

Jeffery C. Allen
Chair
Idaho

Ed Schriever
Idaho

Doug Grob
Montana

Mike Milburn
Montana



Northwest Power and Conservation Council

KC Golden
Vice Chair
Washington

Thomas L (Les) Purce
Washington

Ginny Burdick
Oregon

Louie Pitt, Jr.
Oregon

April 2, 2024

MEMORANDUM

TO: Council Members

FROM: Mark Fritsch

SUBJECT: Final report for Project #2016-001-00¹, *BPA Project Action Effectiveness Monitoring (AEM) Programmatic*

BACKGROUND:

Presenter: Dave Kaplowe, Idaho and Montana Implementation Manager for *Bonneville Power Administration*; and Dr. Phil Roni - *Principal Scientist with Cramer Fish Sciences and an Affiliate Professor at the University of Washington School of Aquatic and Fishery Sciences.*

Summary: Dave and Phil will provide an overview of the purpose and results of the recently completed Action Effectiveness Monitoring (AEM) project (2014 to 2023) that was designed to evaluate and provide both short-term and long-term results for previously completed and newer habitat restoration and improvement projects in the Columbia River Basin.

Relevance: This project has provided information and understanding in the development of the Fish and Wildlife Program's effort to refine and establish the Columbia Basin Tributary Habitat RM&E Strategy. The AEM project's design programmatically evaluated reach-scale effectiveness of

¹ In October 2015, two AEM projects (i.e., Project #2011-008-00 and Project #2012-011-00) were consolidated into Project #2016-001-00.

salmon and steelhead habitat improvement and restoration actions in the interior Columbia River Basin to assist in ensuring effective restoration techniques are being used in the F&W Program.

Workplan: 2024 Fish and Wildlife Division Work Plan; Program planning and coordination; Program implementation

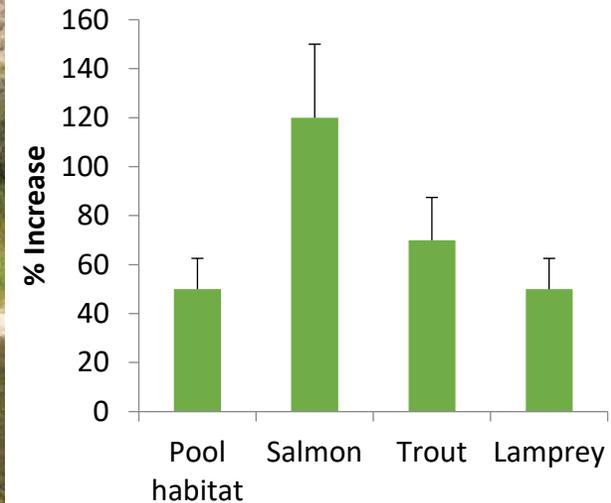
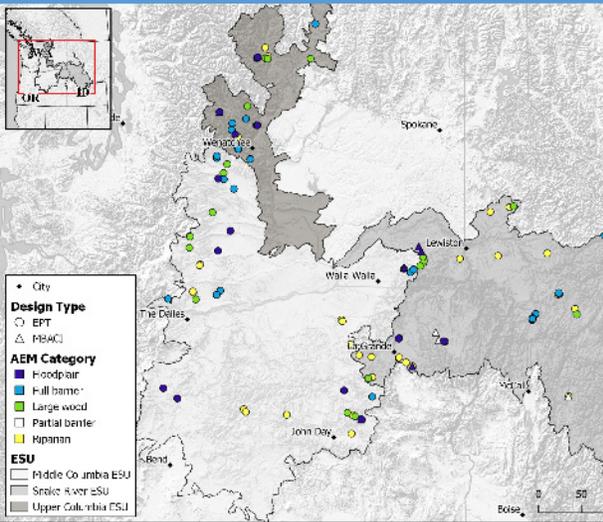
Background: The Action Effectiveness Monitoring Program (AEM) was developed in 2013 and implemented in 2014 to assist in addressing the need for an approach for project-level effectiveness monitoring in the Fish and Wildlife Program. The goals of the AEM approach were to: (a) quantify localized improvements in habitat and juvenile salmonid abundance resulting from restoration, and (b) help guide future restoration and improvement efforts to ensure the Fish and Wildlife Program is implementing effective habitat restoration techniques. Specifically, AEM is designed to evaluate project actions across the interior Columbia River Basin to: a) determine the effect of different actions on fish and habitat, b) why some projects within an action type are more effective than others, and c) whether there are differences in project effectiveness among regions.

The AEM project evaluated five major project types including: fish passage barriers, large wood placement, riparian planting and invasive vegetation removal, floodplain enhancement, and partial fish passage barriers. The AEM project has provided detailed results on the success of these habitat improvement actions and adaptive management recommendations for future habitat improvement projects in the Basin.

More Info:

- [Columbia Basin Tributary Habitat RM&E Strategy](#)
- [Action Effectiveness Monitoring, 2022 Annual and Final Report](#)

Action Effectiveness Monitoring Program Final Results and Adaptive Management Recommendations (2013 to 2023)



Phil Roni^{1,2}, Shelby Burgess¹, Kai Ross¹ and Dave Kaplowe³



¹Watershed Sciences Lab, Cramer Fish Sciences

²School of Aquatic and Fisheries Sciences, University of Washington

³Bonneville Power Administration



Presentation Outline

- Background on AEM
- Methods, Results and Recommendations
 - Complete passage barriers
 - Partial passage barriers
 - Large wood placement
 - Riparian planting and invasive plant removal
 - Floodplain restoration
- Summary
 - Adaptive management recommendations
 - Monitoring recommendations
 - Publications



ACTION EFFECTIVENESS MONITORING

2022 Annual and Final Report



Project Number 2016-001-00

Report covers work performed under BPA contract #71969, 74809, 78579

Report was completed under BPA contract #78579

Report covers work performed from March 1, 2022 – September 30, 2023

Prepared by:

Phil Roni, Jake Kvistad, Shelby Burgess, and Kai Ross

Cramer Fish Sciences

Watershed Sciences Lab

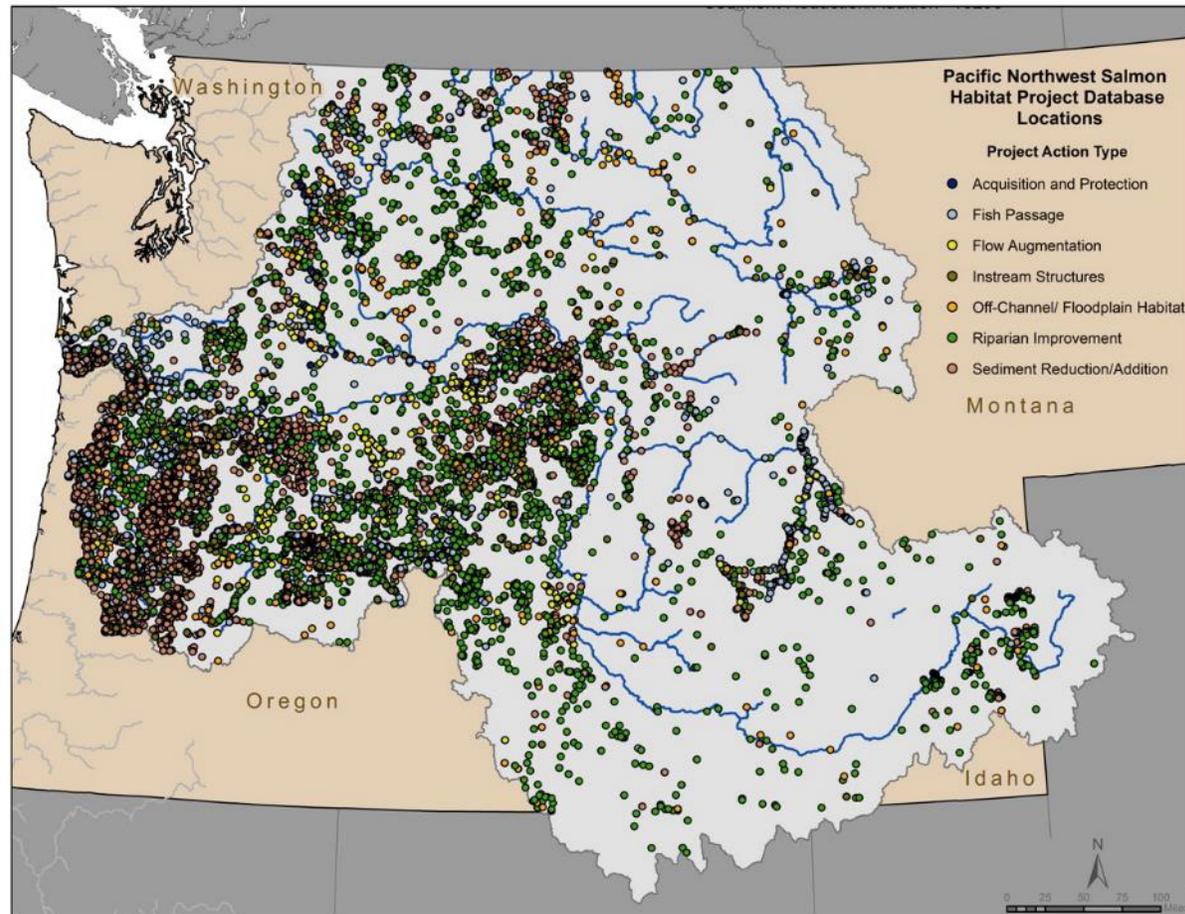
1125 12th Avenue NW, Suite B-1

Issaquah, WA 98027

Report created: August 23, 2023

"This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA."

Action Effectiveness Monitoring (AEM): A brief history



- > 5,000 habitat projects since 2005
- Prior to 2014 done inconsistent and little info on effectiveness
- Recommendations for programmatic approach by NWPC, ISRP, etc.
- Developed in 2013, initiated in 2014
 - Roni et al. (2014, 2015)
- Two separate contracts

AEM Goals

- Determine reach-scale physical & biological effectiveness of common habitat improvement (restoration) techniques in interior Columbia Basin
- Help guide future restoration efforts for BPA Fish and Wildlife Program
- Cost-effective approach that doesn't require monitoring every project
- New (>2014) and completed projects (<2014)
- *Compatible with SRFB*, CHaMP*, some data collection by partners*

**Important constraints*

AEM Overarching Questions/Hypotheses

- What is the effect of different action categories on habitat and fish at the reach scale?
- Within an action category, why are some projects more successful than others in producing physical and biological improvements?
- Are there differences among geographic areas (ESUs) in physical and biological success of action types?

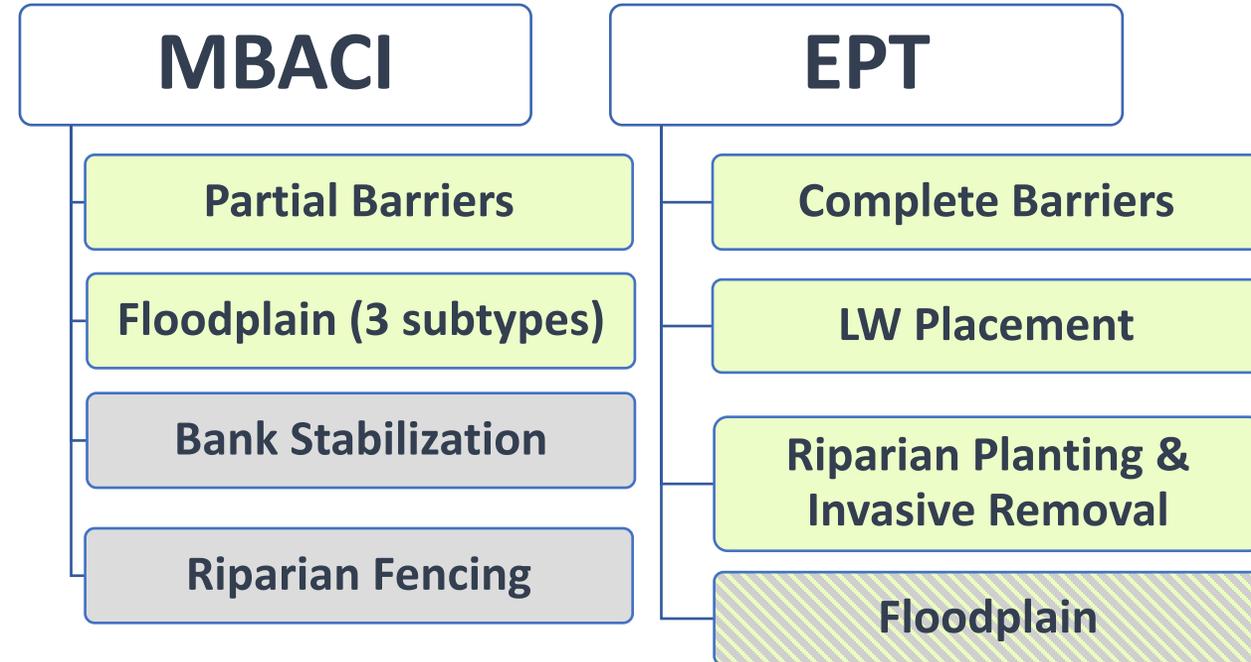
AEM Study Design

Project planned for after 2014

- Multiple-before-after control-impact (MBACI)
- 12-15 projects per restoration action type
- Monitoring in years -2, -1, and +1, +3, +5

Project completed before 2014

- Extensive post-treatment (EPT)
- 30+ projects w/ paired treatment & controls
- Treatment and control selection critical
- Sampling once well after restoration



Ultimately monitored 128 projects



◆ City

Design Type

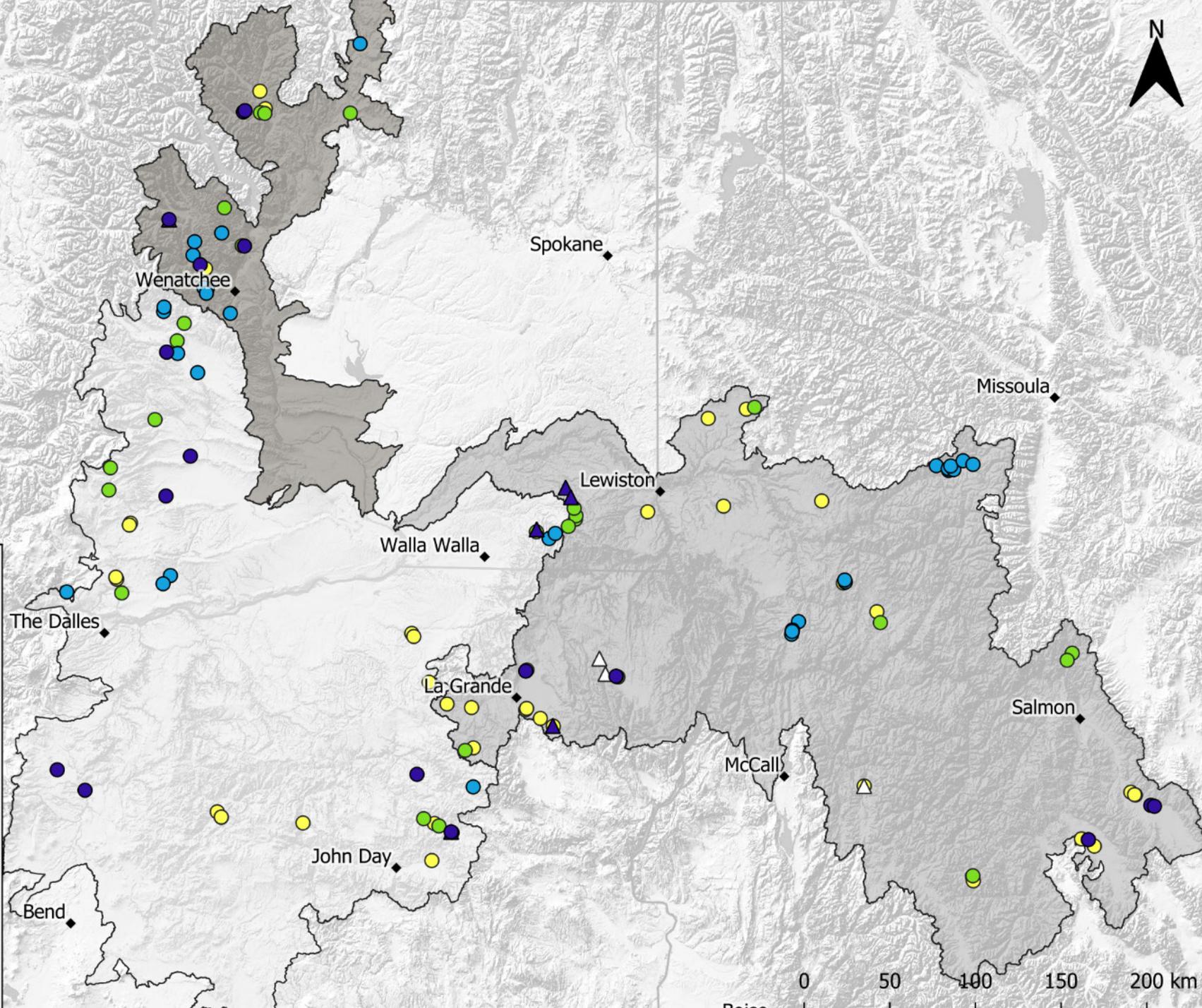
- EPT
- △ MBACI

AEM Category

- Floodplain
- Full barrier
- Large wood
- Partial barrier
- Riparian

ESU

- Middle Columbia ESU
- Snake River ESU
- Upper Columbia ESU



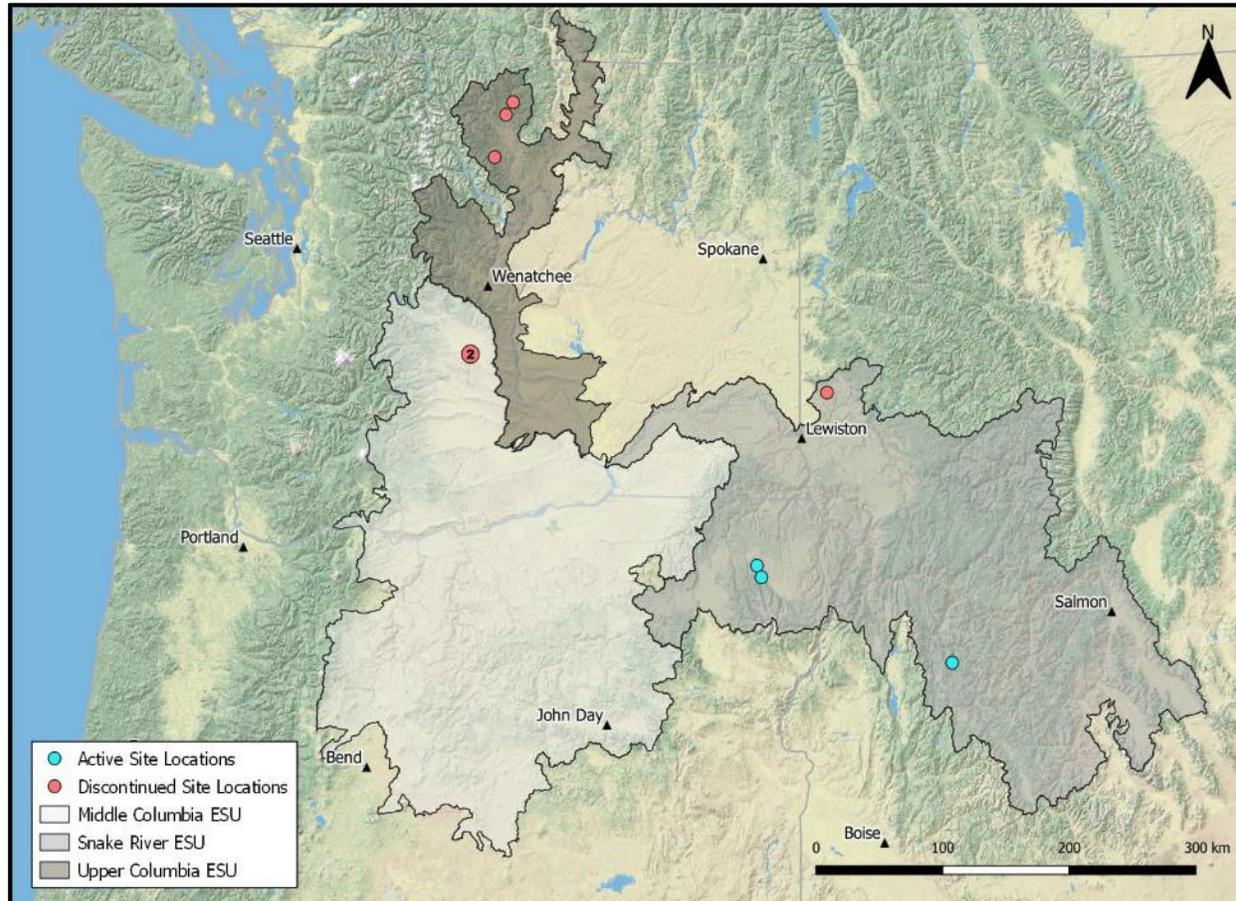
MBACI Adaptive Management

- Concerns with MBACI implementation from 2014 to 2017 led to AEM Program being put out to bid
- AEM put all under one contract in Feb. 2018
- We reviewed all data, protocols, and sites in early 2018
- Identified issues with prior implementation
 - Restoration implementation issues
 - Control site selection (despite training)
 - Timing of data collection
 - SRFB and CHaMP protocol and data issues*

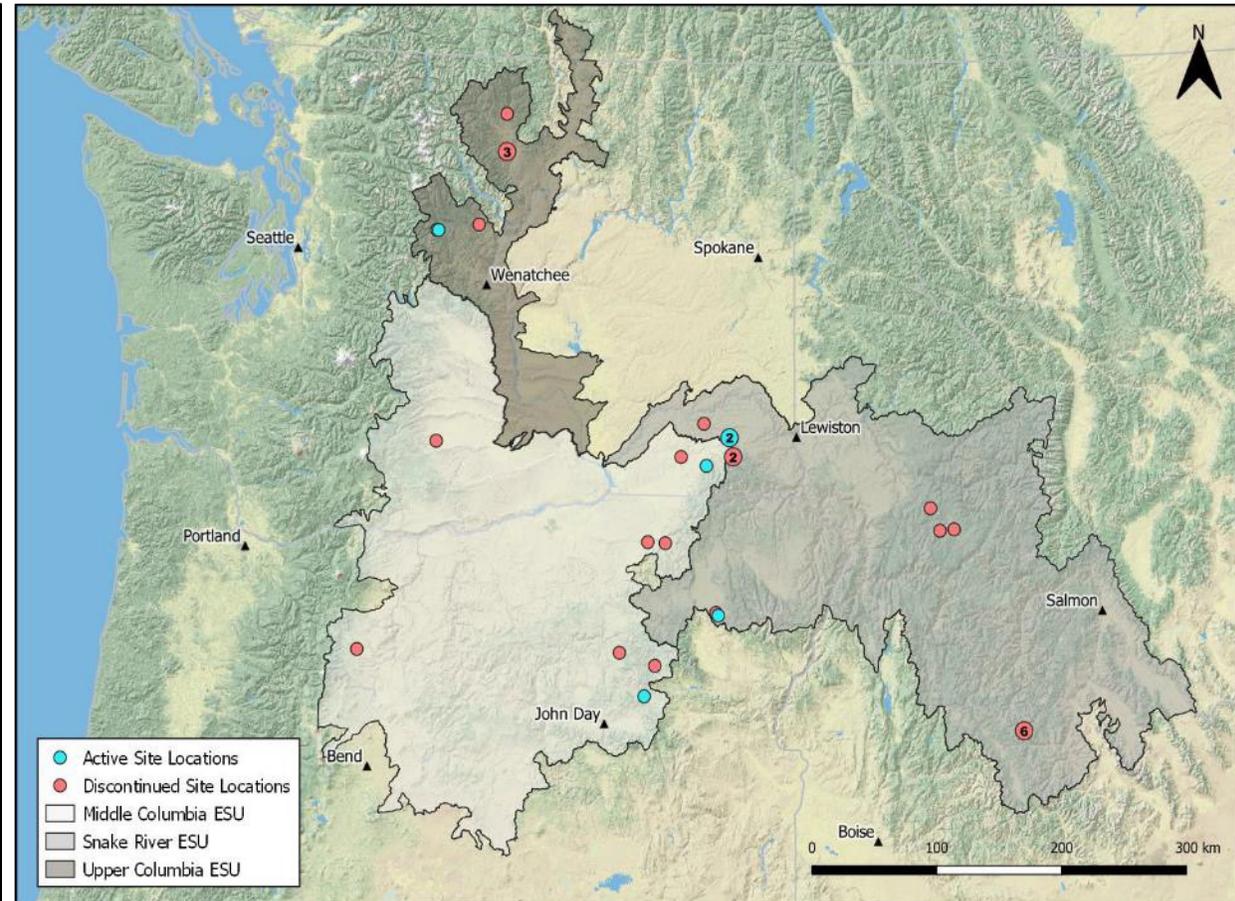


MBACI – Adaptive Management

Partial Barrier - 3 of 9 Sites OK



Floodplain Projects – 6 of 32 Sites OK



Methods and Results by Project Type

Complete Barriers



Large Wood



Riparian Planting



Partial Barriers



Floodplain (MBACI)



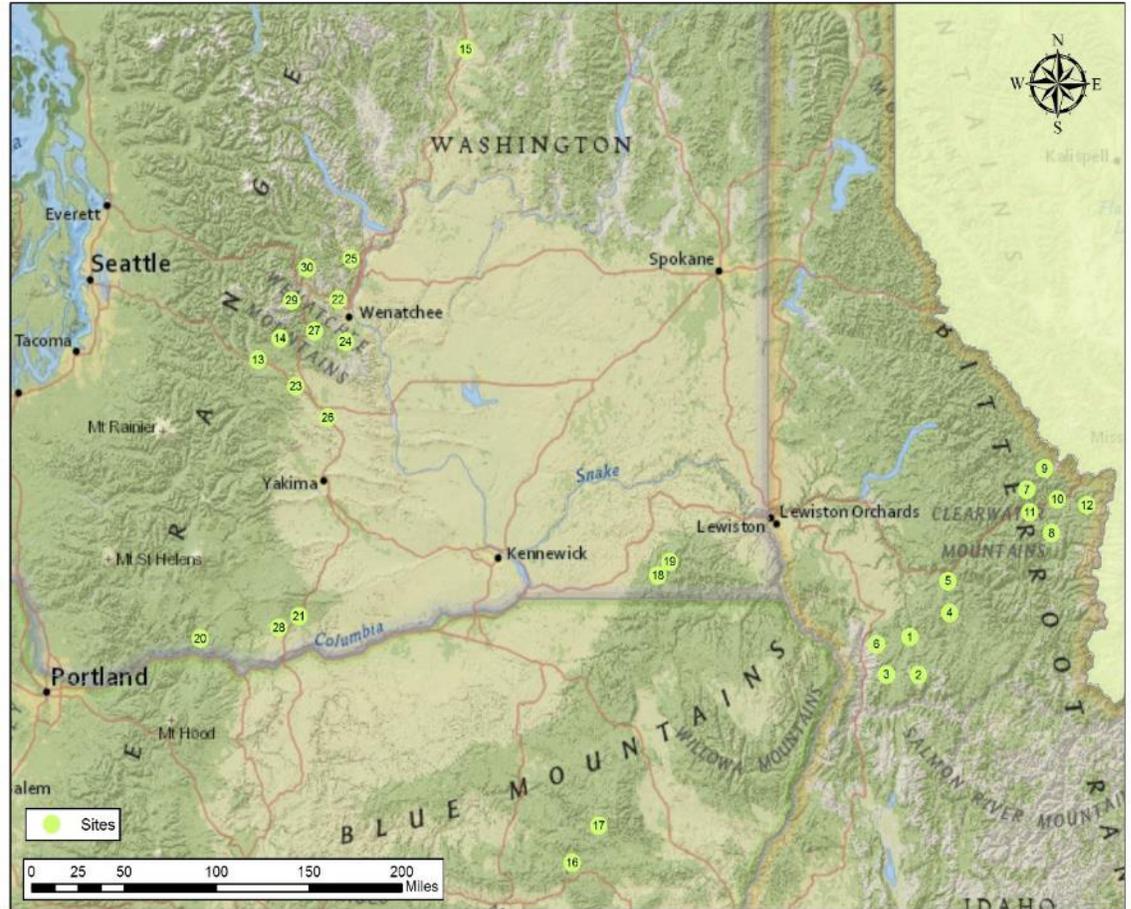
Floodplain (EPT)



Complete Barrier Removal Projects

EPT Design

- Of > 100 BPA projects since 2004, sampled 32 with suitable treatment and control reaches*
- Sampled fish and habitat above and below former barrier (culvert)
 - 3-pass electrofishing
 - Long-profile habitat survey



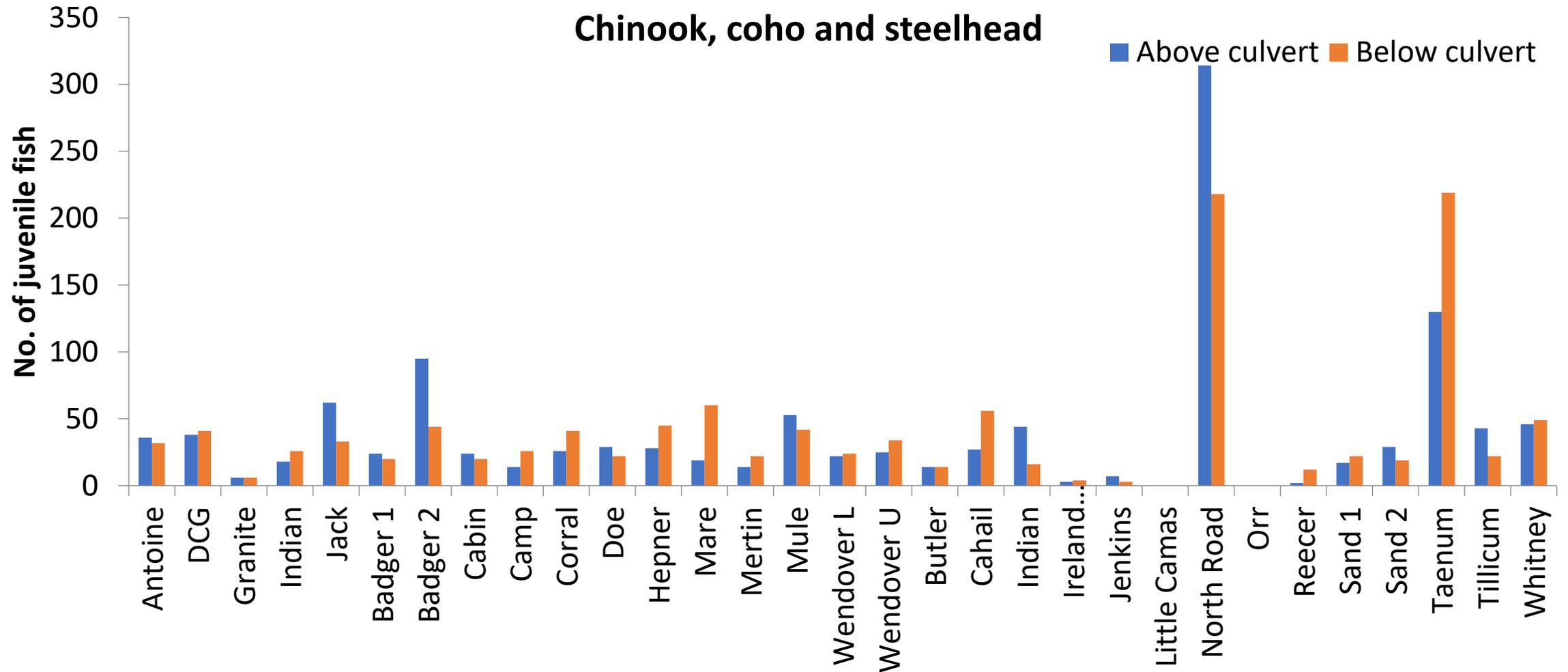
* Identified 43, but could not sample all due to fire or landowner access issues

Questions – Complete Barriers

- Are the post-barrier juvenile salmon and steelhead numbers similar above and below the barrier?
- Is there a relationship between habitat quality and the number of juvenile salmon and steelhead above and below the barrier?
- Is there a relationship between the success and the time since barrier removal?
- Does response/success differ among ESUs?



No difference in # of fish above and below former barriers



* No difference is good thing for barrier removal !

Summary - Complete Barrier Projects

- Post-treatment anadromous fish numbers similar above and below culvert
- Barrier removals successful at providing fish passage
- No relationship between project age or habitat and fish numbers above and below barrier



Recommendations – Complete Barriers

Adaptive Management

- Prioritize barrier removals for target species
- Documentation of Chinook and steelhead use of streams
- Confirm amount of habitat upstream to assist with prioritization

Monitoring

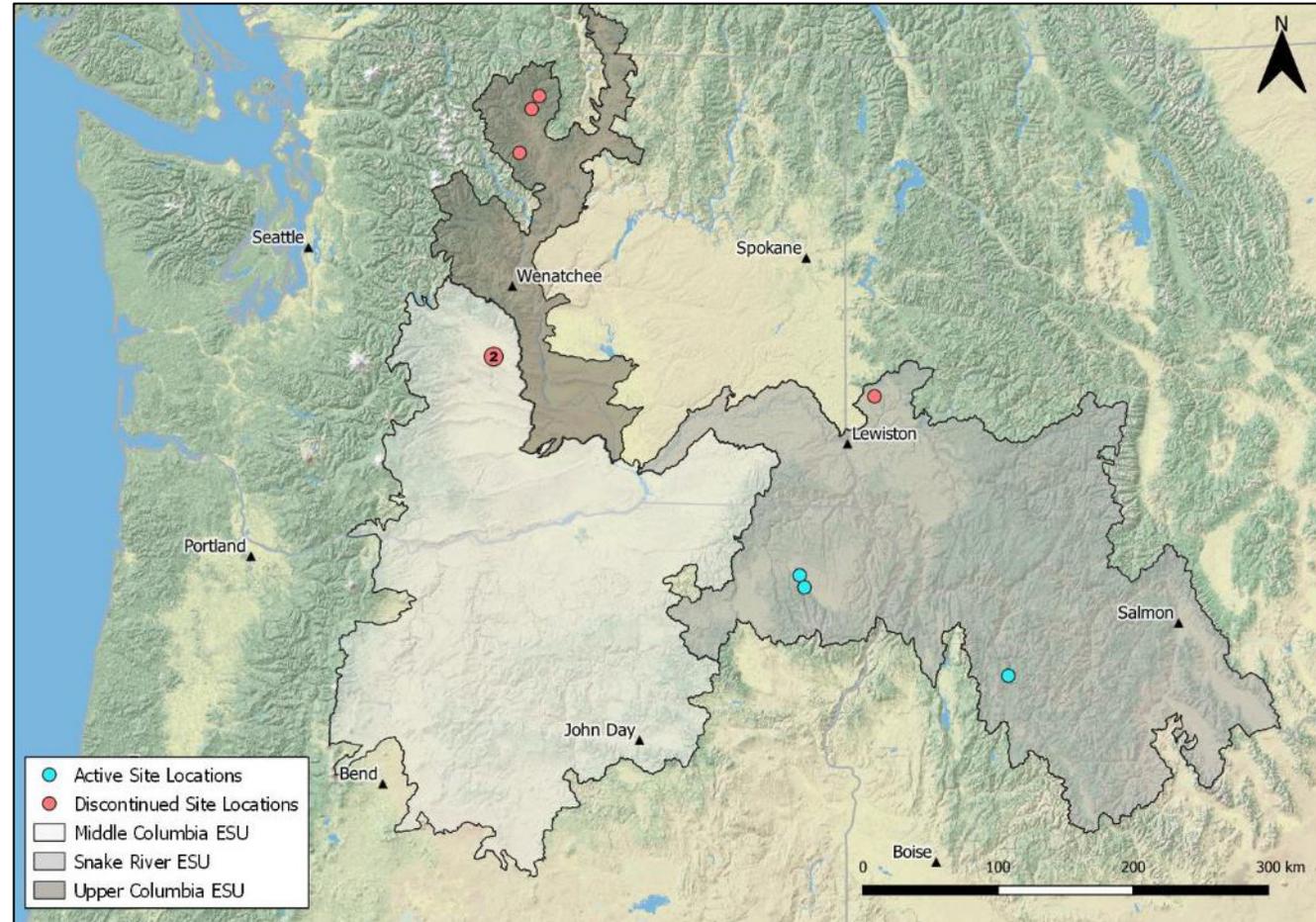
- Could be resampled at later date to examine long-term effectiveness



Partial Barrier Removal Projects

MBACI Design

- Originally 9 sites identified
- 2018 MBACI Adapt. Mgt.
 - 3 not implemented
 - 3 timing or full barriers issues
 - 3 Suitable sites
- Snorkel surveys/electrofishing
- Long-profile habitat surveys



Question – Partial Barriers

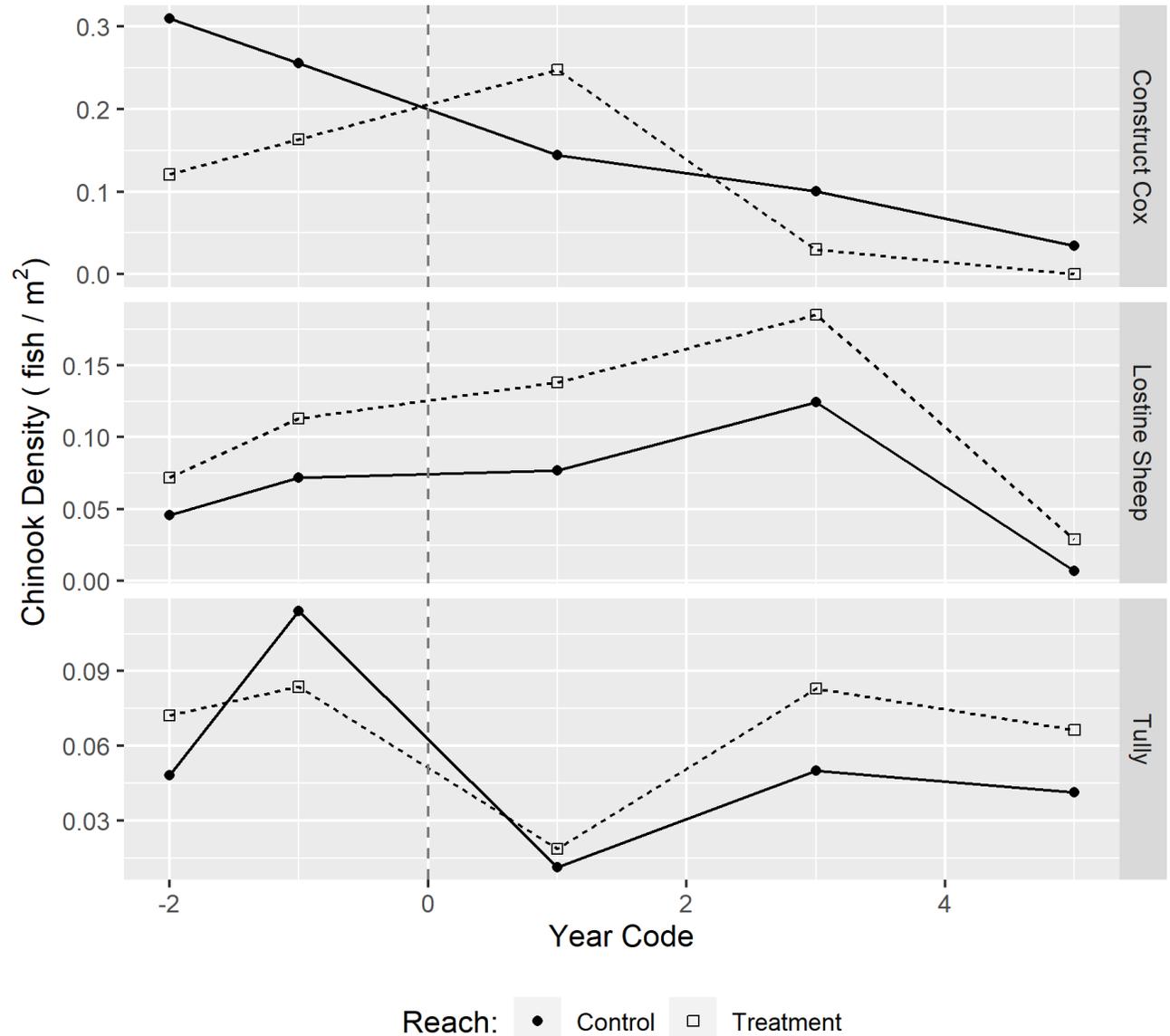
- Are the post-barrier removal juvenile salmon and steelhead numbers similar above and below the barrier?
- Is there a relationship between habitat quality and the number of salmon and steelhead before and after barrier removal?
- Have the partial-barrier removal projects continued to meet WDFW’s fish passage and design criteria?



Site name	2014	2015	2016	2017	2018	2019	2020	2021	2022
Construct Cox	Year -2	Year -1	Year +1		Year +3		Year +5		
Lostine Sheep Ridge		Year -2	Year -1*	Year +1		Year +3		Year +5	
Tully		Year -2	Year -1		Year +1		Year +3		Year +5

Results – Partial Barriers

- No differences
 - Juvenile Chinook
 - Juvenile steelhead
- Similar abundance before and after restoration
- Similar habitat above and below & before and after
- Barriers meeting fish passage design criteria



Recommendations - Partial Barrier Projects

Adaptive Management

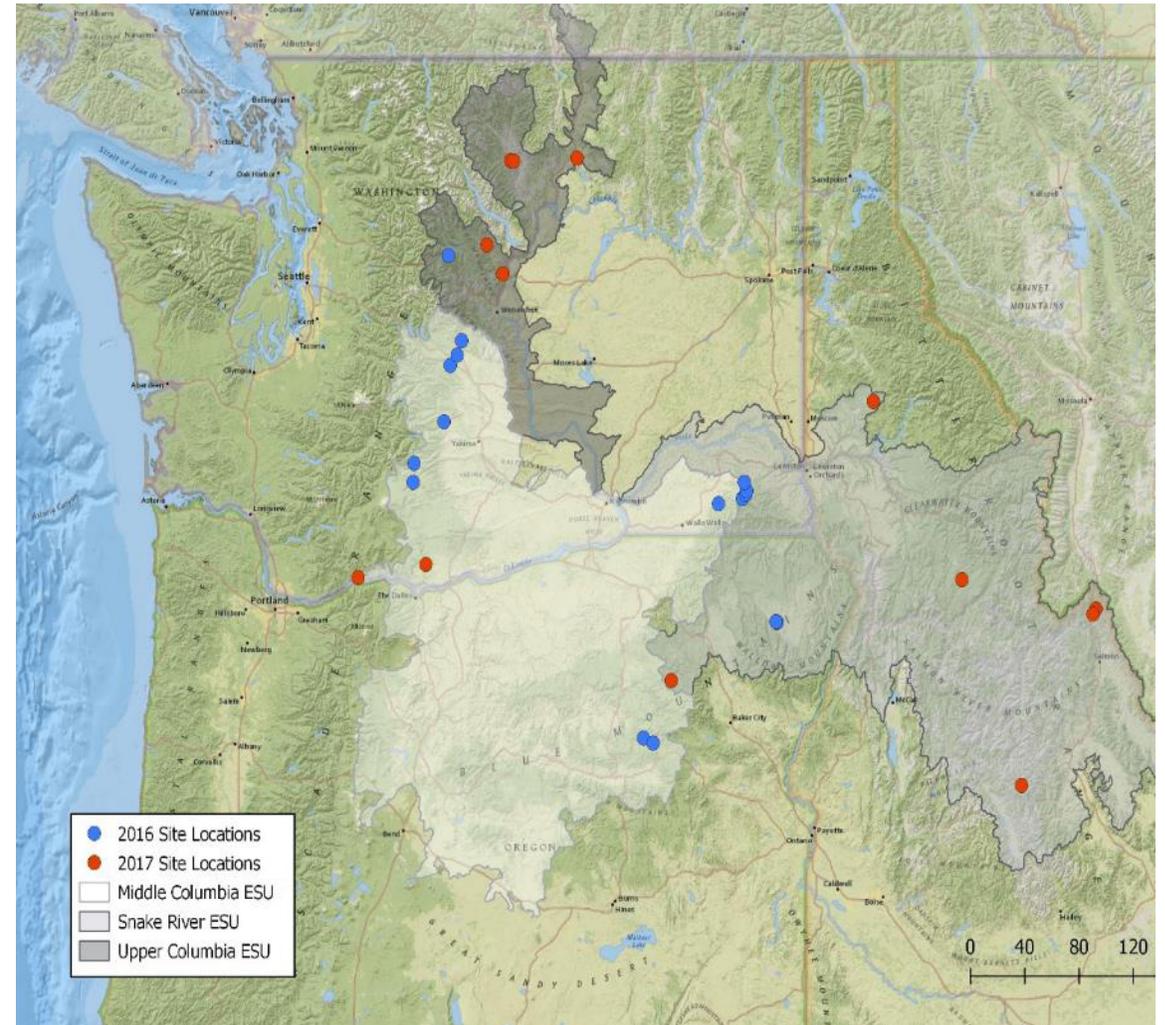
- Confirmation of Chinook and steelhead use of streams and at what flows, life stage, and seasons the barriers are limiting migration
- Consider other restoration actions to improve habitat at the barrier as well as upstream and downstream of the barrier

Monitoring

- Consider monitoring for longer particularly if it is only a barrier in some years or flows
- Consider monitoring other seasons and life stages

Large Wood Placement EPT Design

- Of 227 completed projects, identified and sampled 29 with suitable treatment and controls
- Sampled fish and habitat in treatment and control reaches
 - Snorkel surveys
 - Long-profile habitat surveys
 - Large wood surveys

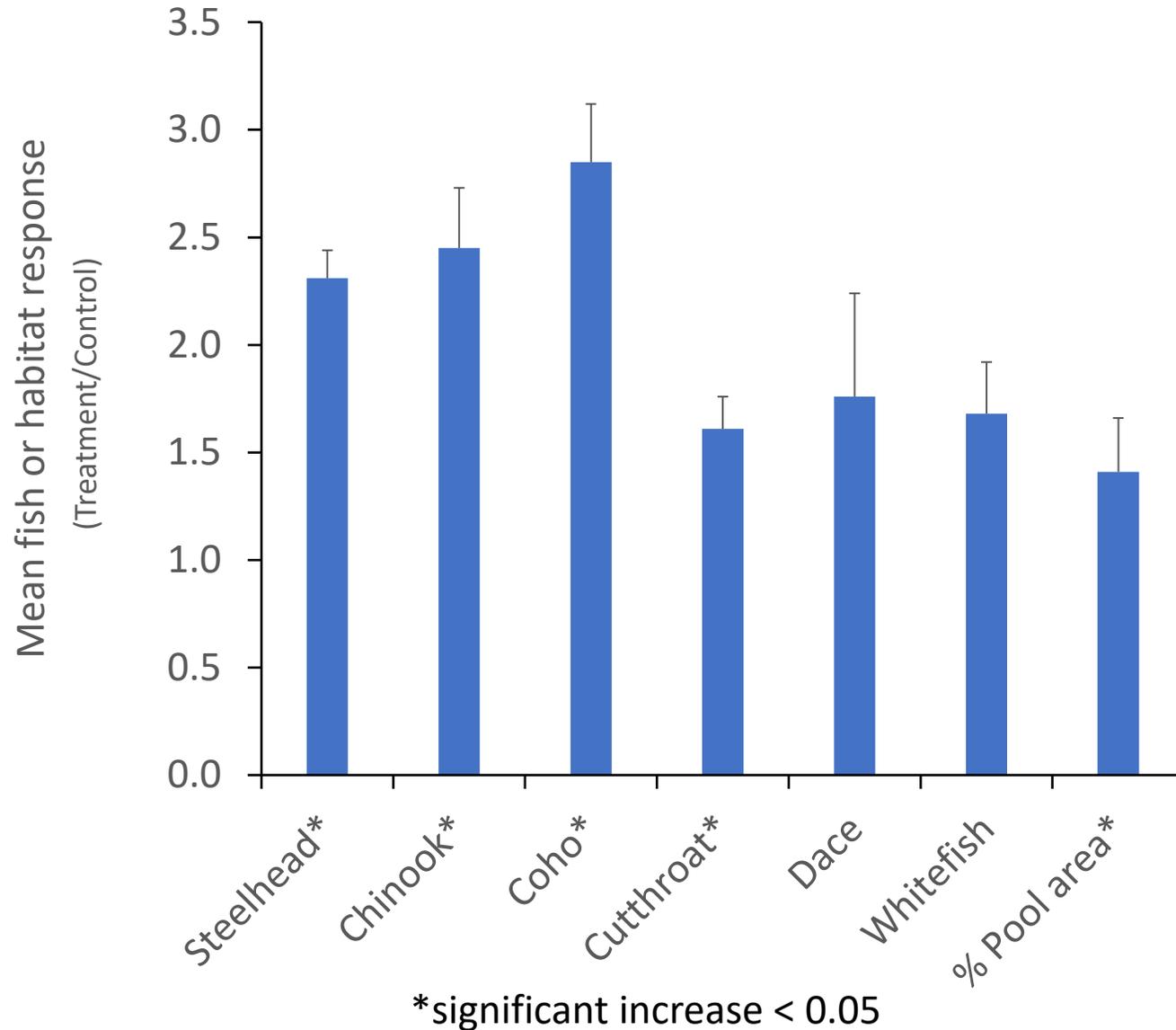


Questions – Large Wood Placement

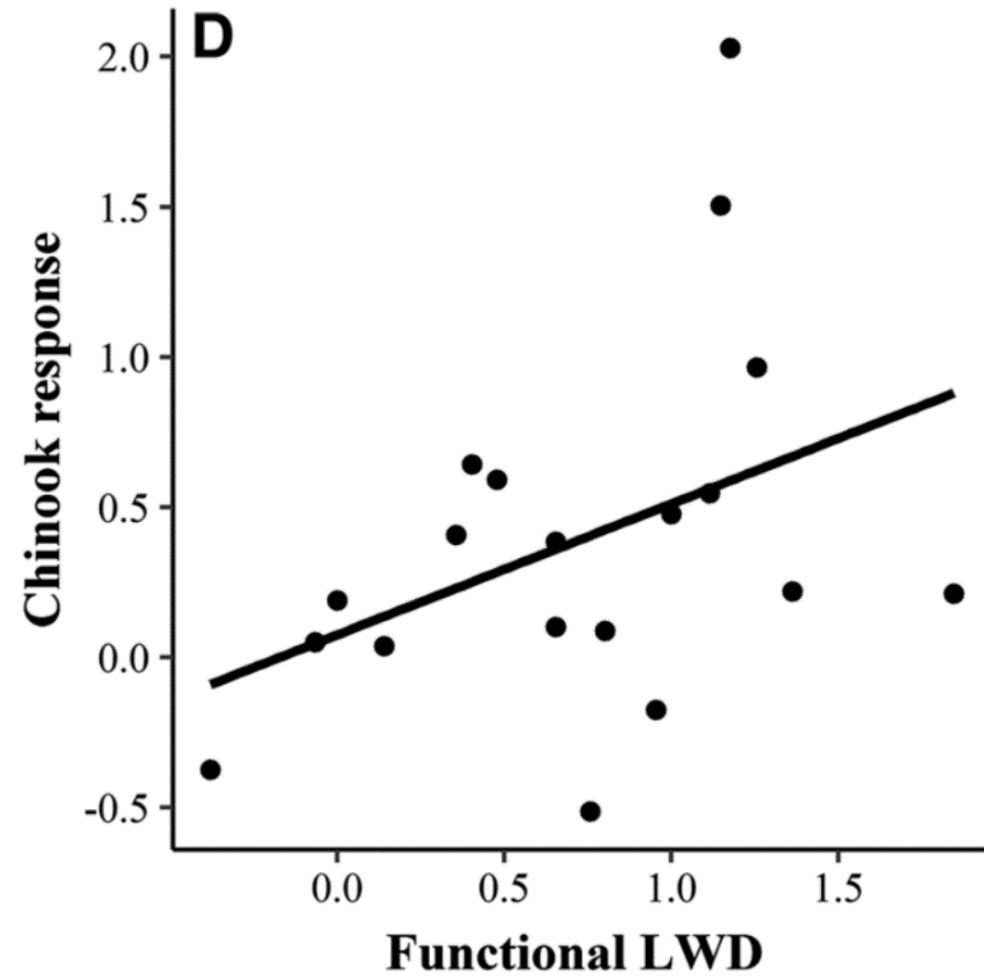
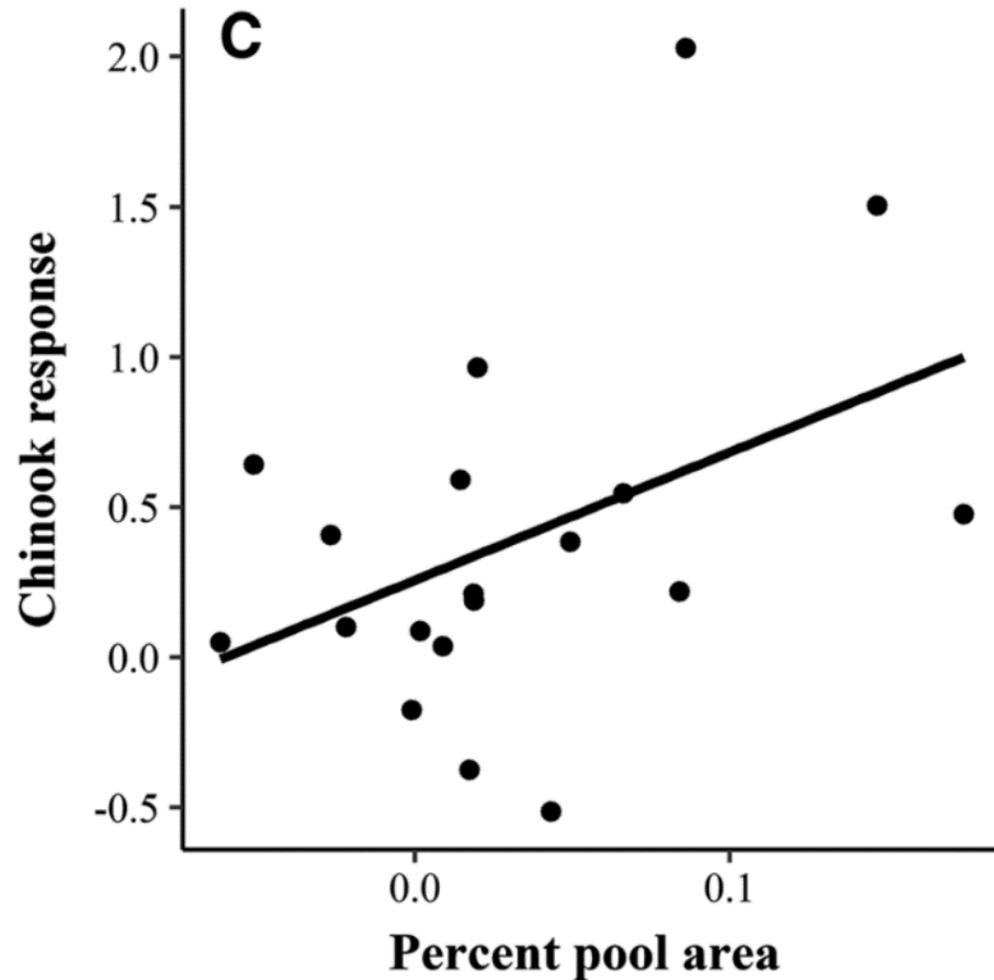
- Do juvenile salmon and steelhead numbers differ between treatment and control reaches?
- What is the effect of LWD placement on physical habitat and total and functional LWD levels?
- Is fish response to LWD placement related to difference in habitat quality among sites?
- Are there differences among ESUs in physical and biological response to LWD placement?



Results - Large Wood Placement



Juvenile Chinook Response Correlated with Percent Pool and Pool Forming Wood



Summary – Large Wood Placement

- Instream habitat (pool metrics, habitat complexity, wood) increased by >40%
- More than two-fold increase in juvenile salmonids abundance
- Projects with largest amount of “functional” wood in low flow channel most successful



Recommendations – Large Wood Placement

Adaptive Management

- Focus on placing “functional wood” that interacts with the thalweg or spans the channel
- Ensure the amount and location of placed wood is near historical targets and conditions

Monitoring

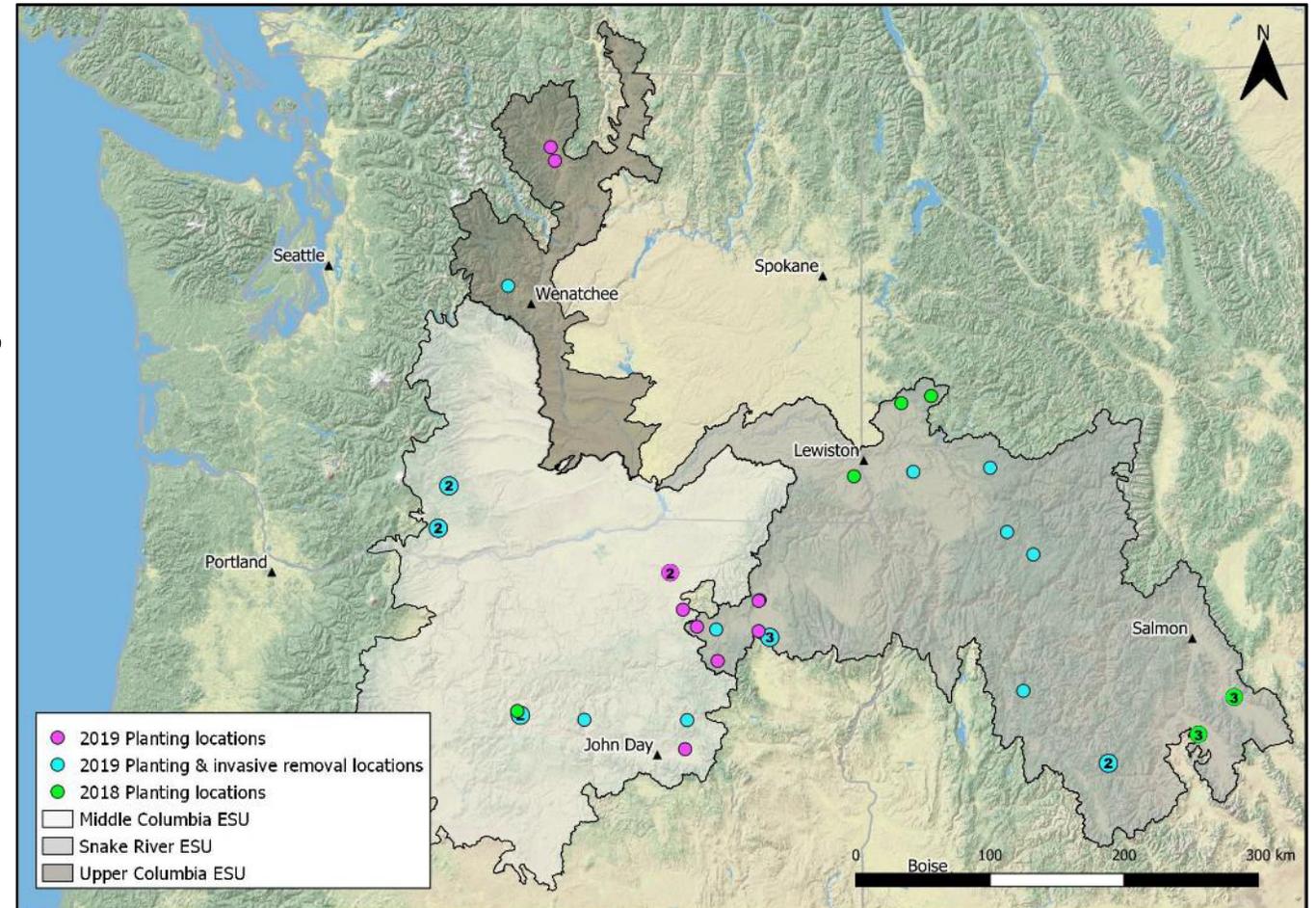
- Sites could be resampled to look at long-term response to LWD placement as well as sample some newer sites



Riparian Planting and Invasive Plant Removal

EPT Design

- Sampled 41 with suitable treatment and controls
- Measured riparian plant species abundance, richness, diversity, vegetation structure and cover, stream shade
- Biggest challenge was locating suitable sites

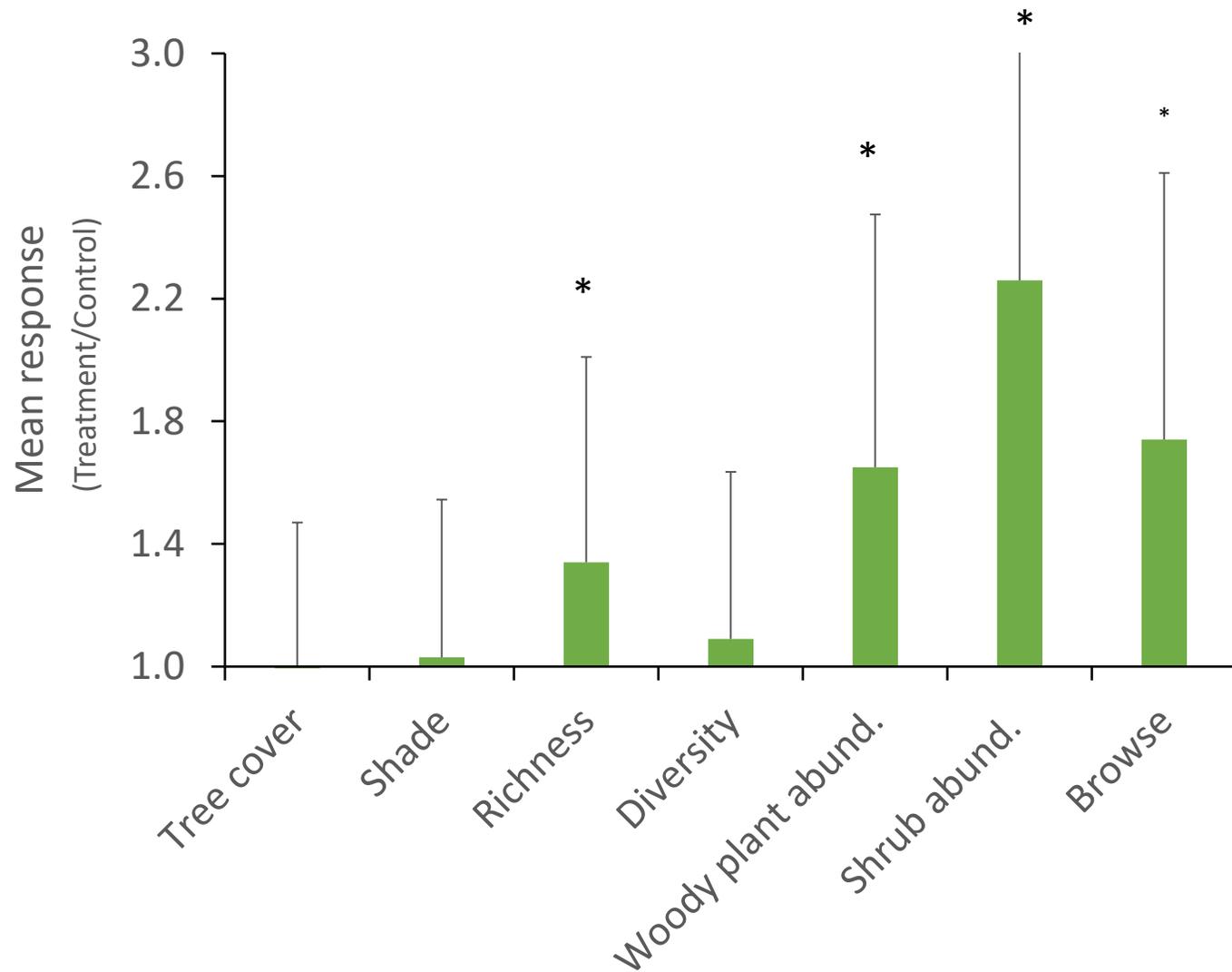


Questions – Riparian Planting and Invasive Removal

- Did treatment (planting and invasive vegetation removal) lead to increases in native species abundance and diversity?
- Did treatment lead to increased cover of native woody plant species?
- Did treatment lead to increased riparian condition (e.g., structure, shade)?
- Has riparian vegetation structure changed?

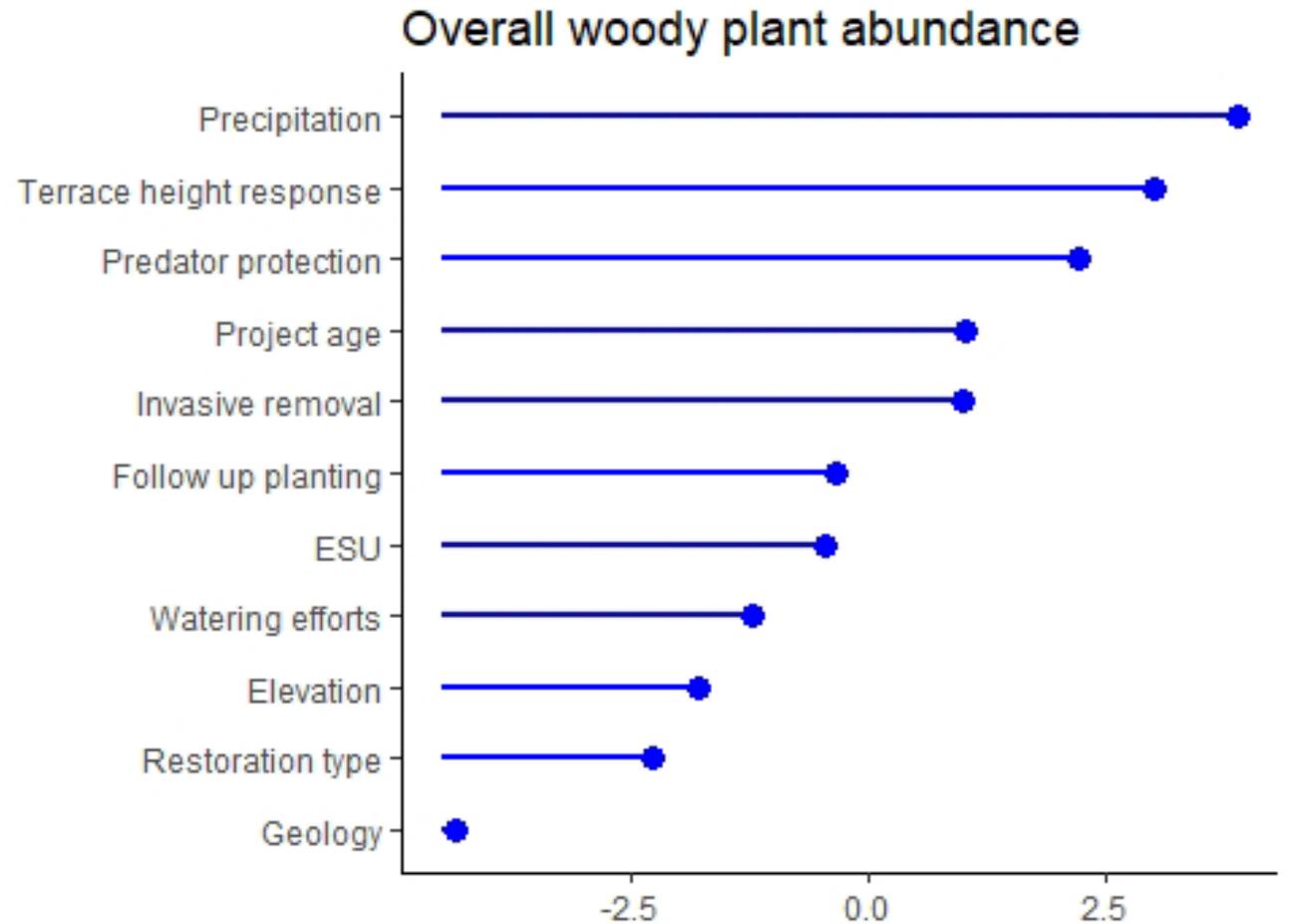


Results – Riparian



Many factors influence project success

- Several factors influencing project success
 - Precipitation (climate)
 - Water table (terrace height)
 - Predator protection
 - Age of project
 - Additional treatments



Relative importance of explanatory variables from random forest models

Summary - Riparian

- Projects having a positive effect on shrub and overall woody plant metrics
- Limited response on shade and cover likely due to lack of time and interactions with other factors
- Climate, predation, project age, terrace height, and follow-up treatments influence success
- Project reporting issues in CBFISH made locating projects difficult despite large number of previous riparian projects



Recommendations – Riparian

Adaptive Management

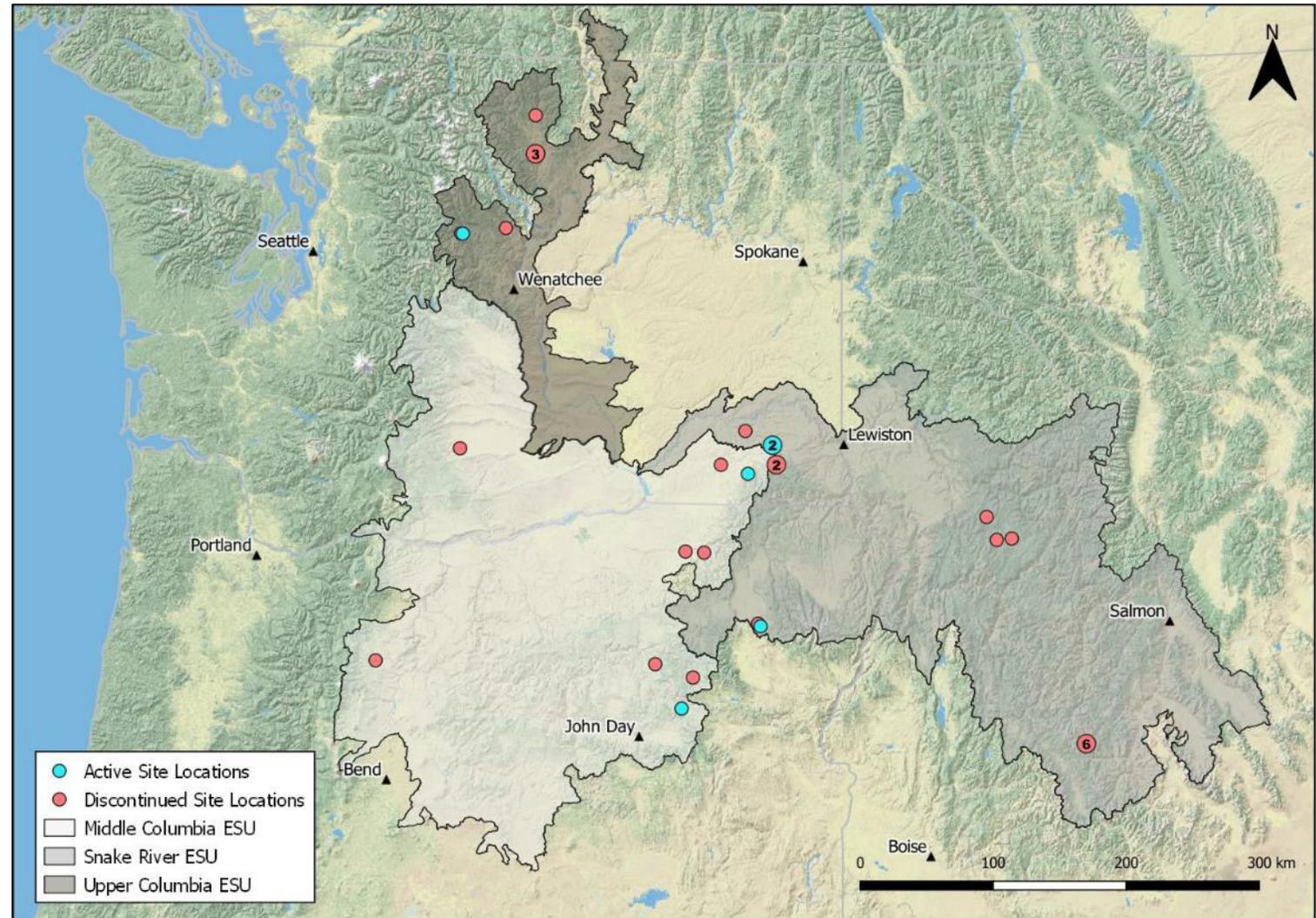
- Prioritize areas for riparian restoration so projects are less opportunistic
- Design for site conditions (e.g., precip., elev., geology, hydrology, predators)
- Follow up treatments and maintenance
- Better documentation of projects and objectives
- Consider developing a design manual based on sponsors experiences

Monitoring

- Better documentation of project location and specifics in CBFISH
- Use of before and after surveys/design
- Use of remote sensing combined with field surveys to monitoring plant growth, diversity, survival through time
- Longer term monitoring (>10 years) needed particularly in more arid sites

Floodplain Projects – MBACI Design

- 6 Sites of original 32 selected
- MBACI 2 years before, 1, 3 and 5 years after
- CHAMP Protocol
- Snorkel surveys



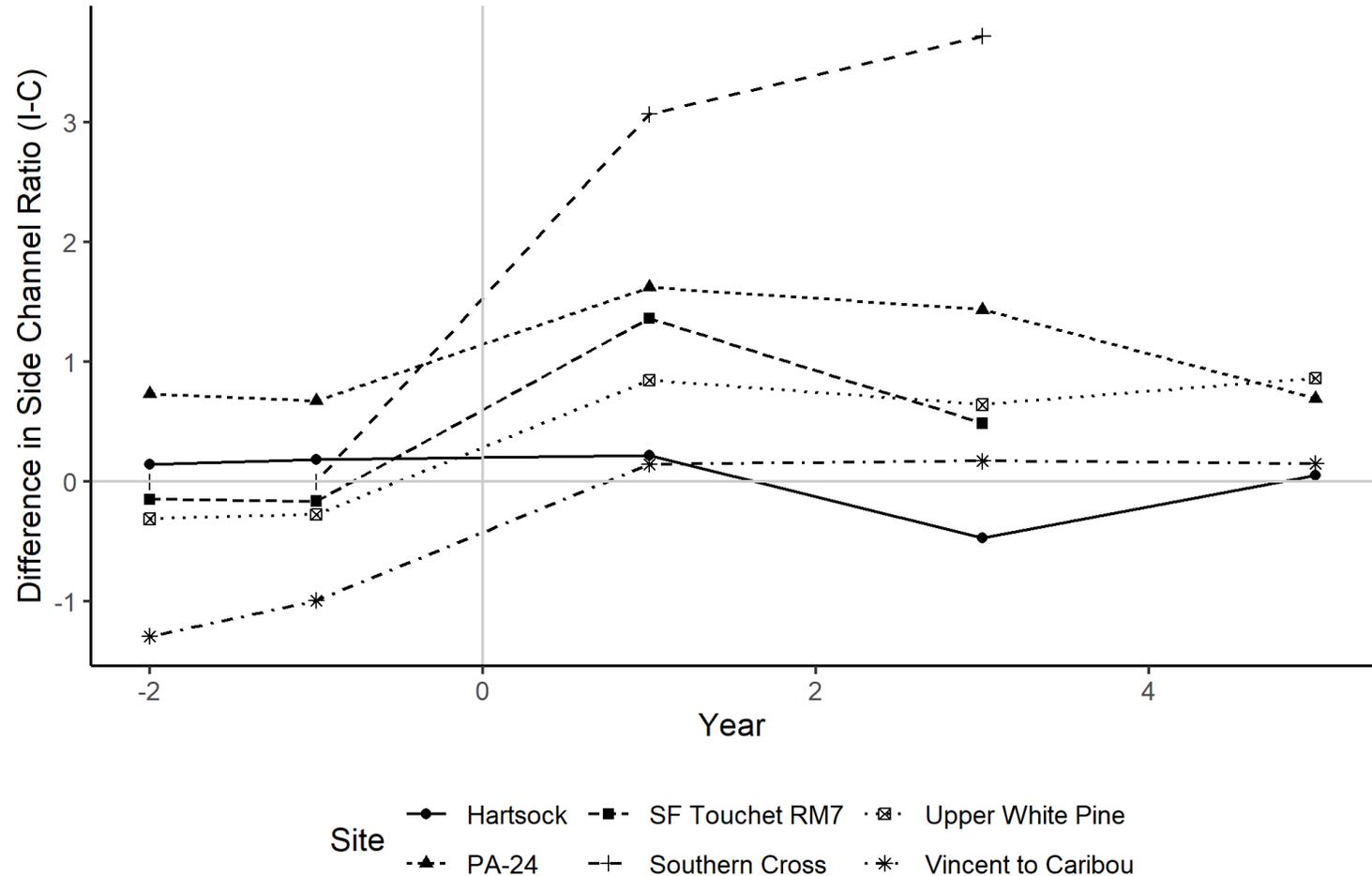
Questions – Floodplain MBACI

- What is the effect of restoration on juvenile salmon and steelhead abundance?
- What is the effect of restoration on slow water habitats and habitat complexity?
- What is the effect of the specific floodplain restoration actions on channel dynamics?
- Are there differences in project effectiveness among ESUs?*



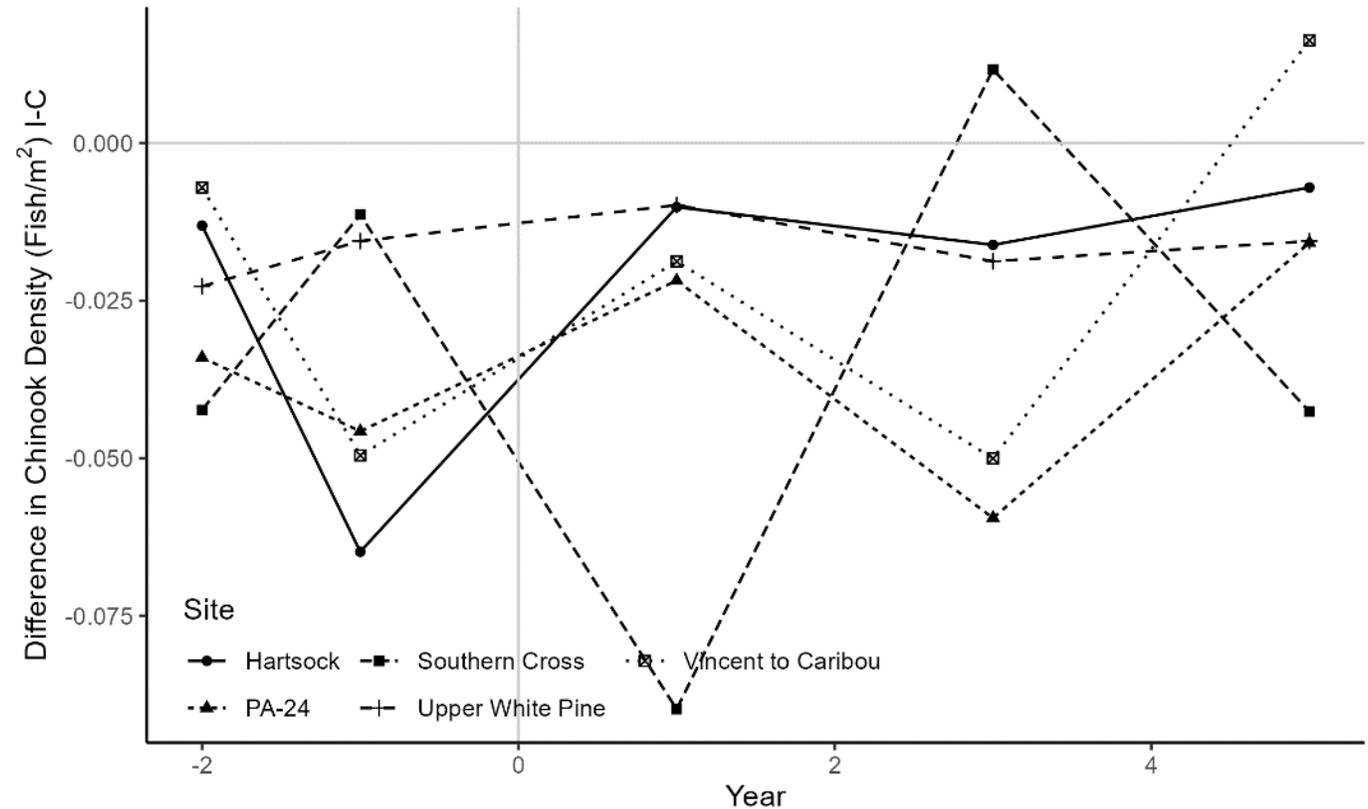
Results – Floodplain MBACI

- Significant improvements in
 - Bankfull side-channel junctions
 - Side channel ratio
 - River complexity index
 - Large wood



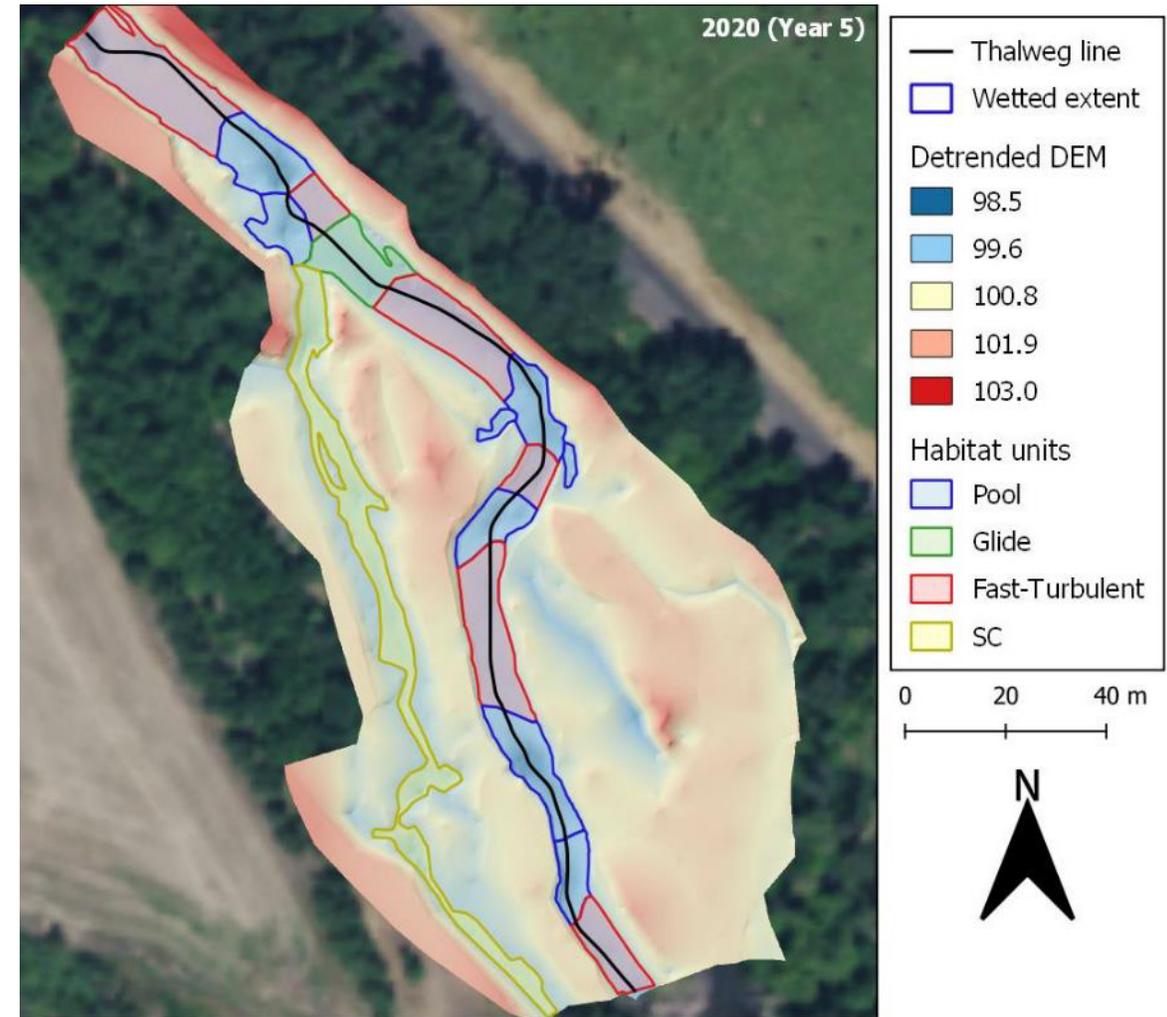
Results – Floodplain MBACI

- No response
 - Pool/riffle ratio
 - Percent pool/slow water
 - Habitat diversity
 - Fine sediment
 - W/D ratio
 - Sinuosity
 - Juvenile Chinook
 - Juvenile Steelhead



Summary – Floodplain MBACI

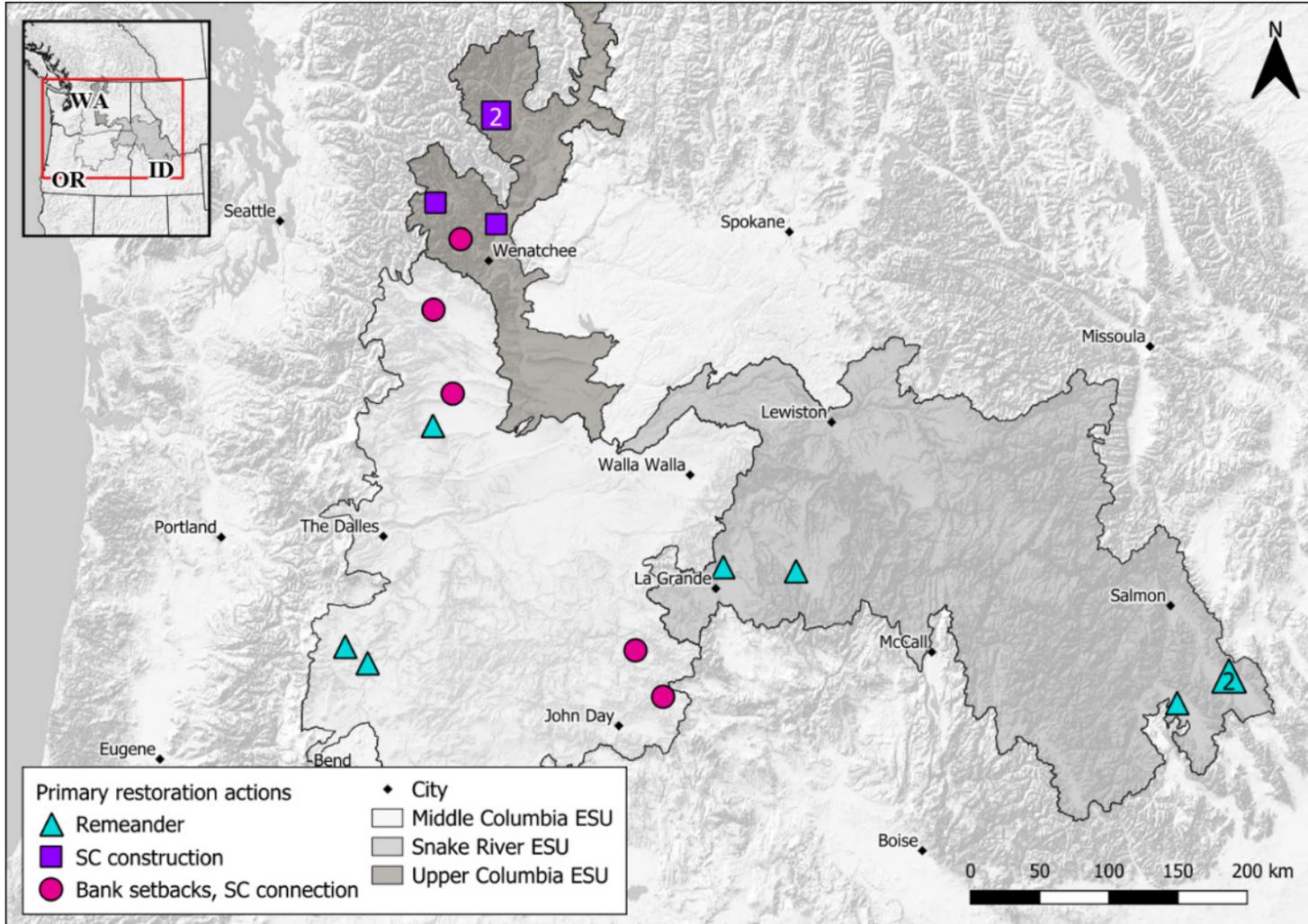
- Positive increases some key floodplain metrics
 - Side channels and wood result of construction
- No fish response is somewhat surprising, but
 - Little change in many instream habitat metrics
 - Sample size is small (number of sites)
 - Highly variable restoration treatments
- CHaMP protocol and program issues



Recommendations – MBACI Floodplain

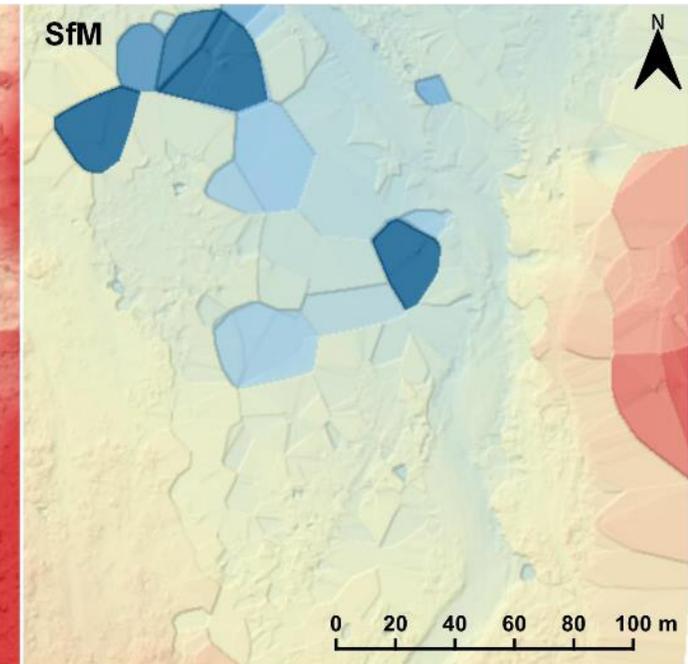
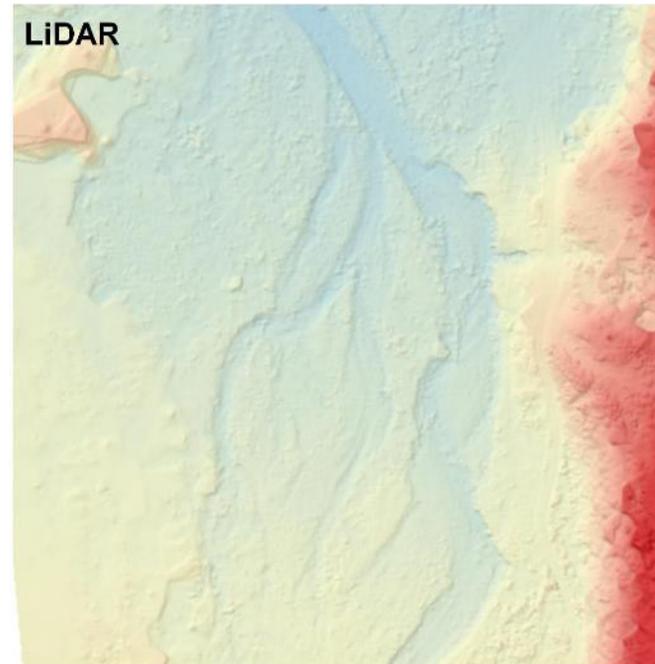
- Adaptive Management – See EPT Floodplain
- Monitoring Recommendations
 - CHaMP protocol not suitable for floodplain monitoring
 - MBACI design and CHaMP implementation issues
 - Use newer remote sensing-based methods that map entire floodplain
 - Consider EPT design
- Two review papers to help adaptively manage AEM Floodplain monitoring
 - **Roni, P.**, J. E. Hall, S. M. Drenner, and D. Arterburn. 2019. Monitoring the effectiveness of floodplain habitat restoration: A review of methods and recommendations for future monitoring. *Wiley Interdisciplinary Reviews: Water* 6(4):e1355.
 - **Roni, P.**, U. Åberg, and C. Weber. 2018. A review of approaches for monitoring the effectiveness of regional river habitat restoration programs. *North American Journal of Fisheries Management* 38: 1170-1186.

Floodplain Projects – EPT Design



Floodplain Project Evaluation with EPT Design

- Reviewed methods for monitoring floodplain projects (Roni et al. 2019)
- Reviewed designs for monitoring restoration projects (Roni et al. 2018)
- Compared and tested protocols in 2019 (4 sites)
 - Drone LiDAR vs SfM
 - Morphological Quality Index and other metrics
 - Bathymetry/topography w/ RTK
 - Time and efficiency



SfM – structure from motion, RTK – real time kinematic

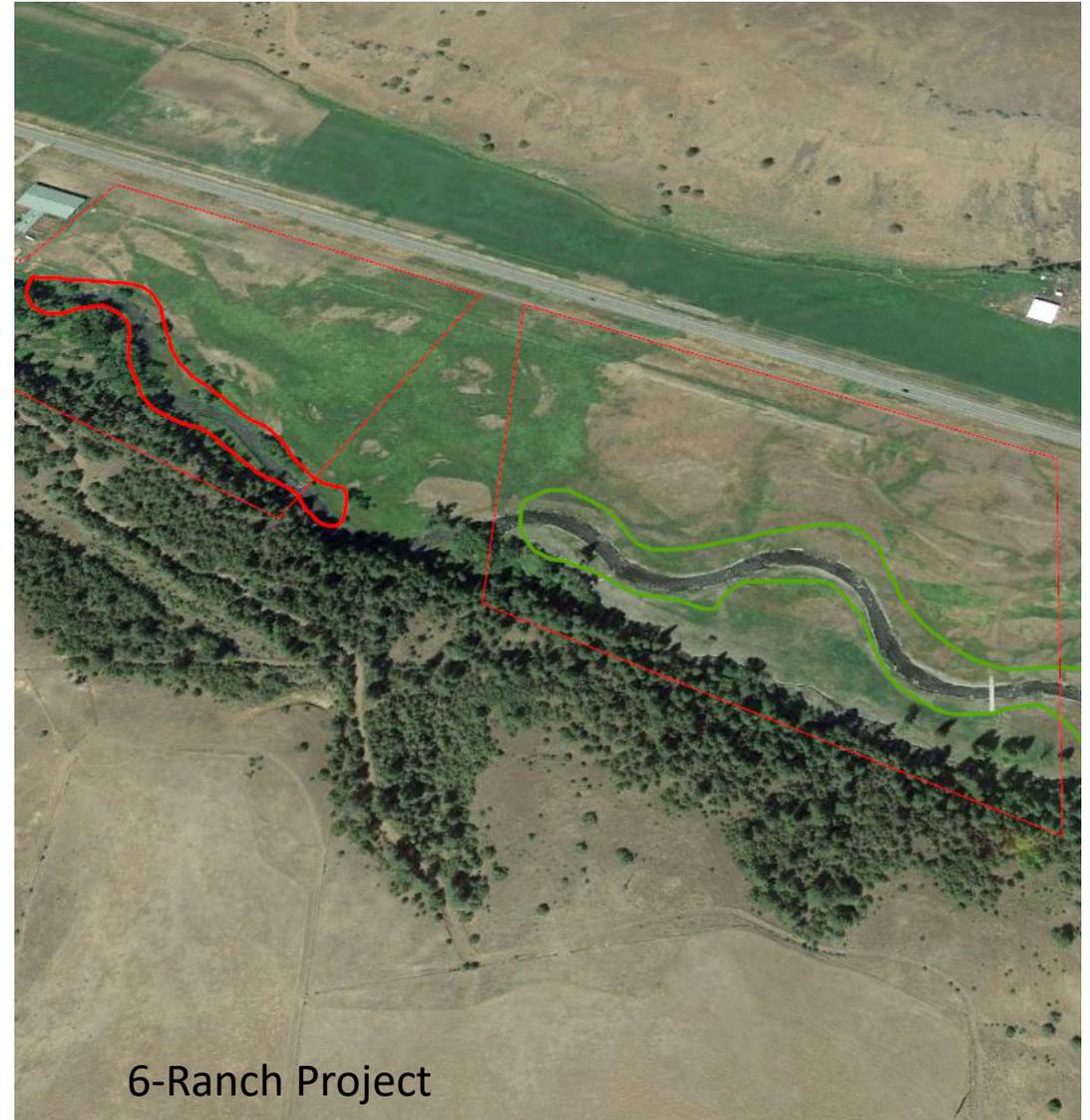
Questions – EPT Floodplain

- What is the effect of floodplain restoration on:
 - juvenile salmon and steelhead abundance?
 - physical habitat and large wood?
 - channel and floodplain morphology, complexity, and connectivity metrics?
- Are there differences in restoration effectiveness among ESUs?

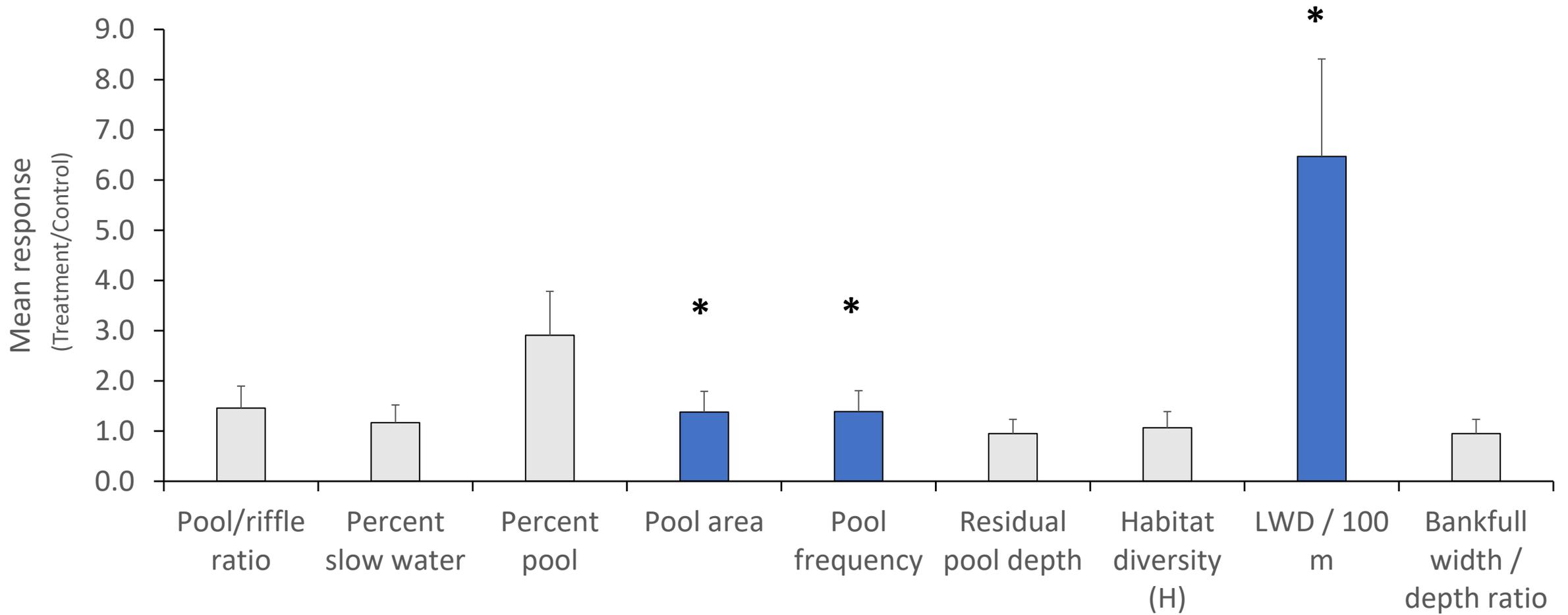


Floodplain Project Evaluation with EPT Design

- Methods, drone-based LiDAR coupled with RTK topo-bathymetry, revised metrics at low and high flow that focus on floodplain, snorkel surveys
- Identified 20 sites with suitable paired treatment and controls (sampled 17)
- Floodplain projects completed at least 3 years ago

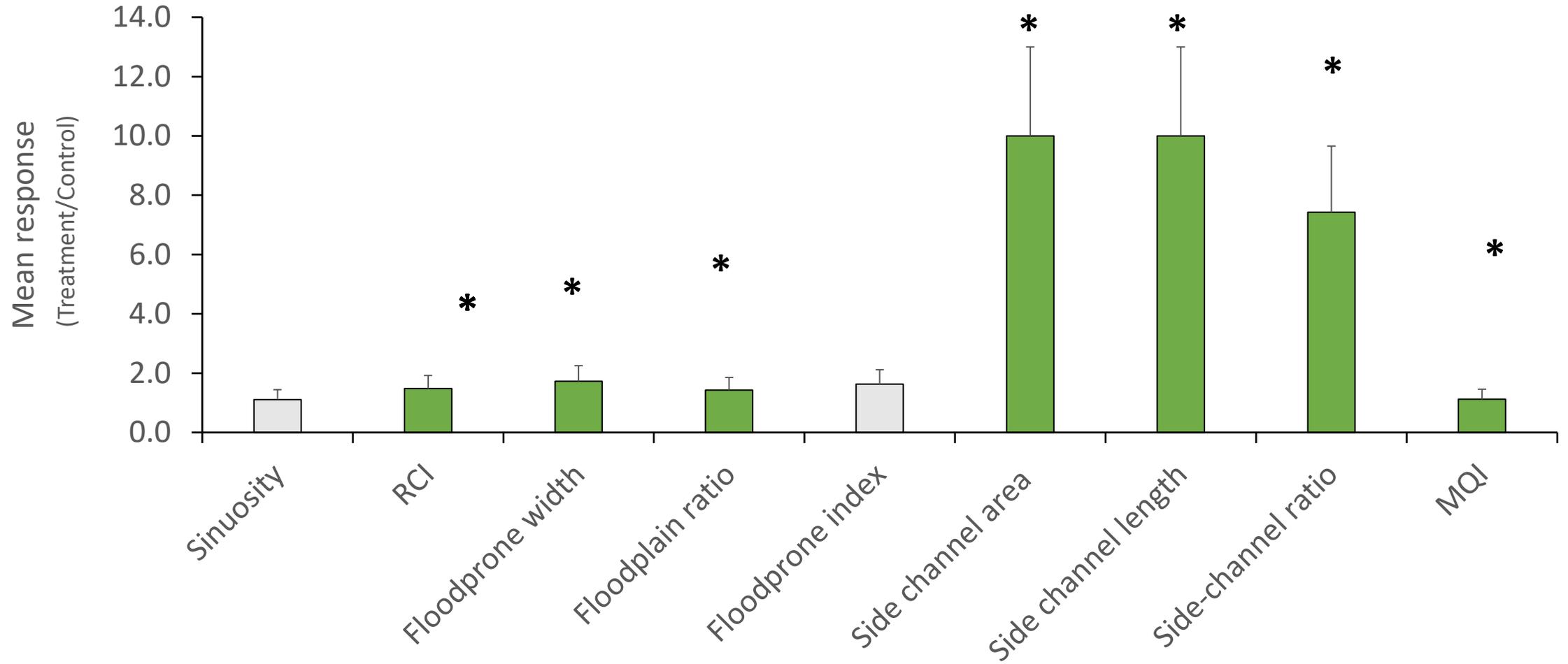


EPT Floodplain Results - Instream Habitat Metrics



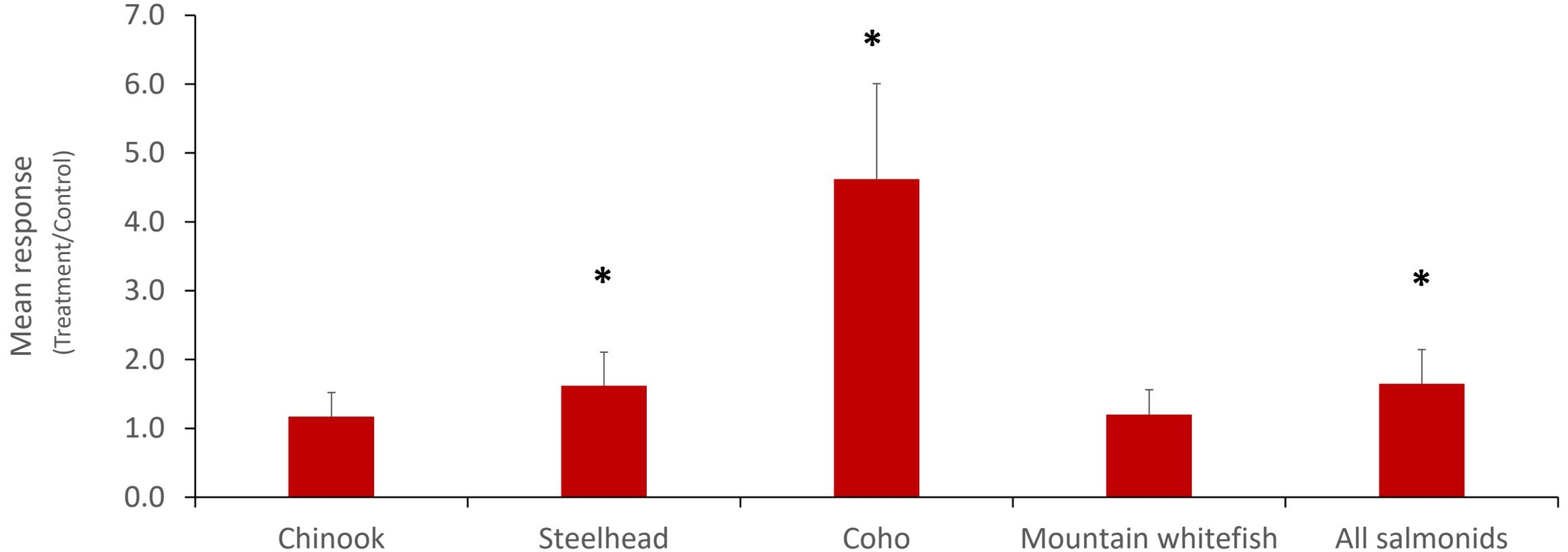
* Statistically significant

EPT Floodplain Results - Floodplain Metrics



* Statistically significant

EPT Floodplain - Fish Response



* Statistically significant

EPT Floodplain - Summary of Results

- Significant positive response to for steelhead and coho
- Chinook not significant but response positively correlated with slow water habitat and habitat complexity
- Combination of field and LiDAR data efficient method for monitoring floodplain projects



Recommendations – Floodplain Projects

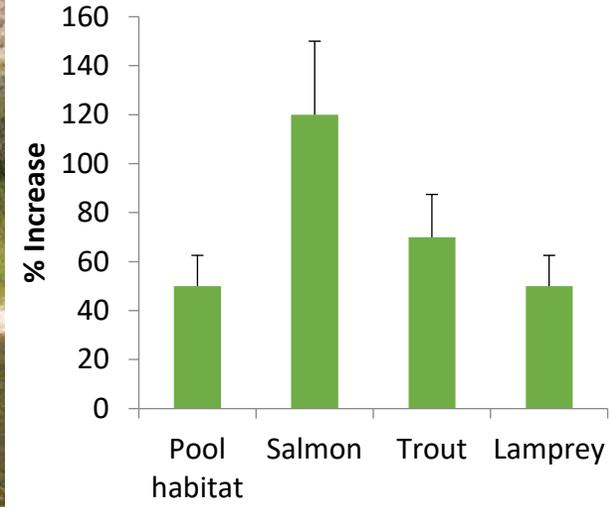
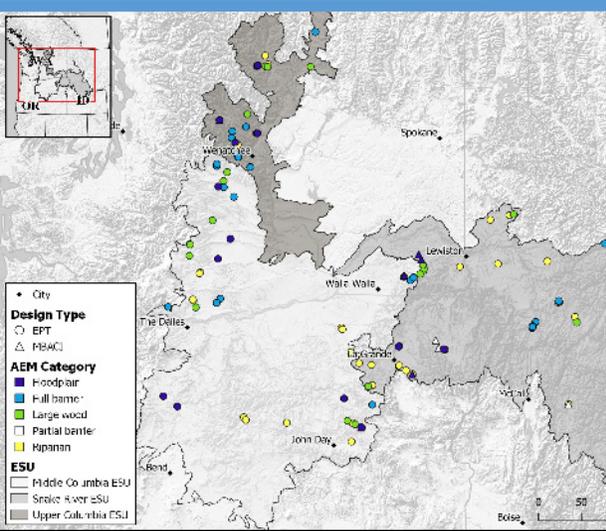
Adaptive Management

- Consider the project setting and factors limiting floodplain connectivity
- Document fish use and other potential factors limiting success (e.g., temp, WQ)
- Restore floodplain process rather than create static channels or habitat features
- Ensure improves side channel connectivity and instream conditions (e.g., pools and habitat complexity).

Monitoring

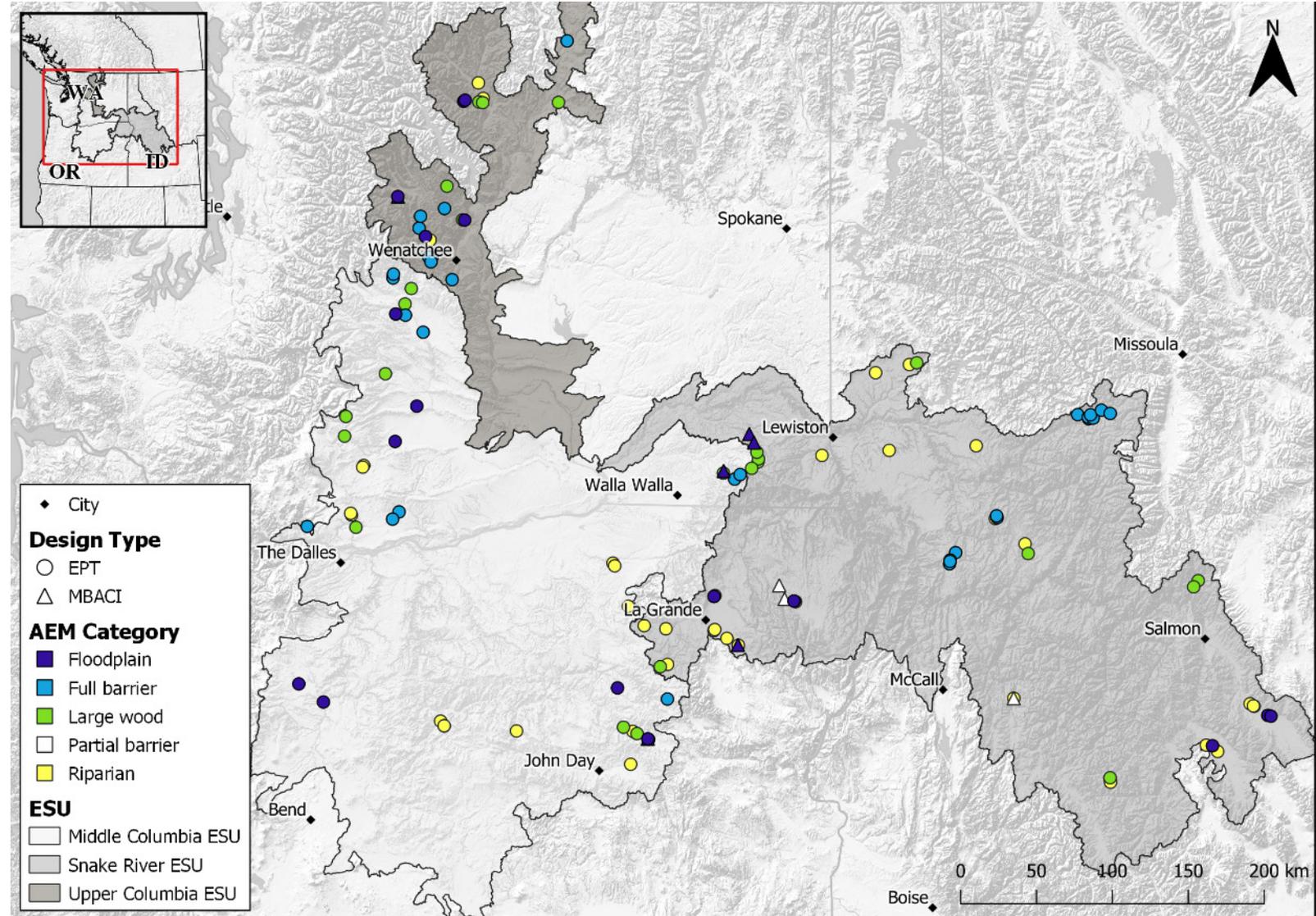
- EPT design more tractable than MBACI
- Consider using simple BA design to evaluate large floodplain projects (e.g., Entiat)
- Remote sensing with field data best approach for floodplain and other projects

Overall AEM Summary



AEM Program 2014 to 2023 Successes

- Successfully evaluated most common project types
- Evaluated more than 125 projects
- Adaptively managed program over 10 years
- Worked with dozens of BPA partners
- Provided adaptive management recommendations
- Published 10 papers



AEM Summary of Results by Project Type

- Full barriers – strong positive fish response
- Partial barriers – limited success
- Large woody debris – strong positive fish response
- Riparian planting/Invasive removal – positive response for some metrics, many site-specific factors influence success
- Floodplain projects – positive response to many instream and habitat metrics. Positive response to juvenile steelhead and coho
- Little differences among ESUs in success



ACTION EFFECTIVENESS MONITORING

2022 Annual and Final Report



*Project Number 2016-001-00
Report covers work performed under BPA contract #71969, 74809, 78579
Report was completed under BPA contract #78579
Report covers work performed from March 1, 2022 – September 30, 2023*

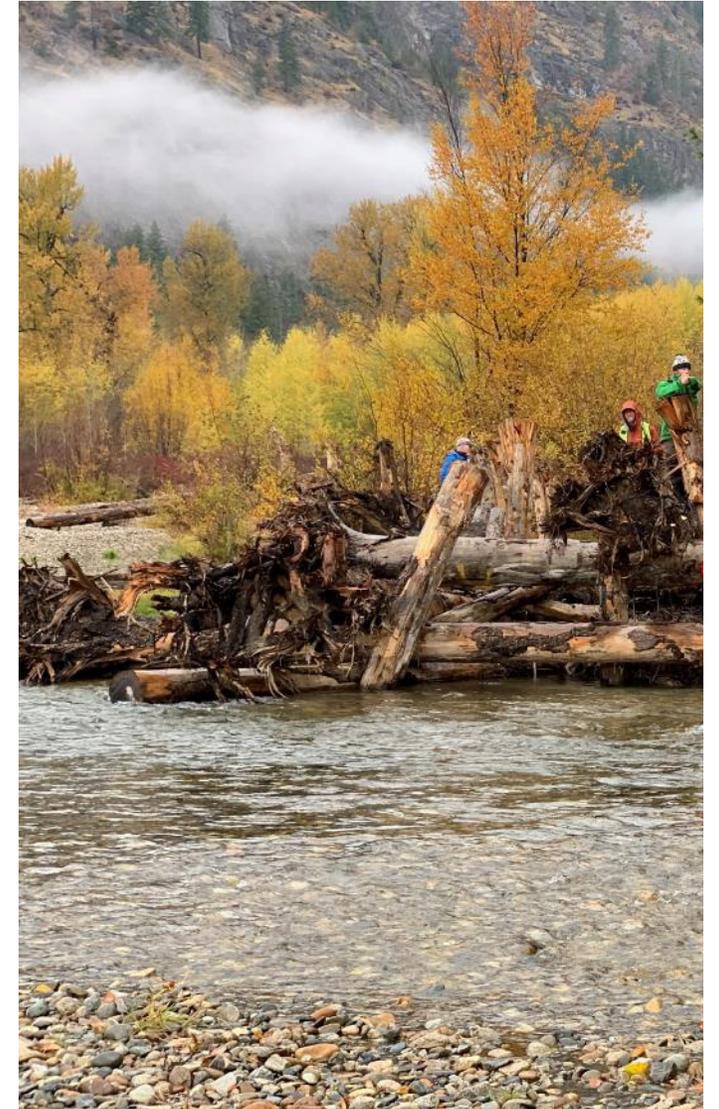
Prepared by:
Phil Roni, Jake Kvistad, Shelby Burgess, and Kai Ross
Cramer Fish Sciences
Watershed Sciences Lab
1125 12th Avenue NW, Suite B-1
Issaquah, WA 98027

Report created: August 23, 2023

"This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA."

AEM Adaptive Management Recommendations

- Large Wood
 - Amount of “in-channel wood” closer to historical targets
 - Functional LW (i.e., creating pools)
 - LW in thalweg or spanning channel not on margins!!!
- Barriers
 - Prioritize for target species
 - Documentation of Chinook and steelhead use
 - Partial barriers require longer term monitoring
- Riparian
 - Prioritization – less opportunistic
 - Design for site conditions



AEM Adaptive Management Recommendations

- Floodplain
 - Determine factors limiting floodplain connectivity
 - Use techniques that restore processes rather than create static channels or habitat features
 - Ensure restoration improves floodplain, side channel connectivity and instream habitat
- Overall Tributary Habitat Program
 - Better project documentation needed in CBFISH
 - Consistent design criteria and objectives for future EM
 - Worked with BPA THP to refine future designs
- Consider additional monitoring of large floodplain projects
 - using BA design and remote sensing
 - see EntiatPilot, GRMW, and SRFB pilot examples



Recommendations for Future Effectiveness Monitoring

- The use of an EPT or BA experimental design
- Diligent selection of treatment and controls
- Limiting data collection to one or a few organizations
- Development monitoring protocols specific to program
- Broader use of remote sensing
- Revisiting AEM sites to determine longer term effectiveness
- Combined implementation and effectiveness monitoring
- RM&E Strategy - focus on floodplain restoration



ACTION EFFECTIVENESS MONITORING

2022 Annual and Final Report



Project Number 2016-001-00

Report covers work performed under BPA contract #71969, 74809, 78579

Report was completed under BPA contract #78579

Report covers work performed from March 1, 2022 – September 30, 2023

Prepared by:

Phil Roni, Jake Kvistad, Shelby Burgess, and Kai Ross
Cramer Fish Sciences
Watershed Sciences Lab
1125 12th Avenue NW, Suite B-1
Issaquah, WA 98027

Report created: August 23, 2023

"This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA."

Publications from AEM

(Not including 9 annual reports)

- **Roni, P.**, and 8 coauthors. *In review*. Evaluation of floodplain restoration effectiveness in the interior Columbia River basin using a combination of remote sensing and field data. Canadian Journal of Fisheries and Aquatic Sciences.
- Burgess, S., C. Clark, K. Ross, M. Krall, and **P. Roni**. 2023. Evaluation of riparian enhancement actions in the Columbia River Basin. Journal of the American Water Resources Association 189. doi.org/10.1016/j.ecoleng.2023.106897
- Clark, C., M. Krall, M., P. Roni, and K. Ceder, 2021. Reach-scale stream temperature response to large wood placement. Restoration Ecology, 29(7), p.e13433.
- Clark, C., **P. Roni**, J. Keeton, and G. Pess. 2020. Evaluation of the removal of impassible barriers on anadromous salmon and steelhead in the Columbia River Basin. Fisheries Management and Ecology 27:102-110.
- **Roni, P.**, J. E. Hall, S. M. Drenner, and D. Arterburn. 2019. Monitoring the effectiveness of floodplain habitat restoration: A review of methods and recommendations for future monitoring. Wiley Interdisciplinary Reviews: Water 6(4):e1355.
- **Roni, P.** 2019. Does river restoration increase fish abundance and survival or simply concentrate fish? The effects of project scale, location, and fish life history. Fisheries 44:7-19.
- Clark, C., **P. Roni**, and S. Burgess. 2019. Response of juvenile salmonids to large wood placement in Columbia River tributaries. Hydrobiologia 842(1):173-190.
- **Roni, P.**, U. Åberg, and C. Weber. 2018. A review of approaches for monitoring the effectiveness of regional river habitat restoration programs. North American Journal of Fisheries Management 38: 1170-1186.
- **Roni, P.**, P. J. Anders, T. J. Beechie, and D. J. Kaplowe. 2018. Review of tools for identifying, planning, and implementing habitat restoration for Pacific salmon and steelhead. North American Journal of Fisheries Management 38(2):355-376.
- **Roni, P.**, Beechie, T., Pess, G. and K. Hanson. 2015. Wood placement in river restoration: Fact, fiction and future direction. Canadian Journal of Fisheries and Aquatic Sciences 72(3): 466-478.

Final Report

Roni, P., J. Kvistad, S. Burgess, and K. Ross. 2023. Action Effectiveness Monitoring 2022 Annual and Final Report. Project No. 2016-001-00. Report to Bonneville Power Administration, Portland, Oregon.

Additional papers to consider if funding available:

- Overall summary and lessons from AEM program
- Proper selection of treatments and controls



ACTION EFFECTIVENESS MONITORING

2022 Annual and Final Report



Project Number 2016-001-00

*Report covers work performed under BPA contract #71969, 74809, 78579
Report was completed under BPA contract #78579*

Report covers work performed from March 1, 2022 – September 30, 2023

Prepared by:

Phil Roni, Jake Kvistad, Shelby Burgess, and Kai Ross
Cramer Fish Sciences
Watershed Sciences Lab
1125 12th Avenue NW, Suite B-1
Issaquah, WA 98027

Report created: August 23, 2023

"This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA."

AEM Data and Info

<https://aemonitoring.org/>

BPA-AEM Data Portal



[About](#)

[Map](#)

[Raw Data](#)

[Publications and Reports](#)

[Contact us](#)

AEM Overview

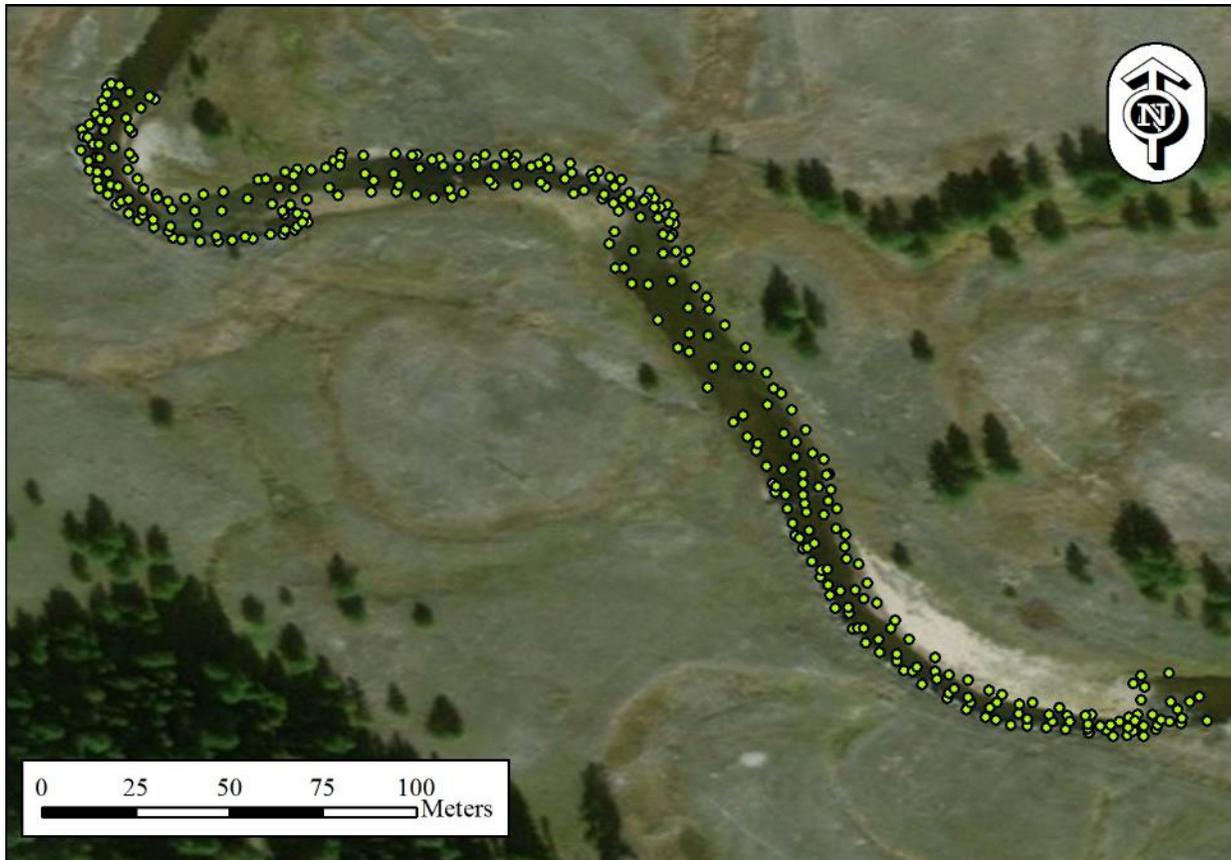
The Bonneville Power Administration (BPA) and its partners have funded thousands of riverine restoration actions across the Columbia River Basin (CRB) to improve habitat for anadromous fish as part of the Northwest Power and Conservation Council's Fish and Wildlife Program. The Action Effectiveness Monitoring (AEM) Program was developed to address the pressing need for a programmatic approach to project-level effectiveness monitoring in the CRB. The goals of the AEM Program are to quantify improvements in localized habitat and fish abundance as a function of restoration actions implemented in the CRB and to help guide future restoration and improvement efforts to ensure the BPA is investing in effective restoration techniques. Specifically, AEM is designed to programatically evaluate projects across the interior CRB to determine 1) the effect of different action categories on juvenile Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* and stream habitat at the reach scale, 2) why some projects within an action type are more effective than others, and 3) whether there are differences in project success among regions (Chinook ESUs).

Acknowledgements

Numerous organizations, collaborators and land owners make AEM possible including in no particular order: CRITFC, Confederated Tribes of the Warm Springs, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Shoshone Bannock Tribe, IDFG, WDFW, ODFW, and NOAA, Yakama Tribe, Confederated Tribes of the Coleville Reservation, Chelan County Conservation District, Snake River Salmon Recovery Board, Upper Columbia Salmon Recover Board, Yakima Basin Fish and Wildlife Recovery Board, Bonneville Power Administration, NOAA Fisheries, North Arrow, Sitka Technology Group, Nez Perce Soil and Water Conservation District, and numerous other organizations and private landowners



Results - Large Wood & Water temp



Raw Temperature Data



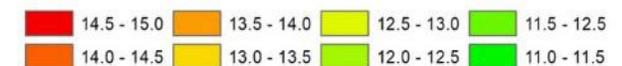
Detrended Temperature Data



* 9 sites – no sig. diff. in temp when detrended for time of sampling

Clark, C., M. Krall, M., P. Roni, and K. Ceder, 2021. Reach-scale stream temperature response to large wood placement. *Restoration Ecology*, 29(7), p.e13433.

Temperature (deg. C)



Site name	Barrier type	ESU	Year	HUC-10 Basin	Sample detail	Description
Big Meadows	Culvert	SR	2018	Big Bear Creek	Drop	Full barrier to fish migration (not partial migration barrier)
Blackpine	Culvert	UC	n/a	Twisp River	Drop	Not yet implemented in 2018
Caribou 33	Diversion	MC	2017	Wilson Creek-Cherry Creek	Drop	Sample timing issue
Construct Cox	Culvert	SR	2015	Johnson Creek	Retain	
Eight Mile	Velocity	UC	n/a	Lower Chewuch River	Drop	Not yet implemented in 2018
Lostine Sheep Ridge	Diversion	SR	2016	Lostine River	Retain	
Parke	Diversion	MC	2018	Wilson Creek-Cherry Creek	Drop	Sample timing issue
Tully	Diversion	SR	2016	Lostine River	Retain	
Twenty Mile	Ford crossing	UC	n/a	Lower Chewuch River	Drop	Not yet implemented in 2018