Source Assessment of PBDEs Impacting Juvenile Chinook in the Snohomish River System

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Ecology lead source assessment of PBDEs from 2019 to 2022 in Snohomish, Skykomish, Snoqualmie Rivers

- Assess and prioritize potential sources of PBDEs that may be impacting the health of outmigrating juvenile Chinook
- Identify potential pathways of PBDEs from source to juvenile Chinook
- Monitored PBDEs during low (late summer) and high (spring) river flow conditions
  - 6 sampling event, 4 low flow, 2 high flow
Methods

- Water – passive samplers (SPMDs), estimate water conc. integrated over ~30 days
- Biofilms – mixture of algae, cyanobacteria, detritus; collected from river substrates
- Sediment – benthic and suspended, collected throughout estuary
- Invertebrates – mixture of species; juvenile Chinook prey items; surface tows/algae mats
- Analyzed samples for 43 PBDE congeners by EPA Method 1614A
Study Results

PBDEs in water & sediments

Prey Item Concentrations and Temporal Trends

PBDE Accumulation and Concentration
2019-2022 PBDE Water Concentration in Snohomish River & Estuary

Lower Mainstem

Upper Mainstem

Sloughs

Sample Site

WWTP Outfall

CSO
2022 Snohomish Main Stem High vs Low Flow PBDE Water Concentrations

- Everett WWTP Outfall 015 discharge
  - No Discharge during Low Flow Sampling period
  - Active Discharge during High Flow Sampling period
2019-2022 Total PBDE Water Concentration in Skykomish & Snoqualmie Rivers

Skykomish

Snoqualmie

Lower Mainstem Snohomish High Flow Average

Lower Mainstem Snohomish Low Flow Average

Sample Site

WWTP Outfall

CSO

Sample Site

WWTP Outfall

CSO
PBDEs in Bottom Sediments

- Concentration Range from 130 to 3800 pg/g
- Highest concentrations at SNOH01.8 & 13
- Similar concentration across sloughs
Suspended Sediments

- Low Flow - similar concentration of PBDEs along main stem
- High Flow - varying PBDE concentrations
- Active WWTP discharge during both events
Temporal Variations in Invertebrate PBDE Concentrations

• Highest PBDE concentrations occur in spring
  • Coincides with occurrence of juvenile Chinook in Snohomish estuary
• Declining trend in concentrations over summer
• Similar temporal pattern in 2021 & 2022
• Max 2021-2022 PBDE concentration ~7x greater than 2019 low flow event invertebrates
PBDEs in Juvenile Chinook Stomach Contents

Juvenile Chinook are accumulating the PBDEs from their food source.

Lower Snohomish Mainstem

$r^2 = 0.99, p < 0.001$

$y = 0.21 + 0.57x$
PBDE Accumulation & Concentration

- Water conc. average = 0.024 ppt
- Biofilm conc. average = 297.1 ppt
  - ~12,500x increase from water
- Invertebrate conc. average = 1477.3 ppt
  - ~5x increase from biofilms
- Primary producers (biofilms) and invertebrates concentrate and accumulate PBDEs
- Calculated from average conc. measured during 2019 low flow sampling event
PBDEs in the Snohomish Estuary
Results Summary

• Elevated PBDE concentrations in lower Snohomish main stem & near city of Monroe
  • Elevated PBDEs in water, sediment, biofilms, & inverts.
  • Associated with WWTP discharges
• Bioconcentration and bioaccumulation of PBDEs from water to biofilms and invertebrates
• Temporal trend of invertebrate PBDE concentrations in Snohomish mainstem
  • Highest in spring, declining through summer
  • Juvenile Chinook prey contain high levels of PBDEs
• PBDE congener accumulation differs across environmental media
Study
Conclusions

• WWTP discharges of PBDEs impact localized areas surrounding the discharge zone in the Snohomish mainstem and near the city of Monroe.

• Uptake and transformation of PBDEs in the food web concentrates and increases potential impacts on outmigrating juvenile Chinook salmon in the Snohomish estuary.
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Questions?

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PBDEs in Biofilms

- Collected during 2019 low flow event
- Highest concentrations located in mainstem of Snohomish
- Elevated concentrations near city of Sultan and Snoqualmie
2022 Temporal Trends of Suspended Sediment Total PBDE Concentrations

![Temporal Trends of Suspended Sediment Total PBDE Concentrations](chart.png)