A Look Back at Five Decades of Stream Restoration:

Using Lessons Learned to Approach Future Challenges

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WILDLAND HYDROLOGY

FORT COLLINS, COLORADO

ECOSTREAM 2018, ASHEVILLE, NORTH CAROLINA

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Walla Walla River following the 1964 Flood — What is the River Telling Us?

Central Tendency to Meander

Fire Impacts

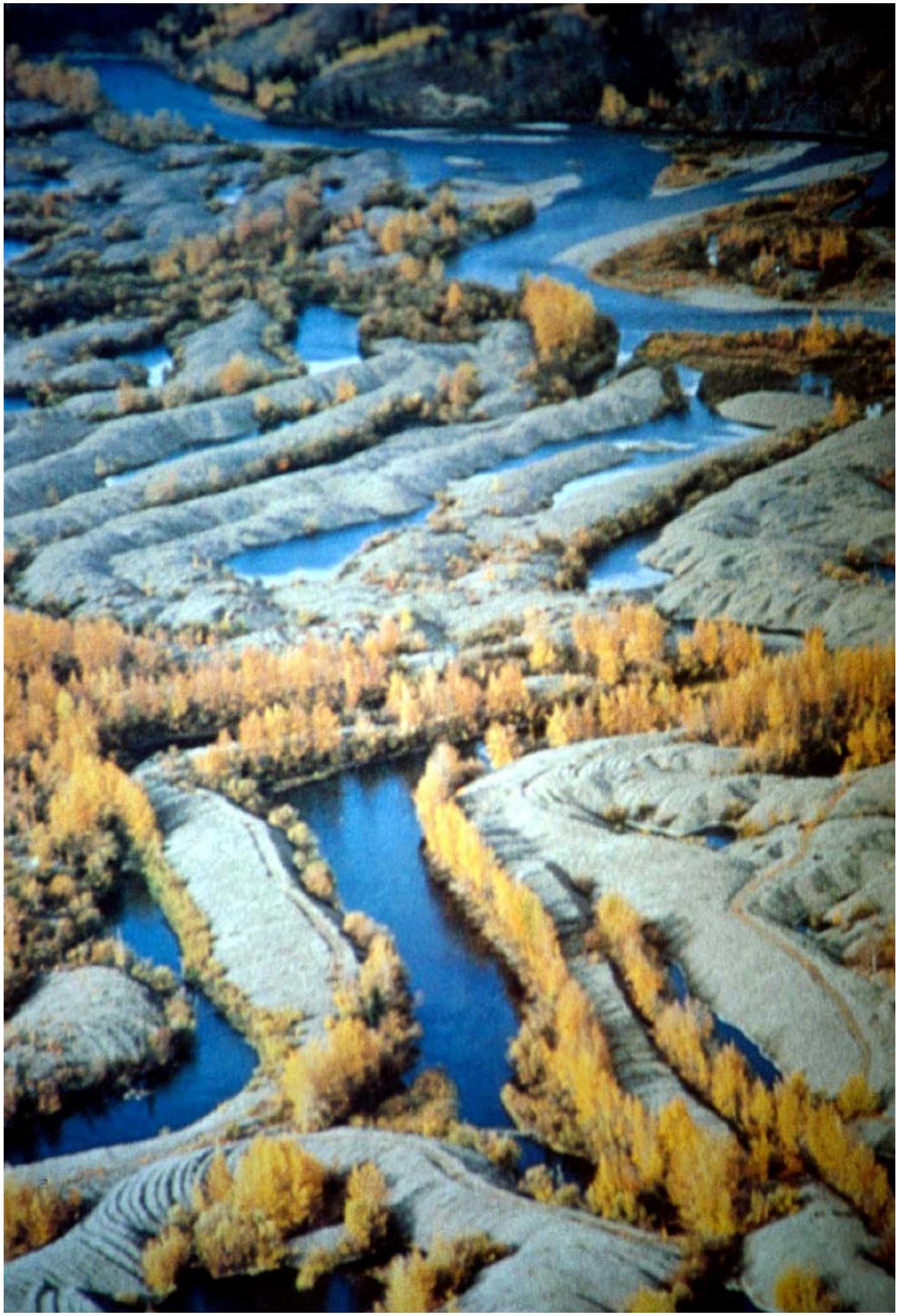
Aggradation/Degradation Processes from Fire

Overgrazing Impacts

Flood Impacts

Continued Hard Control

Hurricane Impacts



Mining Impacts

Migration barriers and problem diversions

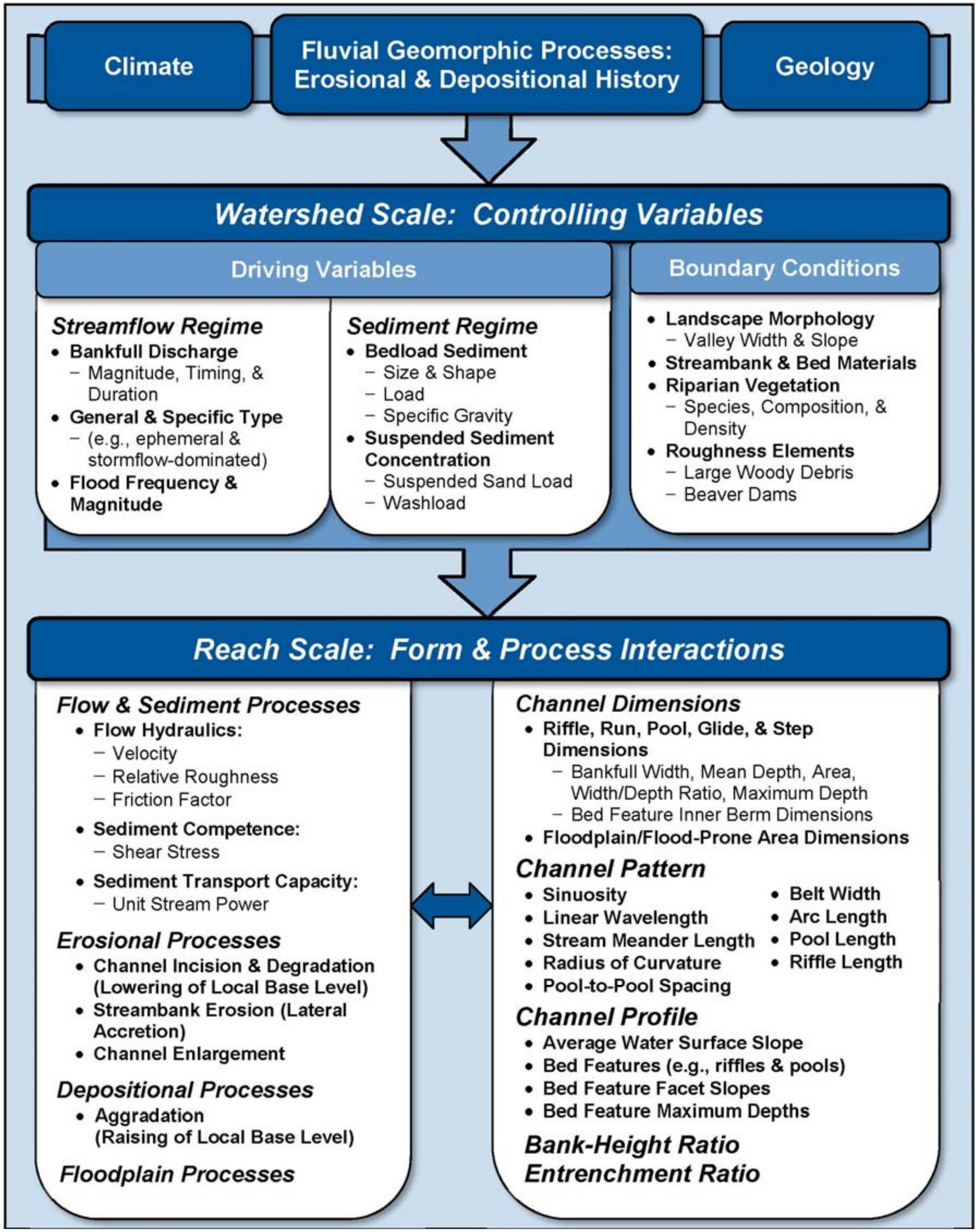
Road crossing impacts

Impacts from spraying riparian vegetation

River Restoration & Natural Channel Design

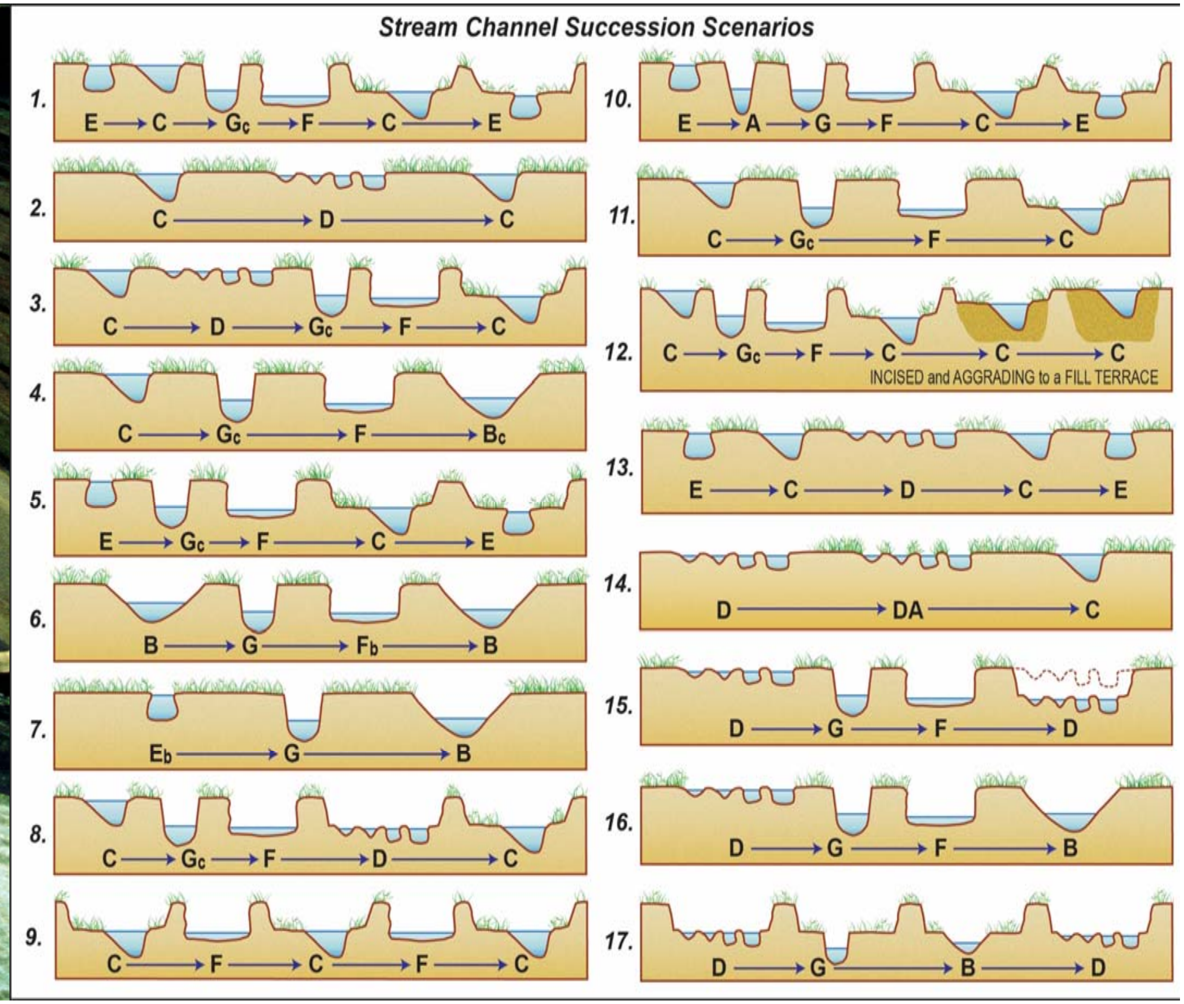
To establish a self-regulating, functioning river system associated with physical, ecological, and chemical components by emulating the natural stable form within the constraints imposed by the larger landscape conditions

Restoration must be considered at the appropriate scales commensurate with the impacts

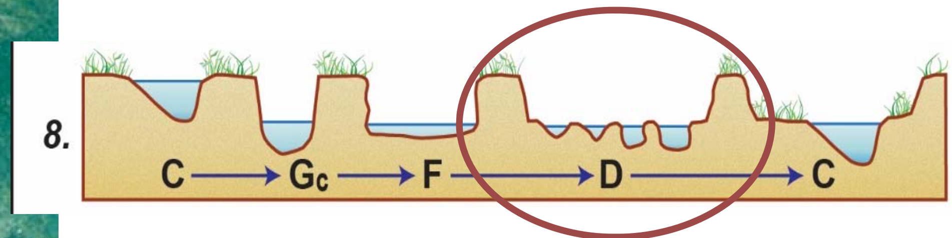


Lessons Learned

Critical to understand the central tendency of the natural stable and functioning stream type



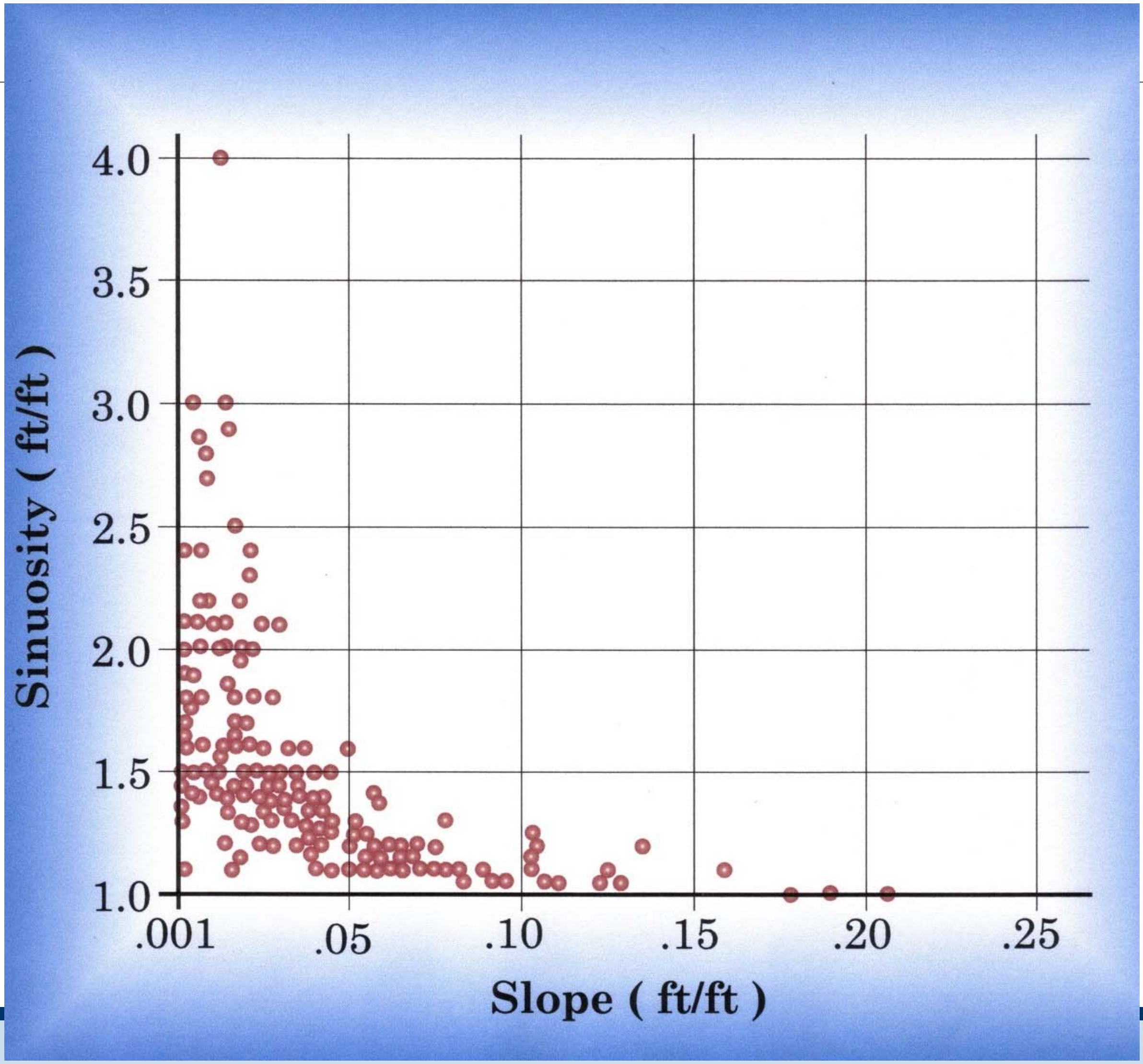
Consequences of channel straightening



Lessons Learned:

Effective use of small and frequently-spaced check structures- 1930's-1960's

Sinuosity to Slope Relation for Natural Rivers



Lateral Adjustment & Channel Incision from Beaver Dam

Sheep Creek, Colorado

Constructed "Beaver Dam Analog"-1968

Lessons Learned:
Avoid Check Dams and similar cross-channel structures in larger streams

Log Check Dams, Fish Creek, Colorado, 1975

Must understand stream potential and degree of departure from the reference condition

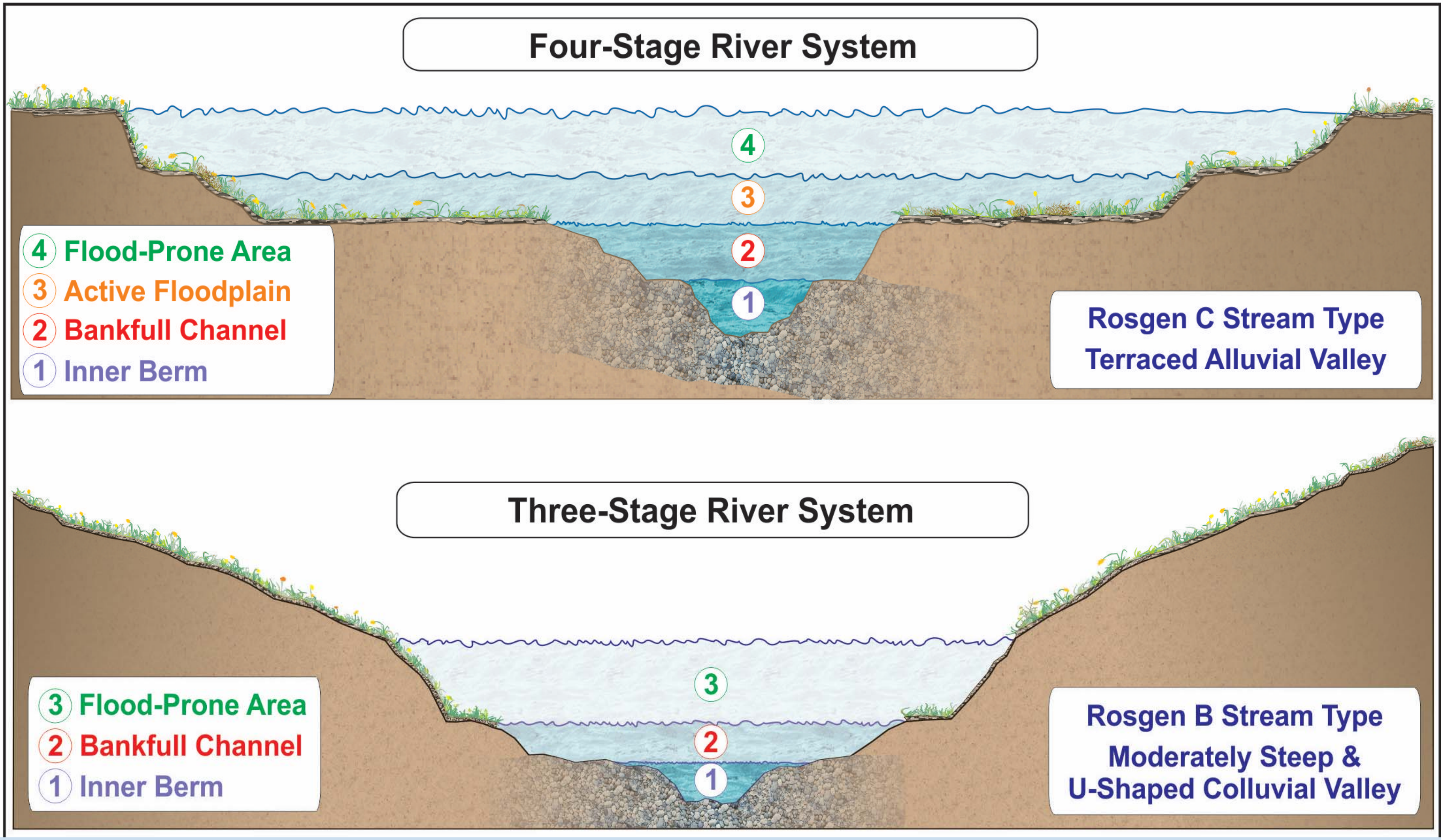
D4 Impaired Reach
Upper Blackfoot River, MT

C4 Reference Reach
Upper Blackfoot River, MT
Downstream of the D4 Impaired Reach

Must understand *natural* vs. *anthropogenic* rates of erosion

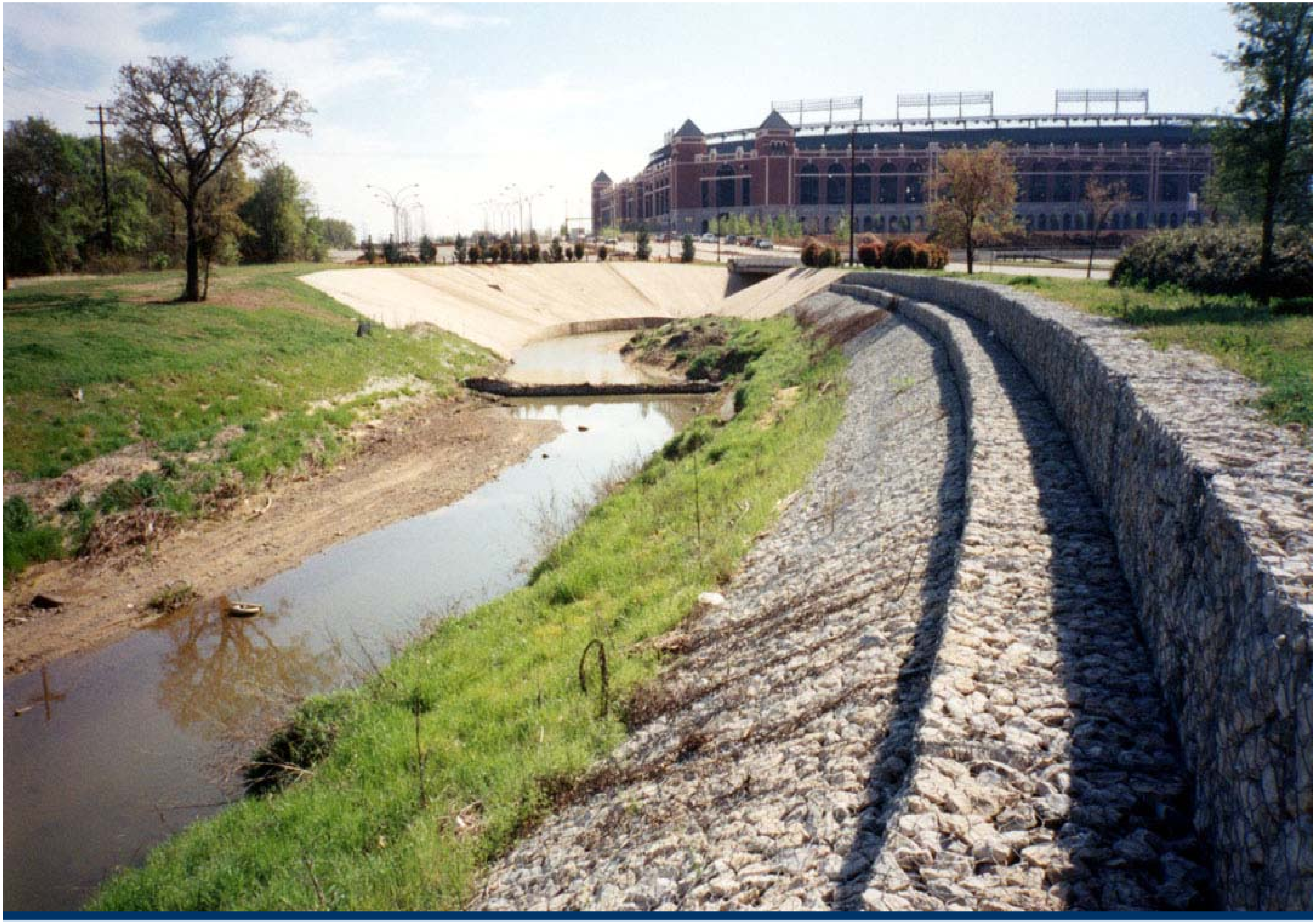
Geologically a naturally-high sediment supply in A3a+ stream type

Designing a Multi-Stage River System is critical to accommodate various streamflow conditions versus "One Size Fits All Flows"



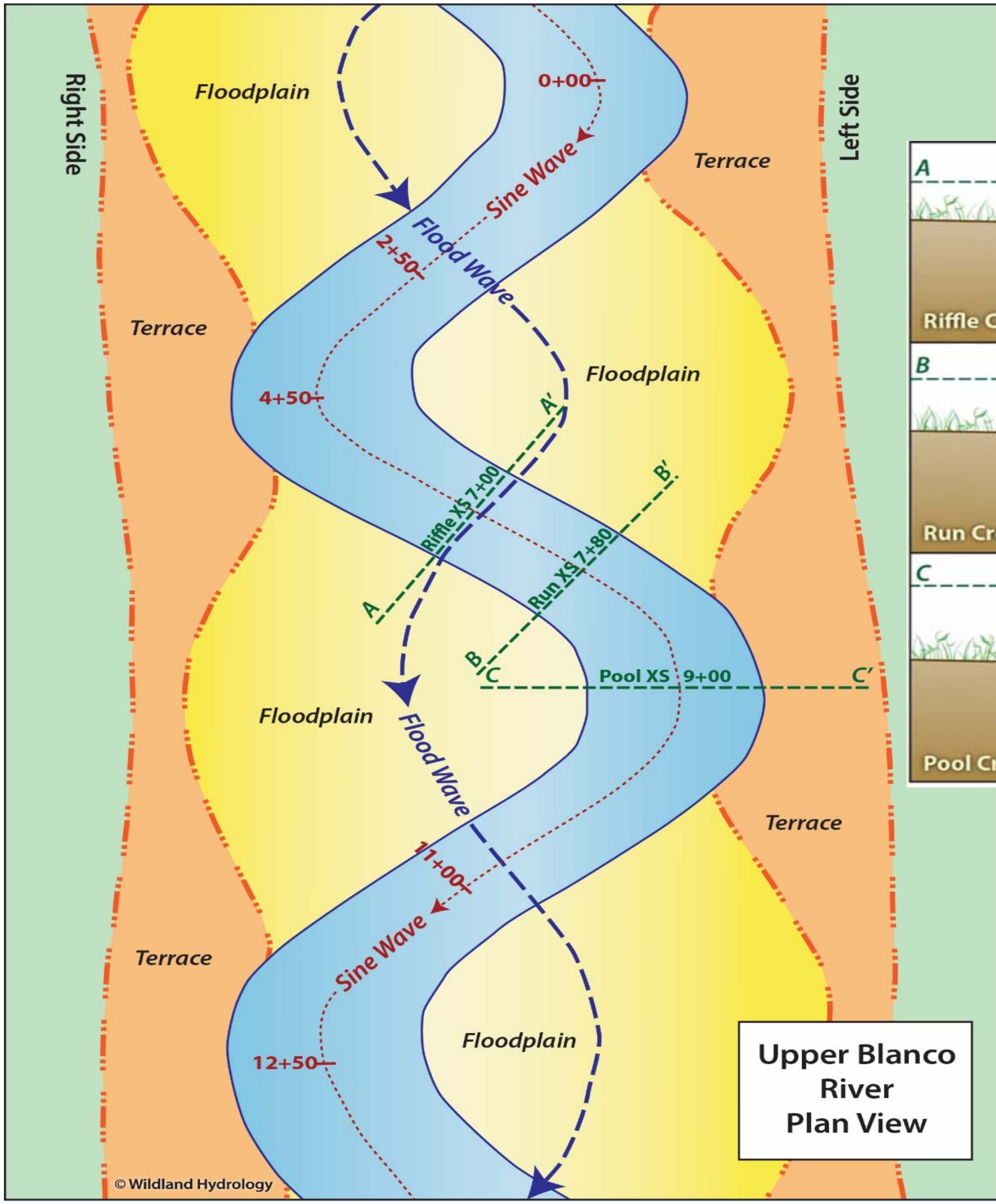
Advantages of the Multi-Stage River System

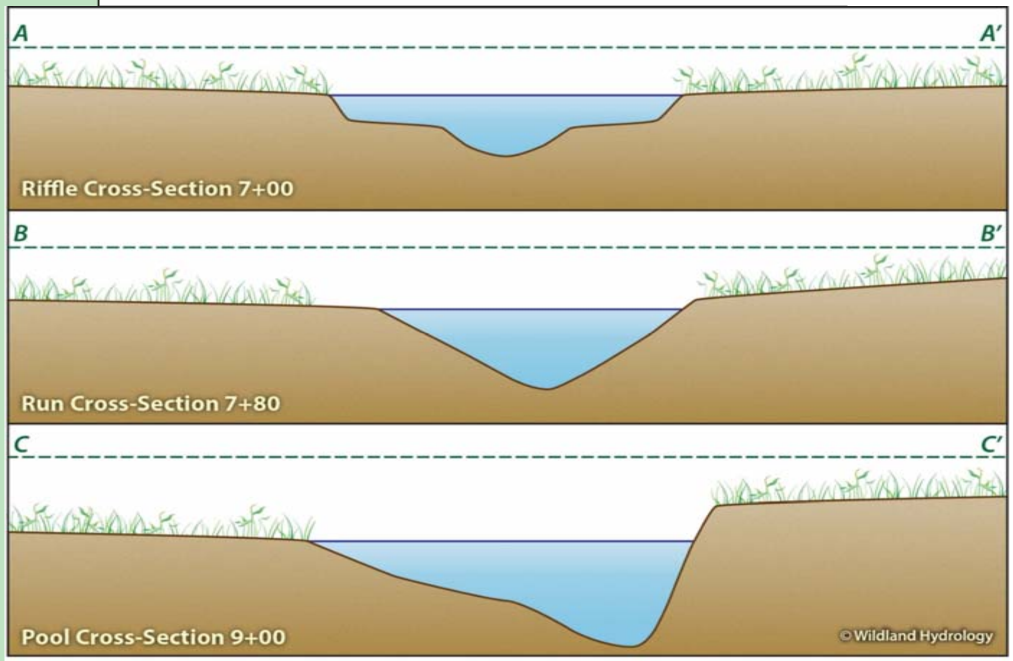
1. Solution for altered flow regimes associated with climate change, urban development, and operational hydrology of reservoirs and diversions
2. Allows for a functioning riparian ecosystem with reduced streambank erosion rates
3. Improves hydraulic and sediment transport efficiency associated with decreases in flood stage for the same magnitude flood
4. Supports hydrological connectivity with improved habitat, ecological richness, and biodiversity for a range of terrestrial and aquatic taxa



Meandering concrete channel with a floodplain… Semi-Progressive

Must design and properly grade floodplain and terrace features





Blanco River Restoration – 1987

Post-Restoration, Blanco River, 29 Years Later (2015)
Featured in "*50 places to Fish before I Die*"

Lessons Learned: Structures

Incorporating wood with more natural-looking structures

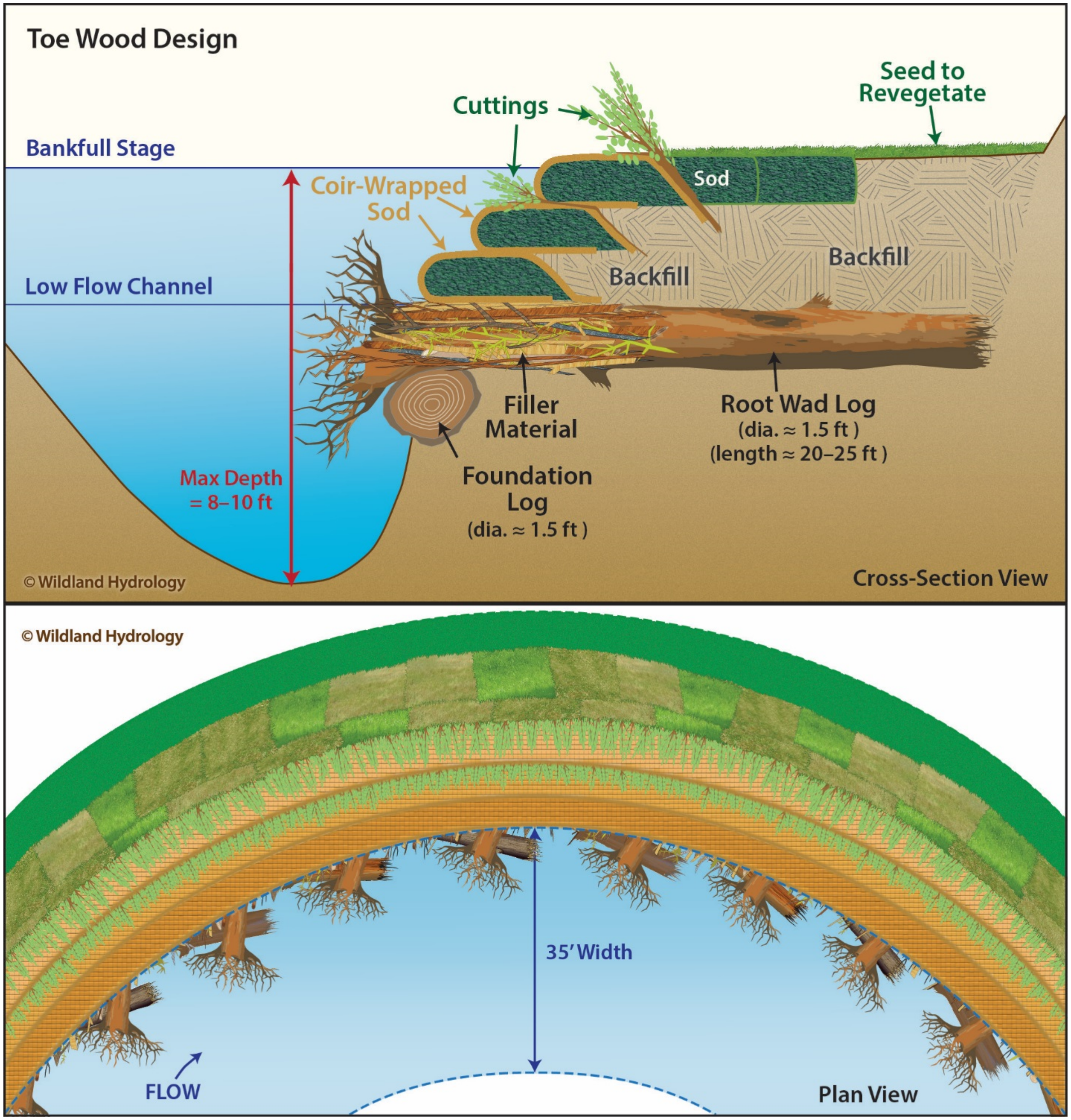
Introduced Instream Wood

"Natural Channel Design" with Root Wads

Spring Creek, Arkansas, 2011

Top of ELJ showing I-beams, cable, and boulder rip-rap, Hoh River, Washington

Toe Wood Structure



Streambank Erosion Prior to Toe Wood Treatment- Yampa River, 2016

Post-Construction Yampa River, Colorado, 2017

The Toe Wood Structure

Yampa River, Post-Implementation, 2017

Toe Wood, Yampa River, One Year Later

Submerged Toe Wood with a Log Vane J-Hook, Crystal Creek, Idaho

Lessons Learned: Structures

Must understand purposes & appropriate use of structures

Accelerated velocity vectors along plane of elevated logs causing incision & bank erosion

Pennsylvania, 2018 (photo by Mark Thomas)

Must understand sediment transport capacity

Avoid conservative-driven, over-structuring designs

The Cross-Vane Structure

Crystal Creek, Idaho

Blanco River, Colorado


Cross-Vane?
Maryland

The Log Roller Structure

Natural “Log Rollers”
Goose Creek, Oregon

Constructed Log Rollers,
Roaring Fork Little Snake, CO

Converging Rock Clusters

Crystal Creek, Idaho

Laramie River, Colorado

Random boulders placed for fish habitat

Step-Pool Structures

Natural Log Step-Pools, Goose Creek, Oregon

Roaring Fork Little Snake River, Colorado

Structures

Incorporate flow resistance & natural energy dissipation to prevent degradation & accelerated erosion

Blue River, Colorado

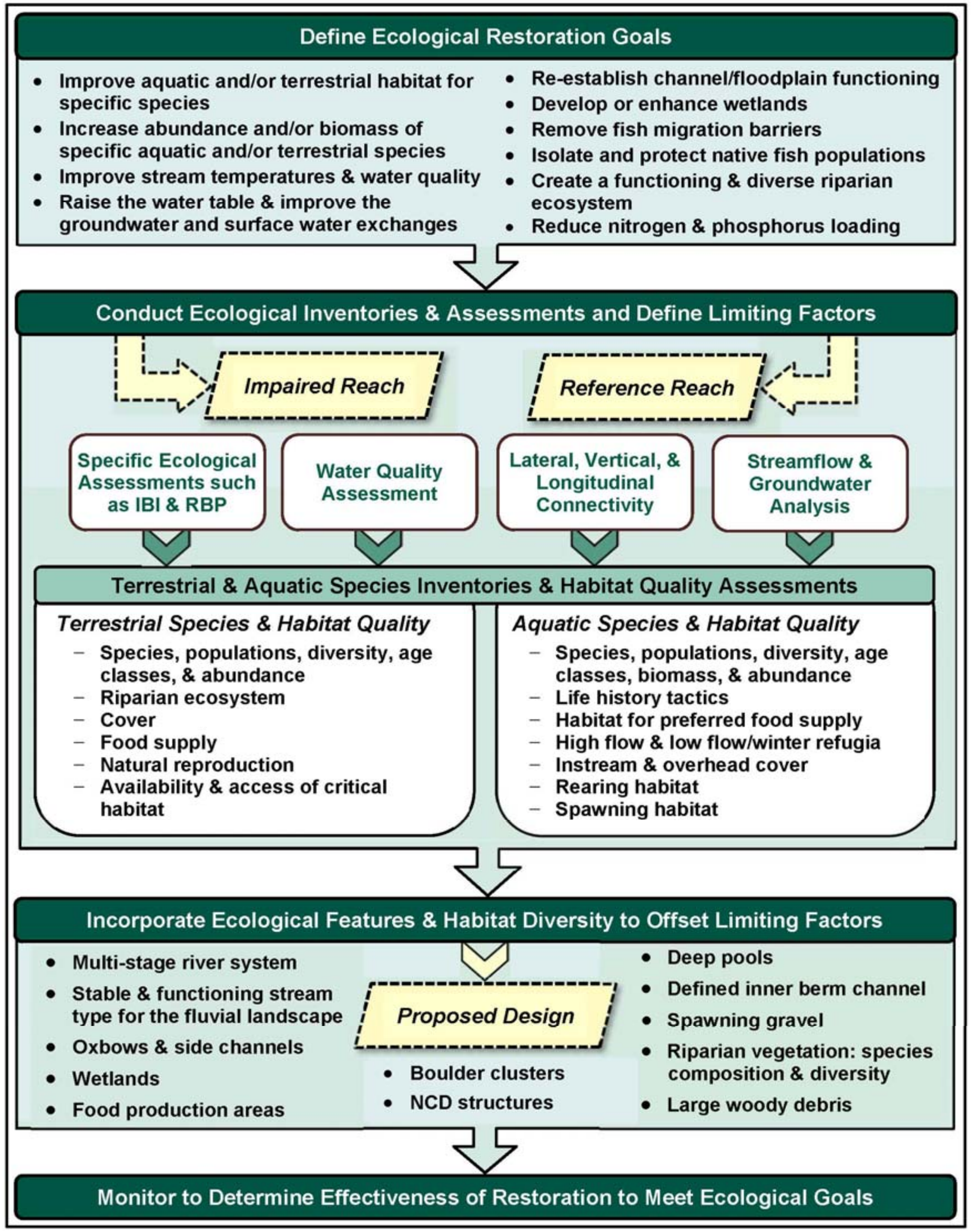
Structures

Avoid using structures to stabilize banks without securing the proper channel morphology & functioning

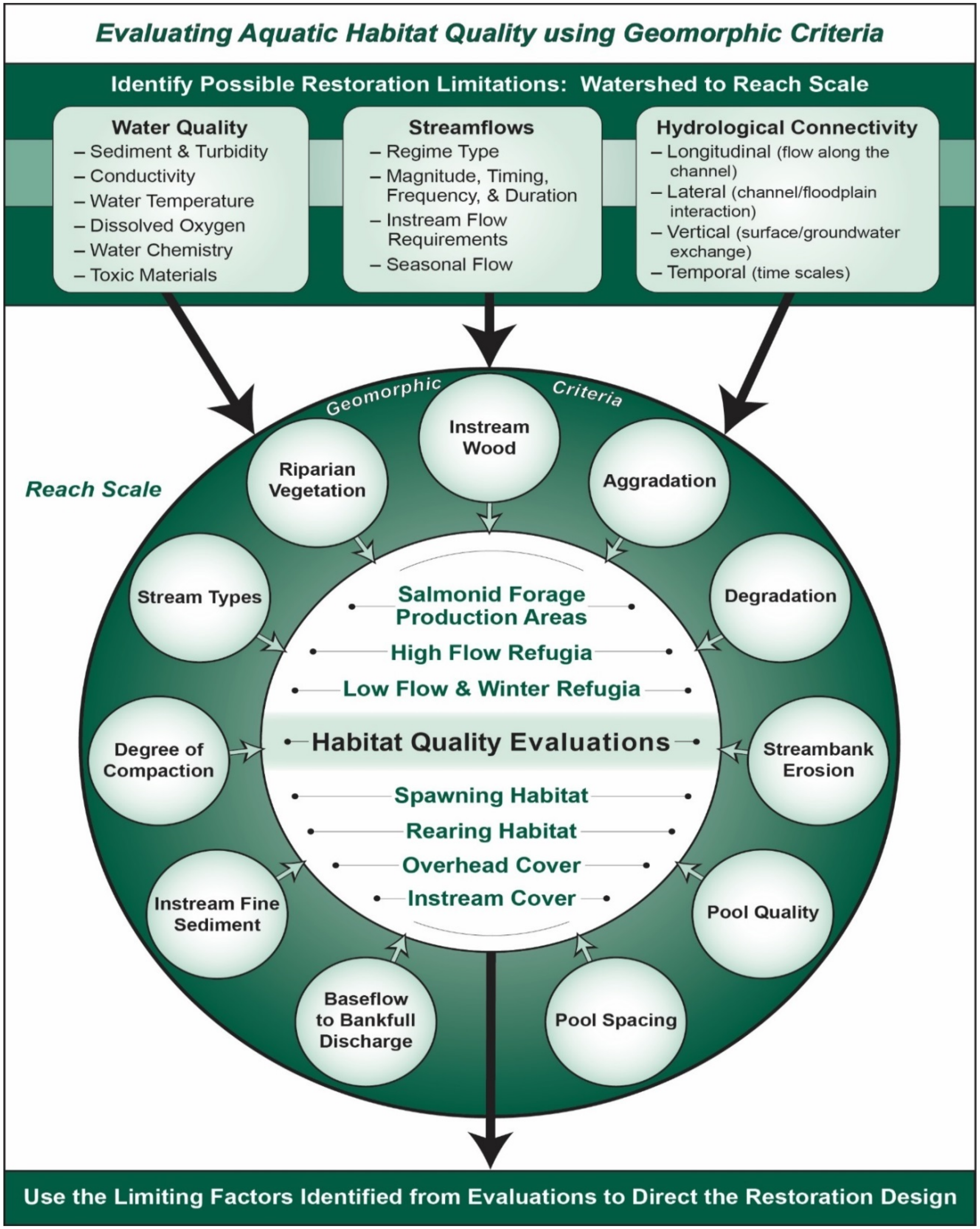
Ontario, Canada

Lessons Learned: “Enhancing” Fish Habitat

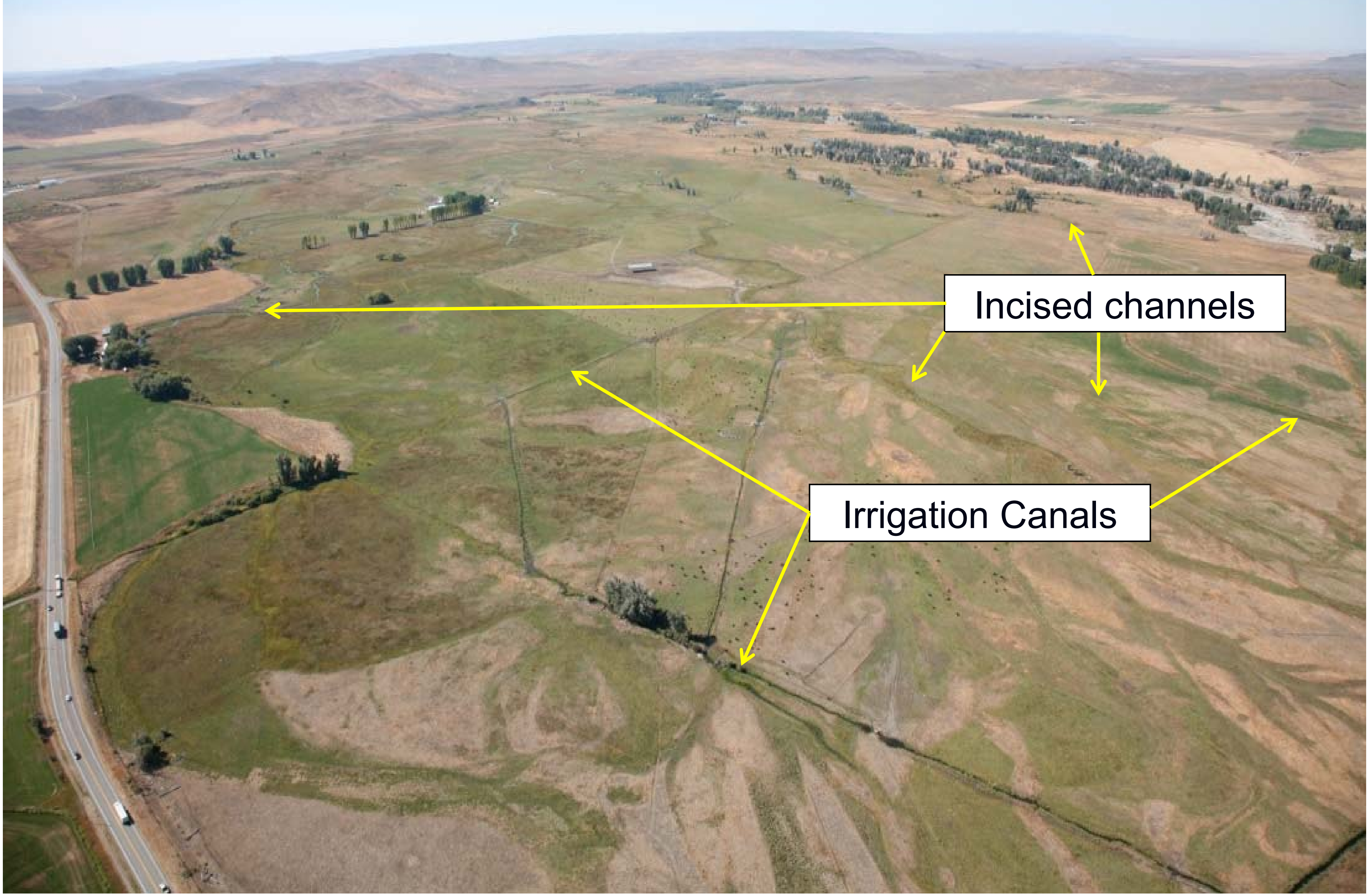
Critical to incorporate ecological principles throughout assessment and design



Assess Limiting Factors of Habitat using Geomorphic Criteria



Heartrock Ranch, Big Wood Basin, Idaho

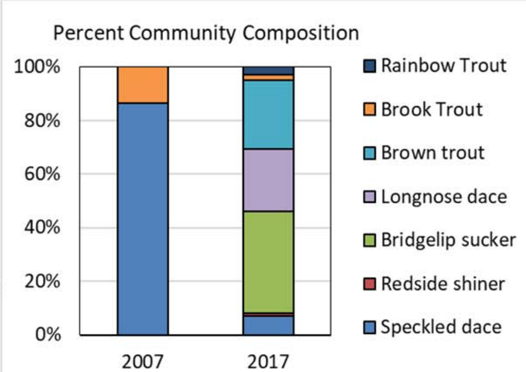


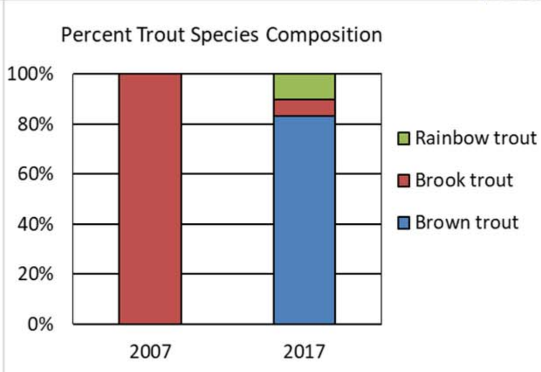
Identified Limiting Factors

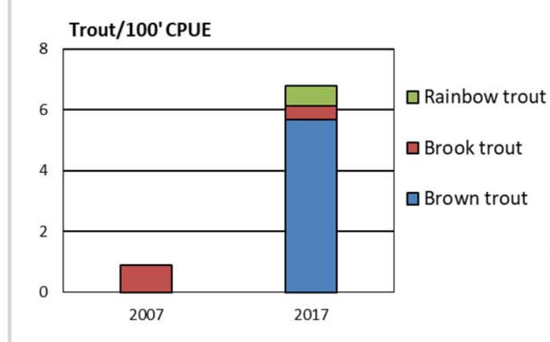
- Incised channels with disconnected floodplains
- Lack of sediment transport capacity due to overwide and shallow channel
- Poor pool quality
- Limited instream wood and undercut banks
- Invasion of fine sediments generated from streambanks
- No off-channel features for habitat complexity or diversity for terrestrial and aquatic species
- Limited woody vegetation
- Poor spawning habitat and gravels
- Limited holding cover during low flows or high flows

Increased fish habitat complexity, mean annual discharge, & forage production

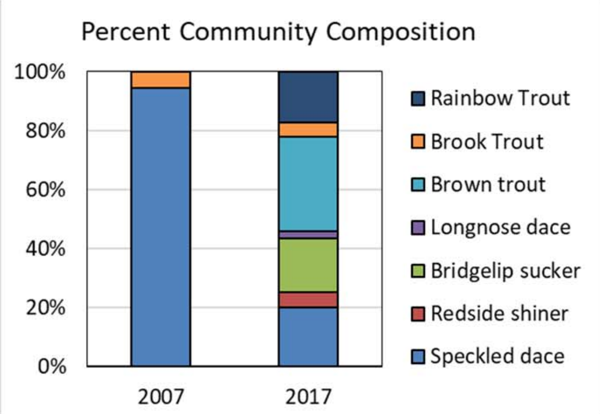
Black Slough, Big Wood Basin, ID

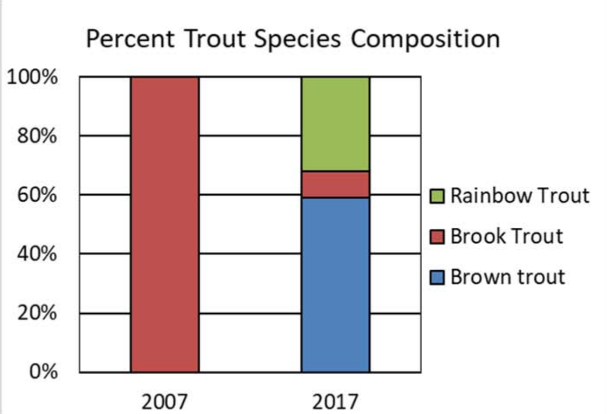


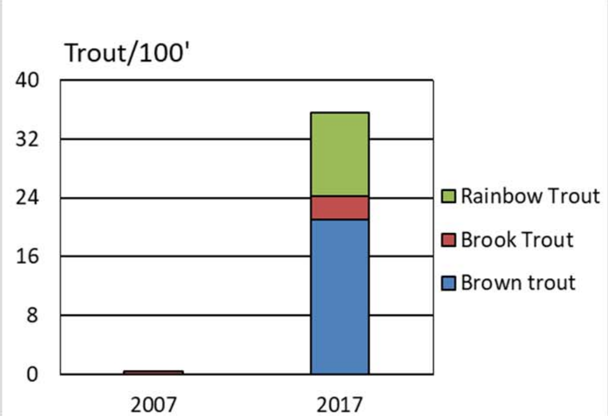




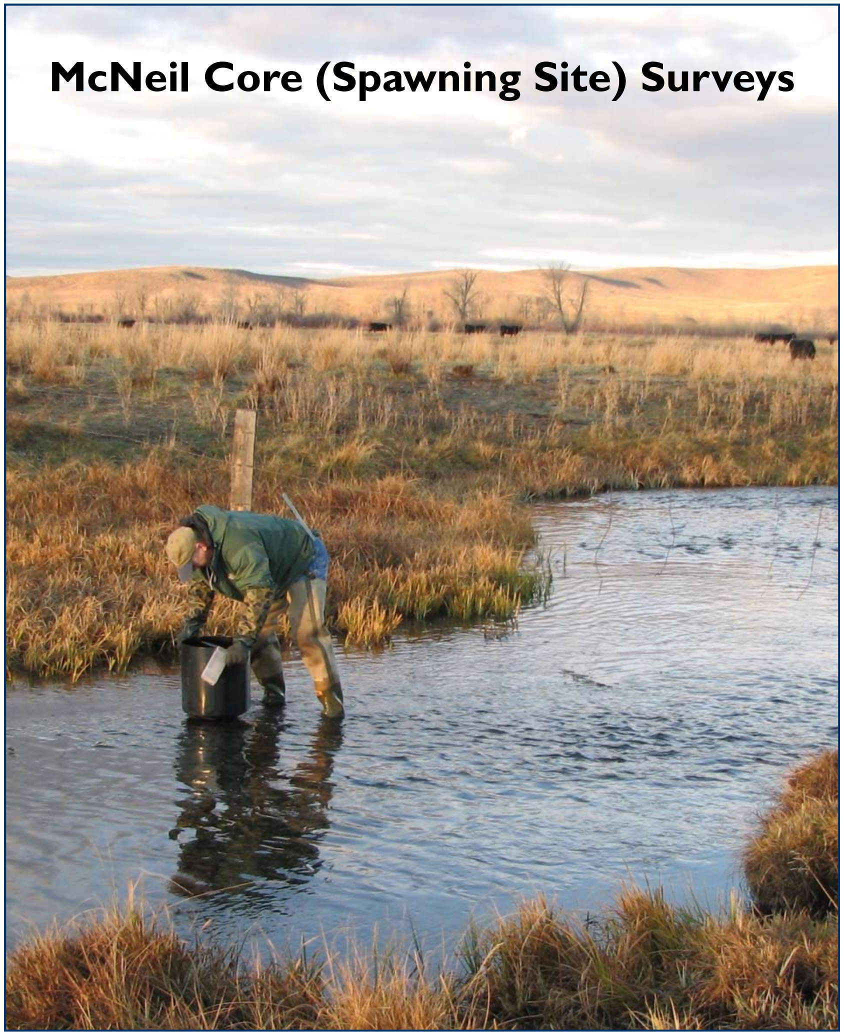
Crystal Creek, Big Wood Basin, Idaho



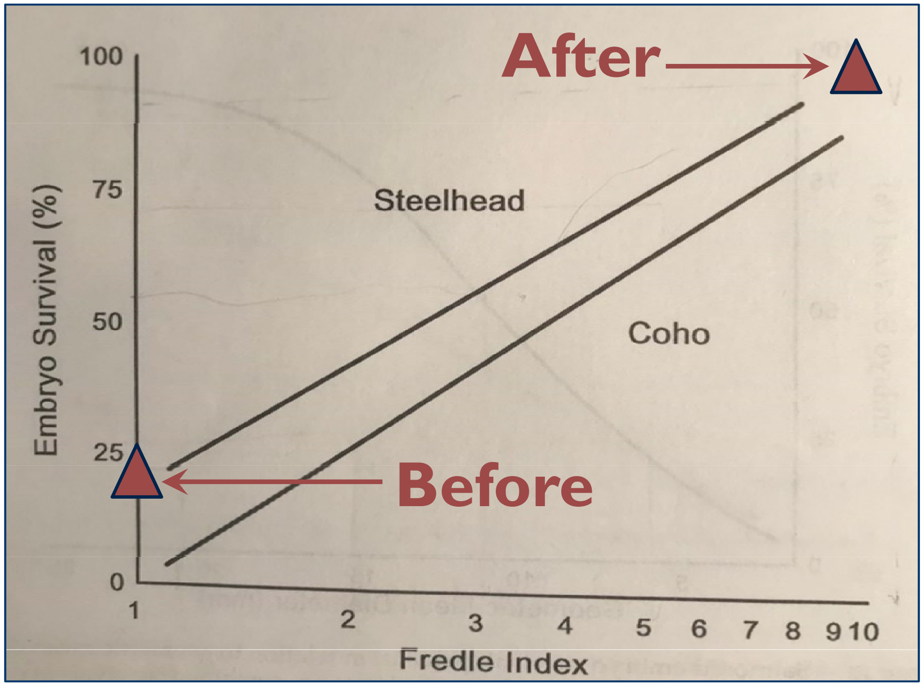




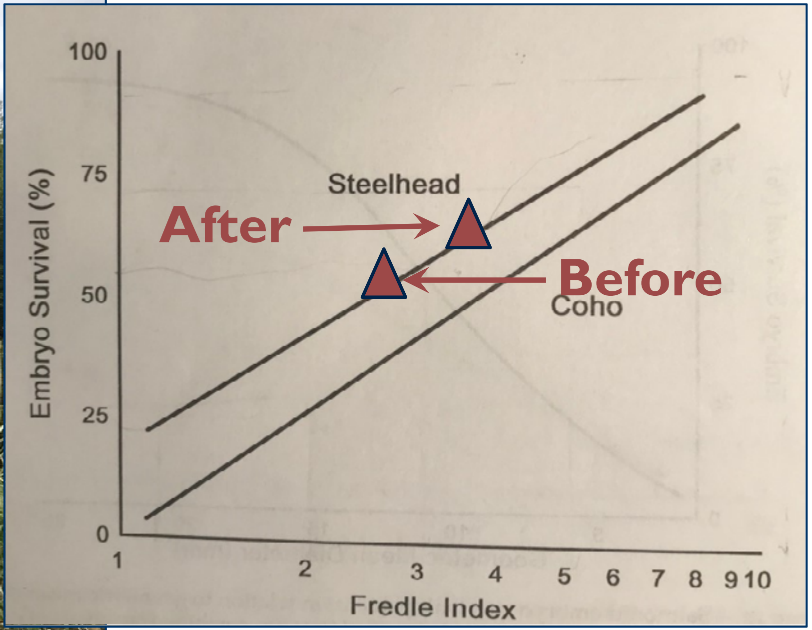
Monitoring is critical to evaluate restoration effectiveness to meet ecological goals

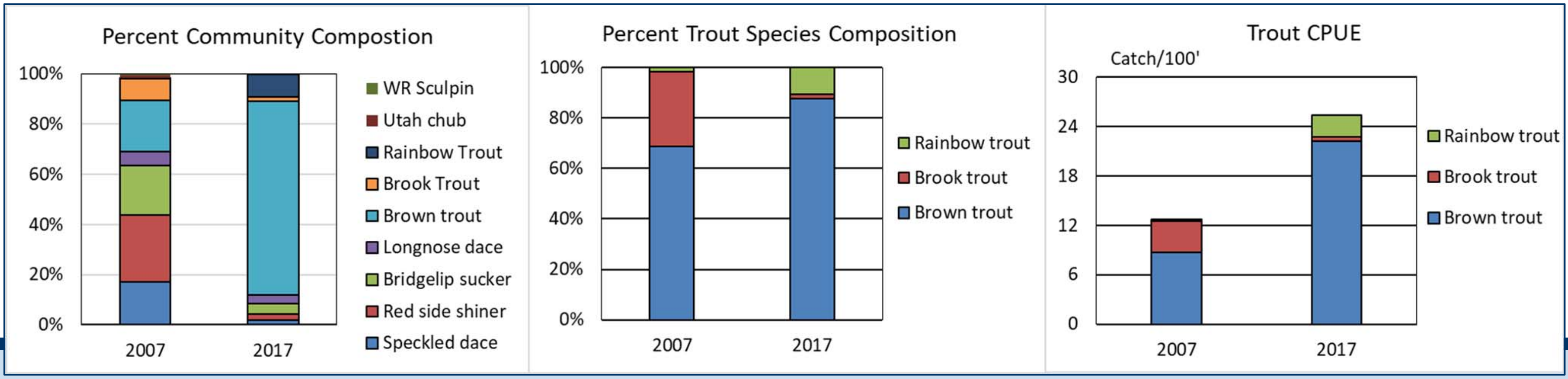


Crystal Creek McNeil Core Samples 2007 & 2017

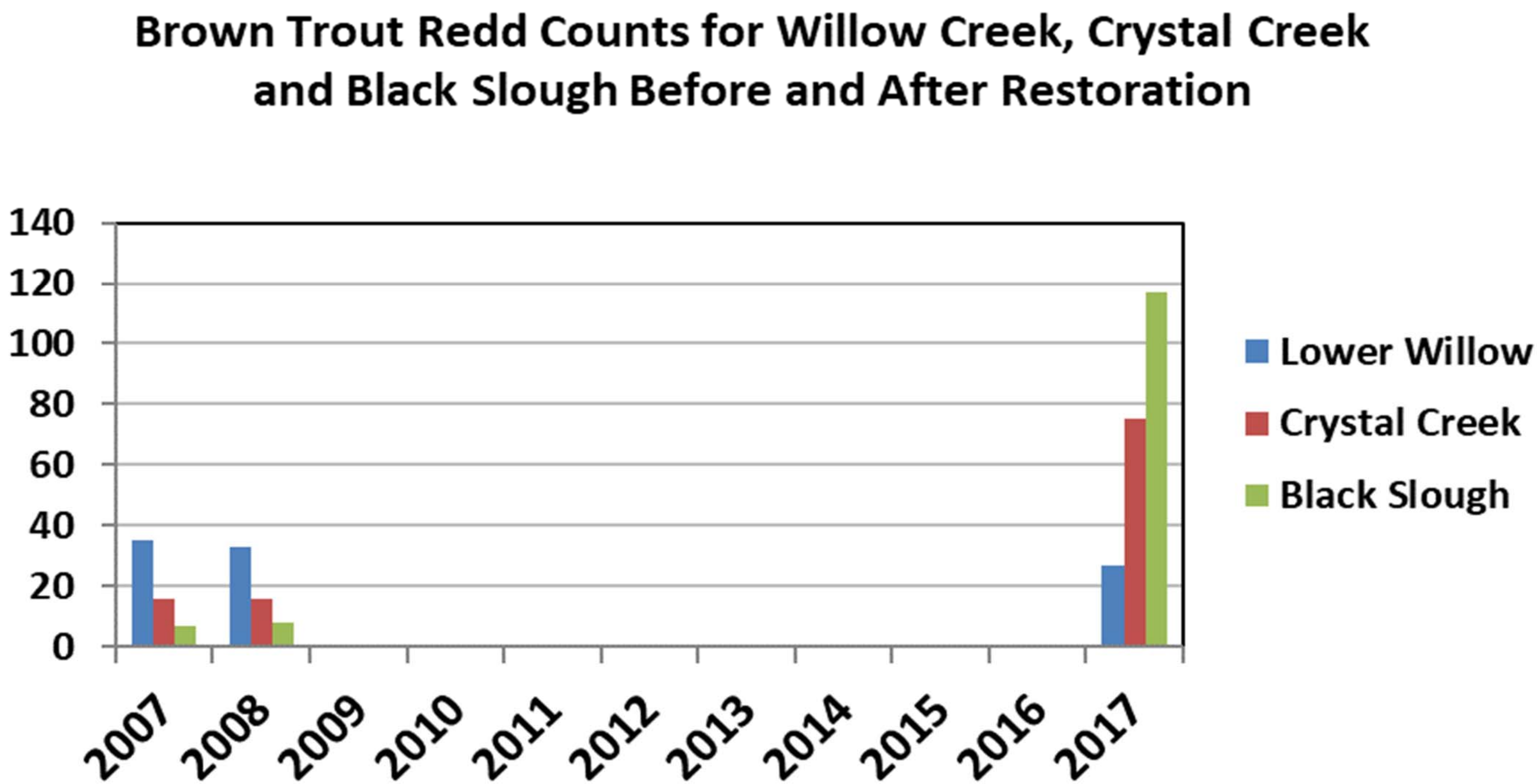


Willow Creek Reference Reach, Big Wood Basin, ID





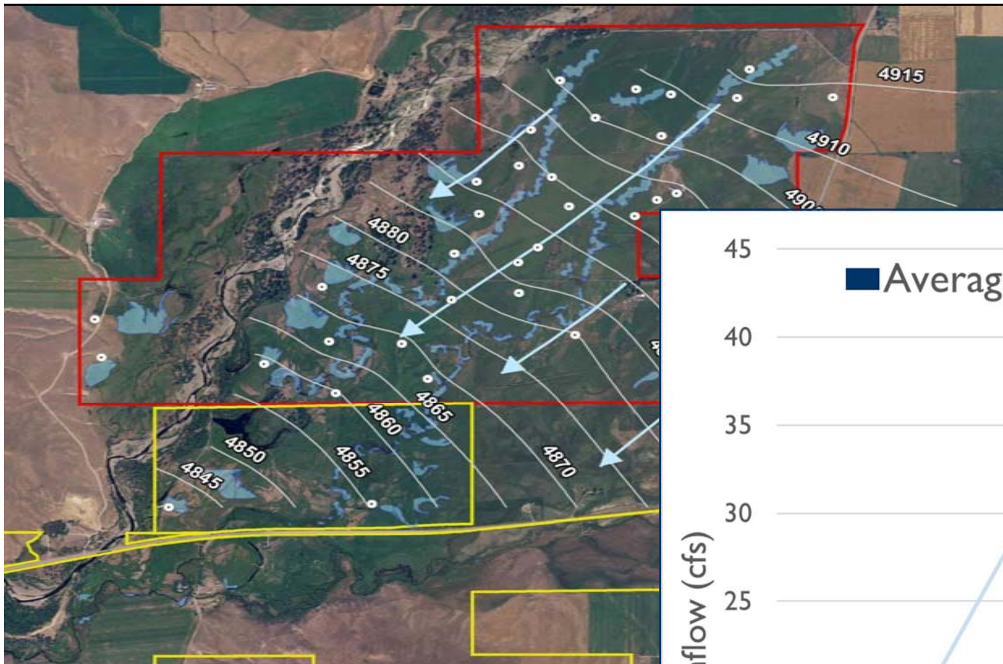
Increases in Redd Counts in the Restored Black Slough & Crystal Creek (Lower Willow – Control)

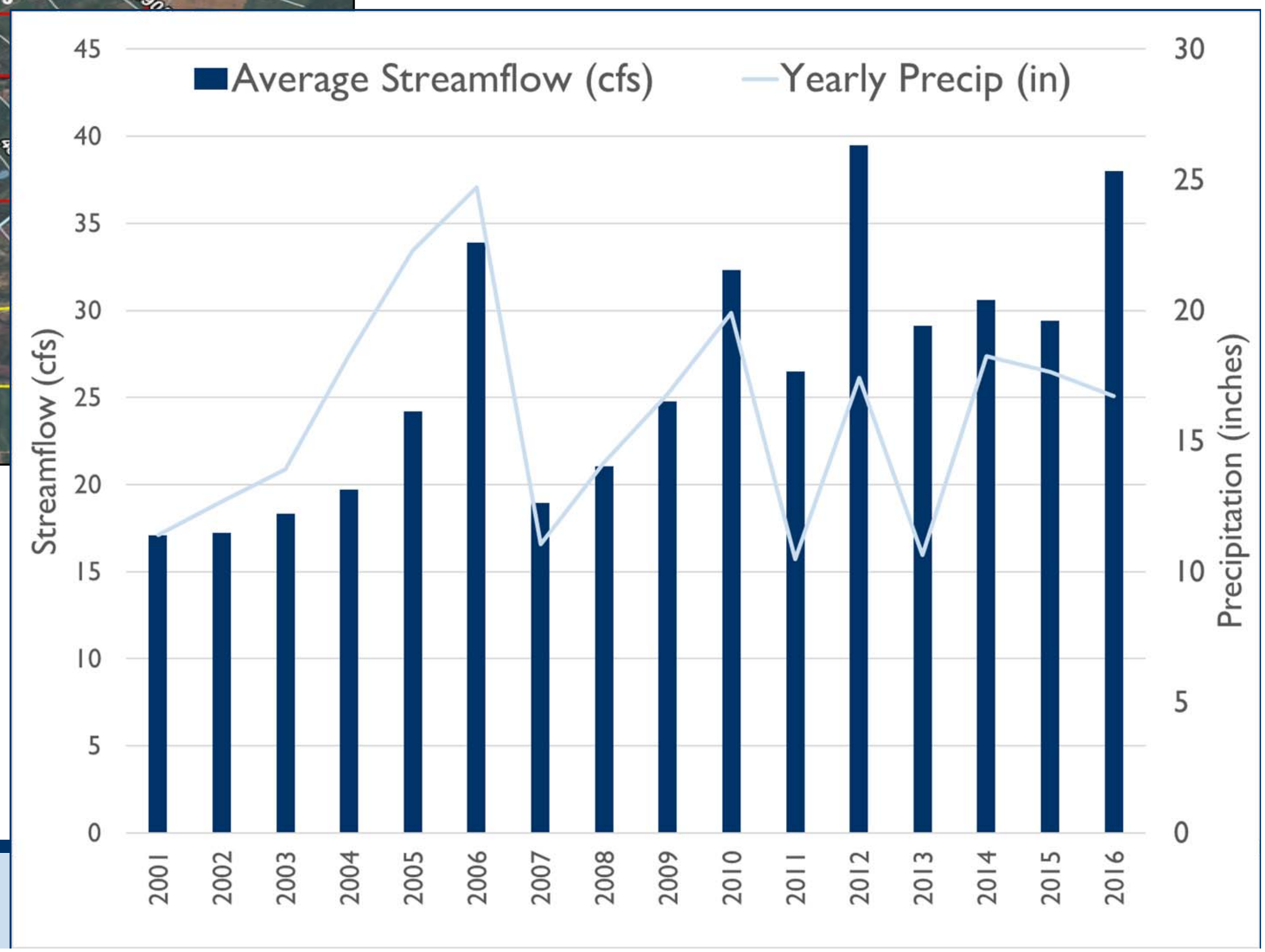


Restoration completed in Fall 2011.

Monitoring plans should be designed specific to the identified limiting factors

Groundwater & Streamflow Monitoring






The End…or is it ?
Blue River Habitat Restoration

The Future

- Mentoring
- Formal Apprentiships-Certification
- Design Criteria…Minimum Standards for NCD
- Direct Integration of Multiple Disciplines
- Success Criteria (Understand Natural Variability from the Reference Reach)
- Formal Training Opportunities
- Sharing of Reference Reach and Regional Curve Data (Flow and Sediment)
- Accountability
- Monitoring (Effectiveness, Implementation, Validation)