Water Quality and Salmon in the Lower Columbia River: Results of the Lower Columbia Estuary Partnership's Ecosystem Monitoring Project and Estuary

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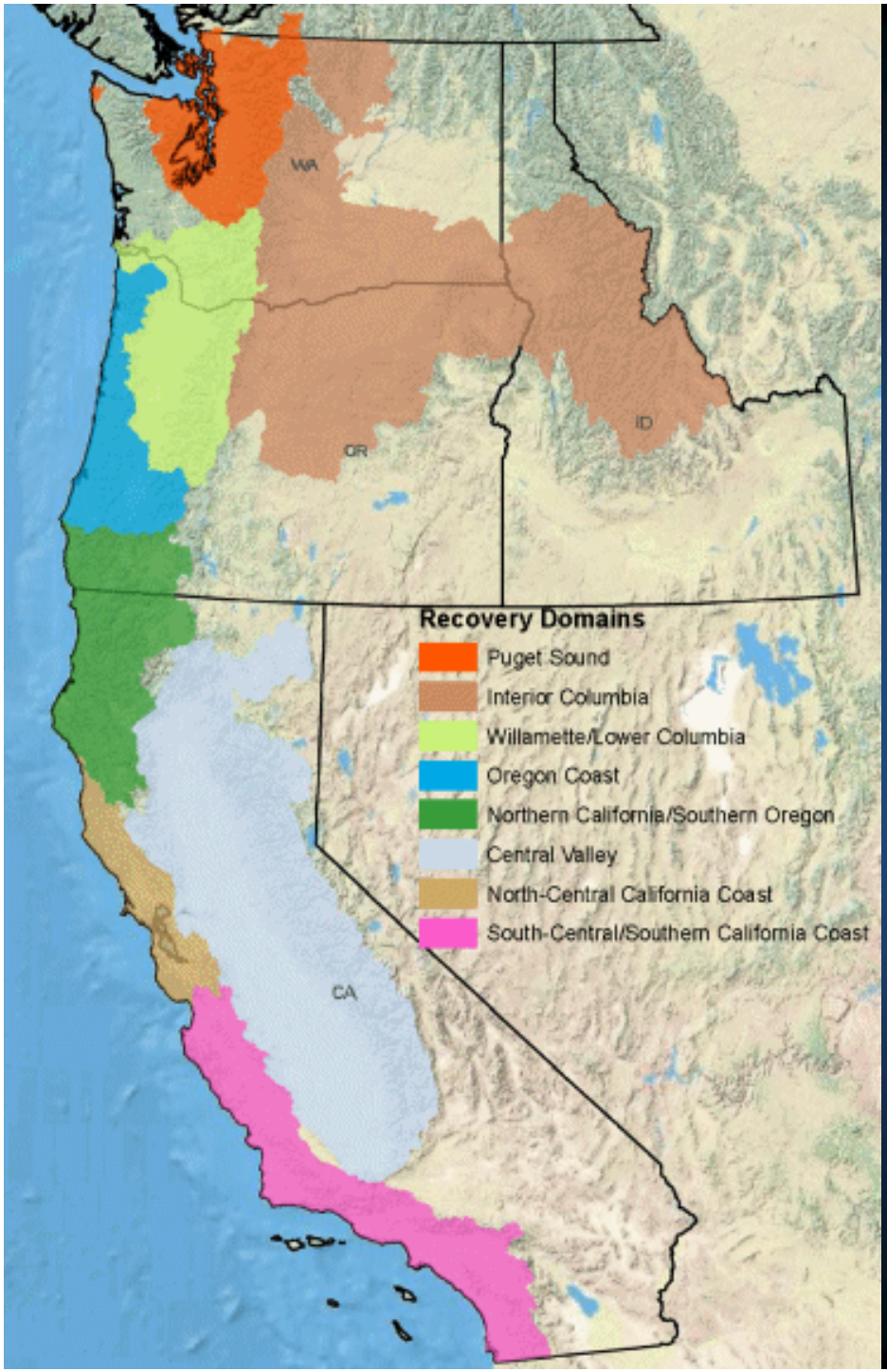
8th National Water Quality Monitoring Conference,

Portland, OR, April 30-May 4, 2012

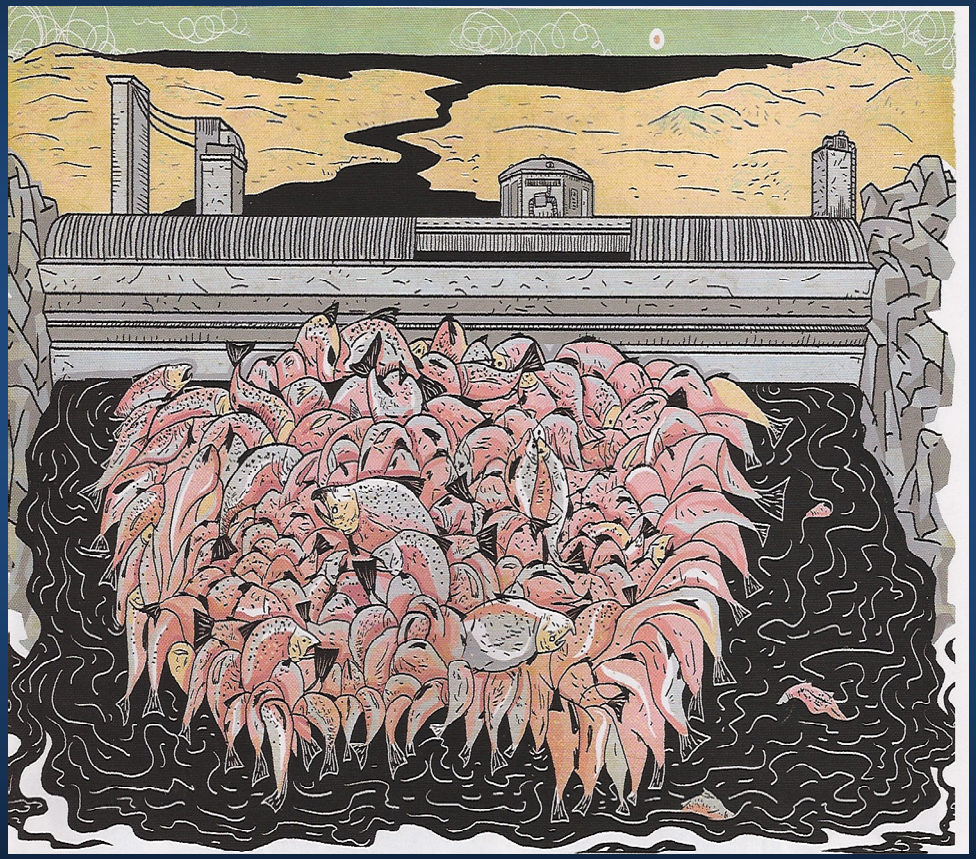


Twenty-seven salmon and steelhead population segments, or Evolutionarily Significant Units (ESUs), are currently listed as either threatened or endangered under the U.S. Endangered Species Act (ESA).

This include 13 stocks in the Columbia Basin

- Snake River Spring/Summer Chinook
- Snake River Fall Chinook
- Lower Columbia River Chinook
- Upper Willamette River Chinook
- Upper Columbia River Spring Chinook
- Lower Columbia River Coho
- Columbia River Chum
- Snake River Sockeye
- Upper Willamette Steelhead
- Snake River Steelhead
- Lower Columbia River Steelhead
- Upper Columbia River Steelhead
- Middle Columbia River Steelhead

Factors Contributing to Salmon Population Declines



- Harvest
- Hydropower
- Hatchery practices
- Habitat loss
- Predation
- Climate change
- Disease

Factors Contributing to Salmon Population Declines

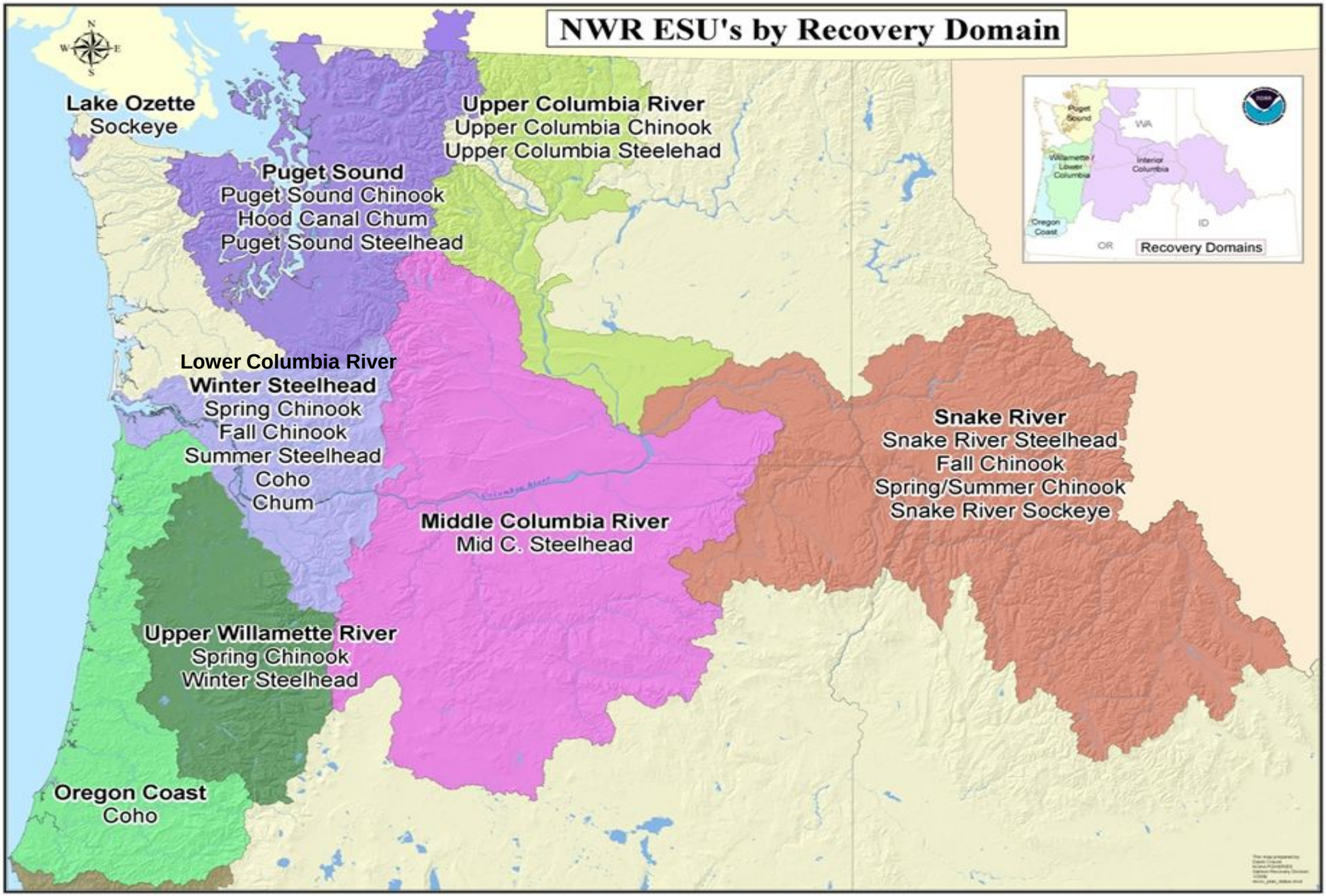
- Harvest
- Hydropower
- Hatchery practices
- Habitat loss
- Toxic chemicals
- Predation
- Climate change
- Disease

Factors Affecting Salmon Toxicity Risk

Exposure profiles and toxicity risks are likely to differ among salmon stocks:

- **with different geographic ranges and migratory pathways**
- **that utilize regions with different land use patterns**
- **with different life histories**

Where they are, how long they're there, and what's going on there


NWR ESU's by Recovery Domain
Lake Ozette
Sockeye
Puget Sound
Puget Sound Chinook
Hood Canal Chum
Puget Sound Steelhead
Upper Columbia River
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Lower Columbia River
Winter Steelhead
Spring Chinook
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Coho
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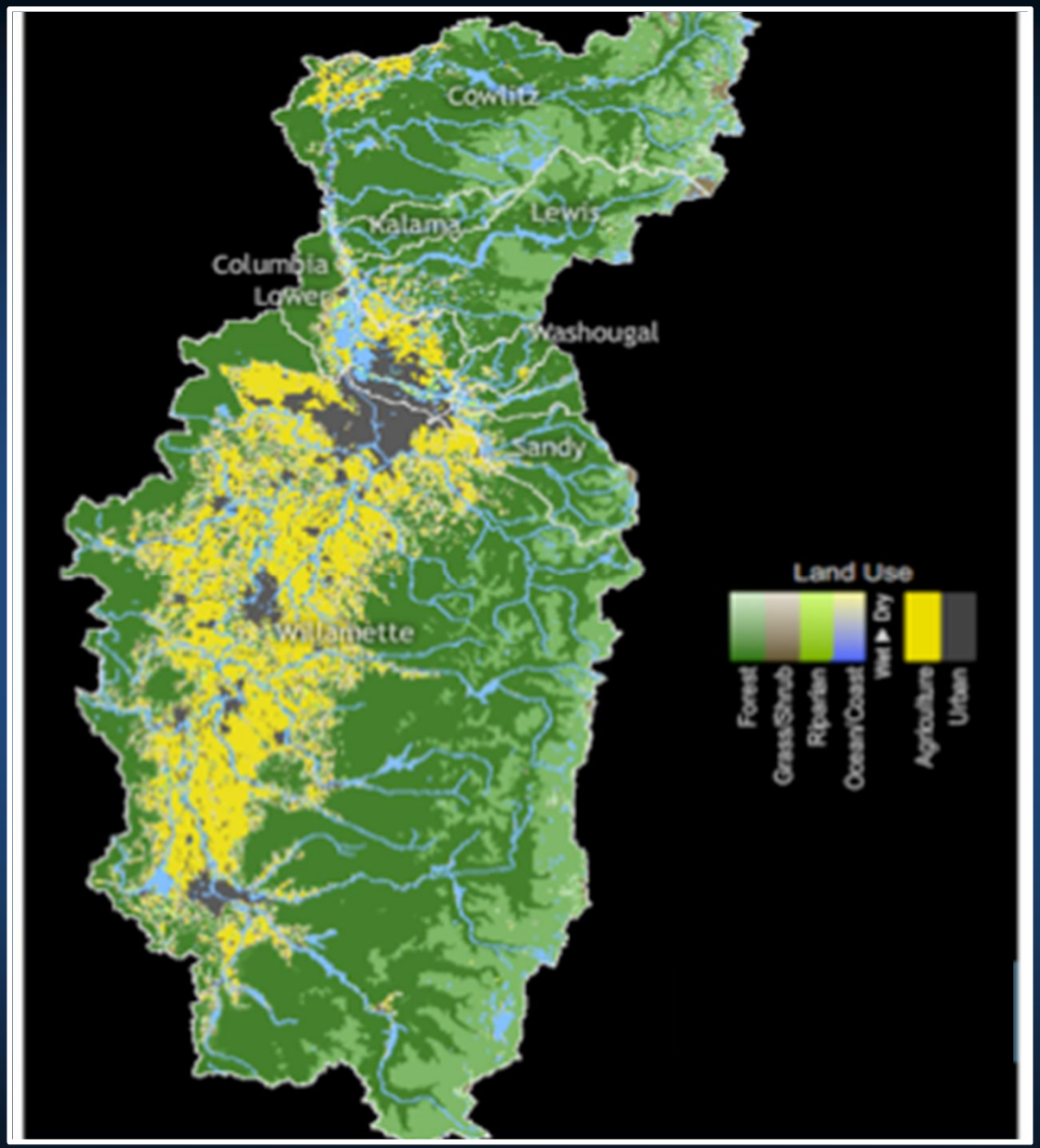


Land use patterns in the Lower Columbia Province

Urban areas around Portland

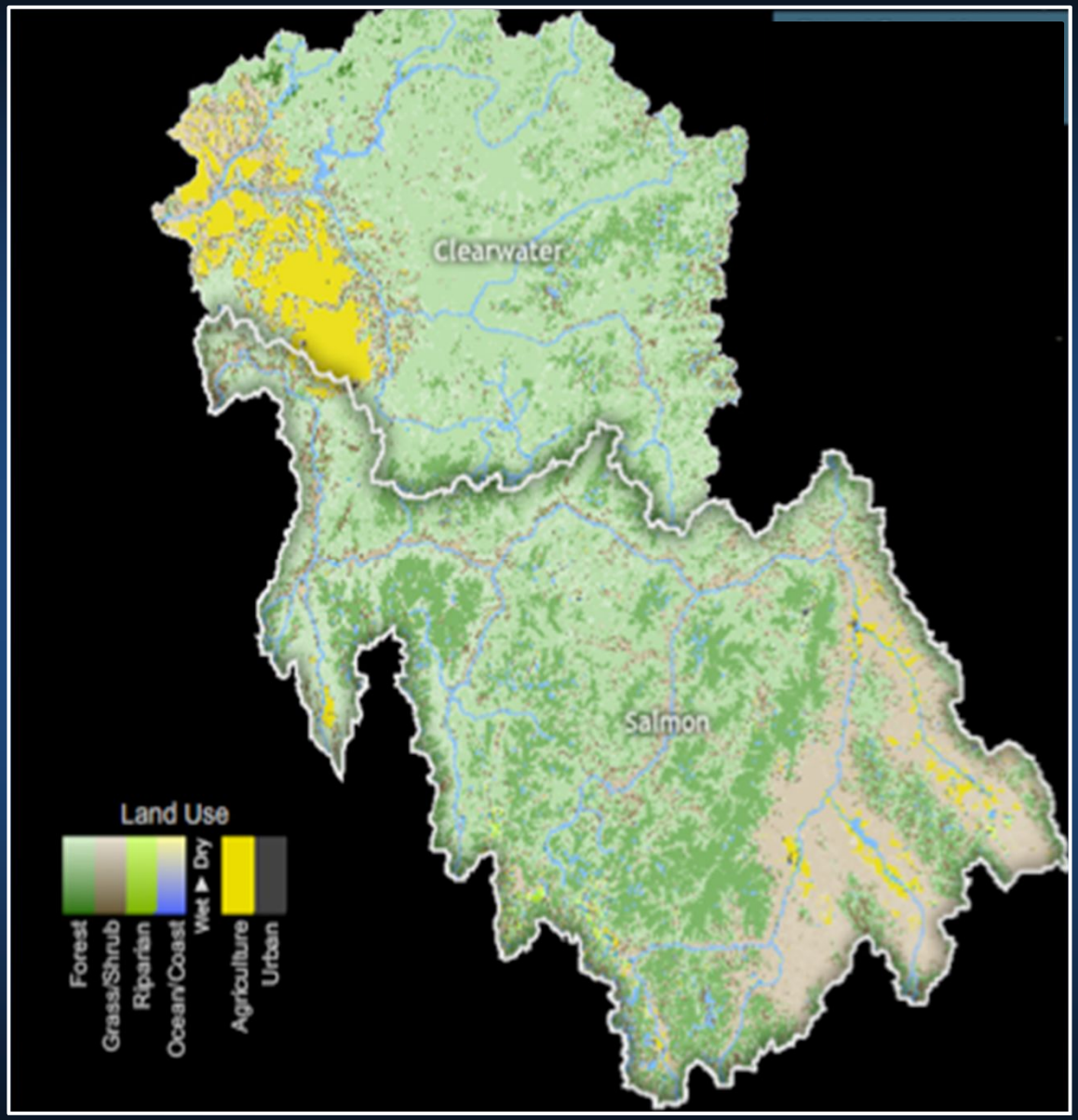
Significant agriculture in Willamette Valley

Other areas forested

Exposure risks:
Industrial contaminants, wastewater contaminants in urban areas

Pesticides in agricultural areas

Low contamination, or specific pesticides and herbicides in forested areas



Land use patterns in the Mountain Snake Province

Minimal urban development

Some agricultural in Clearwater drainage

Other areas forested or rangeland

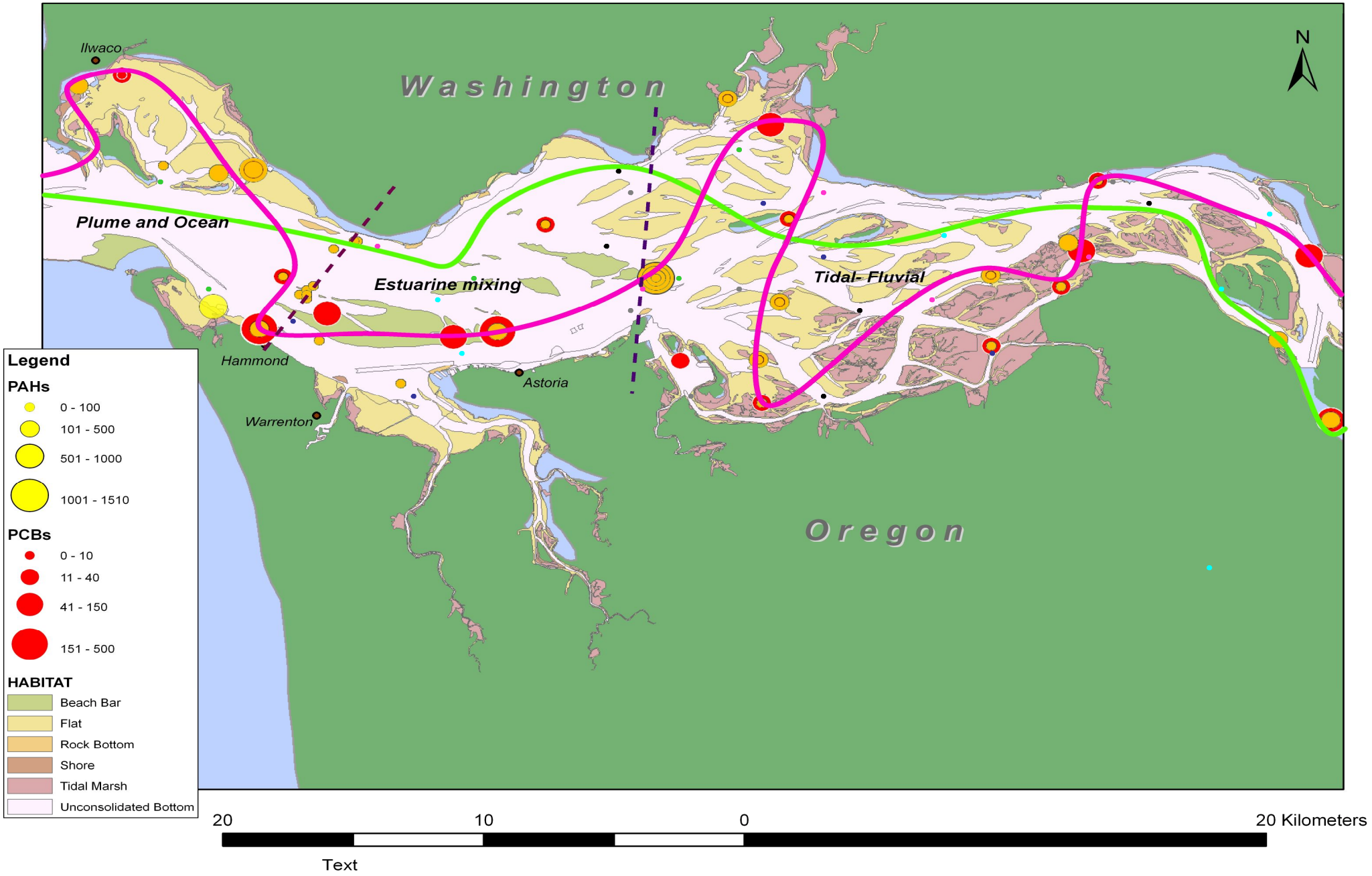
Exposure risks:

Pesticides in agricultural areas

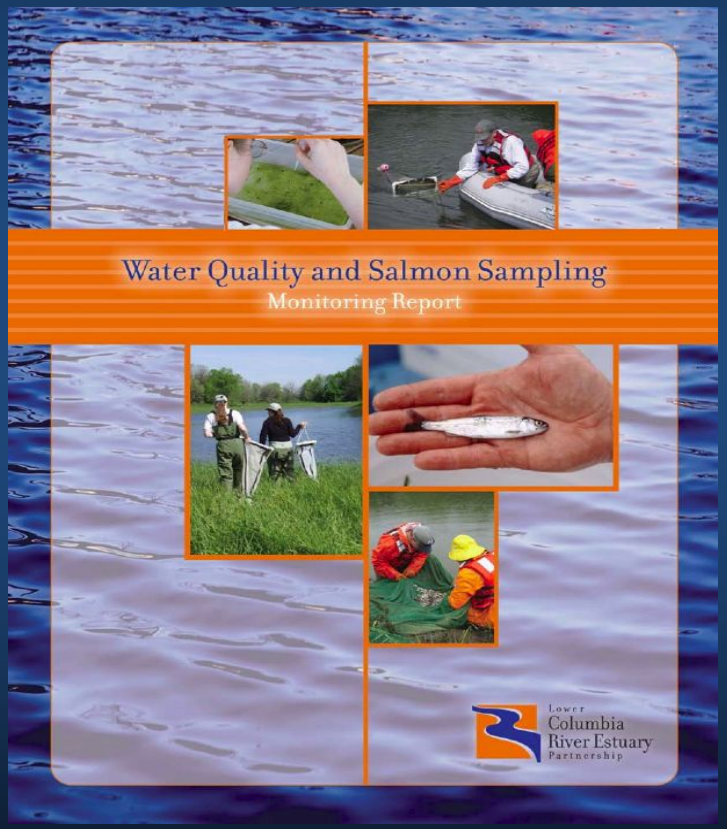
Low contamination, or specific pesticides and herbicides in forested areas

Salmon life history characteristics

Ocean Type (fall Chinook)	Stream Type (spring Chinook)
Short freshwater rearing period	Long freshwater rearing period (overwinter)
Smaller size at time of estuarine entry	Larger size at time of estuarine entry
Longer period of estuarine residence	Shorter period of estuarine residence
Primarily utilize shallow water estuarine habitats, especially vegetated	Primarily utilize deeper, main channel estuarine habitats
Migrate to ocean as subyearlings	Migrate to ocean as yearlings
Longer ocean residence	Shorter ocean residence
Adults run in Summer and Fall, spawn soon after entering freshwater	Adults run in Spring and Summer, spend months in freshwater before spawning


Ilwaco
Washington
N
Plume and Ocean
Estuarine mixing
Tidal- Fluvial
Hammond
Astoria
Warrenton
Oregon
Legend
PAHs
0 - 100
101 - 500
501 - 1000
1001 - 1510
PCBs
0 - 10
11 - 40
41 - 150
151 - 500
HABITAT
Beach Bar
Flat
Rock Bottom
Shore
Tidal Marsh
Unconsolidated Bottom
20
10
0
20 Kilometers
Text

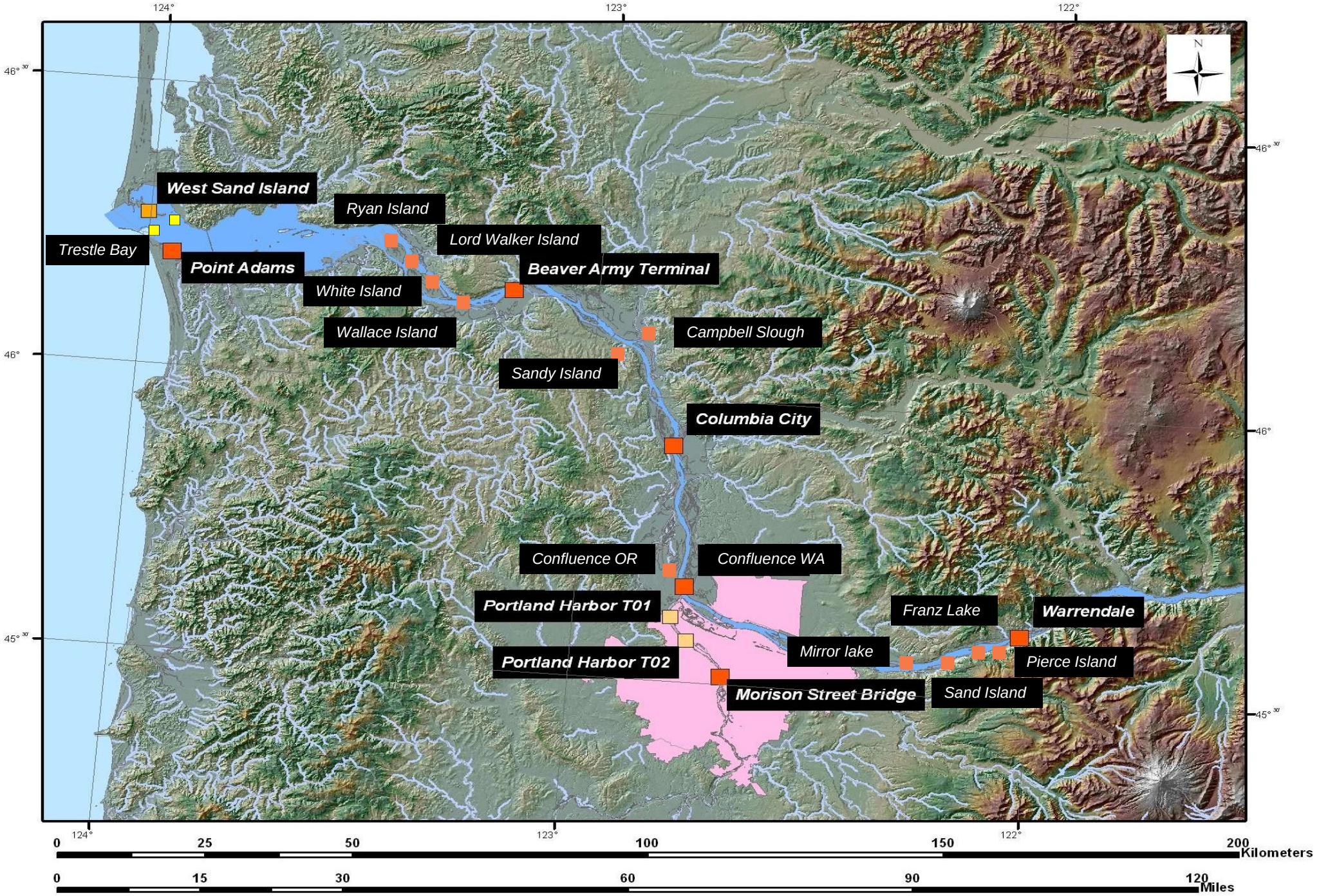
Lower Columbia Estuary Water Quality Monitoring Project: Salmon and Water Quality Component



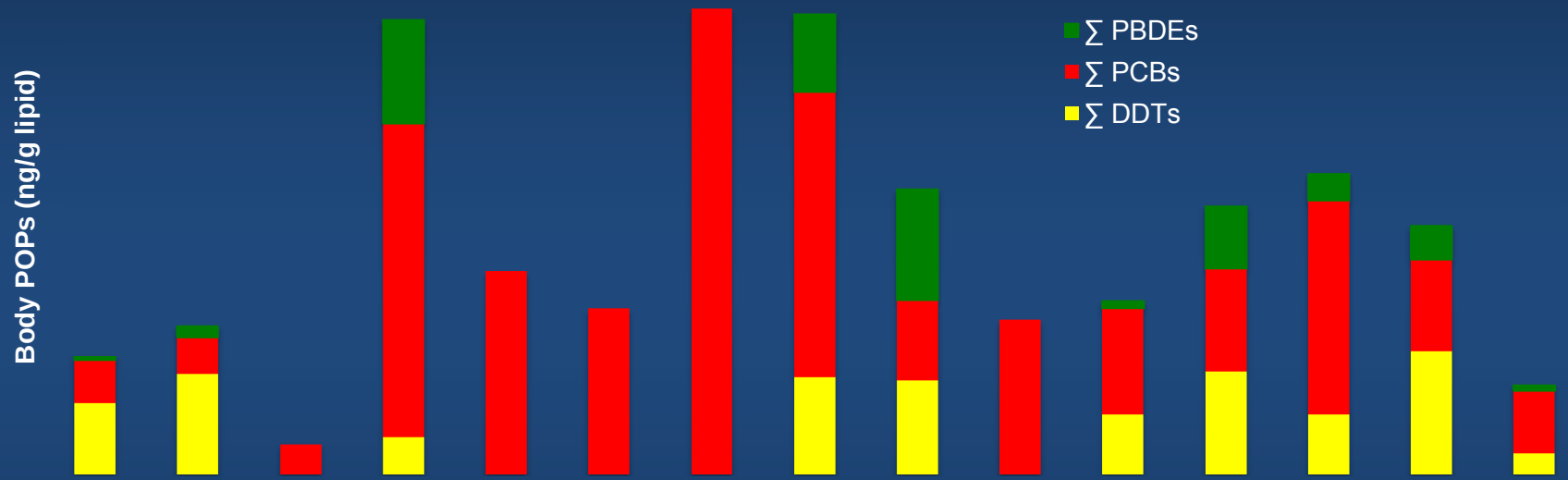
- Administered through Lower Columbia River Estuary Partnership with support from the Bonneville Power Administration
- Conducted by NOAA Fisheries and USGS
- Additional data collected with
  - NOAA's National Ocean Service and Portland Harbor NRDA Trustees
  - US Army Corps of Engineers
  - City of Portland

Chinook salmon (*Oncorhynchus tshawytscha)*

- **Snake River Spring/Summer Chinook**
- **Snake River Fall Chinook**
- **Lower Columbia River Chinook**
- **Upper Willamette River Chinook**
- **Upper Columbia River Spring Chinook**


West Sand Island
Ryan Island
Lord Walker Island
Trestle Bay
Point Adams
Beaver Army Terminal
White Island
Wallace Island
Campbell Slough
Sandy Island
Columbia City
Confluence OR
Confluence WA
Portland Harbor T01
Franz Lake
Warrendale
Mirror lake
Portland Harbor T02
Pierce Island
Morison Street Bridge
Sand Island
124°
123°
122°
46° 30'
46°
45° 30'
N
0 25 50 100 150 200 Kilometers
0 15 30 60 90 120 Miles

Contaminants in Diet Samples from Juvenile Chinook Salmon from Lower Columbia River Monitoring Sites



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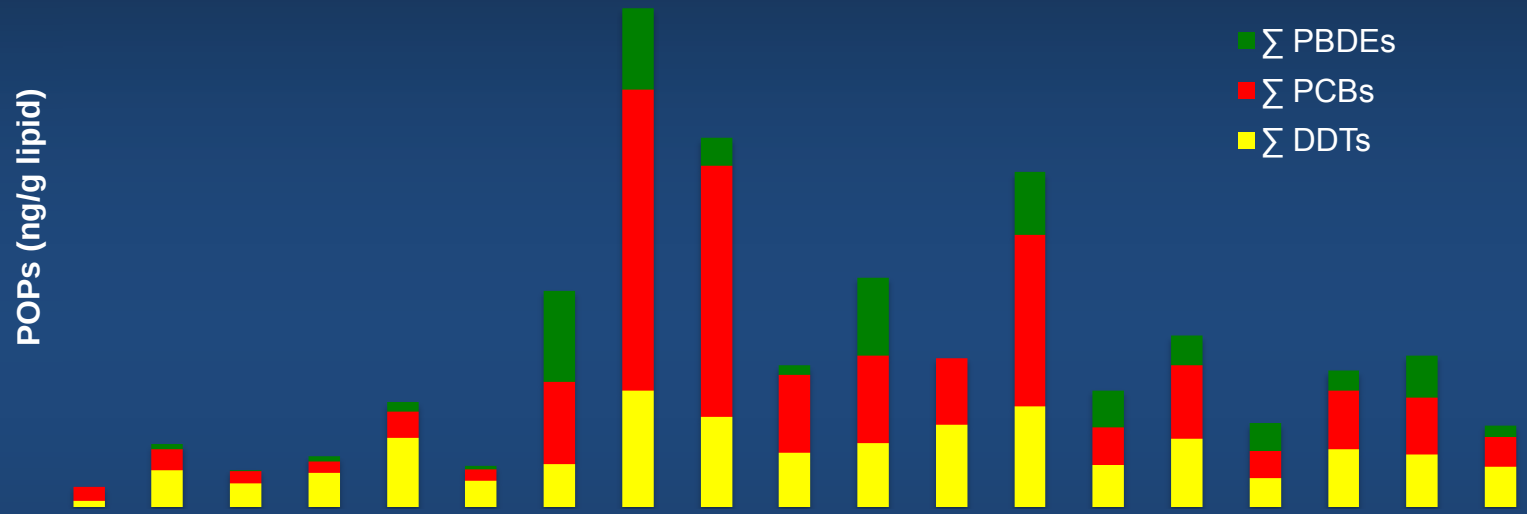
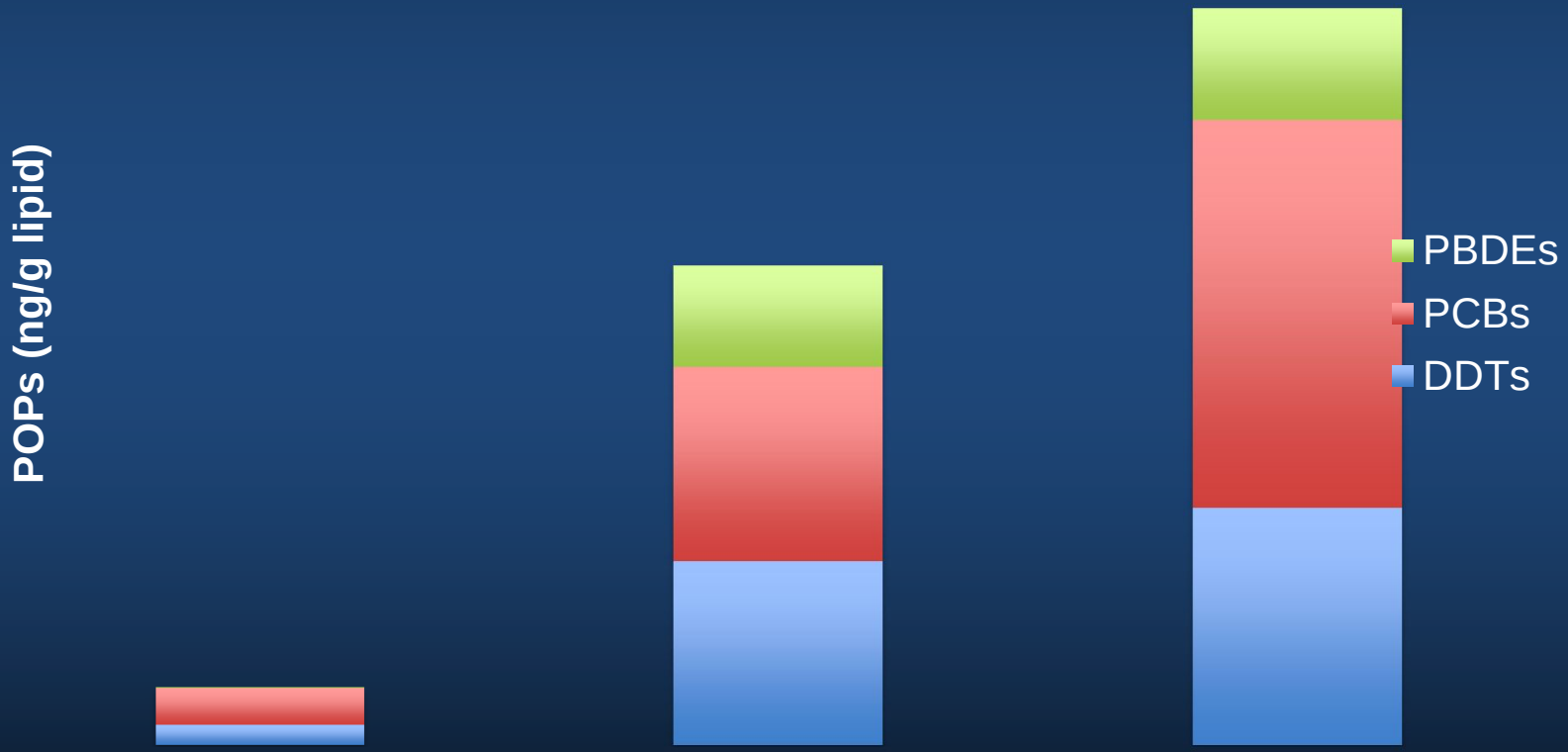
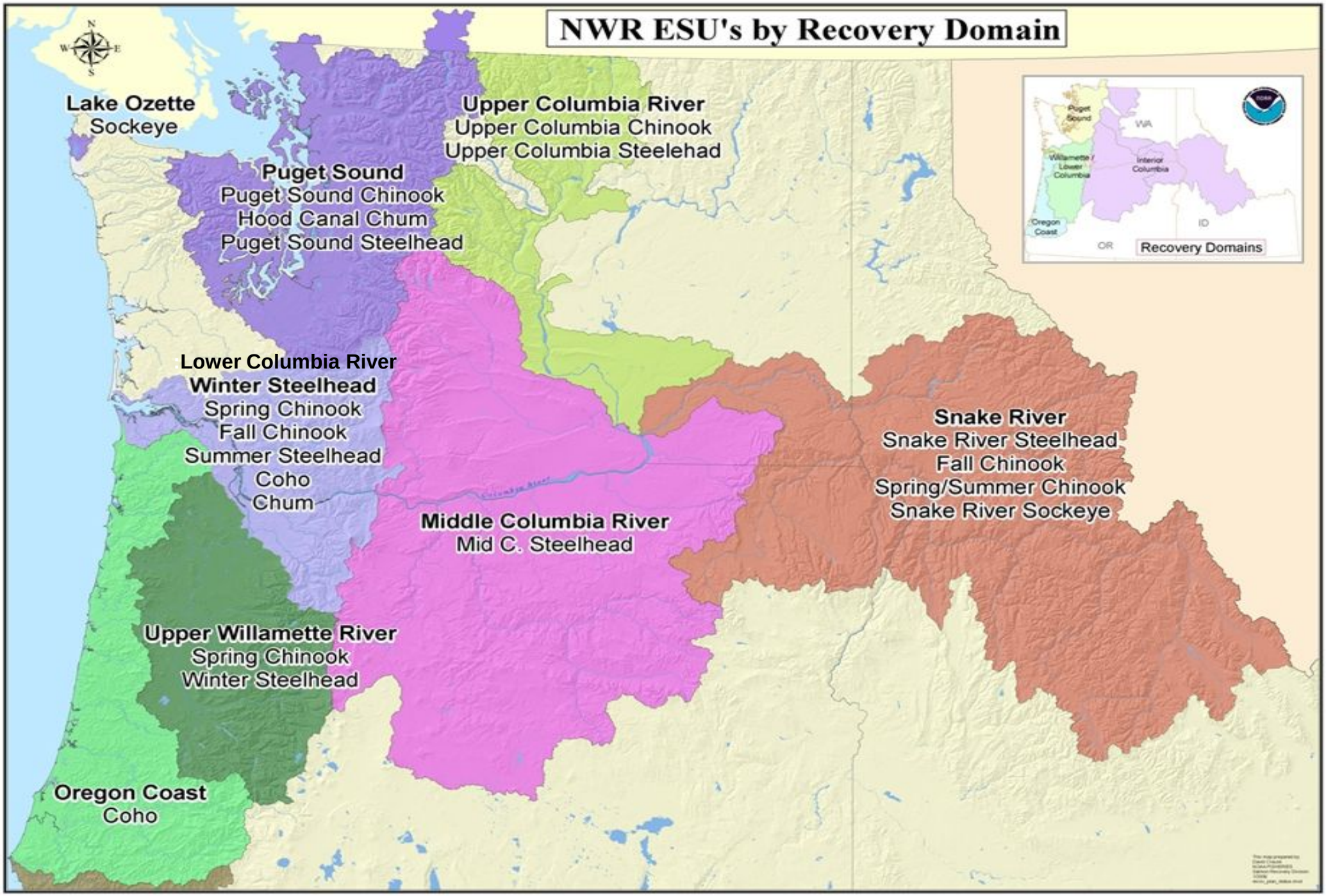


COLUMBIA RIVER GORGE
—VISITORS ASSOCIATION—

Contaminants in marked hatchery Chinook salmon vs. unmarked, presumably wild Chinook salmon

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Winter Steelhead
Oregon Coast
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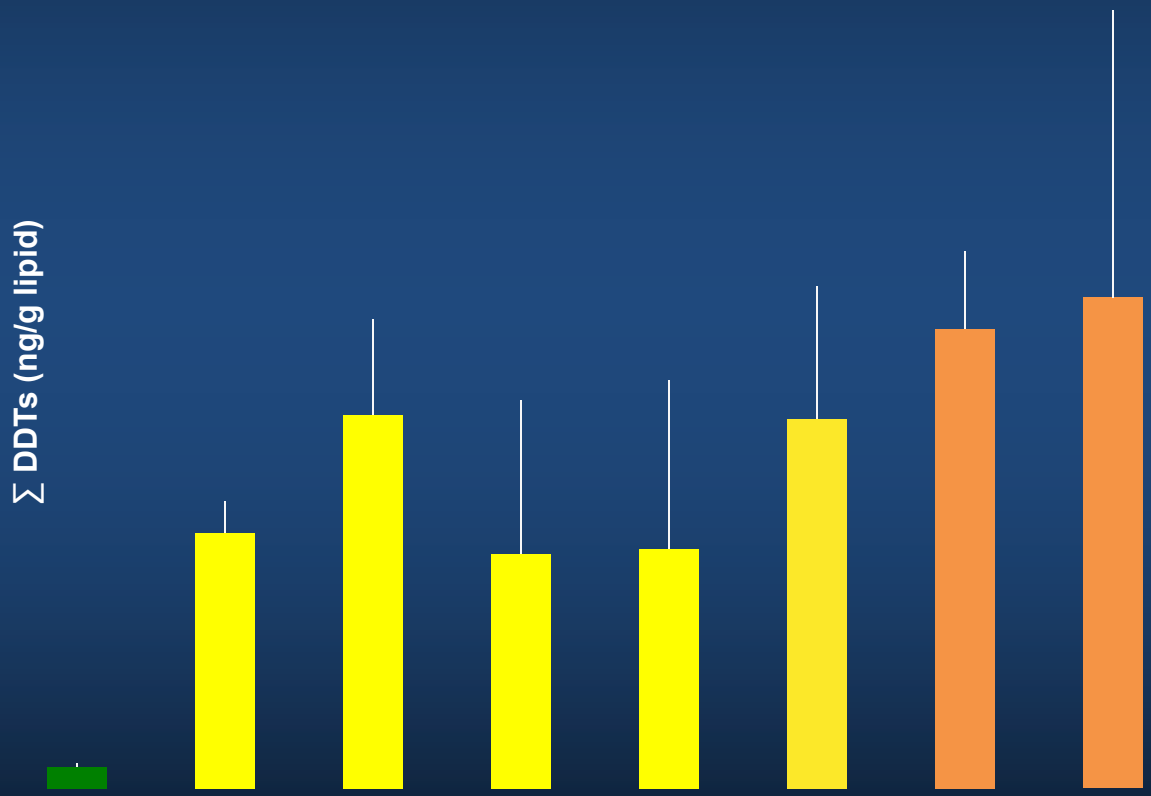
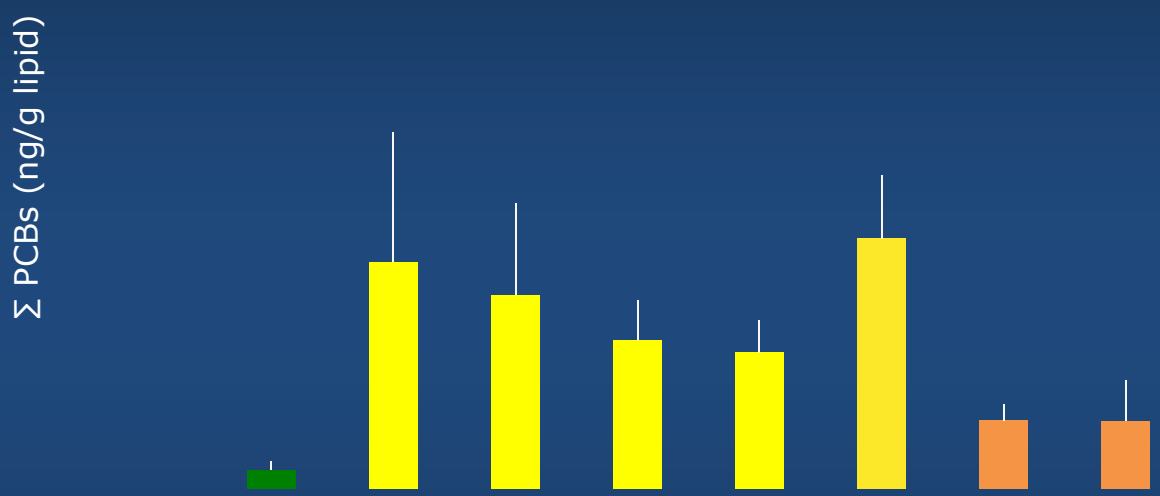
DDTs in Fall Chinook vs. Spring Chinook



Concentrations of DDTs, a representative agricultural pesticide, are comparable in spring and fall Chinook salmon stocks

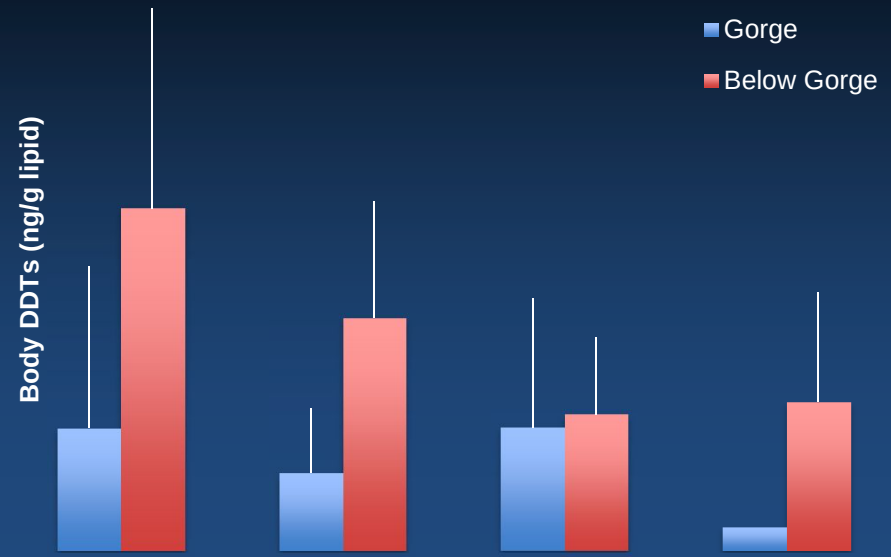
PCBs in Fall Chinook vs. Spring Chinook

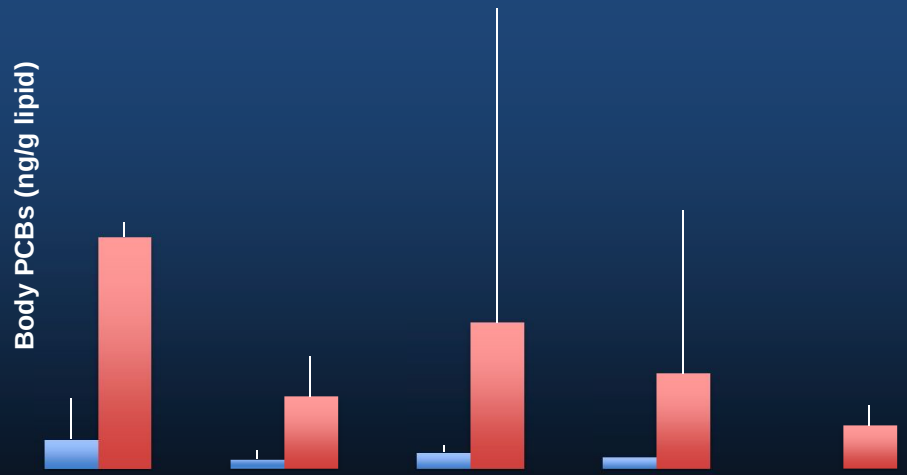


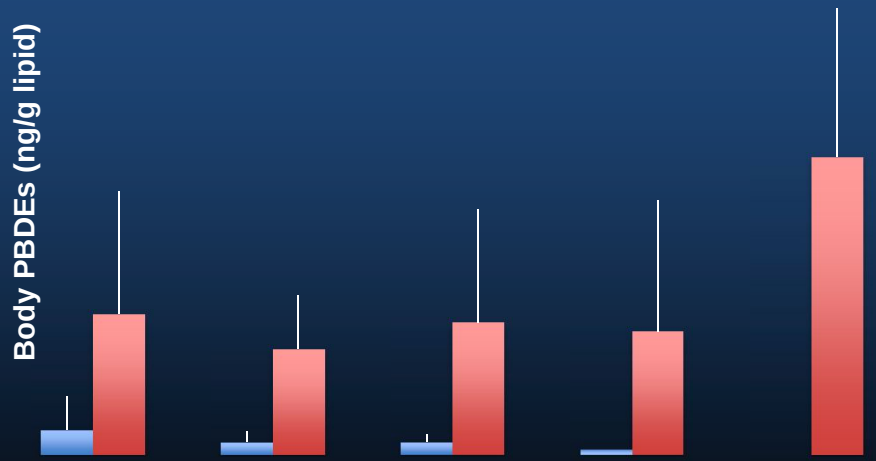
Concentrations of industrial contaminants (PCBs and PBDEs) are highest in fall Chinook stocks that feed and rear in the lower river and estuary

Lower concentrations in spring Chinook that feed and rear primarily upriver

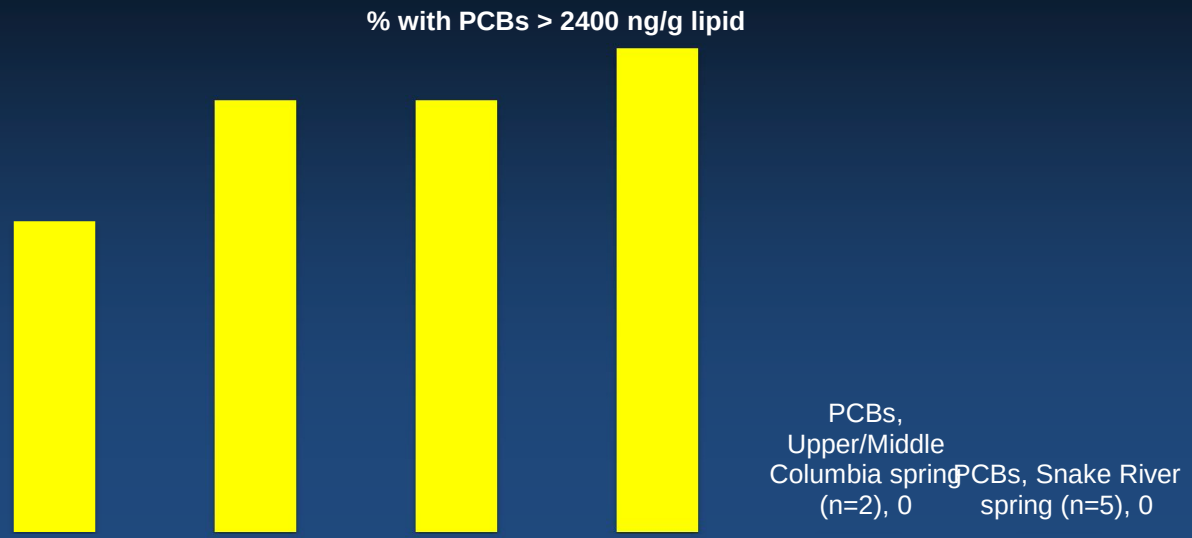
POPs in Columbia River juvenile salmon stocks from sites in the Columbia Gorge and below the Gorge

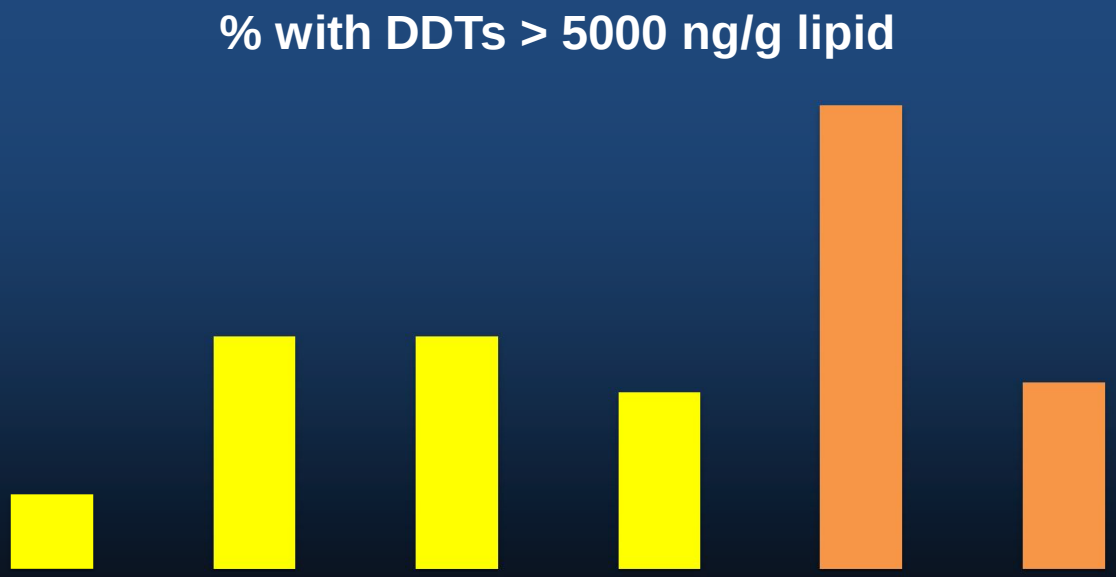






Contaminant concentrations above health effect thresholds





Industrial/urban contaminants (e.g., PCBs) are a greater threat to fall Chinook and Upper Willamette stocks that feed and rear in the lower river and estuary

Agricultural pesticides (e.g., DDTs) are a greater risk for Interior Columbia spring Chinook stocks that feed and rear primarily upriver

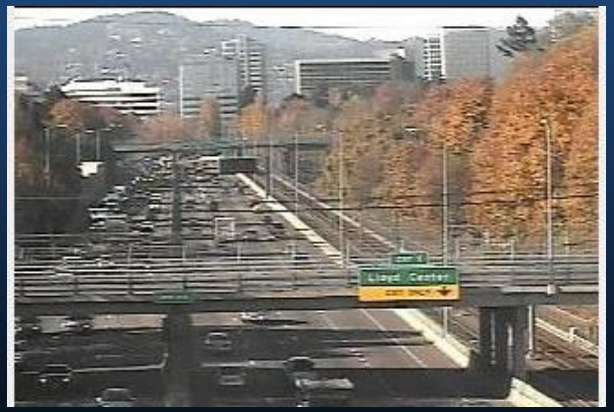
Other Contaminants Also Pose Risks

Wastewater Compounds—Pharmaceuticals, personal care products, caffeine, nicotine

Current use pesticides--common as mixtures in fish habitats

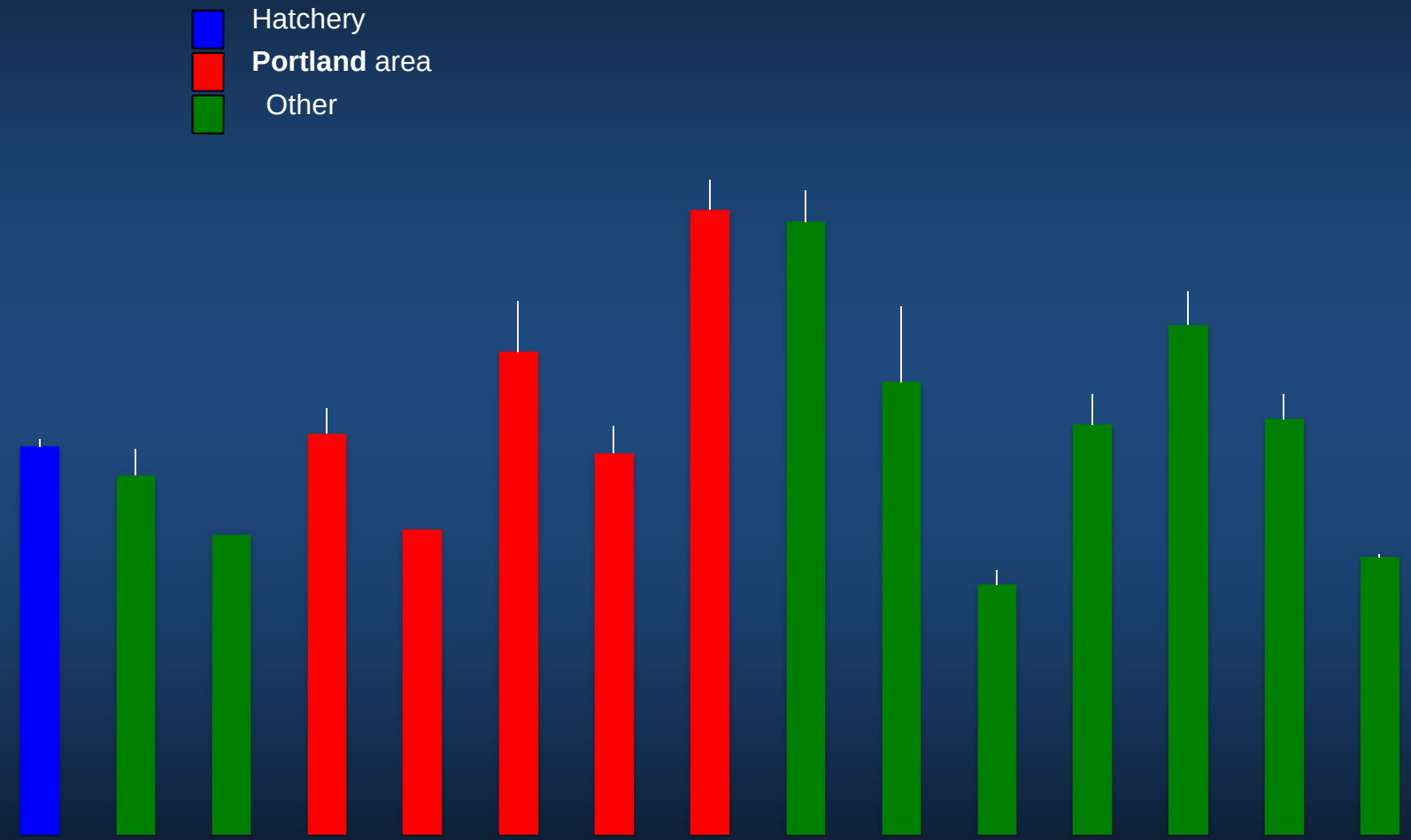
- organophosphate insecticides (diazanon, chlorpyrifos)
- carbamate insecticides (carbaryl, carbofuran)
- pyrethroid insecticides (cypermethrin, esfenvalerate)
- Herbicides (2,4-D, atrazine)

Trace metals (e.g., copper, found in road runoff and storm water)

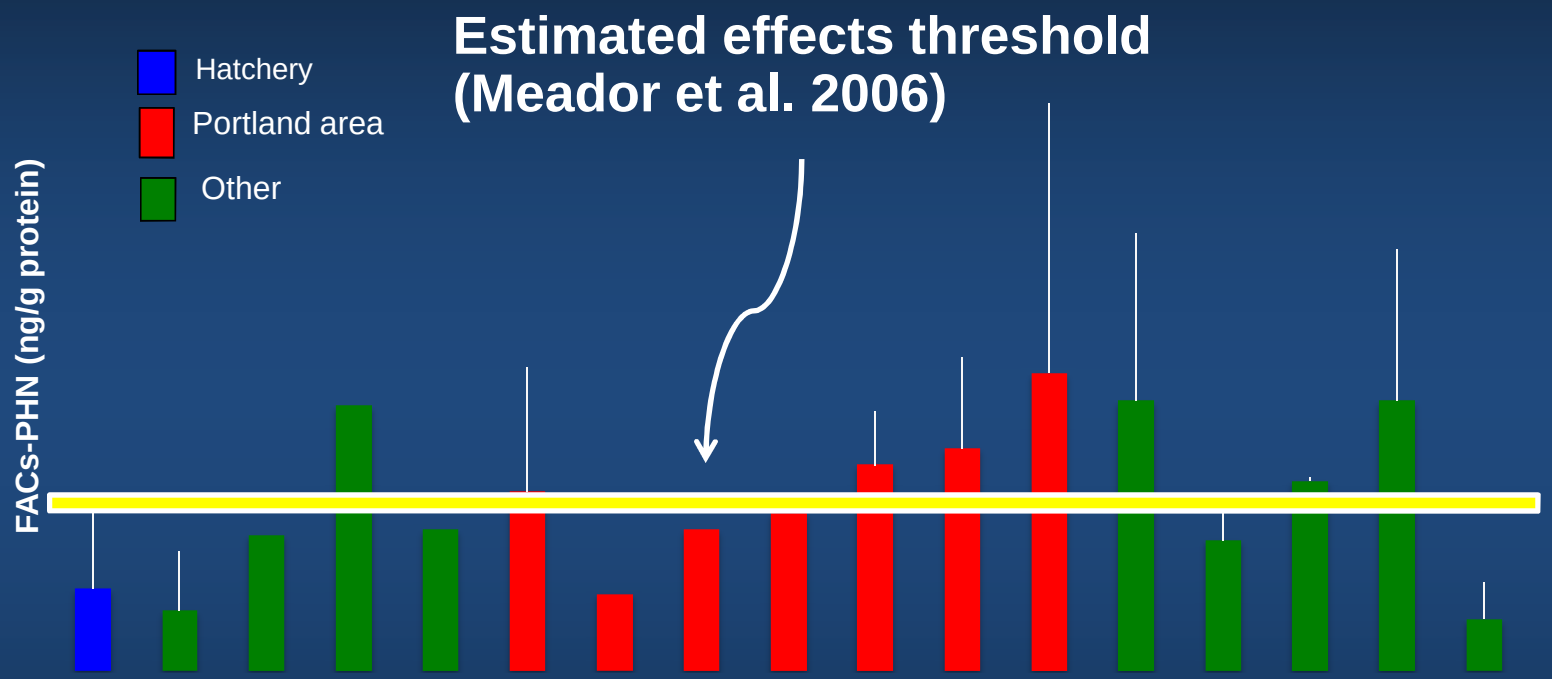


Polycyclic aromatic hydrocarbons (e.g., fossil fuels, car exhaust, cresote)

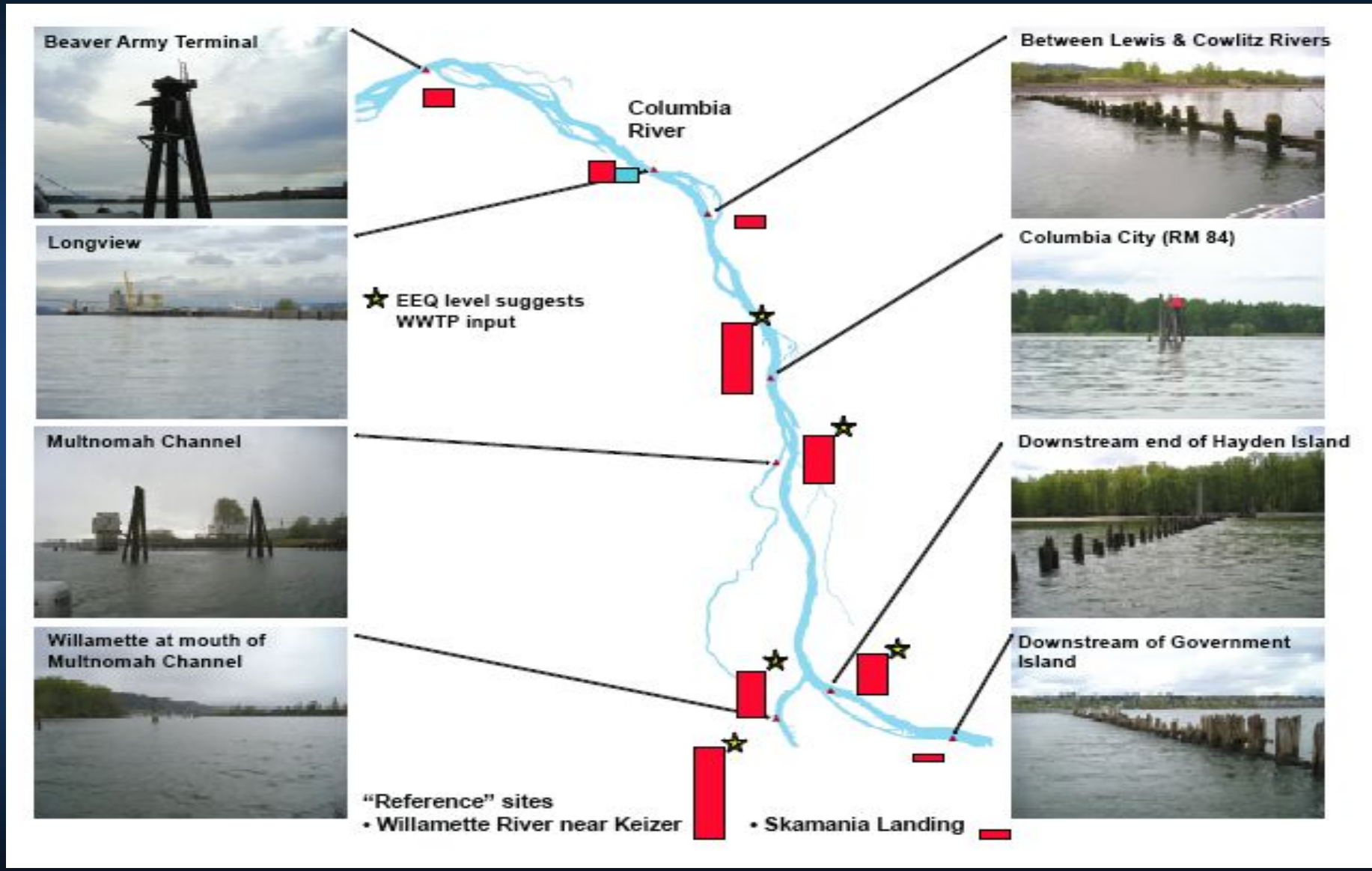
PAHs in Juvenile Salmon Stomach Contents



PAH metabolites in juvenile Chinook salmon bile

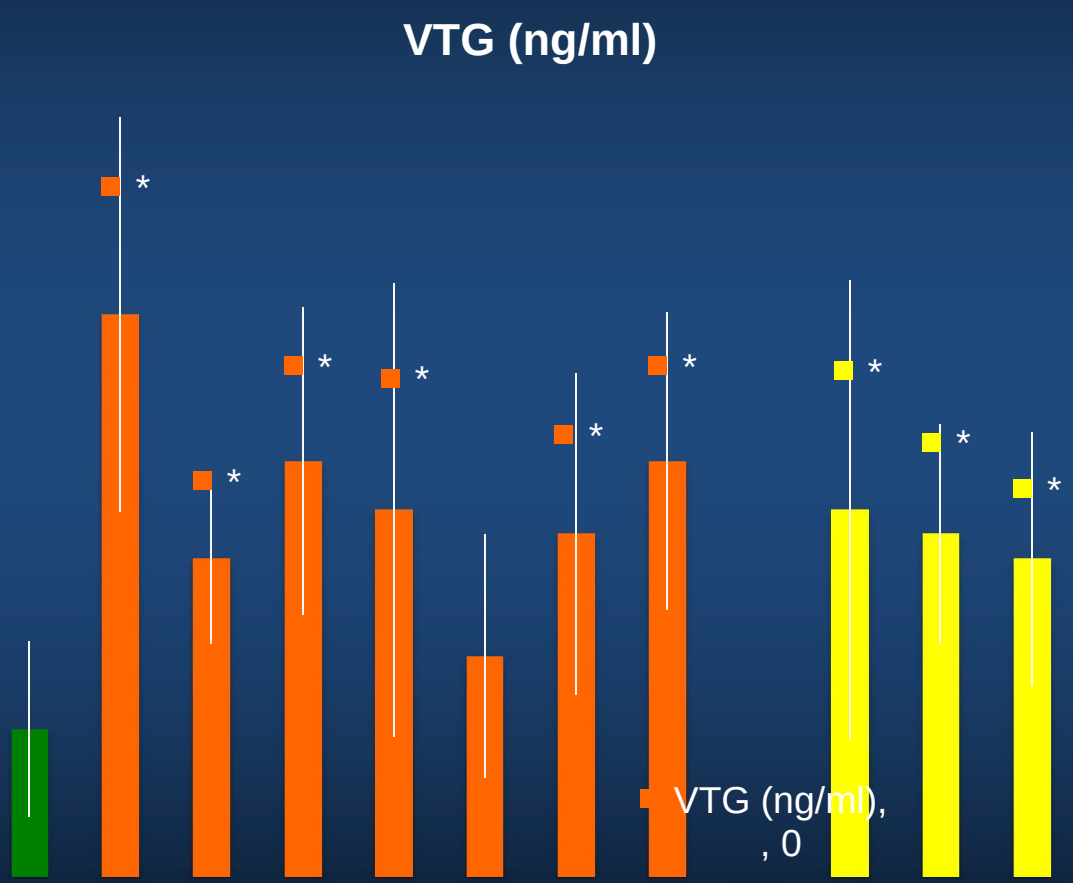


Estrogenic activity in Columbia River waters*



* Data from Elena Nilsen and Jennifer Morace, USGS Portland water quality laboratory

Exposure to Environmental Estrogens



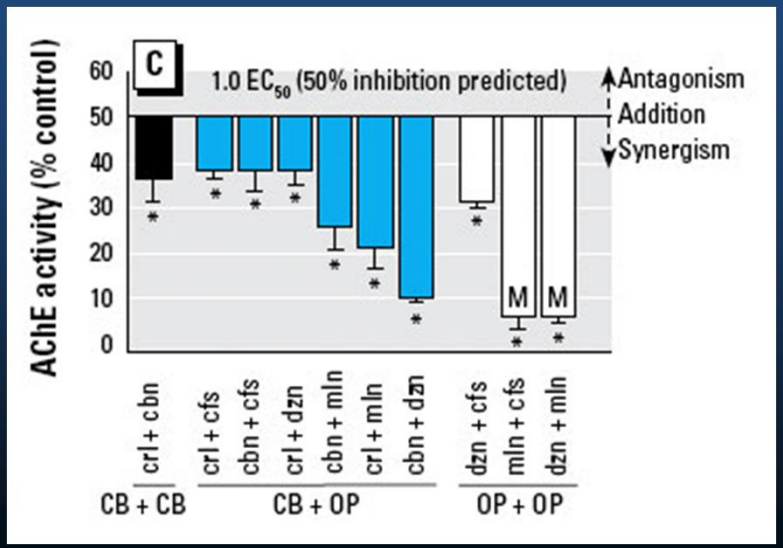
Vitellogenin—yolk protein whose production is regulated by estrogen

Normally only found in egg-bearing female fish

Presence in juveniles and males is a sign of exposure to environmental estrogens

Screening of Lower Columbia salmon revealed signs of vitellogenin production in juvenile salmon from multiple sites

Current use pesticides and dissolved copper are toxic to fish sensory systems



Problems with olfaction and related behaviors (prey capture, predator avoidance) at concentrations as low as 0.2 ug/L.

The U.S. Geological Survey of 811 United States stream sites detected a median copper concentration of 1.2 ugL.

Impairment of sensory functions important to survival of juvenile salmonids is likely to be widespread.

(See Hecht et al. 2007. NOAA Tech Memo NMFS-NWFSC-83).

Organophosphate pesticides disrupt olfaction in salmon, interfere with prey capture and predator avoidance

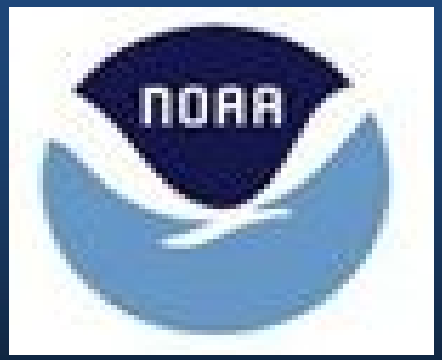
Some pesticides combinations can have lethal synergistic effects

(see Labenia et al. 2007. Mar. Ecol. Prog. Ser. 329:1-11; Scholz and Hopkins. 2006. Environ. Toxicol. Chem. 25:1185-1186,Laetz et al.2009. Environ Health Perspect *117:348–353).*

What is being done about the problem?

- Portland Harbor Superfund Clean-up – might have positive effects on multiple populations
- Toxics in FCRPS Biological Opinion and salmon recovery plans
- Consultations with EPA on current use pesticides
- Legislation to phase out copper in brake pads
- Oregon Toxics Consultation on water quality standards
- Research on effects of additional chemicals – forest herbicides, fire retardants used on forest fires
- Revisions to Sediment Evaluation Framework

Acknowledgement to our Funders and Cooperators and Staff



NOAA Fisheries

Bernadita Anulacion
Mary Arkoosh
David Baldwin
Jennie Bolton
Frank Loge
Cathy Laetz
Dan Lomax
Jennifer King
Mark Myers
Karen Peck
Catherine Sloan
Laurie Weitkamp
Maryjean Willis
Gladys Yanagida

USGS

Greg Fuhrer
Joe Rinella
Elena Nilsen

LCREP

Keith Marcoe
Catherine Corbett
Debrah Marriott

BPA

Tracey Yerxa
Jill Leary

City of Portland
Kaitlin Lovett