Flow and Survival Studies to Support Coho Recovery in Flow-Impaired Tributaries

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Flow and Survival Studies to Support Coho Recovery in Flow-Impaired Tributaries

Part I. Predicting distribution of wetted habitats and implications for flow and fish management

Part II. Survival of juvenile coho in relation to environmental conditions in lower Russian River tributaries

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Part I. Predicting the distribution of wetted habitats: implications for fish and flow management

Hana Moidu

Background

In California, intermittent streams make up much of the river network

Seasonal drying acts as a bottleneck for fish populations, including endangered coho

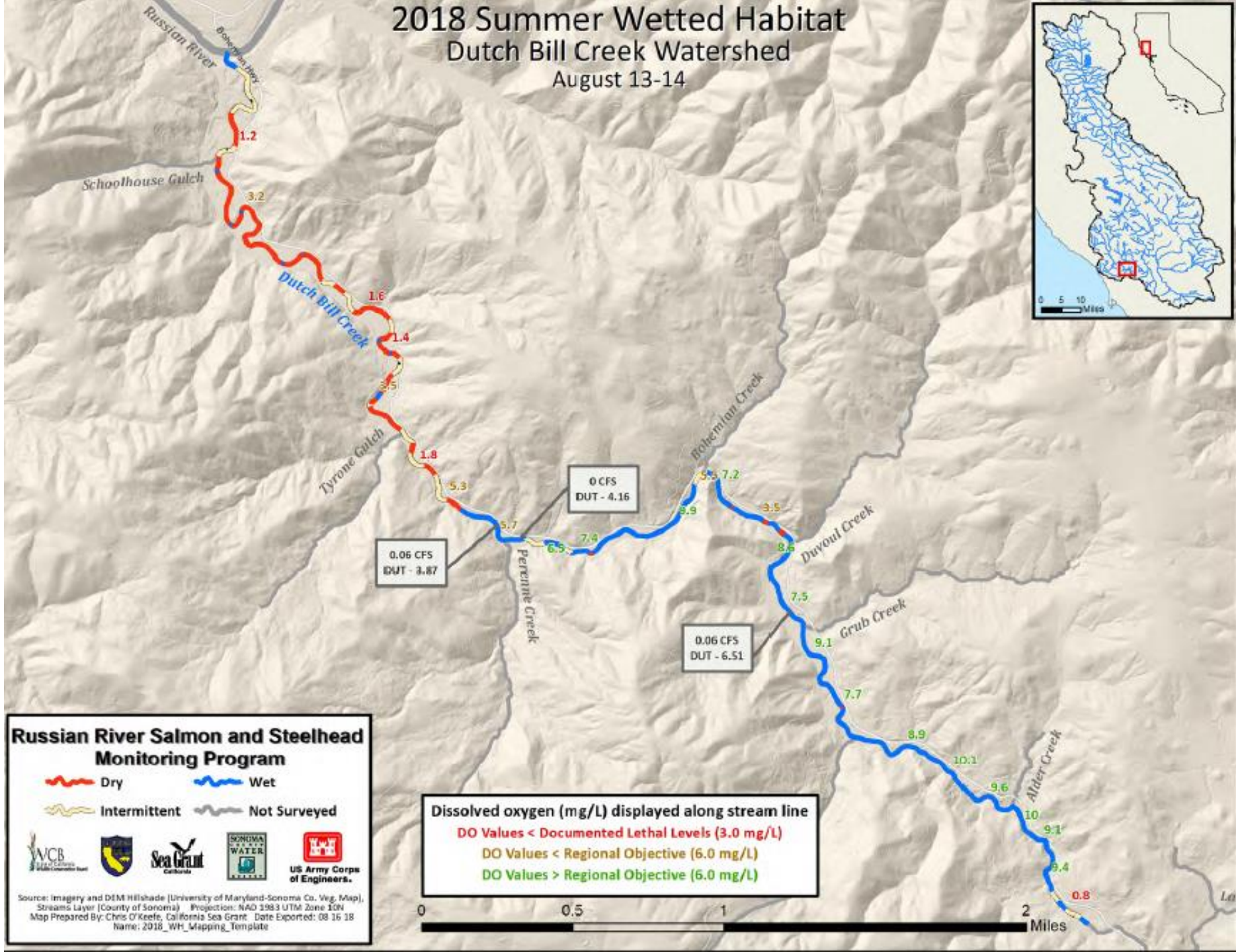
Organisms rely on persistent wetted reaches during dry periods

Extent of drying varies with water year

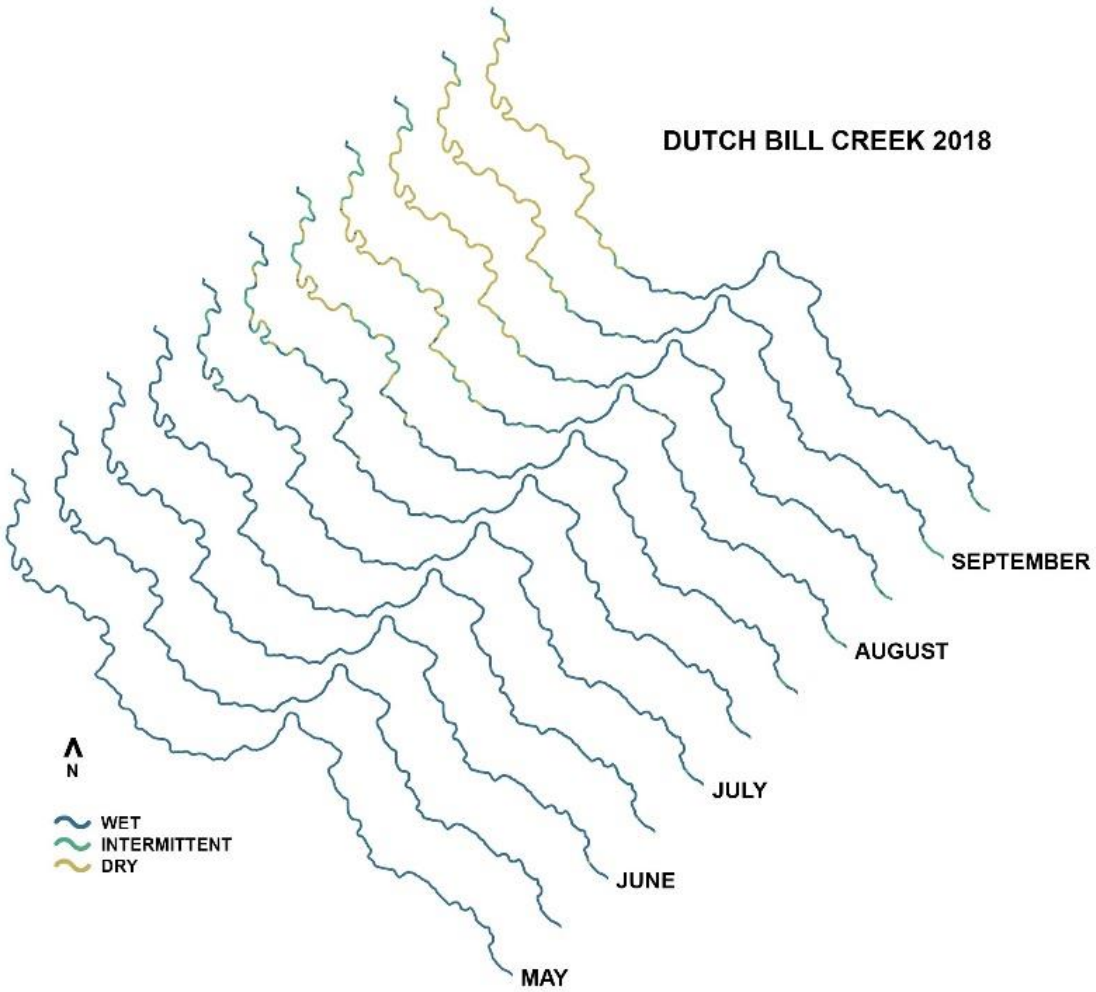
Study Question

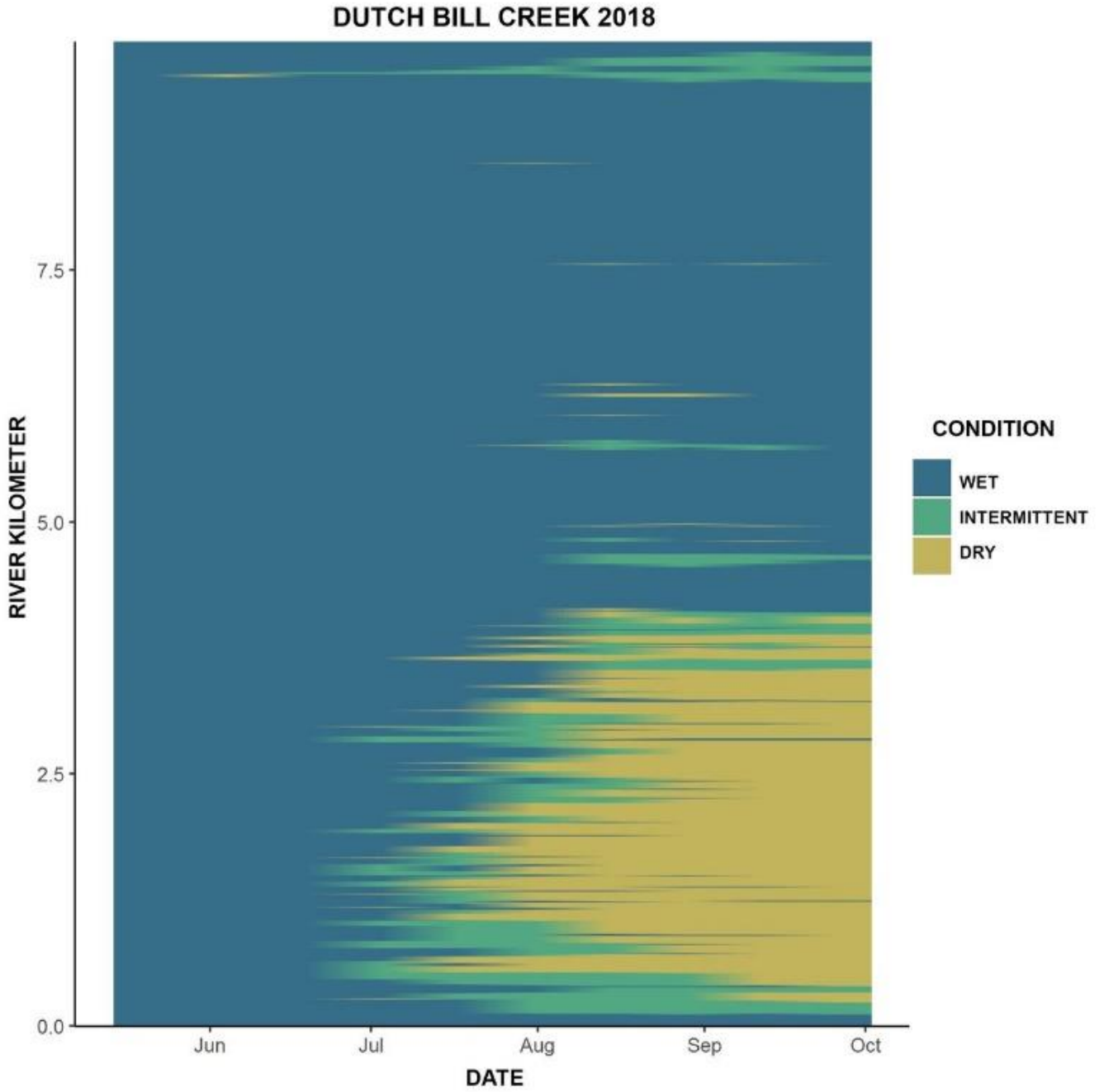
Can we predict streamflow permanence spatially and temporally?

Wet Dry Mapping



Wet Dry Mapping



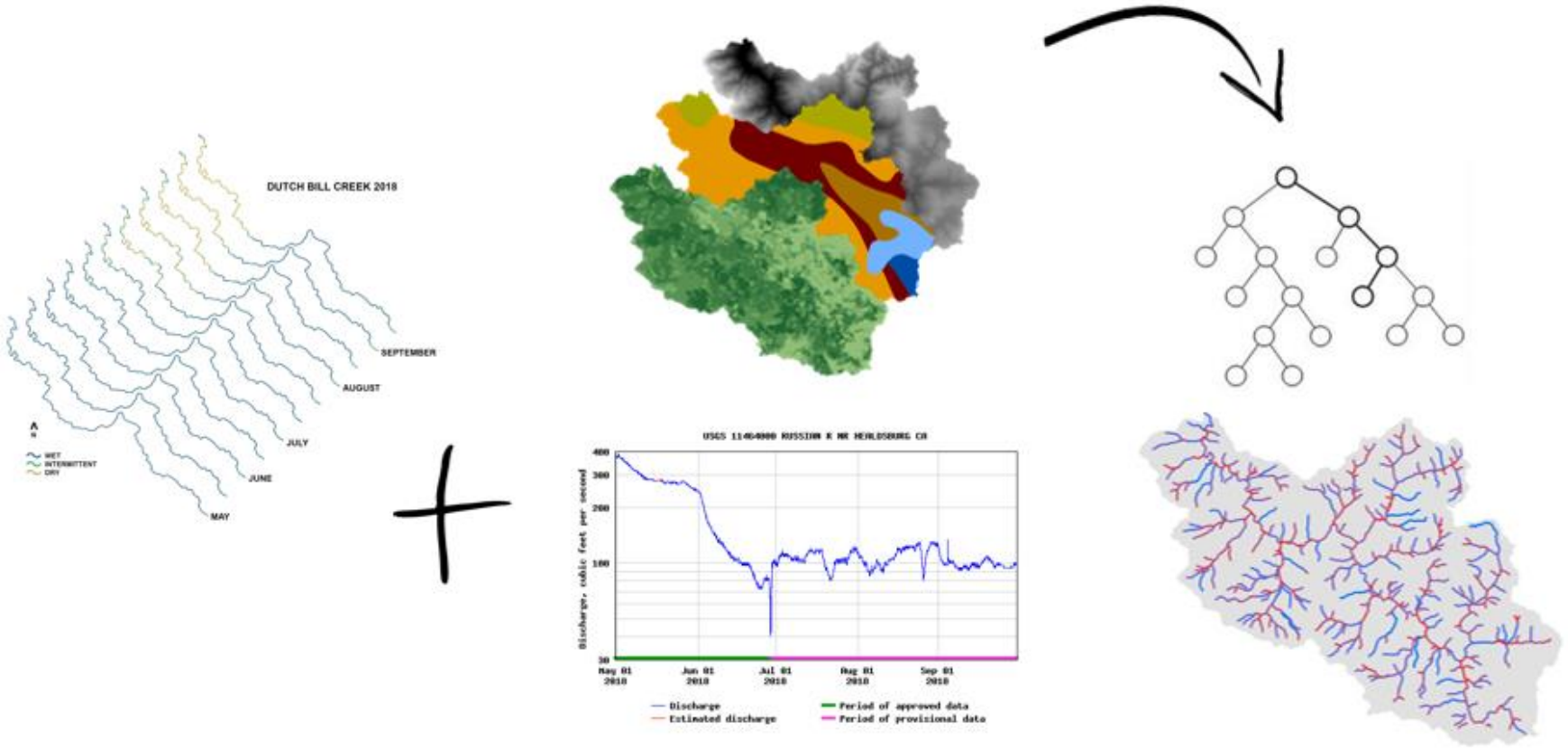


Spatiotemporal Prediction of Flow Permanence

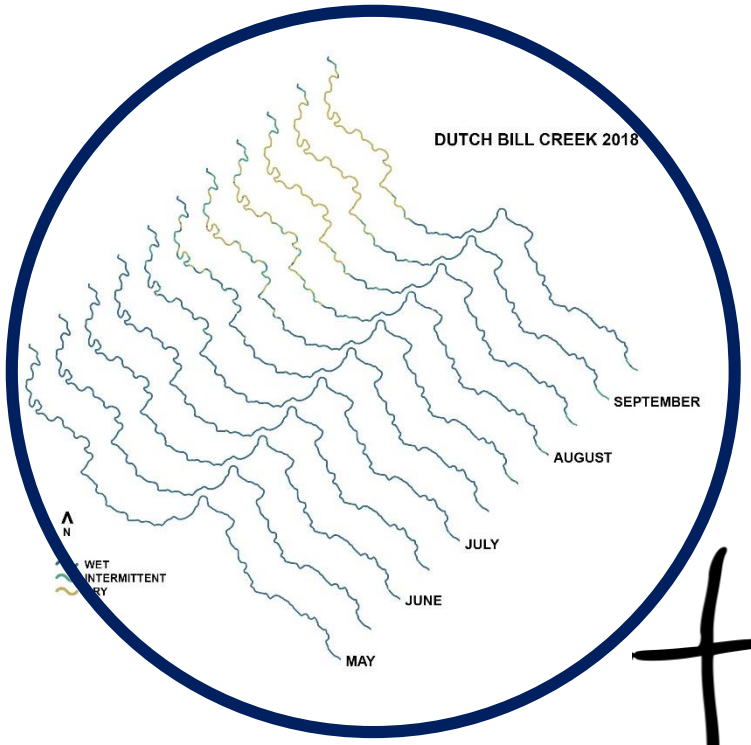
Develop a model to predict end-of-season flow permanence over space and time

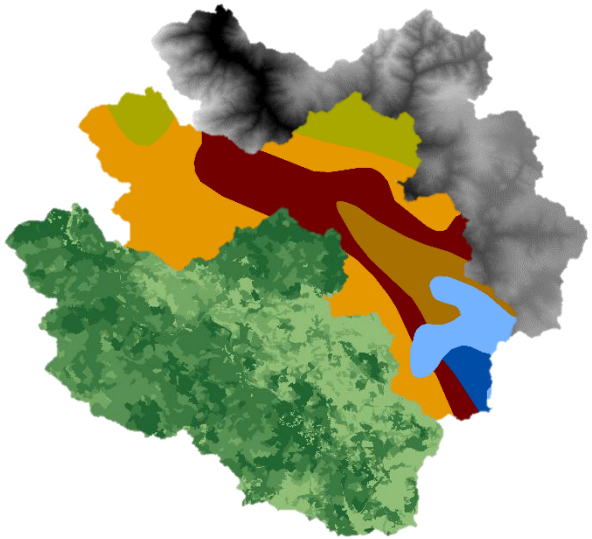
Relate wet/dry observations and predictor variables

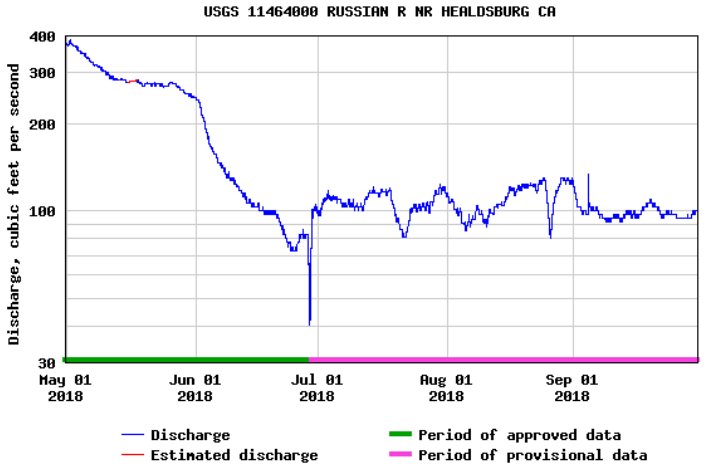
Outcome of the model is the probability of streamflow permanence for each river kilometer segment

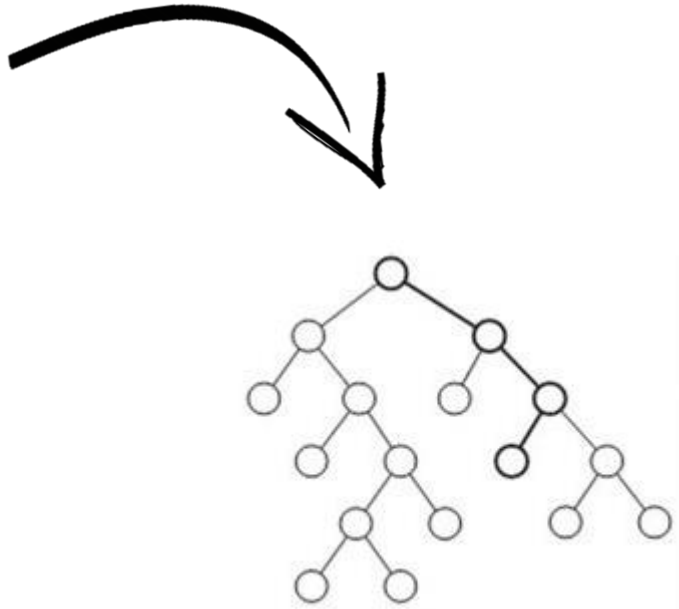


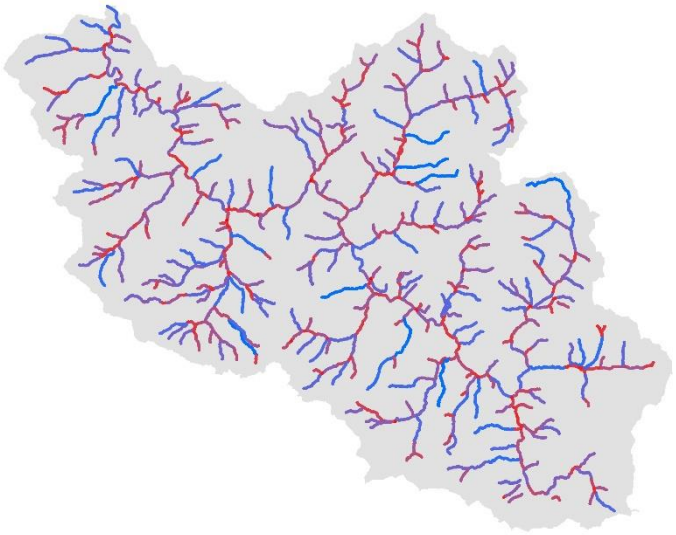
Workflow Schematic











Observations **Predictor Variables** **Probability of Wetted Channel**

Wet Dry Mapping Observations

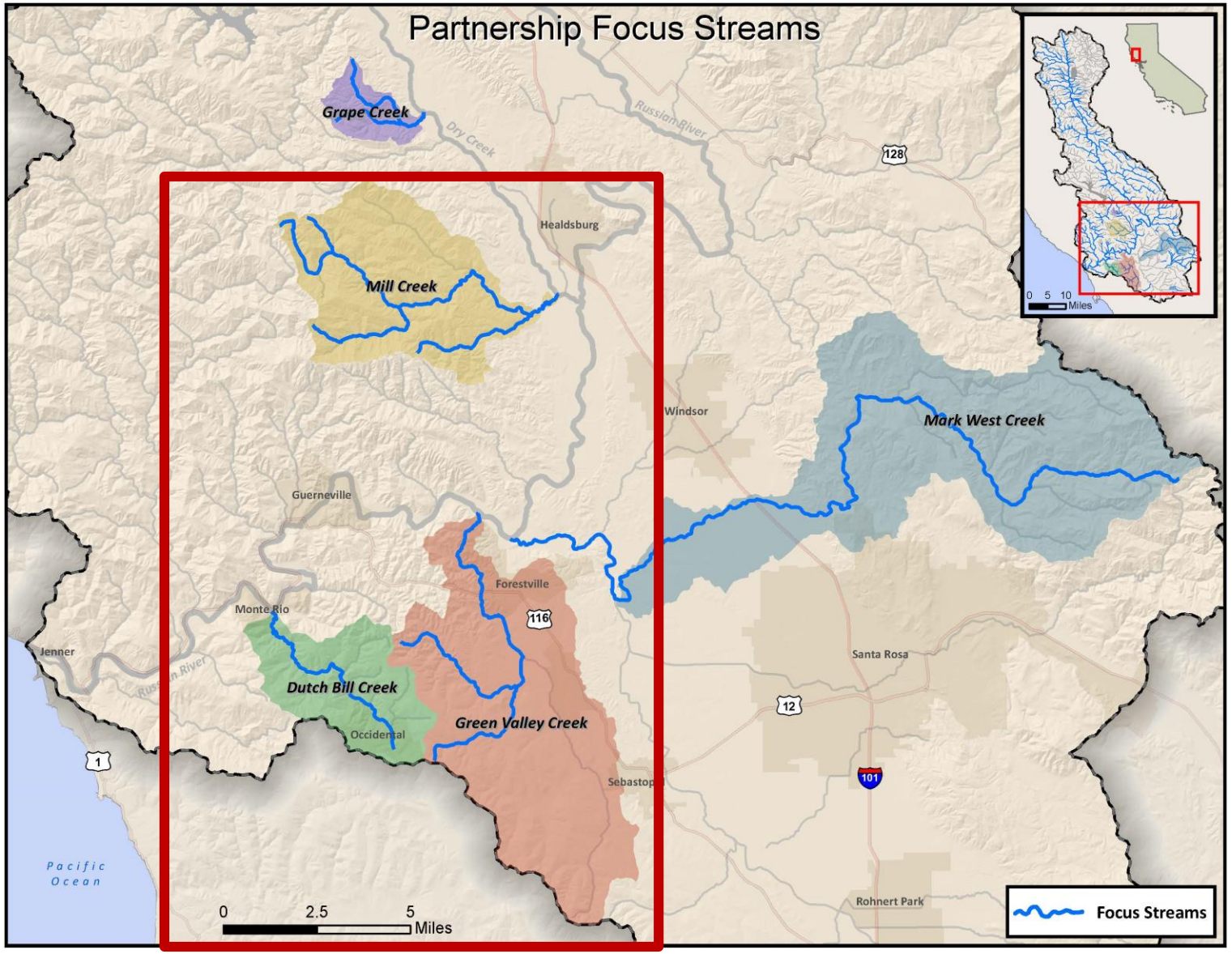
Repeated wet/dry mapping by RRSSMP

Observations throughout the drying season for:

- Dutch Bill Creek
- Green Valley Creek
- Mill Creek

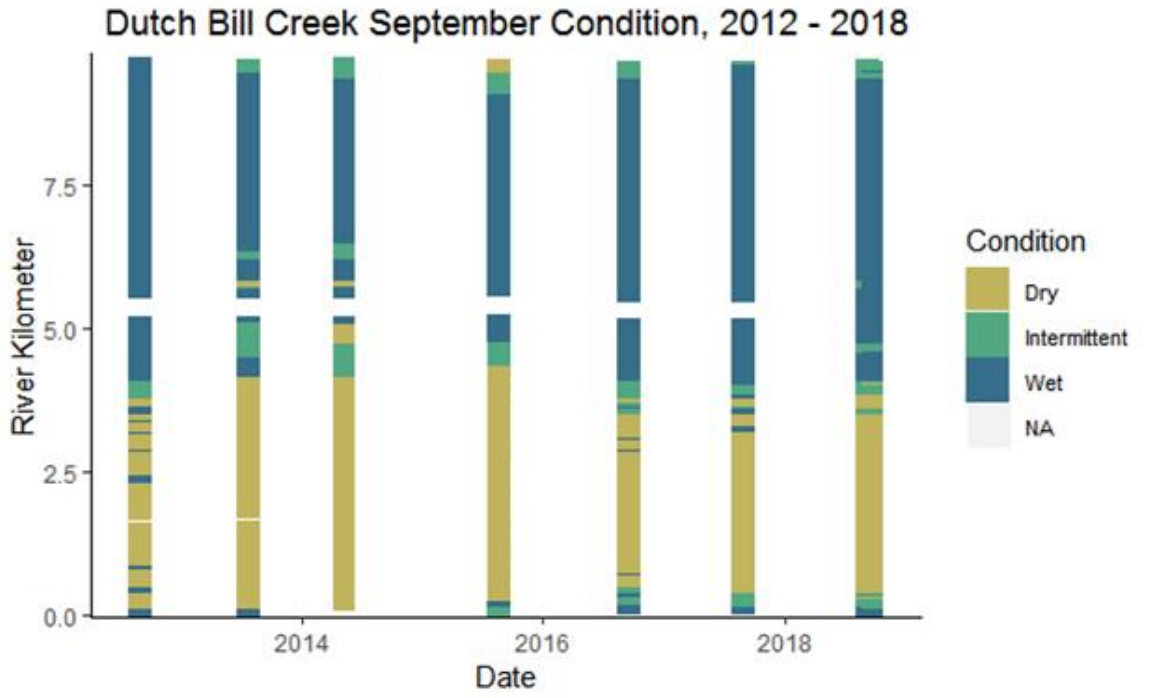
Observations span a variety of climatic scenarios

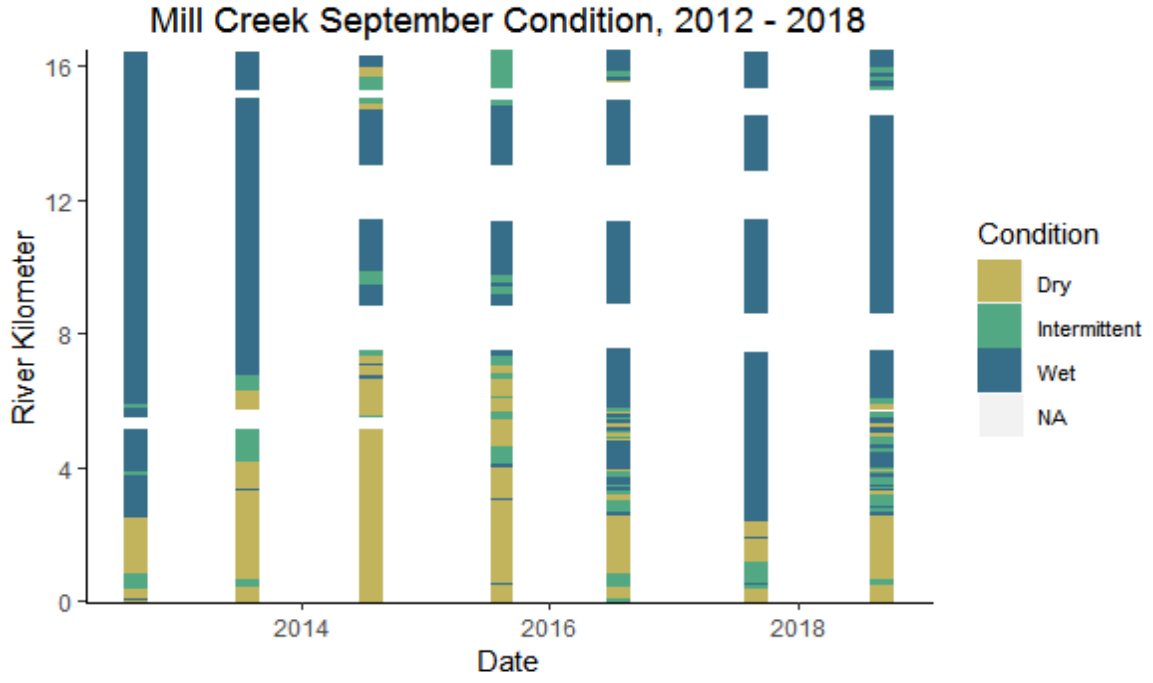
Can be used to determine how streamflow permanence changes with respect to antecedent conditions



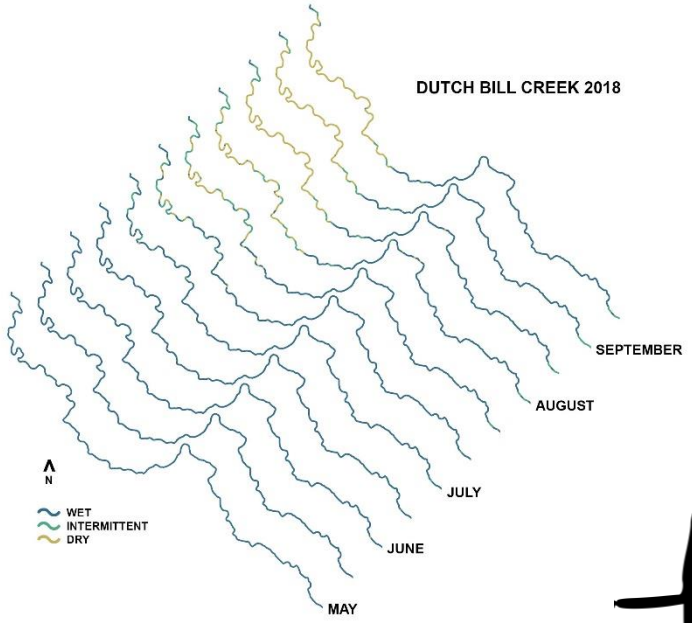
Wet Dry Mapping Observations

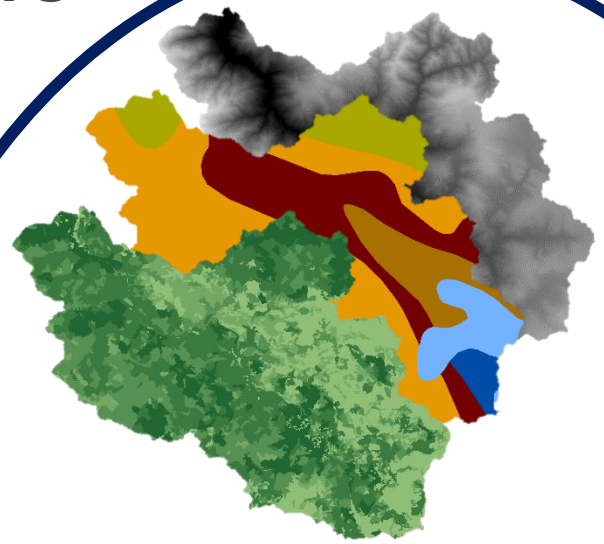
Differences in antecedent precipitation and local physical conditions reflected in annual wet-dry mapping data

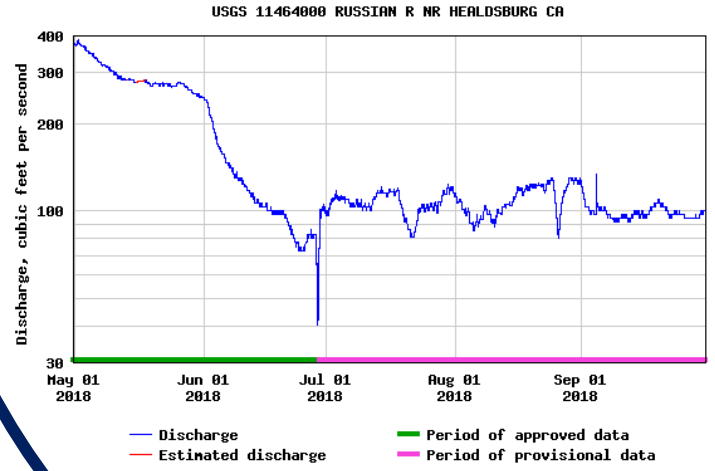


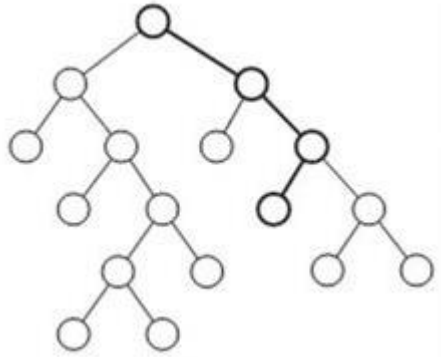


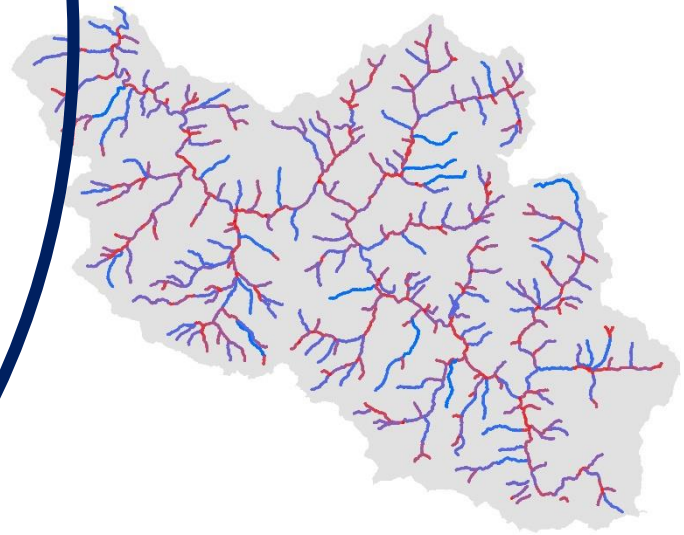
Workflow Schematic











Observations

Predictor Variables

Probability of Wetted Channel

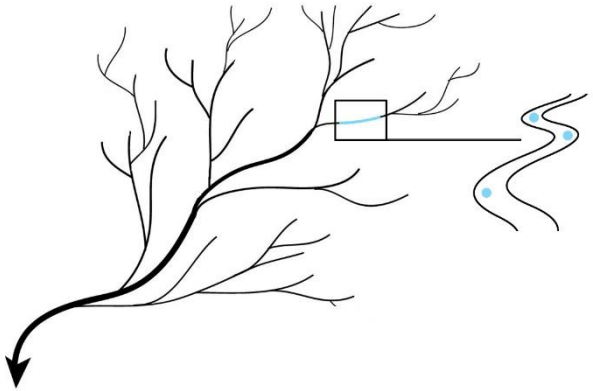
Potential Controls on Flow Intermittency

Meteorology
- Precipitation events
  - Low frequency
  - Low duration
  - Low intensity
- Climate

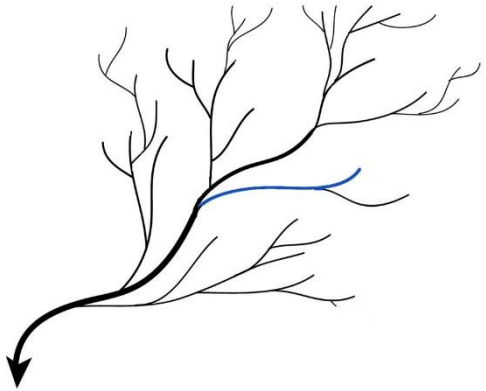
Geology
- Grain size
- Slope
- Aggrading/degrading
- Lithology
- Drainage area

Landcover
- Water exportation
- Groundwater extraction
- Agriculture
- Urbanization
- Deforestaton

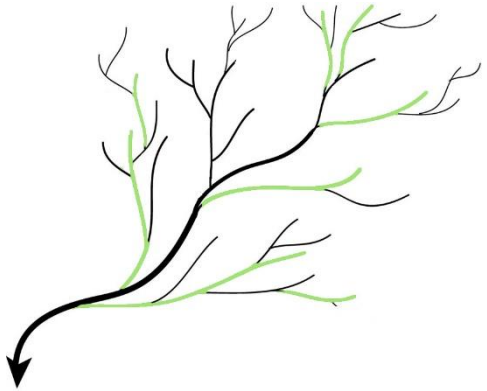
Importance of control depends on scale; reaches will behave differently in wide valley floor versus confined channel



reach



section



phase

drainage

Costigan et al., 2016

Predictor Variables

Meteorology

- Temperature
- Precipitation
- Evapotranspiration
- Discharge

Geomorphology

- Geology
- Slope
- Valley width
- Elevation
- Curvature
- Drainage area
- Soil class
- Water capacity of soil
- Permeable lithology

Landcover

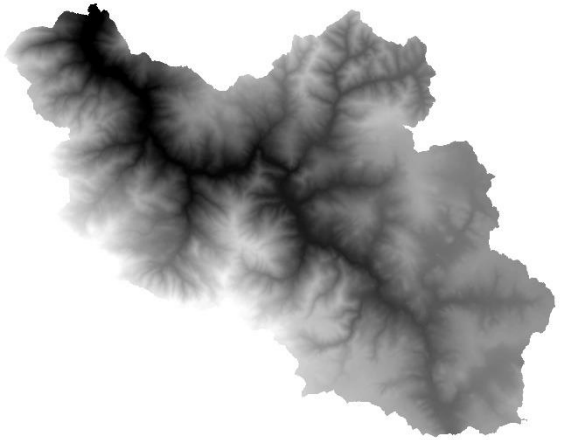
- Percent of basin:
  - Forest
  - Agriculture
  - Irrigated
  - Developed
- Canopy density

Variables determined at the basin scale

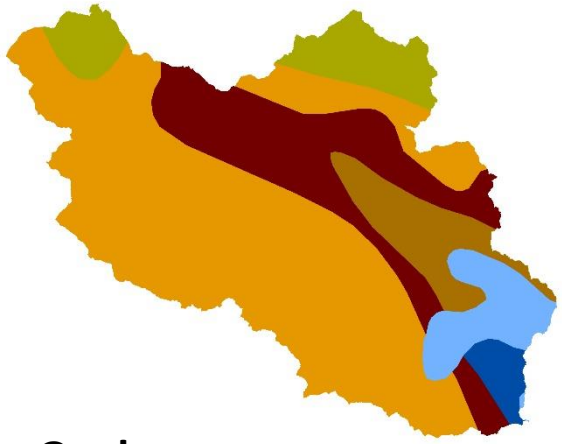
Variables determined at the reach scale

Predictor Variable Data Layers

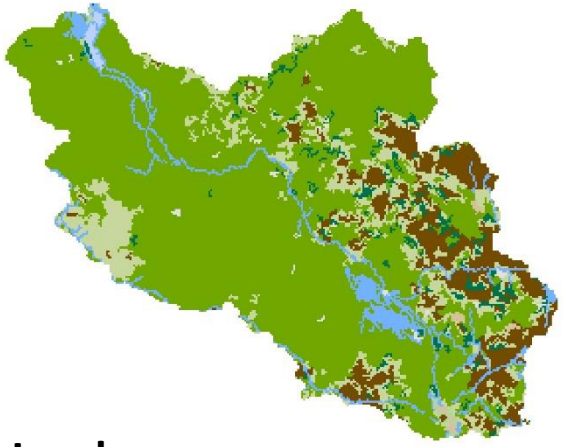
Dutch Bill Creek watershed



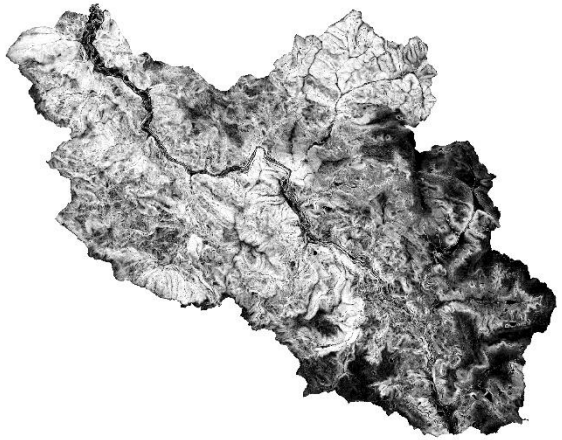
Topography



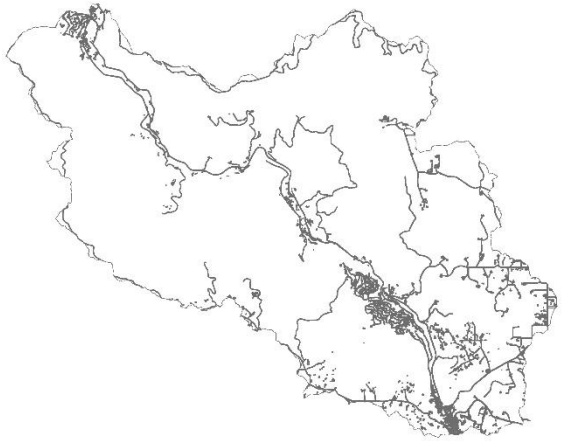
Geology



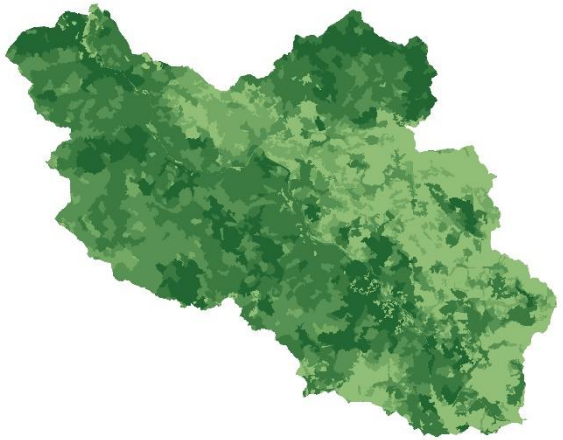
Land cover



Slope

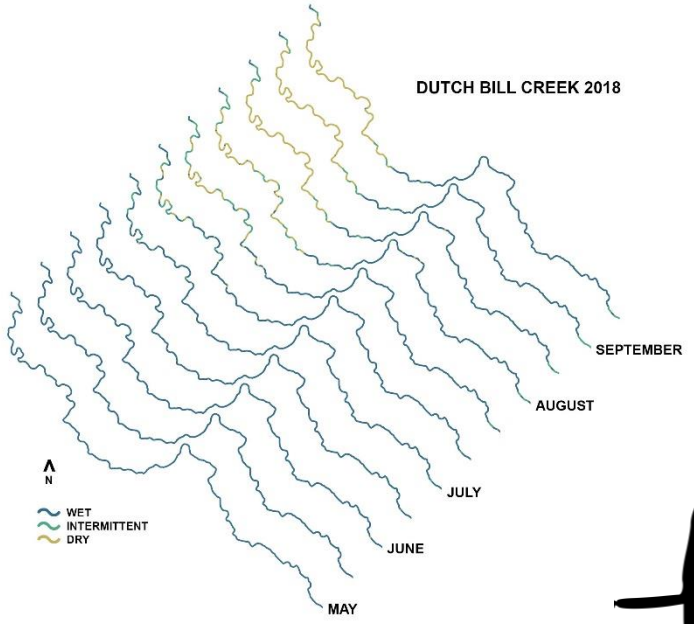


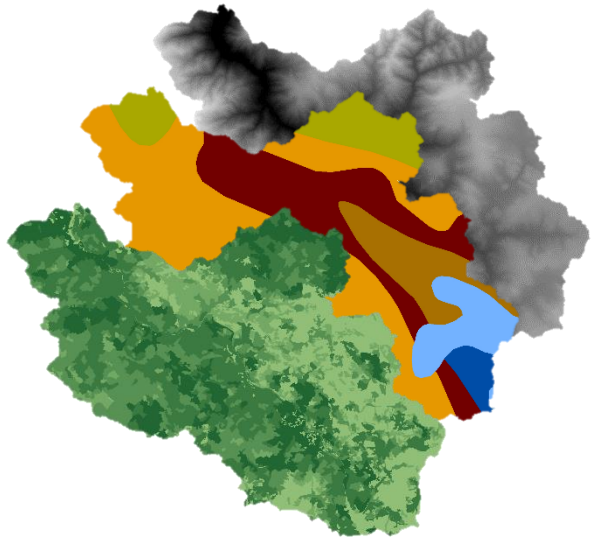
Impervious surfaces

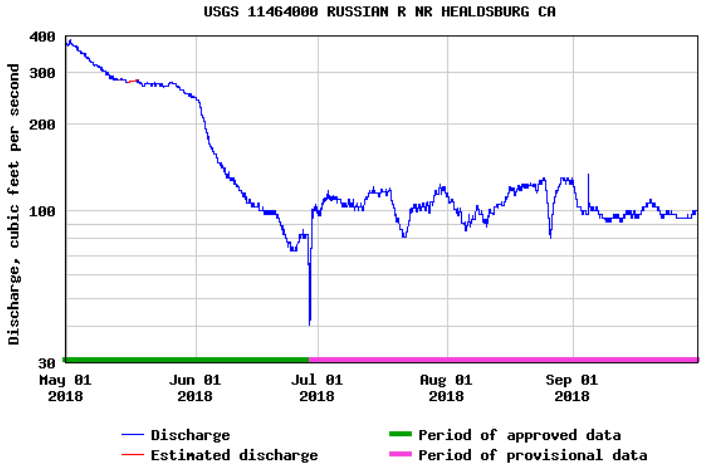


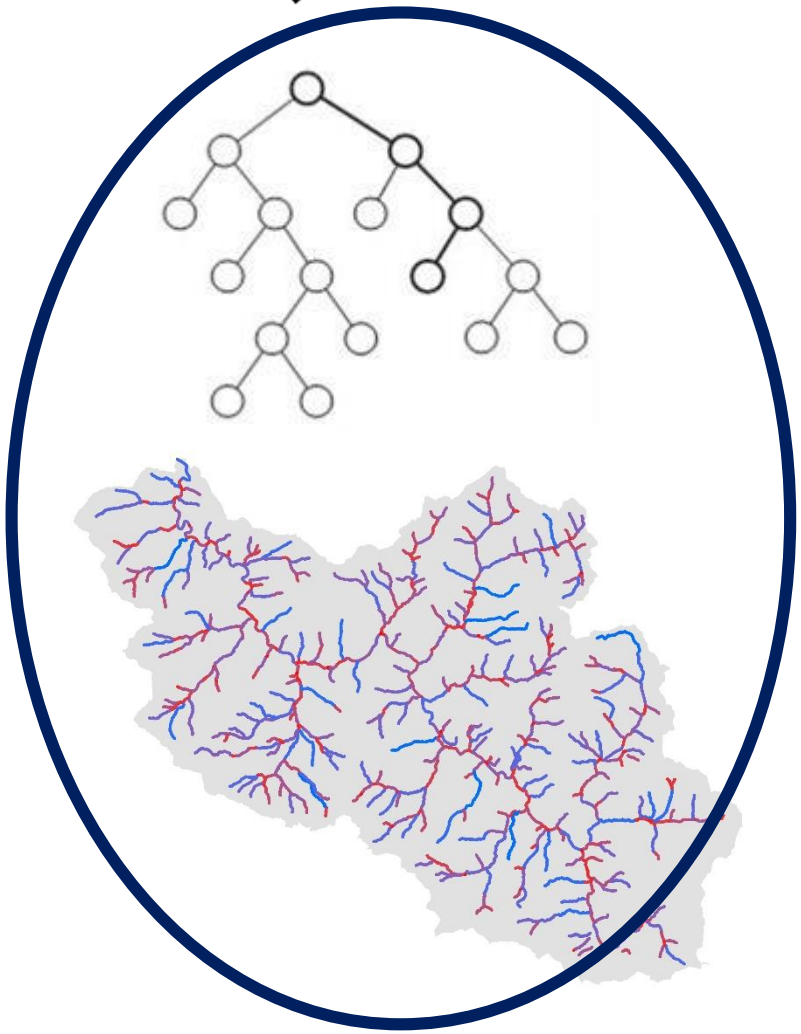
Canopy density

Workflow Schematic









Observations

Predictor Variables

Probability of Wetted Channel

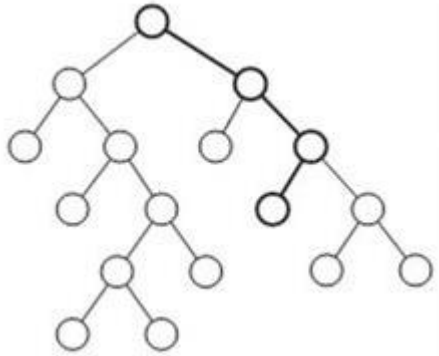
Predictive Modeling (in progress)

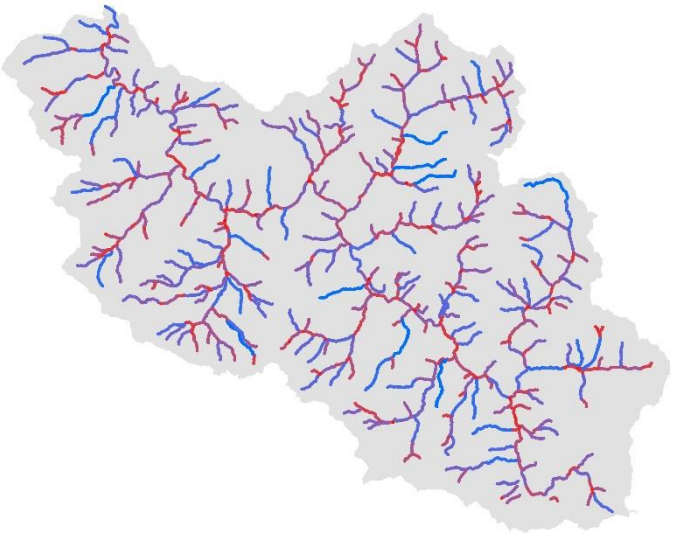
Testing random forest (classification) models with varying predictor and spatial scale of response

Evaluate model performance and sensitivity of the model

Determine the critical variables required to predict end-of-season streamflow permanence

Assess model accuracy in other watersheds





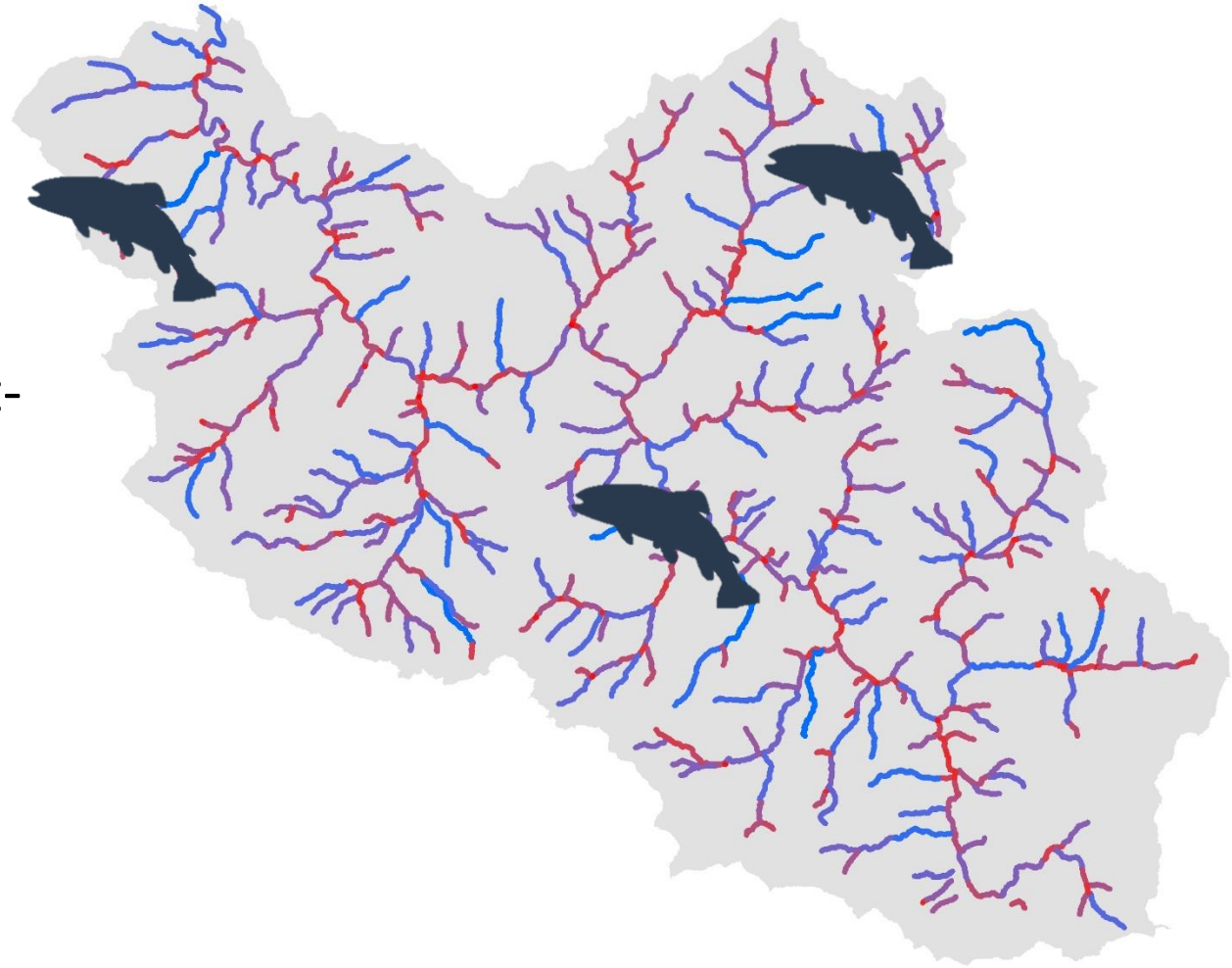
Streamflow Permanence Probability

Implications for drought impacts

This research will help identify physical and climatic controls on intermittency

Potential tool to manage systems for short-term flow enhancement and fish rescue

Could help to predict long-term responses of intermittent stream habitats to climate change, water withdrawals, and flow enhancement efforts



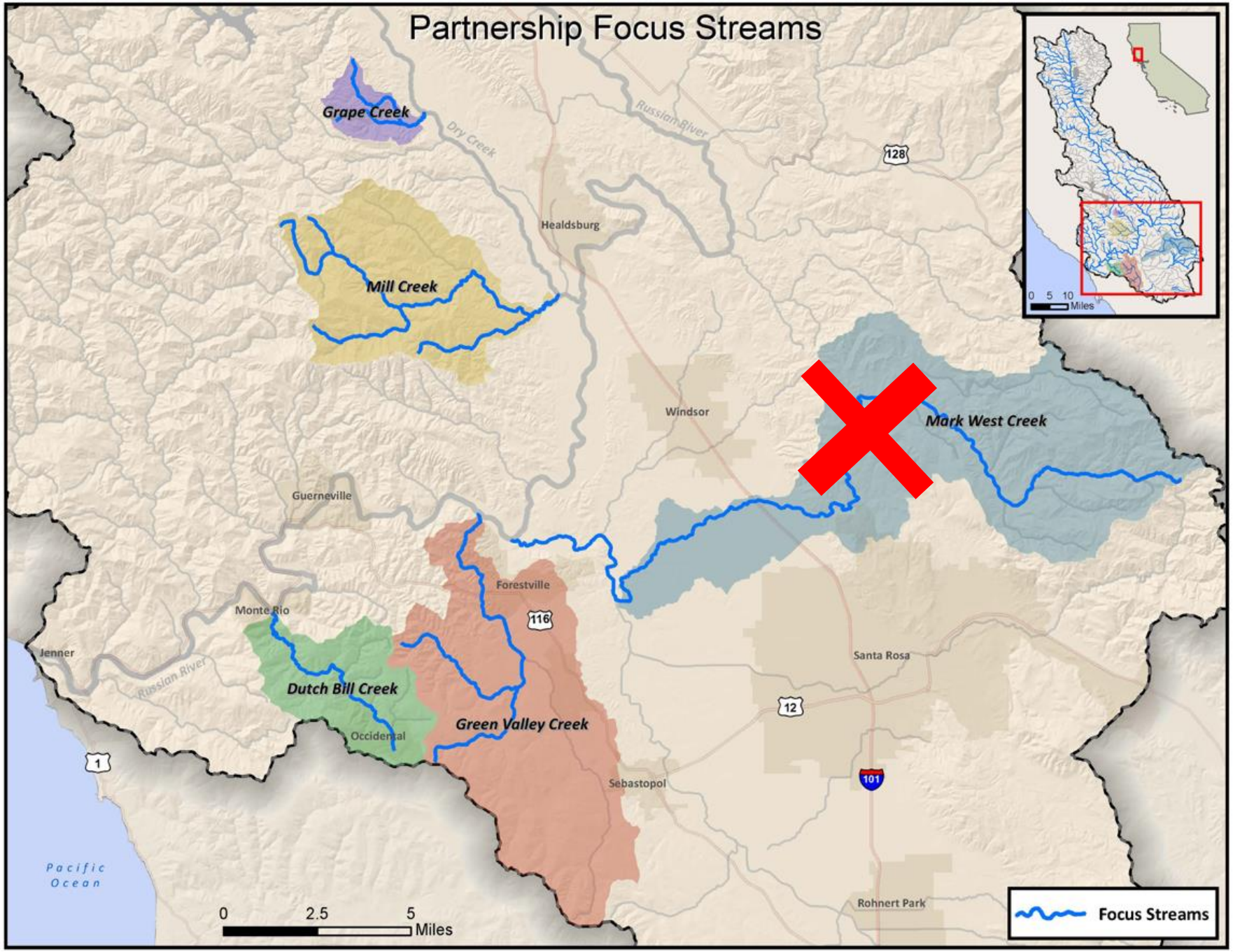
Part II. Environmental controls on juvenile salmon survival in lower Russian River tributaries

Ross Vander Vorste

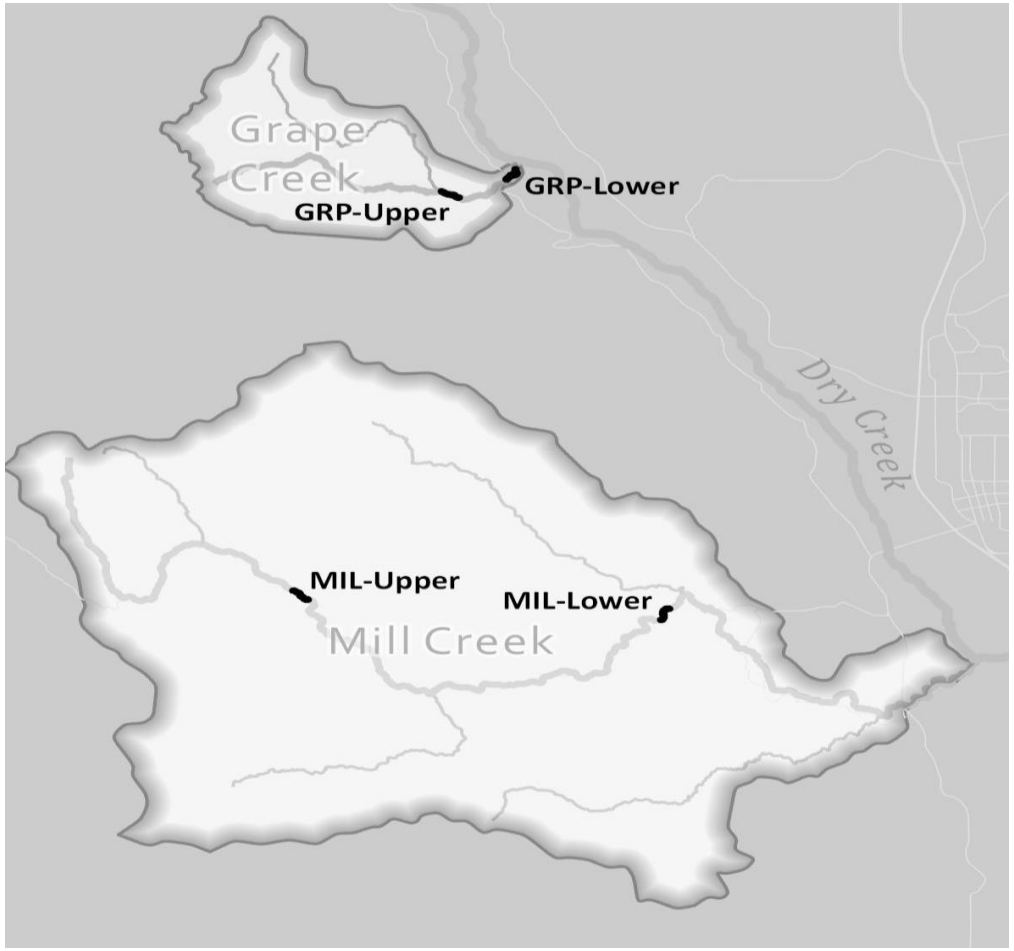
Study Question

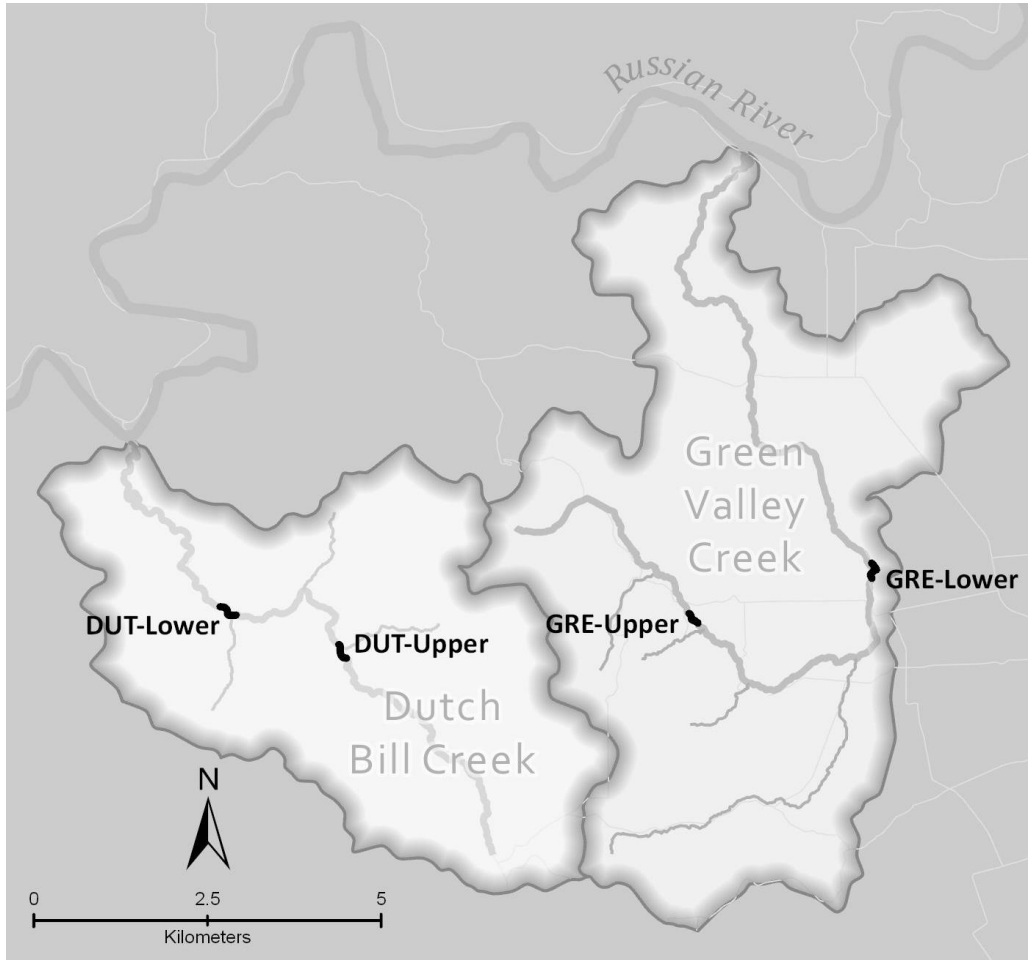
What factors predict the over-summer survival of juvenile coho salmon?

Study Area: Streams



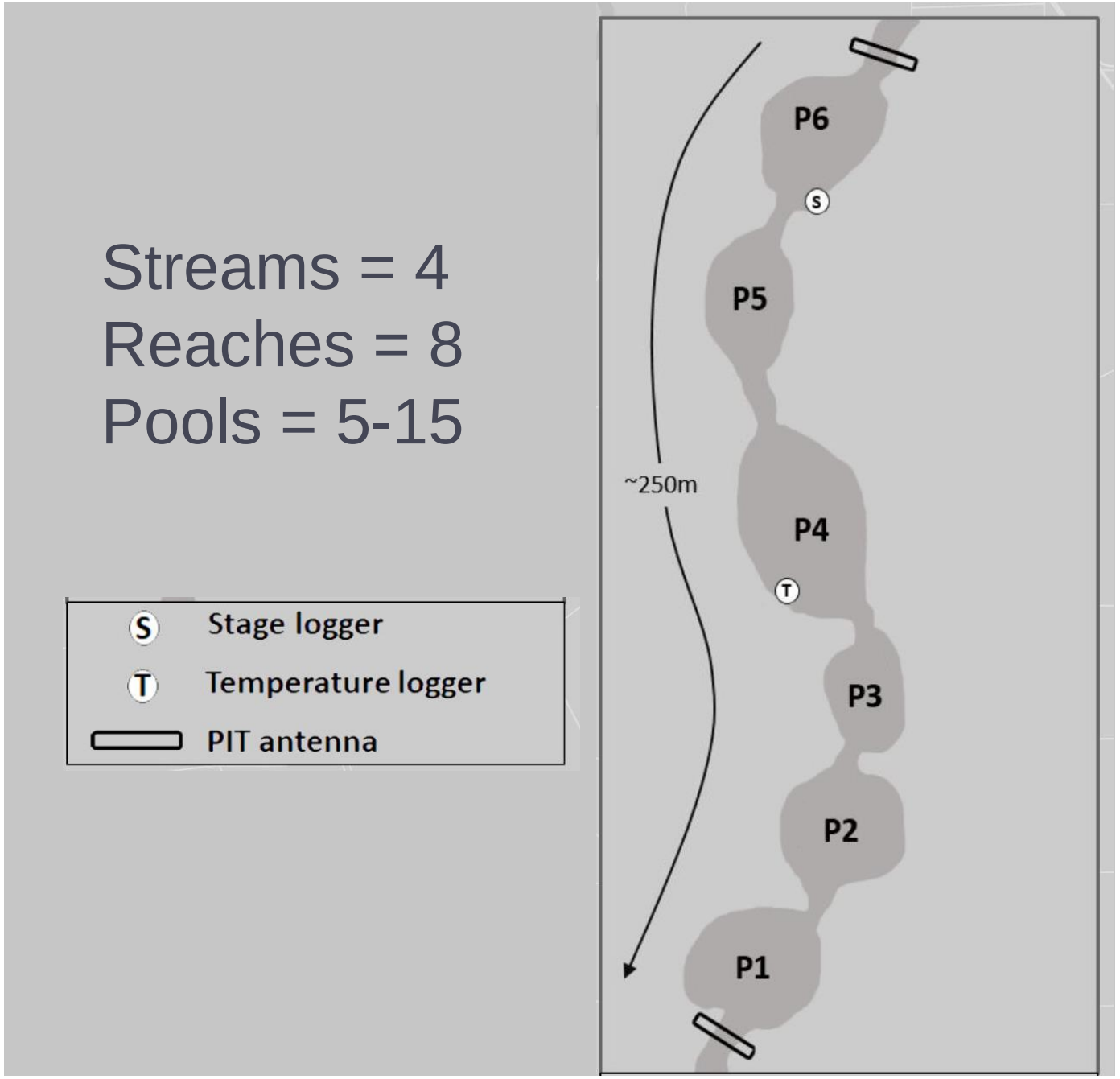
Study Area: Reaches



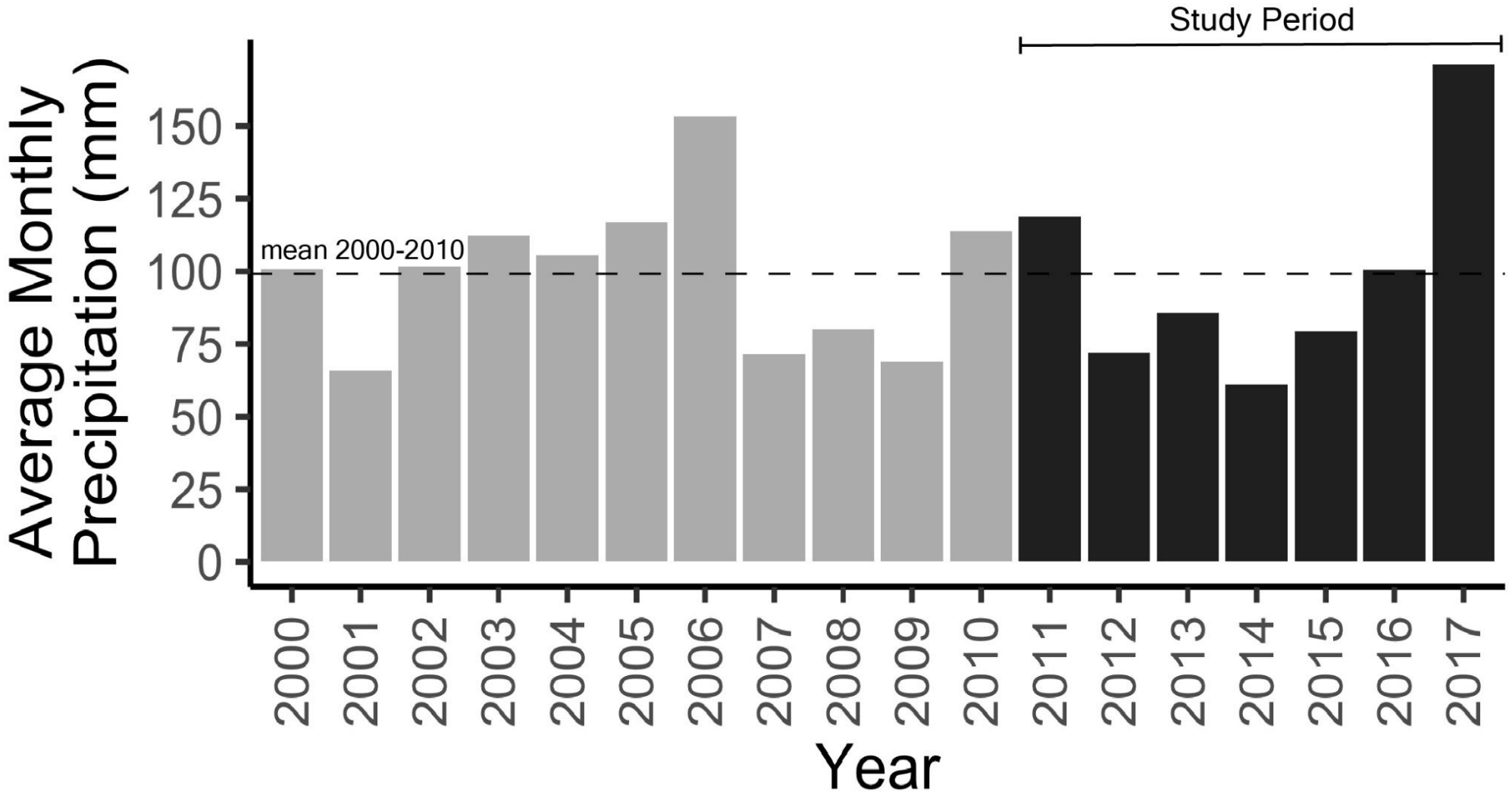


Study Area: Pools

Streams = 4
Reaches = 8
Pools = 5-15



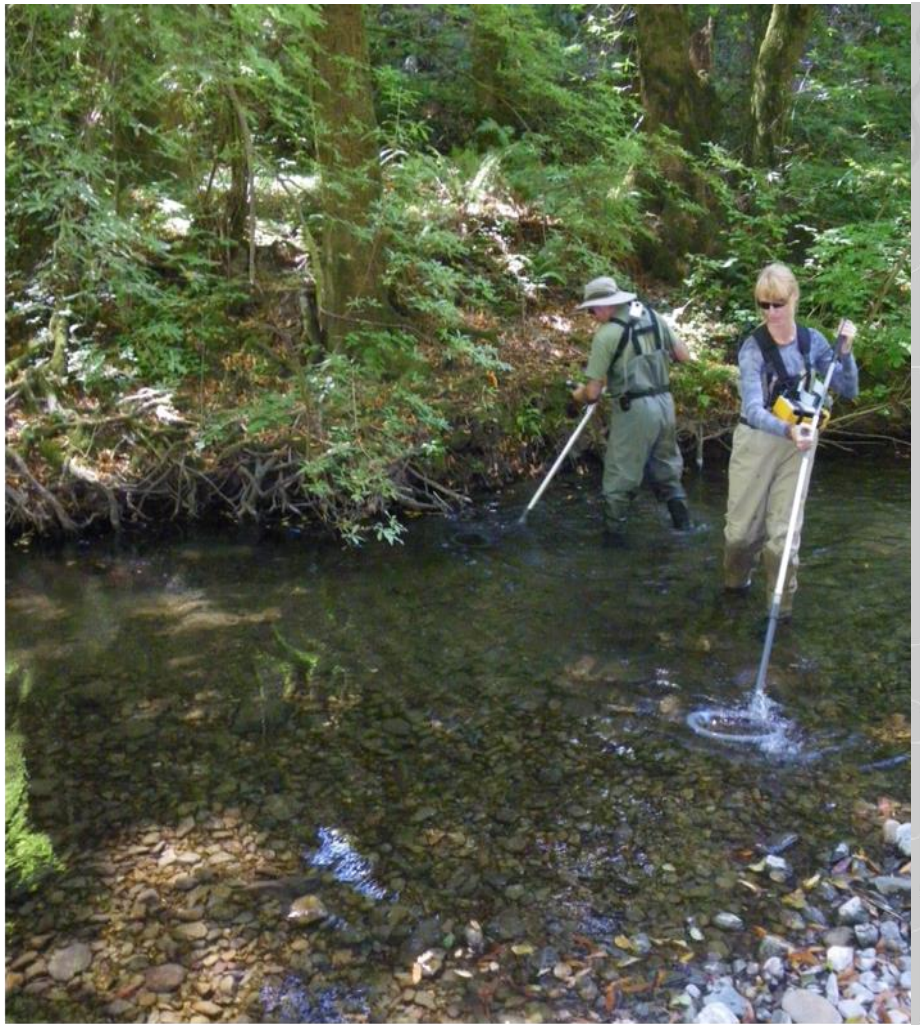
Study Period (2011-2017)

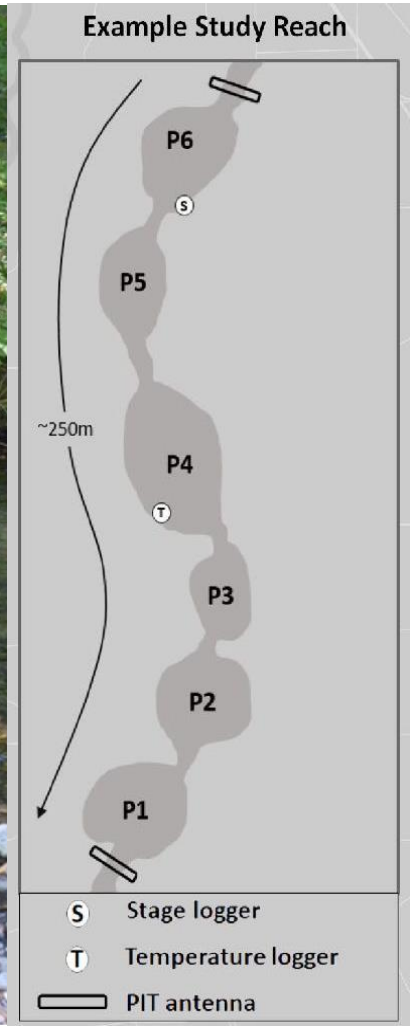


Fish Sampling

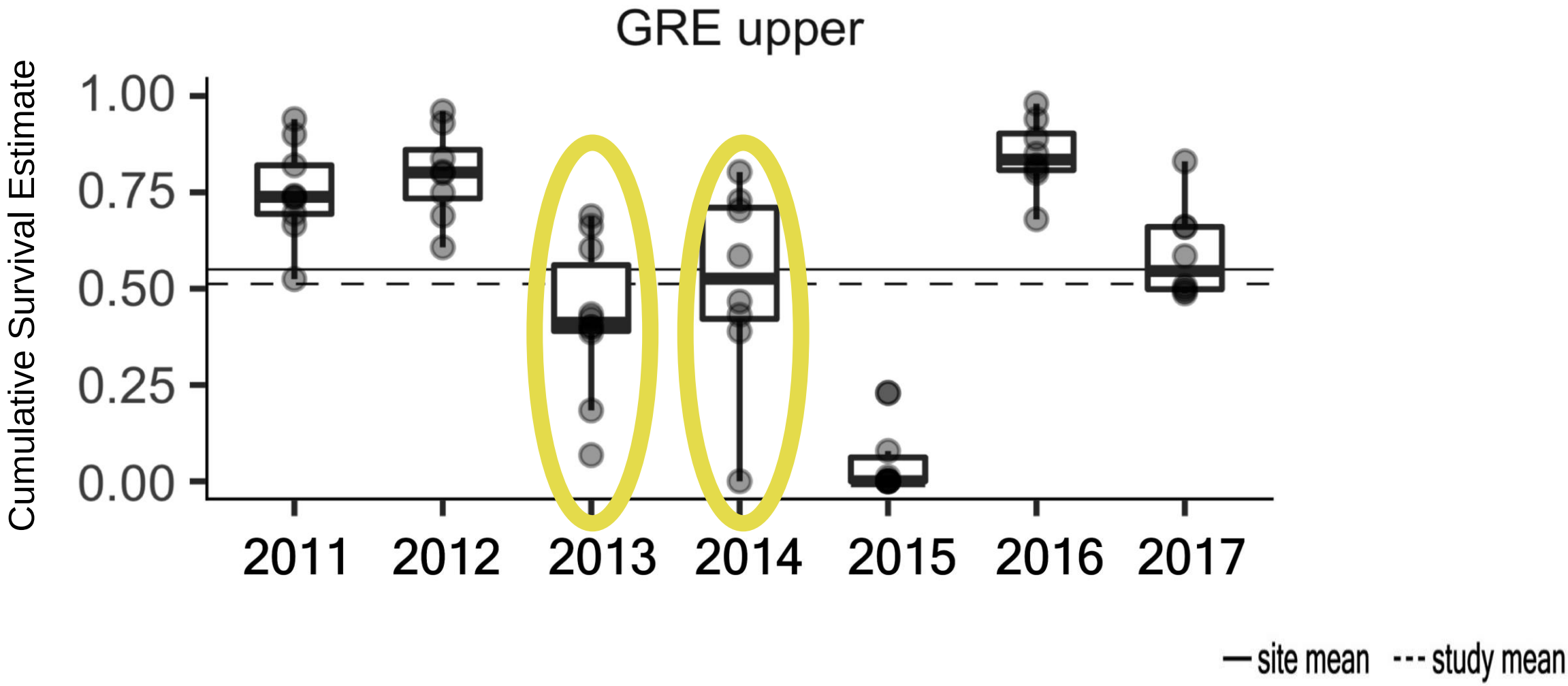
Tagging and Releasing

Wanding Surveys

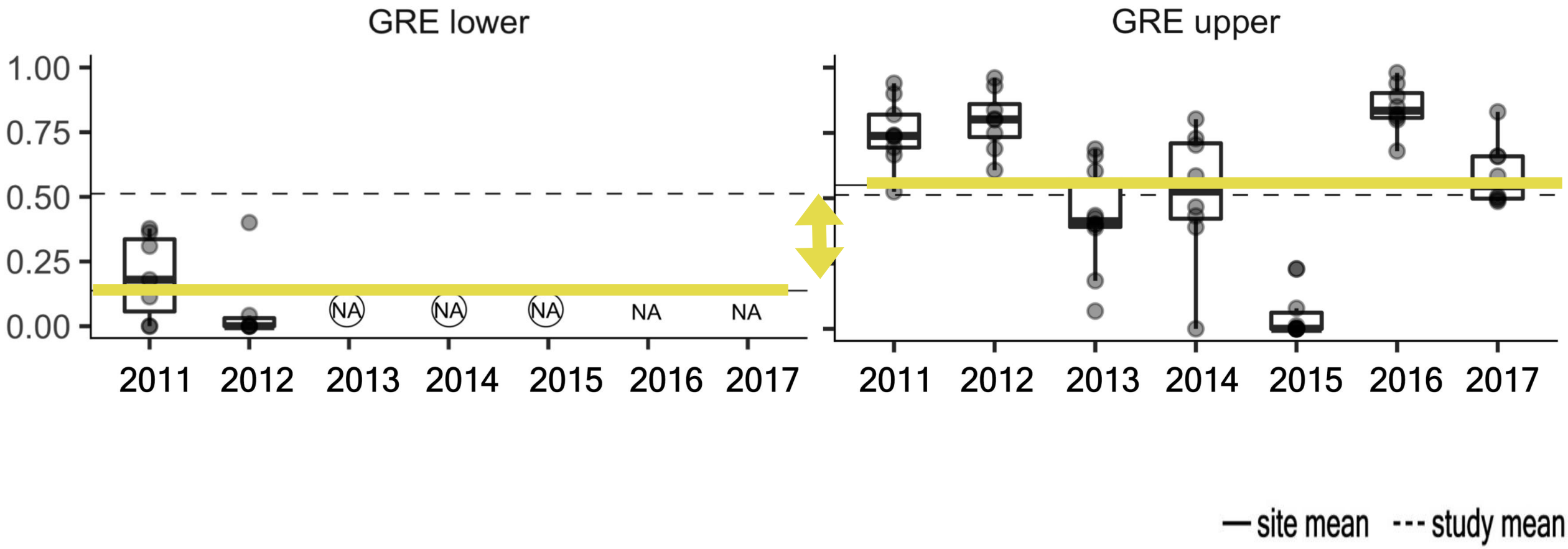




Over-Summer Survival: Within-Reach Variability

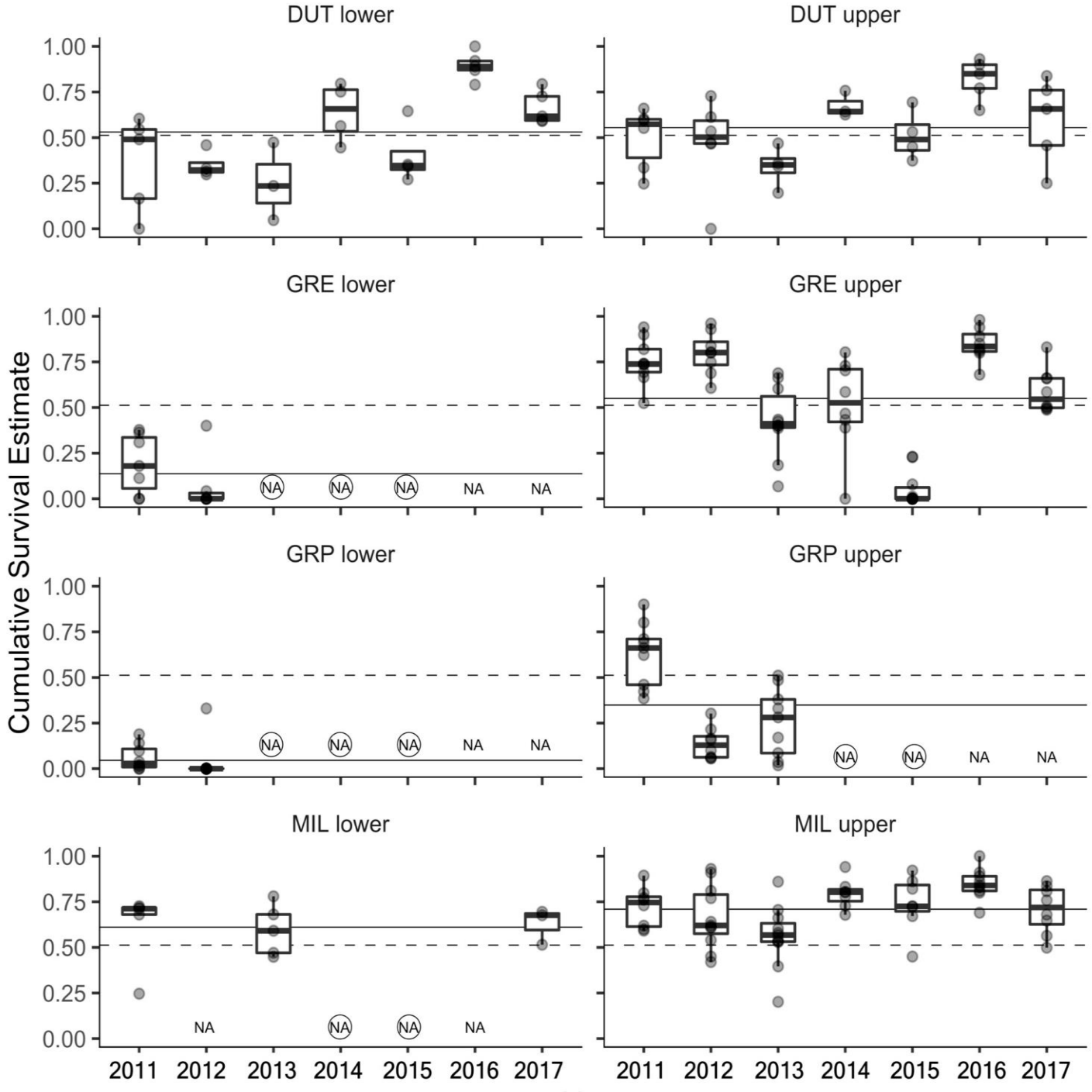


Over-Summer Survival: Between-Reach Variability



Over-Summer Survival Estimates

All Site and Years



Predictor Variables

Streamflow

Mean Flow
Min. Flow
Max. Flow
Antecedent Flow
Disconnection

Physical

Pool Volume
Max. Depth
Mean Depth

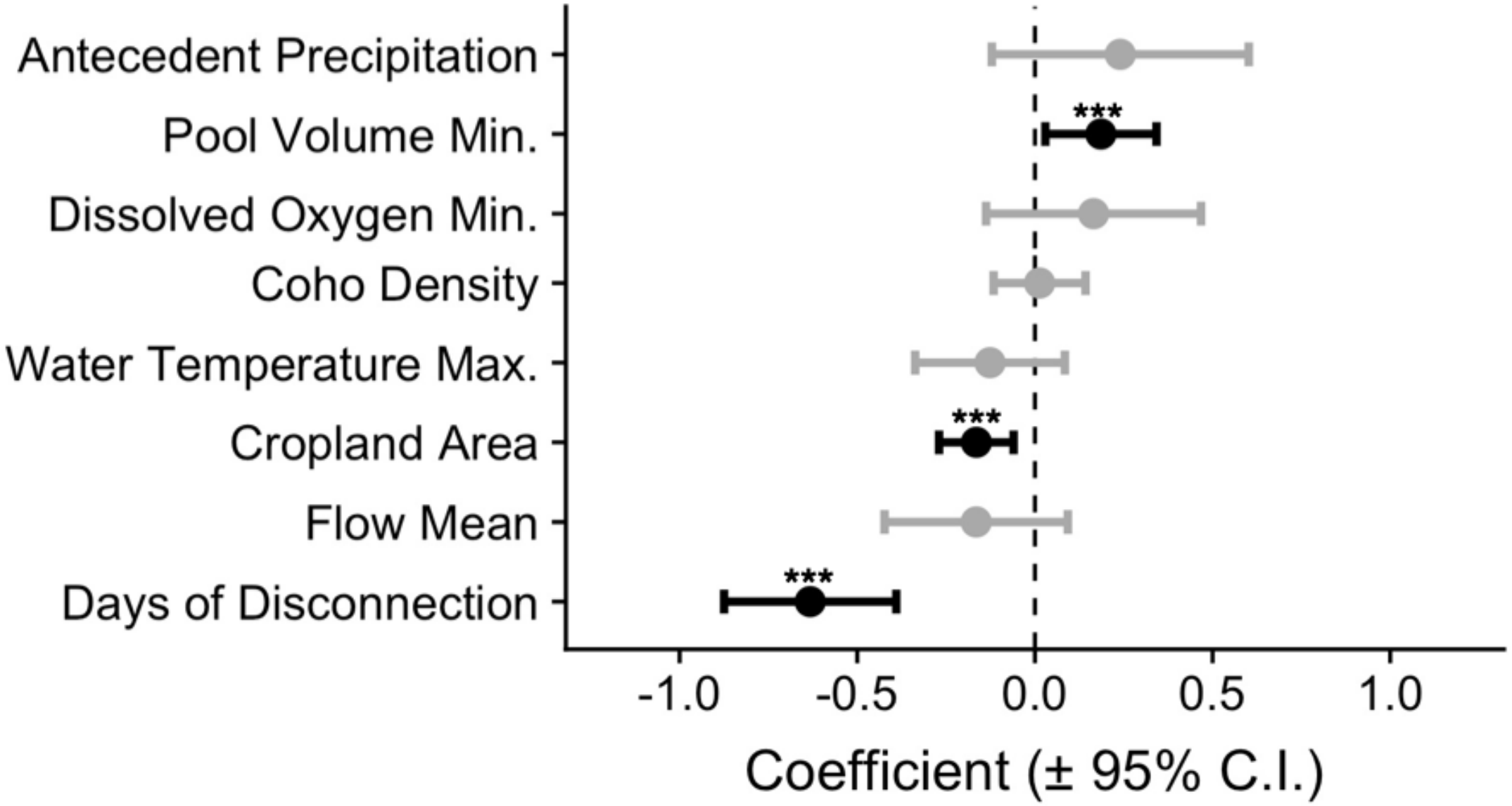
Water Quality

Mean Temperature
Max. Temperature
Dissolved Oxygen
Weekly Mean Temp.

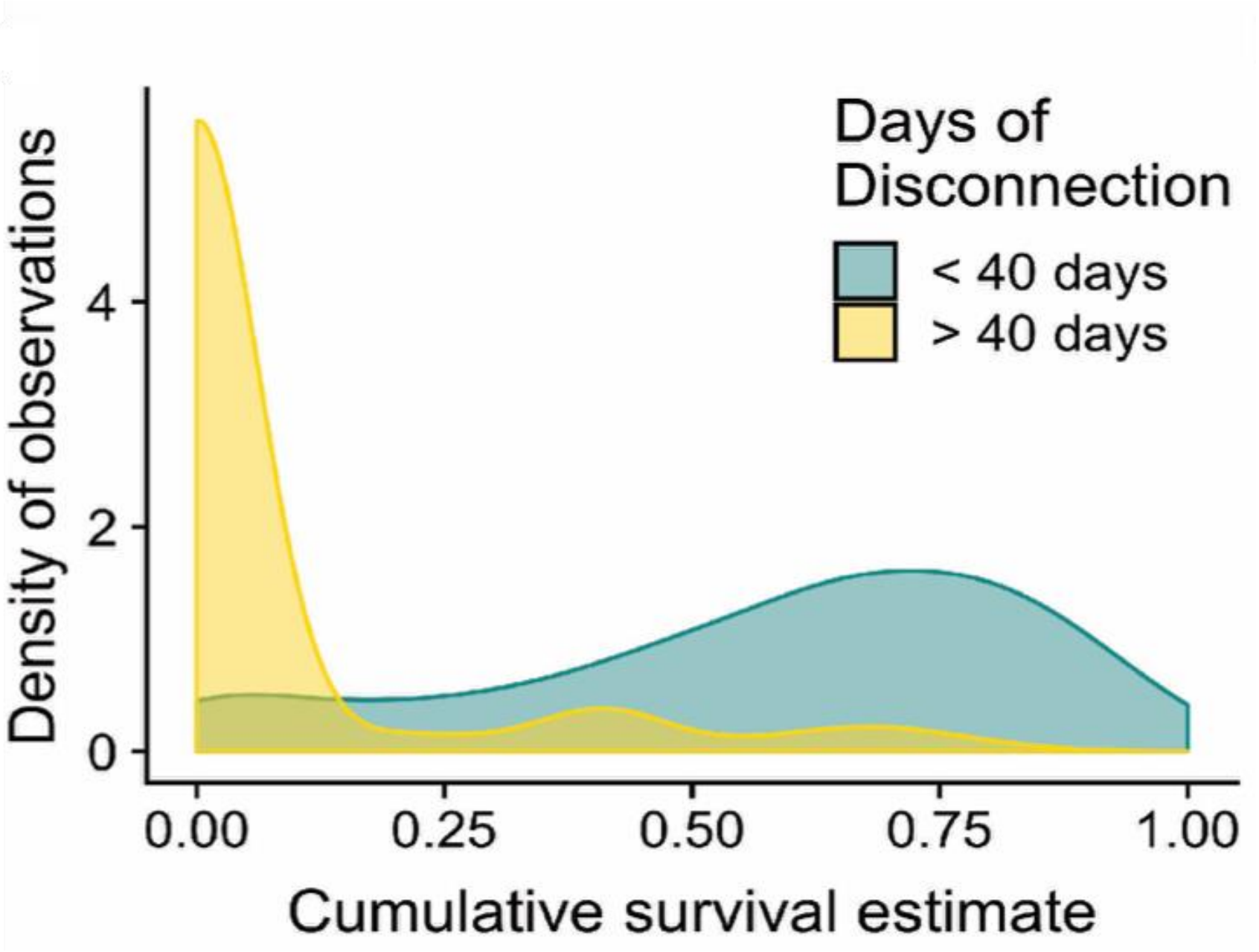
Other

Cropland Area
Total Precipitation
Antecedent Precip.
Coho Density

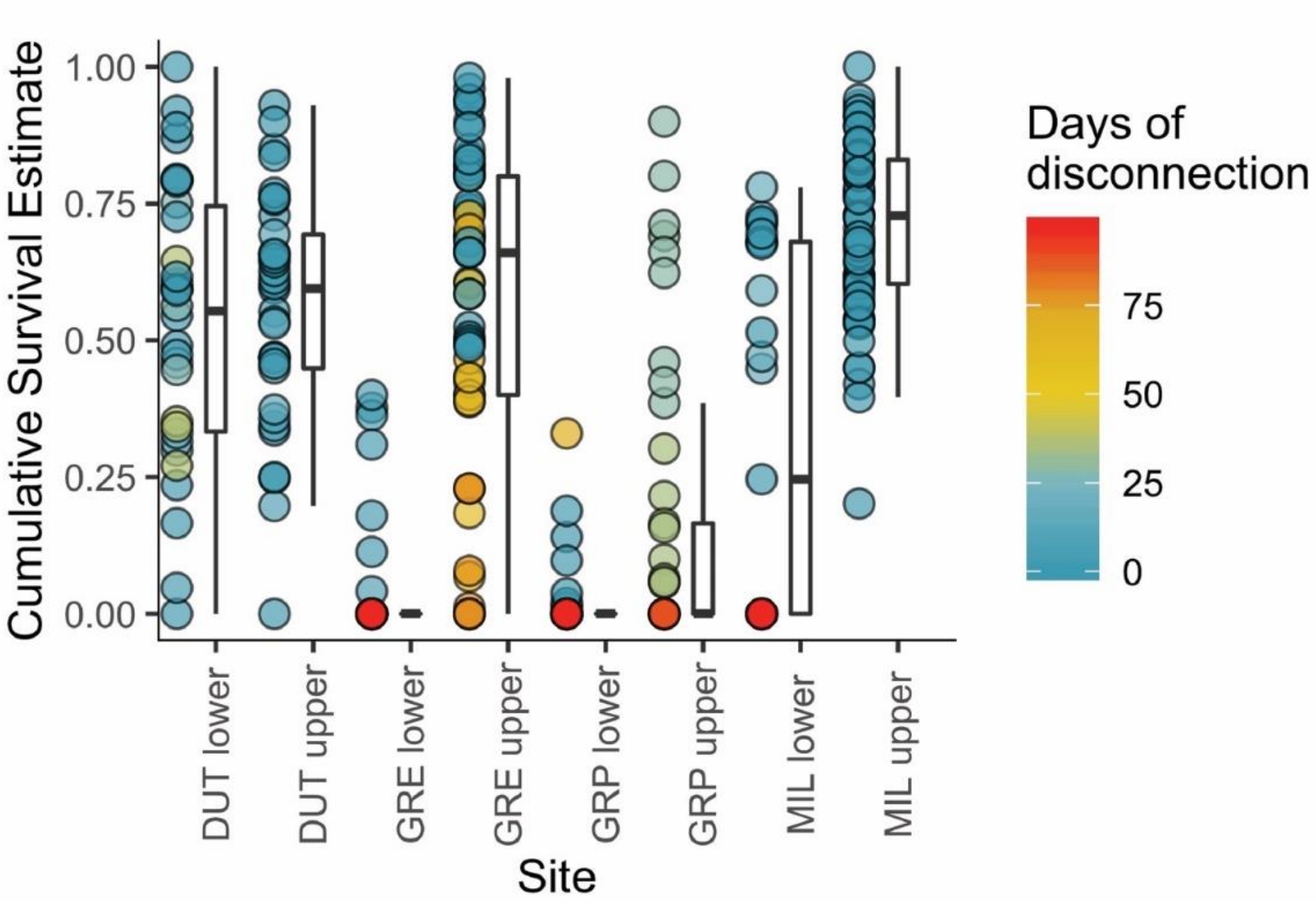
Results


Antecedent Precipitation
Pool Volume Min.
Dissolved Oxygen Min.
Coho Density
Water Temperature Max.
Cropland Area
Flow Mean
Days of Disconnection
***
***
***
-1.0
-0.5
0.0
0.5
1.0
Coefficient (± 95% C.I.)

Results


Days of Disconnection
< 40 days
> 40 days
Density of observations
0
2
4
0.00
0.25
0.50
0.75
1.00
Cumulative survival estimate

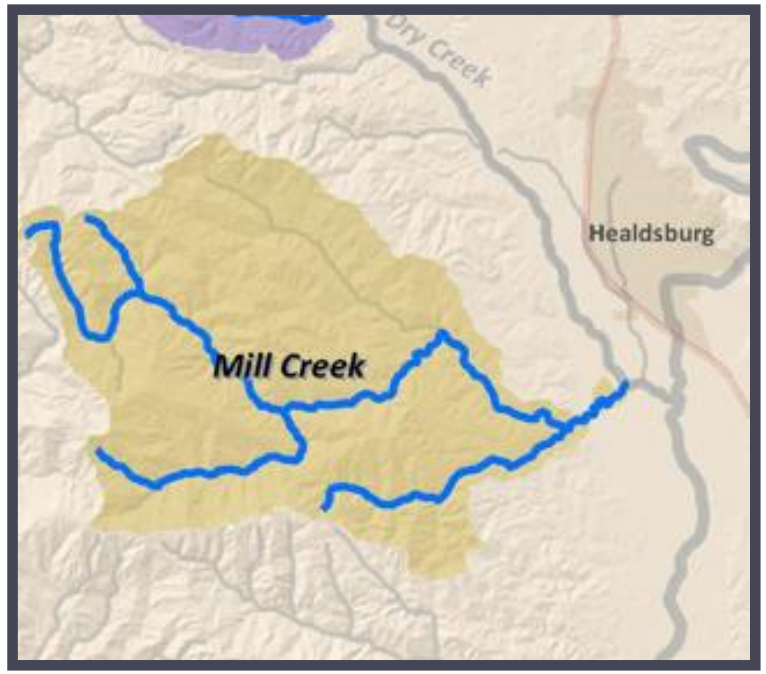
Results

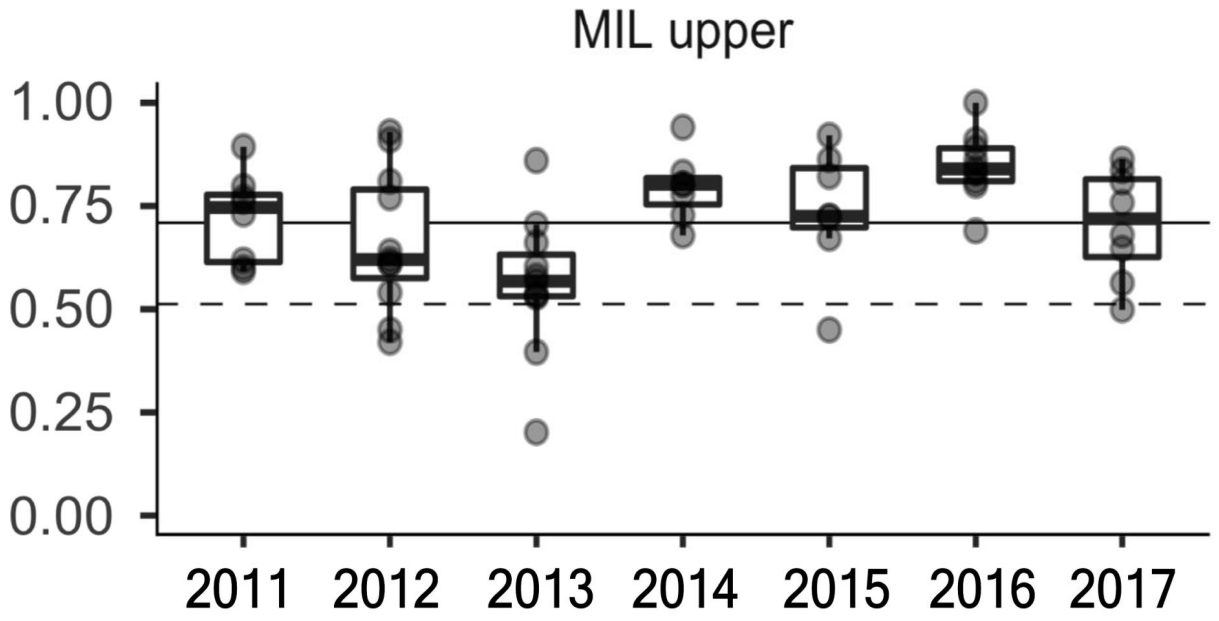

Cumulative Survival Estimate
1.00
0.75
0.50
0.25
0.00
DUT lower
DUT upper
GRE lower
GRE upper
GRP lower
GRP upper
MIL lower
MIL upper
Site
Days of disconnection
75
50
25
0

The Good News

Some sites acted as <u>drought refugia</u>

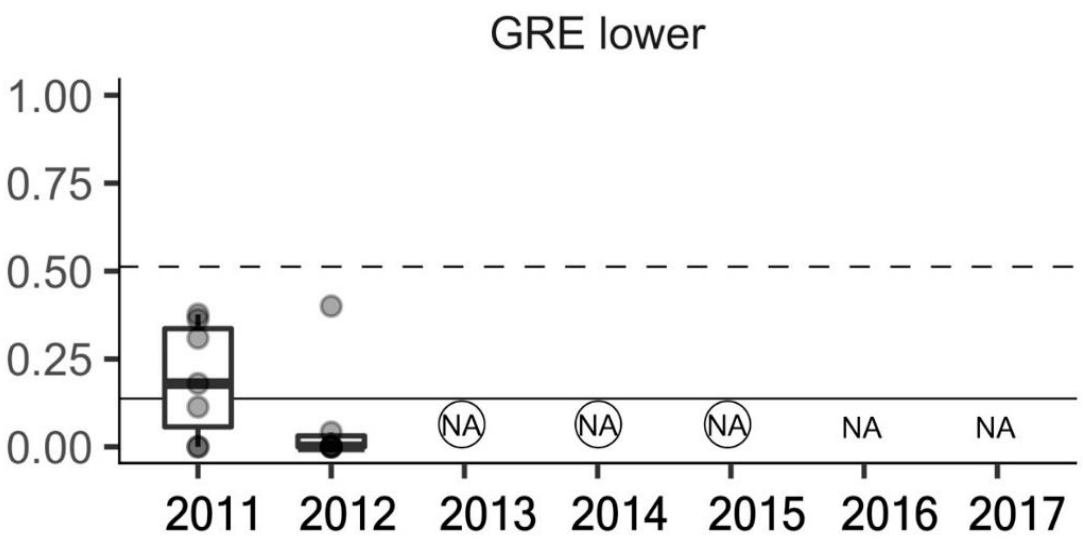
Local habitats that are buffered from drought relative to their surroundings

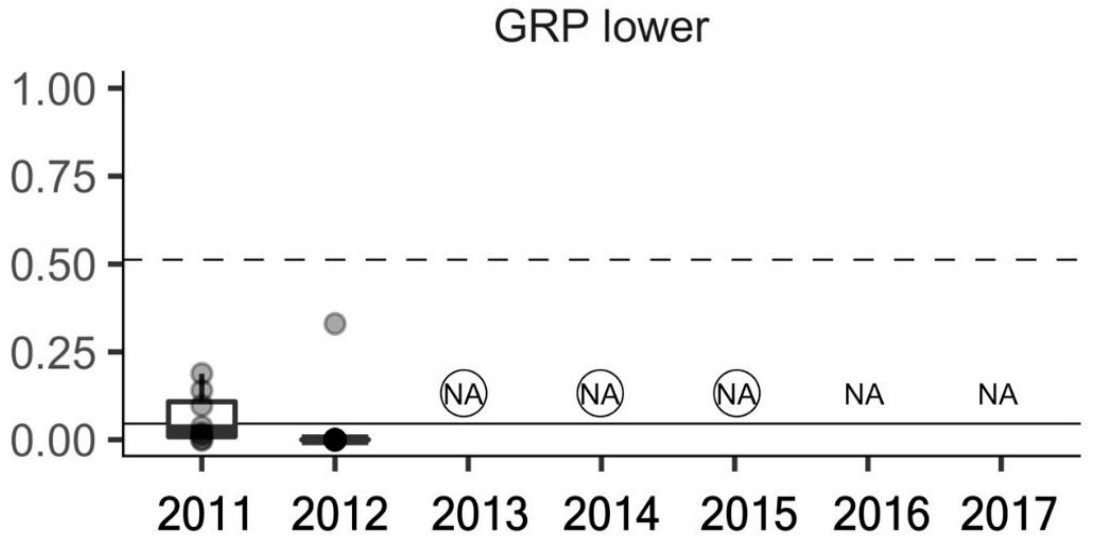




The Bad News

But, many sites did not support fish during drought





Silver Lining?

While flow intermittence may be unavoidable in some cases, management efforts to delay the timing and limit the duration of disconnection has the potential to improve fish survival

Flow enhancement project on Porter Creek


Thank you!
tgrantham@berkeley.edu