Management Applications from Intensively Monitored Watersheds

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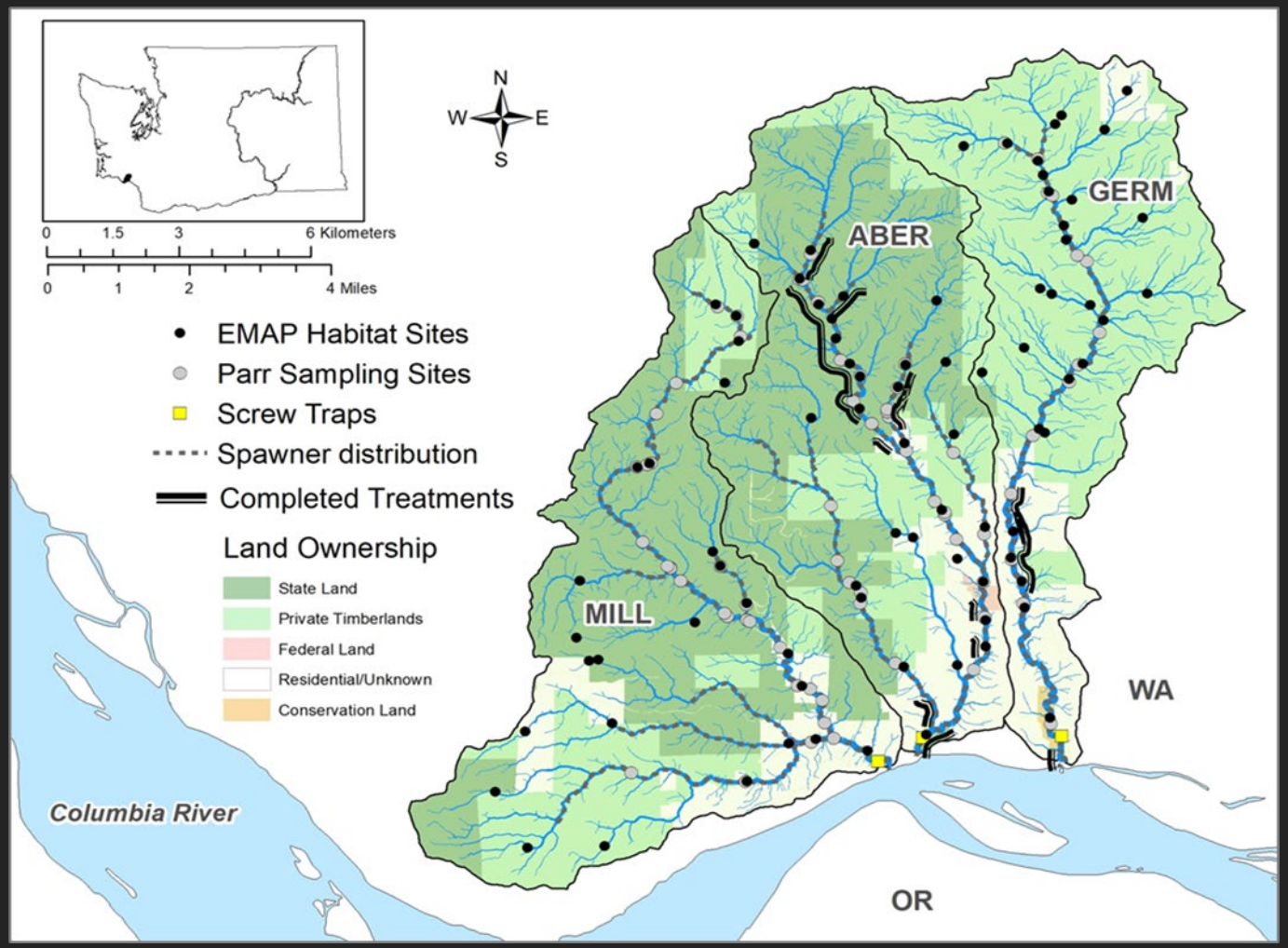
SRFB Science Advisory Panel

Intensively Monitored Watersheds

- IMWs (Intensively Monitored Watersheds) initially established in early 2000s to develop a better understanding of the contribution habitat restoration could make to salmon recovery
- IMW concept - concentrate restoration treatments and monitoring resources at a site to maximize the ability to detect and quantify fish and habitat responses
- IMW approach still considered one of the few study designs capable of evaluating watershed-scale salmon and steelhead responses to habitat restoration

Illustration of IMW Design

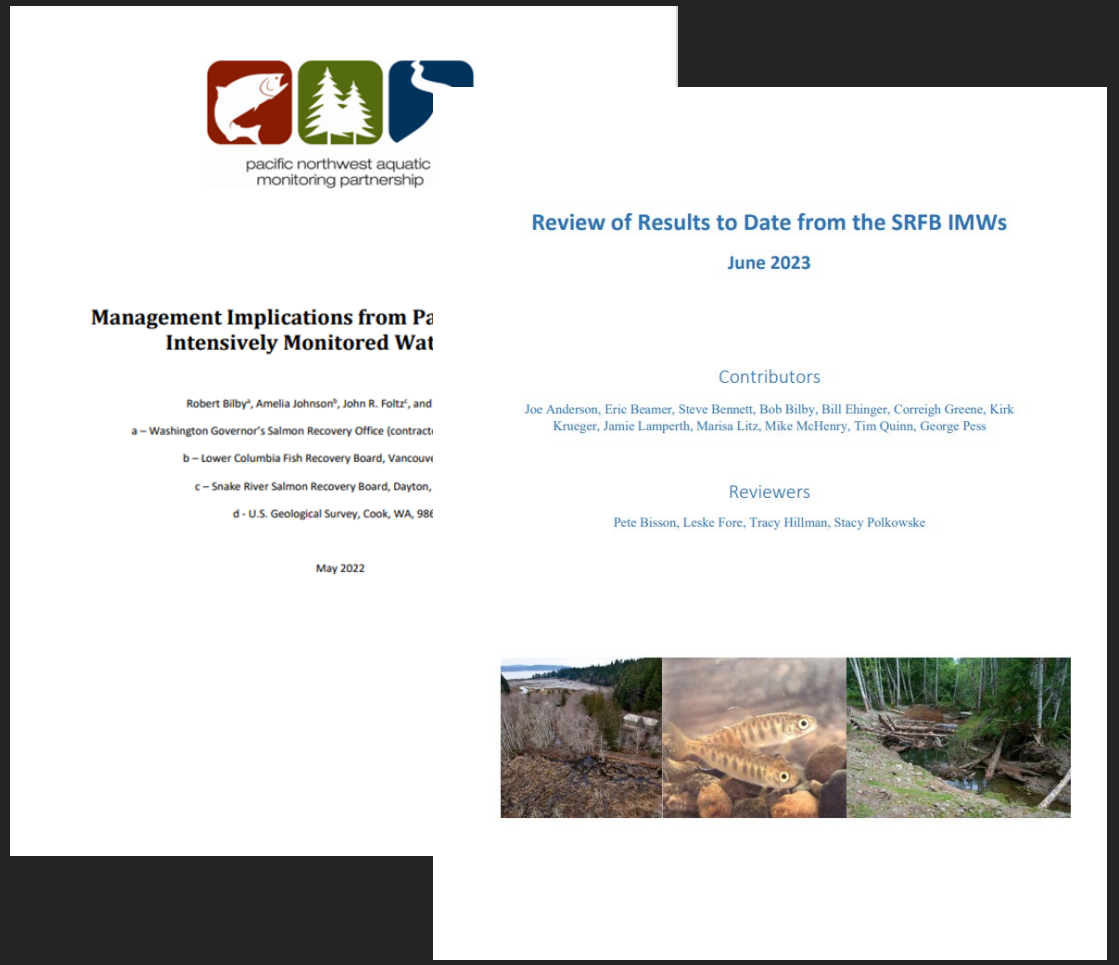


Common IMW Elements

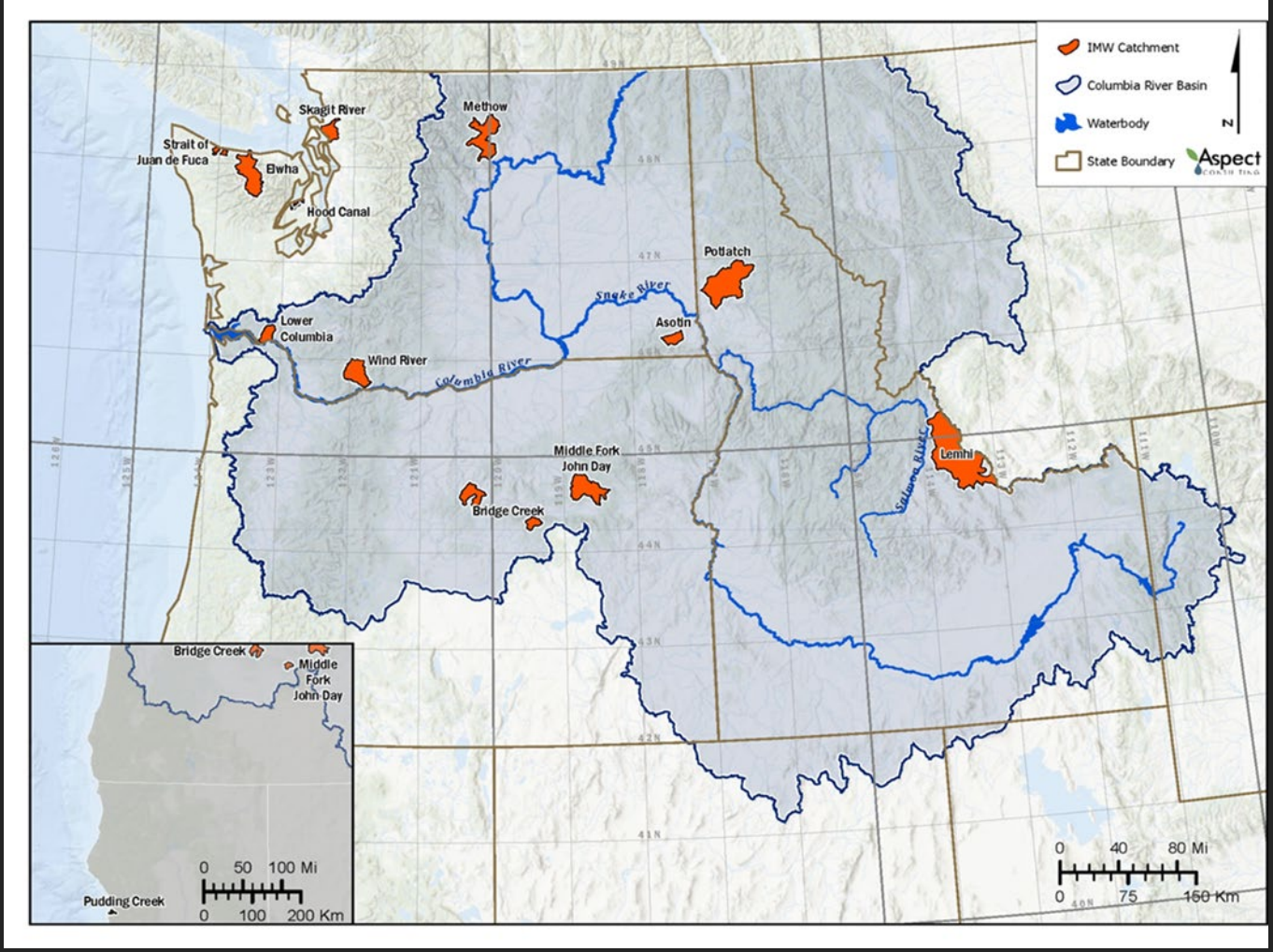
- One reference watershed
- Ambitious restoration program
- Intensive monitoring of habitat and fish populations

IMW Reviews – 2022, 2023

- Two recent reviews of IMW results
  - 2022 – PNAMP review of 13 IMWs across the PNW
  - 2023 – Review of the IMWs supported by the SRFB
- Purpose of both reviews identify management implications of IMW results to date



PNAMP IMW Review



- Survey sent to IMW PIs
- Information on restoration actions, habitat and fish responses, and results to date
- 13 IMWs responded
- Responses used as the basis for a series of workshops in late 2021
- Generated a series of key findings and management recommendations – published in 2022

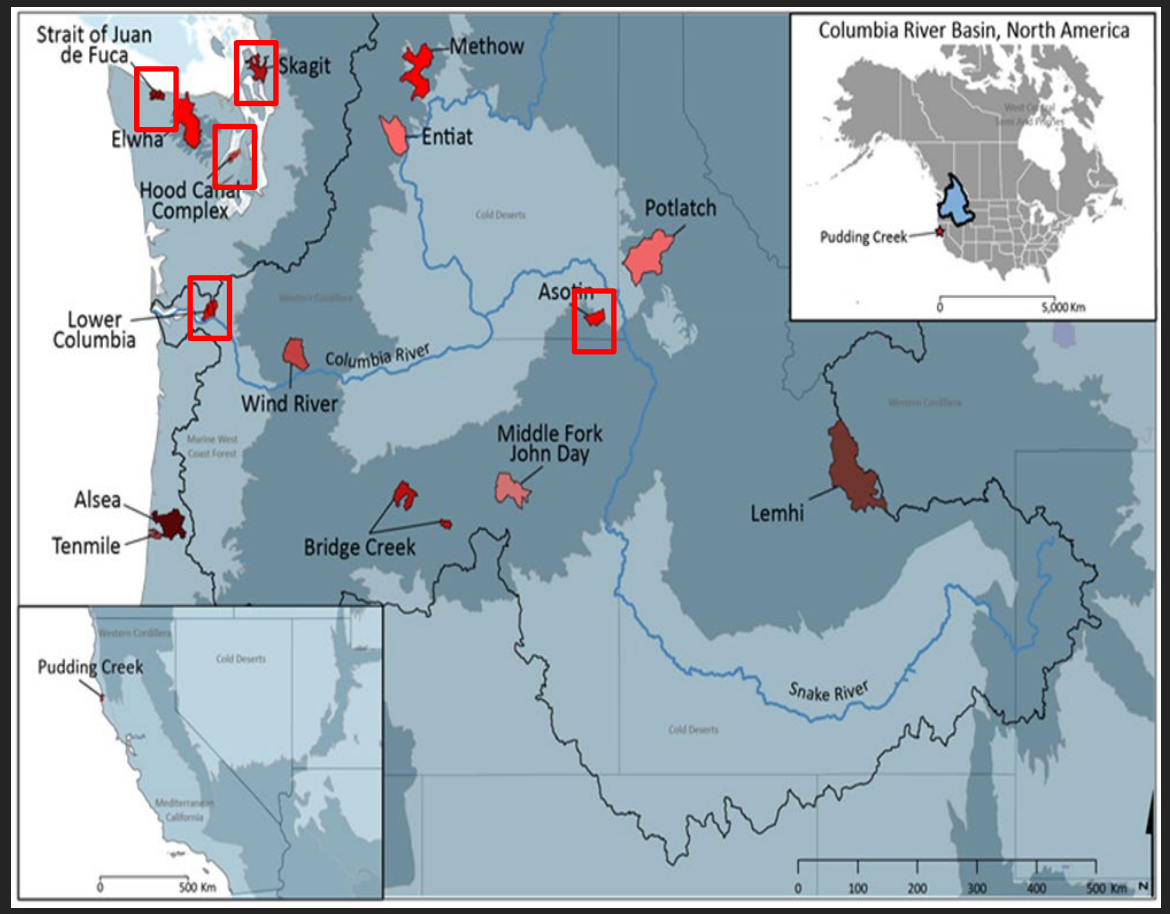
Fish Responses

Fish Response	Increased	Decreased	No Change
Adult returns	2 (22%)	1 (11%)	6 (67%)
Adult marine survival	0 (0%)	0 (0%)	3 (100%)
Redd numbers	2 (29%)	0 (0%)	5 (71%)
Juvenile density or abundance	6 (55%)	1 (9%)	4 (36%)
Juvenile survival	7 (64%)	0 (0%)	4 (36%)
Juvenile growth	2 (25%)	0 (0%)	6 (75%)
Smolt production	9 (75%)	0 (0%)	3 (25%)
Juvenile residence time	2 (40%)	0 (0%)	3 (60%)
Life history diversity*	3 (67%)	1 (33%)	0 (0%)
Composite Fish Response	46%	6%	52%

Key Findings - PNAMP Review

- Correction of barriers limiting longitudinal movement of fish (upstream-downstream) consistently produced positive responses
- Removal of lateral barriers (enabling access to floodplain or delta habitats) generally produced positive fish responses – Beaver Dam Analogs proved to be particularly effective in improving floodplain connectivity
- Responses to wood placement varied – some positive, some with no response
- Fish response to habitat actions is impacted by out-of-basin factors (e.g., fishing, hatcheries, hydropower, variable ocean conditions, climate change)

SRFB IMWs



- IMWs established in early 2000s
- 4 freshwater IMWs
- 1 estuary IMW
- All SRFB-funded IMWs are ongoing
- Synthesis provides an interim look at what we are learning – focus on management implications
- Address uncertainties surfaced in the PNAMP IMW review

Improvements in Population Metrics

Coho

	Straits	Hood Canal	Lower Columbia
Adult Returns	? (1 of 2)	no	? (1 of 2)
Parr Abundance	no	no	no
Parr-Smolt Survival	yes (1 of 2)	yes (1 of 3)	yes (1 of 2)
Smolt Production	no	no	yes (1 of 2)

Steelhead

	Asotin	Straits	Hood Canal	Lower Columbia
Adult Returns	no	no	no	no
Parr Abundance	yes (3 of 3)	no	no	no
Survival	no	no	no	no
Smolt Production	yes (2 of 3)	no	no	no

Chinook

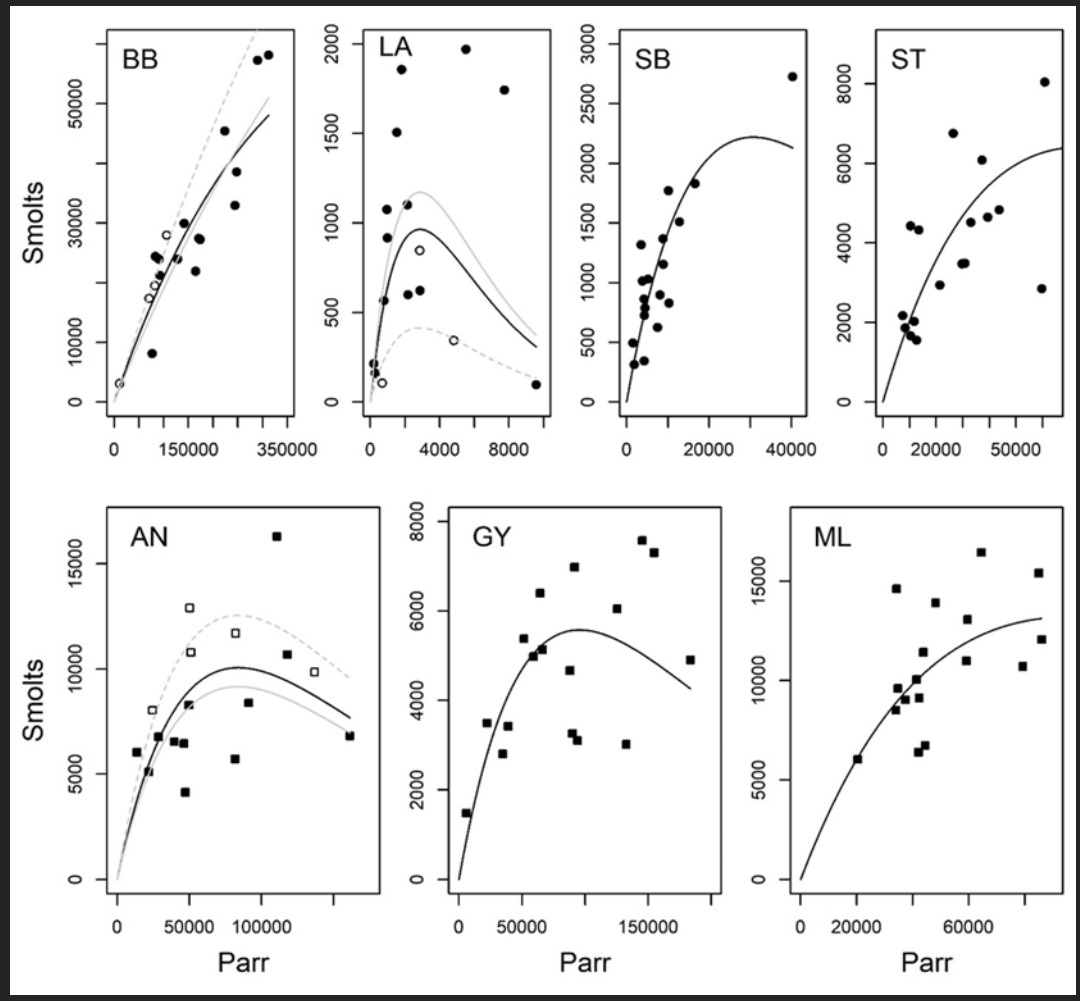
	Lower Columbia	Skagit
Adult Returns	no	?
Density	no	yes
Growth Rate	no	yes

Key Findings – SRFB Review

- Barrier removal was consistently effective
- Tributary and headwater reaches are important rearing habitat for Coho
- Positive fish response more likely with strong density-dependence
- Wood projects require intensive treatment to generate a fish response
- Early emigration of Coho observed at many IMWs; factors responsible not fully understood

Is Low Escapement Impacting Restoration Response?

- If no evidence of density dependence focus on actions that impact density independent mortality factors
- If density dependence is evident, focus on increasing habitat availability



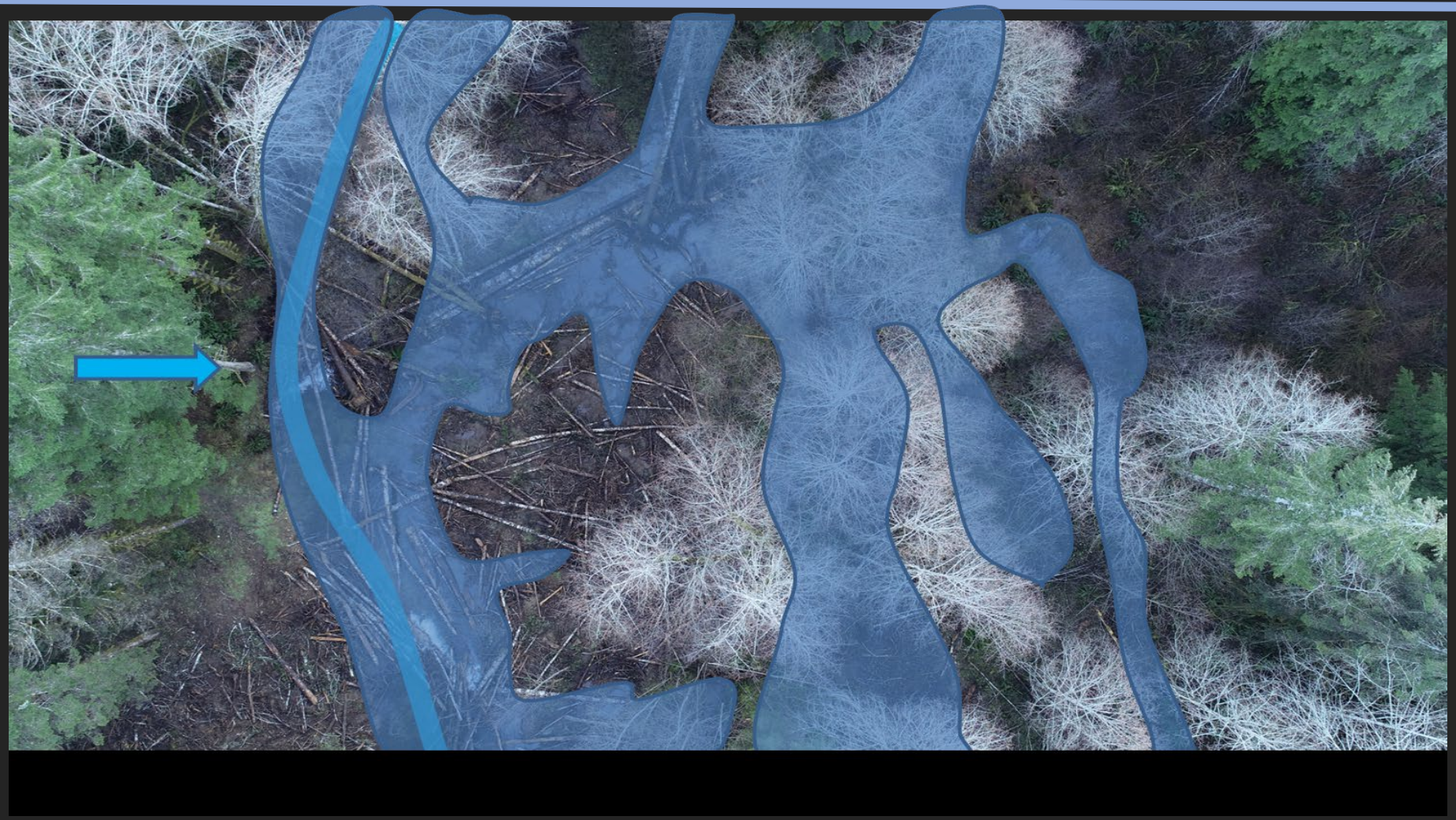
Effective Wood Projects

- Successful wood treatment projects all included:
  - Concertation of wood placement
  - Repeated wood applications
  - Treated sites that trap and retain transported wood and sediment
  - Enhanced connection between channel and floodplain
- Apply wood treatments in watersheds with clear evidence of density-dependence

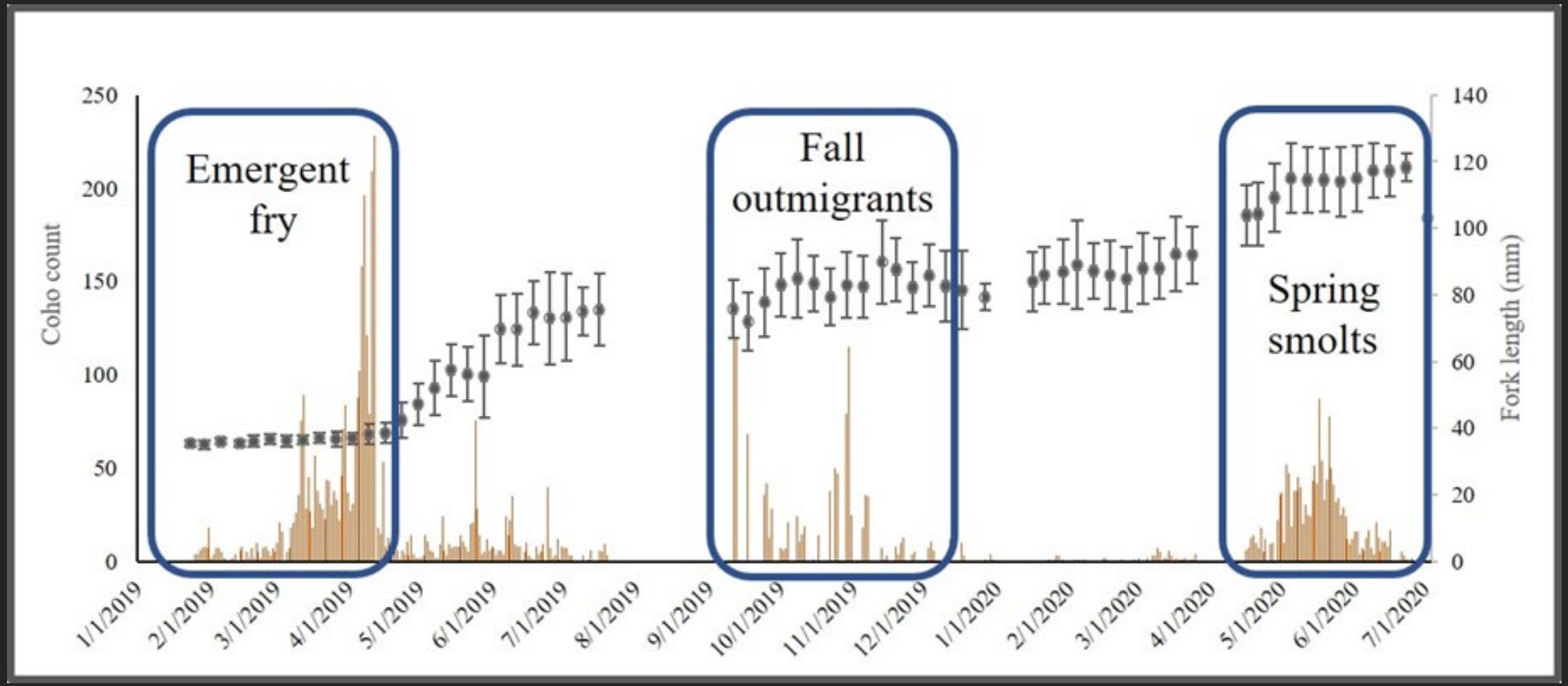
Abernathy Creek Project

Photos: Cowlitz Indian Tribe; Eli Asher

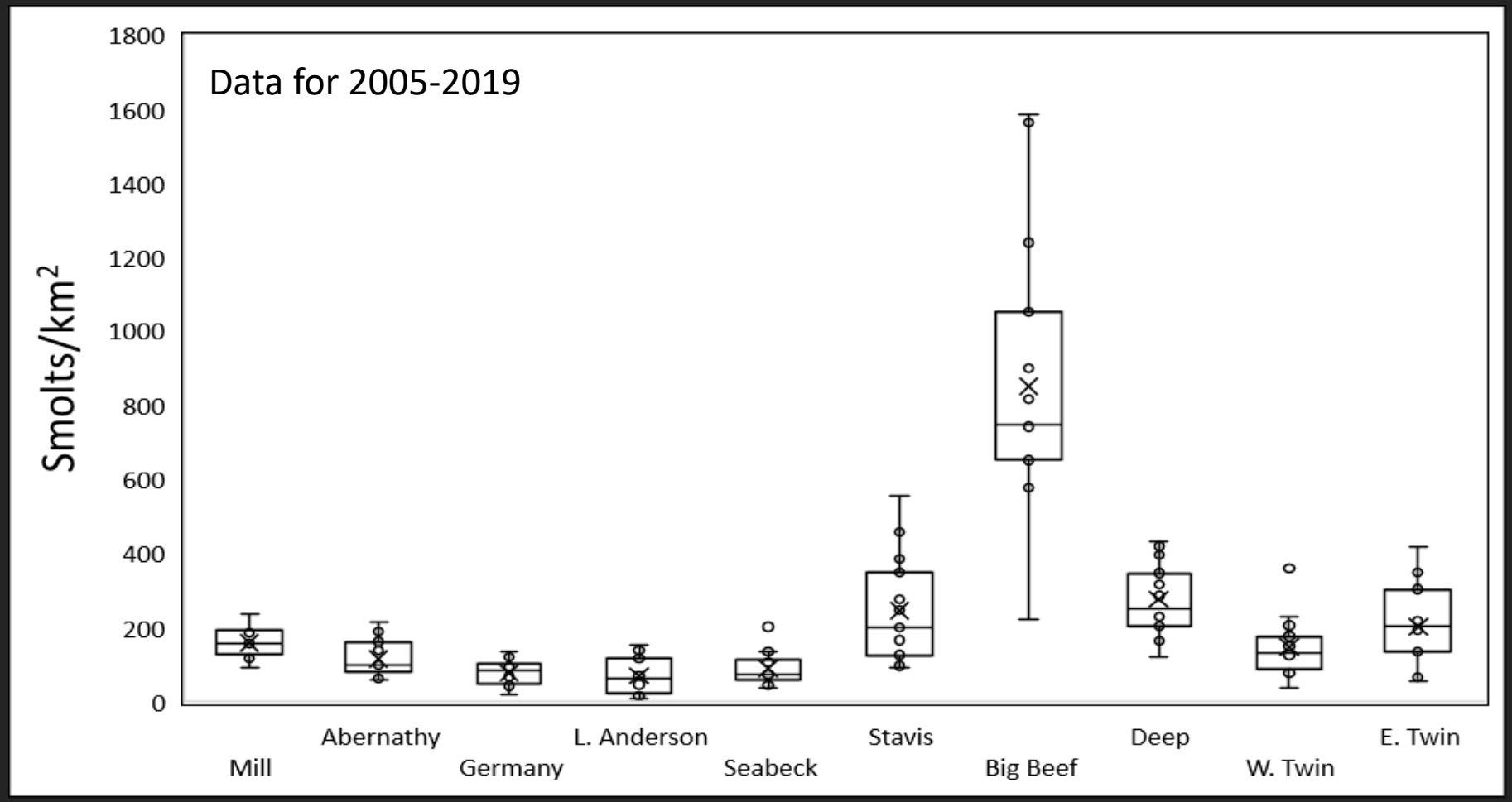
Post-Treatment Channel Response



Juvenile Coho Emigration – Abernathy Creek



IMW Watershed Coho Smolt Production



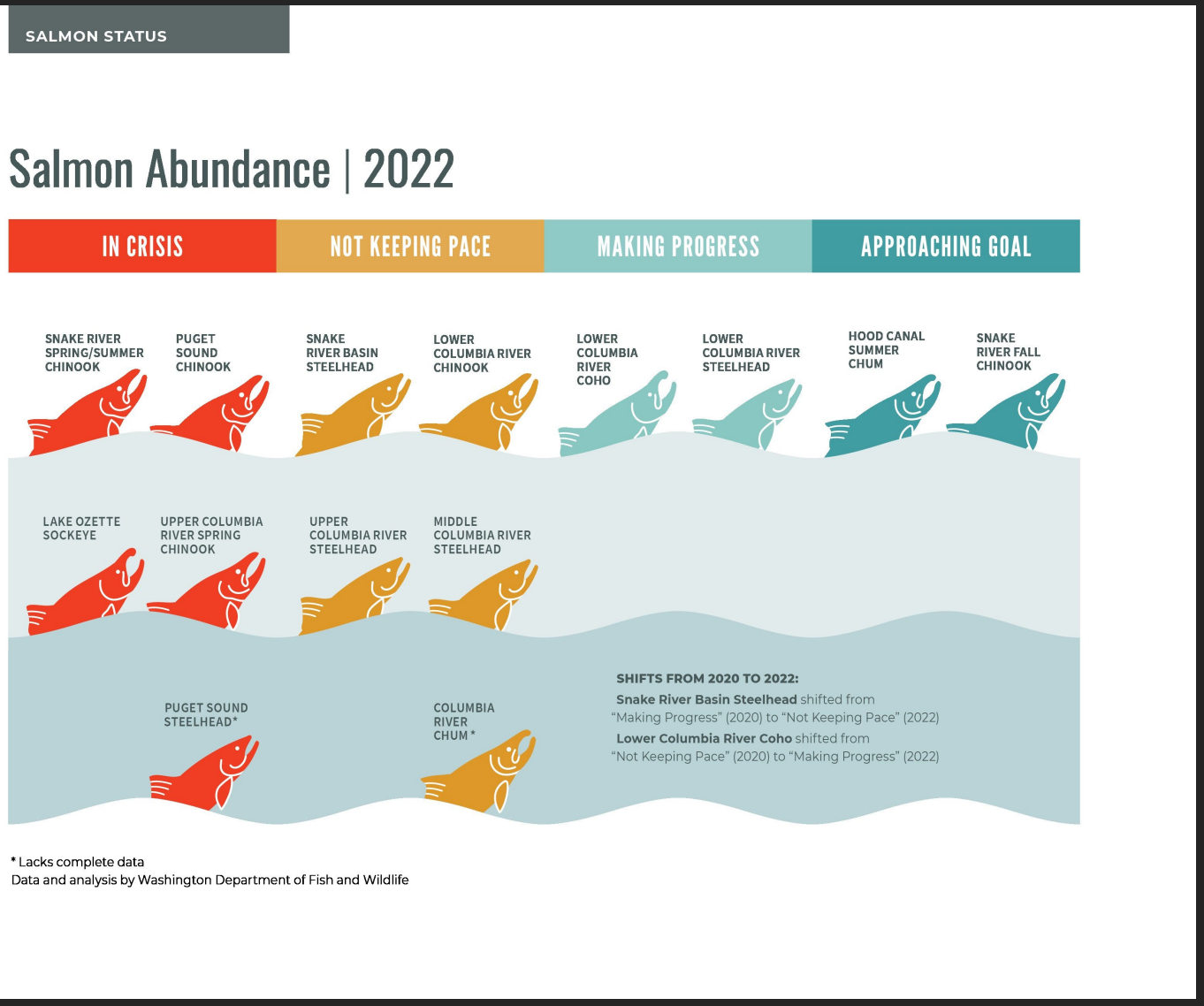
Key Questions

- What habitat factors that have the greatest influence on salmon populations:
  - What causes emigration of Coho fry and parr?
  - What causes the spatial variation in salmon production?
  - Why was there no detectable Steelhead response in the western WA IMWs?

Conclusions

- Habitat restoration contributes to salmon recovery
- Some restoration treatment types are consistently effective
- Fish response expected to be greater with strong density-dependence
- Fish response at IMWs has generally been modest
- Better identification of the factors controlling salmon production is required to improve results

Lack of Progress



- Over two decades of salmon recovery efforts in the PNW Region – but fish response has been slow
- In the Columbia Basin, $9 billion has been spent on salmon recovery to date (Jaeger and Scheuerell 2023): naturally spawning populations at less than 5% of historic levels
- In WA only a few populations of Chinook or steelhead have increased in abundance since listing

GSRO (Governor's Salmon Recovery Office). 2022. State of salmon report. GSRO, Olympia, Washington. Available: https://stateofsalmon.wa.gov.

EXTRA SLIDES

PERSPECTIVE

Why Aren't Salmon Responding to Habitat Restoration in the Pacific Northwest?

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Declines in populations of Pacific salmon *Oncorhynchus* spp. in the Pacific Northwest have led to listings under the Endangered Species Act. One objective of current recovery efforts is the restoration of freshwater and estuarine habitats, which had been occurring prior to Endangered Species Act listing but increased dramatically afterwards. However, few listed populations are improving. We believe that there are five factors contributing to the lack of population response to habitat restoration:

- Not enough restoration has been done.
- We are not doing the right things in the right places at the right times.
- Ongoing habitat degradation is offsetting restoration benefits.
- Not enough time has passed.
- Monitoring has been inadequate to detect changes in Pacific salmon abundance.

All factors contribute to the disappointing progress on Pacific salmon recovery, although their importance varies. Two factors are more consistently significant than the others. Resources available to address habitat damage remain insufficient. The scale of the problem is large, so the response needs to be correspondingly large to yield desired outcomes. Of equal significance is the failure of restoration programs to identify elements controlling fish production. Implementing the right projects in the right places is key to improving the outcomes of restoration.

INTRODUCTION

The abundance of many populations of Pacific salmon *Oncorhynchus* spp. in Washington, Oregon, and California has declined dramatically over the past 150 years (Nehlsen et al. 1991; Ford 2022), leading to listing of 28 distinct evolutionarily significant units (ESUs) across five species (Chinook Salmon *O. tshawytscha*, Coho Salmon *O. kisutch*, Chum Salmon *O. keta*, Sockeye Salmon *O. nerka*, and steelhead *O. mykiss*) and hundreds of populations under the Endangered Species Act (ESA) (Figure 1). The vulnerable status of these populations, and the economic, cultural, and ecological significance of Pacific salmon in the Pacific Northwest have launched a regionwide, decades-long effort to recover Pacific salmon (Katz et al. 2007; Barnas et al. 2015). After almost three decades, however, few of the listed ESUs are improving (Table 1; GSRO 2020), raising questions about why we are not seeing better progress.

Many programs have been established to address declining abundances of salmon and steelhead. These programs are conventionally segregated into four major management sectors: harvest, hatcheries, hydropower, and habitat (Nehlsen et al. 1991; NRC 1996; Ruckelshaus et al. 2002). Impacts on Pacific salmon abundance from degradation of spawning, rearing, and migration habitats are often considered the most ecologically complex and difficult to manage because of competing societal desires (NRC 1996). Habitat impacts occur across a patchwork of private, state, and federal lands with different management objectives and regulations (Lombard 2006). Addressing impacts through regulatory mechanisms, therefore, has been challenging. Regulatory protections have been augmented by active restoration of degraded freshwater and estuarine habitats. The restoration effort has been supported by a considerable investment; billions of dollars have been dedicated to Pacific salmon recovery over the past several decades in the Pacific Northwest (GSRO 2020). Nonetheless, most salmon and steelhead populations have shown little response. In Washington, for example, only two listed ESUs are nearing goals established in recovery plans, Hood Canal summer Chum Salmon and Snake River fall Chinook Salmon (Table 1). Among the 12 other listed ESUs in the state, only 2 have made modest progress since listing but are far from meeting recovery goals. The four improving ESUs have been influenced by changes in harvest, hatchery practices, and dam operations (for Snake River fall Chinook Salmon and Snake River steelhead) in addition to habitat restoration efforts. Thus, it is unclear the extent to which habitat restoration has contributed to improvement. The remaining 10 ESUs have not increased in abundance since listing, with 3 ESUs considered to be "in crisis" (GSRO 2020).

So, why are we not seeing more progress? In this paper, we identify five factors that help explain why salmon and steelhead populations may not be responding as expected to habitat restoration efforts. It is our hope that by identifying the factors contributing to lack of progress, we can accelerate the

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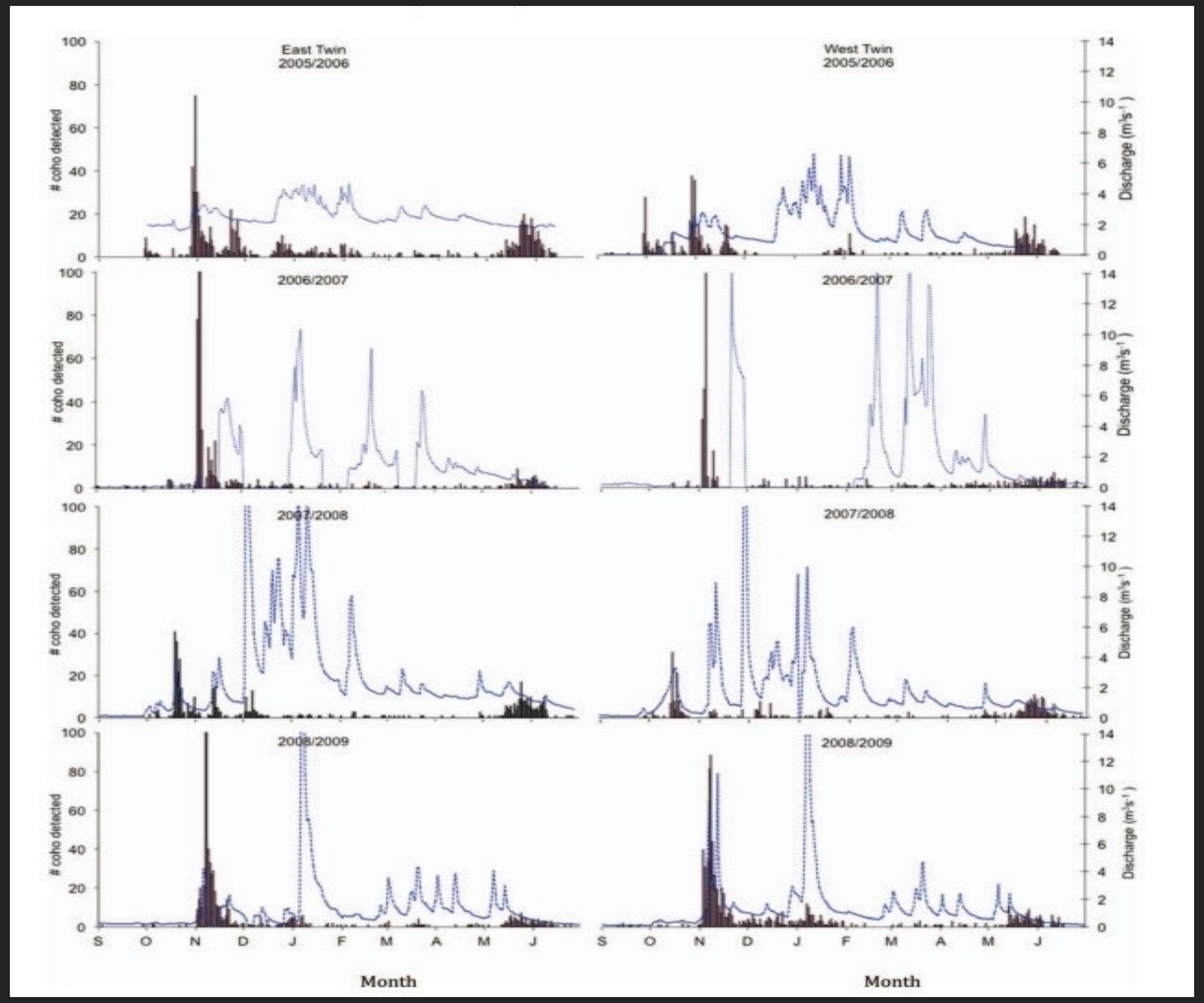
Five Reasons for Lack of Progress

1. Not enough restoration has been done
2. We are not doing the right things in the right places
3. Ongoing habitat degradation is offsetting restoration benefits
4. Not enough time has passed
5. Monitoring has been inadequate to detect changes in Pacific salmon abundance

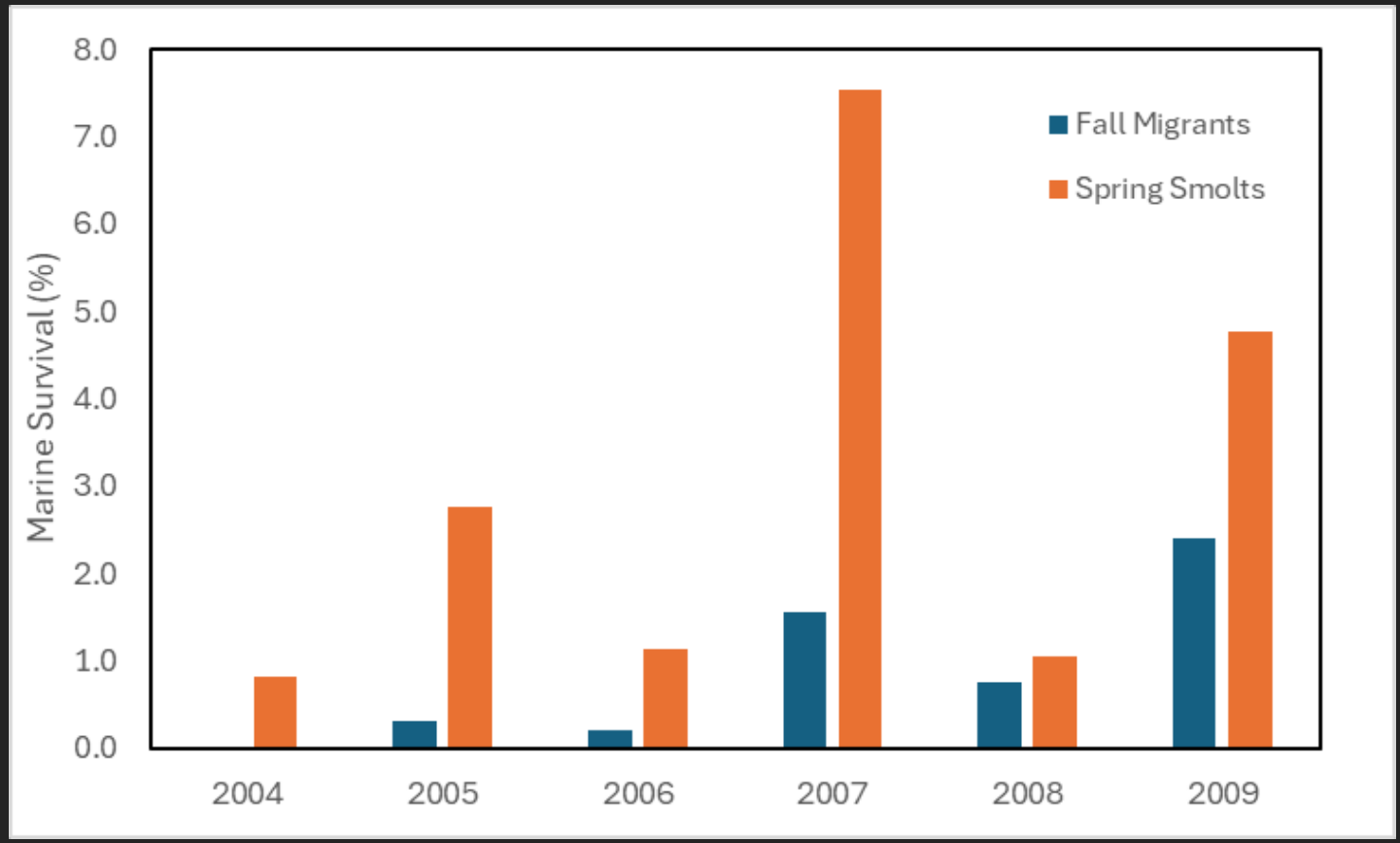
Juvenile Coho Emigration- East and West Twin R.



Roni et al. 2012

Migration Timing and Marine Survival

- Both Spring and fall migrants contribute to adult returns
- Survival of spring migrants is more than 3X higher than fall migrants



(Bennett et al. 2014)

Abernathy Creek Coho Response

- Coho smolt production increased posttreatment
- No Steelhead response