

WATS 5350 CAPSTONE

LOW-TECH APPROACHES



  Stephen Bennett



PURPOSE

- Background
- Structure types



Jeremy Maestas

OUTLINE: Low-Tech Approaches



- I. Background of low-tech
- II. Low-Tech approaches to be aware of
- III. Low-Tech structures we will focus on (i.e. BDAs and PALS)

Design Manual References – Chapters 1 & 4

Chapter 1 – BACKGROUND & PURPOSE



Prepared by:

Scott M. Shahverdian, Joseph M. Wheaton, Stephen N. Bennett, Nicolaas Bouwes & Jeremy D. Maestas

Recommended Citation:
Shahverdian, S., Wheaton, J.M., Bennett, S.N., Bouwes, N. and Maestas, J.D., 2019. Chapter 1 – Background & Purpose. In: J.M. Wheaton, S.N. Bennett, N. Bouwes, J.D. Maestas and S.M. Shahverdian (Editors), Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Utah State University Wheaton Restoration Consortium, Logan, Utah, 29 pp.



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IMPLICATIONS FOR PRACTICE

- Riverscapes are composed of connected floodplain and channel habitats that together make up the valley bottom.
- The scope of degradation of riverscapes is massive. Tens of thousands of miles of riverscapes are in poor or fair condition.
- Structural starvation is both a direct cause of degradation, as well as a consequence of land use changes and direct modification of stream and riparian areas.
- Engineering-based restoration tends to emphasize channel form and stability, rather than promoting the direct modification of stream and riparian areas.
- Process-based restoration focuses on restoring physical processes that lead to healthy riverscapes.
- Low-cost, simple, hand-built structures have been used for over a century. Restoration principles are needed to guide the use of low-tech structures in order to address the scope of degradation, which will require that practitioners "let the system do the work."
- The overarching goal of low-tech restoration is to improve the health of as many miles of riverscapes as possible and to promote and maintain the full range of self-sustaining riverscape processes.

RIVERSCAPE RESTORATION MANUAL

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CHAPTER 1: BACKGROUND & PURPOSE

Chapter 4 – MIMICKING & PROMOTING WOOD ACCUMULATION & BEAVER DAM ACTIVITY WITH POST-ASSISTED LOG STRUCTURES & BEAVER DAM ANALOGUES



Prepared by:

Scott M. Shahverdian, Joseph M. Wheaton, Stephen N. Bennett, Nicolaas Bouwes, Reid Camp, Christopher E. Jordan, Elijah Portugal, and Nicholas Weber

Recommended Citation:
Shahverdian, S.M., Wheaton, J.M., Bennett, S.N., Bouwes, N., Camp, R., Jordan, C.E., Portugal, E. and Weber, N., 2019. Chapter 4 – Mimicking and Promoting Wood Accumulation and Beaver Dam Activity with Post-Assisted Log Structures and Beaver Dam Analogues. In: J.M. Wheaton, S.N. Bennett, N. Bouwes, J.D. Maestas and S.M. Shahverdian (Editors), Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Utah State University Restoration Consortium, Logan, Utah, 68 pp.



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IMPLICATIONS FOR PRACTICE

- Post-assisted log structures (PALS) and beaver dam analogues (BDAs) are hand-built structures. PALS mimic and promote the processes of wood accumulation, whereas BDAs mimic and promote beaver dam activity.
- PALS and BDAs are permeable, temporary structures, built using natural materials.
- BDAs differ from PALS in that BDAs create ponds using a variety of fill materials; PALS are built with only woody material, which tends to be larger diameter than the woody material used for BDAs.
- PALS and BDAs are both intended to address the broad impairment of structural starvation in wadeable streams, but can also be used to mitigate against a range of more specific impairments.
- PALS and BDAs can be built using a variety of natural materials, and built to a range of different shapes, sizes and orientations.
- PALS and BDAs are most likely to achieve restoration goals when built in high numbers.
- Some PALS and BDAs are likely to breach and/or lose some wood, but when many structures are installed, that material will accumulate on downstream structures or in natural accumulation areas leading to more complexity.

RIVERSCAPE RESTORATION MANUAL

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

Chap 1: Shahverdian et al. (2019a)

DOI: [10.13140/RG.2.2.11621.45286](https://doi.org/10.13140/RG.2.2.11621.45286)

Chap 4: Shahverdian et al. (2019a)

DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

Low-Tech Approaches – Definition

Low-tech process-based restoration

noun

1. A practice of using simple, low unit-cost, structural additions (e.g., wood and beaver dams) to [riverscapes](#) to mimic functions and promote specific processes. Hallmarks of this approach include an explicit focus on the promoting geomorphic and [fluvial](#) processes, a conscious effort to use cost-effective, low-tech treatments (e.g., hand-built, natural materials, non-engineered, short-term design life-spans) because of the need to efficiently scale-up application, and 'Letting the [system](#) do the work', which defers critical decision making to riverscapes and beaver.



Low technology



Low technology, often abbreviated low tech, is simple technology, often of a traditional or non-mechanical kind, such as crafts and tools that pre-date the Industrial Revolution. It is the opposite of high technology. [Wikipedia](#)

Adapted from figure 6.10C (p. 254) a of Bennett et al. (2019)

Chapter 6 of LTPBR Manual

DOI: [10.13140/RG.2.2.25043.22567](https://doi.org/10.13140/RG.2.2.25043.22567)

Low-Tech Approaches – Restoration Principles



Strength in numbers

Figure 6.15a (p 261) of Bennett et al. (2019) – Chapter 6 LTPBR
Manual DOI: [10.13140/RG.2.2.25043.22567](https://doi.org/10.13140/RG.2.2.25043.22567)

See Wheaton et al. (2019) – Chapter 2 LTPBR Manual for Principles
DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)



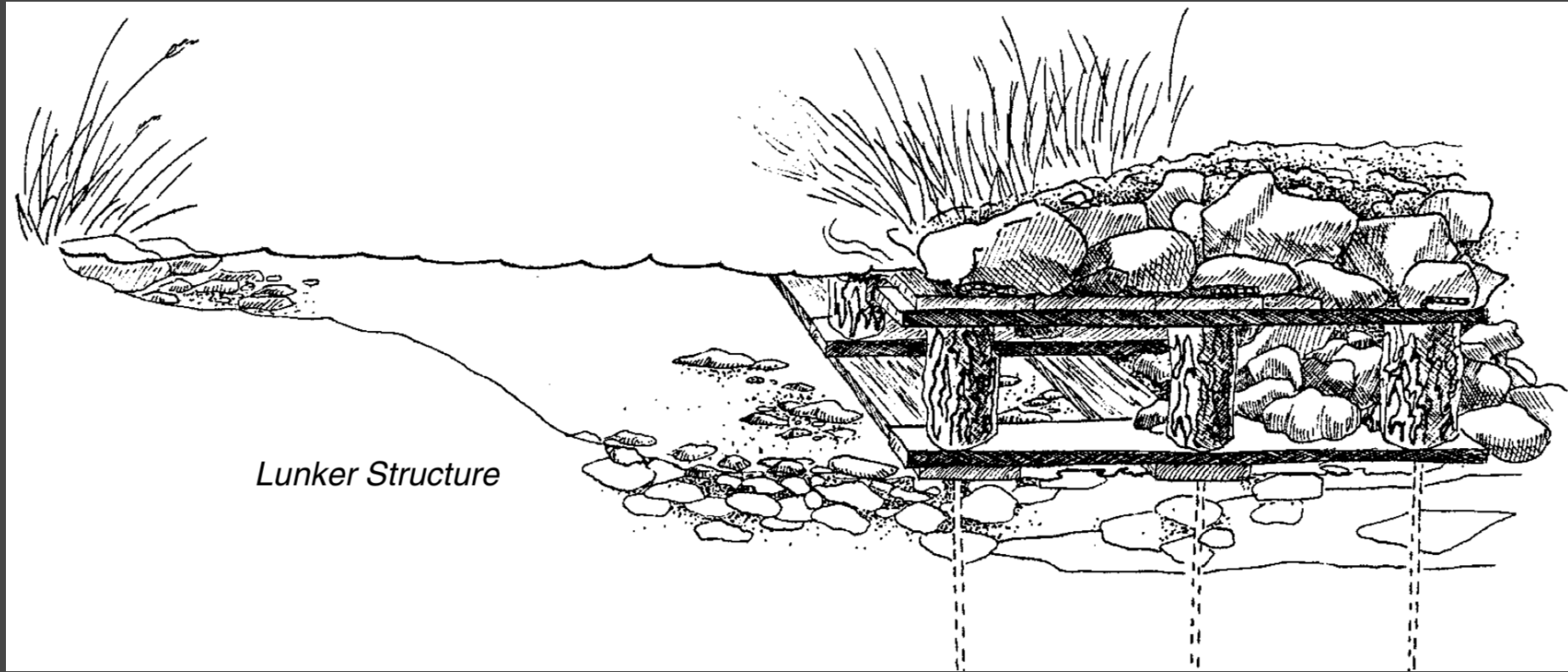
cc ELR – Steve Bennett

Make a mess

What Low-Tech Approaches are NOT

**NASA Spent Millions to Develop a Pen
that Would Write in Space - the Soviet
Cosmonauts Used a Pencil~**

Low-Tech Approaches are not form mimicry!



From Avery (2004): WDNR

What's the "PBR" in Low-tech



CC ELR — Steve Bennett

Promoting natural rates and magnitudes ...

PBR principles



- Root cause
- Consistent
- Scale
- Clear goals

Low-tech is not new



See Heter (1950): Journal of Wildlife Management



California transplants beaver into El Corado National Forest via parachute in 1950 (Source: CA Dept. of Fish and Wildlife)³⁰

Low-tech is not new



Gully erosion

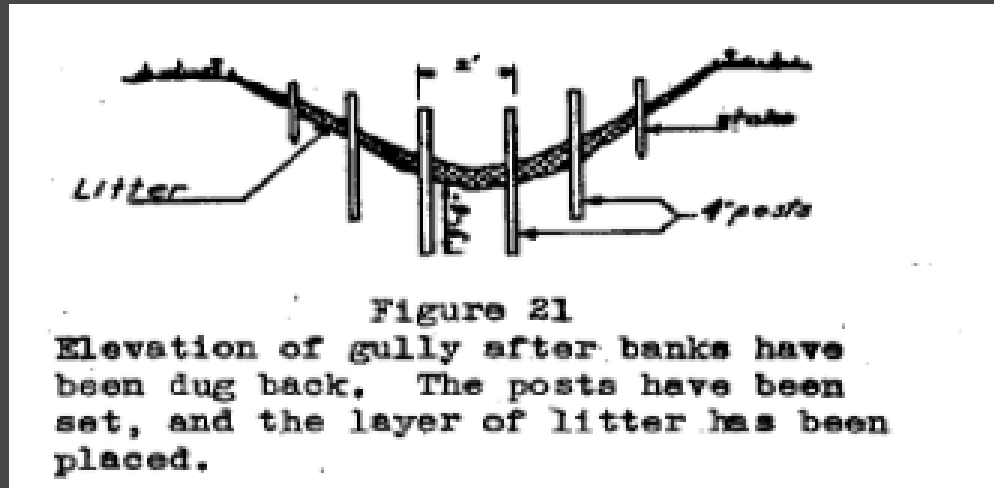
Figure 66 from Frédéric Liébault (2003) PhD Thesis
See also: Demontzey (1892 & 1894)



Channel incision

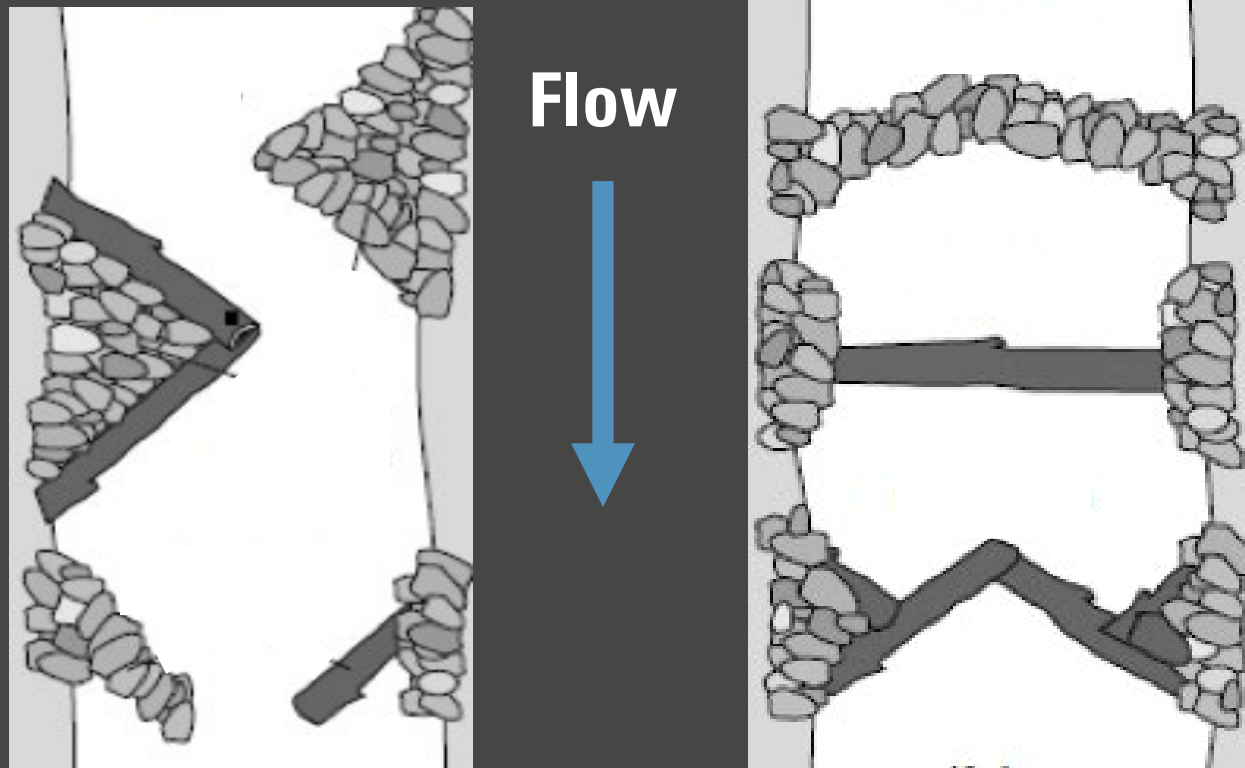
SCS (1930s)
See also: [Kraebel & Pilsbury](#) (1934) USFS

Low-tech is not new



- Build in phases
- Temporary, simple, pervious

Modern wood structures



From Thompson (2005)

DOI: [10.1130/2005.4016\(04\)](https://doi.org/10.1130/2005.4016(04))

Current wood structures – are they better?



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Low-tech options



Management



Intervention

Grazing & riparian Management

Maggie and Susie Creek, NV



Carol Evans
BLM



Jon Griggs
Rancher



United States Department of Agriculture
Northwest Climate Hub

If You Build It, They Will Come: Ranching, Riparian Revegetation, and Beaver Colonization in Elko County, Nevada

Susan Charnley



Grazing & riparian Management

Susie Creek, NV



1989

Summer grazing



1994

Fall grazing

Grazing & riparian management



2003

Fall Grazing, Beavers



2017

Beavers, Intensive Grazing

Beaver Management



CC BY Joe Wheaton

Figure 1.9 (p. 41) of Shahverdian et al.
(2019) – Chapter 1 of LTPBR Manual

DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

Intervention - Adding wood



Zeedyk Structures

“Sticks and Stones”



Bill Zeedyk



Let the water do the work resources



EROSION CONTROL FIELD GUIDE

By Craig Sponholtz & Avery C. Anderson



WORKING WITH NATURE TO HEAL EROSION

Soil loss caused by flowing water diminishes the fertility, productivity and healing capacity of the land. This guide was created to empower landowners and managers to take action and reverse soil erosion at every opportunity. These methods promote harvesting and storing runoff and sediment with structures based on natural forms that initiate long-lasting regenerative processes.

For more information visit
www.WatershedArtisans.com
and www.QuiviraCoalition.org

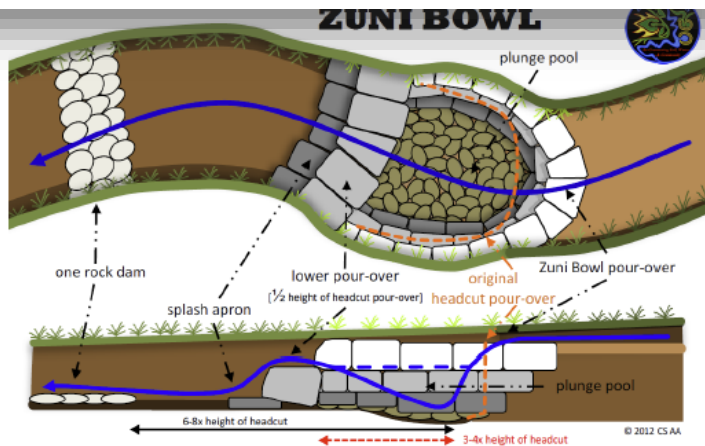


Figure 8. Zuni Bowl plan and cross-sectional views (Sponholtz and Anderson 2013; figure courtesy of C. Sponholtz).

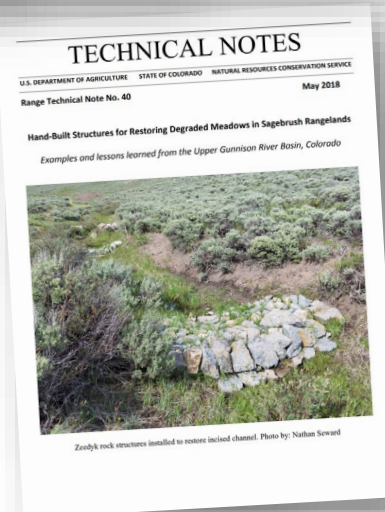
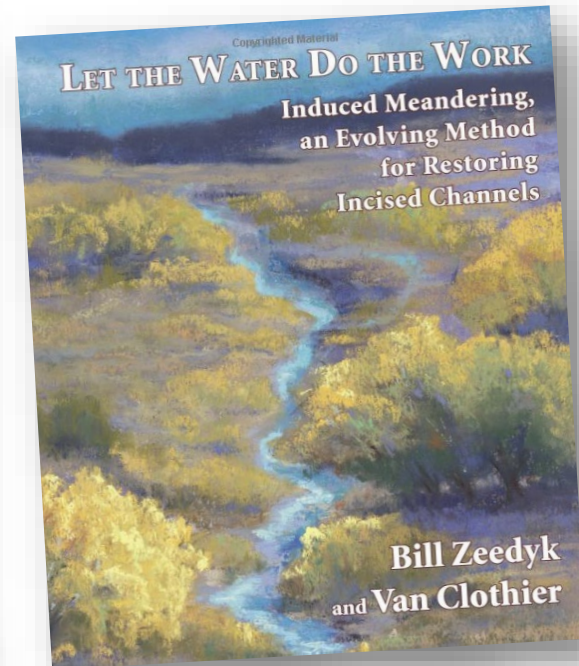


Table 5 – A list of typical low-tech approaches to promoting specific process-based restoration outcomes.

Name	Helpful Reference(s)
Promoting and/or Mimicking Wood Accumulation	
Seeding of Wood – Direct Recruitment of Unanchored Wood	
Direct Felling	Carah et al. (2014)
Grip-Hoisting	Micelston (2014)
Structural Placement of Wood Accumulations	
Post-Assisted Log Structures	Chapter 4 (Shahverdian et al., 2019a)
Improving Supply of Woody Material	
Riparian Plantings	Hall et al. (2011)
Grazing Management	Swanson et al. (2015)
Promoting and/or Mimicking Beaver Dam Activity	
Beaver Translocation	Woodruff and Pollock (2015)
Beaver Dam Analogues	Chapter 4 (Shahverdian et al., 2019a)
Trapping Closures	Figure 9; (Valachovic)
Erosion Control (often for intermittent & ephemeral channels)	
Baffles	Zeedyk and Clothier (2009)
One Rock Dams	Maestas et al. (2018); Zeedyk and Clothier (2009)
Post and Brush Plugs	Kraebel and Pillsbury (1934)
Tree Dam	Kraebel and Pillsbury (1934)
Tree Plug	Kraebel and Pillsbury (1934)
Vanes	Zeedyk and Clothier (2009)
Wicker Weirs	Kraebel and Pillsbury (1934)
Zuni Bowls	Maestas et al. (2018); Zeedyk and Clothier (2009)

OUTLINE: Low-Tech Approaches



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PALS and BDAs



P A L S

POST-ASSISTED LOG STRUCTURES

- PALS are handbuilt structures that mimic and promote the processes of **wood accumulation**.
- Woody material of various sizes pinned together with untreated wooden posts driven into the substrate.

B D A s

BEAVER DAM ANALOGUES

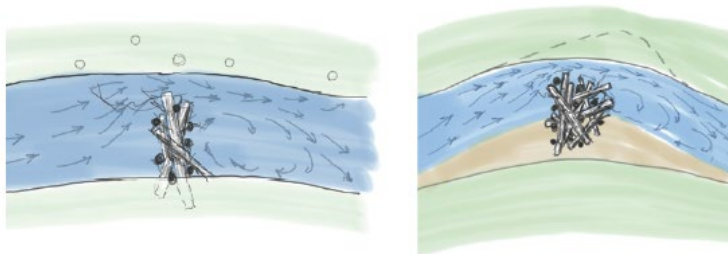
- BDAs are handbuilt structures that mimic and promote the processes of **beaver dam activity**.
- BDAs are a permeable, channel-spanning structure with a constant crest elevation, constructed with a mixture of woody debris and fill material to promote temporary ponding of water.



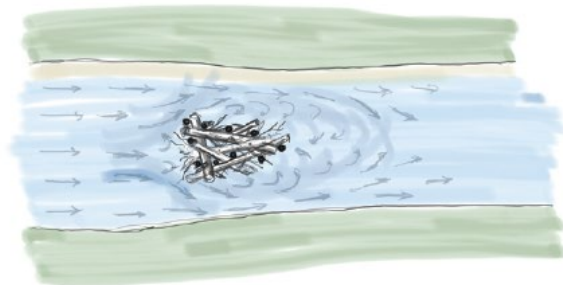
From Page 23 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

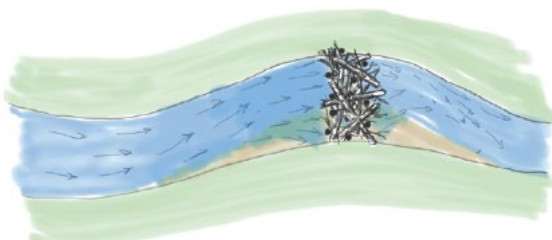
BANK-ATTACHED PALS



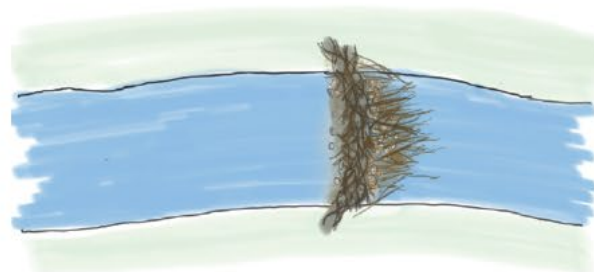
MID-CHANNEL PALS



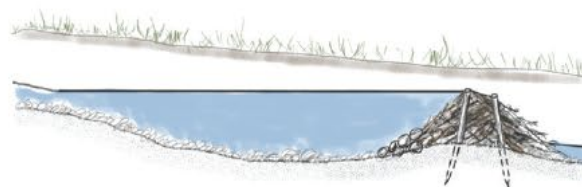
CHANNEL-SPANNING PALS



POSTLESS BDA



POST-ASSISTED BDA



POST-LINE WICKER WEAVE



Low-tech structures to mimic



Beaver dams



**Wood
accumulations**

Mimic → **Promote** → **Sustain**



Beaver dams
Beaver Dam Activity



Wood
accumulations

Beaver dam activity ... “Why go to the trouble”



Beaver dam anatomy



Beaver dam anatomy



Goals of mimicking beaver dam activity?



Ponds, floodplain connection, diversity of depths and flows (aka complexity)

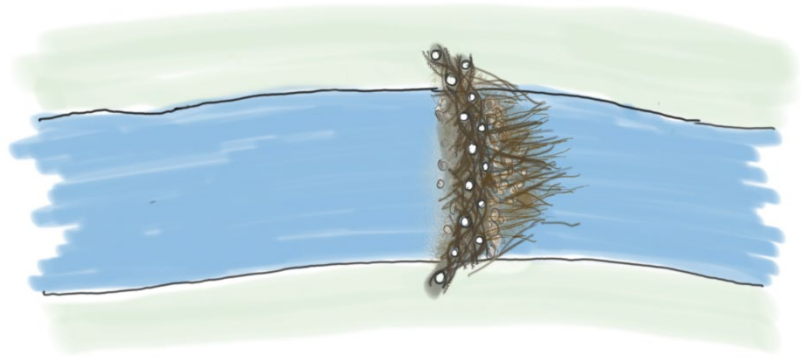
How do we mimic beaver dam activity?



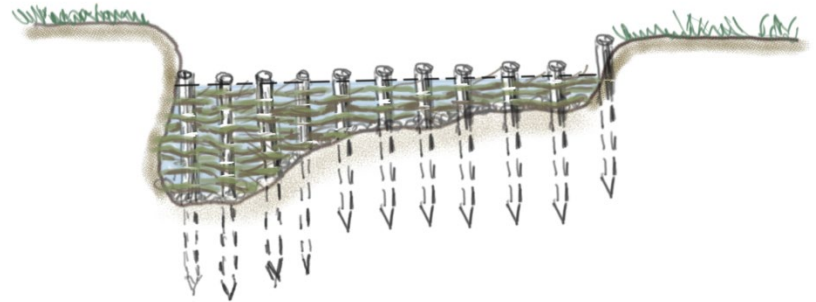
pages 35-48 pocket guide

Post-Line Wicker Weave (Beaver Dam Analog v.1)

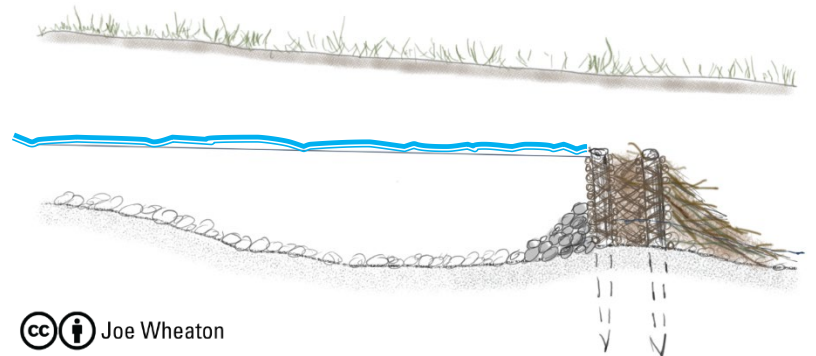
Planform



Cross-section



Profile



CC BY Joe Wheaton

Flow



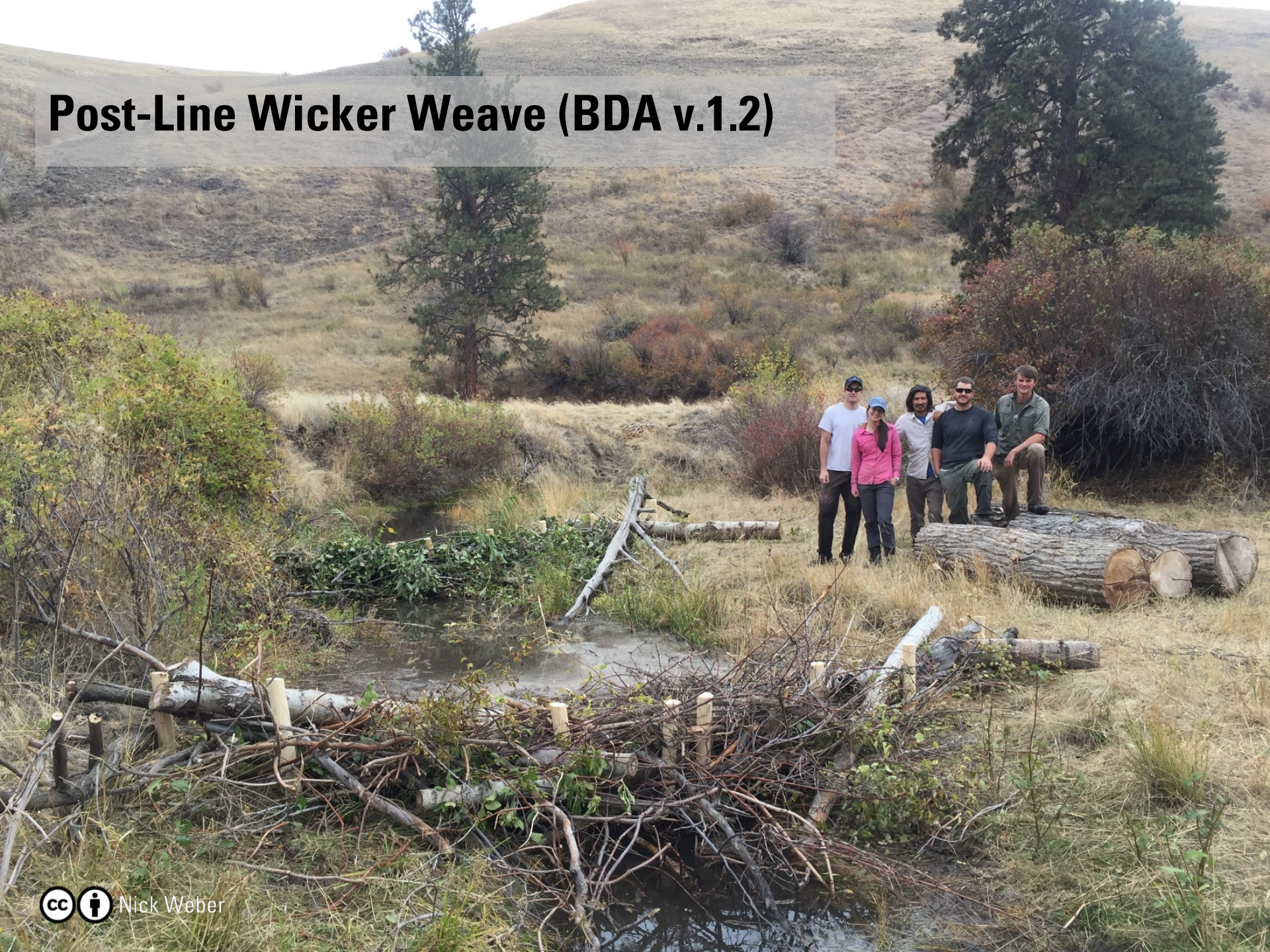
Post-Line Wicker Weave (BDA v.1)



Post-Line Wicker Weave (BDA v.1.1)

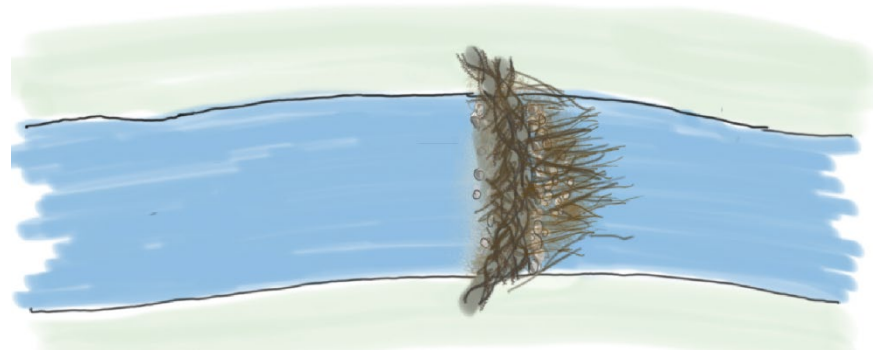


Post-Line Wicker Weave (BDA v.1.2)

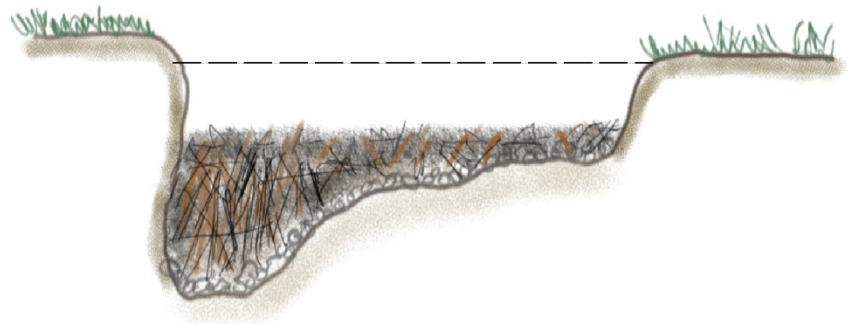


Postless beaver dam analogues (BDA v.2.0)

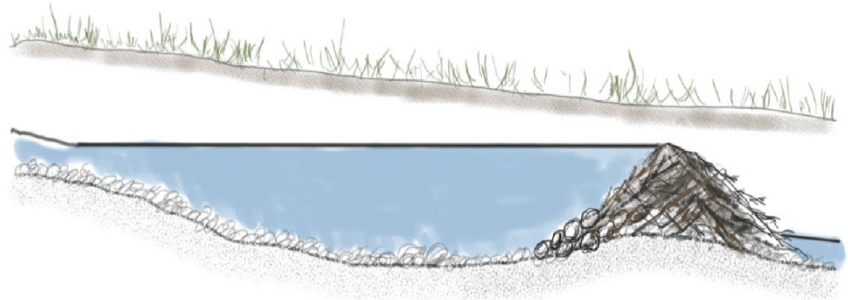
Planform



Cross-section



Profile



From pages 35-48 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/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](https://doi.org/10.13140/RG.2.2.22526.64324)

Flow



  Joe Wheaton

Postless beaver dam analogues (BDAs v.2.0)



Low
order!

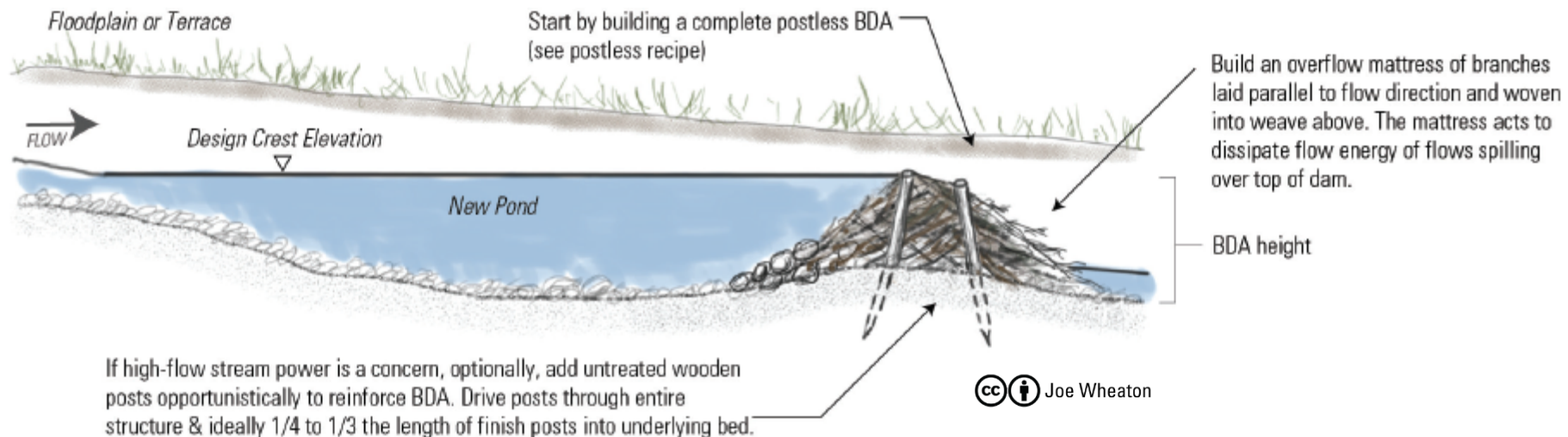


POST-ASSISTED BDA

- Posts can provide some temporary anchoring and stability to help with initial dam stability during high flows in systems with flashier flow regimes or that produce larger magnitude floods.
- 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 as extra reinforcement after the fact.

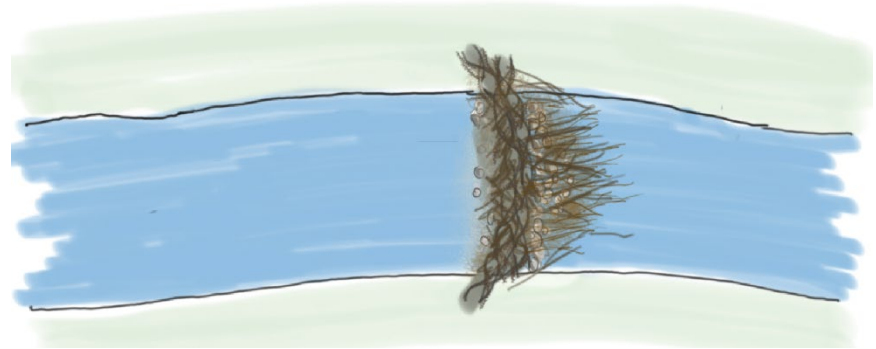


PROFILE VIEW WITH POSTS

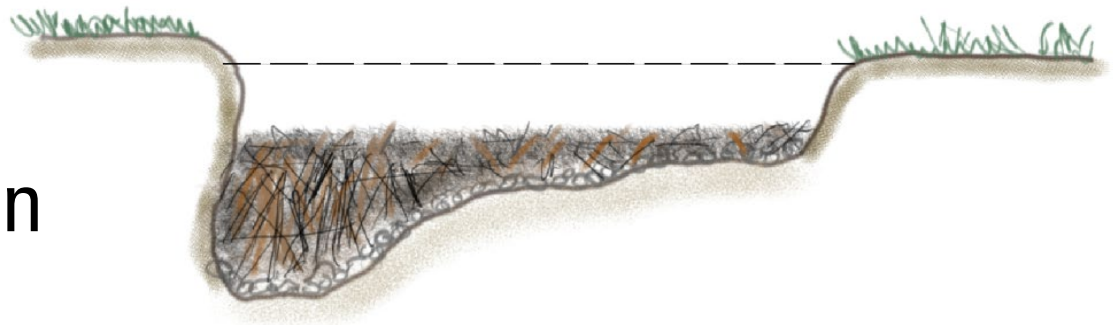


Mimic beaver – Postless beaver dam analogues (BDAs)

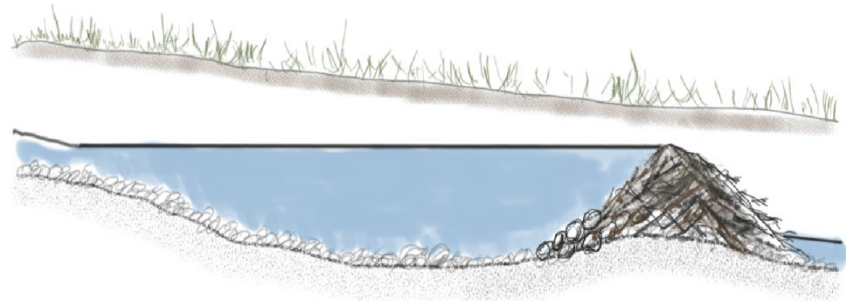
Planform



Cross-section



Profile

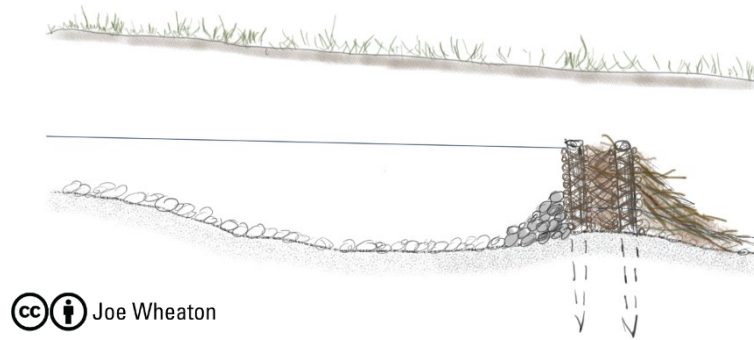


cc i Joe Wheaton

Flow



Post-Line Wicker Weave



Adapted from Figure 4.34 & 4.38 of Appendix E of
Shahverdian et al. (2019) – Chapter 4 LTPBR Manual
DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

See also pages 35-48 of Pocket Guide;
Wheaton et al. (2019)
DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)



What about mimicking wood accumulation?



Natural wood accumulations



Goals of mimicking wood accumulations?



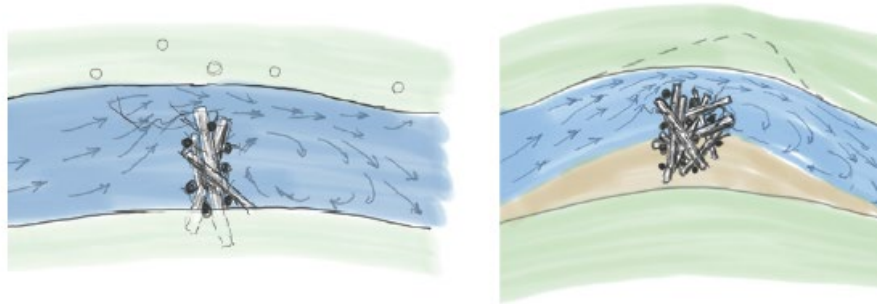
Complexity, Overbank Flow

How do we mimic wood accumulations?

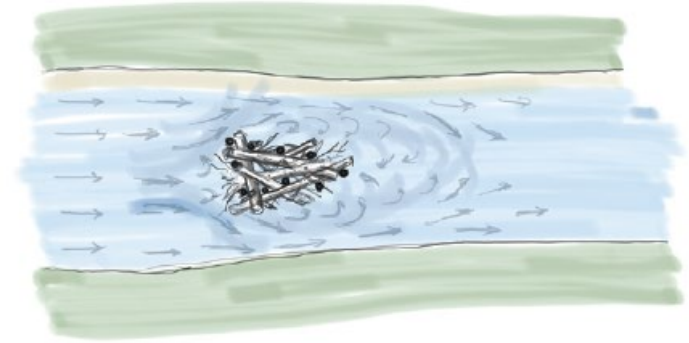


Types of Post-Assisted Log Structures (PALS)

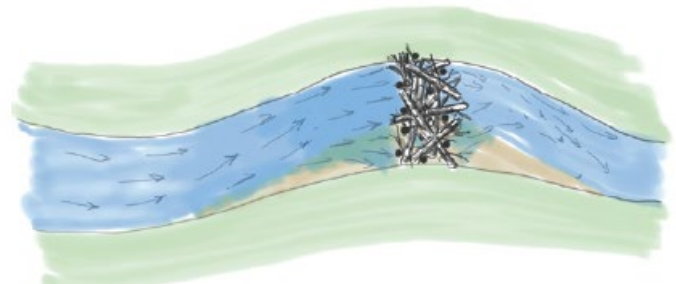
BANK-ATTACHED PALS



MID-CHANNEL PALS



CHANNEL-SPANNING PALS



From pages 24-34 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See also Appendix D of Shahverdian et al. (2019) – Chapter 4

LTPBR Manual DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

PALS vs. BDA?

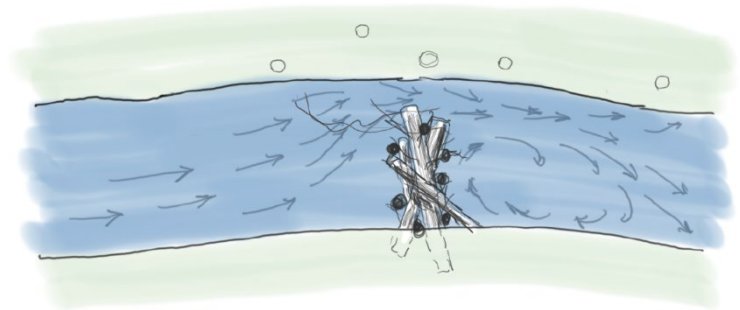


PALS vs. BDA?

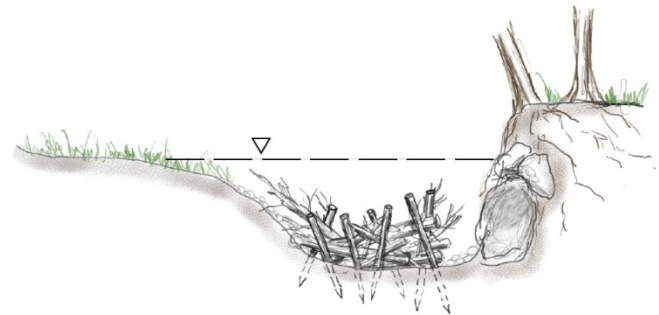
- Source sediment
- Widen channel
- Aggrade
- Larger materials
- High flows

Bank-attached PALS - Constriction Jet

Planform



Cross-section



Profile



Adapted from Figure 4.23 of Appendix D of Shahverdian et al. (2019)
– Chapter 4 LTPBR Manual DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

Flow

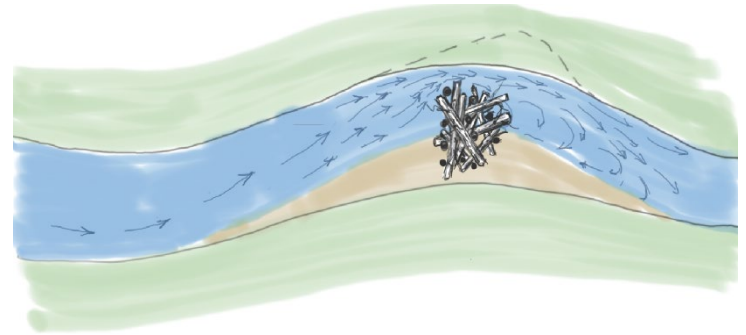


Bank-attached PALS - Constriction Jet

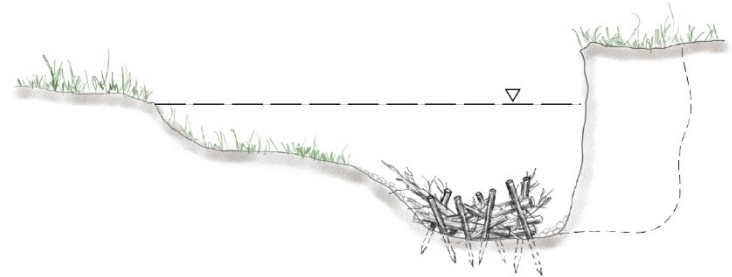


Bank-attached PALS – Bank Blaster

Planform



Cross-section



Profile



Flow



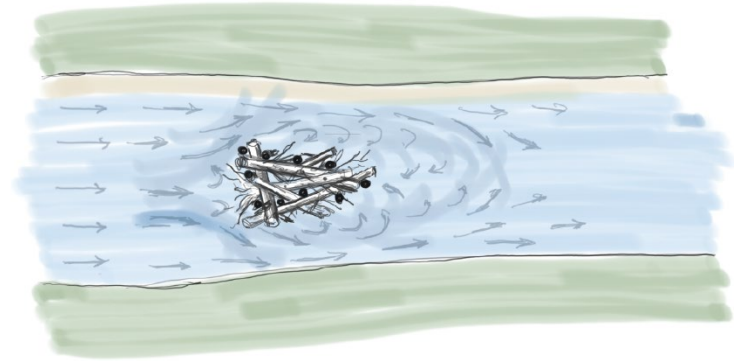
Bank-attached PALS – Bank Blaster



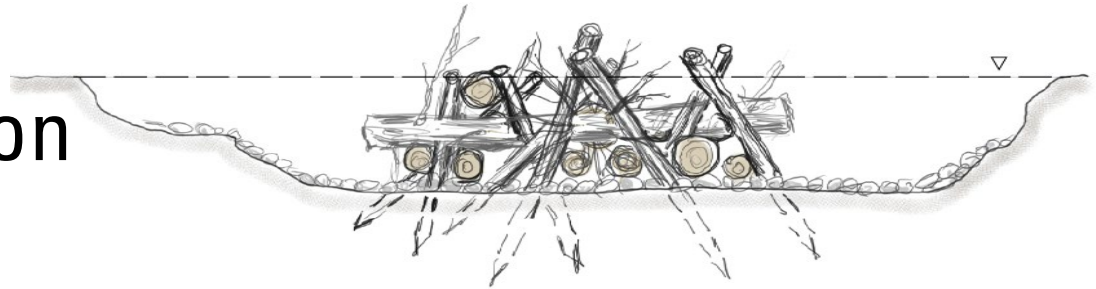
Photo from Joshua White, 2019 (USFWS)

Mid-channel PALS

Planform



Cross-section



Profile



Adapted from Figure 4.25 of Appendix D of Shahverdian et al. (2019)
– Chapter 4 LTPBR Manual DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

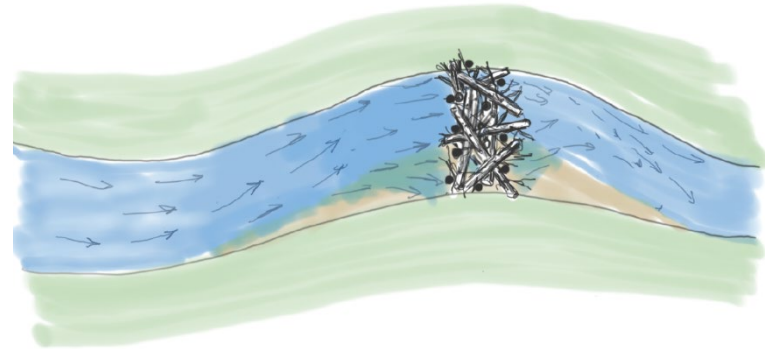
Flow 

Mid-channel PALS

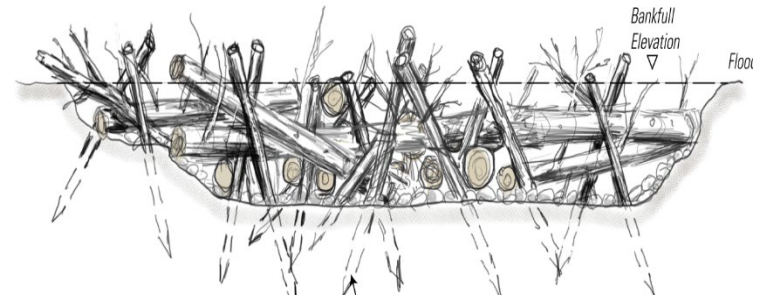


Channel spanning PALS

Planform



Cross-section



Profile



Flow



Mimic wood accumulations – Channel spanning PALS



ANABRANCH
SOLUTIONS

Mimic wood accumulations – Channel spanning PALS





Simpler PALS & ALS can do trick for cheaper



Photo from Joshua White, 2019 (USFWS)

Wood Accumulation

Tree Recruitment



Wood Accumulation

Noun or Verb?



CONCEPT OF HYDRAULIC PURCHASE

A small mid-channel post-assisted log structure (only 15% of bankfull width), but with more **effective 'hydraulic purchase'** and more effective at typical floods. at invoking specific hydraulic & geomorphic responses.

Mid-Channel
PALS

Price:
\$
Hydraulic
Purchase:
👍😊

Channel spanning LWD

Free-board \geq
to bankfull height

Artificially placed large woody debris, looks impressive and draws our eye to it. However, this tree is taller/longer than the stream width and as placed here is nothing more than a **channel-spanner**, with virtually **no hydraulic purchase** until very rare, high floods.

Price:
\$\$\$
Hydraulic
Purchase:
👎😞

Impressive root wad doing nothing (hydraulically) at low flow or even typical high flows. Trees with their full root wads cost much more than logs alone, and typically require heavy equipment to harvest, move and place.

**Longer-term...
Transaction Completed**



OBLIQUE VIEW LOOKING UPSTREAM

Fresh diagonal bar
deposits on floodplain

PALS-04
MC

PALS-05
CS

PALS-06
CS

PALS-07
BA-rr

PALS-11
CS

PALS-12
CS

PALS-13
BA-rl

PALS-14
BA-rl

PALS-01
CS

PALS-02
BA-rr

PALS-03
MC

PALS-08
BA-rl

PALS-09
MC

PALS-10
CS

COMPLEX 1

COMPLEX 2

COMPLEX 3

Structurally forced flooding
on diagonal bar complex

Structurally-forced
overbank flooding

Valley Bottom Margin

FLOW

Hillslopes

Fan

Hillslopes

HD LWD



ANABRANCH
SOLUTIONS

From Wheaton et al. (2019) Riverscape Design Manual

- Example of how AM can be **& ADAPTIVE MANAGEMENT** done for cheaper...

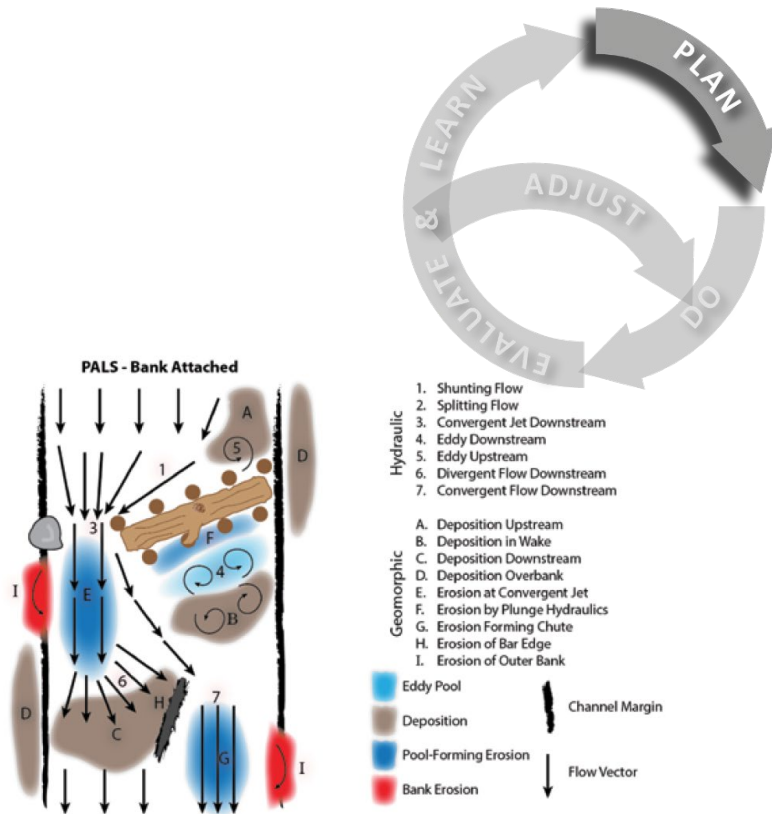
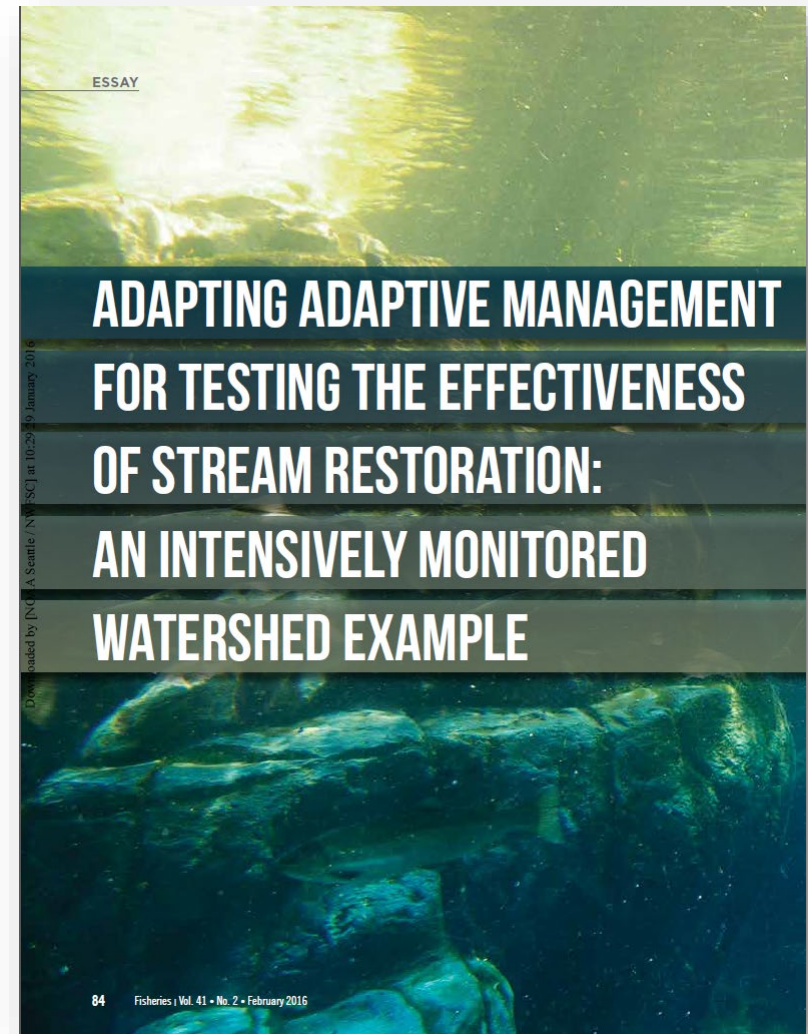


Figure 3. An example of detailed design hypotheses for a postassisted log structure (PALS) used to increase large woody debris (LWD) in the Asotin Creek intensively monitored watershed treatment sections. Each number refers to either a hypothesized hydraulic or geomorphic response. Blue = scour, brown = deposition, red = undercut bank creation. Adapted from Camp (2015).



SUMMARY: Low-Tech Approaches

- Simple, cost-effective, process-based
- Scale to scope of problem

