Ecological Restoration:

Analysis - Design - Results

U.S. Fish and Wildlife Service
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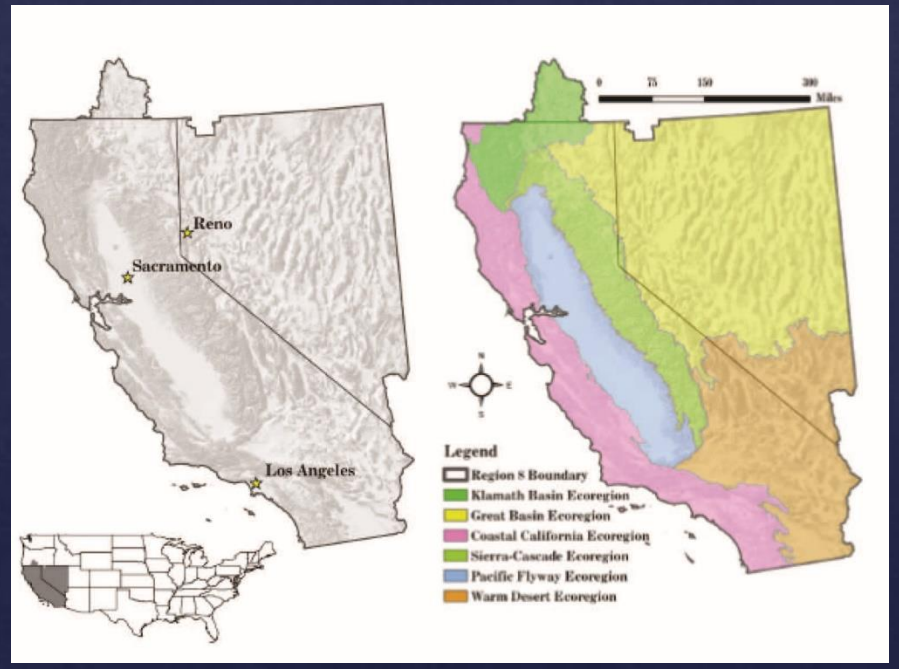
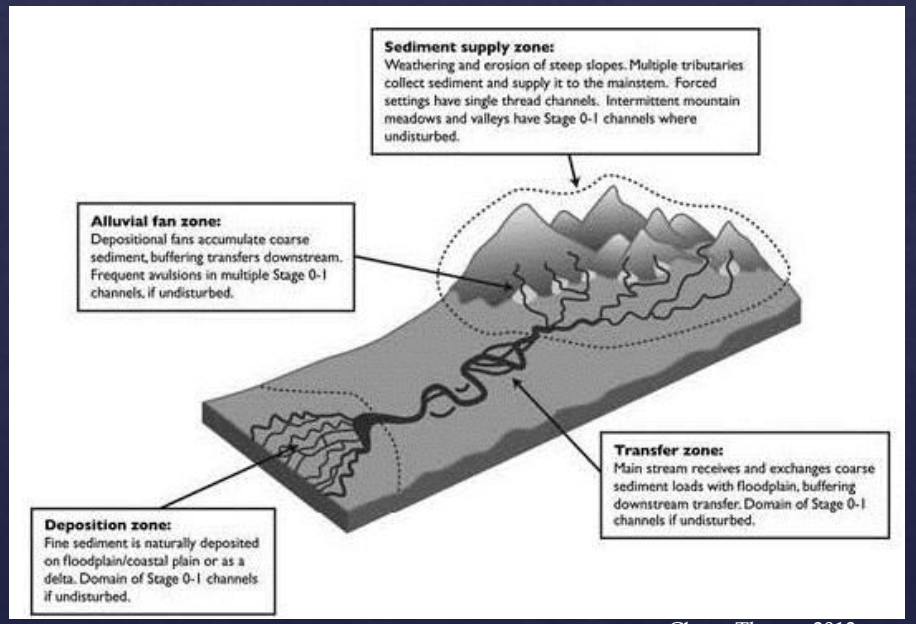
Mission Statement
"working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American People"





Cluer , Thorne. 2012.

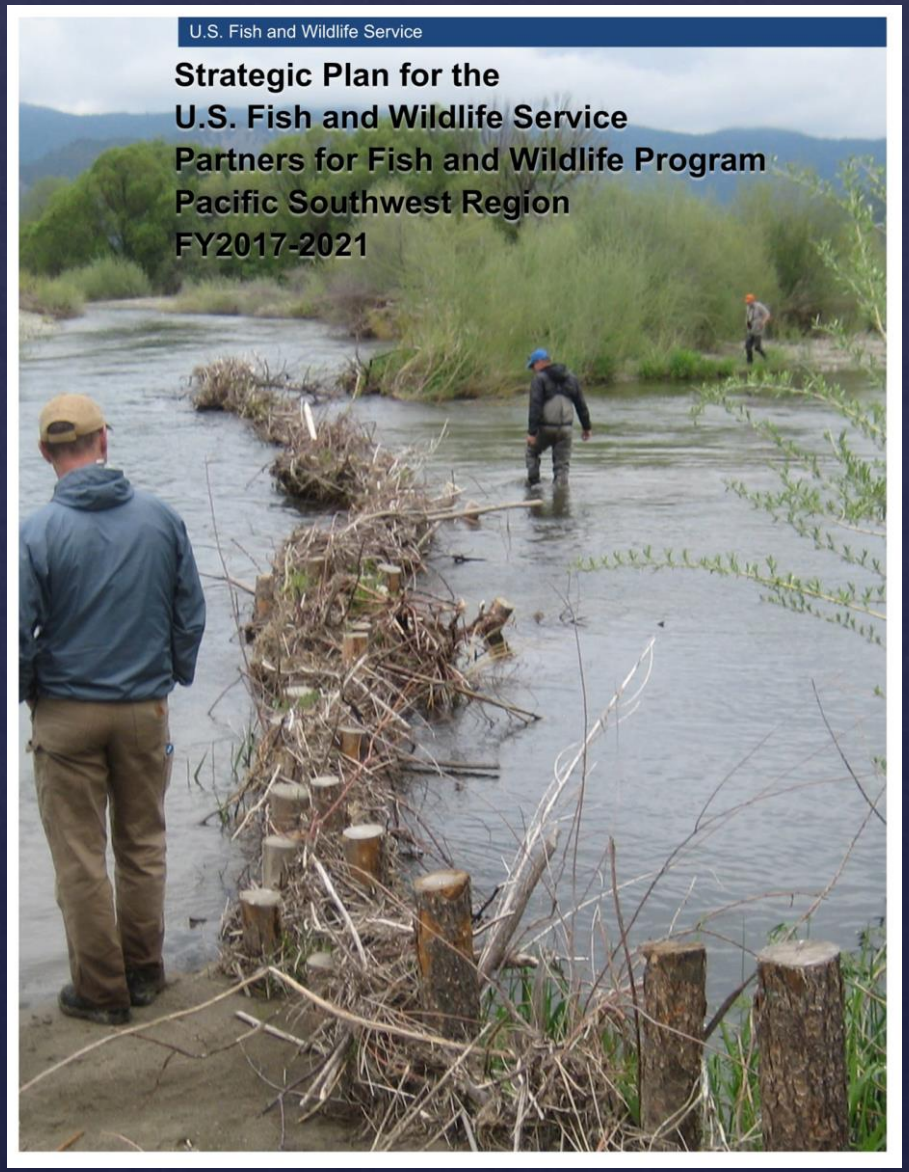
U.S. Fish and Wildlife Service
Partners for Fish & Wildlife

Since 1990 - 62,000 acres of voluntary wetland and wildlife habitat restoration

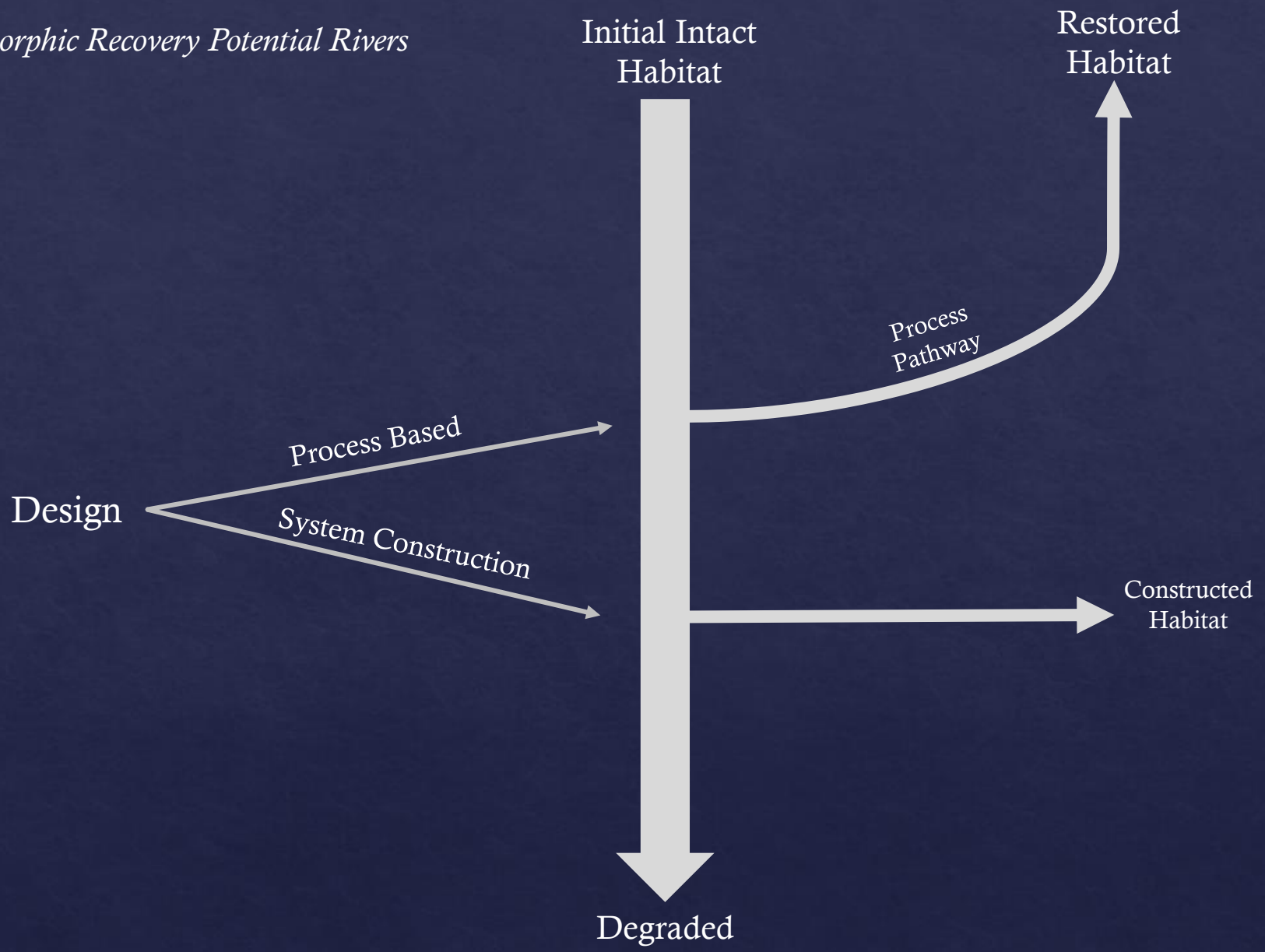
Purpose

Increase the pace and scale of restoration
- Science-based
- Sustainable
- Economically viable

How do we get the best return on this public investment?
Opportunities for Low Risk and High Return?



Fryirs et al., 2016
Assessing the Geomorphic Recovery Potential Rivers



Traditional Ecological Knowledge

Managing ecosystems and working with disturbance regimes

A Sand County Almanac, Aldo Leopold, (1949)

“The art of land doctoring is being practiced with vigor, but the science of land health is yet to be born. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity.”

Palmer et. al, 2005 and others

Ecological Restoration: relaxing human constraints on natural development of patterns of diversity. Restoration measures should NOT focus on directly recreating natural structures or states but on reestablishing the conditions under which natural states create themselves.

Standards for Ecological Restoration

Palmer 2005: “standards”

1. **A dynamic ecological endpoint is initially identified and used to guide the restoration.**
2. The ecological conditions of the stream are measurably improved.
3. Through the use of natural fluvial and ecological processes, the restored stream must be more self-sustaining and resilient to perturbations than pre-restoration conditions, so that minimal maintenance is needed.
4. **The implementation of the restoration does not inflict lasting harm.**
5. Pre- and post-project assessments are completed and the data are made publically available so that the restoration community as a whole can benefit from knowledge learned.

Beechie 2010: “Principles”

1. **Restoration actions should address the root causes of degradation**
2. Actions must be consistent with the physical and biological potential of the site
3. Actions should be at a scale commensurate with environmental problems
4. Actions should have clearly articulated outcomes for dynamics

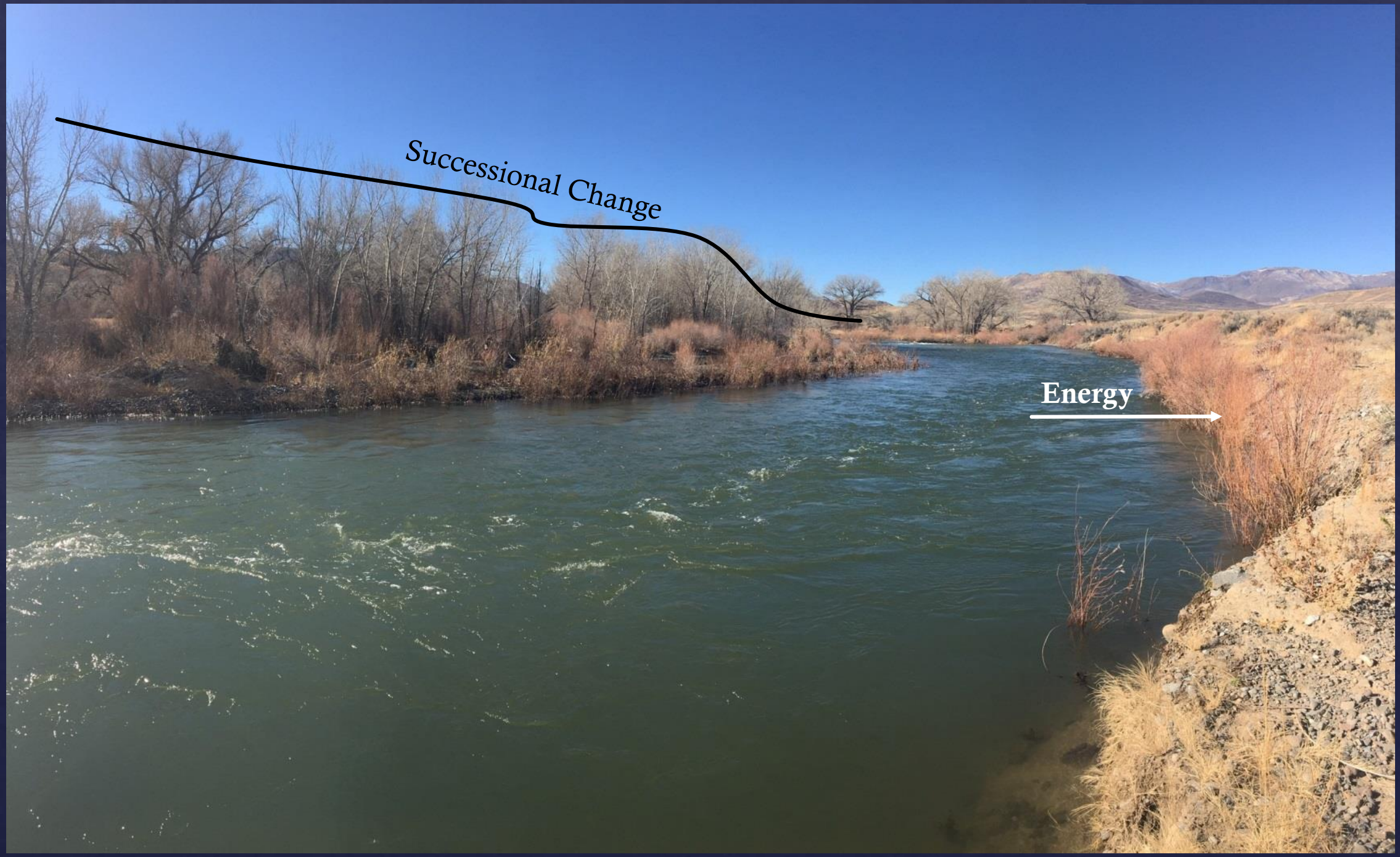
If Ecological Objectives are claimed for publically funded projects then these are scientifically based design standards for meeting those objectives

2 Design Criteria

1. SPACE - Open space for fluvial process

2. ENEREGY - Use stream energy to do geomorphic work


Basis for design criteria: Open space for energy
Space
Dynamic Change
Energy
Time


Successional Change
Energy

Tracking Geomorphic Recovery Potential

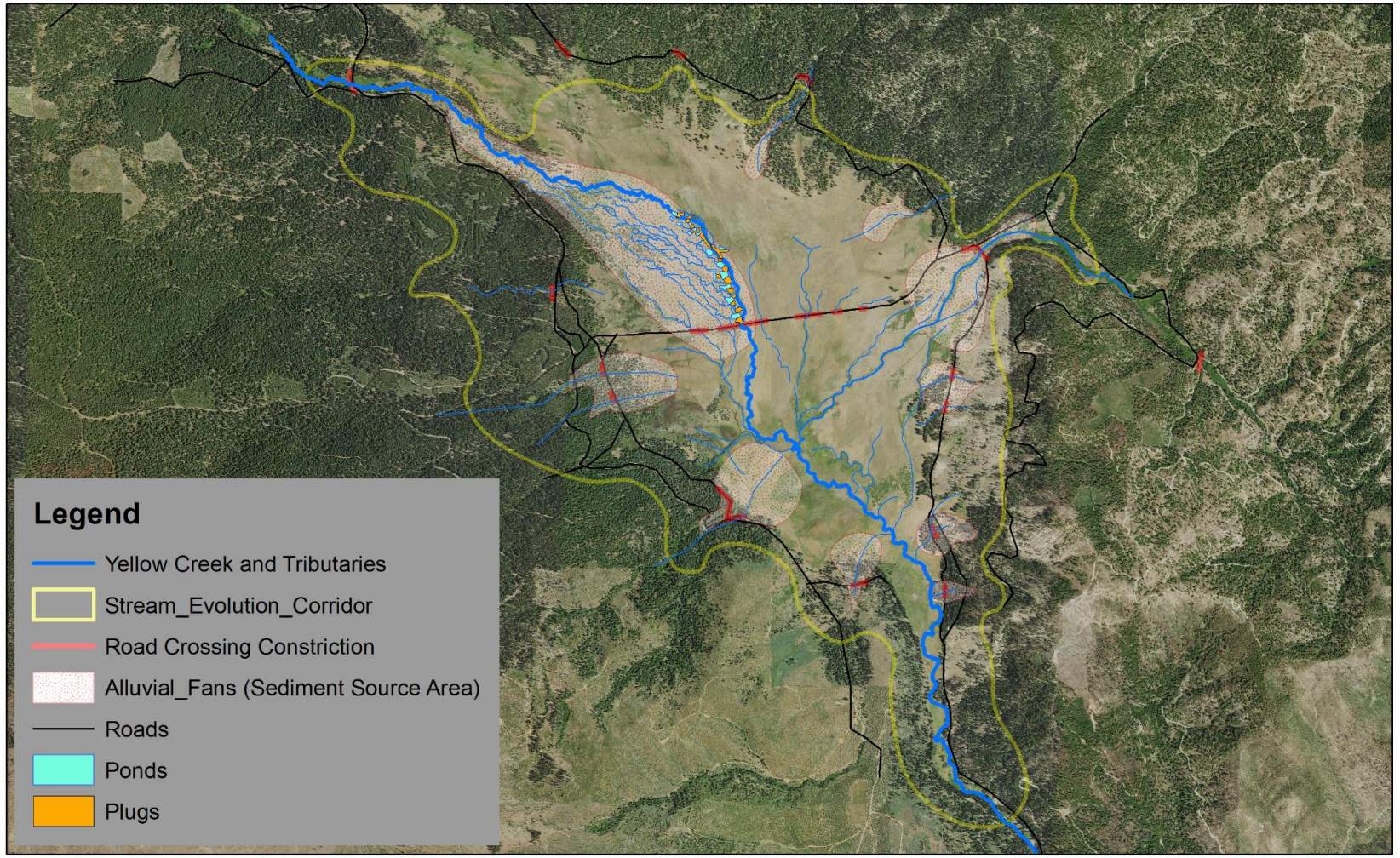
(Tasmam Kojom, Yellow Creek)

Dynamic Change

U. S. Fish & Wildlife Service

_____Habitat Restoration Office ____
_____ Auburn, California

Tasmam Kojom Meadow - Primary Sediment Source Areas and Disconnections within the Stream Evolution Corridor



Produced by: Partners for Fish & Wildlife Program
____location
Created by: dciotti
Date: 2/2/2018
Data Sources:

0 0.5 1 2 Miles


BDA Biogenic
Structure

Inputs

Constants	
density of water (kg/m^3)	1000
gravity (m/s^2)	9.8

Variables	Metric for Calcs	
flow (m^3/s)	11.3833616	m^3/s
Slope (m/m)	0.0136	
Reach Length (m)	5000	
Flood Duration (s)	86400	

Conversions	
1 gal = 139000 btu	
1055.06 joule/btu	
1 gal of diesel (joules) =	146653340
1 cubic m = 35.3147 cubic ft	

Solution	
Gallons of diesel=	4469.17442

one day of a two year event @ tasmam kojom upper meadow

2 year flow from stream stats
lidar analysis of yellow creek
gis analysis of yellow creek reach
currently assumed to be 1 day in duration

US units
402 cfs

Statistic	Value	Unit
2 Year Peak Flood	402	ft^3/s
5 Year Peak Flood	889	ft^3/s
10 Year Peak Flood	1360	ft^3/s
25 Year Peak Flood	2080	ft^3/s
50 Year Peak Flood	2780	ft^3/s
100 Year Peak Flood	3590	ft^3/s
200 Year Peak Flood	4500	ft^3/s
500 Year Peak Flood	5910	ft^3/s

Fuel Consumption for medium excavator under medium load equals 3 gallons per hour

Hours of excavator work performed by a 2 year flood event over the course of 1 day: 1489.725 hours
Assuming 10 hour work days: 149 days

WATER RESOURCES RESEARCH, VOL. 36, NO. 8, PAGES 2373–2379, AUGUST 2000

Stress partitioning in streams by large woody debris

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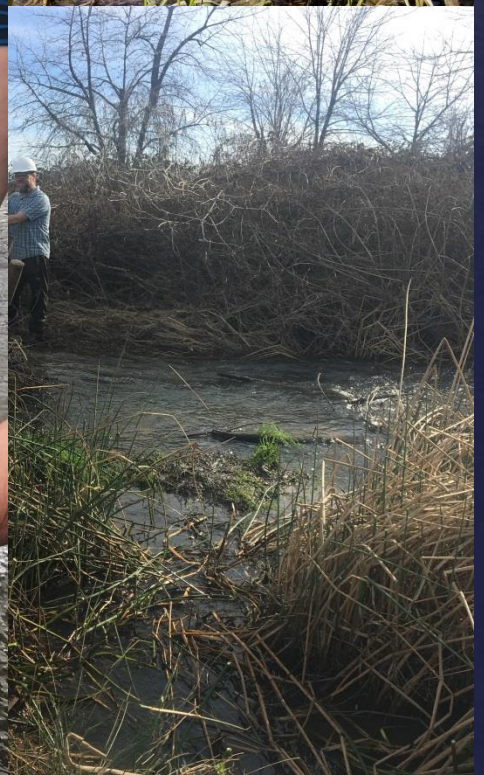
Abstract. Using simple theoretical models and field measurements from a spring-dominated stream, we quantify how large woody debris affect channel hydraulics and morphology at both the local and reach-averaged scales. Because spring-dominated streams have nearly constant discharge, they provide a unique natural opportunity to study flow and transport processes near the channel-forming flow. We first show that the drag on a floating log is identical to the theoretical value for widely separated cylinders at similar Reynolds numbers. We then use simple theoretical models to estimate the partitioning of flow shear stress between woody debris and streambeds. The inferred stress partitioning is consistent with an estimate based on a comparison of local and reach-averaged measurements of the water surface slope. Our measurements show that even though large woody debris cover less than 2% of the streambed, they provide roughly half of the total flow resistance. As large woody debris are added to a stream, the total shear stress increases (because the water depth increases), but the shear stress borne by the bed decreases, as a growing fraction of the total shear stress is borne by the debris. Our analysis shows that simple theoretical models of stress partitioning may provide a convenient mathematical framework for assessing how changes in debris loading affect streams.

Constriction Dam

Accelerate Process –widening and tree recruitment using stream energy

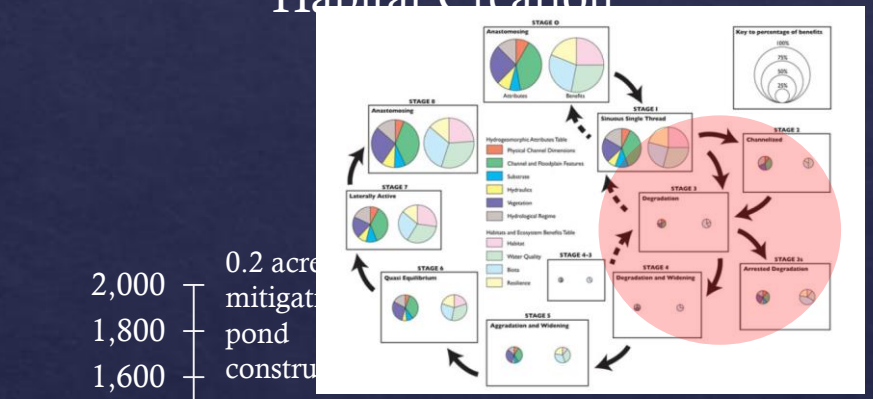
Depositional Zone

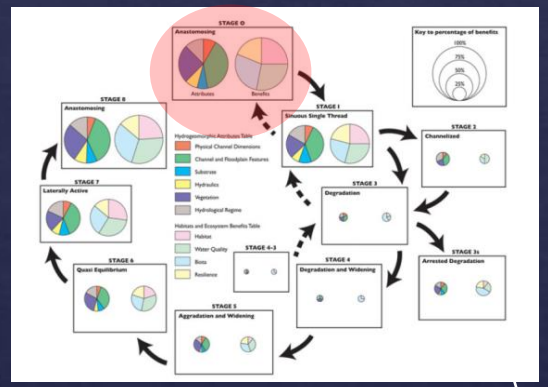


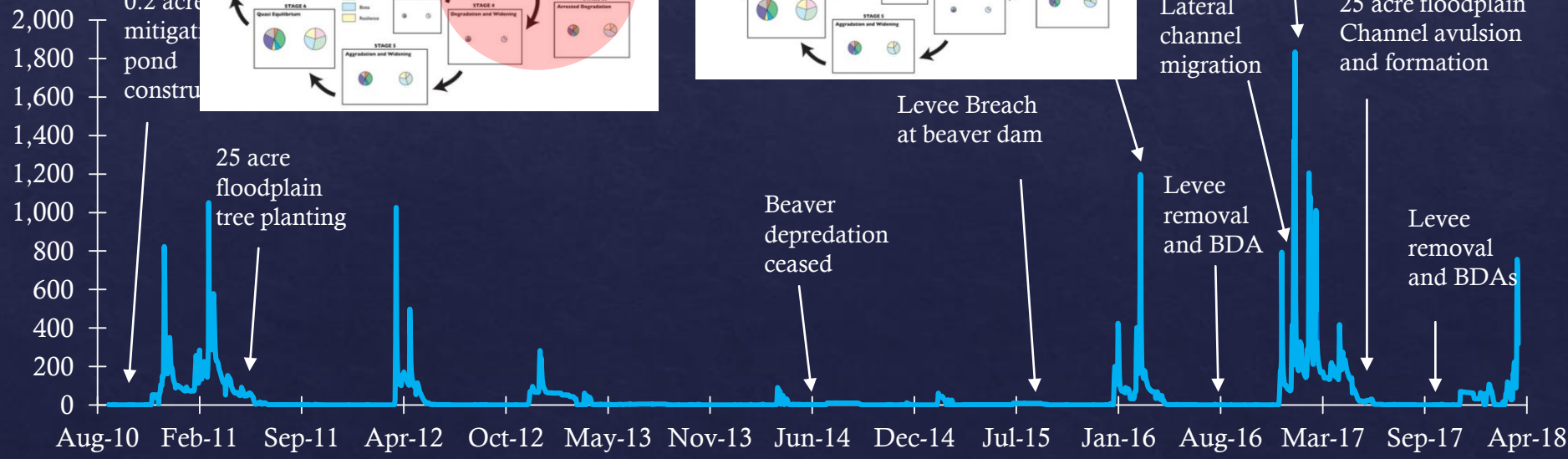
Gauging system recovery to stage zero

Habitat Creation

Habitat Restoration



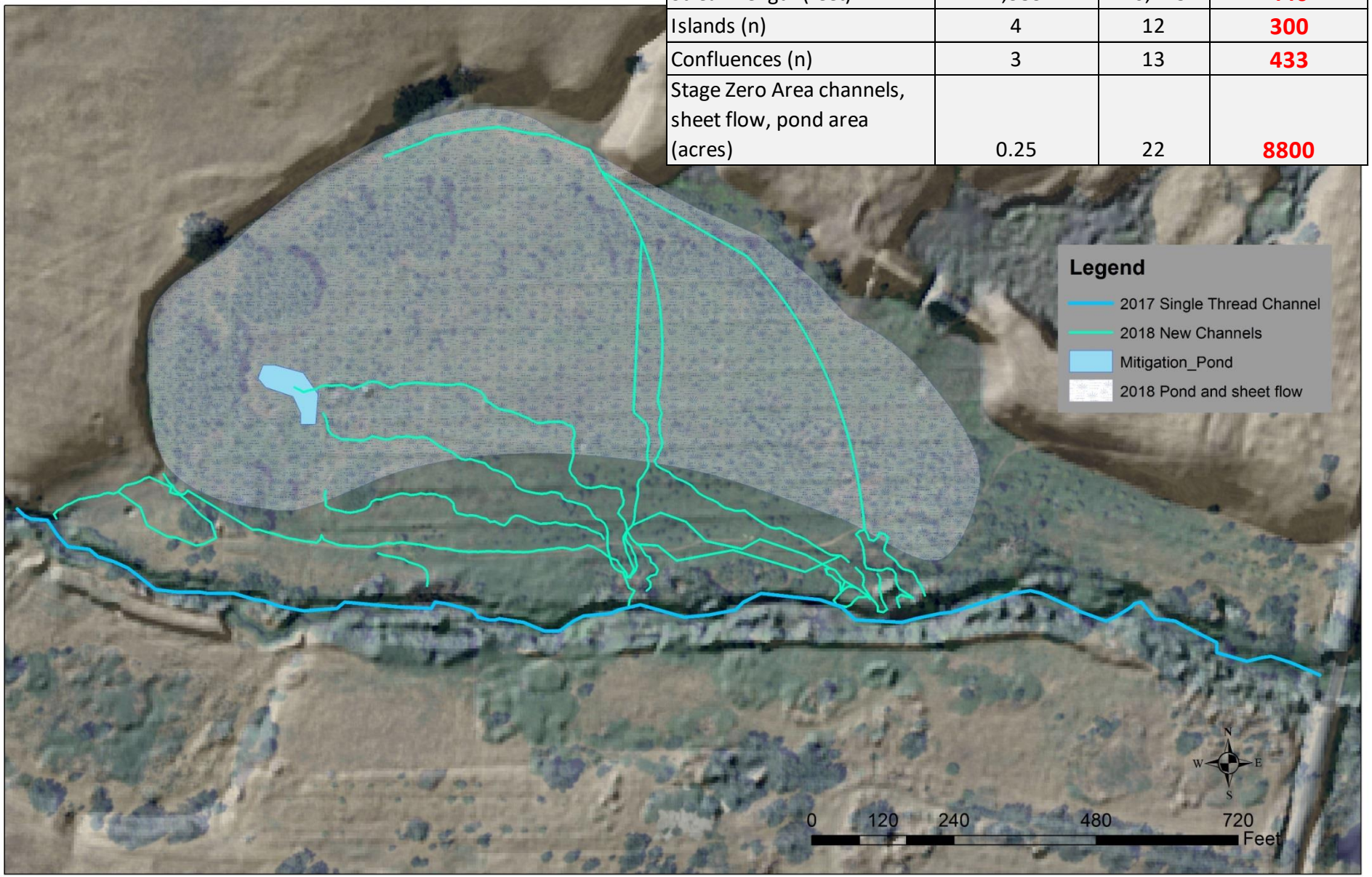




Before / After

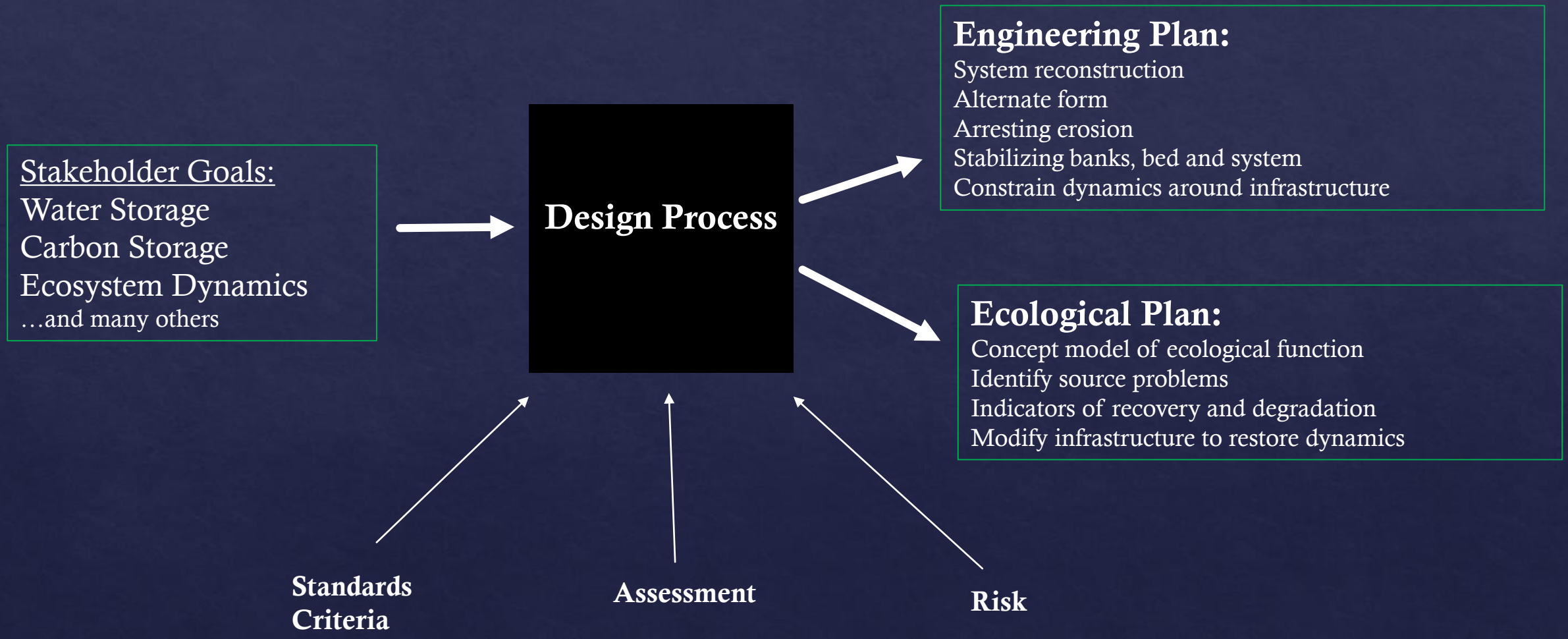
2018

Gauging Evolution to Stage Zero			
Habitat Attributes	**2017**	**2018**	**% Increase**
Stream length (feet)	2,383	10,478	**440**
Islands (n)	4	12	**300**
Confluences (n)	3	13	**433**
Stage Zero Area channels, sheet flow, pond area (acres)	0.25	22	**8800**




Pre Project Audrain Meadow peat soils eroding July 2016

Inside the "Black Box" of River Restoration (Mika et al, 2010)



1. Opening dynamic fluvial space is low risk
2. Using stream energy to meet form objective is low risk

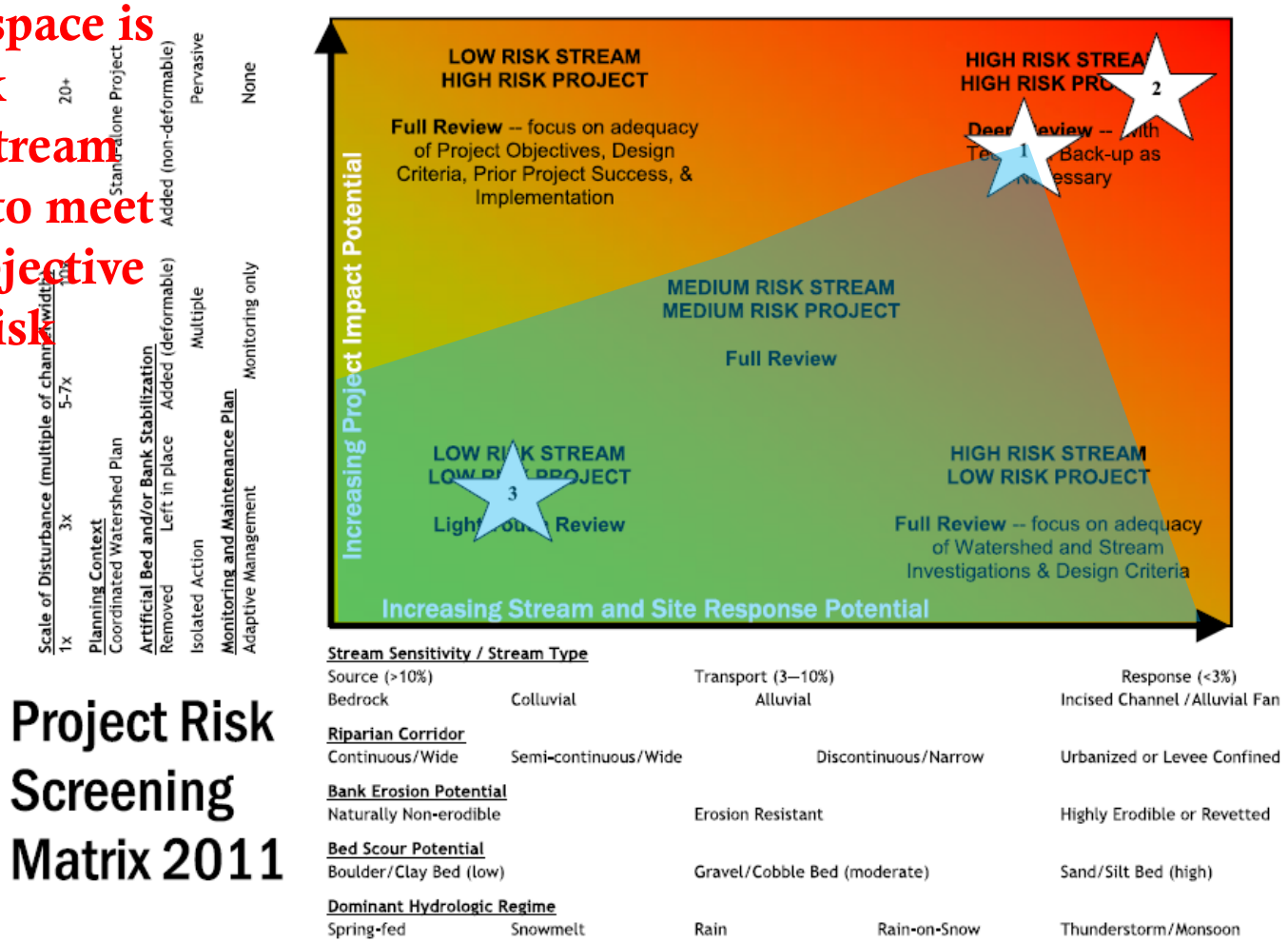


Figure 7. 2011 matrix with three example proposals for restoration projects plotted in their appropriate review categories based on evaluation of risks to aquatic species and in-stream habitat: 1. culvert replacement, 2. channel construction and 3. large wood placement. This figure is available in colour online at wileyonlinelibrary.com/journal/rra