LTPBR WORKSHOP

Testing the Effectiveness of Low-Tech Process-Based Restoration

Wood Accumulation

Beaver Dam Activity
Mimicking, Promoting, and Sustaining Beaver Dam Activity to Restore an Incised Stream: The Bridge Creek Creek IMW
Bridge Creek Intensively Monitored Watershed

Oregon, USA

Bridge Creek Watershed
• 710 km²

John Day Basin

Mid-Columbia Steelhead

ELR - Nick Weber
Pre-restoration Incision stage

Timescale (yrs. logarithmic)

- Aggrading & Widening
- Anastomosing
- Incised/Incising

Stage 0: Incising
Stages 1-3: Incised
Stage 4: Widening
Stage 5: Aggrading & Widening
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
Pre-restoration
Dam Persistence

1988 - 2005

Includes data from: Demmer and Beschta (2008) DOI: 10.3955/0029-344X-82.4.309
Restoration Approach - Mimic Beaver Dam Analog Structures (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
Some BDAs

Adapted from figure 4.6 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
A stream comes back to life
Across the U.S. West, scientists and land managers are using beaver dam analogs (BDAs) to heal damaged streams, re-establish beaver populations, and aid wildlife. In some cases, researchers have seen positive changes in just 1 to 3 years.

Incised stream

Restored stream

Adding dams
Beaver trapping and overgrazing have caused countless creeks to cut deep trenches and water tables to drop, drying floodplains. Installing BDAs can help.

Widening the trench
BDAs divert flows, causing streams to cut into banks, widening the incised channel, and creating a supply of sediment that helps raise the stream bed.

Beavers return
As BDAs trap sediment, the stream bed rebuilds and forces water onto the floodplain, recharging groundwater. Slower flows allow beavers to recolonize.

A complex haven
Re-established beavers raise water tables, irrigate new stands of willow and alder, and create a maze of pools and side channels for fish and wildlife.

From Goldfarb (2018) Science:
http://science.sciencemag.org/content/360/6393/1058
Bridge Creek IMW

- Testing BDA Assisted Incision Recovery Model
- Benefits to Fish Populations?
4 Treatment Reaches ~ 1 km

BDA Complex

BDA Structure
**Post-restoration**

**Beaver dams and BDAs - Promote**

![Graph showing the number of beaver dams and BDAs over time, with a focus on Bridge Creek and treatment versus control reaches.](image)

Figure 4 from Bouwes et al (2016) DOI: [10.1038/srep28581](https://doi.org/10.1038/srep28581)
Post-restoration Beaver response SUSTAIN?

ACTIVE BEAVER DAMS

- 2008 = 22 (pre-BDAs)
- 2016 = 164!
Post-restoration
Aggradation and pool formation
deposition \(\sim 1\text{m} < 1\text{yr}\)
Post-restoration Floodplain Connection
Indudation area increased 228%
Side channel area area increased 1216%
Post-restoration Water Table Elevation Change

1’-3’ Increase in height of water table
Post-restoration Ponds
Restoration Response (treatment scale)

General cooling below complexes

![Graph showing temperature changes over downstream river kilometers]

- Temperature Logger
- Above and Below Treatment

Max Temp (°C) - Aug 15th, 2014
Restoration Response (treatment scale)
Compressed Diel Temperature Range

- Treatment reach - Dam influenced
- Control reach - No dams

Before dam establishment
After dam establishment

2008
2013

August 9th - 17th

DOI: 10.1371/journal.pone.0176313
Restoration Response (dam scale)

Temperature Refugia (increased spatial variability)

### Treatment

- Temperature measurement location
- Beaver dam

### Control

- Flow
- 0 m, 10 m, 20 m

**Graphs:**
- Beaver/BDA impounded
- Temperature (°C)
  - Minimum: 10
  - Maximum: 25
- Unimpounded
  - Temperature (°C)
  - Minimum: 26
  - Maximum: 27

**July 2015**


DOI: [10.1371/journal.pone.0176313](https://doi.org/10.1371/journal.pone.0176313)
Figure 1 from Bouwes et al (2016) DOI: 10.1038/srep28581
Post-restoration
Riparian Vegetation (increase)

Expansion of Riparian Zone...
Retraction of Sagebrush

New vegetation growth

2005 (Before)
2010 (After)

Figure from Carol Volk
(South Fork Research)
If signal is meaningful, we ought to be able to measure this from space
Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands

Nicholas L. Silverman1,2, Brady W. Allred1, John Patrick Donnelly3, Teresa B. Chapman4, Jeremy D. Maestas5, Joseph M. Wheaton6, Jeff White7, David E. Naugle1

Beaver Dam Analogues
(Mid-term: 9 yrs)

Grazing Management
(Long-term: 20+ yrs)

Zeedyk Structures
(Short-term: 2-5 yrs)

DOI: https://doi.org/10.1111/rec.12869
Results: Zeedyk Structures – Gunnison, CO

Silverman et al. (2018)
DOI: https://doi.org/10.1111/rec.12869
Results: Beaver Dam Analogues – Bridge Creek, OR

Silverman et al. (2018)
DOI: https://doi.org/10.1111/rec.12869

- ~20% increase in productivity
- natural storage
- resiliency
Results: Grazing Management – Maggie Creek, NV

Silverman et al. (2018)
DOI: 10.1111/rec.12869
Restored sites are more productive AND they’re staying greener longer

Gunnison

Greatest Improvement
Oct. - Nov.

Bridge Creek

Greatest Improvement
Sep. - Nov.

Maggie Creek

Greatest Improvement
Jul. - Nov.

Silverman et al. (2018)
DOI: 10.1111/rec.12869
Building Resiliency Over Time...

Productivity no longer sensitive to precipitation!

Years since restoration

Resiliency

Zeedyk Structures
(Short-term: 2-5 yrs)

Beaver Dam Analogs
(Mid-term: 9 yrs)

Grazing Management
(Long-term: 20+ yrs)

Silverman et al. (2018)
DOI: 10.1111/rec.12869
Oh, and you can do same analysis too!
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
Change in juvenile steelhead abundance, growth, survival and Production: 2006-2015. Error bars = 90% CI.

Figure 7 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:
- 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.
PIT-tagged *O. mykiss*

Passive Instream Antenna

Adult Trap

Intact BDA / Beaver Dam

BDA Treatment Reach

Adult Steelhead Passage
2016
Post-restoration

164 Beaver Dams

29% Passage

BDA Treatment Reach
Passive Instream Antenna
Adult Trap
Intact BDA / Beaver Dam

John Day River
Bridge Creek
Bear Creek
Flow
West Branch
Gable Cr.
Is the story over?

ELR - Nick Weber
Conclusion

- BDAs allowed beaver to build longer lasting dams
- Beaver dam building activity increased 8-10 fold
- Floodplain reconnected
- 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