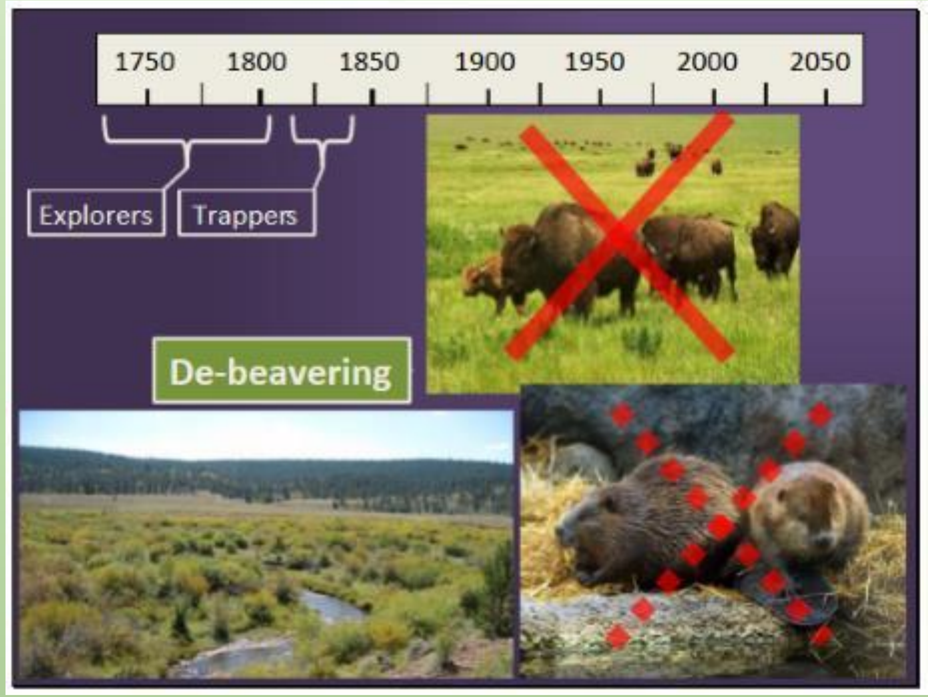
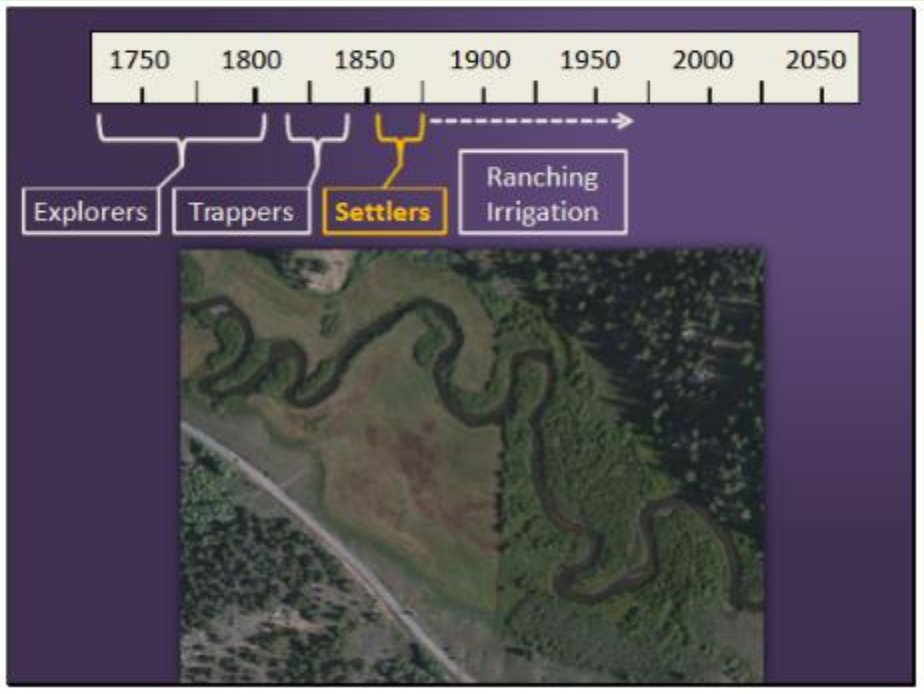
Restoring Natural Stream Processes

Amy Chadwick | Great West Engineering

March 11, 2020

A Brief History of Wetland Loss



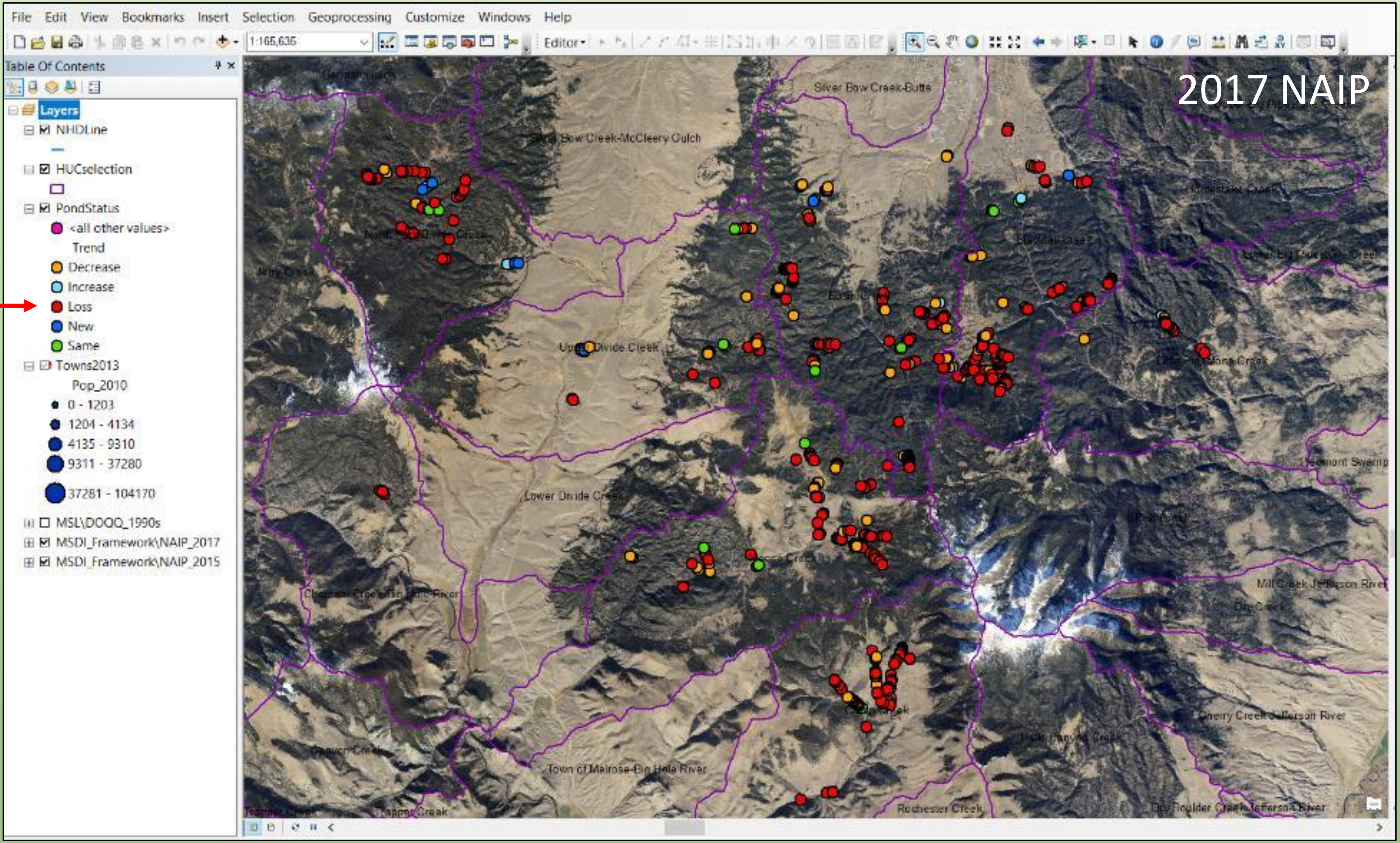


Credit: Mark Beardsley, EcoMetrics
https://www.researchgate.net/publication/329177927_Restoring_Stage_0_Beaver_Streams_in_the_Southern_Rockies

Bottom line: Most people don't realize how much streams and valley bottoms have changed, in how they look and how they function.

Changes in stream systems equal loss of a lot of water storage.

Beaver pond loss in last 20 years (1996-2017) Butte-Big Hole High Divide Area (some watersheds not yet surveyed)



Example mapped sites: ponded 20 years ago; now converting to upland

Dams at red arrows active approx. 20 yrs ago

Loss in Stream Length, Wetlands, and Habitat Diversity

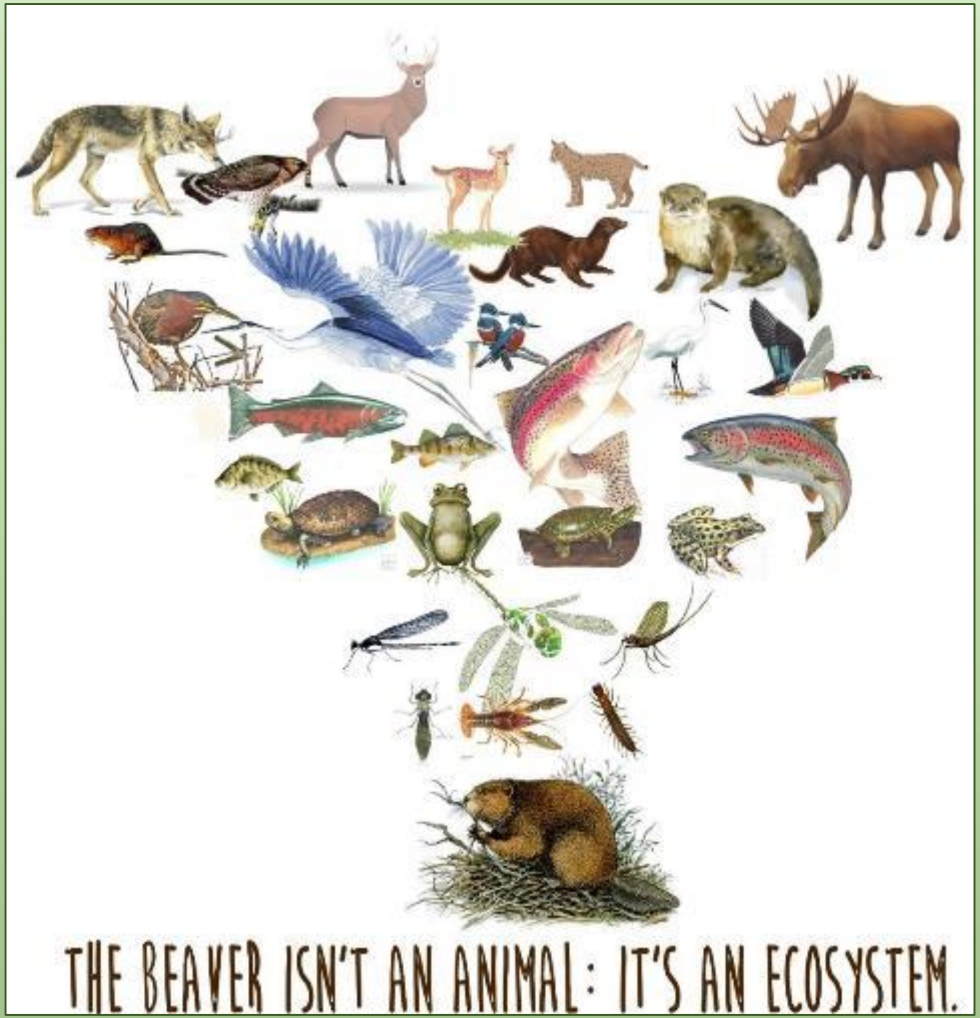
Beaver ponds and other wetlands filter water and reduce storm surges

On large rivers, this can happen on side channels and floodplains.

Photos: Amy Chadwick

Water storage and meadow-building

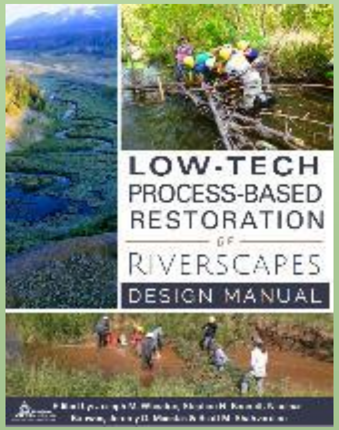
Beavers are a Keystone Species



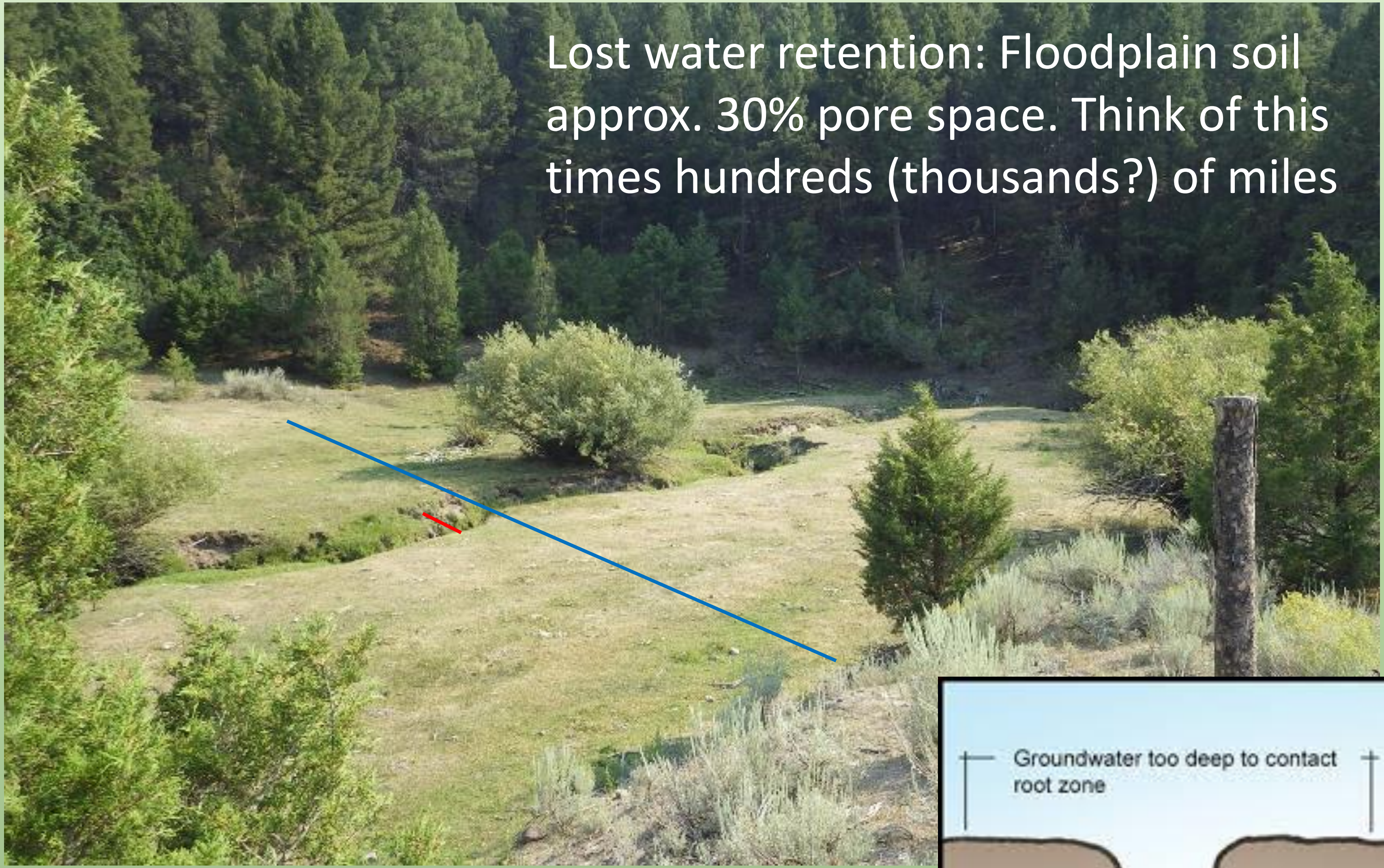
Credit: Heidi Perryman, Martinez Beavers

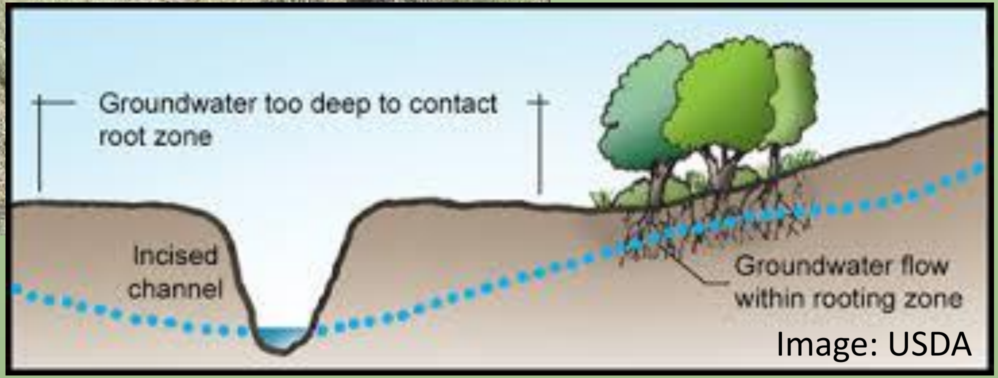
Beavers improve stream resilience to fire and provide refuge

Photo credit:

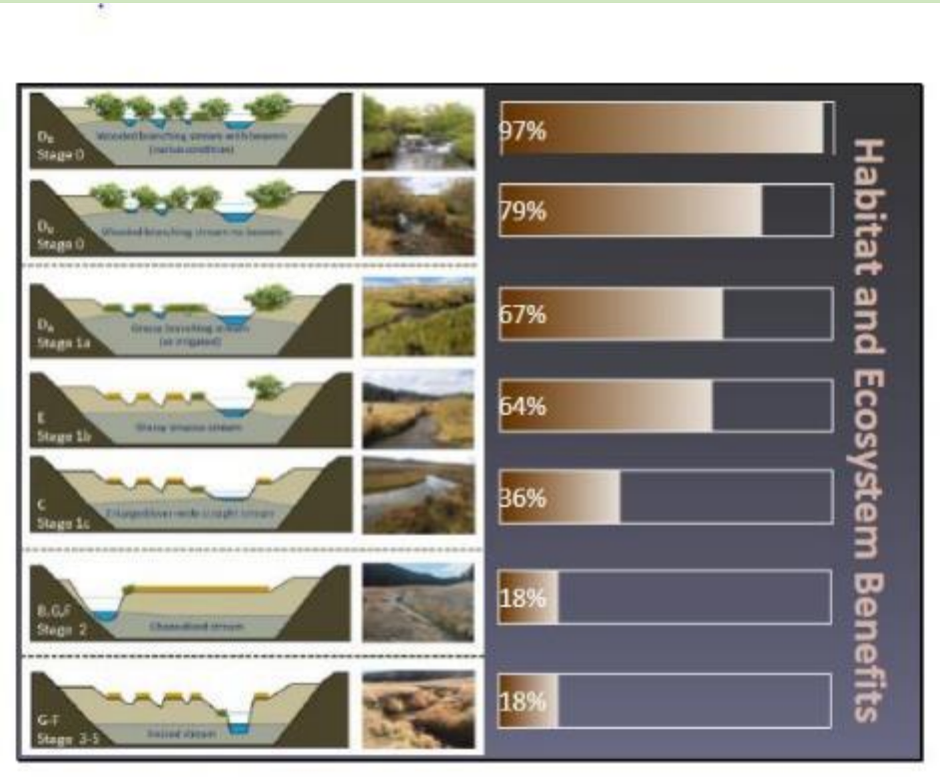


Subirrigation: Past and Present





- Channel simplification results in loss of ecosystem benefits
- Lowered water table and channel incision may mean loss of beaver habitat
- So how do we re-set this framework?



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The "Stage Zero" paradigm shift

RIVER RESEARCH AND APPLICATIONS
River Res. Applic. **30**: 135–154 (2014)
Published online 10 January 2013 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/rra.2631

A STREAM EVOLUTION MODEL INTEGRATING HABITAT AND ECOSYSTEM BENEFITS

B. CLUER[a]* AND C. THORNE[b]
[a] *Fluvial Geomorphologist, Southwest Region, NOAA's National Marine Fisheries Service, Santa Rosa, California, USA*
[b] *Chair of Physical Geography, University of Nottingham, Nottingham, UK*

The old way: only down

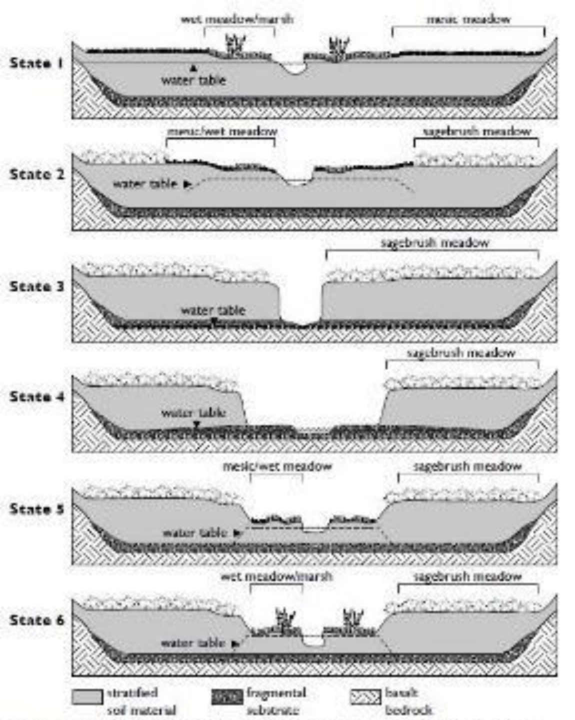
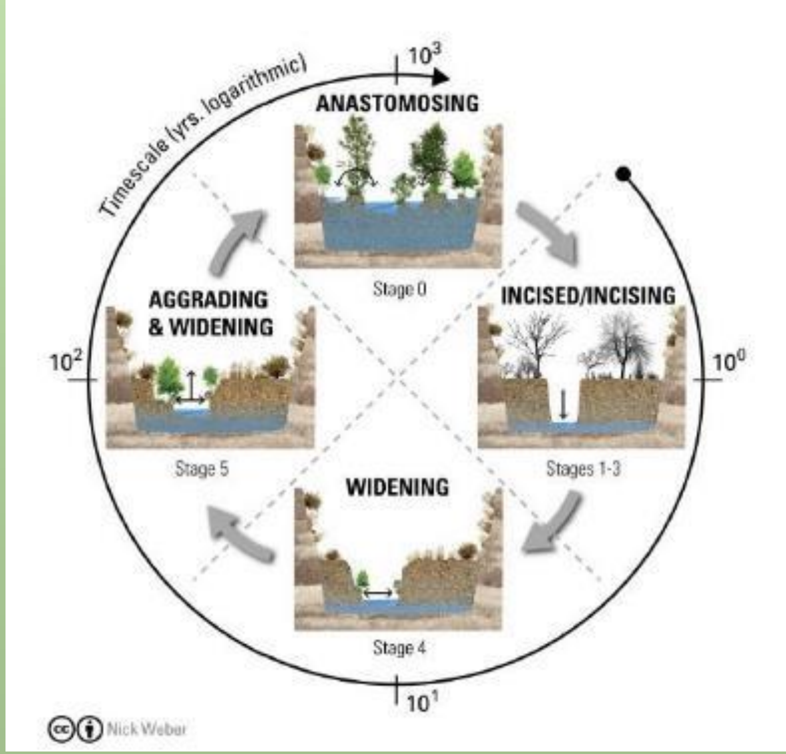


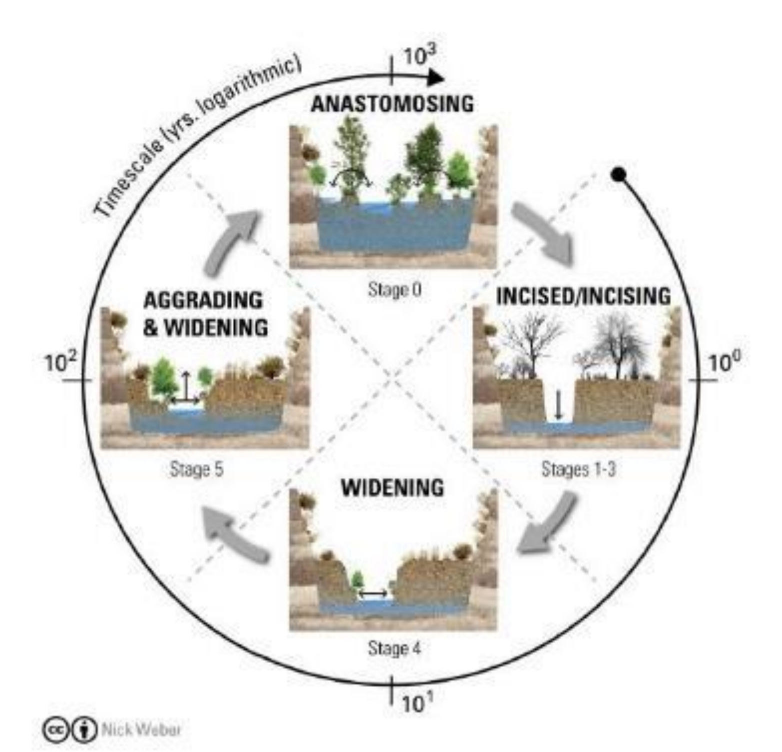
Figure 7. Succession of states for an alluvial valley-bottom type (adapted from Jensen et al. 1989).

Stage 0: pre-disturbance conditions or similar

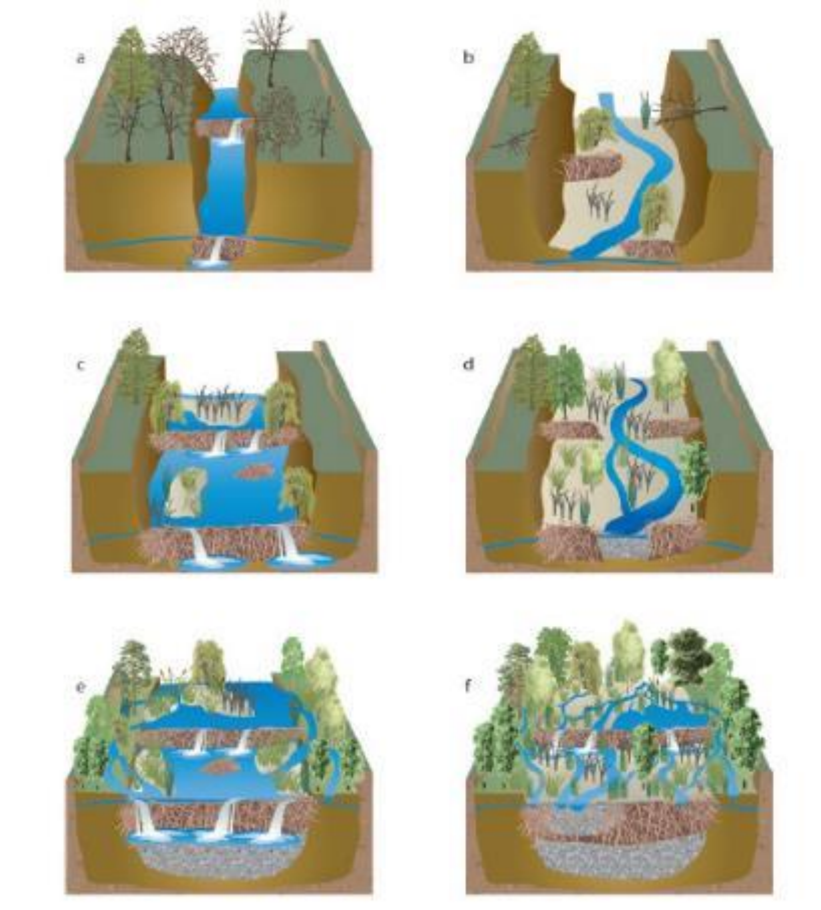


Beavers and the stage 0 stream evolution model

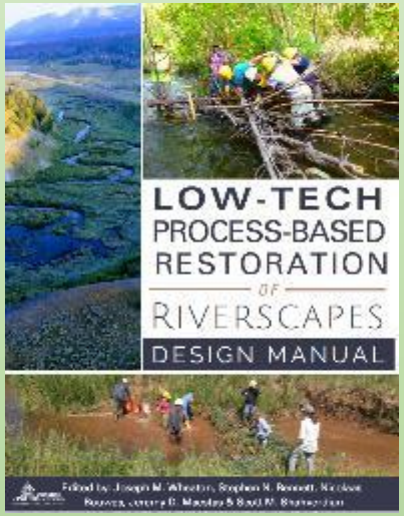
Without beavers: centuries to recovery



With beavers: one to a few years to recovery



As seen in:



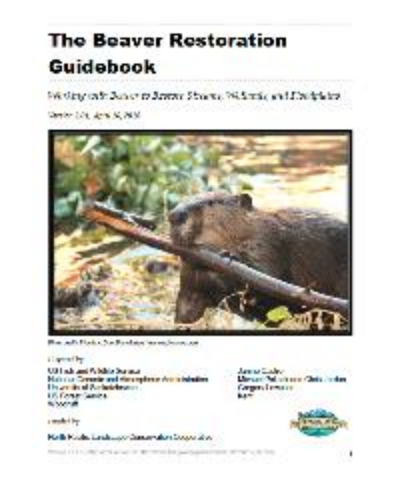
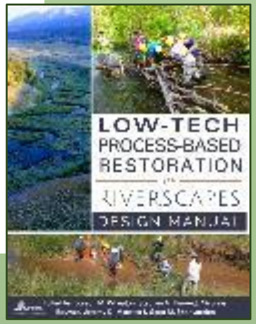
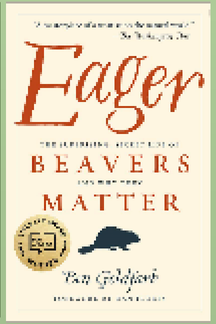


Figure 18 – An example from Goldfarb (2018a) of achieving a self-sustaining condition where meals of beaver dam analogues (BDAs) mimic beaver dam activity, and then the maintenance and expansion of beaver dam activity is taken over by actual beaver, and then they maintain a complex system state. Figure © Science by [V. Altounian](#).





Channel Stabilization vs. Stream Corridor Restoration

Traditional Approach

- Framework is single-thread channel and free-flowing stream
- Design-intensive
- Goal is channel and bank stability and/or in-stream habitat
- Relatively high cost – generally piecemeal, small site
- Appropriate for larger, high-energy streams, and near infrastructure

Restoring to Stage 0

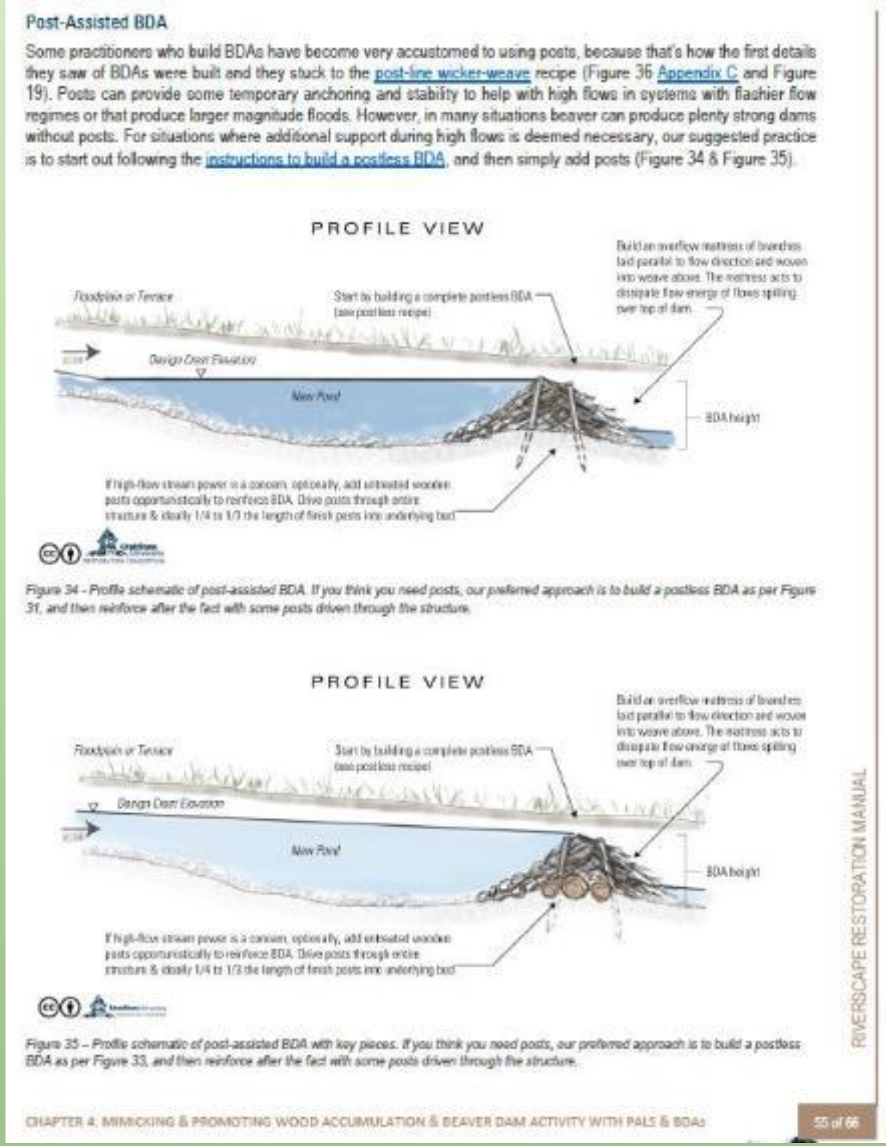
- Framework is beaver-influenced floodplain – whole valley bottom
- Conceptual design only, adaptive
- Goal is change - a messy channel and stable floodplain ecosystem
- Cost-effectiveness allows greater area to be restored
- Appropriate for smaller systems, where stable channel not needed

Low-Tech, Process-Based Restoration to achieve Stage 0

Beaver Dam Analogs (BDAs)

- Built to similar scale as natural beaver dam and to fit natural setting
- Made of natural materials, preferably sourced on-site (though often use purchased wooden posts)
- May use willow or conifer branches, native sod, cobble, mud, cattails…
- Can be constructed with or without posts
- Other natural, degradable materials sometimes used (e.g. coir fabric)

Post-Assisted BDAs



Post-Assisted BDA

Some practitioners who build BDAs have become very accustomed to using posts, because that's how the first details they saw of BDAs were built and they stuck to the post-line wicker-weave recipe (Figure 36 Appendix C and Figure 19). Posts can provide some temporary anchoring and stability to help with high flows in systems with flashier flow regimes or that produce larger magnitude floods. However, in many situations beaver can produce plenty strong dams without posts. For situations where additional support during high flows is deemed necessary, our suggested practice is to start out following the instructions to build a postless BDA, and then simply add posts (Figure 34 & Figure 35).

PROFILE VIEW

Floodplain or Terrace
Start by building a complete postless BDA (see postless recipe)
Build an overflow mattress of branches laid parallel to flow direction and woven into weave above. The mattress acts to dissipate flow energy of flows spilling over top of dam.
Design Crest Elevation
New Pond
BDA height
If high-flow stream power is a concern, optionally, add untreated wooden posts opportunistically to reinforce BDA. Drive posts through entire structure & ideally 1/4 to 1/3 the length of finish posts into underlying bed

Figure 34 - Profile schematic of post-assisted BDA. If you think you need posts, our preferred approach is to build a postless BDA as per Figure 31, and then reinforce after the fact with some posts driven through the structure.

PROFILE VIEW

Floodplain or Terrace
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Build an overflow mattress of branches laid parallel to flow direction and woven into weave above. The mattress acts to dissipate flow energy of flows spilling over top of dam.
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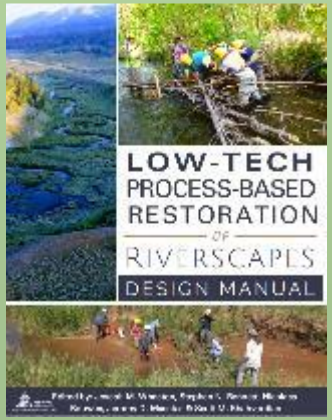
Figure 35 – Profile schematic of post-assisted BDA with key pieces. If you think you need posts, our preferred approach is to build a postless BDA as per Figure 33, and then reinforce after the fact with some posts driven through the structure.

RIVERSCAPE RESTORATION MANUAL

CHAPTER 4: MIMICKING & PROMOTING WOOD ACCUMULATION & BEAVER DAM ACTIVITY WITH PALS & BDAs 55 of 66

As seen in:



Post-assisted BDAs go well with conifer control

Use young conifers, willow, sod sourced on-site

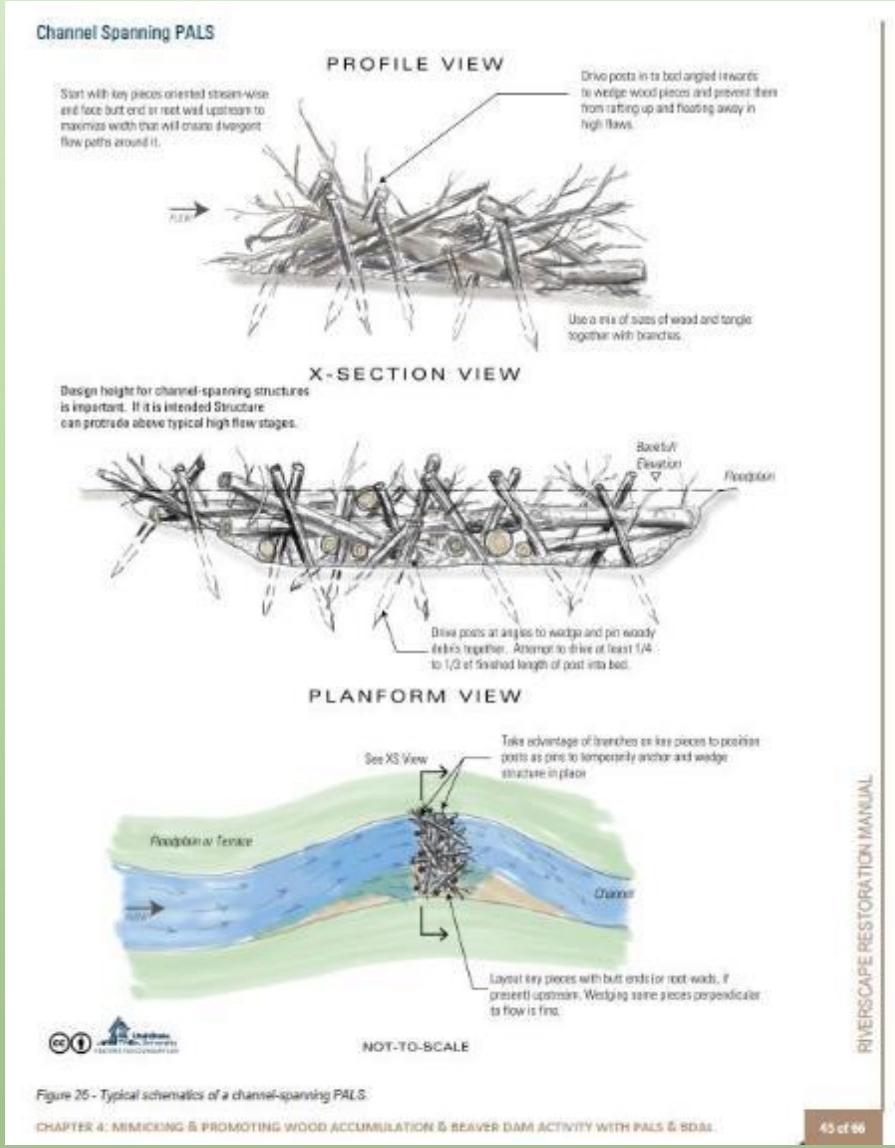
Photos: Amy Chadwick, Great West Engineering

Postless BDAs- Brush, Sod, Gravel Structures

All use materials native to site

Photos by Scott Gillilan, Gillilan Associates Inc.

Post-Assisted Logjam (PAL)



Or a hybrid: Partial BDA and PAL hybrid structure for fish habitat

- Enhances pool depth and undercut bank habitat
- Allows good through-flow for water and fish passage
- Provides cover for fish

Plan for Recovery in Phases in Incised Channels

Phase 2 Build: Use Phase 1 BDA as base for Phase 2 BDA to reach low terrace


Before Restoration
(low flow)


After Construction


1Year After Construction
(High flow)


2.5 Yrs After Construction
(Low flow)

Shift in focus from preventing sediment recruitment to re-establishing natural process of sediment-trapping.

The channel bed and floodplain sediment deposits, not just the structures, will create new “sponge” and diversify stream flow.

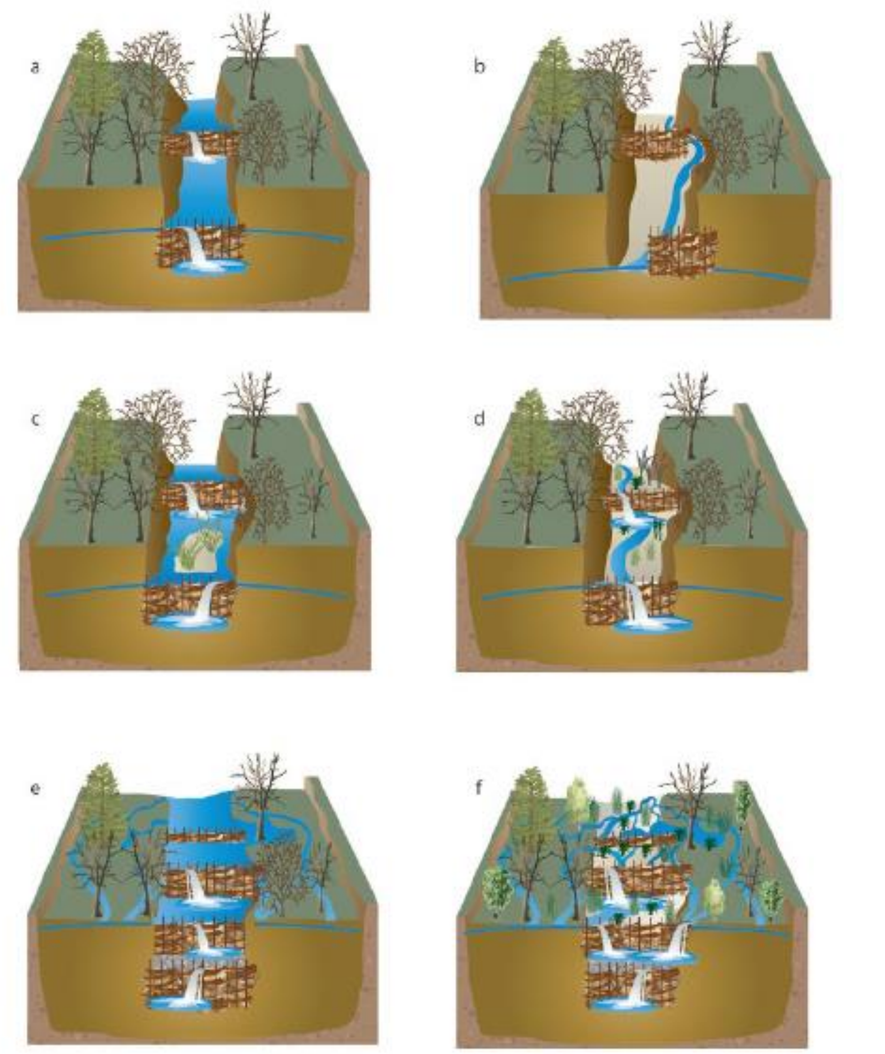


Figure 13 – Expected geomorphic responses following the Cluer and Thorne (2013) channel evolution model (from Stage 3 to 0) after the installation (a) of BDAs, their initial 'failure' by end-cutting (b), subsequent repair (c) and aggradation leading to floodplain reconnection in an incised system. Figure from Pollock et al. (2014). In practice, PALS can force the same processes of channel-widening and aggradation as BDAs.

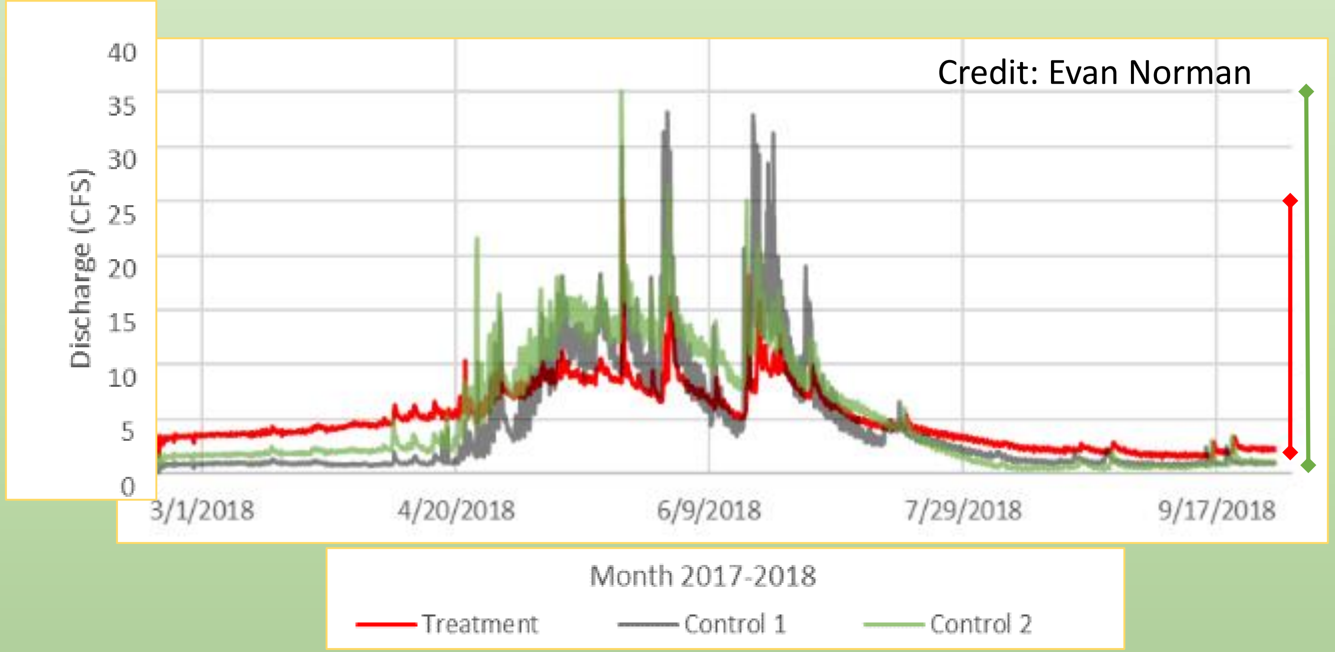
Credit: Wheaton et al. 2019

Achieving Stage 0 = “Prescribed Flooding”

Resilience to Drought and Flooding
Encouraging multiple small-scale floods moderates the high and low extremes of flow magnitude.


Photo: Evan Norman

Returning to a Natural Hydrograph – Delayed Response



Reduced flood flows and higher late-season flows at restored site compared to control locations. Pattern **only evident after 2 years** after construction (Flow basically unchanged in year 1-2).

BDAs can set the stage for beavers to do the rest of the work.

Dealing with “nuisance” activity:

Non-lethal management needs to be in the toolbox

Credit: Heidi Perryman, Martinez Beavers


Flow Devices to Protect Culverts and Headgates

Many of the best opportunities are on private land

Consider where BDAs or beavers can work into an operation while providing ecosystem services

The future lies in finding the balance between nature and human needs

Branches of beaver-based restoration

- Process-based restoration to restore natural floodplain processes and habitat
- Beaver relocation/translocation/reintroduction
- Non-lethal beaver management, finding common ground

Dovetails with aspen release, conifer control and other vegetation management, grazing management

In some cases may complement traditional restoration design

Thank You

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achadwick[at]greatwesteng.com