Assessment of per- and polyfluoroalkyl substances in Biscayne Bay Oysters

Catie Kaylor
catiekaylor@tamu.edu
Texas A&M University
Mentor(s): Natalia Soares Quinete, Danni Cui, Leila Soledade Lemos
FIU Coastal Ecosystems REU Site

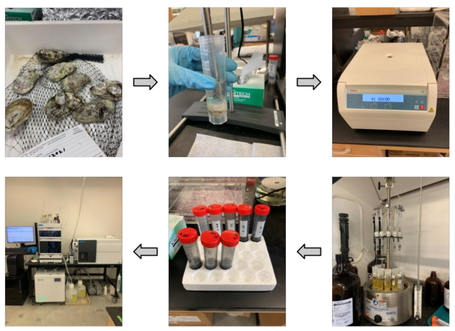
BACKGROUND

- Per- and polyfluoroalkyl substances (PFAS) are utilized for their unique properties in different industrial and consumer products, such as nonstick cookware and firefighting foam.
- PFAS are considered “forever chemicals” because they are not easily broken down and are bioaccumulated in the food chain. They also have negative health effects on marine fauna and humans[1].
- Oysters are filter-feeding sessile organisms, which makes them great bioindicators of environmental health.
- There is a knowledge gap of the amount of exposure of PFAS to American oysters (*Crassostrea virginica)* in South Florida.
- The main goal of this study was to evaluate if American oysters from Biscayne Bay were exposed to PFAS.

METHODS

- In November 2020, seventeen American oysters were collected from Biscayne Bay, FL, USA.
- The oysters were cleaned, measured, weighed, then spiked with internal standards and extracted with a methanol and potassium hydroxide solution[2].
- The oyster samples were then homogenized, centrifuged, and the supernatant was pipetted out to a separate tube. This procedure was repeated twice.
- After extractions, the samples were evaporated, cleaned by adding graphitized carbon and florisil, centrifuged and supernatant was pipetted out to another vial using a syringe and filter system.
- The samples were quantified using liquid chromatography-tandem mass spectrometry.
- Throughout the procedure, polypropylene tubes were used to avoid cross-contamination.
- A condition index was calculated using the following equation[3]:

[soft tissue wet weight (g) × 100] × [total animal fresh weight (g)]$^{-1}$



Biscayne Bay oysters are exposed to PFAS, which might be impacting their development.

PFAS Concentrations in Biscayne Bay Oysters

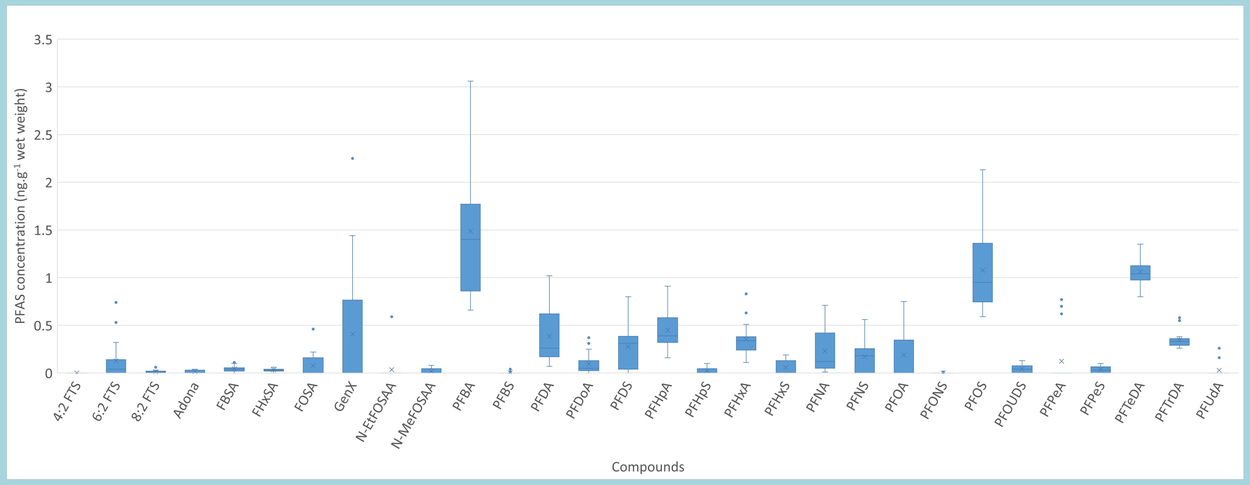


Figure 1: The concentrations of 30 target compounds of PFAS.

∑PFAS in Different Locations

Reference	Location	Animal	ΣPFAS (ng.g^{-1} wet weight) / # of Congeners
Kannan et al., 2001	Gulf of Mexico and Chesapeake Bay, U.S.	oysters	340.6 (n = 1)
Teunen et al., 2021	Belgium	mussels	22.4 (n = 13)
Our Study	Florida, U.S.	oysters	7.20 (n = 30)
Lee et al., 2019	Korea	bivalves	6.62 (n = 25)
Guo et al., 2019	China	mussels	5.97 (n = 23)
Abafe et al. , 2021	South Africa	mussels	5.78 (n = 15)
Maryland Department of the Environment	Maryland, U.S.	oysters	1.57 (n = 36)
Guo et al., 2019	China	oysters	0.990 (n = 23)
Abafe et al. , 2021	South Africa	oysters	0.654 (n = 15)

Figure 2: The comparison of the sum of PFAS in different bivalves' species around the world.

REFERENCES
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[2] Aquilina-Beck AA et al. 2020. Uptake and Biological Effects of Perfluorooctane Sulfonate Exposure in the Adult Eastern Oyster *Crassostrea virginica*. Archives of Environmental Contamination and Toxicology 79:333–342.
[3] Galvao P et al. 2014. Estimating the Potential Production of the Brown Mussel *Perna perna* (Linnaeus, 1758) Reared in Three Tropical Bays by Different Methods of Condition Indices. Journal of Marine Biology 2015:948053.
[4] EPA 2011. Intake of Fish and Shellfish. In: Exposure Factors Handbook. EPA: 206 p.

Hazard Risks for Human Consumption

	Hazard Risk - Florida Population (EDI: 0.8 g/Kg. day)	Hazard Risk - Heavy Consumers Population (EDI: 1.5 g/Kg. day)
PFOA	0.1067	0.2000
PFOS	0.4320	0.8100
PFHxS	0.0048	0.0090
PFNA	0.0613	0.1150
TOTAL	0.6048	1.1340

Figure 3: The hazard risks of 4 different PFAS compared between the Florida general population and heavy seafood consumers. EDI: estimated daily intake Source: EPA (2011).

The Correlation of Biometrics, Condition Index, and Contaminants

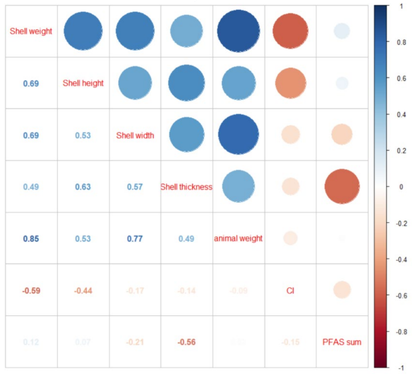

Figure 4: Spearman’s Rank Correlation Plot between the biometric variables, condition index, and the sum of PFAS.

CONCLUSIONS

- Out of all 30 target compounds tested, PFBA and PFOS had the highest concentrations.
- The strongest correlations were found among the oyster biometrics, but a moderate negative correlation was found between the sum of PFAS and shell thickness. This could mean that PFAS contamination might be affecting oyster development (growth and metabolism) in Biscayne Bay which can lead to large ecological impacts.
- Although oysters in Biscayne Bay are not typically consumed, their hazard risk value indicates that heavy seafood consumers would be at high risk from eating them.

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