# Process-based Design Criteria for Ecological Restoration

15th Annual UC Berkeley River Restoration Symposium

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# Design Criteria

*Space + Energy + Materials = Change/Time*

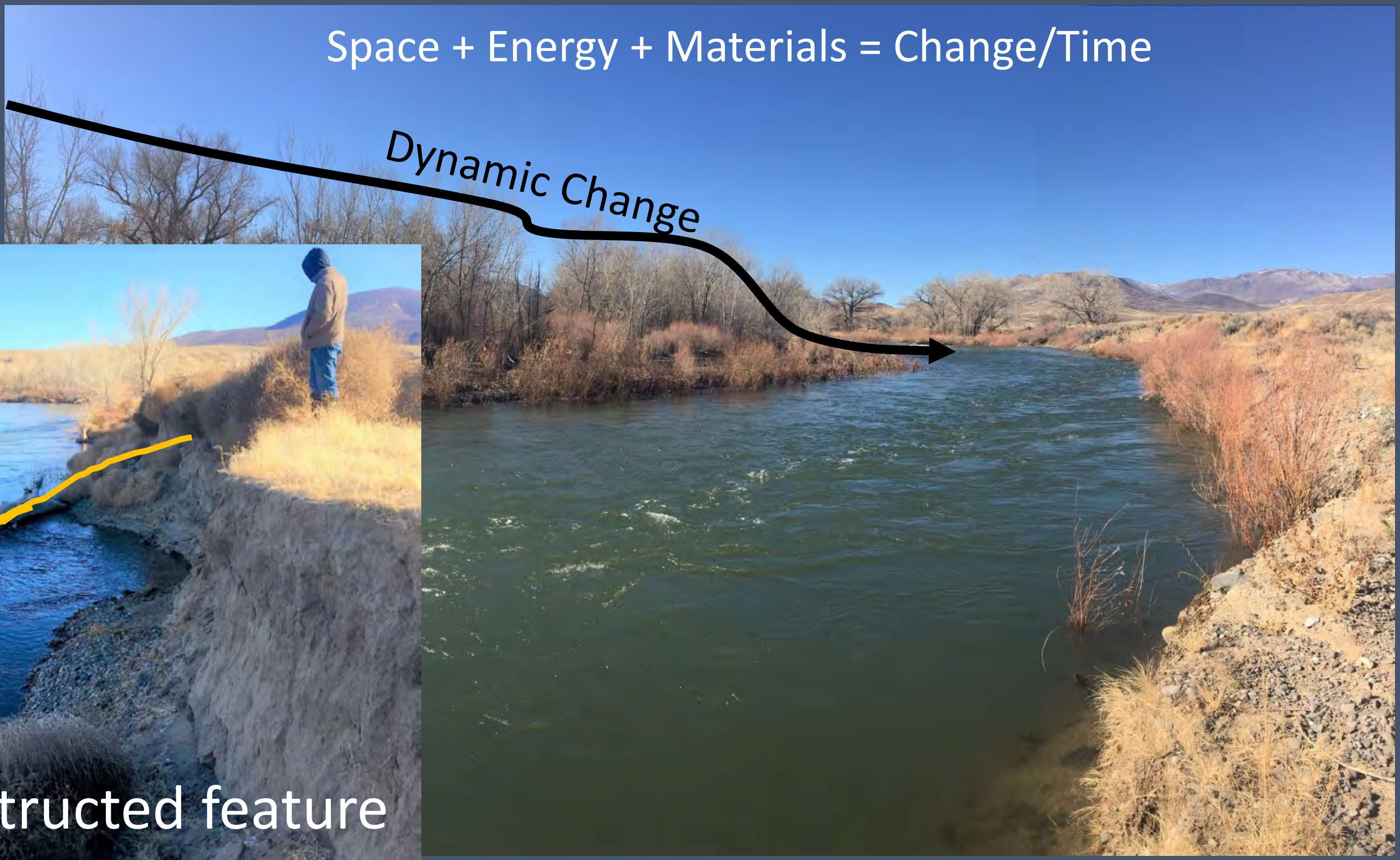
Result in a net gain in fluvial process **SPACE**

Capitalize on natural **ENERGY**

Use geomorphically appropriate **MATERIALS**

Meet habitat objectives over **TIME**

# Integrity of functional ecosystem




Form-based Construction
What will the project accomplish? Stabilize a bank and channel

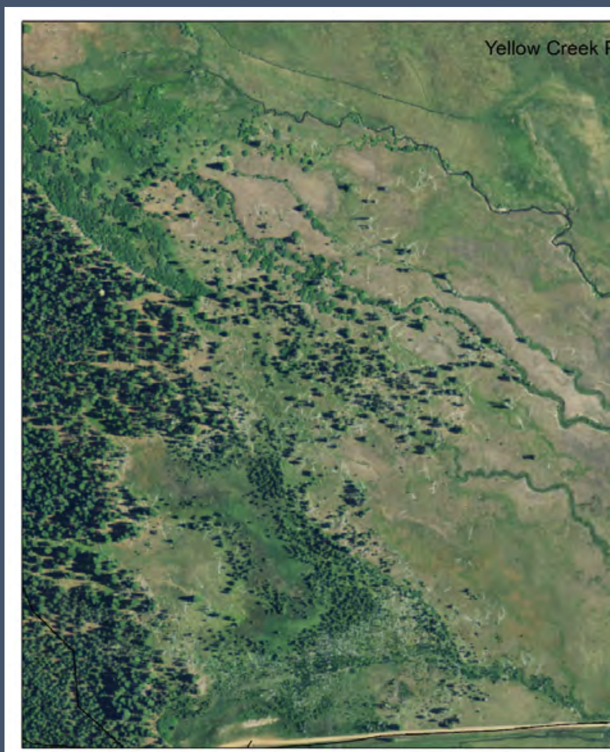
How will project be undertaken? Heavy equipment and rock

# Restoration Design

Infrastructure Protection/Modification

Habitat Construction

Process-based Restoration


Yellow Creek


Draft Tásmam Kojóm and Yellow Creek Restoration Analysis
October 25, 2017
Prepared for Maidu Summit Consortium
Prepared by Damion Ciotti and Jared McKee, U.S. Fish and Wildlife Service
Habitat Restoration Office

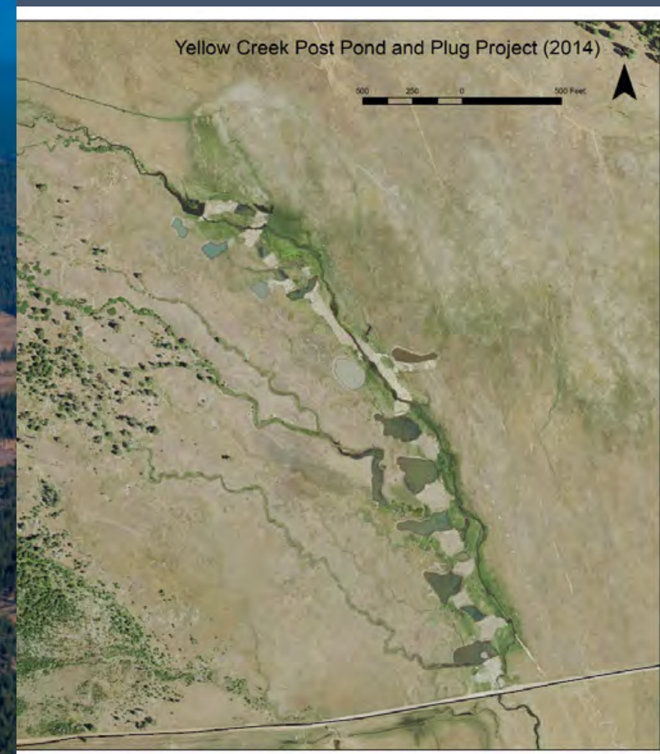

Yellow Creek Post Pond and Plug Project (2014)


Photo courtesy Brian Cluer

# Process-based Standards

Traditional Ecological Knowledge

- **Spiritual land ethic**
- **Working with disturbance regimes**
- **Bigger time and spatial scales**

Standards for Ecological Restoration

(Palmer et al, 2005):

- **Dynamic ecological endpoint**
- **Restoration does not inflict lasting harm**

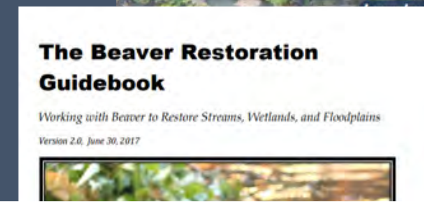
Principles for Process-based Restoration

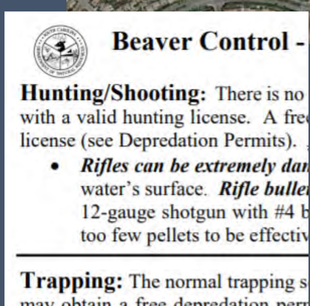
(Beechie et al, 2010):

- **Address root causes of degradation**
- **Scale commensurate with problem**

1. Address source problems

2. Work with system recovery

**Beaver Control -**

**Hunting/Shooting:** There is no
with a valid hunting license. A fre
license (see Depredation Permits).

- ***Rifles can be extremely da***
water's surface. ***Rifle bulle***
12-gauge shotgun with #4 b
too few pellets to be effecti

**Trapping:** The normal trapping s
may obtain a free depredation per

# Application of the Design Criteria

*Space + Energy + Materials = Change/Time*

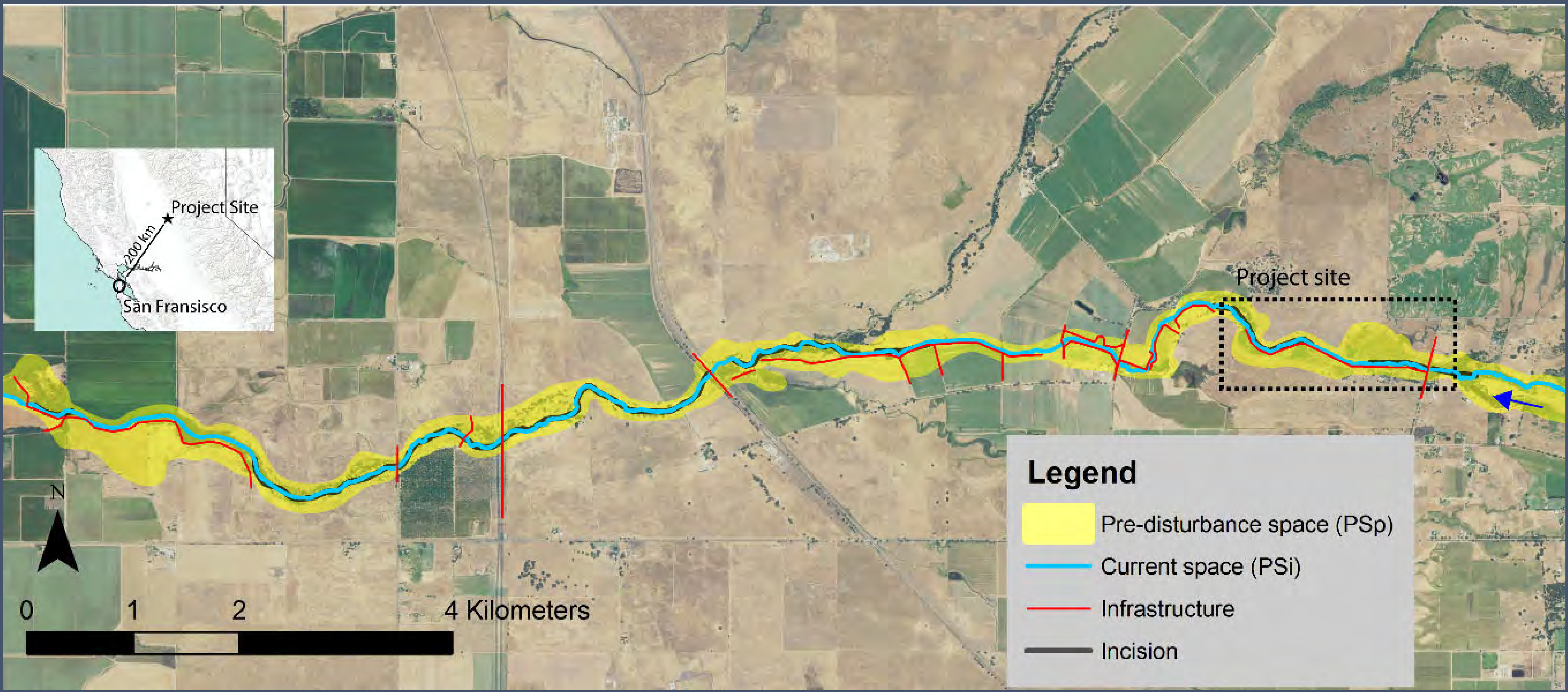
Result in a net gain in fluvial process **SPACE**

Capitalize on natural **ENERGY**

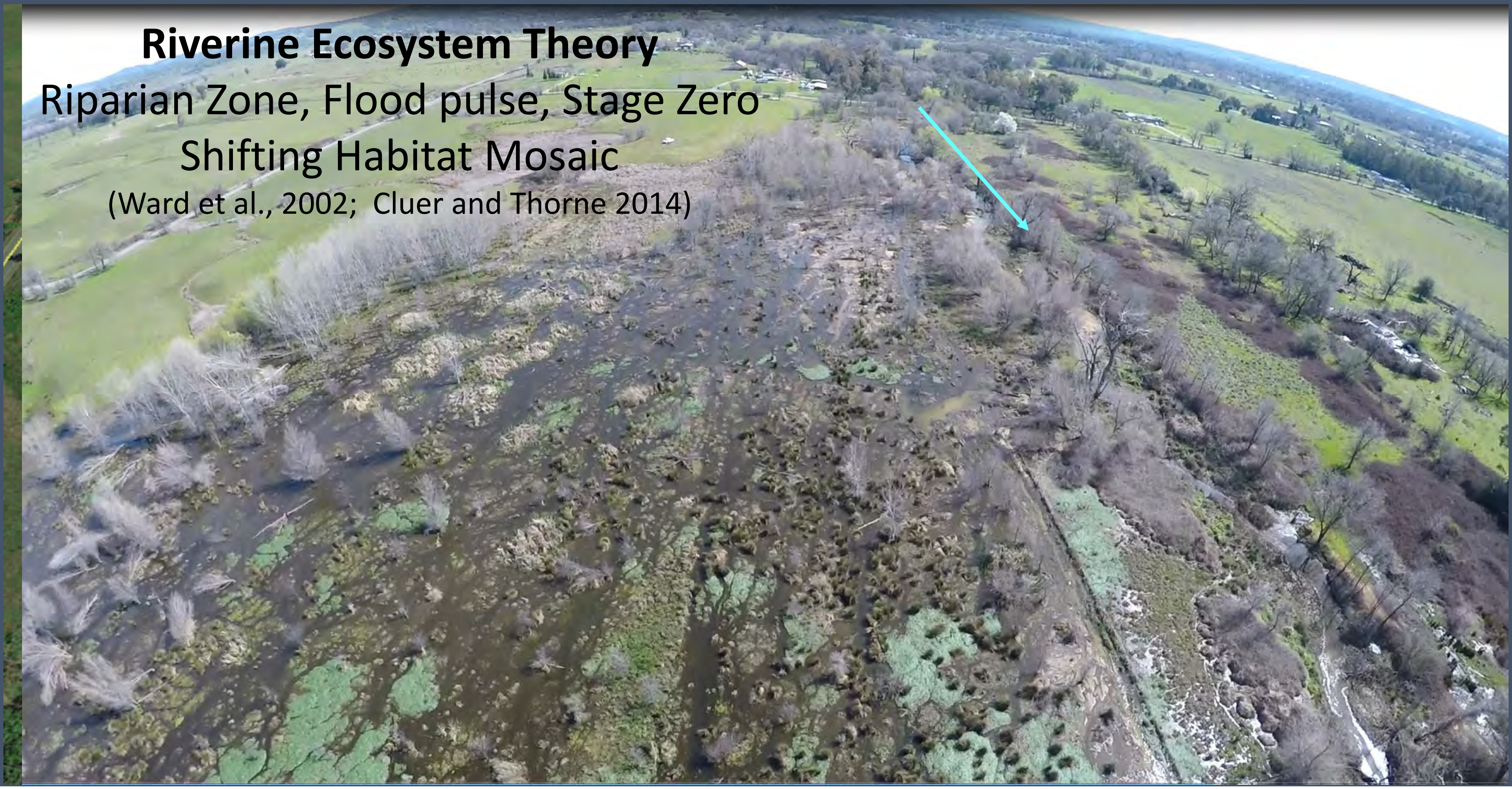
Use geomorphically appropriate **MATERIALS**

Meet habitat objectives over **TIME**

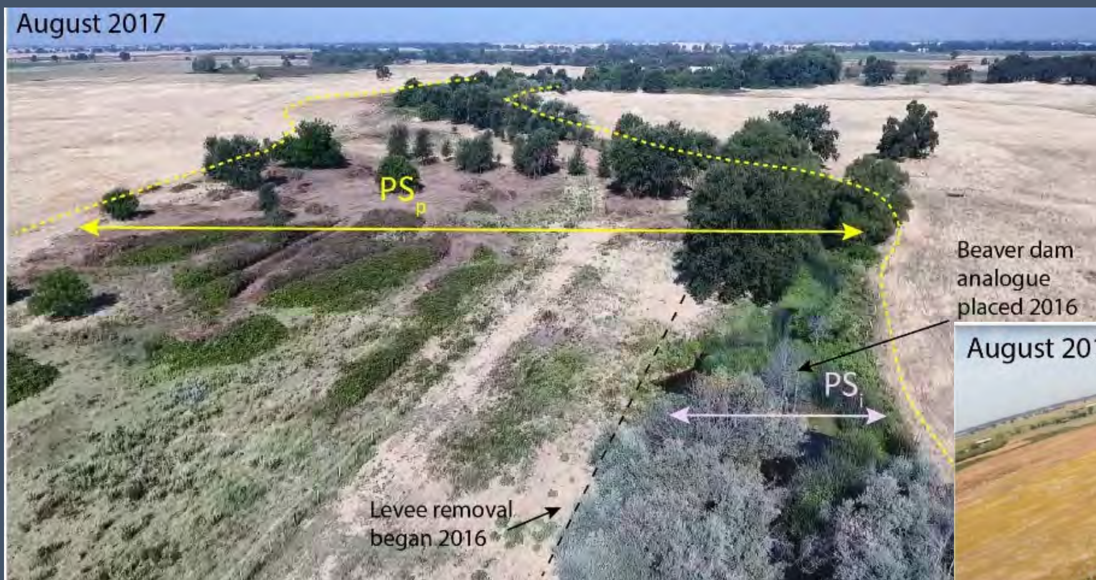
# Doty Ravine Stream Corridor



# Setting the Project Goal - Dynamic End Point



# Space: Project actions increase the spatial extent of fluvial processes and connectivity lost due to human alterations

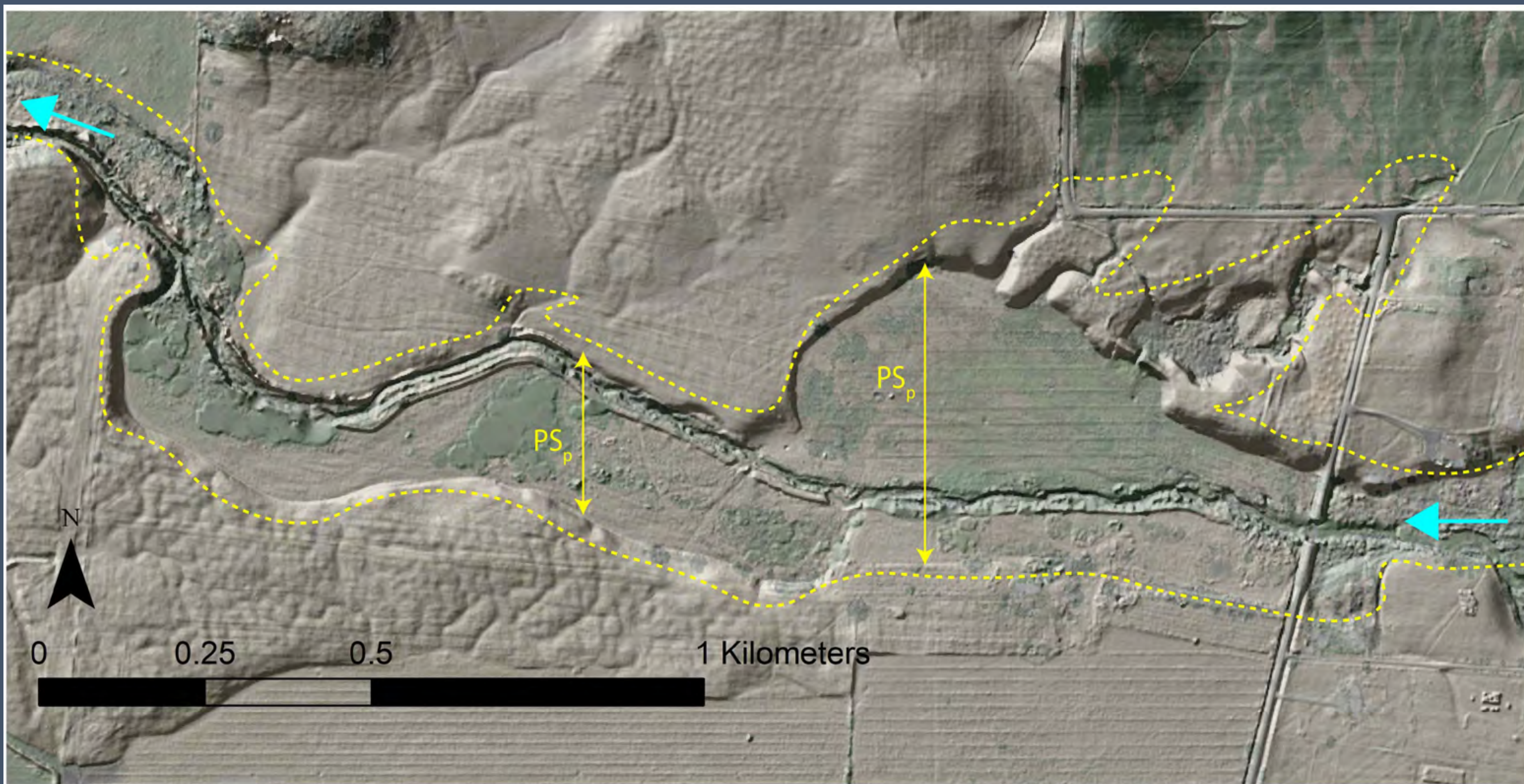



Applied Geomorphic Analysis: Connectivity, process space, source problems

(Kondolf and Piegay 2003; Fryirs and Brierley 2016)

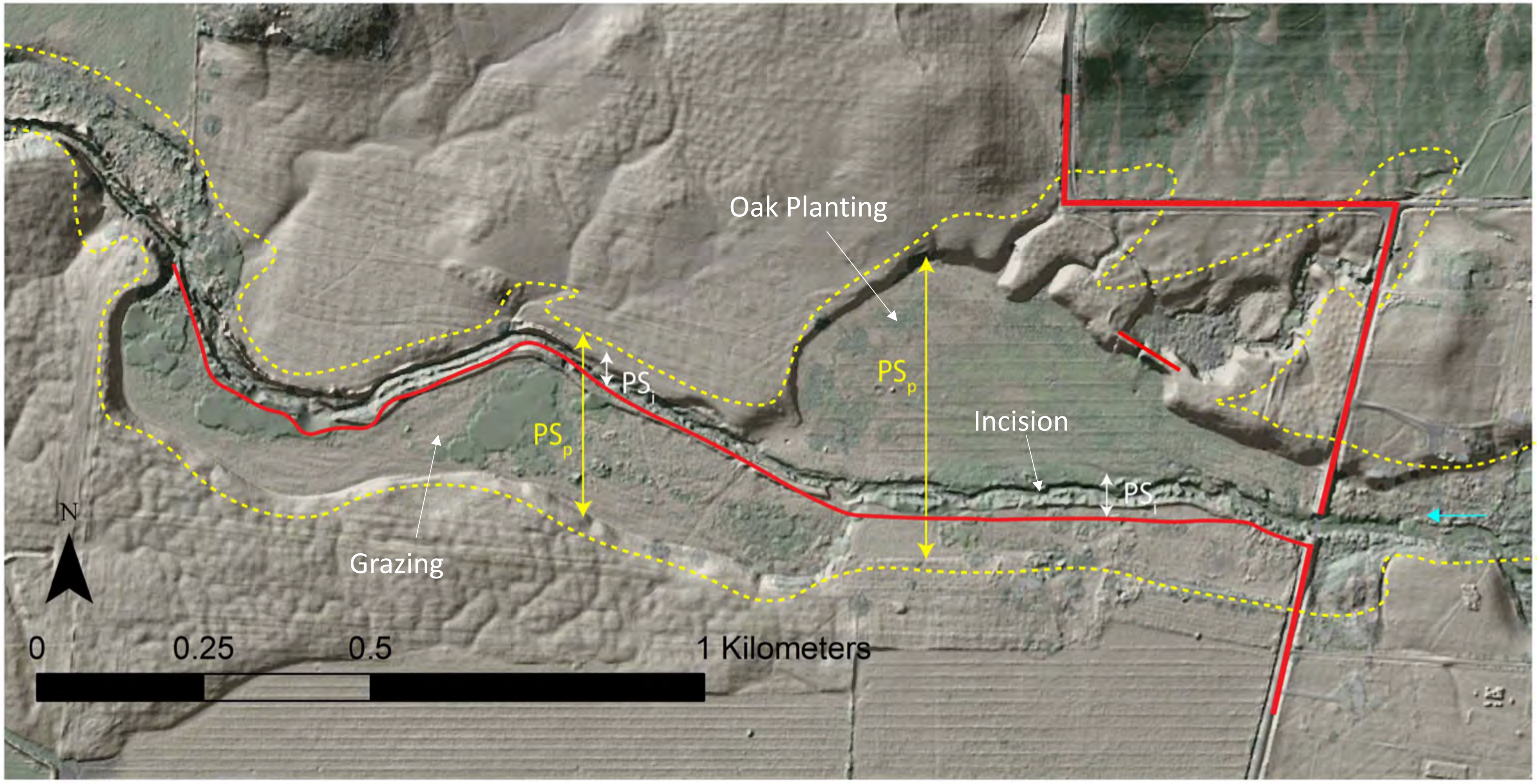
# Space

**Available process space 67 acres**



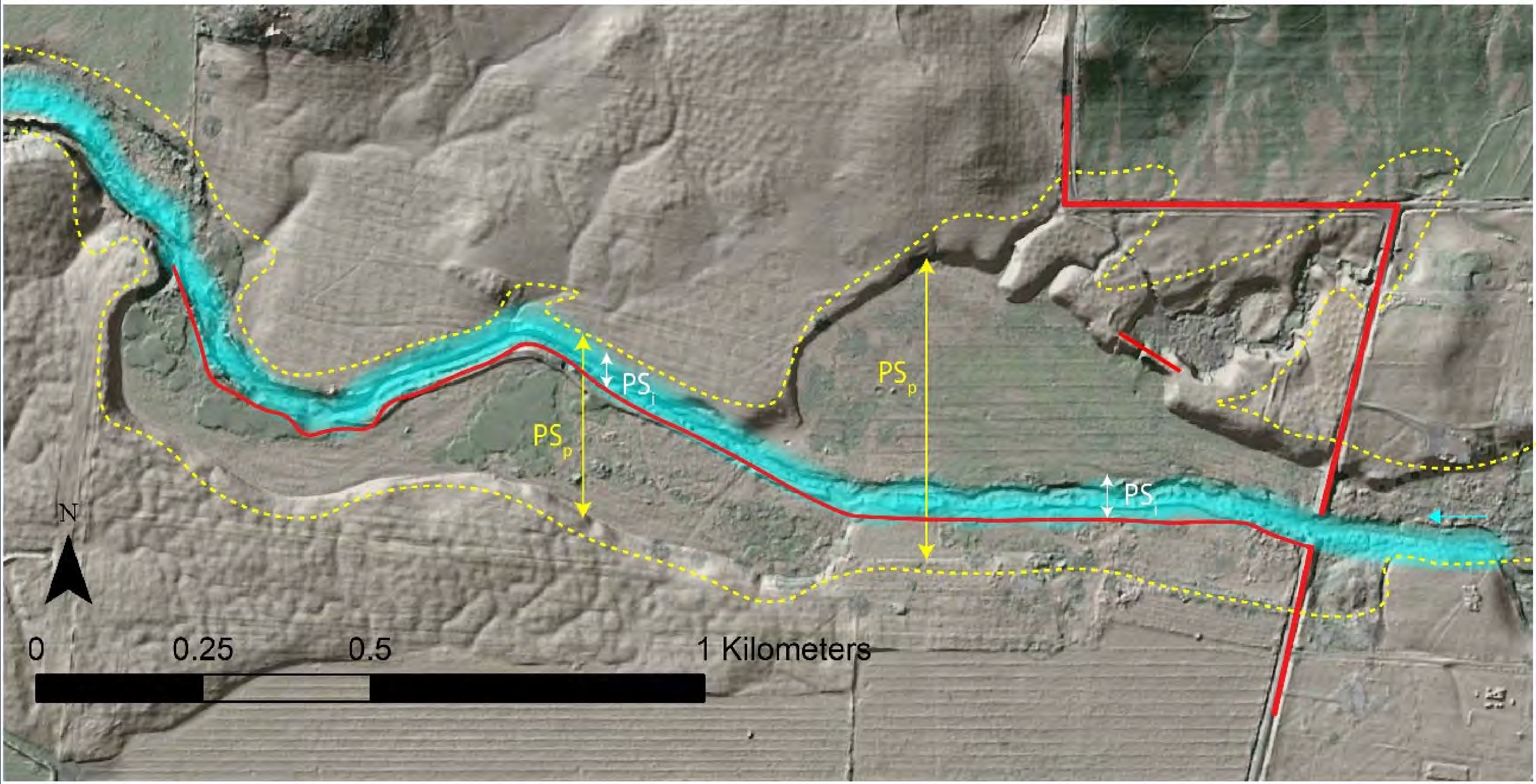
# Space

## Disconnections



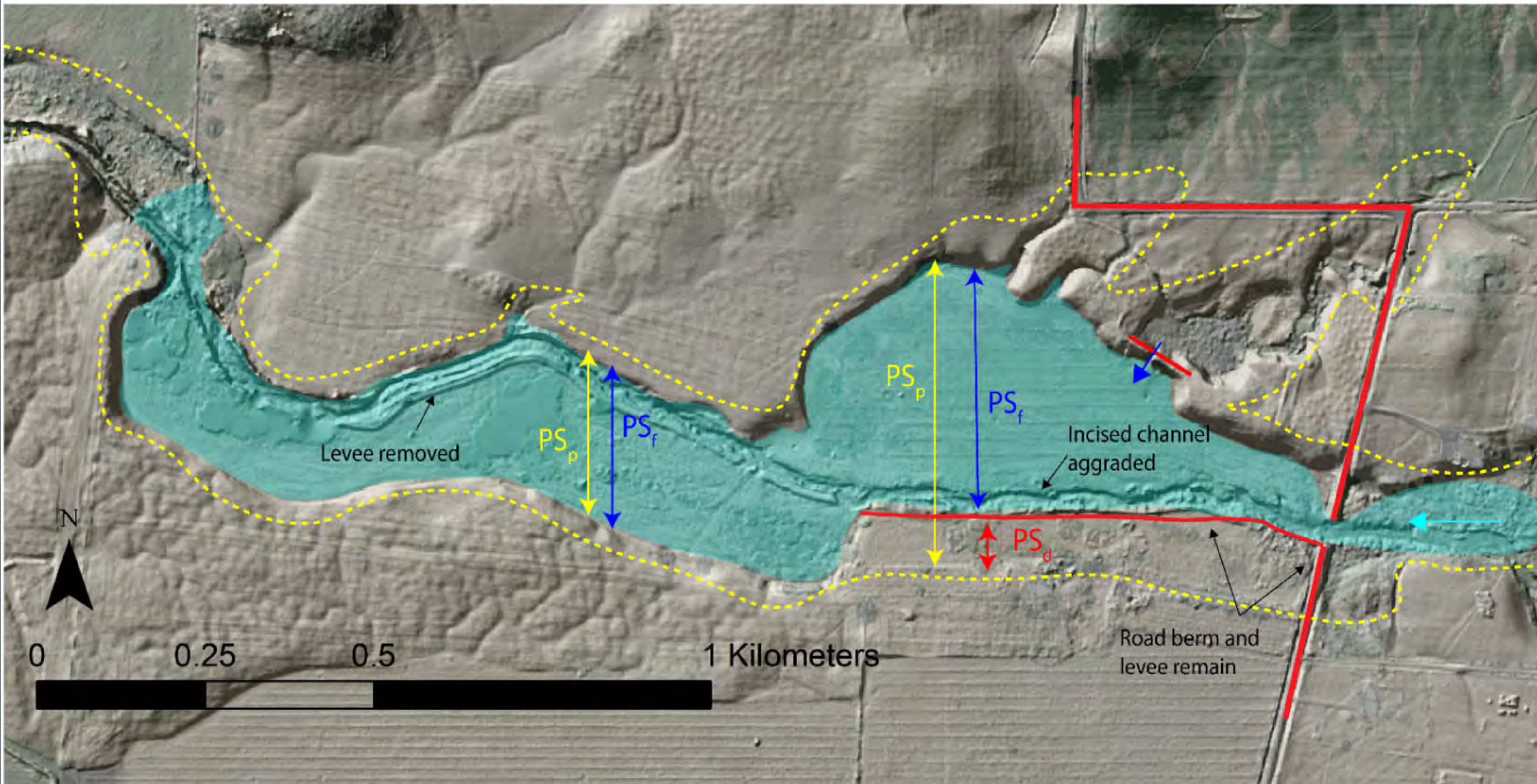
# Space

Starting Process Space 7 acres
Available Process Space 67 acres



# Space

Final project process space 57 acres



Energy: Project actions capitalize on natural energy within the system to do the work of restoration and minimize the use of external mechanical energy

Fluvial Energy (Flood pulse)

Solar Energy (Primary production)

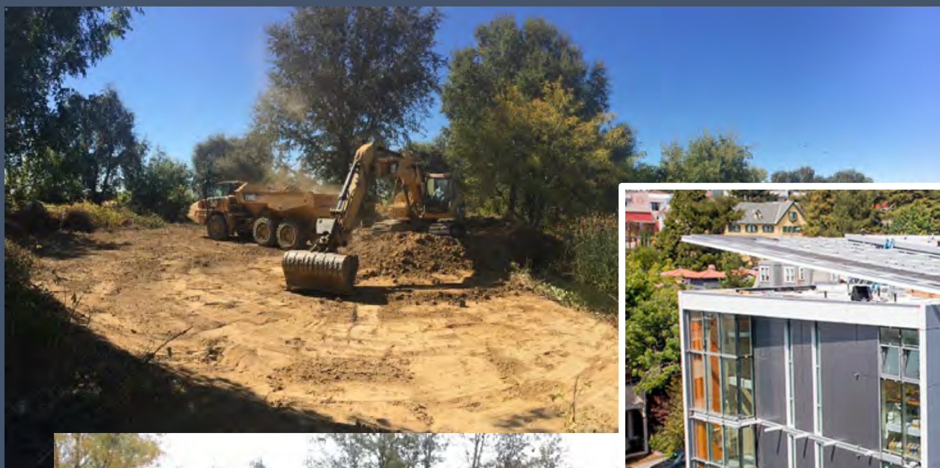
Biological Energy (Beaver, willow, wolves)

**Ecological Engineering**

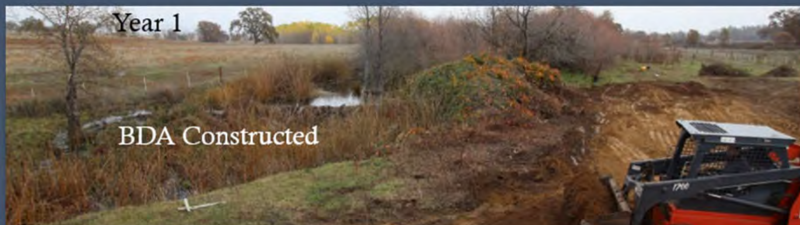
Self design, energy efficiency, accelerate process, mimicry

(HT Odum; Pollock et al., 2014; Wheaton et al. 2018)

# Energy

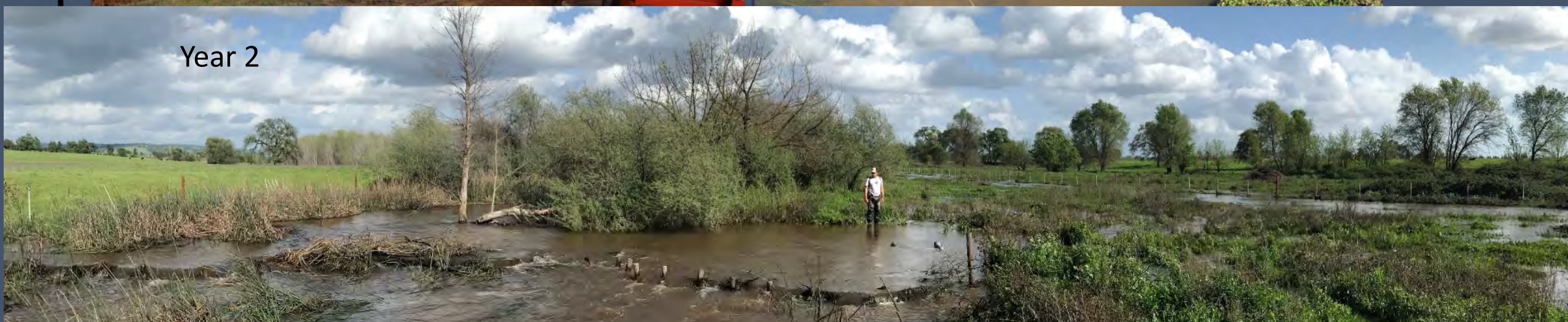


2 yr flood event = 21 backhoe days of energy
7.2 tons of carbon.
(McKee et al. 2019 in review)





Self-system design




Year 2

Geomorphic Work

Year 3

Biological Work

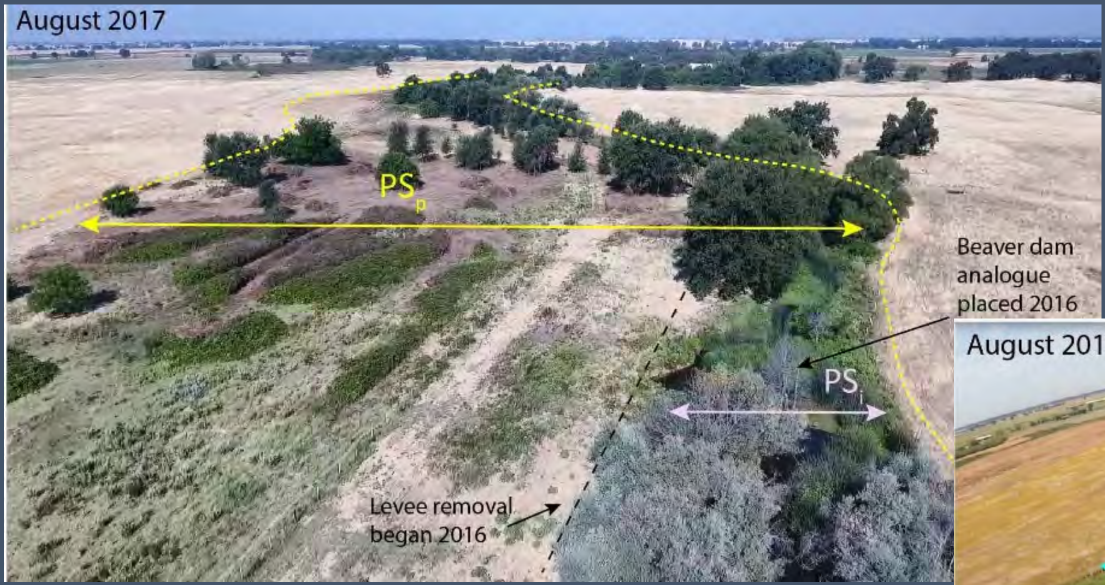
# Materials: Do not over-stabilize project elements or unnaturally constrain channel migration. (Native and geomorphically appropriate)

# Time: Achieve habitat objectives over time via restored geomorphic and biologic processes

**Geomorphic work**

**Biological work**

# Time


August 2017
PS$_p$
Beaver dam analogue placed 2016
PS$_i$
Levee removal began 2016

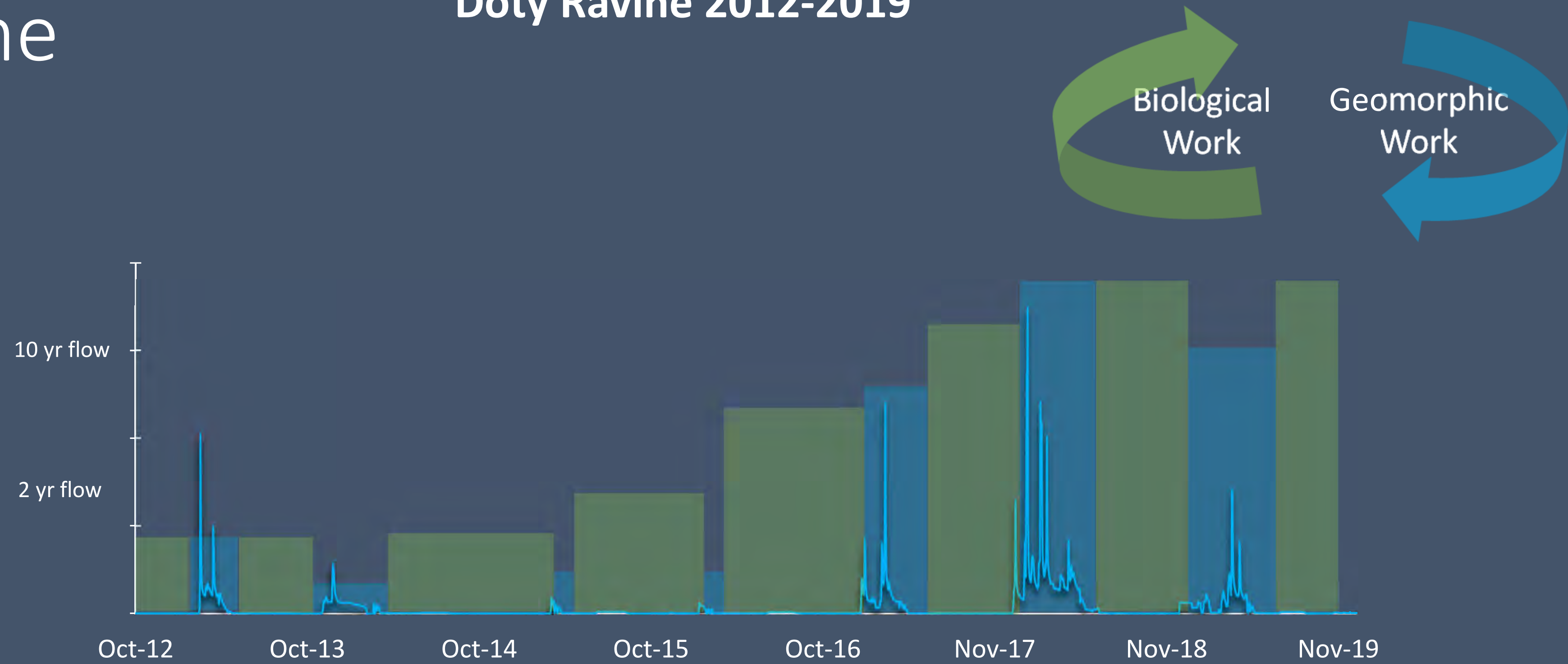

August 2019
PS$_f$
Stable depositional zone forms 2019
PS$_i$

# Time

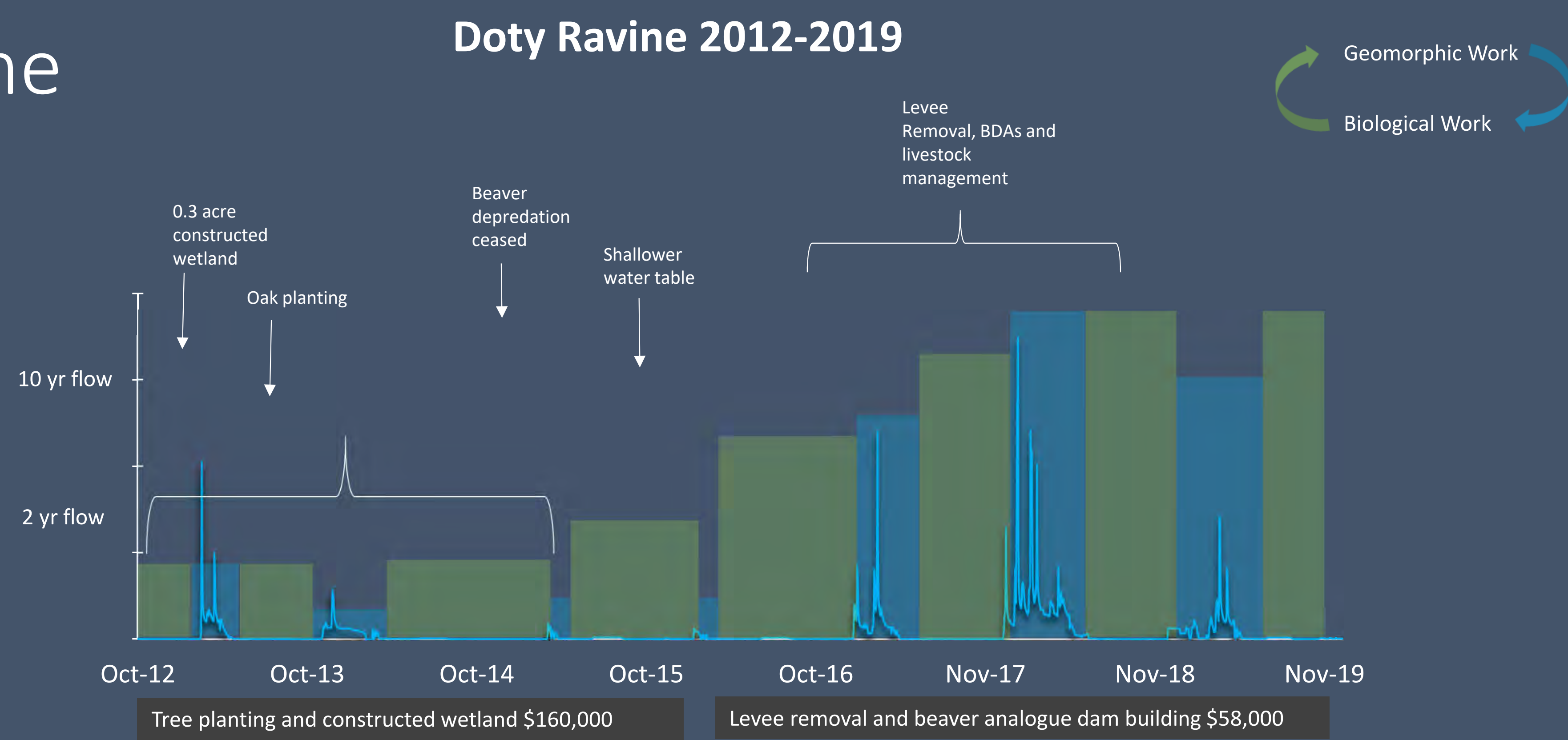
Doty Ravine 2012-2019
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Nov-17
Nov-18
Nov-19

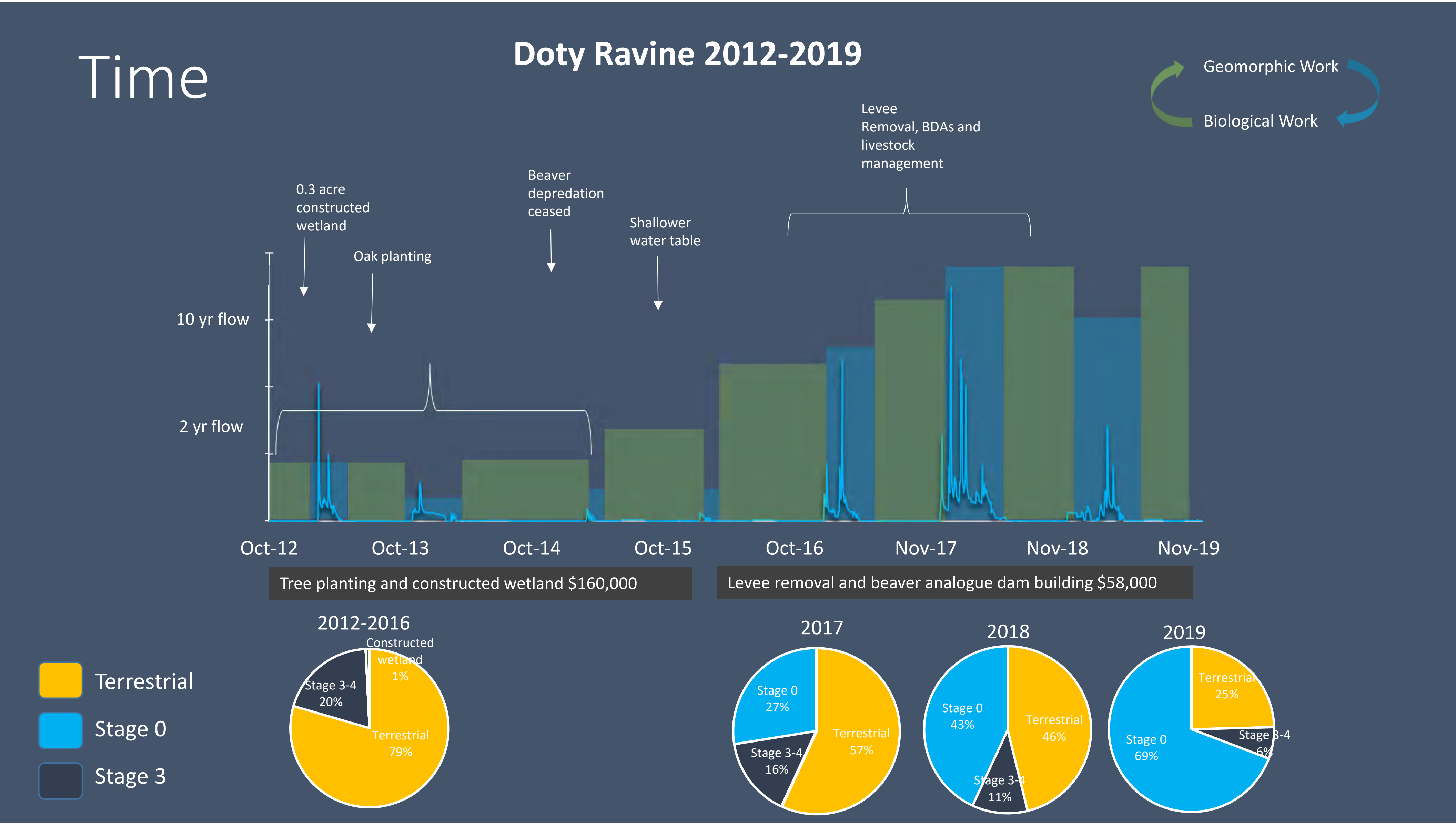
# Time

**Doty Ravine 2012-2019**



# Time


Doty Ravine 2012-2019
Geomorphic Work
Biological Work
Levee
Removal, BDAs and
livestock
management
0.3 acre
constructed
wetland
Beaver
depredation
ceased
Shallower
water table
Oak planting
10 yr flow
2 yr flow
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Nov-17
Nov-18
Nov-19
Tree planting and constructed wetland $160,000
Levee removal and beaver analogue dam building $58,000


Time
Doty Ravine 2012-2019
Geomorphic Work
Biological Work
Levee Removal, BDAs and livestock management
0.3 acre constructed wetland
Oak planting
Beaver depredation ceased
Shallower water table
10 yr flow
2 yr flow
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Nov-17
Nov-18
Nov-19
Tree planting and constructed wetland $160,000
Levee removal and beaver analogue dam building $58,000
2012-2016
Constructed wetland 1%
Stage 3-4 20%
Terrestrial 79%
2017
Stage 0 27%
Stage 3-4 16%
Terrestrial 57%
2018
Stage 0 43%
Terrestrial 46%
Stage 3-4 11%
2019
Terrestrial 25%
Stage 3-4 6%
Stage 0 69%
Terrestrial
Stage 0
Stage 3

PREPARED BY: PARTNERS FOR FISH AND WILDLIFE PROGRAM
U.S. FISH AND WILDLIFE SERVICE

# SEVENMILE CREEK AND UPPER KLAMATH LAKE FRINGE WETLAND

## CONCEPTUAL ALTERNATIVES

KLAMATH COUNTY, OR
JUNE 2019




| LOCATION | |
|---|---|
| LATITUDE | 42.59188° N |
| LONGITUDE | 122.019997° W |
| TRS | T34S R7-1/2E & T35S R7-1/2E |
| WATERBODIES | SEVENMILE CREEK, FOURMILE CREEK, UPPER KLAMATH LAKE, AGENCY LAKE |

| ABBREVIATIONS | |
|---|---|
| ALT | ALTERNATIVE |
| APPROX | APPROXIAMATE |
| CMP | CORRUGATED METAL PIPE |
| CY | CUBIC YARDS |
| DBH | DIAMETER BREAT HEIGHT |
| FT or ' | FEET |
| IN OR " | INCHES |
| MIN | MINIMUM |
| NTS | NOT TO SCALE |
| % | PERCENT |
| RD | ROAD |
| TBD | TO BE DETERMINED |
| TYP | TYPICAL |
| WSE | WATER SURFACE ELEVATION |

SHEET INDEX





COVER SHEET, SHEET INDEX
VICINITY MAP &ABBREVIATIONS


Y3
Y3
Y2
Y1
1000 Feet
N

Space

Energy

Materials

Time

References


1. Kondolf, G.M., Piegay, H., 2003. Tools in fluvial geomorphology: problem statement and recent practice. In: Kondolf, G.M., Piegay, H. (Eds.), Tools in Fluvial Geomorphology. John Wiley & Sons, Chichester, England
2. Beechie TJ, Sear DA, Olden JD, Pess GR, Buffington JM, Moir H, Roni P, Pollock MM. 2010. Process-based principles for restoring river ecosystems. BioScience 60: 209–222.
3. Palmer MA, et al. 2005. Standards for Ecologically Successful River Restoration. Journal of Applied Ecology 42-2: 209–217.
4. Pollock, M. M., T. J. Beechie, J. M. Wheaton, C. E. Jordan, N. Bouwes, N. Weber, and C. Volk. 2014. Using Beaver Dams to Restore Incised Stream Ecosystems. Bioscience 64:279-290.
5. Odum, H.T., Odum, B., 2003. Concepts and methods of ecological engineering. Ecological 5 Engineering, 20 (5): 339-361.
6. Cluer B, Thorne C. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications. 2014 Feb 1;30(2):135-54.