PFAS and Sediments: Status and Implications

WPPA Fall Seminar 2023

Presented by Erik Naylor

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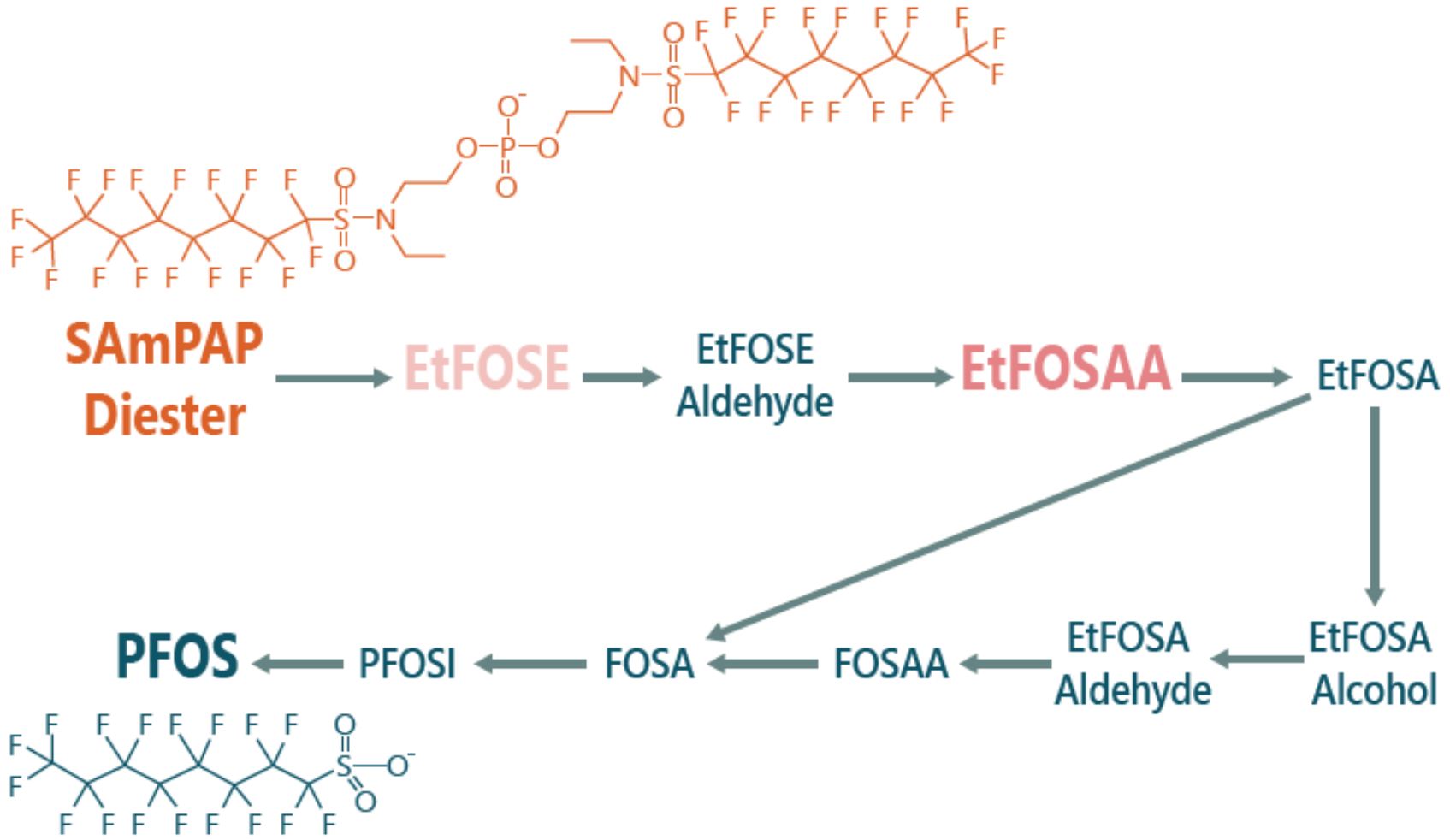
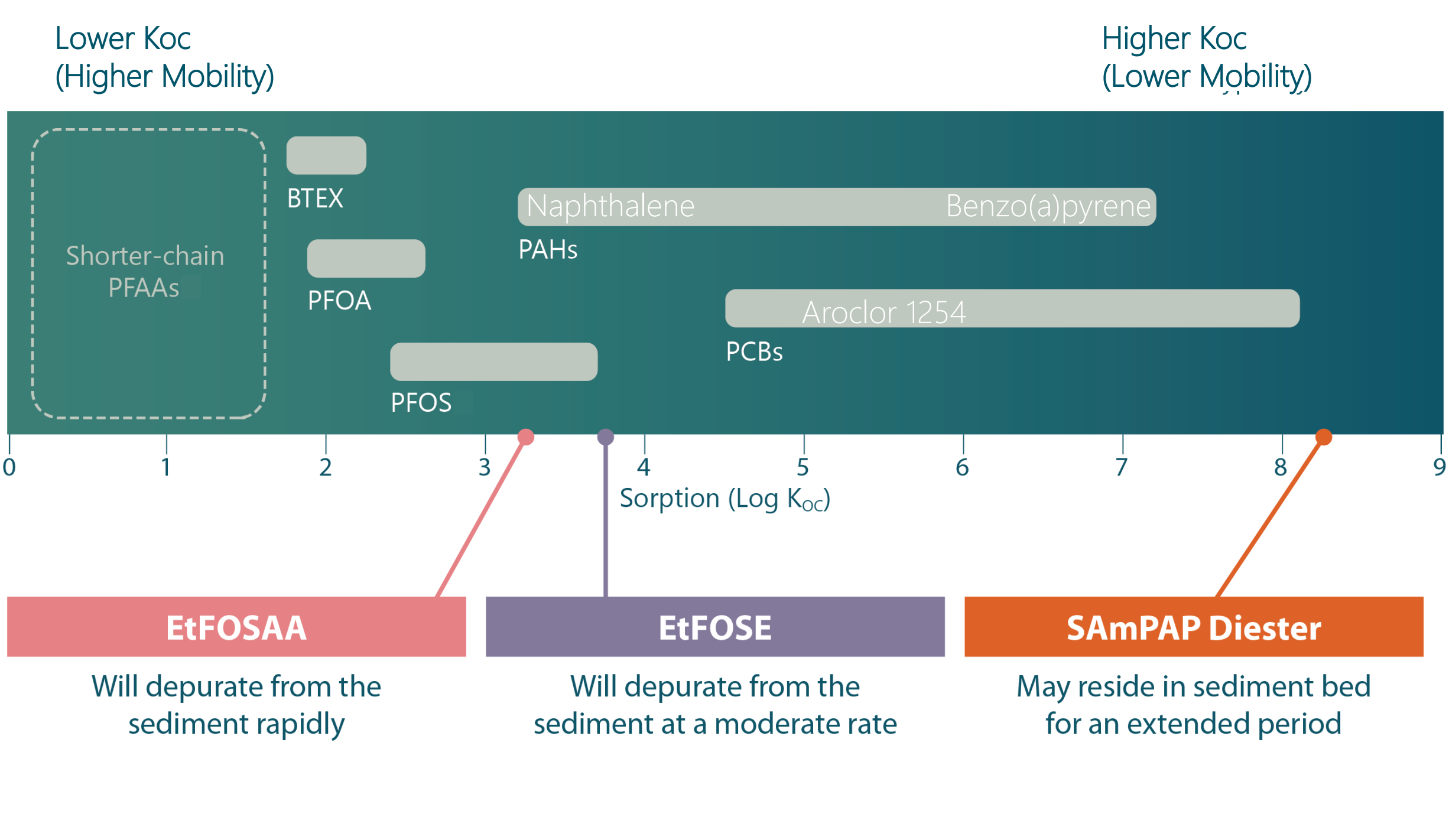
Compare and Contrast (PCBs v. PFAS)

Parameter	PCBs	PFAS
CERCLA Hazardous Substance	Yes	Not yet
Washington Hazardous Substance	Yes	Yes
Importance of Degradation Products	Focus on original contaminant	Precursor transformations to PFAA (e.g., PFOS) very important
Mobility in Sediments	PCBs bind tightly to sediment (high K_{oc})	Most bind loosely to sediment (low to moderate K_{oc})
Bioaccumulates in Fish	Yes	Yes—to a point
Persistence in Fish Tissue	Long (years)	Short (weeks to months)
Existing Fish Advisories	Yes	Yes
Sediment Cleanup Levels	Yes	Not yet (WA evaluations in progress)
Likely Driver for Sediment Remediation	Very strong driver	Not likely a driver in most cases (some potential exceptions)
Elevated Background Concentrations	Yes (well-developed data set)	Likely (more information needed)
Impacts to Upland Beneficial Reuse Opportunities	Yes	Yes

Importance of Precursors and Transformations

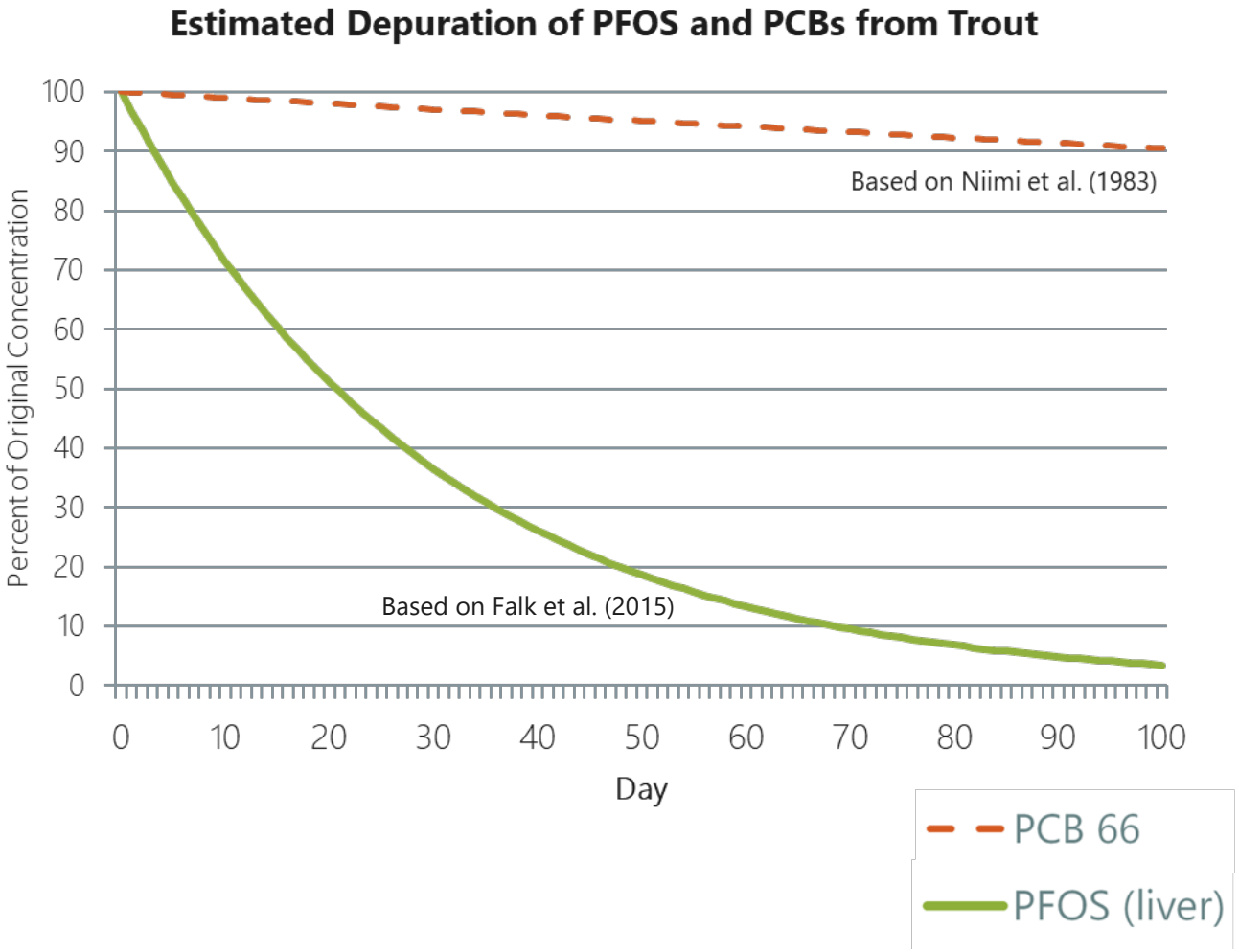


Source: Liu and Avendaño, 2013.

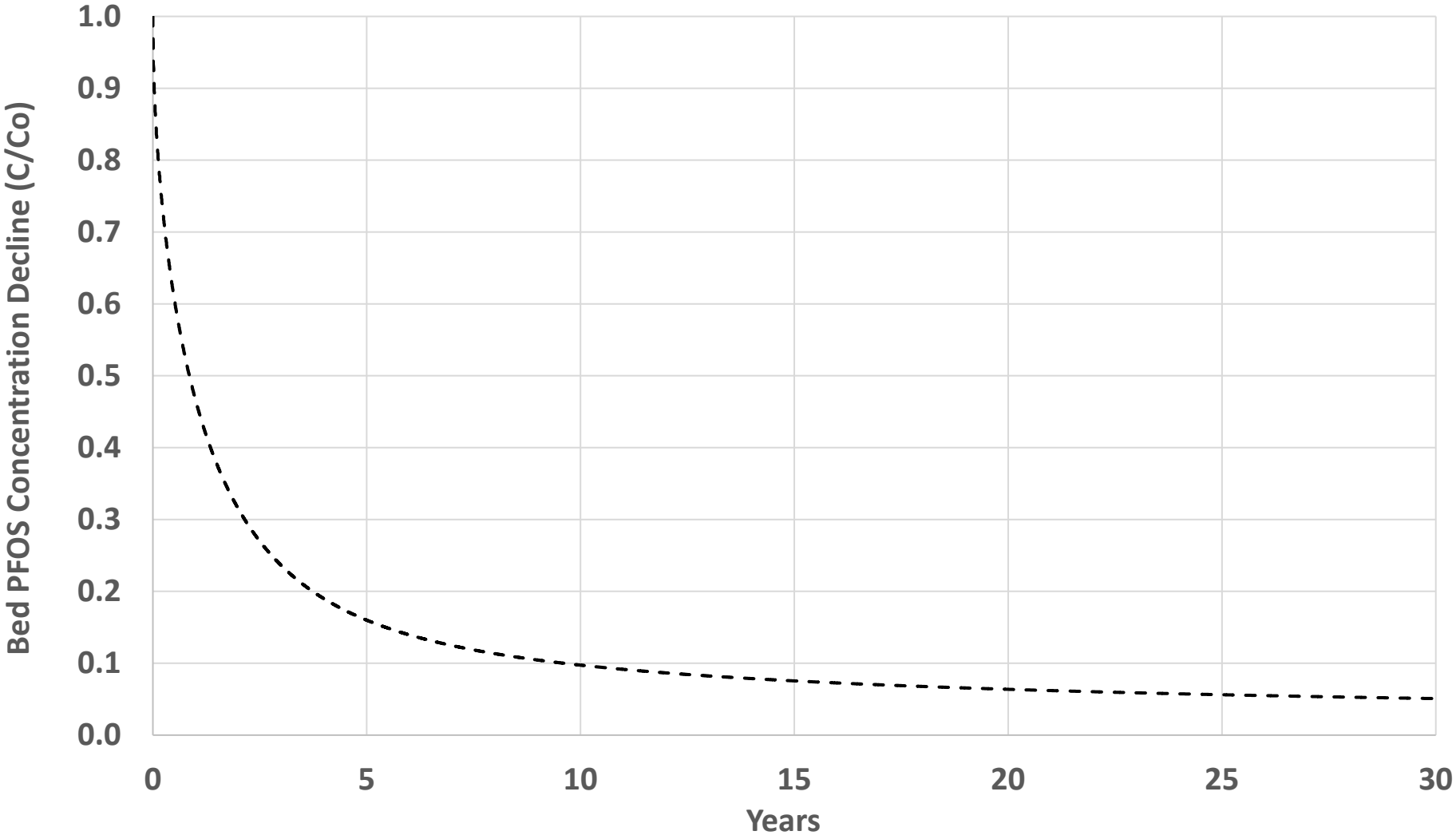

Lower Koc
(Higher Mobility)
Higher Koc
(Lower Mobility)
Shorter-chain PFAAs
BTEX
PFOA
PFOS
Naphthalene
Benzo(a)pyrene
PAHs
Aroclor 1254
PCBs
0
1
2
3
4
5
6
7
8
9
Sorption (Log K_{OC})
EtFOSAA
EtFOSE
SAmPAP Diester
Will depurate from the sediment rapidly
Will depurate from the sediment at a moderate rate
May reside in sediment bed for an extended period

PFOS Is Rapidly Depurated by Fish

- Much faster than for most PCBs
- Elimination via gills is more significant than for other bioaccumulative chemicals
- Without precursors, PFAA concentrations decline quickly due to low sorption to sediments and high depuration in fish



PFOS Sediment Recovery: 1D Model Insights



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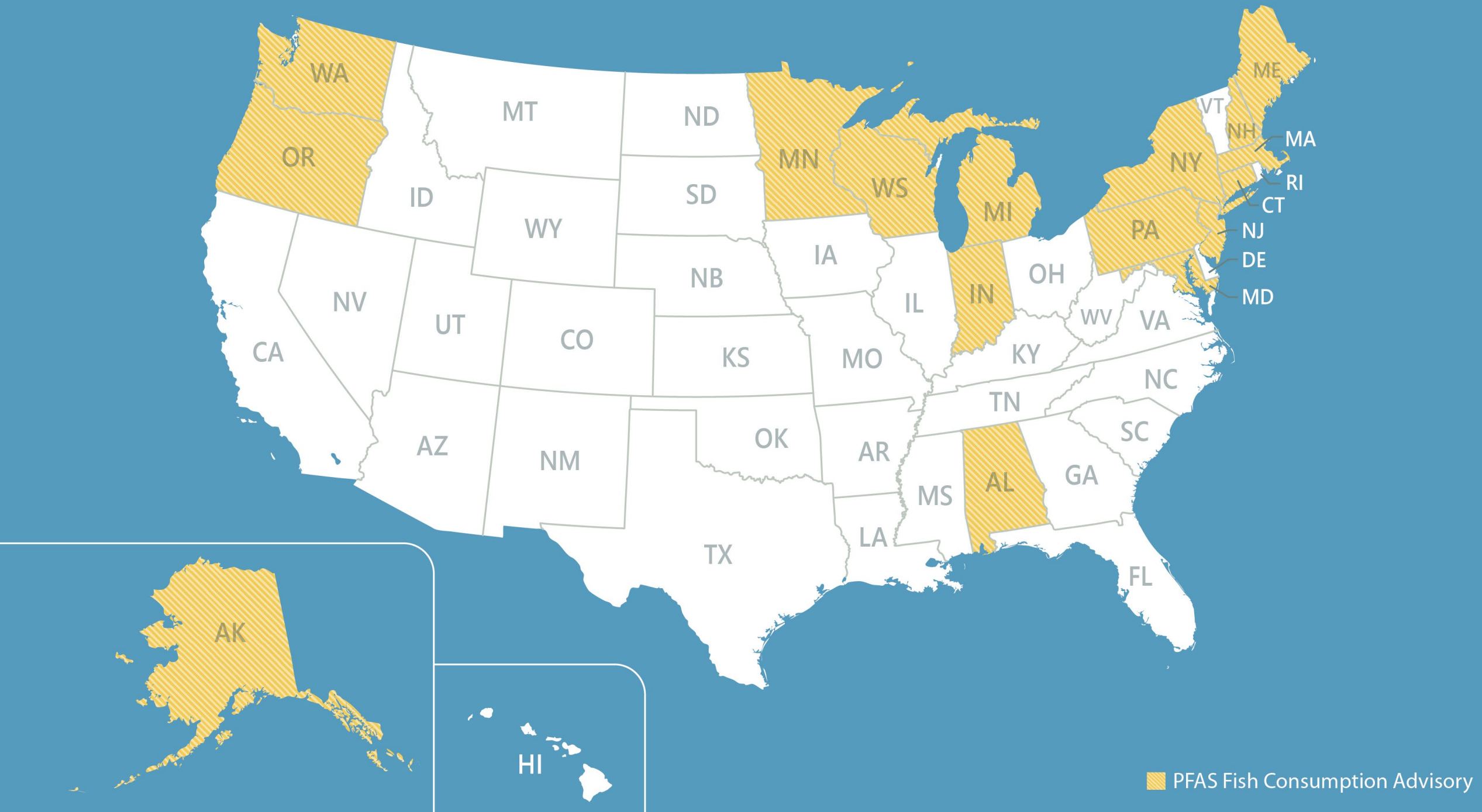
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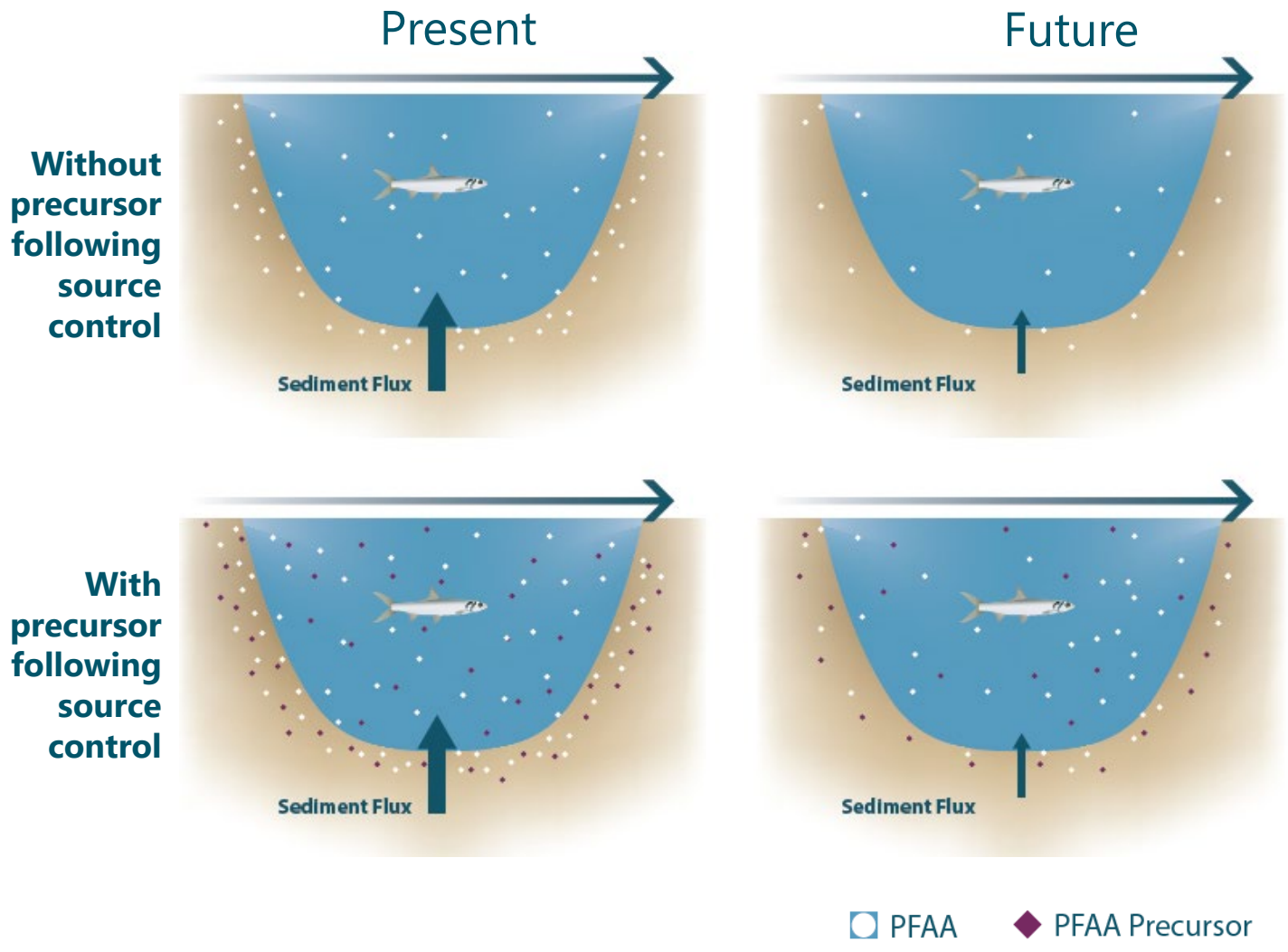
PFAS Fish Consumption Advisory

Status of Sediment Cleanup Standards

- No federal standards or guidance (EPA or USACE)
- No promulgated state or regional cleanup standards
- Washington: Department of Ecology evaluation is ongoing
  - Sediment Management Standards
  - Likely 2-4 Year process
  - Includes literature evaluation, data collection/analysis, risk evaluation
  - Uncertain outcome at this time

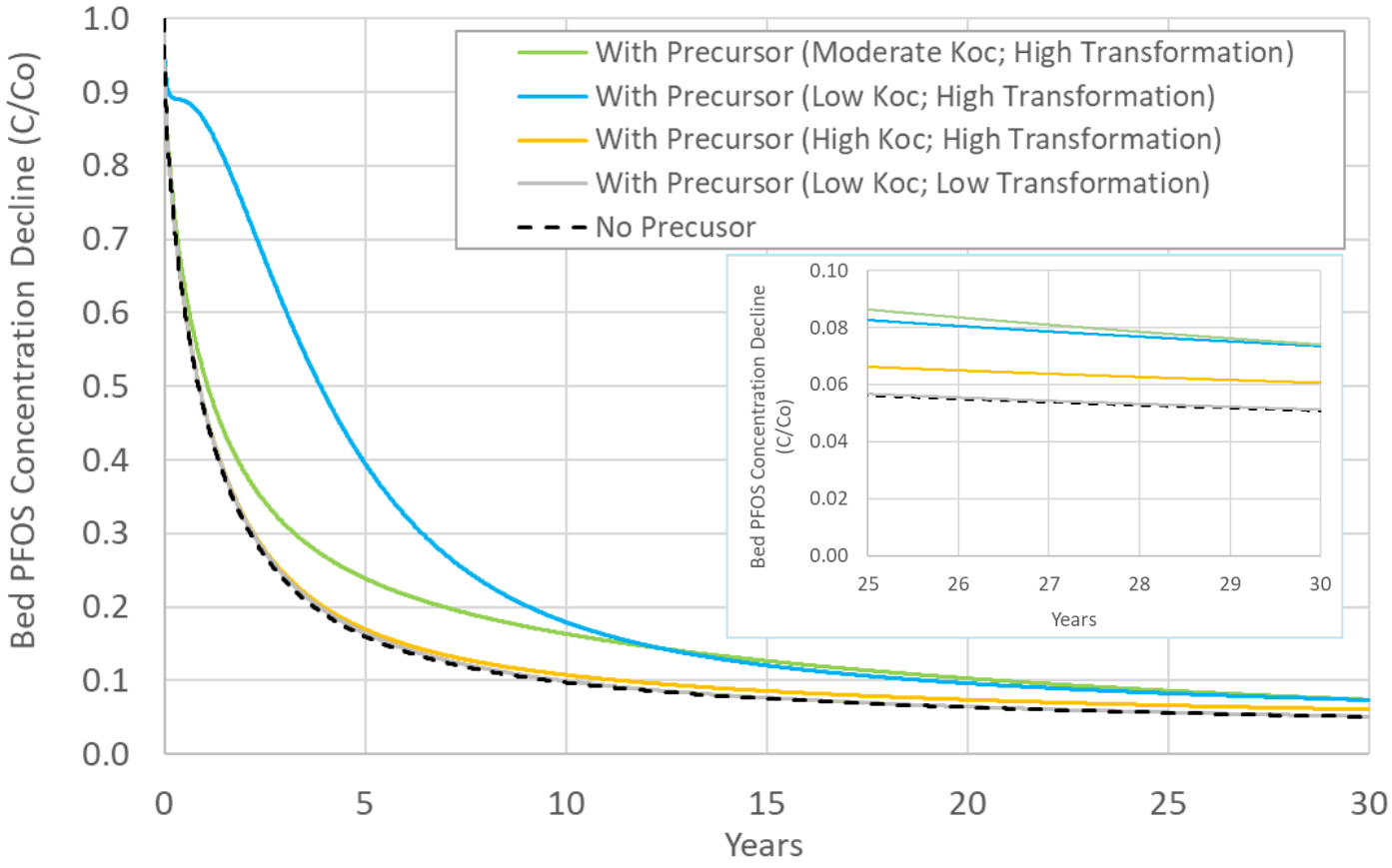
What Type of PFAS are in the Sediment?

- Precursors in sediments may provide a long-term source of PFOS and other PFAAs
- Sediments as a significant source of PFOS/PFAAs only if sediments are a reservoir of certain precursors
- Precursor types vary by sorptive strength & transformation rate



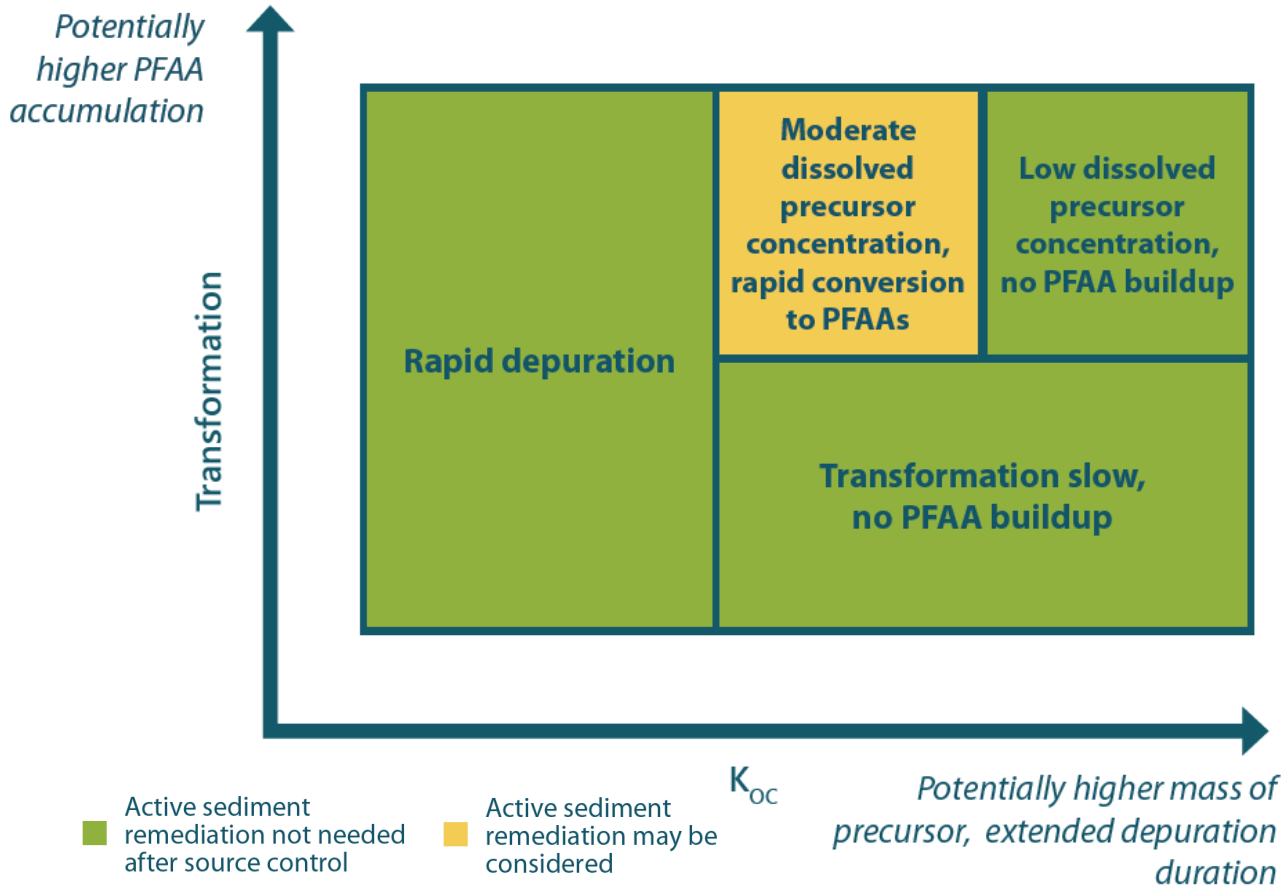
Sediment Recovery of PFOS with Precursors Present: 1D Model Insights

- Precursors may be a consequential long-term source of PFOS under certain conditions
- Relevance of residual PFOS levels will depend on site-specific factors



Influence of Transformation Rate and Sorption

- Active sediment management might be warranted with the presence of…
  - Certain precursors
  - High concentrations
  - Appropriate transformation conditions
- Not clear yet how common these conditions are in real world sediments



Sediment Background

Work in progress on sediment background by USACE

Preliminary survey

PFAS found in 26/26 sediment samples

Image Source: www.pexels.com

Soil Background (Northeast U.S.)

PFOA (ug/kg)	Vermont	New Hampshire	Maine
Maximum	4.9	4.1	5.29
Median	0.4	0.8	Not reported
Percent Detect	91%	96%	65%

PFOS (ug/kg)	Vermont	New Hampshire	Maine
Maximum	9.7	5.4	4.35 (urban) 5.32 (non-urban)
Median	0.7	1.0	Not reported
Percent Detect	100%	100%	81% (urban) 63% (non-urban)

Sediment studies by Guilherme Lotufo (guilherme.lotufo@usace.army.mil)

Mississippi River Beneficial Reuse Example

USACE DMMP 2020

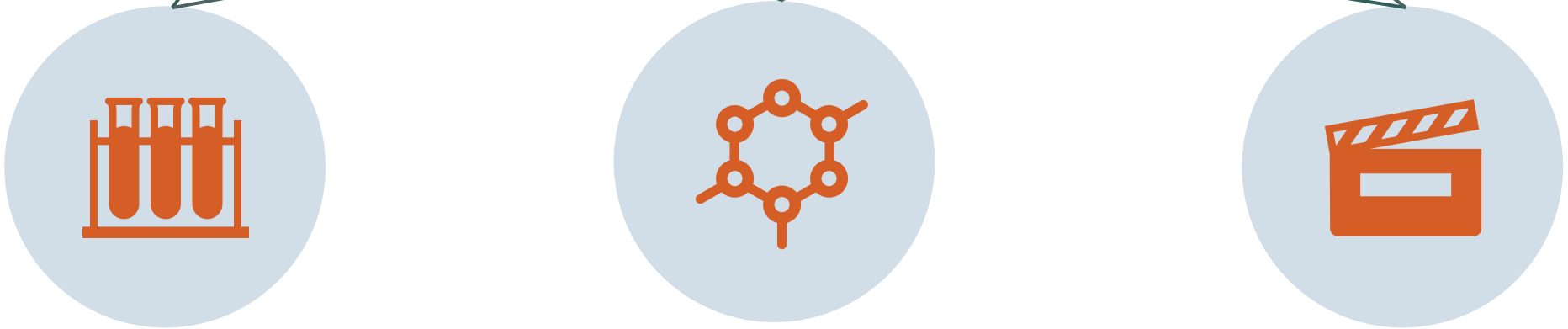
- PFAS in sediment: <1 to 3 ug/kg
  - Soil managed by upland beneficial reuse
  - Minnesota Soil Reference Values
    - 2020 Values: for PFAS = 330 to 63,000 ug/kg
    - Updated Minnesota Values: 41 ug/kg (PFOS)
- Washington Soil Guidance: 0.55 ug/kg
- New York Soil Cleanup Objectives: 1-3 ug/kg
- Potential Impacts for upland reuse options depending on final screening levels

Figure Source: U.S. Army Corps of Engineers, 2020. *Pool 2 Dredged Material Management Plan*.

Considerations for Sediment Projects

Internal Discussion

Regulatory Agency Discussion



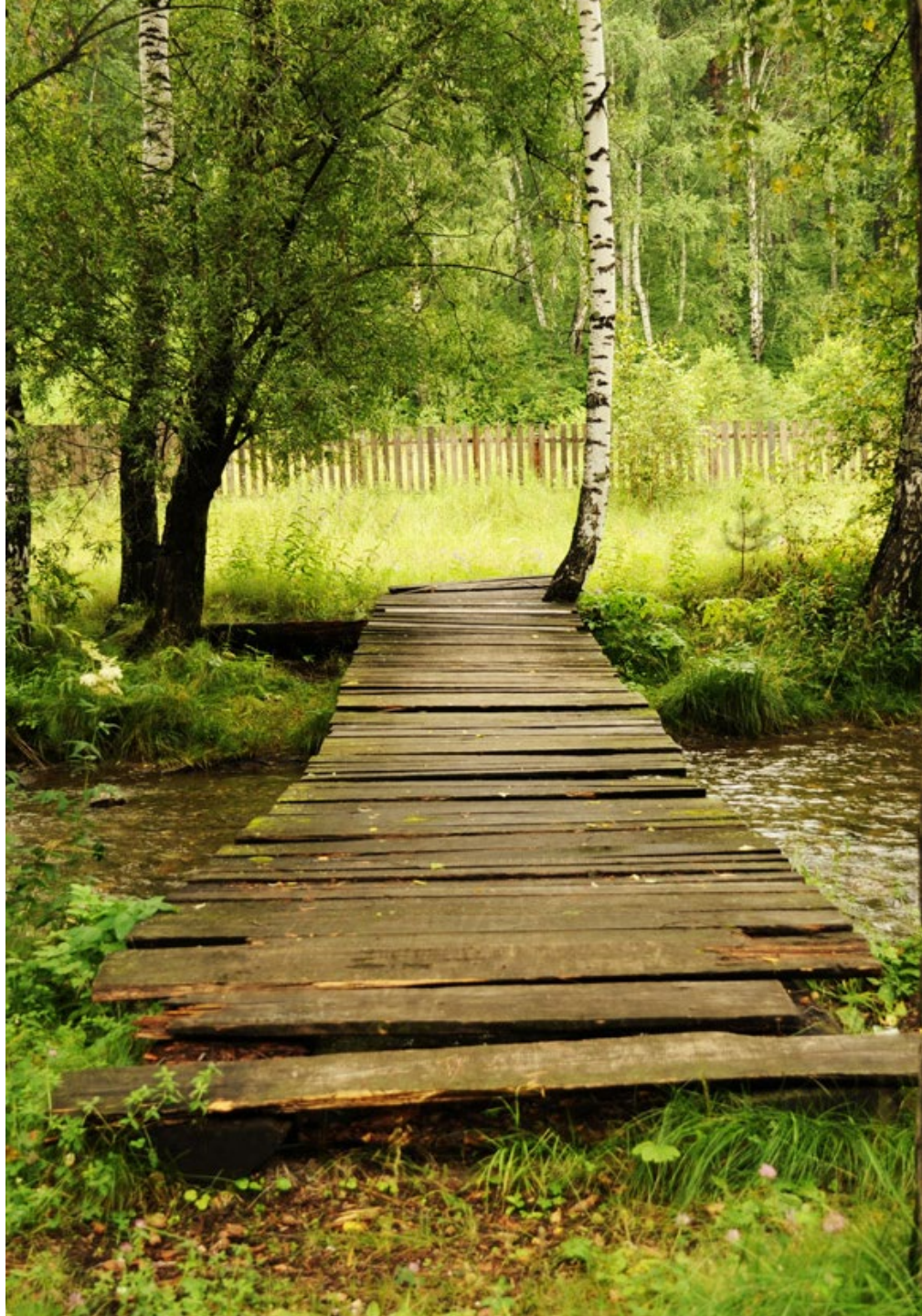
Should We Test for PFAS?

What Compounds Should We Test for?

What Do the Data Mean for My Project?

Key Take-Aways

- PFAS are different from other bioaccumulatives like PCBs
- Fate and transport is complicated and still under study
- PFAS may not be significant sediment contaminants except in certain instances
- PFAS regulations are evolving rapidly
- Clear sediment guidance may be several years away
- Background levels suggest PFAS are likely widespread (more information is needed)
- Multiple considerations will affect project approach



THANK YOU

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REFERENCES

Falk, S. K. Failing, S. Geogii, H. Brunn, and T. Stahl, 2015. “Tissue Specific Uptake and Elimination of Perfluoroalkyl Acids (PFAAs) in Adult Rainbow Trout (*Oncorhynchus mykiss*) After Dietary Exposure.” *Chemosphere* 129:150–156. (Slide 5)

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