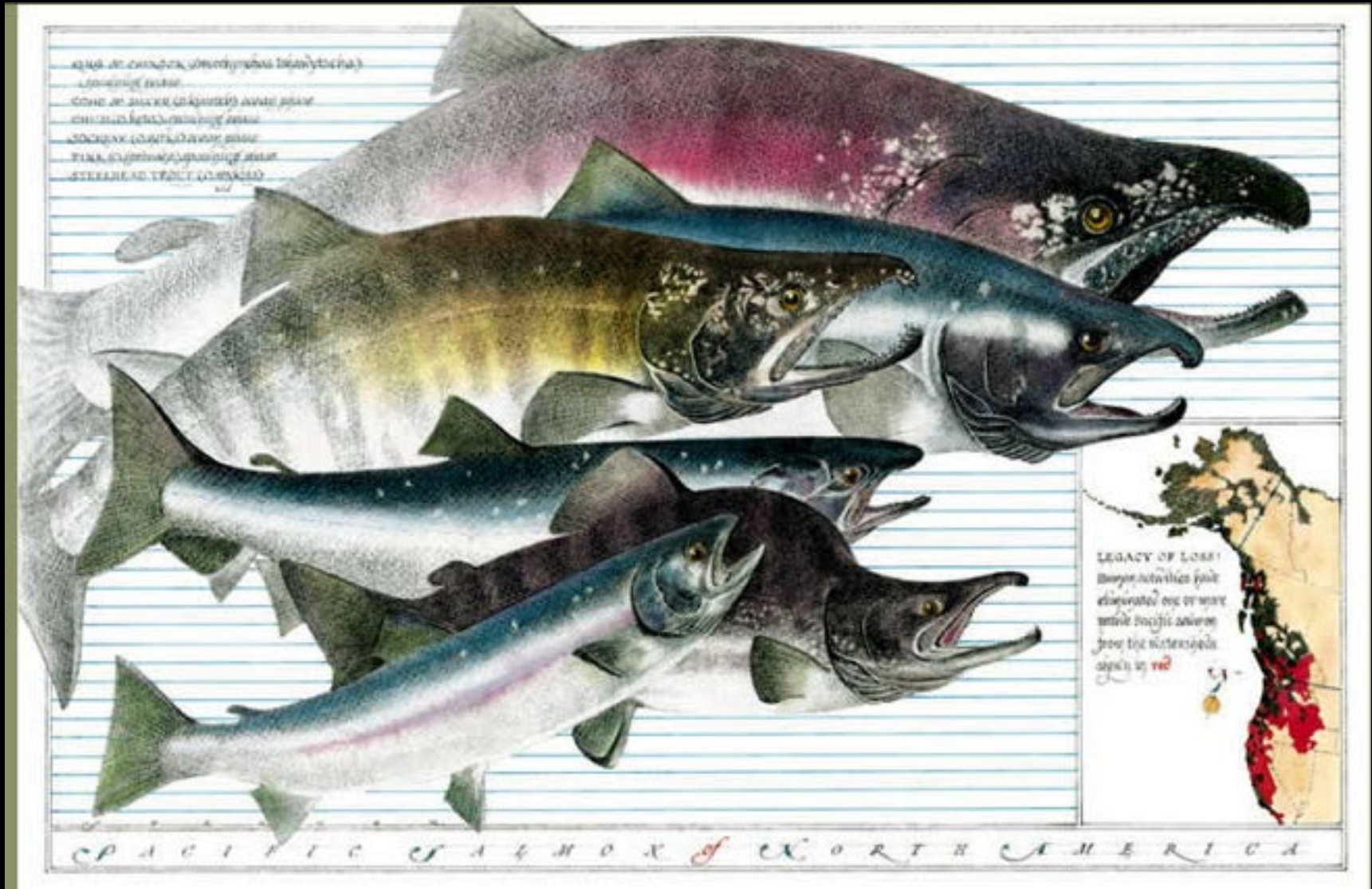
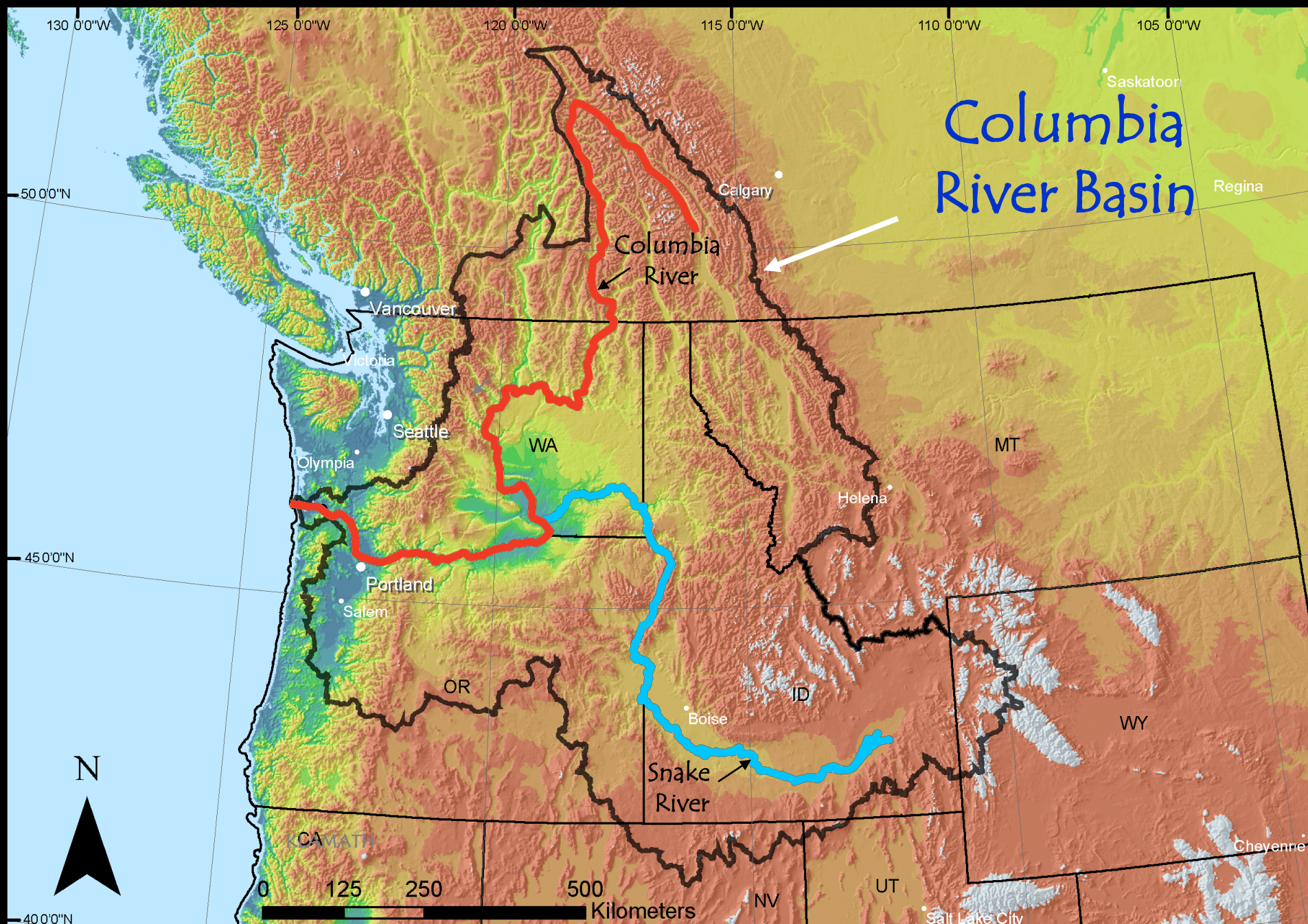


# Pacific Salmon *Oncorhynchus*





# Salmonid Life Cycle

Adult

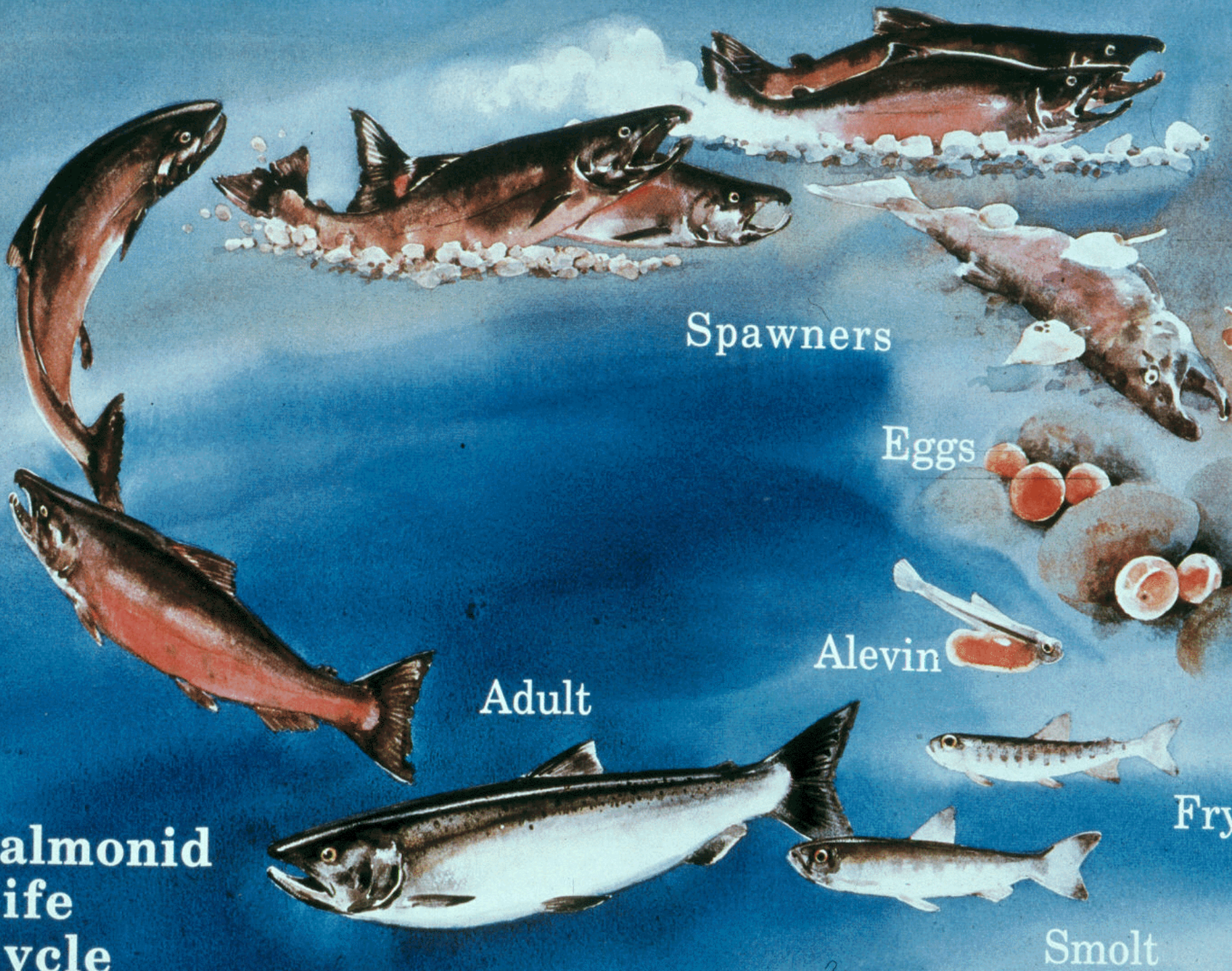
Spawners

Eggs

Alevin

Fry

Smolt







ARKIVE



"Oregoncountry2"  
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# “The Great Barbecue”



SALMON CANNERY - ASTORIA, OREGON.









# ESA Listings in Snake Basin

- **Spring and Summer Chinook**  
*Threatened, April, 1992*
- **Fall Chinook**  
*Threatened, April, 1992*
- **Steelhead**  
*Threatened, August, 1997*
- **Sockeye**  
*Endangered, December, 1991*

# The 4 Hs

- Hatcheries
- Harvest
- Habitat
- Hydro

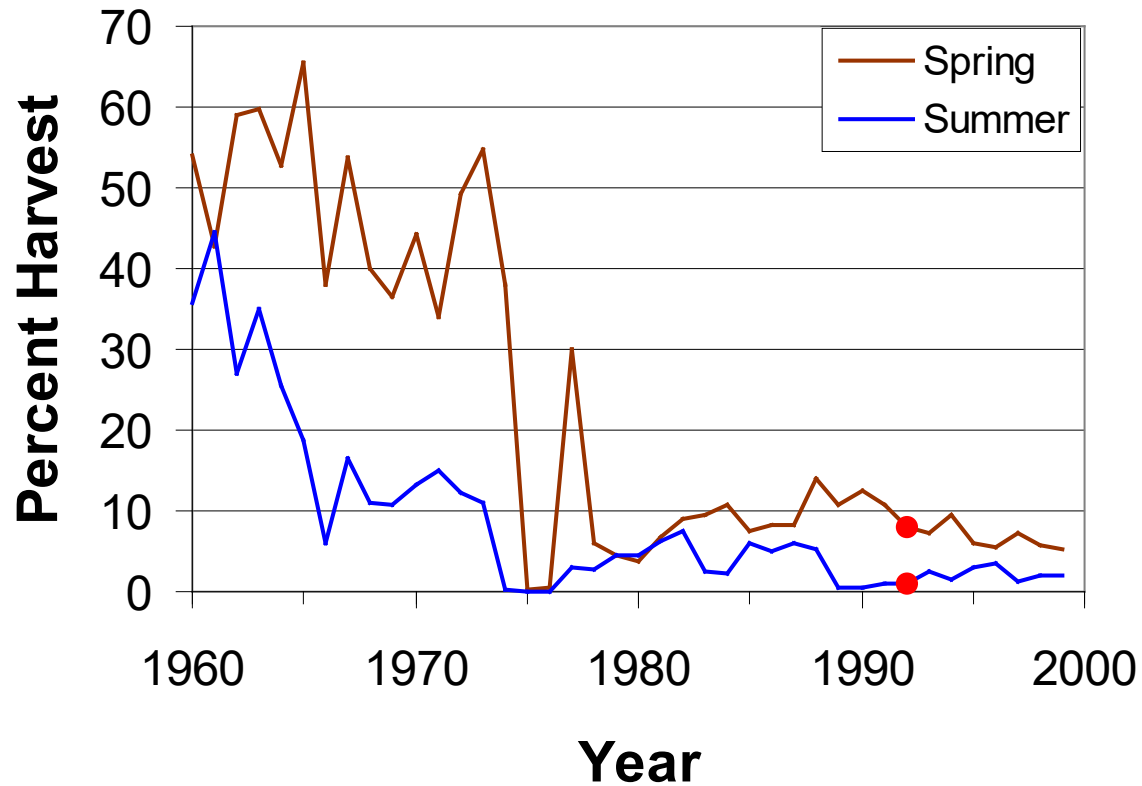


image courtesy of Portland District-  
US Army Corps Of Engineers



No 75 FISHWHEEL Lower Chesapeake

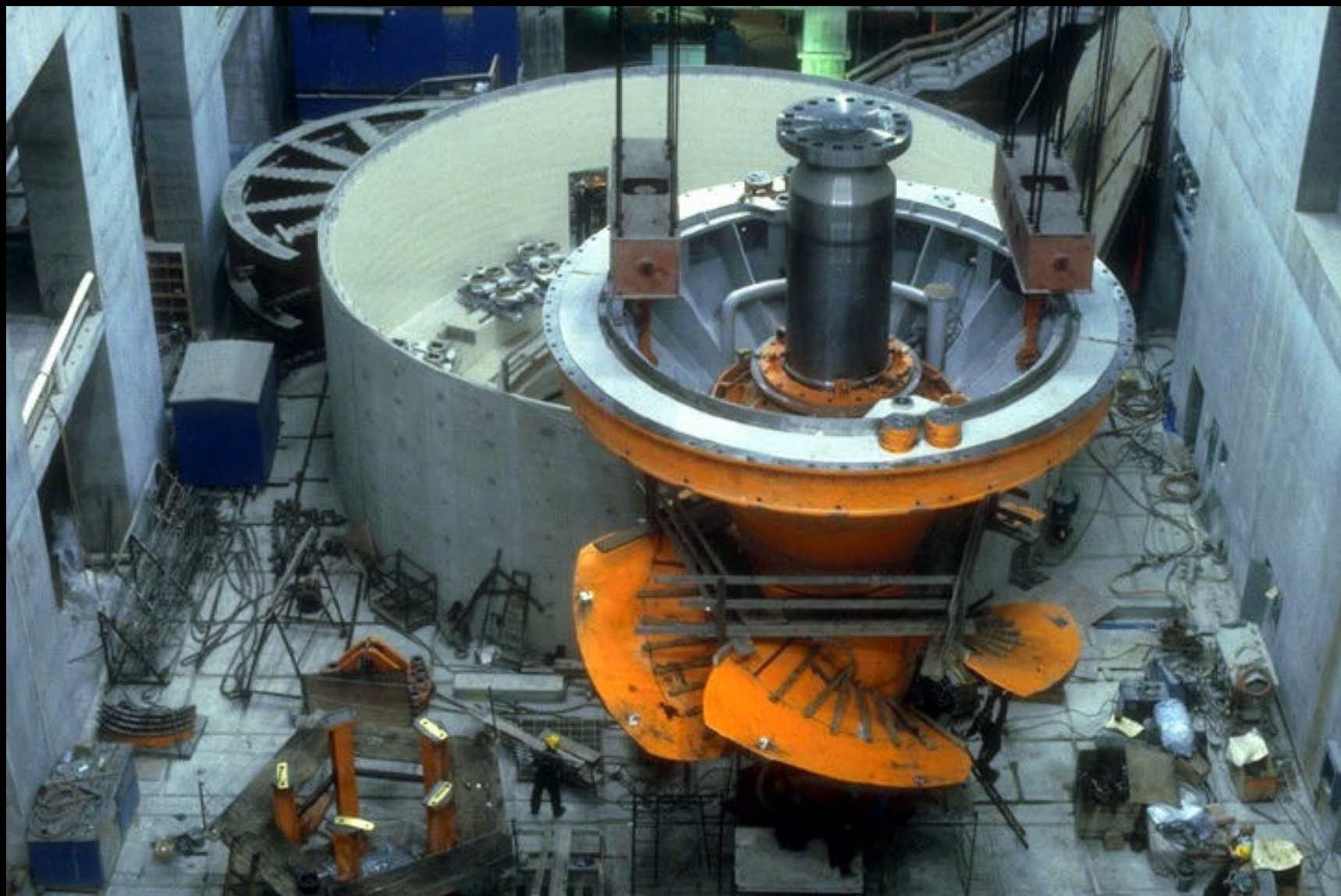
## Spring and Summer Chinook Harvest Rates

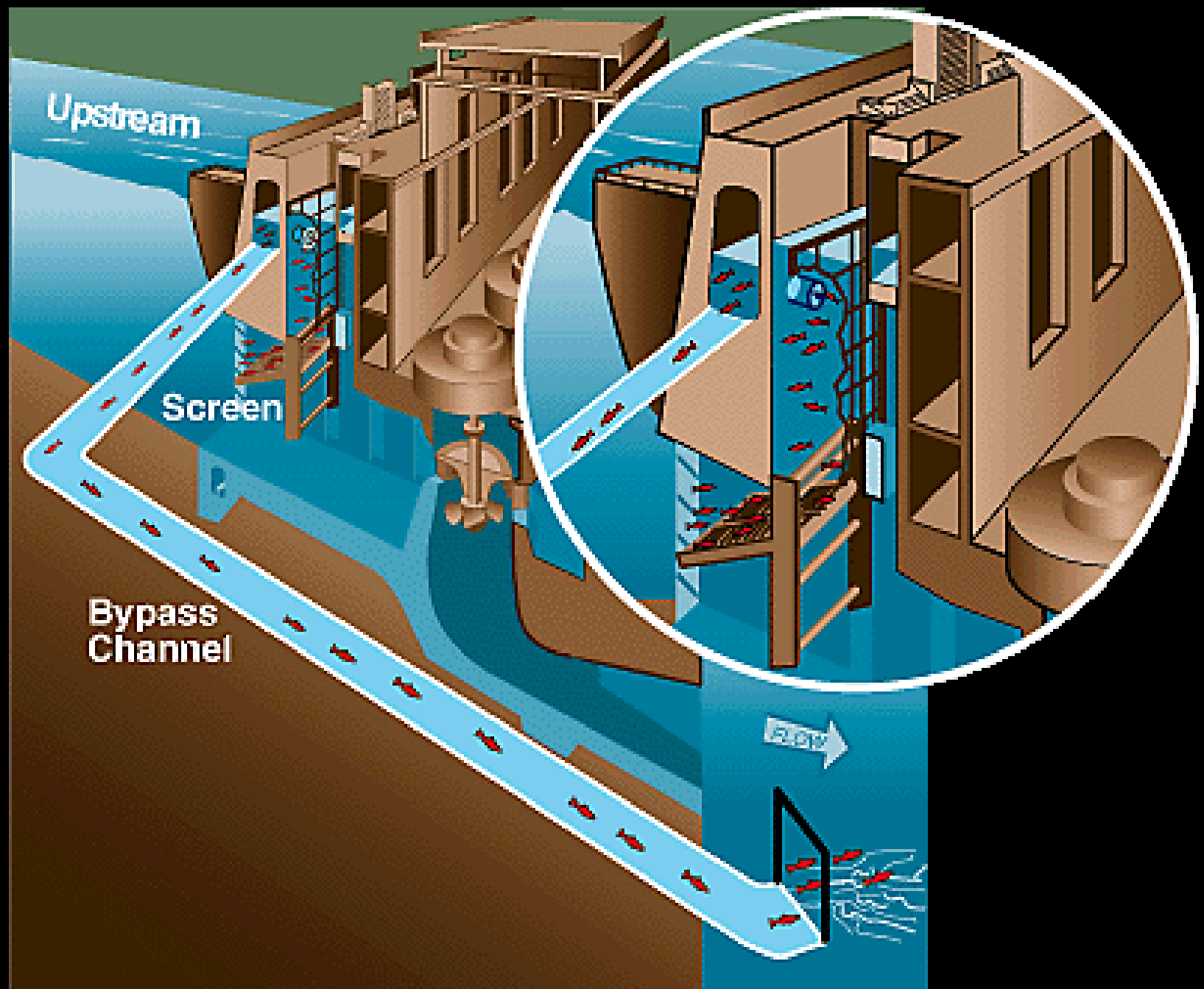


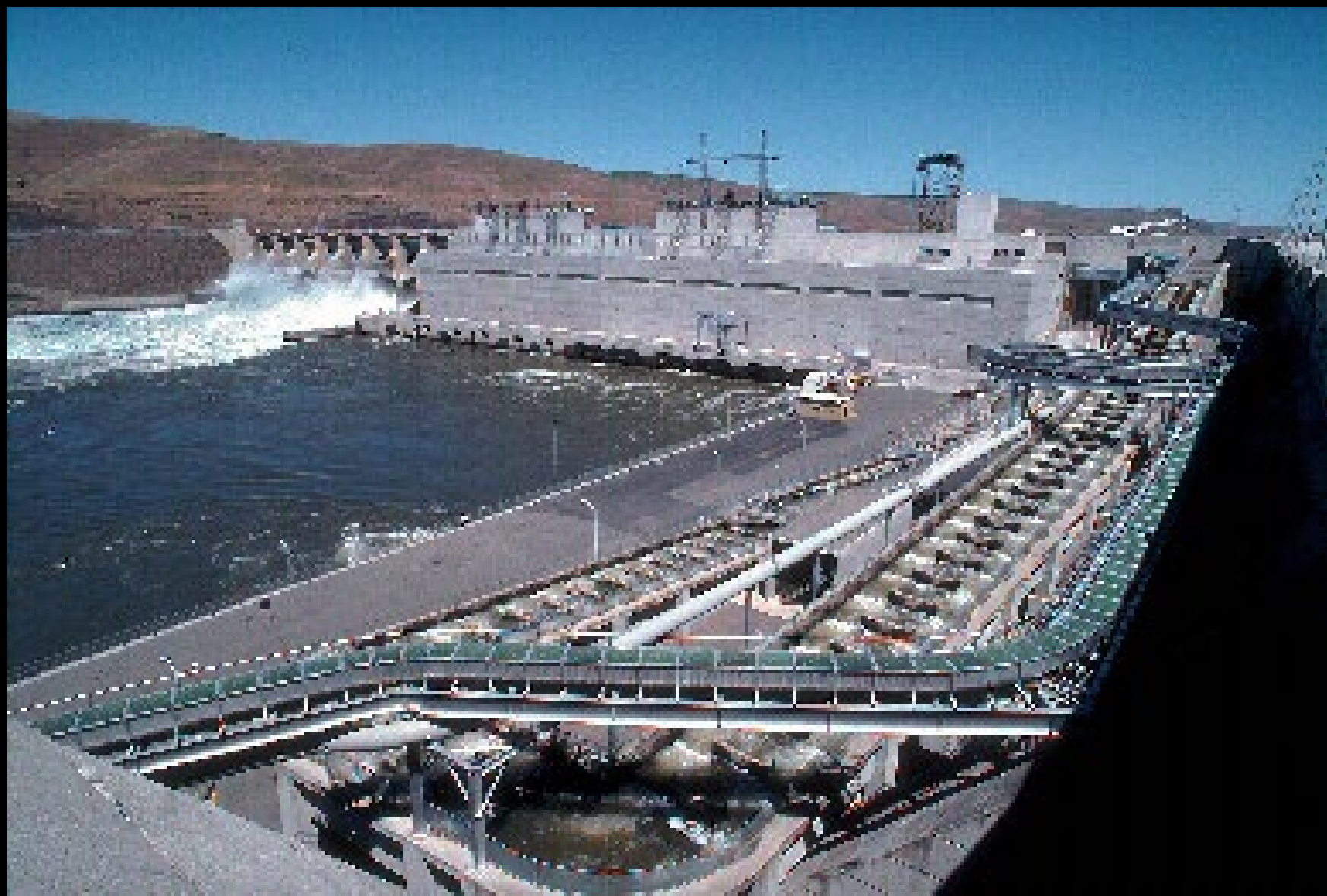
## Vertical Flat Plate Screen - 180 cfs





















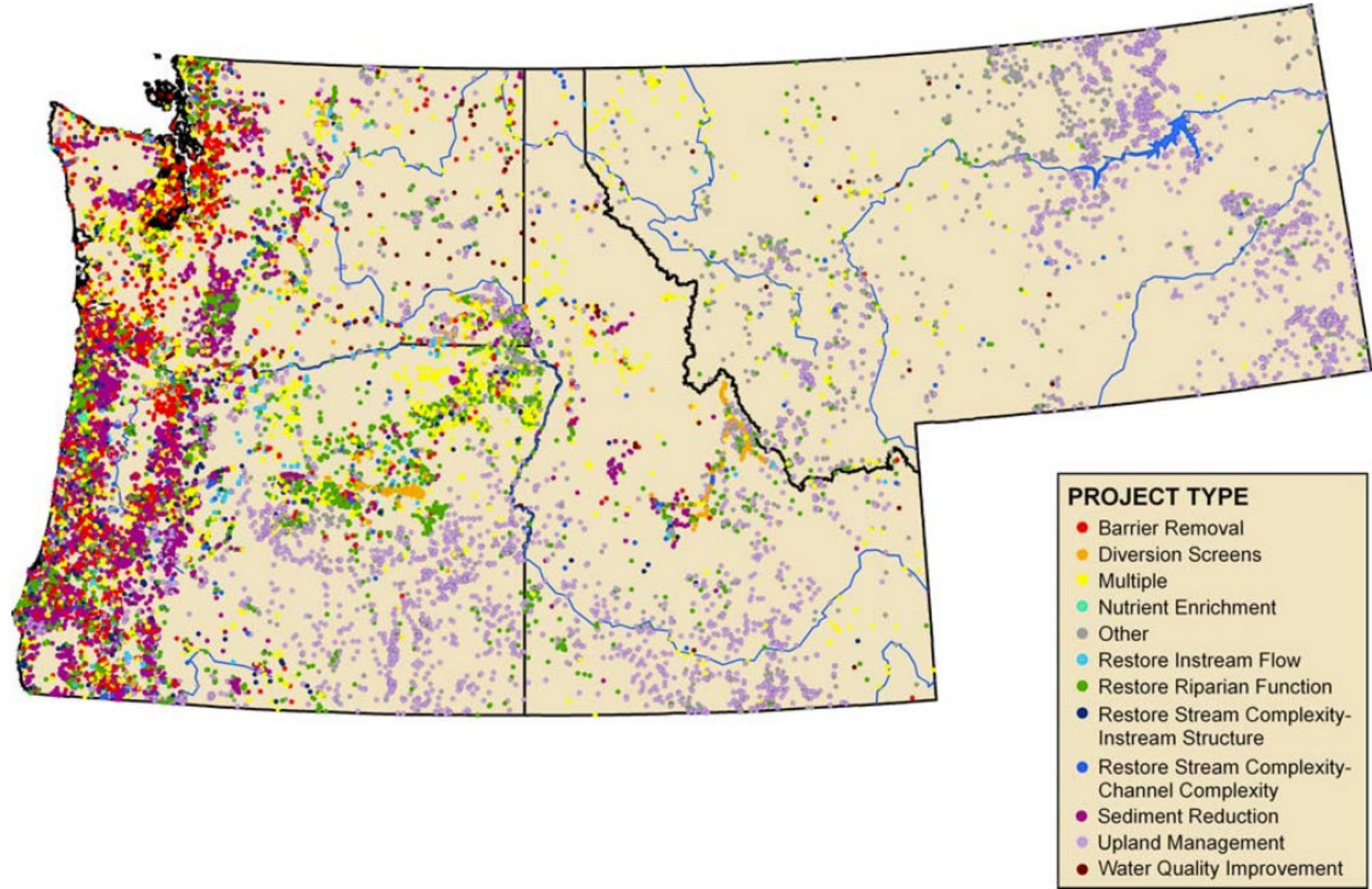






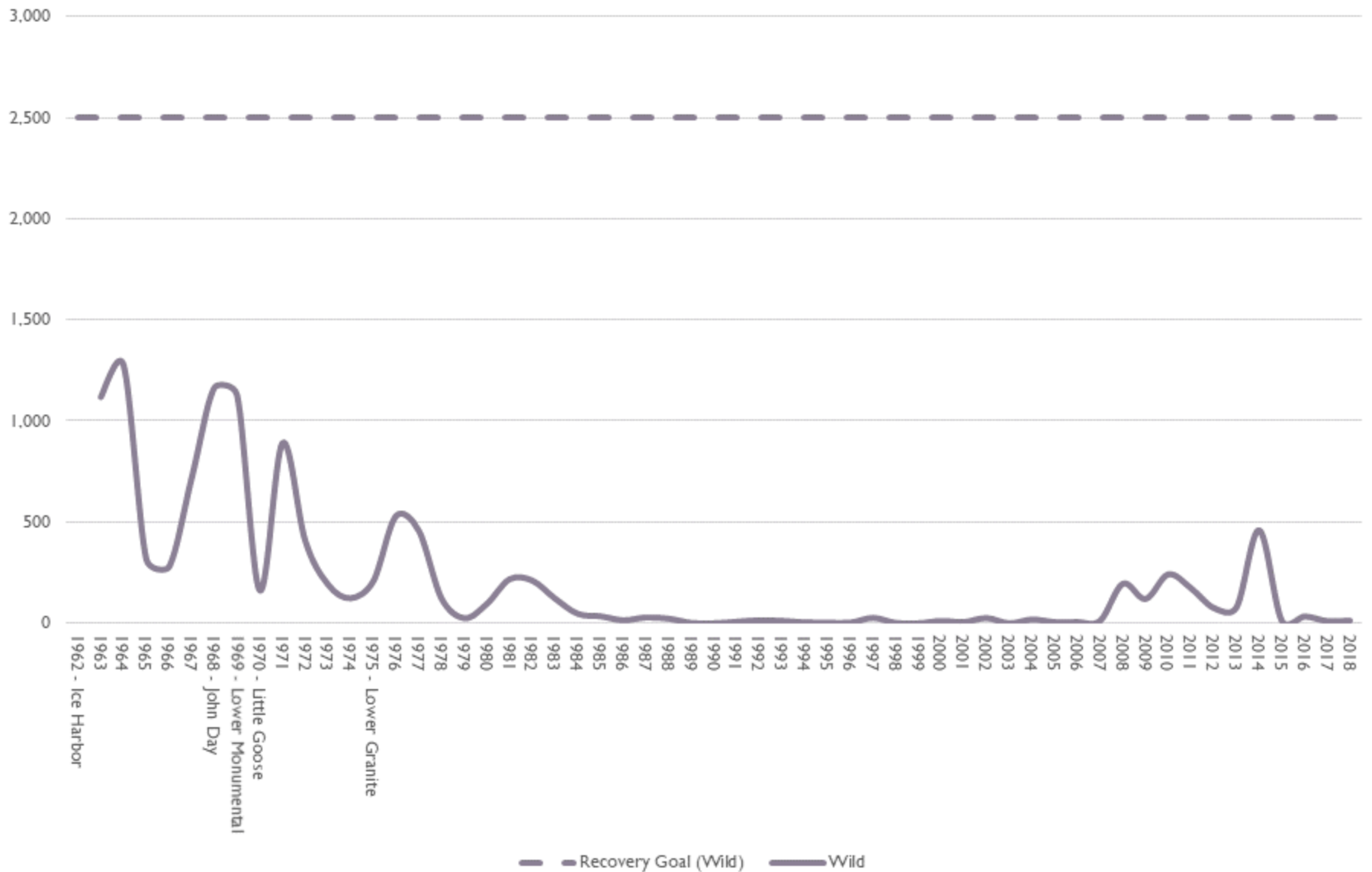


Over 35,000 restoration projects for salmonids since in PNW



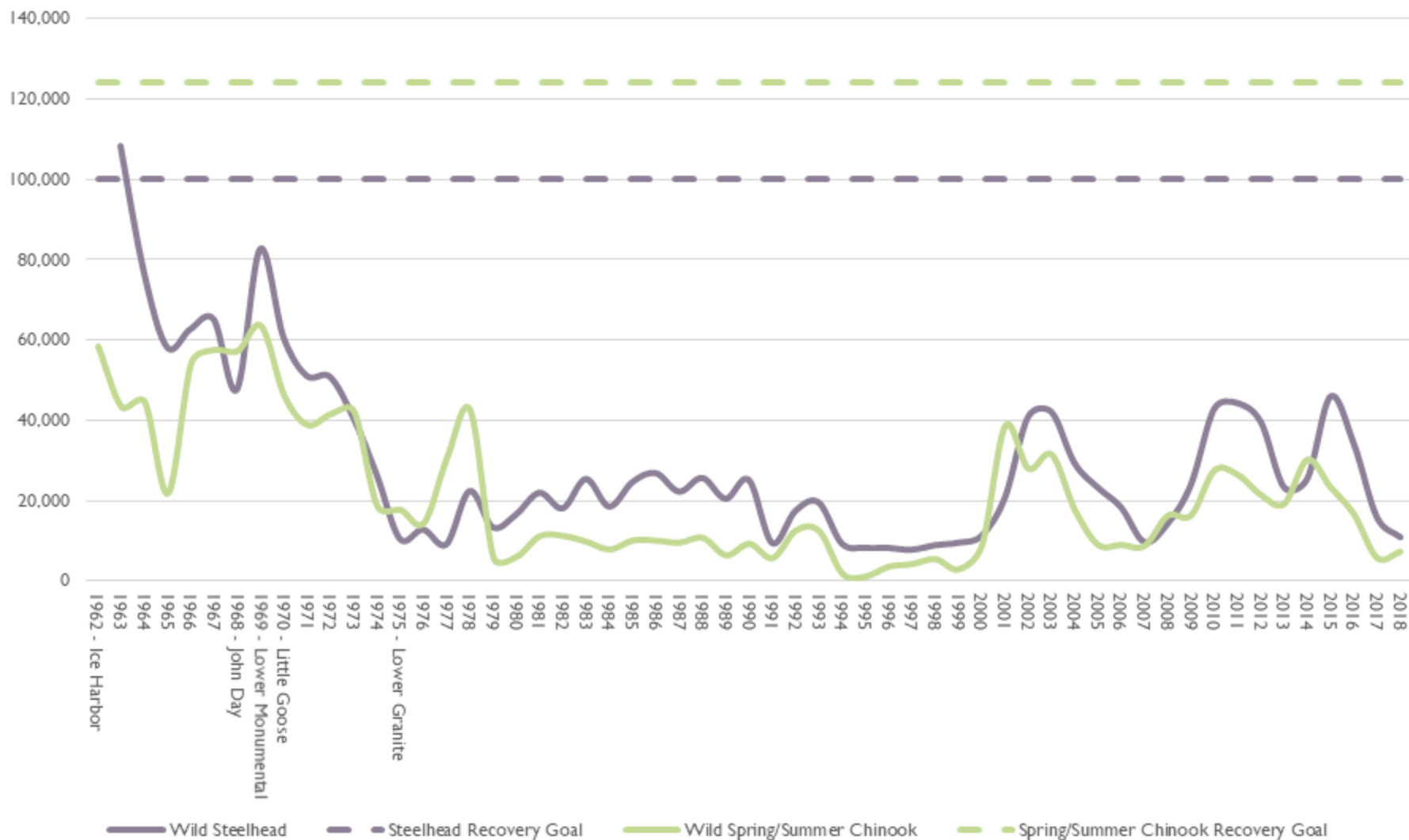
# Wild Snake River Basin Sockeye

Source: Idaho Fish and Game



# Wild Snake River Spring-Summer Chinook and Steelhead

Source: Idaho Fish and Game



# Bridge Creek Intensively Monitored Watershed - Effectiveness of Restoring Processes with BDAs and Beaver Activity

## I. The problem





## II. The solution

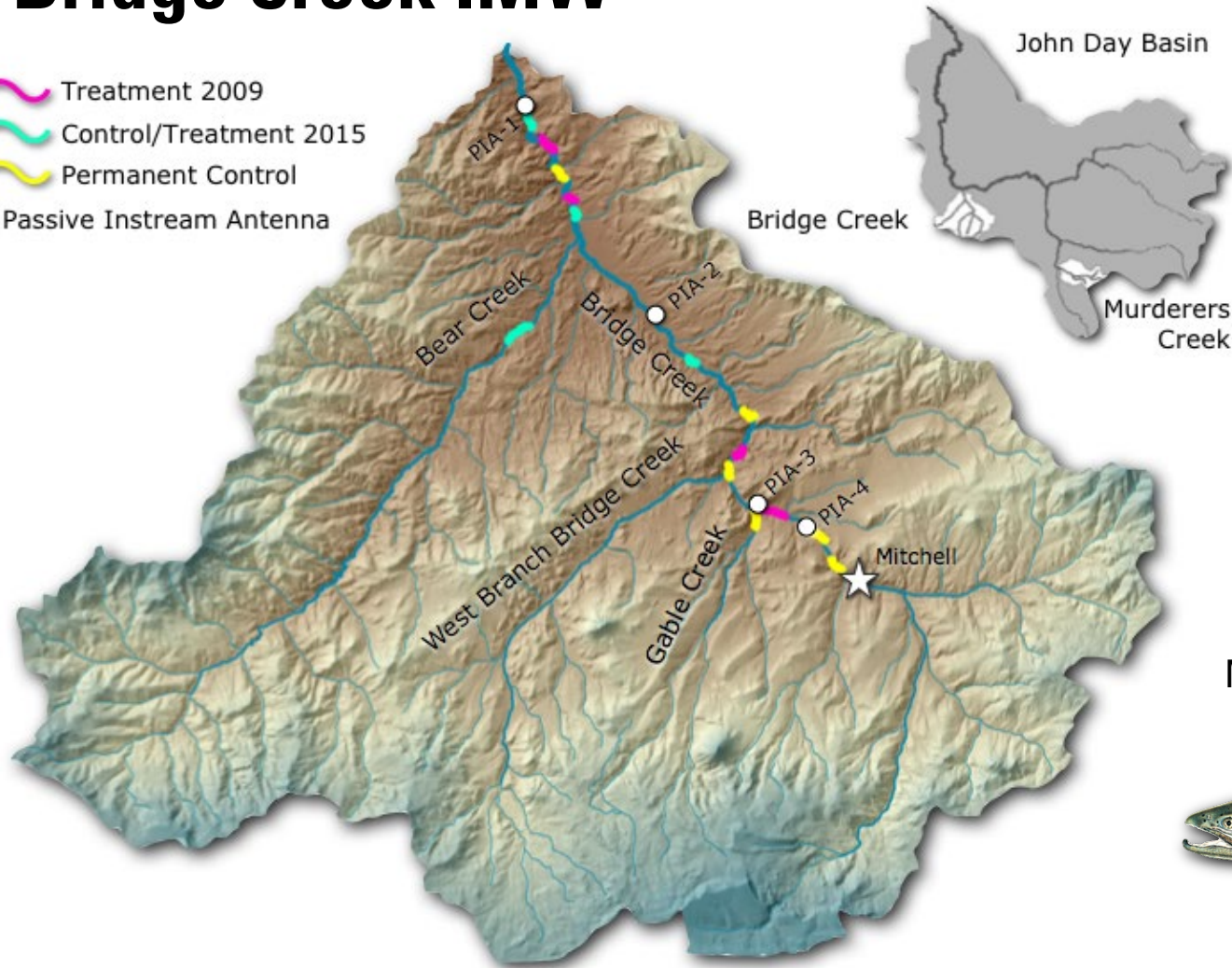
## III. What we found out

- Physical Response
- Fish Response

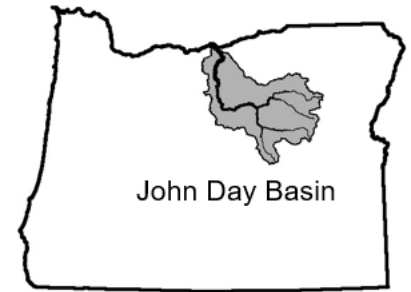


# Bridge Creek IMW

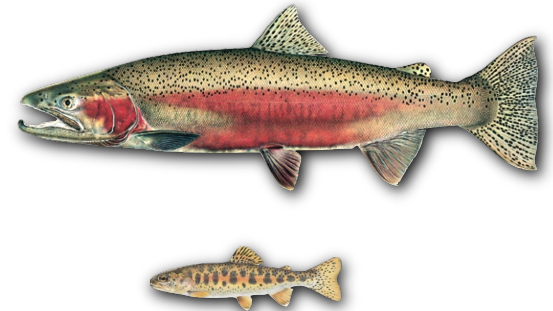
-  Treatment 2009
-  Control/Treatment 2015
-  Permanent Control
-  Passive Instream Antenna



Oregon, USA



Mid-Columbia Steelhead



# Pre-restoration Incised



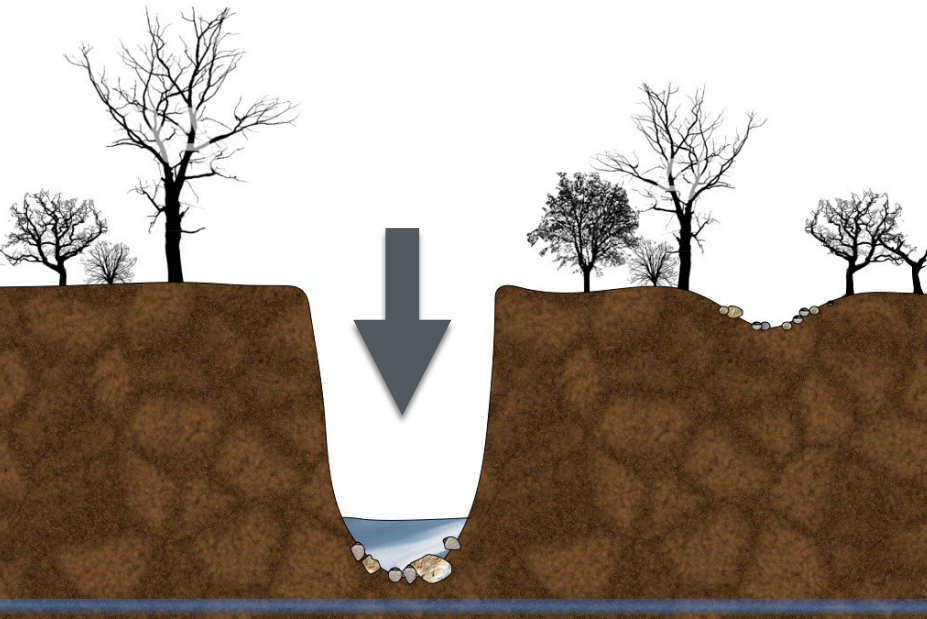
Bridge Creek  
*ca.* 1993

# Channel Incision

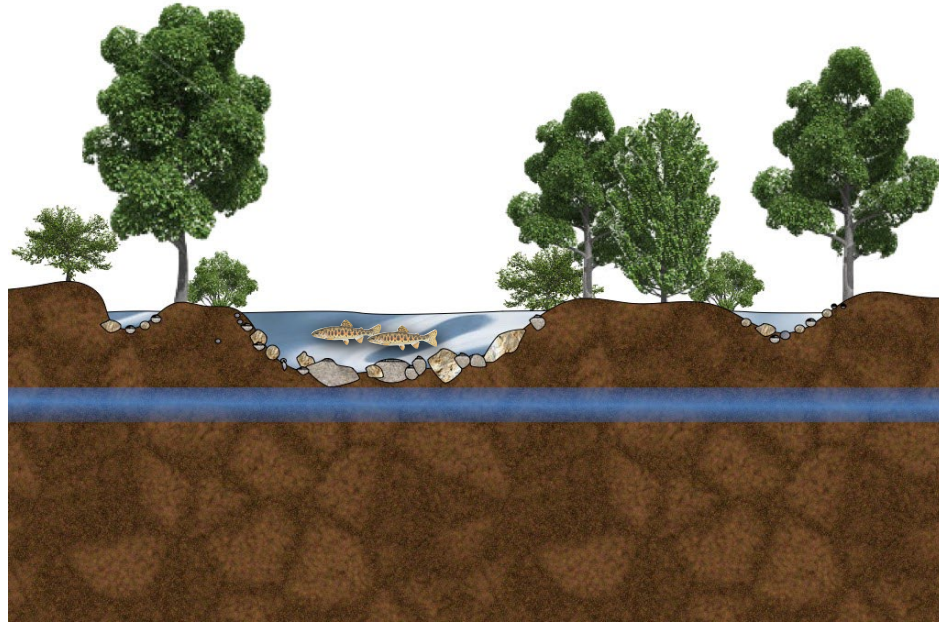
Incised Channel

$10^3$  years

Incision Recovery



- Simplified and static channel
- Hydrologically Disconnected
- Low habitat quality



- Complex and dynamic channel
- Floodplain and groundwater connectivity
- High habitat quality

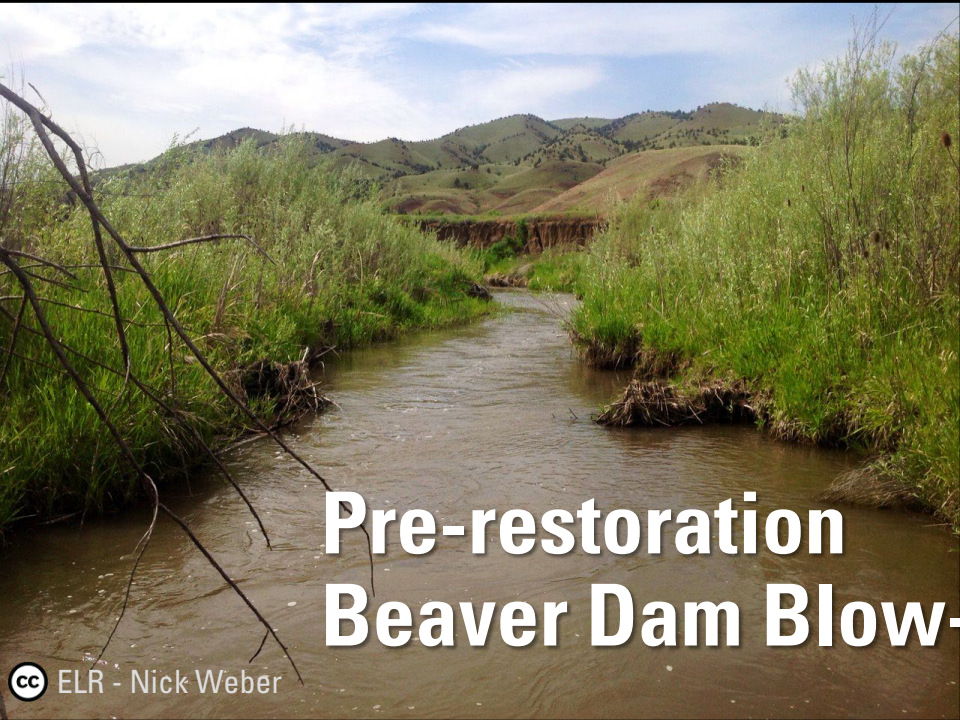
**20 years later.....  
Still Incised**



**Bridge Creek  
2009**

# But Beavers Live in Bridge Creek





**Pre-restoration  
Beaver Dam Blow-outs Common**

# **OUTLINE:** Bridge Creek IMW-Effectiveness of Restoring Processes with BDAs and Beaver Activity

I. The problem

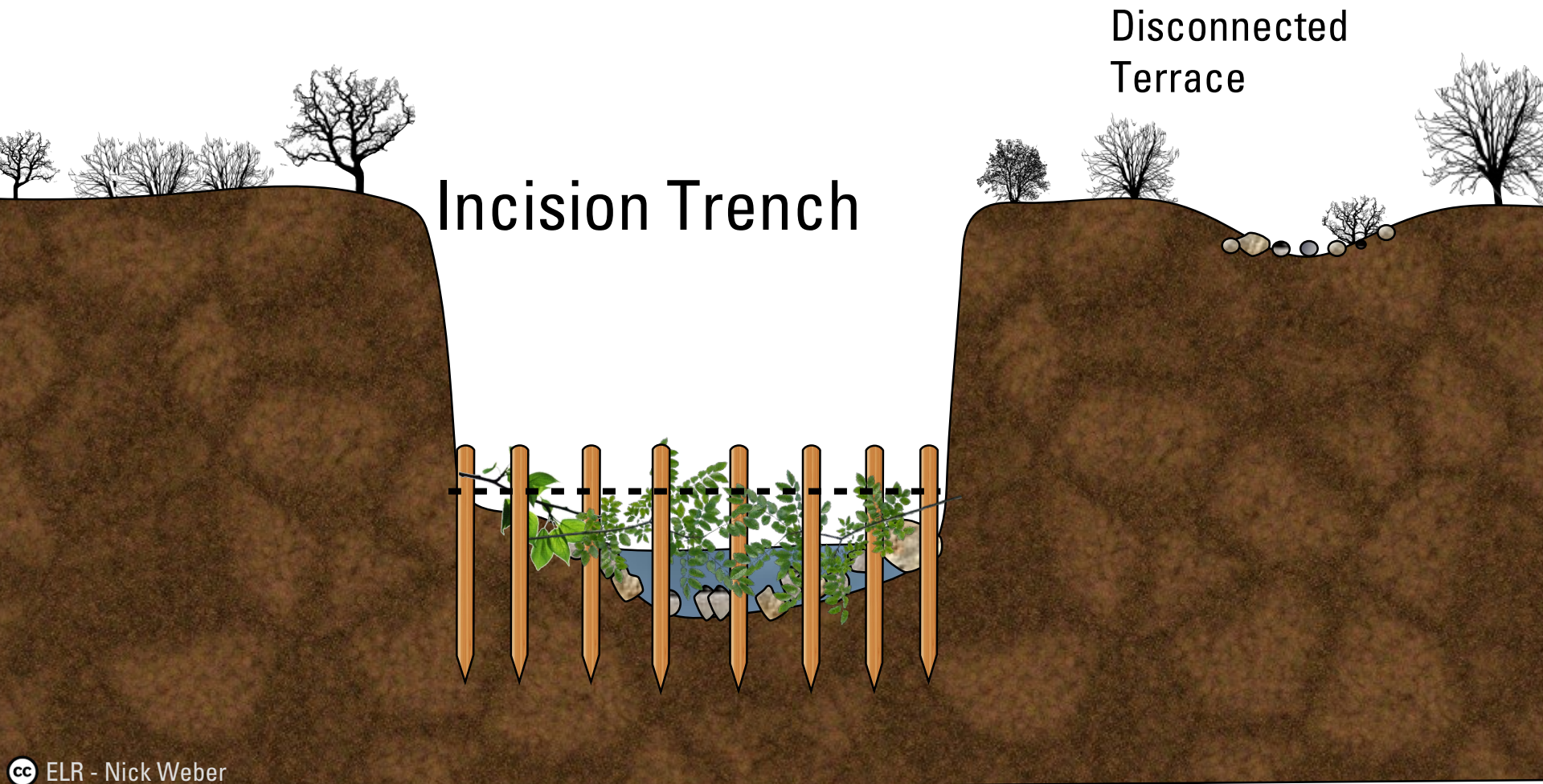
II. The solution

III. What we found out

- Physical Response
- Fish Response



# Restoration Approach-Mimic Beaver Dam Analogs (BDAs)



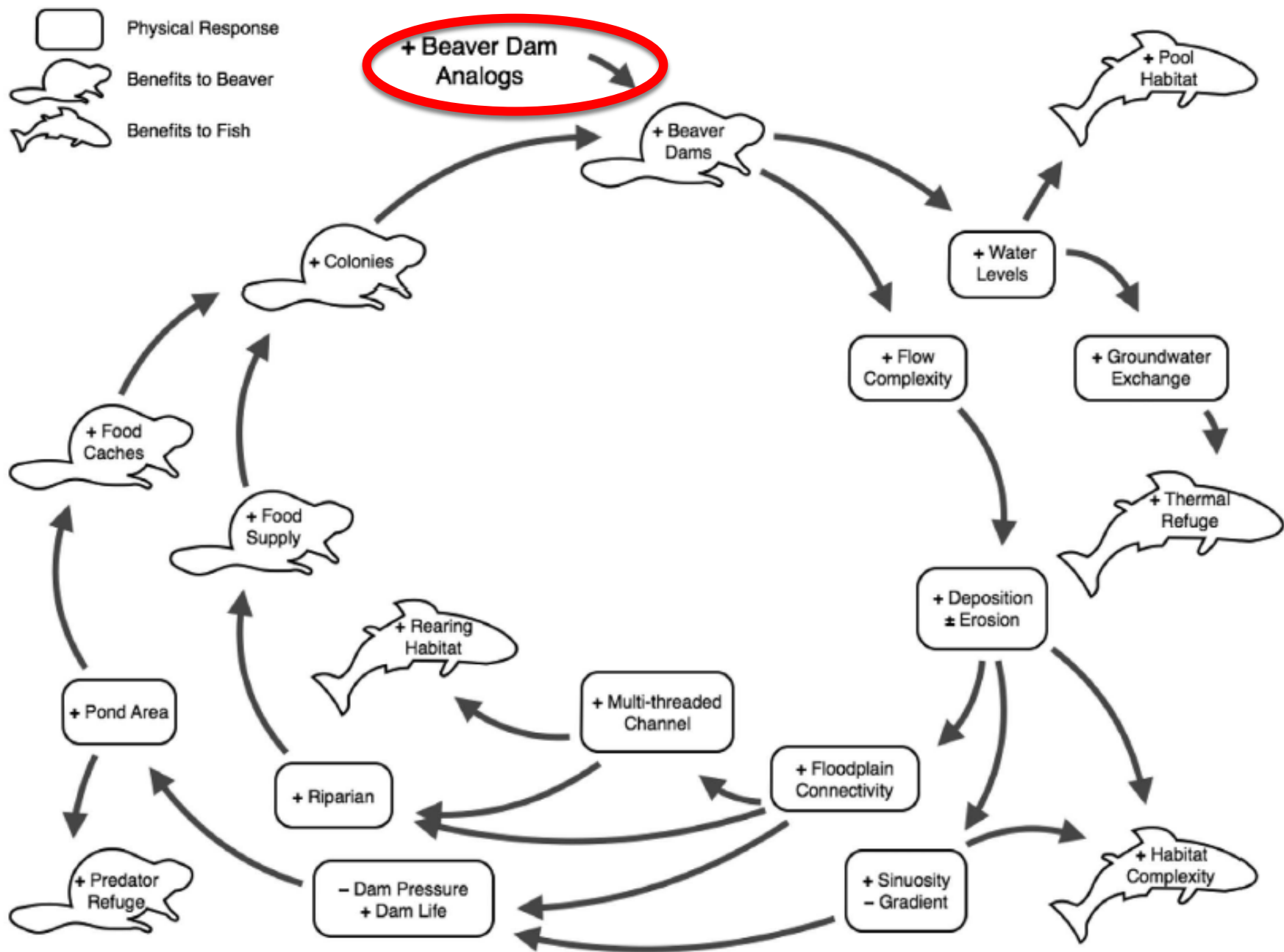


Figure 1 from Bouwes et al (2016) DOI: [10.1038/srep28581](https://doi.org/10.1038/srep28581)

# Mimic – Build BDAs





Treatment Reach



4 Treatment Reaches ~ 1 km



BDA Complex

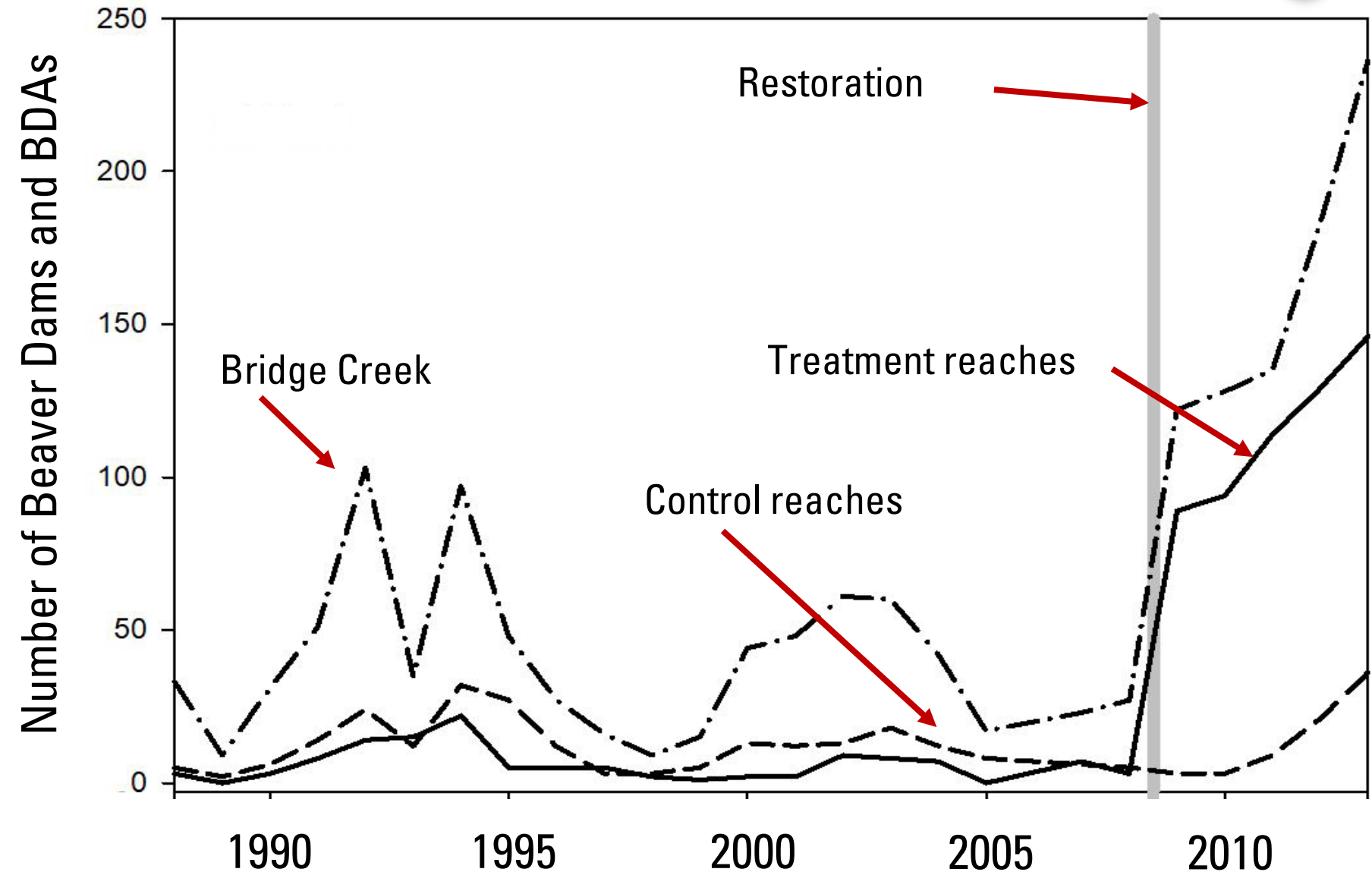


BDA Structure

# Post-restoration



# Post-restoration Beaver Dams and BDAs - Promote



# Post-restoration Aggradation and Pool Formation- Promote deposition $\sim 1\text{m} < 1 \text{ yr}$



# Post-restoration Floodplain Connection - Promote



A photograph of a beaver swimming in a pond. The beaver is in the center of the frame, facing right, with its head and back above water. Its fur is brown and appears wet. The water is calm with some ripples. In the background, there is a dense area of tall green grasses. The lighting suggests it's daytime.

# Post-restoration Beaver Response SUSTAIN?

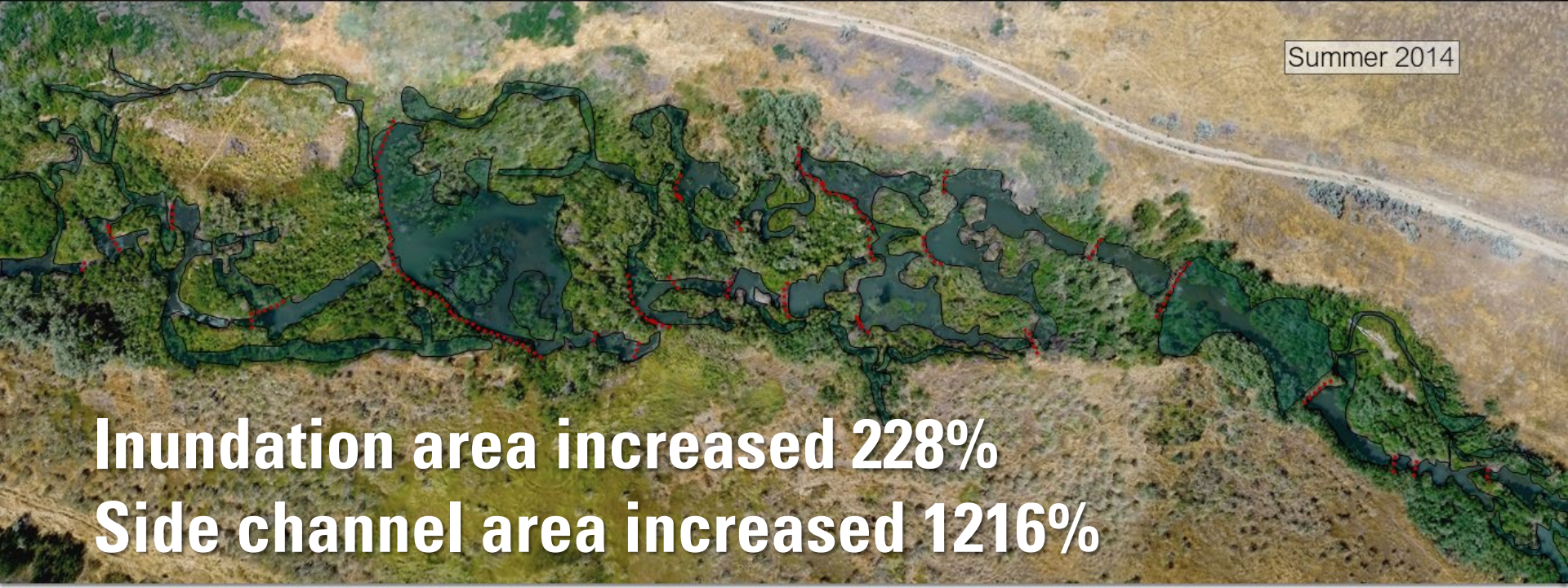
## ACTIVE BEAVER DAMS

- 2008 = 22 (pre-BDAs)
- 2016 = 164!

Summer 2005

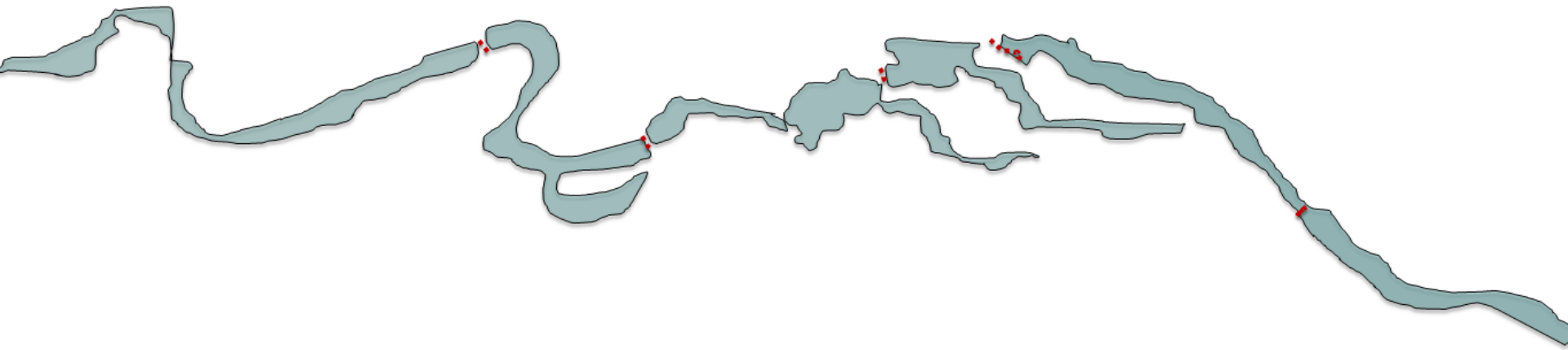


Summer 2014

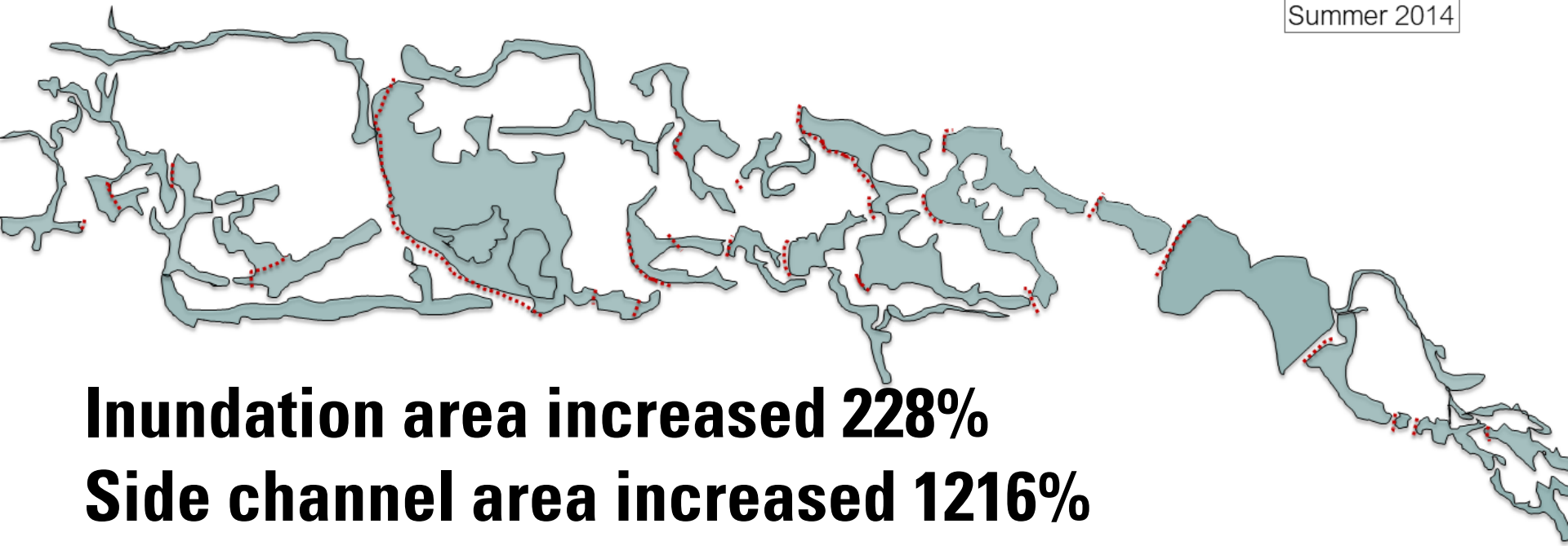


**Inundation area increased 228%**  
**Side channel area increased 1216%**

Summer 2005



Summer 2014



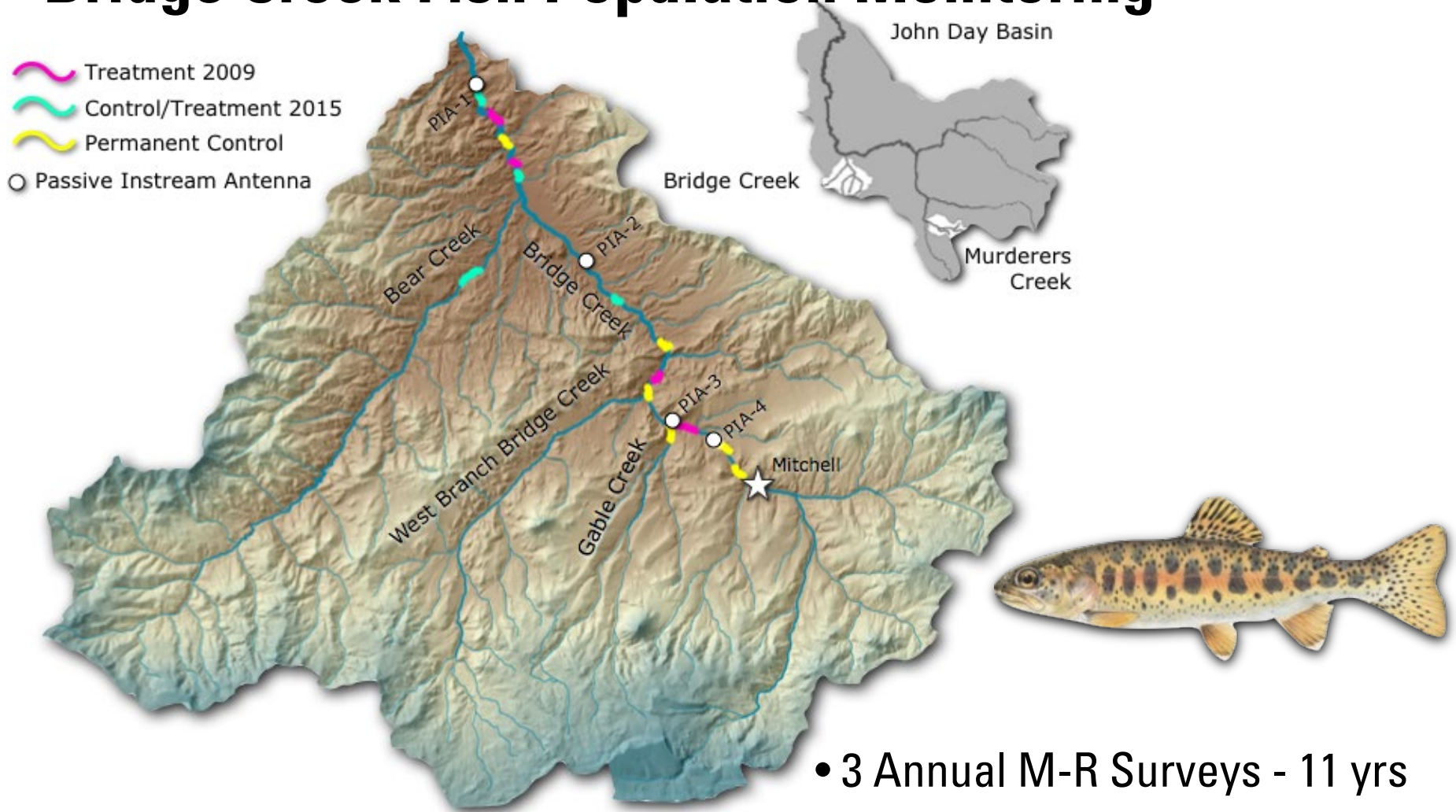
**Inundation area increased 228%**

**Side channel area increased 1216%**

# Post-restoration Fish Response?

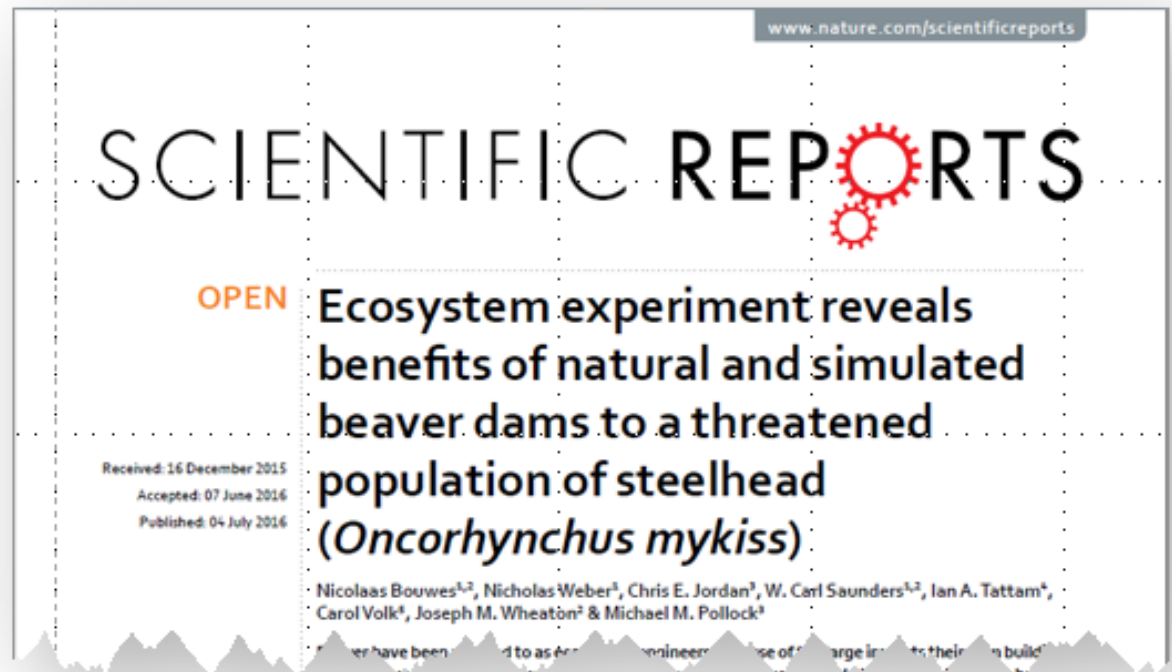


# Bridge Creek Fish Population Monitoring



- 3 Annual M-R Surveys - 11 yrs
- ~ 100,000 Juveniles Pit-tagged
- 4 Passive Instream Antennas
- Adult Steelhead Trap

# Post-restoration Population Level Response



168% increase in abundance

52% increase in survival

172% increase in production