Eel River Ecology, Restoration Challenges, and Opportunities

A Concurrent Session at the 36th Annual Salmonid Restoration Conference held in Fortuna, California from April 11 – 14, 2018.

Session Overview

- Session Coordinator:
  - Darren Mierau, CalTrout

The Eel River, California's third largest river entirely in California, offers unparalleled opportunity for ecosystem restoration and recovery of abundant salmonid populations. The Eel River once sustained huge runs of salmon and steelhead, abundant cutthroat trout, and Pacific lamprey and green sturgeon—important species for local tribes and valuable indicators of ecosystem health. But the river has been transformed during the past century and a half, from one of the most biologically rich and productive river ecosystems along the Pacific Coast to a degraded river with impaired ecosystem functions.

Restoration scientists, agency managers, Tribes, NGOs, and citizen groups have made tremendous efforts over the past decades to restore this valuable natural resource and momentum has been building in recent years. Recent salmon and steelhead abundance trends have ticked upward, offering a glimmer of hope.

But the Eel is at an important crossroads. To sustain and accelerate recent momentum, a landscape-scale, science-based, "all-hands-on-deck" recovery initiative is needed. We must double down on watershed/habitat restoration, invest heavily in tidal marsh and estuarine habitat in the delta, protect water quality across the Eel's seven sub-basins listed as sediment and temperature impaired, thoroughly analyze the feasibility of decommissioning Pacific Gas and Electric's (PG&E) Eel River Dams, and implement new water policies and guidelines to protect against excessive water diversion for cannabis cultivation.

This session will focus on key programs and initiatives brought forward by citizens, resource agencies, tribes, and non-profit groups that offer hope of restoring a wild, healthy, and resilient Eel River.

Presentations

The Video Recording of this Session is Located at https://vimeo.com/album/5136994

(Slide 4) The South Fork Eel River: Recovery Opportunities in One of the North Coast's Premier Stronghold Watersheds
Darren Mierau, CalTrout

(Slide 19) The Eel River Delta: Opportunities and Challenges to Restoring Critical Fisheries Habitat on a Working Landscape
Michael Bowen, California State Coastal Conservancy

(Slide 49) Research Efforts Supporting Instream Flow Planning: Hydrology Modeling, Data Collection, and Stream Classification in the South Fork Eel River Basin
Valerie Zimmer, State Water Board

(Slide 79) Revising Field Sampling Protocols to Enhance the Role of Geomorphic Classification in Instream Flows Studies
Colin Byrne, University of California at Davis, Watershed Sciences

(Slide 110) The Phenology of Food Webs in South Fork Eel River Tributaries: Implications for Water Management
Gabriel Rossi, UC Berkeley, Department of Integrative Sciences

(Slide 151) Removing the Eel River Dams and PG&E's Potter Valley Project to Restore a Wild and Unregulated Eel River Watershed
Scott Greacen, JD, Friends of the Eel River

EEL RIVER ECOLOGY, RESTORATION CHALLENGES, AND OPPORTUNITIES

SALMONID RESTORATION FEDERATION

2018

CALIFORNIA TROUT

Restoring Wild Fish Abundance to the Eel River:

A Basin-Scale Effort to Increase Salmonid Habitat Capacity and Watershed Resiliency

Darren W. Mierau, California Trout

April 14, 2018

CALIFORNIA TROUT

The Eel River – A Few Fun Facts

- 3,684 square miles…third largest watershed entirely in CA
- Equivalent to the Shasta, Scott, Smith, Redwood, and Russian river watersheds combined
- Average annual water yield at Scotia is 5.8 million acre-feet
- The December 24, 1964 flood of record at Scotia was 752,000 cfs
- Fewer than 100,000 people live in the Eel River basin

- No centralized recovery program (e.g., like the Klamath, Trinity, Redwood Creek, Smith River, Russian River)
  - Just the Eel River Forum !

Today's flow is…………?

16,400 cfs

Historical Salmonid Abundance

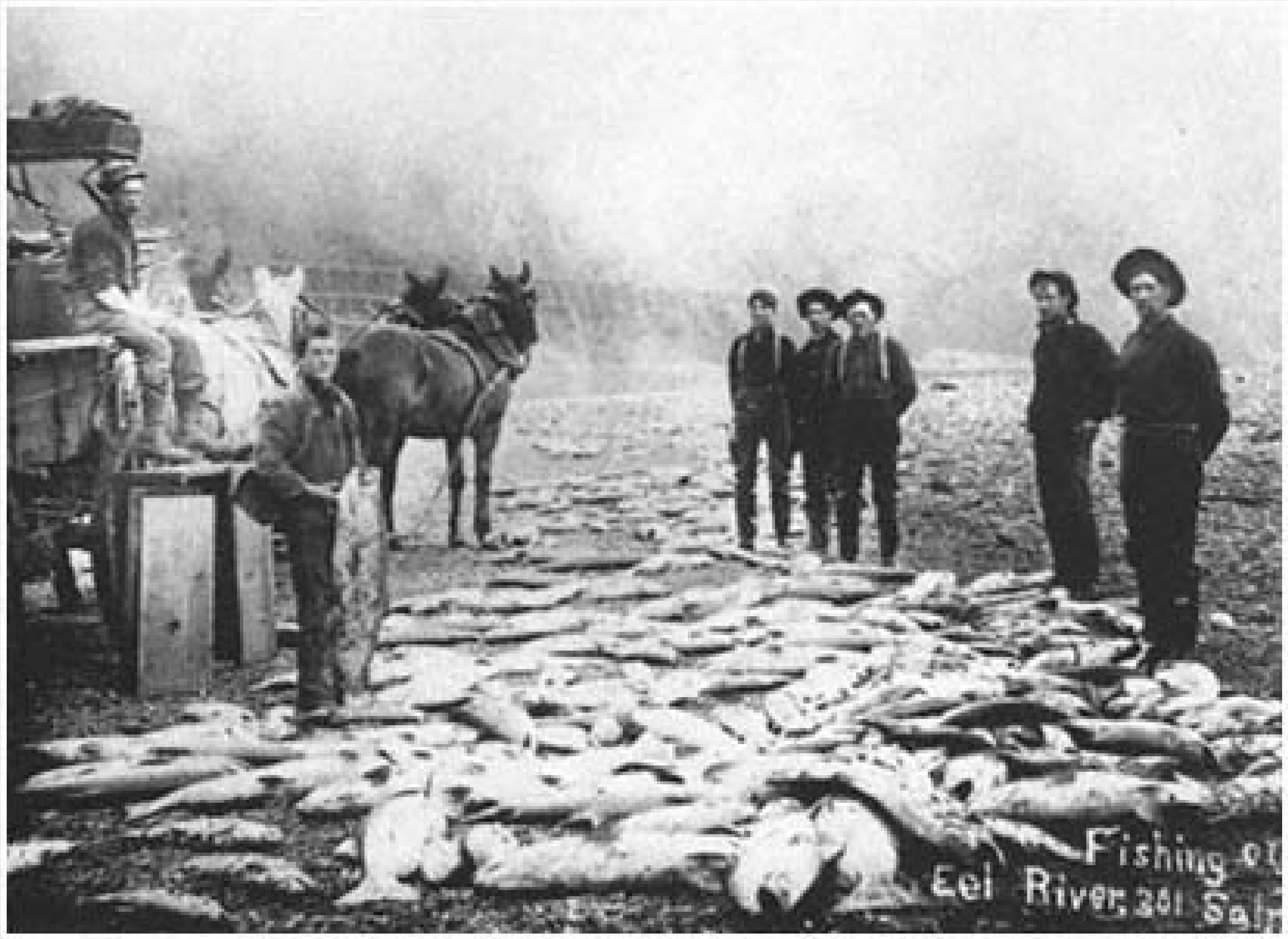
- 1857-1921: on average 93,000 salmon caught per year
  (mostly Chinook)

- Peak abundance: **585,000 salmon caught in 1877**

- Yoshiyama & Moyle (2010) estimated the unexploited salmon population before 1850 to have been:

  100,000 to 800,000 salmon

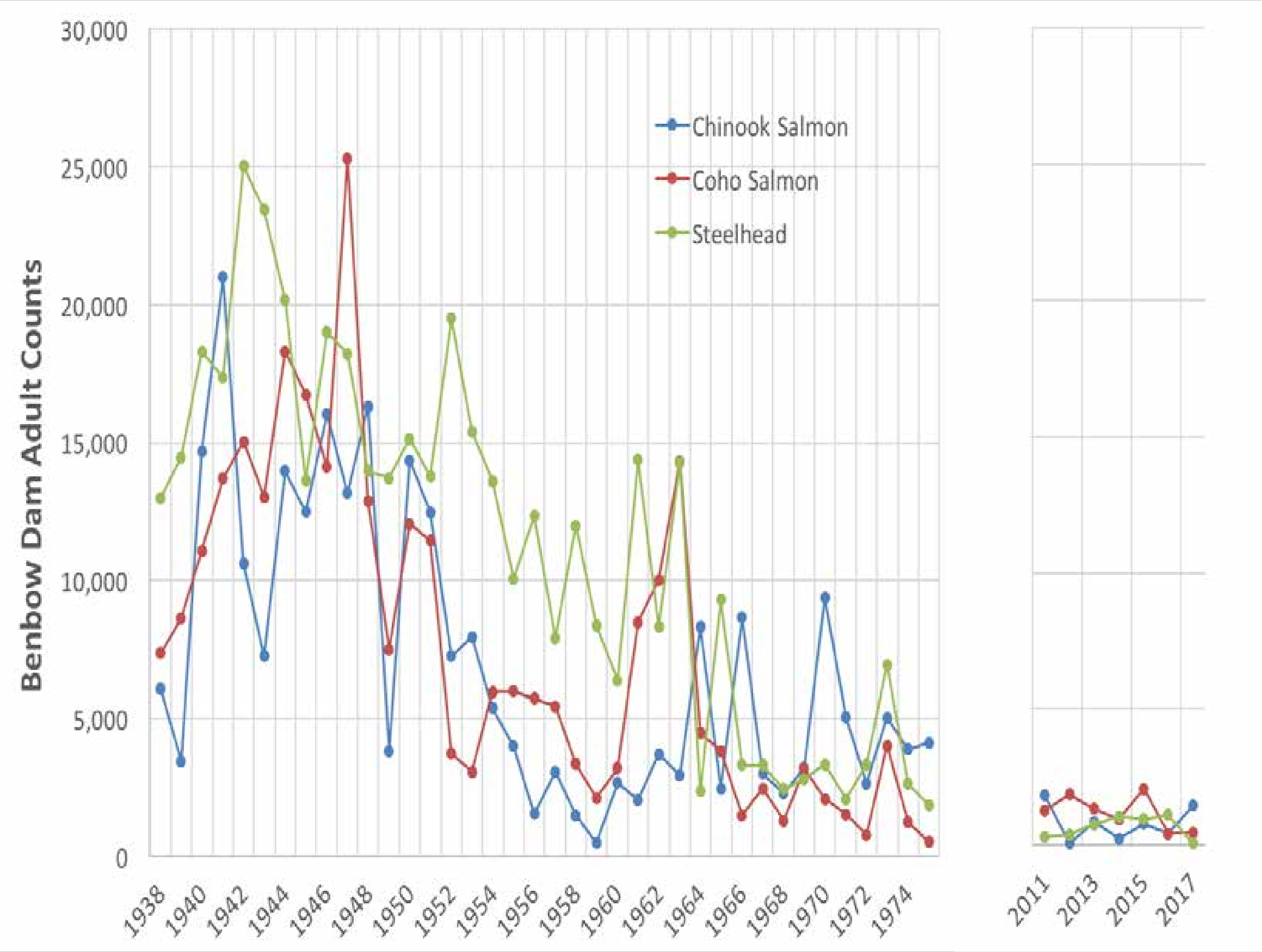
  (combined Chinook and coho)



Basin-Wide Abundance Estimates Through Time

- 1850s to circa 1930s:
  High-100,000s
- 1930s to early-1960s:
  50,000- 100,000
- Recent:
  20,000- 50,000? (guestimate)

- SF Eel CMP Monitoring (2011-2017):
  <1,200 of each Species



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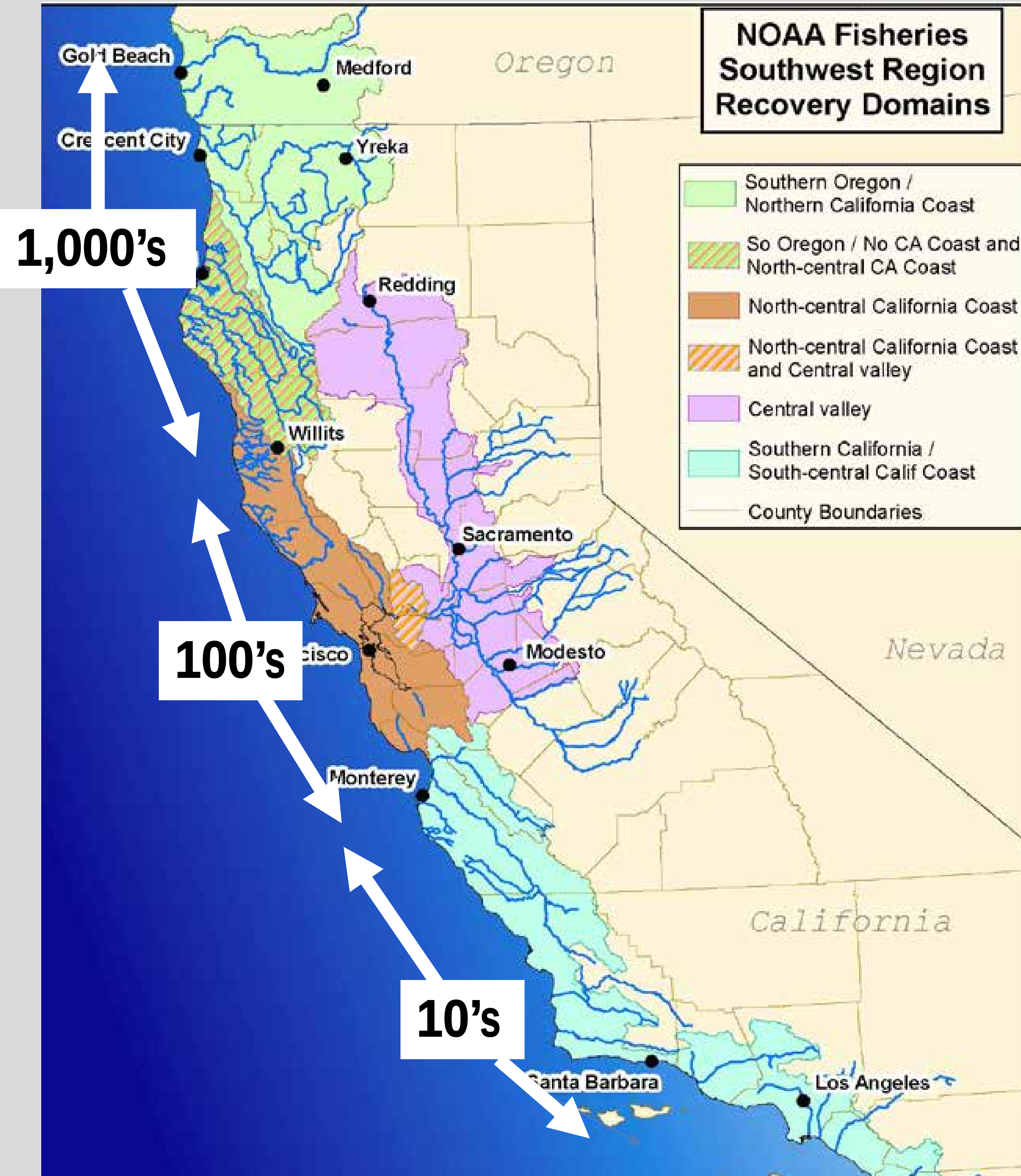
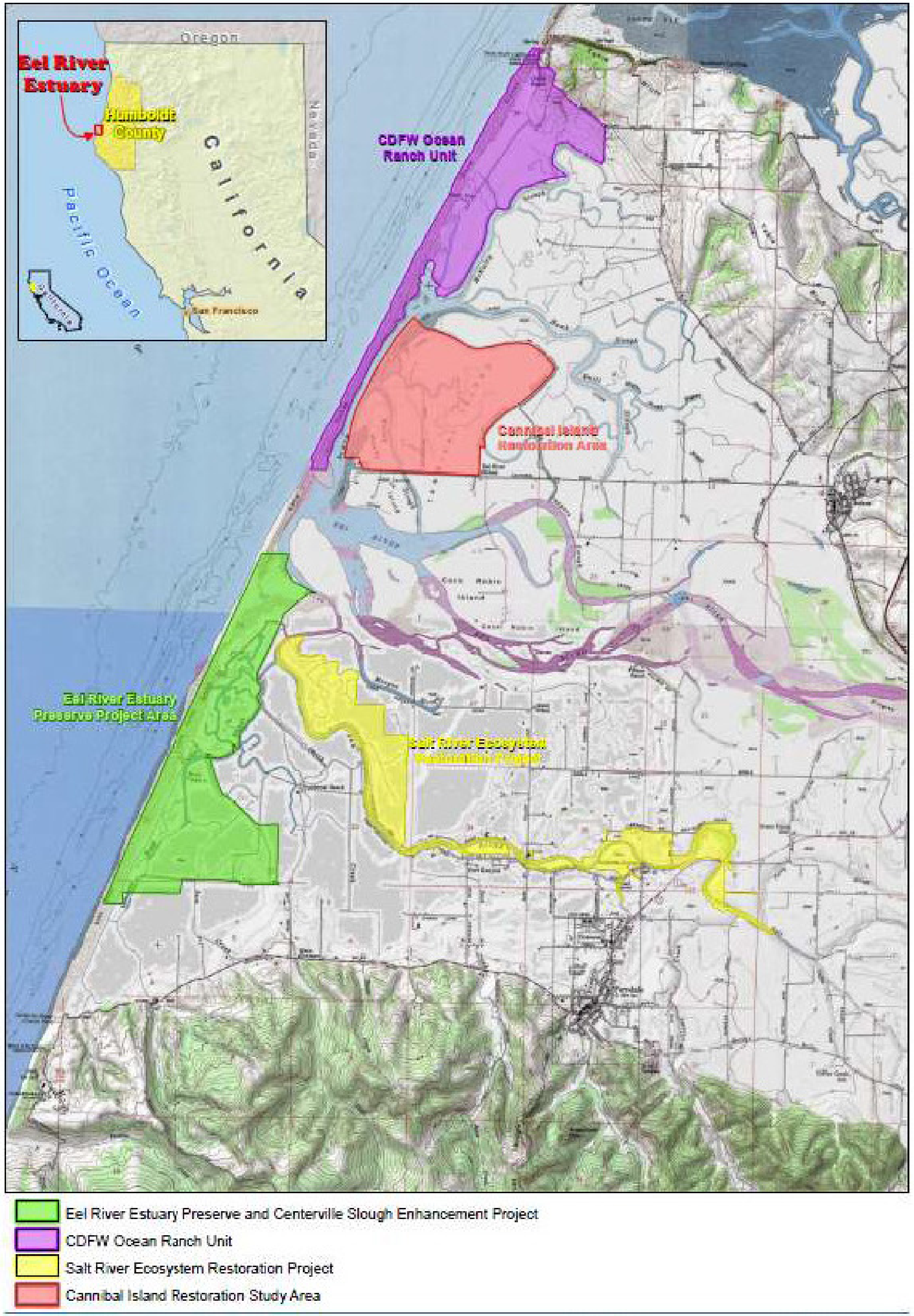
Are we RECOVERING OR FAILING??

- Eel River at the transition from PNW Temperate to Central CA Mediterranean
- Near the southern end of the range of Pacific Salmon
- Teetering on the brink?...which way will it go?



The Eel River Delta and Estuary – Restoring a Vast Landscape

o	Salt River Ecosystem Restoration Project	$20 mil?
o	The Eel River Estuary Preserve	$8 mil?
o	Ocean Ranch Unit CDFW Wildlife Area	$8 mil?
o	Cannibal Island Unit CDFW Wildlife Area	<u>$6 mil?</u>
		~$42 mil



CALIFORNIA TROUT

Fish Passage

Woodman Creek Railroad Crossing Fish Passage Project

- CalTrout
- Mike Love and Associates
- Pacific Watershed Associates
- NCRA Board Approved 2014
- FRGP Grant Application 2016

- $2,245,000 Project Budget

- Construction STARTING NEXT MONTH!

Fish Passage

Bridge Creek Fish Passage Project

- 16 Week Project:
- Excavated and hauled 56,100 yd^3 of material
- Project Costs: $531,749

THE NCRA IS HISTORY!

- SB 1029 (McGuire) will disband the NCRA and transfer “rights and responsibilities” of NWPCo to :

  DOT (2 years) then….

  The “**Great Redwood Trail Agency**”

H/T Friends of the Eel River!!

CALIFORNIA TROUT

Fish Passage

- Cedar Creek

Post- 1964

c. 1960

Water Policy and Management

- CalTrout: Sproul Creek Instream Flow Study
- CalTrout / TU / TNC Water Coalition
- Salmonid Restoration Federation: Redwood Creek
- State Water Board and CDFW: Interim Cannabis Flow Program
- State Water Board CA Water Action Plan: SF Eel River
    - UC Davis
    - Humboldt State University
- Other??

POTTER VALLEY PROJECT

- PG&E's FERC Relicensing
  - 2017-2022

- Habitat Assessment: Upper Mainstem Eel River
  - Emily Cooper

- Jared Huffman: Fish Passage and Water Supply Ad Hoc Committees
  - 2018-2019

So Where's the Payoff?

746 Restoration Projects in SONCC (2000 to 2013)

246 In the Eel River Total

Lower Eel	110
MF Eel	5
SF Eel	121
Upper Eel	10

So 32% of all SONCC Projects were in the Eel River

$138 million Spent in SONCC ($9.3 mil/yr)

$42 million Spent on the EEL RIVER in 14 years

$50-60 Million TOTAL in the Eel River since 2000

How much more will it take to bring back the Eel?

©Thomas Dunklin

California Coho Salmon Restoration:
A Decade in Review

April 2014
Version 1.2

Jeanette Howard, Stefanie Martin, Sally Liu, Dan Porter, Lisa Hulette – The Nature Conservancy
Kurt Fesenmyer, Lisa Bolton, MaryAnn King – Trout Unlimited
Darren Mierau – CalTrout

The Nature Conservancy
Protecting nature. Preserving life.

TROUT UNLIMITED

CALIFORNIA TROUT
KEEPER OF THE STREAMS

Eel River Ecology - Speakers

Michael Bowen

California State Coastal Conservancy

The Eel River Delta: Opportunities and challenges to restoring critical fisheries habitat on a working landscape.

Valerie Zimmer

State Water Resources Control Board

Co-Authors:

Adam Weinberg

Marc Van Camp

Research Efforts Supporting Instream Flow Planning: Hydrology Modeling, Data Collection, and Stream Classification in the South Fork Eel River Basin

Colin Byrne

University of California at Davis, Watershed Sciences

Revising field sampling protocols to enhance the role of geomorphic classification in instream flows studies.

Gabriel Rossi

University of California at Berkeley, Department of Integrative Sciences

The phenology of food webs in South Fork Eel River tributaries: Implications for Water Management

Scott Greacen

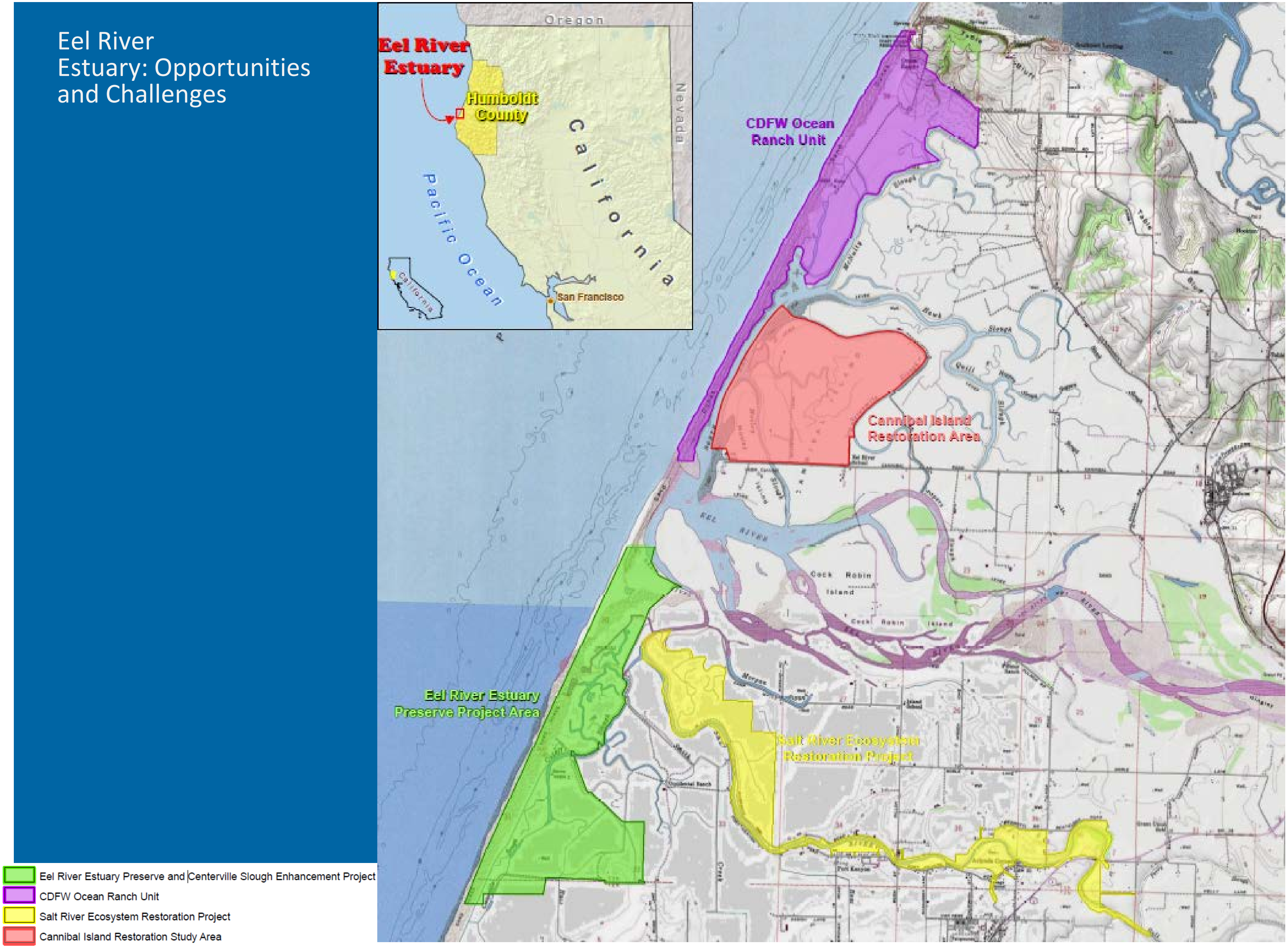
Friends of the Eel River

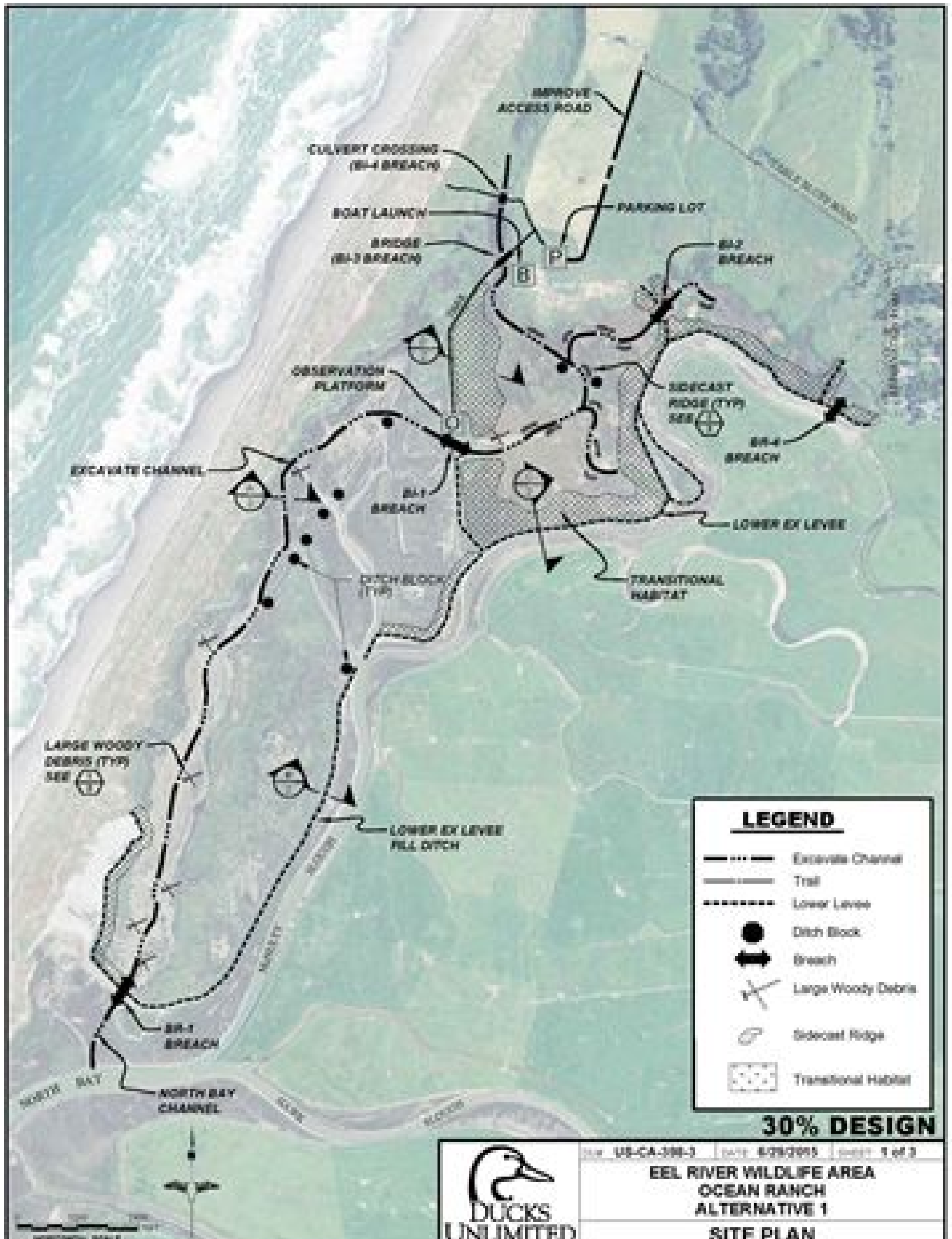
Removing the Eel River Dams and PG&E's Potter Valley Project to restore a wild and unregulated Eel River Watershed.

Eel River Estuary Enhancement

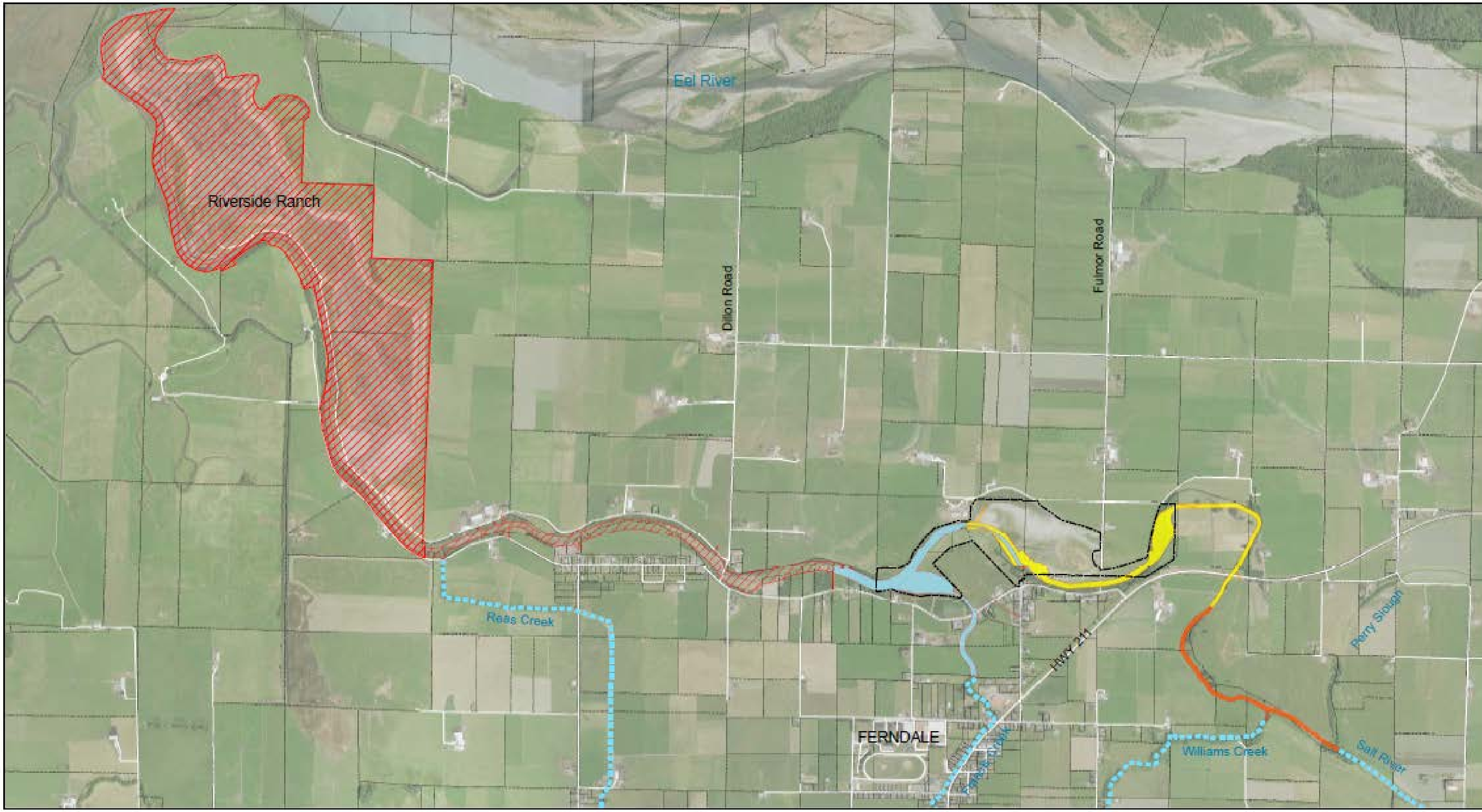
- Eel River Estuary and Centerville Slough Enhancement Project
- Salt River Ecosystem Restoration Project
- Ocean Ranch/Cannibal Island

Eel River Estuary: Opportunities and Challenges





IMPROVE ACCESS ROAD
CULVERT CROSSING (BI-4 BREACH)
BOAT LAUNCH
PARKING LOT
BRIDGE (BI-3 BREACH)
BI-2 BREACH
OBSERVATION PLATFORM
SIDECAST RIDGE (TYP) SEE
BR-4 BREACH
EXCAVATE CHANNEL
BI-1 BREACH
LOWER EX LEVEE
DITCH BLOCK (TYP)
TRANSITIONAL HABITAT
LARGE WOODY DEBRIS (TYP) SEE
LOWER EX LEVEE FILL DITCH
BR-1 BREACH
NORTH BAY CHANNEL
LEGEND
Excavate Channel
Trail
Lower Levee
Ditch Block
Breach
Large Woody Debris
Sidecast Ridge
Transitional Habitat
30% DESIGN
DUCKS UNLIMITED
US-CA-398-3
8/28/2015
1 of 3
EEL RIVER WILDLIFE AREA
OCEAN RANCH
ALTERNATIVE 1
SITE PLAN
HORIZONTAL SCALE



Paper Size 11" x 17" (ANSI B)

0 1,000 2,000 3,000 4,000

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

N

Approx. Parcel Boundaries	2017 Construction
Local Creeks	2018 Construction
NRCS Easement	2019 Construction
Completed Phases (2013-2015)	Approximate Project Limits

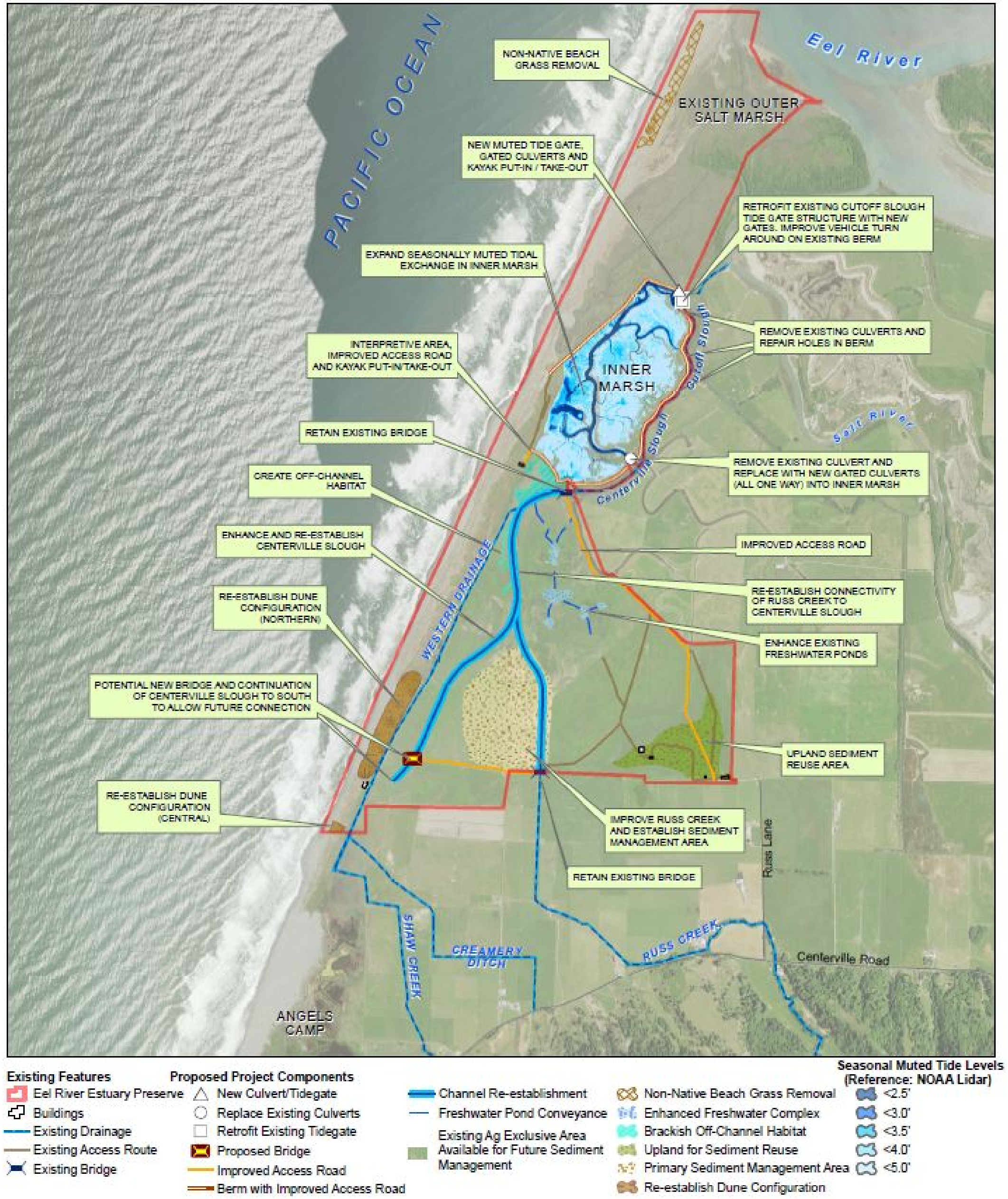
Humboldt County Resource Conservation District
Salt River Ecosystem Restoration Project

Job Number 8410410
Revision A
Date 15 Feb 2018

Completed and Proposed Implementation Phases

718 Third Street Eureka CA 95501 USA T 707 443 8326 F 707 444 8330 E eureka@ghd.com W www.ghd.com

Data source: ESRI Data Custodian, Data Set Name/Title, Version/Date. Created by ashows



PACIFIC OCEAN
Eel River
NON-NATIVE BEACH GRASS REMOVAL
EXISTING OUTER SALT MARSH
NEW MUTED TIDE GATE, GATED CULVERTS AND KAYAK PUT-IN / TAKE-OUT
RETROFIT EXISTING CUTOFF SLOUGH TIDE GATE STRUCTURE WITH NEW GATES. IMPROVE VEHICLE TURN AROUND ON EXISTING BERM
EXPAND SEASONALLY MUTED TIDAL EXCHANGE IN INNER MARSH
REMOVE EXISTING CULVERTS AND REPAIR HOLES IN BERM
INTERPRETIVE AREA, IMPROVED ACCESS ROAD AND KAYAK PUT-IN/TAKE-OUT
INNER MARSH
Cutoff Slough
Salt River
RETAIN EXISTING BRIDGE
REMOVE EXISTING CULVERT AND REPLACE WITH NEW GATED CULVERTS (ALL ONE WAY) INTO INNER MARSH
Centerville Slough
CREATE OFF-CHANNEL HABITAT
ENHANCE AND RE-ESTABLISH CENTERVILLE SLOUGH
IMPROVED ACCESS ROAD
WESTERN DRAINAGE
RE-ESTABLISH CONNECTIVITY OF RUSS CREEK TO CENTERVILLE SLOUGH
RE-ESTABLISH DUNE CONFIGURATION (NORTHERN)
ENHANCE EXISTING FRESHWATER PONDS
POTENTIAL NEW BRIDGE AND CONTINUATION OF CENTERVILLE SLOUGH TO SOUTH TO ALLOW FUTURE CONNECTION
UPLAND SEDIMENT REUSE AREA
RE-ESTABLISH DUNE CONFIGURATION (CENTRAL)
IMPROVE RUSS CREEK AND ESTABLISH SEDIMENT MANAGEMENT AREA
Russ Lane
RETAIN EXISTING BRIDGE
SHAW CREEK
CREAMERY DITCH
RUSS CREEK
Centerville Road
ANGELS CAMP
Existing Features
Eel River Estuary Preserve
Buildings
Existing Drainage
Existing Access Route
Existing Bridge
Proposed Project Components
New Culvert/Tidegate
Replace Existing Culverts
Retrofit Existing Tidegate
Proposed Bridge
Improved Access Road
Berm with Improved Access Road
Channel Re-establishment
Freshwater Pond Conveyance
Existing Ag Exclusive Area Available for Future Sediment Management
Non-Native Beach Grass Removal
Enhanced Freshwater Complex
Brackish Off-Channel Habitat
Upland for Sediment Reuse
Primary Sediment Management Area
Re-establish Dune Configuration
Seasonal Muted Tide Levels (Reference: NOAA Lidar)
<2.5'
<3.0'
<3.5'
<4.0'
<5.0'

Technical Challenges/Opportunities: Certainty Versus Planned Failure

- Conceptual Design
- Hydrology
- Engineering (30, 60, 90, 100)
- Basis of Design
- *Adaptive Management Plan*
- *Project Operations/Water Surface Level Plan*

    **Estuarine setting*

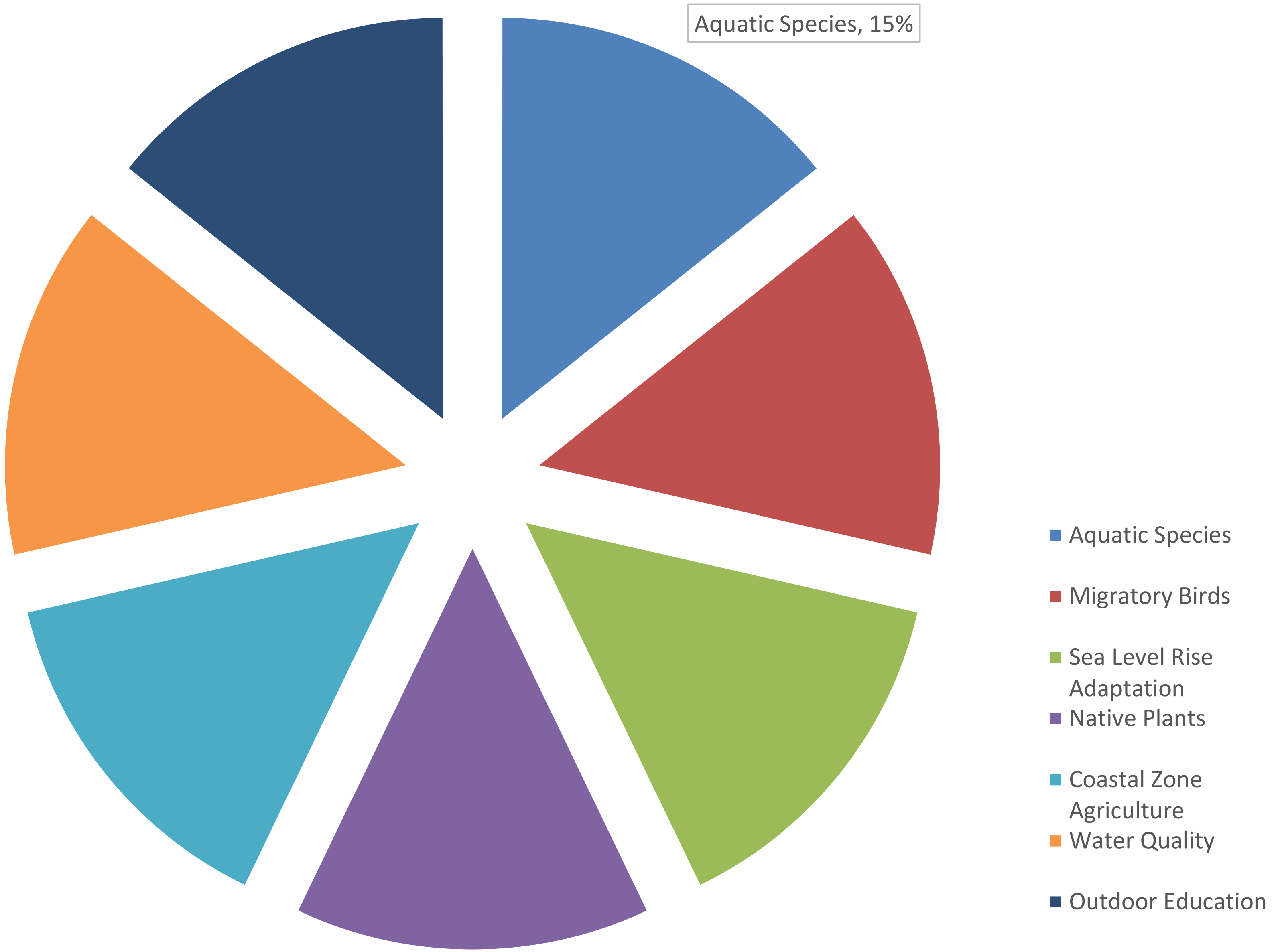
    **Drivers absent or altered*

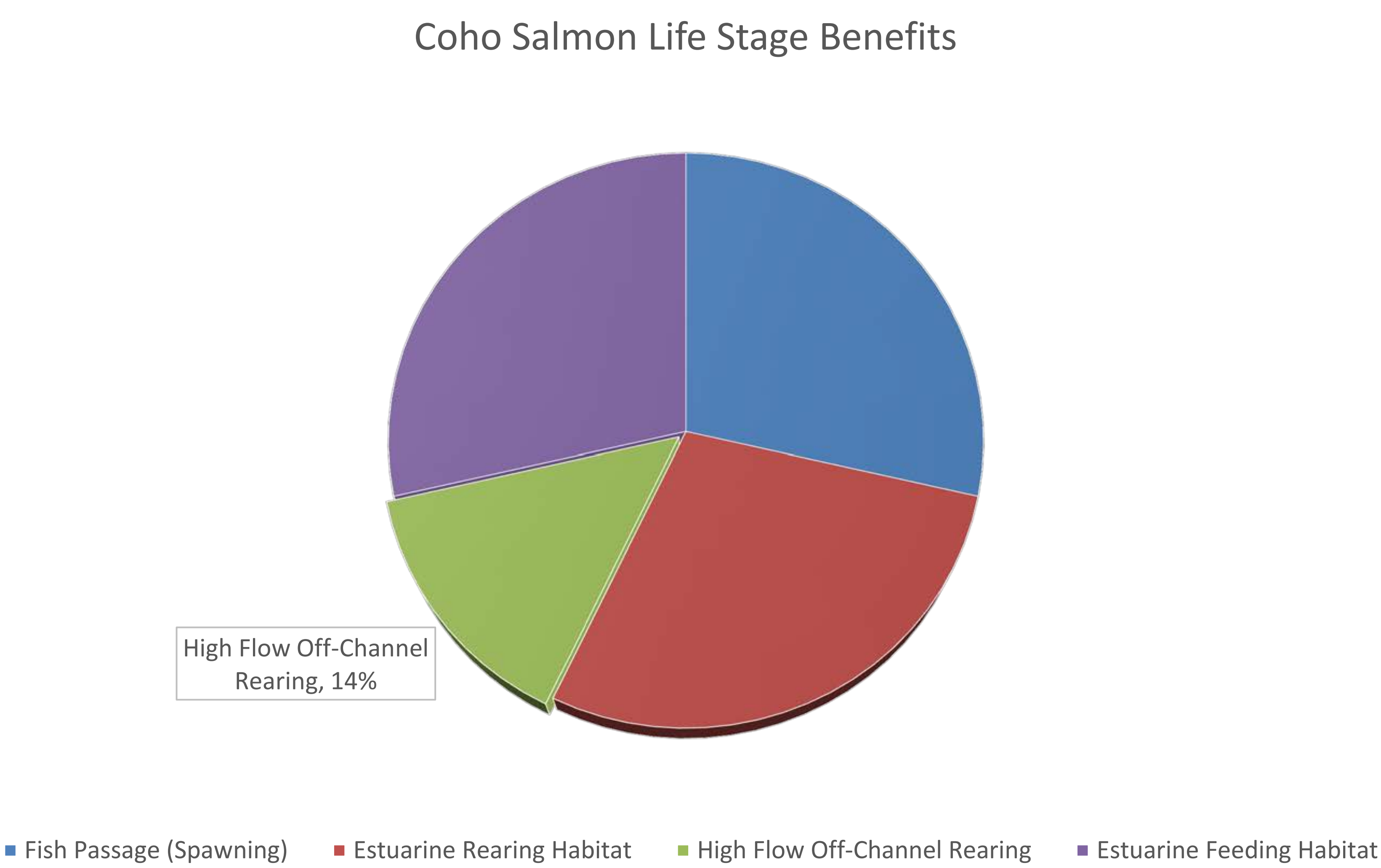
    **Management guidelines essential*

Procedural Challenges/Opportunities

- Overall Visions
  - Maximized habitat or agricultural production?
  - Balanced use or off-channel rearing for non-natal coho salmon?
  - SLR Adaptation Planning/Planned Retreat?
- Access and Site Control
  - Willing landowner needed - No obligations for species recovery on public or private property
- CEQA
  - Disclosure versus Delay
- Fundraising
  - Affordability versus Willingness
- Permitting
  - County Level
    - General Plan
    - Williamson Act
  - State and federally listed species
    - No tidegate standards
  - Coastal Act
    - Fill in wetlands
    - Agricultural Protections

Overall Project Benefits




Coho Salmon Life Stage Benefits
High Flow Off-Channel Rearing, 14%
Fish Passage (Spawning)
Estuarine Rearing Habitat
High Flow Off-Channel Rearing
Estuarine Feeding Habitat

DESIGN REVIEW: WHO TO BELIEVE?

BIOLOGISTS

Much of the historic SEE habitat was ephemeral so plan for periodic maintenance to keep restored off channel habitat in fixed locations from filling with sediment or otherwise destroyed.

ENGINEERS

Conservation Engineering is not convinced that the design will work as intended and anticipates that there will continue to be unpredictable areas of deposition and channel avulsion. It should be noted that the Fisheries Restoration Grants Program does not fund projects with side channels that have the intention of regular maintenance of a constructed channel features that would not otherwise be formed and maintained by the stream itself (CDFW 2017). Maintenance frequency and costs can be unpredictable and established vegetation and aquatic habitat can be disturbed or destroyed by the maintenance activities. Grant program funds are intended to fund projects that restore geomorphic functions to stream channels.

Public Resources Code §30241

The maximum amount of prime agricultural land shall be maintained in agricultural production to assure the protection of the area's agricultural economy and conflicts shall be minimized between agricultural and urban land uses through all of the following:

Public Resources Code §30242

All other lands suitable for agricultural use shall not be converted to nonagricultural uses unless (1) continued or renewed agricultural use is not feasible, or (2) such conversion would preserve prime agricultural land or concentrate development consistent with Section 30250. Any such permitted conversion shall be compatible with continued agricultural use on surrounding lands.

a) Land which qualifies for rating as Class I or II…as determined by the USDA NRCS.

b) Storie Index Rating 80-100

c) Land that supports livestock used for the Production of food and fiber and which has an annual carrying capacity equivalent to at least one animal unit per acre.

d) Land planted with fruit…or crops which have a non-bearing period of less than five years and which will normally return during the commercial bearing period on an annual basis from the production not less than $200 per acre.

e) Land which has returned from the production of unprocessed agricultural plant products on an annual gross value of not less than $200 per acre for three of the five previous years.

- PRC Division 20, Section 30113

f) Additionally, the Humboldt County General Plan includes in their definition: Lands adjacent to a, b, or c, above which presently or historically have been necessary to provide for economically viable agricultural areas….





Groundbreaking! What could go wrong?

Implementation

- Going to Bid (Bid Protest?? ☹)
- Construction management (You did WHAT?)
- Site Control (Again?? ☹)
- Financing and Cash Flow (Uh, can you wait?)
- Insurance (it’s either liability of indemnity)
- Permit Compliance
- MMRP (How do I PAY for this? ☹)
- *Maintenance*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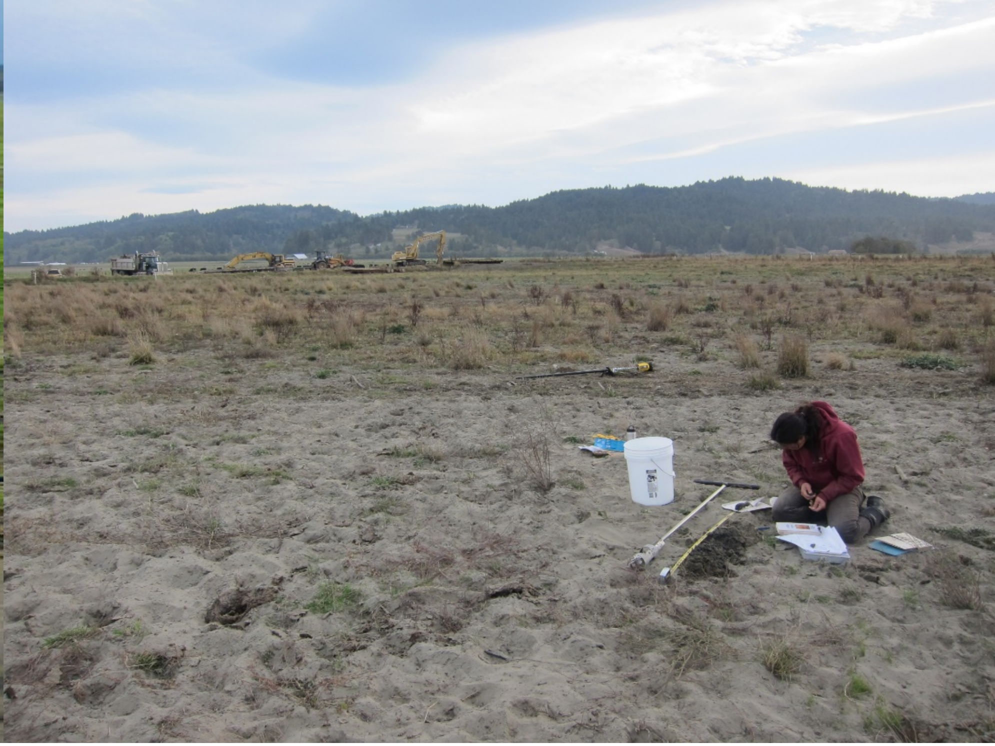






SCHOOL BUS

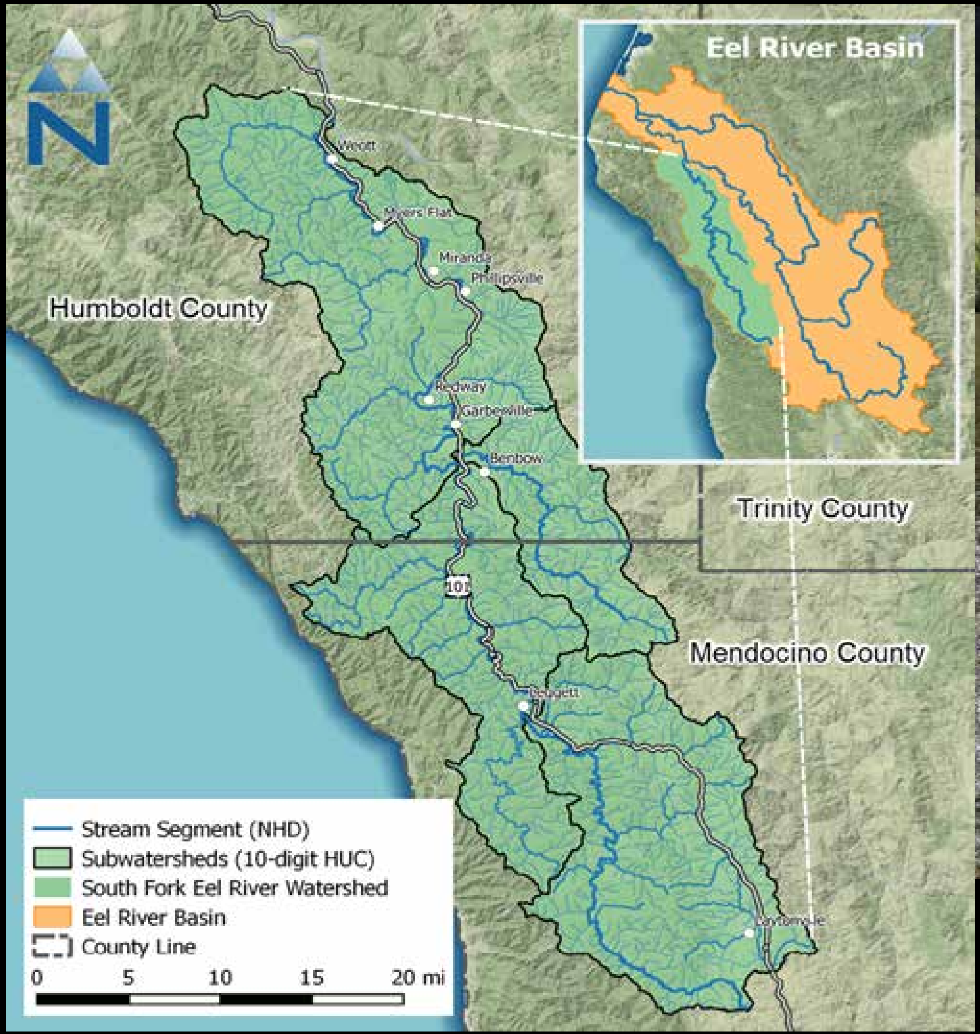

Jan 21, 2017, 9:17:52 AM

JUVENILE SALMONID USE AND RESTORATION ASSESSMENT OF THE TIDAL
PORTIONS OF SELECTED TRIBUTARIES TO HUMBOLDT BAY, CALIFORNIA,
2015-2017

In our study, we defined the Stream Estuary Ecotone (SEE) as the wetland area of low gradient stream extending from where the stream entered the tidal plain, through the upper limit of tidal influence on stream habitat, downstream to the channel bordered by tidal mudflats. This definition of the SEE includes all side channels, off channel ponds, tidal channels, and fringing marsh habitats that are accessible to fish for at least some portion of the tidal cycle.

Research Efforts Supporting Instream Flow Planning:

Hydrology Modeling, Data Collection, and Stream Classification in the South Fork Eel River Basin



Saturday April 14, 2018

Valerie Zimmer, Adam Weinberg

Instream Flow Unit
Division of Water Rights
State Water Resources Control Board

CALIFORNIA WATER BOARDS
State Water Resources Control Board

Outline

- California Water Action Plan (CWAP)
- Science -> Water Management Steps
- South Fork Eel Projects
    - Localized Instream Flow Studies
    - Hydrology Model
    - Stream Gauging
    - Water Allocation Model
    - Distributed Instream Flow Criteria

California Water Action Plan

Three Broad Objectives

- More reliable water supplies
- Restoration of important species and habitat
- à "Enhance Water Flows in Streams Statewide
- More resilient, sustainable managed water resources system

California Water Action Plan: Roles and Responsibilities

CDFW

- Habitat and Passage Studies

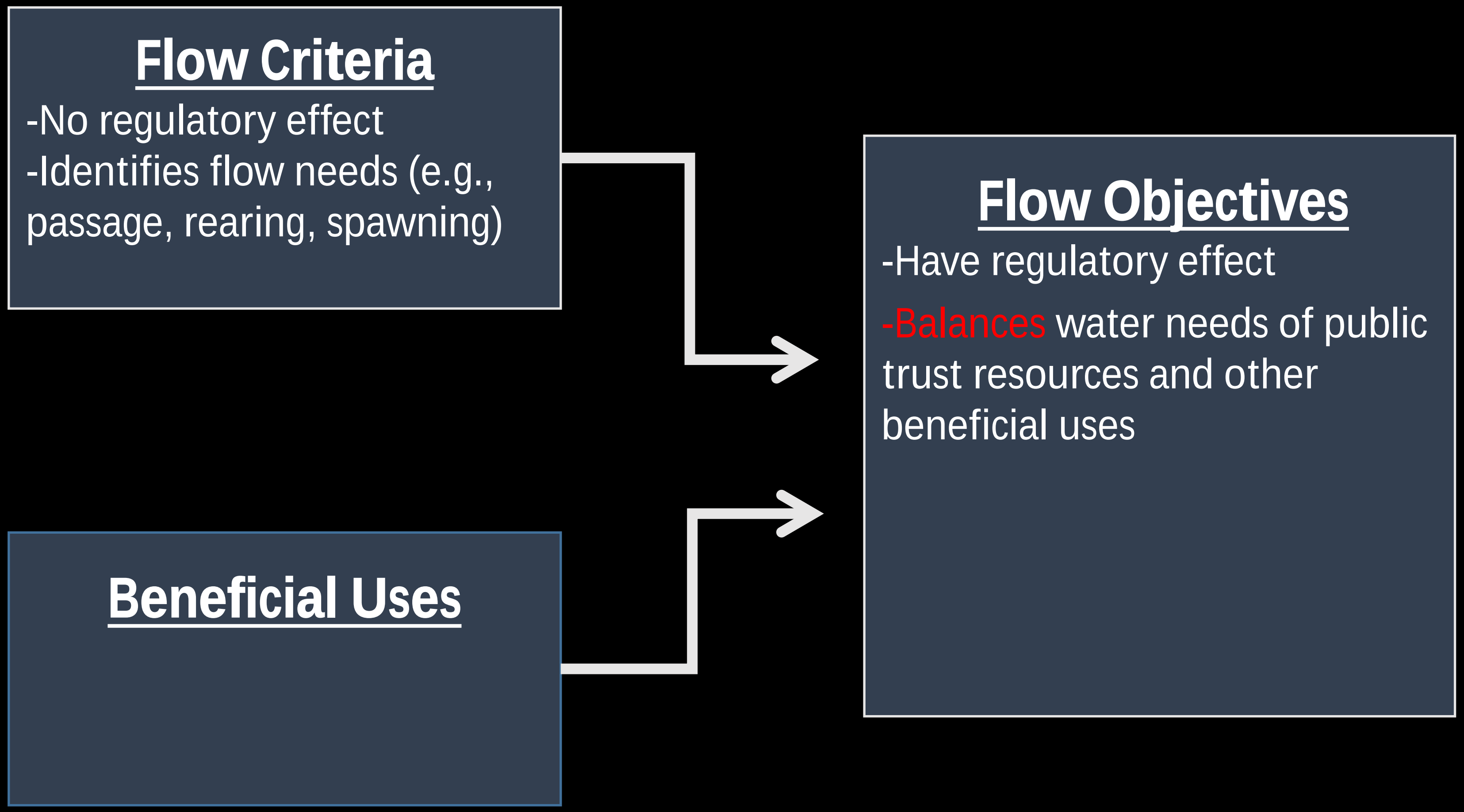
à Instream Flow Criteria (Recommendation)

State Water Board

- Hydrology and Water Use Analyses - BALANCING
- Collect information from other research
- Instream Flow Objectives (Policy)

à Water Management Policy and Implementation

Flow Criteria vs. Flow Objectives



Flow Criteria vs. Flow Objectives

CDFW +
Researchers

Flow Criteria

-No regulatory effect
-Identifies flow needs (e.g., passage, rearing, spawning)

Hydrology

Beneficial Uses

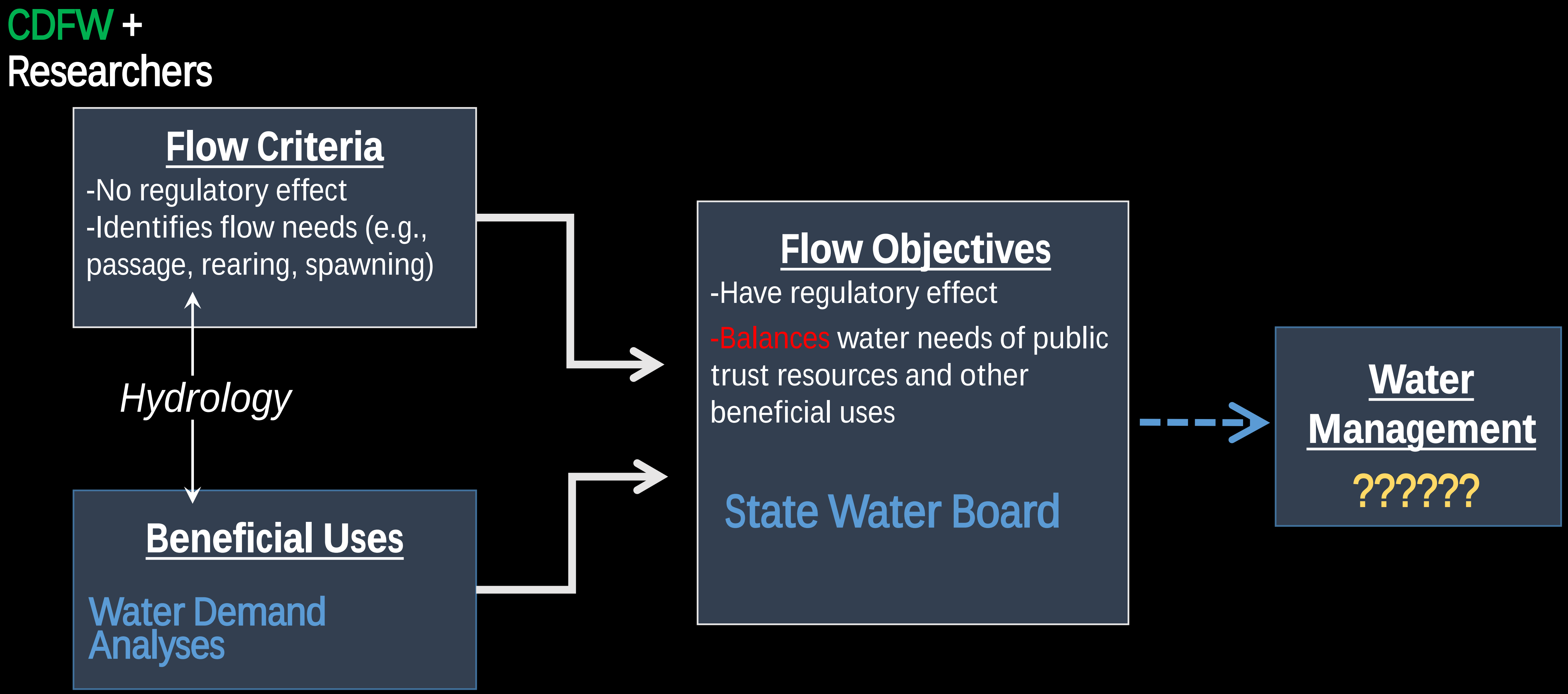
Water Demand Analyses

Flow Objectives

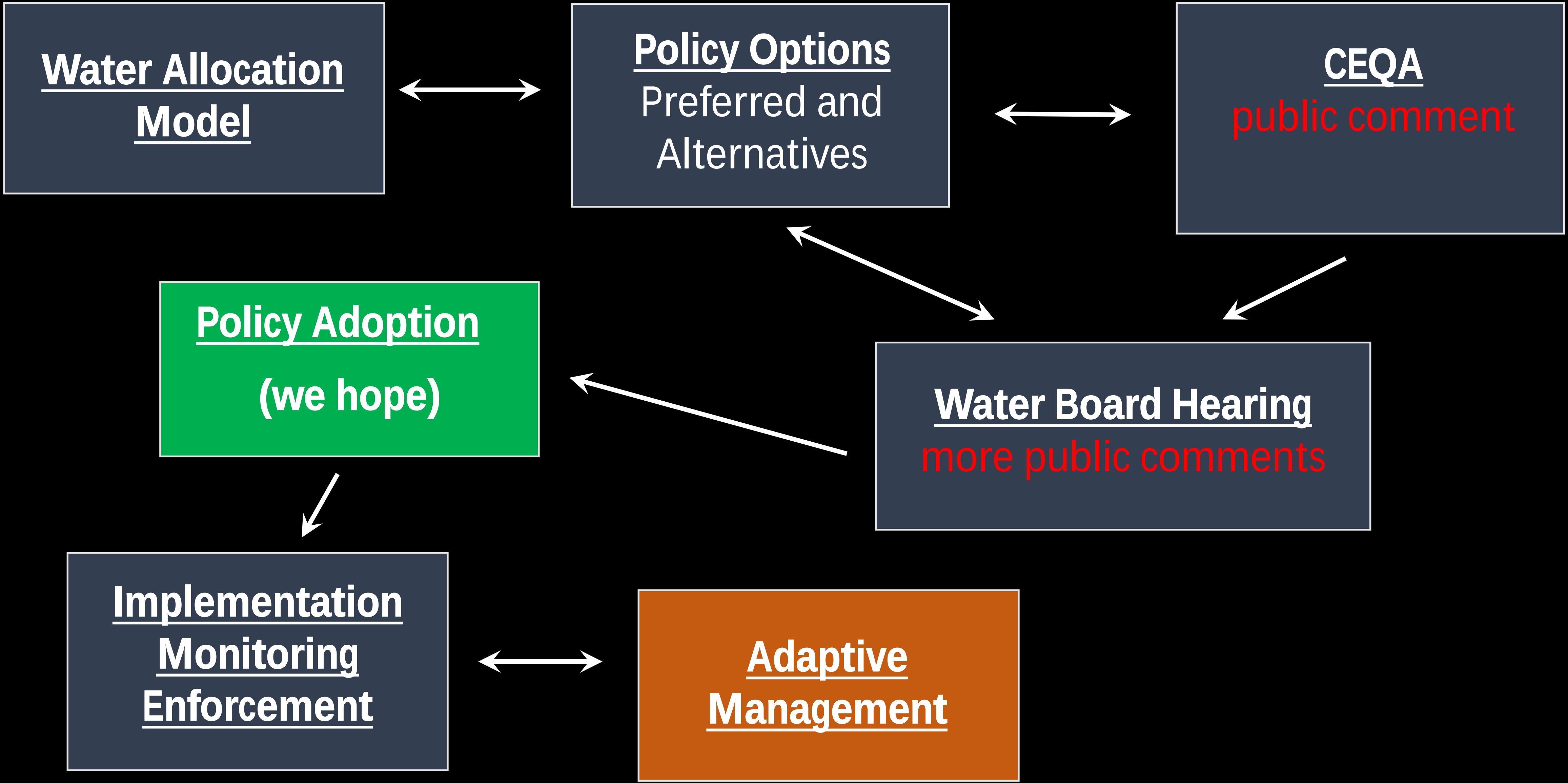
-Have regulatory effect
-Balances water needs of public trust resources and other beneficial uses

State Water Board

Flow Criteria vs. Flow Objectives



Developing Flow Objectives

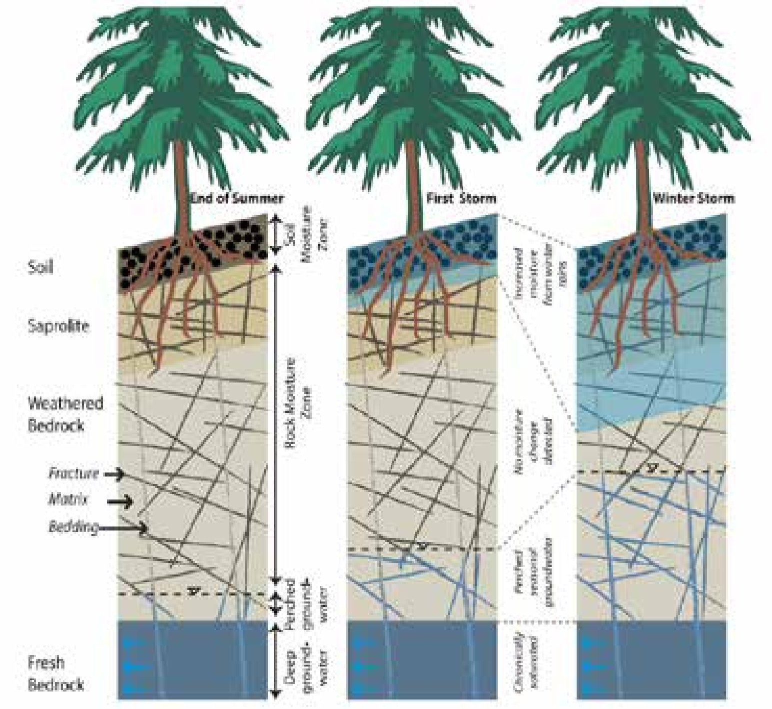


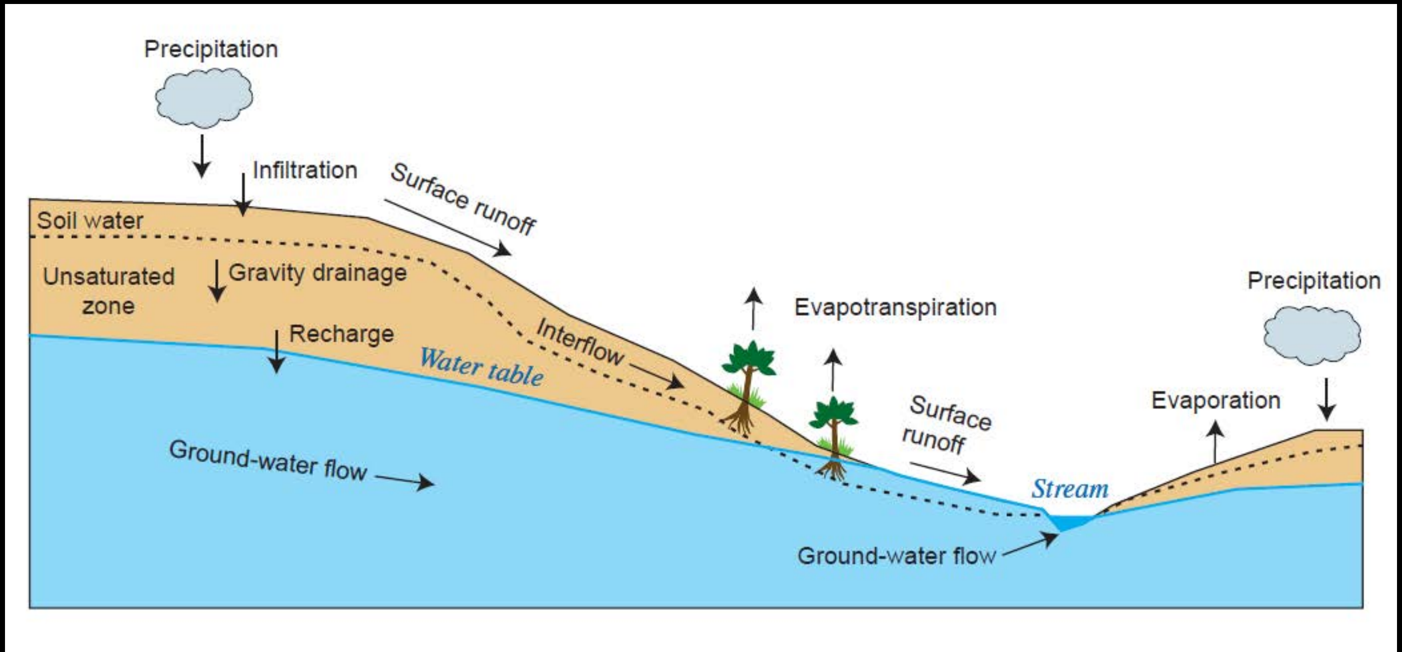
Localized Instream Flow Studies

- Redwood Creek (CDFW)
  - PHABSIM: summer passage and rearing
- Sproul Creek (CalTrout)
  - PHABSIM alongside alternative habitat evaluation methodologies

Hydrology Model

- Rainfall – runoff (surface water) using LSPC model
- MODFLOW groundwater model
- Final product available to the public



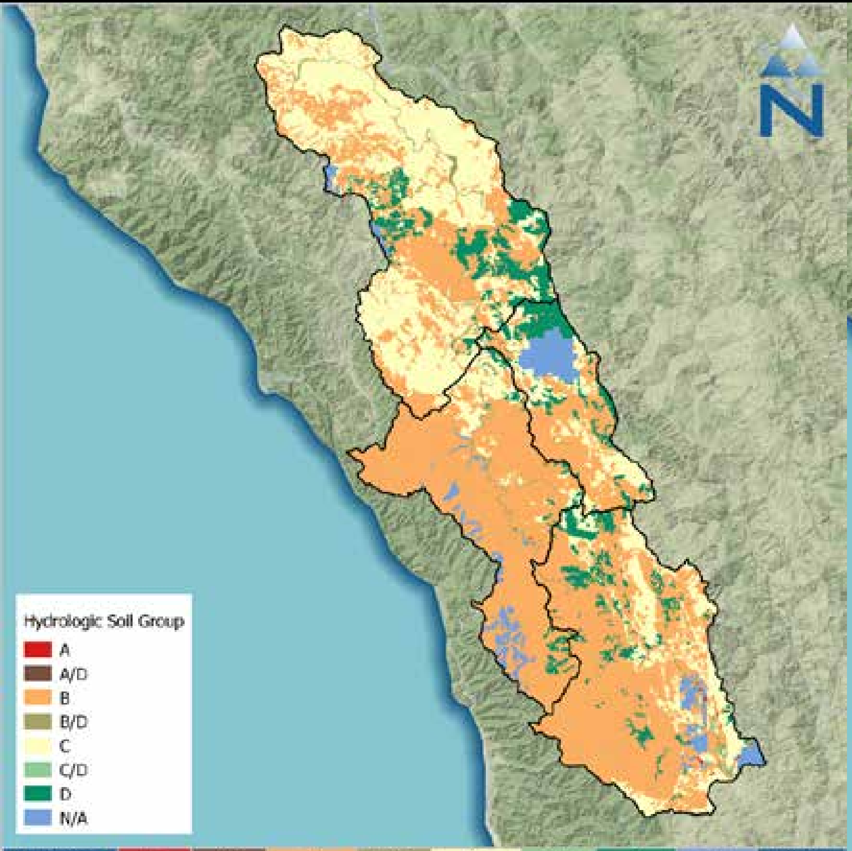


Conceptual model for rock moisture and groundwater dynamics in the weathered bedrock zone
(Salve et al. 2012).

PARADIGM ENVIRONMENTAL

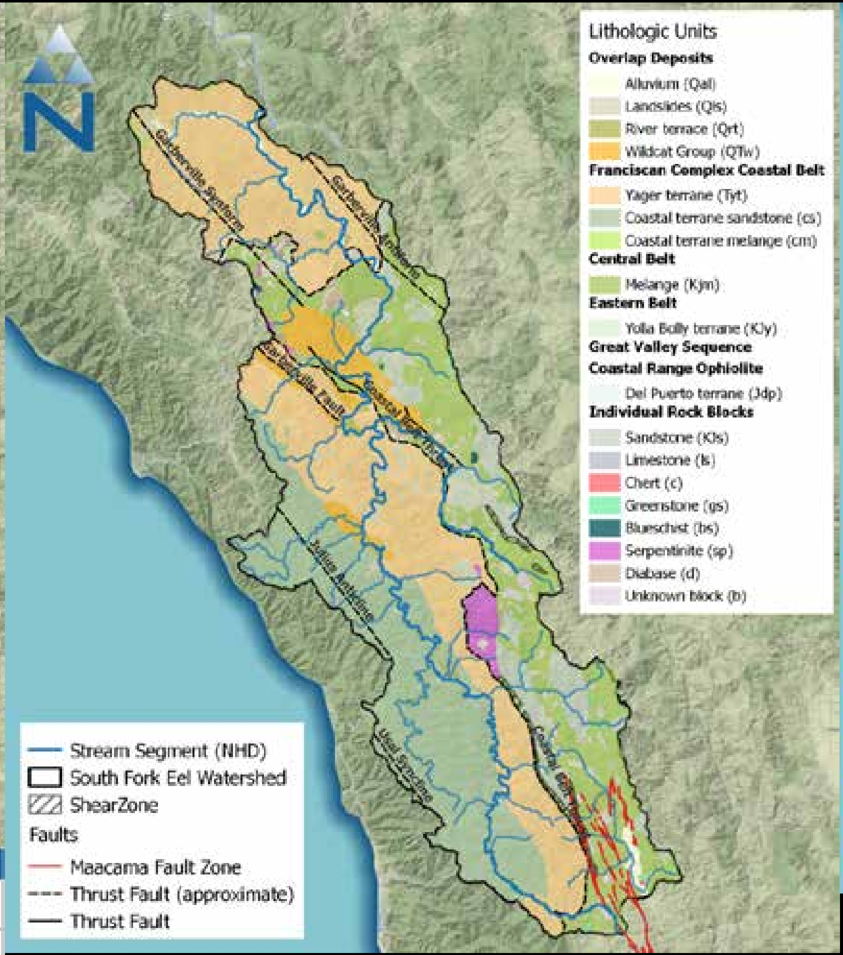
Hydrology Model Components

Soil Type

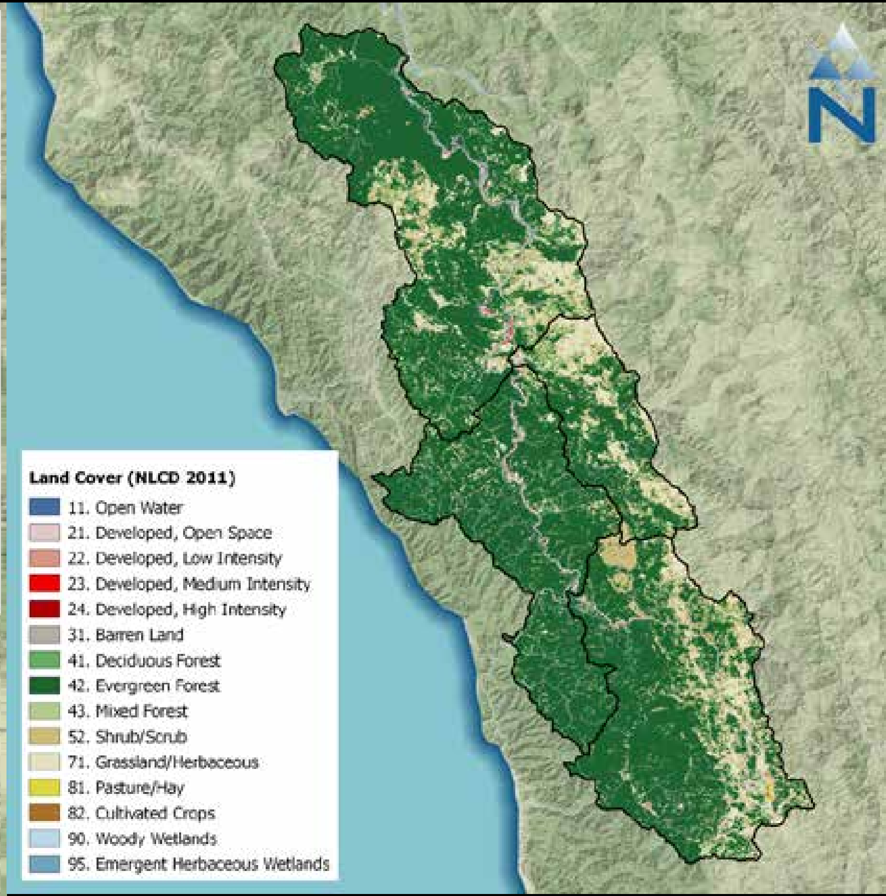


Soil Type	A	A/D	B	B/D	C	C/D	D	N/A	TOTAL
Area (acres)	216	124	243,090	4,843	136,889	735	38,304	17,938	442,137
Percent Area	0.05%	0.03%	54.98%	1.10%	30.96%	0.17%	8.66%	4.06%	100%

Lithology (Rocks)

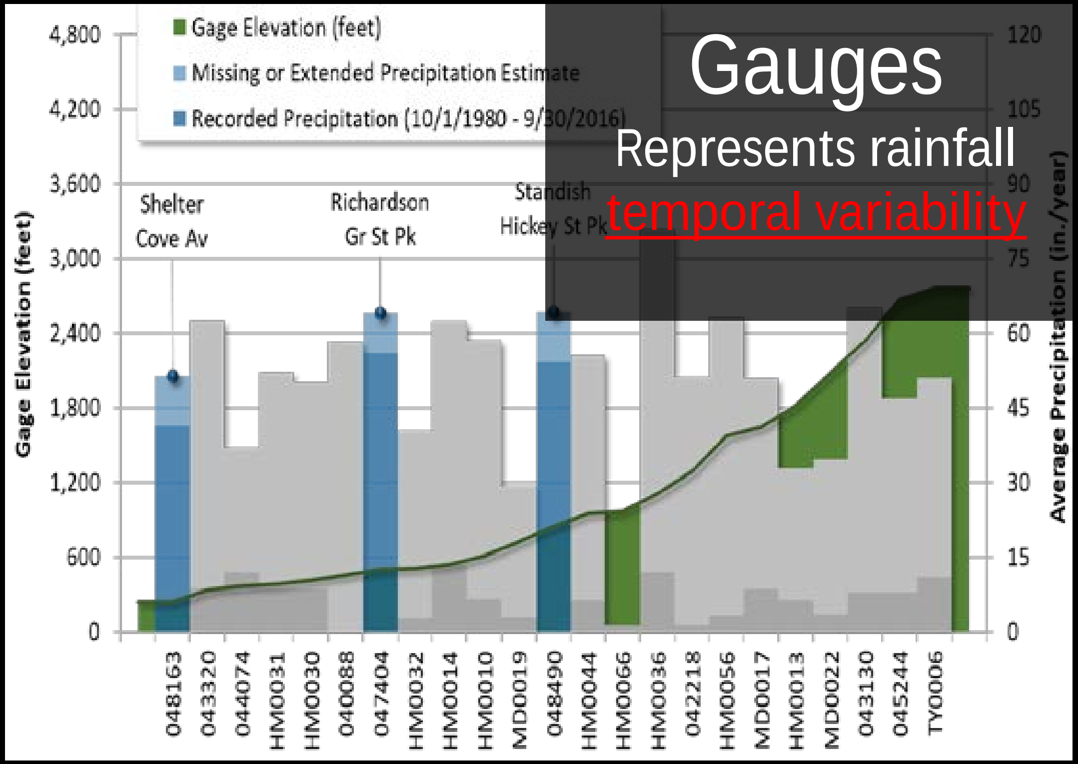


Vegetation



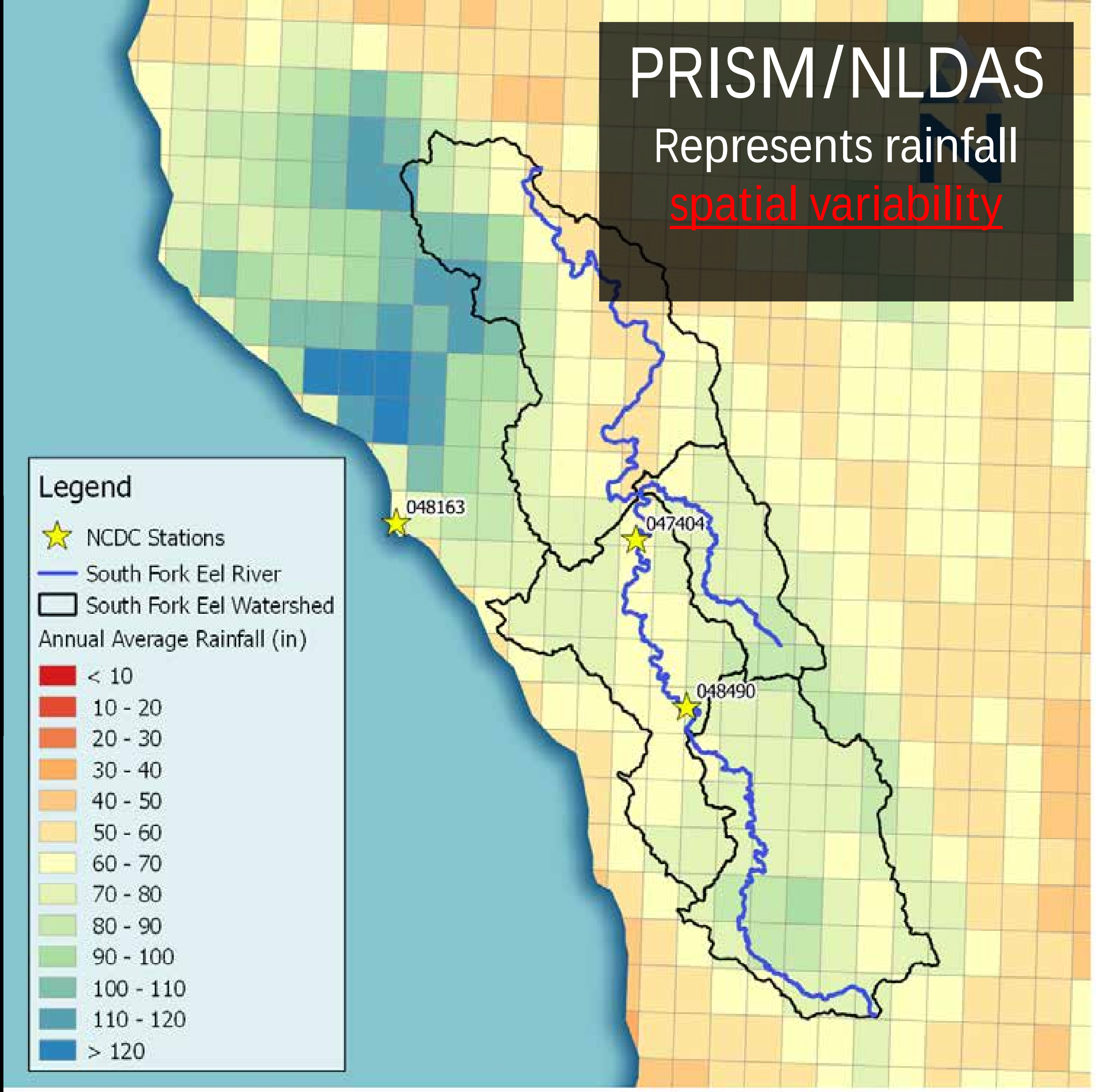
Estimating Rainfall

- Missing gauge records patched using good data from nearby stations (normal ratio method).
- Combining the spatial and temporal variability give precipitation for the entire watershed, including ungauged basins.



Gauges

Represents rainfall temporal variability



PRISM/NLDAS

Represents rainfall spatial variability

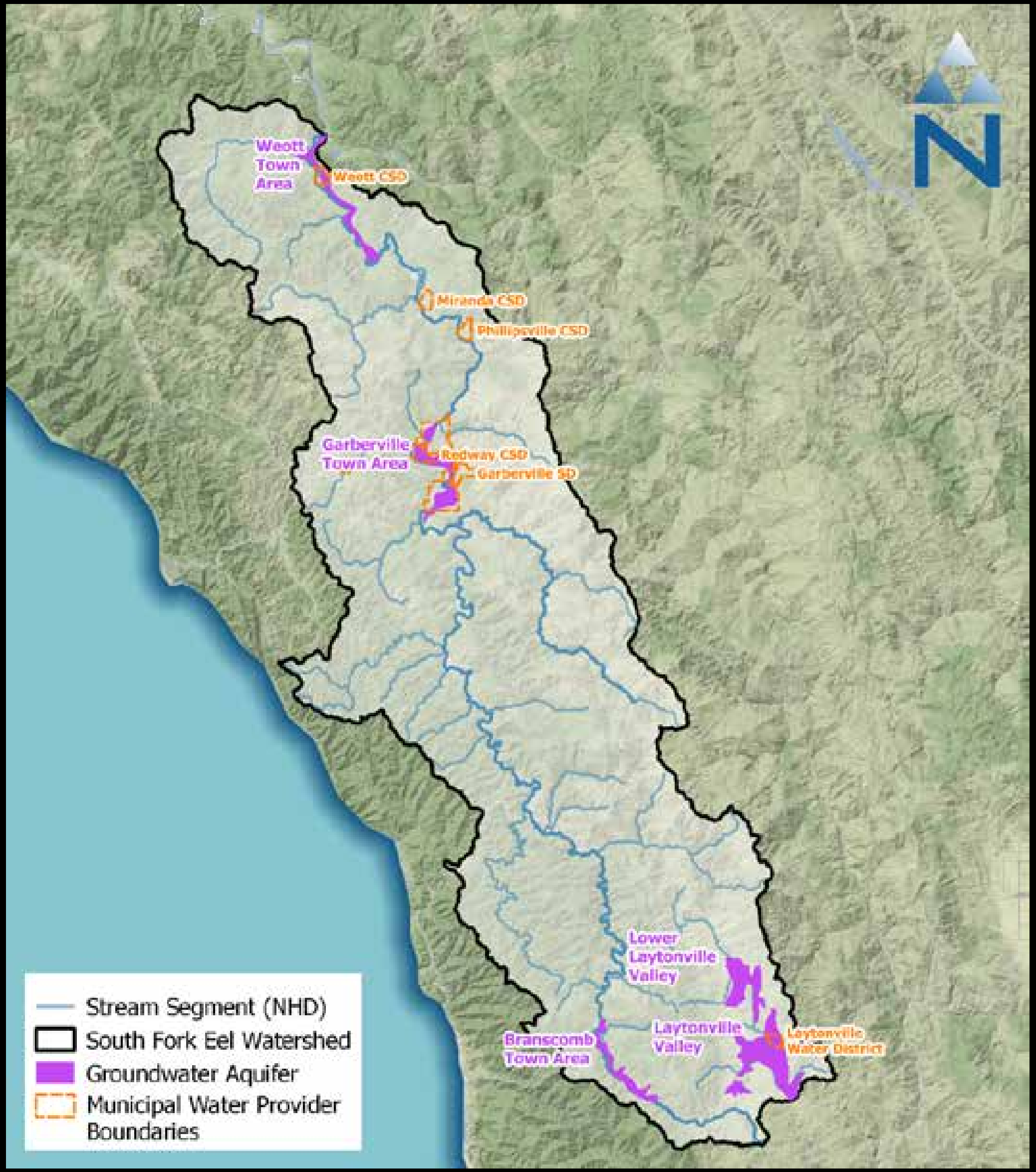
Hydrology Model -> Existing Condition Instream Flows

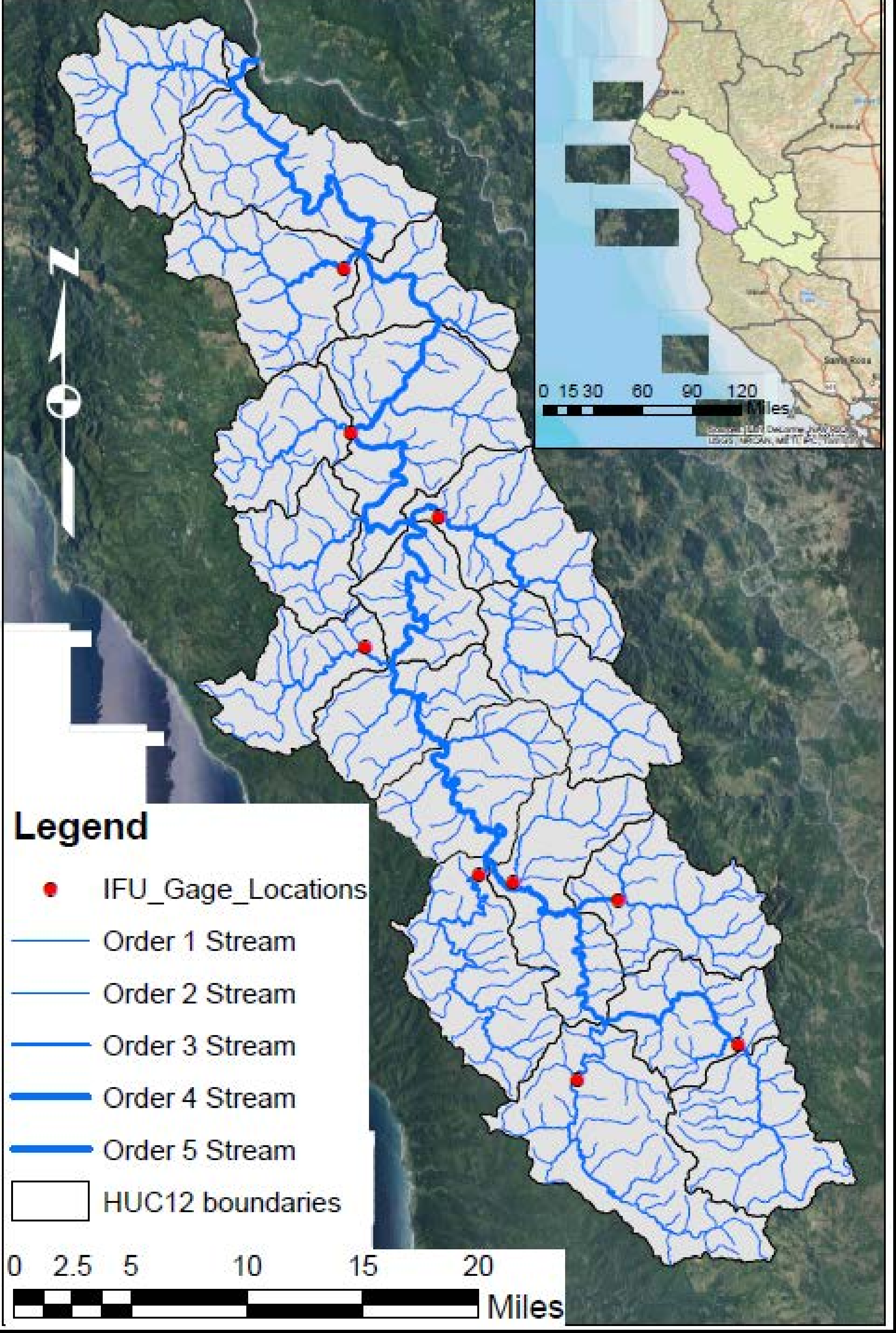
Watershed Characterization

- Physical watershed characteristics
- Meteorology
- Consumptive use
- Hydromodifications
- Groundwater pumping

Study Plan

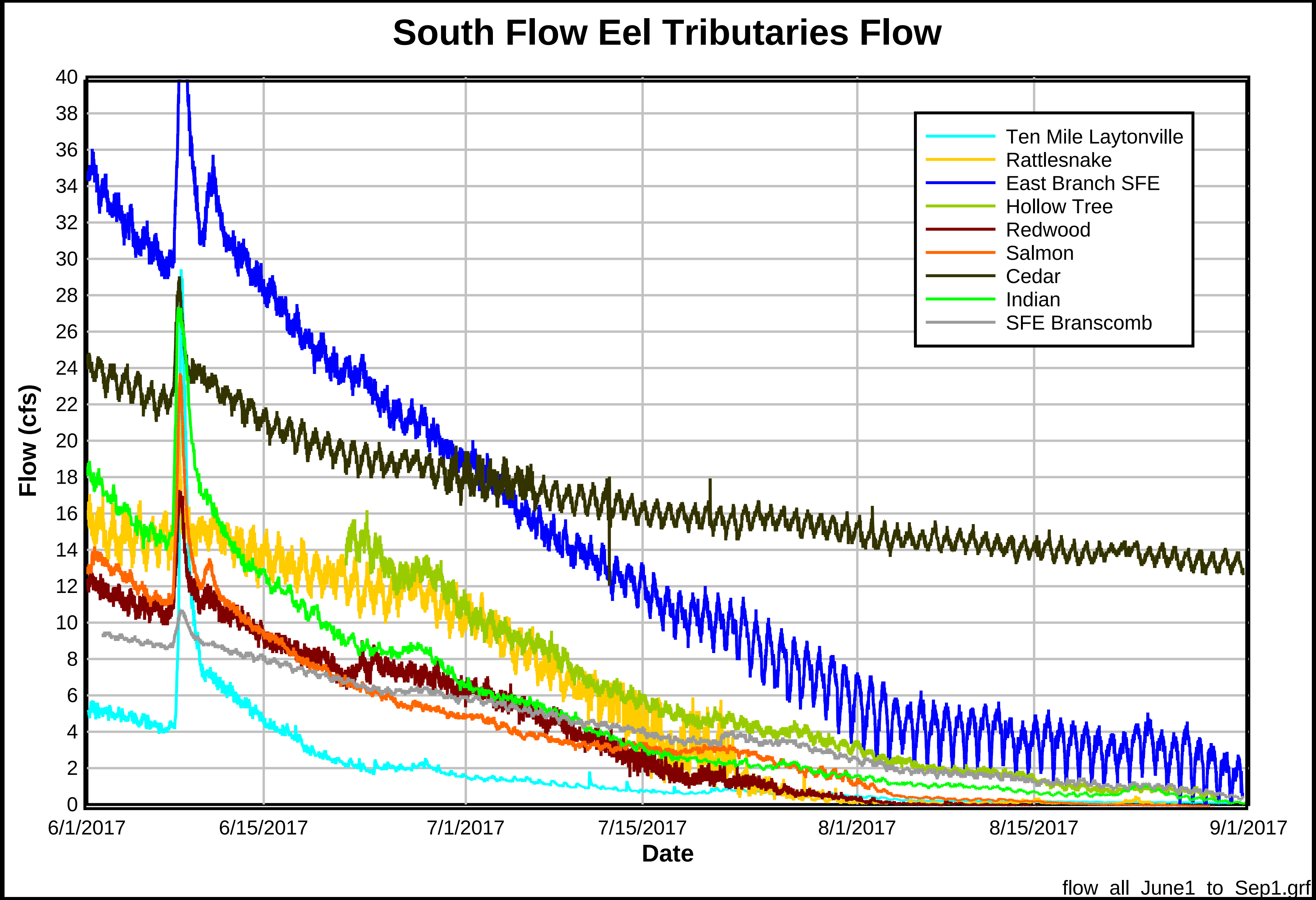
- Process-based systems modeling
- Surface-groundwater interactions
- Impacts/sensitivity of key drivers

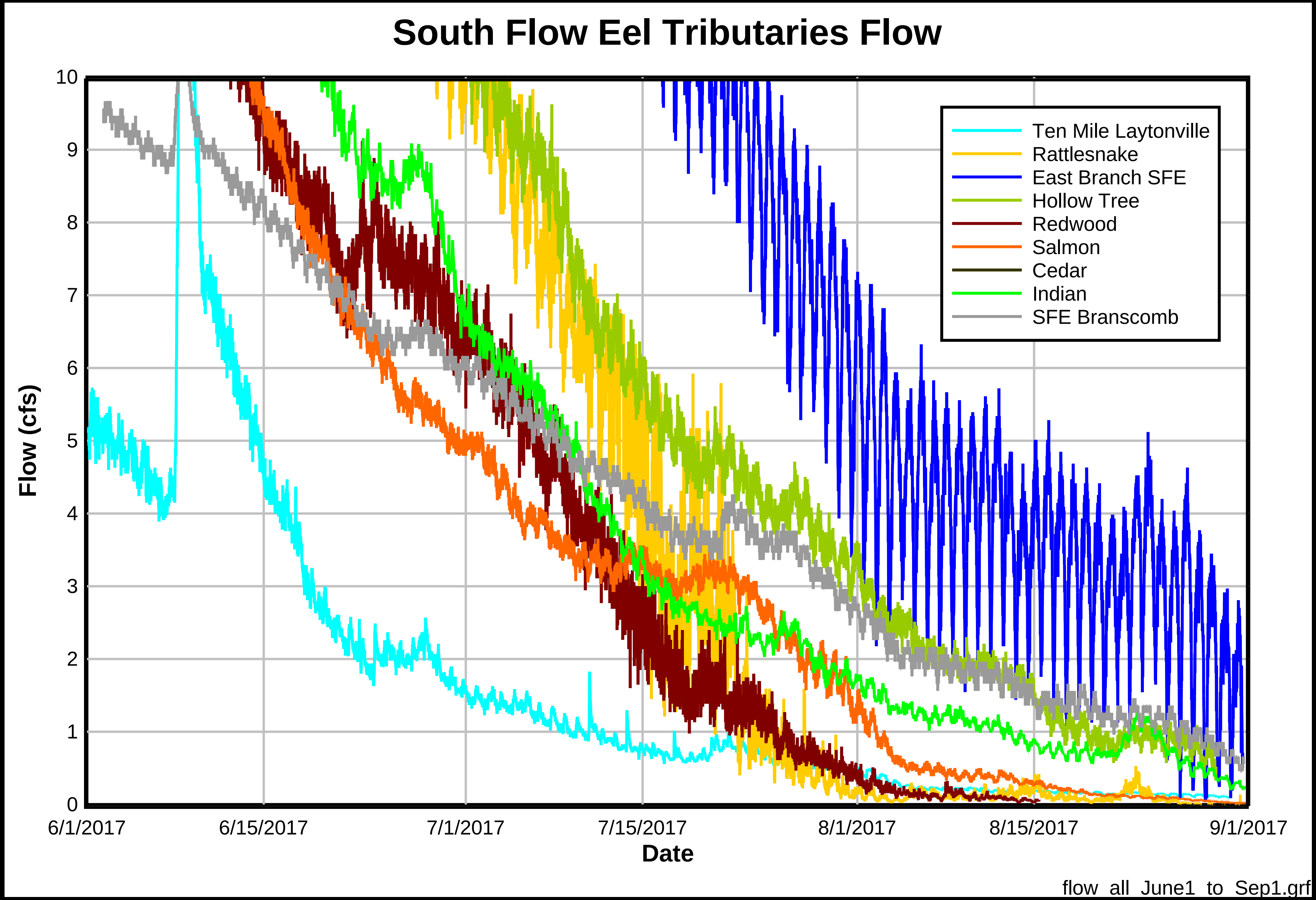


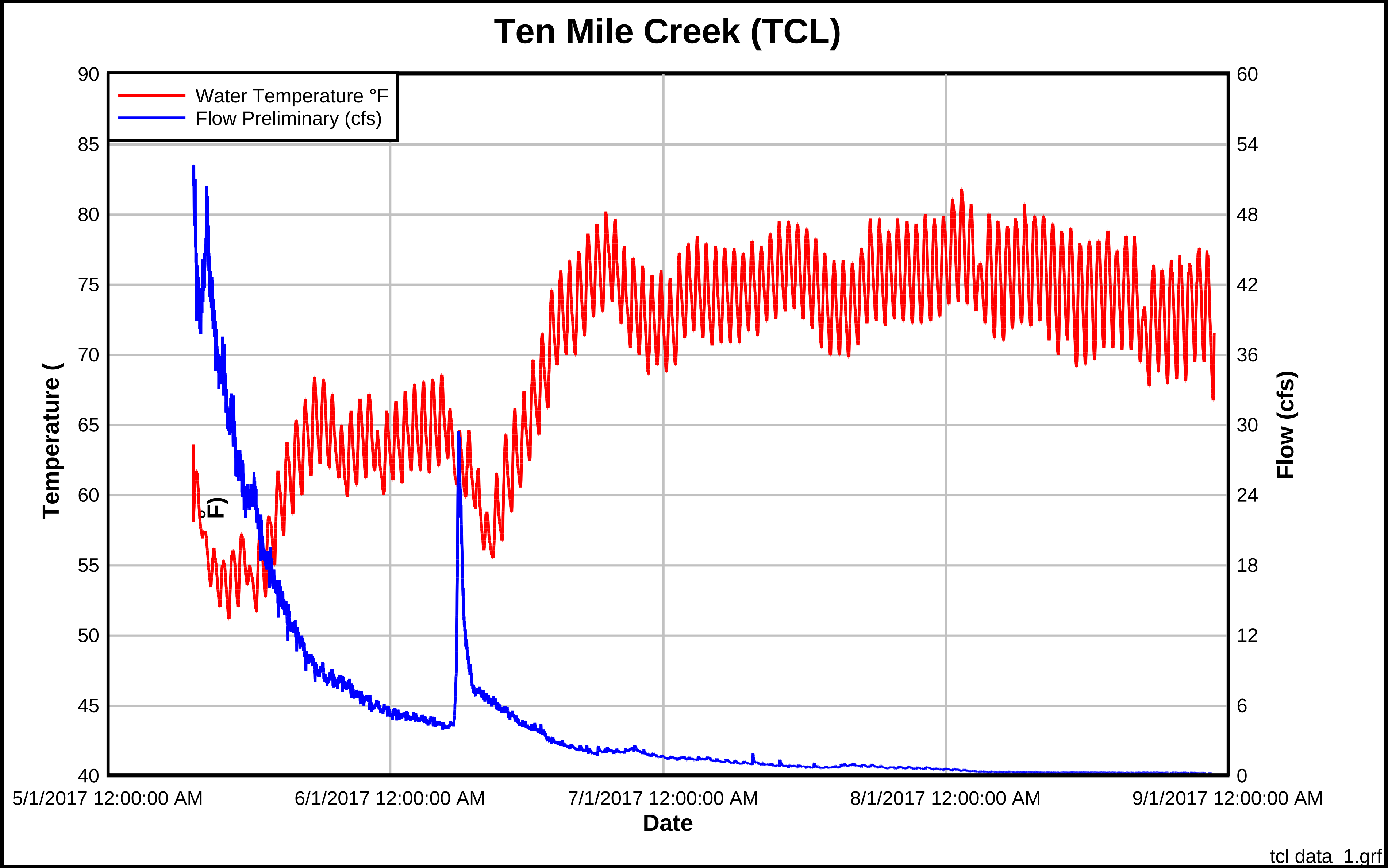


Stream Gauging Effort

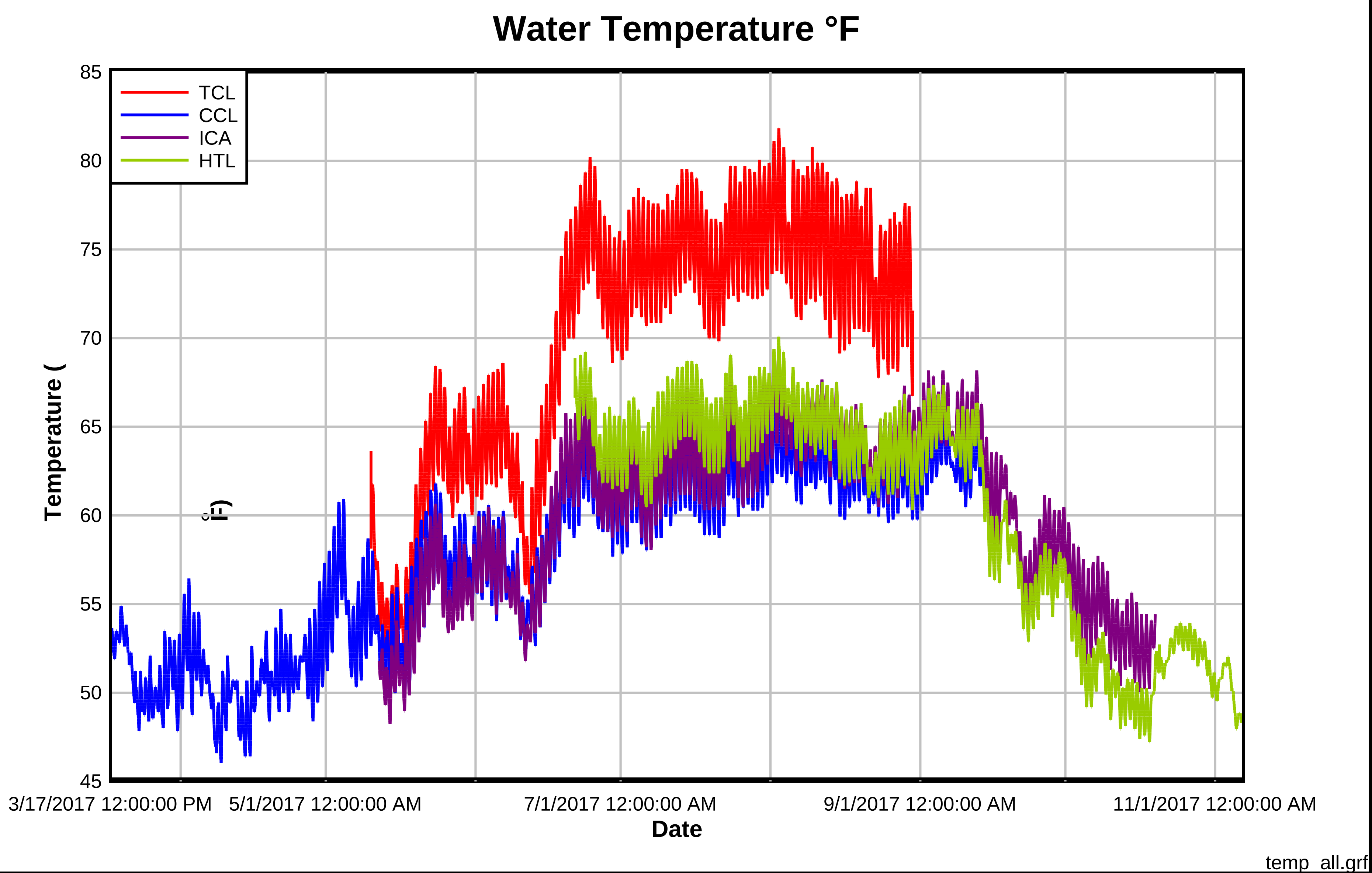
- SF @ Branscomb
- Ten Mile @ Laytonville
- Rattlesnake Creek
- Cedar Creek @ Leggett
- Hollow Tree Creek
- Indian Creek
- East Branch SF Eel @ Benbow
- Redwood Creek @ Redway
- Salmon Creek @ Miranda


South Flow Eel Tributaries Flow
Flow (cfs)
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
6/1/2017
6/15/2017
7/1/2017
7/15/2017
8/1/2017
8/15/2017
9/1/2017
Date
Ten Mile Laytonville
Rattlesnake
East Branch SFE
Hollow Tree
Redwood
Salmon
Cedar
Indian
SFE Branscomb
flow_all_June1_to_Sep1.grf


South Flow Eel Tributaries Flow
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
6/1/2017
6/15/2017
7/1/2017
7/15/2017
8/1/2017
8/15/2017
9/1/2017
Date
Ten Mile Laytonville
Rattlesnake
East Branch SFE
Hollow Tree
Redwood
Salmon
Cedar
Indian
SFE Branscomb
flow_all_June1_to_Sep1.grf



Ten Mile Creek (TCL)
Water Temperature °F
Flow Preliminary (cfs)
Temperature (°F)
Flow (cfs)
90
85
80
75
70
65
60
55
50
45
40
60
54
48
42
36
30
24
18
12
6
0
5/1/2017 12:00:00 AM
6/1/2017 12:00:00 AM
7/1/2017 12:00:00 AM
8/1/2017 12:00:00 AM
9/1/2017 12:00:00 AM
Date
tcl data 1.grf



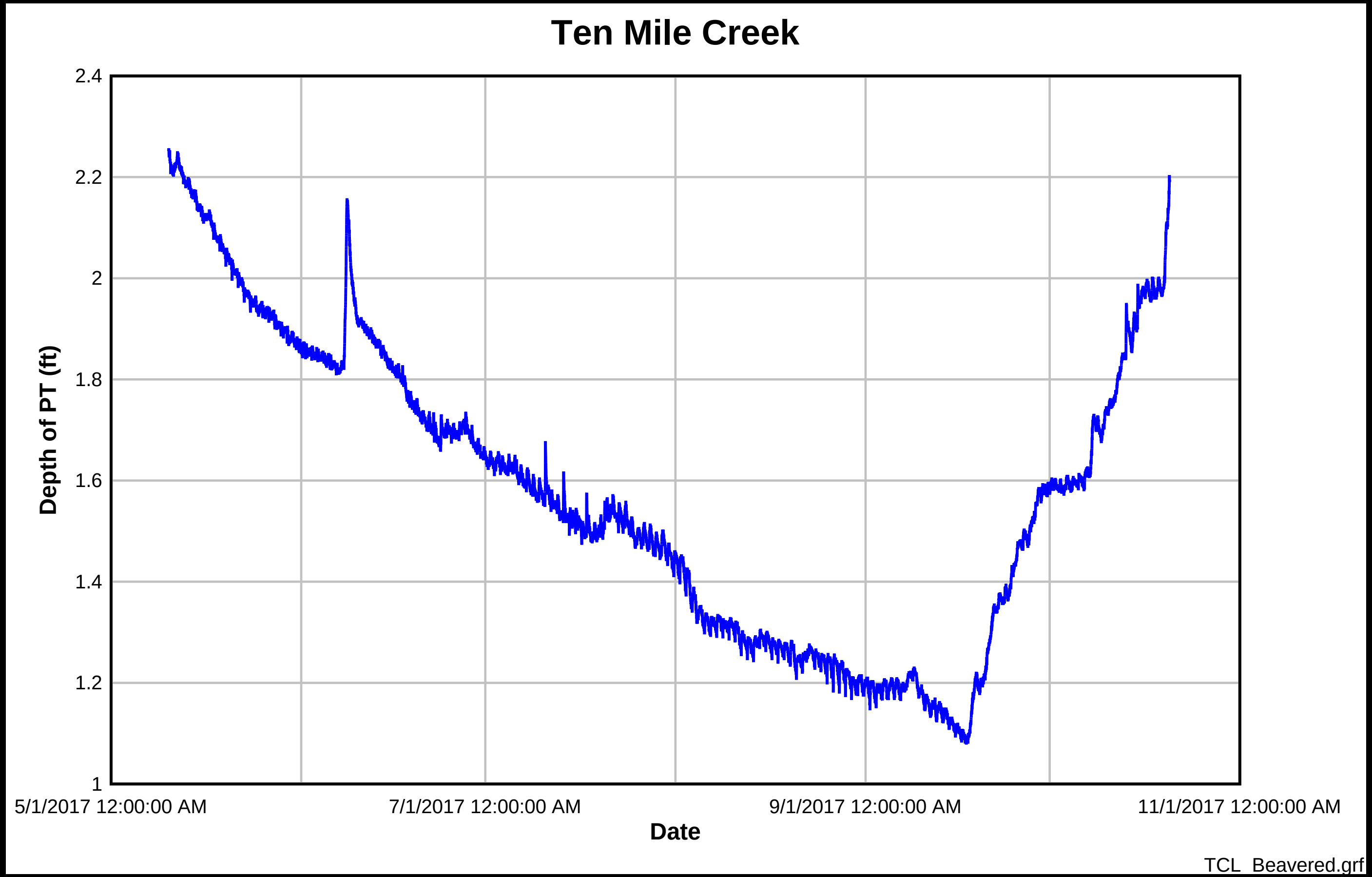
Water Temperature °F
TCL
CCL
ICA
HTL
85
80
75
70
65
60
55
50
45
Temperature (°F)
3/17/2017 12:00:00 PM
5/1/2017 12:00:00 AM
7/1/2017 12:00:00 AM
9/1/2017 12:00:00 AM
11/1/2017 12:00:00 AM
Date
temp_all.grf

Low Flow Monitoring Challenges

Flumes

Leaf Litter

Low Flow Monitoring Challenges



Beavers

Stream Gauging Effort 2018

- Any day now!
- Rattlesnake Creek left in over winter
- Adding Dissolved Oxygen Sensors with CDFW collaboration????
- Moving TCL BEAVERED Gage
- Adding TCL confluence gauge
- Coordinating with other gauging efforts (Sproul, additional TCL tributaries)

Riffle Crest Thalweg Location and Elevation

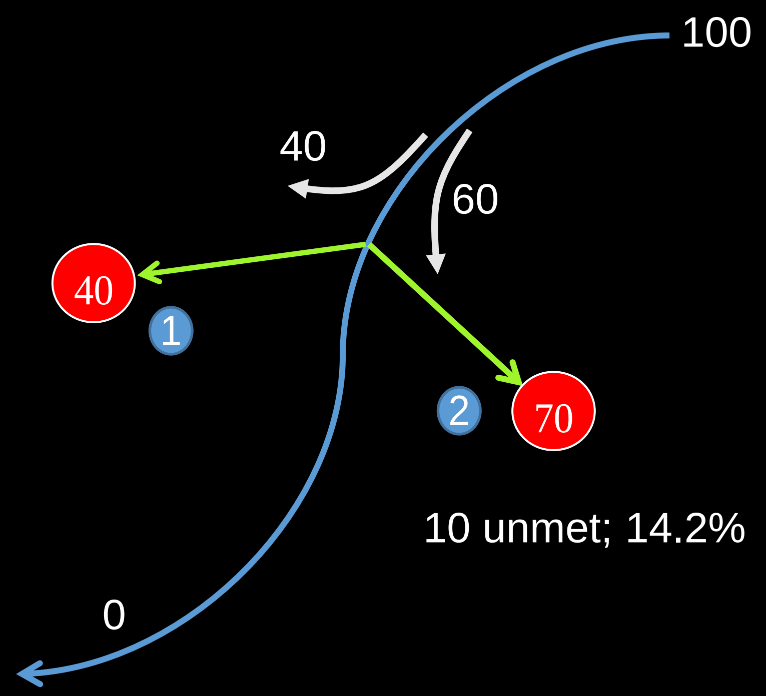
This Slide is for Bill Trush

$$Q = A * RCT^{b}$$

Station	A	b
CCL	27.2	2.44
RSC	64.1	1.65
SCM	7.8	3.22
RCR	67.6	1.97
ICA	31.6	2.62
HTL	66.7	3
ESB	47.1	2.1
SEB	35	4.3

Water Allocation Model

- Demand Representation, with assigned Priorities
- In Stream Flow Requirement
- Solved with a Linear Program



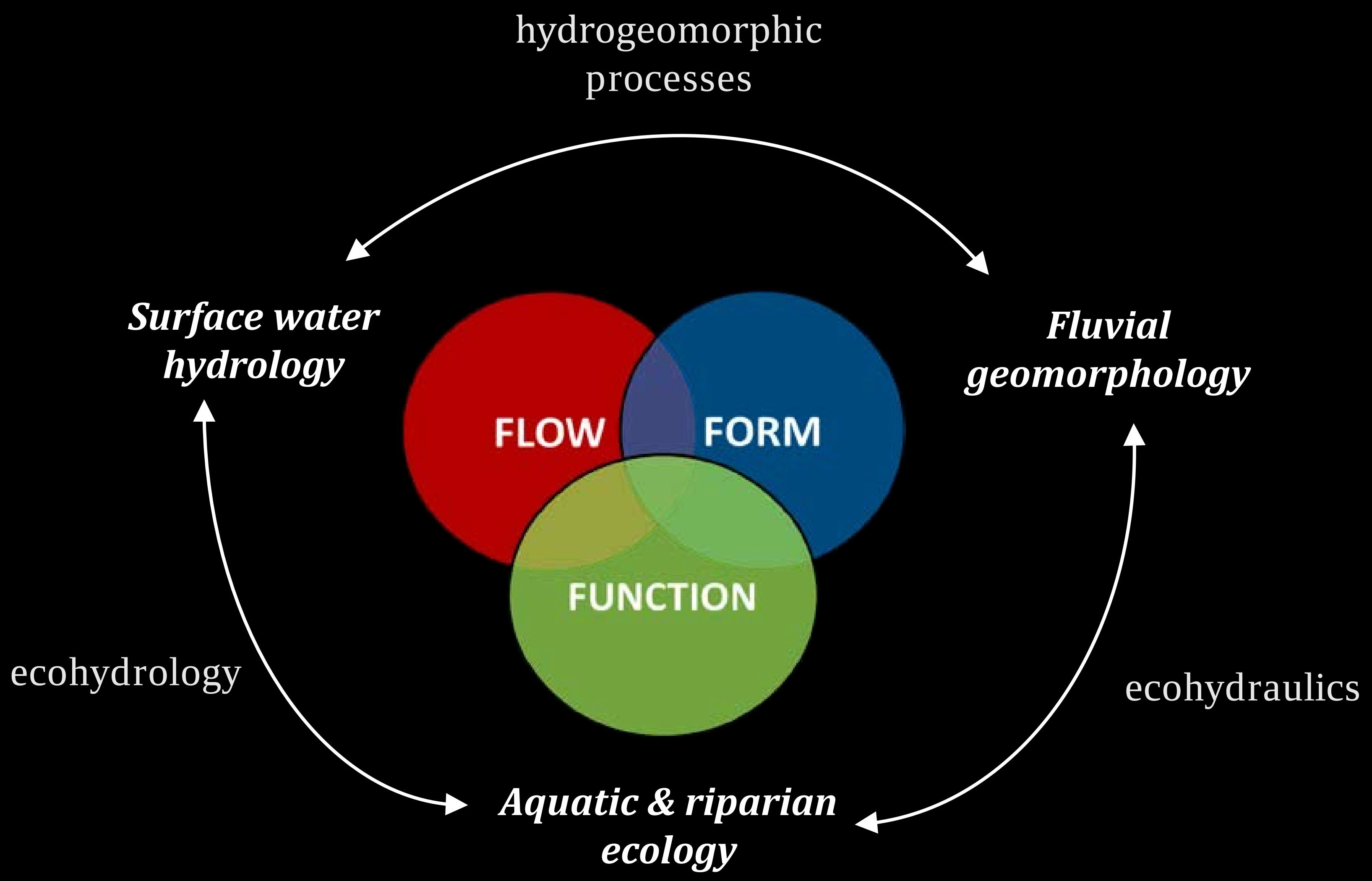
Existing WEAP models in Sacramento River (SacWAM) and Ventura River (being updated for CWAP)

Water Allocation Modeling – Challenges and Issues

- How much detail? Group water rights by type and geographic location?
- How to model unauthorized diversions?
- Groundwater Pumping?
- Reconcile demand from Land Use with Water Rights (Place of Use)?
- Planning Tool vs. Implementation Tool

Instream Flow Criteria:

Form – Flow – Function Framework



UC Davis

Utah State University

UC Berkeley

The Nature Conservancy

Southern California Coastal Water Research Project (SCCWRP)

Humboldt State University

Instream Flow Criteria

Form – Flow – Function Framework

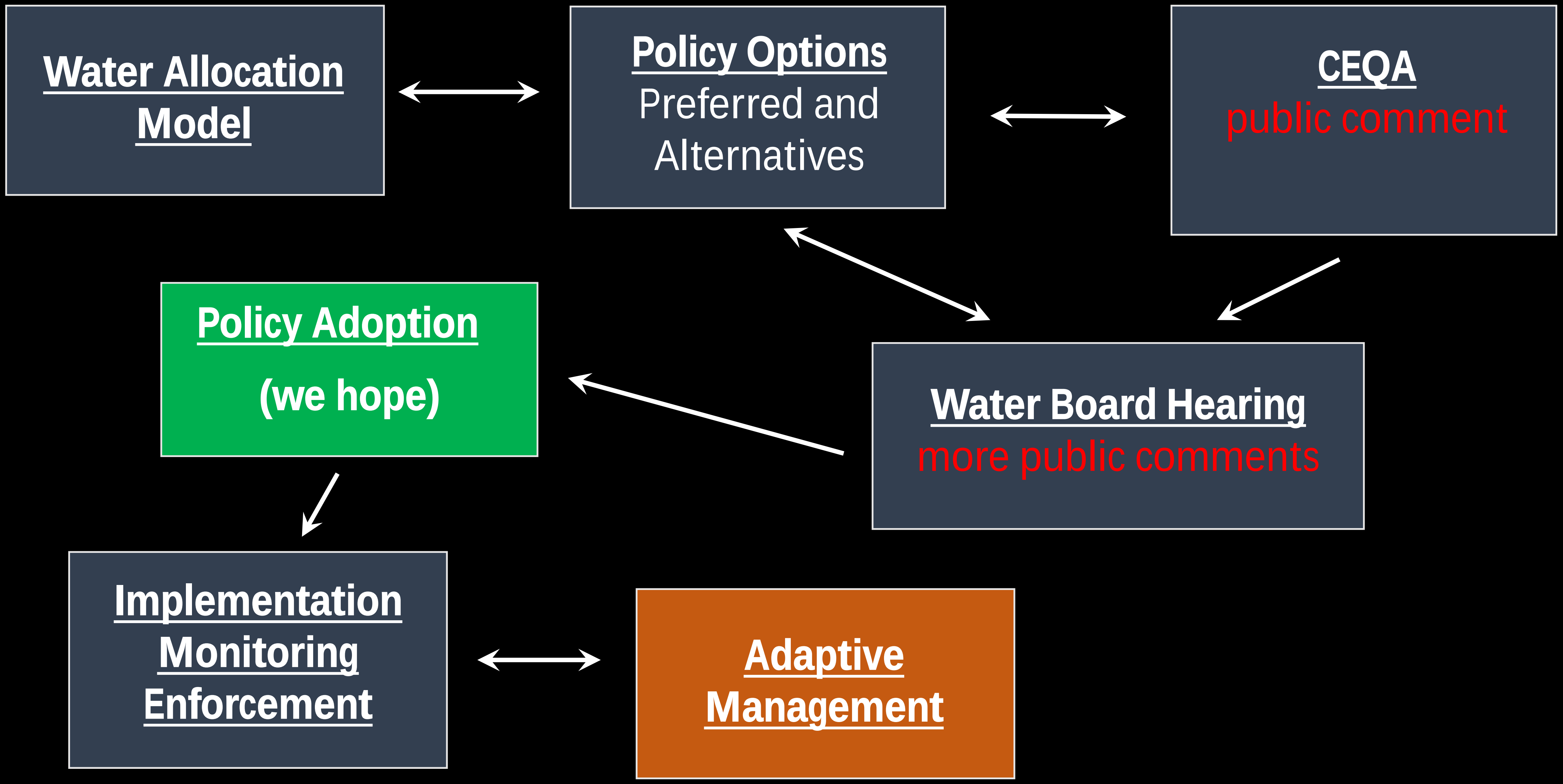
1. Classify stream network
2. Generate synthetic rivers
3. Define ecosystem functions
4. Hydrodynamic modeling
5. Propose performance criteria
6. Assess environmental flow performance or propose optimal e-flows

Credit: Belize Lane. February 13, 2018 presentation to State Water Board

Anticipated Steps Prior to Policy Adoption

- Receive results and recommendations of localized instream flow studies
- Complete modeling (Hydrology/Water Allocation)
- Complete Instream Flow Criteria development
- Identify/analyze policy options
- Select policy recommendation
- Complete CEQA analysis
- Submit policy recommendation and analysis of alternatives to the Board
- Anticipated Policy implementation…. 2021

Policy Adoption Process (visual)



In the meantime....

- Collaborative efforts with agencies, NGOs, and property owners to collect data
- Water Rights enforcement
- Identify other regulatory or non-regulatory opportunities flow and habitat enhancement

Questions?

Valerie Zimmer and Adam Weinberg
916-319-0368
Valerie.zimmer@waterboards.ca.gov

Instream Flow Unit
Division of Water Rights
State Water Resources Control Board

Tiered field sampling protocols to enhance the role of geomorphic classification in instream flow management

Colin Byrne, PhD

Belize Lane, PhD
Gregory Pasternack, PhD
Samuel Sandoval Solis, PhD
Herve Guillon, PhD

Department of Land, Air, and Water Resources

University of California Davis

Contact: cfbyrne@ucdavis.edu

Project Goals

Within the context of incorporating ecological needs into flow management, we seek to:

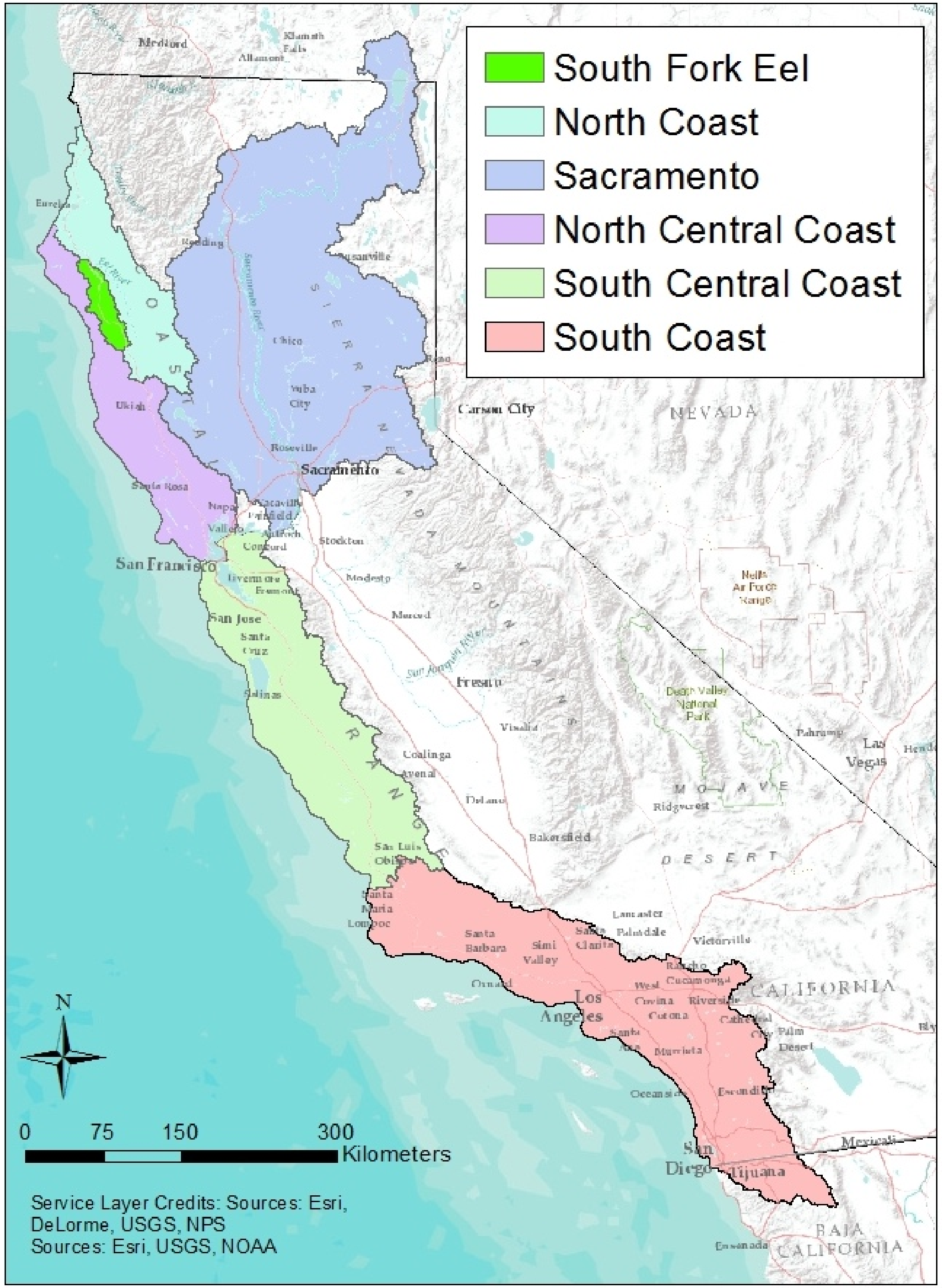
1. Better understand natural geomorphic variability in different hydrologic settings and the diversity of streams throughout California
   - *What type of streams exist in California and how do stream forms change geospatially?*
2. More accurately predict the spatial variability in ecological impacts of alternative environmental flow scenarios within California's diverse regional settings and hydrologic basins
   - *How can we assess ecologic stream conditions (e.g. salmon habitat/requirements) for under various flow conditions accurately and efficiently?*

Objectives for today’s talk:

1. Expand upon the framework of the larger study
2. Describe the two-tier sampling scheme and methodologies
3. Report the results of Tier 1 survey results in the South Fork Eel basin
4. Discuss the future and concurrent Tier 2 sampling and subsequent flow-form-function analysis

Project Locations

- South Fork Eel River is a high priority watershed
- A higher density of sampling sites within the SF Eel watershed is providing a basin specific classification



Scientific Context

- We know that ecohydraulic modeling can inform our understanding of salmon habitat and other ecologic conditions (Crowder & Diplas, 2000, 2006; Jacobson & Galat, 2006, Moir & Pasternack 2008, 2010)

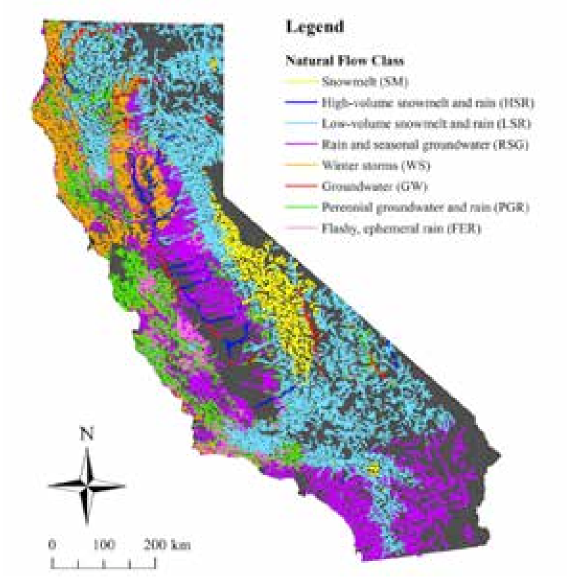
- Problem: We don’t have the capacity to model the majority of stream reaches in California due to a lack of data as well as time and financial requirements

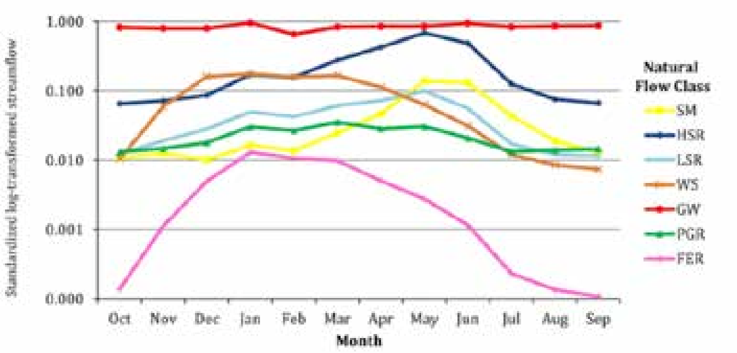
- *What is a potential strategy for assessing ecological conditions over large areas under various flow conditions?*

Background

- Dr. Belize Lane developed the methodology for her PhD work at UC Davis

California Hydrologic Regimes



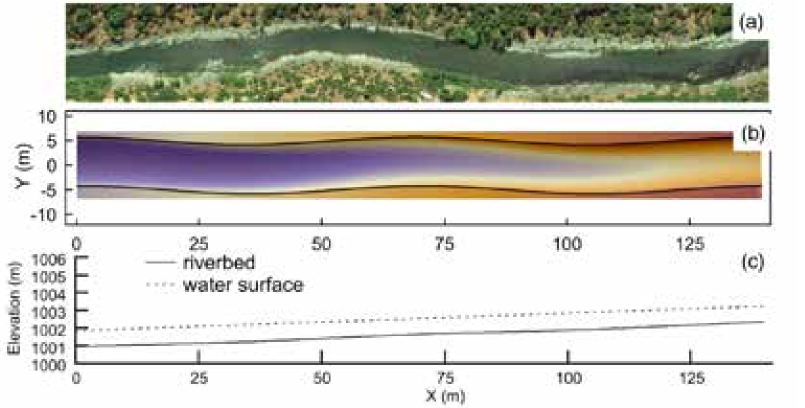


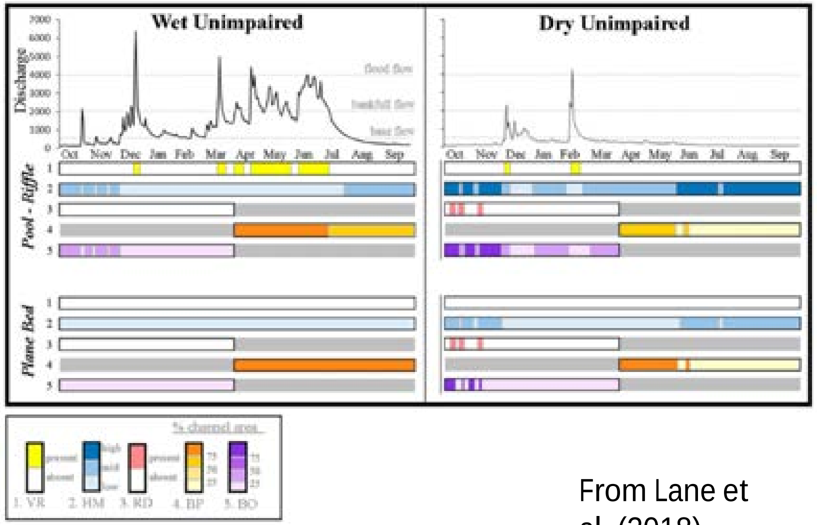
From Lane et al. (2017a)

Geomorphic Classification in the Sacramento Basin

From Lane et al. (2017b)

Flow-Form-Function Relationships





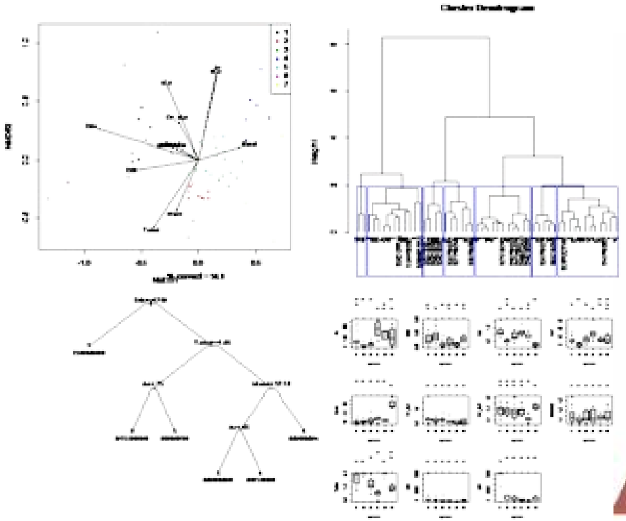
From Lane et al. (2018)

Conceptual Overview

Field Surveys

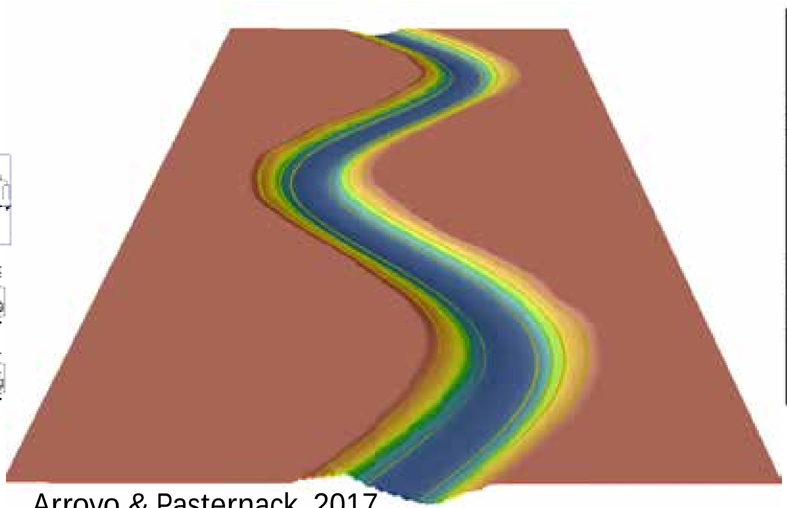
How do we best capture stream variability in areas without near-census data?

Statistical Analysis



What is the best way to identify characteristic stream types from traditional survey data and advanced techniques?

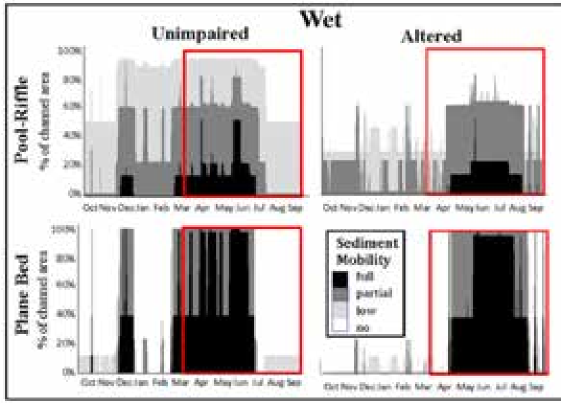
Archetype Development



Arroyo & Pasternack, 2017

Can we create representative forms, or archetypes, of each type of river in California?

Flow-form-function Relationships

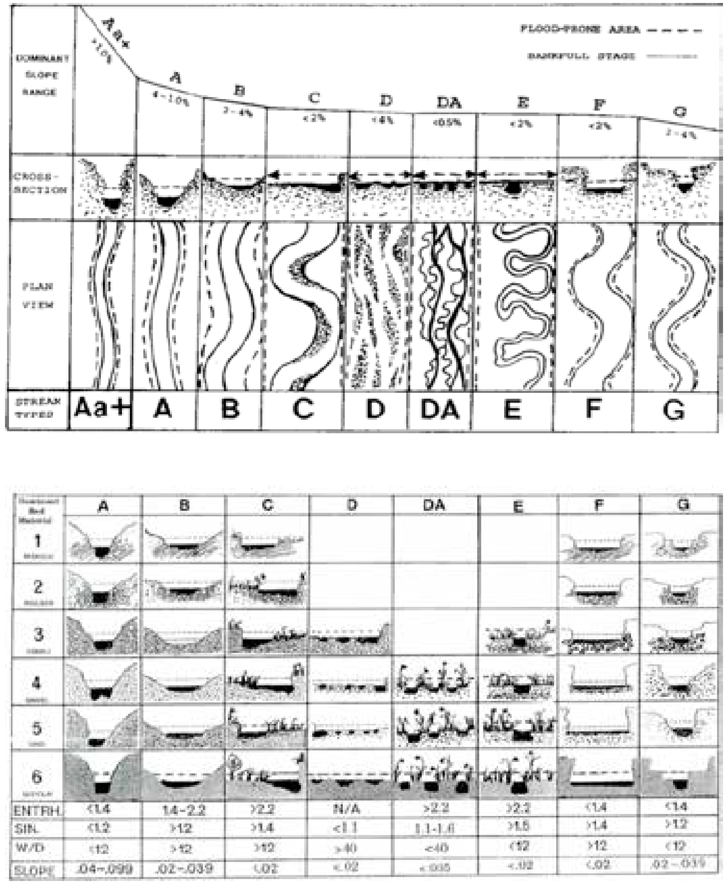


Lane et al. 2018

Using archetypes, what can we learn about stream environmental conditions under various flow conditions and management scenarios?

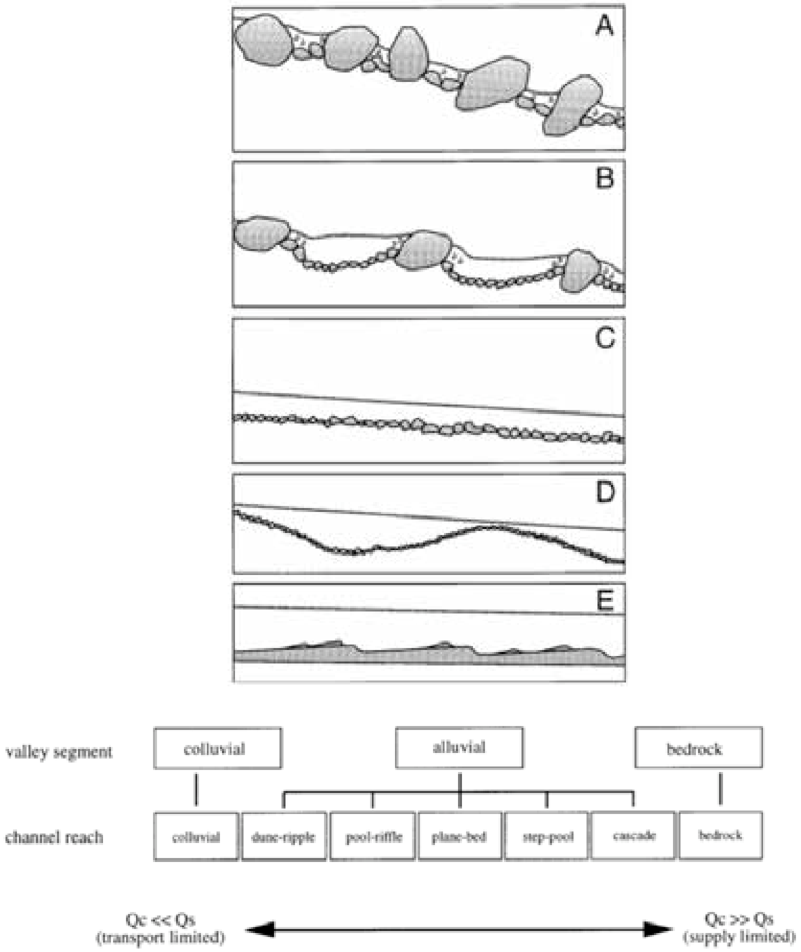
Classification Background

Rosgen Classification

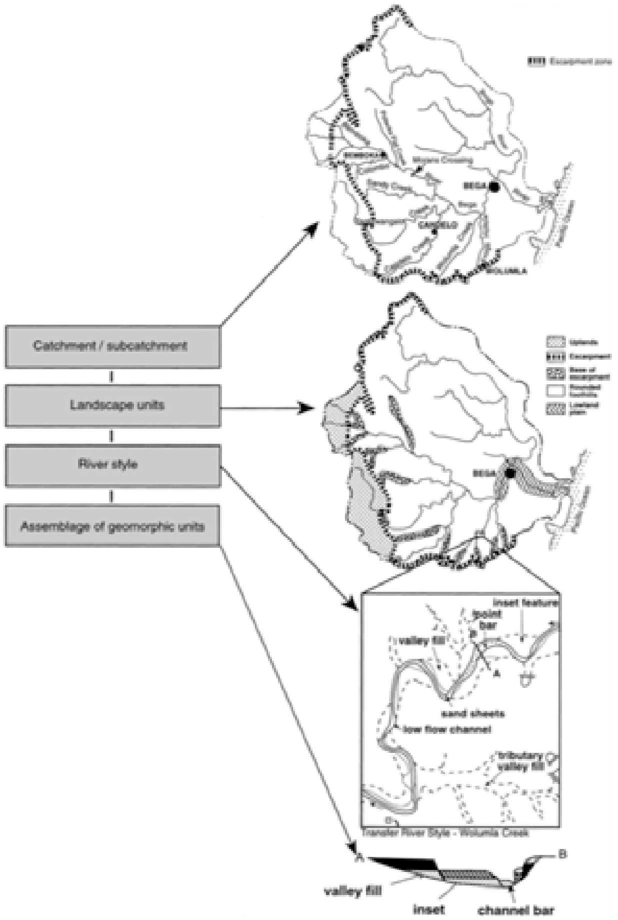


From Rosgen (1994)

Montgomery & Buffington Classification (1997)



River Styles Framework



From Brierley & Fryirs (2000)

Tiered Sampling Protocols

Two tier sampling scheme

Tier 1 Sampling Goal

- to capture the full range of stream diversity throughout a basin and in the context of California

Basin and state scales

Tier 2 Sampling Goal

- to capture instream sub-reach variability in form, given Tier 1 knowledge of geomorphic form of streams within a basin or entire state

Sub-reach scale

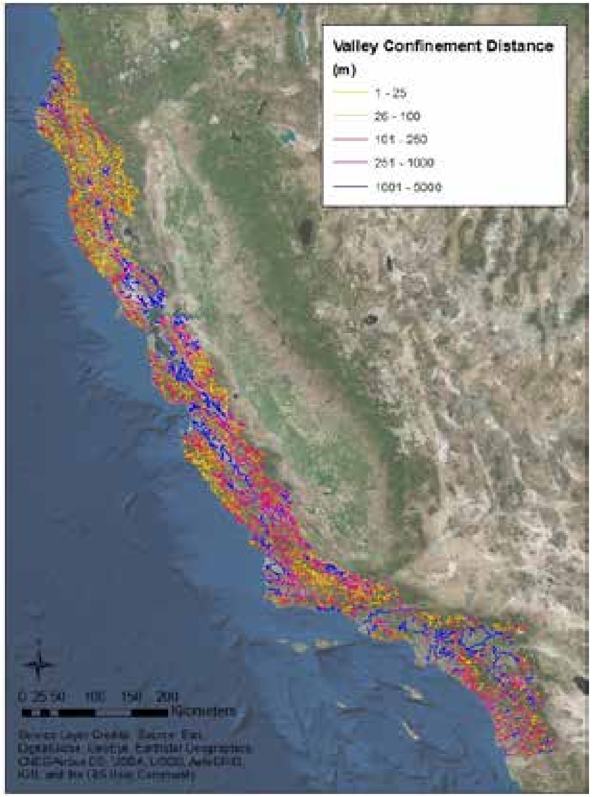
Year 1 Sampling protocol

- *How do we select survey sites that we hope will encompass the entire range of geomorphic form in the state of California?*

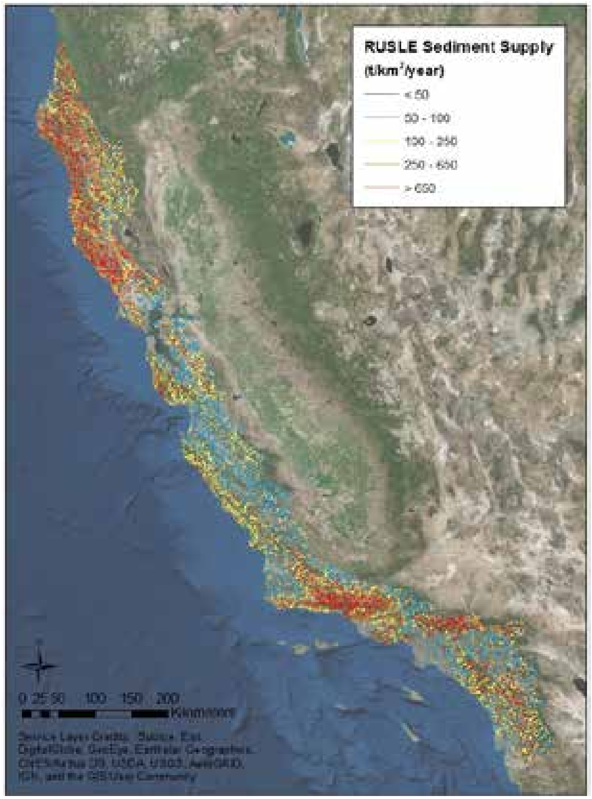
Upper Level Bin

Lower Level Bin

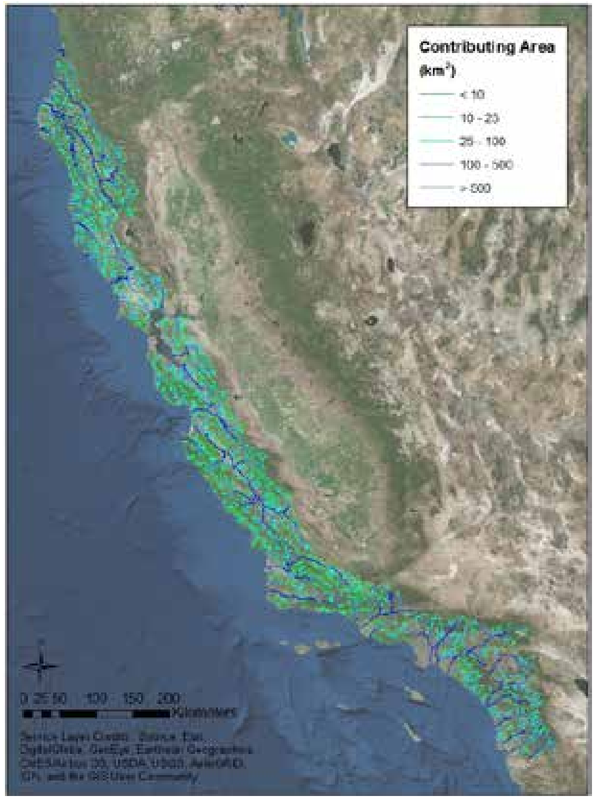
Valley Confinement



Sediment Supply



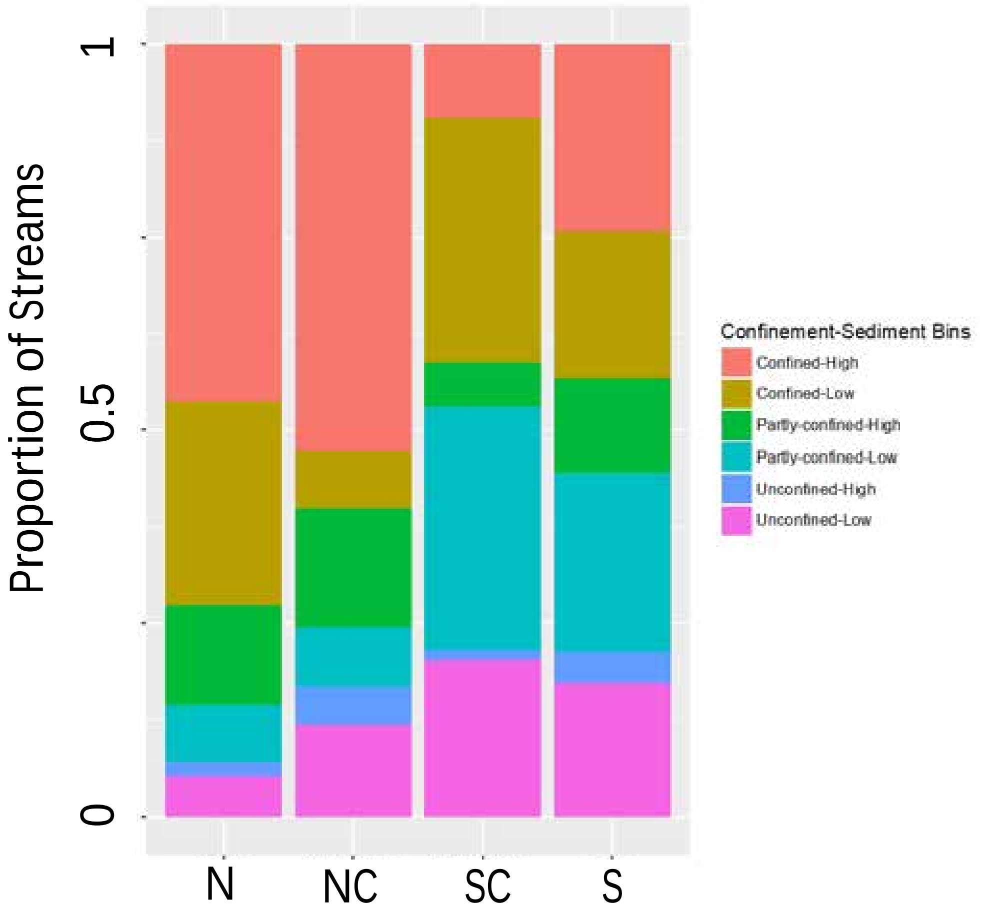
Contributing Area



Slope

Year 1 Sampling protocol

- *How do we select survey sites that we hope will encompass the entire range of geomorphic form in the state of California?*



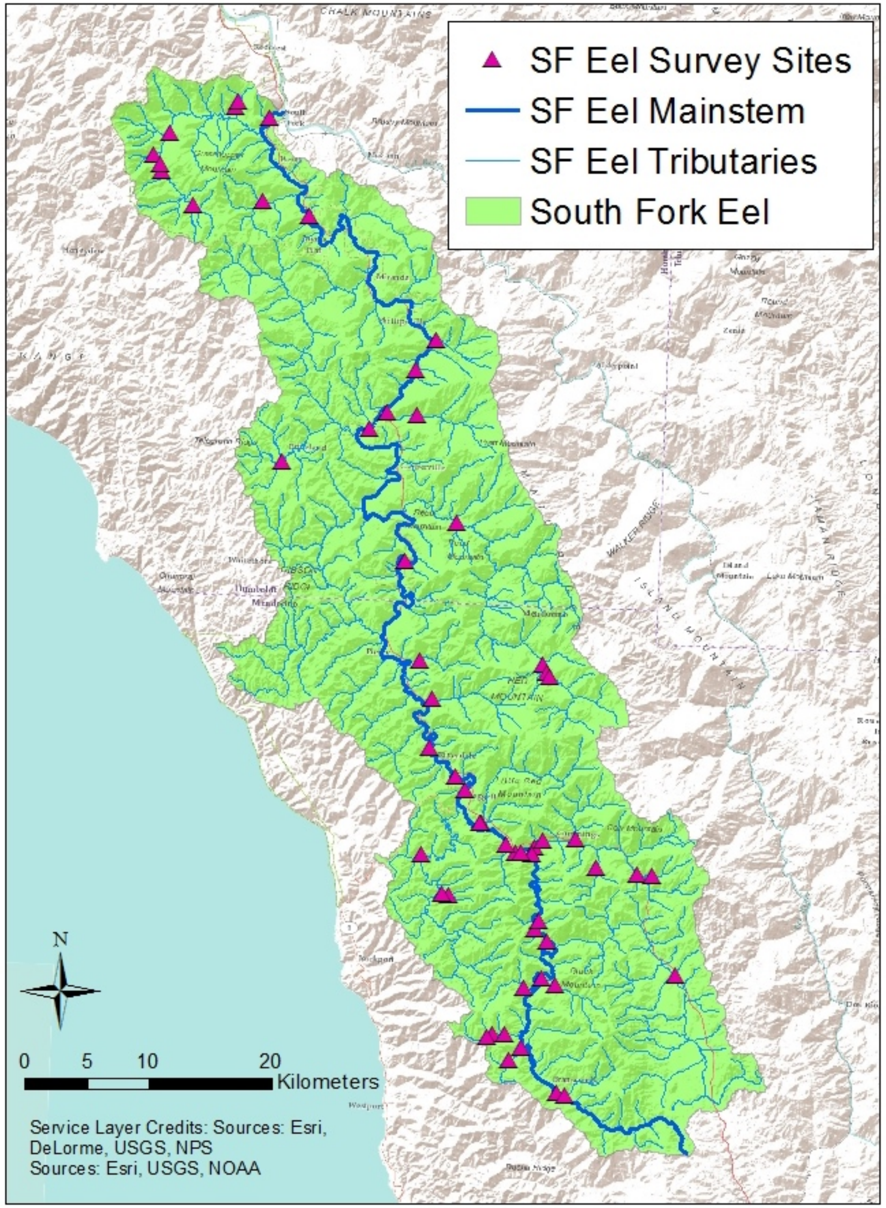
- Northern basins dominated by confined streams with high potential for erosion on hillslopes
- Southern basins have a larger proportion of partly-confined and unconfined terrain (valleys)

- Sites in all bin types are sampled to ensure the full range of geomorphic variability
- Proportional sampling per bin is conducted to maintain a focus on most dominant geomorphic bins

Tier-1 S.F. Eel Data Acquisition, Statistical Analysis, and Classification

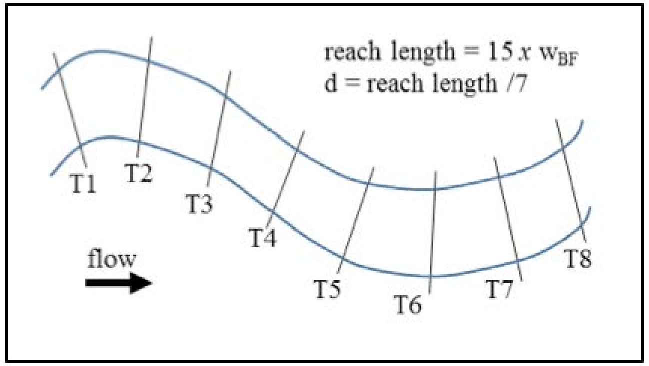
South Fork Eel Tier 1 Sites

- Team from Humboldt State University was responsible for surveying sites in summer 2017



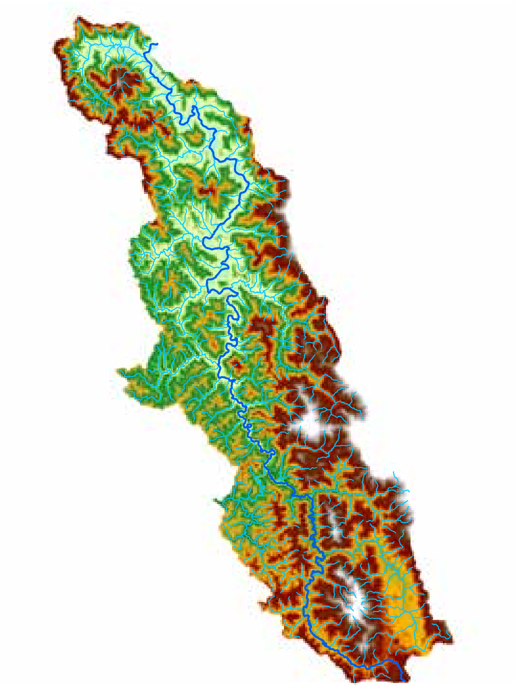
Field Surveys

- Cross-sectional attributes
  - Wetted width and depths
  - Bankfull width and depths
- Longitudinal profiles – slope calculations
- Wolman pebble counts – sediment distributions



Geographic Information Systems Attributes

Contributing Area



Contributing area typically highly correlated with channel width, although stream confinement also plays an important role

Sinuosity

Sinuosity measures the planform curvature of a river. Streams with lower slope and unconfined tend to meander more under natural conditions.

Valley Confinement

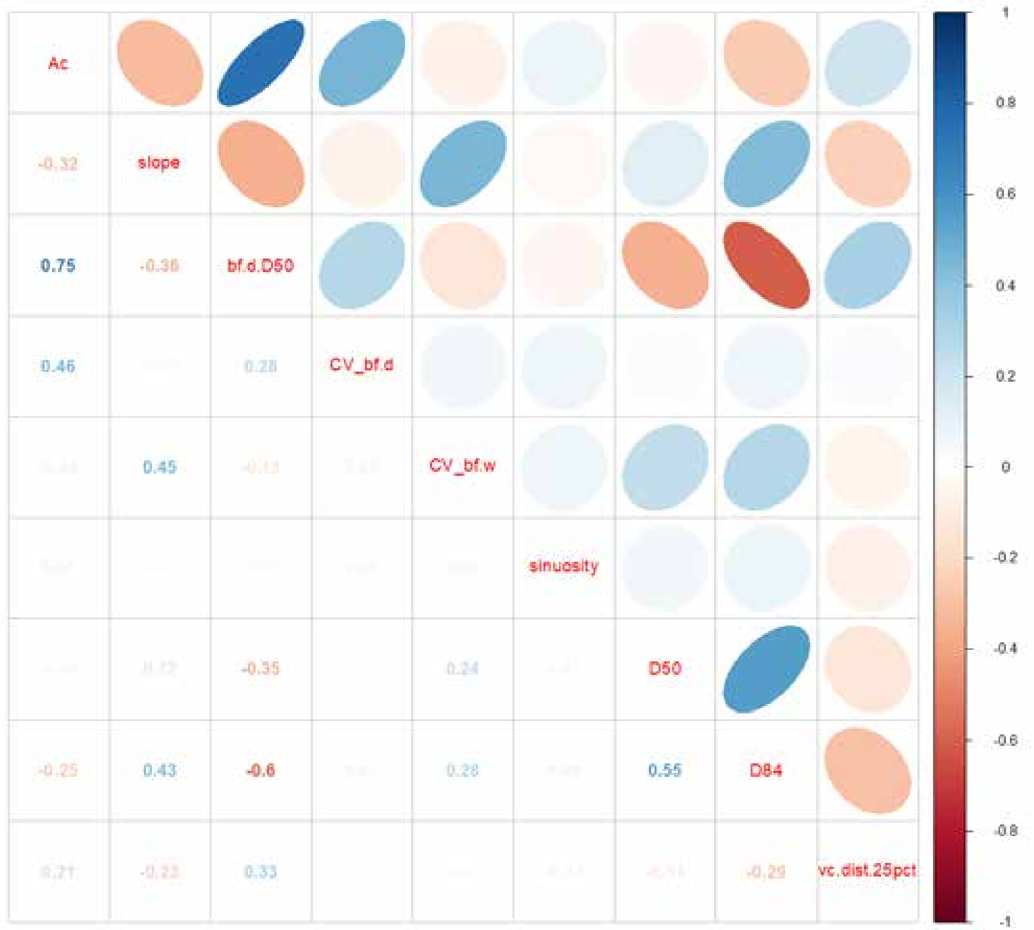
Slope breaks help define the presence of an alluvial floodplain while anthropogenic margins control streams too

Statistical Analysis Methodology

- Linear correlation
- Non-metric multidimensional scaling (NMDS)
- Hierarchical clustering using Ward's Algorithm
- Classification and regression tree (CART) analysis
- Tukey's honestly significant differences between groups

Linear Correlation of Geomorphic Attributes

- Contributing area
- Slope
- Bankfull depth
- Bankfull width
- Width to depth ratio
- Coefficient of variance of depth
- Coefficient of variance of width
- Sinuosity
- Valley confinement
- D50
- D84
- Dmax

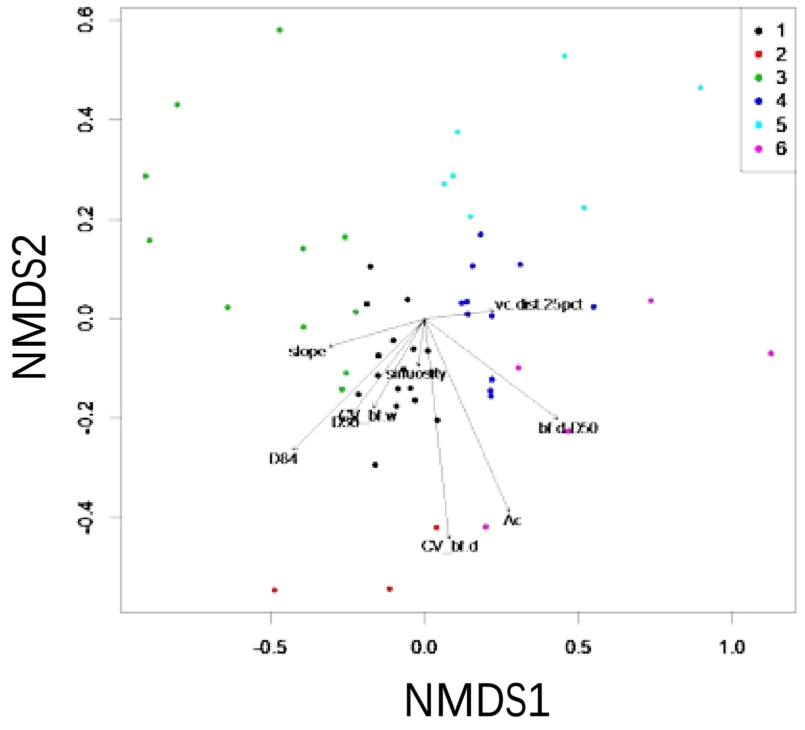


Non-metric Multidimensional Scaling (NMDS)

- R ‘vegan’ package
- Geomorphic attributes are rescaled from 0 – 1 to ensure magnitude of attribute is not influential
- Iterative algorithm which minimizes the stress between sample points

$$Stress = \sqrt{\frac{\sum\left(d_{ij} - \widehat{d_{ij}}\right)^2}{d_{ij}^2}}$$

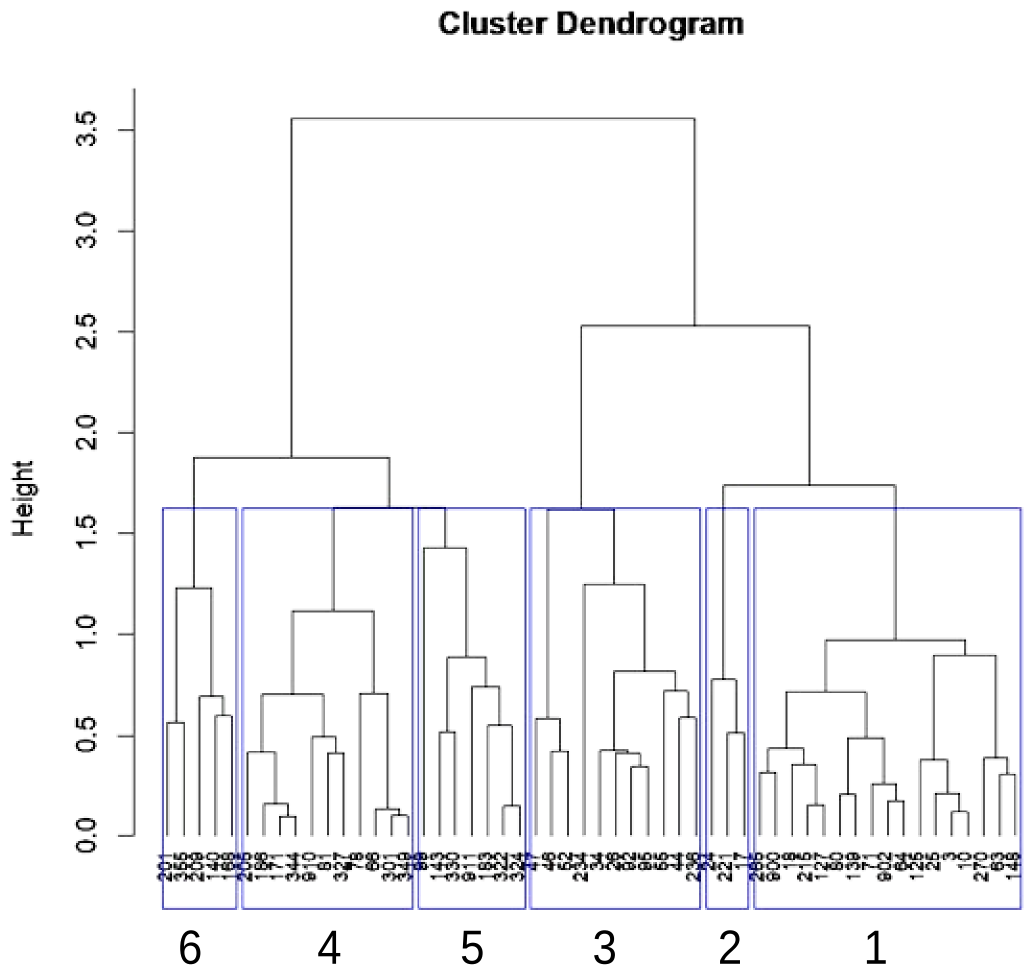
d_{if} is the distance between samples in ordination space
$\widehat{d_{ij}}$ is the distance between samples along fitted space



NMDS plotted with principal component vectors

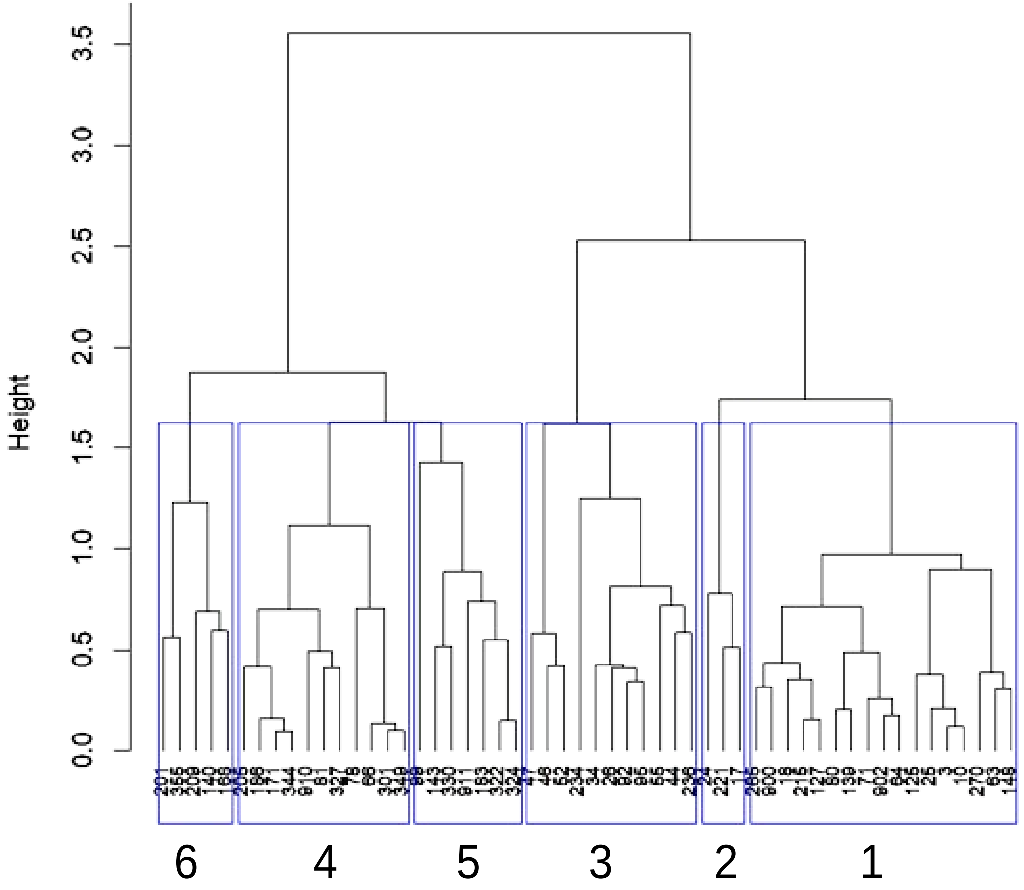
Hierarchical Clustering using Ward's Algorithm

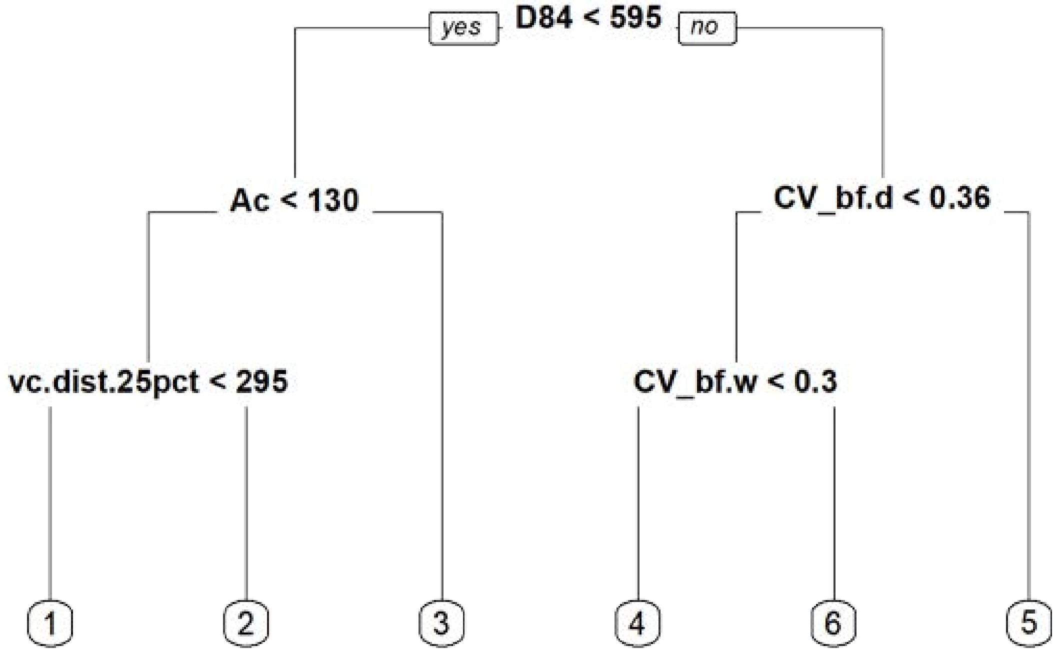
- R 'stats' package
- Begins at the base with each observation belonging to an individual cluster
- Maximizes between cluster variance and minimizes within cluster variance
- Combines the two clusters with the minimum within cluster variance, proceeds to next iteration



Classification Trees

Ward's Hierarchical Cluster Dendrogram

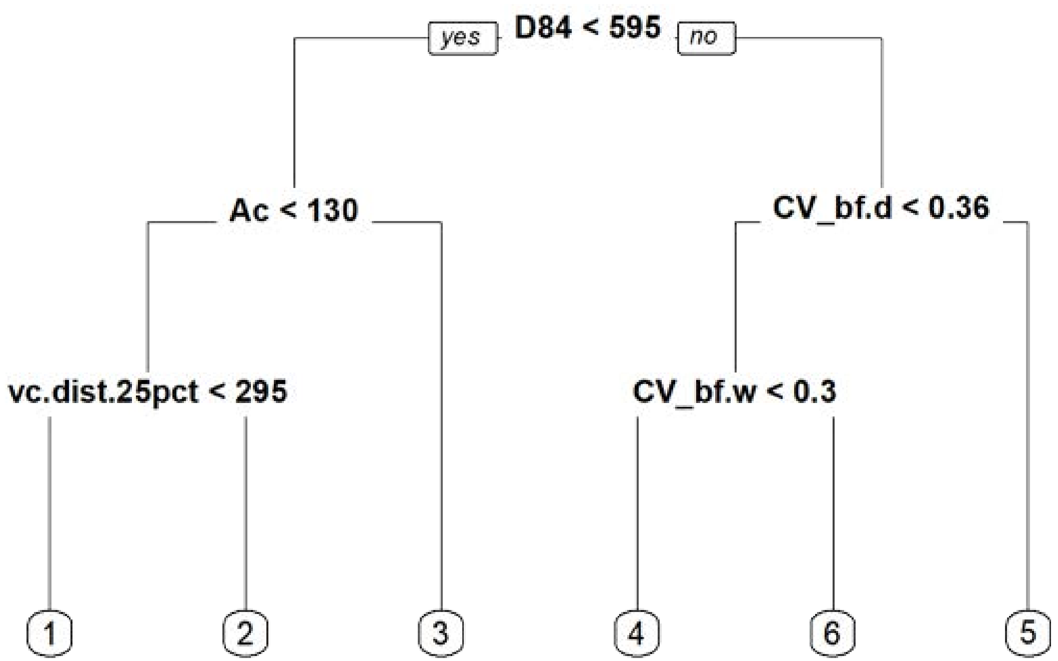


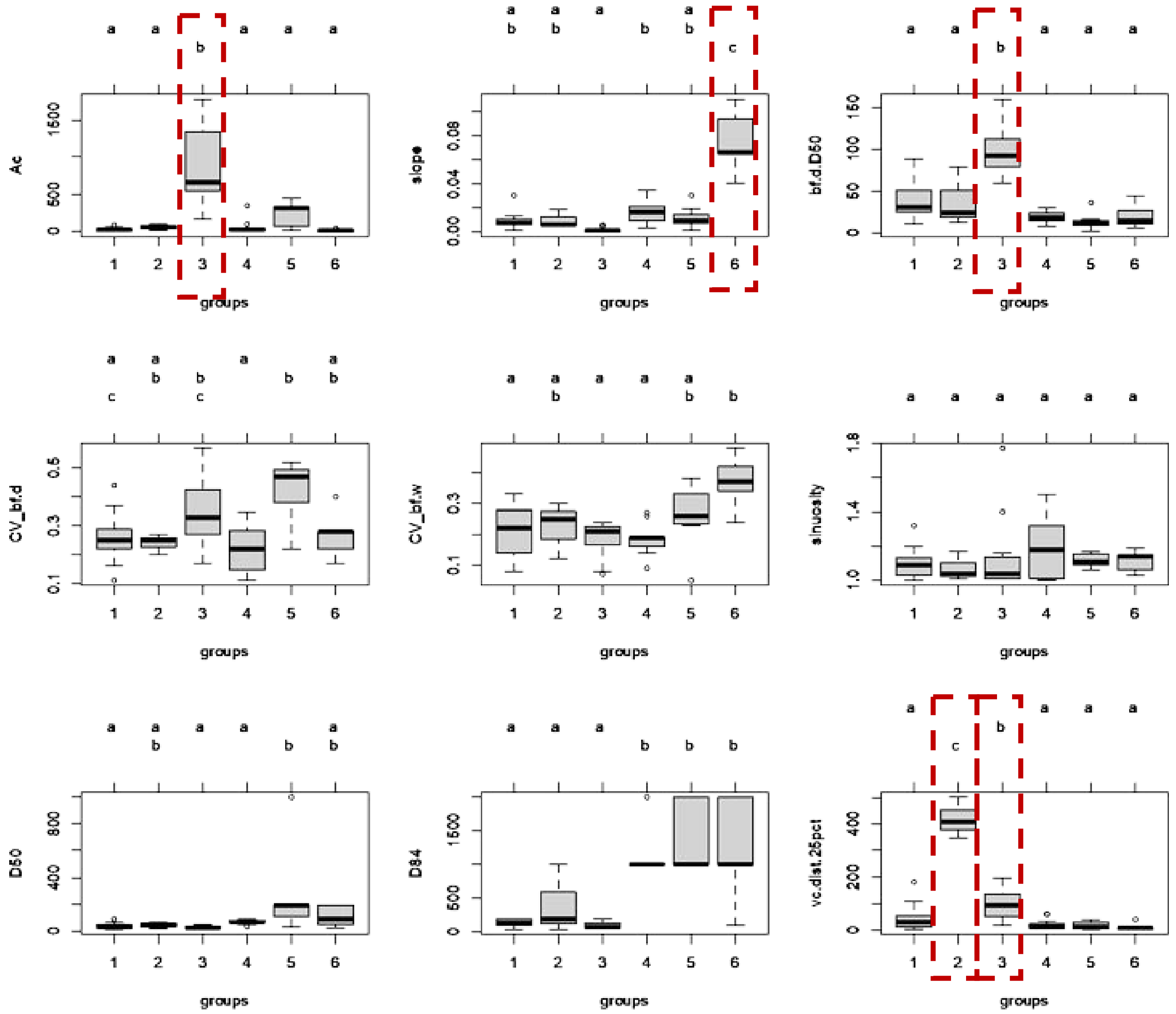


90.7% of Ward Sites correctly predicted

D84 – Sediment size at 84th percentile
Ac – Contributing Area
Vc.dist.25pct – Valley Confinement Distance
CV_bf.d – Coefficient of variation in bankfull depth
CV_bf.w – Coefficient of variation in bankfull width

South Fork Eel Significant Differences





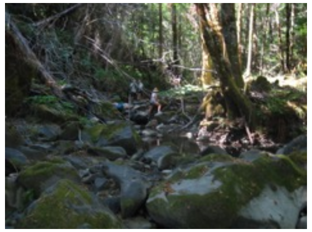
SFE-1 – Confined, <100 km^2, <2% slope, cobble/gravel

SFE-2 – Partly-confined, <100 km^2, <2% slope, cobble/boulder

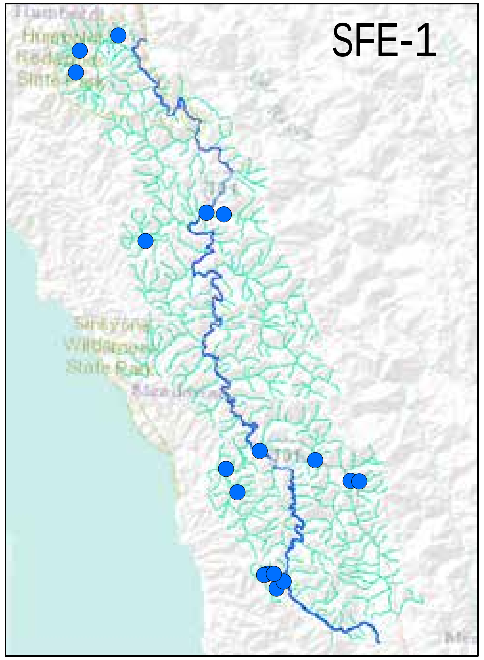
SFE-3 – Partly-confined/confined w/pockets, >500 km^2, <1% slope, >0.3 CV.bf.d, gravel/cobble

SFE-4 – Confined, <4% slope, <0.3 CV.bf.d, boulder/cobble

SFE-5 – Confined, <500 km^2, <2% slope, >0.3 CV.bf.d, >0.25 CV.bf.w, bedrock/boulder



SFE-6 – Confined, <100 km^2, >4% slope, >0.3 CV.b.w, bedrock/boulder

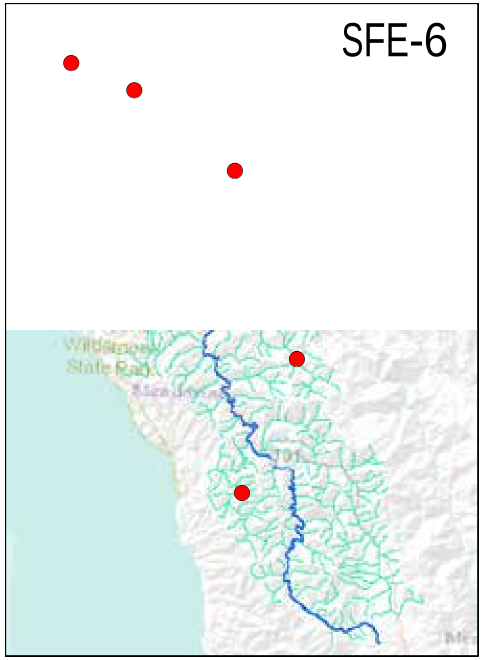


SFE-2

SFE-3

SFE-4

SFE-5



Tier 2 – S.F. Eel Concurrent/Future Work

Two tier sampling scheme

Tier 1 Sampling Goal

- to capture the full range of stream diversity throughout a basin and in the context of California

Basin and state scales

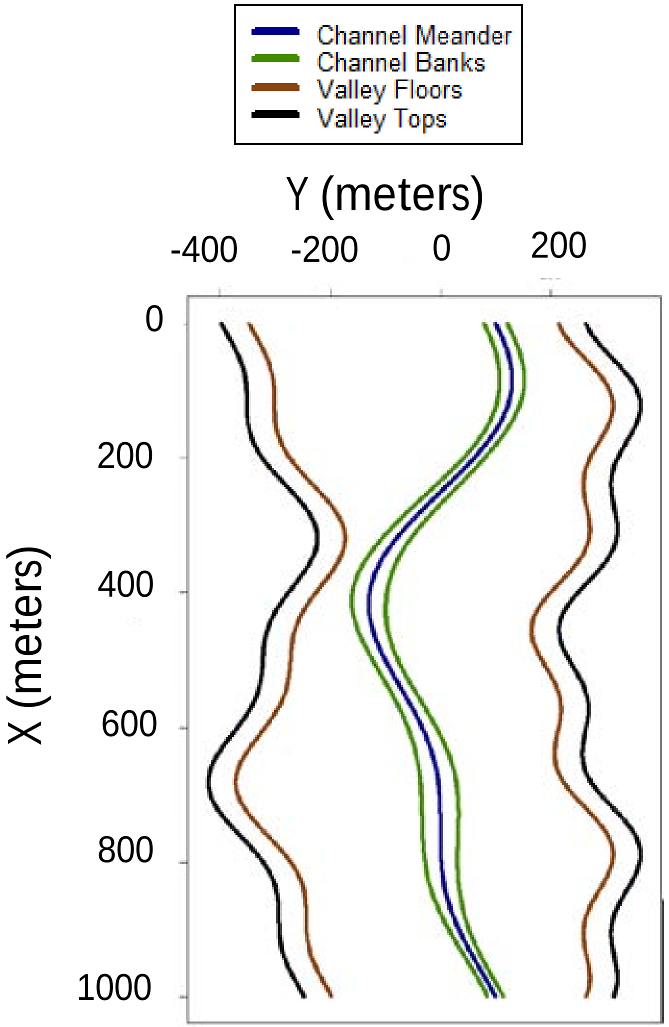
Tier 2 Sampling Goal

- to capture instream sub-reach variability in form, given Tier 1 knowledge of geomorphic form of streams within a basin or entire state

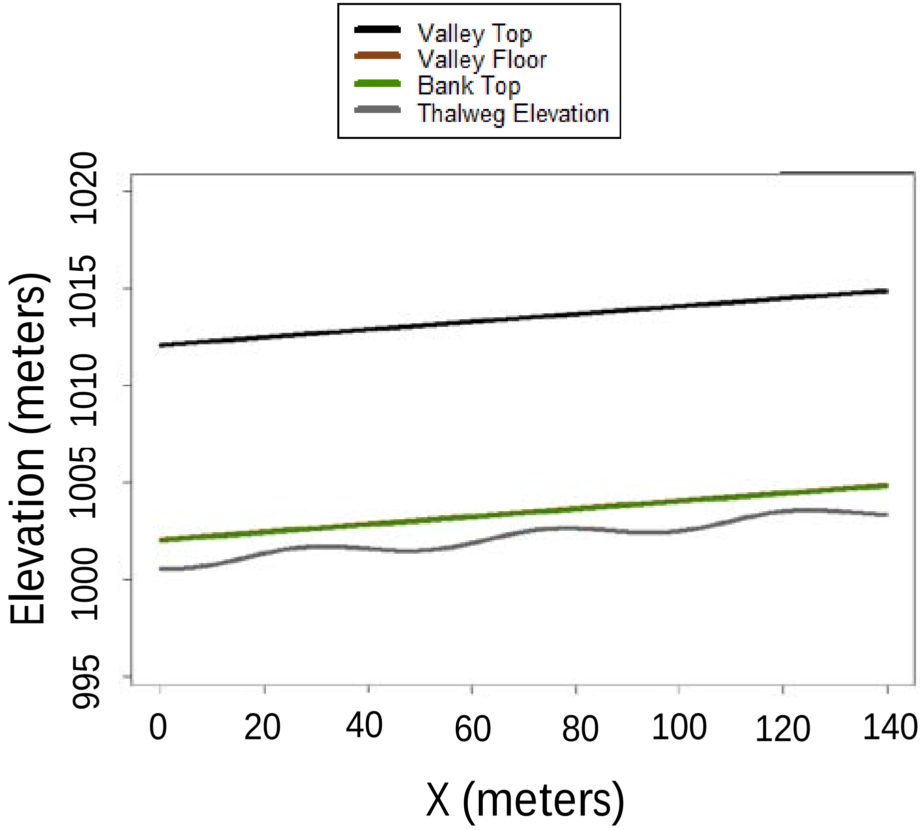
Sub-reach scale

Year 2 Channel Variability – Archetype development

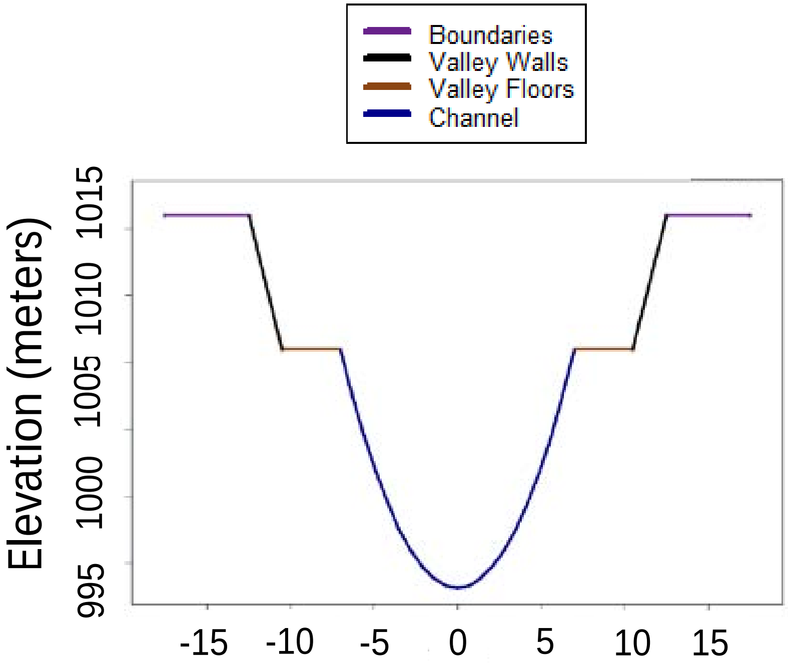
Planform



Longitudinal Profile

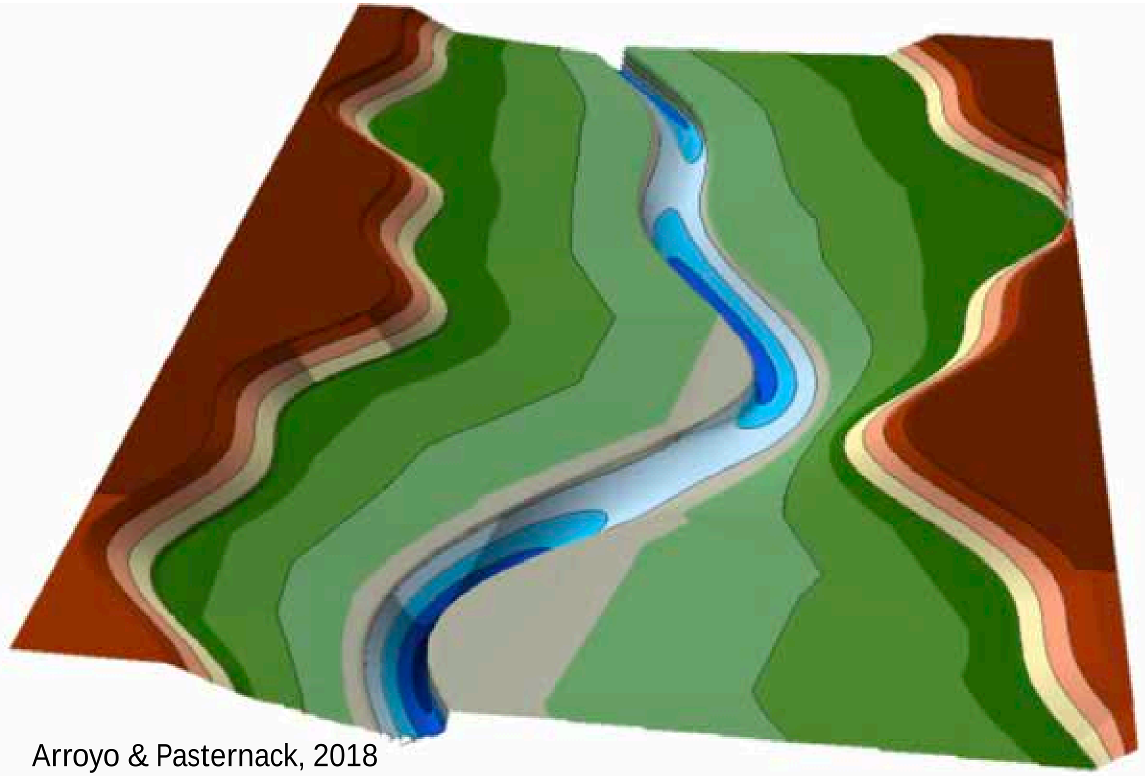


Cross-sectional Form



Archetype Flow Analysis with RiverBuilder

RiverBuilder Synthetic River Valleys



Arroyo & Pasternack, 2018

Figure 7. Representation of topographic points and descriptions used to capture the topography of the stream during surveys. From CHaMP, 2014

Other sources when available:

- LiDAR
- UAV derived topography

Concurrent and Future Work

1. Develop archetypes using ’RiverBuilder’ R package and analyze flow-form-function relationships under various flow scenarios

2. Analyze differences in geomorphic form between hydrologic classification as well as regional similarities and differences

3. Extrapolate site specific geomorphic classification to regional river classification for water management needs (Underway concurrently)

References

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- Jim Graham, PhD
- Emily Cooper
- Mason London


Questions/Comments?

The (partial) Phenology of Food Webs in South Fork Eel River Tributaries:

Behavioral Responses of Juvenile Steelhead and Coho

Gabriel Rossi – University of California Berkeley

Dr. Mary Power, Shelley Pneh, Weston Slaughter, Terrance Wang

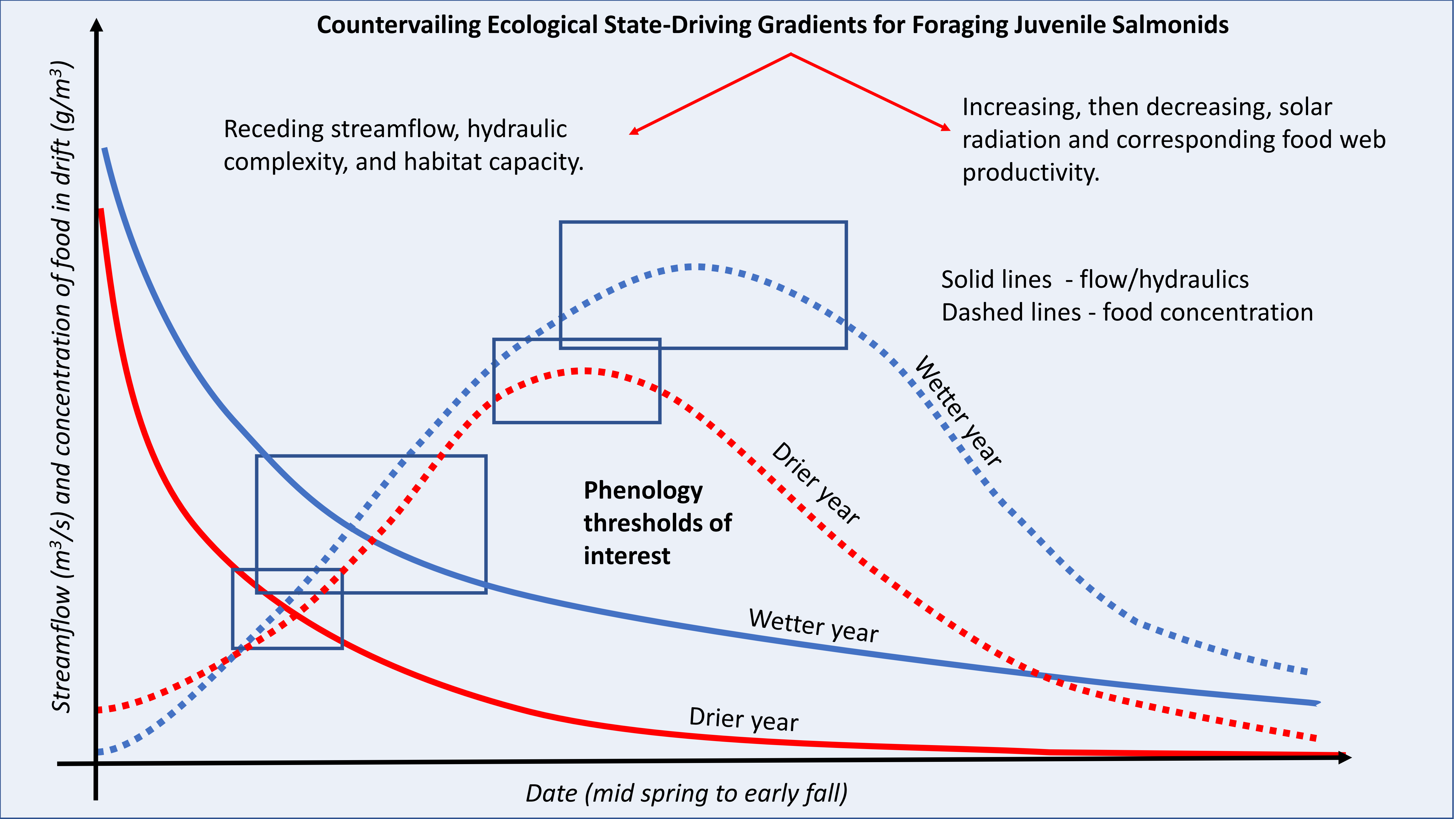
Driving Questions

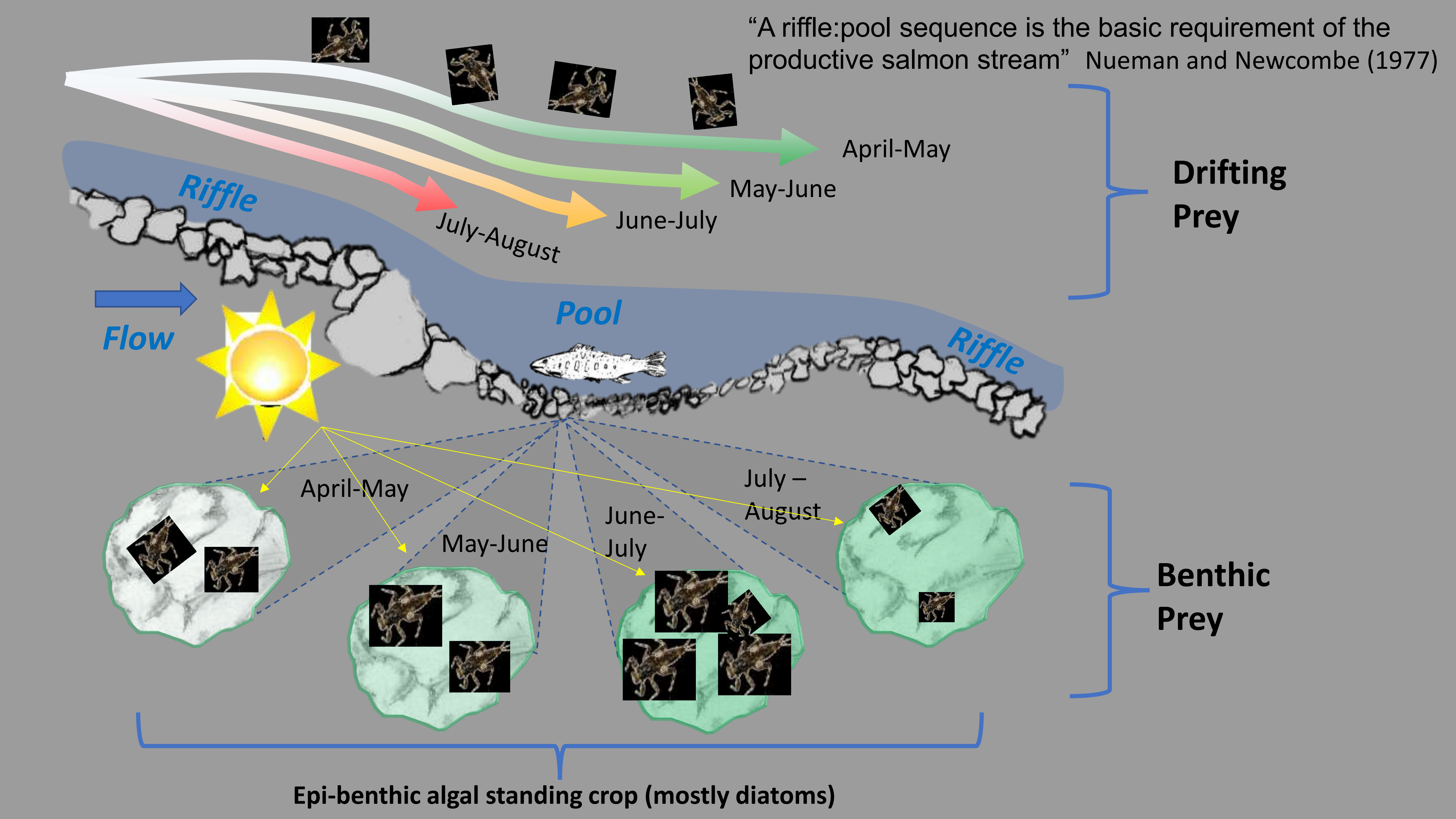
- How much do seasonal changes in stream food webs alter fish behavior and physiology?

- Could differences in food web dynamics drive life history diversity between tributary streams?

- What does these mean for the ecology and management of these tributaries?

Fabre has succinctly noted (1913) that "from the least to the greatest in the zoological progression, the stomach sways the world; the data, supplied by food are chief among all the documents of life." -O'Brien et al. (1990).

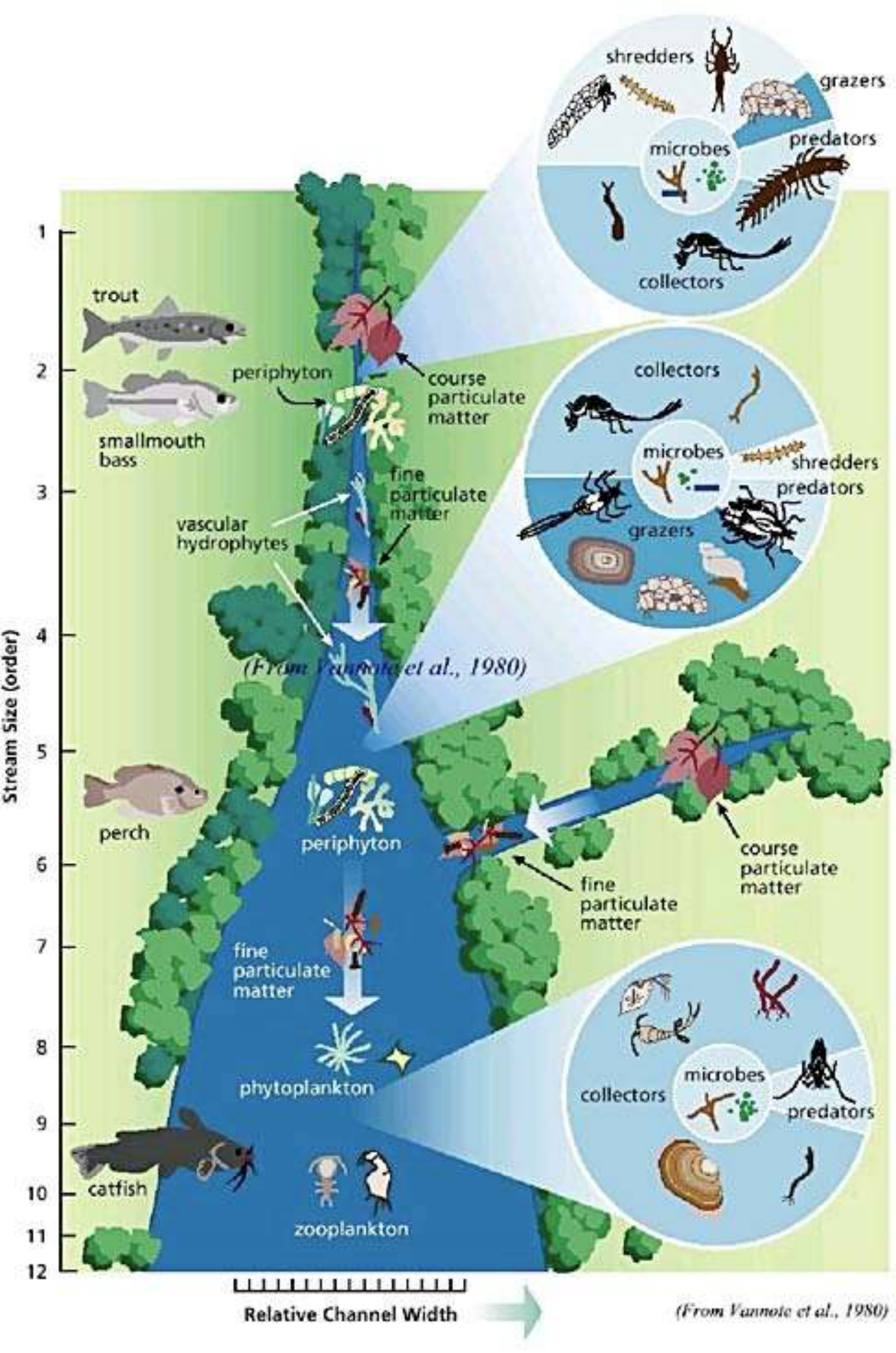

Countervailing Ecological State-Driving Gradients for Foraging Juvenile Salmonids
Receding streamflow, hydraulic complexity, and habitat capacity.
Increasing, then decreasing, solar radiation and corresponding food web productivity.
Solid lines - flow/hydraulics
Dashed lines - food concentration
Wetter year
Drier year
Phenology thresholds of interest
Wetter year
Drier year
Streamflow (m3/s) and concentration of food in drift (g/m3)
Date (mid spring to early fall)



“A riffle:pool sequence is the basic requirement of the productive salmon stream” Nueman and Newcombe (1977)
April-May
May-June
June-July
July-August
Drifting Prey
Riffle
Pool
Riffle
Flow
April-May
May-June
June-July
July – August
Benthic Prey
Epi-benthic algal standing crop (mostly diatoms)

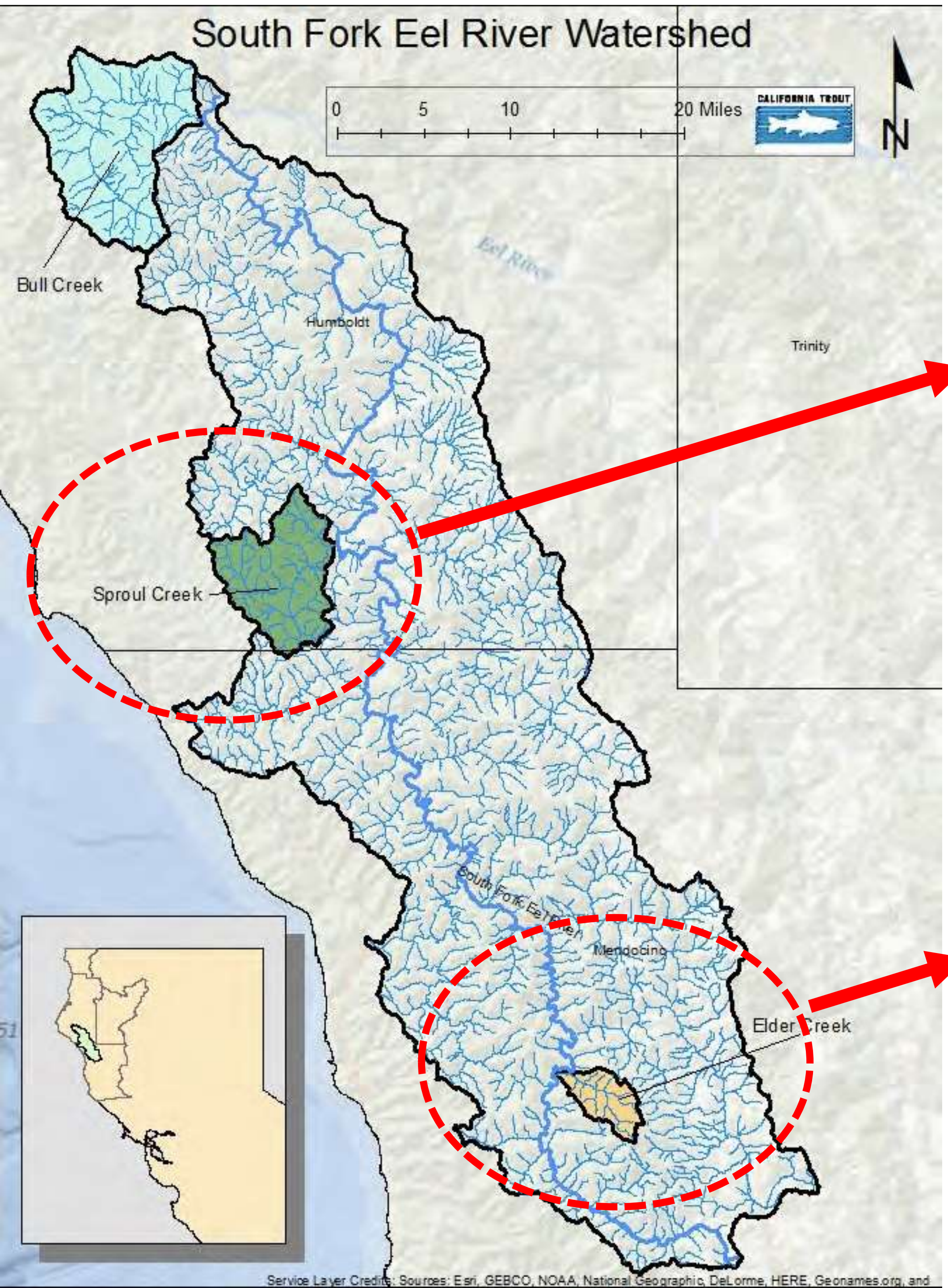
WHY AM I FOCUSING ON AUTOCTHONOUS PRODUCTION IN SMALL STREAMS?

ANSWER – because I'm biased and I only have so much time. Aaand…



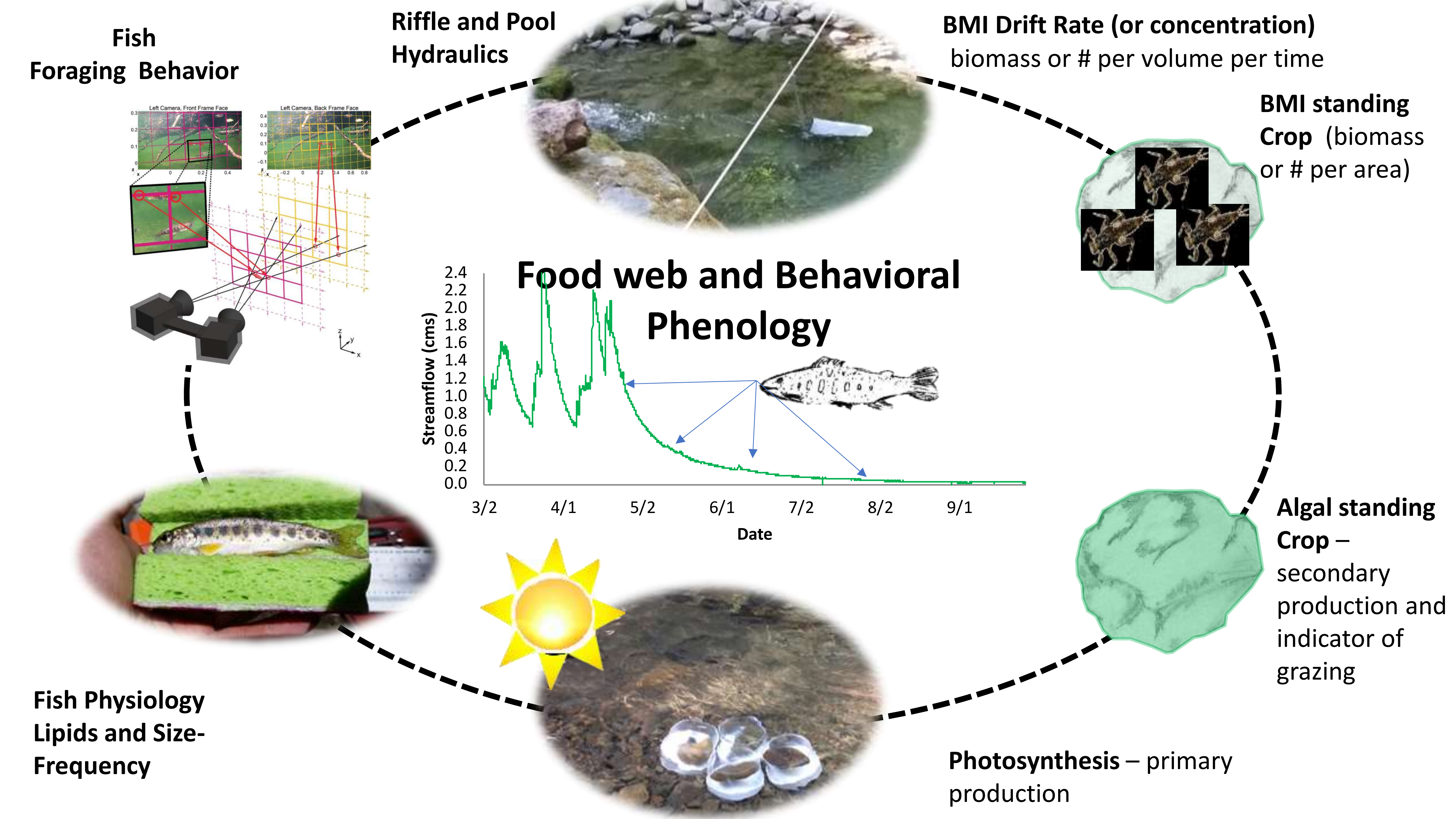
Mayer and Likens 1987, Nakano and Murakami 2001, Power and Sabo 2002: Importance of algae in shaded forest streams, including to terrestrial consumers

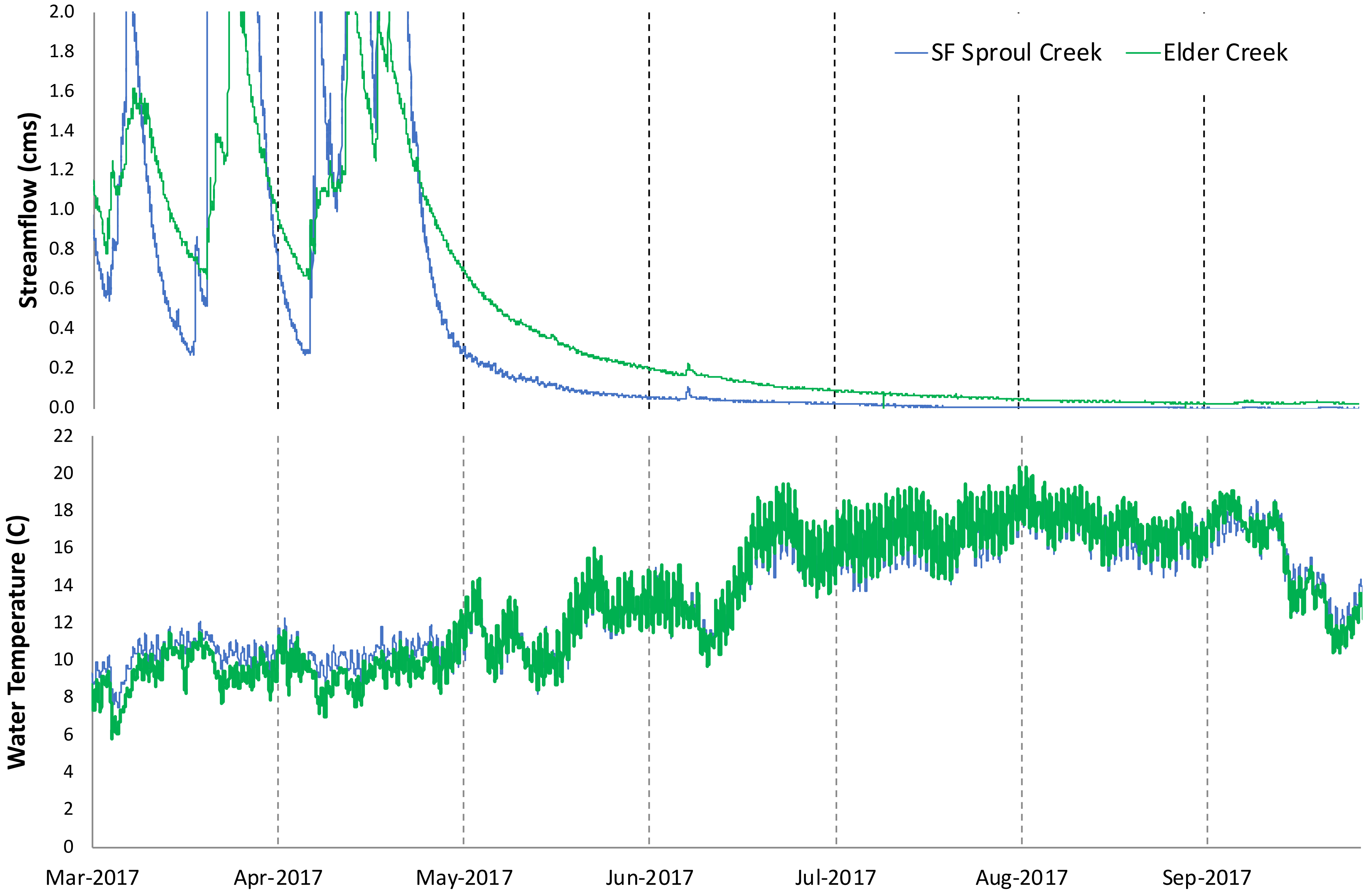
Bear Brook: algae < 2% of the incoming energy, but 50% of the gut contents and 75% of the fuel for growth for Neophylax (Mayer and Likens 1987)

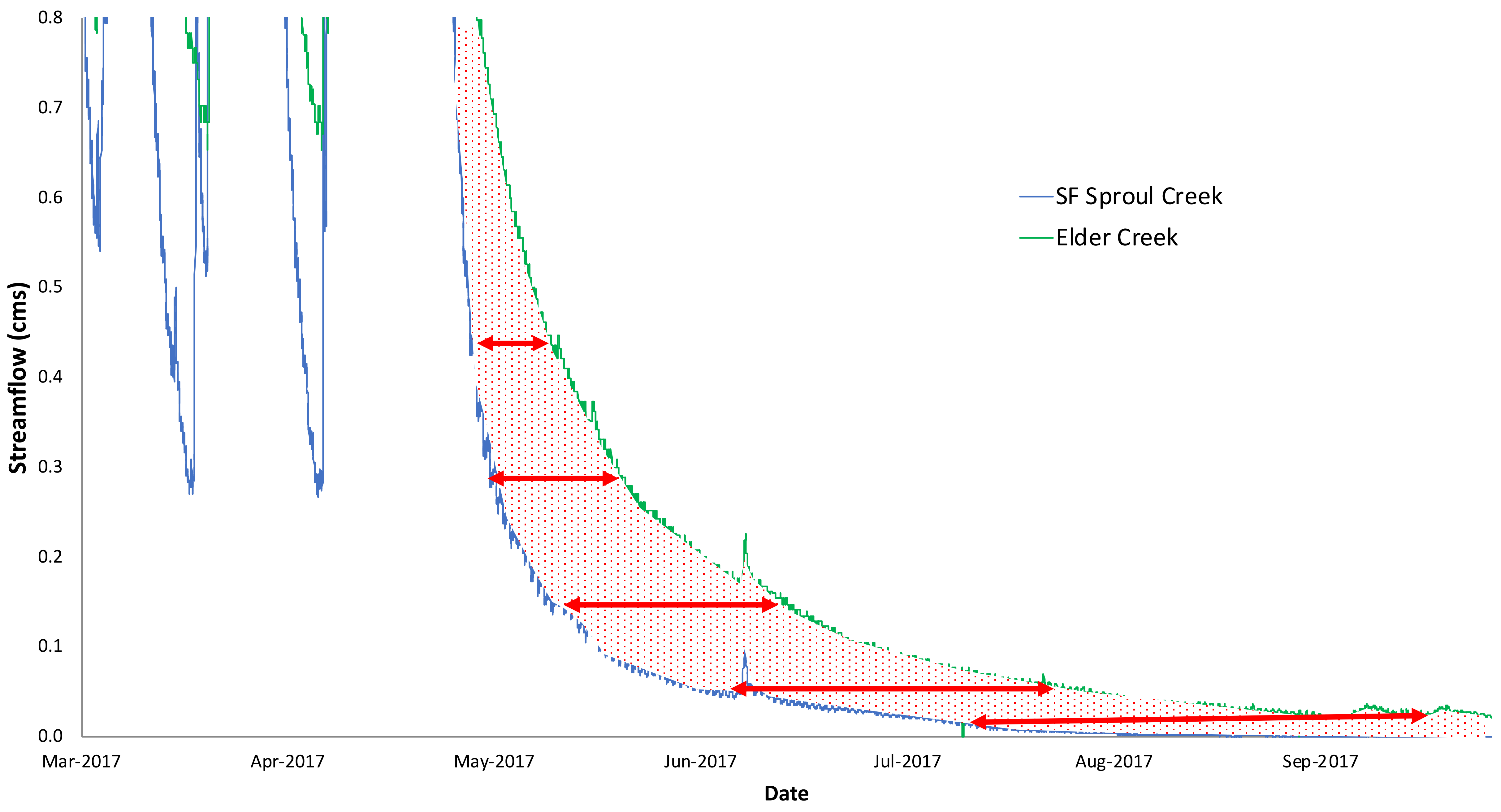

South Fork Eel River Watershed
0
5
10
20 Miles
CALIFORNIA TROUT
N
Bull Creek
Humboldt
Trinity
Eel River
Sproul Creek
South Fork Eel River
Mendocino
Elder Creek
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and


SF SPROUL CREEK ~ 5 mi²

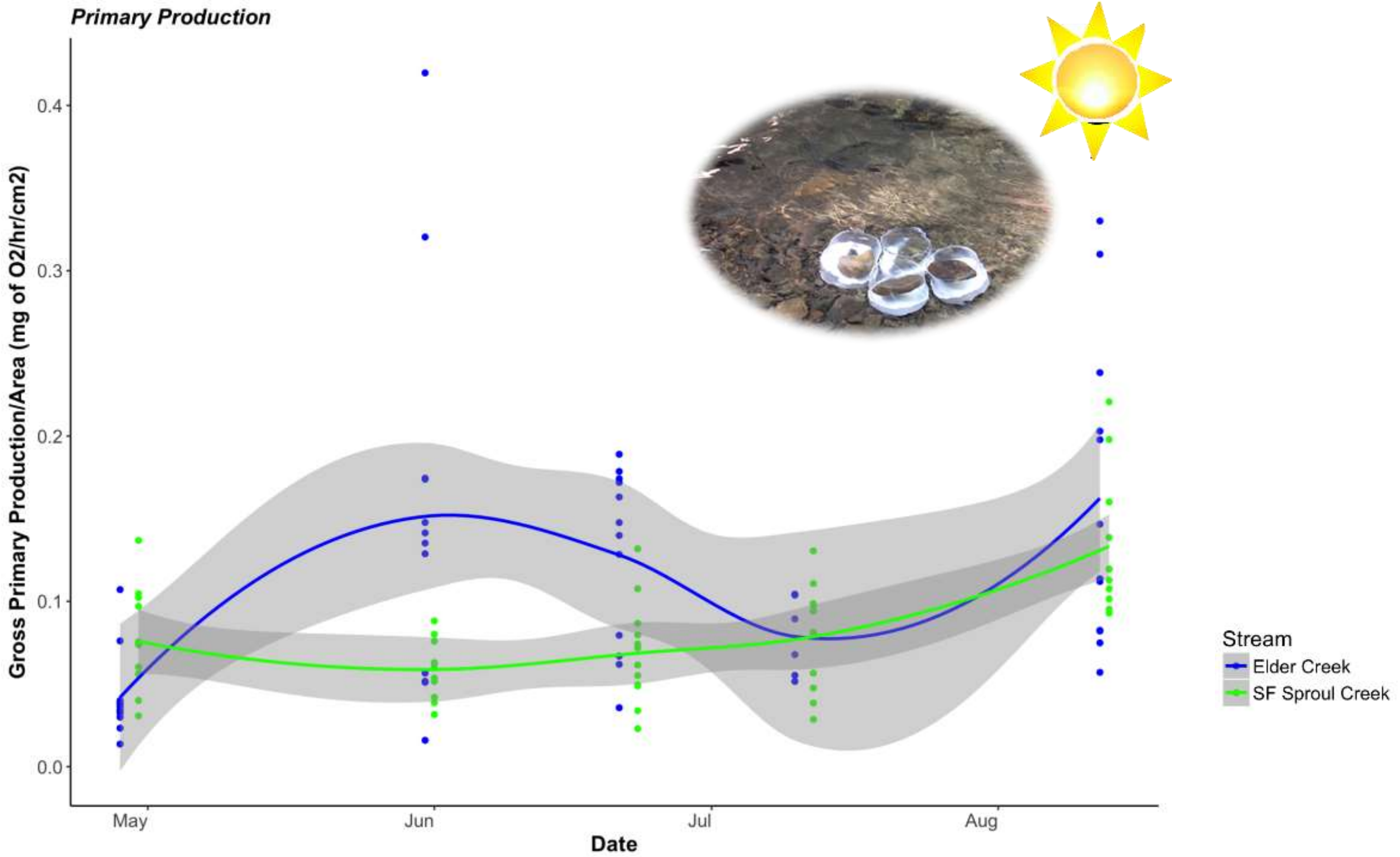

ELDER CREEK ~ 6.5 mi²


Food web and Behavioral Phenology
Fish Foraging Behavior
Left Camera, Front Frame Face
Left Camera, Back Frame Face
Riffle and Pool Hydraulics
BMI Drift Rate (or concentration) biomass or # per volume per time
BMI standing Crop (biomass or # per area)
Algal standing Crop – secondary production and indicator of grazing
Photosynthesis – primary production
Fish Physiology Lipids and Size-Frequency
Streamflow (cms)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/2
4/1
5/2
6/1
7/2
8/2
9/1
Date

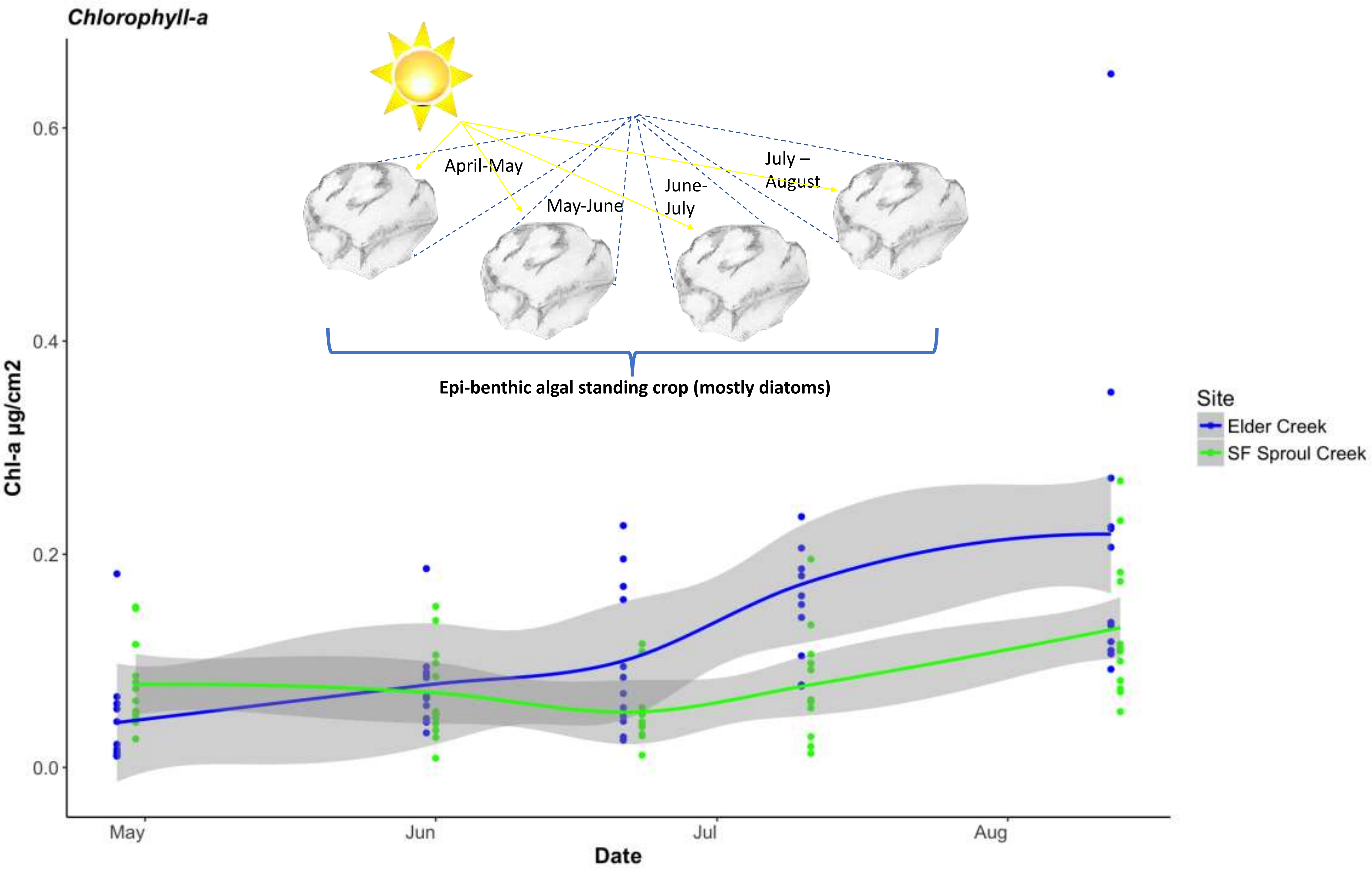

SF Sproul Creek
Elder Creek
Streamflow (cms)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Water Temperature (C)
22
20
18
16
14
12
10
8
6
4
2
0
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017

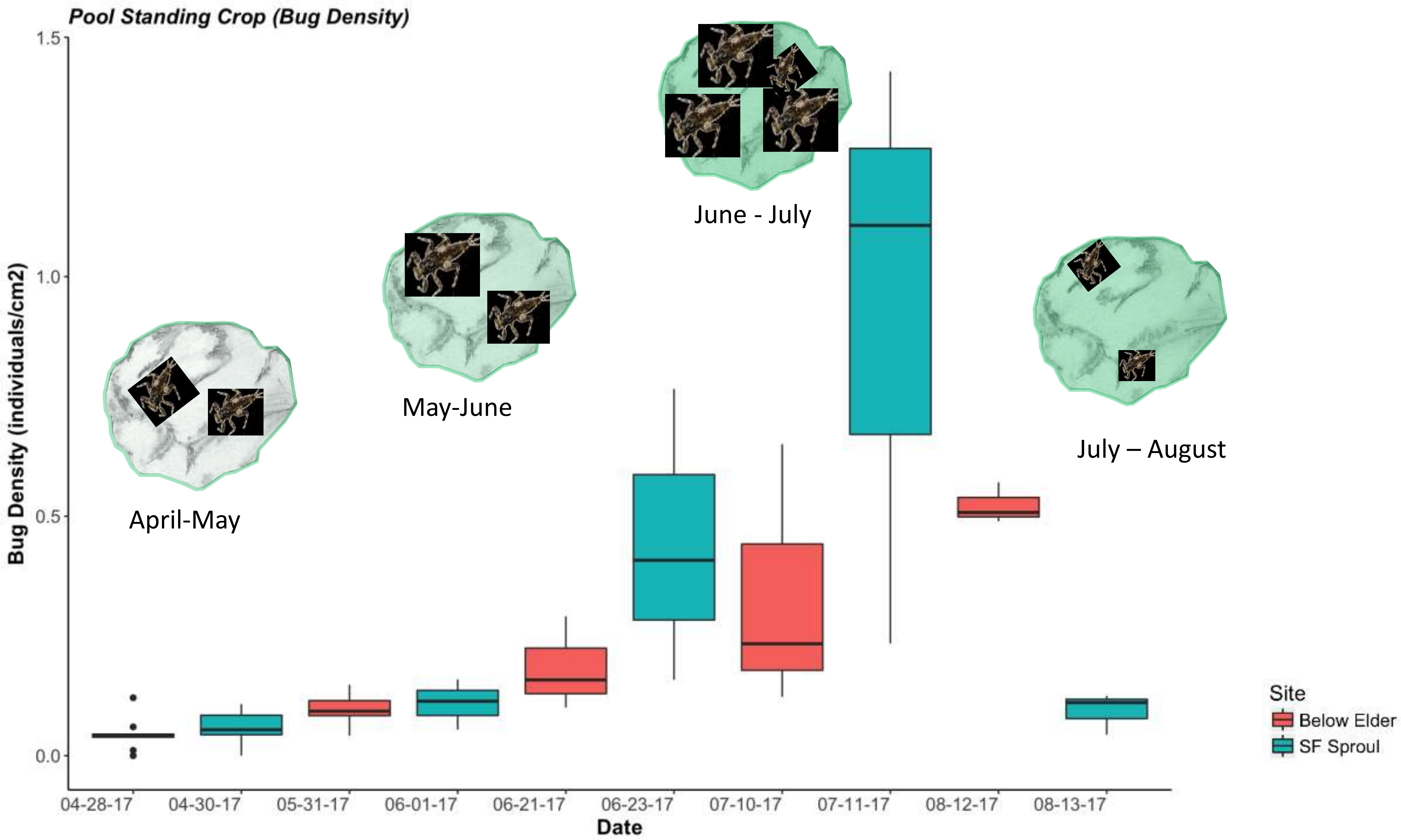


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Streamflow (cms)
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Date
SF Sproul Creek
Elder Creek

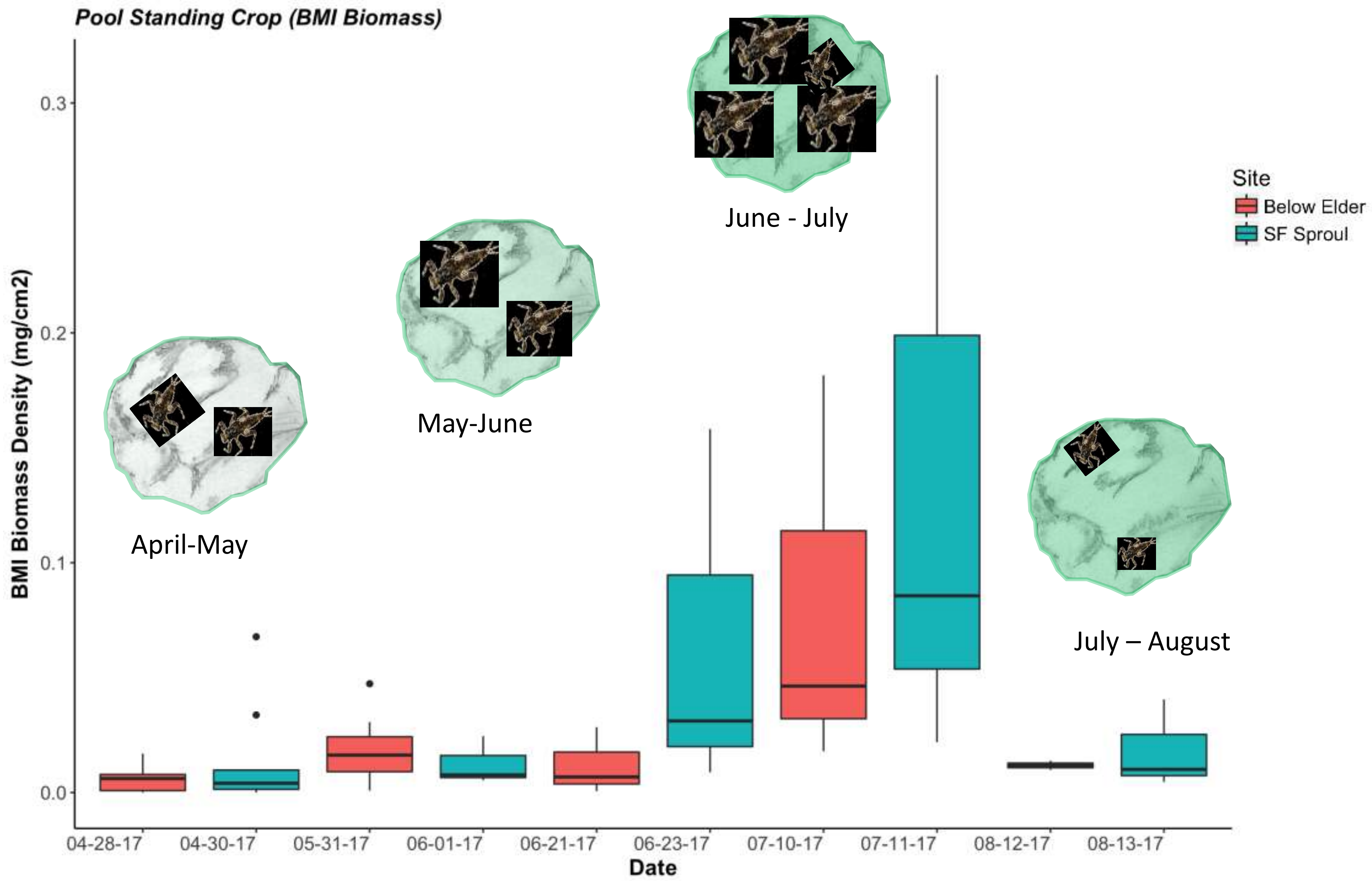


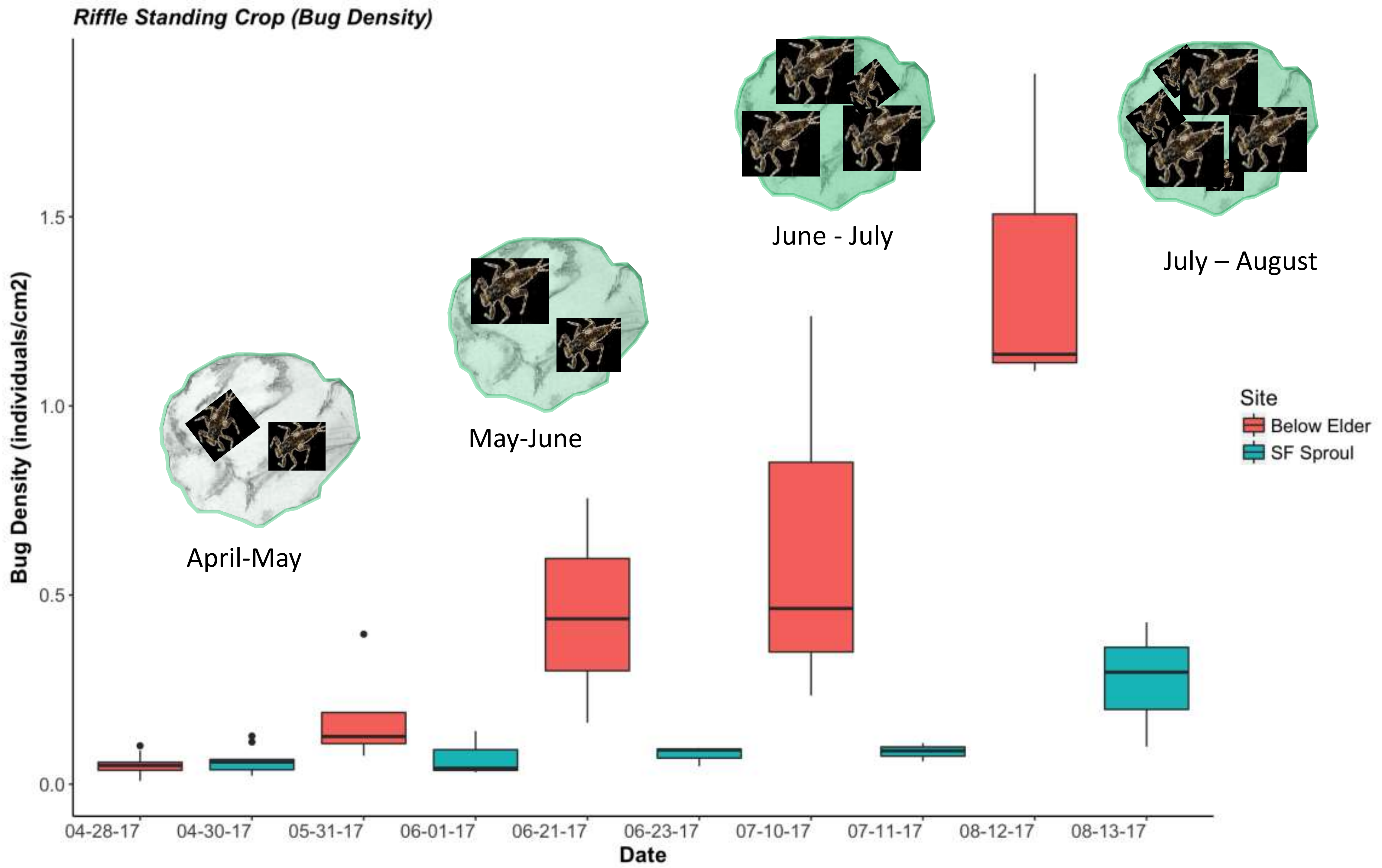
Primary Production
Gross Primary Production/Area (mg of O2/hr/cm2)
0.0
0.1
0.2
0.3
0.4
May
Jun
Jul
Aug
Date
Stream
Elder Creek
SF Sproul Creek


Chlorophyll-a
April-May
May-June
June-
July
July –
August
Epi-benthic algal standing crop (mostly diatoms)
Chl-a µg/cm2
0.6
0.4
0.2
0.0
May
Jun
Jul
Aug
Date
Site
Elder Creek
SF Sproul Creek

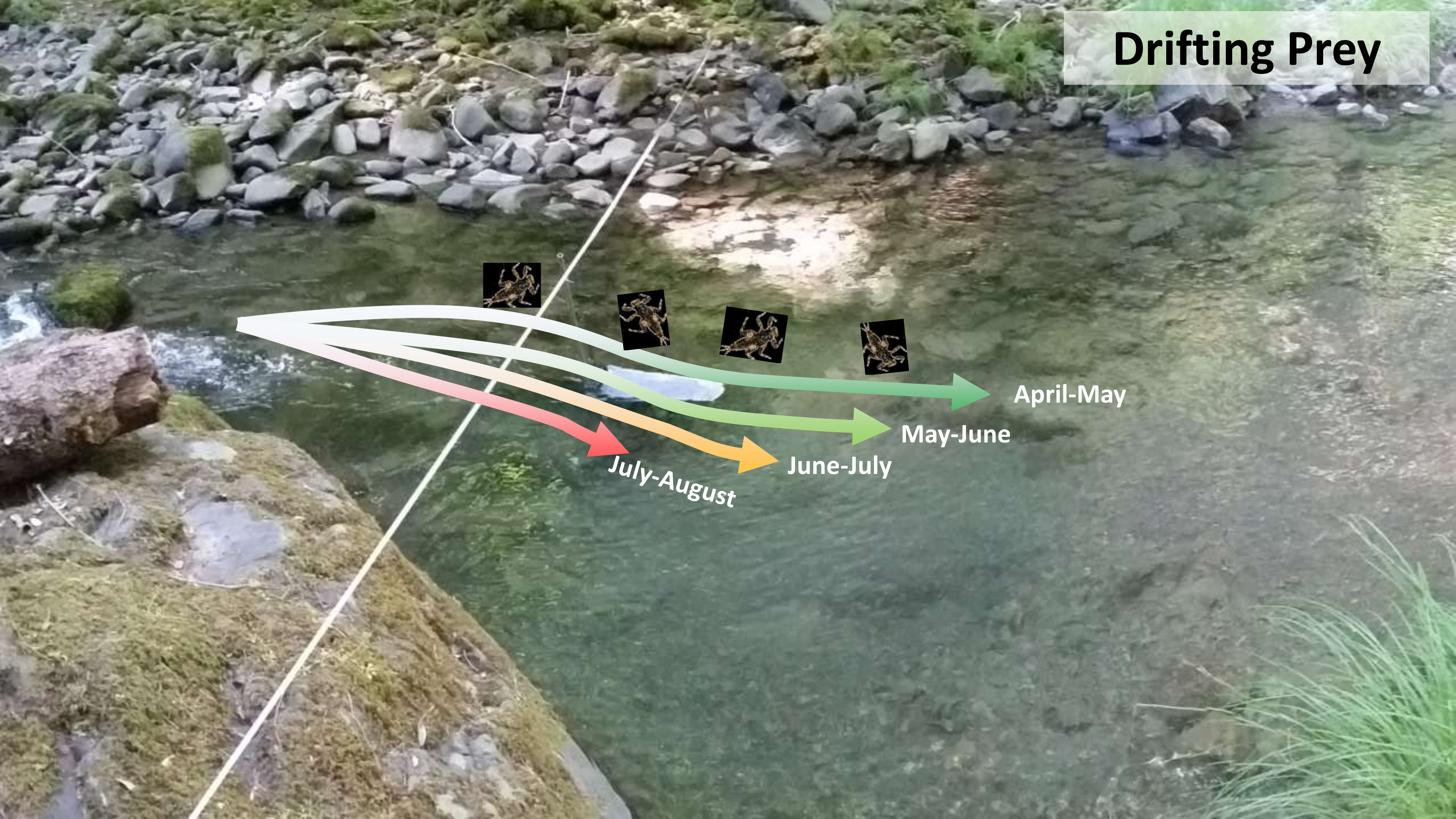


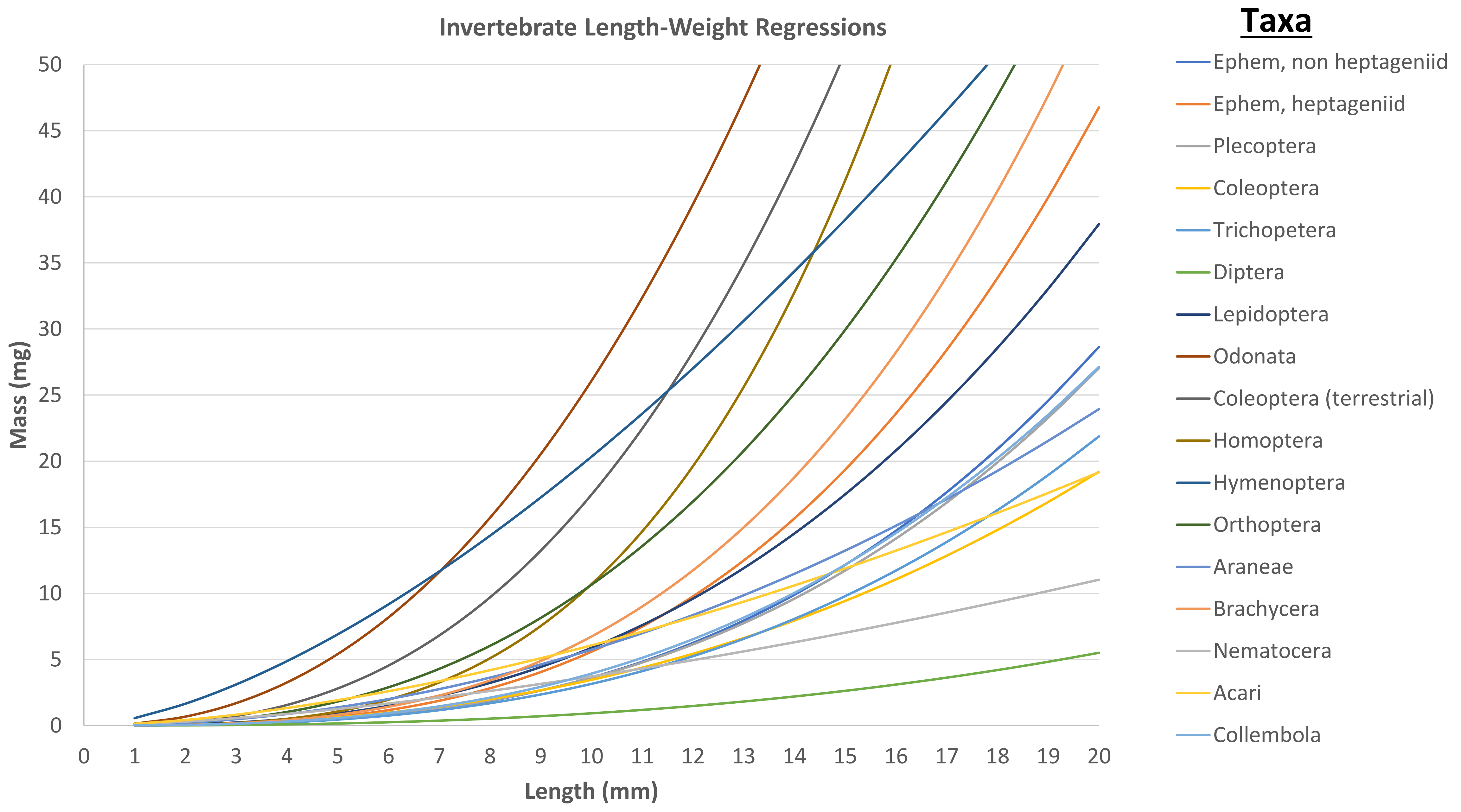
Pool Standing Crop (Bug Density)
Bug Density (individuals/cm2)
1.5
1.0
0.5
0.0
June - July
May-June
July – August
April-May
Date
04-28-17
04-30-17
05-31-17
06-01-17
06-21-17
06-23-17
07-10-17
07-11-17
08-12-17
08-13-17
Site
Below Elder
SF Sproul


Pool Standing Crop (BMI Biomass)
BMI Biomass Density (mg/cm2)
0.3
0.2
0.1
0.0
June - July
May-June
April-May
July – August
Site
Below Elder
SF Sproul
04-28-17
04-30-17
05-31-17
06-01-17
06-21-17
06-23-17
07-10-17
07-11-17
08-12-17
08-13-17
Date

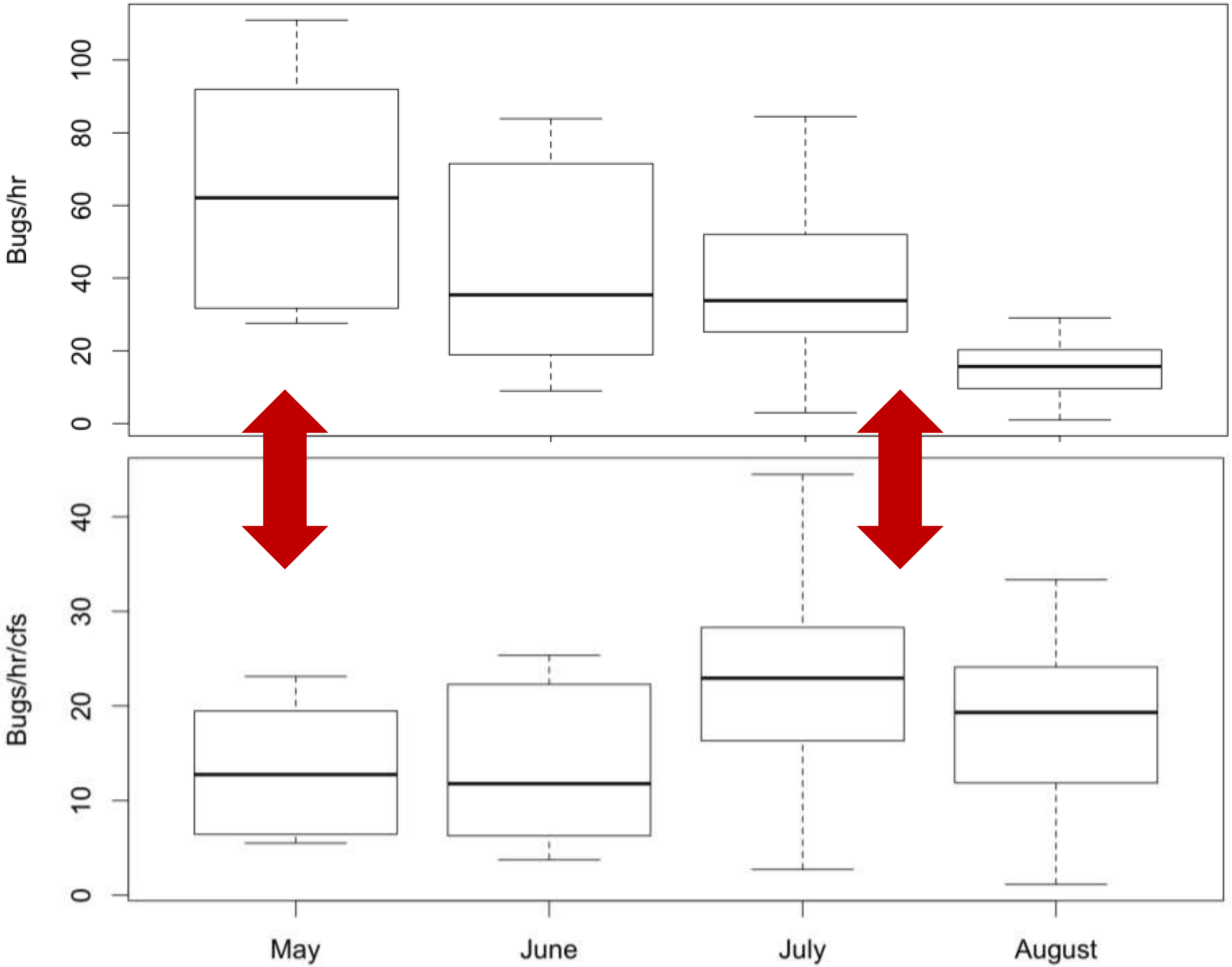

Riffle Standing Crop (Bug Density)
Bug Density (individuals/cm2)
1.5
1.0
0.5
0.0
April-May
May-June
June - July
July – August
Site
Below Elder
SF Sproul
04-28-17
04-30-17
05-31-17
06-01-17
06-21-17
06-23-17
07-10-17
07-11-17
08-12-17
08-13-17
Date

Drifting Prey

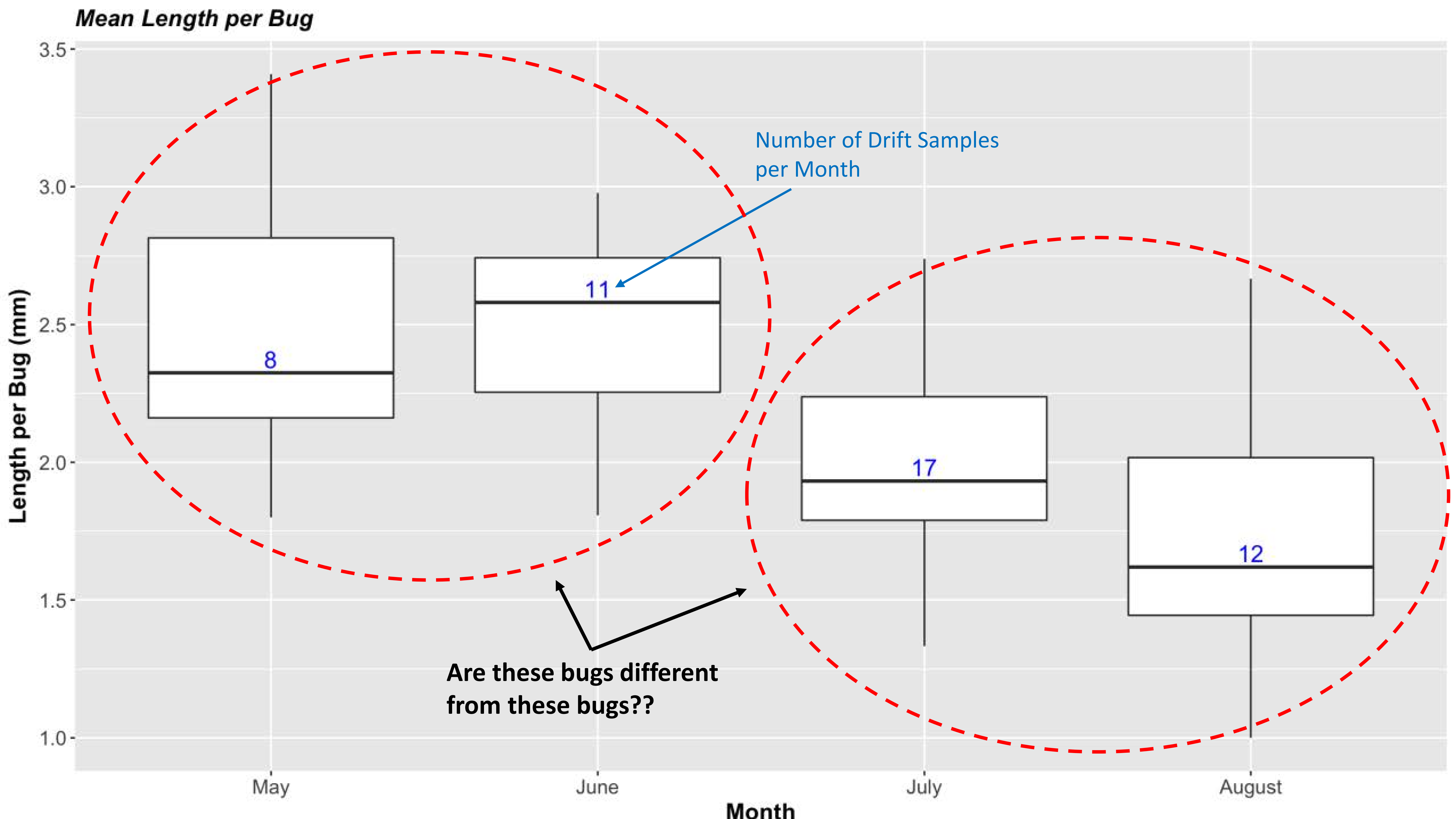


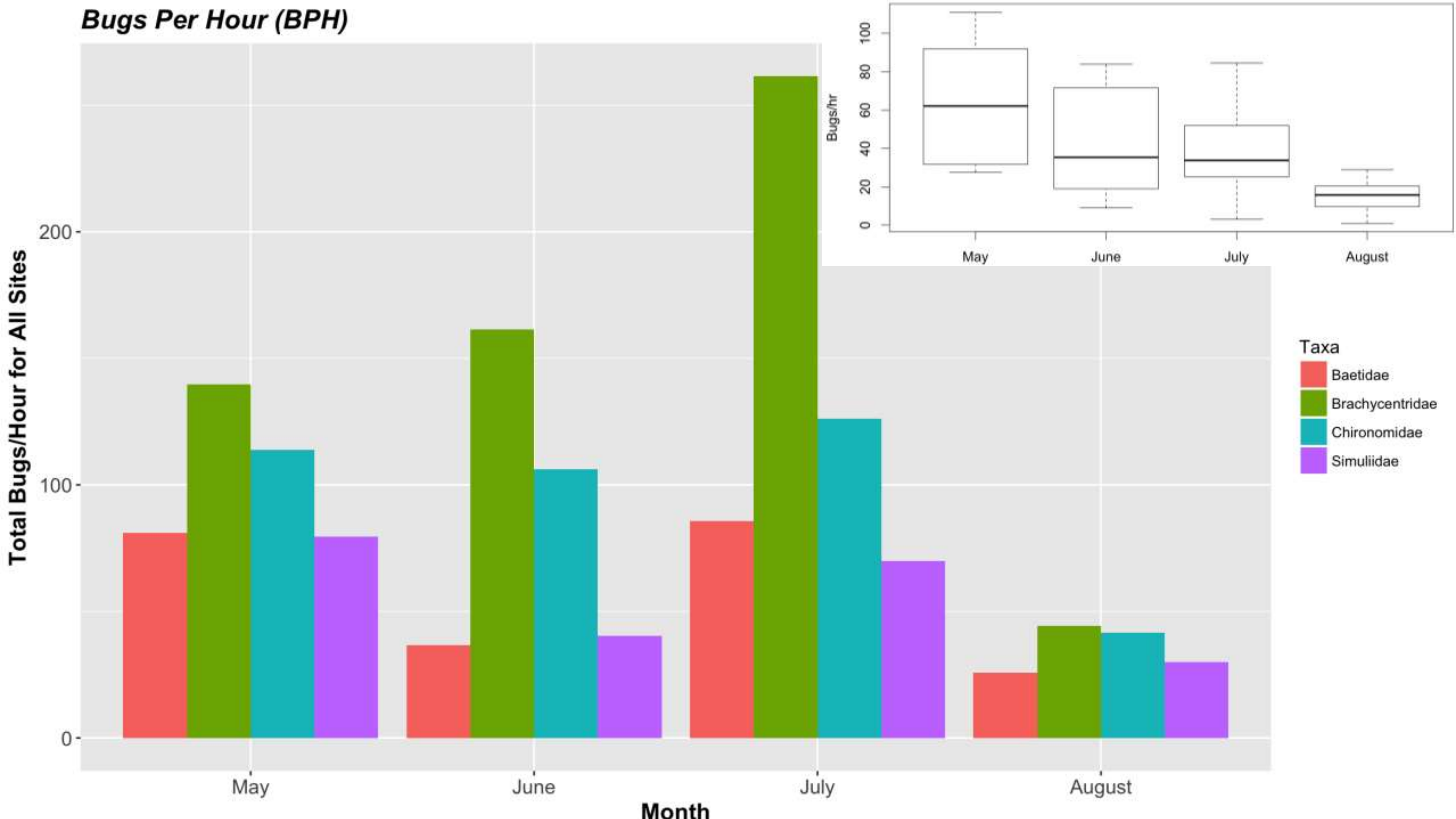


Invertebrate Length-Weight Regressions
Mass (mg)
Length (mm)
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Taxa
Ephem, non heptageniid
Ephem, heptageniid
Plecoptera
Coleoptera
Trichopetera
Diptera
Lepidoptera
Odonata
Coleoptera (terrestrial)
Homoptera
Hymenoptera
Orthoptera
Araneae
Brachycera
Nematocera
Acari
Collembola

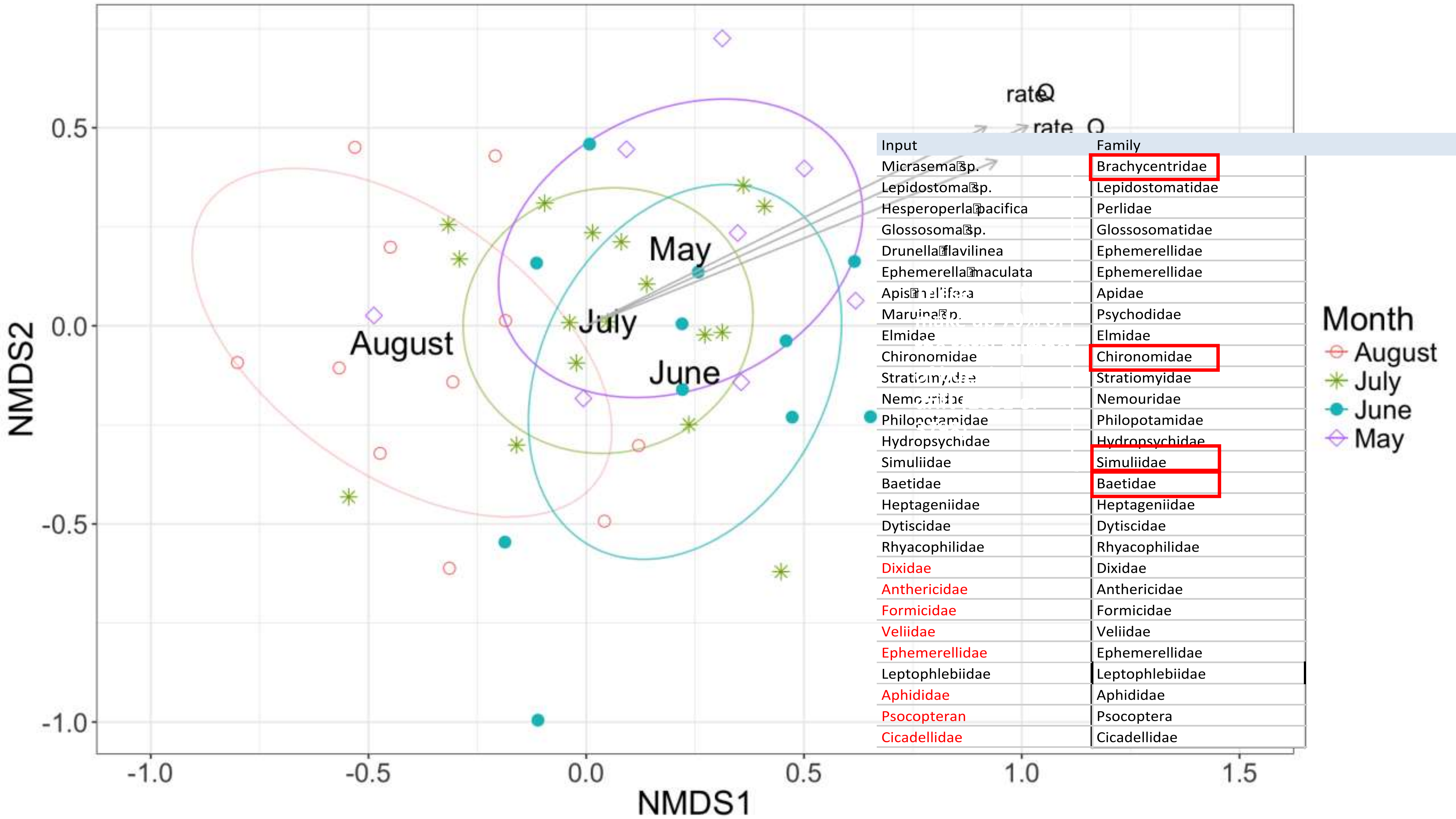


Bugs/hr
0
20
40
60
80
100
Bugs/hr/cfs
0
10
20
30
40
May
June
July
August

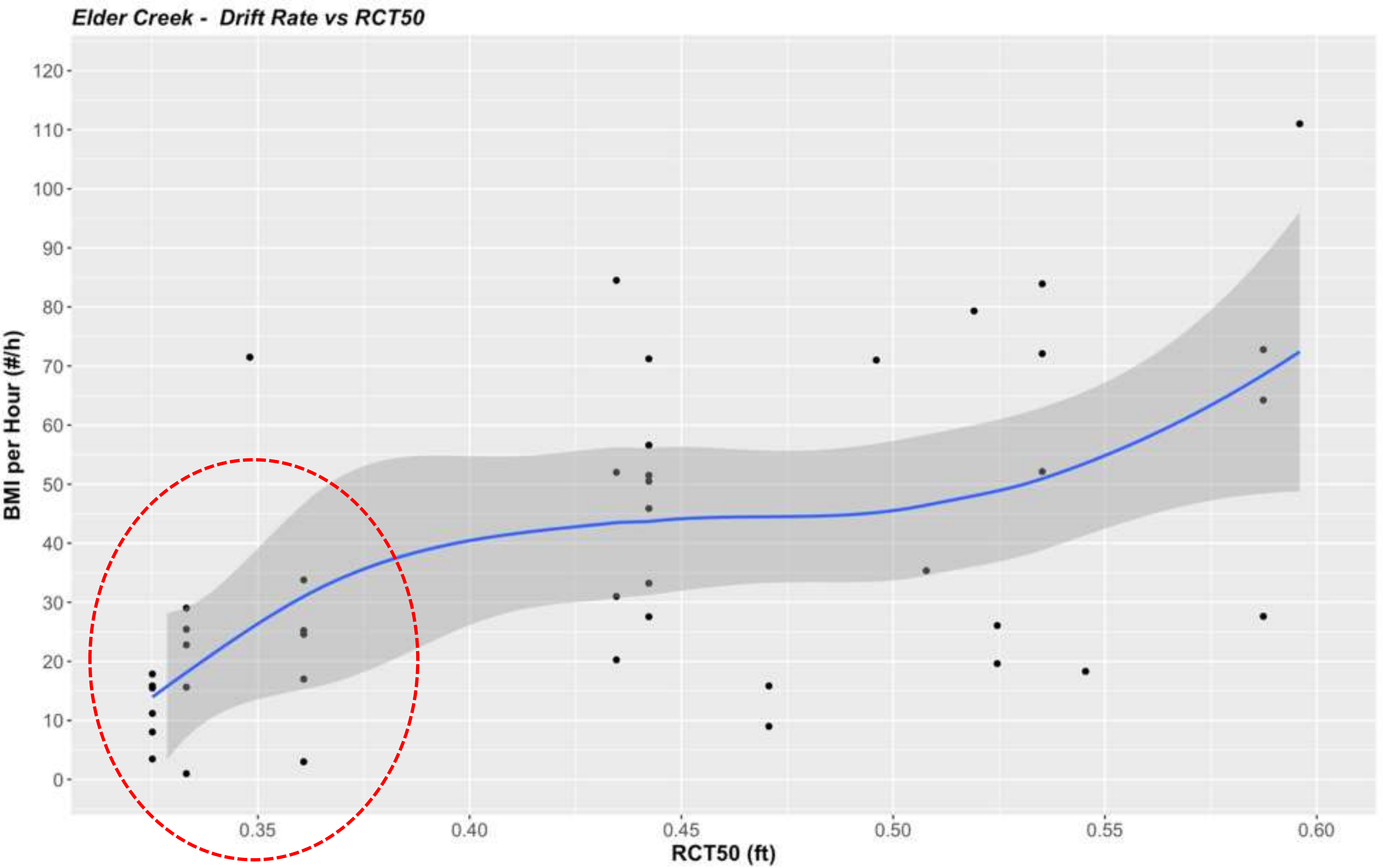

Mean Length per Bug
Length per Bug (mm)
3.5
3.0
2.5
2.0
1.5
1.0
8
11
17
12
Number of Drift Samples per Month
Are these bugs different from these bugs??
May
June
July
August
Month



Bugs Per Hour (BPH)
Total Bugs/Hour for All Sites
0
100
200
May
June
July
August
Month
Taxa
Baetidae
Brachycentridae
Chironomidae
Simuliidae
Bugs/hr
0
20
40
60
80
100
May
June
July
August



Input	Family
Micrasema sp.	Brachycentridae
Lepidostoma sp.	Lepidostomatidae
Hesperoperla pacifica	Perlidae
Glossosoma sp.	Glossosomatidae
Drunella flavilinea	Ephemerellidae
Ephemerella maculata	Ephemerellidae
Apis mellifera	Apidae
Maruina sp.	Psychodidae
Elmidae	Elmidae
Chironomidae	Chironomidae
Stratiomyidae	Stratiomyidae
Nemouridae	Nemouridae
Philopotamidae	Philopotamidae
Hydropsychidae	Hydropsychidae
Simuliidae	Simuliidae
Baetidae	Baetidae
Heptageniidae	Heptageniidae
Dytiscidae	Dytiscidae
Rhyacophilidae	Rhyacophilidae
Dixidae	Dixidae
Anthericidae	Anthericidae
Formicidae	Formicidae
Veliidae	Veliidae
Ephemerellidae	Ephemerellidae
Leptophlebiidae	Leptophlebiidae
Aphididae	Aphididae
Psocopteran	Psocoptera
Cicadellidae	Cicadellidae


Elder Creek - Drift Rate vs RCT50
BMI per Hour (#/h)
RCT50 (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
0.35
0.40
0.45
0.50
0.55
0.60

Behavioral Ecology Vol. 8 No. 4: 414–420

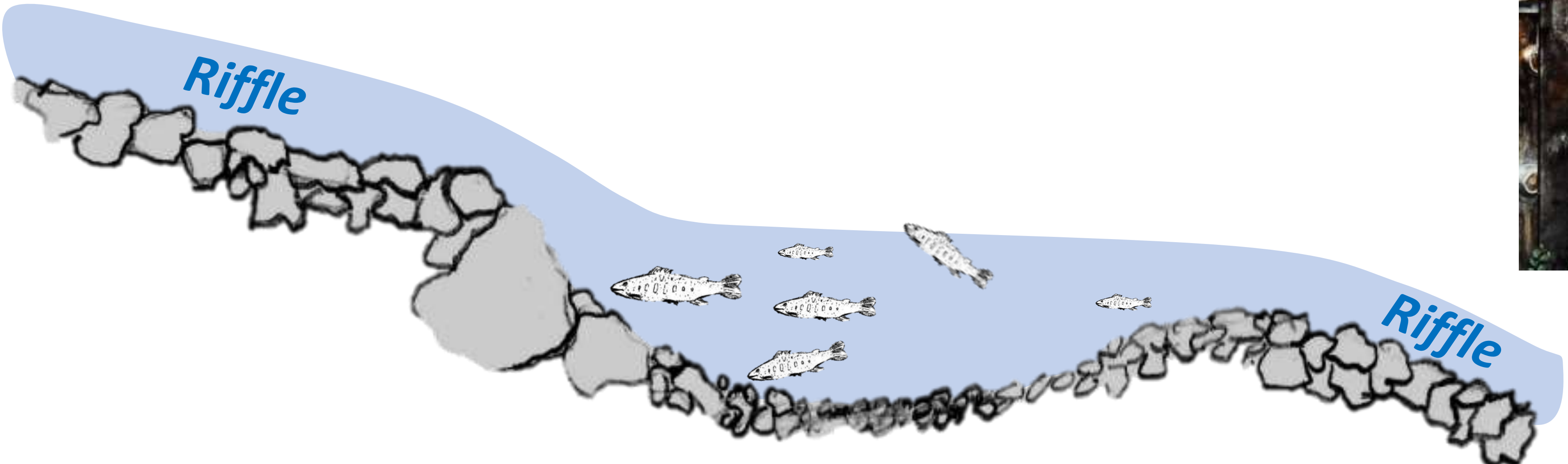
Experimentally induced foraging mode shift by sympatric charrs in a Japanese mountain stream

Kurt D. Fausch,[a] Shigeru Nakano,[b] and Satoshi Kitano[c]
[a]Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, USA, [b]Tomakomai Research Station, Hokkaido University Forests, Takaoka, Tomakomai, Hokkaido 053, Japan, and [c]Research Institute of North Pacific Fisheries, Hokkaido University, Hakodate, Hokkaido 041, Japan

Foraging mode shifts may allow animals flexibility to adapt to a variety of ecological conditions. Theory holds that ectotherms such as fishes should shift from ambush to active search modes when prey density declines, to maintain a minimum encounter rate. *Salvelinus malma* (Dolly Varden) sympatric with *S. leucomaenis* (white-spotted charr) in a northern Japan mountain stream were observed to shift from ambushing drifting invertebrates at fixed focal points to picking benthic invertebrates from the

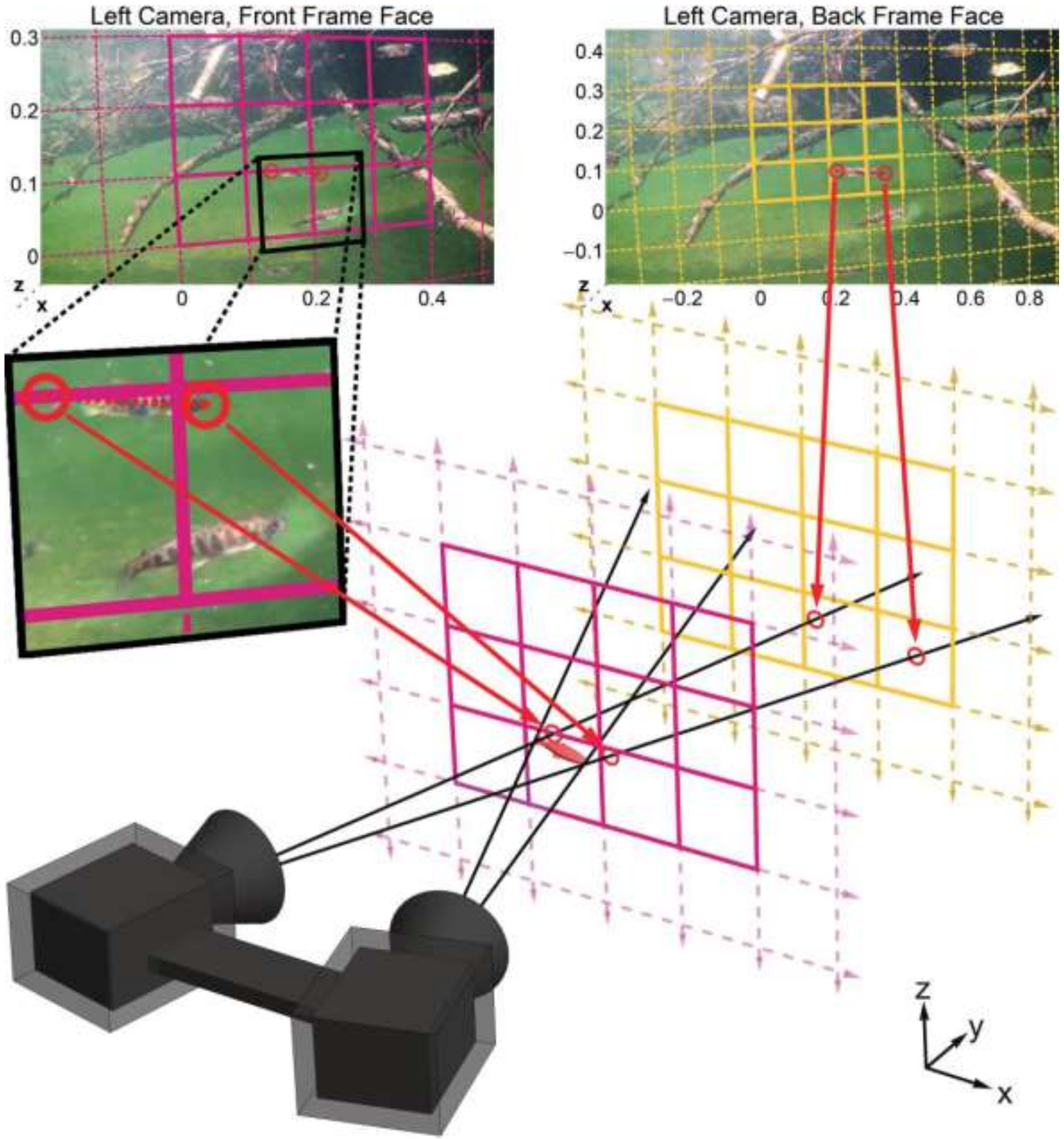
What are the behavioral responses of fish to these food web dynamics?

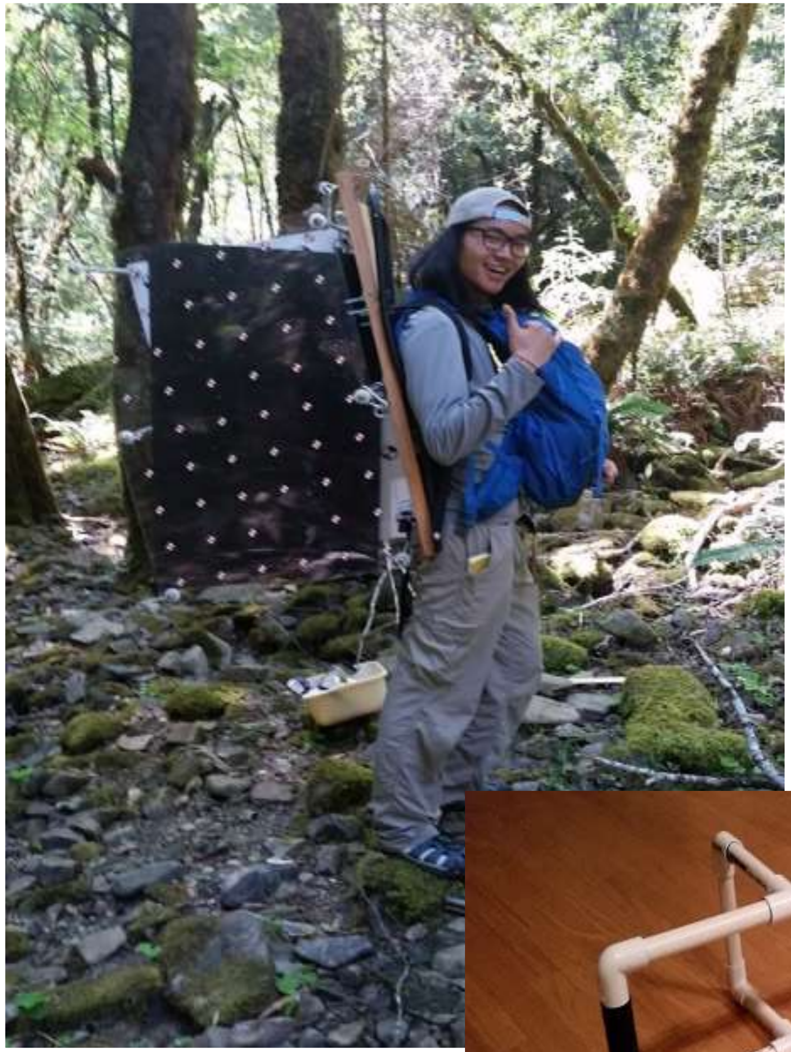
Leading up to – how do we think about managing salmonid populations in tributary streams?



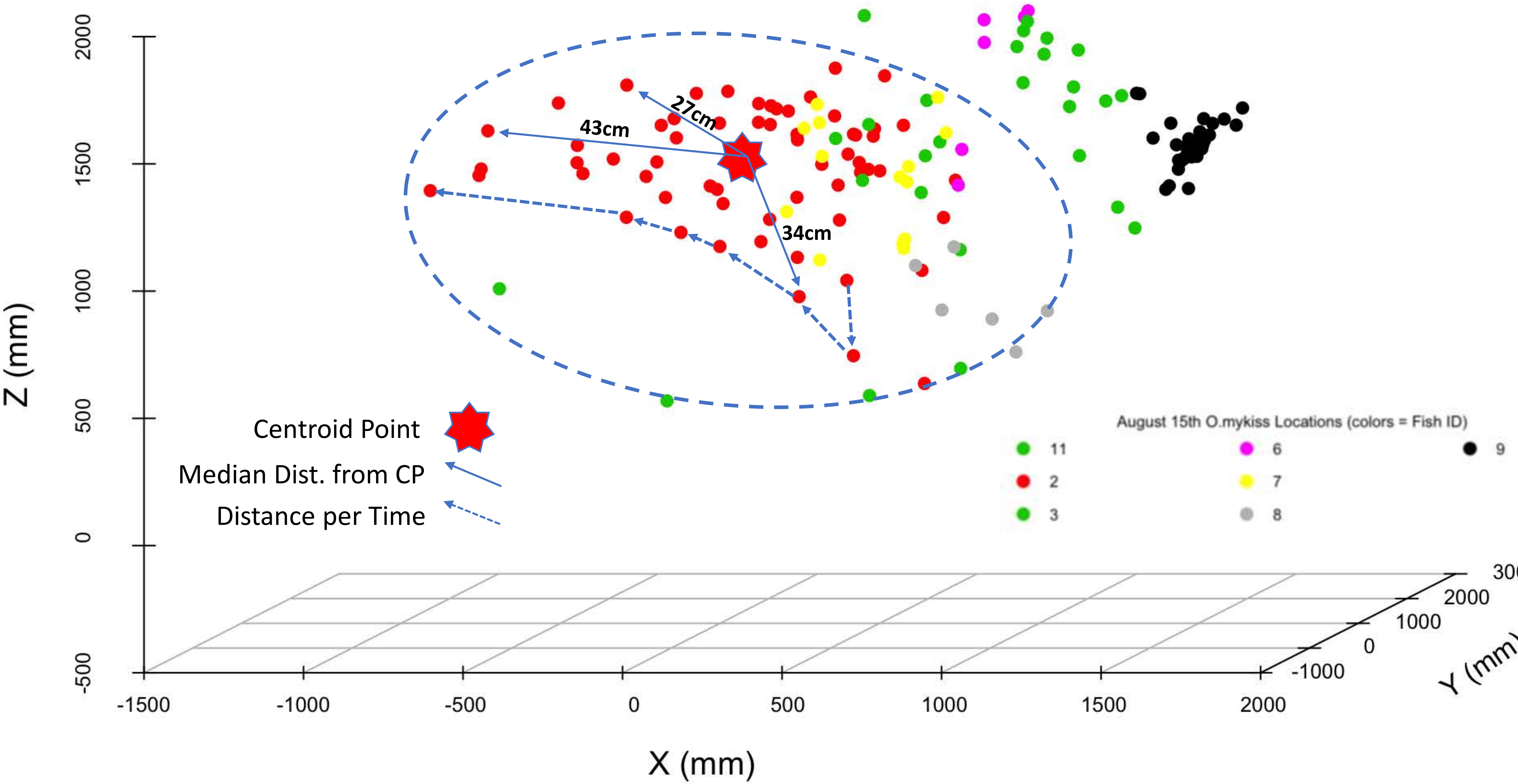
VidSync

Neuswanger 2016

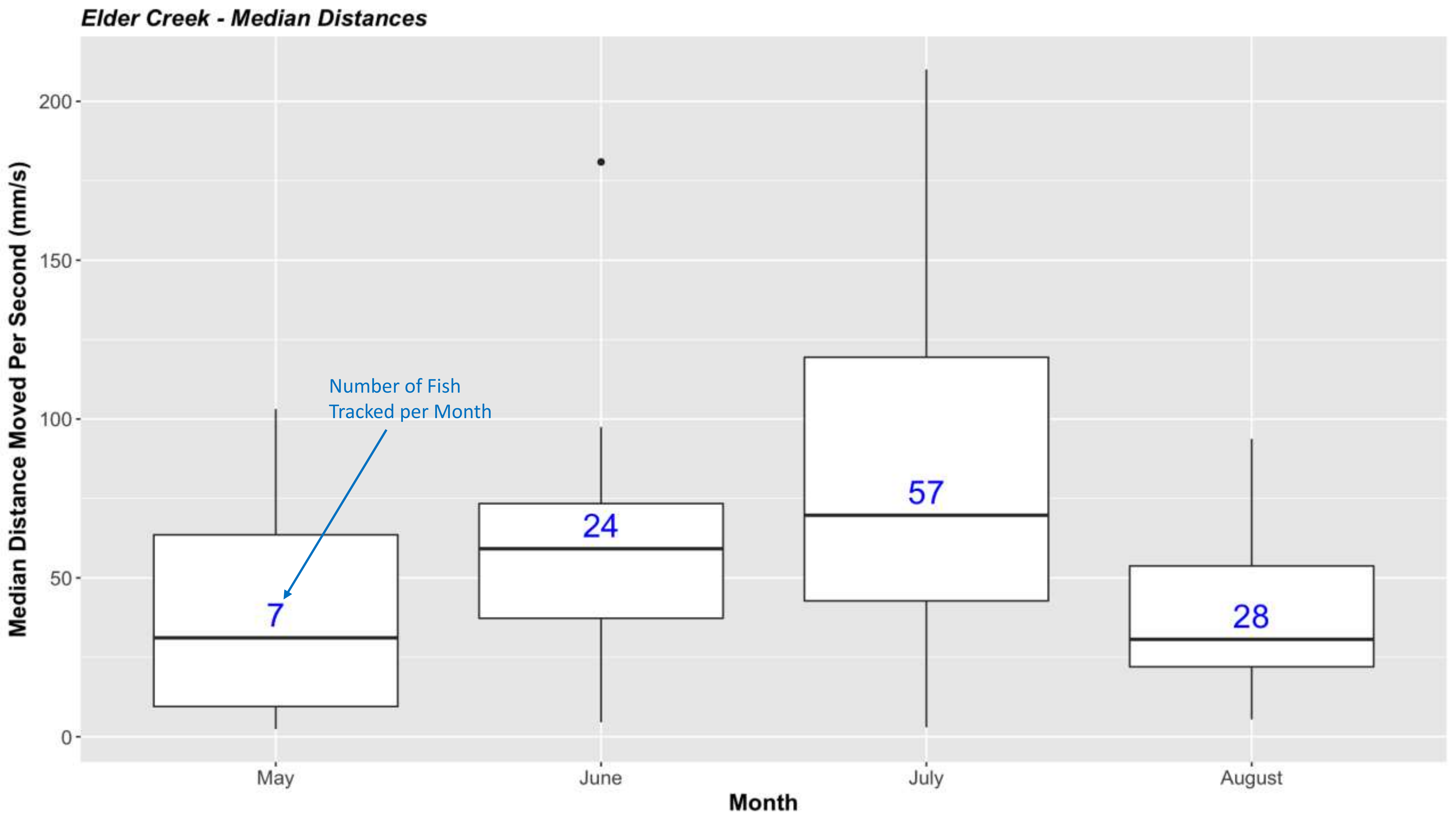




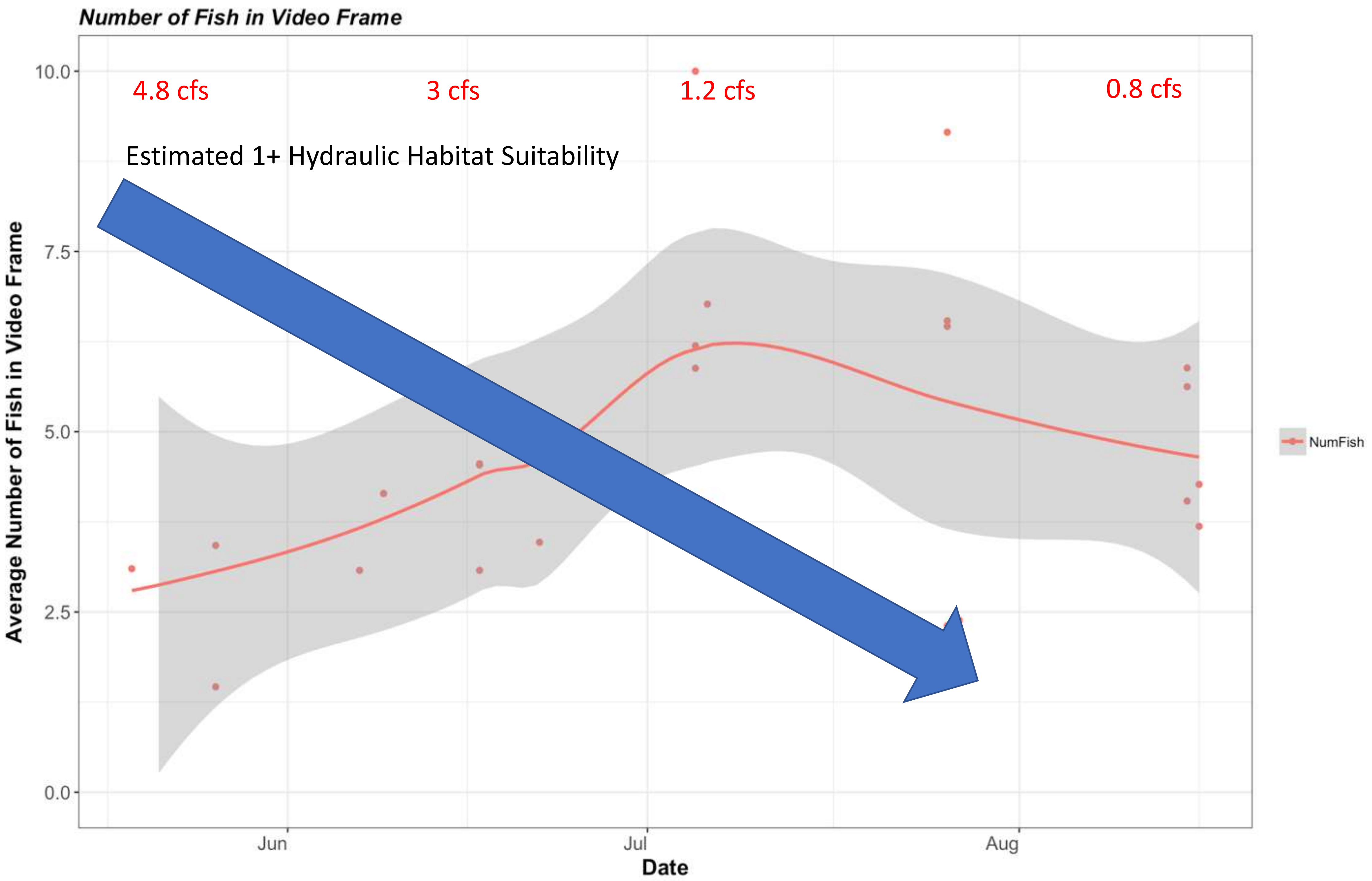
Stereo-video framework to quantify fish behavior. Diagram from Neuswanger (2016).



27cm
43cm
34cm
Centroid Point
Median Dist. from CP
Distance per Time
August 15th O.mykiss Locations (colors = Fish ID)
11
2
3
6
7
8
9
Z (mm)
2000
1500
1000
500
0
-500
-1500
-1000
-500
0
500
1000
1500
2000
X (mm)
-1000
0
1000
2000
Y (mm)



Elder Creek - Median Distances
Median Distance Moved Per Second (mm/s)
200
150
100
50
0
Number of Fish
Tracked per Month
7
24
57
28
May
June
July
August
Month



Number of Fish in Video Frame
4.8 cfs
3 cfs
1.2 cfs
0.8 cfs
Estimated 1+ Hydraulic Habitat Suitability
Average Number of Fish in Video Frame
10.0
7.5
5.0
2.5
0.0
Jun
Jul
Aug
Date
NumFish

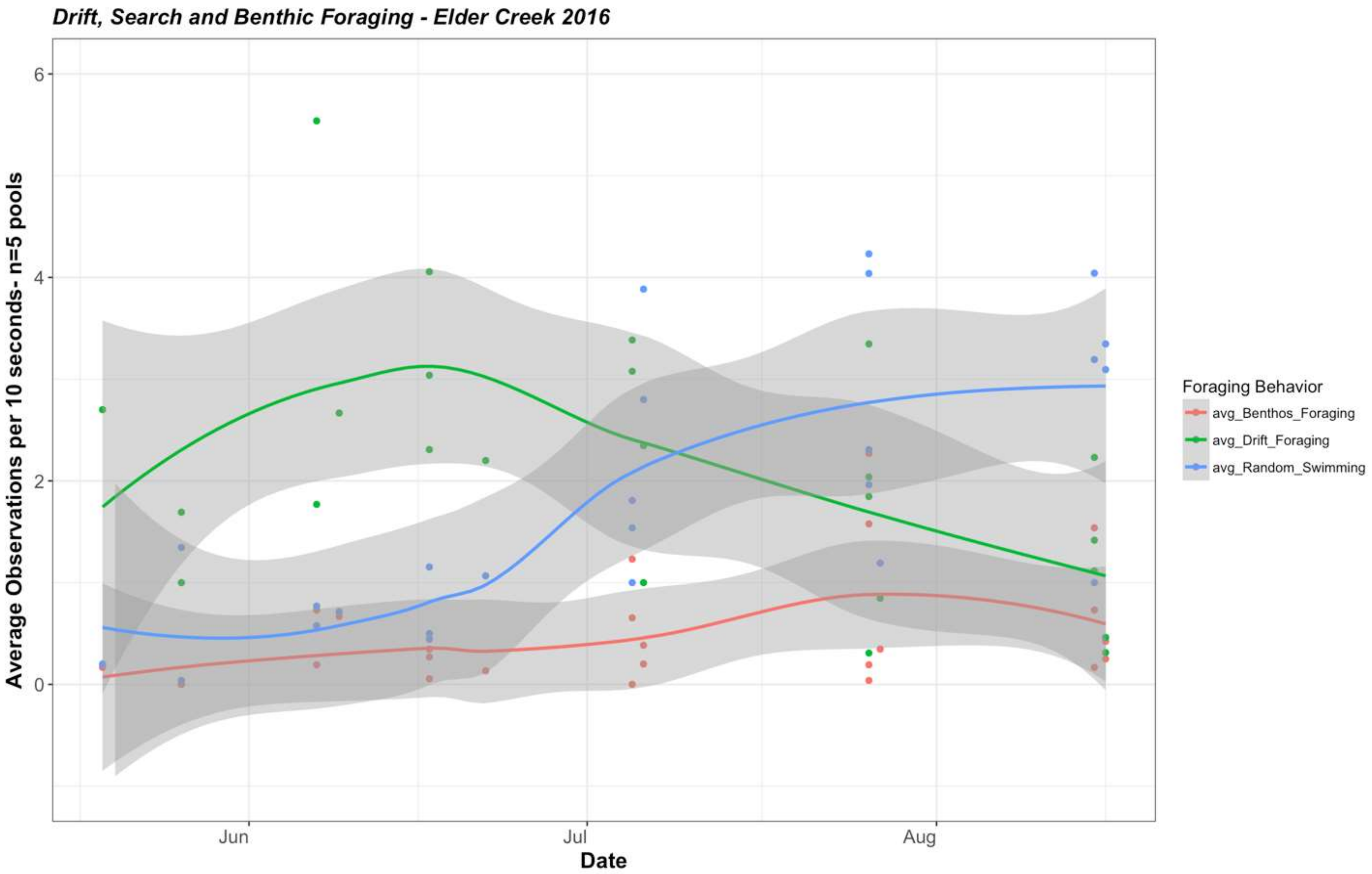

Elder "Upper" May 2 ~ 25 cfs. No fish in water column – probably velocity too high


Elder Upper May 30th ~ 7 cfs. Few fish in water column… but velocities are good.

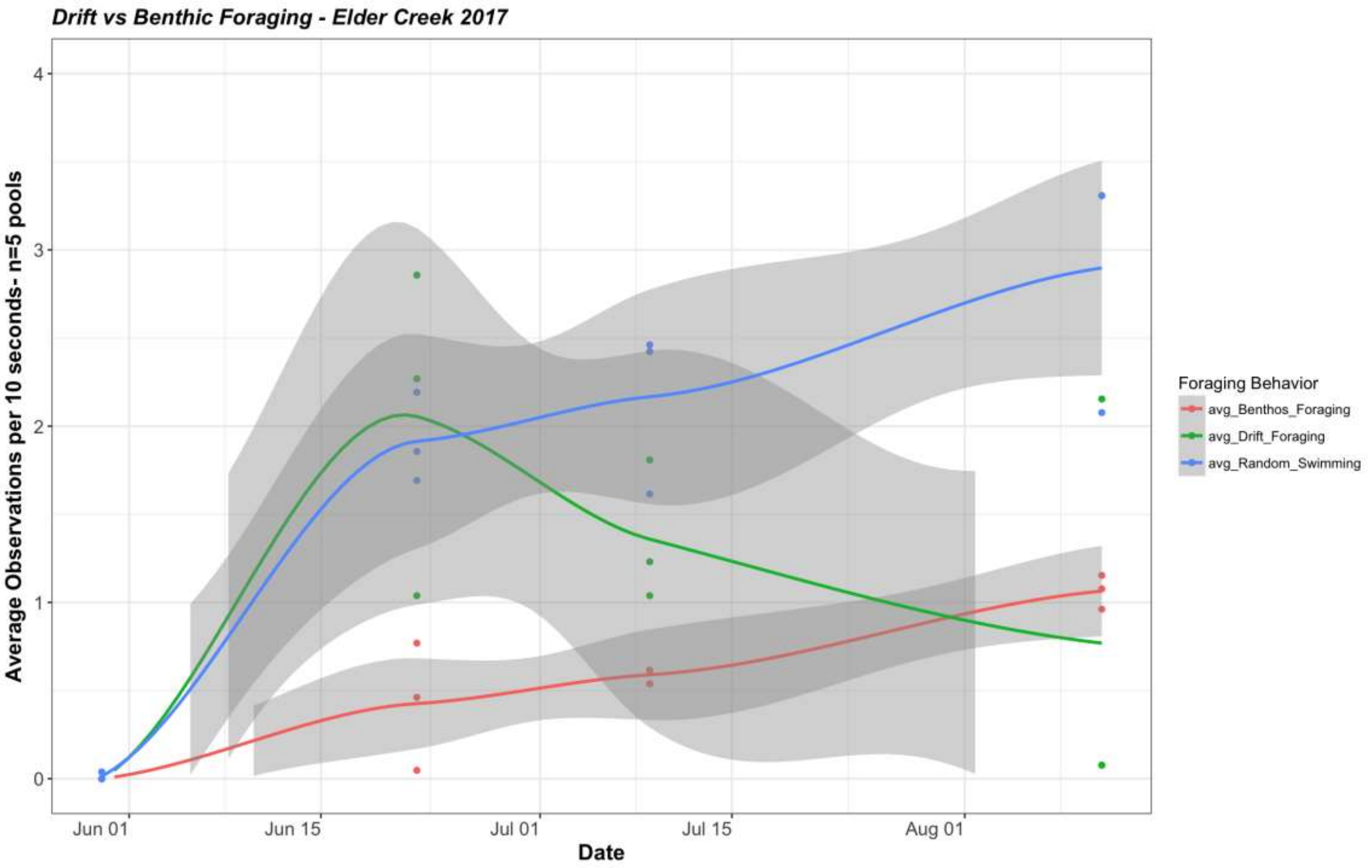

Elder Upper June 22th ~ June 22nd ~ 4 cfs. Fish all over the pool feeding like crazy.

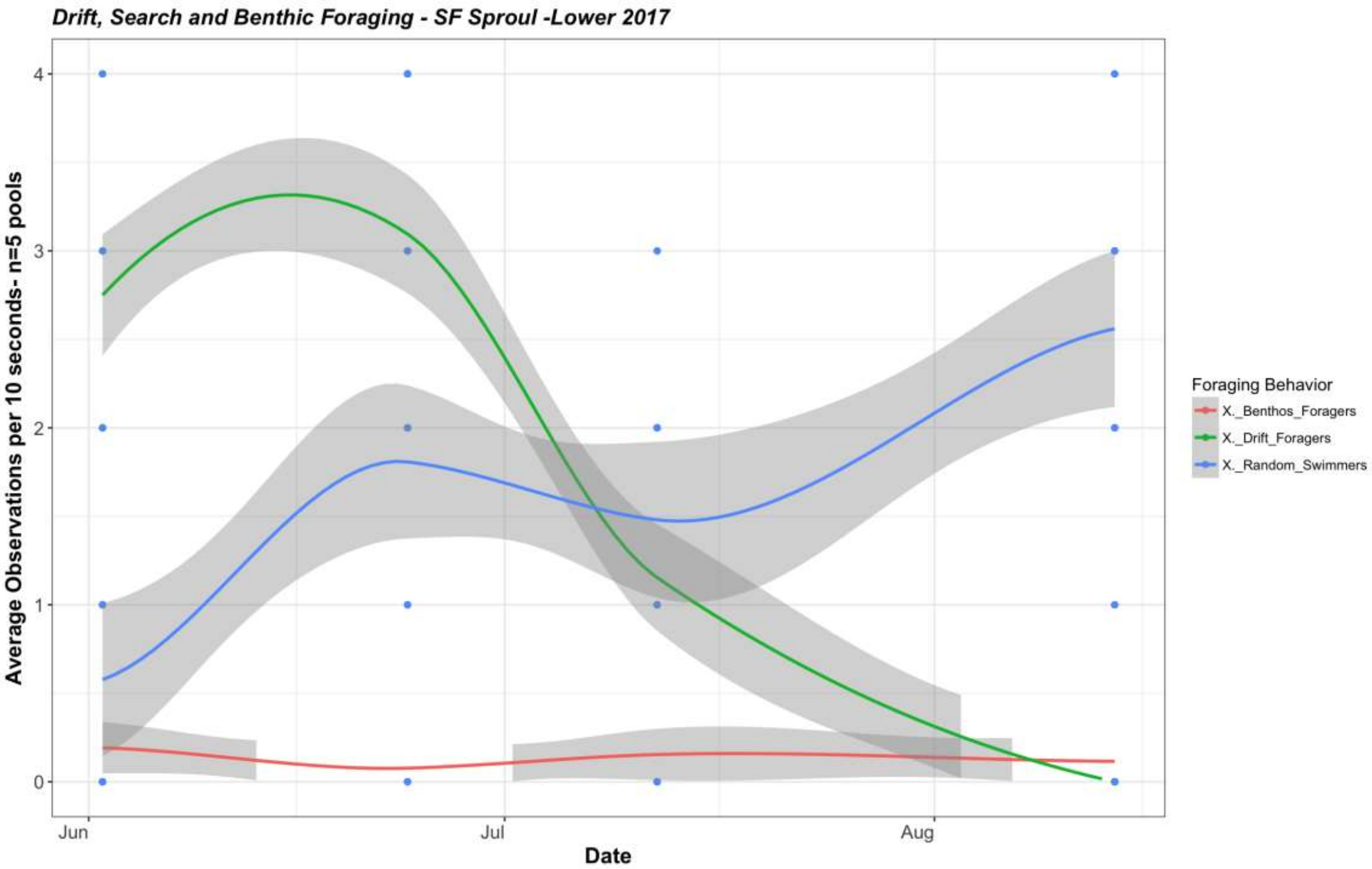

SF Sproul Lower – May 1st 11 cfs.

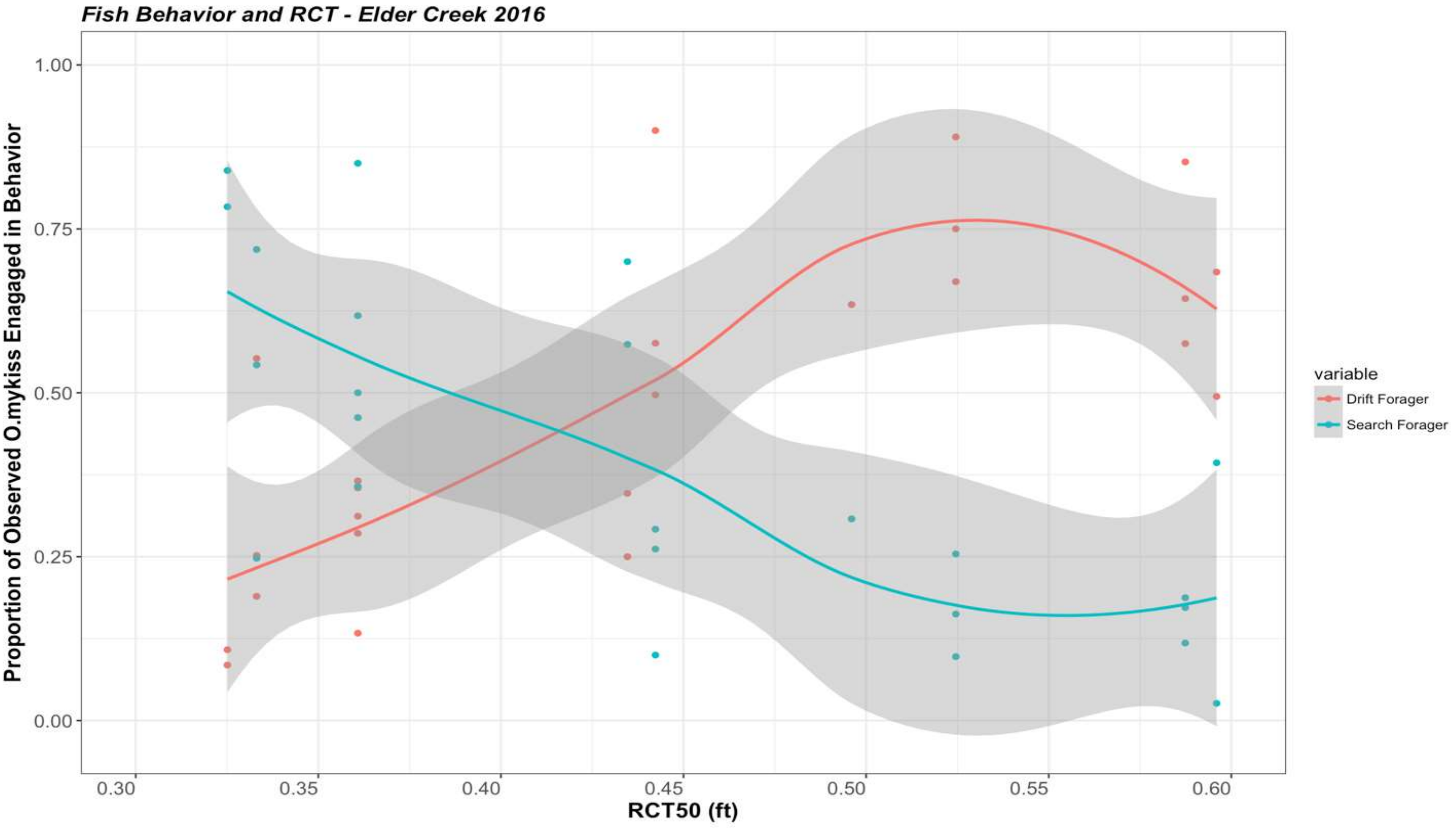

SF Sproul Lower – June 2st 1.7 cfs.



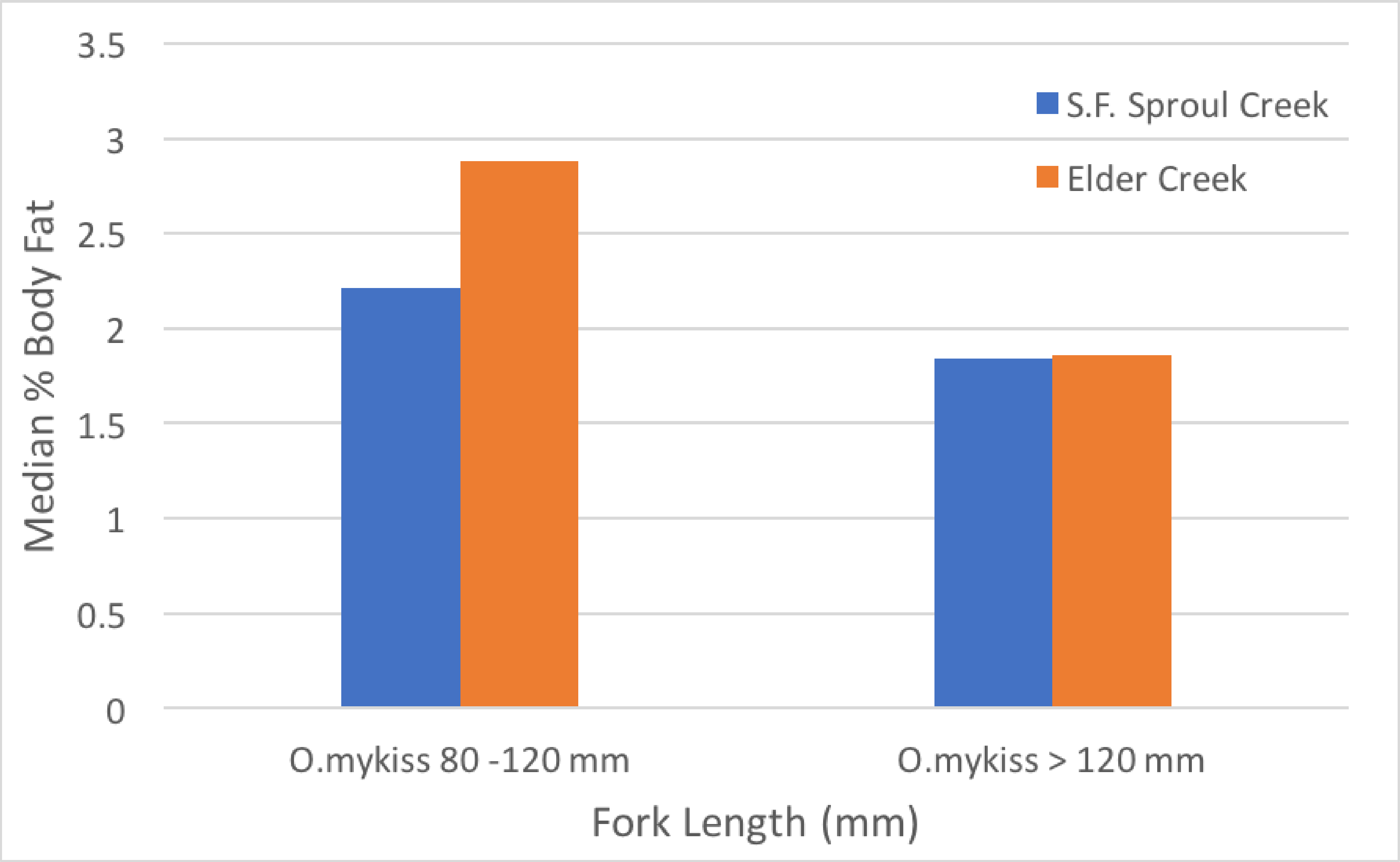
Drift, Search and Benthic Foraging - Elder Creek 2016
Average Observations per 10 seconds- n=5 pools
6
4
2
0
Jun
Jul
Aug
Date
Foraging Behavior
avg_Benthos_Foraging
avg_Drift_Foraging
avg_Random_Swimming


Drift vs Benthic Foraging - Elder Creek 2017
Average Observations per 10 seconds- n=5 pools
0
1
2
3
4
Date
Jun 01
Jun 15
Jul 01
Jul 15
Aug 01
Foraging Behavior
avg_Benthos_Foraging
avg_Drift_Foraging
avg_Random_Swimming


Drift, Search and Benthic Foraging - SF Sproul -Lower 2017
Average Observations per 10 seconds- n=5 pools
0
1
2
3
4
Jun
Jul
Aug
Date
Foraging Behavior
X._Benthos_Foragers
X._Drift_Foragers
X._Random_Swimmers



Fish Behavior and RCT - Elder Creek 2016
Proportion of Observed O.mykiss Enagaged in Behavior
1.00
0.75
0.50
0.25
0.00
0.30
0.35
0.40
0.45
0.50
0.55
0.60
RCT50 (ft)
variable
Drift Forager
Search Forager



3.5
3
2.5
2
1.5
1
0.5
0
Median % Body Fat
S.F. Sproul Creek
Elder Creek
O.mykiss 80 -120 mm
O.mykiss > 120 mm
Fork Length (mm)

Conclusions… hmm

Pool-level populations of juvenile steelhead AND Coho clearly show behavioral foraging shifts as the hydraulic and food web phenologies progress through summer. Very likely this means individuals are shifting their behavior (not much pool movement after July), but I can't prove that.

Juvenile fish entered pools *much* later than I expected, and later (I strongly believe) than hydraulic suitability would have predicted. WHY??

Primary production increased from May to June in Elder, but algal standing crop stayed low… Most fish in June were drift foragers and so… grazing BMI were probably not being suppressed by fish.

Pool BMI biomass peaked in early July, but drift was highest in May (although drift concertation also peaked in July). Importantly (maybe??) fish density peaked in July as well AND fish movement.

Everything changed in August – meaning, much less fish movement, MUCH less BMI biomass, change in BMI community, increased primary production and algal standing crop. This was consistent in both Elder and Sproul Creek. But… and this is important, the change in flow was SMALL. ---What is driving this?? Mary thinks maybe emergence… but the shift to benthic and search foraging makes me think predation plays a role. I will get to the bottom of this this summer!!

Take home message ….. Fabre (1913) was right, the stomach sways the world and we need to pay attention.

Acknowledgments

Mildred E. Mathias Graduate Student Research Grant

Carol Baird Graduate Student Award for Field Research

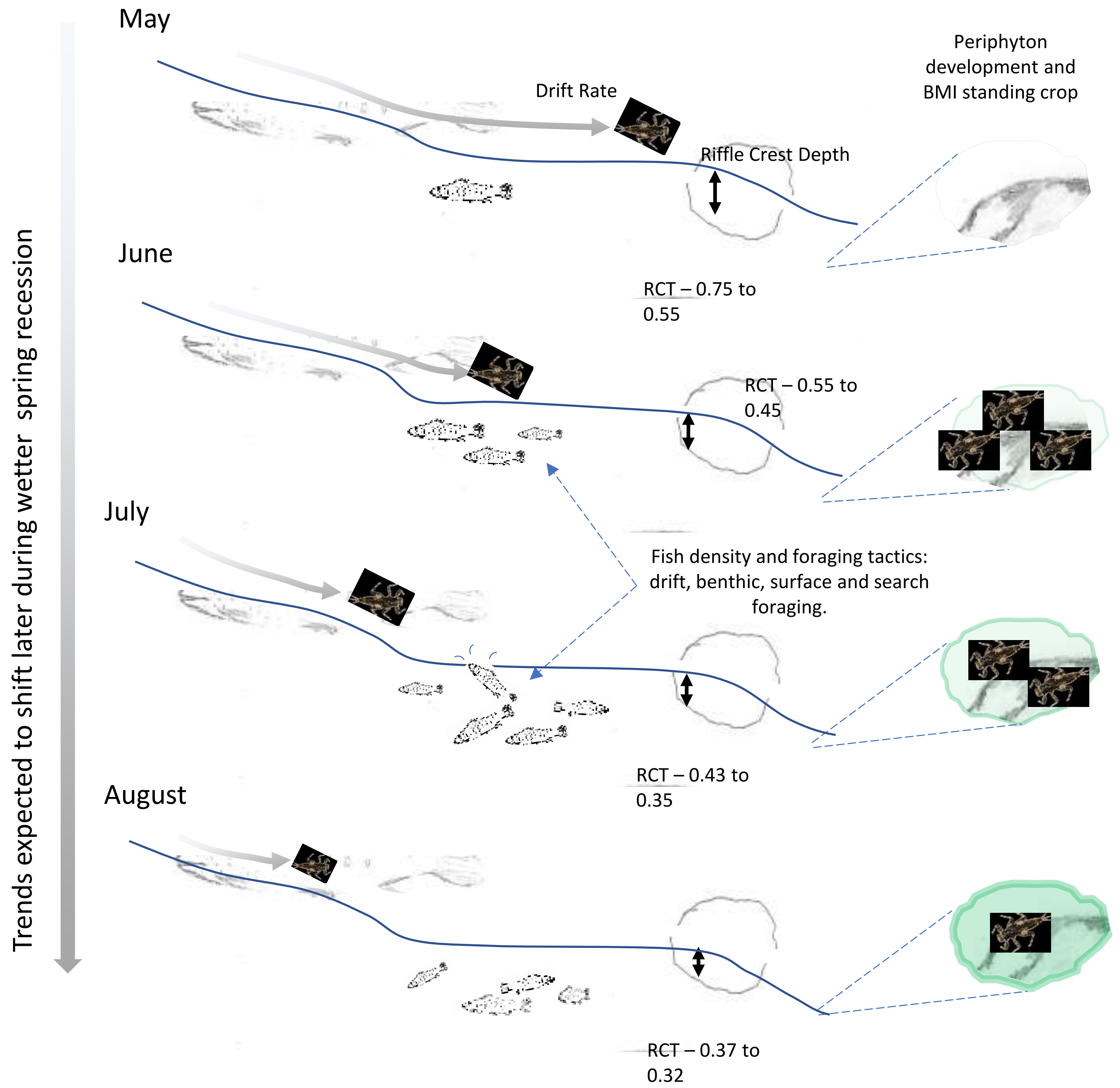
California Trout

UC Natural Reserve System

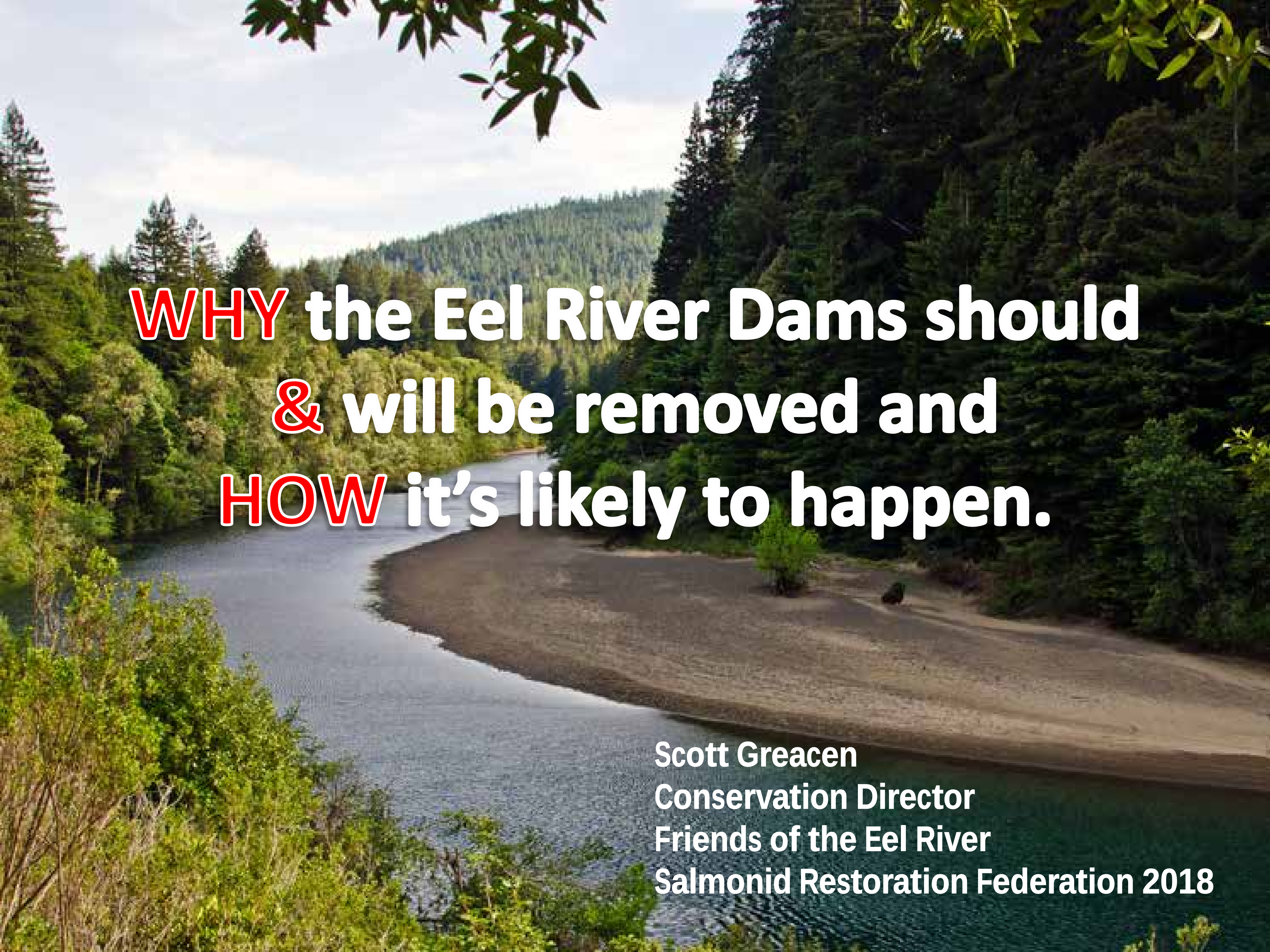
Jason Nueswanger (Developer of Vidsync)

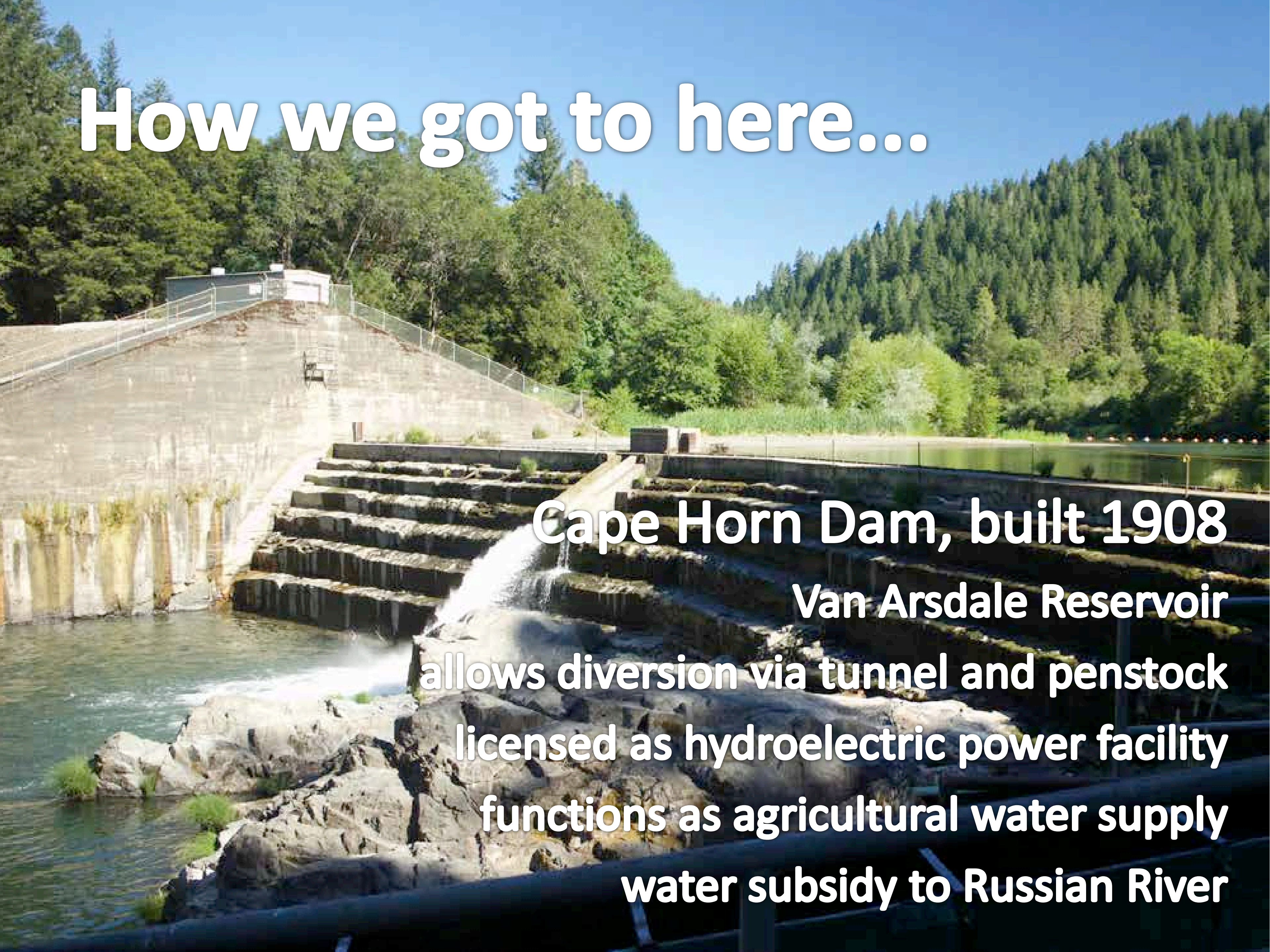
Mary Power, Stephanie Carlson, Shelley Pneh, Keith Bouma-Gregson, Phil Georgakakos, Weston Slaughter, Kobie Boslough, Keane Flynn, Terrance Wang.

Questions



Trends expected to shift later during wetter spring recession
May
Drift Rate
Periphyton development and BMI standing crop
Riffle Crest Depth
June
RCT – 0.75 to 0.55
RCT – 0.55 to 0.45
July
Fish density and foraging tactics: drift, benthic, surface and search foraging.
RCT – 0.43 to 0.35
August
RCT – 0.37 to 0.32


WHY the Eel River Dams should
& will be removed and
HOW it's likely to happen.
Scott Greacen
Conservation Director
Friends of the Eel River
Salmonid Restoration Federation 2018



How we got to here…

Cape Horn Dam, built 1908

Van Arsdale Reservoir

allows diversion via tunnel and penstock

licensed as hydroelectric power facility

functions as agricultural water supply

water subsidy to Russian River

How Scott Dam Got Bent: Before

How Scott Dam Got Bent: During

Flood waters
November 10 1920

3

How Scott Dam Got Bent: After

Is this dam safe?

(Is a water diversion that depends on this dam reliable?)

Reasons for doubt
- past
- present

FERC: everything is fine

We don't consider dam safety in relicensing

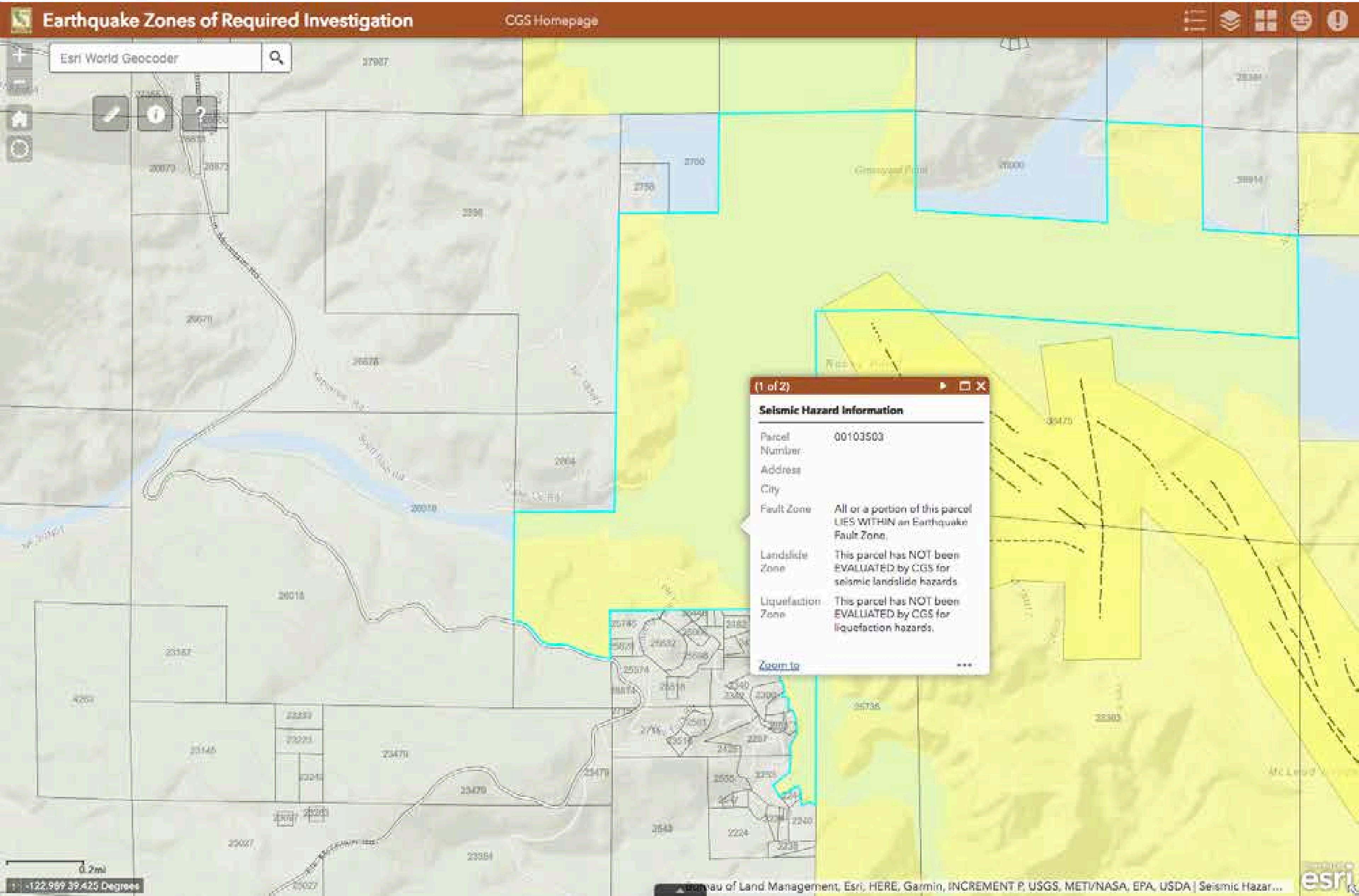
And no, you can't see the evidence because terrorism

Photos of the downstream face of the dam collected over the past fourteen months document the progression of the observed active leaks (See Enclosure 2, Scott Dam Leakage Photos). Deposits observed along numerous construction lifts over the dam face, as well as historical photos in PG&E's files, indicate that seepage from the lifts has occurred in the past. PG&E's operations personnel first alerted engineering staff of a spraying leak about halfway down the dam face (approximately 75 ft below the spill crest) by email on April 20, 2016. Detailed photos of the leak exit point from the dam crest appear to indicate a pipe, bar, or some other structural object protruding from the spray location. Engineering staff recommended that operations personnel document the leak with photos on a weekly basis and immediately report any noticeable spreading of the spray exit location, such as to a nearby horizontal lift or vertical construction joint, or if the seeps visible along the nearby lift become noticeably greater. On April 25, 2016, operations personnel reported that the leak had stopped spraying, but was still seeping. On July 7, 2016, the leak was reported to have started spraying again. PG&E's engineering staff informed FERC via email on July 11, 2016 of the leak, and on July 25, 2016, FERC requested that PG&E file a formal incident report to document the leak and associated planned activities to investigate the leak further.

On August 9, 2015, a M5.1 earthquake occurred approximately 10 miles southeast of the dam. As part of PG&E's post-earthquake response, the dam was inspected immediately after the earthquake. No significant changes in the leak spray pattern were noted (See Enclosure 3, Scott Dam Comparative Photos of Leak). A separate report describing the earthquake and PG&E's response is being prepared and will be forwarded to FERC within 30 days of the incident.

eported by email to the Federal Energy Regulatory Commission's (FERC) San Francisco Regional Office staff on July 11, 2016. As noted in the email, a series of leaks on the downstream face of the dam appear to be related to a horizontal construction lift or lifts that show signs of past seepage (off-color stains along the lifts). However, one of the leaks has become concentrated as a spray as the reservoir water surface elevation has risen. To our knowledge, this spraying leak has not been documented before. The leak does not appear to be a dam safety issue, but PG&E is performing further investigations to better characterize the leak exit point and determine if the leak source can be detected. No compliance deviations have resulted from the incident.

Location, location, location ...

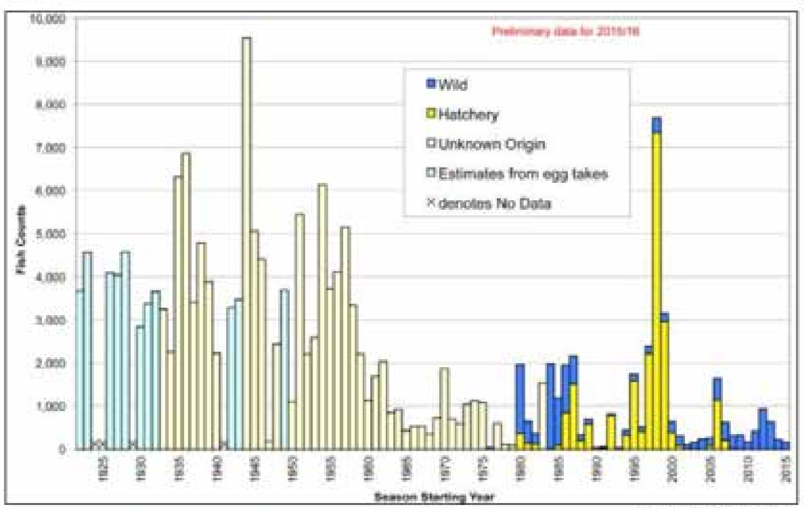


Are the Eel River dams a barrier to salmonid recovery?

- **PIKEMINNOW**
- **Mercury bioaccumulation**

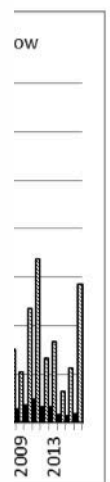
Tissue sampling results for fish from Lake Pillsbury showed high mercury concentrations, averaging 1.31 parts per million (ppm) in 350 millimeter (mm) largemouth bass (*Micropterus salmoides*), and the highest concentration for an individual fish (4.08 ppm in a 559 mm largemouth bass) in statewide sampling (Davis et al. 2009). Consequently, Lake Pillsbury is designated as impaired for mercury on the California 303(d) list (Section 5.2 – Water Quality).

- Diversion flows way down, power production down much more
- population numbers suggest recovery is impossible with dams in place.



Source: PG&E PowerPoint

Figure 5.3-9 Steelhead Counts at Van Arsdale Fisheries Station, 1922–2015



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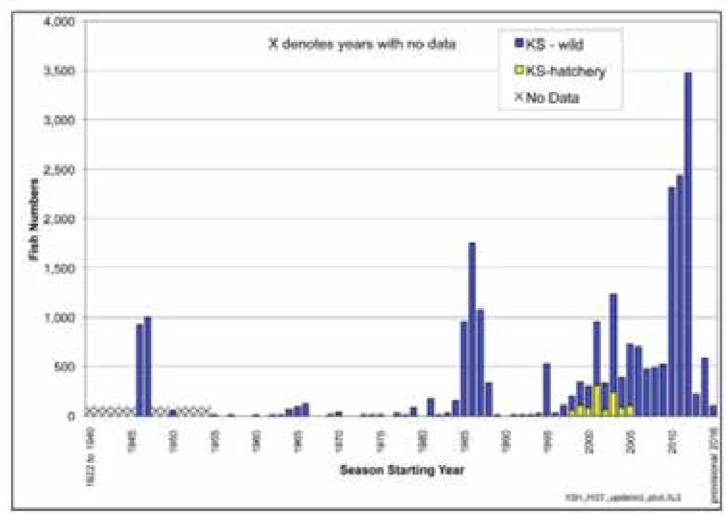

Source: PG&E PowerPoint

Figure 5.3-13 Chinook Counts at Van Arsdale Fisheries Station, 1946–2016


AD.org
Jeremy Monroe

What’s FERC gonna do?

The FERC process is terrible.
What’s the alternative?

A negotiated settlement.

All paths go through FERC.

Two basin solution?

- Raise Coyote Dam, increasing Mendocino storage.
- Adjudicate Russian River water rights.

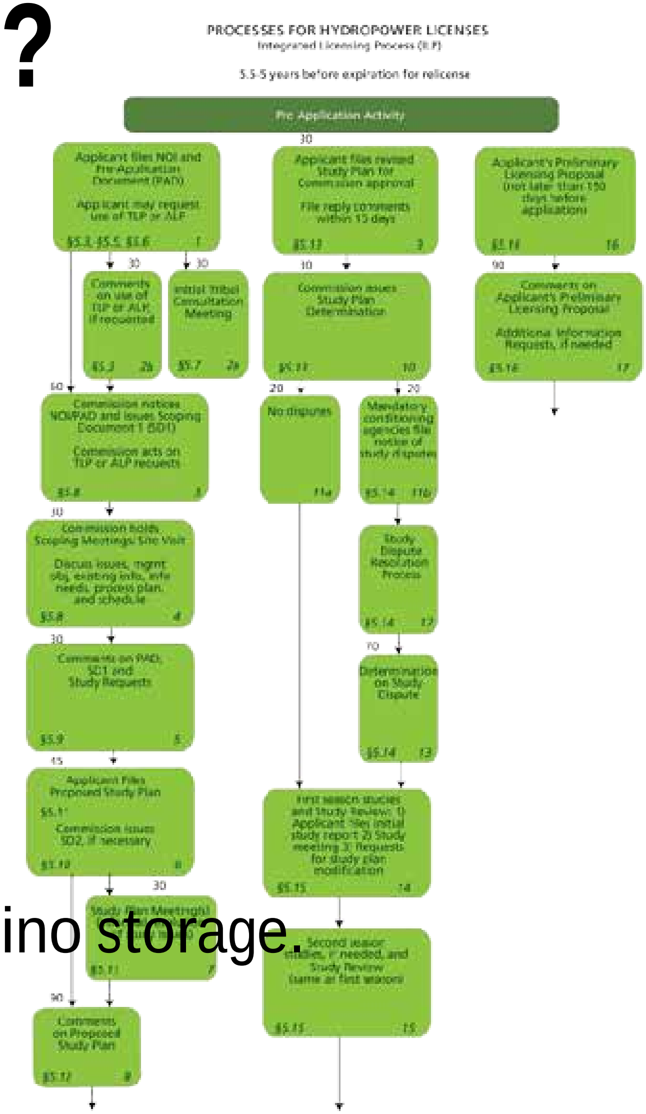

Figure 2.3-1a Integrated Licensing Process (ILP) Pre-Application Activity Flow Chart

PGE's dance

- Started FERC relicensing as scheduled.
- Signaled desire to not own the Eel River dams.
- Feb 22 statement before the Eel Russian River Commission. In two months, to announce:
  - Negotiating deal to **transfer ownership** of the dams; or
  - **Withdraw** notice of intent to relicense; or
  - Continue with **relicensing**.
- No public information about or discussion of potential deal to transfer ownership. But ERRC made it clear they want to make it happen if they can.

Water Rights

Can a purchaser convert PG&E's power water rights into consumptive rights that can be monetized?

Table 4-7 Summary of Existing Water Rights

Appl. No.	License/ Permit No.	SWDU No.	Priority / First Use	Gage	Storage (afa)	Direct Diversion (cfs)	Season		Description (Name of Works)	Point of Diversion	Place of Use	Type of Use	Water Right Class
							Begin	End					
1719	1424	–	3/12/1920	E 1	102,366	–	Nov 1	Jun 1	Lake Pillsbury (Scott Dam)	Eel River	Potter Valley Powerhouse	P, FWL	License
5661	1199	–	8/15/1927	E 1	4,500	–	Nov 1	Apr 30	Lake Pillsbury (Scott Dam)	Eel River	PVID	I	License
6594	5545	–	3/11/1930	E 1	4,908	–	Nov 1	Jun 1	Scott Dam	Eel River	PVID	I	License
				E C6	–	40	May 1	Oct 31	Cape Horn Dam				
–	–	1010	1905	E 16	–	340	–	–	Potter Valley Powerhouse Diversion	Eel River	Potter Valley Powerhouse	P, I	Pre-1914
–	–	4704	1907	E 3	1,457	–	–	–	Van Arsdale	Eel River	Potter Valley Powerhouse and PVID	P, I, D	Pre-1914

Notes:

afa = acre-feet per annum
cfs = cubic feet per second
D = domestic
FWL = fish and wildlife
I = irrigation
P = power
PVID = Potter Valley Irrigation District
SWDU = Statement of Water Diversion and Use

Obstacles to Dam Retention

- Countervailing Rights
- Liabilities
- Dam Safety
- Costs
  - Relicensing
  - Operations and maintenance
- New license unlikely to improve diversion scenario
  - Best case: will further reduce diversions.
  - More likely: fish passage & water quality conditions on new license make it uneconomic.