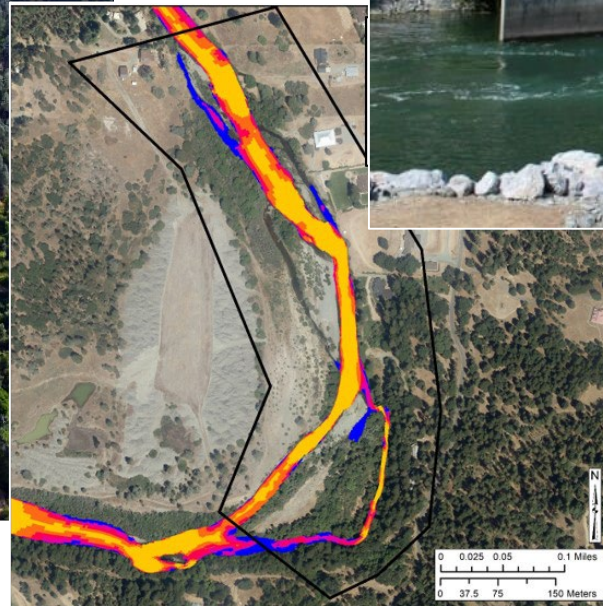


# Trinity River Juvenile Chinook Salmon Habitat Synthesis



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Josh Boyce<sup>2</sup>, Damon Goodman<sup>2</sup>, Nicholas Som<sup>2</sup>, and Justin Alvarez<sup>3</sup>

1. Yurok Tribe Fisheries Department; 2. United States Fish and Wildlife Service; 3. Hoopa Valley Tribe Fisheries Department

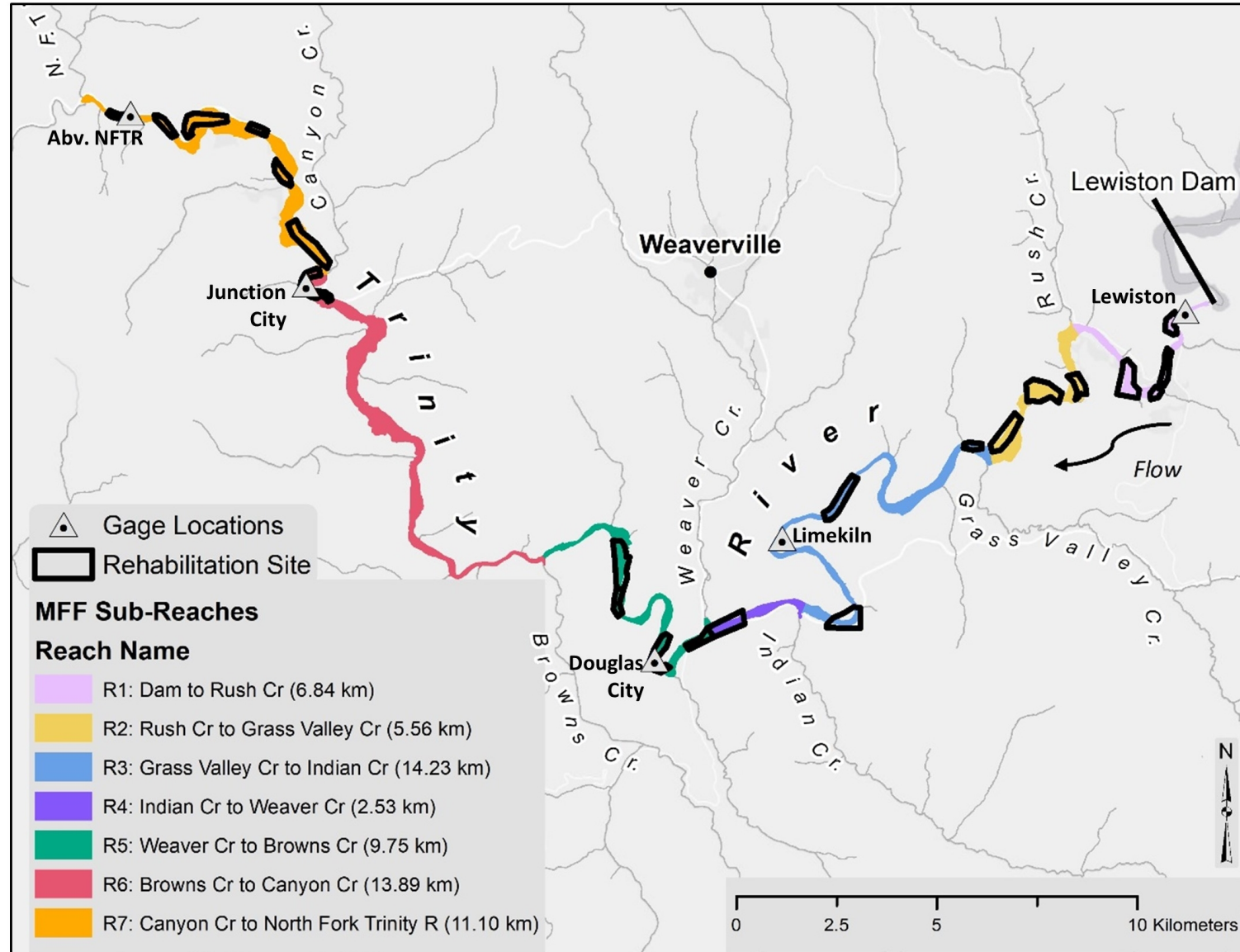
# Objectives

- 1: Evaluate habitat capacity in rehabilitated vs non-rehabilitated areas
- 2: Evaluate habitat capacity between rehabilitation sites
- 3: Evaluate physical metrics related to habitat capacity
- 4: Evaluate capacity related to flow frequency and duration

# Methods Overview

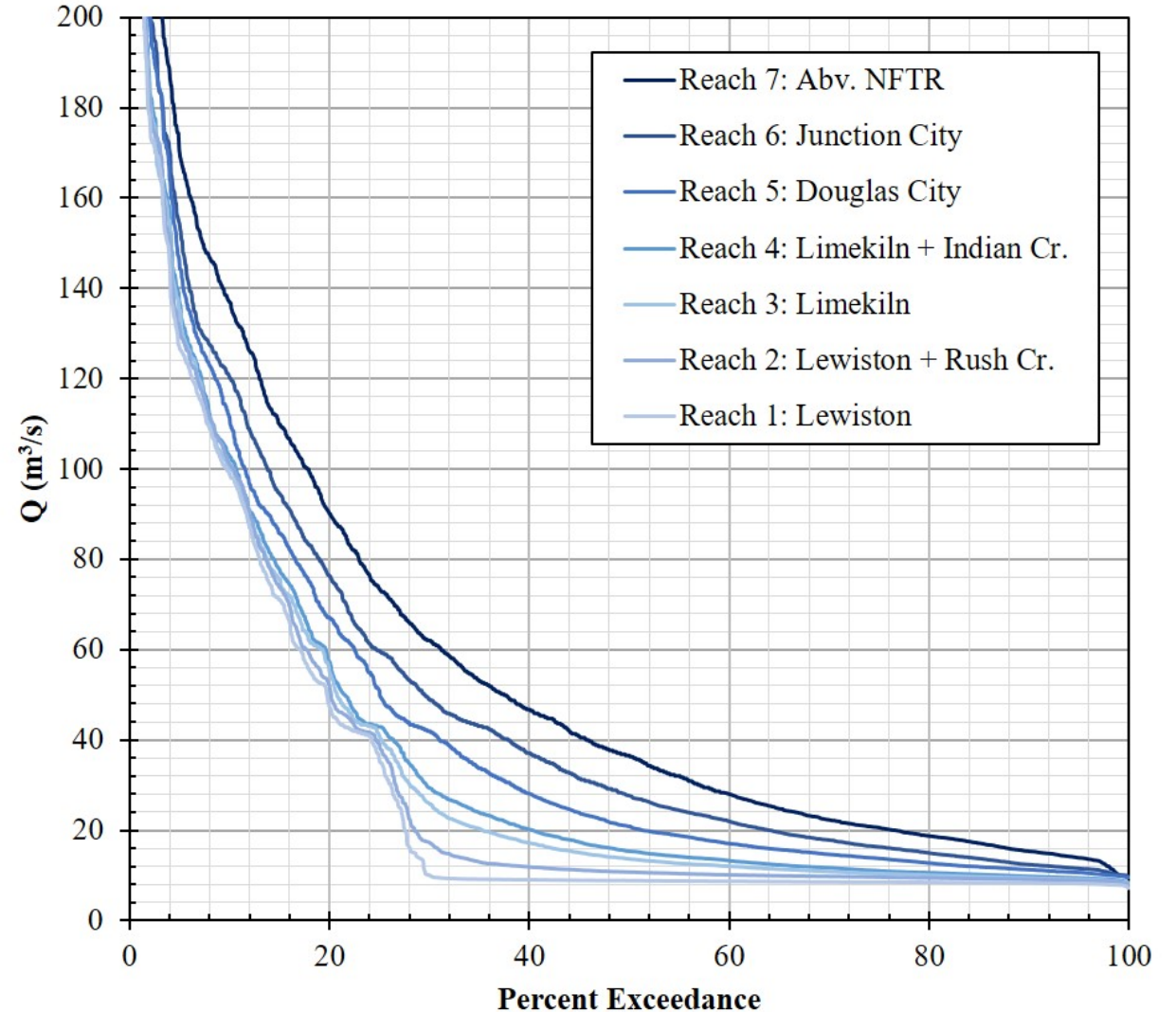
- Capacity model (Som et al. 2018) provides estimates for number of fish; we used model output in a GIS with tools developed by Nate Bradley
- Identify range of flows for capacity evaluation
- Identify reaches for evaluation
- Evaluate habitat capacity

# Study Area: Trinity River Restoration Reach



# Determining the range of $Q$ for evaluating $C$ in the Study Area

- Rearing Period: Jan 1 – May 31
- Exceedance probability of 99.1 cms is 9 – 18% throughout the restoration reach
- Determined flow range of 4.2 – 99.1 cms for evaluating capacity among MFF reaches



# Comparing $C$ across $Q$ with Integrated Area Under the Curve

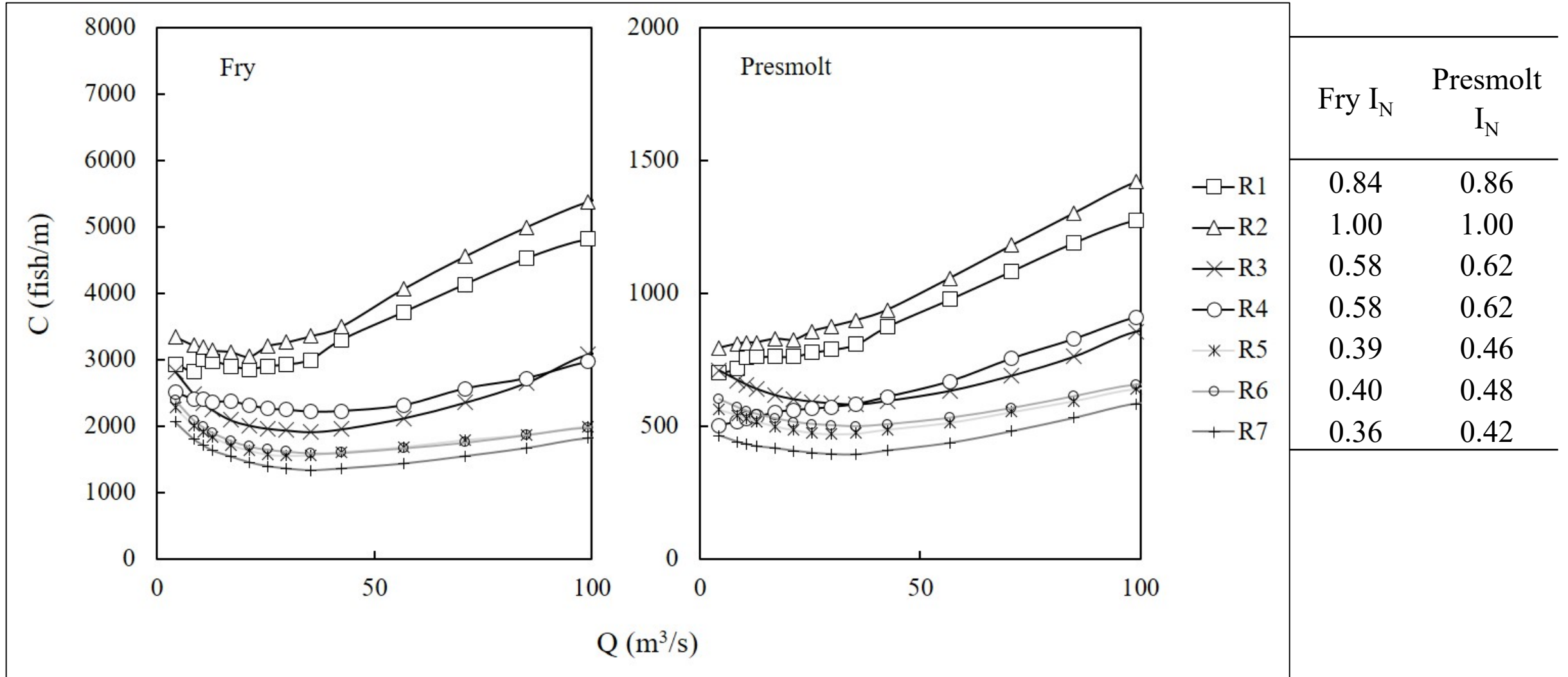
- Integrated Area Under the Curve ( $I$ ) to compare  $C$  to  $Q$  among reaches and sites

$$I = \int_{4.2}^{99.1} C dQ$$

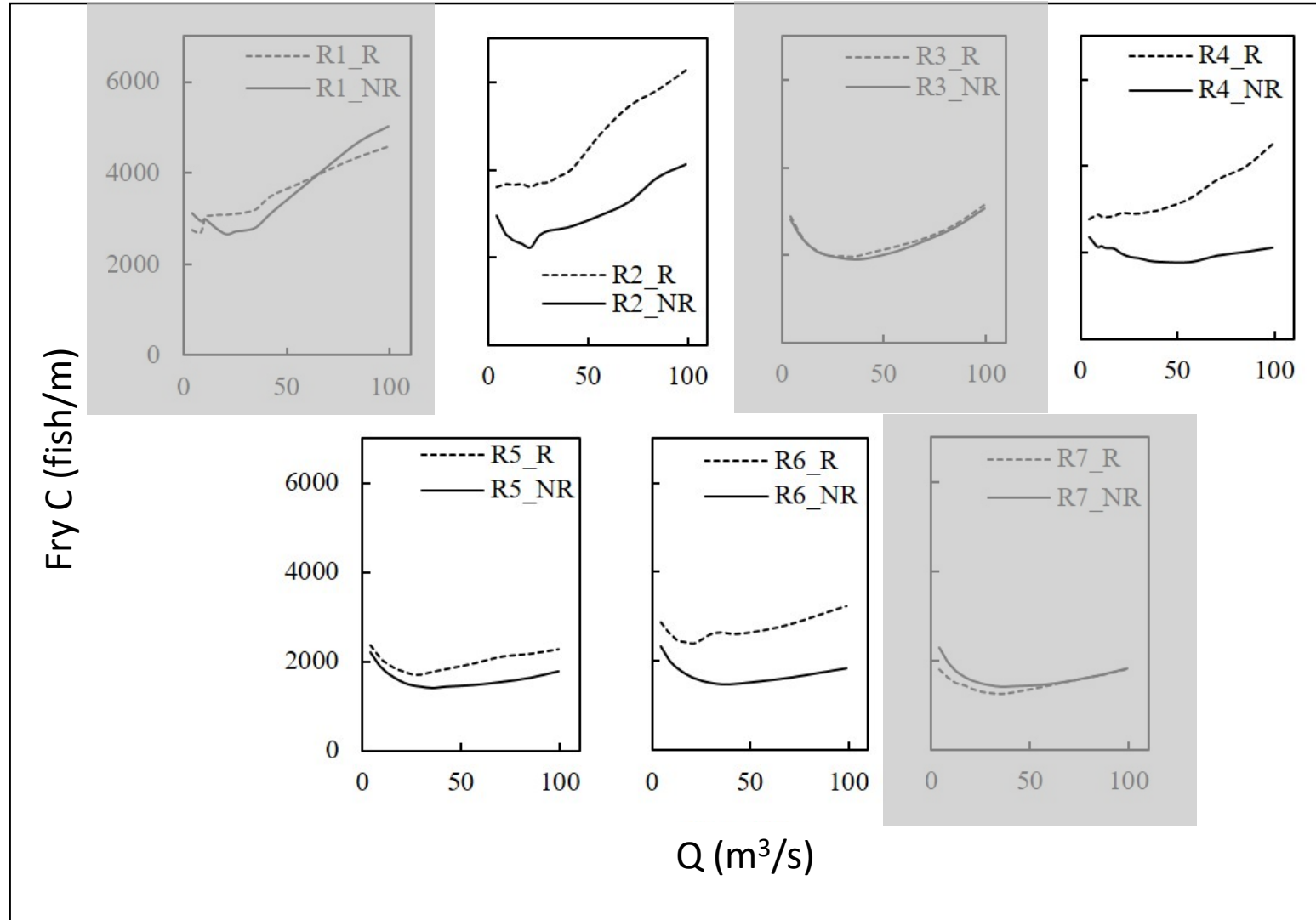
- Normalized  $I$  by dividing all  $I$  values by the greatest  $I$  value ( $I_{max}$ ) among reaches or sites

$$I_N = I / I_{max}$$

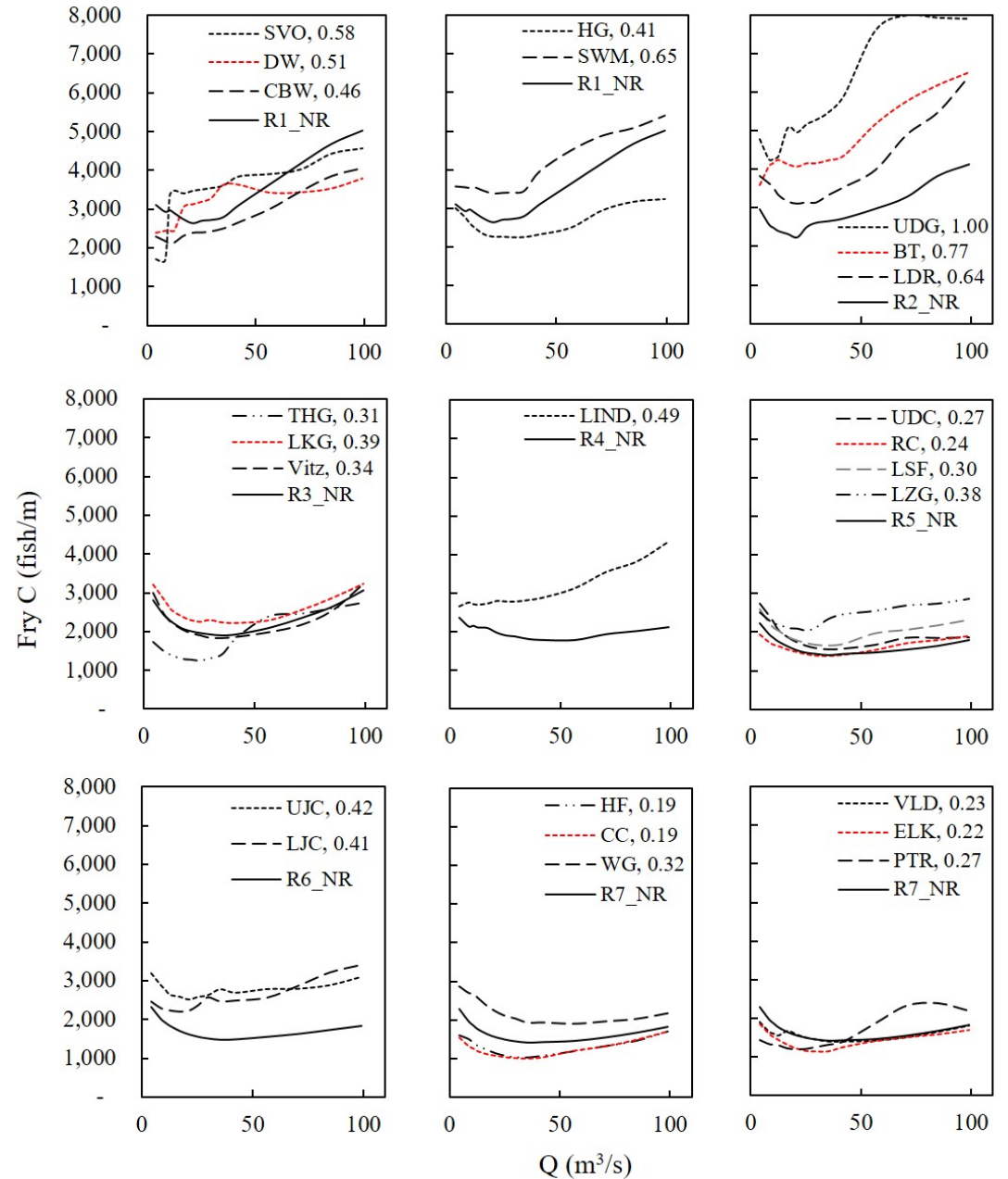
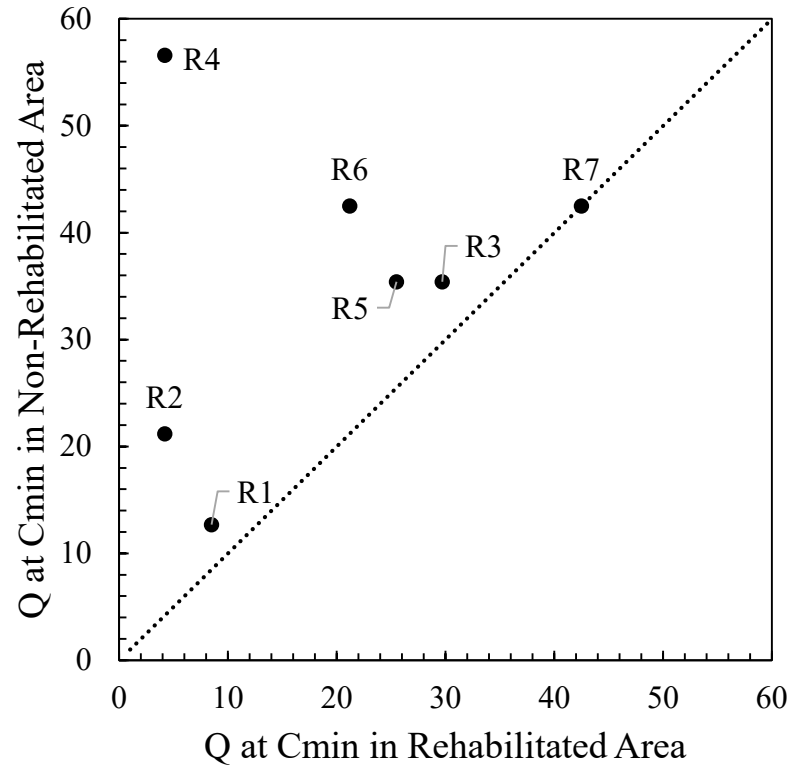
# Objective 1: Reach-scale Capacity ( $I_N$ )



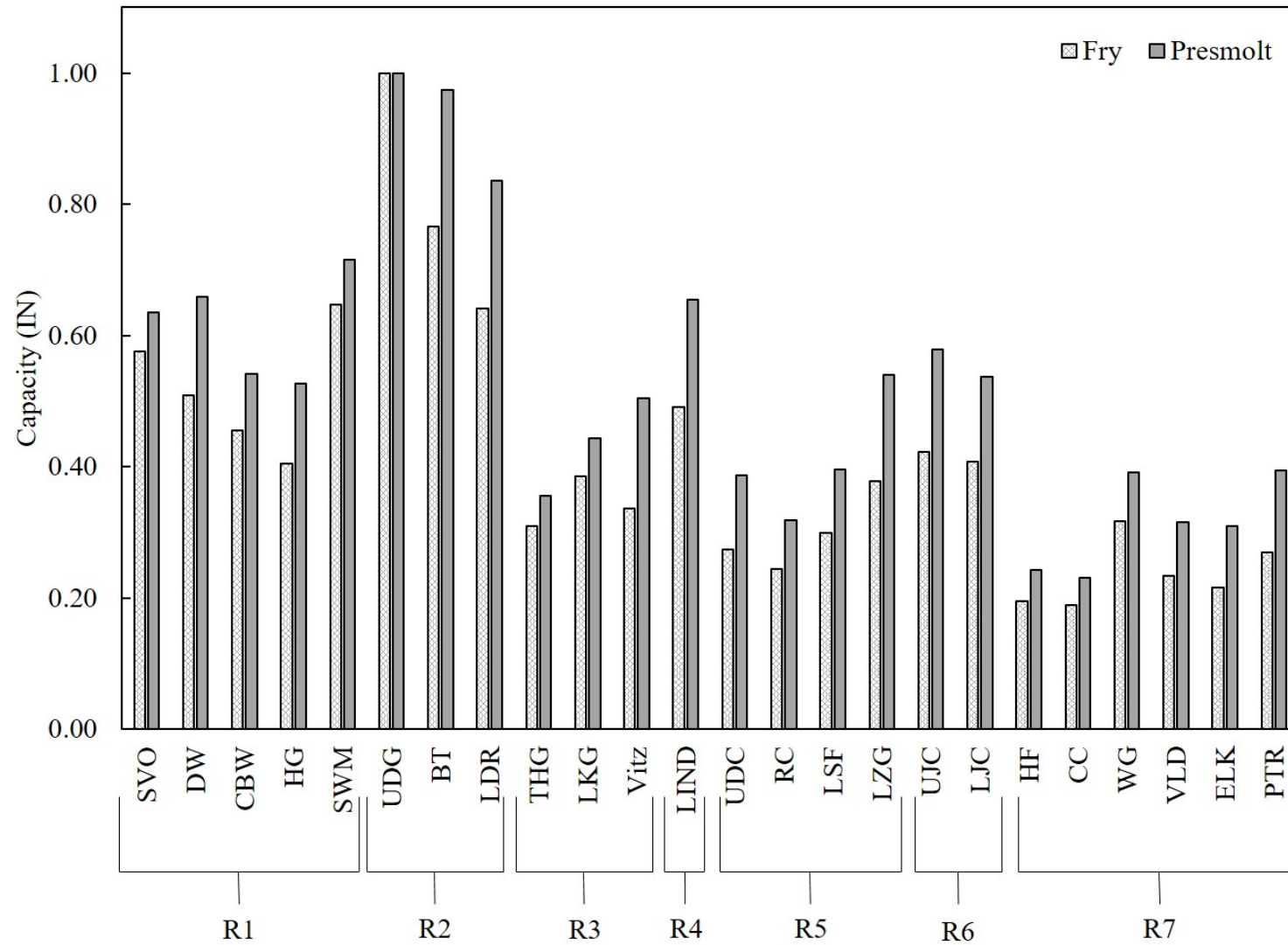
# Objective 1: Rehabilitated vs Non-Rehabilitated



# Objective 2: Minimum Capacity( $C_{min}$ ) in rehabilitation areas



# Objective 2: Site-scale Capacity ( $I_N$ )



# Objective 3: Physical Metrics Linked to Habitat Capacity

- Topographic variability within the channel

$$R^* = [(h_{75} - h_{25}) + (h_{90} - h_{10})] / (h_{90} + h_{10})$$

$$h_x = \text{depth percentile at the reference discharge } Q_R = 56.6 \text{ m}^3/\text{s}$$

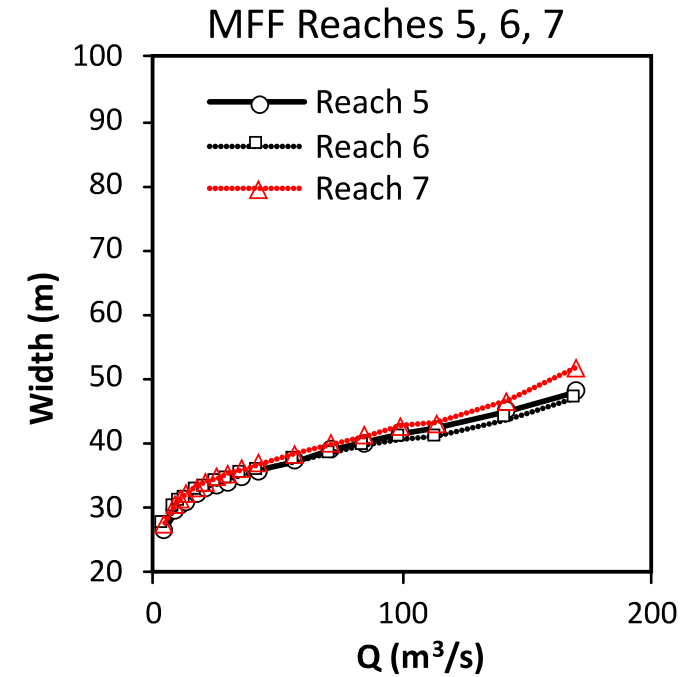
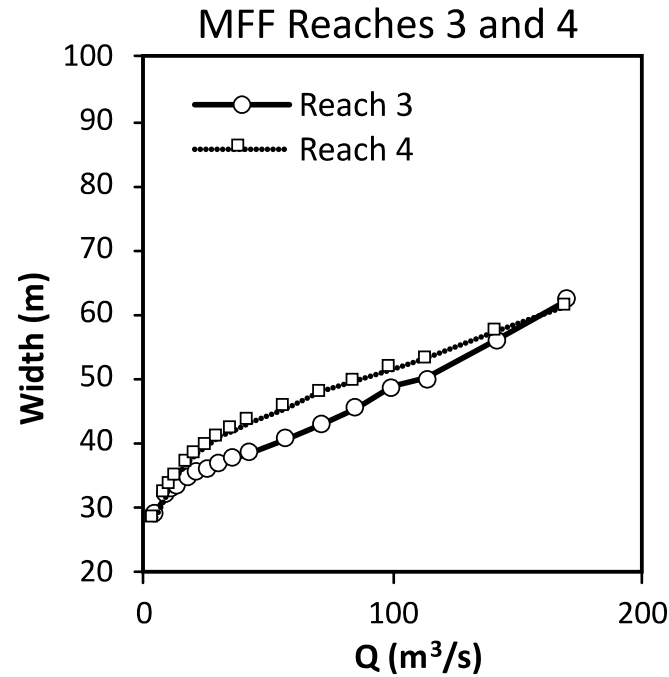
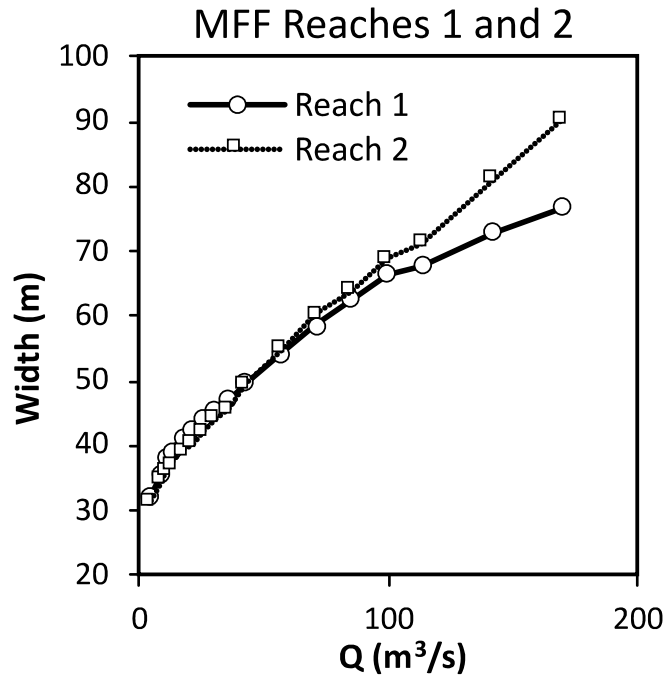
- Mean wetted width as function of discharge

$$W = f(Q); \quad I_{WR} = \int W dQ \quad (Q = 4.2 \text{ m}^3/\text{s to } Q_R)$$

- Compare to habitat variables

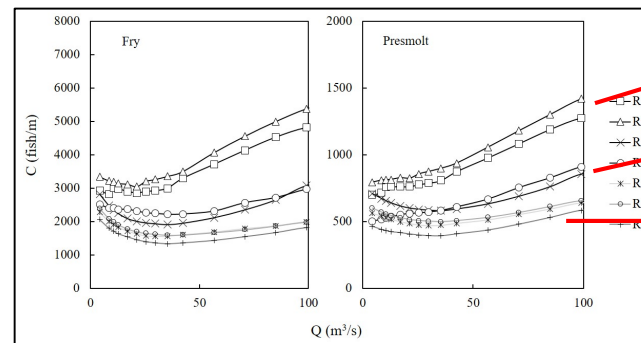
$$C_R = C \text{ at } Q_R; \quad I_R = \int C dQ \quad (Q = 4.2 \text{ m}^3/\text{s to } Q_R); \quad P_0 \text{ (fraction of bed with cover at } Q_R)$$

# Wetted Width ( $W$ )



Reach-averaged wetted width to  $Q$  curves for  $Q = 4.2$  through  $170 \text{ m}^3/\text{s}$  in MFF reaches.

Spatial differences in  $W$  curves mirror differences in  $C$  curves presented earlier.

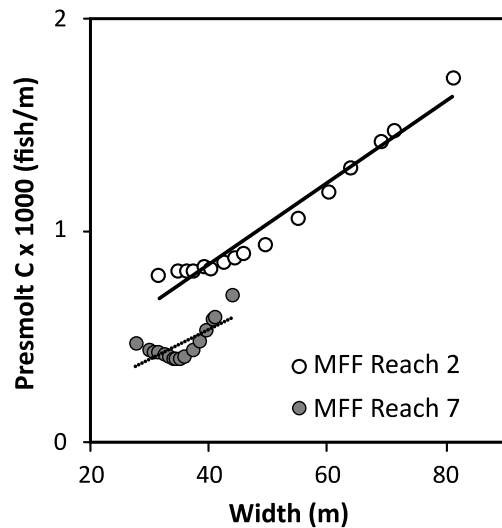
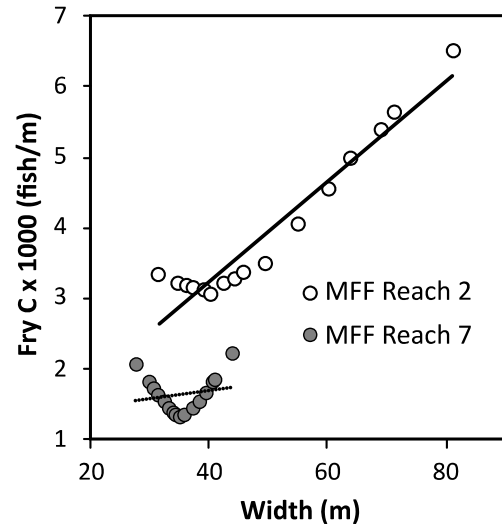


Reaches 1 and 2

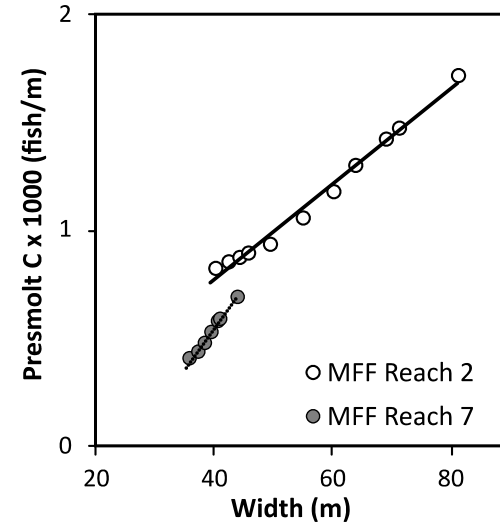
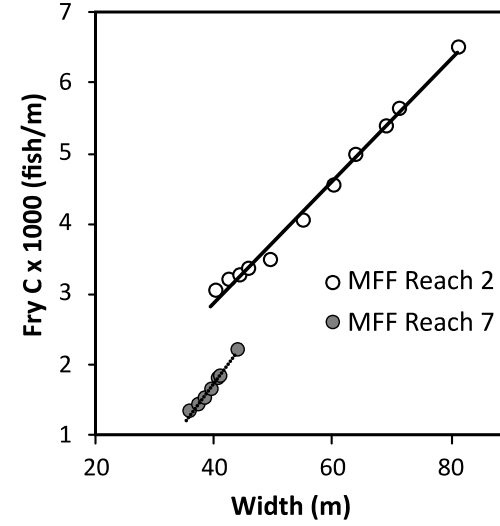
Reaches 3 and 4

Reaches 5, 6, and 7

# Relationship of $W$ to the Habitat Dip

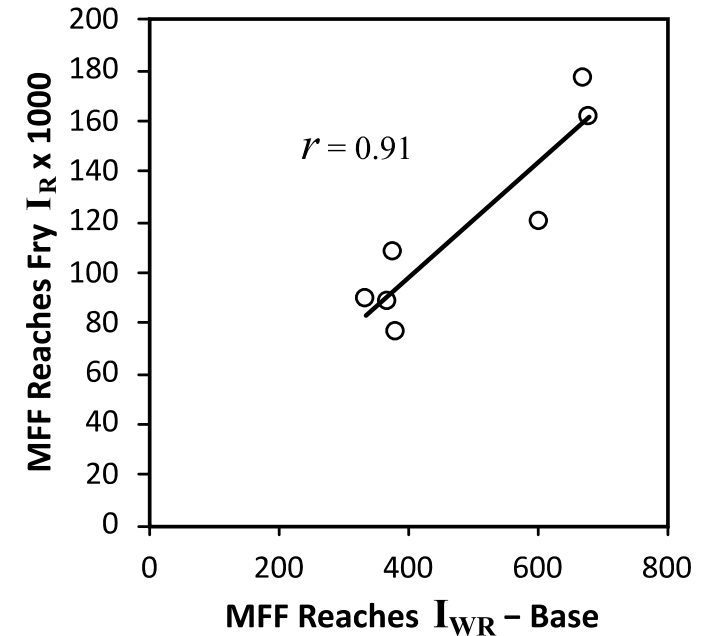
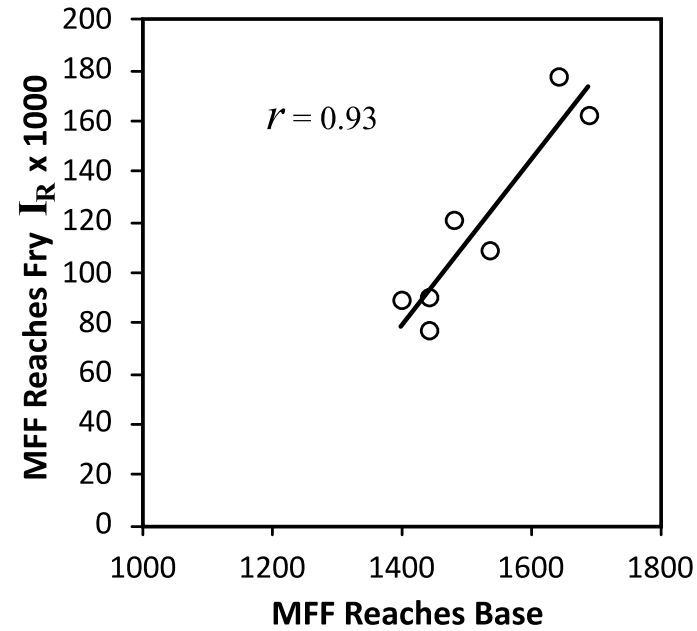
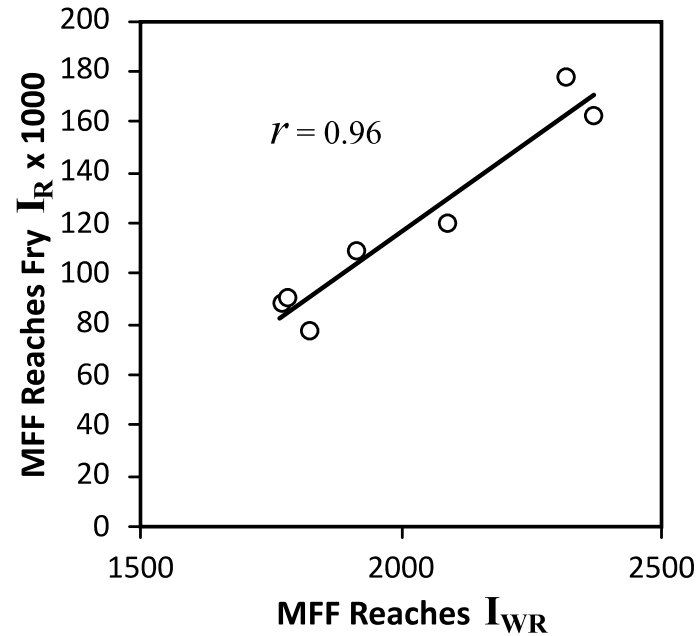


$W$  has no “dip”



$C$  scales with  $W$  to right of the dip

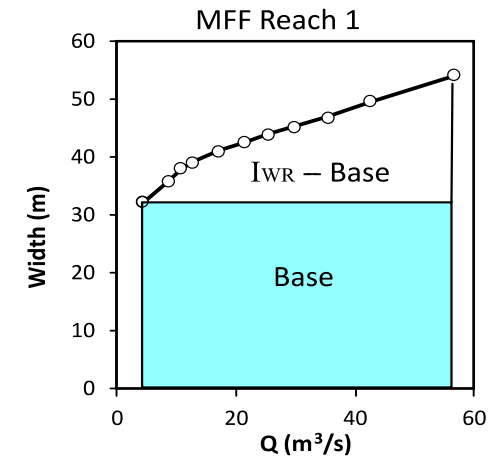
# Integrated Wetted Width ( $I_{WR}$ )



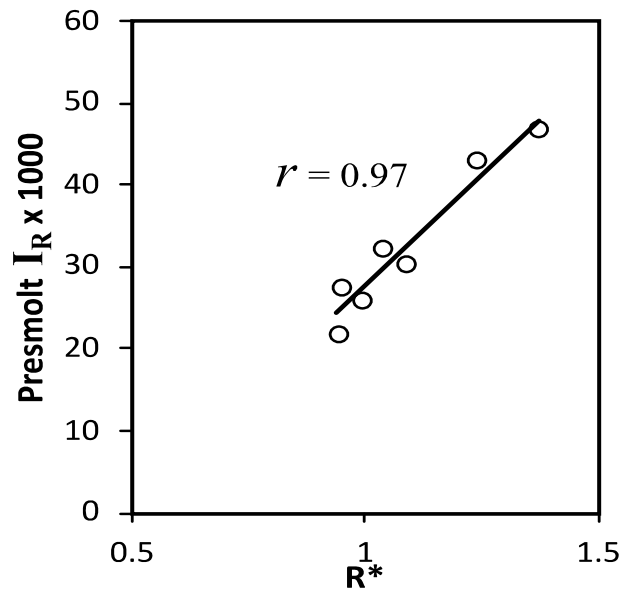
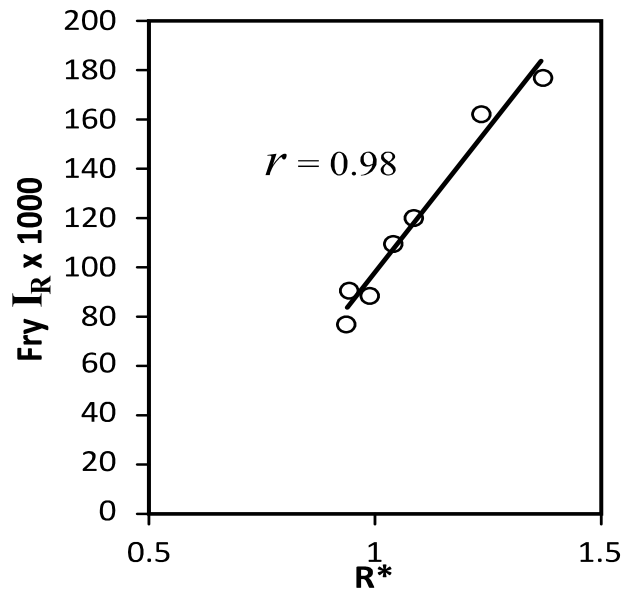
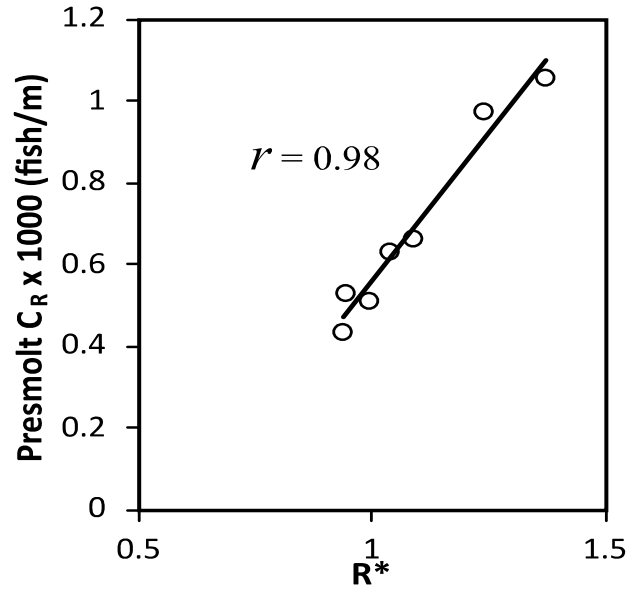
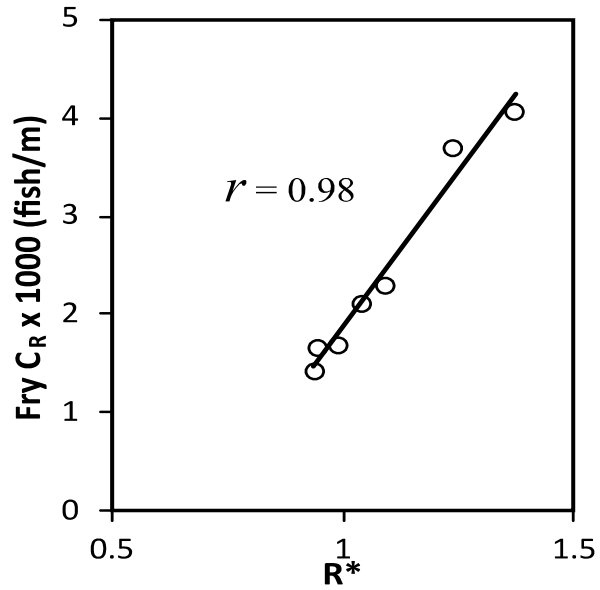
$I_R$  as function of integrated wetted width ( $I_{WR}$ ) in MFF reaches.

Graphs correspond to:

- Total  $I_{WR}$  (left);
- Base = the basal rectangle (center);
- Area above the basal rectangle (right)



# Topographic Complexity ( $R^*$ )



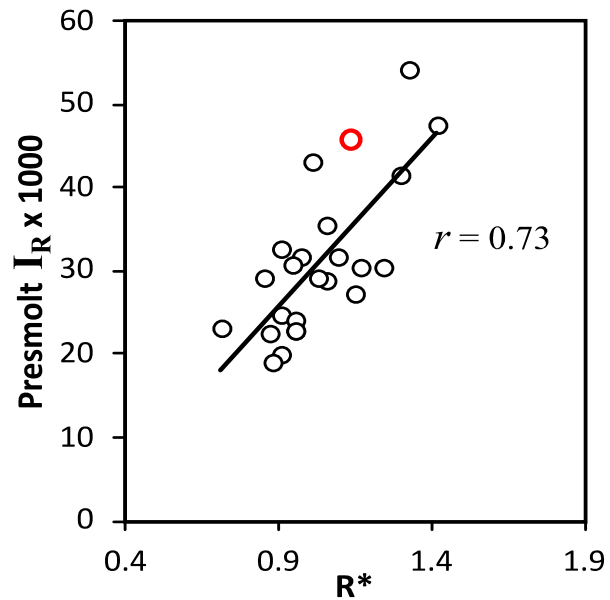
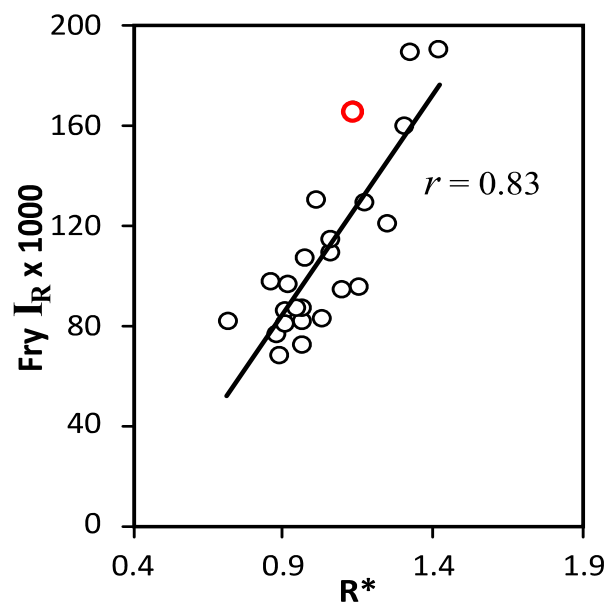
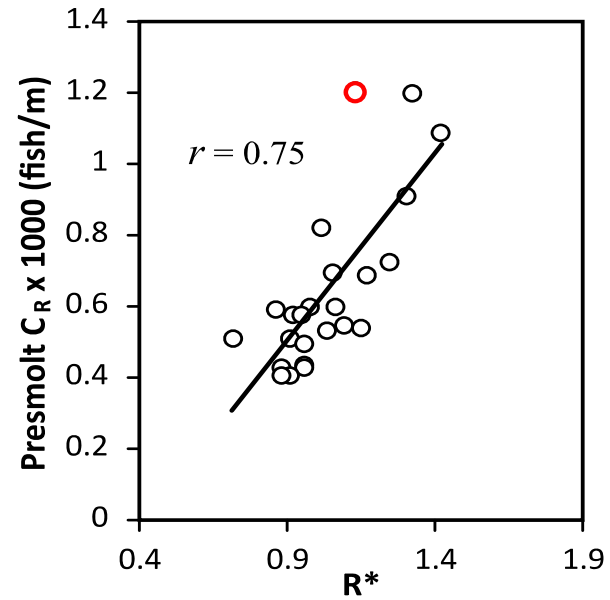
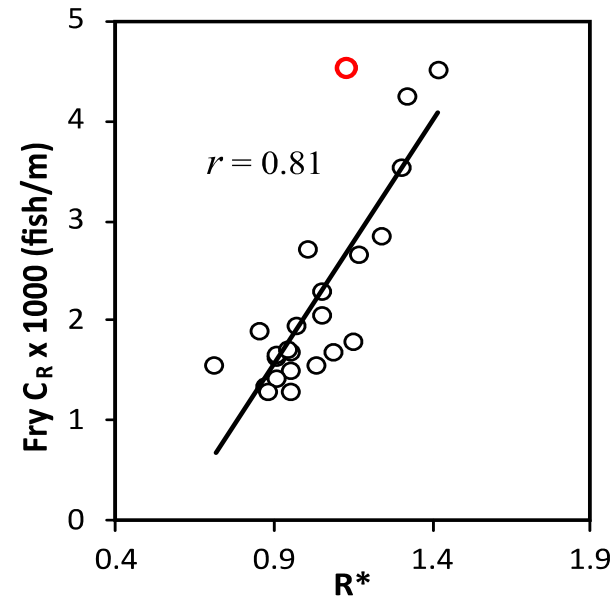
$C_R$  (top) and  $I_R$  (bottom) as functions of  $R^*$  computed for the 7 MFF reaches.

# Elements of Complexity and Habitat Quality

Pearson's correlation coefficient for relations between complexity metrics and variables involved in the computation of  $C$ .

Dependent Variable	$P_0$	<u>Independent Variable</u>	
		Mean Depth	Mean Velocity
$R^*$	0.96	-0.85	-0.94
$I_{WR}$	0.93	-0.93	-0.96
$P_0$	--	-0.99	-0.79

# Spatial Scale Matters for Complexity Metrics

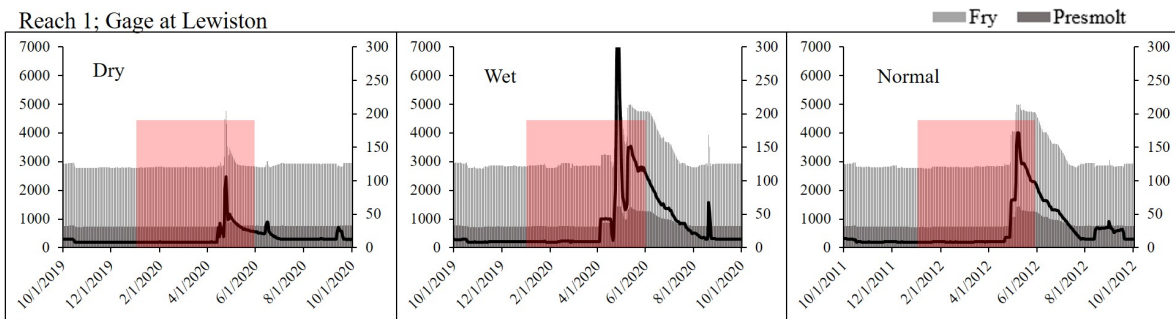


$C_R$  (top) and  $I_R$  (bottom) as functions of  $R^*$  computed for the 24 RC reaches defined by Gaeuman et al. (2016).

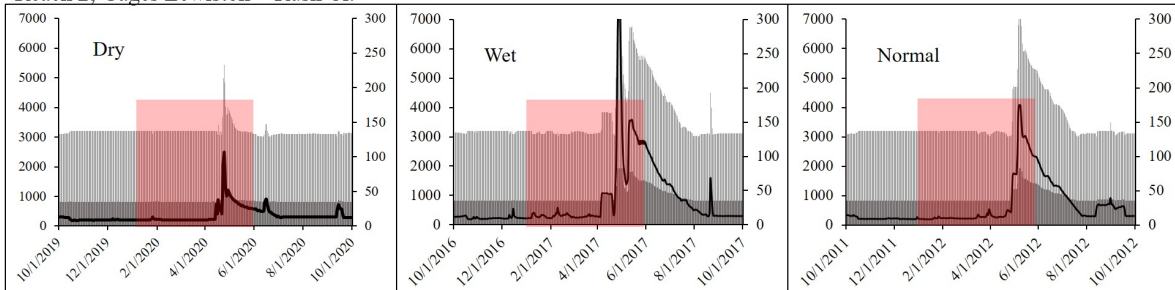
Correlations between either capacity measure and IWR are also weaker for the shorter RC reaches.

# Objective 4: C and hydrographs

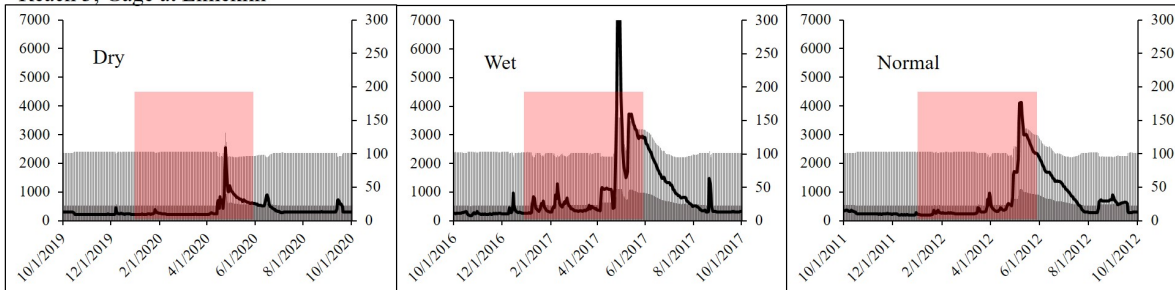
Reach 1; Gage at Lewiston



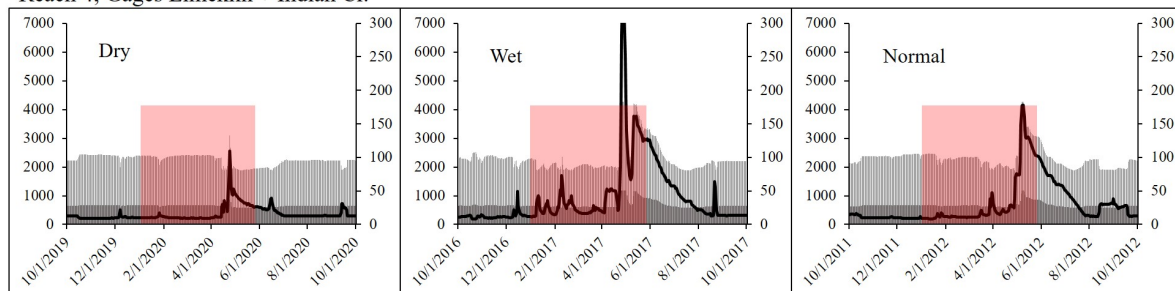
Reach 2; Gages Lewiston + Rush Cr.



Reach 3; Gage at Limekiln

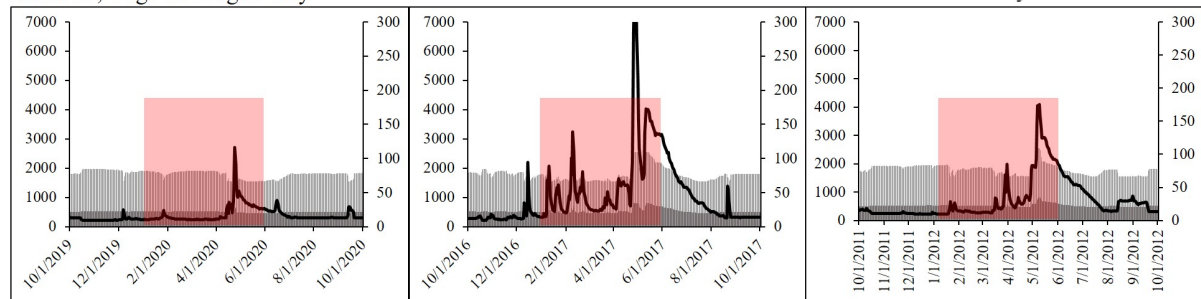


Reach 4; Gages Limekiln + Indian Cr.

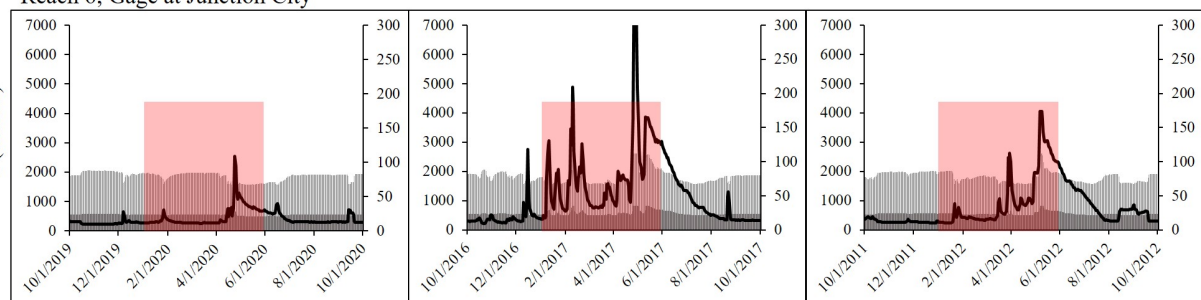


Date

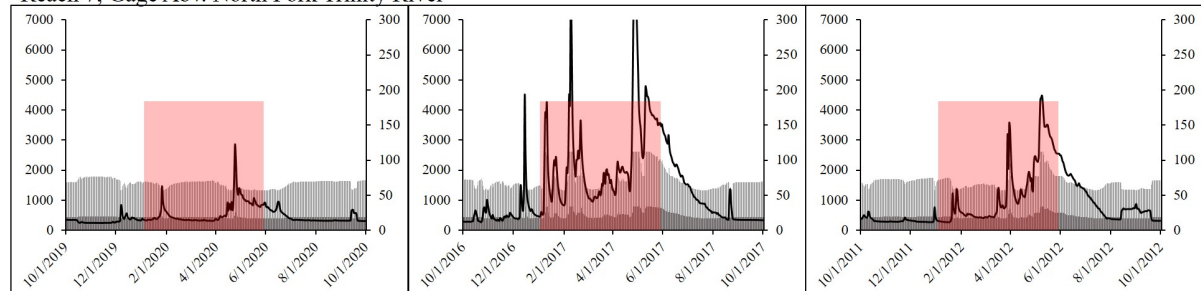
Reach 5; Gage at Douglas City



Reach 6; Gage at Junction City



Reach 7; Gage Abv. North Fork Trinity River



Date

(sum) Q

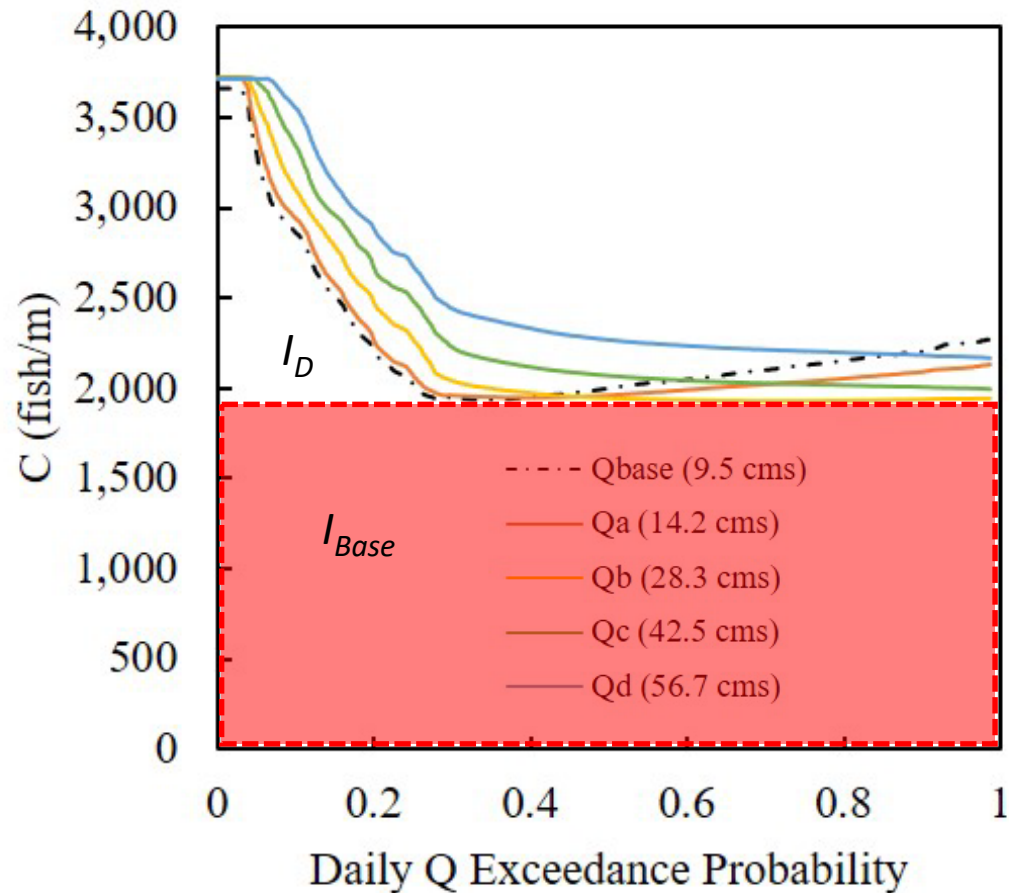
(sum) Q

C (fish/m)

C (fish/m)

(sum) Q

# Objective 4: C in response to elevated baseflows



Increased area from minimum  $I_{Base}$  value among curves

Baseflow Alternative	$Q$ (m <sup>3</sup> /s)	% Change in $I_D$
$Q_{base}$	9.5	10%
$Q_a$	14.2	0%
$Q_b$	28.3	1%
$Q_c$	42.5	50%
$Q_d$	56.7	119%

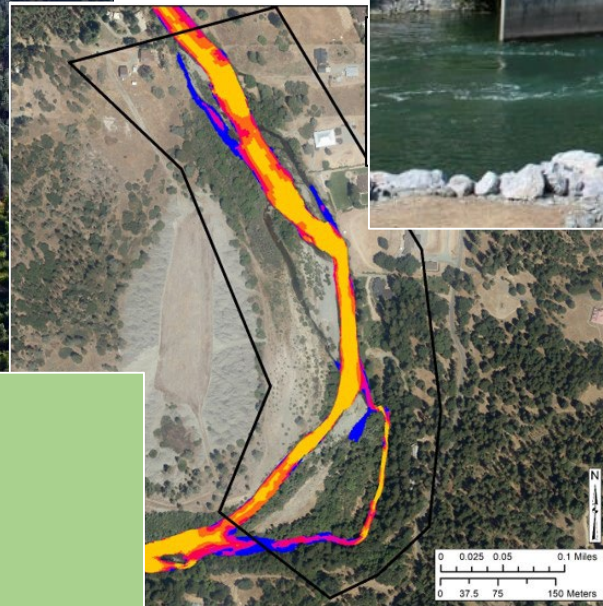
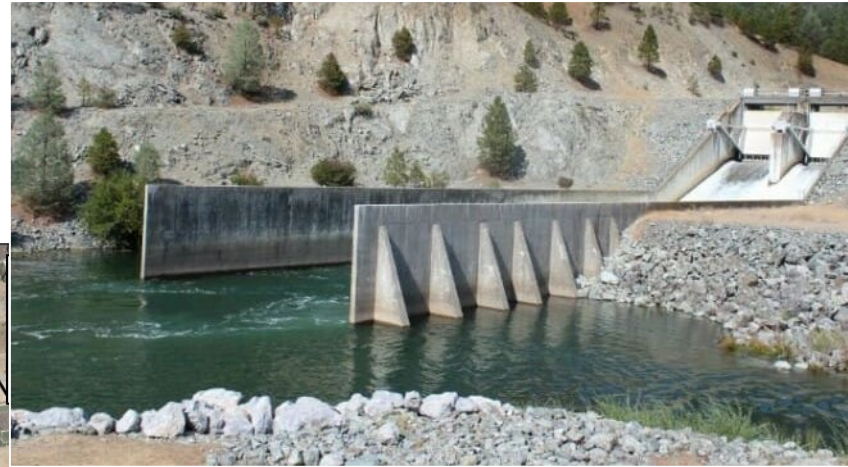
# Summary of Findings

- Flow management and accretionary flows can create bottlenecks in capacity.
- Bottlenecks due to channel confinement exist in downstream reaches.
- Greater wetted widths provide more capacity across all flows.
- Topographic variability influences capacity at low flows.
- Topographic variability, wetted width, and abundance of cover elements vary together and contribute to capacity.
- Rehabilitation sites with the greatest capacity have elevated  $C_{min}$  at lower flows and greater wetted width at low to mid-range flows.
- Rehabilitation has increased capacity, but impacts are differential among reaches.

# Recommendations

- Continue using massive datasets in extensive ways. Several issues in existing data were corrected through this process.
- Restoration efforts and juvenile habitat assessments focus on features inundated at  $\leq 99.1$  cms with ecologically significant flow duration inundations.
- Focus on increasing wetted width in downstream reaches.
- Evaluate sites built since 2017 in Reach 6.
- Evaluate physical metrics ( $R^*$  and  $W$ ) as guides for habitat design and assessment.
- Manage flows to increase capacity during the rearing period.
- Continue capacity evaluations for quantifying changes over time.
- Evaluate fish use in lotic and lentic environments and with other variables.

# Acknowledgements

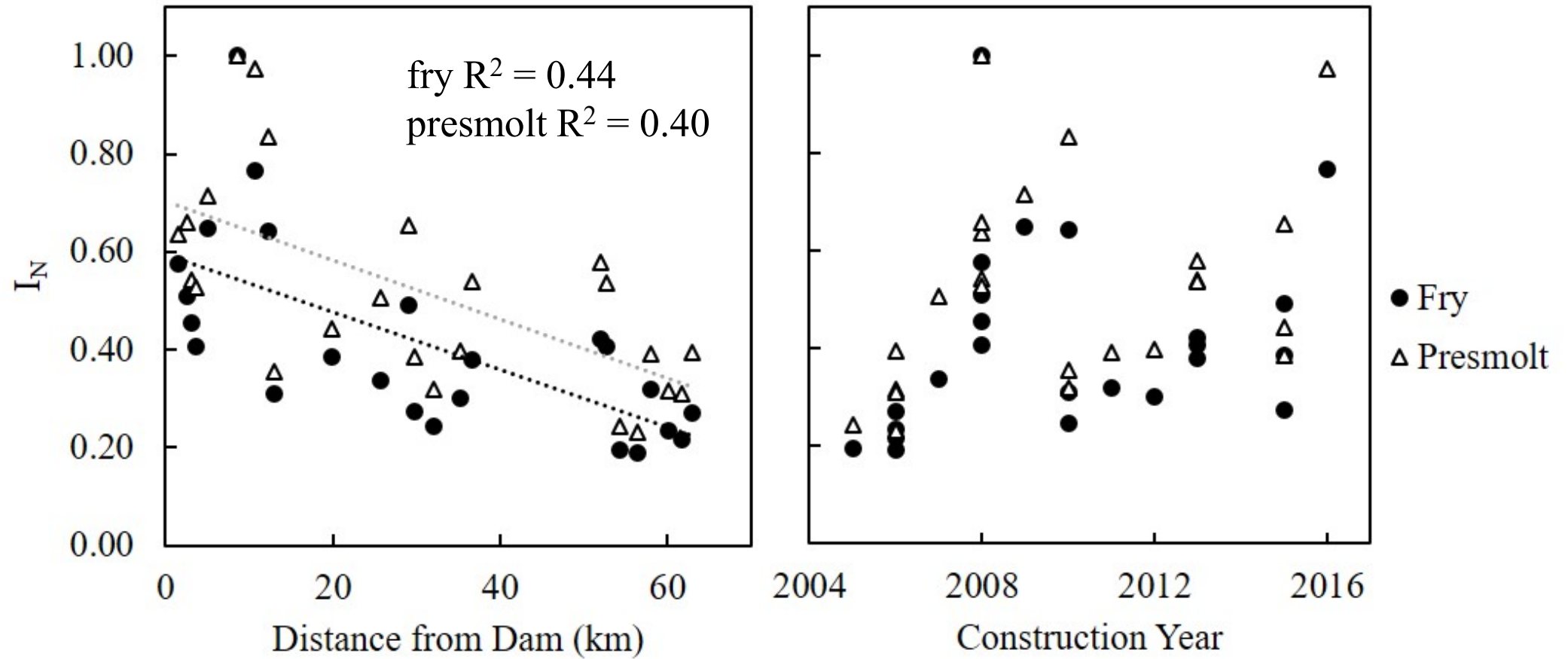


- *TRRP*
- *Reviewers*
- *Nate Bradley*





# Objective 2: Exploring relationships of Capacity at sites



# Objective 4: $C$ with respect to flow durations

