COLORADO RIVER BENTHIC FOODBASE STUDIES IN GLEN AND GRAND CANYONS

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**SCOPE OF WORK:**

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

*CONMAZUT*

Glen Canyon Dam *
Lees Ferry *

**BHA Study Sites**
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.

- Dry, non-BHA Zone
- Seasonal BHA Development Zone
- Permanent BHA Zone

Elevation (~ m):
- Seasonal Maximum Stage
- Minimum Annual Stage
- Thalweg

Distance (~ 10^1-10^2 m)

Ephemeral and permanent aquatic macrophyte cover.
• 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 $Q_{flux} + Sed_{flux} \rightarrow$ Dam $\rightarrow$
  - Daily $Q_{flux}$ & High PAR $\rightarrow$ Cladophora $\rightarrow$ 1996 ROD $\rightarrow$
  - MLFF Flows $\rightarrow$ Chara dominance $\rightarrow$ BHA
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
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?
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/m²
Spatial Variation of BMI Among Zones

Graph (a): Mean BMI Density/m² by Zone for different seasons (Spring, Summer, Autumn, EPT).

Graph (b): Mean No. BMI Species/Sample by Zone for different seasons (Spring, Summer, Autumn, EPT).
Mean Velocity and Substrate Among Zones

Mean Velocity (m/s)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Mean Velocity (m/s)</th>
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<tbody>
<tr>
<td>TC</td>
<td>1.6</td>
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<tr>
<td>UV</td>
<td>1.4</td>
</tr>
<tr>
<td>MZ</td>
<td>1.2</td>
</tr>
<tr>
<td>LV</td>
<td>1.0</td>
</tr>
<tr>
<td>UCR</td>
<td>0.8</td>
</tr>
<tr>
<td>LCR</td>
<td>0.6</td>
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</table>

Percent Cover by Particle Size

<table>
<thead>
<tr>
<th>Zone</th>
<th>Silt</th>
<th>Sand</th>
<th>Pea Gravel (1-10 mm)</th>
<th>Coarse Gravel (1-10 cm)</th>
<th>Small Boulder (10-100 cm)</th>
<th>Large Boulder (&gt;1m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
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<tr>
<td>UVC</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>DOC</td>
<td>100</td>
<td>90</td>
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</tbody>
</table>

Colorado River and Tapeats Creek Microhabitats
Tapeats Creek benthos (TC/UVC/DOC): Little embeddedness
Colorado River benthos (UCR/LCR): High embeddedness, swash zone
BAKSET 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)
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