Contaminants of Emerging Concern: monitoring potential threats to Puget Sound marine and anadromous species

Sandra O'Neill, Molly Shuman-Goodier, Andrea Carey, the TBiOS team, and collaborators



South Sound Science Symposium

October 15, 2026

It takes a village...






NISQUALLY INDIAN TRIBE


SQUAXIN ISLAND TRIBE



The Puyallup Tribe


of Indians
















nəxʷqíyt nəxʷsƛayəm
PORT GAMBLE S'KLALLAM TRIBE













Skagit
River
System
Cooperative





























Toxics Biological Observation System (TBiOS)

Initiated in 1989, we **track contaminant levels and their harmful effects** in Puget Sound marine and anadromous species.

TBiOS Goals

Document **where** and to **what** chemicals species are exposed

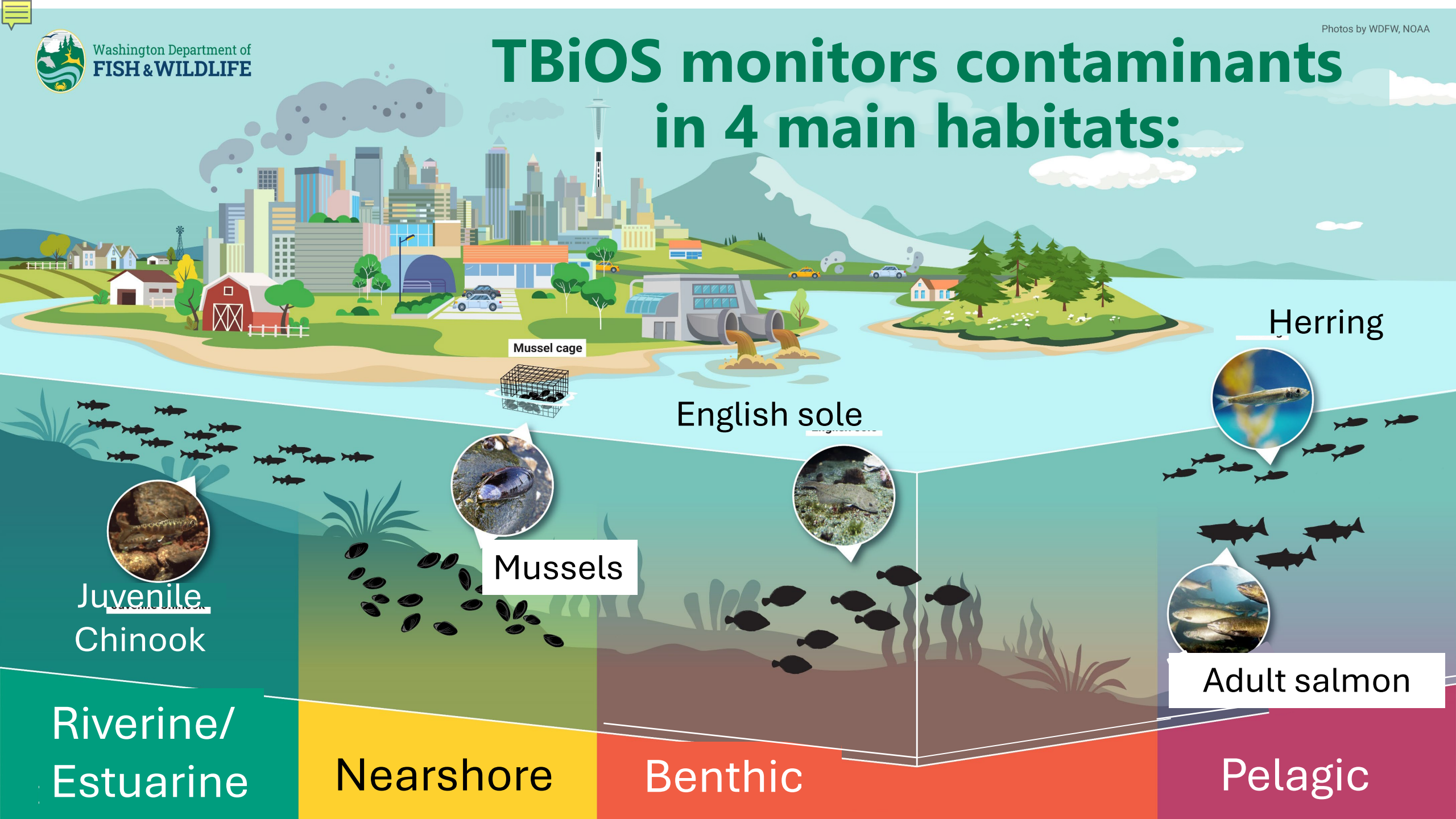
Identify potential adverse **impacts**

Guide efforts to **prevent, reduce,** and **remediate** to advance ecosystem recovery

Washington Department of FISH & WILDLIFE

Photos by WDFW, NOAA

TBiOS monitors contaminants in 4 main habitats:



Assessing Contaminant Exposure

Legacy Contaminants

(known toxic effects to biota)

- PCBs, PBDEs, DDTs
- PAHs
- Metals: copper, mercury, etc.

Contaminants of Emerging Concern (CECs)

(emerging toxic effects to biota)



WDFW staff beach seining for juvenile Chinook in the Duwamish River (credit: WDFW)

Contaminants of Emerging Concern (CECs)

- Pharmaceuticals & Personal Care Products (PPCPs)
- Per & Polyfluoroalkyl Substances (PFAS)
- Tire-related compounds: 6PPD-Q
- Microplastics/Nanoparticles
- Other: Caffeine, Cocaine















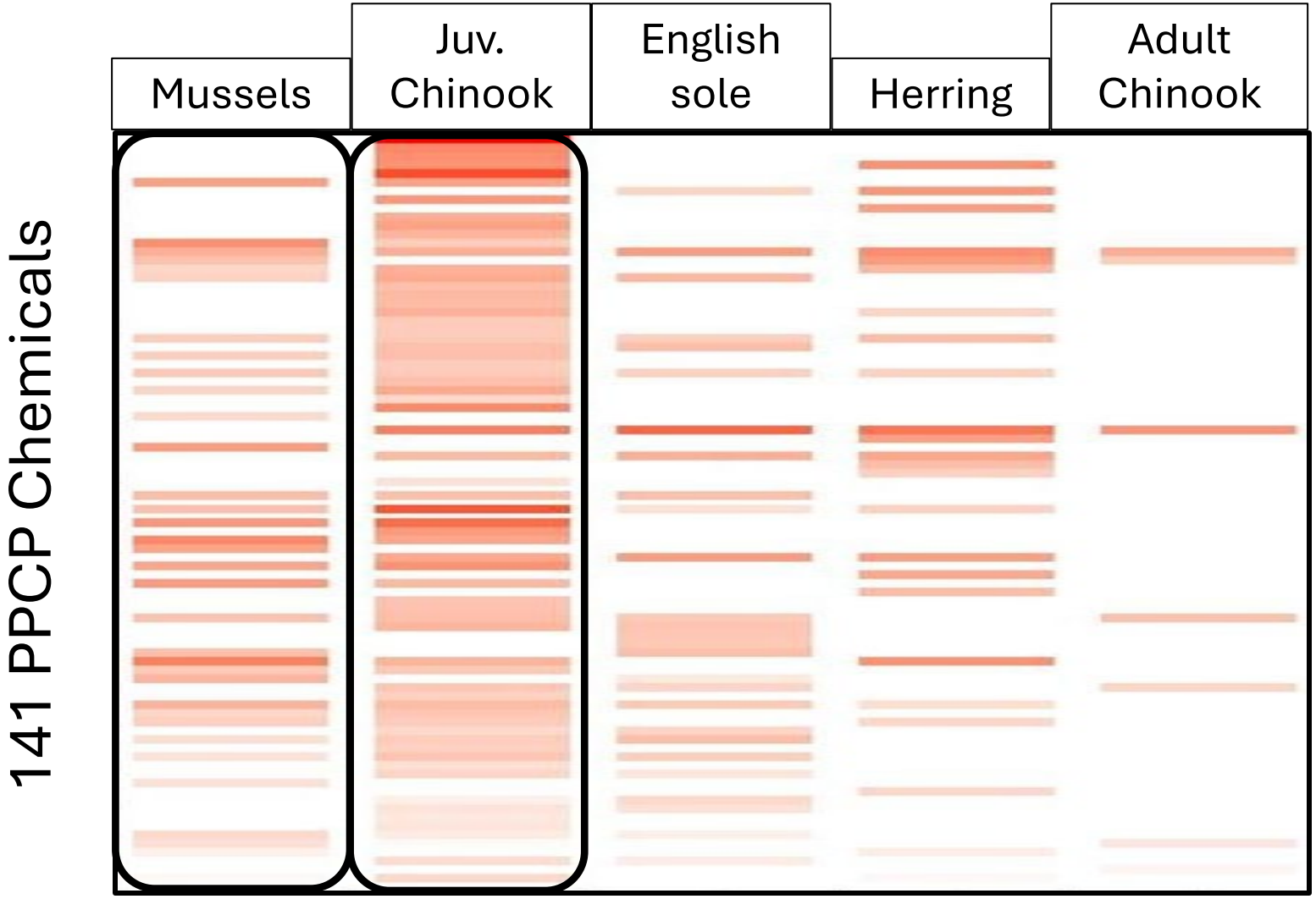






Which Puget Sound species are most exposed to CECs?

CECs are present in every species we monitor



PPCPs detected more frequently and at higher concentrations in riverine/estuary and nearshore species

CEC in Puget Sound Chinook salmon

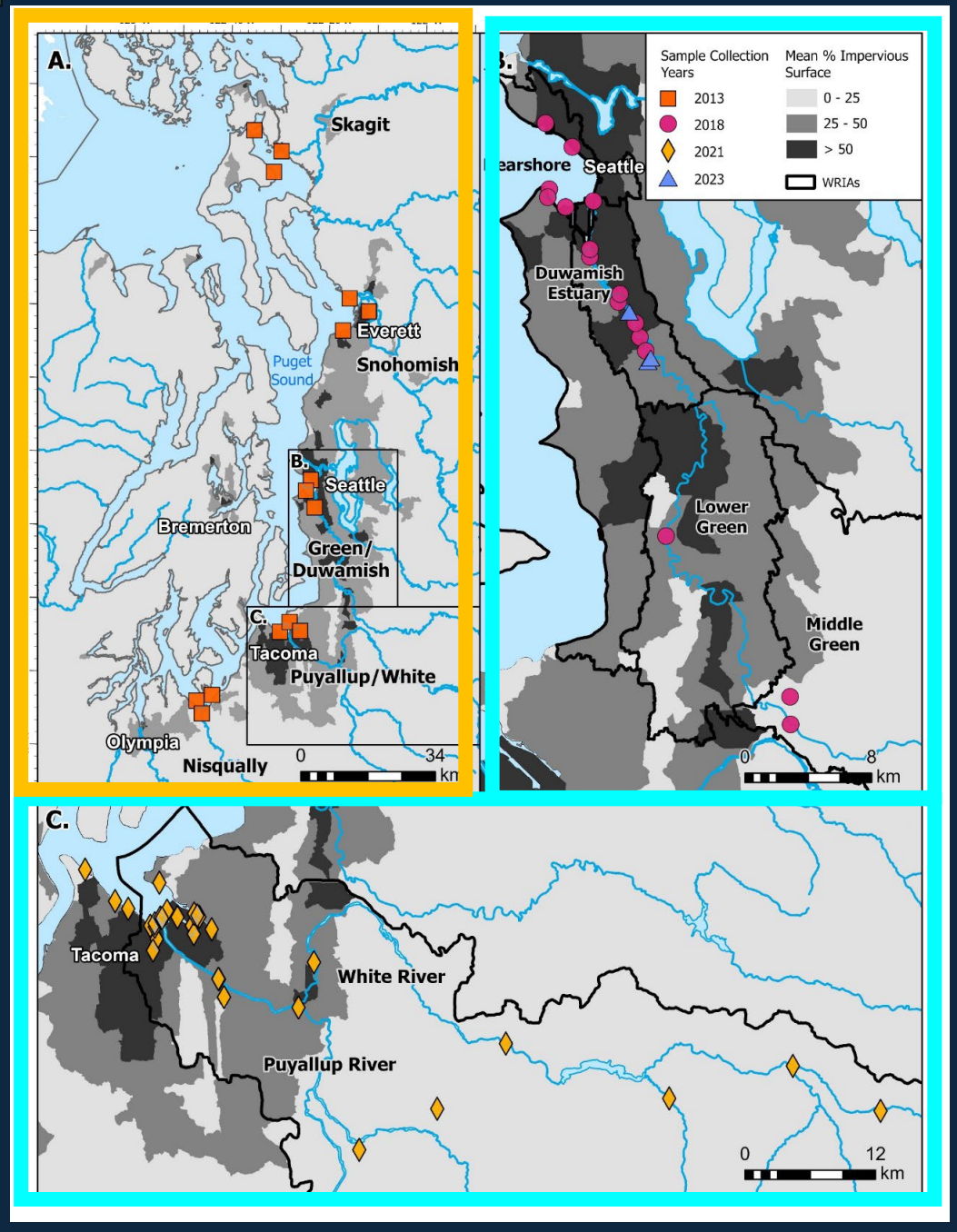


- Identify regions in the two urbanized watersheds where contaminants may be entering the waterways
- Prioritize CEC for future research or actions based on potential impacts to fish health

CEC in Puget Sound Chinook salmon

Study Objectives:

- Characterize exposure to emerging contaminants throughout Puget Sound
- Identify regions in the two urbanized watersheds where contaminants may be entering the waterways
- Prioritize CEC for future research or actions based on potential impacts to fish health



Part I: 5 Watershed Comparison

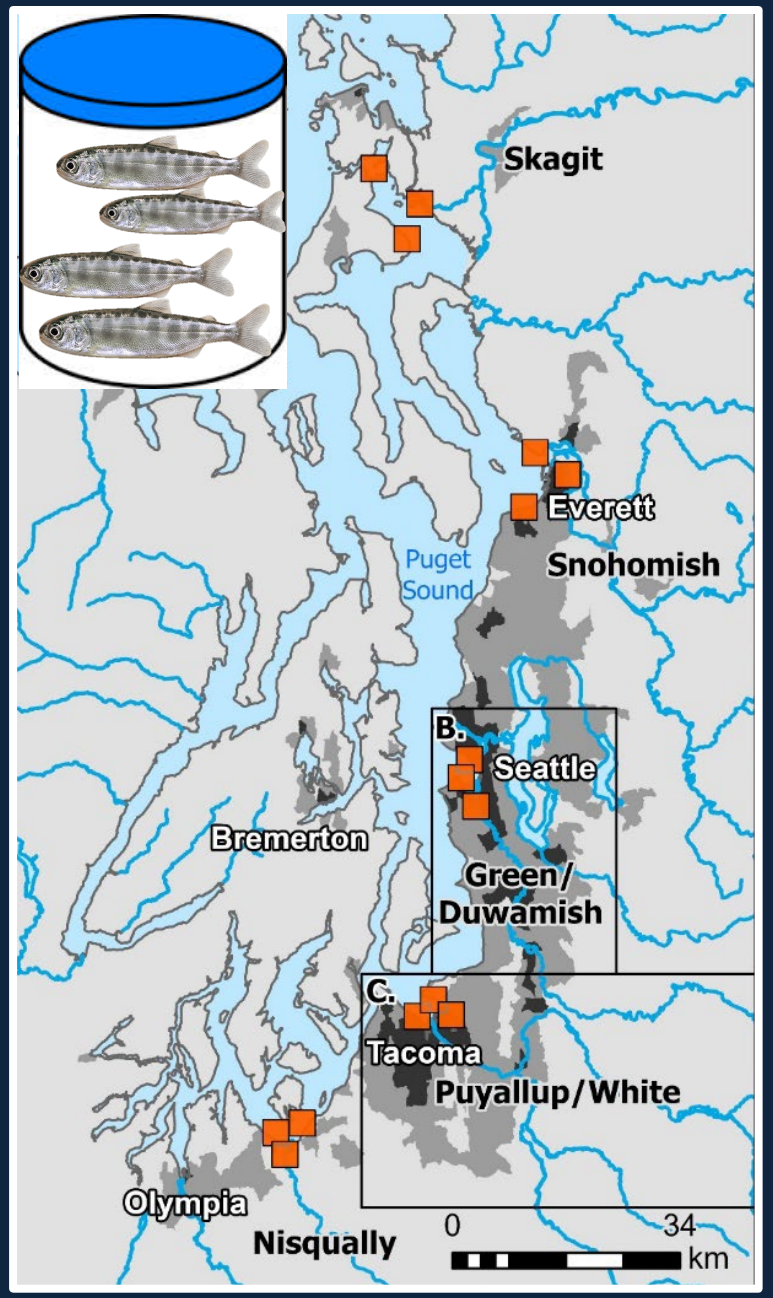
Characterize exposure to emerging contaminants throughout Puget Sound

Part II: Puyallup/White

Part III: Green/Duwamish

Identify regions where contaminants may be entering the waterways

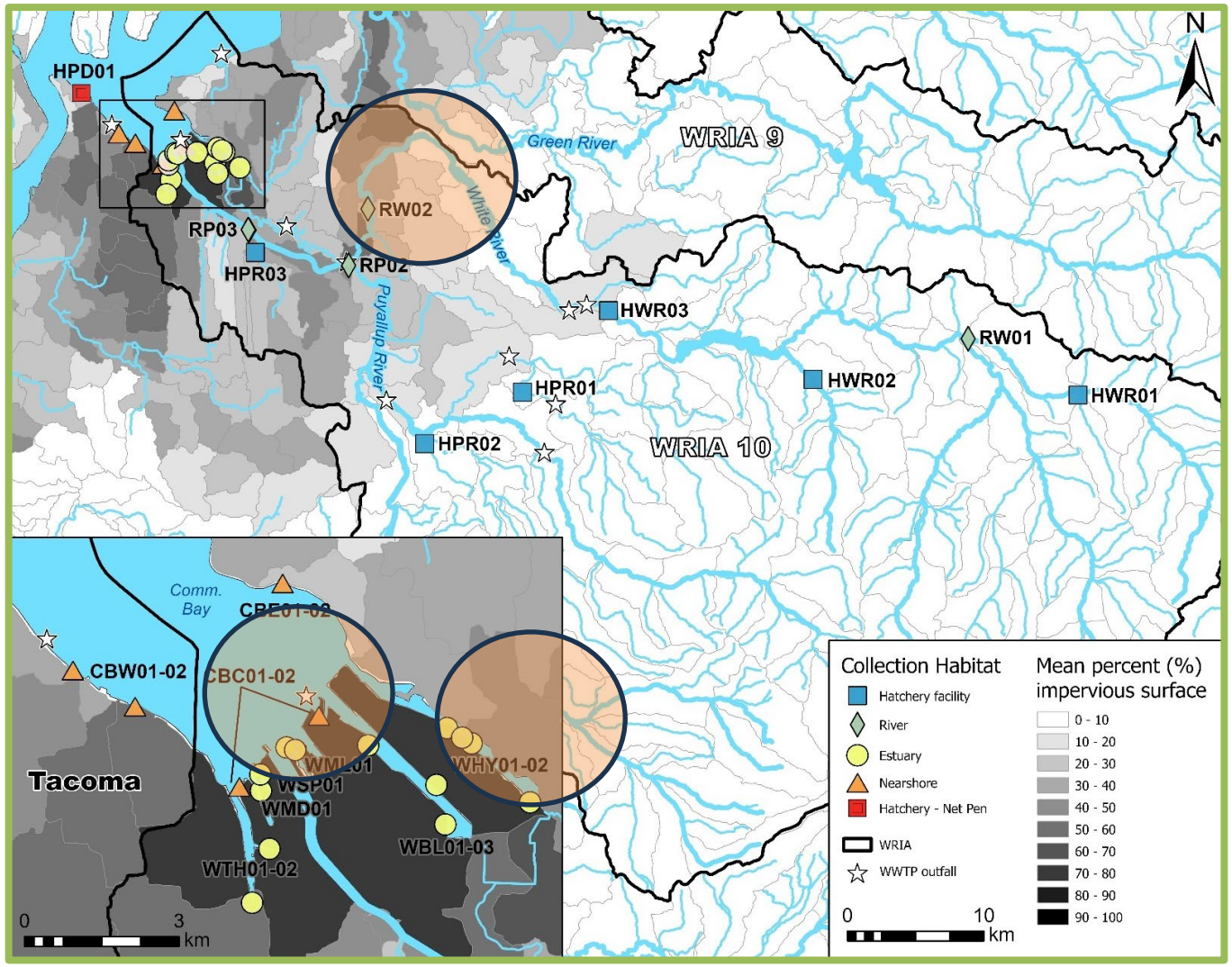
Prioritize CECs for future work based on potential impacts to fish health



Part I: Five Watershed Comparison

- 45 of 192 CECs detected
- 6 CECs detected in all watersheds
  - 4 –nonyl phenols; nonylphenol diethoxylate
  - iopamidol
  - Perfluoro-octane sulfonic acid (PFOS)
  - oxolinic acid
  - DEET
- Developed watersheds had:
  - Higher percentages of CECs detected
  - Highest average and maximum concentrations

Puyallup/White



PFAS

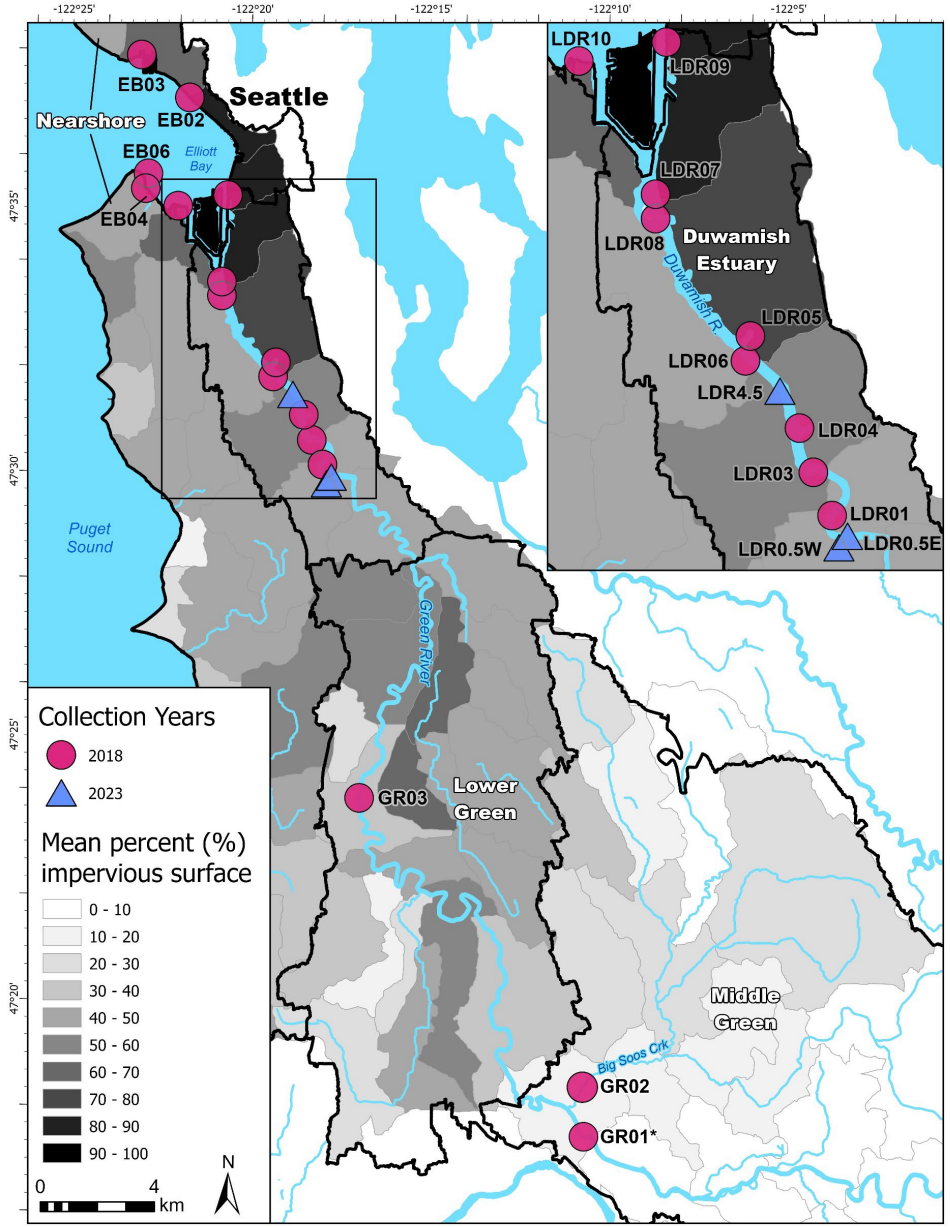
12 of 40 detected

Three hotspots

Concentrations lower in hatchery than wild fish

Concentrations lower in Puyallup/White than Green/Duwamish

Green/Duwamish



Pharmaceuticals and personal care products, alkyl phenols, PFAS

Detected 56 of 185 chemicals

Most often detected:
alkylphenols,
hydrocortisone,
oxytetracycline & metabolites,
diazepam,
PFOS, PFOSA and PFNA



Are CECs detected in salmon at potentially harmful concentrations?



Is the “dose” too high?

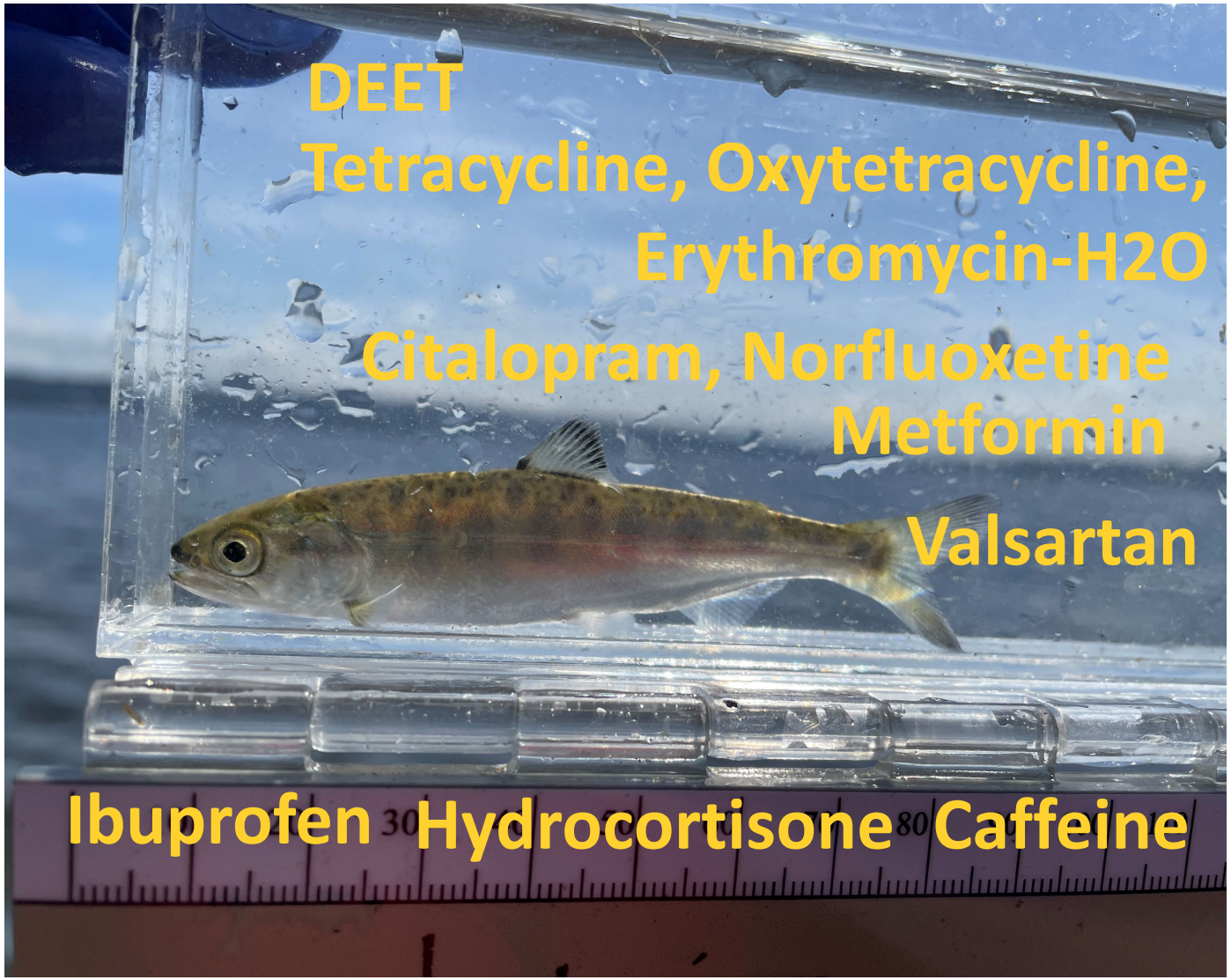
PPCPs in Green/Duwamish Juvenile Chinook

Detected 36 of 145

11 exceeded biological effects thresholds

15 below biological effects threshold

Potential impact of 10 other detected PPCPs unknown



CECs in Puget Sound Chinook salmon

New 2024 Data: PPCPs & PFAS

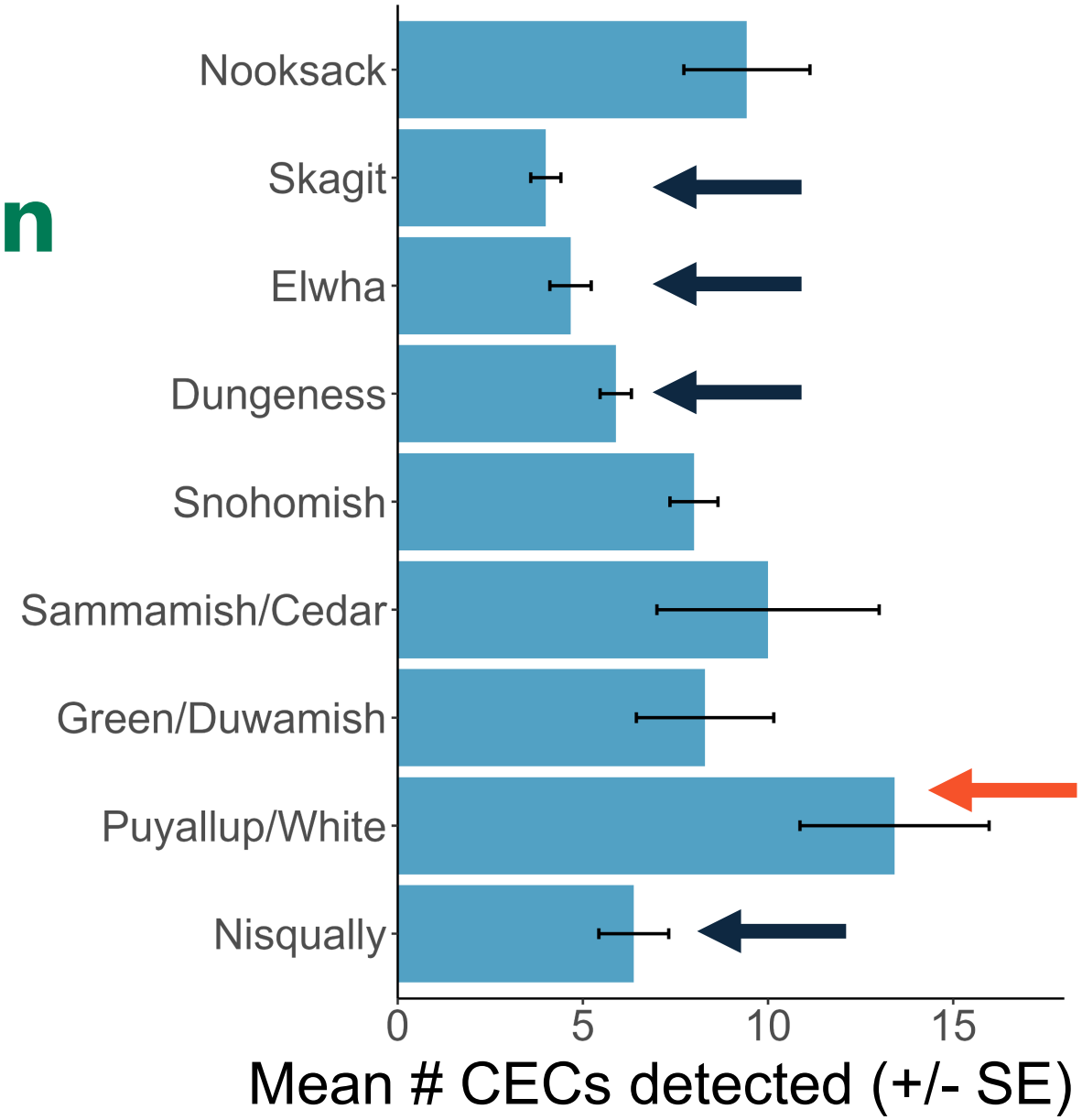


18

Current CEC exposure Juvenile Chinook salmon

Analyzed salmon collected from 9 estuaries for 141 PPCPs & 40 PFAS

- Mean number of CEC detected in samples varied by estuary
- Most CECs observed in Puyallup
- Fewer CECs observed in Skagit, Elwha, Dungeness & **Nisqually**



10 PPCPs Detected in Nisqually juvenile Chinook

Above biological effects thresholds:

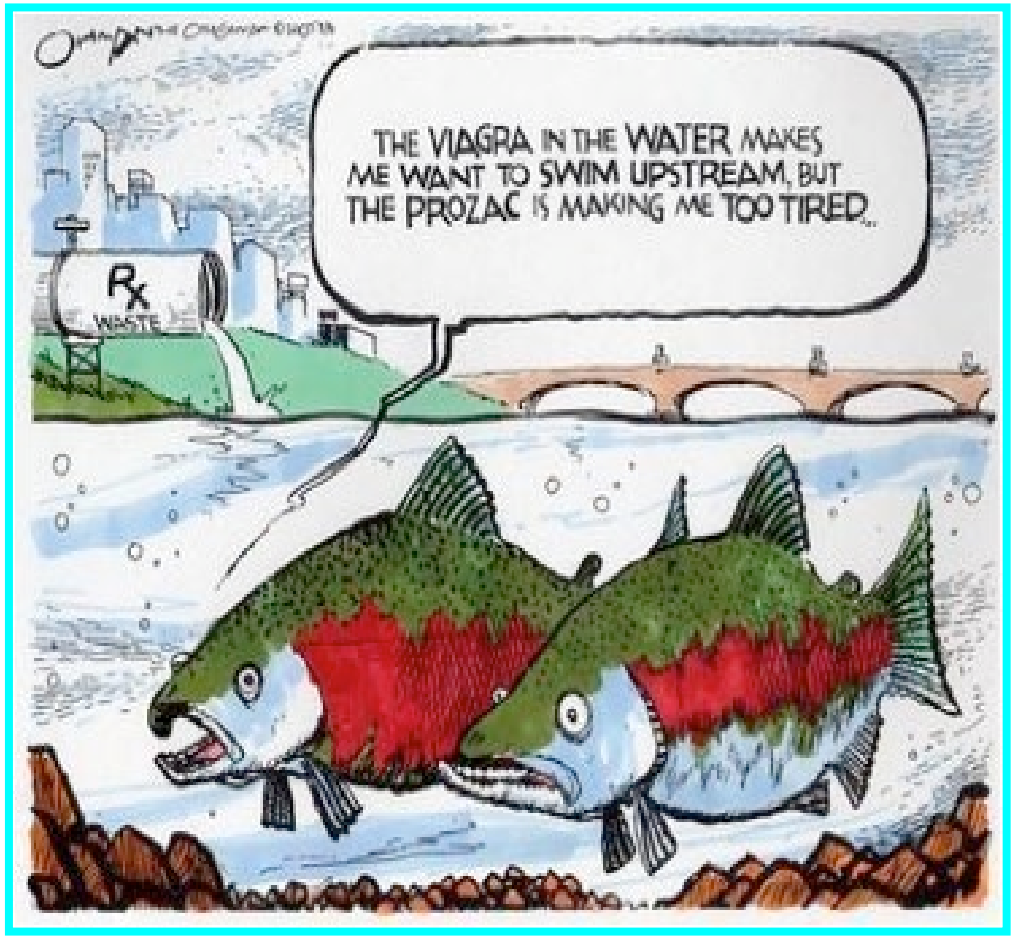
- DEET, Simvastatin, Ibuprofen, and Hydrocortisone

Below Thresholds:

- Amphetamine, Doxycycline, Ofloxacin, Oxytetracycline, and 2-Hydroxy-ibuprofen

No effects data available:

- Bisphenol A



CECs in Puget Sound Chinook salmon

Tire-Related Compounds



Emerging Contaminants – 6PPDQ

Contents lists available at ScienceDirect

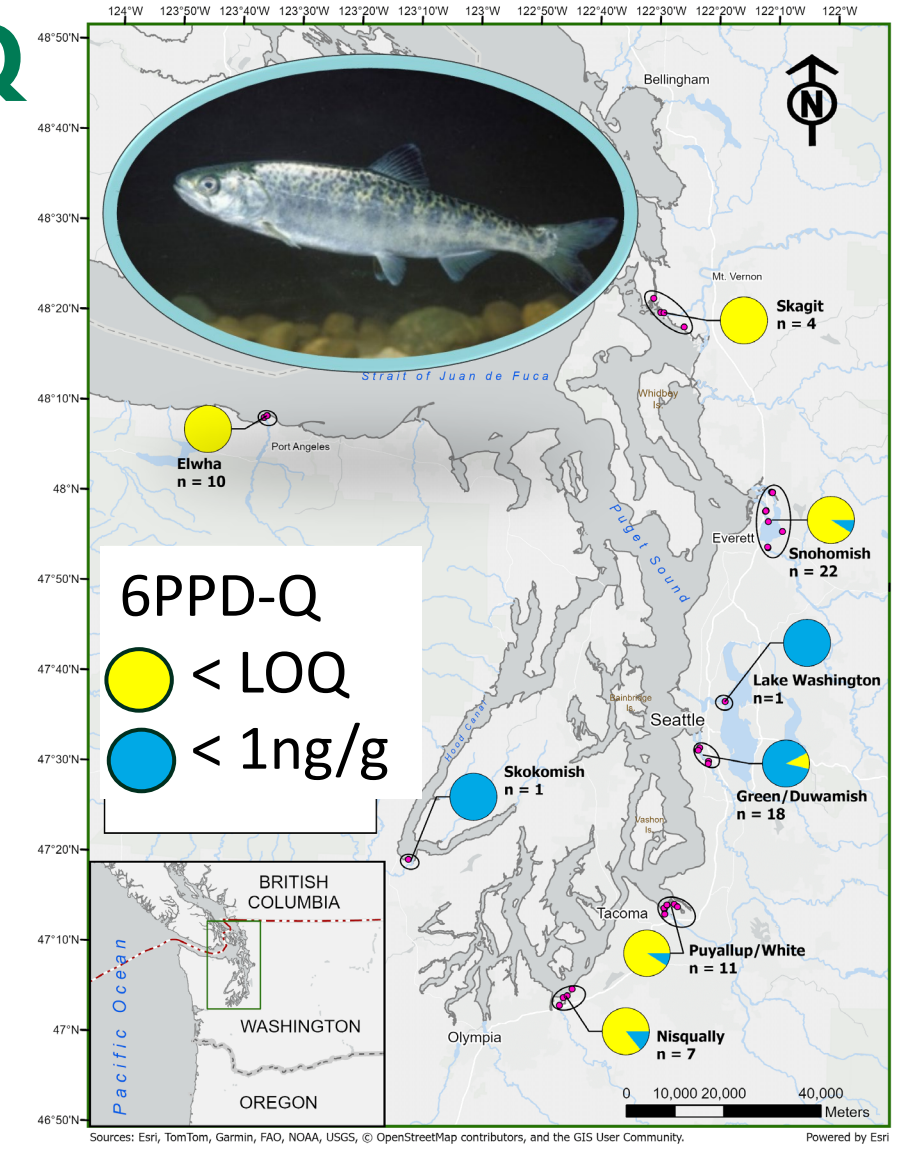
Environmental Research

journal homepage: www.elsevier.com/locate/envres

6PPD-quinone biomonitoring of salmon and mussels in Puget Sound, WA, USA

Li-Jung Kuo [a,*], Molly E. Shuman-Goodier [b], Paul Chittaro [a], Mariko Langness [b], Audriel Schlosser [a], Natasha Winnacott [b], Blake E. Feist [c], Jennie L. Bolton [a], Sandra O'Neill [b], Irvin R. Schultz [a]

- Detected 6PPD-Q in 30% of juvenile Chinook and 49% of mussel samples
- Detected concentration < 1 ng/g ww



Emerging Contaminants – 6PPDQ

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

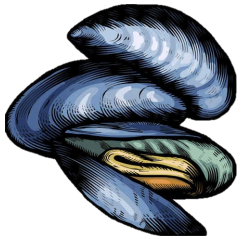
6PPD-quinone biomonitoring of salmon and mussels in Puget Sound, WA, USA

Li-Jung Kuo [a,*], Molly E. Shuman-Goodier [b], Paul Chittaro [a], Mariko Langness [b], Audriel Schlosser [a], Natasha Winnacott [b], Blake E. Feist [c], Jennie L. Bolton [a], Sandra O'Neill [b], Irvin R. Schultz [a]

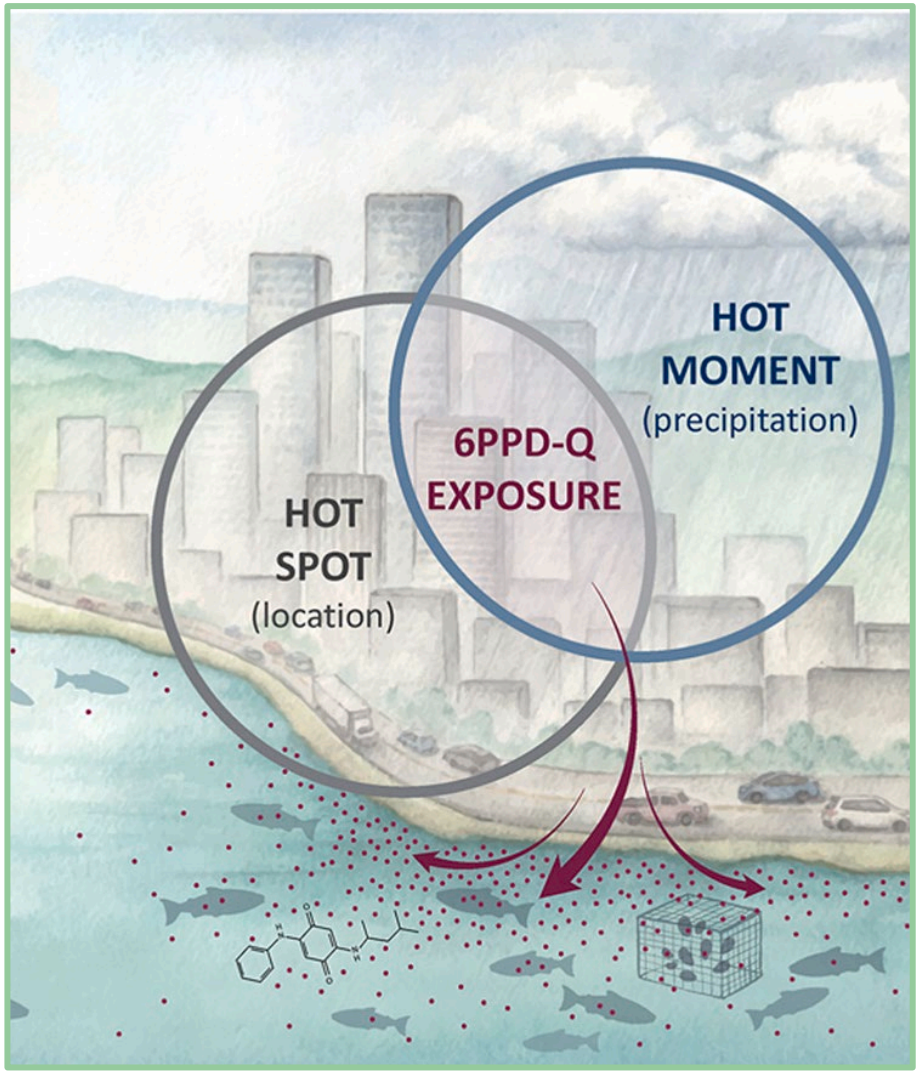
Detections correlated with:

- > 35% impervious surface (hot spots)
- Recent rainfall events (hot moments)

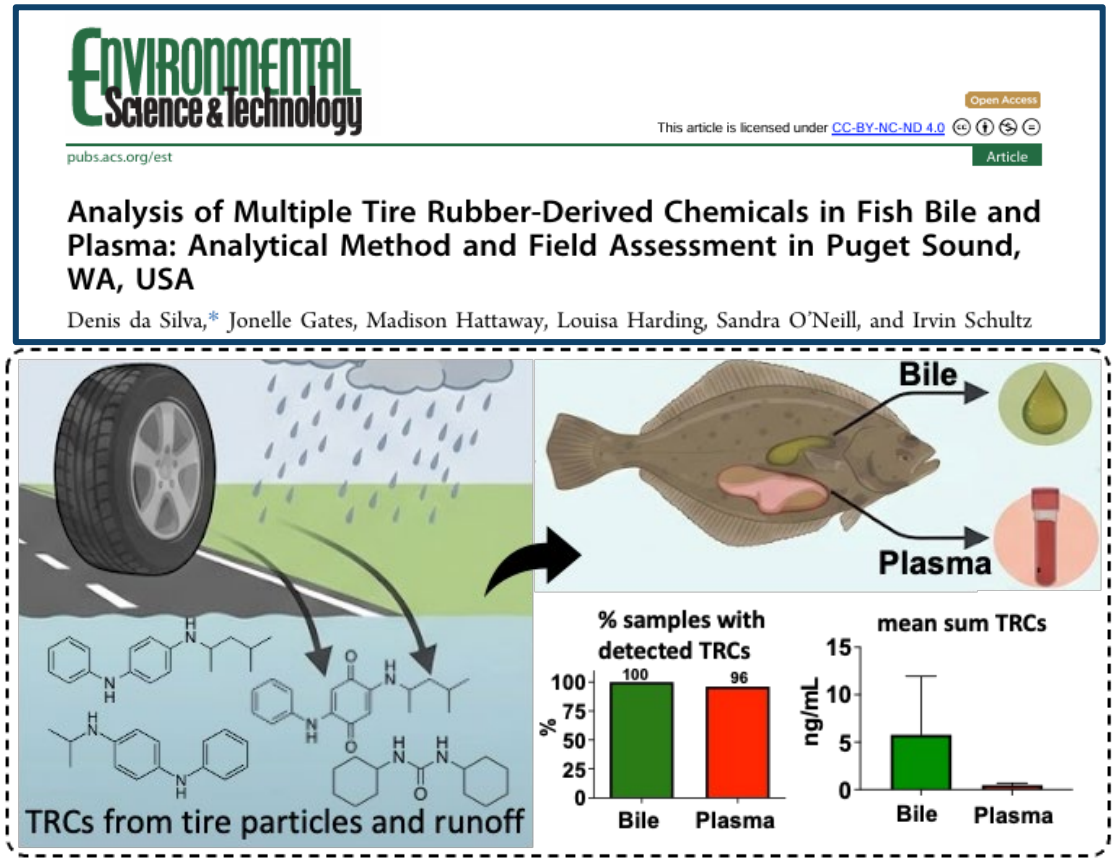








Future Work with Tire-Related Compounds (TRCs)



da Silva et al. 2026. ES&T

- Apply new NOAA methods for measuring 18 TRCs in bile and plasma to solid tissue samples
- Contract with USGS to measure 6PPD in salmon, mussels and other indictor species.

Puget Sound CEC Take Home

- Aquatic species are exposed to complex mixtures of CECs, including in South Sound, especially in river/estuarine and nearshore habitats
- Concentrations and detections are **often** higher in urban areas
- **To date:** 12 priority CECs identified for future research and action
- Synergistic effects from exposure to multiple contaminants likely increase threat of CEC to our aquatic resources.
- Locations with highest concentrations and distinct contaminant mixtures could be targeted for source tracing efforts (e.g., PFAS)

Questions?



Photo by Richard Bell, University of Washington