Bug Flows Implementation and Resource Response

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Grand Canyon Monitoring and Research Center
Southwest Biological Science Center
U.S. Department of the Interior
U.S. Geological Survey
Workplan Project Summary

- Project F: Aquatic Invertebrate Ecology
  - F.1: Influence of dam operations on the food base
  - F.2: Aquatic food base status at humpback chub monitoring locations
  - F.4: Glen Canyon aquatic food base monitoring and research
- Project Objectives: “To determine how the aquatic food base responds to LTEMP flow experiments such as macroinvertebrate production flows”
- Funding Amount and Source: GCDAMP $811,000 (for all of F)
- Cooperators: None for this presentation
- Products: Next slide
# Products/Reports

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Groundwork for Bug Flows

- Cross, et al. 2013 *Ecological Monographs*
  - Fish in River are food limited
  - Not enough “bug meat”
  - Unstable, low-diversity food base

Native and Nonnative Fish Populations of the Colorado River are Food Limited—Evidence from New Food Web Analyses

Summarized by Kennedy, et al 2013
http://pubs.usgs.gov/fs/2013/3039
Should the River have so few insects?

- Likely not!

Evidence elsewhere in West

Evidence pre-dam

Barry Goldwater

Camp 30, August 8, 1940. 69 ½ Mile:
“I am seated on a rock ledge above the river in the Grand Canyon with dozens of the most pestiferous of all insects, the May fly, hovering around my head…”

From Goldwater 1970, Delightful Journey down the Green and Colorado Rivers

Unpublished data, subject to change, do not cite.
### Does it matter to have so few insects?

From USFWS 5-year review
SSA on Humpback Chub

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<tr>
<th>Resource Category</th>
<th>Upper Basin</th>
<th>Lower Basin</th>
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<tbody>
<tr>
<td></td>
<td>Black Rocks</td>
<td>Westwater Canyon</td>
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<tr>
<td>1. Diverse rocky canyon river habitat</td>
<td>Extant</td>
<td>Extirpated</td>
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<td>2a. Suitable flow</td>
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<td>2b. Suitable temperature</td>
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<td>3. Adequate and reliable food supply</td>
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<td>4. Habitat with few nonnative predators and competitors</td>
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<td>5. Suitable water quality</td>
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<td>6. Unimpeded range and connectivity</td>
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<td>7. Persistent populations</td>
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<td>8. High genetic diversity</td>
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- The main issue for Humpback Chub in Grand Canyon
But WHY so few aquatic insects?

- Typical insect life cycle
- Studying multiple life stages yields insight

Citizen science program:
- Light traps for adult insects

From Kennedy, Muehlbauer, and others, 2016, BioScience
Groundwork for Bug Flows

  - Light trap data
  - Throughout Canyon: Spatial pattern in midges
    - High midge counts: low water at dusk
    - Low midge counts: high water at dusk

USGS
Groundwork for Bug Flows

  - Midges (and most other aquatic insects): ‘Cement’ eggs on river edges

Data synthesized from Statzner & Beche 2010, *Freshwater Biology*
Groundwork for Bug Flows

  - Midges (and most other groups): Lay eggs on river edges
  - Eggs dry out, die after ~ 1 hour

Data from Scott Miller, BLM/USU BugLab
Groundwork for Bug Flows

  - Midges (and most other groups): Lay eggs on river edges
  - Eggs dry out and die after ~1 hour
  - Eggs laid at high water die
    - Explains spatial pattern
    - Explains low production/diversity

*Poor egg-laying conditions in Grand Canyon (flow-related)*
Purpose of Bug Flows Experiment

- Improve egg-laying conditions for insects!

- Therefore:
  - Increase midge abundance
  - Increase sensitive EPT abundance/diversity (longer term?)

- Ultimately:
  - Improve fish food base
Design of Bug Flows

- “Give bugs the weekends off!”
- May – August 2018
- Stable, low flows on summer weekends
  - Eggs laid on weekends won’t dry/die
Predicted Responses (long-term)

- Smoothing of spatial pattern
- More midges throughout Canyon

When? Starting 2019

Unpublished data, subject to change, do not cite.
Predicted Responses (long-term)

- Smoothing of spatial pattern
- More midges throughout Canyon
- More caddisflies (EPT)

*When? Starting 2019*

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Bug Flows Monitoring Program

- **Light traps**
  - ~ 1000 samples per year, throughout Canyon
  - Data were the basis for Bug Flows

- **Invertebrate Drift**
  - 10+ year dataset at Lees Ferry
  - Correlated w/ light traps throughout Canyon
  - Food directly available to fish

- **Sticky traps**
- **Egg surveys**
Early results from Glen Canyon
Early results from Glen Canyon (other monitoring)

- May 2018: “It’s buggy out there!”
- Sticky traps: massive emergence event

- Summer 2018: Overall more midges than any other year
Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -6

May weekends: High egg-laying

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Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -6

May weekends: High egg-laying

Unpublished data, subject to change, do not cite.
Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -13

May weekends: High egg-laying

Tens of thousands of egg “ropes”
Early results from Glen Canyon (other monitoring)

Bug Flows

Many emergent rocks

Load-Following

One emergent rock rock

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Early results from Glen Canyon (other monitoring)

- August 2018: Weekday vs. weekend study
  - More emergence on weekends:
    - Unexpected egg-laying benefit of Bug Flows
  - More eggs to hatch
  - Better fishing on weekends
    (AZGFD Creel)
Canyon-wide results
Canyon-wide results

- Weekdays vs. weekends:
  - More midges emerging on “weekend water”

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Canyon-wide results

- **Prediction:** Sine wave flattens
- **Result:** Yes, but different than expected
Canyon-wide results

- **Prediction:** More midges canyon-wide (>1 years)

- **Result:** Encouraging initial signs (more drift after Bug Flows)

Unpublished data, subject to change, do not cite.
Canyon-wide results

- **Prediction:** More caddisflies (>1 years)

- **Result:** Caddisfly population boom in 2018

Unpublished data, subject to change, do not cite.
Conclusions

- Bug Flows in 2018 had ecosystem-wide effect
  - Flow matters!
- More egg-laying, weekend activity
- Less canyon-wide variability (↓ sine)
- More midges (maybe)
- Caddisfly explosion (definitely)

Hard to say all of this is definitely due to Bug Flows. 2019 will be telling!
Potential Next Steps

- **Robust, 3-year test**
  - Conduct Bug Flows again: 2019, 2020

- **Expand experiment into other months?**
  - Earlier (spring): Natural life history timing?
  - Later (fall): Food when critical for fish?

- **Continued monitoring regardless**
  - Effect of 2018 Bug Flows propagates