FACT SHEET

# PFAS IN NEW ENGLAND SHELLFISH

**Jess Brandt and Kaitlyn Campbell, Department of Natural Resources and the Environment & Center for Environmental Sciences and Engineering, University of Connecticut**

**Rainer Lohmann, Graduate School of Oceanography, University of Rhode Island**

**NOAA scientists and state collaborators collect blue mussels in Buzzards Bay, Mass., in 2021 for PFAS analysis as part of the National Mussel Watch Program. Photo: Tony Williams**

### What Are PFAS?

Per- and polyfluoroalkyl substances, commonly referred to as PFAS, are a family of thousands of different manufactured chemicals. PFAS have been in use since the 1940s and commonly occur in a variety of industrial and consumer products, including non-stick coatings, cosmetics, medical devices, textiles, carpets, food packaging, firefighting foams, and metal plating, among others (Gaines 2023; Glüge et al. 2020). PFAS are characterized by their strong molecular bonds and are categorized in two groups based on different chemical structures: PFSAs (perfluoroalkyl sulfonic acids) and PFCAs (perfluoroalkyl carboxylic acids). Some PFAS are PFAS compounds can transform into other types of PFAS after they are released to the environment (Pickard et al. 2022).

PFAS repel oil and water, and are able to withstand high temperatures. These properties make them persistent in the environment where they can build up in water, soil, sediment, plants, and animals over time (Giffard et al. 2022). PFAS contamination is widespread and PFAS are commonly detected in samples from these mediums worldwide (Cousins et al. 2022, EPA 2024). People are routinely exposed to PFAS by using PFAS-containing products and by consuming contaminated water and food, leading to detectable levels of PFAS in their blood and tissues (ATSDR 2024). PFAS exposure has been associated with reproductive, developmental and immune health effects (among others) and the consequences of long-term PFAS exposure for human health is an active area of research (EPA 2024). PFAS are considered contaminants of primary concern due to their global distribution, environmental persistence, bioaccumulation in wildlife and people and potential toxicity.

PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid) are the two PFAS compounds that have received the most scientific and regulatory attention. Between 2000-2015, these compounds were largely phased out of production in the United States and elsewhere due to increasing concerns about their environmental contamination and human health consequences. Despite their status as "legacy" compounds, PFOS and PFOA continue to be detected in environmental samples and are often the most prevalent PFAS compounds due to their persistence. They are listed as "Hazardous" under the U.S. Superfund Law and are regulated in drinking water at the 4 parts per trillion (ppt) level (U.S. EPA). Manufacturers have since replaced PFOS and PFOA with alternative compounds that are thought to be less bioaccumulative and toxic. These alternatives are increasingly reported in studies of PFAS contamination, but relatively little is known about their environmental behavior or health risks (Sunderland et al. 2019).

### PFAS in Aquatic Ecosystems and Food Webs

PFAS are unintentionally released into waterways during manufacturing processes, and during the use and disposal of industrial and consumer products. They also enter surface waters through atmospheric deposition, precipitation, runoff from land surfaces and groundwater discharge (Brumovský et al. 2017). Many PFAS compounds are soluble, meaning they easily travel in water. River flows and effluents from treatment facilities are therefore important for PFAS distribution into coastal areas and the open ocean (Muir and Miaz, 2021). Coastal waters with nearby sources of PFAS tend to have higher concentrations than the open ocean where concentrations become more diluted (Lee et al. 2020, Savvidou et al. 2023).

PFAS compounds differ in their environmental behavior due to differences in their chemical structures. Several compounds have been shown to build up in the tissues of aquatic animals over time (bioaccumulate) and some increase in concentrations along food chains (biomagnification).


**Oyster shucking for soft tissue collection in the Brandt Lab at UConn. Photo: Anika Agrawal**

### PFAS Concentrations in Seafood and Shellfish

Shellfish, such as filter-feeding bivalves, primarily accumulate PFAS from the surrounding water and their diet (Burkhard 2021; Burkhard and Votava 2023), and the compounds and levels of PFAS in their tissues are influenced by those in the water and their food. Even in areas where PFAS concentrations in seawater are low and/or below the level of analytical detection, PFAS may be measured in bivalve tissues due to the concentration enrichment processes of bioaccumulation and biomagnification (Aquilina-Beck et al. 2020). Limited evidence from studies with Eastern oysters suggests that bivalves can eliminate some PFAS compounds from their tissues when transferred to a clean environment (Aquilina-Beck et al. 2020, Campbell et al. *in prep*).

**Dr. Kaitlyn Campbell taking water quality measurements at coastal Long Island Sound study sites. Photo: Chris Perkins.**

Alongside drinking water, food consumption is one of the most important pathways of human exposure to PFAS. The European Food Safety Authority recently estimated that fish and other seafood contribute 86% of adult dietary PFAS exposure (Giffard et al. 2022, Sunderland et al. 2021). However, the importance of seafood to a person's overall exposure to PFAS will depend on the types and amounts of seafood consumed, and the levels of PFAS in that seafood. Current analytical methods only enable researchers to measure a small subset of PFAS compounds and studies typically report concentrations for up to a few dozen compounds. Concentrations are most often reported in units of nanograms of PFAS per gram of tissue on a wet weight basis (ng/g ww, or parts per billion "ppb").

In general, the highest seafood PFAS concentrations are measured in animals collected from contaminated areas such as industrial sites (Ruffle et al. 2020, Sunderland et al. 2021). Seafood harvest is prohibited in these areas. Studies of market-sourced commercial seafood in the United States report that PFAS are infrequently detected in finfish and shellfish (FDA 2019, Ruffle et al. 2020), whereas studies also including samples collected from other parts of the world (primarily Europe and Asia) report that concentrations can exceed 100 ppb (Giffard et al. 2022, Bedi et al. 2023). Due to their history of high-volume use, the legacy compounds PFOS and PFOA are the most commonly measured and detected compounds in shellfish tissues and are often reported to have the highest concentrations among the compounds analyzed (Giffard et al. 2022).

There has been little research on how PFAS occurrence and concentrations differ among seafood types collected from a given location, limiting our understanding of the relative risks of locally-sourced seafood options. Results from Narragansett Bay indicate that benthic omnivores (American lobsters, winter skates, and cancer crab) and pelagic piscivores (striped bass and bluefish) demonstrated the greatest average summed PFAS concentrations across all species sampled (Hedgespeth et al., 2023). Some types of shellfish (lobster, shrimp, and sea scallops) were recently found to have higher concentrations than fish species including cod, haddock, salmon, and tuna collected from the Gulf of Maine, which may be due to differences in both diet types and habitat uses among species (Crawford et

**Table 1. Consumption Guidelines for Fish and Shellfish in New England**[1]

| State | Food item | Compounds | Guideline | Frequency |
|---|---|---|---|---|
| CT | Fish and shellfish | PFOS, PFOA | < 20 ppb | No consumption advice (unlimited consumption) |
| CT | Fish and shellfish | PFOS, PFOA | 20 to < 40 ppb | No more than 1 meal/week |
| CT | Fish and shellfish | PFOS, PFOA | 40 to < 159 ppb | No more than 1 meal/month |
| CT | Fish and shellfish | PFOS, PFOA | ≥159 ppb | Do not eat |
| ME | Fish | PFOS | 3.5 ppb | 1 8-oz meal/week |
| ME | Fish | PFOS | 14 ppb | 1 8-oz meal/month |
| ME | Fish | PFOS | 60 ppb | 3 8-oz meal/year |

al. 2024). Other types of shellfish have been reported as having lower PFAS concentrations than other shellfish (Hedgespeth et al. 2023). Among bivalve shellfish, limited data suggests that clams and mussels may accumulate higher concentrations than scallops and oysters (Guo et al. 2018).

Only a handful of studies have assessed PFAS concentrations in marine shellfish from New England. A study including American lobsters and blue mussels collected from Narragansett Bay detected 11 of the 24 PFAS targeted compounds. Concentrations of individual compounds were mostly in the low parts per billion and summed PFAS concentrations of up to seven compounds measured in an individual sample ranged from below detection limits to 21.1 ppb. Eastern oysters and ribbed mussels deployed offshore near Groton, CT, for two months were found to contain up to seven of the 28 PFAS compounds analyzed. Concentrations of detected compounds were also in the low parts per billion, with summed concentrations ranging from below detection to 5.63 ppb (Campbell et al. *in prep*). Eastern oysters from areas in New Haven where shellfish harvest is prohibited due to contamination had similar concentrations, with elevated levels of specific compounds. These concentrations are similar to those recently reported for lobster and shrimp from the Gulf of Maine (Crawford et al. 2024), and within the lower ranges of summed PFAS concentrations recently reported for several freshwater species in the United States (Barbo et al. 2023).

### Health Concerns for PFAS in Shellfish

The New England studies of PFAS concentrations in shellfish described above report concentrations of PFOS and PFOA that are below the consumption advisory thresholds set by Connecticut and Maine for fish and shellfish (Table 1). Similarly, concentrations in more than 80% of shellfish samples were either below the detection limit or lower than the European Food Safety Authority (EFSA)'s maximum contamination limits for specific PFAS compounds. These results indicate low levels of exposure for these specific compounds from shellfish consumption in New England. Further, advisory thresholds have not been established for all PFAS compounds that have been detected in New England shellfish. However, there is evidence that concentrations vary with shellfish type and location. PFAS risks associated with shellfish consumption in this region will therefore depend on where the shellfish are sourced from, as well as the types, amounts, and frequency of shellfish meals.

### In Summary

PFAS science is rapidly advancing. Studies about PFAS toxicity for aquatic animals and their consumers, including people, will continue to inform the suitability of existing consumption guidelines for protecting aquatic life and public health. While studies about PFAS in New England shellfish are limited in their geographic distribution and the species sampled, they primarily report low concentrations and concentrations below the current advisory thresholds for PFOS and PFOA. Increased monitoring will help us understand where there are relatively high and low concentrations of PFAS in shellfish, as well as the differences in PFAS exposure associated with various shellfish species.

### Learn More

U.S. ATSDR (2024): https://www.atsdr.cdc.gov/pfas/index.html

U.S. EPA (2024): https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas

[1]The New England studies of PFAS concentrations in shellfish described in this table report concentrations of PFOS and PFOA that are below the consumption advisory thresholds set by Connecticut and Maine for fish and shellfish.

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