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science for a changing world

Bug flow optimizations and predictions

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with content and input from

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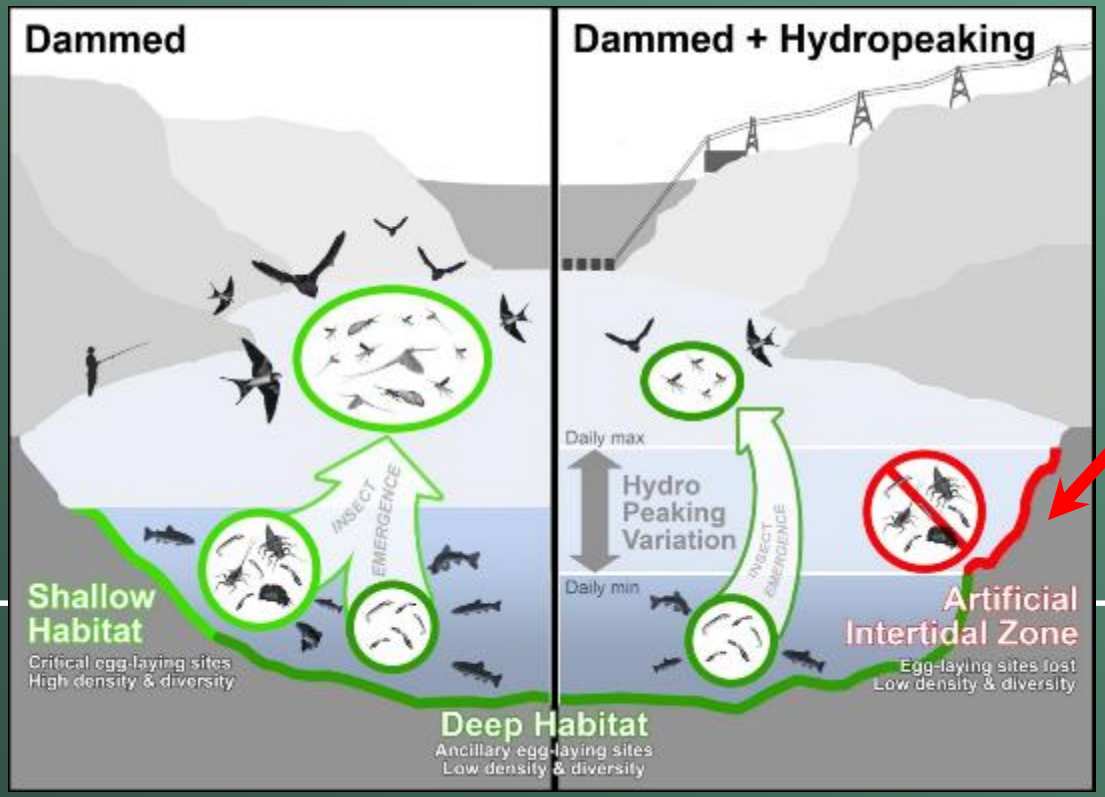
U.S. Department of the Interior
U.S. Geological Survey

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



Want to avoid this

Kennedy et al. 2016
BioScience

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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!

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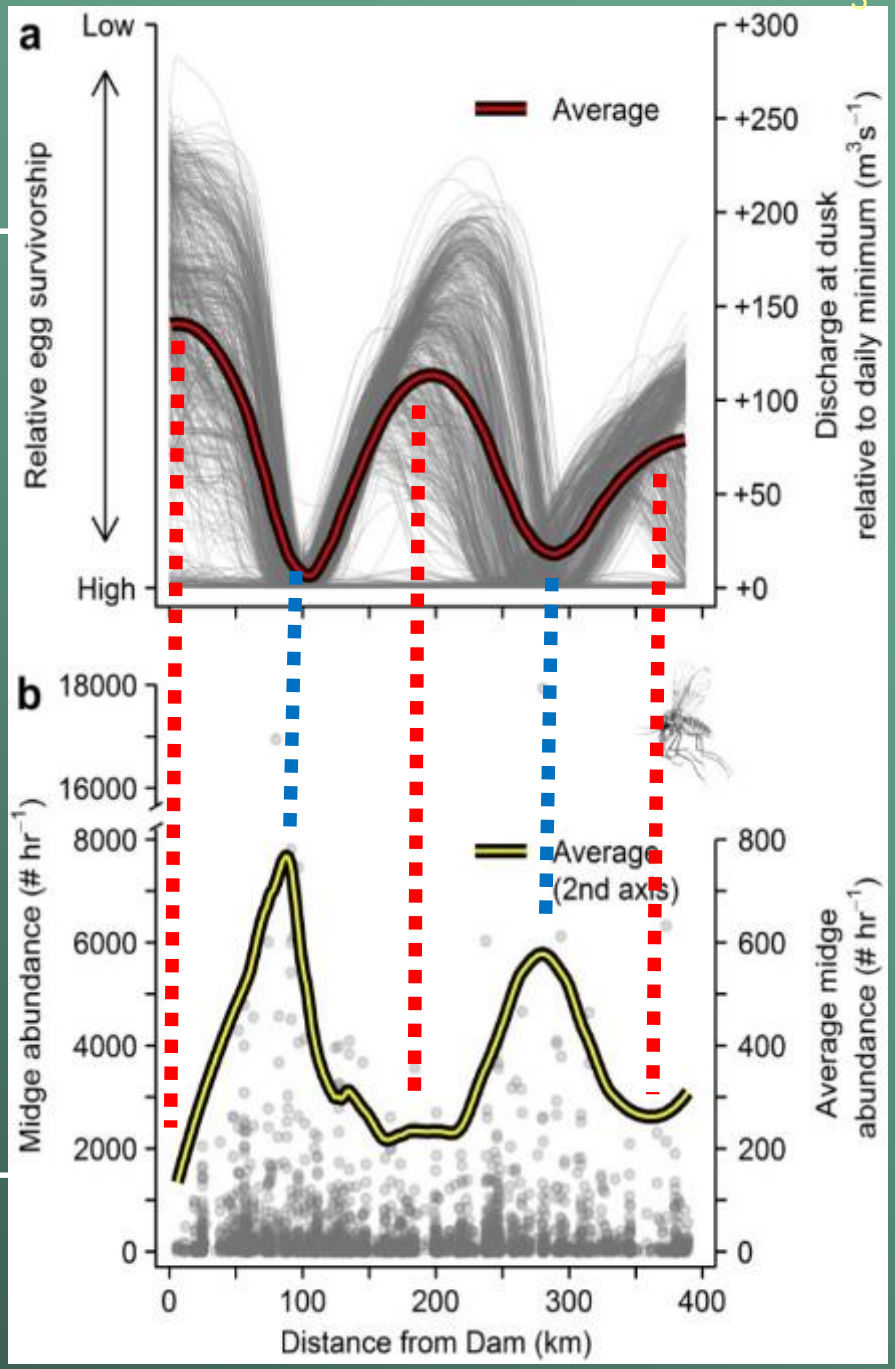
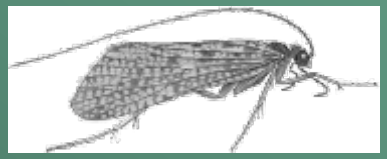


Goals of Bug flows

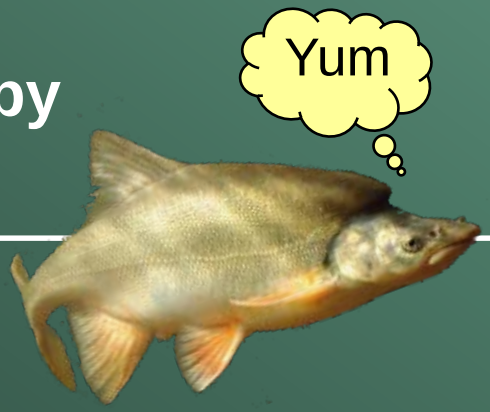
- Improve egg-laying conditions for bugs!

- Thus:
  - Increase abundance of midges

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



  - Make fish fat and happy



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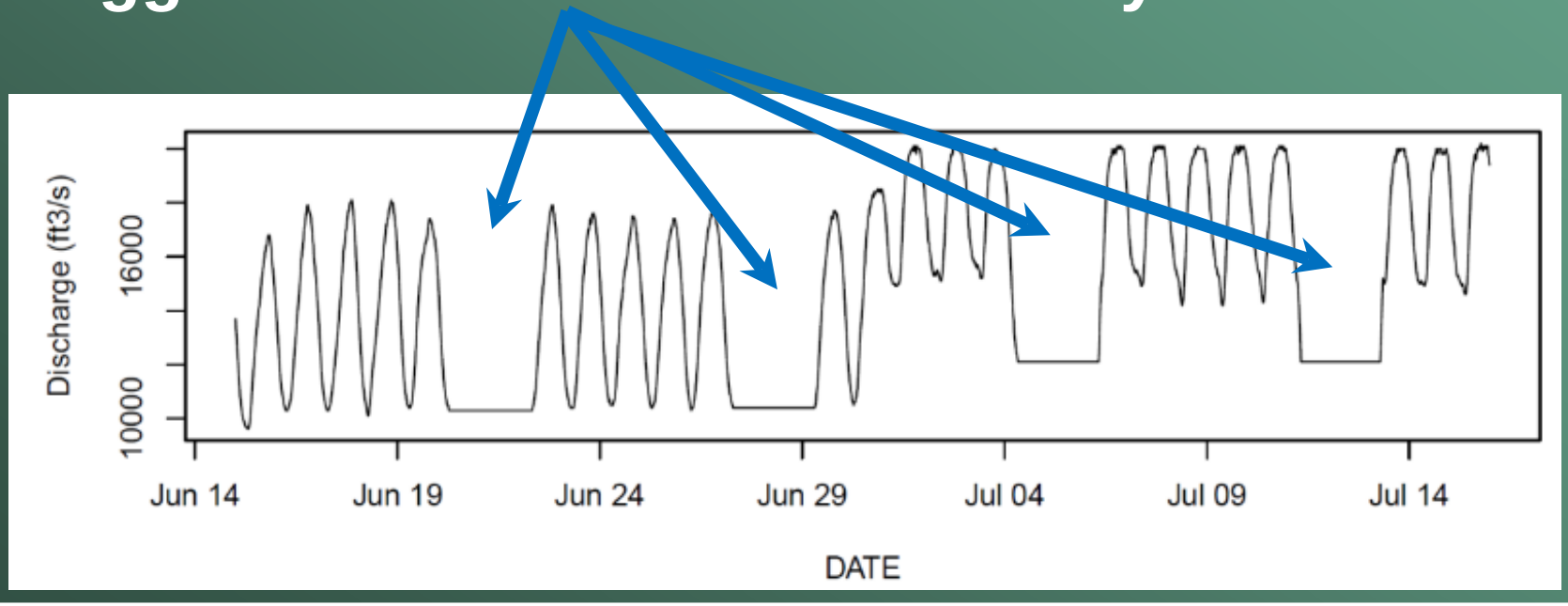
What is a Bug flow?

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



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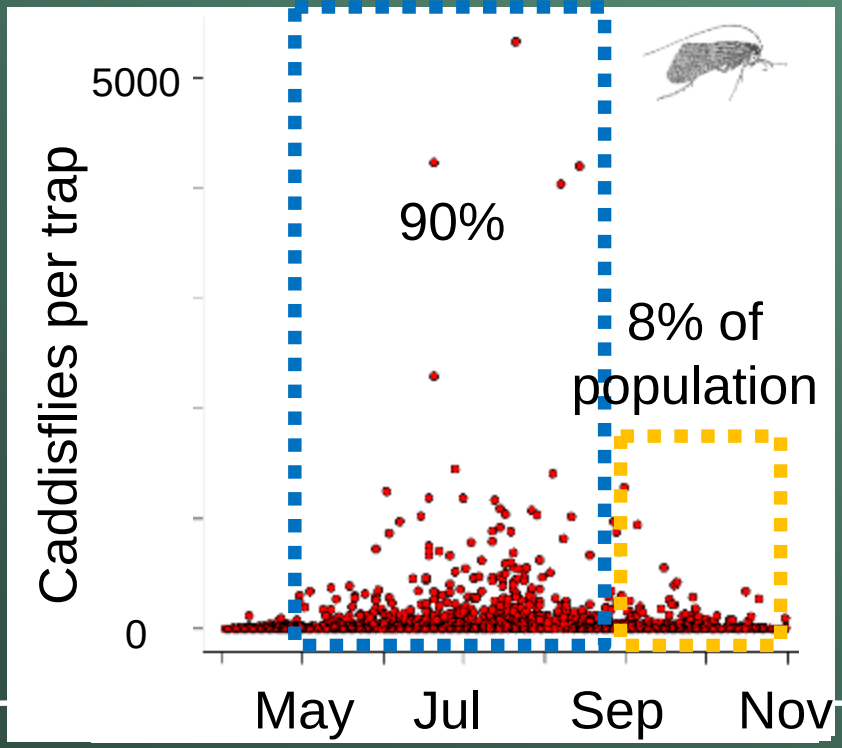
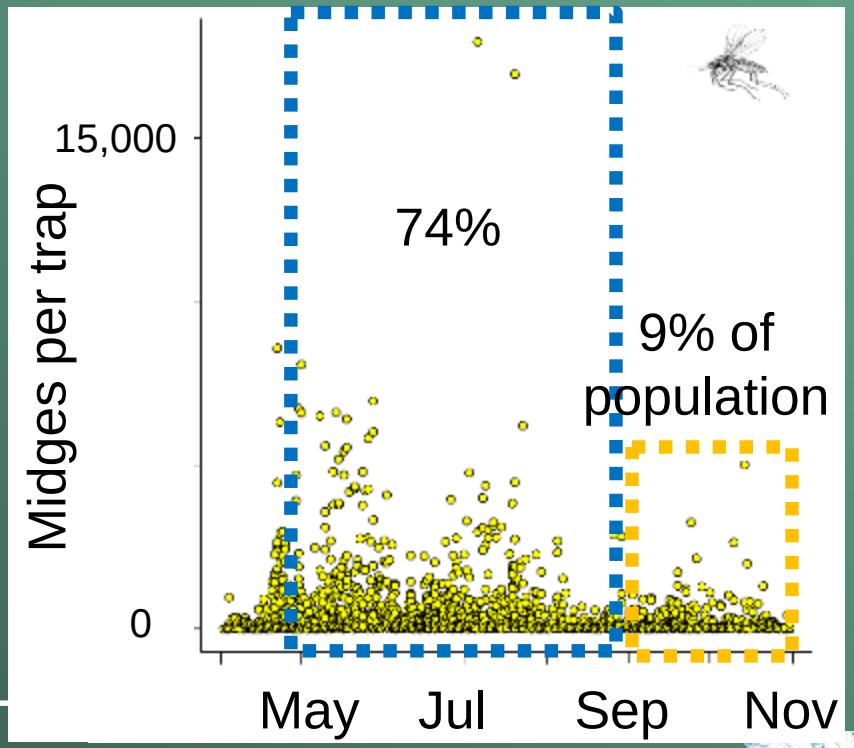
Have we been here before?

- 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





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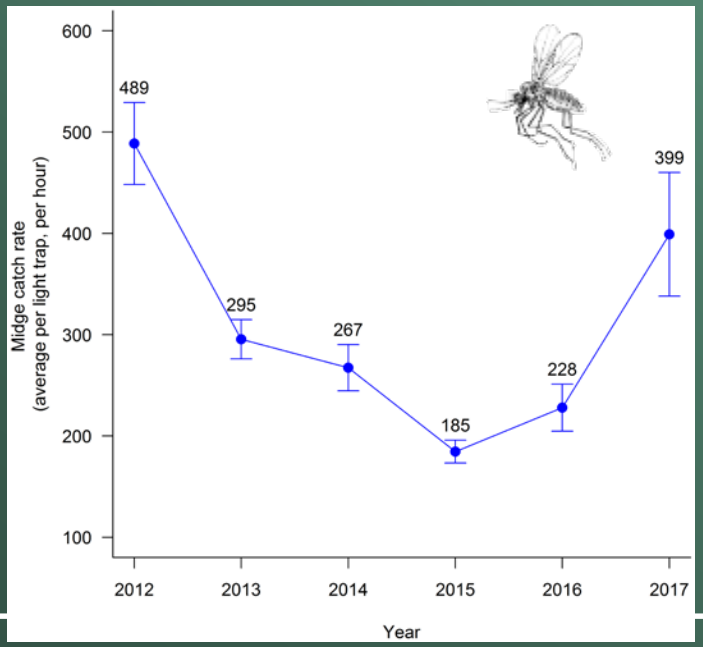
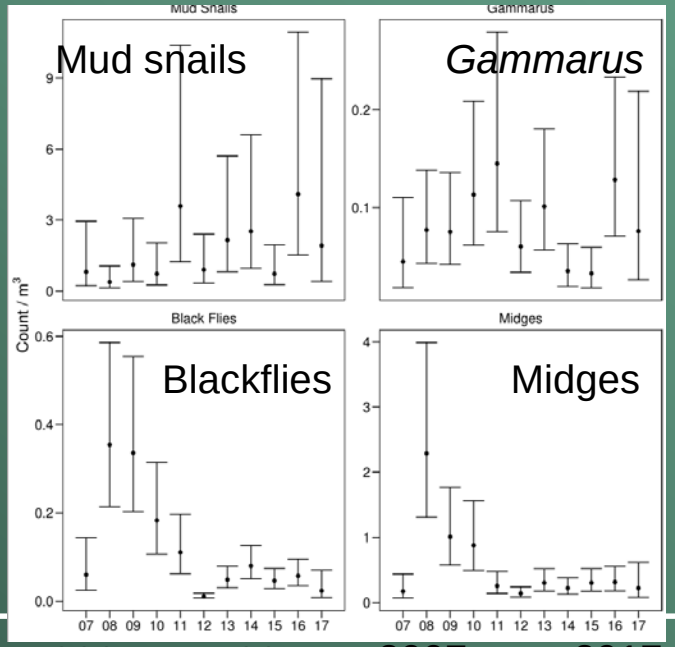
2012-2014 Light trap data

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.





2007 2017 2007 2017

Light traps

Drift

Unpublished data, subject to change, do not cite.

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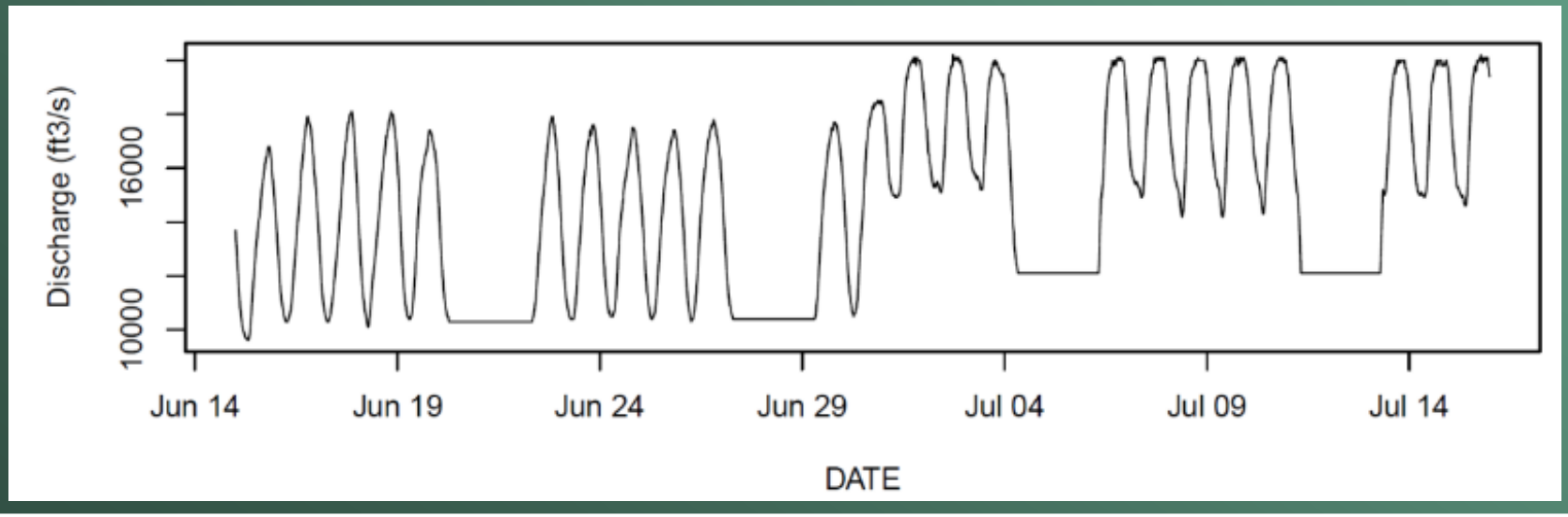

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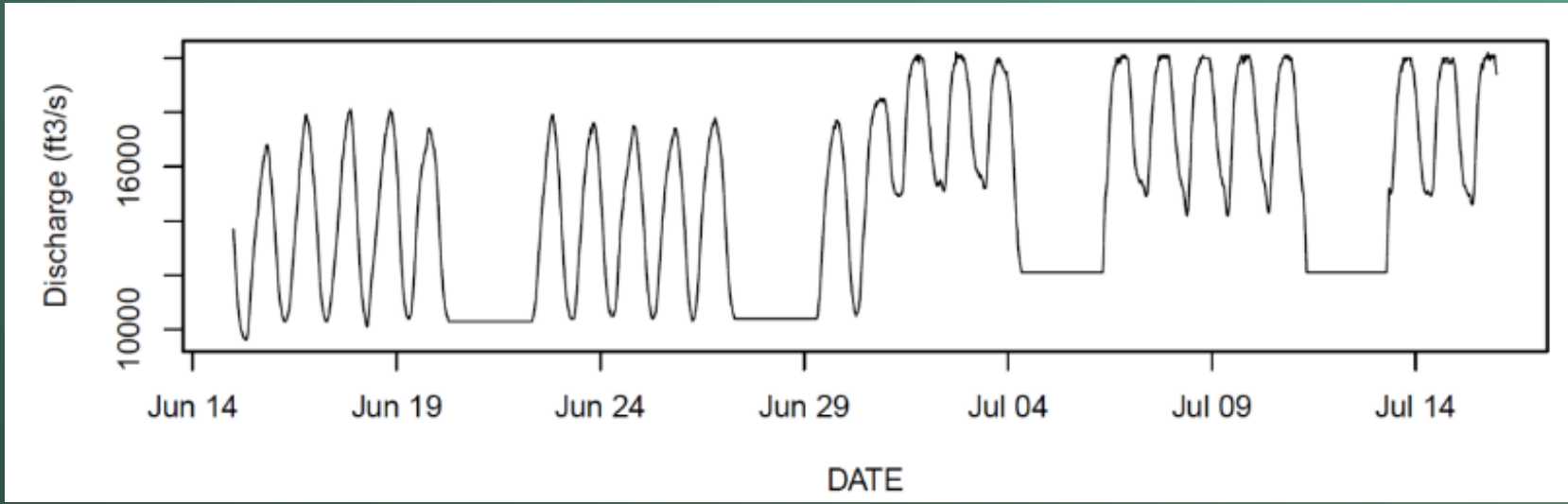
Original Bug flow proposal

- Stable low flows on weekends
- Weekend water level = weekday low level



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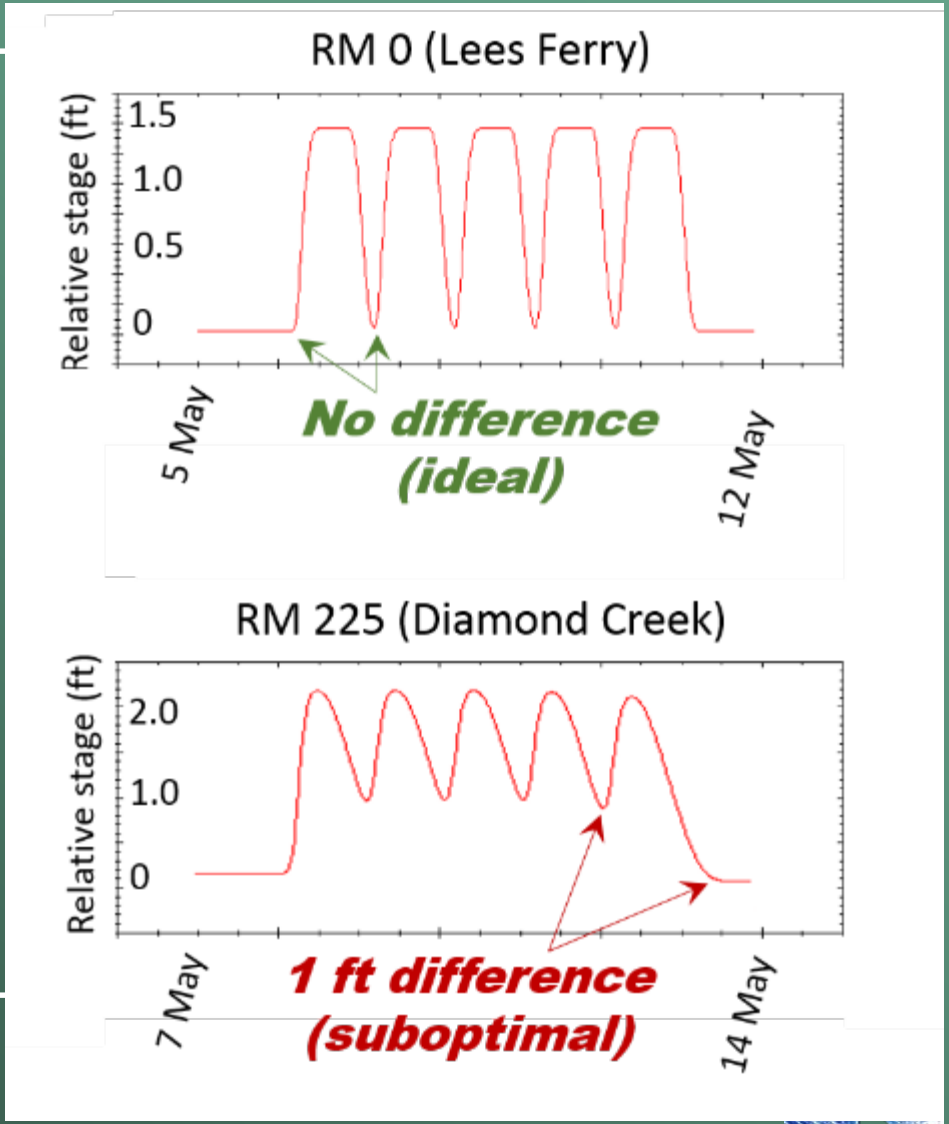
Nuance in a 225-mile-long canyon

- **What works at Lees Ferry:**

- **Doesn't work at Diamond Creek:**

> ½ ft stage change "BAD"



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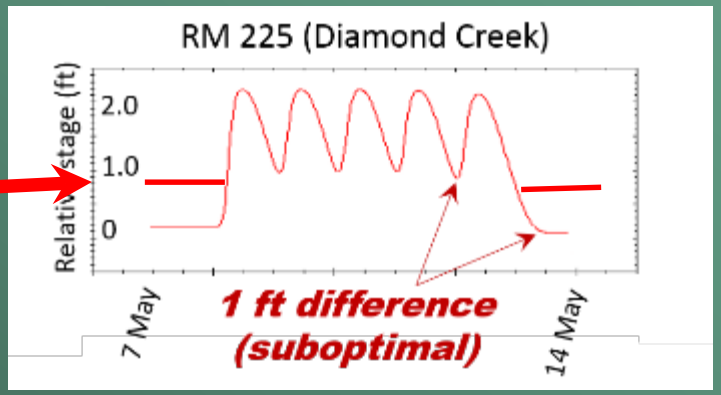
The fix

- **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:
  - ΔStage = weekday low – weekend steady stage

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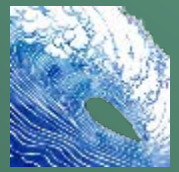
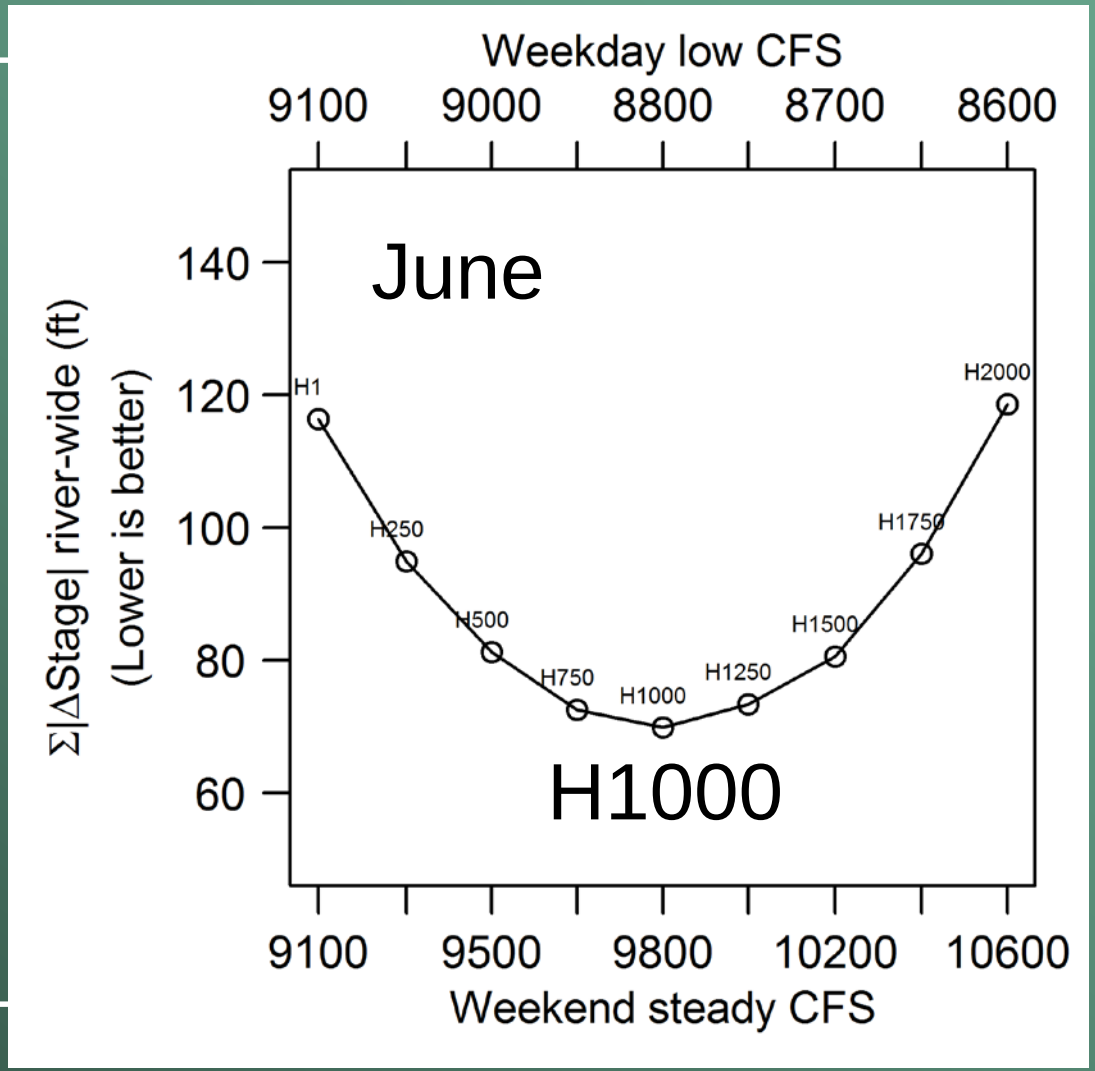


Canyon-wide optimization

- **Σ|ΔStage| across all cross sections (Lower = better)**
- **H = cfs "added" to weekend**
- **~ H1000 best across all months**



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Canyon-wide optimization

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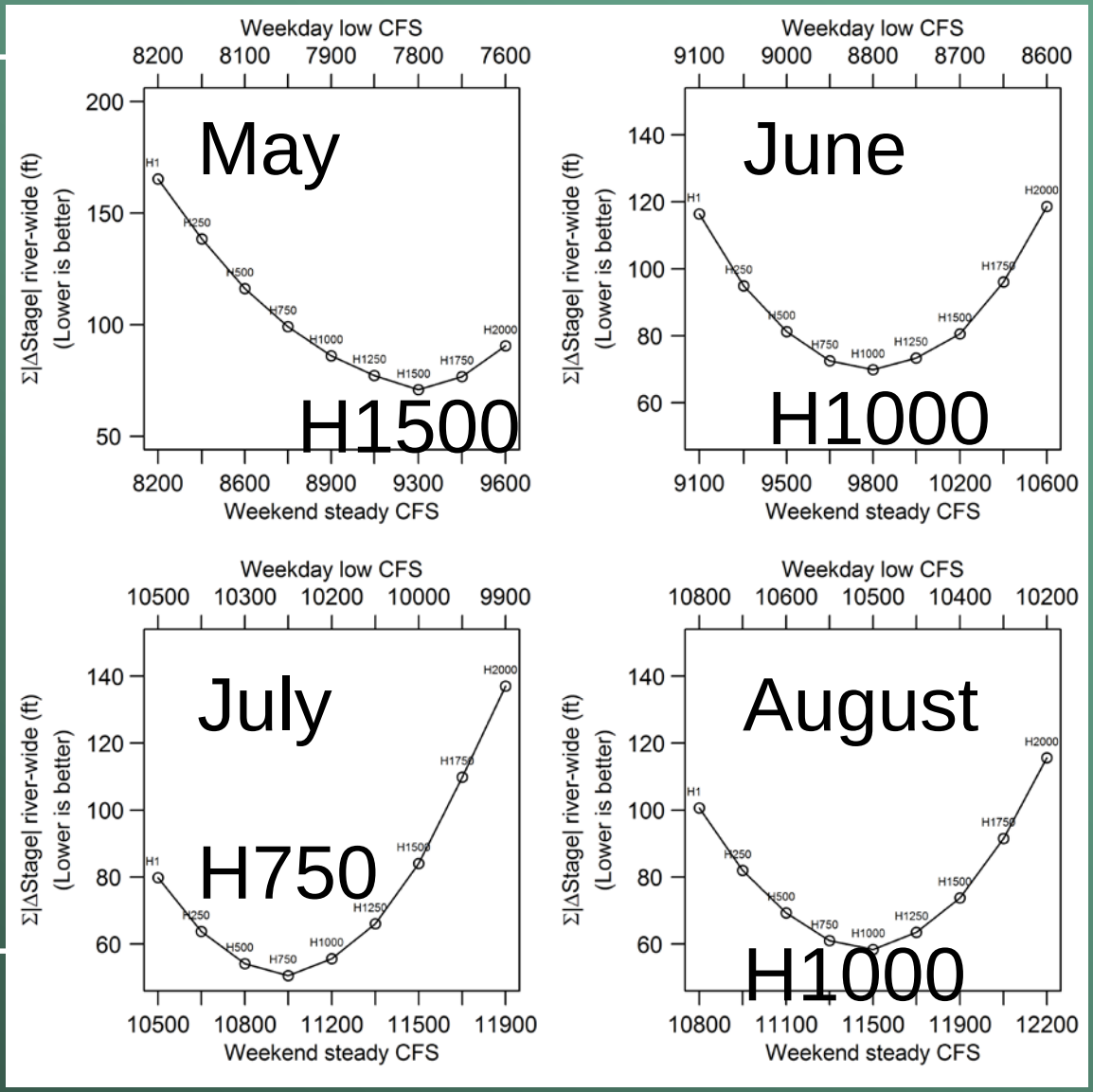

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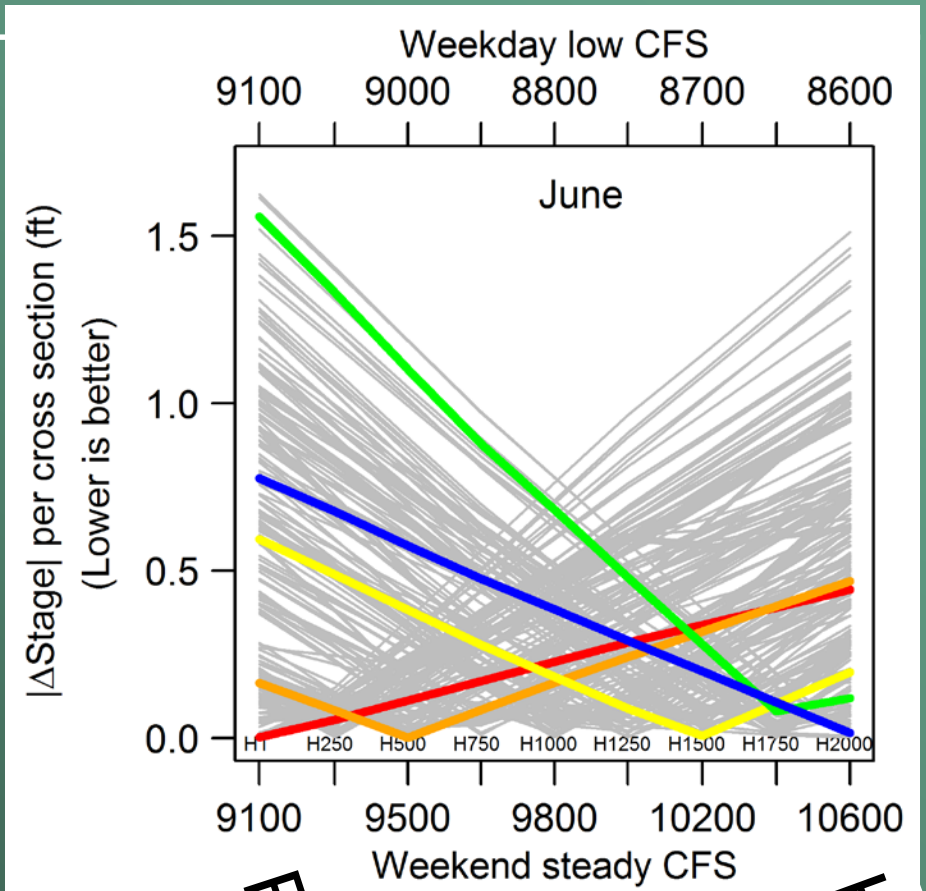
Site-specific optimizations

- 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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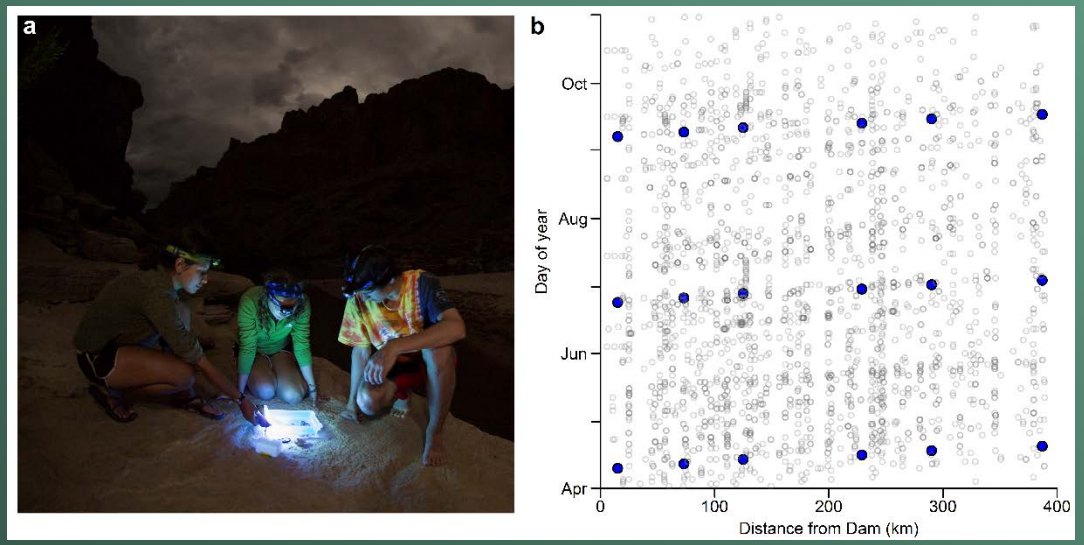
What do we expect?

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



Kennedy et al. 2016
BioScience

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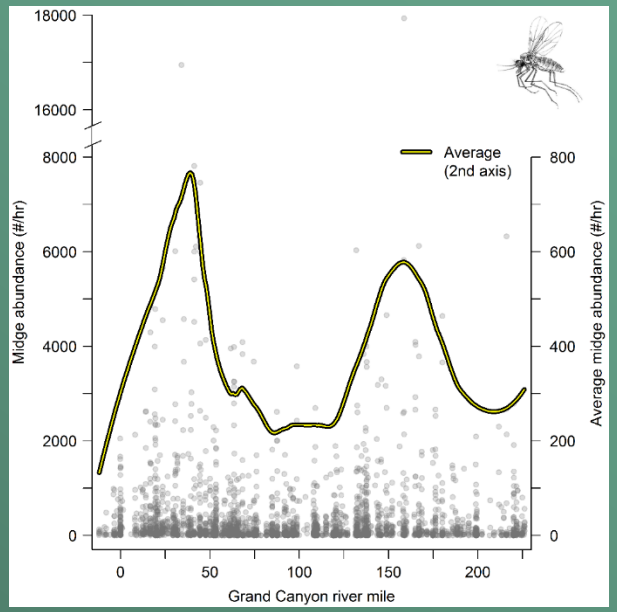
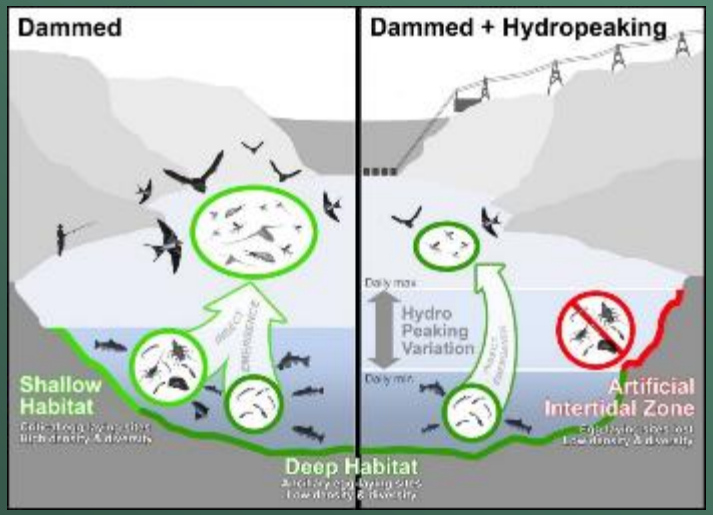
Unpublished data, subject to change, do not cite.

What do we expect?

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





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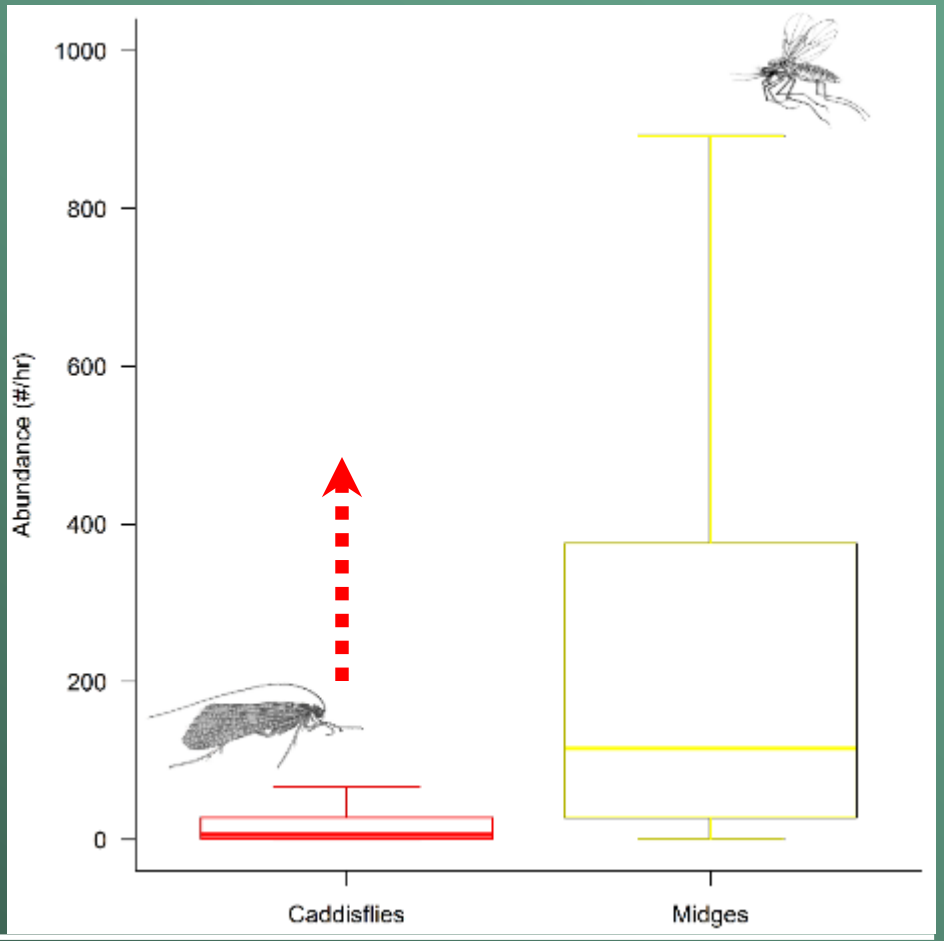
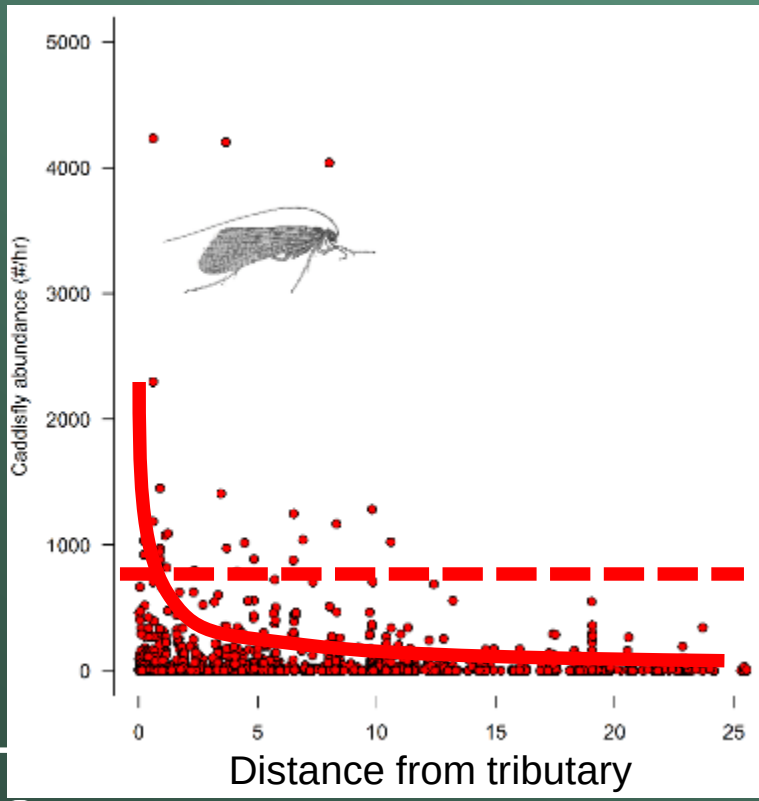
Predicted response: EPT

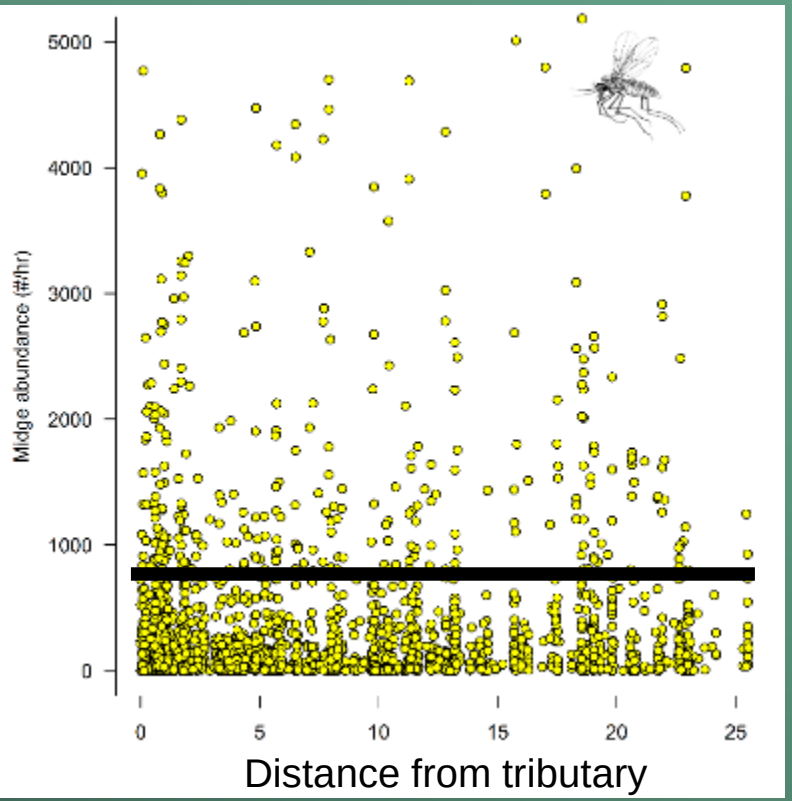
- (Mostly caddisflies)
- Abundances increase
  - Come closer to midge counts



Predicted response: EPT

- Less tied to tributaries
  - Again, resemble midges





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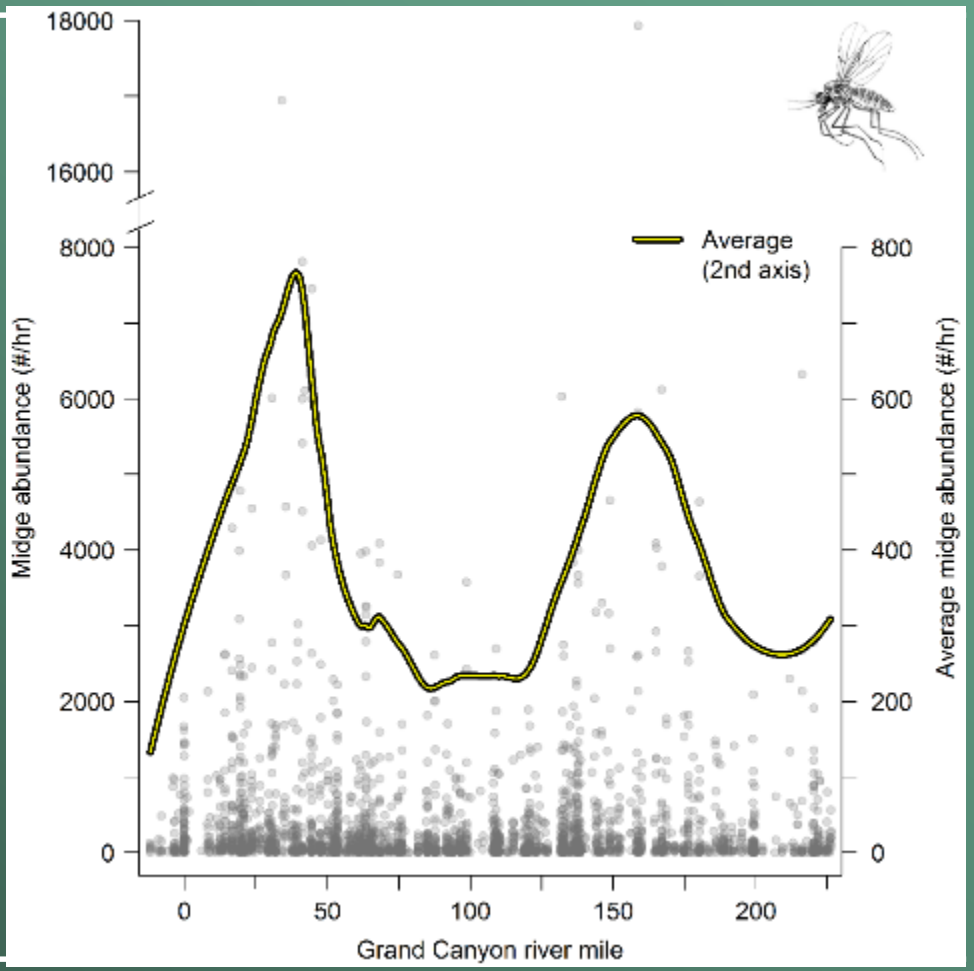
Predicted response: Midges

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



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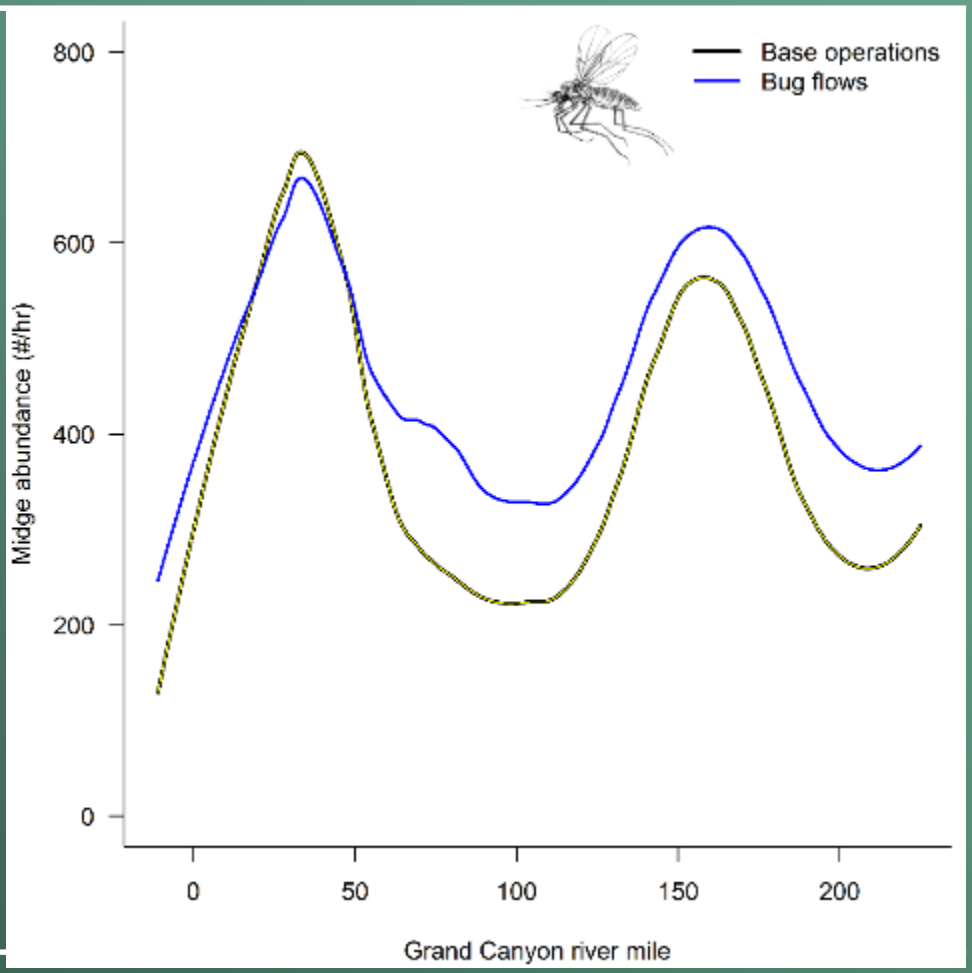
Predicted response: Midges

- Build a shiny, new model
- Result: Optimized Bug flow improves conditions
  - (Just about everywhere)



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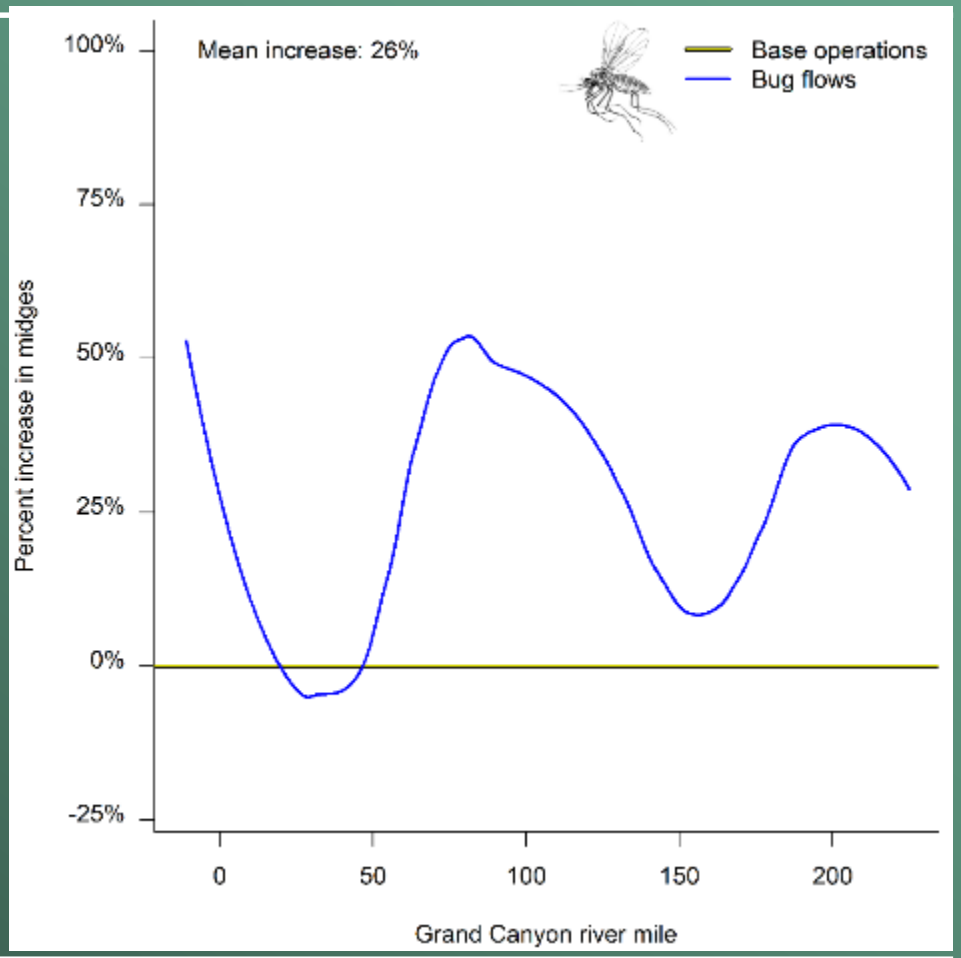
Predicted response: Midges

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



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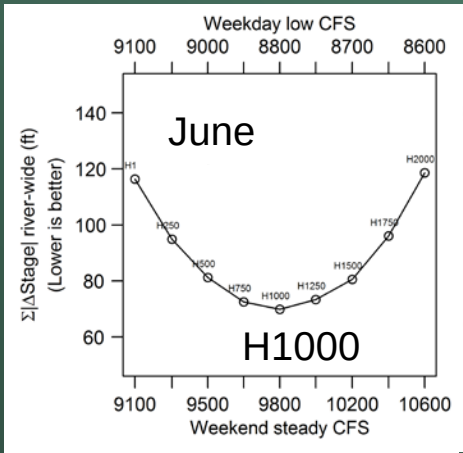
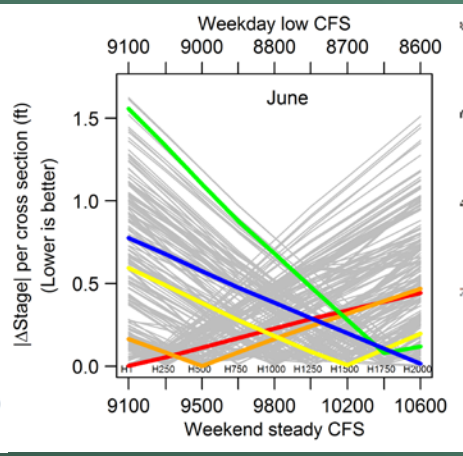
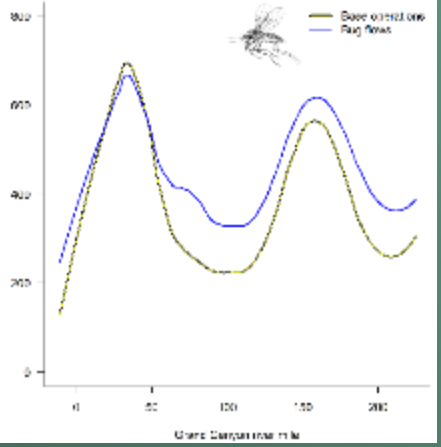
Thanks!

- 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)







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