DOI: 10.25923/d1j6-e075

NATIONAL STATUS AND TRENDS, MUSSEL WATCH PROGRAM
A 2017 Assessment of Contaminants of Emerging Concern in the Gulf of Mexico

November 2023

NOAA TECHNICAL MEMORANDUM NOS NCCOS 323

NOAA NCCOS Monitoring and Assessment Branch

Citation
Swam, L.M., M.M. Rider, D.A. Apeti, and E. Pisarski. 2023. A 2017 Assessment of Contaminants of Emerging Concern in the Gulf of Mexico. NOAA Technical Memorandum NOS NCCOS 323. Silver Spring, MD. 70 pp. DOI 10.25923/d1j6-e075.

Acknowledgements
The National Mussel Watch Program wishes to acknowledge TDI Brooks International for their assistance with field work and sample collection of the data included in this report. We would also like to thank laboratory researchers in the NCCOS Ecotoxicology Laboratory in Charleston, SC, for their analytic contributions to this project, specifically Dr. Edward Wirth. Finally, we would like to thank all of the reviewers and collaborators for their invaluable assistance. This report could not have been completed without the cooperation, time and effort contributed by many, whose collective input has resulted in a document far superior to that which we envisioned on our own.

Reviewers:
1. Dr. Michael Edwards
2. Dr. Kimani Kimbrough
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A 2017 Assessment of Contaminants of Emerging Concern in the Gulf of Mexico

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NOAA Technical Memorandum NOS NCCOS 323

United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
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EXECUTIVE SUMMARY

In 2017, the National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Program (MWP) conducted an assessment of the presence, distribution, and concentrations of contaminants of emerging concern (CECs) in Eastern Oysters (*Crassostrea virginica*) from the Gulf of Mexico's coastal waters. The MWP utilizes a sentinel-based monitoring approach by collecting and analyzing bivalves as surrogates for coastal water pollution. Mussels and oysters are sessile organisms that filter and accumulate particles from water; therefore, measuring contaminant levels in their tissue is a good indicator of local chemical contamination. The oyster samples collected as part of the 2017 assessment were analyzed for alkylphenol compounds (APs), alternative flame retardants (AFRs), polybrominated flame retardants (BFRs) such as polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs), current-use pesticides (CUPs), per- and polyfluoroalkyl substances (PFAS), and pharmaceutical and personal care products (PPCPs). Oyster tissue samples from 44 monitoring sites across the Gulf Coasts of Florida, Alabama, Mississippi, Louisiana, and Texas were analyzed in this study for a total of 13 - 244 individual CEC compounds, depending on the site location.

The results indicated that CECs are present at varying magnitudes of concentration in coastal bivalves and sediments in the Gulf of Mexico. Contaminants were detected in oyster tissue at 37/44 sites assessed in this region, highlighting the ubiquity of these contaminants. However, it was observed that out of the contaminants analyzed, only a limited subset of contaminants represented the majority of detections within each chemical class. The accumulation of CECs in bivalves (and sediment) are often contaminant and location-dependent. Thus, the presence and concentration of a specific contaminant are heavily influenced by its chemistry, sources, fate, and transport.

Broadly, the MWP provides unique data vital to evaluating the health of the Nations' coasts through temporal and spatial evaluation of chemical contamination. Studies such as this not only provide needed data and information for the MWP, but also address CEC data gaps that are relevant to coastal managers as they develop long-term policies to protect ecosystem services provided by the coastal environment within the Gulf of Mexico.

KEY FINDINGS

1. Alkylphenols in the Gulf of Mexico in 2017:
    - 1 out of 4 analyzed AP compounds (NP1EO) was detected in oyster tissue at 1 out of 39 sites analyzed.

2. Alternative Flame Retardants (AFRs) in the Gulf of Mexico in 2017:
    - 1 out of 9 analyzed AFR compounds (TBB) was detected in oyster tissue at 1 out of 42 sites analyzed.

3. Brominated Flame Retardants (BFRs) in the Gulf of Mexico in 2017:
    - No PBB compounds were detected in oyster tissue at any site analyzed.
    - 10 out of 51 analyzed PBDE compounds were detected in oyster tissue at 17 out of 41 sites analyzed.

4. Current Use Pesticides (CUPs) in the Gulf of Mexico in 2017:
    - 3 out of 29 analyzed CUP compounds (cypermethrin, permethrin, quintozene) were detected in oyster tissue at 3 out of 40 sites analyzed.

5. Per- and polyfluoroalkyl Substances (PFAS) in the Gulf of Mexico in 2017:
    - 3 out of 13 analyzed PFAS compounds (PFHxA, PFOSA, PFOS) were detected in oyster tissue at 24 out of 44 sites analyzed.

6. Pharmaceutical and Personal Care Products (PPCPs) in the Gulf of Mexico in 2017:
    - 25 out of 118 analyzed PPCP compounds were detected in oyster tissue at 30 out of 39 sites analyzed.

7. Seven out of 44 oyster tissue sites had no detects of any CEC (ABOB, CBCR, CBSR, CCDC, CCNB, CLCL, LMSB). These sites are generally located in more rural areas of the Gulf Coast, near South Padre Island, TX, Matagorda Bay, TX, and Terrebonne, LA, locations with comparatively less human development than other sites assessed in this study.

8. One out of 44 oyster tissue sites (TBHB) was categorized as having "very high" contamination relative to all sites analyzed in this study and is located near Tampa Bay, FL. Other sites with “high” contamination were generally located in more densely populated and developed areas such as Lake Charles, LA, Pensacola, FL, Panama City, FL, and Tampa Bay, FL.

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COMMONLY USED ACRONYMS

AFR	Alternative flame retardant
AL	Alabama
AP	Alkylphenol compound
BFR	Polybrominated flame retardant
CUP	Current-use pesticide
dw	dry weight
FL	Florida
g	gram
GoM	Gulf of Mexico
HBCD	Hexabromocyclododecanes
LA	Louisiana
MDL	Method detection limit
MS	Mississippi
MWP	Mussel Watch Program
ng	nanogram
NCCOS	National Centers for Coastal Ocean Science
NOAA	National Oceanic and Atmospheric Administration
NS&T	National Status & Trends
PBB	Polybrominated biphenyl
PBDE	Polybrominated diphenyl ether
PFAS	Per- and polyfluoroalkyl substances
PPCP	Pharmaceutical and personal care product
TX	Texas
U.S.	United States
ww	wet weight

Introduction

1.0 HISTORY OF MUSSEL WATCH PROGRAM

The National Mussel Watch Program (MWP), which began in 1986, was designed by the National Oceanic and Atmospheric Administration (NOAA) to monitor the nation's coastal waters for chemical contaminants and biological indicators of water quality. The MWP was established in response to a legislative mandate under Section 202 of Title II of the Marine Protection, Research and Sanctuaries Act (MPRSA) (33 USC 1442), which called on the Secretary of Commerce to initiate a continuous monitoring program, among other activities. The MWP design is based on the periodic collection and analysis of bivalves (oysters and mussels) and sediment from a network of monitoring sites located throughout the nation's coastal zones. To date, NOAA's MWP is one of the longest-running, continuous coastal monitoring programs.

The MWP monitoring sites are found along all of the U.S. coastlines including Alaska, the Great Lakes, Hawaii, and in territories such as Puerto Rico. Different target bivalves are used as sentinel species. Mussels and oysters are sessile organisms that filter and accumulate particles from water and their body burden reflects ambient concentrations; therefore, measuring contaminant levels in their tissue is a good indicator of local chemical contamination (Farrington, 1983). Mussels (*Mytilus* species) are collected from the North Atlantic and Pacific coasts, oysters (*Crassostrea virginica*) are collected from the mid-Atlantic (Delaware Bay) southward and along the Gulf Coast, the invasive zebra and quagga mussels (*Dreissena* species) are collected from the Great Lakes, mangrove oysters (*Crassostrea rhizophorae*) are collected from Puerto Rico, and Hawaiian oysters (*Dendostrea sandvicensis*) are collected from Hawaii.

A fundamental challenge faced by any long-term environmental monitoring program is how to evolve in response to changing conditions and drivers. In 2013, due to budgetary constraints, the National Centers for Coastal Ocean Science (NCCOS) undertook the task of re-designing the MWP, moving from a nationwide annual monitoring approach to the rotating regional monitoring model that is currently employed. The regional approach allows the program to improve its presence in coastal communities by increasing interaction with local stakeholders, integrating inputs from coastal resource managers, and providing specific data needs to help fill local data gaps. By making adaptive changes and leveraging regional partnerships, the program has increased its scientific relevance and reputation and has evolved to include more than 300 monitoring sites (Figure 1) and nearly 600 chemical contaminants including metals, legacy organic compounds, and contaminants of emerging concern (CECs).

The MWP provides unique data that is vital to evaluating the health of the nation's estuarine and coastal waters and bivalves, particularly describing the levels of chemical contamination. The MWP dataset allows for temporal and spatial evaluation of regional and national changes in chemical distribution, including CECs as their potential risks are identified. The programs' long-term data supports the assessment of impacts of unforeseen events such as oil spills and hurricanes, the evaluation of sanctuary statuses, the analysis of resource and ecosystem service trends, and the evaluation of the effectiveness of regulations that ban toxic chemicals or support legislation such as the Clean Air and Clean Water Acts.

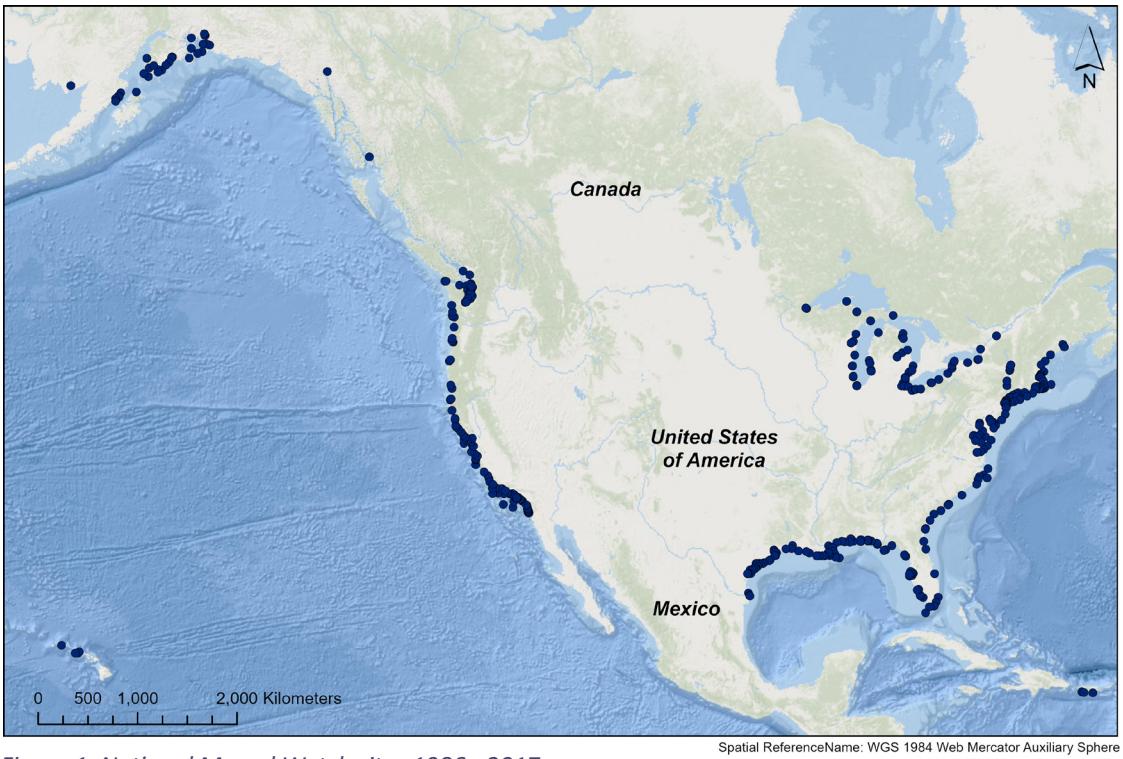


Figure 1. National Mussel Watch sites 1986 - 2017.

Introduction

2.0 INTRODUCTION

The MWP has long-term monitoring sites spanning the Gulf of Mexico (GoM) coast; a subset of these were analyzed in this study (Figure 2). The Gulf of Mexico is an expansive waterbody that receives waters from more than 150 rivers, including the Mississippi, Ohio, and Missouri Rivers, and runoff from 31 of the 50 states (Kim et al., 1999; Mitsch et al., 2001). The presence of many barrier islands and peninsulas, including the 130-mile (210 km) Padre Island along the Texas coast, and the many inlets, bays, and lagoons throughout the region cause this coastline to be very complex. These landforms and expansive marshland protect the numerous bays and inlets by acting as a barrier to oncoming waves, but they also serve to entrain sediments from upland areas. The large estuarine wetland systems along the northern coast of the Gulf of Mexico are the result of continuous transport and deposition of riverine and marine sediments in an area with a low to moderate wave energy and low tidal range (generally less than 1.0 m) (Ellis and Smith, 2021; Mata et al., 2011). The Gulf Coast climate is considered a humid subtropical habitat, and as such, the region is vulnerable to extreme weather events including hurricanes and severe thunderstorms (Mitsch et al., 2001). The physiography, climate, and hydrology in the Gulf of Mexico provide natural conditions that support a rich and abundant diversity of plant and animal communities in the basin. The Gulf of Mexico region is highly productive both ecologically and economically. The marshlands along the Louisiana and Texas coasts provide breeding grounds and nurseries for marine life that drive the fishing and shrimping industries. Many estuaries along the coast also contain oyster reefs, seagrass beds, and salt marshes. Oysters, shrimp, blue crab, and finfish are the most harvested species with a value of over $134 million in economic impact annually. Apalachicola Bay alone provides approximately 90% of Florida's oyster harvest and 10% of the total U.S. harvest of those species (FDEP, 2013). The regional economy is also dominated by energy, petrochemical, and tourism industries. The discovery of oil and gas deposits along the coast and offshore, combined with easy access to shipping, have made the Gulf of Mexico the heart of the United States (U.S.) petrochemical industry. This region also features other essential industries including aerospace and biomedical research sectors, as well as established agricultural industries. The water quality that sustains this high productivity has been affected by a combination of natural and mainly anthropogenic factors such as growing urbanization, industries, and agriculture (Kim et al., 1999; LaMourie et al., 2023; Sunkara et al., 2023). Chemical contaminants in the GoM may be caused by nonpoint sources such as river input and long-range atmospheric depositions (Vazquez-Botello et al., 2004). Significant point sources of toxic hydrocarbon related contaminats in the Gulf region are seepage from its abundant oil reserves and oil spills such as Deepwater Horizon in 2010 (Apeti et al., 2013).

Coastal chemical pollution along the Gulf of Mexico coast of the U.S. has been assessed and monitored by the National Oceanic and Atmospheric Administration (NOAA), National Status and Trends Program (NS&T) for resource and ecosystem management and production since 1986 (Kimbrough et al., 2008). Statewide water quality monitoring efforts conducted by the Texas Parks and Wildlife Department, the Louisiana Department of Wildlife and Fisheries, the Mississippi Department of Marine Resources, the Alabama Department of Marine Resources, and the Florida Department of Environmental Protection, among others, also happen frequently in the region However, the NS&T Program is one of the few, if only, continuous monitoring programs for chemical contaminants in the region. The NS&T Mussel Watch Program (MWP) has provided relevant data and information to coastal managers and the scientific community, but has historically focused on legacy contaminants. These legacy contaminants include trace elements (i.e., heavy metals), polycyclic aromatic hydrocarbons (PAHs), and persistent organic pollutants such as butyltins (BTs), dieldrins, chlordanes, hexachlorocyclohexanes (HCHs), dichlorodiphenyltrichloroethane (DDT), chlorobenzenes, endosulfans, chlorpyrifos, and polychlorinated biphenyls (PCBs).

As management and policy decisions have helped decrease the prevalence and impact of many legacy contaminants (e.g. DDTs and Mirex), monitoring agencies have begun to focus on the assessment and potential impacts of new and less regulated contaminants, known as contaminants of emerging concerns (CECs), many of which are manufactured to replace other banned chemicals. The scope and impact of these CECs are largely unknown and potentially vast (Diamond et al., 2011), which makes prioritizing the list of CECs to monitor challenging. Based on the Environmental Protection Agency (EPA) recommendations as described in Ankley et al. (2008), classes of CECs to consider for monitoring should include 1) persistent organic pollutants such as flame retardants, current-use pesticides, and industrial byproducts; 2) pharmaceutical and personal care products such as prescription, illegal, over-the-counter drugs, sunscreens, and synthetic musks; 3) veterinary medicines such as antimicrobials, antibiotics, antifungals, and growth hormones for animals; 4) endocrine-disrupting chemicals and other compounds capable of modulating normal hormone functions and steroidal synthesis; and 5) nanoparticles such as carbon nanotubes or nano-scale particulates, of which little is known about either their environmental fate or effects. Additionally, diverse classes of CECs were evaluated in a variety of matrices (sediment, water, fish, and bivalves) during the Southern California Bight project in 2009-2010, and the resulting studies provided insight into the detection and concentrations of CECs in different environmental media (Dodder et al.,

2014; Maruya et al., 2016). Based on these data inputs and considerations, the MWP CEC list includes contaminants for which methods are established and for which literature indicates their potential environmental persistence and ecological and human toxicity.

In 2017, the MWP conducted a comprehensive assessment of CECs in the Gulf of Mexico. The study was designed within the MWP regional monitoring approach framework, which balances flexibility in study design with the cost of broad CEC surveys. The objectives of this study were to 1) assess the presence and distribution of alkylphenol compounds, flame retardants, current-use pesticides, pharmaceutical and personal care products, and per- and polyfluoroalkyl substances associated with human activity that may bioaccumulate in the Gulf of Mexico; 2) compare contamination in the Gulf of Mexico in 2017 to previous studies in other regions; and 3) make the data electronically available to coastal resource managers and other stakeholders in the Gulf of Mexico region.

3.0 METHODS

3.1 Study Area and Sampling Design

The MWP has 85 long-term monitoring sites in coastal waters in the Gulf of Mexico. Monitoring sites were historically selected in locations with abundant bivalve populations to allow for repetitive sampling and to convey information about the degree of chemical contamination in the general area over time. The sites were not randomly selected nor designed to target specific pollution sources.

Sample collection at these sites was contracted to and conducted by TDI Brooks International following standard protocols utilized by the MWP (Apeti et al., 2012) in primarily September - November 2017. In 2017, oyster samples (*Crassostrea virginica*) were collected via hand picking, oyster tongs, or oyster dredging from 44 sites. Although 61 sites were identified for collection throughout the Gulf of Mexico, only 44 sites yielded sufficient oysters for analysis (Figure 2). Out of the 61 identified sites, APEB (Apalachicola Bay, East Bay) was the only site not attempted for sampling in 2017 based on the recent and realized absence of oysters throughout the area (Table 2).

In this study, several classes of CECs were analyzed in oyster tissue. Analyses of alkylphenol compounds (4 compounds) and pharmaceutical and personal care products (118 compounds) were conducted for 39 sites, analyses of current-use pesticides (30 compounds) were conducted for 40 sites, analyses for brominated flame retardants (70) were conducted for 41 sites, analyses for alternative flame retardants (3) were conducted for 42 sites, and per- and polyfluoroalkyl substances (13) were conducted for 44 sites (Table 1). The varying site counts for analyses are due to limited quantity of oyster tissue available for laboratory analysis.

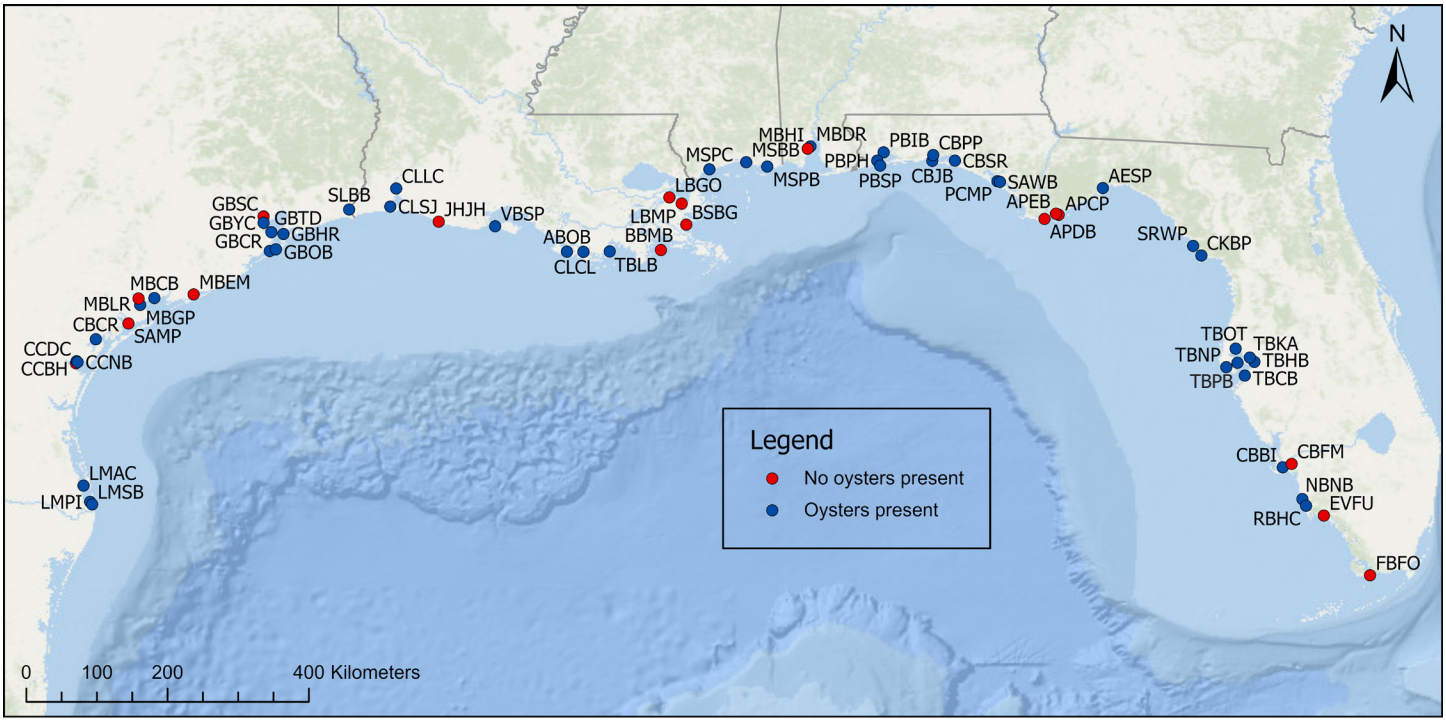


Figure 2. Map of MWP sites in the Gulf of Mexico region sampled in 2017 and their respective collection status.

3.2 Analytical Methods

Analyses for this study were conducted by three laboratories (Table 1). Detailed descriptions of analytical methods for CECs analyzed in this study by TDI Brooks (PBDEs and PBBs) can be found in Kimbrough et al. (2007). Detailed descriptions of analytical methods for CECs analyzed in this study by AXYS (AFRs, CUPs, and PFAS) are proprietary and confidential, so the specific method name used in the analysis is mentioned in the "Chemical Description" section of each contaminant class along with the lab contact information here (SGS AXYS Analytical Services LTD., 2045 Mills Road W., Sidney, BC, Canada, V8L 5X2. Tel. (250) 655-5800, Fax (250) 655-5811) for further reference. Detailed descriptions of analytical methods for CECs analyzed in this study by NCCOS Ecotoxicology Laboratory in Charleston (APs and PPCPs) can be found in Petrovic et al. (2002), Loyo-Rosales et al. (2003), and Apeti et al. (2018). For all contaminant classes, a background summary ("Chemical Description") and analysis summary ("Results Summary") can be found within this document.

3.3 Data Analysis

Data management and analysis were conducted using a combination of R version 4.1.2 (R Core Team, 2013), Microsoft Excel (Microsoft Corporation, 2018), ArcGIS (ESRI, 2011), and JMP12 Software (JMP, 2022).

AXYS reports data in wet weight (ng/g ww), whereas TDI Brooks and the NCCOS Ecotoxicology Laboratory (Ecotox Lab) in Charleston, SC report data in dry weight (ng/g dw). All contaminant concentrations were converted to wet weight (ng/g ww) using percent moisture content measured by TDI Brooks for consistency throughout this document (Table A1).

Concentrations of all CEC classes were blank corrected (blank concentration subtracted from the contaminant concentration), and then any resulting values below the method detection limit (MDL) were categorized as undetected and were assigned a value of 0. The MDLs for data from TDI and Ecotox were also converted to wet weight units. The MDL is defined as the lowest concentration able to be detected by the analytical instrument or method.

Overall site contamination analysis was done using a multivariate cluster analysis (the Ward Method) for oyster tissue. Sums of contaminant concentrations within each of the 14 contaminant classes were calculated and a clustering analysis was conducted on each class. This analysis clusters contaminant concentrations into significantly different groups such that values contained within a group are more like each other than any other value of a different group. The categories derived from the clusters were not representative measurements that exceeded any regulatory thresholds; rather, they denoted concentrations that were significantly higher than the preceding category. For each contaminant class, sites were clustered into three groups to represent high contamination (value=3), medium contamination (value=2), and low contamination (value=1). Then absent (or non-detected) contamination was adjusted post-analysis (value=0). Once each site had a cluster value for each contaminant class, the total summary of clusters of all classes was calculated for each site. Since not all classes were analyzed at every site, the final sum at each site was normalized by the maximum value possible at that site (i.e., (sum cluster values)/(# chemical classes analyzed *3)×100). These normalized values were again clustered using the Ward Method to generate five groups of sites with statistically different degrees of overall contamination within this study (absent (not detected), low, medium, high, and very high) and were presented in a map.

Table 1. Laboratories at which analyses were conducted on oyster tissue for the 2017 Gulf of Mexico survey.

Chemical Class	Number of Sites	Laboratory
AP	39	Ecotox Lab
AFR	42	AXYS
BFR (PBB, PBDE)	41	TDI
CUP	40	AXYS
PFAS	44	AXYS
PPCP	39	Ecotox Lab

Methods

Table 2. Mussel Watch sites selected for 2017 Gulf of Mexico survey. ● signifies the site was analyzed for CECs in 2017. An attempt was made to sample 61 sites in this survey, but only 44 sites yielded oysters to be analyzed. FL - Florida, AL - Alabama, MS - Mississippi, LA - Louisiana, TX - Texas.

Site	State	General Location	Specific Location	Latitude	Longitude	Tissue Sampled?
ABOB	LA	Atchafalaya Bay	Oyster Bayou	29.25550	-91.13617	●
AESP	FL	Apalachee Bay	Spring Creek	30.06333	-84.32200	●
APCP	FL	Apalachicola Bay	Cat Point Bar	29.72417	-84.88417	
APDB	FL	Apalachicola Bay	Dry Bar	29.67250	-85.06567	
APEB	FL	Apalachicola Bay	East Bay	29.73830	-84.91850	
BBMB	LA	Barataria Bay	Middle Bank	29.27667	-89.94200	
BSBG	LA	Breton Sound	Bay Gardene	29.59800	-89.62083	
CBBI	FL	Charlotte Harbor	Bird Island	26.51433	-82.03450	●
CBCR	TX	Copano Bay	Copano Reef	28.14200	-97.12800	●
CBFM	FL	Charlotte Harbor	Fort Meyers	26.55833	-81.92283	
CBJB	FL	Choctawhatchee Bay	Joe's Bayou	30.41083	-86.49083	●
CBPP	FL	Choctawhatchee Bay	Postil Point	30.48233	-86.47933	●
CBSR	FL	Choctawhatchee Bay	Off Santa Rosa	30.41200	-86.20367	●
CCBH	TX	Corpus Christi	Boat Harbor	27.83617	-97.38017	
CCDC	TX	Corpus Christi	Doyle City	27.86183	-97.37262	●
CCNB	TX	Corpus Christi	Nueces Bay	27.85217	-97.35983	●
CKBP	FL	Cedar Key	Black Point	29.20667	-83.06950	●
CLCL	LA	Caillou Lake	Caillou Lake	29.25317	-90.92667	●
CLLC	LA	Calcasieu Lake	Lake Charles	30.05867	-93.30750	●
CLSJ	LA	Calcasieu Lake	St. Johns Island	29.82900	-93.38400	●
EVFU	FL	Everglades	Faka Union Bay	25.90233	-81.51233	
FBFO	FL	Florida Bay	Flamingo	25.14117	-80.92367	
GBCR	TX	Galveston Bay	Confederate Reef	29.26333	-94.91633	●
GBHR	TX	Galveston Bay	Hanna Reef	29.48033	-94.74183	●
GBOB	TX	Galveston Bay	Offatts Bayou	29.28400	-94.83633	●
GBSC	TX	Galveston Bay	Ship Channel	29.70450	-94.99300	
GBTD	TX	Galveston Bay	Todd's Dump	29.50300	-94.89600	●
GBYC	TX	Galveston Bay	Yacht Club	29.62200	-94.99583	●
JHJH	LA	Joseph Harbor Bayou	Joseph Harbor Bayou	29.63683	-92.76683	
LBGO	LA	Lake Borgne	Gulf Outlet	29.94483	-89.83533	
LBMP	LA	Lake Borgne	Malheureux Point	29.86700	-89.67850	

Table 2 cont. Mussel Watch sites selected for 2017 Gulf of Mexico survey. ● signifies the site was analyzed for CECs in 2017. An attempt was made to sample 61 sites in this survey, but only 44 sites yielded oysters to be analyzed. FL - Florida, AL - Alabama, MS - Mississippi, LA - Louisiana, TX - Texas.

Site	State	General Location	Specific Location	Latitude	Longitude	Tissue Sampled?
LMAC	TX	Lower Laguna Madre	Arroyo Colorado	26.28250	-97.28533	●
LMPI	TX	Lower Laguna Madre	Port Isabel	26.07483	-97.19950	●
LMSB	TX	Lower Laguna Madre	South Bay	26.04317	-97.17600	●
MBCB	TX	Matagorda Bay	Carancahua Bay	28.66500	-96.38300	●
MBDR	AL	Mobile Bay	Dog River	30.59167	-88.03983	●
MBEM	TX	Matagorda Bay	East Matagorda	28.71117	-95.88333	
MBGP	TX	Matagorda Bay	Gallinipper Point	28.57883	-96.56300	●
MBHI	AL	Mobile Bay	Hollingers Is. Chan.	30.56333	-88.07500	
MBLR	TX	Matagorda Bay	Lavaca River Mouth	28.66033	-96.58450	
MSBB	MS	Mississippi Sound	Biloxi Bay	30.39250	-88.85750	●
MSPB	MS	Mississippi Sound	Pascagoula Bay	30.33600	-88.58917	●
MSPC	MS	Mississippi Sound	Pass Christian	30.30233	-89.32717	●
NBNB	FL	Naples Bay	Naples Bay	26.11183	-81.78517	●
PBIB	FL	Pensacola Bay	Indian Bayou	30.51667	-87.11167	●
PBPH	FL	Pensacola Bay	Public Harbor	30.41367	-87.19133	●
PBSP	FL	Pensacola Bay	Sabine Point	30.34983	-87.15467	●
PCMP	FL	Panama City	Municipal Pier	30.15117	-85.66300	●
RBHC	FL	Rookery Bay	Henderson Creek	26.02700	-81.73883	●
SAMP	TX	San Antonio Bay	Mosquito Point	28.34400	-96.71233	
SAWB	FL	St. Andrew Bay	Watson Bayou	30.14250	-85.63217	●
SLBB	LA	Sabine Lake	Blue Buck Point	29.79083	-93.90633	●
SRWP	FL	Suwannee River	West Pass	29.32917	-83.17417	●
TBCB	FL	Tampa Bay	Cockroach Bay	27.68100	-82.51767	●
TBHB	FL	Tampa Bay	Hillsborough Bay	27.85483	-82.39467	●
TBKA	FL	Tampa Bay	Peter O. Knight Airport	27.90967	-82.45383	●
TBLB	LA	Terrebonne Bay	Lake Barre	29.25950	-90.59433	●
TBNP	FL	Tampa Bay	Navarez Park	27.78717	-82.75400	●
TBOT	FL	Tampa Bay	Old Tampa Bay	28.02367	-82.63283	●
TBPB	FL	Tampa Bay	Papys Bayou	27.84433	-82.61150	●
VBSP	LA	Vermilion Bay	Southwest Pass	29.57950	-92.05100	●

4.0 RESULTS - ALKYL PHENOL COMPOUNDS

4.1 APs Chemical Description

Alkylphenols (APs) are a class of chemicals used in detergents and surfactants in industrial processes (Ying et al. 2002). Some household detergents (i.e., laundry soaps) also include APs. The most common sources of APs in aquatic systems are wastewater and septic system discharges (Ying et al., 2002). These compounds are persistent in the environment, have a strong affinity for suspended particles, and are well preserved in bottom sediments (Ying et al., 2002). In the environment, alkylphenol ethoxylate surfactants biodegrade into more environmentally stable metabolites, such as the alkylphenol n-ethoxylates, alkylphenoxy acetic, alkylphenoxy polyethoxy acetic acids, and alkylphenols (EPA, 2014a). This study focused on four AP metabolites in oyster tissues (Table 3). The compounds 4-nonylphenol (4-NP) and 4-n-octylphenol (4n-OP) are degradation products of 4-nonylphenol mono-ethoxylate (NP1E0) and 4-nonylphenol di-ethoxylate (NP2E0), which are byproducts of the parent alkylphenol polyethoxylate. These degradation products are reportedly more toxic than the parent compounds and act as hormone mimics (Ying et al., 2002). APs are shown to have estrogenic endocrine-disrupting effects on vertebrate organisms, and they have been linked to severe decreases in lobster larval survival and juvenile lobster hormonal changes (Laufer et al., 2013). In this study, the MWP measured two NPEO and two NP compounds (Table 3) for which analytical methods are well established. These four compounds were included in the EPA New Use Rules list of 15 toxic AP compounds (EPA, 2014a).

AP analyses were conducted by the NCCOS Ecotoxicology Laboratory in Charleston, SC.

Table 3. AP compounds tested (4).

Chemical Code	Chemical Name	Application
4-NP	4-nonylphenol	Manufacture AP ethoxylates (detergents, cleaners)
4n-OP	4-n-octylphenol	Intermediate chemical for thermal stabilization
NP1EO	4-nonylphenol mono-ethoxylate	Used in cleaners, adhesives, paints, food packaging
NP2EO	4-nonylphenol di-ethoxylate	Used in cleaners, adhesives, paints, food packaging

4.2 Presence, Distribution, and Contamination Level of APs

NUMBER OF COMPOUNDS DETECTED:
1 / 4

NUMBER OF SITES WITH DETECTS:
1 / 39

MOST DETECTED COMPOUND:
NP1EO

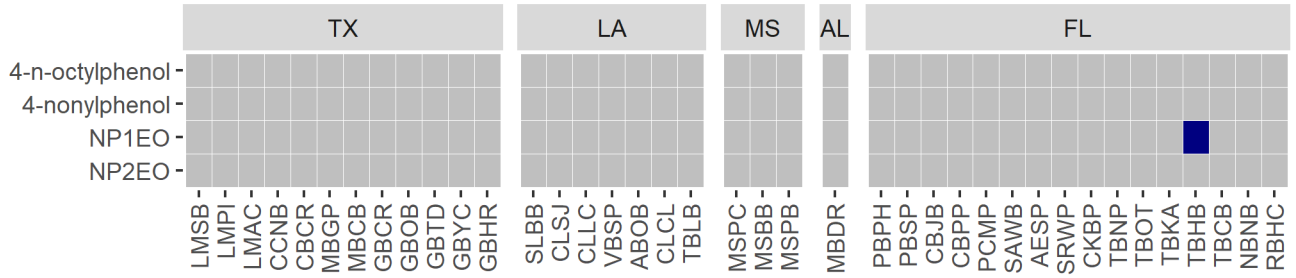


Figure 3. Distribution map showing the presence ( ) and absence ( ) of AP compounds measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 4. Coastwide frequency of AP compound detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
NP1EO	1	39	2.6

Table 5. Number of AP compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
TBHB	1	4	25.0

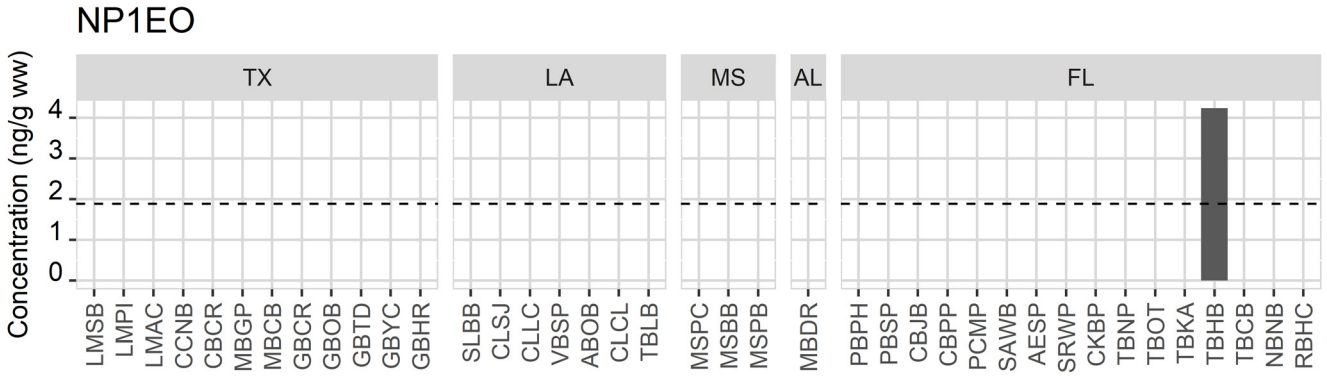


Figure 4. Bar graphs showing the magnitude of AP compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

4.3 APs Summary

Oyster Tissue:

- APs were analyzed at 39 out of 44 sites.
  - Not analyzed at sites CBBI, CBSR, CCDC, PBIB, and TBPB due to insufficient sample mass.
- 1/4 AP compounds were detected at least once (Figure 3).
- NP1EO was the most commonly detected AP compound with a frequency of 2.6% (Table 4).
- An AP concentration was only detected once for NP1EO at a concentration of 4.23 ng/g ww at site TBHB (Figure 4).
- Overall, APs were detected 1/156 possible times (4 compounds x 39 sites) for an overall 0.64% frequency of detection in the Gulf of Mexico (Table 5).

General Observations:

- APs were only detected a single time throughout the whole Gulf of Mexico coast in 2017 at a low concentration, suggesting that they are not an abundant contaminant or of high concern for the region (Figure 5).
- AP compounds were detected at lower concentrations in the Gulf of Mexico than in either the Gulf of Maine (Table A3) or the Southern California Bight (Table A5).

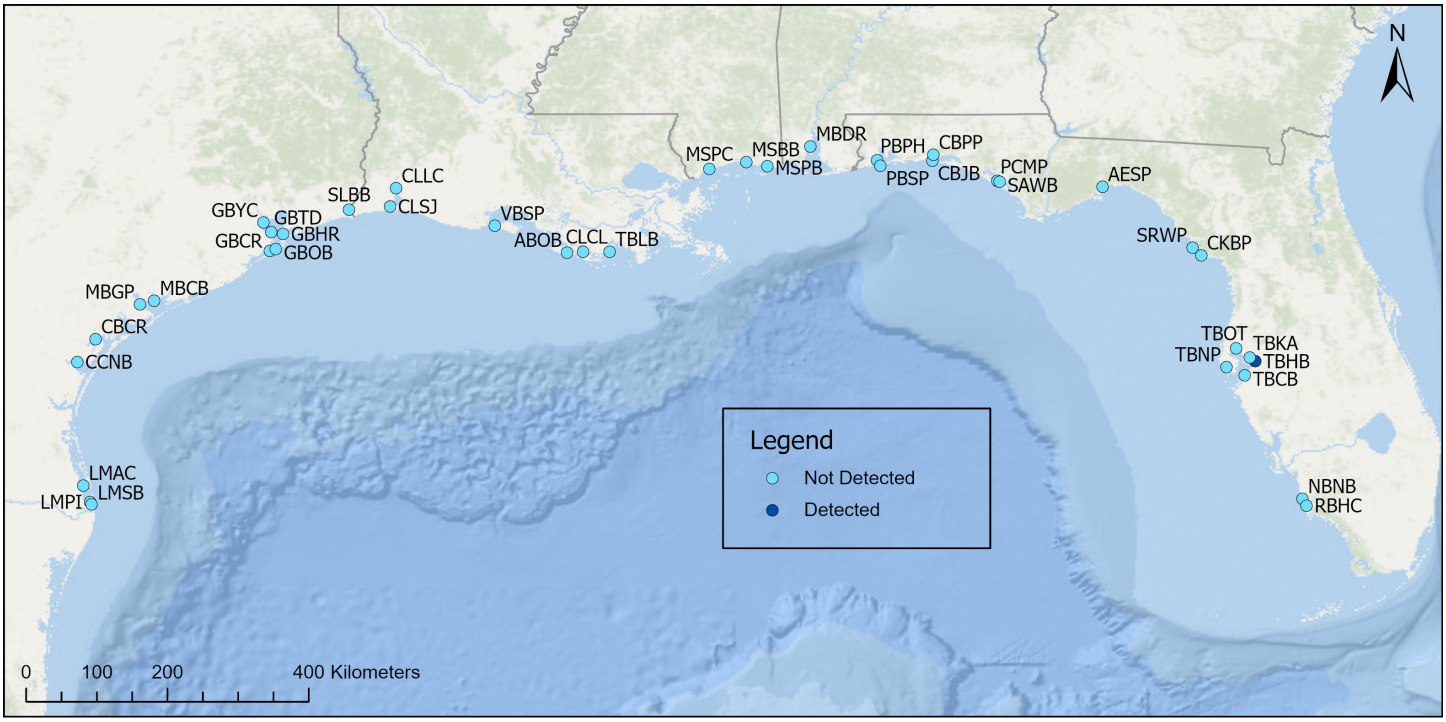


Figure 5. Map of Mussel Watch sites in 2017 in the Gulf of Mexico highlighting locations of sites with AP compounds detected in oyster tissue.

5.0 RESULTS - ALTERNATIVE FLAME RETARDANTS

5.1 AFRs Chemical Description

Alternative flame retardants (AFRs) are added to a wide variety of industrial and consumer products such as textiles, rugs, furniture, and plastics (de Wit, 2002). There are several groups of chemicals characterized as AFRs including hexabromocyclododecanes (HBCDs) and chlorinated organophosphate chemicals (CPP) that were analyzed in this study (Table 6). Although brominated, HBCDs are classified here as an "alternative flame retardant" because they were initially introduced as an alternative to brominated flame retardants such as PBBs and PBDEs, but have since been banned themselves. HBCDs are primarily used in household consumer products such as upholstery, polystyrene, and textiles. HBCDs are ubiquitous in the environment, but their ecotoxicity is not well understood (de Wit, 2002). The chlorinated organophosphate flame retardants such as tris(1,3-dichloroisopropyl)phosphate (TDCPP) are mainly used as additives in textiles. As additives, chlorinated organophosphate flame retardants tend to leach into water and air over time. In the environment, TDCPP can accumulate in animal fat tissues (Andresen et al., 2004). The brominated flame retardants 2-ethylhexyl tetrabromobenzoate (TBB) and 2-ethylhexyl 3,4,5,6-tetrabromophthalate (TBPH) and their metabolites have anti-androgenic and anti-thyroid hormonal activities properties (Klopcic et al., 2016). The chemicals TBB and TBPH were introduced as replacements for the PBDEs and functionally reduce flammability in products like electronic devices, textiles, plastics, coatings, and polyurethane foams.

AFR analyses were conducted by SGS AXYS Analytical Services LTD. The analytical method used was MLA-070 Rev 02.

Table 6. AFR compounds tested (9).

Chemical Code	Chemical Name
alpha-HBCD	α-hexabromocyclododecane
beta-HBCD	β-hexabromocyclododecane
gamma-HBCD	γ-hexabromocyclododecane
BTBPE	1,2-Bis(2,4,6-tribromophenoxy)ethane
TBB	4,5,6,7-tetrabromobenzotriazole
TBPH	bis(2-ethylhexyl) tetrabromophthalate
TCEP	Tris(2-chloroethyl) phosphate
TCPP	Tris (chloroisopropyl) phosphate
TDCPP	Tris(1,3-dichloroisopropyl)phosphate

5.2 Presence, Distribution, and Contamination Level of AFRs

NUMBER OF COMPOUNDS DETECTED:
1 / 9

NUMBER OF SITES WITH DETECTS:
1 / 42

MOST DETECTED COMPOUND:
TBB

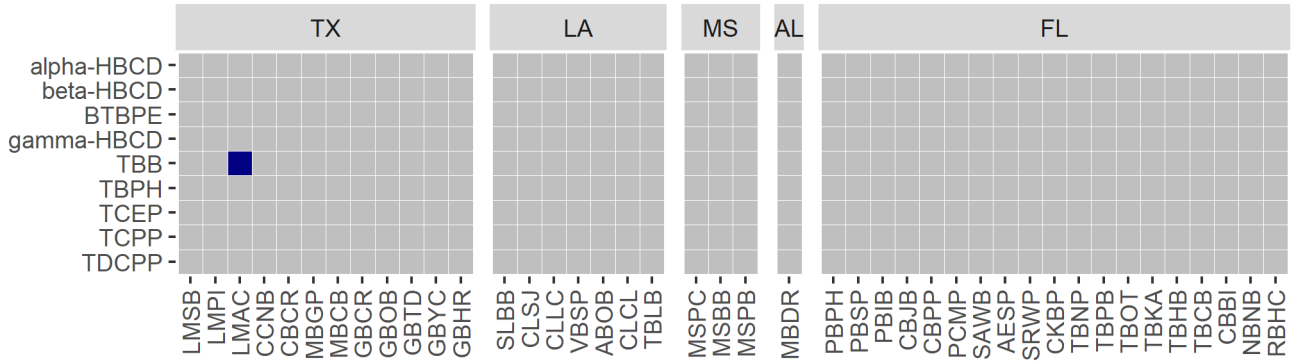


Figure 6. Distribution map showing the presence ( ) and absence ( ) of AFR compounds measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 7. Coastwide frequency of AFR compound detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
TBB	1	42	2.4

Table 8. Number of AFR compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
LMAC	1	9	11.1

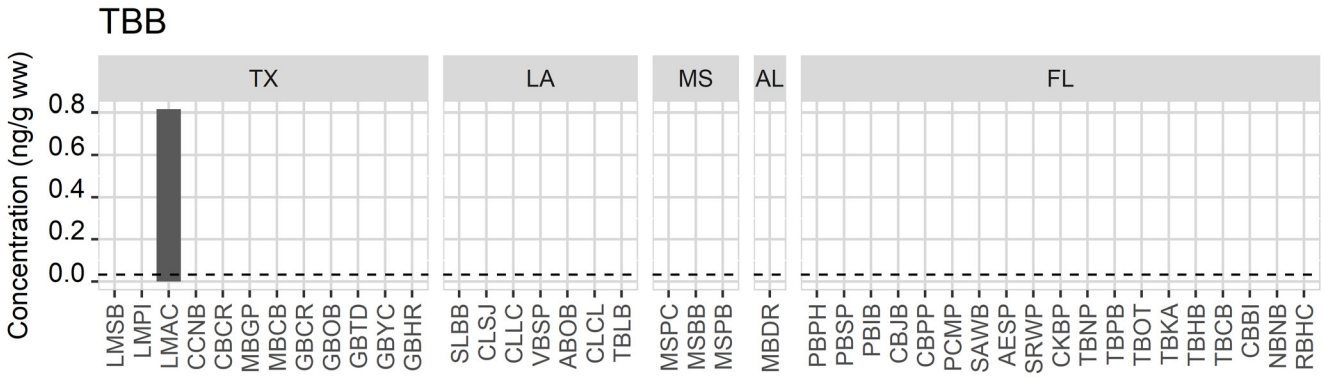


Figure 7. Bar graphs showing the magnitude of AFR compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

5.3 AFRs Summary

Oyster Tissue:

- AFRs were analyzed at 42 out of 44 sites.
  - Not analyzed at sites CBSR and CCDC due to insufficient sample mass.
- 1/9 AFR compounds were detected at least once (Figure 6).
- TBB was the most commonly detected AFR compound with a frequency of 2.4% (Table 7).
- An AFR concentration was only detected once for TBB at a concentration of 0.82 ng/g ww at site LMAC (Figure 7).
- Overall, AFRs were detected 1/378 possible times (9 compounds x 42 sites) for an overall 0.26% frequency of detection in the Gulf of Mexico (Table 8).

General Observations:

- AFRs were only detected a single time throughout the whole Gulf of Mexico coast in 2017 at a low concentration, suggesting that they are not an abundant contaminant or of high concern for the region (Figure 8).
- AFR compounds were detected at lower concentrations in the Gulf of Mexico than in the Gulf of Maine (Table A3).

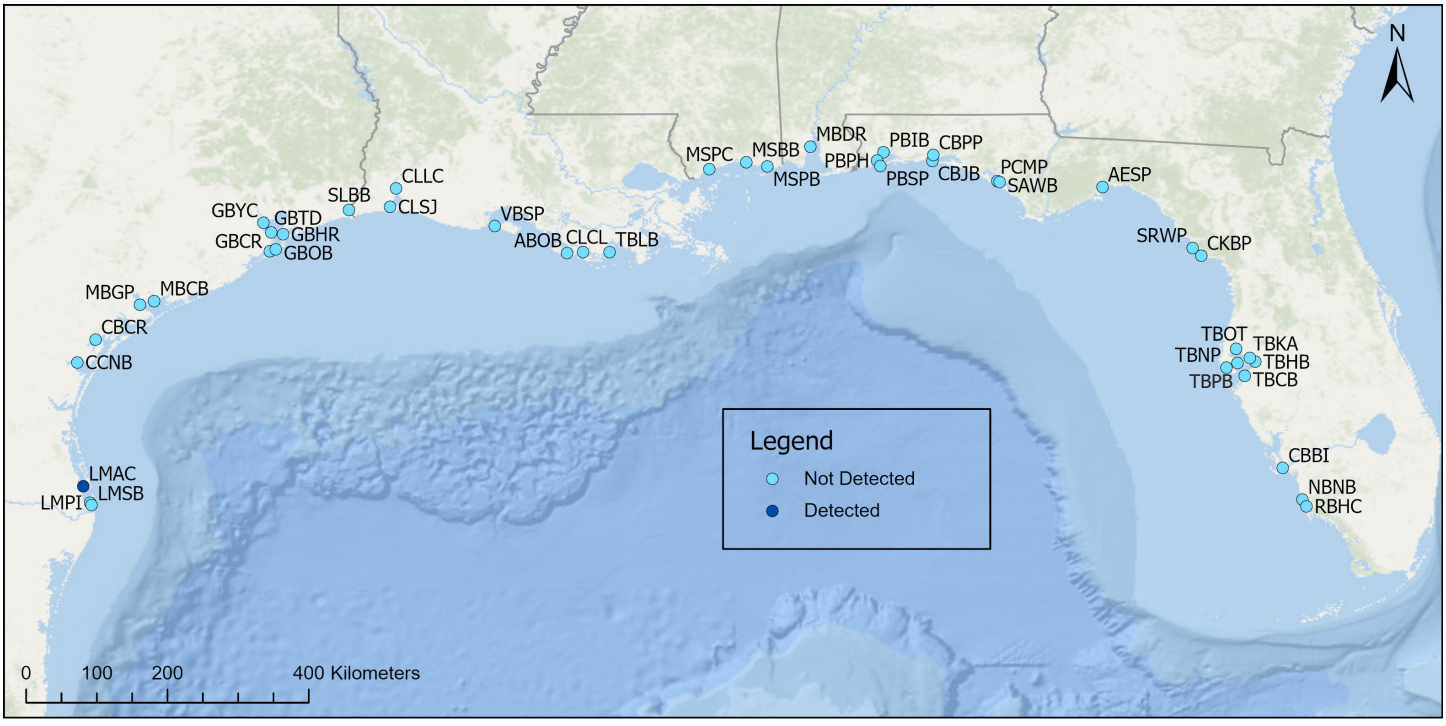


Figure 8. Map of Mussel Watch sites in 2017 in the Gulf of Mexico highlighting locations of sites with AFR compounds detected in oyster tissue.

6.0 RESULTS - BROMINATED FLAME RETARDANTS

6.1 BFRs Chemical Description

Brominated flame retardants (BFRs), such as polybrominated diphenyl ethers (PBDEs) and polybrominated biphenyls (PBBs), are a group of chemicals with 209 possible unique congeners used in firefighting materials and in consumer and household products to reduce flammability (ATSDR, 2015). A subset of these congeners was analyzed in this study (19 PBBs and 51 PBDEs). Commercially, three types of PBDE industrial mixtures have been available: pentabromodiphenyl ether (penta-BDE), octabromodiphenyl ether (octa-BDE), and decabromodiphenyl ether (deca-BDE) mixtures (EPA, 2014b). As the products that contain these compounds age and degrade or are discarded, PBDEs leach into the environment. PBDEs have become ubiquitous in the environment and are detected in materials including household dust, human breast milk, sediment, and wildlife (ATSDR, 2015). The less brominated PBDEs, like tetra-, penta-, and hexa-BDE, demonstrate a high affinity for lipids and tend to bioaccumulate in animals and humans. In contrast, highly brominated PBDEs like deca-BDE tend to absorb more into sediment and soil. The toxicology of PBDEs is not well understood, but PBDEs have been associated with tumors, neurodevelopmental toxicity, and thyroid hormone imbalance (Siddiqi et al., 2003). Some PBDE congeners have hepatotoxic and mutagenic effects, while others may act as estrogen receptor agonists *in vitro* (Meerts et al., 2001). Due to their ubiquitous distribution, persistence, and potential for toxicity, the manufacturing of the penta- and octa-BDE mixtures began to be phased out in 2004, and the deca- mixture in 2013 (EPA, 2014b; Schreder and La Guardia, 2014).

Like PBDEs, PBBs are classified as persistent organic pollutants; however, their environmental impacts are not well understood (ATSDR, 2015). Although it is not definitively known whether PBBs can cause cancer in human beings, cancer in lab mice exposed to very high concentrations has been observed. As a result of these animal tests, the United States Department of Health and Human Services has concluded that PBBs might reasonably be characterized as carcinogens (Wang, 2009). The application of PBB in firefighting materials is now controlled as a hazardous substance (Safe, 1984).

BFR analyses were performed by TDI-Brooks International Inc. following procedures used by the NOAA NS&T Program (Kimbrough et al., 2007). PBBs and PBDEs were kept separate in this report (Table 9, Table 10).

No PBBs were detected in this study, so these results were not displayed.

Table 9. PBB compounds tested (19).

Chemical Code	Chemical Name
PBB 1	PBB 1 (2-MonoBB)
PBB 2	PBB 2 (3-MonoBB)
PBB 3	PBB 3 (4-MonoBB)
PBB 4	PBB 4 (2,2'-DiBB)
PBB 7	PBB 7 (2,4-DiBB)
PBB 9	PBB 9 (2,5-DiBB)
PBB 10	PBB 10 (2,6-DiBB)
PBB 15	PBB 15 (4,4'-DiBB)
PBB 18	PBB 18 (2,2',5-TriBB)
PBB 26	PBB 26 (2,3',5-TriBB)
PBB 30	PBB 30 (2,4,6-TriBB)
PBB 31	PBB 31 (2,4',5-TriBB)
PBB 49	PBB 49 (2,2',4,5'-TetraBB)
PBB 52	PBB 52 (2,2',5,5'-TetraBB)
PBB 53	PBB 53 (2,2',5,6'-TetraBB)
PBB 77	PBB 77 (3,3',4,4'-TetraBB)
PBB 80	PBB 80 (3,3',5,5'-TetraBB)
PBB 103	PBB 103 (2,2',4,5',6-PentaBB)
PBB 155	PBB 155 (2,2',4,4',6,6'-HexaBB)

Results - BFRs

Table 10. PBDE compounds tested (51).

Chemical Code	Chemical Name
PBDE-1	BDE 1 (2-MonoBDE)
PBDE-2	BDE 2 (3-MonoBDE)
PBDE-3	BDE 3 (4-MonoBDE)
PBDE-7	BDE 7 (2,4-DiBDE)
PBDE-8	BDE 8 (2,4'-DiBDE)
PBDE-10	BDE 10 (2,6-DiBDE)
PBDE-11	BDE 11 (3,3'-DiBDE)
PBDE-12	BDE 12 (3,4-DiBDE)
PBDE-13	BDE 13 (3,4'-DiBDE)
PBDE-15	BDE 15 (4,4'-DiBDE)
PBDE-17	BDE 17 (2,2',4-TriBDE)
PBDE-25	BDE 25 (2,3',4-TriBDE)
PBDE-28	BDE 28 (2,4,4'-TriBDE)
PBDE-30	BDE 30 (2,4,6-TriBDE)
PBDE-32	BDE 32 (2,4',6-TriBDE)
PBDE-33	BDE 33 (2',3,4-TriBDE)
PBDE-35	BDE 35 (3,3',4-TriBDE)
PBDE-37	BDE 37 (3,4,4'-TriBDE)
PBDE-47	BDE 47 (2,2',4,4'-TetraBDE)
PBDE-66	BDE 66 (2,3',4,4'-TetraBDE)
PBDE-71_49	BDE 49/71 (2,2',4,5'-TetraBDE/ 2,3',4',6-TetraPDE)
PBDE-75	BDE 75 (2,4,4',6-TetraBDE)
PBDE-77	BDE 77 (3,3',4,4'-TetraBDE)
PBDE-85	BDE 85 (2,2',3,4,4'-PentaBDE)
PBDE-99	BDE 99 (2,2',4,4',5-PentaBDE)

Chemical Code	Chemical Name
PBDE-100	BDE 100 (2,2',4,4',6-PentaBDE)
PBDE-116	BDE 116 (2,3,4,5,6-PentaBDE)
PBDE-118	BDE 118 (2,3',4,4',5-PentaBDE)
PBDE-119	BDE 119 (2,3',4,4',6-PentaBDE)
PBDE-126	BDE 126 (3,3',4,4',5-PentaBDE)
PBDE-138	BDE 138 (2,2',3,4,4',5'-HexaBDE)
PBDE-153	BDE 153 (2,2',4,4',5,5'-HexaBDE)
PBDE-154	BDE 154 (2,2',4,4',5,6'-HexaBDE)
PBDE-155	BDE 155 (2,2',4,4',6,6'-HexaBDE)
PBDE-166	BDE 166 (2,3,4,4',5,6-HexaBDE)
PBDE-181	BDE 181 (2,2',3,4,4',5,6-HeptaBDE)
PBDE-183	BDE 183 (2,2',3,4,4',5',6-HeptaBDE)
PBDE-190	BDE 190 (2,3,3',4,4',5,6-HeptaBDE)
PBDE-194	BDE 194 (2,2',3,3',4,4',5,5'-OctaBDE)
PBDE-195	BDE 195 (2,2',3,3',4,4',5,6-OctaBDE)
PBDE-196	BDE 196 (2,2',3,3',4,4',5,6'-OctaBDE)
PBDE-197	BDE 197 (2,2',3,3',4,4',6,6'-OctaBDE)
PBDE-198_199_203_200	BDE 198/199/203/200 (OctaBDE)
PBDE-201	BDE 201 (2,2',3,3',4,5',6,6'-OctaBDE)
PBDE-202	BDE 202 (2,2',3,3',5,5',6,6'-OctaBDE)
PBDE-204	BDE 204 (2,2',3,4,4',5,6,6'-OctaBDE)
PBDE-205	BDE 205 (2,3,3',4,4',5,5',6-OctaBDE)
PBDE-206	BDE 206 (2,2',3,3',4,4',5,5',6-NonaBDE)
PBDE-207	BDE 207 (2,2',3,3',4,4',5,6,6'-NonaBDE)
PBDE-208	BDE 208 (2,2',3,3',4,5,5',6,6-NonaBDE)
PBDE-209	BDE 209 (2,2',3,3',4,4',5,5',6,6'-DecaBDE)

6.2 Presence, Distribution, and Contamination Level of BFRs

NUMBER OF COMPOUNDS DETECTED:
10 / 51

NUMBER OF SITES WITH DETECTS:
17 / 41

MOST DETECTED COMPOUND:
PBDE-47

Table 11. Coastwide frequency of PBDE compound detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
PBDE-47	10	41	24.4
PBDE-209	7	41	17.1
PBDE-71_49	5	41	12.2
PBDE-66	3	41	7.3
PBDE-17	2	41	4.9
PBDE-99	2	41	4.9
PBDE-100	1	41	2.4
PBDE-28	1	41	2.4
PBDE-77	1	41	2.4
PBDE-85	1	41	2.4

Table 12. Number of PBDE compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
GBYC	5	51	9.8
SAWB	3	51	5.9
TBKA	3	51	5.9
NBNB	3	51	5.9
GBOB	2	51	3.9
MBDR	2	51	3.9
PBPH	2	51	3.9
CBPP	2	51	3.9
TBPB	2	51	3.9
TBCB	2	51	3.9
GBTD	1	51	2.0
PBSP	1	51	2.0
CBJB	1	51	2.0
PCMP	1	51	2.0
SRWP	1	51	2.0
TBHB	1	51	2.0
RBHC	1	51	2.0

Results - BFRs

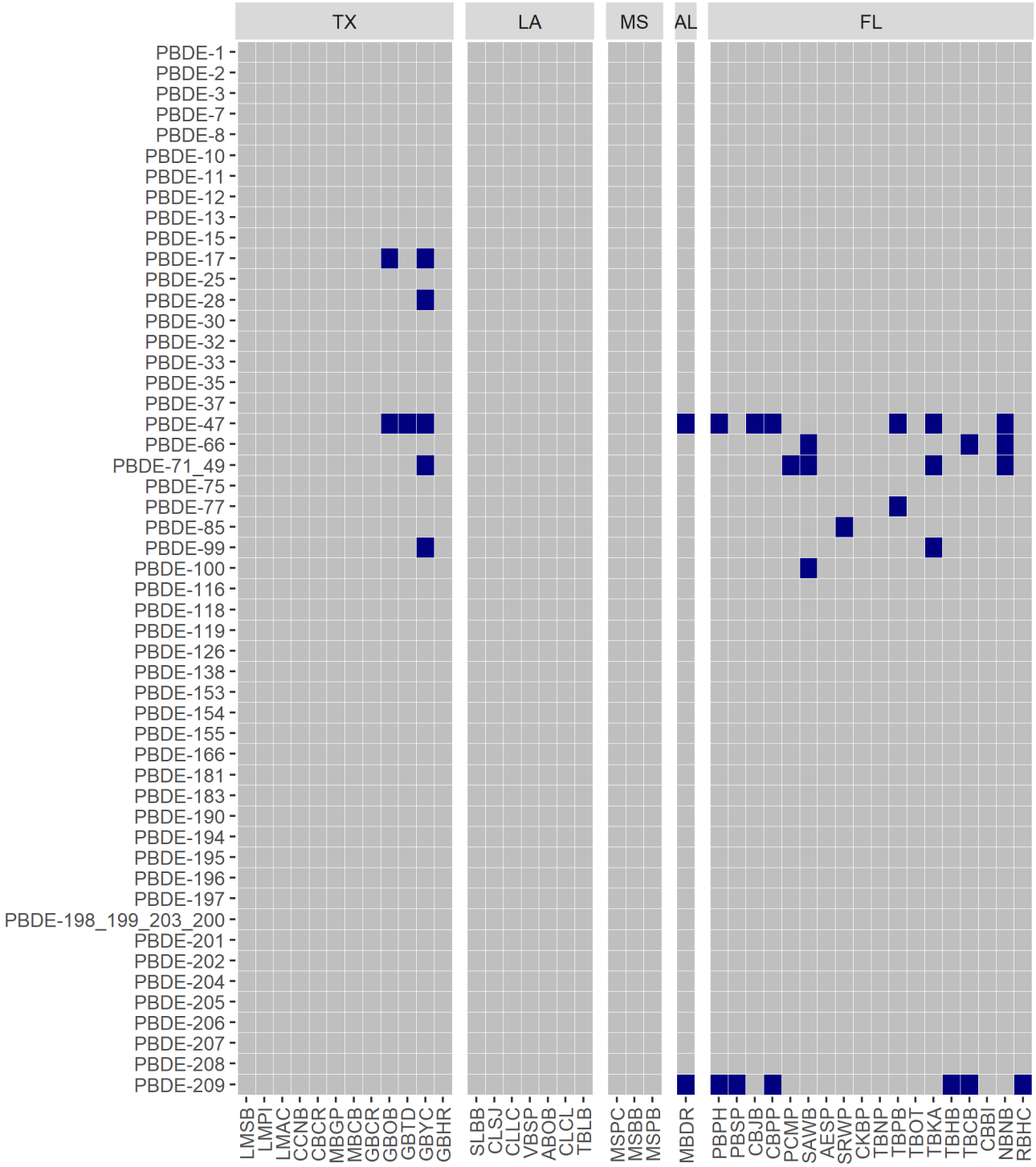


Figure 9. Distribution map showing the presence ( ) and absence ( ) of PBDE compounds measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Results - BFRs

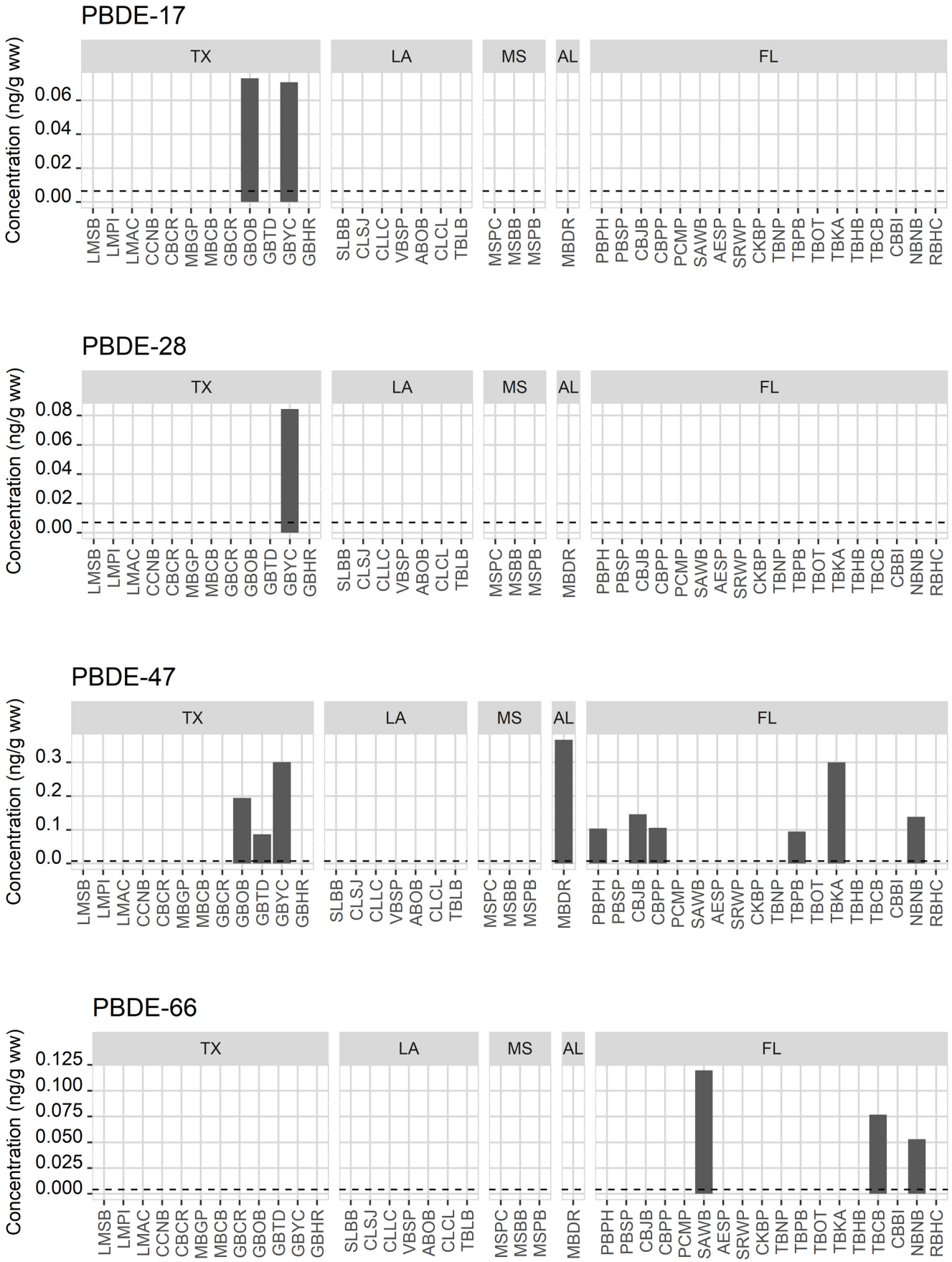


Figure 10. Bar graphs showing the magnitude of PBDE compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

Results - BFRs

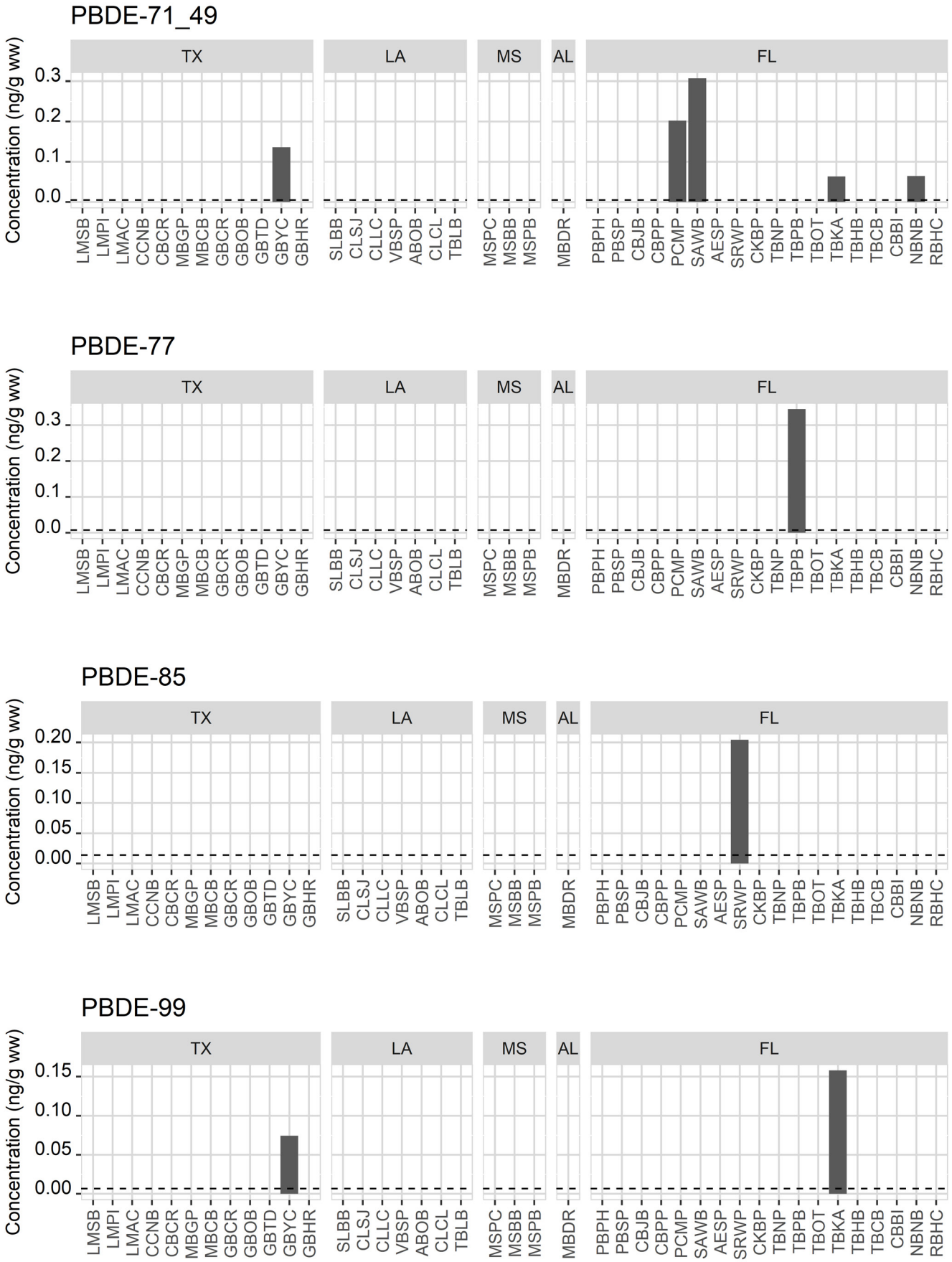


Figure 10 cont. Bar graphs showing the magnitude of PBDE compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

Results - BFRs

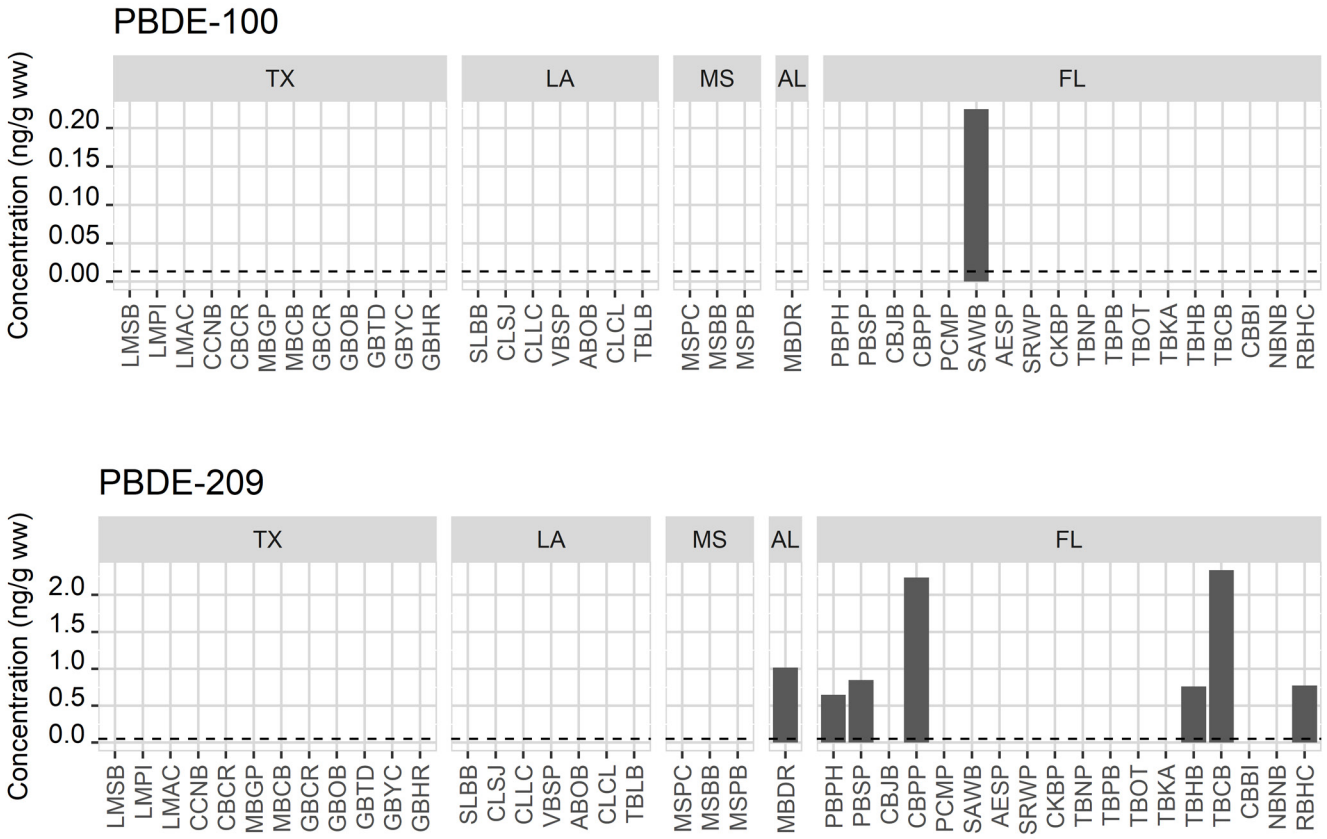


Figure 10 cont. Bar graphs showing the magnitude of PBDE compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

6.3 BFRs Summary

Oyster Tissue:

- BFRs were analyzed at 41 out of 44 sites.
  - Not analyzed at sites CBSR, CCDC, and PBIB due to insufficient sample mass.
- No PBB compounds were detected.
- 10/51 BFR compounds were detected at least once (Figure 9).
- PBDE-47 was the most commonly detected BFR compound with a frequency of 24.4% (Table 11).
- Minimum concentration detected was 0.05 ng/g ww of PBDE-66 at site NBNB (Figure 10).
- Maximum concentration detected was 2.33 ng/g ww of PBDE-209 at site TBCB (Figure 10).
- Overall, BFRs were detected 33/2,091 possible times (51 compounds x 41 sites) for an overall 1.58% frequency of detection in the Gulf of Mexico (Table 12).

General Observations:

- BFRs in oyster tissue were primarily detected along the Florida coast and near Galveston Bay, TX in 2017, possibly suggesting differences in state- and city-wide management of point and nonpoint sources (Figure 11).
- BFR compounds were detected at lower concentrations in the Gulf of Mexico than in either the Gulf of Maine (Table A3) or the Southern California Bight (Table A5).

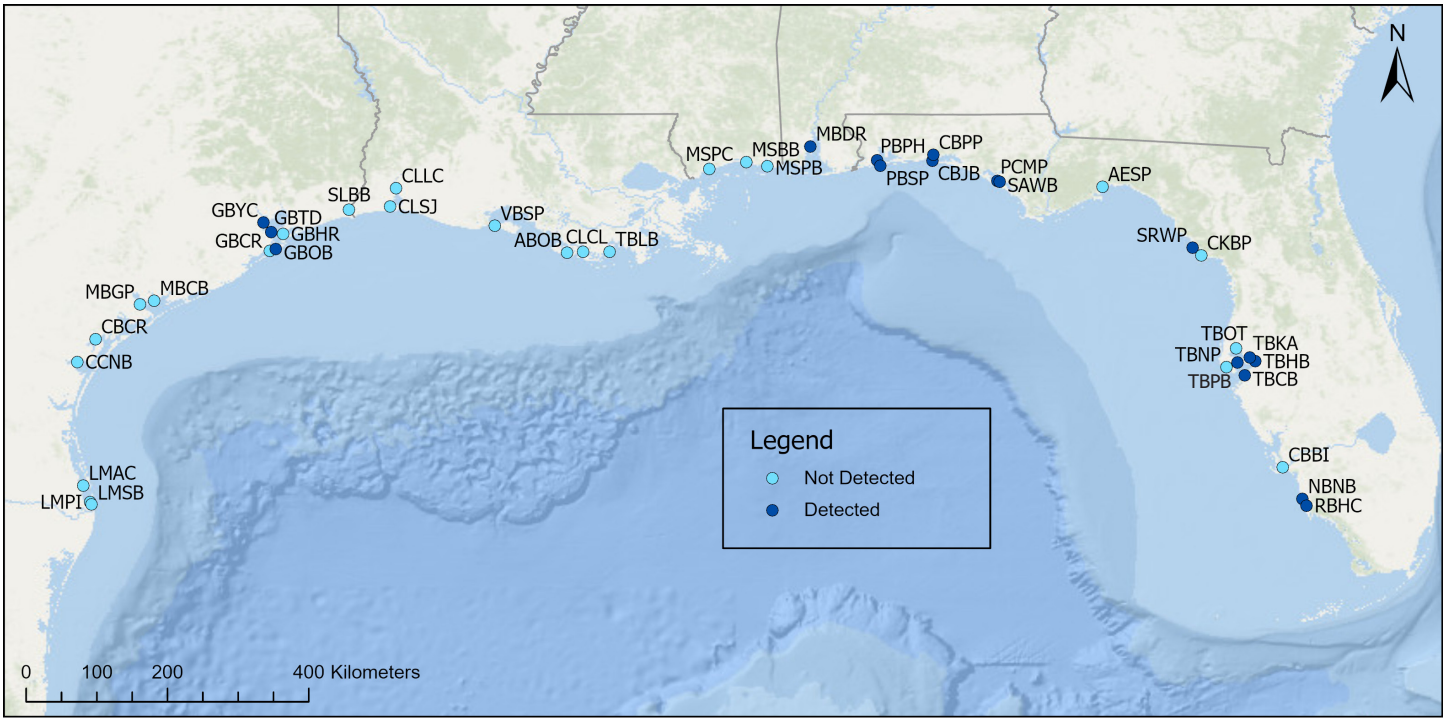


Figure 11. Map of Mussel Watch sites in 2017 in the Gulf of Mexico highlighting locations of sites with PBDE compounds detected in oyster tissue.

7.0 RESULTS - CURRENT USE PESTICIDES

7.1 CUPs Chemical Description

Primary examples of current-use pesticides (CUPs) include organophosphates, neonicotinoids, pyrethroids, n-methyl carbamates, and insect growth regulator hormones (EPA, 2011). CUPs are generally a group of semi-volatile chemicals that span multiple chemical classes and can be analyzed concurrently. In this report, CUP chemicals include pesticides and their associated degradation products. These pesticides are typically more water-soluble than legacy organochlorine pesticides, such as DDT and chlordane, and often do not bioaccumulate in organisms. It has been estimated that in 2007, over 565 million kg of current-use pesticides were used in the USA (EPA, 2011). Among pesticides, herbicides accounted for 40% of total usage and insecticides accounted for 17% (EPA, 2011). While agricultural application accounts for over 60% of pesticides used, urban usage is increasing (EPA, 2011). Pesticides enter the environment seasonally through surface run-off, pesticide drift, direct discharge, and atmospheric long-range transport (USGS, 1999; Federighi, 2008). The list of CUP chemicals measured in this study is limited by available analytical methods (Table 13). Out of the CUP compounds tested, ametryn, phorate, and terbufos data were flagged by the lab as Non-Quantifiable for all tissue analyses, and diazinon oxon data was flagged as non-quantifiable for all sediment analyses, so are not included in this report.

CUP analyses were conducted by SGS AXYS Analytical Services LTD. The analytical method used was MLA-035 Rev 07.

Phosmet was not reported at 14 sites because results were flagged with "lock mass interference present" during analysis.

Results - CUPs

Table 13. CUP compounds tested (33).

Chemical Name	Application
Atrazine	Herbicide (control pre- and postemergence broadleaf weeds in crops)
Azinphos-Methyl	Broad spectrum organophosphate acetylcholinesterase inhibitor insecticide
Captan	Fungicide
Chlorothalonil	Broad spectrum non-systemic fungicide
Cyanazine	Herbicide
Cypermethrin	Insecticide (used in large-scale commercial agricultural applications)
Dacthal	Pre-emergent herbicide (used to kill grass and many common weeds)
Desethylatrazine	Herbicide (breakdown product of atrazine)
Diazinon	Nonsystemic organophosphate insecticide (control cockroaches, silverfish, ants, and fleas)
Diazinon-Oxon	Nonsystemic organophosphate insecticide (control cockroaches, silverfish, ants, and fleas)
Dimethoate	Organophosphate acetylcholinesterase inhibitor (used as an insecticide and acaricide)
Disulfoton	Organophosphate acetylcholinesterase inhibitor (used as an insecticide)
Disulfoton Sulfone	Organophosphate acetylcholinesterase inhibitor (used as an insecticide)
Ethion	Organophosphate insecticide
Fenitrothion	Phosphorothioate (organophosphate) insecticide
Fonofos	Organothiophosphate insecticide (primarily used on corn)
Hexazinone	Organic compound (used as a broad-spectrum herbicide)
Malathion	Pesticide (widely used in agriculture and residential landscaping)
Methoxychlor	Insecticide (used to protect crops, ornamentals, livestock, and pets)
Metribuzin	Herbicide (used pre- and post-emergence in crops (soy bean, potatoes, tomatoes sugarcane))
Octachlorostyrene	By-product of industrial chemical processes (PVC recycling, Al refining, solvent degreasing)
Parathion-Ethyl	Organothiophosphate insecticide (known as “Folidol”)
Parathion-Methyl	Insecticide (used on crops (e.g., cotton))
Permethrin	Medication and insecticide (treat scabies and lice; sprayed on clothing or mosquito nets)
Perthane	Insecticide
Phosmet	Non-systemic organophosphate insecticide (used on plants and animals)
Pirimiphos-Methyl	Phosphorothioate (used as an insecticide)
Quintozene	Fungicide
Simazine	Herbicide of the triazine class (used to control broad-leaved weeds and annual grasses)
Tecnazene	Fungicide

7.2 Presence, Distribution, and Contamination Level of CUPs

NUMBER OF COMPOUNDS DETECTED:
3 / 29

NUMBER OF SITES WITH DETECTS:
3 / 40

MOST DETECTED COMPOUND:
Cypermethrin, Permethrin, Quintozene

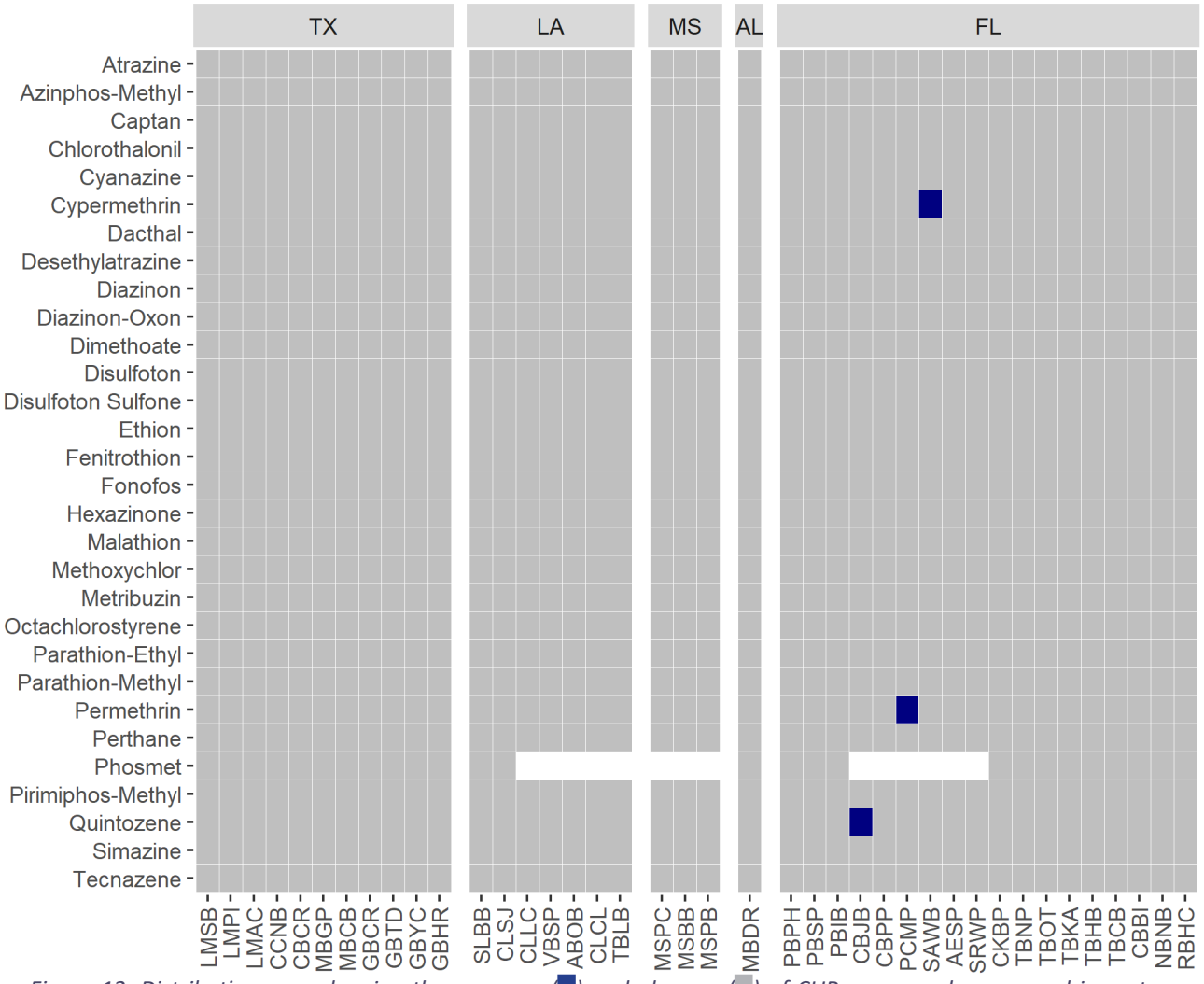


Figure 12. Distribution map showing the presence ( ) and absence ( ) of CUP compounds measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 14. Coastwide frequency of CUP compound detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Cypermethrin	1	40	2.5
Permethrin	1	40	2.5
Quintozene	1	40	2.5

Table 15. Number of CUP compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
CBJB	1	29	3.5
PCMP	1	29	3.5
SAWB	1	29	3.5

Results - CUPs

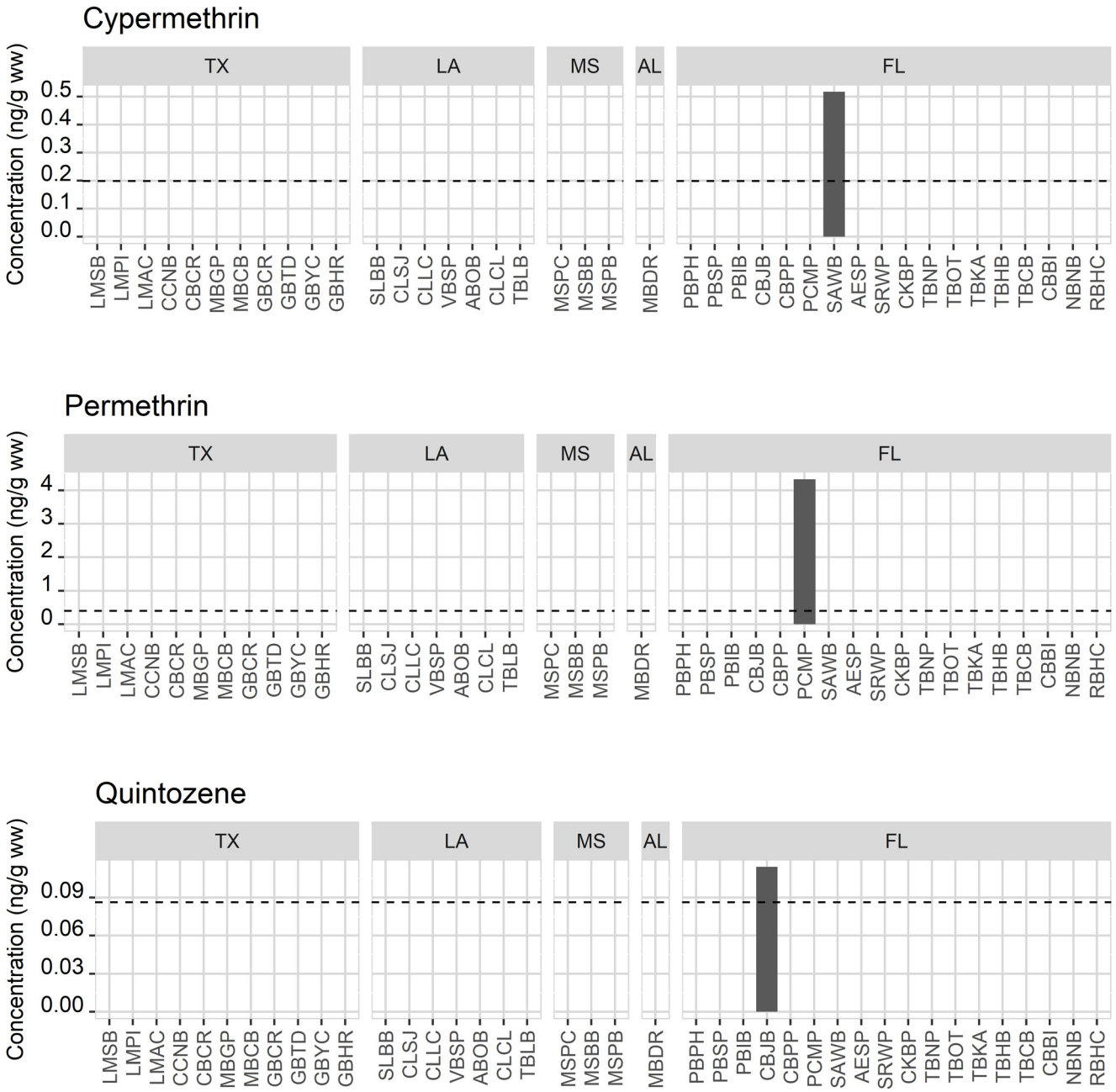


Figure 13. Bar graphs showing the magnitude of CUP compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

7.3 CUPs Summary

Oyster Tissue:

- CUPs were analyzed at 40 out of 44 sites.
  - Not analyzed at sites CBSR, CCDC, GBOB, and TBPB due to insufficient sample mass.
- 3/29 CUP compounds were detected at least once (Figure 12).
- Cypermethrin, permethrin, and quintozene were the most commonly detected CUP compounds with a frequency of 2.5% (Table 14).
- Minimum concentration detected was 0.11 ng/g ww of quintozene at site CBJB (Figure 13).
- Maximum concentration detected was 4.32 ng/g ww of permethrin at site PCMP (Figure 13).
- Overall, CUPs were detected 3/1,160 possible times (29 compounds x 40 sites) for an overall 0.26% frequency of detection in the Gulf of Mexico (Table 15).

General Observations:

- CUPs were only detected at sites near Panama City, FL and in Choctawhatchee Bay, FL, possibly suggesting localized point sources of contamination (Figure 14).

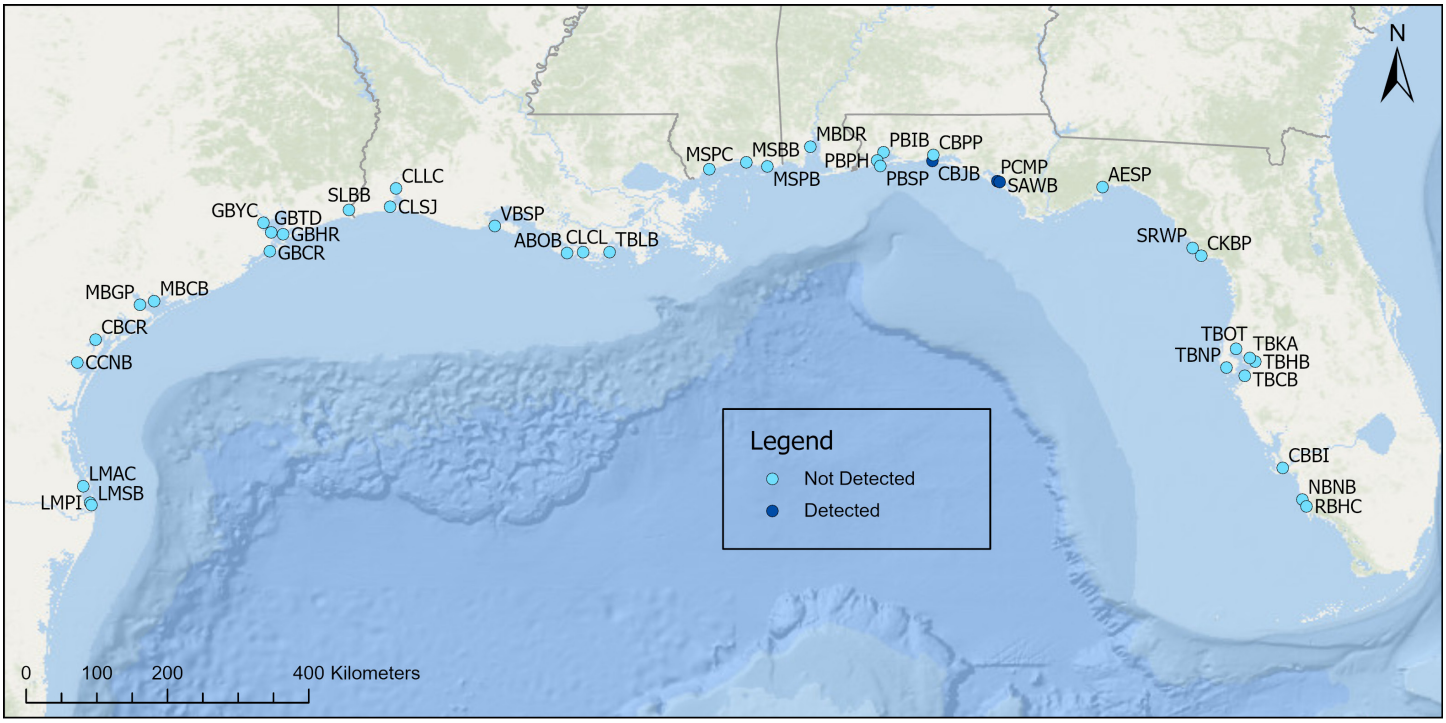


Figure 14. Map of Mussel Watch sites in 2017 in the Gulf of Mexico highlighting locations of sites with CUP compounds detected in oyster tissue.

8.0 RESULTS - PER- AND POLYFLUOROALKYL SUBSTANCES

8.1 PFAS Chemical Description

Per- and polyfluoroalkyl substances (PFAS) are a group of fluorine-containing compounds used in industrial processes related to surface protection/coatings, fire-fighting foam, insecticides, and commercial polymer manufacturing (ATSDR, 2018). Typically, PFAS enter the aquatic environment through aqueous effluent from fire training/fire response sites, industrial sites, wastewater treatment plants, and runoff from the land application of contaminated biosolids (ATSDR, 2018). This class of chemicals appears to accumulate in the environment and, because of their widespread use, they are becoming ubiquitous in sediment and tissue samples in coastal habitats (Chen et al., 2012; CDC, 2018). When they are taken up by organisms, PFAS are suspected to be endocrine disruptors and can cause developmental problems in animals (Grun and Blumberg, 2009). Perfluorooctane sulfonic acid (PFOS) is one of the most toxic PFAS contaminants, according to available toxicological data. It has been linked to liver damage, cancer, and immune system suppression in humans (CDC, 2018). Thus, this class of CECs has garnered increasing interest in the past 10-15 years. While the manufacturing of PFOS and PFOA has been phased out in the US, the EPA and several states have started developing health-based guidelines for PFOS and PFOA in drinking water (Corder et al., 2018). There are thousands of PFAS pollutants, but only a few are becoming more routinely monitored in the environment. The MWP program measures 13 PFAS (Table 16), which are considered toxic and for which methodologies are well developed.

PFAS analyses were conducted by SGS AXYS Analytical Services LTD. The analytical method used was MLA-110 Rev 02.

Table 16. PFAS compounds tested (13).

Chemical Code	Chemical Name
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutane sulfonic acid
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFOSA	Perfluorooctane sulfonamide
PFPeA	Perfluoropentanoic acid
PFUnA	Perfluoroundecanoic acid

8.2 Presence, Distribution, and Contamination Level of PFAS

NUMBER OF COMPOUNDS DETECTED:
3 / 13

NUMBER OF SITES WITH DETECTS:
24 / 44

MOST DETECTED COMPOUND:
PFHxA

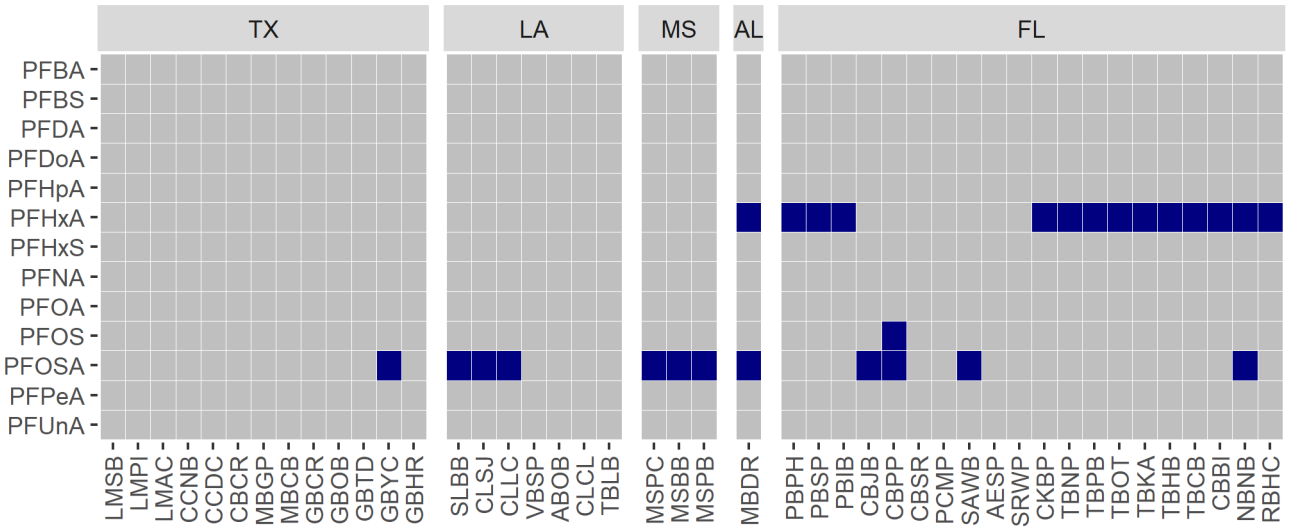


Figure 15. Distribution map showing the presence ( ) and absence ( ) of PFAS compounds measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 17. Coastwide frequency of PFAS compound detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
PFHxA	14	44	31.8
PFOSA	12	44	27.3
PFOS	1	44	2.3

Table 18. Number of PFAS compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
MBDR	2	13	15.4
CBPP	2	13	15.4
NBNB	2	13	15.4
GBYC	1	13	7.7
SLBB	1	13	7.7
CLSJ	1	13	7.7
CLLC	1	13	7.7
MSPC	1	13	7.7
MSBB	1	13	7.7

Table 18 cont. Number of PFAS compound detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
MSPB	1	13	7.7
PBPH	1	13	7.7
PBSP	1	13	7.7
PBIB	1	13	7.7
CBJB	1	13	7.7
SAWB	1	13	7.7
CKBP	1	13	7.7
TBNP	1	13	7.7
TBPB	1	13	7.7
TBOT	1	13	7.7
TBKA	1	13	7.7
TBHB	1	13	7.7
TBCB	1	13	7.7
CBBI	1	13	7.7
RBHC	1	13	7.7

Results - PFASs

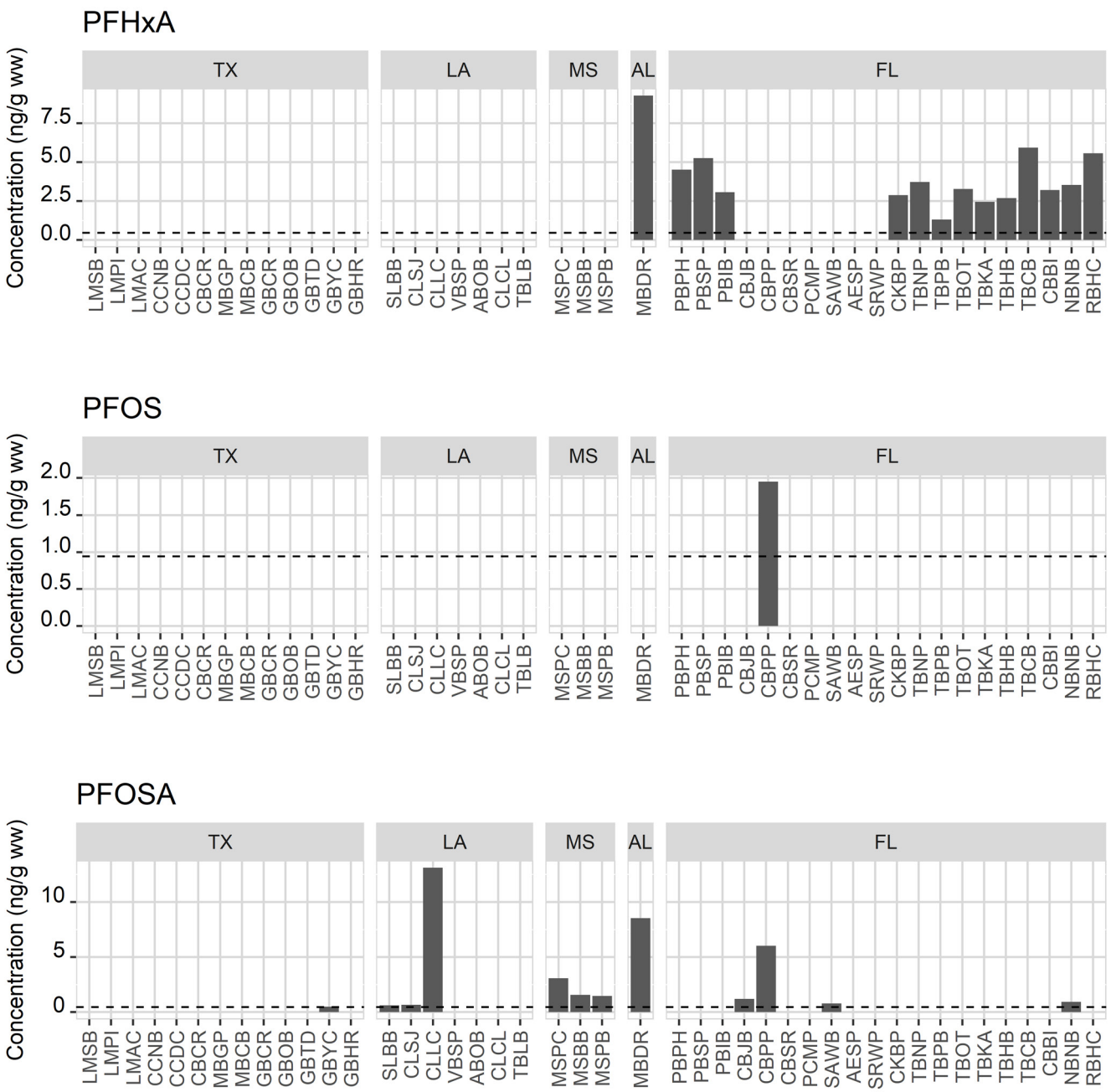


Figure 16. Bar graphs showing the magnitude of PFAS compounds detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

8.4 PFAS Summary

Oyster Tissue:

- PFAS were analyzed at 44 out of 44 sites.
- 3/13 PFAS compounds were detected at least once (Figure 15).
- PFHxA was the most commonly detected PFAS compound with a frequency of 31.8% (Table 17).
- Minimum concentration detected was 0.49 ng/g ww of PFOSA at site GBYC (Figure 16).
- Maximum concentration detected was 13.1 ng/g ww of PFOSA at site CLLC (Figure 16).
- Overall, PFAS were detected 27/1,276 possible times (29 compounds x 44 sites) for an overall 2.12% frequency of detection in the Gulf of Mexico (Table 18).

General Observations:

- PFAS were primarily detected along the Florida coast and between Galveston, TX and Lake Charles, LA possibly suggesting differences in state- and city-wide management of point and nonpoint sources (Figure 17).
- Compounds PFOS and PFOSA were detected at higher concentrations in the Gulf of Mexico than in the Southern California Bight (Table A5) but at lower concentrations than in the Gulf of Maine (Table A3).

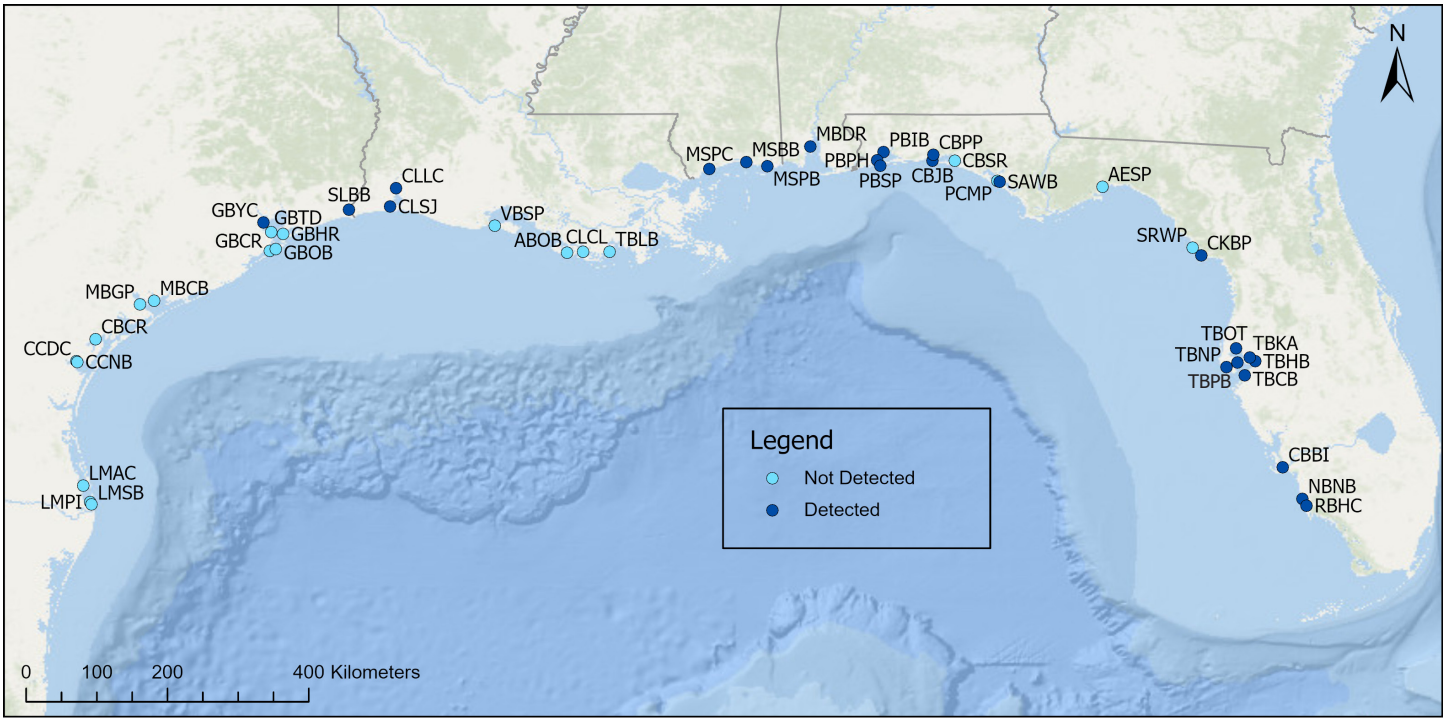


Figure 17. Map of Mussel Watch sites in 2017 in the Gulf of Mexico highlighting locations of sites with PFAS compounds detected in oyster tissue.

9.0 RESULTS - PHARMACEUTICAL AND PERSONAL CARE PRODUCTS

9.1 PPCPs Chemical Description

Environmental detections of pharmaceuticals and personal care products (PPCPs) include a wide spectrum of therapeutic and consumer-use compounds such as prescription and over-the-counter medications, hormones, synthetic fragrances, detergents, disinfectants, insect repellants, and antimicrobial agents. In 2009, an estimated 3.9 billion prescriptions were written for the top 300 pharmaceuticals in the U.S. (Lundy, 2010). Pharmaceutical companies produce over 22.6 million kg (50 million pounds) of antibiotics annually in the U.S., with approximately 60% for human use and 40% for animal agriculture use (Levy, 1998). There are numerous pathways by which PPCPs are introduced into the environment, although the primary routes include wastewater discharge or improper disposal of unused drugs (Daughton and Ternes, 1999). Because pharmaceuticals are designed to have a biological effect, the major environmental concerns associated with PPCPs are their potential ecotoxicity and unintentional human health impacts. Potential impacts of PPCPs in the environment include abnormal physiological effects, impaired reproduction, and increased cancer rates (Boyd and Furlong, 2002). According to the U.S. EPA, many CECs, including PPCPs, are suspected to be endocrine disruptors, which alter the normal functions of hormones, resulting in various health effects (Ankley et al., 2008). PPCPs represent a diverse class of emerging contaminants, and the PPCPs analyzed in this study are grouped by broad usage including prescriptions for Antibiotic, Cardiovascular, Psychiatric, Hormone, Steroid, and Misc. uses, Recreational and Personal Care Drugs and Products, and Other (Tables 19 – 26).

PPCP analyses were conducted by the NCCOS Ecotoxicology Laboratory in Charleston, SC.

No Bisphenol A was detected in this study, so results for the PPCP Other contaminant group were not displayed.

Table 19. Antibiotic Prescription Drug compounds tested (29).

Chemical Name	Application	Chemical Name	Application
Azithromycin	Macrolide antibiotic	Penicillin V	β-lactam antibiotics
Carbadox	Quinoxaline antibiotic	Roxithromycin	Macrolide antibiotic
Ciprofloxacin	Quinoline antibiotic	Sarafloxacin	Fluoroquinolone antibiotic
Clarithromycin	Macrolide antibiotic	Sulfachloropyridazine	Sulfonamide antibiotic
Clinafloxacin	Quinoline antibiotic	Sulfadiazine	Sulfonamide antibiotic
Cloxacillin	β-lactam antibiotics	Sulfadimethoxine	Sulfonamide antibiotic
Enrofloxacin	Quinolone antibiotic	Sulfamerazine	Sulfonamide antibiotic
Flumequine	Quinolone antibiotic	Sulfamethazine	Sulfonamide antibiotic
Lomefloxacin	Quinoline antibiotic	Sulfamethizole	Sulfonamide antibiotic
Norfloxacin	Quinoline antibiotic	Sulfamethoxazole	Sulfonamide antibiotic
Ofloxacin	Quinoline antibiotic	Sulfanilamide	Sulfonamide antibiotic
Ormetoprim	Macrolide antibiotic	Sulfathiazole	Sulfonamide antibiotic
Oxacillin	β-lactam antibiotics	Trimethoprim	Pyrimidine antibiotic
Oxolinic Acid	Quinolone antibiotic	Tylosin	Macrolide antibiotic
Penicillin G	β-lactam antibiotics		

Results - PPCPs

Table 20. Cardiovascular Prescription Drug compounds tested (17).

Chemical Name	Application
Albuterol	Antiasthmatic
Amlodipine	Calcium Channel Blocker
Atenolol	Beta Blocking Agent
Atorvastatin	HMG-CoA reductase inhibitors
Clonidine	Sedative; Anti-hypertensive
Dehydronifedipine	Nifedipine metabolite
Digoxin	Cardiac glycoside
Diltiazem	Antihypertensive
Enalapril	Antihypertensive drug
Gemfibrozil	Antilipemic
Metoprolol	Beta Blocking Agent
Norverapamil	Antihypertensive
Propranolol	Beta Blocking Agent
Simvastatin	HMG-CoA reductase inhibitors
Valsartan	Angiotensin receptor blockers
Verapamil	Beta Blocking Agent
Warfarin	Anticoagulant

Table 21. Hormone Prescription Drug compounds tested (4).

Chemical Name	Application
17a-Dihydroequilin	Steroidal estrogen
17a-estradiol	Weak estrogen
17a-Ethynyl estradiol	Oral contraceptive
17B-estradiol	Menopause symptom & cancer treatment
Allyl Trenbolone	Synchronize estrus in animals
Androstenedione	Biosynthesis estrogen & testosterone
Androsterone	Endogenous steroid hormone
Desogestrel	Oral contraceptive
Diethylstilbestrol	Nonsteroidal estrogen
Equilenin	Steroidal estrogen (conjugated)
Equilin	Conjugated/esterified estrogen
Estriol	Endogenous estrogen
Estrone	Endogenous estrogen
Norgestrel	Oral contraceptive progestin
Progesterone	Endogenous steroid hormone
Testosterone	Male sex hormone

Table 22. Psychiatric Prescription Drug compounds tested (12).

Chemical Name	Application
10-hydroxy-amitriptyline	Antidepressant Metabolite
Alprazolam	Anxiolytic; Sedative
Amitriptyline	Antidepressant
Amphetamine	Stimulant
Citalopram	Antidepressant; SSRI
Diazepam	Anti-anxiety; Sedative
Fluoxetine	Antidepressant; SSRI
Meprobamate	Sedative; Anti-anxiety (anxiolytic)
Norfluoxetine	Antidepressant
Paroxetine	Antidepressant; SSRI
Sertraline	Antidepressant; SSRI
Venlafaxine	Antidepressant

Table 23. Steroid Prescription Drug compounds tested (10).

Chemical Name	Application
Betamethasone	Steroid
Digoxigenin	Immunohistochemical marker
Fluocinonide	Steroid; Corticosteroid
Fluticasone propionate	Steroid
Hydrocortisone	Steroid
Methylprednisolone	Steroid; Corticosteroid
Prednisolone	Steroid
Prednisone	Steroid; Corticosteroid

Results - PPCPs

Table 24. Recreational and Personal Care Drugs and Products compounds tested (17).

Chemical Name	Application
1,7-Dimethylxanthine	Antispasmodic, caffeine metabolite
2-Hydroxy-ibuprofen	Analgesic metabolite; NSAID
Acetaminophen	Antipyretic; Analgesic
Benzoylecgonine	Metabolite of cocaine
Caffeine	Stimulant
Cimetidine	Anti-acid reflux
Clotrimazole	Antifungal
Cocaine	Stimulant
Cotinine	Nicotine metabolite
DEET	Insect repellent
Diphenhydramine	Antihistamine
Ibuprofen	Analgesic
Miconazole	Antifungal agent
Naproxen	Non-steroidal anti-inflammatory drug
Ranitidine	Anti-acid reflux
Triclocarban	Antimicrobial; Disinfectant
Triclosan	Antimicrobial; Disinfectant

Table 25. Misc. Prescription Drug compounds tested (18).

Chemical Name	Application
Benztropine	Anticholinergic; Antiparkinson
Busulfan	Antineoplastic; Alkylating agent
Carbamazepine	Anticonvulsant
Codeine	Opioid; Analgesic
Desmethyldiltiazem	Antianginal; Antihypertensive
Etoposide	Anti-Inflammatory; Chemotherapy
Furosemide	Diuretic
Glipizide	Sulfonylurea; Anti-diabetic
Glyburide	Anti-diabetic
Hydrochlorothiazide	Diuretic
Hydrocodone	Opioid; Analgesic
Metformin	Anti-diabetes
Oxycodone	Opioid; Analgesic
Promethazine	Antihistamine
Propoxyphene	Analgesic
Theophylline	Methylxanthines; Respiratory tract
Thiabendazole	Fungicide; Parasiticide
Triamterene	Diuretic

Table 26. Other PPCP compounds tested (1).

Chemical Name	Application
Bisphenol A	Flame retardant; Synthetic; Xenoestrogen

9.2 Presence, Distribution, and Contamination Level of Antibiotic Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
4 / 29

NUMBER OF SITES WITH DETECTS:
5 / 39

MOST DETECTED COMPOUND:
Azithromycin, Oxolinic Acid

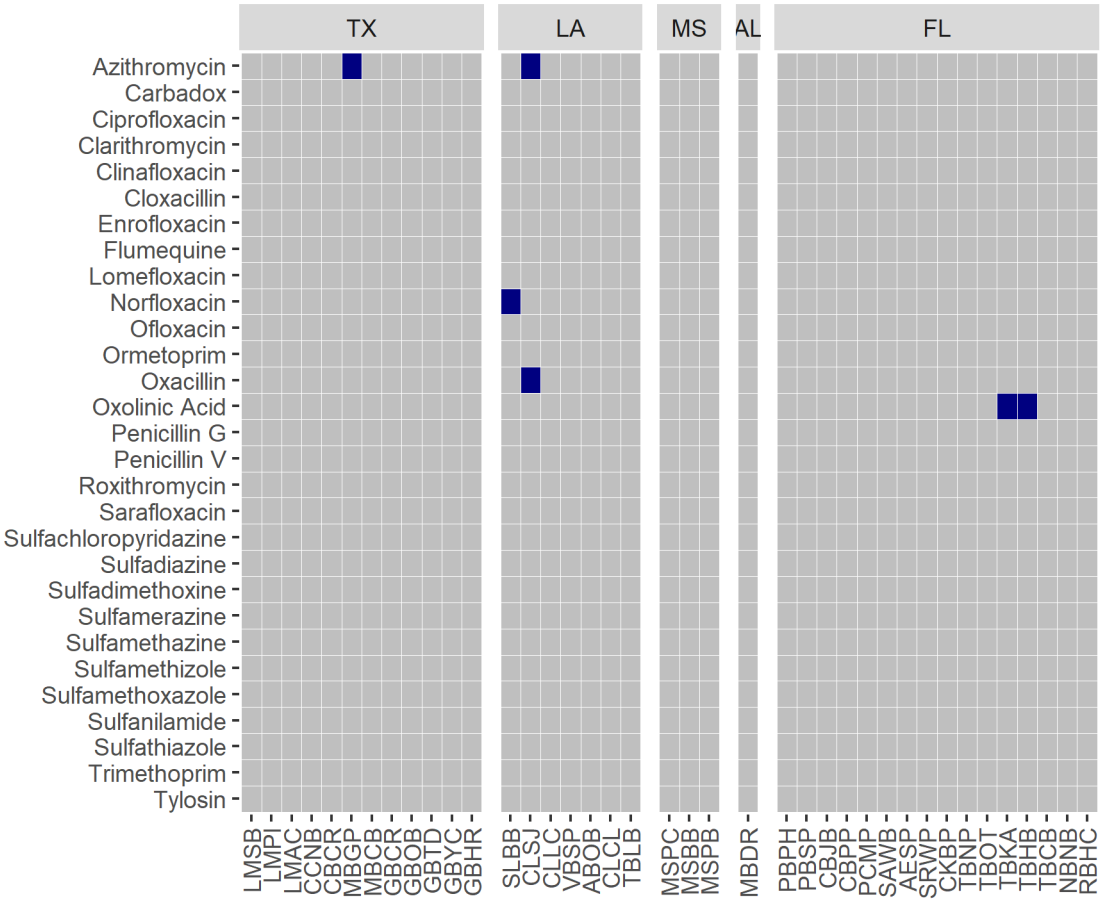


Figure 18. Distribution map showing the presence ( ) and absence ( ) of Antibiotic Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 27. Coastwide frequency of Antibiotic Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Azithromycin	2	39	5.1
Oxolinic Acid	2	39	5.1
Norfloxacin	1	39	2.6
Oxacillin	1	39	2.6

Table 28. Number of Antibiotic Prescription Drug detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
CLSJ	2	29	6.9
MBGP	1	29	3.4
SLBB	1	29	3.4
TBKA	1	29	3.4
TBHB	1	29	3.4

Results - PPCPs

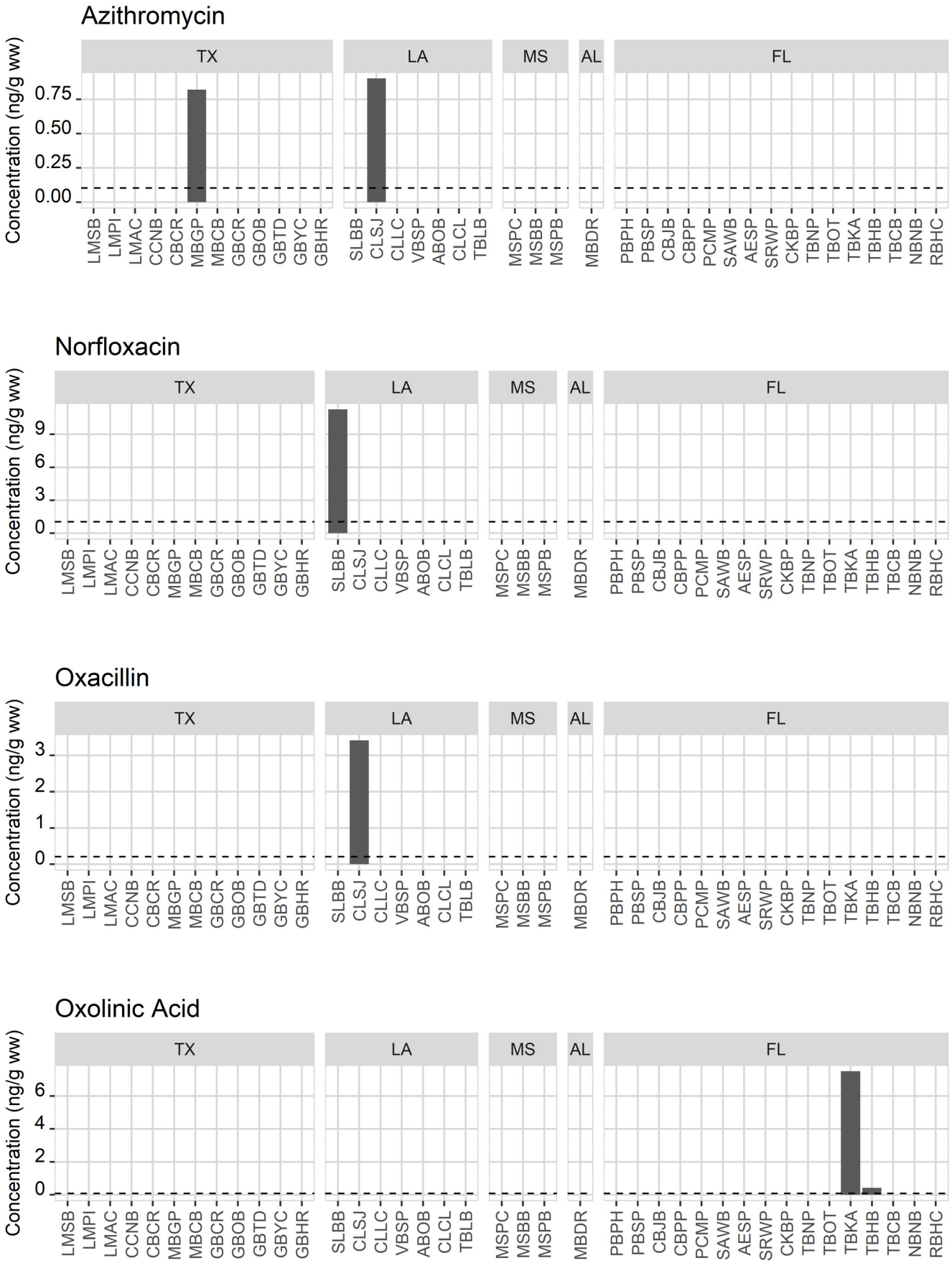


Figure 19. Bar graphs showing the magnitude of Antibiotic Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.3 Presence, Distribution, and Contamination Level of Cardiovascular Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
1 / 17

NUMBER OF SITES WITH DETECTS:
1 / 39

MOST DETECTED COMPOUND:
Warfarin

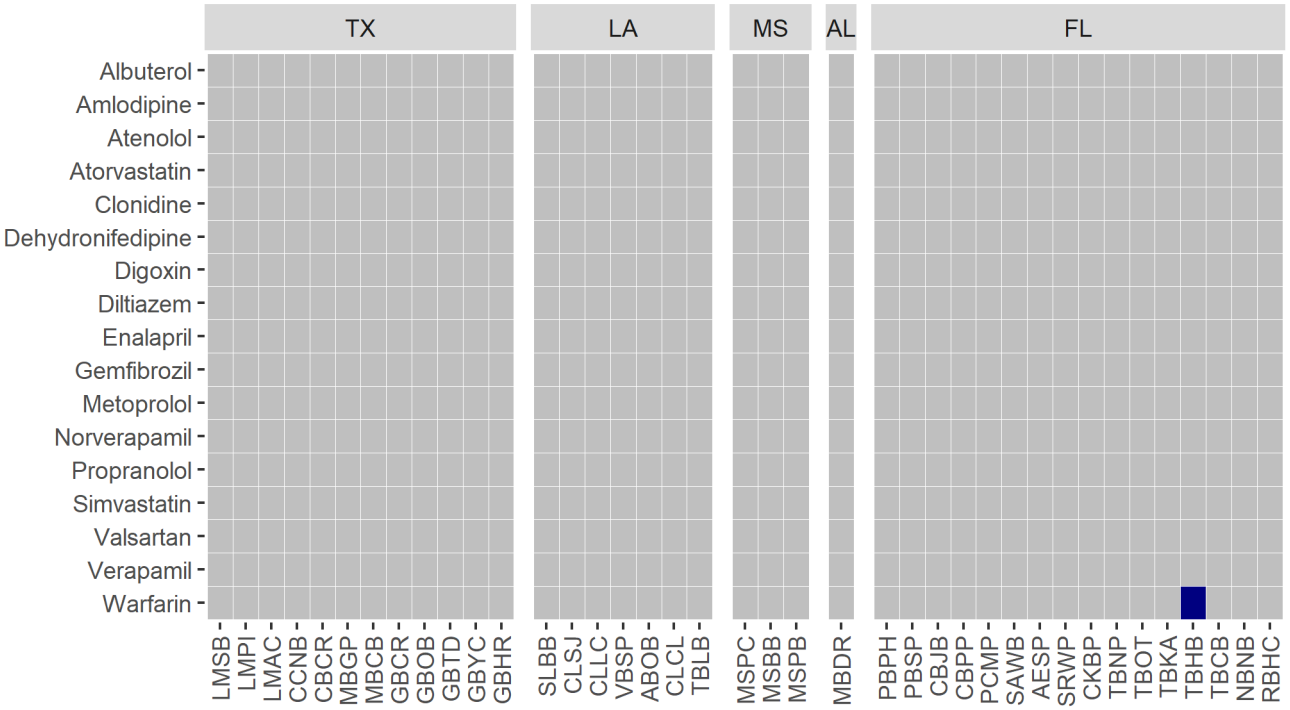


Figure 20. Distribution map showing the presence ( ) and absence ( ) of Cardiovascular Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 29. Coastwide frequency of Cardiovascular Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Warfarin	1	39	2.6

Table 30. Number of Cardiovascular Prescription Drug detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
TBHB	1	17	5.9

Results - PPCPs

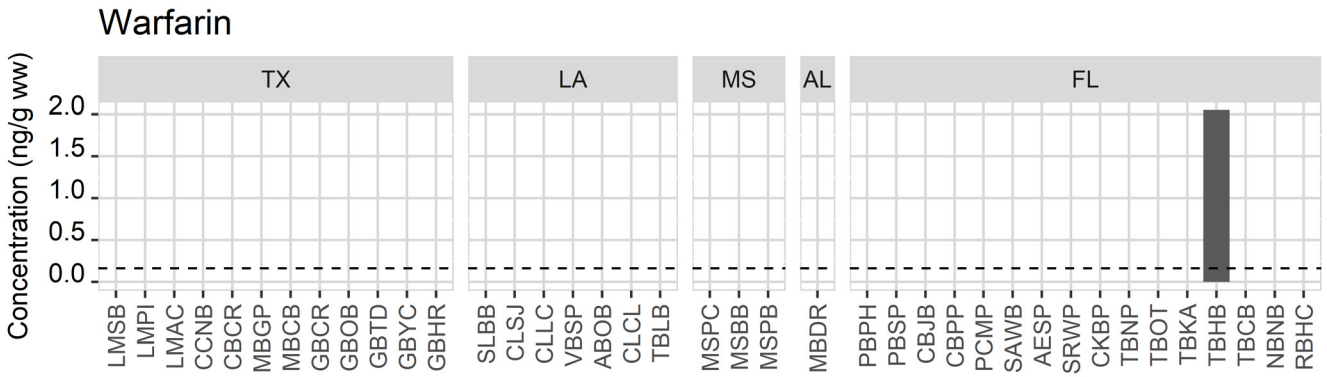


Figure 21. Bar graphs showing the magnitude of Cardiovascular Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.4 Presence, Distribution, and Contamination Level of Hormone Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
2 / 16

NUMBER OF SITES WITH DETECTS:
5 / 39

MOST DETECTED COMPOUND:
17B-estradiol

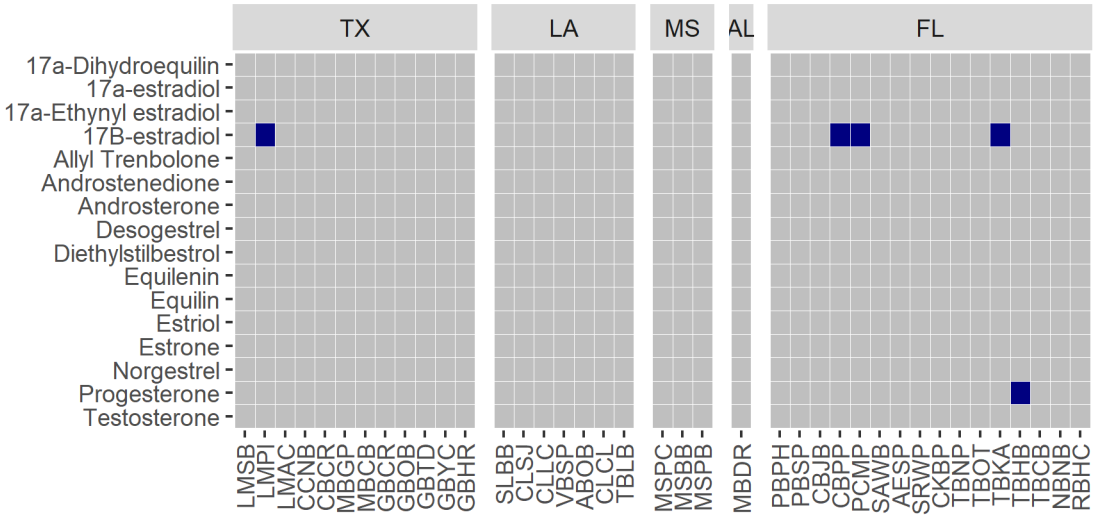


Figure 22. Distribution map showing the presence ( ) and absence ( ) of Hormone Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 31. Coastwide frequency of Hormone Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
17B-estradiol	4	39	10.3
Progesterone	1	39	2.6

Table 32. Number of Hormone Prescription Drug detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
LMPI	1	16	6.3
CBPP	1	16	6.3
PCMP	1	16	6.3
TBKA	1	16	6.3
TBHB	1	16	6.3

Results - PPCPs

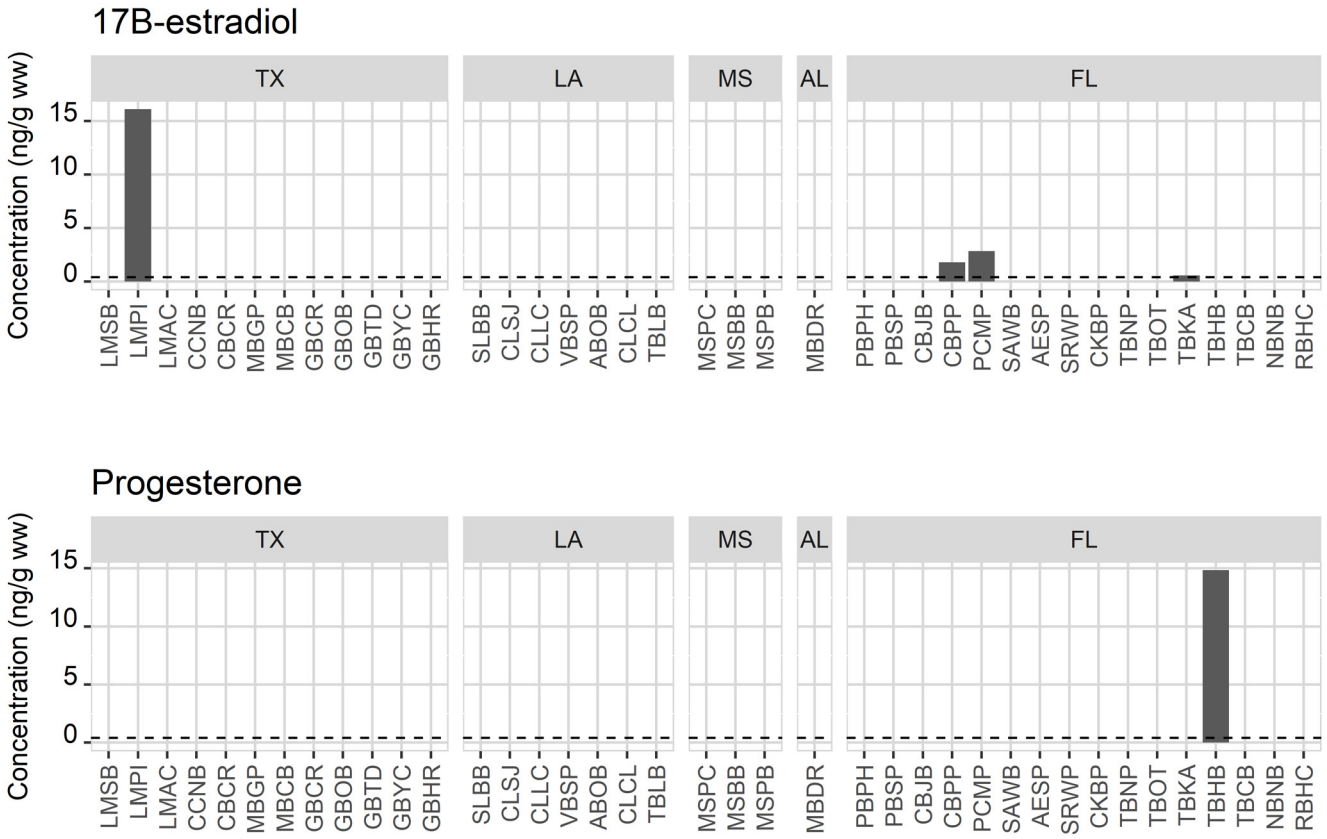


Figure 23. Bar graphs showing the magnitude of Hormone Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.5 Presence, Distribution, and Contamination Level of Psychiatric Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
8 / 12

NUMBER OF SITES WITH DETECTS:
21 / 39

MOST DETECTED COMPOUND:
Sertraline

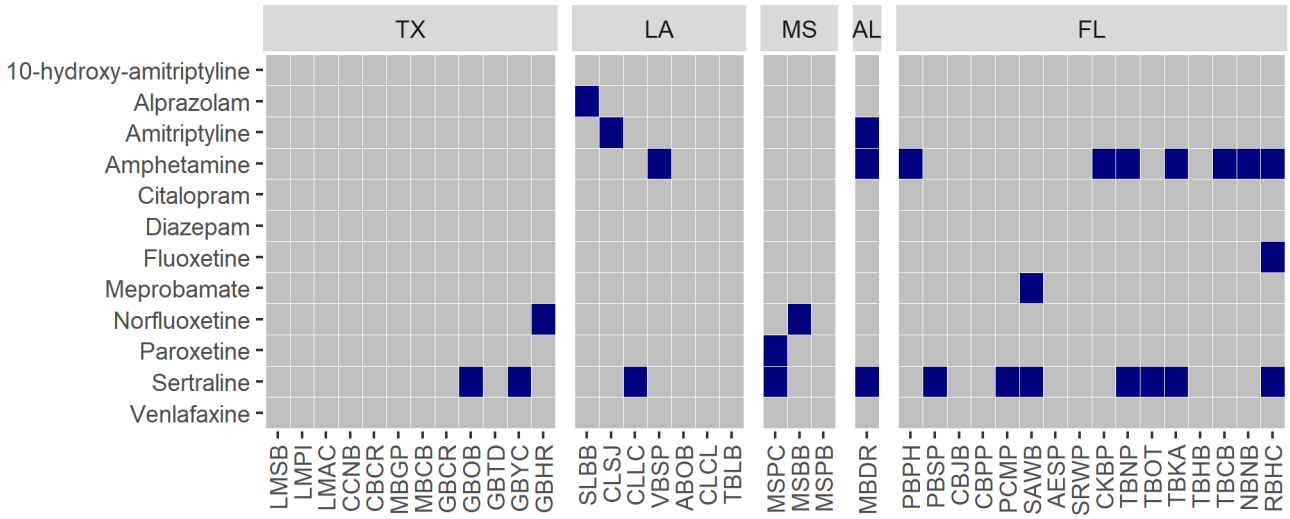


Figure 24. Distribution map showing the presence ( ) and absence ( ) of Psychiatric Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Results - PPCPs

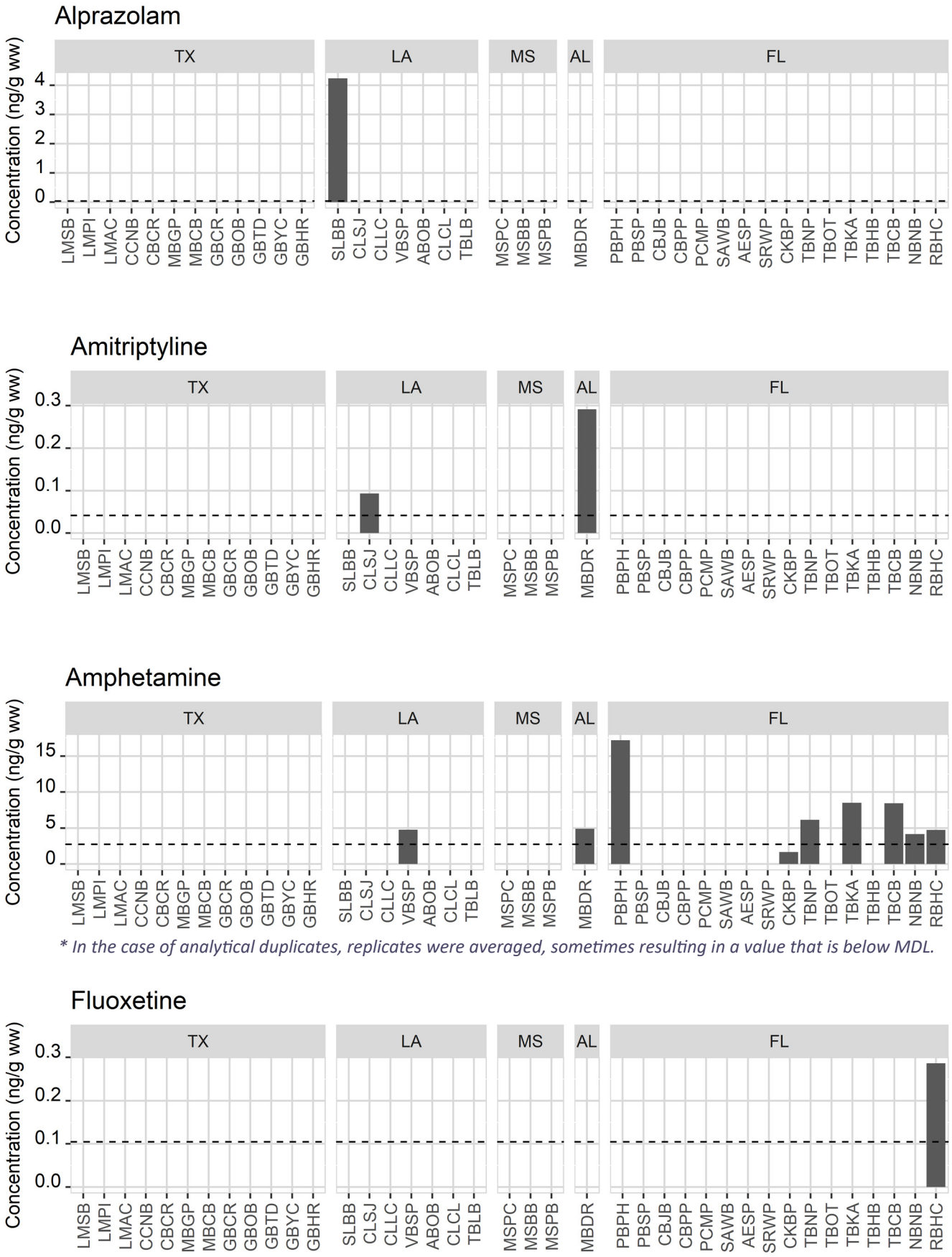
Table 33. Coastwide frequency of Psychiatric Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Sertraline	12	39	30.8
Amphetamine	9	39	23.1
Amitriptyline	2	39	5.1
Norfluoxetine	2	39	5.1
Alprazolam	1	39	2.6
Fluoxetine	1	39	2.6
Meprobamate	1	39	2.6
Paroxetine	1	39	2.6

Table 34. Number of Psychiatric Prescription Drug detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
MBDR	3	12	25.0
RBHC	3	12	25.0
MSPC	2	12	16.7
SAWB	2	12	16.7
TBNP	2	12	16.7
TBKA	2	12	16.7
GBOB	1	12	8.3
GBYC	1	12	8.3
GBHR	1	12	8.3
SLBB	1	12	8.3
CLSJ	1	12	8.3
CLLC	1	12	8.3
VBSP	1	12	8.3
MSBB	1	12	8.3
PBPH	1	12	8.3
PBSP	1	12	8.3
PCMP	1	12	8.3
CKBP	1	12	8.3
TBOT	1	12	8.3
TBCB	1	12	8.3
NBNB	1	12	8.3

Results - PPCPs



** In the case of analytical duplicates, replicates were averaged, sometimes resulting in a value that is below MDL.*

Figure 25. Bar graphs showing the magnitude of Psychiatric Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

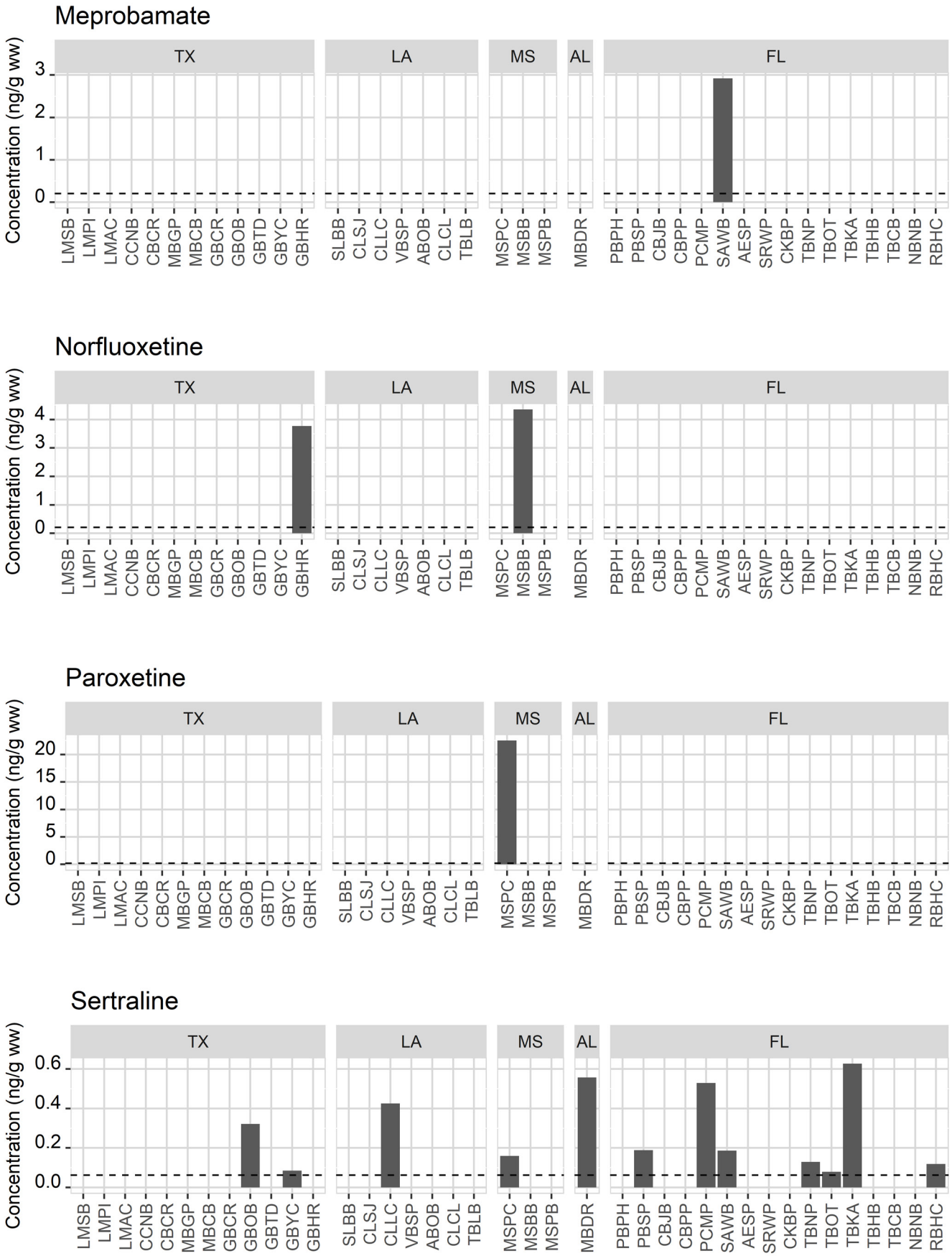


Figure 25 cont. Bar graphs showing the magnitude of Psychiatric Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.6 Presence, Distribution, and Contamination Level of Steroid Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
1 / 8

NUMBER OF SITES WITH DETECTS:
1 / 39

MOST DETECTED COMPOUND:
Fluocinonide

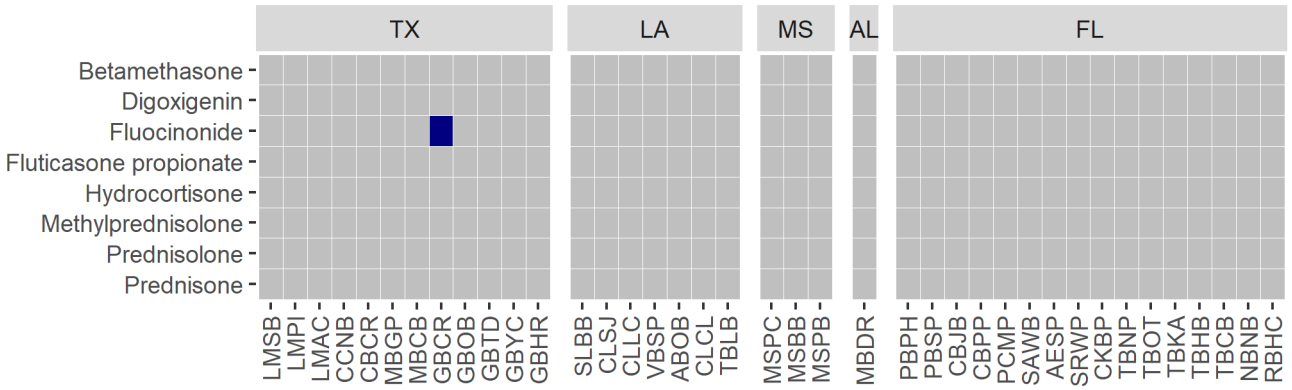


Figure 26. Distribution map showing the presence ( ) and absence ( ) of Steroid Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 35. Coastwide frequency of Steroid Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Fluocinonide	1	39	2.6

Table 36. Number of Steroid Prescription detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
GBCR	1	8	12.5

Results - PPCPs

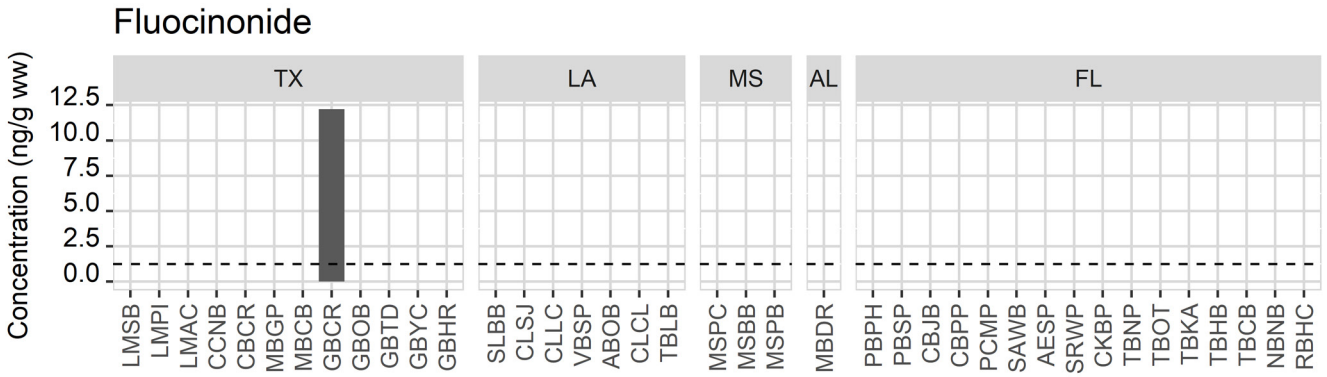


Figure 27. Bar graphs showing the magnitude of Steroid Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.7 Presence, Distribution, and Contamination Level of Recreational and Personal Care Drugs & Products

NUMBER OF COMPOUNDS DETECTED:
7 / 17

NUMBER OF SITES WITH DETECTS:
20 / 39

MOST DETECTED COMPOUND:
Cocaine

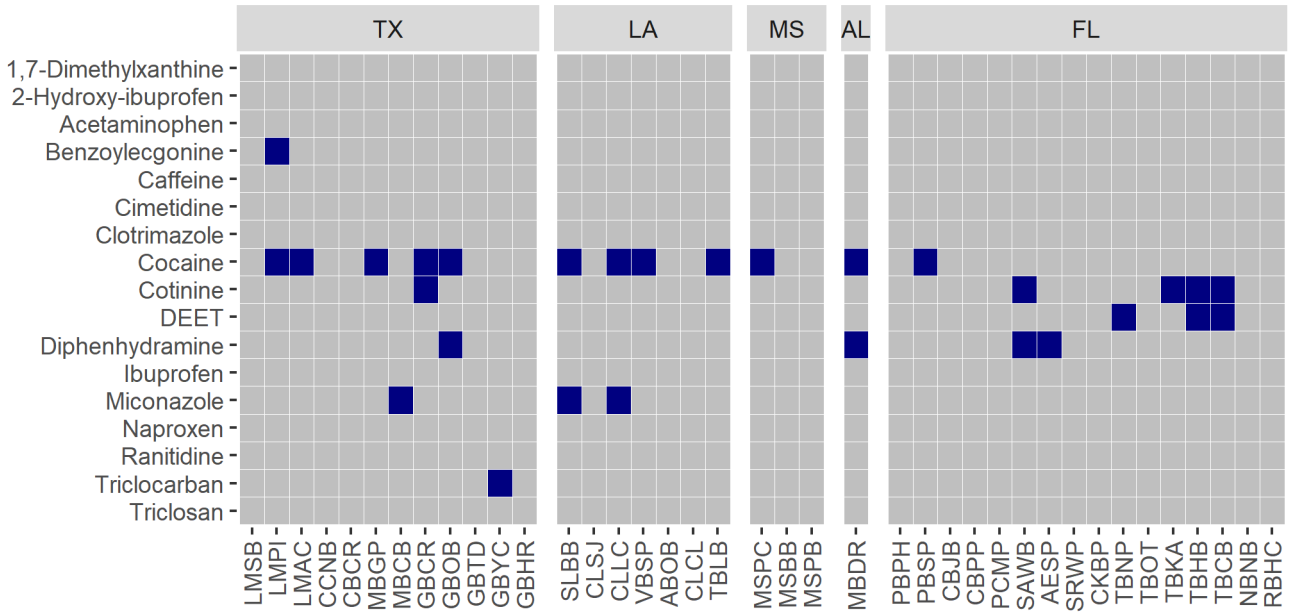


Figure 28. Distribution map showing the presence ( ) and absence ( ) of Recreational and Personal Care Drugs and Products measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Results - PPCPs

Table 37. Coastwide frequency of Recreational and Personal Care Drugs and Products detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Cocaine	12	39	30.8
Cotinine	5	39	12.8
Diphenhydramine	4	39	10.3
DEET	3	39	7.7
Miconazole	3	39	7.7
Benzoylecgonine	1	39	2.6
Triclocarban	1	39	2.6

Table 38. Number of Recreational and Personal Care Drugs and Products detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
LMPI	2	17	11.8
GBCR	2	17	11.8
GBOB	2	17	11.8
SLBB	2	17	11.8
CLLC	2	17	11.8
MBDR	2	17	11.8
SAWB	2	17	11.8
TBHB	2	17	11.8
TBCB	2	17	11.8
LMAC	1	17	5.9
MBGP	1	17	5.9
MBCB	1	17	5.9
GBYC	1	17	5.9
VBSP	1	17	5.9
TBLB	1	17	5.9
MSPC	1	17	5.9
PBSP	1	17	5.9
AESP	1	17	5.9
TBNP	1	17	5.9
TBKA	1	17	5.9

Results - PPCPs

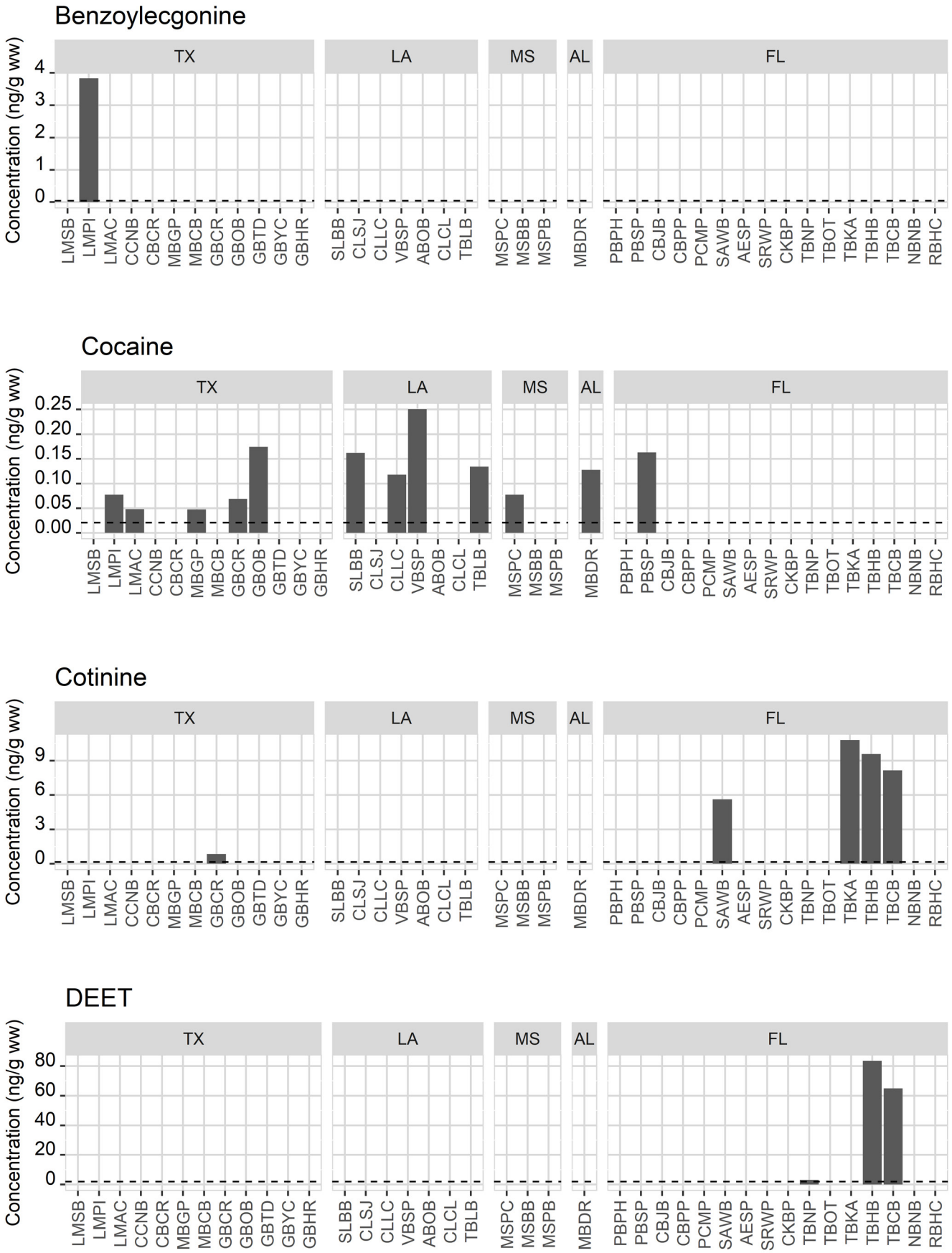


Figure 29. Bar graphs showing the magnitude of Recreational and Personal Care Drugs and Products detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

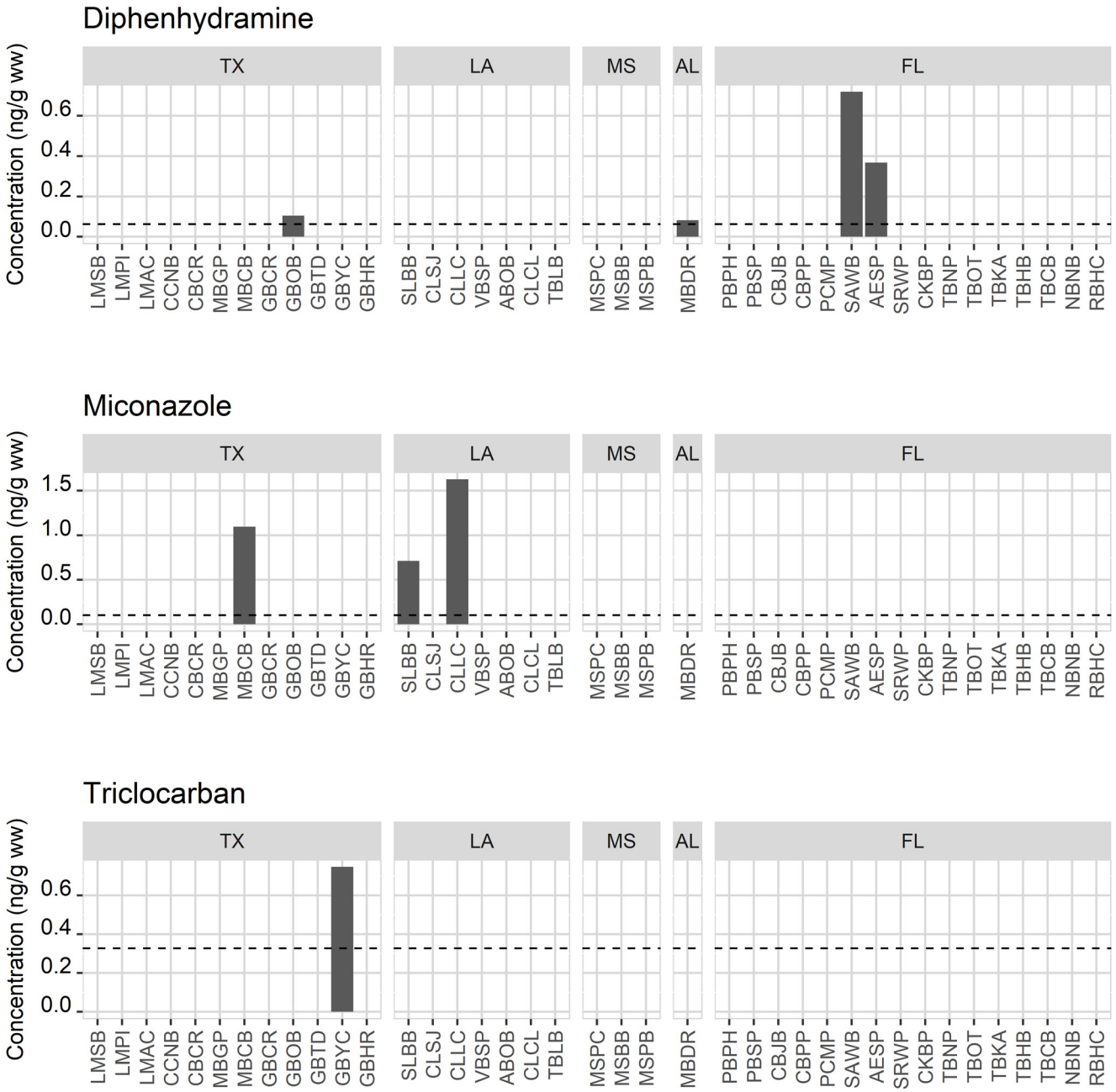


Figure 29 cont. Bar graphs showing the magnitude of Recreational and Personal Care Drugs and Products detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.8 Presence, Distribution, and Contamination Level of Misc. Prescription Drugs

NUMBER OF COMPOUNDS DETECTED:
2 / 18

NUMBER OF SITES WITH DETECTS:
8 / 39

MOST DETECTED COMPOUND:
Thiabendazole

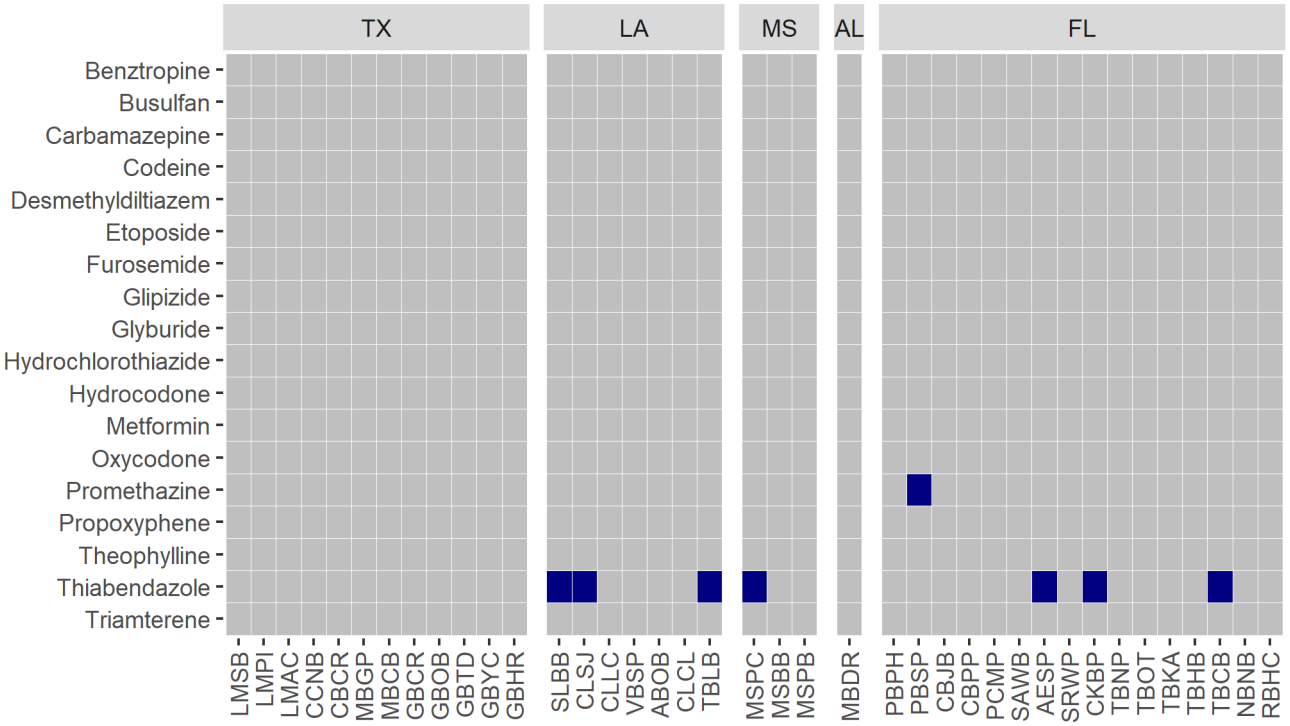


Figure 30. Distribution map showing the presence ( ) and absence ( ) of Misc. Prescription Drugs measured in oyster tissues in 2017 in the Gulf of Mexico. Sites are listed geographically from west to east, following the GoM coastline.

Table 39. Coastwide frequency of Misc. Prescription Drug detection in oyster tissue when compound was detected at least once.

Compound	# Detects	# Sites Sampled	Frequency (%)
Thiabendazole	7	39	17.9
Promethazine	1	39	2.6

Table 40. Number of Misc. Prescription Drug detects in oyster tissue at each site when at least one compound was detected.

Site	# Detects	# Compounds Analyzed	Frequency (%)
SLBB	1	18	5.6
CLSJ	1	18	5.6
TBLB	1	18	5.6
MSPC	1	18	5.6
PBSP	1	18	5.6
AESP	1	18	5.6
CKBP	1	18	5.6
TBCB	1	18	5.6

Results - PPCPs

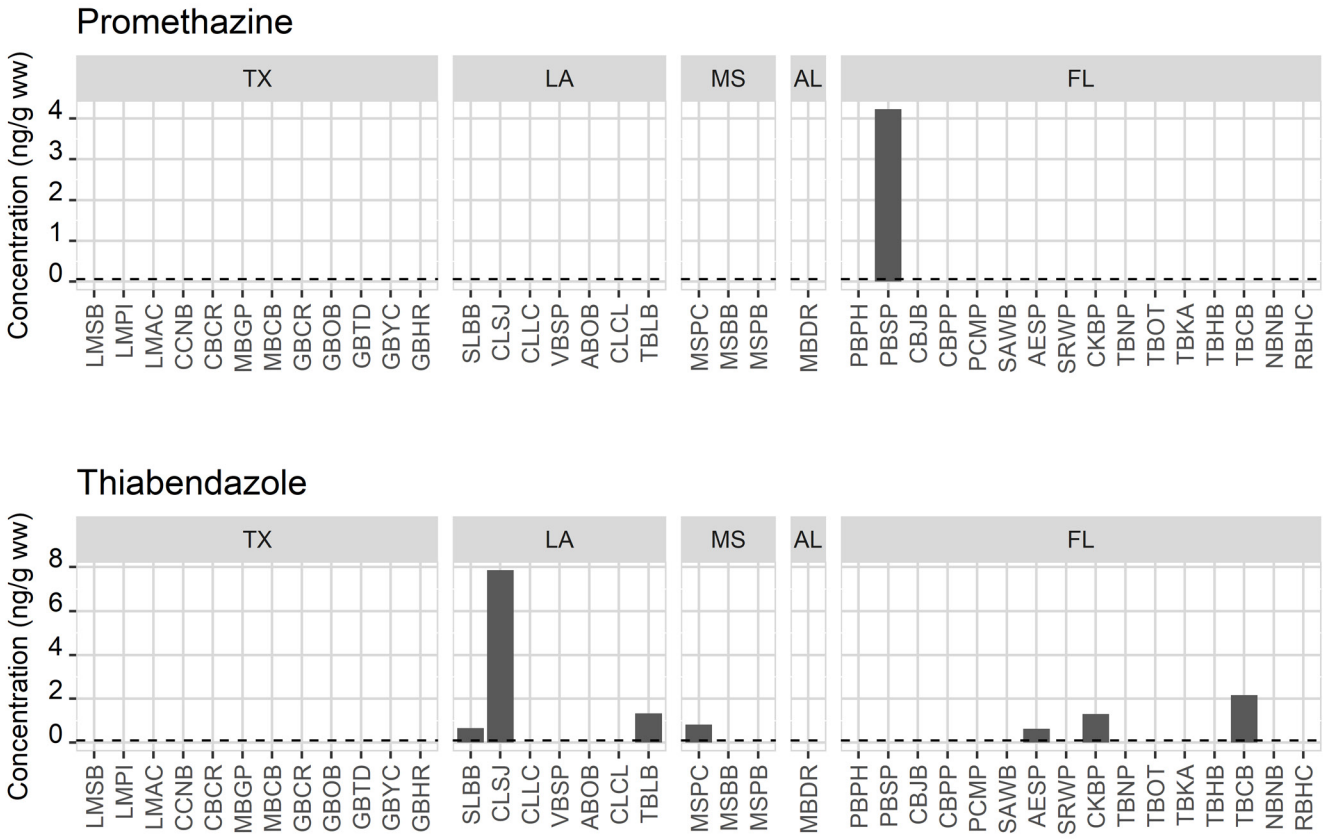


Figure 31. Bar graphs showing the magnitude of Misc. Prescription Drugs detected in oyster tissue in 2017 in the Gulf of Mexico. Dotted line represents the minimum weight-corrected MDL. Sites are listed geographically from west to east, following the GoM coastline.

9.9 PPCPs Summary

Oyster Tissue:

- PPCPs were analyzed at 39 out of 44 sites.
  - Not analyzed at sites CBSR, CCDC, CCNB, PBIB, and TBPB due to insufficient sample mass.
- PPCPs were detected at 30/39 sites.
- 25/118 PPCP compounds were detected at least once (Figure 18; Figure 20; Figure 22; Figure 24; Figure 26; Figure 28; Figure 30).
- Sertraline and cocaine were the most commonly detected PPCP compound with a frequency of 30.77% (Table 27; Table 29; Table 31; Table 33; Table 35; Table 37; Table 39).
- Minimum concentration detected was 0.05 ng/g ww of cocaine at site MBGP (Figure 19; FIgure 21; Figure 23; Figure 25; Figure 27; Figure 29; FIgure 31).
- Maximum concentration detected was 83.45 ng/g ww of DEET at site TBHB (Figure 19; FIgure 21; Figure 23; Figure 25; Figure 27; Figure 29; FIgure 31).
- Overall, PPCPs were detected 79/4,602 possible times (118 compounds x 39 sites) for an overall 0.02% frequency of detection in the Gulf of Mexico.
  - Antibiotic Prescription Drugs were detected 6/1,131 possible times (29 compounds x 39 sites) for an overall 0.53% frequency of detection in the Gulf of Mexico (Table 28).
  - Cardiovascular Prescription Drugs were detected 1/663 possible times (17 compounds x 39 sites) for an overall 0.15% frequency of detection in the Gulf of Mexico (Table 30).
  - Psychiatric Prescription Drugs were detected 29/468 possible times (12 compounds x 39 sites) for an overall 6.20% frequency of detection in the Gulf of Mexico (Table 32).
  - Hormone Prescription Drugs were detected 5/624 possible times (16 compounds x 39 sites) for an overall 0.8% frequency of detection in the Gulf of Mexico (Table 34).
  - Steroid Prescription Drugs were detected 1/312 possible times (8 compounds x 39 sites) for an overall 0.32% frequency of detection in the Gulf of Mexico (Table 36).
  - Recreational and Personal Care Drugs and Products were detected 29/663 possible times (17 compounds x 39 sites) for an overall 4.37% frequency of detection in the Gulf of Mexico (Table 38).
  - Misc. Prescription Drugs were detected 8/702 possible times (18 compounds x 39 sites) for an overall 1.13% frequency of detection in the Gulf of Mexico (Table 40).

General Observations:

- PPCPs were detected ubiquitously across the Gulf of Mexico coastlines, especially compared to other contaminant groups analyzed in this study (Figure 32).
- Overall, Psychiatric Prescription Drugs and Recreational and Personal Care Drugs and Products were the most prevalent groups of contaminants in the region.
- PPCPs were detected at lower concentrations in the Gulf of Mexico than in either the Gulf of Maine (Table A3) or the Southern California Bight (Table A5), with the exceptions of 17B-estradiol and DEET in the Gulf of Maine (Table A3) and Norfluoxetine and DEET in the Southern California Bight (Table A5).

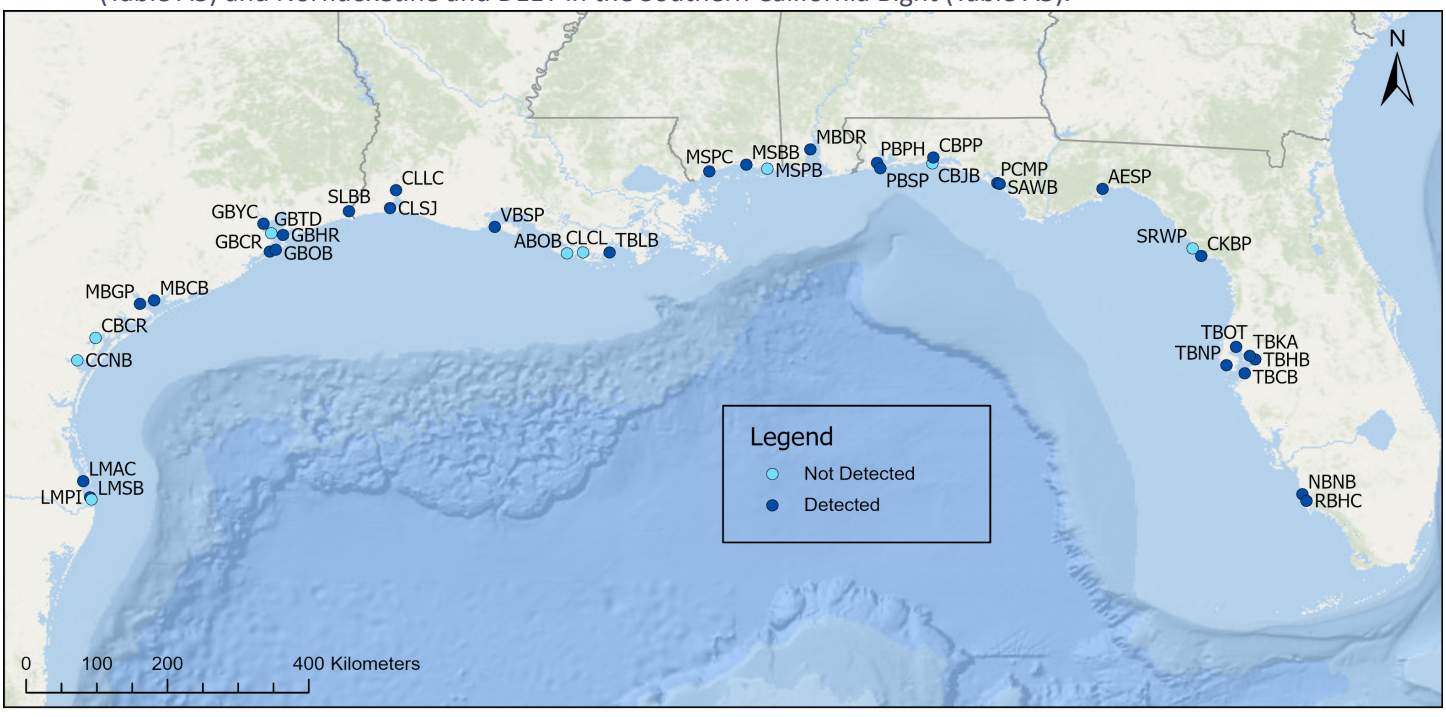


Figure 32. Map of Mussel Watch sites in the Gulf of Mexico highlighting locations of sites with PPCP compounds detected.

10.0 SUMMARY

Oysters are good indicators of water quality; hence, they have been used worldwide as sentinel species for chemical pollution in aquatic systems (Farrington, 1983). In this study, oyster tissue samples (*Crassostrea virginica*) were assessed for alkylphenol compounds (APs), alternative flame retardants (AFRs), polybrominated flame retardants (BFRs (PBDEs and PBBs)), current-use pesticides (CUPs), per- and polyfluoroalkyl substances (PFAS), and pharmaceutical and personal care products (PPCPs). The oyster samples were collected at historic MWP monitoring sites in the Gulf of Mexico. Sample collection was conducted by TDI Brooks Int. following standard protocols (Apeti et al., 2012). Depending on site location, oyster tissue from 44 monitoring sites was analyzed for a total of 13 - 244 individual CEC compounds. Separate result summaries for each CEC chemical class can be found in the Summary subsection of each CEC chemical class section within this document. This summary attempts to integrate all CEC contamination results into one analysis to assess the overall contamination of sites in the Gulf of Mexico (Figure 33). Overall site contamination analysis was done using a multivariate cluster analysis for sums of contaminant concentrations in oyster tissue samples. For each contaminant class, sites were clustered into five groups with statistically different degrees of overall contamination within this study.

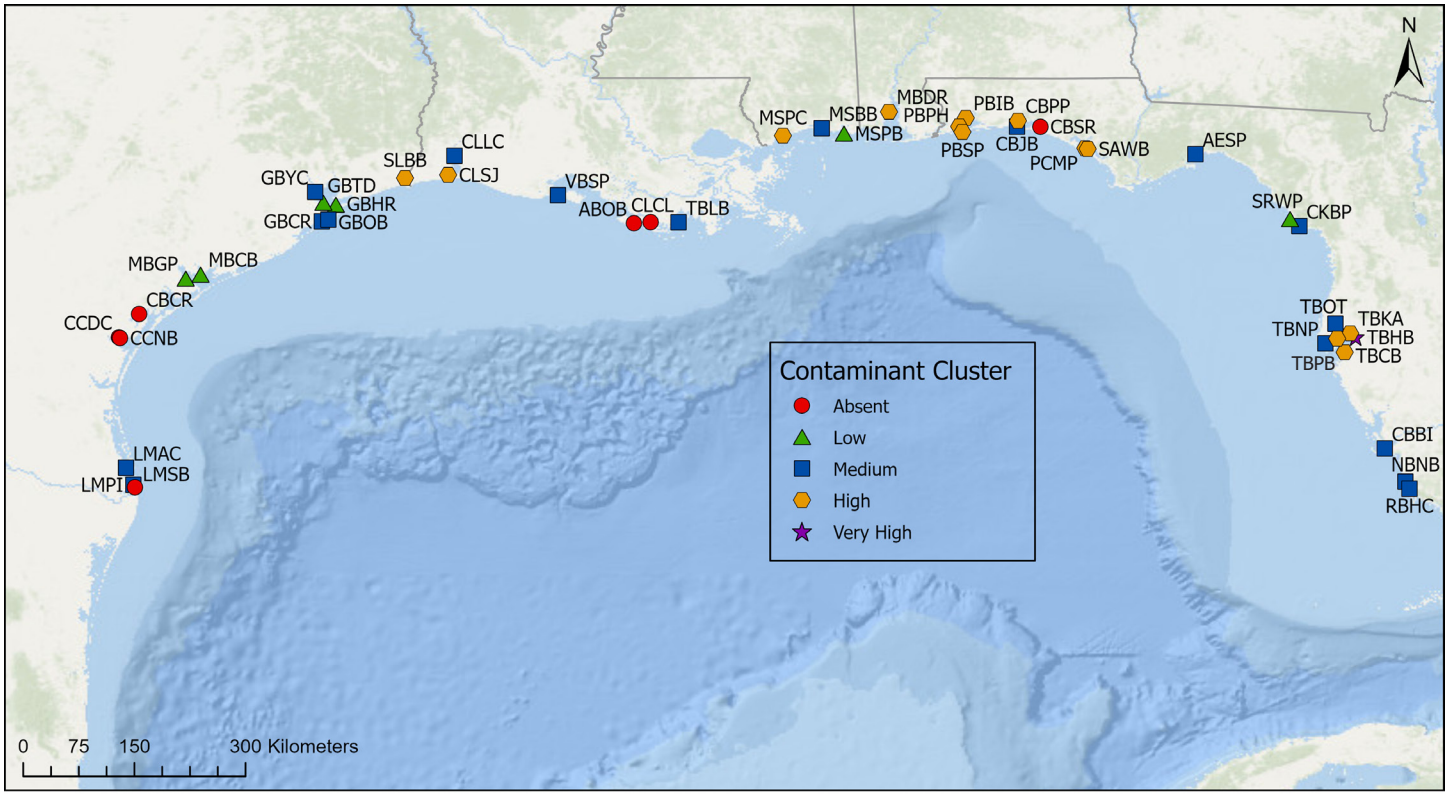


Figure 33. Map of Mussel Watch sites in the Gulf of Mexico highlighting locations with Absent, Low, Medium, High, and Very High degrees of contamination respective to one another in this study in oyster tissue.

The first observation of note is that seven oyster tissue sites (ABOB, CBCR, CBSR, CCDC, CCNB, CLCL, LMSB) had no detects of any CEC in any chemical class (Table 41, Table A2). These sites are generally located in more rural areas of the Gulf Coast, near South Padre Island, TX, Matagorda Bay, TX, and Terrebonne, LA where there is comparatively less human development than other sites assessed in this study (Figure 33). This distance from human presence and resulting inputs could explain the absence of detectable CEC contamination. Generally, the results indicate that, respective to sites analyzed in this study, low and medium contamination occurs across the Gulf of Mexico, and high and very high contamination occurs primarily in more densely populated and developed areas such as Lake Charles, LA, Pensacola, FL, Panama City, FL, and Tampa Bay, FL (Figure 33, Table A2). Most notably, the only site categorized as having “very high” contamination relative to the other sites analyzed (TBHB) is located near Tampa Bay, FL (Table A2).

Overall, the results indicate that CECs are present to varying magnitudes in the Gulf of Mexico and are accumulating at various concentrations in oysters. Oyster tissue samples from 37 out of 44 sites analyzed exhibited the presence of at least one CEC compound, highlighting the ubiquity of these contaminants in this region (Table 41). In oyster tissue, PFAS had the highest detection frequency (4.7%), followed by PPCPs (1.7%) (Table 42). It is important to note that the presence, magnitude, and bioaccumulation of CECs in organisms such as oysters are typically compound-dependent, with a small subset of contaminants representing the majority of detections within each chemical class.

Summary

Table 41. Summary of coastwide Gulf of Mexico compound detection frequency in oyster tissue at each site.

Site	Total Compounds Detected	Total Compounds Analyzed	Total Detection Frequency	AP Total	AFR Total	PBB Total	PBDE Total	CUP Total	PFAS Total	PPCP Total
ABOB	0	243	0.0	0	0	0	0	0	0	0
AESP	2	243	0.8	0	0	0	0	0	0	2
CBBI	1	122	0.8	--	0	0	0	0	1	--
CBCR	0	244	0.0	0	0	0	0	0	0	0
CBJB	3	243	1.2	0	0	0	1	1	1	0
CBPP	5	243	2.1	0	0	0	2	0	2	1
CBSR	0	13	0.0	--	--	--	--	--	0	--
CCDC	0	13	0.0	--	--	--	--	--	0	--
CCNB	0	244	0.0	0	0	0	0	0	0	0
CKBP	3	244	1.2	0	0	0	0	0	1	2
CLCL	0	243	0.0	0	0	0	0	0	0	0
CLLC	4	243	1.6	0	0	0	0	0	1	3
CLSJ	5	244	2.0	0	0	0	0	0	1	4
GBCR	3	244	1.2	0	0	0	0	0	0	3
GBHR	1	244	0.4	0	0	0	0	0	0	1
GBOB	5	214	2.3	0	0	0	2	--	0	3
GBTD	1	244	0.4	0	0	0	1	0	0	0
GBYC	8	244	3.3	0	0	0	5	0	1	2
LMAC	2	244	0.8	0	1	0	0	0	0	1
LMPI	3	244	1.2	0	0	0	0	0	0	3
LMSB	0	244	0.0	0	0	0	0	0	0	0
MBCB	1	244	0.4	0	0	0	0	0	0	1

Table 41 cont. Summary of coastwide Gulf of Mexico compound detection frequency in oyster tissue at each site.

Site	Total Compounds Detected	Total Compounds Analyzed	Total Detection Frequency	AP Total	AFR Total	PBB Total	PBDE Total	CUP Total	PFAS Total	PPCP Total
MBDR	9	244	3.7	0	0	0	2	0	2	5
MBGP	2	244	0.8	0	0	0	0	0	0	2
MSBB	2	243	0.8	0	0	0	0	0	1	1
MSPB	1	243	0.4	0	0	0	0	0	1	0
MSPC	5	243	2.1	0	0	0	0	0	1	4
NBNB	6	244	2.5	0	0	0	3	0	2	1
PBIB	1	52	1.9	--	0	--	--	0	1	--
PBPH	4	244	1.6	0	0	0	2	0	1	1
PBSP	5	244	2.0	0	0	0	1	0	1	3
PCMP	4	243	1.6	0	0	0	1	1	0	2
RBHC	5	244	2.0	0	0	0	1	0	1	3
SAWB	9	243	3.7	0	0	0	3	1	1	4
SLBB	6	244	2.5	0	0	0	0	0	1	5
SRWP	1	243	0.4	0	0	0	1	0	0	0
TBCB	7	244	2.9	0	0	0	2	0	1	4
TBHB	8	244	3.3	1	0	0	1	0	1	5
TBKA	9	244	3.7	0	0	0	3	0	1	5
TBLB	2	243	0.8	0	0	0	0	0	0	2
TBNP	4	244	1.6	0	0	0	0	0	1	3
TBOT	2	244	0.8	0	0	0	0	0	1	1
TBPB	3	92	3.3	--	0	0	2	--	1	--
VBSP	2	243	0.8	0	0	0	0	0	0	2

Table 42. Summary of coastwide Gulf of Mexico compound detection frequency in oyster tissue for each CEC compound class.

Compound Class	Total Detected	Total Possible Detects*	Total Detection Frequency
AP	1	156	0.6
AFR	1	378	0.3
PBB	0	779	0.0
PBDE	33	2091	1.6
CUP	3	1186**	0.3
PFAS	27	572	4.7
PPCP	79	4602	1.7

** Total Possible Detects = # Compounds * # Sites*

*** 14 is subtracted from Total Possible Detects because Phosmet was not analyzed at 14 sites*

Summary

While information regarding the environmental occurrence, distribution, toxicity, and overall impacts of CECs is still limited, the results of this study in the Gulf of Mexico were compared to two similar studies conducted in the Gulf of Maine in 2015/2016 (Apeti et al., 2021) and in the Southern California Bight in 2018 (Swam et al., 2023). Contaminant concentrations were normalized by percent lipid content for all studies to more accurately compare between species (Table A3; Table A5). A total of 23 CECs were detected in both the Gulf of Maine study (Apeti et al., 2021) and this Gulf of Mexico study (Table A3). Of those 23 compounds, the normalized contaminant concentrations were generally comparable, with 21/23 compounds having a difference of less than 1,000 ng/g lipid (Table A3). Further, all compounds analyzed in both studies were detected at lower average concentrations in the Gulf of Mexico in 2017 compared to the Gulf of Maine in 2015/2016 (Table A3), with the exception of 17B-estradiol and DEET (Table A3). These comparisons provide context that the concentrations found in the Gulf of Mexico in this study are generally consistent with existing data and suggest that CEC contamination may be comparatively lower in the region. More broadly, comparisons of the detection frequency of each chemical class between the two studies showed similar contamination frequencies for all classes, except for APs, which had nearly 10% lower frequency in the Gulf of Mexico (Table A4).

A total of 20 CECs were detected in both the Southern California Bight study (Swam et al., 2023) and this Gulf of Mexico study (Table A5). Of those 20 compounds, the normalized contaminant concentrations were generally comparable, with 18/20 compounds having a difference of less than 500 ng/g lipid. Further, APs, PBDEs, and most PPCPs were detected at lower average concentrations in the Gulf of Mexico in 2017 compared to the Southern California Bight in 2018 (Table A5). Conversely, PFOS, PFOSA, Norfluoxetine, and DEET were detected at comparatively higher concentrations in the Gulf of Mexico compared to the Southern California Bight in 2018 (Table A5). These comparisons provide context that the concentrations found in the Gulf of Mexico in this study are generally consistent with existing data and suggest that CEC contamination may be comparatively lower in the region, with the exception of a few contaminants. More broadly, comparisons of the detection frequency of each chemical class between the two studies showed similar contamination frequencies for all classes, except for APs, which had 16% lower frequency in the Gulf of Mexico (Table A6).

The influence of both anthropogenic and environmental factors makes it difficult to accurately predict the presence and concentration of CEC compounds in the environment. However, this study shows that they are present and bioaccumulating to varying magnitudes in coastal bivalves and sediment. This study provides needed data and information for the National MWP and provides contamination data required by coastal resource managers and other stakeholders as they develop long-term policies to protect the services provided by the coastal environment within this region.

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APPENDICES

Table A1. Percent dry values for tissue samples at each site collected in the Gulf of Mexico in 2017.

Site	% Dry of Tissue Samples*	Site	% Dry of Tissue Samples*
ABOB	9.68	MBDR	9.40
AESP	4.85	MBGP	4.10
CBBI	12.15	MSBB	6.84
CBCR	9.57	MSPB	6.84
CBJB	10.14	MSPC	4.96
CBPP	7.25	NBNB	9.82
CBSR	8.89	PBIB	10.09
CCDC	11.20	PBPH	7.21
CCNB	10.14	PBSP	8.82
CKBP	14.52	PCMP	10.22
CLCL	9.35	RBHC	3.88
CLLC	5.71	SAWB	8.80
CLSJ	7.14	SLBB	3.68
GBCR	7.58	SRWP	12.70
GBHR	7.48	TBCB	12.39
GBOB	7.14	TBHB	9.24
GBTD	1.68	TBKA	9.80
GBYC	7.14	TBLB	9.09
LMAC	10.71	TBNP	11.95
LMPI	10.43	TBOT	5.45
LMSB	8.18	TBPB	12.00
MBCB	5.52	VBSP	6.50

** conc. (ng/g ww) = conc. (ng/g dw) x (% dry / 100)*

Table A2. Breakdown of cluster analysis for oyster tissue in the Gulf of Mexico. The first section of the table is the cluster value assigned for each chemical class. The second section of the table is the calculations conducted to normalize the chemical class cluster sums by the number of chemical classes assessed at each site. The final column is the overall chemical contamination cluster rank assigned to each site.

Site	AP Clust	AFR Clust	PBB Clust	PBDE Clust	CUP Clust	PFAS Clust	PPCP Antibiotic Rx Clust	PPCP Cardio Rx Clust	PPCP Hormone Rx Clust	PPCP Psychiatric Rx Clust	PPCP Steroid Rx Clust	PPCP Misc. Rx Clust	Other PPCP Clust	PPCP Rec & PC Clust	Clust Sum	# Chem Classes Analyzed	Normalized Clust Value	Overall Clust Rank
ABOB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0	0
AESP	0	0	0	0	0	0	0	0	0	0	0	2	0	1	3	14	7.1	2
CBBI	--	0	0	0	0	2	--	--	--	--	--	--	--	--	2	5	13.3	2
CBCR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0	0
CBJB	0	0	0	1	1	1	0	0	0	0	0	0	0	0	3	14	7.1	2
CBPP	0	0	0	3	0	2	0	0	2	0	0	0	0	0	7	14	16.7	3
CBSR	--	--	--	--	--	0	--	--	--	--	--	--	--	--	0	1	0.0	0
CCDC	--	--	--	--	--	0	--	--	--	--	--	--	--	--	0	1	0.0	0
CCNB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0	0
CKBP	0	0	0	0	0	2	0	0	0	1	0	2	0	0	5	14	11.9	2
CLCL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0	0
CLLC	0	0	0	0	0	3	0	0	0	1	0	0	0	1	5	14	11.9	2
CLSJ	0	0	0	0	0	1	2	0	0	1	0	3	0	0	7	14	16.7	3
GBCR	0	0	0	0	0	0	0	0	0	0	3	0	0	1	4	14	9.5	2
GBHR	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	14	4.8	1
GBOB	0	0	0	1	--	0	0	0	0	1	0	0	0	1	3	13	7.7	2
GBTD	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	14	2.4	1
GBYC	0	0	0	2	0	1	0	0	0	1	0	0	0	1	5	14	11.9	2
LMAC	0	3	0	0	0	0	0	0	0	0	0	0	0	1	4	14	9.5	2
LMPI	0	0	0	0	0	0	0	0	3	0	0	0	0	1	4	14	9.5	2
LMSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0	0
MBCB	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	14	2.4	1

Table A2 cont. Breakdown of cluster analysis for oyster tissue in the Gulf of Mexico. The first section of the table is the cluster value assigned for each chemical class. The second section of the table is the calculations conducted to normalize the chemical class cluster sums by the number of chemical classes assessed at each site. The final column is the overall chemical contamination cluster rank assigned to each site.

Site	AP Clust	AFR Clust	PBB Clust	PBDE Clust	CUP Clust	PFAS Clust	PPCP Antibiotic Rx Clust	PPCP Cardio Rx Clust	PPCP Hormone Rx Clust	PPCP Psychiatric Rx Clust	PPCP Steroid Rx Clust	PPCP Misc. Rx Clust	Other PPCP Clust	PPCP Rec & PC Clust	Clust Sum	# Chem Classes Analyzed	Normalized Clust Value	Overall Clust Rank
MBDR	0	0	0	2	0	3	0	0	0	2	0	0	0	1	8	14	19.0	3
MBGP	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	14	4.8	1
MSBB	0	0	0	0	0	1	0	0	0	2	0	0	0	0	3	14	7.1	2
MSPB	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	14	2.4	1
MSPC	0	0	0	0	0	2	0	0	0	3	0	2	0	1	8	14	19.0	3
NBNB	0	0	0	1	0	2	0	0	0	2	0	0	0	0	5	14	11.9	2
PBIB	--	0	--	--	0	2	--	--	--	--	--	--	--	--	2	3	22.2	3
PBPH	0	0	0	2	0	2	0	0	0	3	0	0	0	0	7	14	16.7	3
PBSP	0	0	0	2	0	2	0	0	0	1	0	3	0	1	9	14	21.4	3
PCMP	0	0	0	1	3	0	0	0	2	1	0	0	0	0	7	14	16.7	3
RBHC	0	0	0	2	0	2	0	0	0	2	0	0	0	0	6	14	14.3	2
SAWB	0	0	0	2	2	1	0	0	0	2	0	0	0	1	8	14	19.0	3
SLBB	0	0	0	0	0	1	3	0	0	2	0	2	0	1	9	14	21.4	3
SRWP	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	14	2.4	1
TBCB	0	0	0	3	0	2	0	0	0	2	0	2	0	2	11	14	26.2	3
TBHB	3	0	0	2	0	2	1	3	3	0	0	0	0	3	17	14	40.5	4
TBKA	0	0	0	2	0	2	2	0	1	2	0	0	0	1	10	14	23.8	3
TBLB	0	0	0	0	0	0	0	0	0	0	0	2	0	1	3	14	7.1	2
TBNP	0	0	0	0	0	2	0	0	0	2	0	0	0	1	5	14	11.9	2
TBOT	0	0	0	0	0	2	0	0	0	1	0	0	0	0	3	14	7.1	2
TBPB	--	0	0	2	--	1	--	--	--	--	--	--	--	--	3	4	25.0	3
VBSP	0	0	0	0	0	0	0	0	0	2	0	0	0	1	3	14	7.1	2

Appendices

Table A3. Compound average concentration (ng/g lipid) comparison for compounds analyzed and detected in both this 2017 Gulf of Mexico study and the 2015/2016 Gulf of Maine MWP study. Concentrations have been normalized by % lipid** to account for species differences between studies.*

Chemical Class	Compound	Gulf of Mexico 2017 Average	Gulf of Maine 2015/2016 Average	Diff GoM - GoMaine
AFR	TBB	2.72	144.02	-141.30
Alkylphenols	NP1EO	15.21	866.61	-851.40
PBDE	PBDE-100	0.77	20.64	-19.87
PBDE	PBDE-47	6.28	19.45	-13.17
PBDE	PBDE-66	0.85	6.27	-5.41
PBDE	PBDE-71/49	2.65	20.97	-18.32
PBDE	PBDE-77	1.18	18.18	-17.00
PBDE	PBDE-99	0.79	12.32	-11.52
PFAS	PFOS	6.21	56.58	-50.37
PFAS	PFOSA	122.51	133.43	-10.92
PPCP Prescription Drugs (Antibiotic)	Azithromycin	6.19	110.07	-103.88
PPCP Prescription Drugs (Hormone)	17B-estradiol	76.55	61.14	15.41
PPCP Prescription Drugs (Psychiatric)	Amitriptyline	1.38	221.89	-220.51
PPCP Prescription Drugs (Psychiatric)	Fluoxetine	1.03	463.77	-462.74
PPCP Prescription Drugs (Psychiatric)	Meprobamate	10.50	5616.95	-5606.45
PPCP Prescription Drugs (Psychiatric)	Sertraline	12.26	415.89	-403.63
PPCP Recreational and Personal Care Drugs & Products	Benzoylecgonine	13.78	341.19	-327.41
PPCP Recreational and Personal Care Drugs & Products	Cocaine	5.21	119.62	-114.41
PPCP Recreational and Personal Care Drugs & Products	Cotinine	125.70	1427.00	-1301.30
PPCP Recreational and Personal Care Drugs & Products	DEET	545.04	513.66	31.38
PPCP Recreational and Personal Care Drugs & Products	Diphenhydramine	4.58	114.55	-109.97
PPCP Recreational and Personal Care Drugs & Products	Miconazole	12.35	337.62	-325.28
PPCP Recreational and Personal Care Drugs & Products	Triclocarban	2.68	341.50	-338.82

** conc. (ng/g lipid) = conc. (ng/g ww) / (% lipid / 100)*

*** % lipid average of 2017 Gulf of Mexico oysters: 0.713%; % lipid average of 2015/2016 Gulf of Maine mussels: 1.058%*

Table A4. Chemical class frequency of detection comparison between this 2017 Gulf of Mexico study and the 2015/2016 Gulf of Maine MWP study.

Chemical Class	Gulf of Mexico 2017			Gulf of Maine 2015/2016			Difference in Frequency
	# Detects	# Analyzed	Frequency (%)	# Detects	# Analyzed	Frequency (%)	
AP	1	156	0.6	16	160	10.0	-9.4
AFR	1	378	0.3	7	342	2.0	-1.8
PBB	0	779	0.0	0	779	0.0	0.0
PBDE	33	2091	1.6	150	2091	7.2	-5.6
CUP	3	1186*	0.3	0	1308	0.0	0.3
PFAS	27	572	4.7	18	480	3.8	1.0
PPCP	79	4602	1.7	113	4838	2.3	-0.6

** 14 is subtracted from # Analyzed because Phosmet was not analyzed at 14 sites*

Appendices

Table A5. Compound average concentration (ng/g lipid) comparison for compounds analyzed and detected in both this 2017 Gulf of Mexico study and the 2018 Southern California Bight MWP study. Concentrations have been normalized by % lipid** to account for species differences between studies.*

Chemical Class	Compound	Gulf of Mexico 2017 Average	Southern California Bight 2018 Average	Diff GoM - SoCal
Alkylphenols	NP1EO	15.21	1583.16	-1567.95
PBDE	PBDE-100	0.77	7.93	-7.16
PBDE	PBDE-17	0.49	2.05	-1.55
PBDE	PBDE-28	0.29	0.87	-0.58
PBDE	PBDE-47	6.28	39.61	-33.33
PBDE	PBDE-66	0.85	3.91	-3.06
PBDE	PBDE-71_49	2.65	7.92	-5.27
PBDE	PBDE-77	1.18	1.70	-0.52
PBDE	PBDE-85	0.70	0.97	-0.27
PBDE	PBDE-99	0.79	22.02	-21.23
PFAS	PFOS	6.21	1.05	5.16
PFAS	PFOSA	122.51	19.22	103.30
PPCP Prescription Drugs (Psychiatric)	Amitriptyline	1.38	3.26	-1.88
PPCP Prescription Drugs (Psychiatric)	Fluoxetine	1.03	7.18	-6.15
PPCP Prescription Drugs (Psychiatric)	Norfluoxetine	29.20	7.45	21.76
PPCP Prescription Drugs (Psychiatric)	Sertraline	12.26	39.84	-27.59
PPCP Prescription Drugs (Steroid)	Fluocinonide	43.93	87.78	-43.85
PPCP Recreational and Personal Care Drugs & Products	DEET	545.04	4.29	540.76
PPCP Recreational and Personal Care Drugs & Products	Diphenhydramine	4.58	6.05	-1.47
PPCP Recreational and Personal Care Drugs & Products	Triclocarban	2.68	5.76	-3.07

** conc. (ng/g lipid) = conc. (ng/g ww) / (% lipid / 100)*

*** % lipid average of 2017 Gulf of Mexico oysters: 0.713%; % lipid average of 2018 Southern California Bight mussels: 1.082%*

Table A6. Chemical class frequency of detection comparison between this 2017 Gulf of Mexico study and the 2018 Southern California Bight MWP study.

Chemical Class	Gulf of Mexico 2017			Southern California Bight 2018			Difference in Frequency
	# Detects	# Analyzed	Frequency (%)	# Detects	# Analyzed	Frequency (%)	
AP	1	156	0.6	22	132	16.7	-16.0
AFR	1	378	0.3	2	99	2.0	-1.8
PBB	0	779	0.0	0	646	0.0	0.0
PBDE	33	2091	1.6	76	1734	4.4	-2.8
CUP	3	1186*	0.3	2	990	0.2	0.1
PFAS	27	572	4.7	64	1089	5.9	-1.2
PPCP	79	4602	1.7	69	1409	4.9	-3.2

** 14 is subtracted from # Analyzed because Phosmet was not analyzed at 14 sites*

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