Biological planning considerations for wood placement in large rivers

Photo courtesy of Roger Peters

Photo courtesy of John McMillan

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Questions

- How do you determine from a biological perspective if wood placement is necessary?

- How do you manage "expectations" and not over or undersell the potential results?

Photo courtesy of John McMillan

How do you determine from a biological perspective if wood placement is necessary?

- Does the lack of wood limit fish production, biotic diversity, or food resources at a reach or watershed scale?
- Limiting factors analysis
- Are there results from other studies that measure potential biological or physical response with similar actions?
- Empirical results using literature & extrapolation

Using limiting factors to determine if a lack of wood "limits" fish production at a reach or watershed scale

- Limiting factors analysis or"Law of the minimum"
  - Growth of an organism is controlled by the scarcest resource, not by the total of resources available.

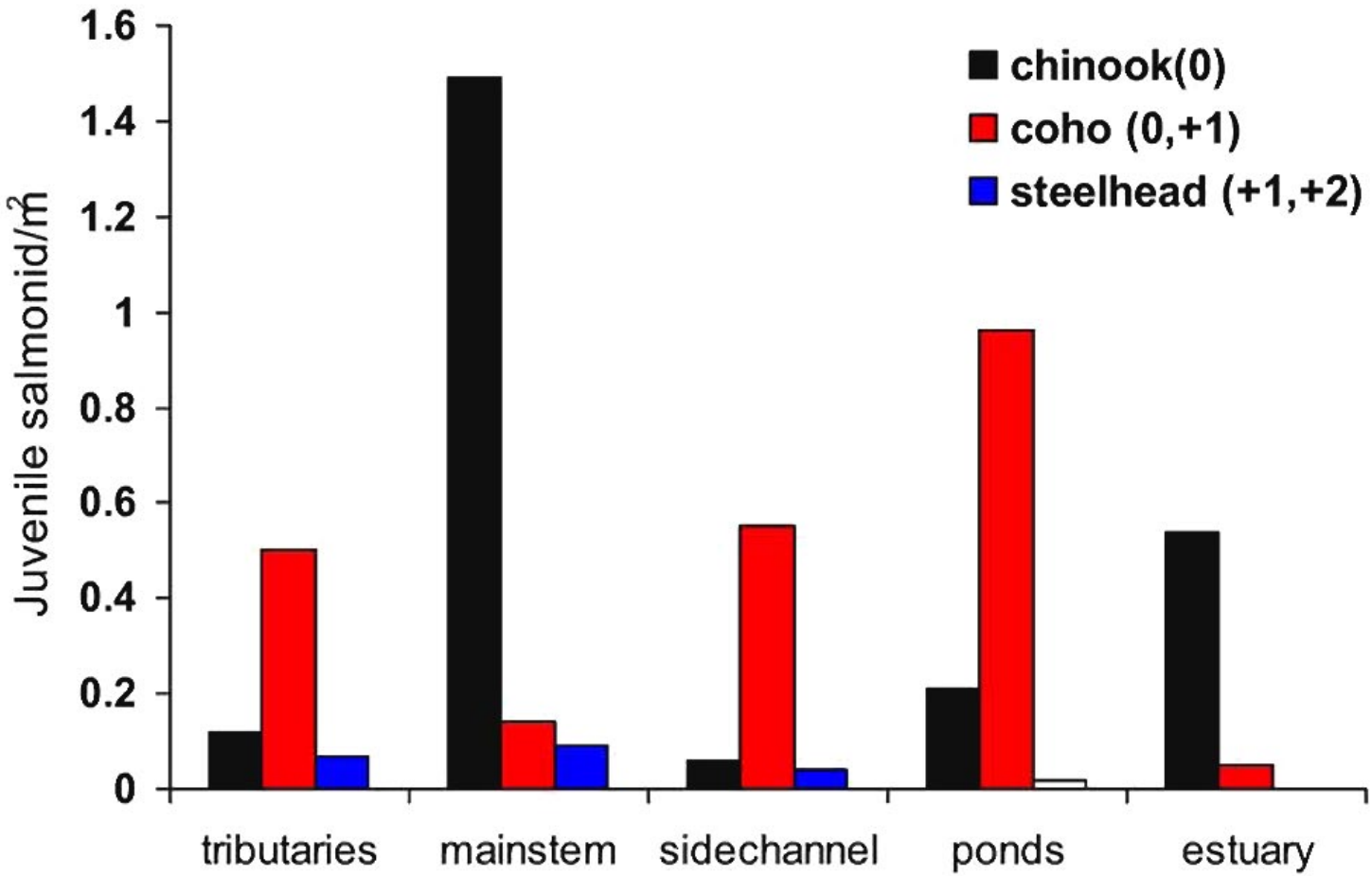
- Used in 19th century agriculture
  - P or N-limited

- Hankin & Reeves (1989) – extended idea to salmon
  - Compares capacity of different habitat types and quality
  - Assumes density-dependence can be limiting
  - Excludes procedures not yet or not well develop to integrate into analysis

Limiting factors analysis

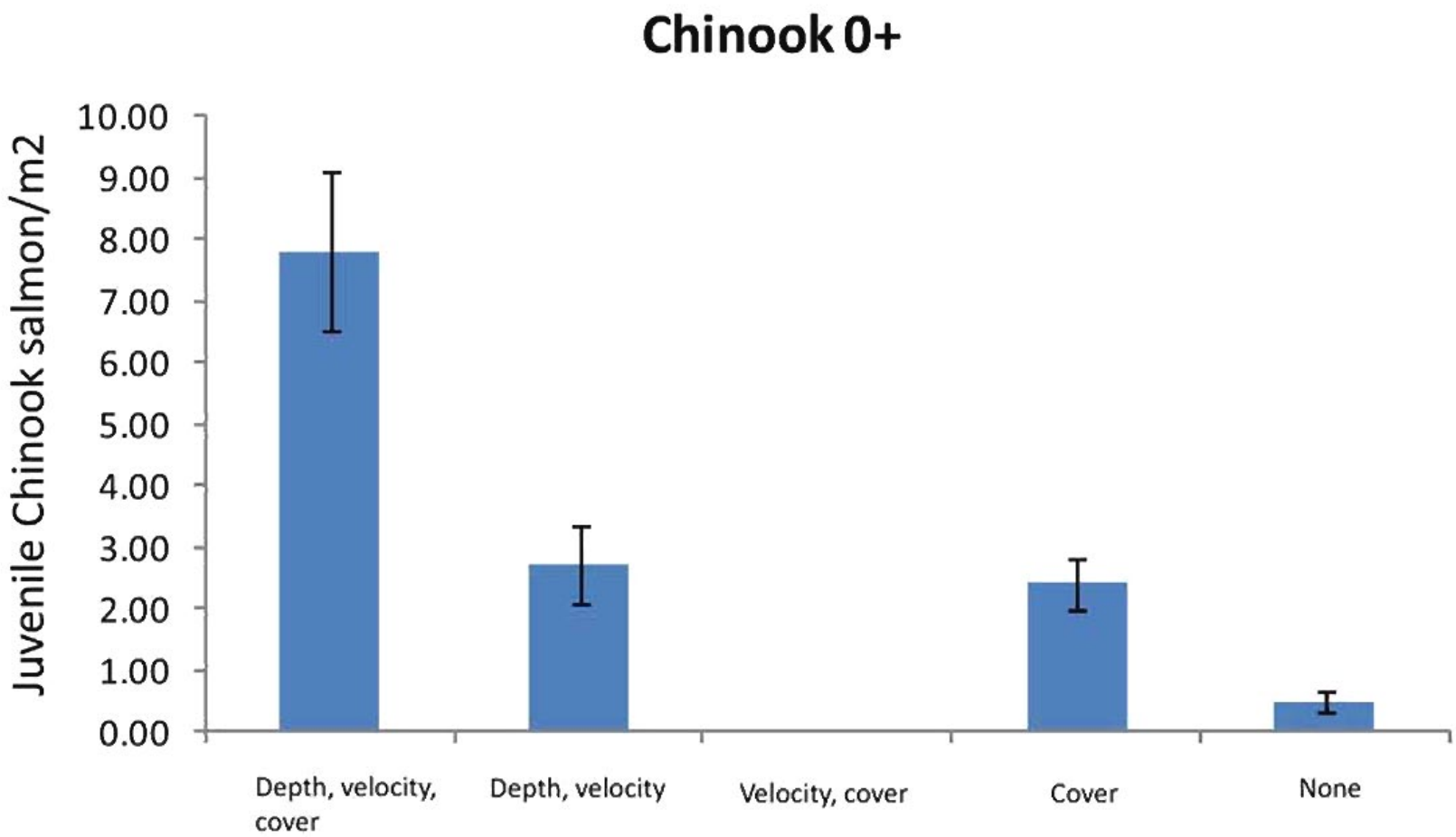
- Identify fish use by habitat type and/or quality for each life stage or season
- Classify habitat types and/or quality at the appropriate scale
  - Site (project), reach (Rkm x.x to y.y) or watershed (stream x)
- Multiply habitat types and/or quality with fish use
  - Mean
  - Distribution
- Sum habitat carrying capacity to identify current potential
  - Compare life stage differences
- Develop scenarios to compare current potential v. another point in time
  - Historic v. current
  - Current v. restored
- Compare virtual "before v. after" by location or "increase by restoration action" to assess relative change in habitat capacity & fish use

Fish use by habitat type and/or quality



Pess et al. 2002

Fish use by habitat type and/or quality



- Appropriate depth < 0.61m, appropriate velocity < 0.15m/sec, appropriate cover < 0.60m away.

Goodman et al. 2010

Classify habitat types and/or quality at the appropriate scale

Rkm X.X to Y.Y	Habitat area (m^2)			
	Depth, velocity, cover	Depth, velocity	Cover	None
Reach 1	1,023	810	891	17,696
Reach 2				
Reach 3				
Reach 4				
Reach 5				

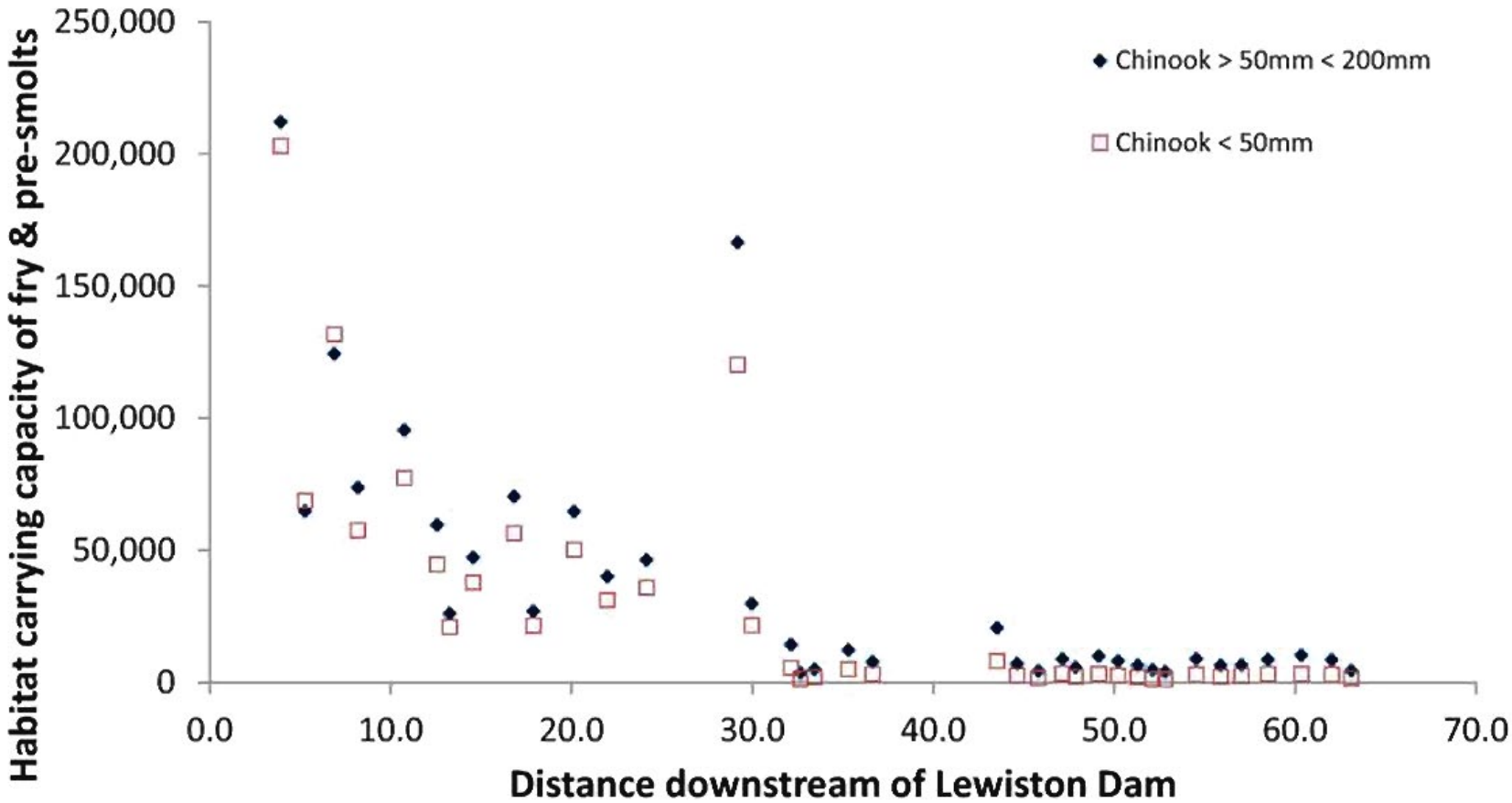
Multiplying existing habitat type and/or quality with fish use

Rkm X.X to Y.Y	Habitat area (m^2)			
Fish density (fish/m^2)	D,V,C	D,V,NC	ND,NV,C	ND,NV,NC
(1,000 times)	1,023	810	891	17,696
8.72				
6.43				
7.77				

…….to get average & sd for

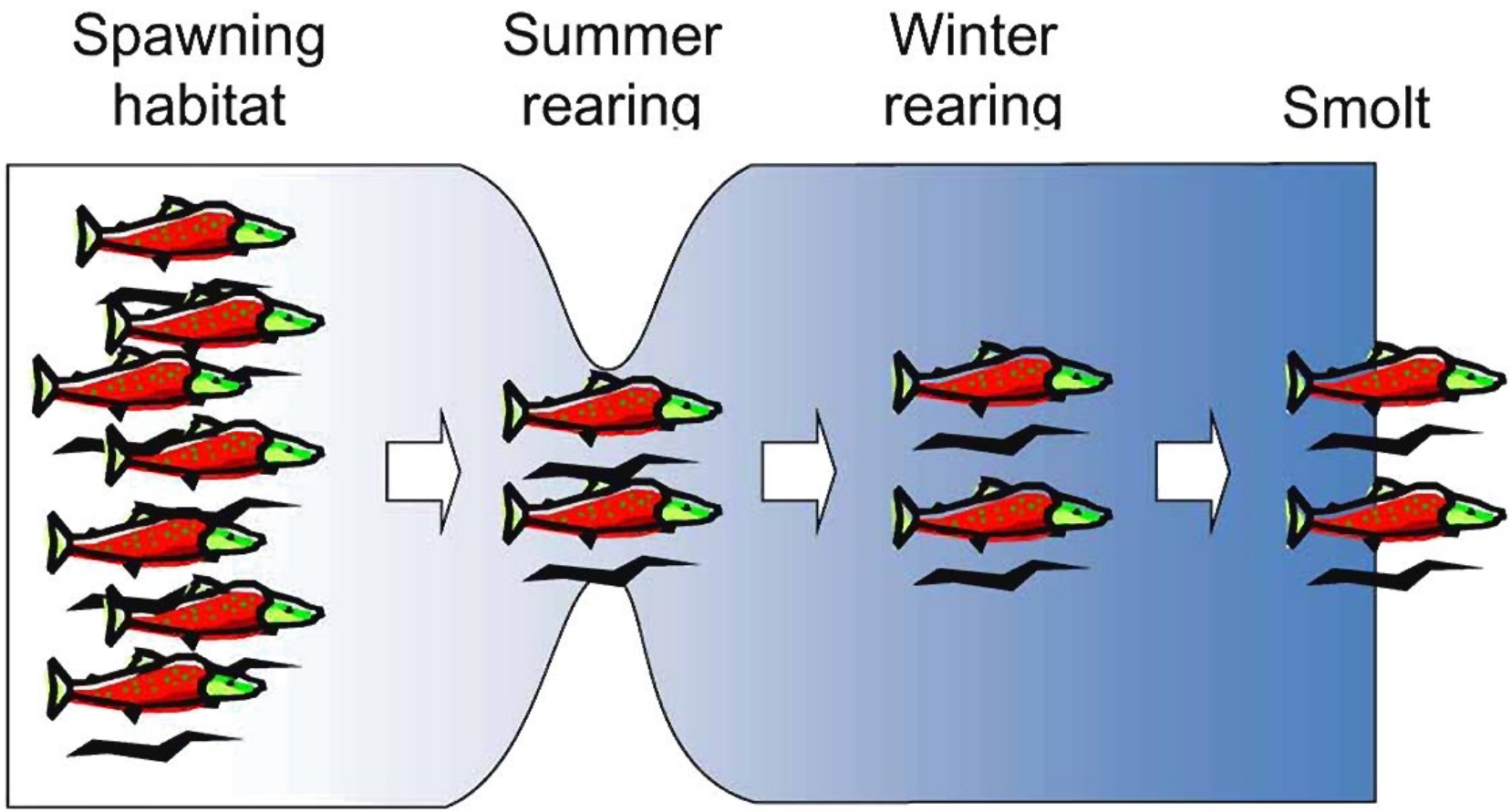
each category by reach

Sum habitat carrying capacity to identify current potential



- Pre-smolt Chinook habitat carrying capacity is > than fry Chinook habitat carrying capacity.
- How do we increase fry Chinook habitat carrying capacity?

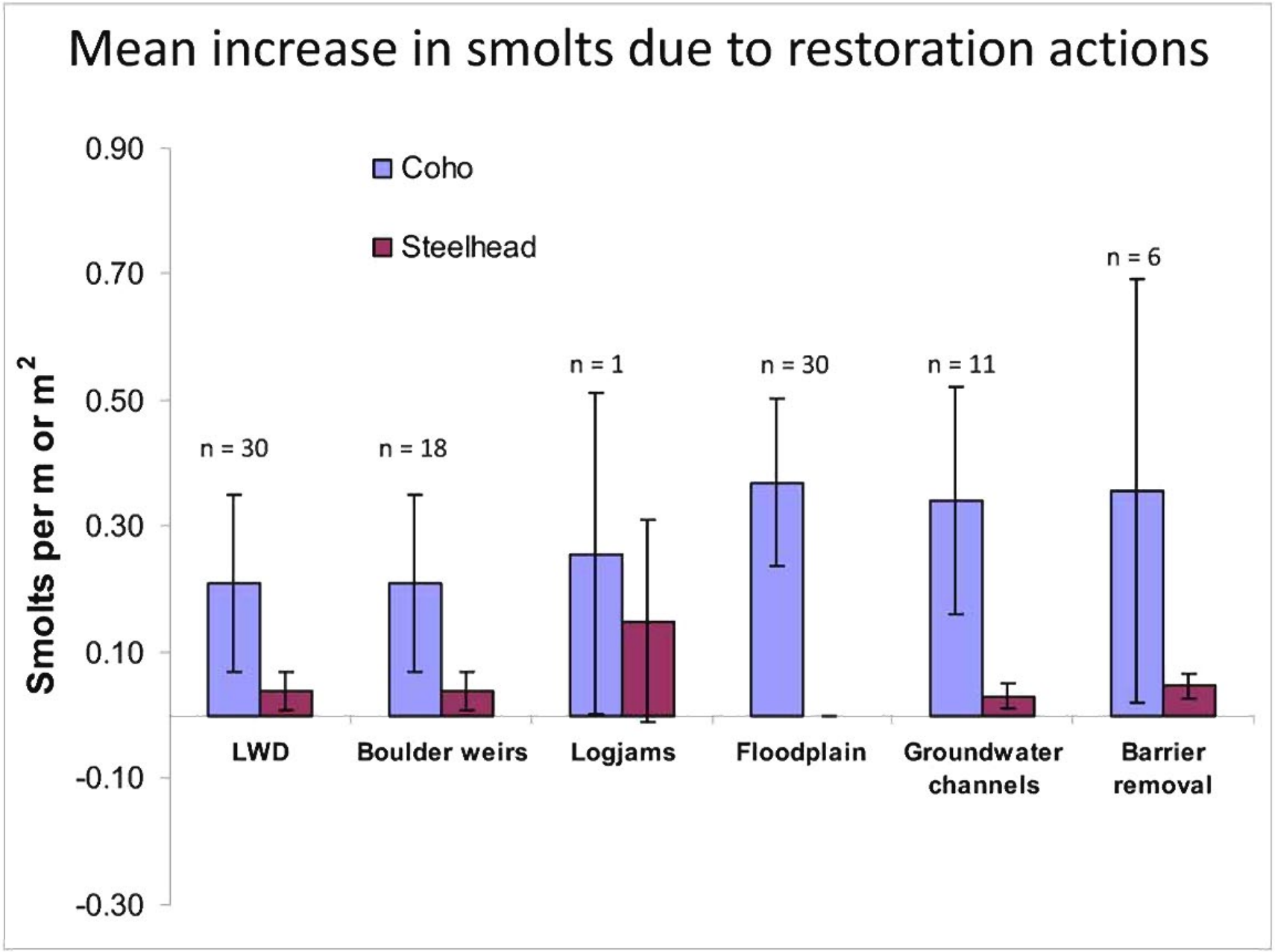
Habitats or habitat quality associated with a specific life stage or season may limit potential



Develop scenarios to compare current v. restored

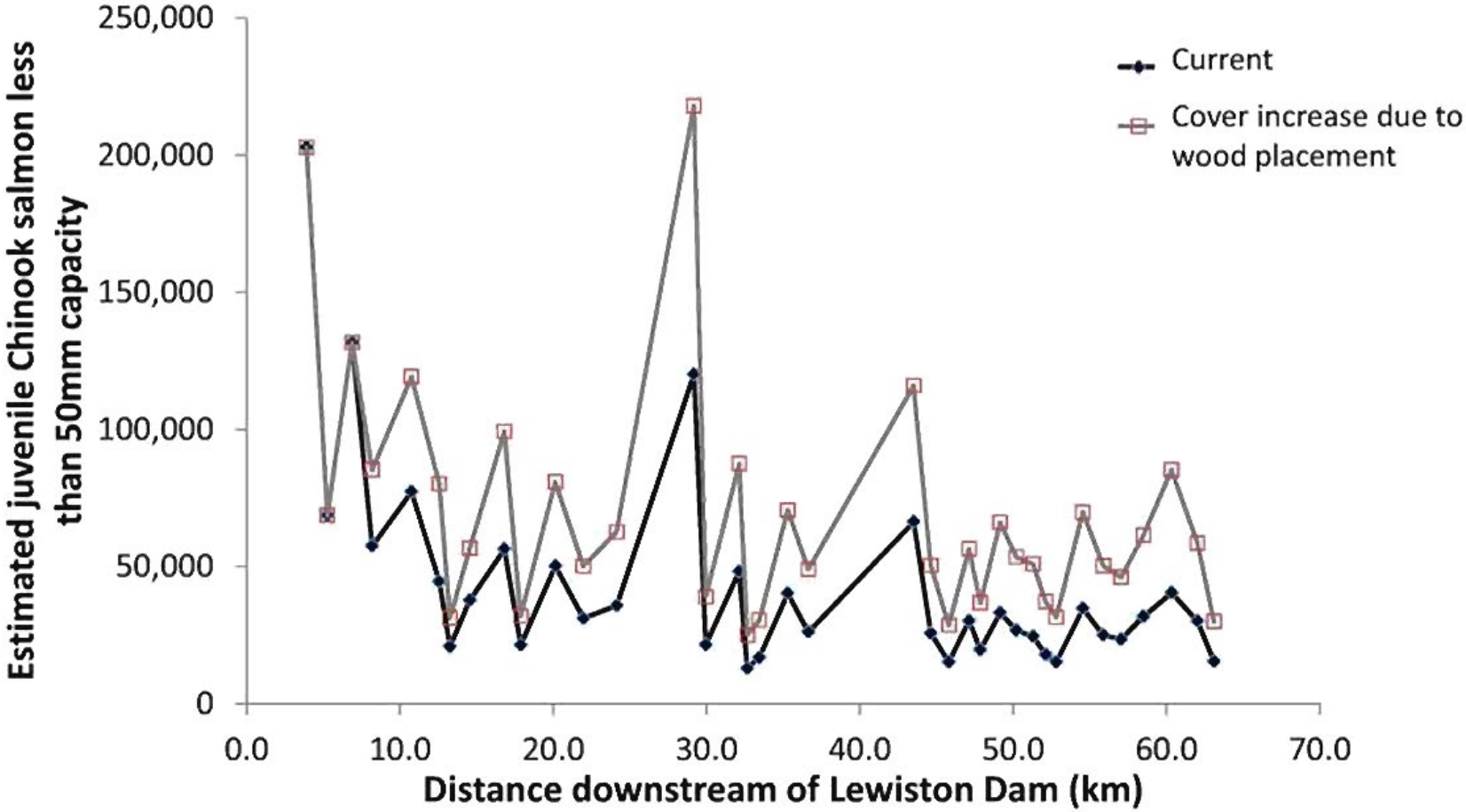
Salmon Habitat	Restoration type
Streams/Rivers	
small – accessible	**Wood placement**
small - inaccessible	Barrier removal
medium	Boulder weir placements
large	**Logjam construction**
Floodplain habitat	
lost side channels	Develop groundwater channels
lost sloughs	Floodplain reconnection

*Small = <15m bfw, medium = <25m bfw, large = >25m bfw

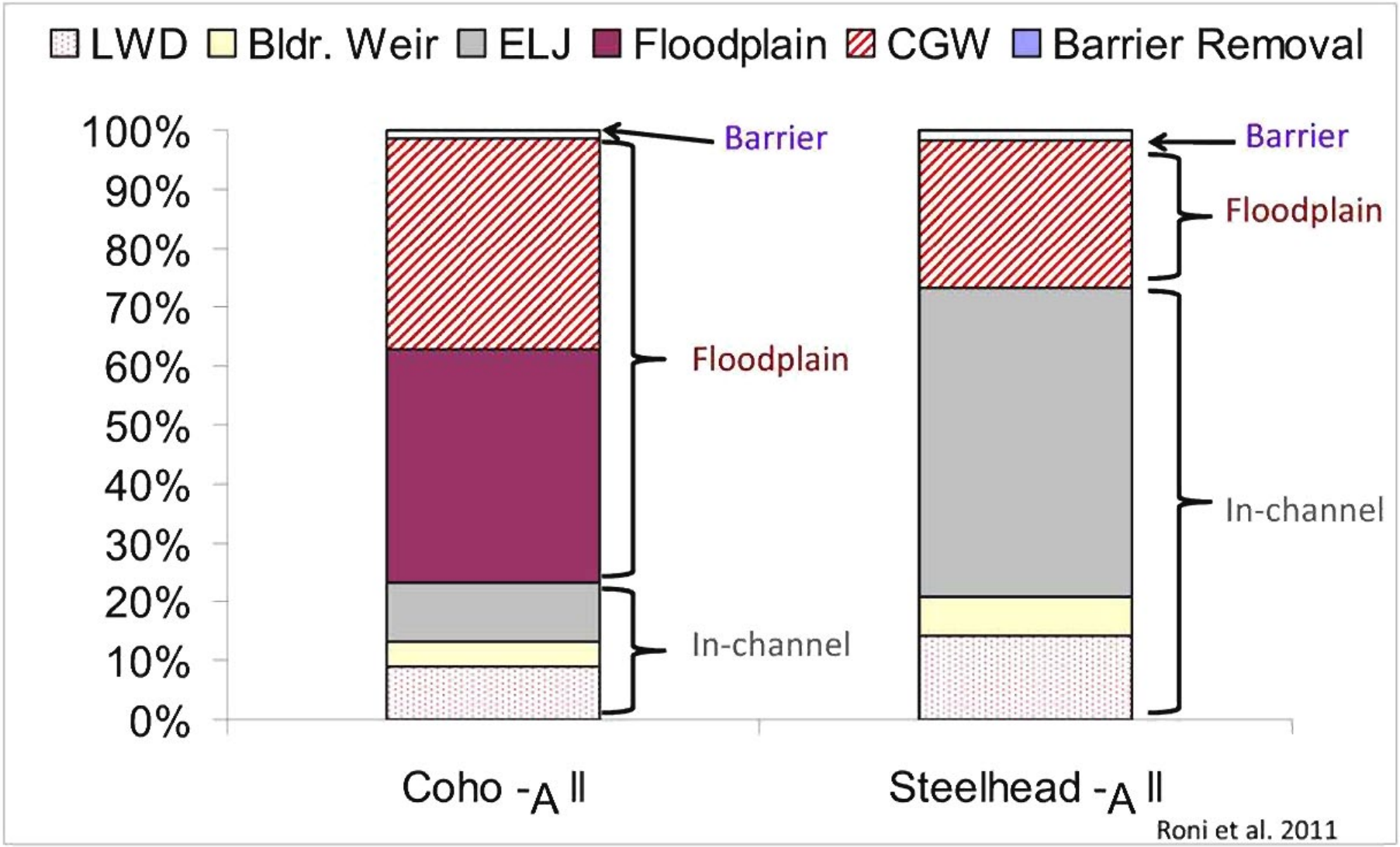


Roni et al. 2011

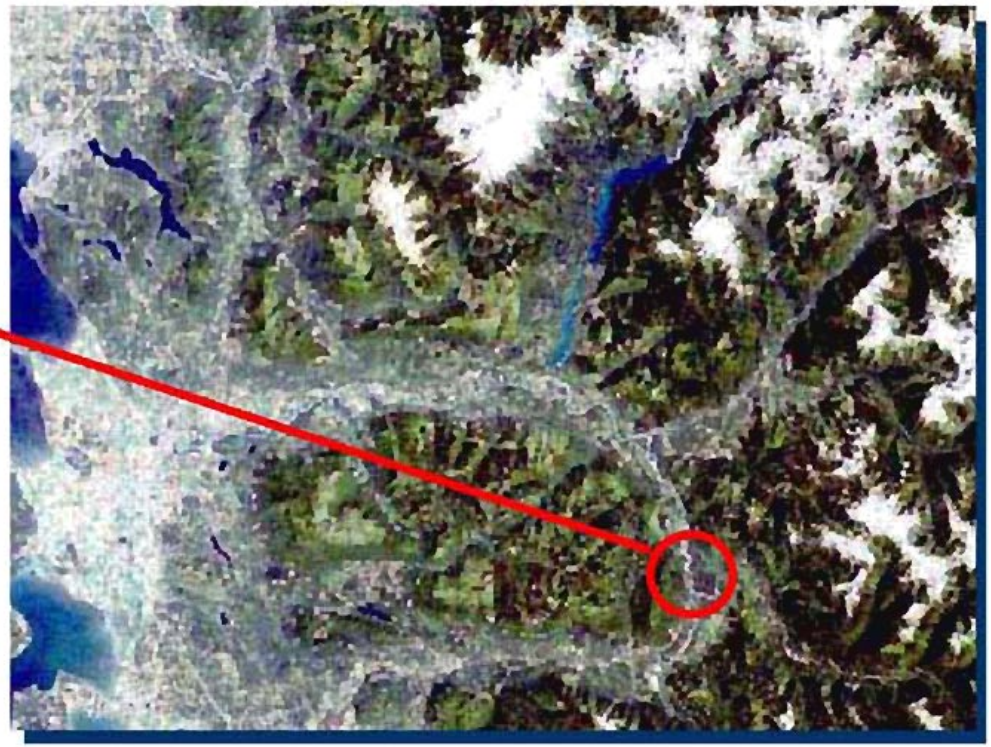
Compare virtual "before v. after" to assess relative change in habitat capacity & fish use by a one or several restoration actions

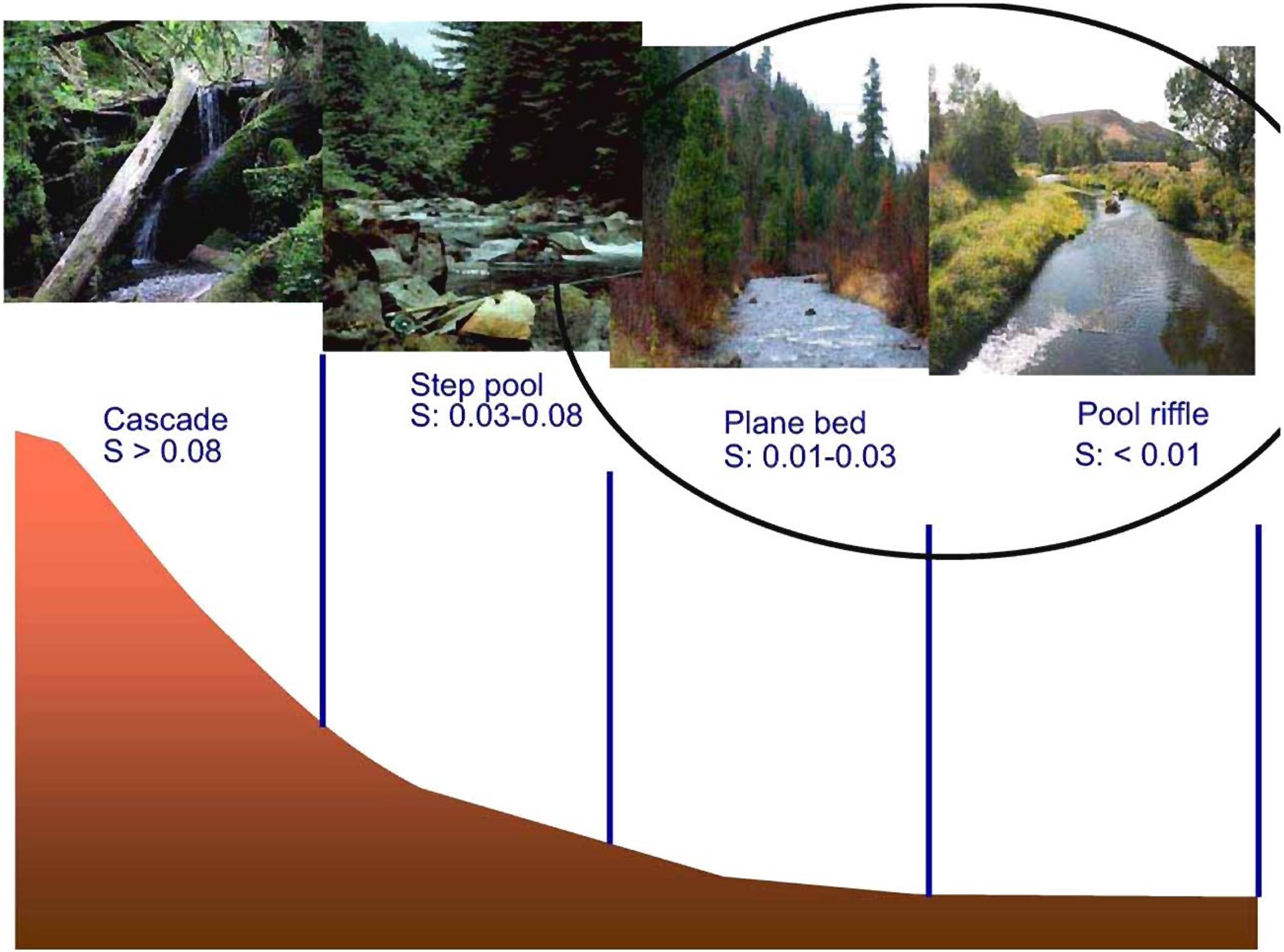


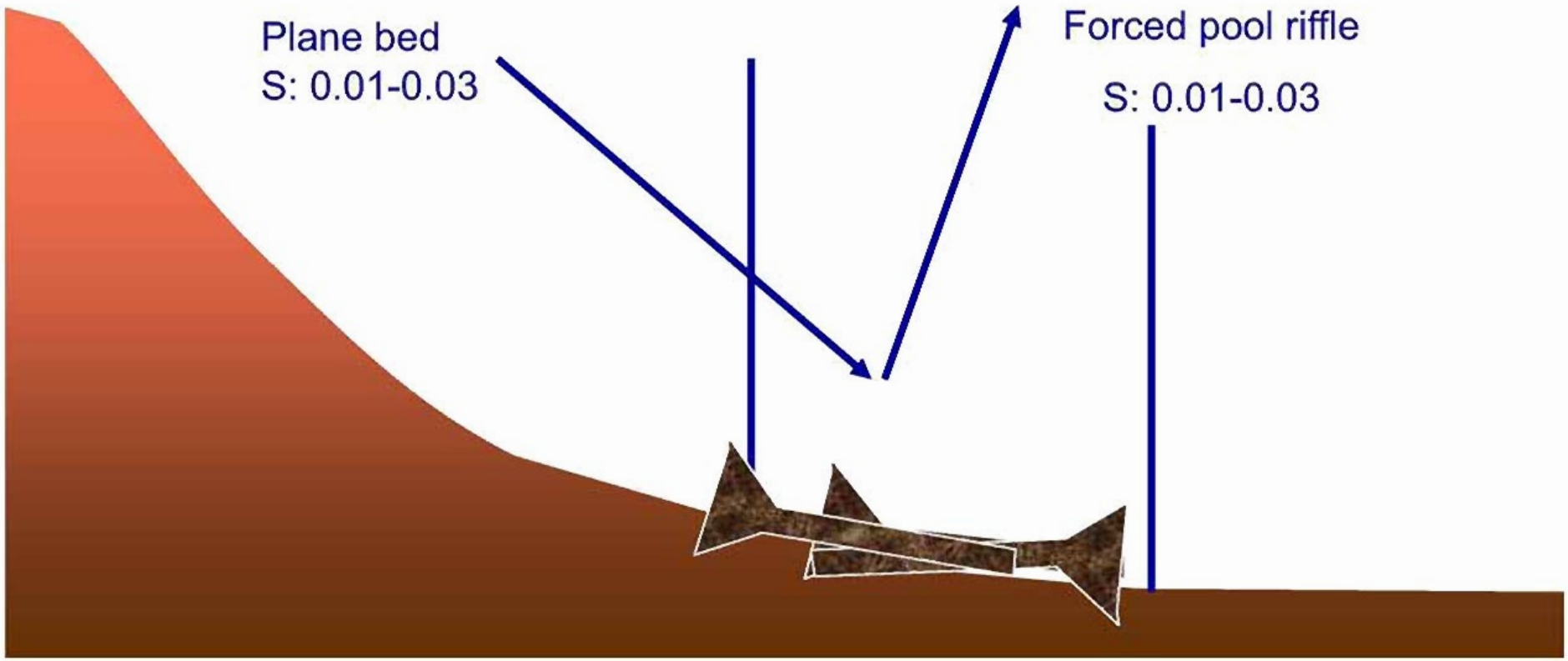
Compare virtual "increase by restoration action" to assess relative change in habitat capacity & fish use



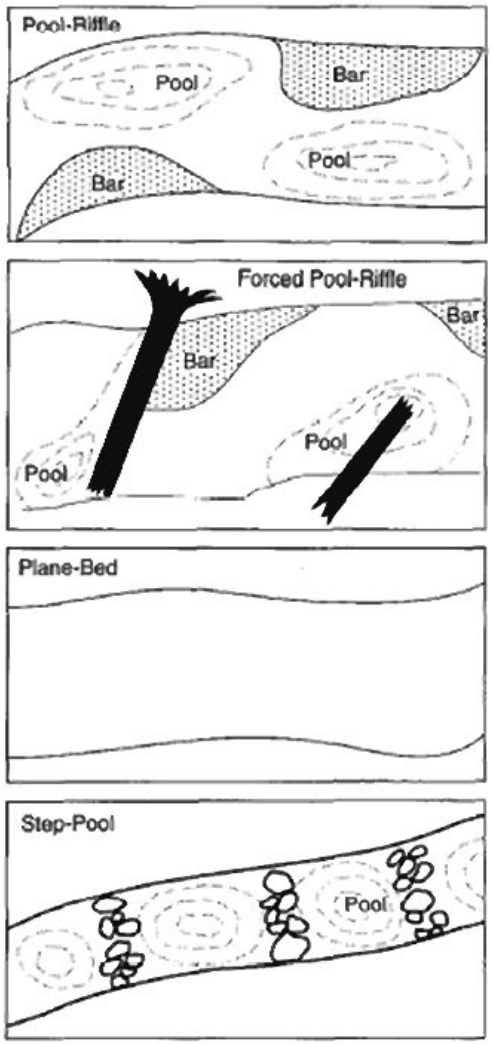
Empirical results using literature & extrapolation

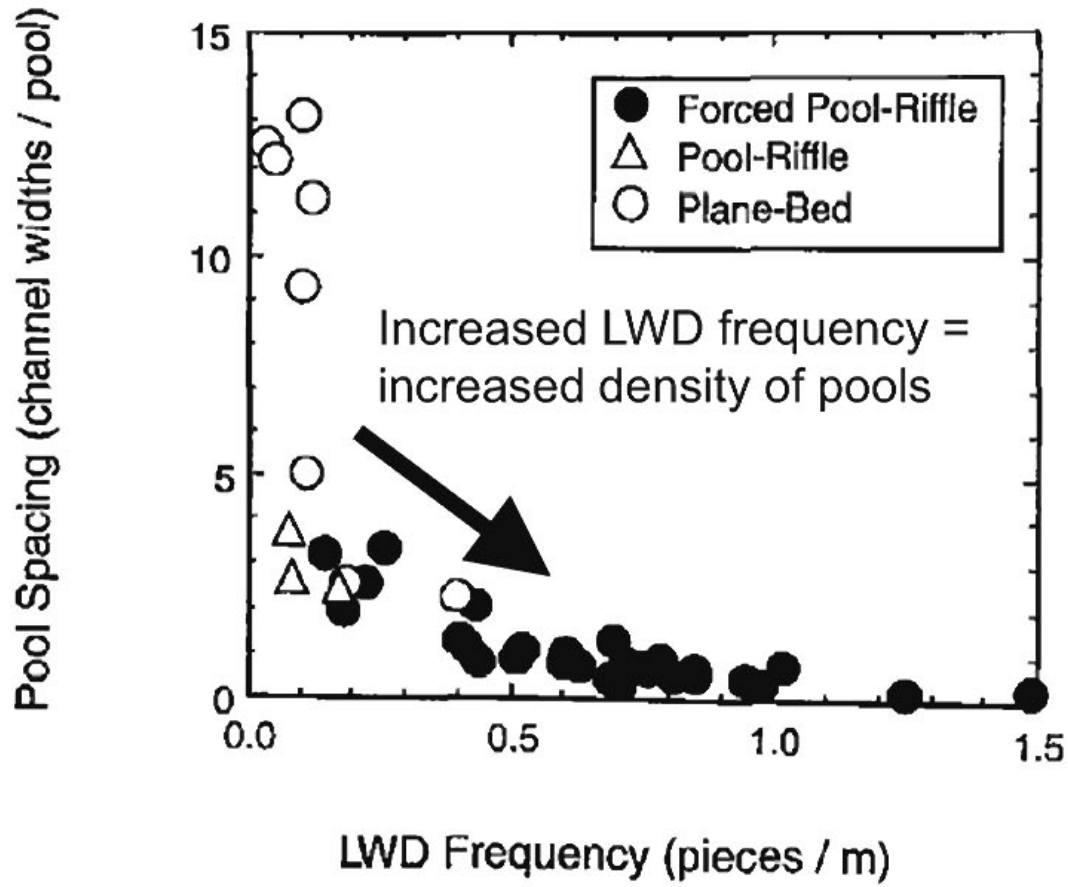



Cascade
S > 0.08
Step pool
S: 0.03-0.08
Plane bed
S: 0.01-0.03
Pool riffle
S: < 0.01


Plane bed
S: 0.01-0.03
Forced pool riffle
S: 0.01-0.03

Empirical results using literature & extrapolation

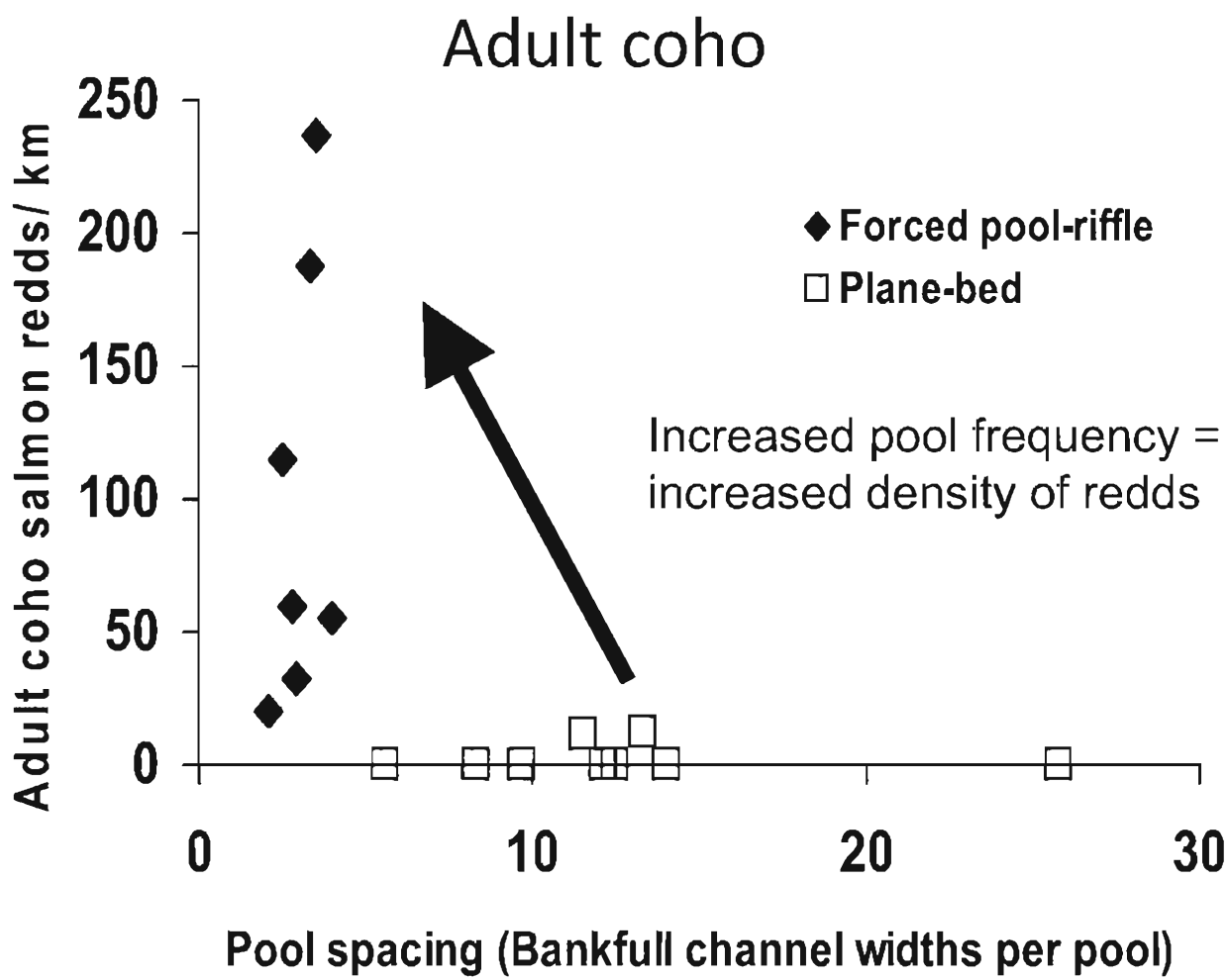




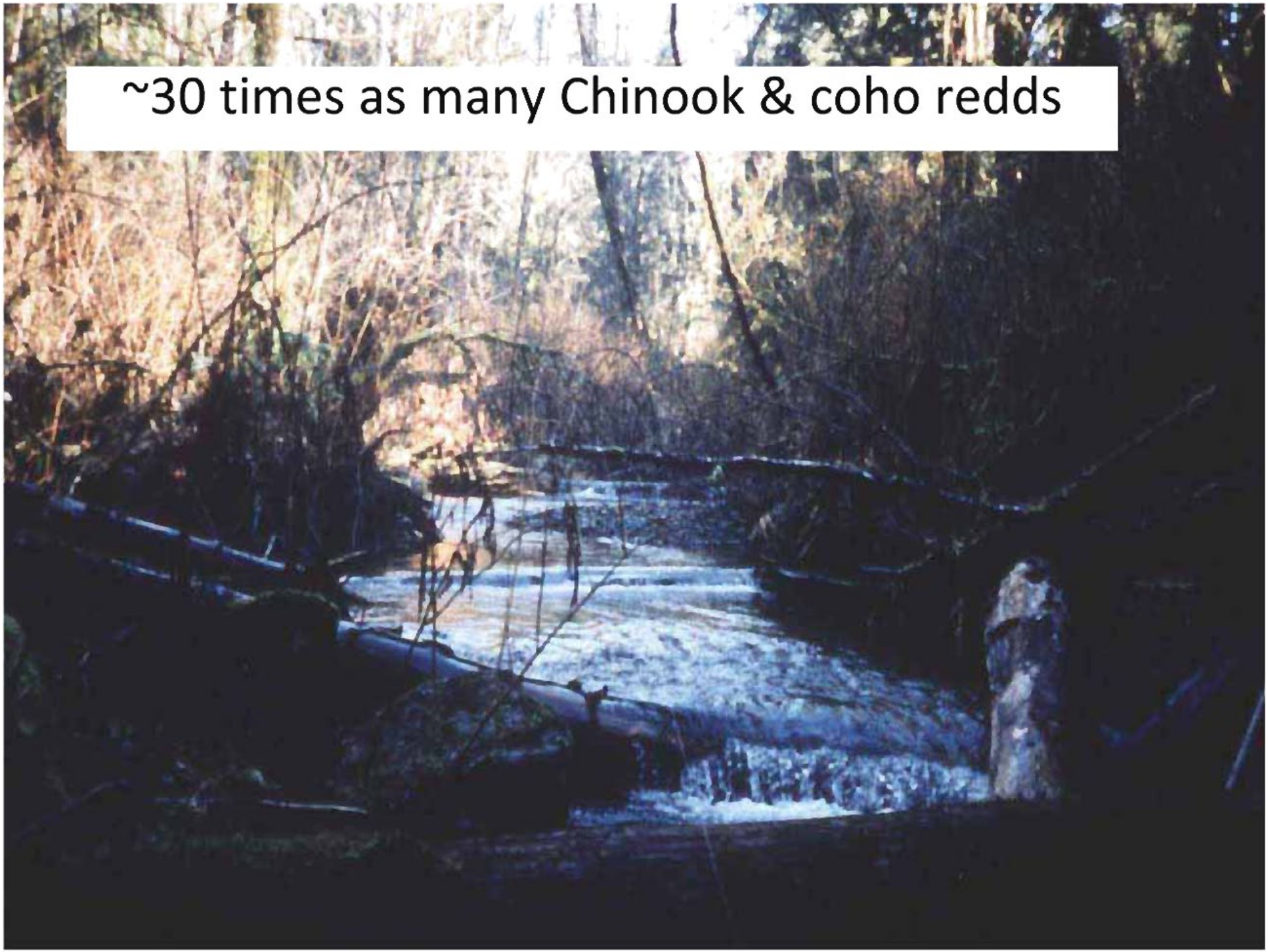
Montgomery et al. 1995

Empirical results using literature & extrapolation

Increased frequency of pools & increased adult salmon use

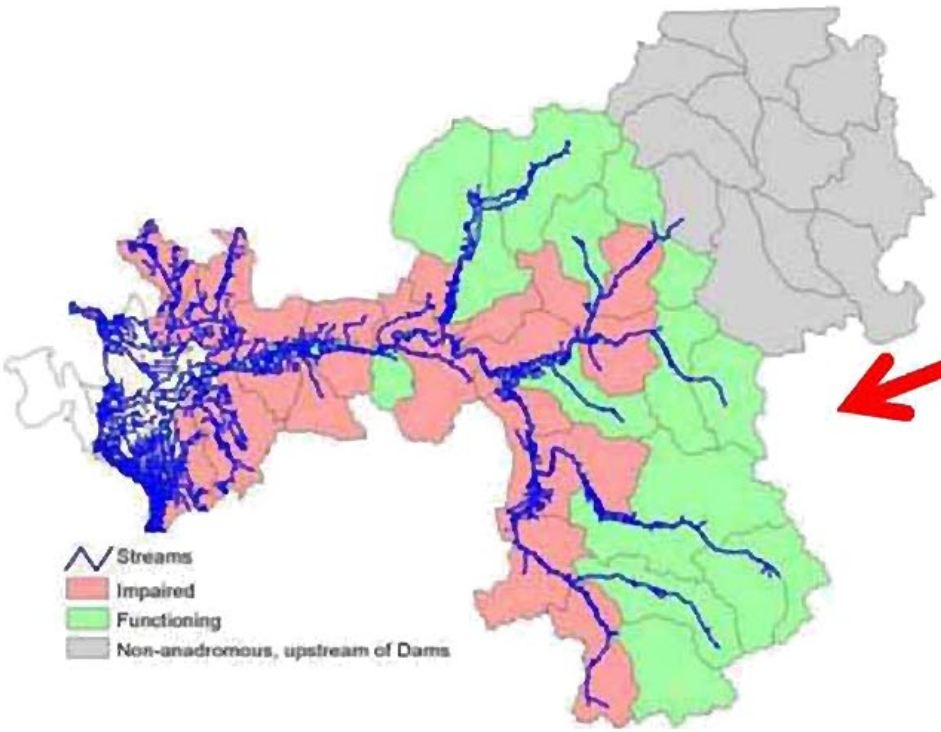


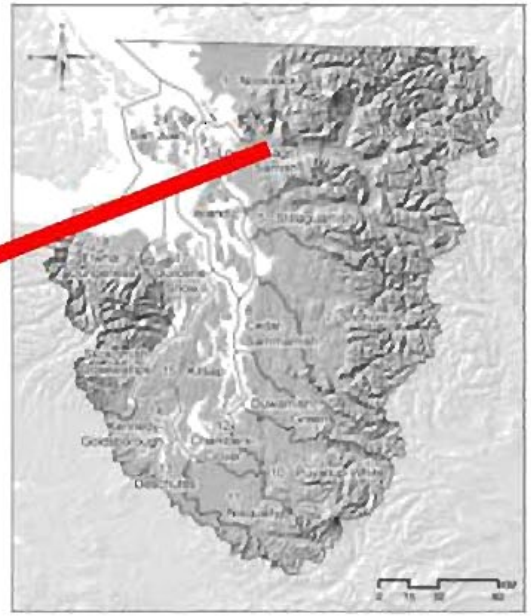
Montgomery et al. 1999


~30 times as many Chinook & coho redds

Empirical results using literature & extrapolation

Loss of pools & reduced adult salmon use



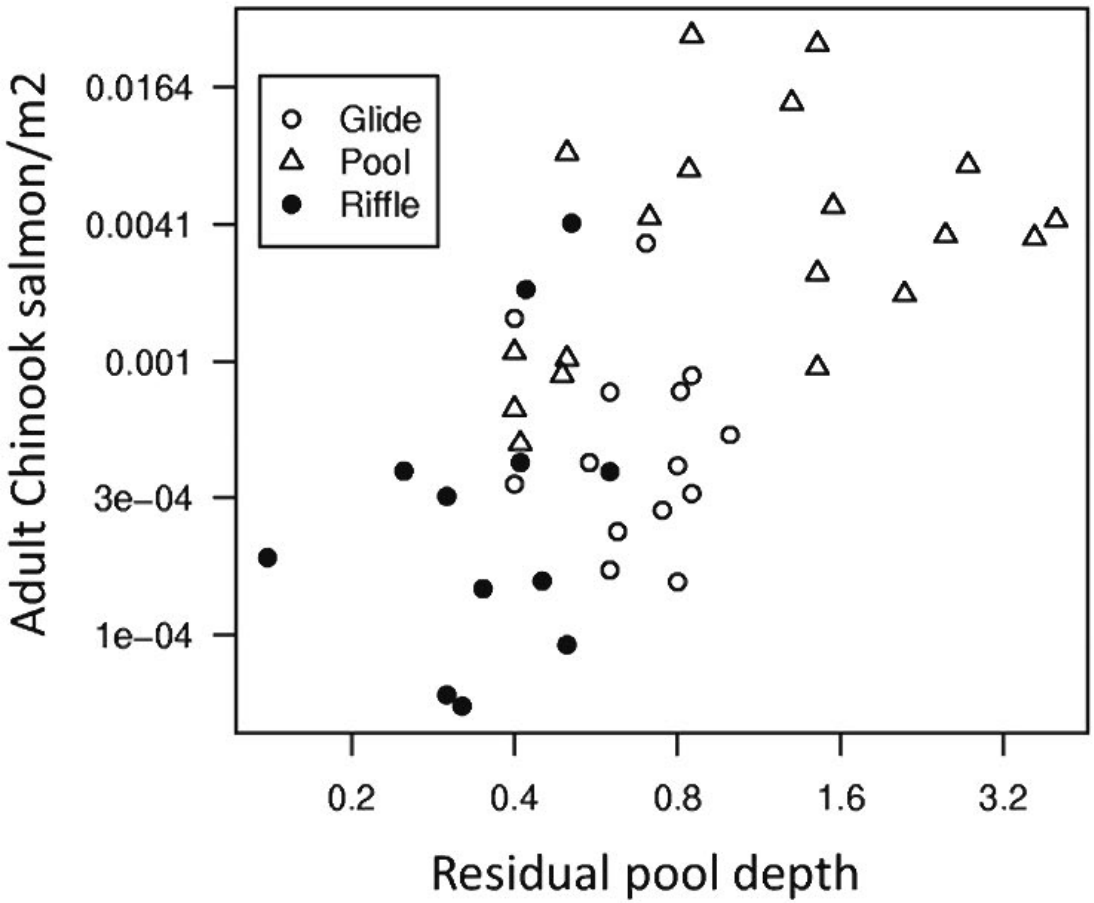


http://www.skagitcoop.org/index.php/welcome/

- An estimated 1/3 of all forced pool-riffle channel types converted to plane-bed in a typical Puget Sound watershed

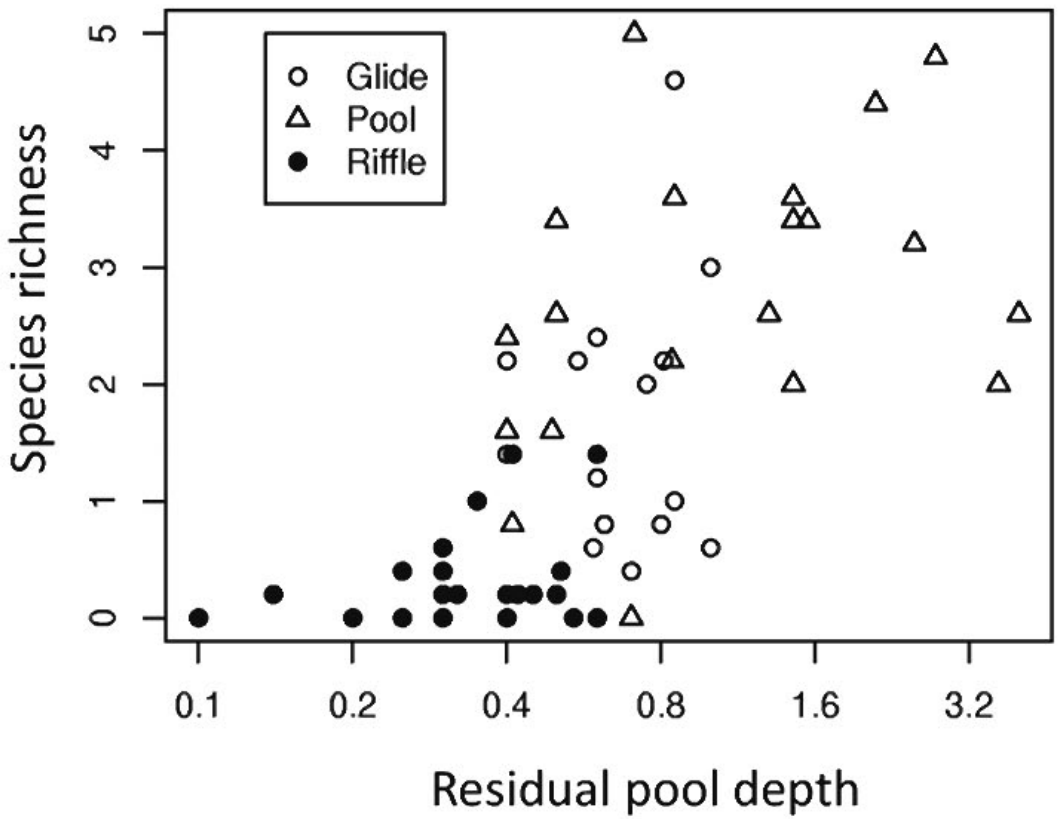
Empirical results using literature & extrapolation

Increased magnitude of pools & increased adult salmon use



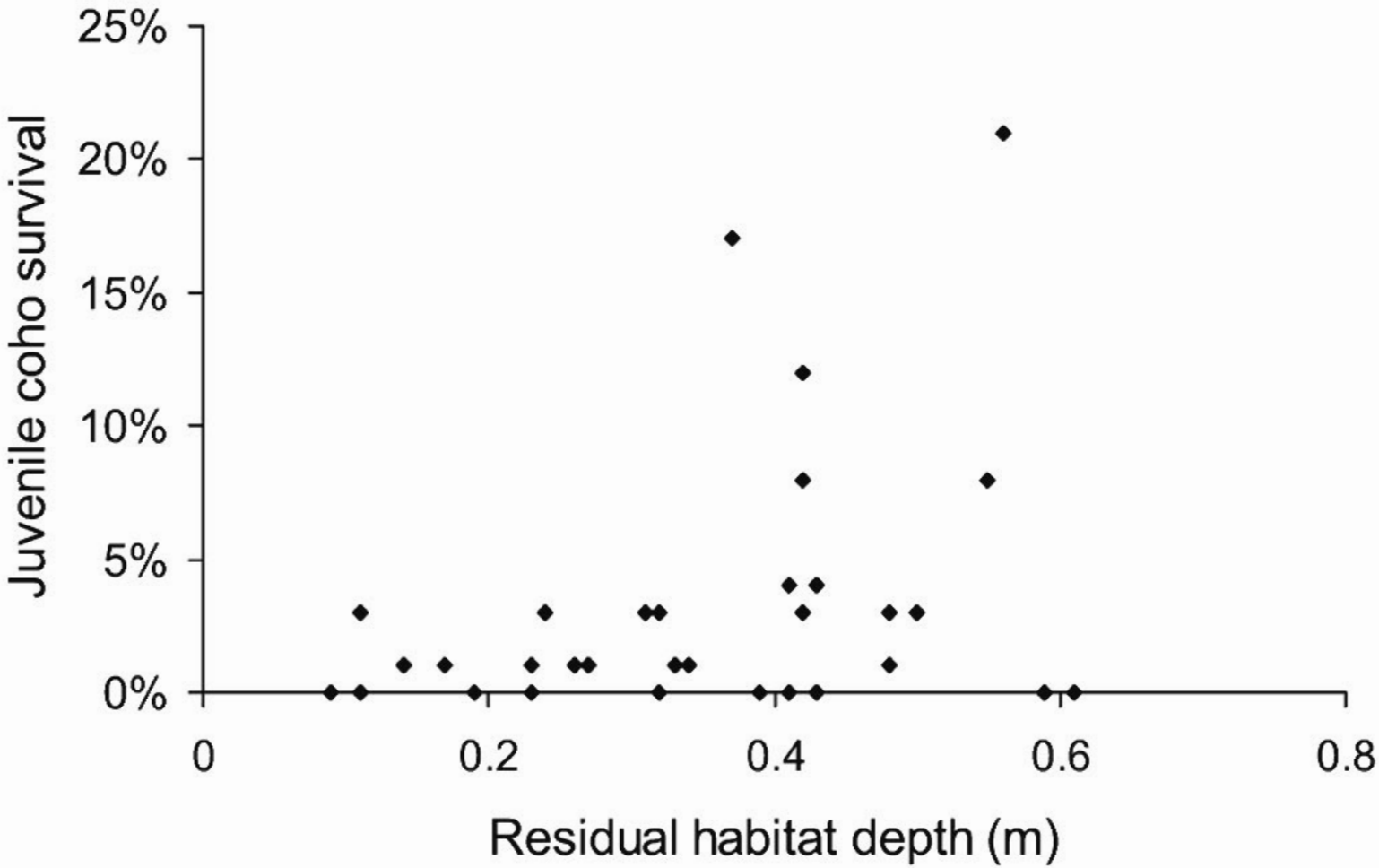
Empirical results using literature & extrapolation

Increased magnitude of pools & increased species abundance



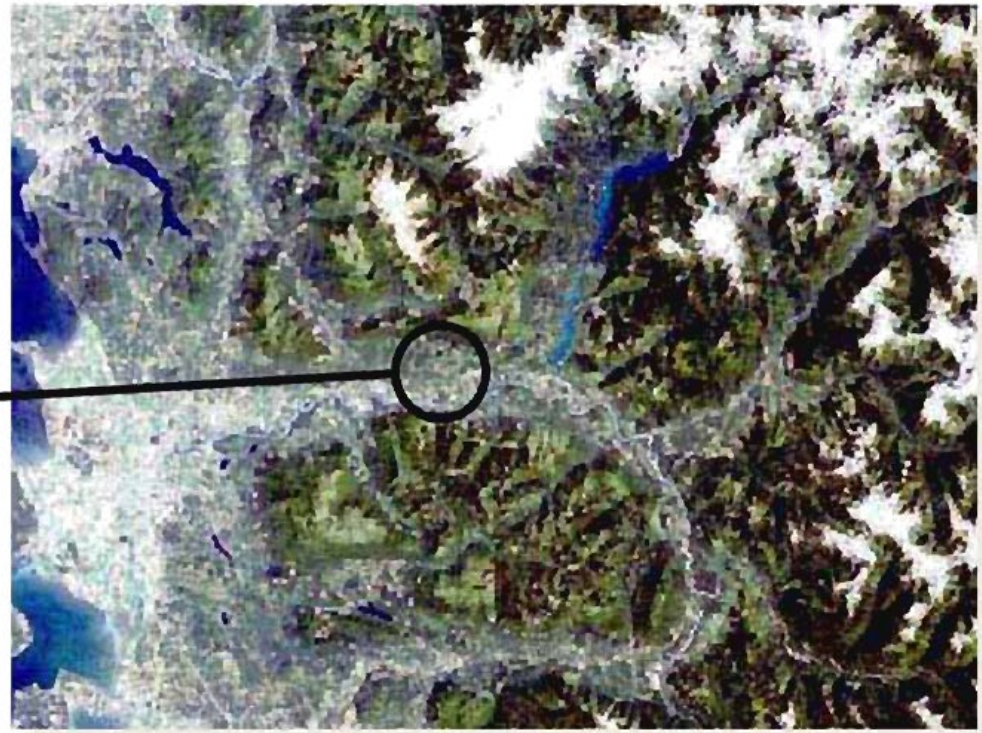
Empirical results using literature & extrapolation

Increased magnitude of pools & increased juvenile coho survival



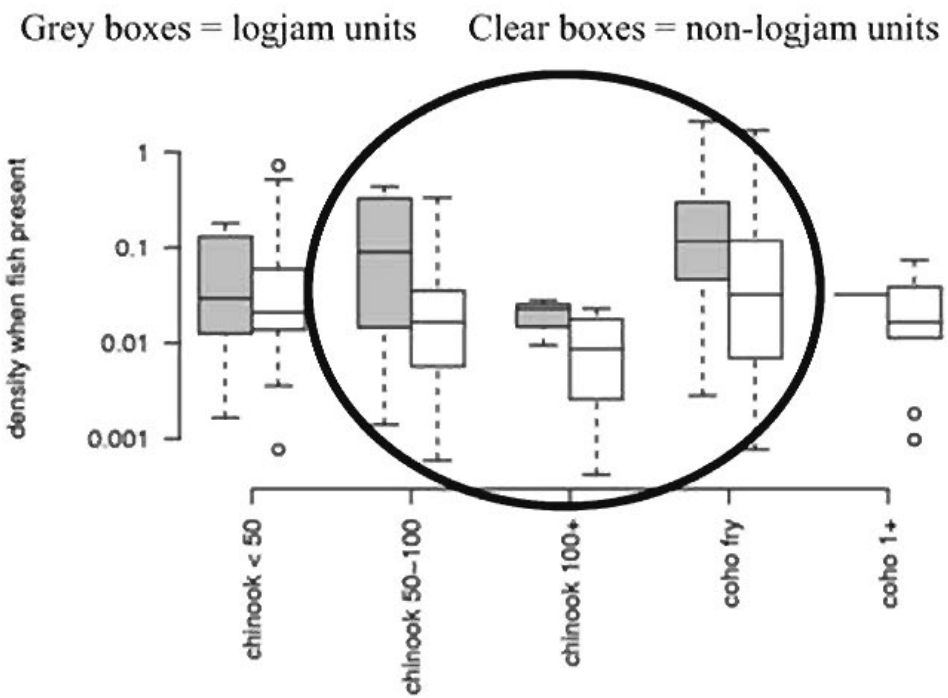
Pess et al. 2011

Empirical results using literature & extrapolation



Empirical results using literature & extrapolation

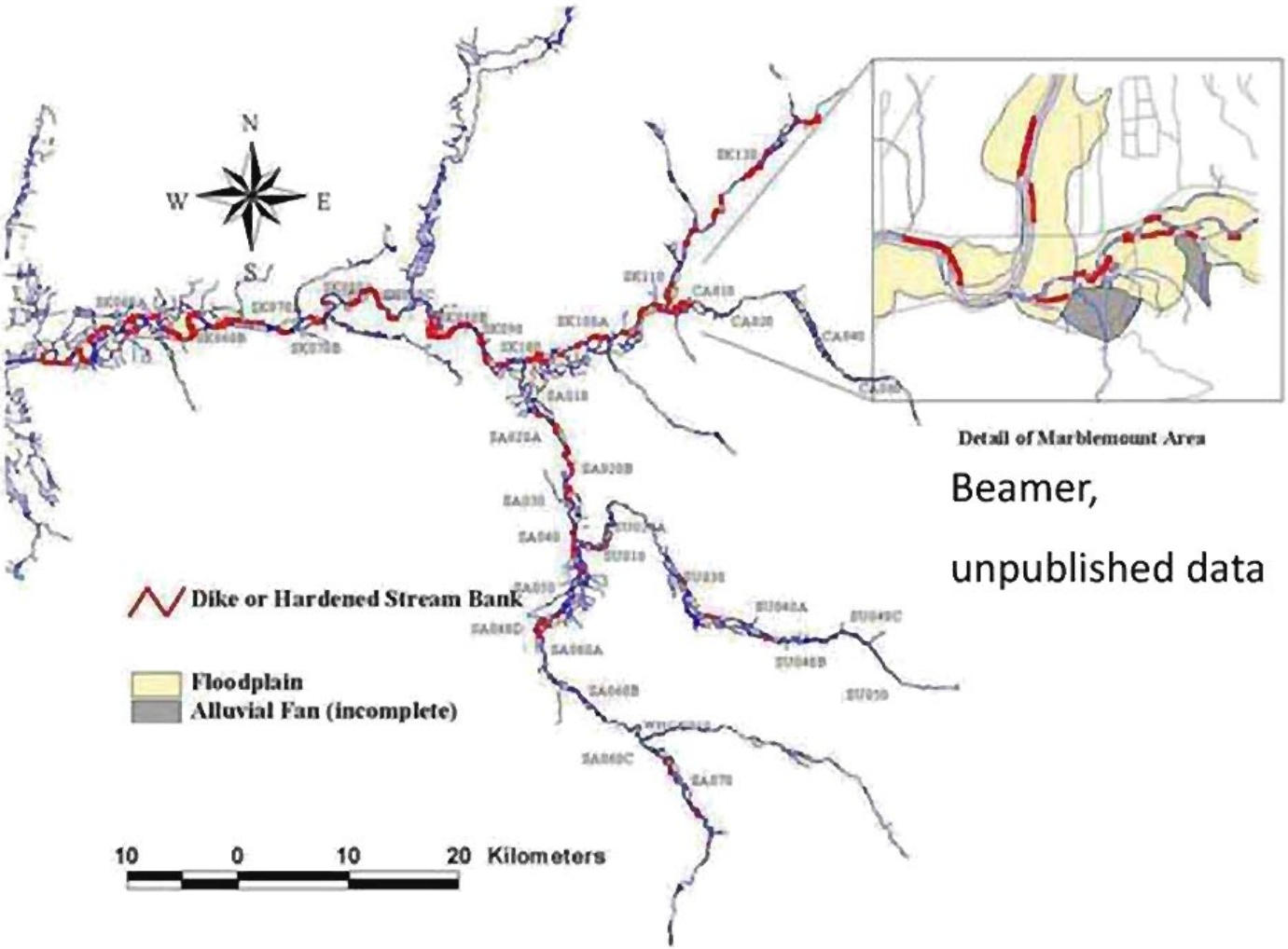
Increased fish use with an increase in habitat complexity



Pess et al. in press.

Empirical results using literature & extrapolation

Decreased fish use due to a decrease in habitat complexity



Beamer,

unpublished data

Figure 2-15a. Map of impaired main channel areas based on diking and stream bank hardening. (upstream of delta only)

How do you manage “expectations” and not over or undersell the potential results?

- State the fact that wood placement typically improves some aspects of watershed structure & function, but does not restore watershed processes by itself.

- Identify, target, and monitor what you think are the limiting life stages and factors associated wood placement with respect to your focus.

- Discuss the longevity of wood placement over time, what does it mean to the resource?

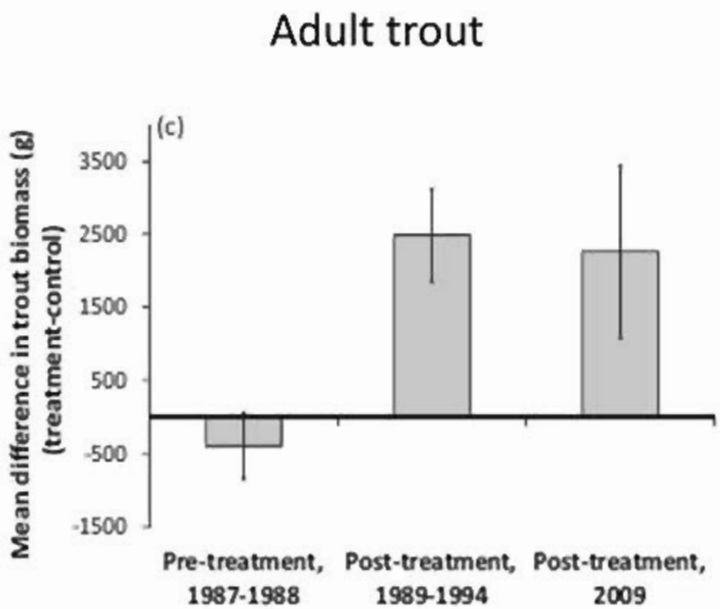
Watershed structure & function v. processes

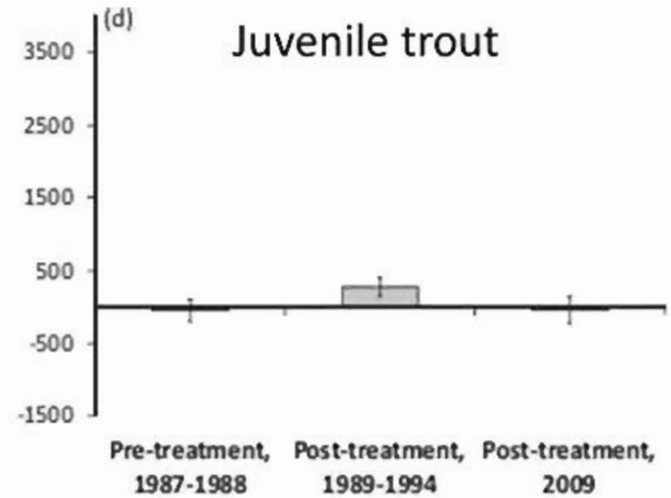
- Treat the root cause of ecosystem changes
- Tailor restoration to local potential
- Match the scale of restoration to the scale of the problem
- Be explicit about expected outcomes

Beechie et al. 2010.

Target the right life stage & focus on limiting factors

- Trout populations 20 years after wood placement
  - Adult trout abundance
    - increased rapidly after structures were installed
    - remained 53% higher in treatment sections 21 years later.
  - Juvenile trout abundance
    - No change detected
    - Fry recruitment is strongly influenced by effects of annual snowmelt runoff.

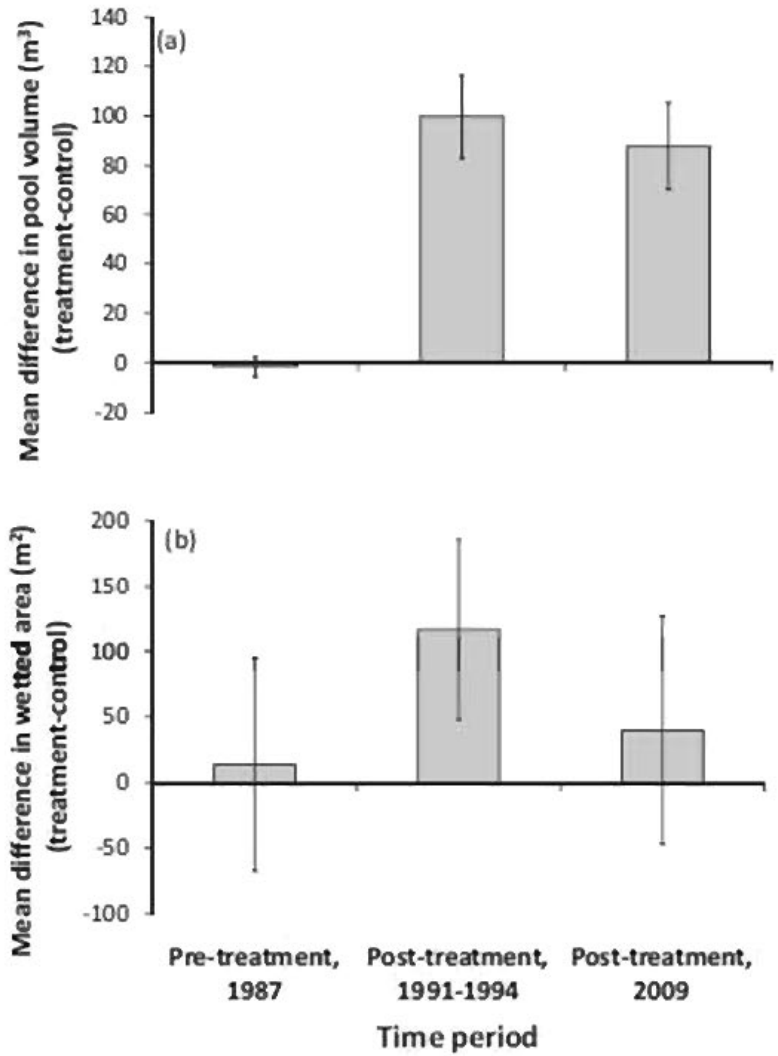




White et al. 2011

Target the right life stage & focus on limiting factors

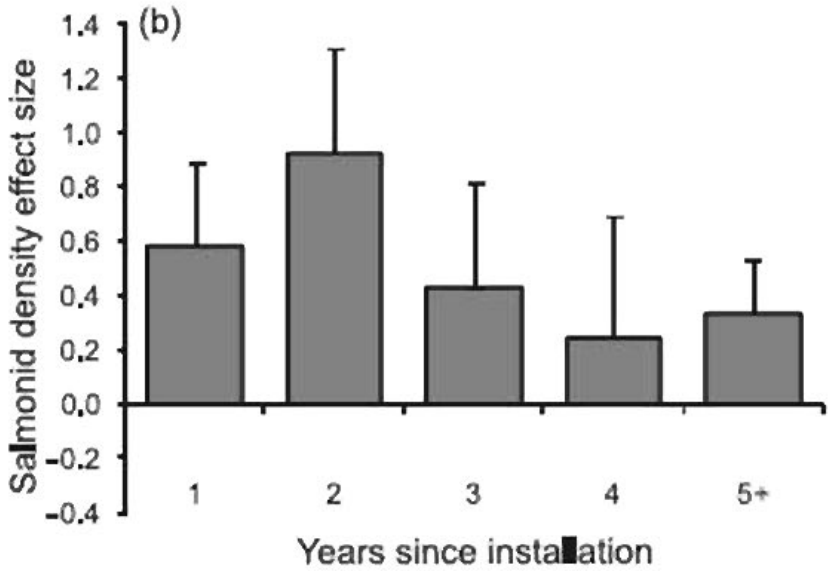
- Trout populations 20 years after wood placement
  - The increase in pool volume & wetted area has maintained over time.



White et al. 2011, Roni et al. 2002, Pess et al, in press.

Discuss the longevity of wood placement over time, what does it mean to the resource?

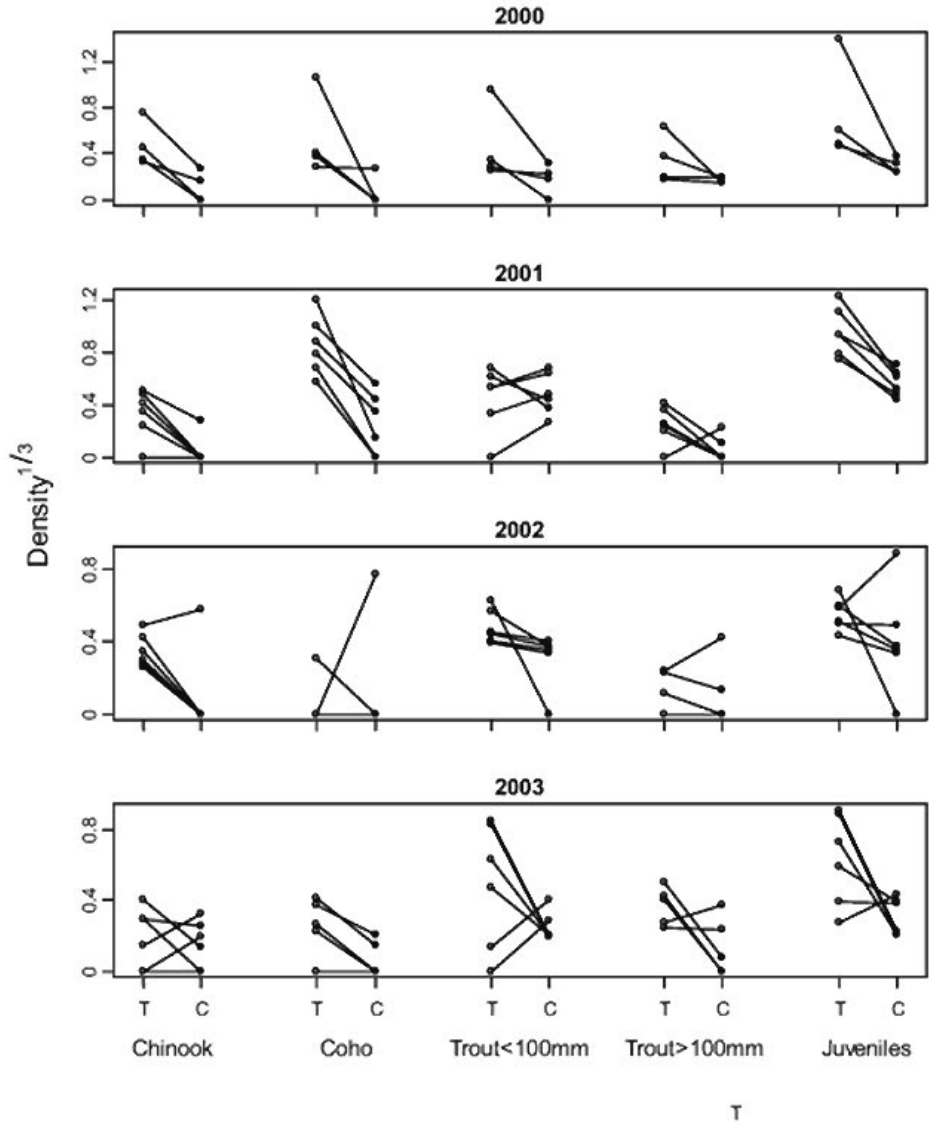
- Structures & fish abundance meta-analysis
  - Salmonid densities decrease after two years.
  - However, most studies do not go beyond 1 year monitoring.



Whiteway et al. 2010

Discuss the longevity of wood placement over time, what does it mean to the resource?

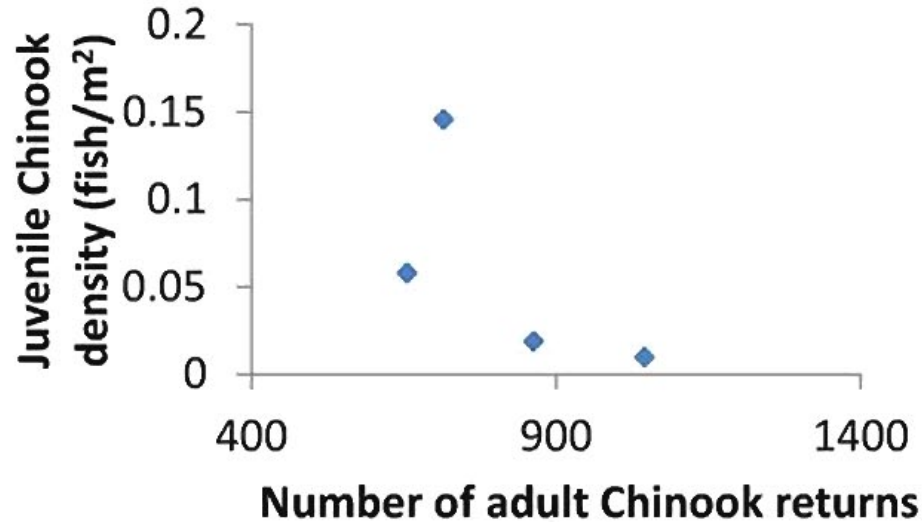
- Salmonid response to ELJs
  - Decline in the difference between the control and treatment sites over time after year 2.
  - ELJs have been stable
    - Two of the largest floods in 100 years have occurred since construction
  - **Why the decline?**

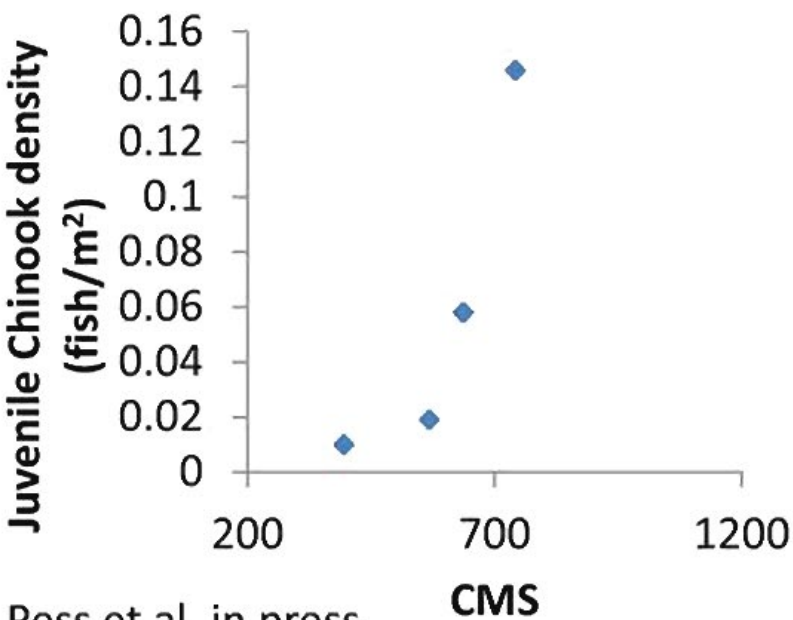


Pess et al. in press

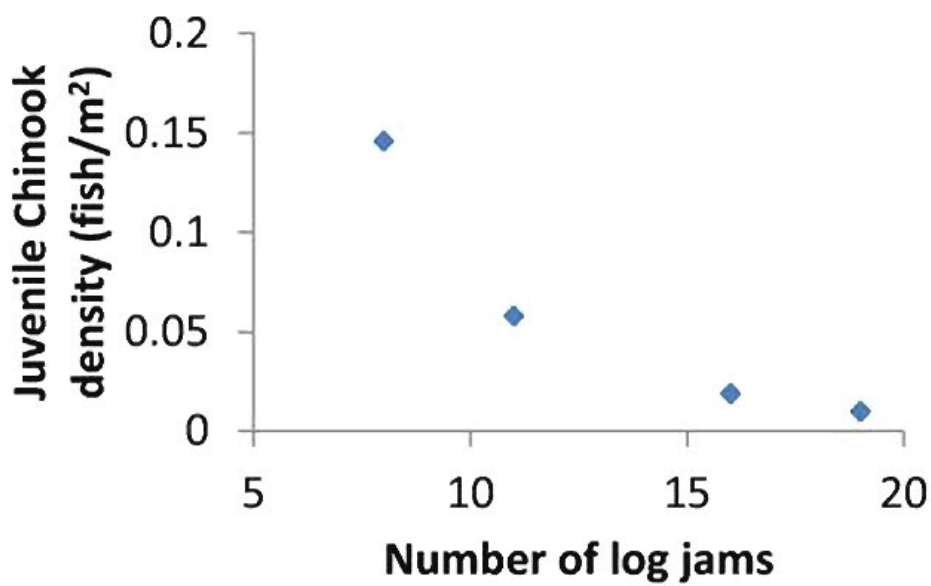
Discuss the longevity of wood placement over time, what does it mean to the resource?

- Inter-annual variation
  - Adult population size
  - Summer low flow
  - Number of other treatments





Pess et al, in press



Final thoughts

- Use a systematic method at the appropriate scale to define the biological needs & benefits for wood placement relative to the current conditions and alternative actions
- Target the right life stage
- Focus on limiting factors
- Remember to acknowledge wood placement restores structure and function but not process
- Structures that maintain over time have long-term benefits to salmonids.

Photo courtesy of John McMillan

Thanks

References

- Eric Beamer – Contact Skagit River System Cooperative Phone: 360.466.7241.; e-mail: ebeamer@skagitcoop.org. Skagit River documents - http://www.skagitcoop.org/index.php/welcome/

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