Embracing Chaos Stage Zero Experience from the Sierra Foothills

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Jared McKee

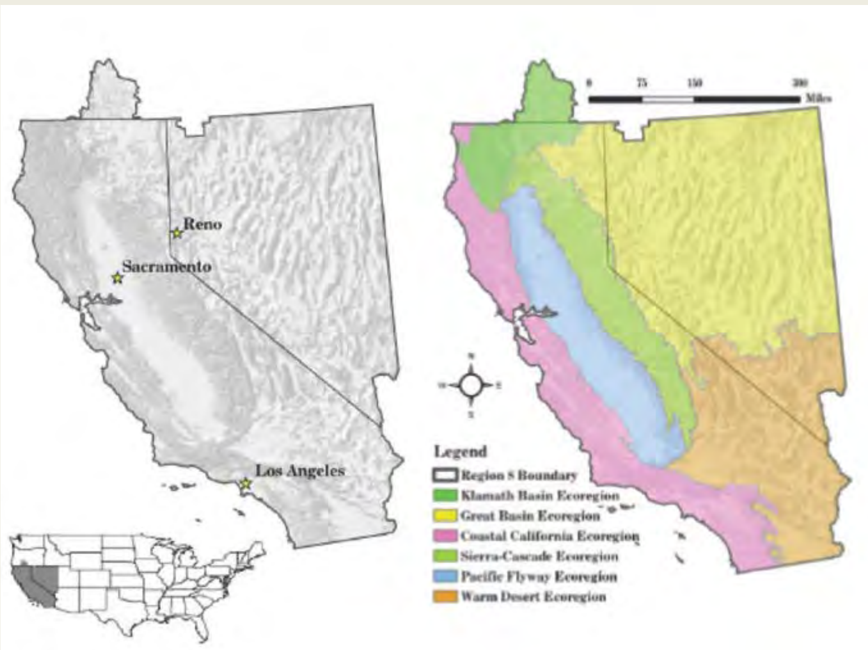
Audience Check-In

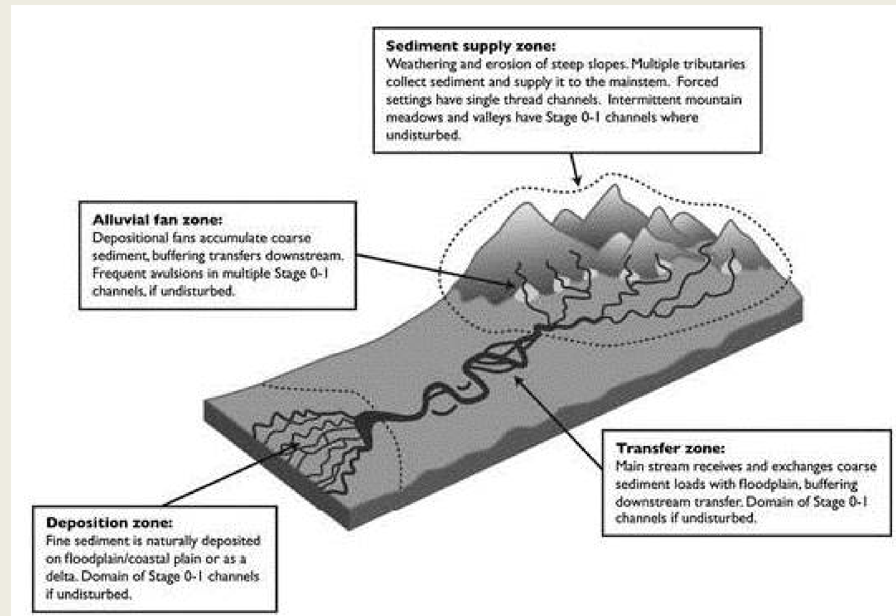
- What's your role in the restoration world?
  - Permitter, Funder, Researcher, Land Manager, Restoration Practitioner?
- Do the projects you are seeing meet the stated goals?
- Does the current pace and scale of restoration match the needs?
- Will resources for restoration go up or down in the future?

Partners for Fish and Wildlife Program

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"



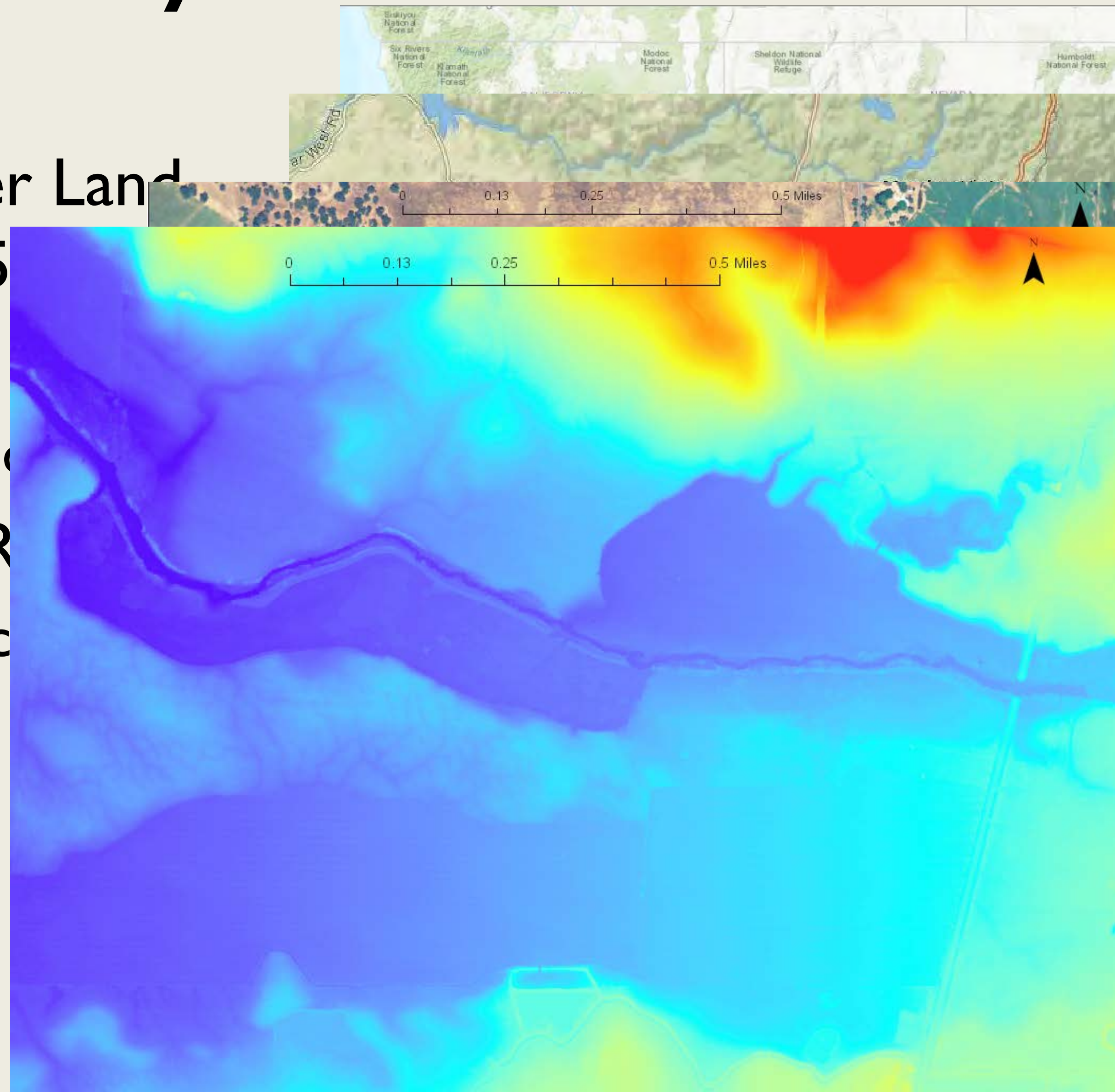


Cluer , Thorne. 2012.

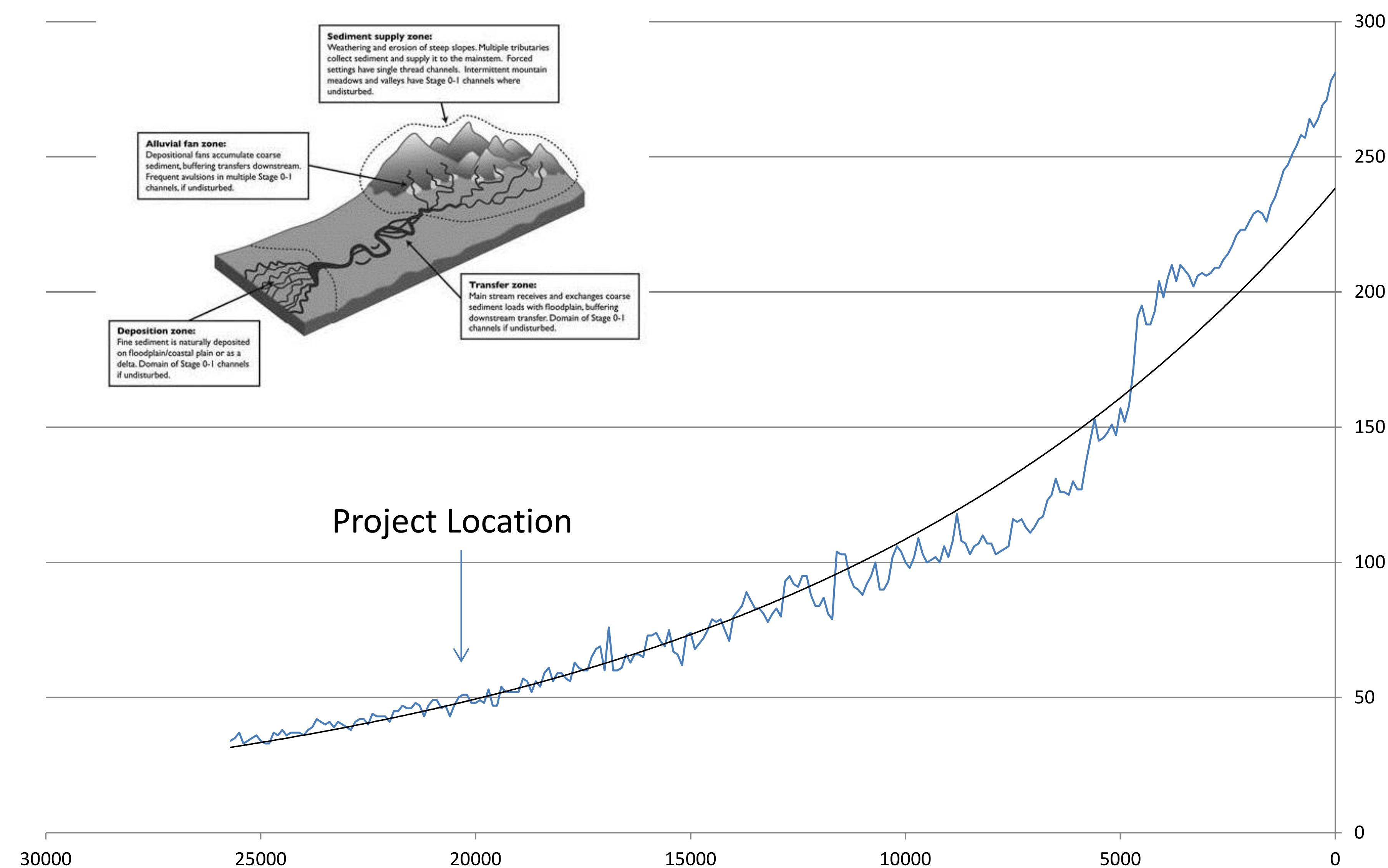
Since 1990 - 62,000 acres of voluntary wetland and wildlife habitat restoration

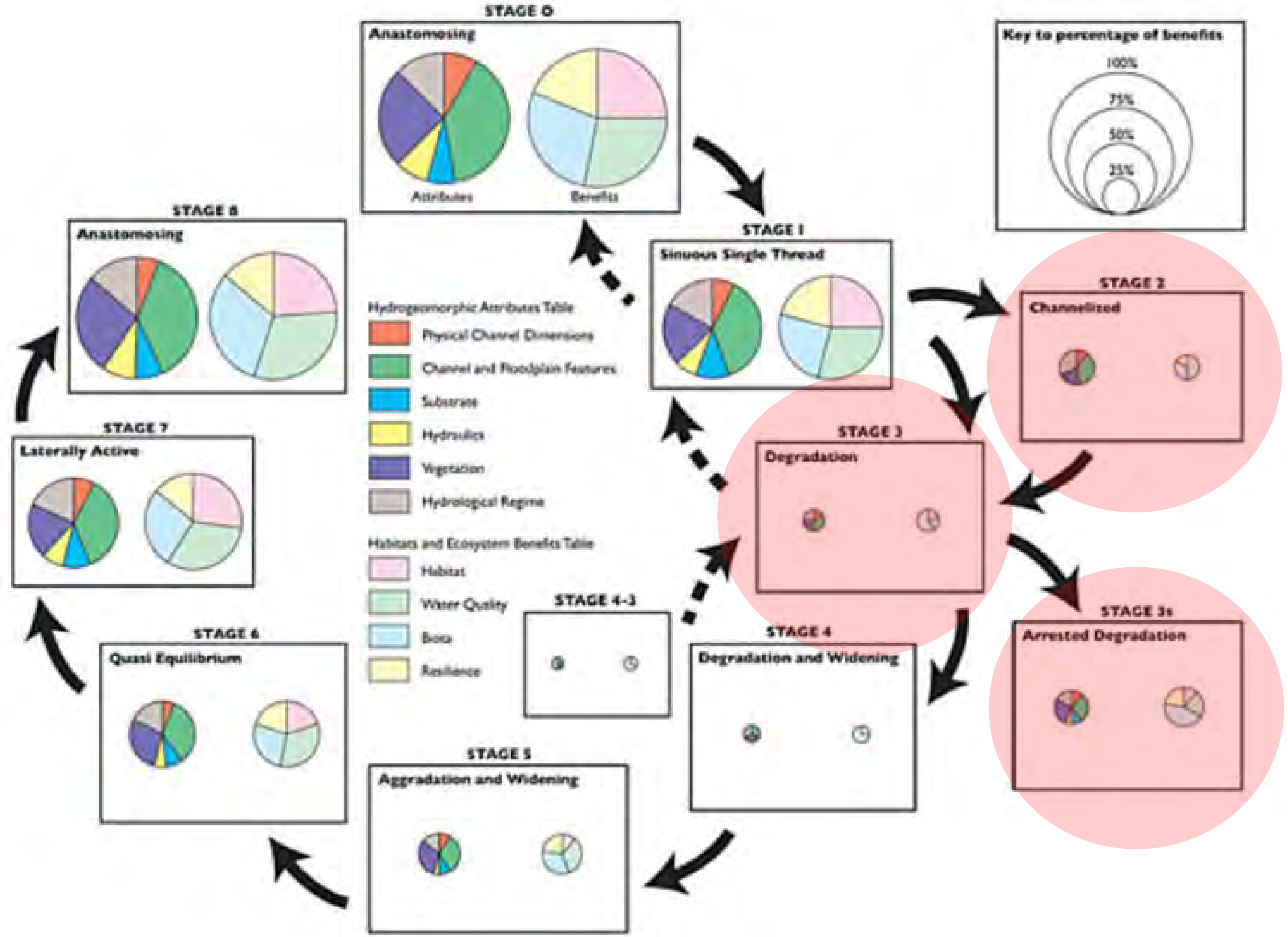
Doty Ravine

- Fast Facts
  - Owned by Placer Land Trust since 2005
  - 427 acres total
    - 55 acres of flood
  - 1 mile of Doty R
    - Steelhead Critic



Watershed Long Pro




STAGE 0
Anastomosing
Attributes
Benefits
Key to percentage of benefits
100%
75%
50%
25%
STAGE 1
Sinuous Single Thread
STAGE 2
Channelized
STAGE 3
Degradation
STAGE 3s
Arrested Degradation
STAGE 4
Degradation and Widening
STAGE 4-3
STAGE 5
Aggradation and Widening
STAGE 6
Quasi Equilibrium
STAGE 7
Laterally Active
STAGE 8
Anastomosing
Hydrogeomorphic Attributes Table
Physical Channel Dimensions
Channel and Floodplain Features
Substrate
Hydraulics
Vegetation
Hydrological Regime
Habitats and Ecosystem Benefits Table
Habitat
Water Quality
Biota
Resilience

0 0.13 0.25 0.5 Miles

Project Goals

Foundational Goal – Restore fluvial processes that create and maintain dynamic, complex, high quality habitat

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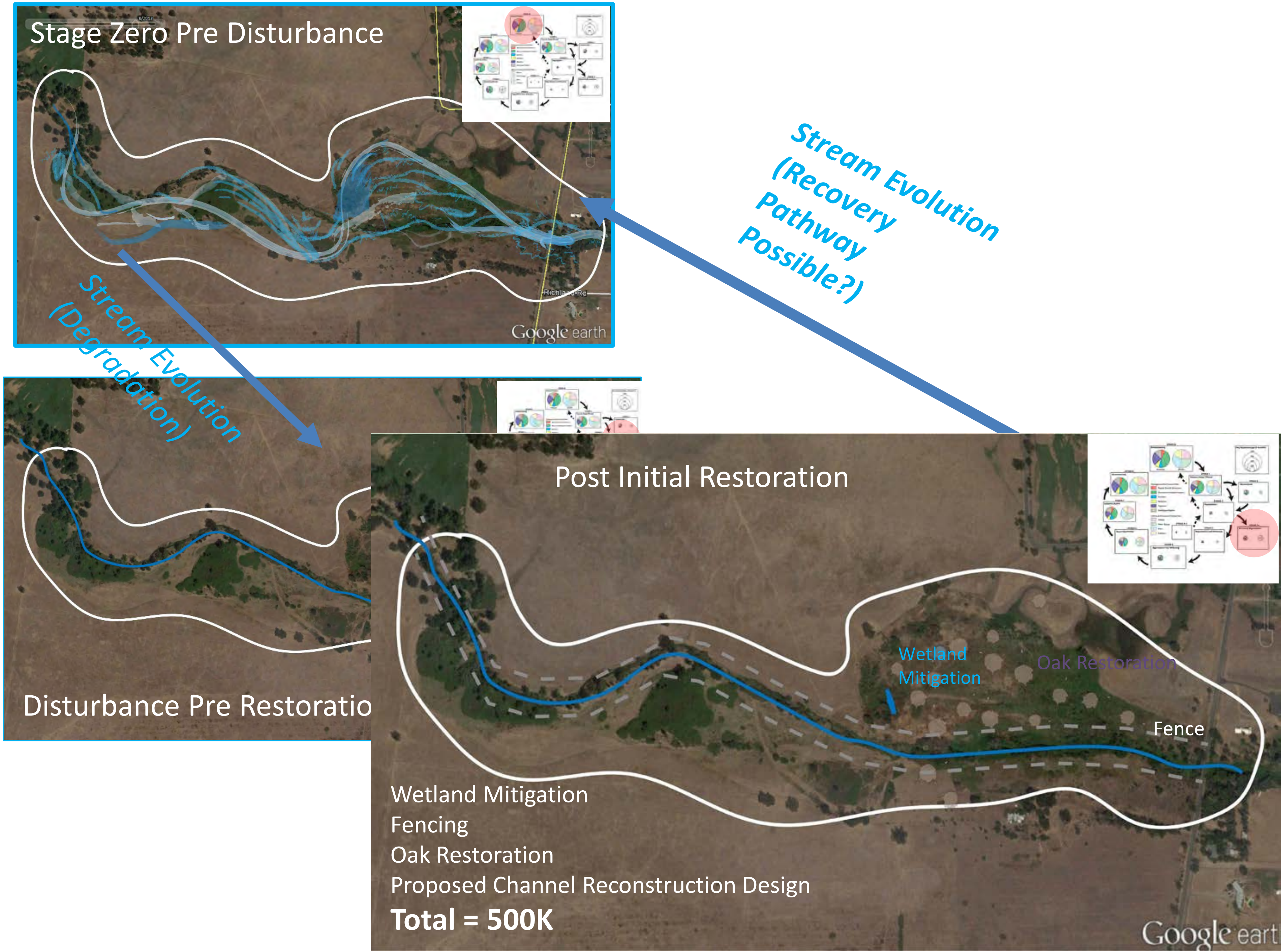
- *Improve and increase riparian habitat*
- *Increase stream length and complexity of channelized and leveed Doty Ravine*
- *Increase groundwater recharge*
- *Control invasive plant species*
- *Integrate active livestock operation within restoration plan*

Restoration Actions

- Wetland Mitigation
- Riparian Planting / Oak Planting
- Riparian Fencing and Off Stream Water Structures


Stage Zero Pre Disturbance
Google earth
Stream Evolution (Recovery Pathway Possible?)
Stream Evolution (Degradation)
Disturbance Pre Restoratio
Post Initial Restoration
Wetland Mitigation
Oak Restoration
Fence
Wetland Mitigation
Fencing
Oak Restoration
Proposed Channel Reconstruction Design
Total = 500K

Aerial Time Series 2003 - 2013

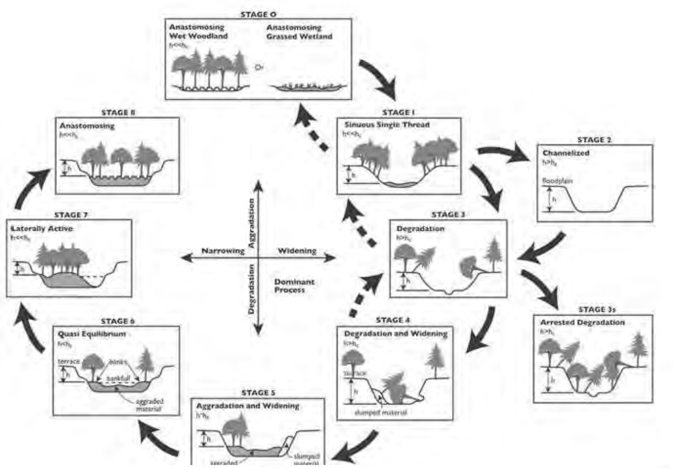
Were our goals realized?

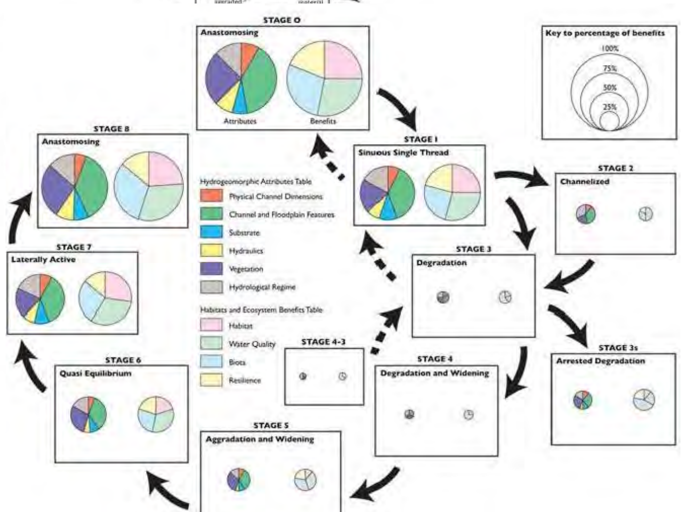
- Improve and increase instream habitat for native aquatic fauna
- Improve and increase riparian habitat
- Increase stream length and complexity of channelized and leveed Doty Ravine

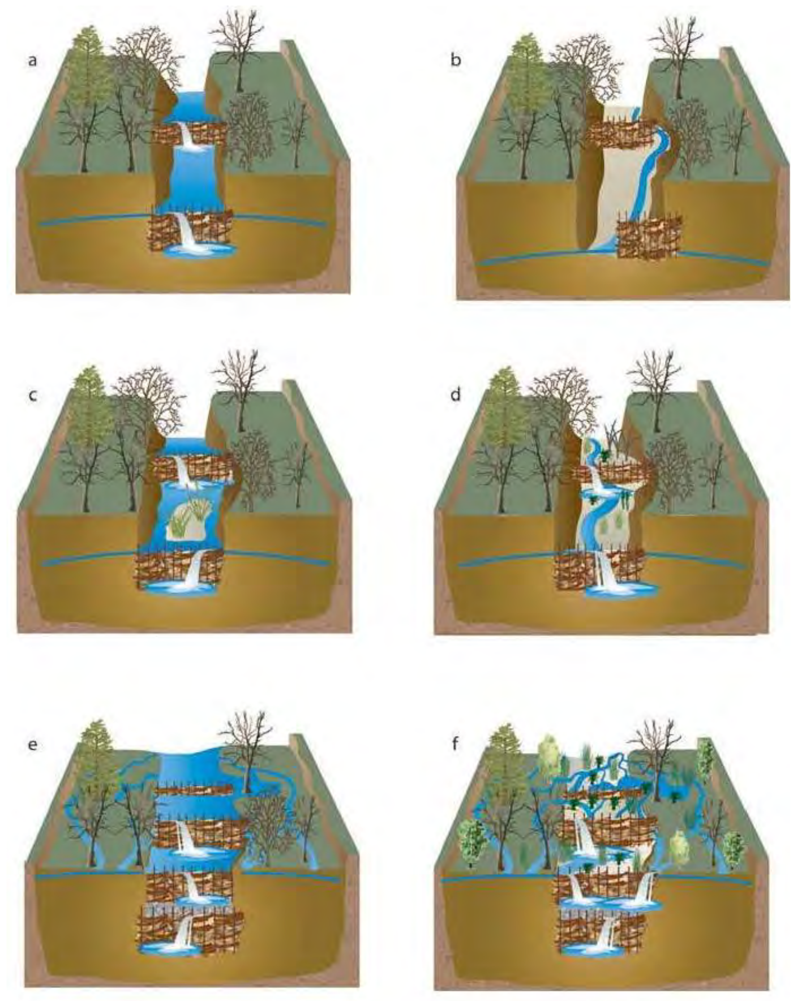
- Integrate active livestock operation within restoration plan
- Increase groundwater recharge
- Control invasive plant species

And then 2014 happened

- Cluer and Thorne - A Stream Evolution Model Integrating Habitat and Ecosystem Benefits
- Pollack et al. - Using Beaver Dams to Restore Incised Stream Ecosystems







Plus what we were already thinking about

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

Problem with Ecological Restoration standards

- somewhat subjective
- many designers funders and regulators don't understand ecological science or how to apply ecological science to on the ground management and design of fluvial systems

Current standard is to apply engineering/construction criteria such as deformability and stabilization, threshold channel design, "Natural" Channel design

Limited guidance for integrating ecological science with design.

We propose at least 2 Criteria that provide a vehicle for transferring 20 years of ecological science into restoration practice:

Maximum Space and Zero Energy **Design Criteria**

encourage practitioners to:

1. *Open space for fluvial process*
2. *Use stream energy to do geomorphic work*

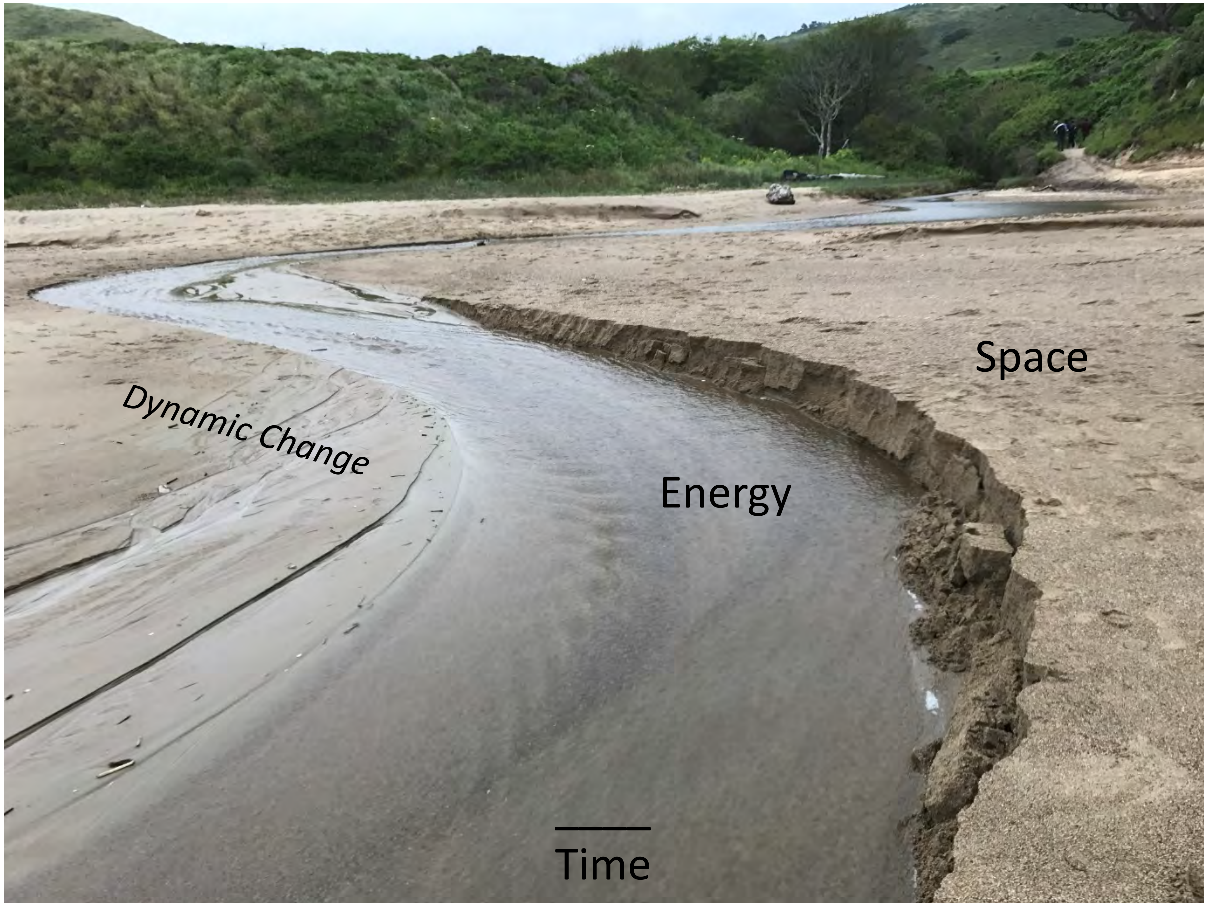
Ecologically based design criteria for low gradient alluvial stream and river systems

MAX SPACE Performance based criteria (What is the project to achieve?):

1. Maximize space for fluvial energy (Does the action increase or decrease space for habitat forming energy to operate?)
2. Reconnect fluvial energy with open space (Channel migration space and source sediment and energy connections)

ZERO ENERGY (MAX STREAM ENERGY) **Prescriptive Based Criteria (How will the project be undertaken?):**

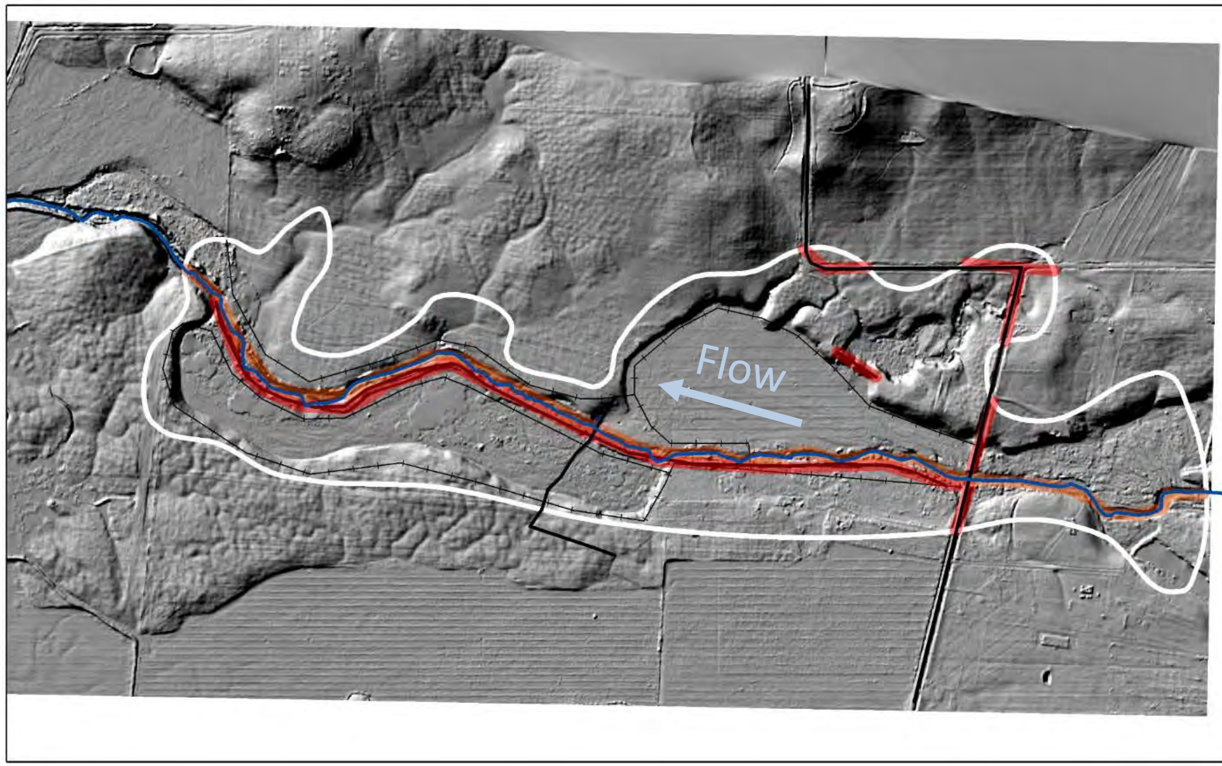
1. Maximize use of stream energy to do geomorphic work
2. Minimize diesel energy inputs unless modifying infrastructure
3. Use geomorphically appropriate material to create hydraulic resistance



#1 Criteria SPACE

Design process that leads to actions that increase space for habitat forming energy to operate.

- Delineate an area Stream Evolution Corridor (SEC)
- Management unit where you try to restore fluvial energy and sediment conveyance that will
- Creates and maintains habitat over the long term



SEC is already in the literature…. Kind of

Design focused on removing infrastructure and management constraints to dynamic system is in the literature
Erodible Corridor Concept, Process Zone, “Channel Migration Zone” River Styles, Restore Eco-geomorphic Process (Pollock et al 2014)

Vs

“Natural” Channel Design focused on stabilizing system around arbitrary boundaries or old infrastructure is most commonly used
Rosgen or common stream or river engineering practices

IMPORTANT to do it up front and have stakeholder agreement on it

Criteria 1: Maximum Space

Ecological design is removing system constraints so fluvial energy can expand, create, and maintain habitat

1. What is the natural extent of fluvial dynamic space?
2. What is the current extent of dynamic fluvial space?
3. What are the anthropogenic impacts to fluvial dynamics?
4. What modifications can be made to infrastructure and management to expand fluvial space now or in the future?

Answering these questions gets at source problems and ecosystem scale restoration instead of addressing site specific symptoms

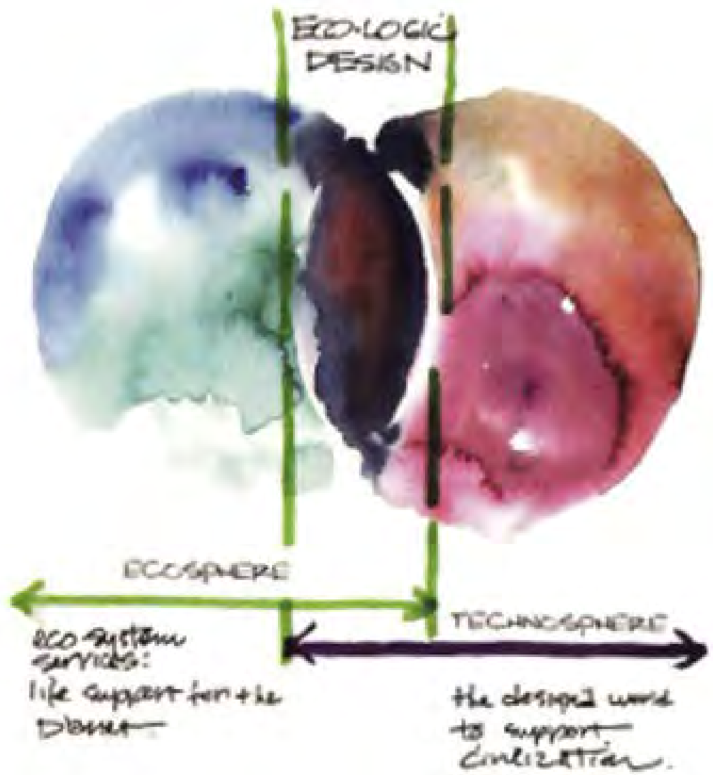
Fundamental questions for stream design but rarely analyzed and presented to stakeholders

Criteria 2: ZERO ENERGY

Prescriptive Based

Tells practitioner HOW they have to implement project and ensures ecological approach

1. "Net Zero Energy" Maximize use of stream energy for meeting form objective (aim for C neutral) unless you are modifying infrastructure
2. Use geomorphically appropriate material (Pollock et al 2003, 2007, 2012; Manga and Kirchner 2000)



This criteria is well established in Green Architecture

Ecological Design is strongly rooted in Architecture

Ecological design – *"any form of design that minimizes environmentally destructive impacts by integrating itself with living processes"*

Sim Van der Ryn
Architect/Ecologist

ZERO ENERGY Criteria Borrowing from Eco Architectural Design

Eco Architecture

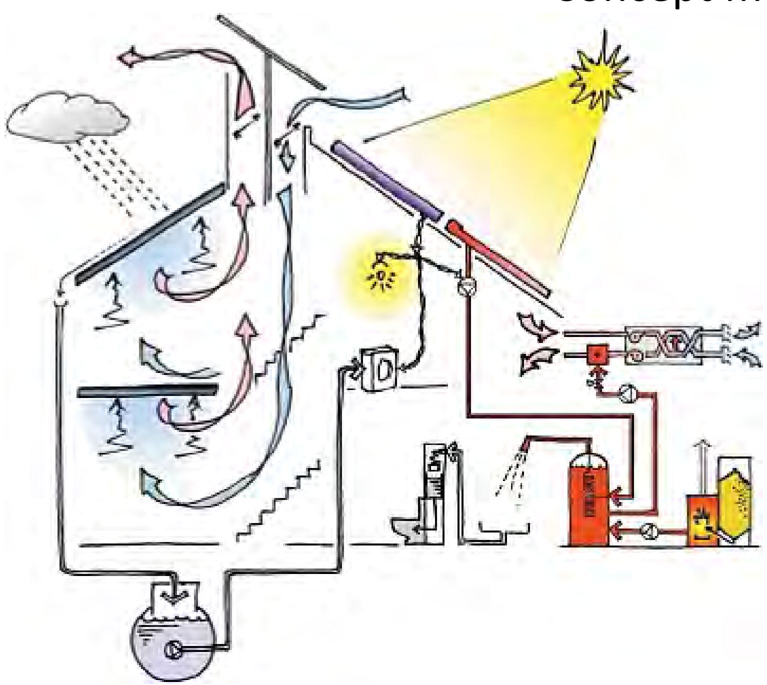
1. Focus on energy available (solar and wind) to meet heating, cooling and space objectives over time
2. Design optimizes passive strategies
3. Situate house to maximize energy need

Eco stream design

1. Focus on Stream energy hillslope/channel gradients, discharge and sediment supply to meet form and habitat objectives over time
2. Design should optimize passive strategies
3. Modify infrastructure to maximize stream energy need

Concept models on Energy Flow

Home vs SEC



Do we want anthropogenic habitat or naturally formed habitat?

If we construct in this space we take away space for Natural process formation and again we lower the return on our investment and risk further degrading to natural processes.

“Rosgen” channel vs Stage Zero channel

Hint – Embrace the Chaos


Lat, Lon: 41.195302, -121.719335
Alt: 3990ft MSL WGS84
CEP: 10ft
71° N71E
-1.0°
-10.2°

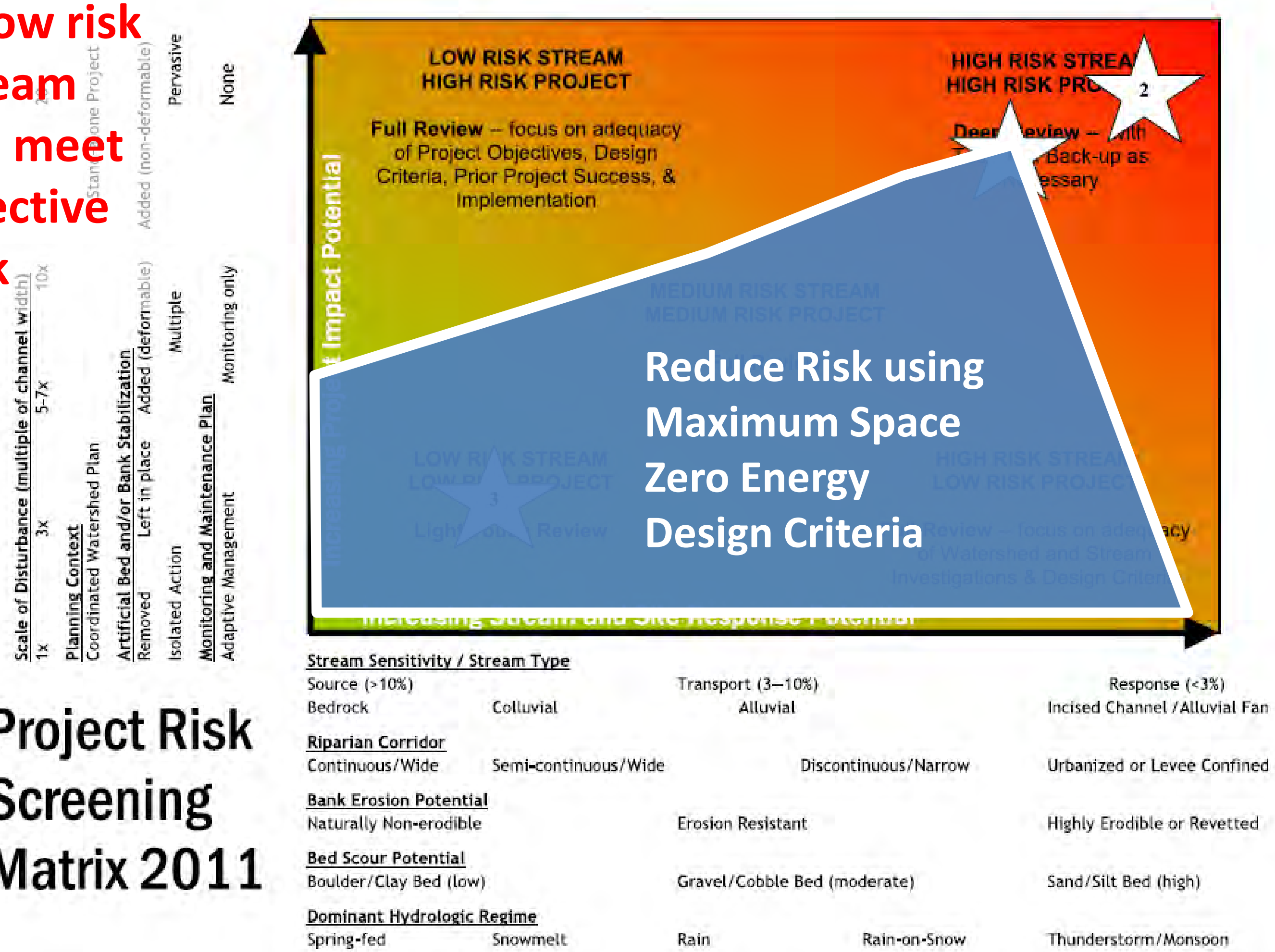
Criteria #2 Maximize Stream Energy Minimize Fossil Fuel Input

When working in the stream channel this prescriptive criteria places bounds on how the practitioner can work and requires them to:

Exhaust all stream energy before using diesel energy

- Doesn't apply to infrastructure modification
- Reduces habitat disturbance
- Requires practitioner to build habitat using prevailing sediment and energy
- Very low risk of constructing forms that are overwhelmed or non compatible with system dynamic or scale

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



Project Risk Screening Matrix 2011

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

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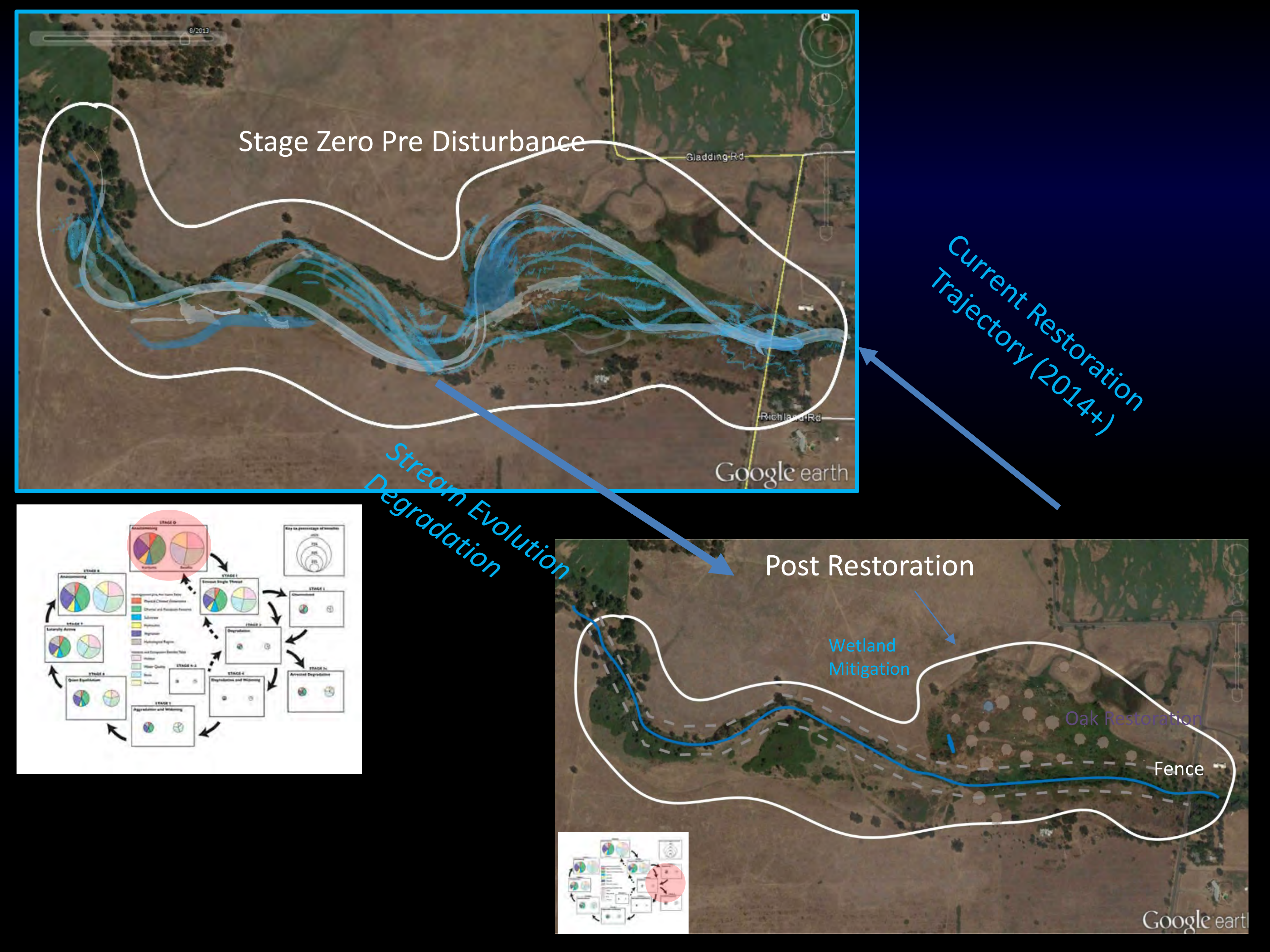
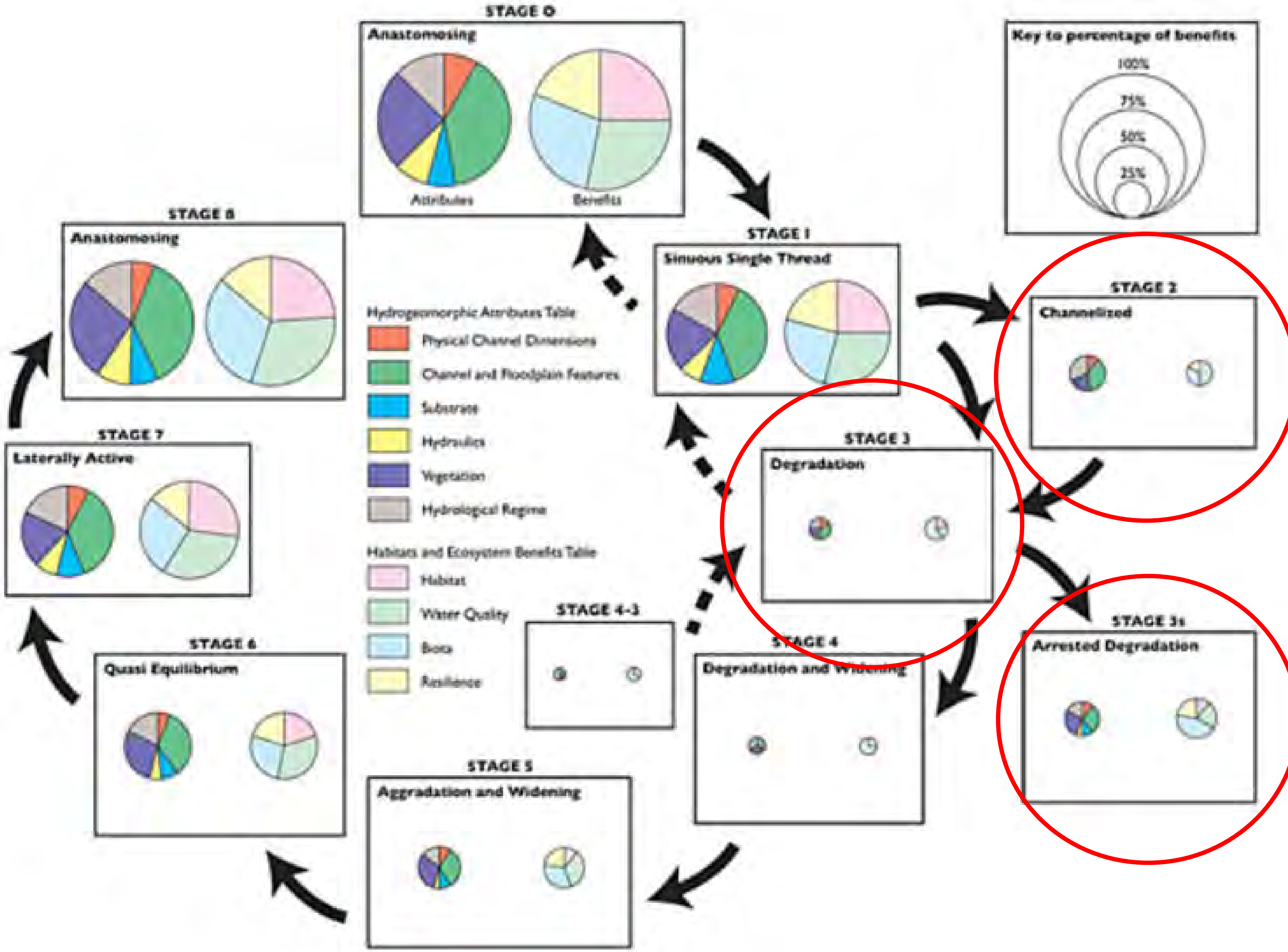


8/2013
Stage Zero Pre Disturbance
Gladding Rd
Richland Rd
Google earth
Current Restoration Trajectory (2014+)
Stream Evolution Degradation
Post Restoration
Wetland Mitigation
Oak Restoration
Fence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Restoration Actions

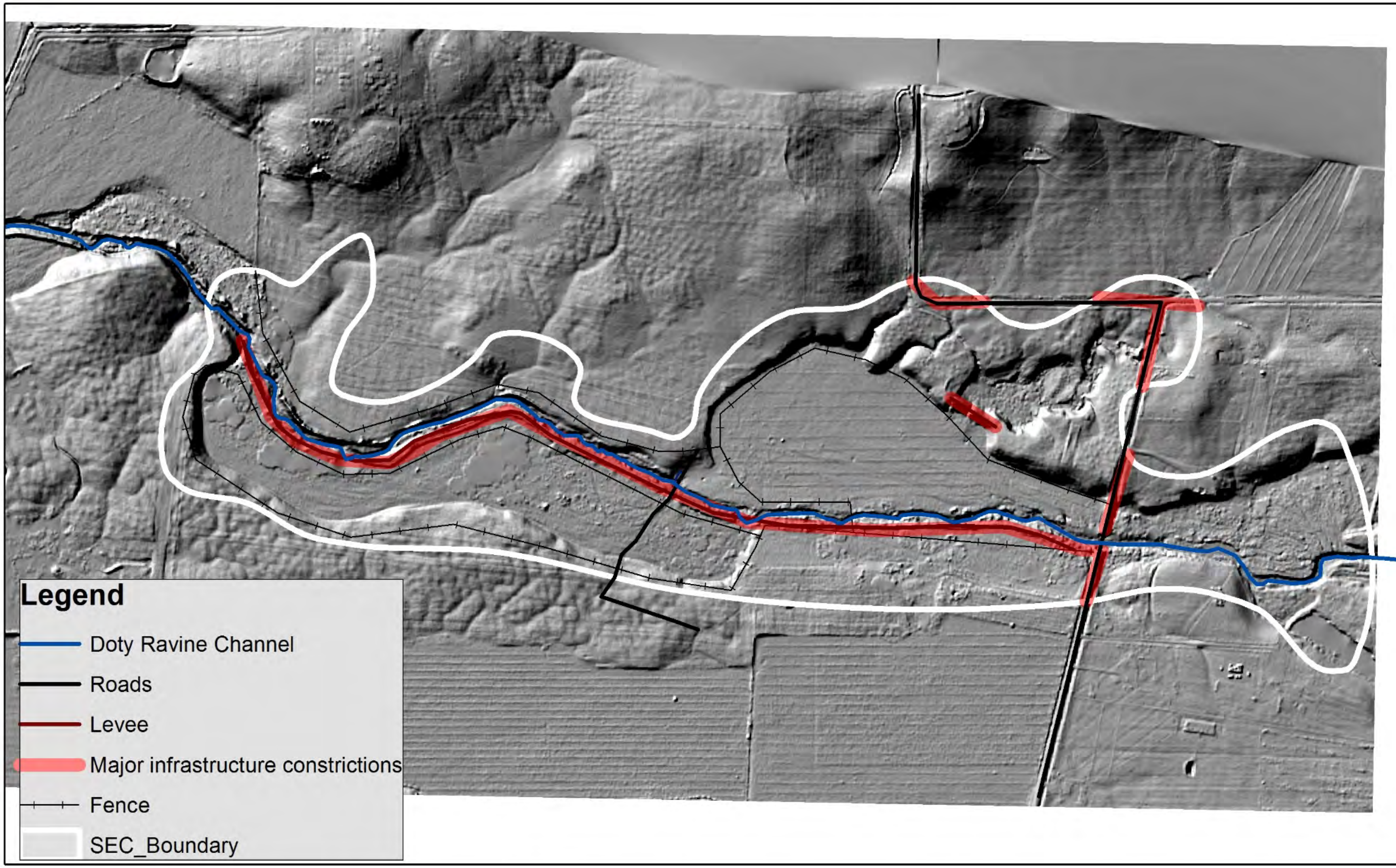
- ~~Wetland Mitigation~~
- ~~Riparian Planting / Oak Planting~~
- ~~Riparian Fencing and Off stream Water Structures~~
- Beaver Peace Treaty
- Levee Removal
- Beaver Dam Support and Beaver Dam Analogues
- Constriction Dam – Tree Blaster – Complex Small Wood Jams

U. S. Fish & Wildlife Service

_____Office Name ____

________ County, California

Doty Ravine Stream Evolution Corridor (SEC) Constrictions



Produced by: Partners for Fish & Wildlife Program
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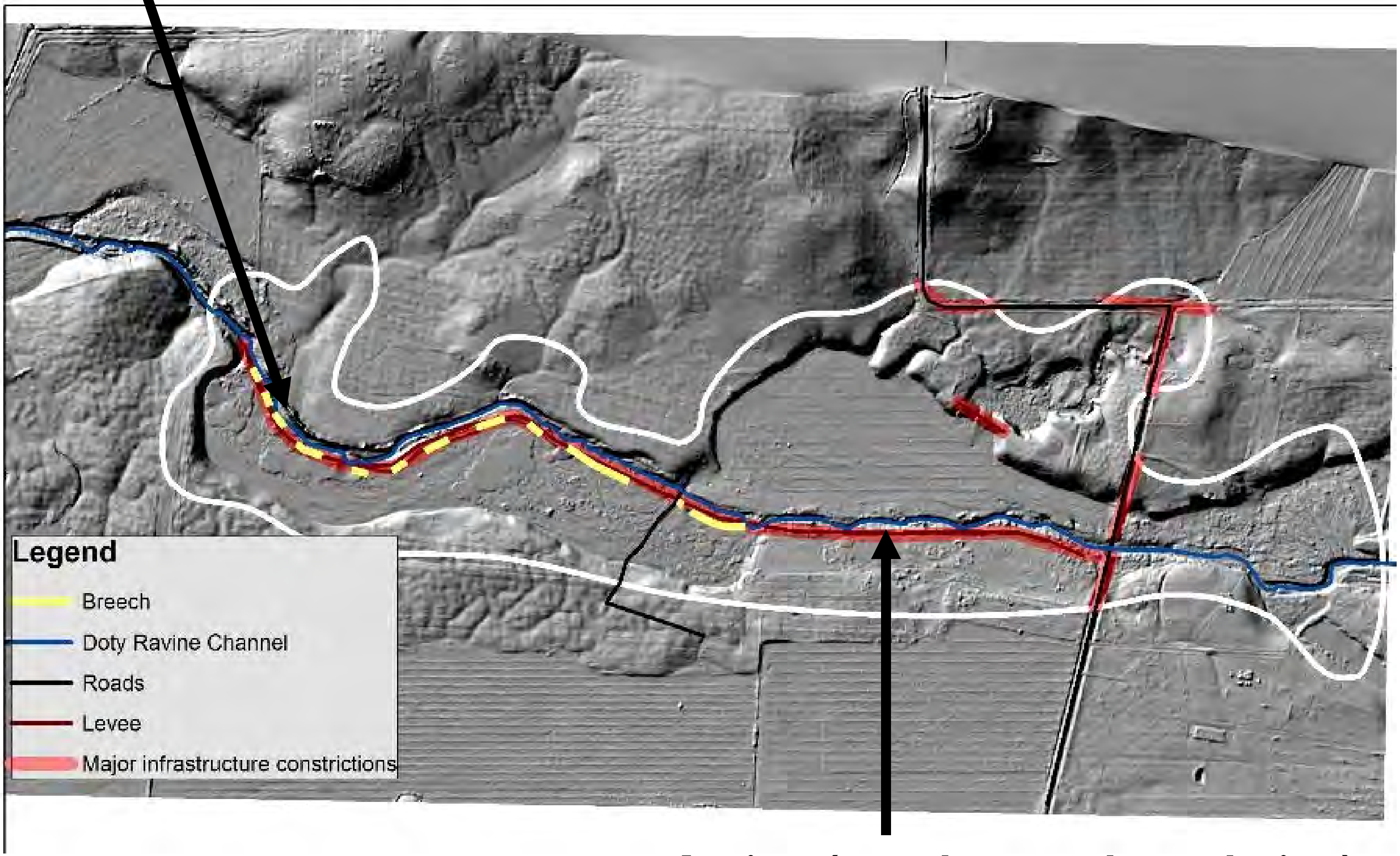
Created by: dciotti
Date: 2/28/2018
Data Sources:

Action (levee Breach)
Opens SEC space



Action (stop beaver depredation)
Reconnects SEC space with stream energy

Levee breaching will be about 40K
Redo fencing 20K
BDAs 5K

Beaver Dam Support

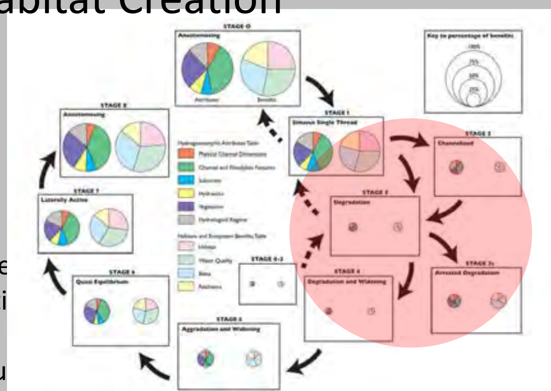
Beaver Dam Analogue

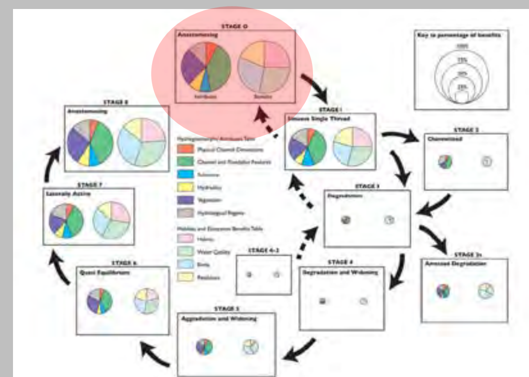
Constriction Dam

Accelerate Process –widening and tree recruitment using stream energy

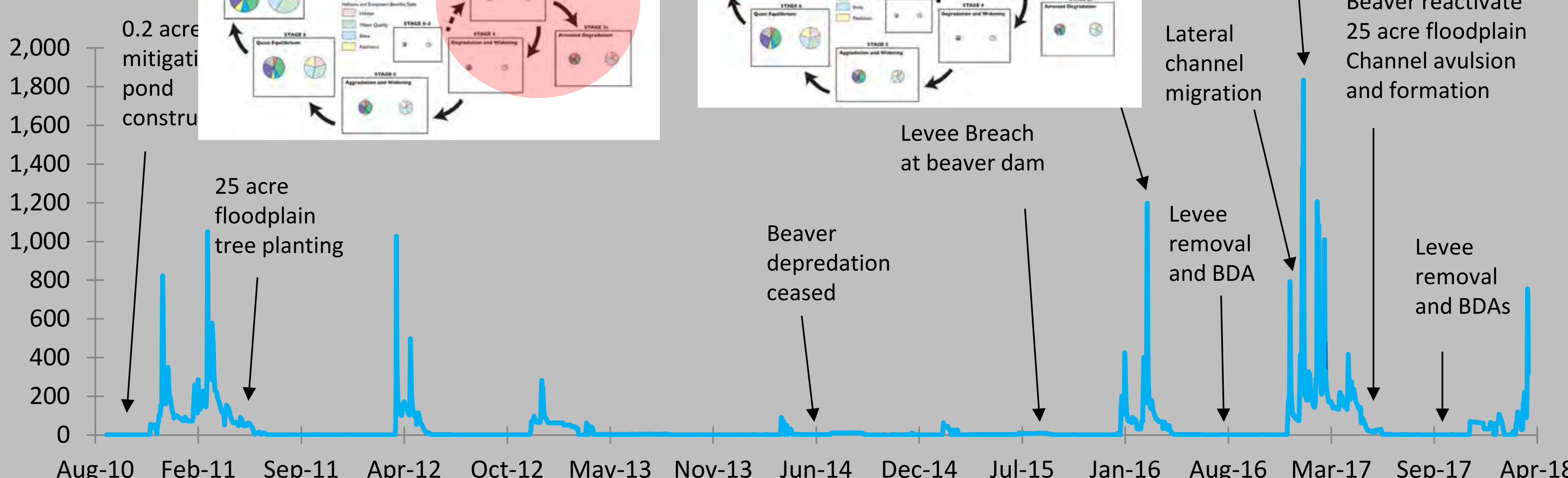
Gauging system recovery to stage zero

Habitat Creation





Habitat Restoration



Aerial Time Series 2014 – 2018

Before / After

Before / After

Stage Zero Area

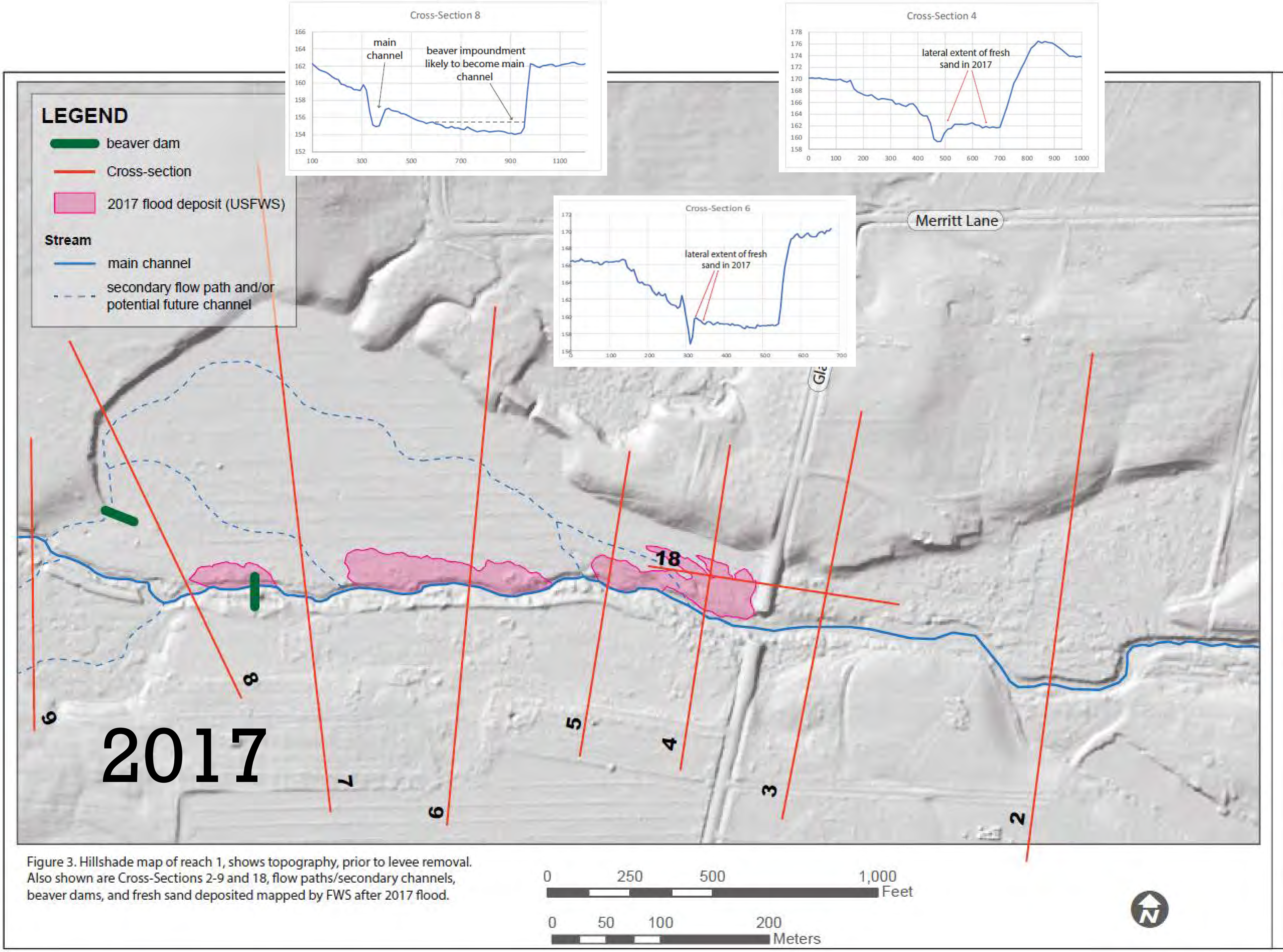
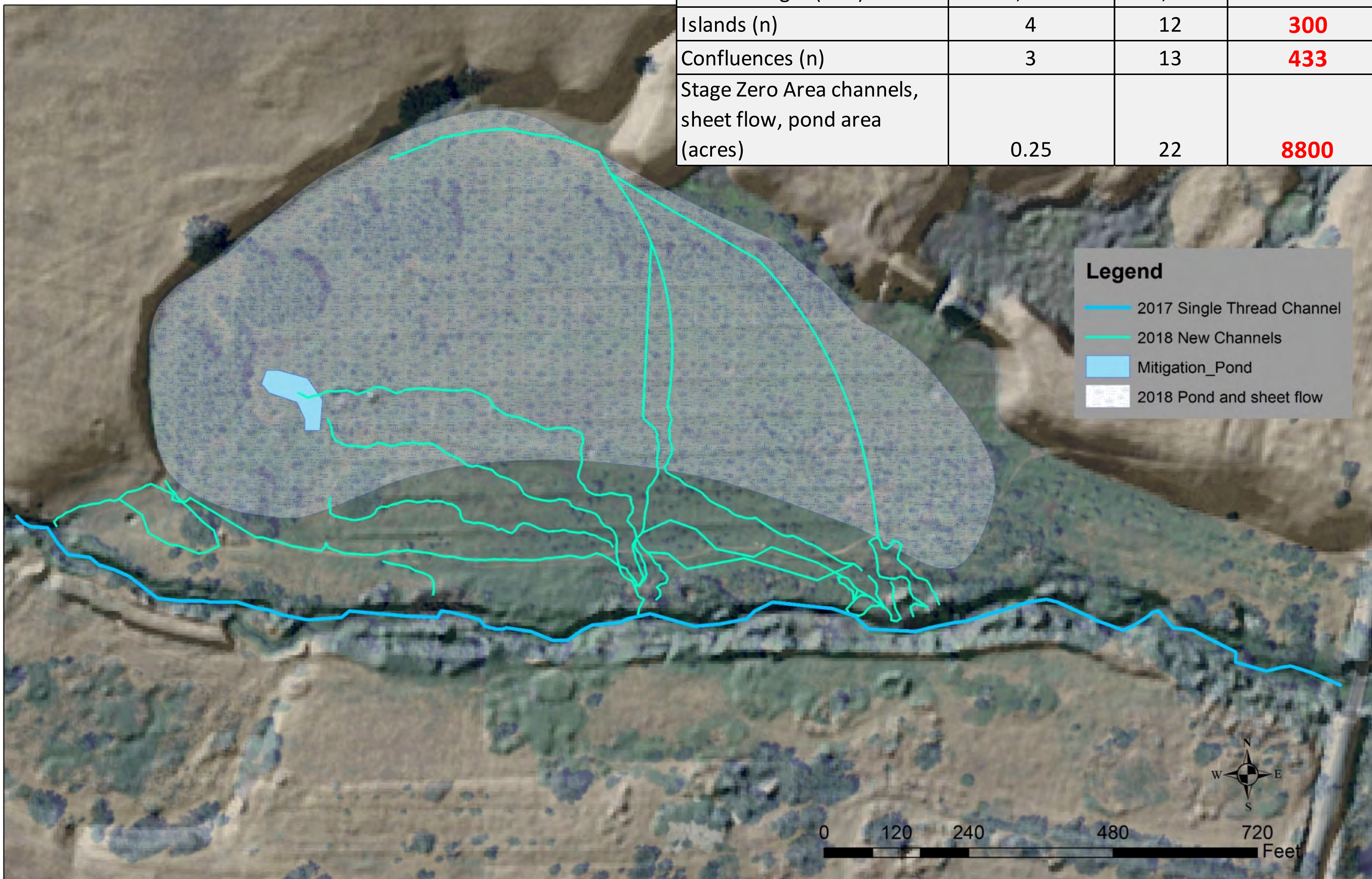
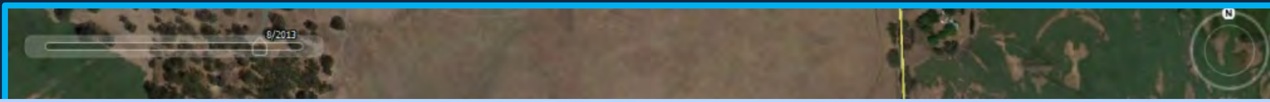


Figure 3. Hillshade map of reach 1, shows topography, prior to levee removal. Also shown are Cross-Sections 2-9 and 18, flow paths/secondary channels, beaver dams, and fresh sand deposited mapped by FWS after 2017 flood.

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**




8/2013


Google

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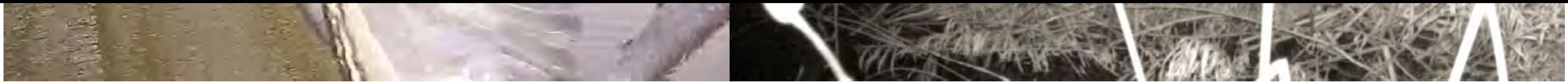
Habitat Use




QUESTIONS