Bug flow optimizations and predictions

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with content and input from
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FY15-17 Project 5
FY18-20 Project F
Why Bug flows?

- Daily hydropower flows create “tides”
- Insects lay eggs at water line at dusk
- When tide drops, eggs dry, die

Kennedy et al. 2016
*BioScience*
How do we know?

- Water takes time moving through Canyon
- Some places high water at dusk
- Other places low water at dusk

Kennedy et al. 2016
*BioScience*

Midges track these patterns!
Goals of Bug flows

- Improve egg-laying conditions for bugs!

Thus:

- Increase abundance of midges

- Increase abundance/diversity of EPT
  - (mayflies, stoneflies, caddisflies)

- Make fish fat and happy

Yum
What is a Bug flow?

- “Give bugs the weekend off”
- Stable low flows on summer weekends
- Eggs laid on weekends never dry

Unpublished data, subject to change, do not cite.
Have we been here before?

- Past steady flows have occurred
  - But…

- Summer 2000: Looked for effects *during* flow
  - (no robust monitoring of after-effects)

- 2008-2012: Steady low flows Sept/Oct
Previous fall steady low flows

- Sept/Oct past peak of bug activity
- Not much egg-laying going on

2012-2014 Light trap data

Unpublished data, subject to change, do not cite.
Did we see a fall steady response?

- Not really (no surprise)
- Plus, lots of other things going on
  - HFEs, Phosphorous, light traps just starting, etc.

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What is a Bug flow?

- “Give bugs the weekend off”
- Stable low flows on summer weekends
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Original Bug flow proposal

- Stable low flows on weekends
- Weekend water level = weekday low level
Nuance in a 225-mile-long canyon

- What works at Lees Ferry:

- Doesn’t work at Diamond Creek:

  \[ \text{Relative stage (ft)} \]
  \[ \text{RM 0 (Lees Ferry)} \]
  \[ \text{RM 225 (Diamond Creek)} \]

> \( \frac{1}{2} \text{ ft stage change “BAD”} \)

Unpublished data, subject to change, do not cite.
The fix

- Take less water out of weekends

  Raises weekend baseline downstream

  Can make conditions as ideal as possible:
  1. Canyon-wide
  2. Or, at certain sites

Tradeoffs!

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Bug flows optimization

- Take CRFS model from Sed. guys
  - 218 cross sections throughout Canyon

- Take hydrographs from WAPA
  - “Add” 500 cfs, 1000 cfs, etc. to weekends

- Run a bunch of simulations

- Try to minimize:
  - $\Delta$Stage = weekday low – weekend steady stage

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Canyon-wide optimization

- $\sum |\Delta \text{Stage}|$ across all cross sections (Lower = better)
- $H =$ cfs “added” to weekend
- $\sim H1000$ best across all months

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Canyon-wide optimization

- $\sum |\Delta \text{Stage}|$ across all cross sections (Lower = better)
- $H =$ cfs “added” to weekend
- $\sim H1000$ best across all months

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Site-specific optimizations

- Look at sites of particular interest
  - All individual cross sections
  - RM 0 (Lees Ferry)
  - RM 61 (LCR)
  - RM 157 (Havasu Creek)
  - RM 200 (Parashant)
  - RM 225 (Diamond Creek)

- Higher “H” needed farther downstream

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What do we expect?

- Focusing on light trap data
  - ~ 1000 samples per year, throughout Canyon
  - Robust dataset for tracking response

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Kennedy et al. 2016
*BioScience*
What do we expect?

1. More midges
2. More EPT, more diversity?

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Predicted response: EPT

- (Mostly caddisflies)

- Abundances increase
  - Come closer to midge counts
Predicted response: EPT

- Less tied to tributaries
  - Again, resemble midges

Unpublished data, subject to change, do not cite.
Predicted response: Midges

- Take existing pattern
- Get amount of time at dusk, with < 5” daily Δstage
  - 218 sites
- Base flow and optimized Bug flow scenarios

Unpublished data, subject to change, do not cite.
Predicted response: Midges

- Build a shiny, new model

- Result: Optimized Bug flow improves conditions

  - (Just about everywhere)
Predicted response: Midges

- Improved by how much?
  - 26%, canyon-wide

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Thanks!

- Bug pickers (for counting the bugs)
- All the bugs (for science)
- Mike Dodrill, Sed guys, and WAPA (for the models and data)
- Y’all (for listening to a 20 minute talk about bug modeling)