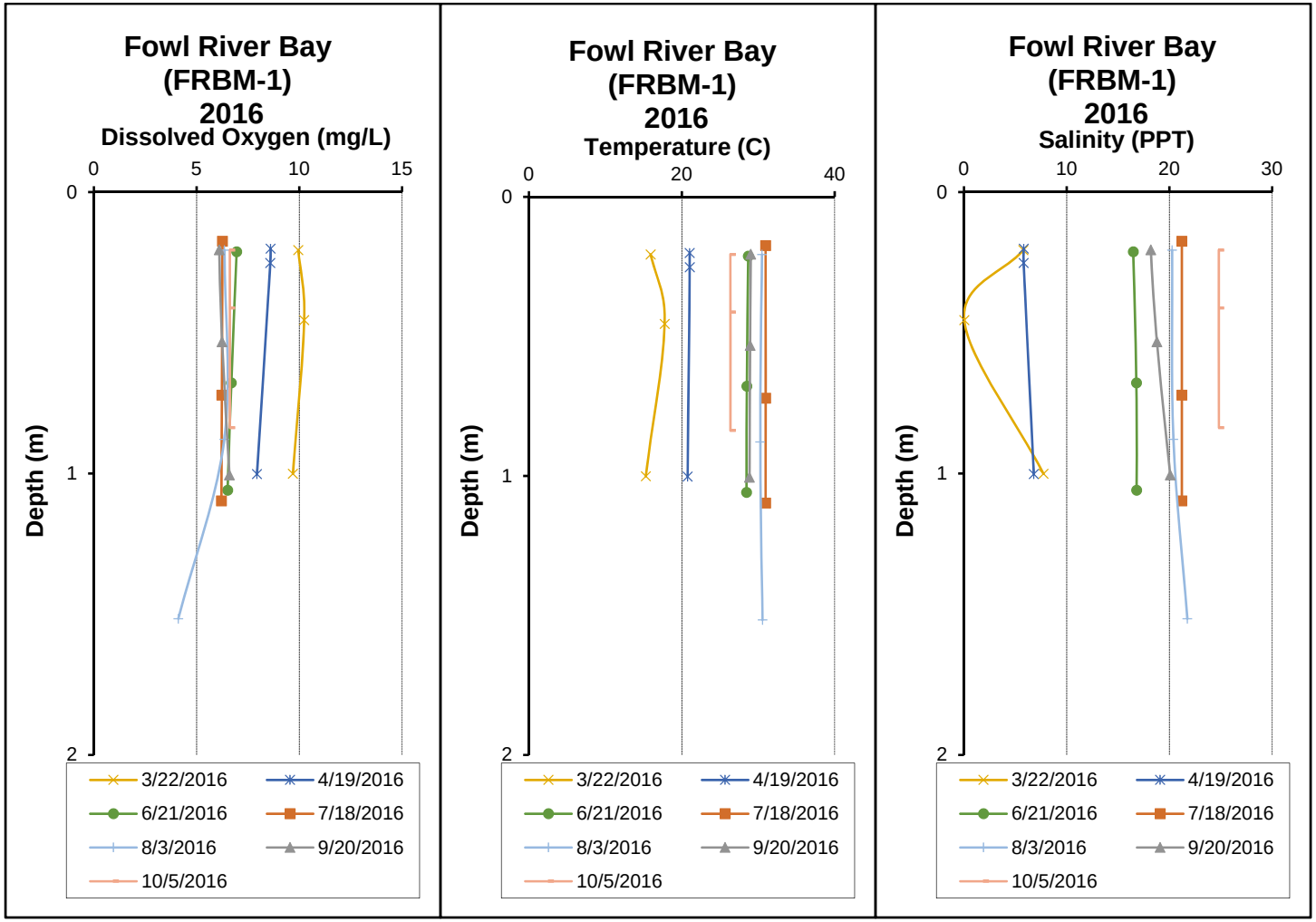


Figure 11. (continued)

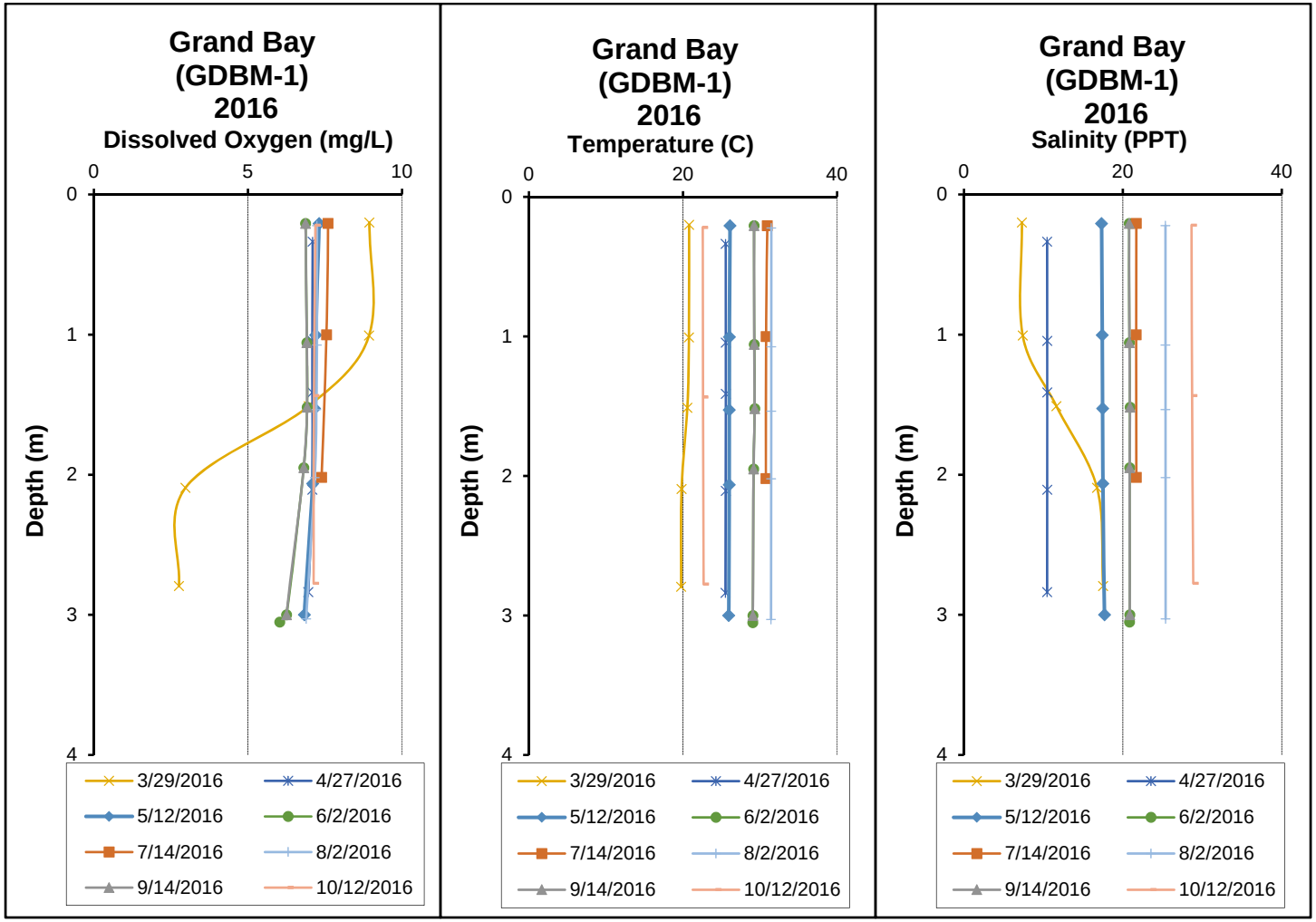


Figure 11. (continued)

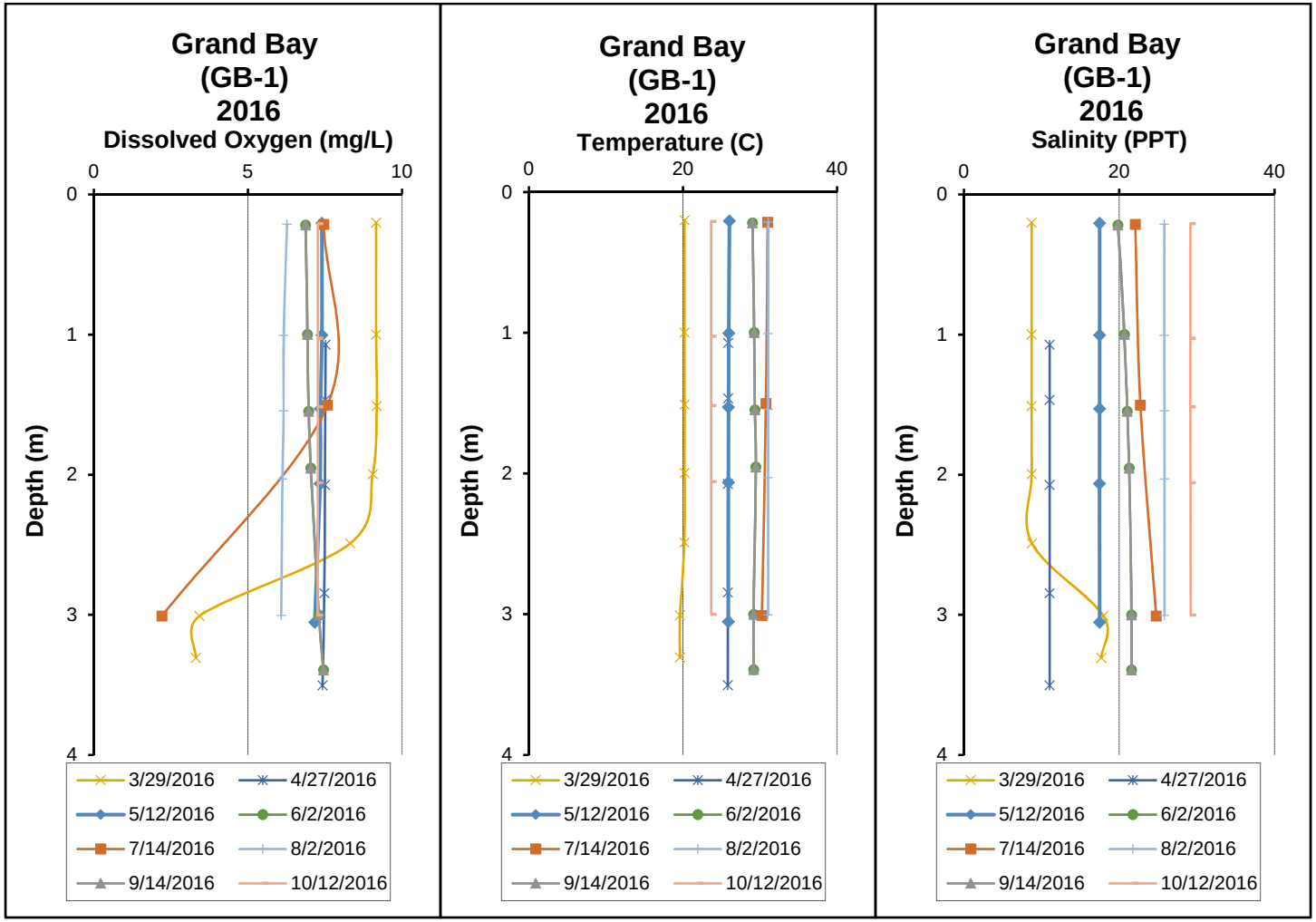


Figure 11. (continued)

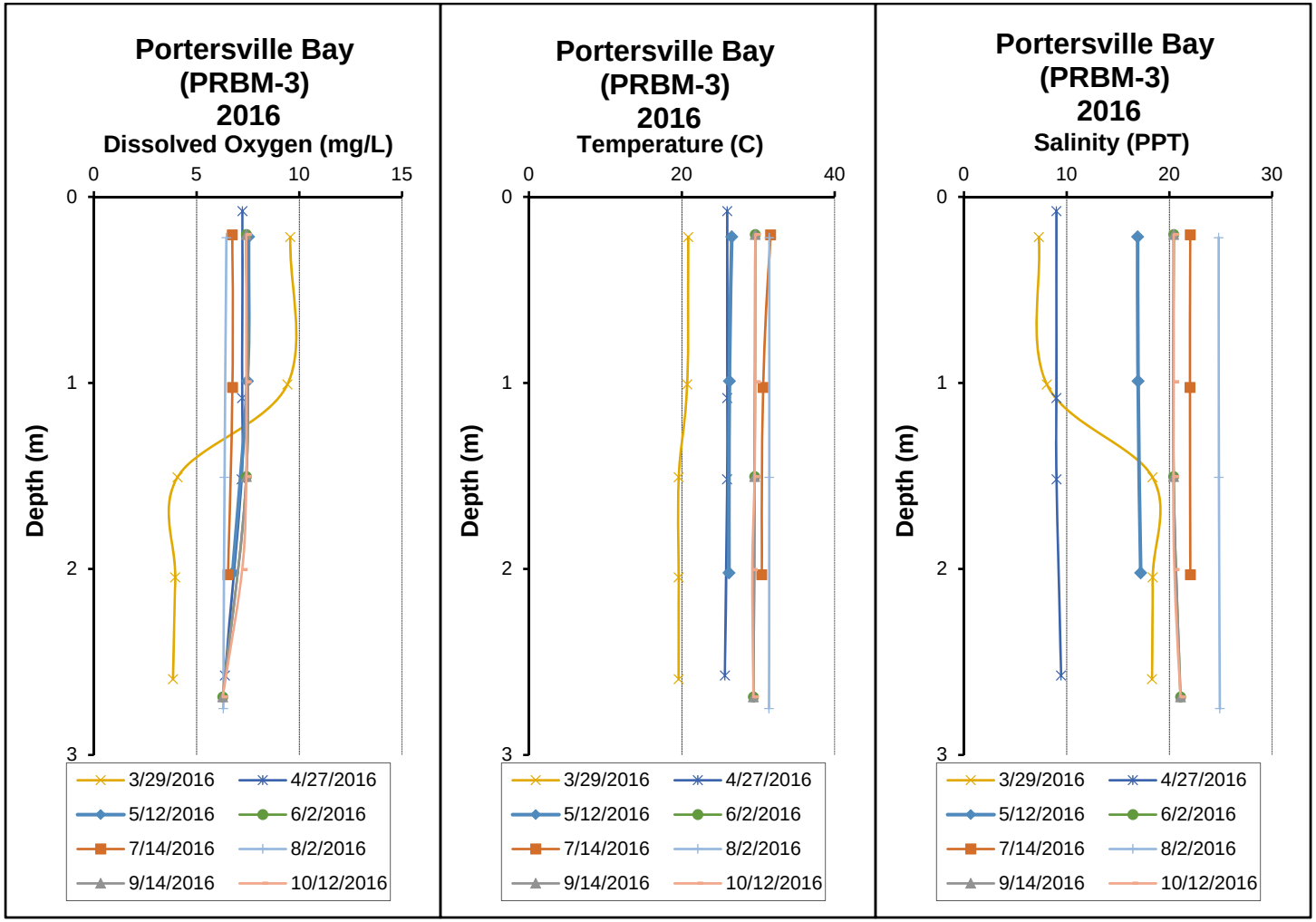


Figure 11. (continued)

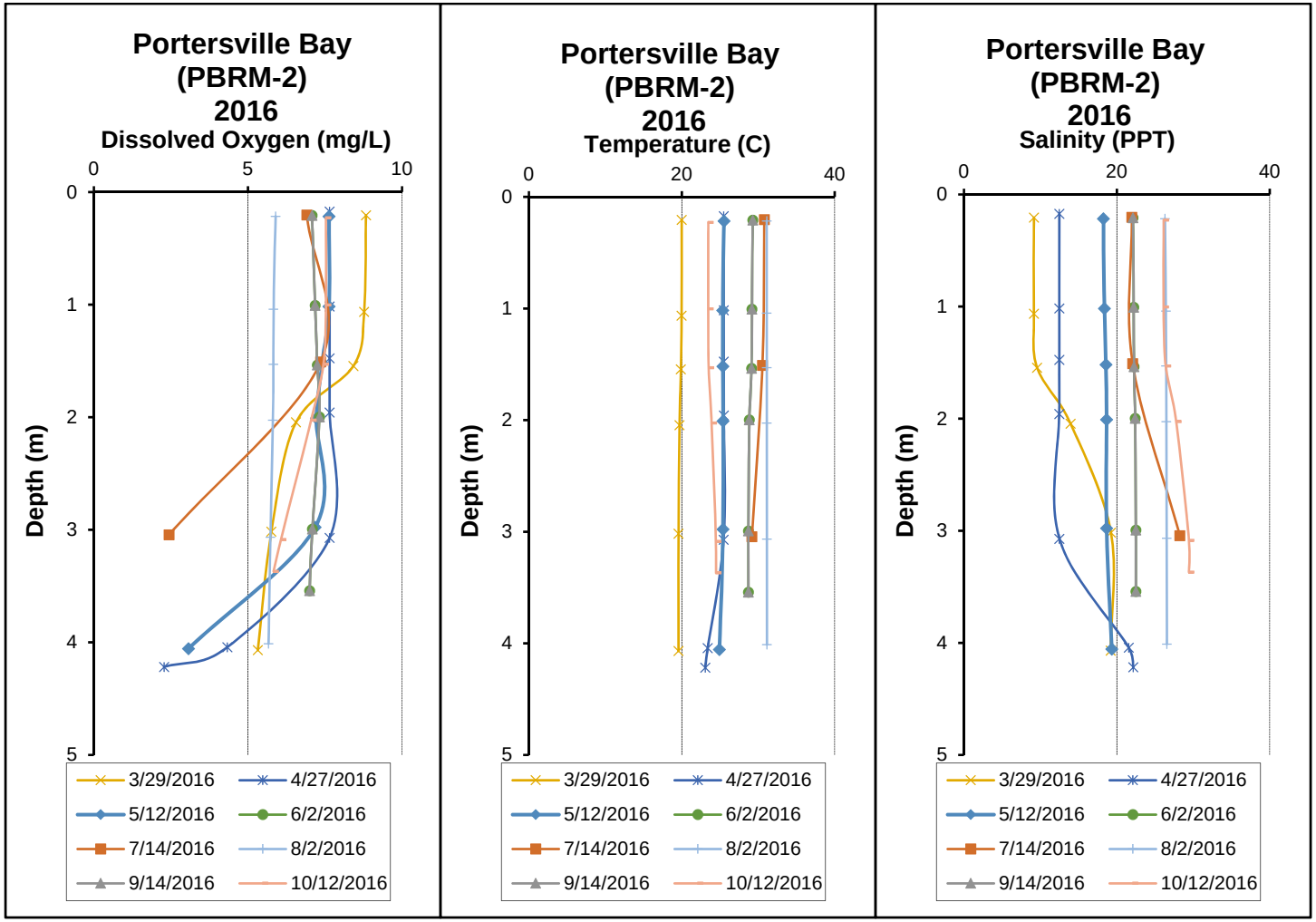


Figure 11. (continued)

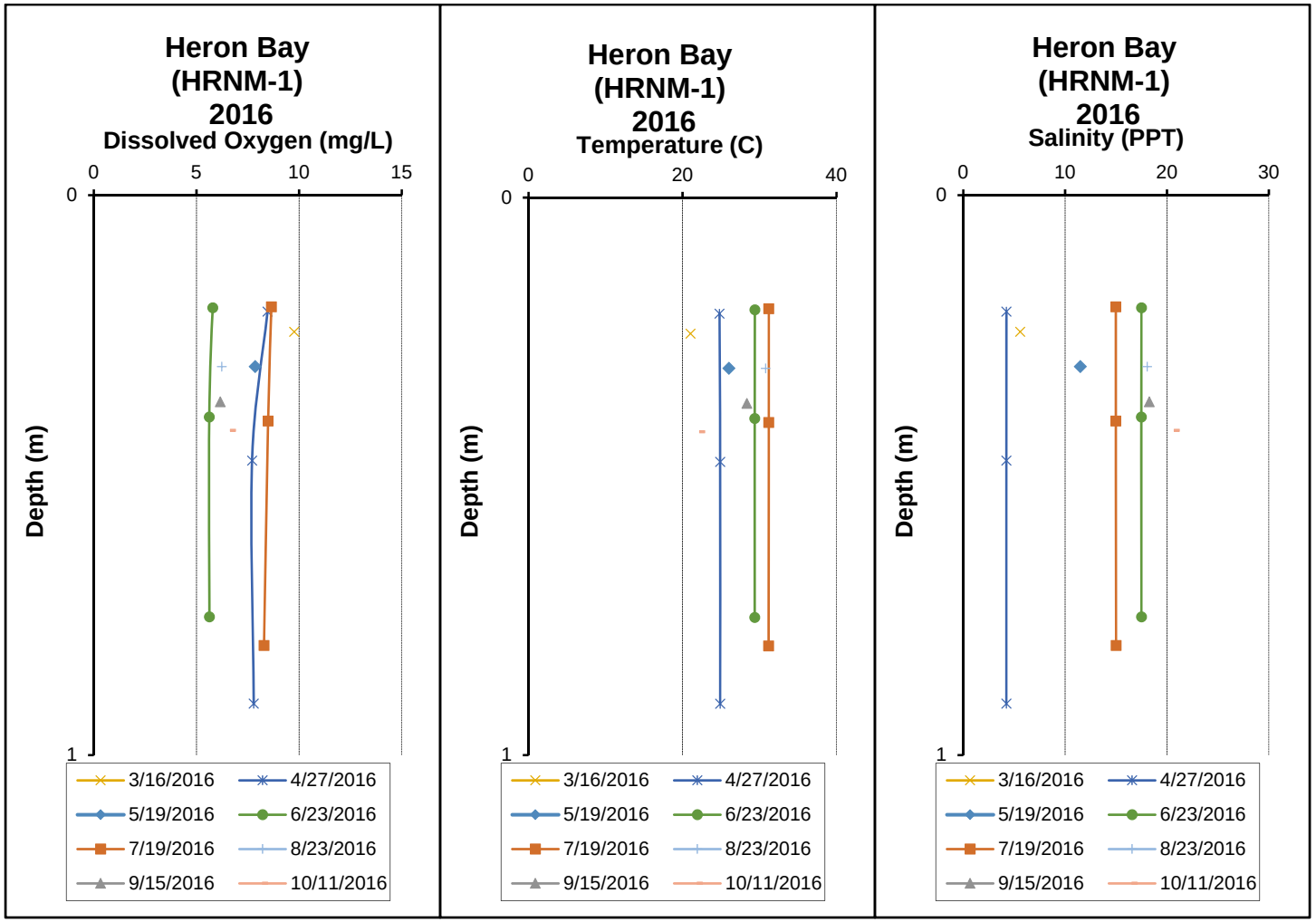


Figure 11. (continued)

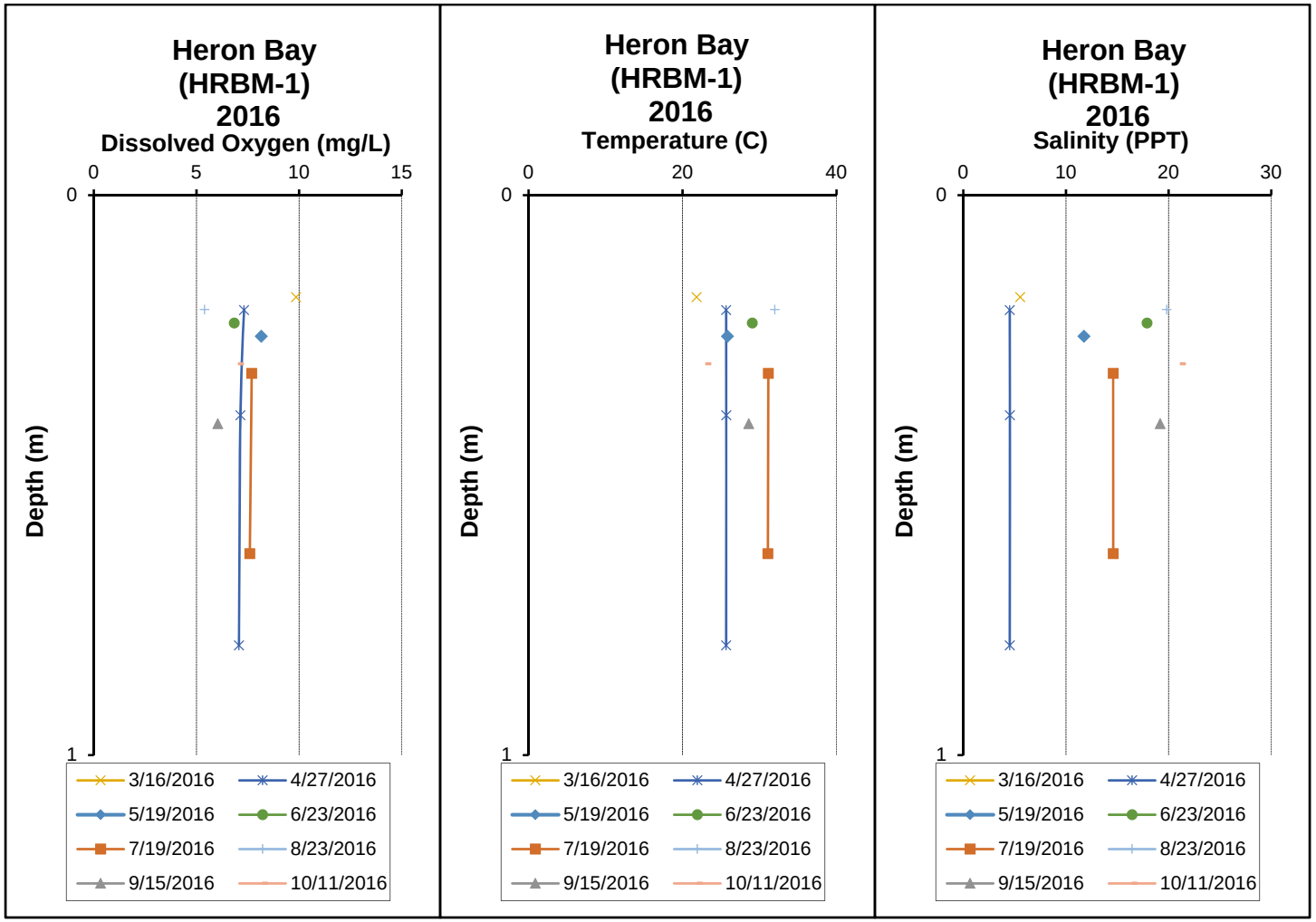


Figure 11. (continued)

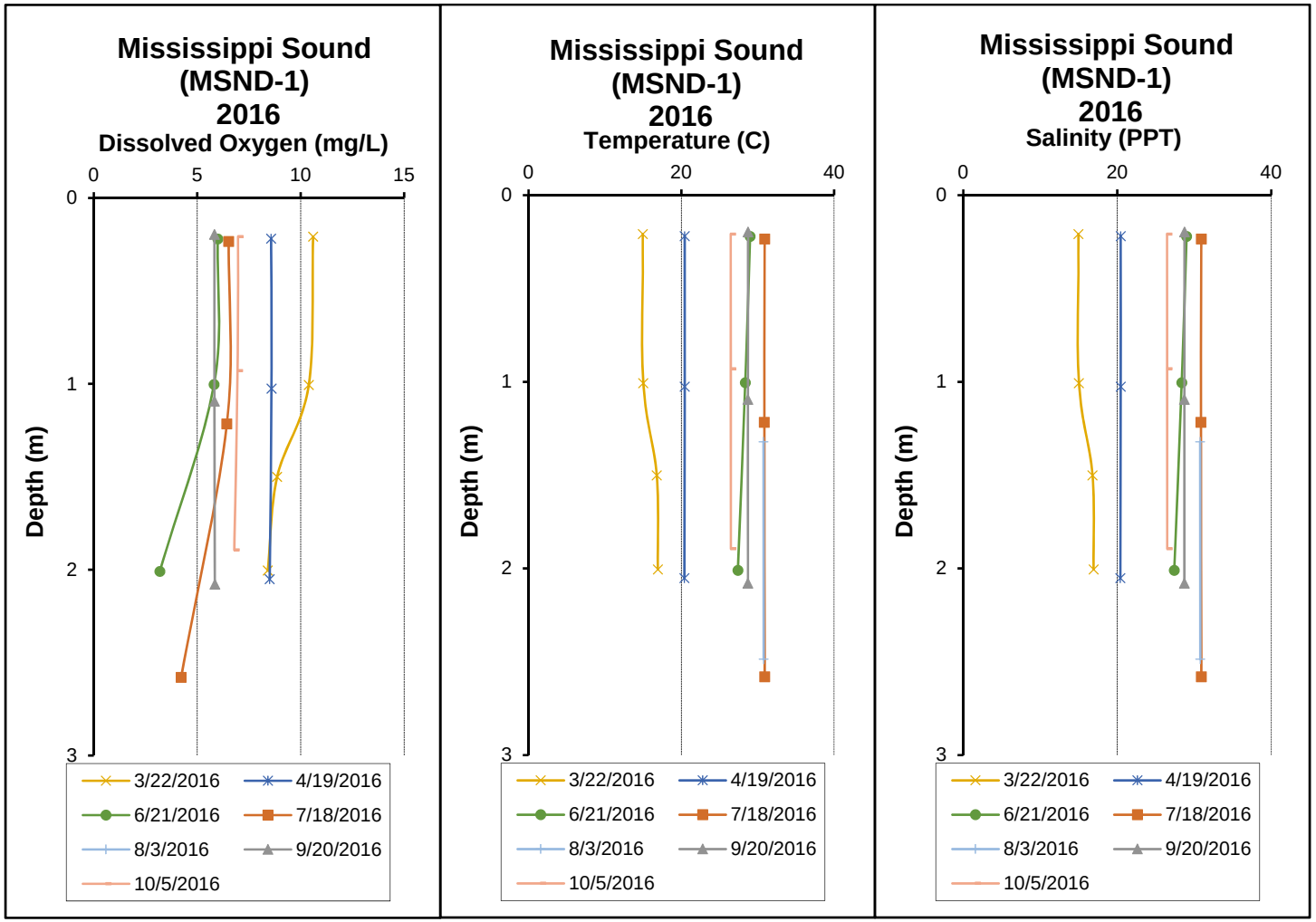


Figure 11. (continued)

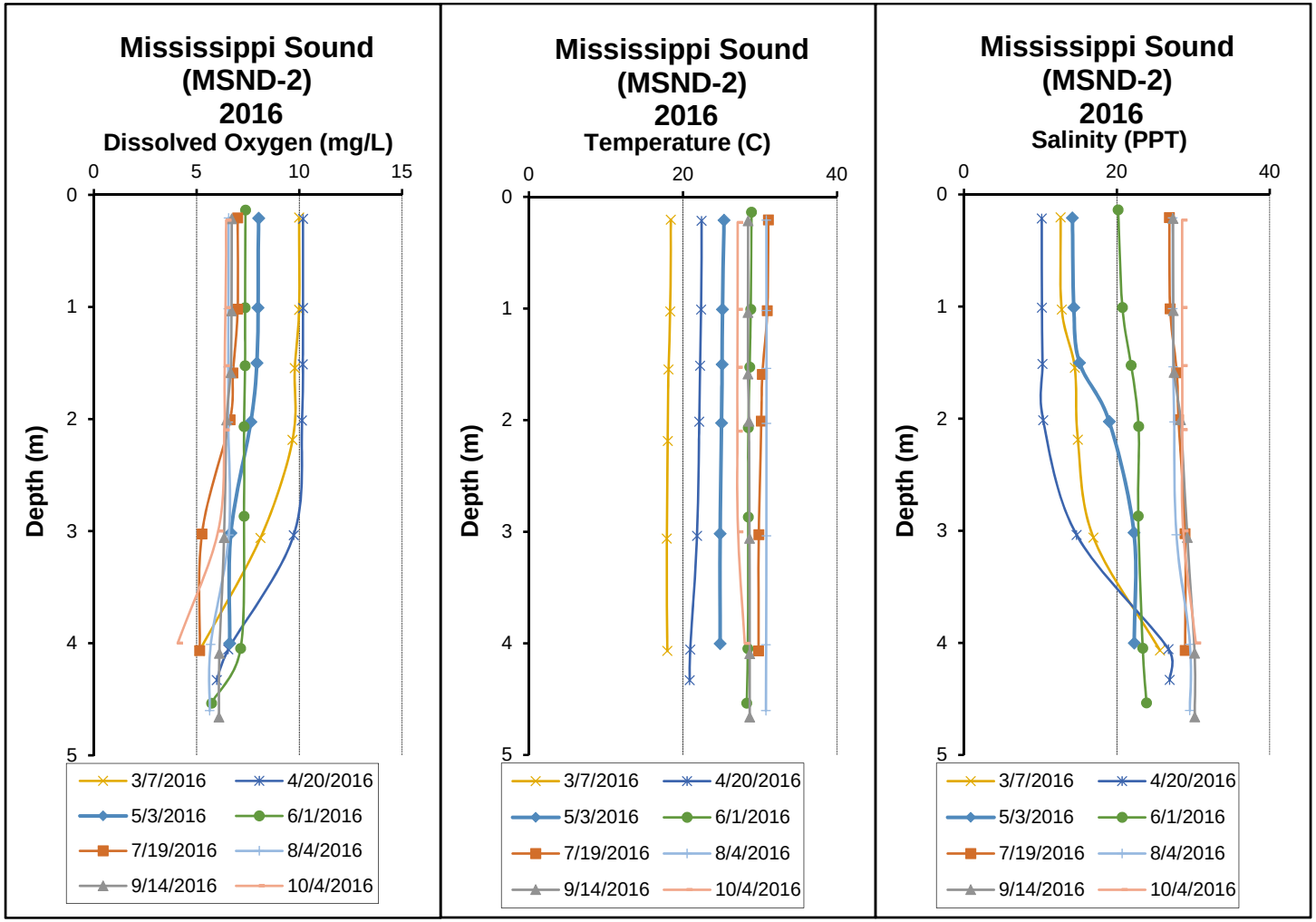


Figure 11. (continued)

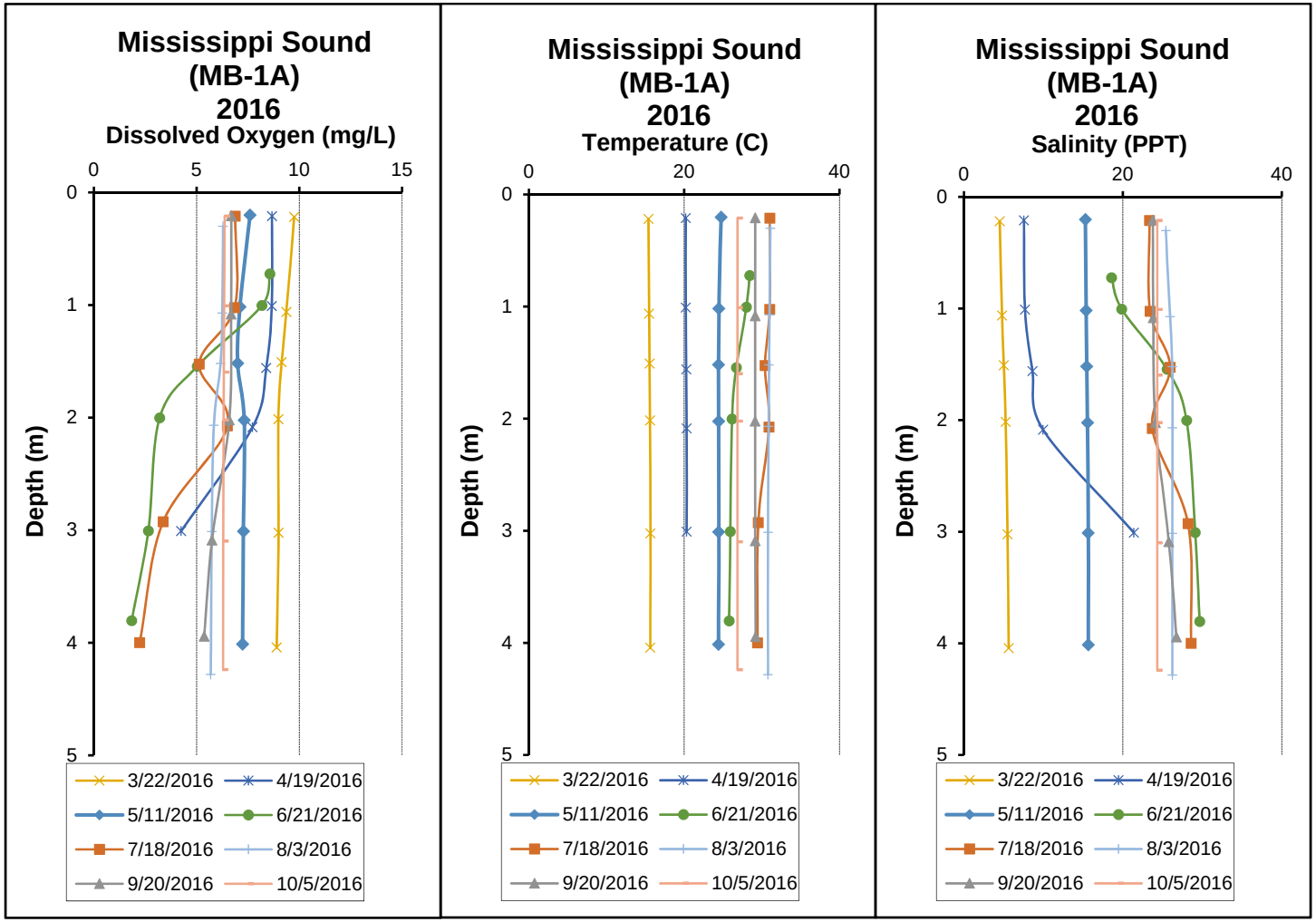


Figure 11. (continued)

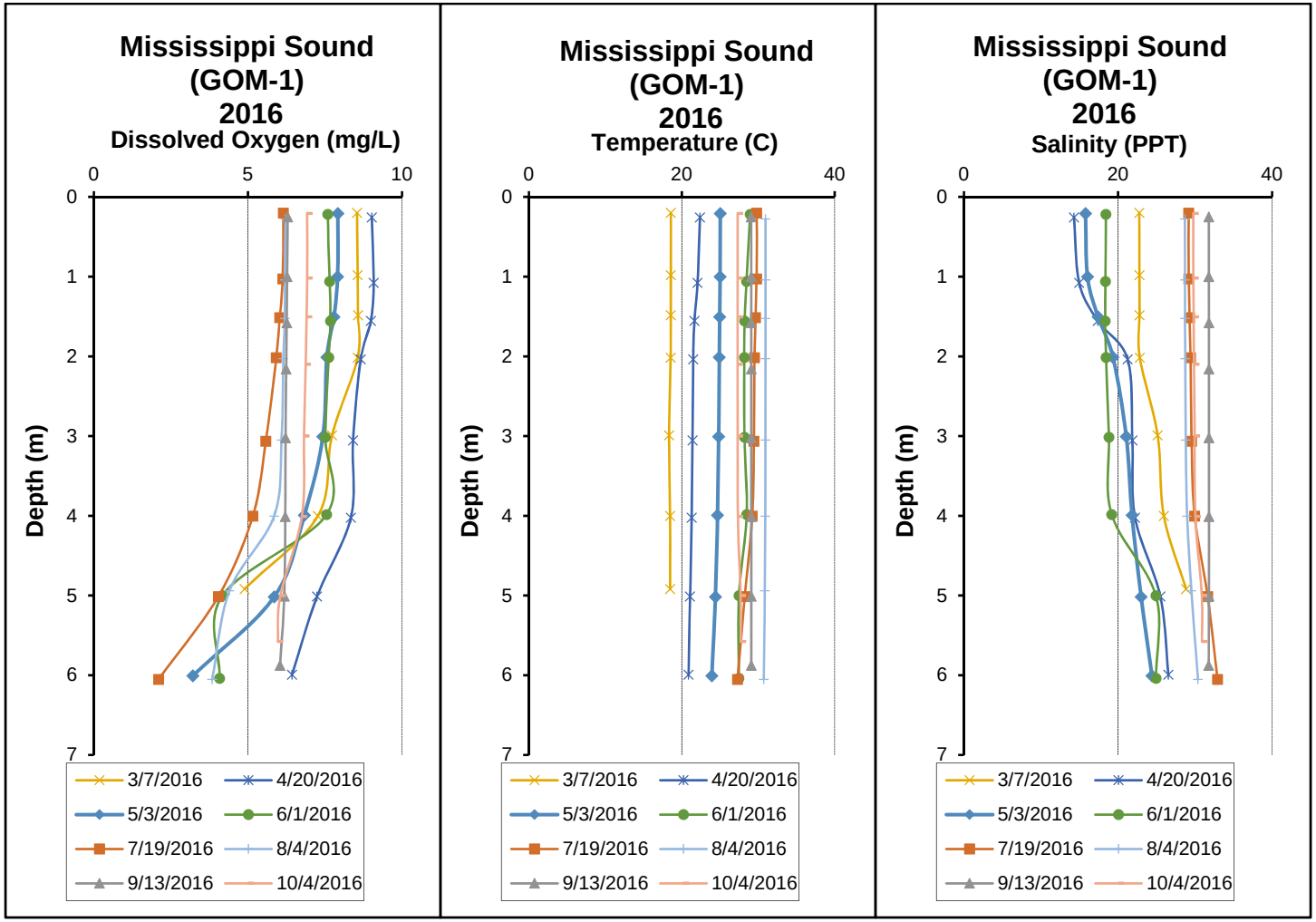
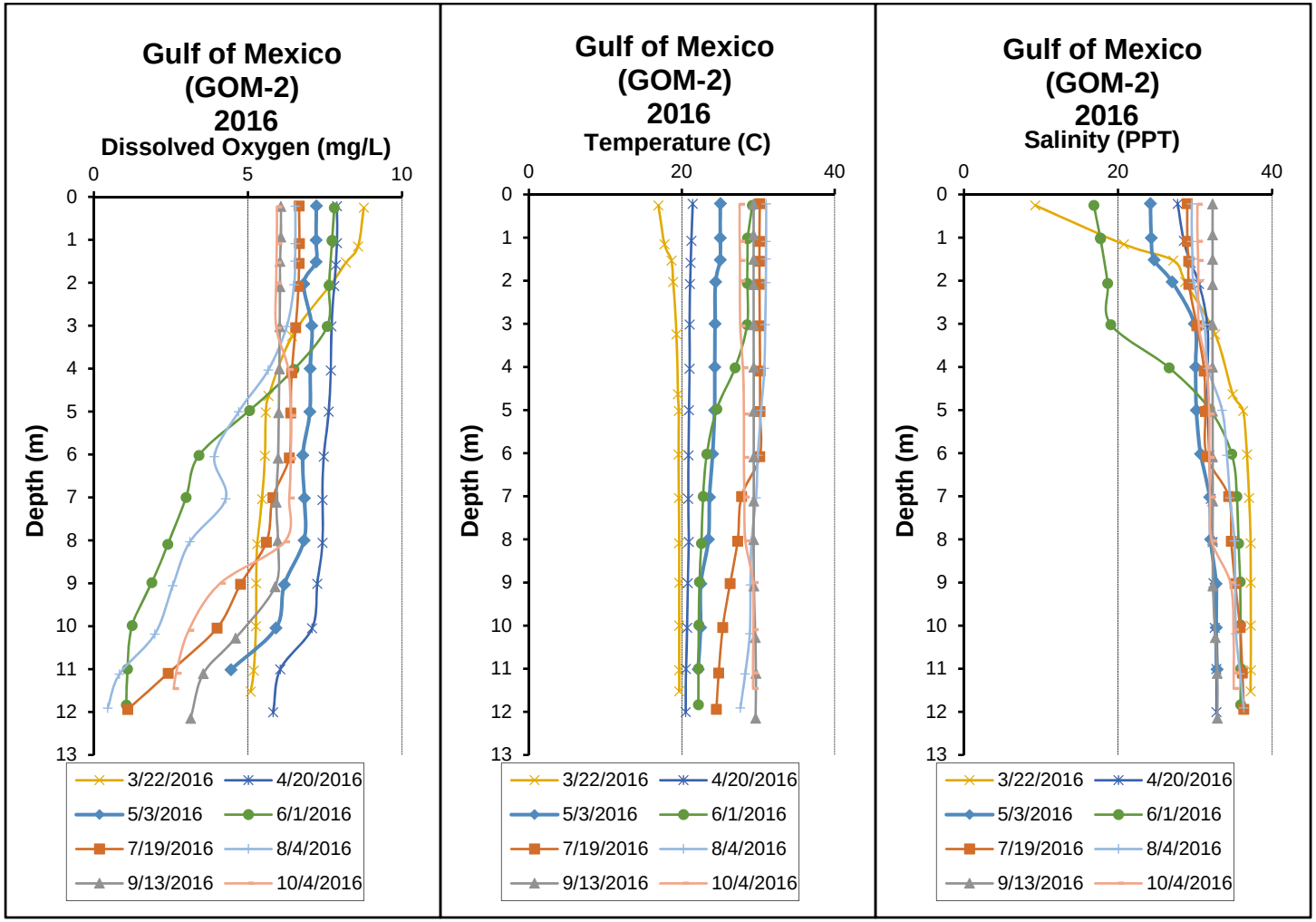


Figure 11. (continued)



REFERENCES

ADEM. 2012. Quality Management Plan (QMP) For the Alabama Department of Environmental Management, Alabama Department of Environmental Management (ADEM), Montgomery AL. 58 pp.

ADEM. 2015. Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring in Alabama. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 78 pp.

ADEM. 2016. Alabama's Water Quality Assessment and Listing Methodology, Alabama Department of Environmental Management (ADEM), Montgomery, AL. pp 8-11

ADEM. 2016 (as amended). Standard Operating Procedures #2041 In Situ Surface Water Quality Field Measurements-Temperature, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2044 In Situ Surface Water Quality Field Measurements–Turbidity, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2046 Photic Zone Measurement and Visibility Determination, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2047 In Situ Surface Water Quality Field Measurements–By Datasonde, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2061 General Surface Water Sample Collection, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2062 Dissolved Reactive Phosphorus (DRP) Surface Water Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2016 (as amended). Standard Operating Procedures #2063 Water Column Chlorophyll a Sample Collection and Field Processing, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

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

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2012. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1998. Standard methods for the examination of water and wastewater. 20th edition. APHA, Washington, D.C

APPENDIX

Appendix Table 1. Summary of Mississippi Sound Sub-Watershed water quality data collected March-October, 2016. 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.

	Parameter	N		Min	Max	Med	Avg	SD	E	Q
TC-2	**Physical**									
	Temperature (°C)	8		19.5	30.0	27.8	25.9	4.3		
	Turbidity (NTU)	8		1.7	32.1	8.4	12.0	11.2		
	Total Dissolved Solids (mg/L)	8		1770.0	27700.0	12455.0	13316.2	9555.8		
	Total Suspended Solids (mg/L)	8		5.0	13.0	9.5	9.1	3.4		
	Specific Conductance (µmhos/cm)	8		3148.0	41063.2	19990.5	20179.7	13350.5		
	Alkalinity (mg/L)	8		10.1	106.2	68.6	61.6	35.8		
	Chemical									
	Dissolved Oxygen (mg/L)	7		3.5 [C]	8.6	6.4	6.5	1.8	1	
	pH (SU)	8		6.5	8.3	7.4	7.4	0.6		
[J]	Ammonia Nitrogen (mg/L)	8	<	0.028	0.060	0.015	0.024	0.017		
	Nitrate+Nitrite Nitrogen (mg/L)	8	<	0.010	0.175	0.025	0.050	0.061		
	Total Kjeldahl Nitrogen (mg/L)	8		0.370	1.200	0.640	0.679	0.243		
	Dis Reactive Phosphorus (mg/L)	8	<	0.007	0.095	0.028	0.035	0.028		
	Total Phosphorus (mg/L)	8		0.042	0.125	0.066	0.073	0.026		
[J]	CBOD-5 (mg/L)	8	<	2.0	2.5	1.0	1.2	0.5		
	Chlorides (mg/L)	8		920.0	17000.0	6400.0	7277.5	5498.3		
	Biological									
	Chlorophyll a (mg/m³)	8	<	1.00	2.00	0.90	1.08	0.66		
[J,L]	Enterococci (MPN/DL)	8		10	30	5	9	9		

A= *F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C=,*F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
FR-1	**Physical**								
	Temperature (°C)	8	19.3	30.9 C	27.2	25.6	4.5		
	Turbidity (NTU)	8	14.3	31.3	18.7	19.5	5.3		
	Total Dissolved Solids (mg/L)	8	133.0	19100.0	10635.0	9606.6	6323.0		
	Total Suspended Solids (mg/L)	8	11.0	24.0	17.0	17.0	3.9		
	Specific Conductance (µmhos/cm)	8	147.7	32530.8	18991.0	17094.6	11276.2		
	Hardness (mg/L)	1				24.3			
	J Alkalinity (mg/L)	8	8.1	84.8	56.5	48.3	29.3		
	Monthly Stream Flow (cfs)	2	-1284.8	5.9	-639.4	-639.4	911.6		
	Measured Stream Flow (cfs)	2	-1284.8	5.9	-639.4	-639.4	911.6		
	Chemical								
	Dissolved Oxygen (mg/L)	8	1.6 C	35.8	6.9	10.0	10.7	2	
	pH (SU)	8	7.0	8.0	7.6	7.6	0.3		
	J Ammonia Nitrogen (mg/L)	8 <	0.030	0.120	0.022	0.039	0.038		
	J Nitrate+Nitrite Nitrogen (mg/L)	8 <	0.006	0.225	0.006	0.038	0.076		
	J Total Kjeldahl Nitrogen (mg/L)	8	0.470	1.100	0.580	0.695	0.266		
	Dis Reactive Phosphorus (mg/L)	8 <	0.003	0.032	0.008	0.013	0.012		
	Total Phosphorus (mg/L)	8 <	0.005	0.079	0.058	0.052	0.024		
	J CBOD-5 (mg/L)	8 <	2.0	2.7	1.0	1.5	0.7		
	Chlorides (mg/L)	8	42.0	11000.0	6150.0	5412.8	3587.5		
	J Sulfate (mg/L)	1				50.00			
	Total Metals								
	J Aluminum (T) (mg/L)	1				0.039			
	Iron (T) (mg/L)	1				0.269			
	Manganese (T) (mg/L)	1				0.079			
	Dissolved Metals								
	Aluminum (mg/L)	1			<	0.006			
	J Antimony (µg/L)	1			<	2.917			
	Arsenic (µg/L)	1				5.790 H		1	
	Cadmium (µg/L)	1			<	0.839			
	J Chromium (µg/L)	1				1.500			
	Copper (µg/L)	1				89.800 S		1	
	Iron (mg/L)	1			<	0.021			
	J Lead (µg/L)	1			<	3.440			
	J Manganese (mg/L)	1				0.011			
	J Nickel (µg/L)	1				3.480			
	Selenium (µg/L)	1				65.600 A		1	
	Silver (µg/L)	1			<	0.905			
	Thallium (µg/L)	1			<	1.090			
	Zinc (µg/L)	1			<	10.600			
	Biological								
	Chlorophyll a (mg/m³)	8 <	1.00	3.20	0.75	1.16	0.95		
	J,L Enterococci (MPN/DL)	8	10	70	8	15	22		

A=*S,F&W* aquatic life use criterion exceeded; H= S,F&W human health criterion exceeded; C=*S,F&W* criterion violated; S=metals adjusted for hardness; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
BLB-1	**Physical**								
	Temperature (°C)	8	19.3	30.9 C	28.3	26.4	4.7	2	
	Turbidity (NTU)	11	3.4	15.8	9.2	9.2	4.7		
	Total Dissolved Solids (mg/L)	8	1200.0	27700.0	5800.0	10492.5	10379.8		
	J Total Suspended Solids (mg/L)	8	3.0	16.0	7.5	7.8	4.5		
	Specific Conductance (µmhos/cm)	8	5170.2	41571.4	31508.7	27044.2	13041.2		
	Hardness (mg/L)	2	192.0	207.0	199.5	199.5	10.6		
	Alkalinity (mg/L)	8	13.4	104.5	76.5	64.8	32.5		
	Monthly Stream Flow (cfs)	5	-25.5	33.5	6.1	3.2	21.3		
	Measured Stream Flow (cfs)	5	-25.5	33.5	6.1	3.2	21.3		
	Chemical								
	Dissolved Oxygen (mg/L)	8	0.3 C	4.7	2.1	2.2	1.9	8	
	pH (SU)	8	6.8	7.6	7.2	7.2	0.3		
	J Ammonia Nitrogen (mg/L)	8	0.060	0.350	0.145	0.166	0.101		
	Nitrate+Nitrite Nitrogen (mg/L)	8 <	0.010	0.171	0.044	0.069	0.059		
	Total Kjeldahl Nitrogen (mg/L)	8	0.430	1.800	0.615	0.908	0.514		
	J Dis Reactive Phosphorus (mg/L)	8	0.007	0.073	0.048	0.042	0.028		
	Total Phosphorus (mg/L)	8	0.031	0.178	0.098	0.095	0.061		
	J CBOD-5 (mg/L)	8 <	2.0	4.4	1.6	2.1	1.4		
	Chlorides (mg/L)	8	590.0	15000.0	8850.0	7898.8	5016.1		
	Total Metals								
	Aluminum (T) (mg/L)	2 <	0.014	0.762	0.384	0.384	0.534		
	Iron (T) (mg/L)	2	0.204	0.564	0.384	0.384	0.254		
	Manganese (T) (mg/L)	2	0.031	0.071	0.051	0.051	0.028		
	Dissolved Metals								
	Aluminum (mg/L)	2 <	0.014	0.457	0.232	0.232	0.318		
	J Antimony (µg/L)	2 <	0.371	2.817	0.890	0.890	0.734		
	Arsenic (µg/L)	2 <	0.699	5.830 H	3.090	3.090	3.875	1	
	Cadmium (µg/L)	2 <	0.780	0.839	0.405	0.405	0.021		
	J Chromium (µg/L)	2 <	1.050	1.600	1.062	1.062	0.760		
	Copper (µg/L)	2 <	3.620	68.800 S	35.305	35.305	47.369	1	
	J Iron (mg/L)	2	0.022	0.366	0.194	0.194	0.243		
	Lead (µg/L)	2 <	0.128	3.440	0.892	0.892	1.171		
	J Manganese (mg/L)	2	0.030	0.031	0.030	0.030	0.001		
	J Nickel (µg/L)	2 <	2.740	3.260	2.185	2.185	0.785		
	Selenium (µg/L)	2 <	1.440	29.200 A	14.960	14.960	20.138	1	
	J Silver (µg/L)	2 <	0.135	0.905	0.294	0.294	0.224		
	Thallium (µg/L)	2 <	0.086	1.090	0.294	0.294	0.355		
	Zinc (µg/L)	2 <	10.600	17.000	11.150	11.150	8.273		
	Biological								
	Chlorophyll a (mg/m³)	8 <	1.00	4.80	0.50	1.56	1.74		
	J,L Enterococci (MPN/DL)	8	10	240 H	46	68	75	1	

A=*S,F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C=*S,F&W* criterion violated; S=Metals adjusted for hardness; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
BLBM-1	**Physical**								
	Temperature (°C)	8	19.5	31.5 C	28.3	26.9	4.6	3	
	Turbidity (NTU)	11	5.3	16.5	8.7	9.1	3.0		
	Total Dissolved Solids (mg/L)	8	1720.0	28200.0	10020.0	12960.0	10978.6		
	Total Suspended Solids (mg/L)	8	6.0	12.0	8.5	9.0	2.4		
	Specific Conductance (µmhos/cm)	8	13972.8	42031.8	32686.6	30442.4	11108.8		
	Hardness (mg/L)	2 <	0.2	501.0	250.5	250.5	354.2		
	Alkalinity (mg/L)	8	22.1	97.3	76.8	71.8	26.2		
	Monthly Stream Flow (cfs)	5	-1134.3	169.2	53.1	-154.0	552.6		
	Measured Stream Flow (cfs)	5	-1134.3	169.2	53.1	-154.0	552.6		
	Chemical								
	Dissolved Oxygen (mg/L)	8	1.0 C	7.2	3.4	3.7	2.1	6	
	pH (SU)	8	6.6	7.9	7.6	7.4	0.5		
	J Ammonia Nitrogen (mg/L)	8 <	0.030	0.250	0.135	0.116	0.078		
	J Nitrate+Nitrite Nitrogen (mg/L)	8 <	0.010	0.106	0.022	0.030	0.033		
	Total Kjeldahl Nitrogen (mg/L)	8	0.230	1.800	0.715	0.905	0.540		
	J Dis Reactive Phosphorus (mg/L)	8 <	0.007	0.046	0.034	0.029	0.017		
	Total Phosphorus (mg/L)	8	0.039	0.113	0.072	0.073	0.024		
	J CBOD-5 (mg/L)	8 <	2.0	3.5	2.1	2.0	1.0		
	Chlorides (mg/L)	8	1600.0	16000.0	9650.0	9437.5	4967.0		
	Total Metals								
	J Aluminum (T) (mg/L)	2	0.026	0.798	0.412	0.412	0.546		
	J Iron (T) (mg/L)	2	0.175	0.557	0.366	0.366	0.270		
	Manganese (T) (mg/L)	2	0.066	0.077	0.072	0.072	0.008		
	Dissolved Metals								
	Aluminum (mg/L)	2 <	0.014	0.568	0.288	0.288	0.397		
	J Antimony (µg/L)	2 <	0.345	2.917	0.902	0.902	0.787		
	J Arsenic (µg/L)	2	0.808	5.780 AH	3.294	3.294	3.516	2	
	Cadmium (µg/L)	2 <	0.780	0.839	0.405	0.405	0.021		
	J Chromium (µg/L)	2 <	1.050	1.780 S	1.152	1.152	0.887	1	
	Copper (µg/L)	2	31.000	32.720 S	31.860	31.860	1.216	1	
	Iron (mg/L)	2 <	0.015	0.367	0.187	0.187	0.254		
	Lead (µg/L)	2 <	0.128	3.440	0.892	0.892	1.171		
	J Manganese (mg/L)	2	0.009	0.069	0.039	0.039	0.042		
	J Nickel (µg/L)	2 <	2.270	3.260 S	1.950	1.950	0.452	1	
	Selenium (µg/L)	2	7.180	30.100 A	18.640	18.640	16.207	2	
	J Silver (µg/L)	2 <	0.063	0.905 S	0.258	0.258	0.275	1	
	Thallium (µg/L)	2 <	0.086	1.090	0.294	0.294	0.355		
	Zinc (µg/L)	2 <	6.580	10.600 S	5.940	5.940	0.905	1	
	Biological								
	Chlorophyll a (mg/m³)	8 <	1.00	4.80	0.90	1.68	1.60		
	J,L Enterococci (MPN/DL)	8	10	60	25	26	21		

A=*S,F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C=*S,F&W* criterion violated; S=Metals adjusted for hardness; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
WFRM-2	**Physical**								
	Temperature (°C)	7	15.7	31.4 [C]	28.4	26.3	5.7	2	
	Turbidity (NTU)	13	4.7	33.2	13.4	15.7	7.6		
	Total Dissolved Solids (mg/L)	8	231.0	20200.0	12150.0	10400.5	8061.9		
	Total Suspended Solids (mg/L)	8	10.0	29.0	17.5	18.0	6.3		
	Specific Conductance (µmhos/cm)	7	325.5	29576.3	19754.3	15782.5	12916.5		
	[J] Alkalinity (mg/L)	8	6.6	99.0	49.6	49.4	34.9		
	Chemical								
	Dissolved Oxygen (mg/L)	7	2.4 [C]	7.5	5.0	5.4	1.8	3	
	pH (SU)	7	6.6	7.7	7.3	7.2	0.4		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.030	0.170	0.040	0.049	0.051		
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003	0.170	0.005	0.030	0.058		
	[J] Total Kjeldahl Nitrogen (mg/L)	8	0.550	1.200	0.710	0.802	0.253		
	Dis Reactive Phosphorus (mg/L)	8	< 0.003	0.013	0.004	0.006	0.004		
	Total Phosphorus (mg/L)	8	0.038	0.092	0.052	0.056	0.018		
	[J] CBOD-5 (mg/L)	8	< 2.0	2.8	1.0	1.2	0.6		
	Chlorides (mg/L)	8	91.0	10000.0	7100.0	5573.9	4151.6		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	2.90	1.55	1.56	1.03		
	[J] Enterococci (MPN/DL)	8	10	70	10	27	25		

A=*S,F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C=*S,F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
FRBM-1	**Physical**								
	Temperature (°C)	7	17.8	31.0 [C]	28.5	26.3	5.0	2	
	Turbidity (NTU)	13	2.5	17.6	13.6	11.4	5.2		
	Total Dissolved Solids (mg/L)	8	6720.0	26500.0	18650.0	17503.8	7445.0		
	Total Suspended Solids (mg/L)	8	8.0	28.0	17.5	17.8	6.1		
	Specific Conductance (µmhos/cm)	7	56.3	39035.7	30411.2	24867.7	14224.8		
	Alkalinity (mg/L)	8	44.4	96.4	77.6	71.3	19.2		
	Chemical								
	Dissolved Oxygen (mg/L)	7	6.2	10.2	6.6	7.3	1.5		
	pH (SU)	7	7.8	8.0	8.0	7.9	0.1		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.030	0.015	0.020	0.008		
	Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.006	0.022	0.005	0.007	0.006		
	[J] Total Kjeldahl Nitrogen (mg/L)	8	0.580	1.700	0.855	1.004	0.447		
	[J] Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.046	0.004	0.011	0.015		
	Total Phosphorus (mg/L)	8	0.039	0.072	0.051	0.053	0.012		
	[J] CBOD-5 (mg/L)	8	< 2.0	< 2.0	1.0	1.1	0.4		
	Chlorides (mg/L)	8	3700.0	15000.0	10200.0	9275.0	3773.1		
	Biological								
	Chlorophyll a (mg/m^3)	8	< 1.00	12.00	0.50	2.25	3.98		
	[J,L] Enterococci (MPN/DL)	8	10	10	5	7	3		

A=*S,F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C=*S,F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

		Parameter	N		Min		Max		Med	Avg	SD	E	Q
GDBM-1		**Physical**											
		Temperature (°C)	8		20.6		31.4	C	27.7	27.0	3.9	2	
		Turbidity (NTU)	13		2.1		18.1		5.7	7.0	4.5		
		Total Dissolved Solids (mg/L)	8		8760.0		29200.0		22800.0	20945.0	7584.7		
		Total Suspended Solids (mg/L)	8		7.0		23.0		10.0	12.0	5.4		
		Specific Conductance (µmhos/cm)	8		17779.9		44400.2		33531.2	31482.9	9251.7		
		Alkalinity (mg/L)	8		51.8		99.9		72.4	72.4	17.1		
		Chemical											
		Dissolved Oxygen (mg/L)	8		6.9		7.6		7.1	7.1	0.2		
		pH (SU)	8		7.8		8.2		8.1	8.1	0.2		
	J	Ammonia Nitrogen (mg/L)	8	<	0.028		0.030		0.015	0.017	0.005		
		Nitrate+Nitrite Nitrogen (mg/L)	8	<	0.003		0.010		0.005	0.004	0.001		
		Total Kjeldahl Nitrogen (mg/L)	8		0.500		1.500		0.965	1.015	0.299		
		Dis Reactive Phosphorus (mg/L)	8	<	0.007		0.058		0.004	0.016	0.023		
	J	Total Phosphorus (mg/L)	8		0.034		0.060		0.050	0.048	0.008		
	J	CBOD-5 (mg/L)	8	<	2.0	<	2.0		1.0	1.1	0.4		
		Chlorides (mg/L)	8		5000.0		17000.0		11500.0	11150.0	4050.7		
		Biological											
		Chlorophyll a (mg/m³)	8	<	1.00		3.80		0.50	1.26	1.28		
	J,L	Enterococci (MPN/DL)	8		10		10		5	6	2		

A=SH, *S, F&W* aquatic life use criterion exceeded; H=SH, H, F&W human health criterion exceeded; C=SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
GB-1	**Physical**								
	Temperature (°C)	8	20.2	31.0 [C]	27.6	27.0	3.8	2	
	Turbidity (NTU)	13	0.1	10.3	4.3	4.6	3.0		
	Total Dissolved Solids (mg/L)	8	9900.0	31300.0	22650.0	21587.5	7831.2		
	Total Suspended Solids (mg/L)	8	6.0	14.0	8.5	9.0	3.0		
	Specific Conductance (µmhos/cm)	8	14948.5	45063.6	33696.1	31414.2	10337.0		
	Alkalinity (mg/L)	8	36.6	101.0	72.5	72.8	22.5		
	Chemical								
	Dissolved Oxygen (mg/L)	8	6.2	9.2	7.3	7.4	0.8		
	pH (SU)	8	8.0	8.2	8.1	8.1	0.1		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.030	0.015	0.015	0.000		
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003	0.012	0.005	0.005	0.003		
	Total Kjeldahl Nitrogen (mg/L)	8	0.530	1.400	1.100	0.982	0.317		
	[J] Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.056	0.004	0.016	0.023		
	[J] Total Phosphorus (mg/L)	8	< 0.005	0.059	0.042	0.039	0.017		
	[J] CBOD-5 (mg/L)	8	< 2.0	2.1	1.0	1.1	0.4		
	Chlorides (mg/L)	8	5400.0	18000.0	12000.0	11650.0	4185.3		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	1.90	0.50	0.68	0.50		
	[J,L] Enterococci (MPN/DL)	8	10	10	5	6	2		

A=SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C=SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
PRBM-3	**Physical**								
	Temperature (°C)	8	19.6	31.4 [C]	29.5	27.8	3.8	2	
	Turbidity (NTU)	14	3.0	15.4	7.3	7.6	4.0		
	Total Dissolved Solids (mg/L)	8	9210.0	29800.0	22050.0	19788.8	8288.5		
	Total Suspended Solids (mg/L)	8	8.0	16.0	9.0	10.6	3.2		
	Specific Conductance (µmhos/cm)	8	15471.9	39236.5	32813.6	30693.9	7058.0		
	Alkalinity (mg/L)	8	58.1	101.0	78.4	77.8	17.2		
	Chemical								
	Dissolved Oxygen (mg/L)	8	4.1 [C]	7.5	7.3	6.8	1.2	1	
	pH (SU)	8	7.6	8.2	8.1	8.0	0.2		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.030	0.015	0.017	0.005		
	Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003	0.020	0.005	0.006	0.006		
	Total Kjeldahl Nitrogen (mg/L)	8	0.500	1.700	1.000	1.006	0.414		
	Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.052	0.004	0.015	0.022		
	[J] Total Phosphorus (mg/L)	8	0.031	0.058	0.046	0.046	0.008		
	[J] CBOD-5 (mg/L)	8	< 2.0	< 2.0	1.0	1.0	0.0		
	Chlorides (mg/L)	8	5500.0	15000.0	12000.0	10987.5	3437.4		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	13.50	0.50	3.44	5.48		
	[L] Enterococci (MPN/DL)	8	10	10	5	5	0		

A=SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C=SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
PBRM-2	**Physical**								
	Temperature (°C)	8	19.9	31.1 [C]	27.3	26.8	3.9	2	
	Turbidity (NTU)	13	1.2	14.4	4.1	5.4	4.0		
	Total Dissolved Solids (mg/L)	8	9460.0	28200.0	24150.0	21795.0	7108.4		
	[J] Total Suspended Solids (mg/L)	8	3.0	18.0	10.0	9.6	4.4		
	Specific Conductance (µmhos/cm)	8	16280.2	41513.0	35359.2	32006.5	9137.7		
	Alkalinity (mg/L)	8	57.6	102.0	76.8	76.7	15.4		
	Chemical								
	Dissolved Oxygen (mg/L)	8	5.8	8.4	7.4	7.3	0.7		
	pH (SU)	8	8.0	8.2	8.2	8.1	0.1		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.030	0.015	0.015	0.000		
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003	0.041	0.005	0.009	0.013		
	Total Kjeldahl Nitrogen (mg/L)	8	0.430	1.300	0.965	0.949	0.353		
	Dis Reactive Phosphorus (mg/L)	8	< 0.003	0.054	0.004	0.016	0.024		
	[J] Total Phosphorus (mg/L)	8	0.021	0.062	0.048	0.047	0.013		
	[J] CBOD-5 (mg/L)	8	< 2.0	< 2.0	1.0	1.0	0.0		
	Chlorides (mg/L)	8	5700.0	15000.0	12500.0	11662.5	3425.5		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	< 1.00	0.50	0.56	0.18		
	[J,L] Enterococci (MPN/DL)	8	10	10	5	6	2		

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E Q
HRNM-1	**Physical**							
	Temperature (°C)	8	21.0	31.2 [C]	27.2	26.7	3.8	
	Turbidity (NTU)	8	10.7	67.0	23.1	25.1	18.1	
	Total Dissolved Solids (mg/L)	8	4510.0	21300.0	17550.0	14523.8	6532.7	
	Total Suspended Solids (mg/L)	8	13.0	38.0	21.0	23.5	9.4	
	Specific Conductance (µmhos/cm)	8	7662.5	33070.4	26671.9	22795.6	9567.2	
	Alkalinity (mg/L)	8	38.7	87.0	68.3	66.1	18.7	
	Chemical							
	Dissolved Oxygen (mg/L)	8	5.6	9.8	7.2	7.3	1.4	
	pH (SU)	8	6.7	8.1	7.9	7.7	0.4	
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.090	0.022	0.032	0.026	
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.006	0.108	0.005	0.019	0.036	
	Total Kjeldahl Nitrogen (mg/L)	8	0.450	1.800	0.765	0.852	0.430	
	[J] Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.039	0.016	0.019	0.016	
	Total Phosphorus (mg/L)	8	0.050	0.131	0.062	0.070	0.026	
	[J] CBOD-5 (mg/L)	8	< 2.0	4.6	1.0	1.6	1.3	
	Chlorides (mg/L)	8	2500.0	10000.0	8200.0	7350.0	2994.3	
	Biological							
	Chlorophyll a (mg/m³)	8	< 1.00	5.80	2.80	2.46	1.89	
	[L] Enterococci (MPN/DL)	8	10	10	5	5	0	

A=,*F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C= *F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
HRBM-1	**Physical**								
	Temperature (°C)	7	21.8	32.0 [C]	25.8	26.9	3.9	2	
	Turbidity (NTU)	8	16.4	68.7	27.0	33.9	17.4		
	Total Dissolved Solids (mg/L)	8	4820.0	21900.0	17600.0	15135.0	6915.7		
	Total Suspended Solids (mg/L)	8	20.0	81.0	33.0	39.4	18.9		
	Specific Conductance (µmhos/cm)	7	8191.9	33704.7	24245.4	22679.8	10521.7		
	Alkalinity (mg/L)	8	20.6	89.0	72.4	65.6	23.3		
	Chemical								
	Dissolved Oxygen (mg/L)	7	5.4	9.8	7.1	7.3	1.4		
	pH (SU)	7	6.7	8.0	7.8	7.7	0.4		
	[J] Ammonia Nitrogen (mg/L)	8	< 0.028	0.070	0.030	0.036	0.022		
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.006	0.082	0.016	0.022	0.026		
	[J] Total Kjeldahl Nitrogen (mg/L)	8	0.570	1.700	0.850	0.929	0.360		
	[J] Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.036	0.005	0.012	0.014		
	Total Phosphorus (mg/L)	8	0.047	0.113	0.072	0.074	0.020		
	[J] CBOD-5 (mg/L)	8	< 2.0	3.3	1.0	1.5	0.8		
	Chlorides (mg/L)	8	2800.0	11000.0	8900.0	7837.5	3303.6		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	3.20	1.35	1.39	0.94		
	[L] Enterococci (MPN/DL)	8	10	10	5	5	0		

A= *F&W* aquatic life use criterion exceeded; H= F&W human health criterion exceeded; C= *F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
MSND-1	**Physical**								
	Temperature (°C)	6		16.8	30.9 [C]	27.4	25.6	5.8	2
	Turbidity (NTU)	12		3.8	38.5	14.3	14.6	9.8	
	Total Dissolved Solids (mg/L)	8		7890.0	27900.0	23850.0	20252.5	8197.5	
	Total Suspended Solids (mg/L)	8		10.0	49.0	17.5	21.2	12.8	
	Specific Conductance (µmhos/cm)	6		13225.9	39799.3	36069.0	30450.2	10941.0	
	Alkalinity (mg/L)	8		54.7	103.0	75.4	77.6	19.3	
	Chemical								
	Dissolved Oxygen (mg/L)	6		5.8	8.9	6.7	7.1	1.3	
	pH (SU)	6		7.9	8.1	8.0	8.0	0.1	
	[J] Ammonia Nitrogen (mg/L)	8	<	0.028	0.040	0.015	0.020	0.010	
	[J] Nitrate+Nitrite Nitrogen (mg/L)	8	<	0.006	0.103	0.005	0.020	0.034	
	Total Kjeldahl Nitrogen (mg/L)	8		0.560	1.400	1.200	1.082	0.324	
	Dis Reactive Phosphorus (mg/L)	8	<	0.007	0.058	0.028	0.029	0.026	
	Total Phosphorus (mg/L)	8		0.050	0.095	0.055	0.063	0.017	
	[J] CBOD-5 (mg/L)	8	<	2.0	< 2.0	1.0	1.0	0.0	
	Chlorides (mg/L)	8		4600.0	15000.0	11300.0	10387.5	3985.1	
	Biological								
	Chlorophyll a (mg/m³)	8	<	1.00	1.90	0.50	0.85	0.53	
	[J,L] Enterococci (MPN/DL)	8		10	10	5	6	2	

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
MSND-2	**Physical**								
	Temperature (°C)	8	18.1	30.8 C	27.7	26.3	4.4	2	
	Turbidity (NTU)	12	0.7	7.1	3.5	3.7	2.0		
	Total Dissolved Solids (mg/L)	8	12500.0	30600.0	25950.0	24100.0	6756.6		
	J Total Suspended Solids (mg/L)	8	4.0	12.0	8.5	8.2	2.2		
	Specific Conductance (µmhos/cm)	8	17414.3	44326.7	38798.9	34298.5	10784.8		
	Alkalinity (mg/L)	8	15.0	109.9	90.0	81.9	31.8		
	Chemical								
	Dissolved Oxygen (mg/L)	8	6.4	10.2	7.1	7.7	1.5		
	pH (SU)	8	8.0	8.4	8.2	8.2	0.1		
	J Ammonia Nitrogen (mg/L)	8	< 0.028	0.030	0.015	0.017	0.005		
	Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003	0.021	0.005	0.006	0.006		
	Total Kjeldahl Nitrogen (mg/L)	8	0.440	1.600	1.100	1.075	0.453		
	Dis Reactive Phosphorus (mg/L)	8	< 0.007	0.059	0.004	0.015	0.022		
	Total Phosphorus (mg/L)	8	0.028	0.058	0.048	0.044	0.012		
	J CBOD-5 (mg/L)	8	< 2.0	< 2.0	1.0	1.0	0.0		
	Chlorides (mg/L)	8	6700.0	17000.0	13500.0	12925.0	3655.4		
	Biological								
	Chlorophyll a (mg/m³)	8	< 1.00	1.20	0.50	0.68	0.32		
	L Enterococci (MPN/DL)	8	10	420 H	5	57	147	1	

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min	Max	Med	Avg	SD	E	Q
MB-1A	**Physical**								
	Temperature (°C)	7	15.6	30.9 [C]	26.7	25.0	5.5	2	
	Turbidity (NTU)	12	5.5	75.7	10.7	20.5	21.6		
	Total Dissolved Solids (mg/L)	8	4880.0	28600.0	21650.0	19265.0	8843.4		
	Total Suspended Solids (mg/L)	8	7.0	25.0	14.0	15.0	5.9		
	Specific Conductance (µmhos/cm)	7	8930.3	41226.9	38373.2	29936.8	13613.1		
	Hardness (mg/L)	1	<			0.2			
	Alkalinity (mg/L)	8	36.9	96.7	85.8	76.1	21.7		
	Chemical								
	Dissolved Oxygen (mg/L)	7	5.0	9.1	6.3	6.7	1.6		
	pH (SU)	7	7.8	8.1	7.9	8.0	0.1		
	[J] Ammonia Nitrogen (mg/L)	8	<	0.028	0.030	0.015	0.017	0.005	
	Nitrate+Nitrite Nitrogen (mg/L)	8	<	0.003	0.159	0.005	0.037	0.063	
	[J] Total Kjeldahl Nitrogen (mg/L)	8		0.200	1.600	0.985	0.960	0.510	
	Dis Reactive Phosphorus (mg/L)	8	<	0.007	0.056	0.030	0.030	0.022	
	Total Phosphorus (mg/L)	8		0.035	0.073	0.060	0.057	0.015	
	[J] CBOD-5 (mg/L)	8	<	2.0	3.6	1.0	1.3	0.9	
	Chlorides (mg/L)	8		2600.0	14000.0	12000.0	10300.0	4501.4	
	Total Metals								
	Aluminum (T) (mg/L)	1				0.135			
	Iron (T) (mg/L)	1				0.256			
	Manganese (T) (mg/L)	1				0.028			
	Dissolved Metals								
	Aluminum (mg/L)	1			<	0.014			
	[J] Antimony (µg/L)	1				0.291			
	Arsenic (µg/L)	1				8.310 [H]		1	
	Cadmium (µg/L)	1			<	0.780			
	[J] Chromium (µg/L)	1				2.140 [S]		1	
	Copper (µg/L)	1				31.900 [S]		1	
	Iron (mg/L)	1			<	0.015			
	Lead (µg/L)	1			<	0.128			
	Manganese (mg/L)	1			<	0.006			
	[J] Nickel (µg/L)	1				2.660 [S]		1	
	Selenium (µg/L)	1				48.100 [A]		1	
	Silver (µg/L)	1			<	0.013			
	Thallium (µg/L)	1			<	0.086			
	Zinc (µg/L)	1			<	1.909			
	Biological								
	Chlorophyll a (mg/m³)	8	<	1.00	3.50	0.95	1.40	1.12	
	[L] Fecal Coliform (MPN/DL)	2		1.0	1.0	0.5	0.5	0.0	
	[J,L] Enterococci (MPN/DL)	8		10	10	5	6	2	

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; S= Metals adjusted for hardness; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min		Max		Med	Avg	SD	E	Q
GOM-1	**Physical**										
	Temperature (°C)	8	18.6		31.0	C	27.8	26.3	4.3	1	
	Turbidity (NTU)	12	1.0		4.3		2.3	2.6	1.2		
	Total Dissolved Solids (mg/L)	8	1970.0		34600.0		28500.0	24658.8	10550.8		
	Total Suspended Solids (mg/L)	8	5.0		9.0		7.5	7.1	1.6		
	Specific Conductance (µmhos/cm)	8	28160.9		48865.6		40336.2	38384.7	8835.9		
	Alkalinity (mg/L)	8	36.2		114.0		96.0	82.8	30.4		
	Chemical										
	Dissolved Oxygen (mg/L)	8	6.0		9.0		7.3	7.3	1.1		
	pH (SU)	8	8.1		8.2		8.1	8.1	0.0		
	J Ammonia Nitrogen (mg/L)	8	< 0.028		0.030		0.015	0.015	0.000		
	Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003		0.020		0.005	0.006	0.006		
	J Total Kjeldahl Nitrogen (mg/L)	8	0.130		1.800		1.250	1.090	0.590		
	J Dis Reactive Phosphorus (mg/L)	8	< 0.007		0.044		0.004	0.008	0.014		
	J Total Phosphorus (mg/L)	8	< 0.005		0.069		0.042	0.042	0.021		
	J CBOD-5 (mg/L)	8	< 2.0	<	2.0		1.0	1.0	0.0		
	Chlorides (mg/L)	8	680.0		18000.0		15000.0	12960.0	5778.9		
	Biological										
	Chlorophyll a (mg/m³)	8	< 1.00	<	1.00		0.50	0.50	0.00		
	L Enterococci (MPN/DL)	8	10		460	H	5	62	161	1	

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.

	Parameter	N	Min		Max		Med	Avg	SD	E	Q
GOM-2	**Physical**										
	Temperature (°C)	8	18.7		31.0	C	28.1	26.4	4.5	2	
	Turbidity (NTU)	12	0.0		2.6		0.9	1.0	0.7		
	Total Dissolved Solids (mg/L)	8	3220.0		34700.0		32400.0	27552.5	10601.7		
	J Total Suspended Solids (mg/L)	8	3.0		9.0		6.0	5.8	2.0		
	Specific Conductance (µmhos/cm)	8	28722.2		49534.4		45332.2	42863.2	6543.3		
	Alkalinity (mg/L)	8	38.2		115.0		97.6	93.2	26.0		
	Chemical										
	Dissolved Oxygen (mg/L)	8	5.9		8.2		6.9	7.0	0.8		
	pH (SU)	8	8.1		8.2		8.1	8.1	0.0		
	J Ammonia Nitrogen (mg/L)	8	< 0.028		0.030		0.015	0.017	0.005		
	Nitrate+Nitrite Nitrogen (mg/L)	8	< 0.003		0.032		0.005	0.008	0.010		
	Total Kjeldahl Nitrogen (mg/L)	8	< 0.057		1.900		1.245	1.103	0.748		
	Dis Reactive Phosphorus (mg/L)	8	< 0.003		0.007		0.004	0.003	0.001		
	Total Phosphorus (mg/L)	8	< 0.005		0.092		0.060	0.054	0.035		
	J CBOD-5 (mg/L)	8	< 2.0	<	2.0		1.0	1.0	0.0		
	Chlorides (mg/L)	8	13000.0		20000.0		17500.0	17000.0	2267.8		
	Biological										
	Chlorophyll a (mg/m³)	8	< 1.00	<	1.00		0.50	0.50	0.00		
	J,L Enterococci (MPN/DL)	8	10		250	H	5	36	86	1	

A= SH, *S, F&W* aquatic life use criterion exceeded; H= SH, S, F&W human health criterion exceeded; C= SH, *S, F&W* criterion violated; E=# samples that exceeded criteria; J= estimate; L= estimate; N=# samples; Q=number of samples that have uncertain exceedances.