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Salish Sea Ecosystem Conference

2018 Salish Sea Ecosystem Conference  
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## Input of PBDE exposure in juvenile Chinook salmon along their out-migrant pathway through the Snohomish River, WA

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Carey, Andrea J.; West, James E.; Fisk, Robert J.; Langness, Mariko M.; Ylitalo, Gina Maria; and O'Neill, Sandra M., "Input of PBDE exposure in juvenile Chinook salmon along their out-migrant pathway through the Snohomish River, WA" (2018). *Salish Sea Ecosystem Conference*. 355.  
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**Speaker**

Andrea J. Carey, James E. West, Robert J. Fisk, Mariko M. Langness, Gina Maria Ylitalo, and Sandra M. O'Neill

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

Andrea Carey<sup>1</sup>, James West<sup>1</sup>, Robert Fisk<sup>1</sup>, Mariko Langness<sup>1</sup>, Gina Ylitalo<sup>2</sup> and Sandra O'Neill<sup>1</sup>



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# Acknowledgments



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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**

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## **NOAA NWFSC**

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## **WA Dept of Ecology**

### **Other**

Jason Toft  
Madilyn Gamble  
Steve Damm

# 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

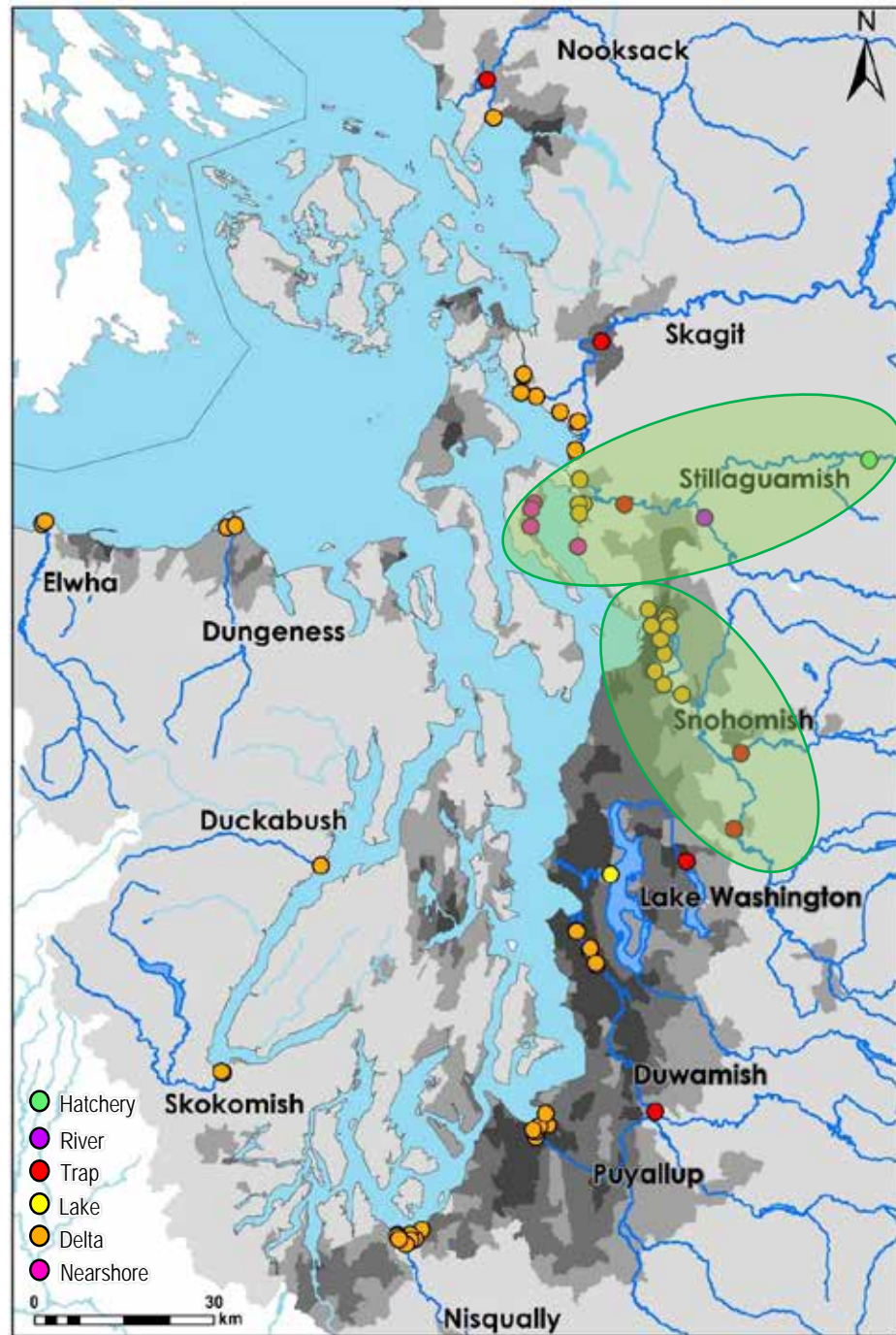
- 11 deltas + Lake Washington

## Focus Studies

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

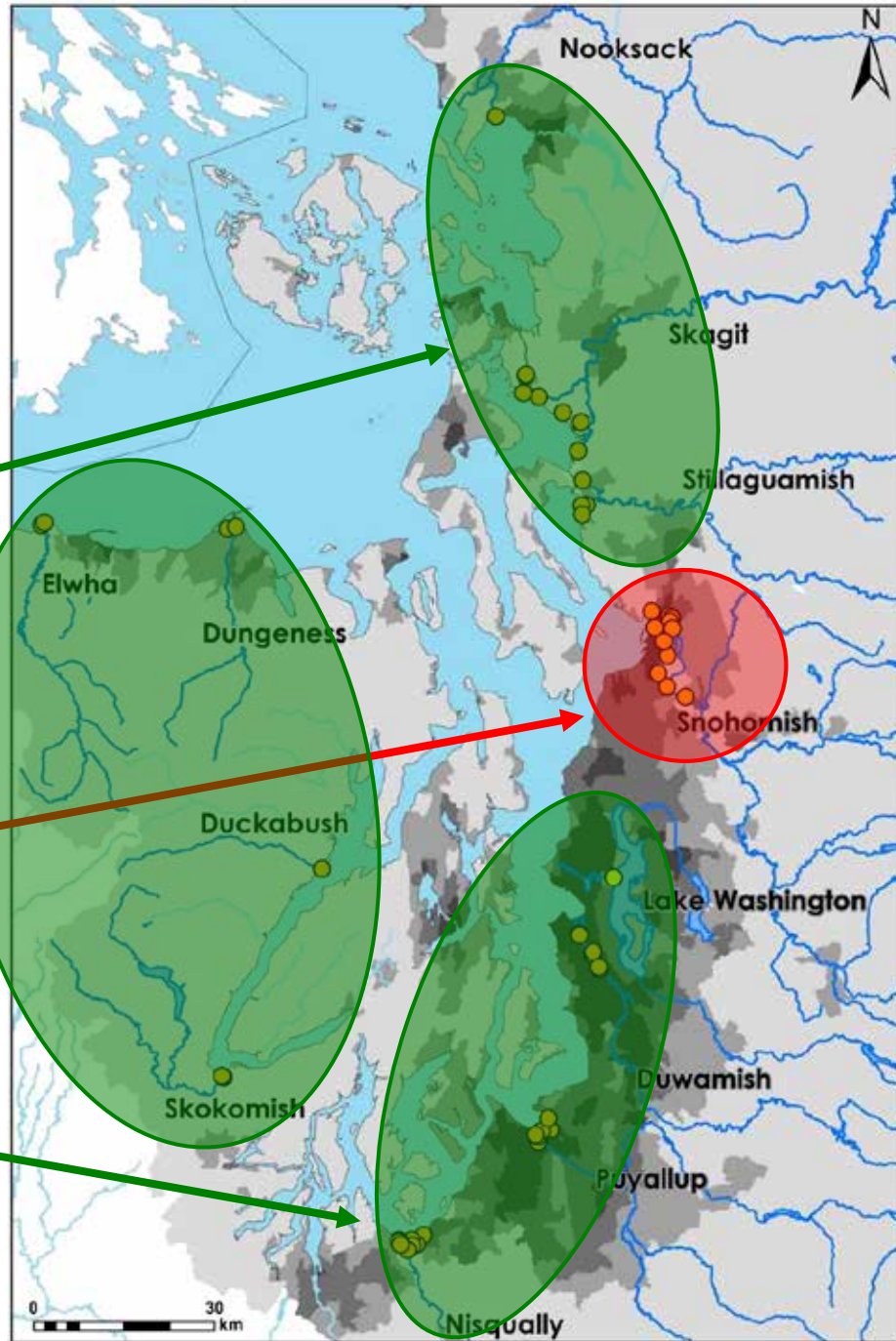
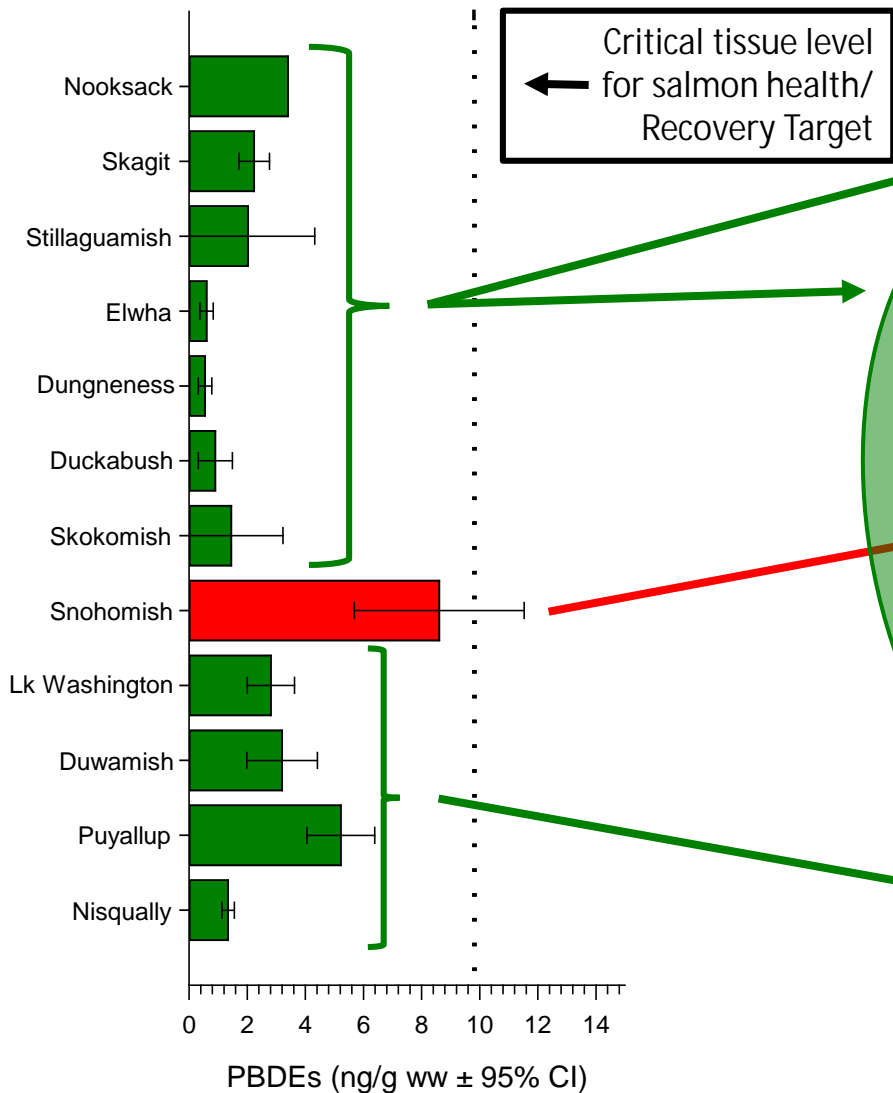
## Persistent Organic Pollutants (POPs)

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



# PBDEs in Juvenile Chinook Salmon

Based on wet weight concentrations



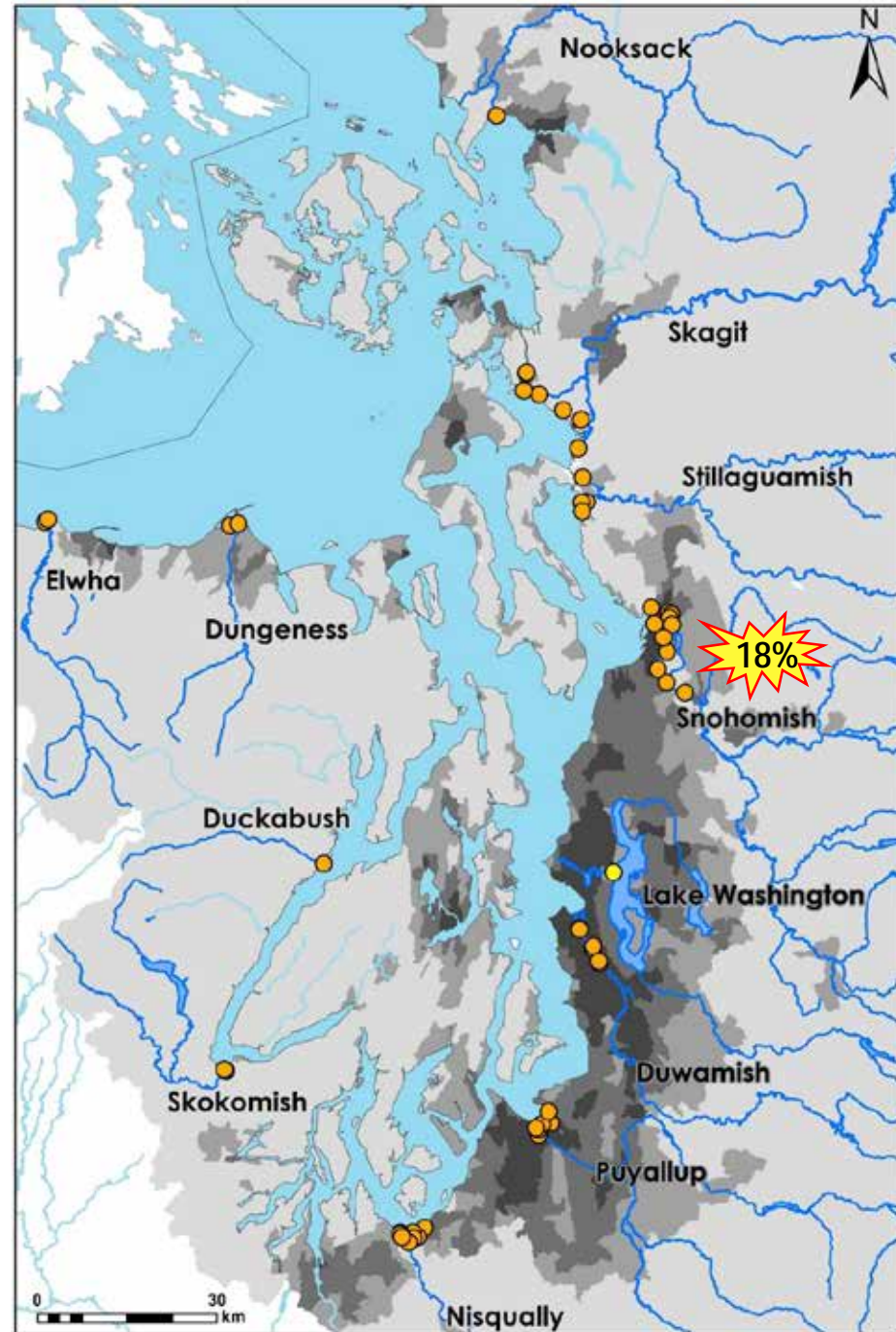
# PBDE Adverse Effects in Juvenile Chinook Salmon

Based on wet weight concentrations

## PBDE Critical Tissue Level

(Arkoosh et al. 2010, 2013)

- Increased disease susceptibility 





# 2016 Snohomish Focus Study

## Questions:

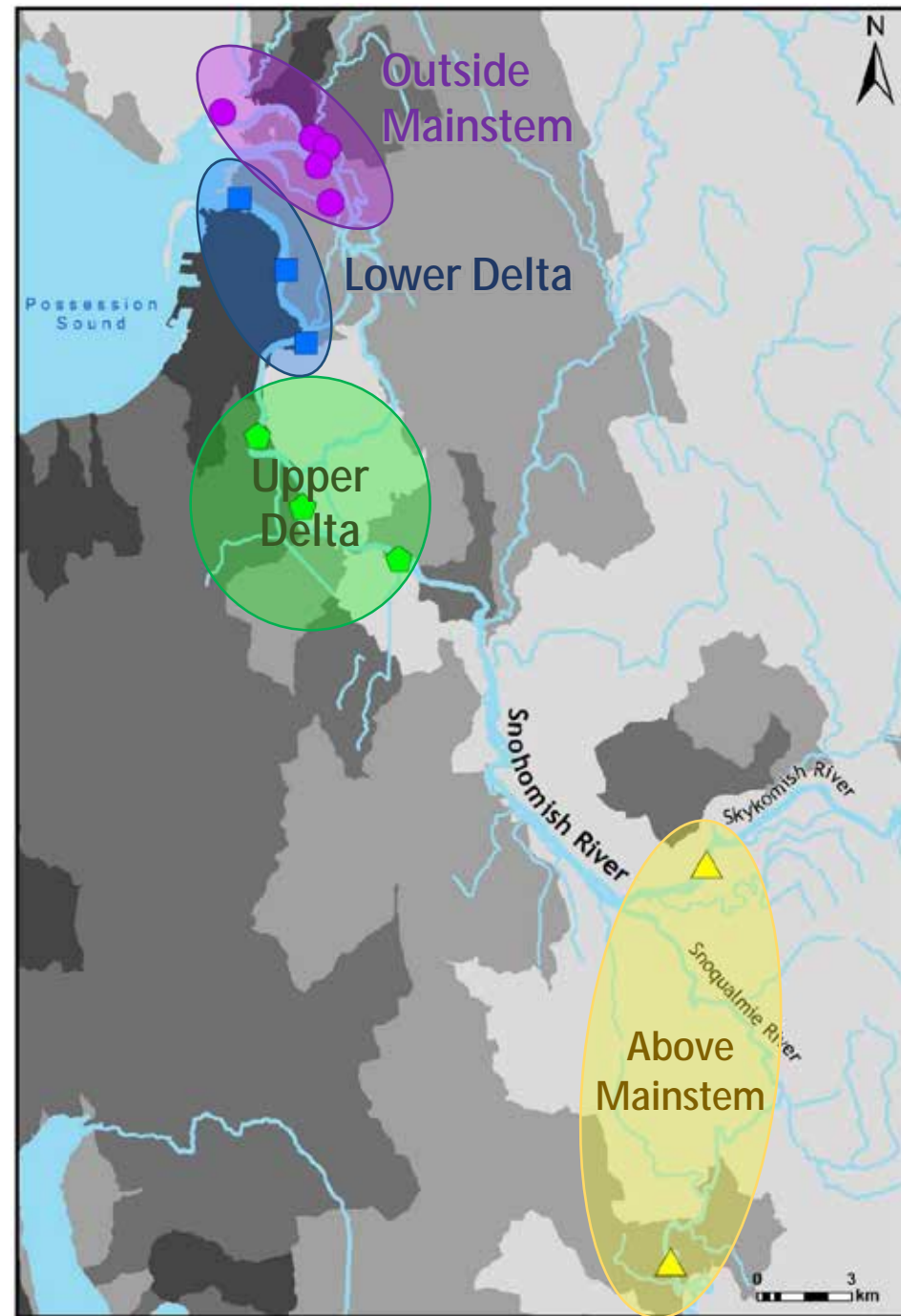
- Where are juvenile Chinook exposed to and accumulating PBDEs?
- What is the “source” of PBDE inputs?

## Hypothesis 1:

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

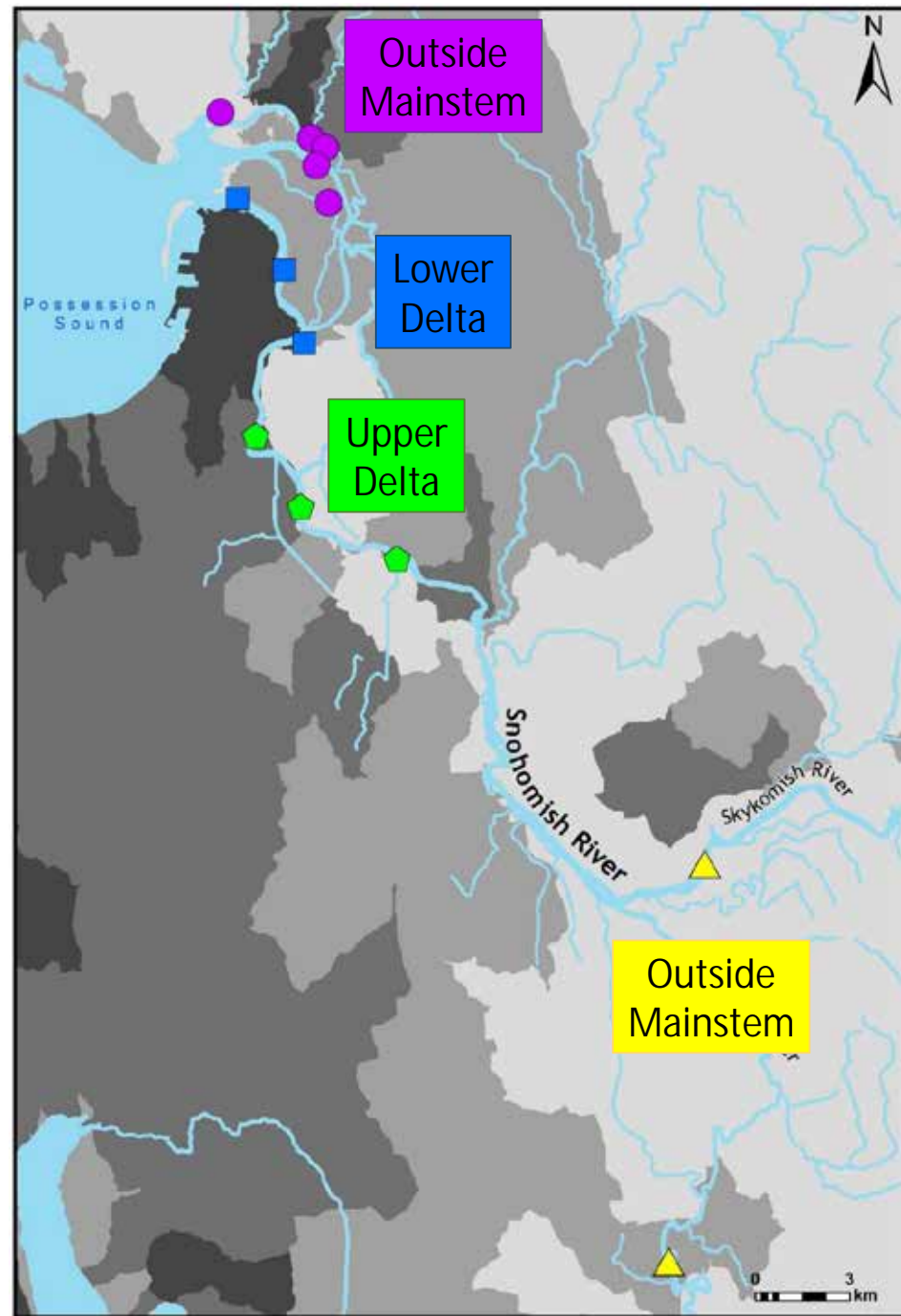
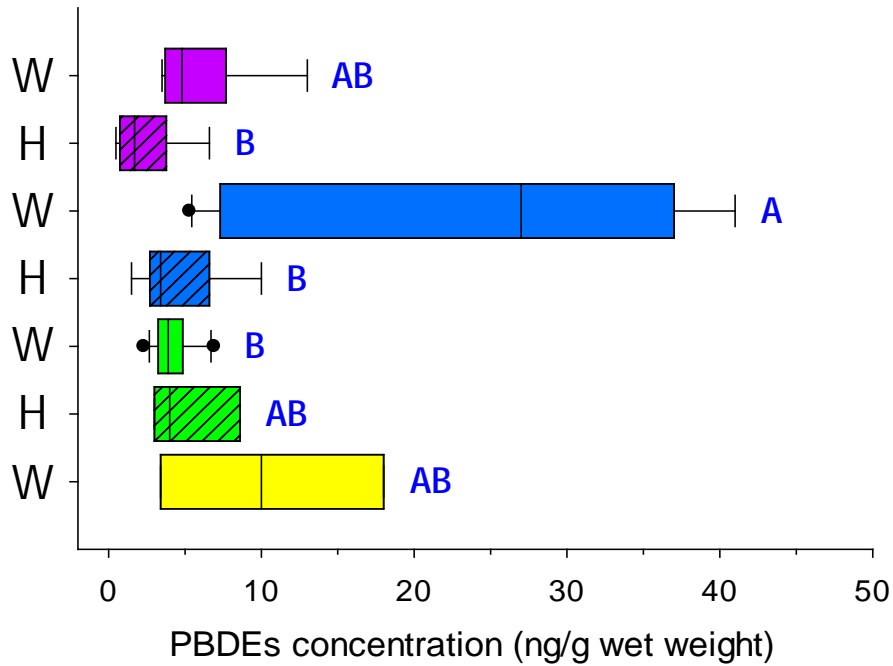
## Hypothesis 2:

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



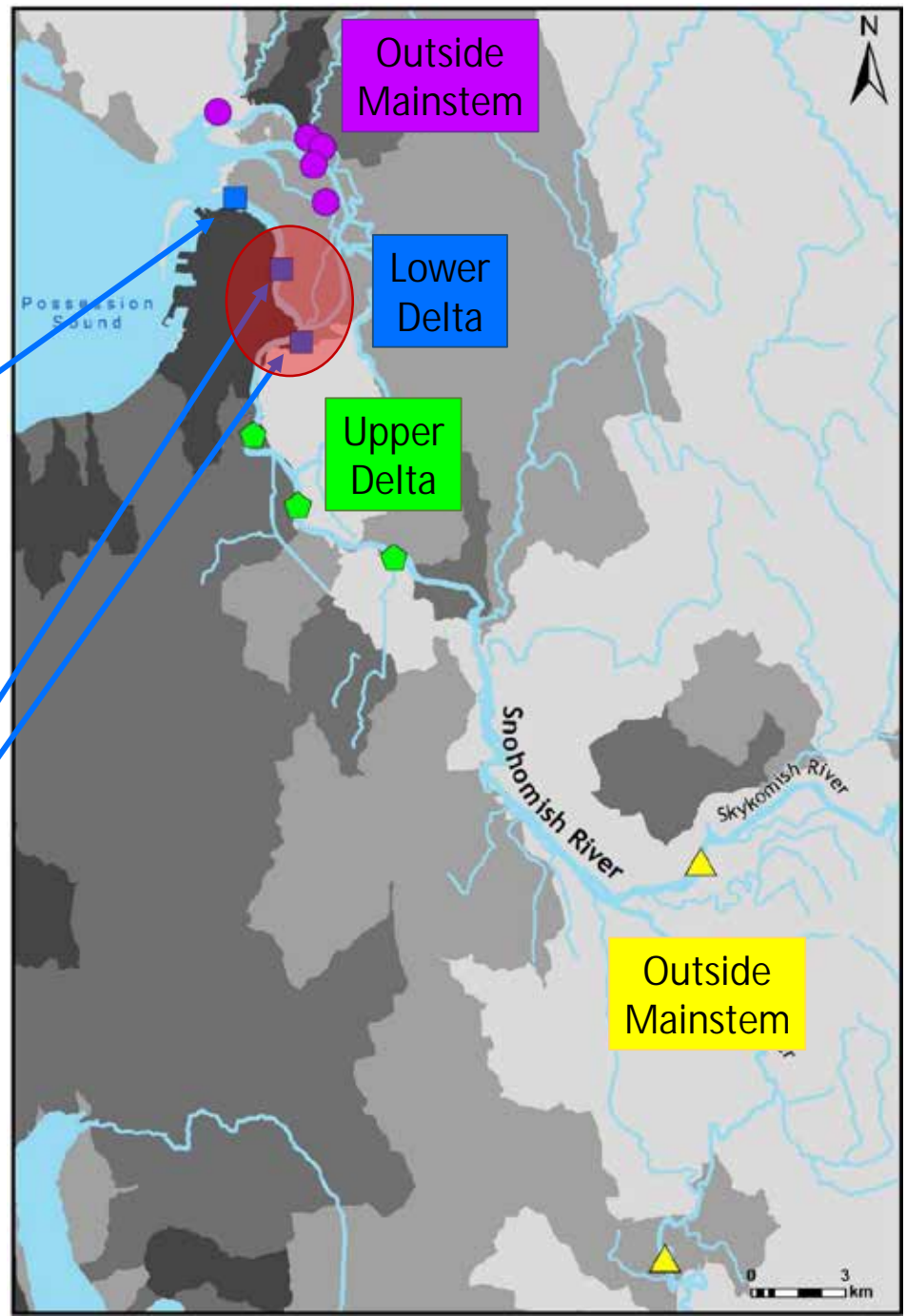
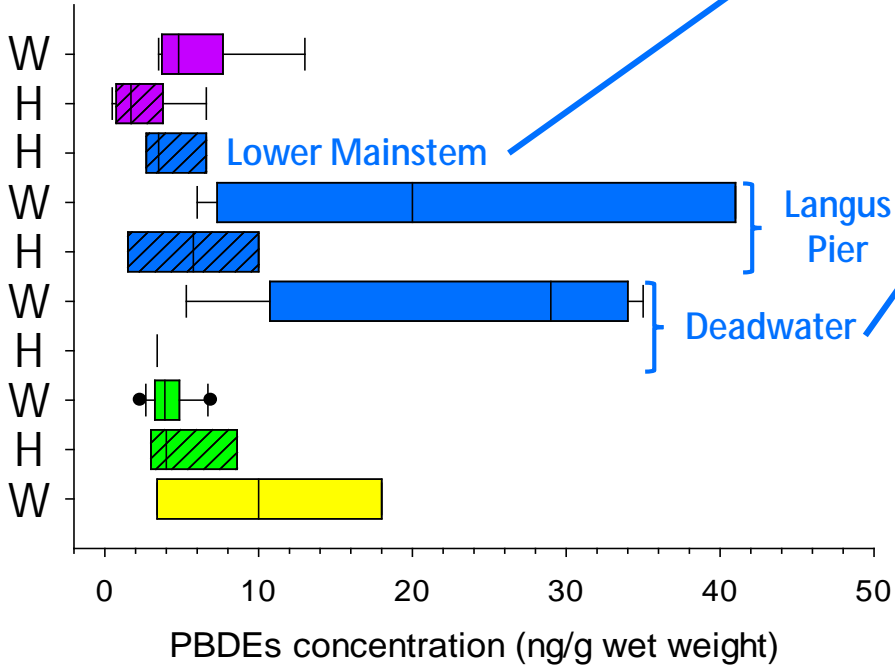
# PBDE Concentrations by Region

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

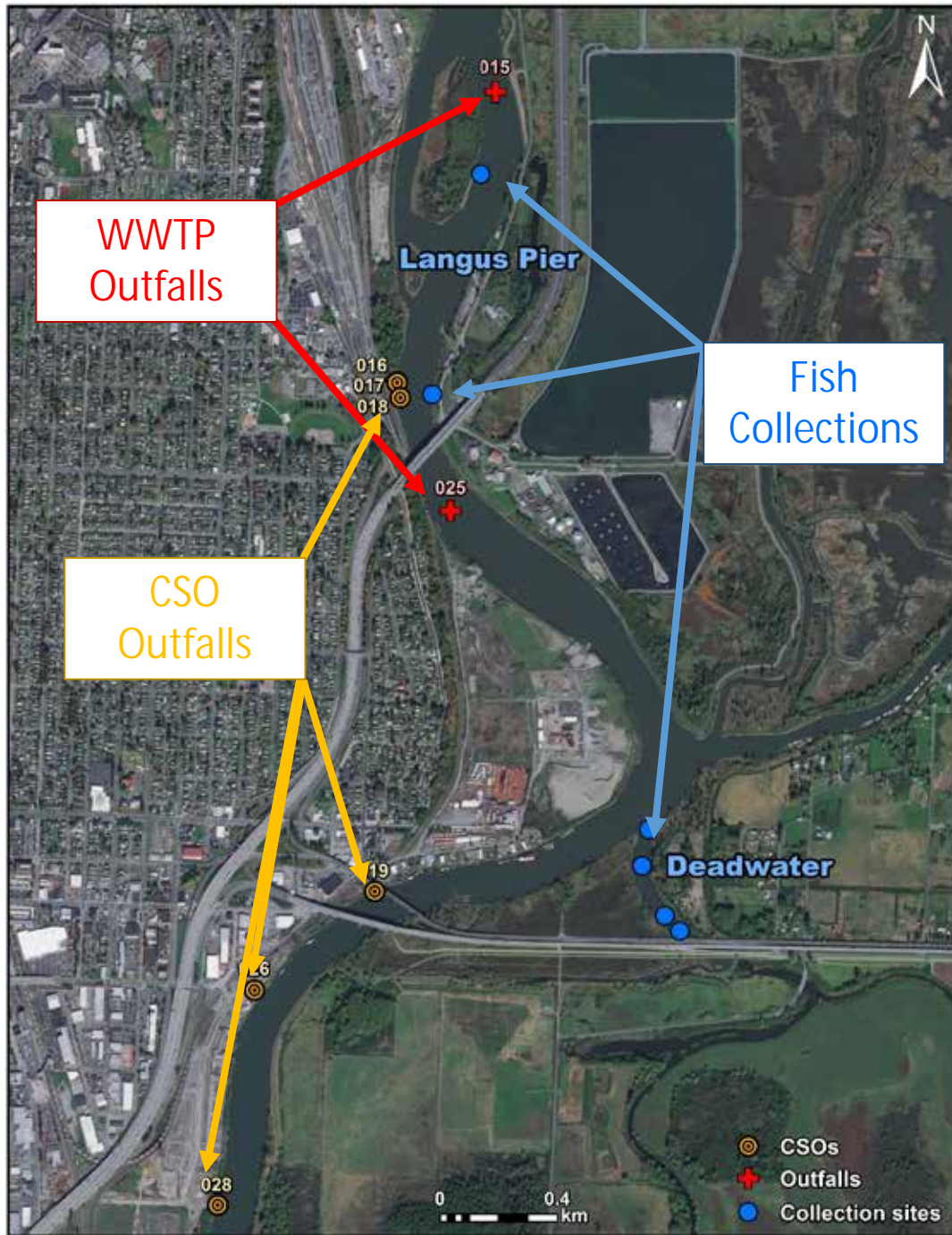


# PBDE Concentrations by Region

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

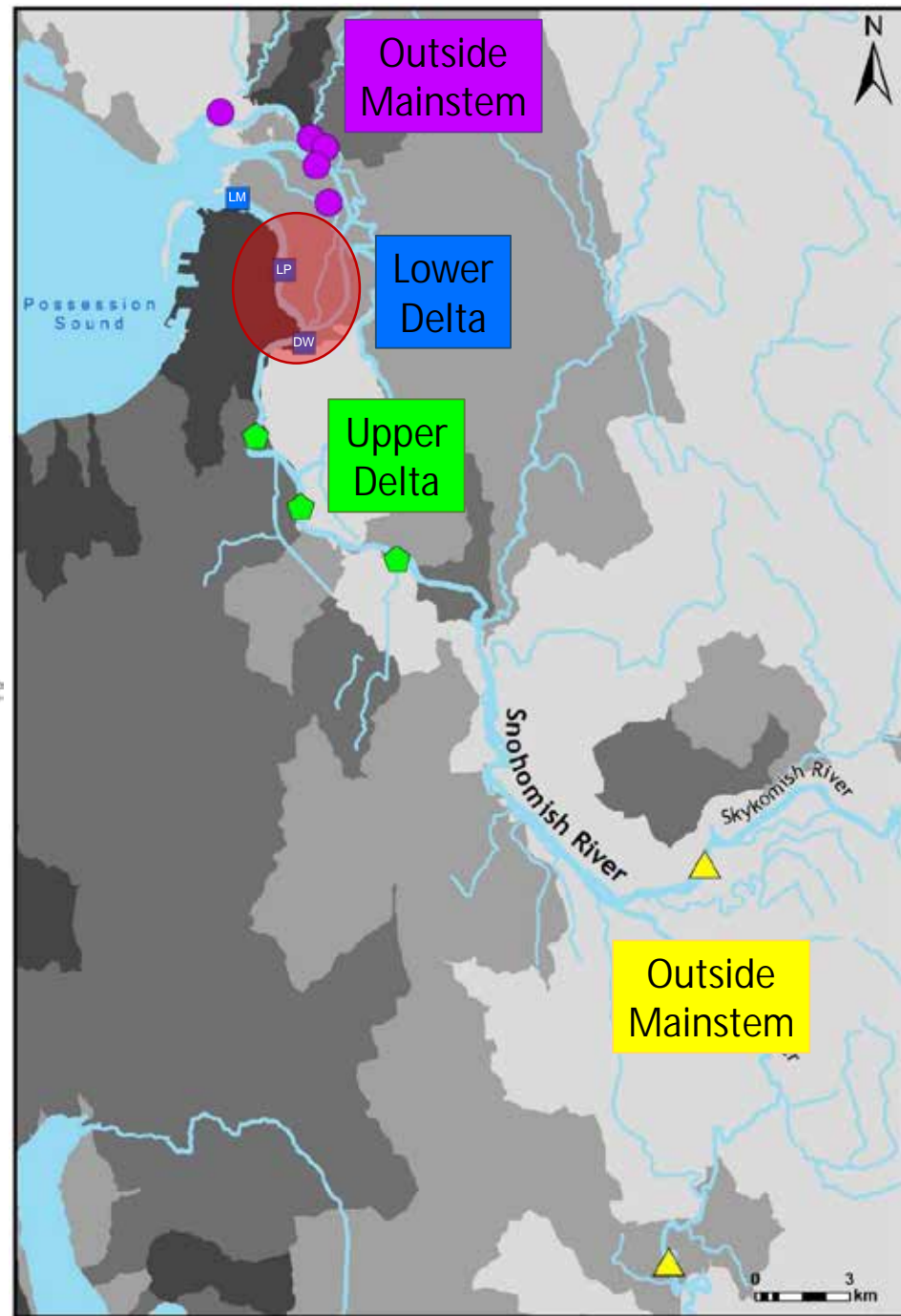
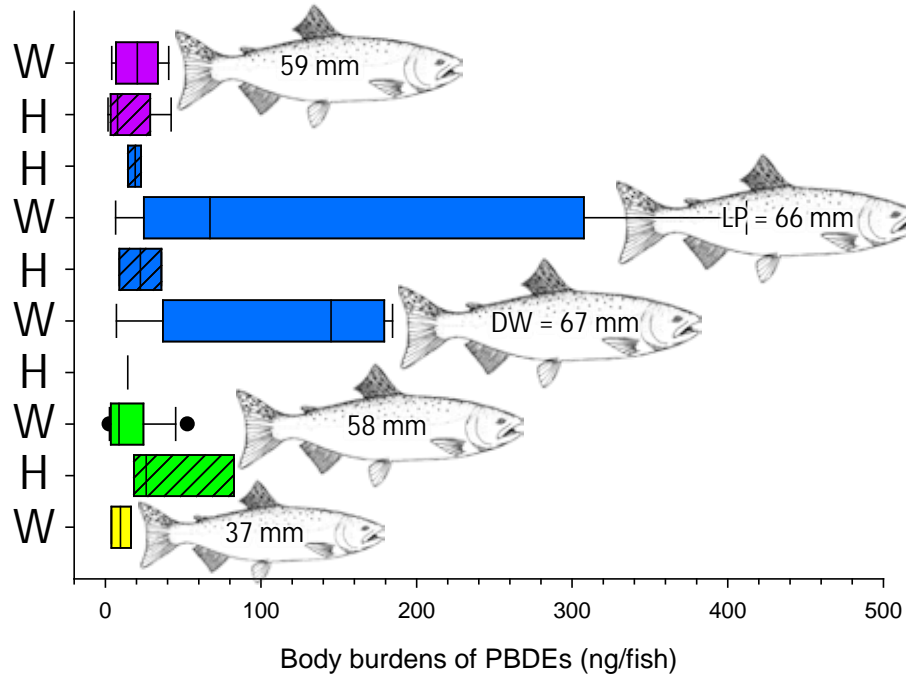


# Location of Sampling Sites and Outfalls



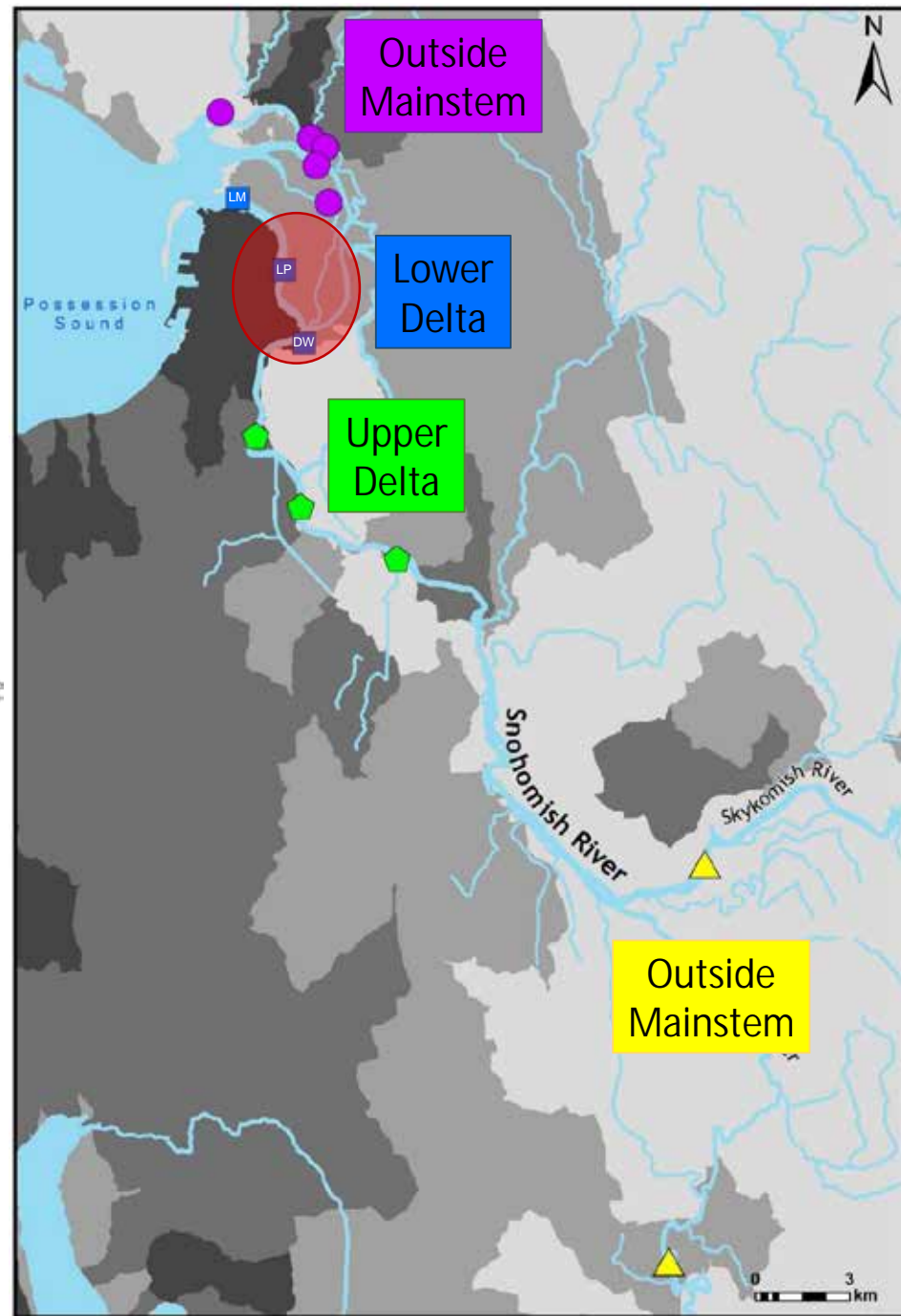
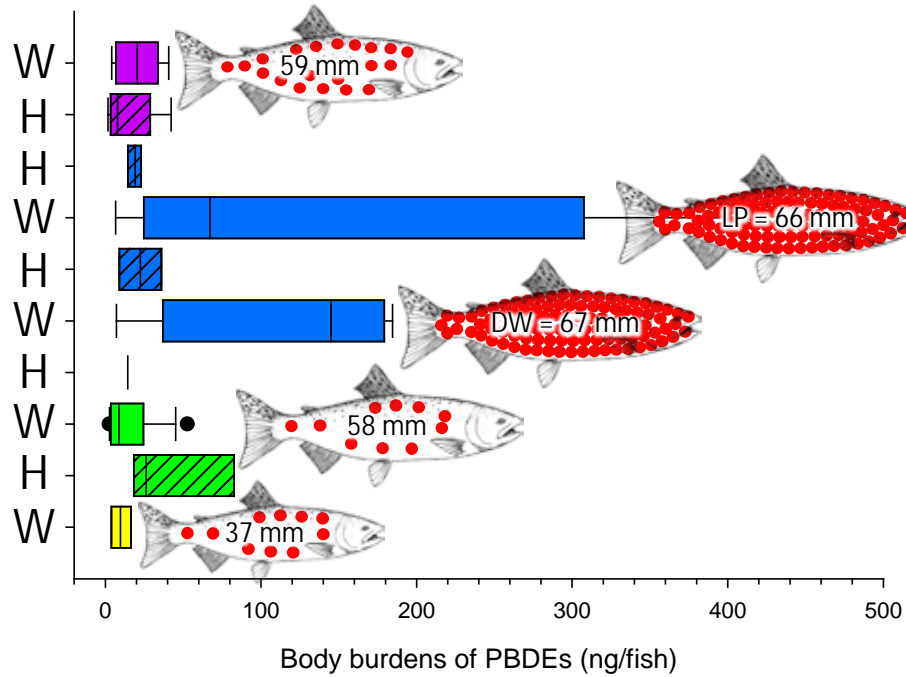
# PBDE Body Burdens

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

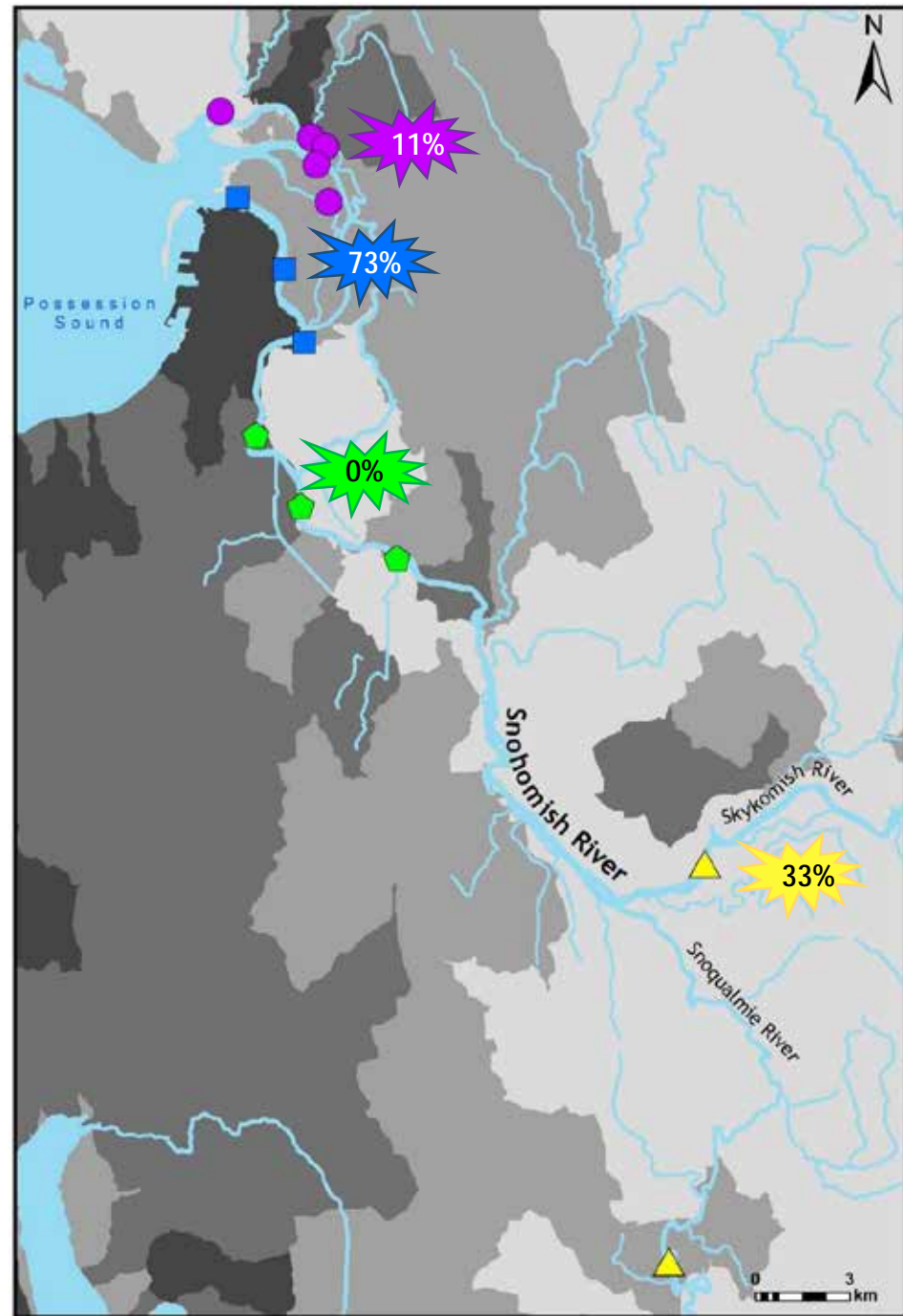
Based on wet weight concentrations

## 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

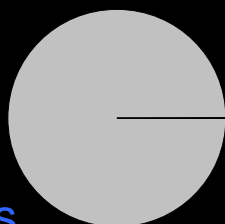


DDTs



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

% PCBs

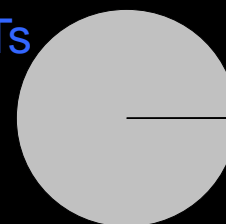


% PBDEs

% DDTs

% HCB

% DDTs



% PCBs

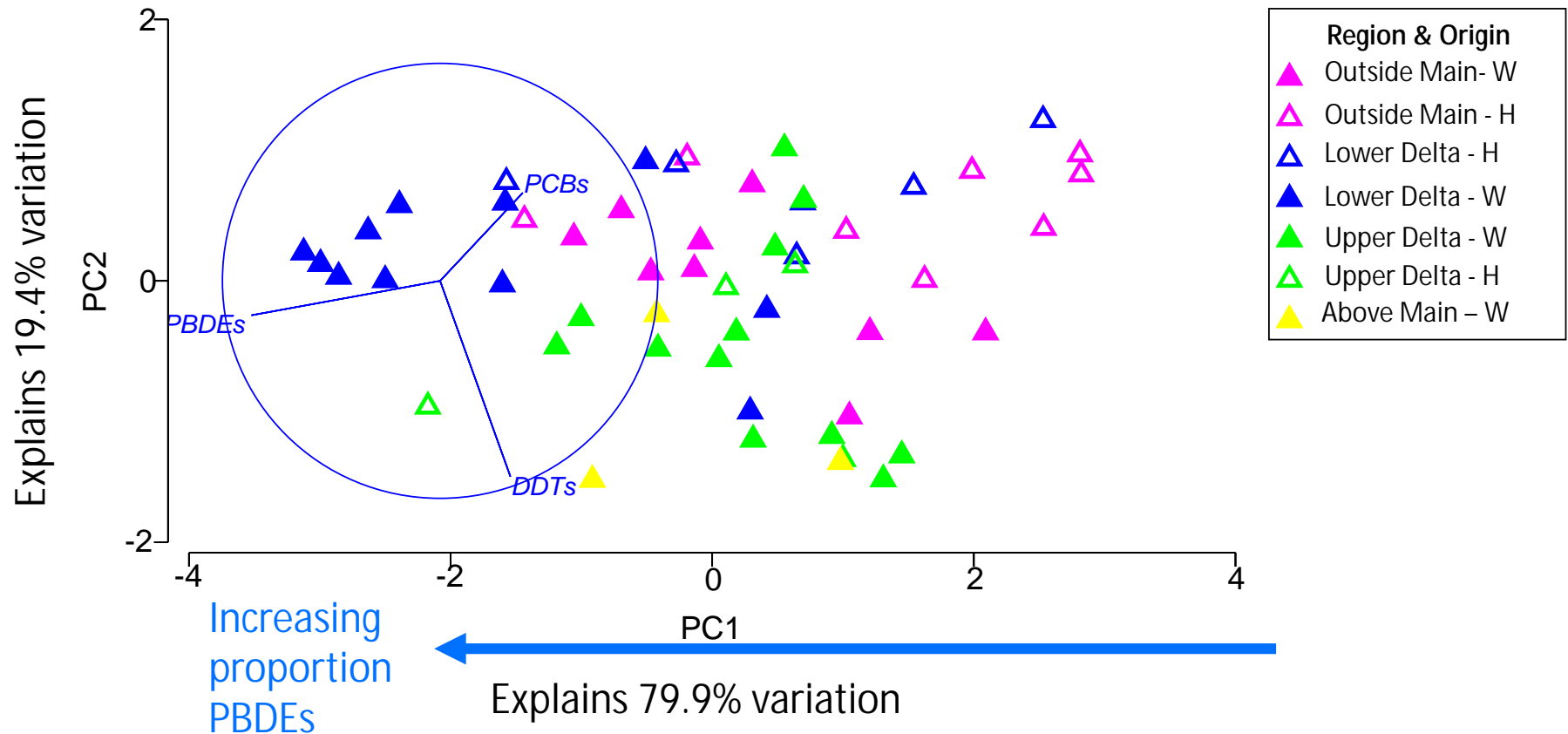
% PBDEs

% HCB



# 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").



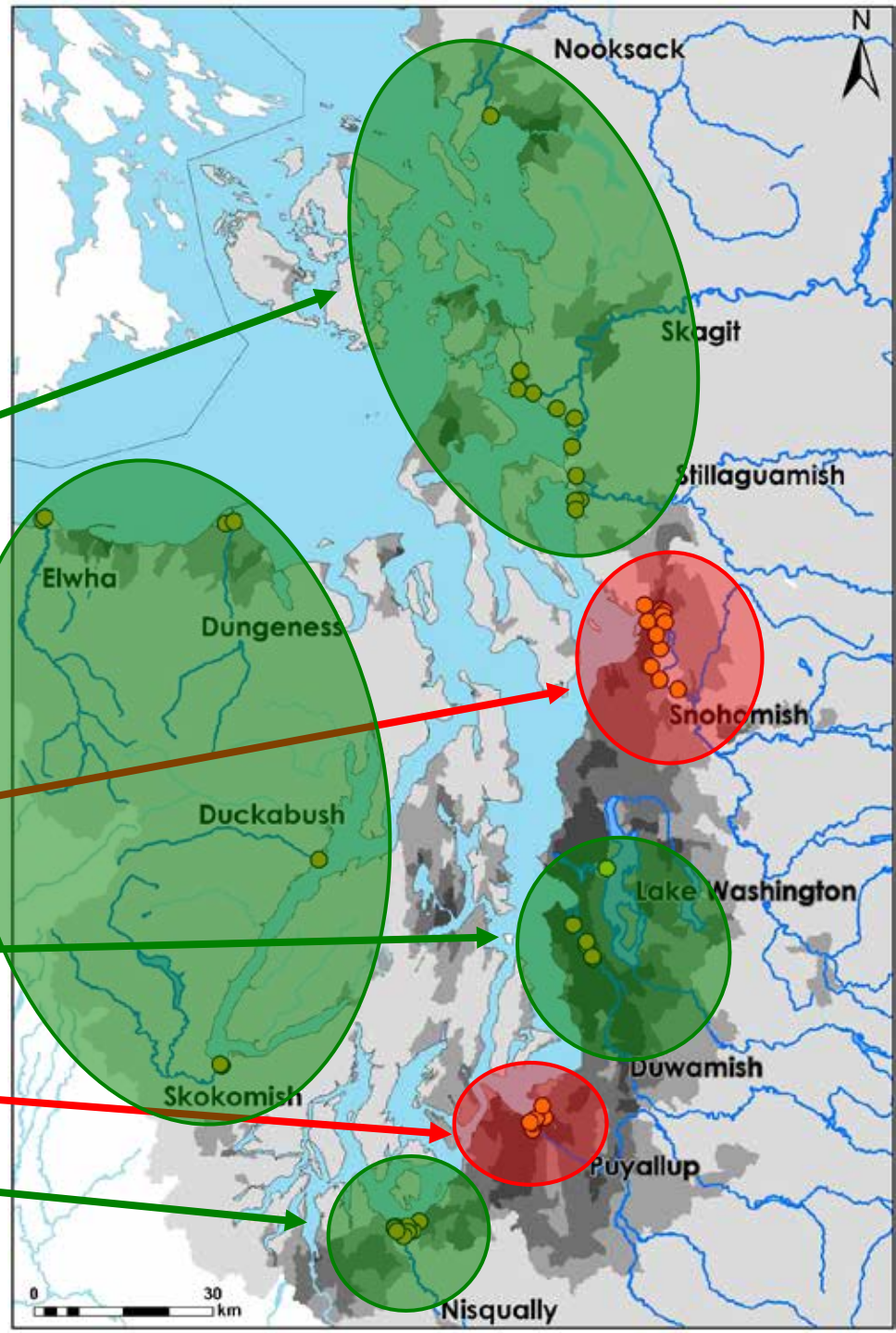
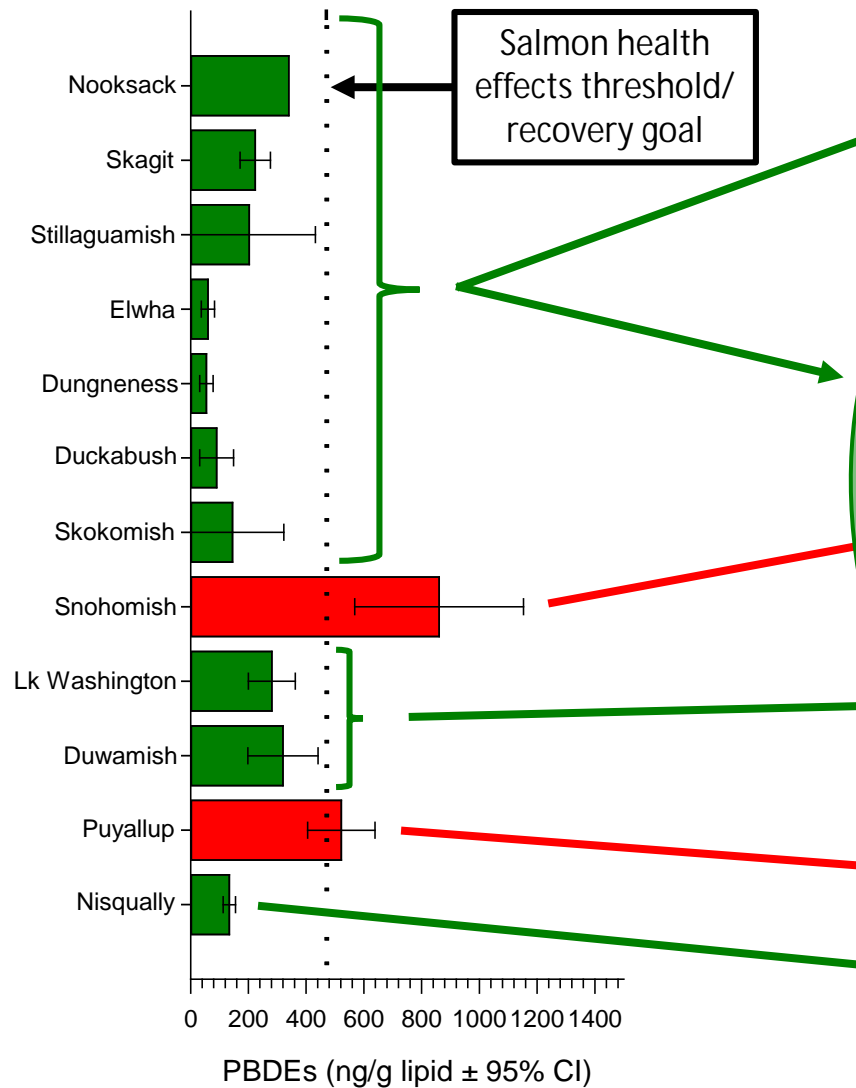
# Conclusions



- 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





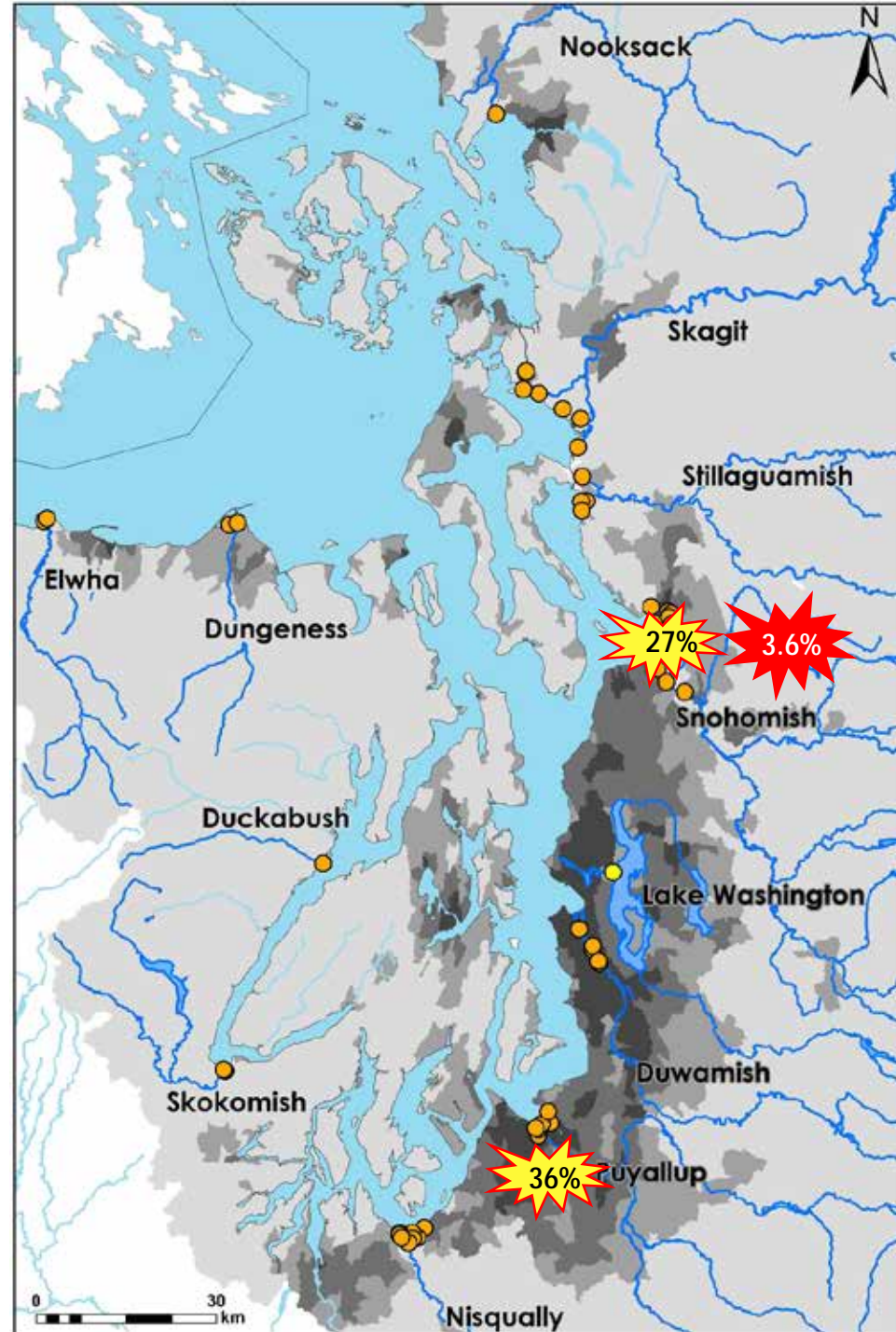
# PBDEs in Juvenile Chinook Salmon

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

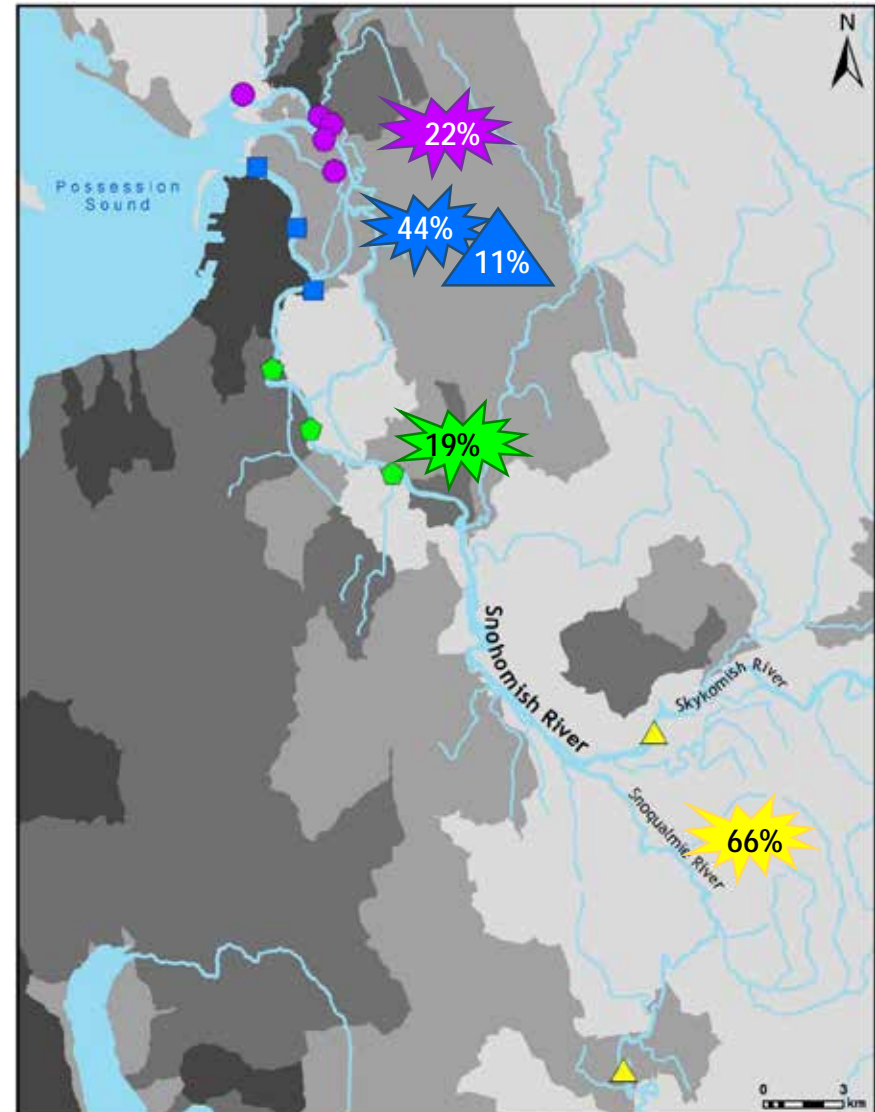
(hatchery and wild origin fish)

Lipid normalized

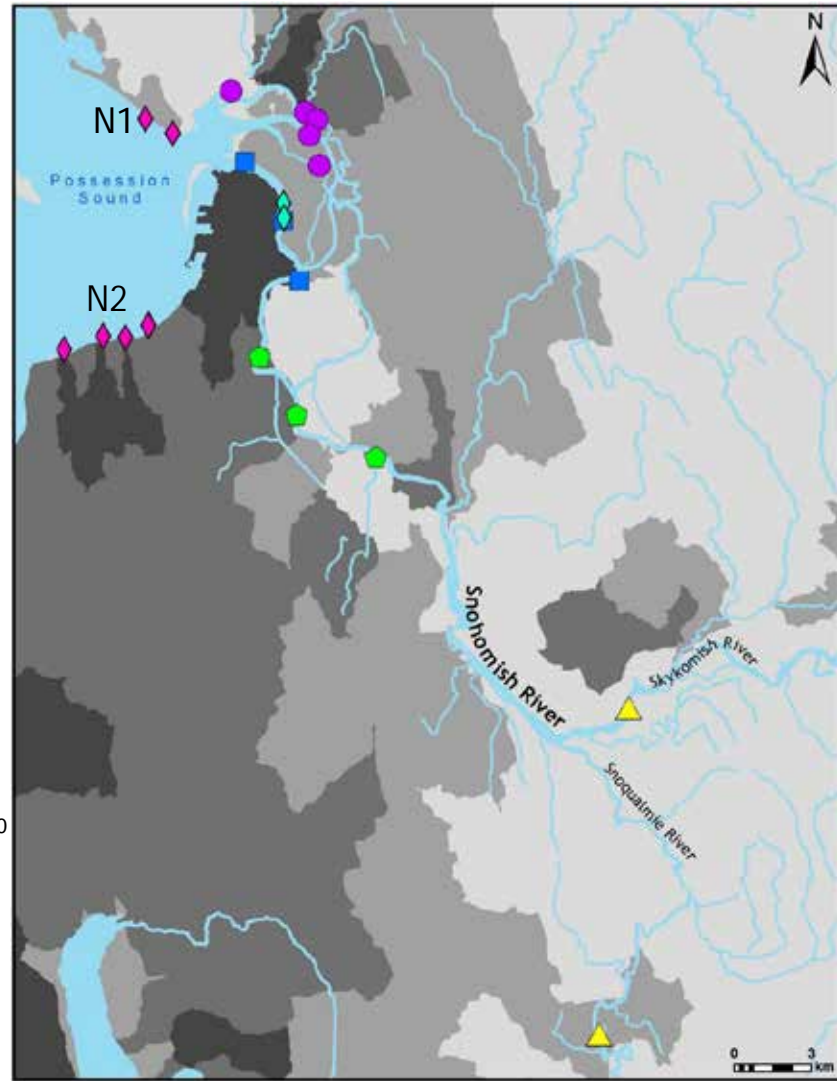
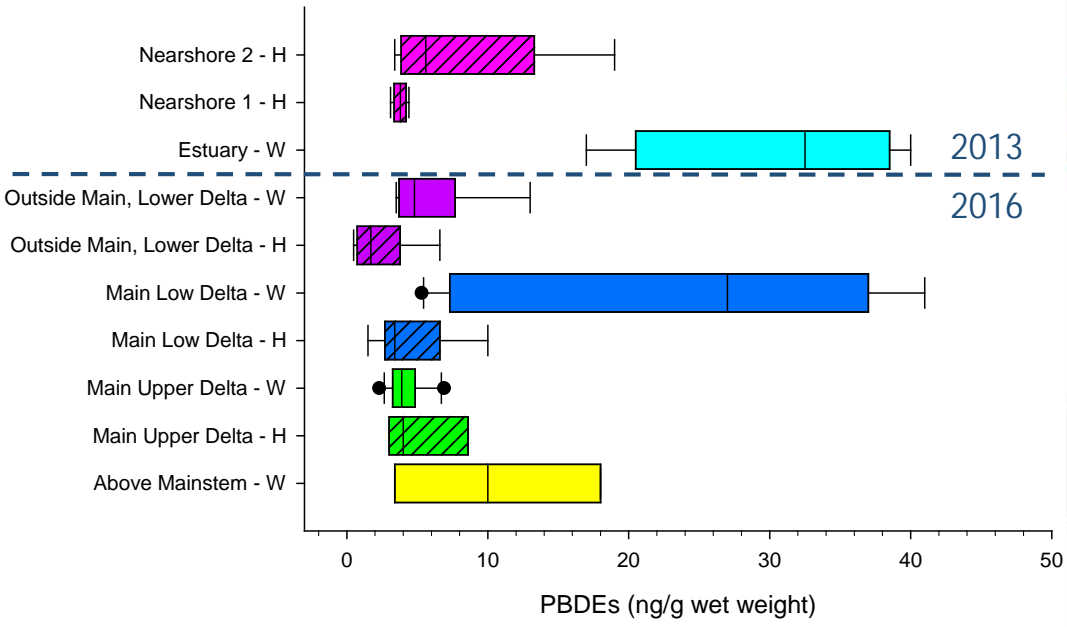
## Predicted PBDE Adverse effects

(Arkoosh et al. 2010, 2013)

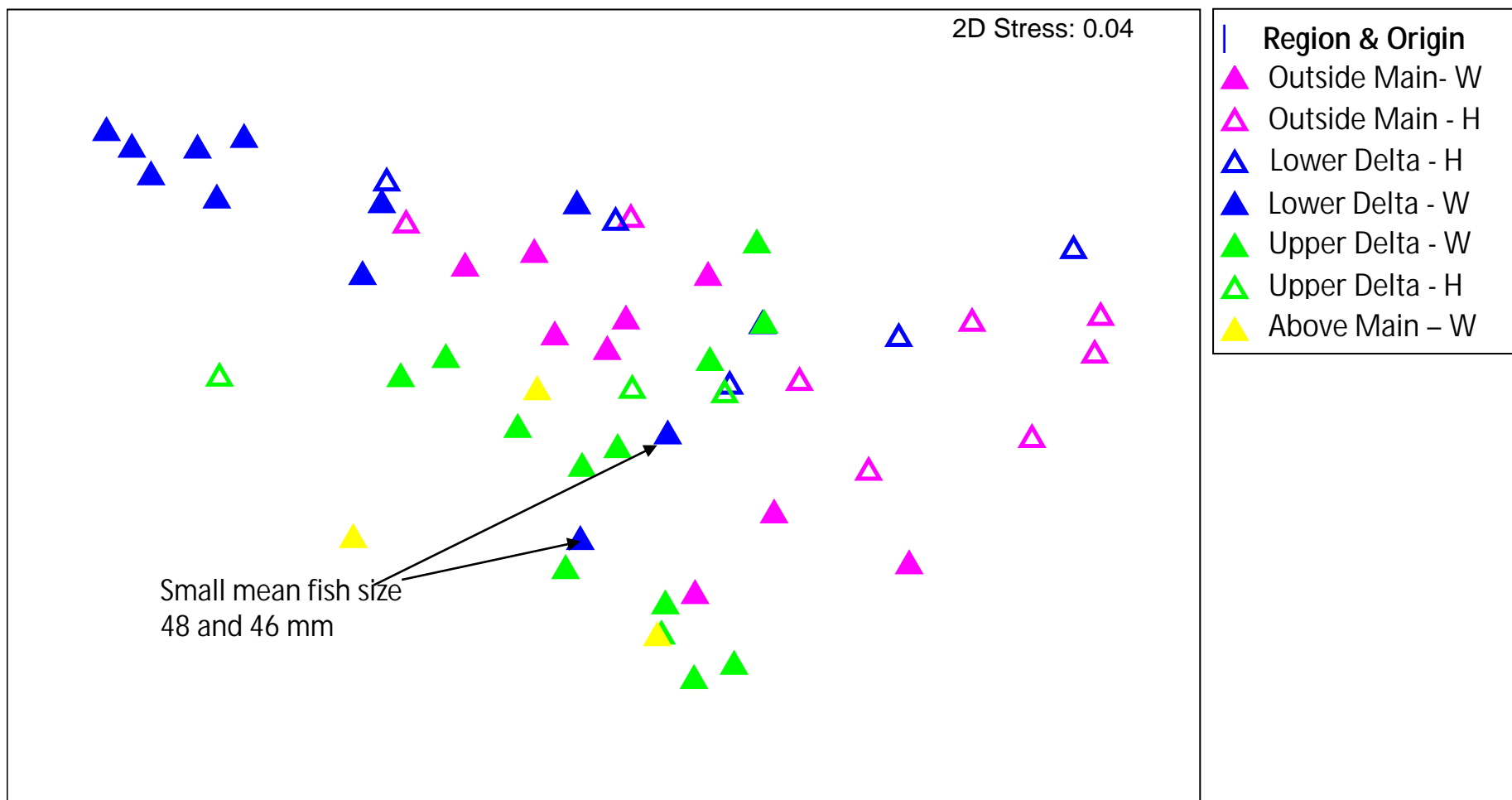
- Increased disease susceptibility 
- Altered thyroid function 



# PBDEs – 2013 vs 2016



# POP Fingerprints in Juvenile Chinook salmon



# Region x Origin 'Means Plot'

(Based on Results of Anosim Comparisons)

