Large Wood Technical Field School
Caspar Community Center, Mendocino Coast
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Did Wood Make More Fish?

Response to Large Wood Treatment in Pudding Creek.

One River's Story from a Long-term BACI Experiment.

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Overview

- Purpose of the study
- Study Design/Habitat restoration approach
- Methods/Findings

Collaboration

- Funded through FRGP
- Founded in life cycle monitoring data

Coastal Monitoring Program

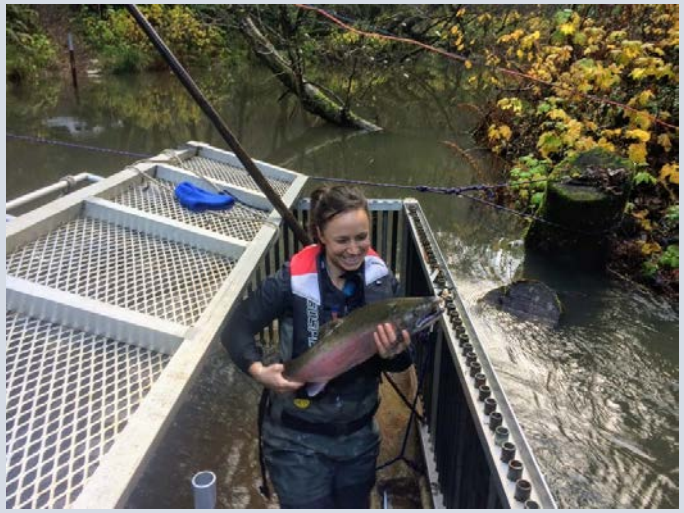
Coastal Monitoring Sample Strategy - Two Stage

Spawning surveys

- Redd counts
- 339 reaches in 500+ miles
- Sample 15% (41 reaches)
- Adult and redd estimates

Life Cycle Monitoring (LCM)

- Redd census and smolt estimates
- Calibrate regional redd estimates
- Reduce uncertainty and bias
- Collect multiple life history attributes
- Fish metrics to evaluate trends



Watersheds of coastal Mendocino

- Coniferous redwood forest
- Unregulated flow directly into Pacific
- Mix of bar built and riverine estuaries
- Peak stream flows occur during winter-recede through spring and summer
- Bar-built estuaries close to the ocean during low flow period
- Some of the best populations of CCC Coho

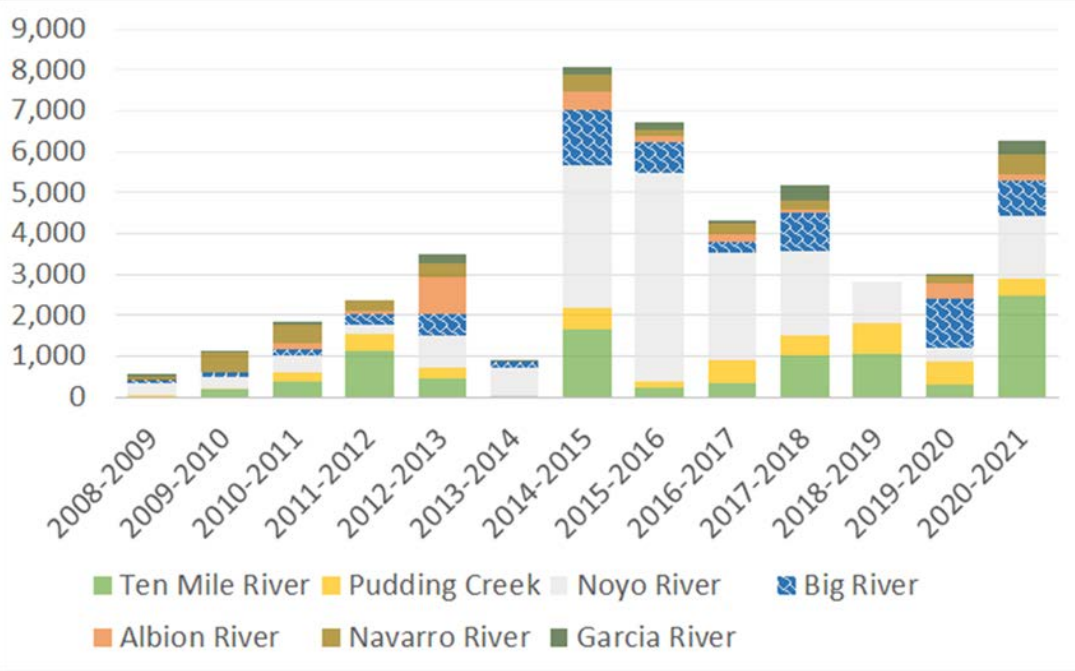
CCC Coho Salmon
Status: Endangered

NC Steelhead
Status: *Threatened*

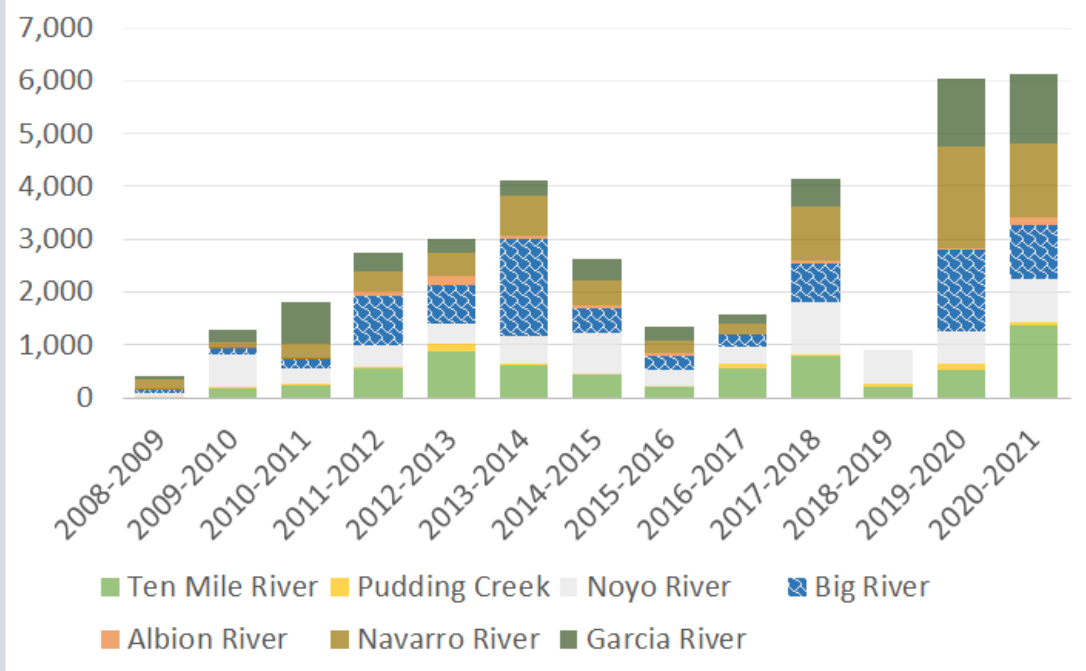
Coastal Chinook Salmon Status: *Threatened*

Adult escapement estimates

Coho Salmon



Steelhead



Habitat loss

Timber harvest:

- Loss of riparian trees
- Erosion and siltation
- Channel simplification and incision
- Loss of floodplain connectivity

Fish crisis:

- Environmental laws
- Stream cleaning
- Small scale hatchery effort
- Current restoration

Historic land practices degraded watershed function decreasing salmonid abundance and diversity.

Current Restoration

- **Listing and recovery plan actions**
- **Extensive amount of habitat restoration investment through the Northern Coastal California**
  - barrier removals
  - road decommissioning and improvement
  - installation of LWD and channel reconstruction
  - beginning in estuaries
- **A lot of progress. Is it working?**

Look to Fish Monitoring

- Examine what may be limiting salmon in the freshwater life stage.

- Help inform best strategies to return rivers to their natural state and improve fish abundance and diversity.

Answering questions at LCMs

- Important aspect of salmonid LCM monitoring is *"developing an understanding of the relationships between habitat and salmonid survival to help interpret regional trends and direct effective restoration actions"*

- Do management actions that increase habitat quantity and quality lead to increased abundance and recovery of salmonid populations?

Preparing for BACI study

Hypothesis: Density dependence occurs in freshwater life stages and that some seasonal physical factors limit salmon populations.

- Examined fish habitat relationships using data from three long term life cycle monitoring stations
- Life stage specific survival and physical stream factors (flow, temperature, and turbidity)
- Spurred habitat data collection

Limiting Factors

Limiting factors are the conditions that inhibit populations of organisms or ecological processes and functions relative to their restoration and protection potential (CBMRCD 2005)

- High stream flows negatively correlated with survival suggesting winter habitat was limiting
- Summer = low growth period
- Density dependence in streams and seasonal physical factors limit salmon populations

Action: Increase habitat for fish during periods that are limiting

Investigation of the relationship between physical habitat and salmonid abundance in two coastal northern California streams

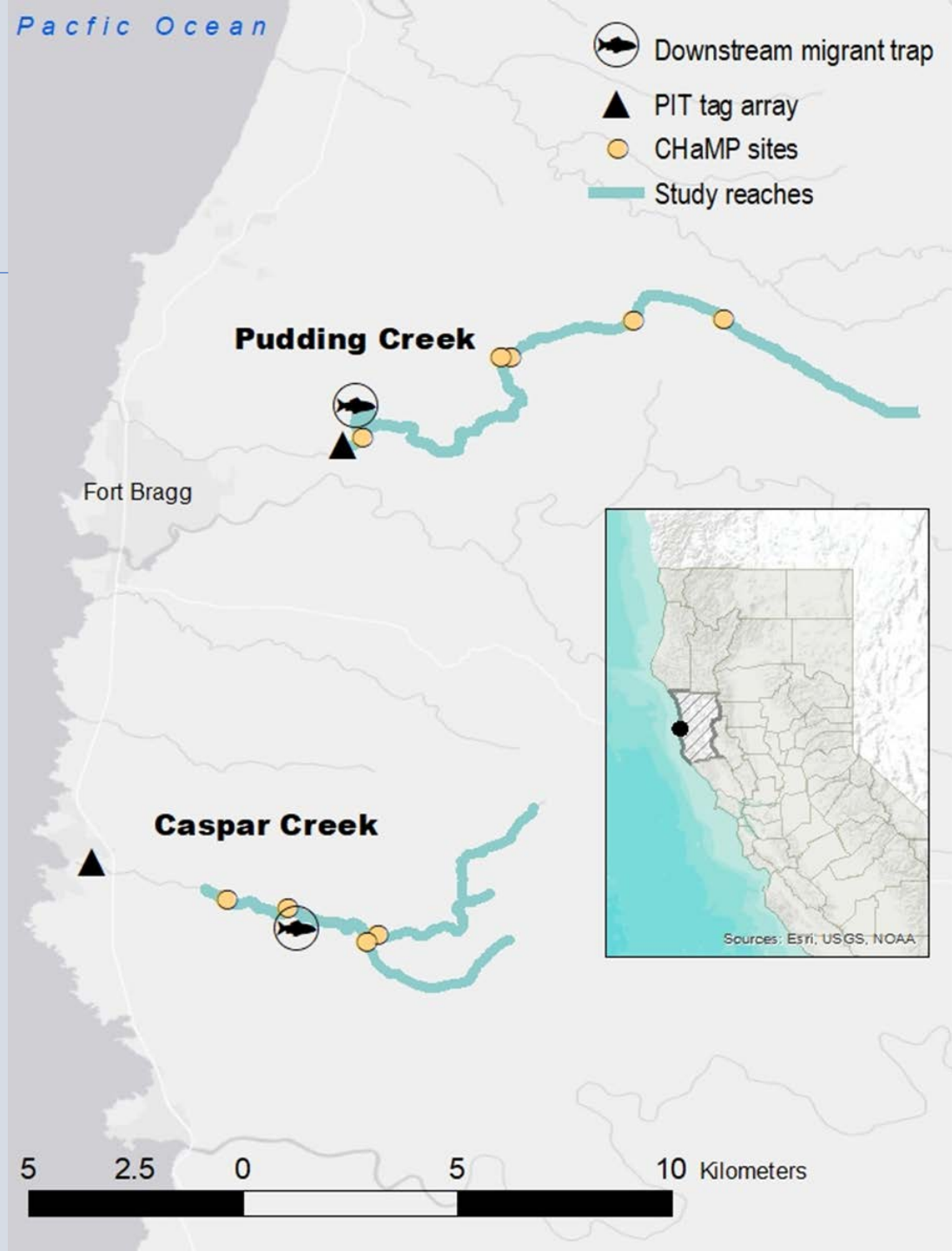
SEAN P. GALLAGHER*, JOE FERREIRA, EMILY LANG, WENDY HOLLOWAY, AND DAVID W. WRIGHT

Experimental Design

- Limiting factors to survival
- Determine treatment and control
- Apply treatment
- Evaluate fish response to restoration and quantify changes in fish abundance, growth and survival due to restoration at the watershed scale

Study Location

- Two small coastal watersheds
- Coho and steelhead bearing
- LCM
- Similar past and current land use in timber
- Lagoonal estuaries-period of closure



DESIGN: Before-After-Control-Impact (BACI)

Compare conditions on **Impact** stream (*Pudding*) to **Control** stream (*Caspar-untreated*) Before (2011 to 2015) and After (2016-2020) implementing restoration treatment (addition of large wood)

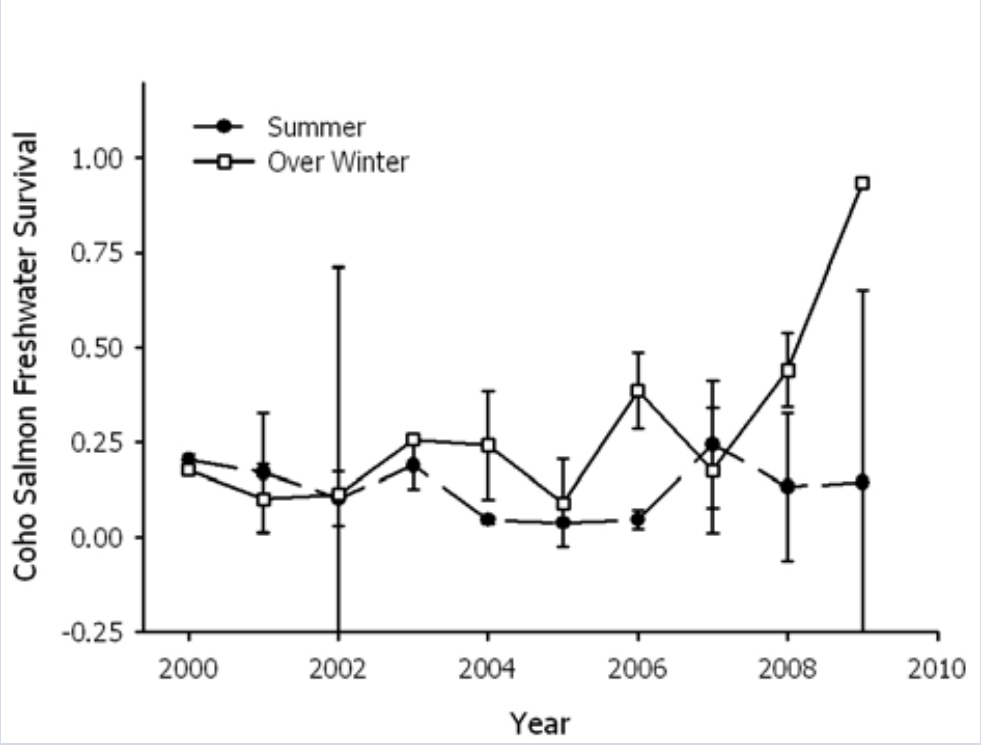
Paired watershed experiment determine fish and habitat response to restoration treatment

Changes observed at the Impact stream need to be greater than those observed in Control. Control needs to be similar in condition to Impact to detect changes caused by the restoration.

Good control

- Few physical differences between the two streams and all the biological metrics varied similarly

- Both had similar trends in:
  - Abundance and survival
  - Survival and stream flow
  - Density dependence
  - Similar physical habitat variables
  - Low instream large wood densities



	Caspar	Pudding
	Control	Treatment
Ownership	Lyme Redwood Forest Co	Jackson State Demonstration Forest
Study area	13.9 km	20.1 km
Watershed size	22 km2	45 km2
Anadromous	16.7 km	25.7 km

Restoration Approach

Goal:

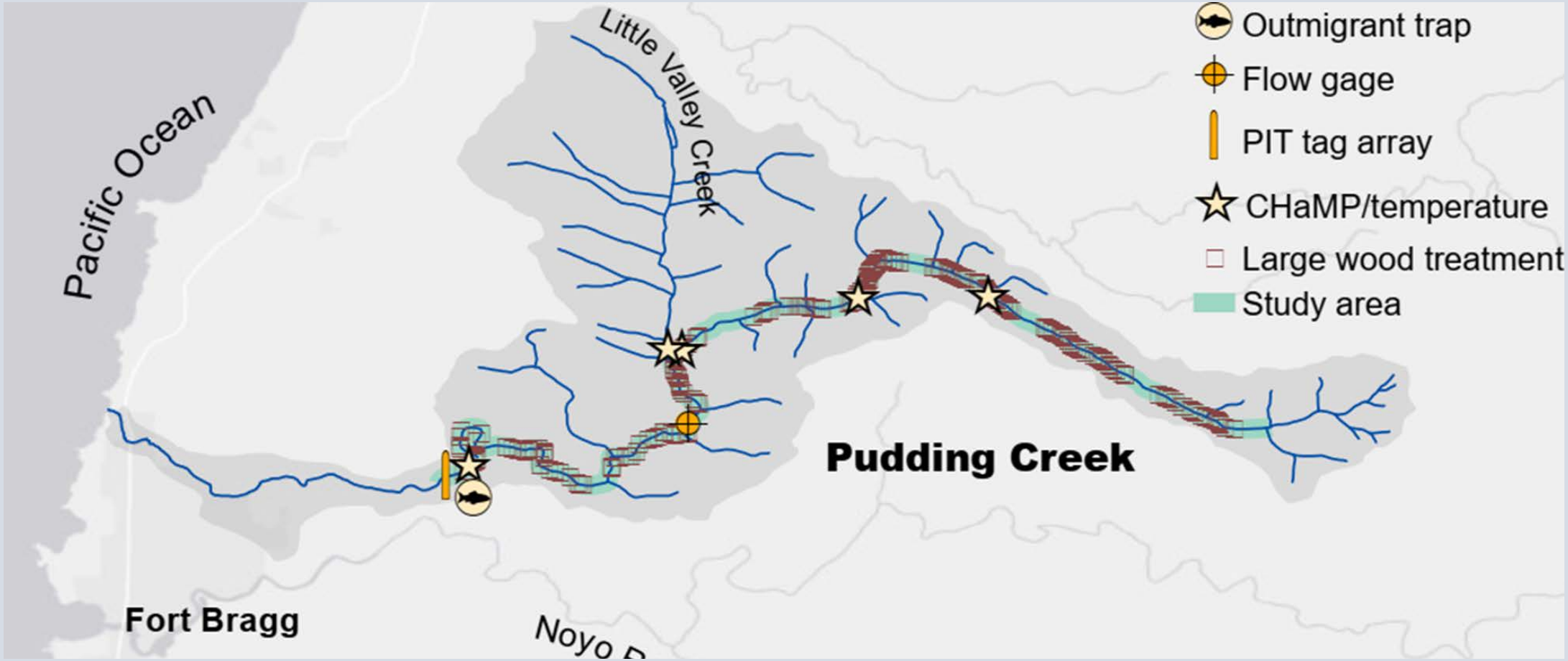
Strategically place large wood to increase habitat complexity instream and connection to important winter habitat (alcoves and floodplains).

Approach:

Whole watershed approach to produce significant and measurable biological response

Design

Treat 80% of anadromous habitat with large wood
Accelerated recruitment strategy



Expected outcomes

- **Biological response:** Improve juvenile growth, abundance, and survival

- **Habitat response:** Increase quantity and quality of summer and winter habitat

Timeline

Study Design

2010-2011

Pre-Treatment Monitoring

2011-2015

Treatment

Summer 2015

Post-Treatment

2015-2020

Share findings

2021 +

Monitoring components

Biological

- Summer Parr, Fall Parr, Smolt
- Abundance, growth, survival
- Annual and seasonal
- PIT tags

Habitat

- Winter and summer
- Intensive and rapid

Analysis: response of metrics and covariates were treatment (pre- or post- LWD implementation), watershed (Pudding and Caspar).....and

Smolt abundance

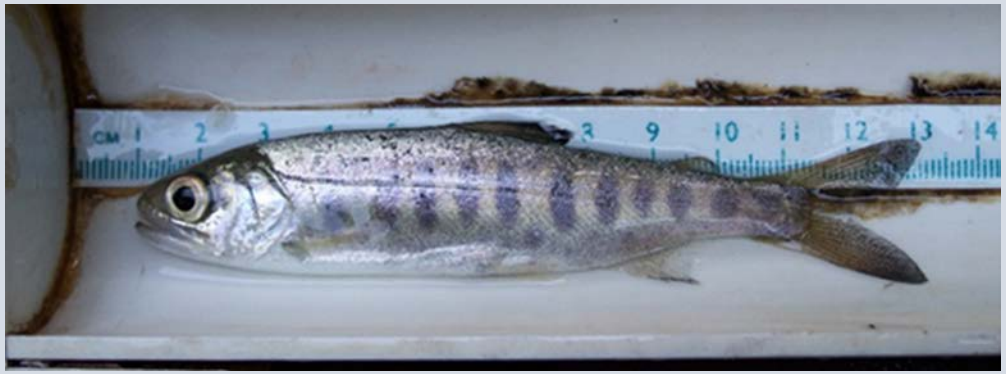
- Outmigrant trap

- Mark recapture techniques to estimate juvenile spring smolt abundance

Growth

- **Summer Growth:** growth rate between summer and fall captures during electrofishing

- **Winter Growth :** between fall capture during electrofishing and recapture at the downstream outmigrant trap.



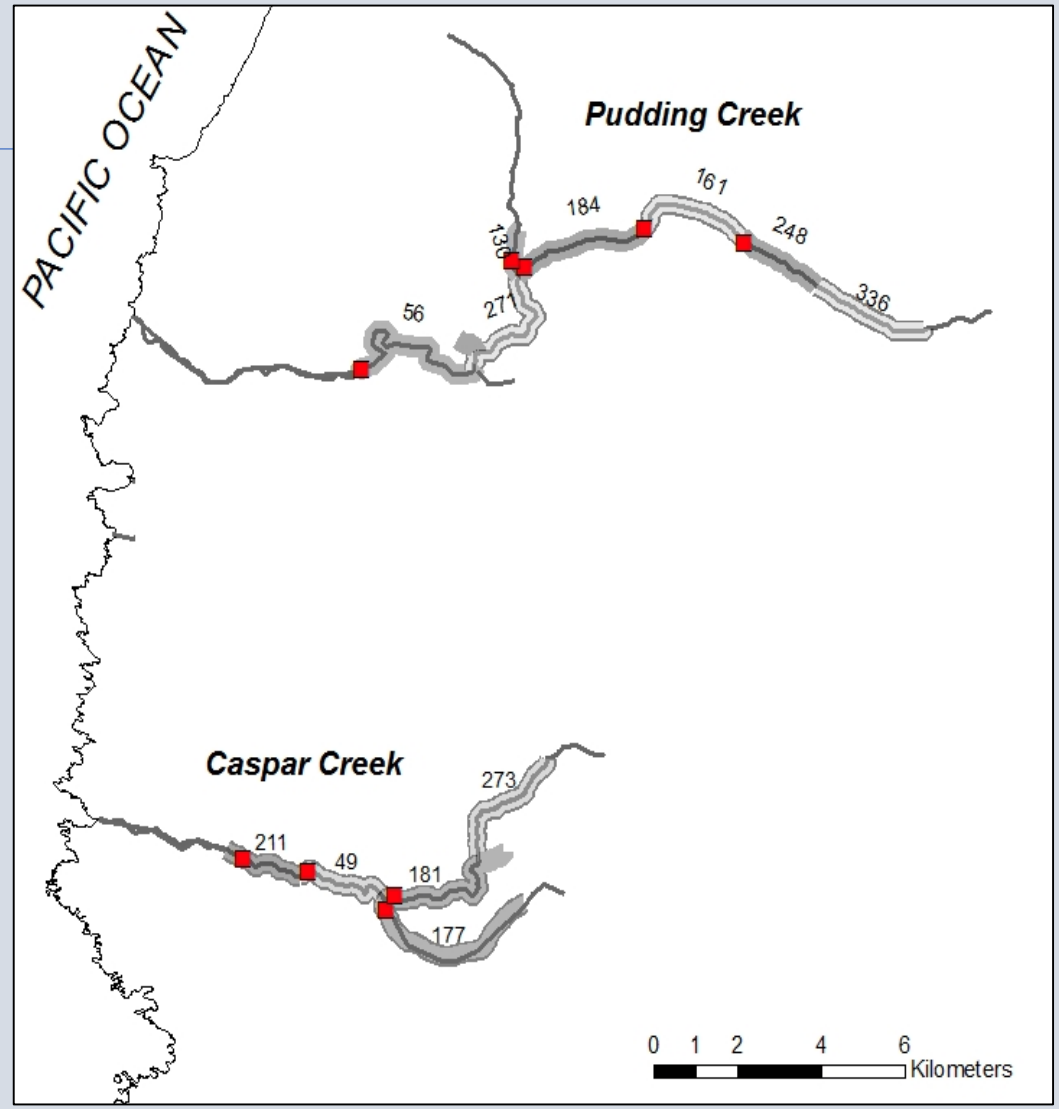
covariates were treatment (pre- or post- LWD implementation), watershed (Pudding and Caspar), and smolt abundance.

Winter survival

- detect movement of tagged salmonids and used for survival analysis
- detection data from electrofishing, downstream out-migrant traps, and downstream PIT arrays.
- covariates selected based on hypotheses relating biological and habitat factors that we expected to influence survival rates

Habitat monitoring

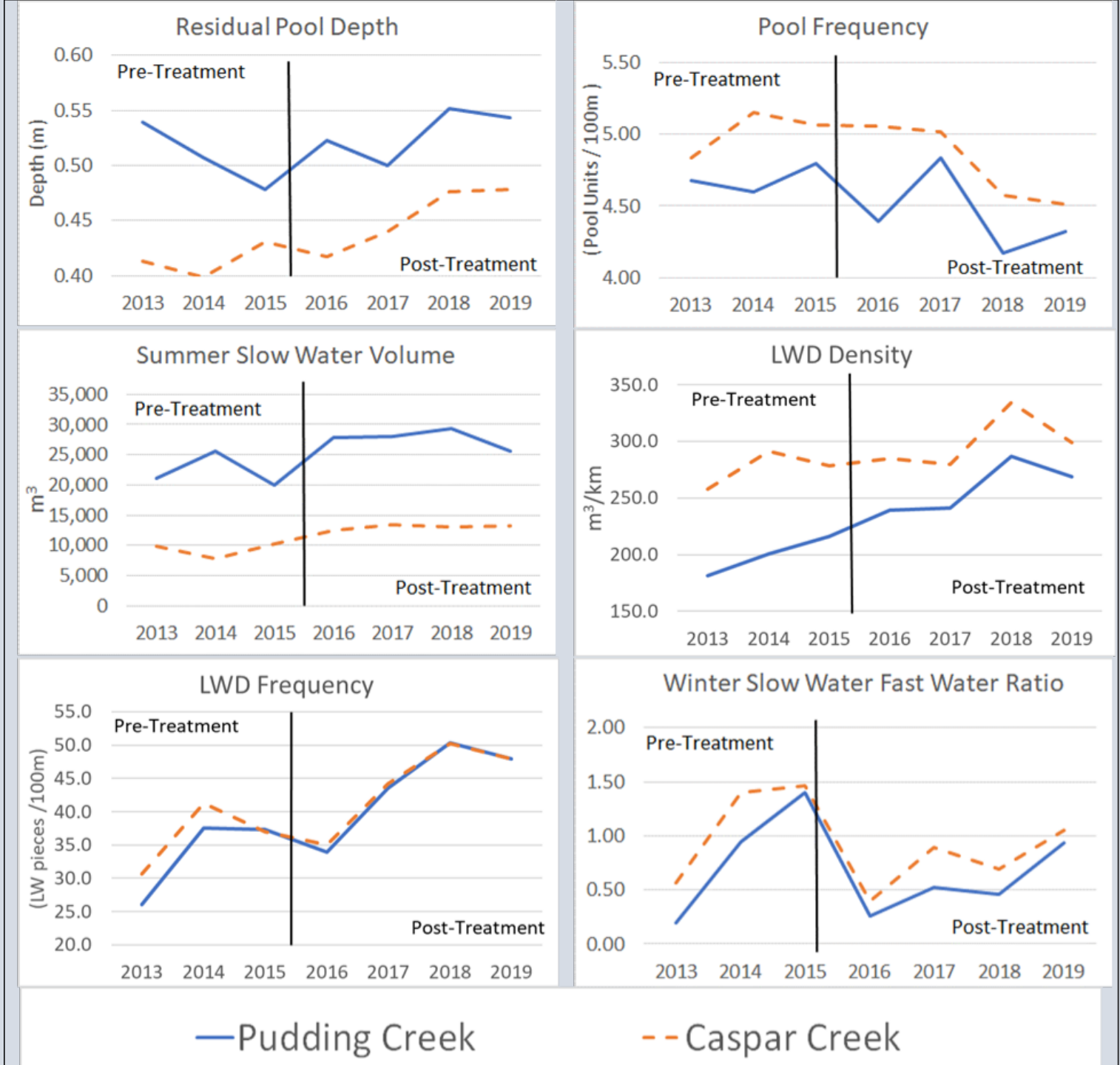
- Winter and Summer
- Columbia Habitat Monitoring Program (CHaMP) protocol:
- Developed rapid protocol (RASH) based on CHaMP methods to survey entire watershed (reach numbers)
- Collected many habitat attributes and for statistical analysis chose metrics repeatable and important to fish



Habitat data

Channel morphology
Substrate composition
Fish Cover
Stream Flow
Water Temperature
Habitat types
Habitat volume
Habitat heterogeneity
Large wood

Metrics Selected



Biological response

- No obvious treatment-based juvenile salmonid response
- Both watersheds experienced a similar increase in growth rates between treatment periods

Fish Response-Abundance

- Decrease in Coho smolt abundance post treatment in Pudding Creek no change in Caspar
- Pudding always had higher smolt abundances than Caspar
- No difference for steelhead

Fish Response-Summer Growth

- Summer growth rates were lower in Pudding Creek for both coho and steelhead
- Coho summer growth increased post-treatment compared to pre-treatment
- No change in growth rates for steelhead
- Pudding steelhead mean summer growth was lower than Caspar

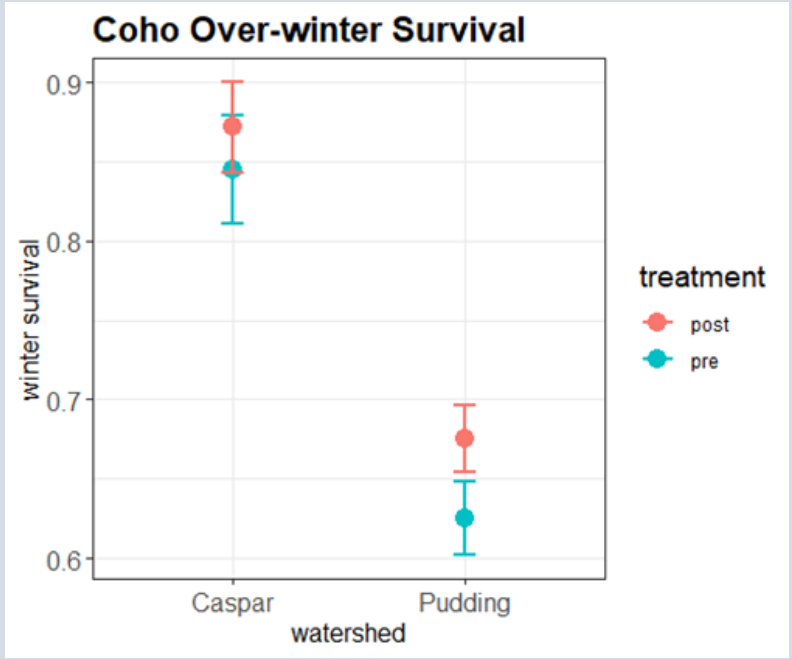
Fish Response-Winter Growth

- was no evidence ($p=0.904$) to suggest a difference between Caspar post-treatment and Pudding pre-treatment Coho winter growth rates.

- strong evidence ($p<0.001$) that Pudding post-treatment winter growth for coho was higher than Pudding pre-treatment but was similar to the increase seen in Caspar ($p<0.001$).

Fish Response-Winter Survival

- Coho winter survival increased in both creeks pre- to post; but increased more on Pudding Creek
- Caspar Creek Coho survival was higher before and after treatment
- Fork length was an important predictor of winter survival in both species
- Coho survival in Pudding decreased with increasing flows while Caspar survival increased

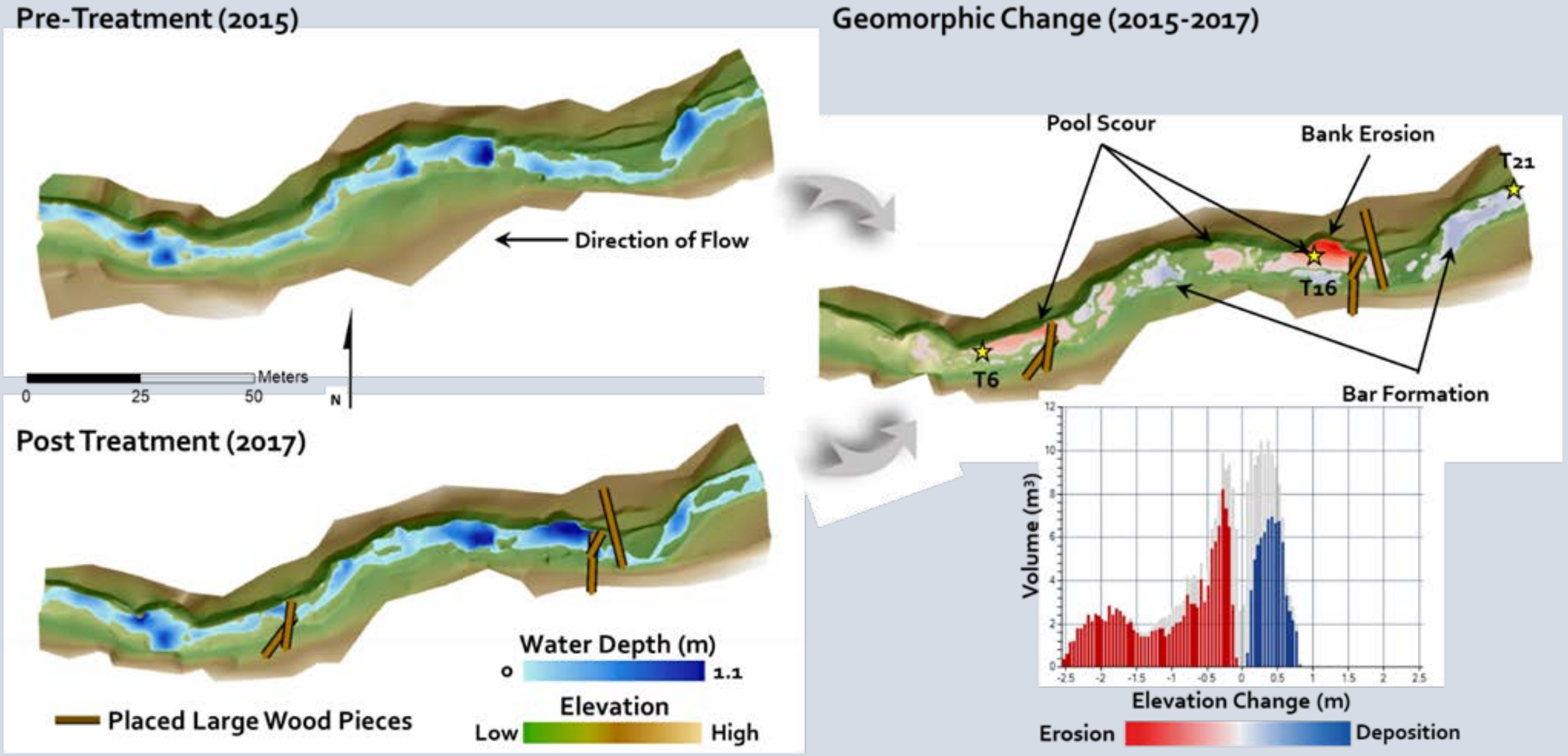


Habitat response

- Large wood increased after the treatment period, and this resulted in a change in the available summer slow water habitat

- While large wood density and slow water increased in both watersheds from pre- to post-treatment, we found evidence that it increased more in Pudding Creek compared with Caspar Creek

- Overall limited habitat change in the metrics we evaluated


Pre-Treatment (2015)
Direction of Flow
Meters
0
25
50
N
Post Treatment (2017)
Placed Large Wood Pieces
Water Depth (m)
0
1.1
Elevation
Low
High
Geomorphic Change (2015-2017)
Pool Scour
Bank Erosion
T21
T16
T6
Bar Formation
Volume (m³)
Elevation Change (m)
Erosion
Deposition

ELR (2021)

Localized pool formation and bed scour

Treatment site during high flows



Conclusions

- We saw wood density increase more in Pudding compared to Caspar following treatment, but we did not see explicit treatment-based improvements in juvenile salmonid response.
- Coho winter growth and survival improved in both watersheds through time-drought impacts
- We did not observe increases in other habitat metrics evaluated, which may be why we did not observe a fish response

Questions

- A decrease in smolt abundance post treatment in Pudding- other limiting factors at other life stages
- Treatment design need more time?
- Protocol to assess habitat connectivity in winter
- How do we incorporate findings into treatment?
- Future evaluations needeed?

Effects of Large Wood Restoration on Salmonid Growth and Survival in a Northern California Watershed: A Before-After-Control-Impact Experiment

Natalie Okun, M.S. Candidate

Humboldt State University

Natural Resources: Fisheries

Advised by Dr. Mark Henderson

Friday, November 19, 2021 at 10am

Zoom link

meeting ID: 814 3347 2840, password: BACI

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