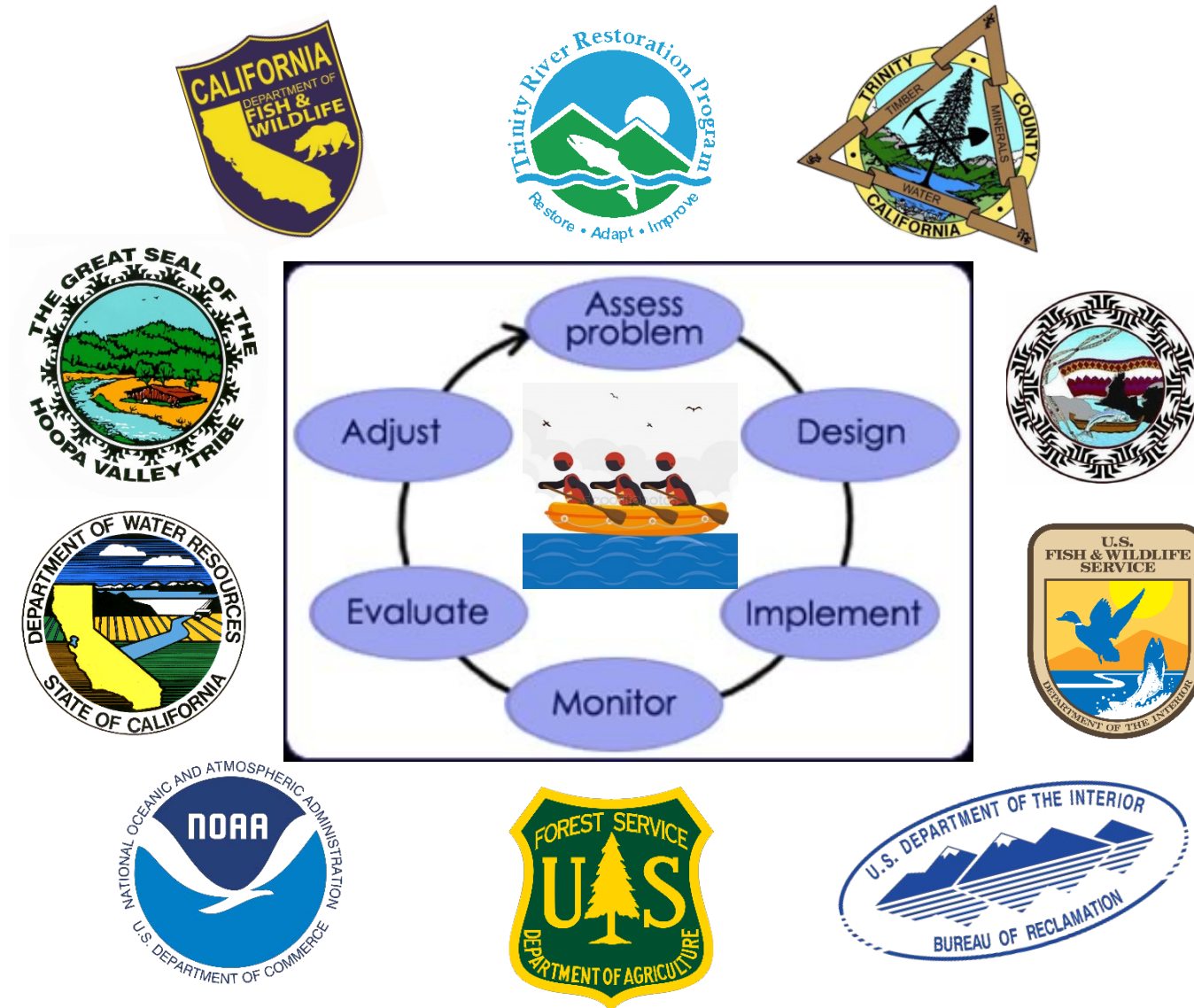


# Riding the adaptive management loop: habitat assessment informs restoration



Josh Boyce, Damon Goodman (USFWS) ● Aaron Martin, Kyle Hopkins (YTFD) ● Justin Alvarez (HVTFD)

# Why monitor salmon rearing habitat?

*“...increased rearing habitat is critical to restore and maintain salmonid populations.”*

-Trinity River Flow Evaluation (1999)

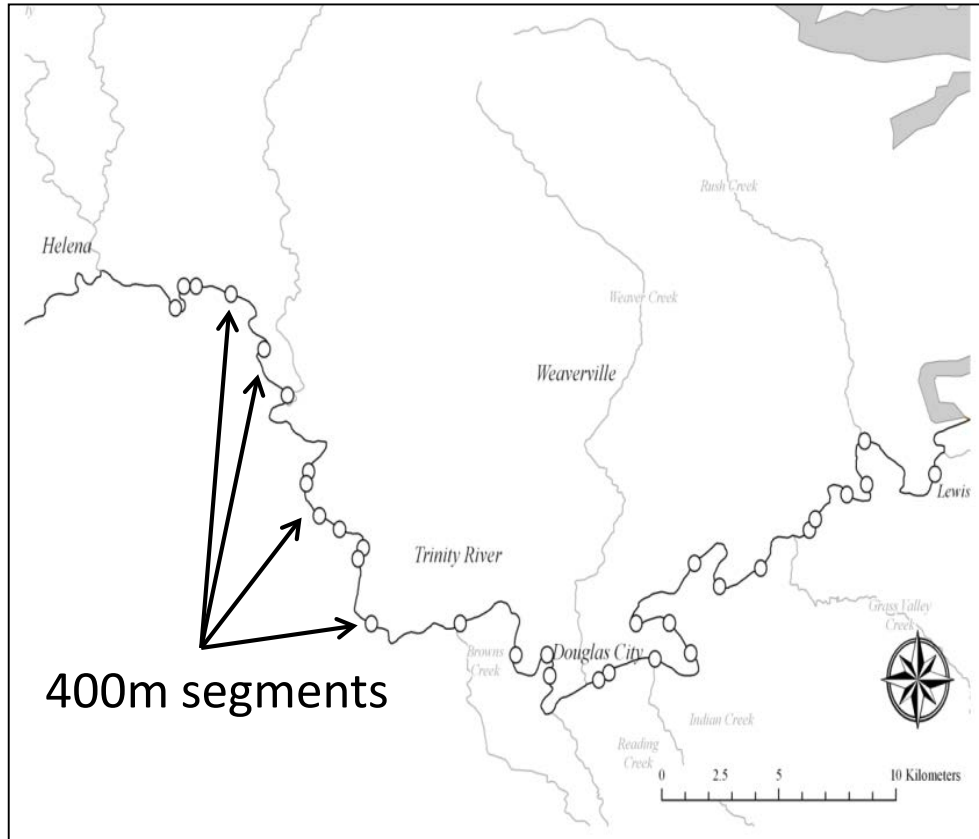
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*“Preferred Alternative:...implementation of an **adaptive management program**.”*

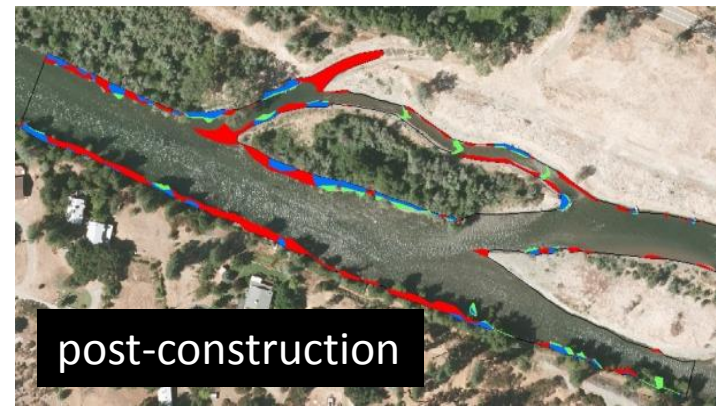
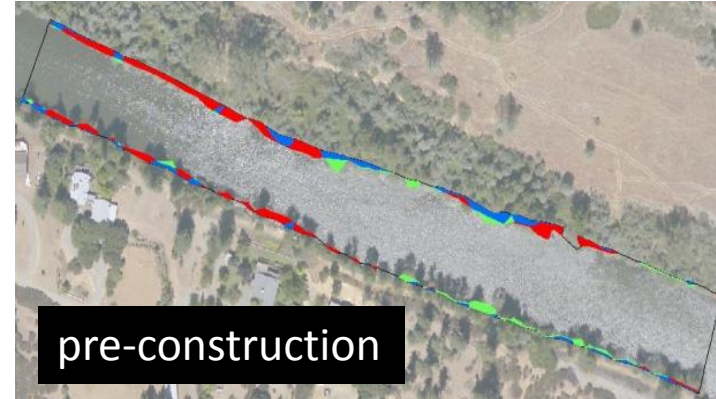
-Record of Decision (2000)

# Multi-scale Effectiveness Monitoring

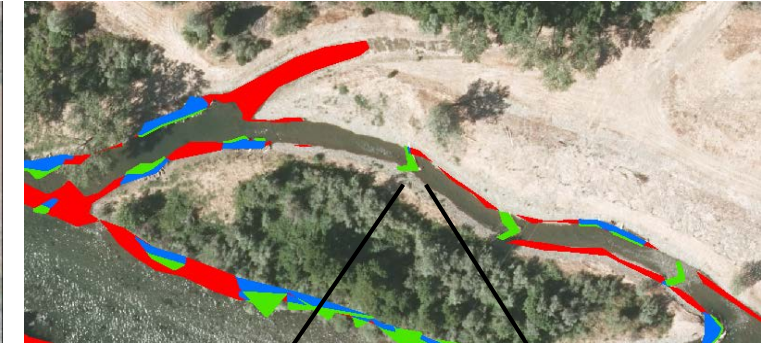
## Systemic Evaluation



## Site Evaluation



## Feature Evaluation



# Multi-scale Effectiveness Monitoring: recent example data sets

Goodman, D.H., N.A. Som, J. Alvarez, and A. Martin. 2015. Restoration Ecology 23(2): 179-185.

## Systemic Scale:

Goodman et al 2016. The effects of restoration on salmon rearing habitats in the restoration reach of the Trinity River at an index streamflow, **2009 to 2013**.

Goodman et al (*in prep*) → **2009-2017**

## Site Scale:

Boyce et al 2018. Trend Analysis of Salmon Rearing Habitat Restoration in the Trinity River at Summer Base Streamflow, **2005-2015**.

Boyce et al (*in prep*) → trends in streamflow to habitat relationships (**2008-2017**)

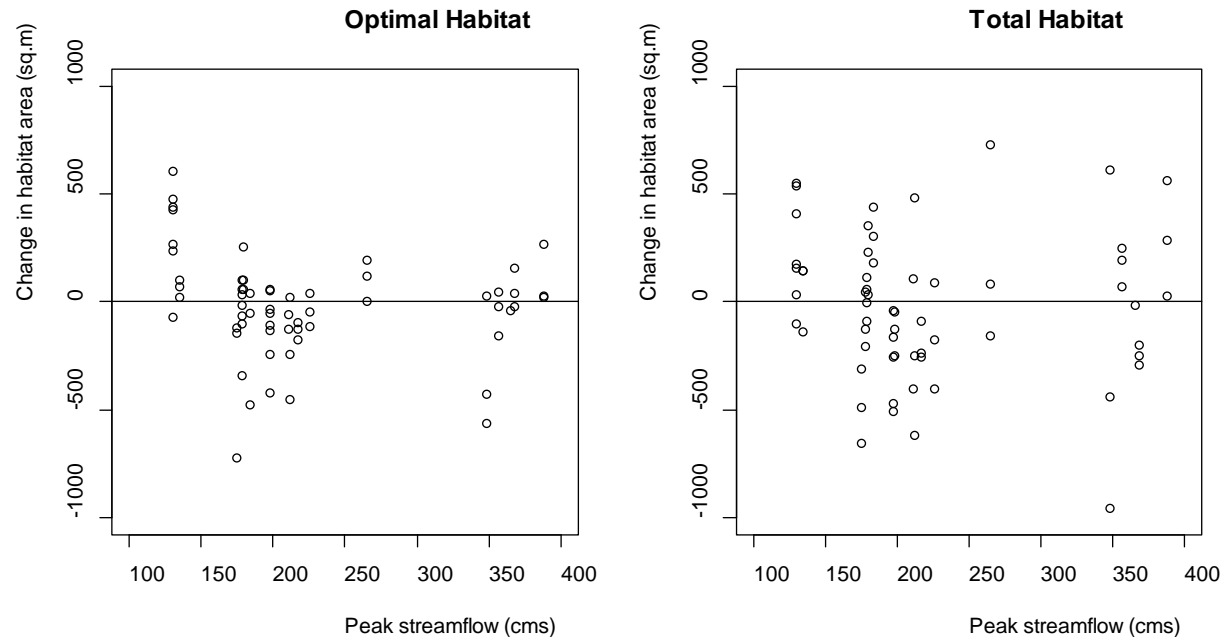
## Feature Scale:

Survival analysis of side channels (Boyce et al 2018)

Boyce and Goodman (*in review*) → “as built” large wood inventory of all rehab sites (**2005-2016**)



# Systemic Scale: Habitat availability at summer base streamflow 450 cfs



## Results:

annual variation in habitat area by site  
(increases and decreases)

larger annual peak streamflows did not relate to  
greater improvements or more variation in habitat area

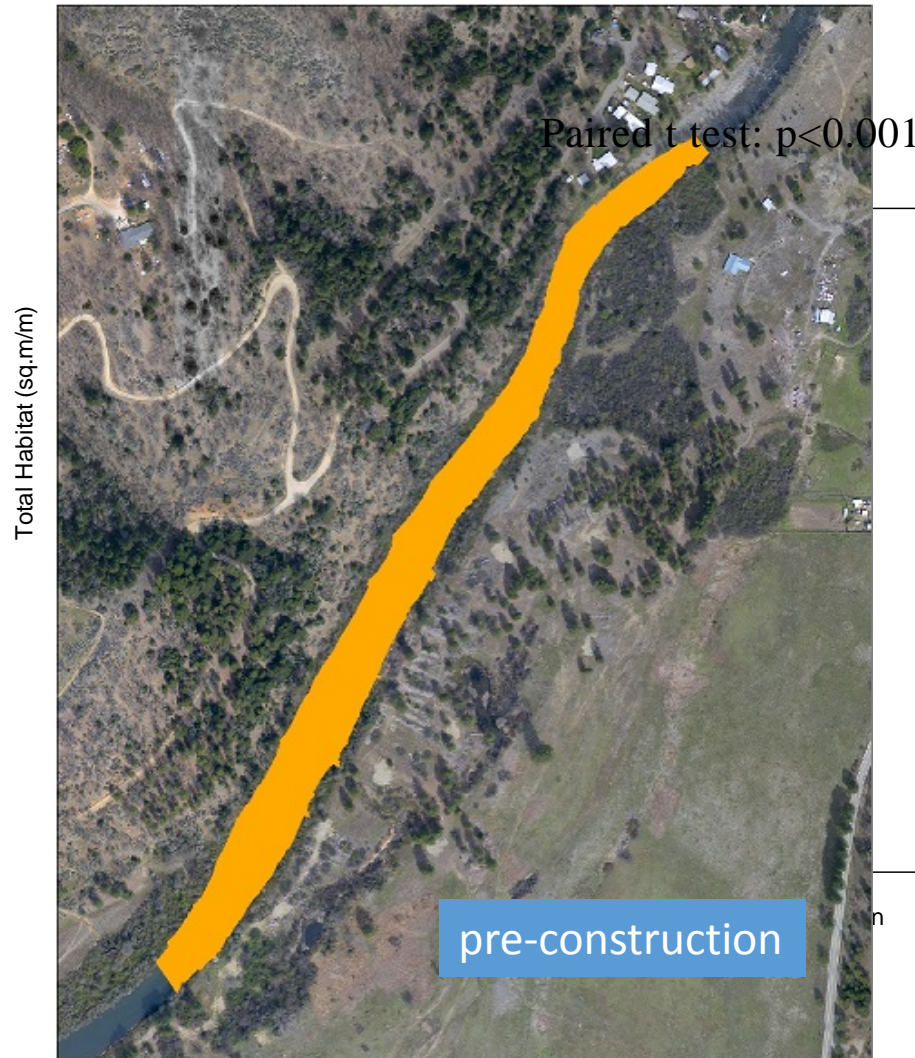
## Conclusions:

synchronize dam releases with flood events to  
increase rate of change

longer time scales for future analyses

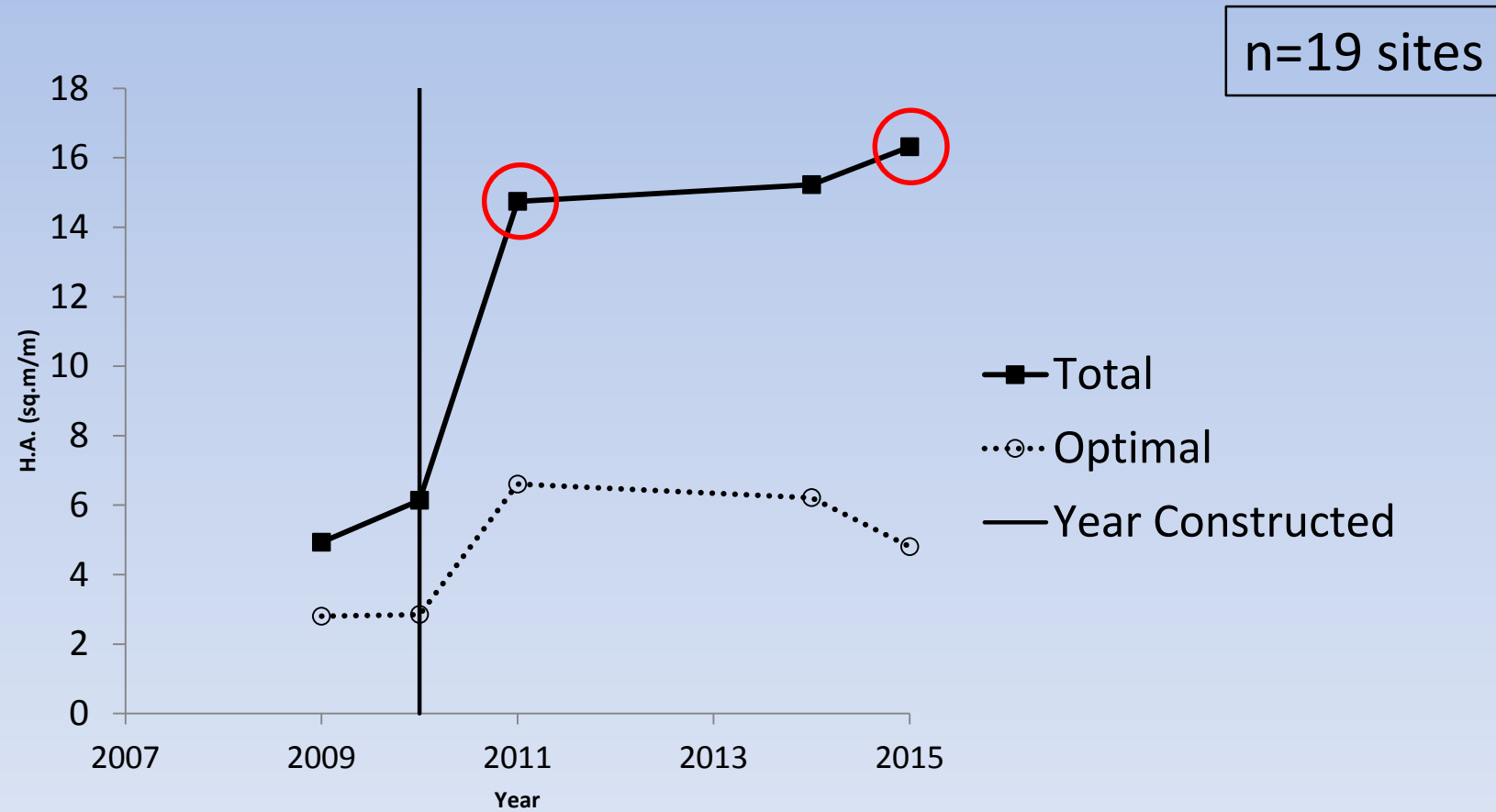
revised sample design based on results (2014-2017)

# Site scale: habitat availability at rehabilitation sites at **450 cfs**

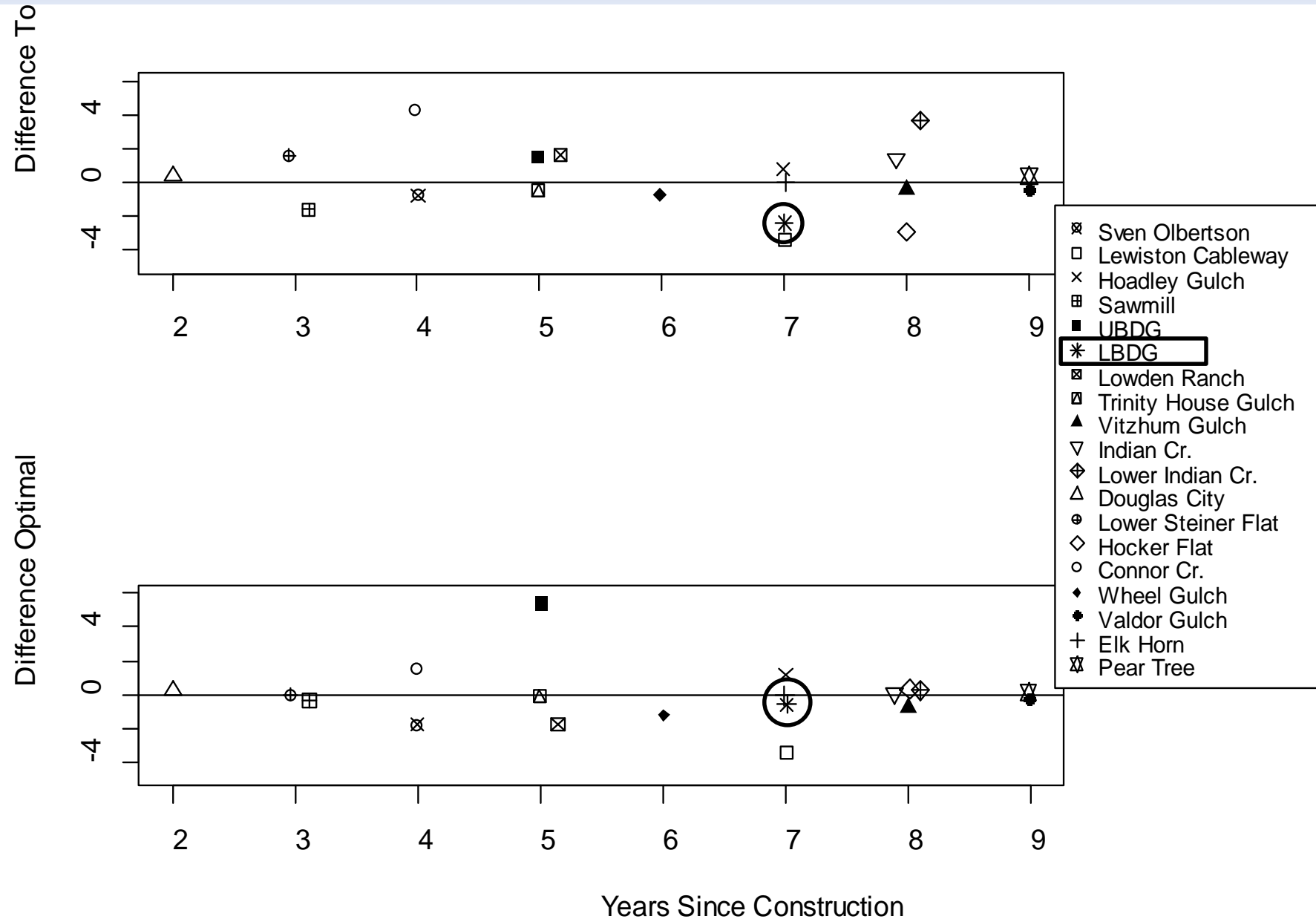


n=13 sites

## Site scale: trends in rearing habitat at 450 cfs



# Site scale: $\sim 50\%$ of sites had more habitat at most recent survey





# Lower Buck Tail-Dark Gulch

**(2008): initial construction**

**provide low-flow rearing habitat off mainstem → side channel**

**reactivate floodplain to facilitate river-induced sinuosity**

**Habitat surveys:**

**2008, 2009, 2010, 2014, 2015 (450 cfs)**

**2008, 2009, 2015 (range of flows)**

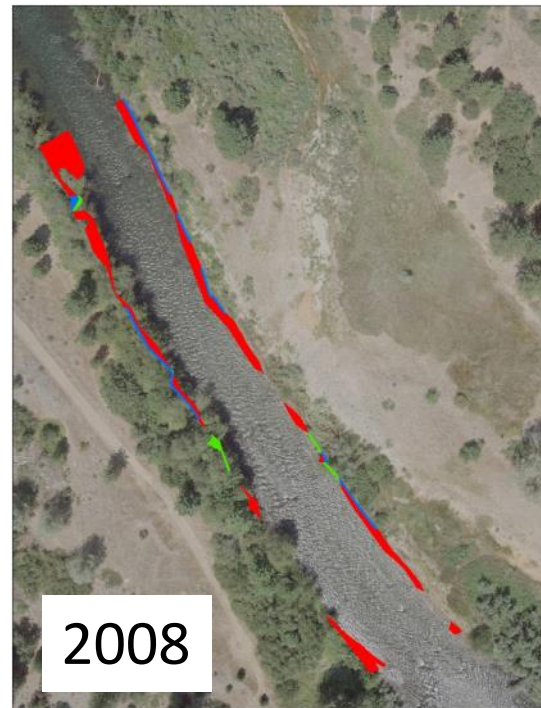
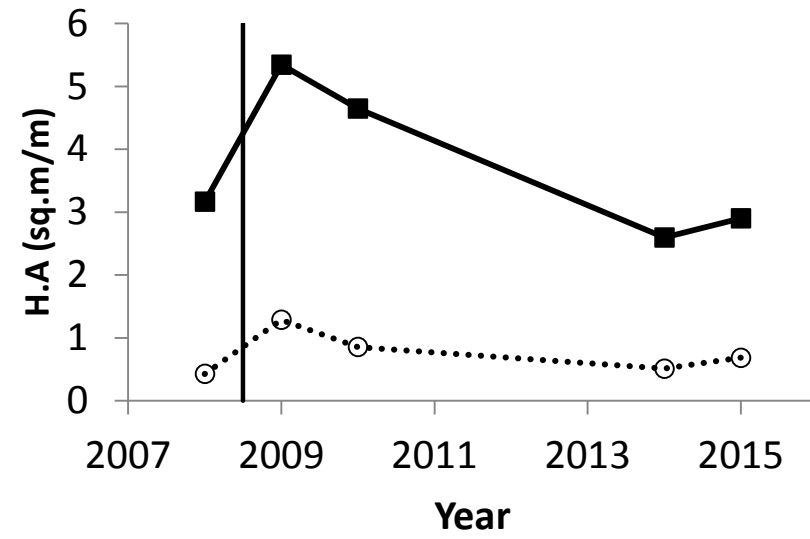
**(2016): re-constructed**

**increase and sustain habitat (300-2,000 cfs) for all life stages → double habitat**

**sc entrance: maintained by location above riffle control and large wood jam**

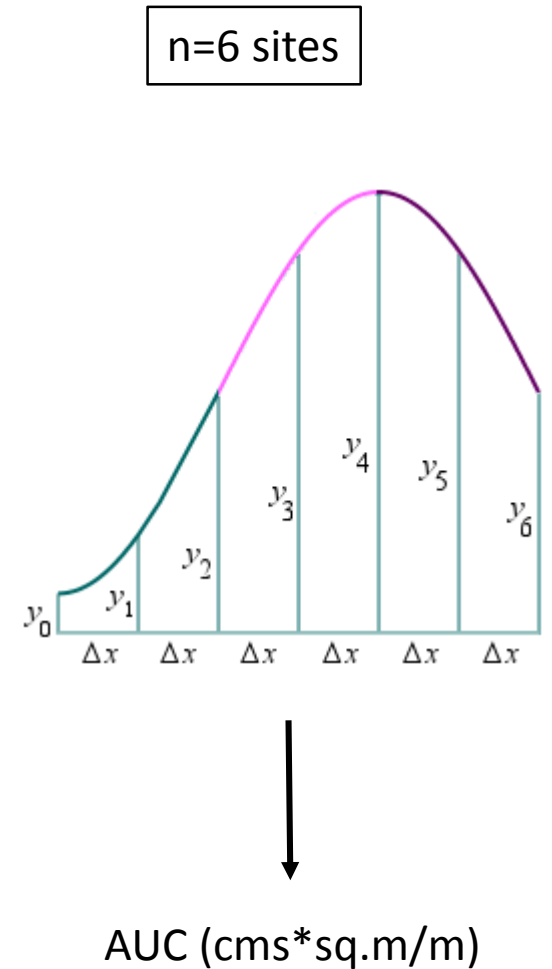
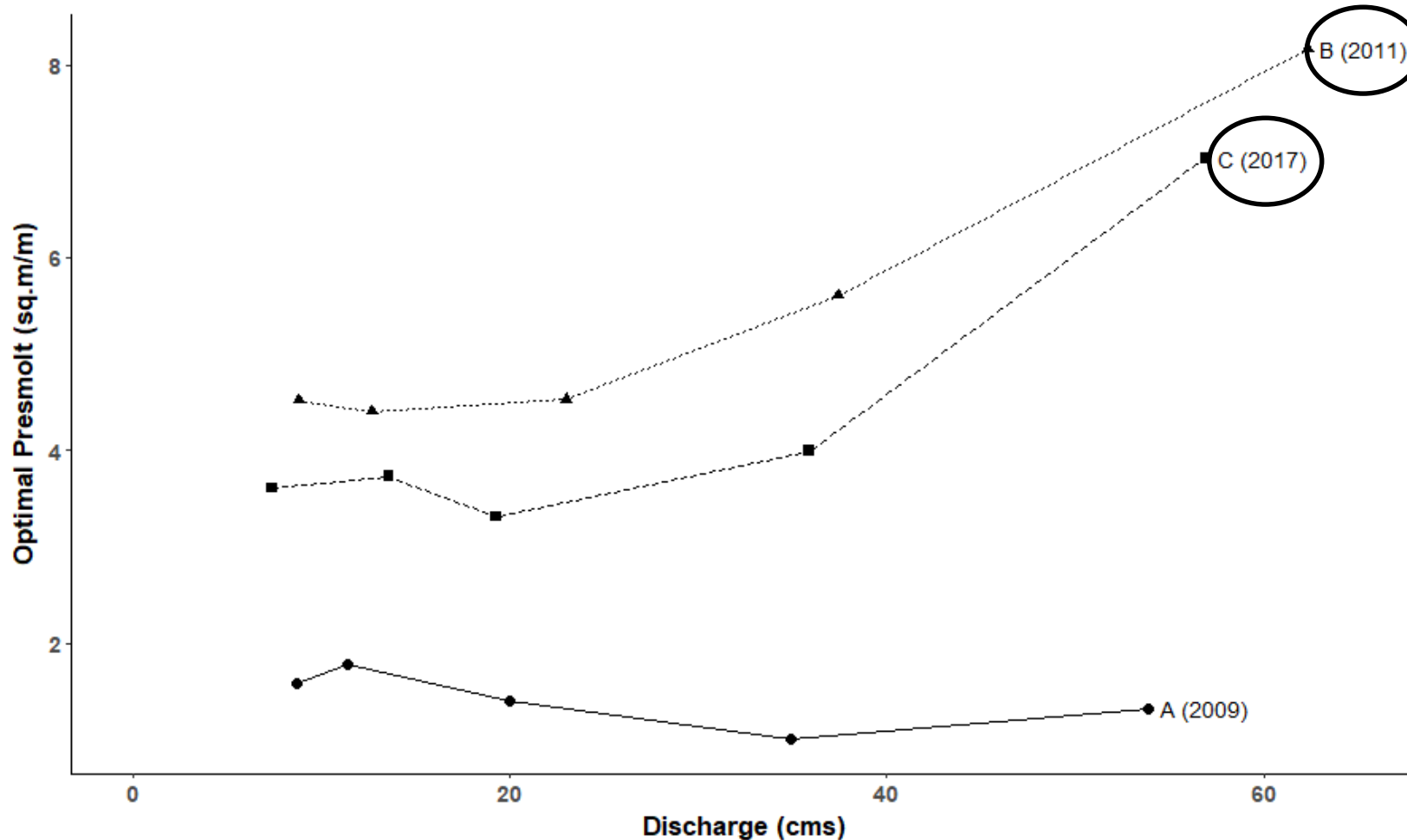
**Habitat surveys: 2015 (pre-con), 2017 (post-con) → range of flows**

## Lower Bucktail Dark Gulch

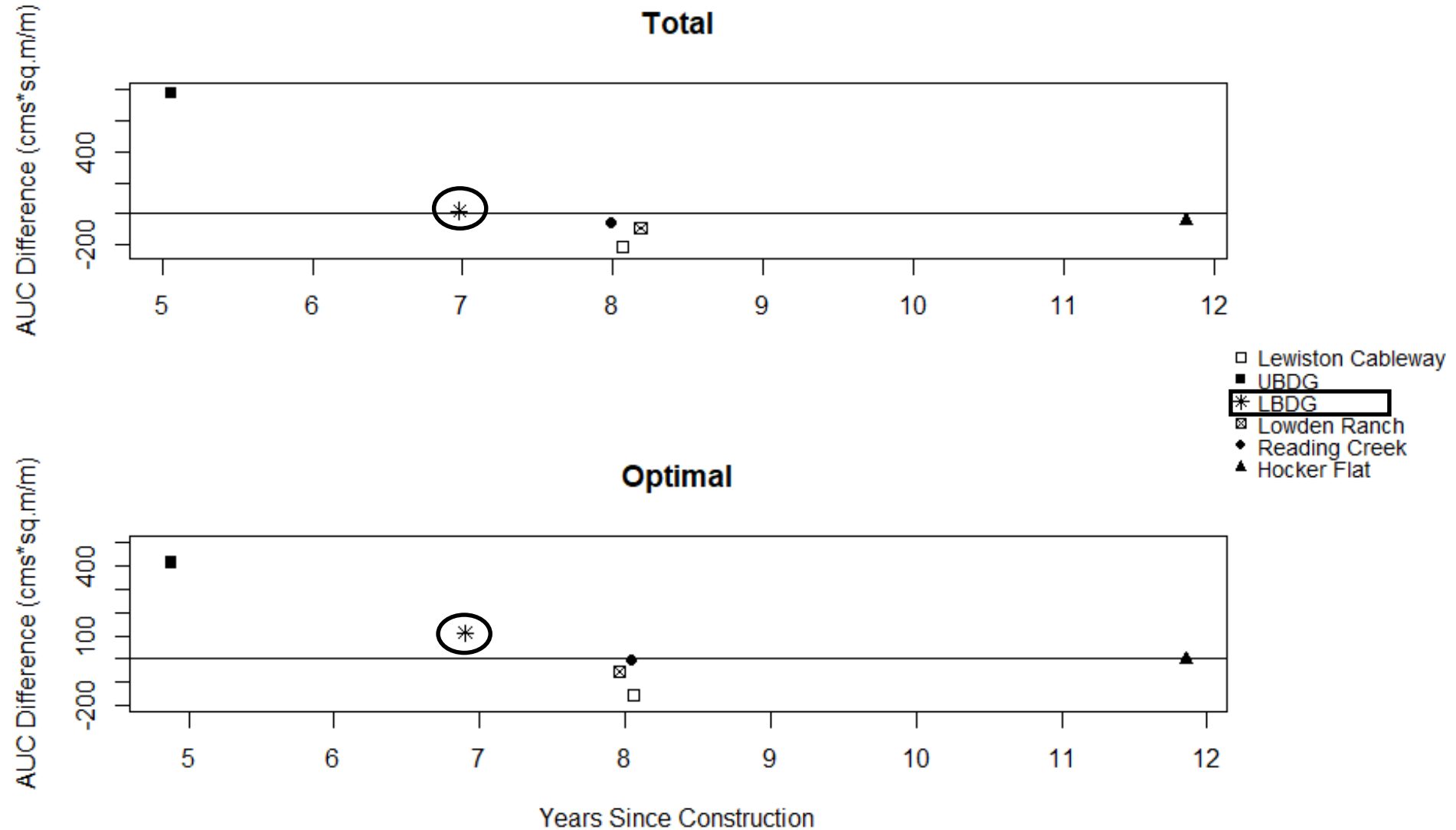


# Site scale: trends in the streamflow to habitat relationship (synthesis report in preparation)

(300-2,000 cfs)

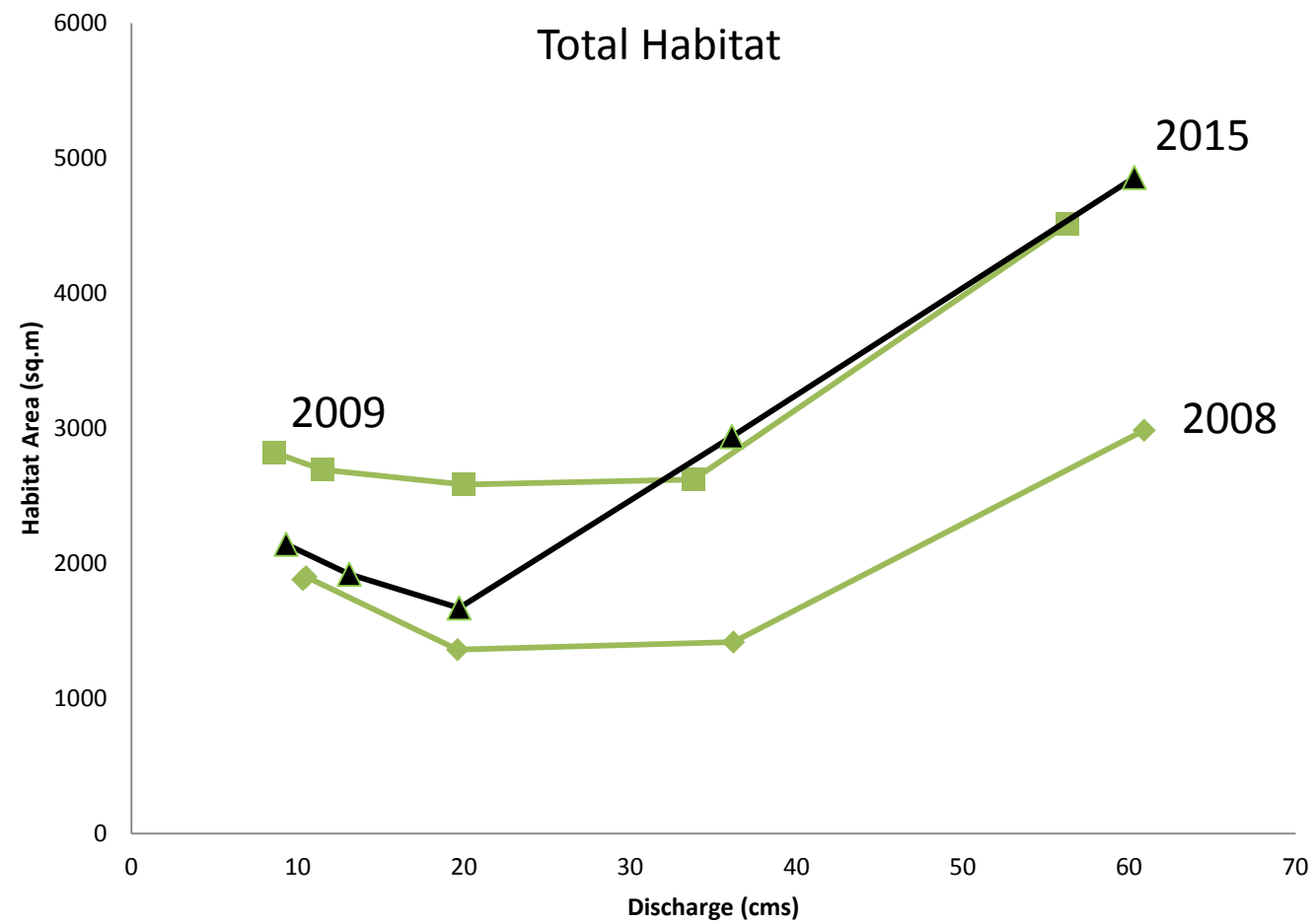


# Site scale: Two of six sites had higher AUC values at most recent survey





# Lower Bucktail-Dark Gulch



habitat losses  
side channel aggradation  
negligible topographic change



reconstruction 2016

# Lower Buck Tail-Dark Gulch

(2008): initial construction

provide low-flow habitat off mainstem → side channel  
reactivate floodplain to facilitate river-induced sinuosity

Habitat surveys: 2008, 2009, 2010, 2014, 2015 (450 cfs)

2008, 2009, 2015 (range of flows)

**(2016): re-constructed**

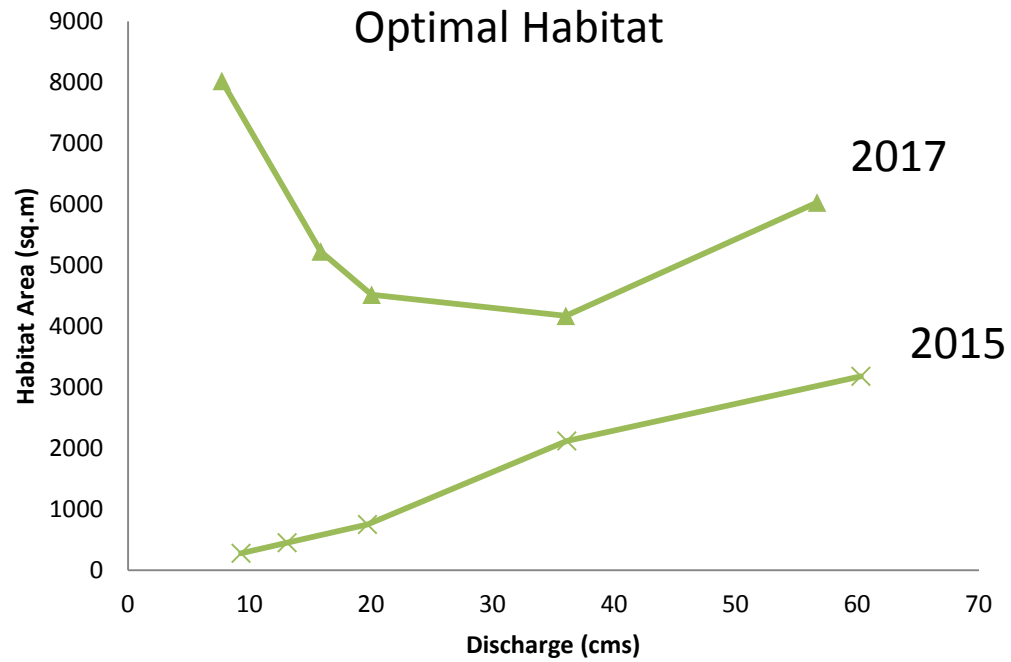
**increase and sustain habitat (300-2,000 cfs) for all life stages → double rearing habitat**

**sc entrance: maintained by location above riffle control and large wood jam**

**Habitat surveys: 2015 (pre-con), 2017 (post-con) → range of flows**

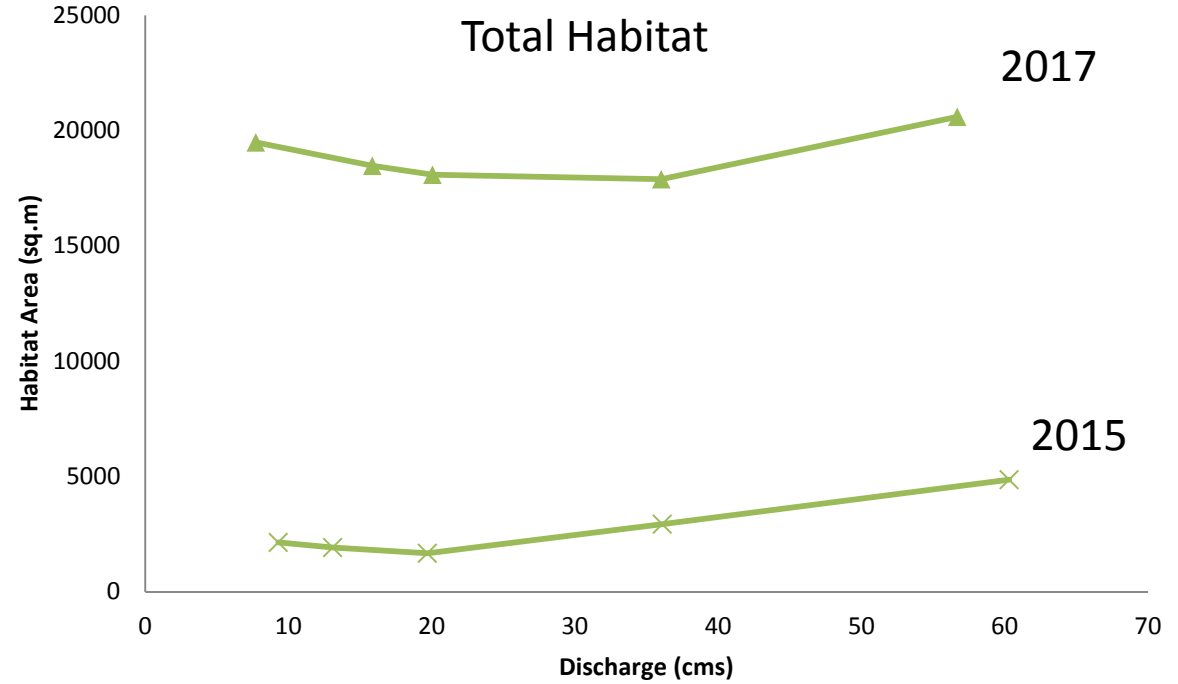
# Lower Bucktail-Dark Gulch

## 2015-2017



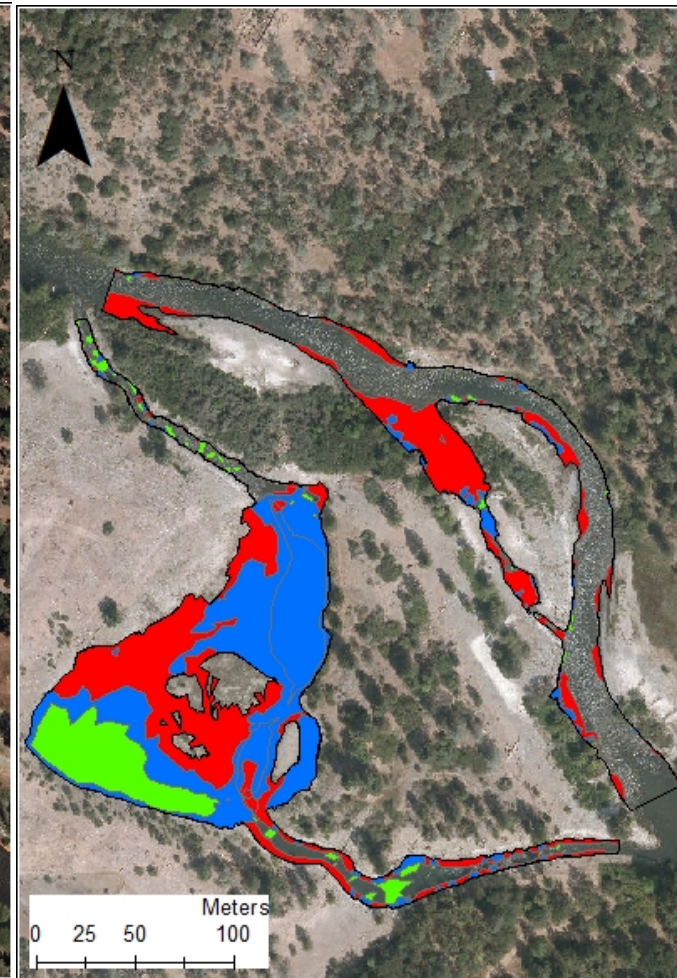
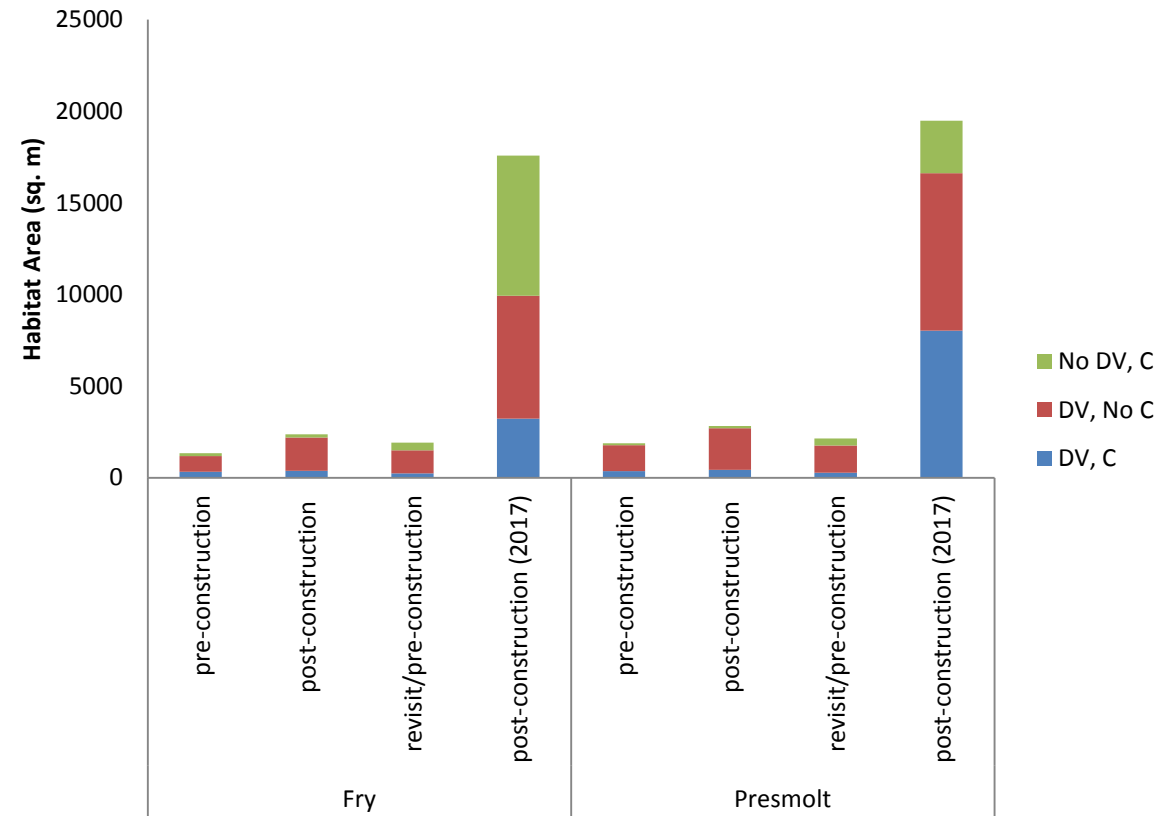
**increases 90% to 2,799%**

post-construction “dip” at intermediate flows



**increases 324% to 984%**

# Lower Buck Tail-Dark Gulch

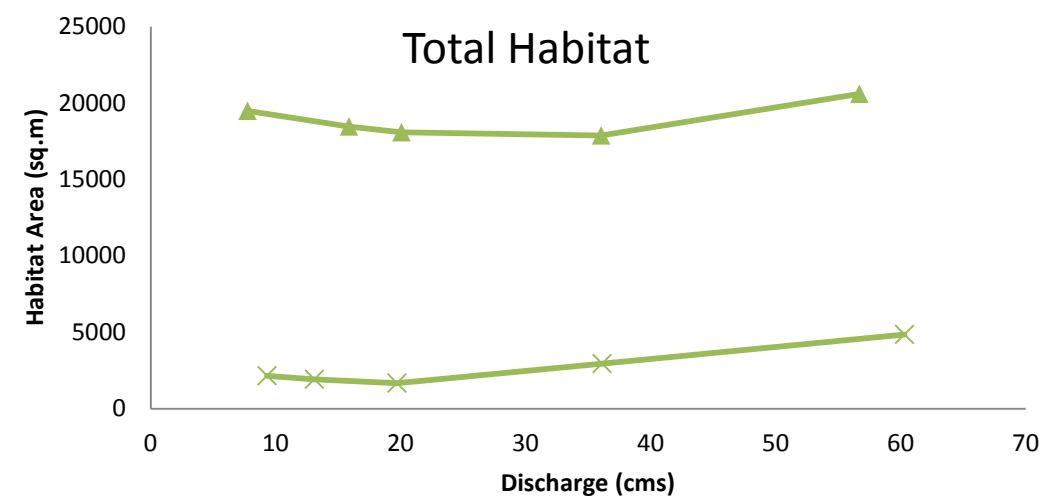
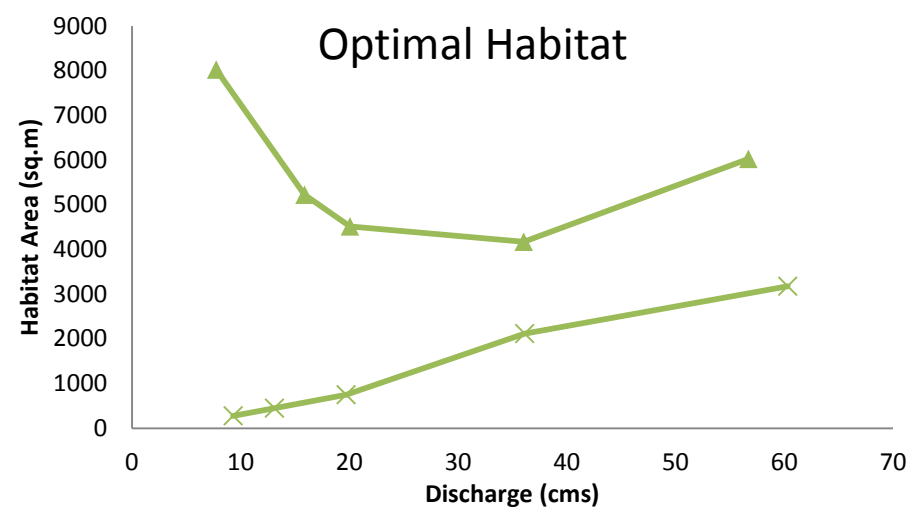
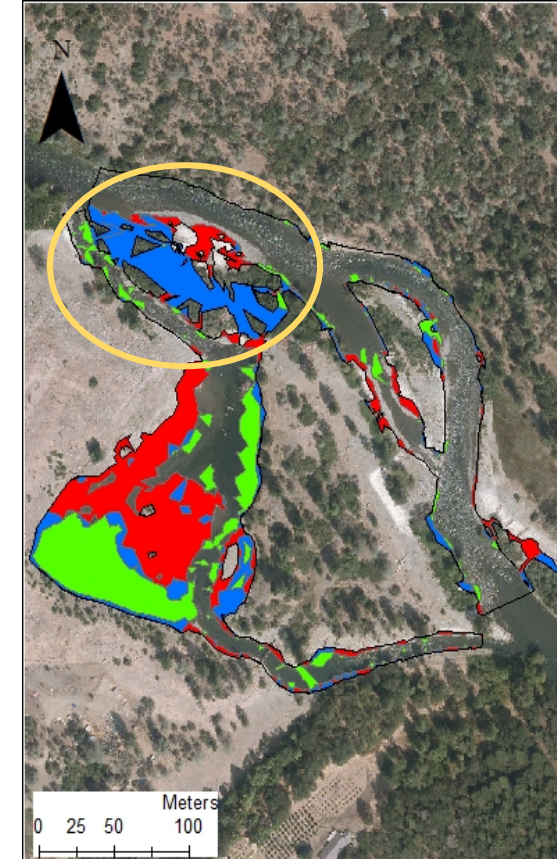
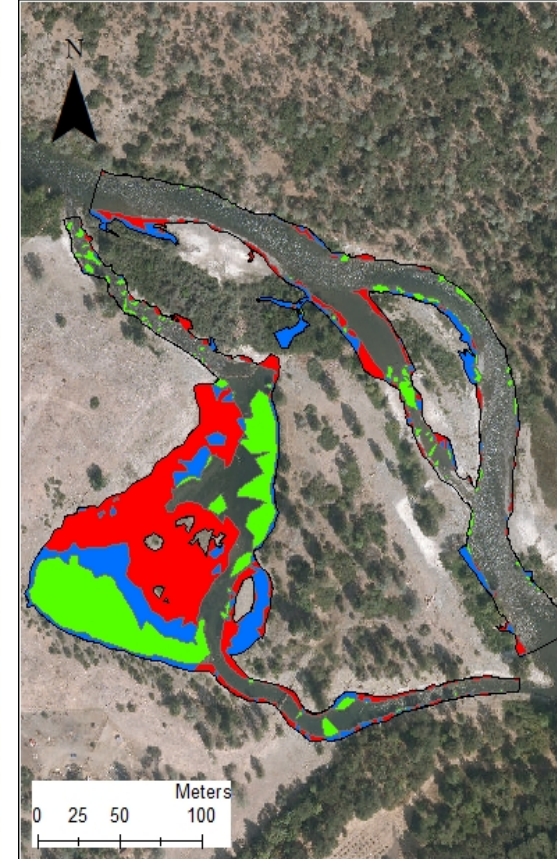
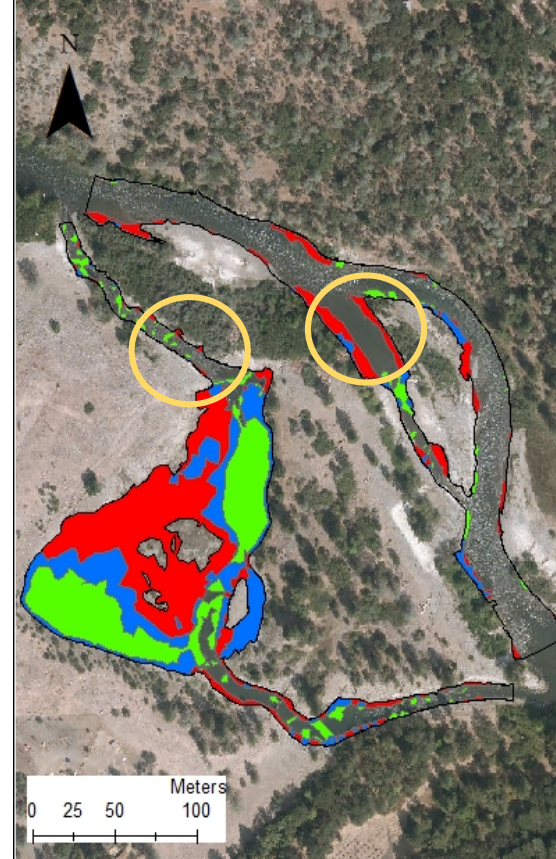
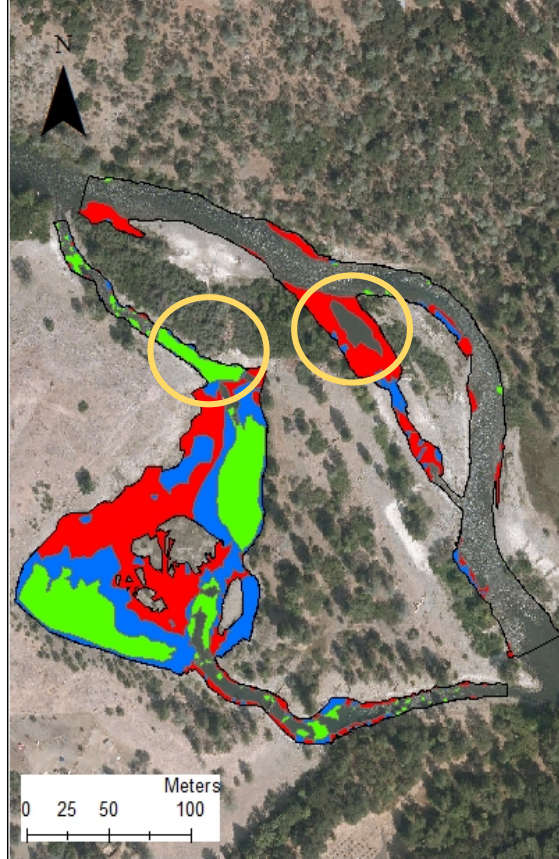


2015

2017

300 cfs





## Lower Buck Tail-Dark Gulch: conclusions

Reconstruction increased habitat at all flows (more than doubled)

sc entrance: looking good so far...

discharge data for future comparisons



## Feature scale:

Compare natural and TRRP constructed side channels, 2005-2015

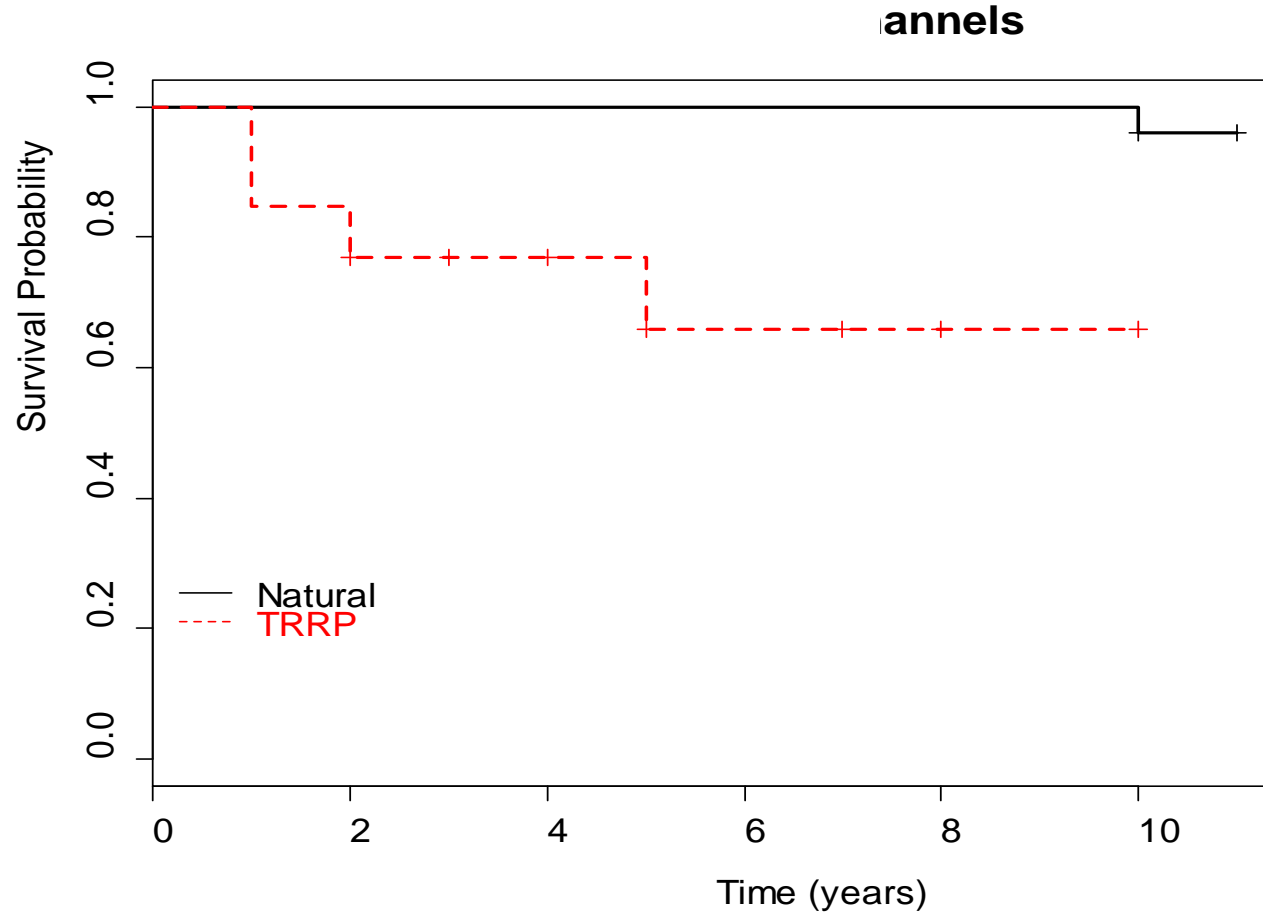


Performance = mainstem connectivity?

Aerial photographs

	Natural	TRRP
Disconnected	12% (3/25)	31% (4/13)
Reconnected	2	0

# Natural side channels have a higher survival rate than constructed side channels



Log Rank Test  
( $\chi^2 = 3.5$ ,  $df = 1$ ,  $P = 0.003$ )



# Aggraded side channels convert to high flow channels/alcoves

Deadwood Creek



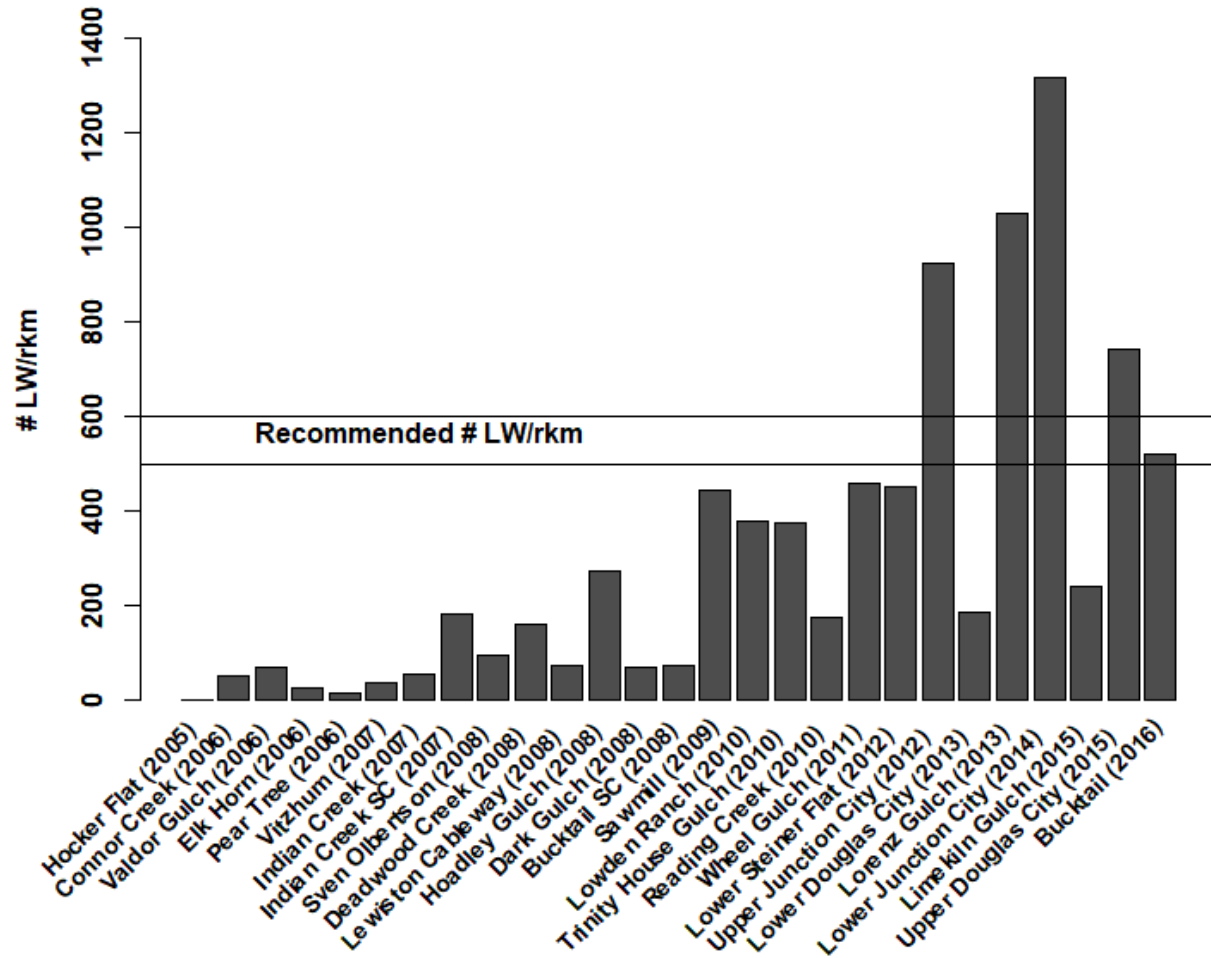


# Large Wood Surveys & Photo monitoring



Boyce, J., and Goodman, D.H. (*in review*). Large Wood Placement at Channel Rehabilitation Sites by the Trinity River Restoration Program, 2005-2016

# TRRP has increased large wood placement over time



Cardno Entrix and CH2MHill 2011. Trinity River large wood analysis and recommendation report.



# Providing feedback to the program...

## Design team meetings

-once a year

## Written summaries

-rapid turnaround

## Technical reports

-peer reviewed

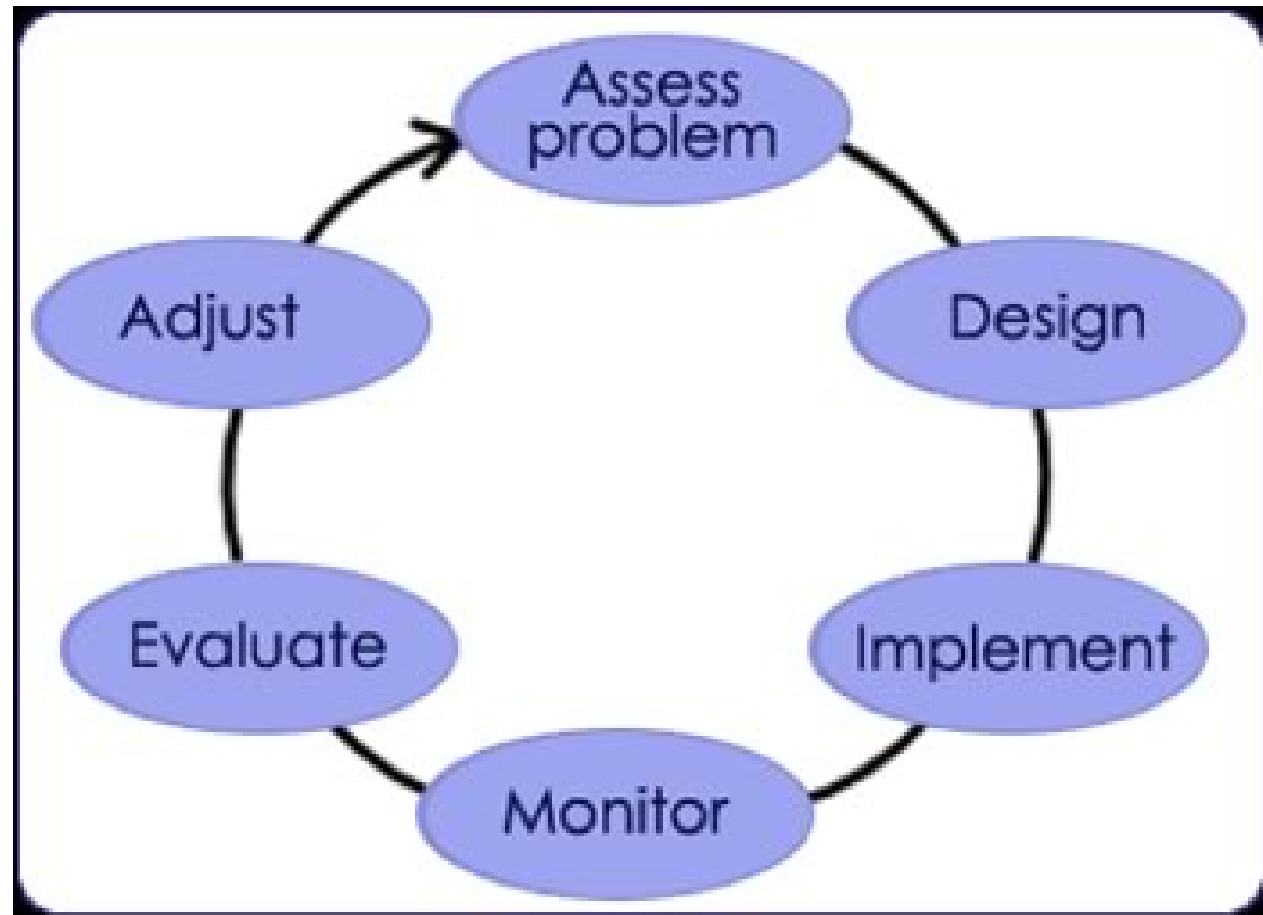
-interested members of the public

## Scholarly Conferences

-e.g. Cal-Neva 2017

## Journal publications

-wider scientific community



Bucktail example



# Recent developments

TRRP website:

Boyce, J., D.H. Goodman, N.A. Som, J. Alvarez and A. Martin. 2018. **Trend Analysis of Salmon Rearing Habitat Restoration in the Trinity River at Summer Base Streamflow, 2005-2015.**

*in review* - Large wood report, 2005-2016

*in prep* - synthesis reports:

streamflow to habitat data 2008-2017

systemic estimate 2009-2017

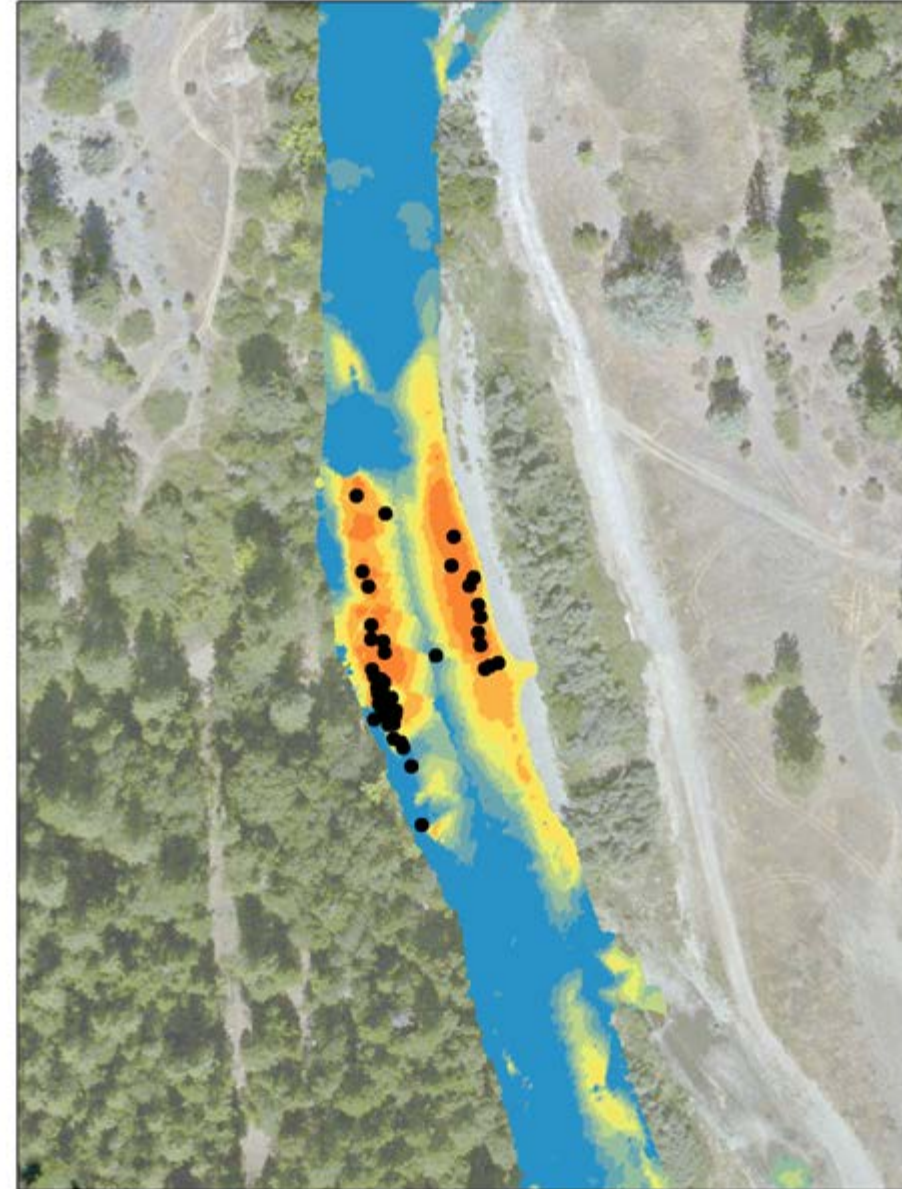
2016 SRH habitat capacity rehabilitation sites (range of flows)

Lower Trinity 2D model development for S3

# The future of habitat monitoring

FY18:

- hydraulic modeling
  - align habitat team and design team methodologies
  - flexible approach
    - life stages/discharges
    - multiple metrics (habitat area/capacity)
  - Wright et al 2017: improving 2D model calibration/validation



# The future of habitat monitoring FY 2019

- Assessment work currently unfunded for FY 2019
- Proposal developed to
  - Provide feedback on channel rehabilitation efforts
  - Continue before-after assessments with hydrodynamic modeling (3 sites)
  - Evaluate post-construction performance (3 sites)
  - Large wood monitoring

