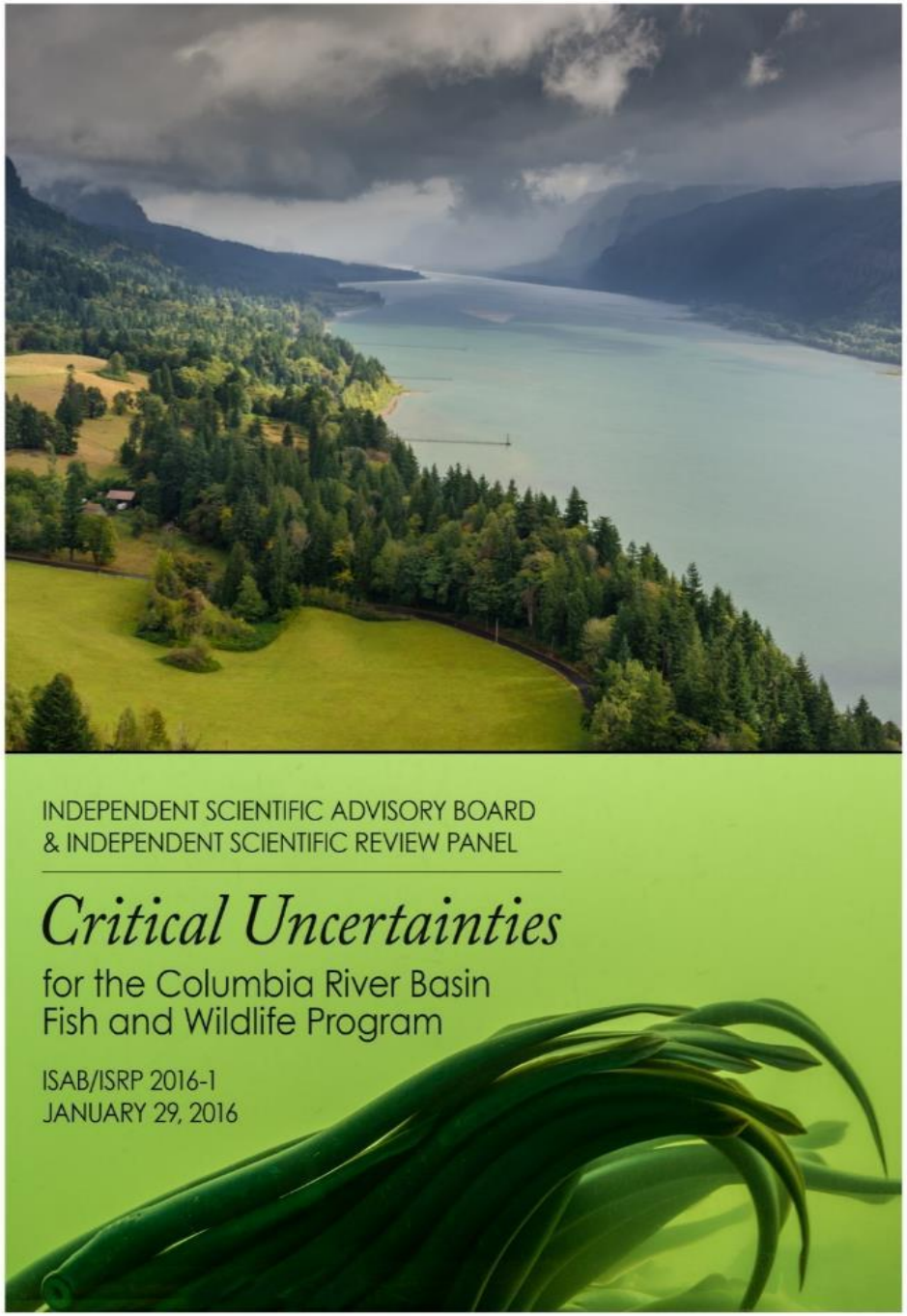

ISAB and ISRP Contributors

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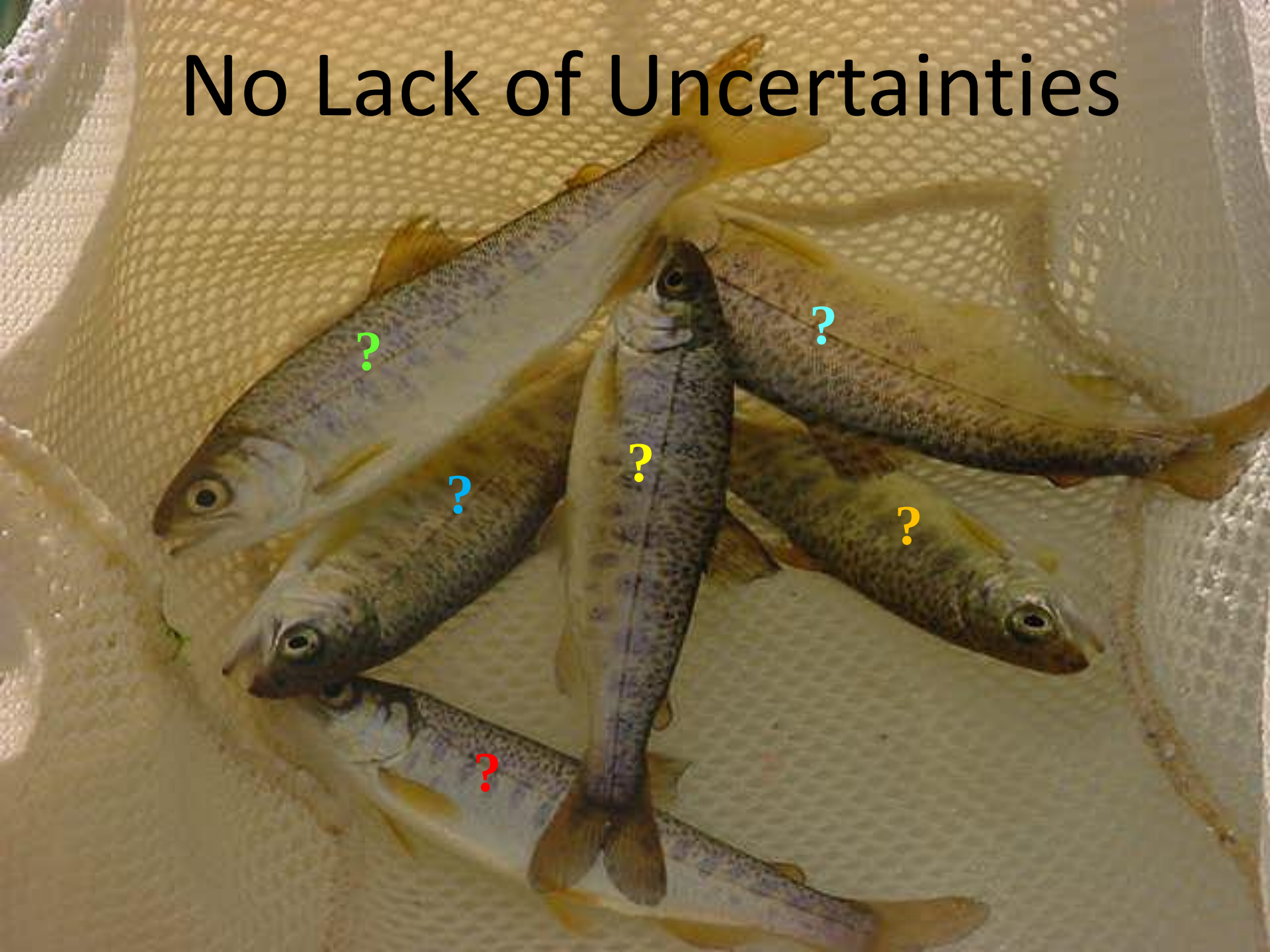
No Lack of Uncertainties



Identifying & Classifying Critical Uncertainties

Steps Taken:

- Council staff searched 130 documents
- 1400 Uncertainties identified
- ISAB/ISRP placed uncertainties into one of 14 themes
- Redundant uncertainties removed
- 700 Uncertainties remained
- Uncertainties in each theme organized into subthemes
- A searchable uncertainties database was created

Image from www.businessinsider.com

Prioritizing Uncertainties (within each theme)

Steps Taken:

- Progress in resolving each uncertainty estimated
- Criticality or importance of each uncertainty estimated

Radientminds.com

Part 1: Current Critical Uncertainties

Creation of Part 1:

- Priority uncertainties in each theme identified
- Rationales for importance developed
- Fifty priority uncertainties in Part 1 by theme.

Photo from: hqworld.net

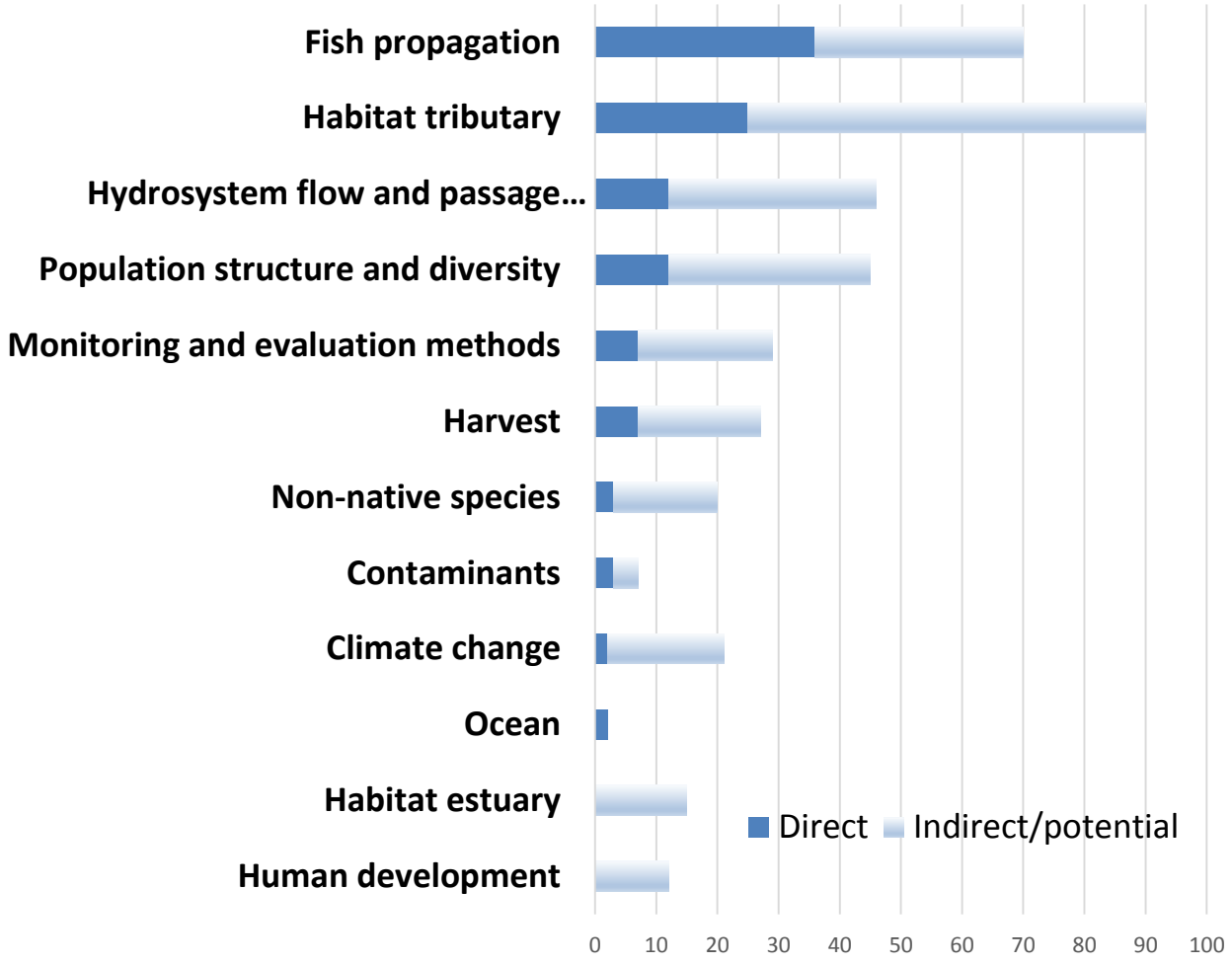
Part 2: Progress Made on Addressing 2006 Research Plan Uncertainties

Approach Used:

- 187 Annual Project Reports reviewed (~ 10,000 pages)
- Determined each project's "Direct" & "Indirect" connections to uncertainties in the 2006 Plan
- A synopsis of each Project was produced (Appendix D)

freeimages.com

Number of Projects that Directly & Indirectly Examined Themes in the 2006 Research Plan



Recommendation: Communicate Research Results & Challenges

Among project proponents, tribes, governmental entities & others

Benefits:

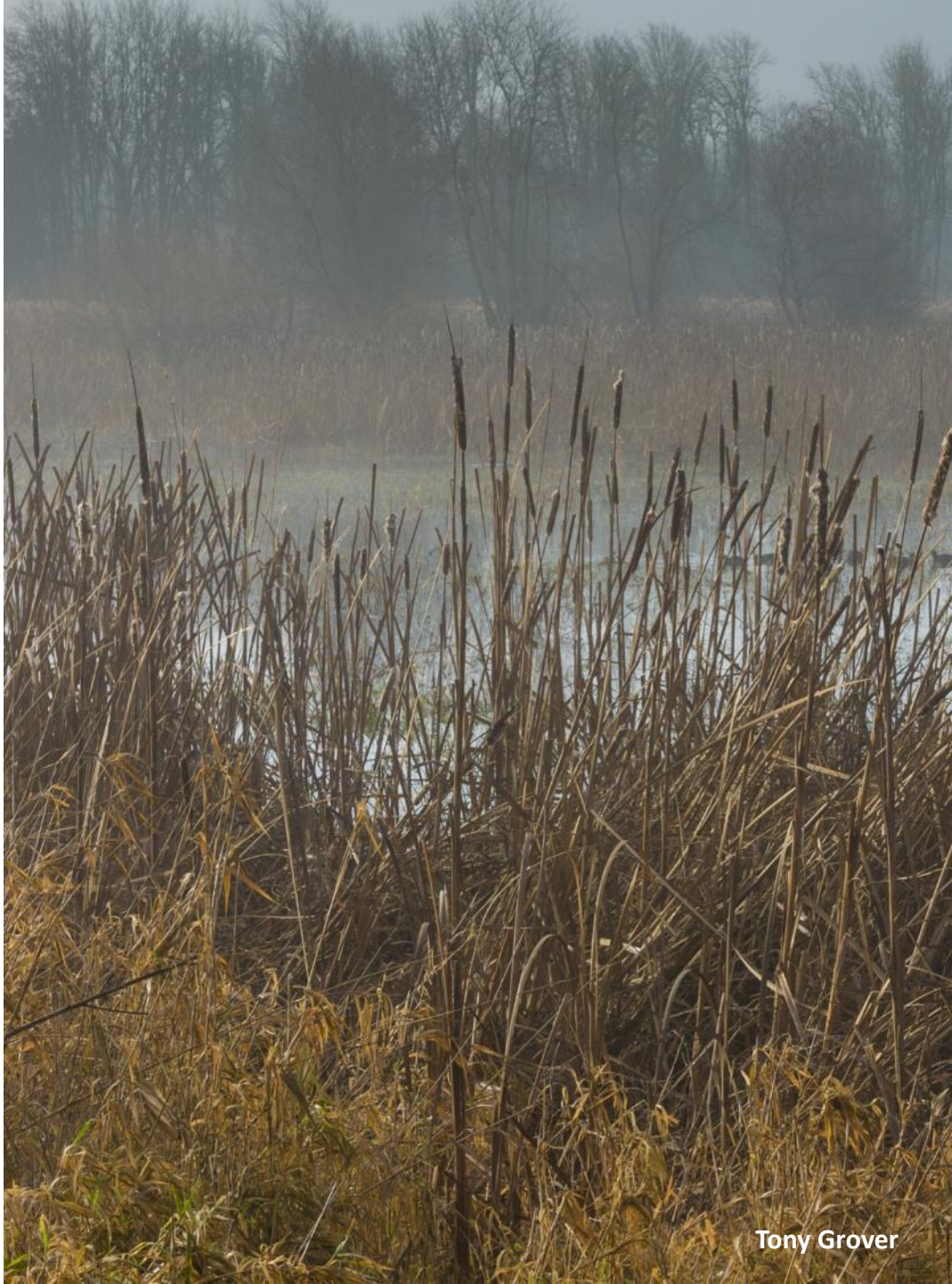
- Formation of research & management partnerships
- Pooling of data & resources
- Spreading of methods & innovations
- Public support of Fish & Wildlife Program

Recommendations

- Anticipate climate change effects
- Ensure water quality & security
- Support research on contaminants
- Evaluate the effects of non-natives
- Continue to assess the benefits & risks of artificial propagation
- Refine approaches for harvesting hatchery fish

Recommendations

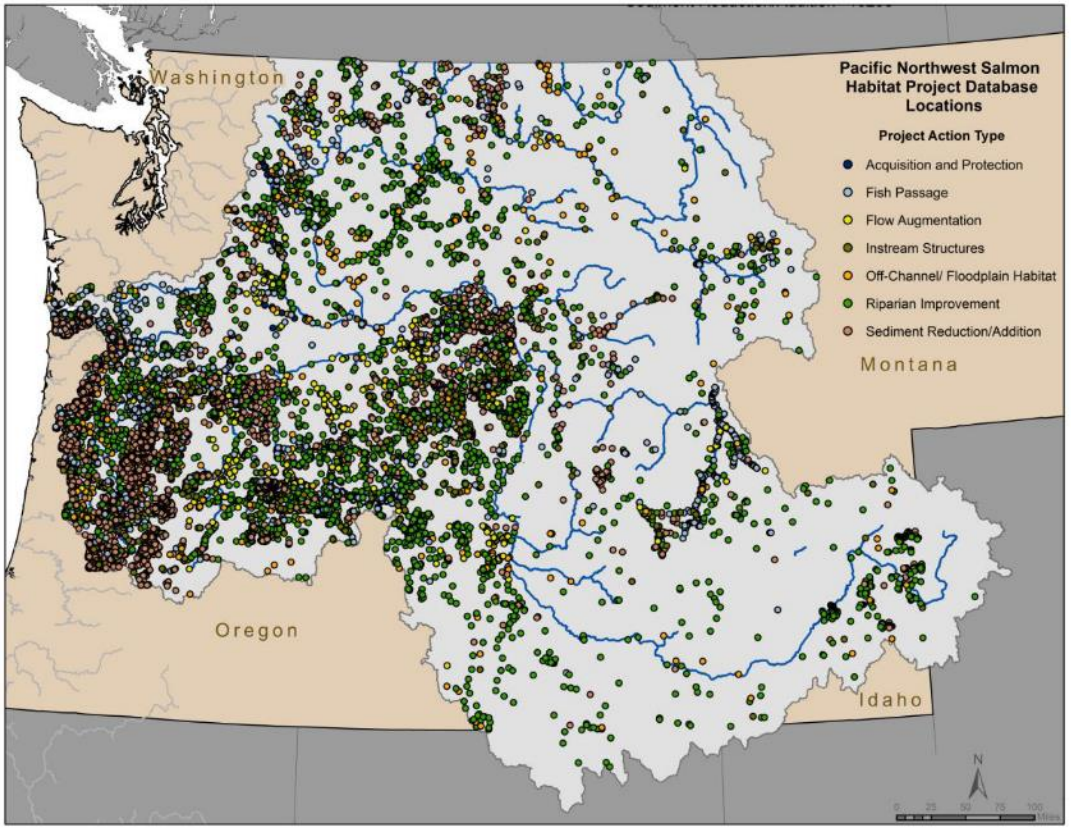
- Track changes in population structure & genetic diversity
- Demand rigorous monitoring & evaluation programs
- Recognize that restoration takes time
- Encourage research on ecological interactions
- Anticipate human development impacts



Habitat Restoration Actions in the Basin

Types of Habitat Restoration

- Fish Passage
- Instream Structures
- Off-Channel/Floodplain
- Riparian Improvement
- Sediment Reduction/Addition
- Acquisition & Protection
- Flow Augmentation



Habitat actions by all entities in the Columbia Basin.

Since 2005, 4,600 sites (Roni et al. 2013)

Uncertainties of Habitat Reconnection & Restoration

Will it:

- ❖ Mitigate downstream habitat loss?
- ❖ Benefit wild populations?
- ❖ Increase resilience against climate change & contaminants?

Photos From: M. Pollock, C. Jordan, N. Bouwes, J. Wheaton, C. Volk, N. Weber, J. Hall, & J. Goldsmith.
www.wnfsc.noaa.gov/research/divisions/fe/wpg/beaver-assist-stld.cfm

How Effective Have These Efforts Been?

Monitoring & Evaluation Programs

- ❑ Integrated Status & Effectiveness Monitoring Program (ISEMP)
- ❑ Columbia River Habitat Monitoring Program (CHaMP)
- ❑ Action Effectiveness Monitoring (AEM)
- ❑ Intensively Monitored Watersheds (IMW's)
- ❑ Intensively Surveyed Watersheds (ISW's)

Recent Results:

- ❑ John Day Subbasin—Bridge Creek Project
  175% increase in juvenile steelhead
- ❑ Methow River Floodplain Reconnection
  400% to 800% increase in fish abundance

Top photo (John Day River Watershed Restoration Strategy); bottom photo (Methow Salmon Recovery Foundation)

Moving Forward: Recognize that Restoration Takes Time

Evaluating conservation actions is complicated by:

- Natural variation
- Sampling error
- Small but meaningful changes

Artificial Propagation Uncertainty: What Are the Effects of Basinwide Releases on Natural Populations?

Tributary Habitat

- Hatchery smolts leave quickly
- Little predation or impact detected
- Precocious parr & residuals may reside in tributaries

Mainstem Habitat

- Observed in Snake River reservoir
  - Depleted food resources
  - Reduced growth
  - Numerical predator response
  - (Smallmouth Bass)
  - Early immigration

Estuary

- Possible competitive & predaceous interactions
- Natural & hatchery fish occupy same areas
- Interactions not well understood

Uncertainty: Can Supplementation Increase Natural Populations of Salmonids?

Results

- Mixed
  - Total adult returns H + NORs increase
  - NOR abundance: stable, decline, increase
  - Increase in harvest, redds, spatial distribution
  - NOR productivity declined

Factors Affecting Supplementation

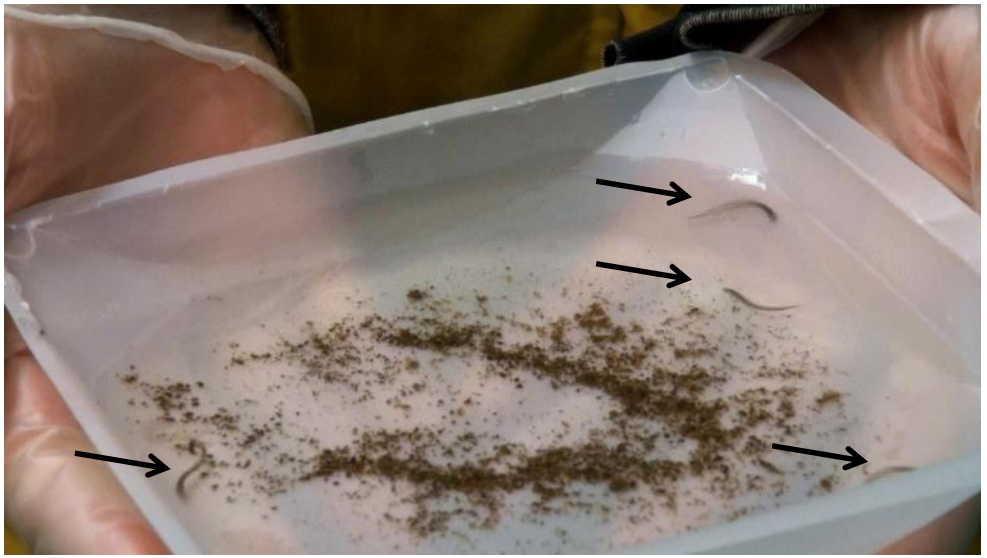
- Release location
- Broodstock origin & history
- Genetic diversity of broodstock
- Domestication effects
- Age & size of hatchery fish at maturation
- Maturation timing of hatchery fish
- Carrying capacity of receiving habitat

Uncertainty: Pacific Lamprey Enhancement Approaches

Images (nwpr.org/post/creating-northwest-lamprey-hatchery)

Lamprey Hatchery—A New Idea

- Uncertainties:
  - Larval food
  - Larval resting substrates
  - Size at out-planting
  - When & where to release
  - Effectiveness evaluation



Moving Forward: Continue Assessments on the Benefits & Risks of Artificial Propagation

- ~140 million hatchery salmon released/year: cumulative impacts are not known
- Supplementation is widely used in the Basin: need to know how effective it is
- Artificial propagation might be important for: Pacific Lamprey & White Sturgeon
- Need to understand genetic effects of artificial propagation

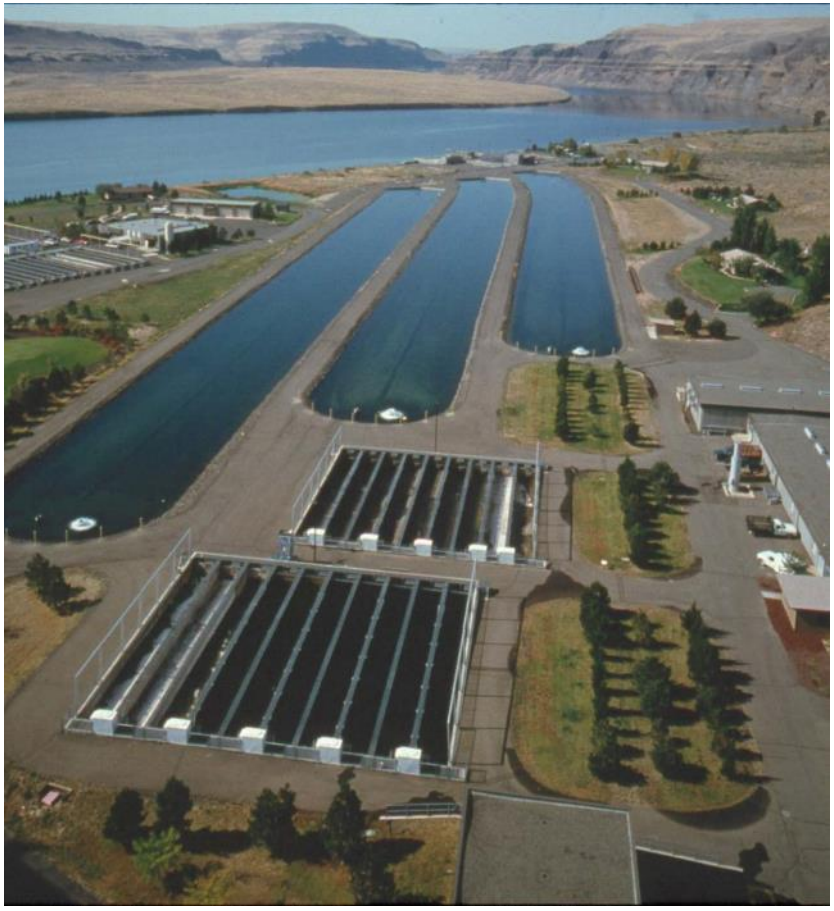


Photo Of Lyons Ferry Hatchery M. Key (2013)

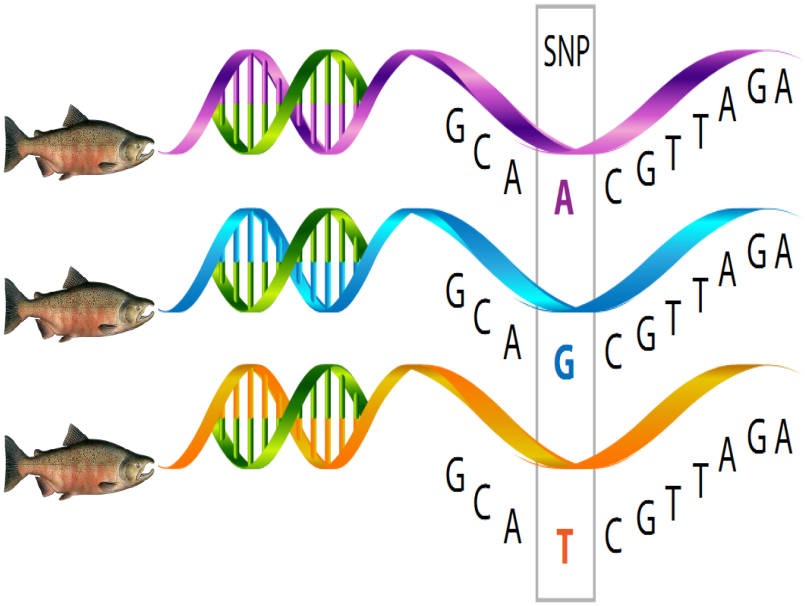
Population Structure & Genetic Diversity

Uncertainties to Resolve

1. Abundance
2. Distribution
3. Fish X habitat relationships (movement patterns)
4. Interconnections among populations (genetic relationships)

Photo: fws.gov

Methods for Assessing Population Structure & Diversity



Environmental DNA (eDNA)

Used to assess distribution patterns
- Detect rare species
- Presence of invasive species
- Estimate abundance

Single Nucleotide Polymorphisms (SNPs)

Used To:
- Identify individual populations
- Examine genetic connections among populations
- Parentage-Based Tagging

Photo: Matthew Laramie

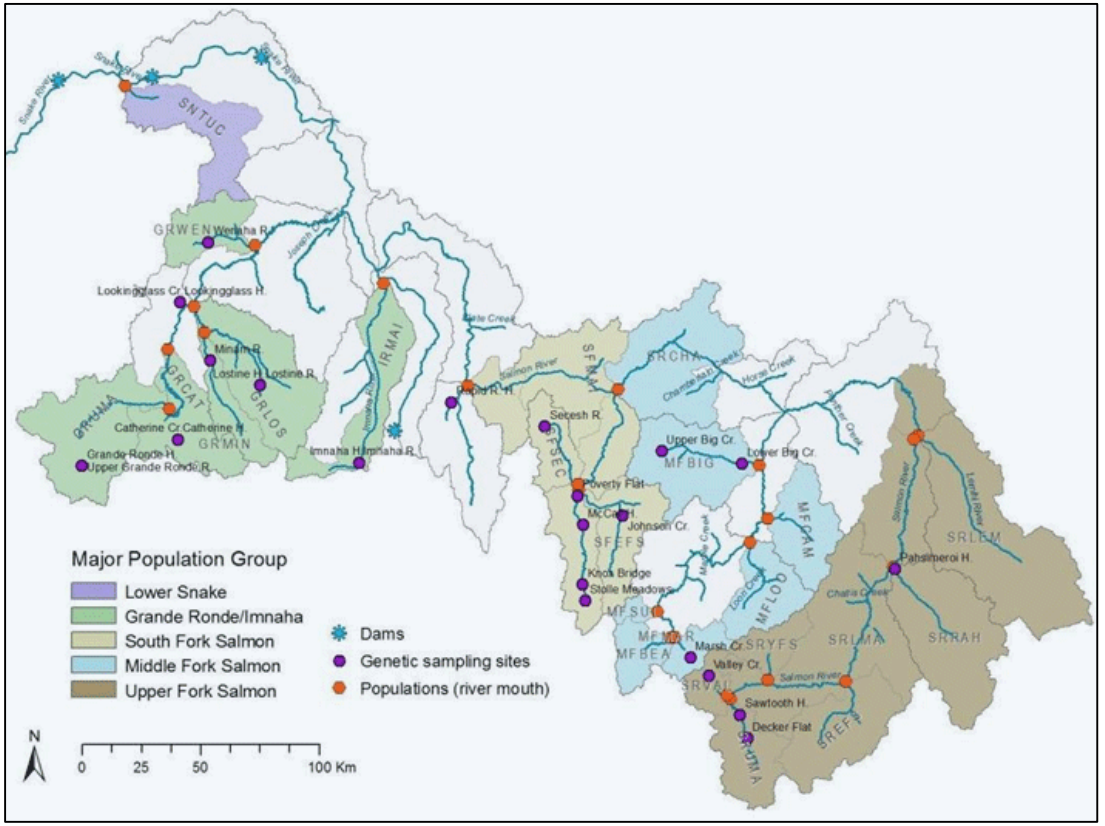
Image from (neuroendoimmune.worldpress.com

Moving Forward: Track Changes in Population Structure & Genetic Diversity

Persistence, Adaptability, Resilience, & Productivity are all linked to genetic diversity

Benefits:

- Allow for viability analyses
- Discover new life histories & habitat type utilization patterns
- Increase knowledge on:
  - Abundance
  - Distribution
  - Interconnections among populations



nwfsc.noaa.gov (A. Fullerton, P. Moran, D. Van Doornik, & R. Zabel)

Role of Mainstem Habitat Poorly Understood

Uncertainties:

- Is it an important rearing area for juvenile salmonids?
- What is the overall abundance of non-native fish species in mainstem habitats?
- What is the cumulative impact of non-native predation on juvenile salmonids?

Potential Impacts Of Non-Native Species

Predation

Hybridization

Competition

Infection (disease & parasites)

Habitat alteration

Smallmouth Bass image (usbr.com); American shad image (wildlife.state.nh.us); brook trout image (westpointmwr.com); purple loosestrife image (dreamtime.com)

Moving Forward: Evaluate The Effects Of Non-Native Species

- No subbasin has < 100 non-native species
- Cumulative impacts on salmonids not known but estimated to be similar to **Hydrosystem and Harvest**
- Benefits:
  - Create Prevention Programs
  - Regulate Abundance
  - Implement Control Measures

lake trout image (maine.gov); small mouth bass image (usbr.gov); walleye image (chartomcharters.com); northern pike image (landbigfish.com); brook trout image (westpointmwr.com)

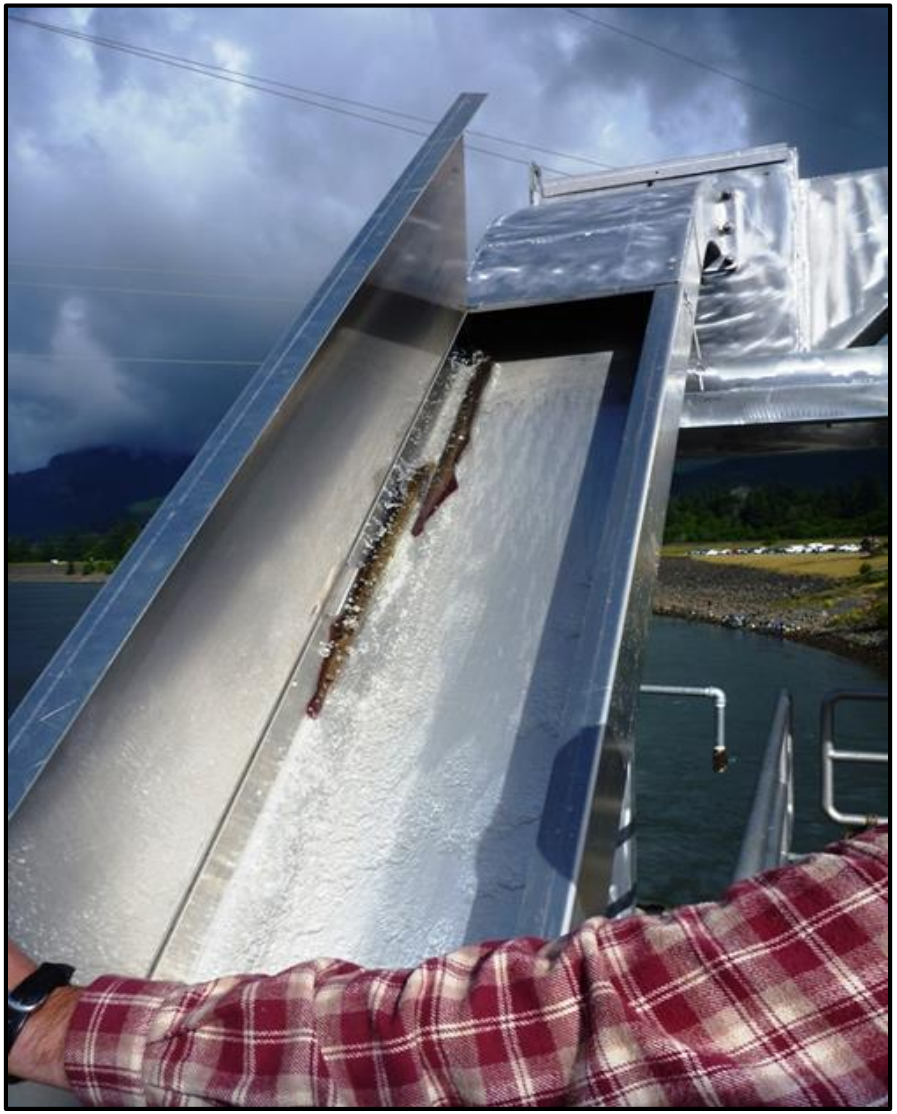
Hydrosystem and Fish Passage

(4 Uncertainties from 2006 & one additional)

Tony Grover

1. How do dam operations affect fish survival (salmonids, eulachon, sturgeon, lamprey, others)?

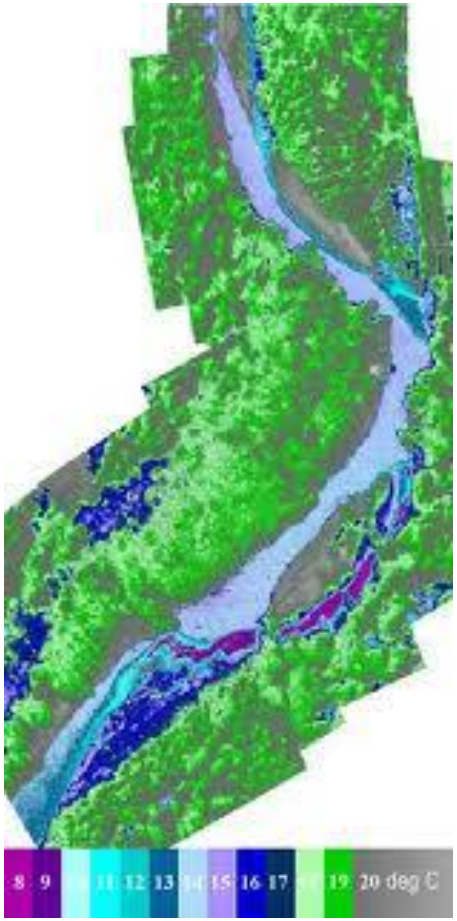
habitatchat.com



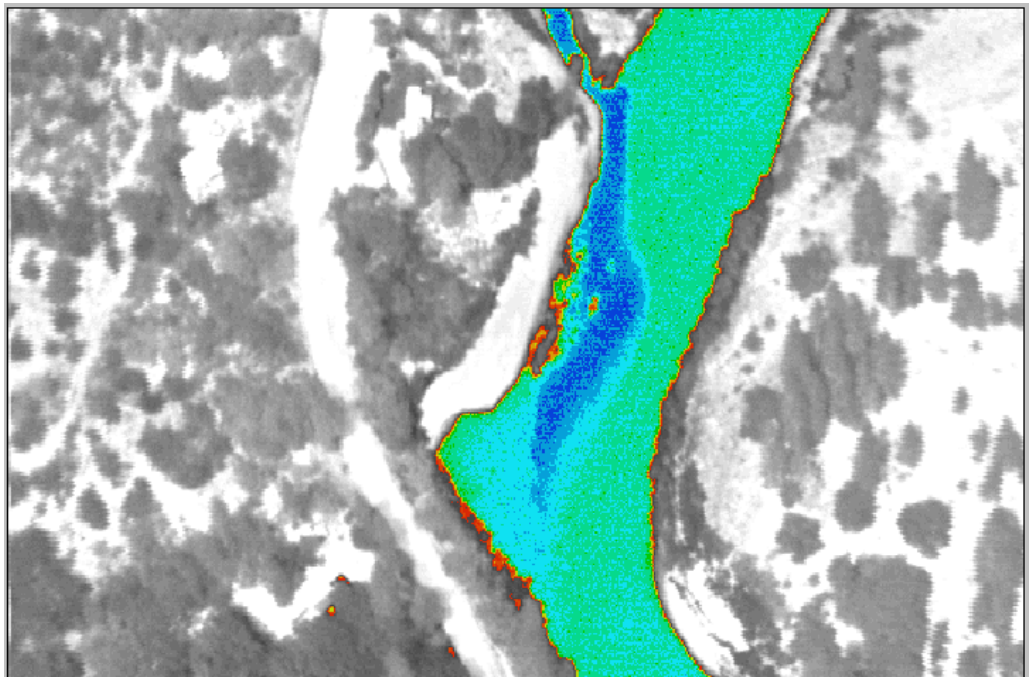
uidaho.edu

2. How do dam operations differentially affect salmon life stages and stocks?

3. How do water temperatures at mainstem dams affect fish passage?



OSU.edu



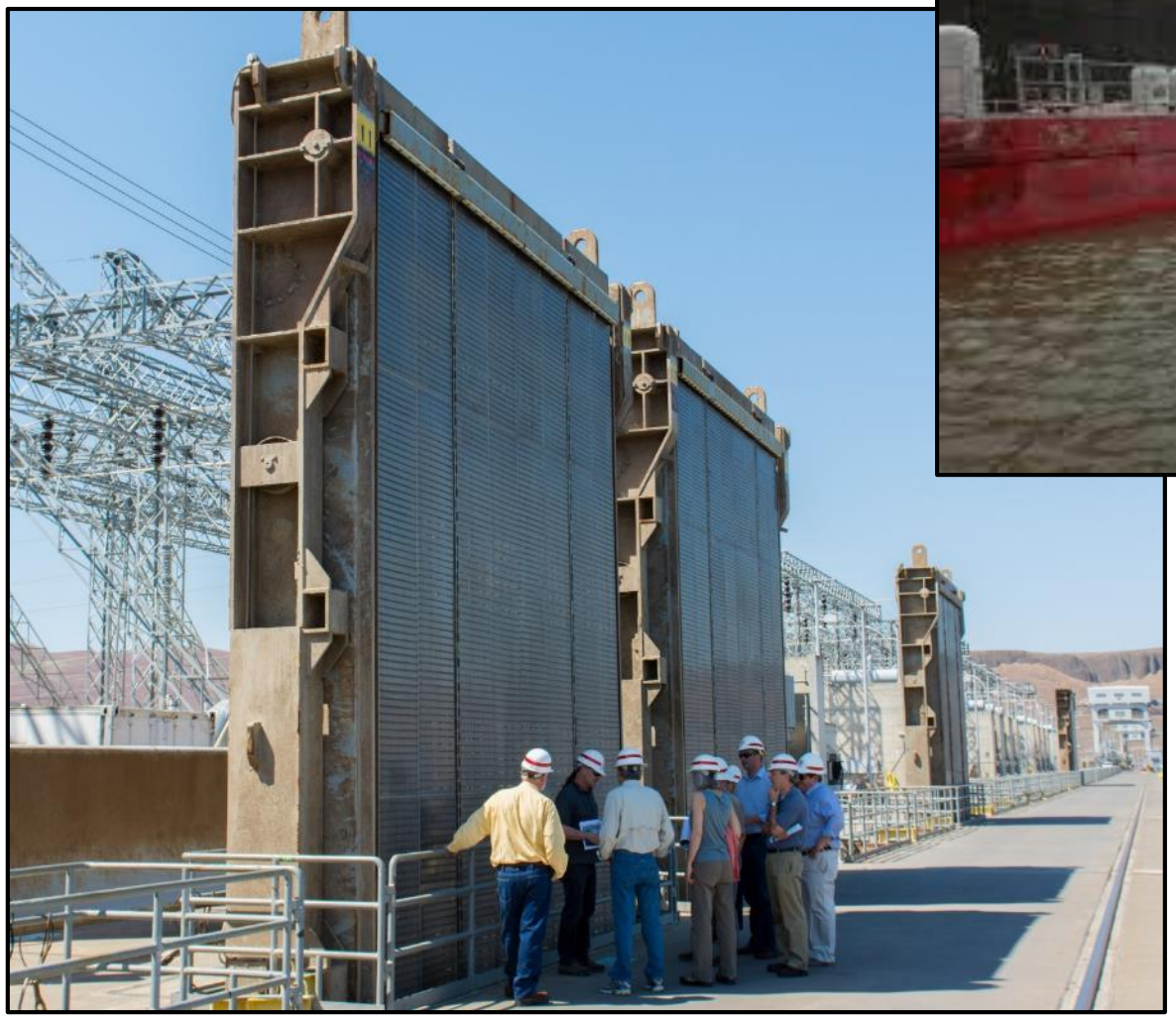
M. Keefer & C. Caudill, Dept. of Fish & Wildlife Sciences, University of Idaho

FLIR Beaver Creek & Klamath River

Forward Looking Infrared camera (FLIR)—senses heat source as infrared radiation

4. How does multiple dam passage vs. transport affect SARs (i.e., D)?

US ARMY COE

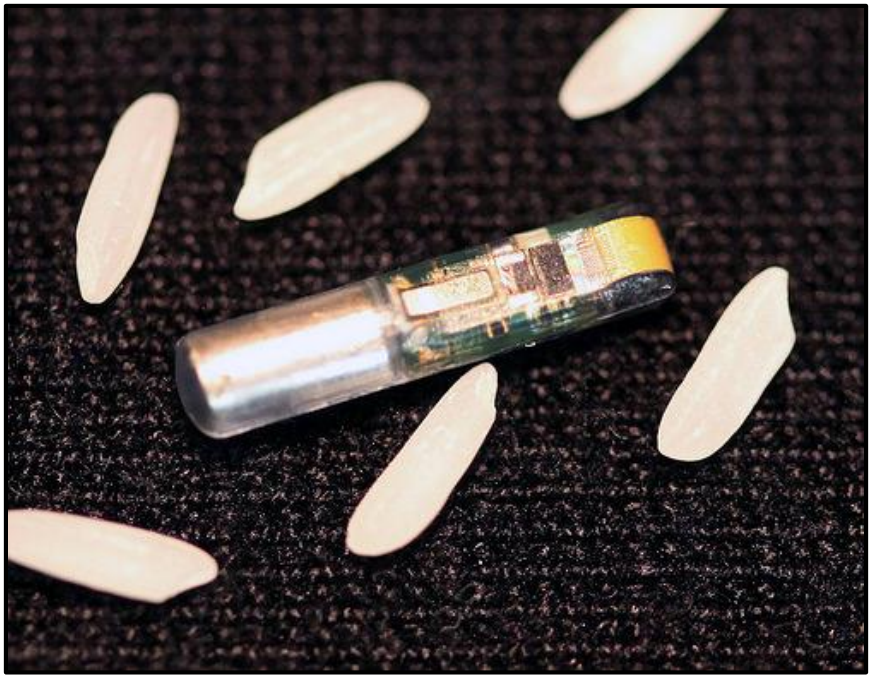


Tony Grover

5. Is reintroduction above blocking dams feasible?

US BOR

Moving Forward: Demand Rigorous Monitoring & Evaluation Programs with Established Objectives



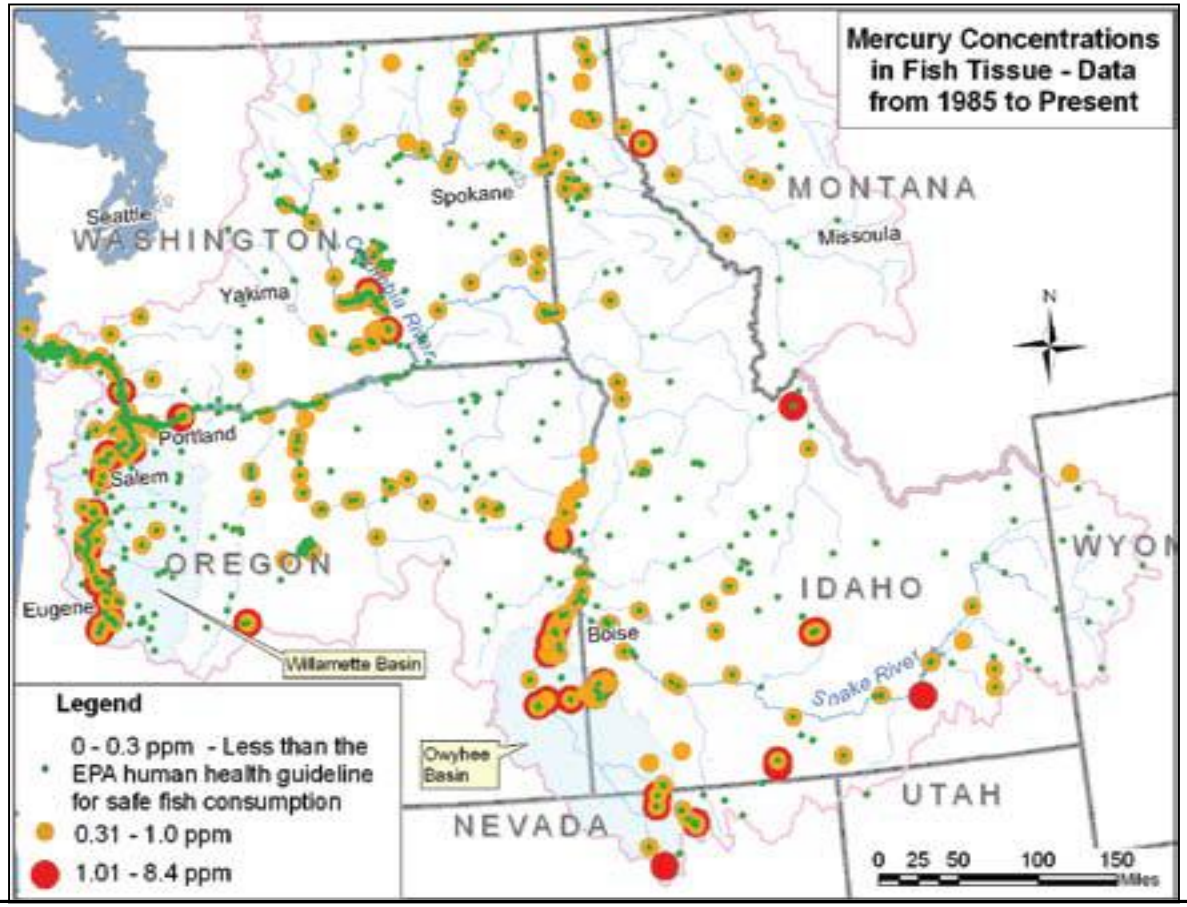
Injectable acoustic Fish Tag—lamprey and smaller fish;
Assess survival & pathways through mainstem dams
PNNL.gov

Contaminants

(same as 2006 Uncertainties)

1. **What are distributions, uses & concentrations of toxics in Basin?**
2. **How do toxics affect fish & wildlife?**

Contaminants Increasing in the Basin

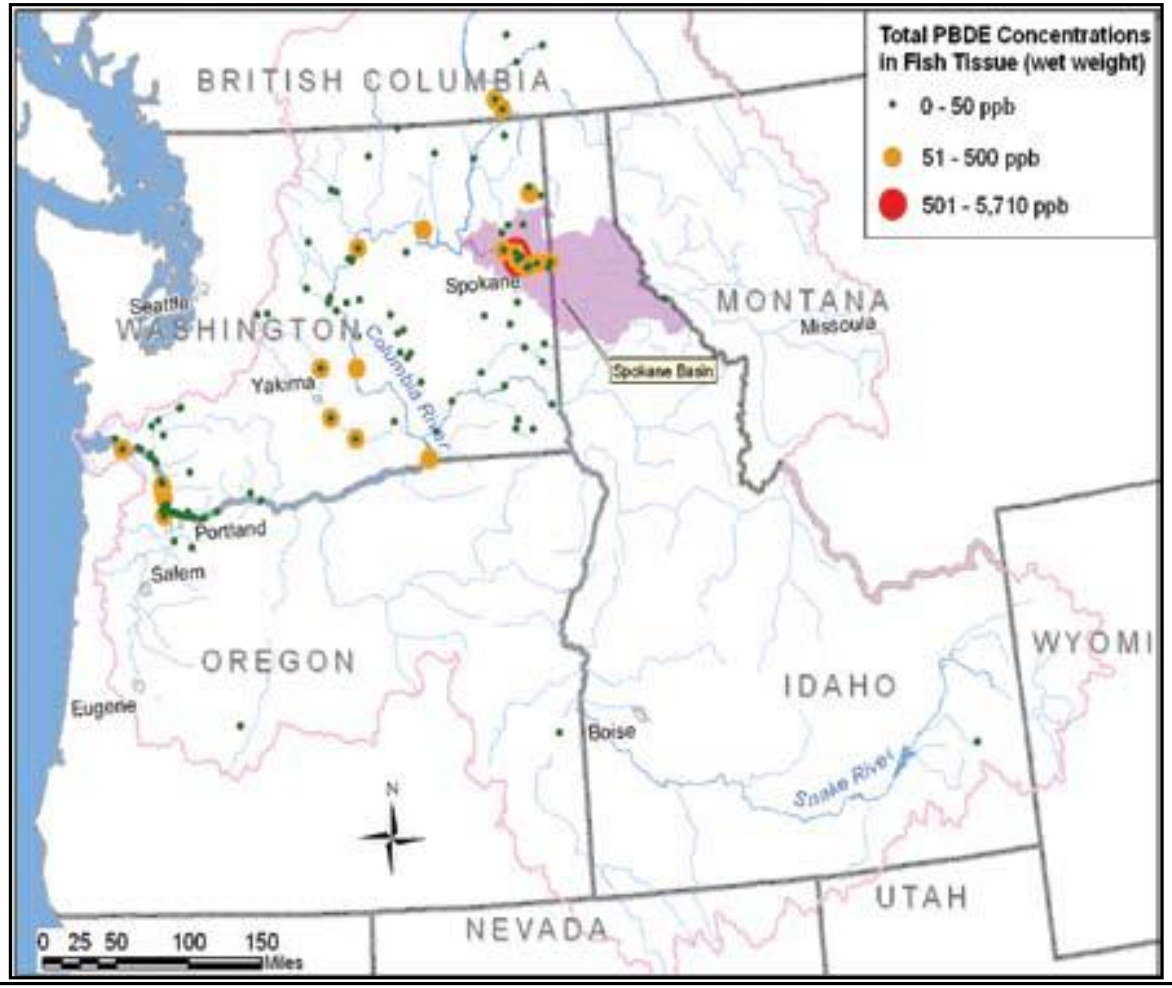


Mercury (& perhaps Current Use Pesticides)

- Sources: atmospheric deposition, smelting & mining, waste & stormwater, Ag runoff
- Responsible for most fish consumption warnings
- Can cause neurological and reproductive problems

Source: EPA. 2009. Columbia River Basin: State of the River Report for Toxics

Chemicals of Emerging Concern (CECs)

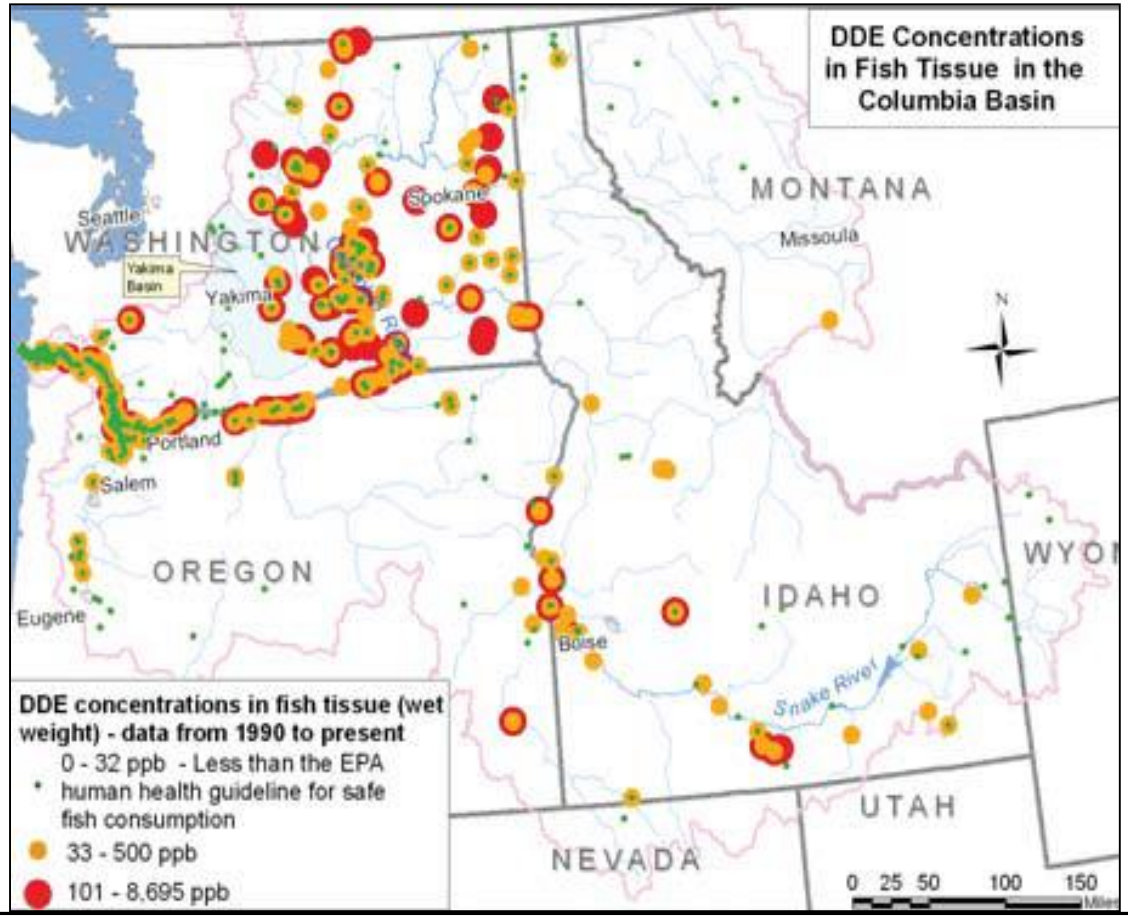


PBDE (Flame Retardants) & pharmaceuticals & others

- Appear to be increasing in fish
- Can harm reproductive, developmental & neurological systems (Endocrine disruption)
- Sources: atmospheric, sewage wastewater, stormwater runoff

Source: EPA. 2009. Columbia River Basin: State of the River Report for Toxics

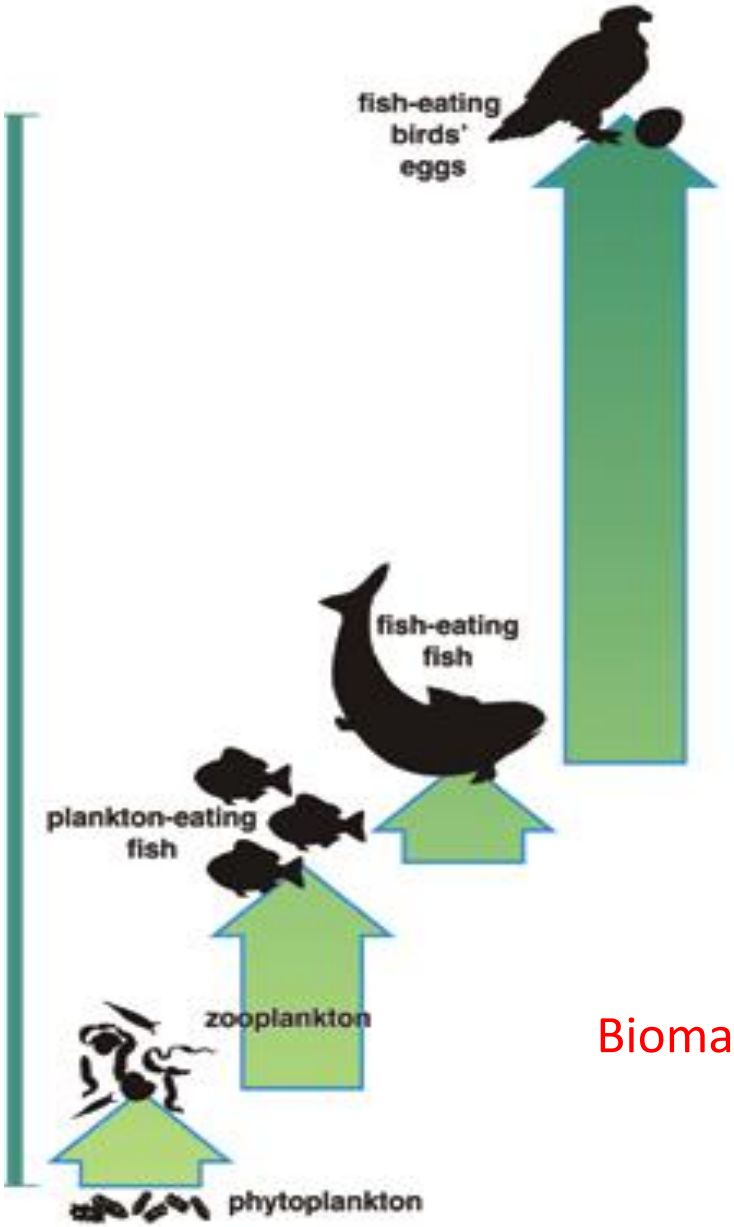
Legacy Contaminants

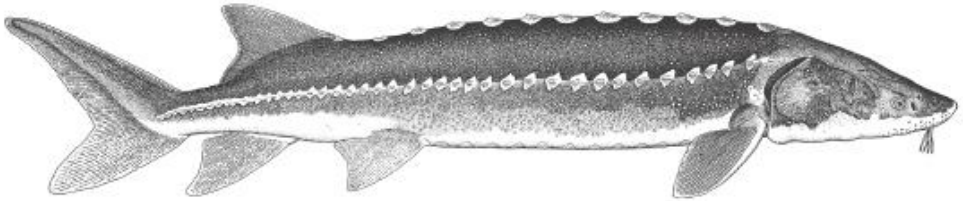


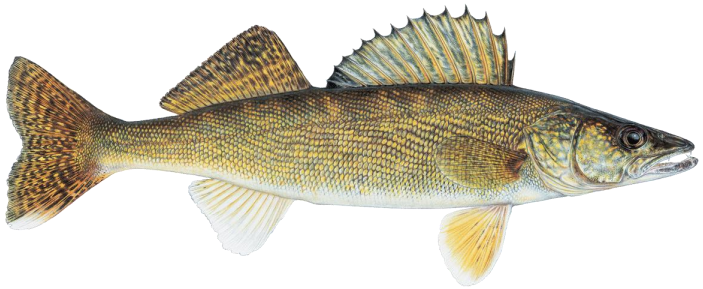
Breakdown products of DDT (also PCBs)

- Banned in 1972 & 1976
- Cause reproductive & development problems – endocrine disruptors
- Sources: runoff from agricultural lands & recycle in sediments

Source: EPA. 2009. Columbia River Basin: State of the River Report for Toxics

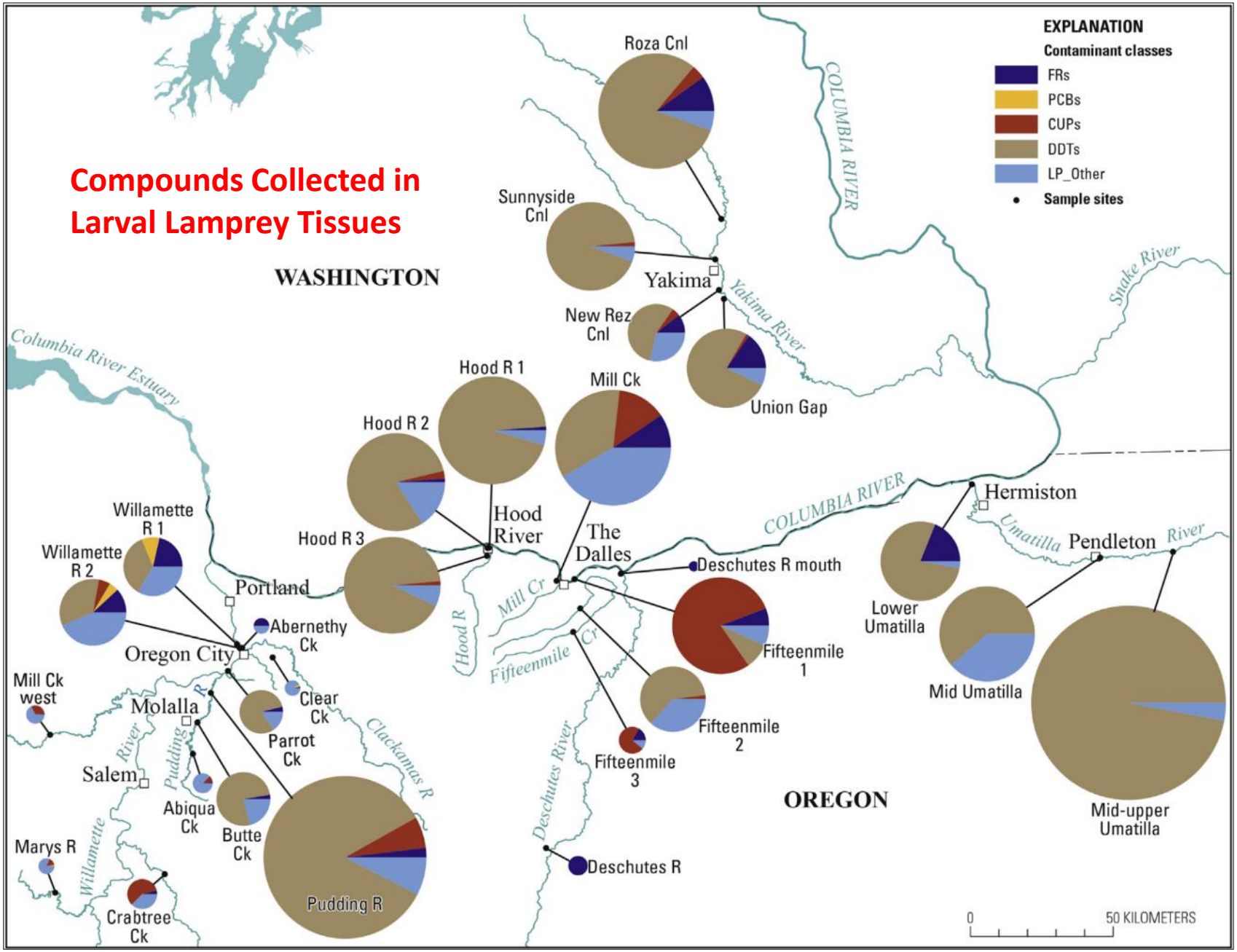






Biomagnification: as much as 5,000 X increased concentration

EPA 2009; Pacific lamprey image (pubs.usgs.gov); white sturgeon image (pac.dfo-mpo.gc.ca); walleye image (chartomcharters.com)



Nilsen, E.B., W.B. Hapke, B. McIlraith, & D. Markovchick. 2015. Environmental Pollution 201:121-130

Moving Forward: Support Research on the Effects of Contaminants

- **Determine Persistence**
- **Track Abundance**
- **Locate Sources**
- **Identify Cleanup Locations**

Climate Change

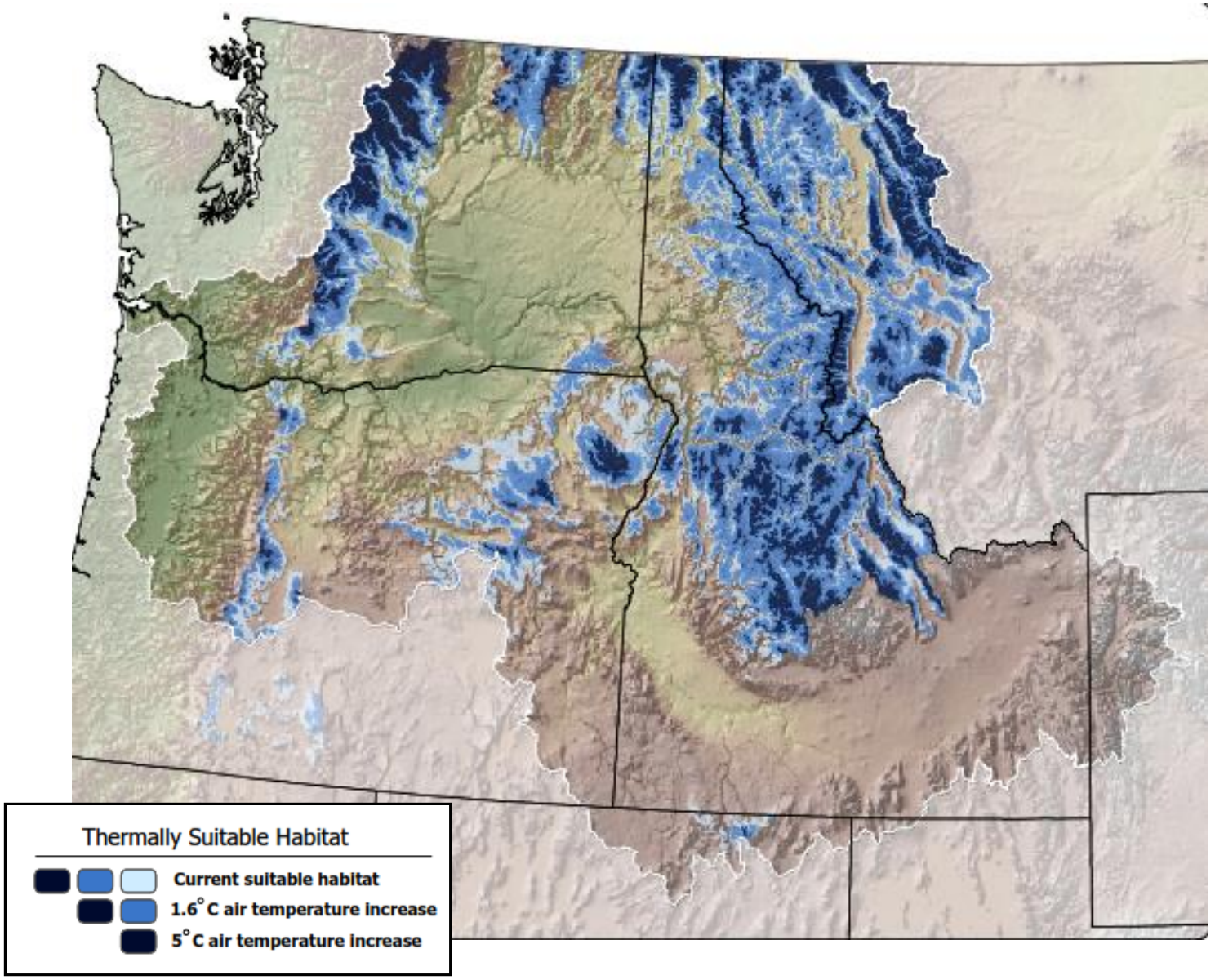
(3 Uncertainties from 2006, restated)

1. How will climate change affect fish & wildlife in the Basin?

2. What strategic actions can we take to ameliorate those effects?

Tony Grover

Modeled Changes in Bull Trout Habitat Due to Climate Change



Rieman, B., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, & D. Meyers. 2007. Transactions of the American Fisheries Society 136:1552-1565.

High Country News Dec 22, 2014
photo Walla Walla Basin Watershed Council

Photo from Kennedy/Jenks Consultants & HDR/EES

Recharging aquifers Walla Walla Subbasin
Pipes of an infiltration gallery—they will be buried.

Before

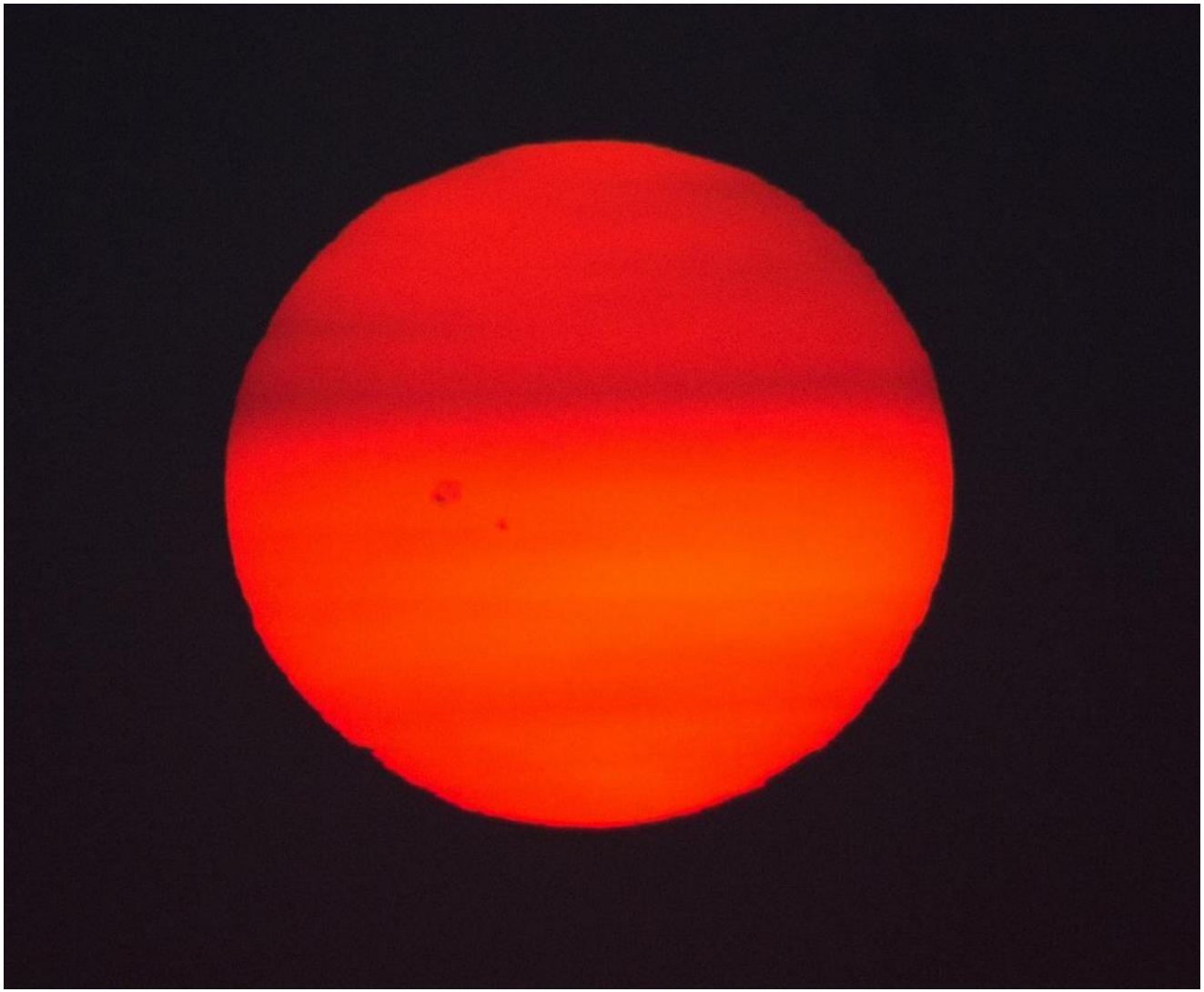
After

Columbia Basin Water Transaction Program

- Lease irrigator's water right
- Develop minimum flow agreements
- Negotiate a change in stream or water source to protect low-flow tributaries
- Purchase land or conservation easements retiring water rights

Federal Caucus: salmonrecovery.gov

Moving Forward: Anticipate Climate Change & Act Strategically



Tony Grover

Why should the Council be concerned about Climate Change & Contaminants?

- Millions spent on fish passage and habitat restoration might be wasted.

- Human health from eating contaminated fish—especially Tribal subsistence fishers.

Control of Salmonid Predators

Doubled Crested Cormorants
(smolt predators)

Sea Lion
(adult salmonid predators)

- ❑ Are Native Species Jeopardized by Predation?

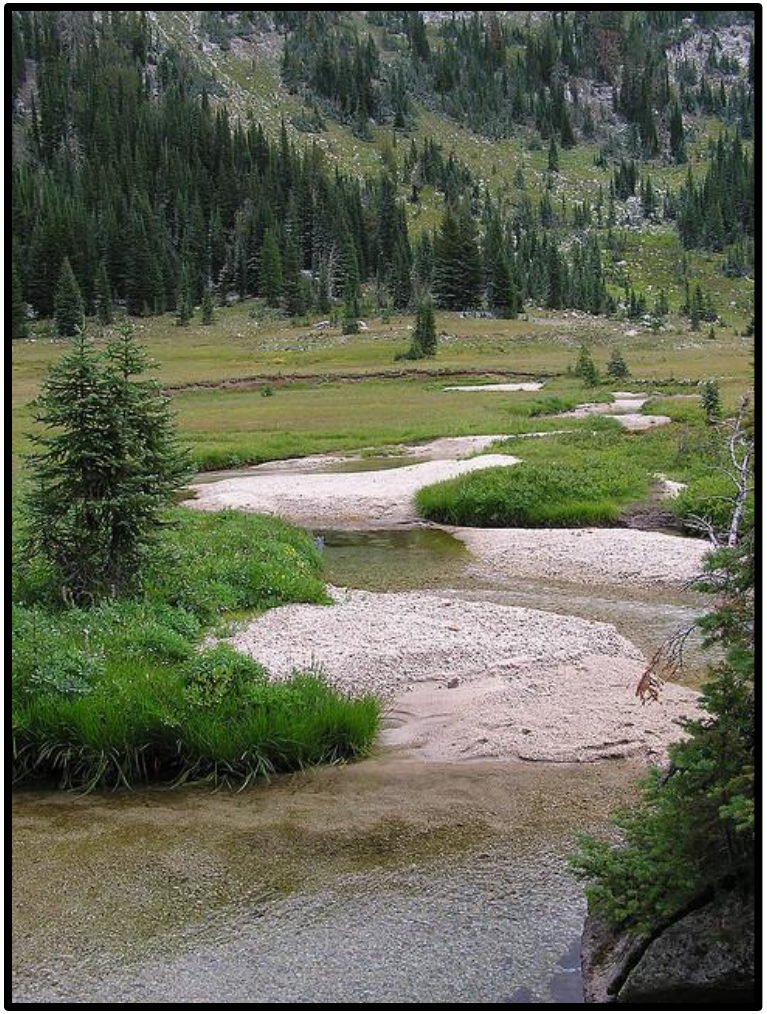
- ❑ Can Management Actions Ameliorate Predator Impacts?
(e.g., changes in hydrosystem operations, habitat modifications, predator control)

Double Crested Cormorant image (news.nationalgeographic.com); Sea Lion image (spokesman.com, Nov 7, 2015)

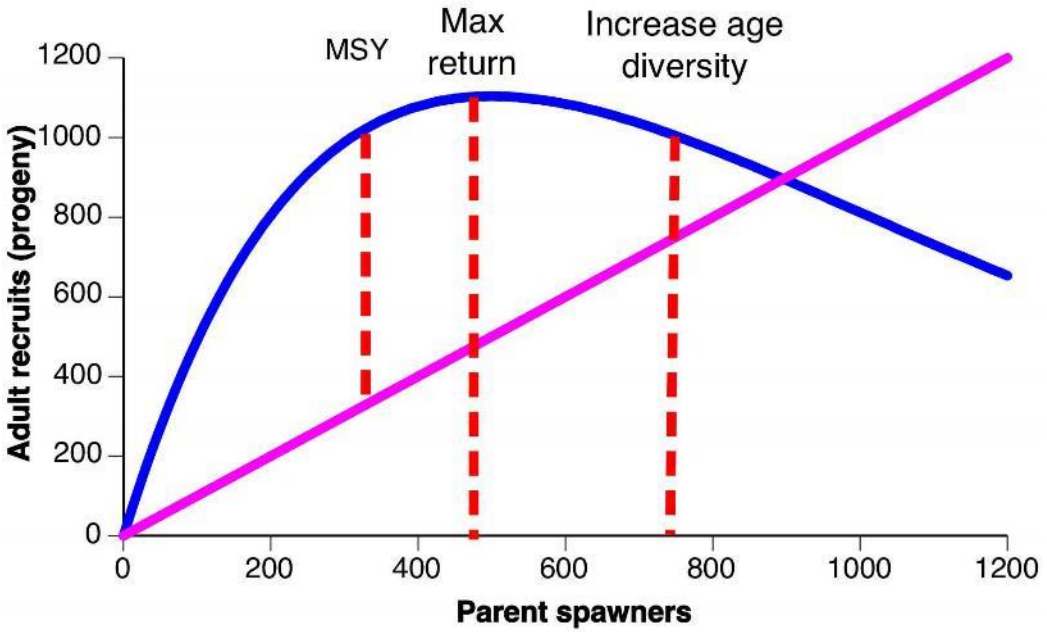
2006 Harvest Uncertainties

- Medium Progress
  - Mixed stock fisheries
  - New harvest strategies
  - Incorporate ecological benefits of spawning escapements
- Most Remain Priority Uncertainties

Sustainable Harvests & Productive Populations



Lostine River Photo Flickr.com



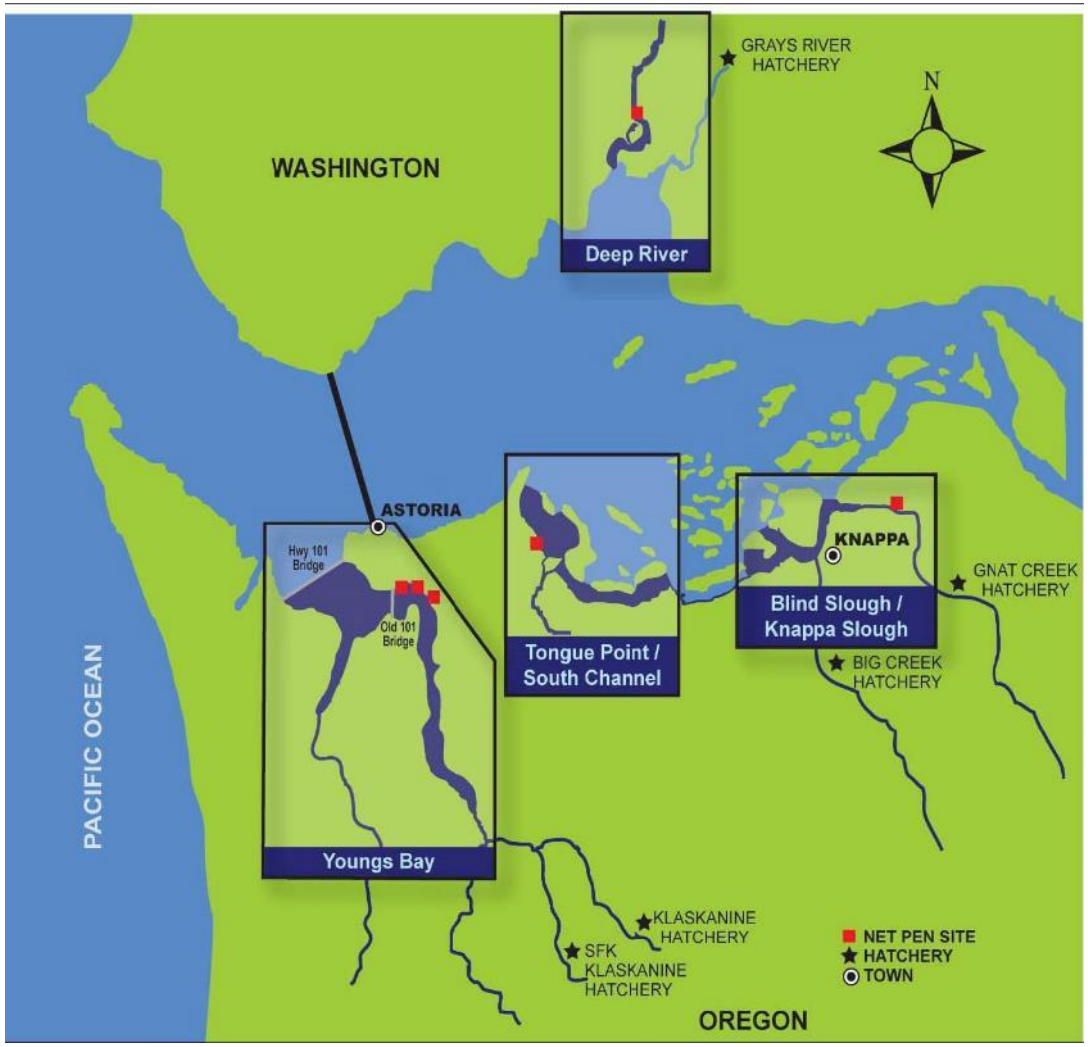
- What is the spawning escapement, including hatchery fish, needed to sustain productive fish populations and harvest?
- What is the biological goal for spawning escapement?

Harvest Strategies that Benefit People & Fish

- Develop new strategies to improve harvest opportunities that minimize negative impacts on natural populations (selectively harvest surplus hatchery fish).

Weir on Okanogan R to harvest hatchery fish and live-release wild fish. Colville Tribes photo.

Example: Select Area Fisheries Evaluation Project



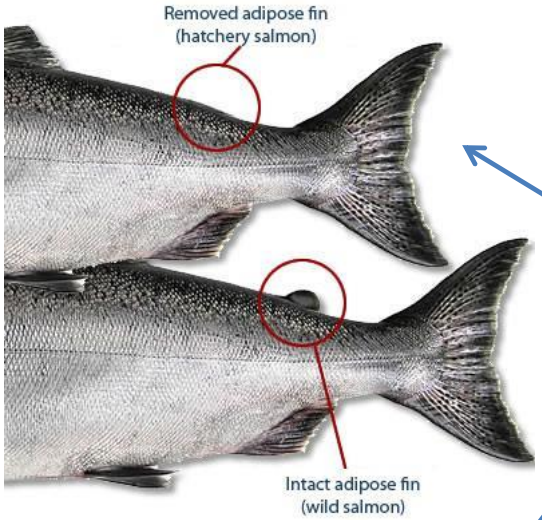
Lower Columbia River SAFE net-pen locations

Harvests of hatchery origin salmon in isolated terminal areas can promote harvests while minimizing harvest effects on wild stocks.

Where else might this approach be used in the Basin?

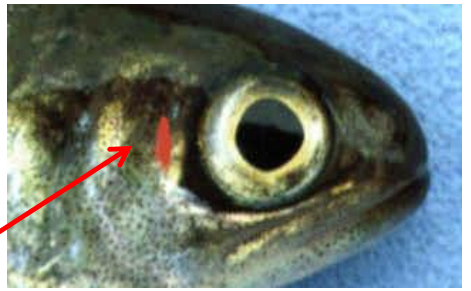
Managing Harvests to Minimize Impacts on Natural-Origin Salmonids

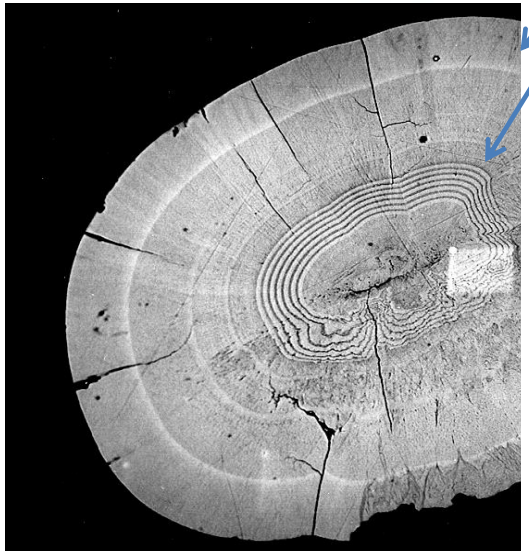
Identification Via Marks & Tags

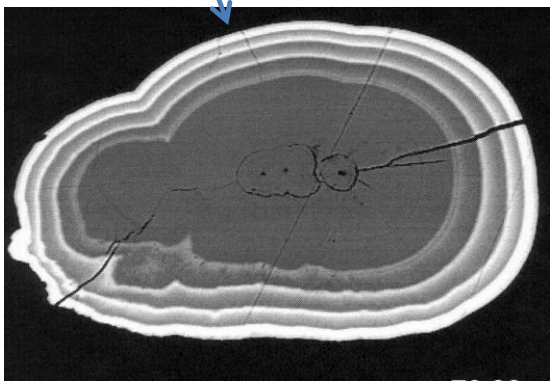


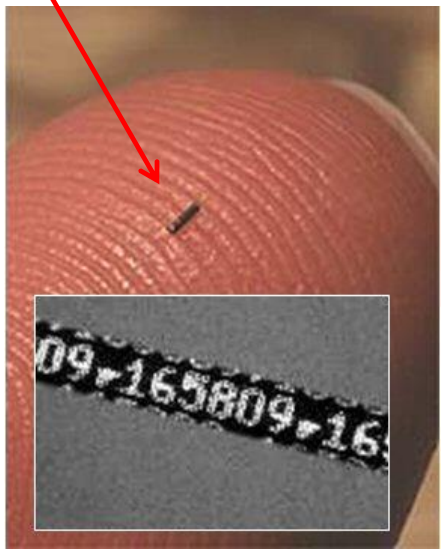
Marks

Tags



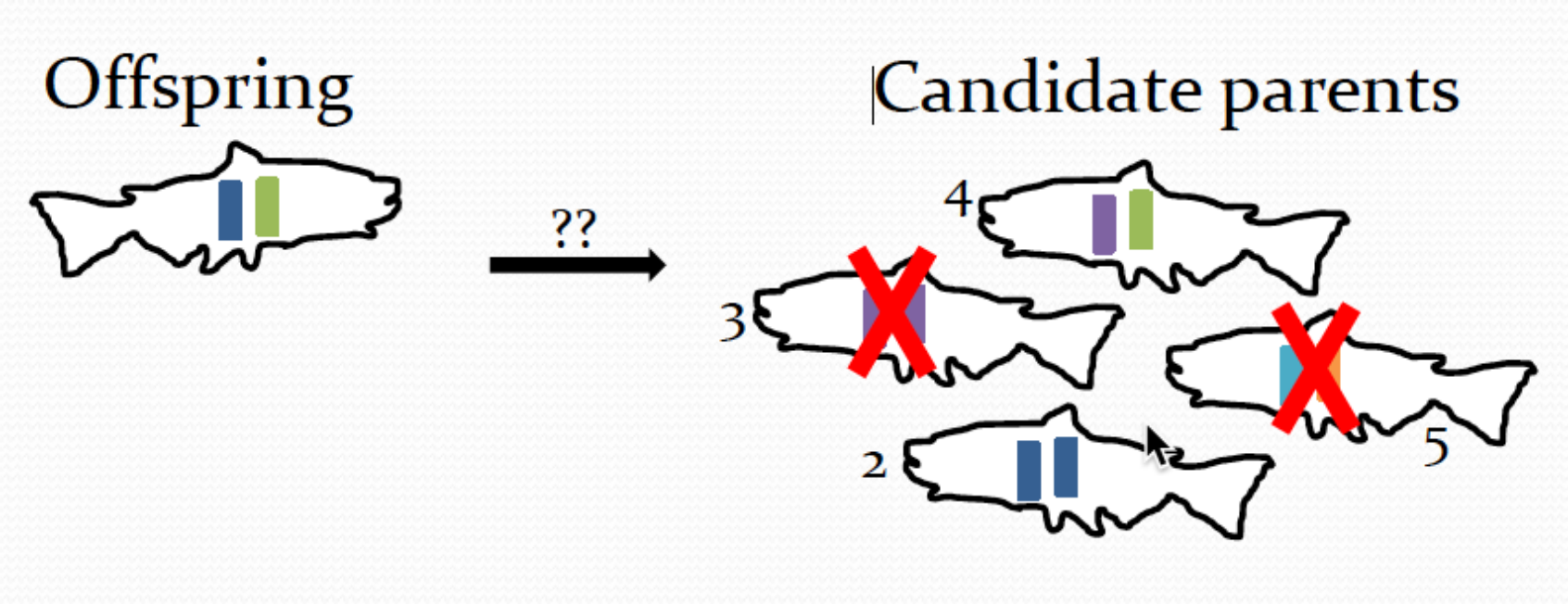






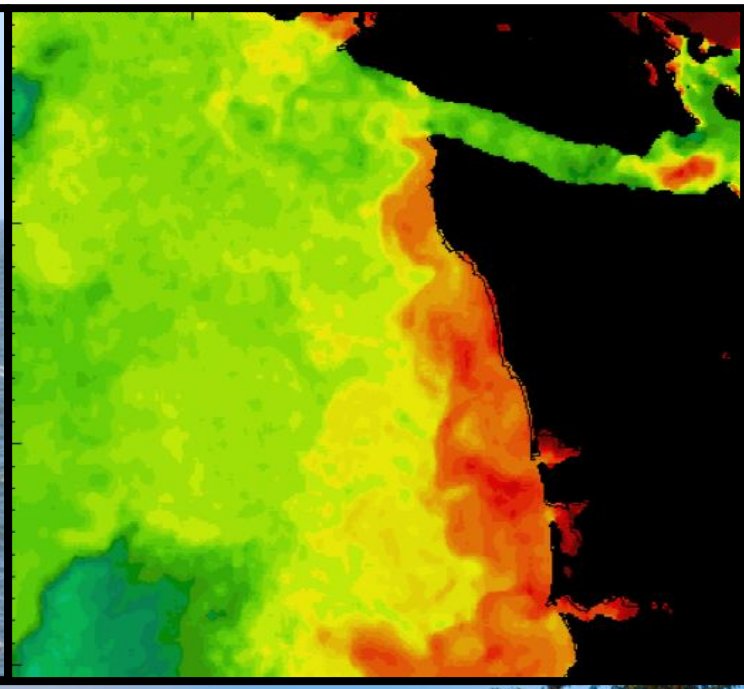
Parentage-Based Tagging & Genetic Stock Identification
IDFG & CRITFC

Produce more accurate stock composition of both hatchery & wild salmon stocks in mixed stock fisheries



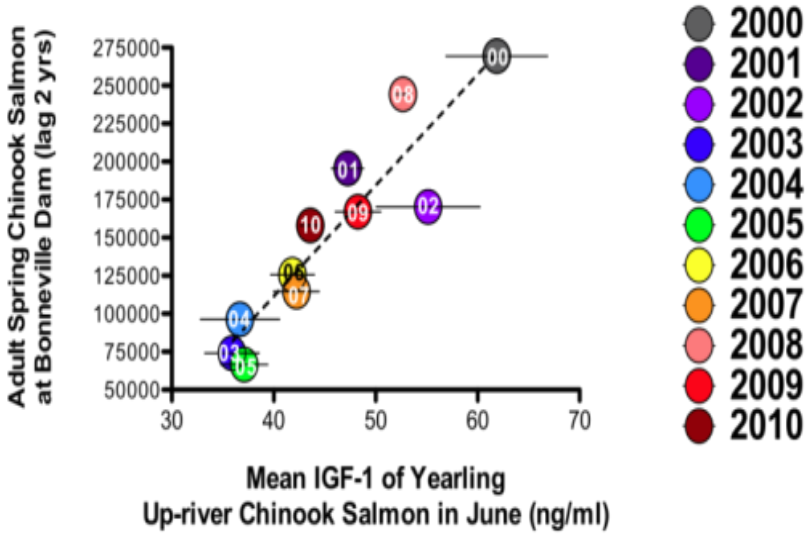
M. Hess

2006 Critical Uncertainties: Estuary, Plume, and Ocean



Fresh & Hayes; T. Grover

How much do specific factors impact growth, fish condition, residence time, age at maturation and survival of focal fish species in the estuary, plume, and ocean?

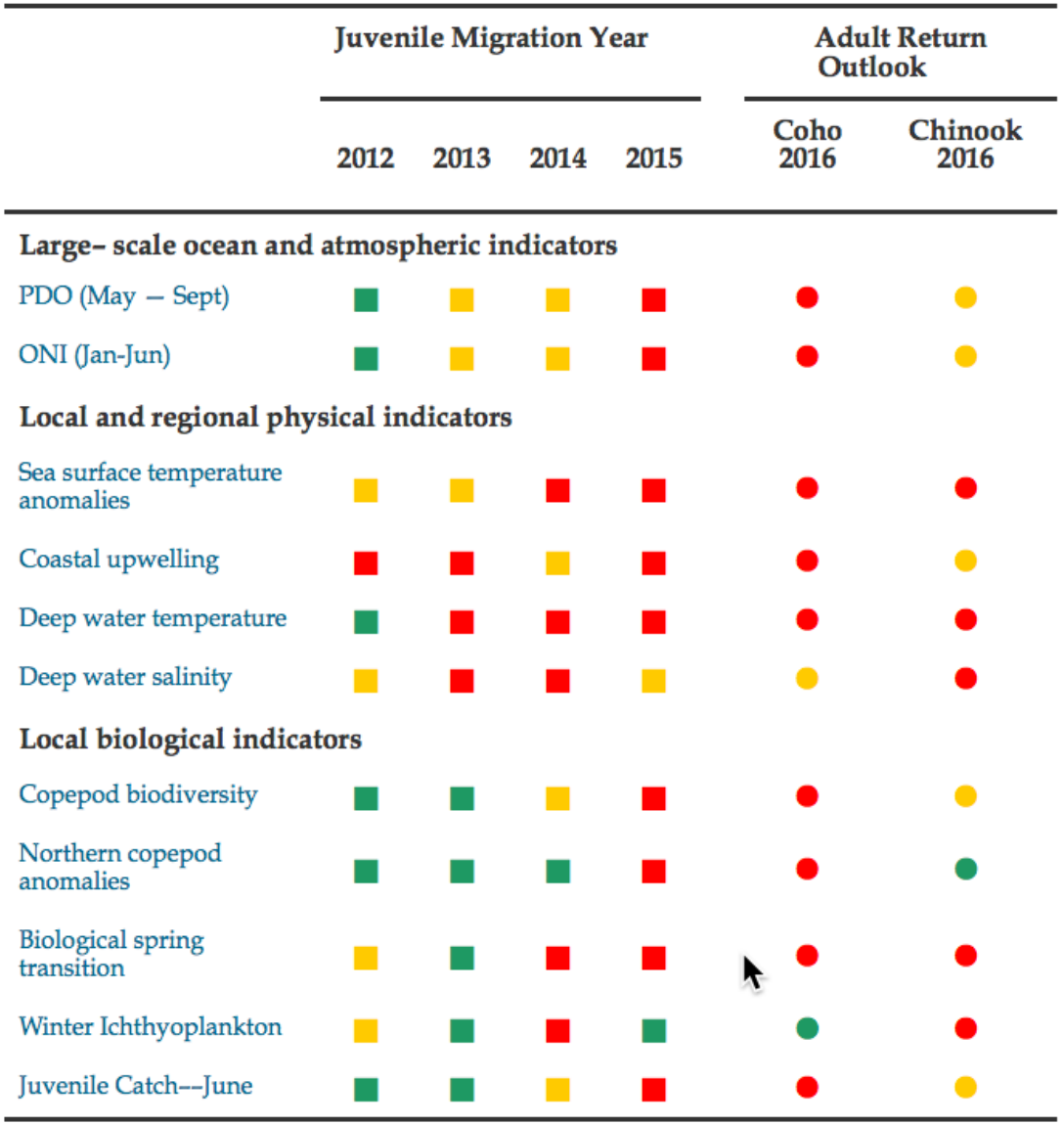


Images from K. Fresh and S. Hayes, NOAA

NOAA's Ocean Ecosystem Indicators for Salmon

Ocean conditions for smolts in 2014 and 2015 were mostly poor.

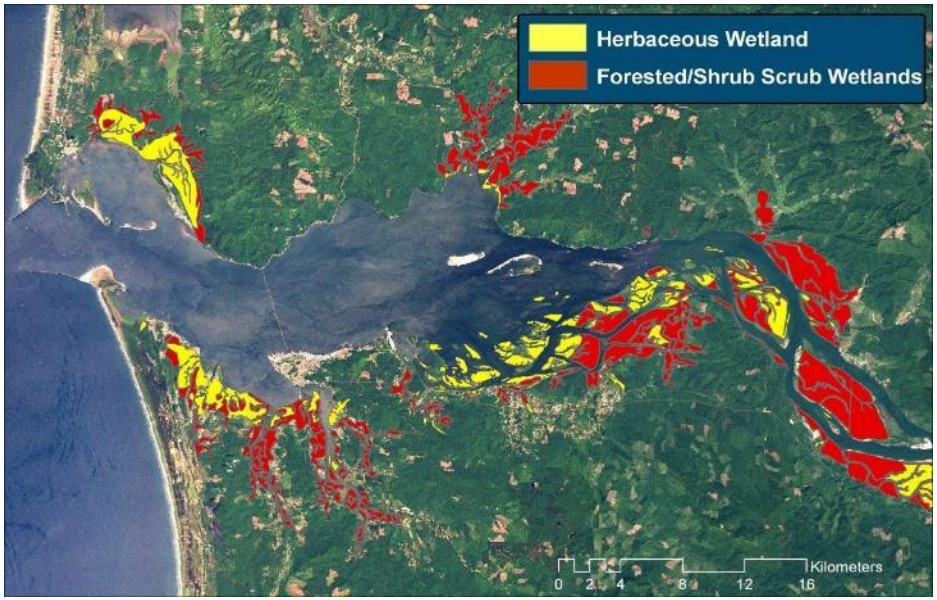
Outlook for coho and Chinook in 2016 is poor to intermediate.



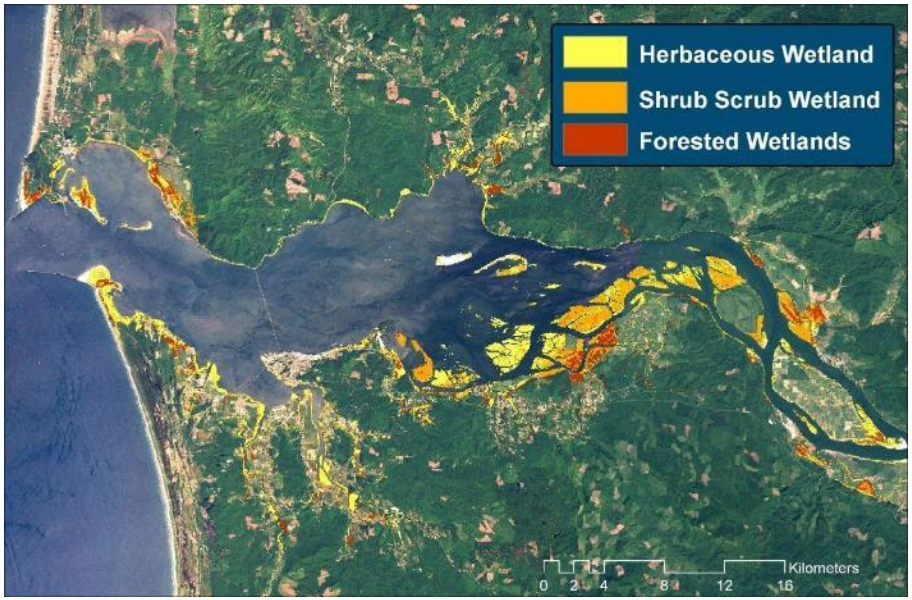
NOAA Fisheries

How can we restore estuarine habitat to increase the carrying capacity of the estuary for salmonids and other focal species?

What are the responses of focal species to alternative restoration actions and locations in the estuary, mainstem, and tributaries that will best inform management decisions?



Historic Wetlands



Present Wetlands

Images: K. Fresh & S. Hayes NOAA Fisheries & Jennifer Burke, UW

Creating a Fish & Wildlife Research Plan:

- Is challenging
- Requires inputs from multiple sources
- Can be improved by quantitative objectives
- Must anticipate future conditions
  - climate
  - landscape
  - societal values


Scott Butner