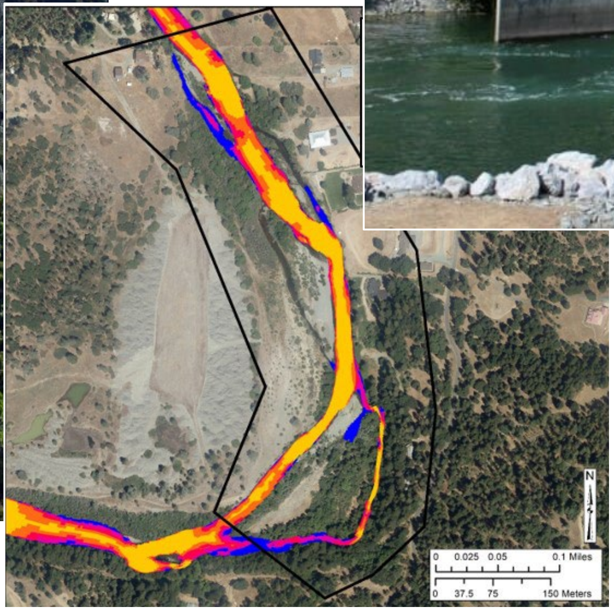
Trinity River Juvenile Chinook Salmon Habitat Synthesis



Emily Cooper-Hertel[1], David Gaeuman[1], Kyle DeJulio[1], Aaron Martin[1],
Josh Boyce[2], Damon Goodman[2], Nicholas Som[2], and Justin Alvarez[3]

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

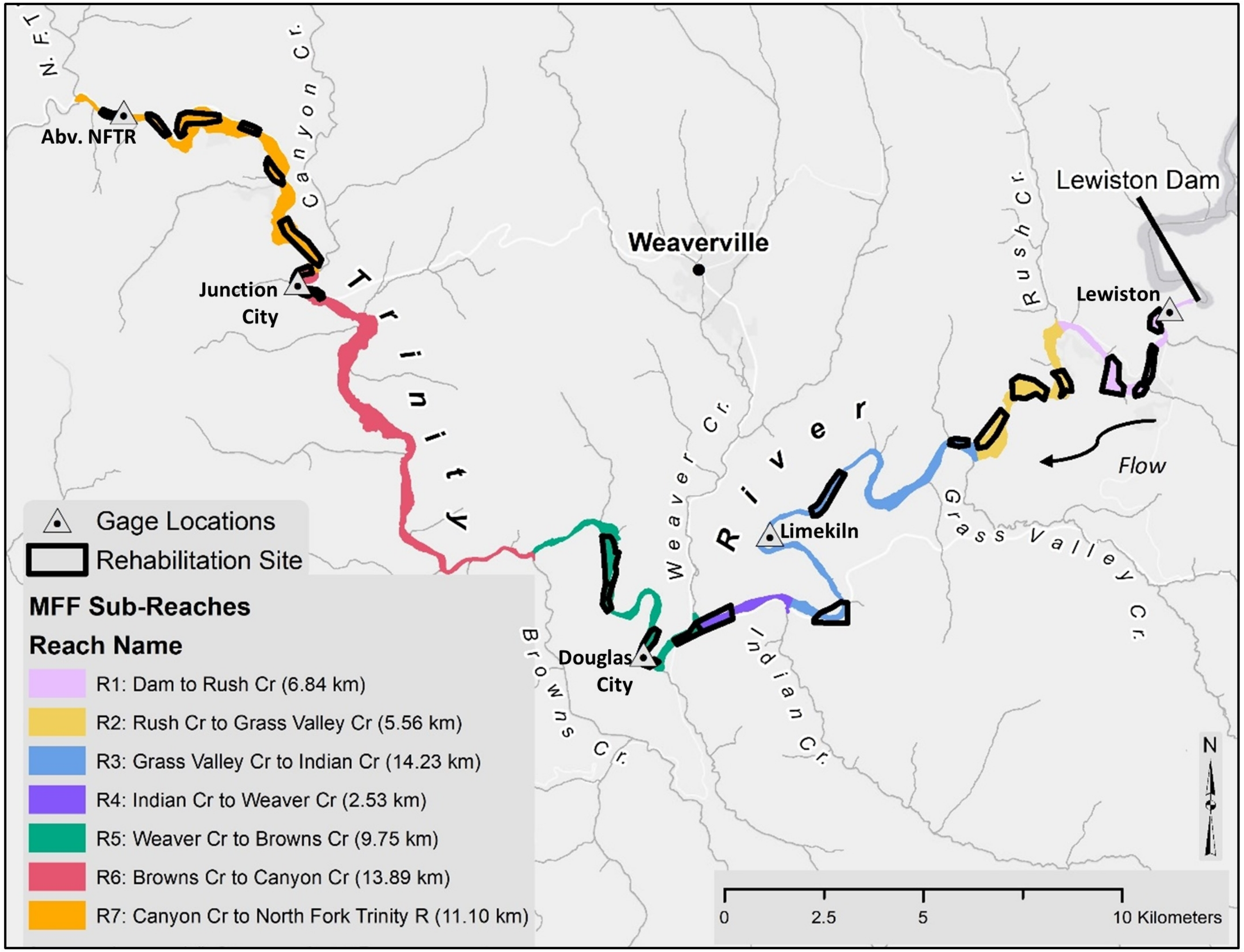
Objectives

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

Methods Overview

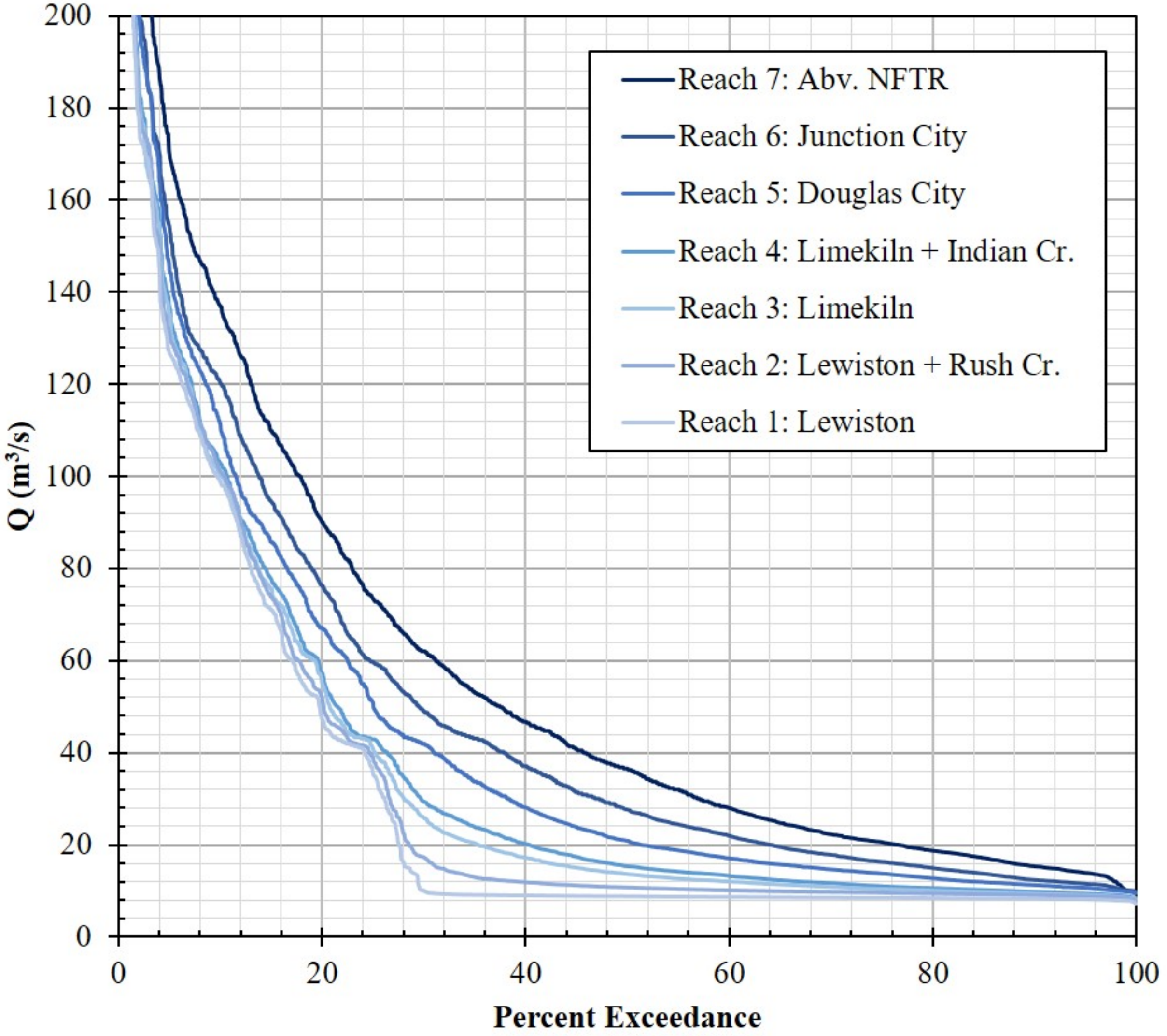
- Capacity model (Som et al. 2018) provides estimates for number of fish; model output was used in a GIS with tools developed by Nate Bradley
- Identify range of flows for capacity evaluation
- Identify reaches for evaluation
- Evaluate habitat capacity

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

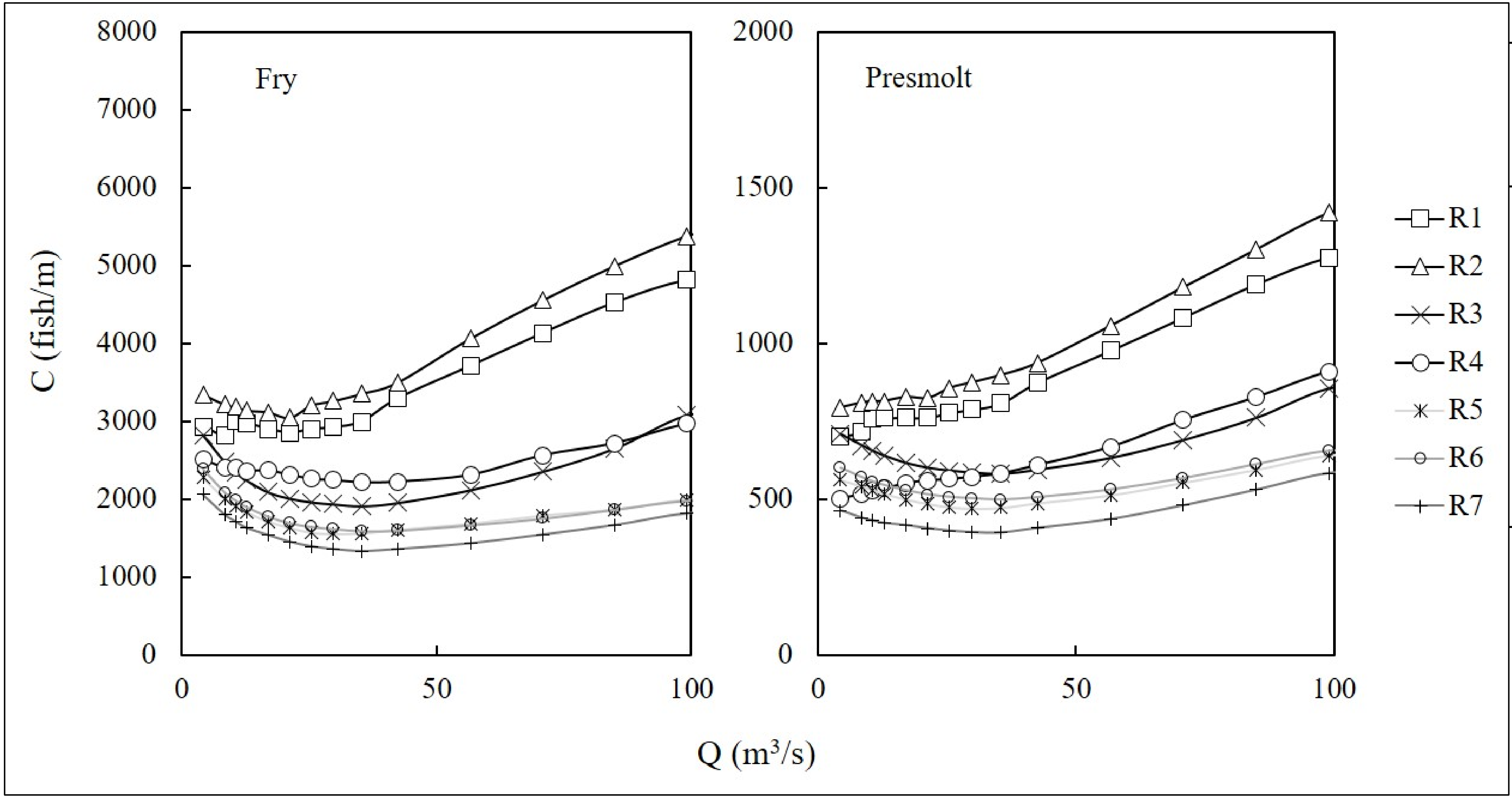
- Integrated Area Under the Curve (I) to compare C to Q among reaches and sites

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

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

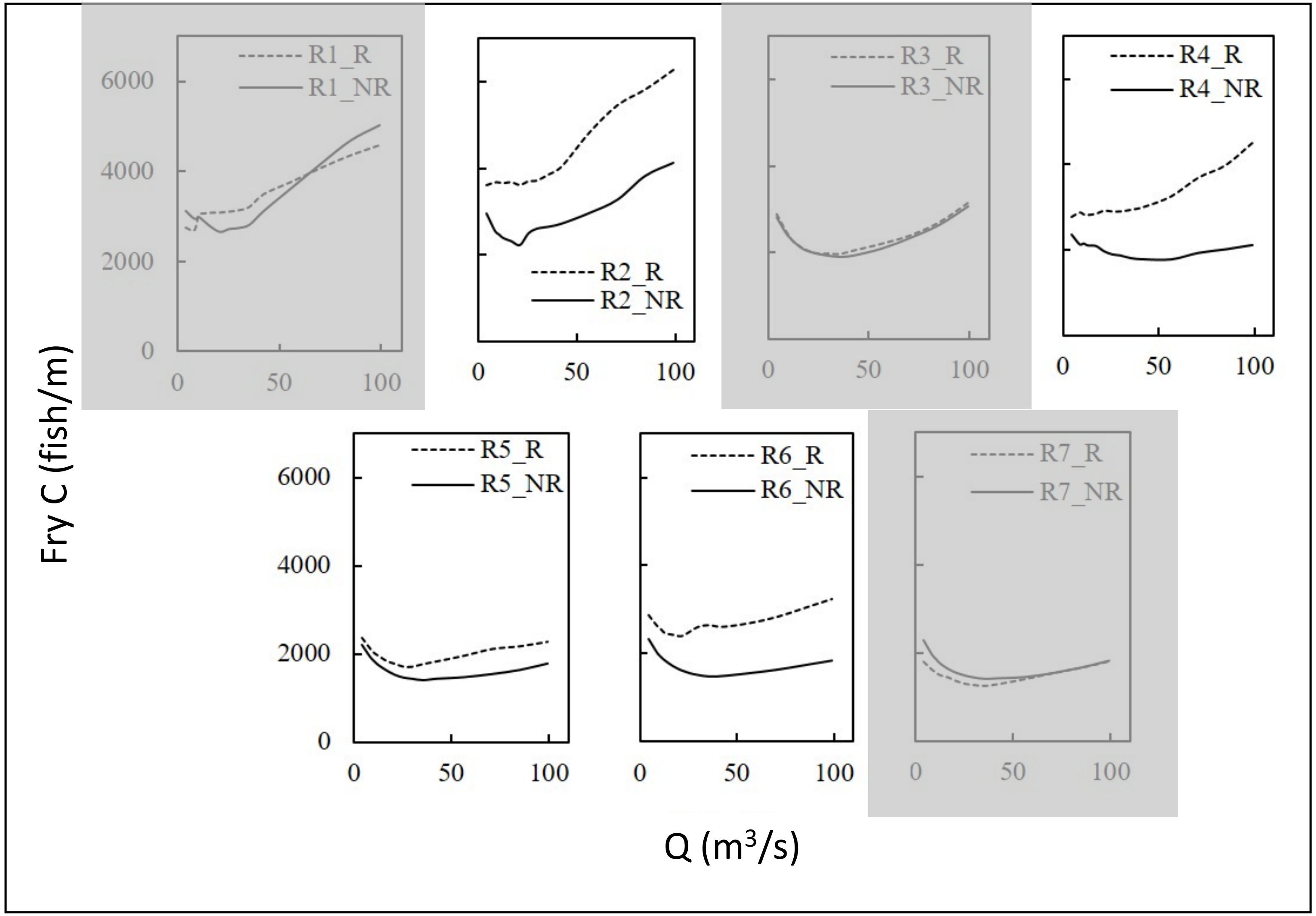
$$I_N = I \,/\, I_{max}$$

Objective 1: Reach-scale Capacity (I_N)

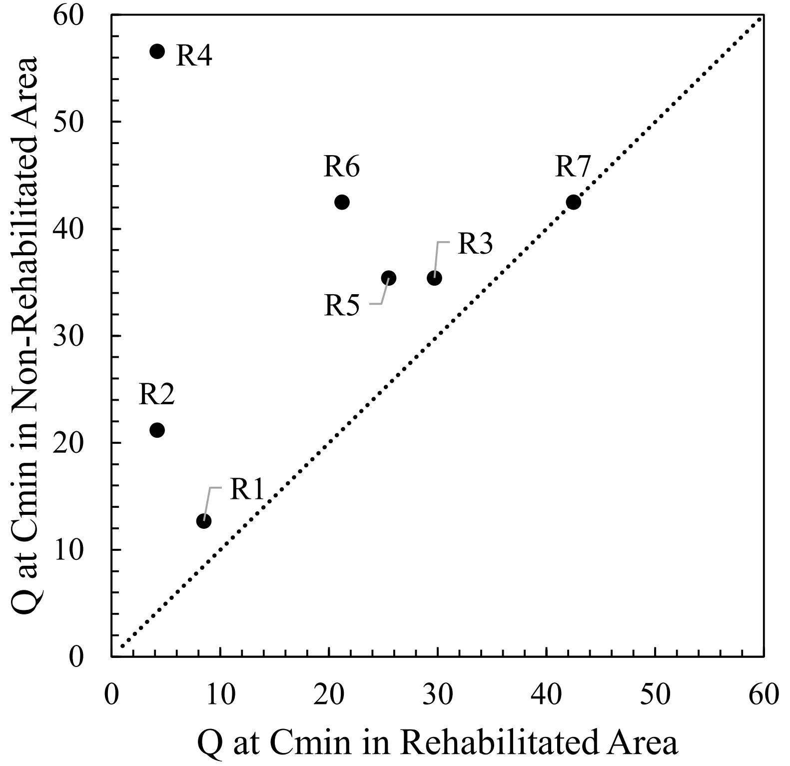


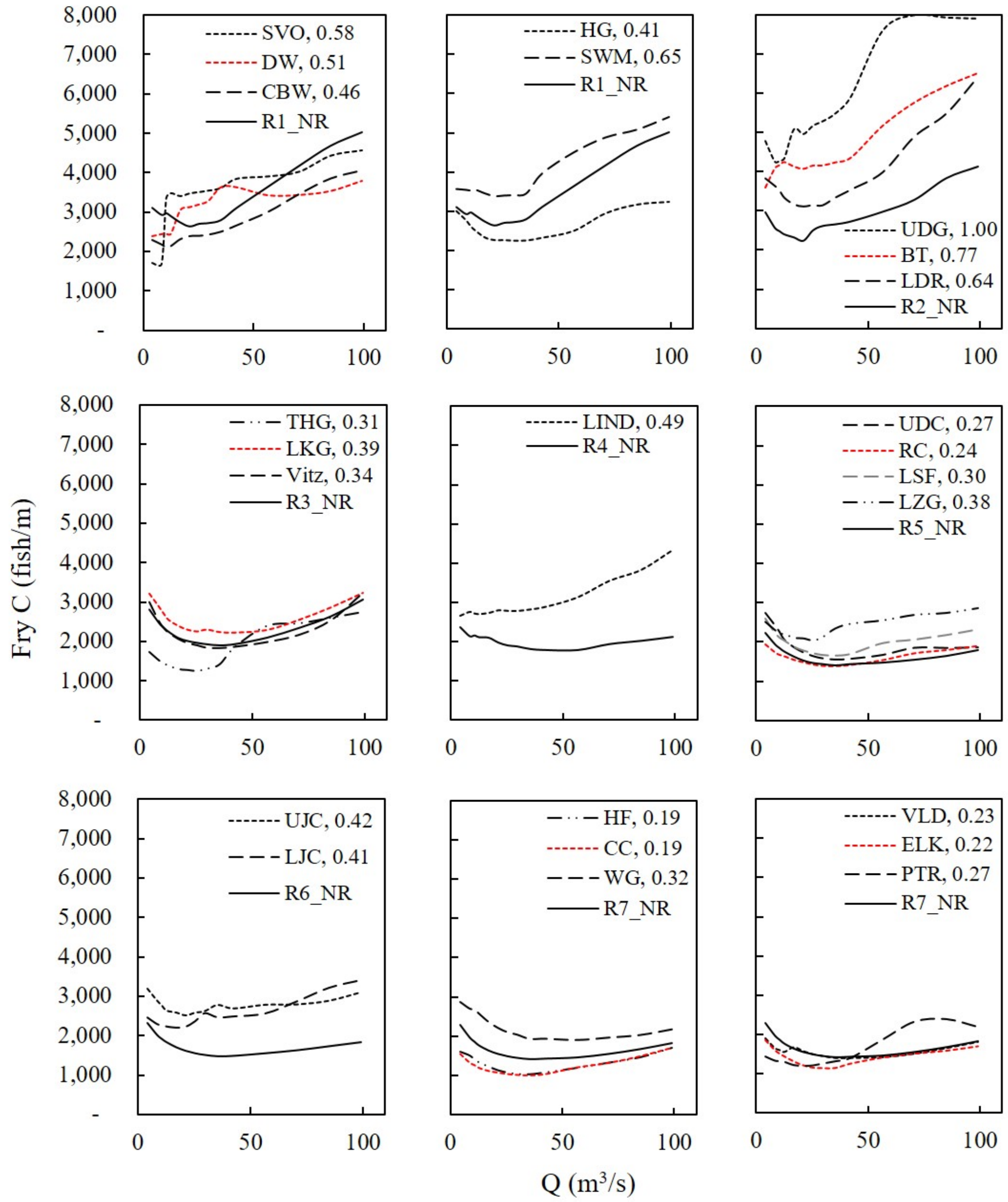
	Fry I_N	Presmolt I_N
R1	0.84	0.86
R2	1.00	1.00
R3	0.58	0.62
R4	0.58	0.62
R5	0.39	0.46
R6	0.40	0.48
R7	0.36	0.42

Objective 1: Rehabilitated vs Non-Rehabilitated

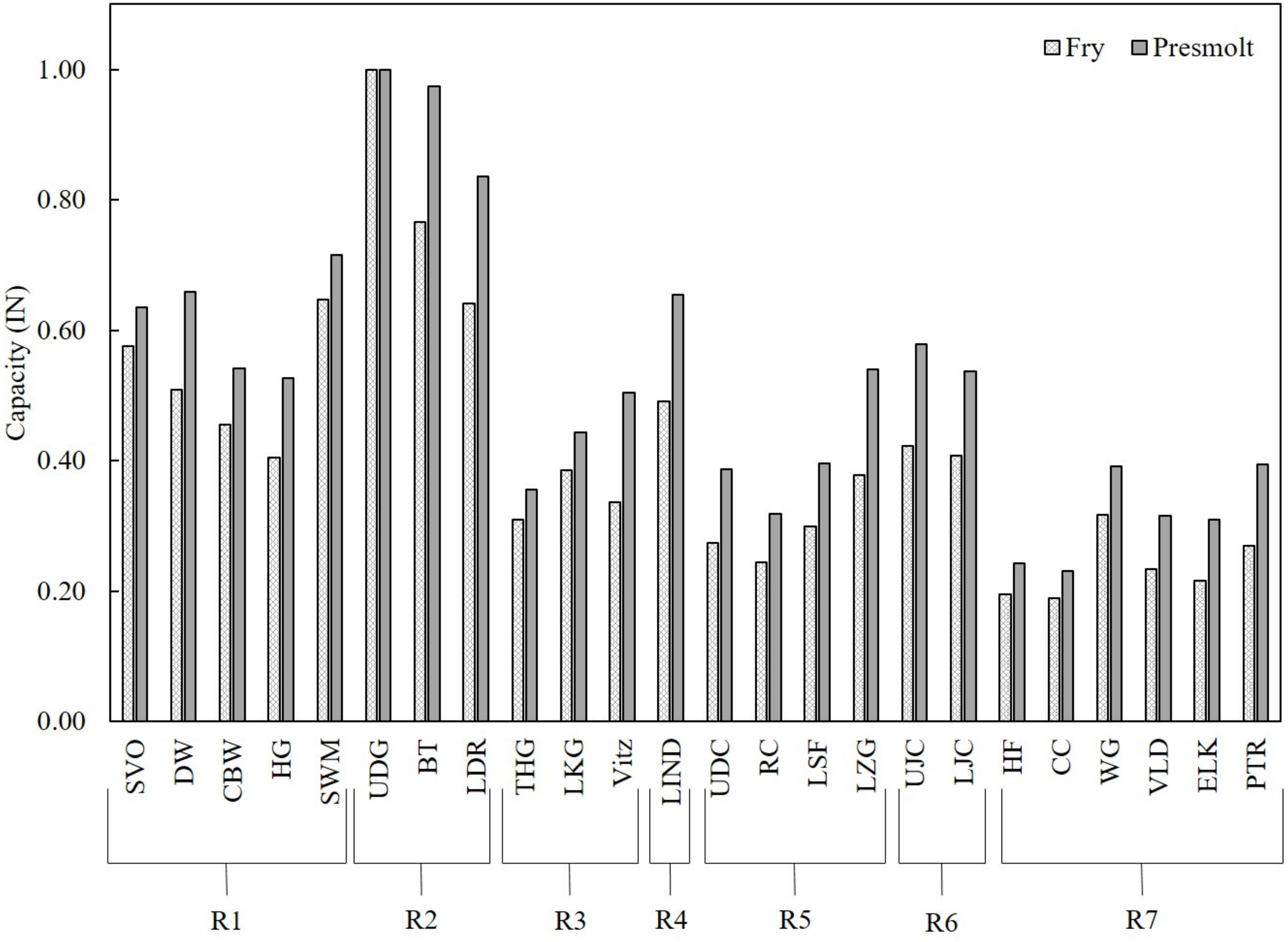


Objective 2: Minimum Capacity(C_{min}) in rehabilitation areas





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} = depth percentile at the reference discharge Q_{R} = 56.6 m^3/s

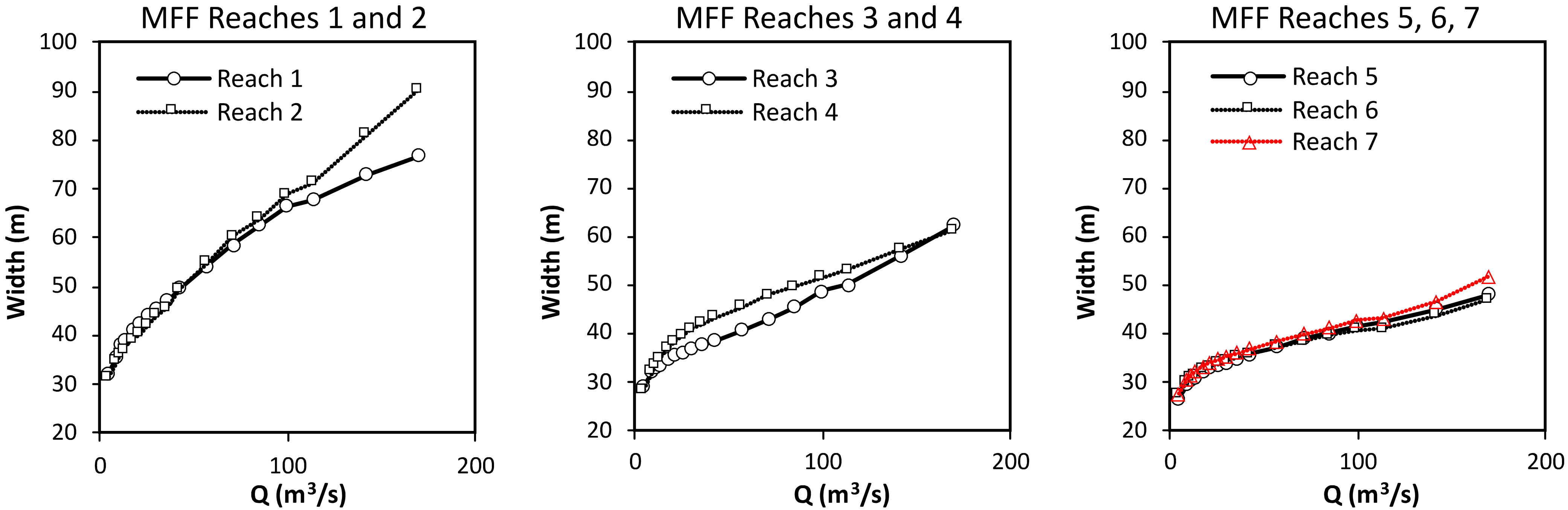
- Mean wetted width as function of discharge

$W = \mathrm{f}(Q)$; $I_{WR} = \int W \, dQ$ (Q = 4.2 m^3/s to Q_{R})

- Compare to habitat variables

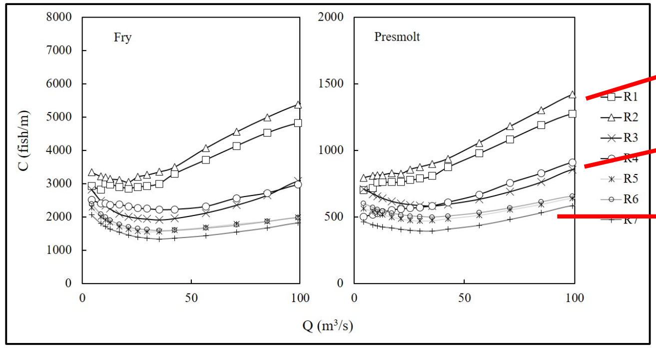
$C_R = C$ at Q_R; $I_R = \int C \, dQ$ (Q = 4.2 m^3/s to Q_{R}); P_0 (fraction of bed with cover at Q_R)

Wetted Width (W)



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

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

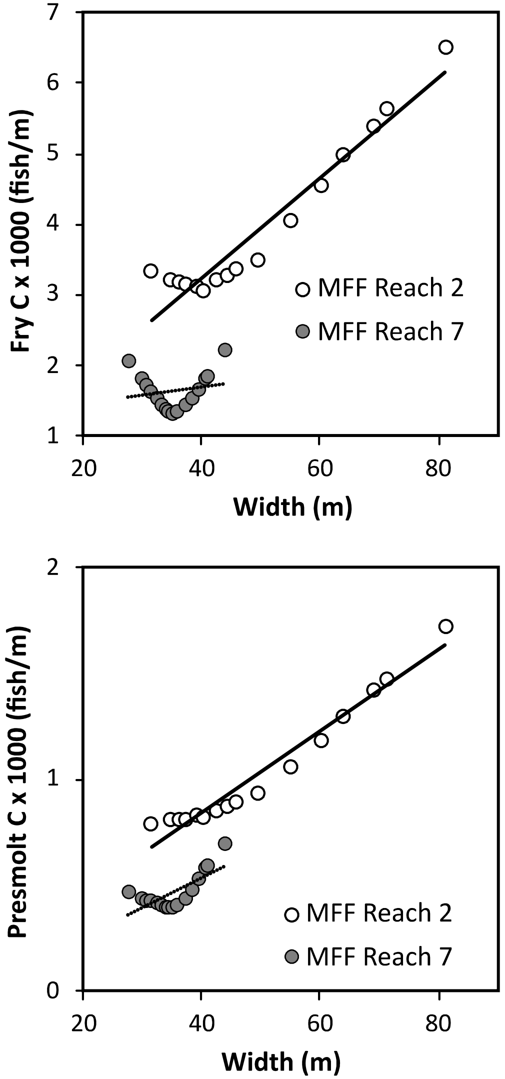


Reaches 1 and 2

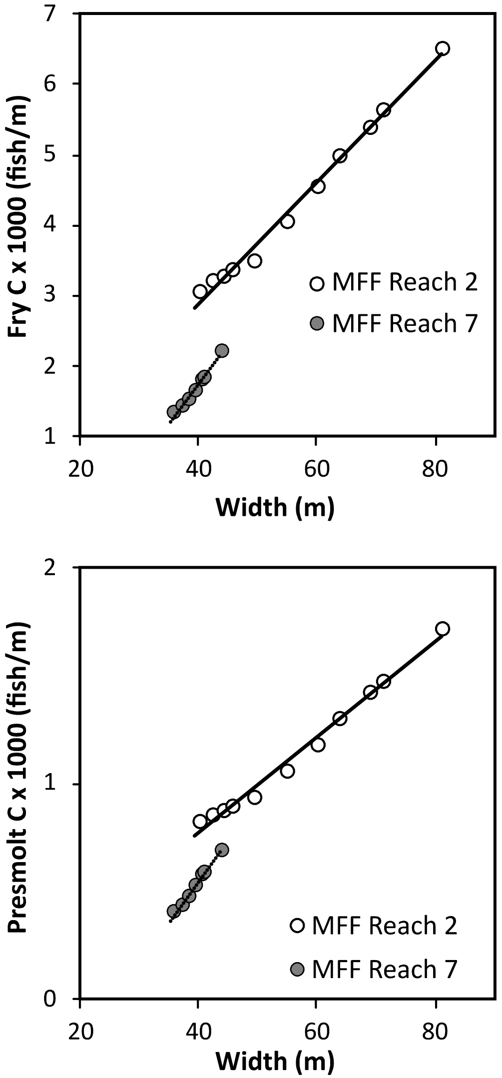
Reaches 3 and 4

Reaches 5, 6, and 7

Relationship of W to the Habitat Dip

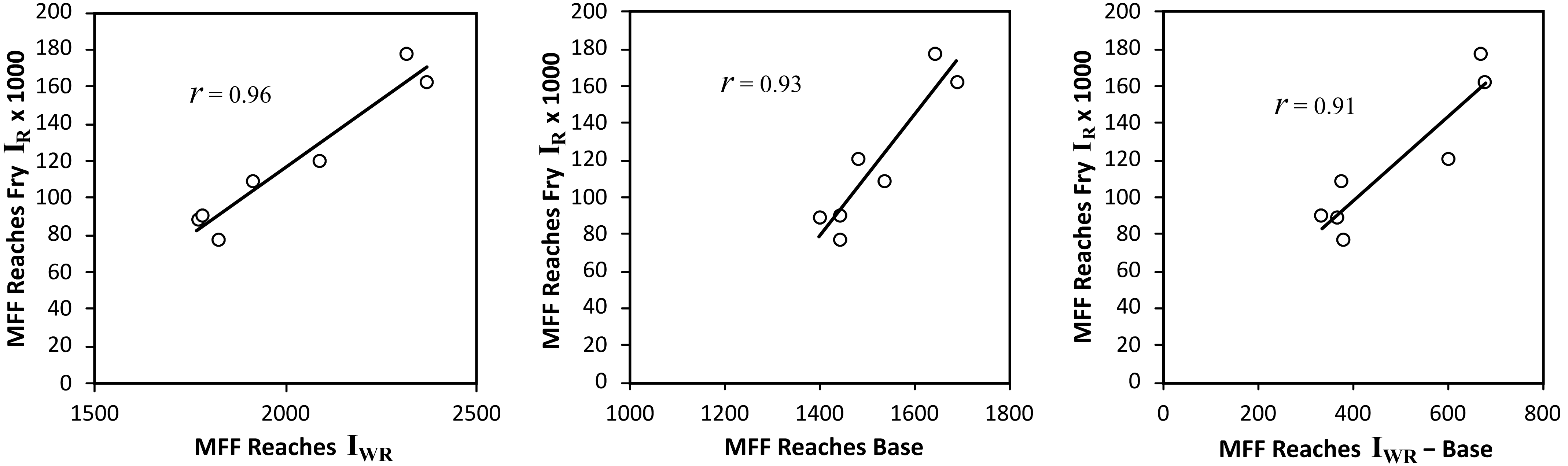


W has no "dip"



C scales with W to right of the dip

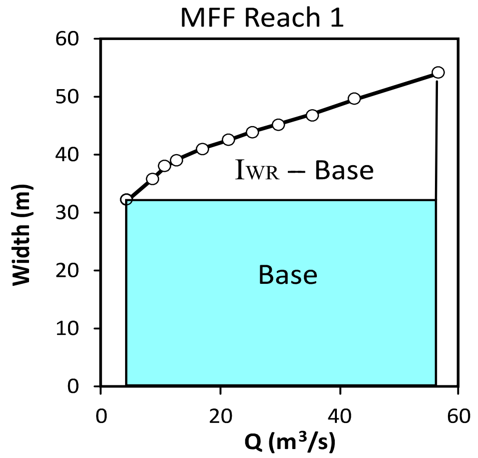
Integrated Wetted Width (I_{WR})



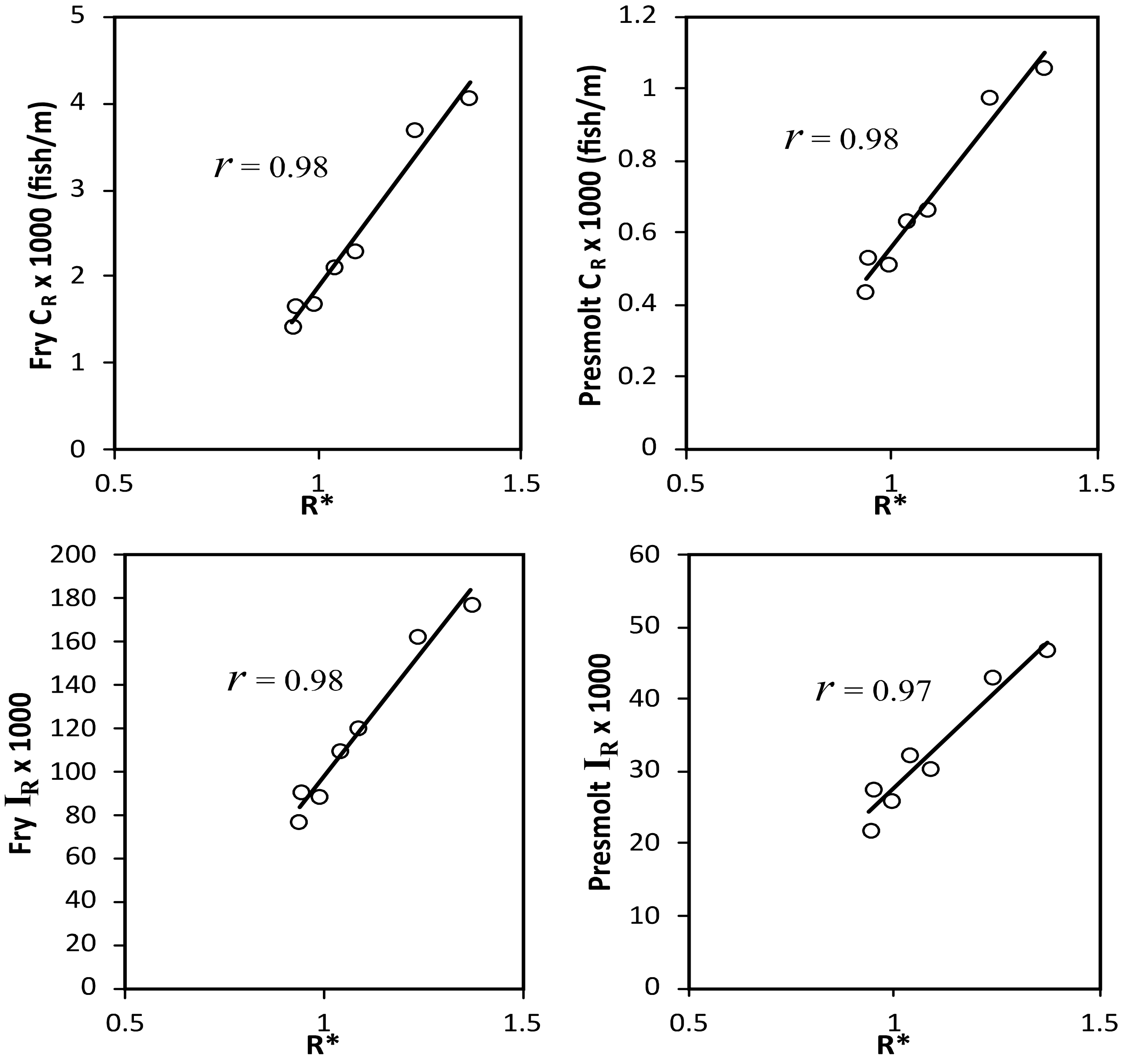
I_R as function of integrated wetted width (I_{WR}) in MFF reaches.

Graphs correspond to:

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



Topographic Complexity ($R*$)



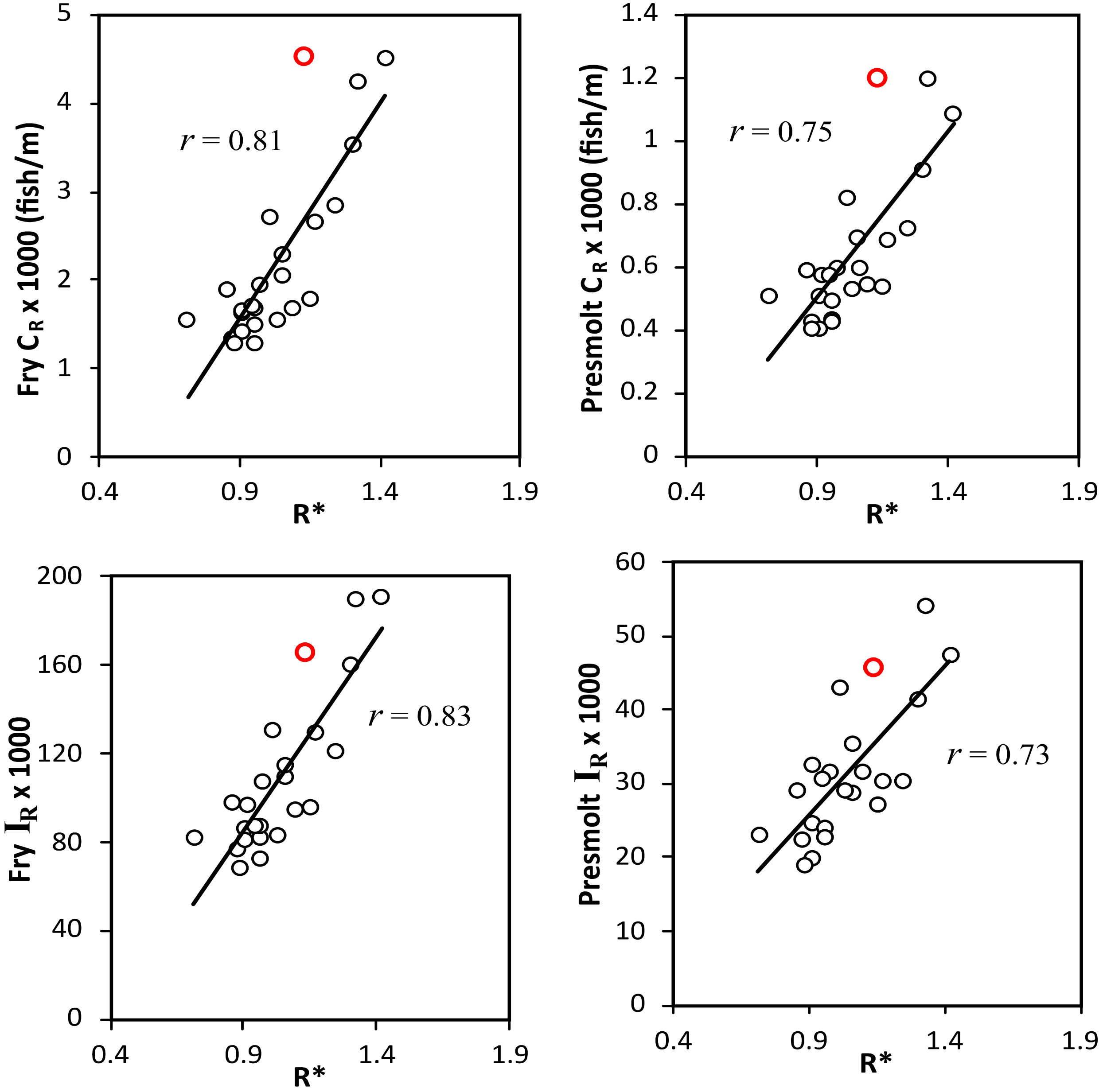
C_R (top) and I_R (bottom) as functions of $R*$ computed for the 7 MFF reaches.

Elements of Complexity and Habitat Quality

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

	Independent Variable		
Dependent Variable	P_0	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

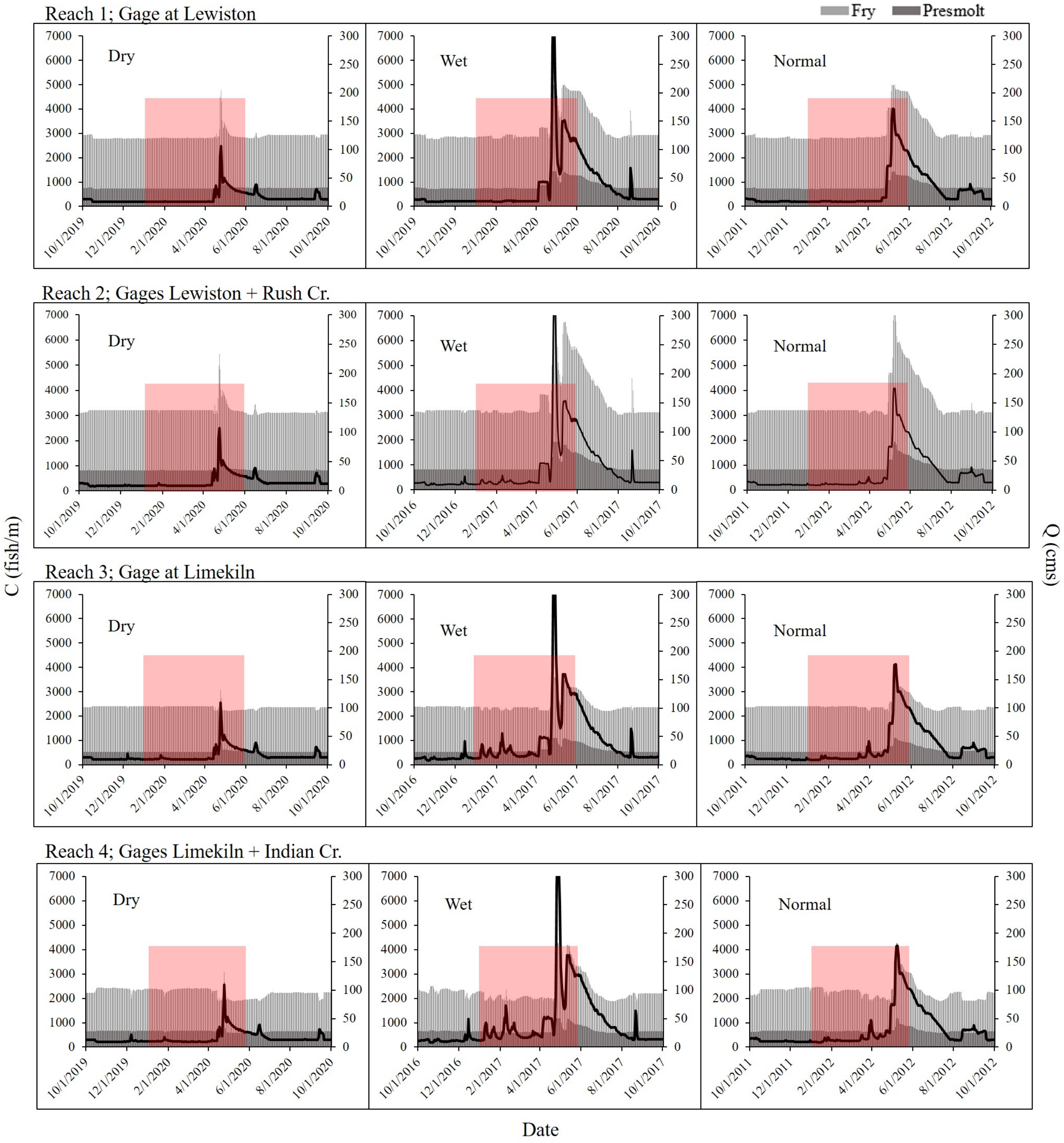
Spatial Scale Matters for Complexity Metrics

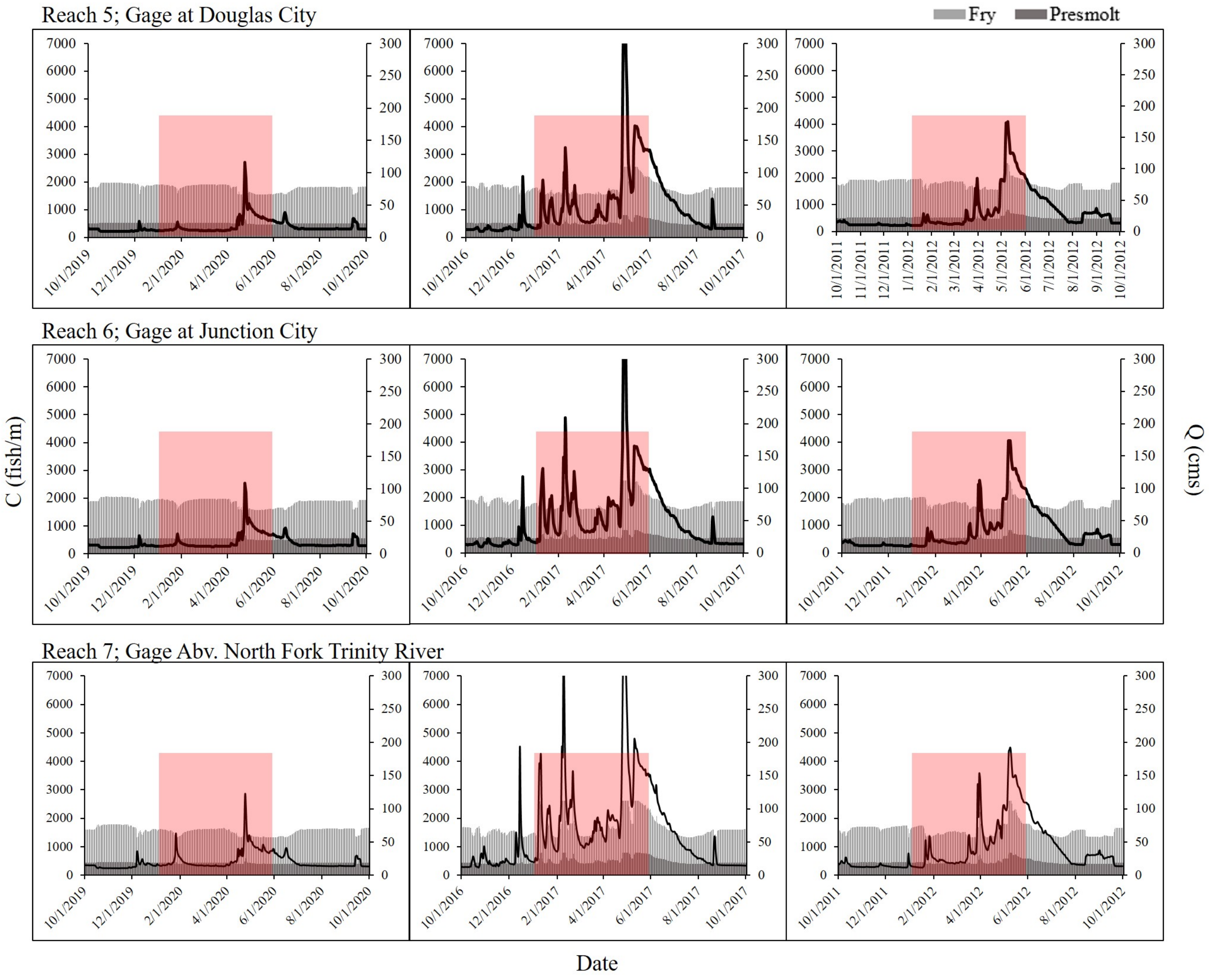


C_R (top) and I_R (bottom) as functions of R^* computed for the 24 RC reaches defined by Gaeuman et al. (2016).

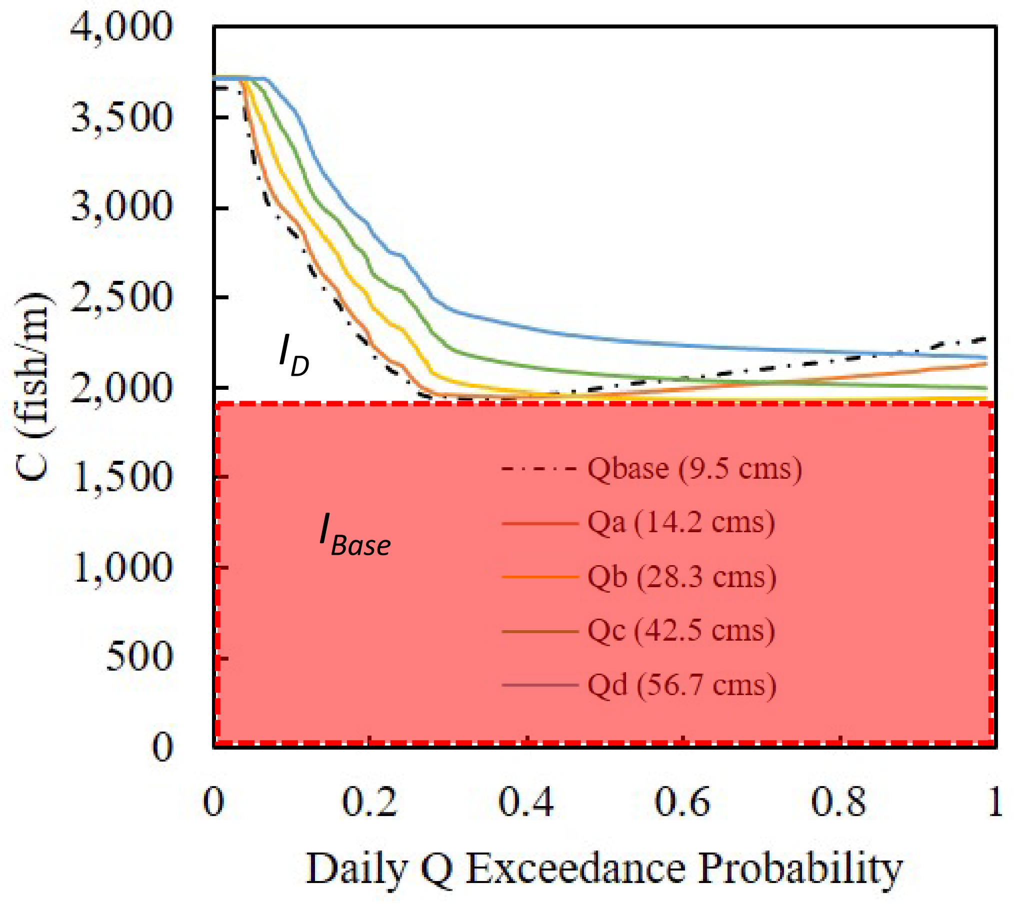
Correlations between either capacity measure and IWR are also weaker for the shorter RC reaches.

Objective 4: *C* and hydrographs





Objective 4: *C* in response to elevated baseflows



Increased area from minimum I_{Base} value among curves

Baseflow Alternative	Q (m^3/s)	% Change in I_D
Qbase	9.5	10%
Qa	14.2	0%
Qb	28.3	1%
Qc	42.5	50%
Qd	56.7	119%

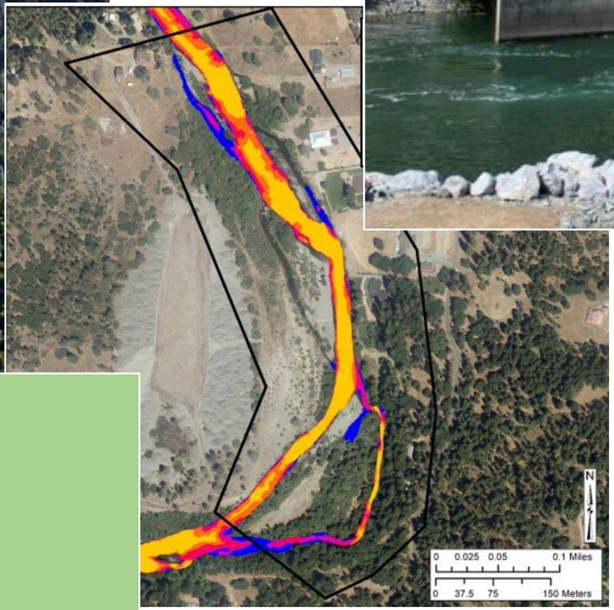
Summary of Findings

- 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 are inter-related and contribute to capacity.
- Rehabilitation sites with the greatest capacity have elevated $C_{min,}$ a wider channel, and allow water to spread beyond the channel at 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 ≤ 99.1 cms and with ecologically significant flow duration inundations.
- Focus on increasing wetted width in downstream reaches.
- Evaluate sites built since 2016 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.

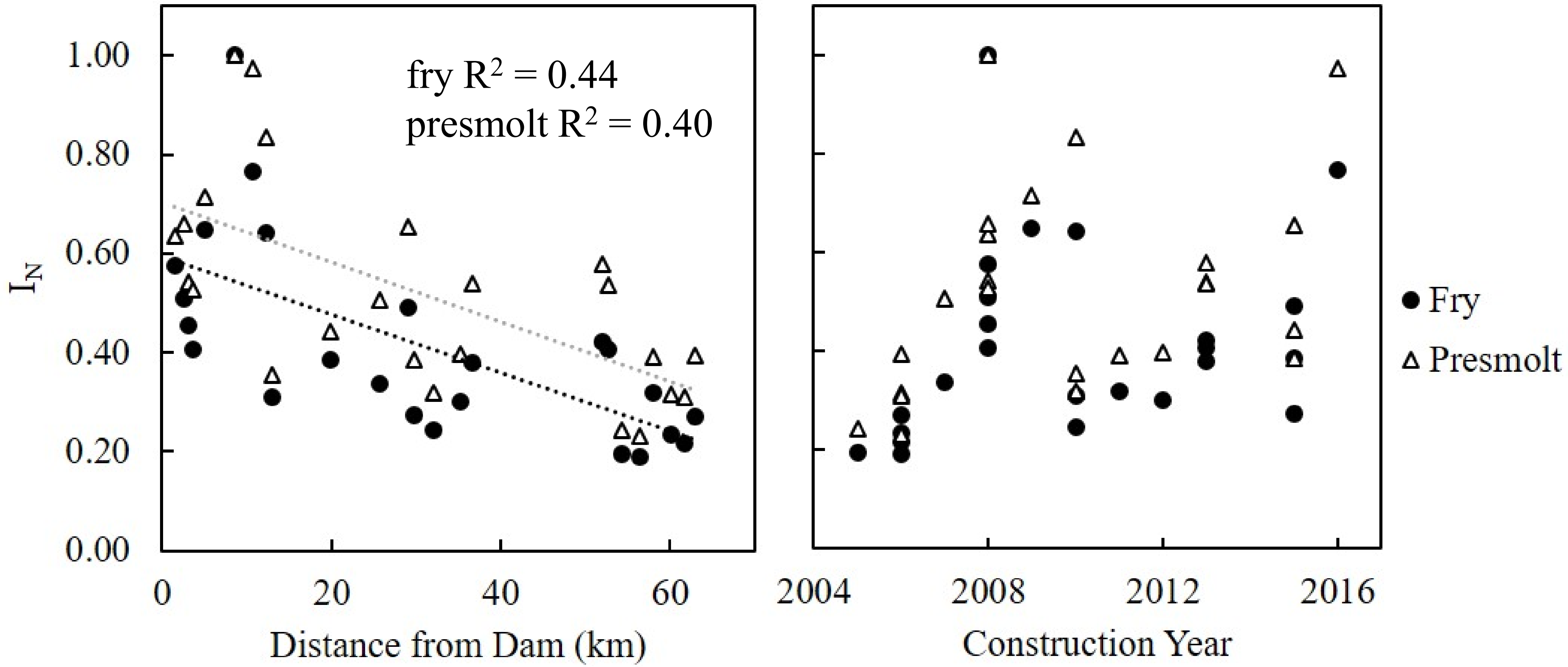
Acknowledgements



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

Trinity River Restoration Program
Restore • Adapt • Improve

Objective 2: Exploring relationships of Capacity at sites



Objective 4: *C* with respect to flow durations