Session B3- Getting scientifically ready for the removal of the Elwha River dams- last call for baseline data

The removal of the Elwha River dams: last call for baseline data

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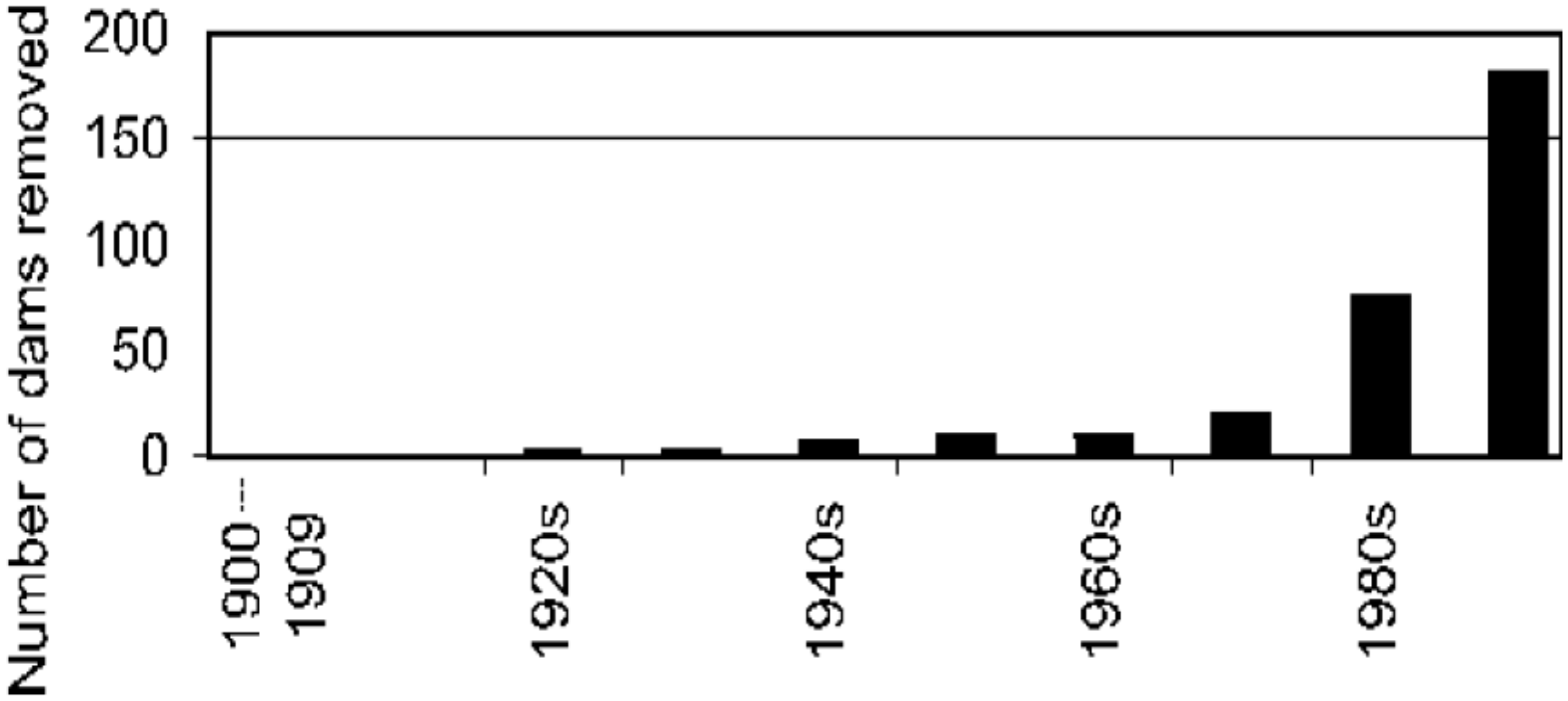
A context for dam removal in the United States

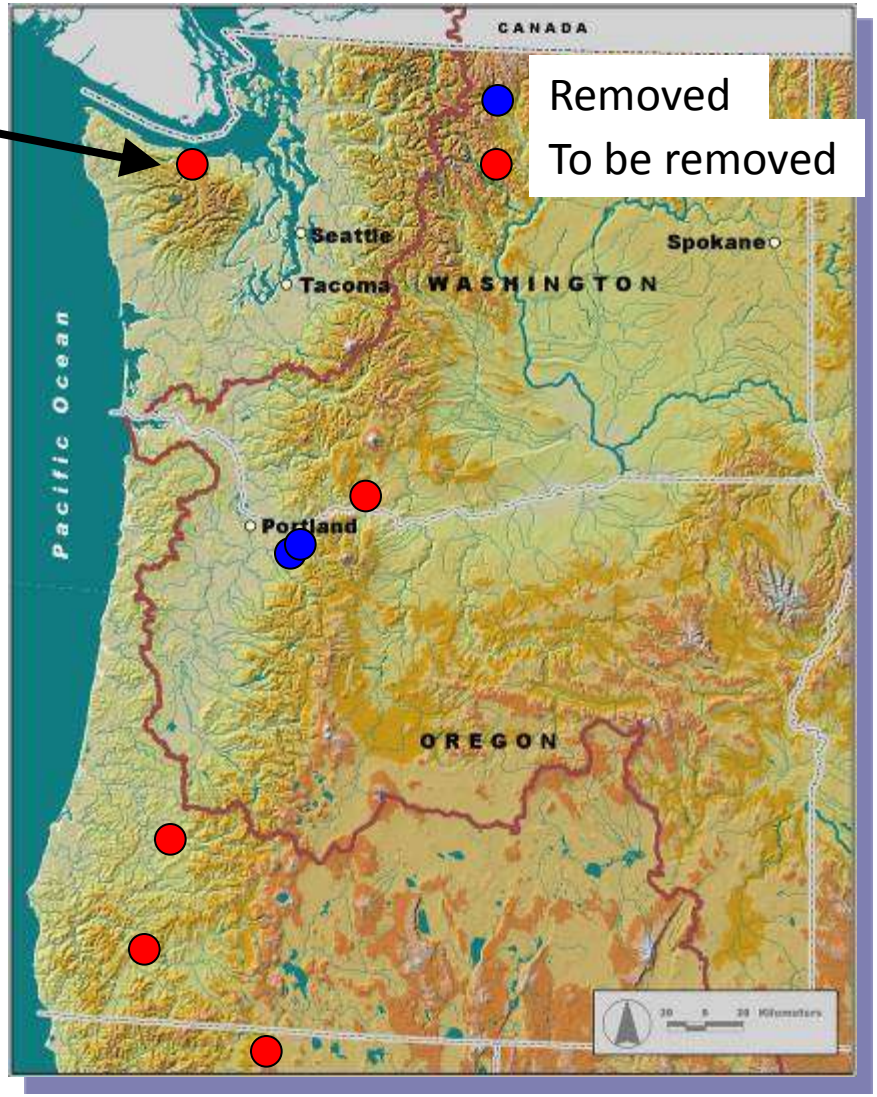


(Heinz Center 2002)

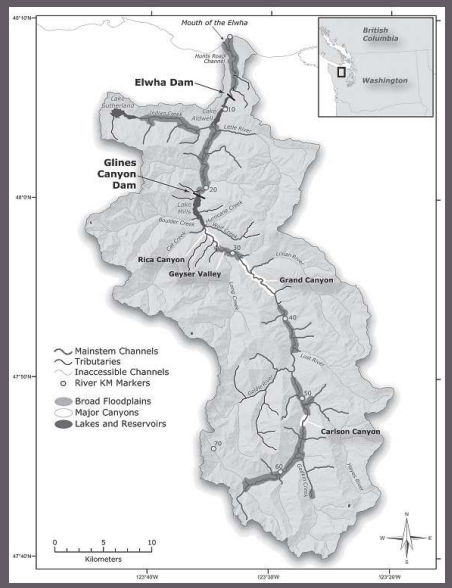
Re-opening of fish passage at Embrey Dam on the Rappahannock River in Fredericksburg, VA.

A context for dam removal in the Pacific Northwest

- Elwha River
- White Salmon River
- Sandy River
- Little Sandy River
- Calapooia (Umpqua) River
- Rogue River
- Klamath River



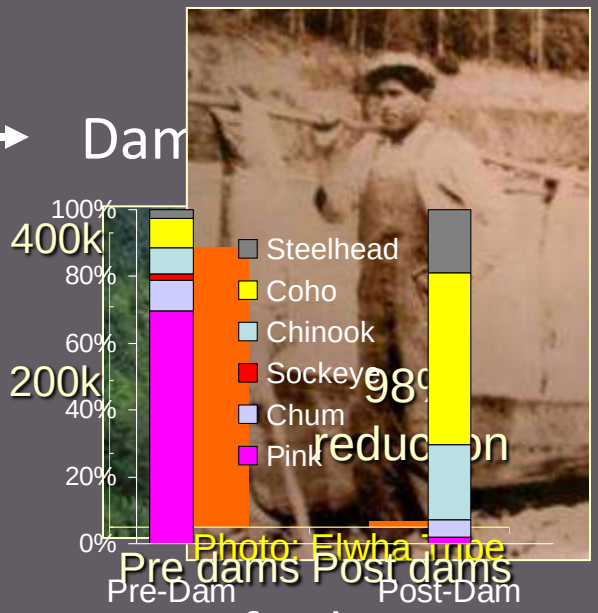
A Recent History of the Elwha River Basin



The Elwha River

Large salmon runs

Dam

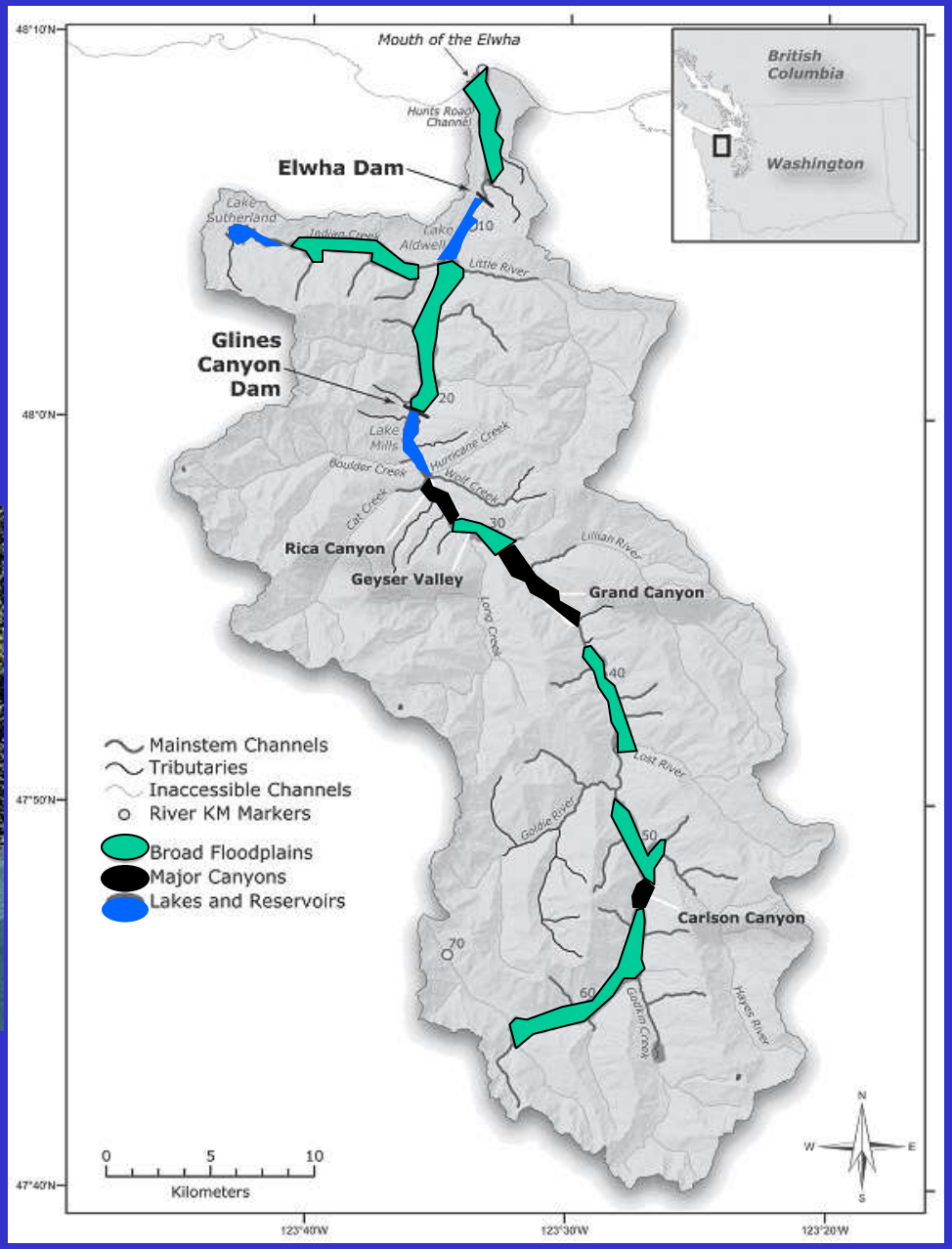


Loss of salmon

Dam removal

The Action – removal of two dams

approx. 18-24 million m^3 behind dams



dams to be removed 2011

Goals & questions

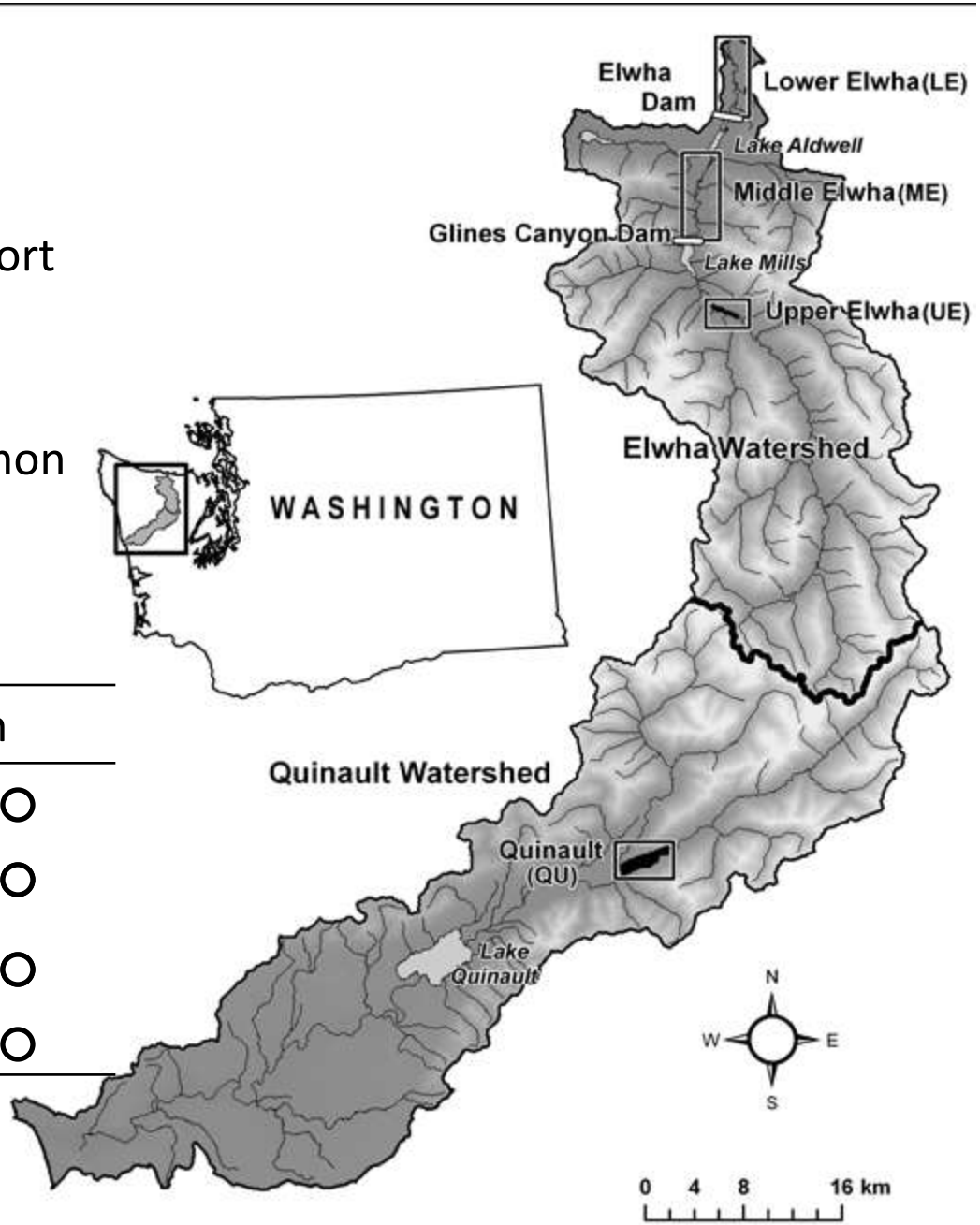
- Goals
  - Quantify the ecological “signal” following dam removal in the Elwha River basin.
  - Share critical findings with other dam removal projects.
- Questions
  - How will habitat condition and ecosystem processes change with the removal of the Elwha River dams?
  - How will salmon populations change with the removal of the Elwha River dams?

Study design

- Post dam removal
  - **Natural** downstream transport of sediment & wood
  - **Allowance of** upstream salmon migration

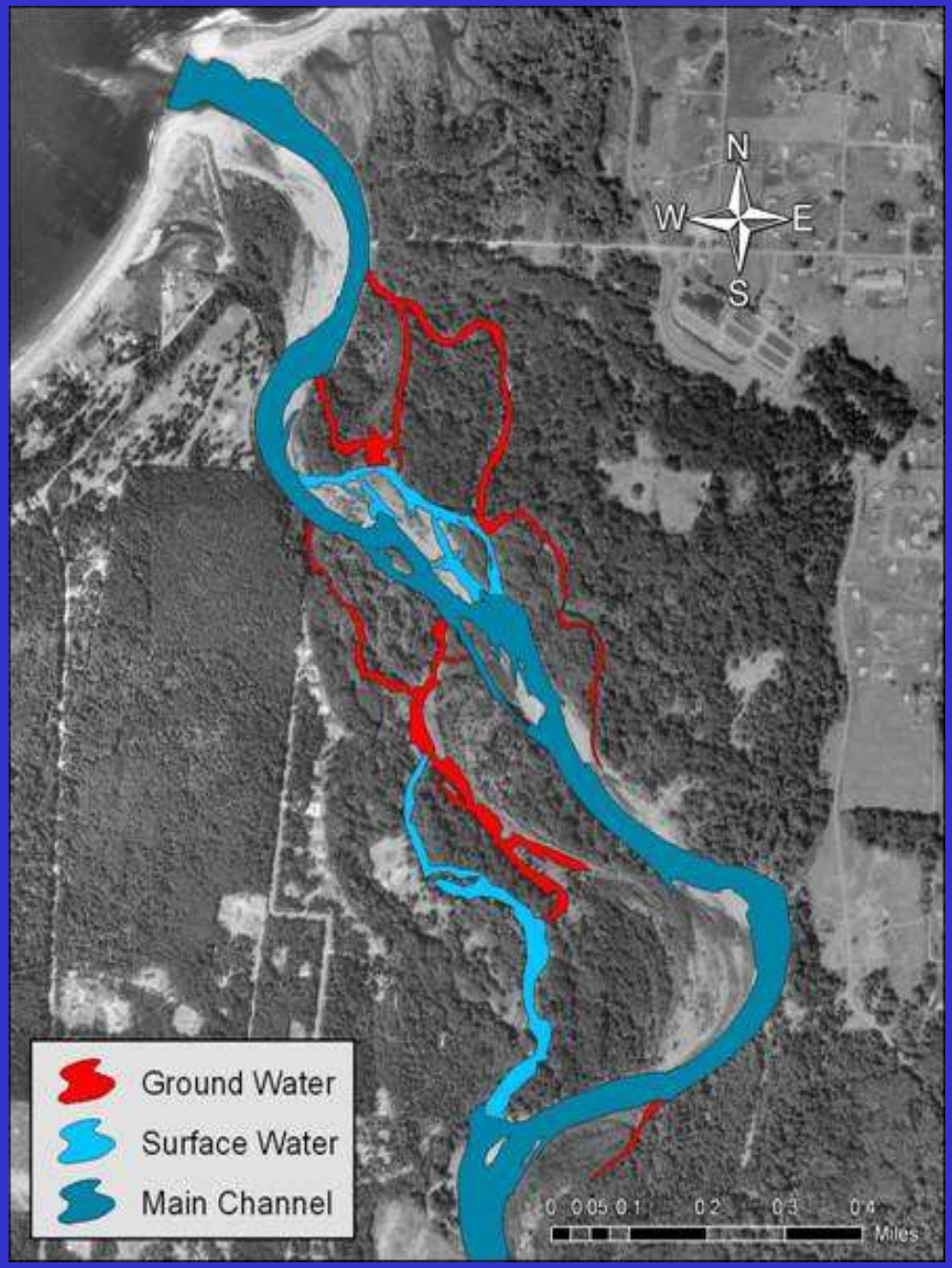
Reach	Sediment	Fish
Quinault	○	○
Upper Elwha	○	○
Middle Elwha	○	○
Lower Elwha	○	○

○ Yes ● No

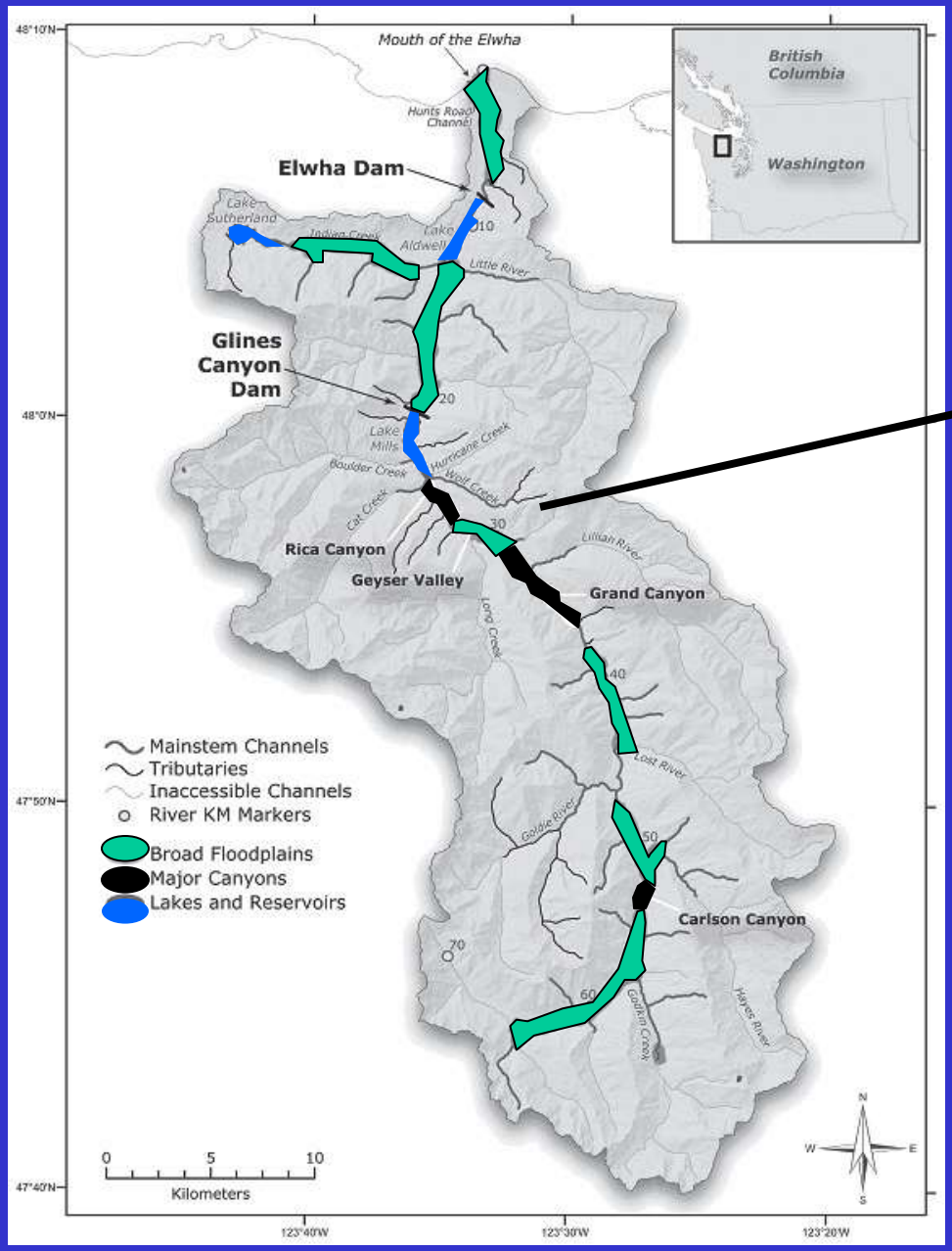


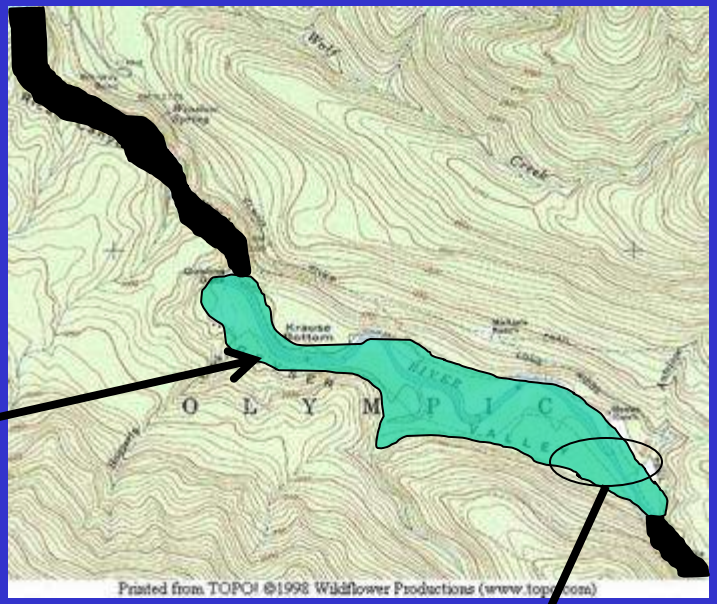
How will habitat conditions & ecosystem processes change with the removal of the Elwha River dams?

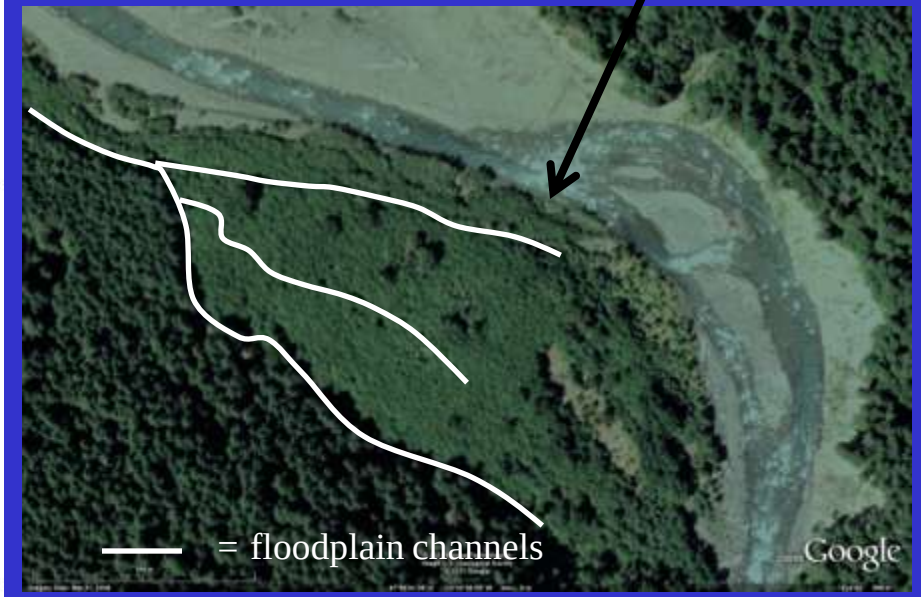
- Increase in sediment & wood supply
- Mainstem channel
  - Channel widening & “aggradation”
  - Increased channel migration rate
- Decrease in riparian stand age
- **Floodplain channels**
  - **Biological refuge?**
  - **Sediment repository?**
  - **Both?**



Floodplains - bounded alluvial valley bottoms

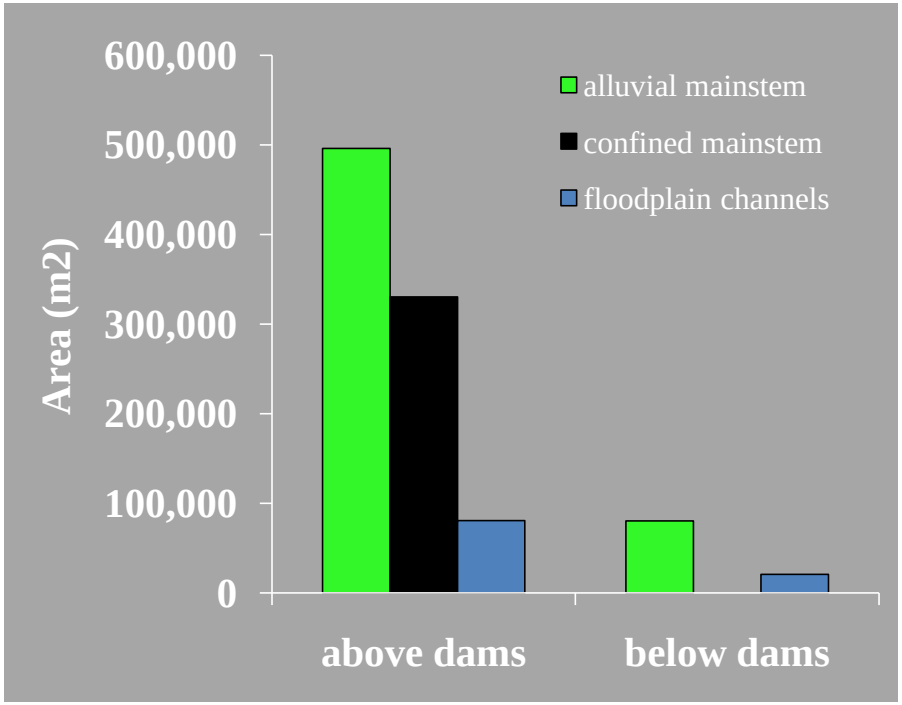






Why are floodplain channels important to the Elwha dam removal?

Large amount of floodplain channels

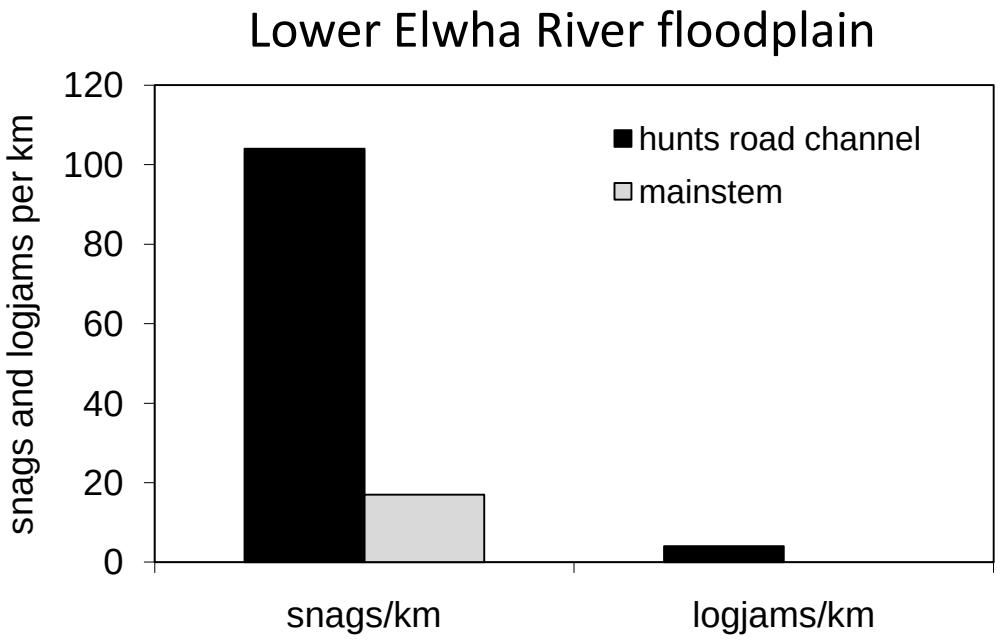


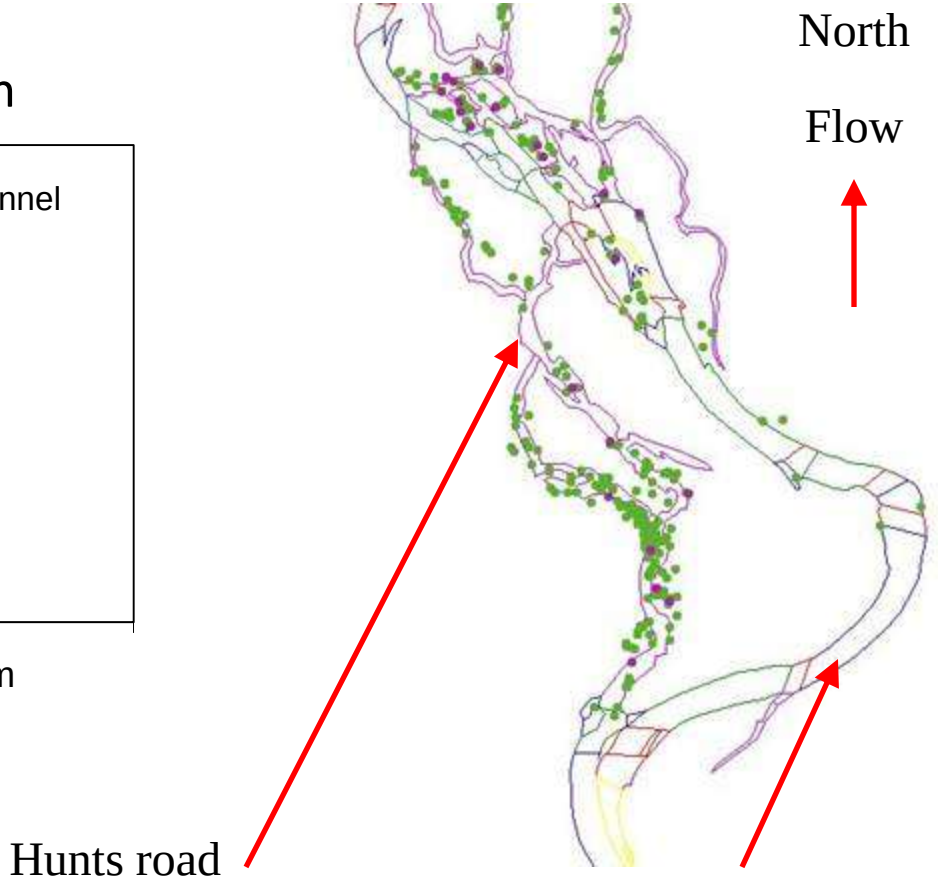
Location	Floodplain channels (km)	Main stem (km)
Upper Elwha	17.50	14.11
Middle Elwha	12.60	8.89
Lower Elwha	7.76	8.05

Pess et al. 2008

Why are floodplain channels important to the Elwha dam removal?

Repository of wood, sediment, water, & nutrients





Pess et al. 2008

Why are floodplain channels important to the Elwha dam removal?

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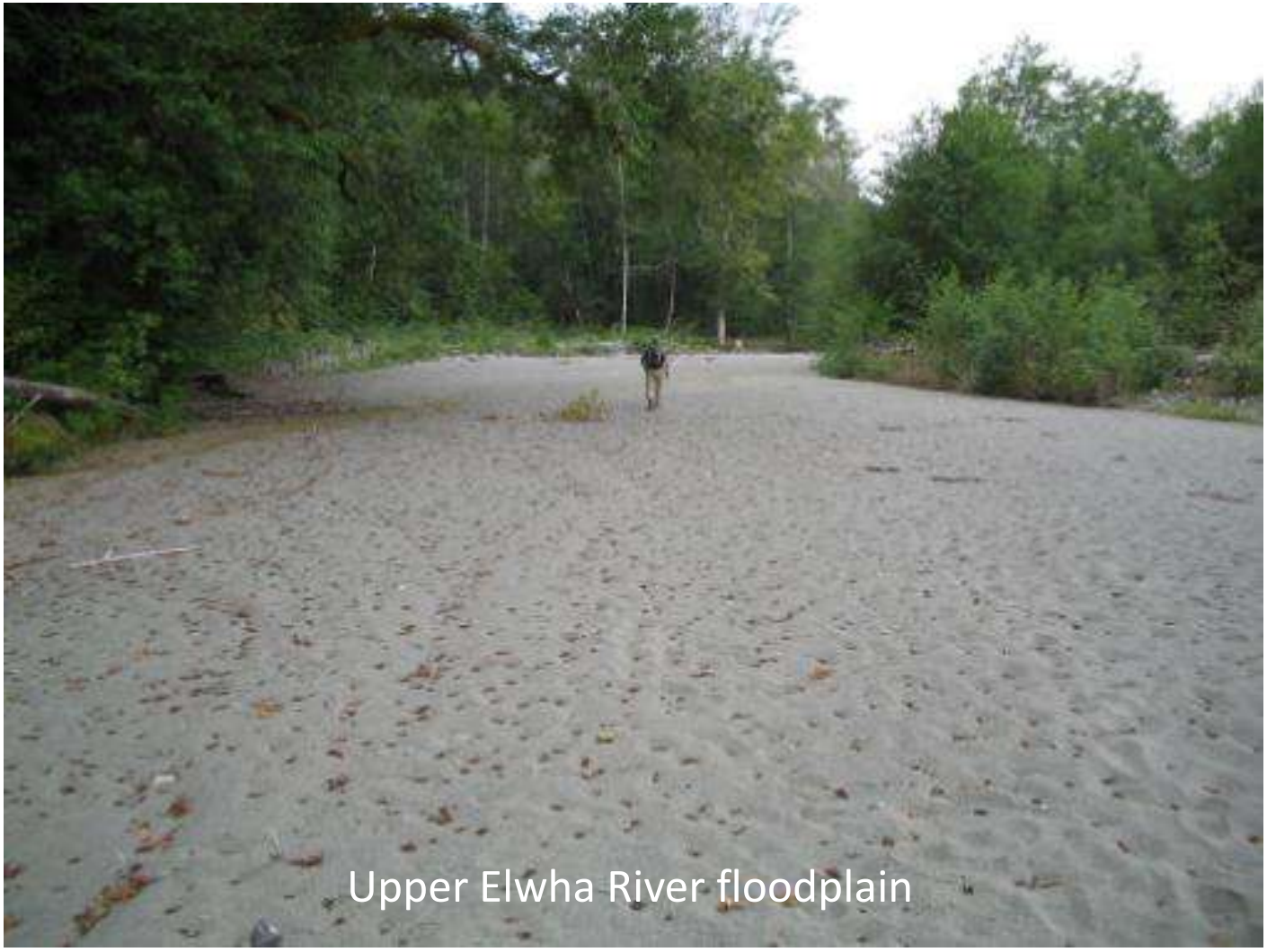
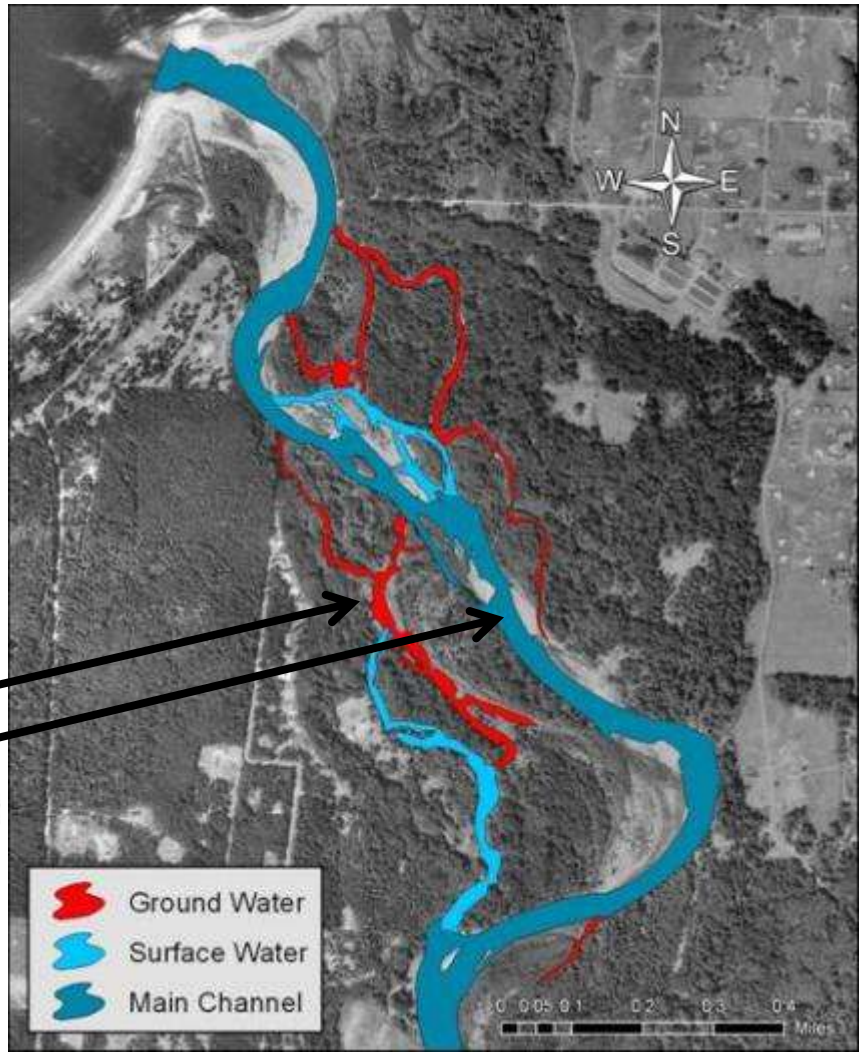


Upper Elwha River floodplain

Why are floodplain channels important to the Elwha dam removal?

Greater habitat use by salmonids

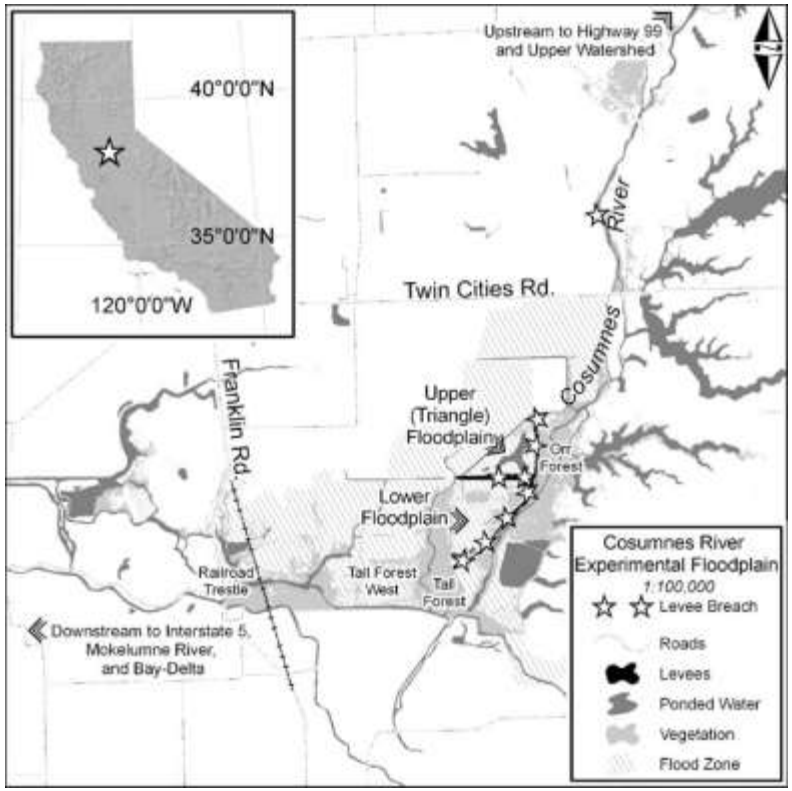


Clear = main stem Black filled = floodplain

Pess et al. 2008

Why are floodplain channels important to the Elwha dam removal?

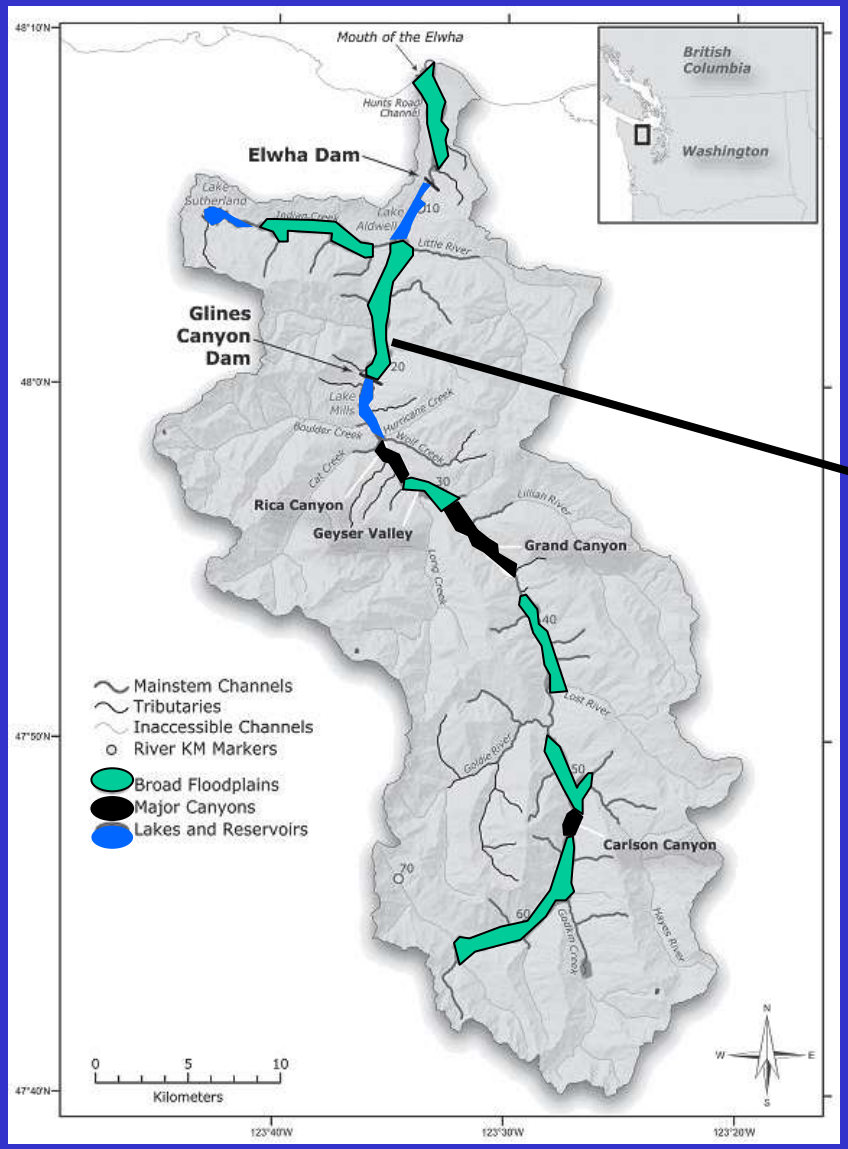
Better condition factor for outmigrating salmonids

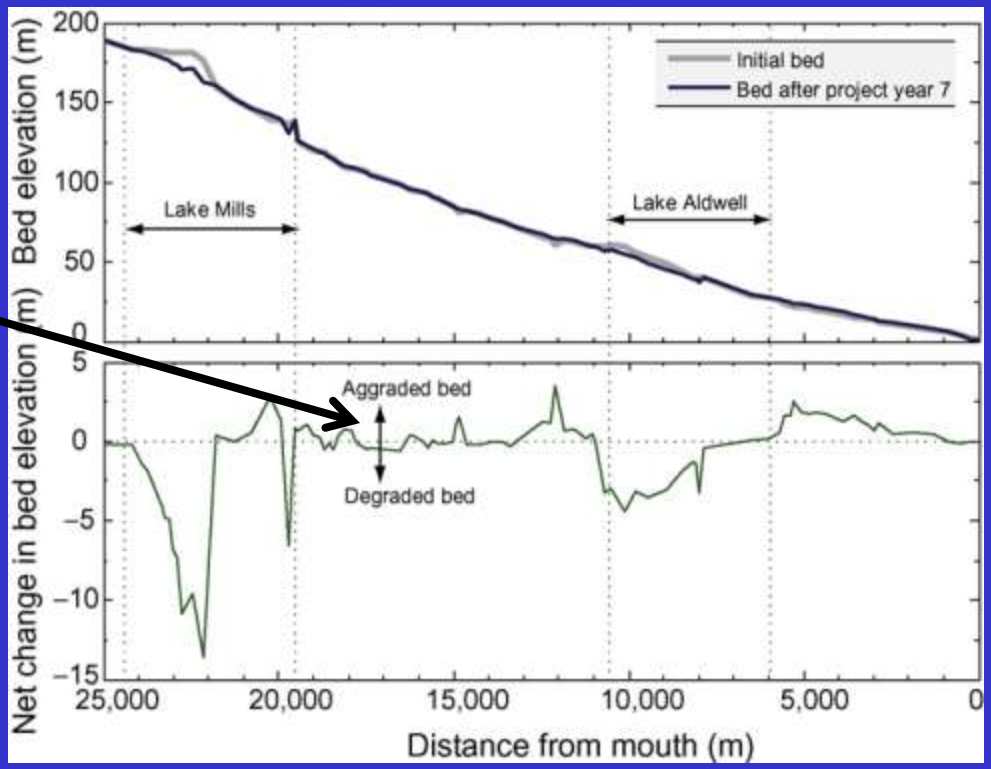


Below floodplain Floodplain

Jeffres et al. 2008
Enclosed experiment, same age Chinook

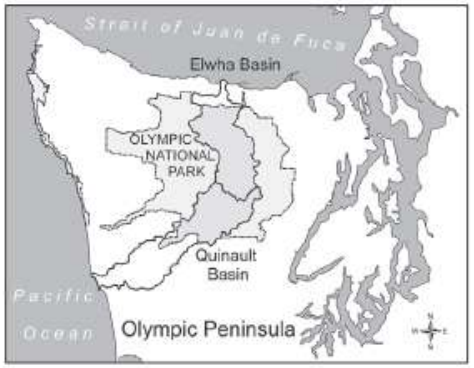
Longitudinal response





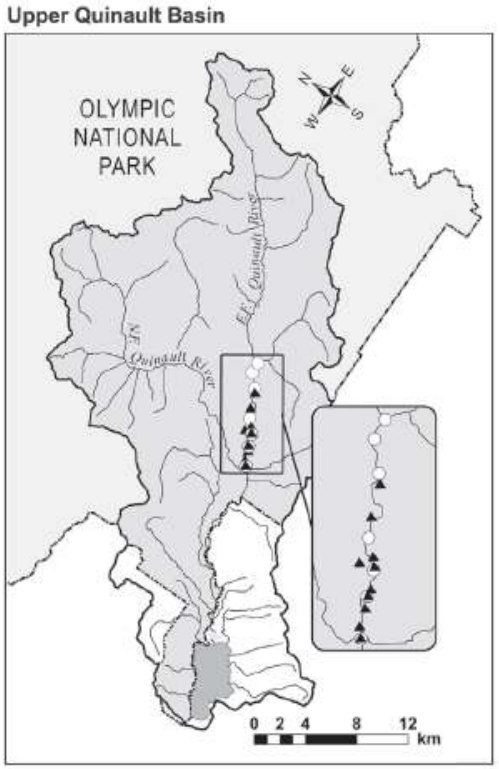
Konrad, C. 2009. Simulating the recovery of suspended sediment transport and river-bed stability in response to dam removal on the Elwha River,Washington. Ecological Engineering 35: 1104–1115

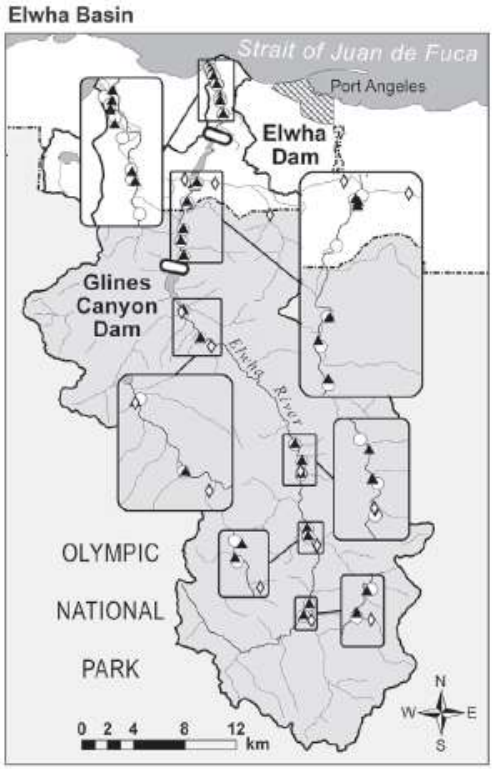
Longitudinal response – Food web indices



Map Legend:
- Dam
- Mainstem Site
- Side Channel Site
- Tributary Site
- Lakes
- ONP Boundary
- Watershed Boundary

- 52 study sites
  - Periphyton
  - Invertebrates
  - Stable isotopes



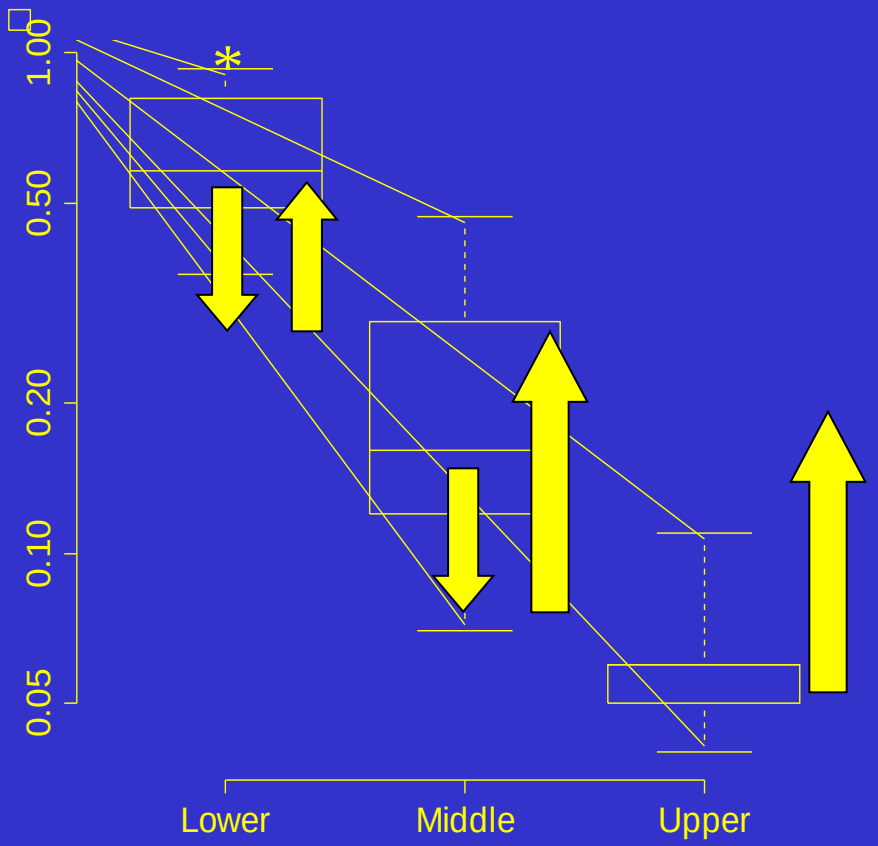


Longitudinal response
Indices of primary productivity

- Initial reduction due to sediment

- Long-term increase due to marine dervied nutrients?

organic matter density (AFDM)



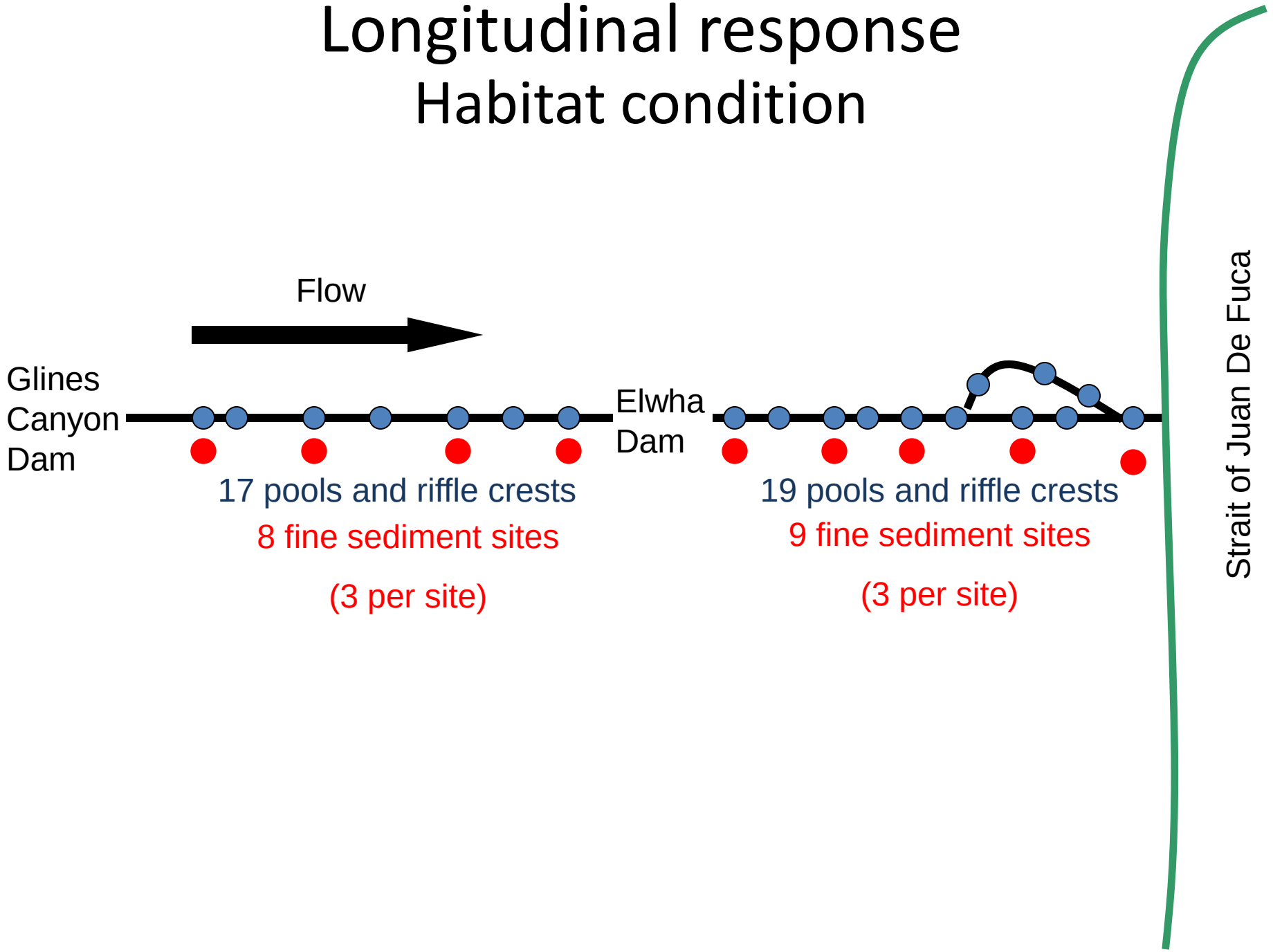
$p < 0.001$, 1-way ANOVA log transformed, Tukey's HSD

Longitudinal response
Habitat condition

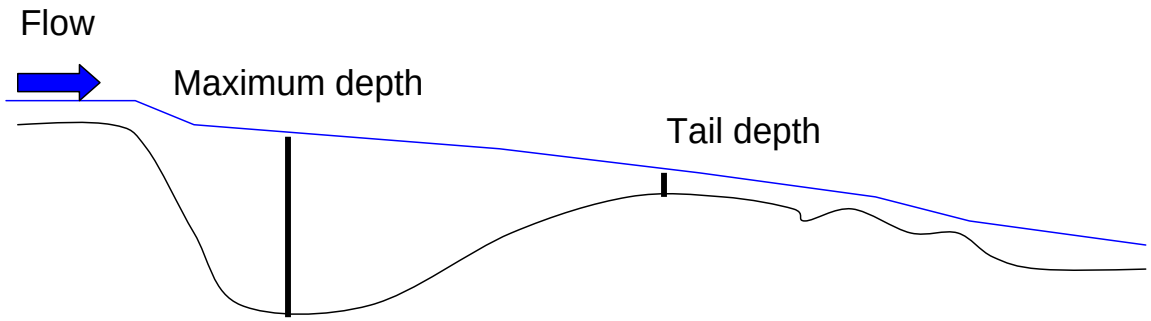
- Pebble counts
- Residual pool depth
- Fine sediment sampling

Photo by John McMillan

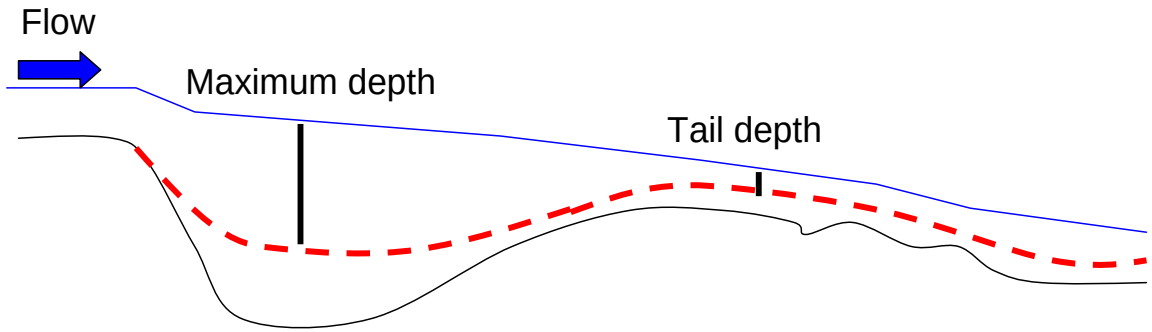
Longitudinal response
Habitat condition



Longitudinal response
Residual pool depth



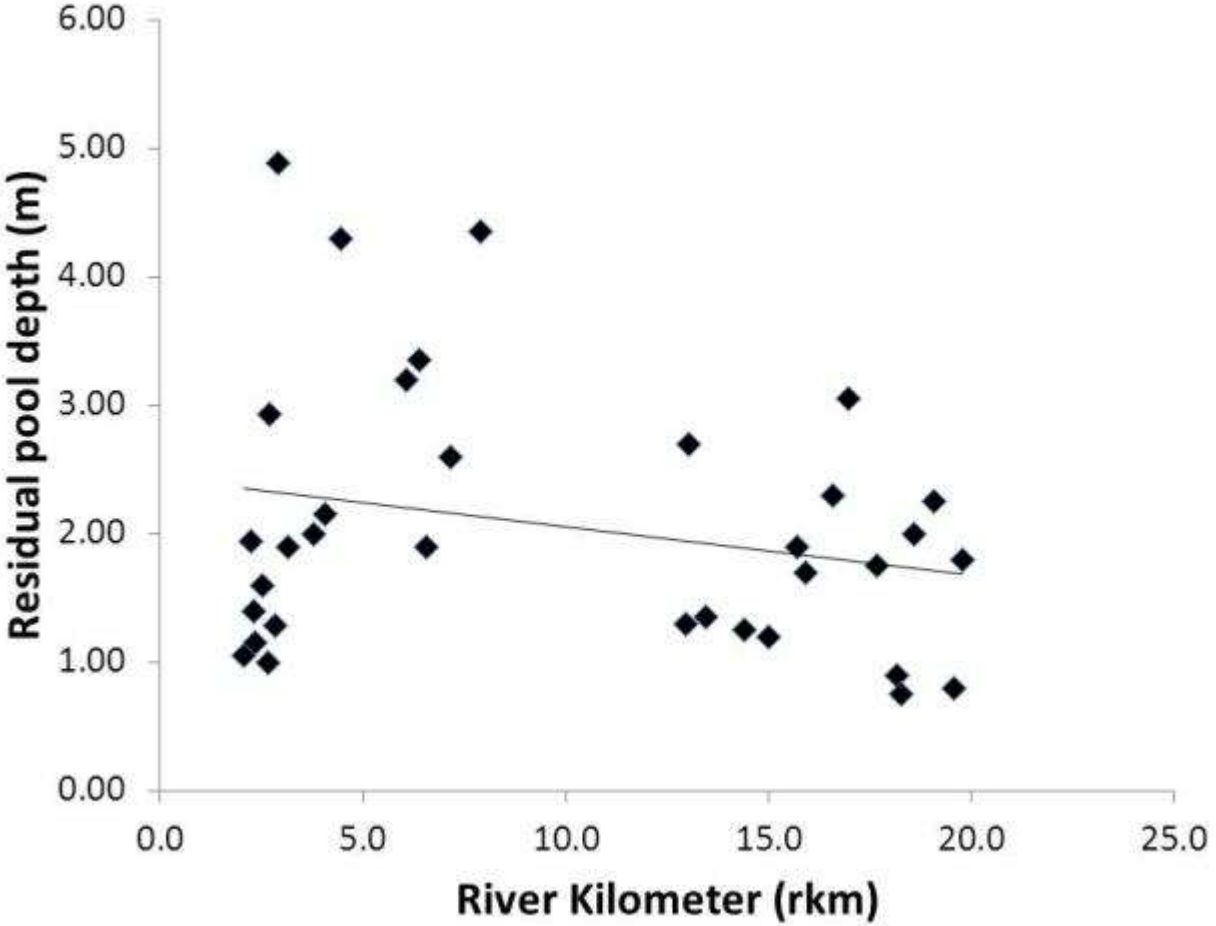
Residual depth = maximum depth – tail depth



= new stream bed post dam removal

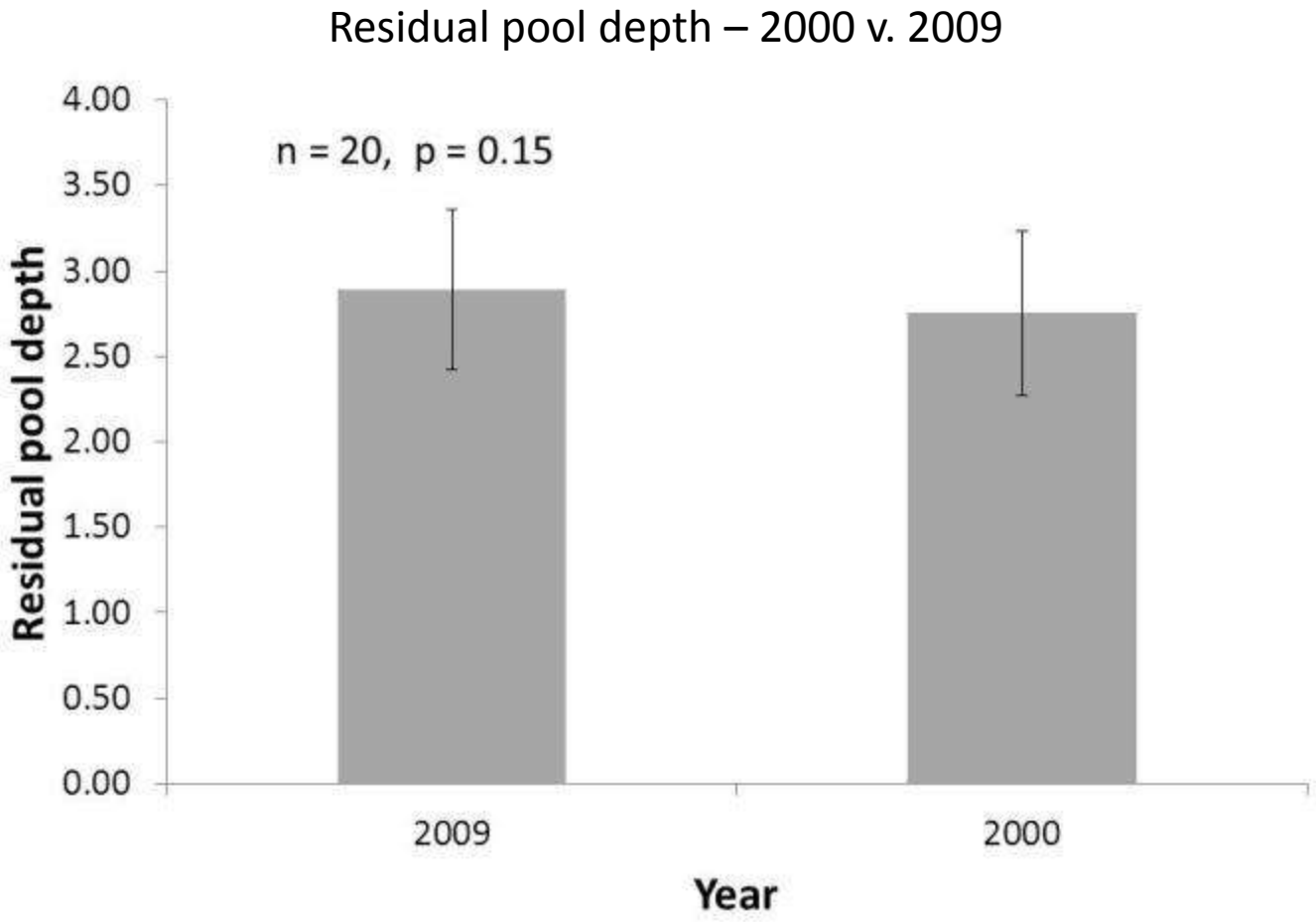
How does residual pool depth vary by spatial location pre dam removal?

Lower & Middle Elwha



Residual pool depth

How does residual pool depth vary by year pre dam removal?



Residual pool depth

How will salmon populations change with the removal of the Elwha River dams?

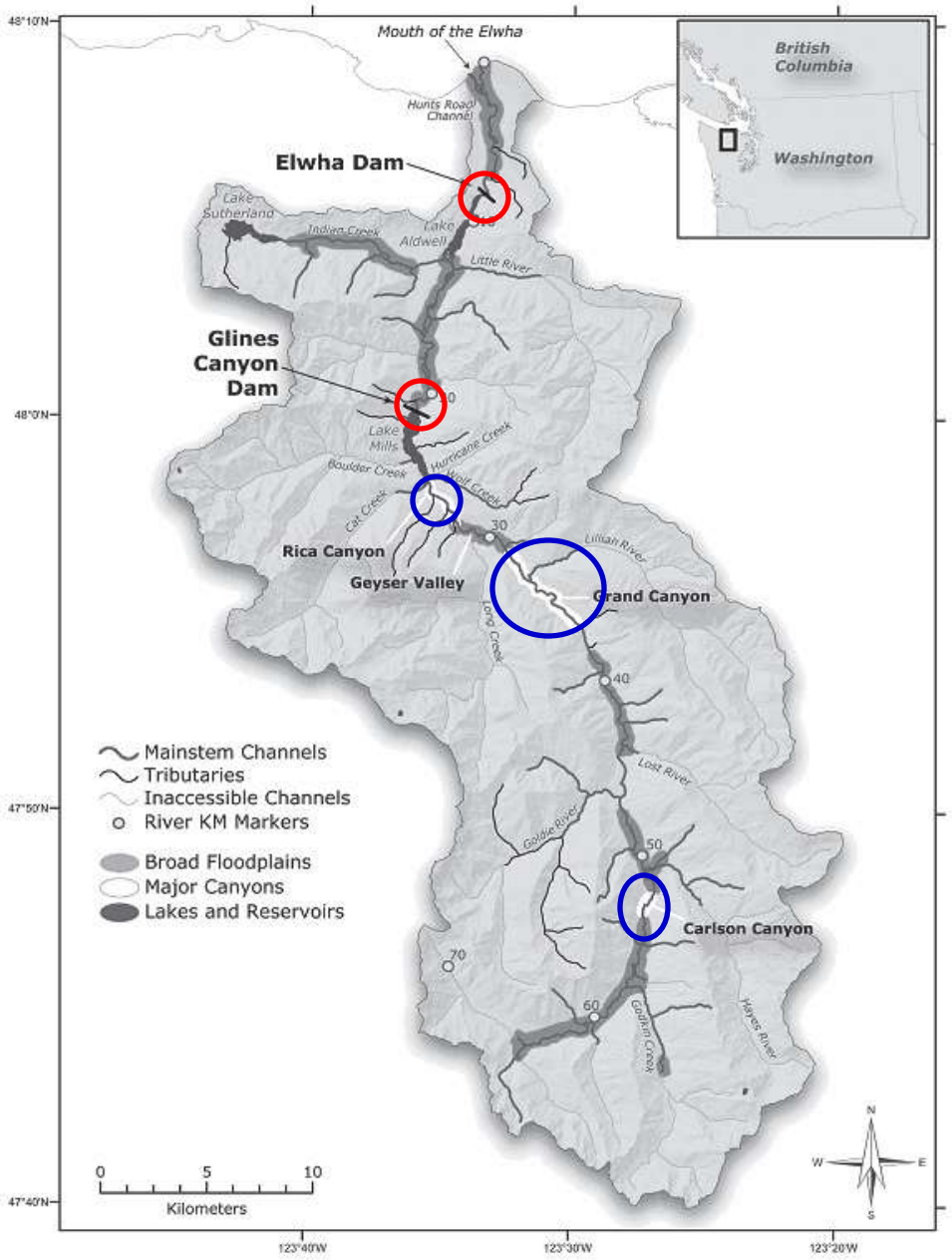
- How long will it take salmon to colonize?
- What habitats and locations will different salmon species colonize?
- How many more salmon will there be?

- Barriers
- Source population size
- Distance from source
- Source stray rate
- Colonizing productivity
- Habitat area & type
- Ocean conditions
- Resident species interaction
- Life history adaptations

Barriers

= dams

= canyons

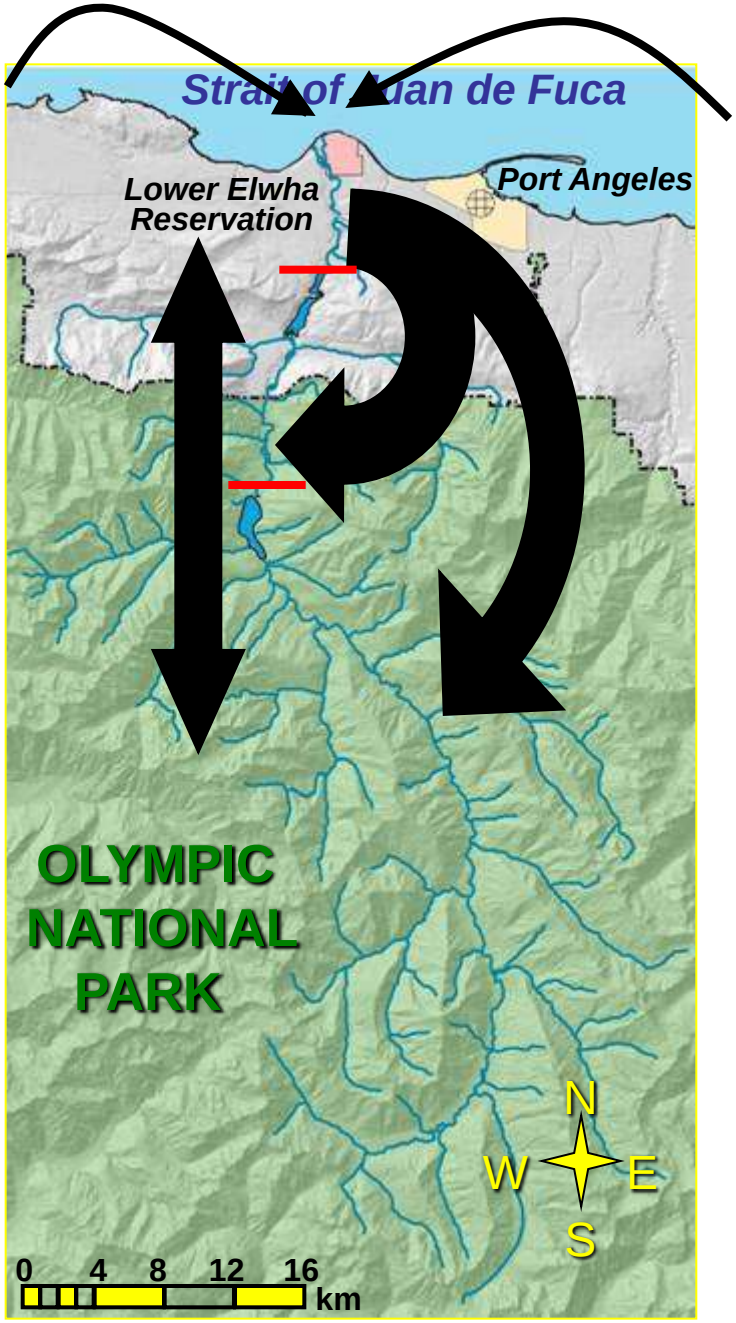


Source population size

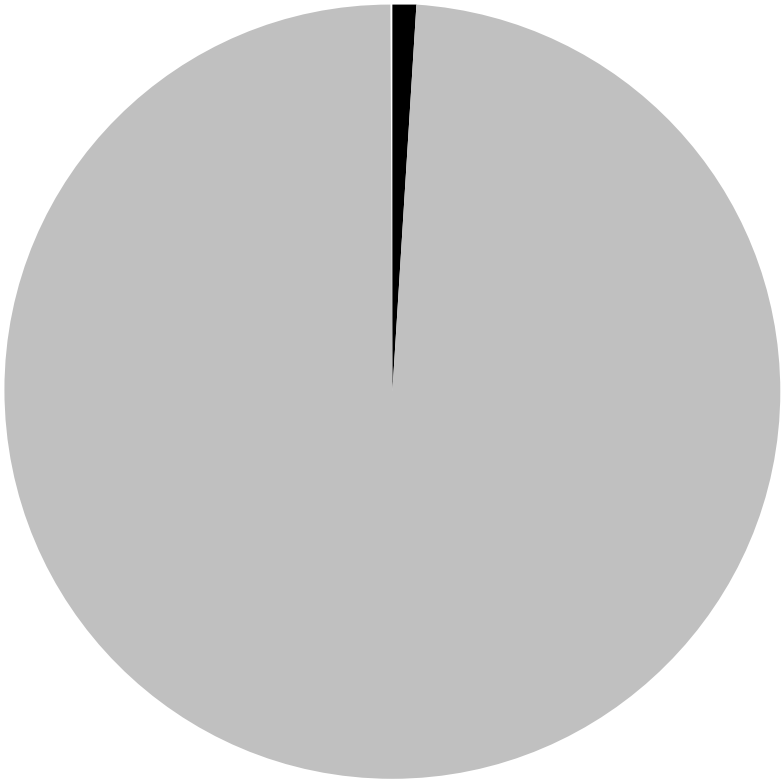
Species	Population size below dams	% Hatchery
Spring Chinook	Unknown	Unknown
Summer/Fall Chinook	~1,500	~75 (?)
Coho	~2,000	~76 (?)
Chum	~100	0
Pink	~100	0
Sockeye	~25	0
Winter steelhead	~500	?
Summer steelhead	~50	?
Sea-run cutthroat	Unknown	0
Char	~500	0

Distance from source population

- Chinook & coho
- Pink & chum
- Sockeye, Steelhead/rainbow, char, & cutthroat



Source population size & stray rate



Population size – 10,000

Stray rate – 1%

strays - 100

Black – strays

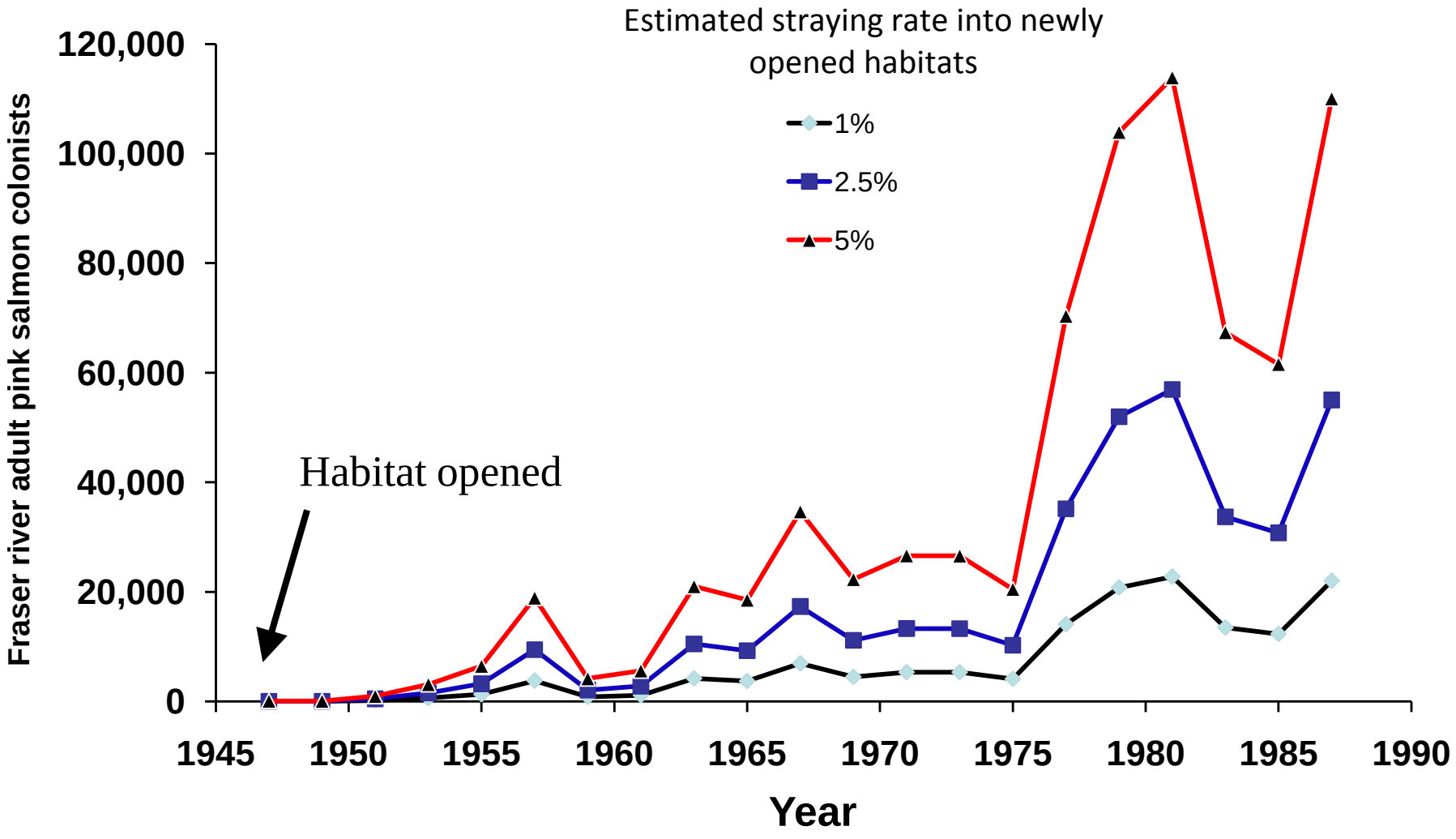
Grey - homed

Population size – 1,000

Stray rate – 10%

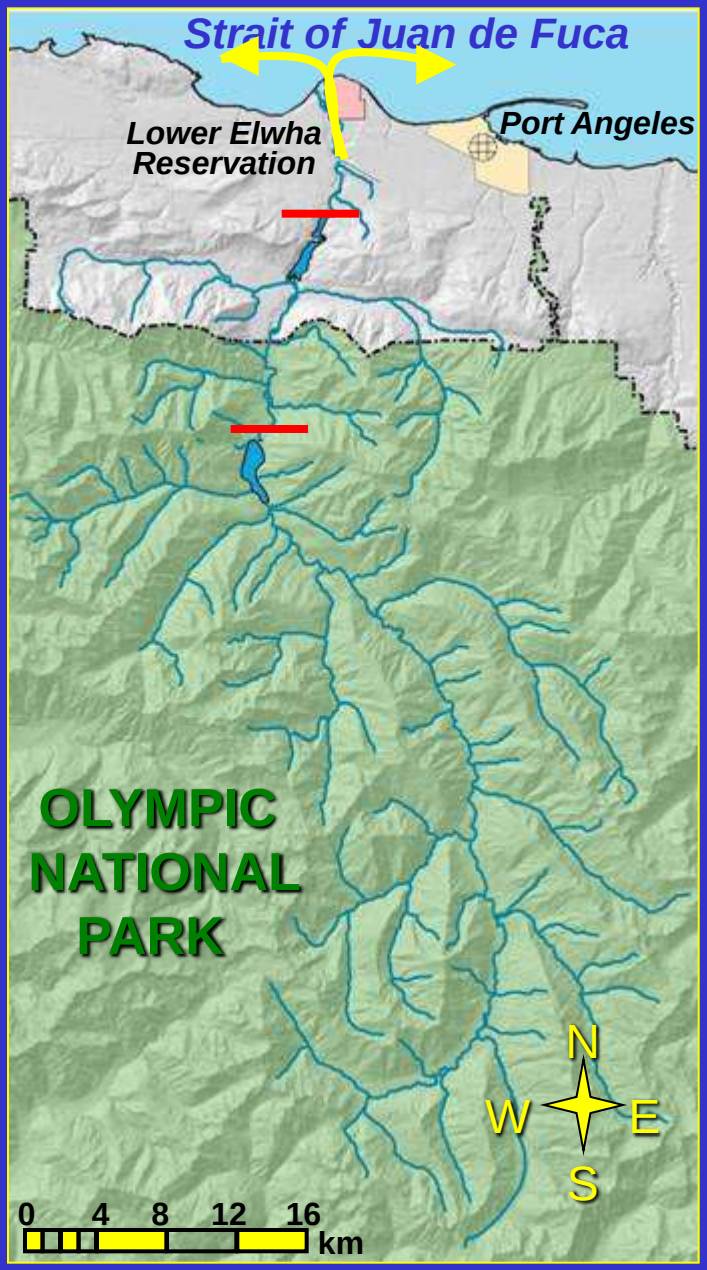
strays - 100

Source stray rate will be a large driver in determining the number of colonists

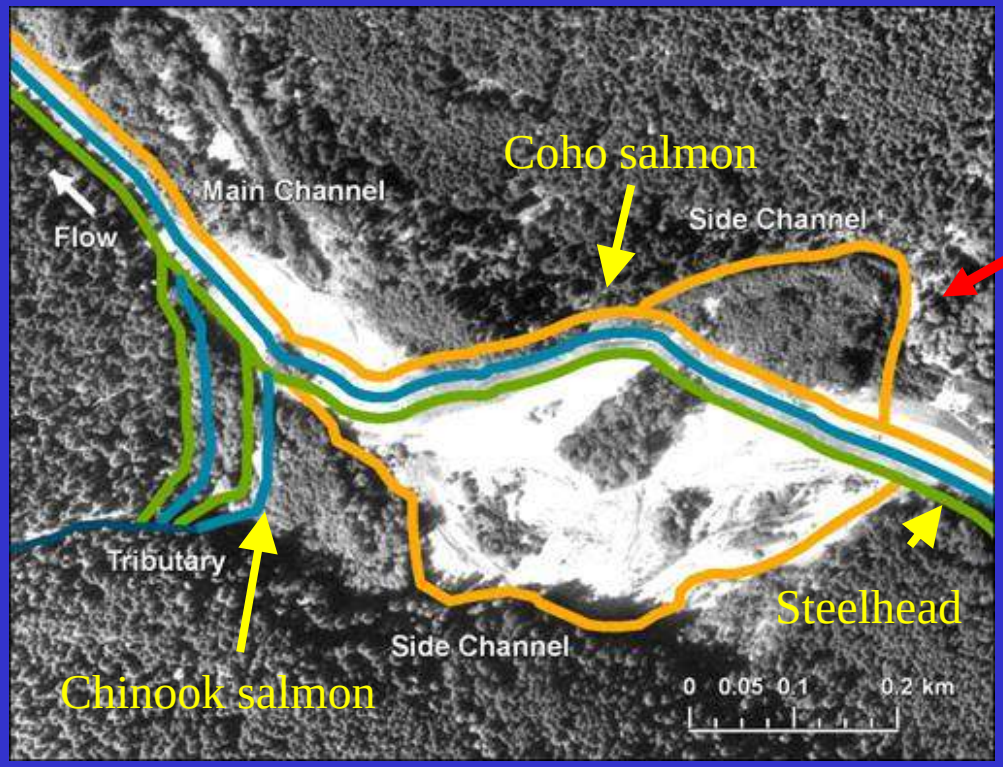


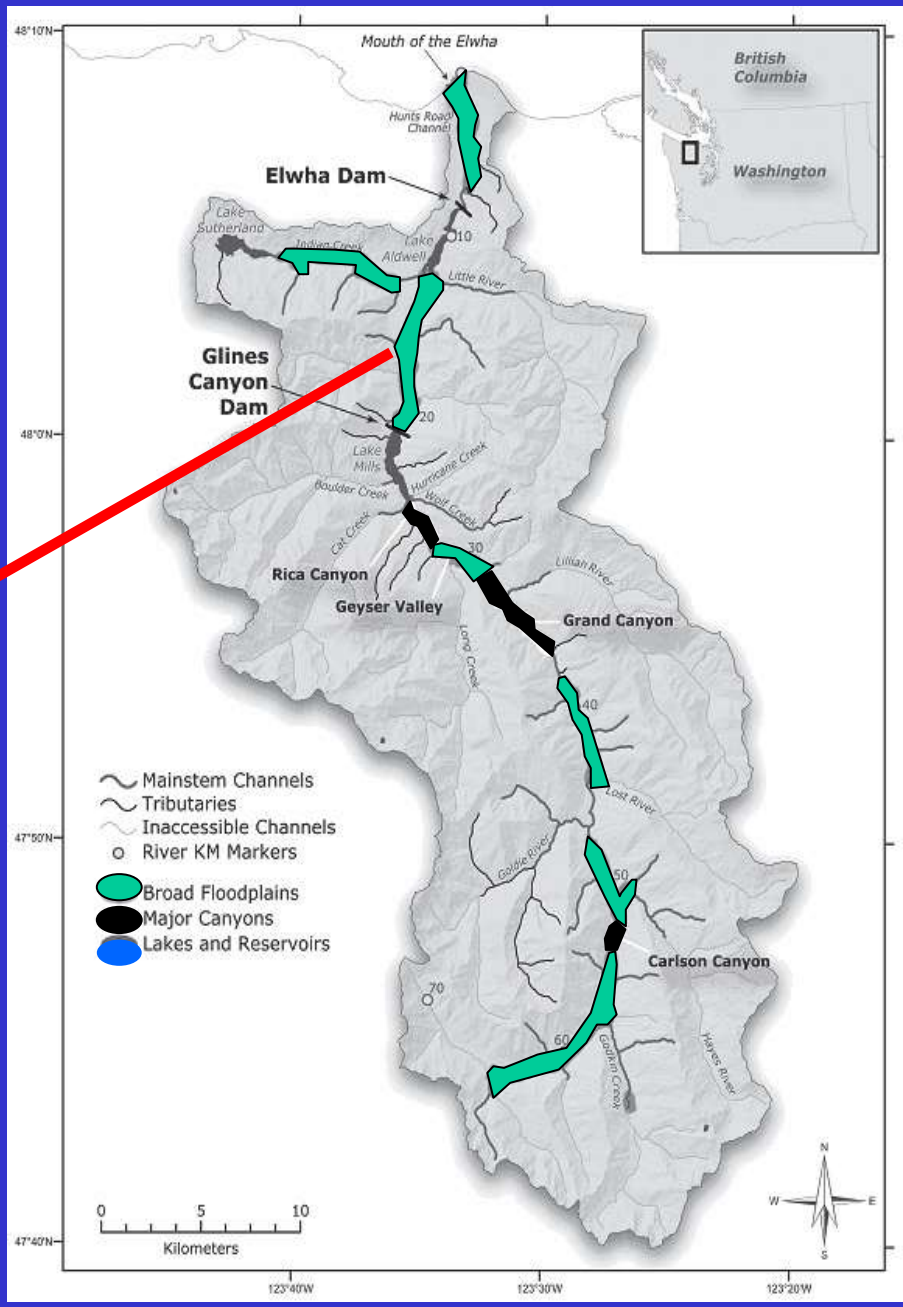
Straying away from sediment source

- High sediment load in a short time period
  - Deleterious effects on salmon
- Straying away from Elwha
- Mt. St. Helens
  - Stray rates increased from 16% to 45%

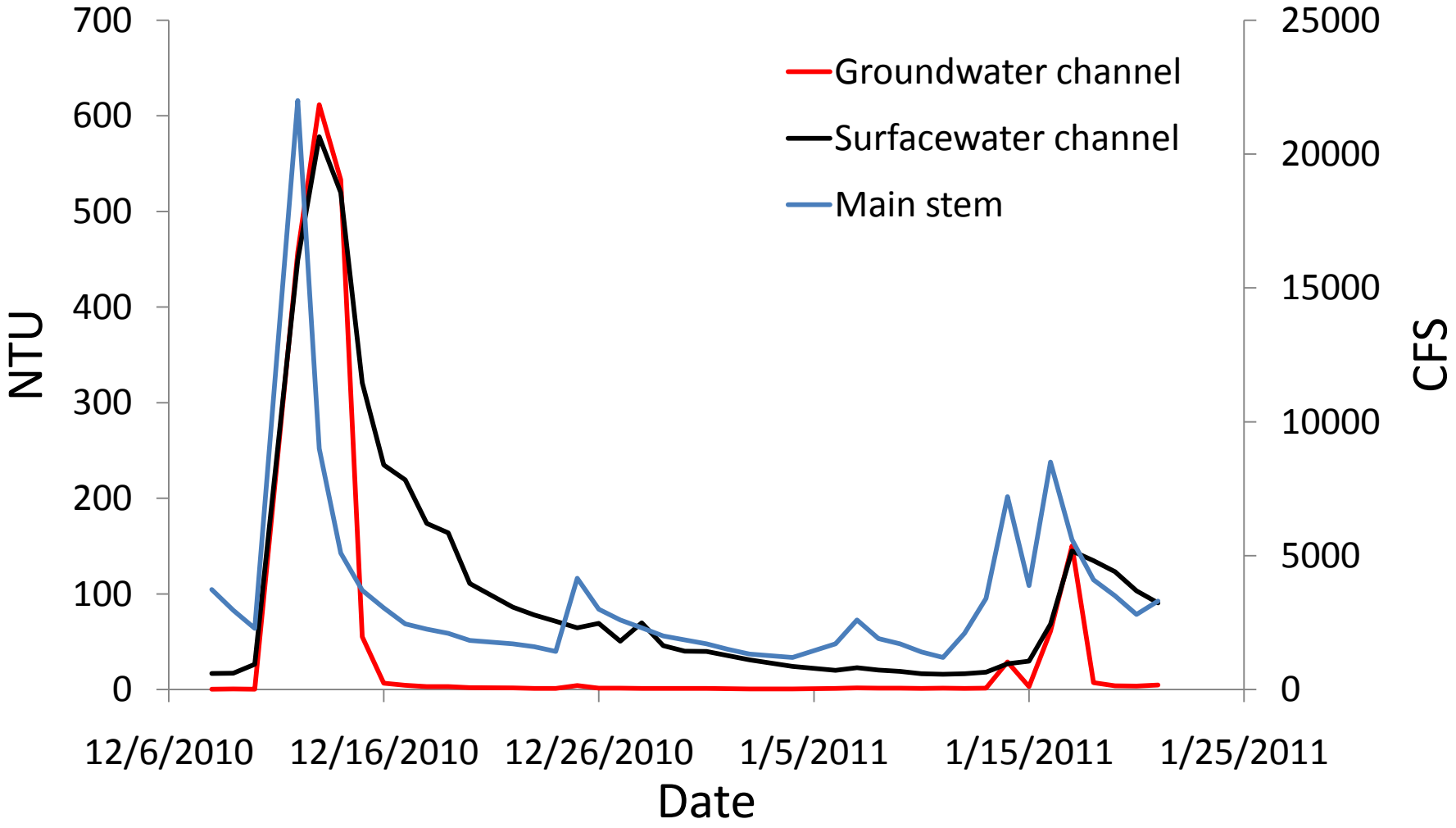


Turbidity & the buffering effects of floodplains





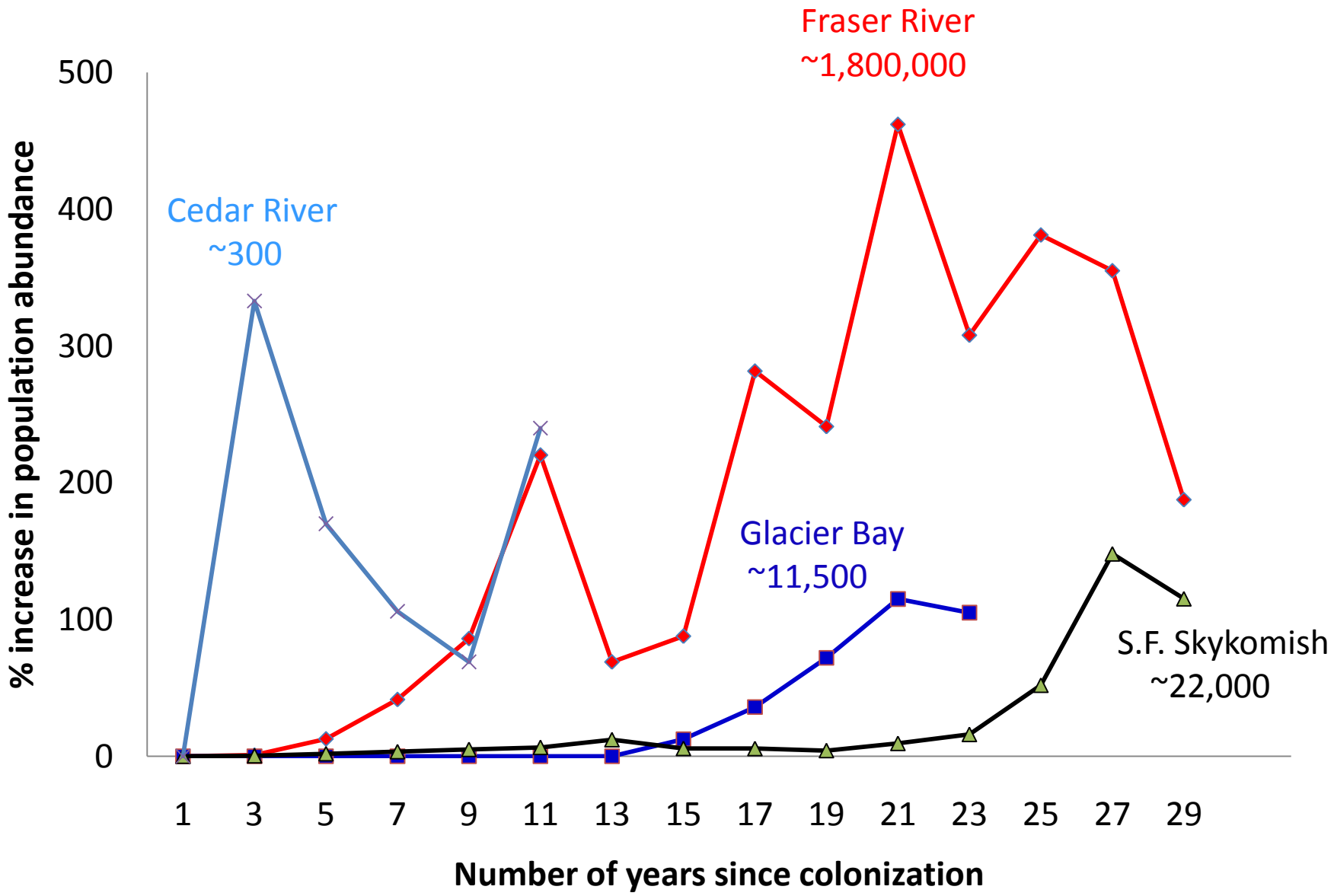
Turbidity & the buffering effects of floodplain channels



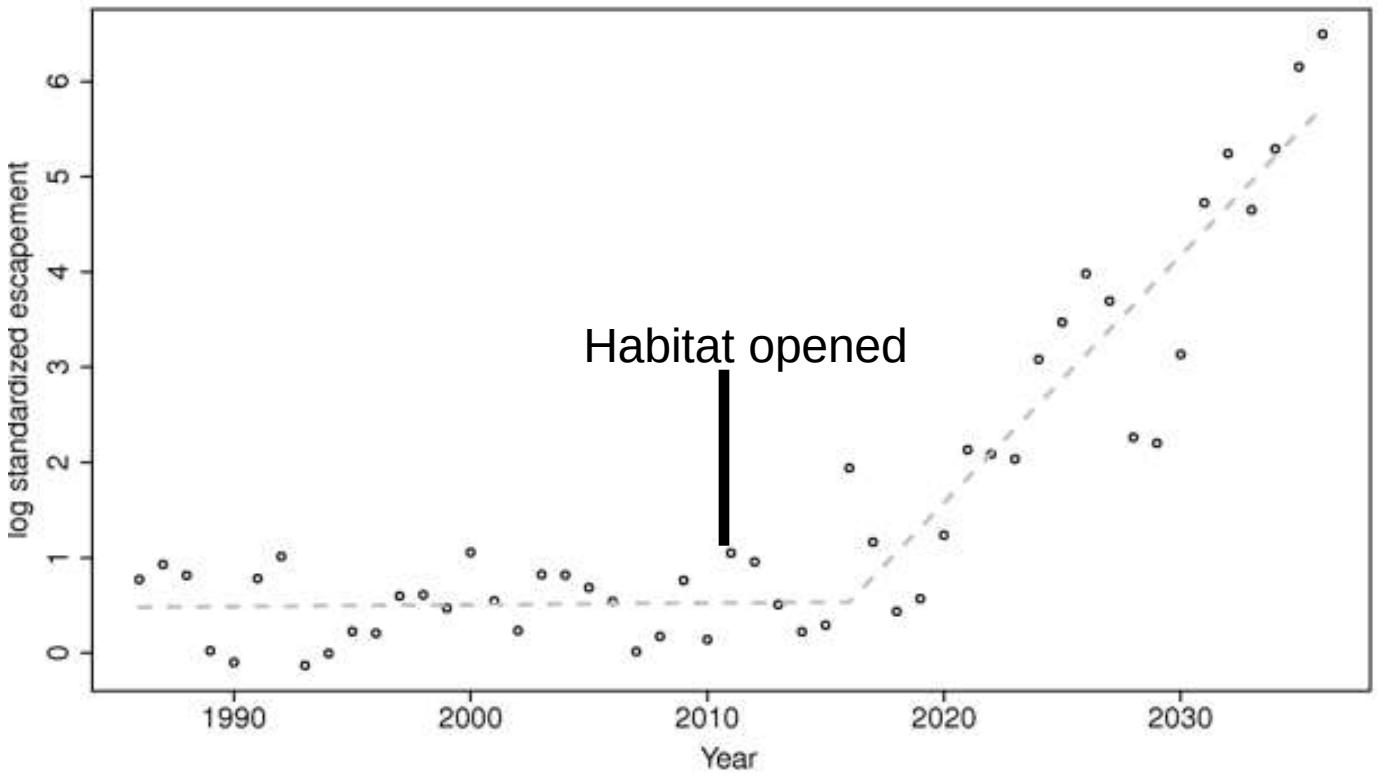
Colonizing productivity

Species	Location	Population growth rate (r)
Pink salmon	Fraser River (Above Hell's Gate), British Columbia, Canada	1.18
Pink salmon	Glacier Bay, Southeast Alaska	2.01
Pink salmon	South Fork Skykomish, Puget Sound, Washington State	1.18
Coho salmon	Cedar River, Puget Sound, Washington State	2.08
Chinook salmon	Cedar River, Puget Sound, Washington State	1.95
Chinook salmon	South Fork Skykomish, Puget Sound, Washington State	1.28

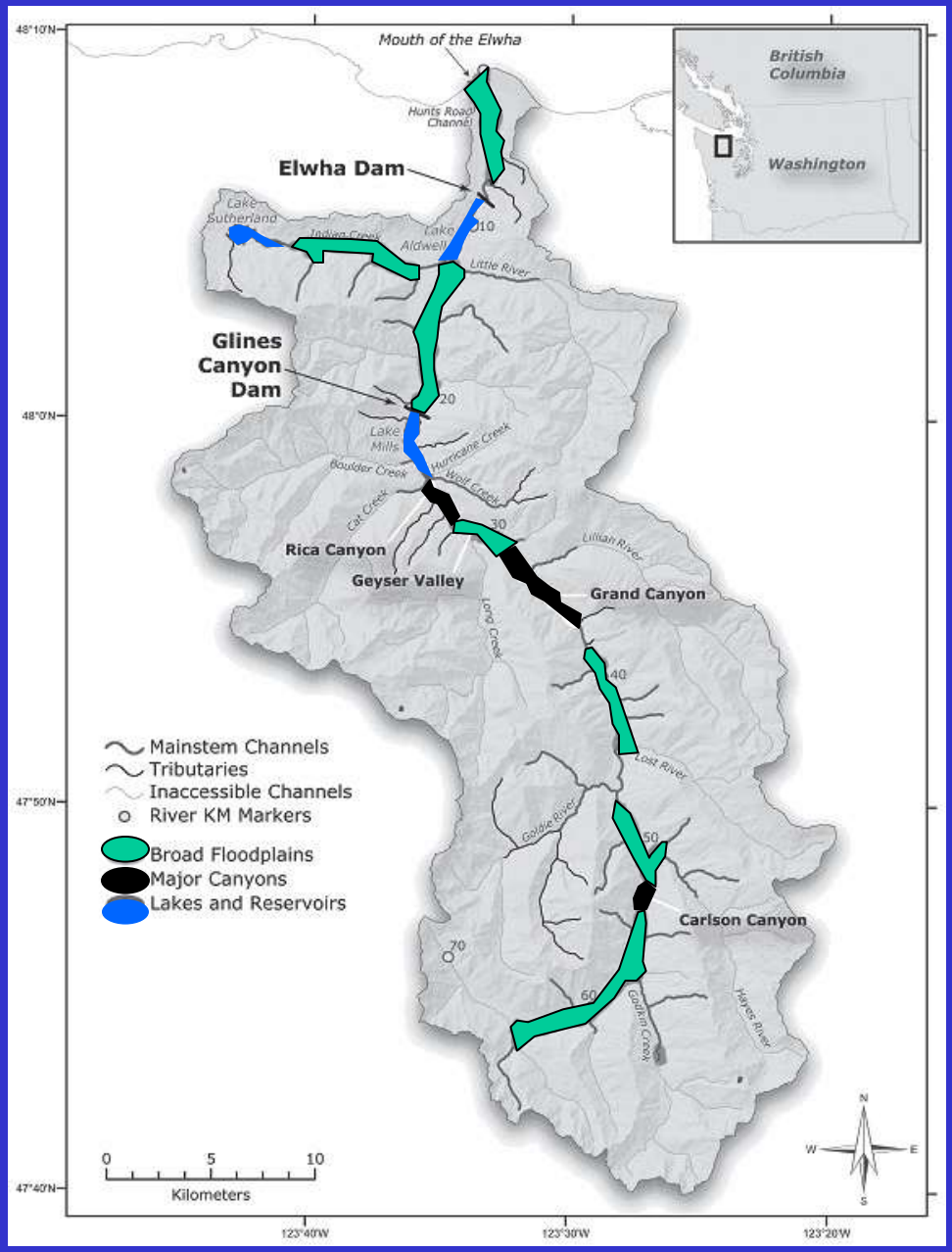
Colonizing productivity & successful colonization



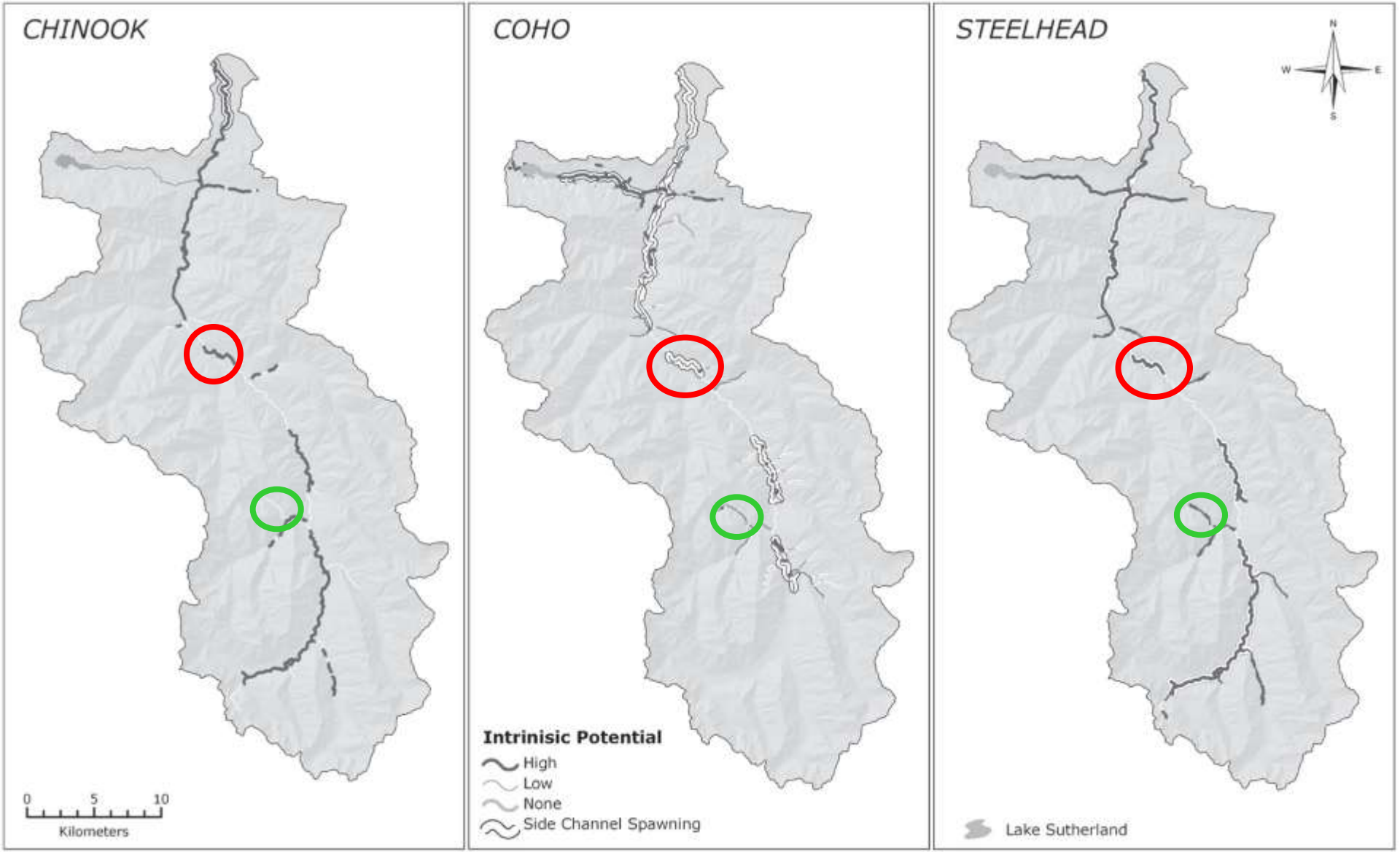
Colonizing productivity & modeled Chinook salmon response in the Elwha River



Elwha habitat area and type



Elwha River salmon redistribution

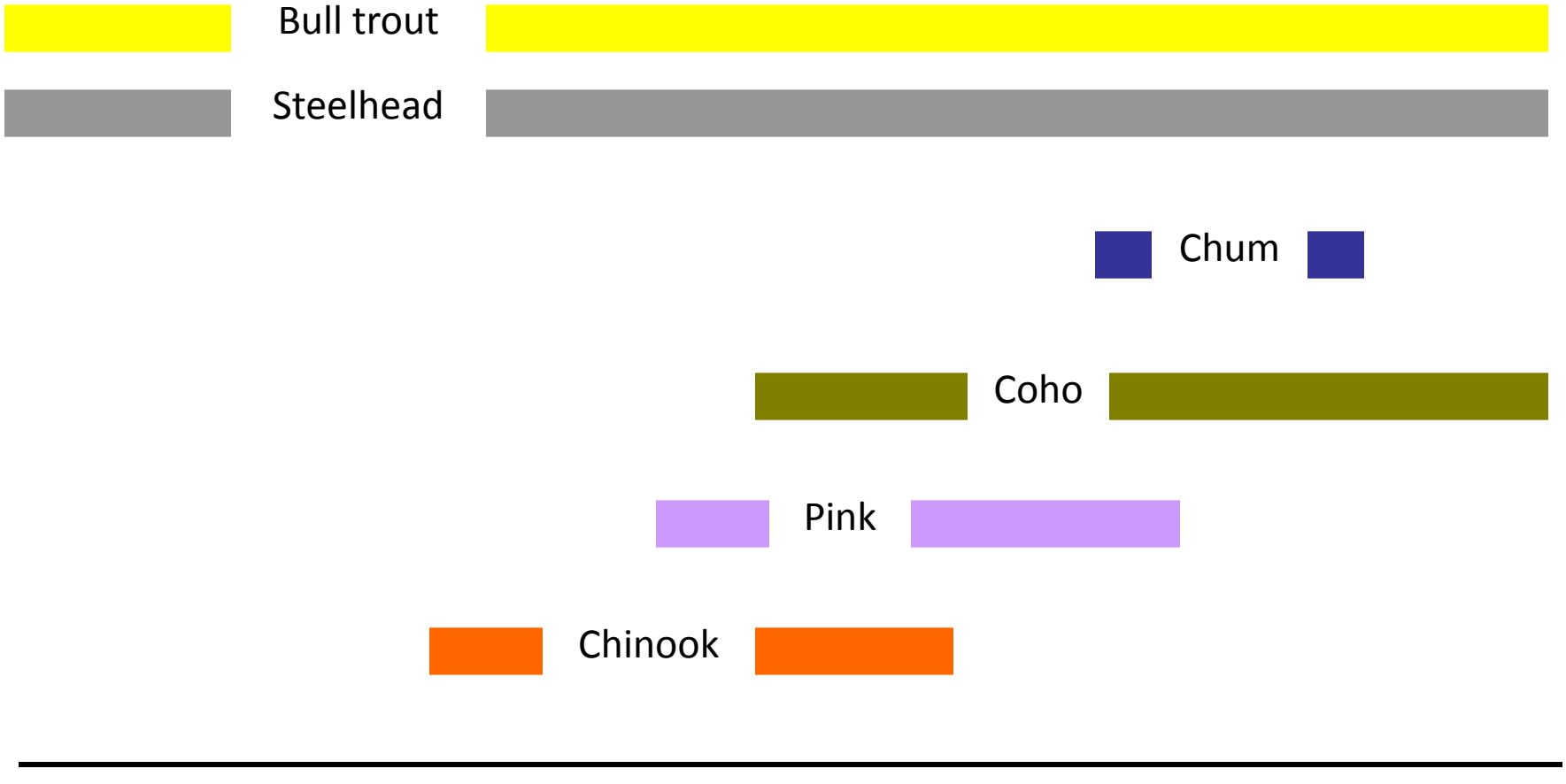


Elwha adult & juvenile enumeration

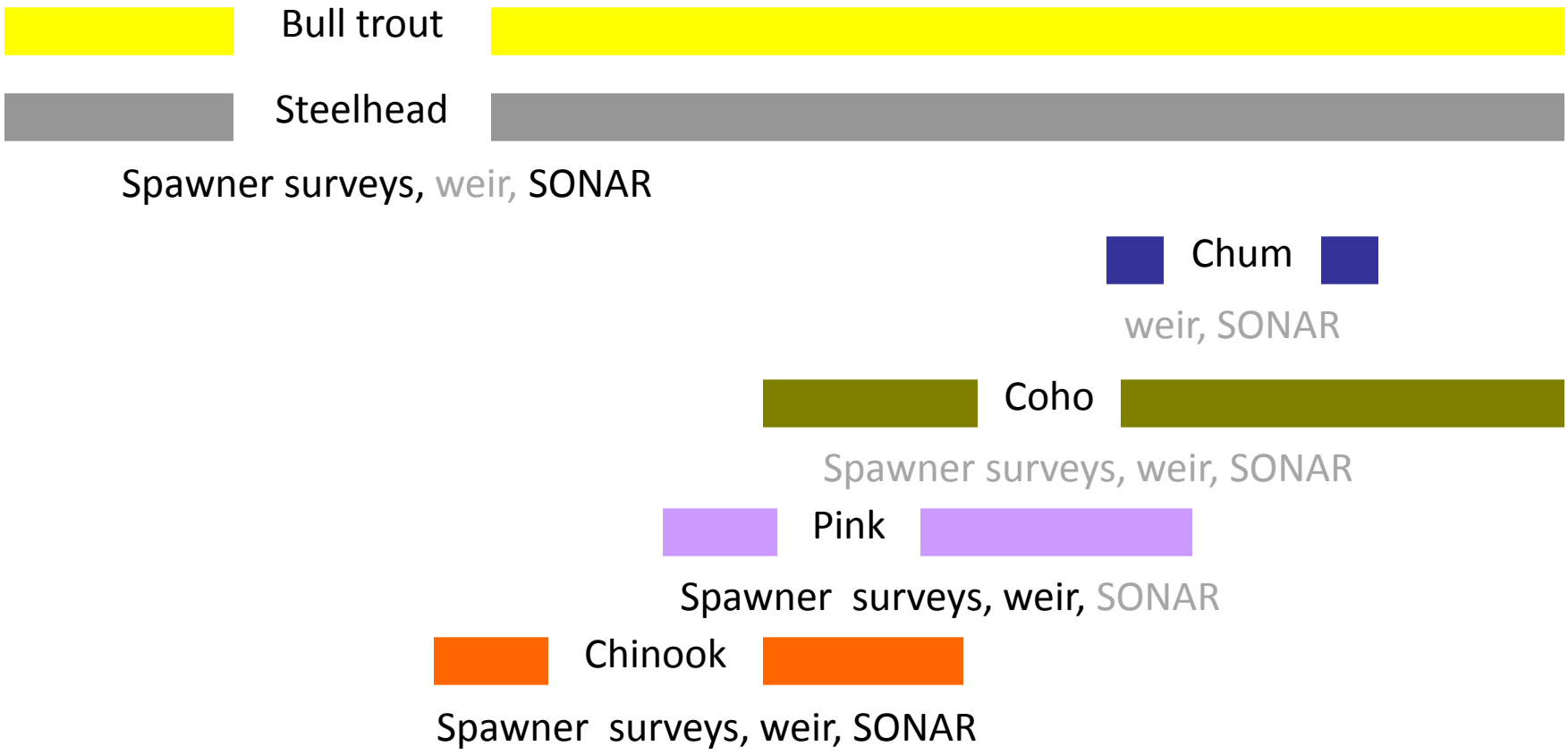
- Redd surveys
- SONAR
- Fish weir
- Snorkel surveys
- Smolt trap
- Various juvenile sampling
  - Snorkel
  - Seine
  - E-fishing

Photos by John McMillan

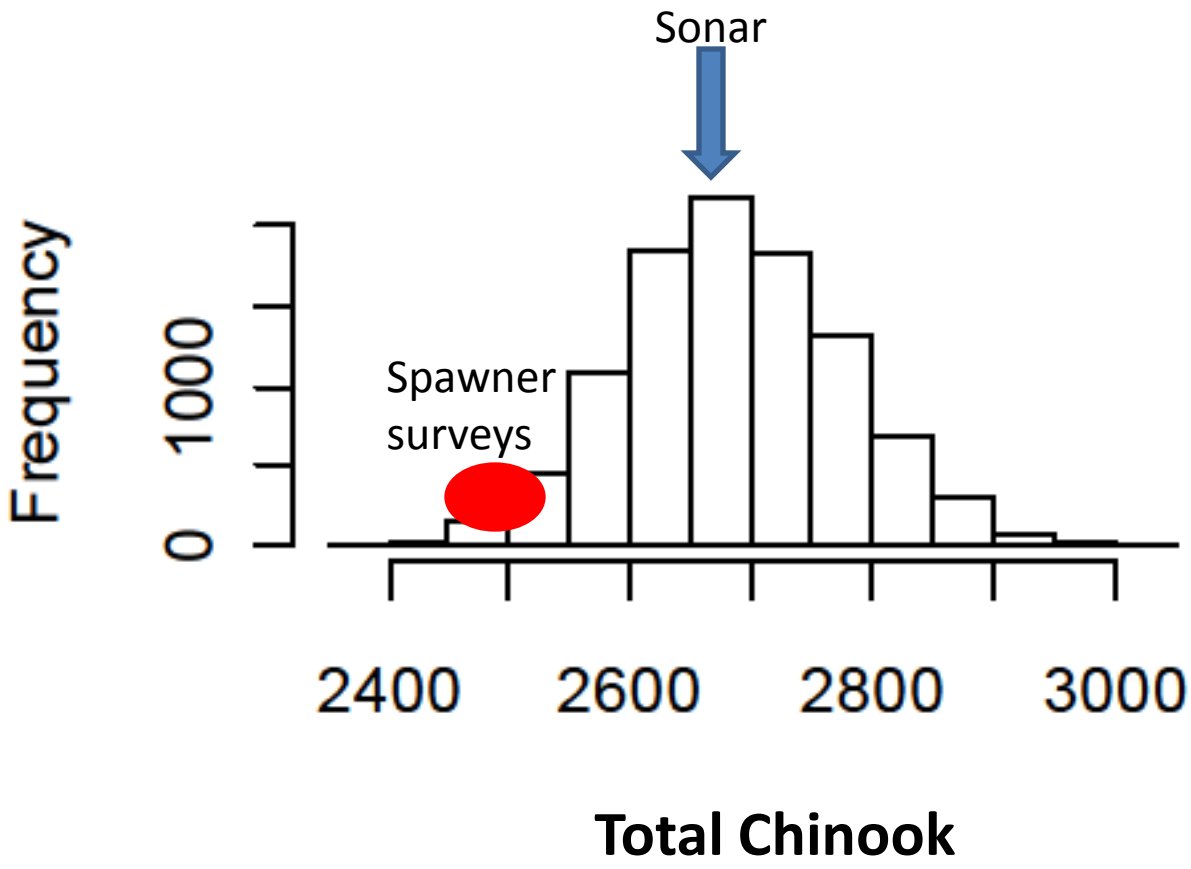
Elwha Adult Residence



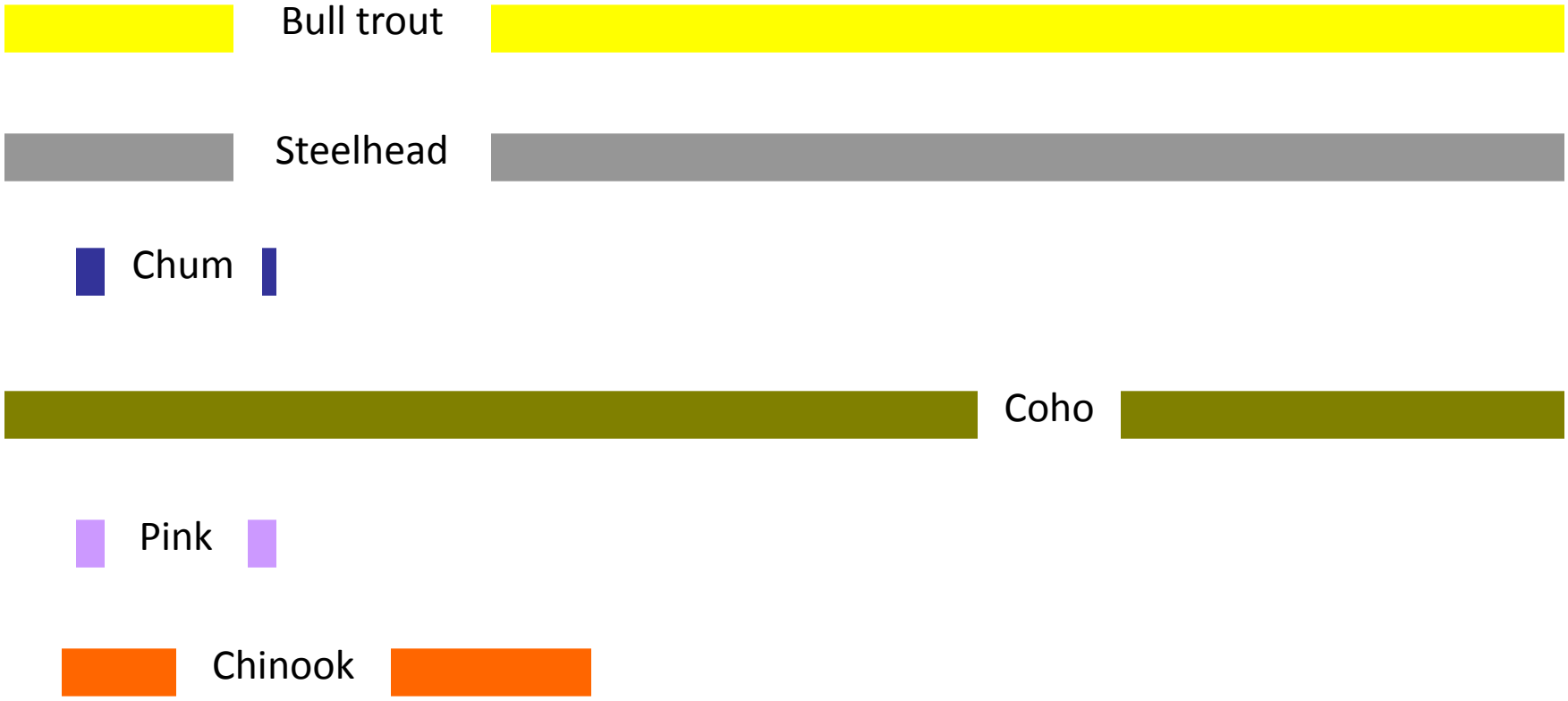
Elwha Adult Residence



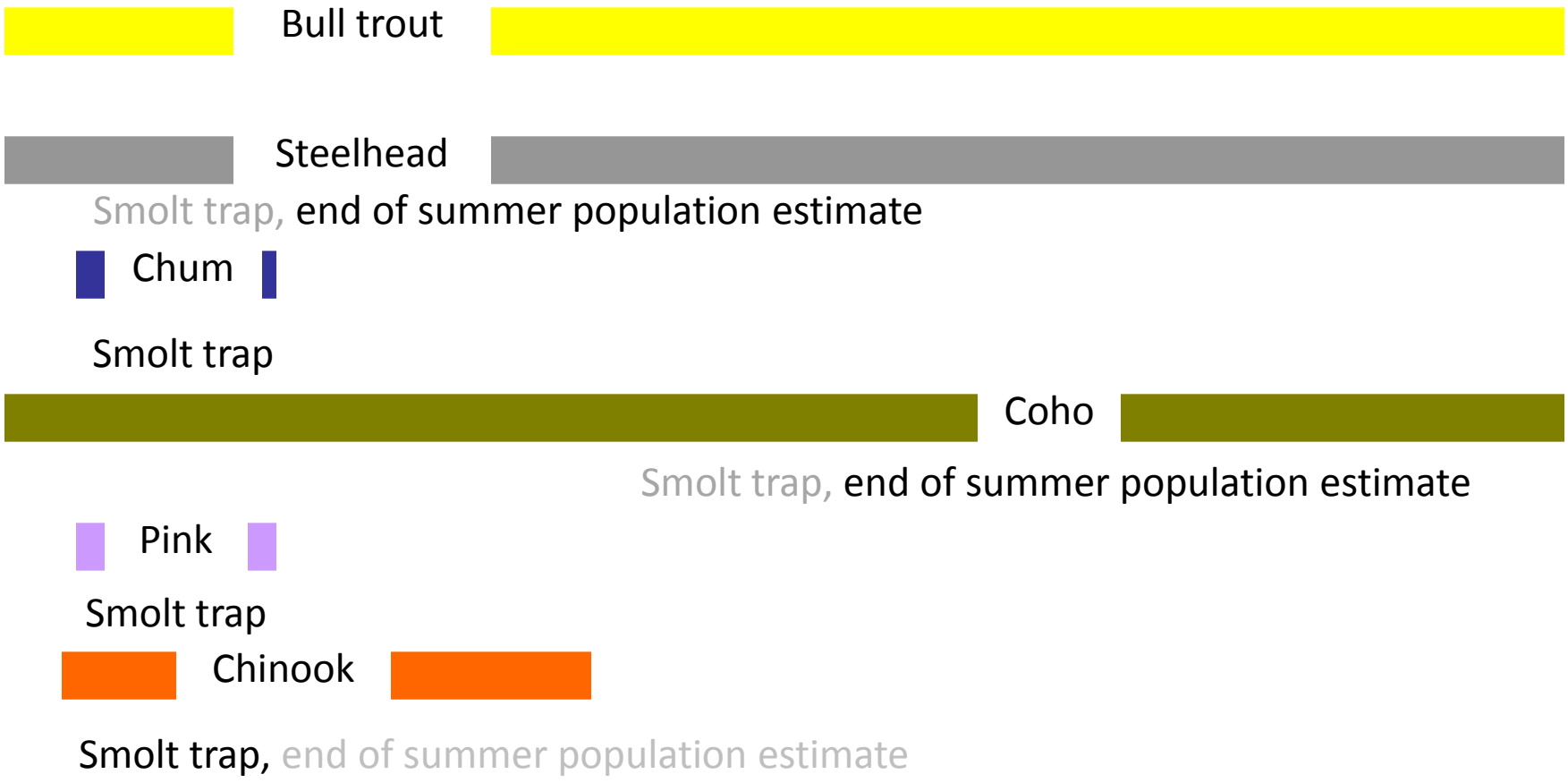
Chinook SONAR v. redd count



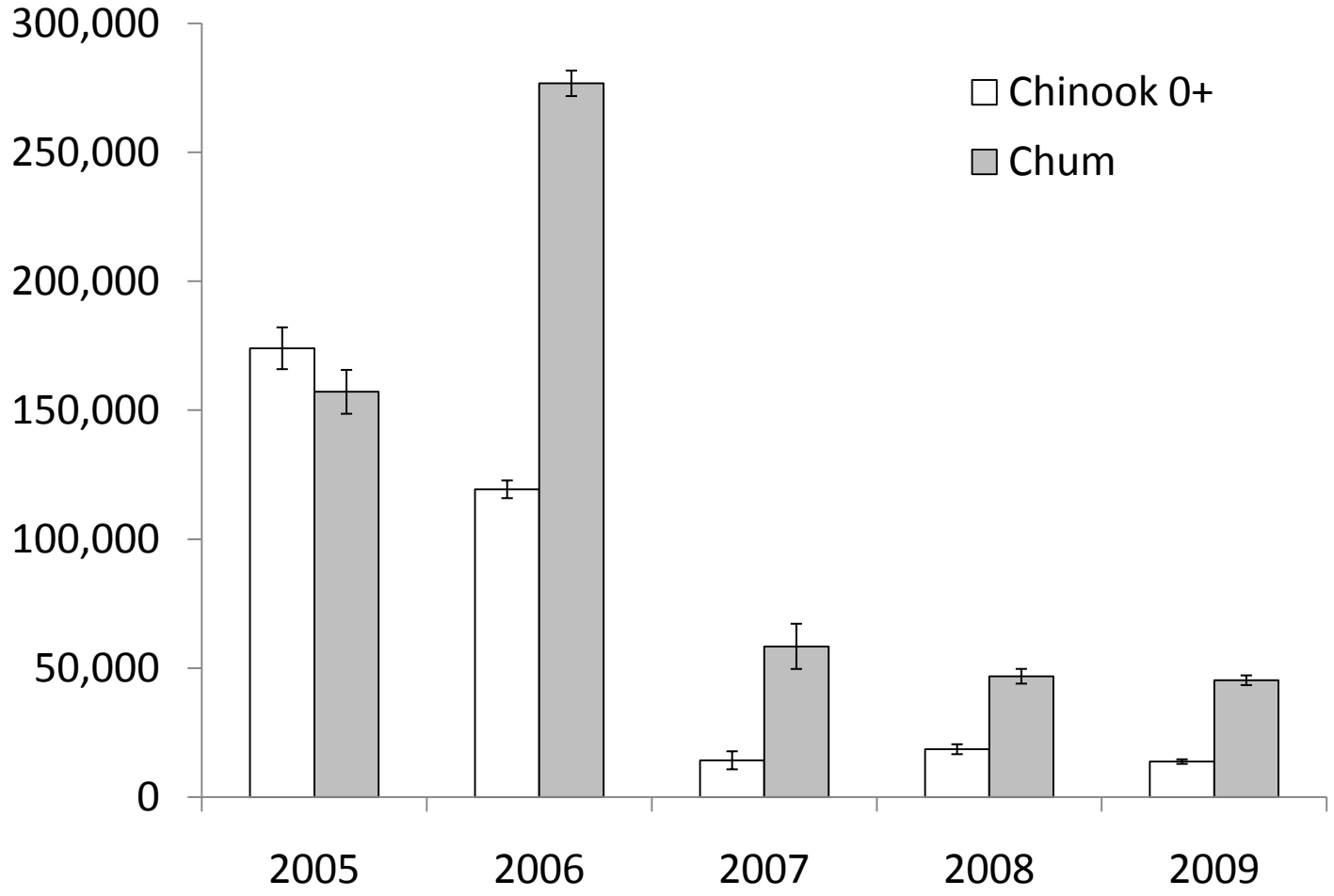
Elwha Juvenile Residence



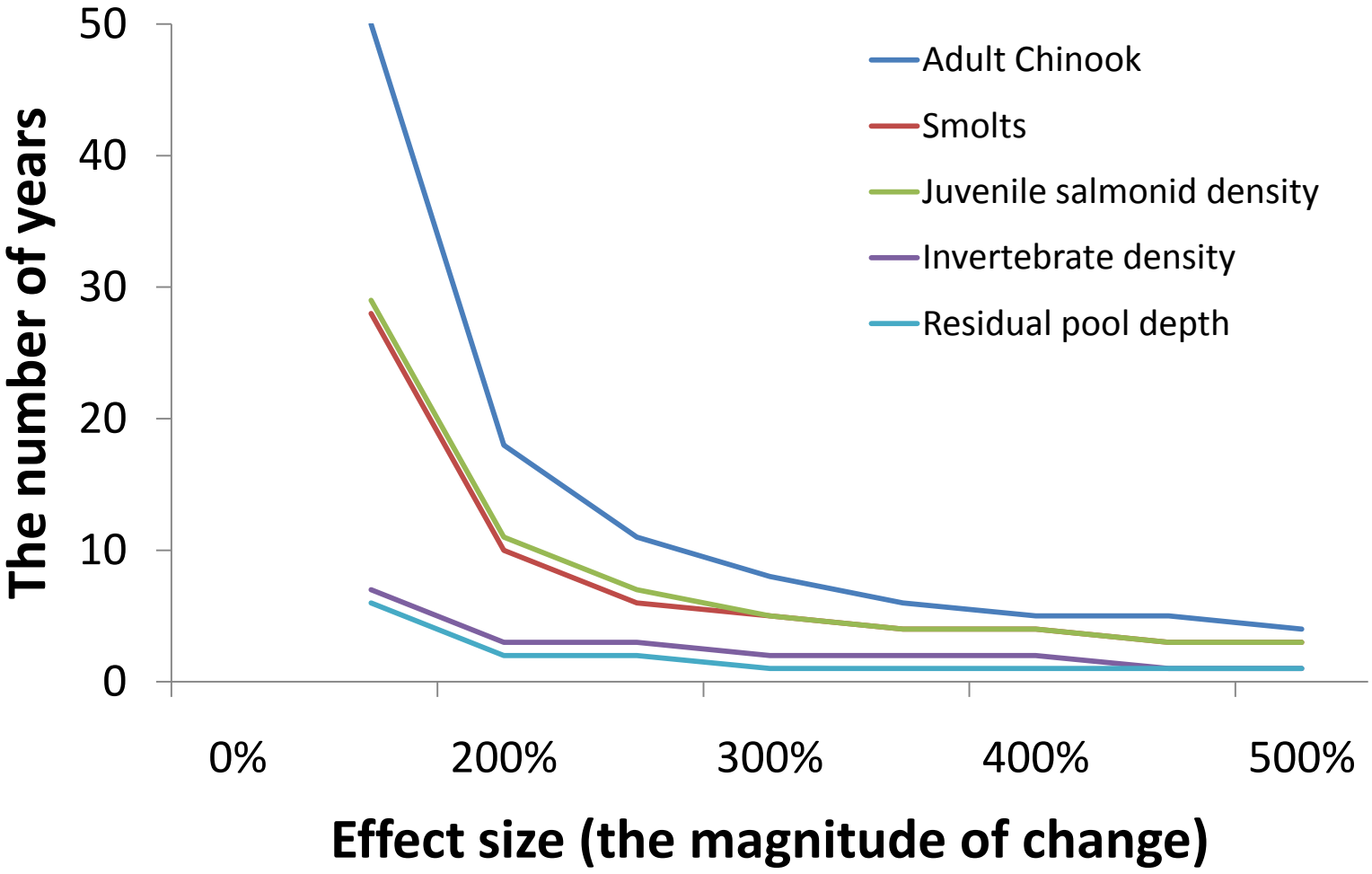
Elwha Juvenile Residence



Elwha river smolt production



How many years until we can detect change due to dam removal?



Elwha River hypotheses summary

- Side channels will act as either;
  - biological refuge
  - sediment repository.
- Primary & secondary productivity
  - Initial decrease – sediment
  - Long term increase – marine derived nutrients & detrital input
- Salmonids will establish self sustaining populations in the middle & upper Elwha

If you forget everything else…

- We don't need to teach an ecosystem what to do. We just need to give it the opportunity to do it.

Acknowledgements

Collaborators

NWFSC – Todd Bennett, Holly Coe,Kurt Fresh, Daniel Hernandez, Kris Kloehn, Gary Winans, Kinsey Frick, Brian Burke

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Bureau of Reclamation – Tim Randle, Jennifer Bountry

U.S. Fish & Wildlife Service - Brad Thompson

U.S. Geological Survey - Jason Dunham, Joe Peterson, Pat Shafroth, Chris Konrad

WDFW – Mike Gross, Dan Rawding

Support

NOAA Fisheries – NWFSC

NOAA Fisheries – Restoration Center, Open Rivers Initiative

Lower Elwha Tribe, USFWS, USGS, NPS

For today's talk - National Conference on Engineering and Ecohydrology for Fish Passage