Colorado River Benthic Foodbase Studies in Glen and Grand Canyons

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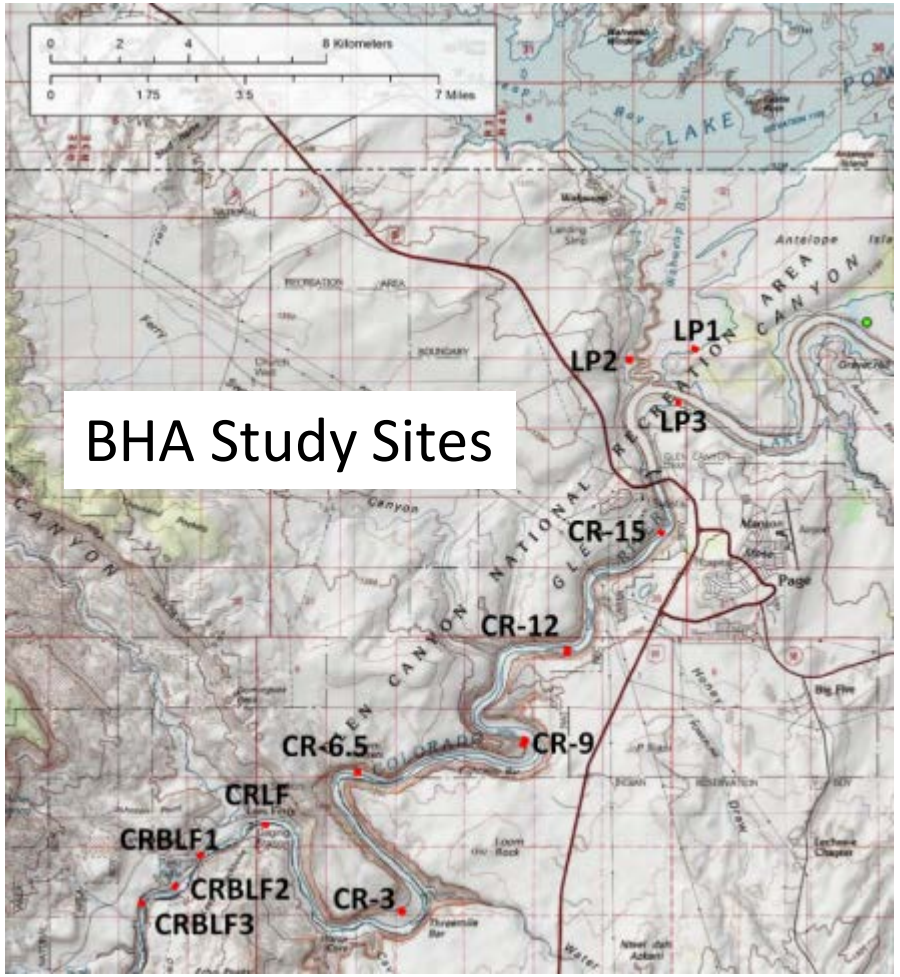
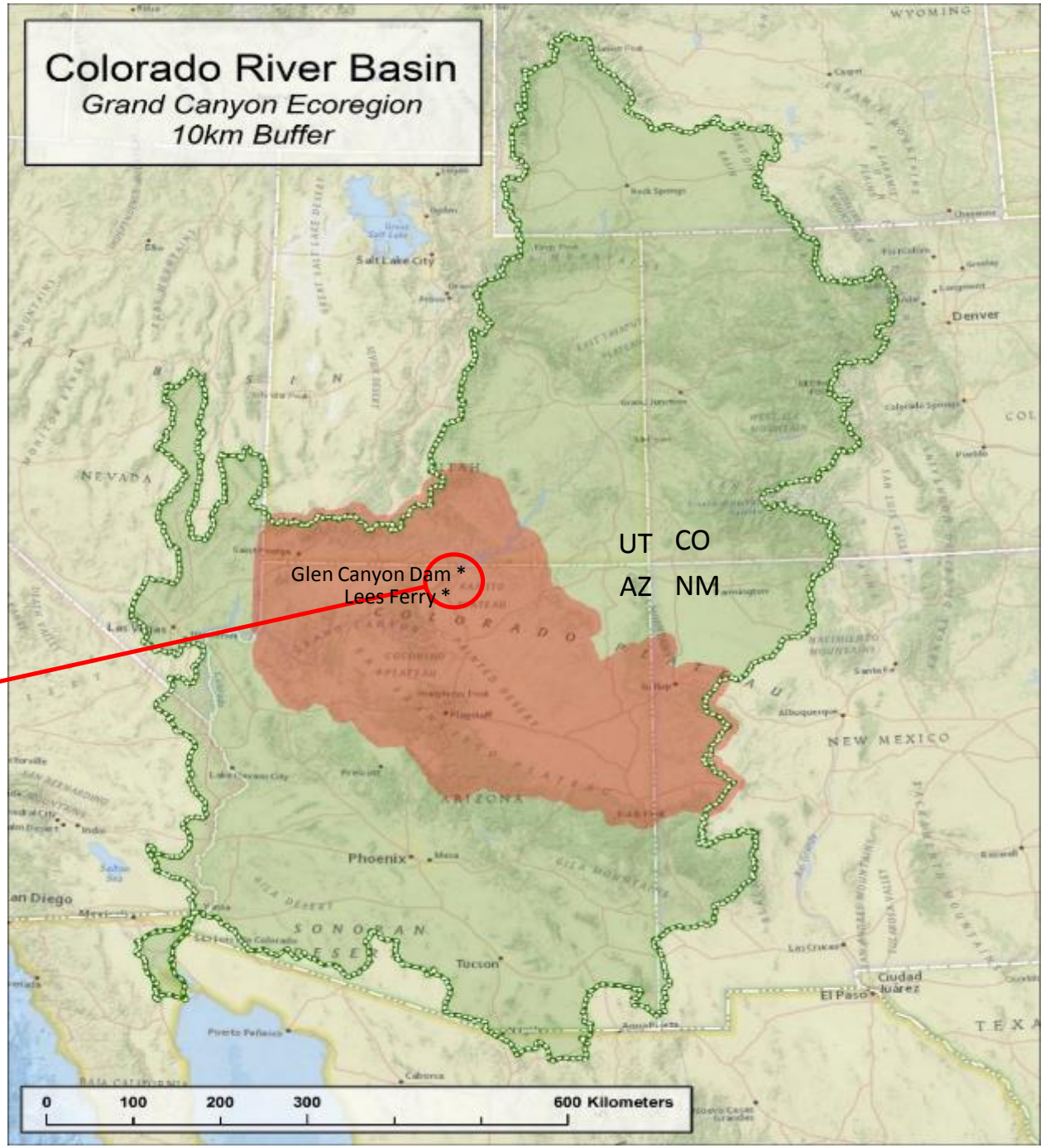
This work was funded by Western Area Power Administration to address foodbase research not funded in the GCDAMP TWP in an effort to broaden our understanding of possible mechanisms that affect the foodbase condition below Glen Canyon Dam.

Scope of Work:

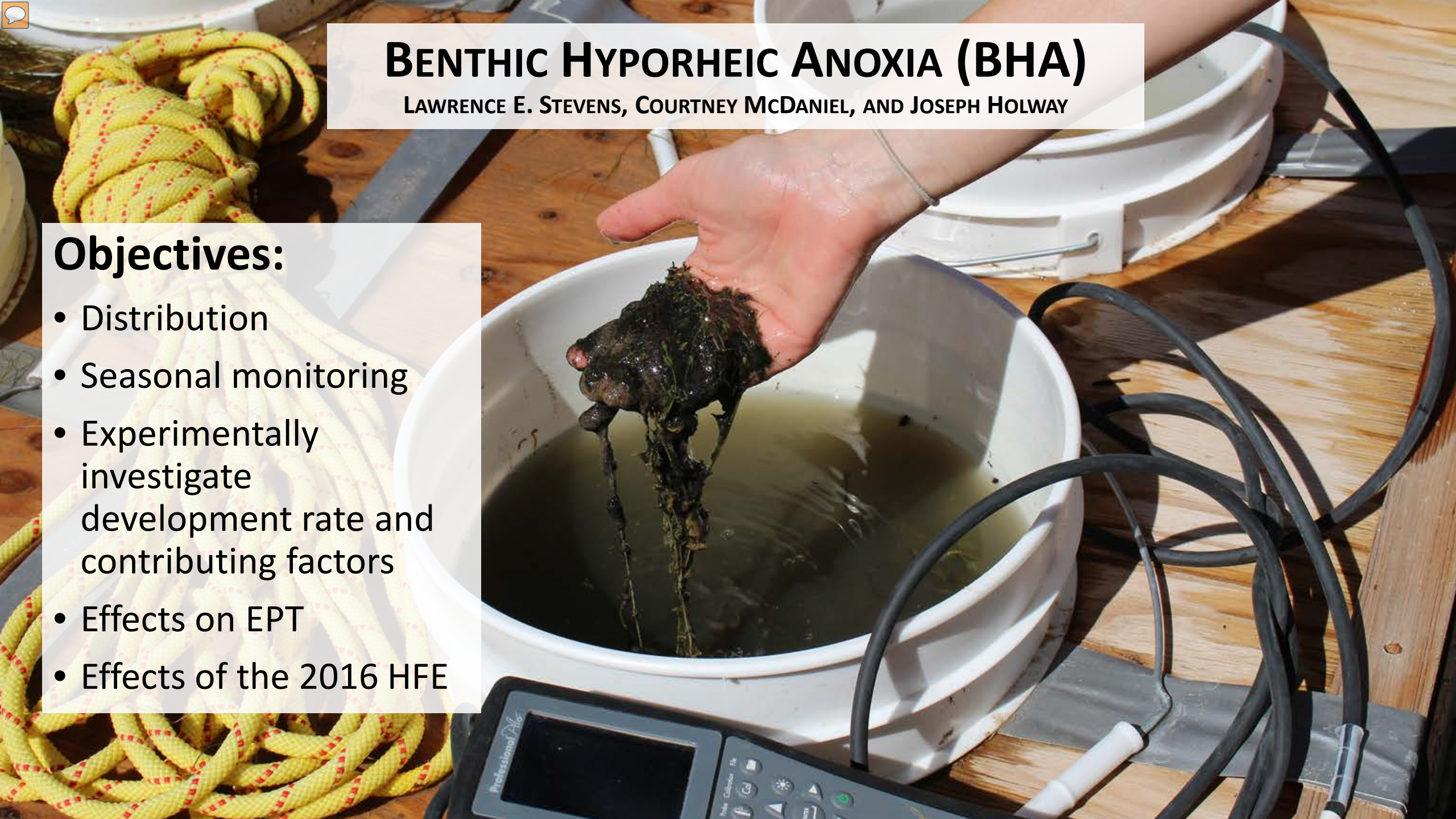
Year 1: Benthic Hyporheic Anoxia (BHA)
Year 2: Hofgnecht Transition in Tapeats Creek





Benthic Hyporheic Anoxia (BHA)

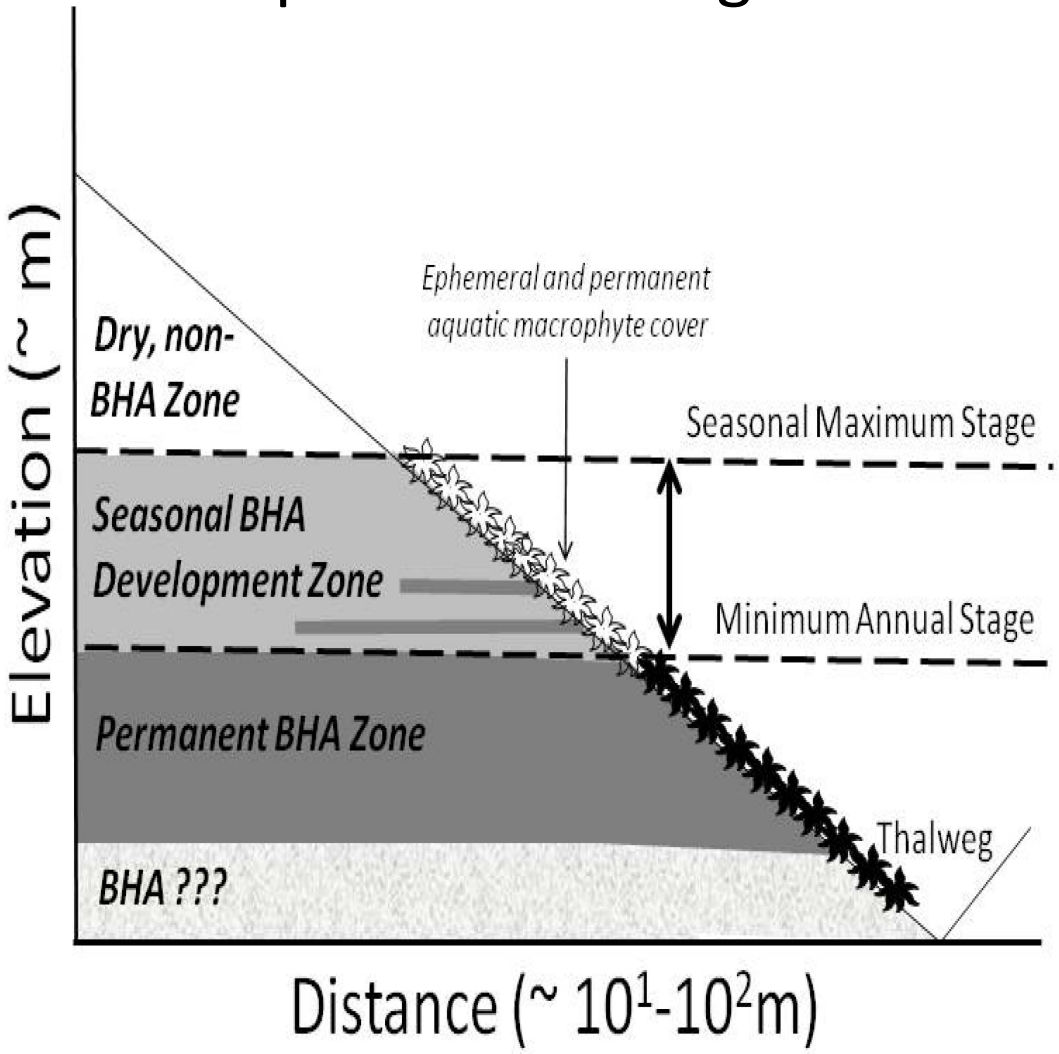
Lawrence E. Stevens, Courtney McDaniel, and Joseph Holway



Objectives:

- Distribution
- Seasonal monitoring
- Experimentally investigate development rate and contributing factors
- Effects on EPT
- Effects of the 2016 HFE

Distribution: BHA omnipresent up to lowest stage

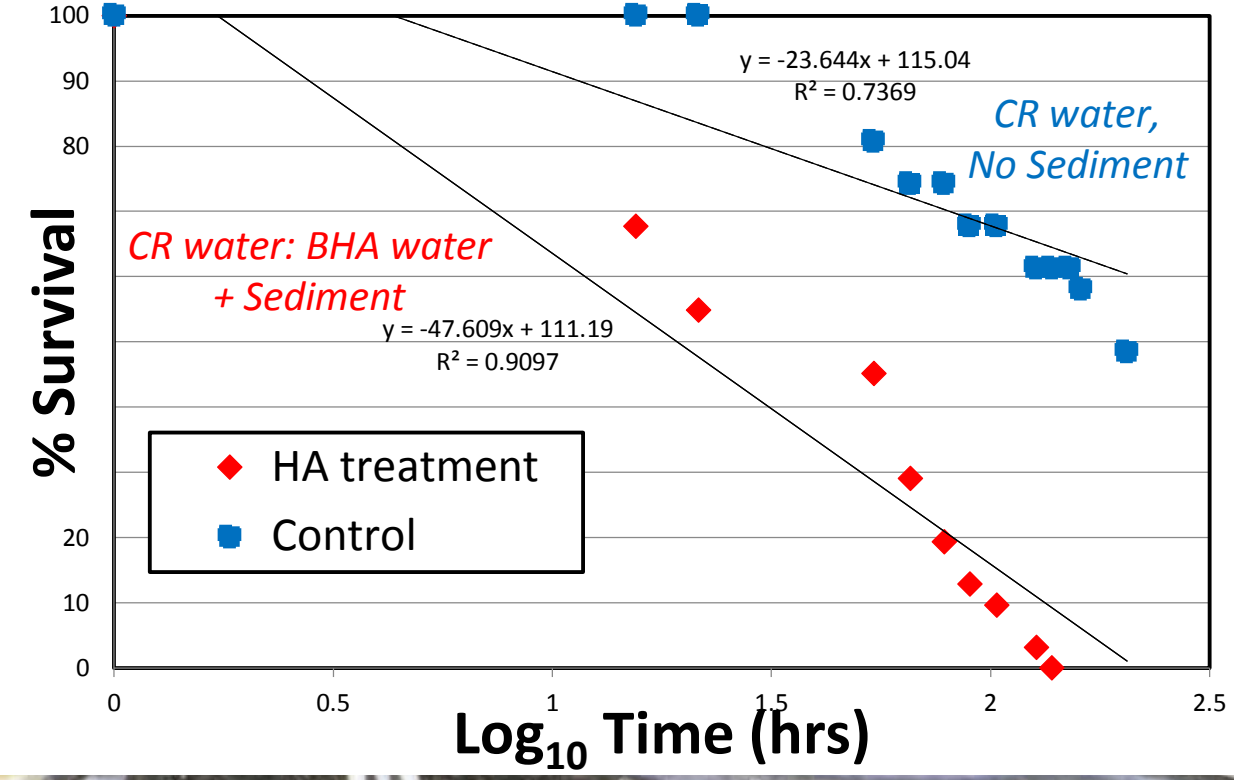


Geochemistry and Macroinvertebrate Responses

- BHA and non-BHA water column geochemistry is ~similar

However

- BHA LD_{50} - *Heptagenia* 18.3 hrs
- Non-BHA LD_{50} - *Heptagenia* 562 hrs



CONCLUSIONS

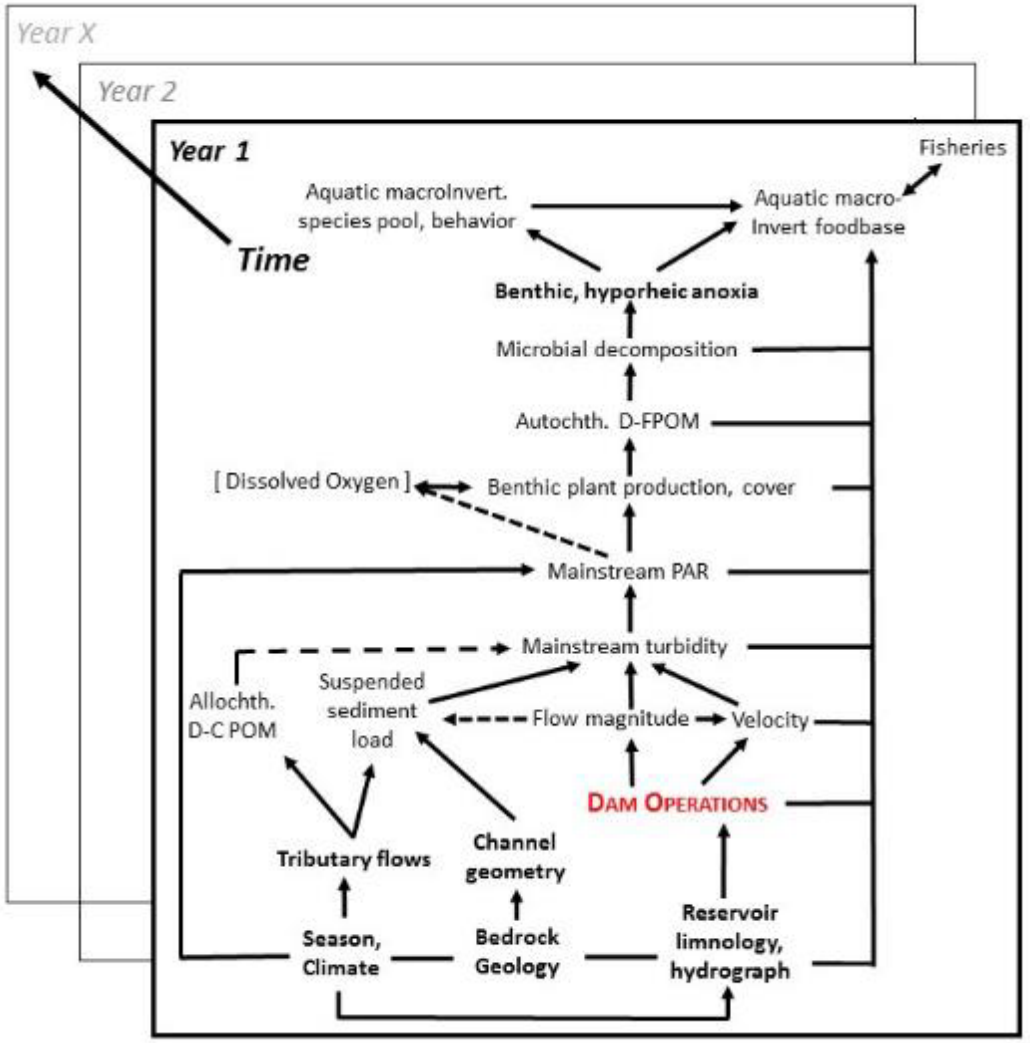
- Located above and below Glen Canyon Dam
- Limited to above Paria River w-expansion downstream unlikely
- Contributors:
  - T_{H2O}
  - Q stability
  - Low DO
  - Chara
- Minor impacts to water quality (water column)
- Detrimental to sensitive macroinvertebrates (EPT)
- Limits aquatic macroinvertebrate assemblage
- Conceptual Model:

Predam Q_{flux}+ Sed_{flux} --> Dam -->

Daily Q_{flux} & High PAR --> Cladophora --> 1996 ROD -->

MLFF Flows --> Chara dominance --> **BHA**

BHA Conceptual Model



Possible mitigation options to reduce the impact of BHA on EPT

- Increase mainstream DO concentration
- Decrease mainstream temperature
- Increase scour or drying of substrates (flow or mechanical)
- Increase mainstream turbidity (limit Chara)
- Other?

Report and publication:
Spring 2018

Colorado River Aquatic Foodbase at the Mouth of Tapeats Creek, Grand Canyon National Park, Arizona

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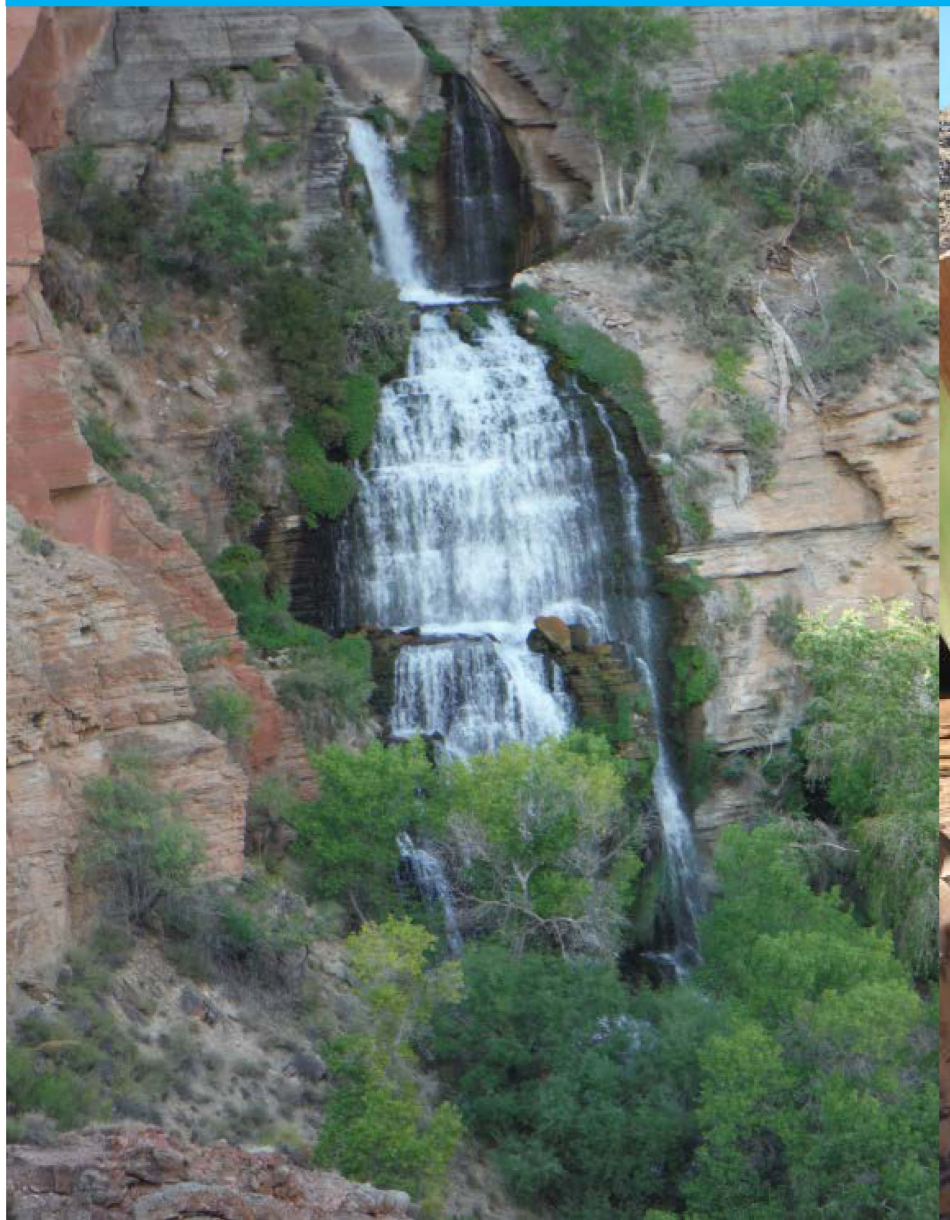


Why Tapeats Creek?

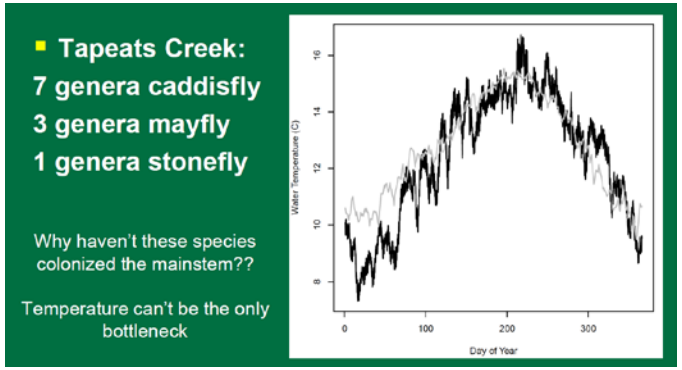
Hofgnecht Transition (1981):

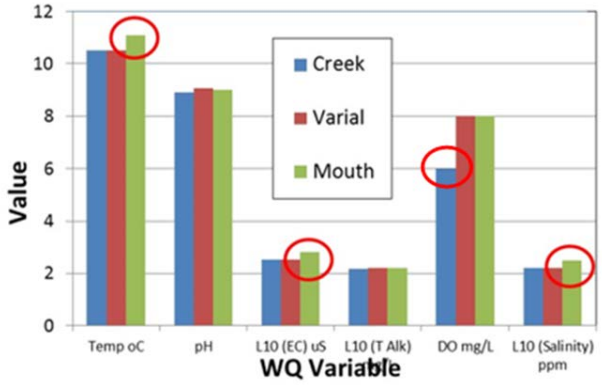
- Discrepancy between tributary and mainstream benthic macroinvertebrate (BMI) biodiversity (esp. EPT)
- Marked riverward decline in species richness at stream confluences in Grand Canyon

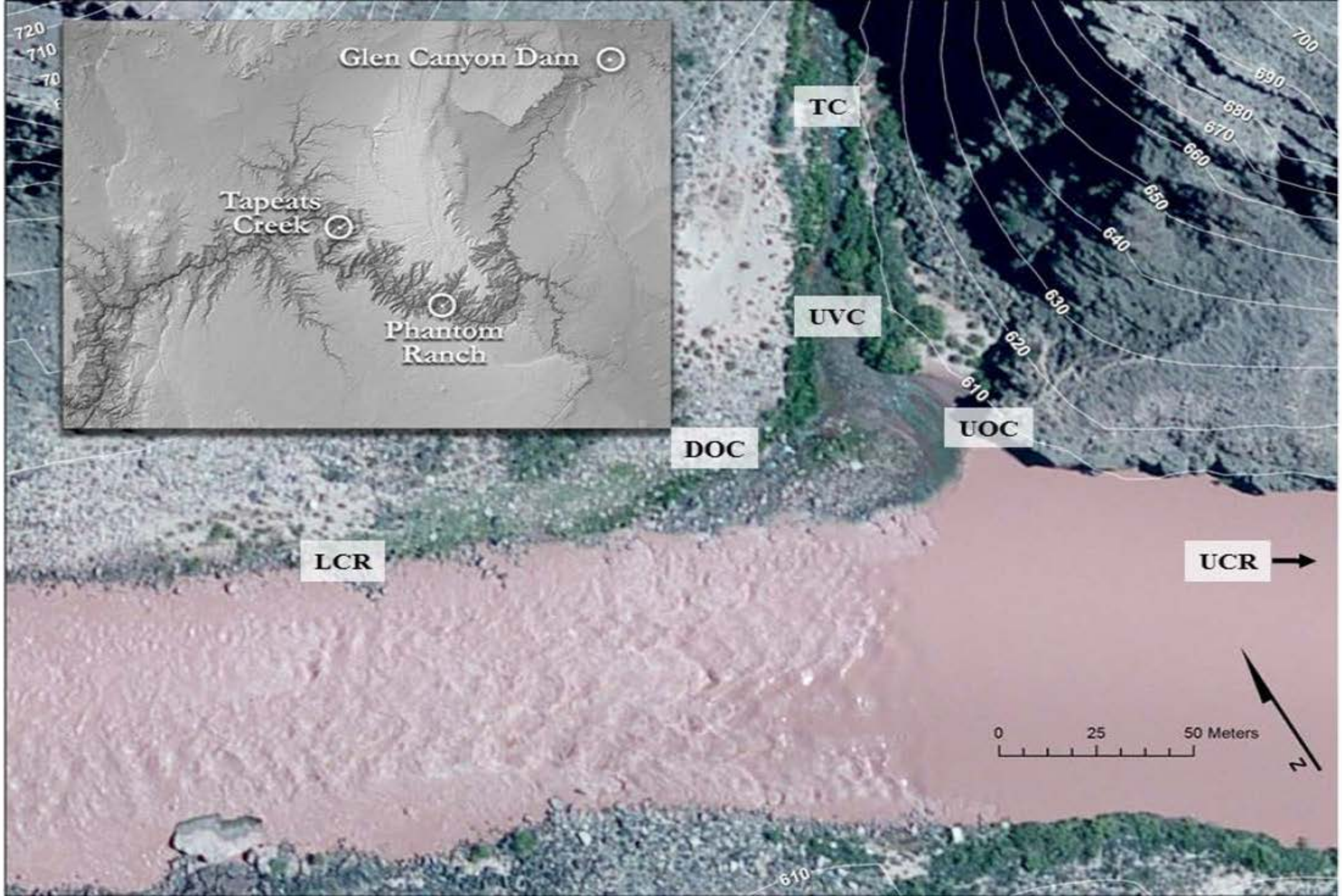
Tapeats Creek is a water quality analog to Glen & Grand Canyons

Question:

Can the rich BMI assemblage of Tapeats Creek be recreated in the regulated Colorado River tailwaters below Glen Canyon Dam?



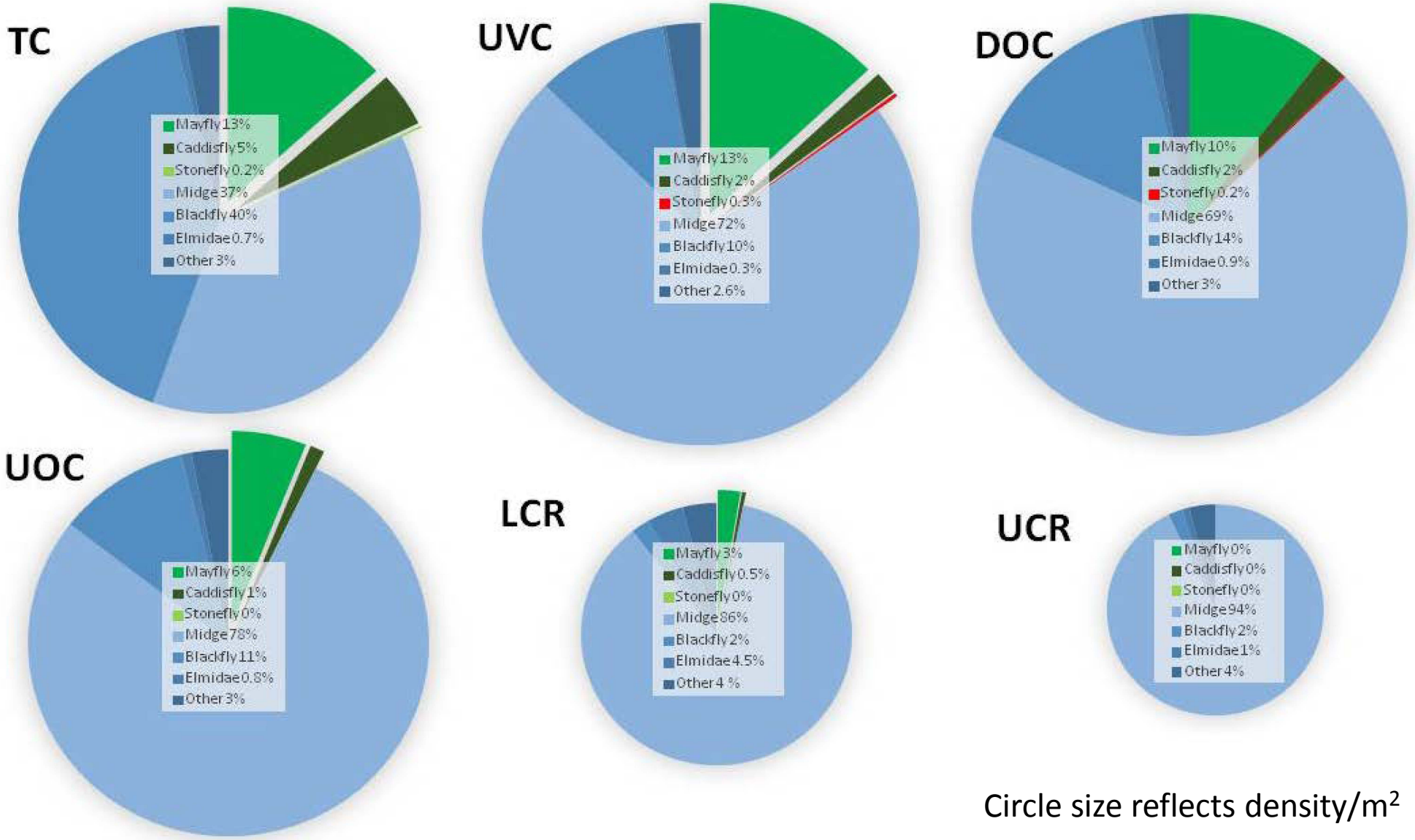



Glen Canyon Dam
Tapeats Creek
Phantom Ranch
TC
UVC
UOC
DOC
LCR
UCR
0
25
50 Meters
N
720
710
700
690
680
670
660
650
640
630
620
610

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

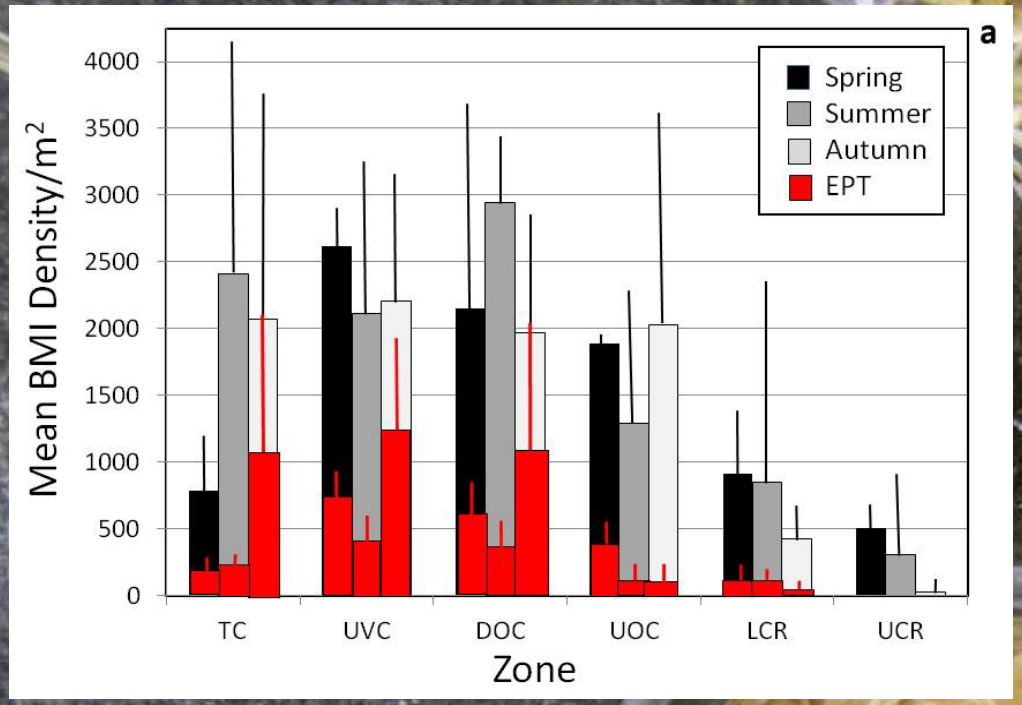
June-July transition Upper Outflow Channel (2017)
Low (~8,000 cfs) vs High (~17,000 cfs)

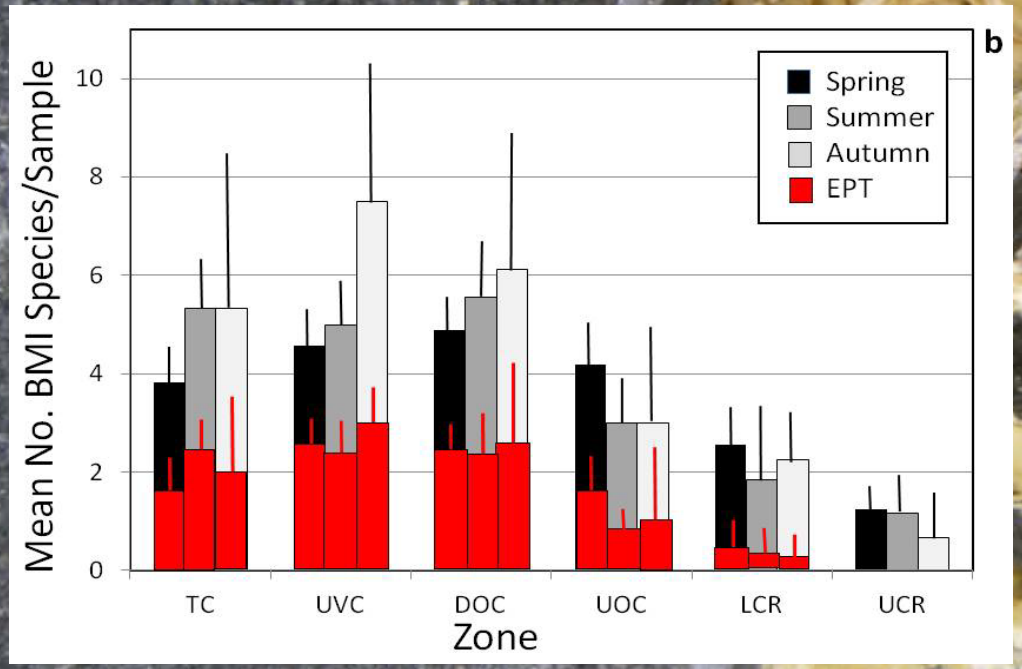
BMI Composition and Abundance Decreases Strongly from Tapeats Creek to the Mainstream

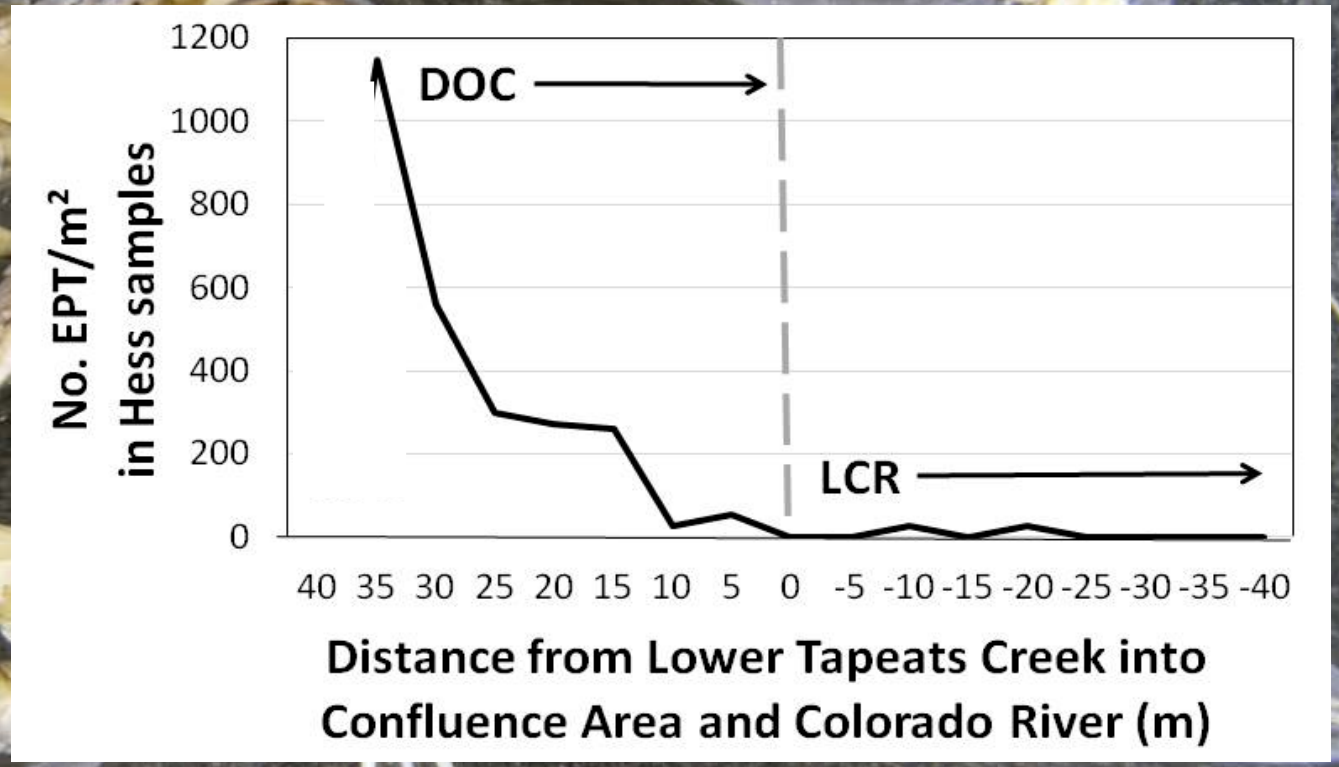


Circle size reflects density/m^2

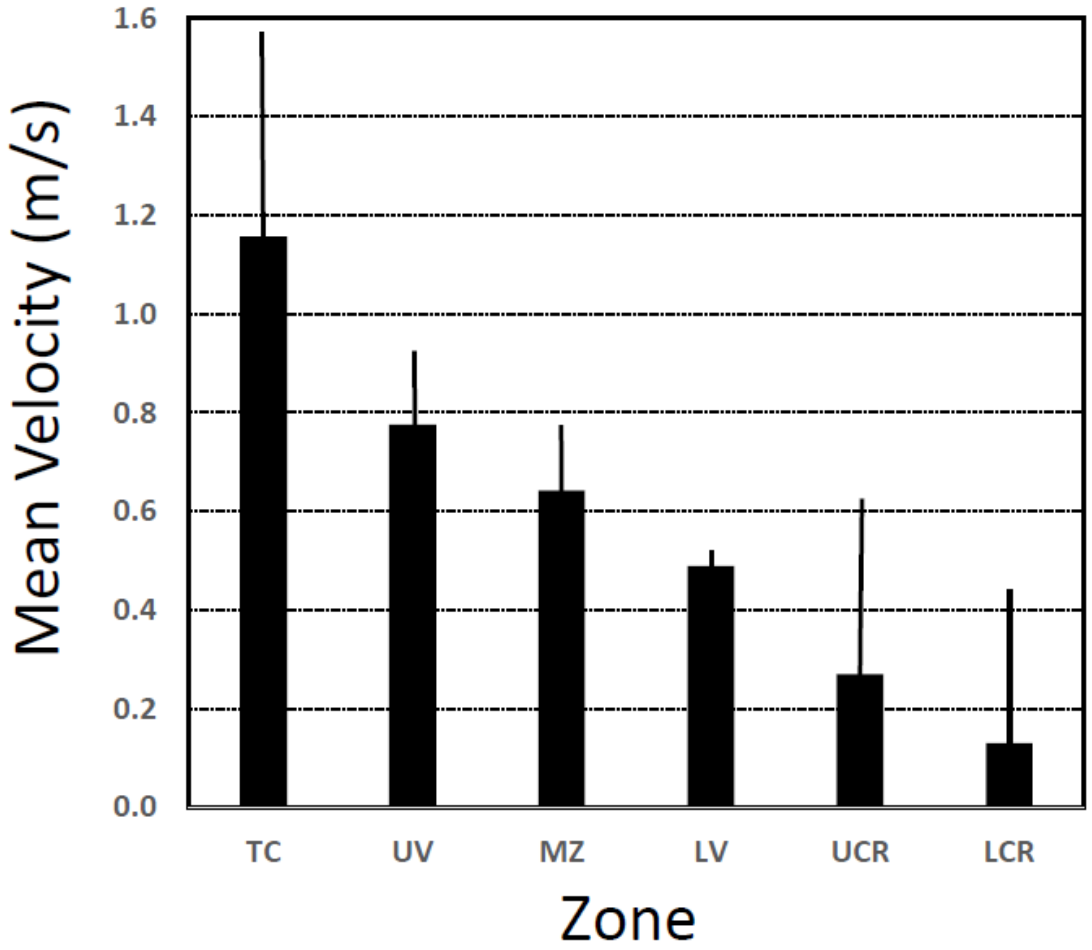
Spatial Variation of BMI Among Zones

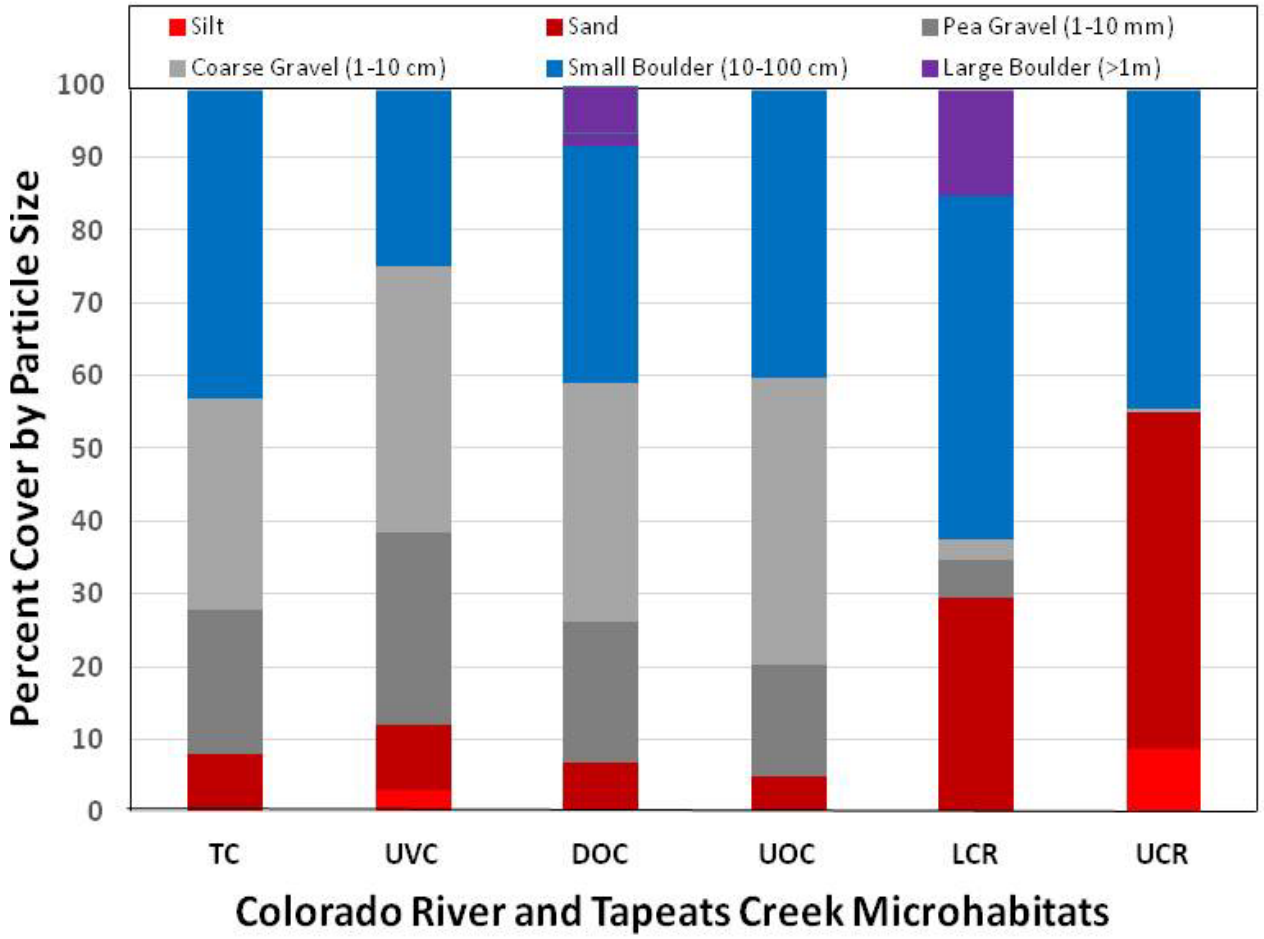






Mean Velocity and Substrate Among Zones



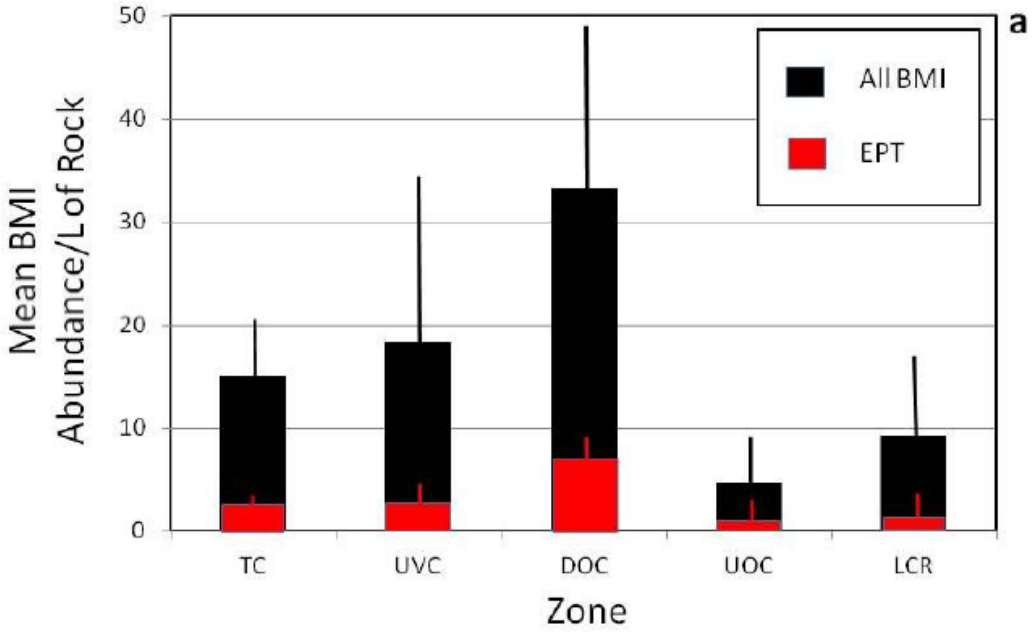


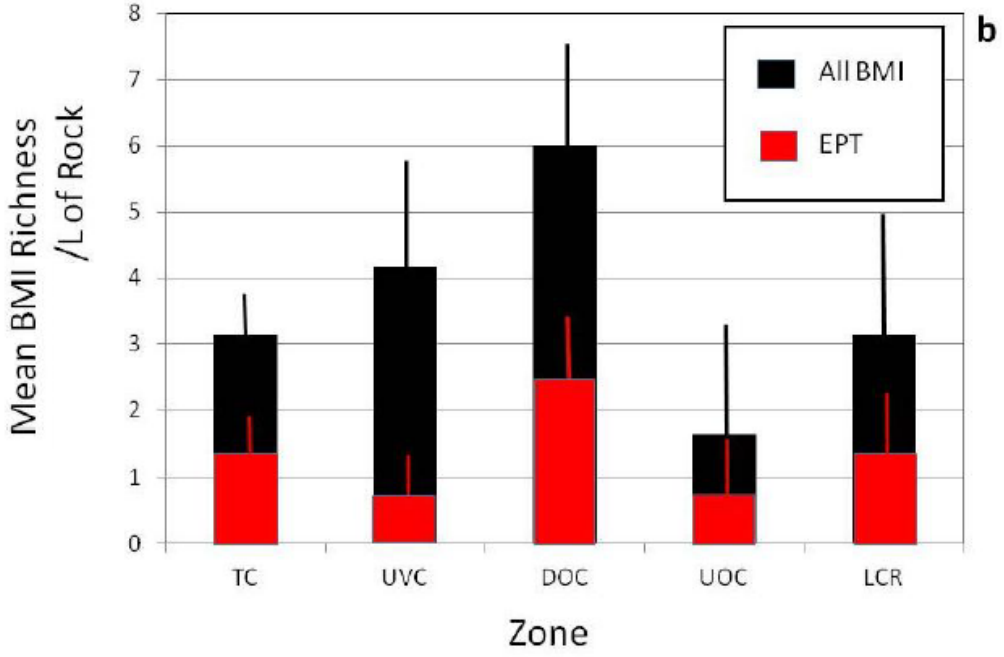
Tapeats Creek benthos (TC/UVC/DOC): Little embeddedness

Colorado River benthos (UCR/LCR): High embeddedness, swash zone

Basket Sampler Results

- BMI and EPT abundance and diversity
- Mainstem = Tapeats Creek
- Quagga colonization





CONCLUSIONS

- High densities and diversity of EPT and other BMI
- Hofgnecht Transition observed
- Transition occurs independent of daily fluctuations
- Water quality similar to mainstem
- Providing suitable habitat in the mainstem allows for colonization equal to Tapeats Creek
- Absence of EPT in the mainstem appears to be due to limitations in larval habitat (sedimentation, embeddedness, flow direction and velocity)
- Model for lack of EPT in the mainstem :

Larval habitat limitation (embeddedness, anoxic substrata)
> Egg desiccation (flow fluctuation)
> Water quality (temp, DO, pH, cond, other geochemistry)

Acknowledgments

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