Beaver-related Restoration Strategies: Documented Benefits From Restoration Evaluations

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ANABRANCH SOLUTIONS
ALTERNATIVE WAYS TO RESTORE RIVERS

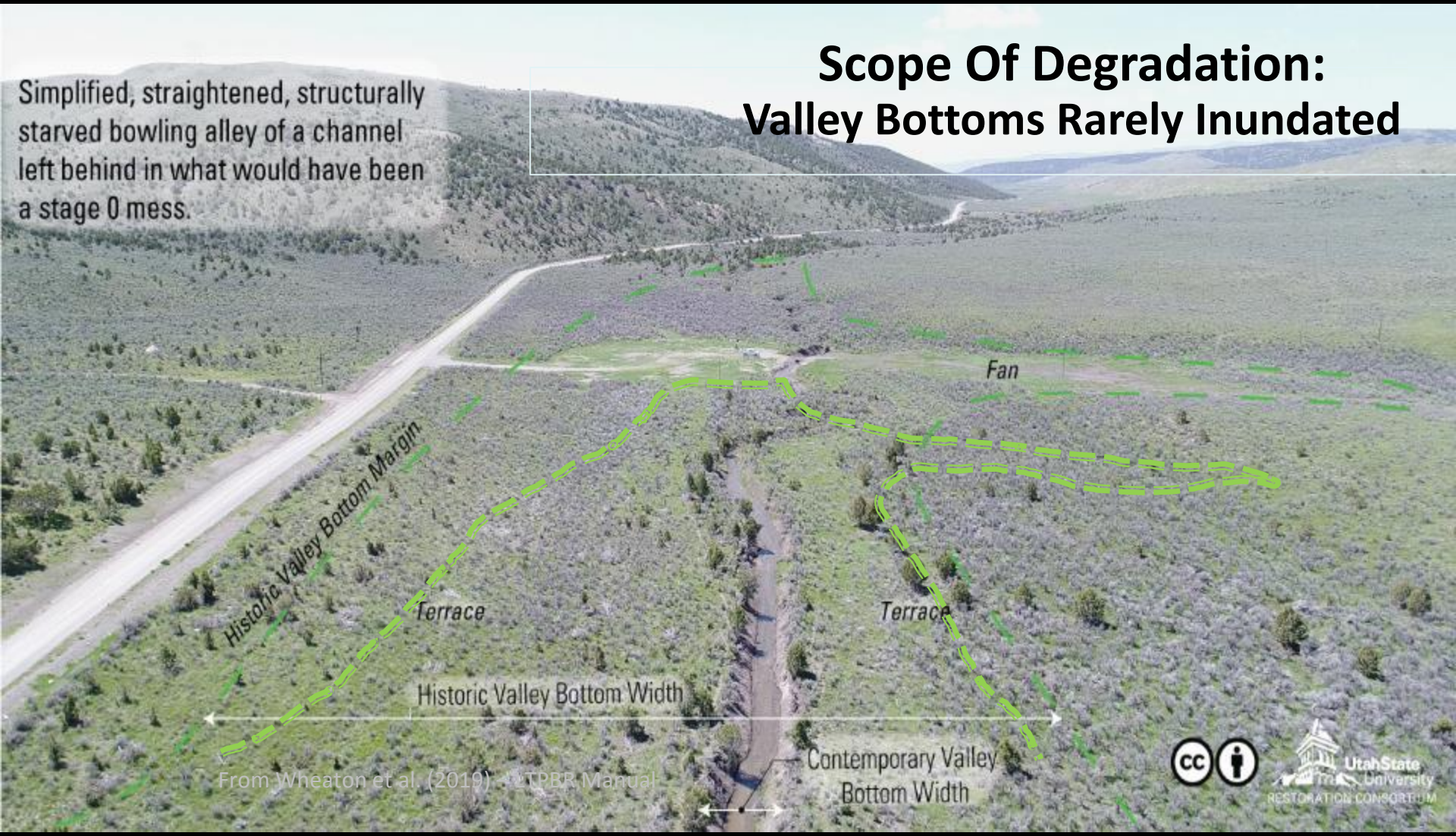
Scope Of Degradation:
We Have Lots Of This

From Wheaton et al. (2019) – LTPBR Manual

DOI: 10.13140/RG.2.2.19590.63049/1

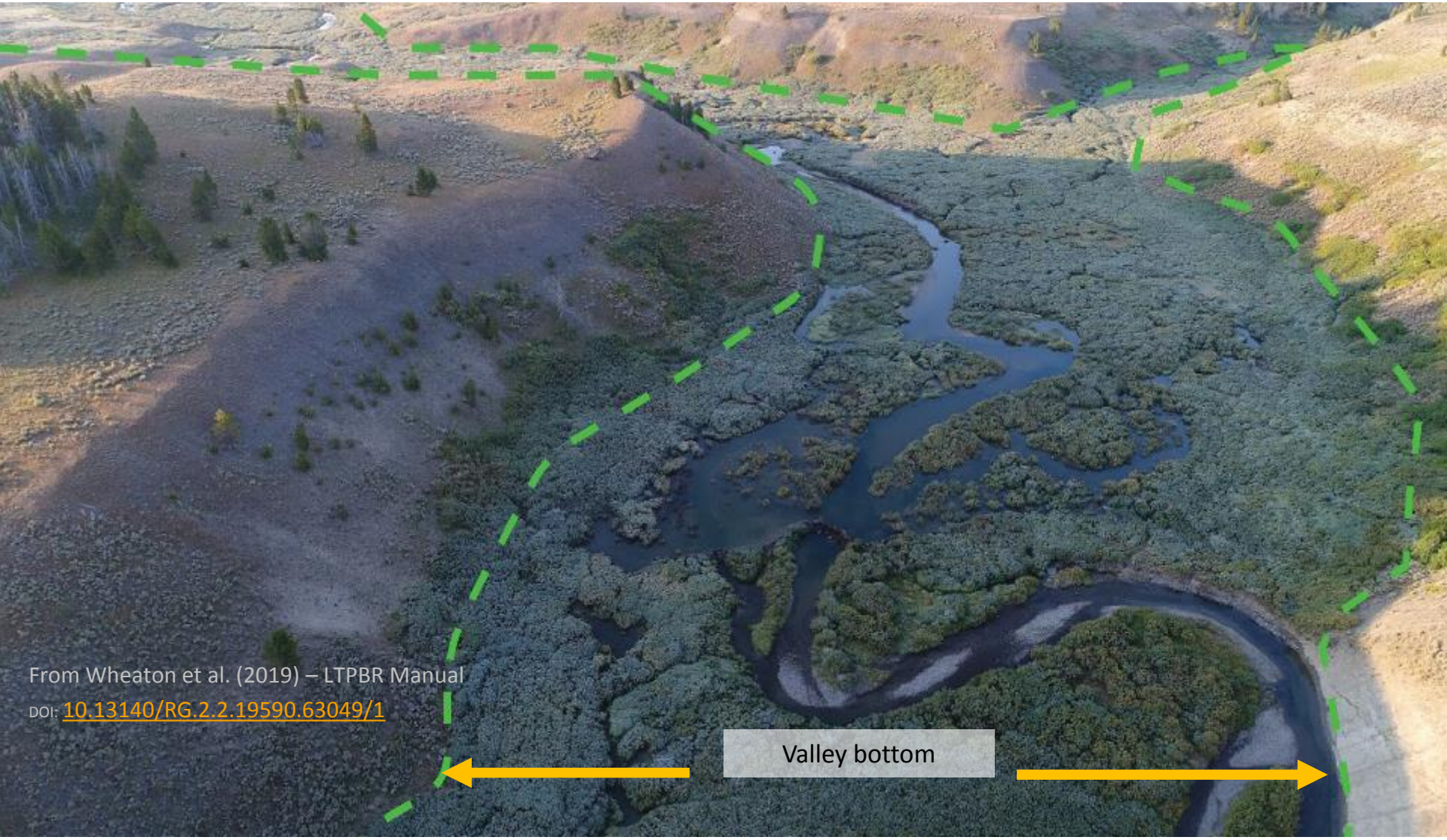
Any Old Forgotten Creek, Western US

Scope Of Degradation:
Valley Bottoms Rarely Inundated



Scope of Degradation – Structurally-Starved

What Is Our Reference Condition? (Stage-0)



Beaver Mediated Restoration Responses: Floodplain Reconnection

- Increase lateral and vertical exchange of water
- Decrease longitudinal exchange of water
- Increase retention of sediment, nutrients
- Increase riparian area / production

Ecosystem Services Provided By Beaver Activity

- Increase habitat quantity and complexity for fish, amphibians, birds, other wildlife,…
- resilience to drought and fire
- flood control
- water storage
- water quality (sediments, nutrients, temperature)
- increased livestock forage

OUTLINE: Bridge Creek IMW-Effectiveness of BDAs and Beaver Activity

I. The problem

II. The proposed solution and what we did

III. What we found out

   I. Physical Response

   II. Fish Response

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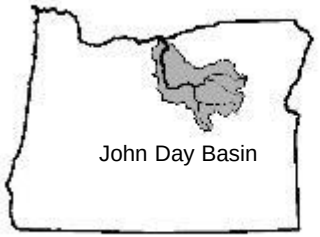
Bridge Creek Intensively Monitored Watershed

Oregon, USA

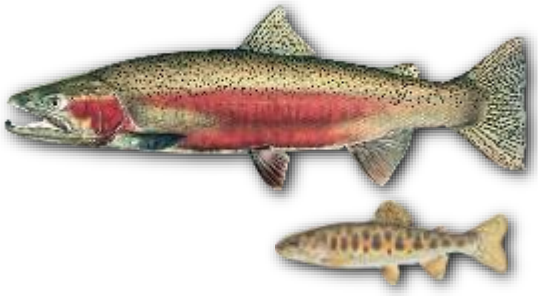


Bridge Creek Watershed

- 710 km^2

John Day Basin

Mid-Columbia Steelhead



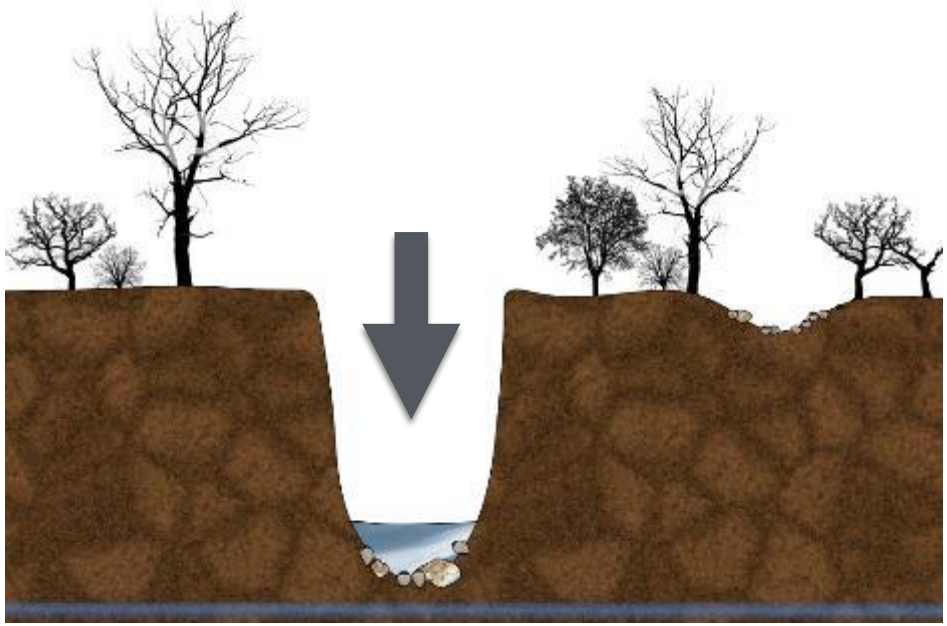

Pre-restoration
Incised
Bridge Creek
ca. 1993

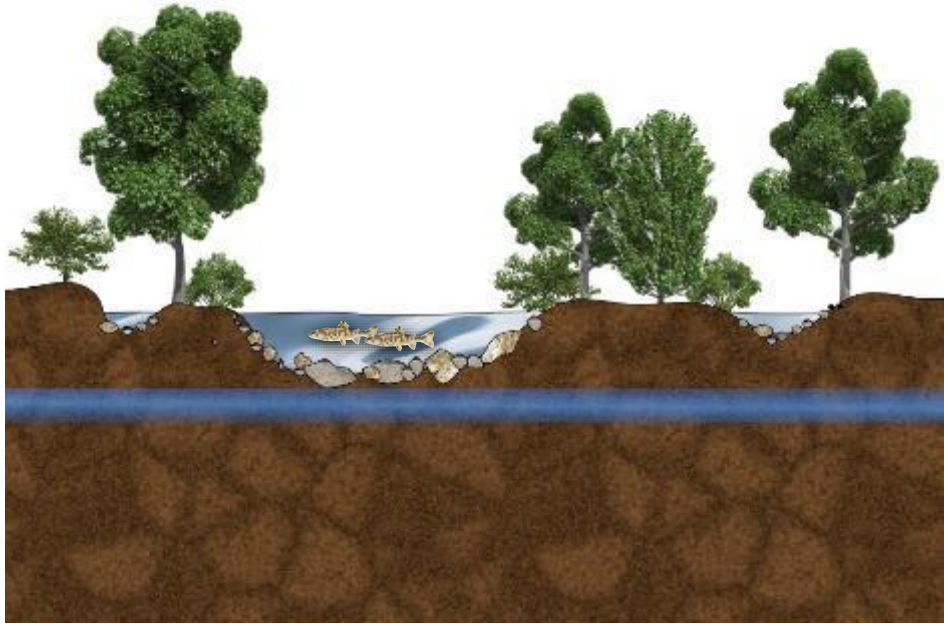
Channel Incision

Incised Channel

10^3 years

Incision Recovery





- Simplified and static channel
- Hydrologically Disconnected
- Low habitat quality

- Complex and dynamic channel
- Floodplain and groundwater connectivity
- High habitat quality

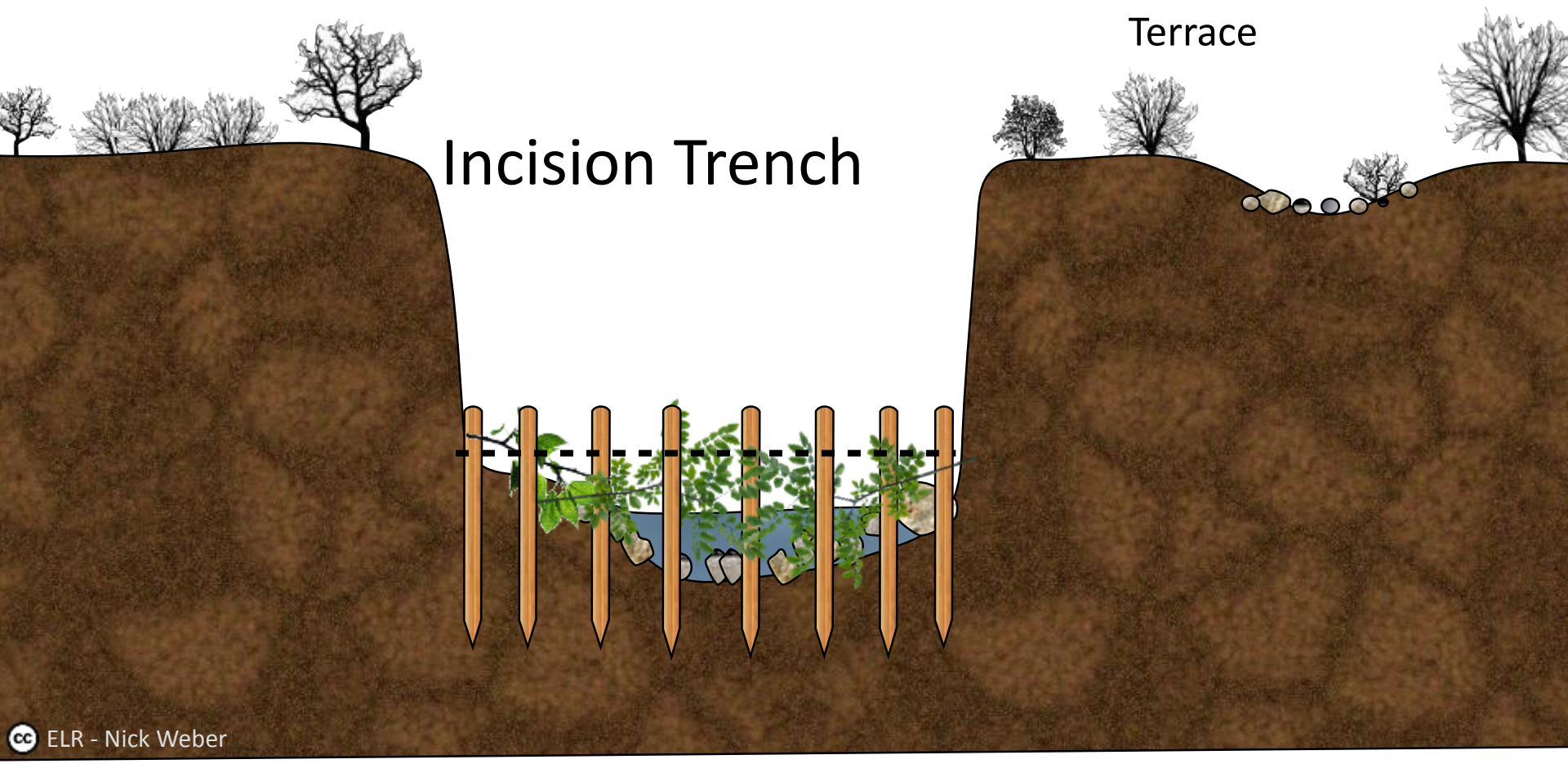
But Beavers Live in Bridge Creek

Dam Persistence

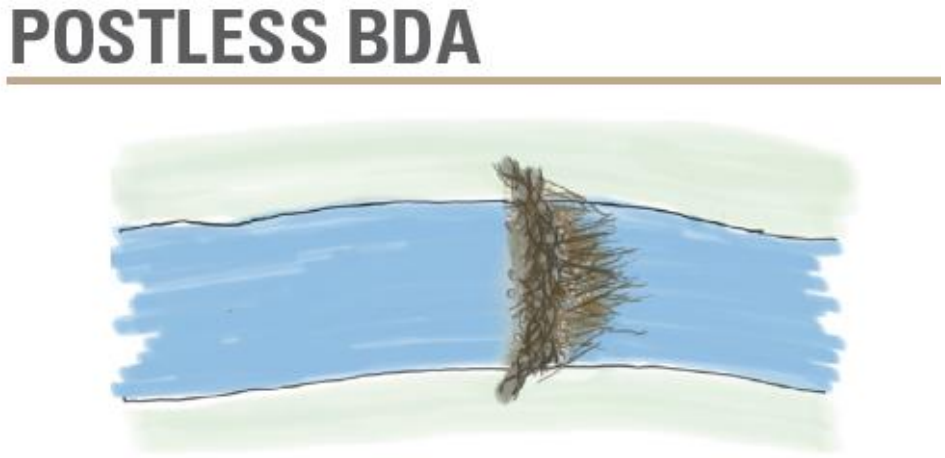
1988 - 2005

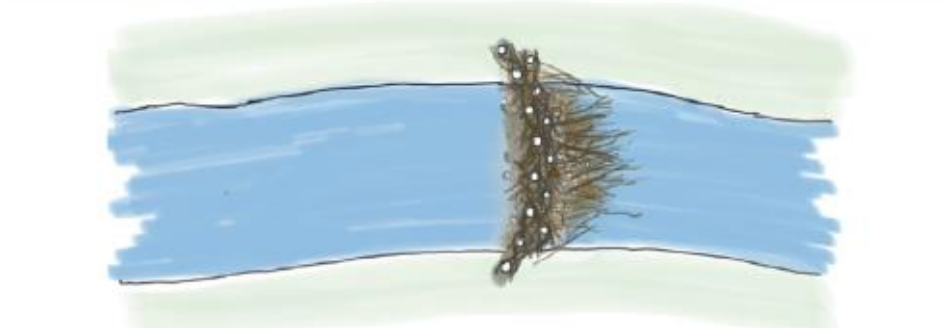
Includes data from: Demmer and Beschta (2008) DOI: 10.3955/0029-344X-82.4.309

Restoration Approach-Mimic Beaver Dam Analogs (BDAs)



Types of BDAs
Beaver Dam Analogues

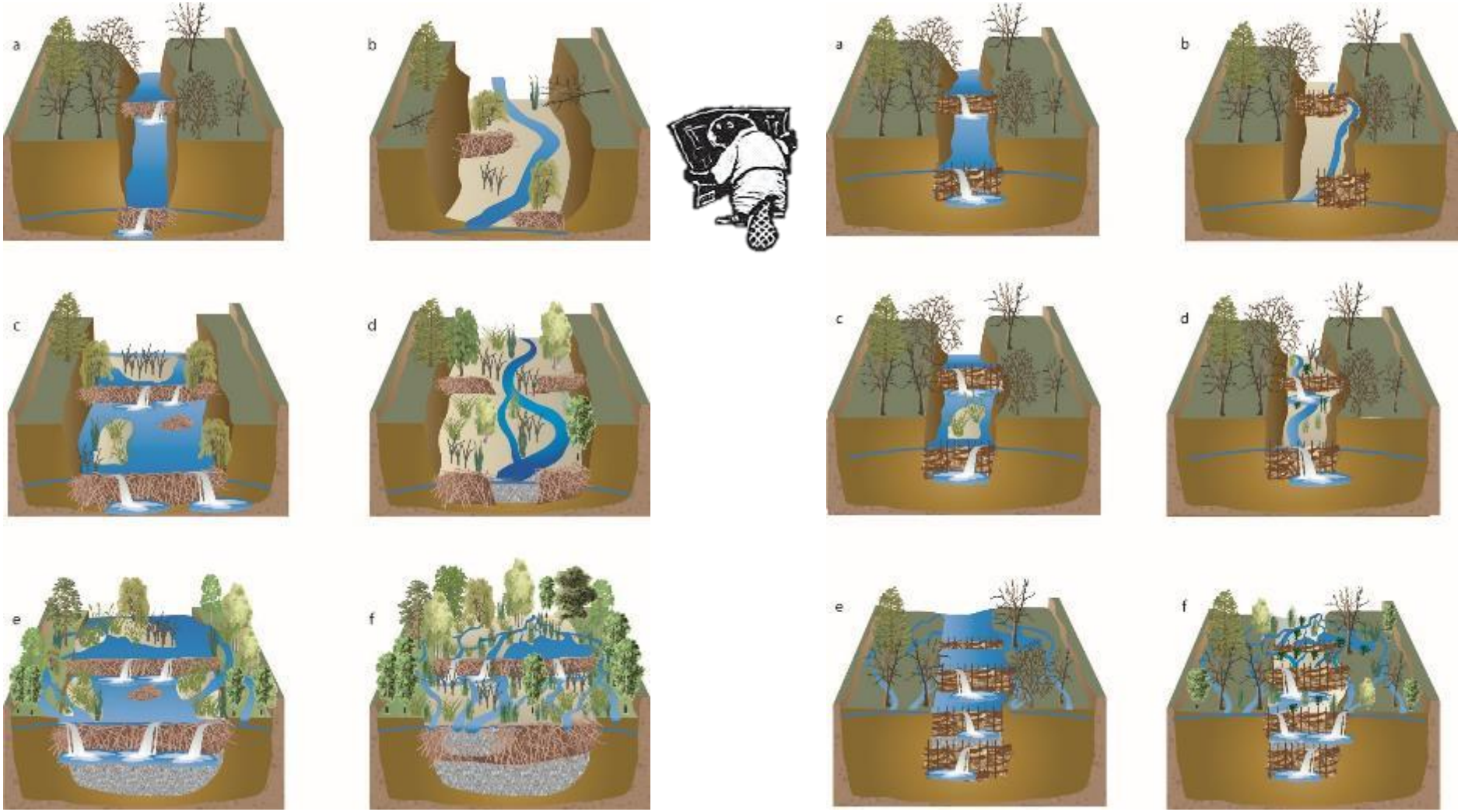




From pages 35-48 of Pocket Guide; Wheaton et al. (2019)
DOI: 10.13140/RG.2.2.28222.13123/1

See also Appendix E of Shahverdian et al. (2019) – Chapter 4
LTPBR Manual DOI: 10.13140/RG.2.2.22526.64324

Using Beaver to Restore Incised Streams

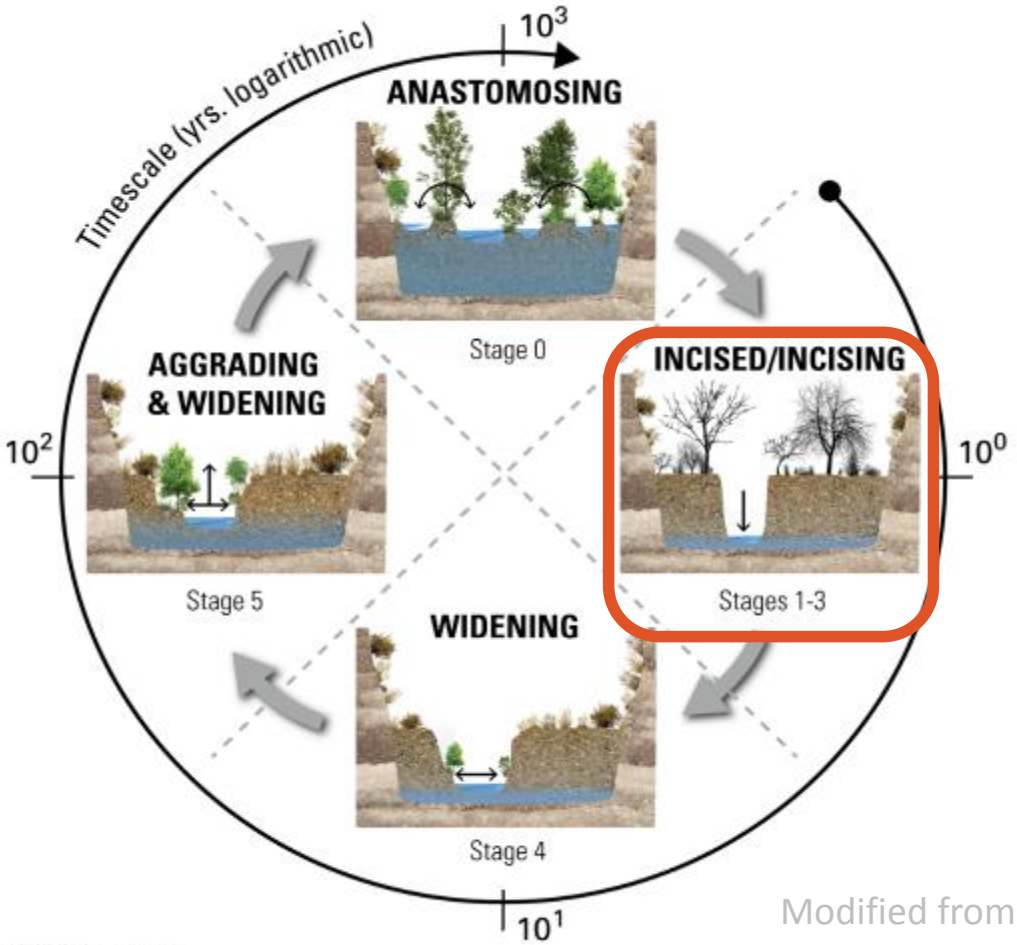


From Pollock et al. (2014) –BioScience

DOI: 10.1093/biosci/biu036

Bridge Creek IMW

- Testing BDA Assisted Incision Recovery Model

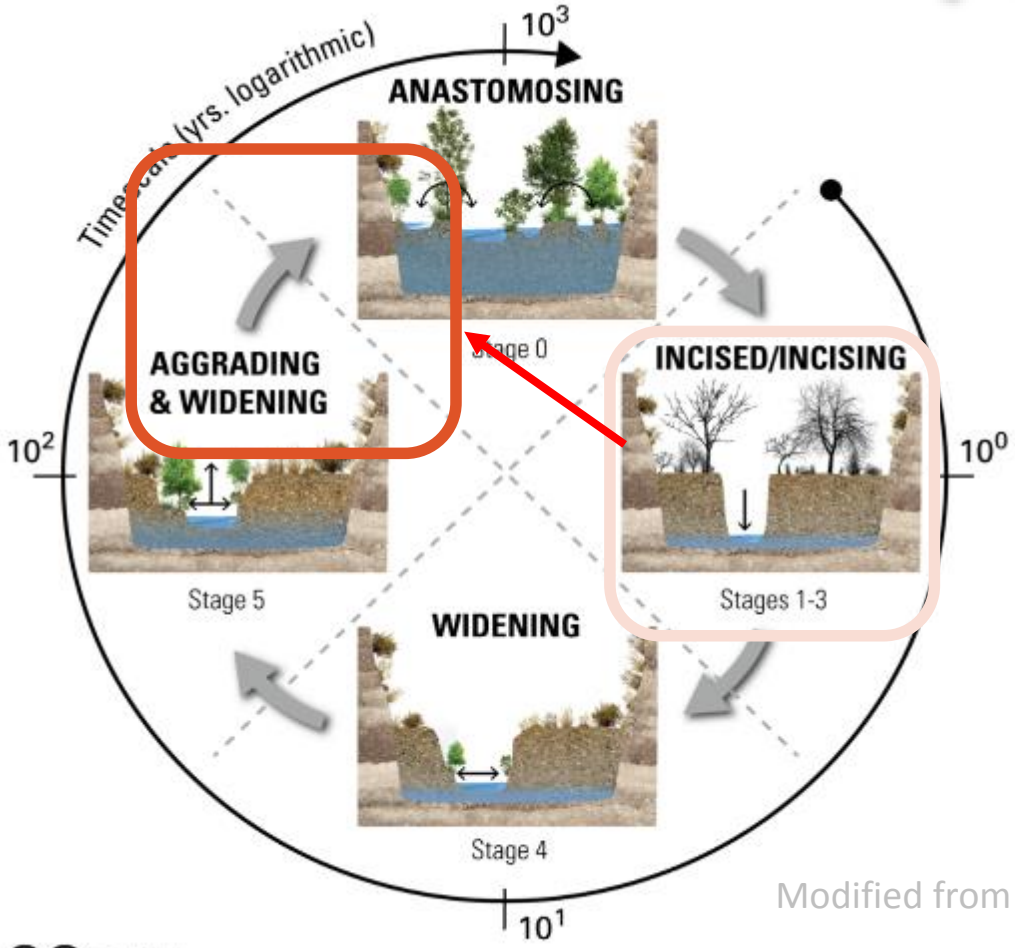


Modified from Pollock et al. (2014) –Bioscience

DOI: 10.1093/biosci/biu036

Bridge Creek IMW

- Testing BDA Assisted Incision Recovery Model
- Benefits to Fish Populations?



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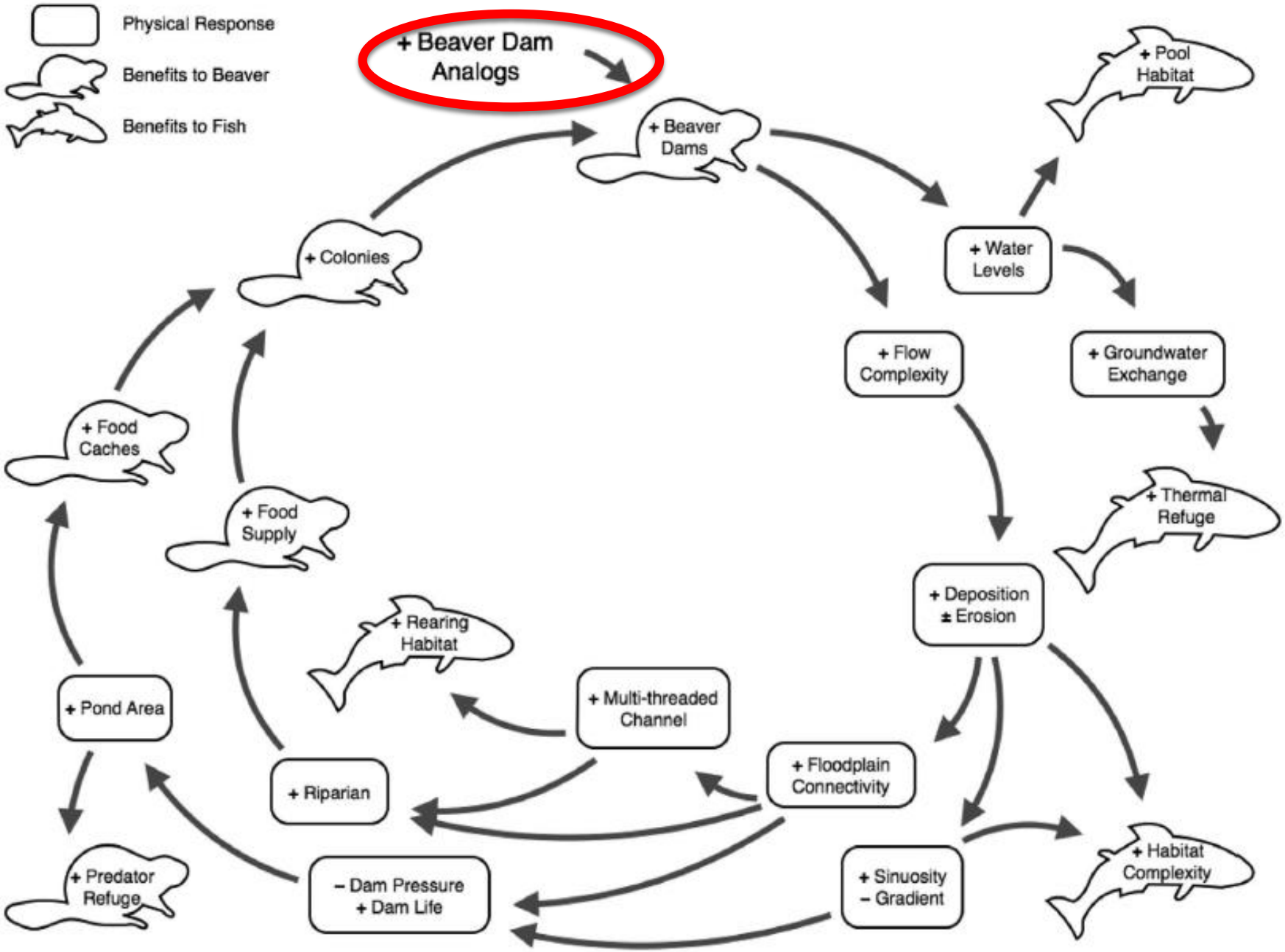
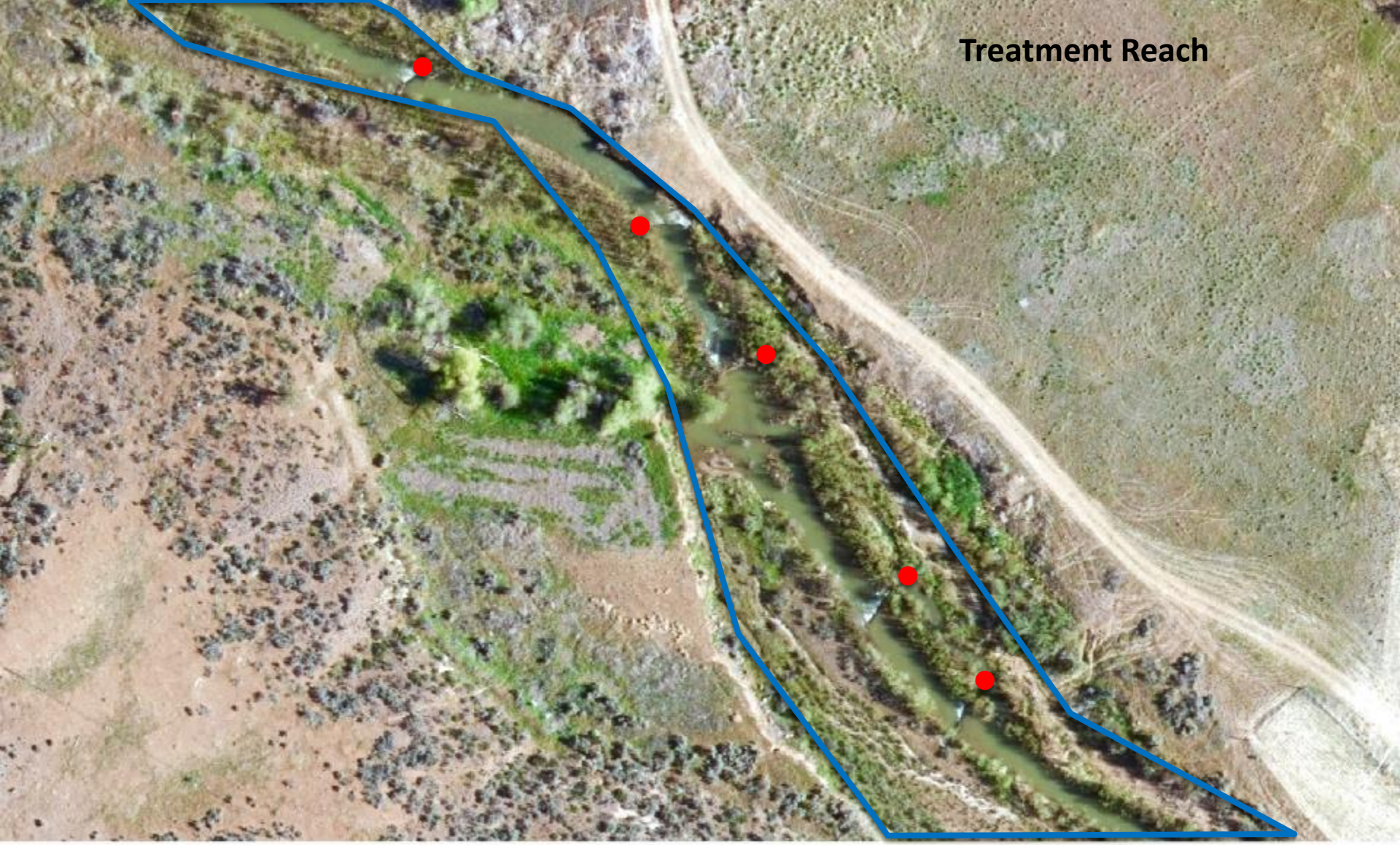


Figure 1 from Bouwes et al (2016) DOI: 10.1038/srep28581

Mimic – Build BDAs



4 Treatment Reaches ~ 1 km

OUTLINE: Bridge Creek IMW-Effectiveness of Restoring Processes with BDAs and Beaver Activity

I. The problem

II. The solution

III. What we found out

- Physical Response
- Fish Response

Post-restoration

Beaver Dams and BDAs - Promote

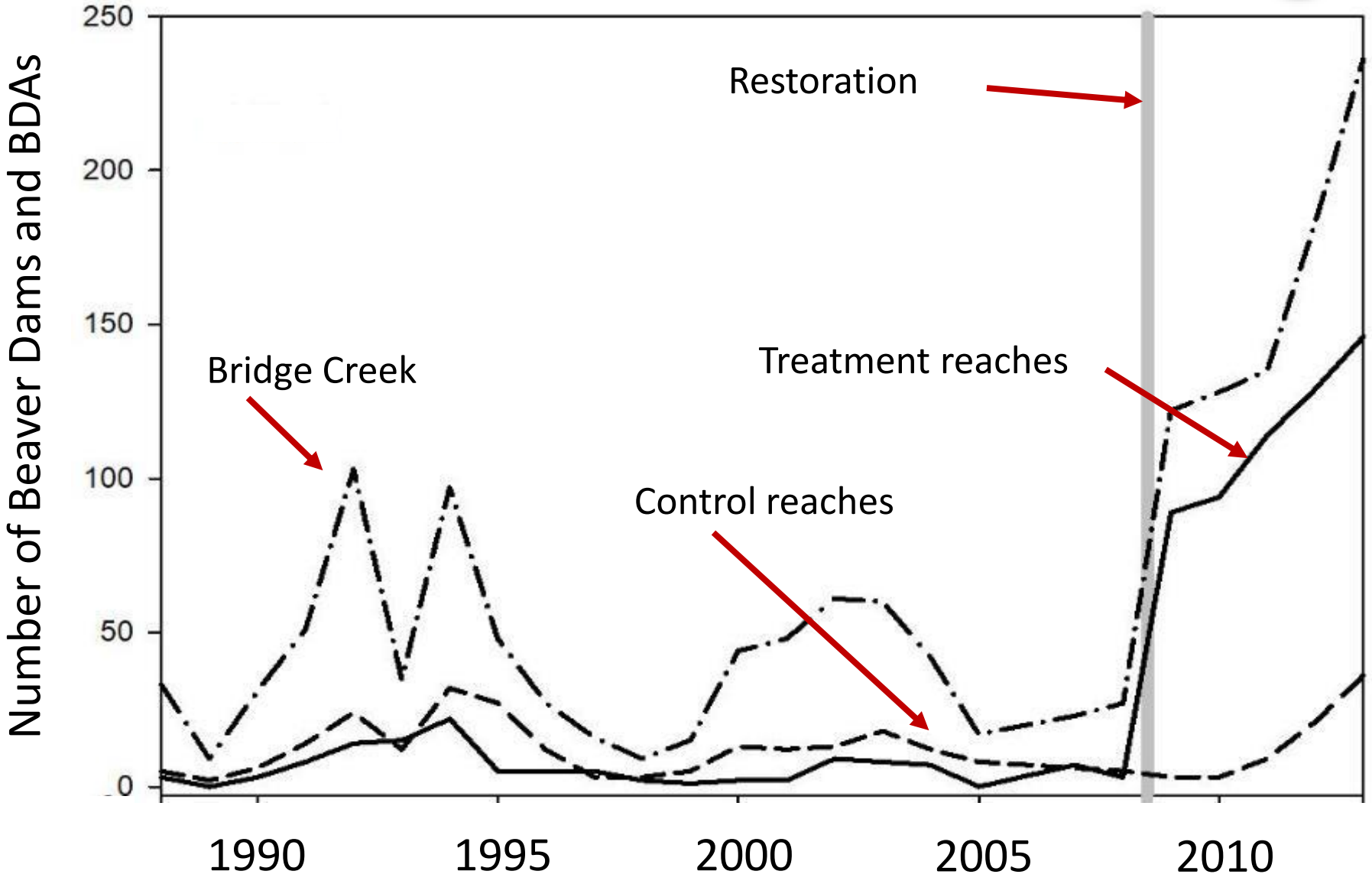


Figure 4 from Bouwes et al (2016) DOI: 10.1038/srep28581

Post-restoration

Aggradation and Pool Formation- Promote deposition ~1m < 1 yr

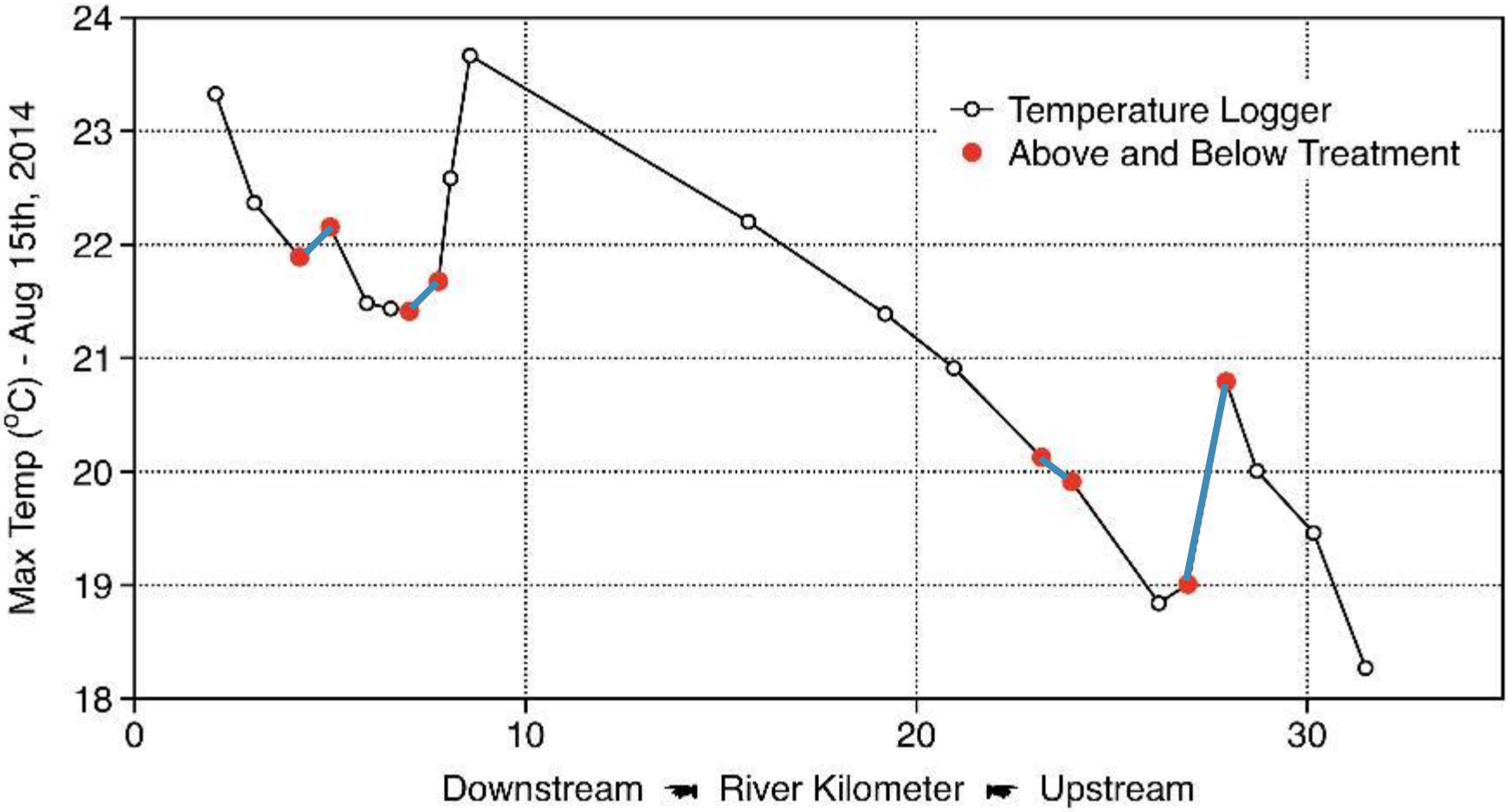
Post-restoration

Floodplain Connection - Promote

Stream Temperature Response

Temperature longitudinal profile

August 2014




Painted Hills Reservoir
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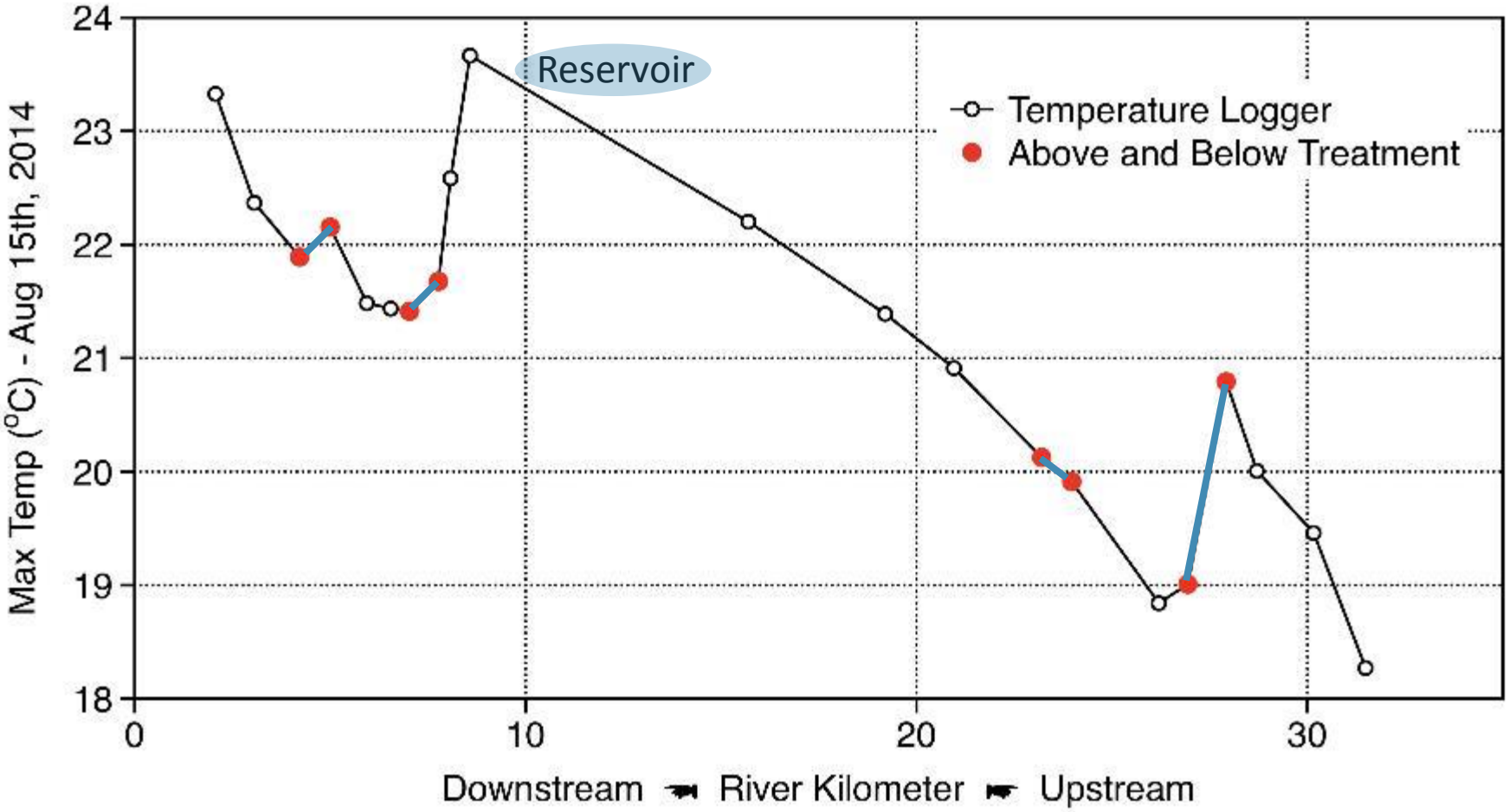
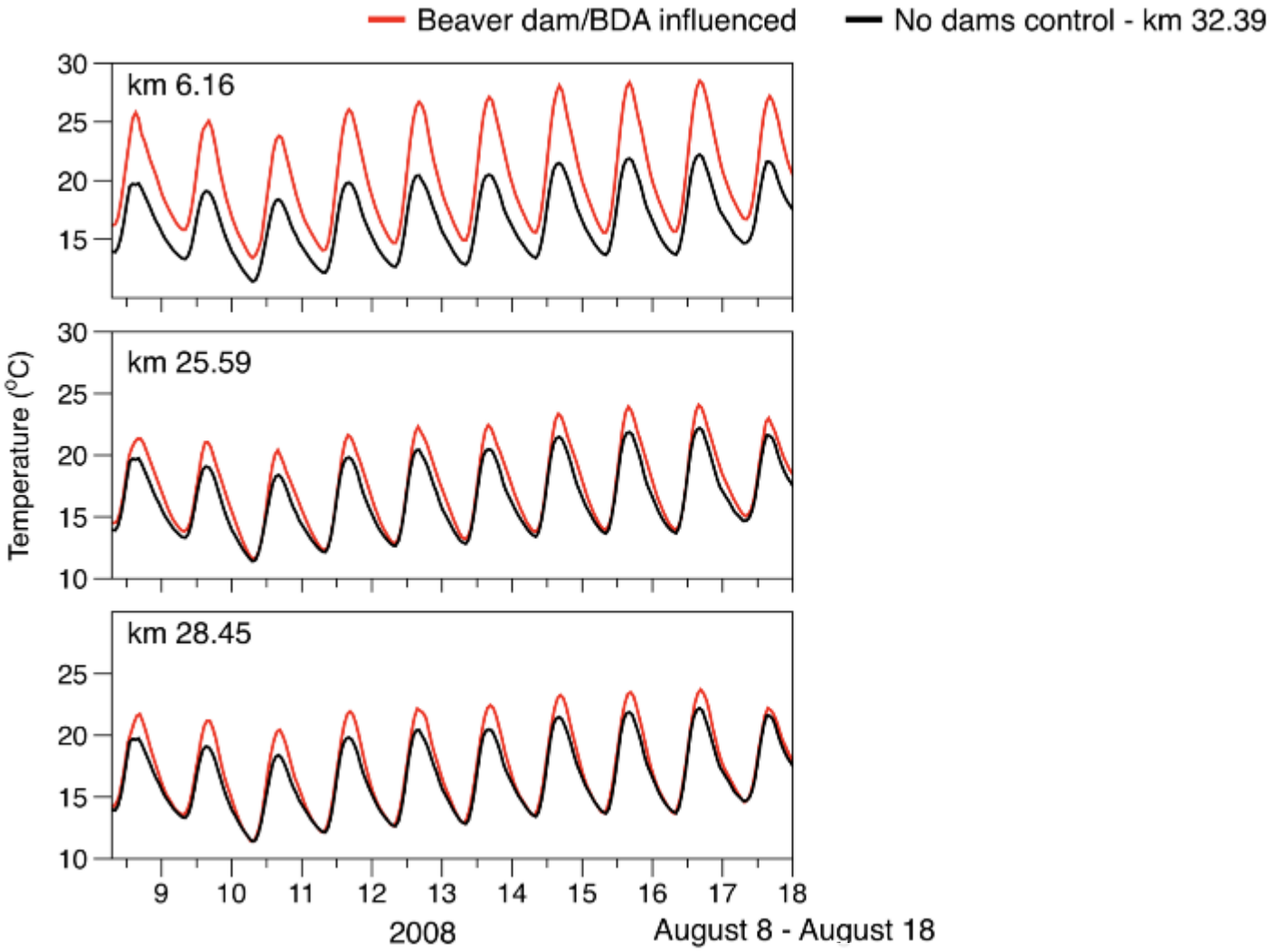
Stream Temperature Response

Temperature longitudinal profile

August 2014



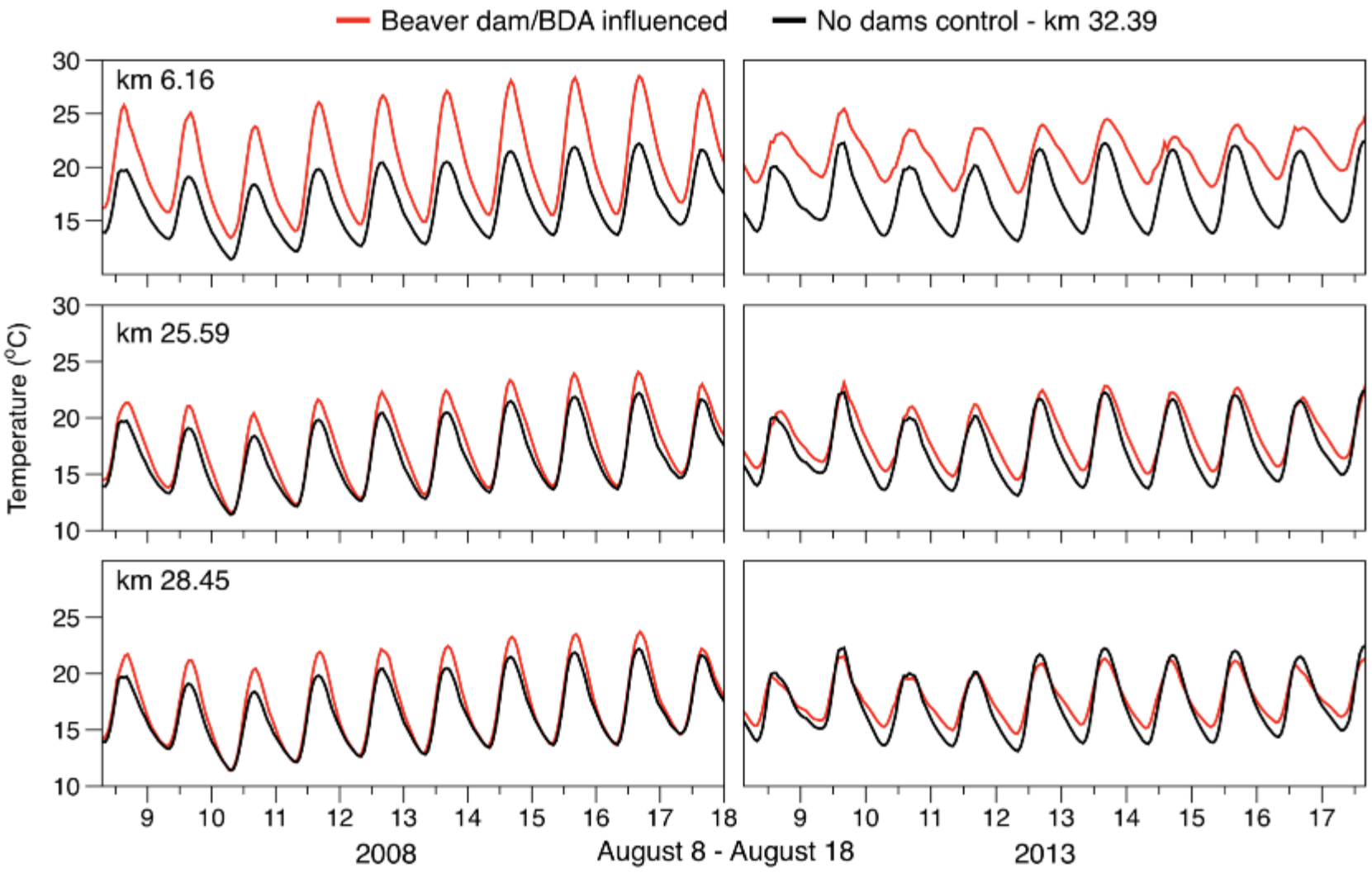
Surface Water Temperature Response



Before

From: Weber et al. (2017) PLoS ONE
DOI: 10.1371/journal.pone.0176313

Surface Water Temperature Response

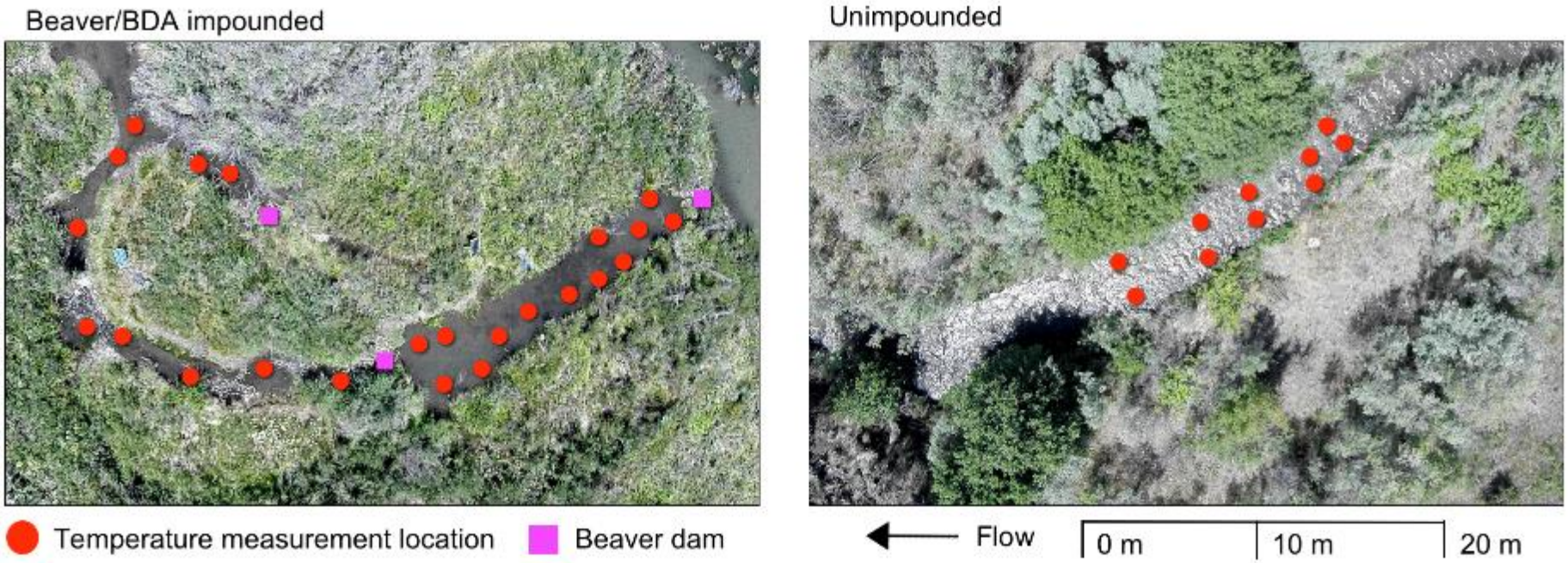


Before

After

From: Weber et al. (2017) PLoS ONE
DOI: 10.1371/journal.pone.0176313

Response: Channel Temperature Heterogeneity



From: Weber et al. (2017) PLoS ONE
DOI: 10.1371/journal.pone.0176313

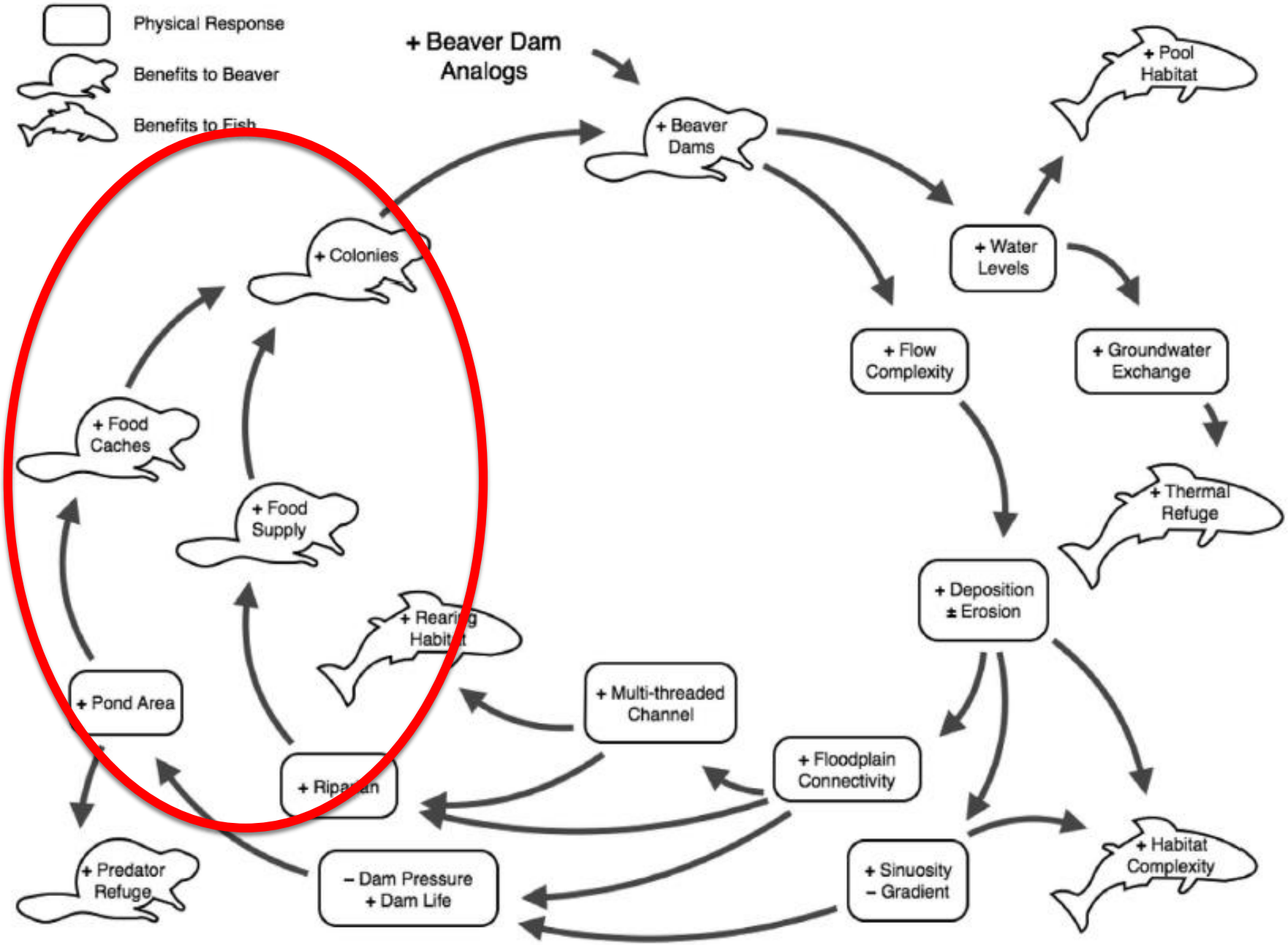
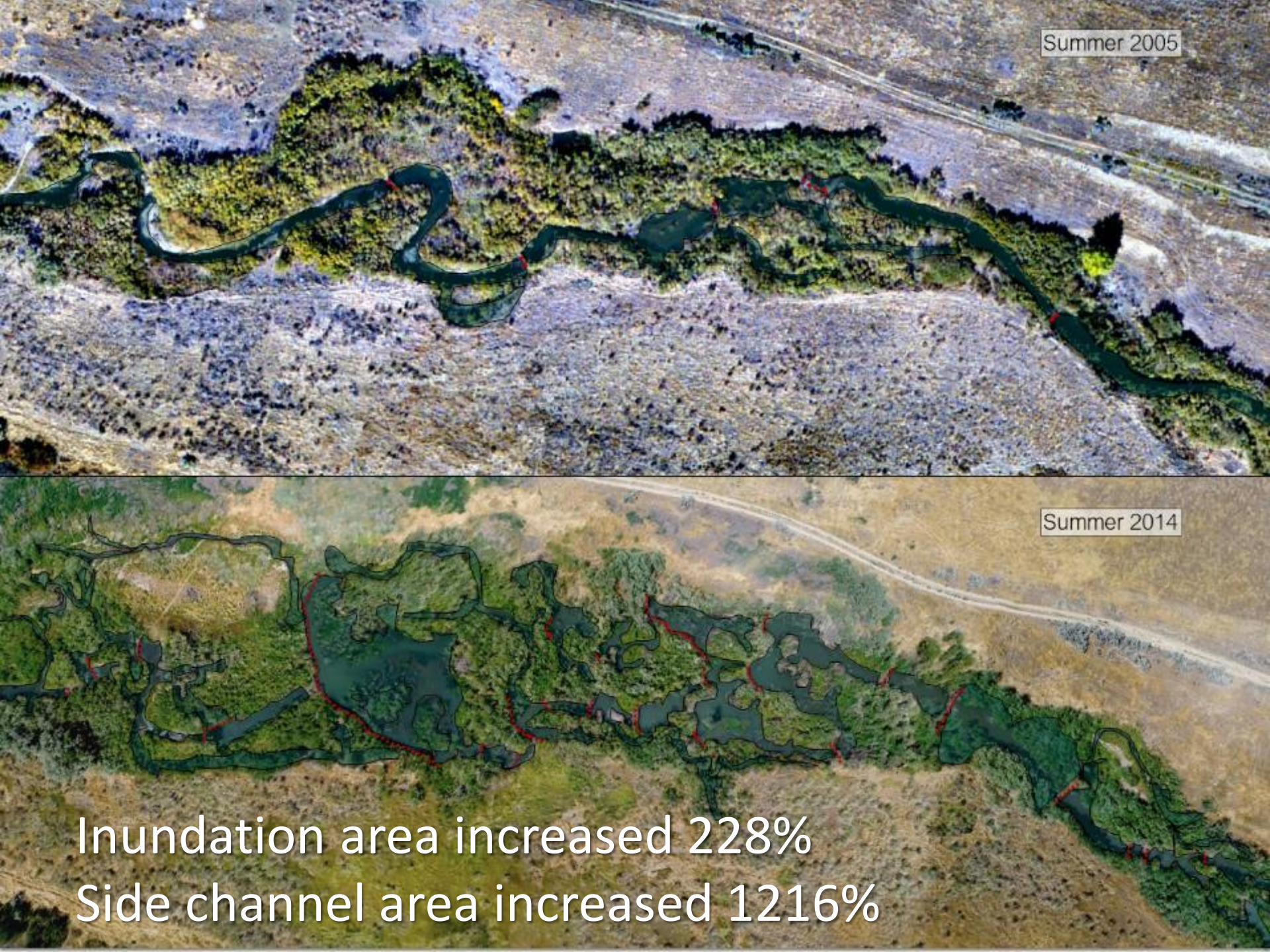


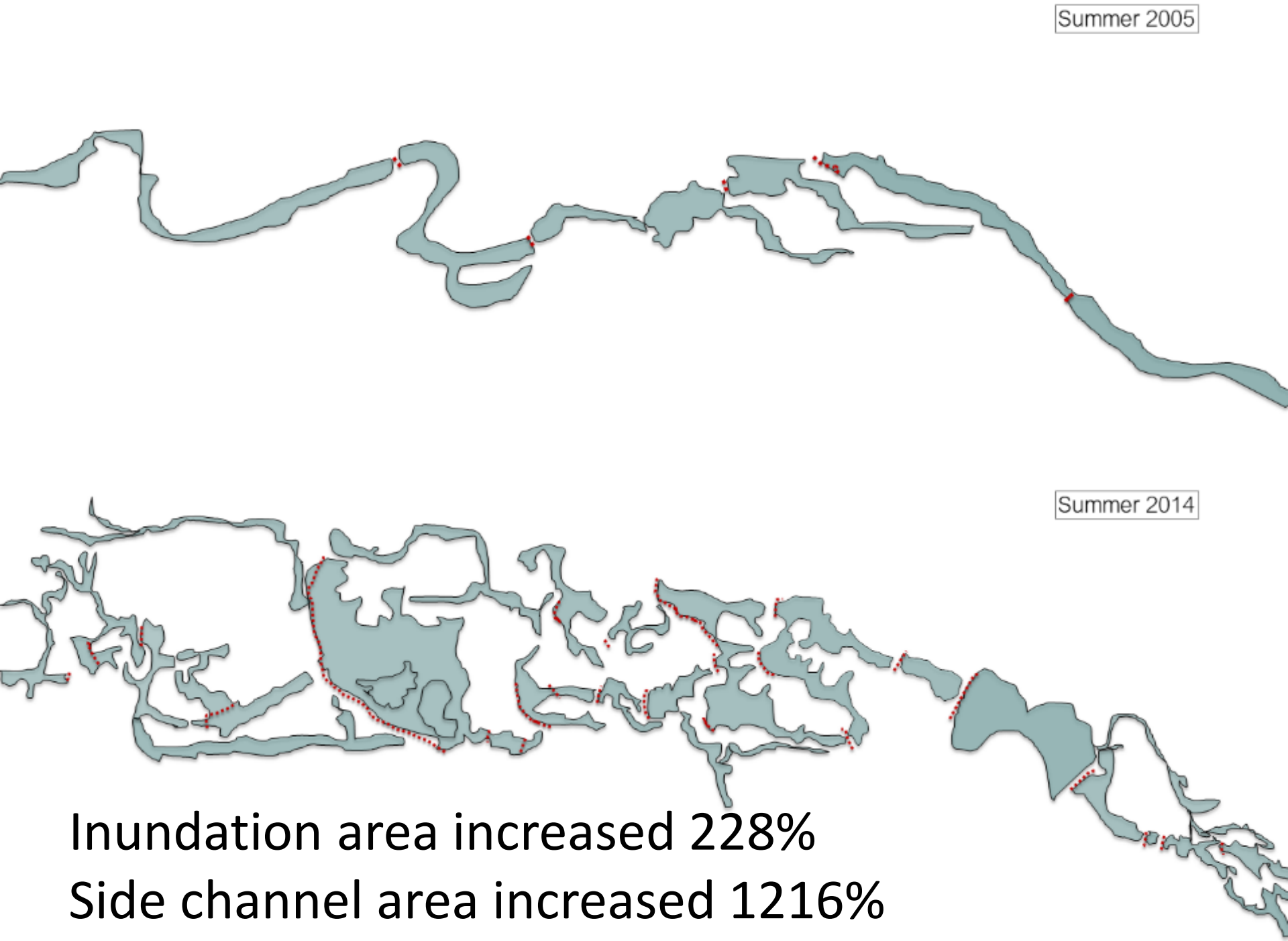
Figure 1 from Bouwes et al (2016) DOI: 10.1038/srep28581

Post-restoration Beaver Response SUSTAIN?

ACTIVE BEAVER DAMS

- 2008 = 22 (pre-BDAs)
- 2016 = 164!


Summer 2005
Summer 2014
Inundation area increased 228%
Side channel area increased 1216%



Inundation area increased 228%

Side channel area increased 1216%

Sustain?

Flood Resistance/Resilience

Flood Resistance/Resilience – Sustain!

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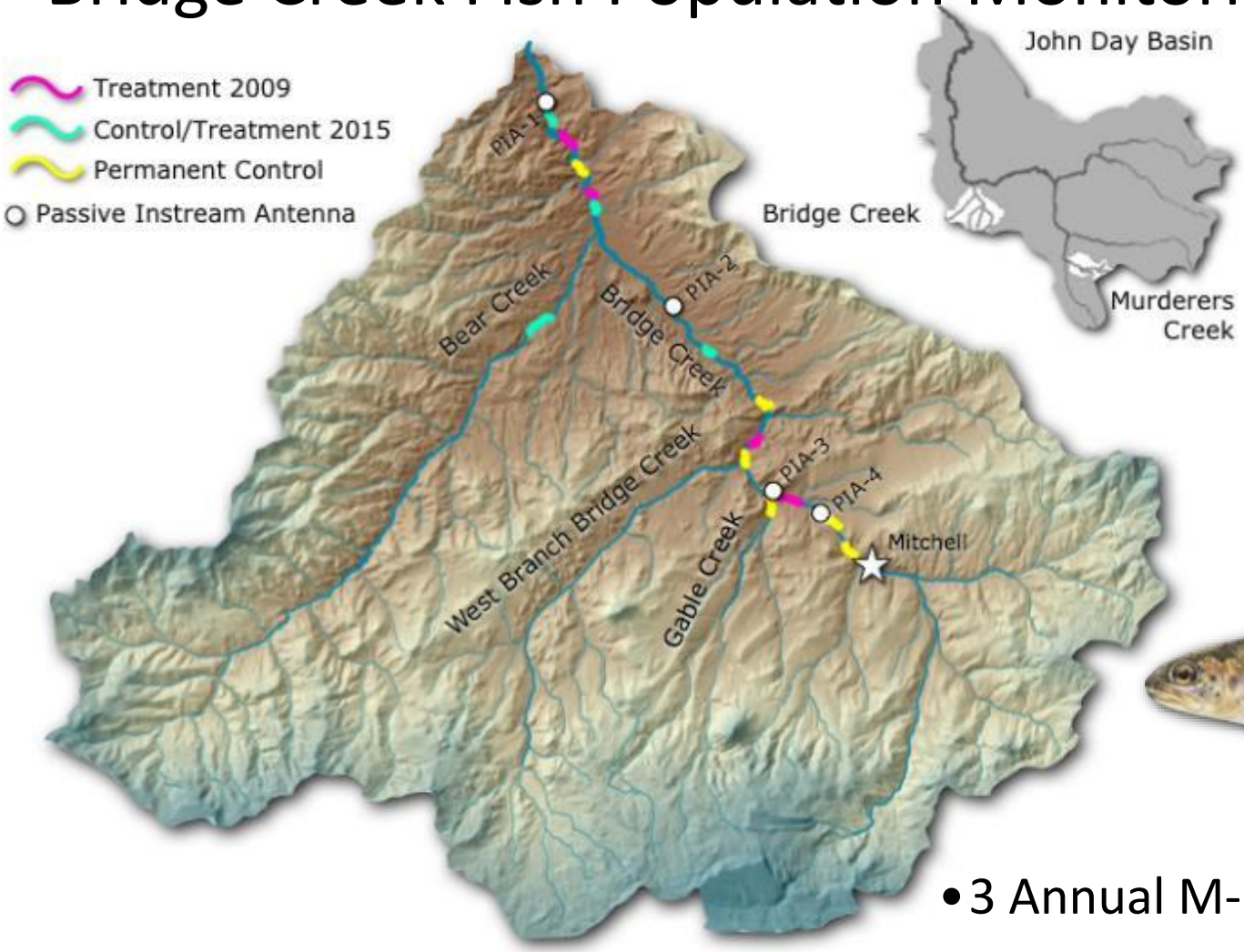
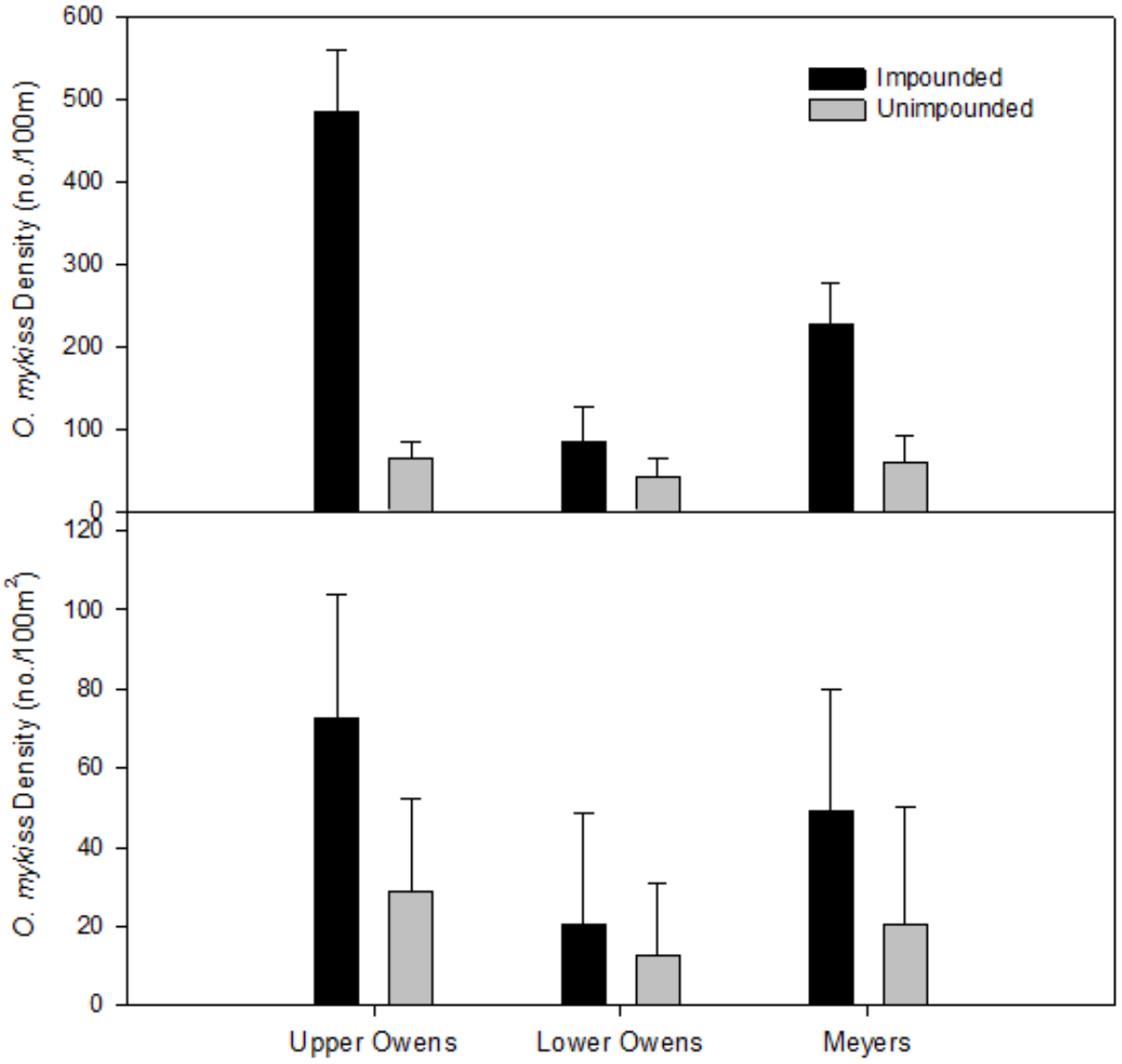
Bridge Creek Fish Population Monitoring



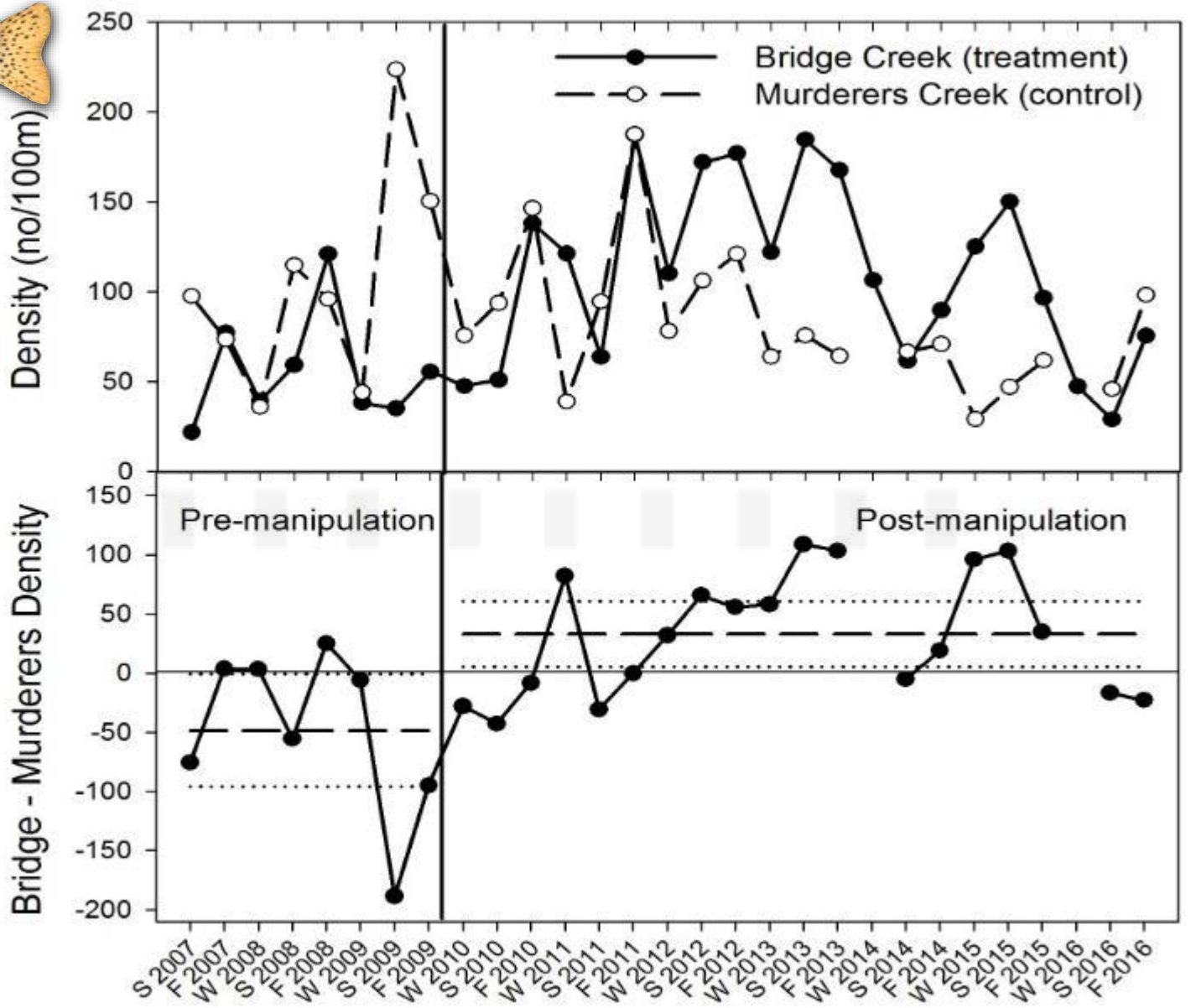
- 3 Annual M-R Surveys - 11 yrs
- ~ 100,000 Juveniles Pit-tagged
- 4 Passive Instream Antennas
- Adult Steelhead Trap

Habitat Preference – Juvenile Steelhead Response



From Bouwes et al (2016) DOI: 10.1038/srep28581

Juvenile *O. Mykiss* Density Response



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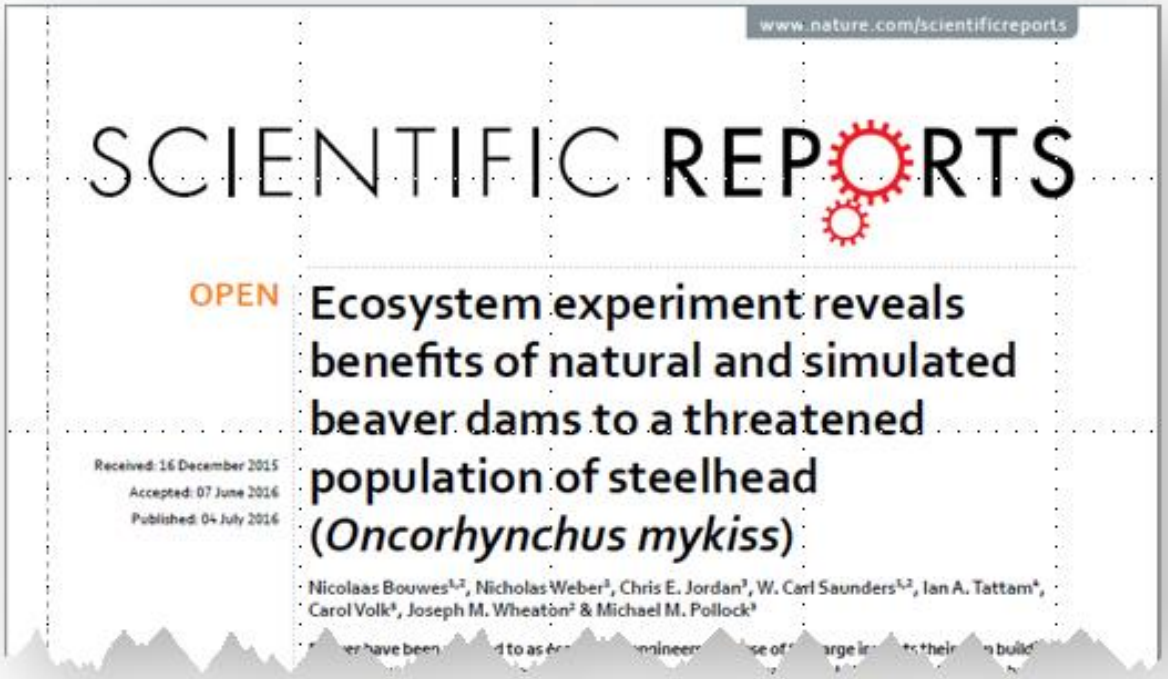
Post-restoration Population Level Response



www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*)

Received: 16 December 2015
Accepted: 07 June 2016
Published: 04 July 2016

Nicolaas Bouwes[1,2], Nicholas Weber[3], Chris E. Jordan[3], W. Carl Saunders[1,2], Ian A. Tattam[4], Carol Volk[4], Joseph M. Wheaton[2] & Michael M. Pollock[3]

168% increase in abundance

52% increase in survival

172% increase in production

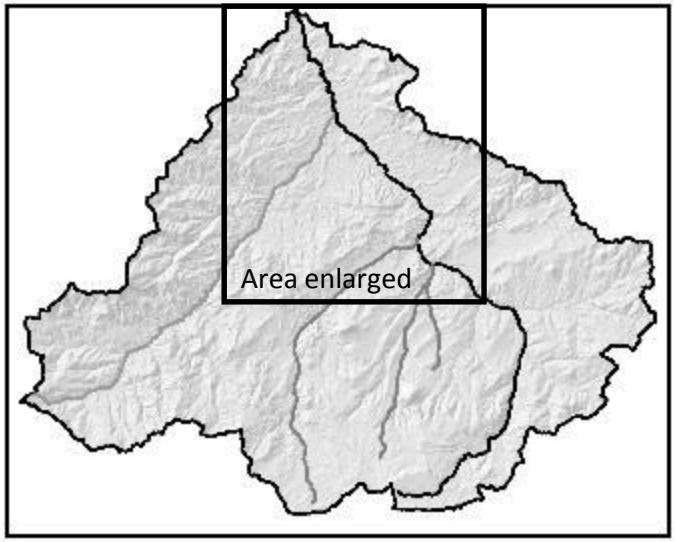
Are beaver dams barriers to fish?

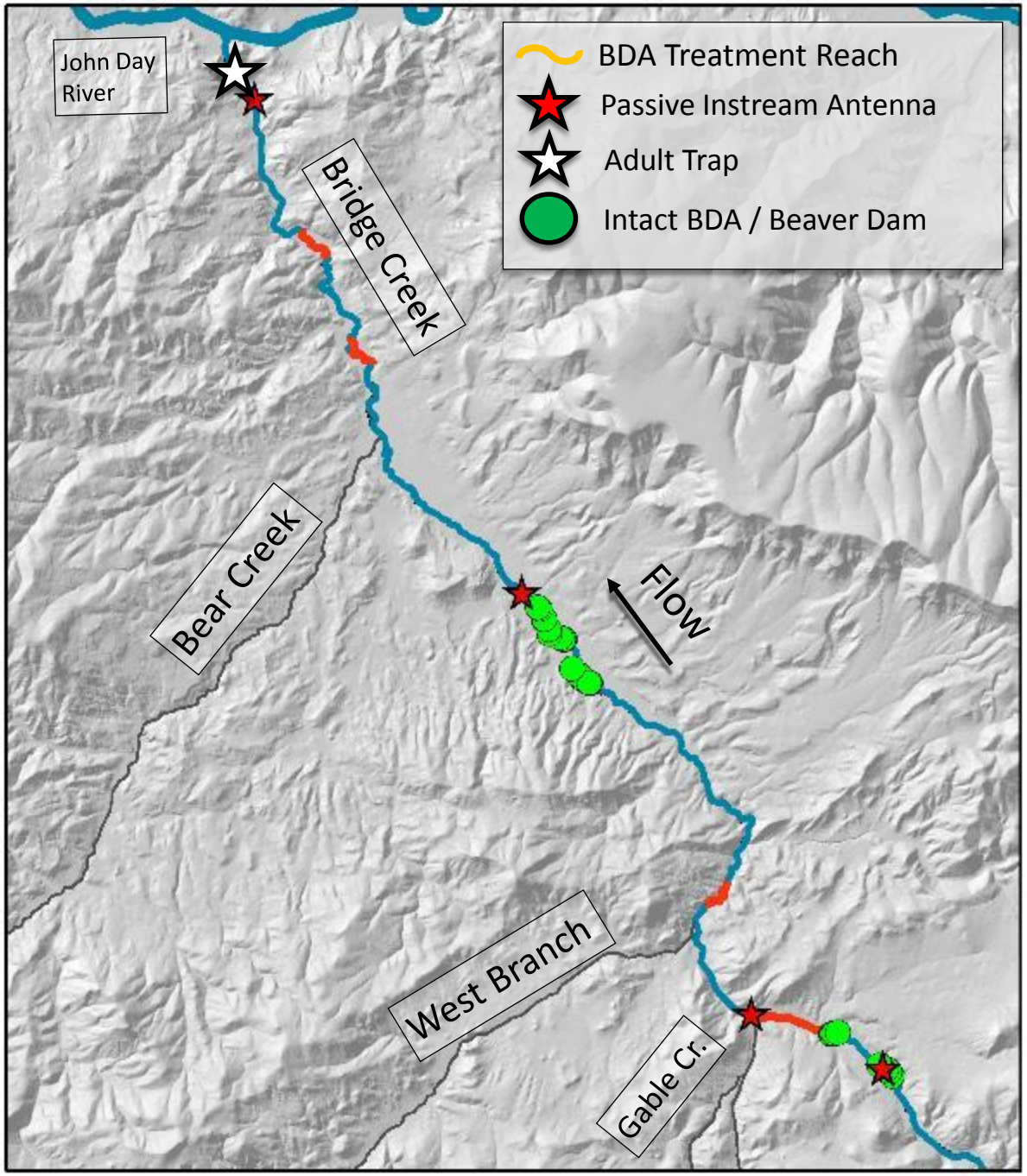
See:

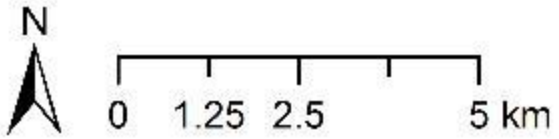
- Kemp et al (2012) . DOI: 10.1111/j.1467-2979.2011.00421.x
- Lokteff et al. (2013). DOI: 10.1080/00028487.2013.797497
- Bouwes et al. 2016. DOI: 10.1038/srep28581.

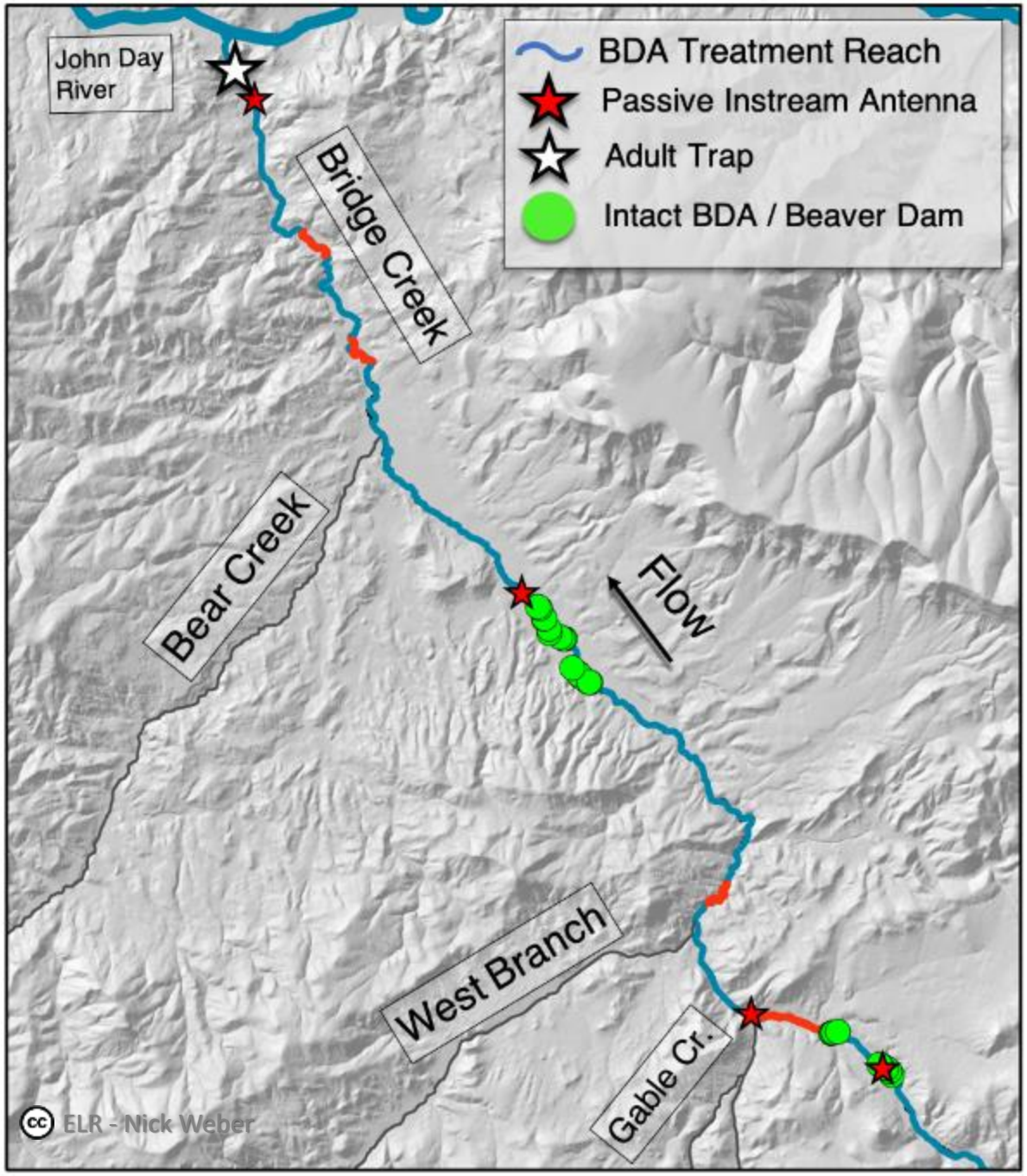
Adult Steelhead Passage

PIT-tagged *O.mykiss*







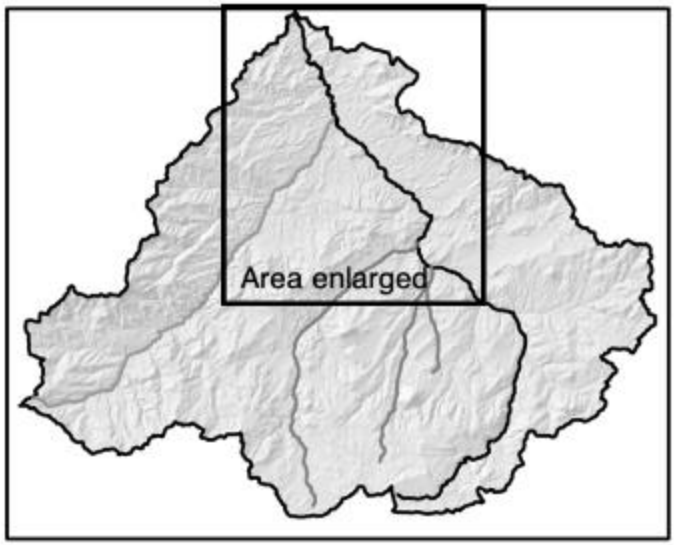


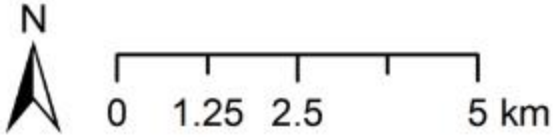
2009

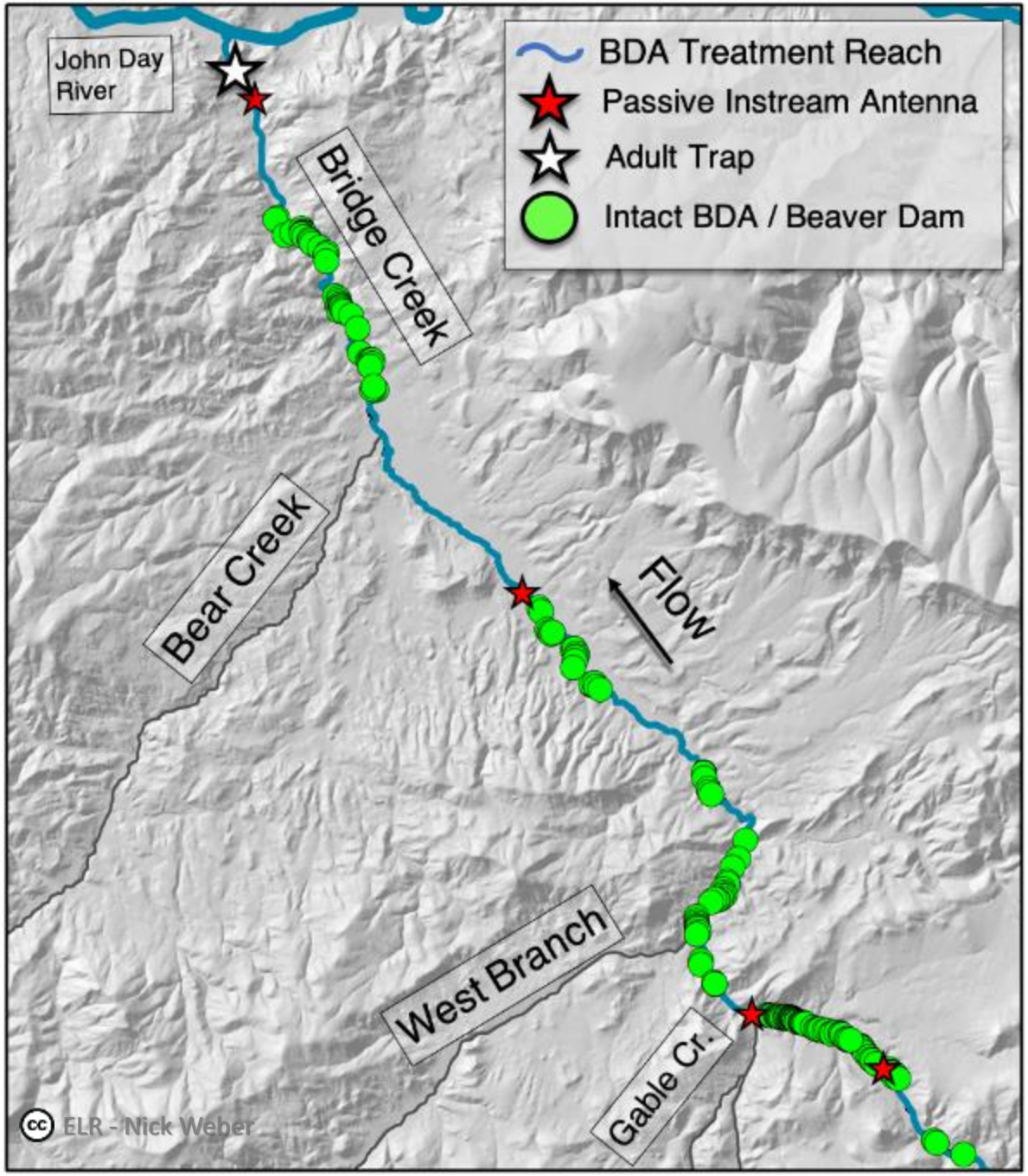
Pre-restoration

22 Beaver Dams

17% Passage





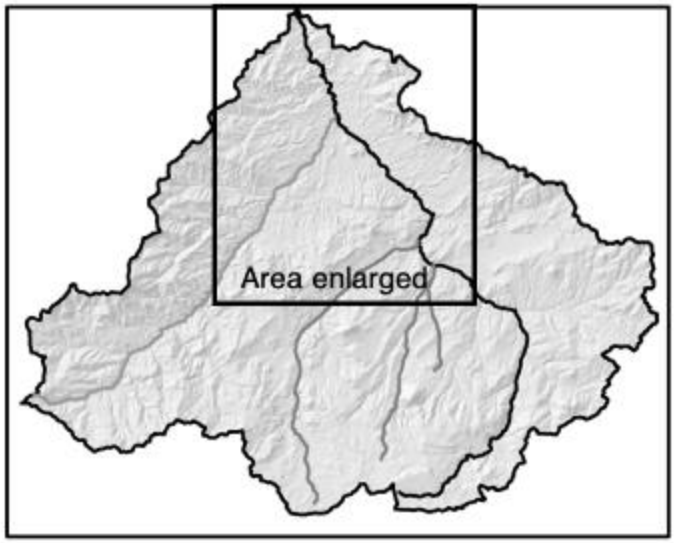


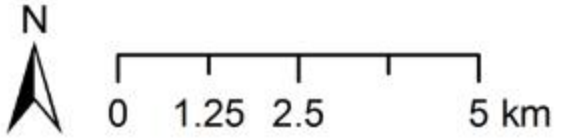
2016

Post-restoration

164 Beaver Dams

29% Passage





Bridge Creek IMW take-homes

- BDAs allowed beaver to build longer lasting dams
- Beaver dam building activity increased 8-10 fold
- Floodplain reconnected/flood resiliency
- Increase water table height
- Temperature decrease, increase variability
- Increase in riparian vegetation
- Increase fish habitat quantity and quality
- Dams are not a migration barrier
- Increase fish production

OUTLINE: Birch Creek – Effectiveness of Restoring Processes with BDAs and Beaver Activity

I. The problem

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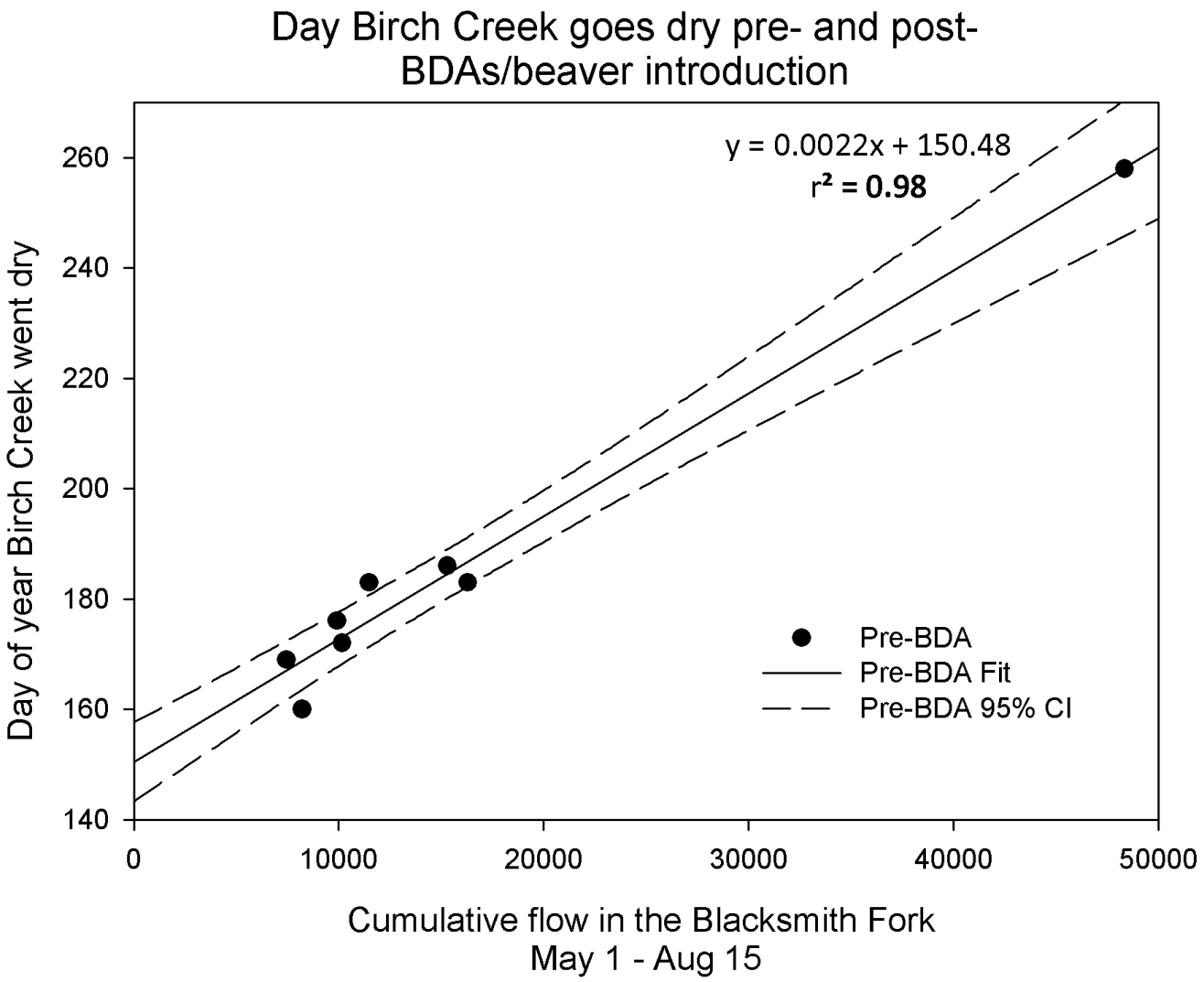
The Journey from Rancher to Conservationist: How Maintaining A Working Landscape Led to the Introduction of Beaver To Restore The Riverscape Of Birch Creek.

Birch Creek from Perennial to Intermittent

June 19, 2007


Day Birch Creek goes dry pre- and post-BDAs/beaver introduction
y = 0.0022x + 150.48
r² = 0.98
Pre-BDA
Pre-BDA Fit
Pre-BDA 95% CI
Day of year Birch Creek went dry
260
240
220
200
180
160
140
0
10000
20000
30000
40000
50000
Cumulative flow in the Blacksmith Fork
May 1 - Aug 15

Jay's Goal – Restore Perennial Flow
In 2008 & 2009, He Brought Beaver Back

Restoring Perennial Flow in Birch Creek

Setting

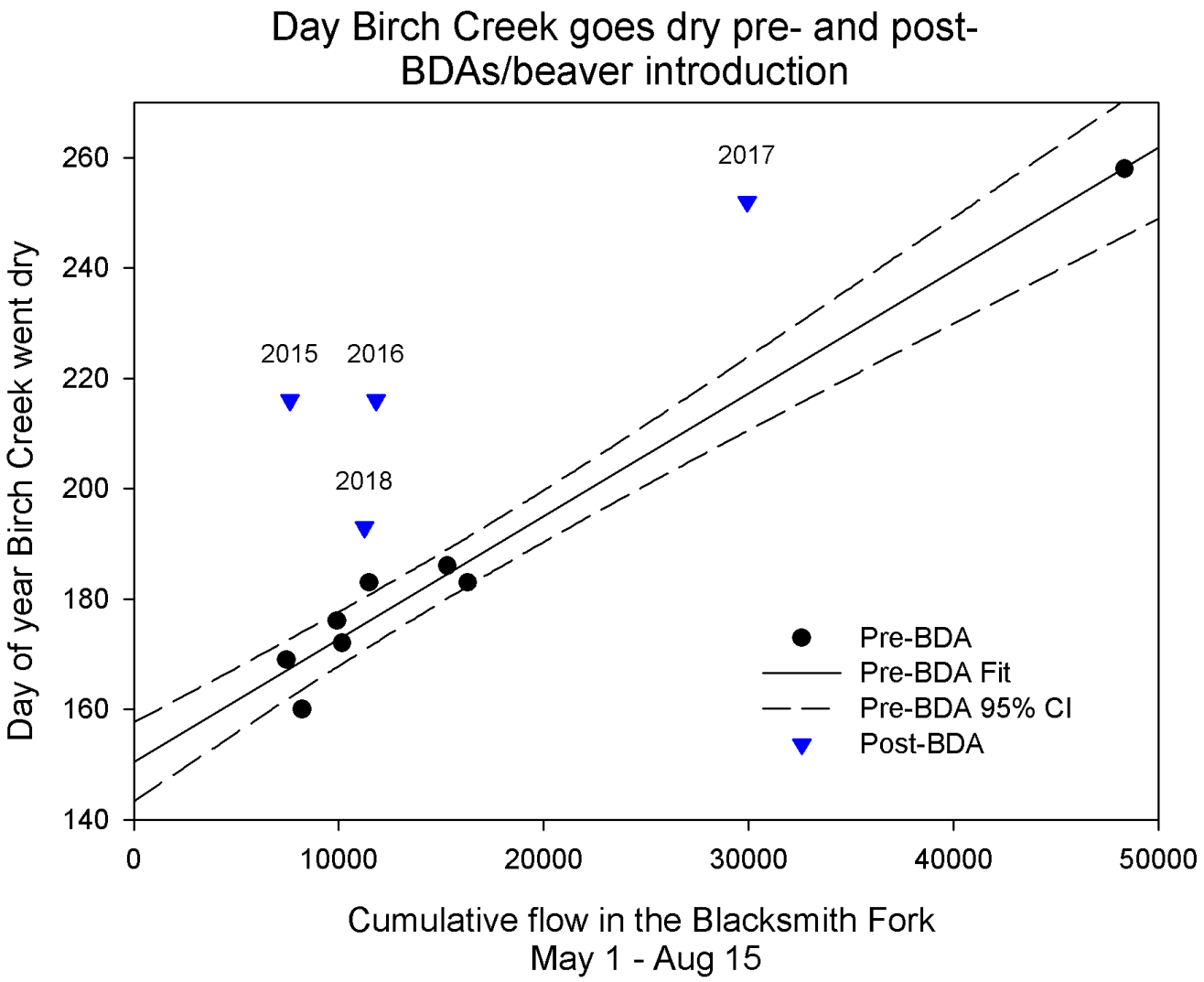
- Abundant forage for beaver
- Shallow water depth – high risk of predation

Strategy

- Build BDAs to provide immediate habitat/refuge for beaver (build enough to give them a choice – 24 BDAs)
- Introduce beaver (5 in 2015, 4 in 2016)

Birch Creek, ID – Restoring Perennial Flow

2019>140 dams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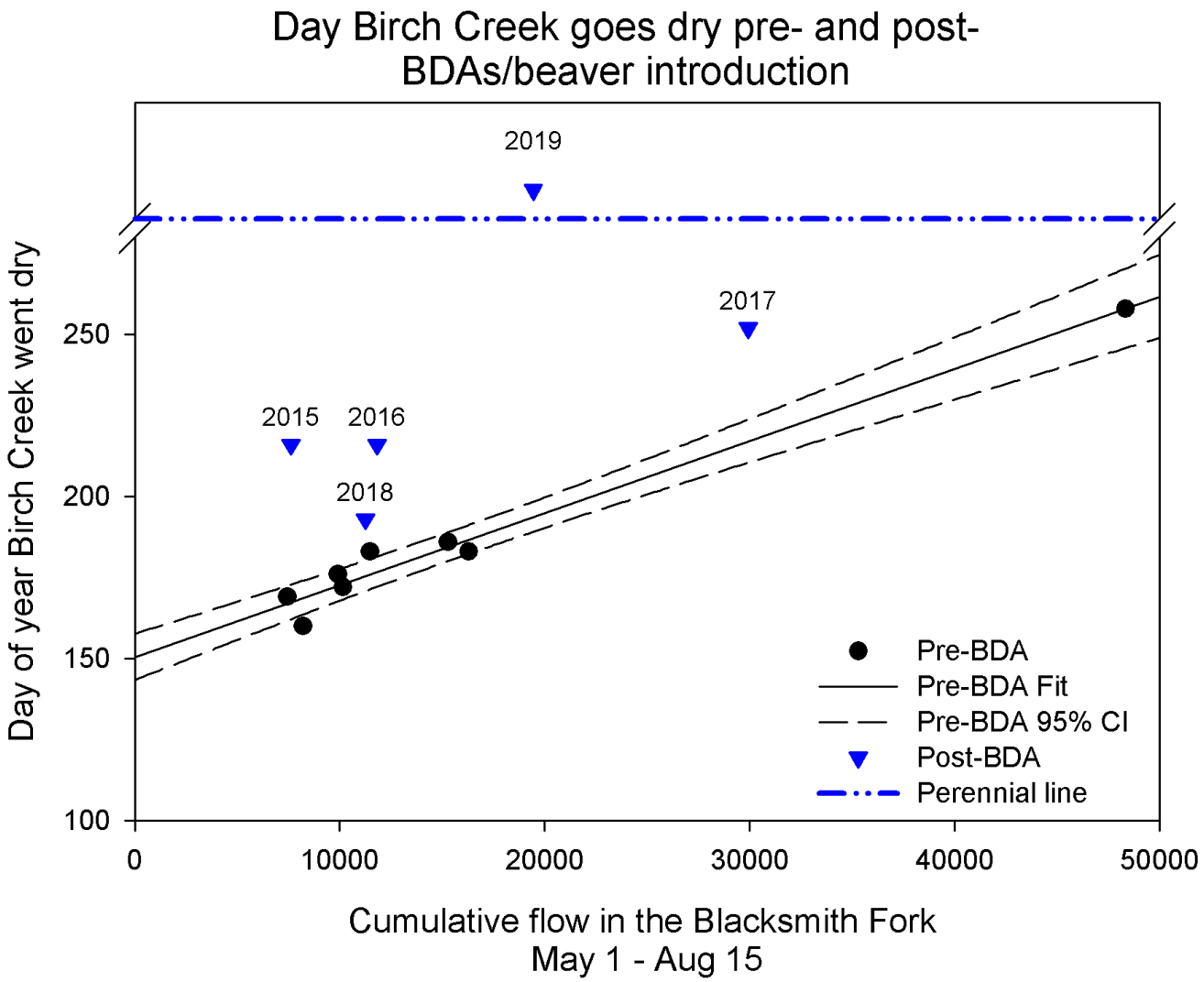
Cumulative flow in the Blacksmith Fork
May 1 - Aug 15
2017
2015
2016
2018
Pre-BDA
Pre-BDA Fit
Pre-BDA 95% CI
Post-BDA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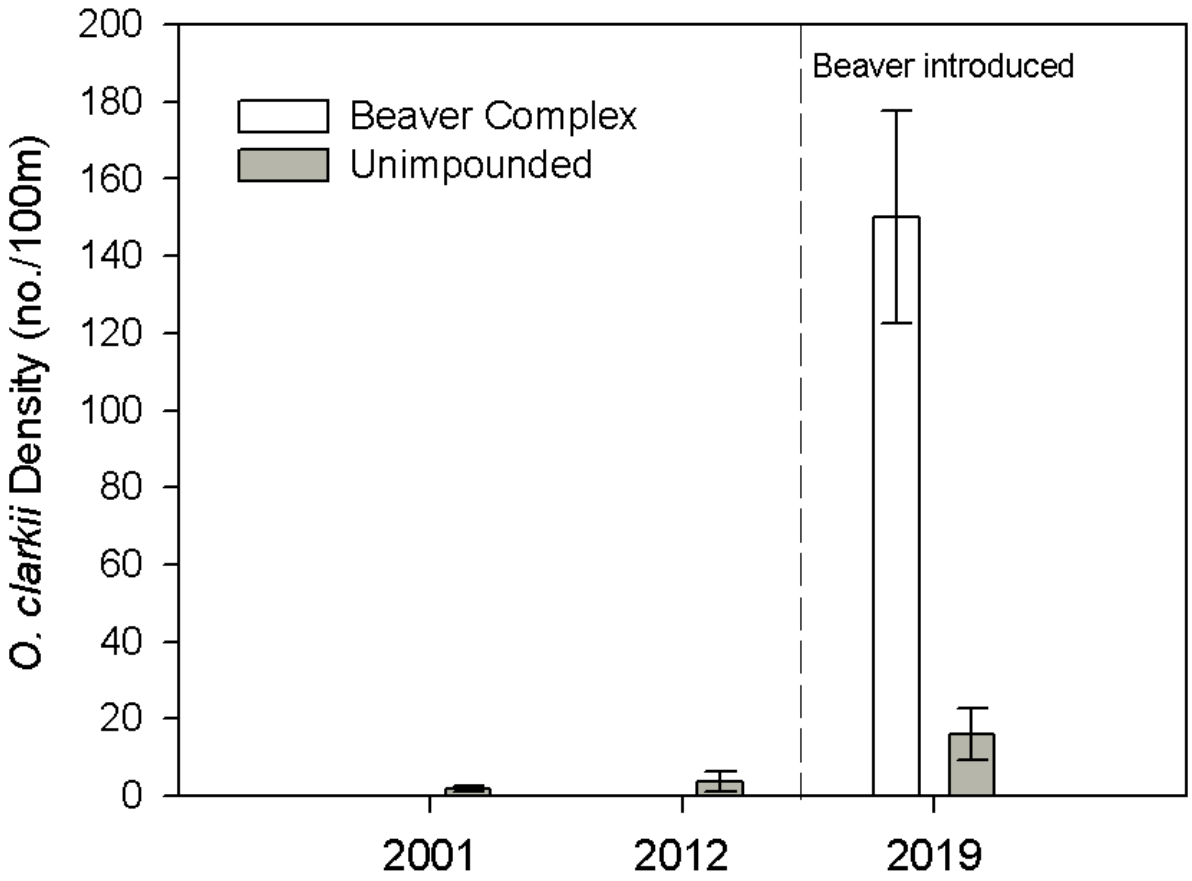
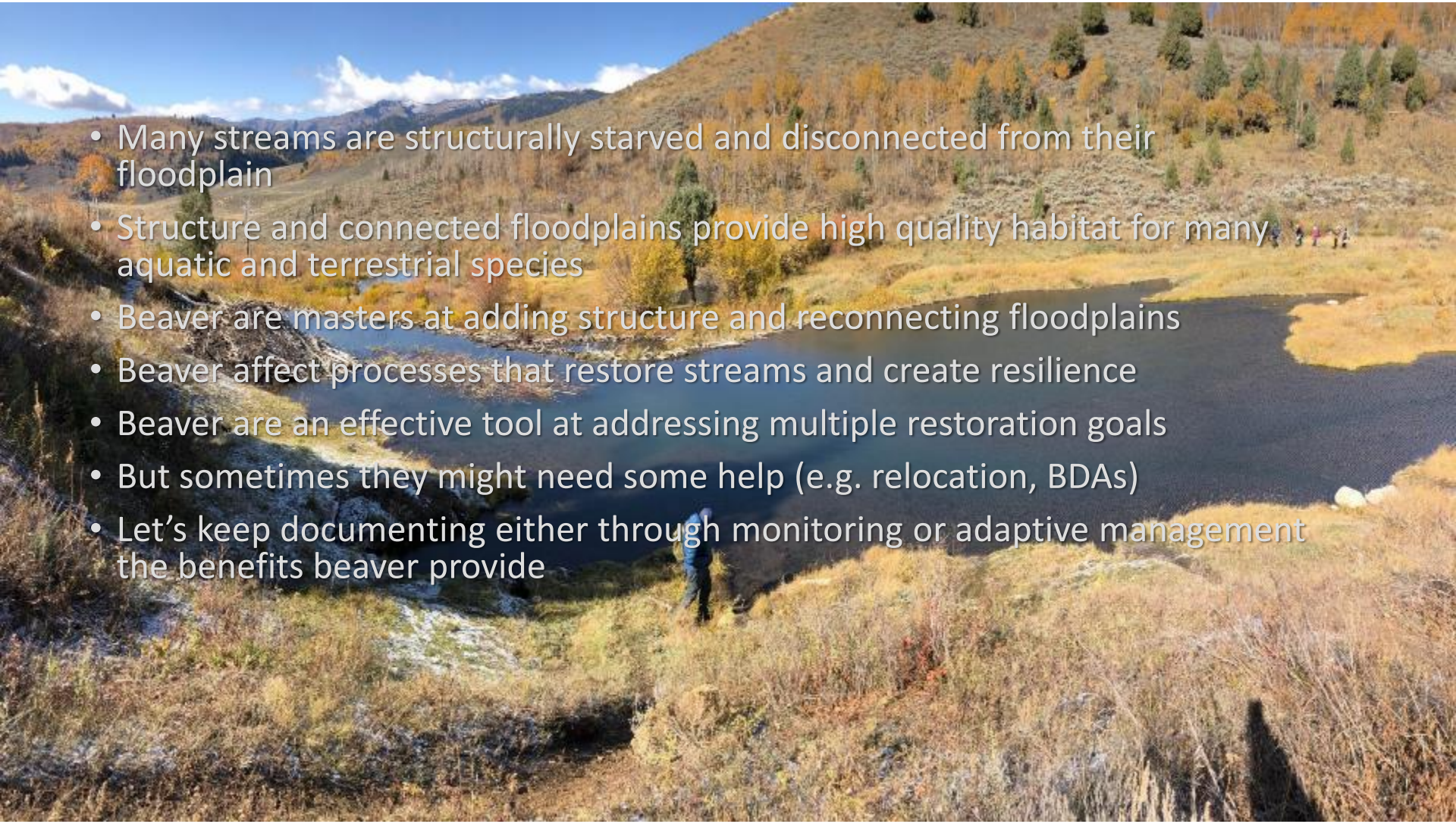
Pre-BDA
Pre-BDA Fit
Pre-BDA 95% CI
Post-BDA
Perennial line
Cumulative flow in the Blacksmith Fork
May 1 - Aug 15

Cutthroat Trout Response



Conclusions



- Many streams are structurally starved and disconnected from their floodplain
- Structure and connected floodplains provide high quality habitat for many aquatic and terrestrial species
- Beaver are masters at adding structure and reconnecting floodplains
- Beaver affect processes that restore streams and create resilience
- Beaver are an effective tool at addressing multiple restoration goals
- But sometimes they might need some help (e.g. relocation, BDAs)
- Let's keep documenting either through monitoring or adaptive management the benefits beaver provide