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Prioritization of Exposure Pathways at Sediment Sites Impacted by Per and Polyfluoroalkyl Substances



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February 14, 2019

NEWS

After water contamination, elevated chemical levels in Bucks, Montco residents' blood

by Justine McDaniel and Laura McCrystal, Updated: December 19, 2018

America's Next Water Contamination Crisis May Already be here

7 of chemicals called PFAS have been everything from carpeting to fast food. They also may have contaminated

ENVIRONMENTAL HEALTH

Farmers learn of PFAS contamination

ALEXANDER SINN • DEC 27, 2018 AT 9:00 AM

asinn@grandhaventribune.com

Michigan's next water crisis is PFAS - and you may already be affected

ROBINSON TWP. — The day after Christmas, Robinson residents began receiving phone calls from Lansing...

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MLive.com

PERSISTENT PROBLEM

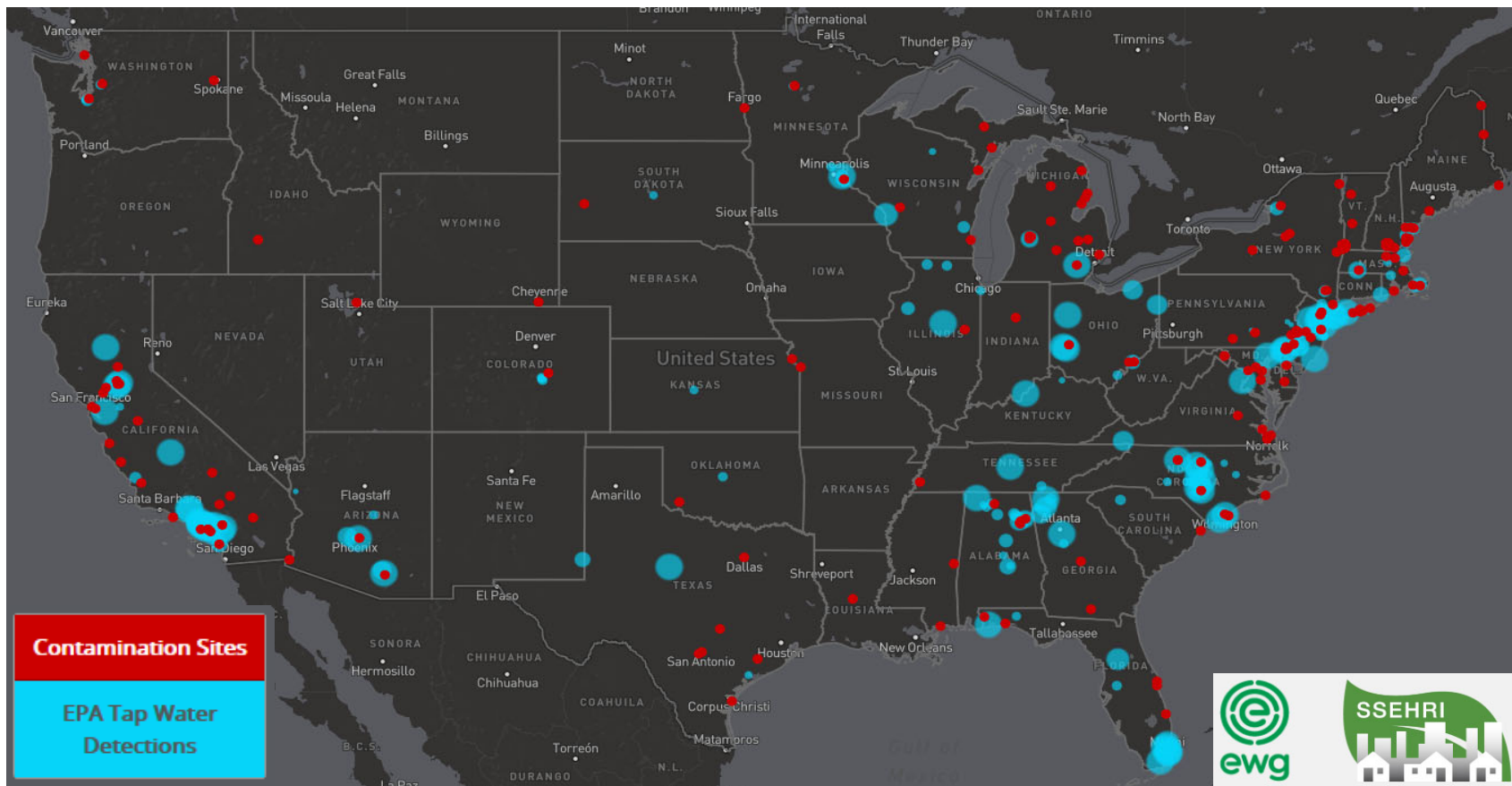
A Teflon chemical contaminating the drinking water could soon be banned

By Zoë Schlanger • September 26, 2018

Health & Science

‘Not a problem you can run away from’: Communities confront the threat of unregulated chemicals in their drinking water

Publicly Notified PFAS Sites – USA

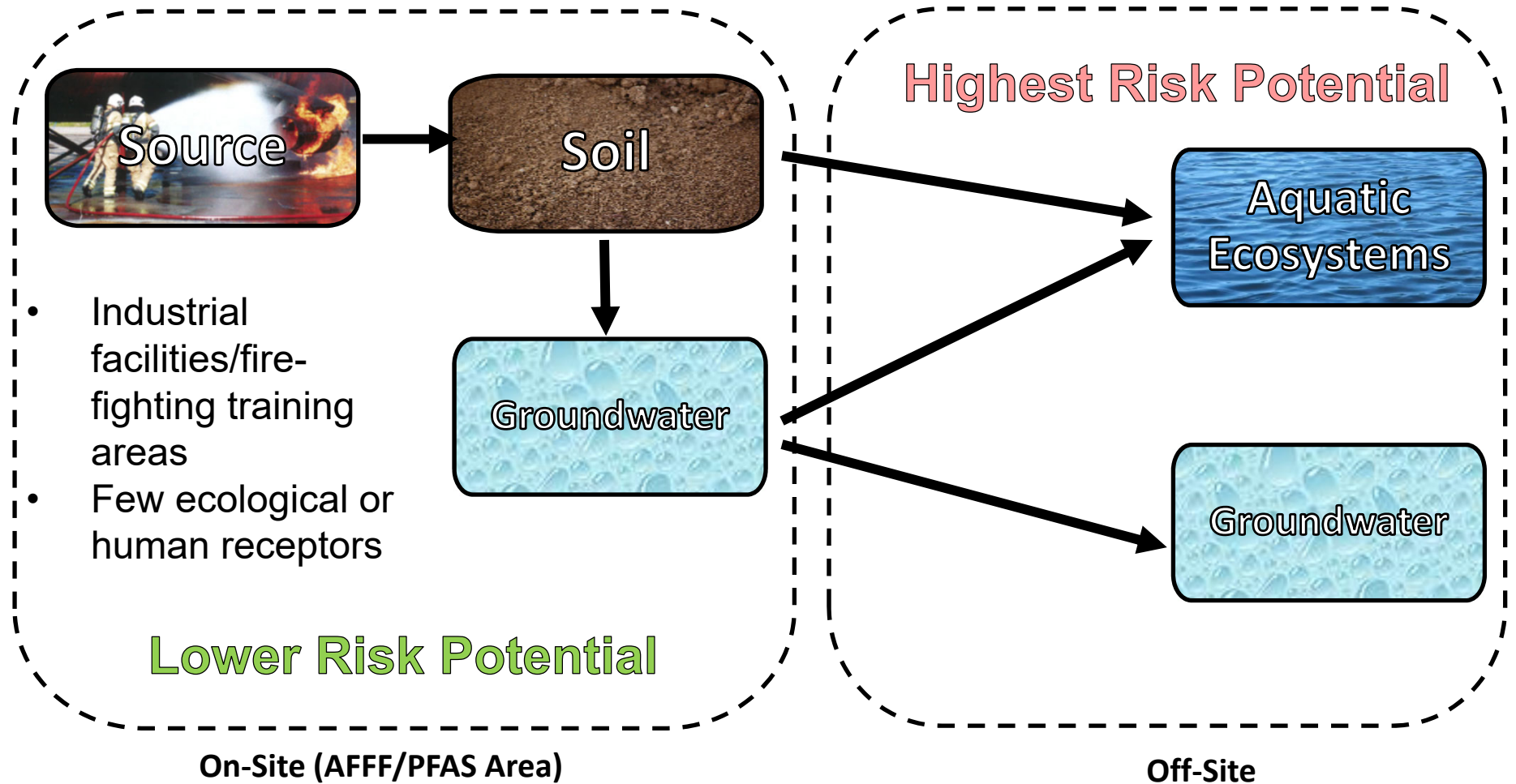


Map courtesy: Environmental Working Group and SSEHRI at Northeastern University

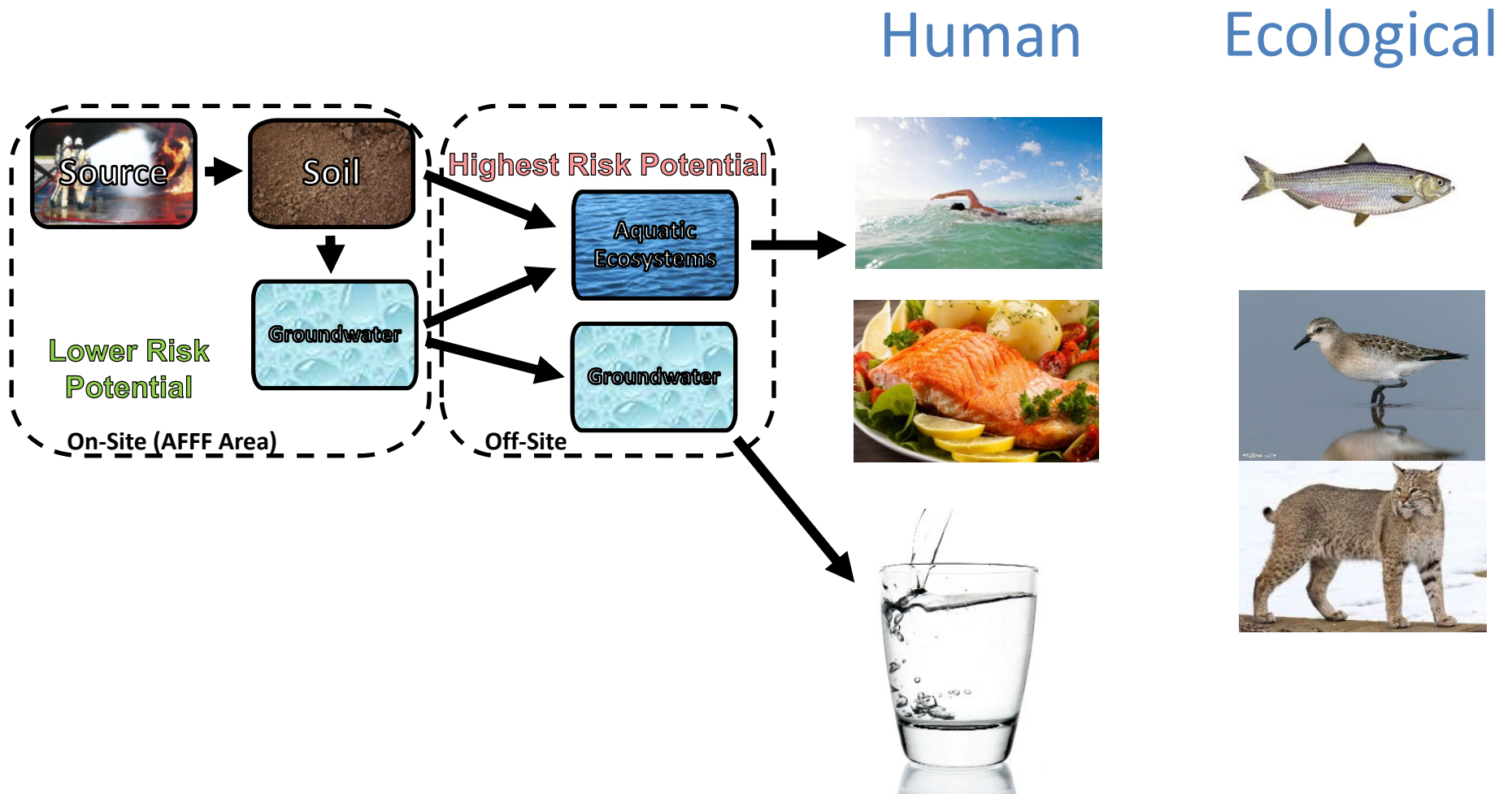
https://www.ewg.org/interactive-maps/2017_pfa/ engineers | scientists | innovators

- Aquatic sites with PFAS impacts are being identified regularly:
 - Mississippi River, Shingle Creek, Lake Superior, MN
 - Charleston Bay, SC
 - Clark's Marsh, Rouge River, MI
 - Etobicoke and Spring Creeks, ON, Canada
 - Moose Creek, Fairbanks North Star Borough, AK
 - Bobai Sea, Taihu Lake, Tangxun Lake, Zhujiang River, China
 - Orge River and Rhone River, France
- Importance of exposure to contaminated sediment relative to contamination in aqueous phases at these locations, however, remains unclear ¹

Conceptual Site Model for PFAS Site



Exposure Pathways at PFAS Sites



Ecological Risk Modeling: Aquatic-dependent Birds and Mammals

- 5 example AFFF case study sites
- 7 PFAS tracked:
 - PFCA: PFHxA, PFOA, PFNA, PFDA
 - PFSA: PFHxS, PFOS, PFDS
- Model Input, measurements of:
 - PFAS in sediment and water
 - PFAS in fish (2 sites)
 - Organic carbon content in sediment
- Model Output, predictions of:
 - PFAS Total Daily Intakes (TDIs) for 4 avian & 2 mammalian receptors, Fractions of TDIs from sediment/water/diet
- More details in Larson et al. 2018

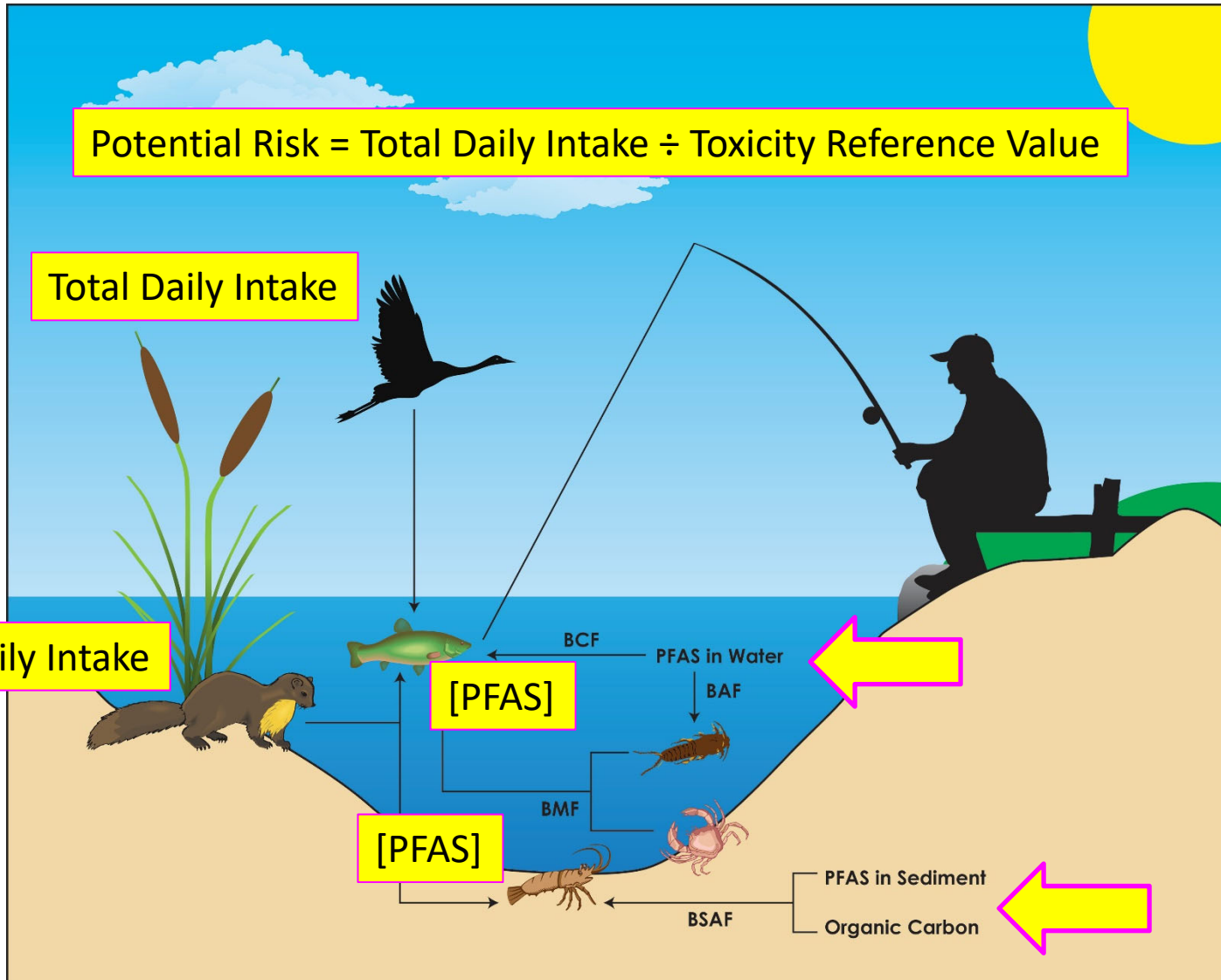


Larson, E.S., Conder, J.M., Arblaster, J.A. 2018. Modeling avian exposures to perfluoroalkyl substances in aquatic habitats impacted by historical aqueous film forming foam releases. Chemosphere 201:335-341.

$$\text{Potential Risk} = \text{Total Daily Intake} \div \text{Toxicity Reference Value}$$

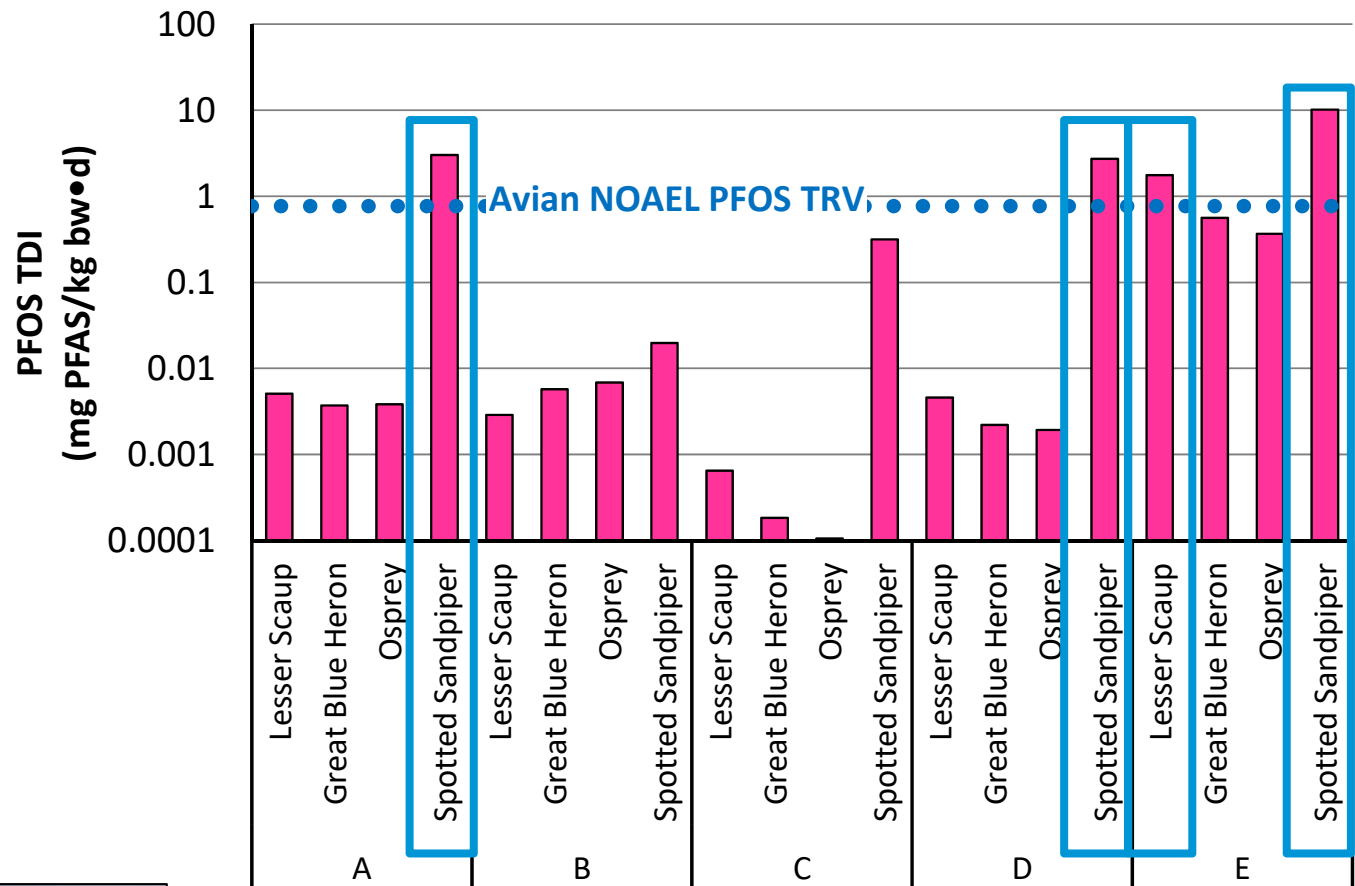
Total Daily Intake

Total Daily Intake



Modeling to Understand Ecological Risk Drivers - Avian

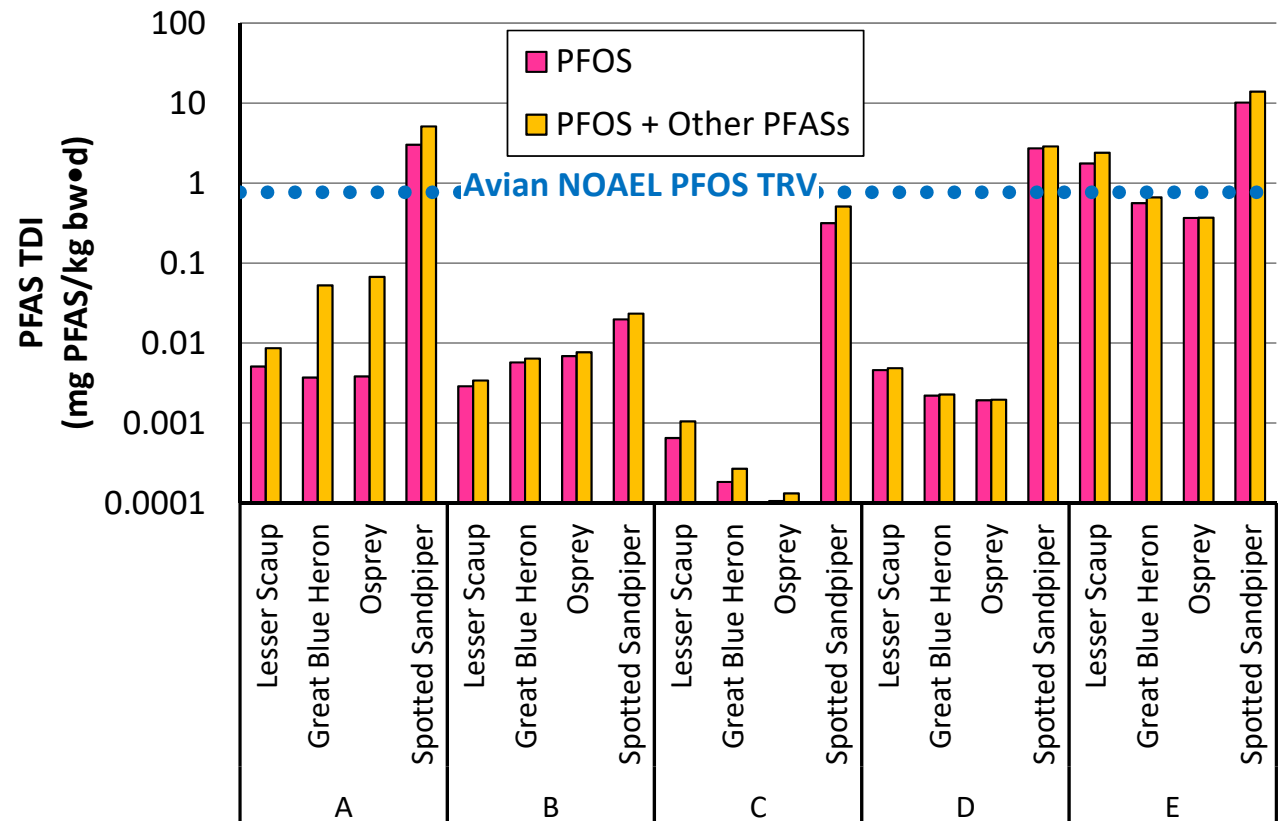
- PFOS exposure highest for scaup and sandpiper
 - Small home ranges
 - Benthic invertebrate diet exposure
- Potential risk to birds at 3 Sites



Modeling to Understand Ecological Risk Drivers

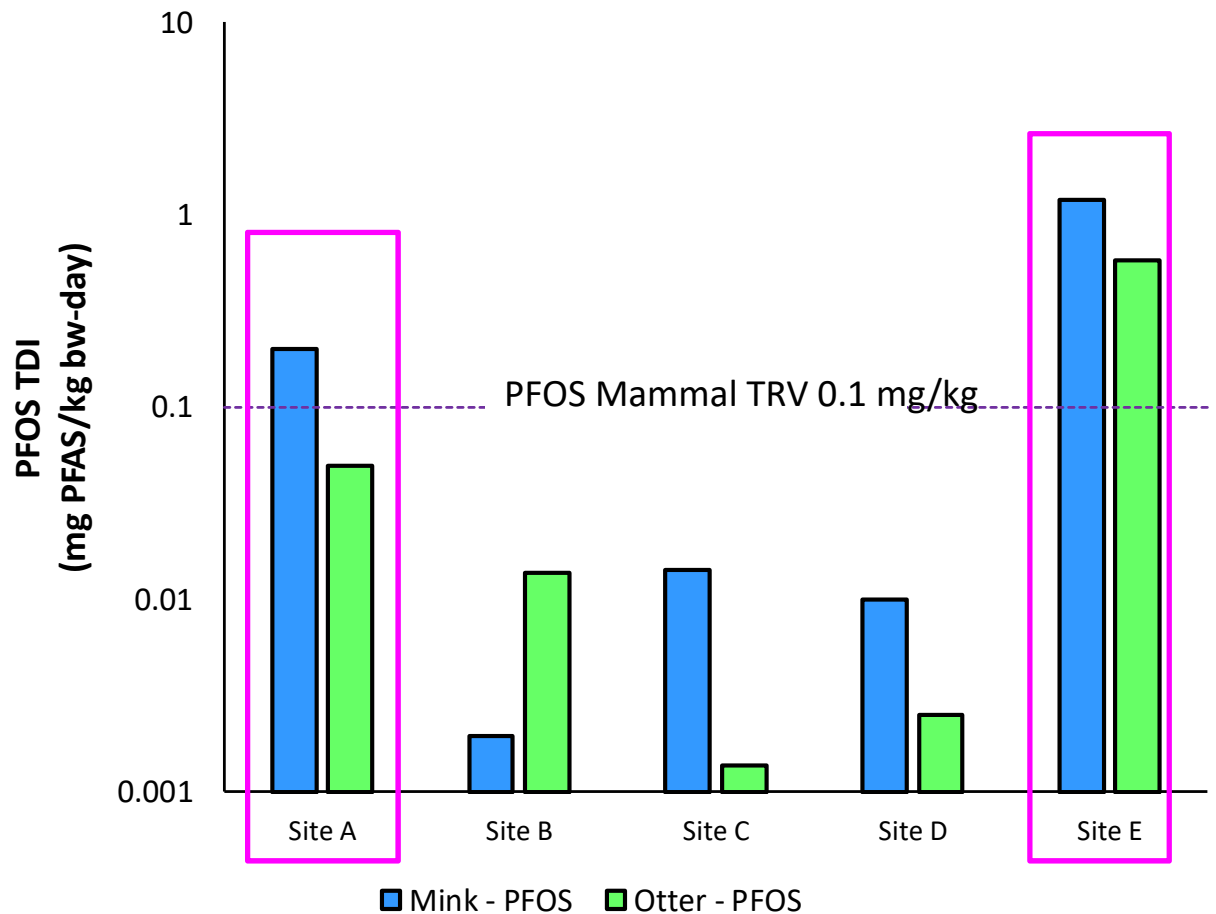
- Avian

- Same conclusion with Σ PFAS
- PFOS is the driver
 - PFOS 73% of PFAS exposure
- Runners-up: other PFSA
 - PFHxS (10%)
 - PFDS (2-15%)



Modeling to Understand Ecological Risk Drivers – Small Mammals

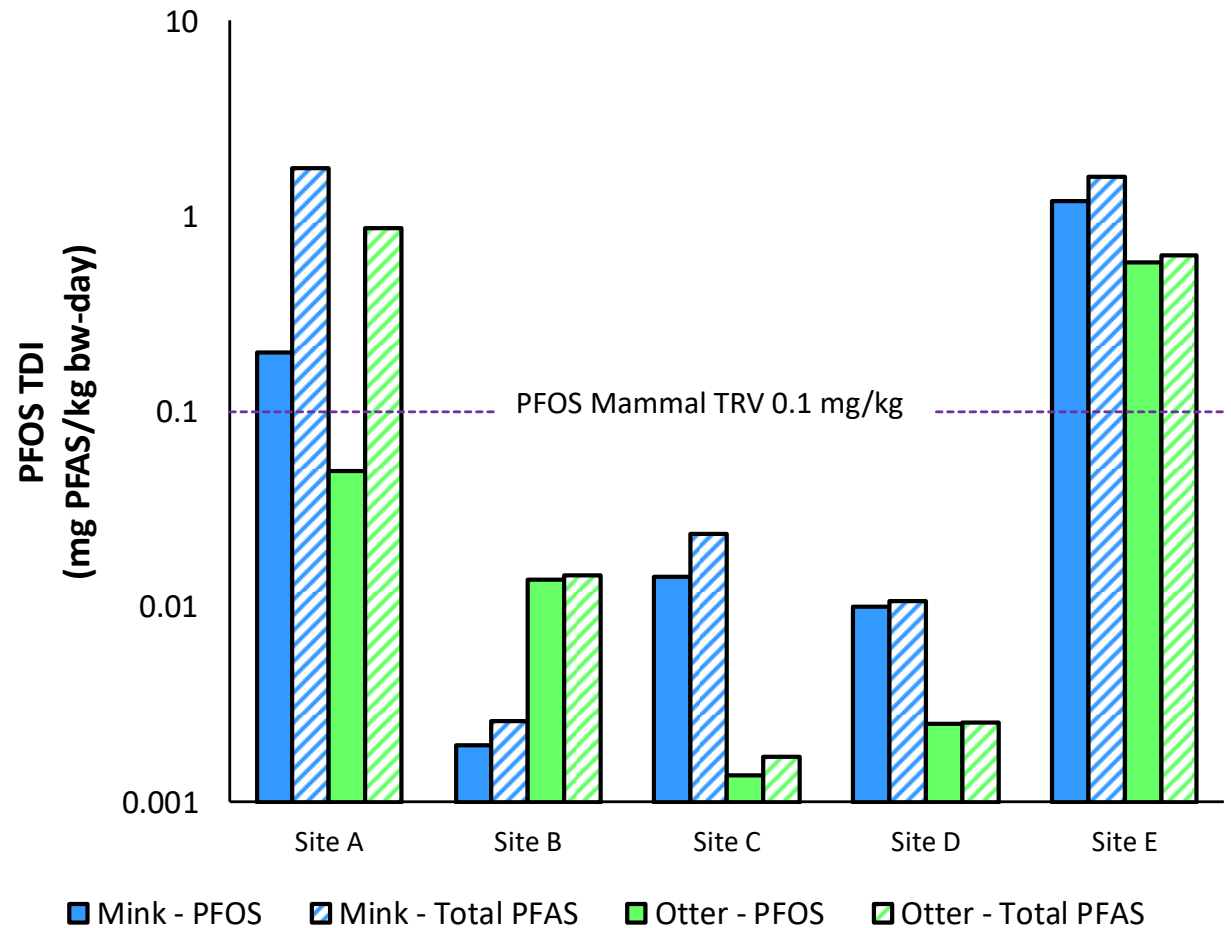
- Estimated exposures for Mink and Otter
 - Mink = 50% fish, 50% benthic invertebrate diet
 - Otter = 100% fish diet
- Higher exposure for Mink
 - Smaller home ranges
 - Consumption of benthic invertebrates
 - Higher incidental sediment ingestion rate



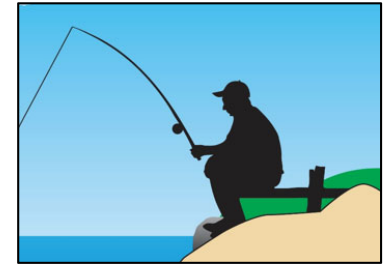
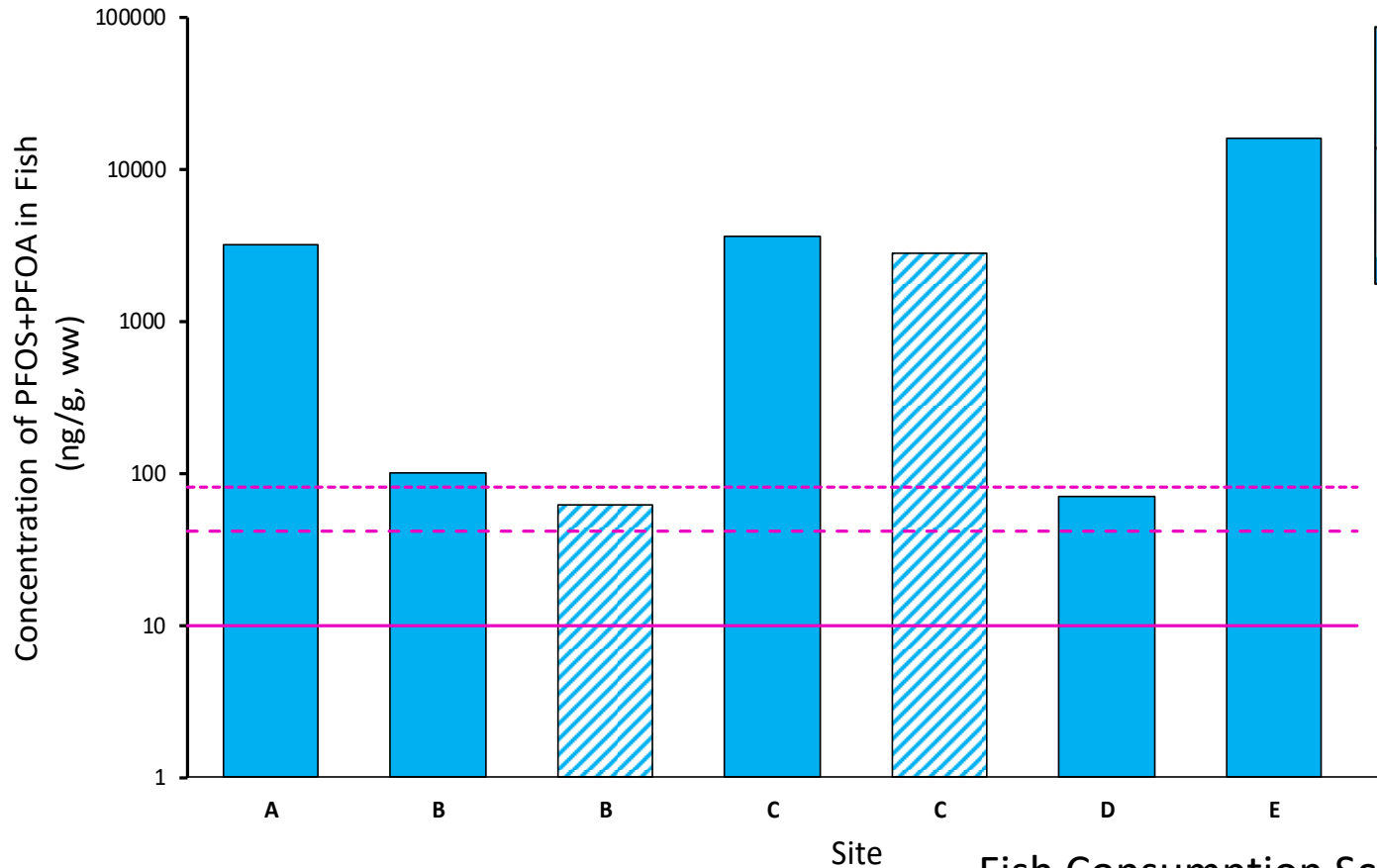
Modeling to Understand Ecological Risk Drivers

– Small Mammals

- PFOS is the driver
 - PFOS 63% (11% to 95%) of PFAS exposure
- Runners-up: other PFASs
 - PFHxS (5 - 20%)
 - PFDS (6 - 83%)



Human Health Risks from Fish Consumption

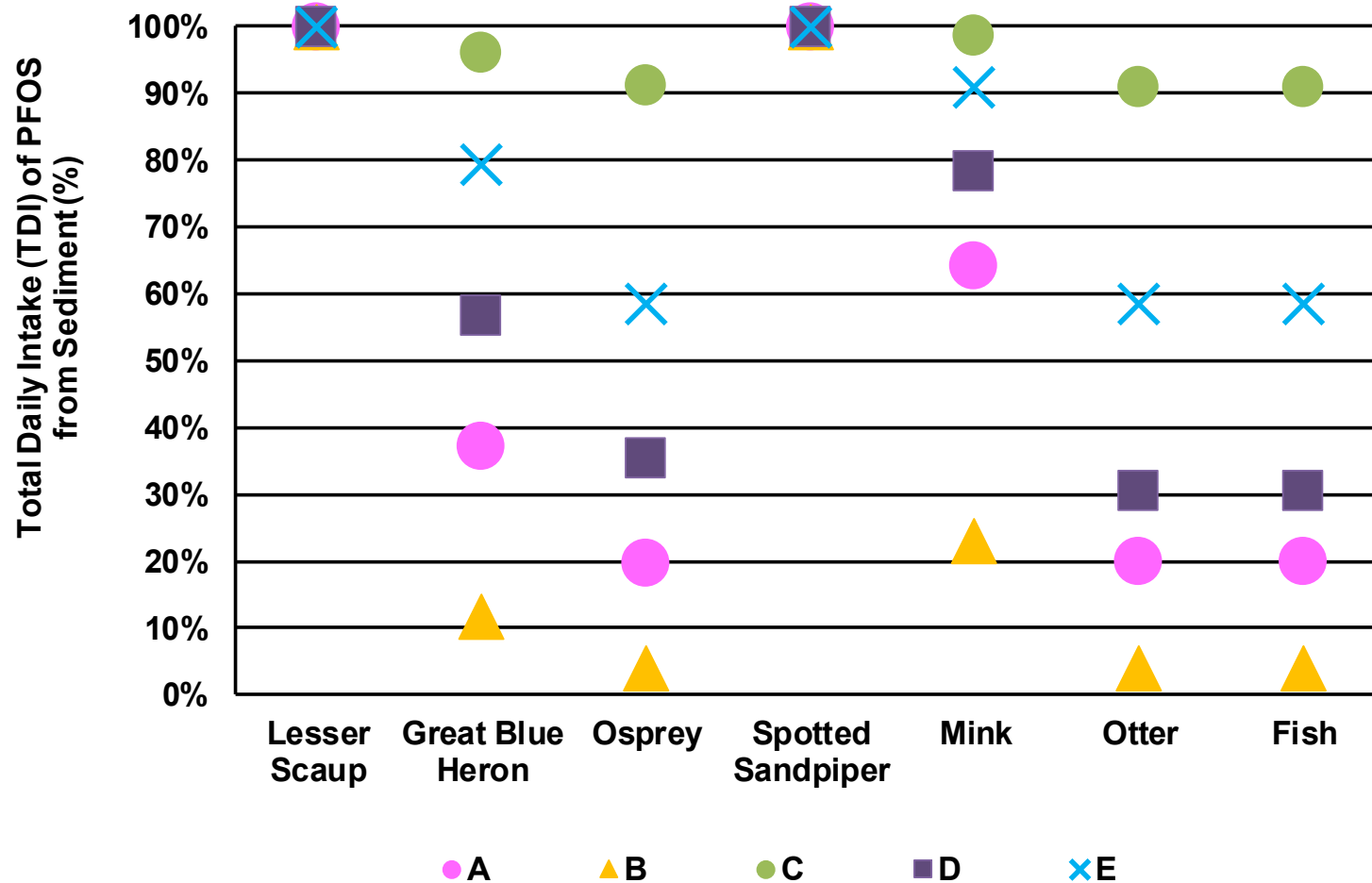


Fish Consumption Screening Levels:

- Ontario (80 ng/g)
- Australia (41 ng/g)
- Minnesota (10 ng/g)

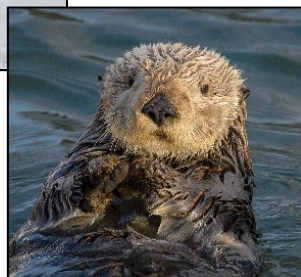
- Modeled
- Measured

Key Takeaway: Sediment Contribution



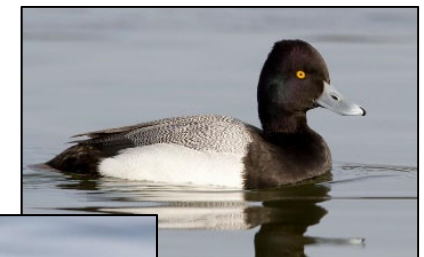
Key Takeaway: Ecological Risk Drivers

Site	Aquatic Toxicity in Surface Water	Birds	Mammals	Human Health
	Exceedance of PFOS Effect Concentrations (> 6.8 µg/L)?	Predicted Exceedance of PFOS NOAEL?	Predicted Exceedance of PFOS NOAEL?	Exceedance of PFOS Fish Criteria?
A	No	Yes	Yes	Yes
B	No	No	No	Yes
C	No	No	No	Yes
D	Yes	Yes	No	Yes
E	No	Yes	Yes	Yes



Evaluation of aquatic life risks would miss potential risks to birds, mammals, and human health

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For Site Practitioners

- Based on conservative assumptions, sediment sites may require investigation at:
 - > 10 ng/g for wildlife receptors; > 1 ng/g for human health
- Bioaccumulation > Aquatic life
- Benthic invertebrates and fish key exposure routes
- Measure TOC in sediments

Critical Research Needs

- Sediment partitioning
- Toxicity of additional PFAS (PFHxS, long chain sulfonates)
- Mechanistic bioaccumulation models

Thank you!

