Northwest Power and Conservation Council

MEMORANDUM

October 12, 2011

TO: Council Members

FROM: Nancy Leonard, Fish, Wildlife and Ecosystem Monitoring and Evaluation Manager

SUBJECT: Effective watershed restoration: key considerations for planning, prioritizing, and evaluation

Dr. Phil Roni is a fisheries research scientist and leads the Watershed Program within NOAA Fisheries Service's Northwest Fisheries Science Center. Dr. Roni has a diversity of research experience, including studies of salmon life history, effects of hydropower operations on salmonids, fish sampling techniques, effects of forestry activities on aquatic biota, identification of essential habitats for sensitive aquatic species, and, most recently, watershed restoration. His current research focuses on watershed restoration and evaluating various habitat rehabilitation techniques such as instream structures, nutrient additions, floodplain restoration, and recovery of urban streams. In addition, he is involved in writing regional, national and international documents and two books on planning, monitoring, and evaluating watershed restoration for fisheries resources.

Dr. Roni will be providing an overview of restoration action effectiveness including approaches for determining how to prioritize which actions to implement; monitoring approaches for assessing action effectiveness at both the reach and watershed scale; and how much restoration within a given reach or watershed may be needed to detect the desired change in habitat capacity and salmon population productivity.

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Northwest Power and Conservation Council

MEMORANDUM

September 29, 2011

TO: Council Members

FROM: Stacy Horton, Policy Analyst/Biologist, Washington Council Staff

SUBJECT: Reach Scale Effectiveness Monitoring Program: An Overview of Results

Jennifer O' Neal is a Watershed Ecology Manager and Fish Biologist for Tetra Tech. Jennifer will present the results of a large-scale habitat effectiveness monitoring program conducted to evaluate the success of habitat actions at the project scale. Monitoring categories include fish passage, in-stream structures, riparian plantings, livestock exclusions, floodplain reconnection, spawning gravel, in-stream diversions, and habitat protection. Regional coordination across monitoring projects may result in the ability to evaluate projects at a regional scale, using consistent methods and metrics. Tetra Tech has been monitoring habitat effectiveness for Washington projects since 2004 and will report its most recent results.

Jennifer has provided slides of the presentation.

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SALMON RECOVERY FUNDING BOARD

Reach Scale Effectiveness Monitoring Program

Overview of Results from a Programmatic Approach

Presented to the Northwest Power and Conservation Council

October 12, 2011

Cooperative Funding and Partners

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Salmon Recovery Funding Board

UPPER COLUMBIA SALMON RECOVERY BOARD

OREGON WATERSHED ENHANCEMENT BOARD
OWEB

Program Development

- A monitoring survey was conducted in Washington in 2003 to assess compatibility of collected data – none found
- Started statewide reach-scale monitoring program (2004)
- Developed coordinated effectiveness monitoring program with the Oregon Watershed Enhancement Board (2006)
- Partnership with Upper Columbia Salmon Recovery Board to expand sample sizes (2011)

Slide 3

Reach-Scale Effectiveness Monitoring Provides…

- Data to quantify project effectiveness at the project category scale
- Information to assist with funding decisions based on performance and cost effectiveness
- Evaluations that ensure accountability for expenditures
- Results that can be used to improve the design of future projects and monitoring programs

Slide 4

Benefits of Programmatic Approach

- Consistent methods and metrics across the program
- Evaluates projects on a regional scale through time
- Significant results in the first 5 years
- Before After Control Impact (BACI) with spatial and temporal replication – increases statistical power
- Sample size of 97 projects – no need to monitor every project

Slide 5

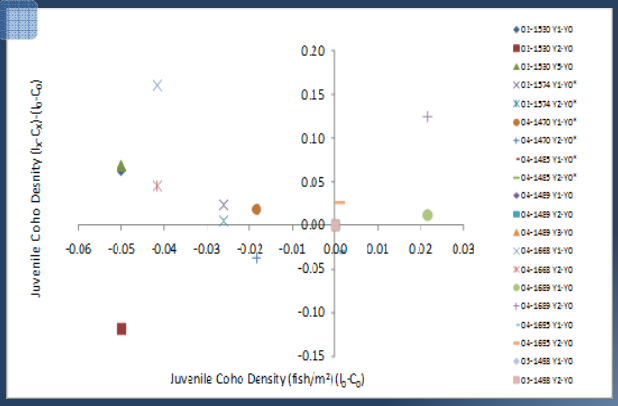
Monitoring Categories

Monitoring Category	Status
MC-1 Fish Passage	Complete
MC-2 Instream Structures	On-going and Expanding
MC-3 Riparian Plantings	On-going
MC-4 Livestock Exclusions	Coordinated, On-going
MC-5/6 Floodplain Reconnection	Improved, On-going and Expanding
MC-7 Spawning Gravel	Deferred
MC-8 Instream Diversions	Complete
MC-10 Habitat Protection	On-going

Slide 6

Fish Passage – Indicators Measured

- Passage Design
- Juvenile Coho Density
- Juvenile Chinook Density
- Steelhead Parr Density
- Coho Spawners
- Chinook Spawners
- Steelhead Spawners
- Redds

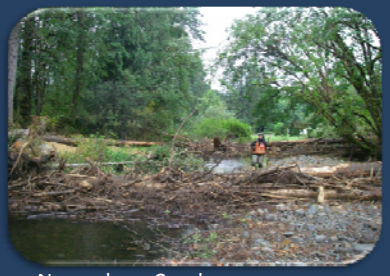


Slide 7

Example In-stream Habitat Projects


Salmon Creek


Upper Washougal River


Newaukum Creek


Dungeness River

Slide 8

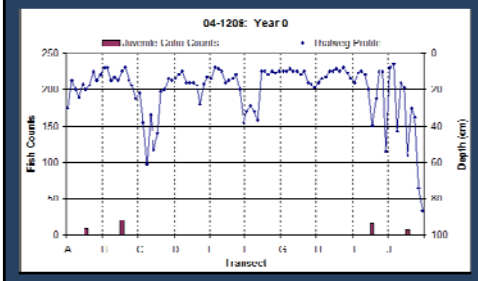
Mixed Results by Species for Instream Structure Projects

Project #	Survey Year	Project Cost	Species	Change in Abundance
02-1444	Y5	$32,942	coho	↓
02-1463	Y5	$236,946	coho	↓
02-1515	Y1	$489,147	chinook	--
02-1561	Y5	$983,853	chinook	--
04-1209	Y1	$925,810	coho	↑
04-1338	Y1	$900,000	coho	↑
04-1448	Y5	$348,430	Steelhead	↓
04-1575	Y5	$378,940	Steelhead	↑
04-1589	Y3	$1,066,351	Steelhead	↑
04-1660	Y1	$892,993	chinook	↑
05-1533	Y3	$105,537	coho	↓
07-1803	Y1	$1,180,386	Steelhead	↑

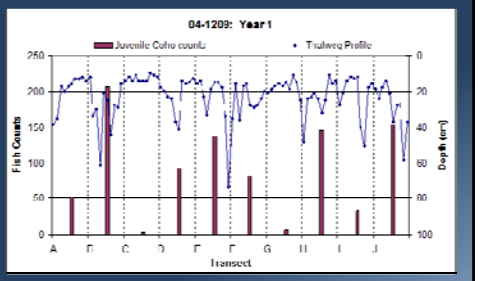
Slide 9

Instream Structure – Site Specific Monitoring

Pre-Project Condition



Post-Project Condition



Slide 10

SRFB – Snow Creek Riparian Planting

Before (Year 0)

After (Year 3)

Slide 11

Riparian Planting - Monitoring Recommendations

- Mean survival of 92.3 in Year 1 and 72.5 in Year 3
- Monitor for survival early and then measure percent cover of woody vegetation
- Fund maintenance and invasive species removal as part of grants
- Plan for bank migration and adjust monitoring accordingly

Slide 12

Livestock Exclusions – Indicators Measured

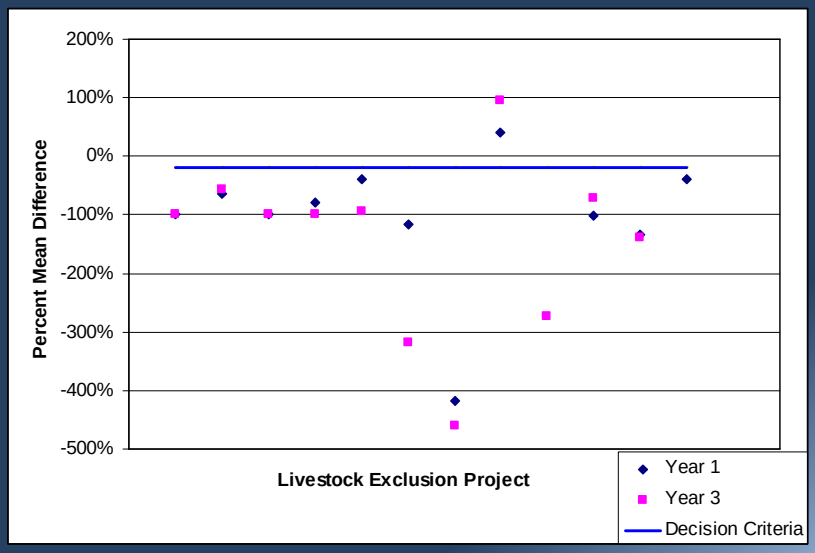
- Exclosure Function
- Bank Erosion
- Riparian Vegetation Structure
- Canopy Density

Before

After

Slide 13

Bank Erosion Results – Year 1 and Year 3 Data



Slide 14

OWEB – Tenmile Lakes Basin Partnership

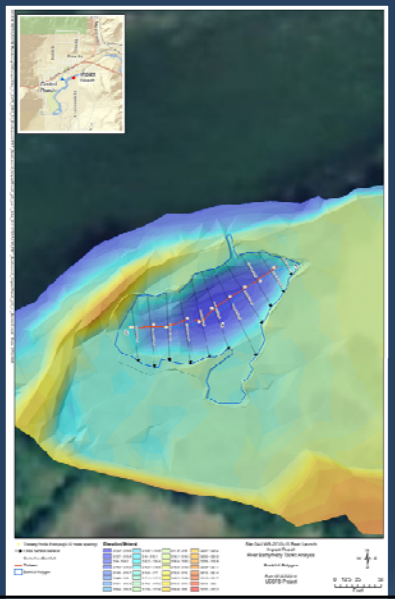
Impact reach prior to project
(Year 0 - 2006)

Impact reach with fencing intact
(Year 3 - 2009)

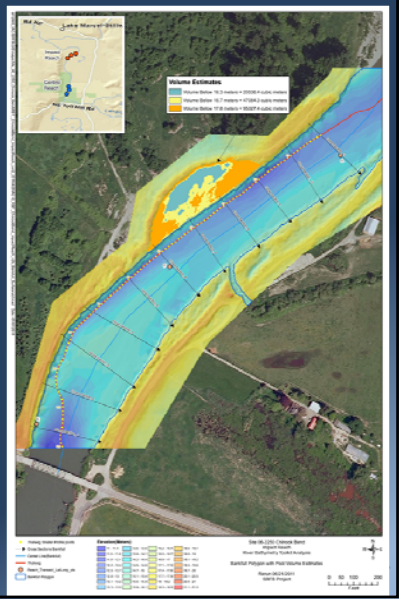
Slide 15

Floodplain Enhancement Monitoring – Topographic Survey

Off-Channel Habitat Reconnection - UCSRB



Floodplain Connectivity



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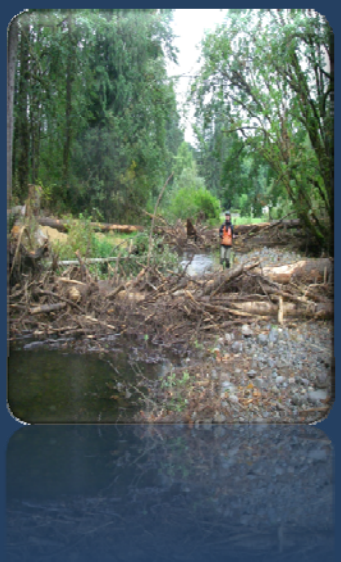
Consistent Methods and Metrics



- Add to statistical power by allowing for data analysis across a large number of projects and contracts
- Necessary in order to detect statistical significance in a shorter time frame
- Allow for assessment of project categories which removes the need to monitor every project and reduces monitoring costs

Slide 17

Significant Results from Monitoring

- Significant Changes Detected to Date
  - **Fish Passage Projects:**
    Juvenile Coho Density Increased (+438% by Year 5)
  - **Instream Structures:**
    Mean Vertical Pool Profile Area Increased
    (+108m^2 by Year 5)
  - **Livestock Exclusion Projects:**
    Bank Erosion Decreased (-138% by Year 5)
  - **Floodplain Reconnection:**
    Floodprone Width Increased (+845% in Year 3)
  - Effective Function Established at Diversion Screens

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Benefits of Coordination

- Regional-scale evaluation of project category effectiveness
- Reduced costs for larger sample size
- Improved statistical power for evaluation of data

- Comparable and compatible data allows sharing across state and jurisdictional boundaries

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Next Steps in Reach Scale Program

- **Fish Passage** – Significant increases in juvenile coho and strong positive trends for other species demonstrate effectiveness; **monitoring complete**
- **In-stream Habitat** – Significantly increasing physical habitat; further investigation, stratification, and increased sample sizes are needed to clarify fish responses
- **Livestock Exclusion** – Significantly decreasing bank erosion, longer term monitoring for vegetation
- **Floodplain Enhancement** – Integrate methods with CHaMP program; increase sample size to test revised protocols widely
- **Diversion Screening** – Assessments demonstrate function; **monitoring complete**

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Summary

- Coordination conserves limited monitoring funding and effort
- Data can be shared seamlessly across the region
- Data analysis is stronger with a larger sample size
- Single report for regional monitoring data with quantified results

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Questions?

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http://hws.ekosystem.us/?p=Page_2dcf09fe-c011-4d40-a62f-710d1d97c13e

"Agencies and tribes can respond to reductions in monitoring funding by reducing monitoring, or by improving efficiency of present monitoring operations"

"Effective salmon management depends on the ability of the agencies, tribes and stakeholders to coordinate activities."

- Columbia River Basin Collaborative Data Sharing Strategy

Effective watershed restoration:

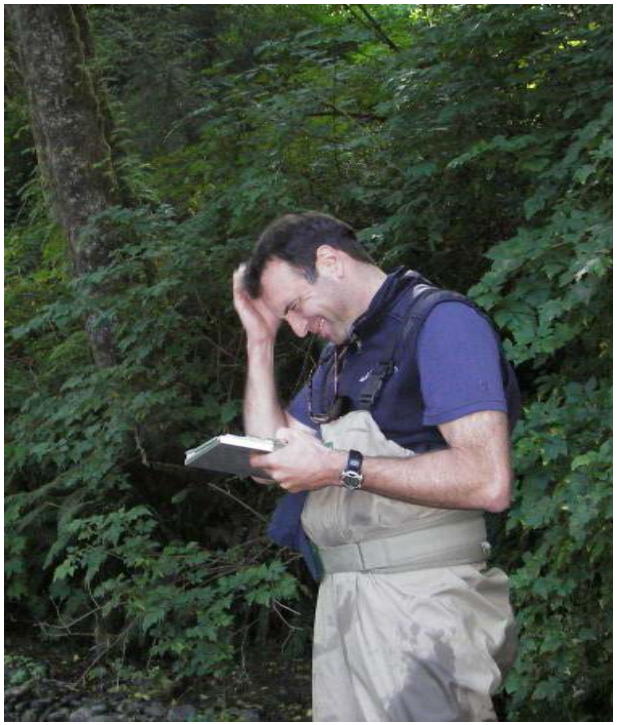
key considerations for planning, prioritizing, and evaluation

Philip Roni Tim Beechie George Pess

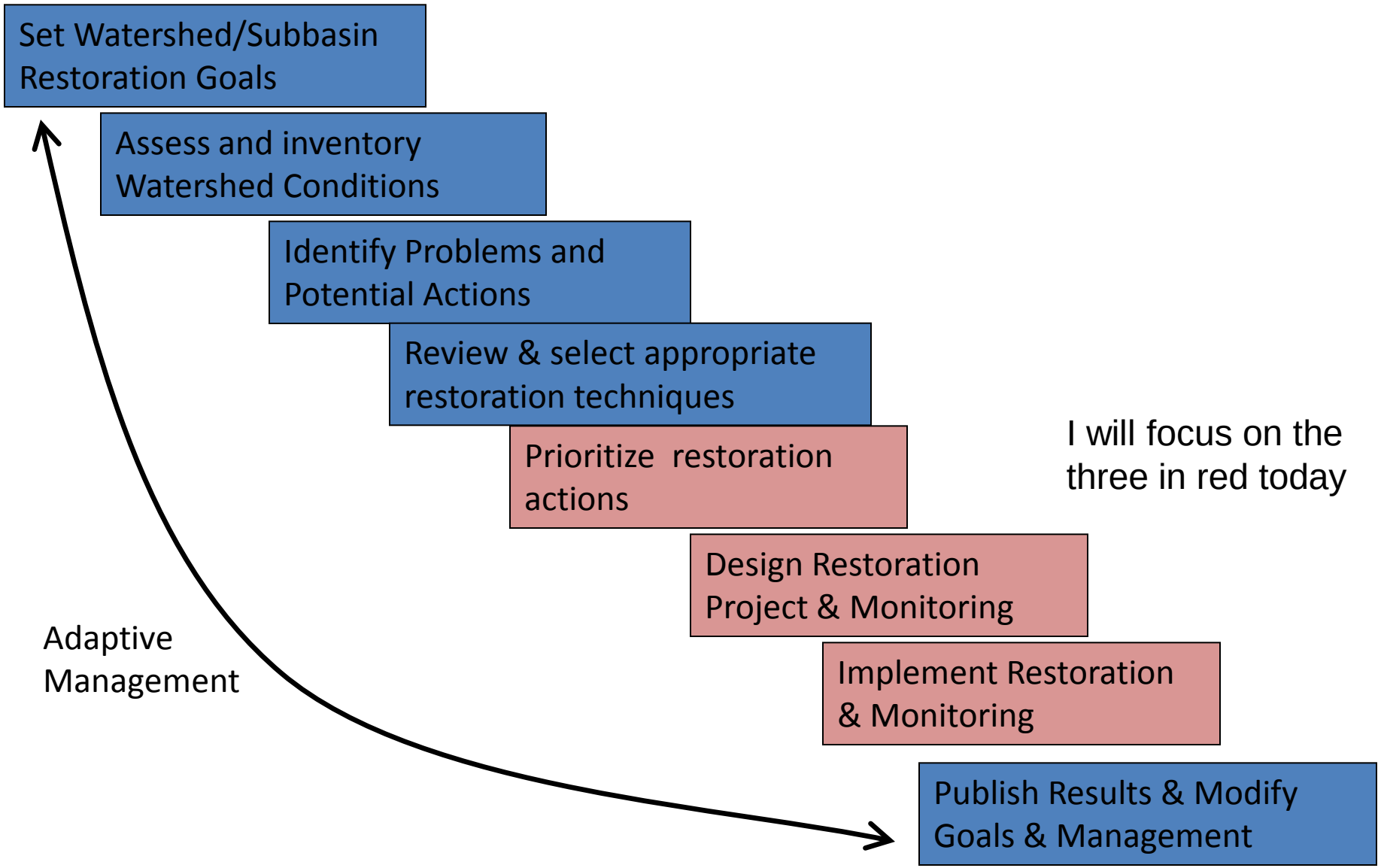
Watershed Program
Northwest Fisheries Science Center
Seattle, WA 98112

Some common problems

- Inadequate habitat assessments
- Ecosystem processes
- Limiting factors
- Design of projects
- Prioritization of projects
- Monitoring and evaluation
- Total amount of restoration



Key Steps in Restoration

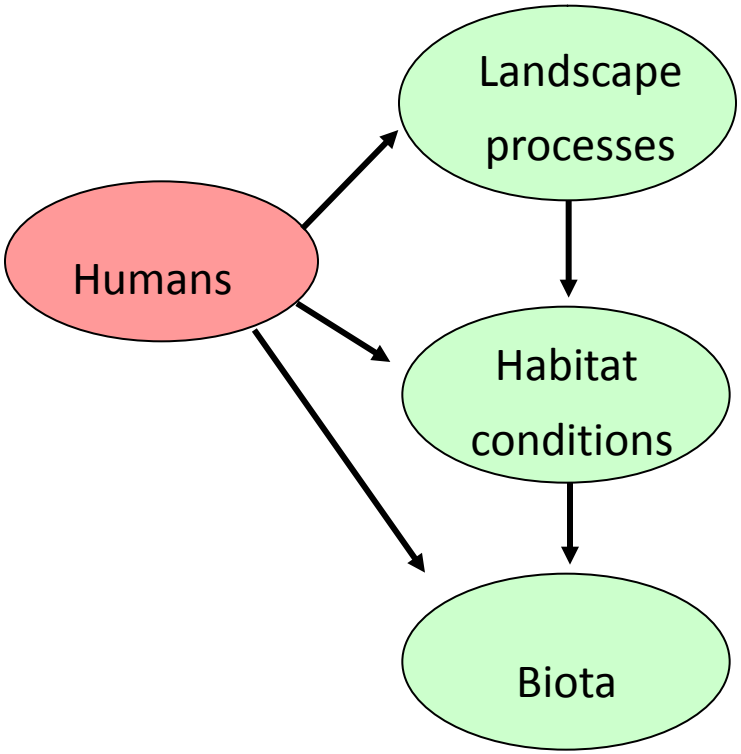


Goals & Objectives

- For restoration
- For assessment
- For restoration design
- For prioritization
- For monitoring & evaluation

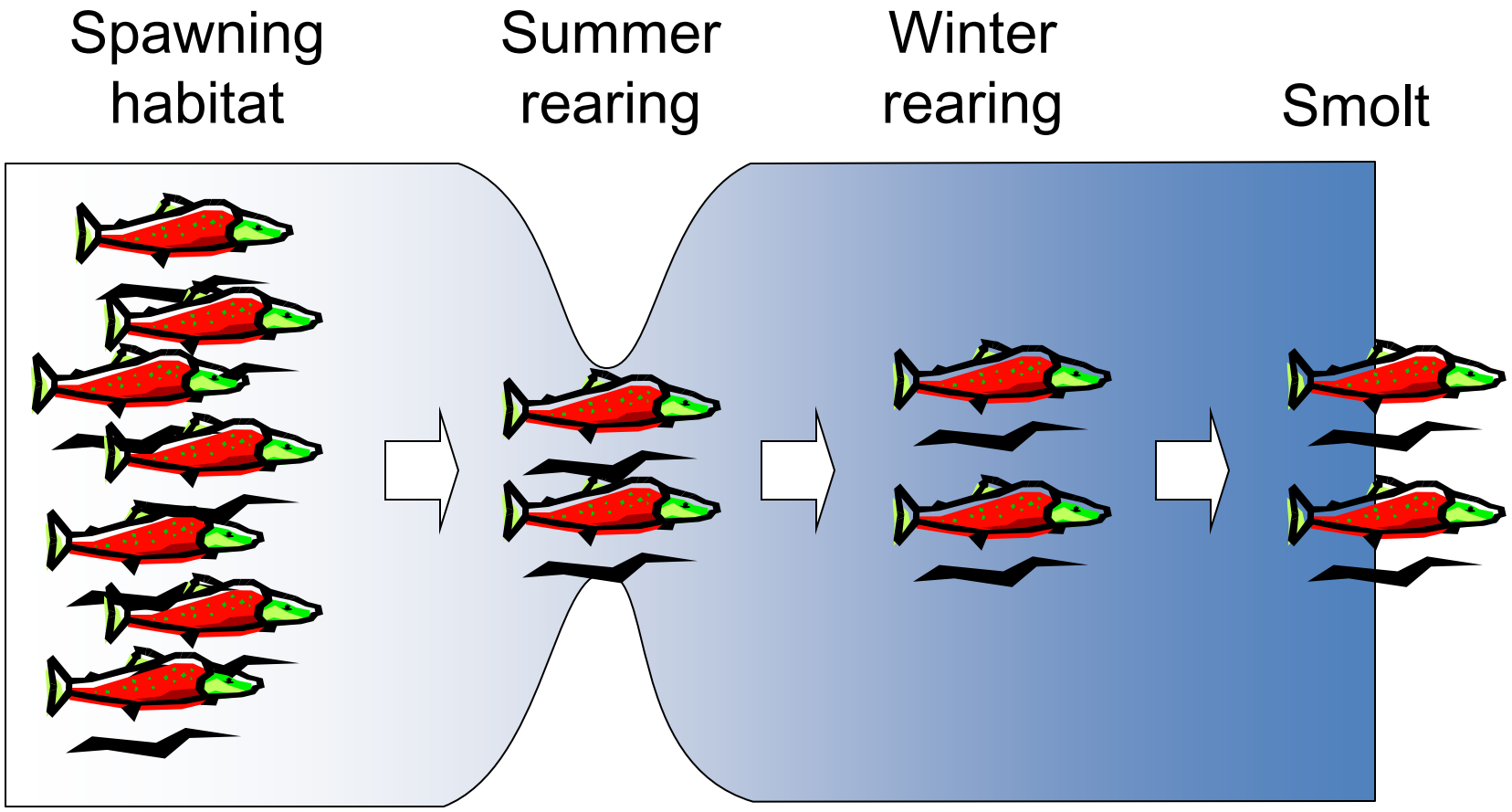
Assessments – identifying problems & actions

- Historical habitat
- Current habitat
- Habitat loss
- Disrupted processes
  - Connectivity
  - Hydrology
  - Riparian
  - Sediment
  - Nutrients



Beechie et al 2003

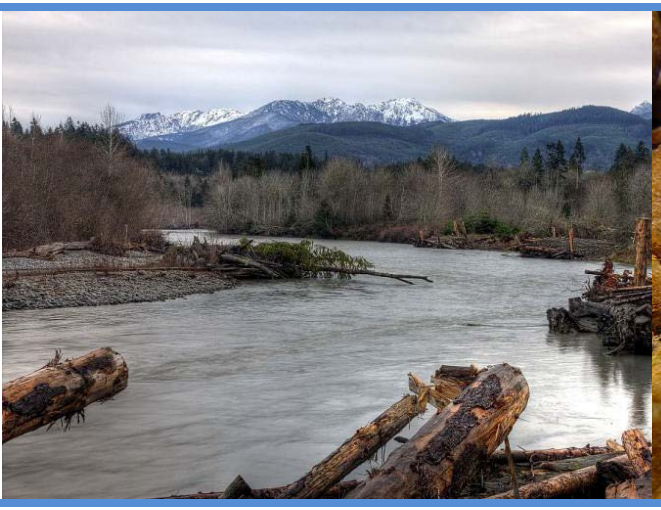
Limiting Factors Analysis to Identify Restoration

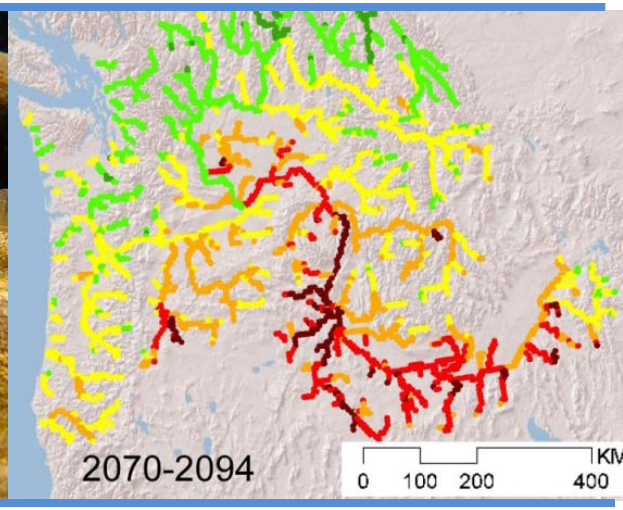


Watershed program
Northwest Fisheries Science Center
National Marine Fisheries Service
Seattle, WA 98112

Selecting Restoration Techniques

- Process-based restoration vs. improvement
- Effectiveness of different techniques
- Restoration and Climate change





Selecting Restoration Techniques

Category of Techniques	Restores Processes	Years till response	Duration of restoration	Reduces Impacts of Climate Δ
Reconnection	Yes	<1	50+	Yes (temp)
Planting of trees	Yes	25 to 100	100+	Yes (temp)
Fencing	Yes	1-5	10+	Yes (temp)
Roads	Yes	10-50	100+	Unlikely
LWD*	No	1-5	20 - 30	Unlikely
Nutrients*	No	<1	1?	No

*** NEED TO BE COUPLED WITH PROCESS BASED RESTORATION** Roni et al. 2002

Prioritization or Sequencing Restoration

- A variety of approaches
  - Project type
  - Location
  - Complex models
  - Multi-criteria scoring systems

- Several key steps
  - Outlining goals, criteria and approach important

Prioritization – Common Approaches

Technique	Length treated	Increase in fish #s	Cost	Cost/fish	# of species present	Restores disrupted process
LWD placement	2 km	500	$100,000	$200	2	no
Floodplain reconnection	1 km	5,000	$500,000	$100	5	yes
Riparian planting	5 km	?	$10,000	?	4	yes
Road removal	8 km	?	$750,000	?	4	yes

Roni et al. 2002, Beechie et al. 2008

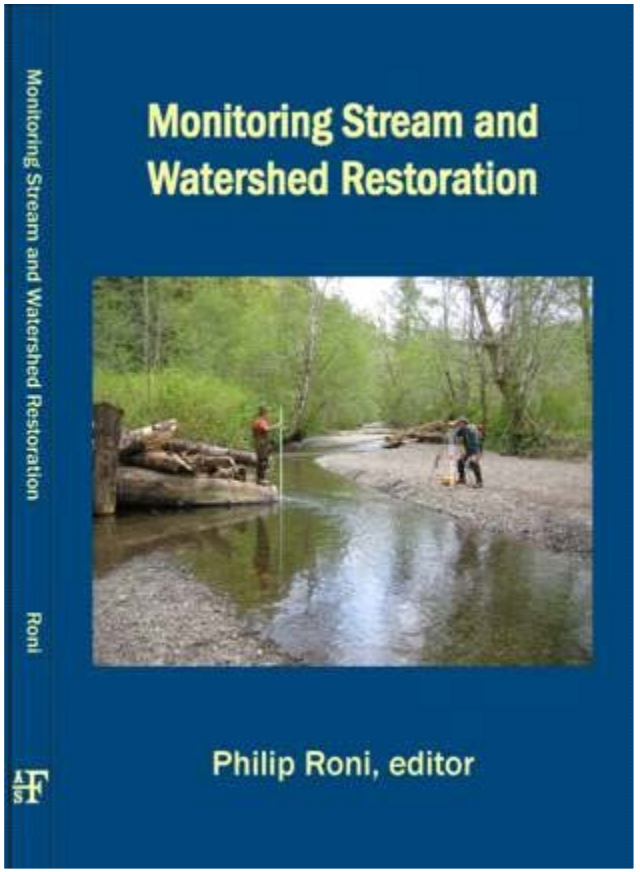
Prioritization – Scoring System

Technique	Length treated	Increase in fish #s	Cost	Cost/fish	# of species present	Restores disrupted process	Total score
LWD placement	2	4	3	3	2	1	**15**
Floodplain reconnection	1	5	2	4	5	5	**18**
Riparian planting	5	2	5	1	4	5	**23**
Road removal	5	2	1	1	4	5	**18**

Score of 1 to 5 – five being highest score

Steps for Designing a Effectiveness Monitoring Program

- Define project goals and objectives
- Define scale
- Define questions/hypotheses
- Determine monitoring design
- Spatial and temporal replication
- Select parameters
- Selecting sampling scheme/protocol
- Implement monitoring



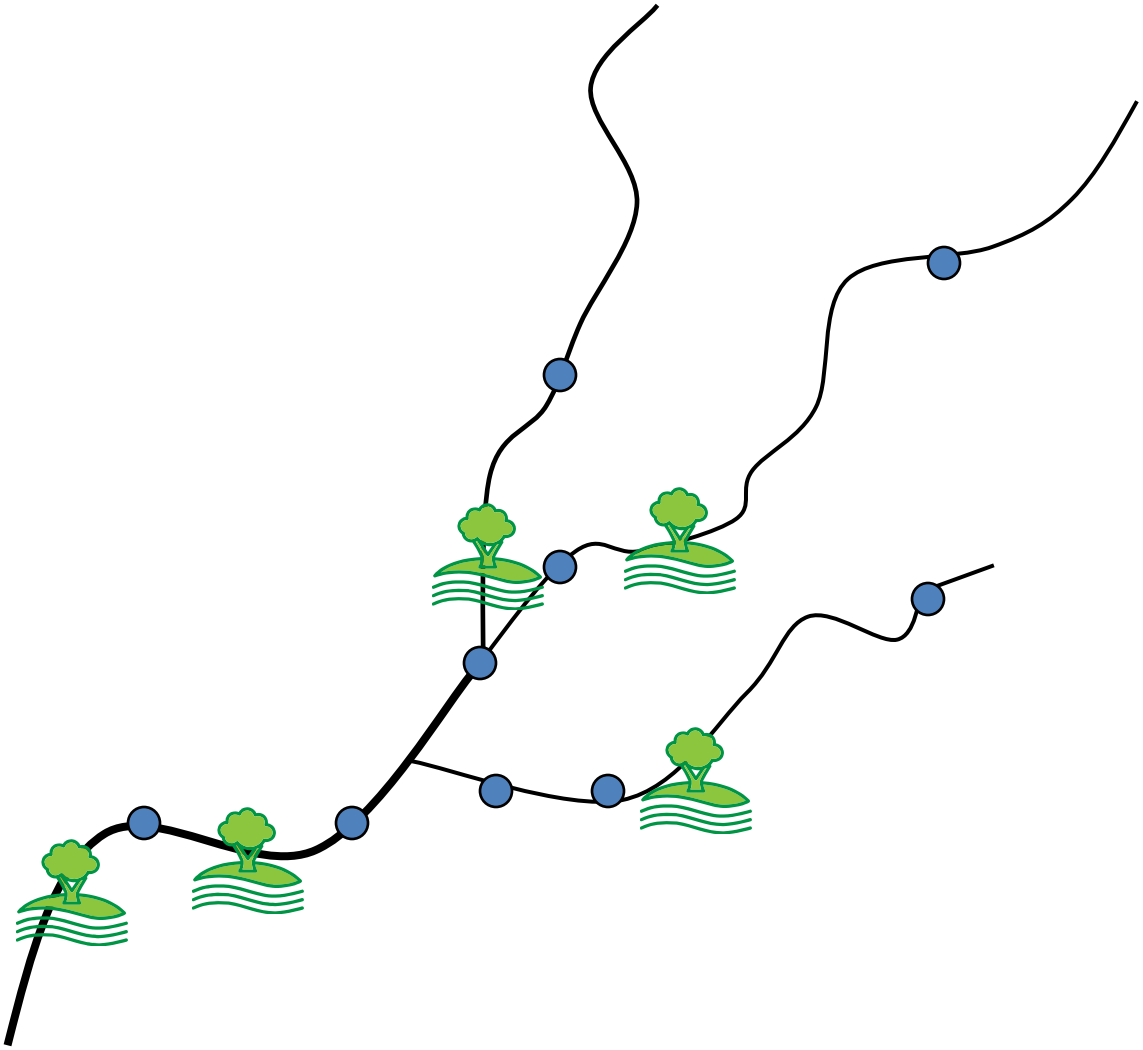
Key Questions or Hypotheses

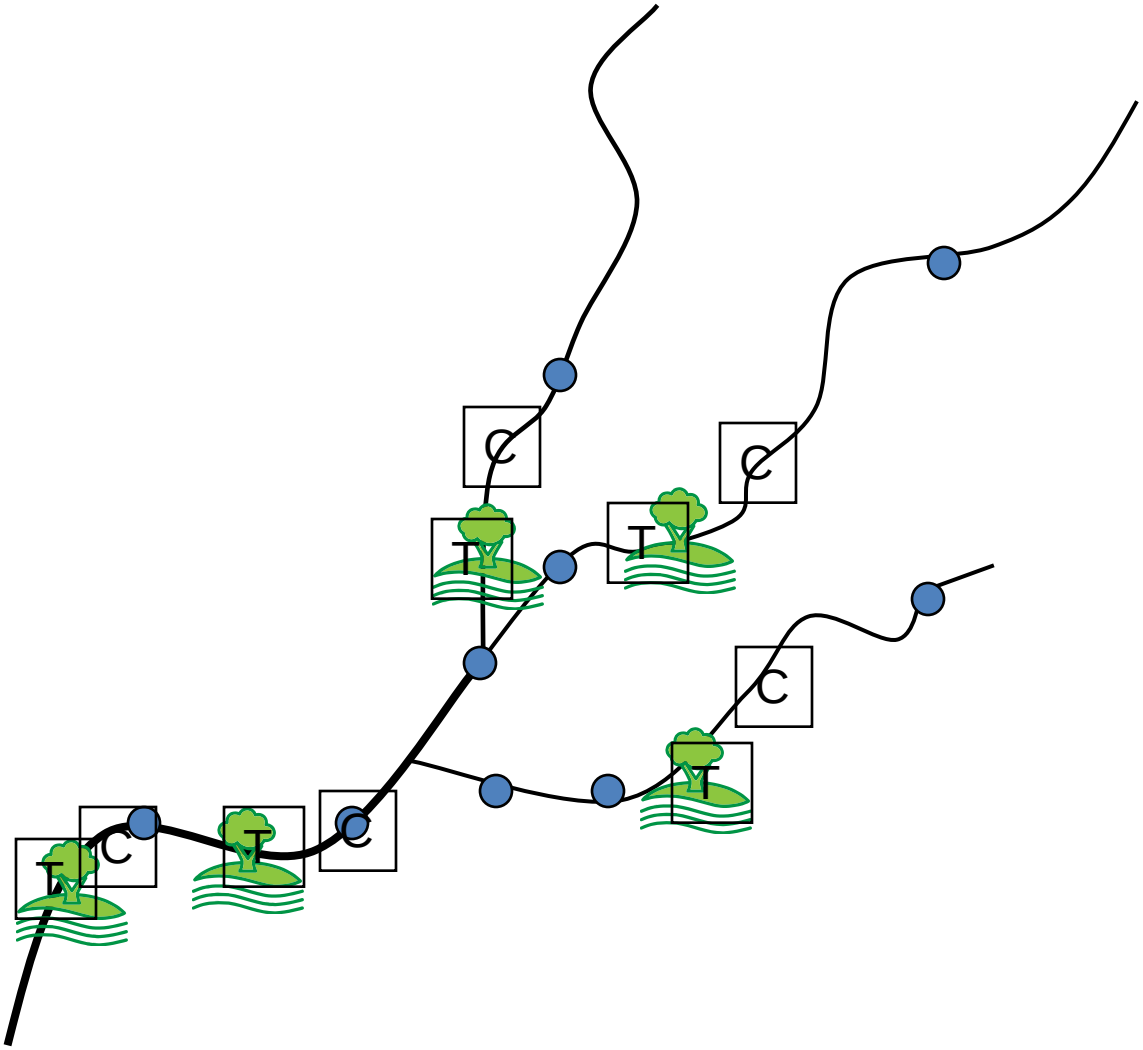
Reach or Project Scale

- **What is effect of project x on local habitat conditions or fish?**
- **What is effect of project like x on local conditions or fish?**

Watershed Scale

- **What is effect of project x on watershed conditions or a fish population?**
- **What is effect of a suite of projects on watershed conditions or a population?**

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Key Questions or Hypotheses

Reach or Project Scale

- **What is effect of project like x on local conditions or fish?**

Watershed Scale

- **What is effect of a suite of projects on watershed conditions or a population?**

M&E Recommendations

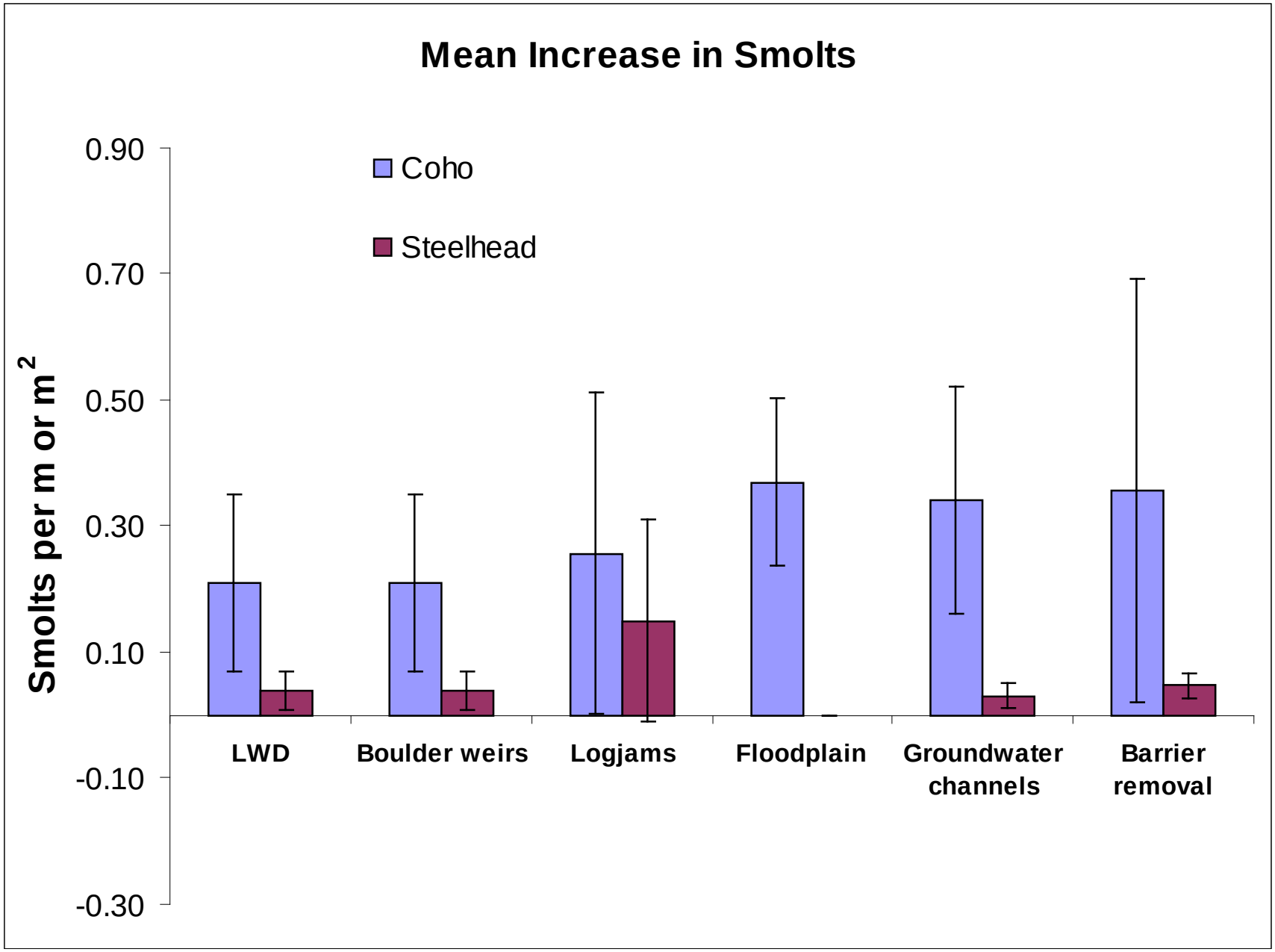
Reach or Project Scale

Retrospective analysis of different project types (15 to 30 of each type)

Watershed Scale

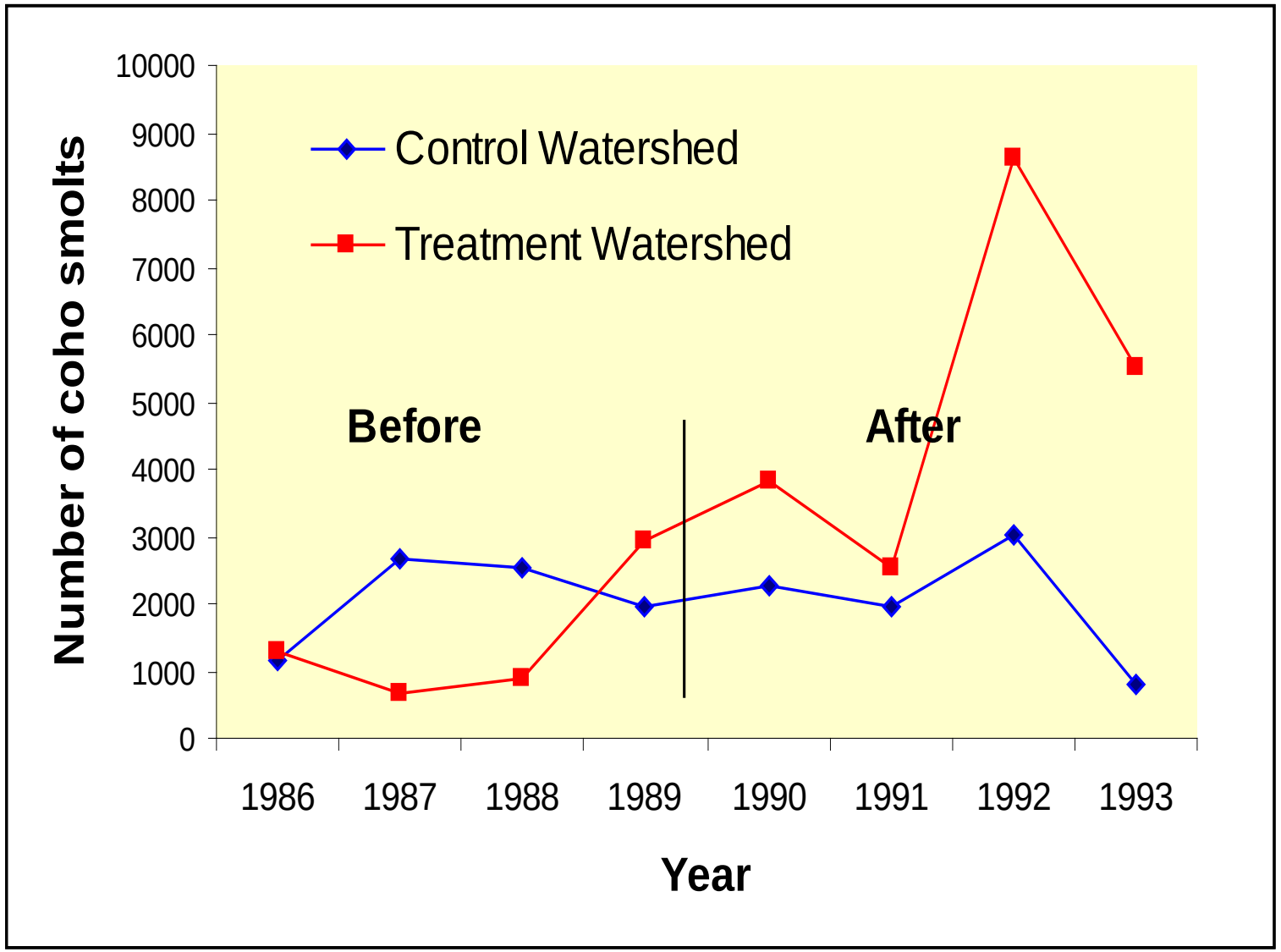
IMW's

(but need to make sure there is "enough restoration" to measure)

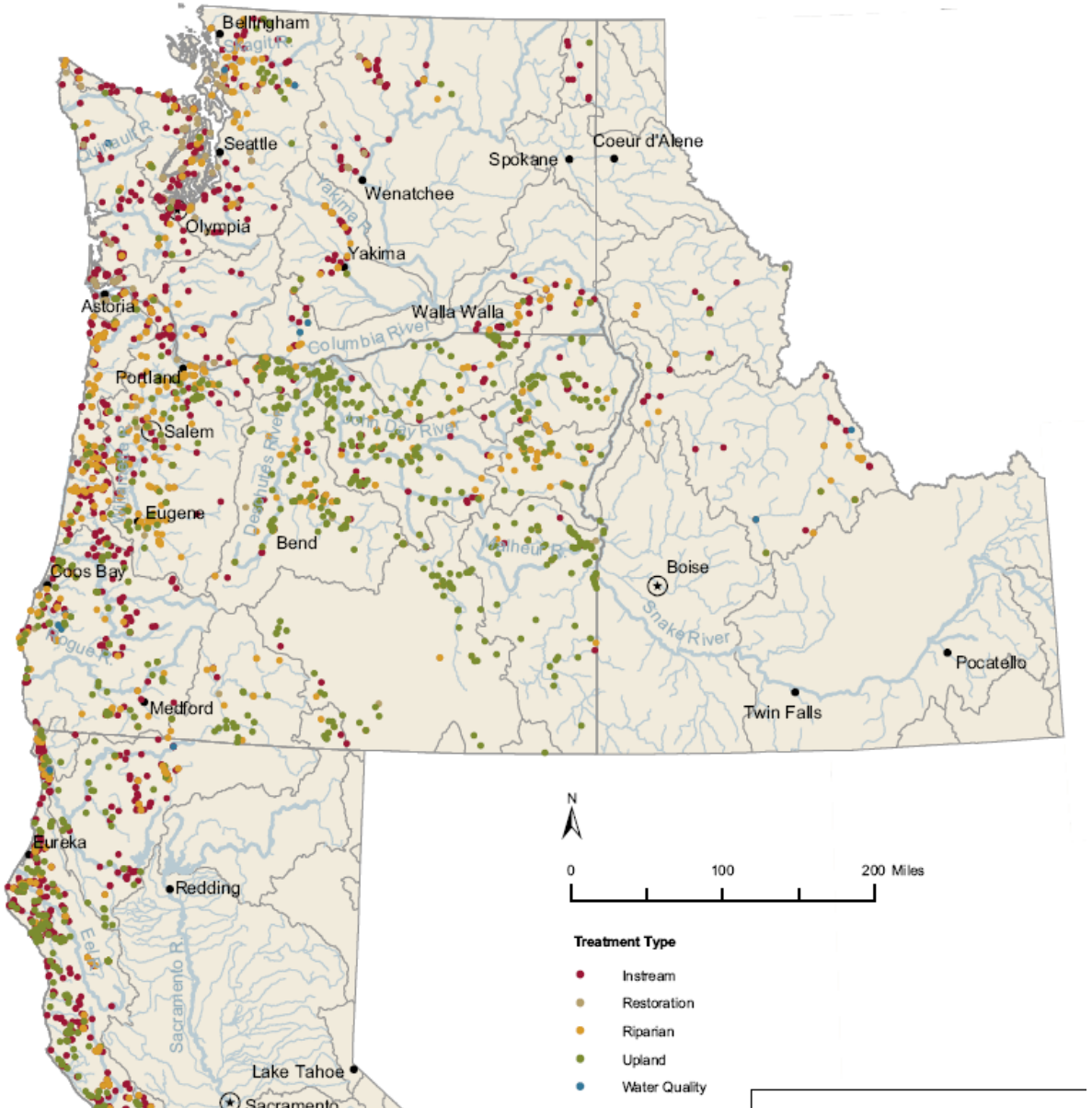

Mean Increase in Smolts
Coho
Steelhead
Smolts per m or m2
0.90
0.70
0.50
0.30
0.10
-0.10
-0.30
LWD
Boulder weirs
Logjams
Floodplain
Groundwater channels
Barrier removal

IMW Example - Alsea Basin

(from Solazzi et al. 2000)



How Much Restoration is Needed?

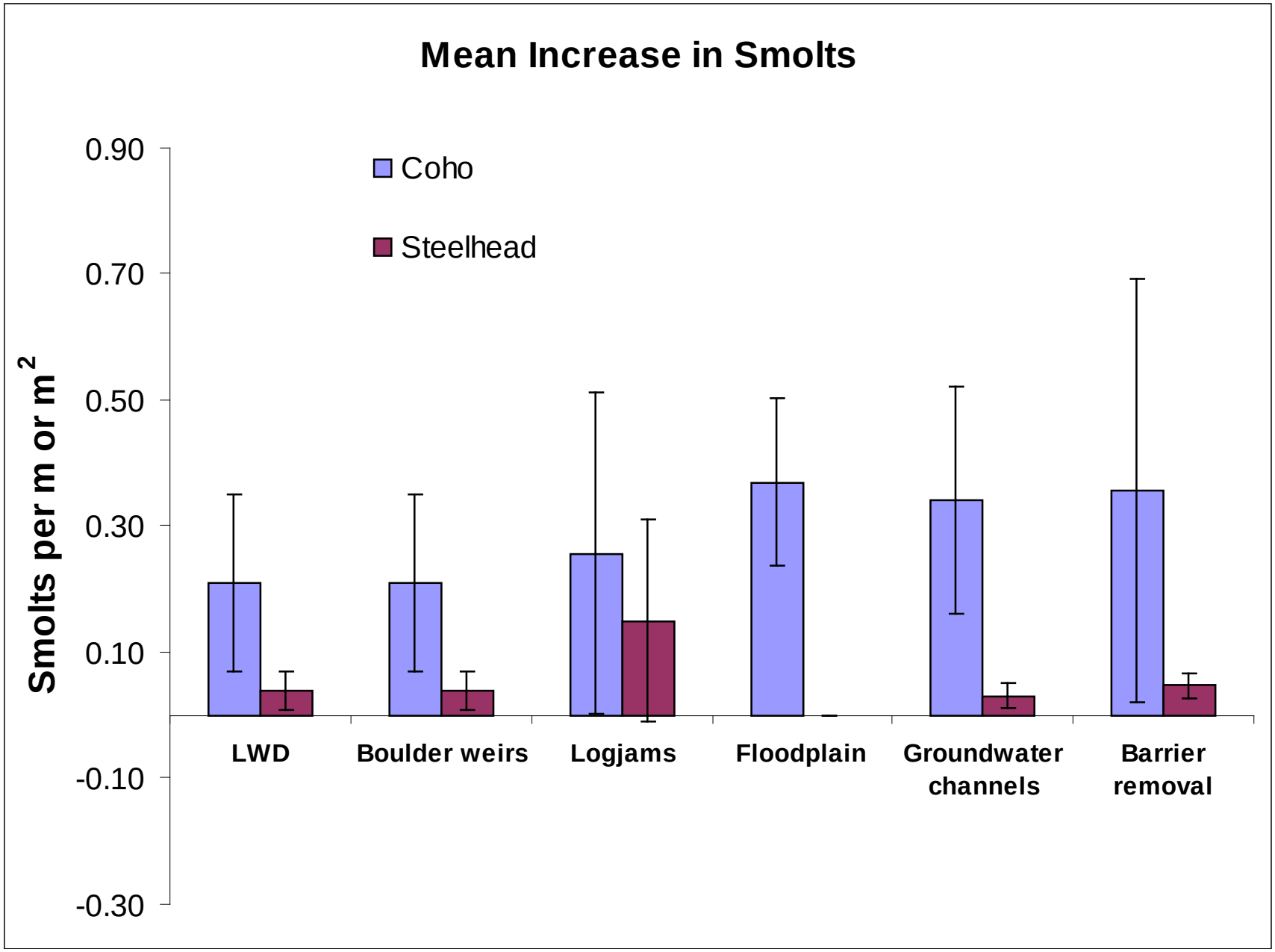


How Much Restoration Is Needed?

Restoration Activities PCSRF 2000 to 2009

Metric or Restoration Activity	All PCSRF	Per Watershed*
Instream kilometers treated	1,413	3
Floodplain hectares treated	4,938	3
Barrier removal (km)	6,918	17

*Puget Sound Basin
NOAA unpublished data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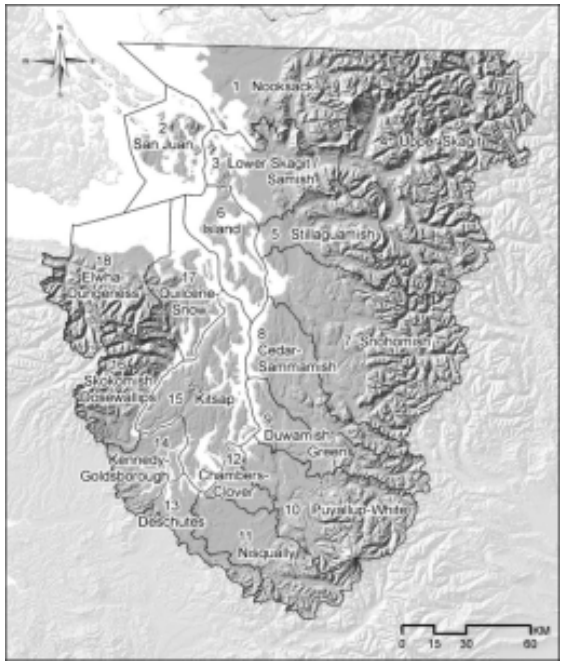
Barrier removal

Typical Puget Sound Watershed

Salmon Habitat	Typical Watershed
Streams/Rivers (km)	
small* – inaccessible	13
small* – accessible	*126*
medium*	58
large*	118
Floodplain habitat (ha)	
Side channels existing	213
Side channels lost	307
Sloughs existing	77
Sloughs lost	320



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

Restoration Actions Applied to Watershed

Salmon Habitat	Restoration type
Streams/Rivers	
small – inaccessible	Barrier removal
small - accessible	LWD addition
medium	Boulder weirs
large	Logjams
Floodplain habitat	
lost side channels	Groundwater channels
lost sloughs	Floodplain reconnection

Summary of Estimates in Model Watershed

Strategy	Coho smolts	Steelhead smolts
Pre-restoration smolt production	230,501	22,386
Scenario 1 – Restore All	285,302	28,001
Scenario 2 - Historic	15,022	1,195

How much restoration is needed to detect an increase in smolts with monitoring?

	Coho	Steelhead
Pre-restoration smolt production	230,501	22,386
Minimum detectable difference (25%)	57,625	5,596
Habitat restoration needed to increase smolts 25%	20%*	20%*

- 100% to be 95% certain

Take Home Messages

- **Several Steps to Restoration Process**
  - Successful restoration requires following all of them
- **Prioritization**
  - Multi-metric scoring systems most transparent
- **M&E**
  - Type of monitoring needed
    - Retrospective studies to examine effectiveness
    - Watershed-scale effectiveness (IMWs)
- **Amount of Restoration**
  - Need to concentrate restoration and do a lot if we want to see a measureable response

Resources

Goals	Beechie et al. 2008. Setting river restoration priorities. NAJFM
Assessments	Beechie et al. 2003. Watershed assessments in recovery planning
Identify actions	Pess et al. 2003.. Watershed assessments and success for restoration Beechie et al. 1994. Estimating habitat and smolt production losses.
Restoration techniques	Roni et al. 2002. A review of restoration & a strategy for prioritizing. NAJFM Roni et al. 2008 Global review of effectiveness of restoration. NAJFM
Prioritization	Roni et al. 2002, Beechie et al.2008
Design	RiverRAT: science base and tools for analyzing stream restoration proposals. http://www.restorationreview.com/ Beechie et al. 2010. Process based restoration. Bioscience
Monitoring	Liermann & Roni 2008. Optimal study design for monitoring fish rest. NAJFM Roni 2005 Monitoring stream and watershed restoration. AFS Book

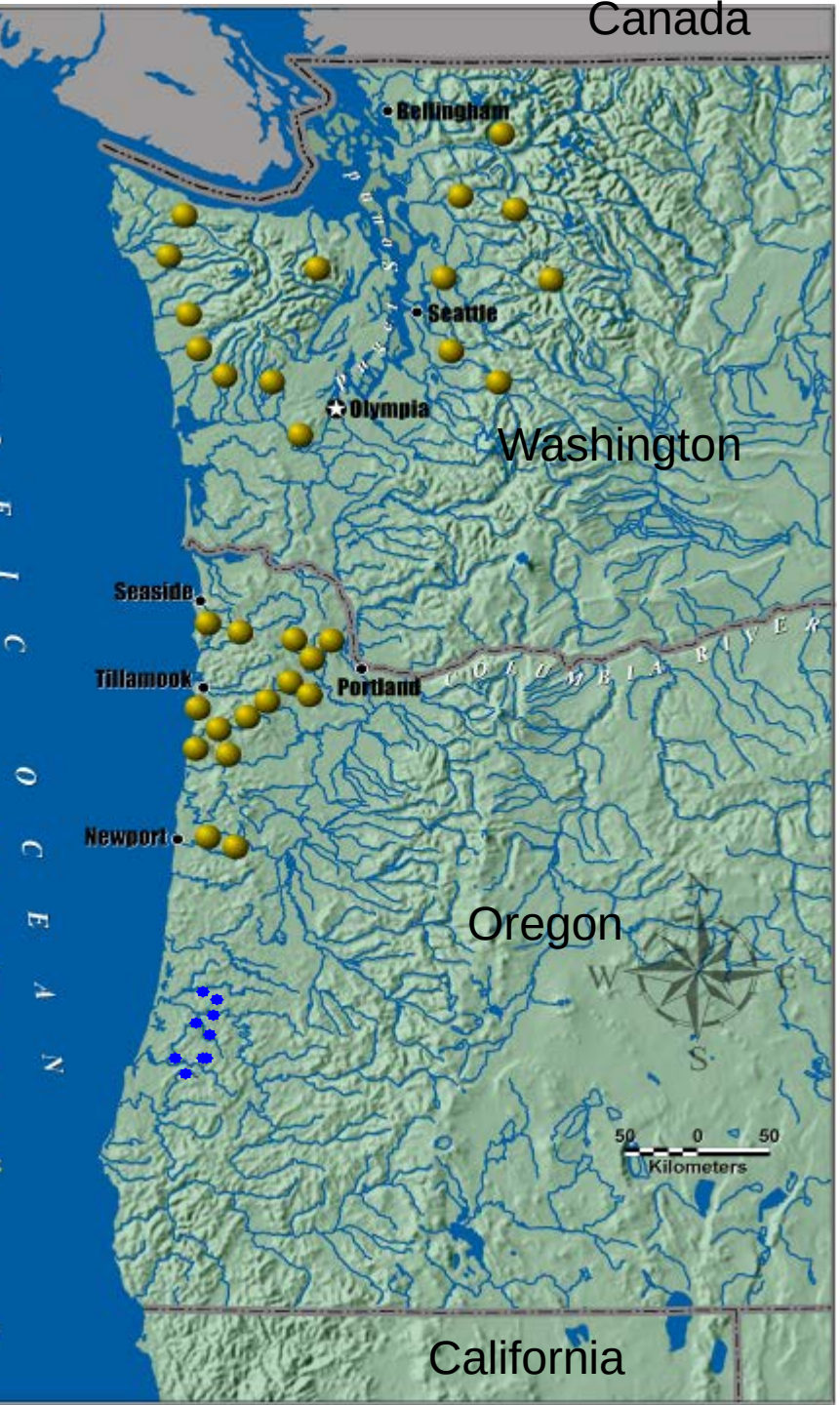
Northwest Fisheries Science Center
Fisheries Ecology Division

WATERSHED PROGRAM

Our mission is to conduct research on freshwater & estuarine ecosystems to assist with the management and recovery of anadromous fishes.

“Additional evaluation studies on stream improvement, especially with reference to the effect on the abundance of fish, are still urgently needed.”

Clarence M. Tarzwell, U.S. Bureau of Fisheries, 1937



Restoration Types Examined

- Log placement in small streams
  (30 sites; Roni and Quinn 2001)
- Boulder structures in streams
  (13 sites; Roni et al. 2008)
- Barrier removal
  (6 sites; Pess et al. 1998)
- Constructed logjams
  (1 site; Pess et al. In press)
- Floodplain rehab
  (30 sites; Roni et al. 2006)
- Groundwater channel
  (11 sites; Morley et al. 2005)

Restoration Design Steps

1. Problem Identification
2. Context & assessment
3. Project goals & objectives
4. Alternatives evaluation
5. Project design
6. Implementation
7. Monitoring & Evaluation

RiverRAT – Design Tool

http://www.restorationreview.com/