

# Low-Tech Process-Based Stream Restoration



Regional District of Nanaimo



Drinking Water & Watershed Protection Program  
Water Data and Dialogue Event



Building Climate Resilience Through Healthy Riverscapes



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Qualicum and Snaw-Naw-As First Nations Territories



# Low-Tech Process-Based Stream Restoration



Introduction to Healthy Watersheds and Riverscapes



Two Concepts



Restoration Approaches and LTPBR



LTPBR: PALS and BDA



Multifaceted benefits of LTPBR for Stream and Watershed Restoration



Why Restoration Context Matters; and LTPBR Planning Process



**ORIGINS**  
ENVIRONMENTAL SERVICES



# Watersheds Are Connected Systems That Sustain Life

**A Watershed Is All The Land That Drains To A Common Stream, Lake, Or Ocean.**

Rainfall • Forests • Agriculture • Communities • Streams • Wetlands • Oceans

**Riverscapes Are Composed Of Connected Floodplain And Channel Habitats That Together Make Up The Valley Bottom.**

**Data Collection, Monitoring & Stewardship**

- ✓ Track Trends And Thresholds
- ✓ Understand Watershed Health
- ✓ Measure Restoration Success
- ✓ Inform Decisions To Protect And Restore Ecosystems





# Watersheds Are Connected Systems That Sustain Life

<b>Biodiversity &amp; Ecosystem Function</b>	Support rich aquatic and terrestrial habitats	Promote nutrient cycling and ecological processes	Maintain thermal and water quality regimes
Enhance landscape connectivity	<b>Water Quality &amp; Natural Infrastructure</b>	Filter pollutants and process sediments	Improve groundwater recharge and water storage
Maintain longitudinal, lateral, and vertical connectivity	<b>Climate Resilience</b>	Increase drought resistance through longer water residence times	Slow and attenuate floods
Reduce downstream erosion	Create moist valley bottoms that can act as natural fire breaks	 <b>Benefits to People</b>	Carbon and nutrient storage
	Cultural, Recreational, Economic values	Improved physical and mental well-being	

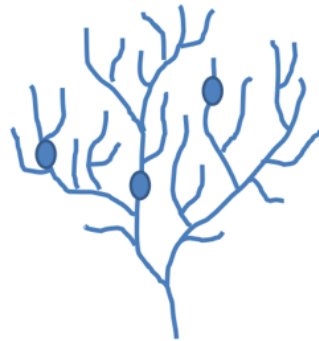
# Healthy Riverscapes = Healthy Watersheds

## Concept 1: Beads on a String

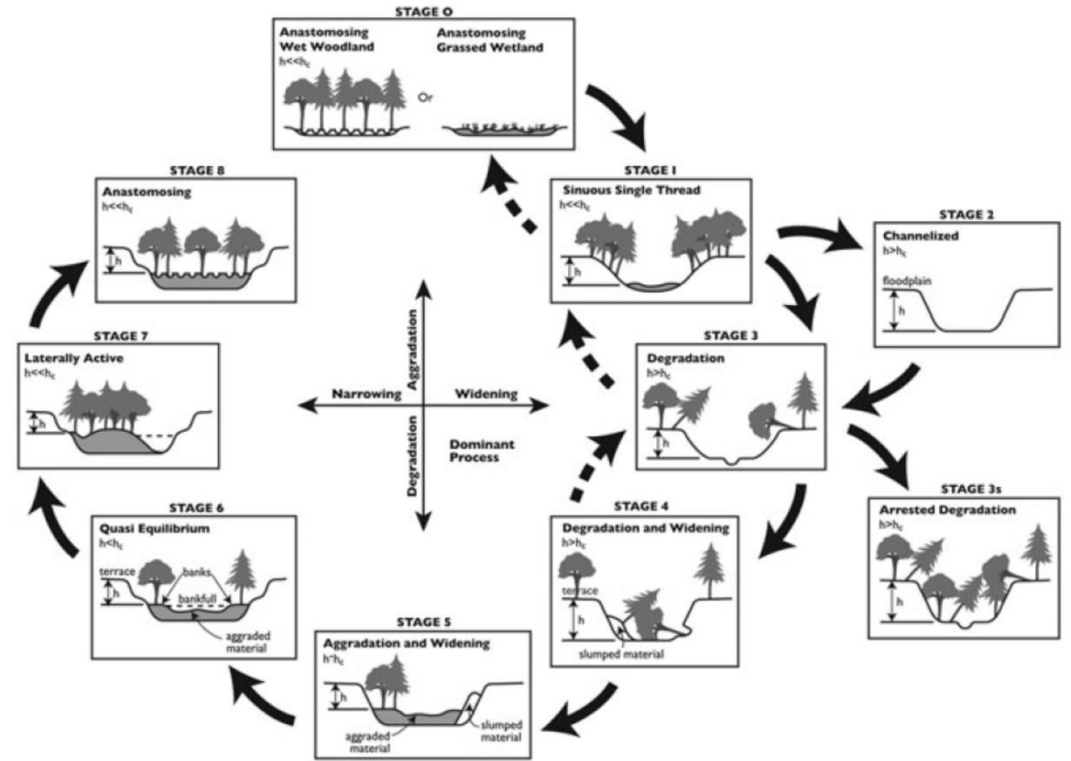
A Pre-settlement



B Today



## Concept 2: Stage 0



# Healthy Riverscapes = Healthy Watersheds

## Concept 1: Beads on a String

A Pre-settlement



B Today



### Undisturbed/Unmodified Watershed

- ✓ Water storage
- ✓ Groundwater recharge
- ✓ Flood attenuation
- ✓ Water filtration
- ✓ Temperature regulation
- ✓ Biodiversity support
- ✓ Drought resilience

With flood and drought events increasing, it is important to look in storing more water and restoring watershed functions.

# Healthy Riverscapes = Healthy Watersheds

## Concept 1: Beads on a String

A Pre-settlement



B Today

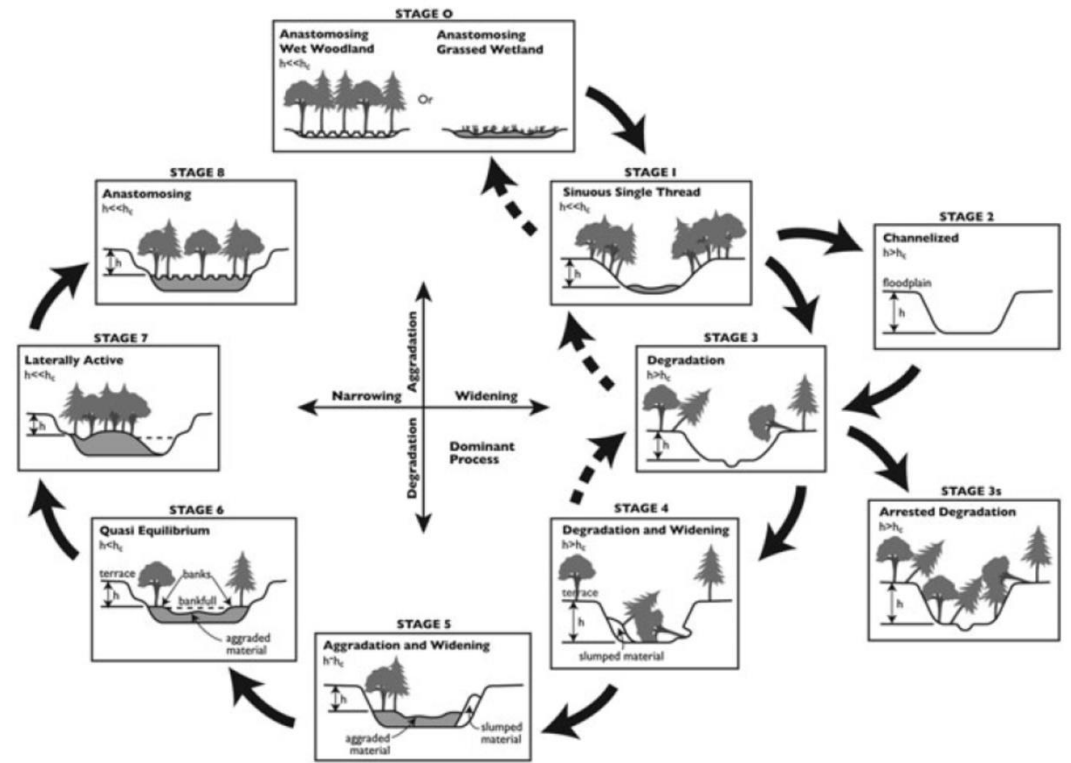


## Today's Trends

- Longer and drier summers
- Reduced summer stream flows
- More intense winter rainfall events
- Increased flooding and erosion
- Warmer water temperatures
- Greater pressure on fish populations and aquatic ecosystems
- Increasing wildfire risk and reduced drought resilience
- Over decades, we straightened channels, disconnected floodplains, removed large wood, drained wetlands, and accelerated water off the landscape.

# Healthy Riverscapes = Healthy Watersheds

## Concept 2: Stage Zero



## Concept 2: Stage Zero

- Stage of riverscape **before** Incision
- Multiple flow paths
- Floodplain connection
- Wetlands and ponds
- Groundwater recharge
- High biodiversity



Credits: LTPBR Manual



# Today's challenge

- Most riverscapes are at **Stage III–IV**
- Single incised channels
- Disconnected floodplains
- Rapid water export
- Strong longitudinal connectivity
- Low lateral connectivity
- Reduced summer flows
- Flashy winter flows
- Less resilience



# Healthy Riverscapes = Healthy Watersheds

## Concept 2: Stage Zero

Stage Zero represents a condition where water has many pathways across the valley bottom.

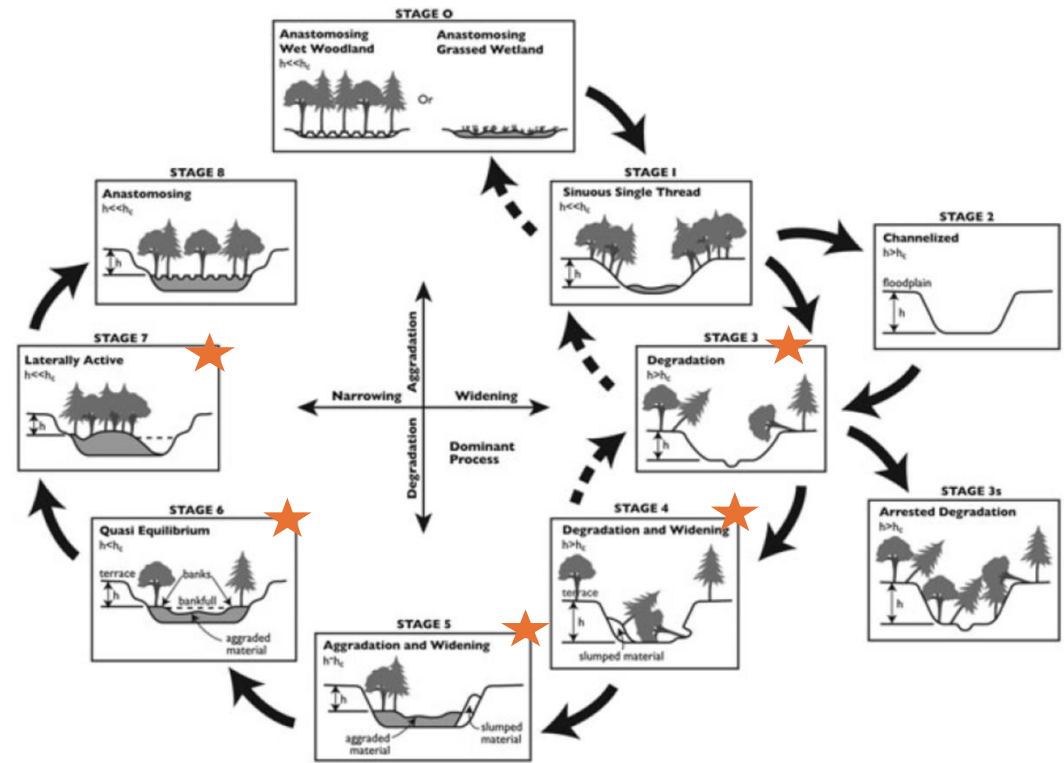
Floodplains, wetlands, side channels, ponds, and groundwater are all connected.

The landscape stores water rather than exporting it quickly downstream.

These systems are naturally resilient.

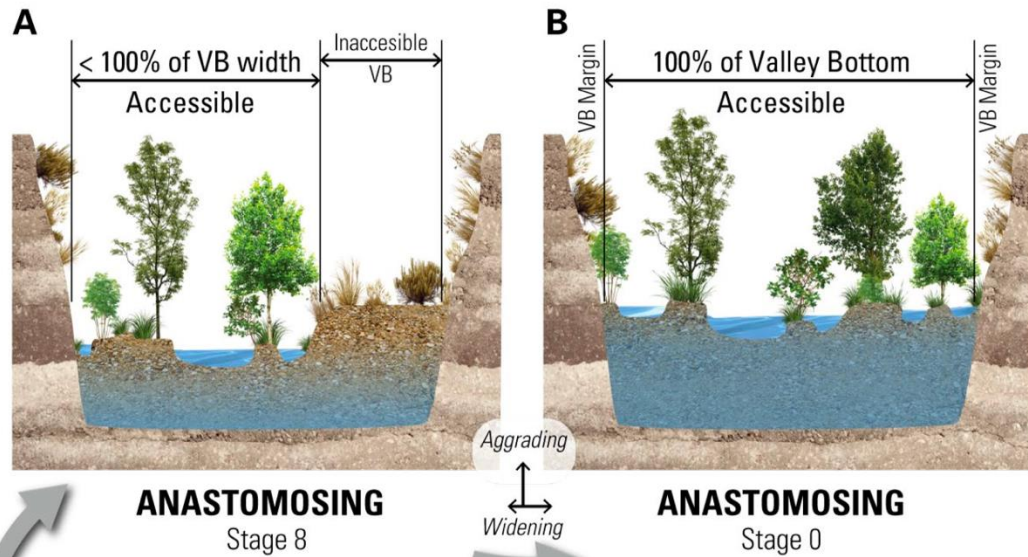
- ★ Many streams today are deeply incised and disconnected from their floodplains.
- ★ In these systems, water is trapped inside a single channel.

## Concept 2: Stage Zero



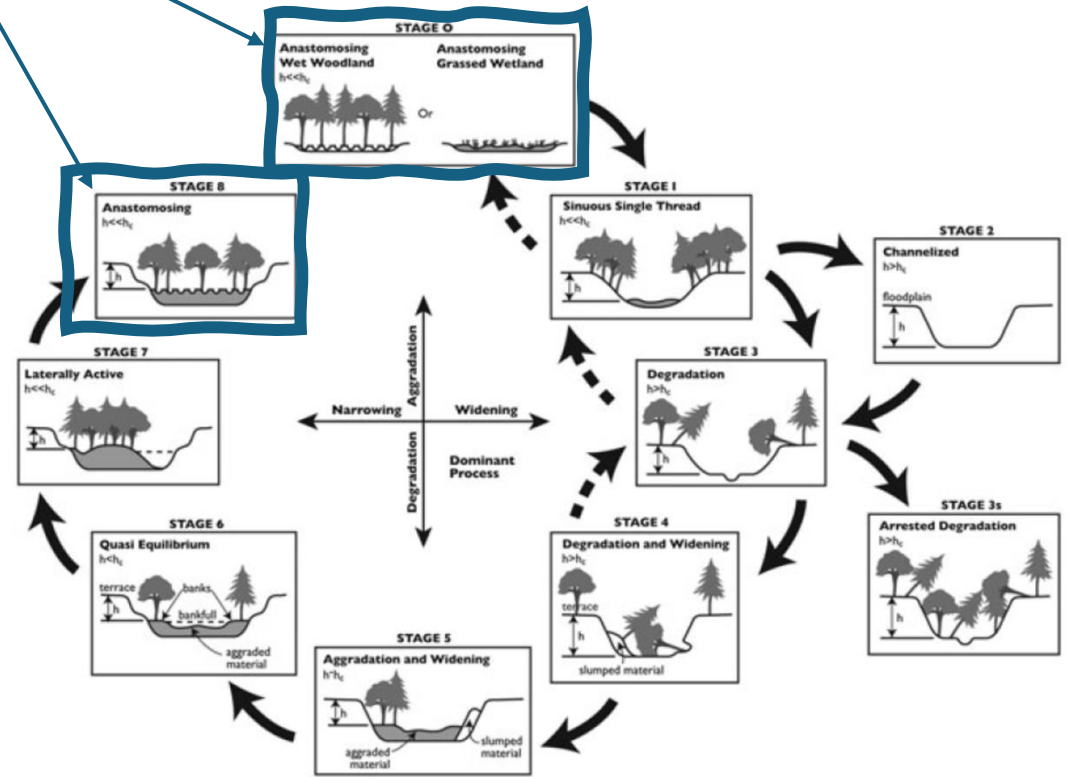
# Healthy Riverscapes = Healthy Watersheds

## Concept 2: Stage Zero



From Stage 5-7

CC Nick Weber

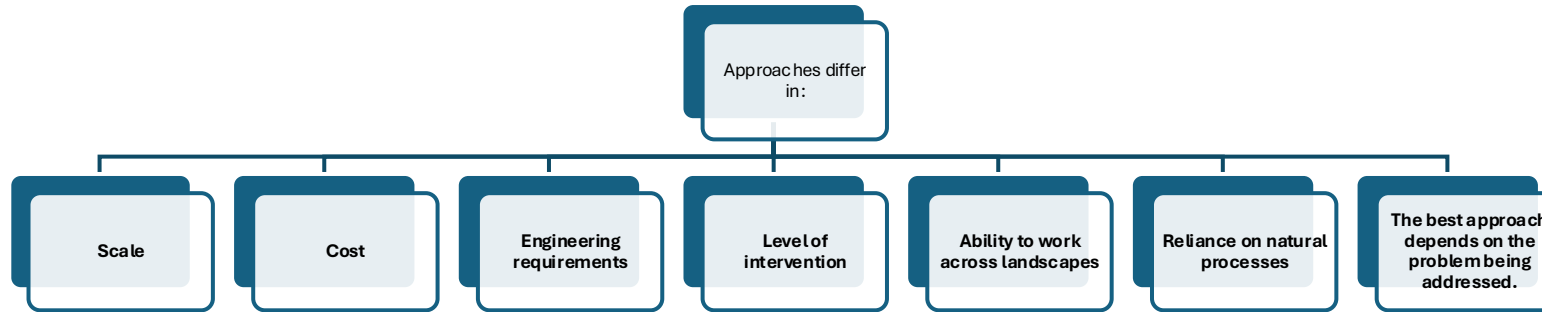


**Anastomosing** (noun): Channels which are multithreaded but split around vegetated islands (i.e., floodplain) and tend to be more stable than braided channels (split around active bars).

Anastomosing behavior exists in Stage 8 but it does not span the entire width of the valley bottom; often occurring in today's anthropogenic landscape

# Available Restoration Approaches

**Many Paths to Restoration:** There is no single way to restore streams and watershed



Approaches	Human Effort	Engineering	Cost	Scale	Examples
<b>Protection &amp; Passive Recovery</b>	Low	Low	\$	Watershed	Passive infrastructures; Fencing; Riparian Setbacks; Water Use Prevention...
<b>Assisted Restoration</b>	Low	Low	\$\$	Site–Reach	Native Species Planting; ISC; Road Decommission...
<b>Low-Tech Process-Based Restoration</b>	Moderate	Low	\$\$	Reach–Valley	BDAs; PALs; Woody debris placement; Hand-Built Swales; Stage-0 Approach,; Bioengineering...
<b>Structural Restoration</b>	High	Moderate	\$\$\$	Reach	Bank armoring; Culvert Replacement; Grade-Control Structures
<b>Ecological Engineering</b>	Very High	High	\$\$\$\$	Site–Reach	Channel Reconstruction; Wetland Creation; Stormwater Treatment Wetlands; Large-Scale River Relocation; Dam Removal...

**LTPBR approach works with natural processes by promoting floodplain connectivity, sediment recruitment, and channel evolution**

# LTPBR in the field

## Post-Assisted Log Structures (PALS)



Credit: Elodie Roger, Black Creek LTPBR with DFO and A-tlegay Fishery Society

## Beaver Dam Analogues (BDA)

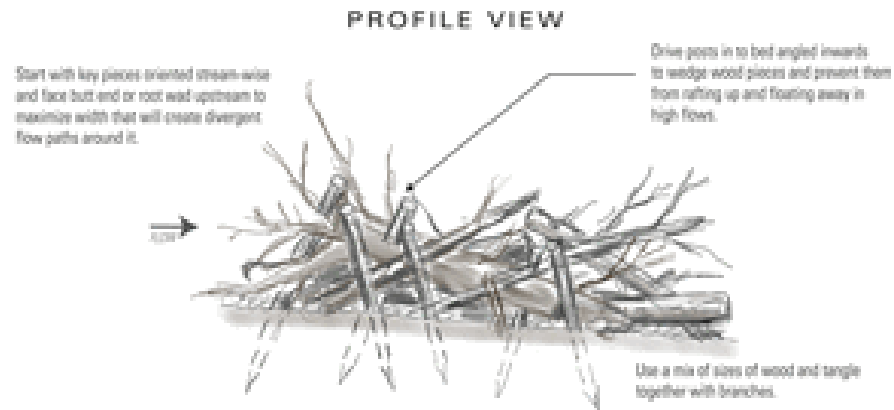


Credit: Elodie Roger, Kelvin Creek LTPBR

# Post-Assisted Log Structures (PALS)

## How they work

- Reduce Velocity & Increase Sedimentation
- Promote stream complexity
- Activate hydrological processes
- Recharge Groundwater

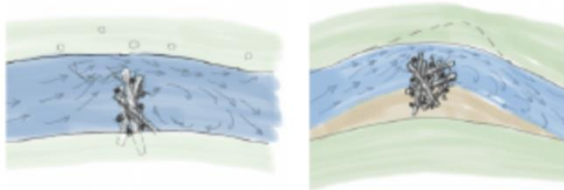


Credit: Elodie Roger, Black Creek LTPBR with DFO and A-tlegay Fishery Society

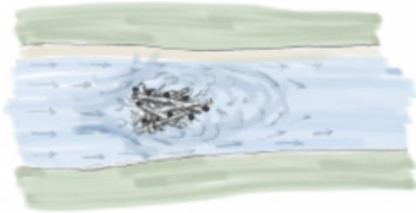
# Post-Assisted Log Structures (PALS)

## Three Types of PALS

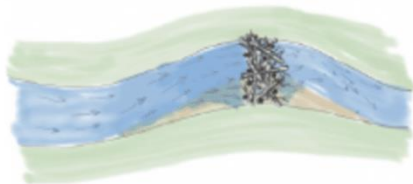
### BANK-ATTACHED PALS



### MID-CHANNEL PALS



### CHANNEL-SPANNING PALS



# Post-Assisted Log Structures (PALS)

## Gathering Woody Debris



Credit: Elodie Roger, Kelvin Creek LTPBR



Credit: Elodie Roger, Kelvin Creek LTPBR

# Post-Assisted Log Structures (PALS)



Credit: Elodie Roger, Kelvin Creek LTPBR with Anabranch Solutions



Credit: Elodie Roger, Black Creek LTPBR with DFO and A-tlegay

# Post-Assisted Log Structures (PALS)



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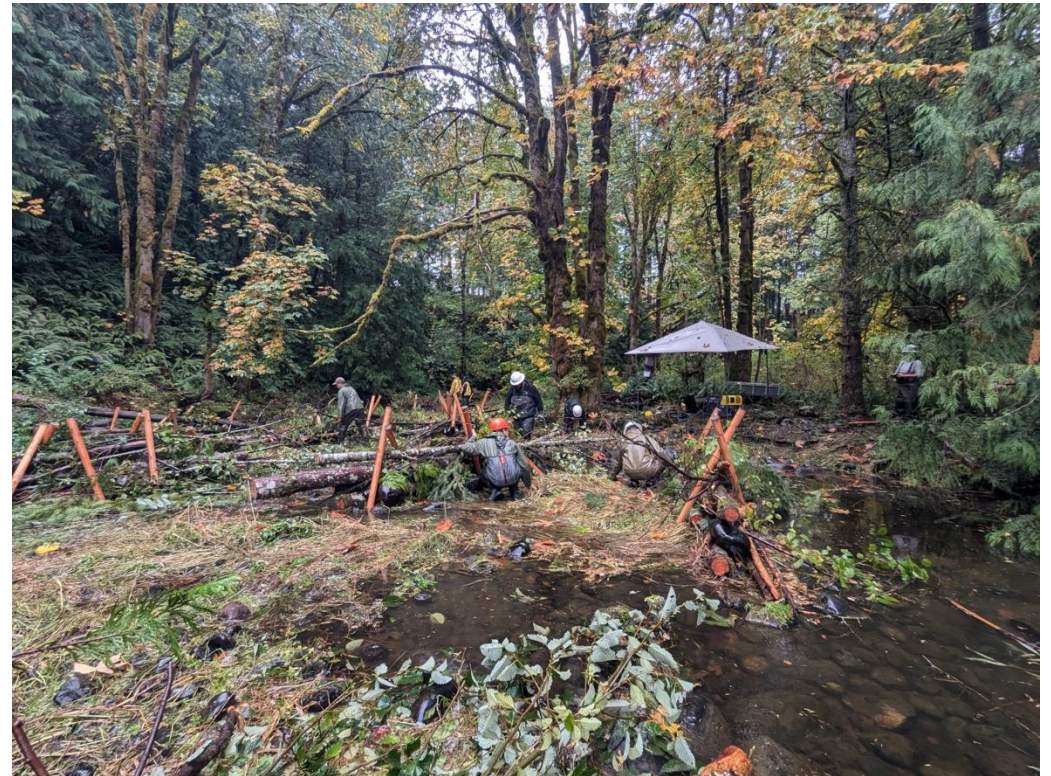
# Post-Assisted Log Structures (PALS)

## Mid Channel PALS



Credit: Elodie Roger, Black Creek LTPBR with DFO and A-tlegay

## ~ 15 Structures installed



Credit: Elodie Roger, Black Creek LTPBR with DFO and A-tlegay

# Beaver Dam Analogues (BDA)

## How they work

- Human-built structures that mimic natural beaver dams.
- Simple, low-cost, and minimally intrusive
- Slow water, trap sediment, and reconnect floodplains
- Enhance hydraulic, geomorphic, and hydrologic processes
- Create deep-water habitat and support successful beaver reintroduction
- Help achieve multiple restoration goals including improved water storage, habitat complexity, and climate resilience.

## Three Types of BDA

### POSTLESS BDA

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### POST-ASSISTED BDA

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### POST-LINE WICKER WEAVE

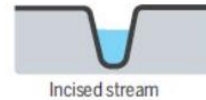
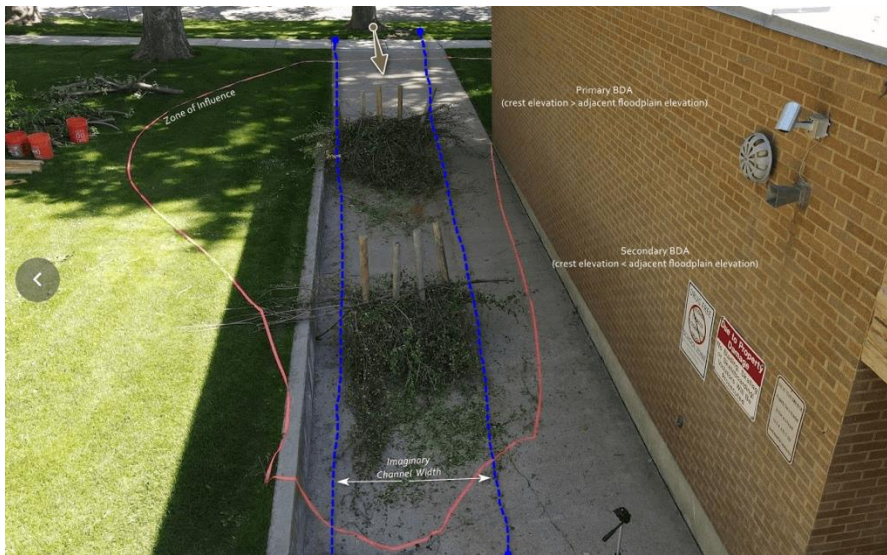
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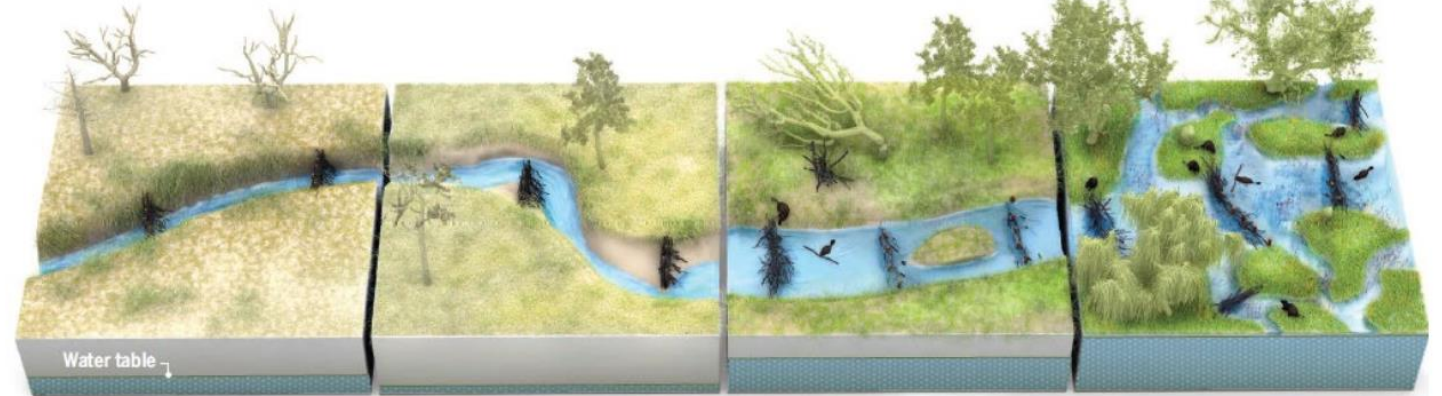
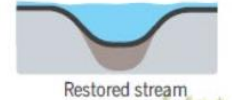
Source: LTPBR of Riverscapes Pocket Guide

# Beaver Dam Analogues (BDA)

## How they work



**A stream comes back to life**  
Across the U.S. West, scientists and land managers are using beaver dam analogues (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.



**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.

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

# Beaver Dam Analogues (BDA)

## Case Study: Kelvin Creek



Credit Left and Right: Elodie Roger, Kelvin Creek LTPBR



Low porosity structure, filled with mud, rocks and organics harvested within the adjacent riparian areas, spanning.

# Beaver Dam Analogues (BDA)



Credit: Elodie Roger, Kelvin Creek LTPBR

## Case Study: Kelvin Creek

Three successive small post-less BDA spanning the wet channel (~3m/12m) in August, allowing fish passage.

### Goals:

- Reactivating flow over the gravel bar
- Deepening pools
- Connecting pools
- Oxygenating aquatic habitat through riffles

A Pre-settlement



B Today



# Beaver Dam Analogues (BDA)



Credit: Elodie Roger, Kelvin Creek LTPBR

## Case Study: Kelvin Creek

One large post-less BDA spanning the wet channel (~20m) built in August.

### Goals:

- Backing up water to previous pool
- Activating the floodplain
- Recharging aquifer
- Increasing hydroperiod for fish survival

# Beaver Dam Analogues (BDA)



Credit: Anabran Solutions Ltd.

**Left: Case Study: US by Anabran Solutions by Dr. Joseph Wheaton**

In semi-arid valleys, BDAs slow runoff and reconnect floodplains, creating pockets of perennial moisture and expanding wetland vegetation across otherwise dry landscapes.



Credit: Environment of the Americas

# Riverscape Principles while applying LTPBR

## 10 Principles

- 1. Streams need space.
- 2. Structure forces complexity and builds resilience.
- 3. The importance of structure varies
- 4. Inefficient conveyance of water is often healthy.
- 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.



# Building Community and Ecological Resilience

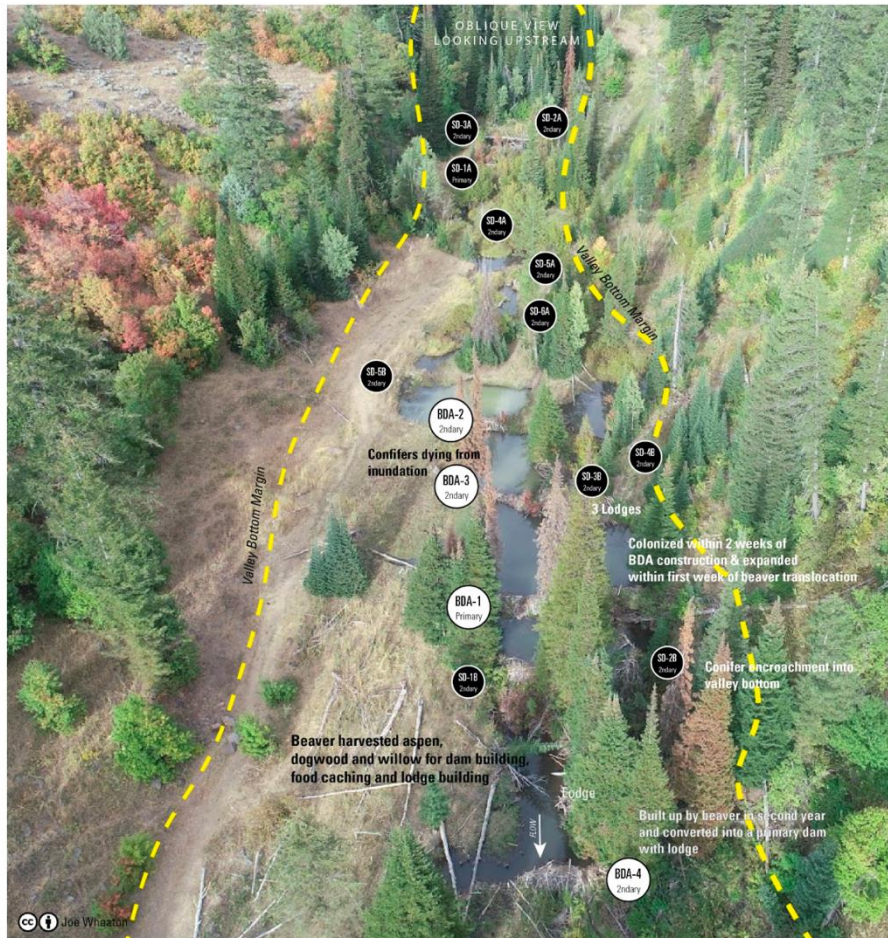


Figure 4 – Complex of four BDAs designed for beaver translocation (white circles), which was successfully colonized by beaver. Beaver built an additional 11 dams (black circles) within one year of translocation. Identifying the hydraulic zone of influence when designing low-tech complexes ensures that risks and opportunities are identified.

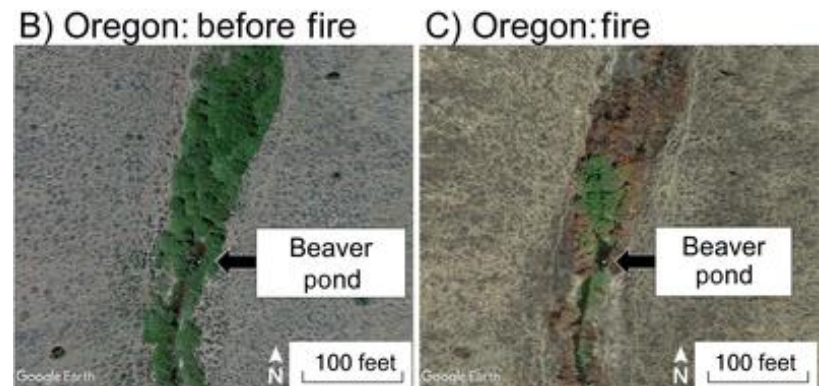
<b>Biodiversity &amp; Ecosystem Function</b>	Support rich aquatic and terrestrial habitats	Promote nutrient cycling and ecological processes	Maintain thermal and water quality regimes
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Maintain longitudinal, lateral, and vertical connectivity	<b>Climate Resilience</b>	Increase drought resistance through longer water residence times	Slow and attenuate floods
Reduce downstream erosion	Create moist valley bottoms that can act as natural fire breaks	<b>Benefits to People</b>	Carbon and nutrient storage
	Cultural, Recreational, Economic values	Improved physical and mental well-being	

# Building Climate Resilience through LTPBR

## Drought & Wildfire Resilience



Credit: Dr. Joe Wheaton, 2018



Credit: Fairfax

**Beaver dams proved to be highly effective in wildfire protection**

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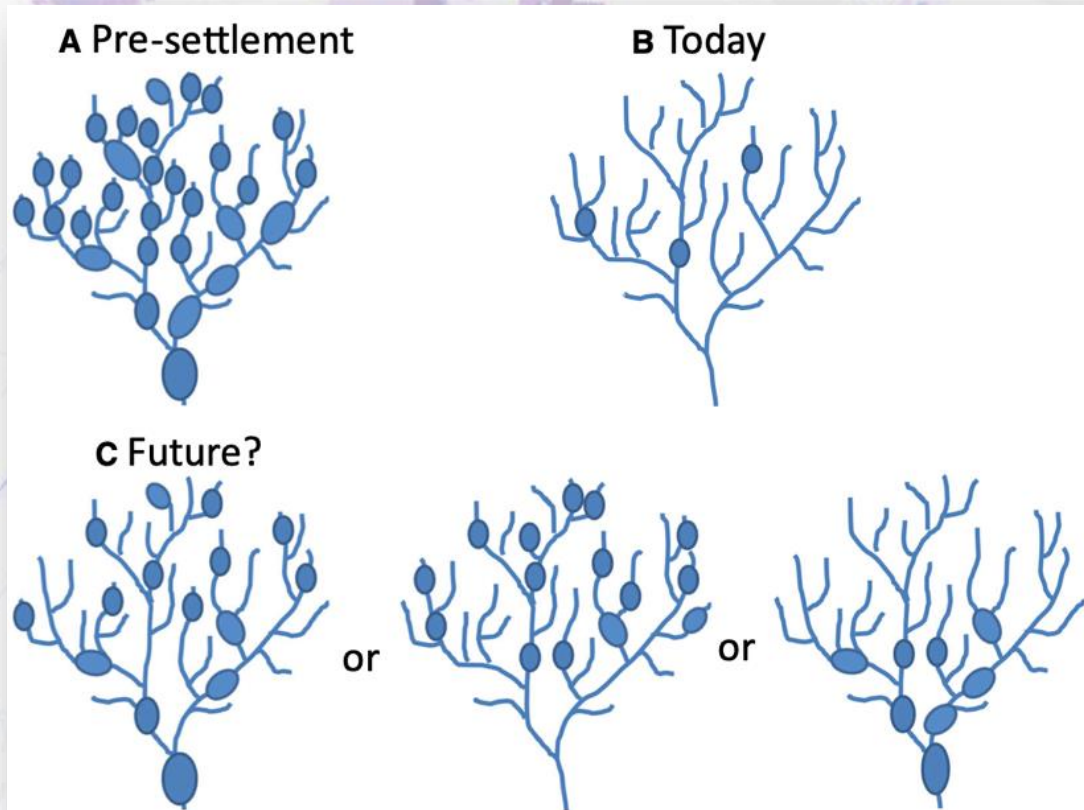


# The Restoration Context Matters

- Nature already knows how to build resilient watersheds
- Riverscapes Restoration Cannot Be Separated From Anthropogenic and Biogeomorphic Context
- Our role is to:
  - Restore processes
  - Work with natural systems
- LTPBR practices intend to:
  - Slow Water
  - Spread Water
  - Store Water
  - Restore Watershed Resilience



# Planning for Restoration



- **Planning and Implementation Most Effective**
  - **Valley Bottoms and "Beads"**
  - **Areas with Remaining Recovery Potential**
    - Incised but not deeply entrenched
    - Structurally starved (no/little wood or beaver dams)
    - Hydrologically disconnected
  - **Low-Risk Settings**
    - Gentle gradients (3-4%)
    - Away from infrastructures and agricultural needs
    - Low stream power
    - Places where structure failure would simply redistribute wood and sediment naturally
- **Land Access and Social Feasibility**
- **Existing Refugia and Intact Processes**
  - Protecting / Enhancing existing beaver habitats, wetlands, perennial pools, riparian areas

# Low-Tech Process Based Stream Restoration

## Thank you !

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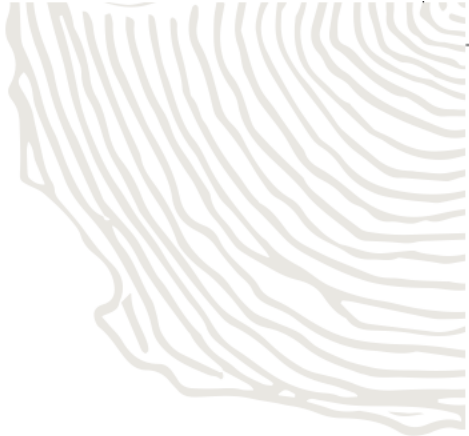






Figure 6 – Example of structurally-forced resilience to fire where beaver dam activity kept parts of the riverscape from burning, providing critical wildlife and livestock refugia during the fire, and assisting in post-fire recovery. Example from Baugh Creek, Idaho.

While less well-documented, structurally-forced complexity may also yield greater resilience to **wildfire**. In one anecdote from central Idaho, beaver dam activity helped preserve riverscape structure and function in the heart of a 65,000-acre **wildfire** (Randall, 2018). The majority of riparian areas within the fire perimeter burned right up to the banks, leaving the floodplains black with ash. However, reaches that supported beaver dam complexes remained largely green and unburned. In larger valley bottoms, beaver dam complexes can act as actual fire breaks during the fire. In narrower valley bottoms like that shown in Figure 6, these complexes were not enough to stop fire but still provided critical refugia during and after the fire for both wildlife and livestock. Moreover, in the post-fire recovery these are critically important habitats and seed banks for recovery as well as helping keep the riverscape resilient to elevated runoff and or debris-flows post-fire.

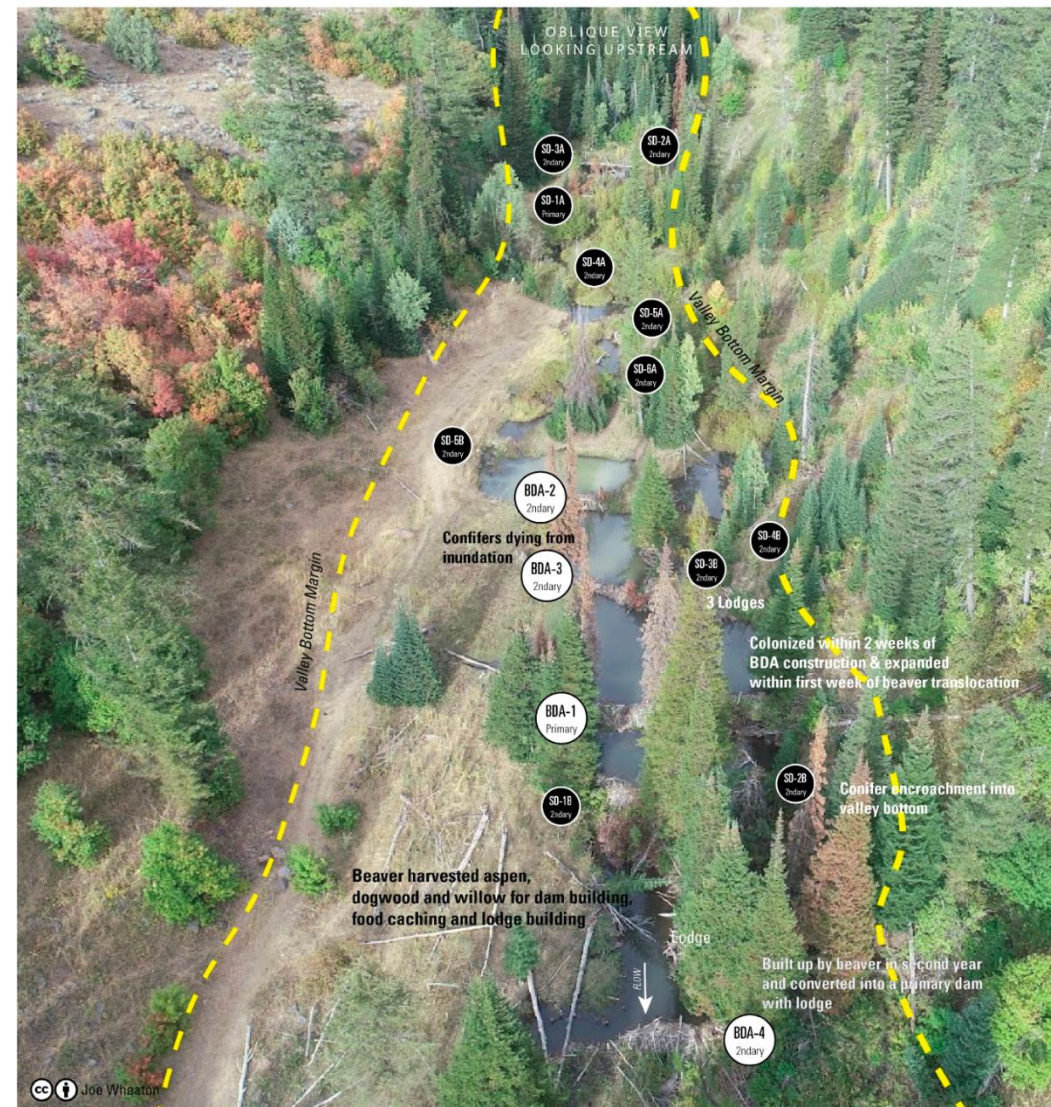


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Credit: McTavish