Beaver-related Restoration Strategies: Documented Benefits From Restoration Evaluations

Nick Bouwes
Scope Of Degradation:
We Have Lots Of This

doi: 10.13140/RG.2.2.19590.63049/1

Any Old Forgotten Creek, Western US
Scope Of Degradation: Valley Bottoms Rarely Inundated

Simplified, straightened, structurally starved bowling alley of a channel left behind in what would have been a stage 0 mess.

From Wheaton et al. (2019) - LTPBR Manual
Scope of Degradation – Structurally-Starved
What Is Our Reference Condition? (Stage-0)

DOI: 10.13140/RG.2.2.19590.63049/1

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

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Bridge Creek Intensively Monitored Watershed

Oregon, USA

Bridge Creek Watershed
- 710 km²

John Day Basin

Bridge Creek

Bridge Creek Watershed

Mid-Columbia Steelhead

Mitchell, OR

West Branch

Gable Creek

Bear Creek

ELR - Nick Weber
Channel Incision

Incised Channel

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

$10^3$ years

Incision Recovery

- Complex and dynamic channel
- Floodplain and groundwater connectivity
- High habitat quality
20 years later....... Still Incised
But Beavers Live in Bridge Creek
Pre-restoration Beaver Dam Blow-outs Common
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)

Incision Trench

Disconnected Terrace

ELR - Nick Weber
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?

Modified from Pollock et al. (2014) – Bioscience
DOI: 10.1093/biosci/biu036
Figure 1 from Bouwes et al (2016) DOI: 10.1038/srep28581
Mimic – Build BDAs
4 Treatment Reaches ~ 1 km
Post-restoration
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 \( \sim 1 \text{m} < 1 \text{yr} \)
Post-restoration
Floodplain Connection - Promote
Stream Temperature Response

Temperature longitudinal profile
August 2014

Max Temp (°C) - Aug 15th, 2014

- o Temperature Logger
- 🟥 Above and Below Treatment

Downstream ➔ River Kilometer ➔ Upstream
Stream Temperature Response

Temperature longitudinal profile
August 2014

- Open circles: Temperature Logger
- Red circles: Above and Below Treatment
Surface Water Temperature Response

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

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
ACTIVE BEAVER DAMS

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

Post-restoration Beaver Response SUSTAIN?
Inundation area increased 228%
Side channel area area increased 1216%
Inundation area increased 228%
Side channel area area increased 1216%
Flood Resistance/Resilience
Flood Resistance/Resilience – Sustain!
OUTLINE: Bridge Creek IMW-Effectiveness of Restoring Processes with BDAs and Beaver Activity

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Post-restoration Fish Response?
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

From Bouwes et al (2016) DOI: 10.1038/srep28581
Post-restoration Population Level Response

168% increase in abundance

52% increase in survival

172% increase in production
Are beaver dams barriers to fish?

See:

• Lokteff et al. (2013). DOI: 10.1080/00028487.2013.797497
• Bouwes et al. 2016. DOI: 10.1038/srep28581.
BDA Treatment Reach
Passive Instream Antenna
Adult Trap
Intact BDA / Beaver Dam

Adult Steelhead Passage

PIT-tagged *O.mykiss*

John Day River
Bridge Creek
Bear Creek
West Branch
Gable Cr.

Area enlarged
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

II. The solution

III. What we found out
   • Physical Response
   • Fish Response
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

\[ y = 0.0022x + 150.48 \]
\[ r^2 = 0.98 \]

Cumulative flow in the Blacksmith Fork
May 1 - Aug 15

Day of year Birch Creek went dry

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
Day Birch Creek goes dry pre- and post-BDAs/beaver introduction

Cumulative flow in the Blacksmith Fork
May 1 - Aug 15
Day Birch Creek goes dry pre- and post-BDAs/beaver introduction

Cumulative flow in the Blacksmith Fork
May 1 - Aug 15

Day of year Birch Creek went dry

- Pre-BDA
- Pre-BDA Fit
- Pre-BDA 95% CI
- Post-BDA
- Perennial line
Cutthroat Trout Response

![Graph showing O. clarkii Density (no./100m) over years 2001, 2012, and 2019. The graph compares Beaver Complex and Unimpounded conditions. The year 2019 shows a significant increase in density, especially under the Unimpounded condition.]
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