NOAA FISHERIES
NWFSC

3.0 Freshwater habitat research & restoration overview

Phil Roni
May 4, 2015

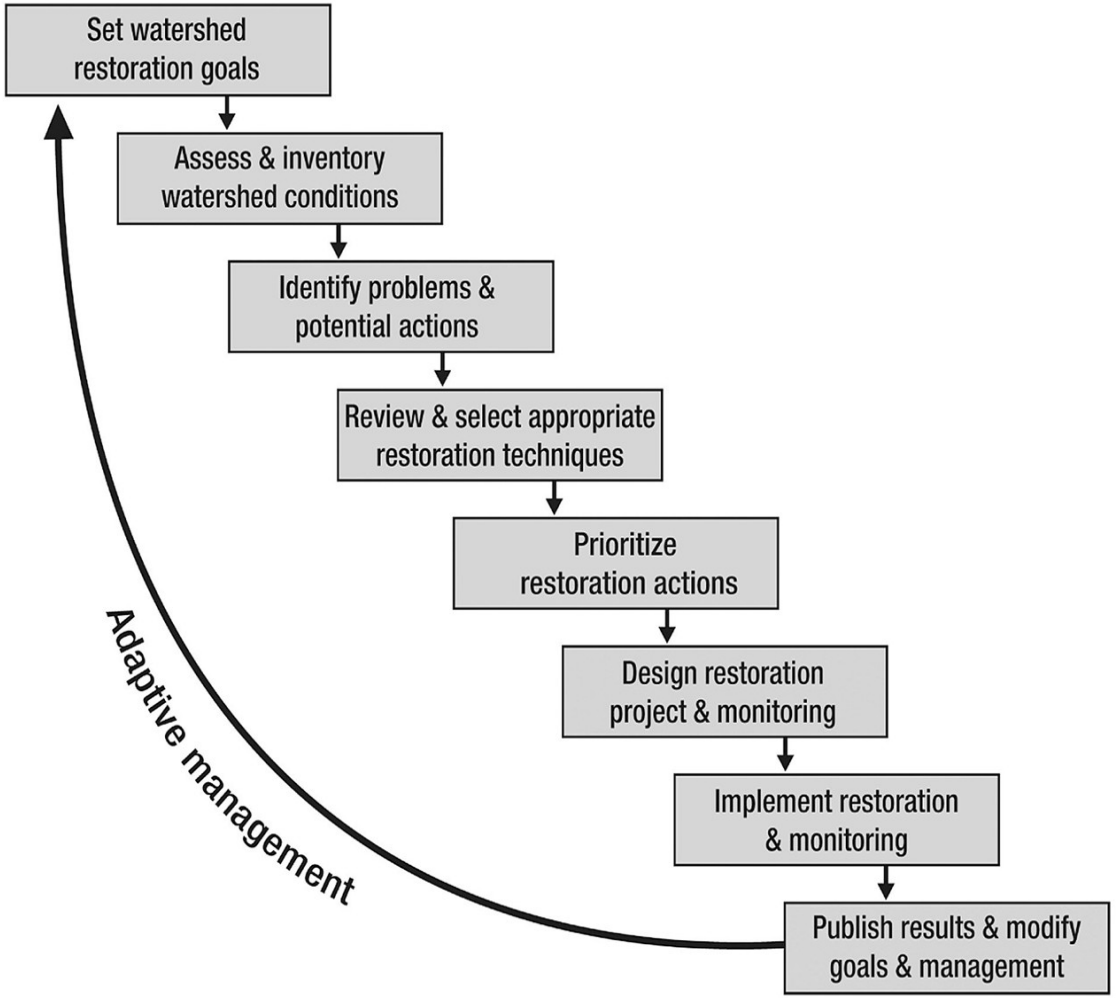
Groups working on freshwater habitat & restoration

- Watershed Program – Phil Roni
- CHaMP & ISEMP programs – Chris Jordan
- Ecotoxicology Program – Nat Scholz
- Life cycle modeling efforts – Rich Zabel
- FE/Landscape Ecology Team - SWFSC

Research Relevant to Protected Species & Freshwater Habitat and Restoration

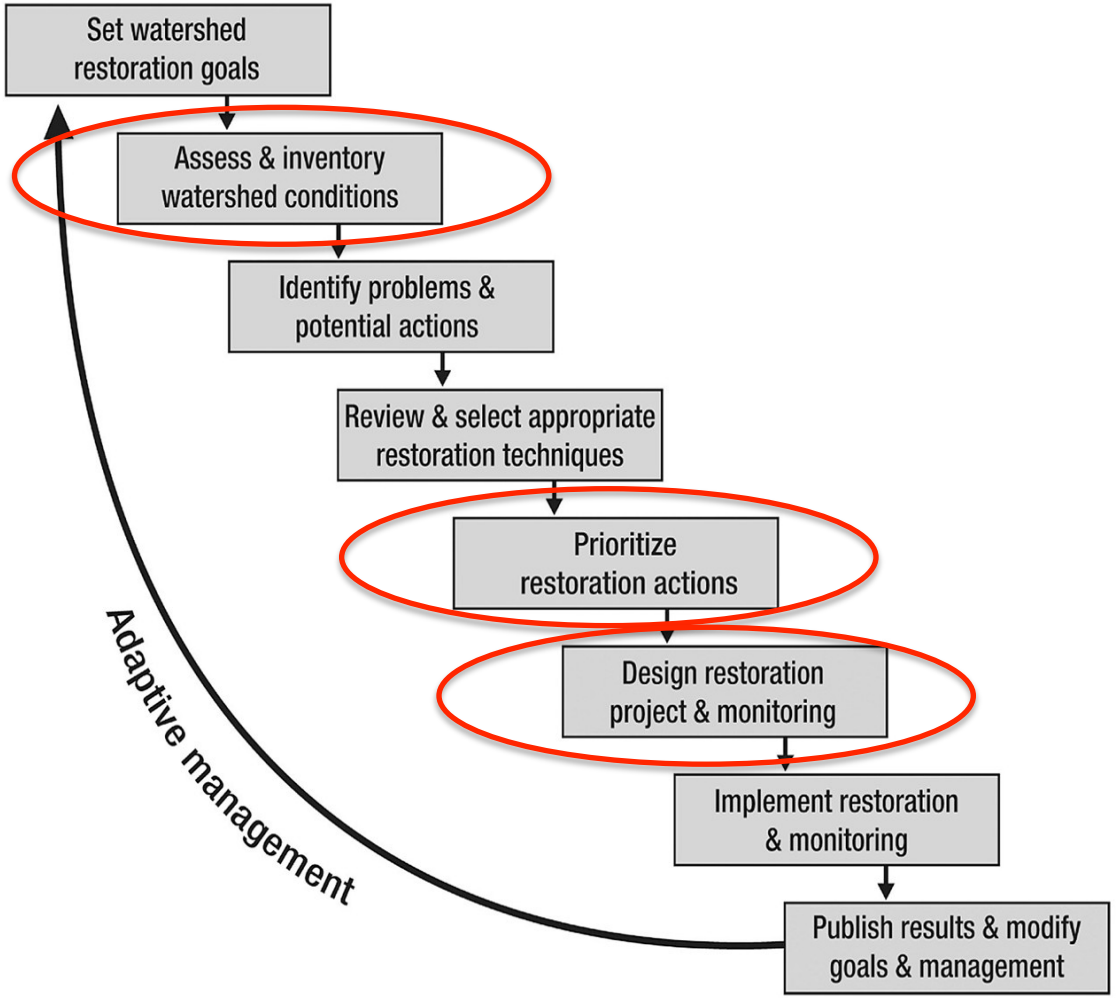
- Assessments for Protected Species including
  - Habitat restoration strategies at various spatial scales (**Assessments**)
  - Effects of climate change on recovery and restoration strategies (**Prioritization**)
- Habitat use, quantity & quality to assess restoration actions (**Evaluation**)

Start to Finish Restoration



Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats, First Edition. Philip Roni and Tim Beechie.

Roadmap for Talk

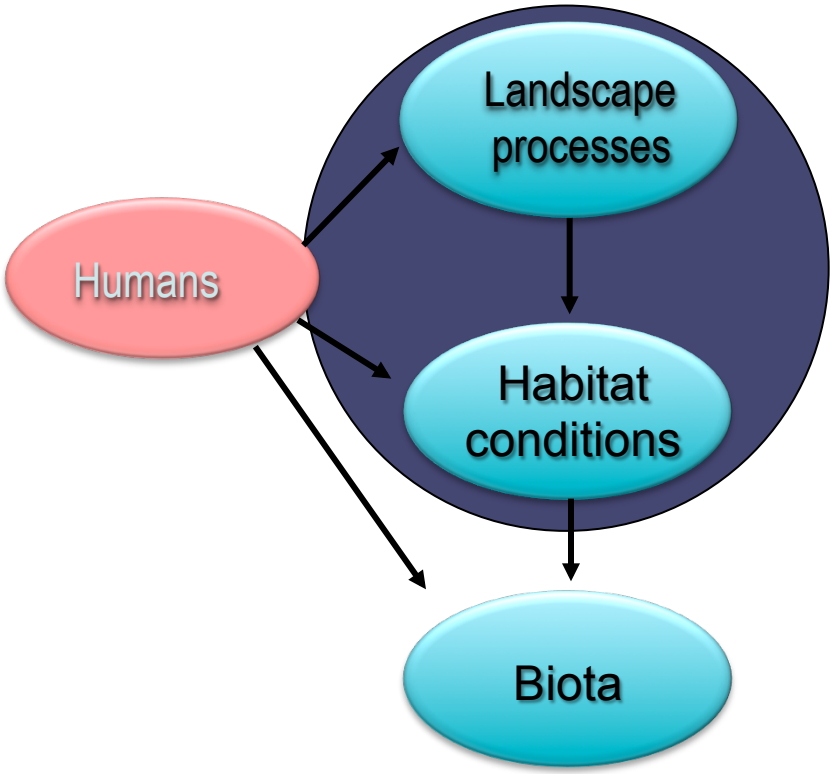


Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats, First Edition. Philip Roni and Tim Beechie.

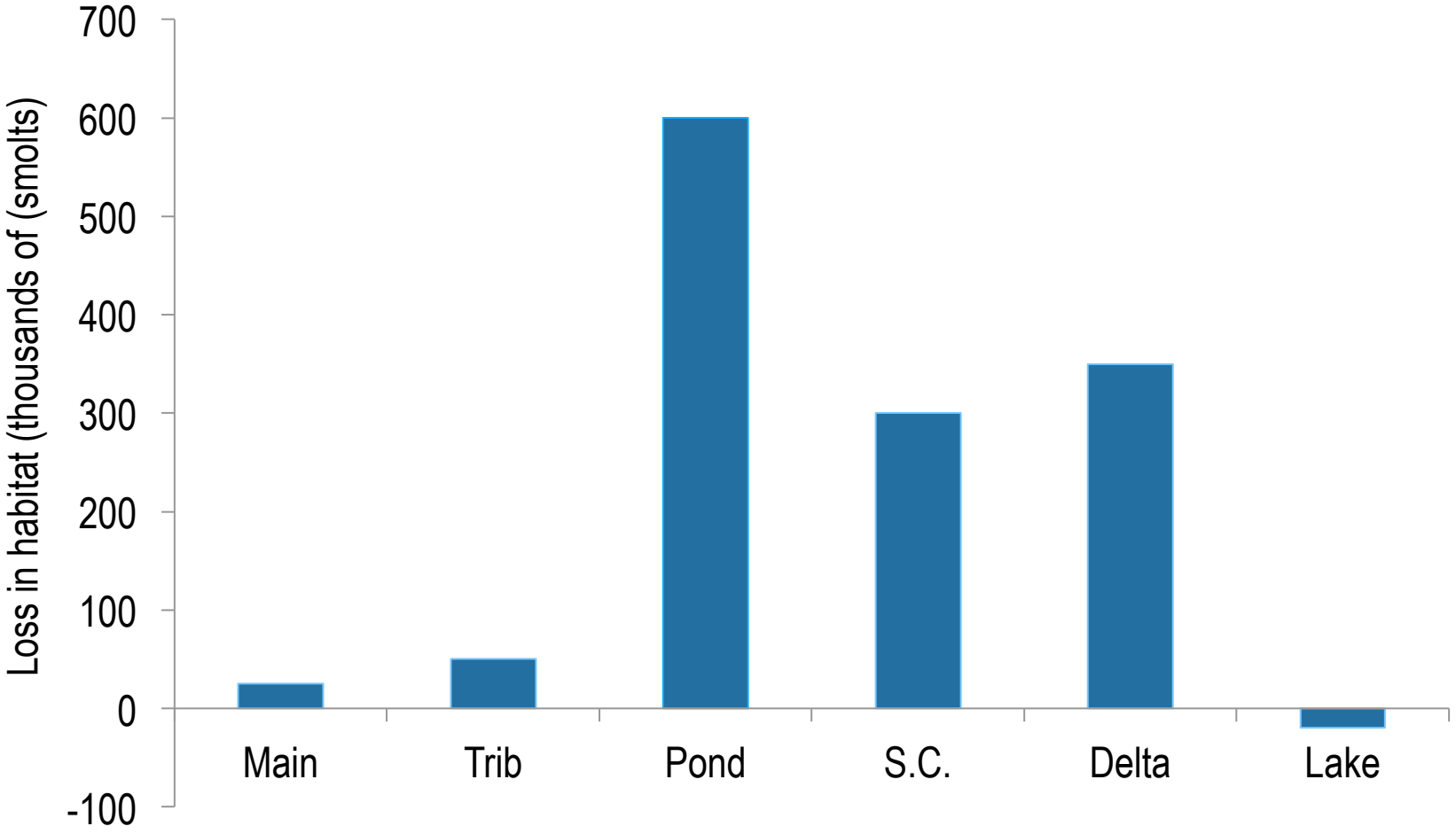
Assessments
Model of Watershed Function

- What are the root causes of habitat and biological change?

- How have habitats changed and how have biota responded?



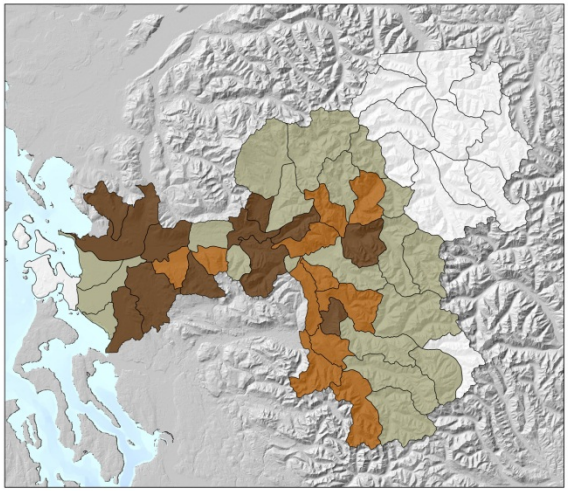
Assessments Skagit Example: How have habitats changed?



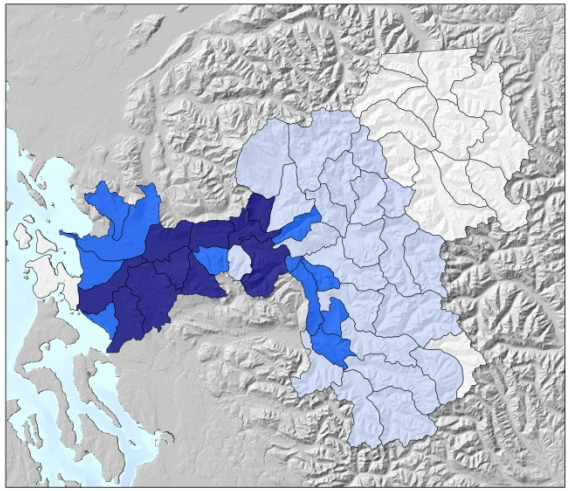
Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats., First Edition. Philip Roni and Tim Beechie, 2013 John Wiley & Sons, Ltd.

How have inputs & connections changed?

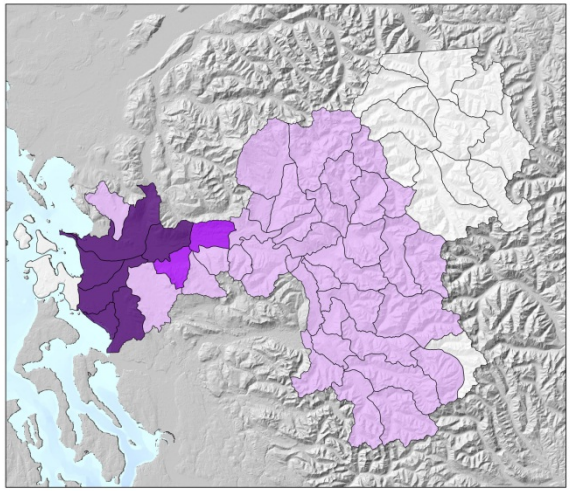
Summary maps of change in sediment supply, hydrology, and migration barriers in the Skagit River Basin



Sediment



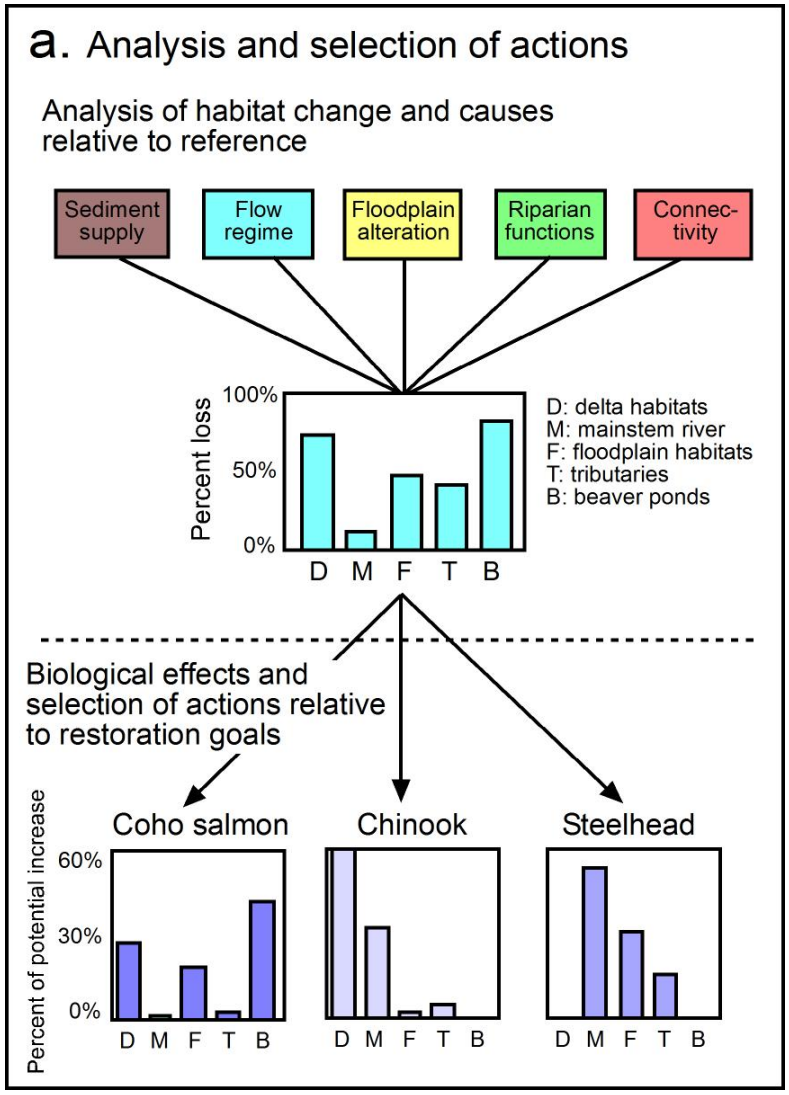
Hydrology



Migratory barriers

Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats., First Edition. Philip Roni and Tim Beechie, 2013 John Wiley & Sons, Ltd.

Habitat use & habitat quantity & quality data to determine & assess restoration actions



Landscape processes - Identify & quantify the causes of habitat change

Habitat conditions – Identify & quantify the loss of habitat quantity and quality

Biota - Selection of restorative actions is determined by the biological requirements of a given species

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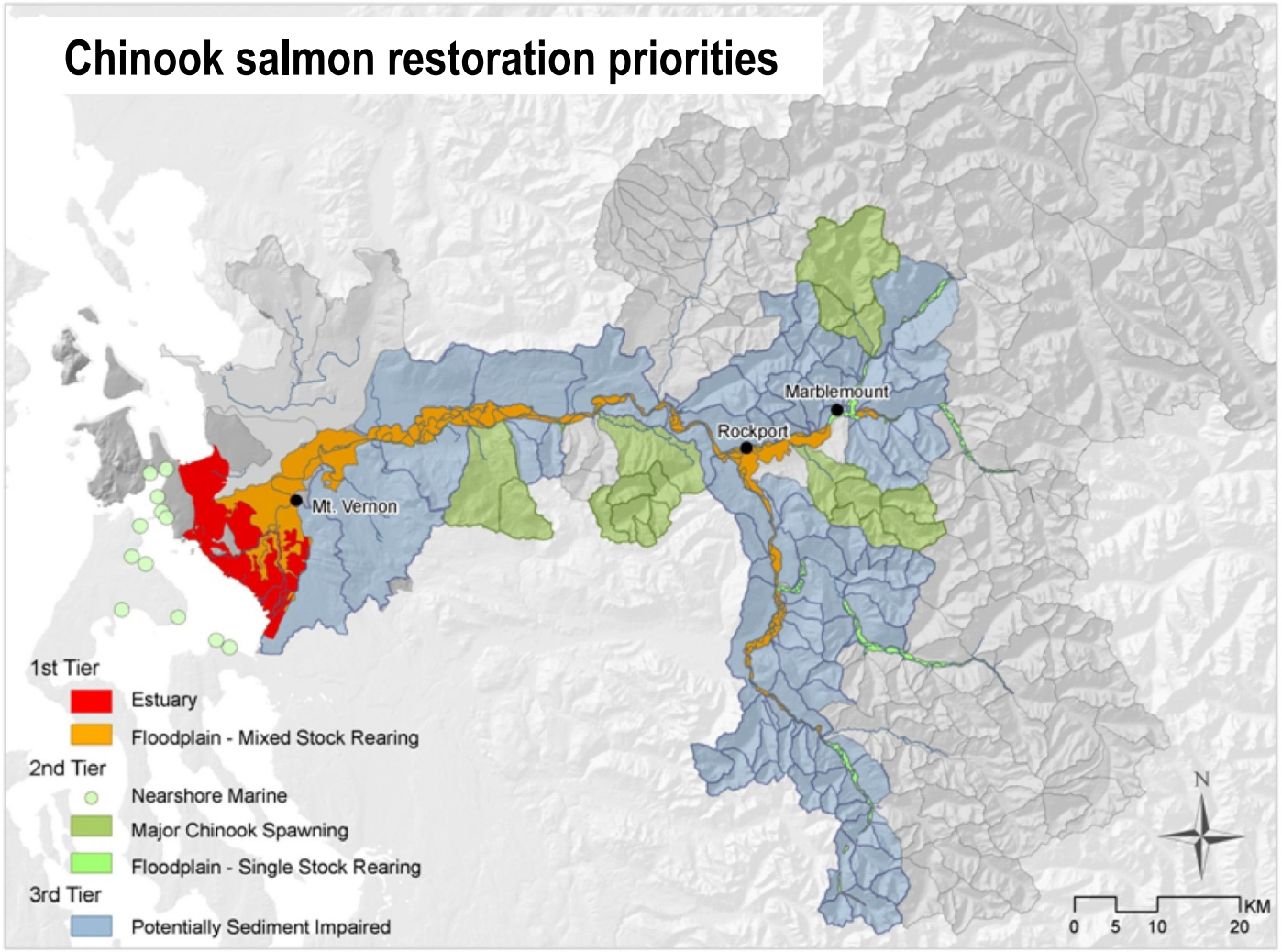

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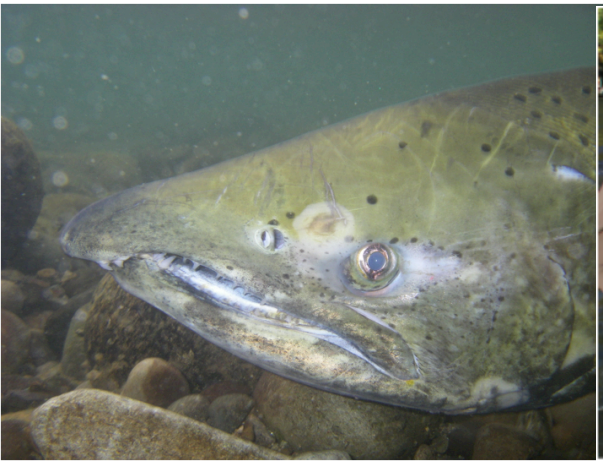
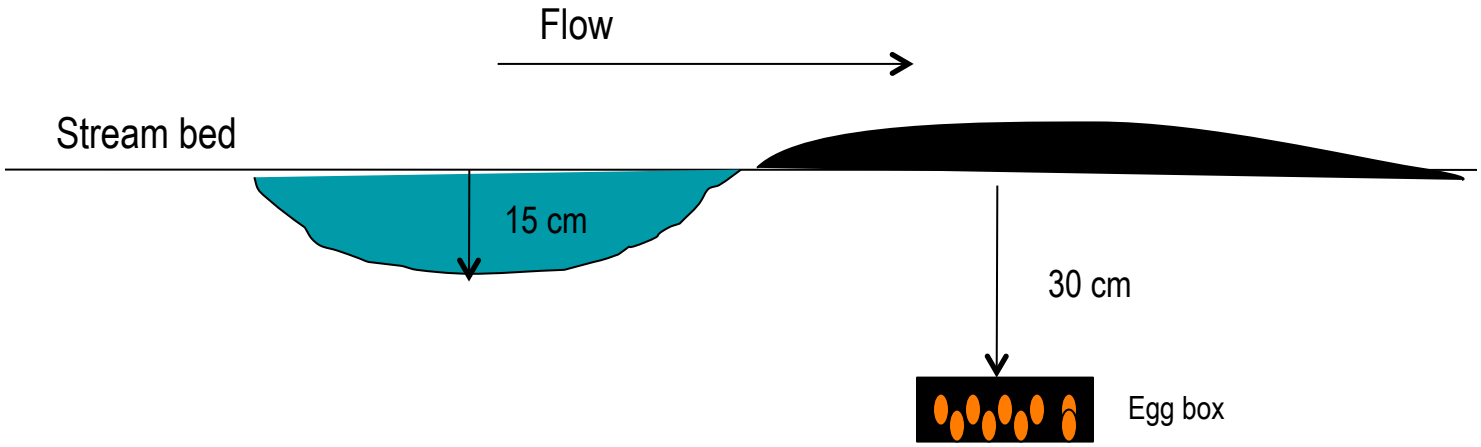
Example studies that support the understanding of watershed assessment and condition

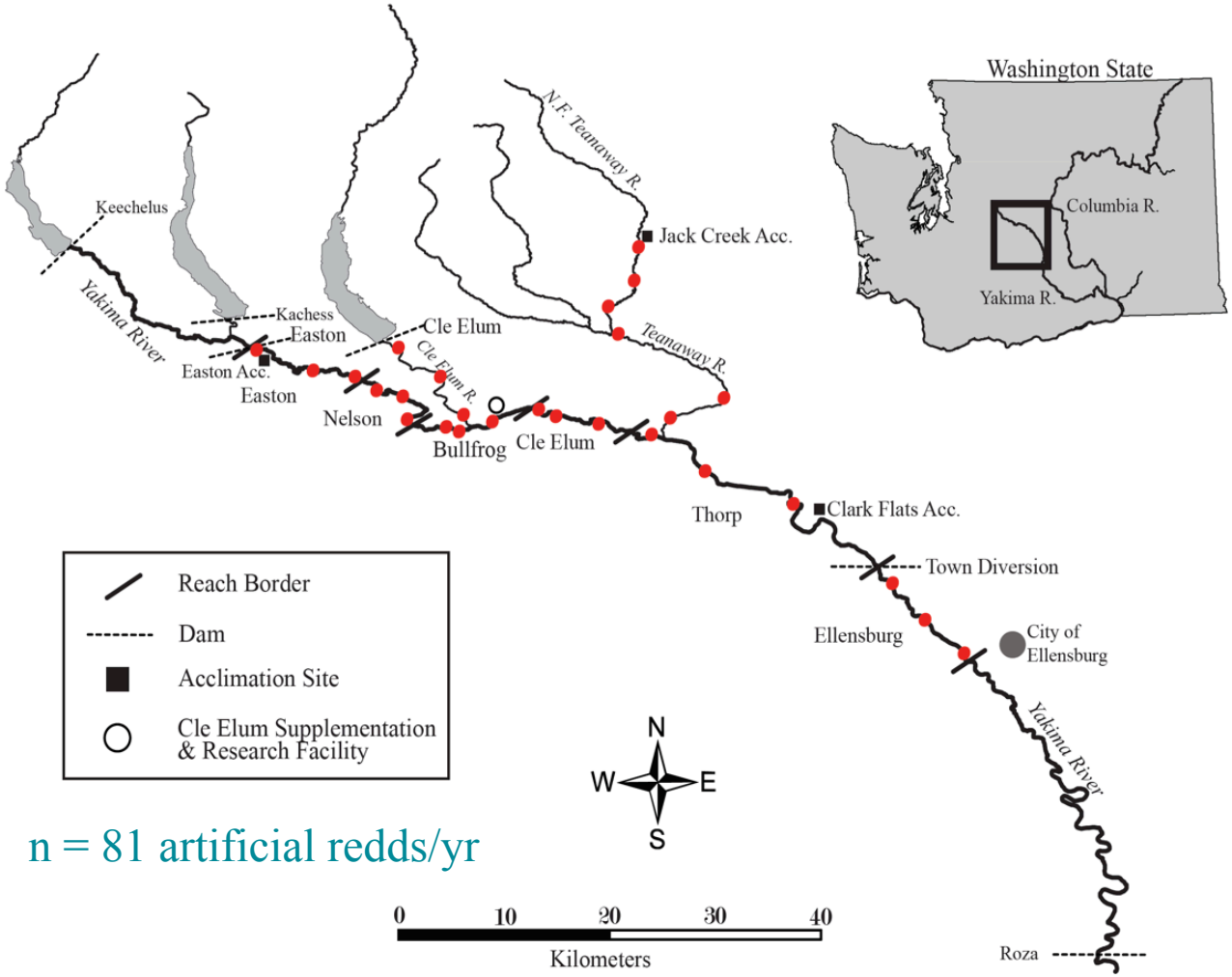
- Predicting natural channel patterns based on landscape & geomorphic controls in the Columbia River basin
- Quantifying egg to fry survival and its sources of variance for Chinook salmon & Steelhead in 3 Columbia River watersheds
- Estimating juvenile and adult salmon habitat availability in the Wenatchee River
- Quantifying differences in estuarine connectivity, food source, & density dependence effects to help prioritize habitat restoration for juvenile Chinook salmon in four Puget Sound estuaries

Egg to Fry Survival in Chinook Salmon



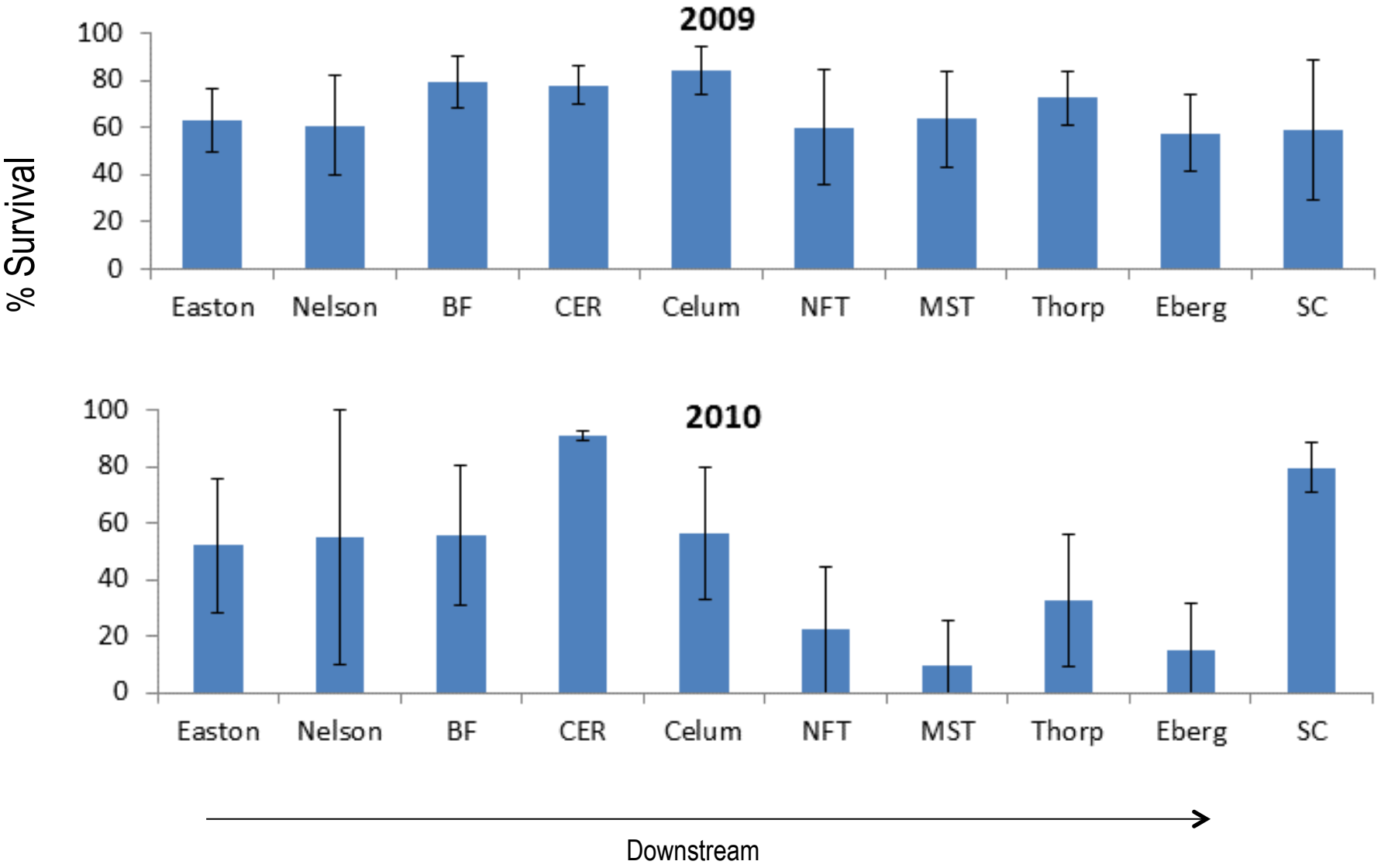



Quantifying egg to fry survival & its sources of variance for Chinook salmon in the Yakima River



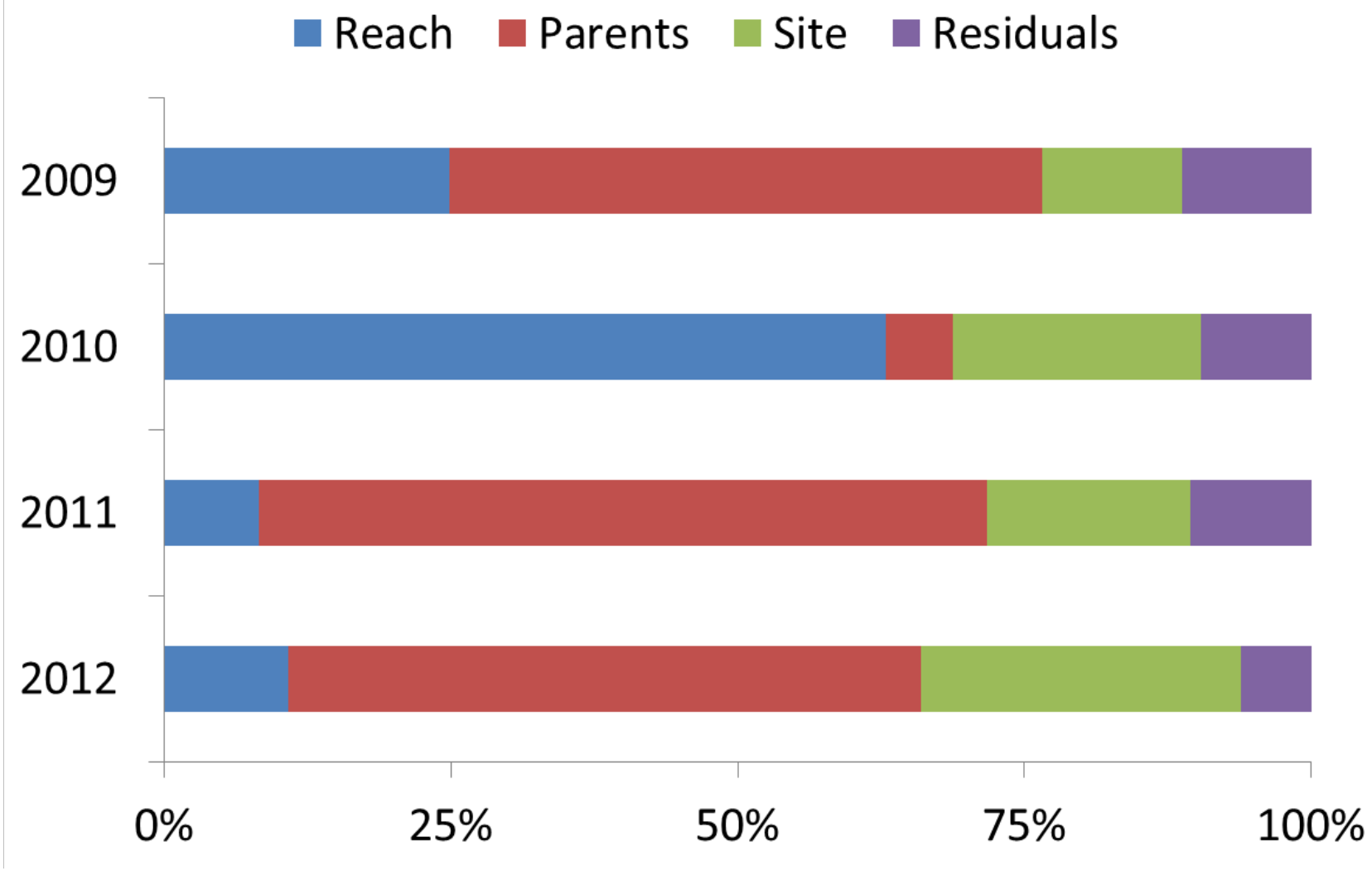
n = 81 artificial redds/yr

Survival by Reach



Johnson et al. 2012; Roni et al. In review

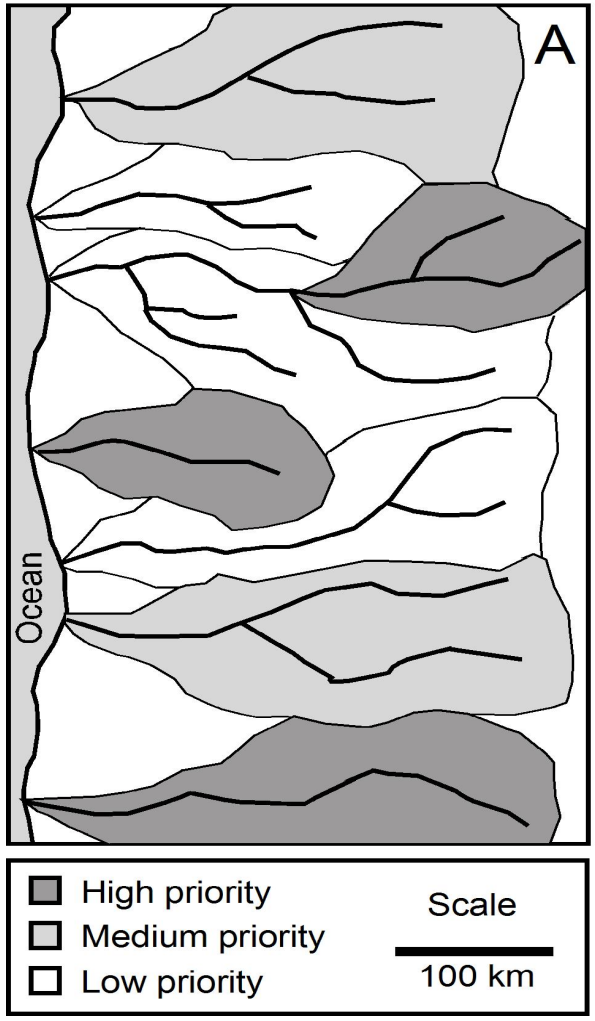
Quantifying egg to fry survival & its sources of variance for Chinook salmon in the Yakima River



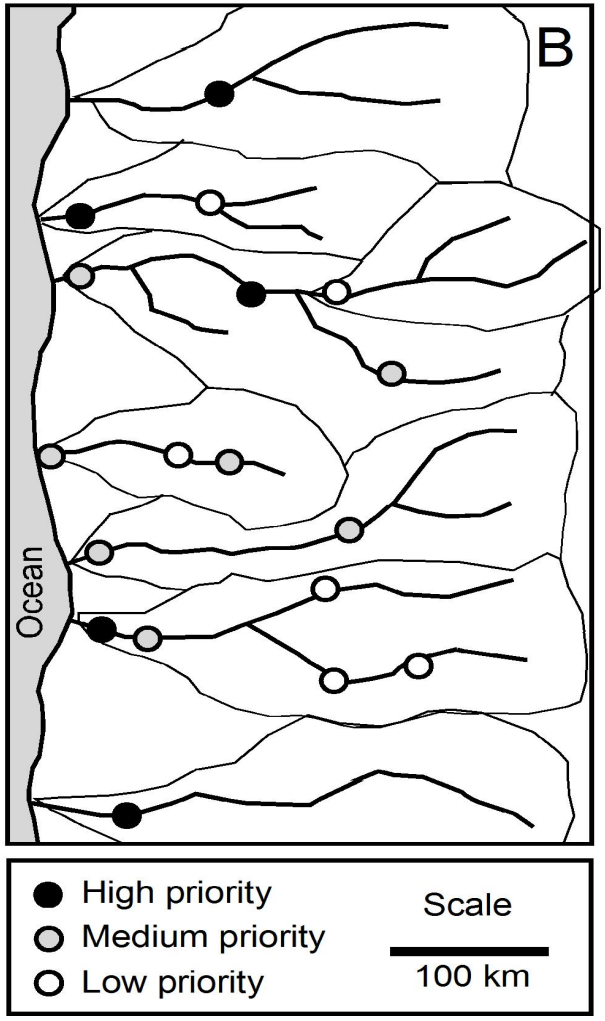
Roni et al. In review

Prioritization of Restoration Actions

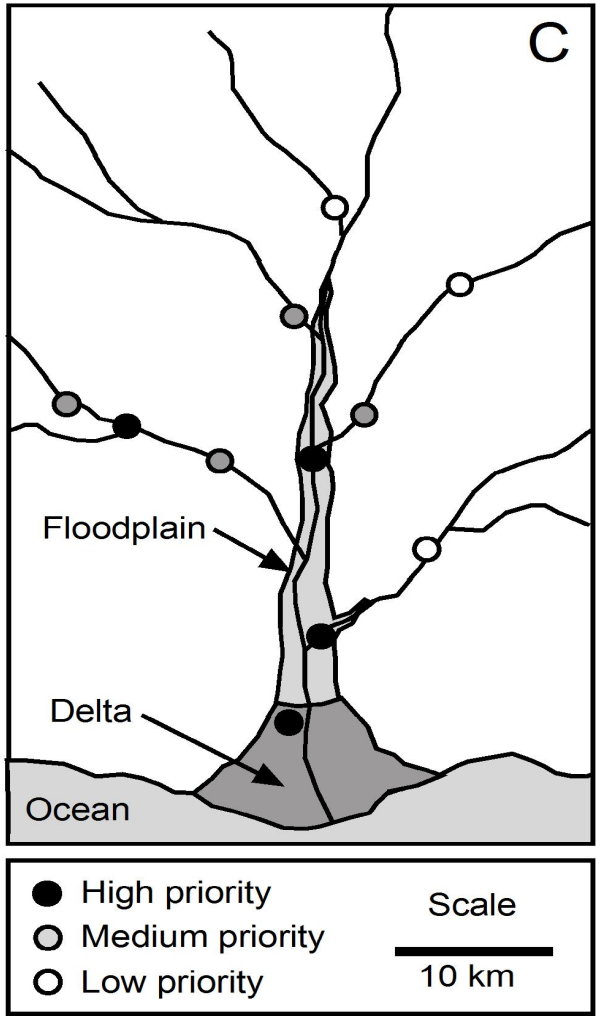
Regional prioritization of watersheds



Regional prioritization of projects



Prioritization of projects within a watershed



Habitat restoration strategies at varying spatial scales

- **Prioritization of habitat restoration**
  - Roni, P., T. J. Beechie, S. Schmutz, S. Muhar. 2013. Prioritization of watersheds and restoration projects. Pages 189-214 in Roni, P., T. J. Beechie. (Eds.) Stream and watershed restoration: a guide to restoring riverine processes and habitats. John Wiley & Sons,.
  - Beechie, T. J., G. R. Pess, P. Roni, G. Giannico. 2008. Setting river restoration priorities: a review of approaches and a general protocol for identifying and prioritizing actions. NAJFM 28(3):891-905.
  - Roni, P., T. J. Beechie, R. E. Bilby, F. E. Leonetti, M. M. Pollock, G. R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. NAJFM 22(1):1-20.
- **Developing habitat restoration strategies**
  - Beechie, T. J., Pess, G. R., Imaki, H., Martin, A., Alvarez, J. and Goodman, D. H. (2015), Comparison of potential increases in juvenile salmonid rearing habitat capacity among alternative restoration scenarios, Trinity River, California. Restoration Ecology, 23: 75–84.
  - Roni, P., G. Pess, S. T. Beechie and S. Morley. 2010. Estimating changes in coho salmon and steelhead abundance from watershed restoration: how much restoration is needed to measurably increase smolt production? NAJFM 30:1469–1484.

Prioritization of Restoration

Protect High Quality Habitats

↓

Water Quality and Quantity

↓

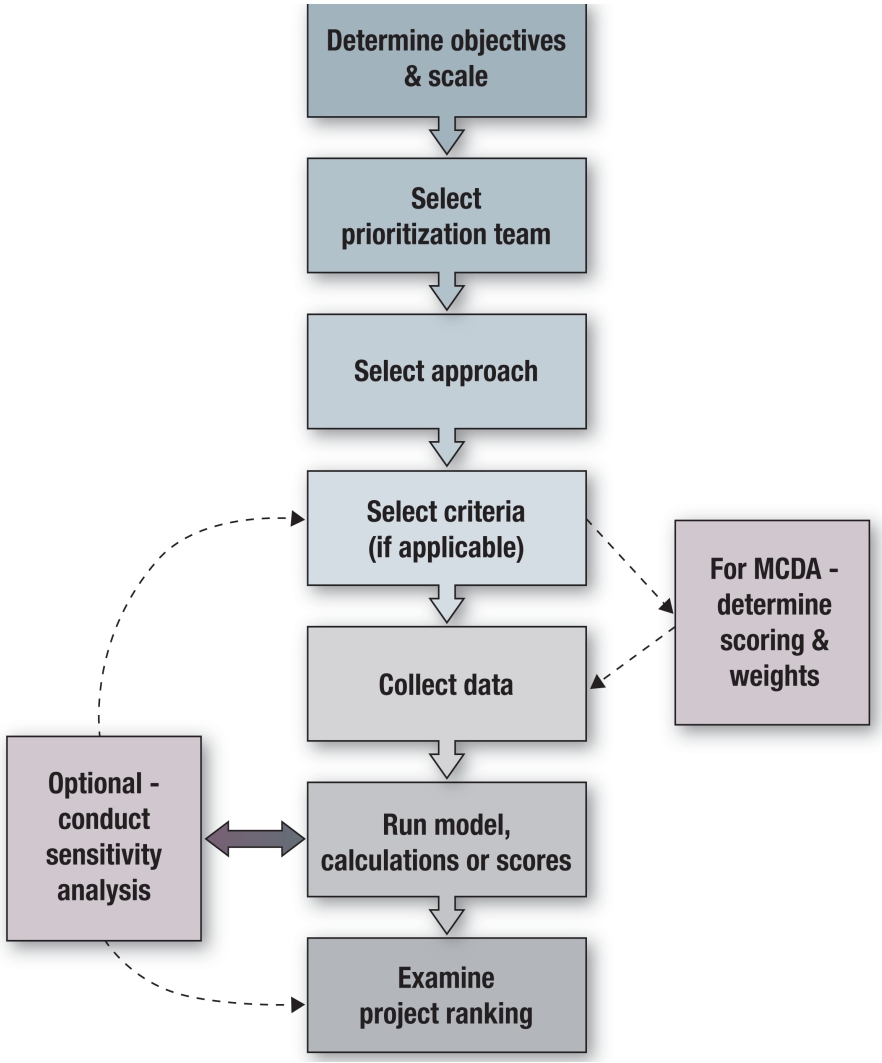
Habitat Connectivity

↓

Restoration of Processes

↓

Habitat improvement



Roni et al. 2002, 2008

Roni and Beechie 2013

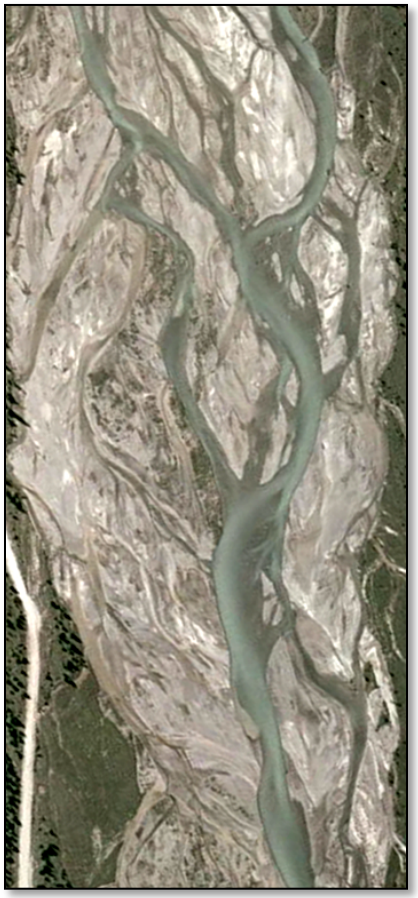
Comparing restoration alternatives for juvenile salmonid rearing habitat capacity Trinity River, California

Characterize geomorphic potential using reference channel patterns

Straight

Meandering

Island Braided



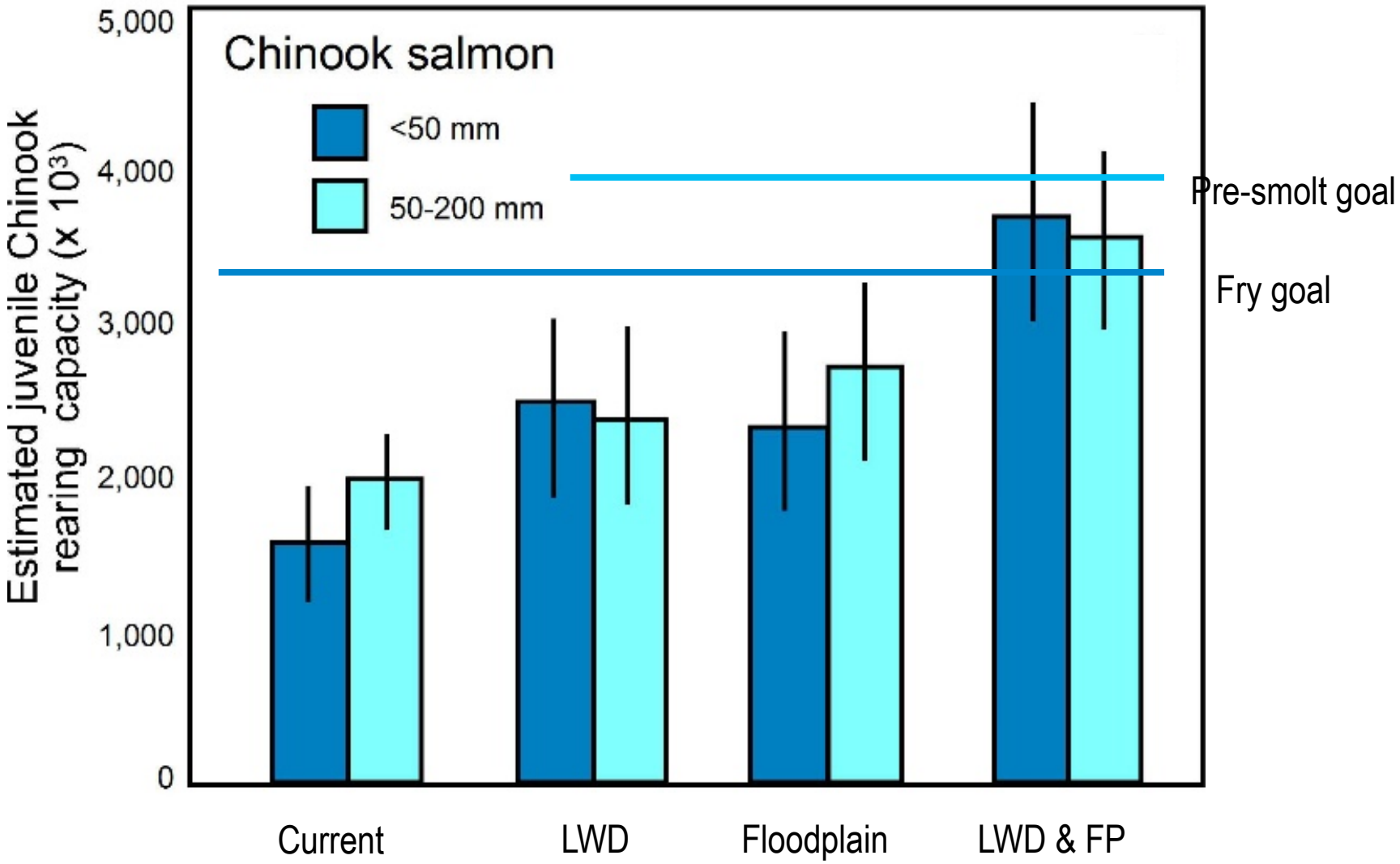
Braided

Re-meandering mainstem & create side-channels

Reach type	Description	Target sinuosity (mainstem length/valley length)	Side-channel length
1	Meandering; moderately confined	1.5	2 side-channels
2	Meandering; confined	1.2	1 side-channel
3	**Island-braided; unconfined**	**1.5**	**3 side-channels**
4	Island-braided; variable confinement	1.2-1.5	1 to 2 side-channels
5	Meandering; variable confinement	1.2-1.5	1 to 3 side channels

Beechie et al. 2015

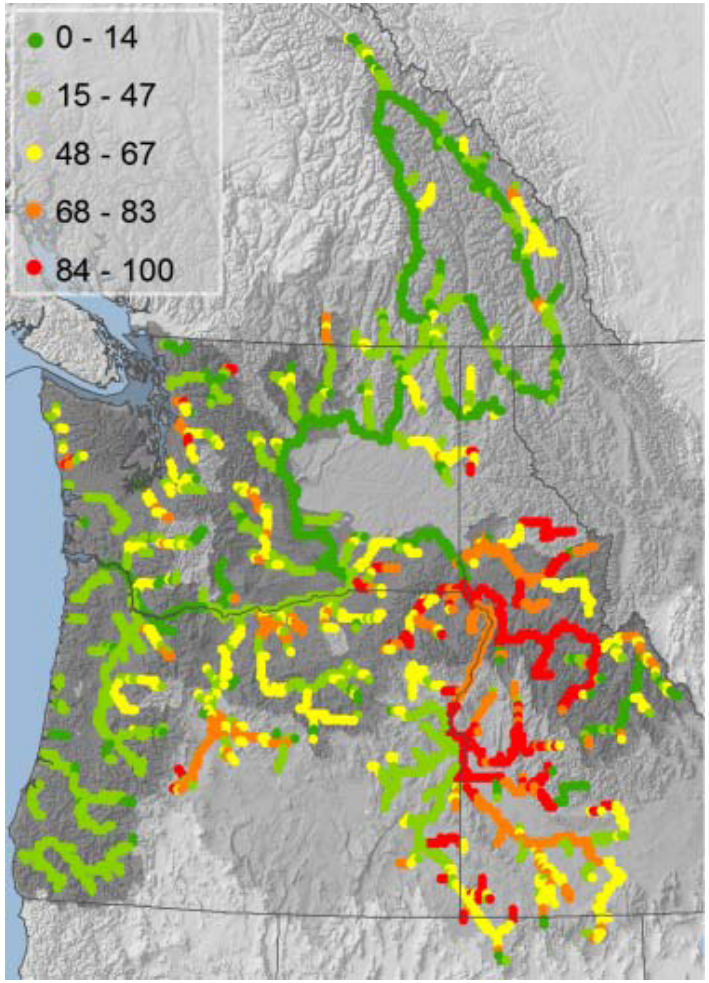
Comparing increases in juvenile salmonid rearing habitat capacity among restoration scenarios, Trinity River, CA



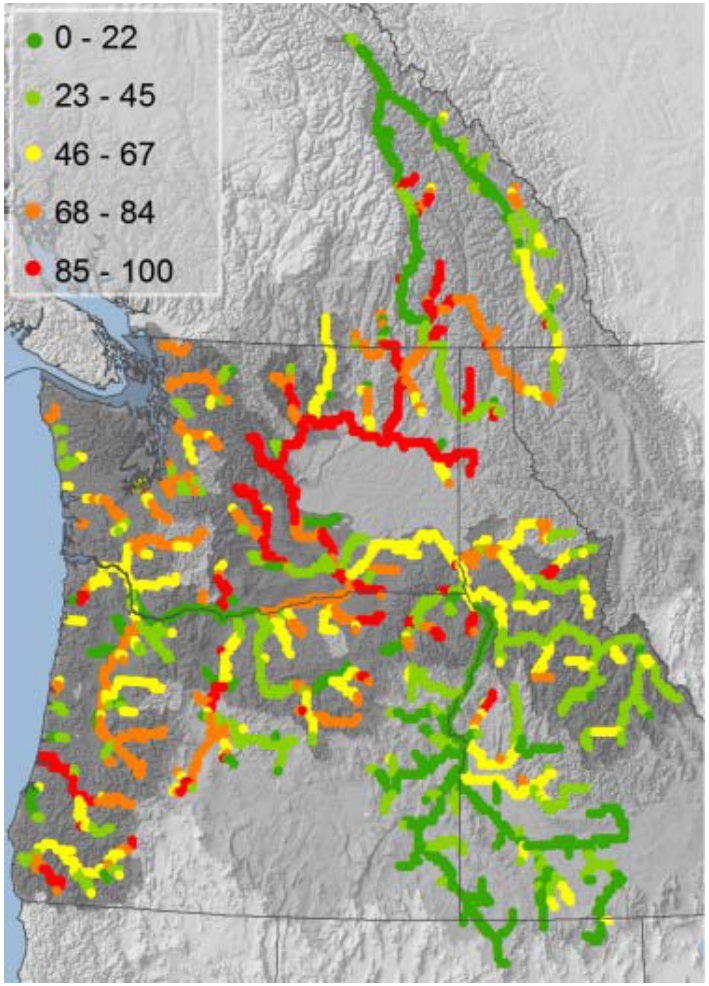
Beechie et al. 2015

Climate Change and Restoration

Future temperature stress (2040s)



Future flow stress (2040s)



Wade et al. 2013

Reducing climate change effects through restoration

Restoration action	Reduce temperature	Increase low flow	Decrease peak flow	Increase resilience
Longitudinal connectivity	Y	Y	N	Y
Floodplain connectivity	Y	N	Y	Y
Restore incised channel	Y	Y	Y	Y
Restore in-stream flow	Y	Y	N	N/Y
Riparian rehabilitation	Y	N/Y	N	N
Sediment reduction	N	N	N	N
In-stream habitat	N	N	N	N
Nutrient enrichment	N	N	N	N

Beechie et al. 2012

Restoration Effectiveness

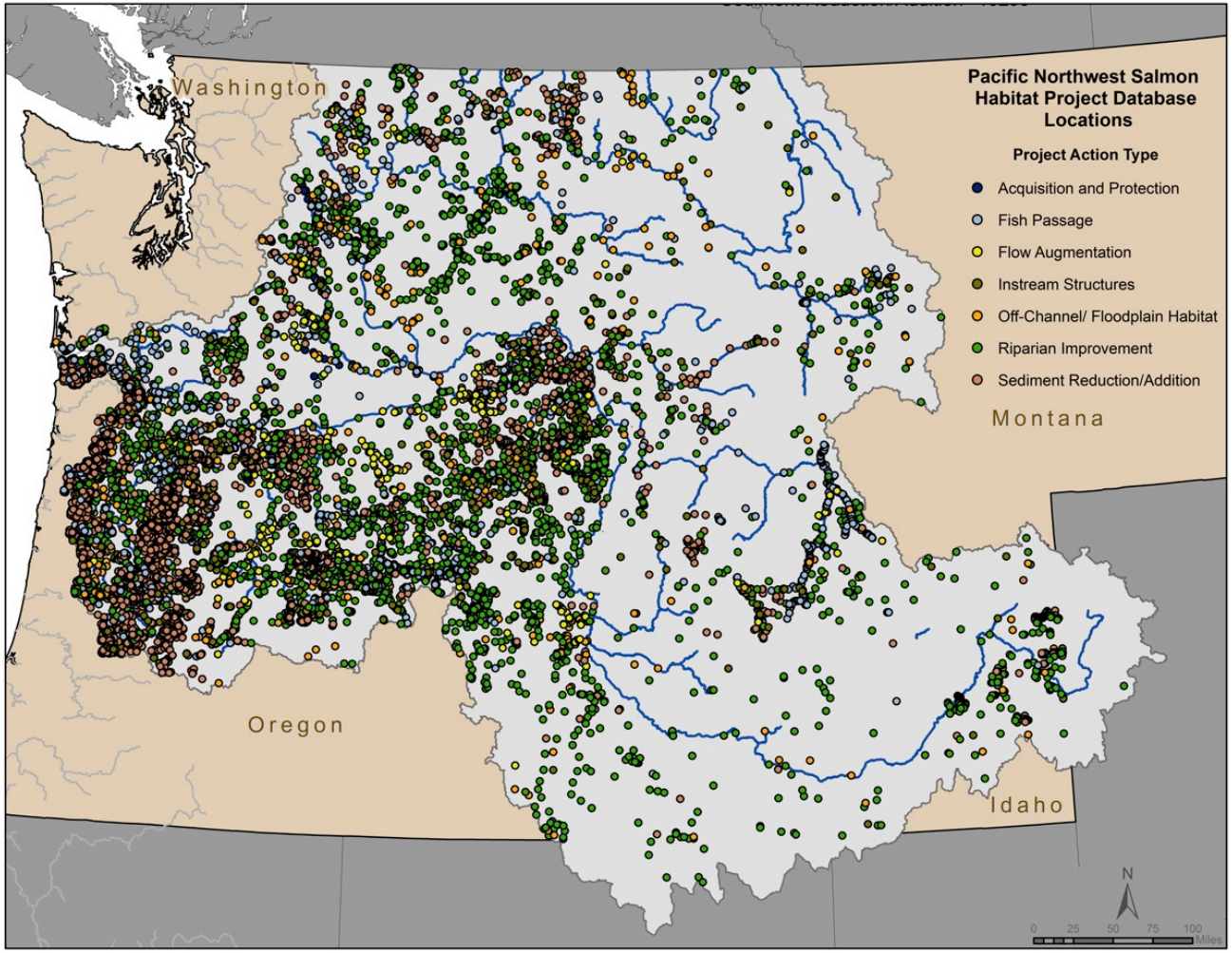
Watershed/Population

- Cedar River barrier removal
- IMWs (DOE & ISEMP)
- Elwha Dam Removal (G. Pess)
- Snohomish or Skagit Estuaries

Project Scale

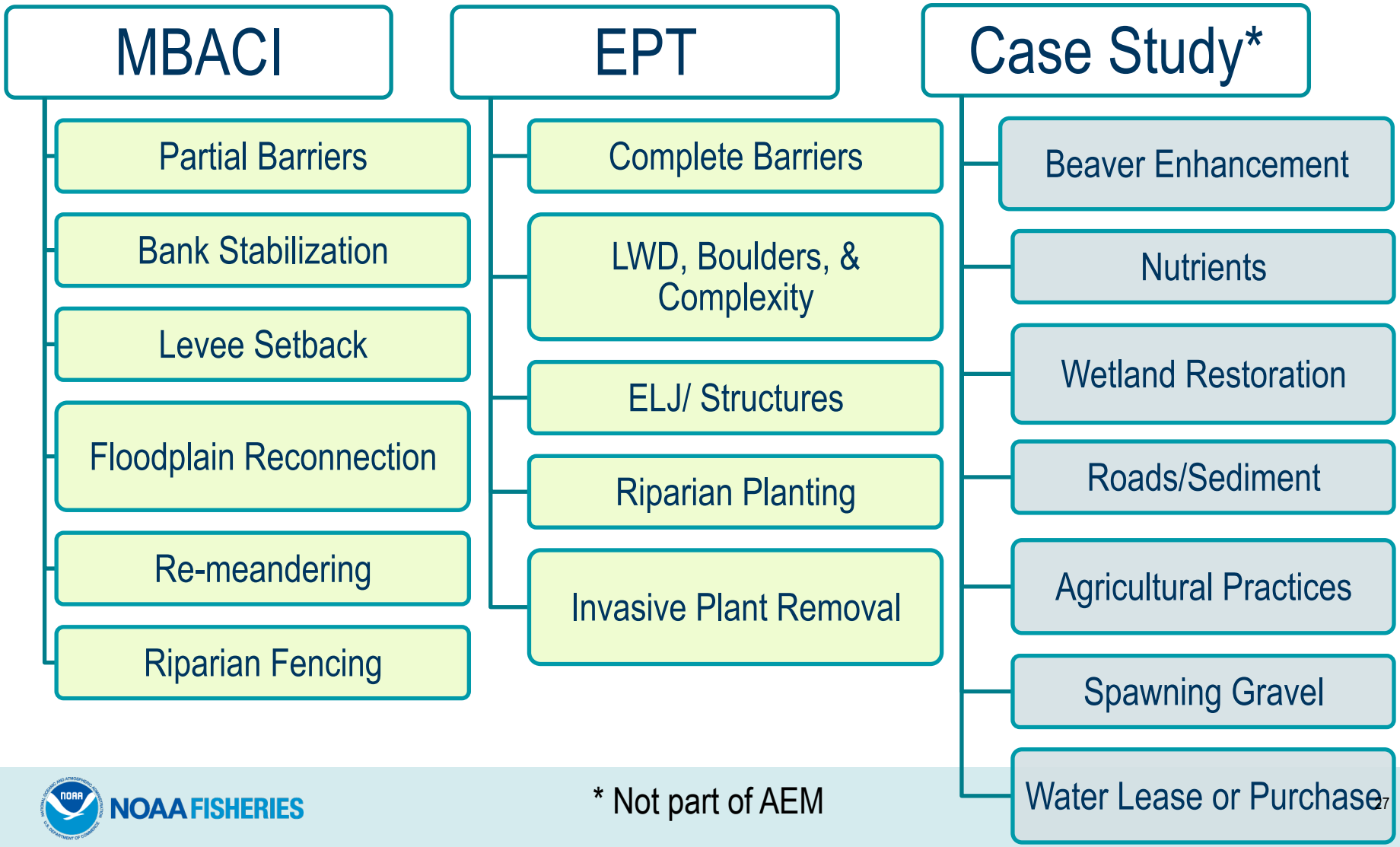
- Instream
- BPA programmatic
- Off-channel/floodplain
- Beaver enhancement
- Carcasses/nutrients
- Riparian
- Urban streams

Action effectiveness monitoring of a variety restoration action types in the Puget Sound, Oregon Coast, and Columbia River Basin



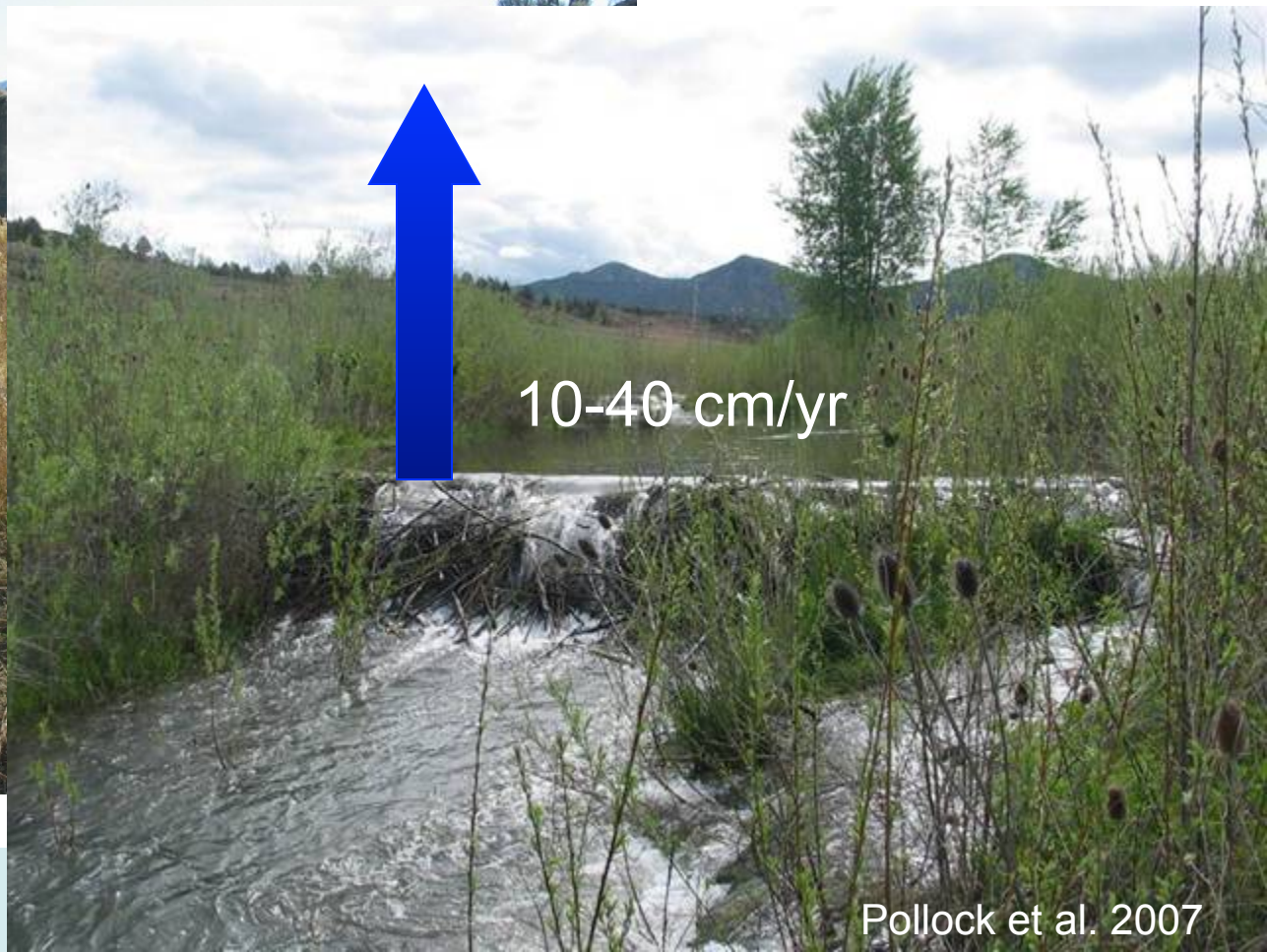
K. Barnas/M. Diaz NOAA

Action effectiveness monitoring of a variety restoration action types in the Puget Sound, Oregon Coast, and Columbia River Basin



* Not part of AEM

Beaver Reintroduction to Restore Floodplain & Riparian Habitat



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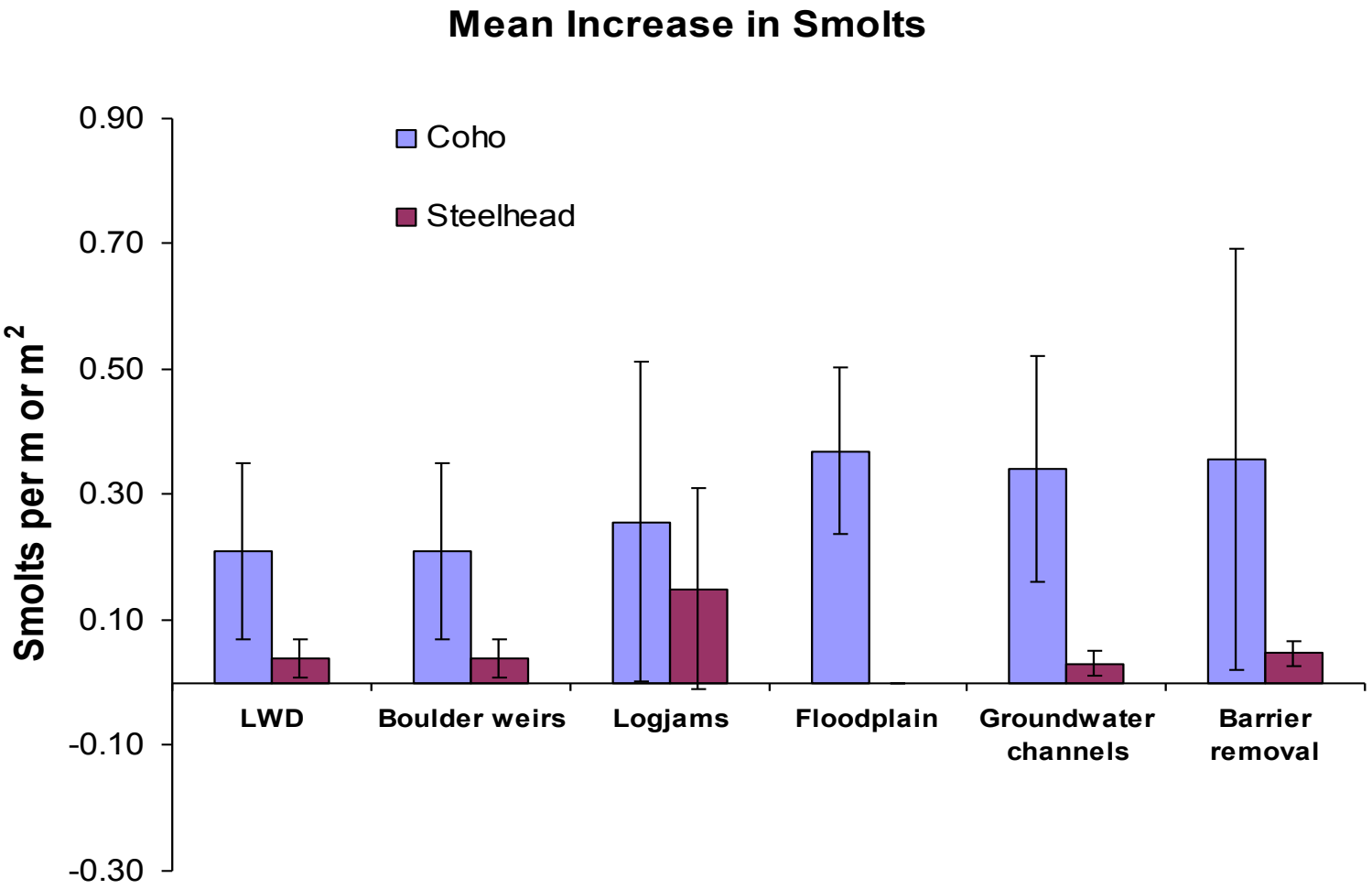
Summary of fish response to various restoration action types



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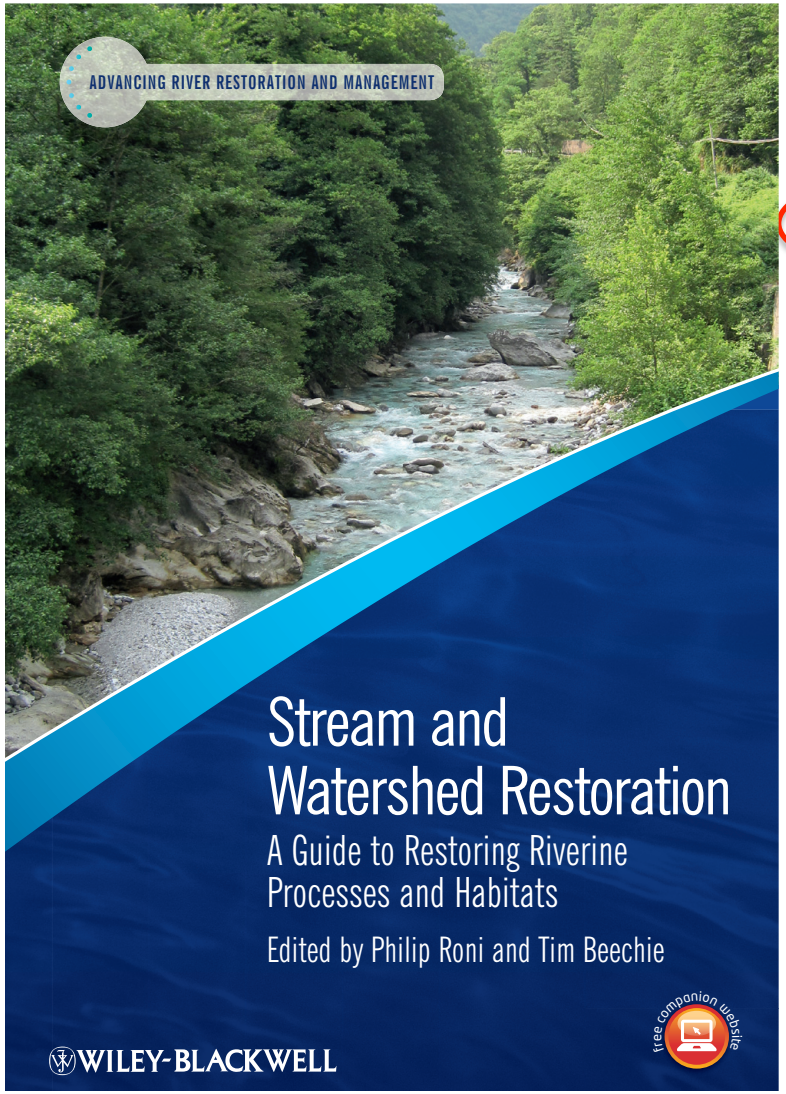
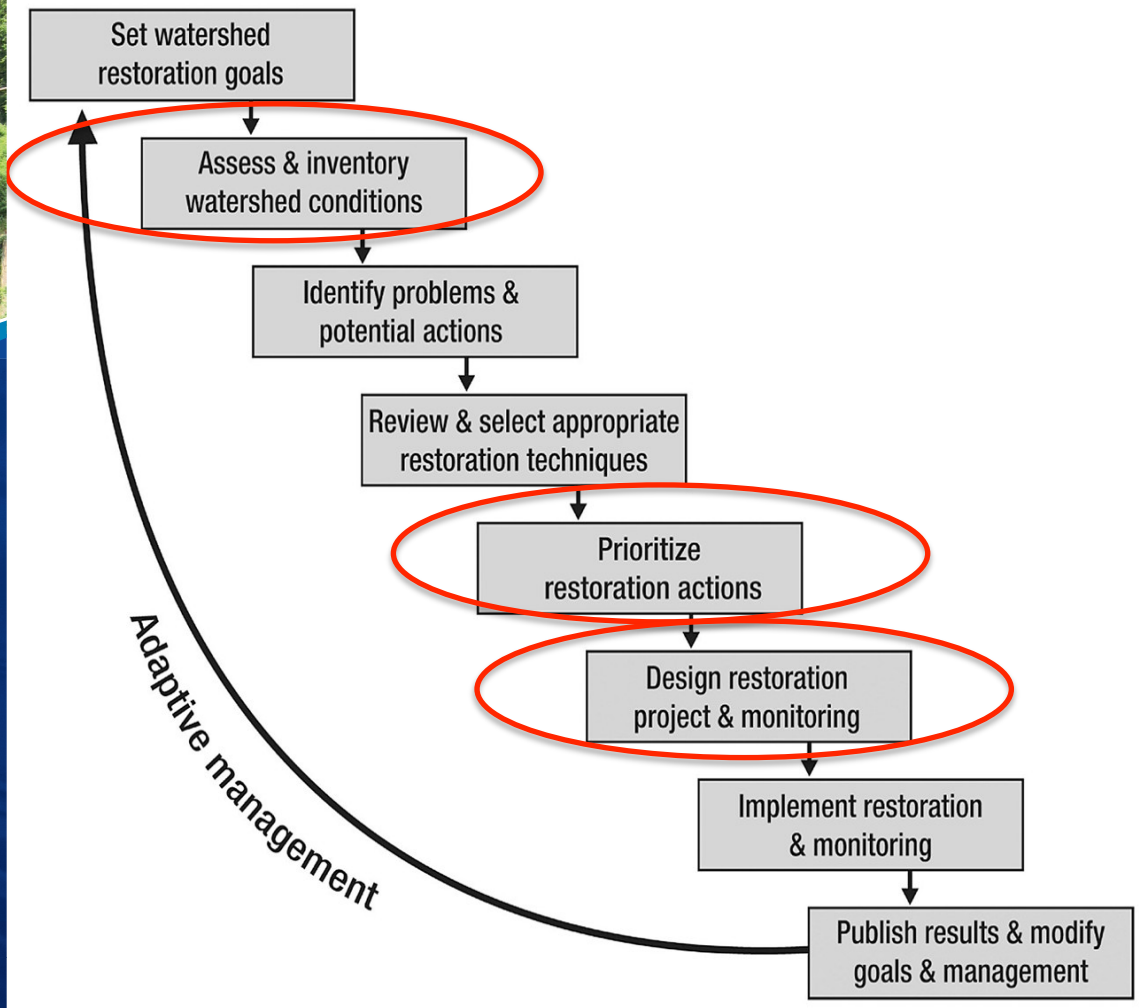
Roni, P., G. R. Pess, T. J. Beechie, S. A. Morley. 2011. Estimating salmon and steelhead response to watershed restoration: how much restoration is enough?. NAJFM 30(6):1469-1484.

Goals, Challenges and Opportunities

- Fish response to habitat change and restoration
  - Site, reach and watershed/population
- Linking changes in processes to limiting habitat and life stage
- Whole watershed start-to-finish examples


ADVANCING RIVER RESTORATION AND MANAGEMENT
Stream and Watershed Restoration
A Guide to Restoring Riverine Processes and Habitats
Edited by Philip Roni and Tim Beechie
WILEY-BLACKWELL
free companion website


Set watershed restoration goals
Assess & inventory watershed conditions
Identify problems & potential actions
Review & select appropriate restoration techniques
Prioritize restoration actions
Design restoration project & monitoring
Implement restoration & monitoring
Publish results & modify goals & management
Adaptive management