

Stage Zero RRNW/PSU Workshop



A Introduction to Low-Tech Process-Based Restoration for Achieving Stage Zero



CC BY NC SA Joe Wheaton



Joe Wheaton

Purpose of Talk

- Introduce some low-tech PBR techniques for achieving anastomosing (stage 0)
- Cover the what & why behind LTPBR as compliment or alternative



OTHER LTPBR PARTNERS

INSTRUCTION TEAM



Joe Wheaton (USU,
Anbranch Solutions)



Jeremy Maestas (NRCS,
West NTSC)



Nick Bouwes (USU, ELR,
Anbranch Solutions)



Steve Bennett (USU,
Anbranch Solutions)



Scott Shahveridan (USU,
Anbranch Solutions)



Jay Wilde (Diamondback
W Ranch)



Mark Beardsley
(EcoMetrics)



Nick Weber
(Anbranch
Solutions, ELR)



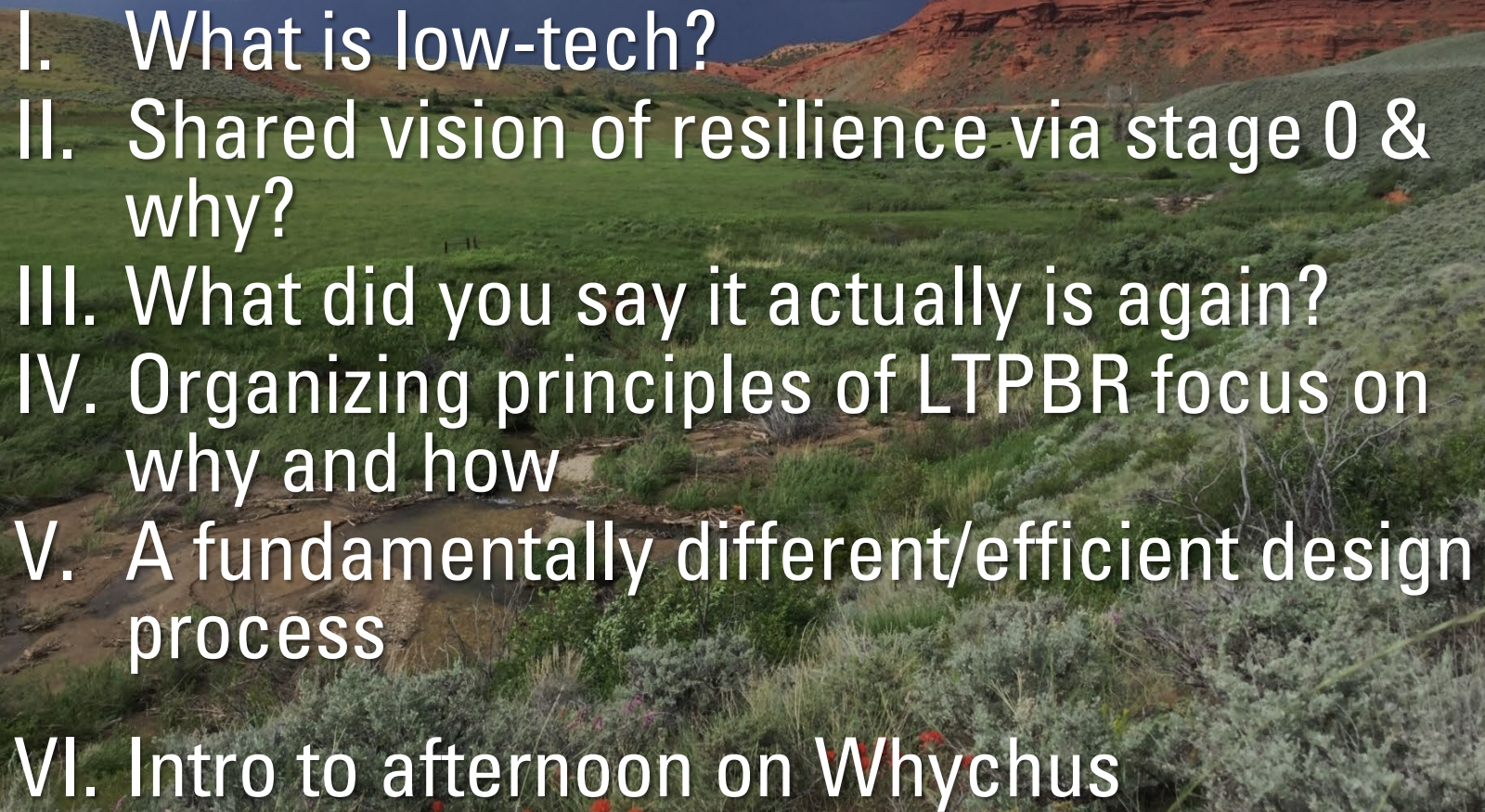
Northwest Fisheries Science Center



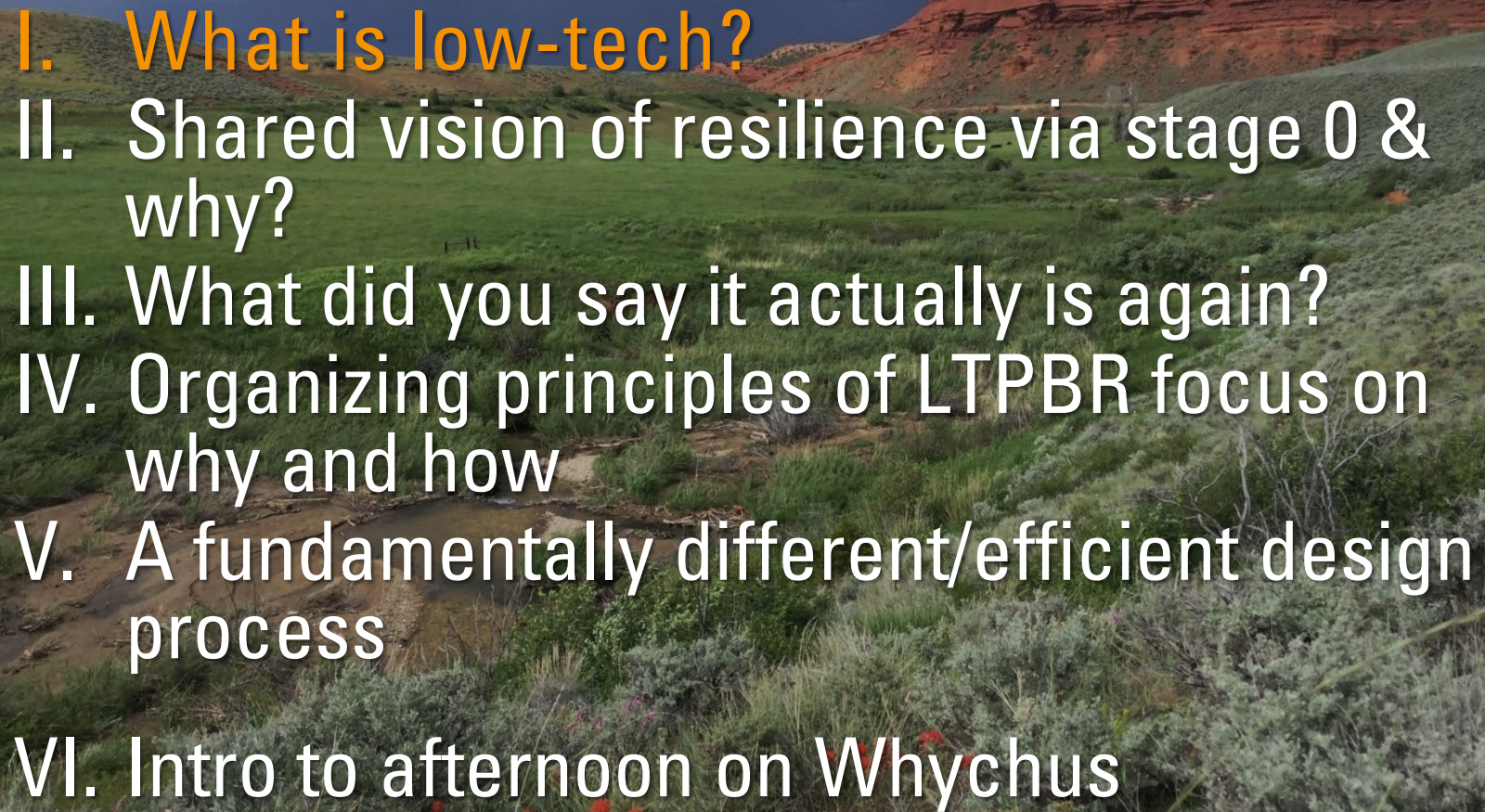
Utah State University
RESTORATION CONSORTIUM



OUTLINE: Intro to LTPBR for Stage 0

- 
- I. What is low-tech?
 - II. Shared vision of resilience via stage 0 & why?
 - III. What did you say it actually is again?
 - IV. Organizing principles of LTPBR focus on why and how
 - V. A fundamentally different/efficient design process
 - VI. Intro to afternoon on Whychus

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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.



PBR? Just a cute can or some science?



Principle	Description
1. Target root causes of habitat and ecosystem change	Restoration actions are designed to address the human alterations to processes that are degrading habitat conditions
2. Tailor restoration actions to local potential	A given reach in a river network operates within specific constraints based on its location within the watershed and climatic and physiographic setting. Understanding the types and magnitudes of processes within a given reach helps design restoration actions.
3. Match the scale of restoration to the scale of the problem	When disrupted processes causing degradation occur at the reach scale, restoration actions at individual sites can effectively address root causes. When causes of degradation occur at the watershed scale, many individual site-scale actions are required.
4. Be explicit about expected outcomes	Process-based restoration is a long-term endeavor and there are often long lag times between implementation and recovery and biota may not improve dramatically with any single action. Articulating restoration goals and pathways is critical to setting appropriate expectations.

BRIDGE CREEK....

A little incision problem...

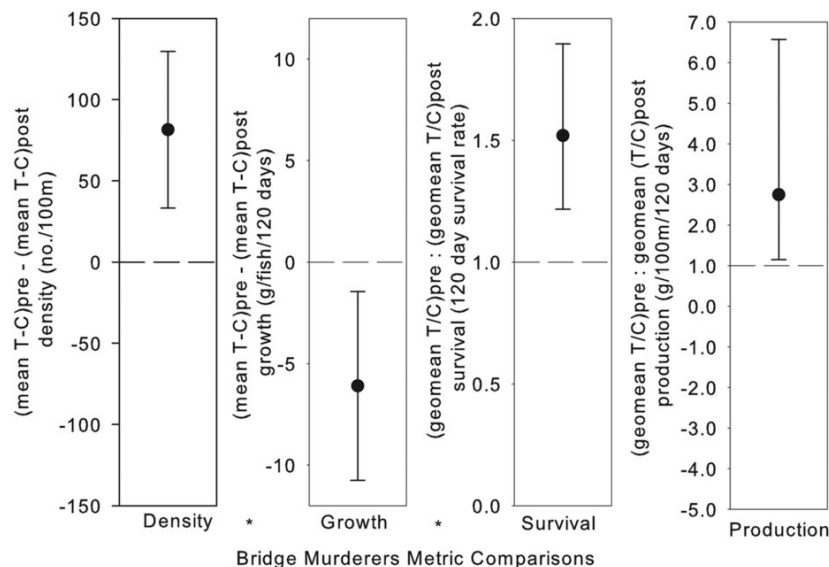


And the experiment that gave
BDAs credibility



WHY LTPBR REALLY GOT ATTENTION...

- Restoration using beaver as a restoration agent actually produced a population level increase in density, survival and production of ESA listed salmon



SCIENTIFIC REPORTS

OPEN

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

Nicolaas Bouwes^{1,2}, Nicholas Weber³, Chris E. Jordan⁴, W. Carl Saunders^{5,2}, Ian A. Tattam⁴, Carol Volk⁴, Joseph M. Wheaton² & Michael M. Pollock³

Beaver have been referred to as ecosystem engineers because of the large impacts their dam building activities have on the landscape; however, the benefits they may provide to fluvial fish species has been debated. We conducted a watershed-scale experiment to test how increasing beaver dam and colony persistence in a highly degraded incised stream affects the freshwater production of steelhead (*Oncorhynchus mykiss*). Following the installation of beaver dam analogs (BDAs), we observed significant increases in the density, survival, and production of juvenile steelhead without impacting upstream and downstream migrations. The steelhead response occurred as the quantity and complexity of their habitat increased. This study is the first large-scale experiment to quantify the benefits of beavers and BDAs to a fish population and its habitat. Beaver mediated restoration may be a viable and efficient strategy to recover ecosystem function of previously incised streams and to increase the production of imperiled fish populations.



Beaver in Eurasia and North America were once abundant and ubiquitous¹. Their dense and barbed fur has great felting properties, and as early as the 1500s, intense trapping to provide pelts mainly for making hats occurred throughout Eurasia². By the early 1700s, beaver were nearly extirpated in Eurasia, and North America became the new source of pelts for international commerce. The exploration, settlement, and many territorial claims of North America by several European countries were driven mainly by the search for beaver-trapping opportunities³.

When Lewis and Clark explored the Pacific Northwest in 1805, salmon and steelhead coexisted with beavers in very high densities^{1,3}. Fur trade in this region began around 1810, attracting pioneers to settle the area. When the British and United States jointly occupied the Oregon Territories (which included the Columbia River Basin), the Hudson Bay Company implemented their "scorched earth" or "fur desert" policy to eliminate all fur-bearing animals. In an attempt to discourage American settlement^{4,5}. As a result, beaver were nearly extirpated from the region by 1900. Around this time, a decrease in the great harvests of Pacific salmon and steelhead was first perceived. Anadromous salmon and steelhead populations have since declined precipitously in the Columbia River Basin, leading to their listing under the U.S. Endangered Species Act (ESA)^{2,6}. Agriculture, timber harvest, mining, grazing, urban development, and water storage and hydroelectric dam construction are commonly cited as the causes for salmonid habitat degradation and population declines⁷, with rare mention of the loss of beaver and their ability to alter aquatic ecosystems with their dam-building activities⁸.

Human activities, including the removal of beaver, have exacerbated the occurrence of stream channel incision, where a rapid down-cutting of the stream bed disconnects the channel from its floodplain^{9,10}. Channel incision is a ubiquitous environmental problem in the Columbia River Basin and throughout the world^{10–12}.

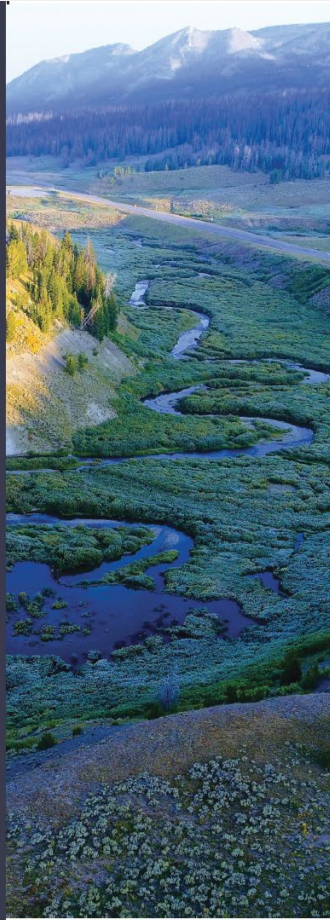
¹Eco Logical Research, Inc., PO BOX 706, Providence, Utah, 84332, USA. ²Watershed Sciences Department, Utah State University, 5210 Old Main Hill, Logan, Utah 84322, USA. ³Northwest Fisheries Science Center, 2725 Montlake Blvd E., Seattle, Washington 98112, USA. ⁴Oregon Department of Fish and Wildlife, Eastern Oregon University, 203 Badgley Hall, One University Boulevard, LaGrande, Oregon 97850, USA. ⁵South Fork Research, Inc. 44842 SE 145th Street, North Bend, Washington, 98045, USA. Correspondence and requests for materials should be addressed to N.B. (email: nbouwes@ecologicalresearch.net)

When riverscapes need some restoration

- Covers:
 - History/Background
 - Guiding Principles
 - Planning
 - Design
 - BDAs/PALS Standards
 - Implementation
- Defines Standard of Practice
- Free PDF download and additional resources
- Print version now available
 - \$60 @  BookBaby
 - Amazon 

LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES

Editors: Wheaton, Bennett, Bouwes, Maestas & Shahverdian



LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES DESIGN MANUAL

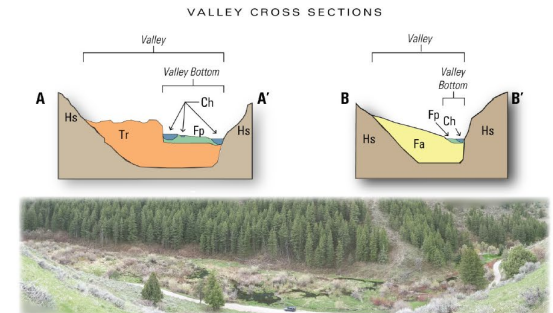
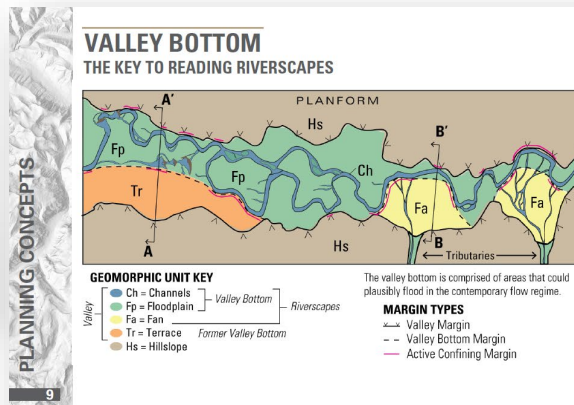
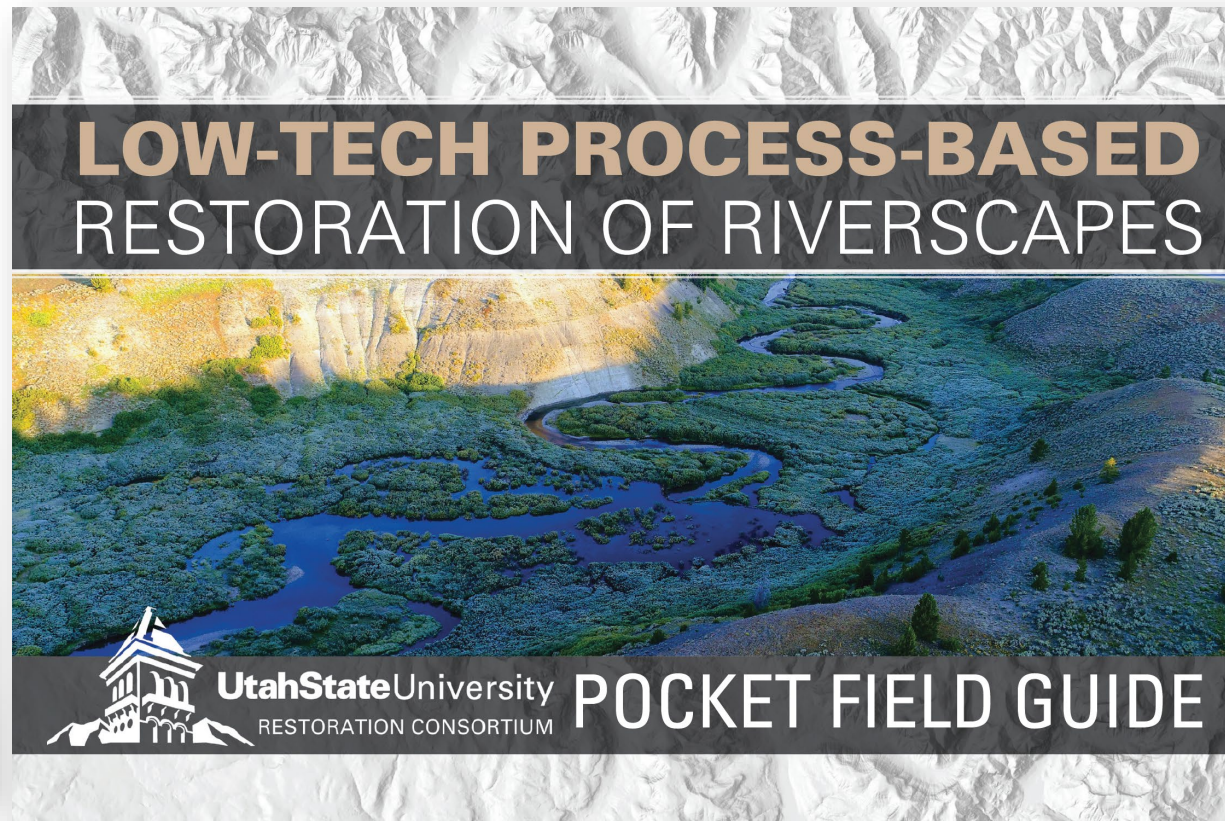
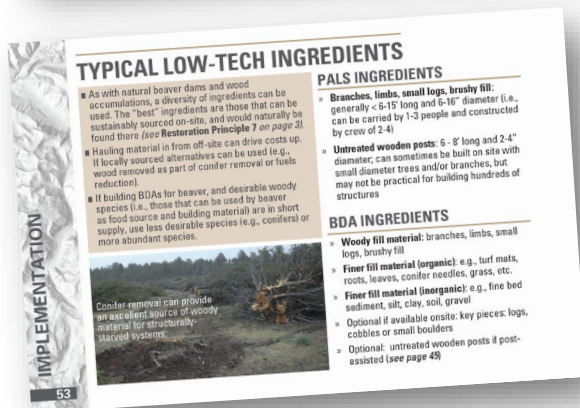
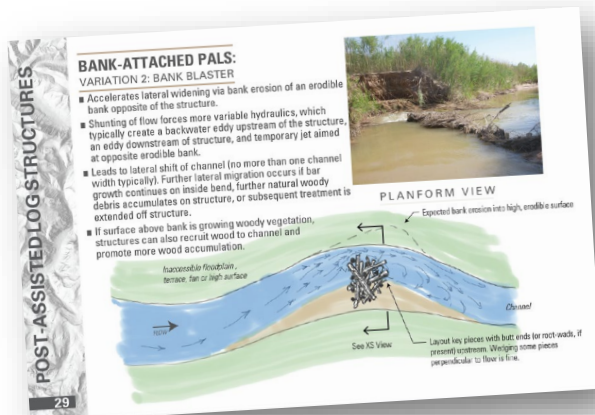


Edited by: Joseph M. Wheaton, Stephen N. Bennett, Nicolaas Bouwes, Jeremy D. Maestas & Scott M. Shahverdian

Free @: <http://lowtechpbr.restoration.usu.edu>

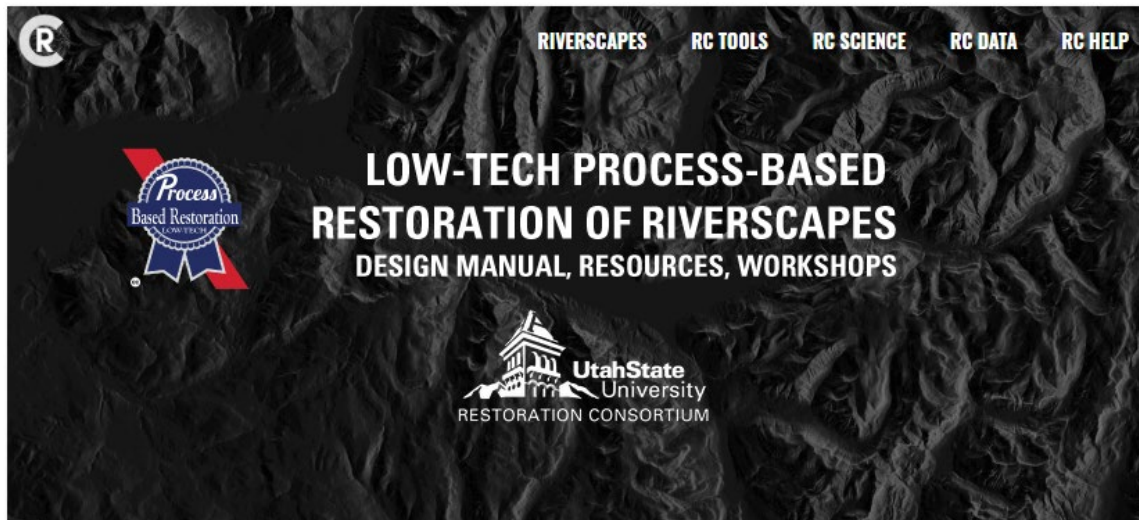
Cliff Notes Version

- Just pictures...



Adapted from Wheaton et al. (2015) 10

Free Digitally @: <http://lowtechpbr.restoration.usu.edu>



Subscribe to the Low-Tech PBR mailing list

Email Address

First Name

Last Name

The purpose of this **design manual** is to provide restoration practitioners with guidelines for implementing a subset of low-tech tools—namely beaver dam analogues (BDAs) and post-assisted log structures

(PALS)—for initiating process-based restoration in structurally-starved riverscapes. While the concept of process-based restoration in riverscapes has been advocated for at least two decades, details and specific examples on how to implement it remain sparse. Here, we describe 'low-tech process-based restoration' (LT-PBR) as a practice of using simple, low unit-cost, structural additions (e.g. wood and beaver

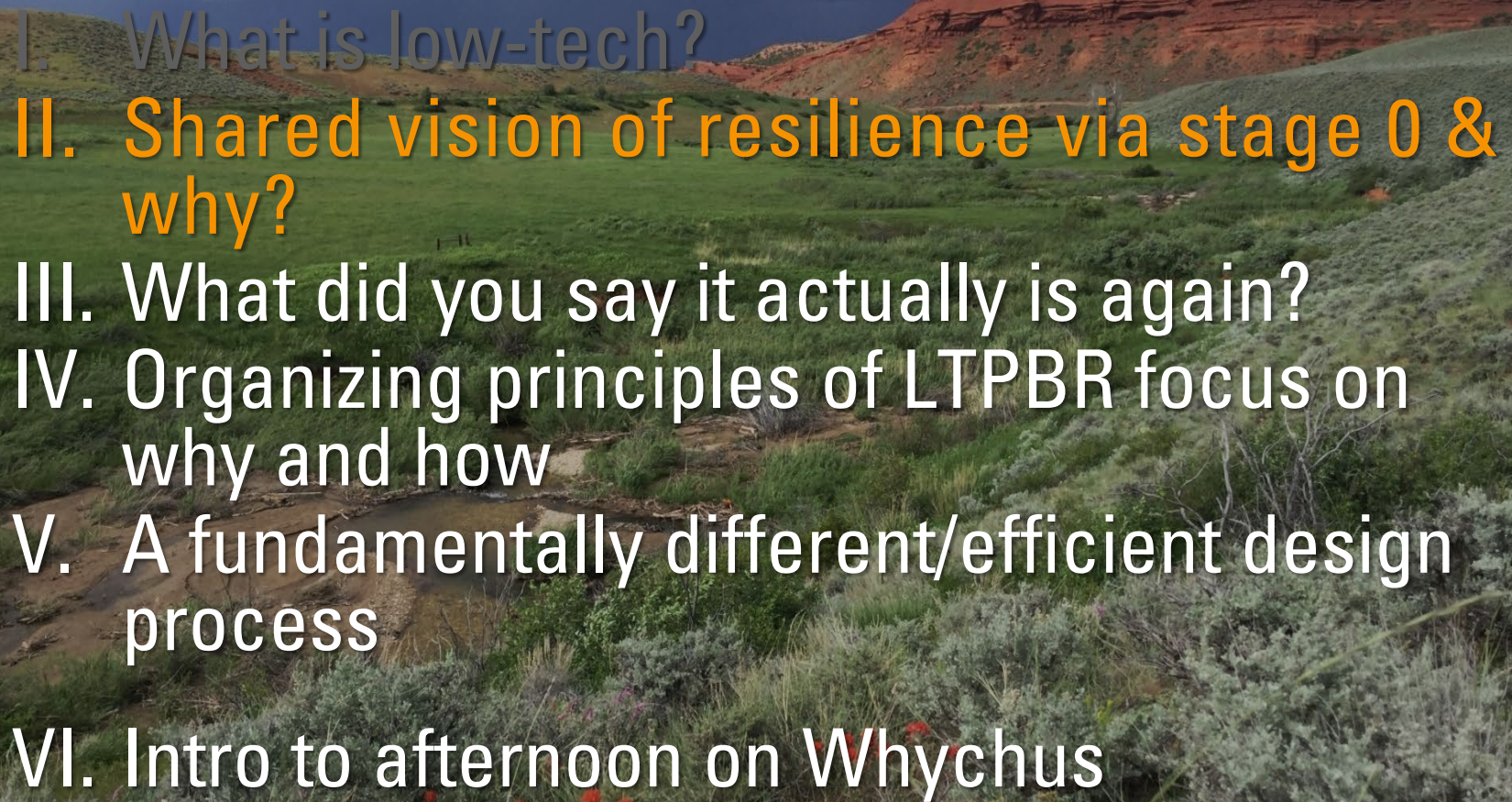


Find:

- Design Manual
- Pocket Guide
- Other Resources
- Workshop Slides
- Links/Videos/Literature



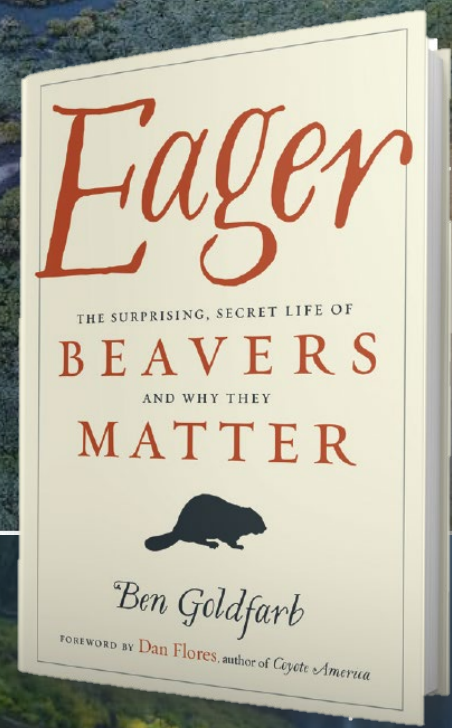
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A

We forgot what
valley bottoms could be & that
these are NOT anomalies!

CC BY Joe Wheaton



E

Adapted from Figure 1.7 (p 36) of Shahverdian et al. (2019) –
Chapter 1 LTPBR Manual DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

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Problem is Simple to State...

Scope of riverscape degradation is massive

- ~ \$10 Billion spent annually, but **barely scratching surface**
- We spend disproportionate \$\$\$\$ on **too few miles** of streams and rivers
- Leaving millions of miles **neglected...**

[Agricultural Stream Ecosystem \(PDF\)](#)

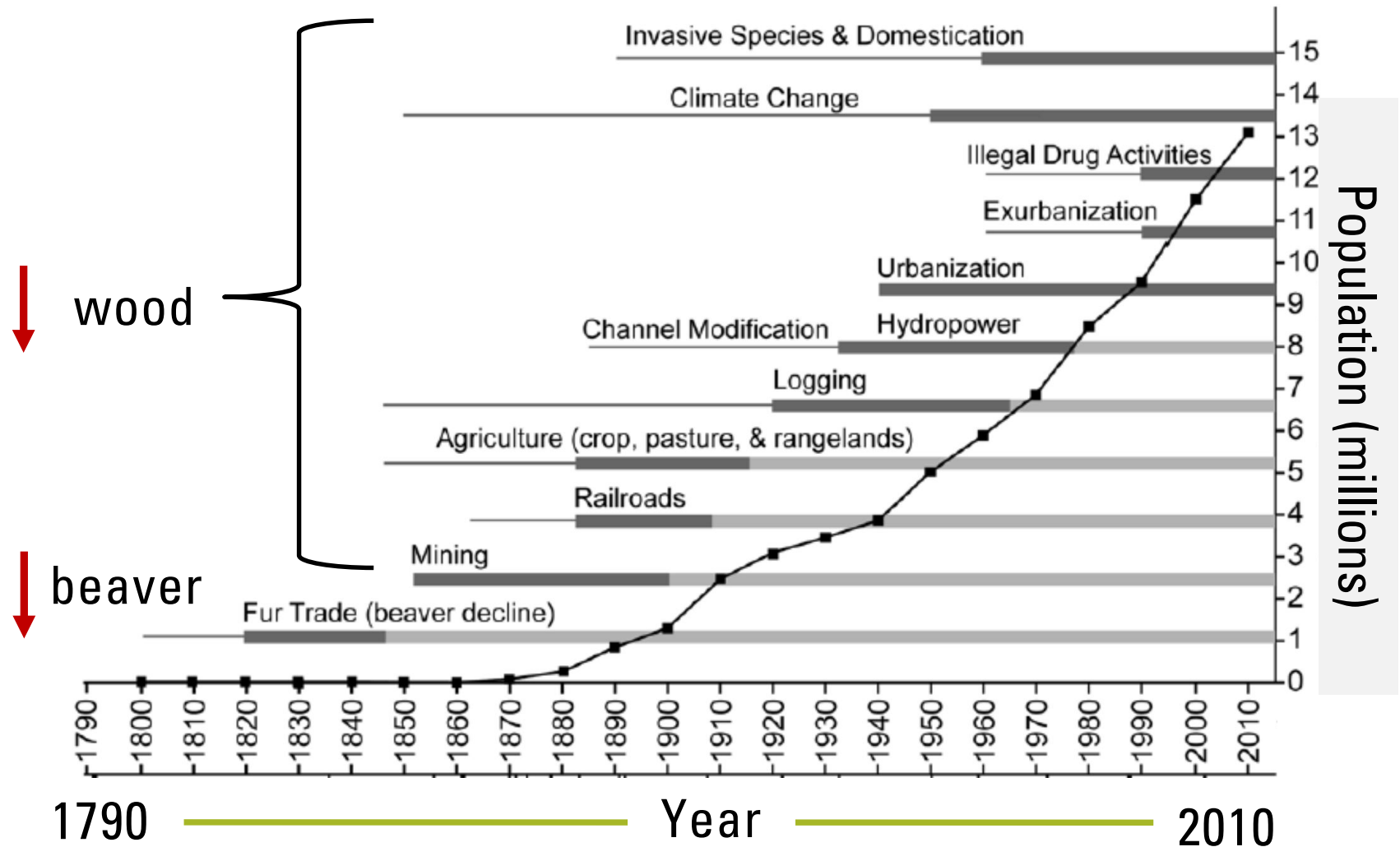


[Urban Stream Ecosystem \(PDF\)](#)



USGS

Underlying Low-Tech PBR is Structural Starvation Hypothesis



Development (bars) and population change (line) in the Columbia River Basin. Dark bars = peak development; light bars = continued effects (Rieman et al. 2015).

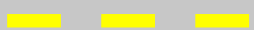
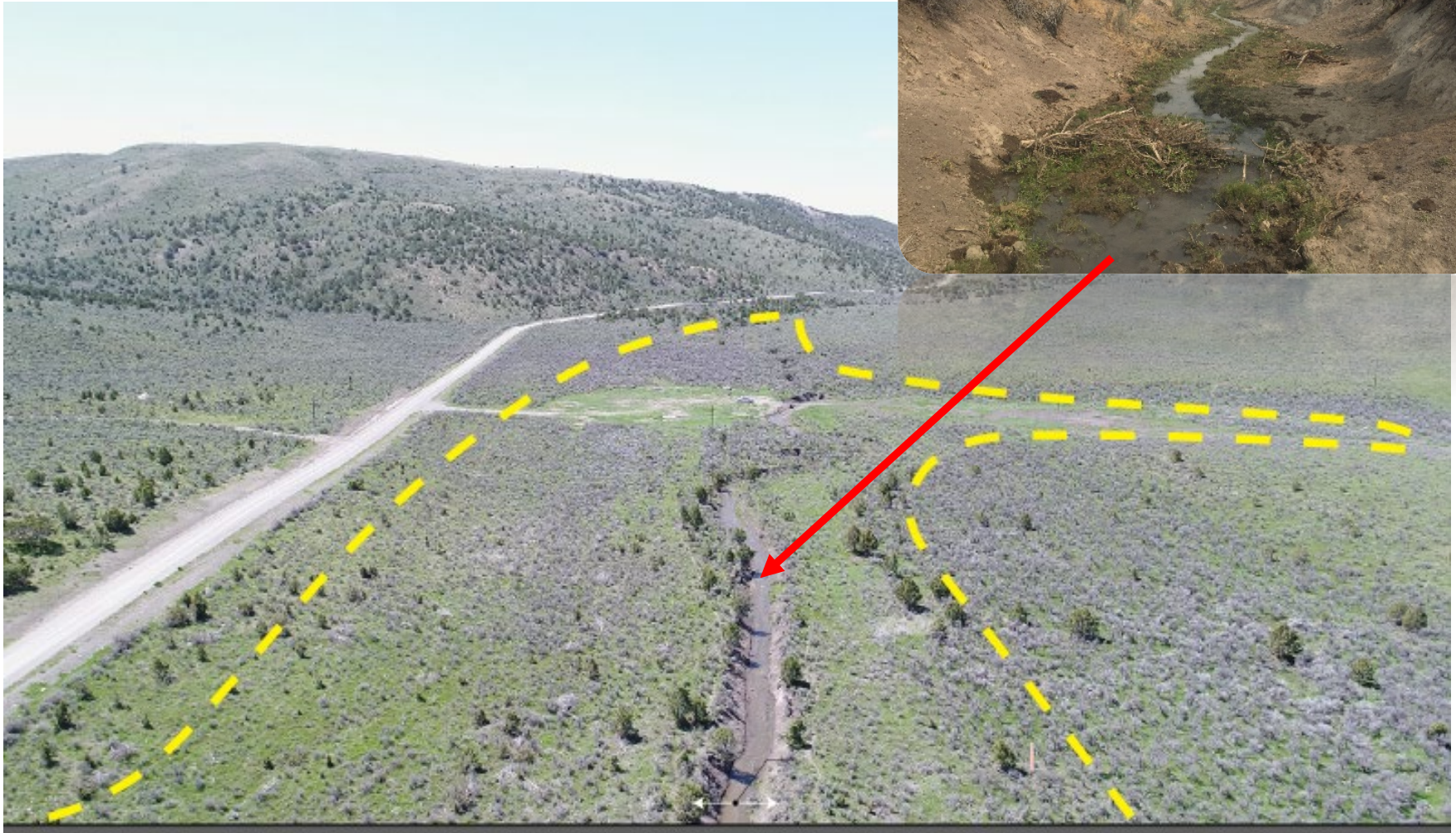
Scope of Riverscapes Problem We Have Lots of This



Adapted from Figure 1.2 (p 31) of Shahverdian et al. (2019) –
Chapter 1 LTPBR Manual DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

Any Old Forgotten Creek, Western US

What's been lost



Historic valley bottom

Adapted from Figure 1.2 (p 31) of Shahveredian et al. (2019) –
Chapter 1 LTPBR Manual DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

Structurally-Starved Bowling Alleys

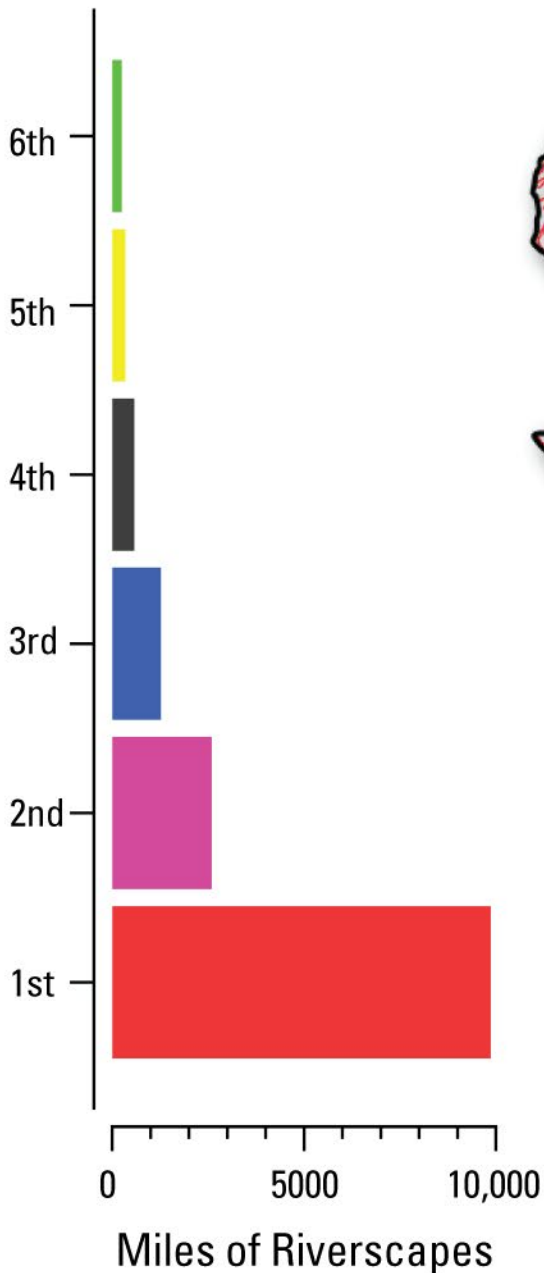


Deceptive.... Young forest, low wood input, locked in, & efficient transport system.

We need scalable solutions... URGENTLY

WADEABLE

Stream Order

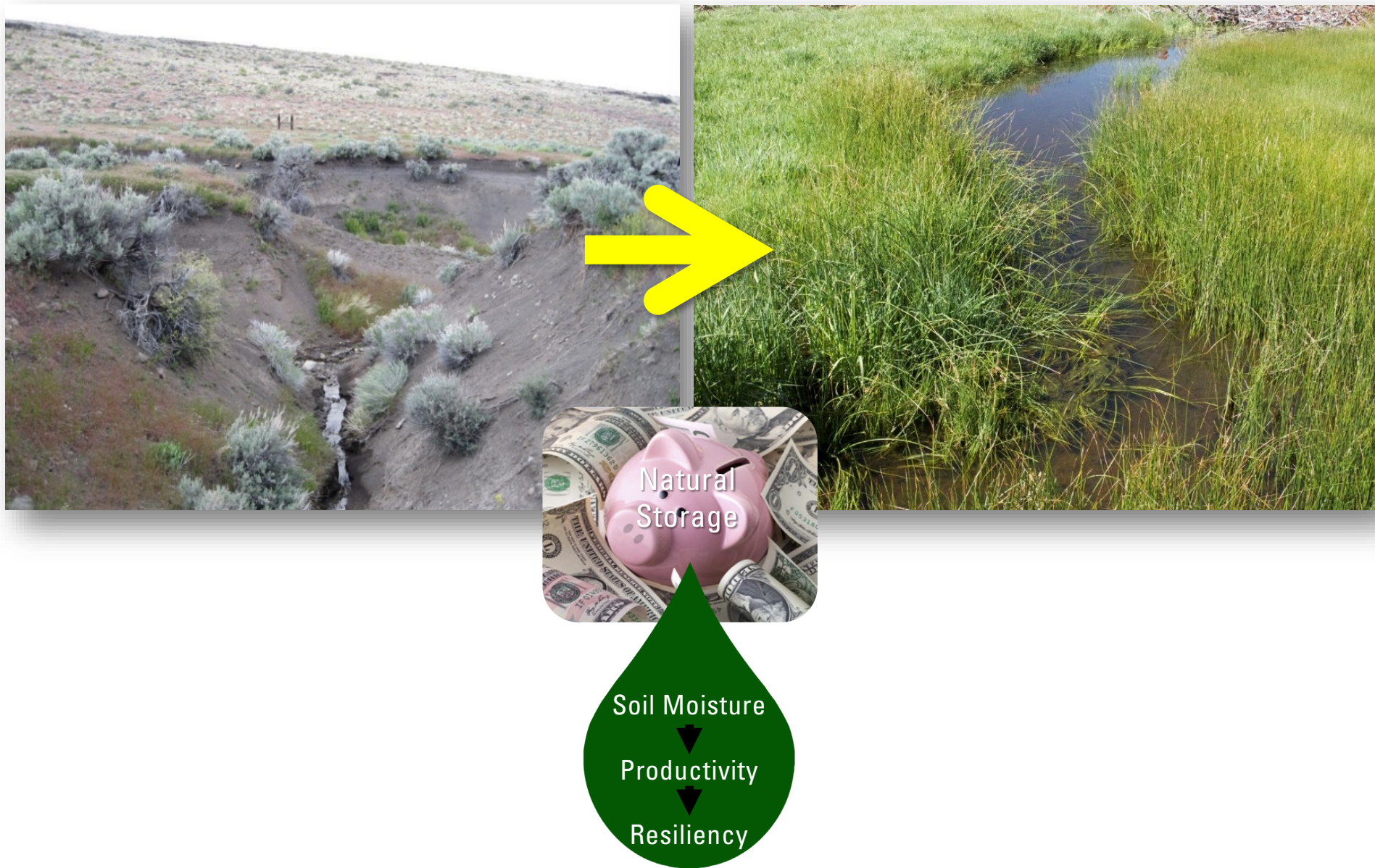


In the West, Water is Life



Photo by: MT Stockgrowers Assoc.

Re-wetting the “sponge”



Shared Vision: **Resiliency**



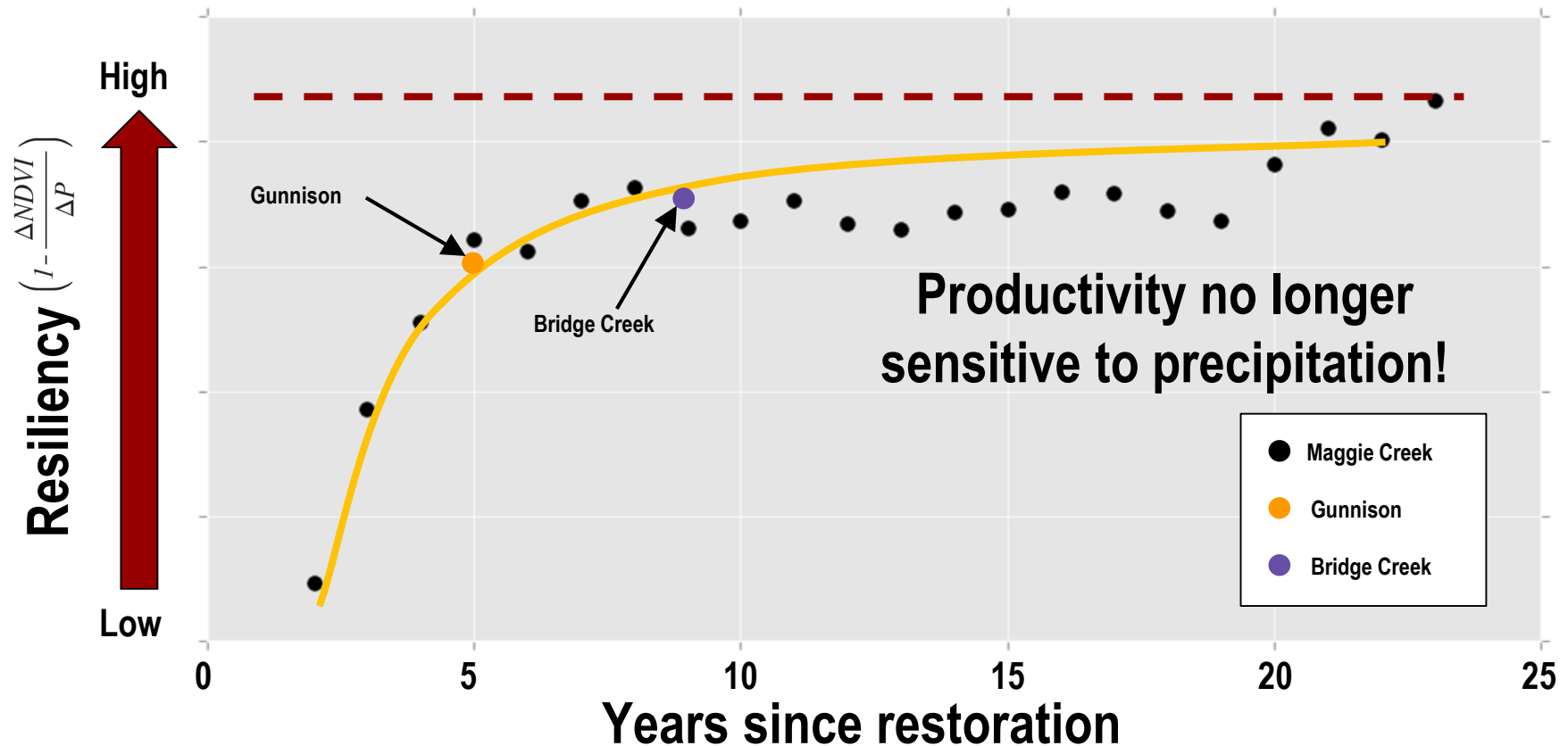
“The ability to maintain hydrologic/ecological functions in the face of drought & intense precipitation events”

~ Gunnison Climate Working Group

BUILDING RESILIENCY OVER TIME...

Silverman et al. (2018)

DOI: <https://doi.org/10.1111/rec.12869>



Zeedyk Structures

(Short-term: 2-5 yrs)



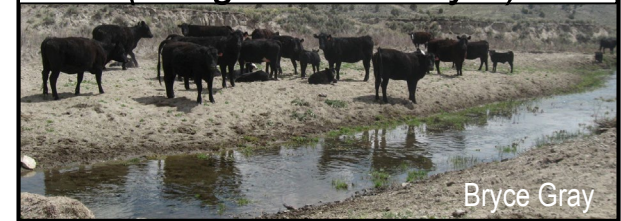
Beaver Dam Analogs

(Mid-term: 9 yrs)



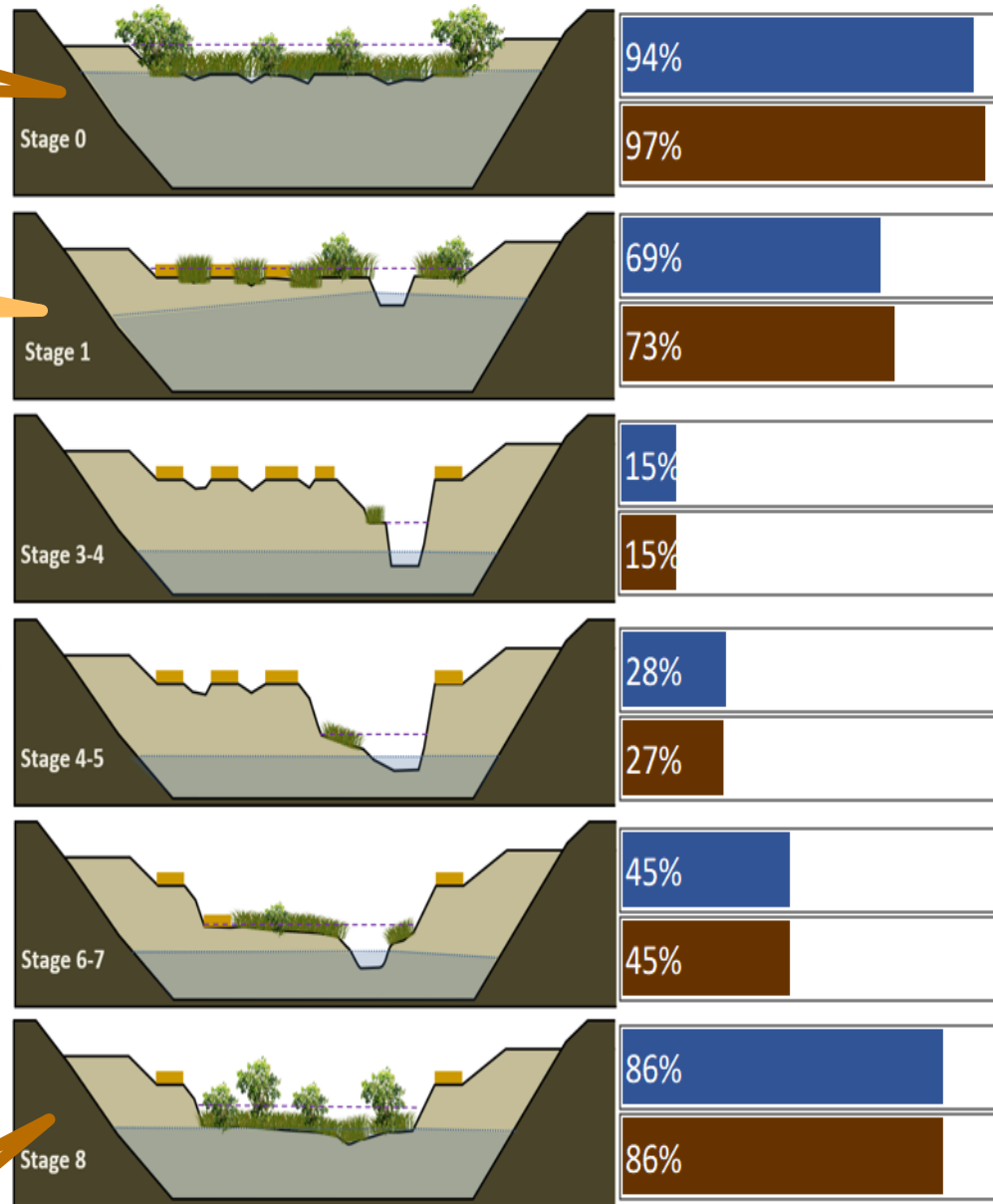
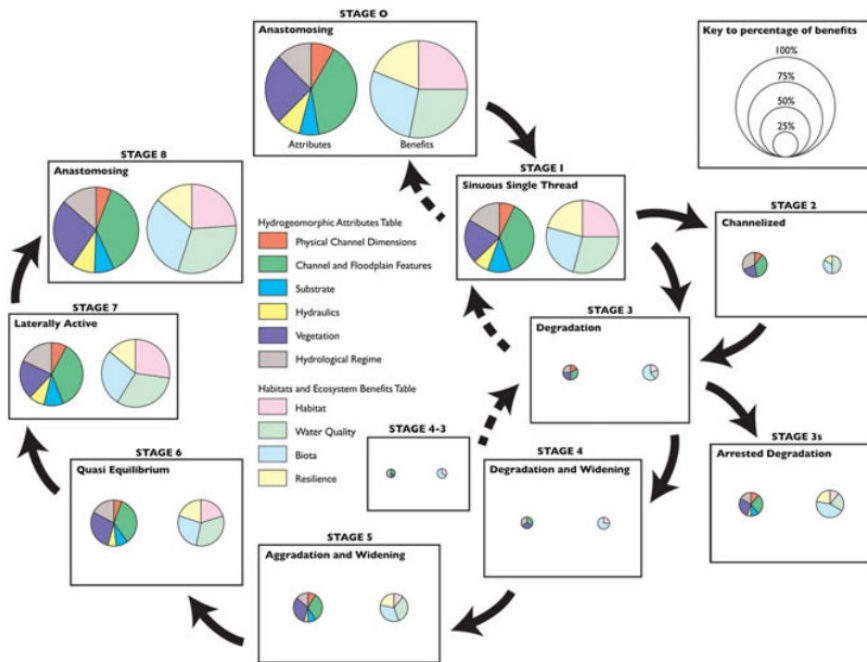
Grazing Management

(Long-term: 20+ yrs)



Go to Zero
... You're a hero!

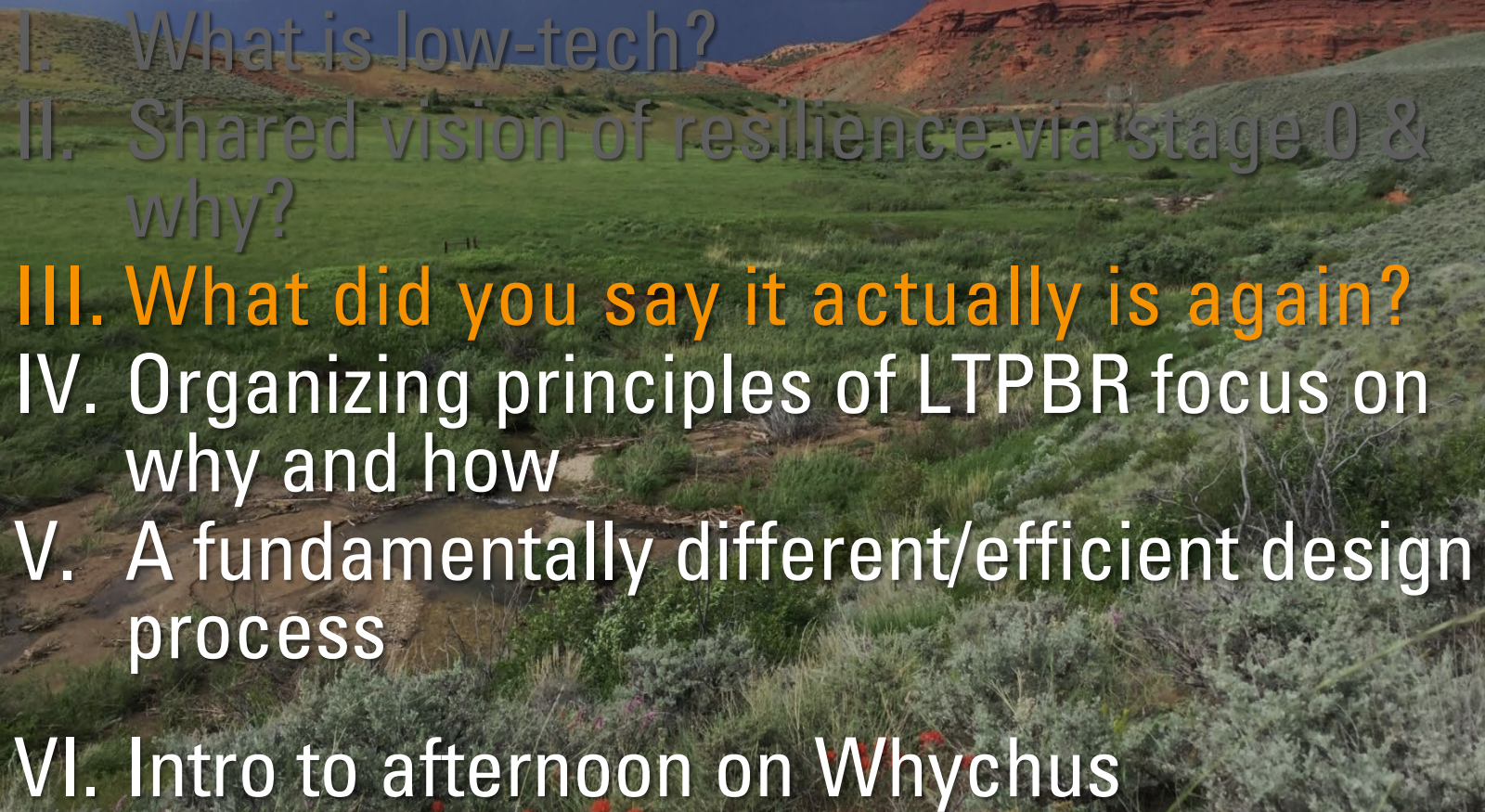
Go to One
... Ho hum.



But if it's too late
... Eight is great!

Hydrogeomorphic attributes
Habitat and ecosystem benefits

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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



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

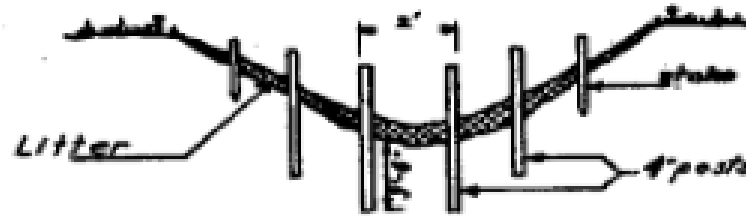


Figure 21
Elevation of gully after banks have been dug back. The posts have been set, and the layer of litter has been placed.

- **Build in phases**
- **Temporary, simple, pervious**

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

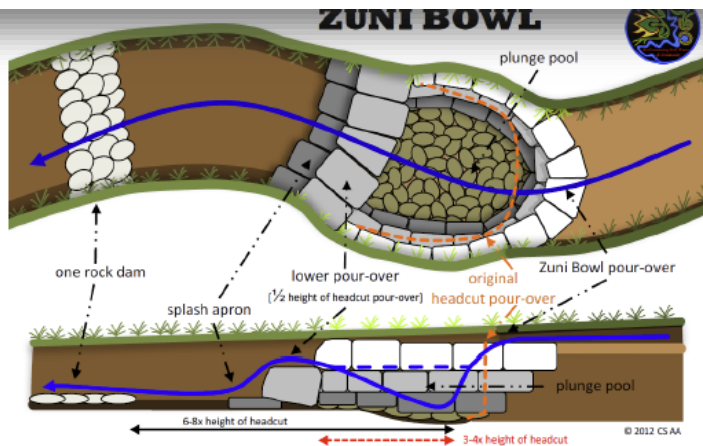
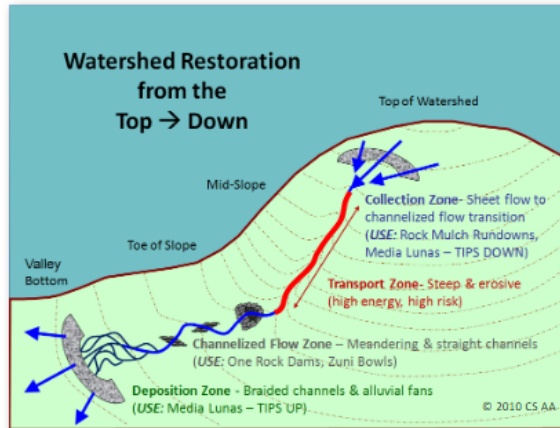


Figure 8. Zuni Bowl plan and cross-sectional views (Sponholtz and Anderson 2013; figure courtesy of C. Sponholtz).

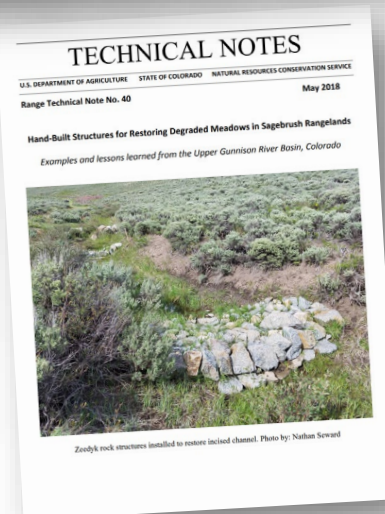
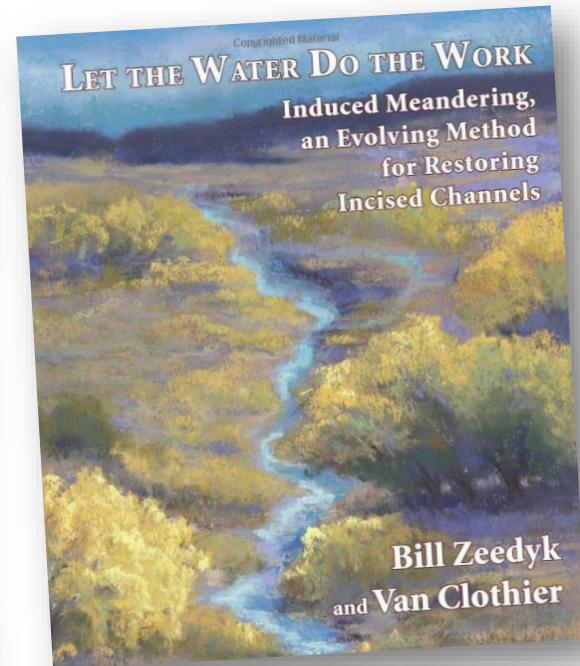


Table 5 – A list of typical low-tech approaches to promoting specific process-based restoration outcomes.

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)

Low-tech structures to mimic



Beaver dams



**Wood
accumulations**

Mimic → **Promote** → **Sustain**



Beaver dams
Beaver Dam Activity



Wood
accumulations

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

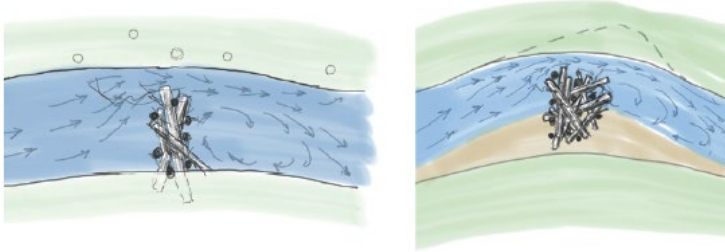
- BDAs are handbuilt structures that mimic and promote the processes of **beaver dam activity**.
- BDAs are a permeable, channel-spanning structure with a constant crest elevation, constructed with a mixture of woody debris and fill material to promote temporary ponding of water.



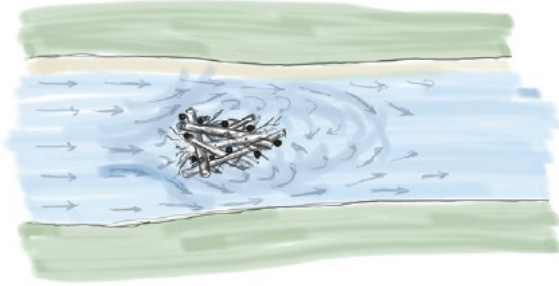
From Page 23 of Pocket Guide; Wheaton et al. (2019)

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

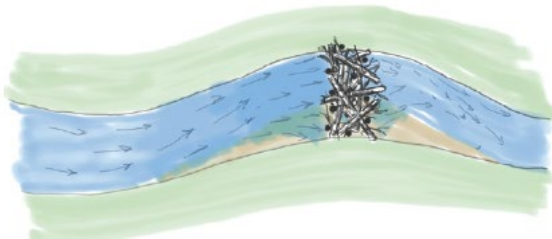
BANK-ATTACHED PALS



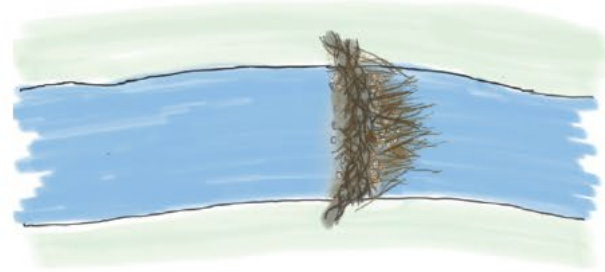
MID-CHANNEL PALS



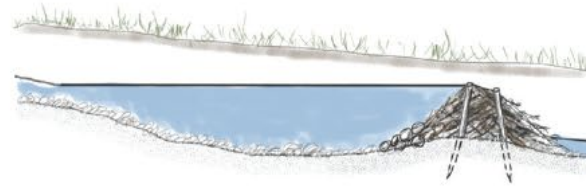
CHANNEL-SPANNING PALS



POSTLESS BDA



POST-ASSISTED BDA

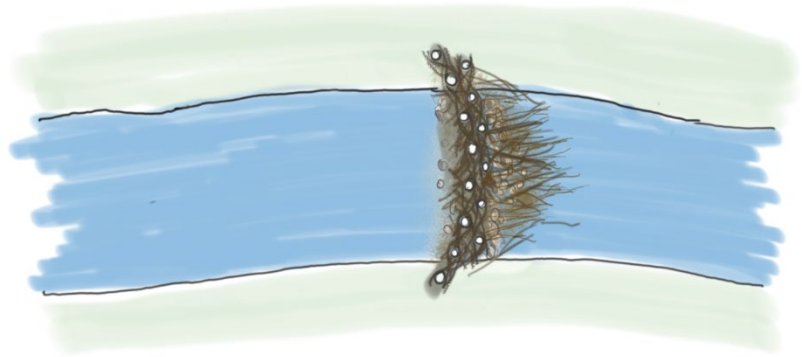


POST-LINE WICKER WEAVE

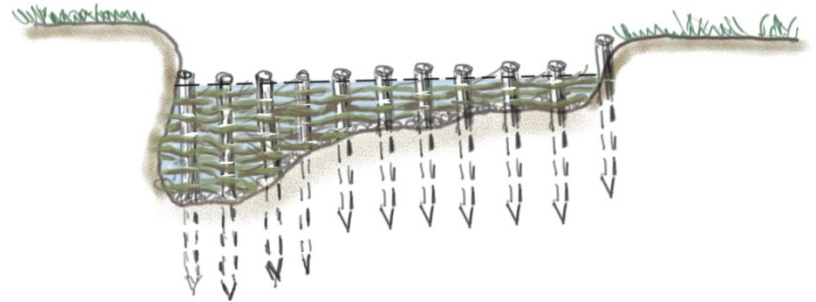


Post-Line Wicker Weave (Beaver Dam Analog v.1)

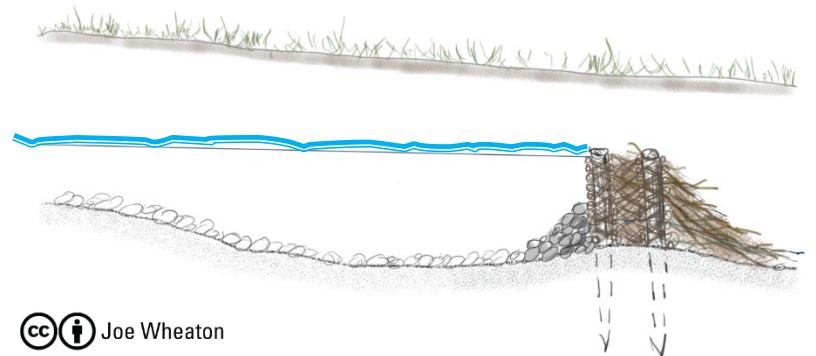
Planform



Cross-section



Profile



CC BY Joe Wheaton

Flow



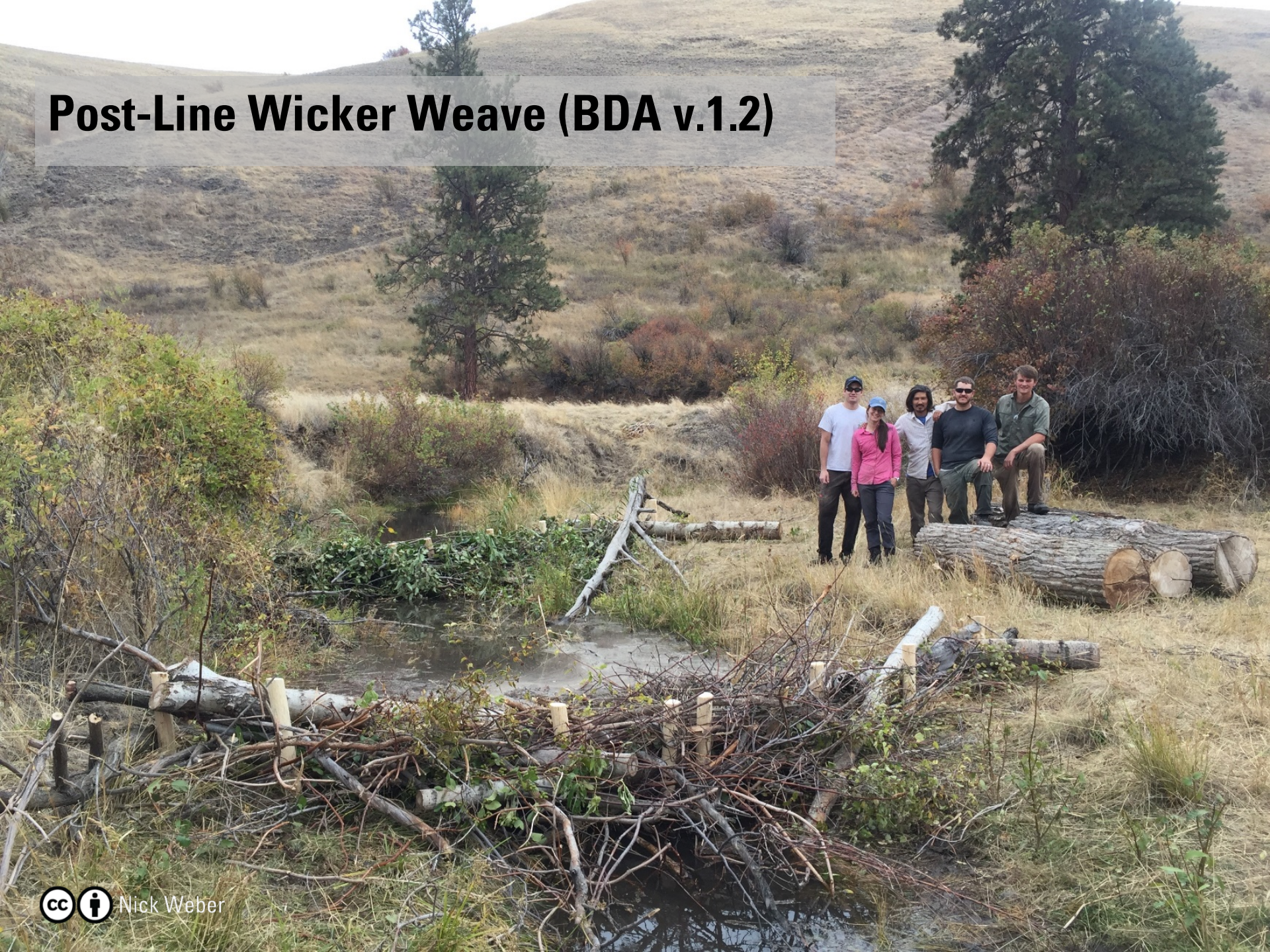
Post-Line Wicker Weave (BDA v.1)



Post-Line Wicker Weave (BDA v.1.1)

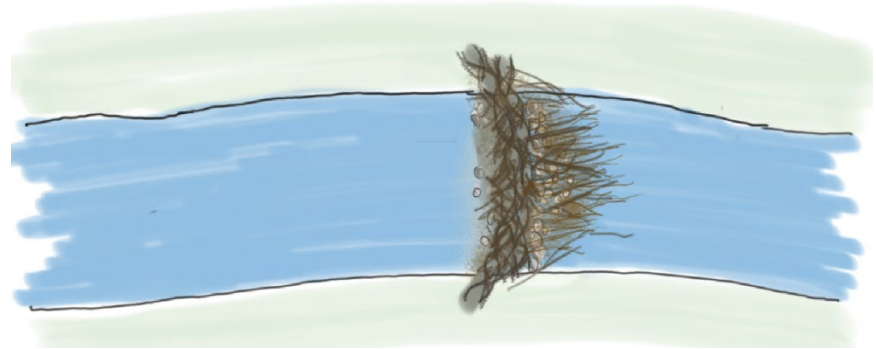


Post-Line Wicker Weave (BDA v.1.2)

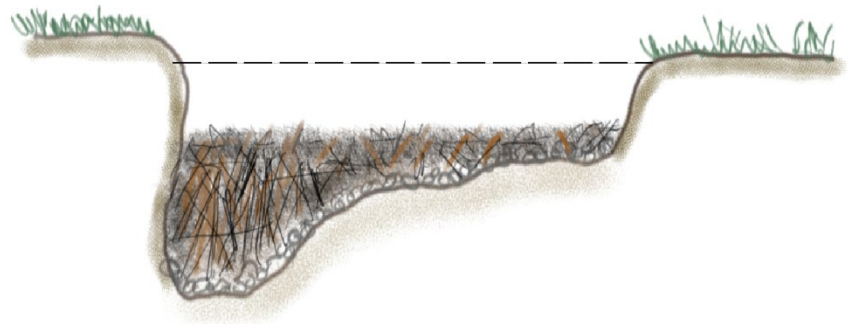


Postless beaver dam analogues (BDA v.2.0)

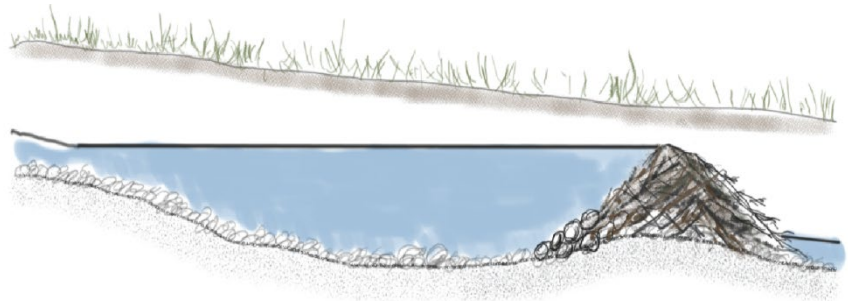
Planform



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!

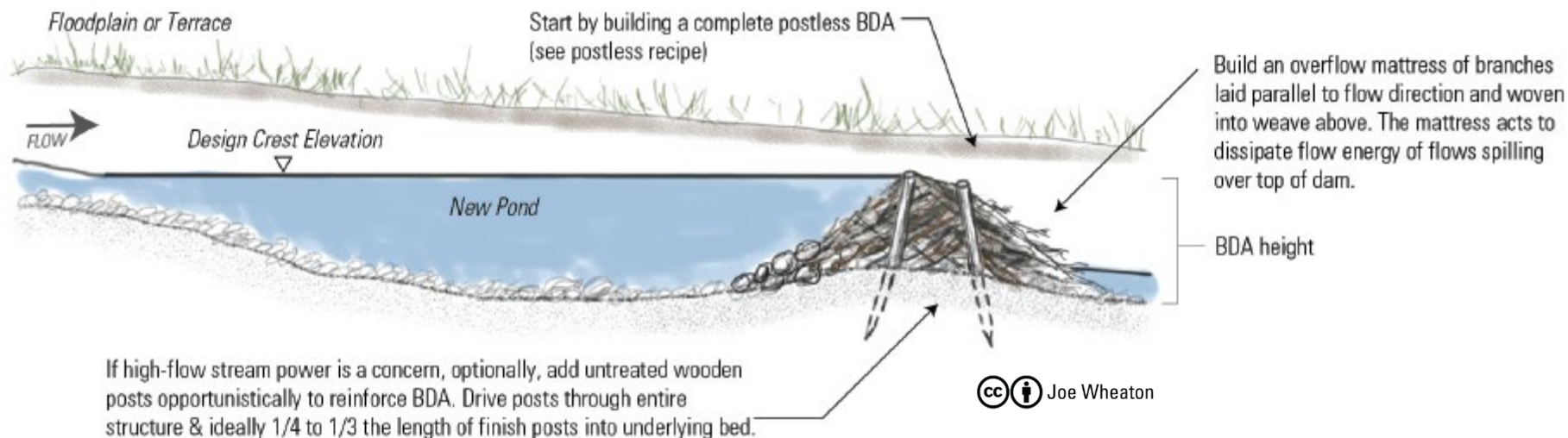


POST-ASSISTED BDA

- 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



What about mimicking wood accumulation?



Natural wood accumulations





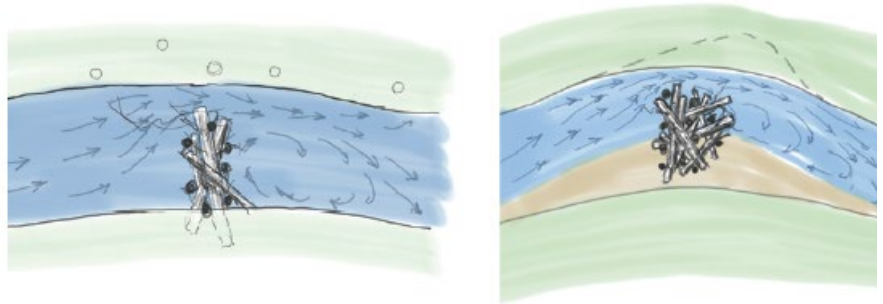
Complexity, Overbank Flow

How do we mimic wood accumulations?

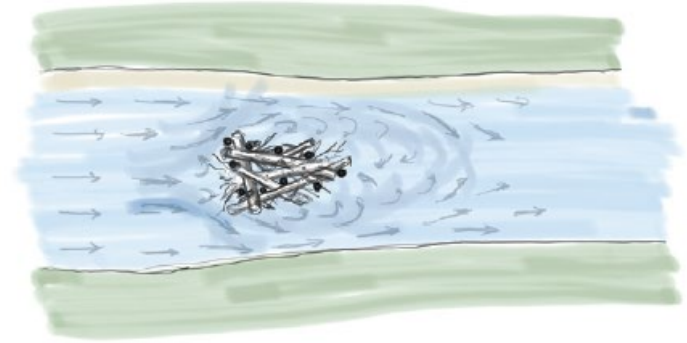


Types of Post-Assisted Log Structures (PALS)

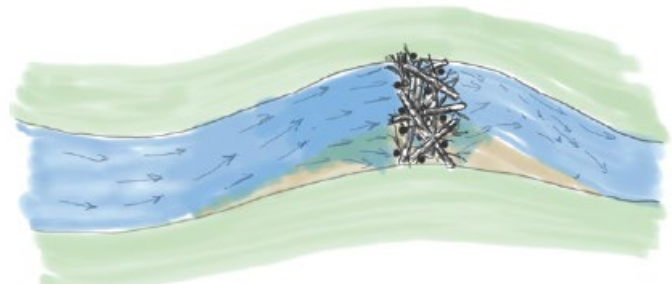
BANK-ATTACHED PALS



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

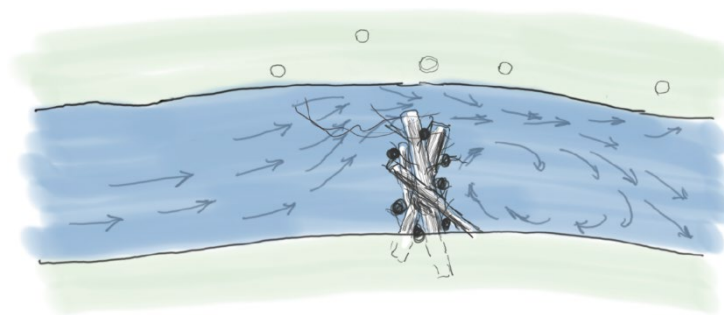
LTPBR Manual DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

PALS or BDA?

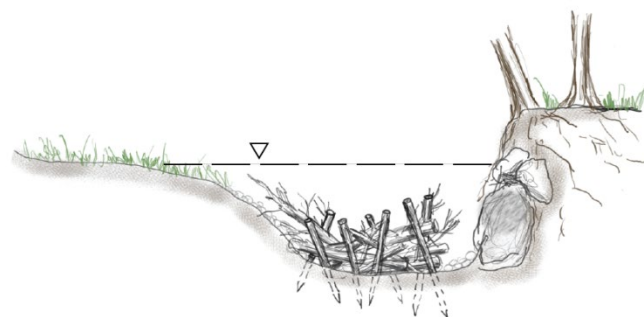


Bank-attached PALS - Constriction Jet

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

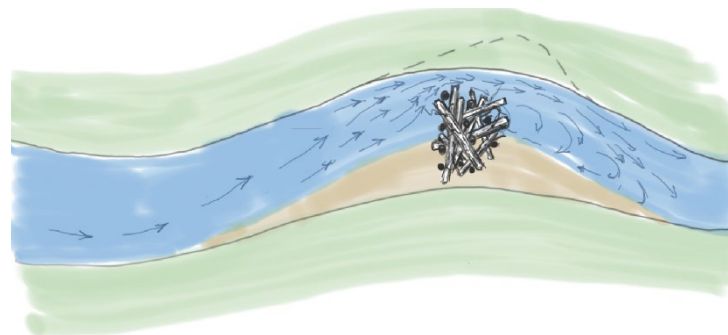


Bank-attached PALS - Constriction Jet

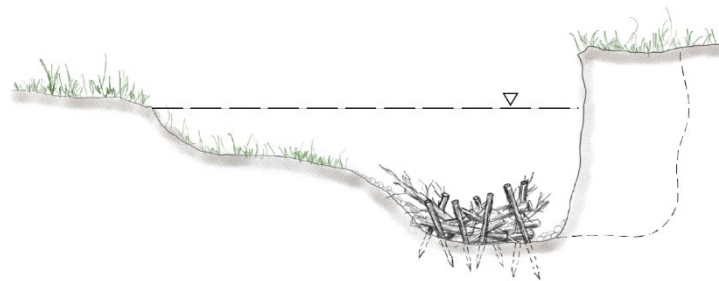


Bank-attached PALS – Bank Blaster

Planform



Cross-section



Profile



Flow



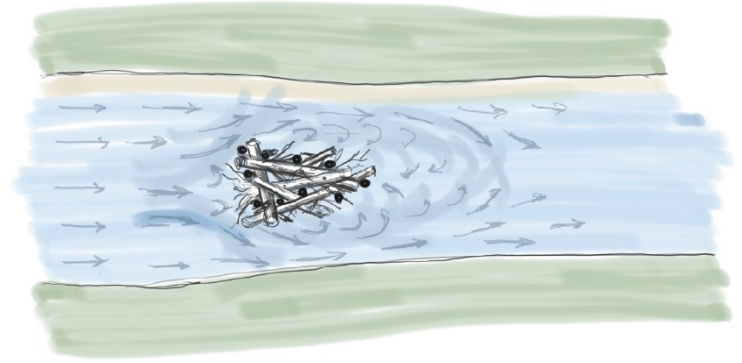
Bank-attached PALS – Bank Blaster



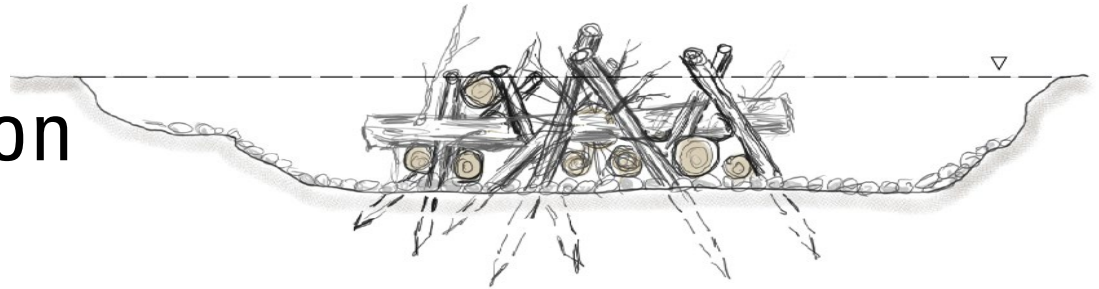
Photo from Joshua White, 2019 (USFWS)

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)

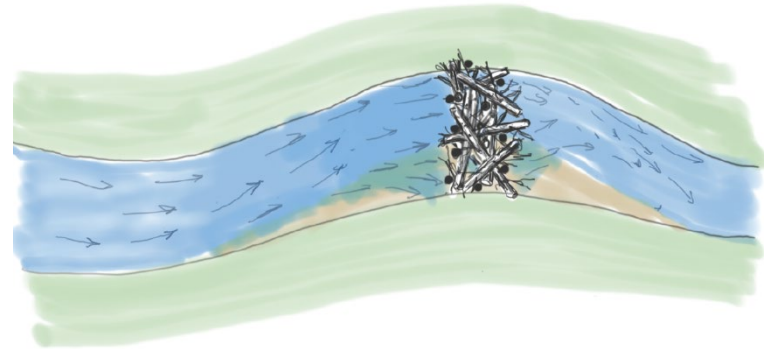
Flow 

Mid-channel PALS

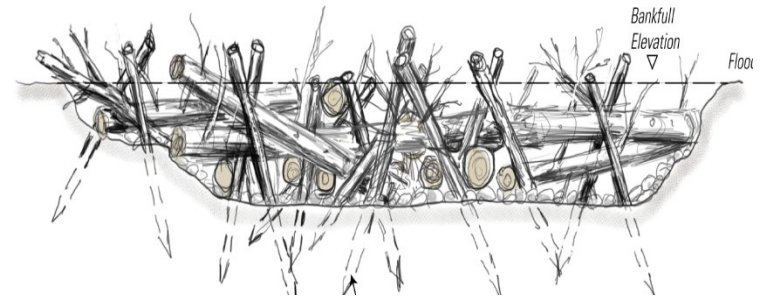


Channel spanning PALS

Planform



Cross-section



Profile



Adapted from Figure 4.26 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



Mimic wood accumulations – Channel spanning PALS

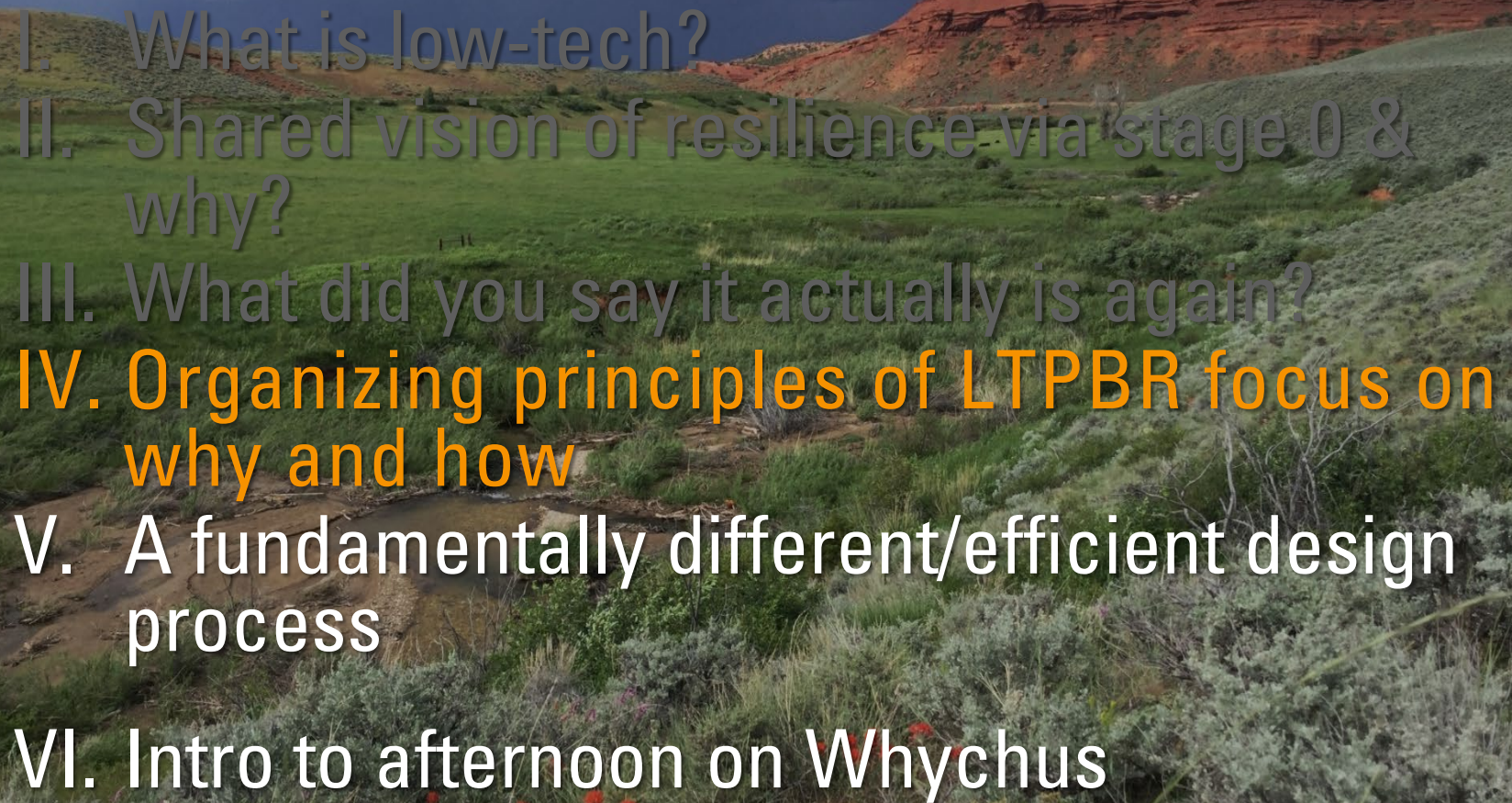


ANABRANCH
SOLUTIONS

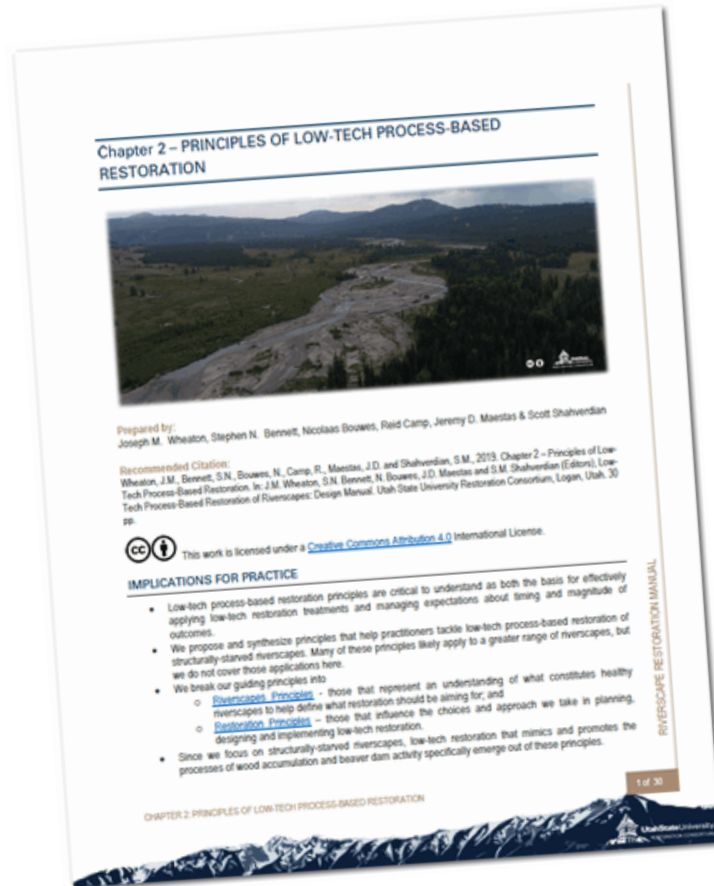
Mimic wood accumulations – Channel spanning PALS



OUTLINE: Intro to LTPBR for Stage 0

- 
- I. What is low-tech?
 - II. Shared vision of resilience via stage 0 & why?
 - III. What did you say it actually is again?
 - IV. Organizing principles of LTPBR focus on why and how
 - V. A fundamentally different/efficient design process
 - VI. Intro to afternoon on Whychus

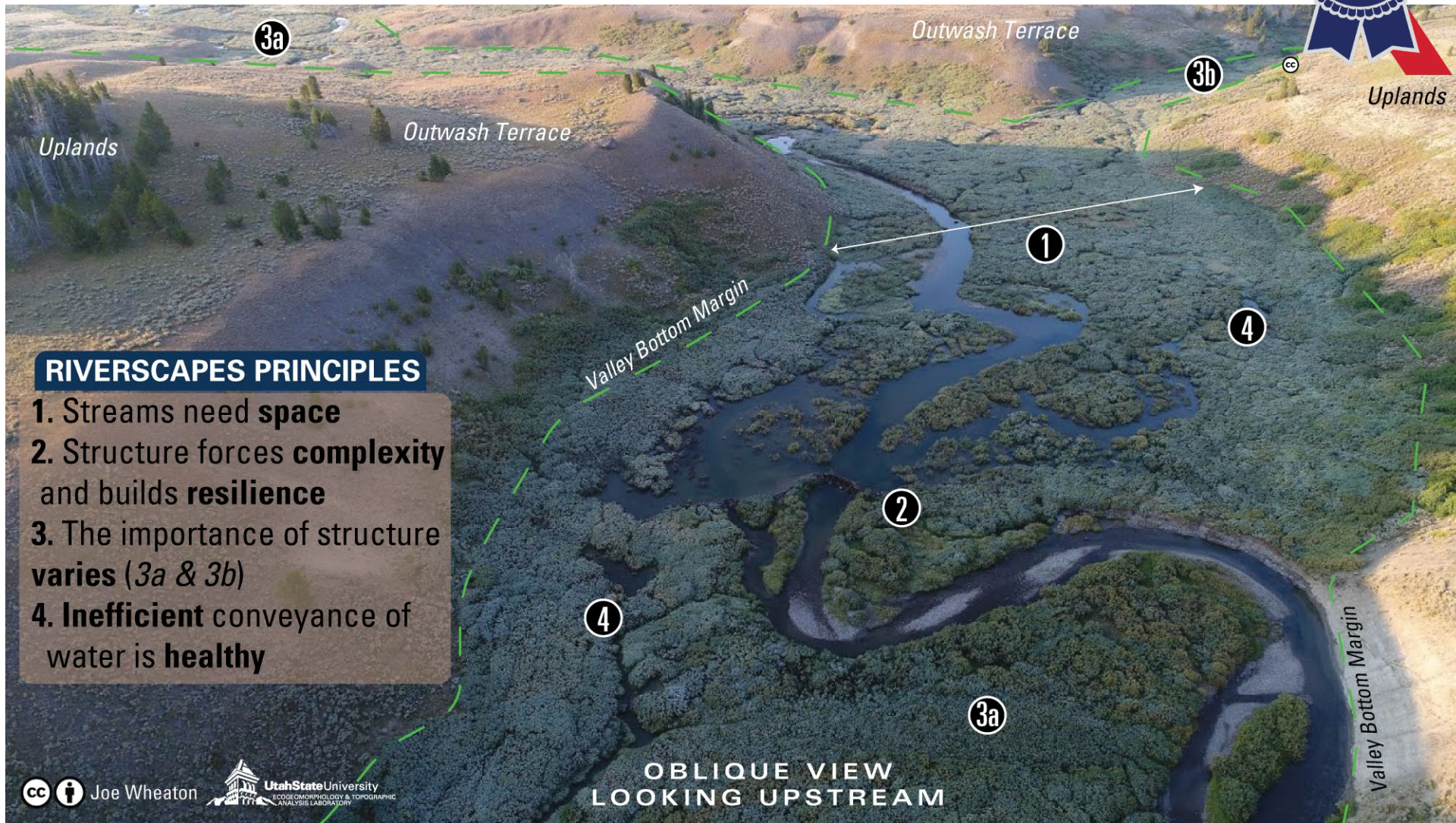
Design Manual References – Chapter 2



Chap 2: Wheaton et al. (2019a)
DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

From pages 1-6 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)

Riverscapes Principles



RIVERSCAPES PRINCIPLES

1. Streams need **space**
2. Structure forces **complexity** and builds **resilience**
3. The importance of structure **varies** (3a & 3b)
4. **Inefficient** conveyance of water is **healthy**

From pages 3-4 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 Wheaton et al. (2019, p 60): Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

STREAMS NEED SPACE

RIVERSCAPES PRINCIPLE 1.

Healthy streams are dynamic, regularly shifting position within their valley bottom, re-working and interacting with their floodplain. Allowing streams to adjust within their valley bottom is essential for maintaining functioning riverscapes.

- Give rivers back their floodplains
- Assess what a river needs to *exercise* during floods
- Either reclaim, or conserve space to flood

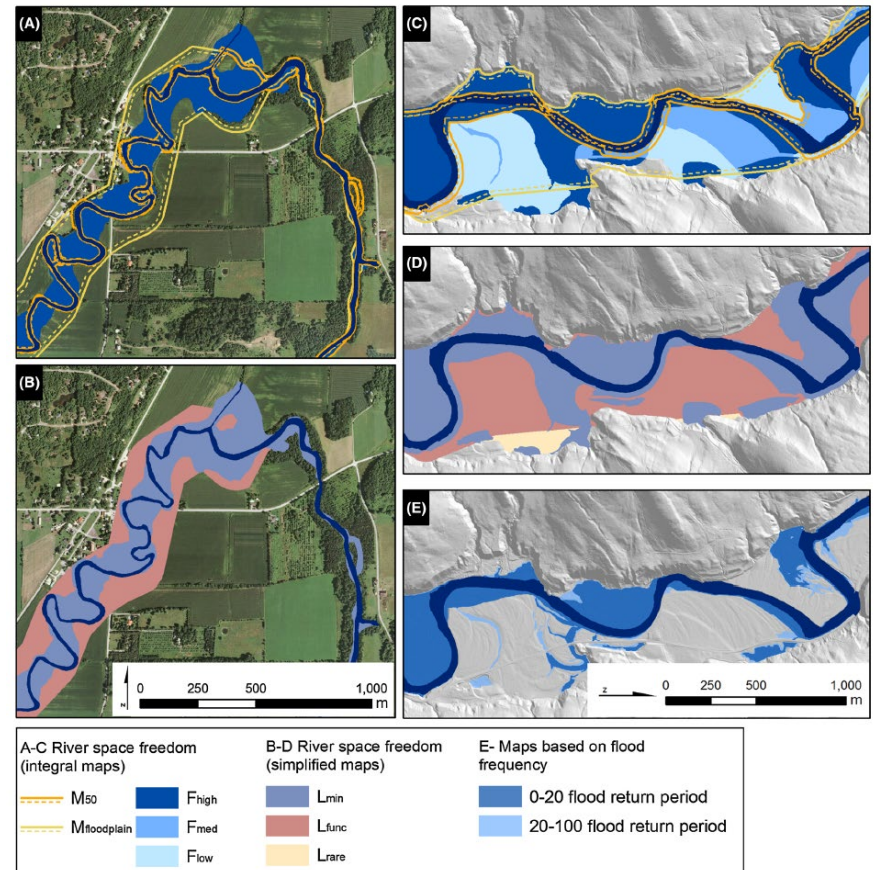
From pages 1-2 of Pocket Guide; Wheaton et al. (2019)

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

See Wheaton et al. (2019, p 61)

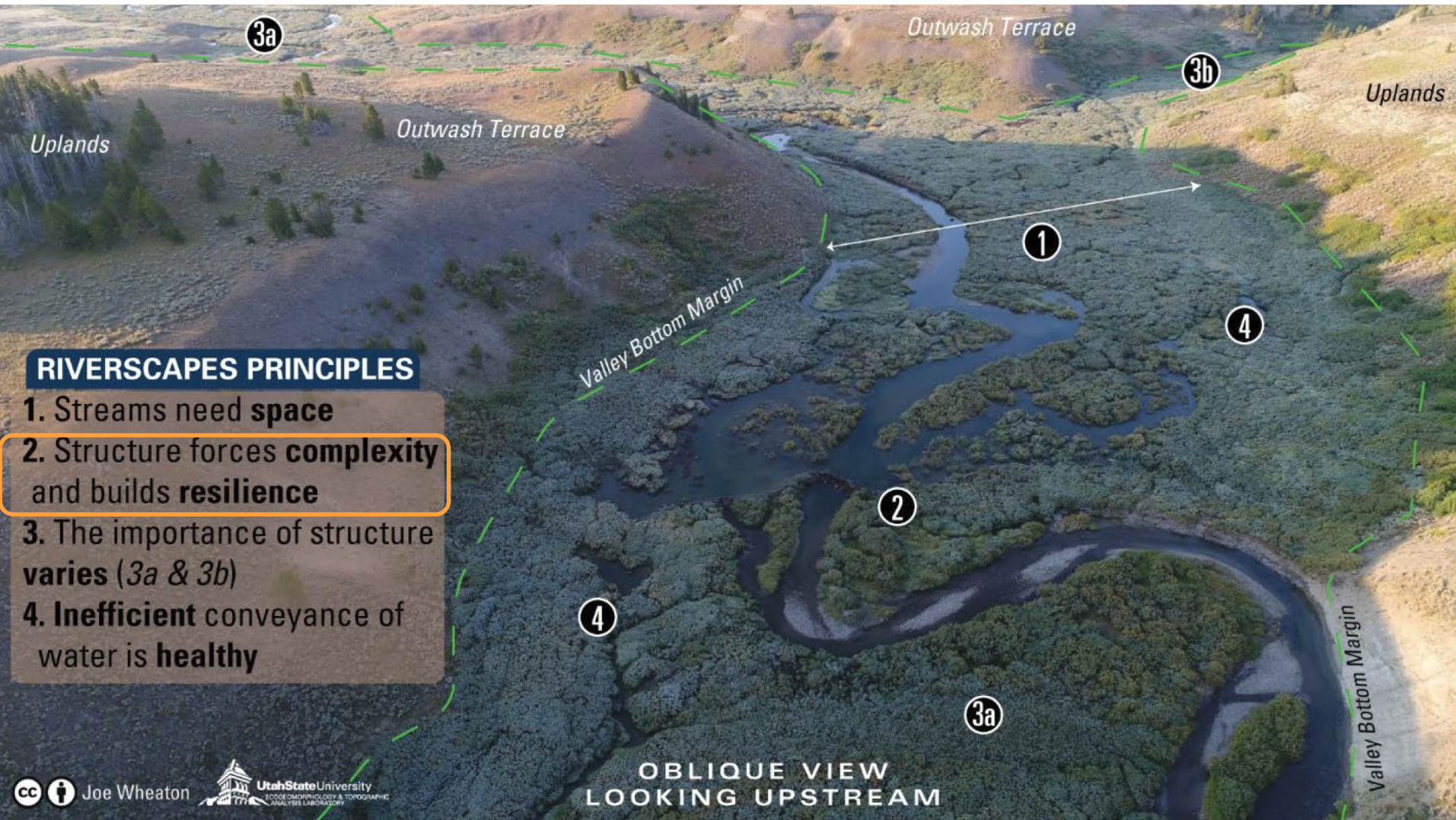
Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)



e.g. Biron (2014). Freedom space for rivers: a sustainable management approach to enhance river resilience. DOI: [10.1007/s00267-014-0366-z](https://doi.org/10.1007/s00267-014-0366-z).

Structural Forcing of key processes



From pages 3-4 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 Wheaton et al. (2019, p 60): Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

STRUCTURE FORCES COMPLEXITY & BUILDS RESILIENCE

RIVERSCAPES PRINCIPLE 2.

Pocket Guide; Wheaton et al. (2019, p. 5)

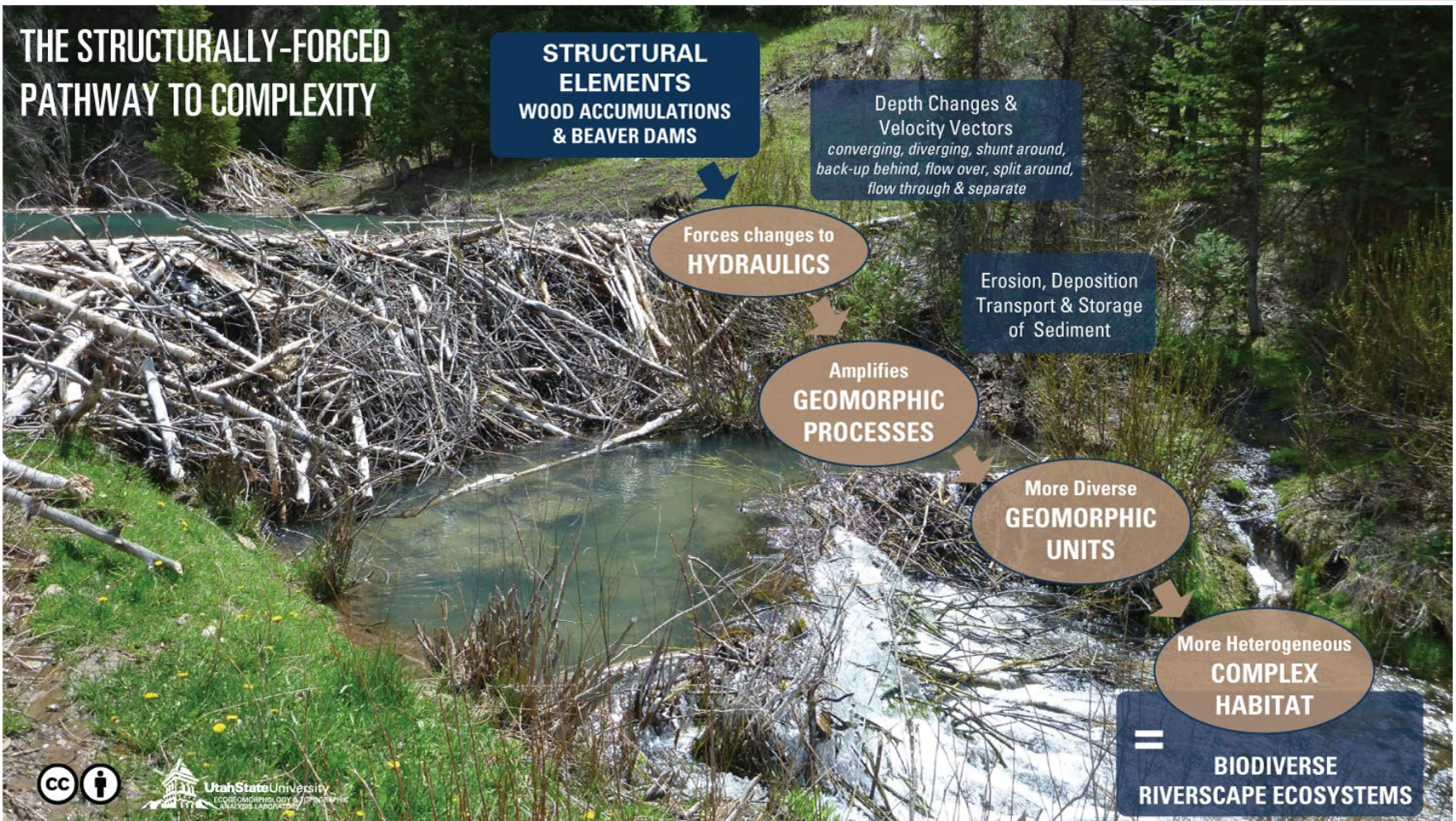
DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See Wheaton et al. (2019, p 64)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)


Structural elements such as beaver dams and large woody debris force changes in flow patterns that produce physically diverse habitats. Physically diverse habitats are more resilient to disturbances than simplified, homogeneous habitats.



Key Processes to Promote



WOOD ACCUMULATION on a
Post-Assisted Log Structure (PALS)



BEAVER DAM ACTIVITY on a
beaver dam analogue (BDA)

From Shahveridan et al. (2019)

Chap 4 LTPBR Manual

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

Need A Simple Before & After?

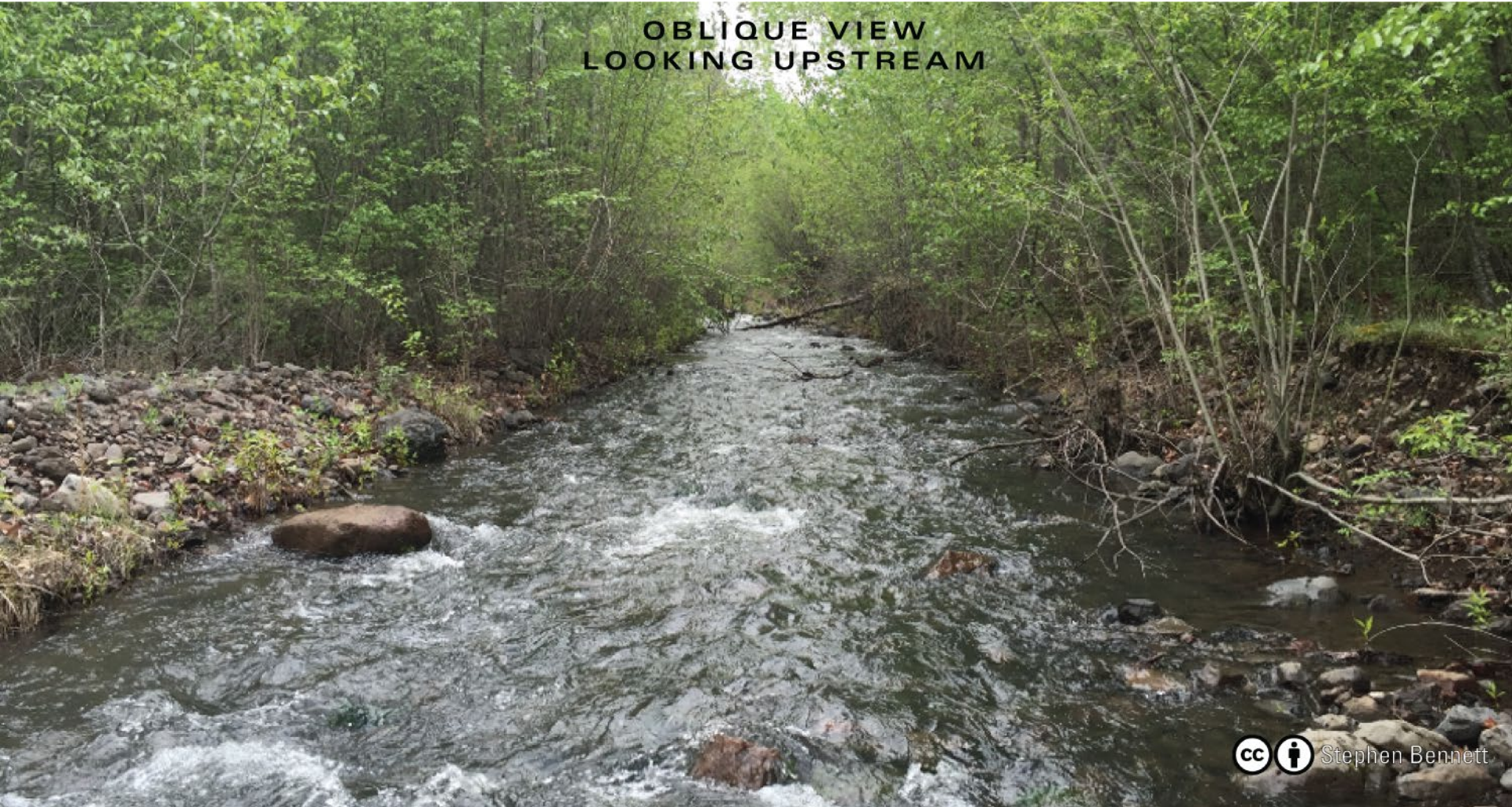
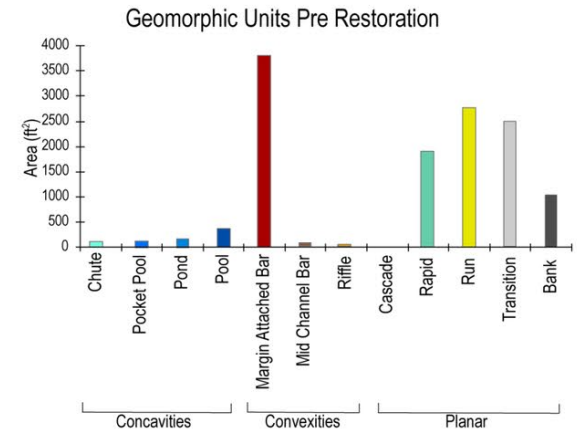
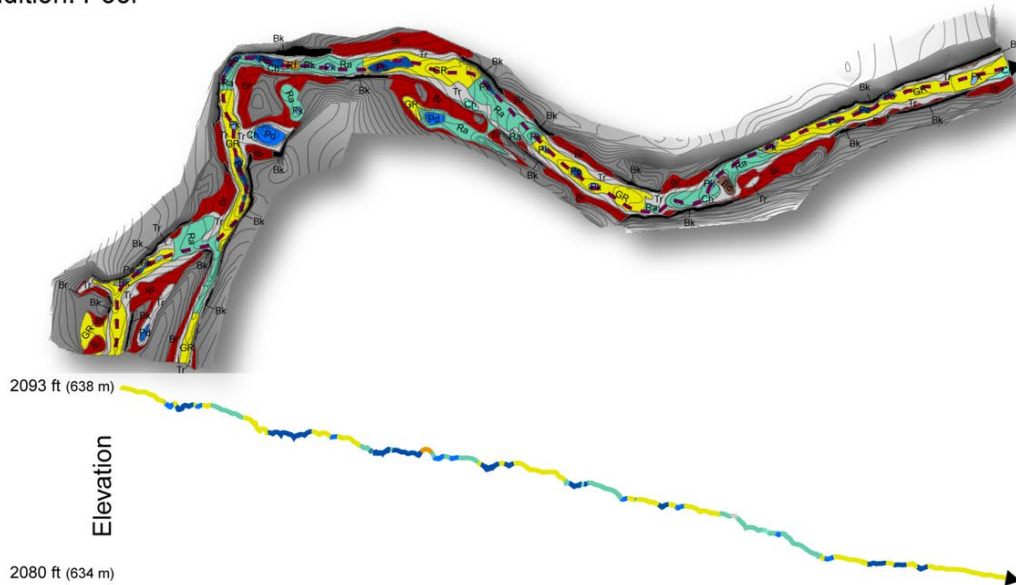


Figure 1.3 (p 32) of Shahverdian et al. (2019) – Chapter 1 LTPBR
Manual DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

Condition: Poor



- Plane bed dominated (rapids & runs)
- Starved of wood..
- Limited interaction with floodplain



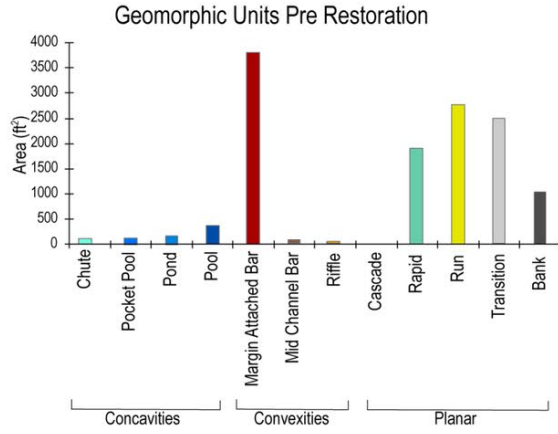
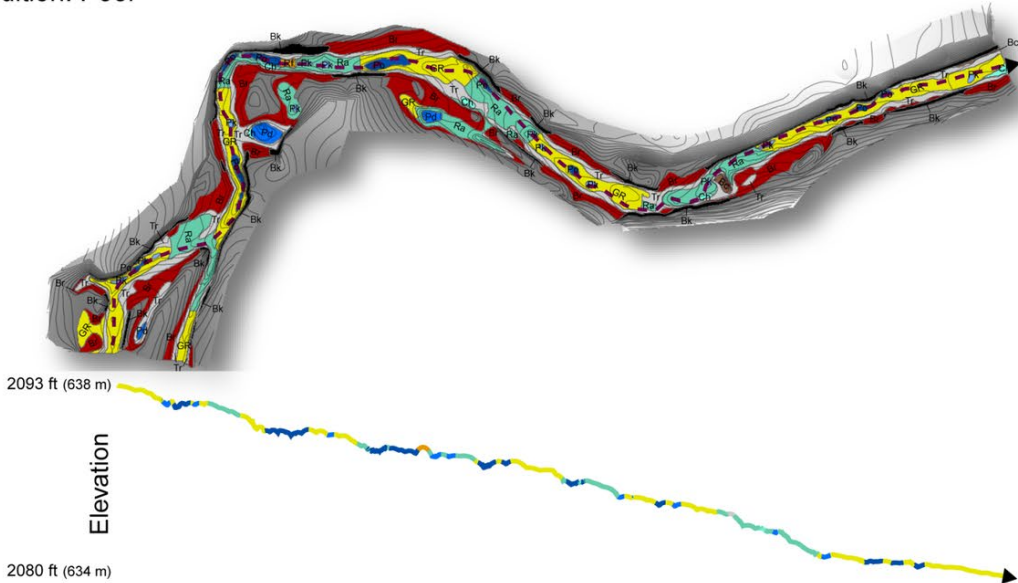
Adding P.A.L.S. (Wood)

HDLOWD

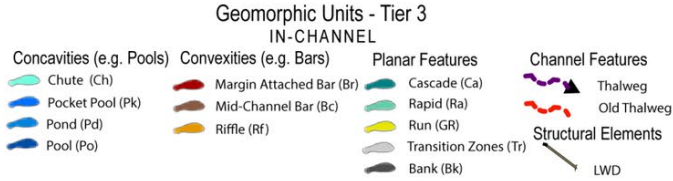
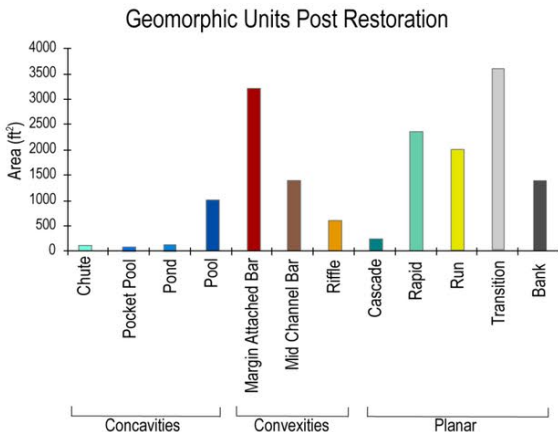
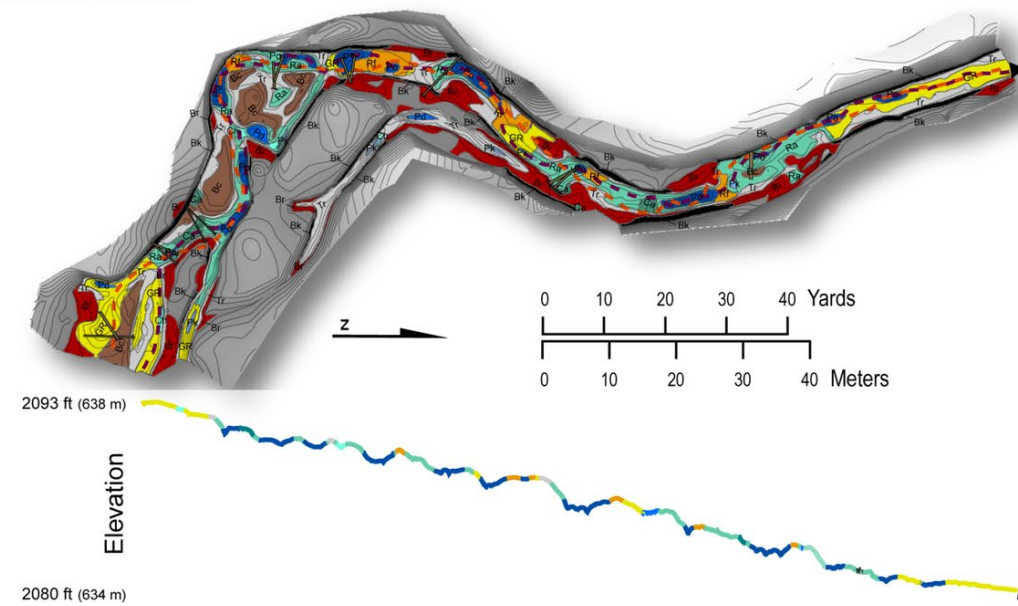


STRUCTURE FORCES COMPLEXITY & BUILDS RESILIENCE
RIVERSCAPES PRINCIPLE 2.

Condition: Poor



Condition: Moderate





NATURAL RESOURCES CONSERVATION SERVICE

On the Range, Water Is Life

Help Conserve Wet Habitat in Sagebrush Country to Benefit Working Lands and Wildlife



Structurally-Forced Resilience

Riparian areas burnt to ground across entire valley bottom in most the watershed

EXCEPT, where beaver dam complexes kept the valley bottoms wet, the riparian areas did not burn!

STRUCTURE FORCES COMPLEXITY & BUILDS RESILIENCE
RIVERSCAPES PRINCIPLE 2.

Figure 2.6 from Wheaton et al. (2019, p 66)

Chapter 2 LTPBR Manual

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

THE IMPORTANCE OF STRUCTURE VARIES

RIVERSCAPES PRINCIPLE 3.

The relative importance and abundance of structural elements varies based on reach type, valley setting, flow regime and watershed context. Recognizing what type of stream you are dealing with (i.e., what other streams it is similar to) helps develop realistic expectations about what that stream should or could look (form) and behave (process) like.

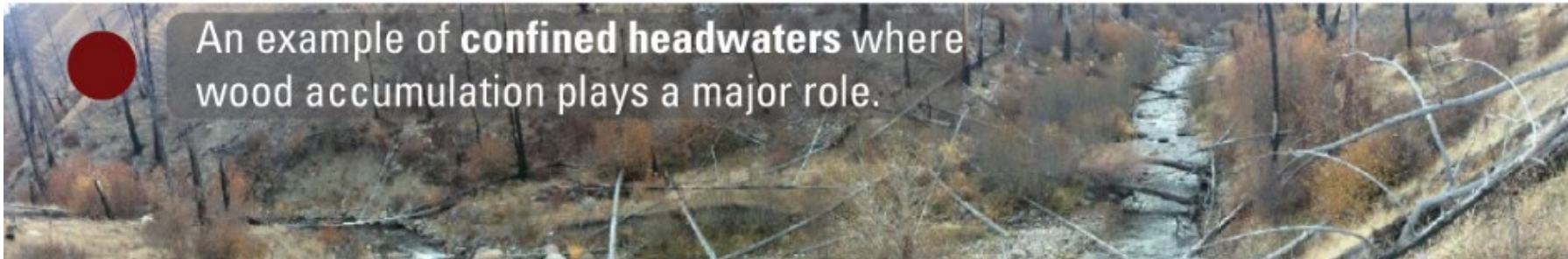
Pocket Guide; Wheaton et al. (2019, p. 8)

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


Figure 2.7 from Wheaton et al. (2019, p 64)

Chapter 2 LTPBR Manual for Principles


DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)



An example of **confined headwaters** where wood accumulation plays a major role.

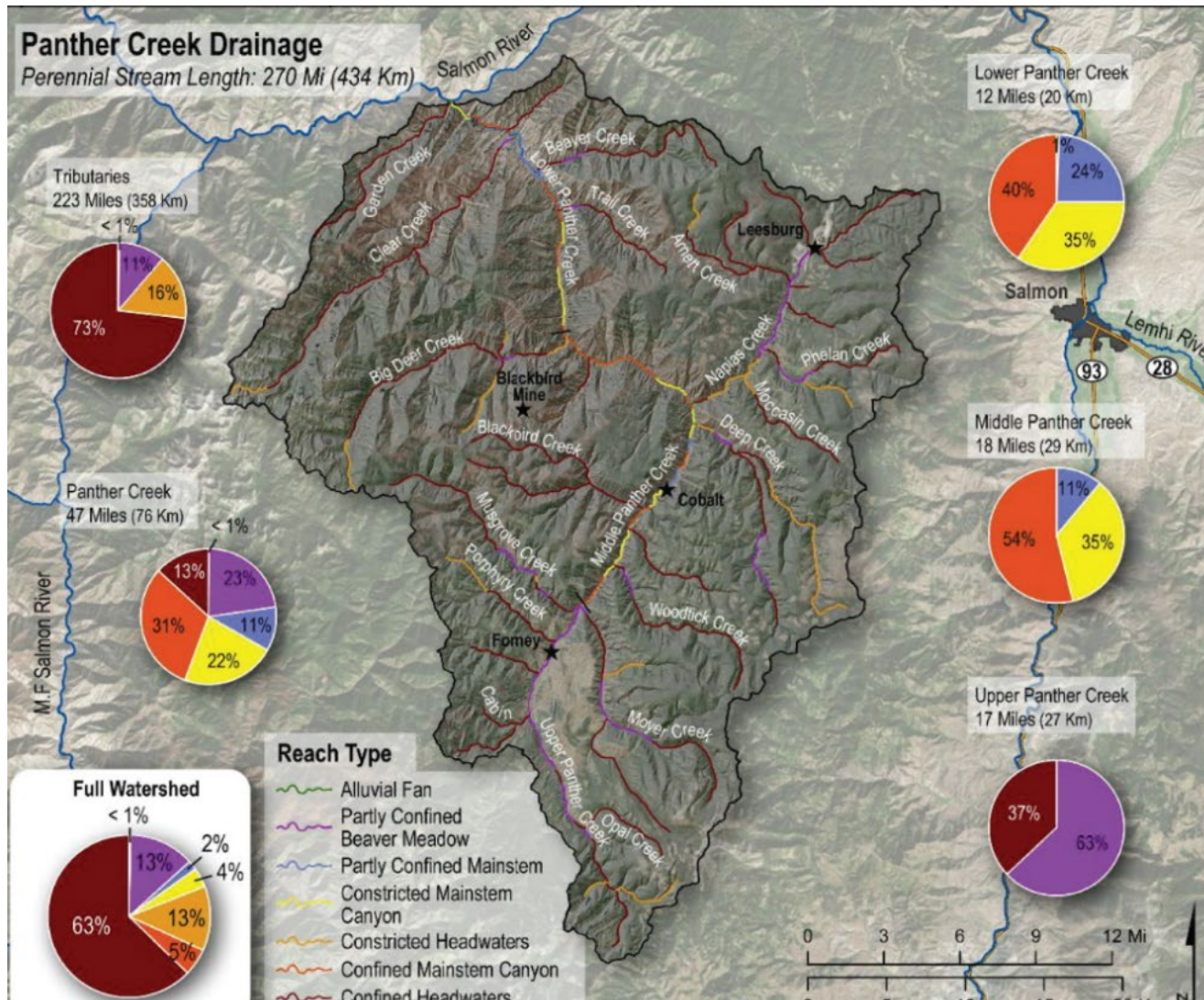


Partly-confined beaver meadow reach where beaver dam activity plays a major role.



Partly-confined mainstem reach where the flow regime plays a larger role than structure.

And we can map geomorphology matters



Pocket Guide; Wheaton et al. (2019, p. 8)

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

Figure 2.7 from Wheaton et al. (2019, p 64)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

INEFFICIENT CONVEYANCE OF WATER IS HEALTHY RIVERSCAPES PRINCIPLE 4.

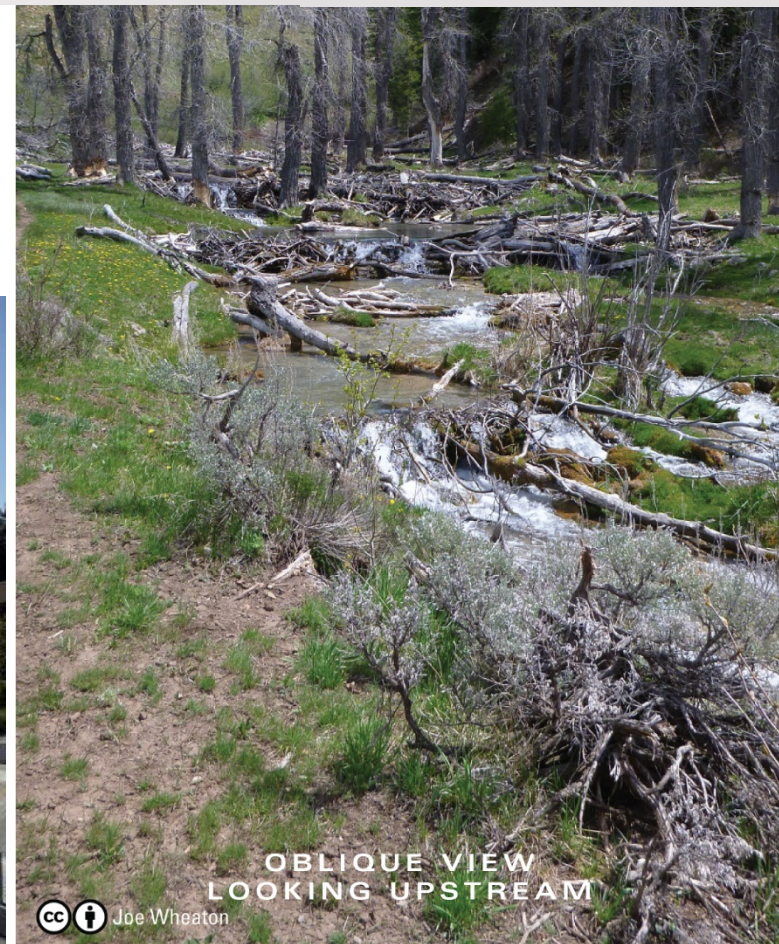
Hydrologic inefficiency is the hallmark of a healthy system. More diverse residence times for water can attenuate potentially damaging floods, fill up valley bottom sponges, and slowly release that water later elevating baseflow and producing critical ecosystem services.

Adapted from figure 2.3 from Wheaton et al.
(2019, p 62)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

Which one wins race? Efficient or Inefficient?



OBLIQUE VIEW
LOOKING UPSTREAM

cc i Joe Wheaton

How Does Flow Change With Dams?

Flow In



- i.e. – What about slowing the water down? Could that help?

Flow Direction

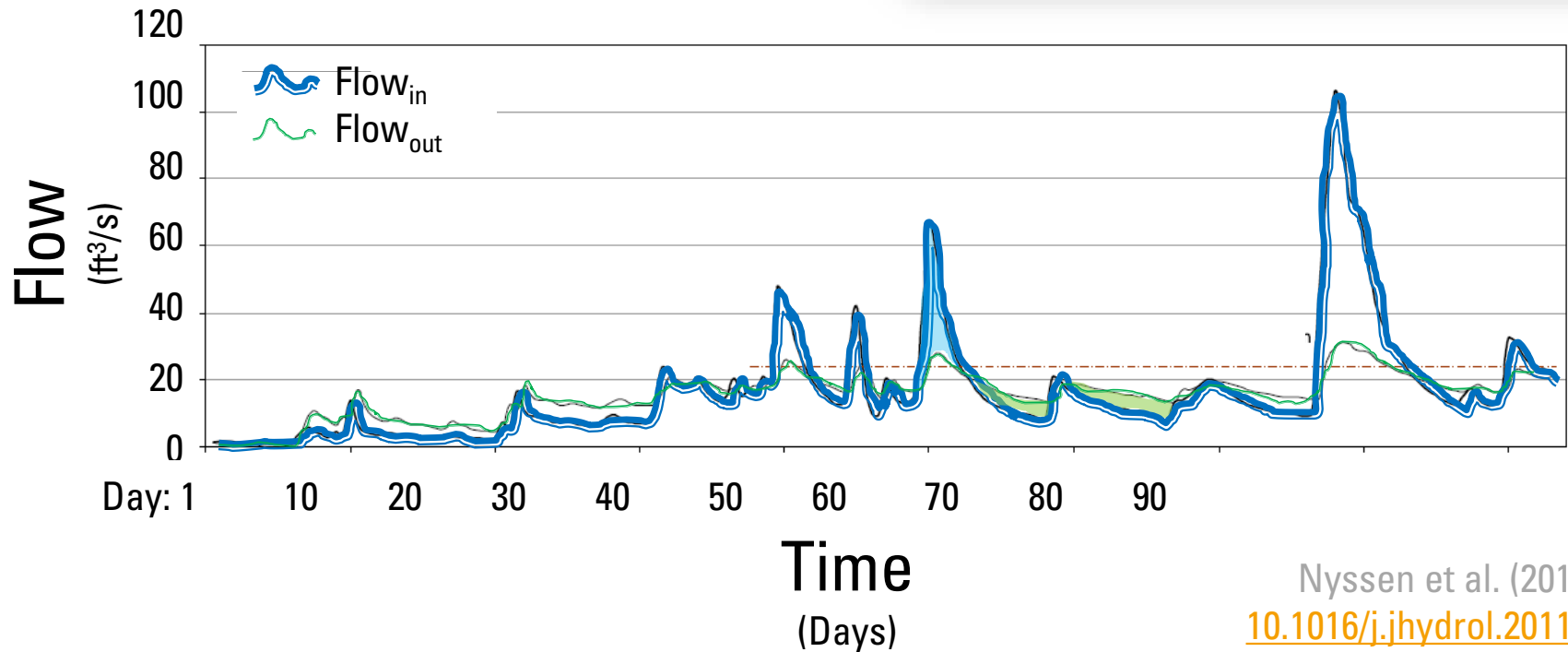
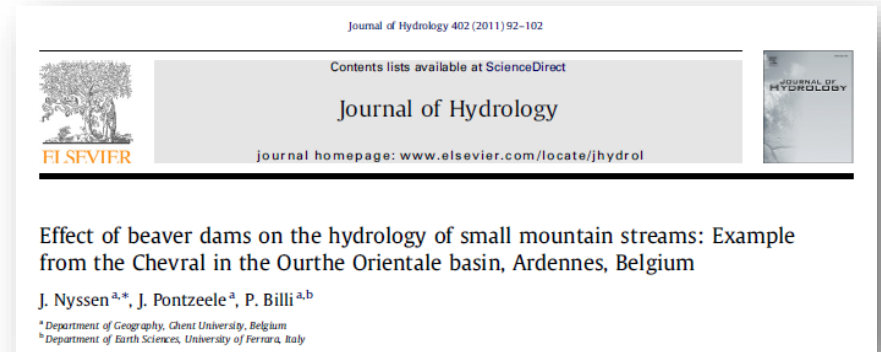
Flow Out



Utah State University
ECOGEOGRAPHY & TOPOGRAPHIC
ANALYSIS LABORATORY

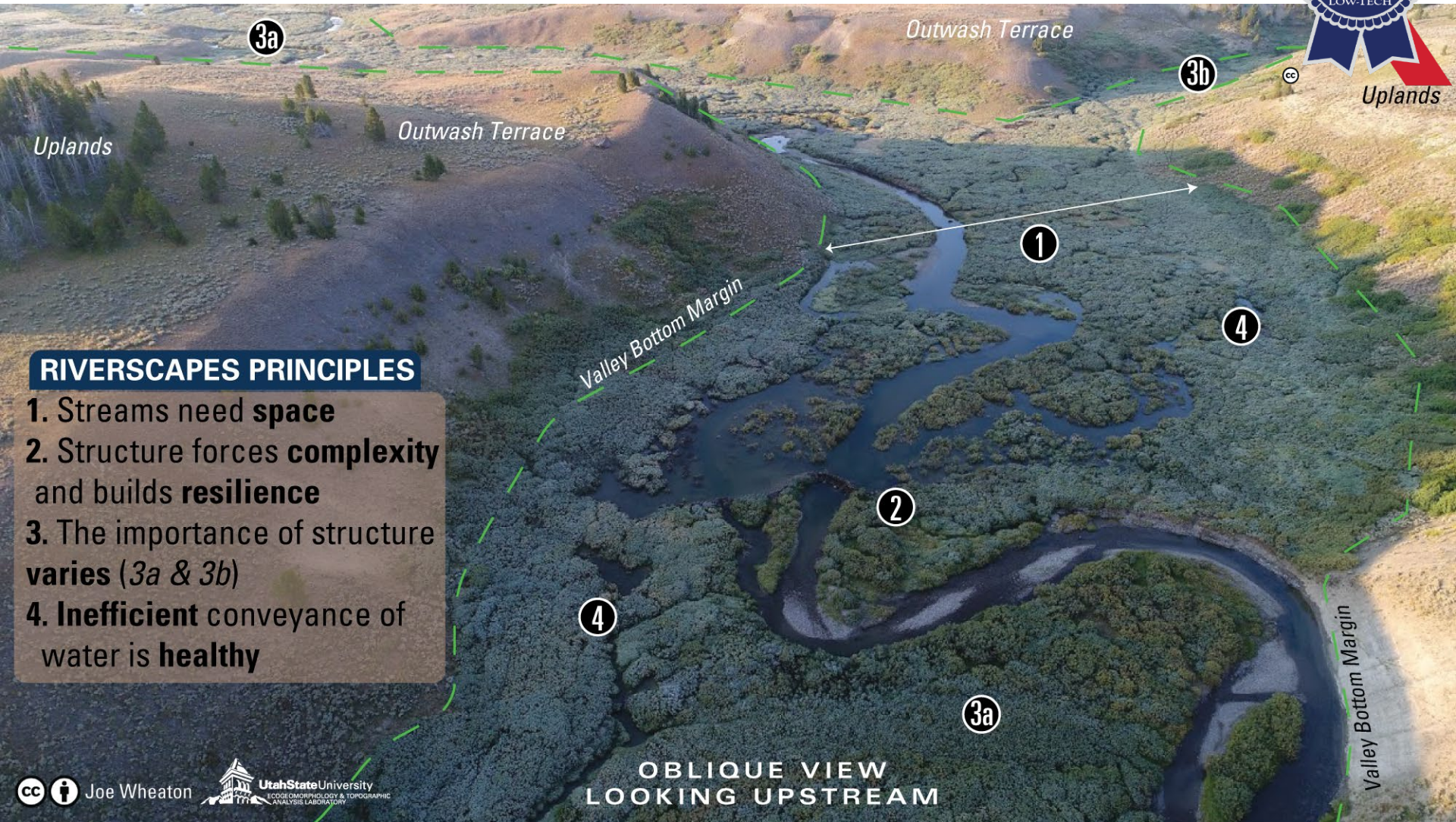
Typical Impact on Flows

- Lower peaks @ flood
- Elevated baseflow following



Nyssen et al. (2011) DOI:
[10.1016/j.jhydrol.2011.03.008](https://doi.org/10.1016/j.jhydrol.2011.03.008)

Review: Riverscapes Principles



RIVERSCAPES PRINCIPLES

1. Streams need **space**
2. Structure forces **complexity** and builds **resilience**
3. The importance of structure **varies** (3a & 3b)
4. **Inefficient** conveyance of water is **healthy**

From pages 3-4 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)

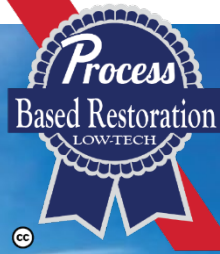
See Wheaton et al. (2019, p 60): Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

RESTORATION PRINCIPLES

5. It's okay to be **messy**
6. There is strength in **numbers**
7. Use **natural** building materials
8. Let the system **do the work**
9. **Defer decision making** to the system
10. **Self-sustaining** systems are the solution

Restoration Principles



From pages 3-4 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 Wheaton et al. (2019, p 72)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

IT'S OKAY TO BE MESSY

RESTORATION PRINCIPLE 5.

When structure is added back to streams, it is meant to mimic and promote the processes of wood accumulation and beaver dam activity. Structures are fed to the system like a meal and should resemble natural structures (log jams, beaver dams, fallen trees) in naturally 'messy' systems. Structures do not have to be perfectly built to yield desirable outcomes. Focus less on the form and more on the processes the structures will promote.



Pocket Guide; Wheaton et al. (2019, p. 3-4)

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

Figure 2.11 from Wheaton et al. (2019, p 73)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

Beaver Like to Make Messes... **So can you**



- And it is precisely that messiness, that is so critical to ecosystem health
- So why not take a cue from the rodent?

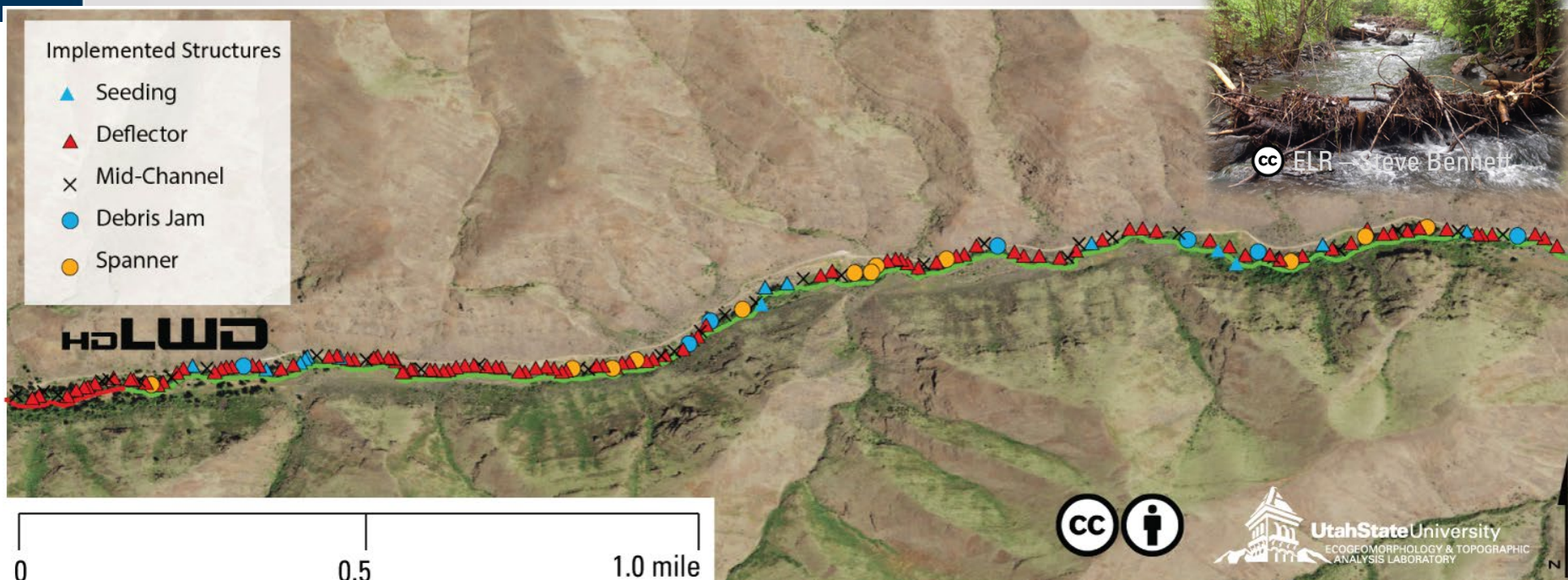
THERE IS STRENGTH IN NUMBERS

RESTORATION PRINCIPLE 6.

A large number of smaller structures working in concert with each other can achieve much more than a few isolated, over-built, highly-secured structures. Using a lot of smaller structures provides redundancy and reduces the importance of any one structure. It generally takes many structures, designed in a complex (see Chapter 5: Shahverdian et al., 2019c), to promote the processes of wood accumulation and beaver dam activity that lead to the desired outcomes.



CC ELR—Steve Bennett



Adapted from Figure 2.10 of Wheaton et al. (2019, p 74-75) – Chapter 2 LTPBR Manual. DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

From pages 3-4 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)

This is what density looks like!

Someone who took this same workshop a few years ago



Courtesy of: Daniel Bertram, Idaho Office of Species Conservation
Location: BLM Salmon Field Office

Build the workforce!



CC Jeremy Maestas

See Wheaton et al. (2019, p. 283)
Chapter 7 of LTPBR Manual
DOI: [10.13140/RG.2.2.18332.33922](https://doi.org/10.13140/RG.2.2.18332.33922).

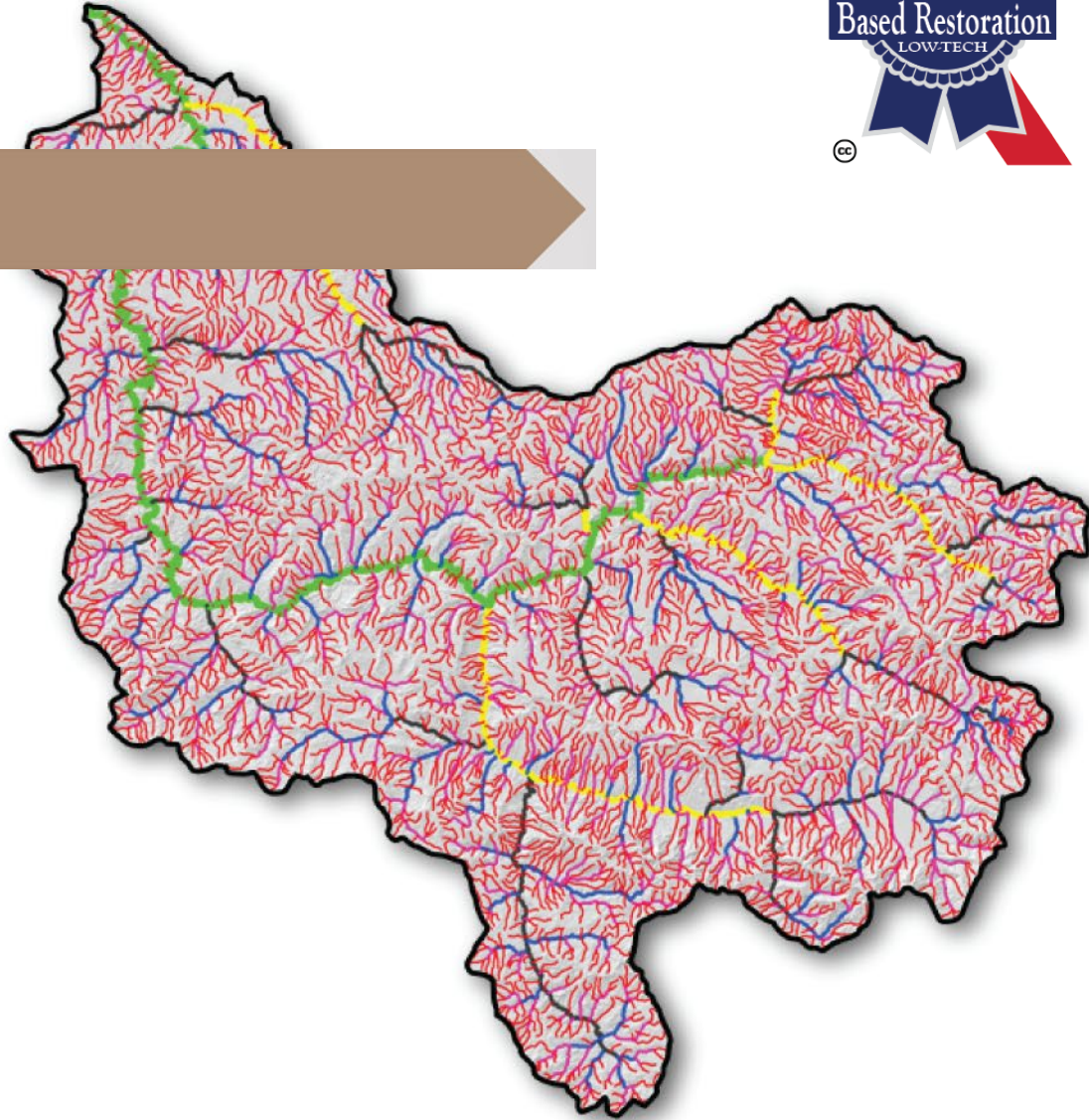
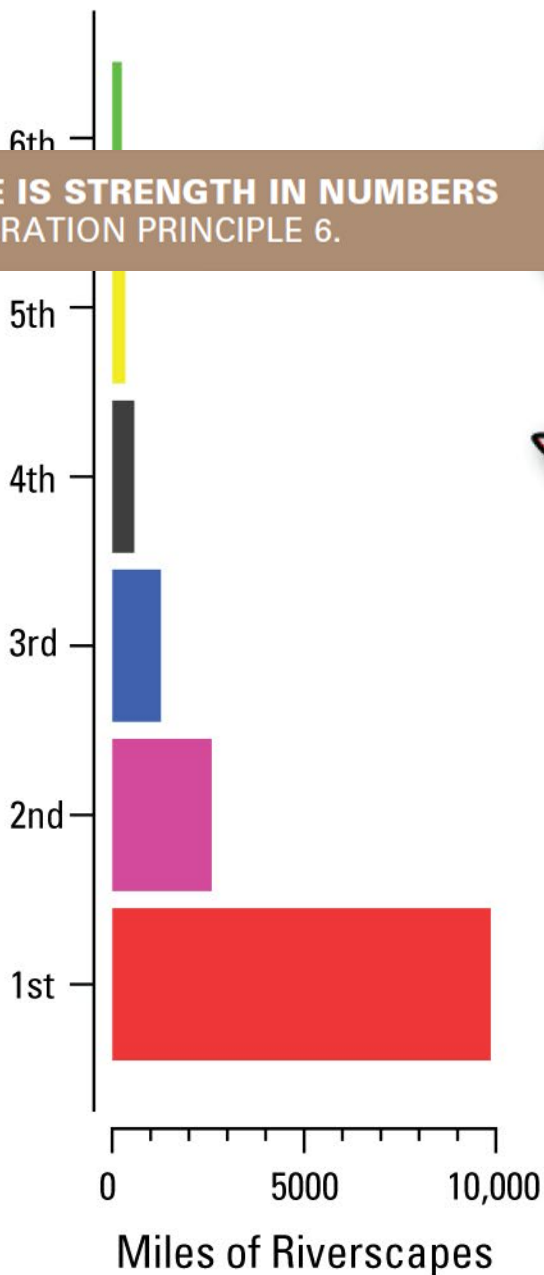
Solution Can Scale Up to Scope of Problem!



THERE IS STRENGTH IN NUMBERS
RESTORATION PRINCIPLE 6.

WADEABLE

Stream Order



USE NATURAL BUILDING MATERIALS

RESTORATION PRINCIPLE 7.

Natural materials should be used as structures are simply intended to initiate process recovery and go away over time. Locally sourced materials are preferable because they simplify logistics and keep costs down.



Pocket Guide; Wheaton et al. (2019, p. 3-4)

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

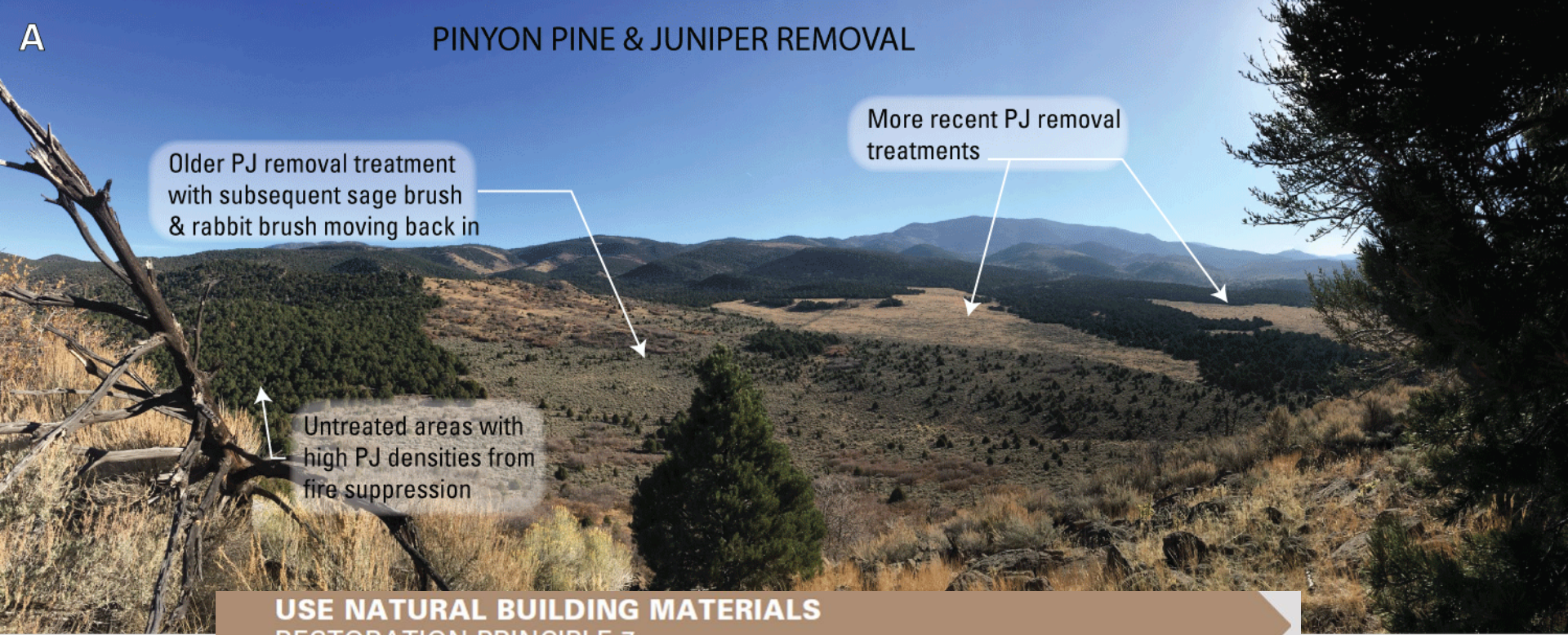
See Wheaton et al. (2019, p 76)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

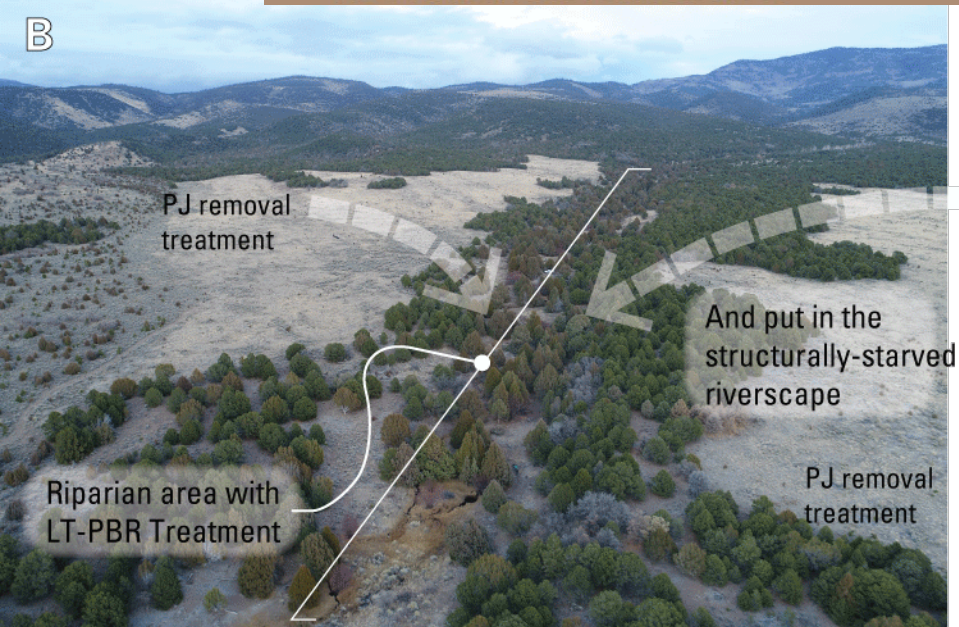
A

PINYON PINE & JUNIPER REMOVAL



USE NATURAL BUILDING MATERIALS
RESTORATION PRINCIPLE 7.

B



C



Figure 6.3 Bennett et al. (2019, p 248)
Chapter 6 LTPBR Manual for Principles
, DOI: [10.13140/RG.2.2.25043.22567](https://doi.org/10.13140/RG.2.2.25043.22567)

LET THE SYSTEM DO THE WORK

RESTORATION PRINCIPLE 8.

Giving the riverscape and/or beaver the tools (structure) to promote natural processes to heal itself with stream power and ecosystem engineering, as opposed to diesel power, promotes efficiency that allows restoration to scale to the scope of degradation.

“What if restoration was about stream power doing the work, not diesel power?”

— Jared McKee (USFWS)



CC BY Joe Wheaton

Pocket Guide; Wheaton et al. (2019, p. 3-4)
DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See Wheaton et al. (2019, p 77)
Chapter 2 LTPBR Manual for Principles
DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

DEFER DECISION MAKING TO THE SYSTEM RESTORATION PRINCIPLE 9.

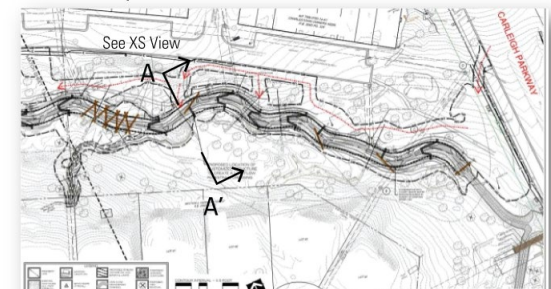
Wherever possible, let the system make critical design decisions for us by simply providing the tools and space it needs to adjust. Deferring decision making to the system downplays the significance of uncertainty due to limited knowledge. For example, choosing a floodplain elevation to grade to based on limited hydrology information can be a complex and uncertain endeavor, but deferring to the hydrology of that system to build its own floodplain grade reduces the importance of uncertainty due to limited knowledge.

What decisions do we make in traditional restoration design?

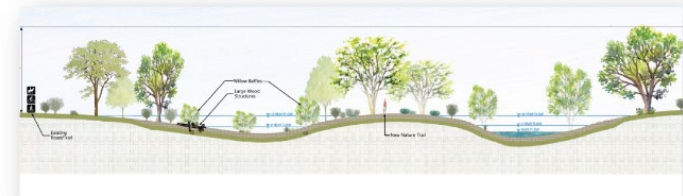
- How far to erode bank?
- Channel width
- Slope
- Planform
- Elevation to set floodplain
- Capacity of channel

STANDARD ENGINEERING PRACTICE

Engineering Plan Indicates where Specific Features to be Installed



Specific Topographic Design Cross Sections (e.g. A-A')



DEFER DECISION MAKING TO THE SYSTEM
RESTORATION PRINCIPLE 9.



Transfer decision making
& liability to the
ecosystem engineer



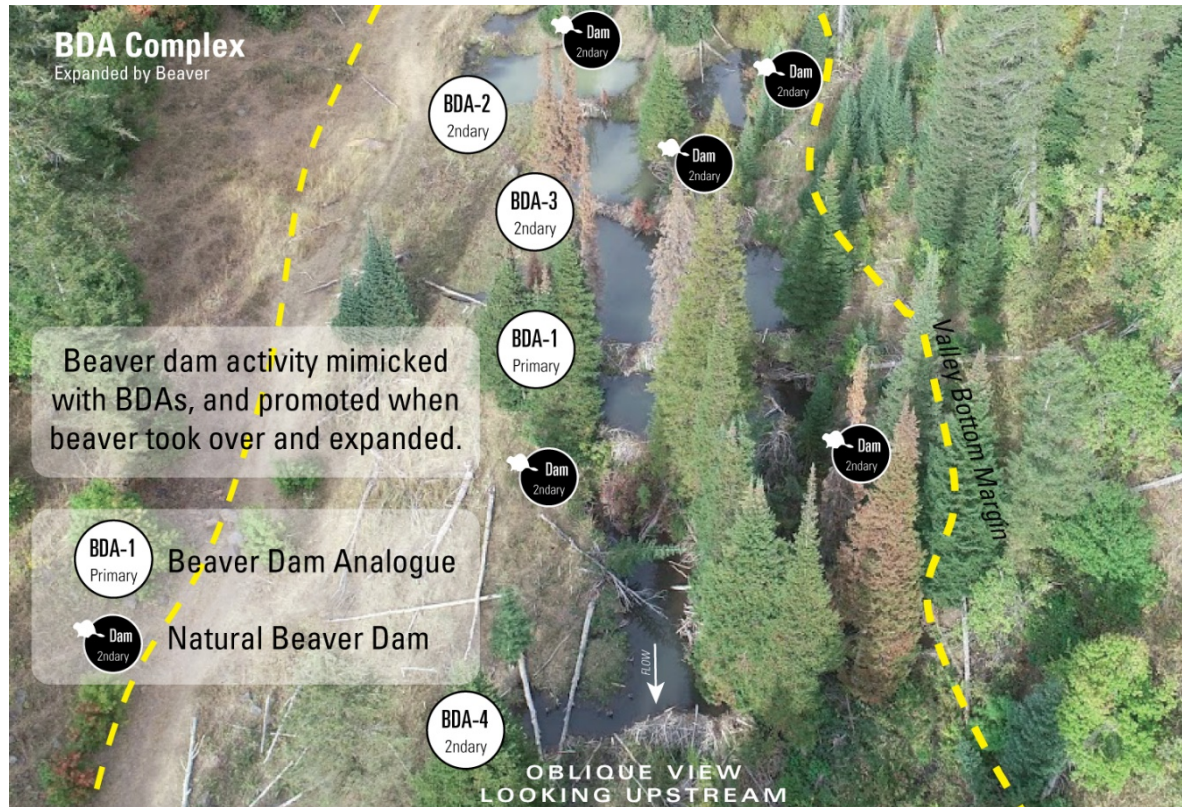
SELF-SUSTAINING SYSTEMS ARE THE SOLUTION
RESTORATION PRINCIPLE 10.

Low-tech restoration actions in and of themselves are not the solution. Rather they are just intended to initiate processes and nudge the system towards the ultimate goal of building a resilient, self-sustaining riverscape.

What's your exit strategy?

Mimic → **Promote** → **Sustain**

From Mimicking to Promoting to Sustaining Processes



How do your restoration actions:

- Immediately **mimic** a process?
- Quickly (relatively) **promote** a process?
- Eventually **sustain** a process?

Mimic → **Promote** → **Sustain**

Adapted from Wheaton et al. (2019)

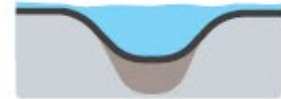
DOI: [10.13140/RG.2.2.19590.63049/1](https://doi.org/10.13140/RG.2.2.19590.63049/1).



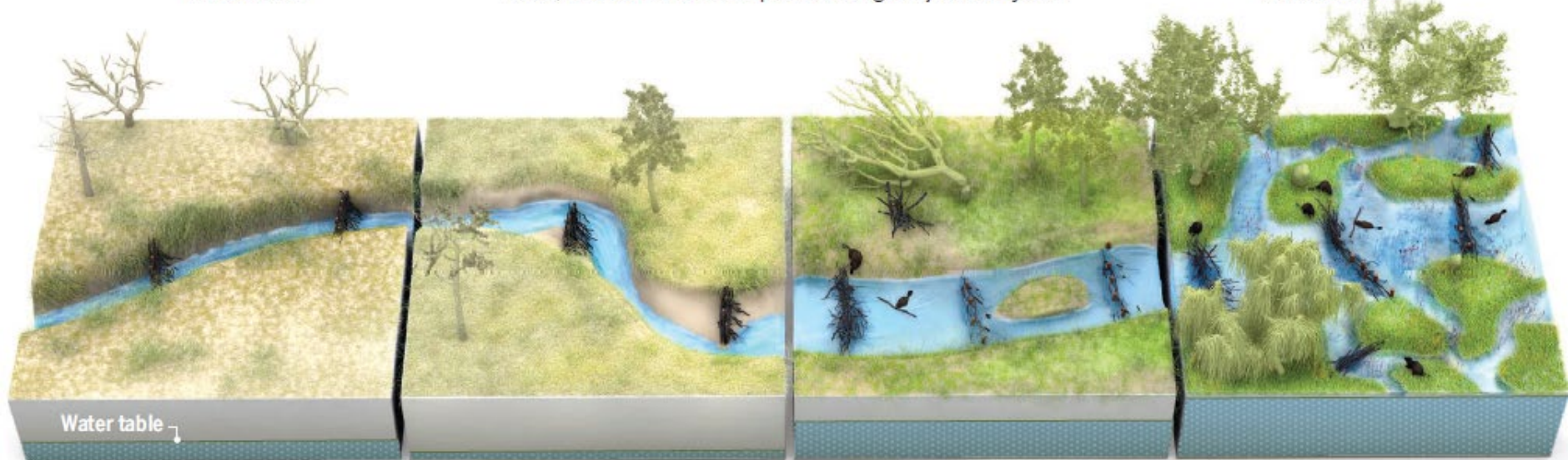
Incised stream

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.



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.

NEWS

FEATURES



BEAVERS, REBOOTED

Artificial beaver dams are a hot restoration strategy, but the projects aren't always welcome

By Ben Goldfarb, in the Scott Valley, California

1058 8 JUNE 2018 • VOL 360 ISSUE 6393

Published by AAAS

sciencemag.org SCIENCE

Mimic → Promote → Sustain

From Goldfarb (2018) Science:

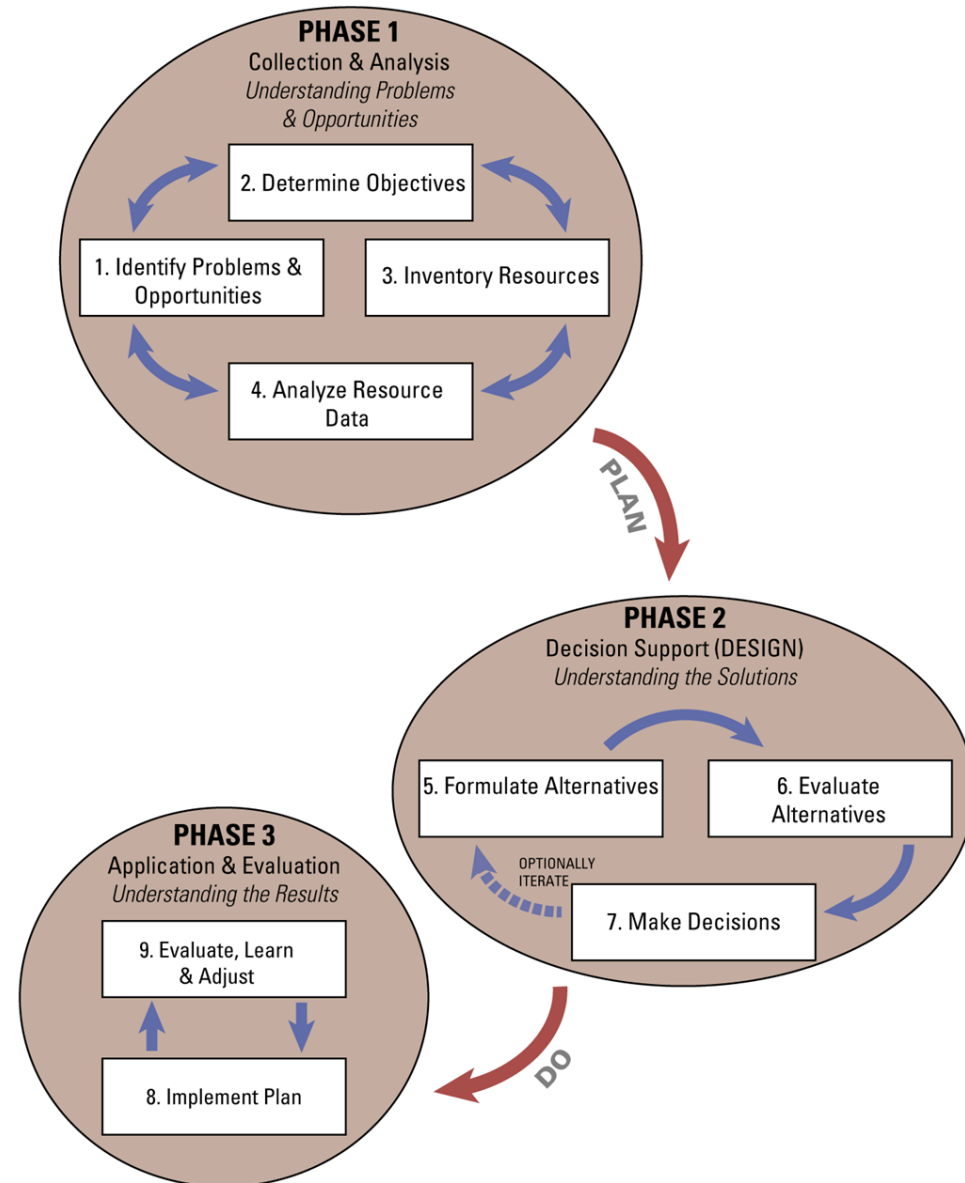
<http://science.sciencemag.org/content/360/6393/1058>

OUTLINE: Intro to LTPBR for Stage 0

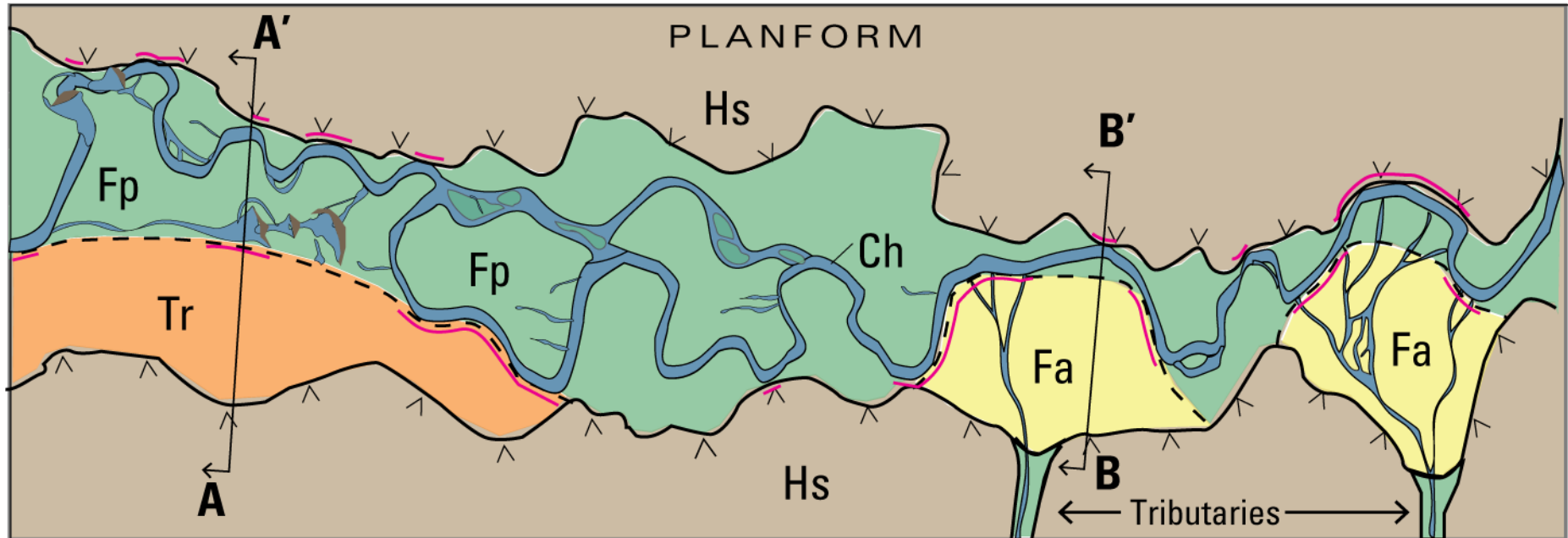
- 
- I. What is low-tech?
 - II. Shared vision of resilience via stage 0 & why?
 - III. What did you say it actually is again?
 - IV. Organizing principles of LTPBR focus on why and how
 - V. A fundamentally different/efficient design process
 - VI. Intro to afternoon on Whychus

Planning

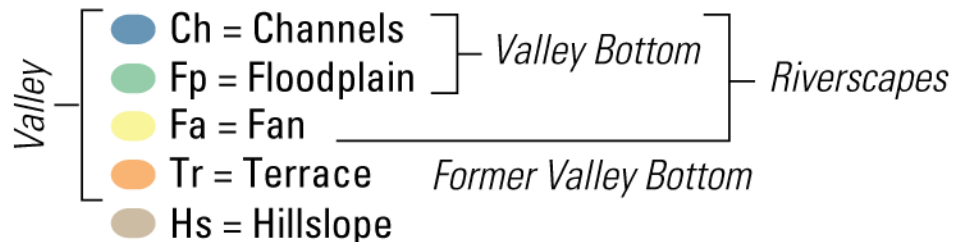
- Standard NRCS CPP without adaptive management
- Presented as a linear process through three phases



Reading your riverscape... to look for opportunities to build resilience



GEOMORPHIC UNIT KEY



The valley bottom is comprised of areas that could plausibly flood in the contemporary flow regime.

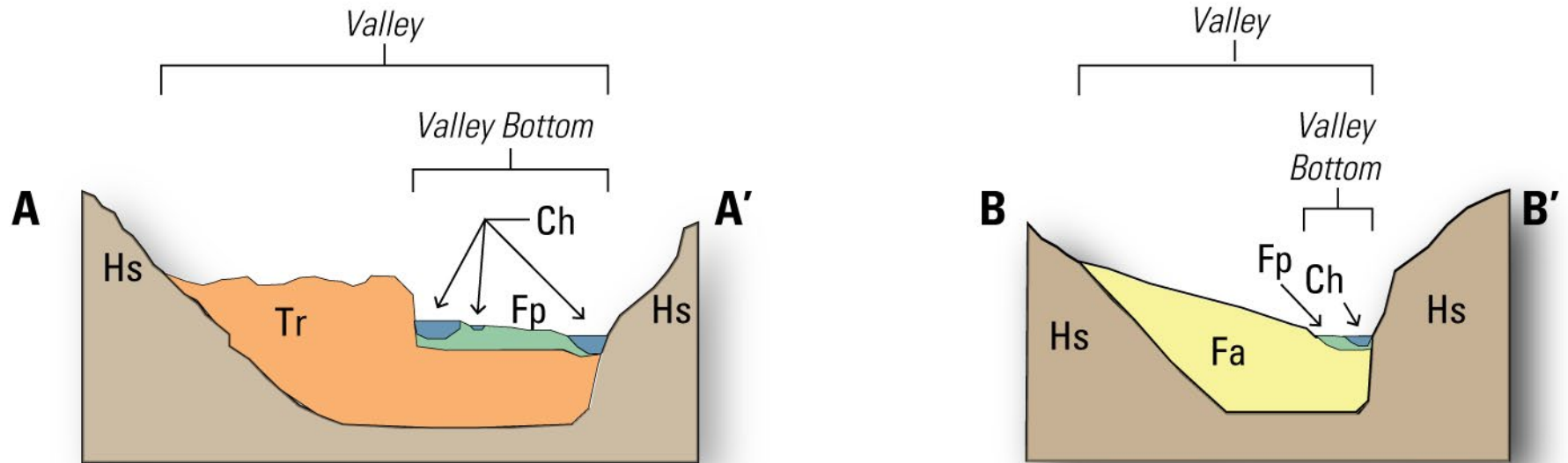
MARGIN TYPES

- ↘↘ Valley Margin
- - Valley Bottom Margin
- Active Confining Margin

**Where are their riverscape & riparian
restoration or conservation opportunities?**

Contrasting Valley Settings Provide different Opportunities

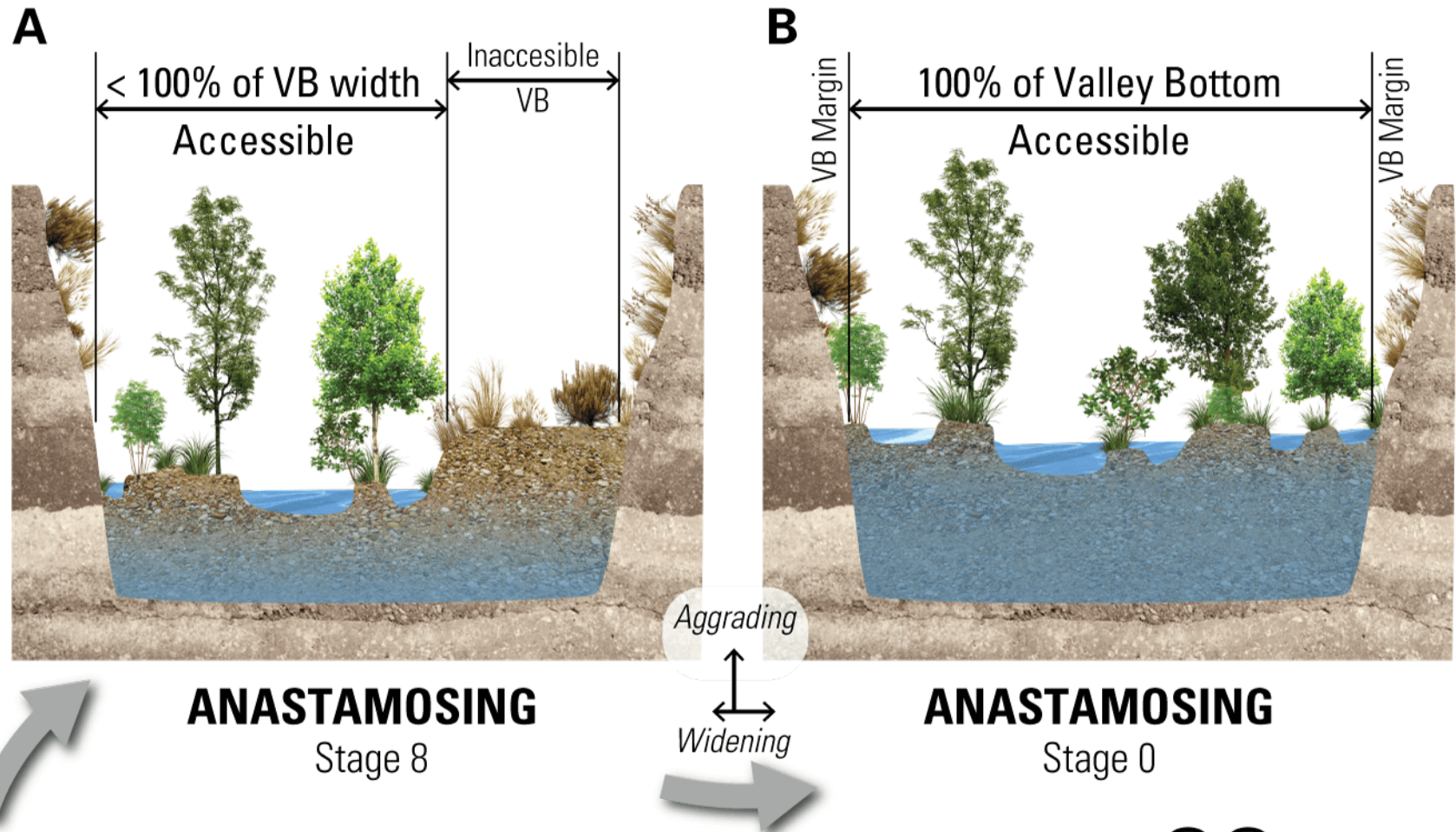
VALLEY CROSS SECTIONS



From page 10 of Pocket Guide; Wheaton et al. (2019)

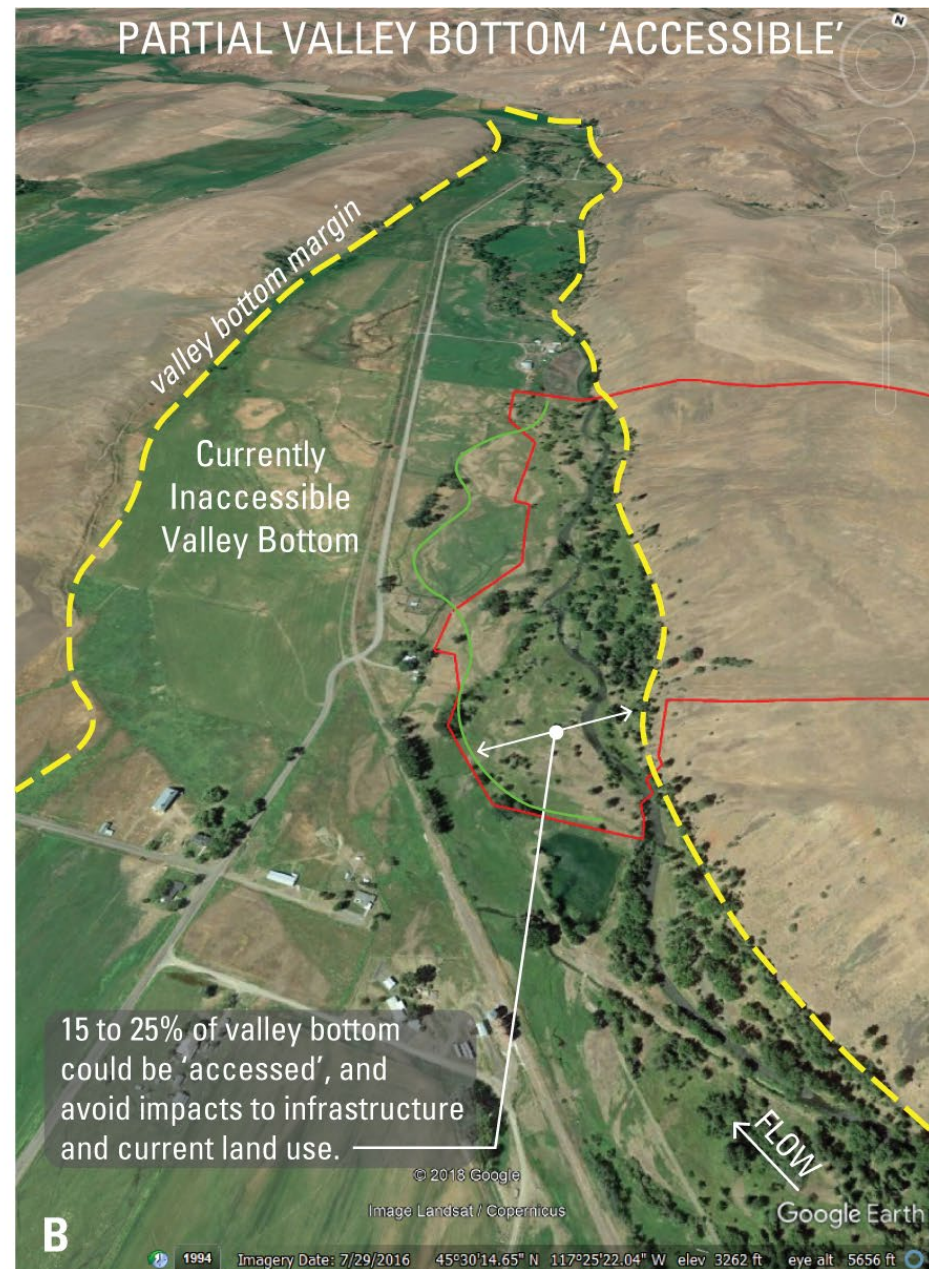
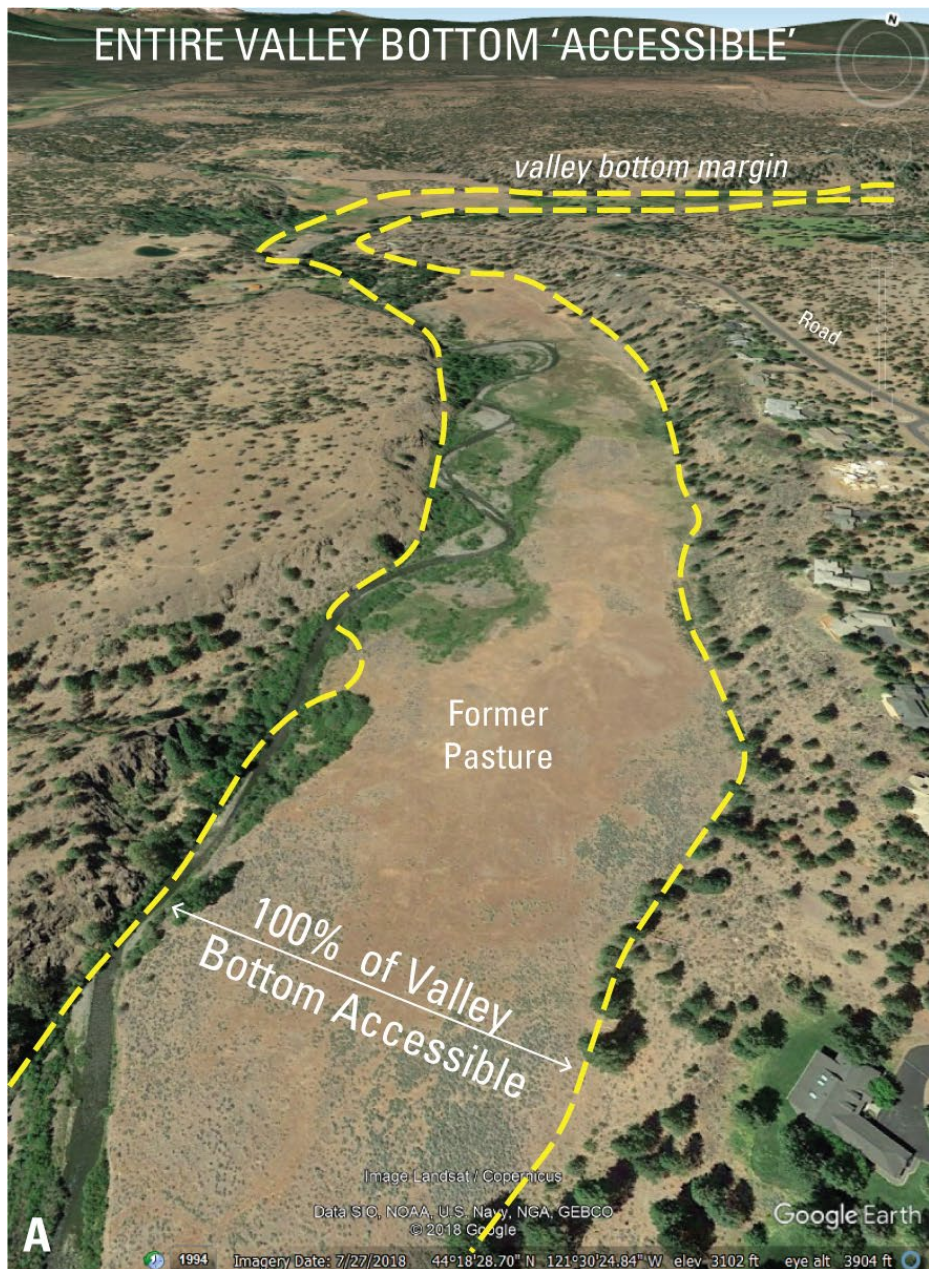
DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

Different Stages/Degrees of Anastamosing



From Stage 5-7

CC BY Nick Weber



From page 14 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)

How much is in play for restoration?

On to Phase 3

- Fed from Design
- Number of treatments estimated in design

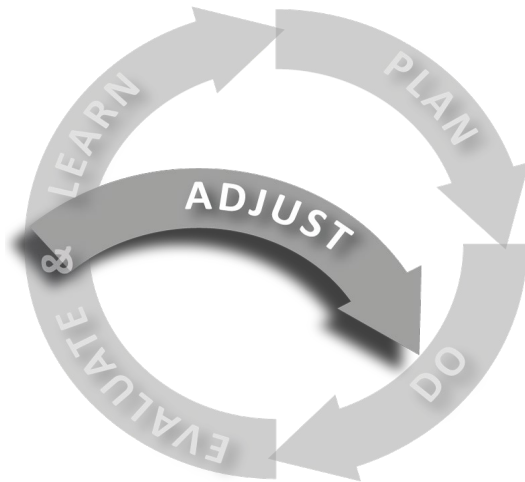
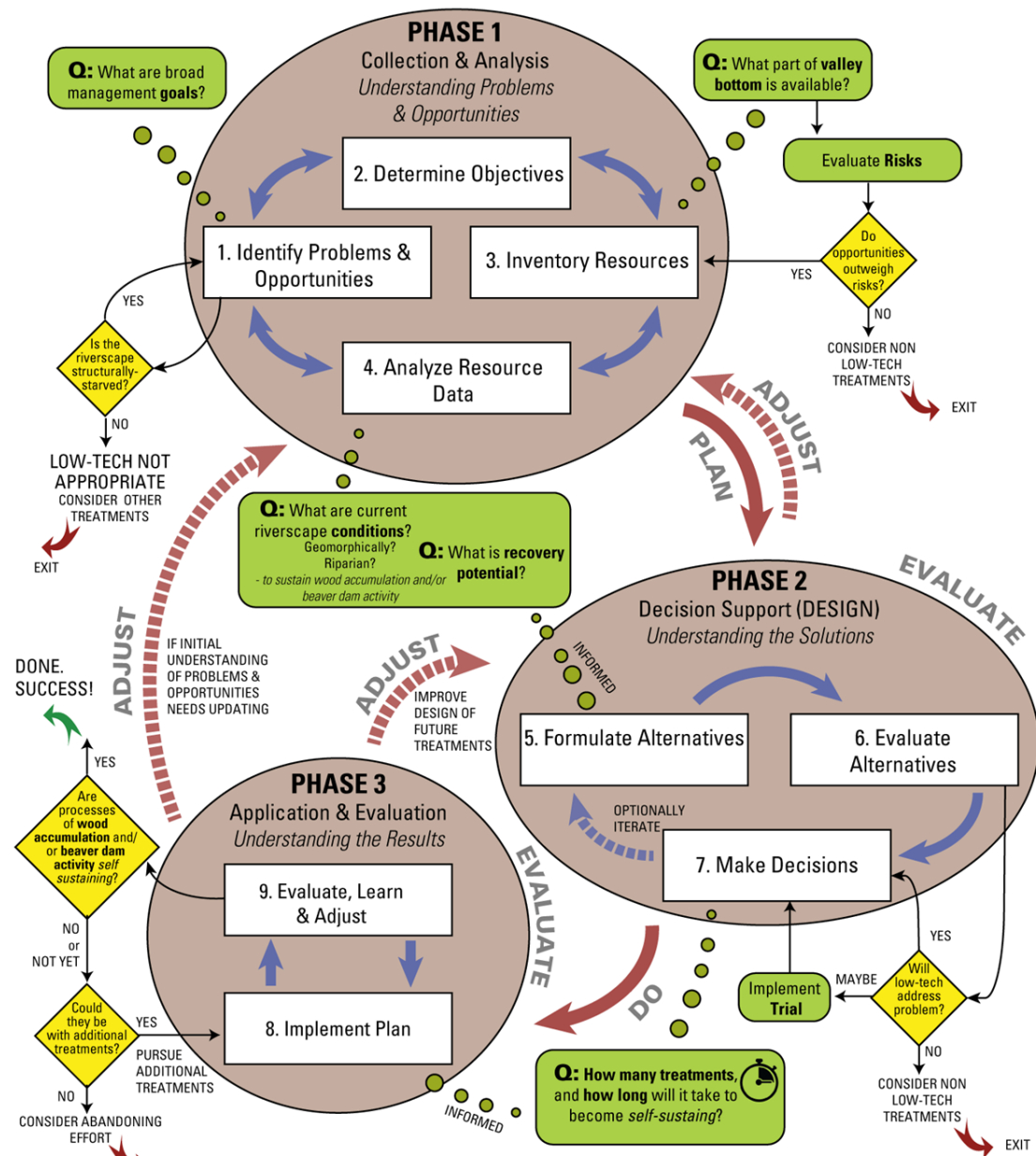


Figure 3.20 from Bennett et al. (2019, p 115)

Chapter 3 LTPBR Manual

DOI: [10.13140/RG.2.2.15815.75680](https://doi.org/10.13140/RG.2.2.15815.75680)



Design Manual References – Chapters 4 & 5

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, 66 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.

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

1 of 68

RIVERSCAPE RESTORATION MANUAL

Chapter 5 – DESIGNING LOW-TECH RESTORATION PROJECTS



Prepared by:

Scott M. Shahverdian, Stephen N. Bennett, Nicolaas Bouwes, Reid Camp, Elijah Portugal and Joseph M. Wheaton

Recommended Citation:
Shahverdian, S.M., Bennett, S.N., Bouwes, N., Camp, R., Portugal, E. and Wheaton, J.M., 2019. Chapter 5-Designing Low-Tech Restoration Projects. In: J.M. Wheaton, S.N. Bennett, N. Bouwes, J.D. Maestas and S. Shahverdian (Editors), Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Utah State University Wheaton Ecogeomorphology & Topographic Analysis Lab, Logan, Utah, 28 pp.



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IMPLICATIONS FOR PRACTICE

- A complex is a group of structures designed to work together to mimic and/or promote specific processes to achieve one or more project objectives. Complexes are the building blocks of a low-tech restoration design.
- The low-tech restoration design process for complexes:
 - is rapid, low-cost, flexible, transparent, field-based, and generates clear and testable design hypotheses;
 - hypothesizes the hydraulic zone of influence (laterally constrained by the valley bottom) of the treatment, which helps set expectations for the extent of impact of the treatment relative to overall project goals and reach objectives for recovery potential;
 - identifies low-flow, typical-flood, and extreme-flood hypotheses (i.e., process-based responses), which articulate the connection between the processes initially mimicked, later promoted, and hopefully eventually taken over naturally by the system.
- Design of low-tech restoration projects focuses on the complex-scale rather than the individual structure to maintain focus on the scope of riverscape degradation due to structural starvation.

CHAPTER 5: DESIGNING LOW-TECH RESTORATION PROJECTS

1 of 28

RIVERSCAPE RESTORATION MANUAL

Chap 4: Shahverdian et al. (2019a)

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

Chap 5: Shahverdian et al. (2019b)

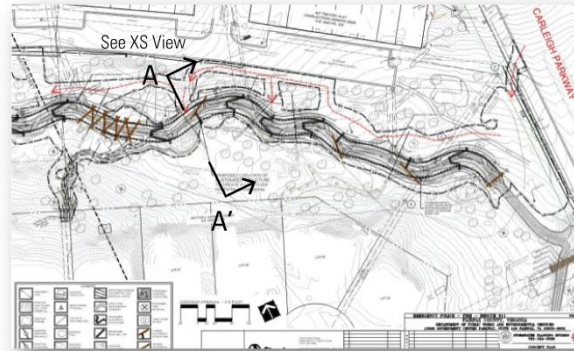
DOI: [10.13140/RG.2.2.11621.45286](https://doi.org/10.13140/RG.2.2.11621.45286)

Common Design Practice for Restoration

- Base topographic map
- Specific cross sections
- Requires extensive pre-project field topographic survey and desktop processing

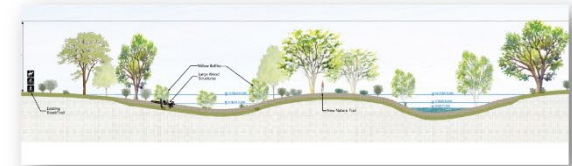
STANDARD ENGINEERING PRACTICE

Engineering Plan Indicates where Specific Features to be Installed



The plan tends to be overlaid on a topographic basemap, and shows specific locations of cross sections and/or profiles.

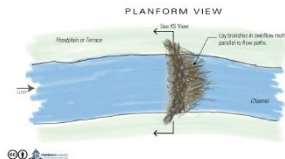
Specific Topographic Design Cross Sections (e.g. A-A')



Cross-Section shown that is not hypothetical or typical, but specific to an actual location on plan.

USED IN BOTH ENGINEERING PRACTICE & STANDARD LOW-TECH PRACTICE

Typical Structure Schematics



Schematics of typical (not specific) planform, cross-section, and/or profile views of standard, recurring design elements (in this case structures). These are only meant to convey what typical structures look like approximately, but need not be followed rigidly.

What is in a Low-Tech Design?

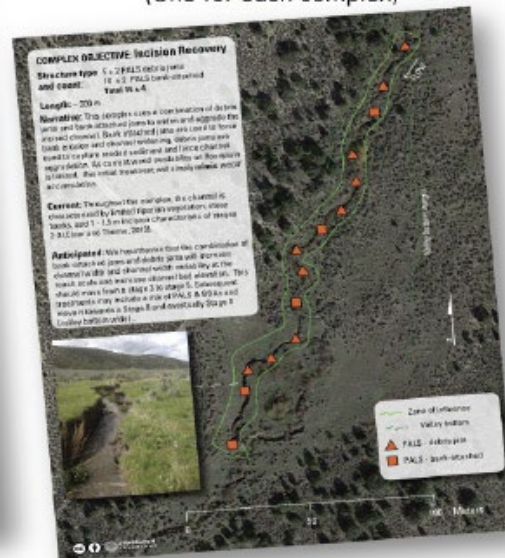
RECOMMENDED MINIMUM DESIGN PACKAGE

Project-Scale Map(s)
(Drainage Network)



Shows complex locations on drainage network.

Complex-Scale Map(s)
(One for each complex)



Shows structure locations within each complex, complexes zone of influence, structure types, & valley bottom extents.

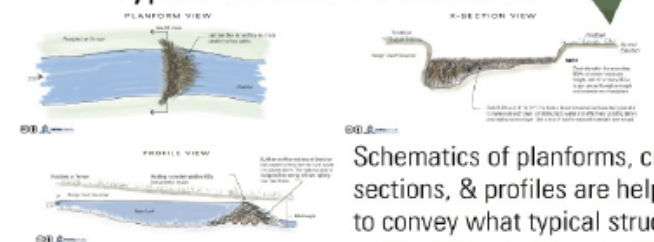
Complex Design Tables

(Clear Complex Objectives & Hypotheses)

[illegible]

Note, structure design tables are possible but not always necessary as during construction not all structures are built exactly as designed, and flexibility is key (e.g. 12-15 structures specified).

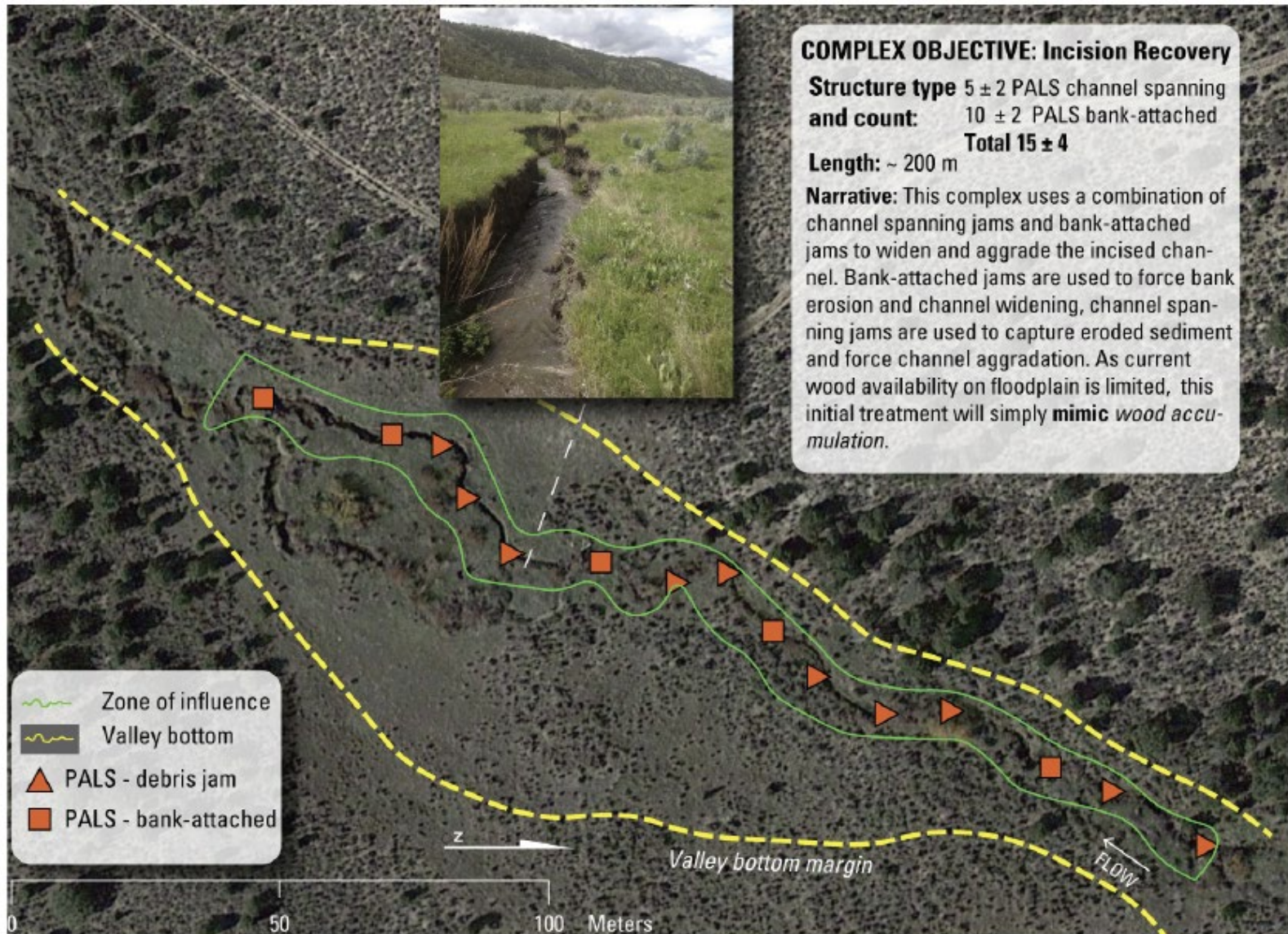
Typical Structure Schematics



Schematics of planforms, cross-sections, & profiles are helpful to convey what typical structures will look like, but need not be followed rigidly.

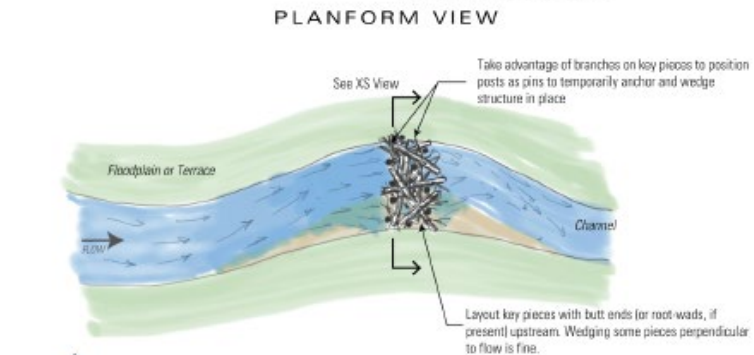
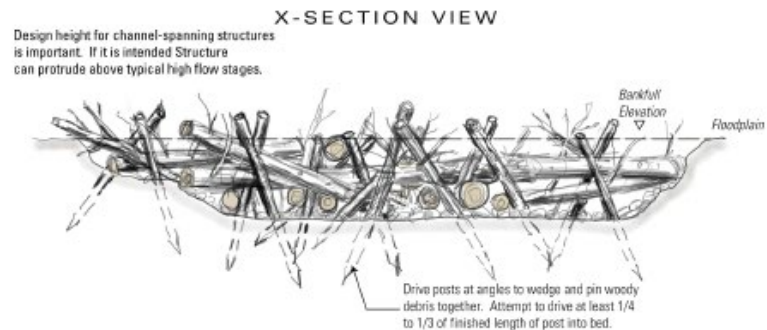
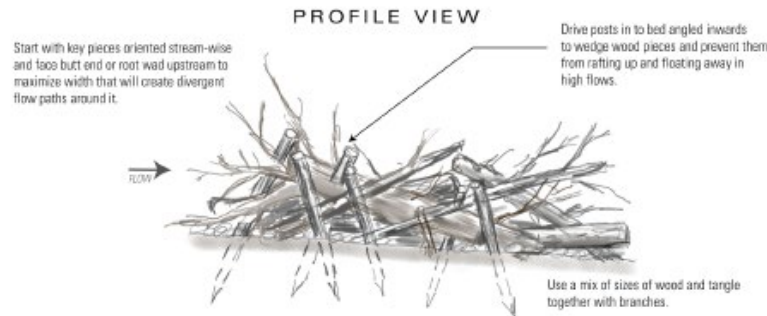
Low-Tech Design – Complex Map

- zone of influence, valley bottom, narrative, ... structure locations?

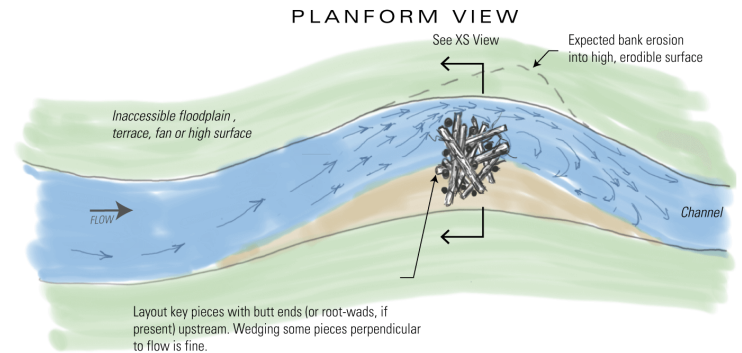
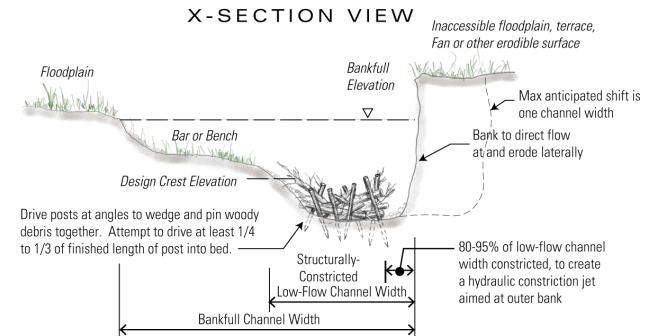
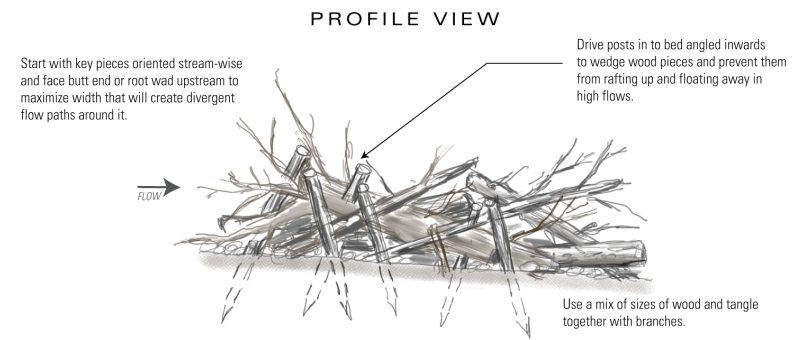


Structure Schematics

- Provide information on typical form



NOT-TO-SCALE



NOT-TO-SCALE

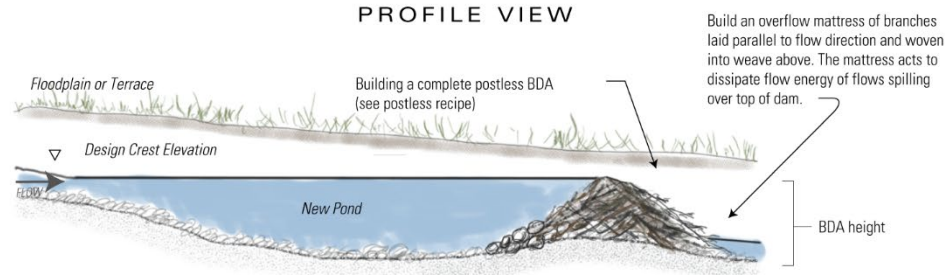
- Do NOT need to be followed rigidly

See Appendices D & E from Chap 4:
Shahverdian et al. (2019; p 184-207)

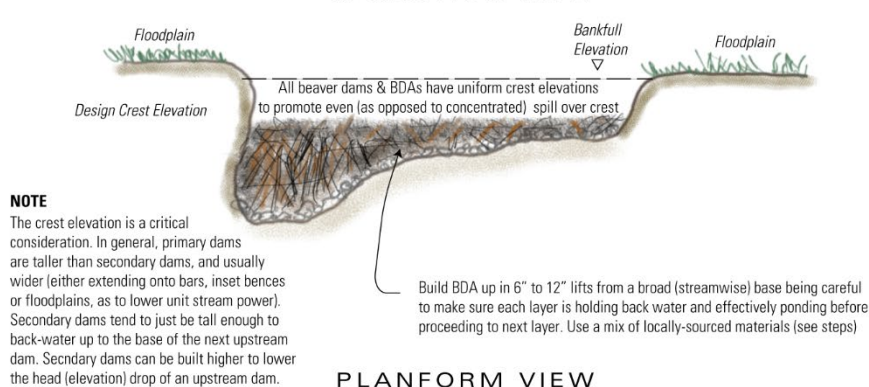
DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)

Some BDA Structure Schematics

PROFILE VIEW

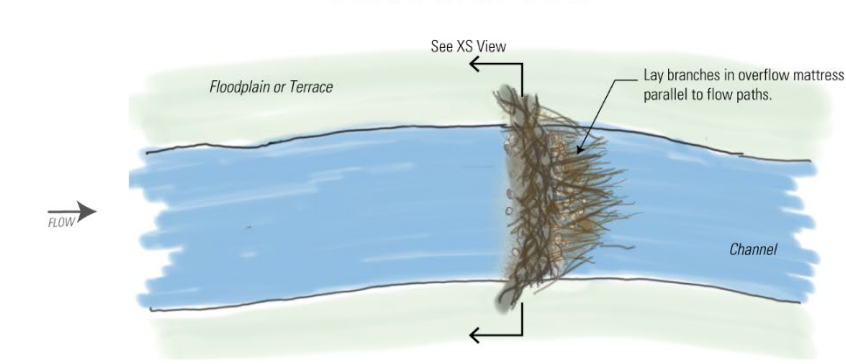


X-SECTION VIEW



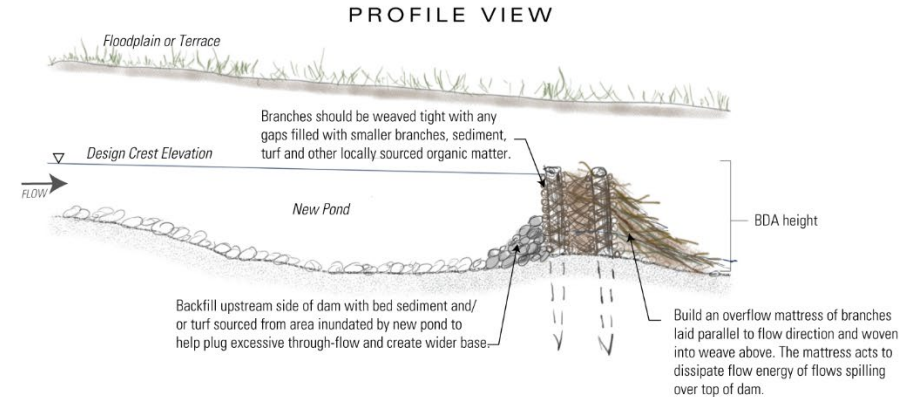
NOTE
The crest elevation is a critical consideration. In general, primary dams are taller than secondary dams, and usually wider (either extending onto bars, inset benches or floodplains, as to lower unit stream power). Secondary dams tend to just be tall enough to back-water up to the base of the next upstream dam. Secondary dams can be built higher to lower the head (elevation) drop of an upstream dam.

PLANFORM VIEW

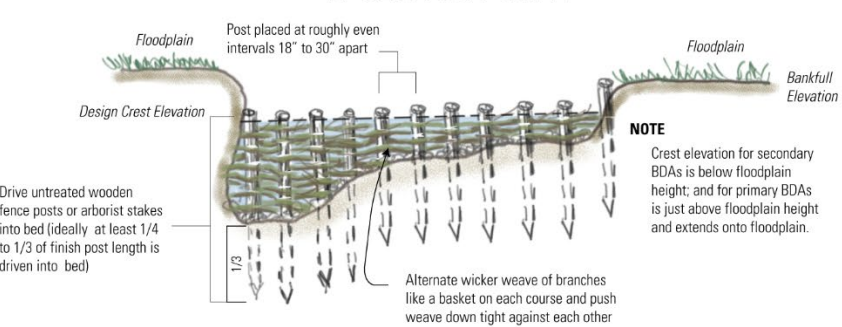


NOT-TO-SCALE

PROFILE VIEW



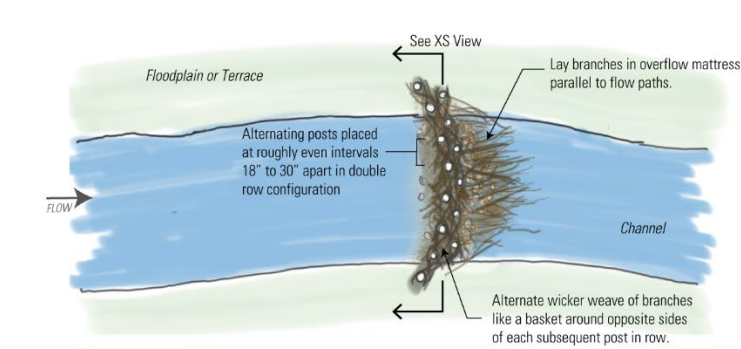
X-SECTION VIEW



Drive untreated wooden fence posts or arborist stakes into bed (ideally at least 1/4 to 1/3 of finish post length is driven into bed)

NOTE
Crest elevation for secondary BDAs is below floodplain height, and for primary BDAs is just above floodplain height and extends onto floodplain.

PLANFORM VIEW



NOT-TO-SCALE

Complex Design - Incision Recovery

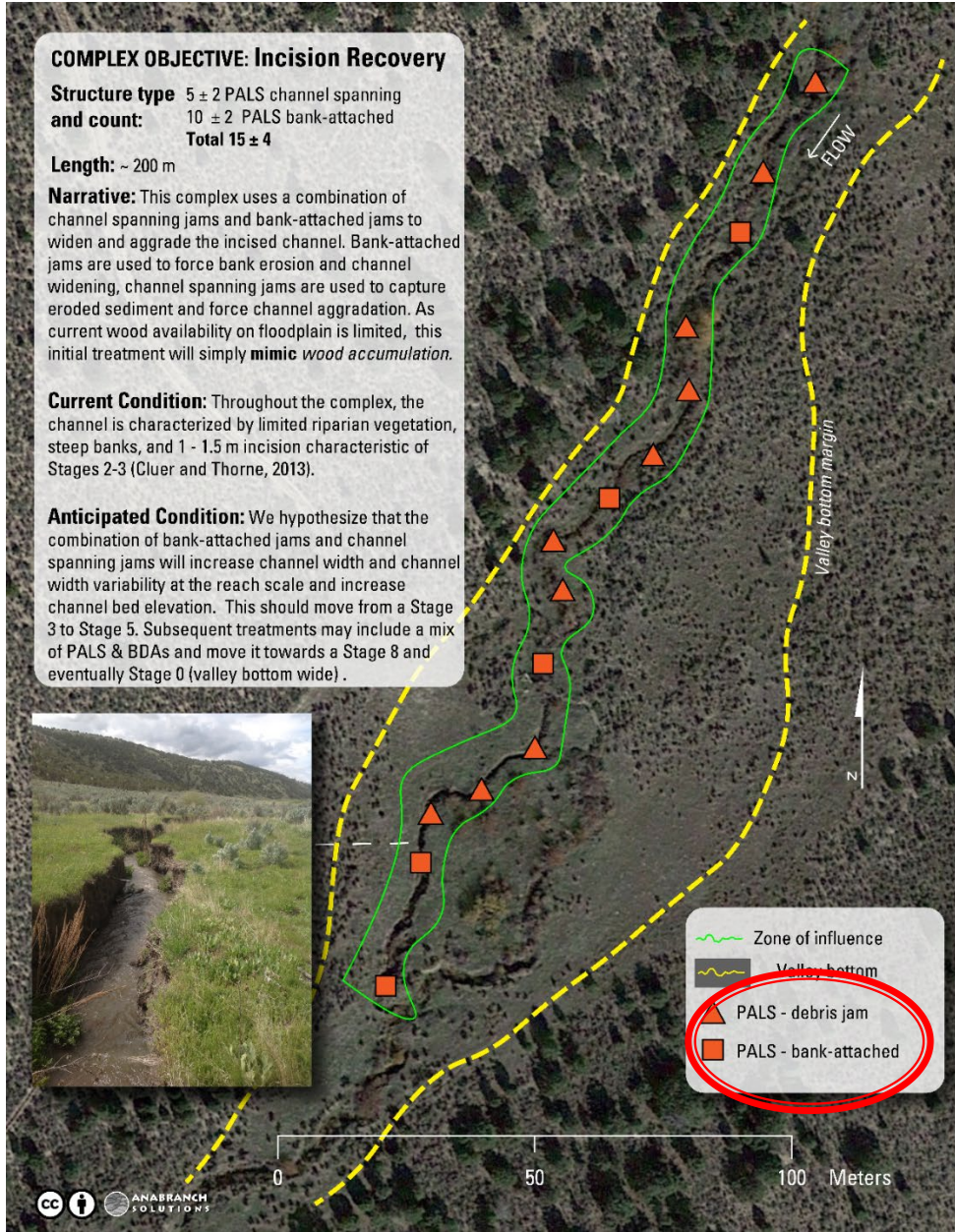
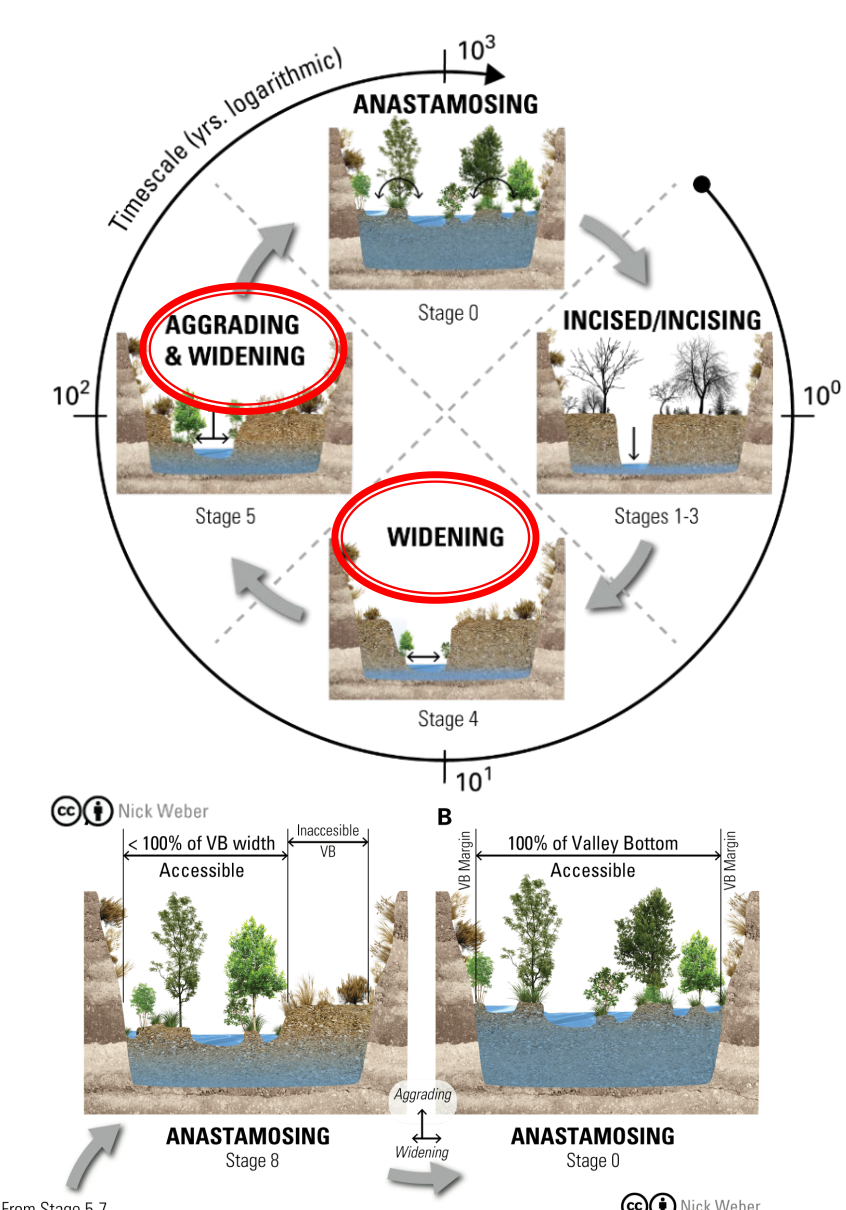


Figure 5.9 from Chap 5: Shahveredian et al. (2019, p 230)

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

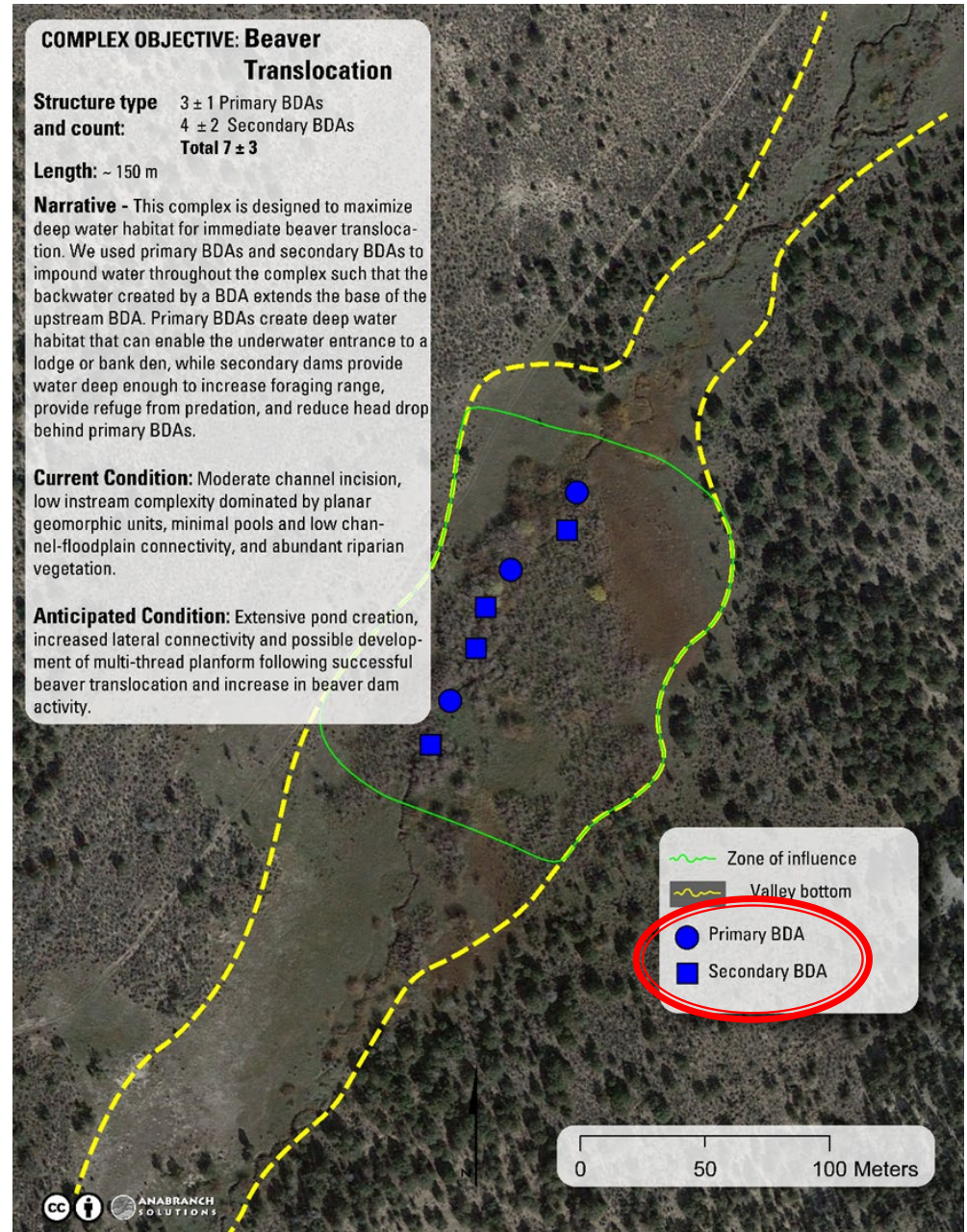
Complex Design – Beaver Translocation

- Maximize deep water habitat with access to forage
- Provide options upstream and downstream of release site

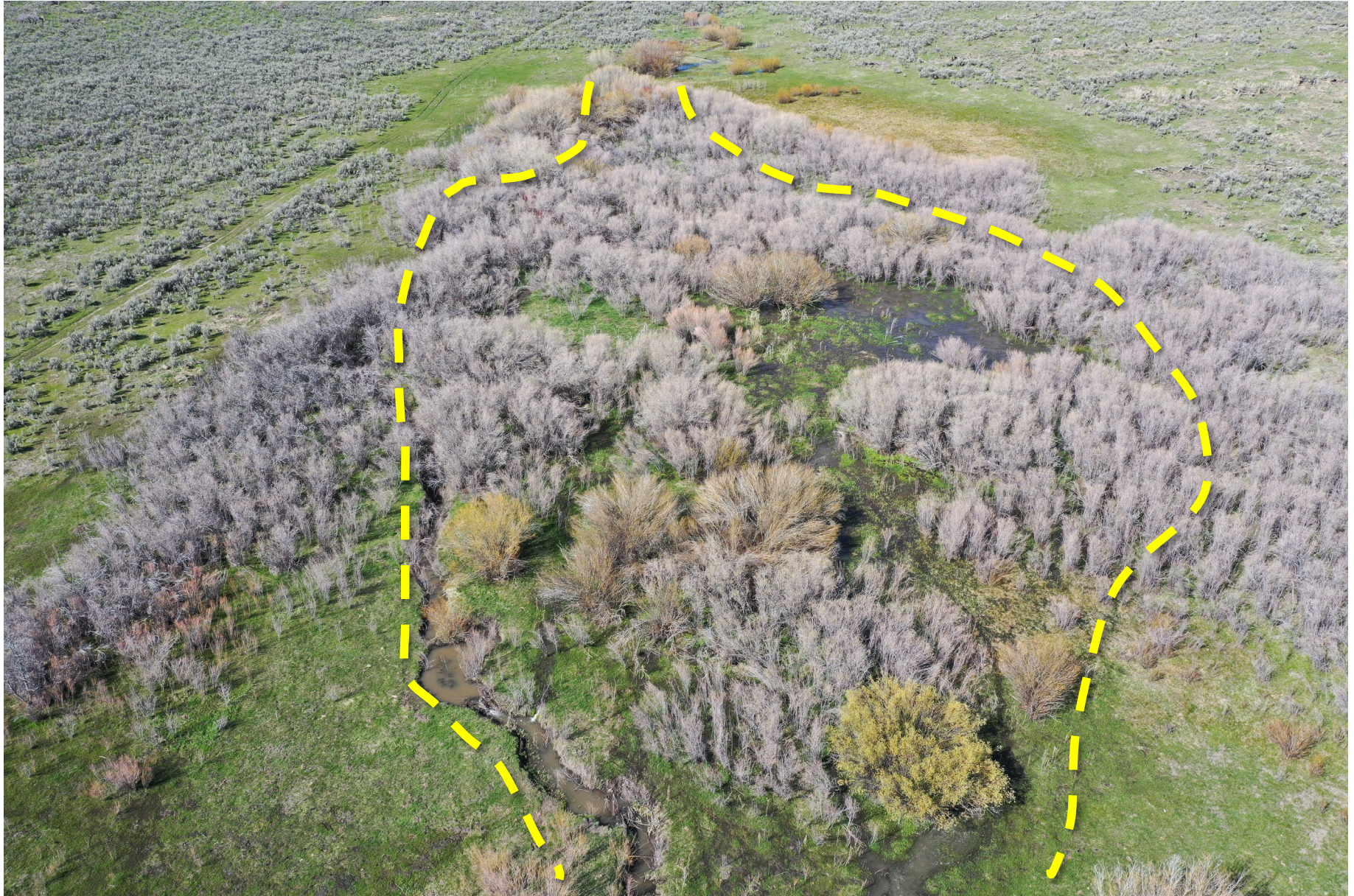


Figure 5.8 from Chap 5: Shahverdian et al. (2019, p 228)

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



Zone of Influence – Beaver Translocation



NRCS Conservation Practice 643 – Specification Sheet

Restoration of Rare or Declining Natural Communities:

Beaver Dam Analogues and Post-Assisted Log Structures for Low-Tech Stream Restoration

Conservation Practice 643 - Specification Sheet



Natural Resources Conservation Service

Client:		Date:	
Location:		County:	
Contract #:		Tract/Field:	
Planner:		Acres:	

Practice Description

Beaver Dam Analogues (BDAs) and Post-Assisted Log Structures (PALS) are low-tech woody structures designed to facilitate process-based restoration of streams and riparian areas. BDAs mimic and promote the processes of beaver activity, while PALS mimic and promote the processes of wood accumulation. Structures are low, semi-permeable, and hand-built using native materials (wood, sod, etc.) with untreated wooden fence posts added where necessary for extra stability. Structures are designed to be short-lived and used primarily as a temporary tool to promote natural process recovery. Typically, 'complexes' consisting of multiple structures are used within a stream reach to meet project objectives. The desired outcome is to initiate restoration of natural processes that self-sustain healthy valley bottoms and riparian habitats. For more details, reference: [Low-Tech Process-Based Restoration of Riverscapes: Pocket Field Guide](#)

Reach Conditions/Complex-Scale Objectives (complex = group of structures designed to work together)

Reach/Complex Name	Length	Baseline Conditions	Goals & Objectives	Target Conditions
Stony Creek	500 ft	Channel incision (~3 feet) limits regular floodplain access. Riparian vegetation minimal and only where inset floodplains have developed.	Improve floodplain connectivity, expand riparian vegetation to improve native fish and wildlife habitat	The desired outcome is to widen incision trench by one active channel width, expand inset floodplain, and increase riparian vegetation extent by 50% within 5 years.

Treatment Specifications

Reach/Complex Name	Structure No.	Structure Type	Approximate Dimensions (ft) (L x W x H)	Site-Specific Notes
Stony Creek	1	Bank-attached PALS	7x2x3	Use bank blaster to force high flows into cutbank

Design drawings and maps See Appendix A for standard structure drawings and installation instructions. Refer to conservation plan map for layout of structures.

Permits and consultations (List stipulations, timing restrictions, conservation measures, and notifications required by permitting/consultations.)

Risk mitigation measures and additional notes (Complete risk considerations checklist and describe any measures needed to reduce risks)

Conservation Practice 643 – Specification Sheet

Operation, Maintenance, and Adaptive Management

BDAs and PALS are intended to be short-term structures to mimic and promote natural processes. The design life is minimally one year, but the functional life of structures is often 5+ years. Maintenance and repair will likely be required until objectives and desired conditions for the complex are achieved. Structures should be inspected annually after peak runoff events but more frequent monitoring is encouraged. The amount and type of maintenance needed depends on project objectives. The failure of an individual structure may not be problematic if undesired impacts are not occurring and management objectives are still being achieved across the whole complex of structures.

Typical maintenance activities include:

- Replacing posts
- Refilling structure with woody material
- Plugging leaks in ponds (BDAs)
- Extending structure length

Since the long-term goal is to restore self-sustaining processes (e.g., wood accumulation and/or beaver dam activity), adaptive management should include regular evaluation to determine if additional treatments are needed through time.

CLIENT'S ACKNOWLEDGEMENT STATEMENT:

- The Client acknowledges that:
- a. They have received a copy of the specification and understand the contents and requirements.
 - b. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by: _____

Date: _____

CERTIFICATION:

I have completed a review of the information provided by the client or have conducted a site visit and certify this practice has been applied according to NRCS standards and specifications.

Certified by: _____

Job title: _____

Date: _____

Conservation Practice 643 – Specification Sheet

BEAVER DAM ANALOGUES

STEP 1

Decide where to locate BDA along stream



STEP 2

Build up first layer only to just above existing water surface, and make sure crest is level across bed and its pooling water upstream to this temporary crest elevation



STEP(S) 3

Build up subsequent layer(s) in 6" to 12" lifts, packing well with mud, turf, leaves, needles, sediment and other material until ponding water to this next temporary crest elevation.



FINISHING STEP

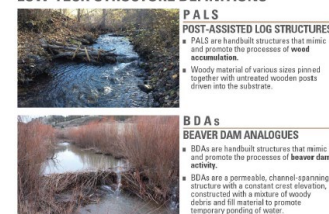
Bring dam up to desired design crest elevation. Make sure crest is perfectly level (no preferential flow or weir effect). If stream is flowing, water should be backed up and ponding, but flow over and through dam should equilibrate so that flow into equals flow out (over and through) heavy dam.



Conservation Practice 643 – Specification Sheet

Appendix A: Structure schematics and installation instructions. From Wheaton et al. 2019. [Low-Tech Process-Based Restoration of Riverscapes: Pocket Field Guide](#). Utah State University Restoration Consortium. Logan, UT.

LOW-TECH STRUCTURE DEFINITIONS



BANK-ATTACHED PALS POSTLESS BDA



MID-CHANNEL PALS POST-ASSISTED BDA



CHANNEL-SPANNING PALS POST-LINE WICKER WEAVE



Conservation Practice 643 – Specification Sheet

HOW TO BUILD BDAs

1. Decide location of BDA dam crest orientation, configuration (e.g., straight or convex downstream), and crest elevation (use landscape flags if necessary). Position yourself with your eye-level at the proposed crest elevation of the dam (make sure it is < 5' in height). Look upstream to find where the pond will backwater to. Adjust crest elevation as necessary to achieve desired size of pond, inundation extent, and overflow patterns. If concerned about head pond (water surface elevation difference) over BDA, build a secondary BDA downstream with a crest elevation set to backwater into base of this BDA (and lessen head pond or elevation difference between water surface in pond and water surface downstream of BDA).
2. Build up first layer or course by widening base upstream and downstream of crest to flat height of 5 to 12" above existing water surface, and make sure it holds back water.
 - a. If larger key pieces (i.e., larger logs, cobble or small boulders) are locally abundant, these can be used to lay out the crest position across the channel. Optionally, they can be 'keyed' in by excavating a small trench (no need to be deeper than ~1/3 of the height of key piece diameter) and place key pieces in and pack with excavated material.
 - b. Lay out first layer of larger fill material, being careful not to go to higher than 6" to 12" above existing water surface. The first layer should be just high enough to backwater a flat water surface behind it.
 - c. Using mud, bed material & turf (typically sourced from backwater area of pond) as fine fill material to plug up leaks, combine with sticks and branches of various sizes to build a wide base. Make sure base is wide enough to accommodate anticipated dam height (most dams will have a 1.5:1 to 3:1 (horizontal : vertical) proportions).
 - d. Build up first layer only to top of key pieces from first layer. Make sure the crest is level across the channel and water is pooling to this temporary crest elevation.

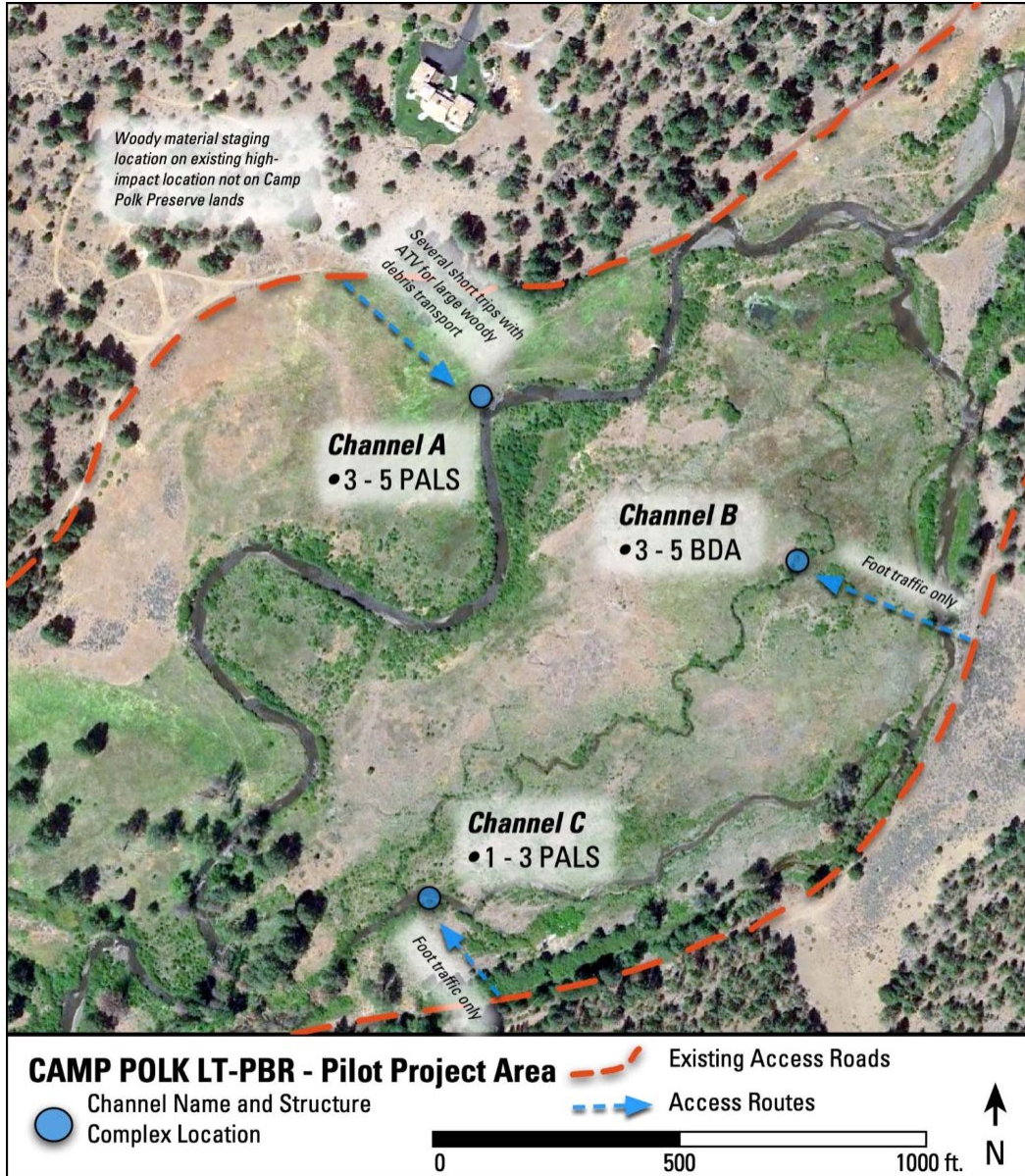
continued >>



OUTLINE: Intro to LTPBR for Stage 0

- 
- I. What is low-tech?
 - II. Shared vision of resilience via stage 0 & why?
 - III. What did you say it actually is again?
 - IV. Organizing principles of LTPBR focus on why and how
 - V. A fundamentally different/efficient design process
 - VI. Intro to afternoon on Whychus

Field Trip – Get to Go Play on Pilot



WHYCHUS CREEK LT-PBR PILOT

LOW TECH - PROCESS BASED (LT-PBR) PILOT RESTORATION AT CAMP POLK MEADOW

SEPTEMBER 25TH, 2019

Start with key pieces oriented stream-wise and face butt end or root wad upstream to maximize width that will create divergent flow paths around it.

FLOW



Drive posts in to bed angled inwards to wedge wood pieces and prevent them from rafting up and floating away in high flows.

Use a mix of sizes of wood and tangle together with branches.

A COOPERATIVE RIVERSCAPE RESTORATION AND EDUCATION PROJECT BETWEEN:



UPPER DESCHUTES
WATERSHED COUNCIL



DESCHUTES
LAND
TRUST

LT-PBR CAMP POLK PRESERVE PILOT - 2019

COMPLEX: A

3 to 5 PALS



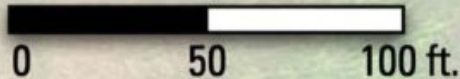
Approx. PALS location



Area of deposition



Area of scour

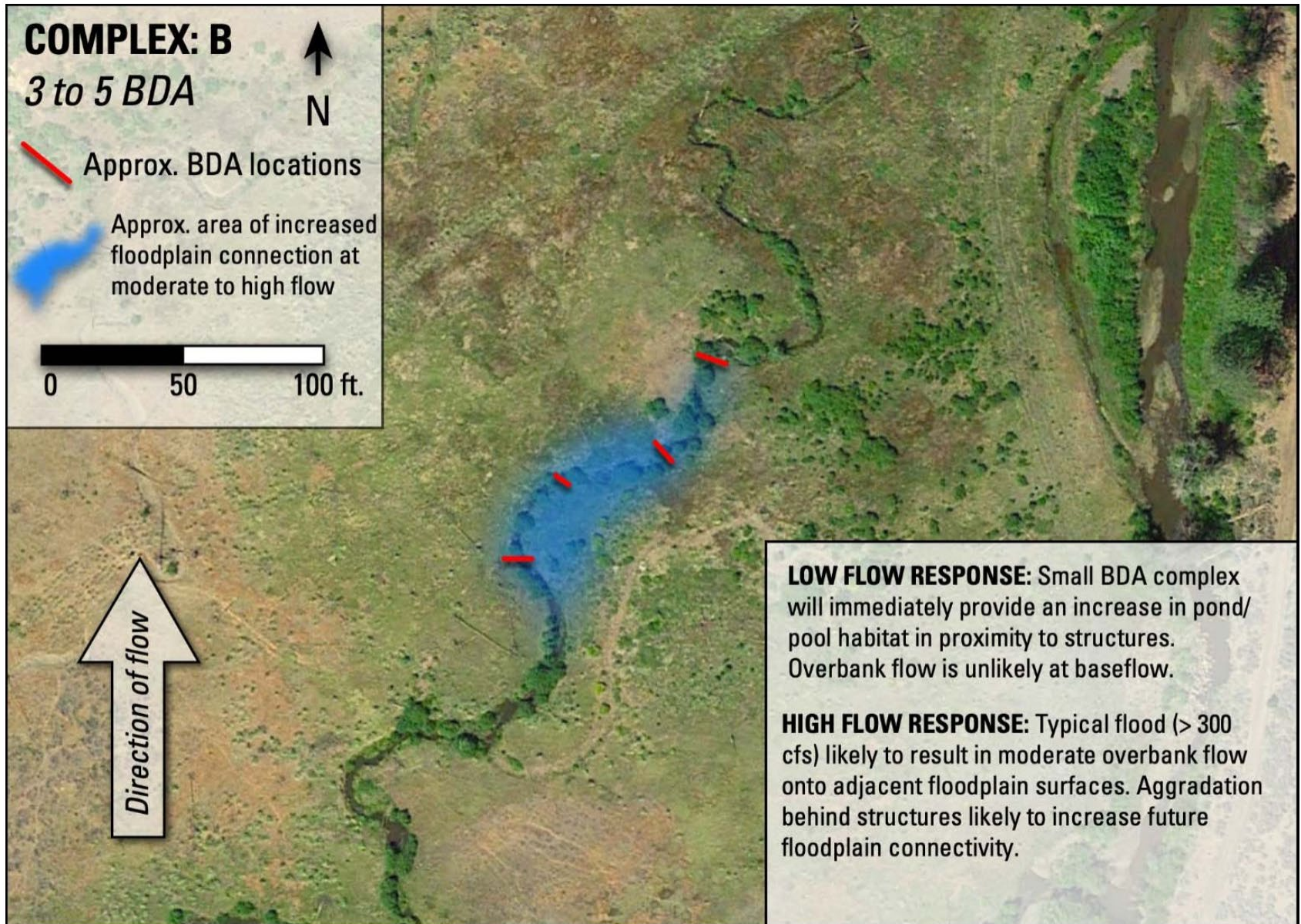


Channel A Cross Section (Figure 4)



LOW FLOW RESPONSE: PALS will result in immediate creation of flow velocity heterogeneity and provide increased hiding cover for juvenile salmonids.

HIGH FLOW RESPONSE: Typical flood (> 300 cfs) likely to initiate processes of channel migration through erosion of outside exposed bank and enhanced point bar deposition. Creation of a scour pool and variation in substrate composition are also likely.



COMPLEX: C

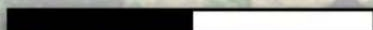
1 to 3 PALS



Approx. PALS location



Area of flow influence



0 50 100 ft.

Channel B

Channel C

Direction of flow

Whychus Creek

LOW FLOW RESPONSE: Small non-channel spanning PALS will immediately begin to enhance flow exchange from channel C to channel B even during low baseflow conditions. Some increase in velocity refugia and hiding cover will also be initiated by the structures.

HIGH FLOW RESPONSE: Flow exchange from channel C to B will be enhanced. Formation of scour pool habitat also likely as a result of some scour during high discharge.

FULLER INTRODUCTION TO MAKE YOU DANGEROUS



LOW-TECH 2.5 Day Training Offered Annually Oct 9-11, @ Utah State University



http://restoration.usu.edu/courses/LTPBR_Logan

Conclusions: Intro to LTPBR for Stage 0

- We need to improve **resilience** of riverscapes & working lands
- Need for **low-tech restoration** is underscored by massive scope of degradation & excessive costs of traditional practices
- We need to reimagine what is possible; Anastomosing (Stage 0/8) is that target!