Apr 5th, 2:30 PM - 2:45 PM

Input of PBDE exposure in juvenile Chinook salmon along their out-migrant pathway through the Snohomish River, WA

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Acknowledgments

WDFW
Lance Campbell
Anna Hildebrandt
Andrew Claiborne
Jeff Grimm
John Sneva
Tracey Scalici
Kelly Kiyohara
Joe Anderson
Pete Topping
Josh Weinheimer
Clayton Kinsel
Val Tribble
Canada DFO
Crew of the Ricker
Long Live the Kings
Iris Kemp
Michael Schmidt

Lummi Nation
Skagit River System Cooperative
Stillaguamish Tribe
Tulalip Tribe
Snohomish County
Puyallup Tribe
Nisqually Tribe
Skokomish Tribe
Port Gamble S'Klallam Tribe
Jamestown S'Klallam Tribe
Lower Elwha Klallam Tribe
Squaxin Tribe
Muckleshoot Tribe
Coastal Watershed Institute
NWIFC

NOAA NWFSC
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Juvenile Chinook Contaminant Surveys

Purpose 1:

Measure contaminant exposure in juvenile Chinook from the Puget Sound evolutionary significant unit (ESU)

- Status and Trend: River Deltas (Estuaries) Habitat

Purpose 2:

Determine where in out-migrant pathway Chinook salmon are exposed to and accumulate contaminants.

- Geographic Extent/Magnitude; Multi-Habitat Focus Study

2016 Survey

Status and Trends

- 11 deltas + Lake Washington

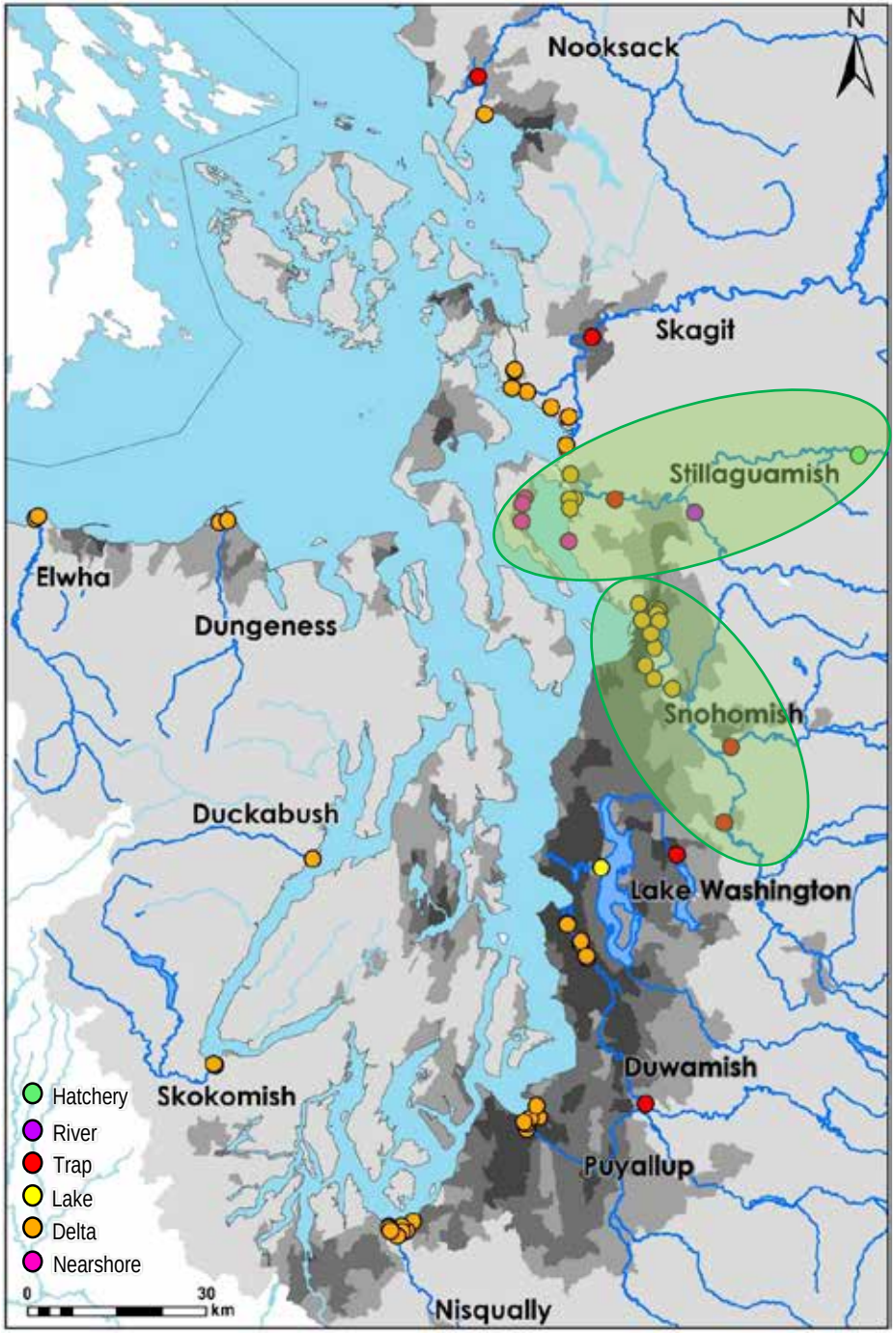
Focus Studies

  - Stillaguamish
  - Snohomish

- # Chinook collected = 1,157
- # composite wholes body samples = 152
  - chemistry, stable isotopes, lipids

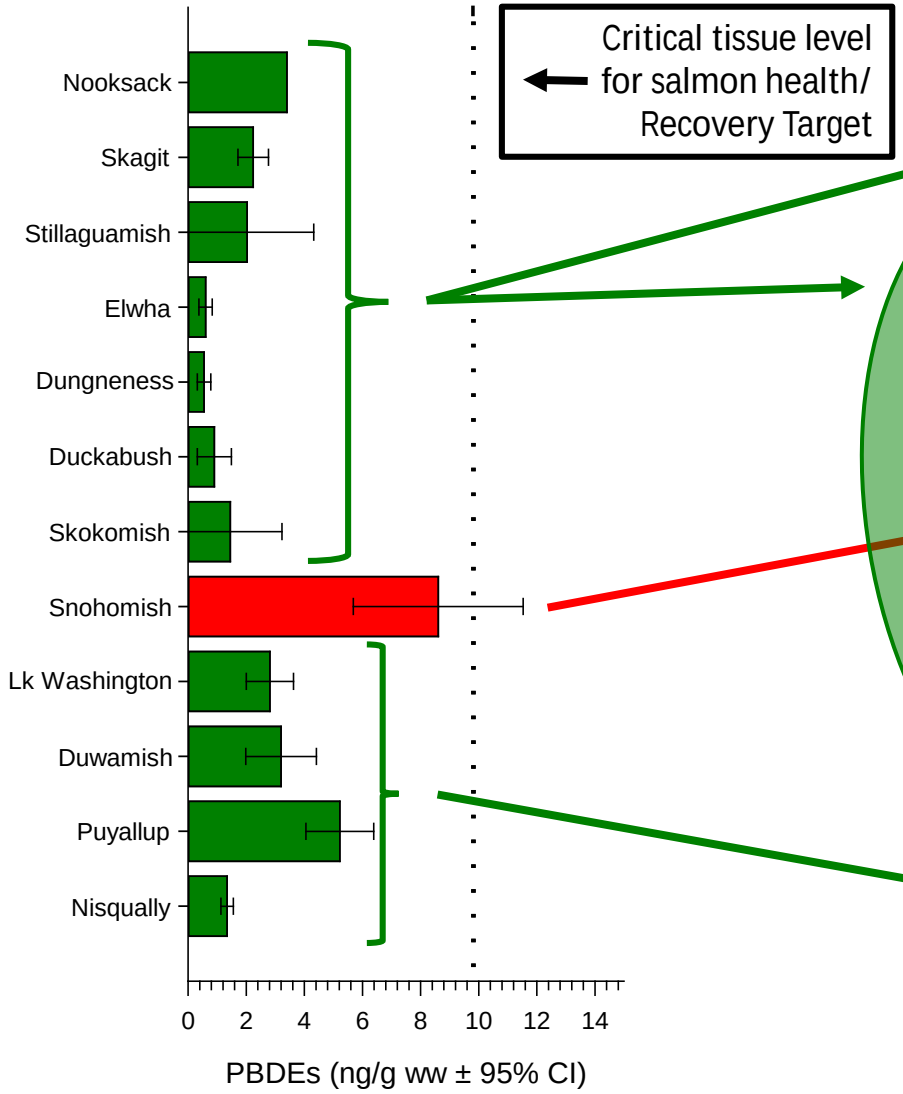
Persistent Organic Pollutants (POPs)

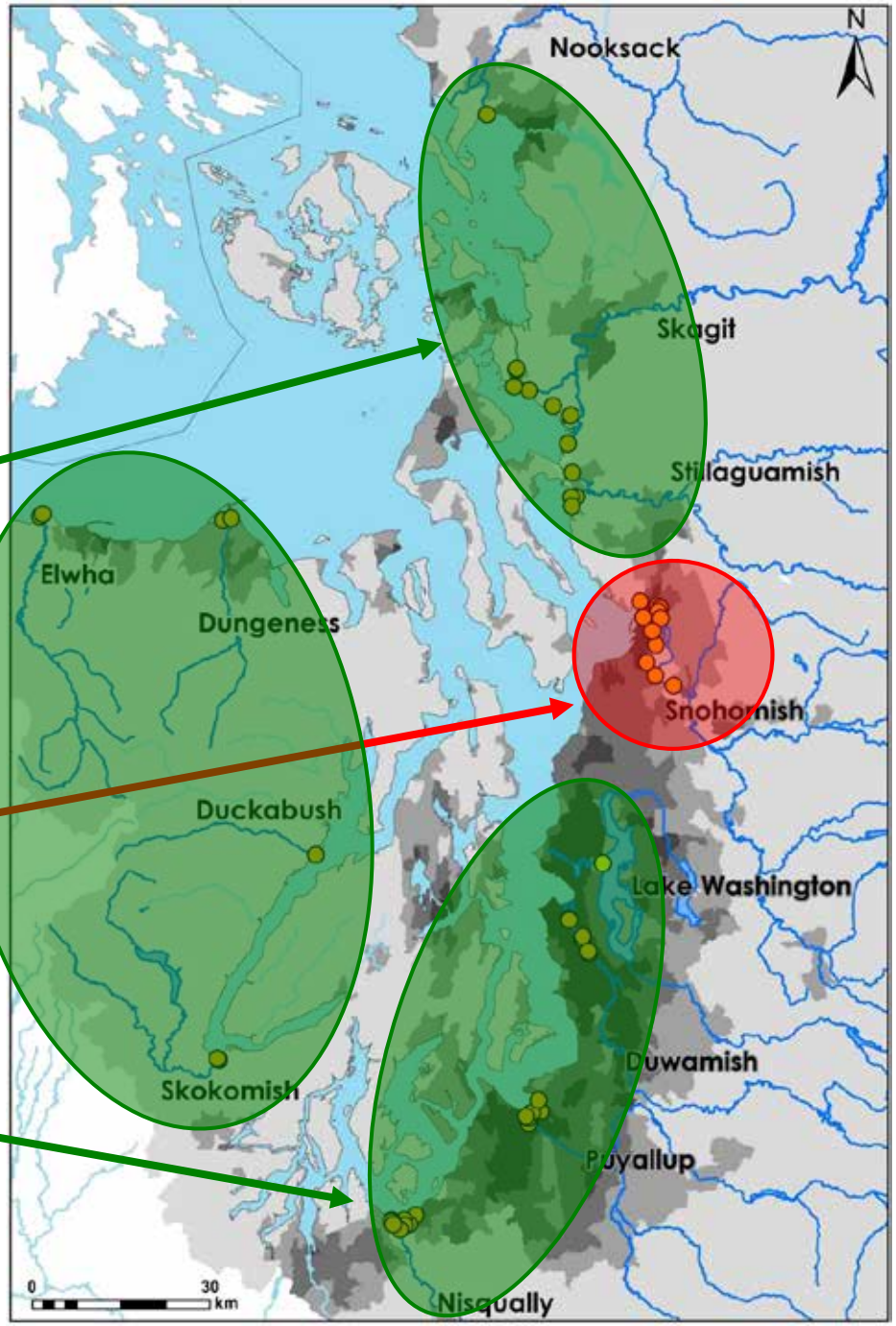
- Polychlorinated biphenyls (PCBs)
- Polybrominated diphenyl ethers (PBDEs)
- Dichlorodiphenyltrichloroethane (DDTs)
- Organochlorine pesticides



PBDEs in Juvenile Chinook Salmon

Based on wet weight concentrations





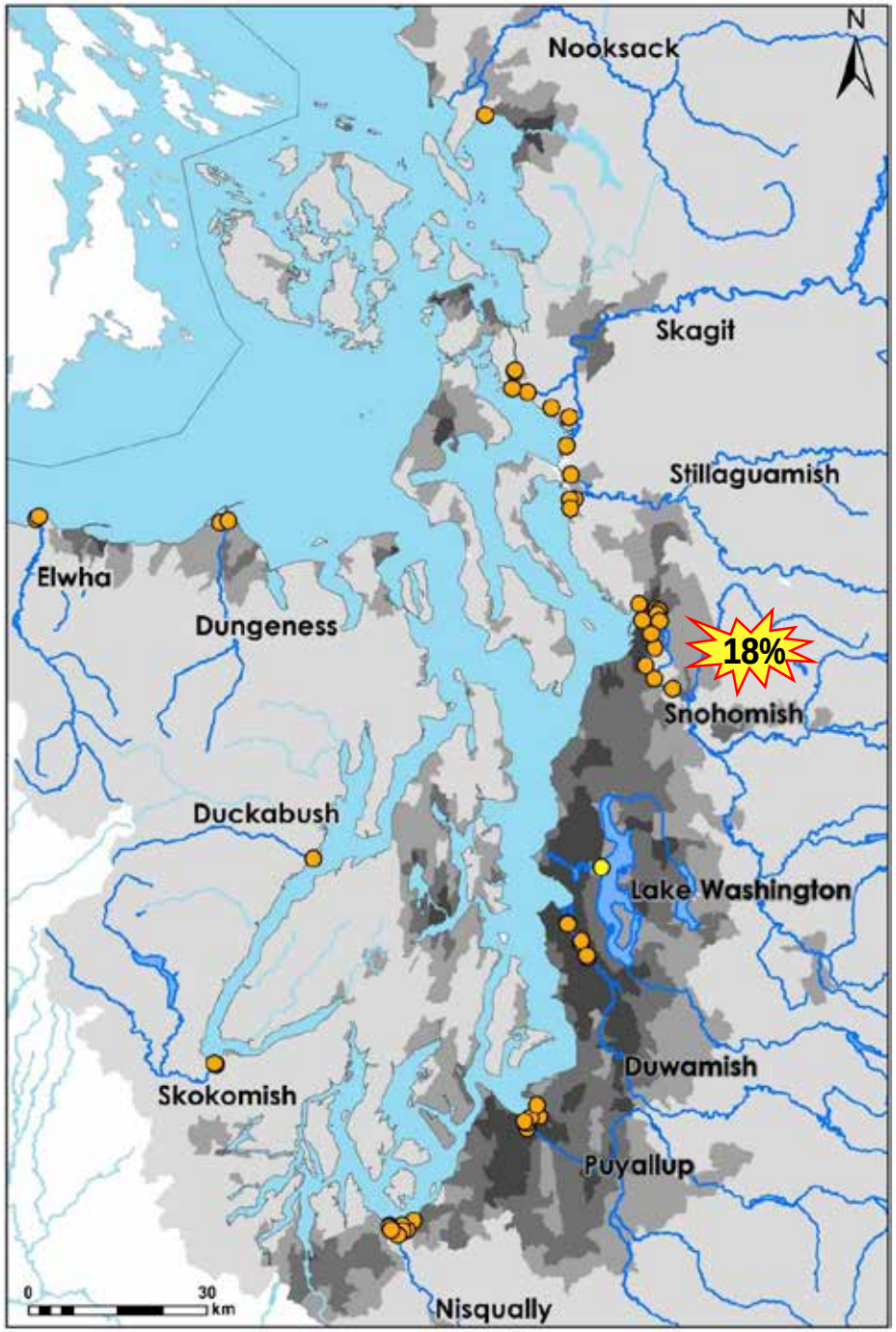
PBDE Adverse Effects in Juvenile Chinook Salmon

Based on wet weight concentrations

PBDE Critical Tissue Level

(Arkoosh et al. 2010, 2013)

- Increased disease susceptibility



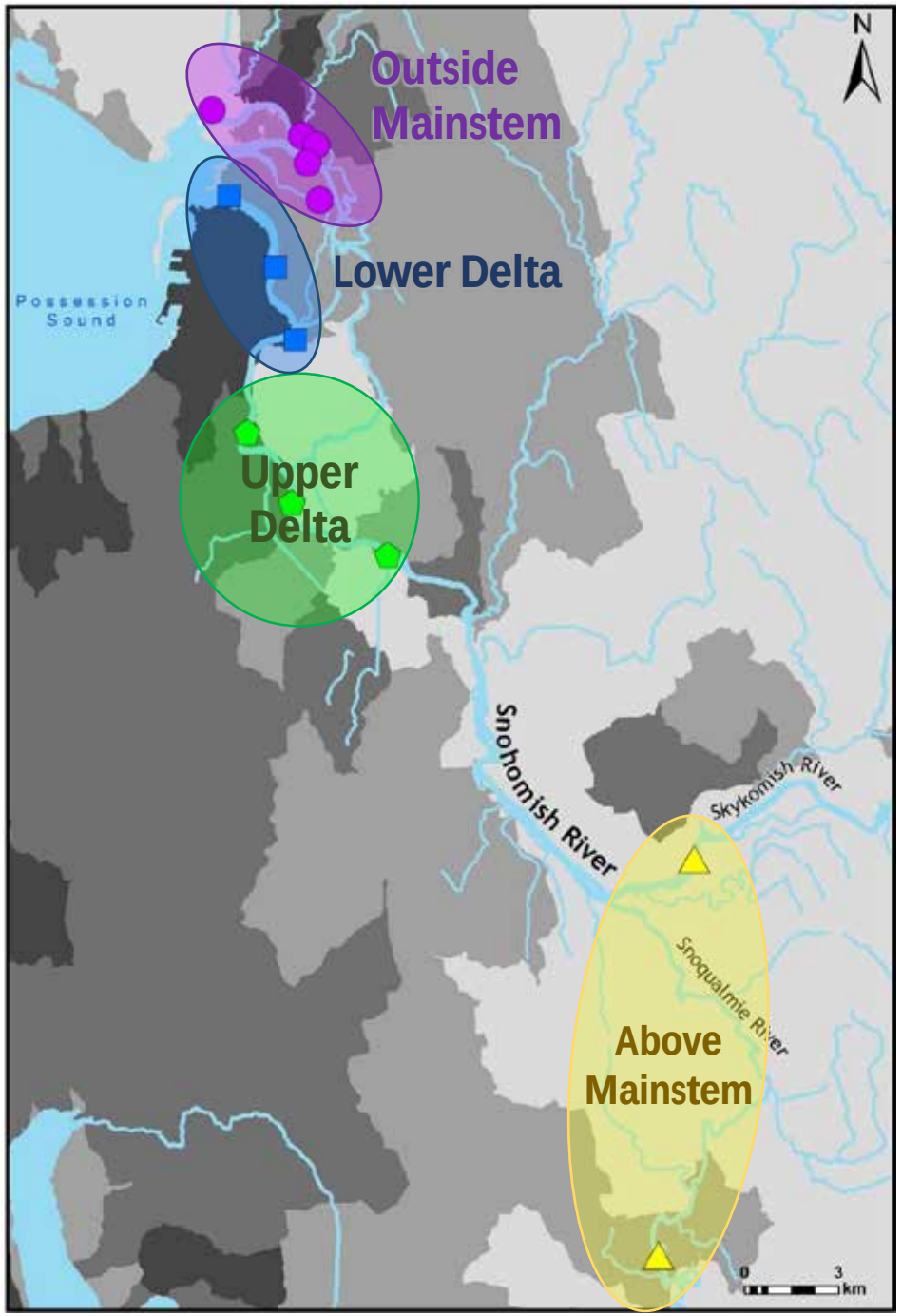
2016 Snohomish Focus Study

Questions:

- Where are juvenile Chinook exposed to and accumulating PBDEs?
- What is the "source" of PBDE inputs?

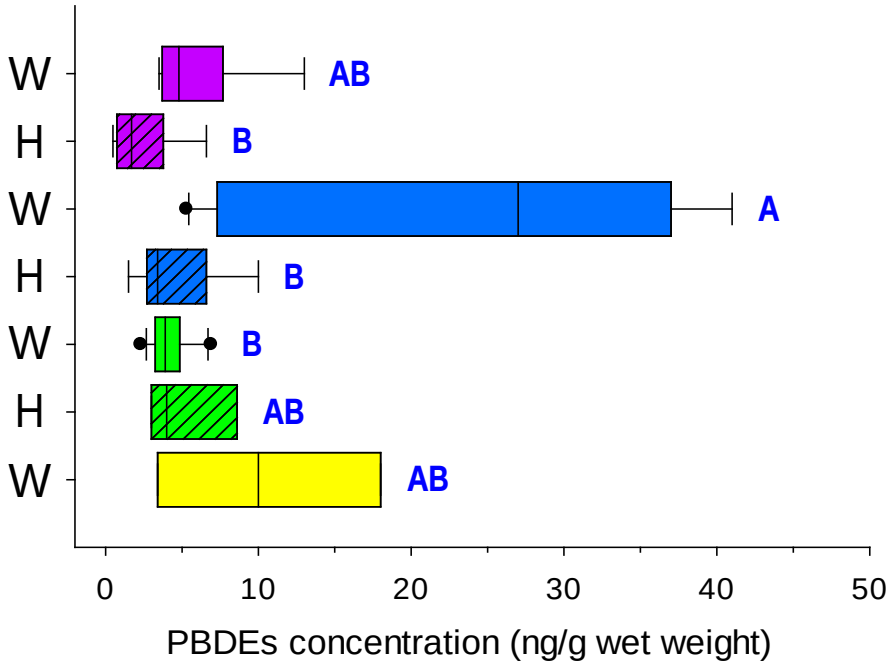
Hypothesis 1:
Salmon are exposed to higher levels of PBDEs in the Mainstem – Lower Delta.

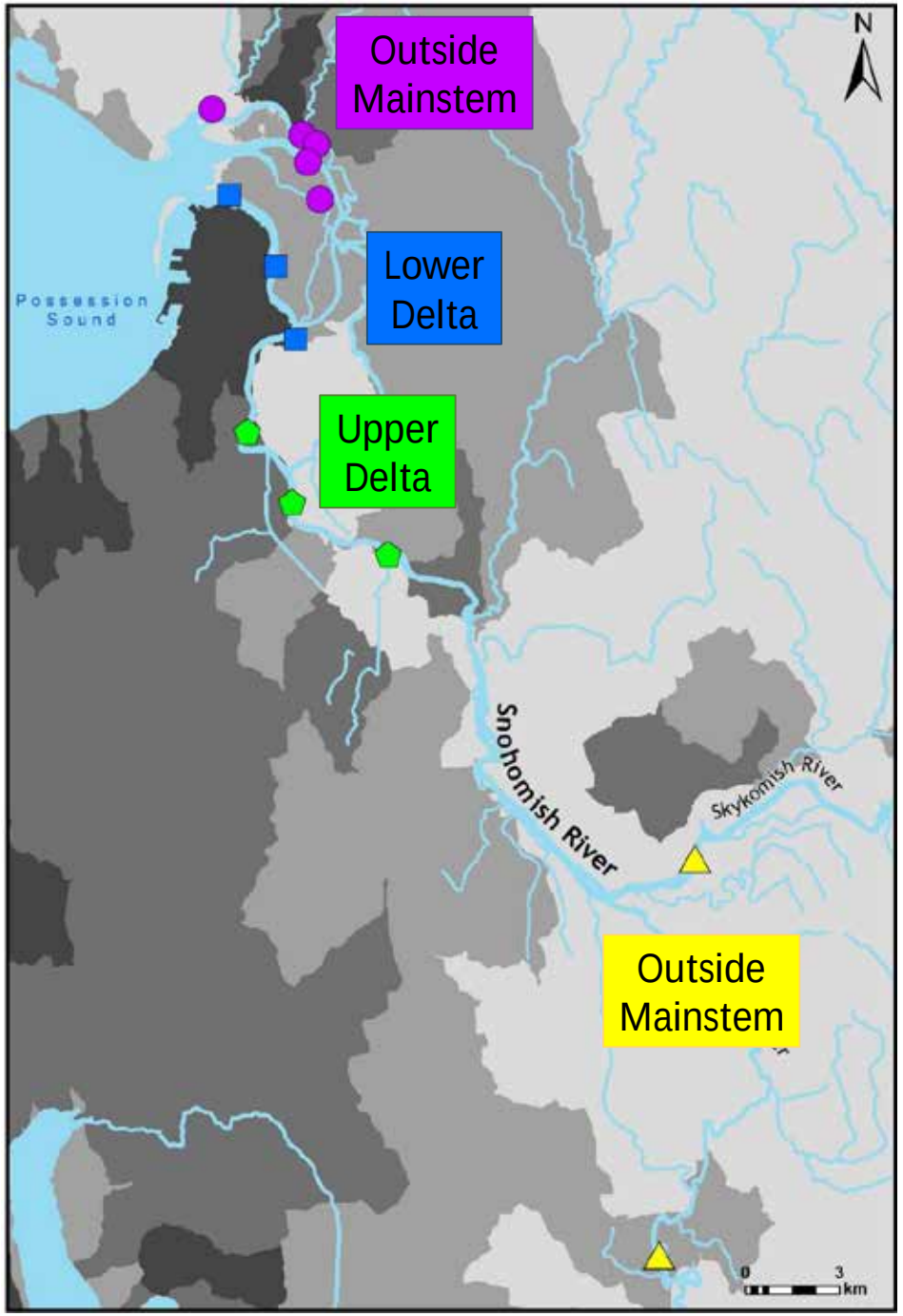
Hypothesis 2:
WWTP/CSO outfalls in the Mainstem – Lower Delta are the major input of PBDEs



PBDE Concentrations by Region

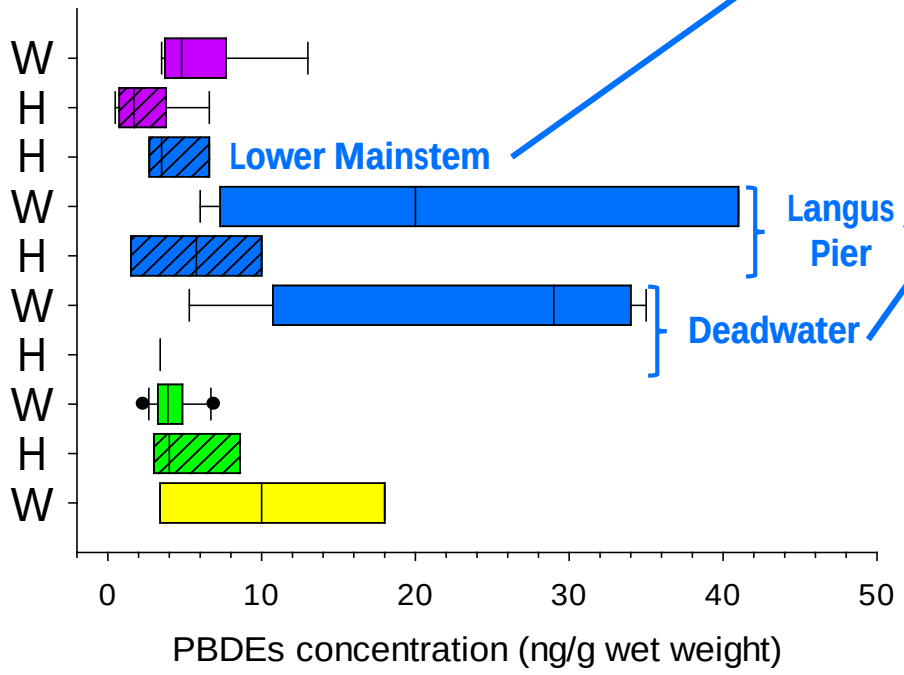
PBDE concentration is significantly elevated in wild Chinook from Mainstem – Lower Delta

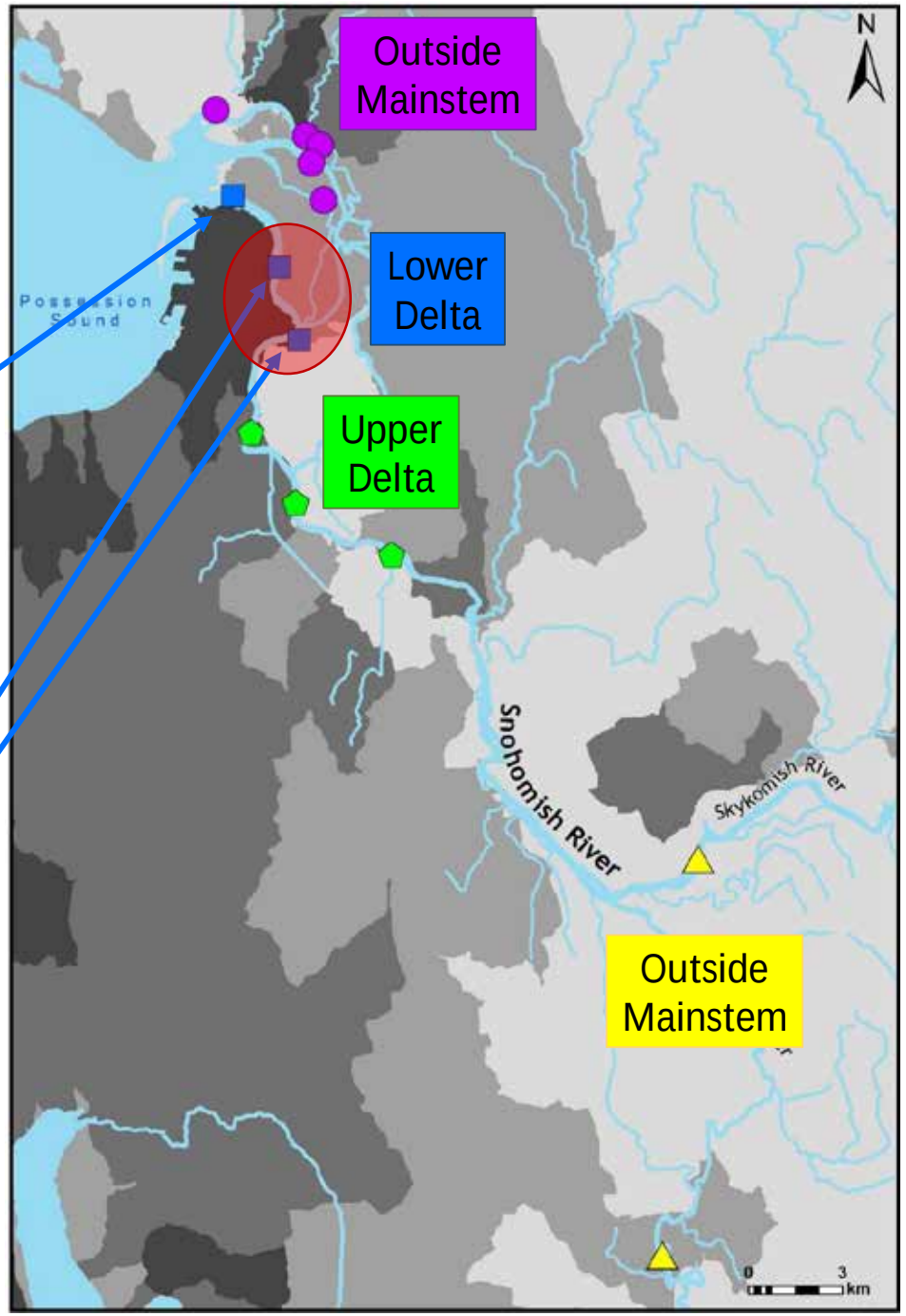




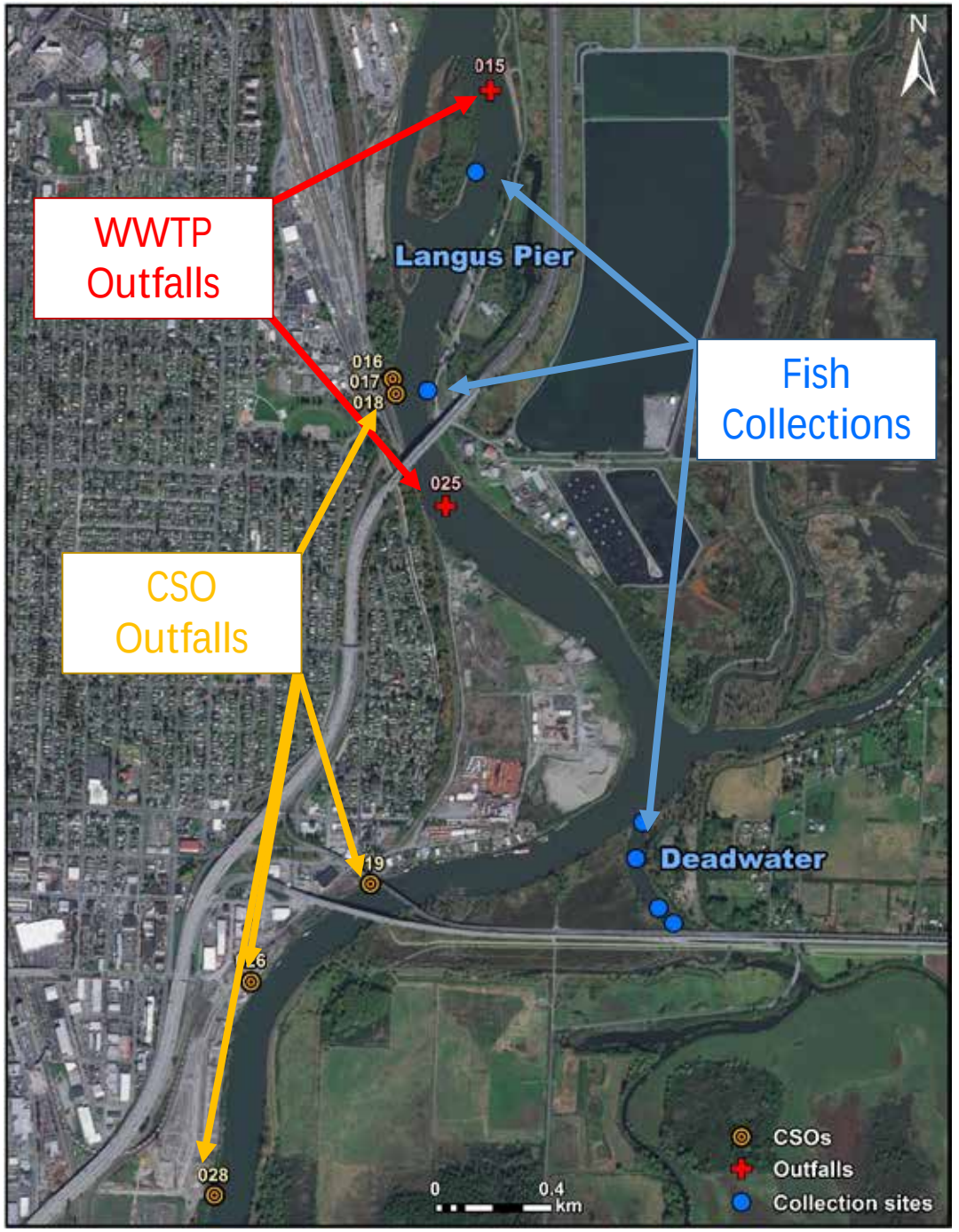
PBDE Concentrations by Region

PBDE concentrations are elevated in wild Chinook from Langus Pier and Deadwater sites



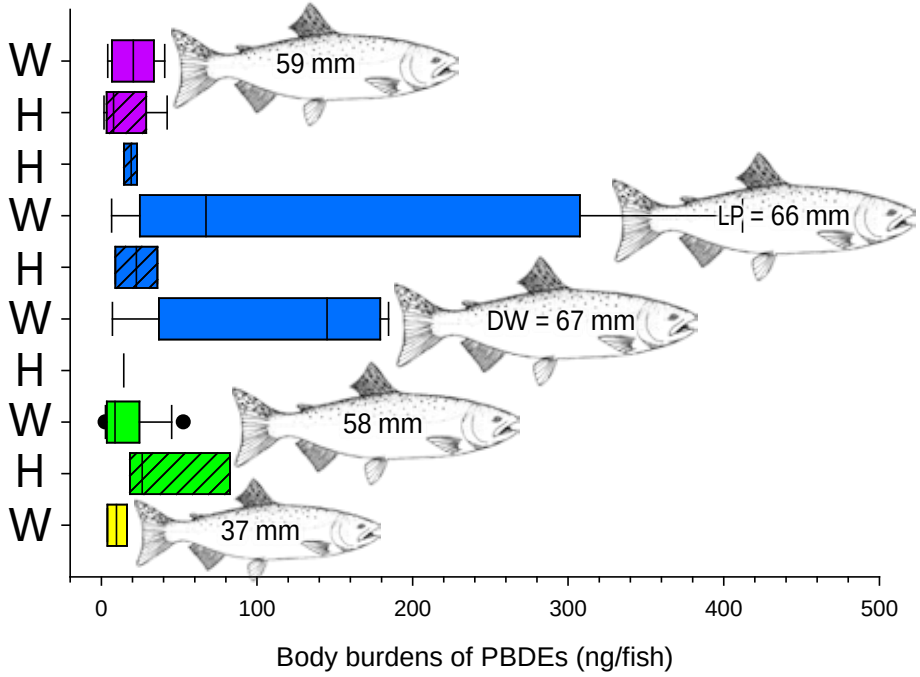


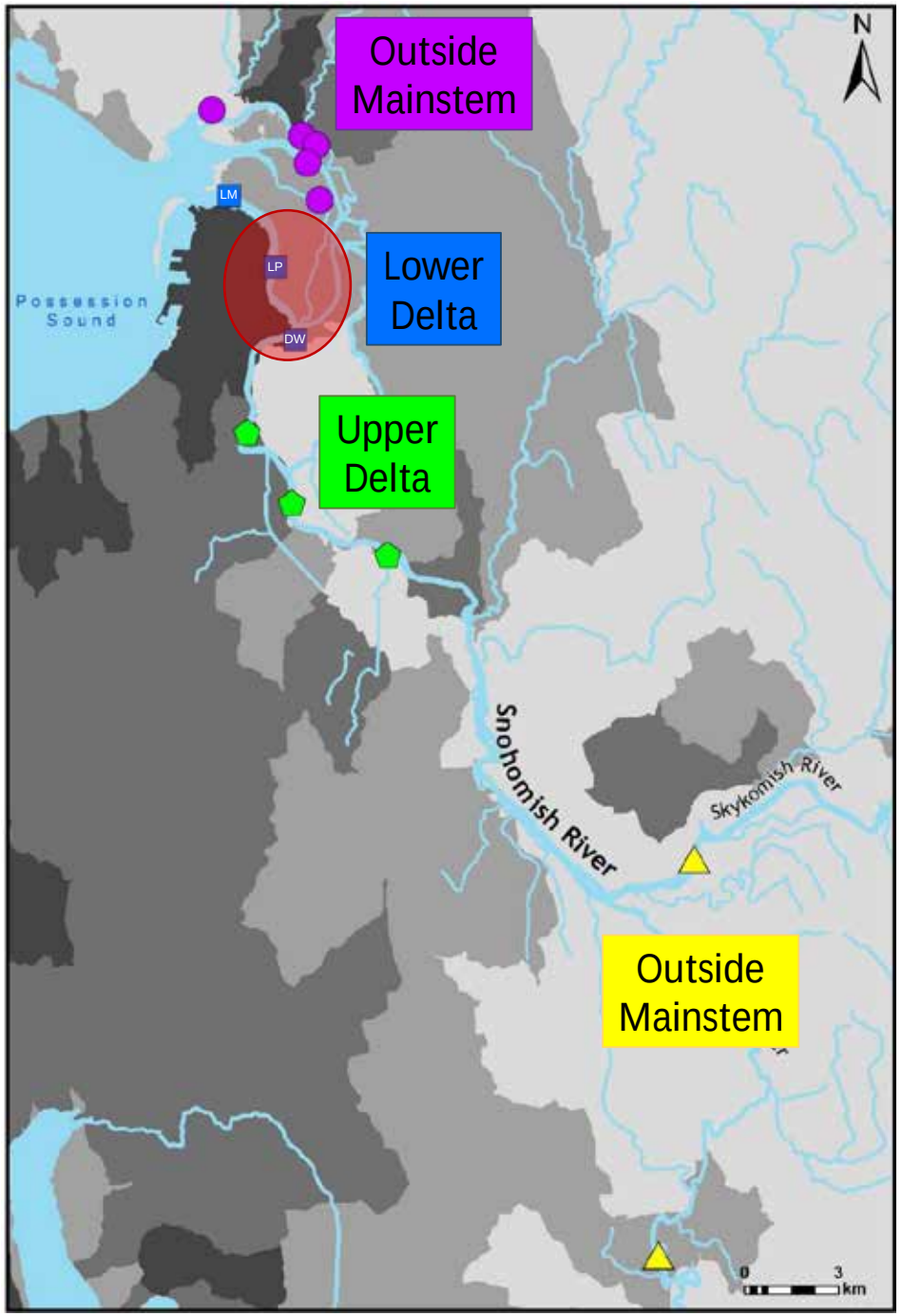
Location of Sampling Sites and Outfalls



PBDE Body Burdens

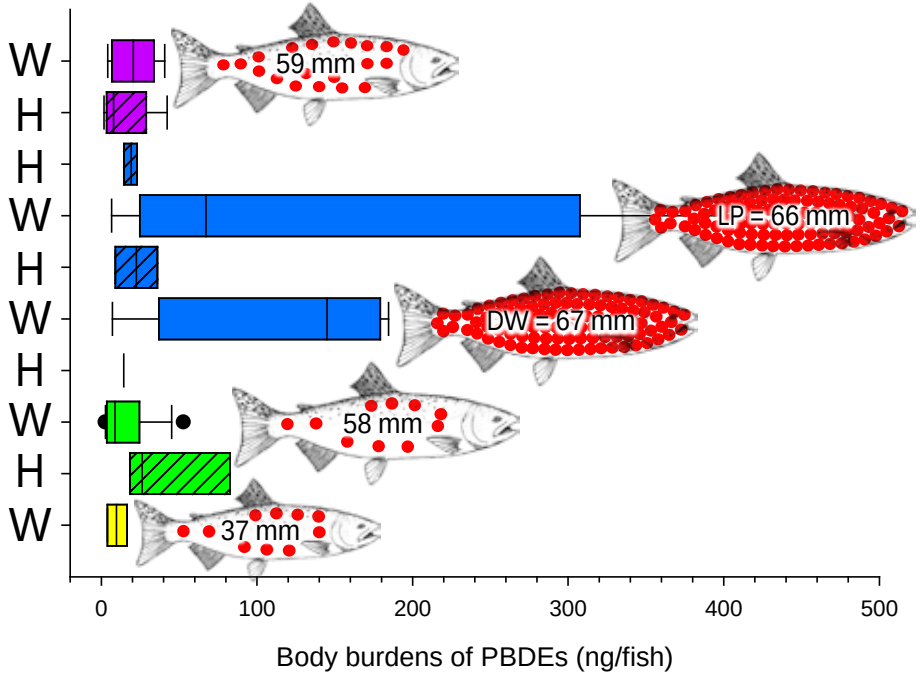
PBDE body burdens increase dramatically in wild Chinook from Langus Pier and Deadwater sites

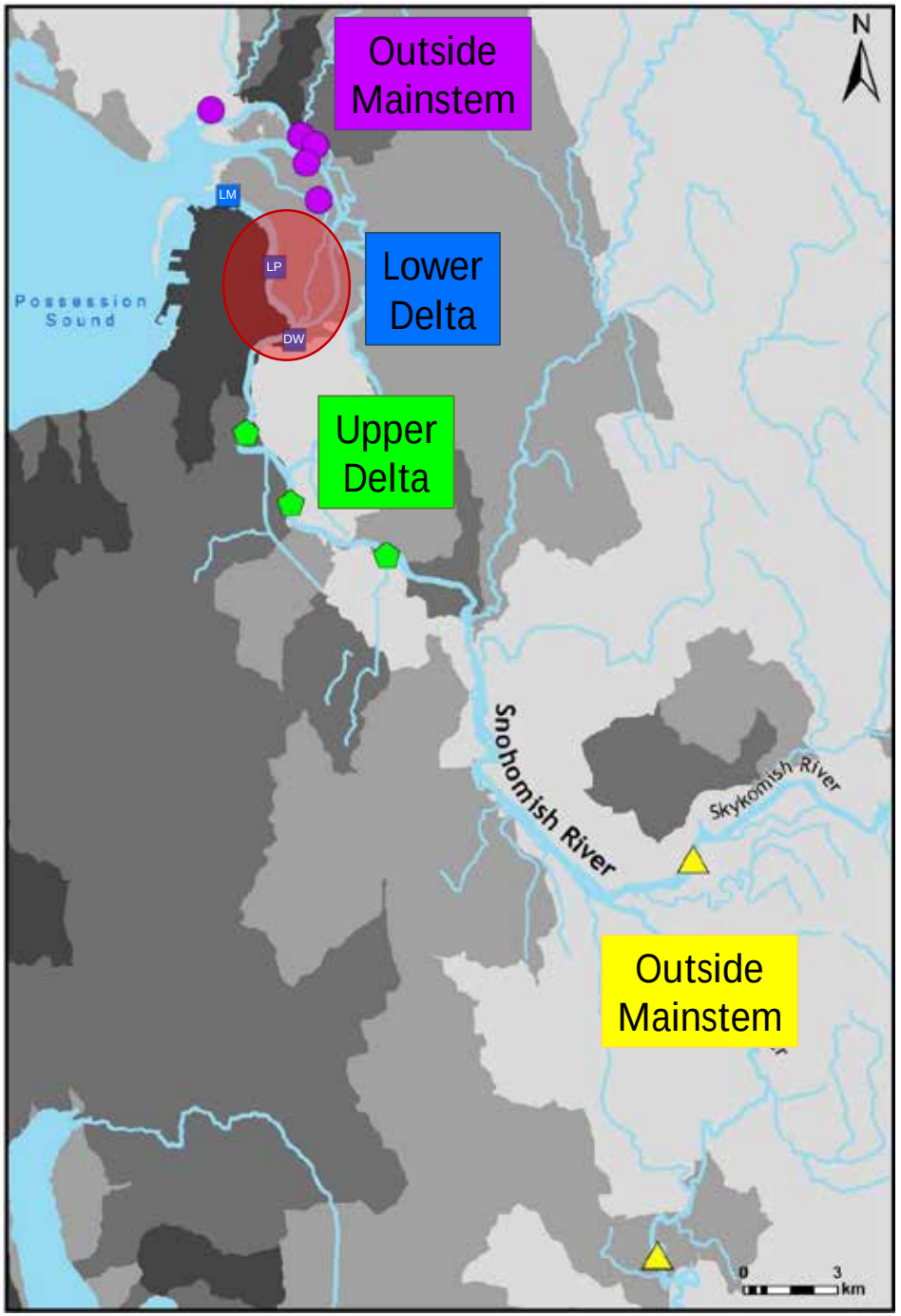




PBDE Body Burdens

Major pathway of PBDEs to Snohomish wild Chinook is in the Mainstem – Lower Delta





PBDEs in Juvenile Chinook Salmon

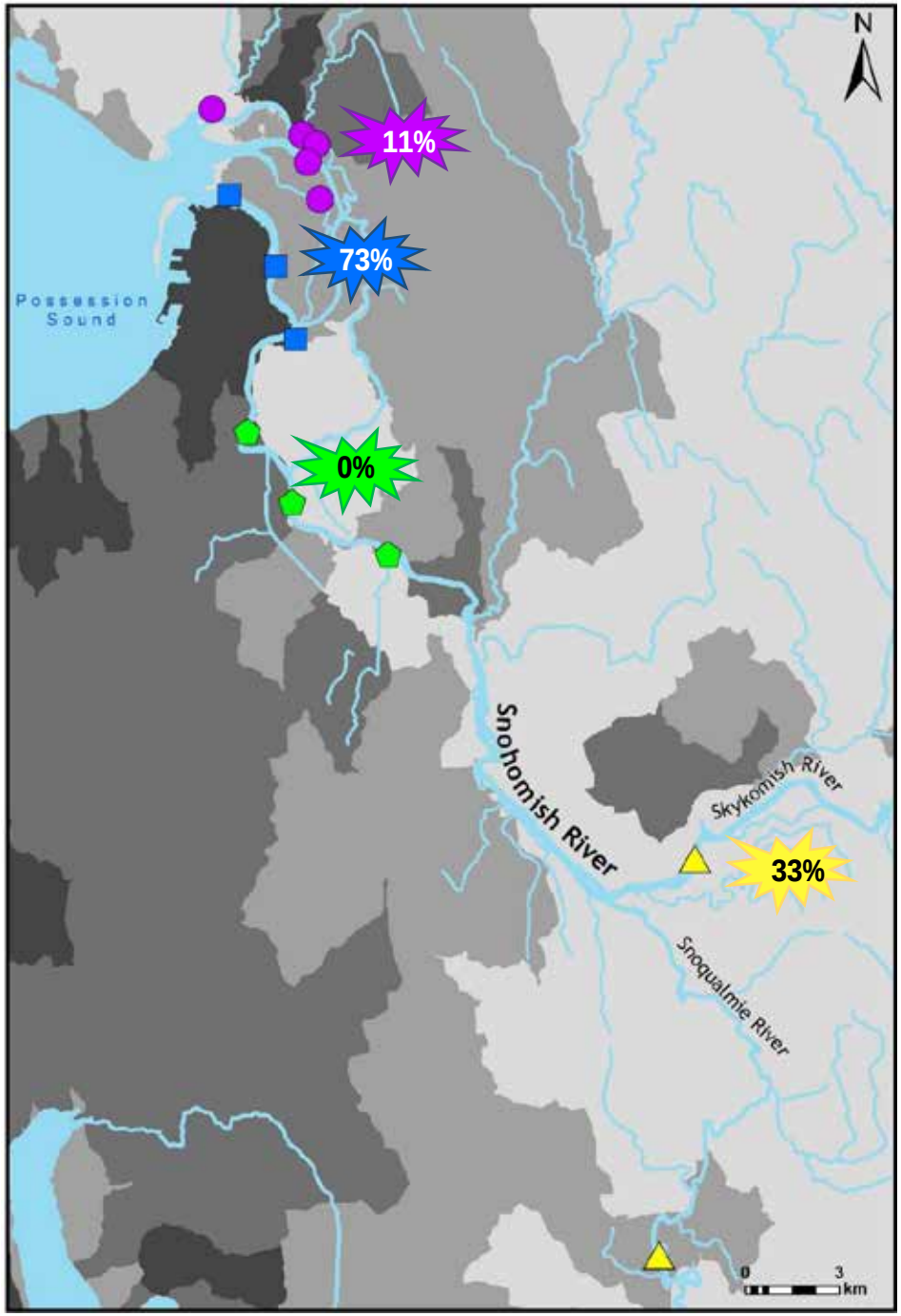
Based on wet weight concentrations

Predicted PBDE adverse effects

(Arkoosh et al. 2010, 2013)

- Increased disease susceptibility

Only WILD fish exceeded the threshold



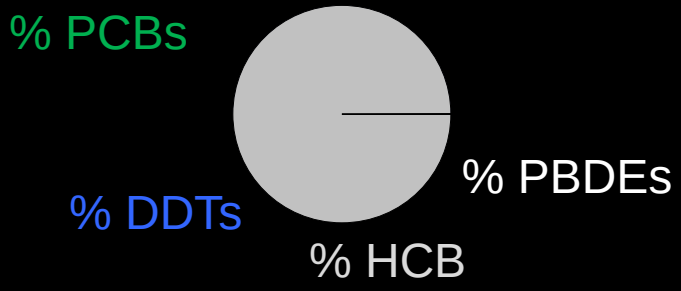
Source Identification
Using Contaminant Fingerprints

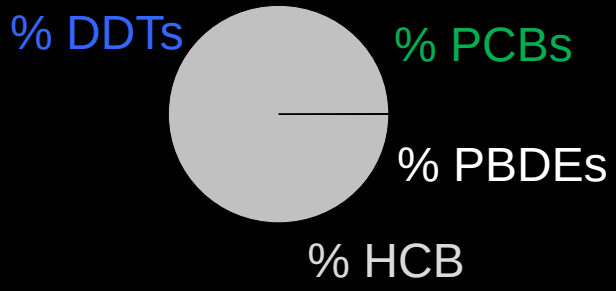
Aquatic environments have distinct patterns of persistent organic pollutants (POPs) based on inputs & environmental attributes

PCBs

DDTs

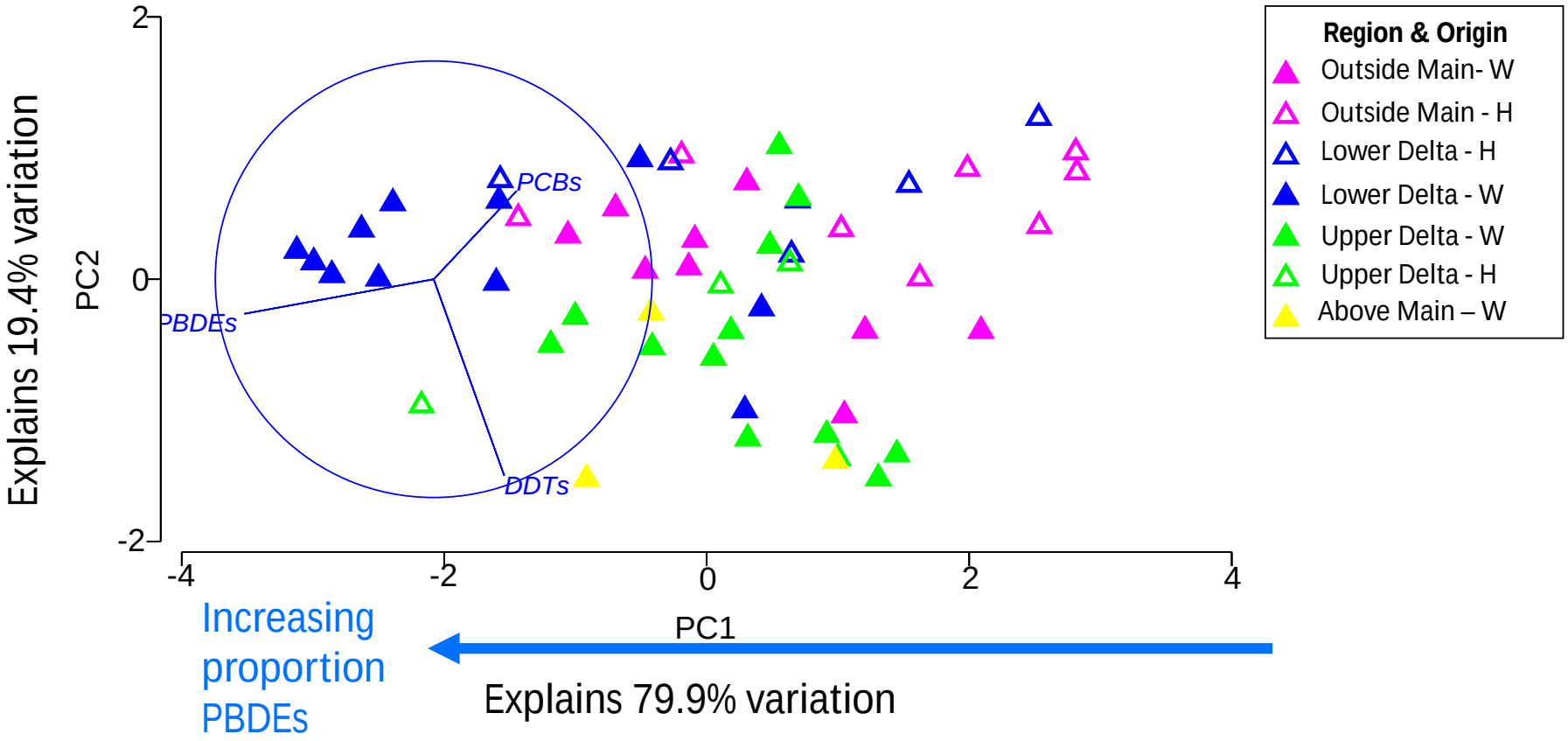
Biota foraging in regions with distinct POPs patterns accumulate specific POPs in proportion to their availability





POP Fingerprints in Juvenile Chinook salmon

Higher accumulation of PBDEs compared to PCBs and DDTs in wild fish in the lower mainstem suggests a wastewater input ("source").



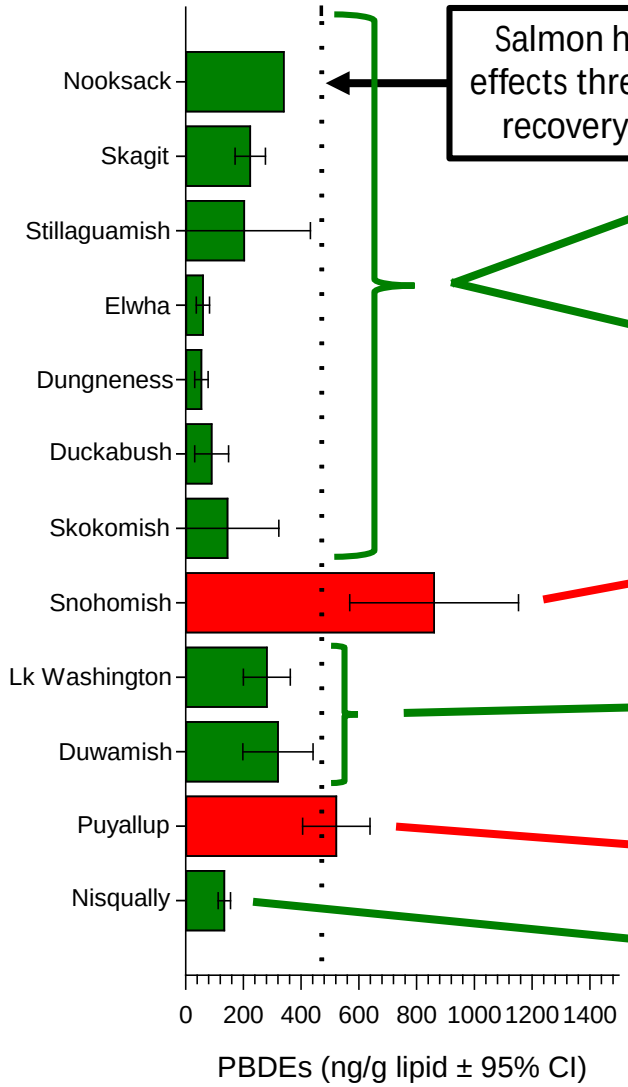
Conclusions

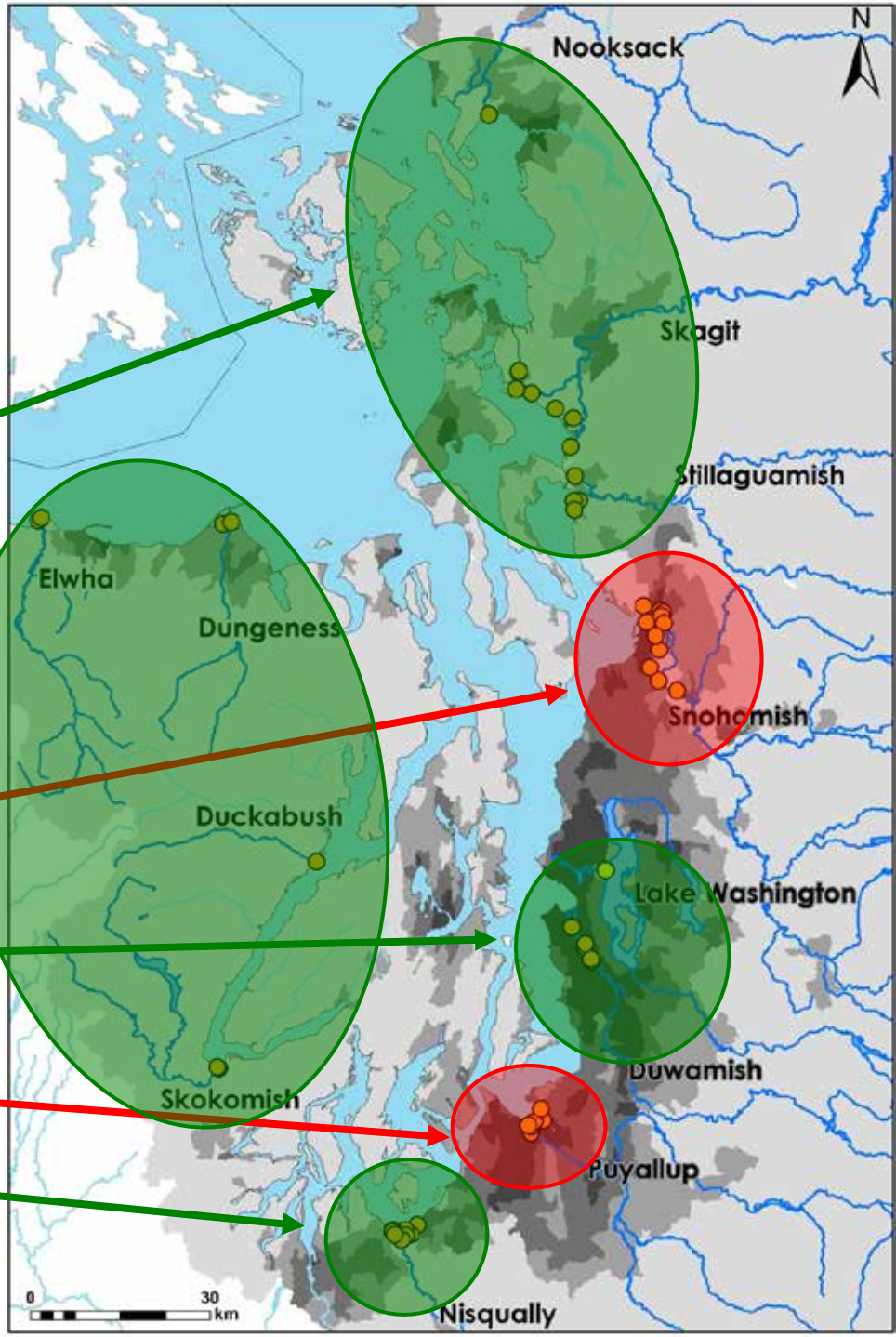
- Wild origin Chinook salmon are exposed to higher levels of PBDEs in the Mainstem - Lower Delta
  - Wild Chinook have elevated PBDE concentrations & body burdens
  - Wild Chinook reside in delta longer than hatchery origin Chinook

- Wastewater in the Mainstem – Lower Delta are possible inputs (i.e. pathways) of PBDEs to salmon
  - Distinct contaminant fingerprints were observed in wild Chinook from the Mainstem – Lower Delta
  - Fingerprints with higher proportions of PBDEs are consistent with input from wastewater
  - Likely wastewater inputs include WWTP effluent & CSO outfalls

PBDEs in Juvenile Chinook Salmon

Based on lipid normalized concentrations





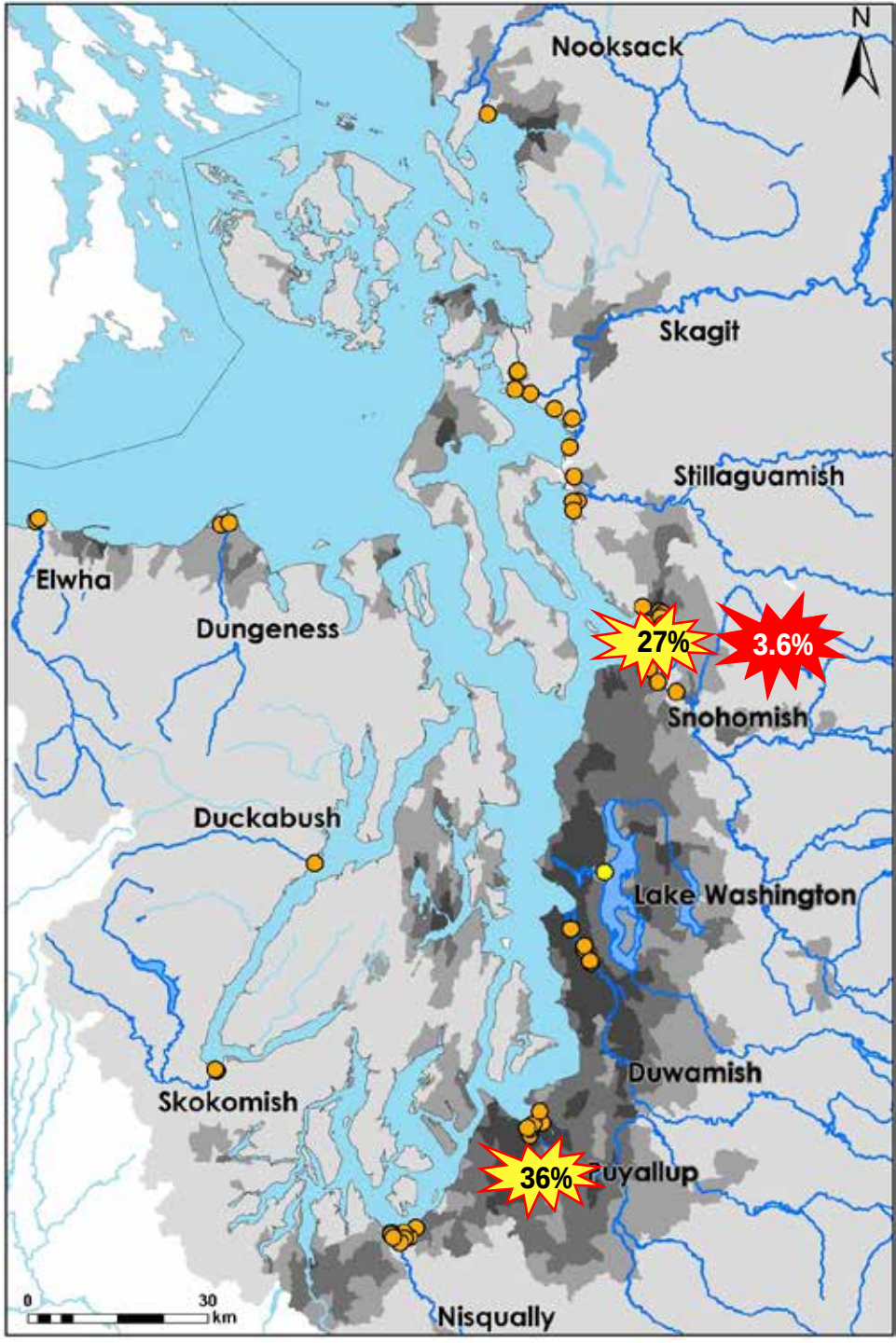
PBDEs in Juvenile Chinook Salmon

Based on lipid normalized concentrations

Predicted PBDE Adverse effects

(Arkoosh et al. 2010, 2013)

- Increased disease susceptibility
- Altered thyroid function



PBDEs in Juvenile Chinook Salmon

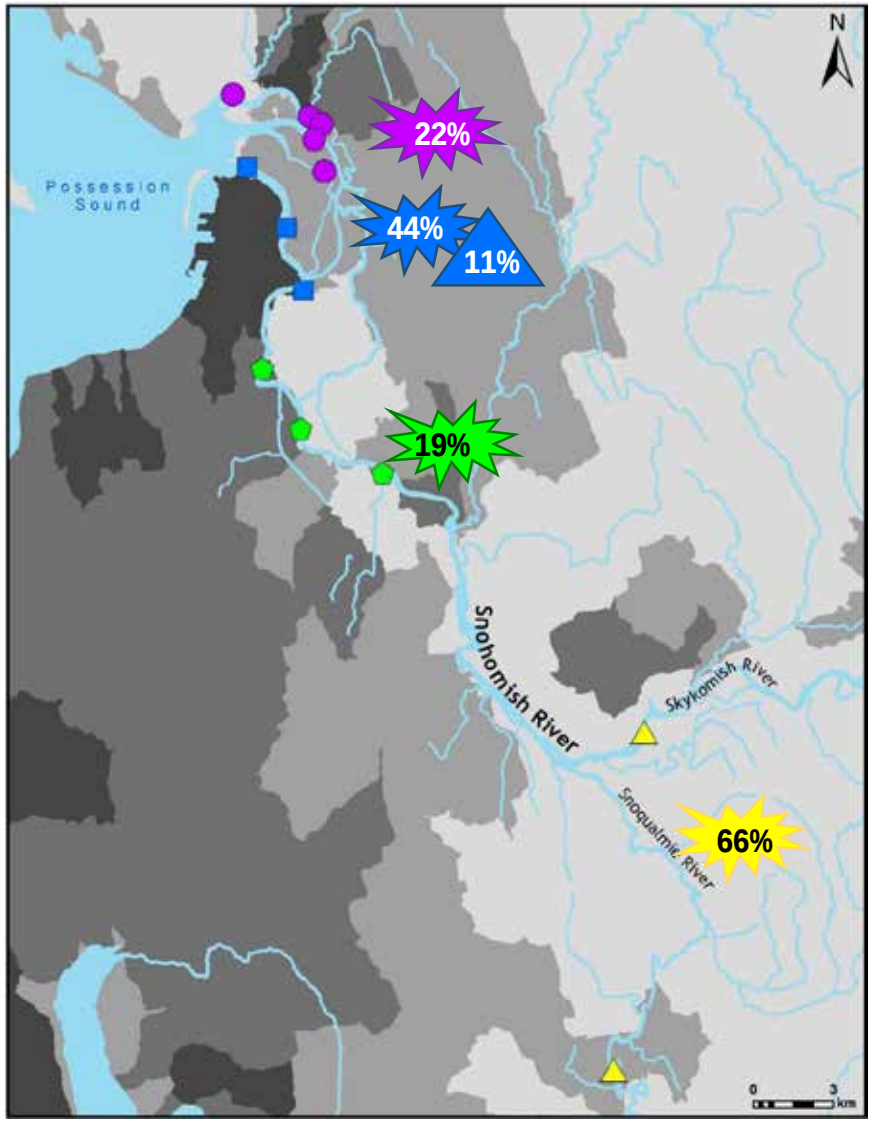
(hatchery and wild origin fish)

Lipid normalized

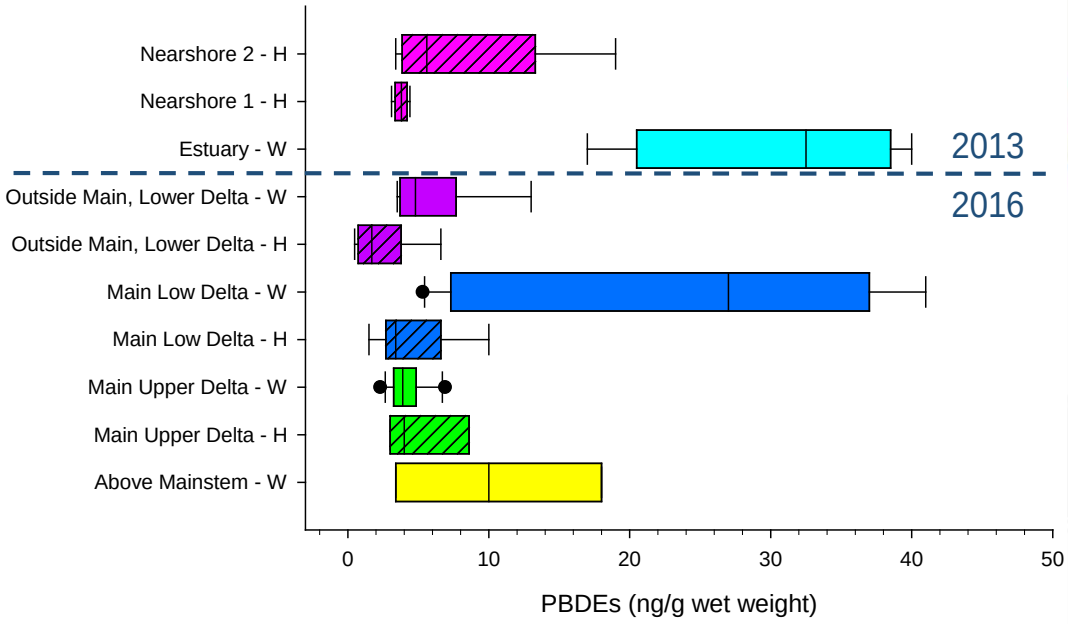
Predicted PBDE Adverse effects

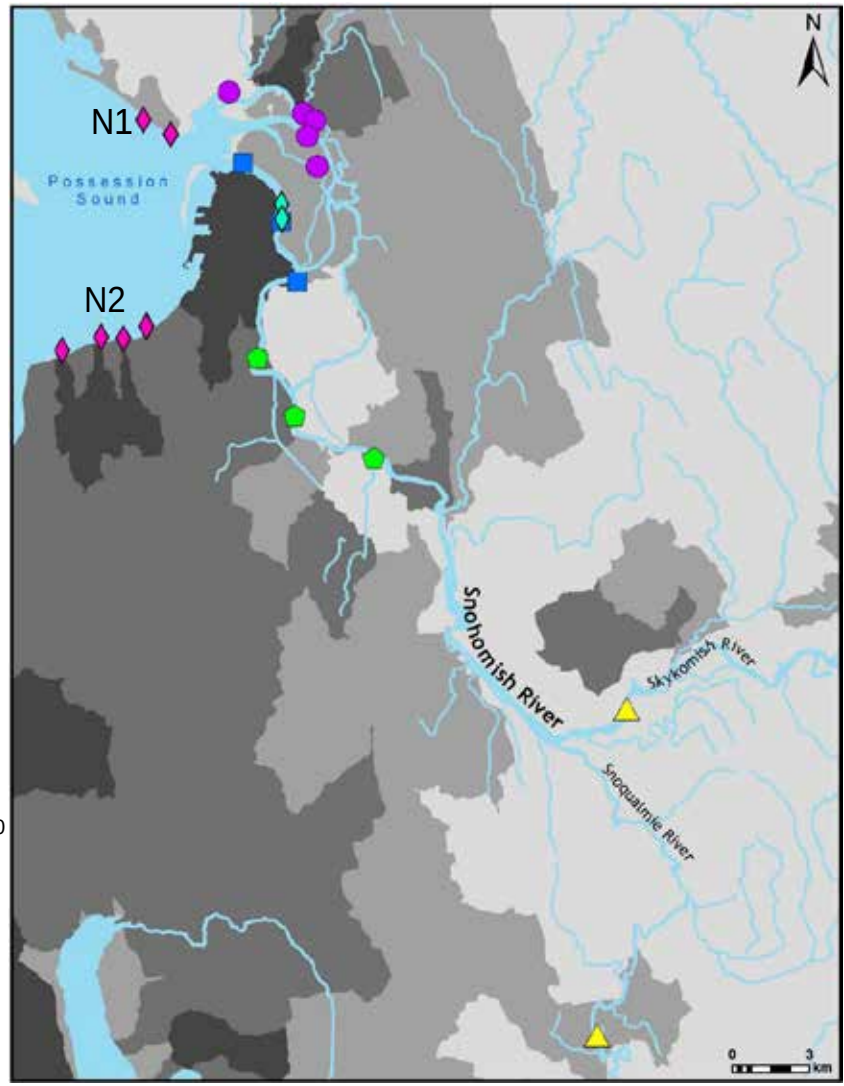
(Arkoosh et al. 2010, 2013)

- Increased disease susceptibility
- Altered thyroid function

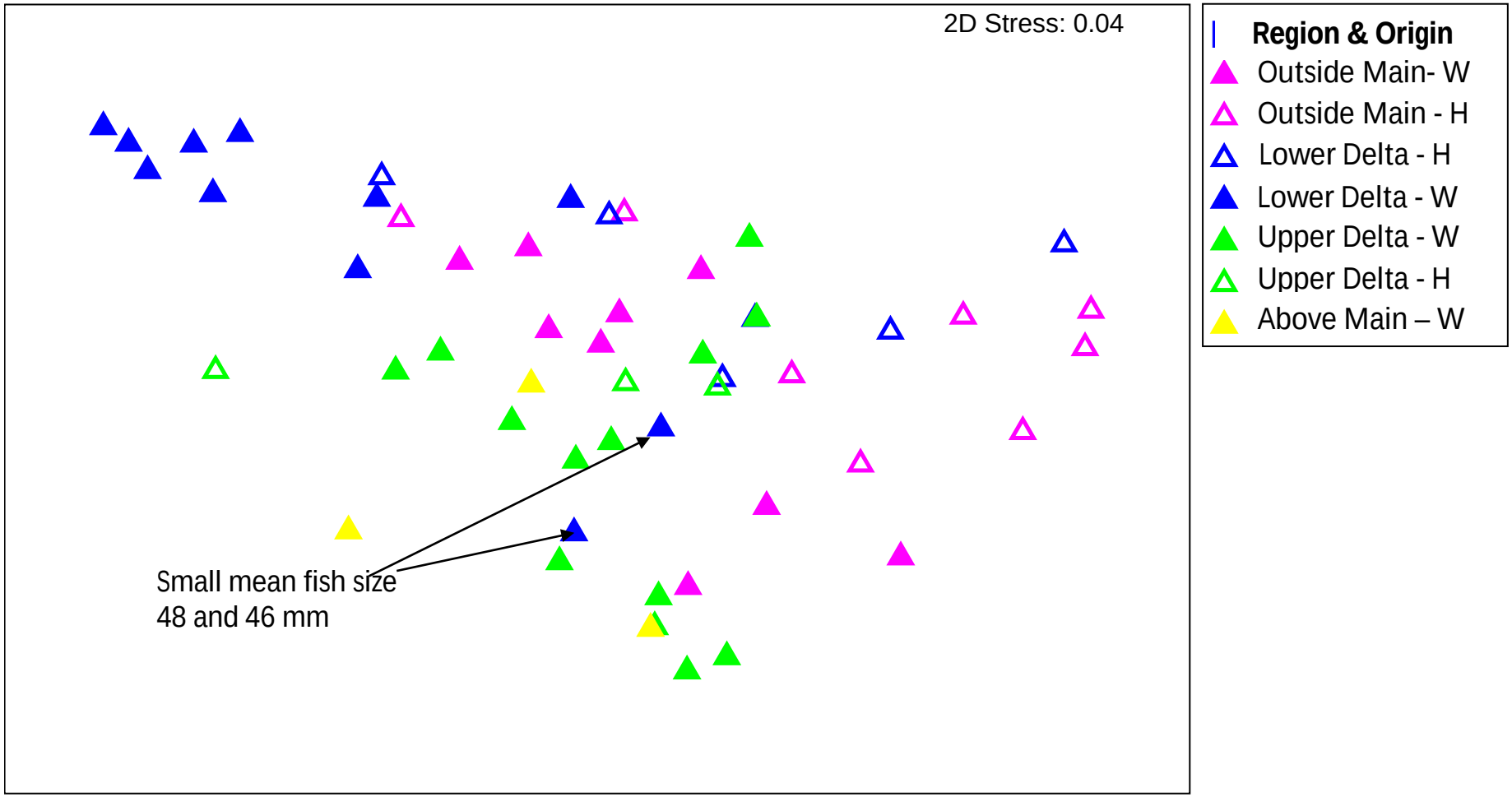


PBDEs – 2013 vs 2016





POP Fingerprints in Juvenile Chinook salmon



Region x Origin ‘Means Plot’
(Based on Results of Anosim Comparisons)