

Contaminants in seaward migrating juvenile salmon from the Puyallup River: potential impacts on their early marine survival



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Washington Department of Fish & Wildlife
2019 Puyallup Watershed Symposium



Toxics-focused Biological Observation System (TBiOS)

We evaluate the ***effects of toxic contaminants*** on marine and anadromous species to:

- guide efforts to ***protect fish and shellfish health***,
- ***ensure seafood safety***, and
- ***promote ecosystem recovery***.

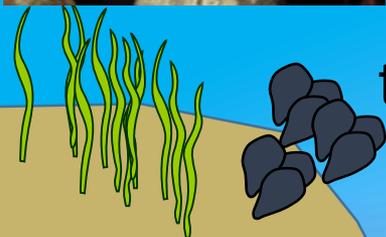




juvenile Chinook salmon



Chinook and coho salmon



transplanted mussels



Pacific herring



TBiOS Indicator Species

Spot prawn



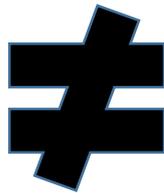
English sole



Dungeness crab

Research Question: Juvenile Chinook Salmon

Are seaward migrating juvenile Chinook salmon in Puget Sound exposed to contaminants at levels high enough to affect their health and productivity?

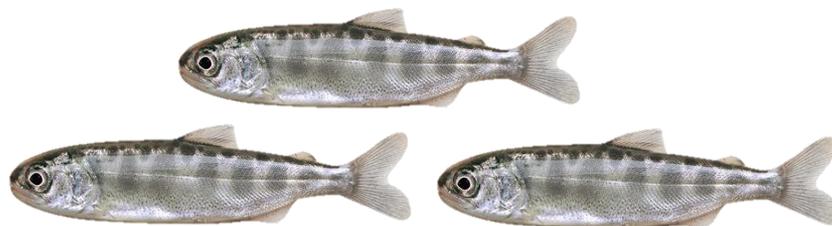


If contaminant levels
are too high,



salmon
won't
survive.

Talk Outline



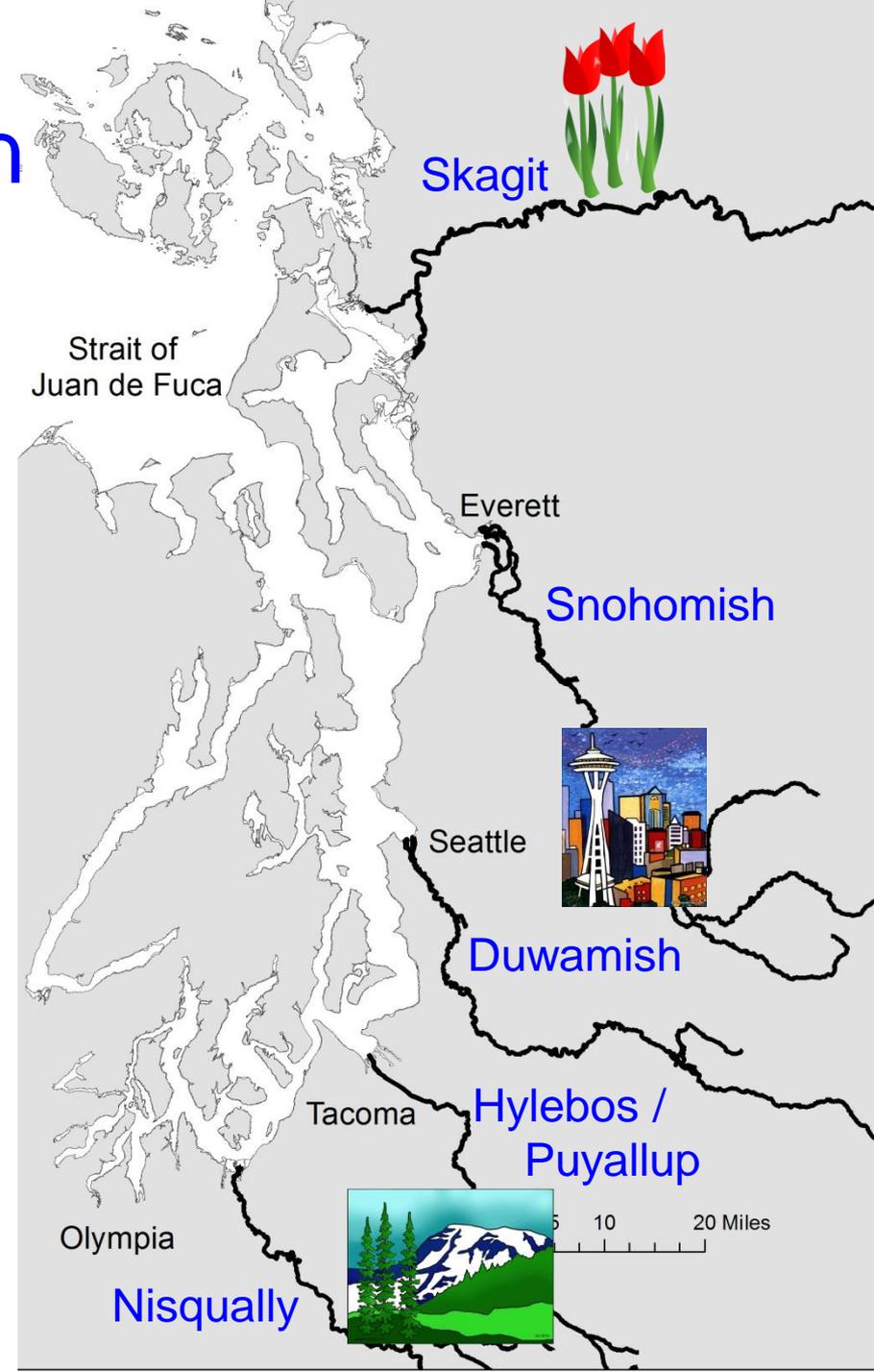
- **Summarize contaminant concerns for juvenile Chinook salmon from Puyallup/Commencement Bay vs. other Puget Sound river systems.**
 - Results based on two major studies:
 - 2013 study of 5 major river estuaries and associated marine nearshore
 - 2016 study of all major Puget Sound river estuaries
 - High PCB results, briefly mention other contaminants of concern
- **Next Steps**
 - Planned in-depth 2020 study of contaminant exposure in Puyallup/ Commencement Bay juvenile Chinook

2013 Sampling Design

5 major rivers systems



2013



2013 Sampling Design

5 major rivers systems

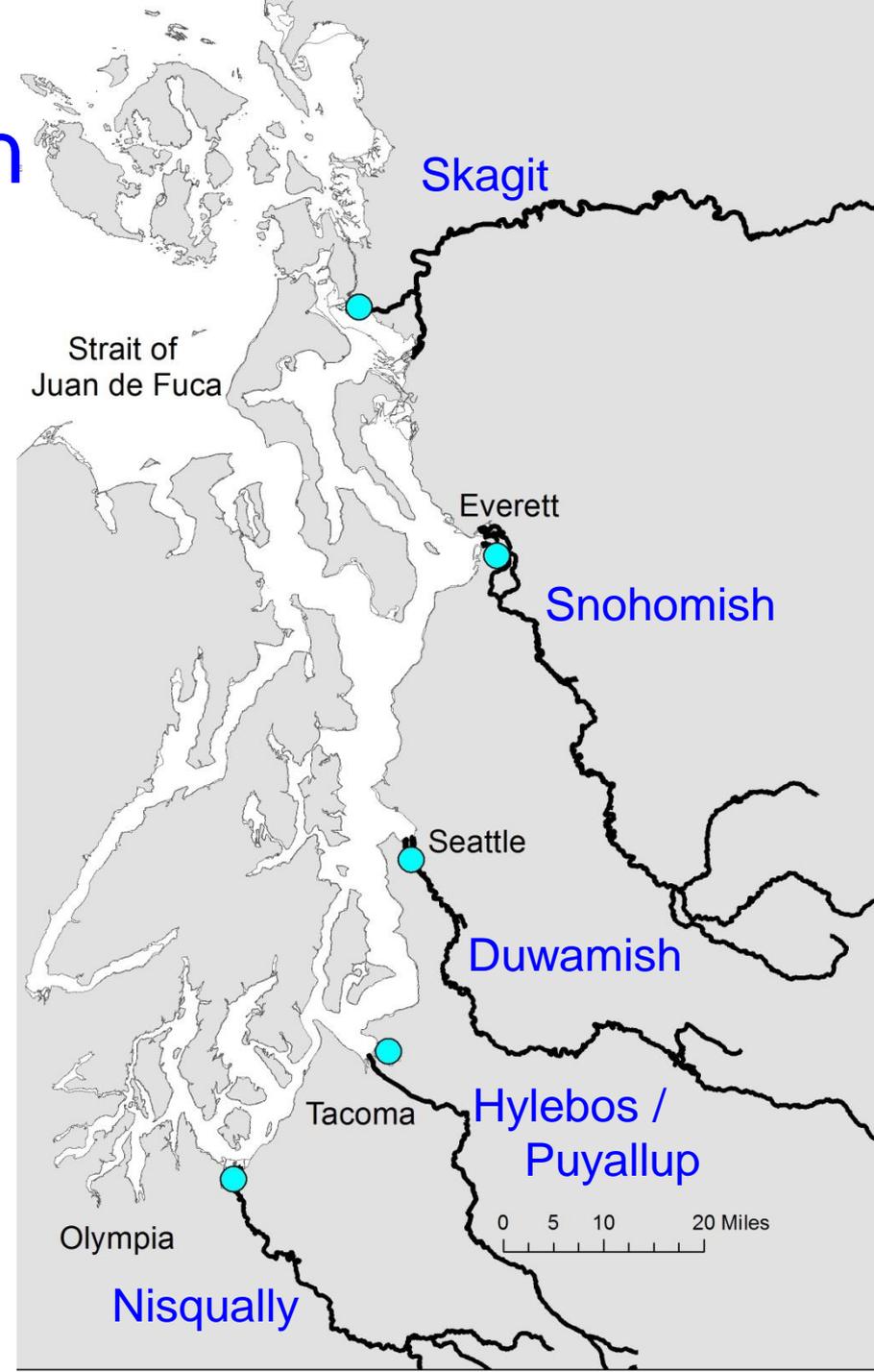
- Estuary habitats (May)



Fall Chinook



2013



2013 Sampling Design

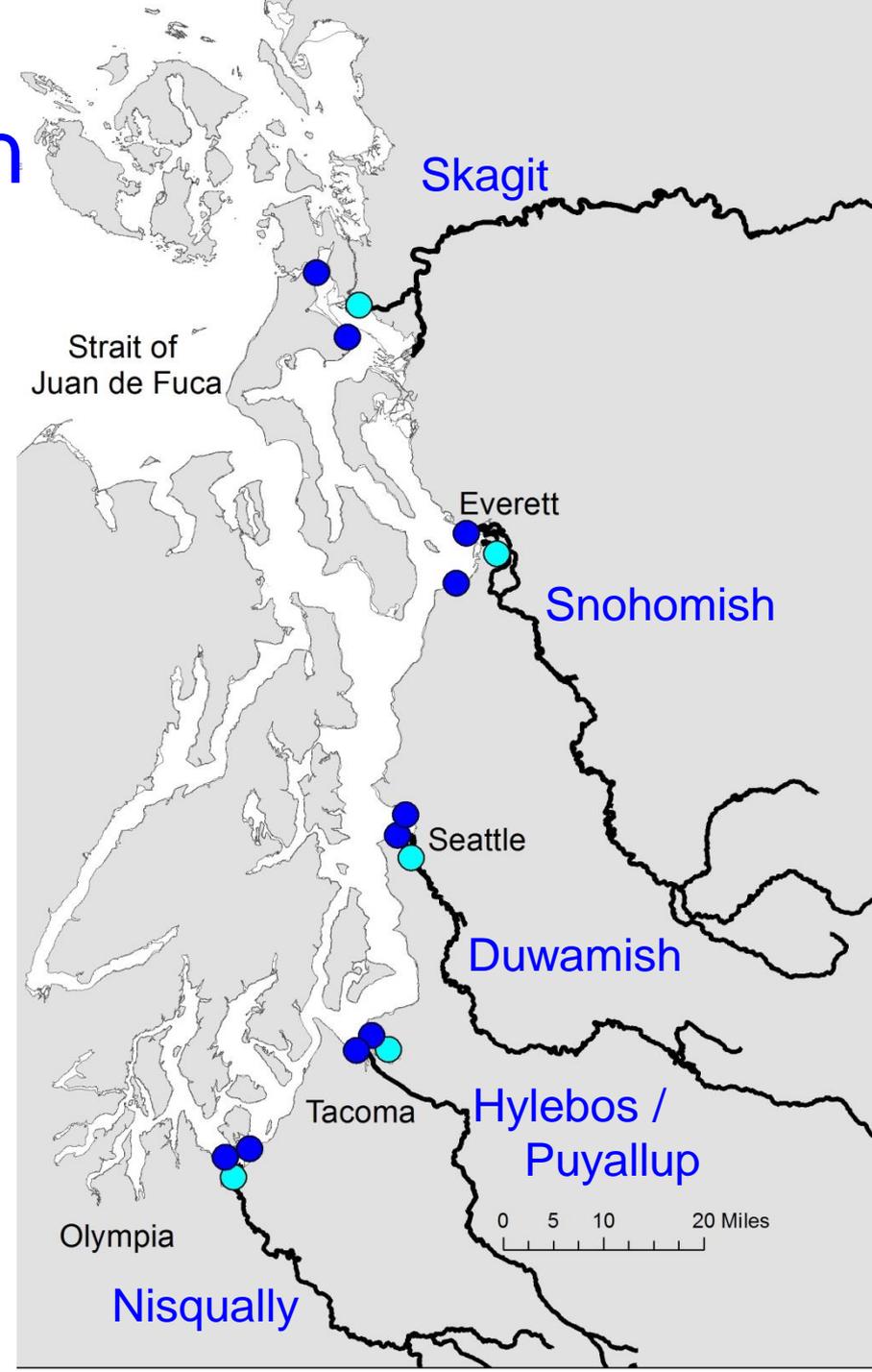
5 major rivers systems

- Estuary habitats (May)
- Marine Nearshore (June)



2013

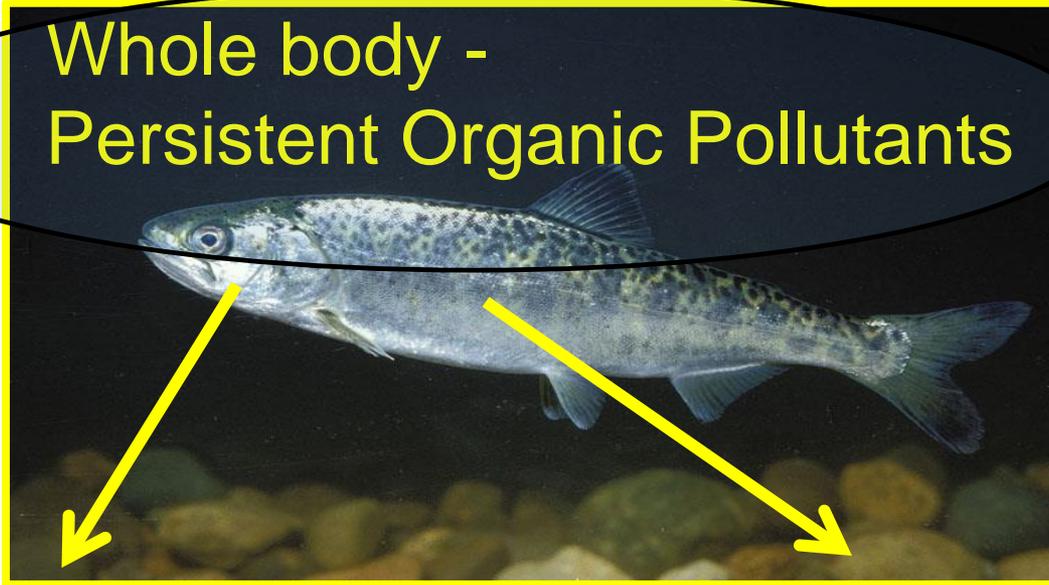
Fall Chinook



Methods: contaminants measured

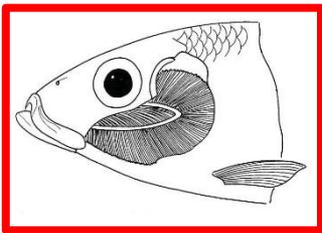
480 fish combined into 67 composite samples

Whole body -
Persistent Organic Pollutants



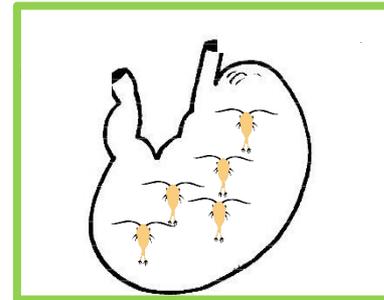
PCBs
PBDEs
DDTs,
HCB
Chlordanes
HCHs

Gills - Metals



Zinc
Cadmium
Copper
Lead
Nickel

Gut Contents - PAHs
 Σ_{37} PAHs



Results:

Persistent Organic Pollutants

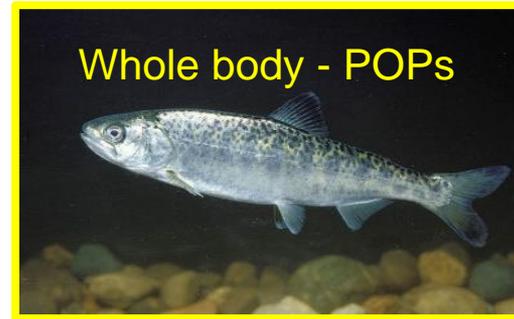
- toxic man-made chemicals; global distribution
- dissolve easily in animal fat (lipophilic)
- not easily metabolized
- bio-accumulate



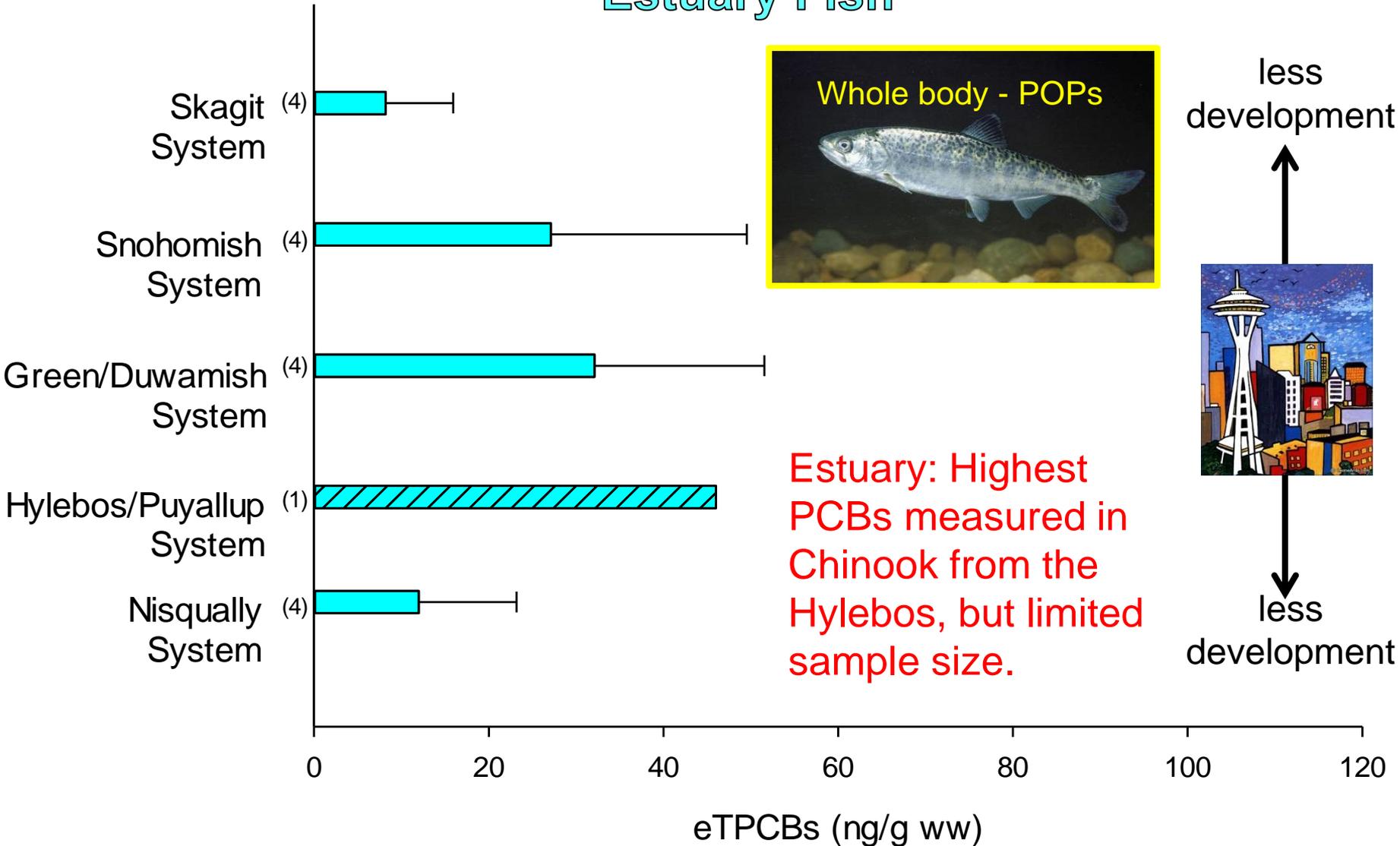
- PCBs
- PBDE
- Chlordanes
- DDTs
- HCB
- HCH

Total Polychlorinated Biphenyls (PCBs)

Estuary Fish



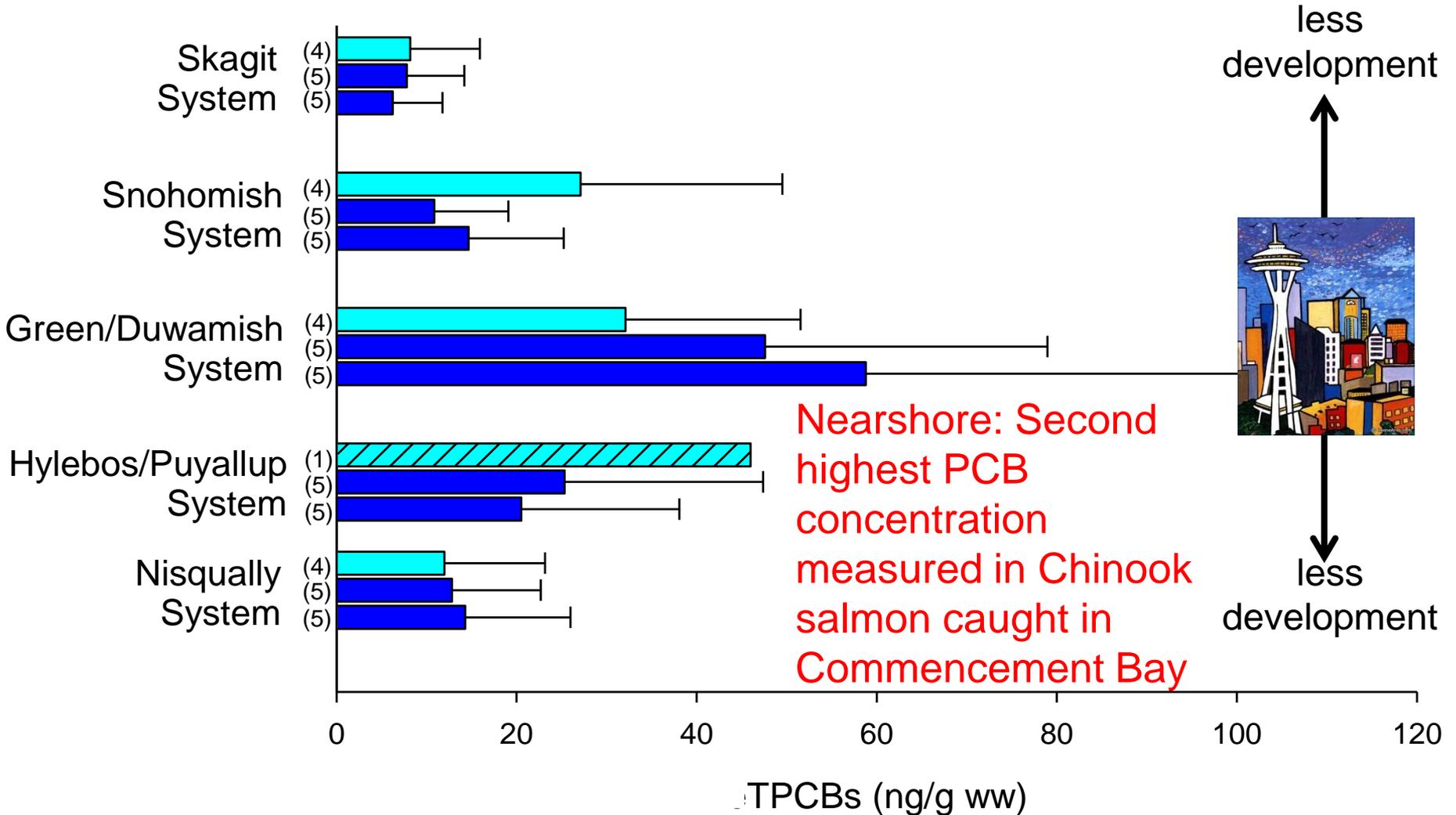
Estuary: Highest PCBs measured in Chinook from the Hylebos, but limited sample size.



Total Polychlorinated Biphenyls (PCBs)

Estuary Fish

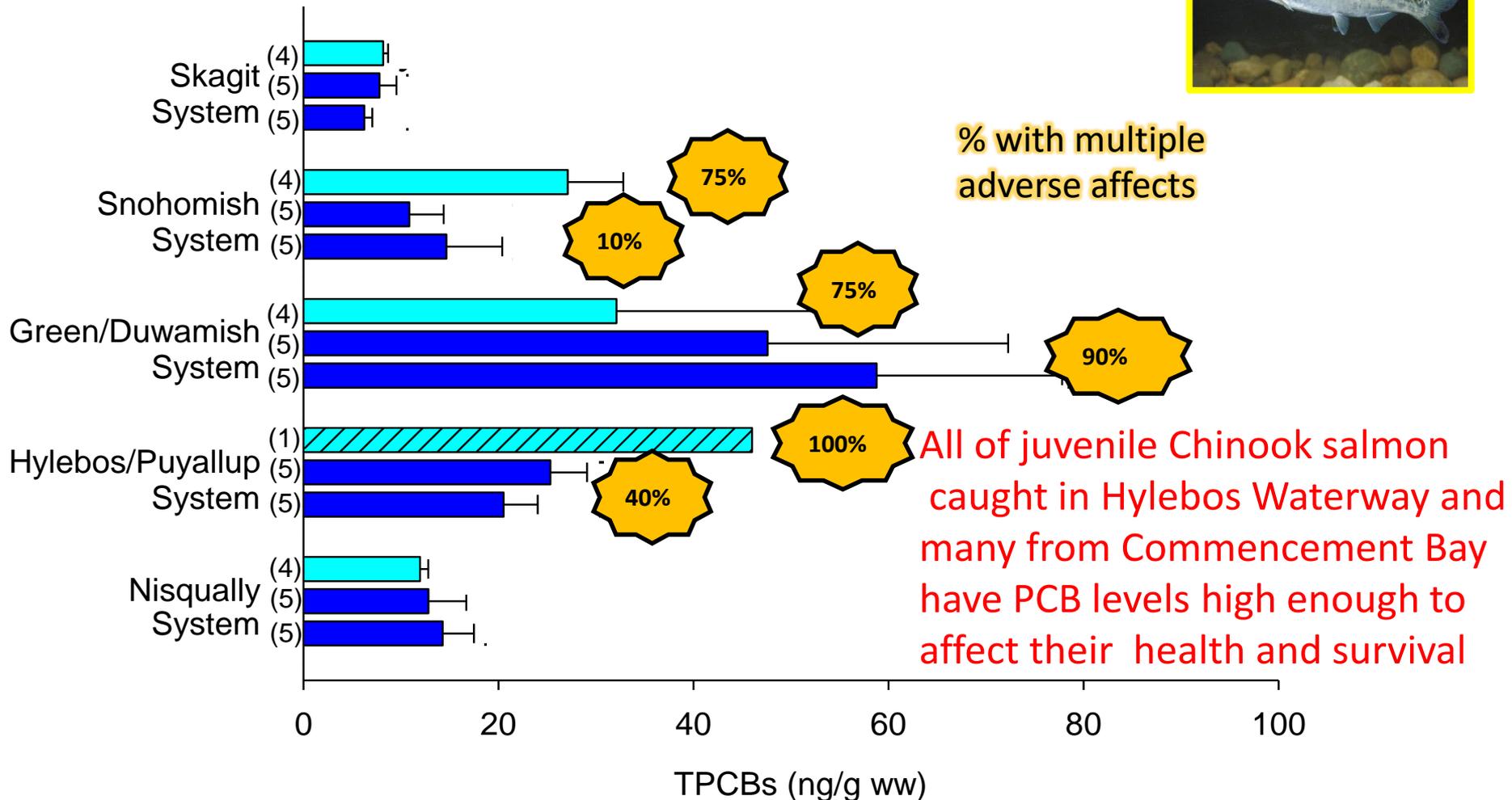
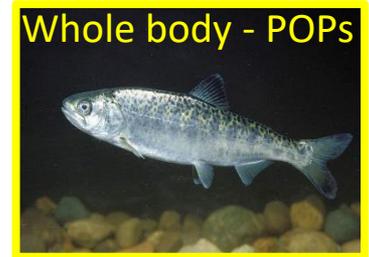
Marine Nearshore Fish



Total Polychlorinated Biphenyls (PCBs)

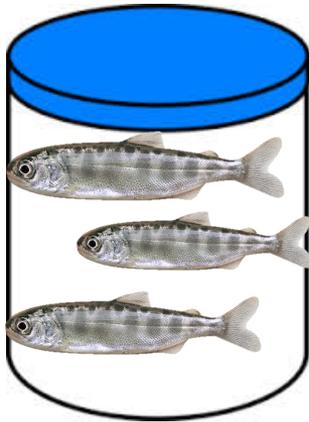
Estuary Fish

Marine Nearshore Fish

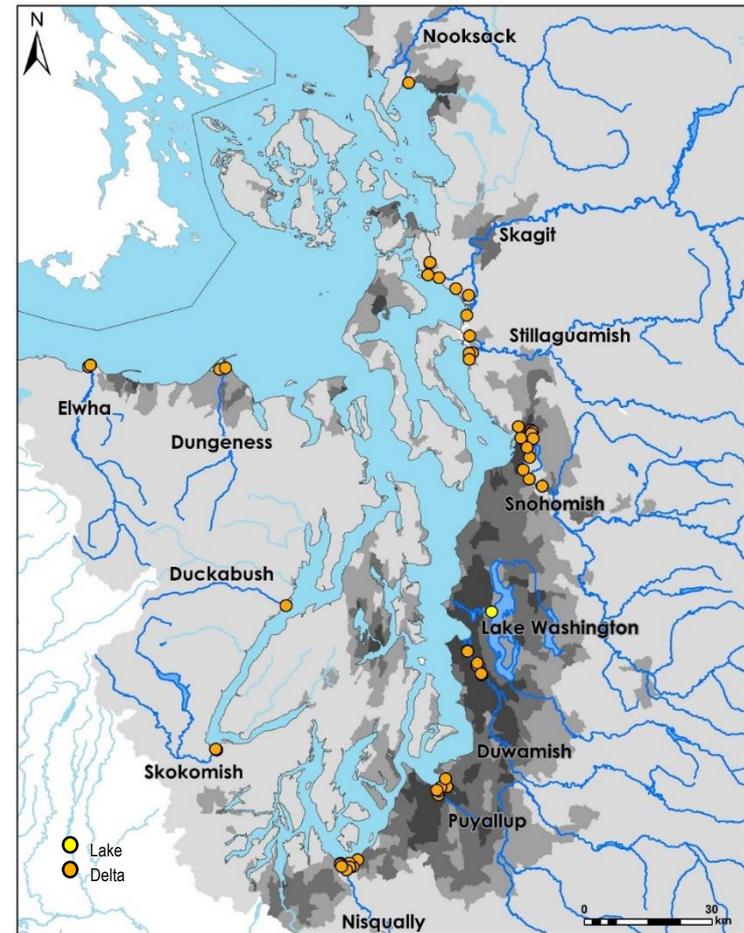


2016 Study Contaminant Study

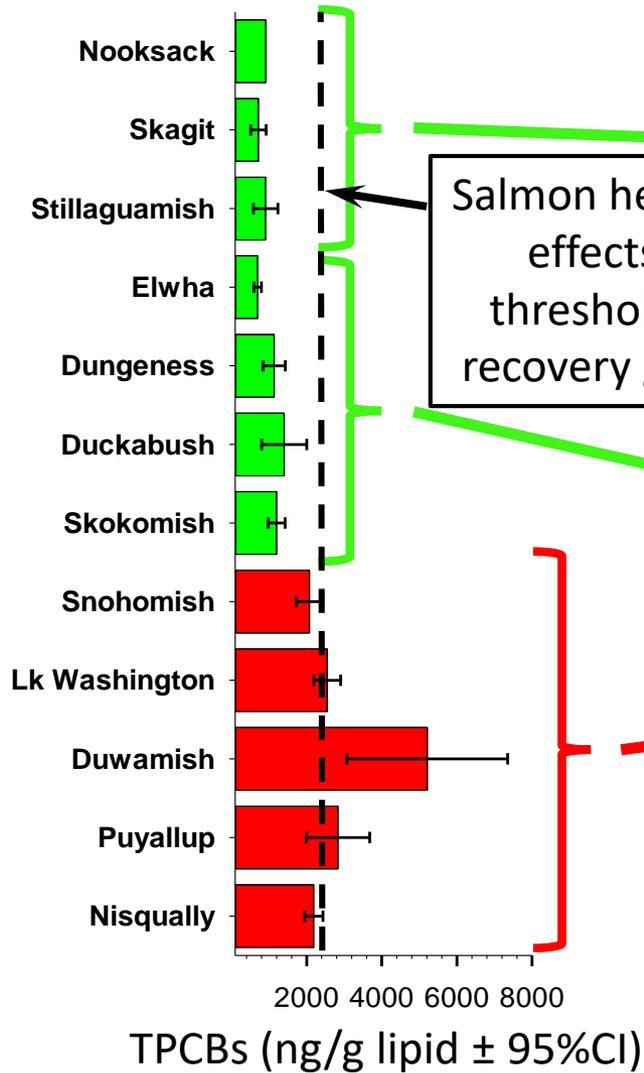
- Sampled juvenile Chinook in **Estuary** habitats of all major rivers with ESA – listed Chinook salmon
- 6 – 8 whole body composite samples per river



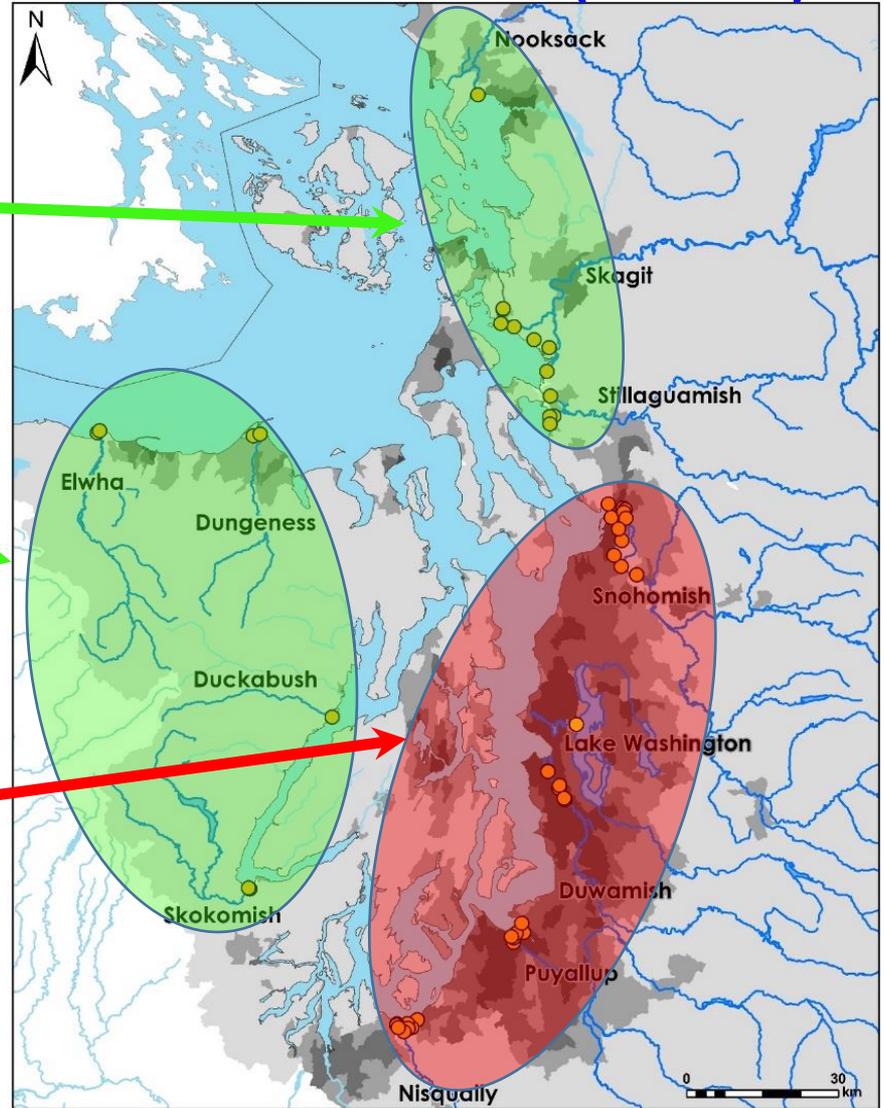
1- 8 fish per
composite sample



PCBs in Juvenile Chinook Salmon (2016)



Salmon health effects threshold/
recovery goal



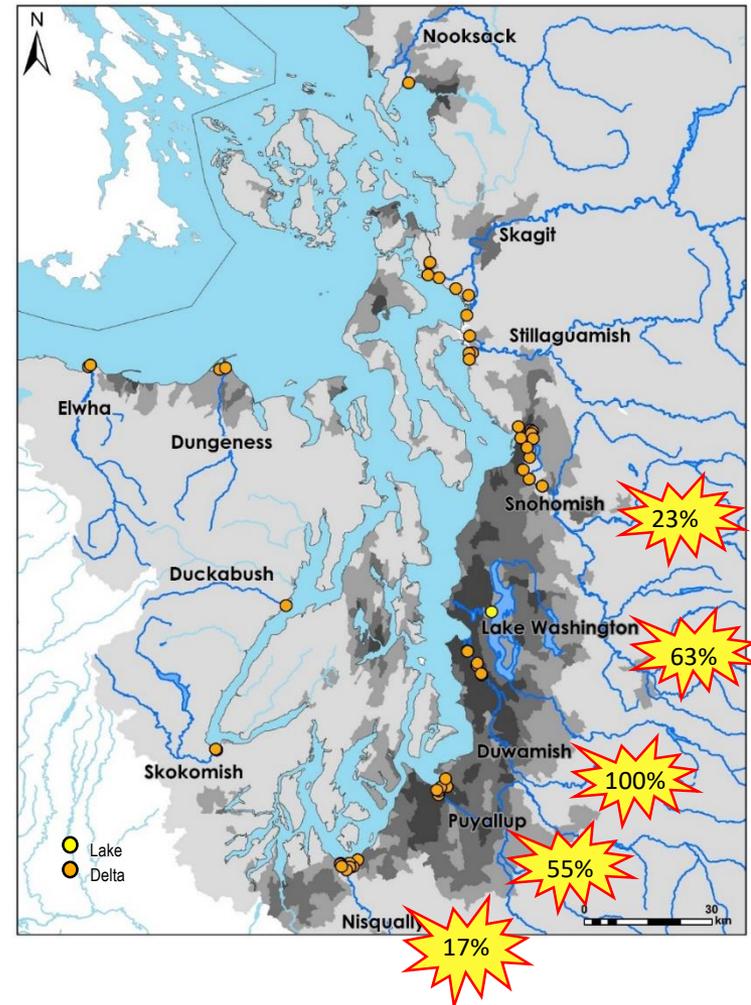
Second highest PCB levels measured in Chinook salmon caught in Commencement Bay

% Chinook Samples Above PCB Critical Body Residues

% with multiple adverse affects

Predicted adverse effects of PCBs
(Meador et al. 2002)

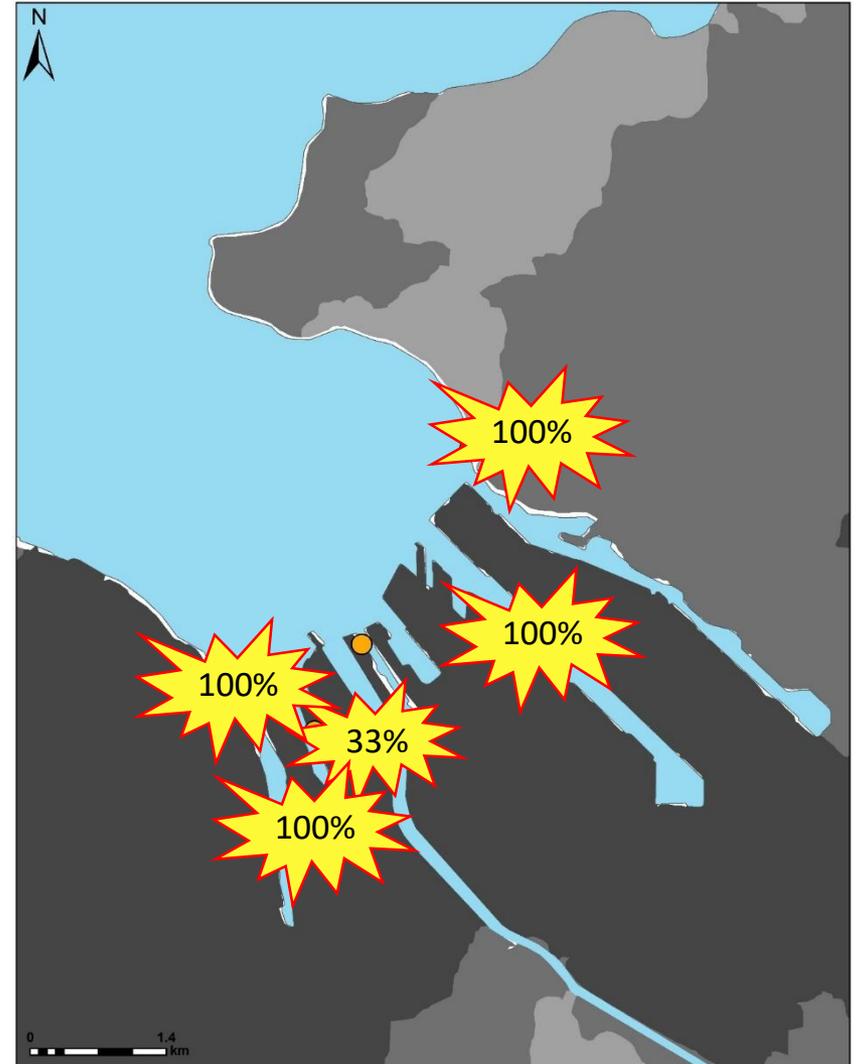
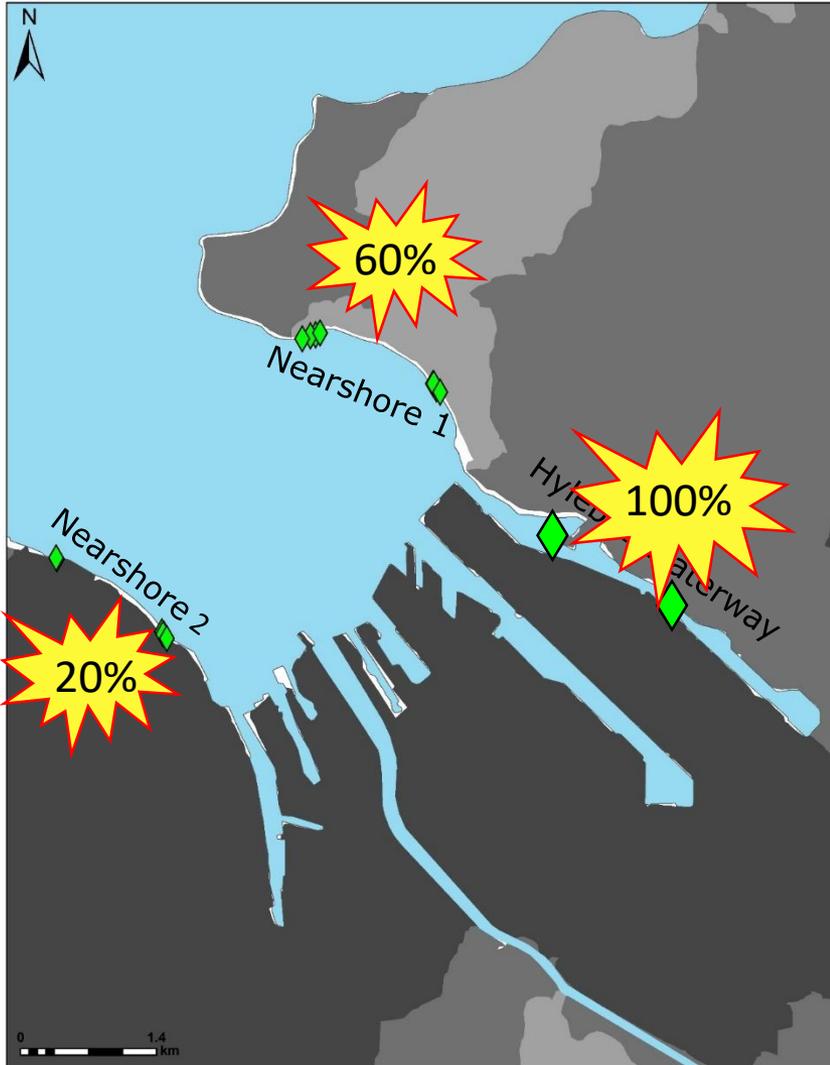
- Mortality
- Impaired growth & reproduction
- Immune dysfunction
- Hormonal alterations
- Enzyme inductions
- Neurotoxicity
- Behavioral responses
- Disease susceptibility
- Mutagenicity



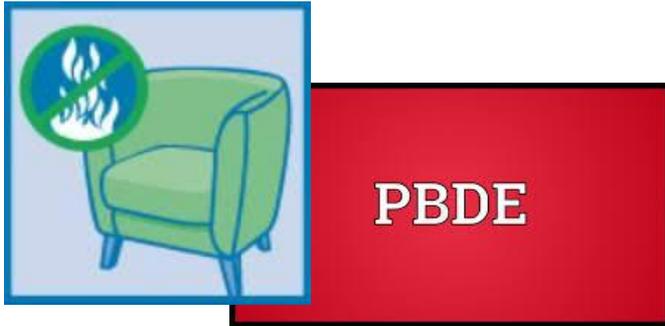
% Chinook Samples Above PCB Critical Body Residues

2016 Estuary/Nearshore Study

2016 Estuary Study



What about other Contaminants?



PBDE flame retardants
above levels of concern

- 100% Hylelos,
- 20% marine nearshore
- 0% estuary samples.



Highest DDT level in
Commencement Bay but
below levels of concern.



Trace metals, PAHs also
elevated level in
Puyallup/Commencement Bay.

What about other Contaminants?

Chemicals of Emerging Concern (CECs)

Pharmaceuticals

Antibiotics, Antihistamine,
Antidepressants, Antifungals
Sedatives, Stimulants
Corticosteroids, Heart Medications,
Metabolic regulators



Personal care products

Surfactants (soaps & detergents)
Antibacterials
Insect repellent (DEET)



Industrial Compounds

Plastics (bisphenol a)
Alkylphenol Ethoxylates
Perfluorinated Compounds



Other

Caffeine

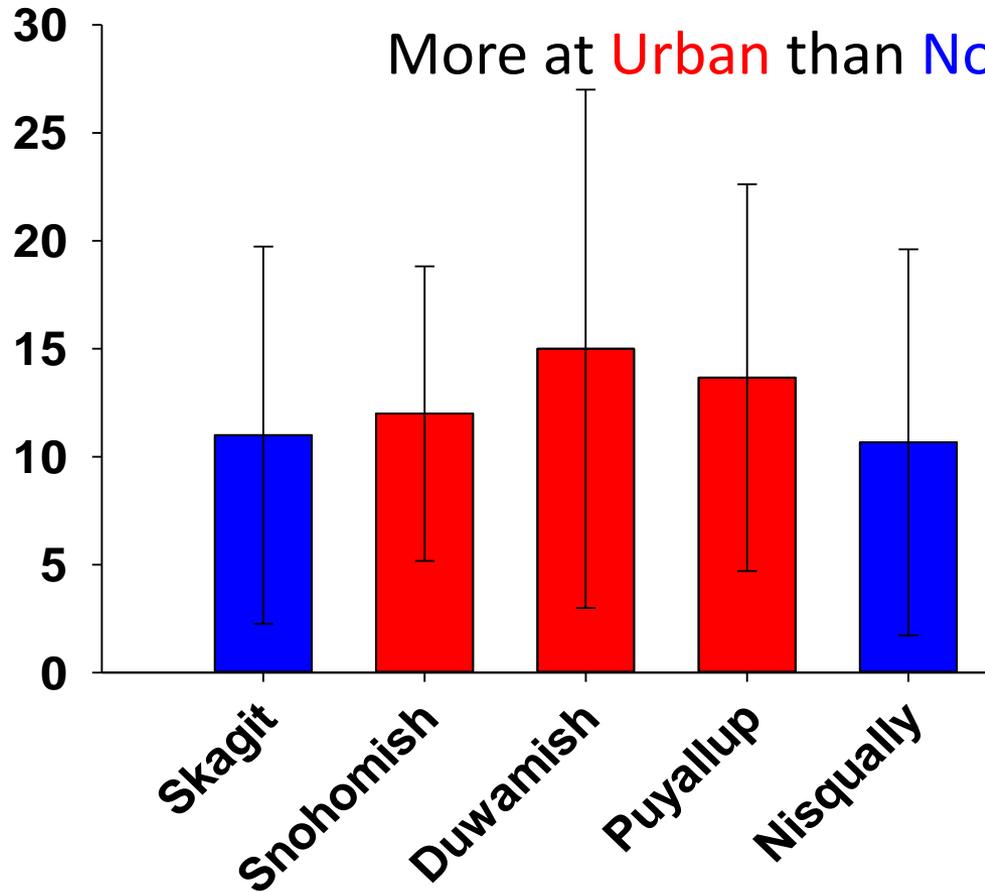


Subset of 2013 samples analyzed for 194 CECs

Number CECs Detected by River System (mean + 95% CI)

48 CECs detected:

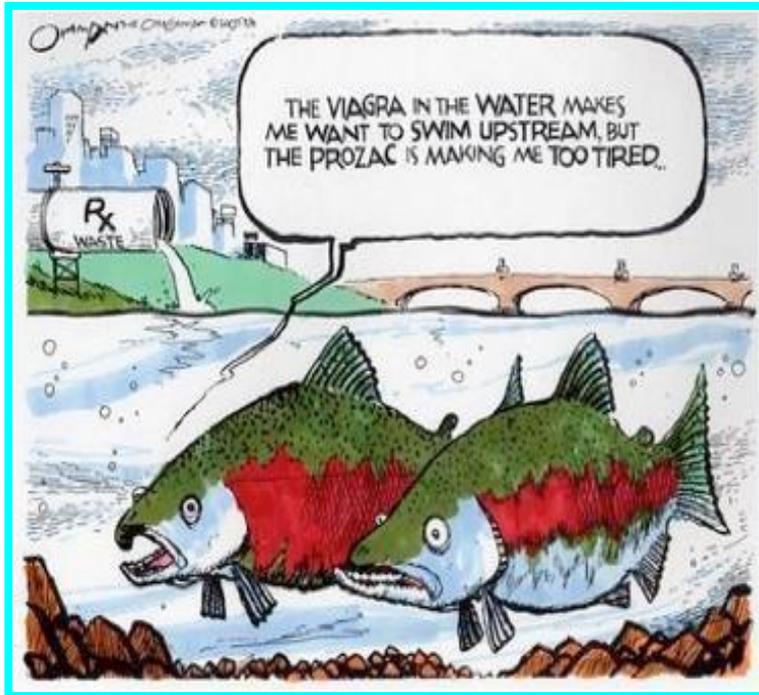
More at **Urban** than **Non-urban** habitats



Concentrations of pharmaceuticals (heart medications & antidepressants) are higher in Puyallup River Chinook.

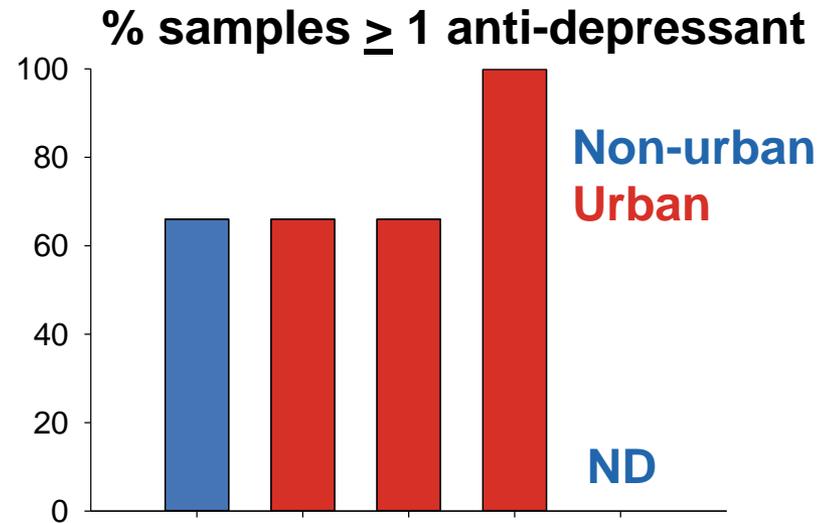
5 Anti-depressants detected

Doses of Zoloft and Prozac are high enough to cause potential adverse effects in Puyallup juvenile Chinook.

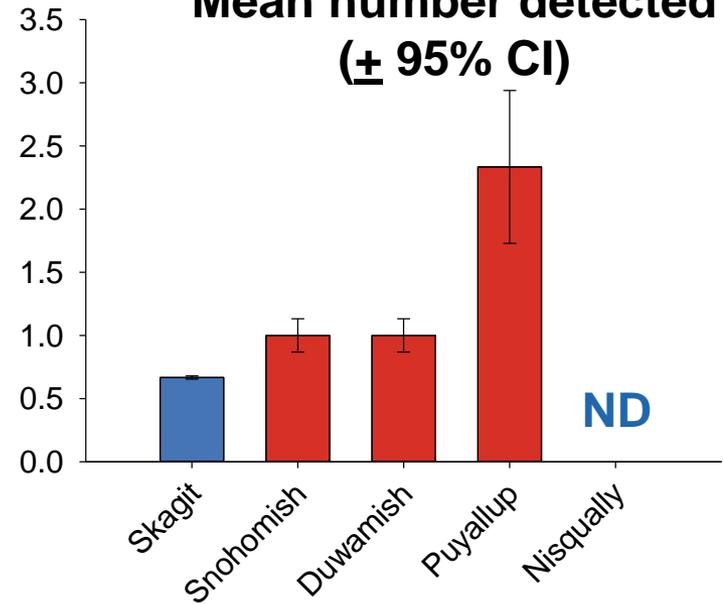


% Samples Containing Anti-depressants

- Citalopram (Celexa) – 40%
- Sertraline (Zoloft) – 27%
- Fluoxetine (Prozac) – 20%
- Norfluoxetine (Prozac metabolite) – 7%
- Amitriptyline – 7%



Mean number detected (\pm 95% CI)



Factors Contributing to Declines in Salmon Marine Survival



- climate change
- food web dynamics
- disease
- habitat loss/alteration
- **toxics**

Do chemically contaminated river estuaries in Puget Sound (Washington, USA) affect the survival rate of hatchery-reared Chinook salmon?

James P. Meador

Abstract: This study examined the rate of survival for hatchery-reared, ocean-type juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to the adult life stage in relation to contamination status for estuaries where they temporarily reside. The hypothesis tested here is that juvenile Chinook from Puget Sound (Washington, USA) area hatcheries exhibit differential survival as categorized by the state of contamination in their respective natal estuaries. Data were examined from 20 hatcheries that released fish to 14 local estuaries in the Greater Puget Sound area over 37 years (1972–2008). A parallel analysis was also conducted for coho salmon (*Oncorhynchus kisutch*) outmigrating from many of the same hatcheries. For all years combined, juvenile Chinook transiting contaminated estuaries exhibited an overall rate of survival that was 45% lower than that for Chinook moving through uncontaminated estuaries, which was confirmed when tested year by year. The results for coho originating from the same hatcheries and sharing a similar marine distribution indicated no substantial differences among estuaries. These observations have important implications for wild juvenile Chinook that spend more time in the estuary compared with hatchery-reared fish.

Résumé : L'étude se penche sur le taux de survie jusqu'au stade de vie adulte de saumons quinnats (*Oncorhynchus tshawytscha*) juvéniles de type océanique élevés en écloserie par rapport à l'état de contamination des estuaires dans lesquels ils résident provisoirement. L'hypothèse testée veut que les saumons quinnats juvéniles issus d'écloseries de la région du Puget Sound (État de Washington, États-Unis) présentent des taux de survie distincts selon l'état de contamination de leurs estuaires nats respectifs. Des données ont été examinées pour 20 écloseries ayant relâché des poissons dans 14 estuaires de la grande région du Puget Sound pendant une période de 37 ans (1972–2008). Une analyse parallèle a également été réalisée pour le saumon coho (*Oncorhynchus kisutch*) migrant vers la mer à partir de bon nombre des mêmes écloseries. Pour toutes les années combinées, les quinnats juvéniles ayant transité par des estuaires contaminés présentent un taux de survie global de 45 % inférieur à celui de saumons quinnats transitant par des estuaires non contaminés, une observation également avérée à l'échelle annuelle. Les résultats pour les saumons cohos issus des mêmes écloseries et présentant une répartition marine semblable n'indiquent aucune différence notable entre estuaires. Ces observations ont d'importantes conséquences en ce qui concerne les saumons quinnats juvéniles sauvages, qui passent plus de temps en estuaire que les poissons élevés en écloserie. [Traduit par la Rédaction]

Can. J. Fish. Aquat. Sci. 71: 162–180

Hatchery Chinook salmon migrating out through Puget Sound

contaminated rivers had a 45% lower marine survival than those from uncontaminated habitats.

Puyallup River hatchery Chinook had a 78% lower marine survival.

Hatchery Coho salmon migrating do not show this pattern.

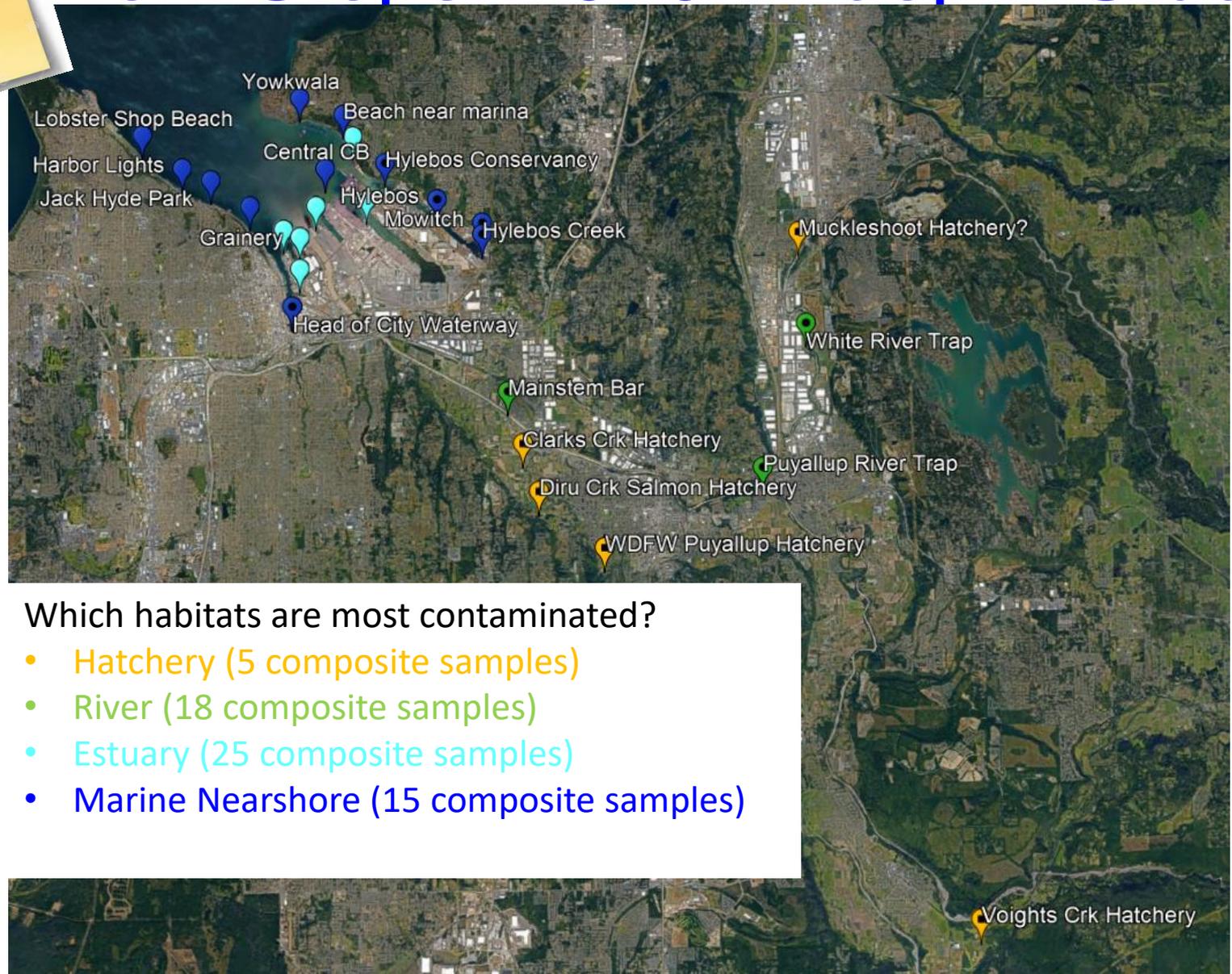
Conclusions:



- Seaward migrating juvenile Chinook salmon from the estuarine and marine nearshore habitats of developed watershed have elevated levels of man-made chemicals (PCBs, PBDE, DDTs, PAHs), some metals (lead) and CECs.
- PCBs, PBDEs, CECs in juvenile Chinook salmon migrating through the Puyallup River and Commencement Bay are high enough to cause adverse effects, likely affecting marine survival. Wild fish more exposed. Effects may be worse with climate change.
- Juvenile coho salmon and steelhead trout are exposed to lower levels of contaminants.
- Contaminants in adult Chinook salmon below levels known to affect human health, except for PCBs in resident fish (i.e., blackmouth).



Next Steps: 2020 In-depth Study



Which habitats are most contaminated?

- Hatchery (5 composite samples)
- River (18 composite samples)
- Estuary (25 composite samples)
- Marine Nearshore (15 composite samples)



Acknowledgments



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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

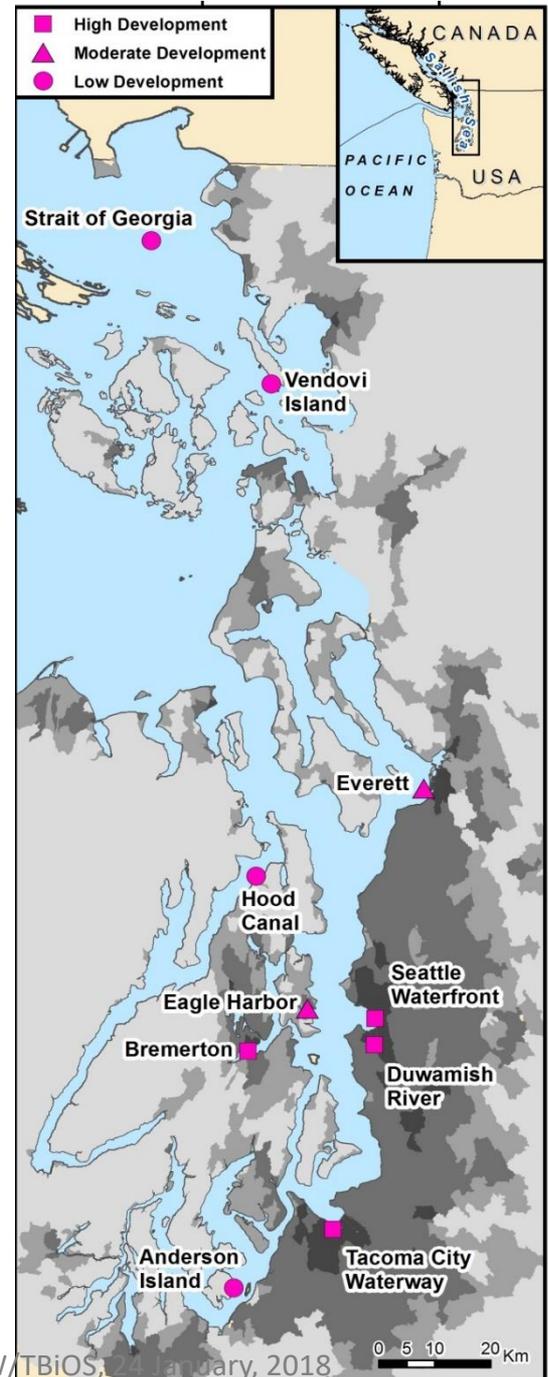
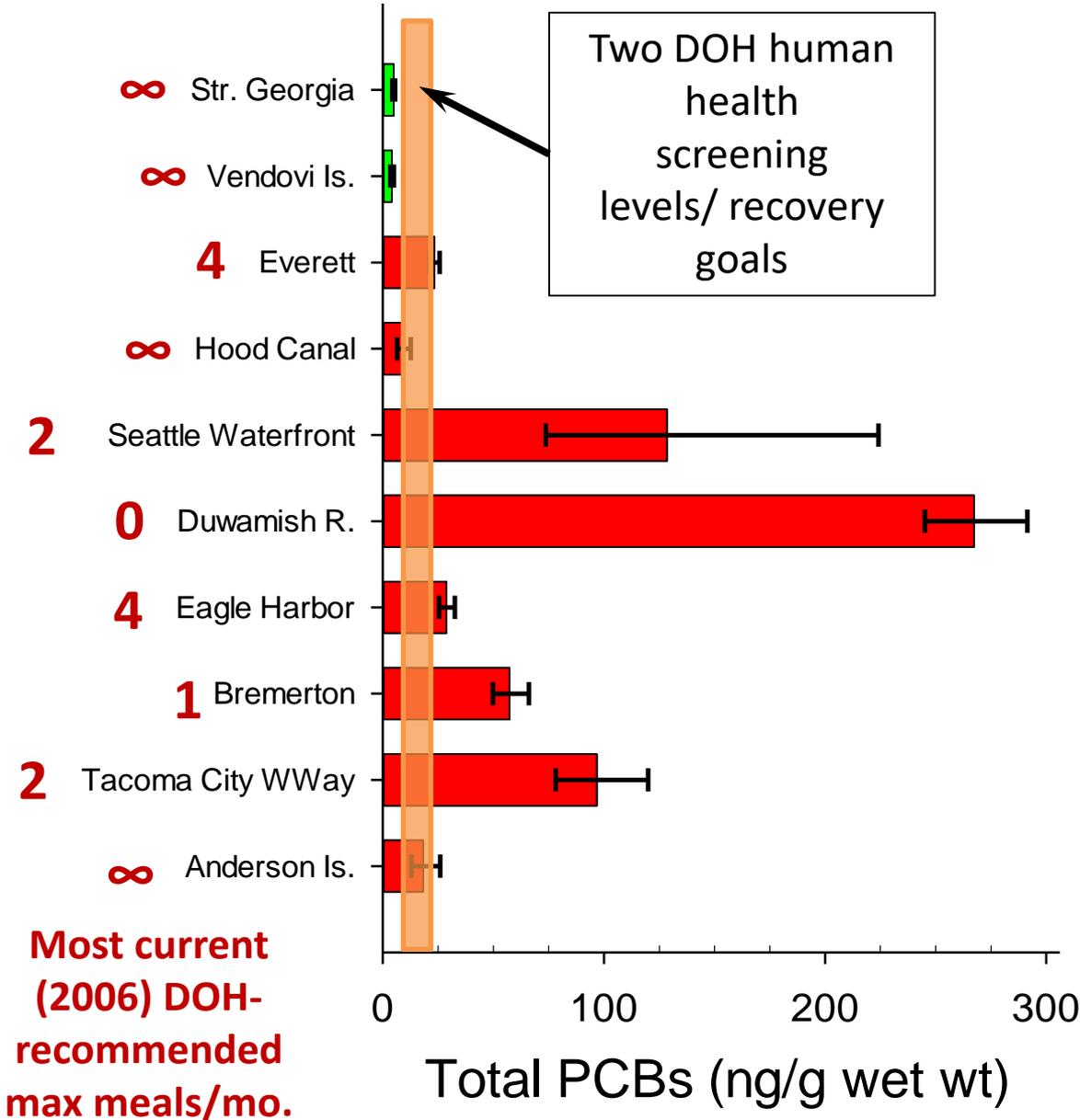
NOAA NWFSC

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Lyndal Johnson
Gina Ylitalo
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WA Dept of Ecology
Tom Gries
Dale Norton
Manchester Lab Staff
Other
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Madilyn Gamble
Steve Damm

A scenic landscape featuring a river flowing through a forested area with a large, snow-capped mountain in the background. The text "Questions?" is overlaid in the center.

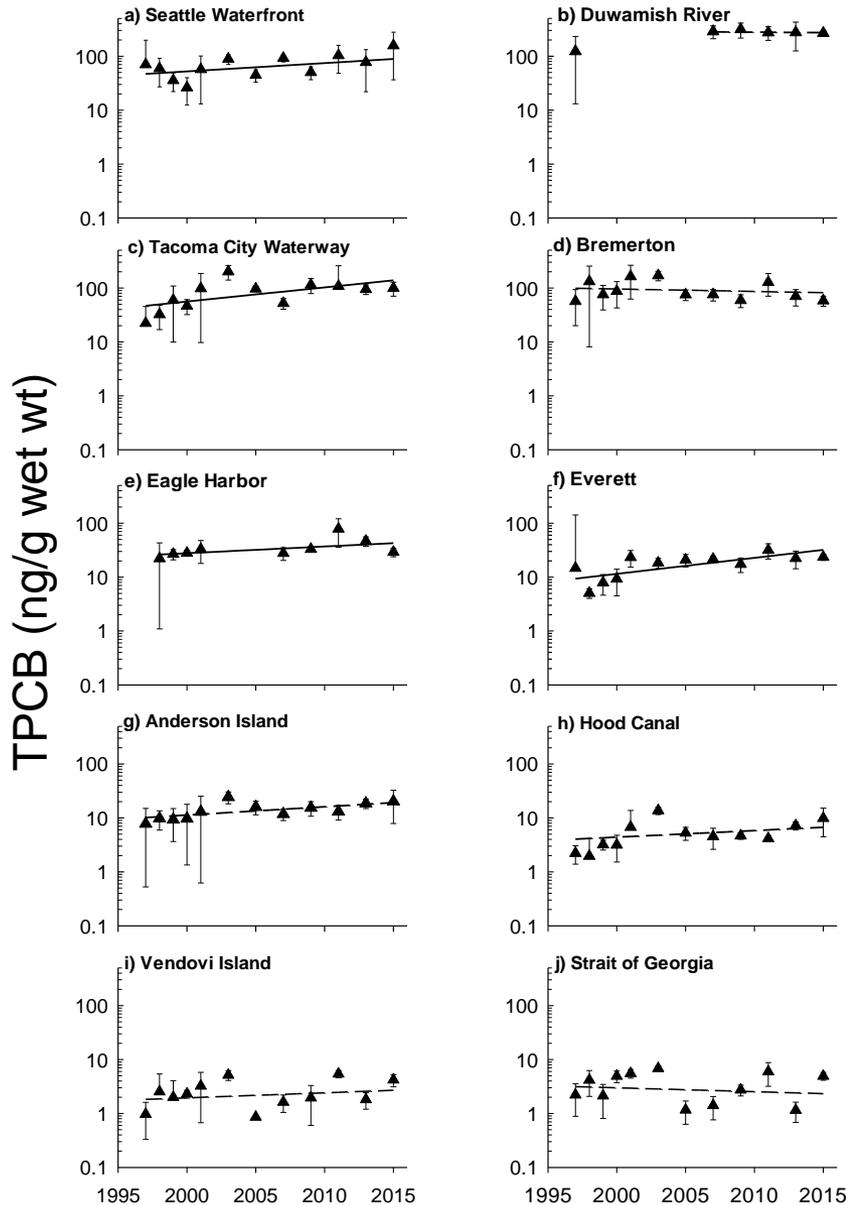
Questions?

2015 English sole PCB Levels



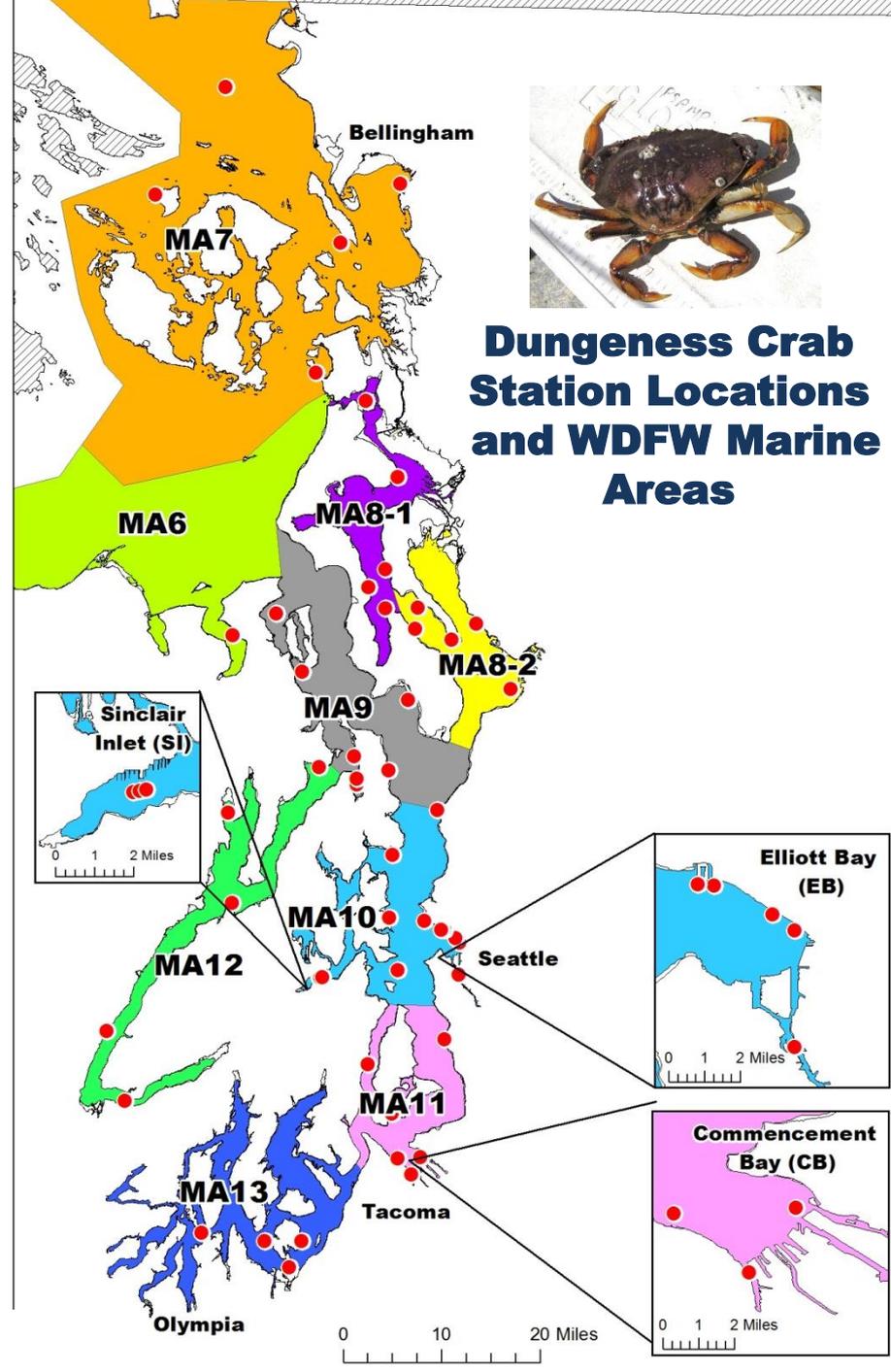
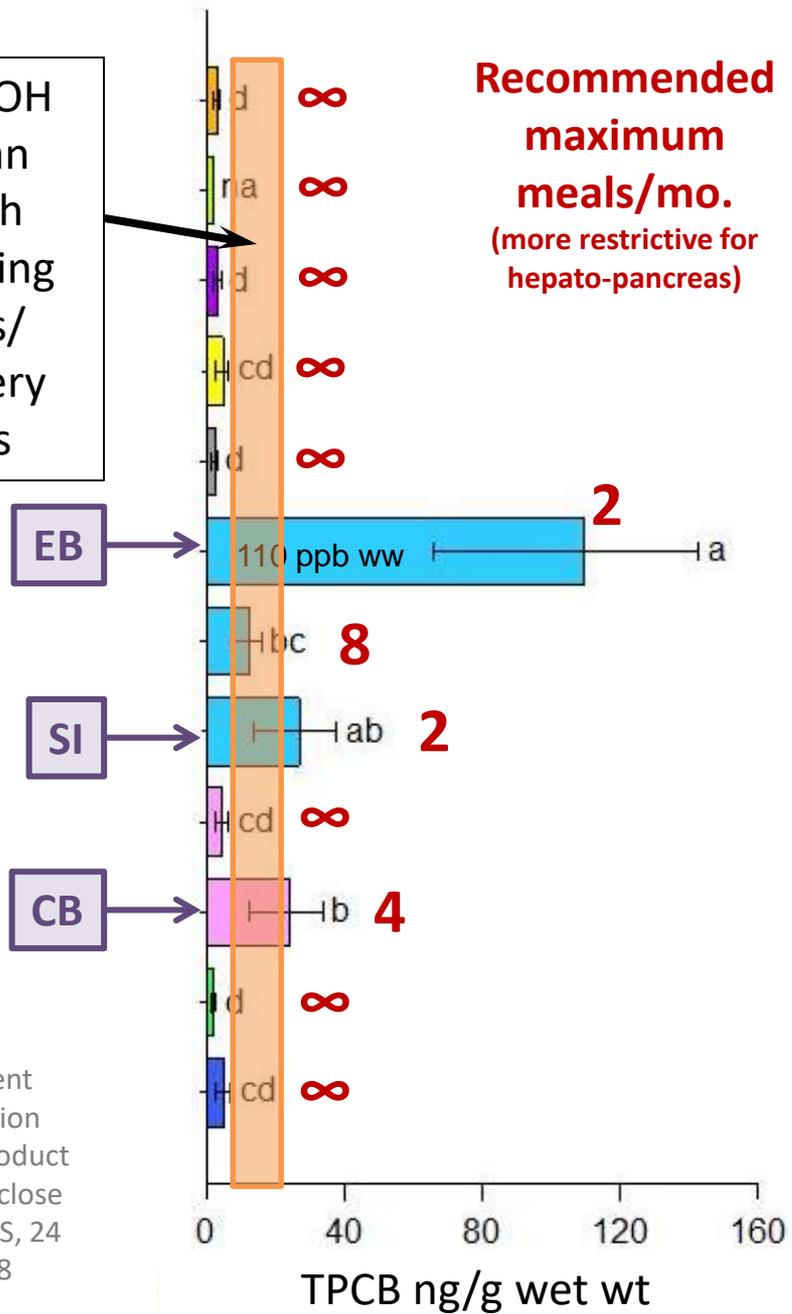
PCBs Through Time in English Sole

No
declining
trends



Total PCBs – CRAB Muscle

Two DOH human health screening levels/recovery goals



Confidential Attorney-Client Communication and Work Product – Do Not Disclose WDFW/TBios, 24 January, 2018

Dungeness Crab (2011-2012 study)

- POPs – highest concentrations in urban areas
 - PCBs – not as high as EB, but were similar to SI (3 highest levels)
 - PBDEs – CB highest levels of all areas, but relatively low when compared to ES
 - DDT – highest levels, similar to EB, but relatively low
- Metals
 - Detected but expected because naturally found in SW
 - Lead and mercury concentrations related to urban habitats
- DOH consumption advisory
 - Muscle - 4 servings/month
 - Butter/hepatopancreas – avoid or 2 servings/month)



Vertical bar chart of PCBs or PBDEs along the bottom? Highlighting Comm Bay?

