

Applying Principles for the Ecological Restoration of Aquatic Resources to Legacy Sediment in Pennsylvania Watersheds



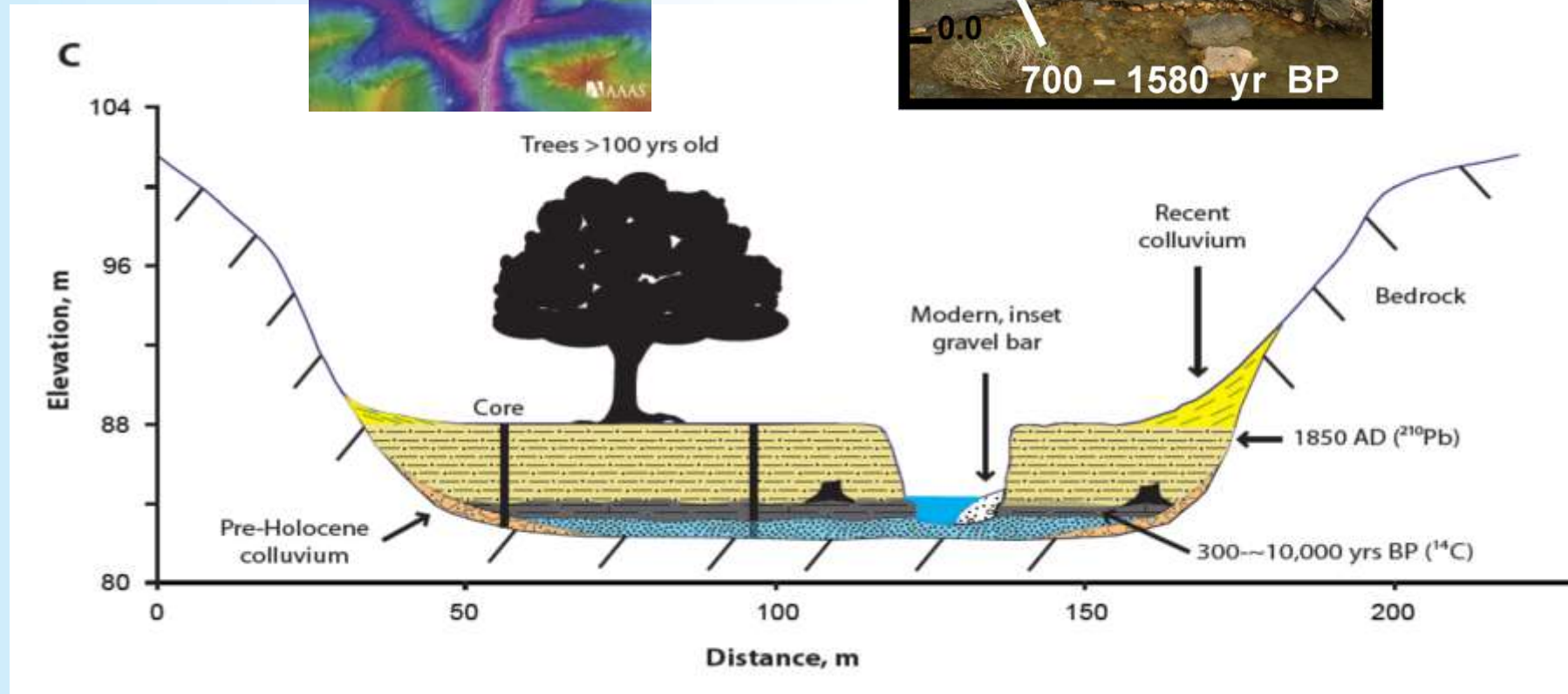
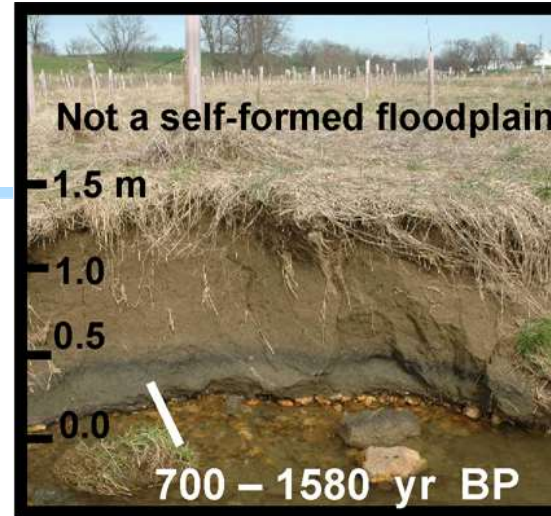
pennsylvania

DEPARTMENT OF ENVIRONMENTAL
PROTECTION

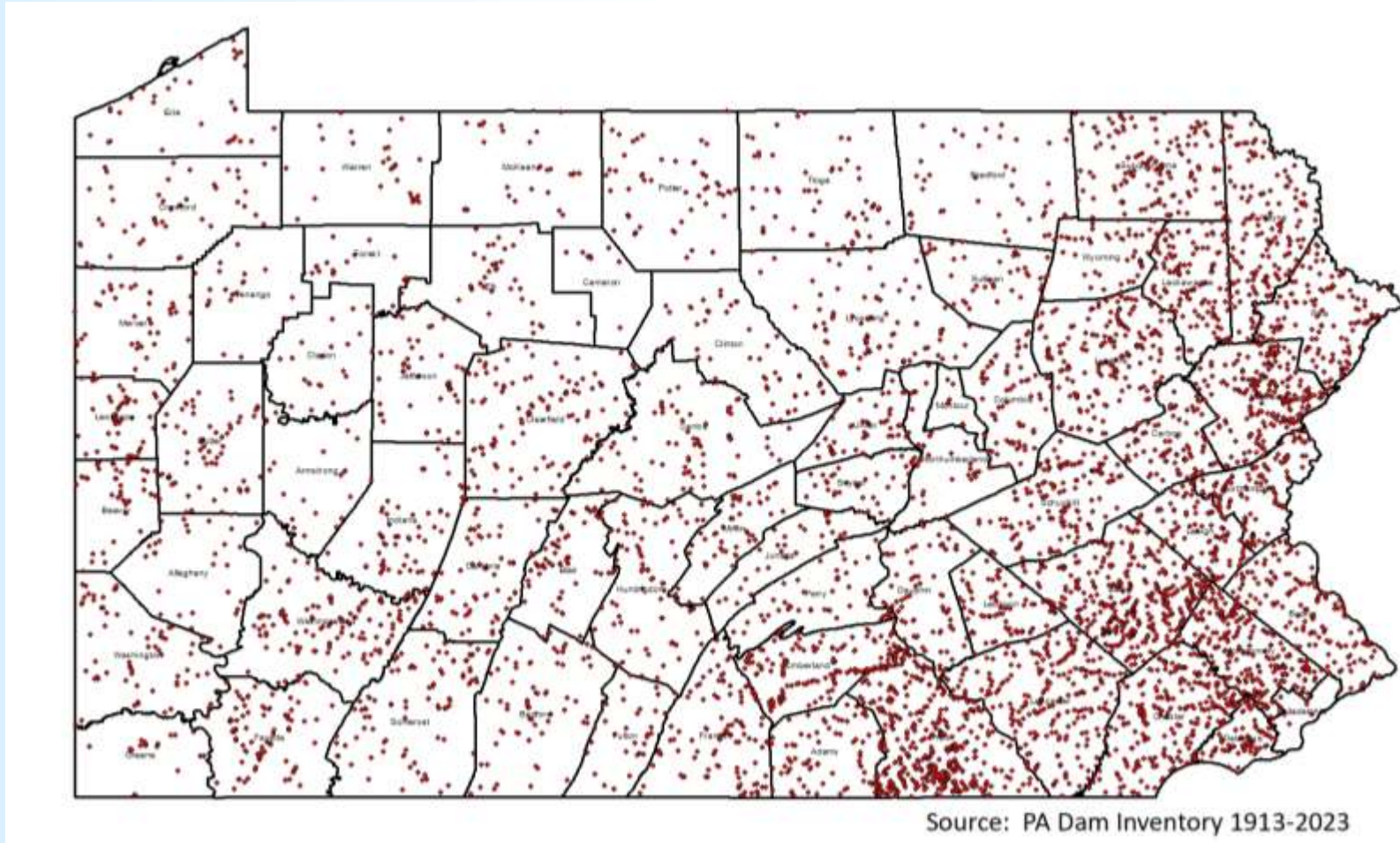
Presentation Outline

- Legacy Sediment
- Restoration Definitions
- Restoration Principles (USEPA, 2000)
- Hypothesis Testing, Monitoring & Outcomes
- Cost-Effectiveness

Legacy Sediment



Breached Dams In Pennsylvania – Targeting Legacy Sediment



What is Aquatic Resource Restoration?

Definitions

National Research Council, 1992 - Adopted by USEPA for wetlands

Restoration of Aquatic Resources – "Return of an ecosystem to a close approximation of its condition prior to disturbance."

"The term restoration means the reestablishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics."

Federal Mitigation Rule Definition of Restoration:

Restoration of Aquatic Resources – "The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource."

What is not Aquatic Resource Restoration?

Enhancement – means the manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s).

Establishment or Creation – means the manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site.

Stabilization – The proper placing, grading, constructing, reinforcing, lining, and covering of soil, rock or earth to ensure their resistance to erosion, sliding or other movement.

Preservation – means the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources.

U.S. EPA's Principles for the Ecological Restoration of Aquatic Resources

- Address ongoing causes of degradation
- Use reference information (historic/in-situ)
- Restore natural structure-(physical/geomorphology)
- Involve a multi-disciplinary team
- Restore ecological integrity (resilience)
- Restore natural function
- Develop clear, achievable, and measurable goals
- Design for self-sustainability (resilience)
- Restore native communities
- Understand the watershed potential
- Anticipate future changes
- Work within the watershed/landscape context
- Monitor and adapt where changes are necessary
- Focus on feasibility
- Preserve and protect aquatic resources **that are not degraded**
- Use passive restoration, **when appropriate**
- Use natural fixes and bioengineering, **when appropriate**

Address Ongoing Causes of Degradation

Address the symptoms

- Stabilize streambanks
- Establish forested riparian buffers
- Construct fish and other aquatic habitat enhancement structures

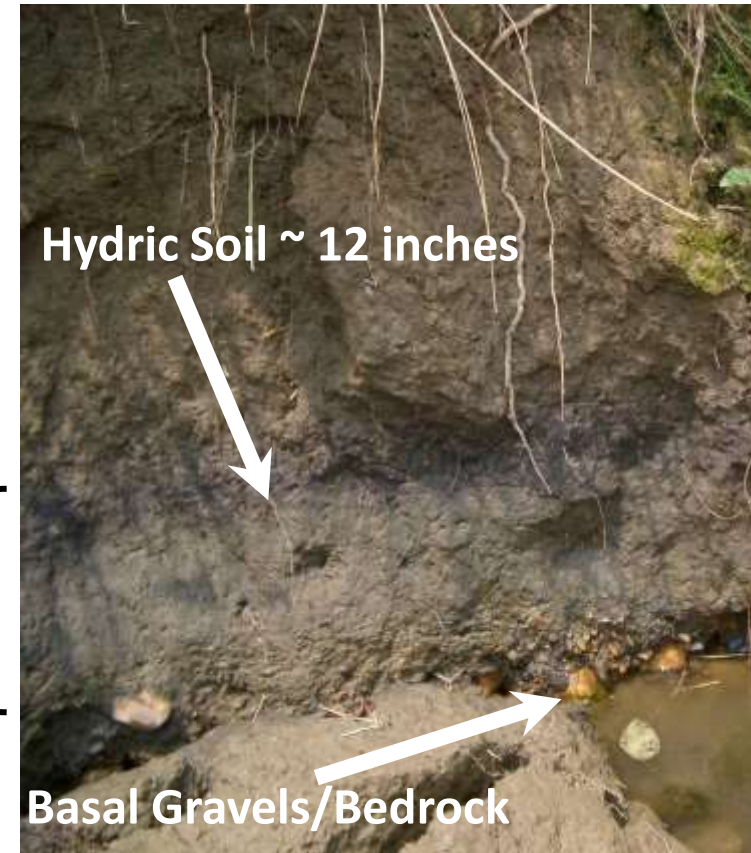
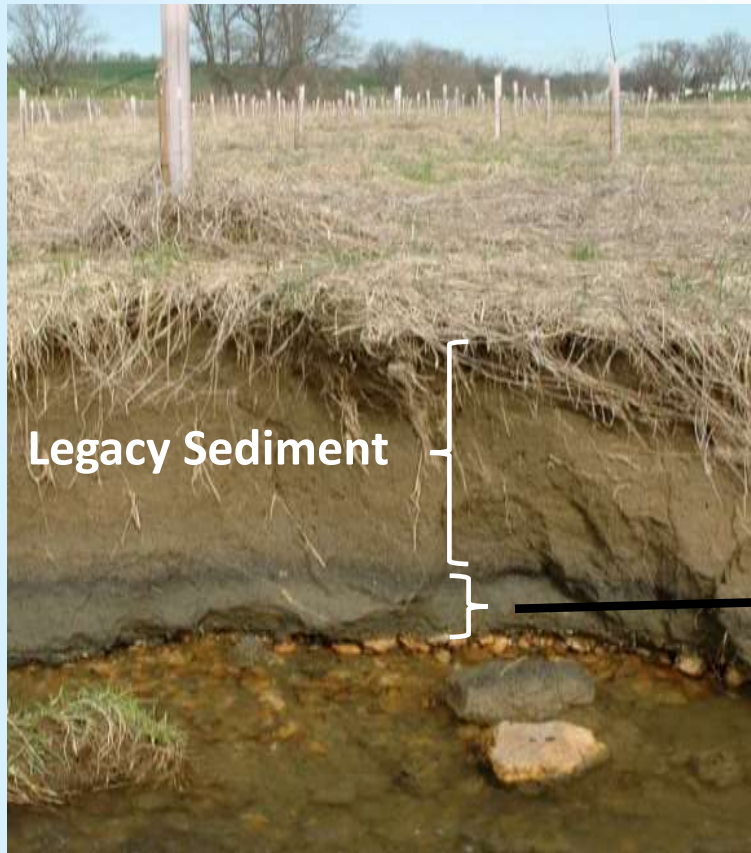
vs.

Fix the underlying problem

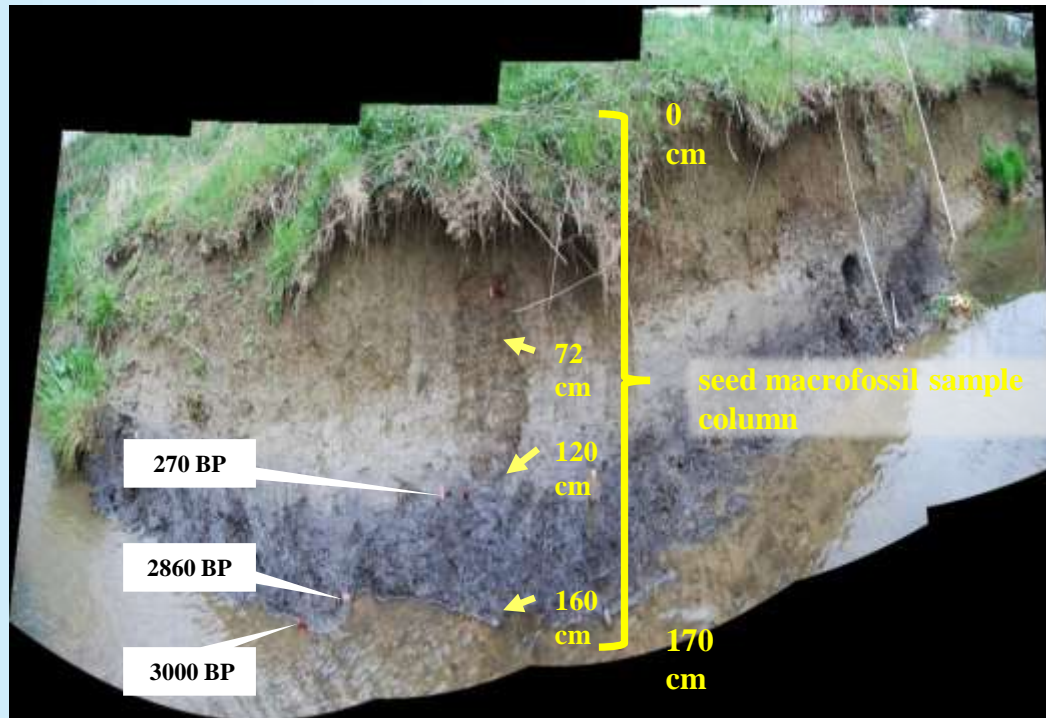
- Remove legacy sediment
- Re-establish natural aquatic ecosystem characteristics and functions - often buried under legacy sediment



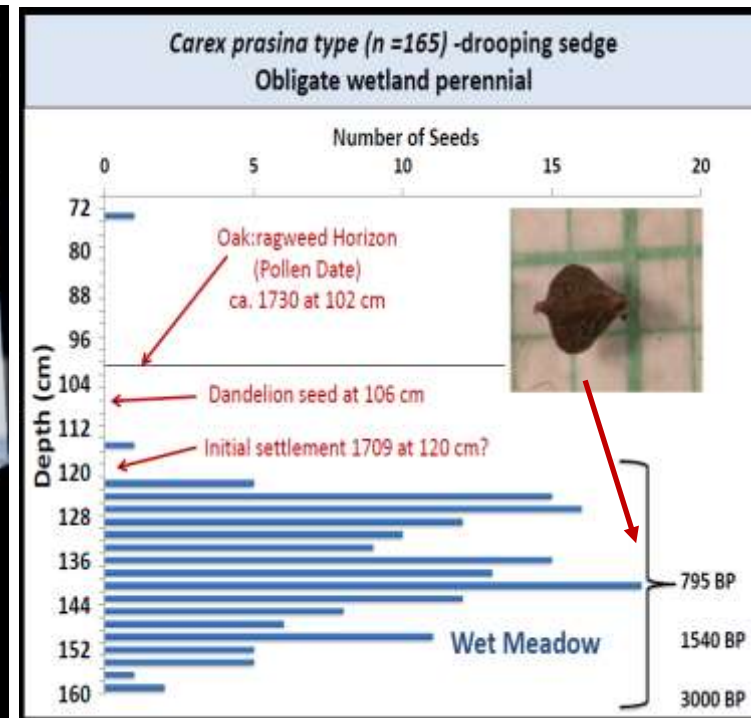
Use Reference Information (historic/in-situ)



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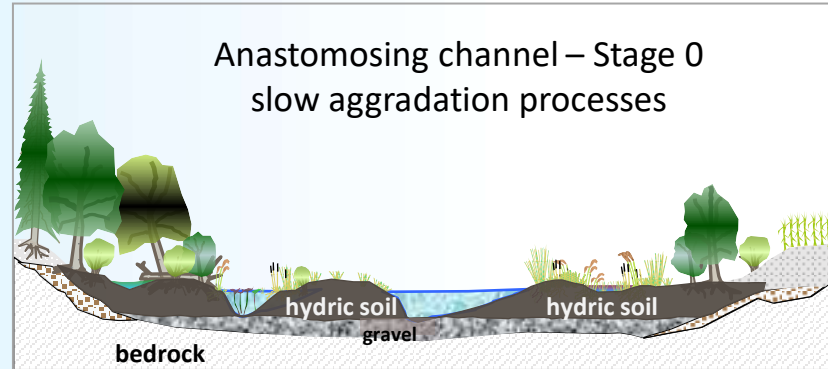


All Dates +/- 40



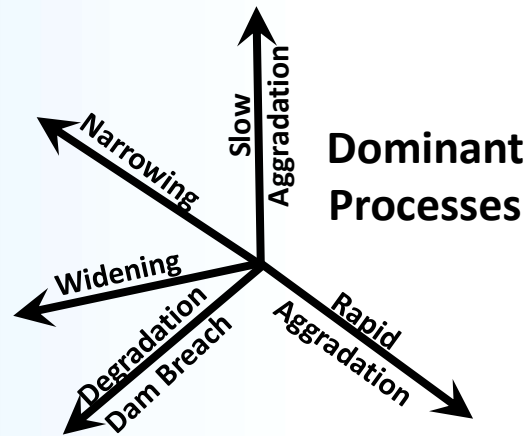
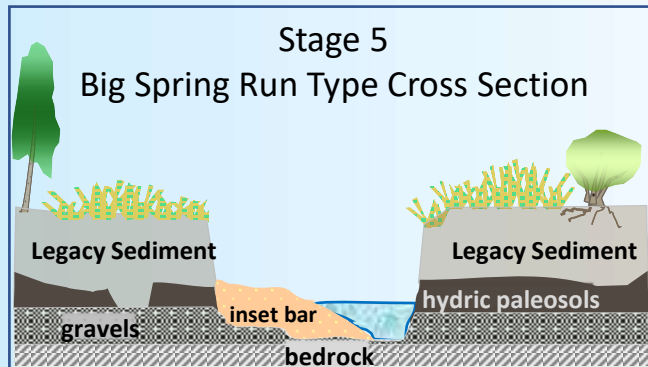
Adapted from Hilgartner et. al. 2012

Restore Natural Structure

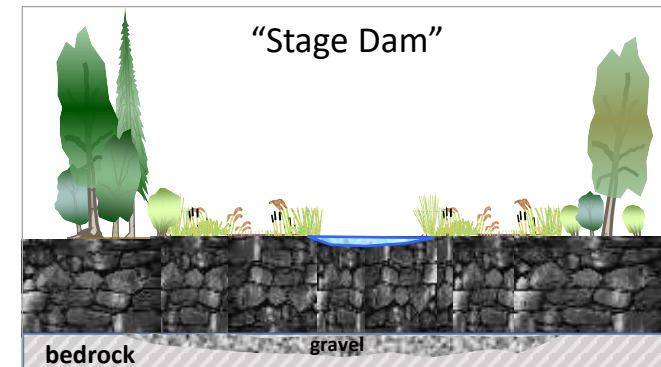


Adapted from Cluer and Thorne, 2013

Legacy sediment removal and aquatic ecosystem restoration

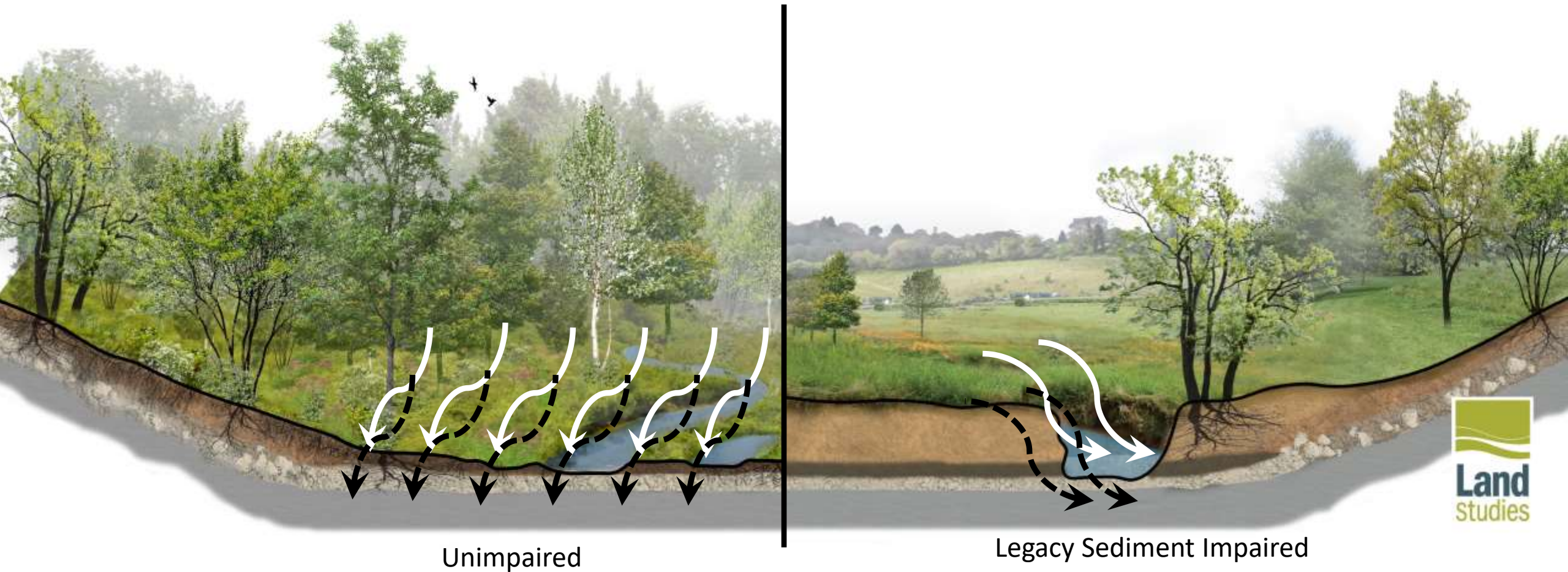


Rapid aggradation



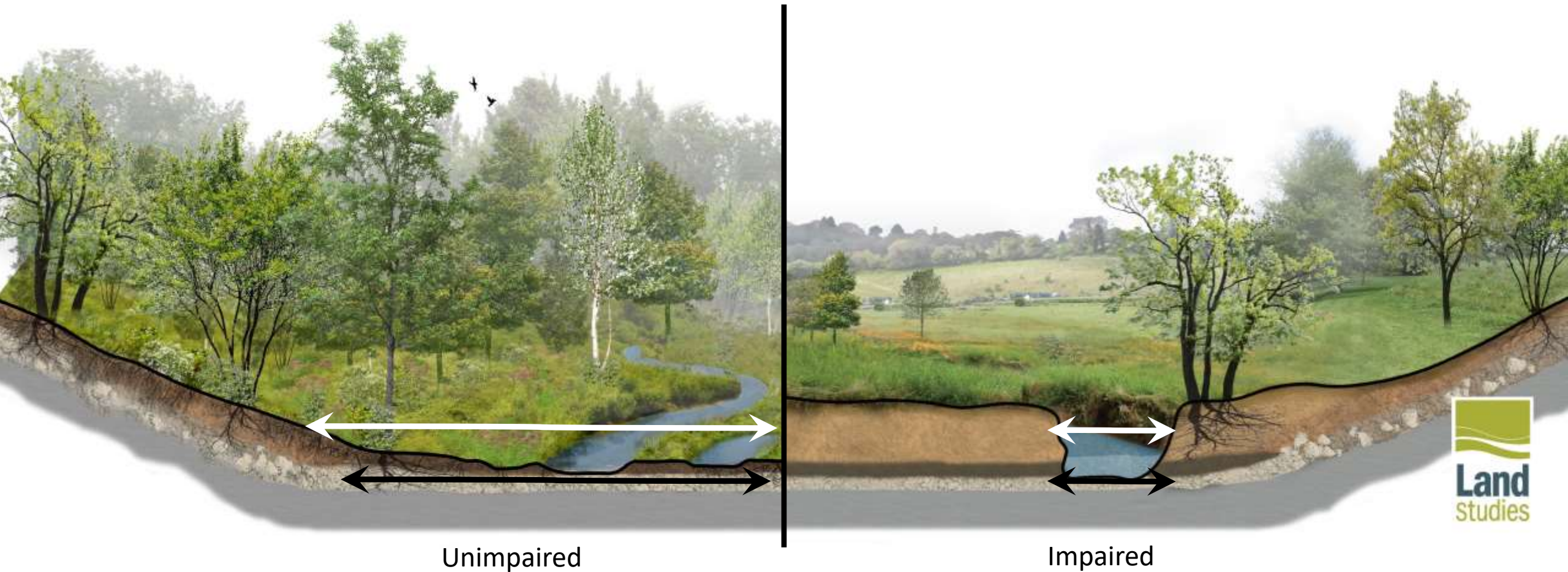
Restore Natural Structure Longitudinal Disconnection

- Down valley connection in the floodplain
- Can be above and below the surface



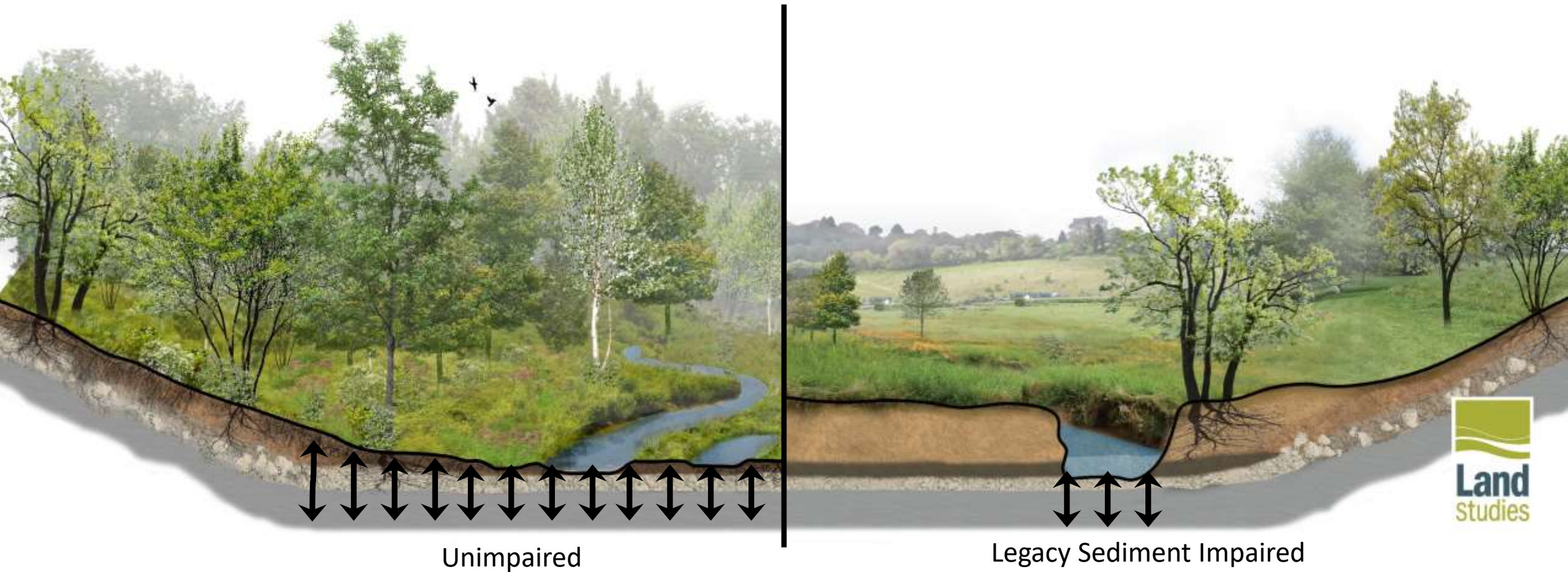
Horizontal Disconnection

- Across the width of the floodplain
- Can be above and below the surface



Restore Natural Structure Vertical Disconnection

- Connection down into the earth
- Dependent on the surface area and subsurface materials

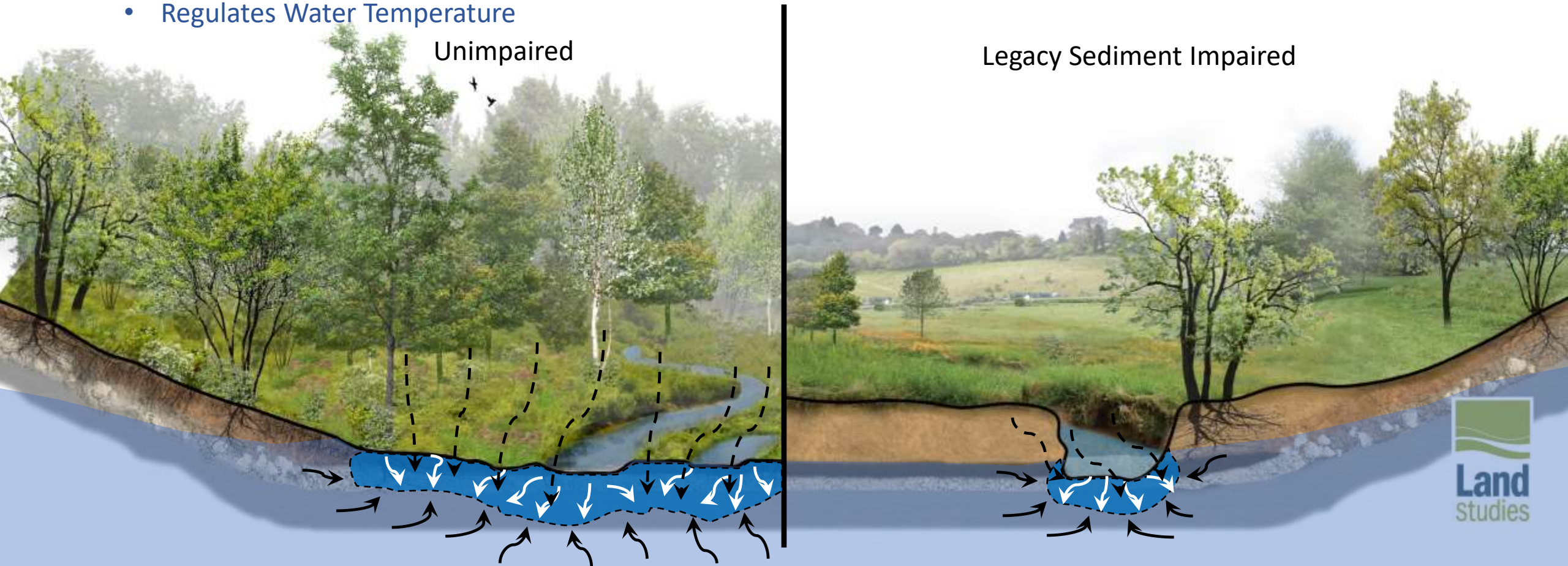


Restore Natural Structure

Hyporheic Zone Disconnection

The connection between surface water and shallow groundwater (subsurface mixing zone)

- Habitat (shelter and reproduction for interstitial organisms like algae and macroinvertebrates, fish and plants)
- Biogeochemical processes (nutrient cycling)
- Regulates Water Temperature

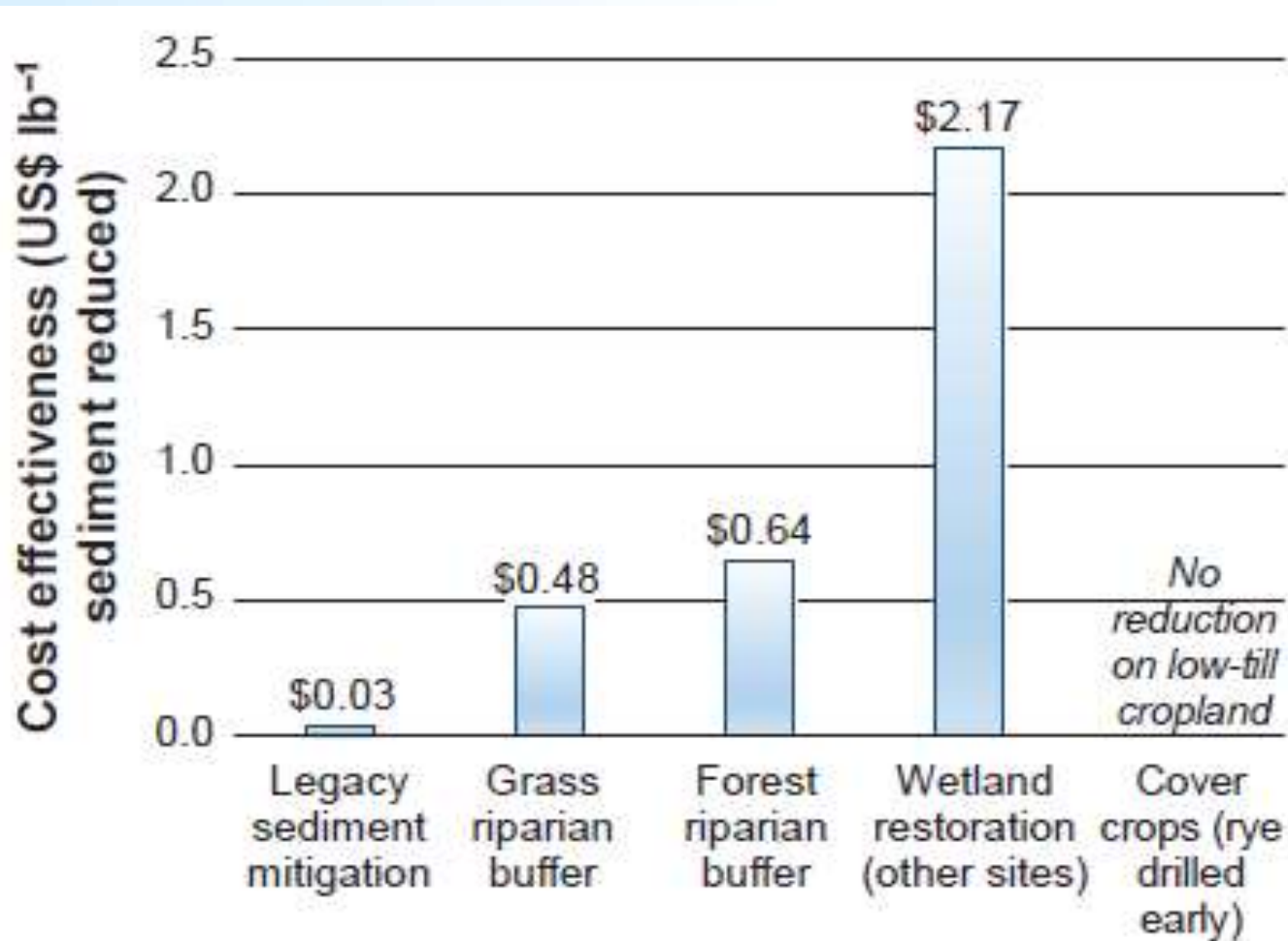


Involve a Multi-disciplinary Team



- A multidisciplinary team planned, designed, constructed and monitored the Big Spring Run restoration project located in the Lower Susquehanna drainage basin 2008-2022
- Team members included a wide range of scientific and technical disciplines
- Project sponsors included governments, academic institutions, non-profits, landowners and other private entities

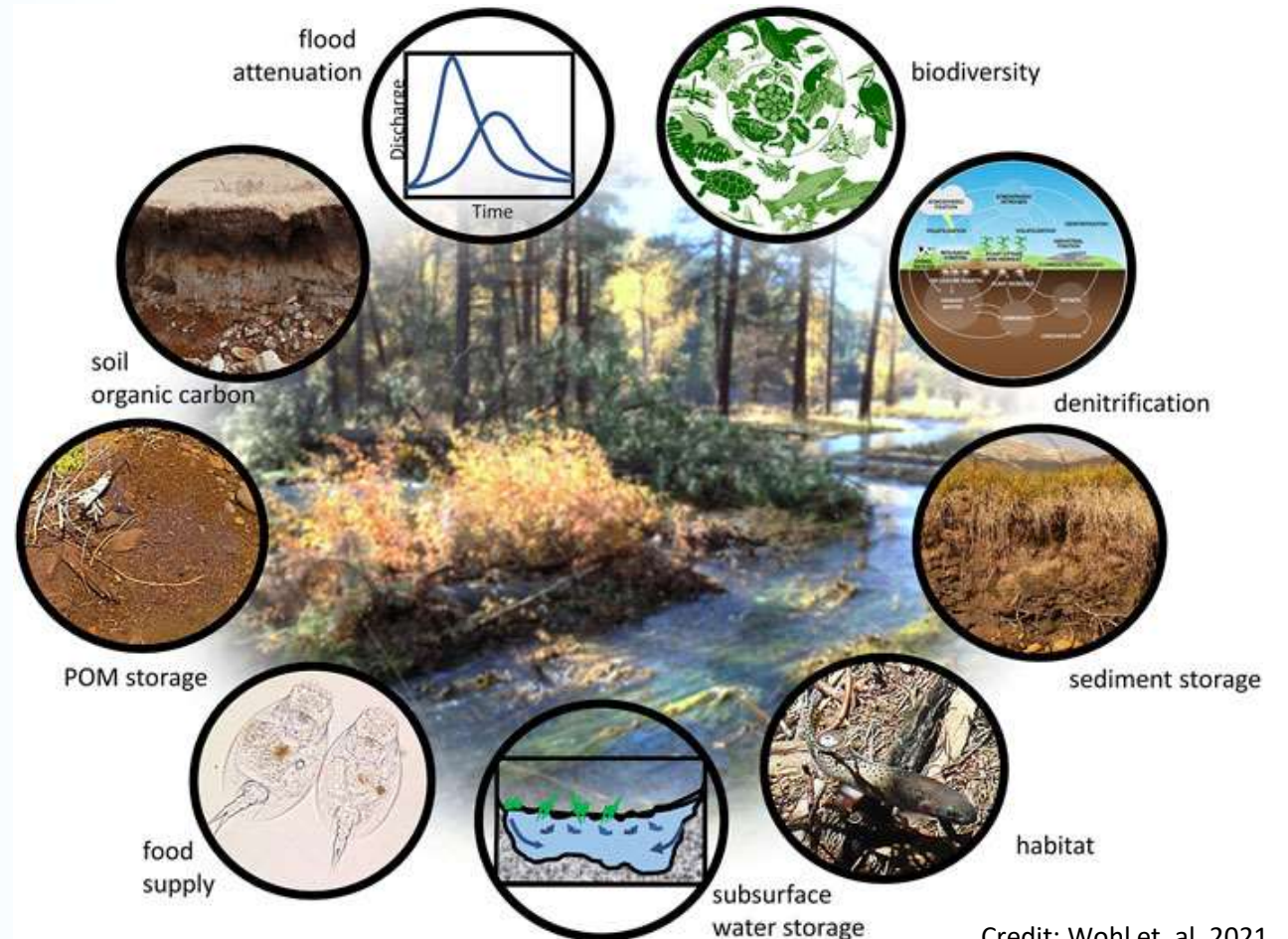
Cost-effectiveness



Summary

Existing characteristics and processes of Pennsylvania's aquatic resources often are defined by the human activities that occurred over the last 300 years.

- Particularly watersheds impacted by legacy sediment
- Resource recovery may be constrained by historic alterations



Summary

Legacy sediment removal restores natural characteristics and processes to degraded ecosystems

- Convert exporting systems to retaining systems
- Restores biogeochemical processing of nutrients and pollutants
 - Denitrification, Cation Exchange Capacity, etc.
- Promotes Carbon Storage
- Provide Flood Attenuation
- Restores Natural Habitats, Especially Wetland/Stream Complexes
- Restores Hyporheic Exchange

