

Lessons From Large-Scale Experiments Testing the Effectiveness of Stream Restoration: Are we there yet?!

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NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



Collaboration and Support

- Snake River Salmon Recovery Board
- Integrated Status and Effectiveness Monitoring Program
- US Forest Service
- Washington Department of Fish and Wildlife
- Oregon Department of Fish and Wildlife
- Utah State University

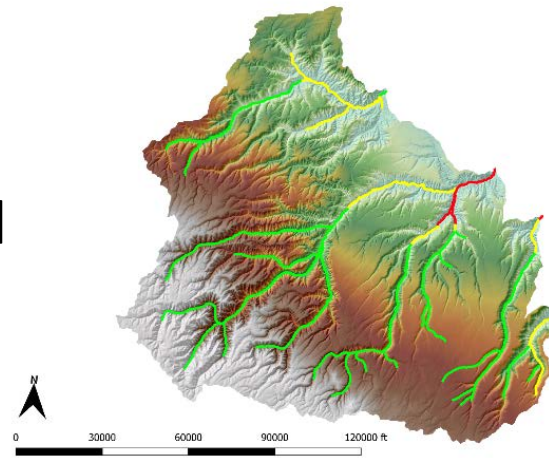




Outline/Message

Intensively Monitored Watershed

- What and Why
- Lessons



Bridge Creek IMW

- Beavers
- Incision



Asotin Creek IMW

- Large woody debris
- Channelization





Setting Restoration Today ... Effective?

- Hard engineering
- Process-based?
- High cost/km
- Small extent





Intensively Monitored Watersheds (IMWs)





Bridge Creek IMW

Beaver dam analogs (BDAs)



Nick Weber
Nick Bouwes



Michael Pollock
Chris Jordan



Joseph
Wheaton



Carol
Volk



Problem Incision





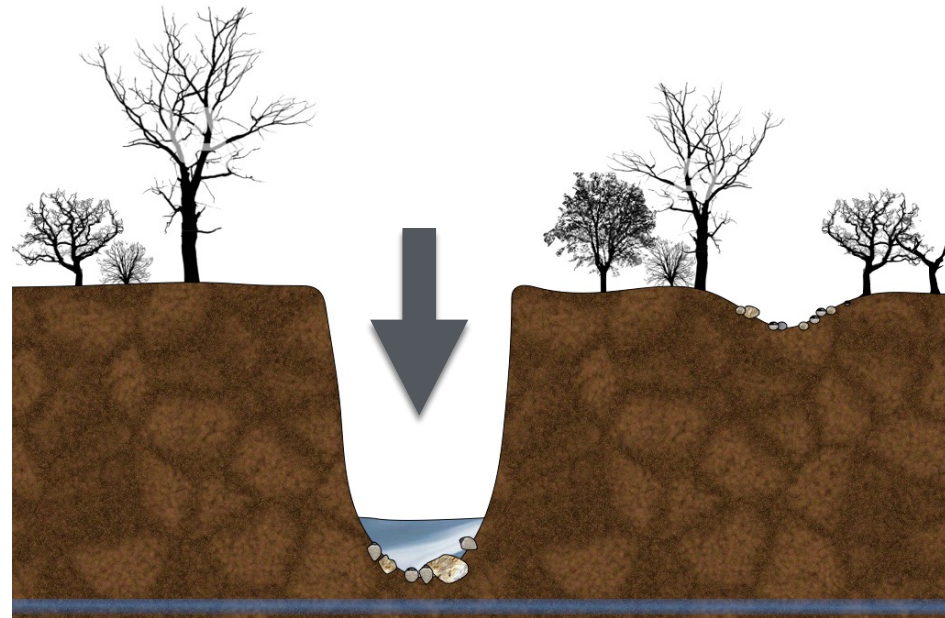
Problem

Incision

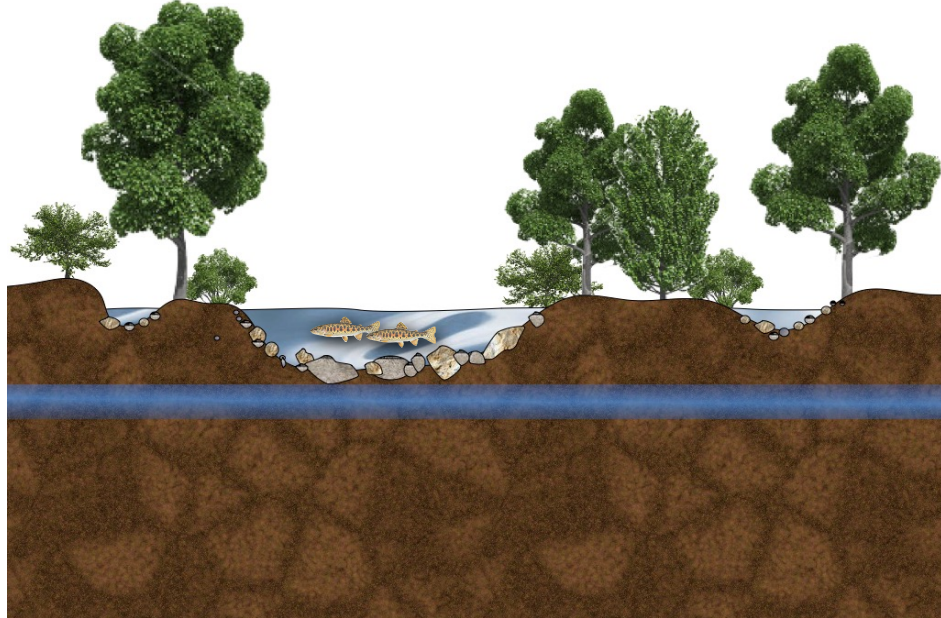
Incised Channel

10^3 years

Incision Recovery



- Simplified habitat
- Limited riparian



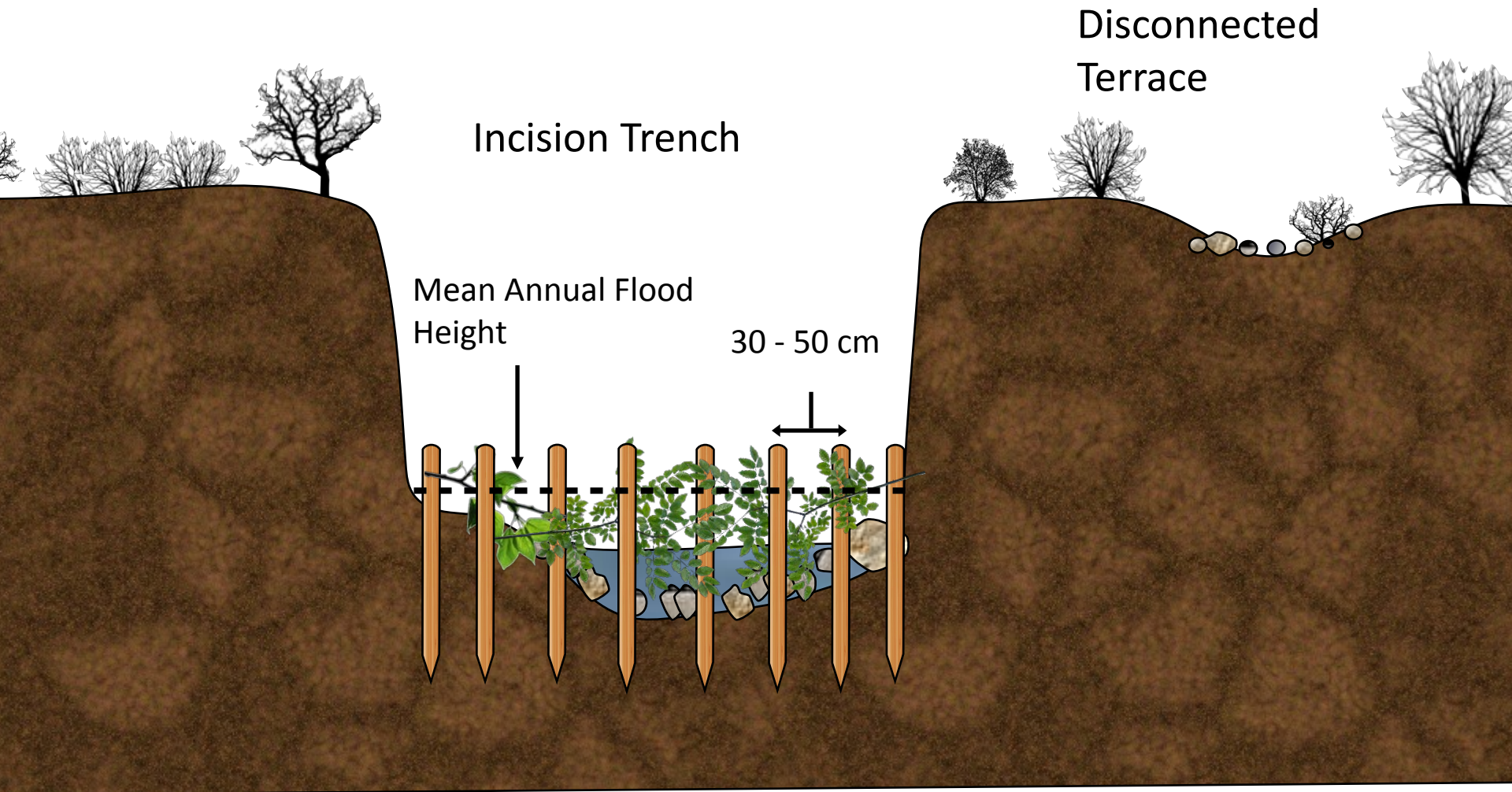
- Complex & dynamic channel
- Healthy riparian





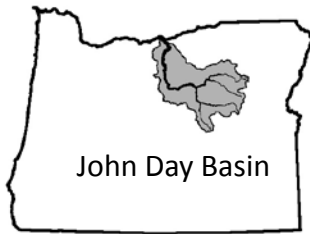
Restoration Approach

Beaver Dam Analog Structures (BDAs)





Oregon



John Day Basin

Bridge Creek Watershed

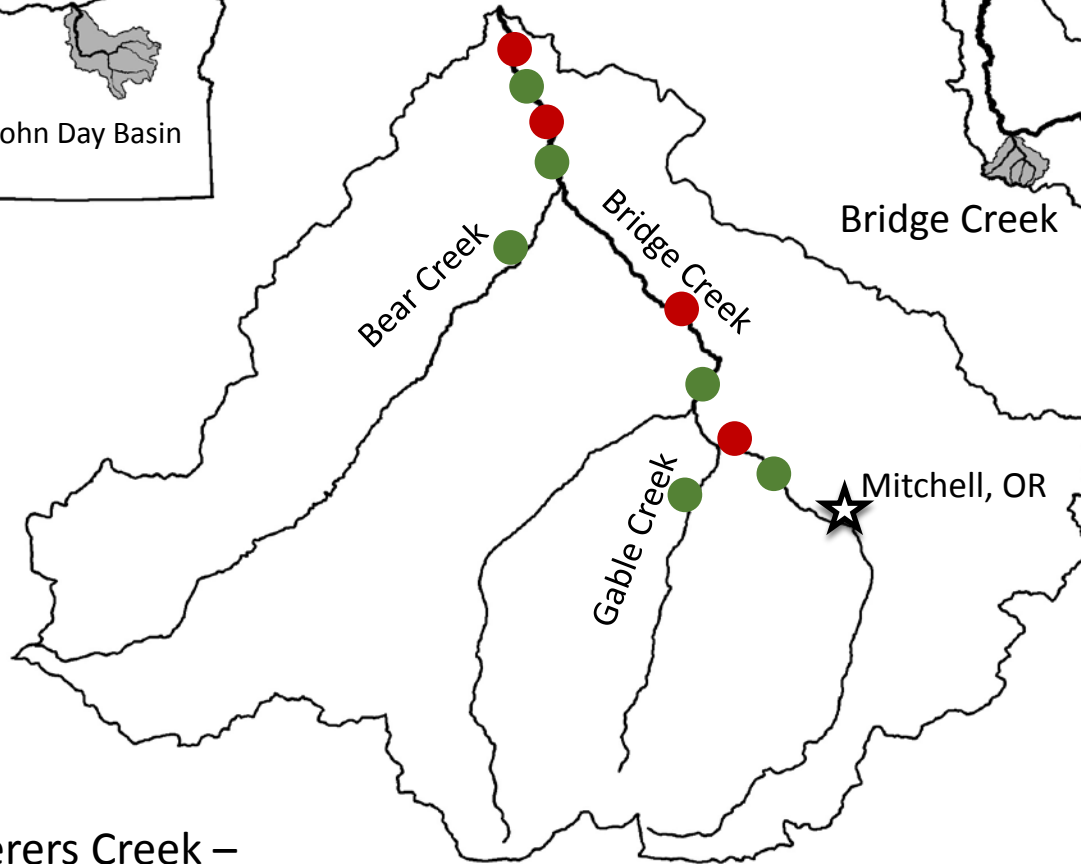
John Day Basin



Bridge Creek

Murderers Creek

- Control
- Treatment



Murderers Creek –
Watershed Control



Summer
steelhead



Monitoring Fish

- Abundance
- Age
- Growth
- Movement
- Survival
- Carrying Capacity
- Smolts/Spawner

Mark-recapture
(summer, fall)



Mobile PIT tag
detection
(all seasons)



PIT tag arrays
(continuous)



Fish In-Fish Out
(Brood year)





Monitoring Habitat

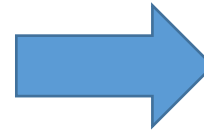
Columbia
Habitat
Monitoring
Protocol
(CHaMP)



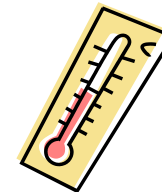
Topographic survey
of channel



Digital
Elevation
Model (DEM)



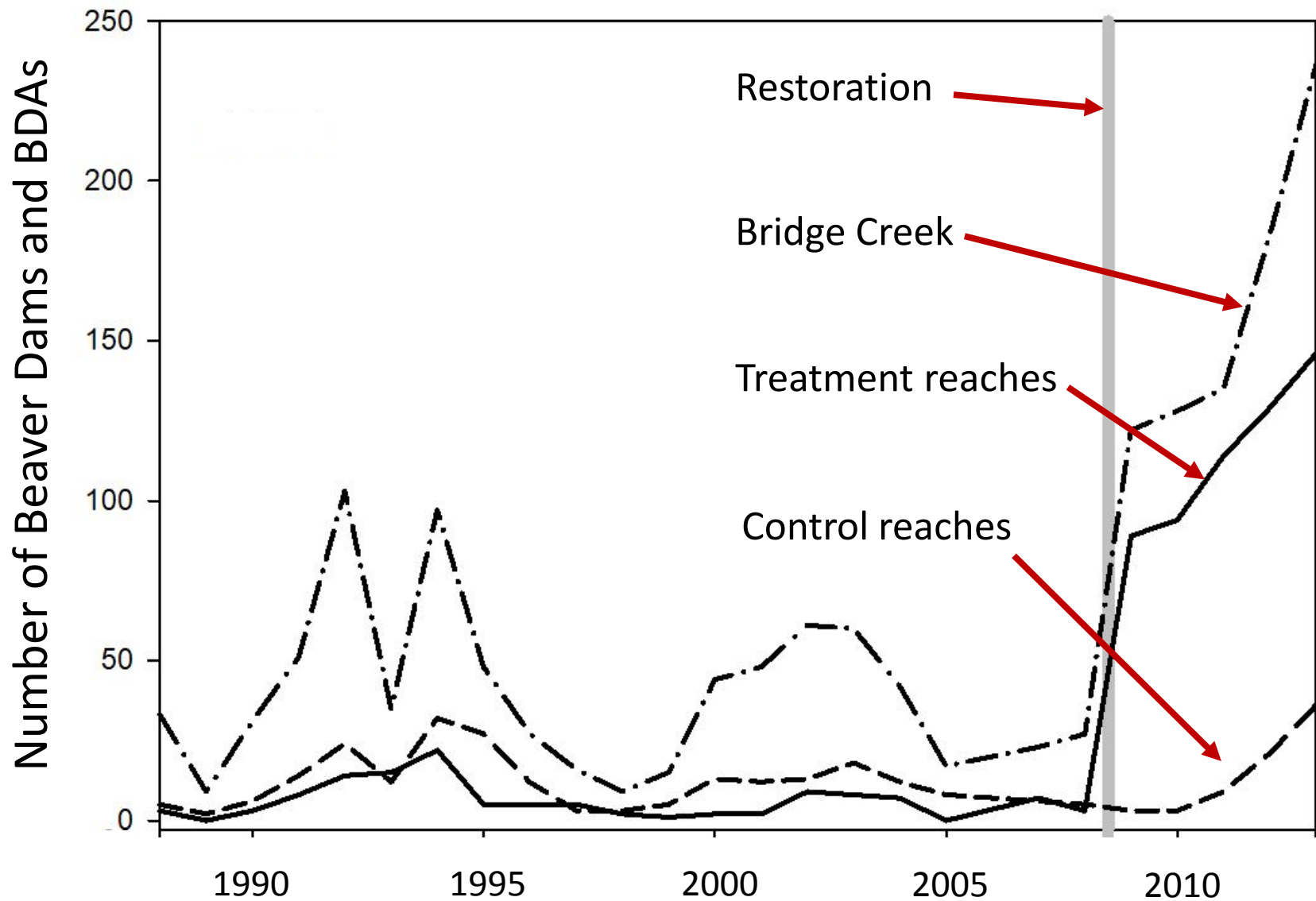
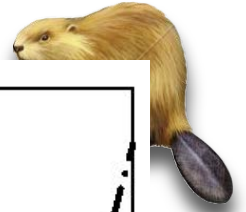
Invertebrate
Drift



Stream
Temperature
& Discharge



BDA treatment & Beaver Response





Restoration Response (treatment scale)

Floodplain Connection (+200%); Deposition (1 m)



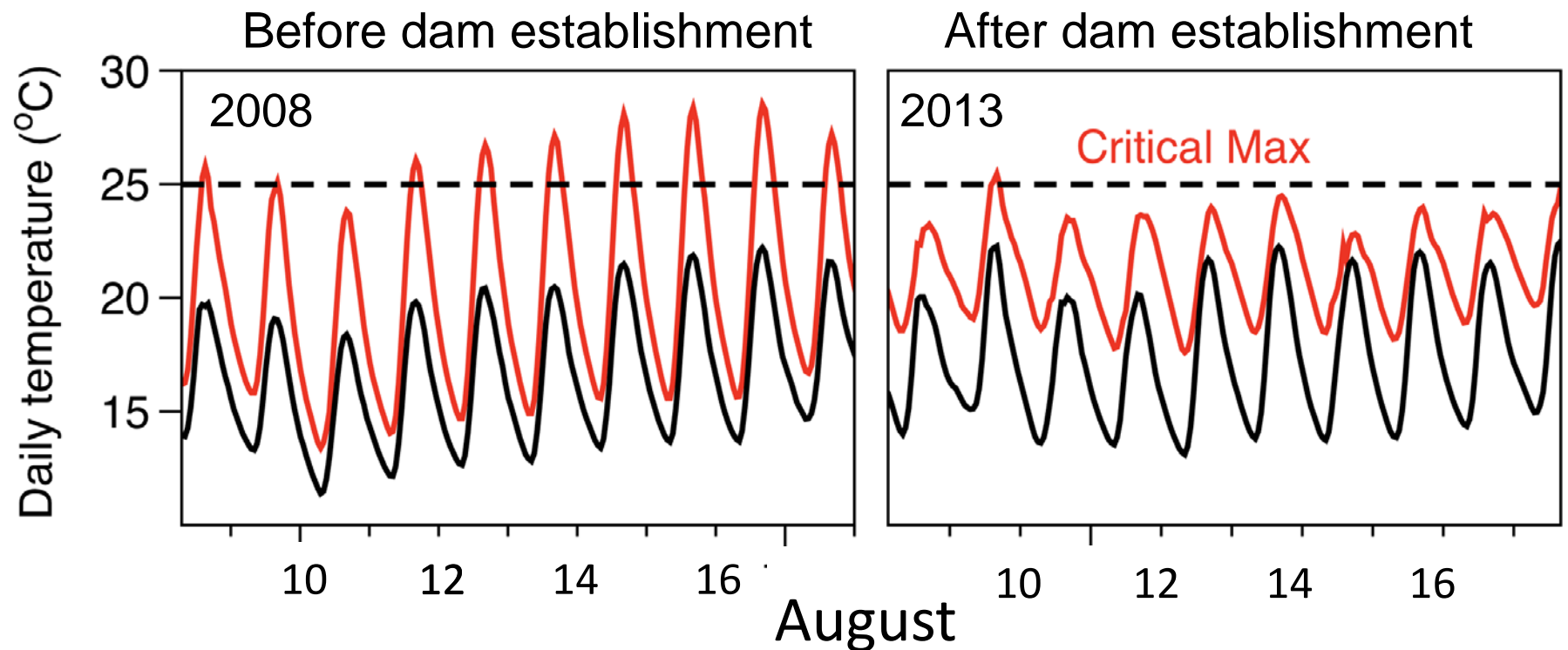


Restoration Response (treatment scale)

Compressed Summer Temperature Range

 Treatment reach - Dam influenced

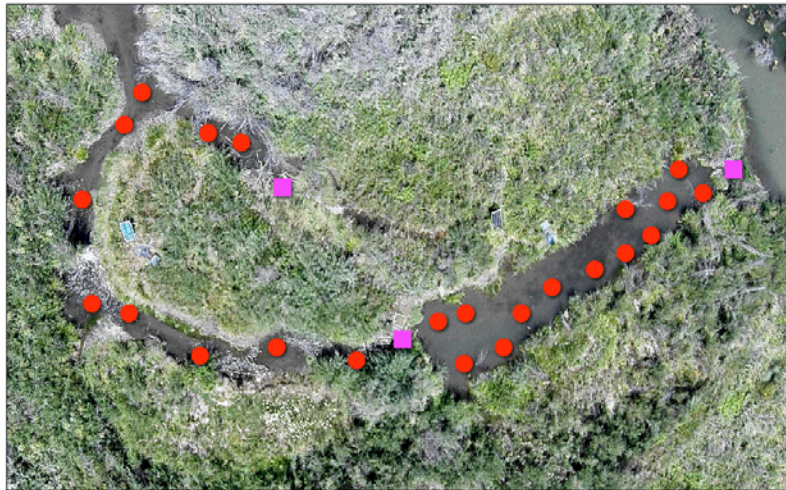
 Control reach - No dams



Restoration Response (site scale)

Temperature refugia

Treatment

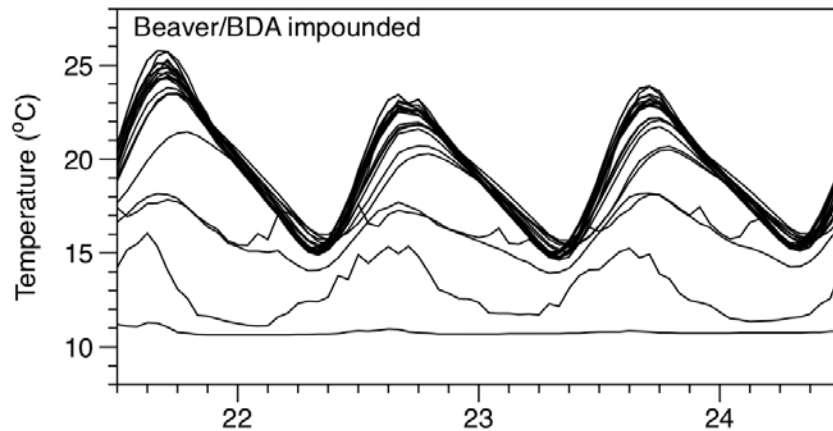


● Temperature measurement location ■ Beaver dam

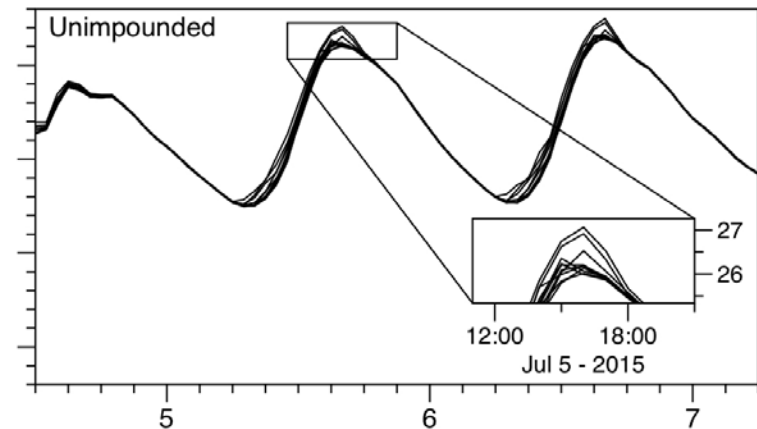
Control



← Flow 0 m 10 m 20 m



July 2015

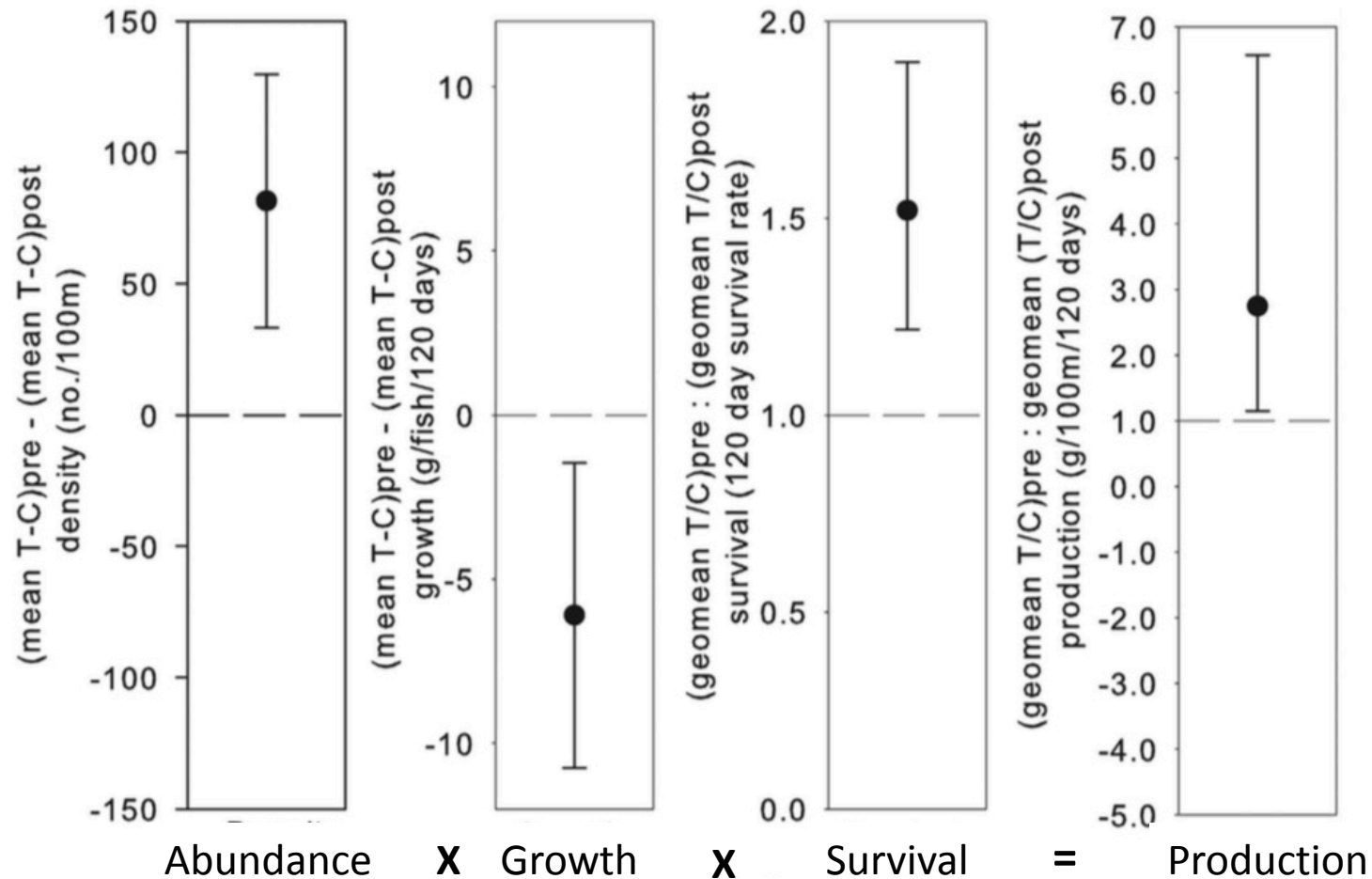


Weber et al. 2017. PLoS ONE

Restoration Response (treatment scale)

Fish

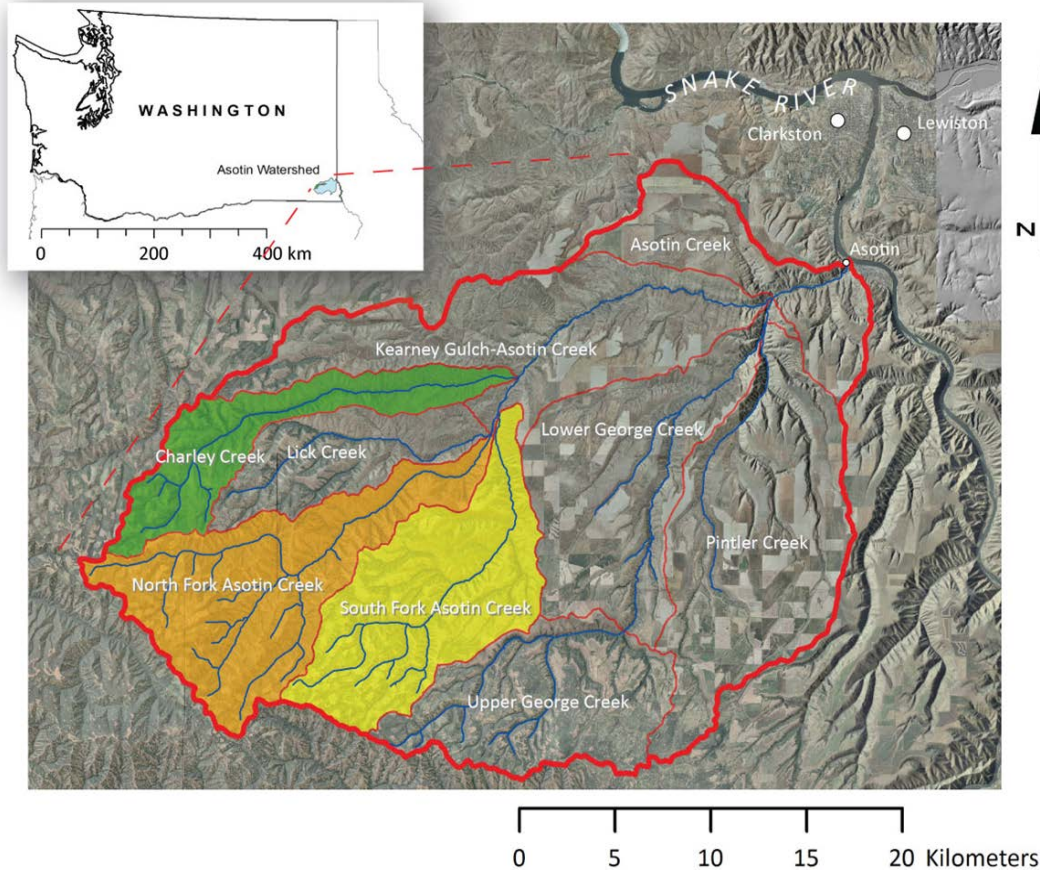




Comparison of treatment minus control for juvenile steelhead abundance, growth, survival and **Production**: 2006-2015.
Error bars = 90% CI.

Asotin Creek IMW, Washington

High Density Large Woody Debris (H_D LWD)



~ 95% wild steelhead
Escapement ~ 650/year

Location of Asotin Creek Intensively Monitored Watershed in southeast Washington. Three colored tributaries comprise the IMW study area: Charley Creek (Green), North Fork (Orange), South Fork (Yellow).



Setting Landscape

Stream	Basin Area (km ²)	Bankfull width (m)	Gradient (%)	Average Discharge (cfs)	Peak Discharge (cfs)
Charley	58	4.8	3.0	9.5	100
North Fork	165	9.8	1.7	60.0	1000
South Fork	104	6.3	2.6	11.5	800





Wood

Scope of the Problem



Young forest, minimal wood input & efficient transport



Restoration Approach

High Density Large Woody Debris ($_{HD}$ LWD)

- Soft-engineering
- Let water do the work¹
- Large extent
- High density (5/100m)
- Lower cost/km (~25%)



¹ (Zeedyk and Clothier 2009)

Restoration Approach

Build a tree



Deflector



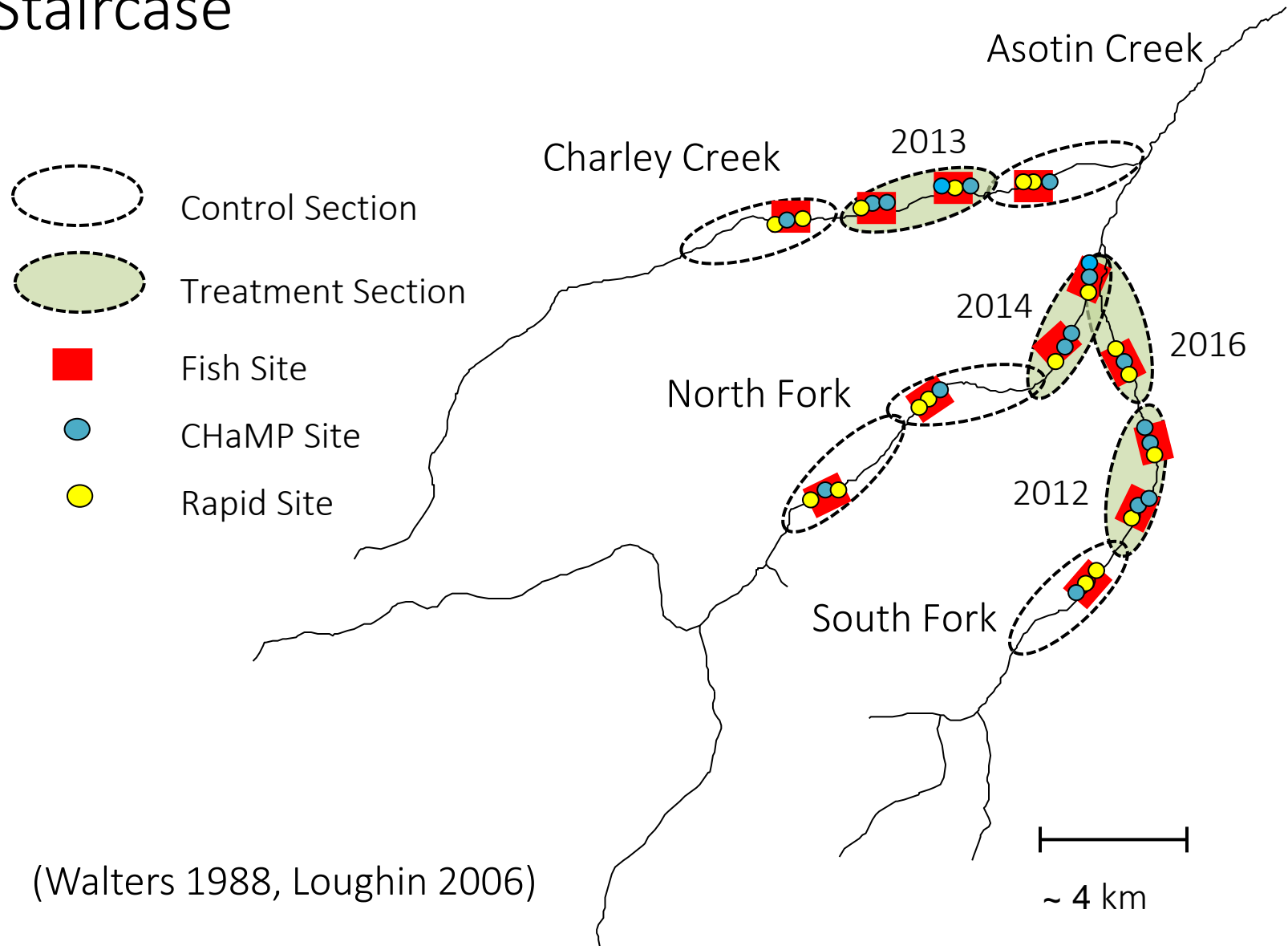
Mid Channel

HALWD

Post Assisted Log
Structures
(PALS)



Experimental Design Staircase

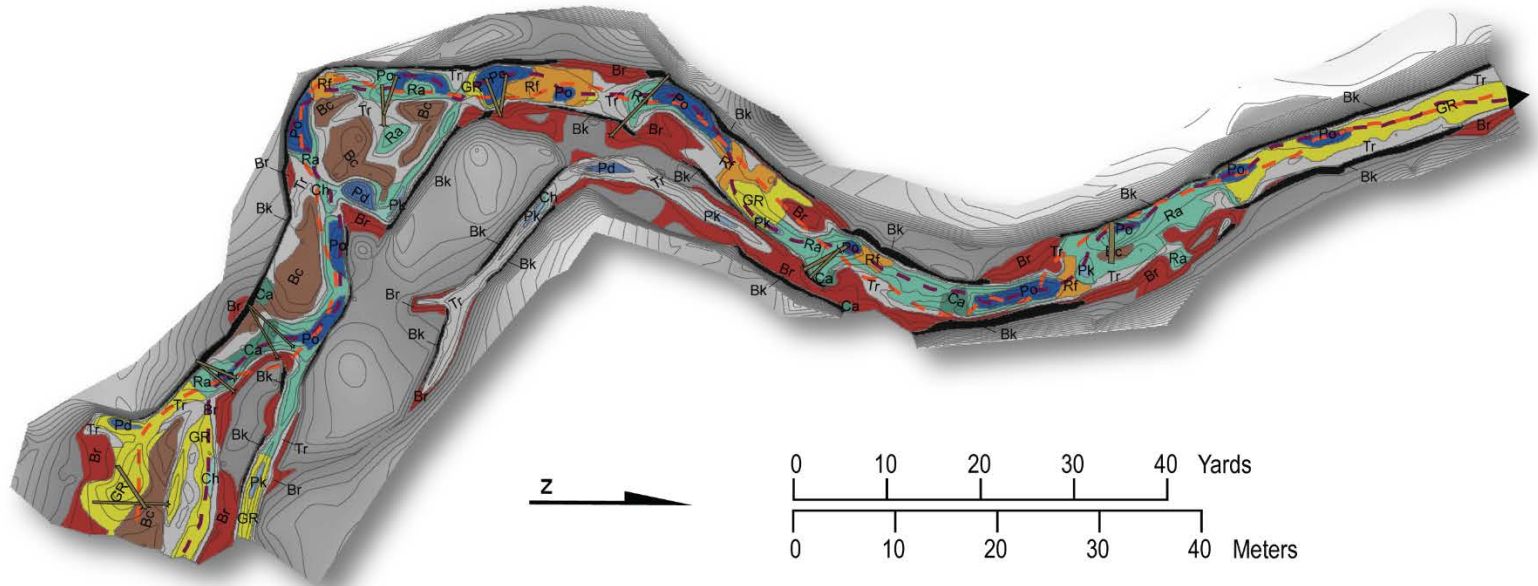


Restoration Response Habitat





Restoration Response Habitat



2093 ft (638 m)

Elevation

2080 ft (634 m)



Geomorphic Units - Tier 3 *In-Channel*

Concavities (e.g. Pools)

- Chute (Ch)
- Pocket Pool (Pk)
- Pond (Pd)
- Pool (Po)

Convexities (e.g. Bars)

- Margin Attached Bar (Br)
- Mid-Channel Bar (Bc)
- Riffle (Rf)

Planar Features

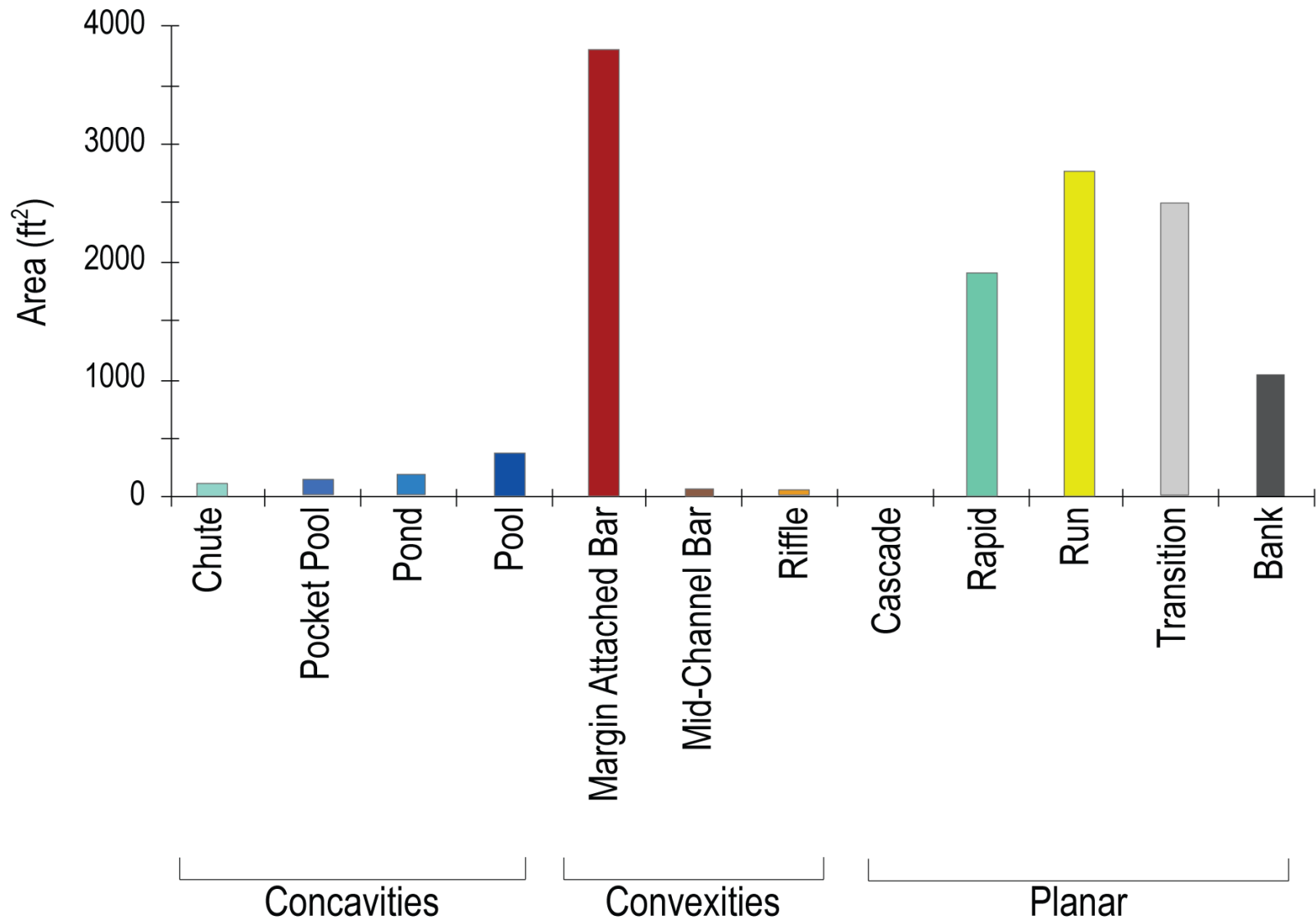
- Cascade (Ca)
- Rapid (Ra)
- Run (GR)
- Transition Zones (Tr)
- Bank (Bk)

Channel Features

- Thalweg
- Old Thalweg
- Structural Elements
- LWD

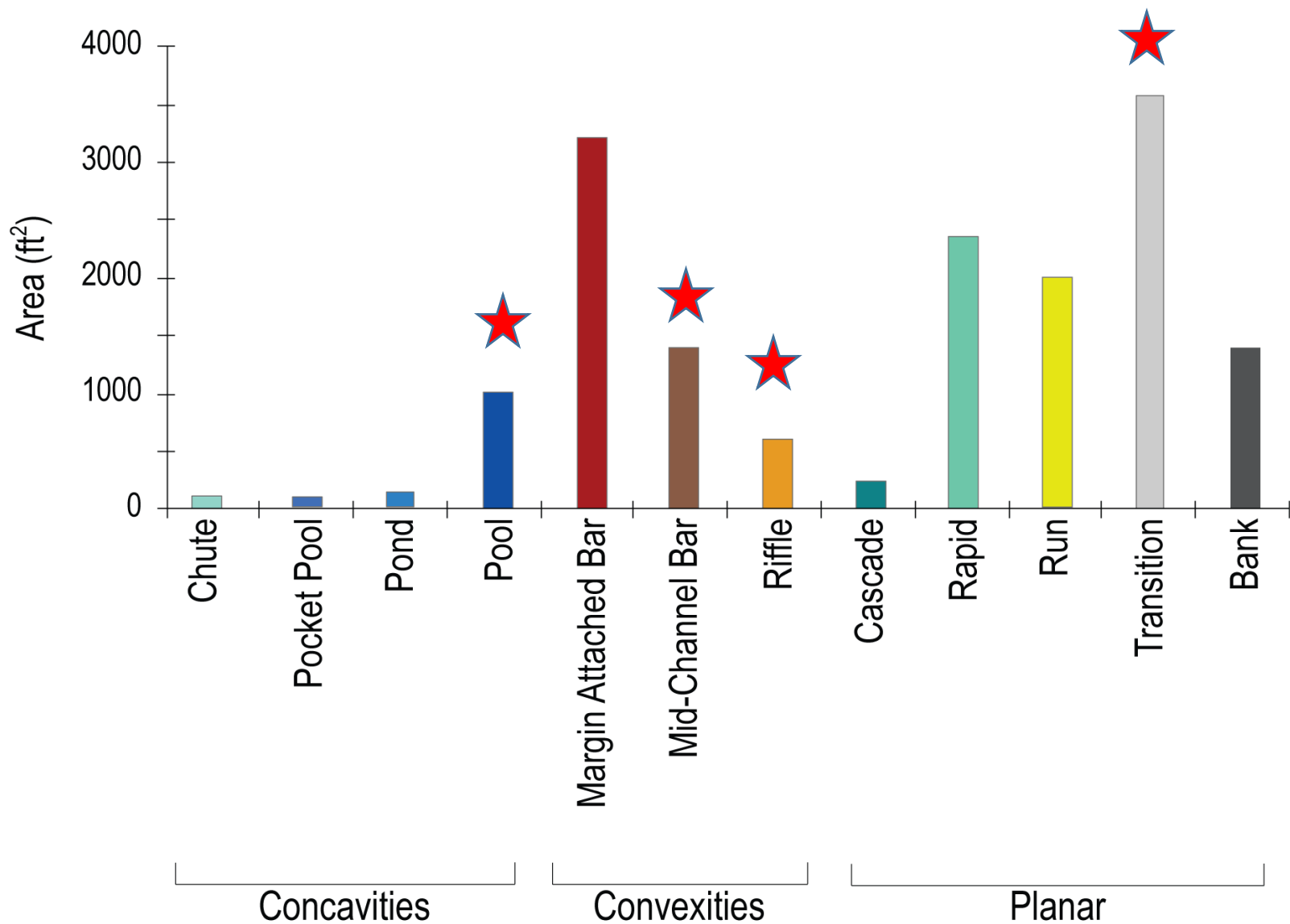


Geomorphic Units Pre Restoration





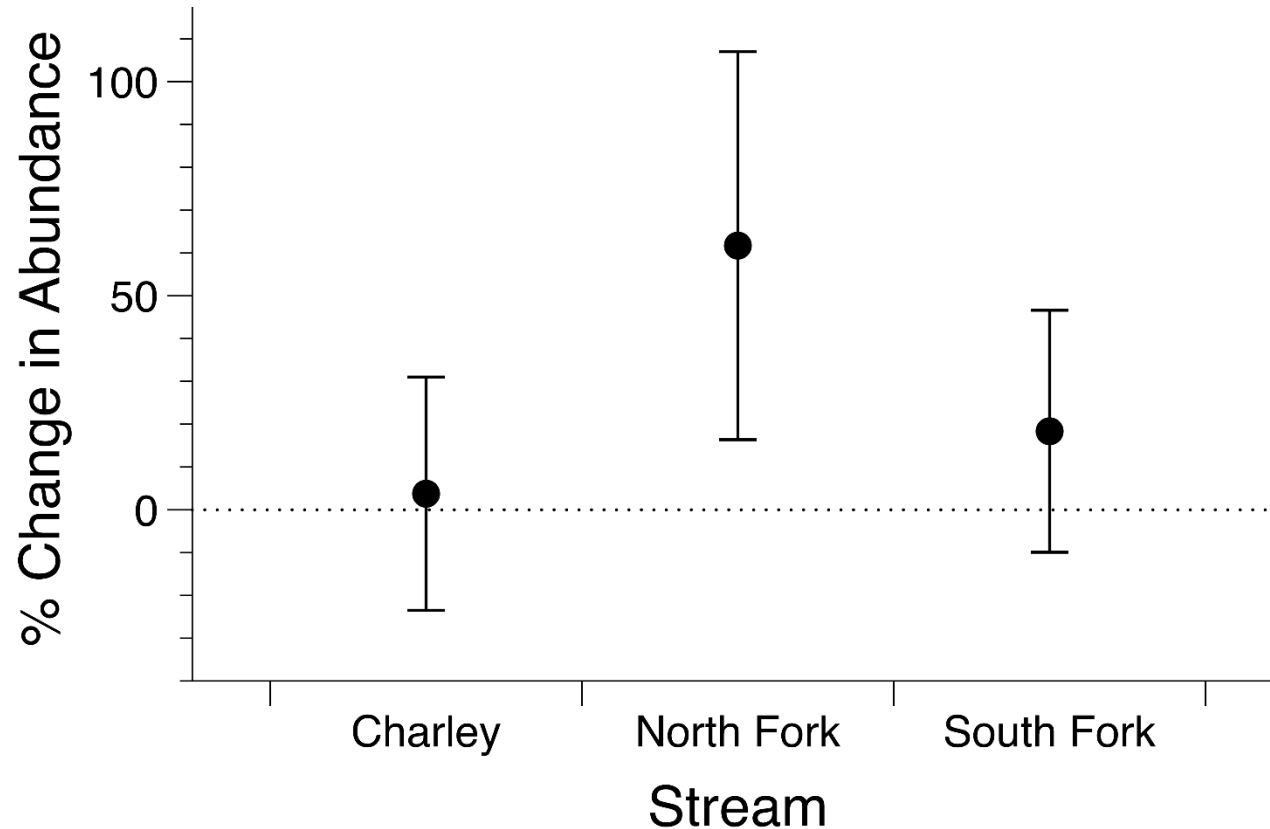
Geomorphic Units Post Restoration





Restoration Response

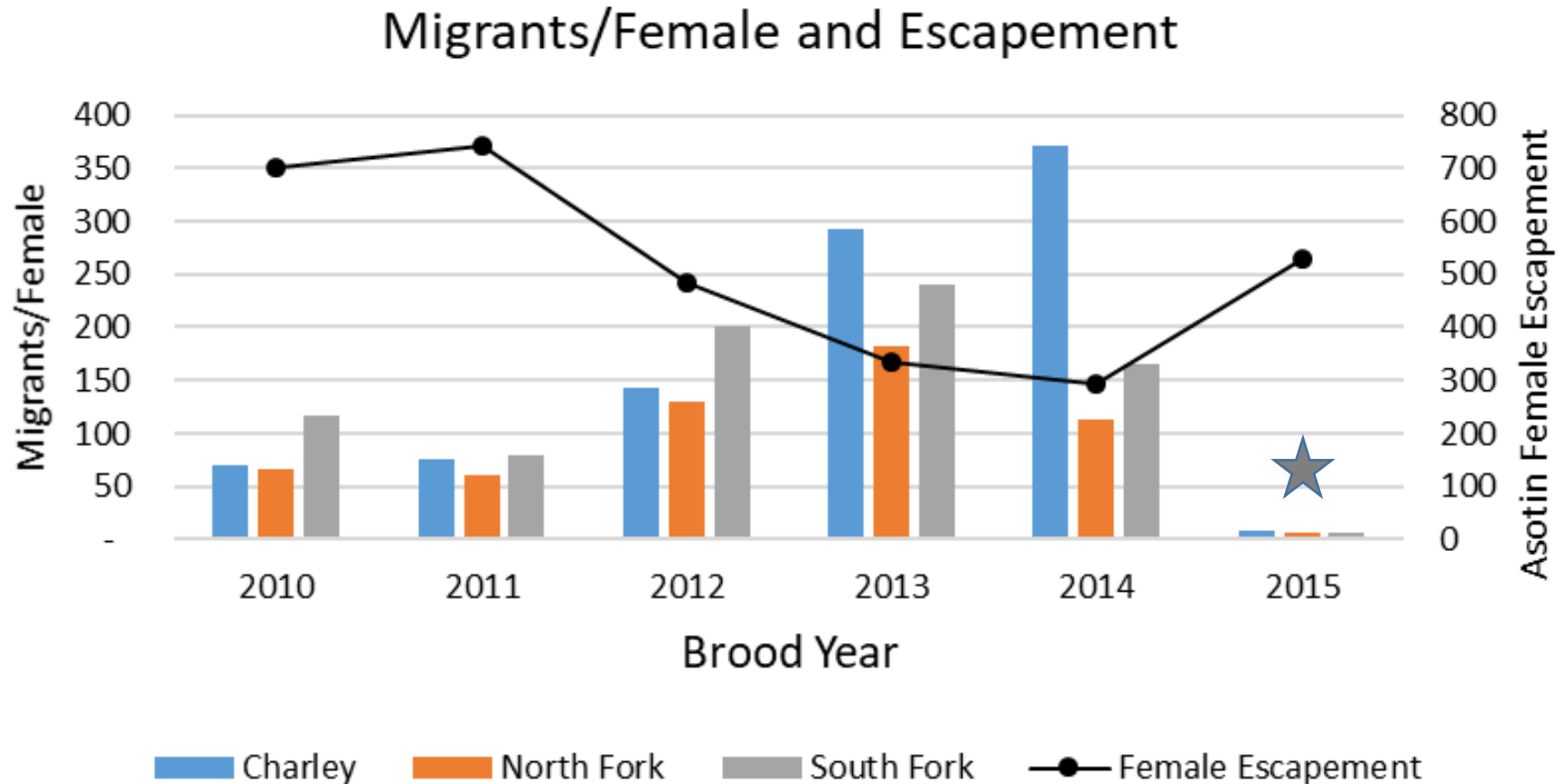
Fish



Change in abundance of juvenile steelhead in treatment sites relative to control sections within each study creek within the Asotin Creek IMW: 2008-2017. Error bars = 90% confidence intervals.





Restoration Response Habitat



Smolts/female (colored bars) by stream and brood year, and total female escapement (black line): 2010-2015.



Take Home Messages

- **Scale** treatment to problem
- Cost-Benefit a **MUST**
- Effectiveness still **unclear** (monitor!)
- Climate Change is **HERE**
 - Flow 
 - Temperature 

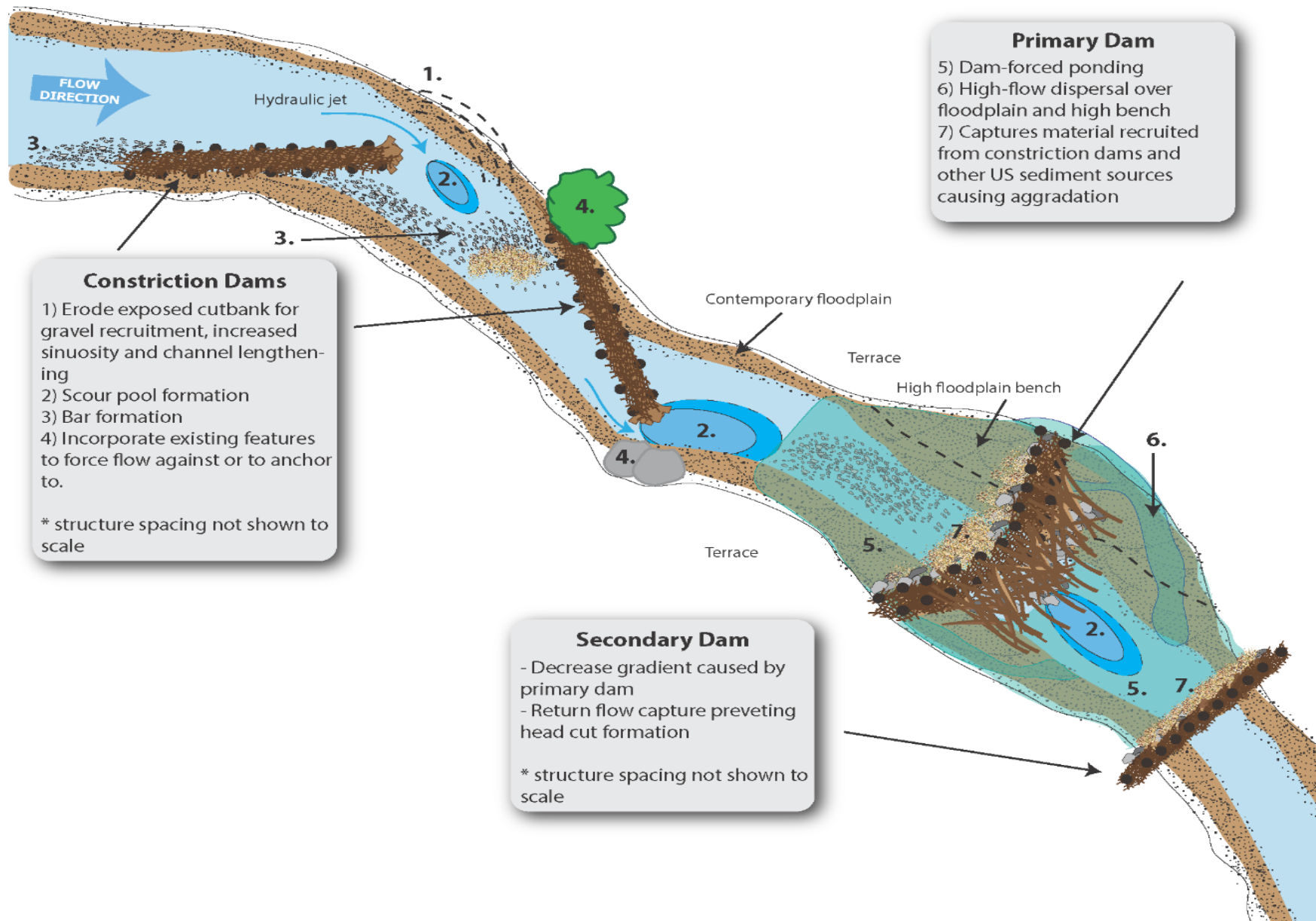


Cheap and Cheerful





BDA Complex

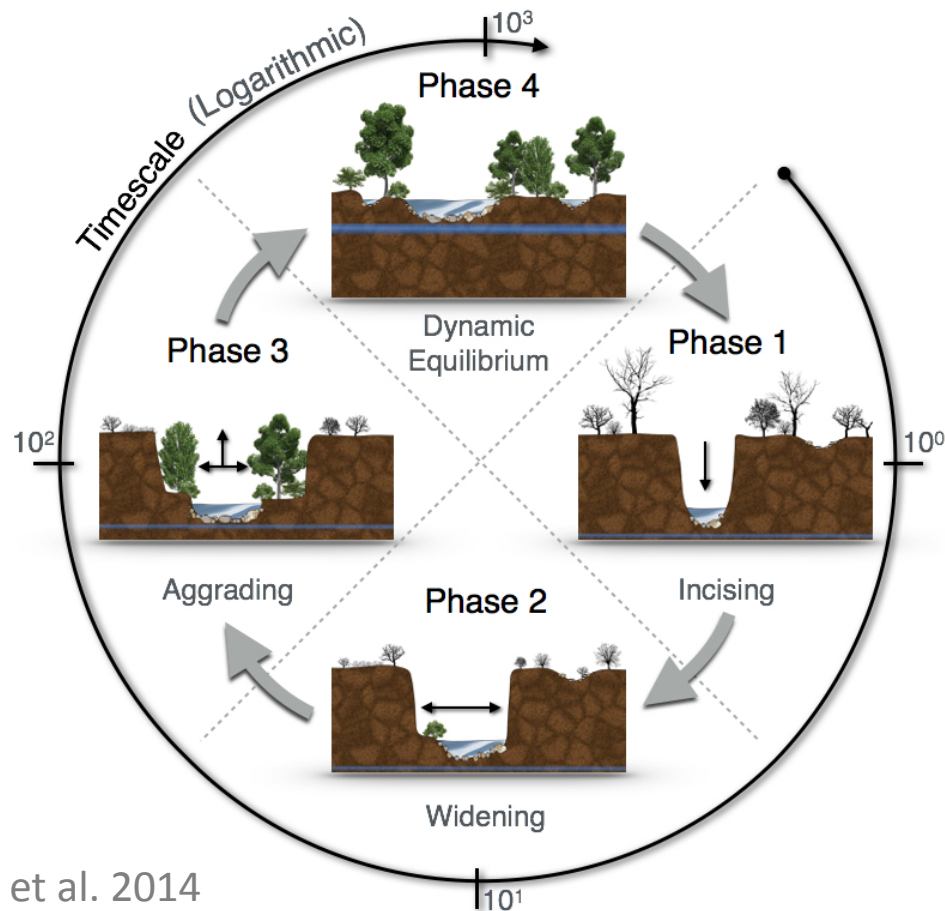




Bridge Creek IMW

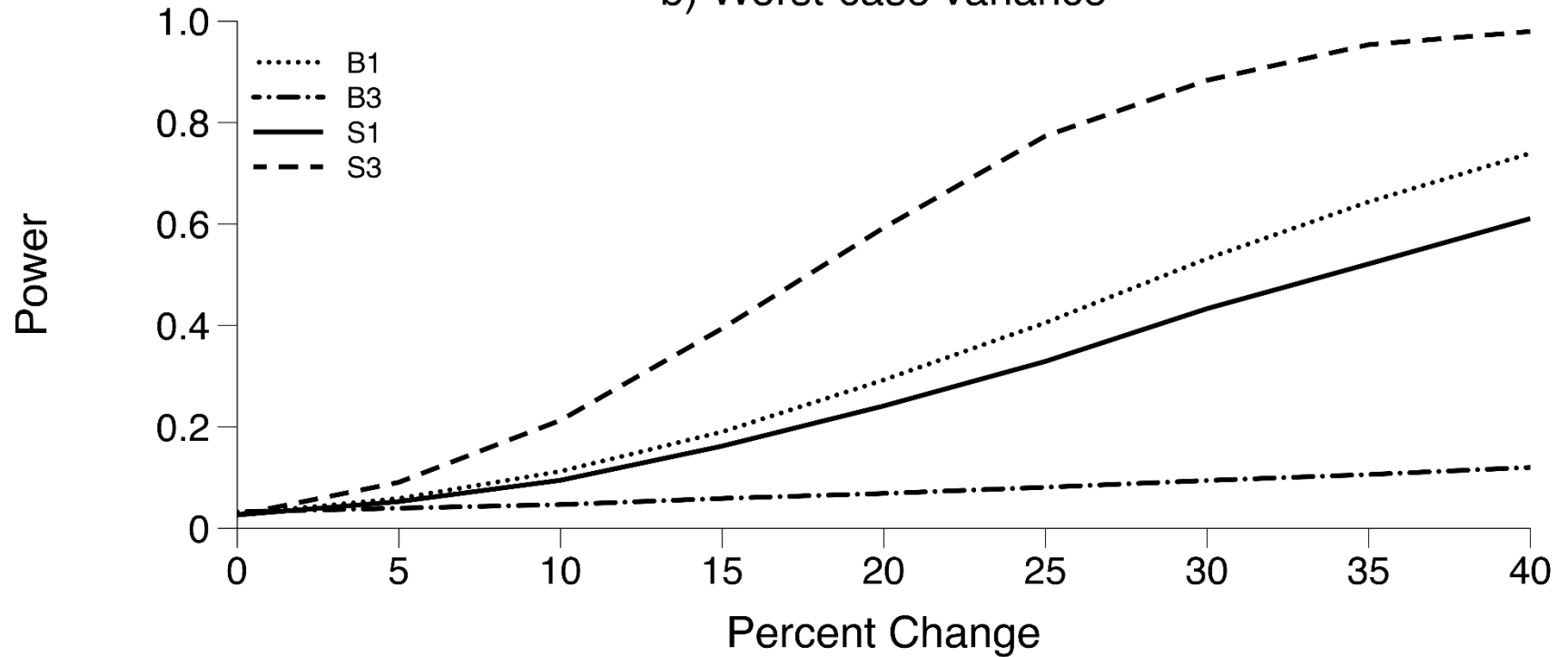


- Testing BDA Assisted Incision Recovery
- Benefits to Fish Populations and Habitat





b) Worst-case variance



B = BACI, S = Staircase design. Number represents number of sections treated in BACI design and number of streams treated in Staircase design.

Background

Wadeable Streams



Charley Creek ~ 4-5 m bankfull:
stream order 2

Low summer flows: 5-25 cfs
Large floods: 5000-6000 cfs



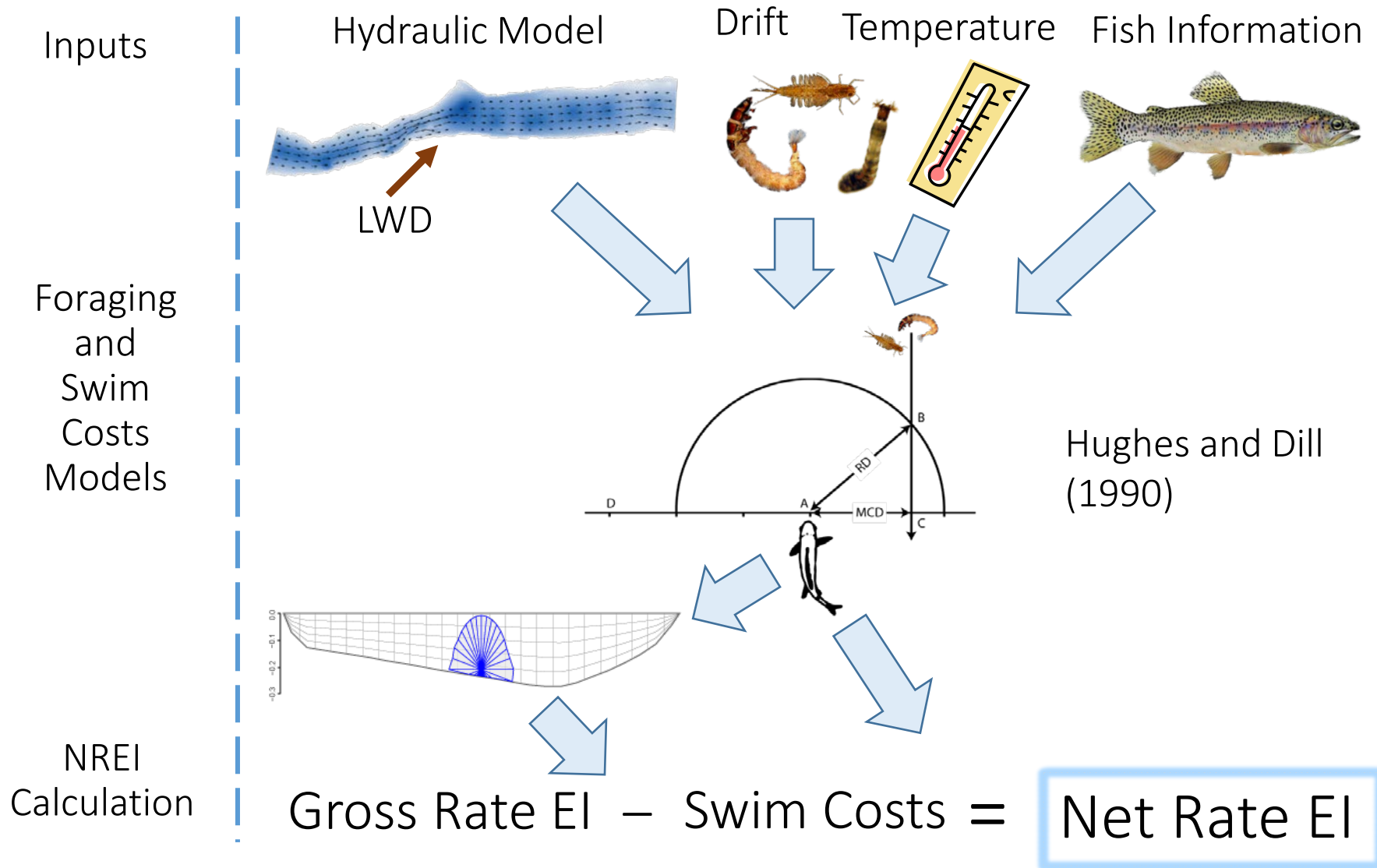
South Fork Asotin Creek ~ 6-7 m bankfull:
stream order 3

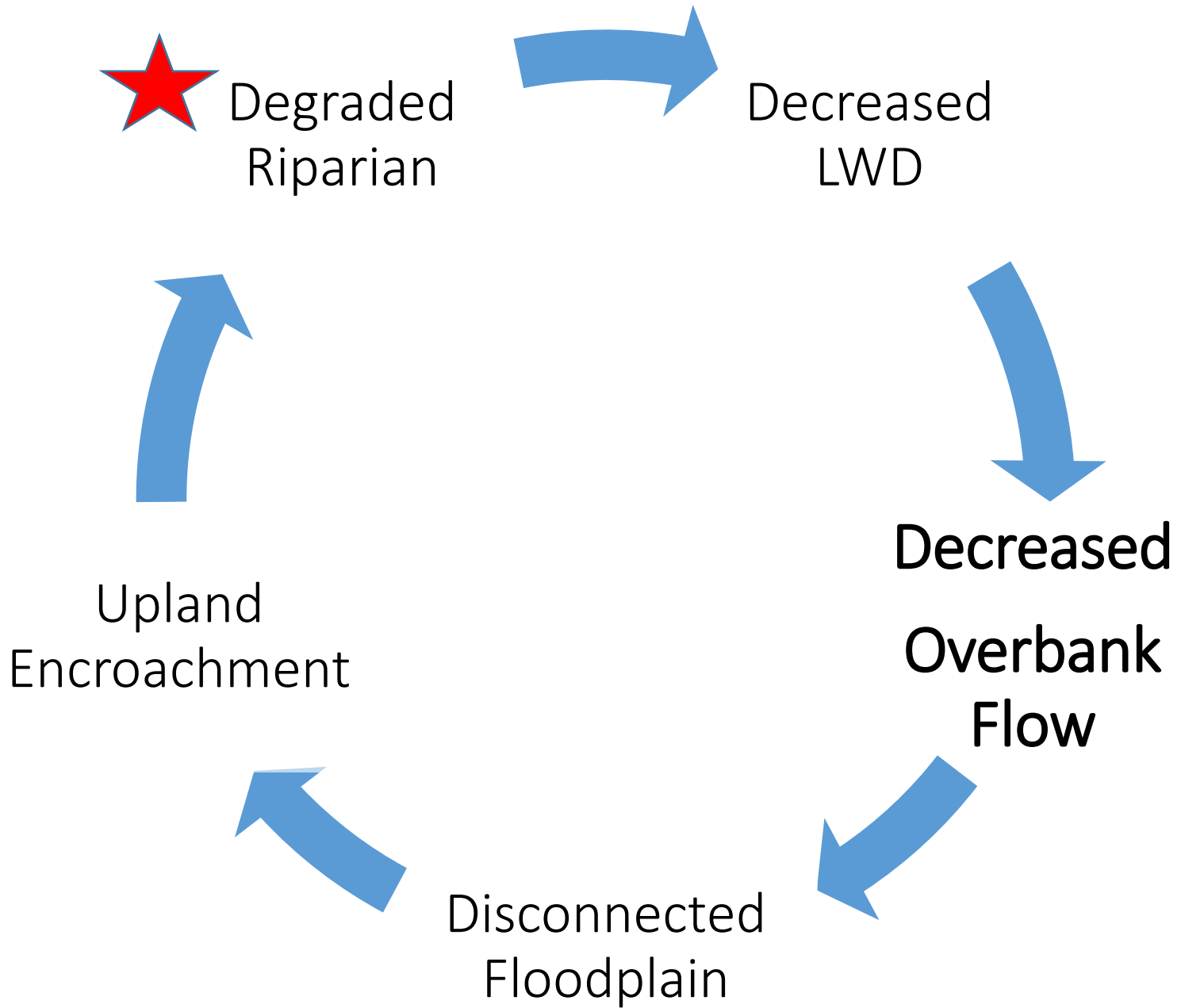


North Fork Asotin Creek ~ 9-10 m bankfull:
stream order 4

Response

Net Rate of Energy Intake (Reach Carrying Capacity)







Soft Engineering Structure Construction

- No engineering specs
- 10-20/day
- 2-6 structures/100 m
- Use local materials
- 5-10 km long treatments





More information and GIS tools



BRAT:
Beaver
Restoration
Assessment
Tool



WRAT:
Wood
Recruitment
Assessment
Tool



RCAT:
Riparian
Condition
Assessment
Tool

<https://joewheaton.org>

<https://cheapcheerful.weebly.com>

<https://eco-logical-research.com>