NJ Department of Environmental Protection
Division of Science & Research

A Factsheet: Determination of fish bioaccumulation factors (BAFs) for selected PFAS contaminants in marine and freshwater systems

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What was the purpose of the study?

This study investigated the bioaccumulation of certain per- and polyfluoroalkyl substances (PFAS) in fish from New Jersey lakes, rivers, and coastal waters. Bioaccumulation is the process by which concentrations of a chemical contaminant increase in an organism over time. Some PFAS bioaccumulate to levels of concern for human health. Therefore, people who eat fish containing these contaminants may be at risk. Sampling and analyzing surface water and fish tissue for levels of PFAS served as the primary method to calculate bioaccumulation factors (BAFs), the ratio of a contaminant's concentration in fish relative to the concentration in water. For some contaminants, ratios of a contaminant in sediment and biota can also be used to derive sediment BAFs. These factors are used to develop water quality standards to protect human health from elevated concentrations of contaminants, in this case PFAS, in surface waters.

What was the general approach?

Preliminary water samples from numerous sites were tested for PFAS and other water quality parameters to identify sites most suitable for this study. A final list of 11 saline water sites and 22 freshwater sites (Figure 1) were selected, and surface water, sediment, and fish tissue samples were collected over two years (2022-2023). These environmental samples were analyzed for PFAS concentrations and other water quality characteristics, including temperature, specific conductance, dissolved oxygen, pH, and salinity to support BAF calculations. Methods to analyze diet were also performed to understand if fish from different parts of the food chain had differences in PFAS bioaccumulation potential. BAFs were determined using mathematical methods outlined by the United States Environmental Protection Agency (USEPA) as well as other statistical methods to represent a holistic view of the bioaccumulation of PFAS into fish tissue. The final values for the BAFs include a 95%

upper confidence limit to account for variability throughout the study and to provide a conservative measure for risk evaluation.

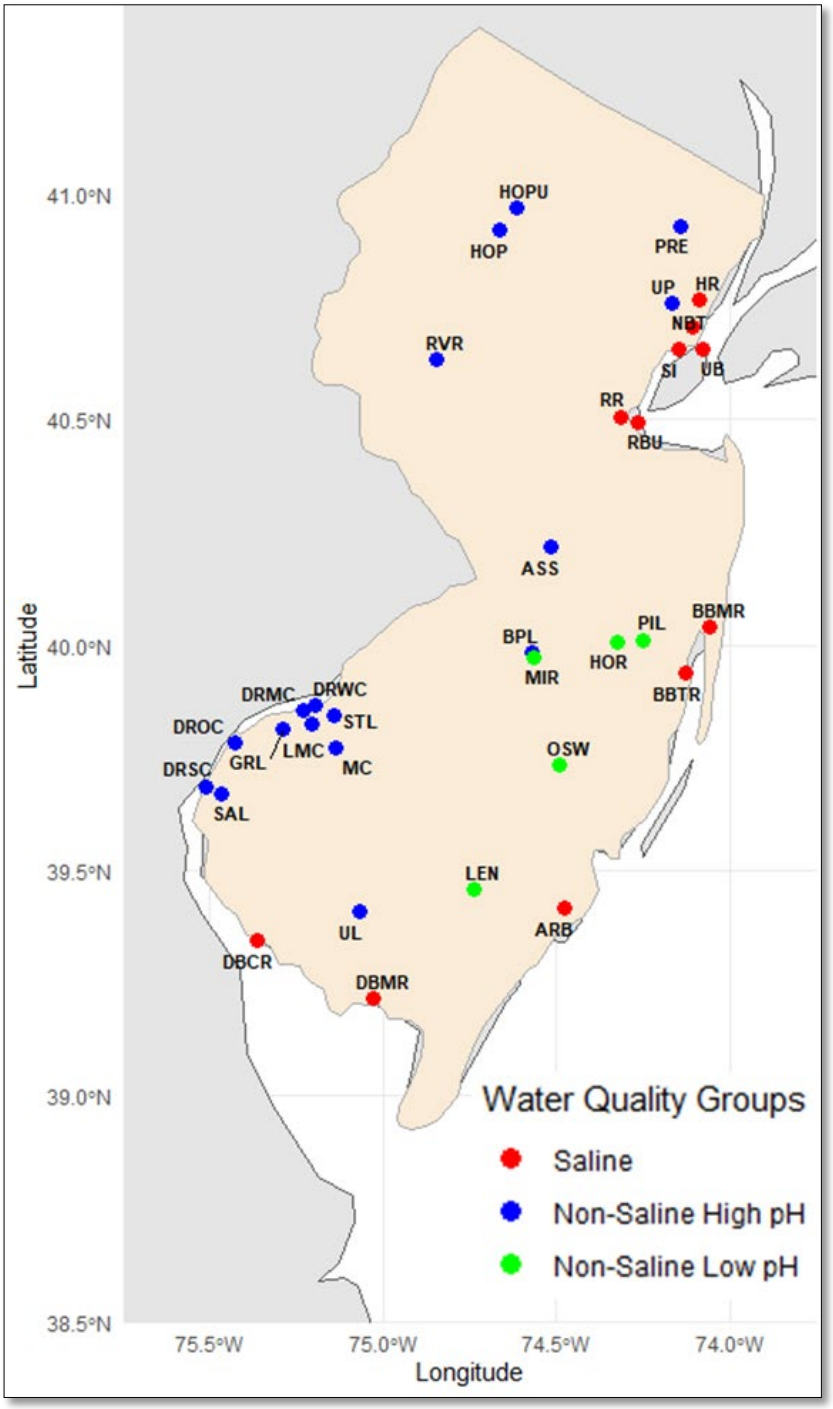

Figure 1. Map of all sites sampled for bioaccumulation factor derivation. All sampling sites across the state were statistically grouped into three broadly defined categories: saline, non-saline high pH, and non-saline low pH. See full report for site names and abbreviations.

Overall, what did the studies show?

At least one PFAS was detected in the surface water samples at all 33 sites. Average PFOS concentrations, a particularly prevalent and bioaccumulative PFAS, ranged from 1.71 to 34.84 nanograms per liter (ng/L). The highest concentrations of PFOS were found at Big Pine Lake, Mantua Creek, and Pine Lake with 34.8, 21.9, and 20.9 ng/L, respectively. PFOS concentrations were below 10 ng/L at 26 sites. Bioaccumulation factors were calculated for 17 PFAS by comparing the concentration of each in water and fish. BAFs were related to water quality parameters, specifically pH and salinity. The variability of species-specific BAFs was relatively high and did not correlate with position in the food chain as is often the case with other bioaccumulative contaminants. Figure 2 shows the distribution of BAFs determined for PFNA, PFOS, and PFOA for species collected in this study. These PFAS have raised concern because they can be toxic and build up in living organisms. Some PFAS, such as PFOS (perfluorooctanoic acid) and PFUnDA (Perfluoroundecanoic acid), are especially bioaccumulative and pose greater concern at elevated levels. Sediment BAFs were also calculated for the benthic species in this study (American eel, oyster toadfish, summer flounder, common carp, and channel catfish); however, no significant differences found across different grouping classes, suggesting that sediment interactions do not affect bioaccumulation in these species.

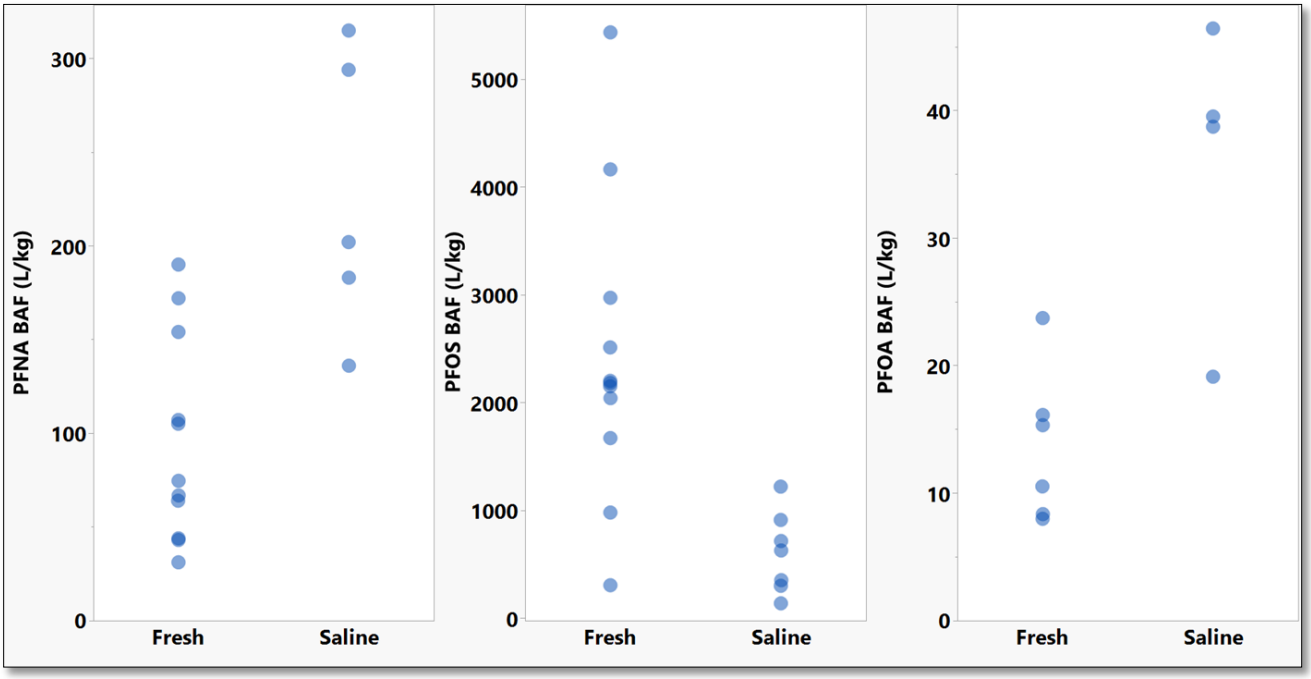

Figure 2. Distribution of species-specific BAFs for PFNA, PFOS, and PFOA for fresh and saline waters to be used in the development of surface water quality criteria. Each blue dot represents a bioaccumulation factor from a different species.

How will DEP use the data?

This study provides the Department with a comprehensive data set consisting of surface water quality data and PFAS concentrations for fish tissue, sediment, and water from 33 sites across the state. BAFs for 17 PFAS were calculated in this study. Additional analyses of these data will help researchers understand which environmental factors (water quality characteristics, trophic level, or species) influence bioaccumulation rates, and how different PFAS distribute across fish tissue, water, and stream sediments. BAFs for three PFAS (PFNA, PFOS, and PFOA; Table 1) will be directly incorporated into the calculations of surface water quality standards intended to protect human health. Data collected through this study will also be used to develop fish consumption advisories which provide recommendations to the public to avoid consuming fish from sites that may have elevated concentrations of PFAS.

New Jersey Determined BAFs (Fillet; L/kg)	PFOS	PFOA	PFNA
Freshwater BAF Geometric Mean	1970	13	81
95% UCL (Geometric Mean) Freshwater*	**2770**	**109**	**295**
Saline water BAF Geometric Mean	495	34	216
95% UCL (Geometric Mean) Saline Waters*	**681**	**158**	**949**

Table 1. Final bioaccumulation factors (and 95% upper confidence limits; 95% UCL) calculated for PFNA, PFOS, and PFOA to be used in surface water quality

Please review the full report for more detailed information at https://hdl.handle.net/10929/144666

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For more information, please contact Dan Millemann at Dan.Millemann@dep.nj.gov.

References: A full list of references used in this study is included within the posted report.