

**Interim Report on Initial Fish Tissue Results for Per- and
Polyfluoroalkyl Substances**

Department for Environmental Protection

Division of Water

September 2022



Contents

Executive Summary..... 3

Introduction and Background 3

Sampling Strategy 4

Laboratory Method..... 4

Results..... 5

 Surface Water Results..... 5

 Fish Tissue Results..... 6

Discussion..... 8

 PFAS Fish Consumption Guidance Adopted by States..... 8

 US EPA PFAS Updates 11

 KY DEP Ongoing Efforts 11

Conclusion..... 12

References 12

Appendices..... 14

 Appendix A. PFAS Tissue Preparation and Analytical Methods..... 14

 Appendix B. Surface Water Sample Results..... 15

 Appendix C. Fish Tissue Sample Results..... 16

 Appendix D. Summary of State Fish and Wildlife Consumption PFAS Guideline Criteria 18

Addendum: Additional Results 20

Tables

Table 1. Target PFAS analytes for fish tissue and surface water testing.. 4

Table 2. PFAS water sample concentrations in ppt using the drinking water lab method..... 6

Table 3. PFAS water sample concentrations in ppt using the drinking water (DW) and non-potable (NP) lab methods.. 6

Table 4. Great Lakes Consortium Meal Advice Categories for All Populations. 8

Figures

Figure 1. Relative proportions of PFAS detected in fish tissue at four stream sample sites. 7

Figure 2. PFOS concentrations in fish fillets from Gunpowder, South Elkhorn, and West Hickman Creeks.8

Figure 3. PFOS concentrations in fish fillets by species from Gunpowder Creek at Oakbrook Park 9

Figure 4. PFOS concentrations in fish fillets by species from the Gunpowder Creek Nature Park 9

Figure 5. PFOS concentrations in fish fillets by species from South Elkhorn Creek..... 10

Figure 6. PFOS concentrations in fish fillets by species from West Hickman Creek..... 10

Executive Summary

In the ongoing effort to better understand the occurrence of per- and polyfluoroalkyl substances (PFAS) in Kentucky, the Kentucky Department for Environmental Protection (DEP) recently incorporated PFAS into its fish contaminant monitoring program. This report summarizes the results of initial testing in fish in three Kentucky streams by the DEP. An addendum has been added to the end of the report with additional stream and reservoir sampling results received through May 2022.

PFAS are a large group of manufactured chemicals that have been widely used for decades. They tend to break down very slowly and can build up in people, wildlife, and the environment. Scientific studies have shown that higher levels of PFAS exposure over time are associated with a wide range of human health effects such as lower birth weights, reduced response to vaccines, decreased fertility, and higher cholesterol levels.

The pilot project initiated in November 2021 included a site on Gunpowder Creek in Boone County, South Elkhorn Creek in Woodford County, and West Hickman Creek in Jessamine County. These streams were known to contain PFAS based on previous water sampling in 2020. In early 2022, an additional site was added on Gunpowder Creek to include stocked trout, and four additional streams were sampled: Otter Creek in Meade County, a tributary of North Elkhorn Creek in Fayette County, and Northern Ditch and Southern Ditch (also known as Pond Creek) in Jefferson County. Around the same time, testing was completed on samples collected from an earlier project involving 13 lakes across the state. Target fish species for both projects included those that are typically consumed, such as bass and bluegill.

PFAS were detected in all 98 samples from the two projects. Perfluorooctane sulfonic acid (PFOS) occurred at the highest concentrations of any PFAS. Results for PFOS ranged between 0.31 and 50 parts per billion (ppb) in fish tissue. Fifteen other PFAS were detected in at least one sample at concentrations of 18 ppb or less. The average concentration of PFOS in fish from the stream study was 13 ppb; the average for fish from the lake study was 5 ppb.

The DEP is actively engaged with partners in the Departments for Public Health (DPH) and Fish and Wildlife Resources (KDFWR) in evaluating the results and considering the latest science and health information relating to PFAS. This includes the latest health advisories information released by the US Environmental Protection Agency (US EPA) on health effects for four PFAS, including PFOS.

The DEP is allocating additional resources to monitoring for PFAS in fish over the next two years to provide the public with additional information to make informed decisions when consuming fish from state waters. The DEP will continue to update citizens on monitoring and sampling results.

Introduction and Background

DEP began testing state waters for PFAS in 2019 by sampling drinking water from 81 community public drinking water treatment plants across the state. Results from that study are summarized in the report, [Evaluation of Kentucky Community Drinking Water for Per- & Polyfluoroalkyl Substances](#) (Kentucky Division of Water [DOW], 2019) available on the Division of Water's [PFAS webpage](#). In 2020, DEP collected and analyzed water samples from 40 surface water locations statewide. Results from that study are also available on the Division's PFAS webpage in the report [Evaluating Kentucky Source Waters for Per- & Polyfluoroalkyl Substances](#) (DOW, 2021).

In November 2021, DEP initiated a pilot project to sample and analyze for PFAS in fish from Kentucky waters. Recent scientific studies have shown that PFAS, and particularly PFOS, can accumulate in fish and that consumption of fish contaminated with PFAS can be a route of exposure for humans (Interstate Technology Regulatory Council, 2020; Bhavsar et al., 2016).

Sampling Strategy

Sampling locations were selected based on reviewing results from the 2020 PFAS source water study and considering areas with public fishing access. As it was late in the field season and involved a new laboratory method for staff, only sites on Gunpowder Creek in Boone County, South Elkhorn Creek in Woodford County, and West Hickman Creek in Jessamine County were sampled in 2021.

At each sampling location, the goal was to collect a minimum of 10 fish that people typically consume such as bass, catfish, or sunfish. Fish selected for testing were the largest of those collected, as they tended to be older, were more likely to be consumed, and had more time to accumulate PFAS. Fish were collected using a backpack electrofishing unit. Water samples also were collected for both the potable (drinking water) and non-potable (groundwater, surface water, wastewater) laboratory methods.

Sample locations from the 2020 PFAS source water study were used for West Hickman and South Elkhorn. The 2020 sampling location for Gunpowder Creek was in the headwaters of the creek. As that was a location where DEP staff would be unlikely to find the appropriate species and size of fish to represent what people would typically consume, the sampling location was moved downstream two miles. Additional water samples were collected at a second site, four miles downstream at the Gunpowder Creek Nature Park in 2021. The site was revisited in February 2022 to sample trout stocked there in the fall of 2021.

Laboratory Method

Fish tissue samples were prepared based on the *Standard Operating Procedure for Preparation and Homogenization of Fish Tissue Samples* (DOW, 2019) and the *Fish Tissue -- PFAS Project Study Plan* (DOW, 2021). Skinless fillets were freeze dried, homogenized, and submitted to the Division of Environmental Program Support (DEPS) for analysis of 27 PFAS (Table 1).

Table 1. Target PFAS analytes for fish tissue (T) and surface water testing using the drinking water (DW) and non-potable (NP) lab methods.

Analyte	Acronym	CAS Number	Method
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	T, NP, DW
1H,1H, 2H, 2H-perfluorohexane sulfonic acid	4:2FTS	757124-72-4	T, NP
1H,1H, 2H, 2H-perfluorooctane sulfonic acid	6:2FTS	27619-97-2	T, NP
1H,1H, 2H, 2H-perfluorodecane sulfonic acid	8:2FTS	39108-34-4	T, NP
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	T, NP, DW
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	T, NP, DW
Perfluorooctane sulfonamide	FOSA	754-91-6	T, NP
Hexafluoropropylene oxide dimer acid	HFPO-DA (Gen-X)	13252-13-6	T, NP, DW

Analyte	Acronym	CAS Number	Method
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	T, NP, DW
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	T, NP, DW
Perfluorobutanesulfonic acid	PFBS	375-73-5	T, NP, DW
Perfluorodecanoic acid	PFDA	335-76-2	T, NP, DW
Perfluorododecanoic acid	PFDoA	307-55-1	T, NP, DW
Perfluorodecanesulfonic acid	PFDS	335-77-3	T, NP
Perfluoroheptanoic acid	PFHpA	375-85-9	T, NP, DW
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	T, NP
Perfluorohexanoic acid	PFHxA	307-24-4	T, NP, DW
Perfluorohexanesulfonic acid	PFHxS	355-46-4	T, NP, DW
Perfluorononanoic acid	PFNA	375-95-1	T, NP, DW
Perflurononanesulfonic acid	PFNS	68259-12-1	T, NP
Perfluorooctanoic acid	PFOA	335-67-1	T, NP, DW
Perfluorooctanesulfonic acid	PFOS	1763-23-1	T, NP, DW
Perfluoropentanoic acid	PFPeA	2706-90-3	T, NP
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	T, NP
Perfluorotetradecanoic acid	PFTDA	376-06-7	T, NP, DW
Perfluorotridecanoic acid	PFTTrDA	72629-94-8	T, NP, DW
Perfluoroundecanoic acid	PFUnA	2058-94-8	T, NP, DW
Perfluorobutanoic acid	PFBA	375-22-4	NP

Water samples were analyzed based on DEPS laboratory methods for drinking water and non-potable waters. These methods were developed based on the US EPA's drinking water lab method 537.1 and the non-potable SW 846 Method 8327. The drinking water method is generally preferred for low turbidity waters as it is possible to detect even lower concentrations of individual PFAS than with the non-potable method. The detection limits for the drinking water method are typically around 1 part per trillion (ppt) or nanogram/liter, while the detection limits for the non-potable method are approximately 20-40 ppt. However, the non-potable method does include an additional 10 PFAS (Table 1).

Tissue samples were prepared and analyzed by DEPS staff using DEPS lab methods based on several references including US EPA Method 8327, US EPA Method 533, US EPA's LC/TOFMS and UPLC-MS Methods for the analysis of PFOS, and Phenomenex TN0124. Additional information on the methods can be found in Appendix A.

Results

Surface Water Results

Water sample results for South Elkhorn Creek included concentrations of PFBS, PFHxA, PFHxS, PFHpA, PFOA, and PFOS all below 5 ppt (Table 2). The West Hickman Creek water sample contained the same analytes all at concentrations below 10 ppt. There were no detections of PFAS at either site using the non-potable lab method.

Table 2. PFAS water sample concentrations in ppt using the drinking water lab method.

	PFBS	PFHxA	PFHxS	PFHpA	PFOA	PFOS
S Elkhorn	2.69	4.49	2.14	1.19	2.23	4.91
W Hickman	3.46	8.88	2.72	1.12	6.17	7.42

The Gunpowder Creek at Oakbrook Park drinking water method sample was lost during lab preparations. Results from the non-potable lab method are shown in Table 3. A water sample also was taken farther downstream at the Gunpowder Nature Park, and this was analyzed using both lab methods. No PFAS were detected using the non-potable lab method at the downstream location. In February 2022, an additional water sample was collected at the Gunpowder Nature Park and analyzed using the drinking water lab method (Table 3). Refer to Appendix B for tables with all of the water sample results.

Table 3. PFAS water sample concentrations in ppt using the drinking water (DW) and non-potable (NP) lab methods. ND indicates an analyte was not detected based on the analytical method’s detection limit. NT indicates that analyte was not tested for in that method.

	PFPeA	PFBS	PFHxA	PFHxS	PFHpA	6:2 FTS	PFOA	PFOS	PFNA
Oakbrook (NP)	110	ND	90.6	141	ND	141	ND	54.6	ND
Gunpowder Nature Park 2021 (DW)	NT	4.27	5.93	7.19	3.25	NT	3.53	7.15	ND
Gunpowder Nature Park 2022 (DW)	NT	1.88	5.56	2.93	2.74	NT	3.22	4.34	0.963

Fish Tissue Results

Fish species collected included largemouth and smallmouth bass, rock bass, rainbow trout, bluegill, green sunfish, and longear sunfish. Dry weight results from the lab were converted to wet weight to reflect the concentrations in the fish prior to the freeze drying lab process. Of the 27 analytes, 15 were not detected in any fish tissue samples (see Appendix C for all tissue sample results). Conversely, PFOS, PFUnA, PFDoA, PFDA were detected in all samples (Figure 1). PFDS, PFTDA, PFTTrDA were found in all samples except for the rainbow trout stocked at Gunpowder Nature Park during the previous fall. Overall, concentrations in the stocked trout were typically lower compared to other fish collected at the Gunpowder Nature Park. PFNA, PFHxS, and 8:2 FTS were detected at both Gunpowder Creek sites at very low levels. PFHpS was detected at Oakbrook, again at a very low concentration. FOSA was detected at West Hickman and South Elkhorn at low levels in most of the smallmouth bass, and in two trout at the Gunpowder Nature Park. PFOA, although frequently found in surface water samples, was not detected in any of the fish tissue samples.

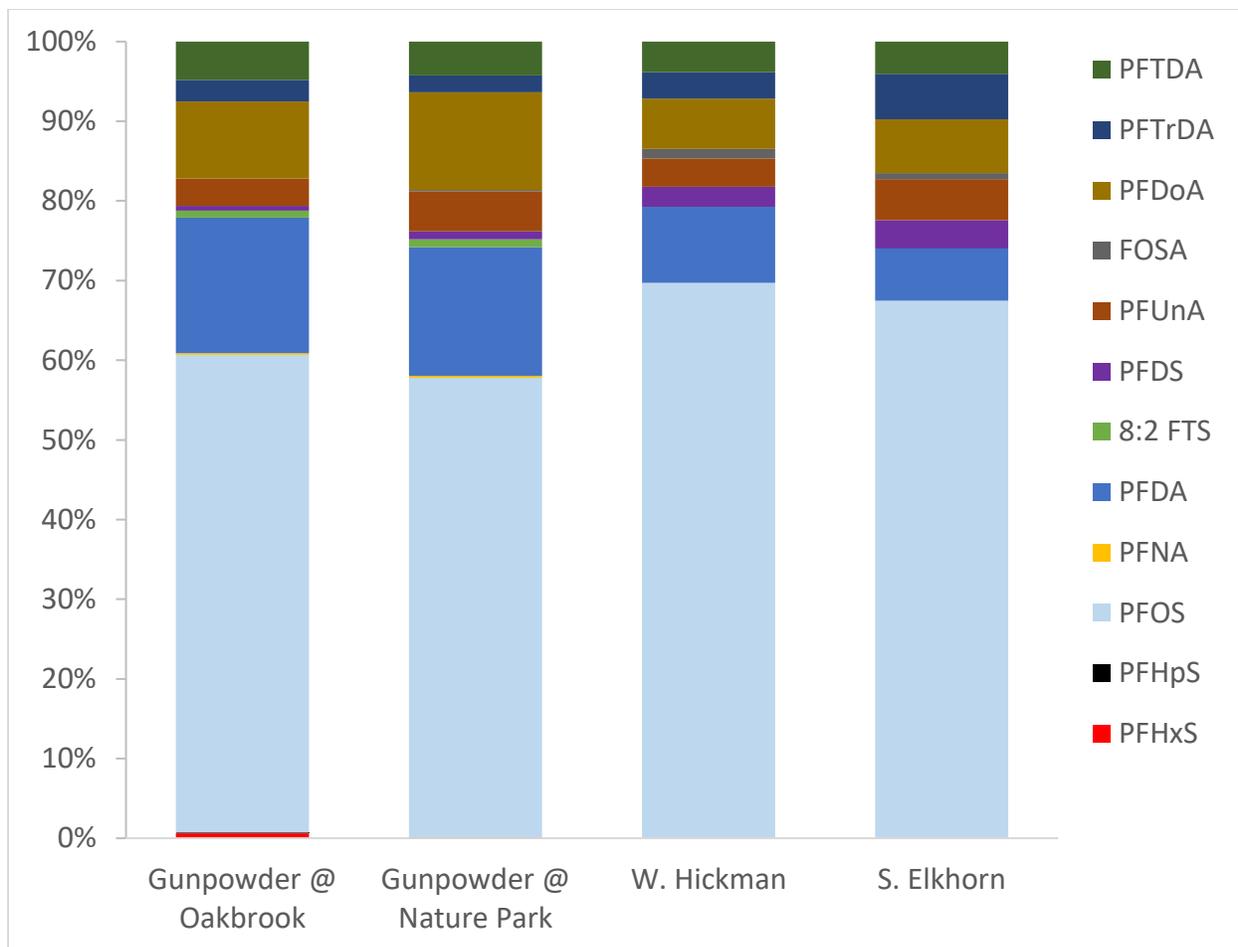


Figure 1. Relative proportions of PFAS detected in fish tissue at four stream sample sites.

PFOS was detected at the highest concentrations of any PFAS at all four waterbodies (Figure 1). Gunpowder Creek at Oakbrook concentrations in tissue ranged between 8.88 parts per billion (ppb) and 49.7 ppb (Figure 2). Gunpowder Creek Nature Park concentrations in tissue ranged between 1.79 ppb and 17.24 ppb. South Elkhorn PFOS concentrations were between 5.80 ppb and 16.6 ppb. West Hickman concentrations were between 4.60 and 19.7 ppb.

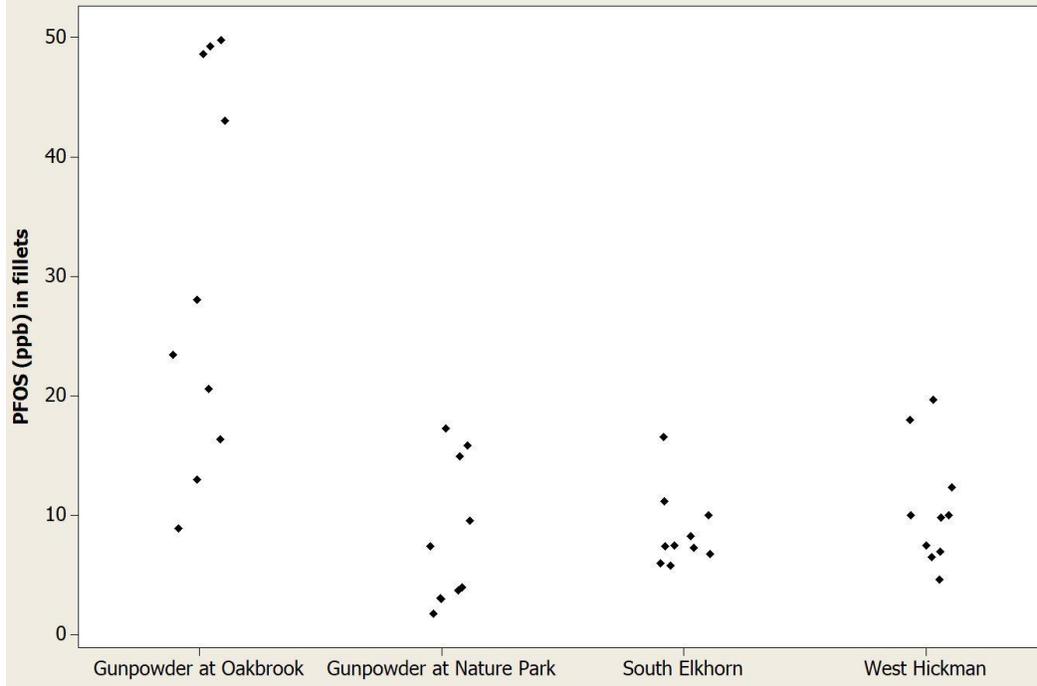


Figure 2. PFOS concentrations in fish filets from Gunpowder, South Elkhorn, and West Hickman Creeks.

Discussion

PFAS Fish Consumption Guidance Adopted by States

A number of states have adopted fish consumption guidelines for certain PFAS. Appendix D includes a summary from the Environmental Council of the States (Longworth, 2022). PFOS is the focus of most guidelines or advisories, though a few states have thresholds for PFOA also. At least one state has guidelines for PFBS or PFNA for fish. Guidance for PFOS varies by state. For example, the “Do Not Eat” threshold for PFOS varies between 159 to over 800 ppb for the general population in various states. New Jersey includes a “Do Not Eat” threshold for the high risk population at anything above 17 ppb. New York’s threshold is greater than 50 ppb for the sensitive population.

The Great Lakes Consortium for Fish Consumption Advisories (GLC), which includes state program representatives from the neighboring states of Indiana, Illinois, and Ohio, as well as Michigan, Minnesota, New York, Pennsylvania, Wisconsin, Ontario, and the Great Lakes Indian Fish and Wildlife Commission published a best practice document for PFOS in 2019. Table 4. Great Lakes Consortium meal advice categories for all populations. outlines their meal advice thresholds (GLC, 2019). Results from Gunpowder, West Hickman, and South Elkhorn are compared with these thresholds in Figures 3-6.

Table 4. Great Lakes Consortium meal advice categories for all populations.

PFOS in Fish (ppb)	Meal Frequency
≤ 10	Unrestricted
> 10-20	2 meals/week
> 20-50	1 meal/week
> 50-200	1 meal/month
> 200	Do Not Eat

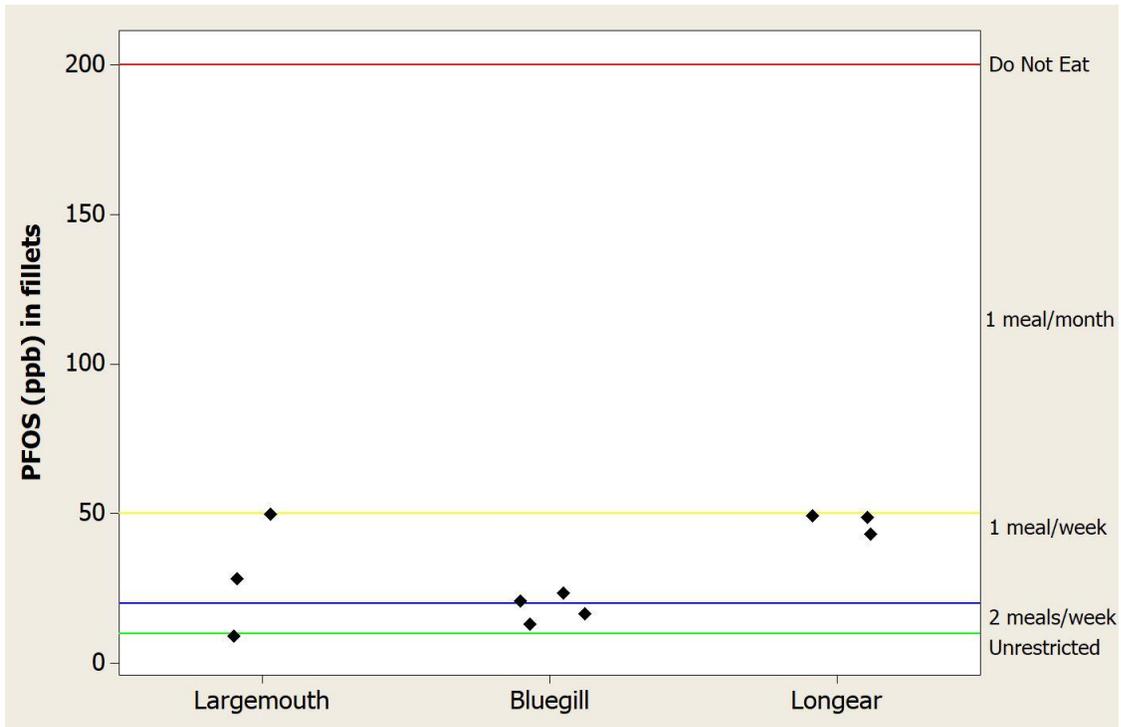


Figure 3. PFOS concentrations in fish fillets by species from Gunpowder Creek at Oakbrook Park with Consortium recommendations included.

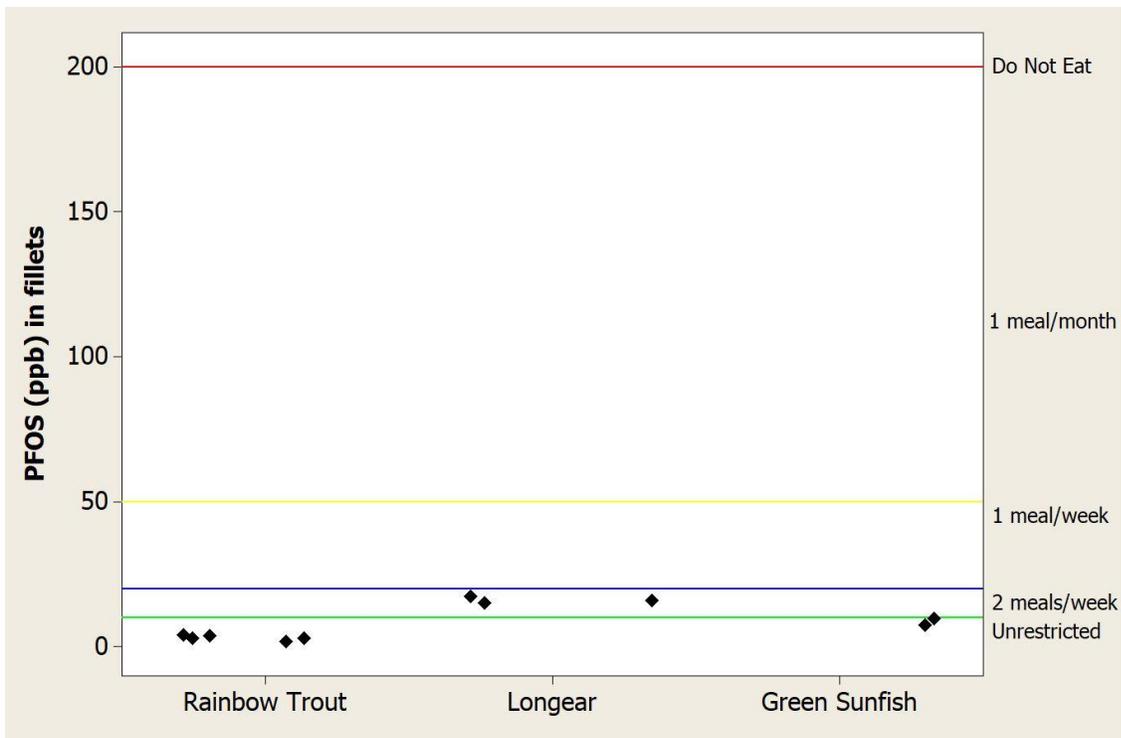


Figure 4. PFOS concentrations in fish fillets by species from the Gunpowder Creek Nature Park with Consortium recommendations included.

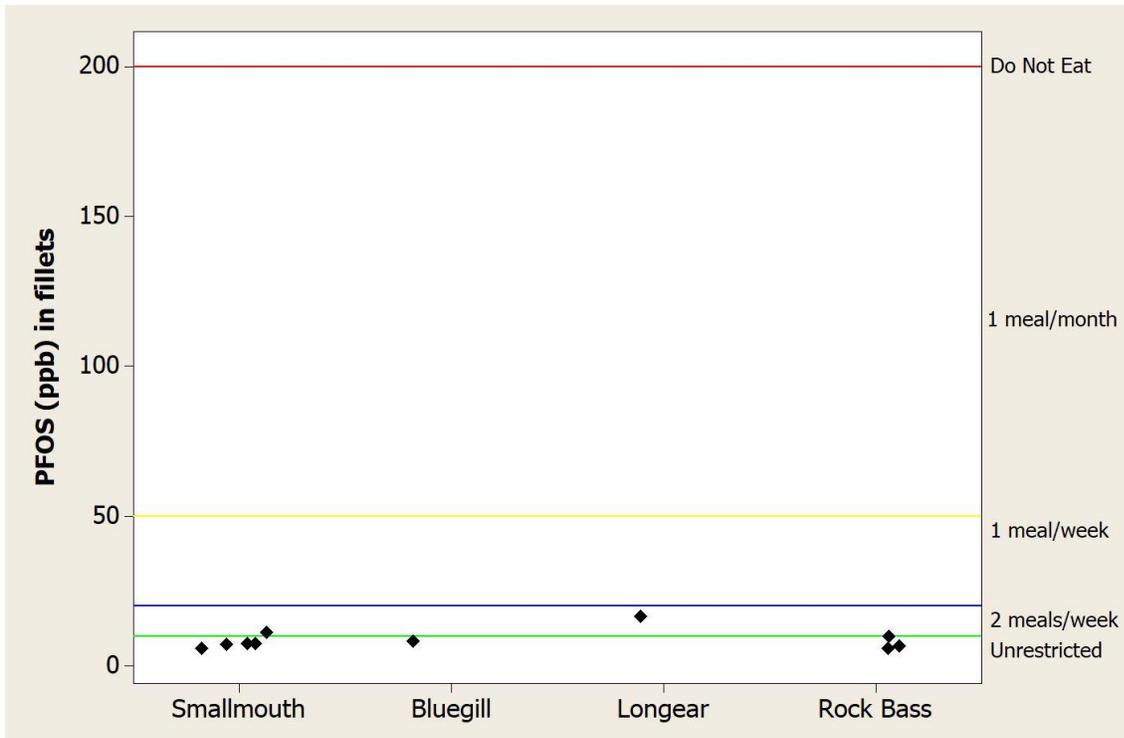


Figure 5. PFOS concentrations in fish fillets by species from South Elkhorn Creek with Consortium recommendations included.

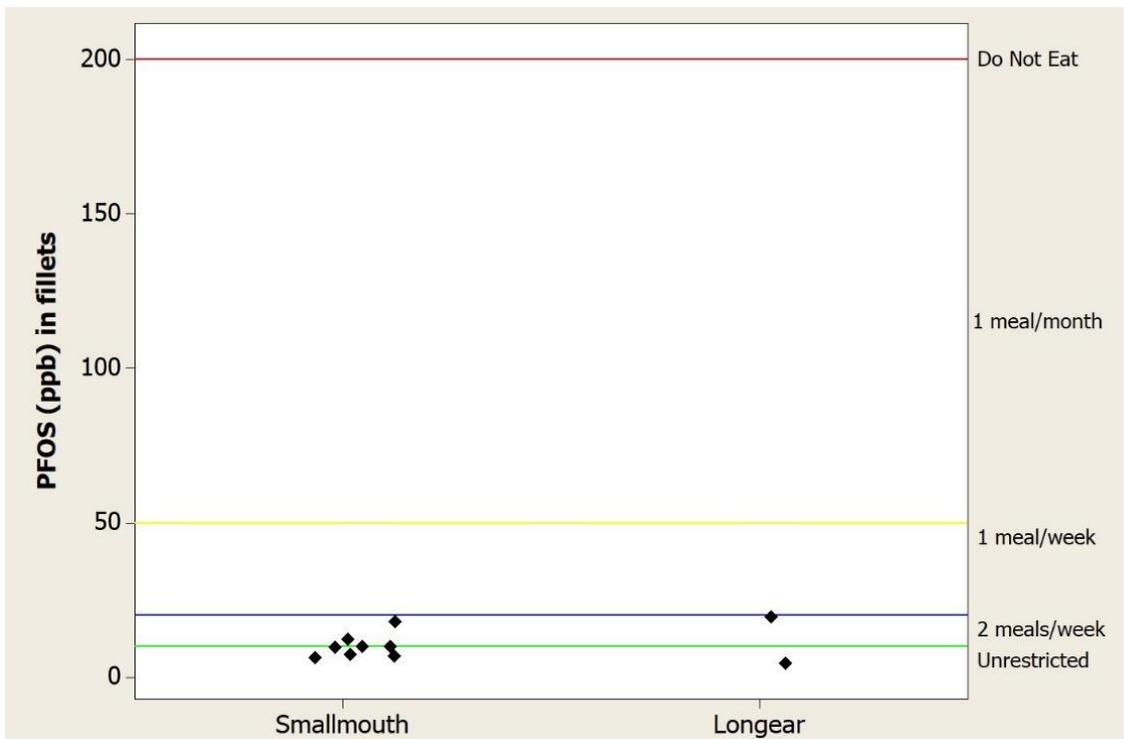


Figure 6. PFOS concentrations in fish fillets by species from West Hickman Creek with Consortium recommendations included.

The Great Lakes Consortium reviewed information available at that time in determining an appropriate PFOS reference dose—an estimate of a daily exposure threshold to PFOS that would be unlikely to cause harmful health effects over a lifetime. They chose to use a reference dose of 0.00002 milligrams per kilogram per day from the US EPA’s 2016 [Drinking Water Health Advisory for PFOS](#) when calculating the fish consumption guidelines.

US EPA PFAS Updates

On June 15, 2022, the US EPA released new interim health advisories (HAs) for both PFOS and PFOA in order to communicate that negative health effects from exposure to these chemicals may occur at much lower thresholds than previously understood. The new interim HA for PFOS, 0.02 ppt, replaces the previous 70 ppt HA number and is intended to protect people from adverse health effects over a lifetime from exposure to PFOS in drinking water. The US EPA selected a much lower draft reference dose in calculating the updated HA. In their June 15th communications on the interim HA, they emphasized that they are still reviewing the scientific literature and the reference dose and associated interim HA may be subject to change in the future. A final rule may be available in the fall of 2023.

Additional details of the US EPA’s overall strategy regarding PFAS can be found in the [PFAS Strategic Roadmap](#) (2021). In terms of fish consumption, US EPA is collecting fish tissue data across the nation as part of the National Lakes Assessment during the spring of 2022. KY DEP staff are assisting in this effort by collecting and shipping fish samples from lakes and reservoirs in Kentucky selected by the US EPA. In the spring of 2023, US EPA plans to provide states with a list of PFAS that are known or thought to occur frequently in edible freshwater fish. This information is intended to serve as guidance for state monitoring and advisory programs on which PFAS to monitor and how to set fish consumption advisories. In the fall of 2024, US EPA anticipates publishing recommended human health water quality criteria involving drinking water and fish consumption for PFOS and PFOA.

Also recently, the US EPA released draft recommended aquatic life criteria for PFOS and PFOA. At present, these draft thresholds are higher than water or tissue results reported in Kentucky. The final criteria are expected to be released after US EPA has an opportunity to review and respond to public comments.

Ongoing Efforts

The DEP continues to monitor and evaluate the occurrence of PFAS in Kentucky. DEP staff are engaged in following the latest science on PFAS, working with US EPA staff and state partners, and communicating PFAS data and information with the citizens of the Commonwealth.

The DEP has committed additional resources over the next two years to gather more fish contaminant data for PFAS in rivers, streams, and reservoirs across the state to assist citizens in making informed decisions when consuming fish from state waters. Additional locations from the 2020 source water study are scheduled for sampling in 2022. DEP staff will also coordinate with KDFWR and DPH staff in selecting additional rivers, streams, and reservoirs across the state to add to sampling scheduled for later in the year.

Information on existing fish consumption advisories is available on the fish consumption advisories web pages for both the Division of Water (<https://eec.ky.gov/Environmental-Protection/Water/Monitor/Pages/Fish-Advisories.aspx>) and the Department of Fish and Wildlife Resources (<https://fw.ky.gov/Fish/Pages/Fish-Consumption-Advisories.aspx>).

Conclusion

Initial PFAS fish tissue testing at waterbodies selected from the 2020 source water study indicates that PFAS is present in fish in Kentucky waters, with PFOS occurring at the highest concentrations in tissue samples thus far. Fish contaminant monitoring for PFAS continues in 2022 with a priority to sample additional waterbodies across the state. The DEP will continue to follow US EPA's efforts with PFAS while coordinating with partner agencies in reviewing and evaluating results as they become available. The DEP will continue to provide updates on its efforts to evaluate PFAS occurrence in Kentucky.

References

- Bhavsar, S. P., Fowler, C., Day, S., Petro, S., Gandhi, N., Gewurtz, S. B., Hao, C., Zhao, X., Drouillard, K.G, & Morse, D. (2016). High levels, partitioning and fish consumption based water guidelines of perfluoroalkyl acids downstream of a former firefighting training facility in Canada. *Environment International*, 94, 415-423.
- Great Lakes Consortium for Fish Consumption Advisories. (2019). *Best Practice for Perfluorooctane Sulfonate (PFOS) Guidelines*. <https://www.health.state.mn.us/communities/environment/fish/docs/consortium/bestpracticepfos.pdf>.
- Great Lakes Consortium for Fish Consumption Advisories. (2007). *A Protocol for Mercury-based Fish Consumption Advice*. <https://www.health.state.mn.us/communities/environment/fish/docs/consortium/mercuryprot.pdf>.
- Great Lakes Consortium for Fish Consumption Advisories. (1993). *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory*. <https://www.health.state.mn.us/communities/environment/fish/docs/consortium/pcbprotocol.pdf>.
- Interstate Technology Regulatory Council. (2020). *Environmental Fate and Transport for Per- and Polyfluoroalkyl Substances*. https://pfas-1.itrcweb.org/fact_sheets_page/PFASFact_Sheet_Fate_and_Transport_April2020.pdf.
- Kentucky Division of Water. (2022). *Fish consumption advisories*. Retrieved March 15, 2022, from <https://eec.ky.gov/Environmental-Protection/Water/Monitor/Pages/Fish-Advisories.aspx>.
- Kentucky Division of Water. (2021). *Evaluating Kentucky Source Waters for Per- & Polyfluoroalkyl Substances*. <https://eec.ky.gov/Environmental-Protection/Water/Reports/Reports/2021-PFASSourceWaterReport.pdf>.
- Kentucky Division of Water. (2021). *Fish tissue -- PFAS project study plan*. Frankfort, Kentucky.
- Kentucky Division of Water. (2019). *Evaluation of Kentucky Community Drinking Water for Per- & Polyfluoroalkyl Substances*. <https://eec.ky.gov/Documents%20for%20URLs/PFAS%20Drinking%20Water%20Report%20Final.pdf>.

Kentucky Division of Water. (2019). *Standard operating procedure for preparation and homogenization of fish tissue samples*. Frankfort, KY. <https://eec.ky.gov/Environmental-Protection/Water/QA/Pages/default.aspx>.

Longworth, S.G. (2022). *Processes and considerations for setting state PFAS standards*. Environmental Council of the States. <https://www.ecos.org/documents/ecos-white-paper-processes-and-considerations-for-setting-state-pfas-standards-2022-update/>.

United States Environmental Protection Agency. (2021). *PFAS strategic roadmap: EPA's commitments to action 2021-2024*. https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf.

Appendices

Appendix A. PFAS Tissue Preparation and Analytical Methods

Preparation:

One gram portion of freeze-dried fish tissue is fortified (spiked) with surrogates (internal standards) and diluted with a 1:2 solution of Acetonitrile and verified PFAS free reagent water. A mixture of magnesium sulfate and sodium chloride is then added. The sample is vortexed and centrifuged so that the organic phase can be easily removed. This organic solution is then treated with a magnesium sulfate and PSA mix, vortexed and centrifuged again. The extract is then concentrated down to below 1 mL and diluted to 15 mL with verified clean reagent water and extracted using a weak anionic resin. The resulting eluent is taken to dryness and reconstituted to 1 mL using a Methanol/Water/Acetic Acid solution.

Analysis:

A 60 µL injection of the 1 mL sample is made into an instrument called an LC/MS/MS. The LC (Liquid Chromatograph) is equipped with a C18 column that is interfaced to a tandem mass spectrometer (MS/MS). The analytes are separated and identified by comparing the acquired mass spectra and retention time to a reference spectra and retention times for calibration standards under identical LC/MS/MS conditions. The concentration of each analyte is determined by using the internal standard technique. Internal standards (called extracted internal standards for this method) analytes have been added to all extracted samples at the same level as the calibration standards to correct for the extraction efficiency of the method analytes. Nearly all the analytes of interest have a corresponding mass-labeled analog. In cases where there are no direct analogs, recommended compounds are used (see EPA 8327 and EPA 533).

Primary reference sources:

US EPA Method 8327: Per-and Polyfluorinated Alkyl Substances (PFAS) using External Calibration and Multiple Reaction Monitoring (MRM) Liquid Chromatography/Tandem Mass Spectroscopy (LC/MS/MS). Revision 0, June 2019.

US EPA Method 533: Determination Of Per- And Polyfluoroalkyl Substances In Drinking Water By Isotope Dilution Anion Exchange Solid Phase Extraction And Liquid Chromatography/Tandem Mass Spectrometry. Revision 0, November 2019.

Phenomenex TN0124: Per- and Polyfluorinated Alkyl Substances (PFAS) from Milk, Eggs, Butter, Cheese, and Fish using QuEChERS, SPE, and LC-MS/MS.

US EPA: LC/TOFMS and UPLC-MS/MS Methods for the Analysis of Perfluorooctanesulfonate (PFOS) and the Reduction of Matrix Interference in Complex Biological Matrices.

Appendix B. Surface Water Sample Results

Drinking Water Results based on EPA 537.1. Value of ND indicate that results were below the limit of detection (LOD). All values are reported as parts per trillion (ppt).

Site	Location	PFHpA	11Cl-PF3OUdS	9Cl-PF3ONS	HFPO-DA	NEtFOSAA	NMeFOSAA	PFBS	PFDA	PFDoA	PFHxS	PFHxA	PFNA	PFOS	PFOA	PFTDA	PFTTrDA	PFUnA	ADONA
South Elkhorn Creek	Moore's Mill Rd, ~15m upstream of bridge	1.19	ND	ND	ND	ND	ND	2.69	ND	ND	2.14	4.49	ND	4.91	2.23	ND	ND	ND	ND
West Hickman Creek	Above KY 1980 bridge	1.12	ND	ND	ND	ND	ND	3.46	ND	ND	2.72	8.88	ND	7.42	6.17	ND	ND	ND	ND
Gunpowder Creek	2021 Gunpowder Creek Nature Park	3.25	ND	ND	ND	ND	ND	4.27	ND	ND	7.19	5.93	ND	7.15	3.53	ND	ND	ND	ND
Gunpowder Creek	2022 Gunpowder Creek Nature Park	2.74	ND	ND	ND	ND	ND	1.88	ND	ND	2.93	5.56	0.963	4.34	3.22	ND	ND	ND	ND

Non-Potable Water Testing Results based on SW846 8327. Value of ND indicate that results were below the limit of detection (LOD). All values are reported as parts per trillion (ppt).

Site	Location	PFHpA	11Cl-PF3OUdS	PFDS	PFHpS	PFNS	6:2 FTS	PFPeS	9Cl-PF3ONS	4:2 FTS	8:2 FTS	PFBA	HFPO-DA	NEtFOSAA	NMeFOSAA	PFPeA	PFBS	PFDA	PFDoA	PFHxS	PFHxA	PFNA	PFOS	FOSA	PFOA	PFTDA	PFTTrDA	PFUnA	ADONA	
South Elkhorn Creek	Moore's Mill Rd, ~15m upstream of bridge	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
West Hickman Creek	Above KY 1980 bridge	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gunpowder Creek	off of Oakbrook Rd	ND	ND	ND	ND	ND	141.00	ND	ND	ND	ND	ND	ND	ND	ND	110.00	ND	ND	ND	141.00	90.60	ND	54.6	ND	ND	ND	ND	ND	ND	ND
Gunpowder Creek	Gunpowder Creek Nature Park	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix C. Fish Tissue Sample Results. All results are reported in parts per billion (ppb). Values of ND indicate that results were below the limit of detection for that analysis.

Site	Sample ID	Common Name	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	HFPO-DA	PFHxS	PFHpA	ADONA	PFHpS	6:2 FTS	PFOA	PFOS	PFNA	9Cl- PF3ONS	PFNS	PFDA	8:2 FTS	NMeFOSAA	PFDS	PFUnA	FOSA	NETFOSAA	11Cl- PF3OUdS	PFDaA	PFTrDA	PFTDA
Gunpowder	21-001	Largemouth bass	ND	ND	ND	ND	ND	ND	0.55	ND	ND	0.13	ND	ND	49.74	0.36	ND	ND	18.05	0.74	ND	0.32	3.55	ND	ND	ND	8.26	2.66	2.84
Gunpowder	21-002	Largemouth bass	ND	ND	ND	ND	ND	ND	0.13	ND	ND	ND	ND	ND	28.06	0.15	ND	ND	15.60	0.24	ND	0.36	2.05	ND	ND	ND	3.54	0.79	1.32
Gunpowder	21-003	Largemouth bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.88	0.09	ND	ND	2.21	0.23	ND	0.16	0.72	ND	ND	ND	0.99	0.33	0.43
Gunpowder	21-004	Bluegill	ND	ND	ND	ND	ND	ND	0.05	ND	ND	ND	ND	ND	12.99	ND	ND	ND	1.67	0.24	ND	0.18	0.88	ND	ND	ND	1.31	0.41	0.46
Gunpowder	21-005	Bluegill	ND	ND	ND	ND	ND	ND	0.25	ND	ND	ND	ND	ND	23.41	ND	ND	ND	2.84	0.81	ND	0.16	0.94	ND	ND	ND	1.78	0.67	0.97
Gunpowder	21-006	Bluegill	ND	ND	ND	ND	ND	ND	0.10	ND	ND	ND	ND	ND	20.58	ND	ND	ND	3.79	0.35	ND	0.14	1.12	ND	ND	ND	2.98	0.64	1.26
Gunpowder	21-007	Bluegill	ND	ND	ND	ND	ND	ND	0.14	ND	ND	ND	ND	ND	16.39	ND	ND	ND	3.26	0.54	ND	0.15	0.62	ND	ND	ND	1.29	0.46	0.51
Gunpowder	21-008	Longear	ND	ND	ND	ND	ND	ND	0.67	ND	ND	0.16	ND	ND	49.27	ND	ND	ND	14.16	0.87	ND	0.56	2.62	ND	ND	ND	10.08	2.54	5.39
Gunpowder	21-009	Longear	ND	ND	ND	ND	ND	ND	0.17	ND	ND	0.08	ND	ND	43.05	ND	ND	ND	11.46	0.22	ND	0.49	2.46	ND	ND	ND	9.38	2.50	4.89
Gunpowder	21-010	Longear	ND	ND	ND	ND	ND	ND	1.00	ND	ND	0.18	ND	ND	48.61	0.25	ND	ND	12.33	0.27	ND	0.45	2.29	ND	ND	ND	8.85	2.61	6.09
South Elkhorn	21-011	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.38	ND	ND	ND	0.72	ND	ND	0.37	0.65	0.24	ND	ND	0.92	0.69	0.59
South Elkhorn	21-012	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.30	ND	ND	ND	0.91	ND	ND	0.28	0.62	ND	ND	ND	0.79	0.67	0.46
South Elkhorn	21-013	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.96	ND	ND	ND	0.82	ND	ND	0.21	0.60	0.23	ND	ND	0.78	0.57	0.45
South Elkhorn	21-014	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.45	ND	ND	ND	0.90	ND	ND	0.38	0.82	0.19	ND	ND	1.03	0.90	0.59
South Elkhorn	21-015	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.15	ND	ND	ND	0.92	ND	ND	0.66	0.82	0.30	ND	ND	0.89	0.75	0.48
South Elkhorn	21-016	Bluegill	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.25	ND	ND	ND	0.44	ND	ND	0.50	0.44	ND	ND	ND	0.61	0.58	0.46
South Elkhorn	21-017	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16.57	ND	ND	ND	1.19	ND	ND	0.82	0.56	ND	ND	ND	0.77	0.62	0.42
South Elkhorn	21-018	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.01	ND	ND	ND	1.06	ND	ND	0.79	0.97	ND	ND	ND	1.20	1.07	0.67
South Elkhorn	21-019	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.74	ND	ND	ND	0.96	ND	ND	0.32	0.72	ND	ND	ND	1.01	0.86	0.63
South Elkhorn	21-020	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.80	ND	ND	ND	0.51	ND	ND	0.25	0.43	ND	ND	ND	0.63	0.64	0.46
West Hickman	21-021	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.93	ND	ND	ND	1.29	ND	ND	0.15	0.47	0.27	ND	ND	0.73	0.40	0.31
West Hickman	21-022	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.47	ND	ND	ND	1.18	ND	ND	0.21	0.47	0.18	ND	ND	0.82	0.41	0.45
West Hickman	21-023	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.00	ND	ND	ND	1.77	ND	ND	0.23	0.61	0.27	ND	ND	0.87	0.45	0.43
West Hickman	21-024	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.81	ND	ND	ND	1.79	ND	ND	0.35	0.53	0.16	ND	ND	0.87	0.35	0.40
West Hickman	21-025	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.31	ND	ND	ND	2.05	ND	ND	0.49	0.67	0.26	ND	ND	1.19	0.47	0.57
West Hickman	21-026	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.97	ND	ND	ND	2.26	ND	ND	0.77	1.01	0.24	ND	ND	1.62	0.77	0.91
West Hickman	21-027	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.46	ND	ND	ND	0.90	ND	ND	0.28	0.30	0.25	ND	ND	0.61	0.32	0.53
West Hickman	21-028	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.03	ND	ND	ND	1.30	ND	ND	0.43	0.51	0.19	ND	ND	0.89	0.50	0.56
West Hickman	21-029	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.68	ND	ND	ND	1.56	ND	ND	0.78	0.62	ND	ND	ND	1.51	0.88	1.17
West Hickman	21-030	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.60	ND	ND	ND	0.34	ND	ND	0.12	0.14	ND	ND	ND	0.44	0.44	0.47
Gunpowder	22-001	Rainbow Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.79	ND	ND	ND	0.21	ND	ND	ND	0.09	0.10	ND	ND	0.17	ND	ND
Gunpowder	22-002	Rainbow Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.04	ND	ND	ND	0.53	ND	ND	ND	0.17	0.12	ND	ND	0.31	ND	ND
Gunpowder	22-003	Rainbow Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.98	0.11	ND	ND	0.50	ND	ND	ND	0.18	ND	ND	ND	0.33	ND	ND
Gunpowder	22-004	Rainbow Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.70	ND	ND	ND	0.66	ND	ND	ND	0.20	ND	ND	ND	0.33	ND	ND

Site	Sample ID	Common Name	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	HFPO-DA	PFHxS	PFHpA	ADONA	PFHpS	6:2 FTS	PFOA	PFOS	PFNA	9Cl- PF3ONS	PFNS	PFDA	8:2 FTS	NMeFOSAA	PFDS	PFUnA	FOSA	NEtFOSAA	11Cl- PF3OUds	PFDoA	PFTTrDA	PFTDA
Gunpowder	22-005	Rainbow Trout	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.99	0.12	ND	ND	0.63	ND	ND	ND	0.16	ND	ND	ND	0.30	ND	ND
Gunpowder	22-006	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.08	ND	ND	ND	ND	ND	17.24	0.11	ND	ND	7.03	0.69	ND	0.29	1.69	ND	ND	ND	3.90	0.70	1.26
Gunpowder	22-007	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.11	ND	ND	ND	ND	ND	15.87	ND	ND	ND	3.40	0.21	ND	0.48	1.41	ND	ND	ND	3.59	0.67	1.43
Gunpowder	22-008	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14.96	ND	ND	ND	3.03	0.21	ND	0.24	1.01	ND	ND	ND	2.44	0.38	0.91
Gunpowder	22-009	Green Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.58	ND	ND	ND	3.76	0.24	ND	0.23	1.24	ND	ND	ND	3.47	0.71	1.44
Gunpowder	22-010	Green Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.39	ND	ND	ND	2.77	ND	ND	0.15	0.89	ND	ND	ND	2.26	0.50	0.89

Appendix D. Summary of State Fish and Wildlife Consumption PFAS Guideline Criteria (Longworth, 2022).

State	Media	PFAS	Guideline Level (unit specified)	Frequency	Target Populations	Resources & Notes
AL	Fish	PFOS	>156 ppb	1 meal per week	General Population	
	Fish	PFOS	>800 ppb	Do Not Eat	General Population	
CT	Fish and Shellfish	PFOA, PFOS	<20 ppb	No consumption advice (unlimited consumption)	General Population	
	Fish and Shellfish	PFOA, PFOS	20 to <40 ppb	No more than 1 meal per week	General Population	
	Fish and Shellfish	PFOA, PFOS	40 to <159 ppb	No more than 1 meal per month	General Population	
	Fish and Shellfish	PFOA, PFOS	≥159 ppb	Do Not Eat	General Population	
ME	Fish	PFOA	0.052 mg/kg		Recreational Angler	
	Fish	PFOS	0.052 mg/kg		Recreational Angler	
	Fish	PFBS	52 mg/kg		Recreational Angler	
	Milk	PFOS	210 µg/L			
	Beef	PFOS	3.4 ng/g			
MI	Fish	PFOS	≤9 ppb	16 meals per month	All Populations	
	Fish	PFOS	>9-13 ppb	12 meals per month	All Populations	
	Fish	PFOS	>13-19 ppb	8 meals per month	All Populations	
	Fish	PFOS	>19-38 ppb	4 meals per month	All Populations	
	Fish	PFOS	>38-75	2 meals per month	All Populations	
	Fish	PFOS	>75-150	1 meal per month	All Populations	
	Fish	PFOS	>150-300	6 meals per year	All Populations	
	Fish	PFOS	>300 ppb	Do Not Eat	All Populations	
	Deer	PFOS	>300 ppb	Do Not Eat	All Populations	
MN	Fish	PFOS	>10-20 ppb	2 meals per week	All Populations	
	Fish	PFOS	>20-50 ppb	1 meal per week	All Populations	
	Fish	PFOS	>50-200 ppb	1 meal per month	All Populations	
	Fish	PFOS	>200 ppb	Do Not Eat	All Populations	
NJ	Fish	PFOS	0.56 ng/g; ppb	Unlimited (based on daily)	General Population and High Risk	
	Fish	PFOS	3.9 ng/g; ppb	1 meal per week	General Population and High Risk	
	Fish	PFOS	17 ng/g; ppb	1 meal per month	General Population and High Risk	
	Fish	PFOS	>17 ng/g; ppb	Do Not Eat	High Risk Population	
	Fish	PFOS	51 ng/g; ppb	1 meal every 3 months	General Population	
	Fish	PFOS	204 ng/g; ppb	1 meal per year	General Population	
	Fish	PFOS	>204 ng/g; ppb	Do Not Eat	General Population	
	Fish	PFNA	0.23 ng/g; ppb	Unlimited (based on daily)	General Population and High Risk	

State	Media	PFAS	Guideline Level (unit specified)	Frequency	Target Populations	Resources & Notes
	Fish	PFNA	1.6 ng/g; ppb	1 meal per week	General Population and High Risk	
	Fish	PFNA	6.9 ng/g; ppb	1 meal per month	General Population and High Risk	
	Fish	PFNA	>6.9 ng/g; ppb	Do Not Eat	High Risk Population	
	Fish	PFNA	21 ng/g; ppb	1 meal every 3 months	General Population	
	Fish	PFNA	84 ng/g; ppb	1 meal per year	General Population	
	Fish	PFNA	>84 ng/g; ppb	Do Not Eat	General Population	
	Fish	PFOA	0.62 ng/g; ppb	Unlimited (based on daily)	General Population and High Risk	
	Fish	PFOA	4.3 ng/g; ppb	1 meal per week	General Population and High Risk	
	Fish	PFOA	19 ng/g; ppb	1 meal per month	General Population and High Risk	
	Fish	PFOA	>19 ng/g; ppb	Do Not Eat	High Risk Population	
	Fish	PFOA	57 ng/g; ppb	1 meal every 3 months	General Population	
	Fish	PFOA	226 ng/g; ppb	1 meal per year	General Population	
	Fish	PFOA	>226 ng/g; ppb	Do Not Eat	General Population	
NY	Fish	PFOS	<50 ppb	4 meals per month	General Population	
	Fish	PFOS	>50-200 ppb	1 meal per month	General Population	
	Fish	PFOS	>50 ppb	Do Not Eat	Sensitive Population	
	Fish	PFOS	>200 ppb	Do Not Eat	General Population	
WA	Fish	PFOS	23 ng/g		General Population	In process
	Fish	PFOS	8 ng/g		High consumers	In process
WI	Fish	PFOS	10-50 ppb	1 meal per week	All Populations	
	Fish	PFOS	50-200 ppb	1 meal per month	All Populations	
	Fish	PFOS	>200 ppb	Do Not Eat	All Populations	
	Wildlife	PFOS	10-50 ppb	1 meal per week	All Populations	
	Wildlife	PFOS	50-200 ppb	1 meal per month	All Populations	
	Wildlife	PFOS	>200 ppb	Do Not Eat	All Populations	

Addendum: Additional Results

Monitoring Kentucky's waterways for per- and polyfluoroalkyl substances (PFAS) continues to be a high priority for the KY Department for Environmental Protection (DEP). Collecting and analyzing water and fish samples is ongoing in 2022. This addendum includes PFAS results available as of June 1, 2022 for fish and water samples collected from an additional 4 streams and 13 reservoirs in Kentucky.

Stream Results

In 2022, DEP staff continued to collect fish and water samples from areas associated with the targeted sampling locations identified in the 2020 source water study. Sampled streams included Otter Creek in Meade County, a tributary of North Elkhorn Creek in Fayette County, and Northern Ditch and Southern Ditch (also known as Pond Creek) in Jefferson County. The Northern and Southern Ditch locations are downstream of Duck Spring Branch, which was the target location for the 2020 study. Due to the small stream size of Duck Spring Branch, sampling locations were moved farther downstream into these waters in order to target fish species and sizes for consumption. DEP staff collected water samples plus five to ten fish at each waterbody. See Table 1 for sample location coordinates.

Table 1. Stream sample location coordinates.

Stream	Latitude	Longitude
North Elkhorn Creek Tributary	38.0858	-84.3561
Southern Ditch	38.1200	-85.7958
Northern Ditch	38.1442	-85.7569
Otter Creek	37.9304	-86.0287

Perfluorooctanesulfonic acid (PFOS) and perfluorodecanoic acid (PFDA) were found in all samples from these four streams (see Appendix A at the end for all results). Perfluoroundecanoic acid (PFUnA) was identified in all samples except for three of the five fish from the tributary to North Elkhorn Creek. Perfluorooctanoic acid (PFOA) was measured in one longear sunfish sample from the unnamed tributary to North Elkhorn Creek. The highest concentration of PFOS was 38.1 ppb from a longear sunfish collected in Southern Ditch (Figure 1). Otter Creek fish samples contained relatively fewer PFAS than the rest of the sampled streams. For example, perfluorododecanoic acid (PFDoA), perfluorodecanesulfonic acid (PFDS), and perfluorotetradecanoic acid (PFTDA) were present in fish from the other three streams, but were not detected in fish from Otter Creek (Figure 2). PFOS was also the only PFAS detected in the water sample from Otter Creek (Table 2). See Appendix B for all water sample results.

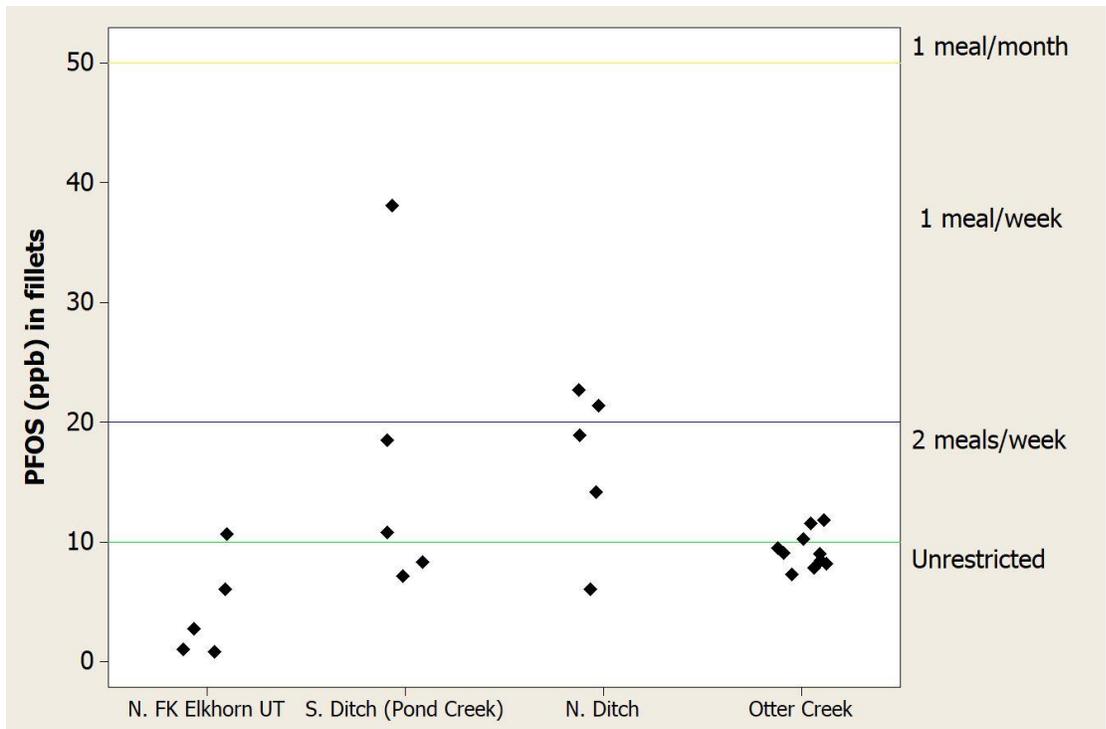


Figure 1. PFOS concentrations in fish fillets from four streams sampled in the spring of 2022. Great Lakes Consortium meal advice categories included as a reference.

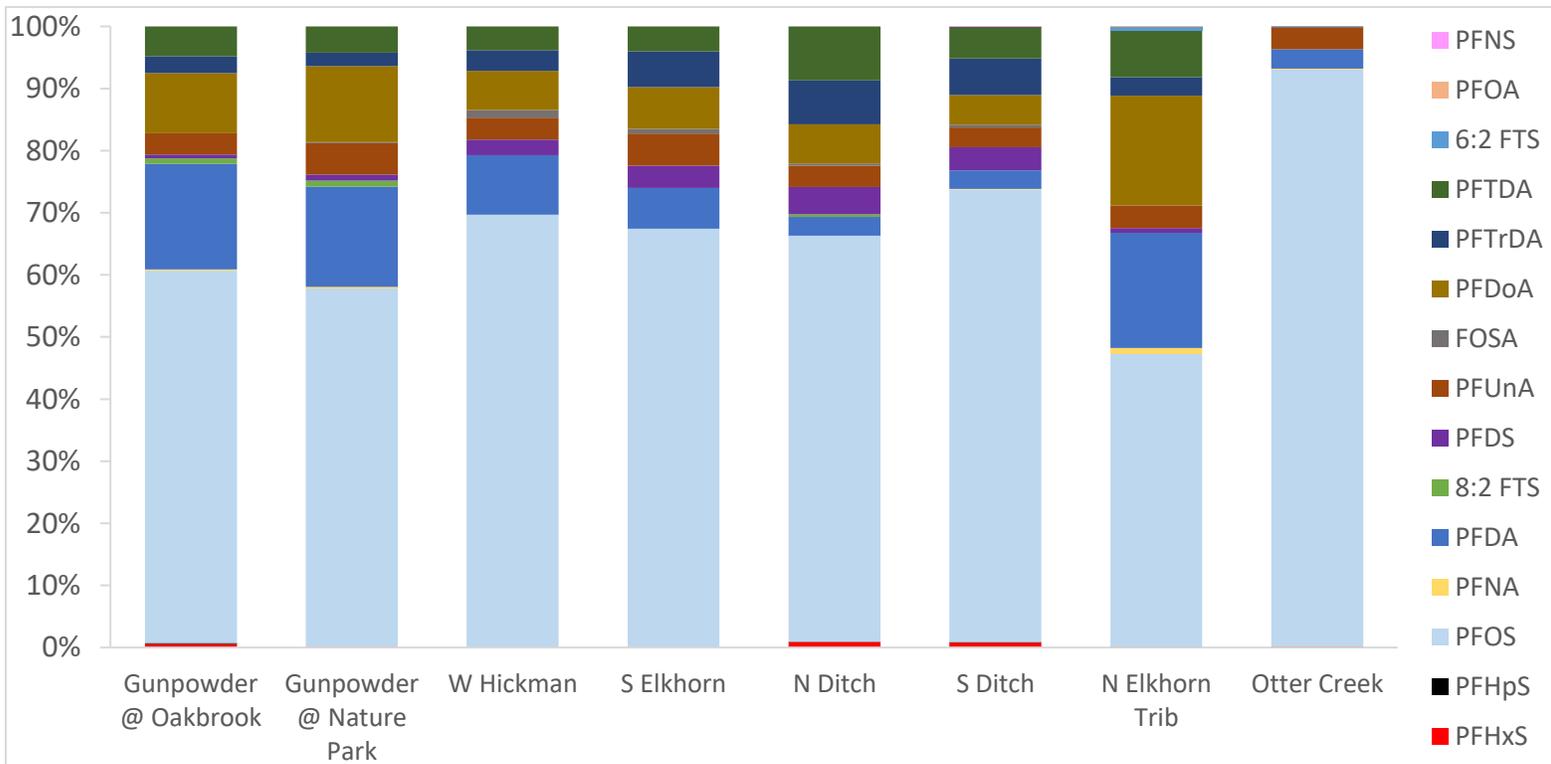


Figure 2. Comparison of relative proportions of PFAS detected in fish tissue from stream sample sites from 2021-2022 sampling efforts.

Table 2. Water sample results in ppt with lab flags included.

Waterbody	PFOS	PFOA	PFBS	PFHxS	PFHPA	PFNA	PFHxA
Northern Ditch	26.6 R	7.60 IR	4.6 R	12.9 R	4.57 IR	1.08 IJR	8.50 IR
Southern Ditch	15.9 R	5.08 IR	2.93 JR	6.27 R	2.68 IJR	ND	4.78 IR
North Elkhorn Creek Trib	1.78 JR	4.00 R	2.34 JR	1.17 JR	2.69 JR	ND	5.42 R
Otter Creek	1.50 JR	ND	ND	ND	ND	ND	ND

Reservoir Results

Thirty-three samples remaining from the regular 2021 rotational fish contaminant monitoring program were analyzed for PFAS in early 2022. These samples came from thirteen lakes across the state (Figure 3). Water samples were not collected for PFAS testing during this earlier monitoring effort.

At these reservoirs, PFOS, PFDA, and PFUnA were found in all samples. PFOS ranged between 0.31-37.1 ppb, PFDA between 0.08 to 1.38 ppb, and PFUnA between 0.10 to 5.66 ppb. For PFOS, the highest result was 37.1 ppb in a three-fish composite sample of white crappie from West Fork Drakes Reservoir near Franklin, KY (Figure 4). PFOA was detected in a five-fish composite of golden rehorse at 0.05 ppb from West Forks Drakes Reservoir. See Appendix C for all reservoir tissue results.



Figure 3. Map of reservoir sampling locations.

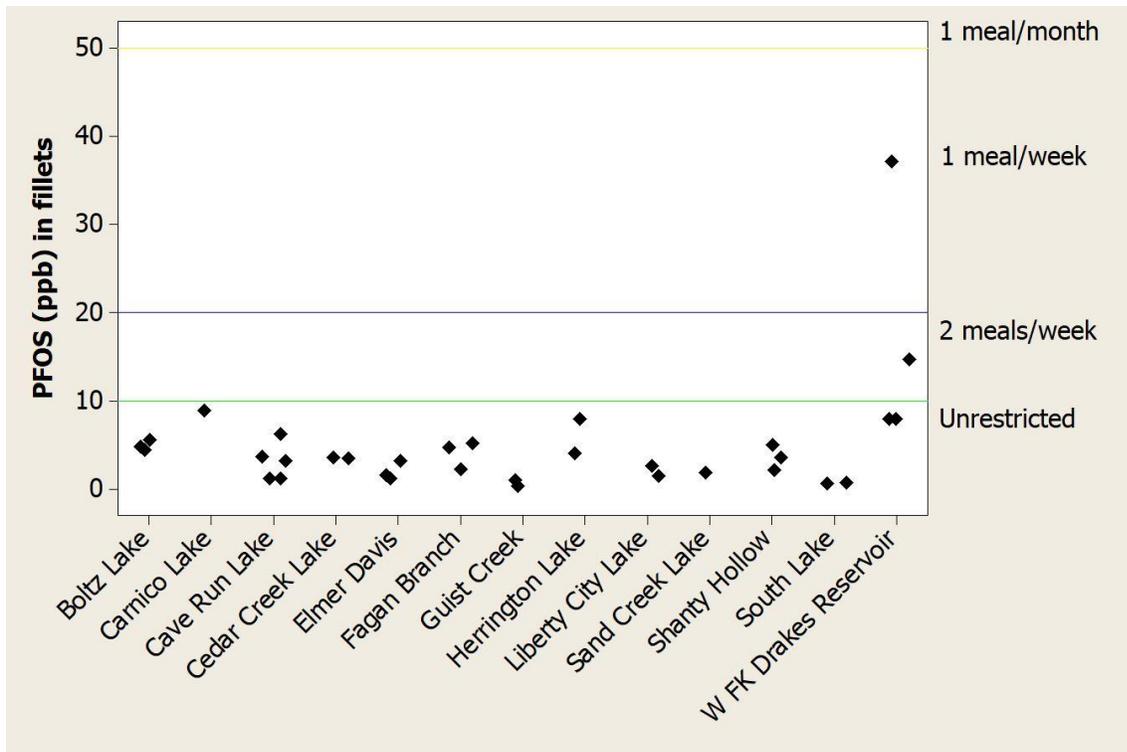


Figure 4. PFOS concentrations in fish fillets from thirteen Kentucky lakes. Great Lakes Consortium meal advice categories included as a reference.

Appendix A. Fish tissue sample results from stream sampling. All results are reported in parts per billion (ppb). Values of ND indicate that results were below the limit of detection for that analysis.

Site	Sample ID	Common Name	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	HFPO-DA	PFHxS	PFHpA	ADONA	PFHpS	6:2 FTS	PFOA	PFOS	PFNA	9Cl-PF3ONS	PFNS	PFDA	8:2 FTS	NMeFOSAA	PFDS	PFUnA	FOSA	NEtFOSAA	11Cl-PF3OUdS	PFDoA	PFTTrDA	PFTDA
N. FK Elkhorn UT	FT22-021	Bluegill	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1732	ND	0.82	ND	ND	ND	0.23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N. FK Elkhorn UT	FT22-022	Bluegill	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.78	ND	ND	ND	0.13	ND	ND	ND	ND	ND	ND	ND	0.25	ND	ND
N. FK Elkhorn UT	FT22-023	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	0.07	ND	10.64	0.27	ND	ND	4.88	ND	ND	0.25	1.18	ND	ND	ND	5.26	0.92	2.30
N. FK Elkhorn UT	FT22-024	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	6.04	0.17	ND	ND	2.69	ND	ND	0.09	0.48	ND	ND	ND	2.48	0.42	1.09
N. FK Elkhorn UT	FT22-025	Green Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.05	ND	ND	ND	0.46	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pond Creek	FT22-016	Spotted Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18.47	ND	ND	ND	0.86	ND	ND	0.71	0.90	0.29	ND	ND	1.02	0.86	0.65
Pond Creek	FT22-017	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.66	ND	ND	0.12	ND	ND	38.11	ND	ND	0.11	1.74	ND	ND	2.55	1.81	ND	ND	ND	2.85	3.76	3.20
Pond Creek	FT22-018	Green sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.33	ND	ND	ND	0.27	ND	ND	0.36	0.35	ND	ND	ND	0.51	0.84	0.62
Pond Creek	FT22-019	Green sunfish	ND	ND	ND	ND	ND	ND	0.07	ND	ND	ND	ND	ND	7.16	ND	ND	ND	0.21	ND	ND	0.34	0.24	0.10	ND	ND	0.51	0.52	0.70
Pond Creek	FT22-020	Warmouth	ND	ND	ND	ND	ND	ND	0.15	ND	ND	ND	ND	ND	10.79	ND	ND	ND	0.33	ND	ND	0.28	0.33	0.11	ND	ND	0.54	0.71	0.58
N. Ditch	FT22-011	Common Carp	ND	ND	ND	ND	ND	ND	0.32	ND	ND	ND	ND	ND	14.20	ND	ND	ND	0.55	0.32	ND	0.64	0.50	0.14	ND	ND	0.82	0.71	0.87
N. Ditch	FT22-012	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.40	ND	ND	0.07	ND	ND	22.68	ND	ND	ND	0.98	0.09	ND	1.41	1.05	0.08	ND	ND	1.88	2.33	2.22
N. Ditch	FT22-013	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.21	ND	ND	ND	ND	ND	18.89	ND	ND	ND	1.27	0.10	ND	1.15	1.21	ND	ND	ND	2.04	1.38	2.28
N. Ditch	FT22-014	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.21	ND	ND	ND	ND	ND	21.40	ND	ND	ND	0.77	ND	ND	1.21	1.05	ND	ND	ND	1.66	2.56	1.96
N. Ditch	FT22-015	Green Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.04	ND	ND	ND	0.27	ND	ND	1.19	0.54	0.28	ND	ND	1.60	2.04	3.69
Otter Creek	FT22-026	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.48	ND	ND	ND	0.30	ND	ND	ND	0.43	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-027	Smallmouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.86	ND	ND	ND	0.29	ND	ND	ND	0.41	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-028	Longear Sunfish	ND	ND	ND	ND	ND	ND	0.16	ND	ND	ND	ND	ND	10.23	0.16	ND	ND	0.39	ND	ND	ND	0.40	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-029	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.04	ND	ND	ND	0.28	ND	ND	ND	0.32	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-030	Longear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.48	ND	ND	ND	0.24	ND	ND	ND	0.26	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-031	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.82	ND	ND	ND	0.34	ND	ND	ND	0.36	ND	ND	ND	ND	0.15	ND
Otter Creek	FT22-032	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.05	ND	ND	ND	0.30	ND	ND	ND	0.26	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-033	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.28	ND	ND	ND	0.28	ND	ND	ND	0.33	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-034	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.16	ND	ND	ND	0.31	ND	ND	ND	0.32	ND	ND	ND	ND	ND	ND
Otter Creek	FT22-035	Rock Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.52	ND	ND	ND	0.36	ND	ND	ND	0.43	ND	ND	ND	ND	ND	ND

Appendix B. Water sample results. All results are reported in parts per trillion (ppt). Values of ND indicate that results were below the limit of detection for that analysis.

Site	PFBS	PFHxA	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA	9Cl-PF3ONS	PFDA	NMeFOSAA	PFUnA	NEtFOSAA	11Cl-PF3OUdS	PFDoA	PFTTrDA	PFTA
Northern Ditch	4.6	8.5	ND	4.57	12.9	ND	7.6	26.6	1.08	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pond Creek	2.93	4.78	ND	2.68	6.27	ND	5.08	15.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N. FK. Elkhorn UT	2.34	5.42	ND	2.69	1.17	ND	4	1.78	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Otter Creek	ND	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix C. Fish tissue sample results from reservoir sampling. All results are reported in parts per billion (ppb). Values of ND indicate that results were below the limit of detection for that analysis.

Site	Sample ID	Common Name	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	HFPO- DA	PFHxS	PFHpA	ADONA	PFHpS	6:2 FTS	PFOA	PFOS	PFNA	9Cl- PF3ONS	PFNS	PFDA	8:2 FTS	NMeFOSAA	PFDS	PFUnA	FOSA	NEtFOSAA	11Cl- PF3OUds	PFDoA	PFTTrDA	PFTDA
Boltz Lake	PF21-032	Largemouth Bass	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	ND	4.78	ND	ND	ND	0.40	ND	ND	ND	0.55	ND	ND	ND	0.24	0.22	ND
Boltz Lake	PF21-034	White Crappie	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	4.42	0.25	ND	ND	0.26	ND	ND	ND	0.13	ND	ND	ND	ND	ND	ND
Boltz Lake	PF21-043	Saugeye	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	5.55	ND	ND	ND	0.32	ND	ND	ND	0.25	ND	ND	ND	ND	ND	ND
Carnico Lake	PF21-040	Largemouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.85	0.08	ND	ND	1.38	ND	ND	ND	0.61	ND	ND	ND	0.14	ND	ND
Cave Run Lake	PF21-58	Largemouth Bass	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	6.25	ND	ND	ND	0.62	ND	ND	0.10	0.64	ND	ND	ND	0.30	0.74	ND
Cave Run Lake	PF21-59	Flathead Catfish	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	3.63	ND	ND	ND	0.31	ND	ND	0.08	0.61	ND	ND	ND	0.29	0.60	ND
Cave Run Lake	PF21-60	Channel Catfish	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	1.19	ND	ND	ND	0.23	ND	ND	0.08	5.66	ND	ND	ND	0.22	0.56	ND
Cave Run Lake	PF21-61	Largemouth Bass	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	3.19	ND	ND	ND	0.19	ND	ND	0.09	0.29	ND	ND	ND	0.11	0.27	ND
Cave Run Lake	PF21-62	Bigmouth Buffalo	ND	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	1.20	ND	ND	ND	0.11	ND	ND	0.08	0.51	ND	ND	ND	0.24	0.91	ND
Cedar Creek	PF21-035	Largemouth Bass	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	3.60	ND	ND	ND	0.31	ND	ND	ND	0.64	ND	ND	ND	0.13	0.23	ND
Cedar Creek	PF21-045	Largemouth Bass	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	3.44	ND	ND	ND	0.32	ND	ND	ND	0.71	ND	ND	ND	0.14	0.25	ND
Elmer davis	PF21-033	Bluegill	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	ND	1.21	ND	ND	ND	0.08	ND	ND	ND	0.13	ND	ND	ND	ND	ND	ND
Elmer davis	PF21-041	Largemouth Bass	ND	ND	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND	3.20	ND	ND	ND	0.27	ND	ND	0.09	0.50	ND	ND	ND	0.18	0.24	ND
Elmer davis	PF21-042	Black Crappie	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.61	0.12	ND	ND	0.11	ND	ND	ND	0.10	ND	ND	ND	ND	ND	ND
Fagan Branch	PF21-037	Largemouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.70	ND	ND	ND	0.90	ND	ND	ND	1.66	ND	ND	ND	0.25	0.56	ND
Fagan Branch	PF21-052	Largemouth Bass	ND	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	5.18	0.12	ND	ND	1.08	ND	ND	ND	1.51	ND	ND	ND	0.20	0.41	ND
Fagan Branch	PF21-053	Black Crappie	ND	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	2.22	0.39	ND	ND	0.41	ND	ND	ND	0.60	ND	ND	ND	ND	0.19	ND
Guist Creek	PF21-054	Largemouth Bass	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	1.02	ND	ND	ND	0.15	ND	ND	ND	0.16	ND	ND	ND	ND	ND	ND
Guist Creek	PF21-055	Channel Catfish	ND	ND	ND	0.09	ND	ND	ND	ND	ND	ND	ND	ND	0.31	ND	ND	ND	0.11	ND	ND	ND	0.14	ND	ND	ND	0.09	ND	ND
Herrington Lake	PF21-56	Largemouth Bass	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	4.03	ND	ND	ND	0.26	ND	ND	ND	0.21	ND	ND	ND	ND	ND	ND
Herrington Lake	PF21-57	Largemouth Bass	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	ND	7.92	ND	ND	ND	0.61	ND	ND	ND	0.45	ND	ND	ND	0.23	ND	ND
Liberty City	PF21-038	Largemouth Bass	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.61	ND	ND	ND	0.19	ND	ND	ND	0.61	ND	ND	ND	0.24	0.57	ND
Liberty City	PF21-039	Channel Catfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.44	ND	ND	ND	0.18	ND	ND	ND	0.52	ND	ND	ND	0.17	0.44	ND
Sand Lick Creek lake	PF21-63	Common Carp	ND	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	1.85	ND	ND	ND	0.22	ND	ND	ND	0.57	ND	ND	ND	0.17	0.29	0.10
Shanty Hollow	PF21-036	Bluegill	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.16	ND	ND	ND	0.13	ND	ND	ND	0.38	ND	ND	ND	ND	0.41	ND
Shanty Hollow	PF21-050	Largemouth Bass	ND	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	3.59	ND	ND	ND	0.28	ND	ND	ND	0.81	ND	ND	ND	0.27	0.55	0.18
Shanty Hollow	PF21-051	Largemouth Bass	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	4.97	ND	ND	ND	0.37	ND	ND	ND	1.07	ND	ND	ND	0.35	0.65	0.20
South Lake	PF21-031	Channel Catfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.62	ND	ND	ND	0.25	ND	ND	ND	0.49	ND	ND	ND	ND	0.39	ND
South Lake	PF21-044	Red Ear Sunfish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.74	0.14	ND	ND	0.25	ND	ND	ND	0.42	ND	ND	ND	ND	0.24	ND
W FK Drakes Reservoir	PF21-046	Largemouth Bass	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	ND	14.65	ND	ND	ND	0.36	ND	ND	ND	0.54	ND	ND	ND	0.23	0.29	0.15
W FK Drakes Reservoir	PF21-047	Bluegill	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.97	ND	ND	ND	0.15	ND	ND	0.06	0.43	ND	ND	ND	0.27	0.46	0.24
W FK Drakes Reservoir	PF21-048	Golden Redhorse	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	0.05	7.95	0.23	ND	ND	0.41	ND	ND	ND	0.52	ND	ND	ND	0.20	0.31	ND
W FK Drakes Reservoir	PF21-049	White Crappie	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.14	ND	ND	37.15	0.43	ND	ND	0.82	ND	ND	ND	0.55	ND	ND	ND	0.18	ND	ND