

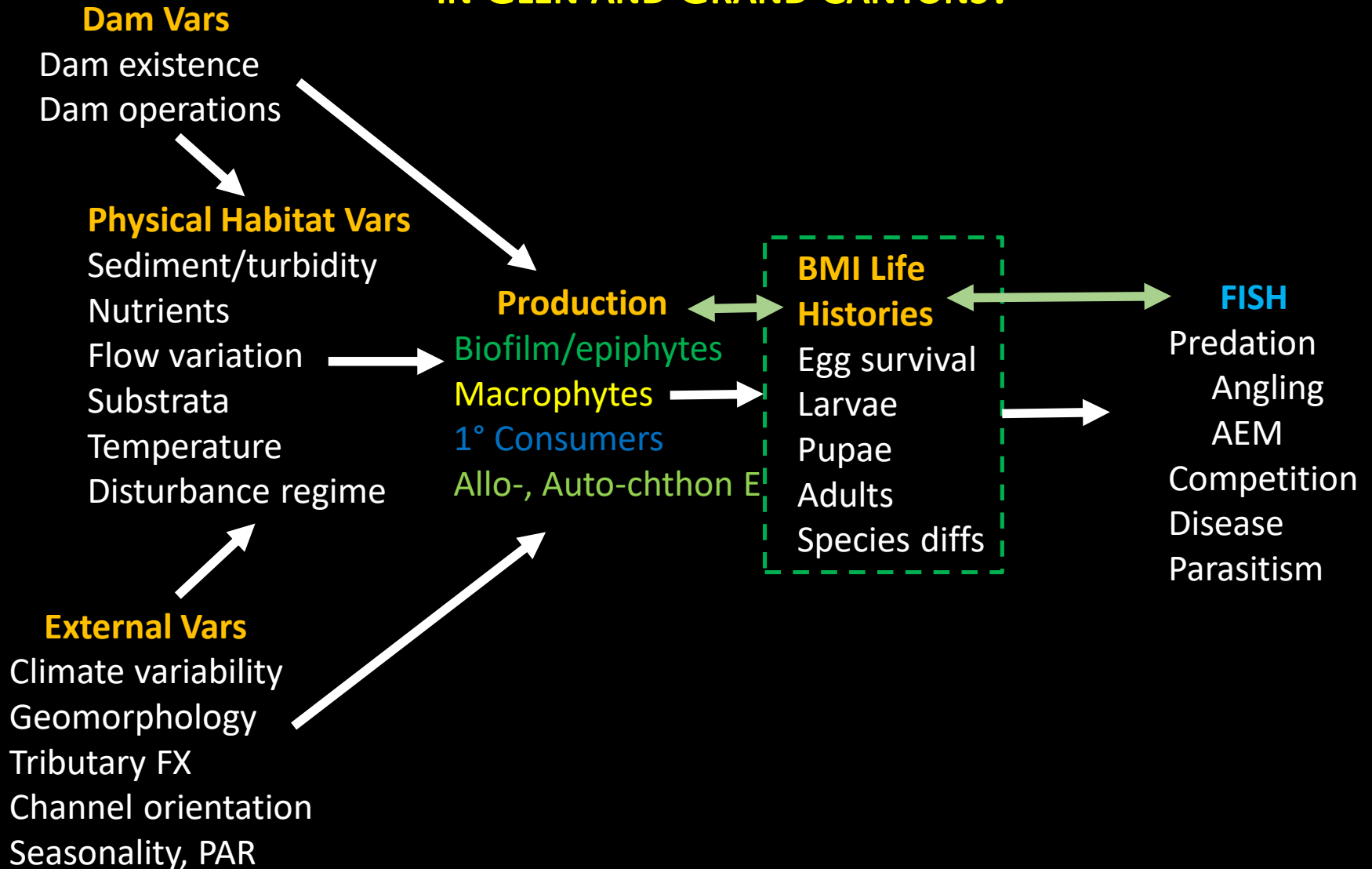
Colorado River Aquatic Foodbase Studies at Tapeats Creek, Grand Canyon National Park, Arizona: A Benthic Discontinuity

L.E. Stevens, J.H. Holway, and C. Ellsworth (2020)

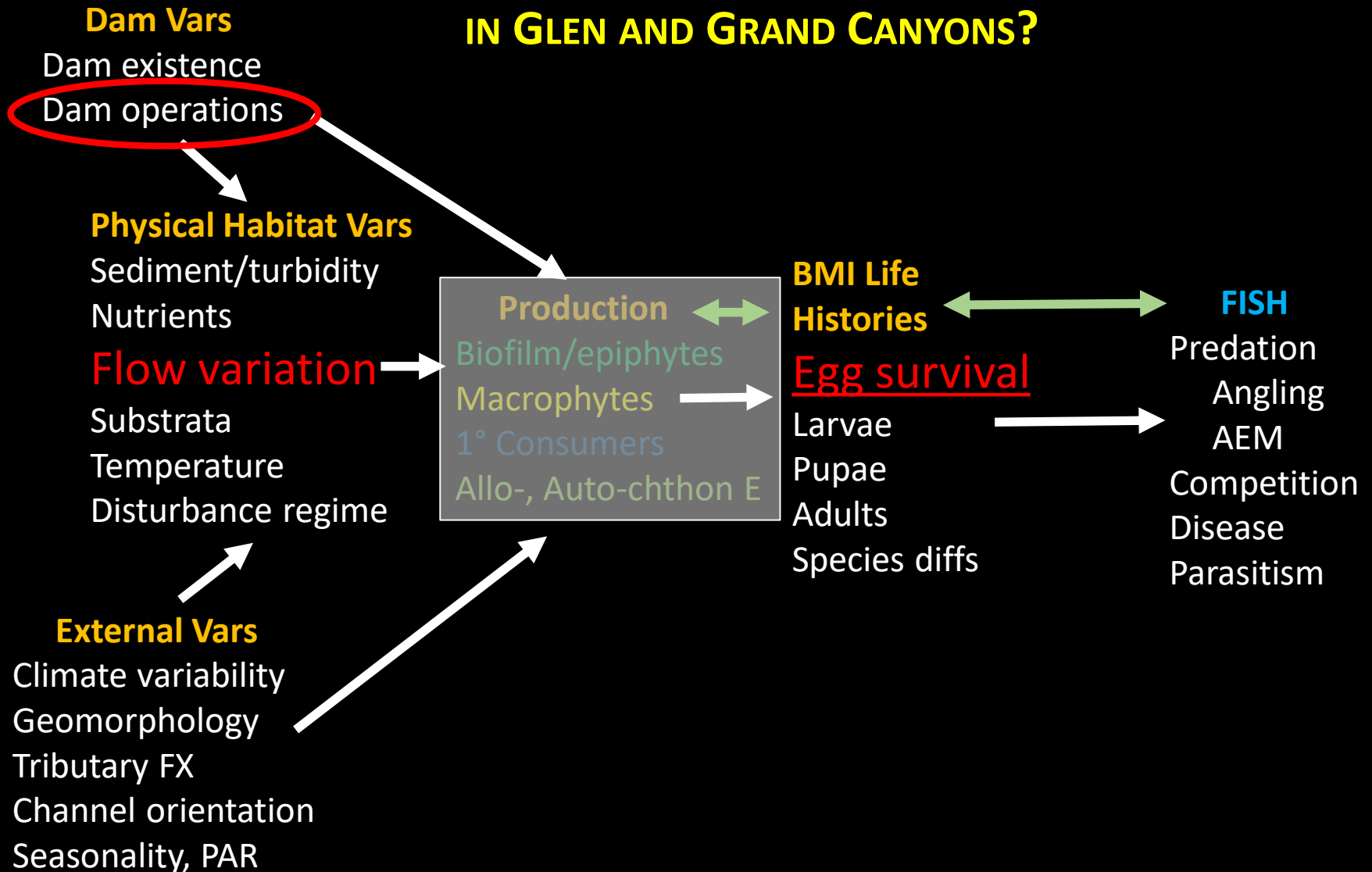


Stevens, L.E., J.H. Holway, and C. Ellsworth. 2020. Benthic discontinuity between an unregulated tributary and the dam-controlled Colorado River, Grand Canyon, Arizona, USA. *Annals of Ecology and Environmental Science* 4(1): 33-48.

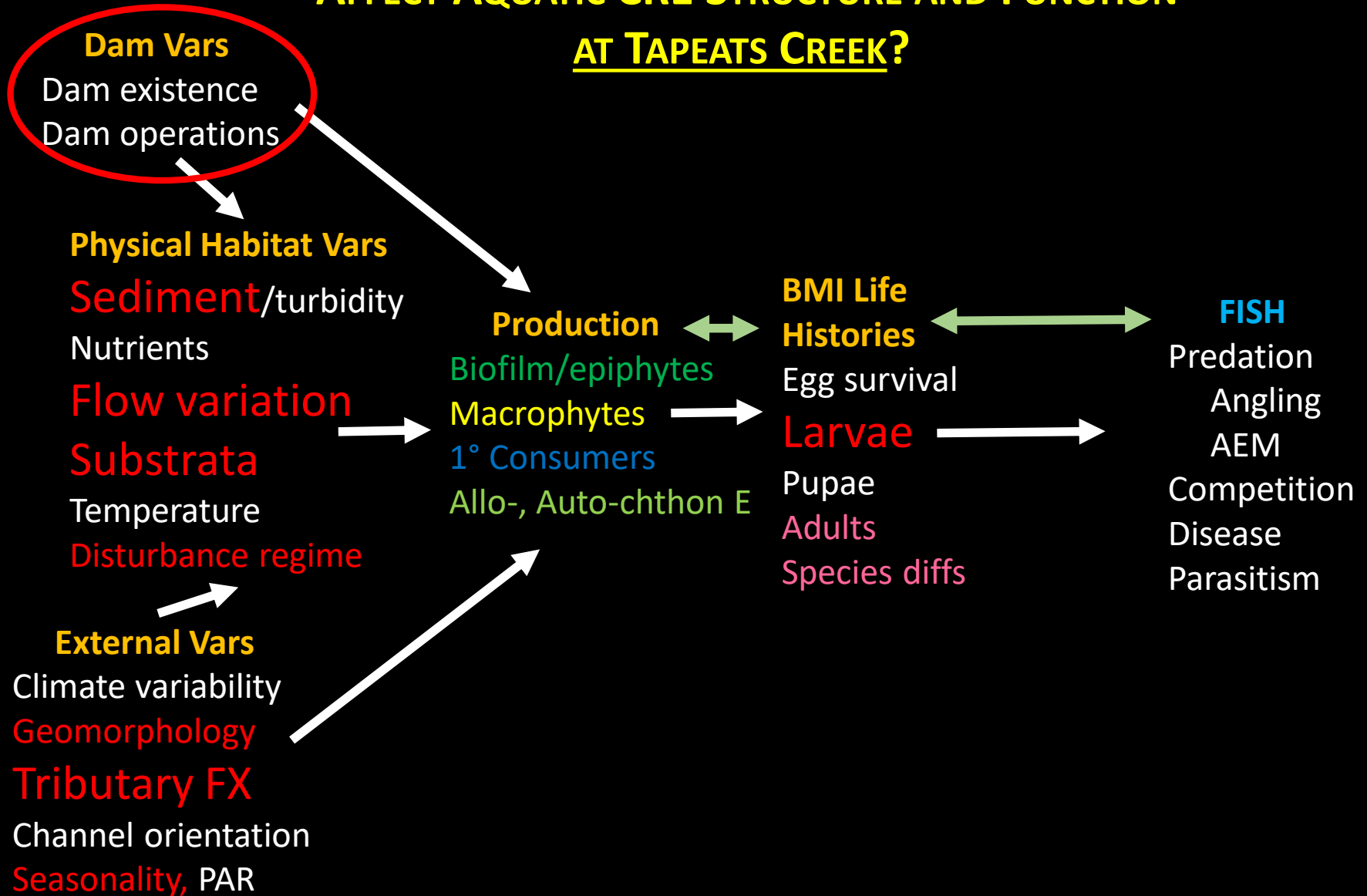
HOW AND TO WHAT EXTENT DOES GLEN CANYON DAM AFFECT AQUATIC CRE BENTHIC COMPOSITION, STRUCTURE, AND FUNCTION IN GLEN AND GRAND CANYONS?



HOW AND TO WHAT EXTENT DOES GLEN CANYON DAM AFFECT AQUATIC CRE STRUCTURE AND FUNCTION IN GLEN AND GRAND CANYONS?



HOW AND TO WHAT EXTENT DOES GLEN CANYON DAM AFFECT AQUATIC CRE STRUCTURE AND FUNCTION AT TAPEATS CREEK?



WHY TAPEATS CREEK?

Hofnecht Benthic Discontinuity (1981):

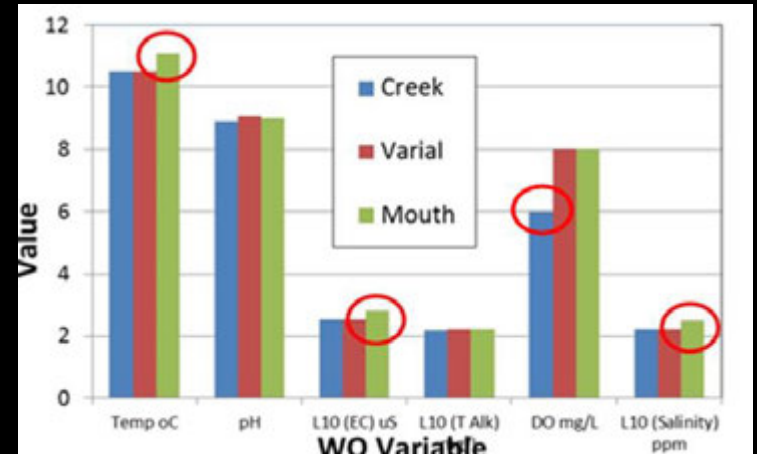
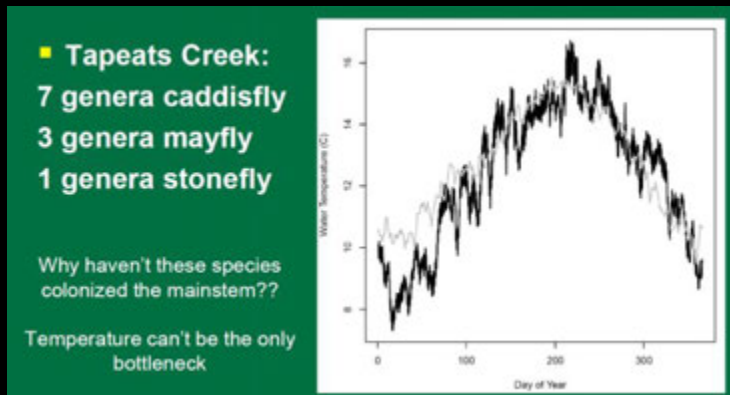
- Marked riverward decline in BMI (especially EPT) richness at GC tributary confluences

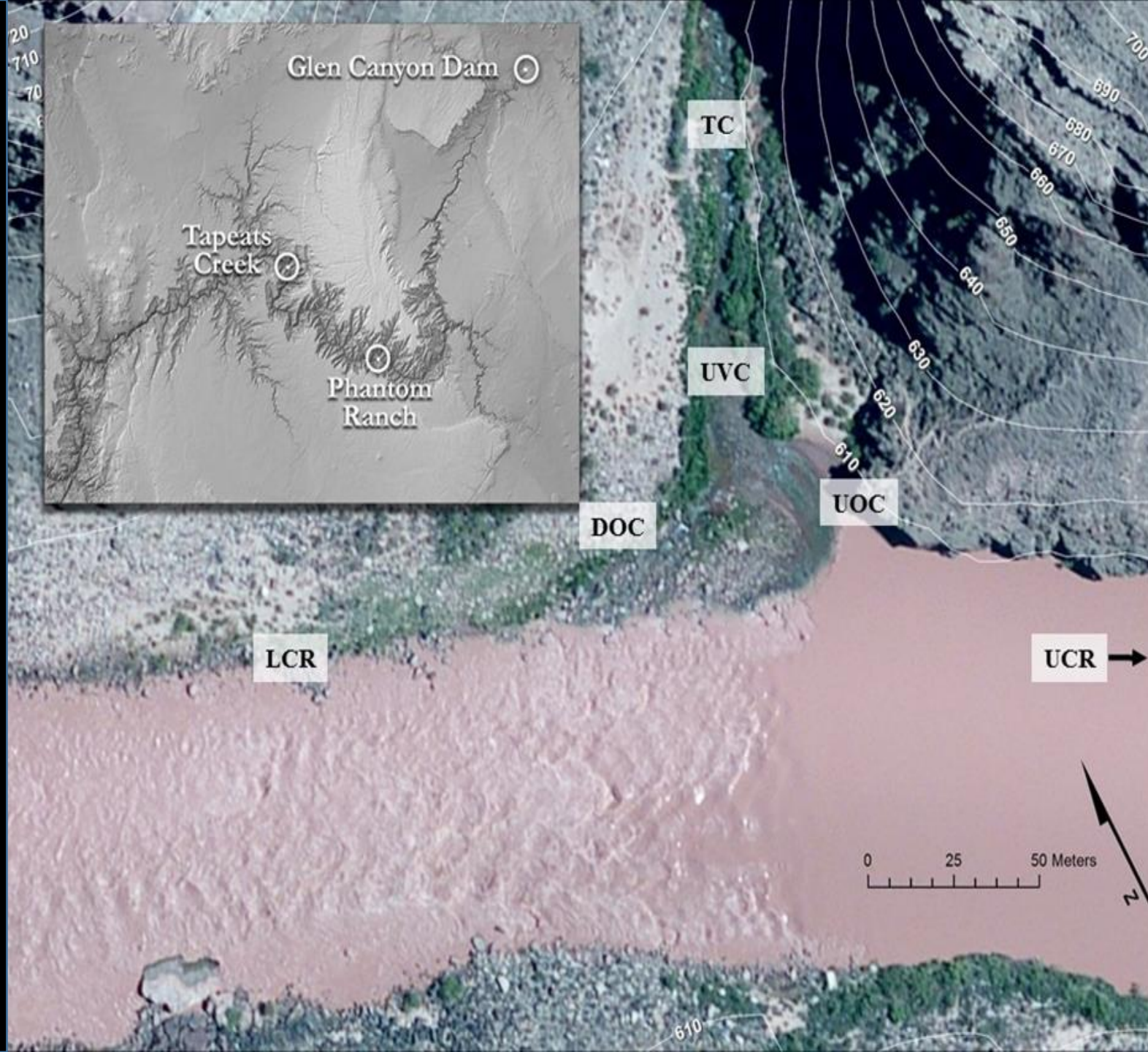
Tapeats Creek: A WQ analogue to tailwaters

Measure and experimentally test factors affecting the tributary-mainstream BMI discontinuity

Why do EPT larvae from the tributary not survive in the adjacent mainstream?

Does this help inform dam management?



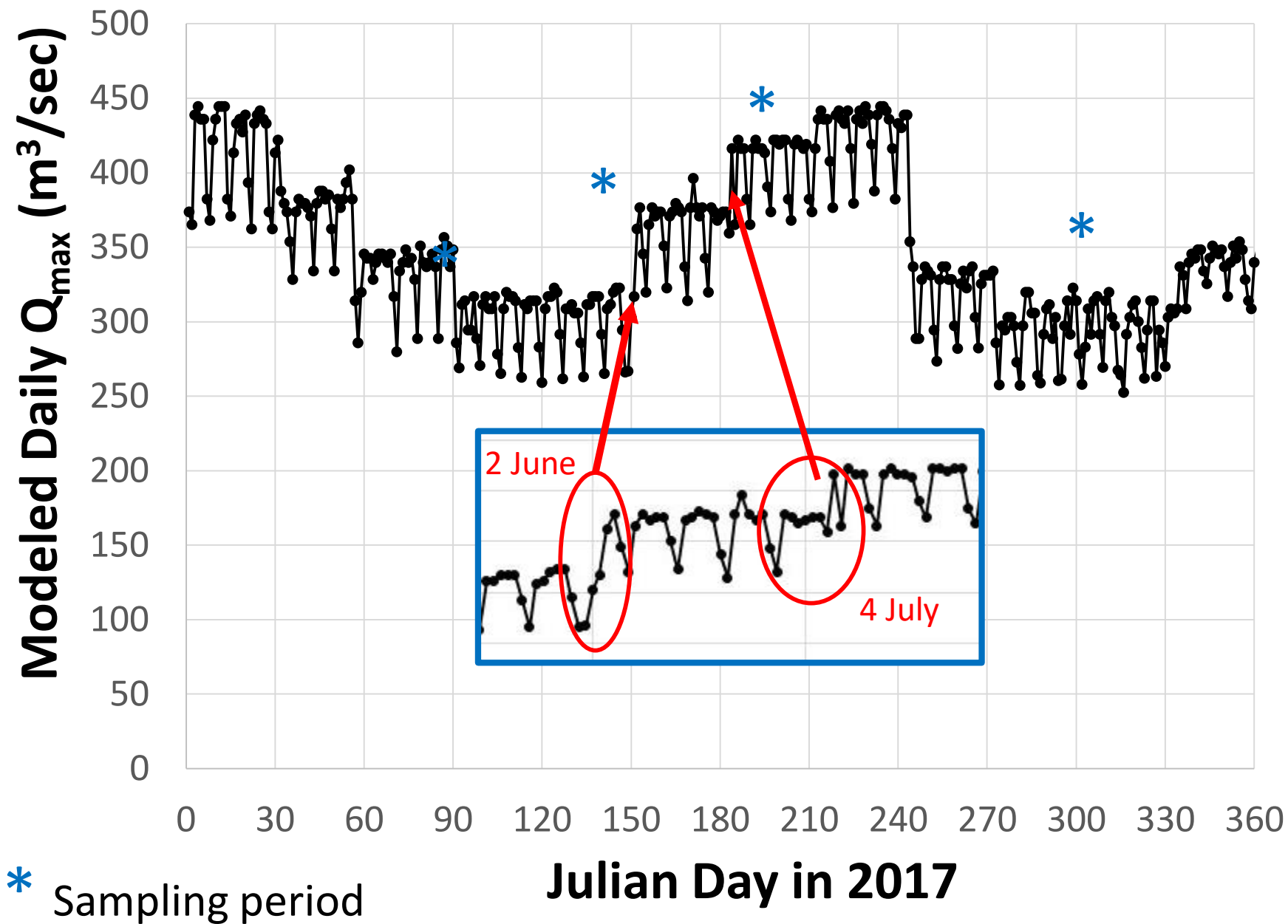




Hess, drift, and experimental basket sampling to evaluate seasonality, water quality, flow variation, sedimentation, and habitat on benthic macroinvertebrates (BMI), esp. EPT



Mainstream Q at Tapeats Creek Confluence in 2017



June-July transition Upper Outflow Channel (2017)

Low (~8,000 cfs) vs High (~17,000 cfs)



UOC 10:00 a.m. on 29 May 2017



UOC 17:00 on 3 June 2017

Tapeats Creek Benthos (TC/UVC/DOC): Few fines, little embeddedness

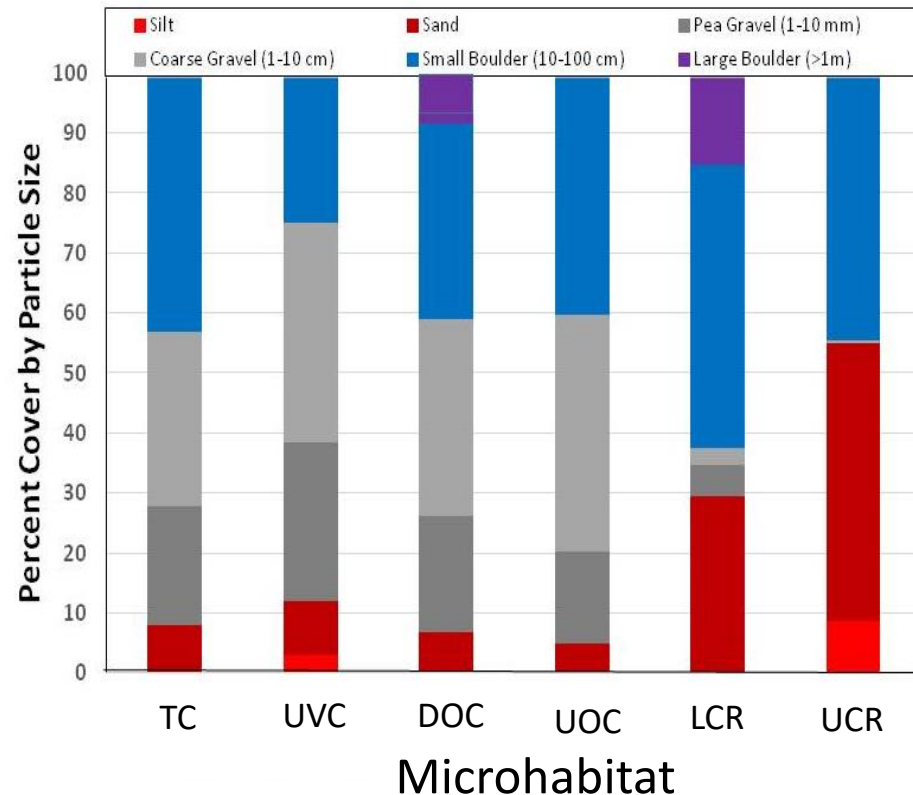
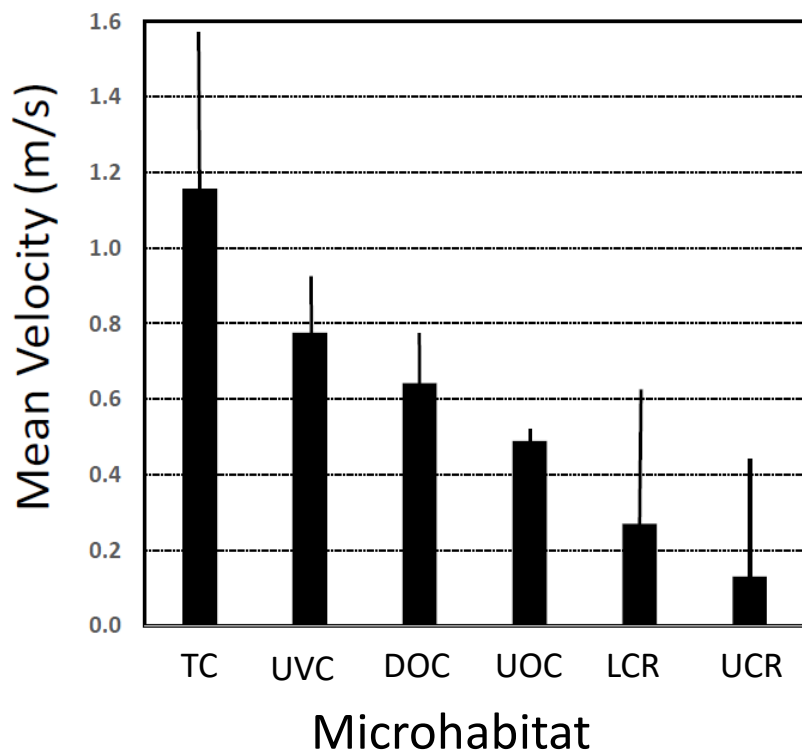


Colorado River benthos (UCR/LCR): High embeddeness Boulders embedded in sand

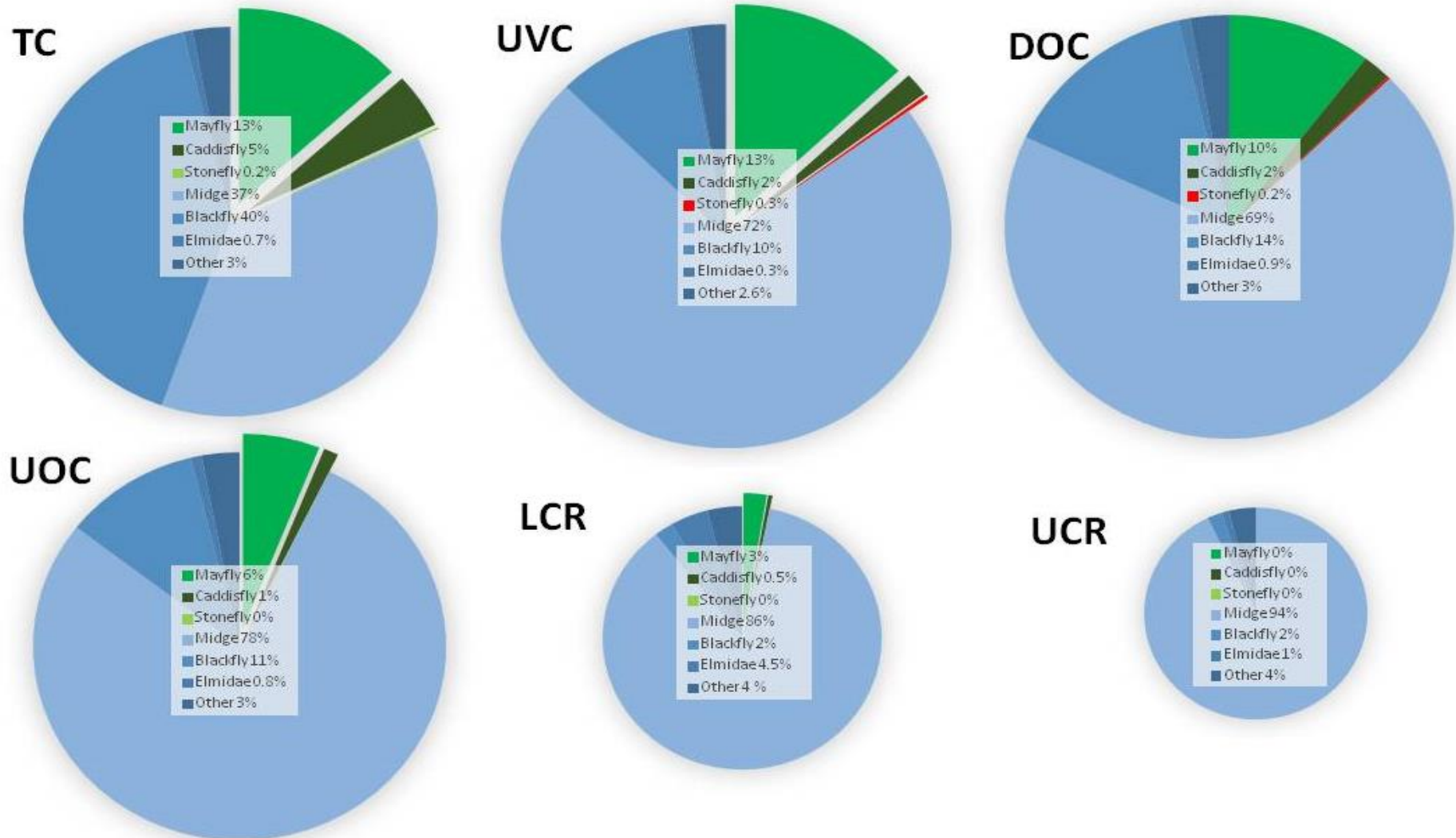


Mean Velocity and Substrata Among Zones

(Mainstream Habitats were Near-shore (<1.5 m depth))

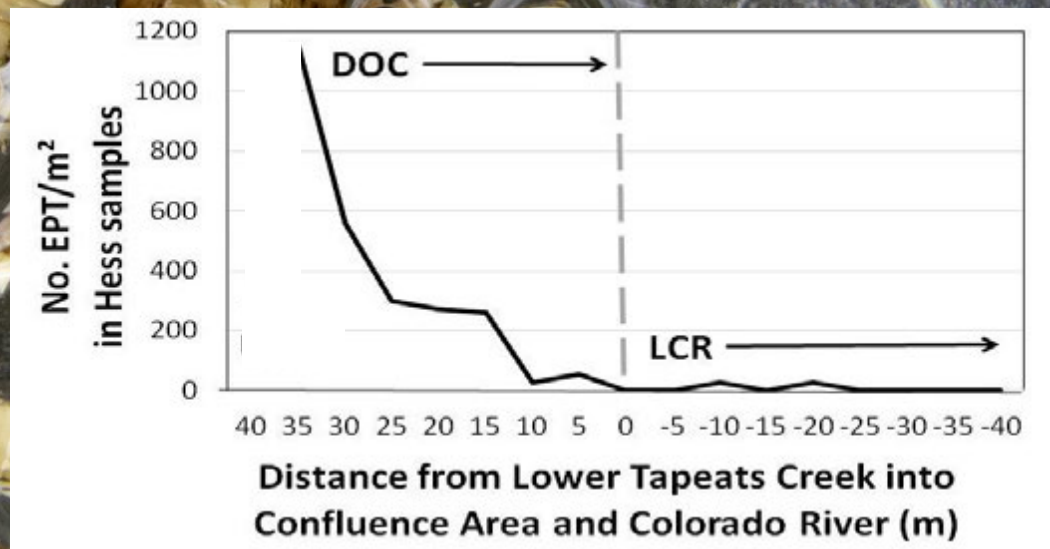
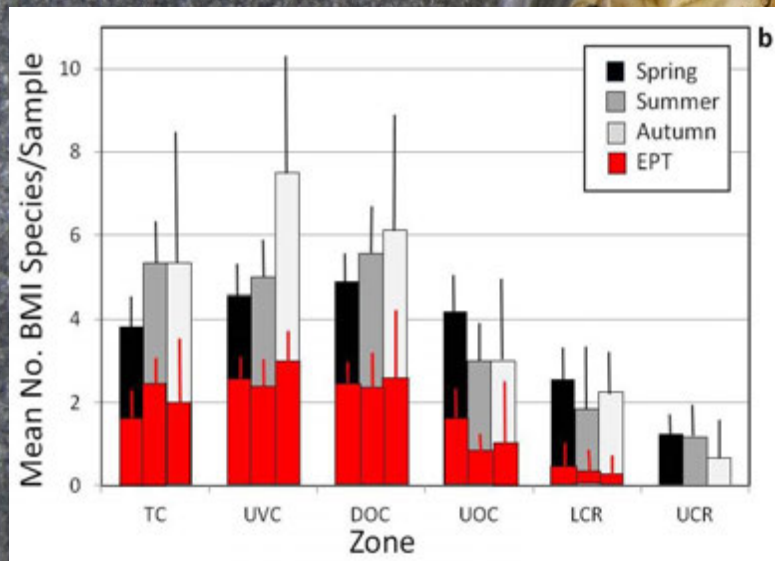
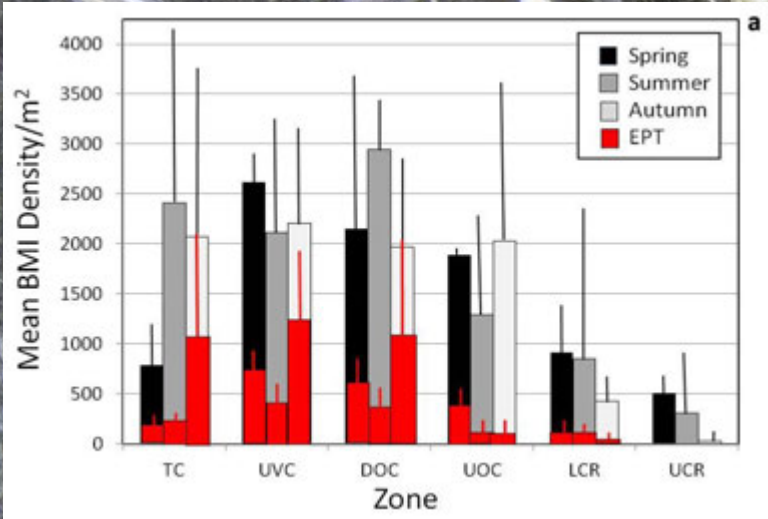


BMI Composition and Abundance Decreases Strongly from Tapeats Creek to the Mainstream



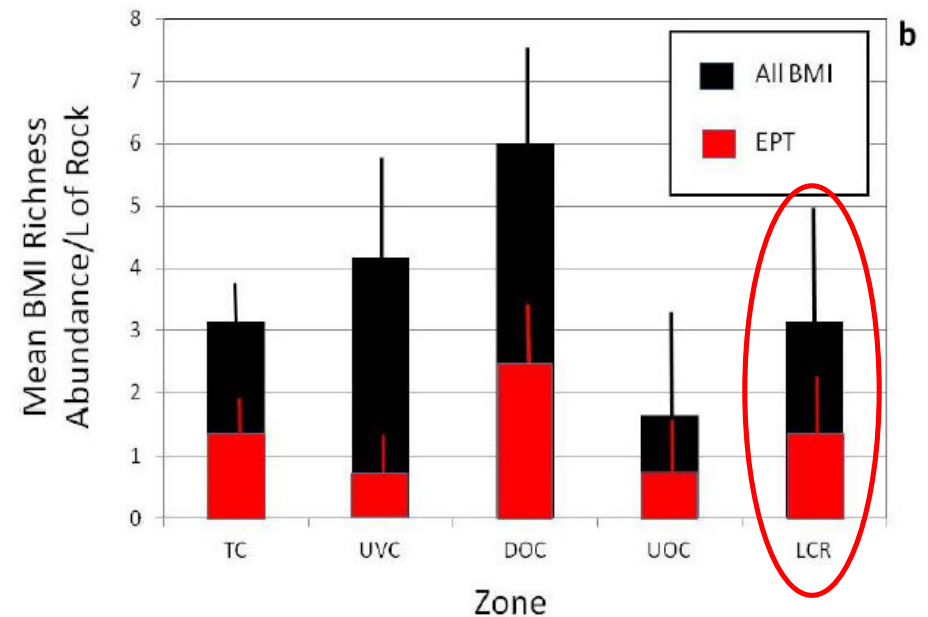
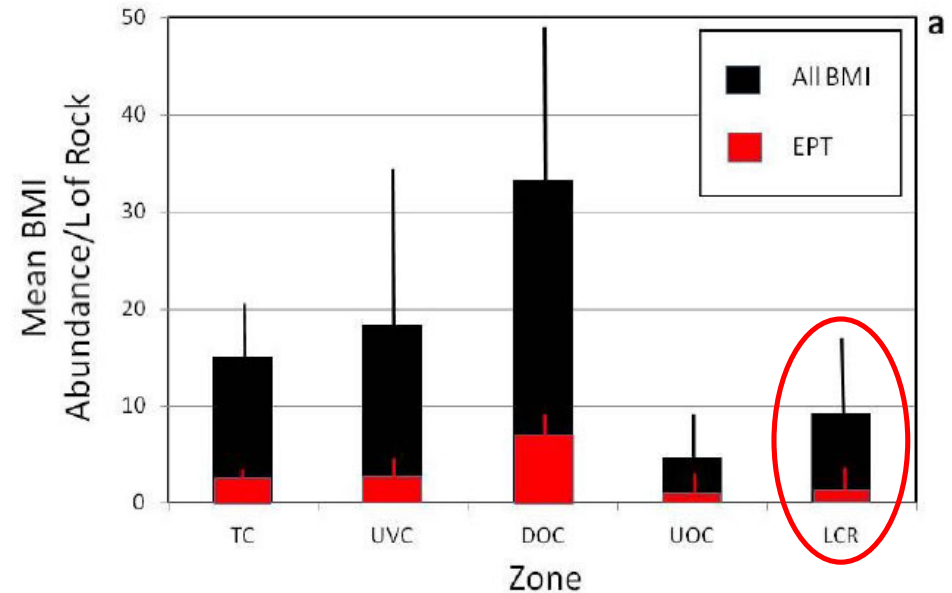
Circle size reflects density/m²

Spatio-Temporal Variation of BMI Among Zones



BASKET SAMPLER RESULTS

- BMI and EPT abundance and richness/L differed only slightly between the LCR and TC
- Embeddedness excludes EPT larvae from occupying the mainstream



Fluctuating Flow Experiment in Tapeats Creek

Methods

Basket samplers

21 day trial duration, 6 reps each

Flow changes:

- Fixed position (unmoved)

- Move 0.5 m vertically and replace

- Day up (0.5 m up to near surface)

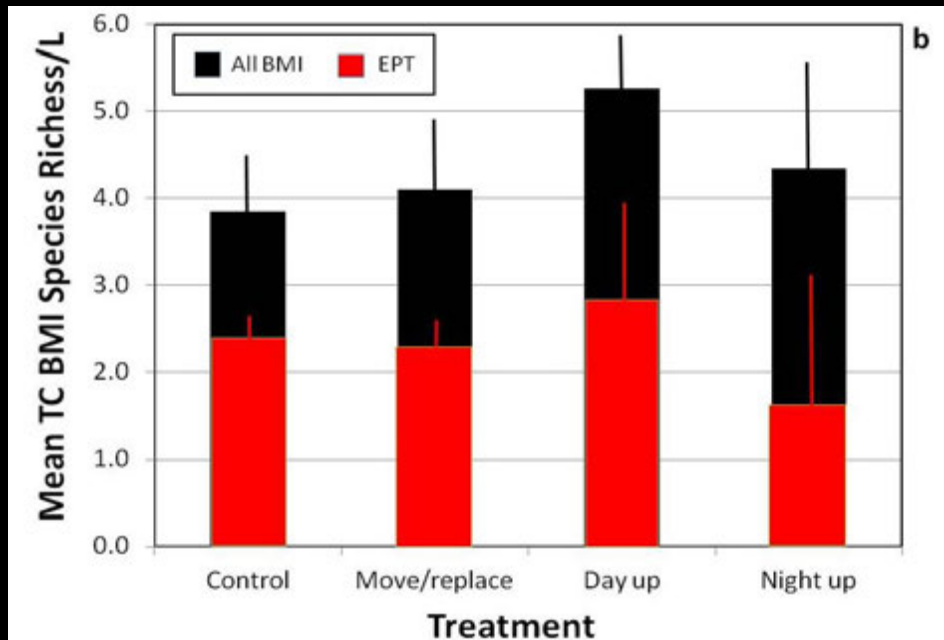
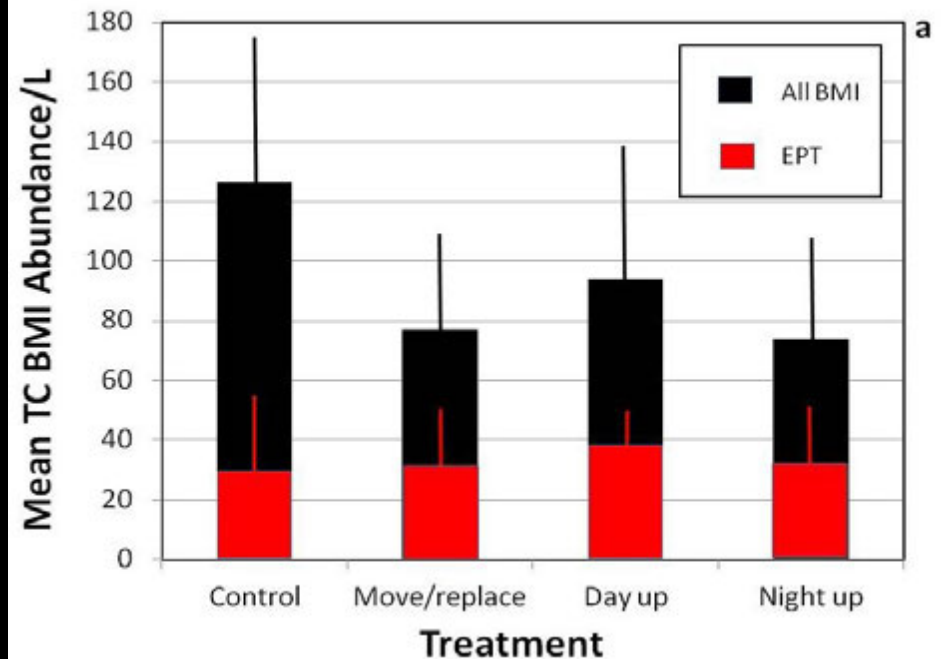
- Night up (0.5 m up to near surface)

Measured BMI, EPT Abundance and S / L gravel

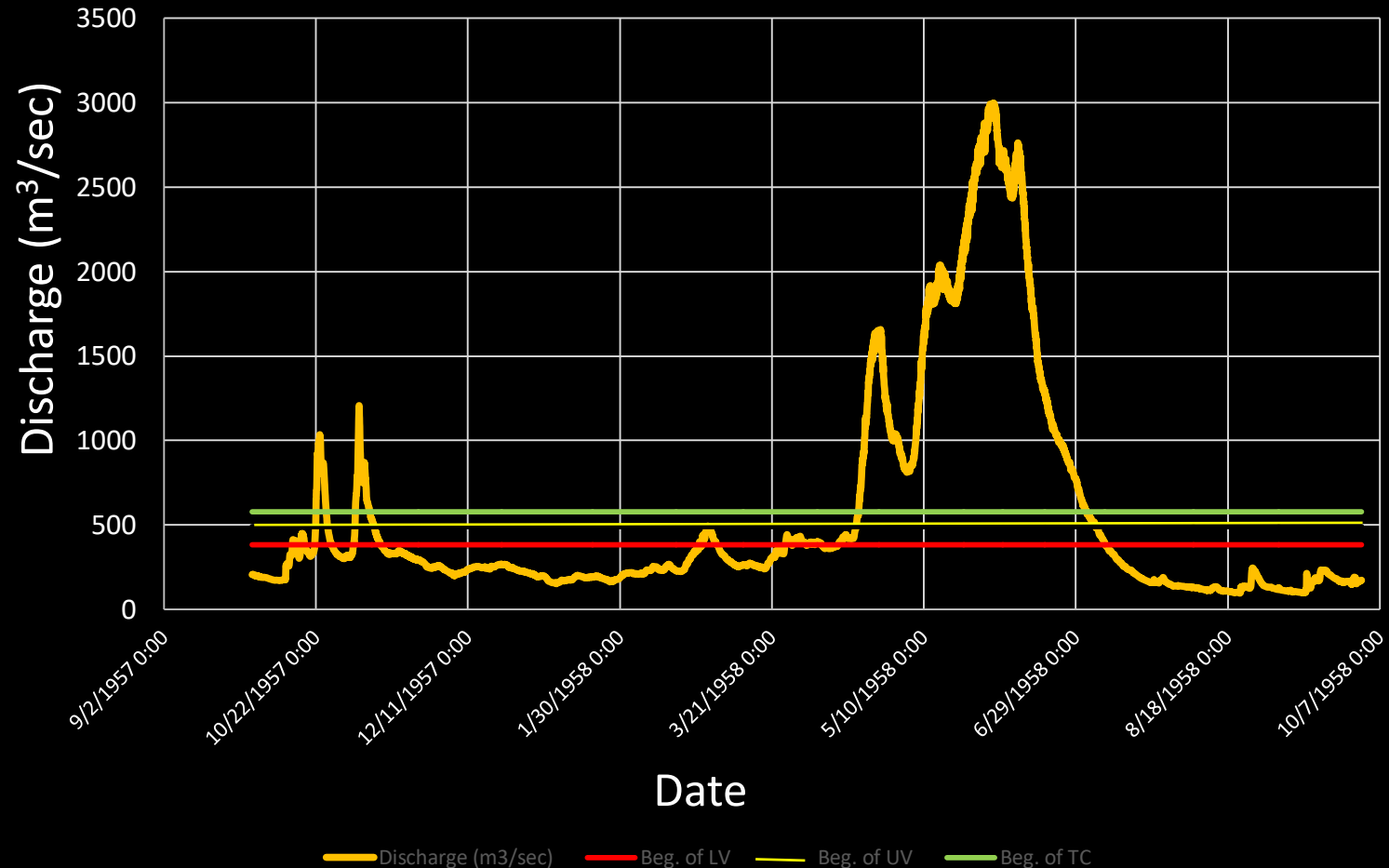
Results

Q_{flux} : Slight increase in control BMI, but nsd
and EPT nsd
nsd on S for BMI and NSD

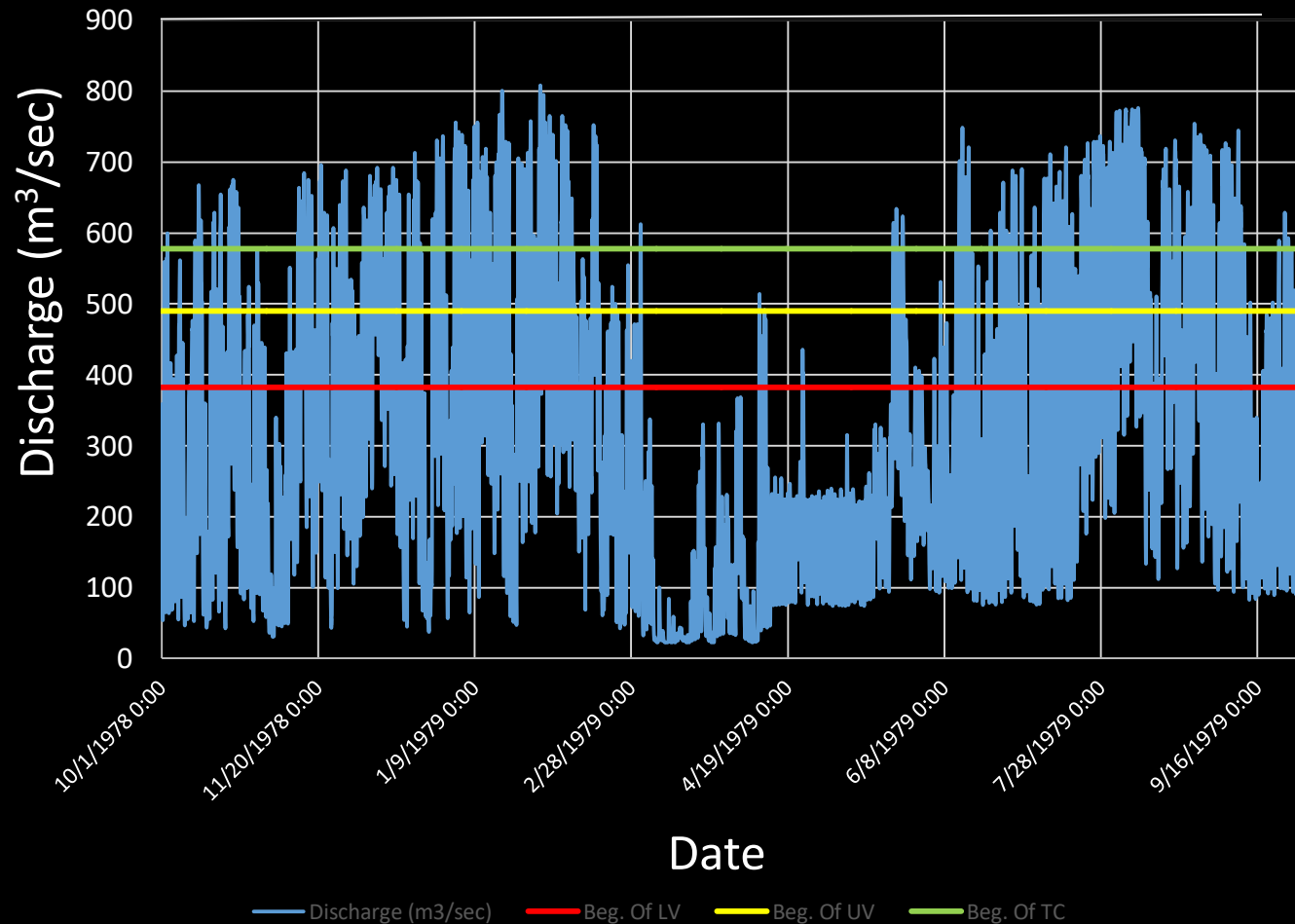
Q_{flux} did not appear to affect colonization



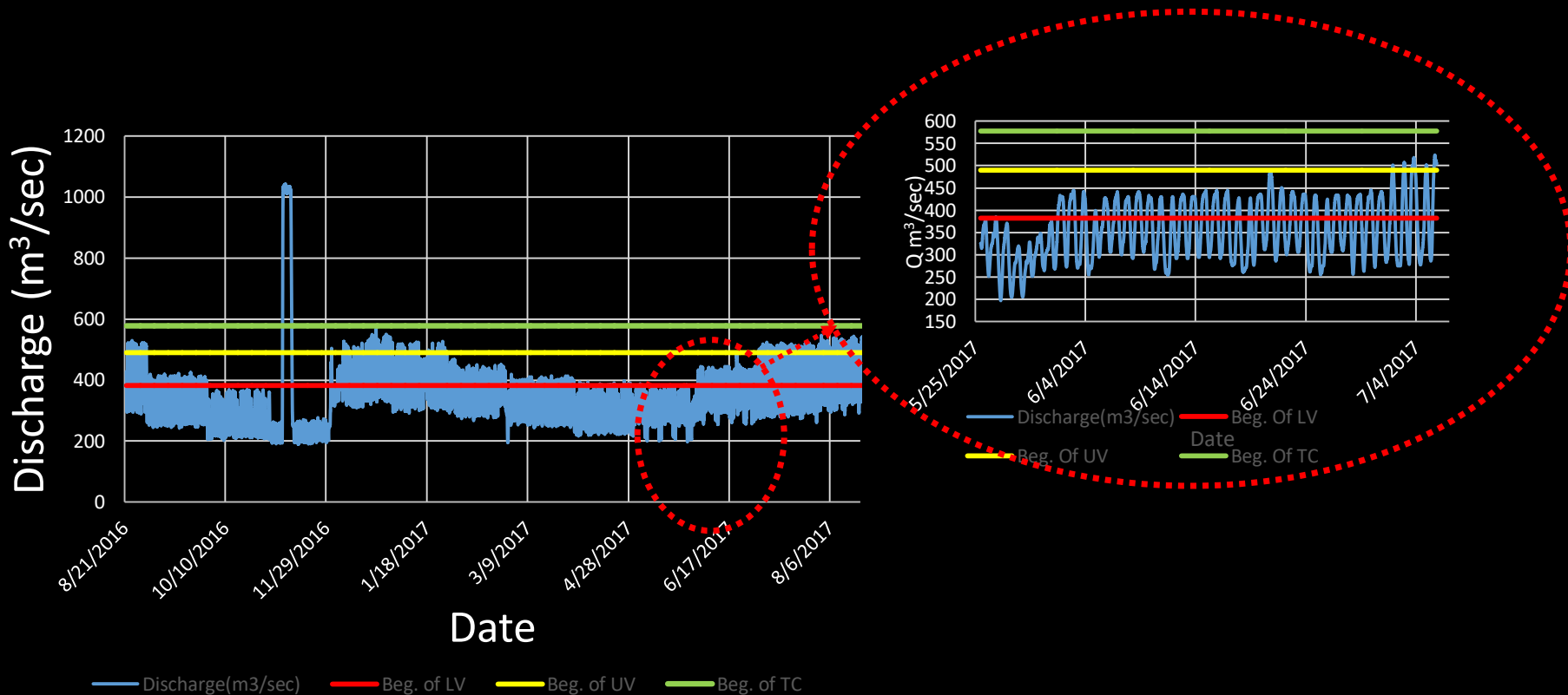
Pre-dam flows inundated lower Tapeats Creek $\leq 25\%$ of time (1957 modeled inundation based on historical Lees Ferry data)



1965-1991 highly varying flows inundated lower Tapeats Creek ca. 25% of the time, but daily inundation
(Modeled 1978 inundation, based on historical flow data at Lees Ferry)



2017 WY MLFF inundated lower Tapeats Creek ca. <1% of time (Modeled based on historical flow data at Lees Ferry)



Pre-dam and 1965-1991 ponding likely limited flow direction and increased in-mouth sedimentation. Contemporary flows likely enhance tributary mouth BMI P and drift into the mainstream.

CONCLUSIONS

- **Water quality conditions ~similar to mainstream in Glen Canyon tailwaters, but sediment grain size patterns and extent of embeddedness differed greatly.**
- **High densities of in-creek EPT and other BMI decreased markedly in the adjacent mainstream in this tributary-mainstream discontinuity (TMD).**
- **Experimental habitat placed in the mainstream allowed larval EPT colonization ~equivalent to that in the adjacent creek within three weeks in July.**
- **Absence of larval EPT in the mainstream due to limited larval habitat quality (sedimentation, embeddedness, flow direction, velocity, and life history).**
- **Decreased BMI in creek occurs independent of daily 0.5 m stage fluctuations that characterize the mainstream. Out-drift did not increase with 1m stage flux.**
- **BMI and EPT P and out-drift is likely considerably greater under contemporary flows than it was either in pre-dam time or from 1965-1991.**
- **Simultaneous management for a positive sand balance and EPT is unlikely: managing for aquatic Diptera, amphipods may be the most practicable strategy.**
- **The intensity of the TMD should be investigated at other CRE tributary mouths.**

Acknowledgements

Thanks to WAPA, Argonne Nat'l Lab, especially Kirk Lagory and Mario Salerno, to MNA, and the NPS Permitting Office. We could not have accomplished this project without the logistical support of the commercial recreational community, particularly Arizona Raft Adventures, Canyoneers Inc., Hatch River Runners, OARS Inc., and Tour West Inc., and their extraordinary staff. Special thanks to Louise Fuchs, Sam Goddard, and David Sinclair for their assistance, athleticism, and enthusiasm for this project.



Questions?