PFAS in Select Connecticut Fish Tissue Samples

Connecticut Department of Energy and Environmental Protection (CT DEEP)

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Introduction

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals defined by containing a very strong carbon-fluorine bond that causes them to degrade extremely slowly in the environment, and are created to resist grease, oil, water and heat. When consumed, PFAS can cause health defects such as cancer and sepsis, as well as impact the immune system, nervous system, and cardiovascular system[1].

One significant source of PFAS exposure in the US is through the ingestion of freshwater fish. Those who are reliant on freshwater fish consumption for sustenance and consume freshwater fish on a weekly basis likely have significantly higher PFOS serum levels, which can negatively impact their health[2].

The US Environmental Protection Agency (EPA) conducts the National River and Streams Assessment (NRSA) on a recurring five-year basis[3]. In order to evaluate the prevalence of PFAS in fish tissue throughout the United States, during the last three NRSA study cycles (2008-09, 2013-14, and 2018-19), fish tissue specimens were tested for PFAS concentration. The first two study cycles analyzed for 13 PFAS compounds while the last study cycle analyzed for 33 total PFAS compounds (original 13 including 20 more).[4, 5]

Study Objectives

This study sought to explore trends in PFAS concentrations in fish tissue collected from Connecticut waterbodies. Specific questions considered included:

1. Have PFOS concentrations in Connecticut fish tissue changed over time?
2. Are there specific water bodies in Connecticut with elevated PFAS concentrations in fish tissue?
3. Does PFOS concentration vary by fish species?
4. How do the Connecticut-specific results compare to the national NRSA study results overall?

Methods

This study utilized data collected through the National River and Streams Assessment (NRSA). Data were downloaded from the US EPA's website[3]. Connecticut data were then manually extracted from this dataset for further analysis using Microsoft Excel.

Average PFAS concentrations for Connecticut fish tissue were calculated by site, waterbody and fish species. These values were compared to national PFAS concentrations calculated by Stahl *et al.* (2014)[4] for the 2008-09 national NSRA dataset, and Stahl *et al.* (2023)[5] for the 2013-14 and 2018-19 national NSRA datasets.

Finally, Connecticut fish tissue concentrations were compared to consumption guidelines established by the CT Department of Public Health (DPH) in 2022[6].

Results

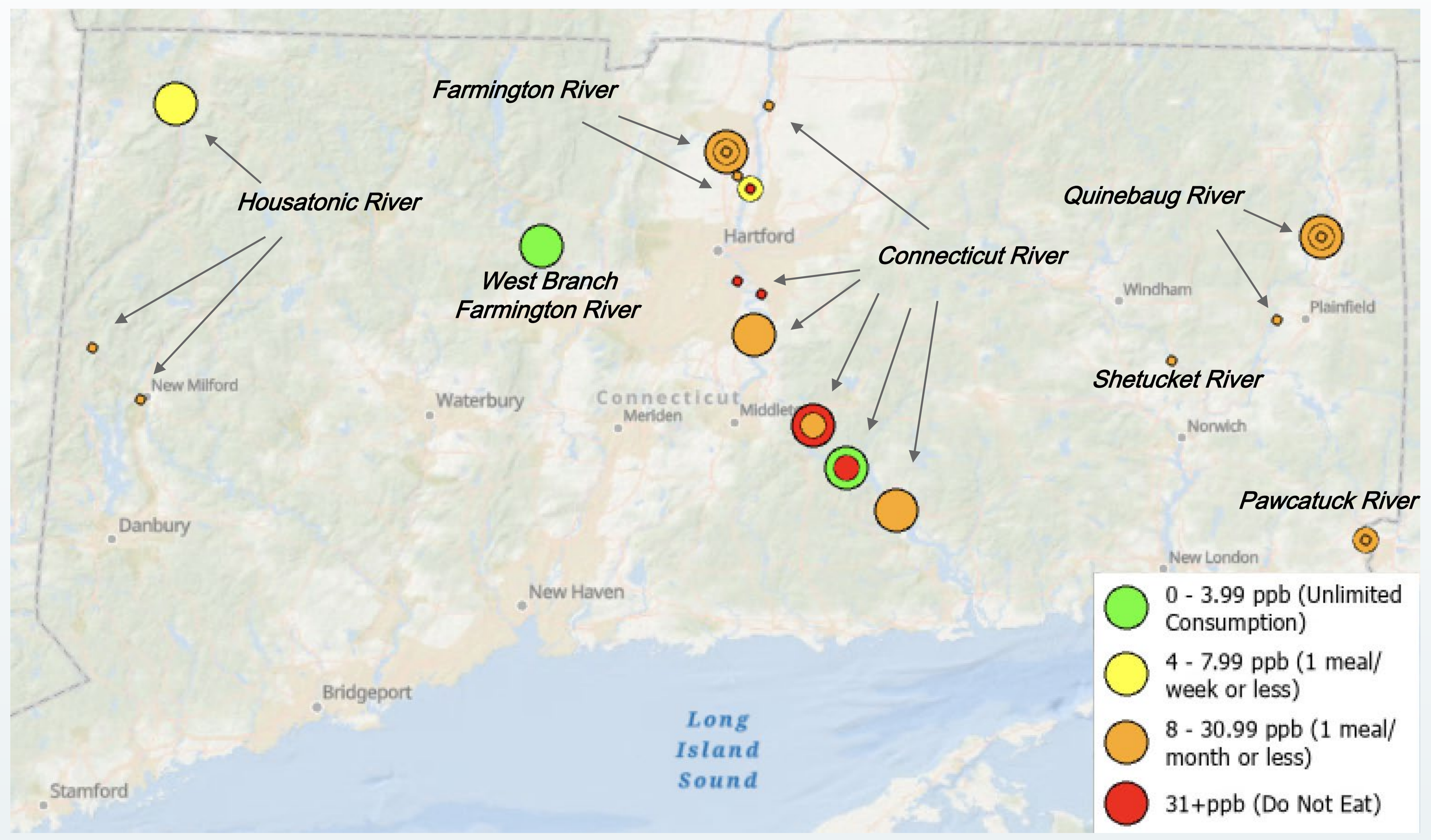

Figure 1. Map depicting NRSA fish tissue collection locations in Connecticut. Sample year is indicated by the size of the dot on the map, with the smallest dots indicating those samples collected between 2008-2009 and the largest being those collected between 2018-2019. Color indicates the average PFOS concentration in the tissue sample following CT DPH guidelines[6].

Abbreviation	PFAS Compound	2008-2009 (n=13)	2013-2014 (n=6)	2018-2019 (n=8)	All Years (n=27)
PFOS	Perfluorooctanesulfonate	92% (12)	100% (6)	100% (8)	96% (26)
PFUnA	Perfluoroundecanoate	62% (8)	100% (6)	100% (8)	81% (22)
PFDA	Perfluorodecanoate	31% (4)	100% (6)	100% (8)	67% (18)
PFDoA	Perfluorododecanoate	38% (5)	100% (6)	88% (7)	67% (18)
PFOSA	Perfluorooctane sulfonamide	0% (0)	83% (5)	75% (6)	41% (11)
PFNA	Perfluorononanoate	0% (0)	67% (4)	75% (6)	37% (10)
PFTeDA	Pefluorotetradecanoic acid	N/A	N/A	75% (6)	22% (6)
PFTrDA	Perfluorotridecanoic acid	N/A	N/A	75% (6)	22% (6)
PFDS	Perfluorodecanesulfonic acid	N/A	N/A	50% (4)	15% (4)
PFHxA	Perfluorohexanoate	0% (0)	33% (2)	0% (0)	7% (2)
PFBA	Perfluorobutyric acid	0% (0)	0% (0)	13% (1)	4% (1)
PFHxS	Perfluorohexane sulfonate	0% (0)	0% (0)	13% (1)	4% (1)
PFOA	Perfluorooctanoate	0% (0)	0% (0)	13% (1)	4% (1)
PFBS	Perfluorobutane sulfonate	0% (0)	0% (0)	0% (0)	0% (0)
PFHpA	Perfluoroheptanoate	0% (0)	0% (0)	0% (0)	0% (0)
PFPeA	Perfluoropentanoate	0% (0)	0% (0)	0% (0)	0% (0)

Table 1. Table of PFAS compound frequencies in Connecticut Samples. This table represents the frequency of detection by PFAS compound. Compounds shaded in gray were detected in less than 10% of samples over all study cycles. The numbers in parentheses indicate the number of samples that the compound was detected in. "N/A" is used to indicate that a compound was not analyzed for during a given study cycle.

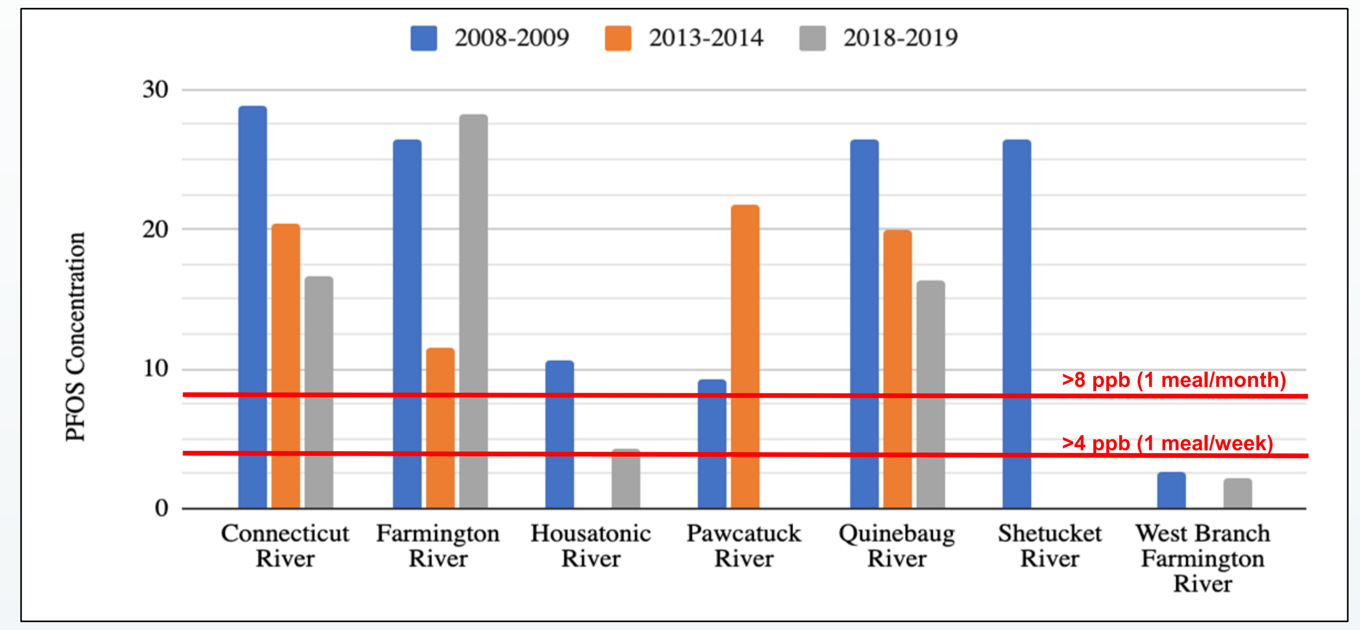

Figure 2. Average PFOS Concentration by Waterbody. Data points represent the average PFOS concentration of all samples collected from that water body during the indicated study cycle. Red lines indict CT-specific PFOS consumption guidelines.[6]

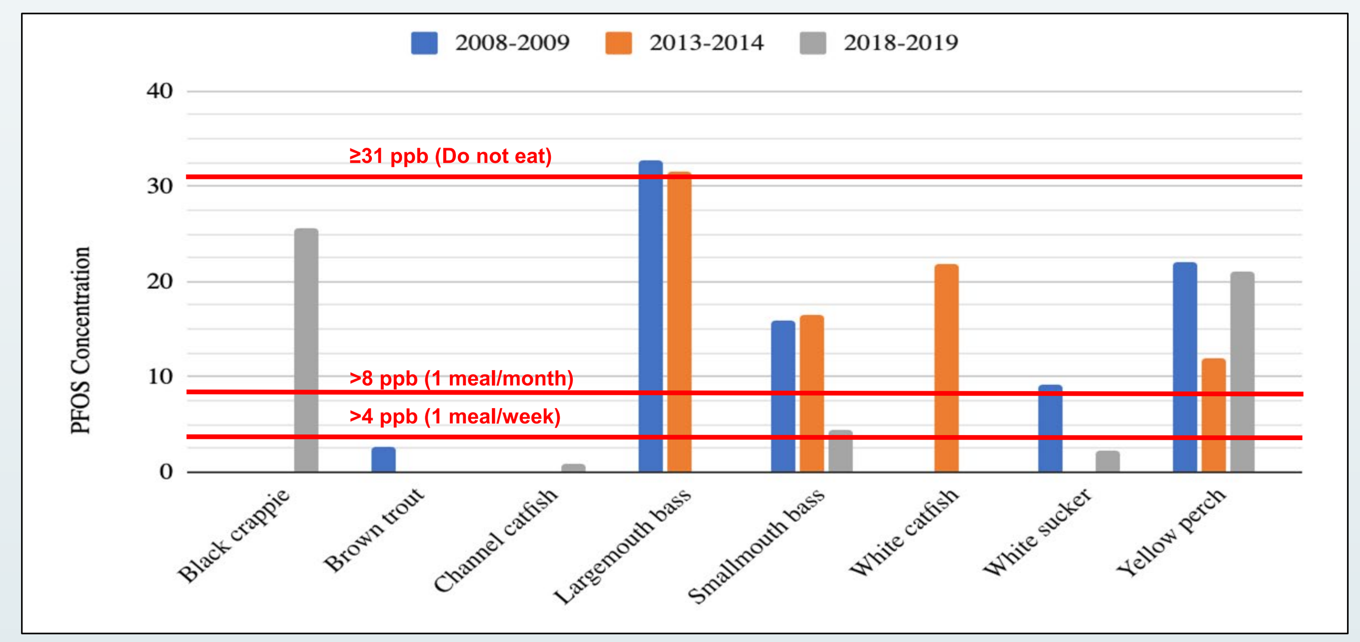

Figure 3. Average PFOS Concentration by Fish Species. Data points represent the average PFOS concentration of all samples of that species during a given study cycle, regardless of the waterbody collected from. For samples that were non-detect for PFOS, the median detection limit was substituted for graphing purposes.

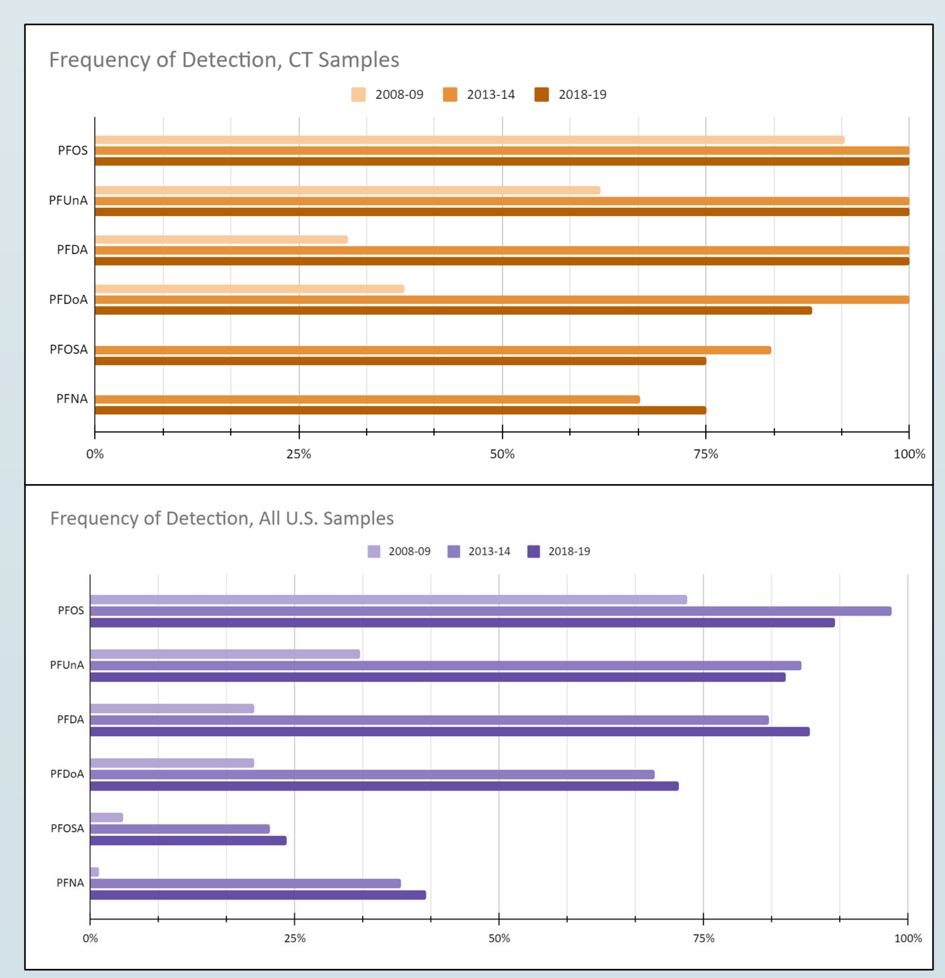

Figure 4. Comparison of PFAS Frequency of Detection: Connecticut vs. all U.S. Samples. Data represent the frequency of detection of a given compound across all samples during the indicated study cycle. Only those PFAS compounds analyzed for during all three study cycles and present in 10% or more of Connecticut samples are shown. (PFTeDA, PFTrDA, and PFDS were detected in greater than 10% of samples collected in Connecticut between 2018-2019, but were not analyzed for in previous cycles and are therefore not included.)

Discussion

No clear trend in PFOS concentrations in Connecticut fish tissue was observed over time (Figure 1). The design of the NRSA was not meant to analyze the data of specific states, but rather the nation as a whole. Therefore, over the three study cycles, each site in Connecticut was only sampled an average of 1.42 times. If all sites had been sampled across all study cycles, trends through time may have been more apparent. Another limitation of this study was that the method detection limits (MDLs) for the PFAS compounds varied between study cycles. MDLs over all study cycles were the highest (least sensitive) in the 2008-09 study cycle and lowest (most sensitive) in the 2013-14 study cycle. Higher MDLs may have prevented detection of PFAS compounds otherwise present.

No clear trend in fish tissue PFOS concentrations was observed by waterbody (Figure 2). PFOS concentrations in the Connecticut River, Housatonic River, Quinebaug River and West Branch Farmington River, may be decreasing with time. Concentrations in the Pawcatuck River, which forms the Connecticut-Rhode Island border, appear to be increasing. No clear trend was observed in the Farmington River watershed. When observing PFOS concentrations in fish tissue collected from Connecticut sites during the NRSA study that have been sampled more than once, there was no overall trend. It was noted, however, that 4 of 6 of these sites were sampled using more than 1 different fish species over all study cycles, which may have drastically influenced results.

PFAS concentrations varied by species (Figure 3). Largemouth bass accumulated the highest PFOS concentrations. By contrast, brown trout, channel catfish and white sucker had lower PFOS concentrations. Data suggests that it may be safer to eat these lower PFAS-accumulating freshwater fish rather than the largemouth bass and black crappie. Curiously, a single brown trout sample collected from the West Branch Farmington River during the 2008-2009 cycle was the only sample that did not show detectable levels of PFOS. This brown trout was potentially hatchery raised. Past analysis of hatchery trout by DEEP has confirmed they are low in PFAS. Perhaps it is safer to consume hatchery-raised stocked fish rather than wild caught fish. PFAS are known to bioaccumulate more in some species more than others[2], which may have contributed to the variability seen in these data. Results in locations should be well-understood and used with caution when comparing bottom-feeding and predator species because different species bioaccumulating PFAS differently will not correctly represent PFAS trends over time at specific sites, especially those featured in more than one study cycle.

When comparing Connecticut and national frequency data, both showed detection of similar compounds, but at different detection rates (Figure 4). In Connecticut, as well as nationally, PFOS, PFUnA, and PFDA were the PFAS compounds detected most frequently in samples. During the last 2 study cycles, these compounds were found in more than 75% of samples in Connecticut as well as nationally. PFDoA, PFOSA, and PFNA were detected in Connecticut samples 2-3 times more often than nationally overall. On the other hand, PFBS, PFHpA and PFPeA were not present in any CT samples, but were observed in samples collected elsewhere in the U.S.

Data interpretation was limited by 1) inconsistent sampling of Connecticut study sites, 2) inconsistent species selection for samples, and 3) changes in laboratory detection limits. While these data are useful for informational purposes, they are insufficient to evaluate PFAS in Connecticut fish tissue on a statewide basis. To effectively evaluate fish tissue PFAS trends in Connecticut, a state-specific study that incorporates multiples species and waterbodies, as well as allows for assessment of variability over time (e.g., by incorporating repeat sampling at a standard set of sites), is needed.

References

[1] Meneguzzi, A., Fava, C., Castelli, M., Minuz, P. (2021). Exposure to Perfluoroalkyl Chemicals and Cardiovascular Disease: Experimental and Epidemiological Evidence. Front Endocrinol (Lausanne), 12, 706352

[2] Barbo, N., Stoiber, T., Naidenko, O. V., Andrews, D. Q. (2023.) Locally caught freshwater fish across the United States are likely a significant source of exposure to PFOS and other perfluorinated compounds. Environmental Research, 220, 115165.

[3] U.S. EPA Website: National Rivers and Streams Assessment. www.epa.gov/national-aquatic-resource-surveys/nrsa

[4] Stahl, L. L., Snyder, B. D., Olsen, A. R., Kincaid, T. M., Wathen, J. B., McCarty, H. B. (2014). Perfluorinated compounds in fish from U.S. urban rivers and the Great Lakes. Science of the Total Environment, 499, 185-195.

[5] Stahl, L. L., Snyder, B. D., McCarty, H. B., Kincaid, T. M., Olsen A. R., Cohen, T. R., & Healey, J. C. (2023). Contaminants in fish from U.S. rivers: Probability-based national assessments. Science of the Total Environment, 861, 160557.

[6] Rusnak, S. (2023). PFOS in Fish Consumption Limits. Connecticut Department of Public Health (CT DPH). Hartford, CT.