Northwest Power and Conservation Council

July 2, 2013

MEMORANDUM

TO: Council members

FROM: Jim Ruff – Manager, Mainstem Passage and River Operations

SUBJECT: Panel presentation on reducing toxic contaminants in the Columbia River Basin

A panel presentation on reducing toxic contaminants in the Columbia River Basin is planned at the July 10, 2013, Council meeting in Seattle, WA. Panelists include Paul Lumley, Executive Director, Columbia River Inter-Tribal Fish Commission; Deane Osterman, Executive Director, Kalispel Tribe Natural Resources Department; Tracy Collier, Science Director of the Puget Sound Partnership and retired Manager of NOAA's Northwest Fisheries Science Center Ecotoxicology Program; and Dennis McLerran, Regional Administrator, U.S. EPA Region 10.

Their comments will focus on the opportunity to provide a stronger regional collaboration for toxics assessment and reduction in the Columbia River Basin through the 2013 Fish and Wildlife Program amendment process. The Council's Fish and Wildlife Program has the potential to be a collaborative forum for a consistent and coordinated approach to toxics reduction in the Basin which can also provide critical accountability to recovery efforts.

Specific comments by the panelists will include the importance of reducing toxics for tribal governments as high fish consumers; the scientific studies that show the compelling and serious effects of toxics on fish, which can have significant impacts on fish health and regional fish recovery efforts; and efforts by the U.S. EPA to work collaboratively with the Northwest states to develop more protective Clean Water Act human health water quality criteria to reduce toxics in fish and water and protect human health.

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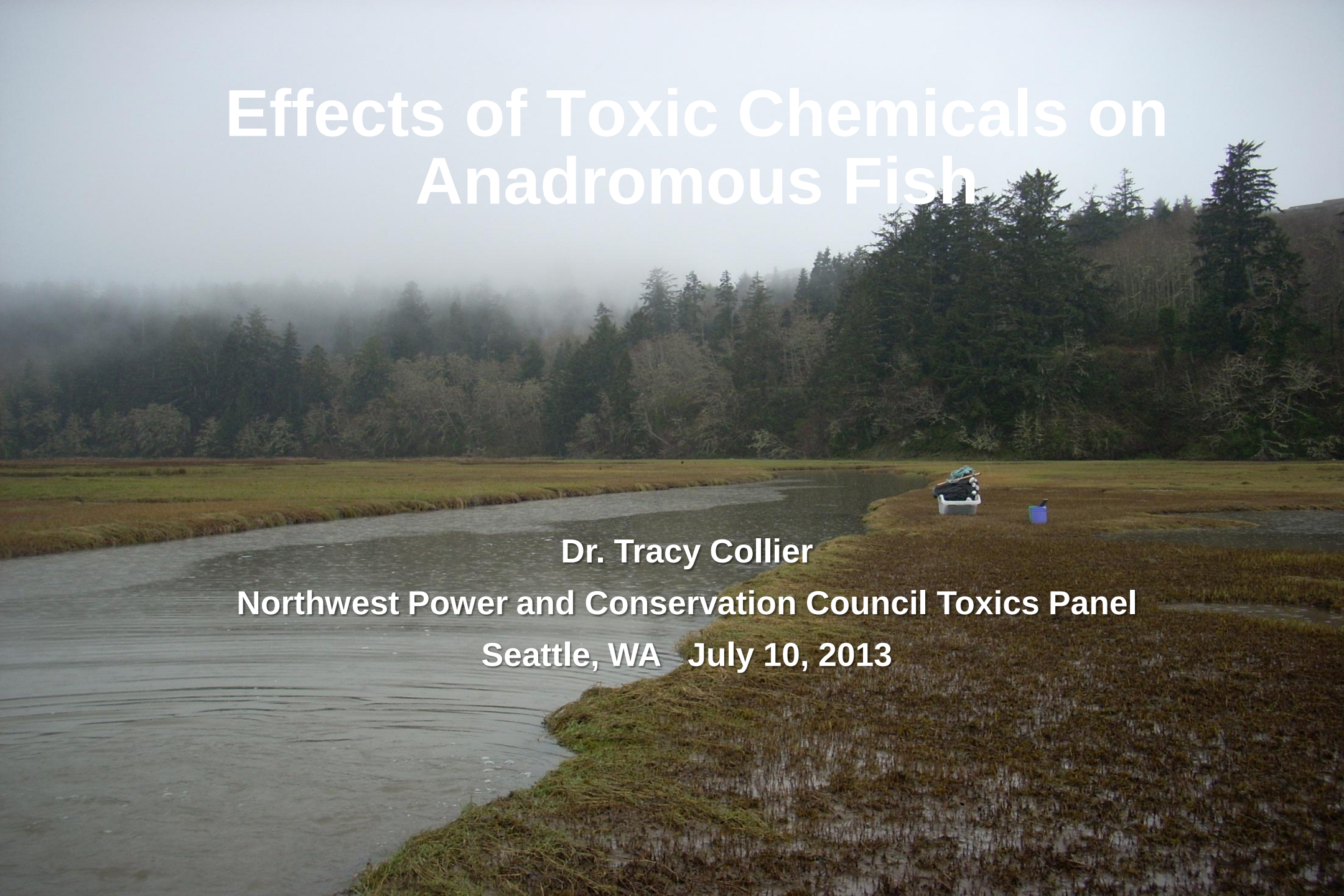
Effects of Toxic Chemicals on Anadromous Fish

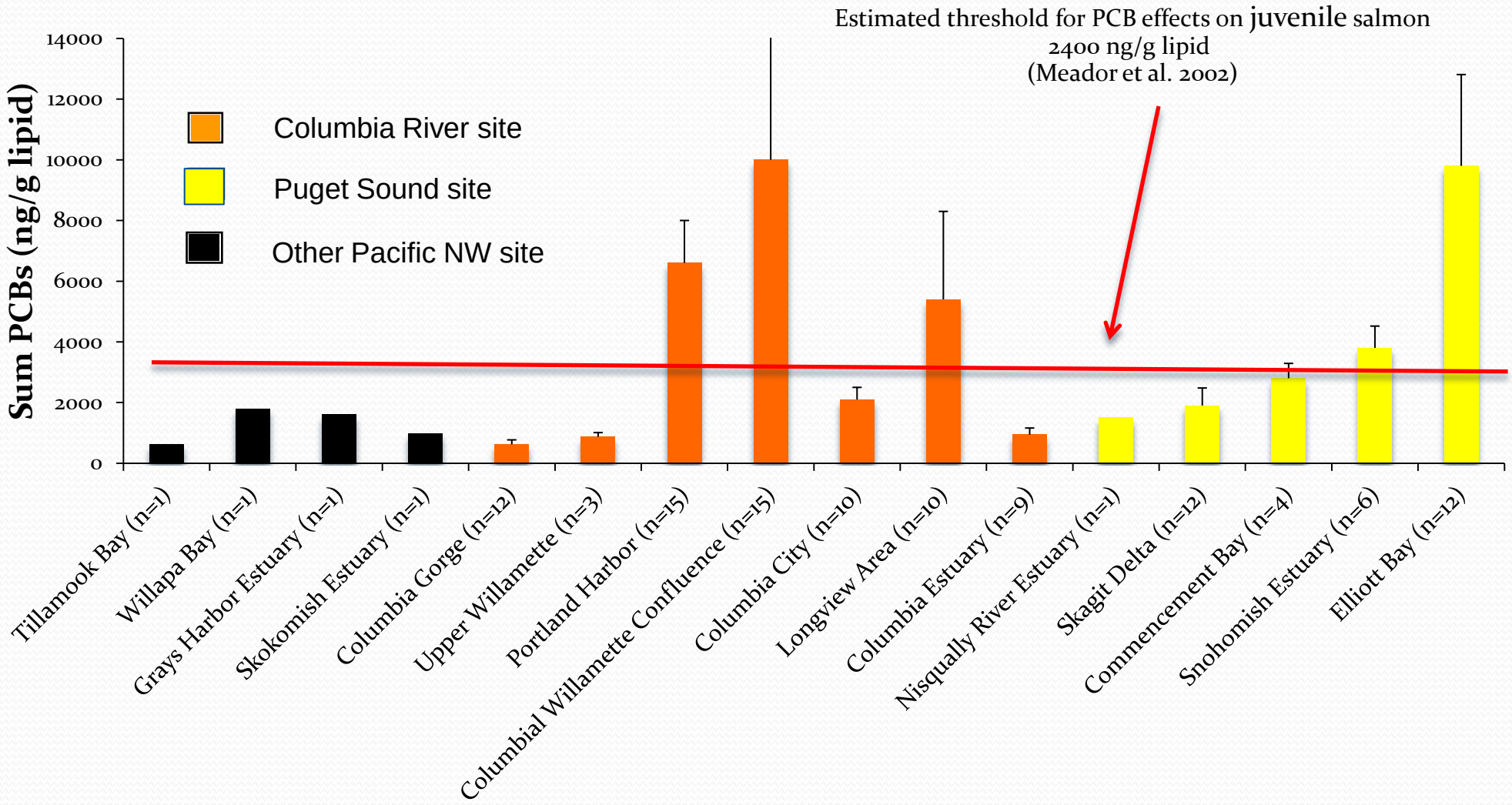


Dr. Tracy Collier

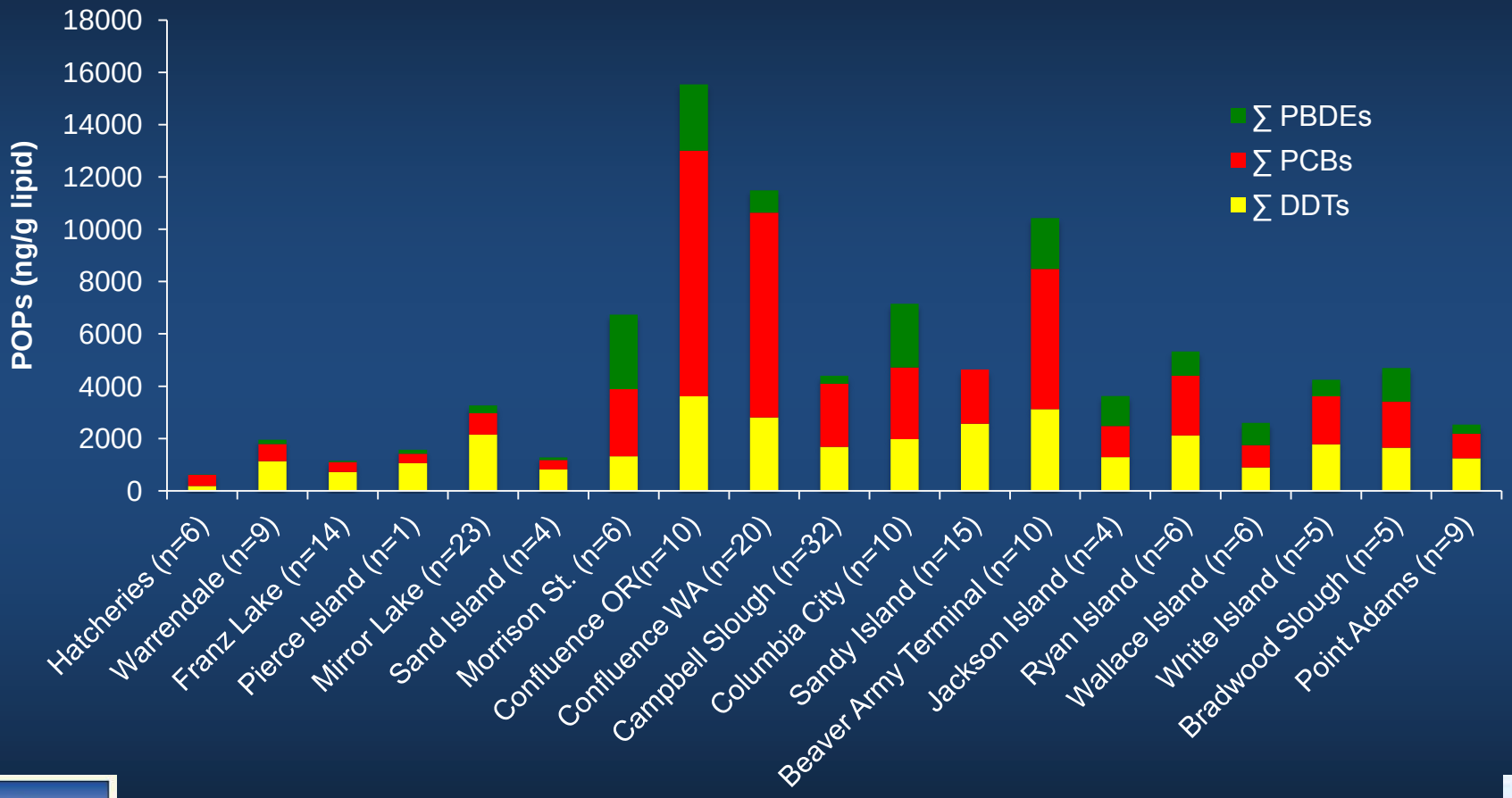
Northwest Power and Conservation Council Toxics Panel

Seattle, WA July 10, 2013

PCBs in juvenile Chinook salmon

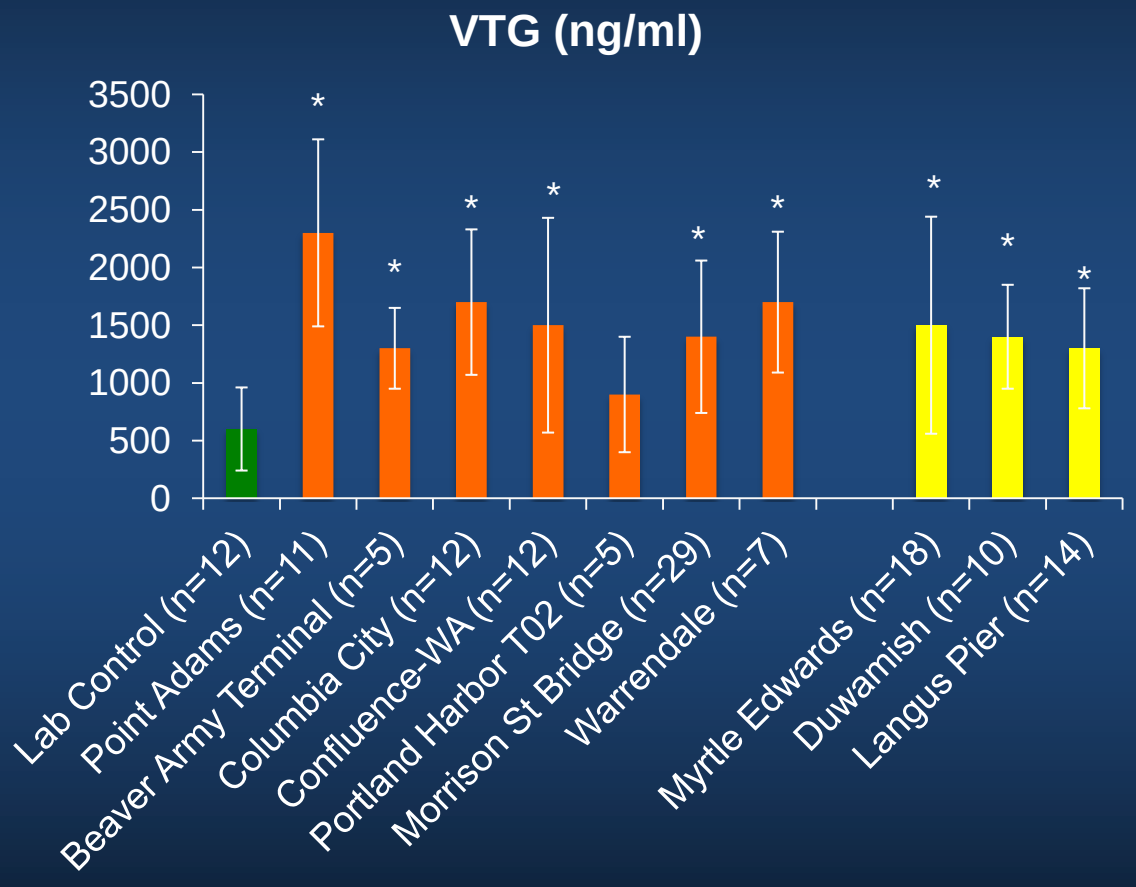


Contaminants in juvenile Chinook salmon from Lower Columbia River



COLUMBIA RIVER GORGE VISITORS ASSOCIATION

Environmental Estrogens (from wastewater)



VTG—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

Lower Columbia and Puget Sound juvenile salmon showed vitellogenin production at multiple sites

Stormwater and Salmon: Research Update

NWFSC NORTHWEST FISHERIES SCIENCE CENTER

Photo by Morgan Bond

NOAA U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Coho pre-spawn mortality is widespread in urban streams receiving stormwater

Longfellow Creek 2003

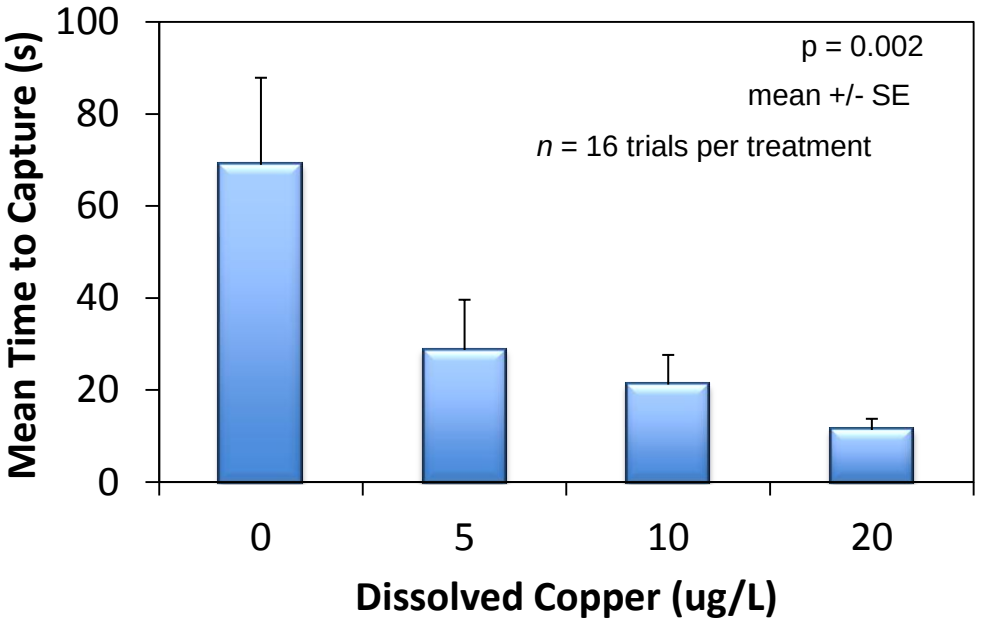
Des Moines Creek 2004

Longfellow Creek 2005

Coho PSM rates measured to date in Seattle-area urban streams have ranged from ~ 40 – 90% of the total run (2002-2009)

Motor vehicles are common sources of PAHs, copper and other metals in stormwater

Copper exposures have consequences for survival



- Copper-exposed coho lose their sense of smell
- They fail to respond to predation cues
- They suffer higher rates of mortality in encounters with predators

Cutthroat trout predators

Environmental Health Perspectives, March 2009

The Synergistic Toxicity of Pesticide Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon

Cathy A. Laetz,[1] David H. Baldwin,[1] Tracy K. Collier,[1] Vincent Hebert,[2] John D. Stark,[3] and Nathaniel L. Scholz[1]

[1]NOAA (National Oceanic and Atmospheric Administration) Fisheries, Northwest Fisheries Science Center, Seattle, Washington, USA; [2]Food and Environmental Quality Laboratory, Washington State University, Richland, Washington, USA; [3]Department of Entomology, Ecotoxicology Program, Washington State University, Puyallup, Washington, USA

Background: Mixtures of organophosphate and carbamate pesticides are commonly detected in freshwater habitats that support threatened and endangered species of Pacific salmon (*Oncorhynchus* sp.). These pesticides inhibit the activity of acetylcholinesterase (AChE) and thus have potential to interfere with behaviors that may be essential for salmon survival. ~~While~~ Although the effects of individual anticholinesterase insecticides on aquatic species have been studied for decades, the neurotoxicity of mixtures is still poorly understood.

Objectives: We assessed whether chemicals in a mixture act in isolation (resulting in additive AChE inhibition) or whether components interact to produce either antagonistic or synergistic toxicity.

Methods: We measured brain AChE inhibition in juvenile coho salmon (*Oncorhynchus kisutch*) exposed to sublethal concentrations of the organophosphates diazinon, malathion, and chlorpyrifos, as well as the carbamates carbaryl and carbofuran. Concentrations of individual chemicals were normalized to their respective median effective ~~EC~~$_{50}$ concentrations (EC_{50}) and collectively fit to a nonlinear regression. We used this curve ~~was used~~ to determine whether toxicologic ~~toxicological~~ responses to binary mixtures were additive, antagonistic, or synergistic.

Results: We observed addition and synergism, ~~were both observed,~~ with a greater degree of synergism at higher exposure concentrations. Several combinations of organophosphates were lethal at concentrations that were sublethal in single-chemical trials.

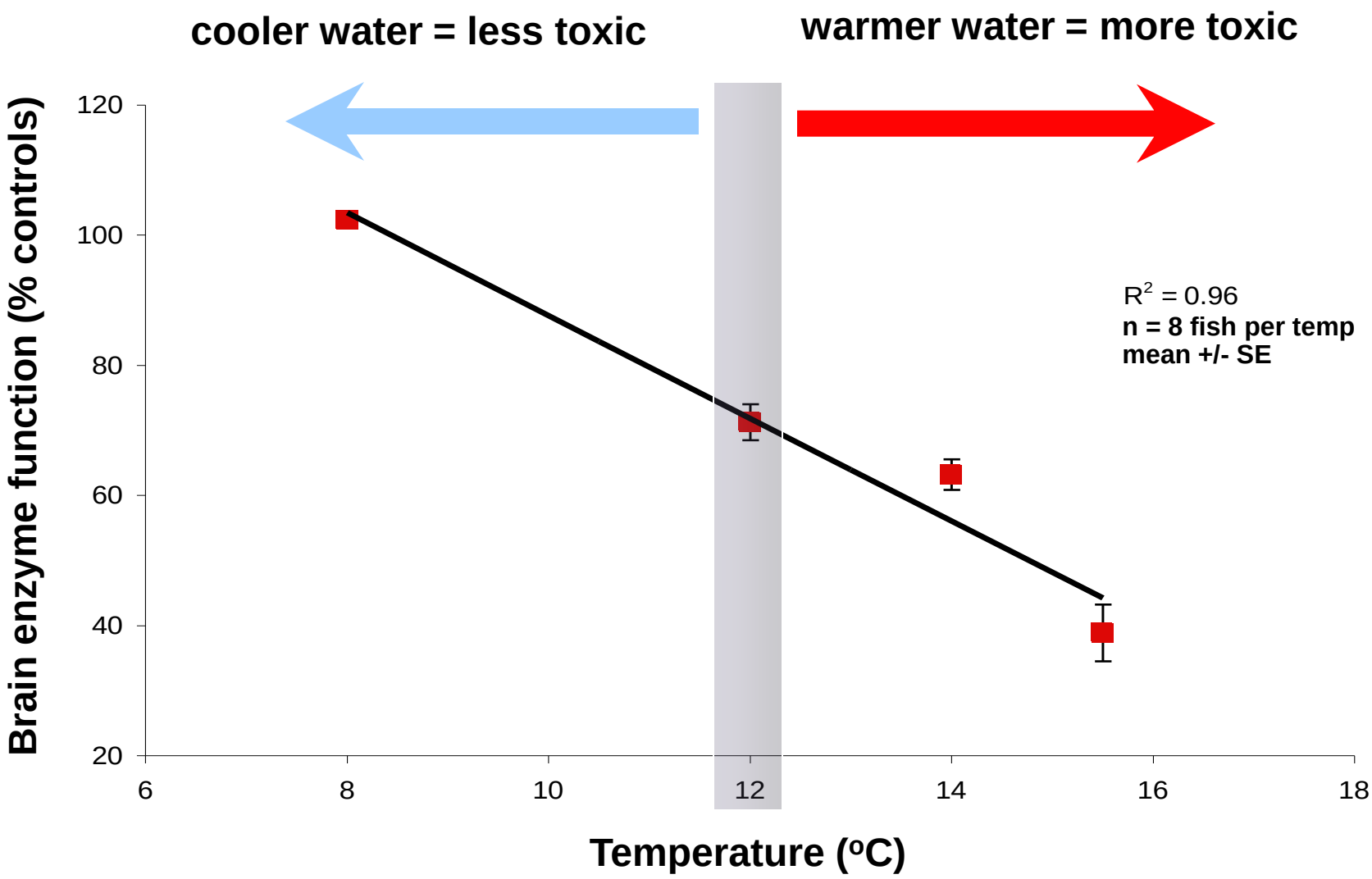
Conclusion: Single-chemical risk assessments are likely to underestimate the impacts of these insecticides on salmon in river systems where mixtures occur. Moreover, mixtures of pesticides that have been commonly reported in salmon habitats may pose a more important challenge for species recovery than previously anticipated.

Key words: acetylcholinesterase, carbamates, conservation, organophosphates, pesticides, risk assessment, salmon, synergy, toxicity. *Environ Health Perspect* 117:000–000 (2009). doi:10.1289/ehp.0800096 available via *http://dx.doi.org/* [Online 14 November 2008]

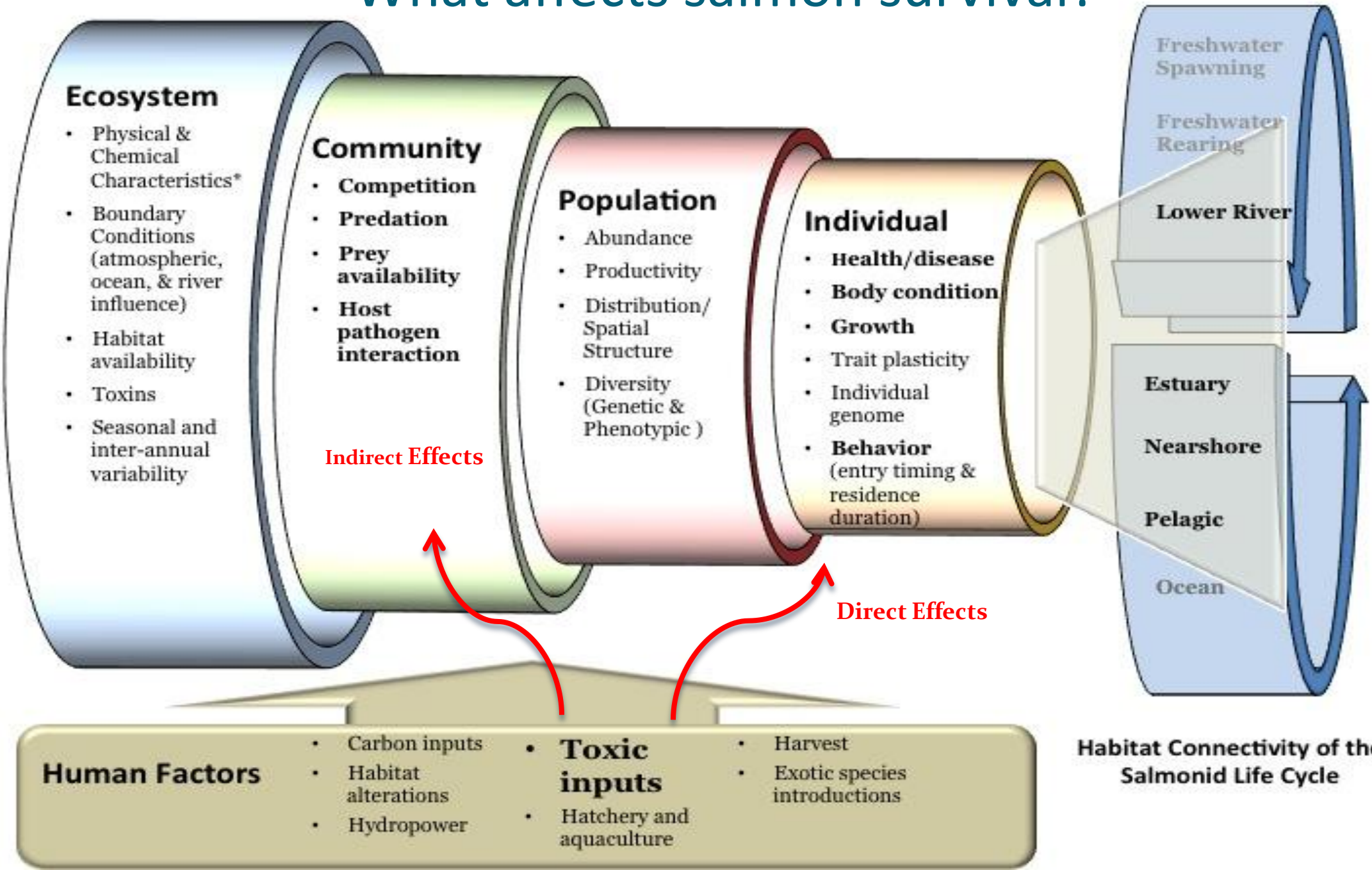
(NRC 1996). Major river systems that drain large agricultural and urban areas in California, Oregon, Washington, and Idaho provide freshwater habitat for ESA-listed salmon and steelhead (Figure 1). Extensive surface water monitoring for pesticides, as part of the U.S. Geological Survey (USGS) National Water Quality Assessment program (NAWQA), has shown that current-use pesticides are frequently detected in these salmon-supporting river systems (Table 1) (see also more recent monitoring studies by Carpenter et al. 2008; USGS 2008; Washington State Department of Ecology 2008). Furthermore, pesticides almost always occur in mixtures with other pesticides. Analysis of NAWQA monitoring data found that > 90% of water samples from urban, agricultural, and mixed-use streams contained two or more pesticides (Gilliom 2007). The ~~toxicological~~ toxicologic effects of these mixtures on the health of salmon are largely unknown.

In the years since the enactment of the FQPA, the U.S. EPA has identified several classes of pesticides that share a common mode of action (U.S. EPA 2002). Among these are the organophosphate (OP) and *N*-methyl carbamate (CB) insecticides. These two classes of

Synergistic neurotoxicity is strongly influenced by temperature



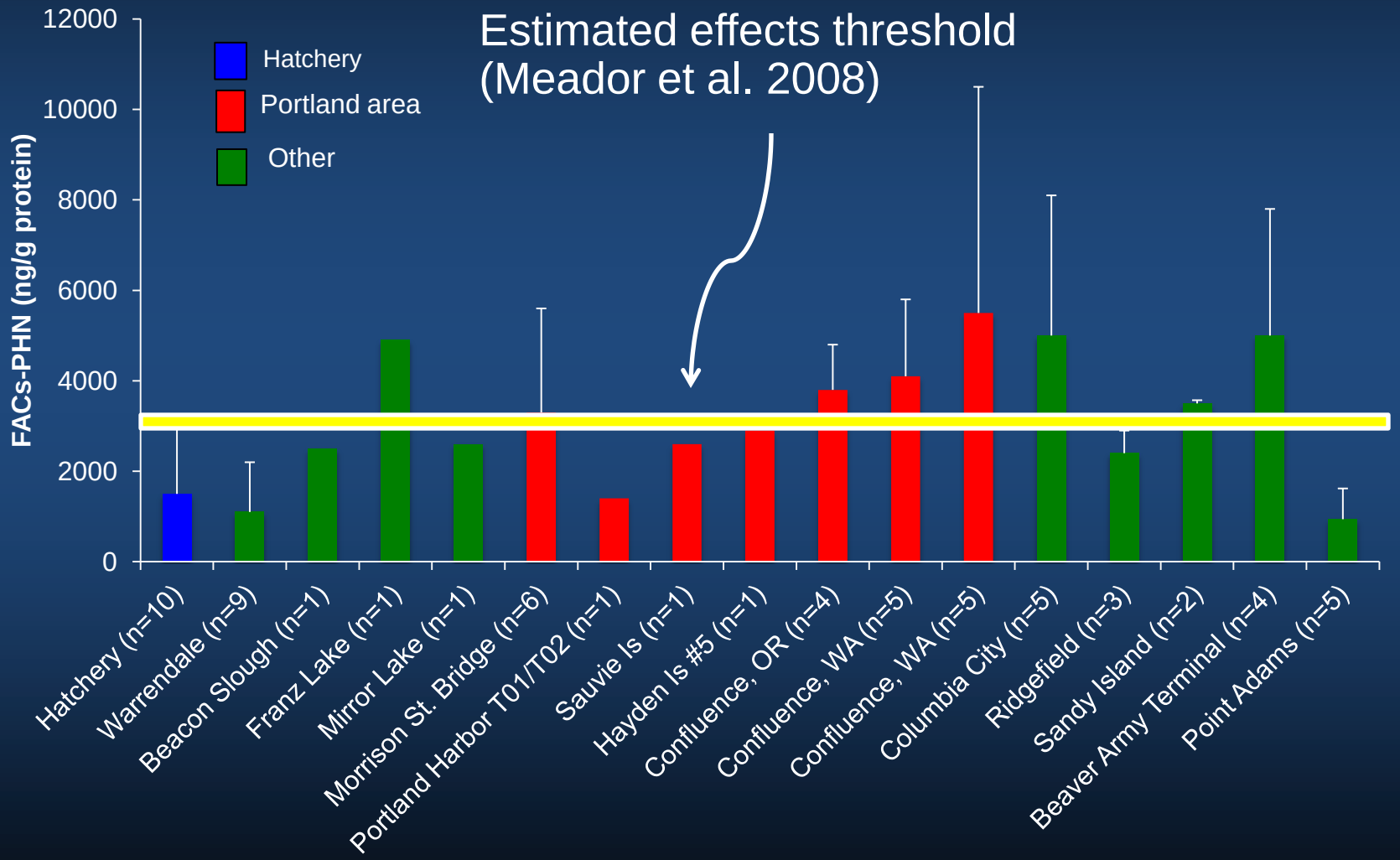
What affects salmon survival?



Toxics and salmon recovery

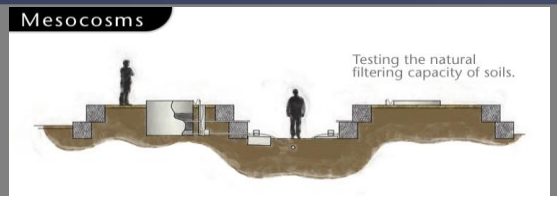
- Threatened Columbia River salmon stocks are being exposed to multiple classes of toxic contaminants at concentrations that cause impairment and likely reduce survival.
- The impacts of contaminants on listed stocks must be accounted for in managing recovery.
- Logical places for management action:
  - Consideration of where habitat restorations are conducted (i.e don't create an attractive nuisance). Monitor for effectiveness.
  - Emphasis on toxics reduction strategies, especially pesticides, stormwater, wastewater discharges, and assessment of effectiveness.
  - Improve the knowledge base concerning toxics and resource health.
- NPCC is in a position to provide leadership.

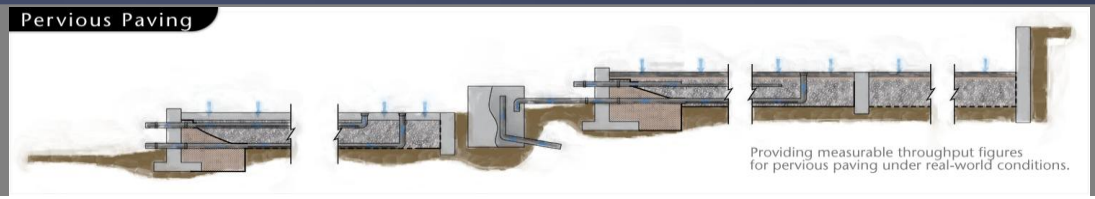
PAH metabolites in juvenile Chinook salmon bile



Evaluating the Effectiveness of Low Impact Development

- New research facility under construction
- Integrate stormwater engineering, landscape architecture, soil chemistry, botany, toxicology, etc.
- Identify cost-effective solutions that work
- Scale these to local communities throughout Puget Sound





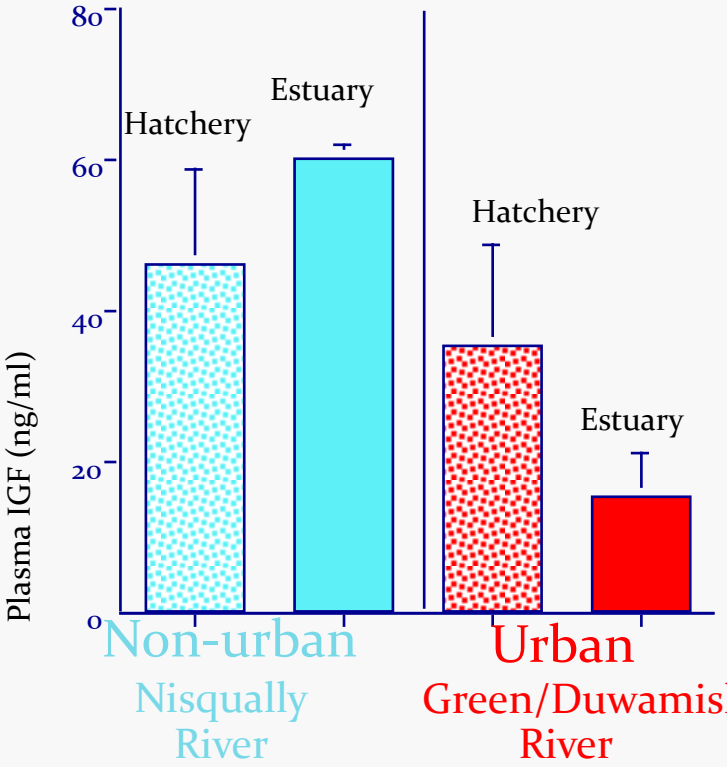
Puyallup Research and Extension Center

LID/Stormwater Management Project

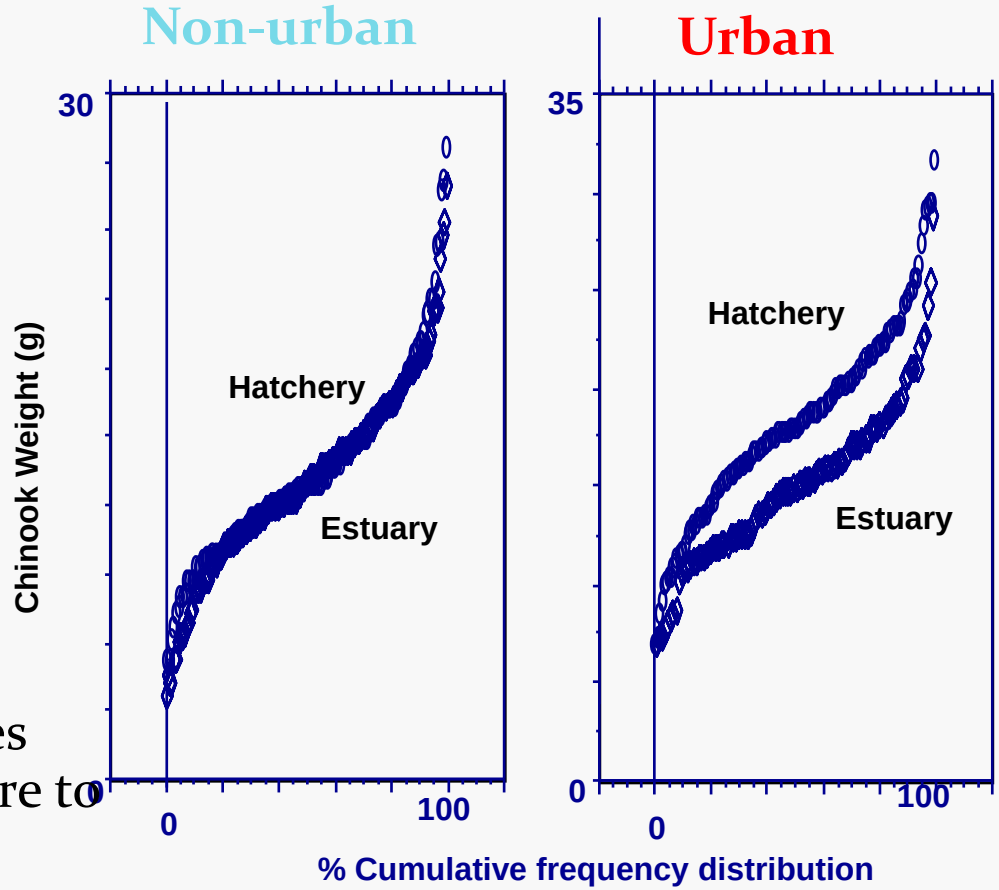
In partnership with the City of Puyallup and the Washington Department of Ecology

WASHINGTON STATE UNIVERSITY

Insulin-like Growth Factor



Subsequent Growth in the Lab

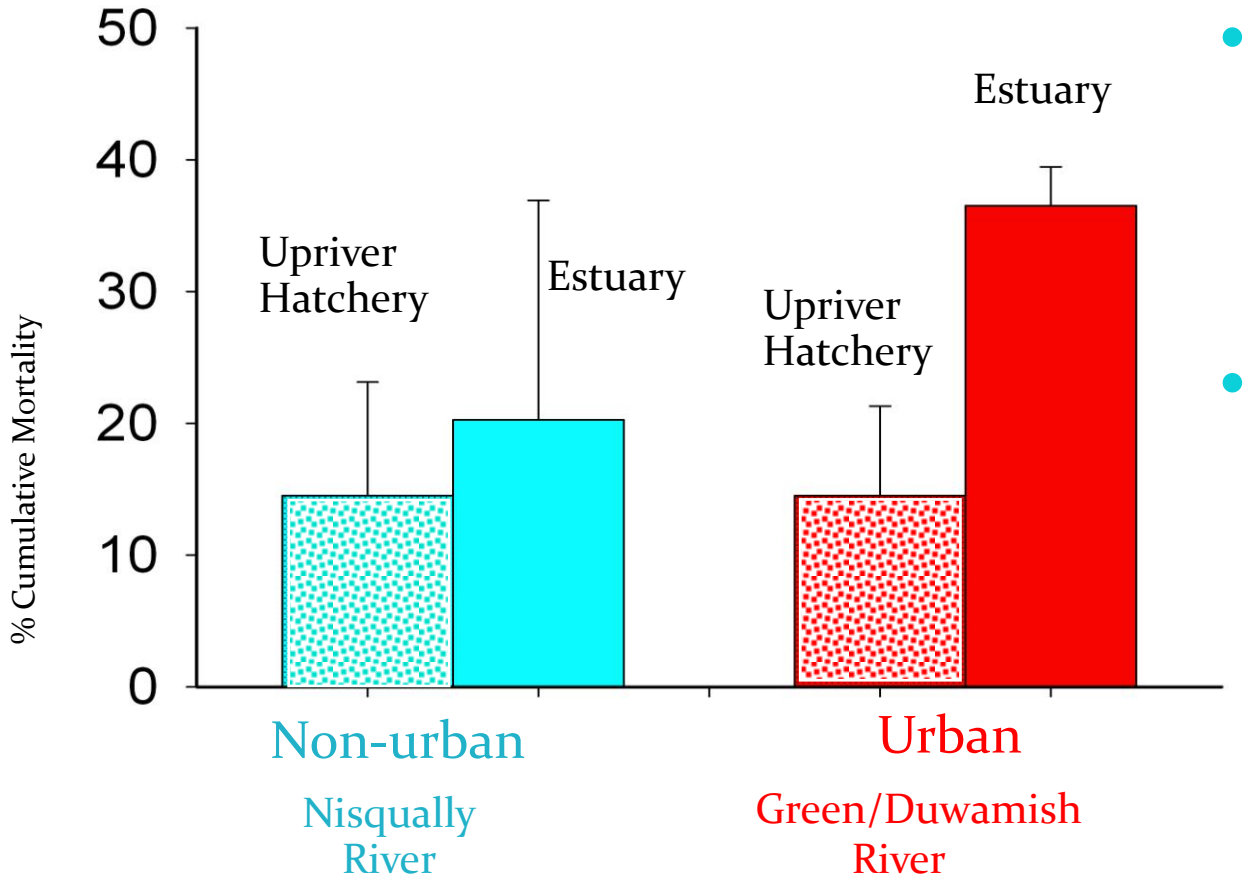


- Follow-up contaminant feeding studies confirm growth is impaired by exposure to toxic chemicals.

- Similar studies completed for Hylebos Waterway.

Casillas et al. 1995a,b; unpublished data

Juvenile Chinook in urban estuaries are more susceptible to mortality from natural pathogens

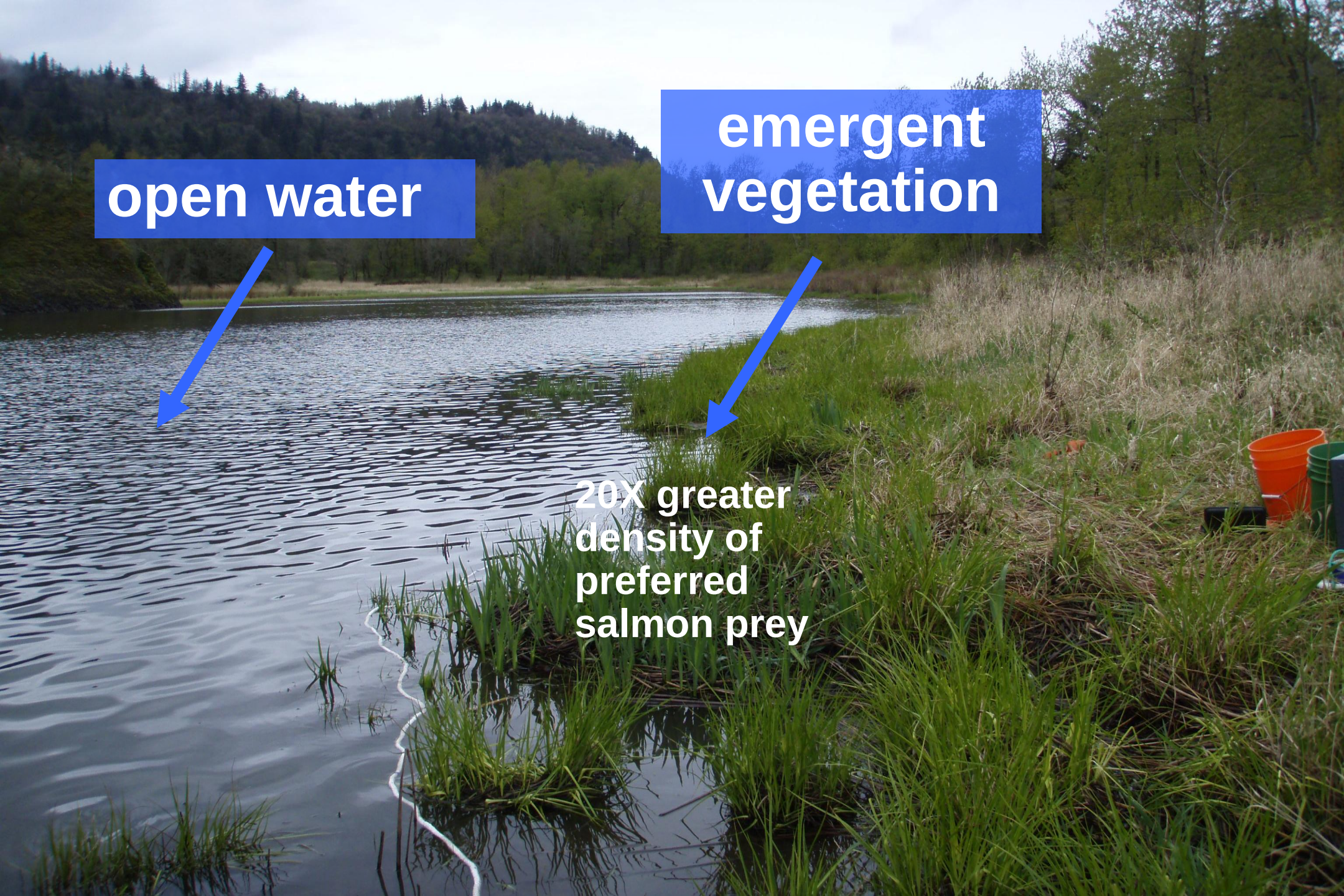


- Additional contaminant feeding studies confirms exposure to toxics impairs immunocompetence.
- Similar studies completed for other Hylebos Waterway and Columbia River

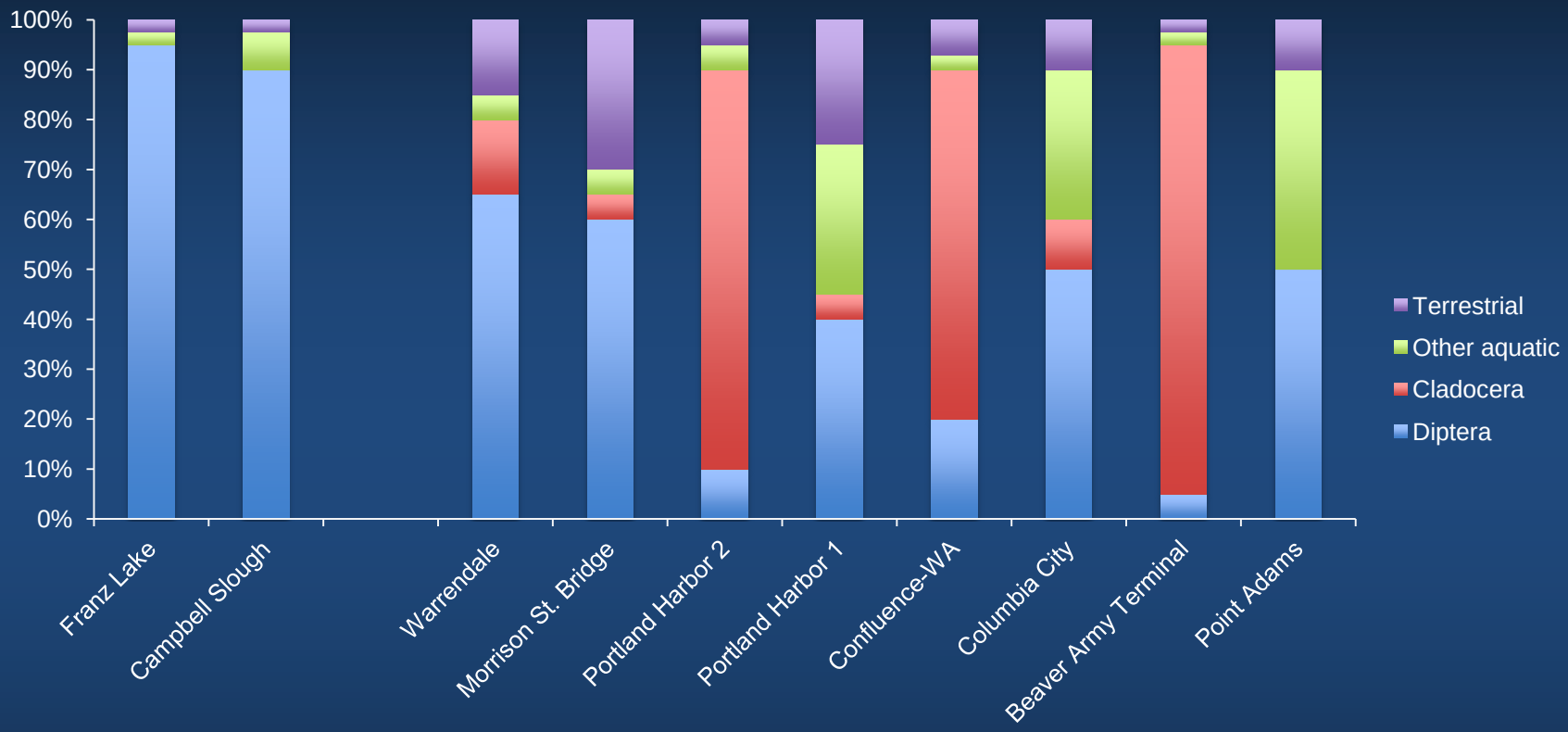
Arkoosh et al. 1998

Contaminants and salmon prey

- Pesticide toxicity to salmon
- Importance of emergent vegetation to salmon prey
- Loss of habitat connectivity and opportunities for recolonization, make it harder for invertebrate communities to recover from pesticide exposures
- Modeling studies (Macneale et al. in prep) suggest that salmon utilizing disturbed habitats with poor connectivity would be especially vulnerable to indirect effects of pesticides applications.


open water
emergent vegetation
20X greater density of preferred salmon prey

Juvenile salmon diets at Lower Columbia River sites



At relatively undisturbed sites, salmon show strong preference for Dipterans; at more disturbed sites other aquatic and terrestrial species are more prevalent in the diet – preferred food may not be available.

Key points

- Toxics reduction efforts will contribute to salmon survival, complement other activities underway to restore stocks, and enhance the effectiveness of habitat restoration efforts

  Longfellow creek slide as example of spending $$$$ for physical habitat restoration but fish are still dying

  “Attractive nuisance”

- Is there some modeling illustration that would help with this?

Portland Harbor NRDA Restoration Planning

Current and planned habitat restoration in Columbia River areas where toxics may be a problem

LCREP & Partner Sites

Restoration Effectiveness Monitoring Attributes

- hydrology (water surface elevation);
- water quality (temperature, salinity, dissolved oxygen);
- elevation (bathymetry, topography);
- landscape features; plant community (composition and cover);
- vegetation plantings (success);
- fish (temporal presence, size/age structure, species).

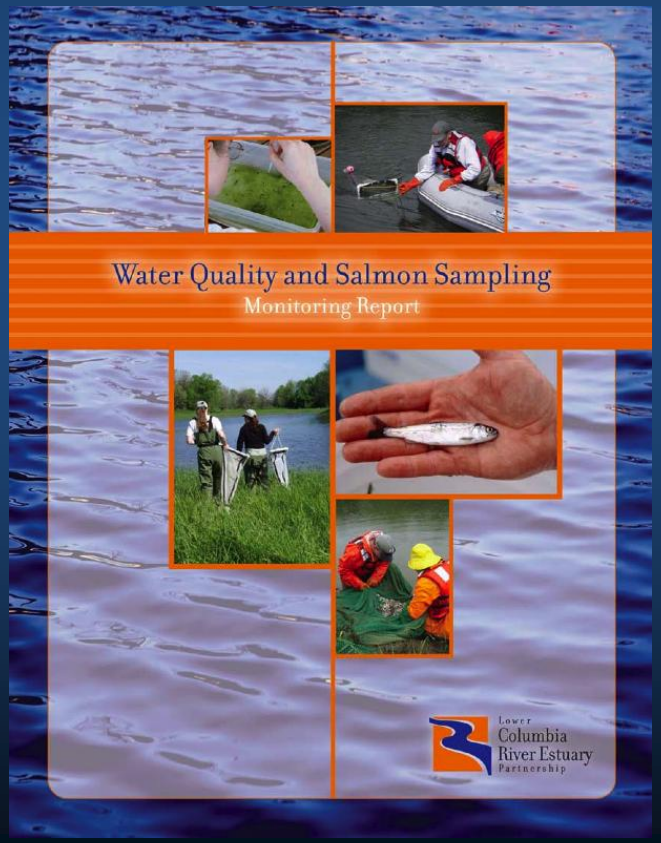
Toxics

Key points

- ISAB and ISRP recommend increased attention to toxics
  - ISAB review of 2009 Fish and Wildlife program states that anthropogenic chemical proliferation in the Columbia Basin is a priority for resolution
  - ISAB food web report (2011) and PNAS article (2012) state that there is an urgent need to quantify and map the spatial patterns of these chemicals; assess their transfer, accumulation, and persistence; and document their impact on Columbia River ecosystems
  - ISRP review of BPA funded habitat projects (2012) specifically addresses toxic contaminants and the need to evaluate and control pesticides and toxic chemicals.

Key points

- The Council has an opportunity to take an active role through cooperation with regional partners, to ensure that monitoring of toxic contaminants and evaluation of their effects on fish and wildlife are addressed

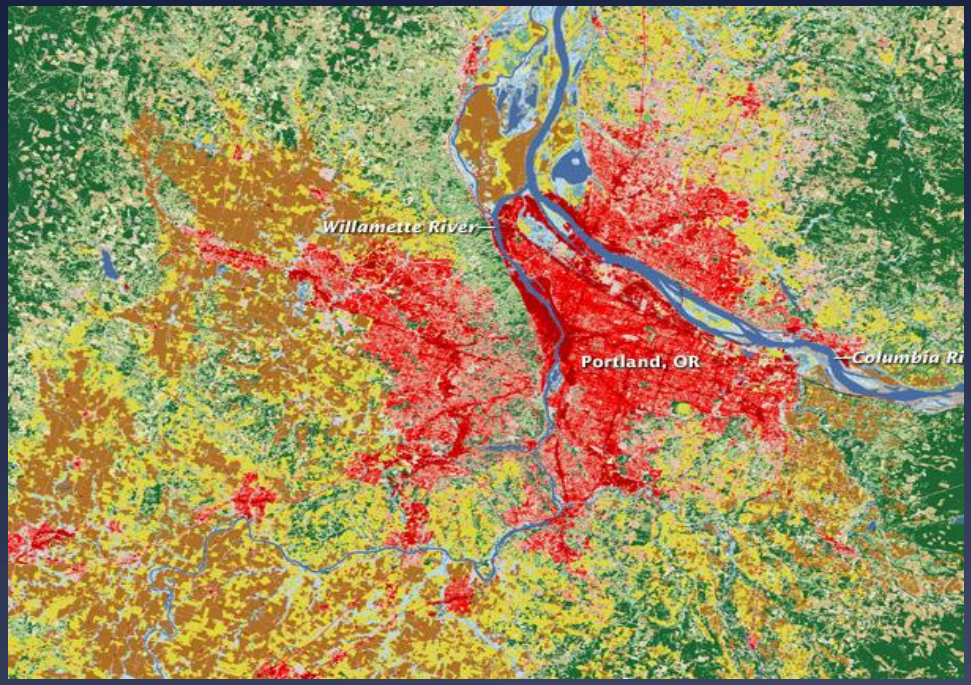


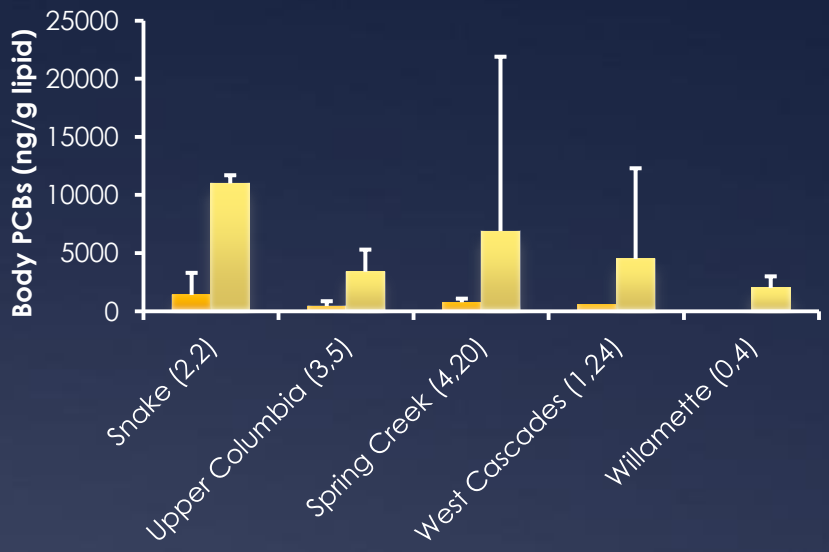
- Collaboration between BPA, Lower Columbia Estuary Partnership, NOAA Fisheries, and USGS has already resulted in the only robust sampling of toxics in juvenile salmon in the Columbia Basin
- Support is needed to continue such efforts and expand them to address additional concerns

Key points

- We know that salmon in the Columbia Basin are exposed to multiple classes of contaminants
  - POPs (DDTs, PCBs)
  - PAHs
  - CECs – PBDEs, pharmaceuticals and personal care products
  - Current use pesticides
- These chemicals can reduce salmon survival through effects on growth, disease resistance, feeding and predator avoidance behaviors, etc.
- Toxics reduction efforts will contribute to salmon survival, complement other activities underway to restore stocks, and enhance the effectiveness of habitat restoration efforts
- ISAB and ISRP both recommend increased attention to toxics contaminants in the Columbia Basin
- The Council has an opportunity to take an active role in addressing this issue through cooperation with regional partners; in fact has already contributed to a very successful collaboration with LCREP, NOAA, and USGS to carry out the only comprehensive survey of toxics in juvenile salmon
- Continued efforts of this type are needed to expand monitoring and research to address issues of concern

Urbanization Impacts on Salmon Habitat

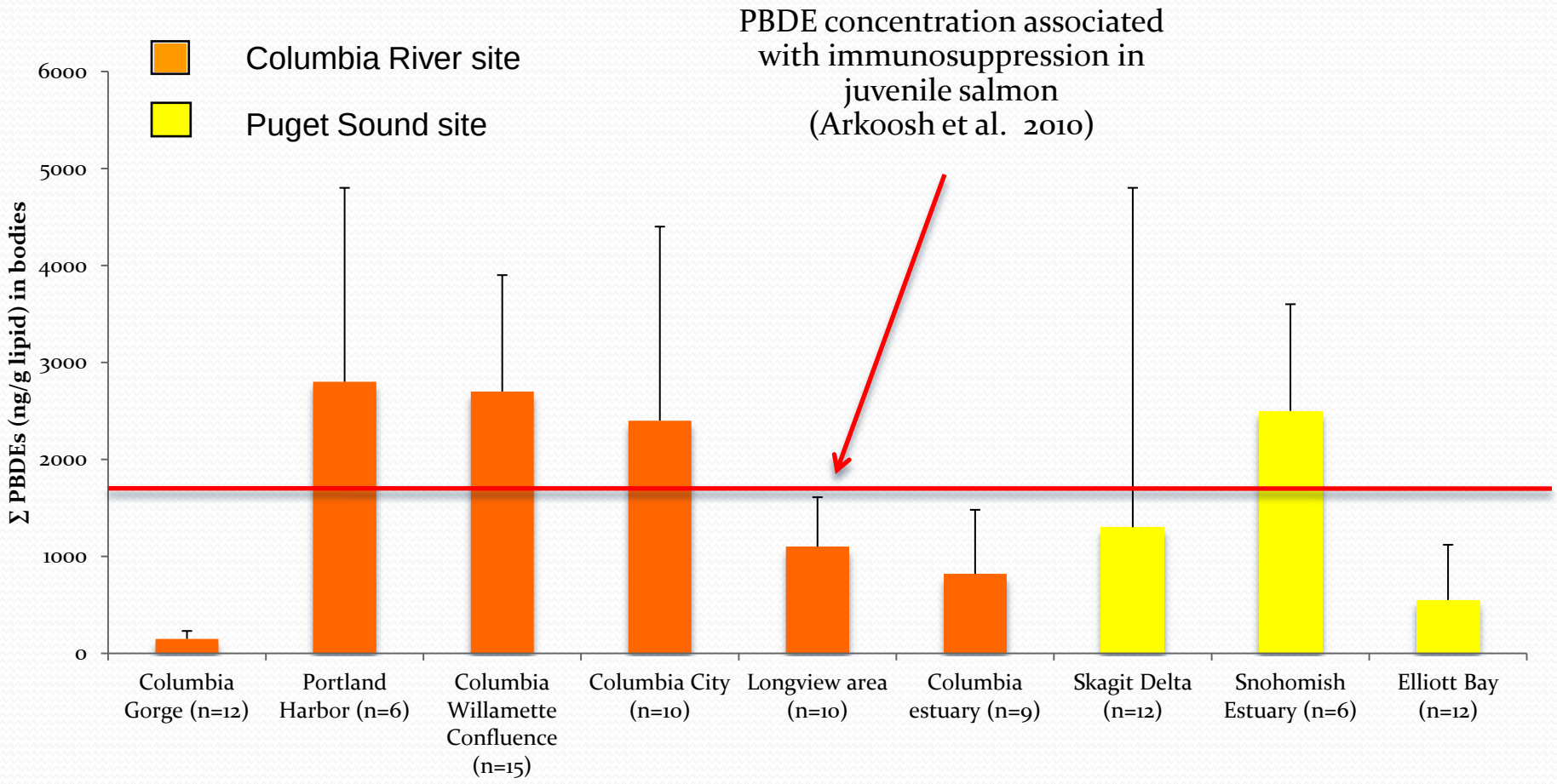




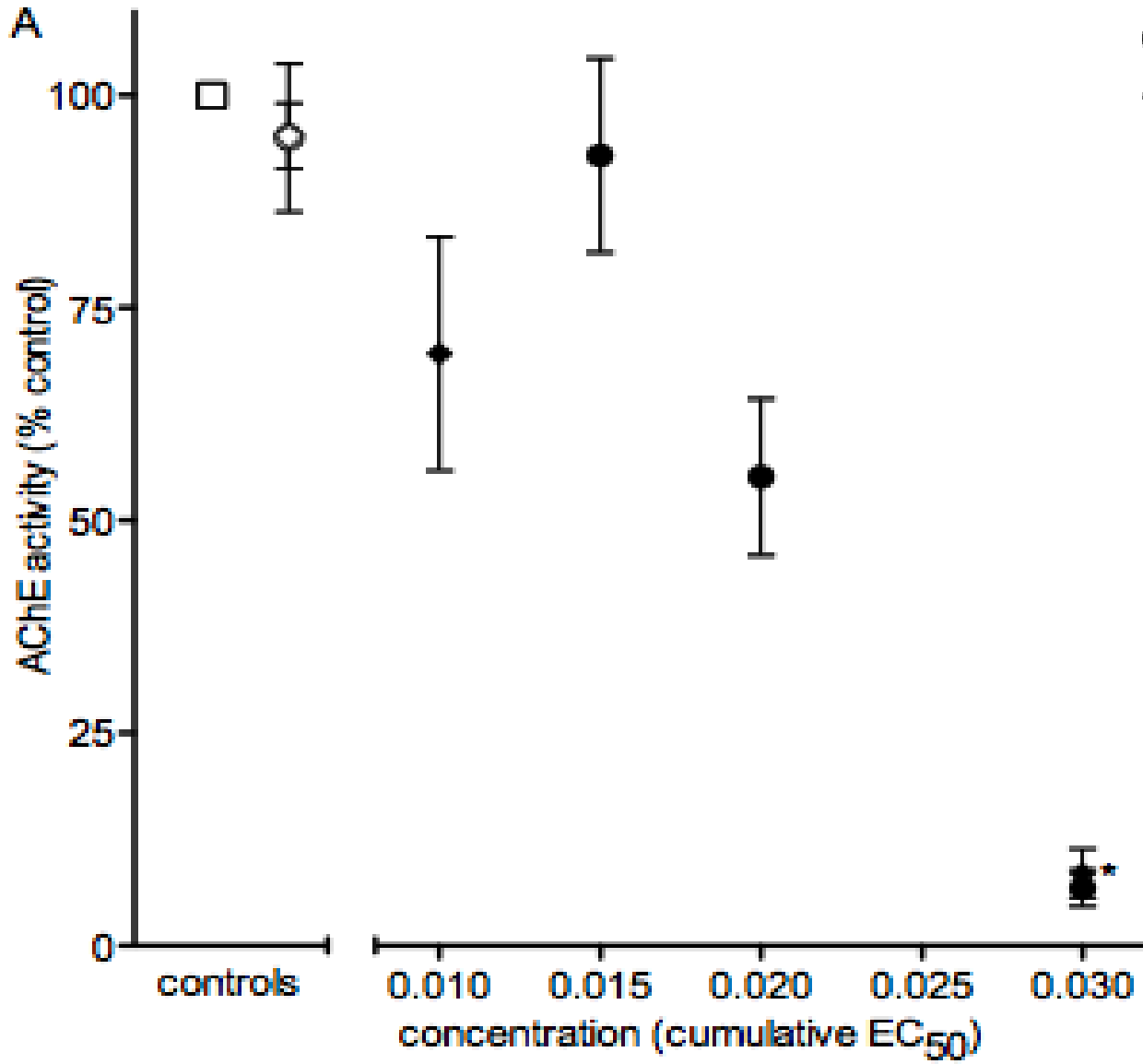
Multiple chinook salmon stocks are absorbing PCBs during outmigration through from urban and industrial areas in Portland and Vancouver

What happens in Portland doesn't stay in Portland!

Wastewater compounds: PBDEs in juvenile Chinook salmon from Pacific Northwest sites



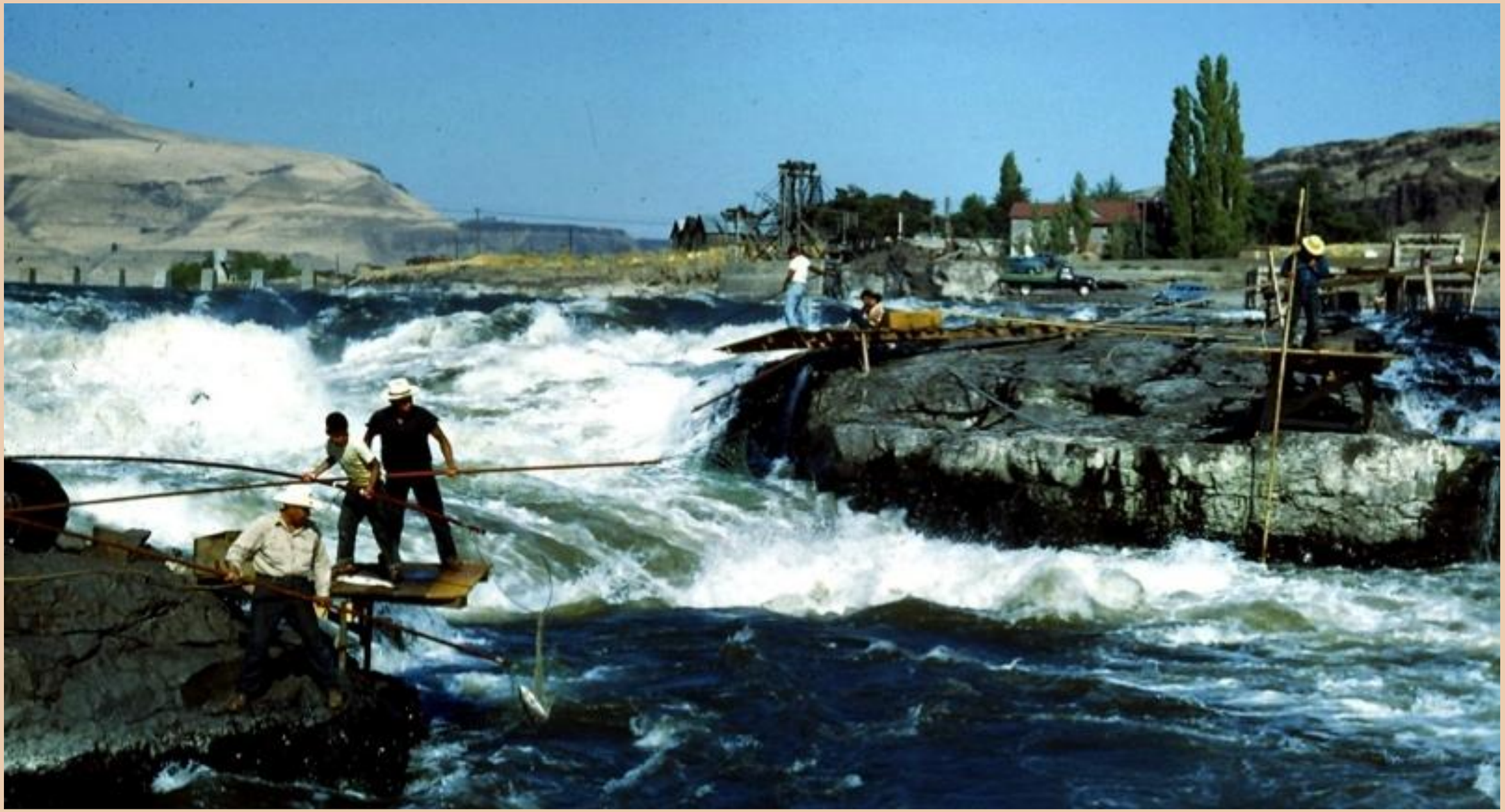
Synergistic toxicity of organophosphate insecticides at low exposure concentrations



0.03 EC_{50} =

2.2 μg/L diazinon
+
1.1 μg/L malathion

1.4 μg/L ethoprop
+
1.1 μg/L malathion

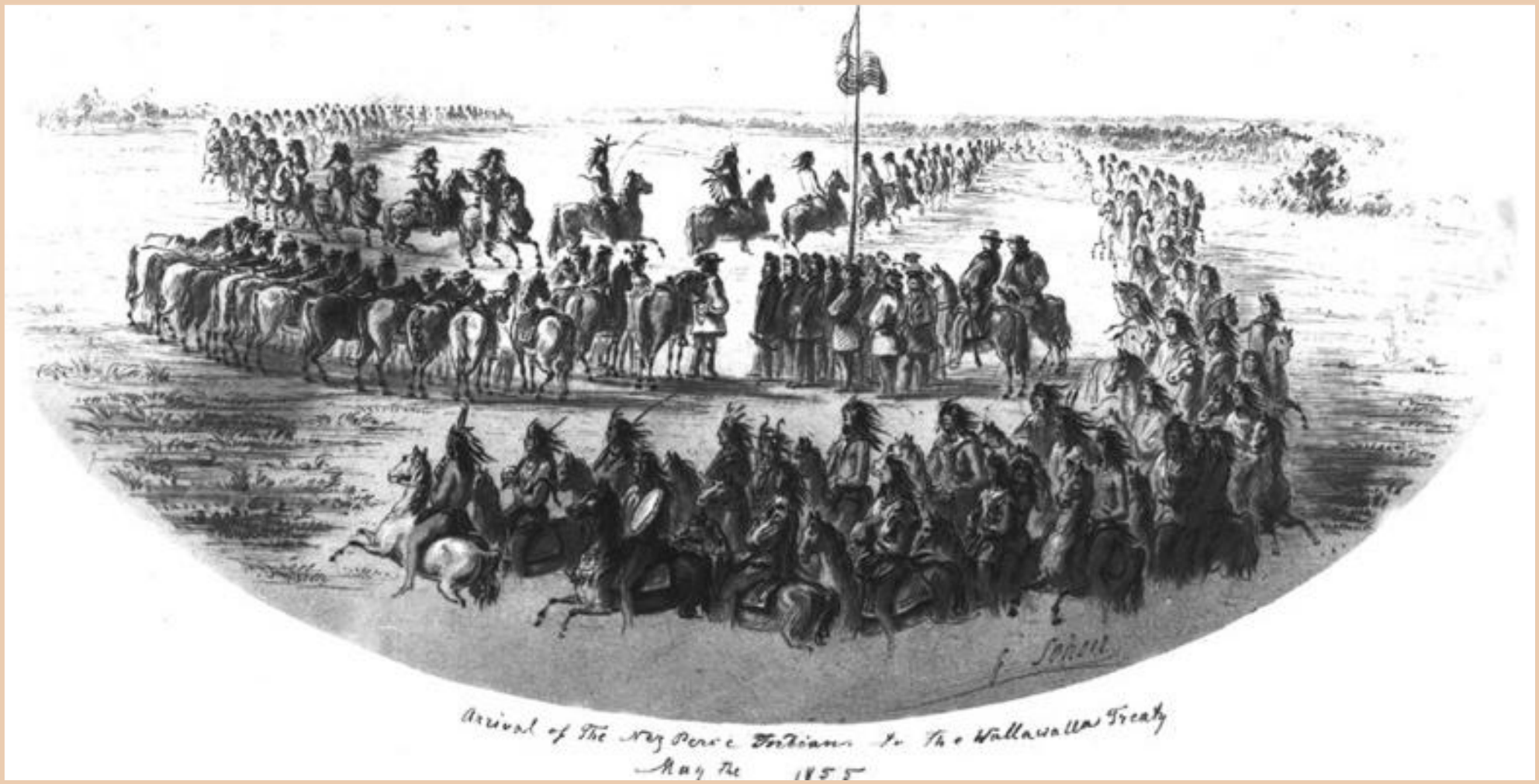


Reducing Toxic Contaminants –Tribal Perspectives

Paul Lumley, Executive Director

Columbia River Inter-Tribal Fish Commission

Fishery Resources are Central to Tribal Culture



"…the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them: together with the privilege of hunting, gathering roots and berries…." —1855 Treaty with the Yakima

Four Tribes' Ceded Lands

Combined, the land comprising this ceded area is:

- 66,591 square miles
- More than 25% of the entire Columbia Basin
- 55% of the rivers and streams that are still accessible to salmon
- Includes almost all of the salmon habitat above Bonneville Dam

Confederated Tribes of the Warm Springs Indian Reservation of Oregon

Columbia River Inter-Tribal Fish Commission

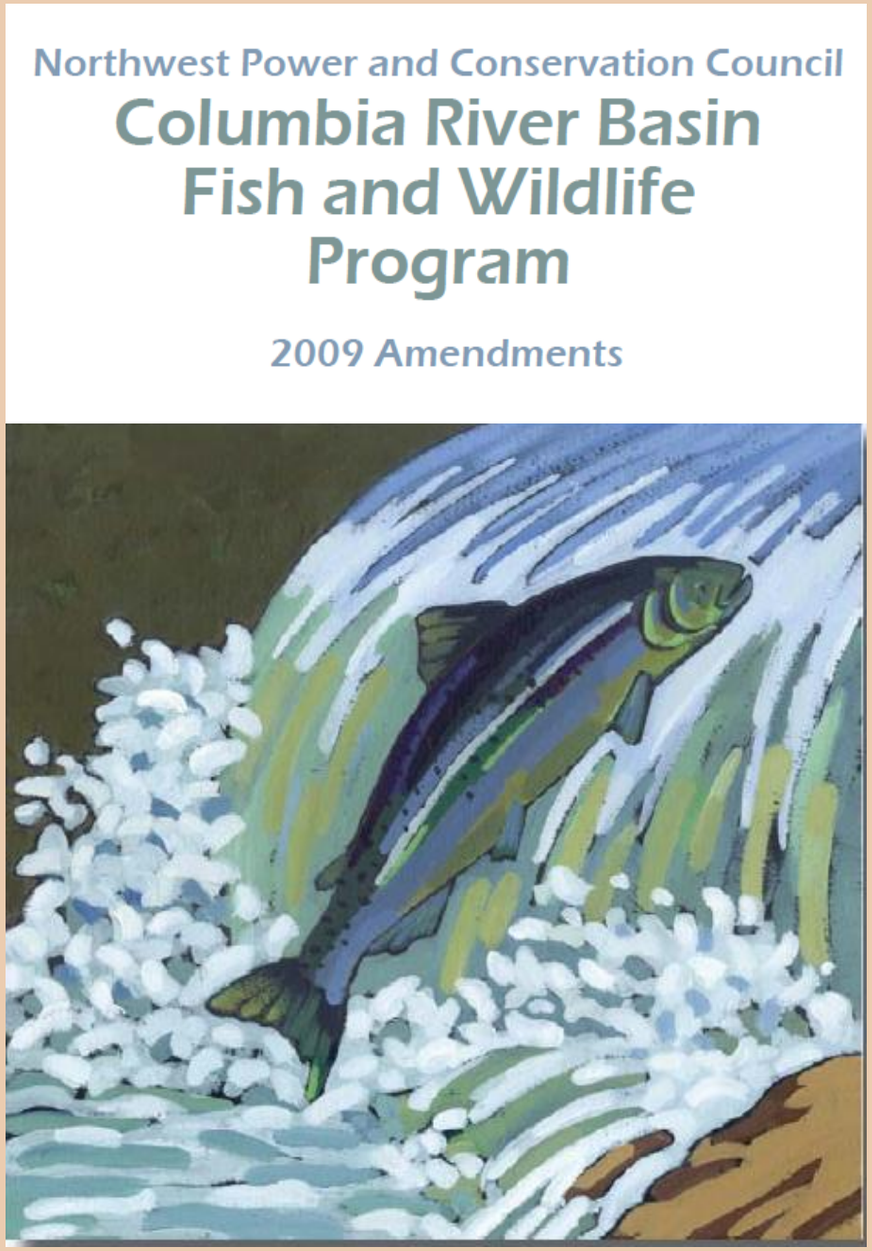
Fish and Wildlife Impacts

Loss of salmon impacted wildlife and other ecosystem functions

Columbia River Inter-Tribal Fish Commission

NPCC Fish & Wildlife Program
2009 Amendments Include a Water Quality Strategy

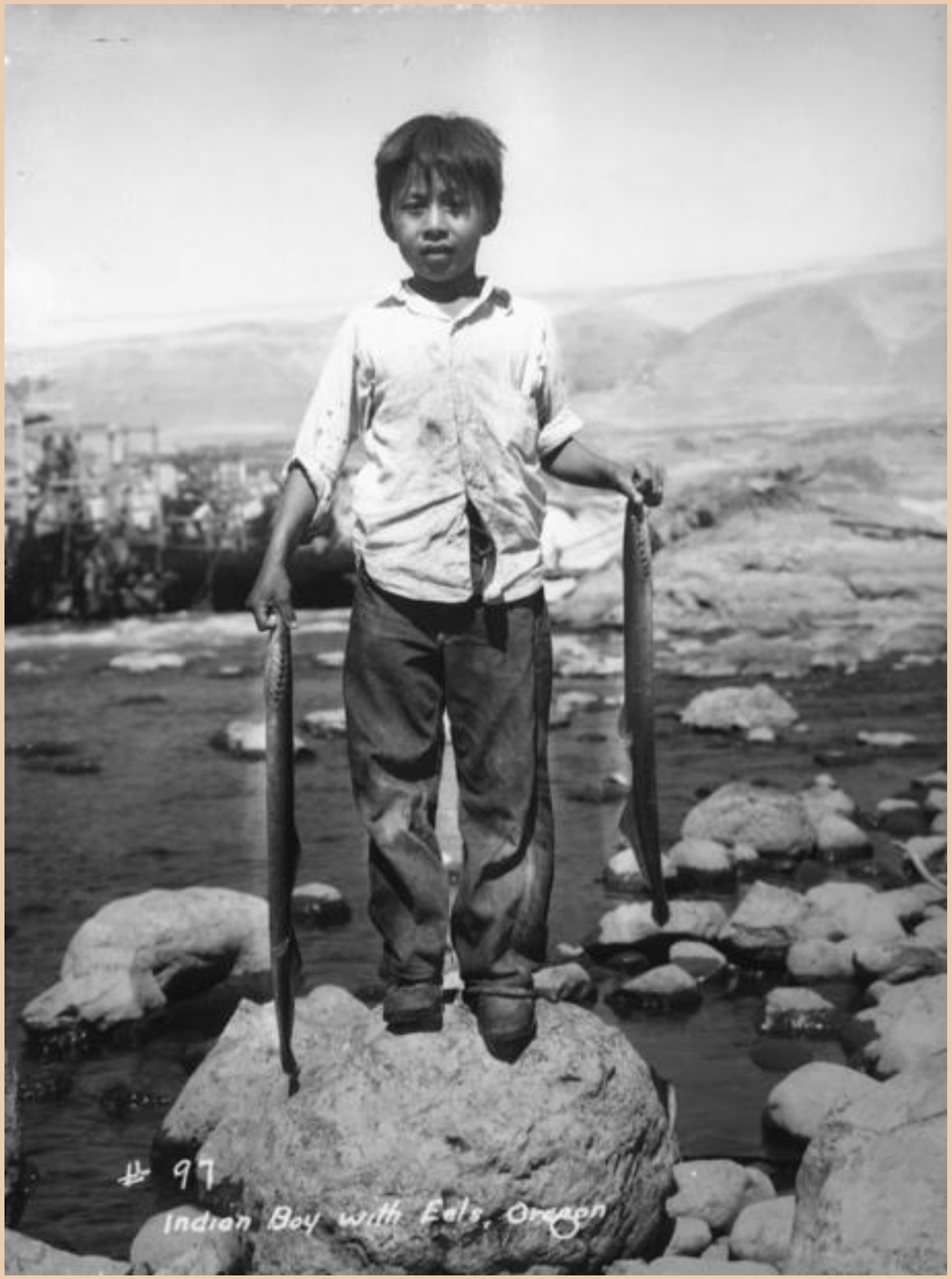
- Implement actions to reduce toxic contaminants in the water to meet state and federal water quality standards. **The federal action agencies should**:
  - Partner with and support efforts to monitor toxic contaminants.
  - Evaluate whether toxic contaminants adversely affect anadromous or resident fish important to this Program.
- Implement actions to reduce toxic contaminants.
- Investigate whether exposure to toxics combined with the stress associated with dam passage, leaves juvenile salmon more susceptible to disease, increased mortality or reduced productivity.



Columbia River Inter-Tribal Fish Commission

Habitat Restoration Actions

- Some BPA funded habitat projects include strategies to reduce the impacts of toxins that pose threats to aquatic resources through projects that:
  - Reduce sediment inputs into streams through road decommissioning, no-till agriculture and cattle enclosures; and the
  - Monitoring of chemicals in mine tailing removals.
- However, <u>additional work is needed</u> to better understand the impact of contaminants on the recovery of key species and foodwebs.


#97
Indian Boy with Eels, Oregon

Lamprey and Sturgeon Concerns

- Pacific lamprey and white sturgeon are particularly vulnerable to bioaccumulation of toxics.
- Many contaminants do not have benchmarks for the level of concern to key species.
- The role of contamination in reduced reproduction and/or rearing success of white sturgeon in impounded areas is unknown.

Basin-wide State Water Quality Standards are Tightening

- October 2011 – EPA approves Oregon's surface water quality standards that used a fish consumption rate of 175 grams/day
- January 2013 – EPA disapproves Oregon's freshwater aquatic life criteria for 3 pollutants
- 2012-2014 – Washington is in the process of revising surface water quality standards to reflect regional fish consumption rates
- May 2012 – EPA disapproves Idaho's request to use a fish consumption rate of 17.5 g/d and funds a 2014 statewide tribal fish consumption survey

Anoxia and Toxics in Reservoirs

Sources and Methylation of Mercury

Without these reservoirs, this contamination would not be such a problem

- Mercury methylation occurs in anoxic reservoirs (depleted of oxygen) making it bioavailable
- Reservoirs in close proximity to agricultural areas may promote mercury methylation
- Once mercury is methylated it enters the aquatic food web
- Little is known about how reservoir management options can best limit methylation

August 2011 - Columbia River Toxics Reduction Working Group Executive Meeting

EPA, State Agencies, Tribes and Environmental Groups partnered to support collaborative efforts to reduce the impact of toxics in the Columbia River Basin

Columbia River Toxics Reduction Working Group
Executive Statement Signatories

August 24, 2011

N. Kathryn Brigham, Confederated Tribes of the Umatilla Indian Reservation

Barry Burnell, Idaho Department of Environmental Quality

Rick Eichstaedt, Spokane Riverkeeper

Paul Lumley, Columbia River Inter-Tribal Fish Commission

Debrah Marriott, Lower Columbia River Estuary Partnership

Dennis McLerran, U.S. Environmental Protection Agency, Region 10

Dick Pedersen, Oregon Department of Environmental Quality

Anthony Paulson, U.S. Geological Survey

Terry Rabot, U.S. Fish and Wildlife Service

Grant Pfeifer, Washington Department of Ecology

Kevin Scribner, Salmon Safe

Heather Ray, Upper Snake River Tribes Foundation

Brett VandenHeuvel, Columbia Riverkeeper

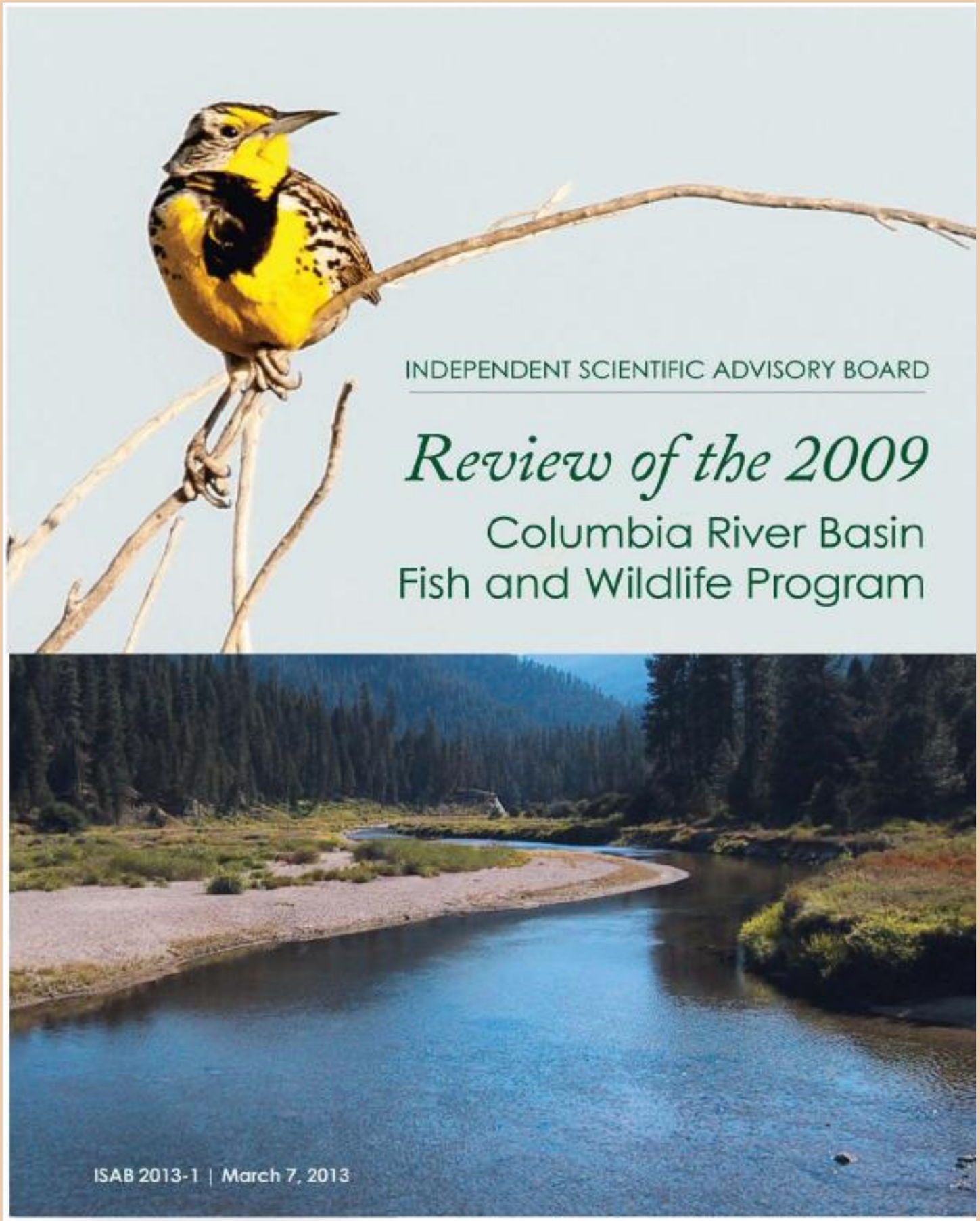
Michael Tehan, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

"…the undersigned **commit to collaborate to reduce toxics** in the Columbia River Basin through the formalization of the Columbia River Toxics Reduction Working Group, including the support of Federal, State, and Tribal executives to guide toxics reduction work in the Columbia Basin through collaborative decision-making."

Columbia River Inter-Tribal Fish Commission

Fish and Wildlife Program Amendment Process

- Toxics are not only a human health issue but also have adverse impacts on species important to the Program
- State water quality standards are becoming more stringent and should be supported
- Incorporate the recommendations of the ISAB and ISRP



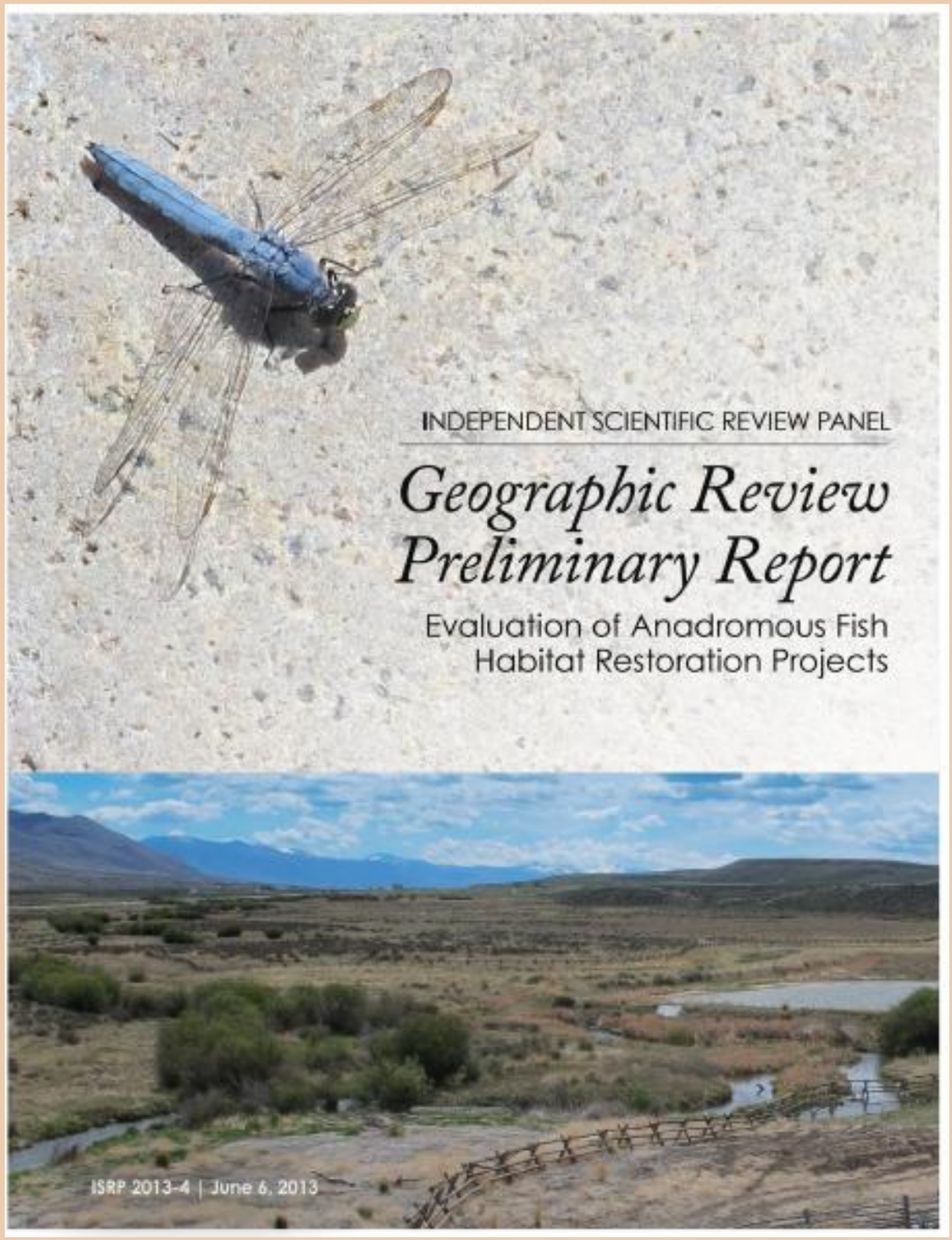
"Threats to the success of the program include proliferation of artificial chemicals and contaminants within the Basin."

"The Council has on opportunity to take an active role – **through cooperation with regional partners** – to ensure that monitoring of toxic contaminants and evaluation of their effects on fish and wildlife are addressed."

Columbia River Inter-Tribal Fish Commission

In June 2013, the ISRP reiterated and emphasized the ISAB recommendation. “Chemical inputs into the watershed are ubiquitous …there is an urgent need to:

- Quantify and map the spatial patterns of these chemicals
- Assess their transfer, accumulation and persistence
- Document their impact on Columbia River ecosystems



Tribal Perspectives

- Fish have been affected by the FCRPS
- Toxic contamination is an often disregarded obstacle to fish recovery
- Toxics that impact fish recovery come from hydrosystem components and other sources
- Mitigation to address toxics is legally appropriate

CRITFC Recommendations

- Inclusion of ISRB and ISAB recommendations into the Fish and Wildlife Plan
- Include an analysis of the impact of contamination as part of current and future habitat restoration programs, particularly for white sturgeon and pacific lamprey
- Investigate how seasonal anoxia in reservoirs impacts the release and transfer of toxics into fish
- Power Council engagement in the Columbia River Toxics Reduction Executive Group to coordinate toxic reduction efforts

Toxics Reduction in the Columbia River Basin

Developing and Implementing Water Quality Standards to Protect Human Health

Kalispel natural resources

Developing WQS to Protect Human Health

- Beneficial use = fish consumption
- To protect the use, basically need to determine:
  - Who to protect
  - Acceptable risk threshold
  - Amount of fish to be consumed

Kalispel natural resources

EPA's 2000 Guidance

- National default standard
  - Who to protect – 90th percentile of U.S. adults
  - Acceptable risk – 1 in 1 million incremental cancer risk
  - Fish consumption rate – 17.5 g/day (prior rate was 6.5)
- Caveats
  - Insufficient to protect subsistence fishermen, women of childbearing age, and children
  - 1 in 10,000 risk to subsistence fishermen okay
- Shortcoming
  - Exclusion of the user groups who benefit the most from eating fish
  - Disproportionate impact on Indians

Kalispel natural resources

Regional Effect of 2000 Guidance

- Oregon
  - Revised WQS submitted based on 17.5 g/day (2004)
  - ODEQ, Umatilla Tribes, and EPA agree to revise 2004 WQS based largely on 1994 CRITFC fish consumption survey (2006)
  - Lawsuit forces EPA to act on 2004 standards; EPA disapproves (2010)
  - EPA approves FCR of 175 g/day with a 1 in 1 million risk level (2011)
  - No implementation to date
- Idaho
  - Revised WQS submitted based on 17.5 g/day (2007)
  - EPA disapproves after being forced to act by lawsuit (2012)
  - Negotiated rulemaking ongoing; no firm completion date
  - 60-day NOI letter sent to EPA for failure to promulgate
- Washington
  - Revised standards have never been submitted

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Current FCRs

- Kalispel – 389 g/day (pending)
- OR – 175 g/day
- WA & ID – 6.5 g/day*

* Despite 13 years having passed since EPA published its national default standard of 17.5 g/day

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Why the Delay?

- Implementation concerns driving descriptive process
- Effects of conflating the two inquiries
  - Lost sight of the underlying beneficial use
    - EPA focus on "accurate" FCR instead of health-based or culturally determined FCR
  - Data obsession
    - Recent budget proviso in Washington
    - Idaho survey process
    - Bear in mind that the CRITFC study included data from Oregon, Washington, and Idaho tribes, and that fish populations have generally increased since the time of the survey
  - Waste
    - Tribes and regulated community have spent millions in data driven arms race

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The Program's Role

- Increased Council leadership for a coordinated regional effort to make sure that the fishes it is working to protect and restore across the basin may be safely eaten
- Opportunity to convene a forum that will shift the FCR discussion toward an aggressive but fair implementation schedule
  - Poor documentation to date regarding actual effect of higher FCR on the regulated community
  - May need to consider ways to soften the regulatory burden on point sources
    - More non-point source accountability
    - Better control and elimination of toxic sites
    - Reduce importation/production of toxic substances

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