

Identification of the source of flame retardant exposure in Steelhead trout in the Nisqually River basin

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Steelhead trout

Oncorhynchus mykiss

Ocean-going rainbow trout

- Rear in freshwater longer than other salmonids (1-4 yrs)
- Migrate quickly to marine waters

PS Steelhead have been declining since the late 1800s

Current run is less than 10% of its historic size

2007 – listed as threatened under the ESA

Vulnerable to contaminant exposure



Image from Quinn 2018, UW Press

2014 Steelhead study

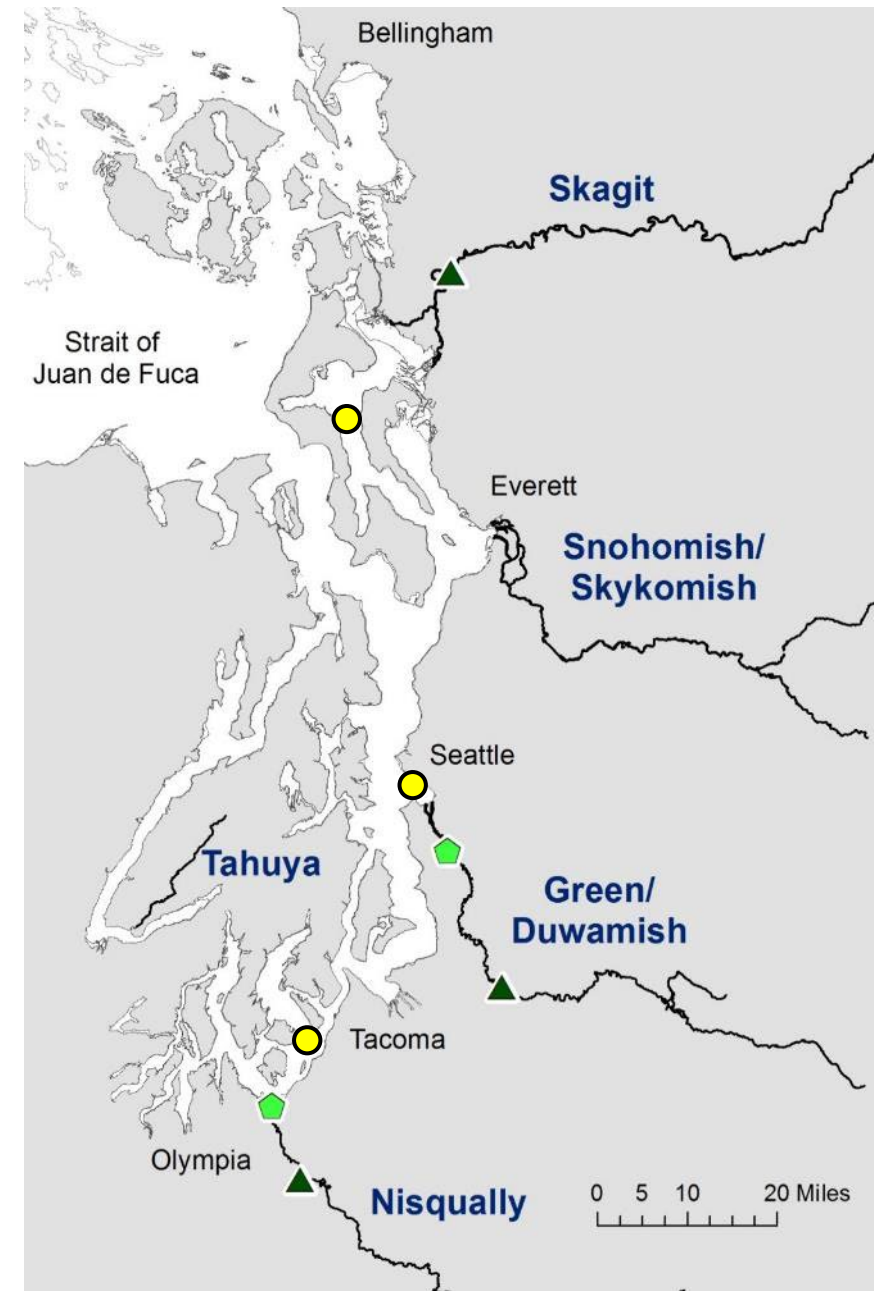
Assess contaminants in wild steelhead trout

- 3 Puget Sound regions

Within each region

- ▲ In-river habitat (traps)
- ◆ Lower River/estuary
- Offshore marine

Hypothesis – Steelhead from Central Puget Sound would have higher contaminant levels.



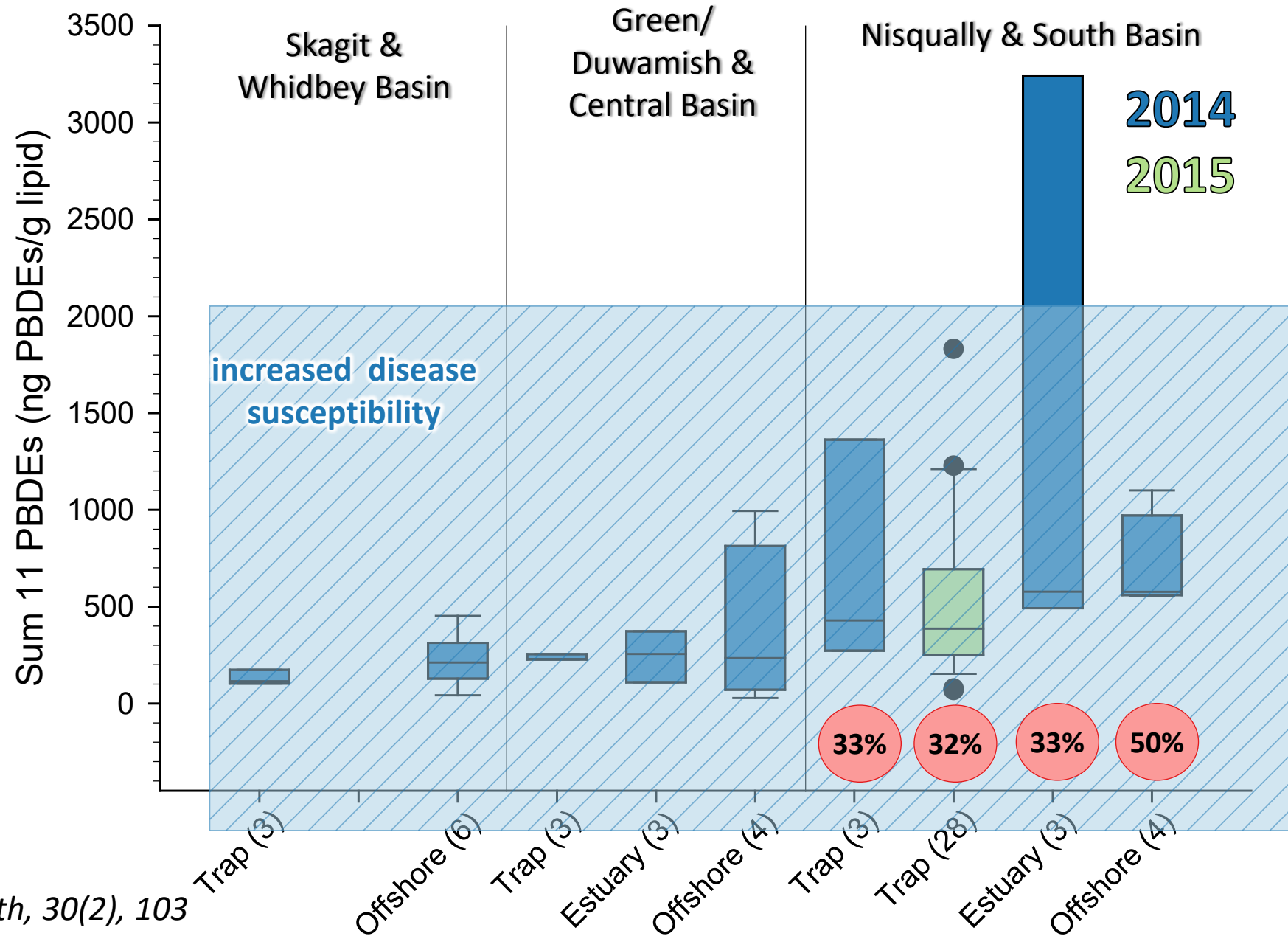
PBDEs in juvenile steelhead trout

2014 Study

- 33-50% of outmigrating steelhead from Nisqually R had levels of PBDEs known to affect the health of salmonids

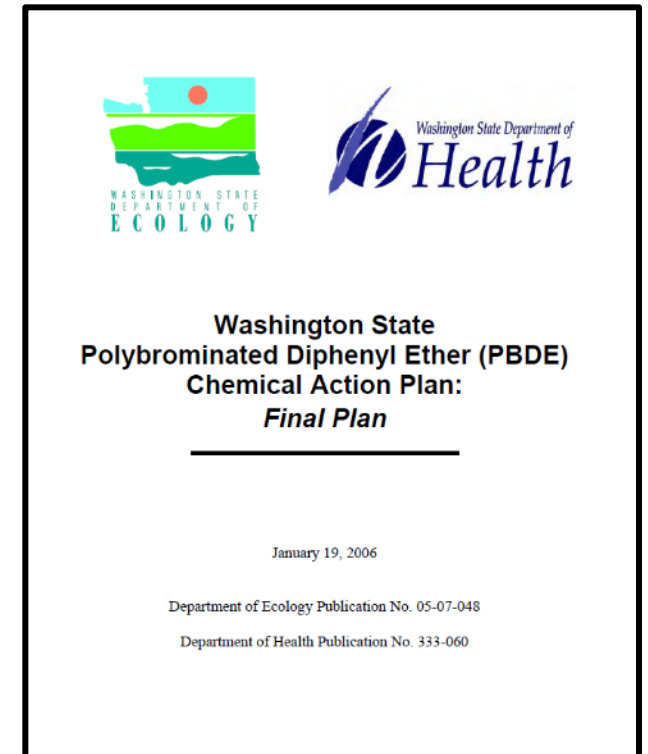
2015 Follow-up sampling

- 33% of steelhead trout from an in-river location had levels of PBDEs known to affect their health



Polybrominated diphenyl ethers (PBDEs)

- Added to commercial and industrial products (plastics, fabrics, foams) = **urban waste streams main pathway**
- Persistent and bioaccumulative
 - 2004 – Voluntary phase-out of penta- & octa-BDE mixtures
 - 2006 – Chemical Action Plan
 - 2012 – most uses of deca-BDE phased out
- There are no surface water criteria or sediment management criteria for PBDEs.
- No consumption advisory for Nisqually River fish

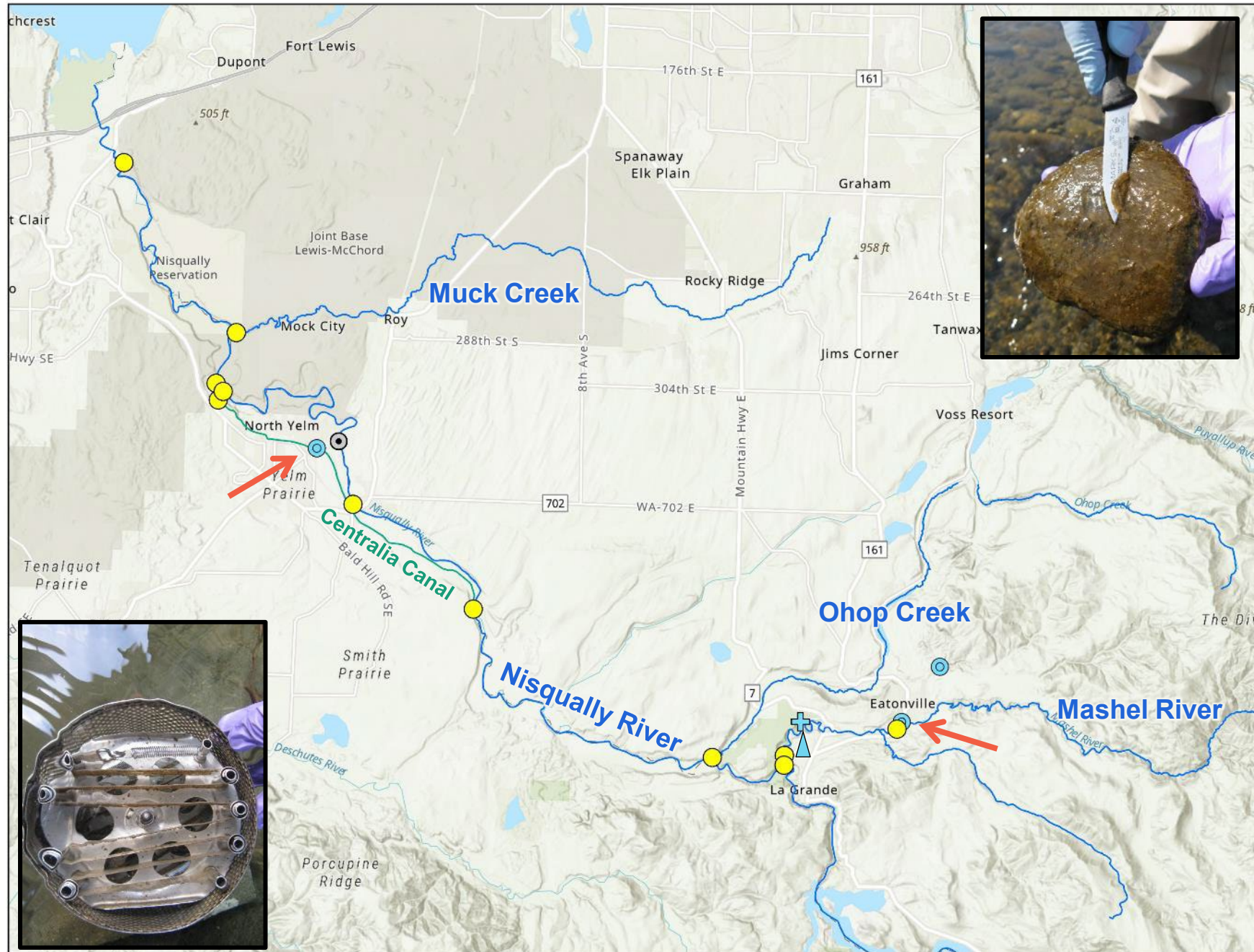




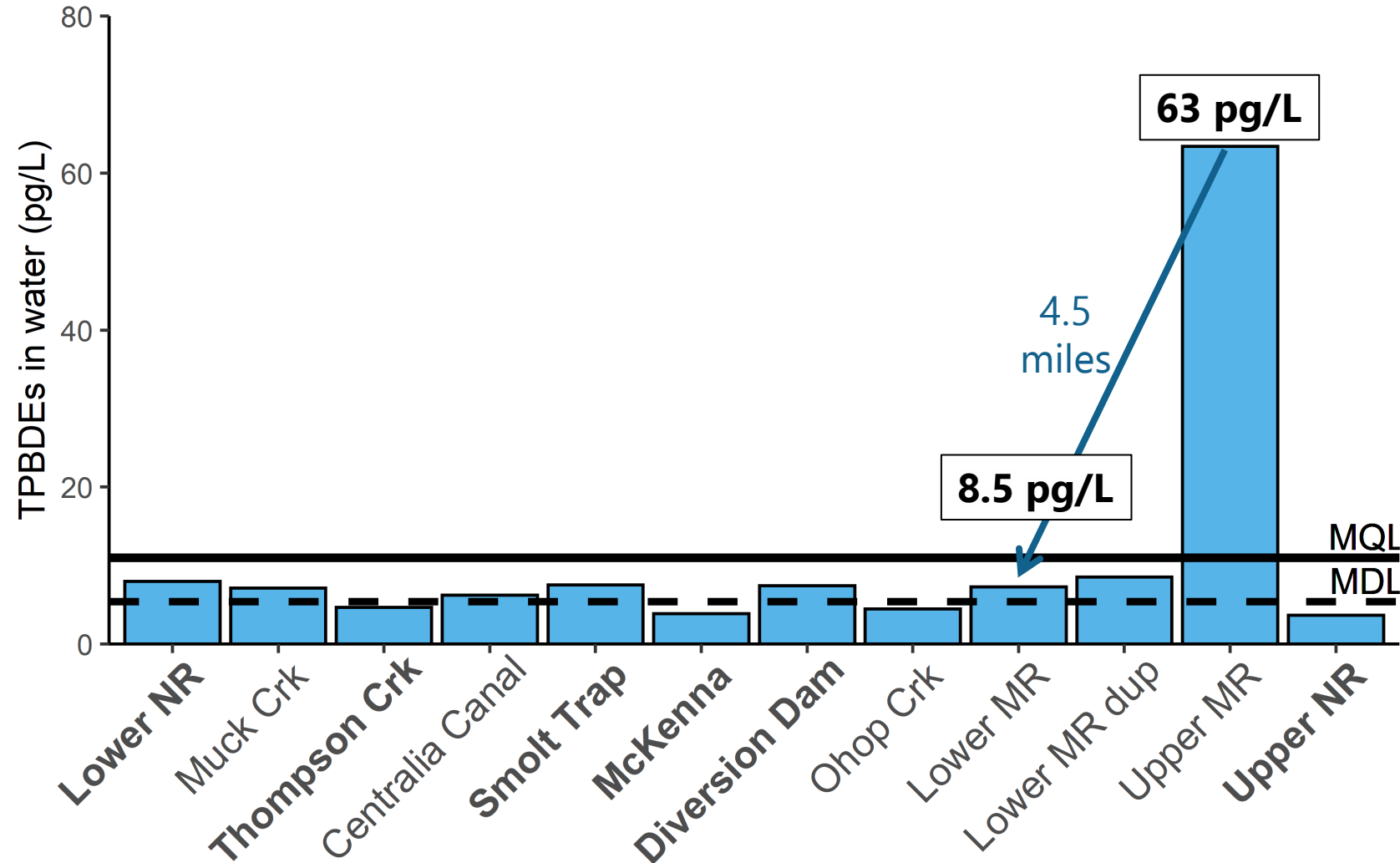
2017 PBDE Source Assessment

2017 Study

- PBDEs sampled using passive water samplers (SPMDs) and concentrations in biofilms (algae, microbes and detritus)
- Sampled at low flow (Aug-Sept)
- The **Yelm WWTP** and **Eatonville WWTP** were discharging during sampling

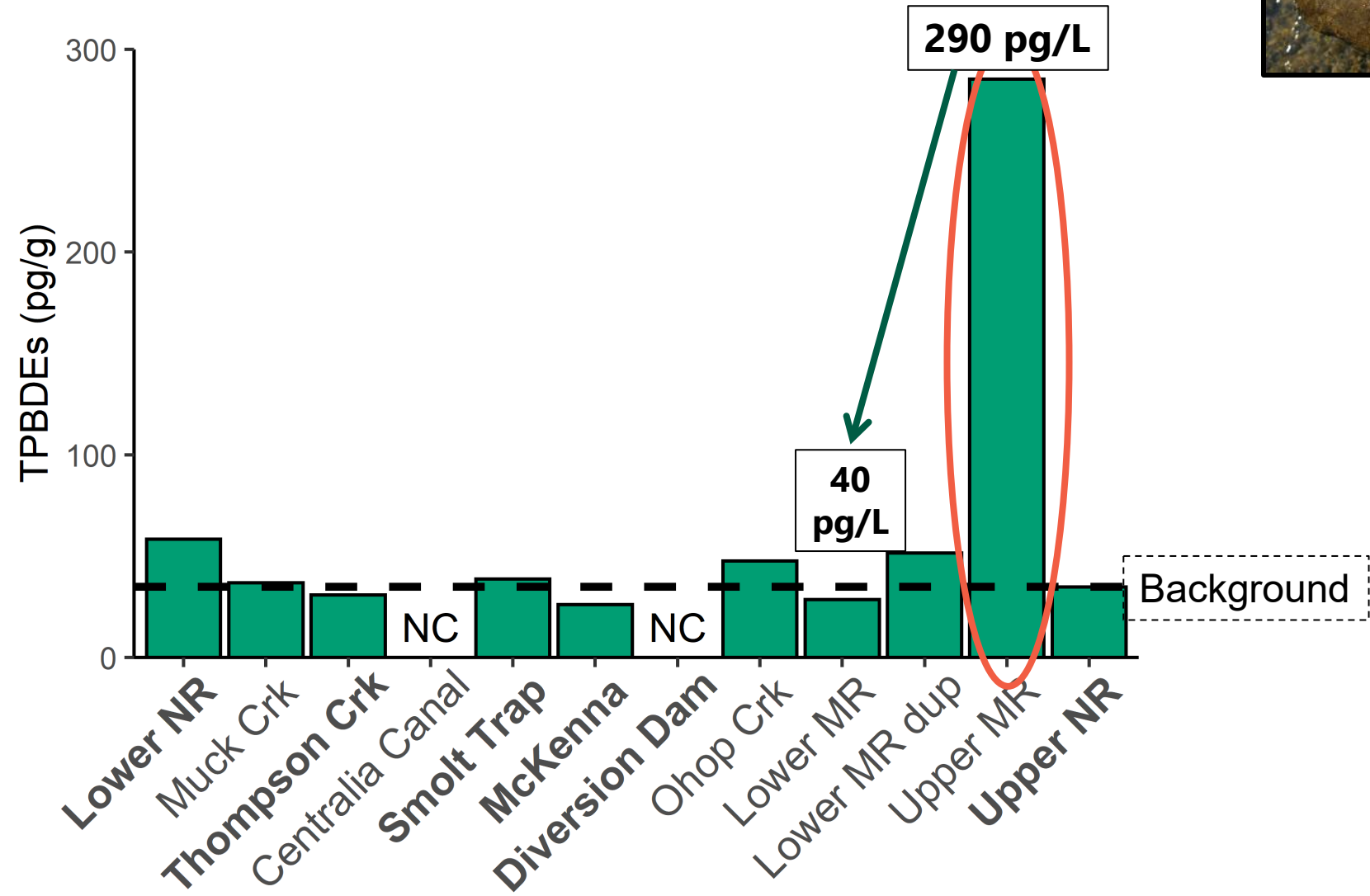


Results – total PBDEs in water



MR = Mashel River; NR = Nisqually River

Results – total PBDEs in biofilm



PBDE Patterns

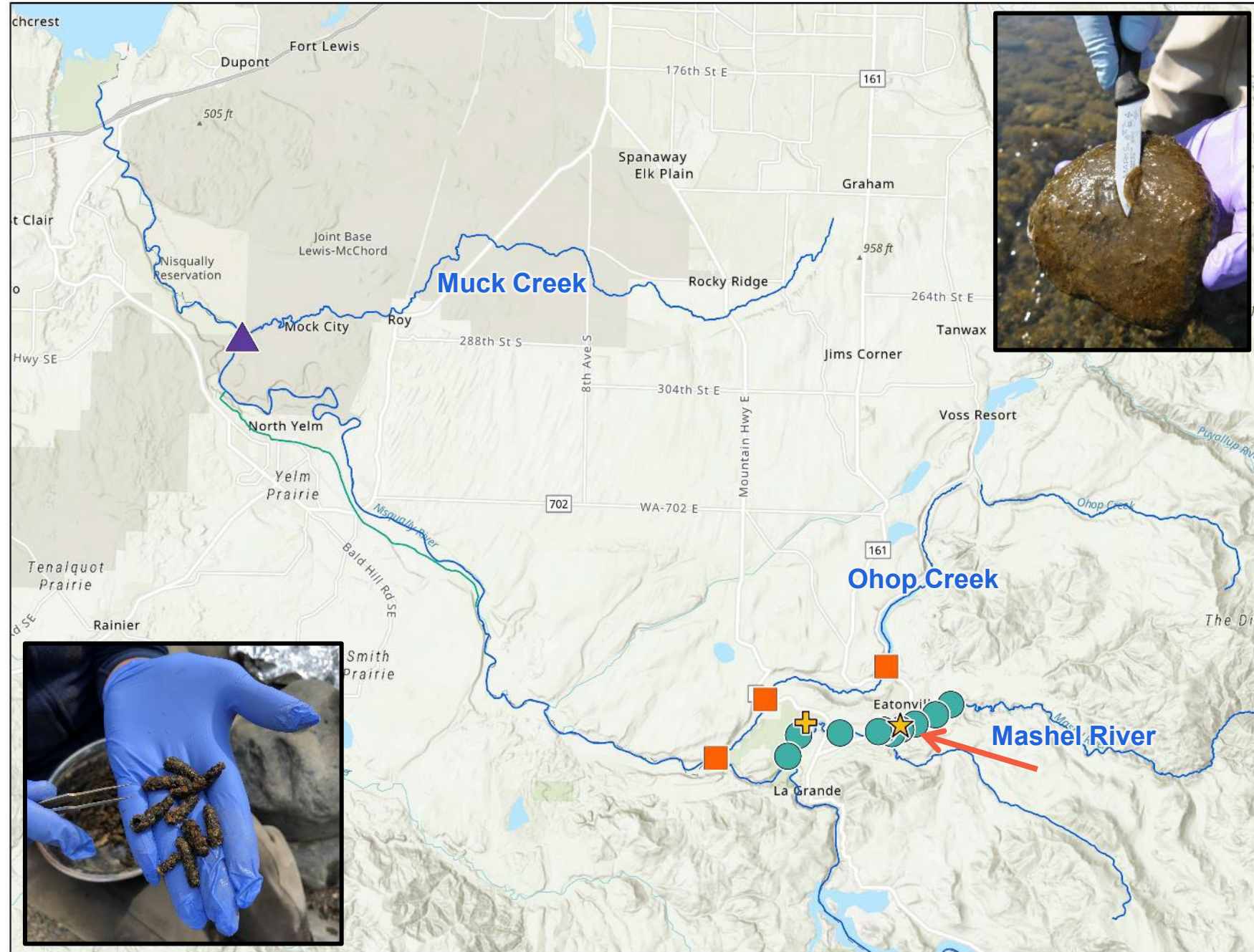
Aquatic environments have distinct patterns of contaminants based on inputs and environmental attributes



Upper Mashel River site (river mile 4.9 near Eatonville WWTP outfall)

2021 Study

- Focused on three of the major tributaries where PBDEs were detected in 2021
- PBDEs sampled using biofilms and invertebrates
- Sampled at low flow (end of August)
- The **Eatonville WWTP** was discharging during sampling



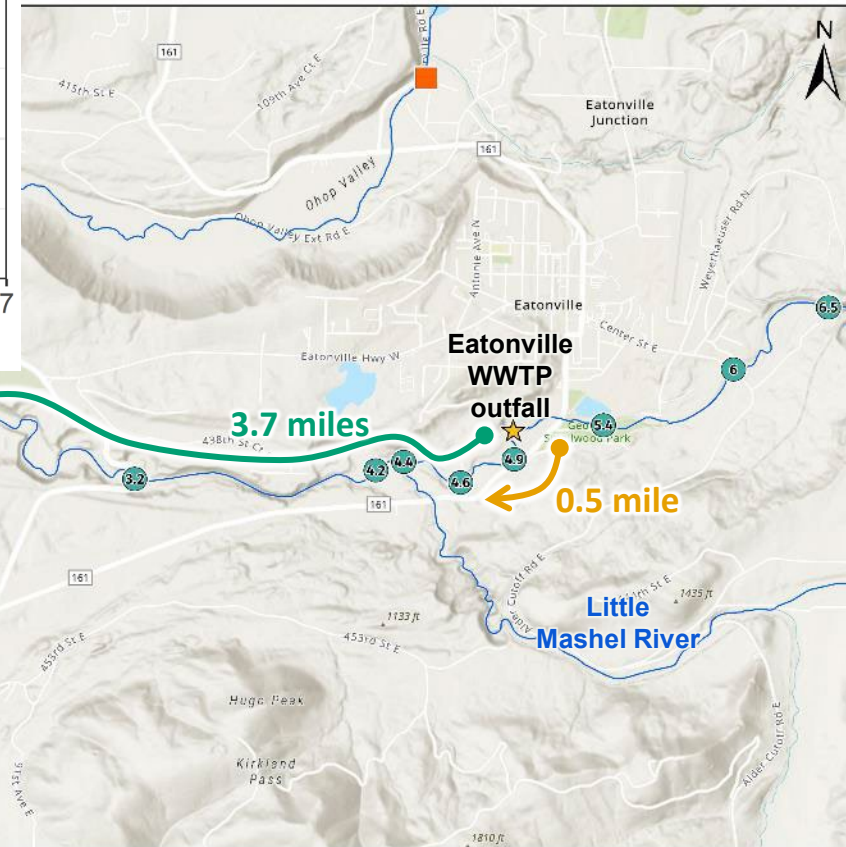
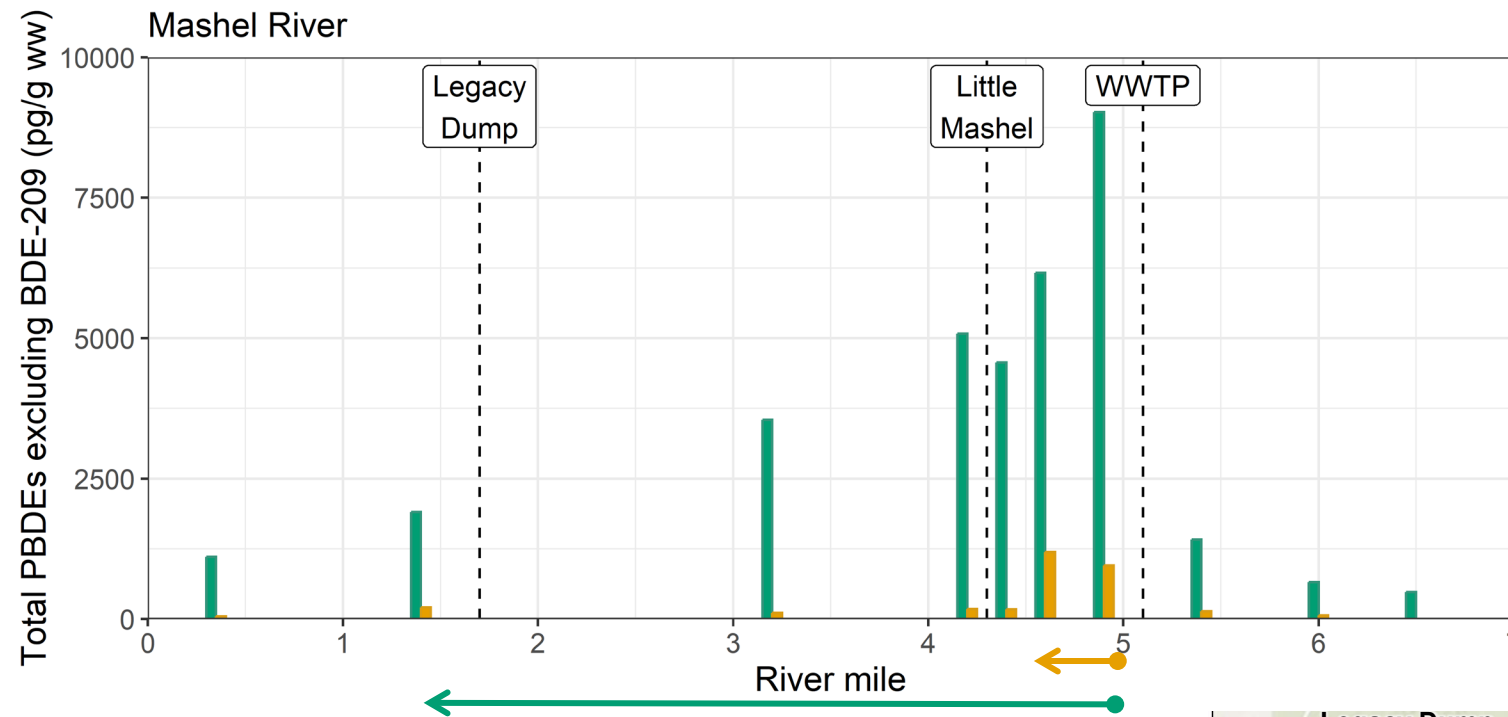
Biofilm and Invertebrate Sampling

Invertebrate sampling:

- larval and pupal stages of the caddisfly (*Dicosmoecus gilvipes*)
- ~ 1 year old
- scraper-grazer, feed on biofilms

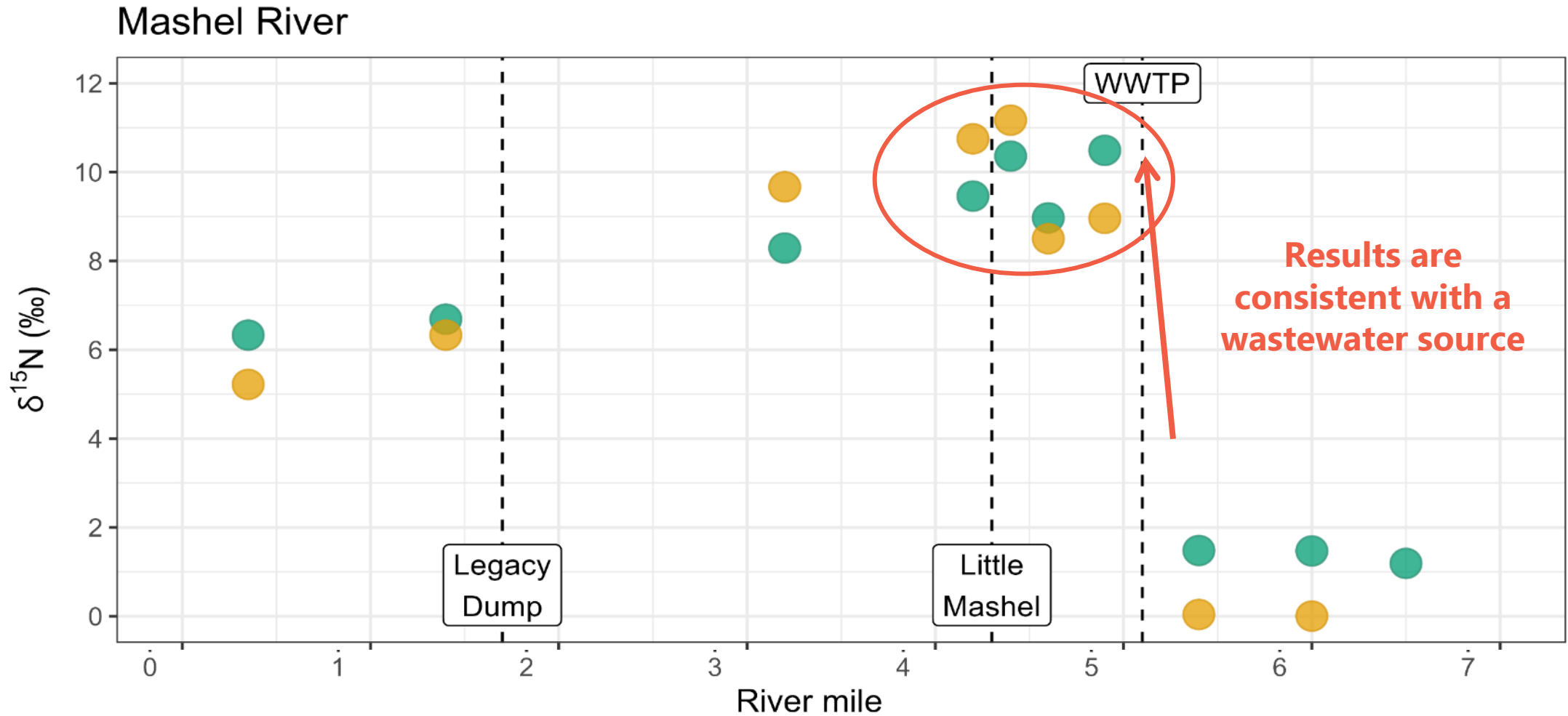
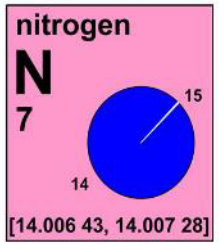


Mashel River – Total PBDEs in Biofilm and Inverts

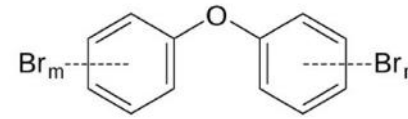


- Upstream of WWTP (RM 4.9) = background
- PBDE elevated downstream of outfall in both biofilm (0.5 mile) and inverts (3.7 miles)
- No evidence of additional sources (Little Mashel or legacy dump)
- **Downstream of RM 4.9 is a PBDE source to steelhead**

- Wastewater effluent can be enriched in ^{15}N
- We observed enrichment (i.e., increase) of $\delta^{15}\text{N}$ in biofilm and inverts just downstream of the outfall
 - $<2\text{‰}$ upstream at Smallwood Park to $>8\text{‰}$ downstream of WWTP outfall



Conclusions



- The location, magnitude and pattern of PBDEs and stable isotopes in our samples suggests the source/pathway is likely the effluent from the Eatonville WWTP
 - Within a half mile stretch of river downstream of the WWTP outfall, PBDEs increased 5x in invertebrates and 6x in biofilm
 - PBDE congener pattern reflects congeners measured in WWTP effluent and steelhead trout
 - Stable isotopes in biofilms downstream of the outfall suggest a wastewater source
- Background levels – Ohop and Muck Creeks and upstream of the Mashel River outfall (data not shown).
- **ESA-listed steelhead trout are likely being exposed to PBDEs in the Mashel River**

Recommendations

- Sample steelhead trout, yearling Chinook, cutthroat trout, or other resident fish from Mashel River to get updated PBDE levels
 - Concurrent sampling of invertebrates
- Monitor PBDEs in Eatonville WWTP influent and effluent to assess trends in PBDE exposure for steelhead and other species
- NOAA Steelhead Recovery Plan



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Land access – Nisqually Indian Tribe, WDFW, Centralia Canal, University of Washington Pack Forest, Nisqually Land Trust

Reports: wdfw.wa.gov Species and habitats Marine toxic contaminants publications

Google: TBioS publications

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