Impacts of Residues in Salmon

(Toxic contaminants in Puget Sound salmon)

Briefing to the Fish and Wildlife Commission

(requested by commissioner Wecker)

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Sandra M. O'Neill, M.Sc.
Friday, June 10, 2016

Photos by Richard Bell, © UW Press

WDFW Fish Program's Toxics in Biota Team

Mission statement

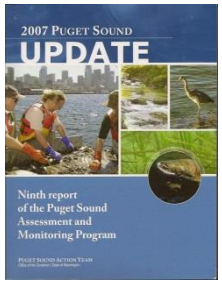
(since 1989…..)

WDFW photo

Evaluate the effects of toxic contaminants on marine and anadromous species to:

- ***guide efforts to protect fish and shellfish health,***
- ***ensure seafood safety (supply data to DOH), and***
- ***promote ecosystem recovery.***

WDFW photo



WDFW photo

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T. Quinn photo

Richard Bell photo

R. Shuman photo

WDFW monitors toxics in sentinel species

Photo by Richard Bell

Photo by Richard Bell

WDFW photo

Pacificwild.org photo

https://en.wikipedia.org/wiki/Krill_fishery

Marchetti/Allen photo

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Vancouver Aquarium photo

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Our Staff……

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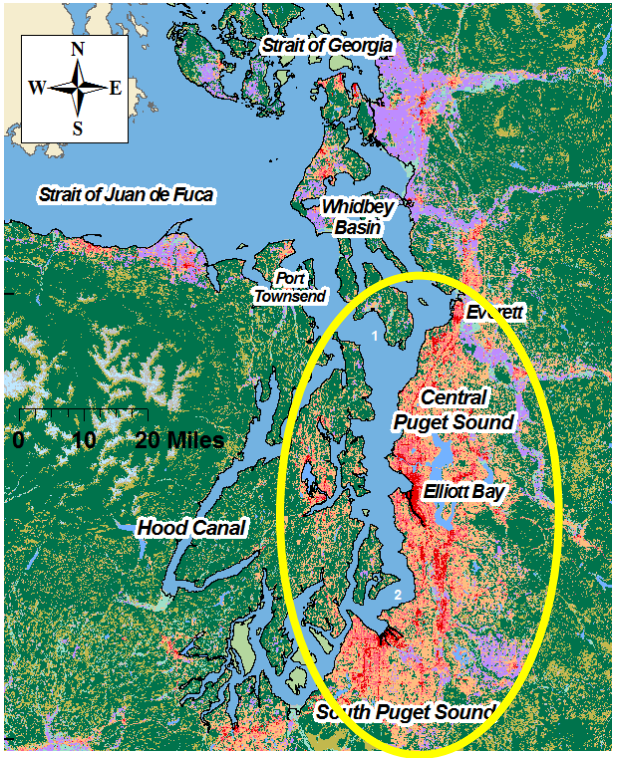
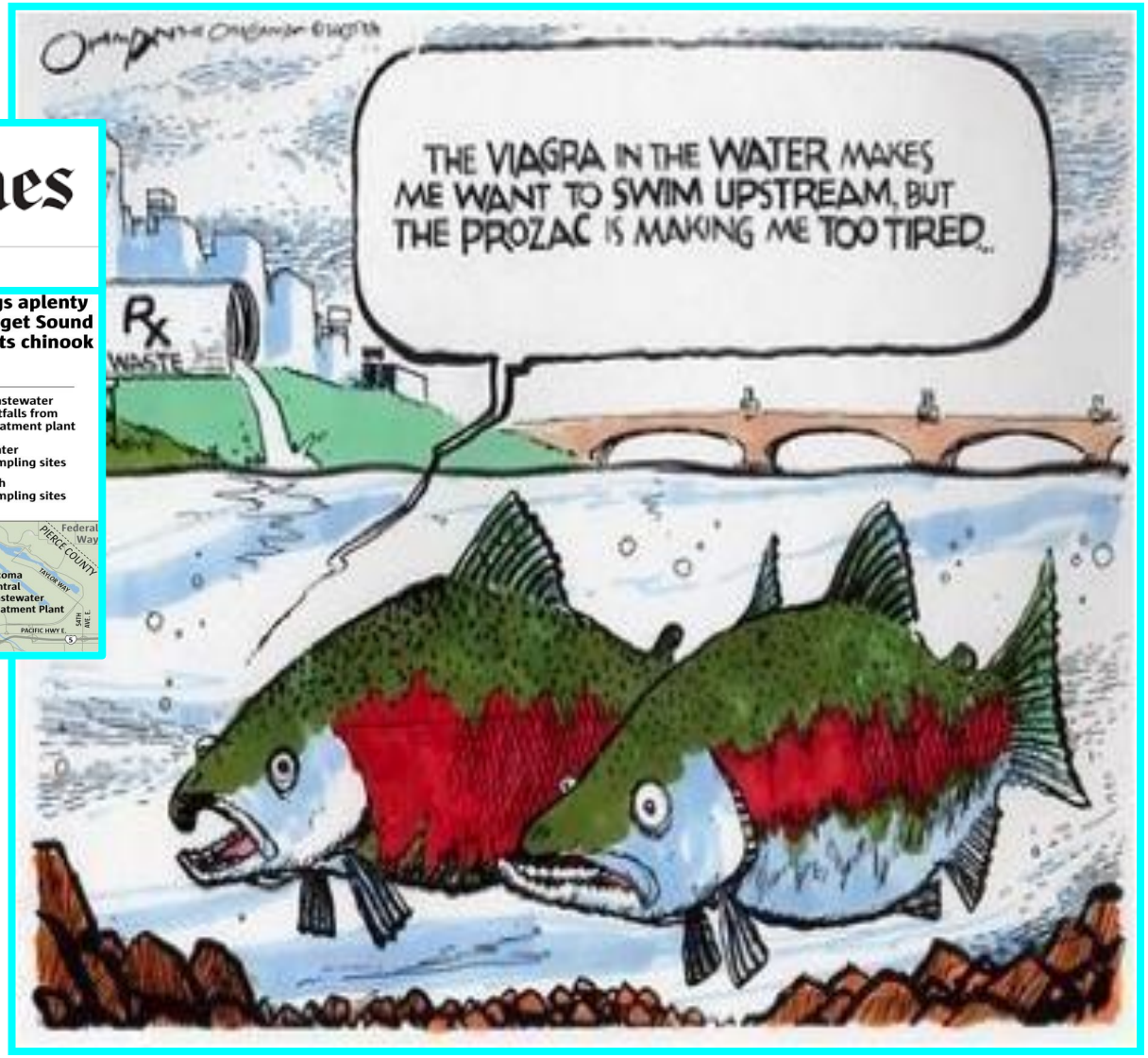
Urbanization Impacts on Salmon

- habitat loss/modification
  - altered water flow timing
  - temperature
- central & south Puget Sound most threatened
- ***<u>toxic contaminants</u>***
  - industrial development
  - wastewater treatment plants & septic system
  - stormwater runoff
  - landfills
  - agriculture



“Drugs aplenty in Puget Sound and its Chinook”



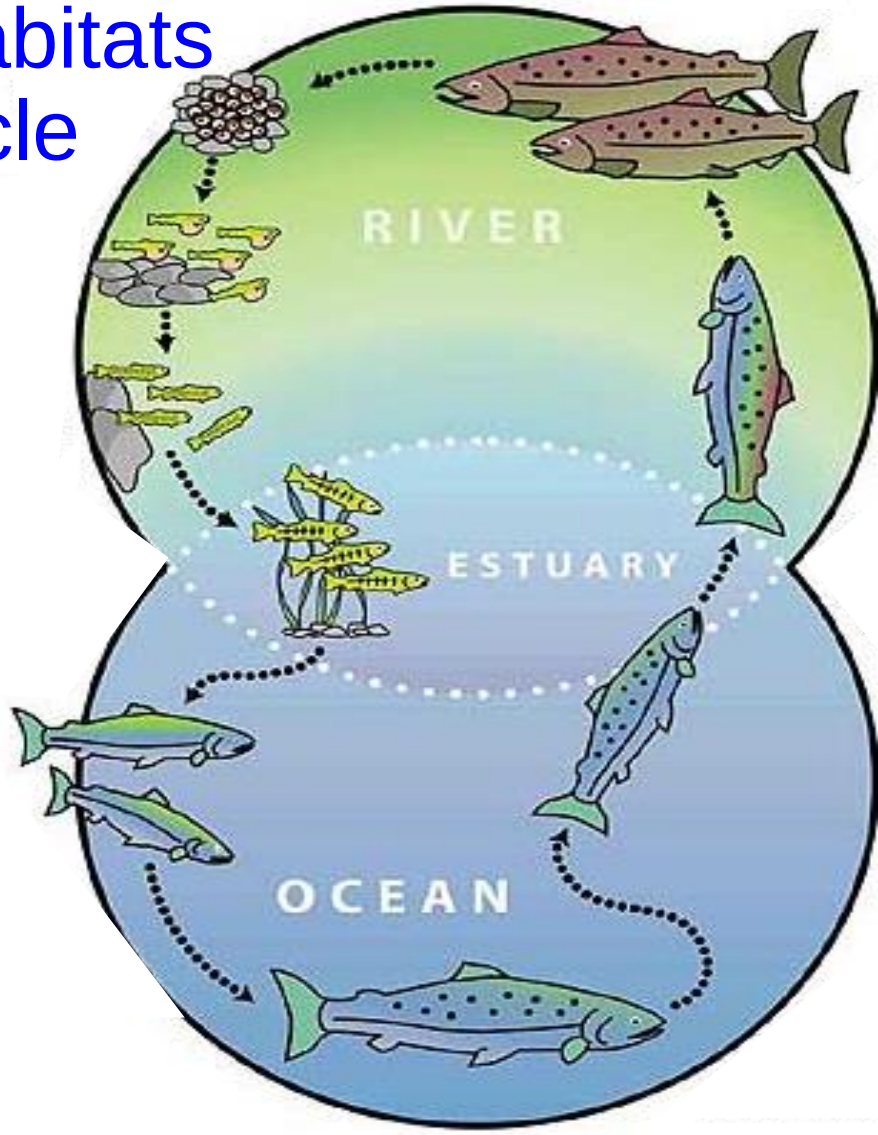
F&W Commission presentation, 10 June, 2016. WA Dept. of Fish and Wildlife, Information subject to changes and amendments over time.

Outline

- Review potential contaminant issues for Puget Sound salmon (Contaminants 101)
- Summarize recent studies on juvenile Chinook salmon
  - NOAA Study on chemical in wastewater
  - WDFW's Contaminant Monitoring Survey
- Summarize WDFW's studies on adult salmon
  - Contaminant exposure in salmon
  - Contaminant transfer up the food web

Salmon may be exposed to contaminants in various habitats throughout their life cycle

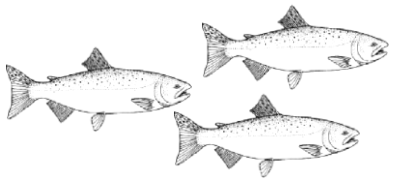
Chinook salmon are most at risk



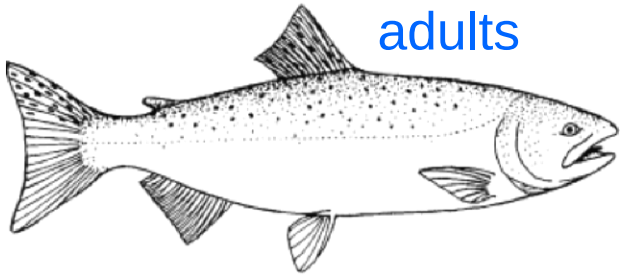
Salmon digital art by David Ehlert, © UW Press

Life cycle graphic from original by GIS Visual Communications Unit, King County Department of Natural Resources

Two Major Types of Contaminants

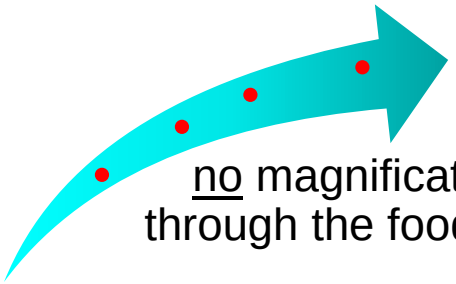


juveniles



adults

Don't accumulate



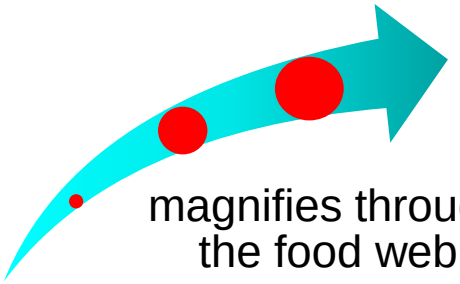
no magnification through the food web

- Salmon Health

- Salmon Health

vs.

Accumulate



magnifies through the food web

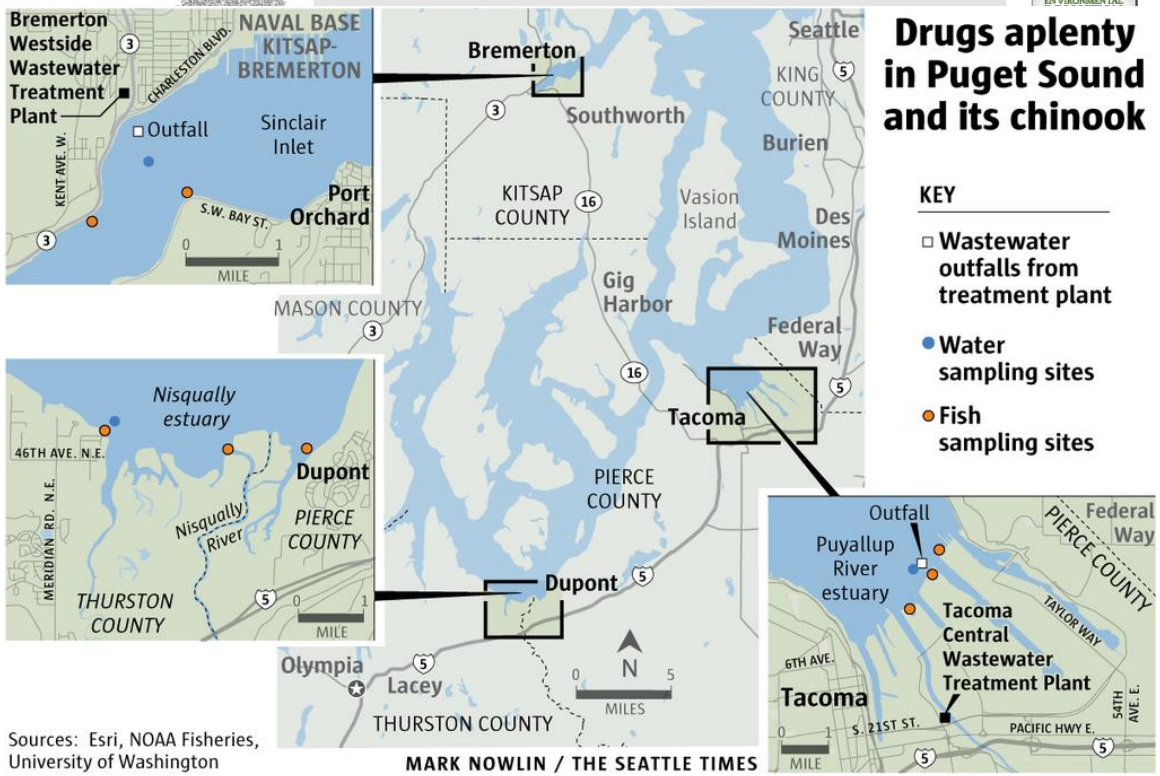
- Salmon Health
  - Fish Health
  - Bird Health
  - Seal Health

- Salmon Health
  - Human Health
  - Killer Whale Health

Chemicals of Emerging Concern in Wastewater

Environmental Pollution 213 (2016) 254–267

Contents lists available at ScienceDirect



1. Introduction

Contaminants of emerging concern (CECs) constitute a wide range of chemicals for which there is limited data on occurrence, (WWTP) effluent discharging via outfalls to these water bodies. Other sources of CECs to waterways include discharges from industrial sources and aquaculture operations, in addition to runoff from impervious surfaces, landfills, biosolids application, and

Salmon samples analyzed

- 2 at Sinclair Inlet
- 2 – Puyallup
- 1 at Nisqually

Contaminant Levels

- Puyallup - highest
- Sinclair In. - intermediate
- Nisqually - lowest

Meador et al. 2016. Environmental Pollution 213:254-267

Chemicals of Emerging Concern Detected in Juvenile Chinook Salmon

Pharmaceuticals

- Antibiotics (erythromycin, ometoprim)
- Antihistamine (diphenhydramine)
- Antidepressants (Prozac, Zoloft)
- Antifungals (miconazole)
- Sedatives (Valium)
- Stimulants (amphetamine)
- Corticosteroids (fluocinonide)
- Metabolic regulators (gemfibrozil, amlodipine)

Personal care products

- Surfactants (soaps & detergents,
- Antibacterials (troclosan, triclocarban)
- Insect repellent (DEET)

Industrial Compounds

- Flame retardants (HBCDD)
- Plastics (bisphenol a)
- Perfluorinated Compounds (PFOS, PFOA)

Other

- Caffeine

What are the potential effects of Chemicals of Emerging Concern?

Juvenile salmon

- This is first look at the “dose”.
- Degree of accumulation is uncertain for some CECs.
- Toxicity unknown for many CECs.
- NOAA is conducting a lab exposure study to determine effects.


Chinook salmon photo by Richard Bell


Belted Kingfisher
http://www.wildlifesouth.com/Featured/2011/Belted_Kingfisher.html

- Potential health concern for some of their predators (fish, birds, seals).
- Less direct health concerns for people and killer whales.

WDFW's Juvenile Chinook Salmon Contaminant Monitoring Survey 2013

Chinook salmon photo by Richard Bell

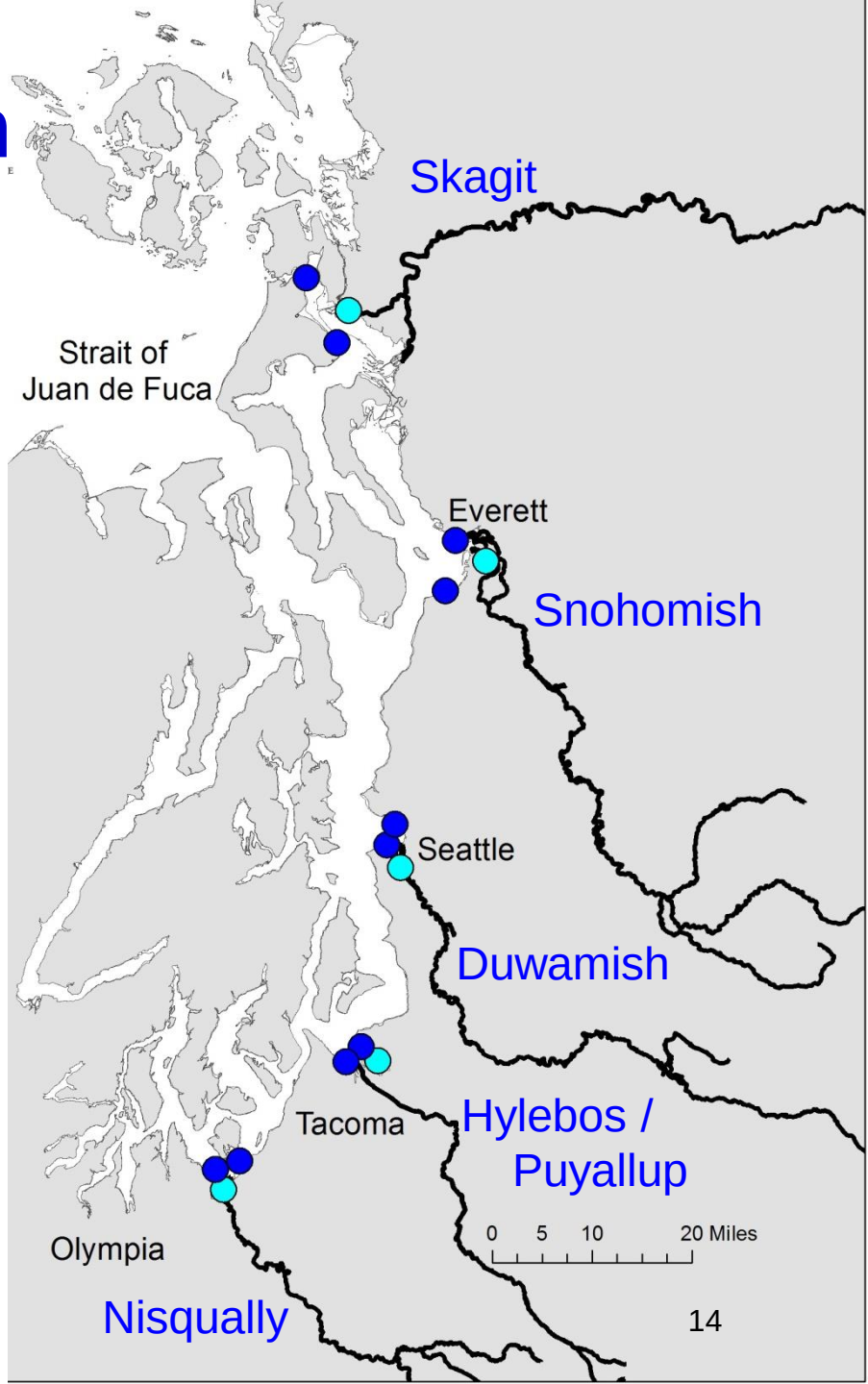
Are juvenile Chinook salmon from Puget Sound exposed to <u>known</u> contaminants of concern, at levels high enough to affect their health and survival?

2013 Sampling Design

Five major river systems

- **Estuary** habitats (May)
- **Marine nearshore** habitats (June)

Boat and seining photos by Andrea Carey



F&W Commission presentation, 10 June, 2016. WA Dept. of Fish and Wildlife, Information subject to changes and amendments over time.

Methods: contaminants measured

583 Chinook salmon combined into 88 composite samples

Accumulative

PCBs (lubricant/coolant)
PBDEs (flame retardants)
DDTs
HCB
Chlordanes
HCHs
} pesticides
Lead
Cadmium

Non-accumulative

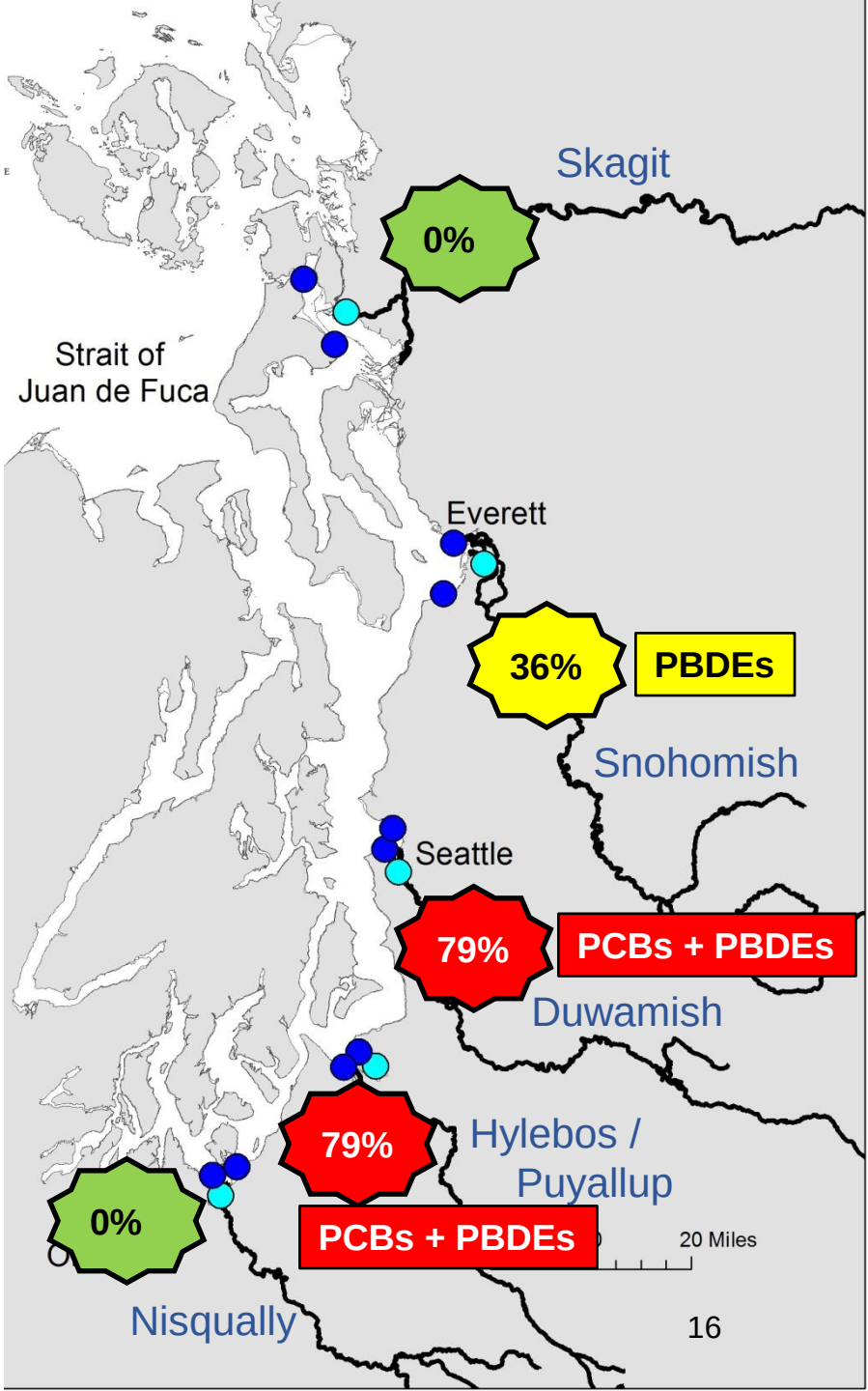
Zinc
Copper
Nickel
$\sum_{37}$ PAHs (hydrocarbons)

2013 Results

% Juvenile Chinook salmon with contaminant levels high enough to cause adverse health effects.

EFFECTS

Mortality
Impaired growth & reproduction
Increased disease susceptibility
Altered thyroid hormone production
Hormone alterations
Vitellogenin induction
Enzyme induction



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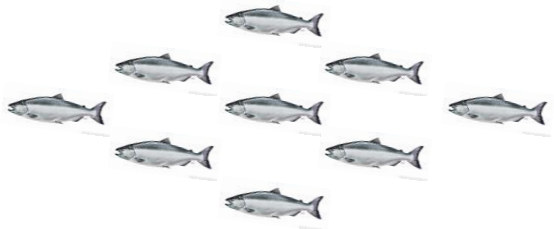
2016 Juvenile Chinook Salmon: Expanded Survey

- Improved sampling design
  - Assess all ESA populations in Puget Sound evolutionarily significant unit (ESU)
  - **Measure more contaminants (CECs)**
  - Model effects of contaminant mixtures



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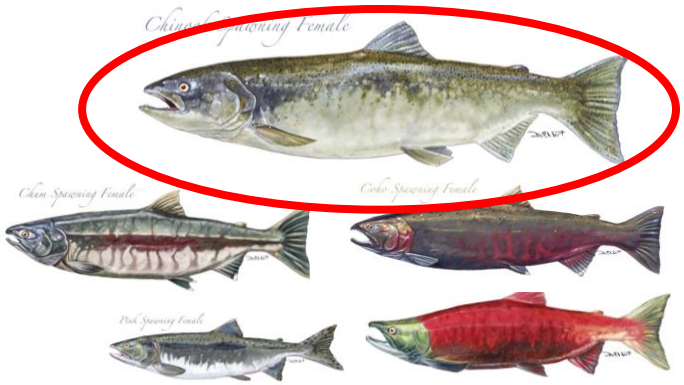
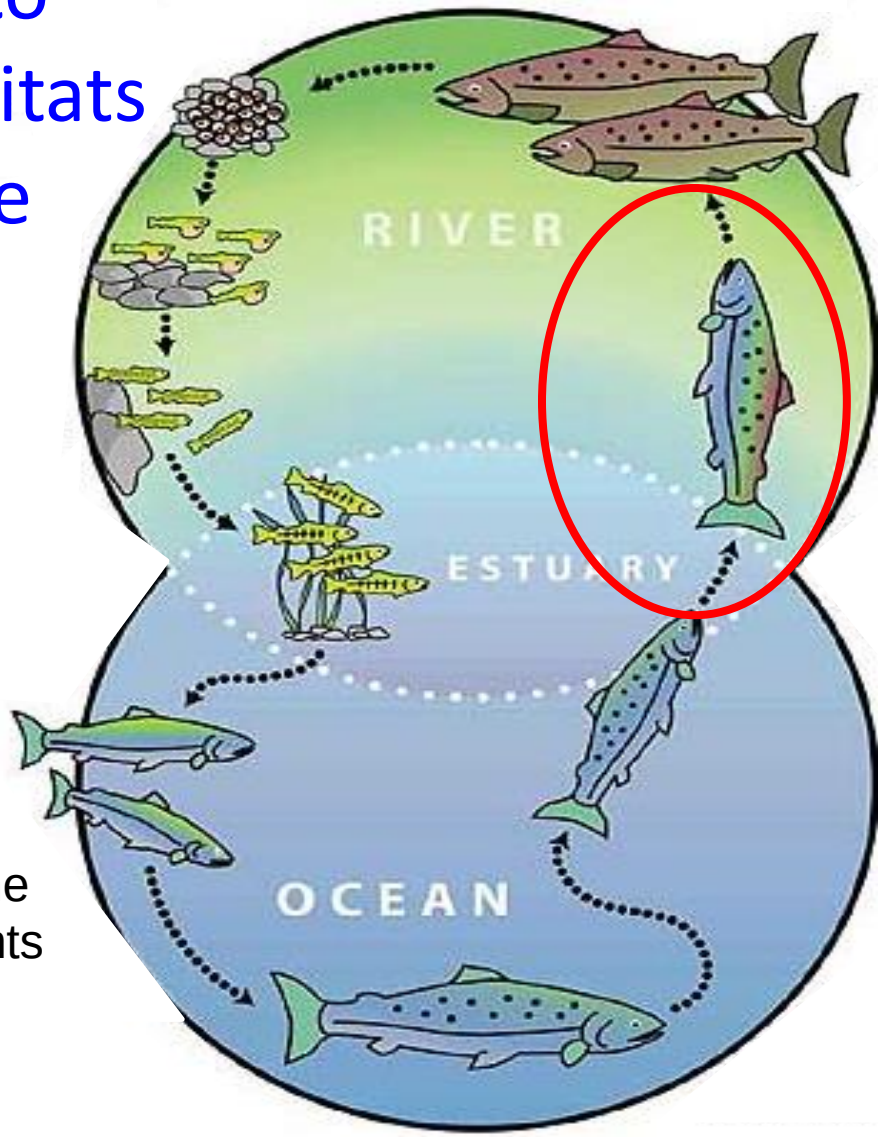
Salmon may be exposed to contaminants in various habitats throughout their life cycle



Chinook salmon are most at risk

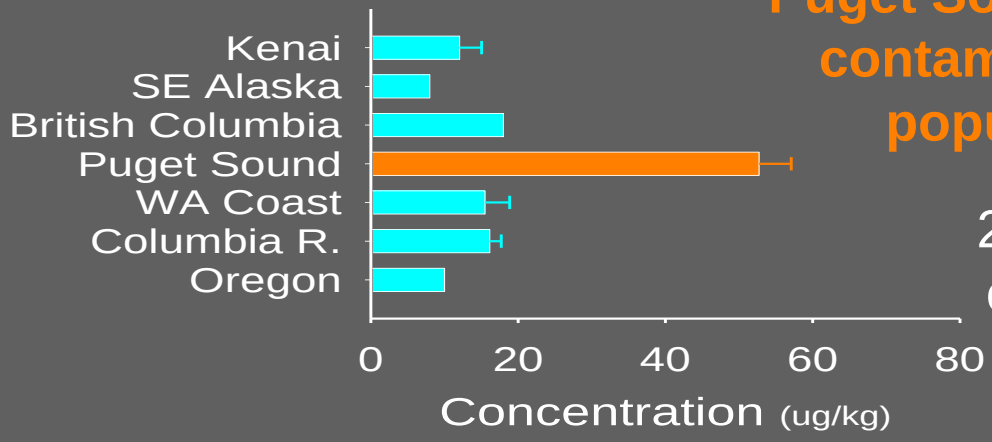
Most of adult salmon growth occurs in marine habitats, thus most accumulative contaminants are accumulated in saltwater, including Puget Sound.



Salmon digital art by David Ehlert, © UW Press

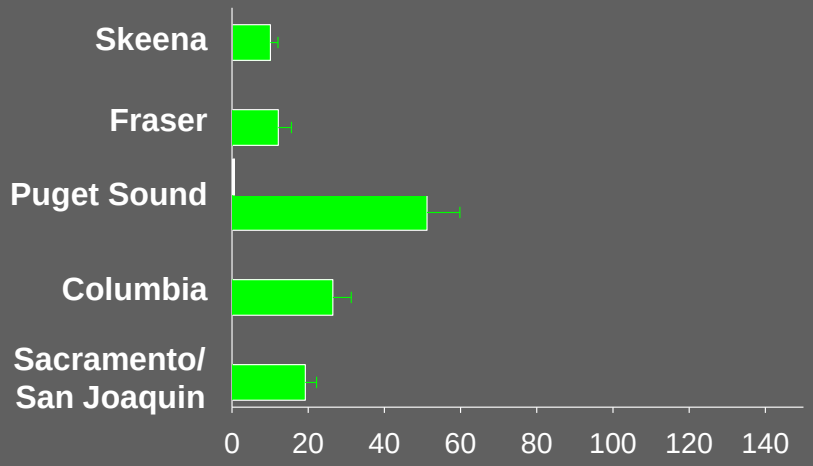
Life cycle graphic from original by GIS Visual Communications Unit, King County Department of Natural Resources

High PCBs in Adult Puget Sound Salmon



Puget Sound Chinook 3 to 5 times more contaminated than other west coast populations (1992- 1998 fillets)

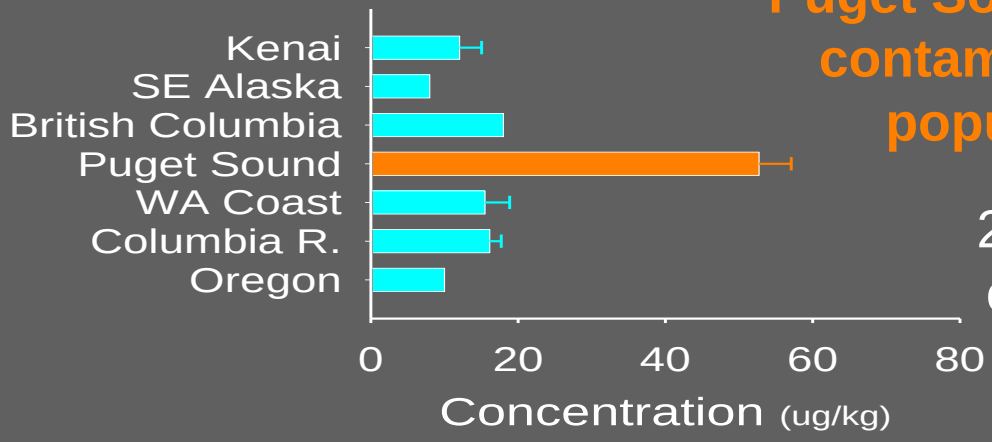
22% of Puget Sound Chinook exceeded an adverse effects threshold



Chinook salmon photo by Richard Bell

O'Neill and West 2009, TAFS 138:616-632
O'Neill et al. in prep

High PCBs in Adult Puget Sound Salmon



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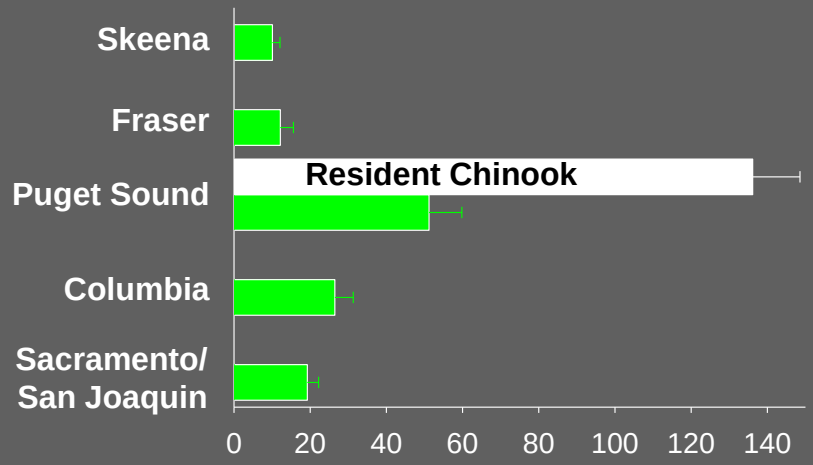


Chinook salmon photo by Richard Bell

A third of Puget Sound Chinook are residents

O'Neill and West 2009, TAFS 138:616-632
O'Neill et al. in prep

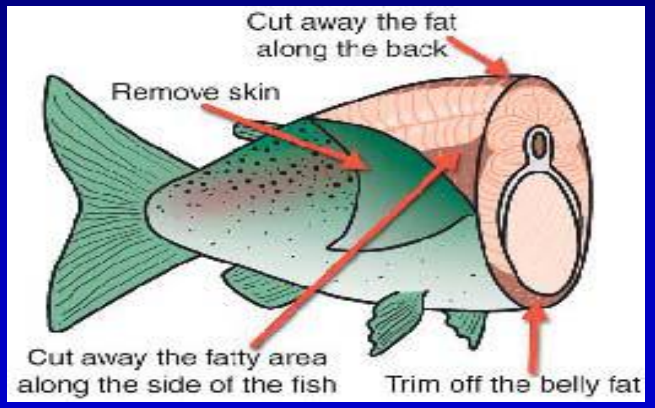
HIGH PCBs in Adult Puget Sound Salmon

2006 DOH Report:

Recommends restricting intake of Puget Sound Chinook salmon

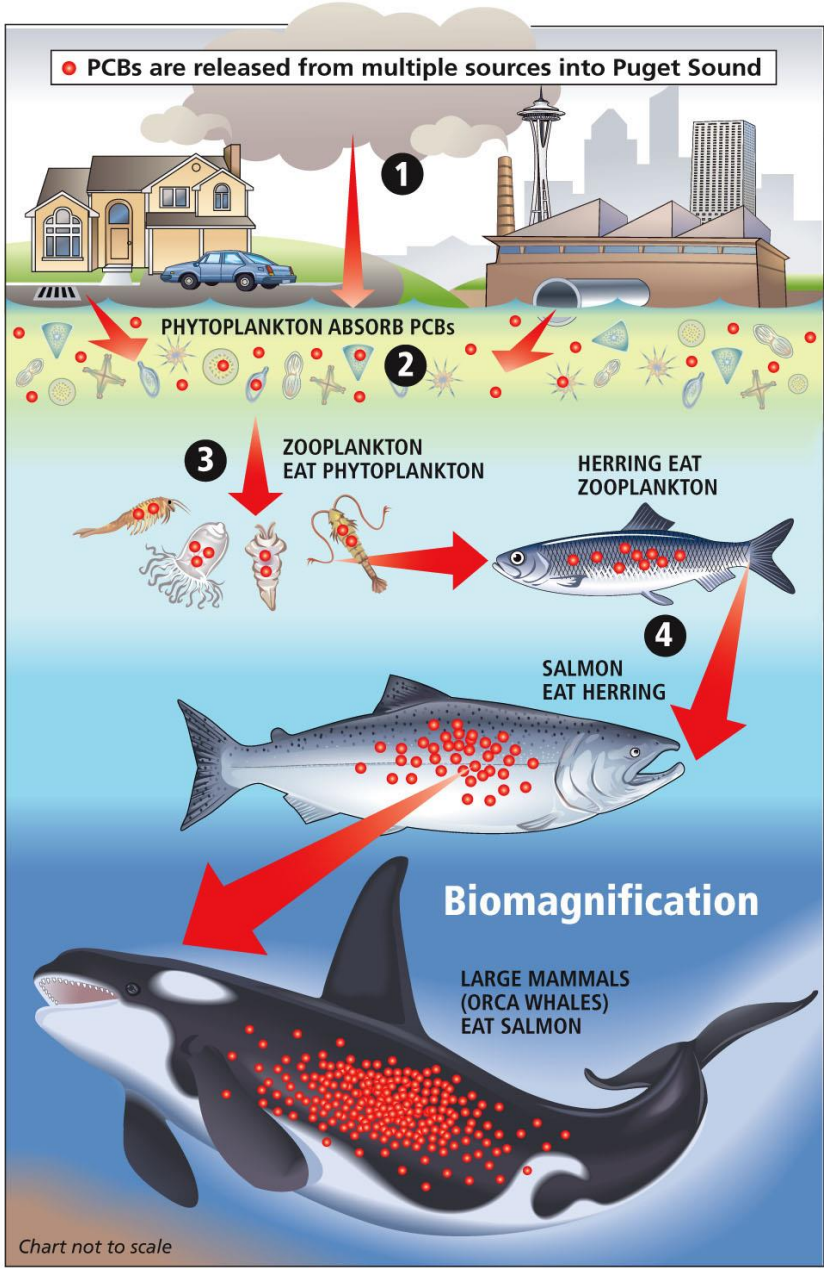
- 4 meals/month
- 2 meals/month for resident fish (blackmouth fishery).

http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-098.pdf



WDFW currently re-analyzing PCBs in resident Chinook salmon

Angler with Chinook salmon -photo by Tom Quinn



Source: Seattle Post-Intelligencer
thezone@seattlepi.com

Bioaccumulative contaminants like PCBs magnify up the pelagic food web

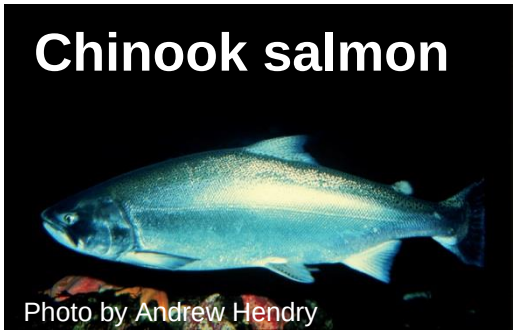


Photo by Graeme Ellis

PCB levels in Puget Sound Chinook salmon may impair the health of killer whales

Hickie et al. 2007

F&W Commission presentation, 10 June, 2016. WA Dept. of Fish and Wildlife, Information subject to changes and amendments over time.

Recap…

- Juvenile salmon, especially Chinook, migrating through ***urban systems*** are exposed to contaminants at levels high enough to reduce their survival. No direct health impacts to people and killer whales.

- Adult Chinook salmon have high levels of PCB and other contaminants because of residency in Puget Sound.

- DOH to review consumption advisories for Chinook salmon.

- Accumulative contaminants in adult Chinook salmon are passed up the food web to apex predators like killer whales and people.

- Adult coho salmon exposed to non-accumulative contaminants in small urban streams – causes prespawn mortality.