Restoring and Managing Riparian Areas

Presentation to the Forest Watershed Management Symposium

12 March 2015 Susanville, CA

Themes from the Science Synthesis for the Sierra Nevada-southern Cascade Range and Case Studies from the Arizona Mountains

Jonathan W. Long (jwlong@fs.fed.us)

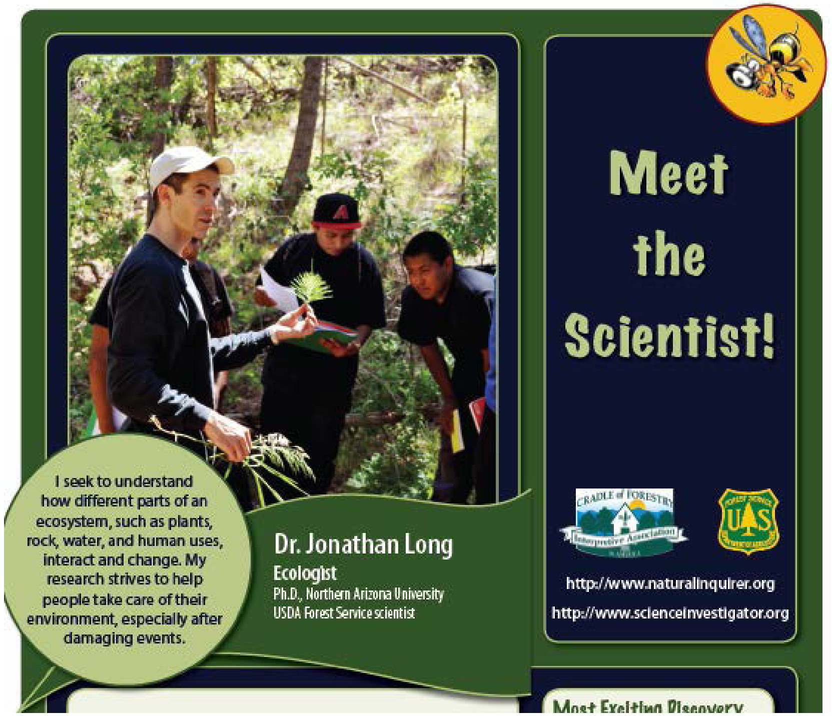
Jonathan Long

USDA Forest Service, Research & Development

Pacific Southwest Research Station

My Background

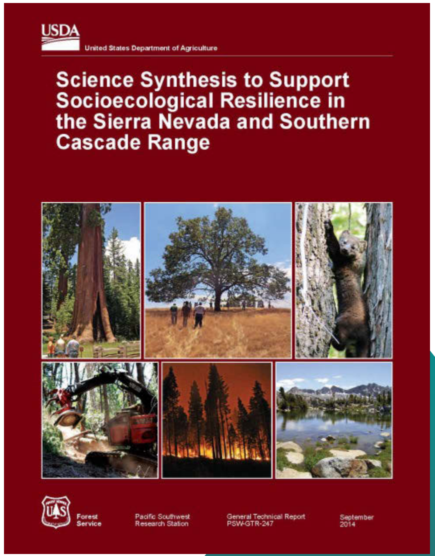
- Research ecologist with US Forest Service Pacific Southwest Research Station
- Previously with Rocky Mountain Research Station, White Mountain Apache Tribe, and University of Arizona Cooperative Extension
- 20+ years of field research on the White Mountain Apache Reservation in east-central Arizona



http://www.fs.fed.us/psw/programs/efh/staff/jwlong/

Outline

1. Science synthesis findings relevant to riparian management
2. Conceptual framework and case studies of meadow restoration and post-fire restoration from the White Mountains of Arizona



USDA
United States Department of Agriculture

Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range

Forest Service | Pacific Southwest Research Station | General Technical Report PSW-GTR-247 | September 2014

General Technical Report PSW-GTR-247 (2014)

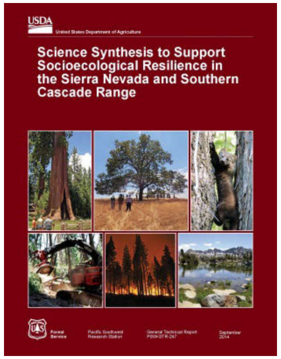
Jonathan Long

Key Points

- Intermittent disturbances that kill trees (esp. fires, floods, blowdowns) can rejuvenate systems
- Some systems benefit from physical interventions to reverse degradation
- Some systems respond well to being left alone


Jonathan Long

Overall Theme: Promoting Socioecological Resilience



- Addressing stressors facing socioecological systems in an integrated manner
- Reestablishing natural disturbance regimes
- Evaluating effects of landscape-scale, integrated restoration treatments on a range of values, especially water

Jonathan Long

Chapter 6.1: Strategies for Aquatic & Riparian Ecosystems

- Restoring fire regimes in upland and riparian forests
- Restoring lakes and rivers:
  - flow regimes below reservoirs
  - maintaining food webs and habitat connectivity
  - Allowing channel migration
- Restoring wet meadows to maintain hyporheic exchange, flooding, and other key processes

Carl Skinner

Hat Creek, Reading Fire

Increased Potential for Extreme Fire Outcomes

Brian Smithers

Altered Stand Conditions + Wildfires + Climate Change
➔ Expect more extreme fire behavior (e.g., Rim and King fires)

- Much greater risk for high-severity crown fire in untreated scenarios than in fuels-treated scenarios (Chapter 4.1)

Jonathan Long

Corral Creek after Rim Fire

Risks of Wildfires to Aquatic Systems

- Reports of isolated, but large debris flows in the Sierra Nevada
→ could they become more frequent under more variable storm events?

Jerry DeGraff

Post-fire debris flow on Oak Creek on east side of Sierra Nevada

Chapter 1.1: Restoring Fire as an Essential Watershed Process

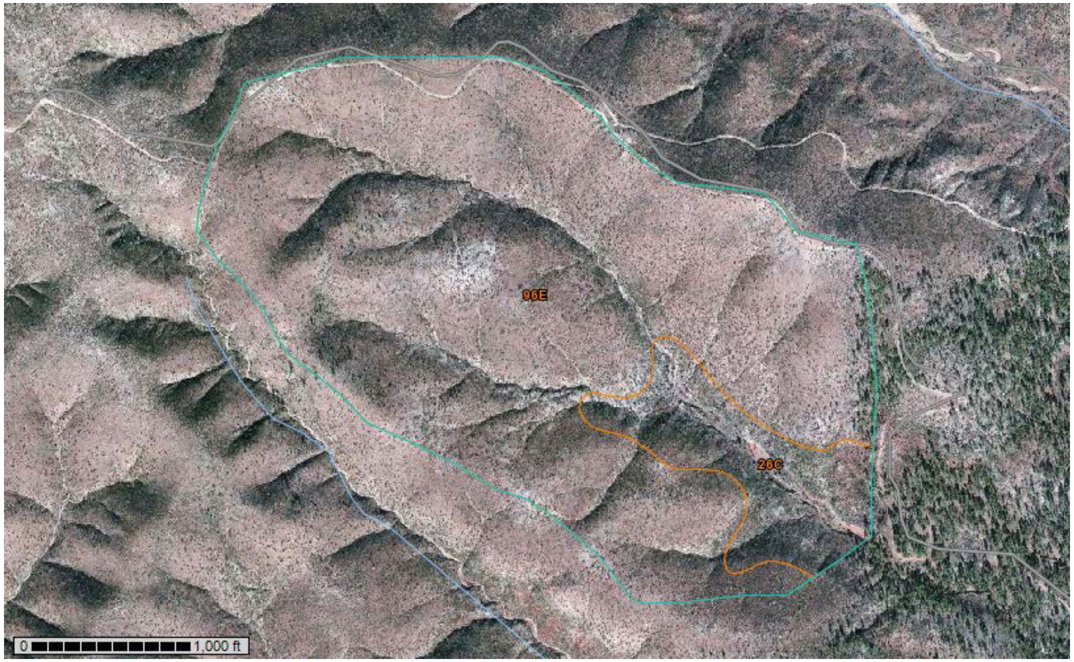
- Rejuvenation of riparian and aquatic habitats by fire is ecologically important
- However, systems that are already degraded conditions or have limited connectivity for aquatic life may be vulnerable

The managed Lion fire burned watersheds occupied by California golden trout

Brent Skaggs

Metrics for Evaluating Fire Effects

- Size of high severity patches
- For aquatic systems, percent of watershed burned at high (or high-moderate) severity may be useful indicator



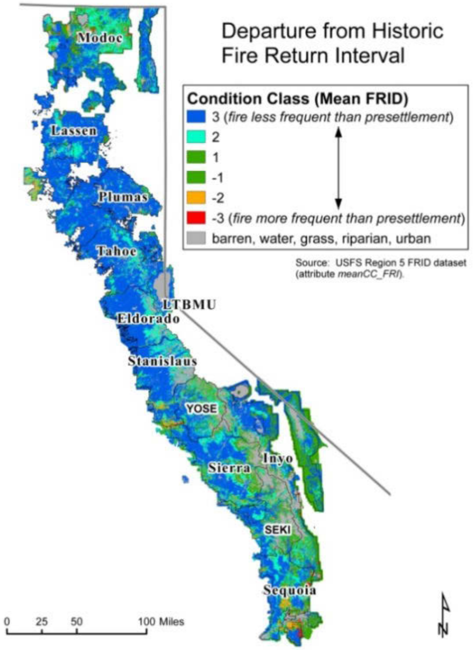
Watershed in Arizona burned at 100% high severity (using BAER criteria), resulted in extensive channel erosion

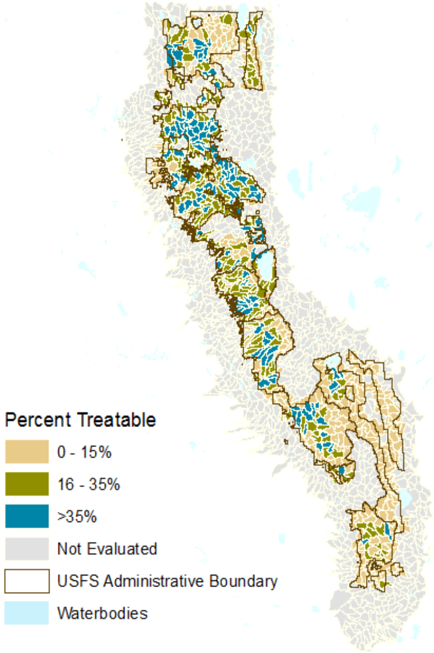
Chapter 1.3: Restoring Process and Heterogeneity Using Fire + Harvesting Treatments

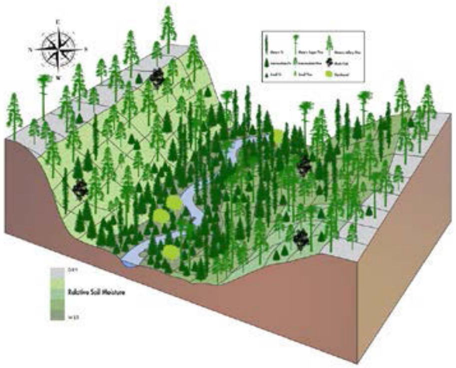
Fire regime

Suitability for treatment

→ *Consider ecological and social factors at multiple scales*







Meso-scale Topography (PSW-GTR-220)

Fine-scale patches

Use More Intense Prescribed Fires?

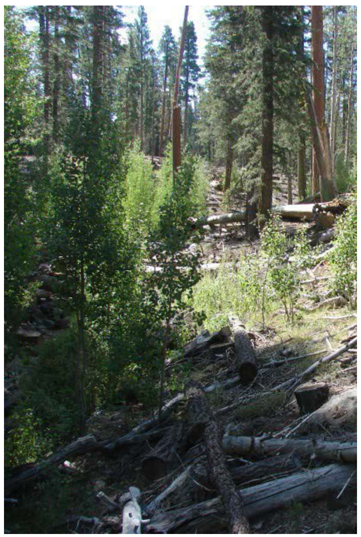
- Typical prescribed fires have often been very light–higher intensity fire in riparian areas may be needed to restore aspen (Krasnow et al. 2012)
- Given limitations on mechanical harvest in many areas, prescribed fire may be important for reshaping forest structure in many areas

Chapter 6.2: Riparian Forest Management

- Recognize the distinctive characteristics of riparian areas in different regions

Guidelines from Wet Pacific Northwest Forests do not translate well to drier, more fire-dominated systems

Jonathan Long



Down logs for wildlife

Accumulations of smaller-sized coarse woody debris due to lack of fire (Knapp 2015) may not be good for small mammals (Sollman et al. in press)

In-stream woody debris

Large woody debris "played a relatively minor role" in channel morphology on the Stanislaus NF, in part due to faster decay (Ruediger and Ward 1996)

Shade

Consider possible benefits (for amphibians and fishes) from reducing shade (PSW-GTR-247 and PSW-GTR-244)

Riparian Forest Restoration

- Plan for heterogeneity based on reference disturbance regimes and landscape attributes
- Do not expect "simple, effective, standardized prescriptions, formulas, or procedures" for attributes such as large woody debris (PSW-GTR-181)
- Consider treatments especially in areas at risk for high-severity fires

Chapter 4.3: Post-fire Management

Riparian areas are generally **resilient** to wildfire, but there are special concerns:

- **Hydrologic effects** of high soil burn severity
- **Long-term productivity and resiliency of riparian habitats**
  - Can grow large trees and provide sources of large woody debris
  - Wildlife habitat and corridors
  - Climate change refugia

Salvage in Riparian Areas

"Without a commitment to monitor management experiments, the effects of postfire riparian logging will remain unknown and highly contentious"

– Reeves et al. 2006, "Postfire Logging in Riparian Areas"

- However, there are reasons to consider salvage in these areas
- Consider removing the trees that you would have removed before the fire to restore structure and fire resilience

Chapter 1.6: Adaptive Management

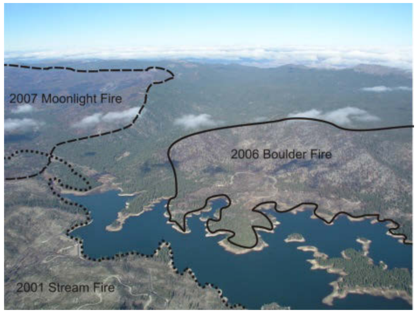
Need combinations of experiments, large demonstration areas, long-term monitoring following large fires, and modeling

A. Evaluate active management for riparian and wildlife zones

B. Evaluate phased treatments to reestablish fire regime

C. Evaluate impacts to water resources and other socioeconomic values following large or multiple fires

Experimental forests and watersheds

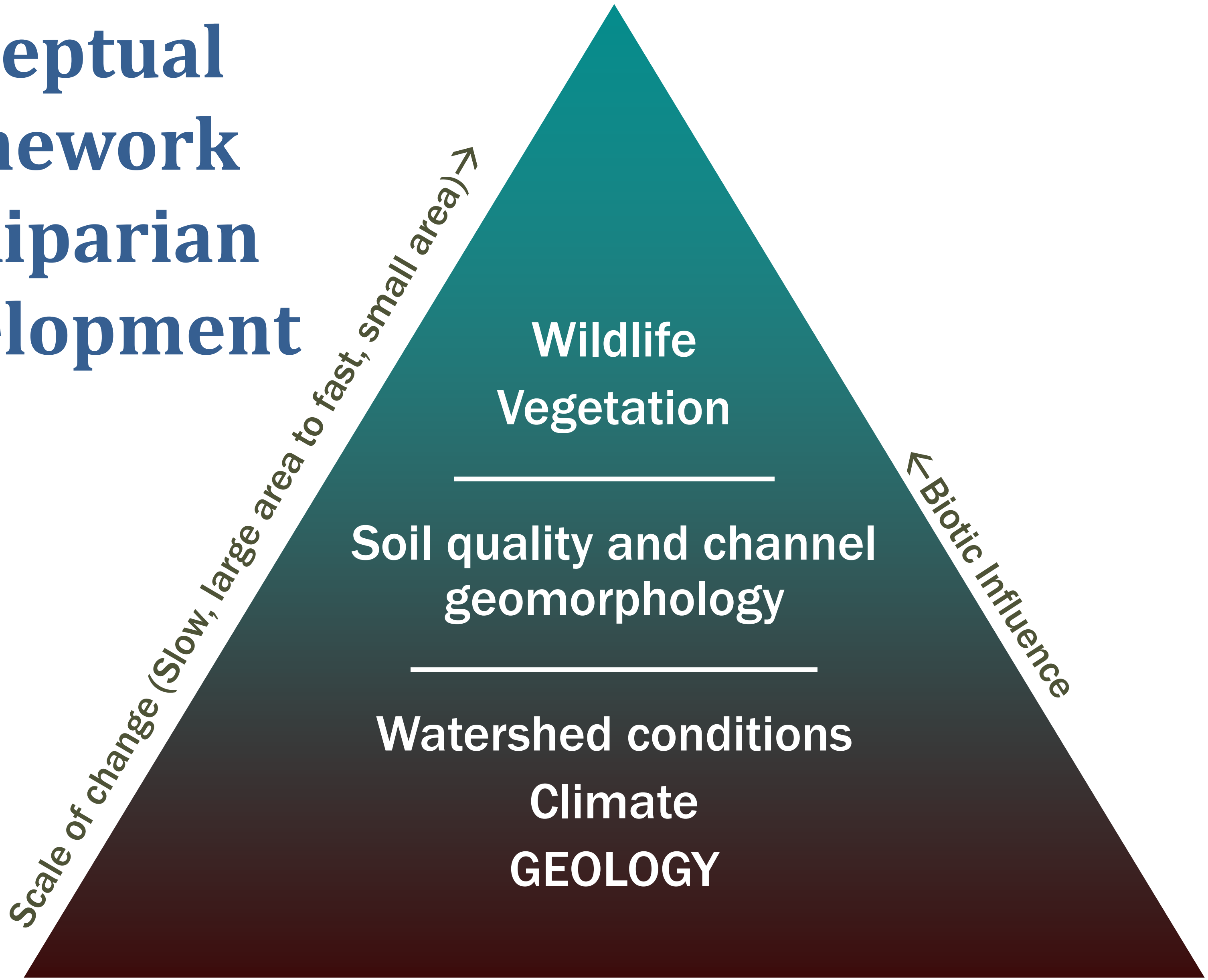


Post-fire studies

CONCEPTUAL FRAMEWORK FOR RIPARIAN RESTORATION AND CASE STUDIES FROM THE WHITE MOUNTAINS OF ARIZONA

1. Conceptual framework
2. Meadow incision and restoration, including Alder encroachment
3. Post-fire incision and restoration

Conceptual Framework for Riparian Development

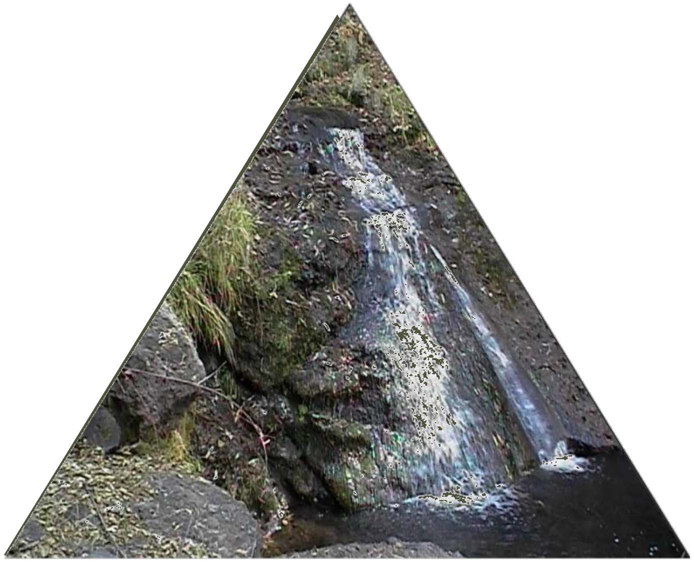


GEOLOGY

controls key processes of riparian development that are fundamental for restoration potential

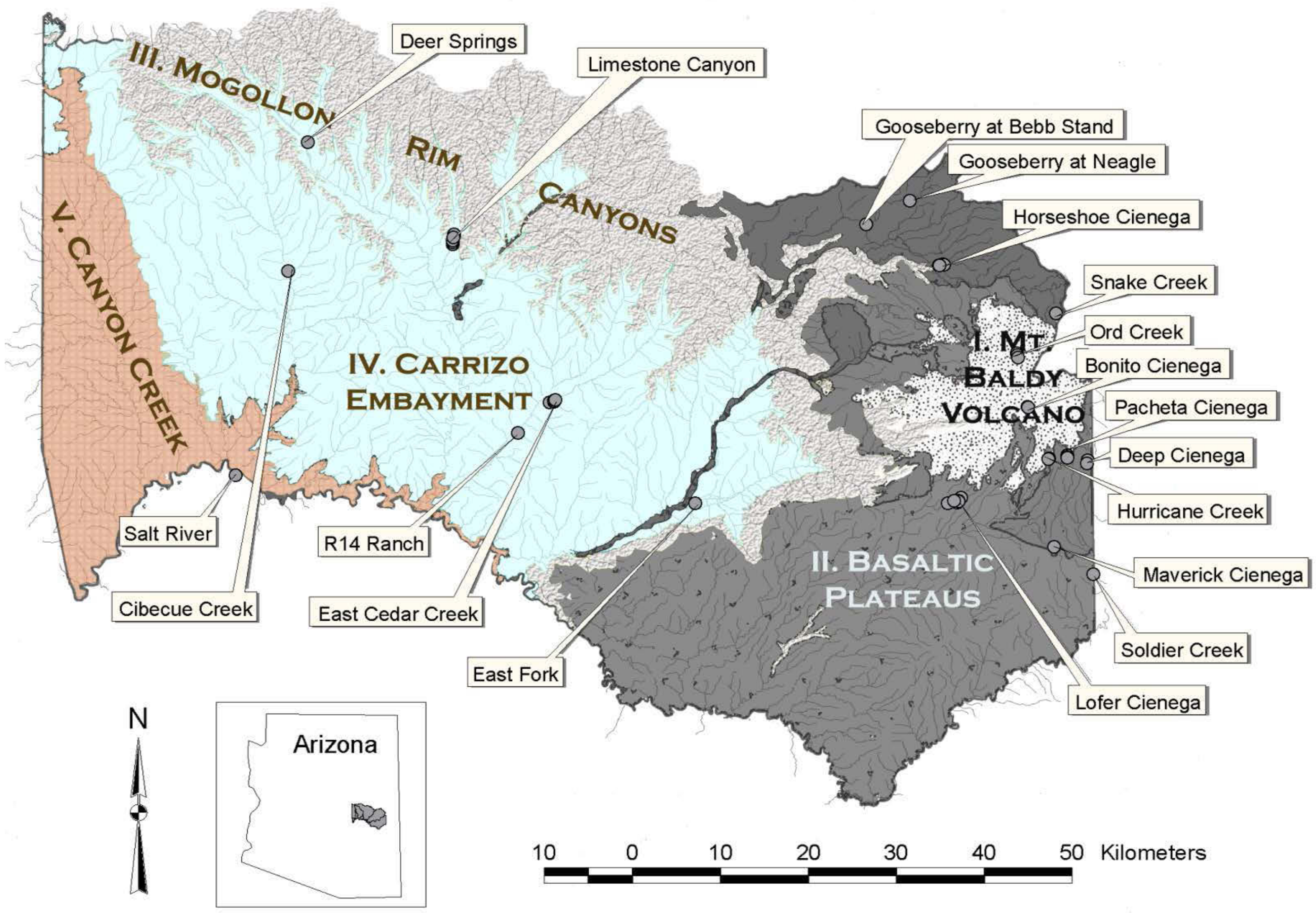
Sediment supply

Channel morphology



Vegetative development

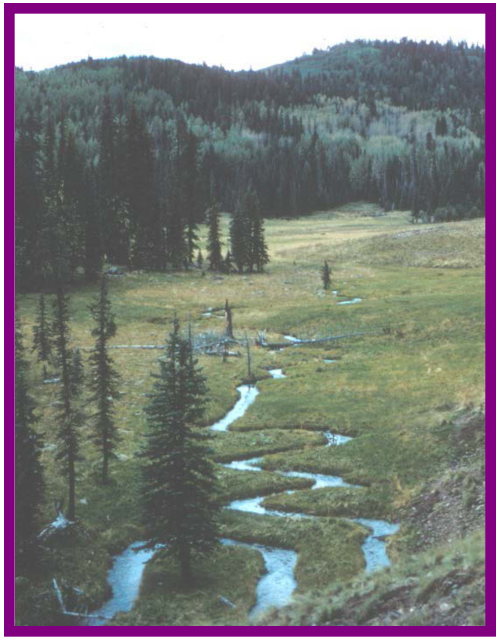
Ecological Context:
White Mountain Apache Reservation



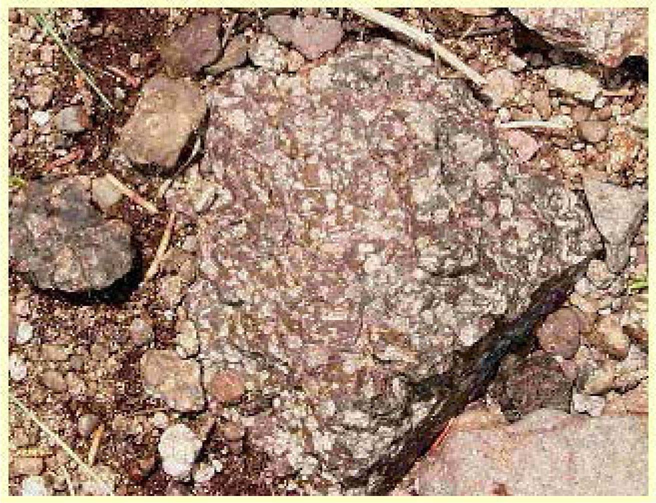
Dominant Lithotypes	Texture	
	Coarse	Fine
Volcanic	I. Felsic volcanics	II. Mafic volcanics 
Sedimentary	III. Sandstone 	IV. Siltstone 

I. Felsic Volcanics

Productive and Stable



Coarse bed materials promote stability



Meadows formed in glacial and pseudo-glacial deposits

Most productive trout habitat

Ord Creek: Very high trout biomass

II. Basaltic Volcanics

- Fine-textured soils vulnerable to degradation

- Lack of coarse substrates limits fish habitat and slows recovery

III. Coarse Sedimentary Areas

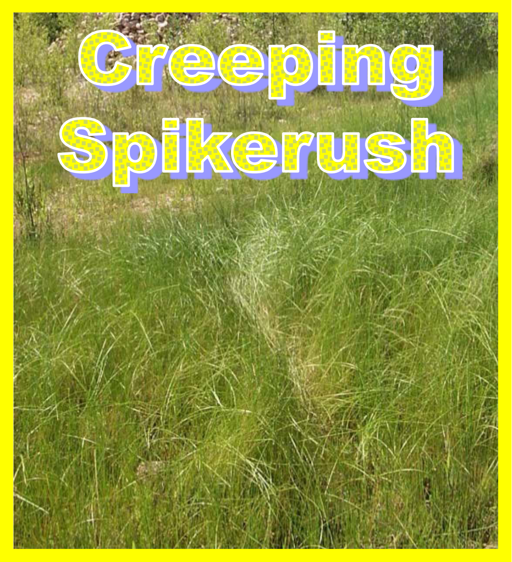
- Lack fine substrates
- Often slow to recover
- Impacted by severe post-fire floods

IV. Fine Sedimentary Areas

- Large watershed areas with high production of fine sediments
- Vulnerable to lateral erosion
- But can reform quickly with water + sediment + vegetation growth

Grass-like plants: keys to wetland recovery

Different species are important in different ecoregions, but cord-like roots and dense leaves to trap sediments are consistently important

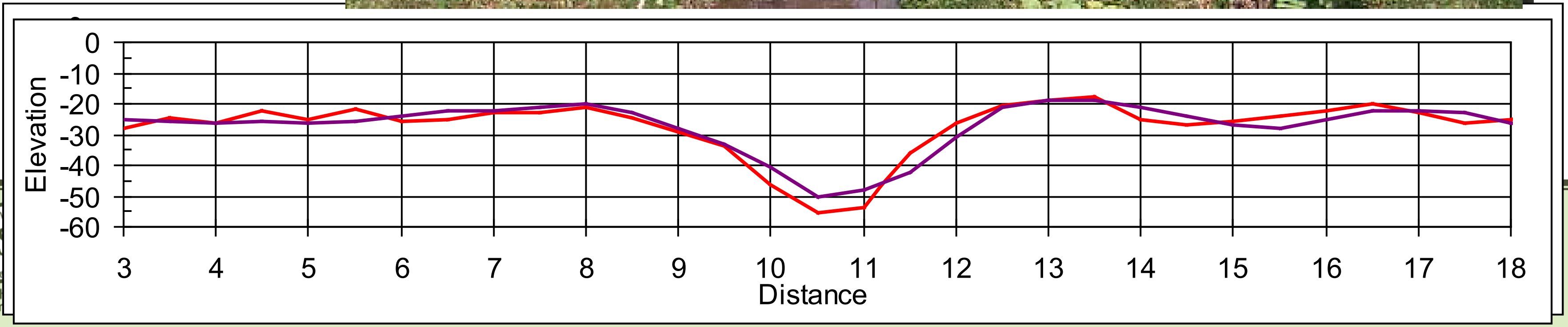


MEADOW RESTORATION CASE STUDIES

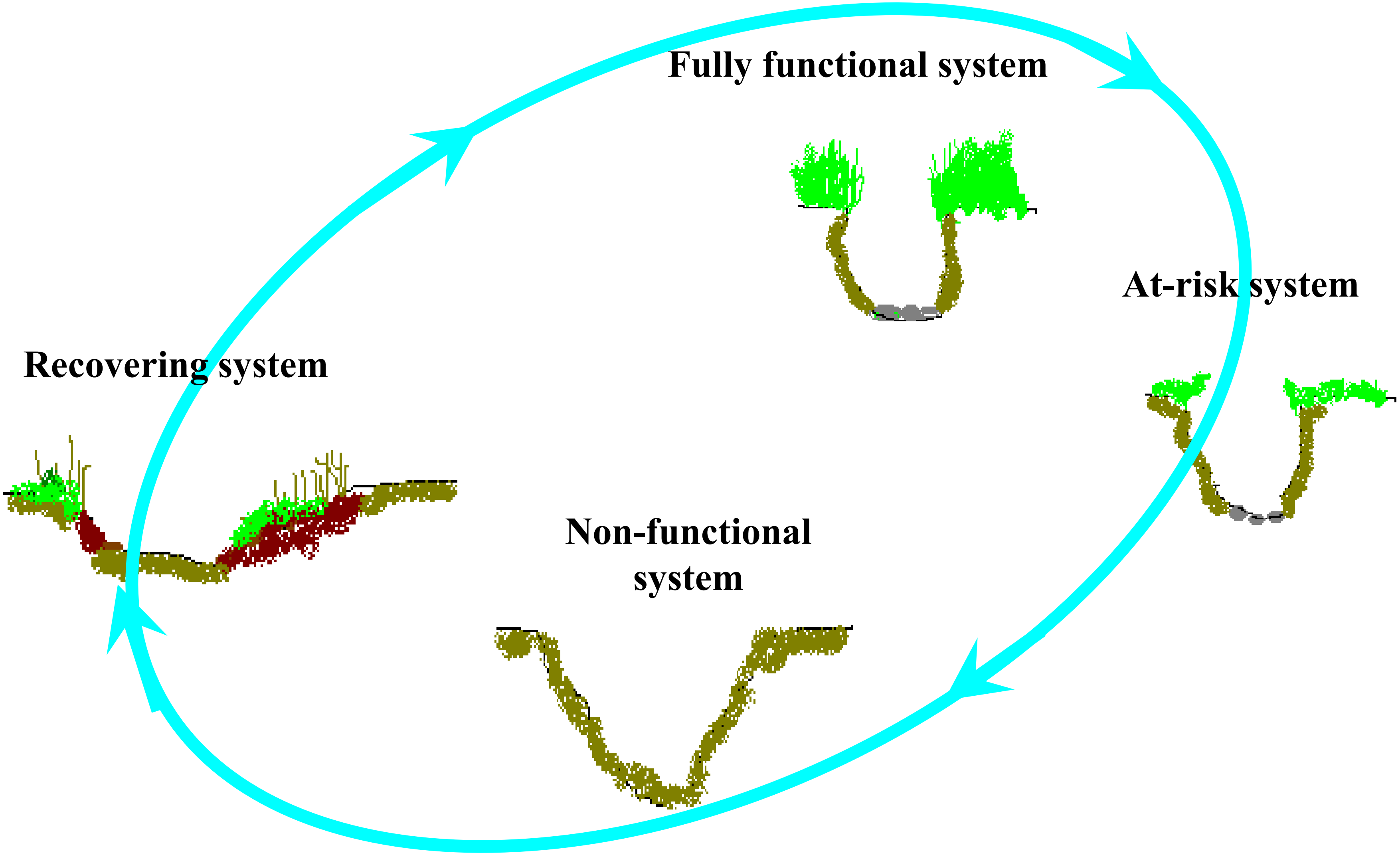
Using “active” and “passive restoration”

Process of Channel Degradation

Native trout residing in scour pools

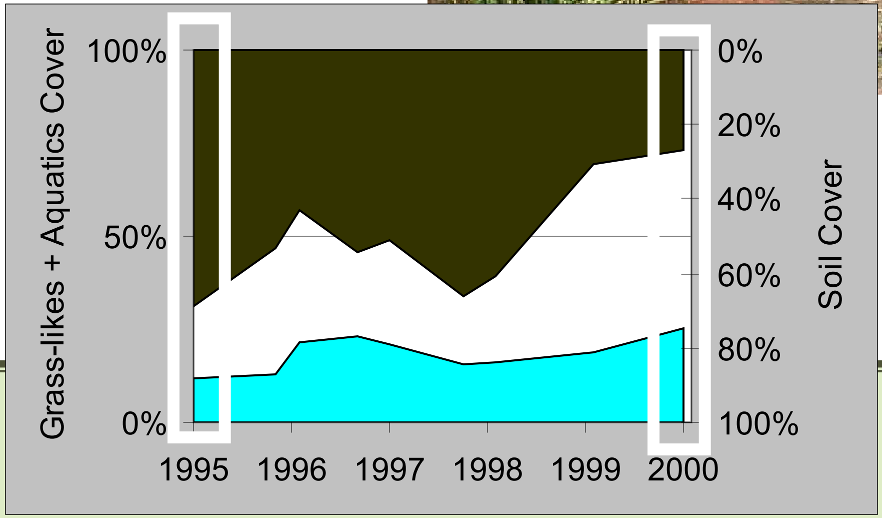


Recovery Process

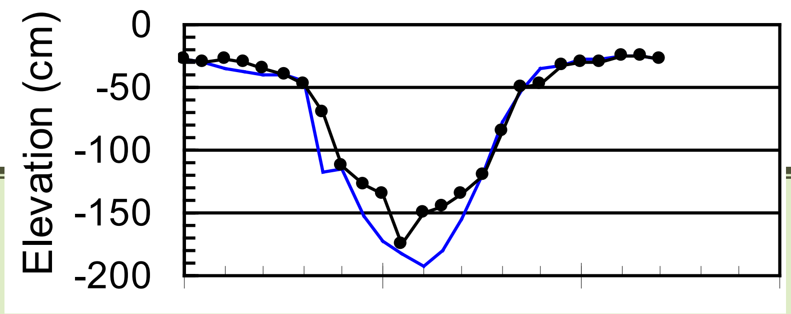


Recovery

Reduction of bare soil



Aggradation



Riffle Formation Treatments

1. Controlling grazing impacts
2. Placing mixtures of gravels and cobbles
3. Transplanting sedges

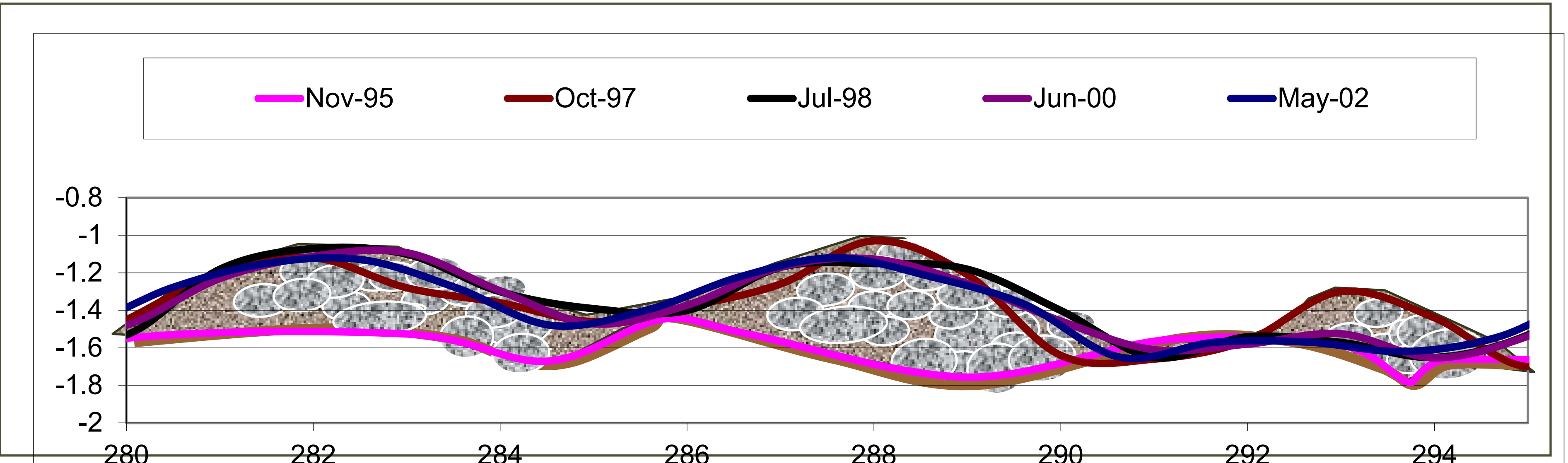
Detailed in Medina and Long (2004) “Placing riffle formations to restore stream functions in a wet meadow.” Ecological Restoration.

Effects on Channel Morphology

- Increase bedform amplitude
- Rearmor bed with coarse substrates

→Increased roughness

→Reduced erosion potential



Effects on Water Level

Reestablishing Formative Processes

1. Pool-riffle development
2. Overbank flooding
3. **Fine sediment deposition**
4. **Vegetative growth**
5. Water table rise
6. Channel armoring

Vegetative growth on bars and riffles

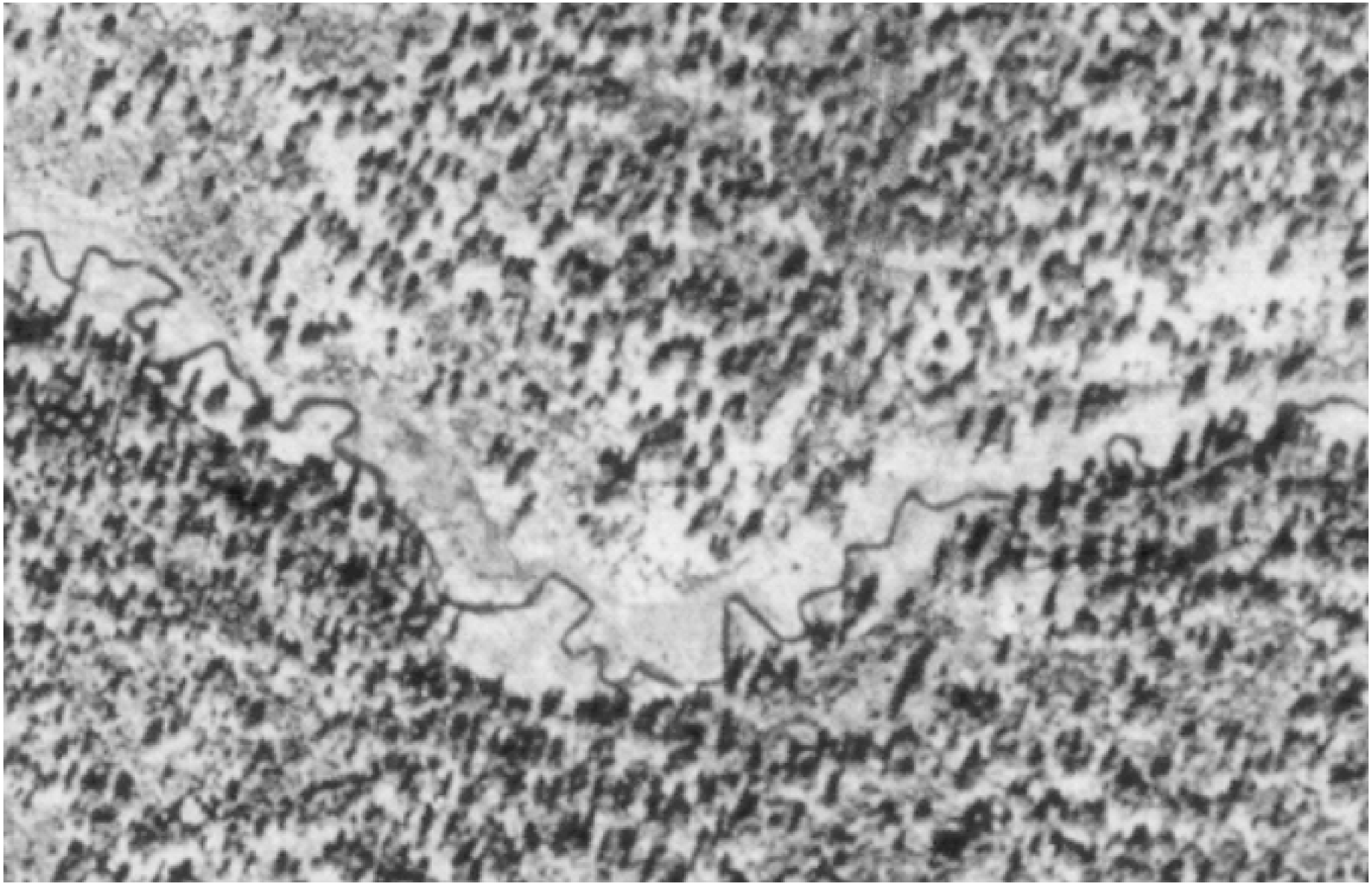
Effects on Bed Substrates

Thinleaf Alder Dynamics

- Common in steeper non-meadow reaches, but encroaches into degraded meadows
- Cycle of growth and dieback

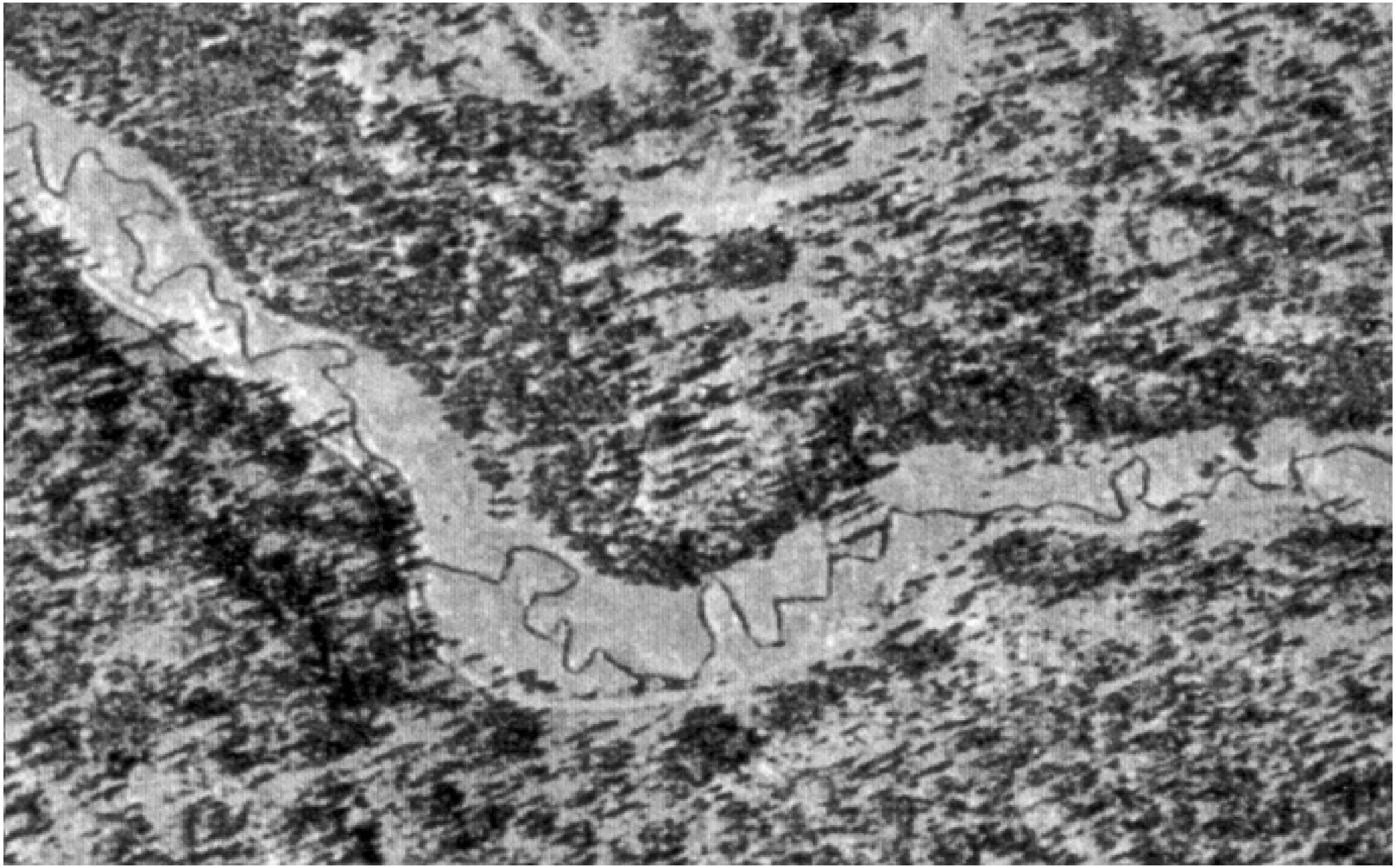
Centerfire Creek, AZ 1935

Open ponderosa pine stands and surrounding open meadow



Centerfire Creek, AZ 1968

Channel incision and a new road



Centerfire Creek, AZ 1993

Alders now line most of the channel

Boggy Creek 1950

Meadow dominated by herbaceous vegetation and widely spaced Bebb willow

Boggy Creek, AZ 1993

Encroachment of alder along the channel

Boggy Creek exclosure (Station 7) July 1993

Boggy Creek exclosure (Station 7)
July 1996

Boggy Creek exclosure (Station 7) July 1998

Thinleaf Alder Dynamics

- Forms weak debris dams that appear to facilitate channel widening

POST-FIRE CASE STUDIES

When to intervene in channels?

"A growing body of literature is discouraging further interference in natural landscape disturbance processes, such as fire and post-fire erosion, because the dynamic response to such disturbances may help maintain more diverse ecosystems that are more resilient to changed climates" (Goode et al. 2012)

Passive Restoration + Fire-Induced Sediment Deposition

Soldier Creek

Resilient to the Wallow Fire *after* active and passive restoration

Soldier Spring Riffle Formations

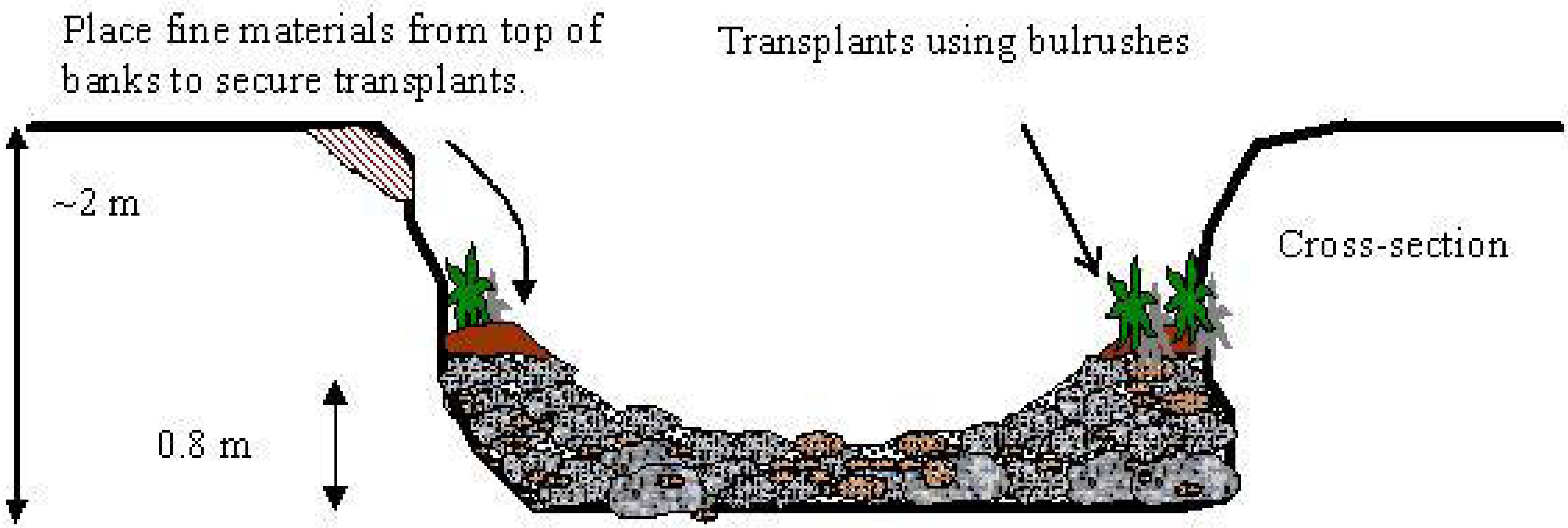
Turkey Spring: Untreated

June 2010

Poor Road-Stream Crossings → Degradation

Restoration Treatments for Headwater Channels

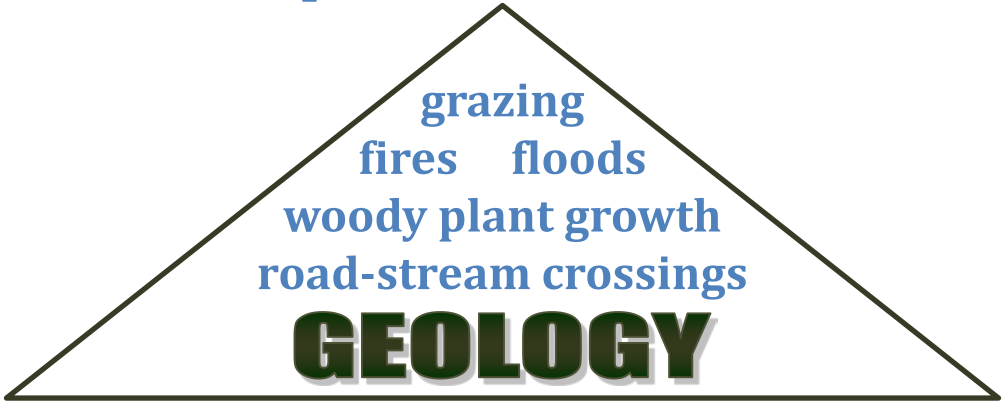
Large rock and sedge/bulrush riffle formations



Treatments at Swamp Spring

Take Home Points

- Understand how geology and disturbances influence site development



- Restoration depends on reestablishing key processes often, but not always, through structural interventions and managing woody vegetation