

The background is a blue gradient with several realistic water droplets of various sizes scattered across the surface. The droplets have highlights and shadows, giving them a three-dimensional appearance.

Probability-based national assessments of contaminants in fish from U.S. rivers

John Healey, USEPA

Blaine Snyder and Tara Cohen, Tetra Tech

Harry McCarty, GDIT

DISCLAIMER

- The research and results presented today were funded by the U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology.
- The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

PURPOSE

Provide

Background on EPA's Fish Tissue Contamination Studies

Describe

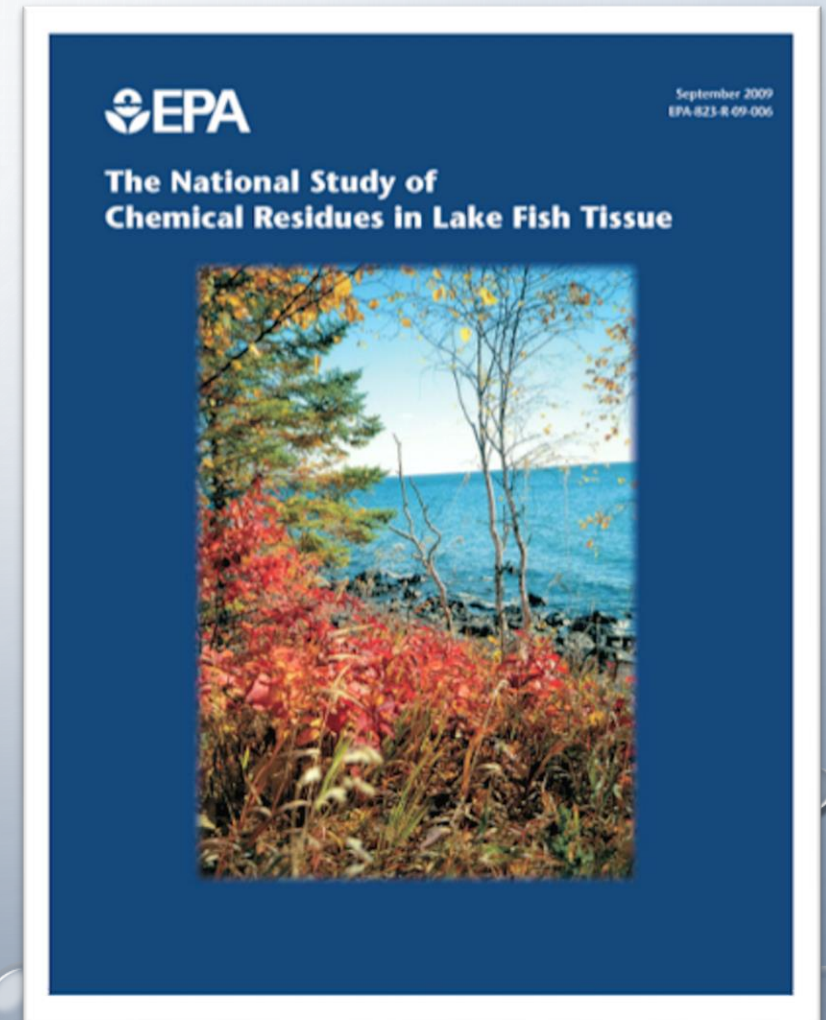
Study design, including sample collection, preparation, and analysis

Summarize

Key findings from fish tissue studies in U.S. rivers

NATIONAL LAKE FISH TISSUE STUDY (NLFTS)

- First national-scale statistically based fish tissue contamination study ([EPA-823-R-09-006](#)).
- Study design (including sample collection and preparation procedures) peer reviewed in 1999.
- Study samples collected at 500 lakes in collaboration with states from 2000-2003.
- Tissue samples analyzed for 268 persistent, bioaccumulative, and toxic chemicals.
- Final report externally peer reviewed and published in 2009.



PUBLISHED SURVEY DESIGN

Environ Monit Assess (2009) 150:91–100
DOI 10.1007/s10661-008-0685-8

Survey design for lakes and reservoirs in the United States to assess contaminants in fish tissue

Anthony R. Olsen · Blaine D. Snyder ·
Leanne L. Stahl · Jennifer L. Pitt

Received: 29 January 2008 / Accepted: 14 February 2008 / Published online: 4 December 2008
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Abstract The National Lake Fish Tissue Study (NLFTS) was the first survey of fish contamination in lakes and reservoirs in the 48 conterminous states based on a probability survey design. This study included the largest set (268) of persistent, bioaccumulative, and toxic (PBT) chemicals ever studied in predator and bottom-dwelling fish species. The U.S. Environmental Protection Agency (USEPA) implemented the study in cooperation with states, tribal nations, and other federal agencies, with field collection occurring at 500 lakes and reservoirs over a four-year period (2000–2003). The sampled lakes and reservoirs were selected using a spatially balanced unequal probability survey design from 270,761 lake ob-

jects in USEPA's River Reach File Version 3 (RF3). The survey design selected 900 lake objects, with a reserve sample of 900, equally distributed across six lake area categories. A total of 1,001 lake objects were evaluated to identify 500 lake objects that met the study's definition of a lake and could be accessed for sampling. Based on the 1,001 evaluated lakes, it was estimated that a target population of 147,343 ($\pm 7\%$ with 95% confidence) lakes and reservoirs met the NLFTS definition of a lake. Of the estimated 147,343 target lakes, 47% were estimated not to be sampleable either due to landowner access denial (35%) or due to physical barriers (12%). It was estimated that a sampled population of 78,664 ($\pm 12\%$ with 95% confidence) lakes met the NLFTS lake definition, had either predator or bottom-dwelling fish present, and could be sampled.

Keywords Fish tissue · Contaminants · Lakes · Reservoirs · Probability survey design · PBTs

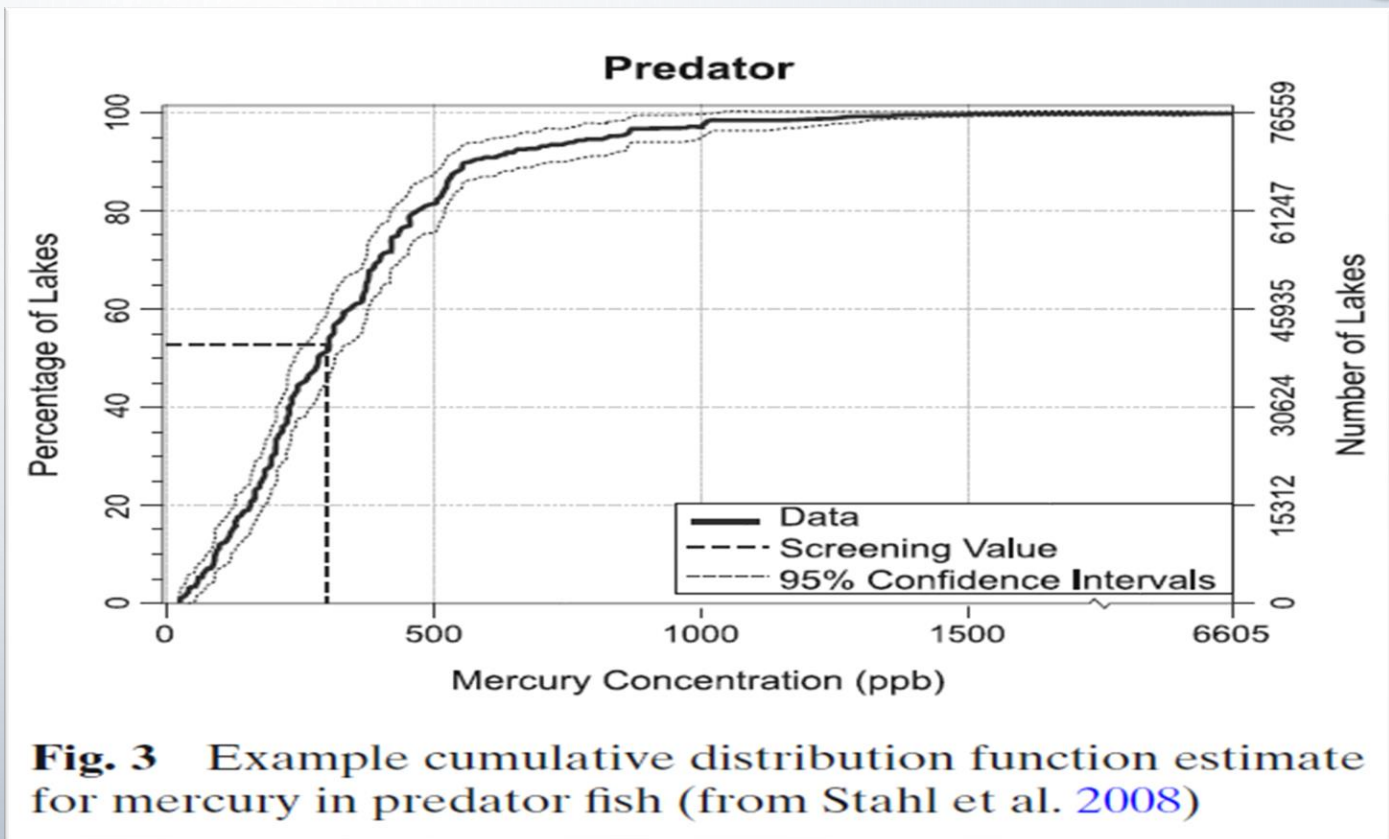
Introduction

In 1998, the U.S. Environmental Protection Agency's (EPA's) Office of Science and Technology (OST) within the Office of Water (OW) held a workshop to initiate a national study of contamination in fish tissue for lakes and reservoirs in the 48 conterminous states. Workshop

A. R. Olsen (✉)
U.S. Environmental Protection Agency,
ORD/National Health and Environmental Effects
Laboratory, Western Ecology Division,
200 S.W. 35th Street, Corvallis, OR 97333-4902, USA
e-mail: olsen.tony@epa.gov

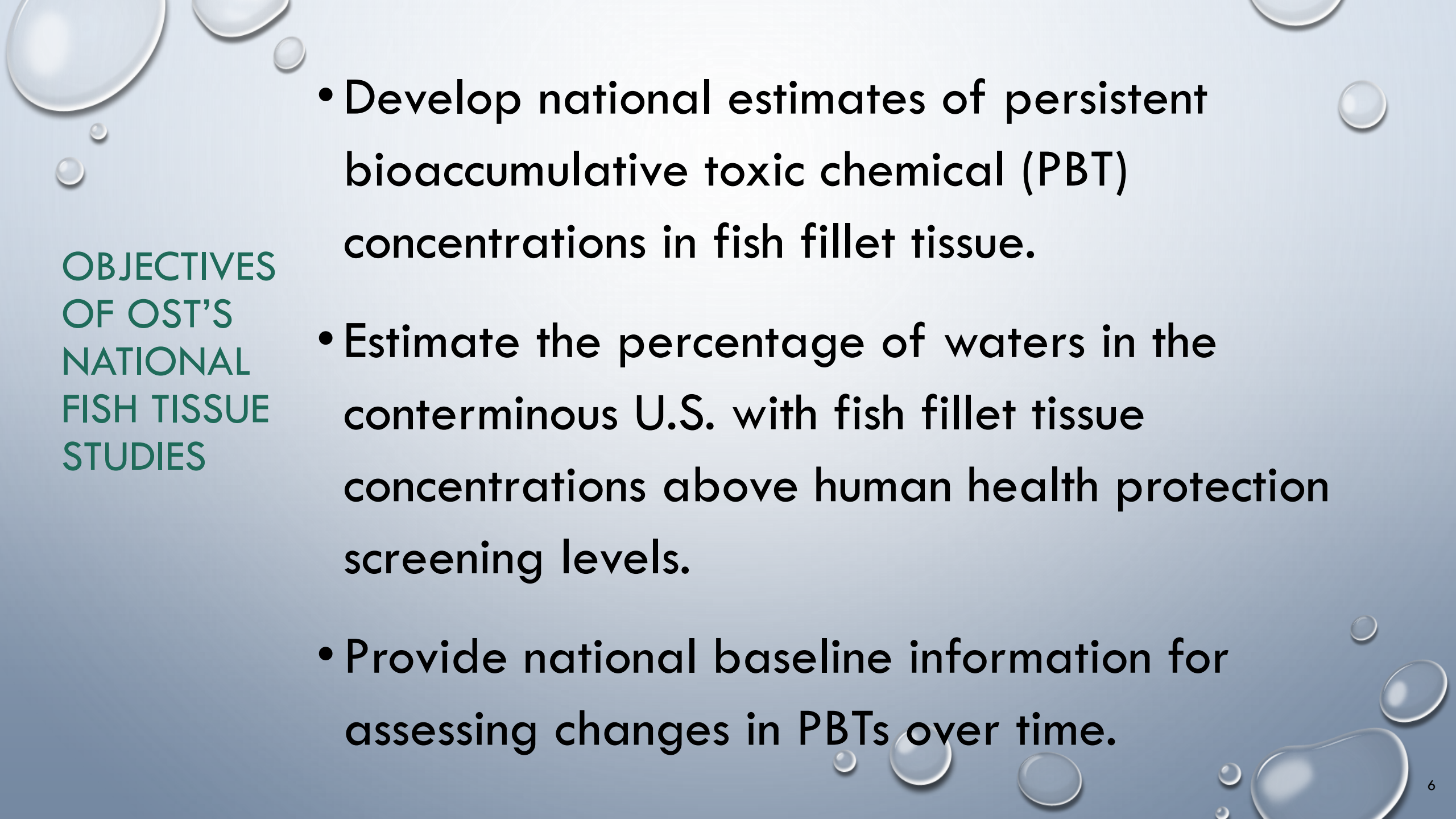
B. D. Snyder · J. L. Pitt
Tetra Tech, Inc., Center for Ecological Sciences,
400 Red Brook Boulevard, Suite 200, Owings Mills,
Baltimore, MD 21117, USA

L. L. Stahl
U.S. Environmental Protection Agency,
OW/Office of Science and Technology,
1200 Pennsylvania Avenue, NW (MC 4305),
Washington, DC 20460, USA



Olsen, A.R., Snyder, B.D., Stahl, L.L. et al., Survey design for lakes and reservoirs in the United States to assess contaminants in fish tissue. *Environ Monit Assess* **150**, 91–100 (2009).

<https://doi.org/10.1007/s10661-008-0685-8>



OBJECTIVES
OF OST'S
NATIONAL
FISH TISSUE
STUDIES

- Develop national estimates of persistent bioaccumulative toxic chemical (PBT) concentrations in fish fillet tissue.
- Estimate the percentage of waters in the conterminous U.S. with fish fillet tissue concentrations above human health protection screening levels.
- Provide national baseline information for assessing changes in PBTs over time.

FISH TISSUE STUDIES CONDUCTED UNDER NARS

- Since 2008, EPA has conducted 7 fish tissue studies under the National Aquatic Resource Surveys (NARS):
 - National Rivers and Streams Assessment (NRSA) – rivers only
 - 2008-09, urban rivers
 - 2013-14
 - 2018-19
 - National Coastal Condition Assessment (NCCA) – Great Lakes only
 - 2010
 - 2015
 - 2020
 - National Lakes Assessment (NLA)
 - 1 study in lakes (2022) – underway

FISH TISSUE STUDIES CONDUCTED UNDER NARS

- All studies used the statistical design of NARS and the peer-reviewed fish composite sample collection and fillet tissue preparation methods from the NLFTS.
- All studies have included analysis of fillet composite samples for mercury, PCBs, and PFAS (other chemical groups, such as PBDEs and dioxins and furans, have been included periodically).
- **This presentation will focus on the two most recent NRSA studies.**

STUDY DESIGN

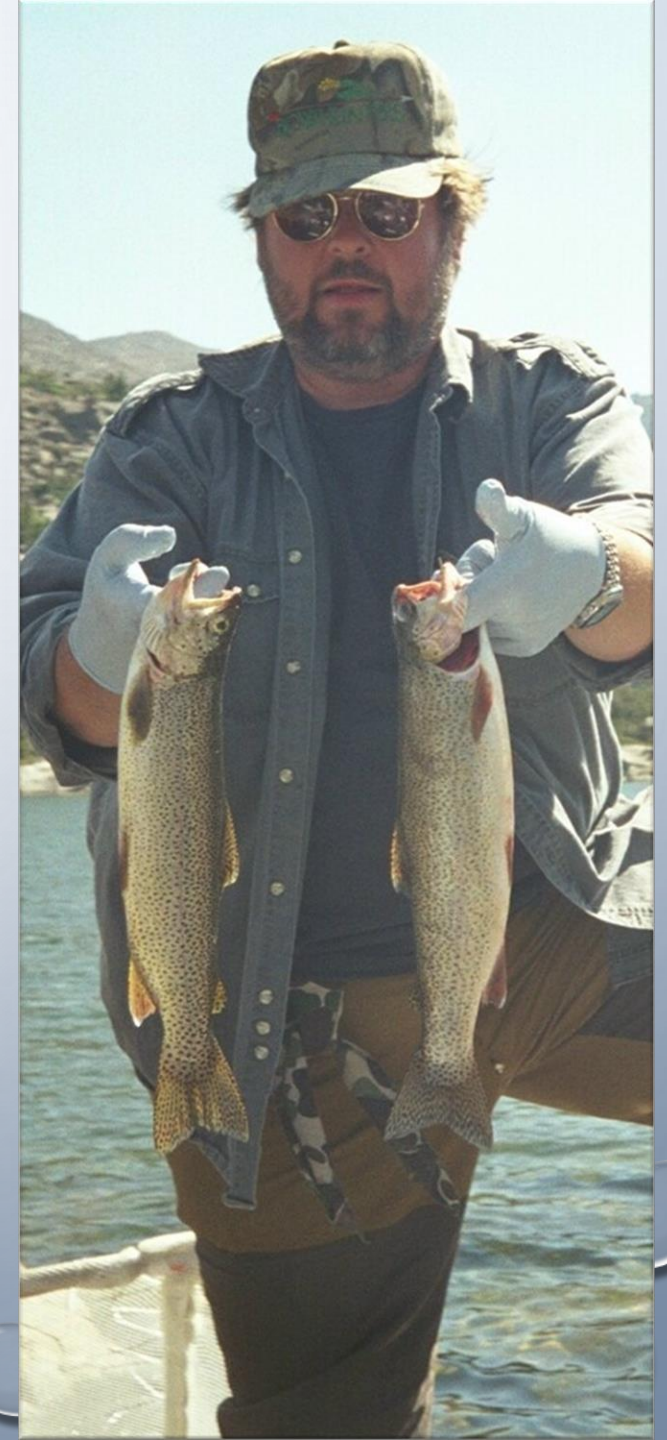
- An unequal probability survey design was developed to allow a comprehensive characterization of mercury, PCB, and PFAS contamination in fish from U.S. rivers.
- Probability-based assessments provide the basis for estimating resource extent and condition and characterizing changes in extent or condition over time with known certainty.

STUDY DESIGN

- Characteristics that distinguish probability sampling designs from other sampling designs:
 - The target population being sampled is clearly defined.
 - Every element in the population has an opportunity to be sampled with known probability.
 - The site selection process includes an explicit random element.

HOW ARE FISH COLLECTED?

- Field crews collect fish by electrofishing, hook and line, and netting methods.
- A composite consists of up to 5 similarly sized adult fish of the same species (75% fish-length rule applies).
- EPA supplies a target species list to field crews based on these criteria:
 - Abundant
 - Commonly consumed by people
 - Large enough to provide sufficient tissue for chemical analyses (adult specimens preferred)
- Fish are handled and shipped from each site using consistent methods derived from the NLFTS and incorporated in an approved QA plan.



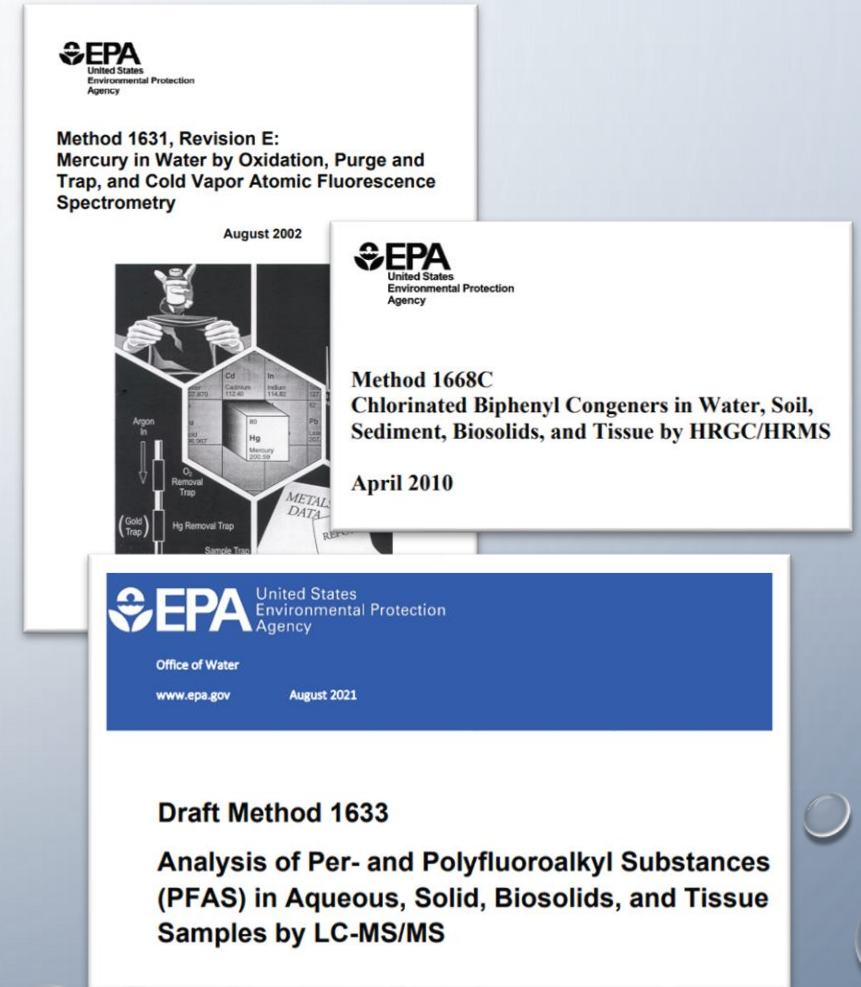
HOW ARE THE FILLET SAMPLES PREPARED?



- Apply standardized approach based on procedures used for the NLFTS.
- Scale and remove fillets from each fish in the composite sample.
- Homogenize fillets for each composite sample using a tissue grinder.
- Divide ground fillet tissue into separate aliquots for each type of chemical analysis (method specifies required tissue volume).
- Complete quality control steps to:
 - Confirm homogeneity based on lipid testing.
 - Verify that equipment cleaning procedures are preventing cross-contamination by analyzing rinsate samples.

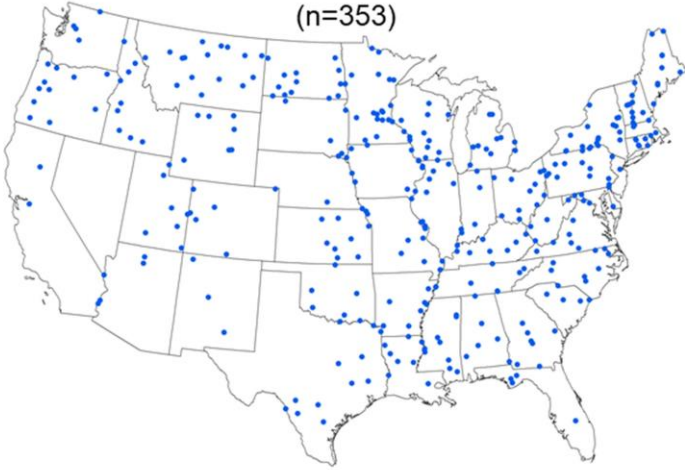
METHODS USED TO ANALYZE THE SAMPLES

- Mercury: EPA Method 1631, Revision E; detects to fractions of one part per billion
- PCBs: EPA Method 1668, Revision C; detects to fractions of one part per trillion
- PFAS: HPLC-MS/MS method developed by a commercial laboratory (similar to EPA Draft Method 1633); detects to fractions of one part per billion

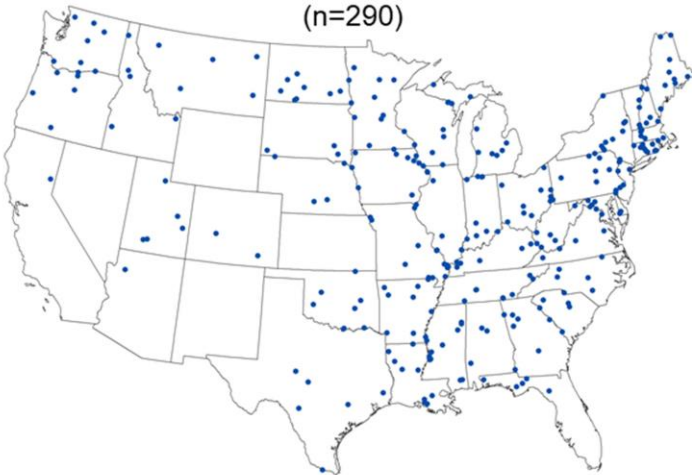


NRSA FISH TISSUE STUDY SAMPLING LOCATIONS

2013-2014 NRSA
(n=353)



2018-2019 NRSA
(n=290)



Number of samples analyzed for each contaminant

	Mercury	PCBs	PFAS
2013-14	353	223	349
2018-19	290	290	290

- Mercury and PCBs were detected in 100% of the samples.
- PFOS was most frequently detected PFAS, in more than 95% of the samples.
- Other commonly detected PFAS include:
 - six carboxylic acids (PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA),
 - one sulfonic acid (PFDS)
 - one sulfonamide (PFOSA)

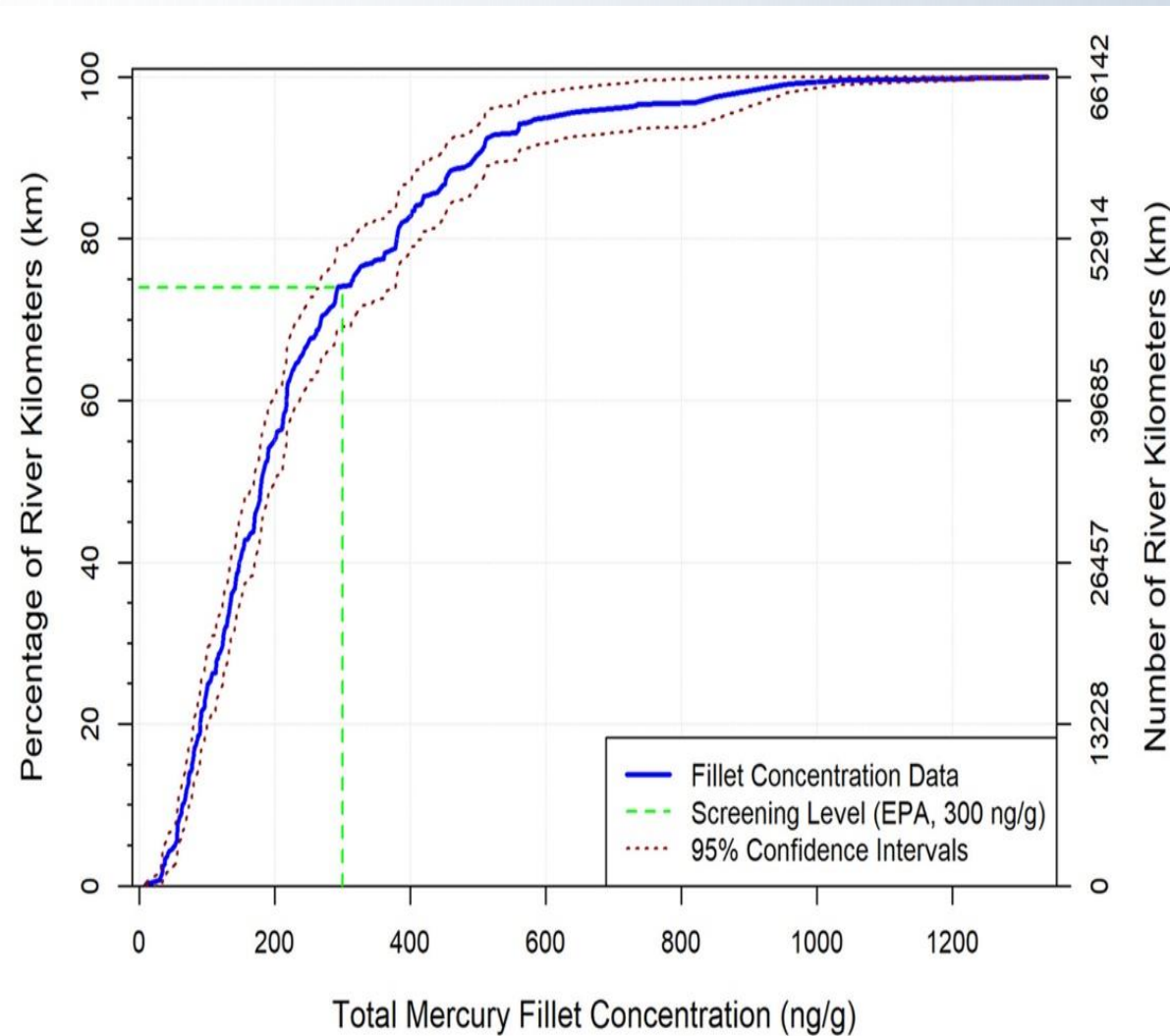
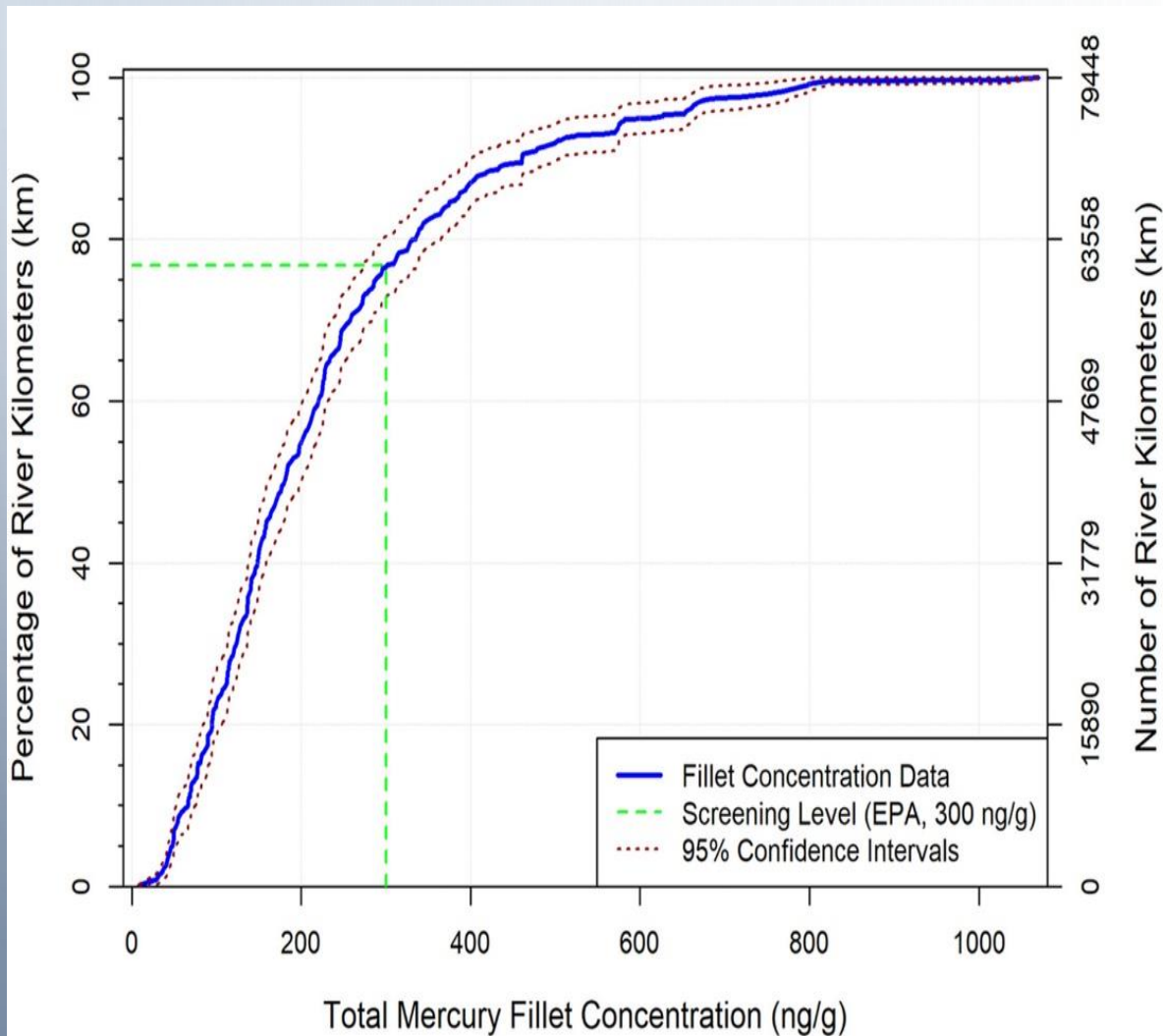
MERCURY - IMPLICATIONS FOR FISH CONSUMPTION

	Fish tissue screening level (ng/g, wet weight)	Fish consumption rate	Percent of sampled population (river km) with fillet concentrations above screening level	
			2013–2014	2018–2019
Noncancer health effects (general population)	300 ng/g	17.5 g/day	23.5%	26.0%

MERCURY - IMPLICATIONS FOR FISH CONSUMPTION

2013-2014

2018-2019

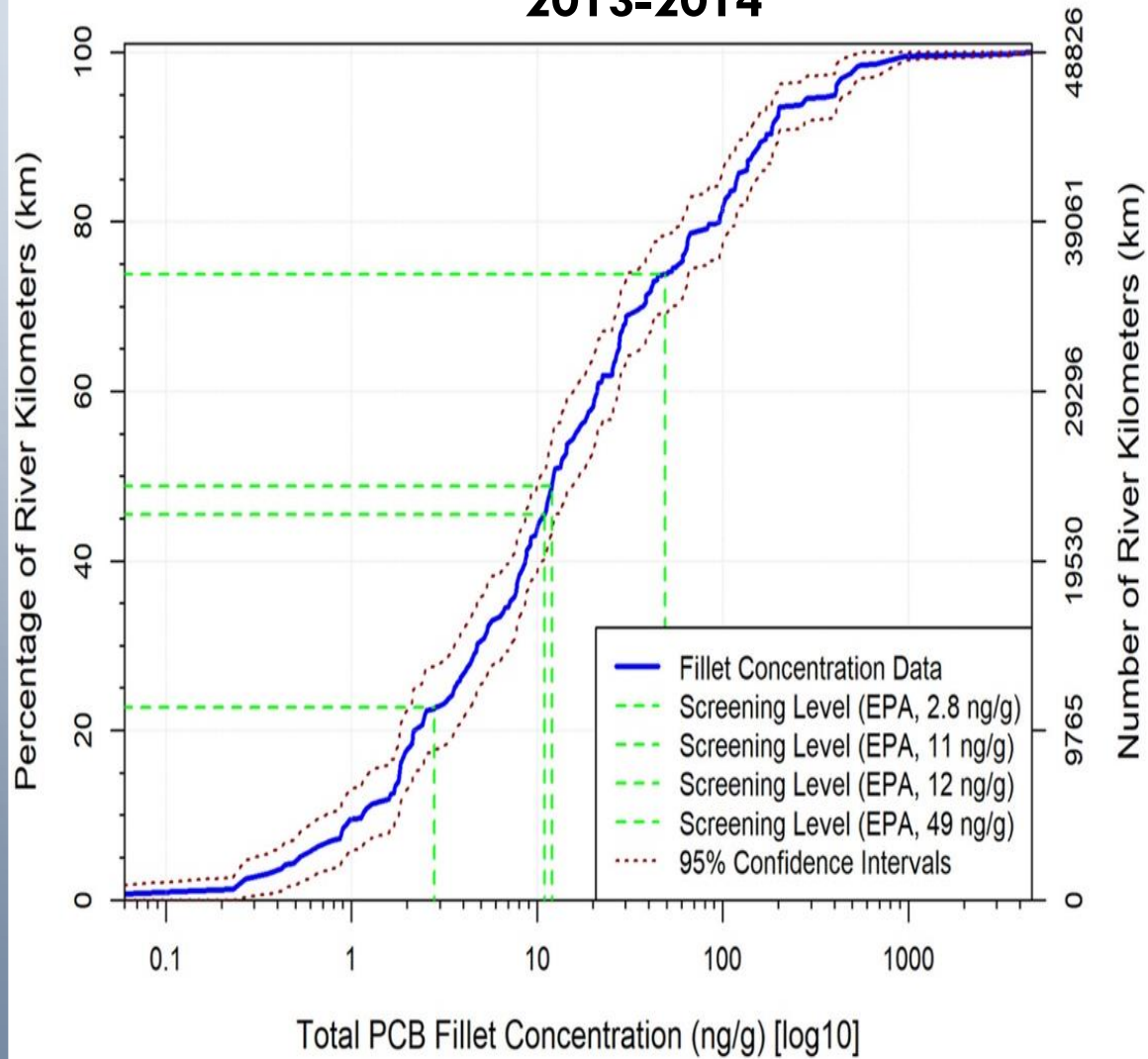


PCBs - IMPLICATIONS FOR FISH CONSUMPTION

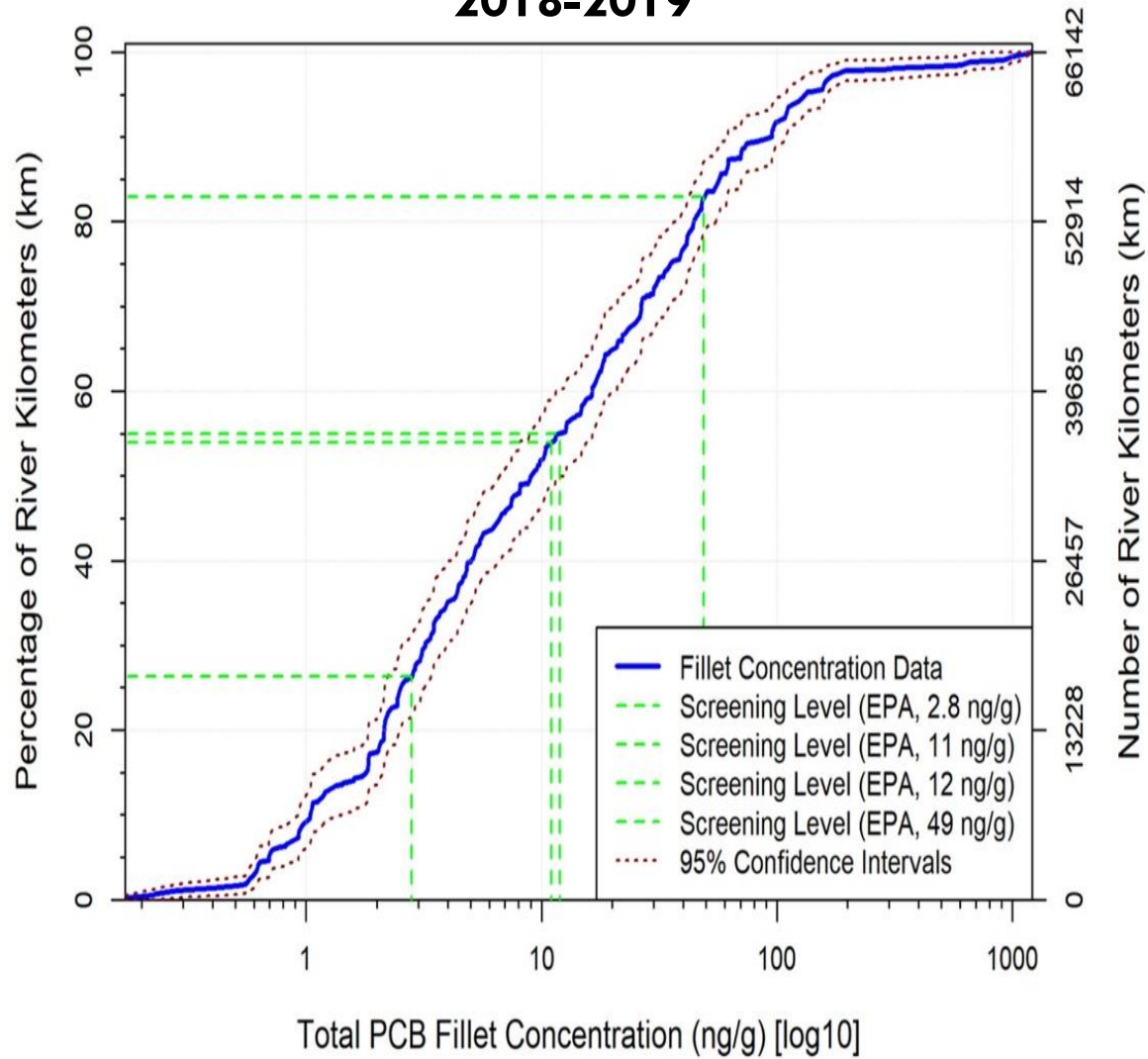
	Fish tissue screening level (ng/g, wet weight)	Fish consumption rate	Percent of sampled population (river km) with fillet concentrations above screening level	
			2013–2014	2018–2019
Cancer screening level (subsistence)	2.8 ng/g	142 g/day	77.4%	73.8%
Noncancer screening level (subsistence)	11 ng/g	142 g/day	54.6%	46.2%*
Cancer screening level (general consumers)	12 ng/g	32.4 g/day	51.6%	45.1%
Noncancer screening level (general consumers)	49 ng/g	32.4 g/day	26.3%	17.3%*

PCBs - IMPLICATIONS FOR FISH CONSUMPTION

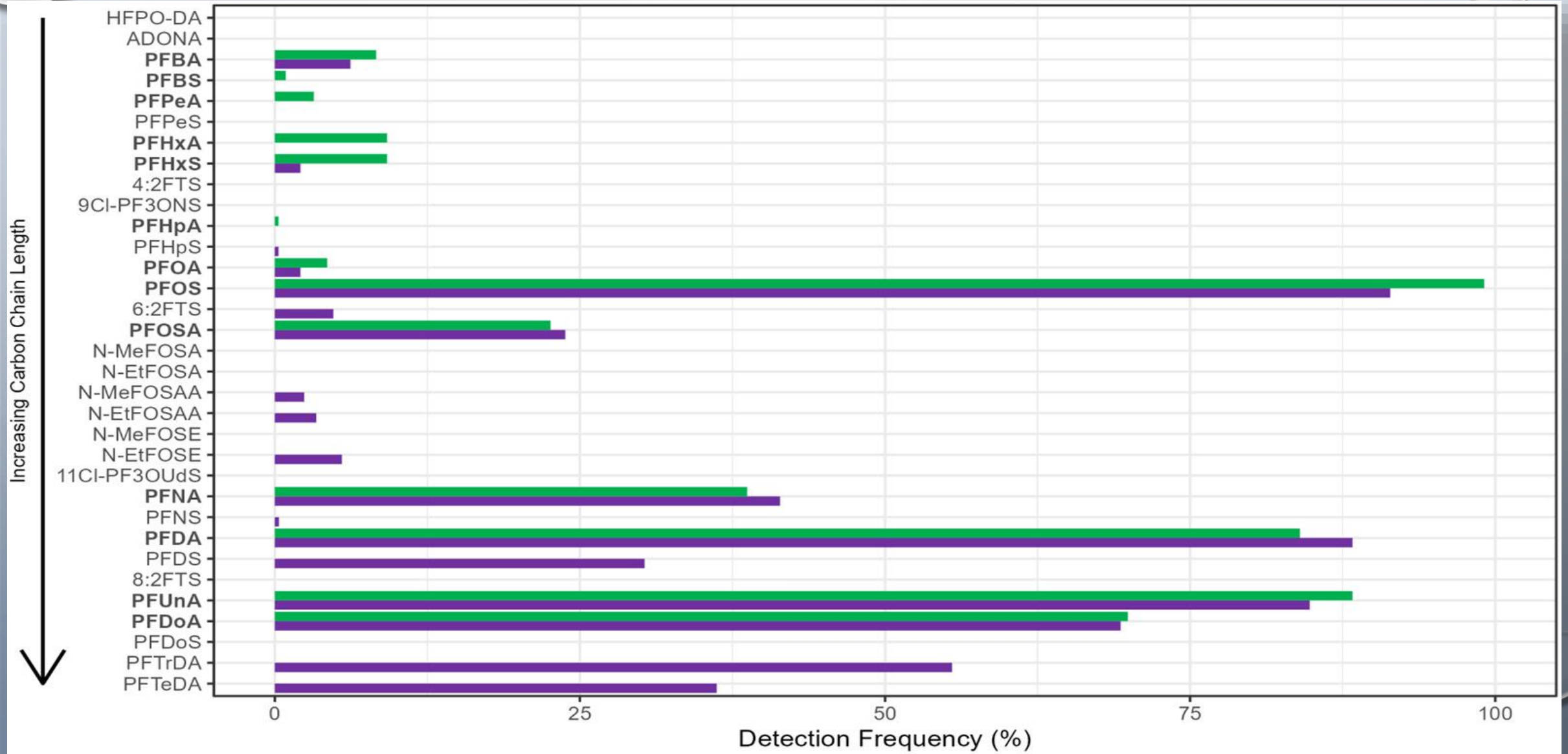
2013-2014



2018-2019



PFAS Detection Frequencies in Fish Fillet Samples



PFOS RFD - IMPLICATIONS FOR FISH CONSUMPTION

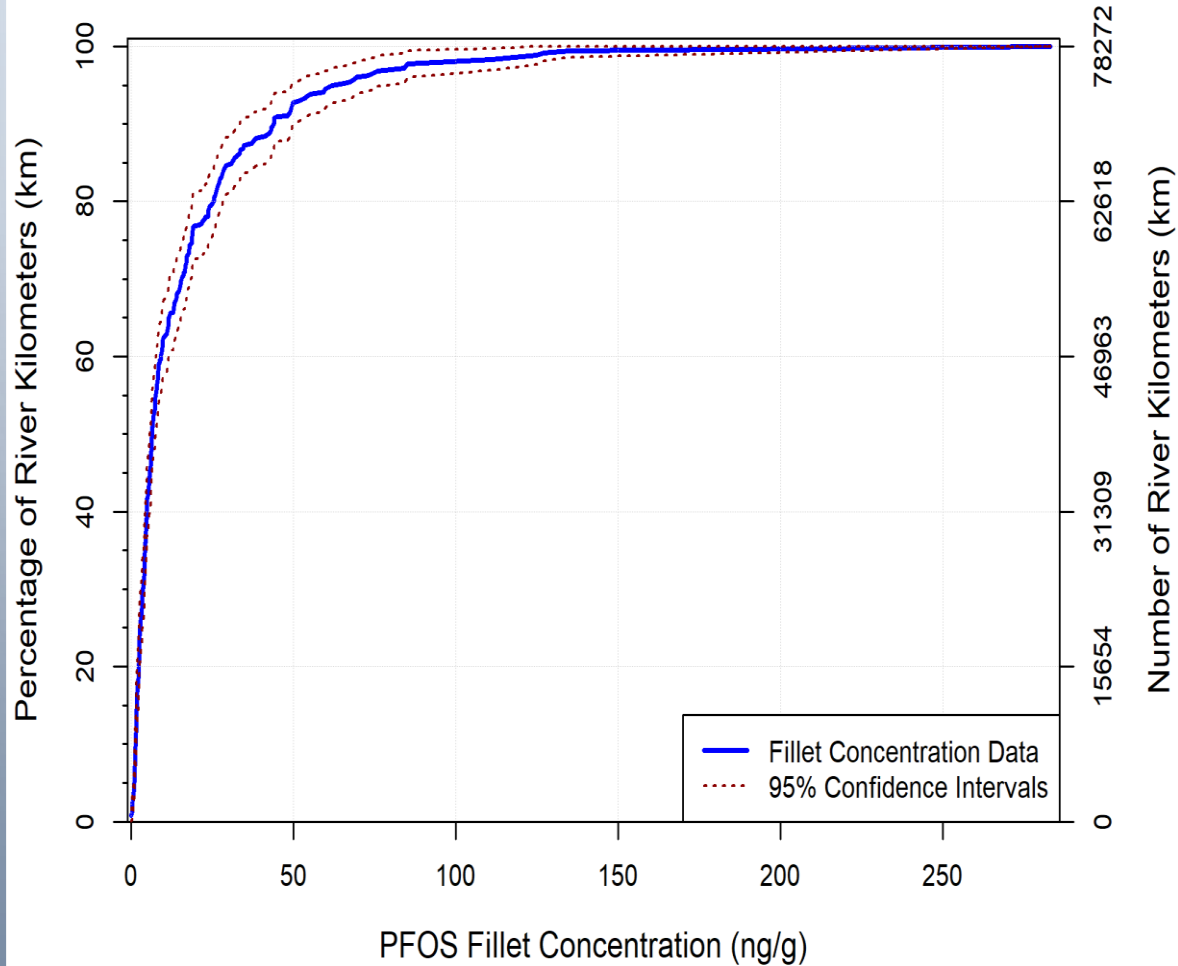
- EPA recently announced the proposed National Primary Drinking Water Regulation for six PFAS, including a revised draft health assessment for PFOS, with a reference dose (RfD) value of 1×10^{-7} mg/kg-day.

$$PFOS \text{ Screening Level} = \frac{RfD * Body \text{ Weight}}{Fish \text{ Consumption Rate}} = \frac{1 * 10^{-7} \frac{mg}{kg-day} * 80kg}{0.032 kg/day} = 0.25 \text{ ppb}$$

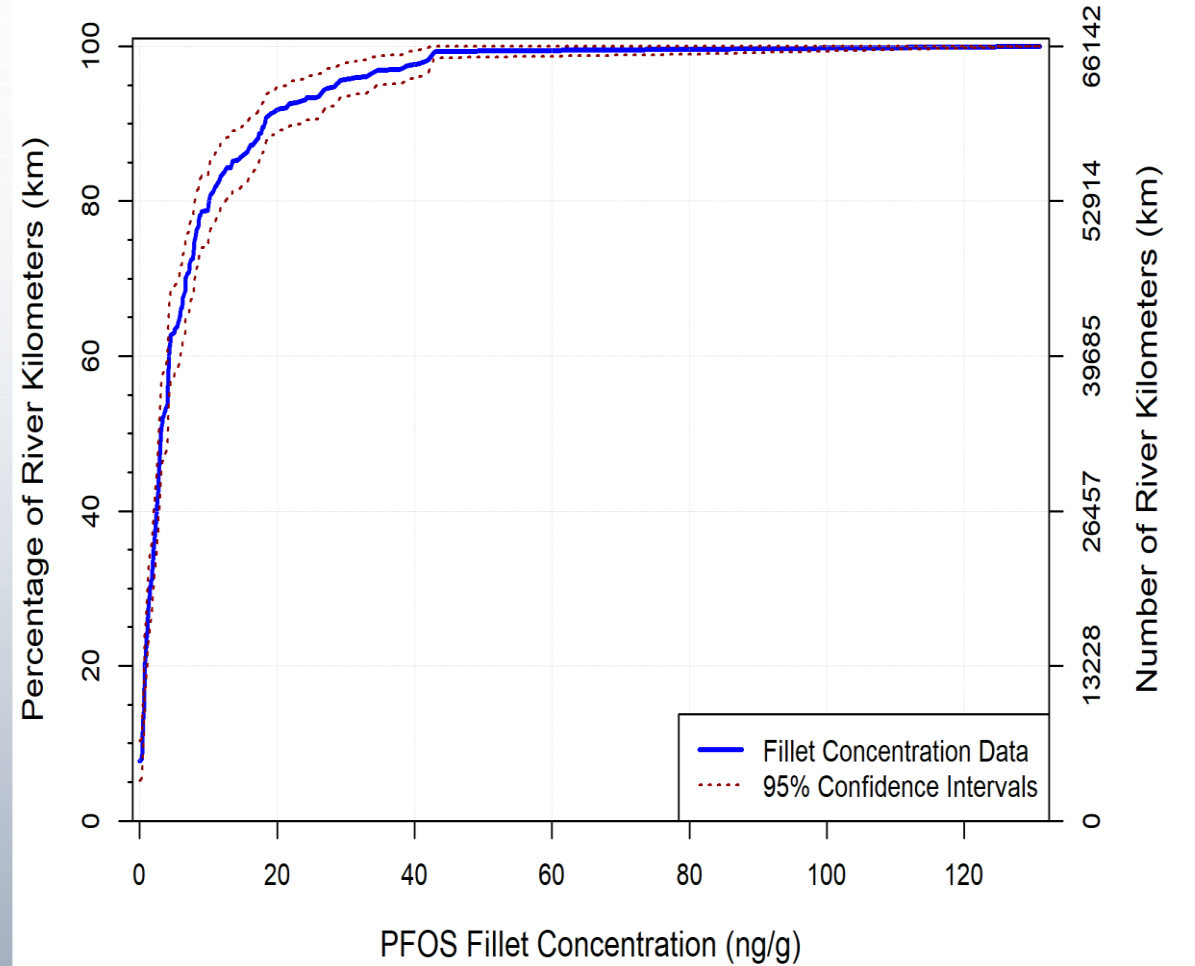
- More than 98 percent of the 2013-14 sampled population, and more than 92 percent of the 2018-19 sampled population, contained fish that exceeded the PFOS screening level.

PFOS - IMPLICATIONS FOR FISH CONSUMPTION

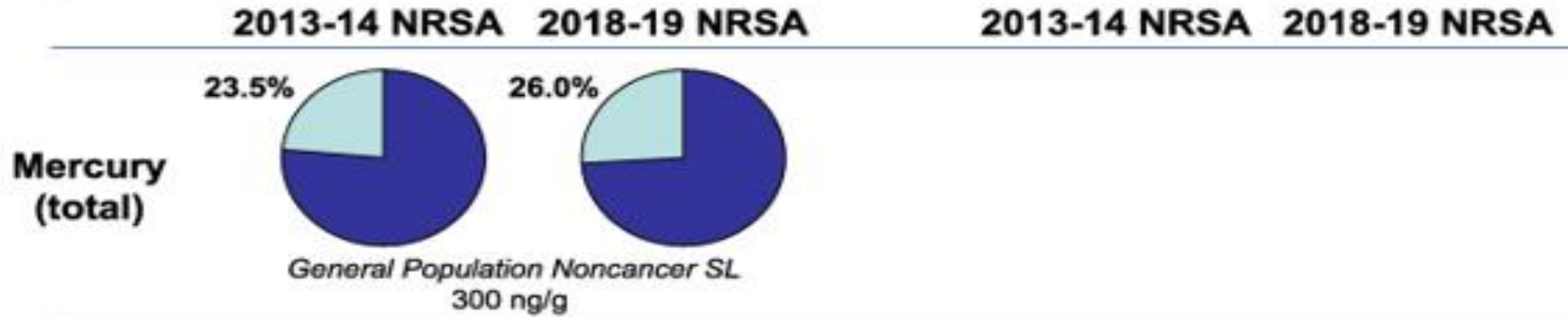
2013-2014



2018-2019



PUBLISHED NRSA RESULTS



Percentage of the sampled population of river km with fillet concentrations **above** the fish tissue screening level (SL)

 Percentage of the sampled population of river km with fillet concentrations **below** the fish tissue screening level (SL)

PUBLISHED NRSA RESULTS

- Stahl, L.L., Snyder, B.D., McCarty, H.B. et al. Contaminants In Fish From U.S. Rivers: Probability-based National Assessments. *Sci. Total Environ.* 861, 160557 (2023).

<https://doi.org/10.1016/j.scitotenv.2022.160557>

- The published results were based on PFOS screening levels derived from 2016 health advisories.
- The recent revised RfD for PFOS from the National Primary Drinking Water Regulation would result in a lower screening level for PFOS, equal to 0.25 ppb, and at least 92% of the assessed waterbodies containing fish above the PFOS screening level.

RESOURCES AND CONTACT INFORMATION

- EPA Human Health Fish Tissue Contaminant Studies:

<https://www.epa.gov/fish-tech/studies-fish-tissue-contamination>

- EPA Fish Advisory Guidance Webpages

<https://www.epa.gov/fish-tech/epa-guidance-developing-fish-advisories>

- Contacts:

John Healey, Healey.John@epa.gov

Lisa Larimer, Larimer.Lisa@epa.gov