

# *PFAS Bioaccumulation in Vertebrates: A Very Brief Overview*

Tyler Hoskins, Ph.D.

Dept. of Forestry and Natural Resources

& The Institute for a Sustainable Future

Purdue University



Institute for a Sustainable Future



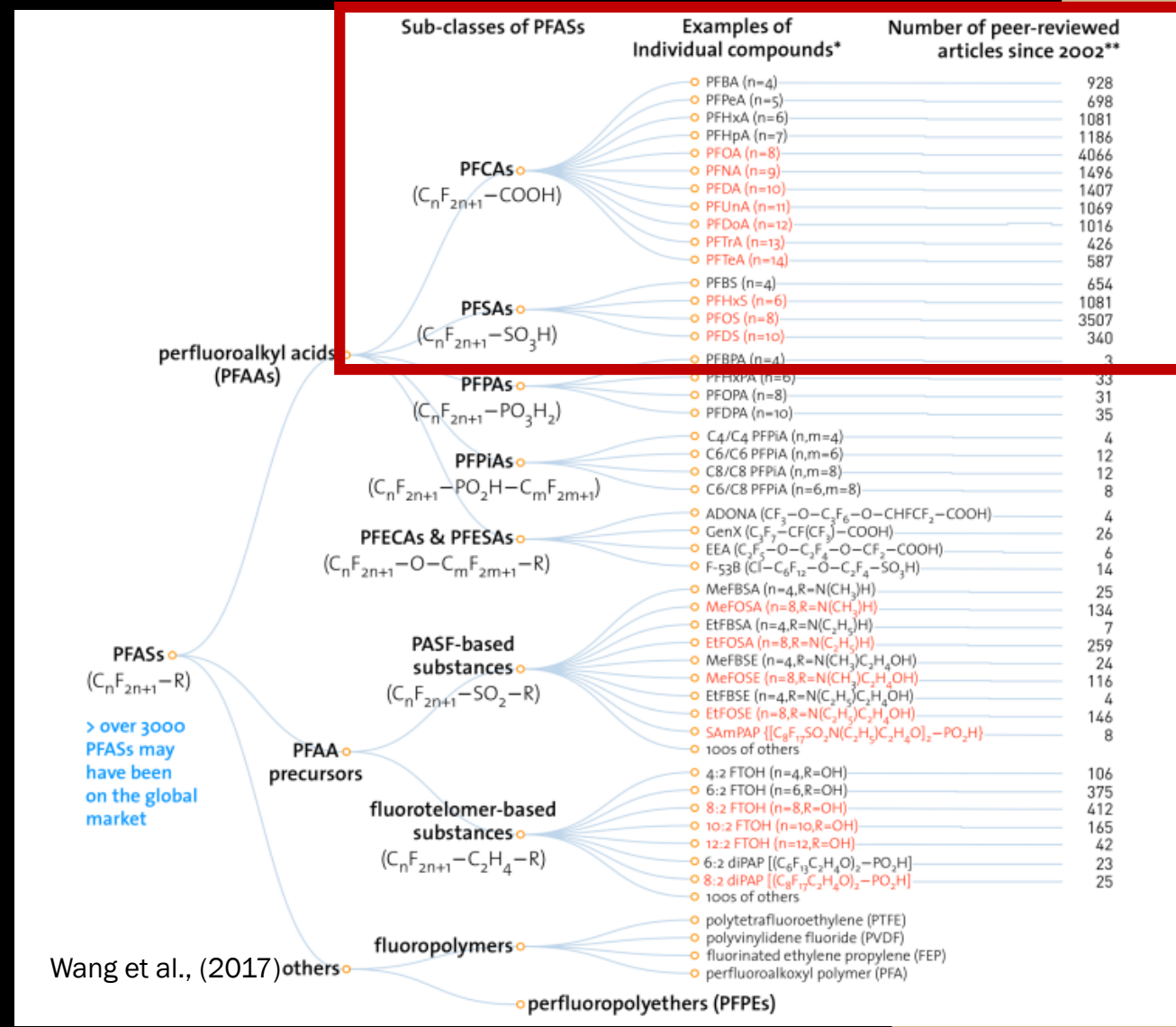
Scan to Connect with the  
PFAS Strategic Research  
Team at Purdue!

# PFAS Are Structurally Diverse: So Are Their Bioaccumulation Potentials

- Bioaccumulation is the process of chemical accumulation in an organism over time
  - Central concept in toxicology and risk assessment
- PFAS are diverse. We know a lot about bioaccumulation for two classes:
  - Perfluorocarboxylic acids (PFCAs, e.g., PFOA)
  - Perfluorosulfonic acids (PFSAs, e.g., PFOS)
- 14,000+ PFAS in other classes not as well studied
  - Some precursors have high bioaccumulation potential
  - Harder to study: can biotransform!
    - Terminal degradation products are usually PFSAs and PFCAs that cannot degrade further

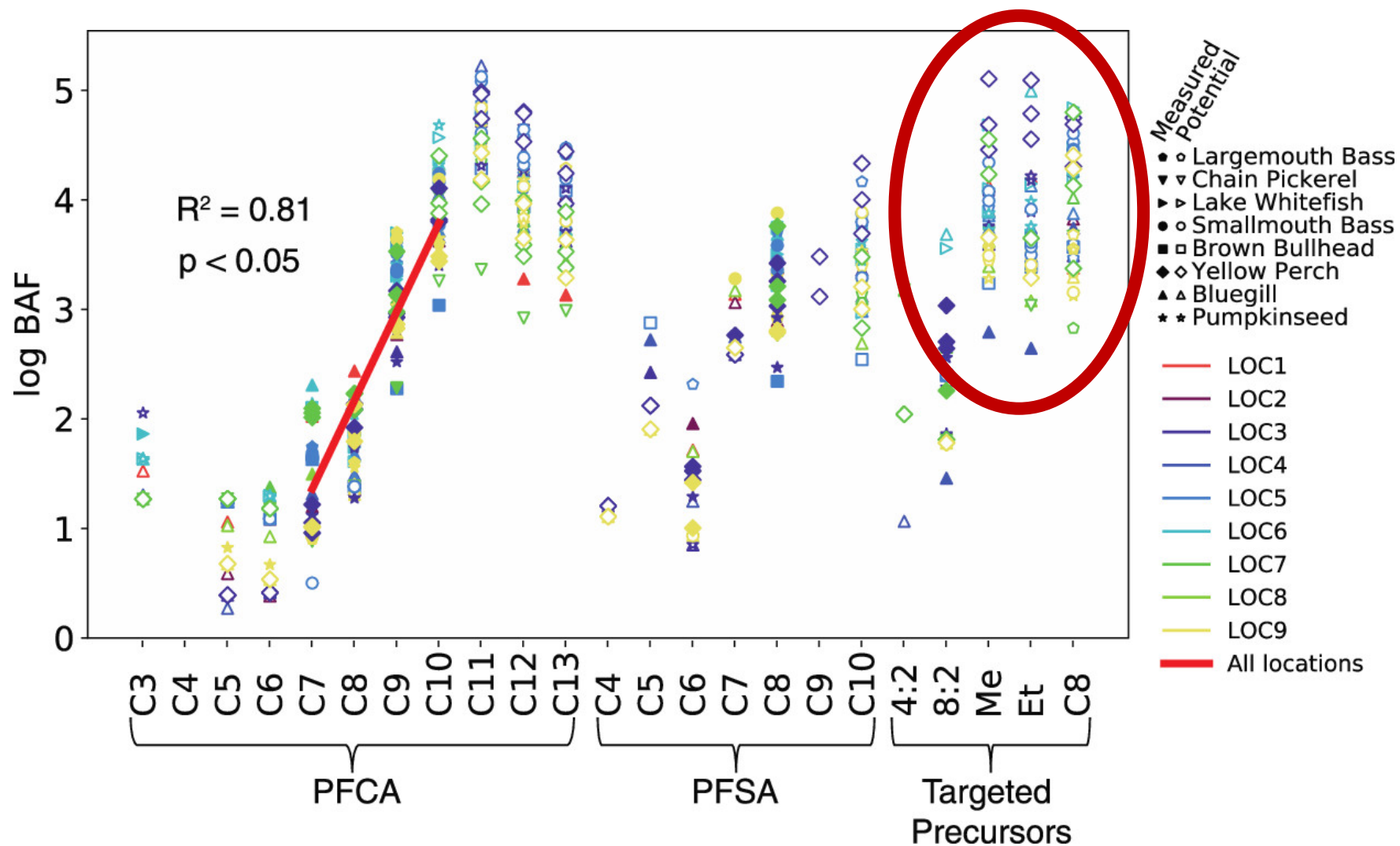


Institute for a Sustainable Future



Wang et al., (2017)

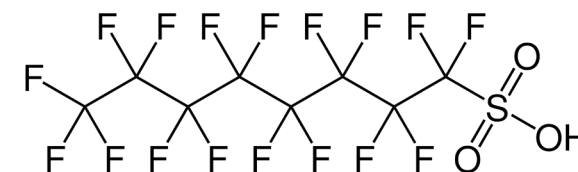
# Structure Correlates with Bioaccumulation



$$\text{BAF} = [\text{Organism}] / [\text{Water}]$$

Chain length is a strong predictor of bioaccumulation. Longer chain = more PFAS

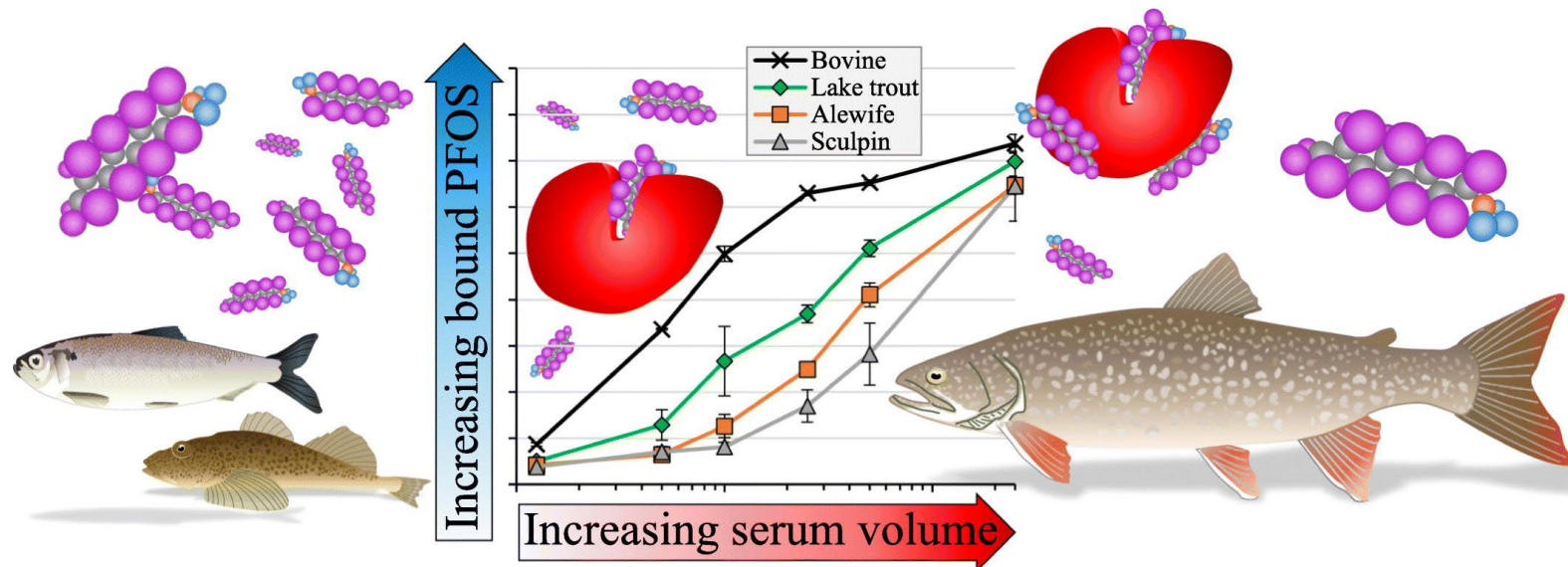
*PFOS, a C8 PFSA*



Precursors can have comparable bioaccumulation potential to long chain PFAS.

# *Breaking the Rules: PFAS Bioaccumulation is Protein-Mediated*

- Historically, persistent pollutants (think DDT, other PCBs, Dioxins) partition to fatty tissues
  - Lipids are so important to bioaccumulation potential that we often normalize to lipid content for these chemicals
- PFAS interact strongly with proteins of all kinds, especially carrier proteins
  - Examples: albumins, hemoglobins, myoglobins, liver-type fatty acid binding proteins (LFAB-Ps), transthyretins, many others
  - Increasing protein concentrations associated with increased [PFAS]!

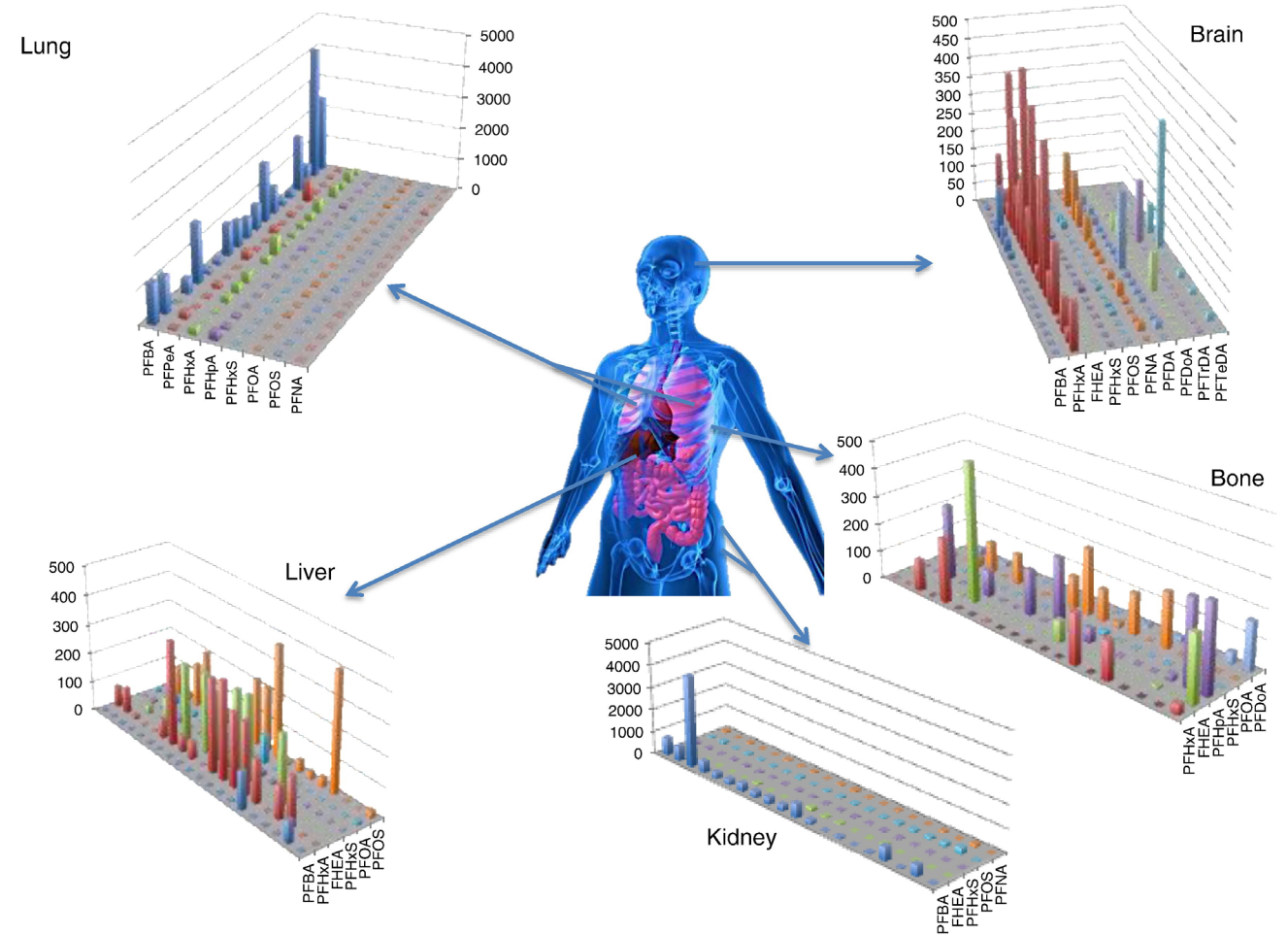


Note the positive relationships between PFOS and serum proteins for bovine albumin and 3 fish

From Point et al., (2023):  
<https://doi.org/10.1016/j.scitotenv.2023.162337>

# *Breaking the Rules: PFAS Bioaccumulation is Protein-Mediated*

- Bioaccumulative PFAS partition preferentially to protein-rich tissues
  - Blood, liver, lung are primary compartments. Less but still significant accumulation in other organs including muscle.
  - Can cross blood-brain barrier
- High variability in accumulation across species and sexes
  - Factors driving variability not yet understood



PFAS profiles differ dramatically across tissues in humans.  
From Pérez et al., (2013): <https://doi.org/10.1016/j.envint.2013.06.004>

# *Elimination Can Be Slow...*

## *But reducing exposure does reduce burdens over time!*

PFAS	Human Male	Human Female
PFOA	2.3 – 3.8 y	2.3 – 3.8 y
PFOS	3.4 – 5.4 y	3.4 – 5.4 y
PFHxS	5.3 - 8.5 y	5.3 - 8.5 y
PFHxA	32 d	NA

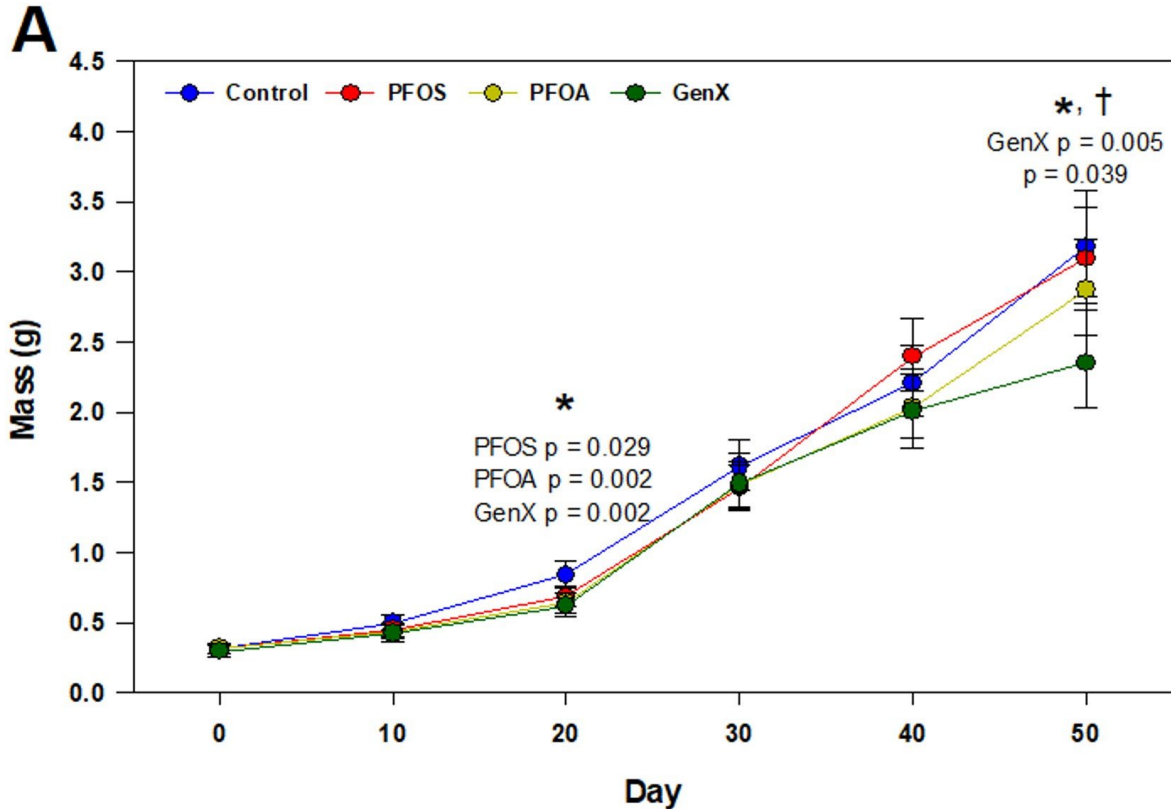
Elimination half-times for 4 common PFAS

PFOS Phase-Out, 2002



Human serum concentrations over time, from National Health & Nutrition Examination Survey (NHANES)

# Final Caveat: Bioaccumulation $\neq$ Toxicity



Larval GenX exposure reduces terrestrial growth in gray treefrogs. From Barragan et al., (2023):

<https://doi.org/10.1021/acs.est.3c03191>

-Although higher tissue burdens *usually* lead to more toxicity, assuming that bioaccumulation potential *always* predicts toxicity is not advisable.

-Example:

-Hexafluoropropylene dimer acid (HFPO-DA, aka “GenX”) is less bioaccumulative than what it replaced (PFOA)

-Emerging evidence that GenX can often be more toxic than PFOA

-Example: Barragan et al., (2023) found that larval exposure to GenX reduced gray treefrog growth after metamorphosis, while PFOA did not



# ***Indiana PFAS Assessment 1.0***

- Purdue's Institute for a Sustainable Future is sponsoring a report on the state of knowledge around PFAS in our state
- Broad focus: sources, fate/transport, ecological effects, human health effects, mitigation options, current regulatory landscape, socioeconomic impacts and more
- Input from PFAS experts across multiple academic institutions and state agencies
- Targeted at non-experts including the public and policymakers
- Expect release in late fall 2024: keep an eye out!



**PURDUE**  
UNIVERSITY®

Institute for a Sustainable Future



# *Thank You*

Contact Me:  
tdhoskin@purdue.edu



Scan to Connect with the  
PFAS Strategic Research  
Team at Purdue!



Institute for a Sustainable Future