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Update on the Progress of the Bug Flow Experiment

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Adaptive Management Working Group Meeting, Flagstaff, AZ

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

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

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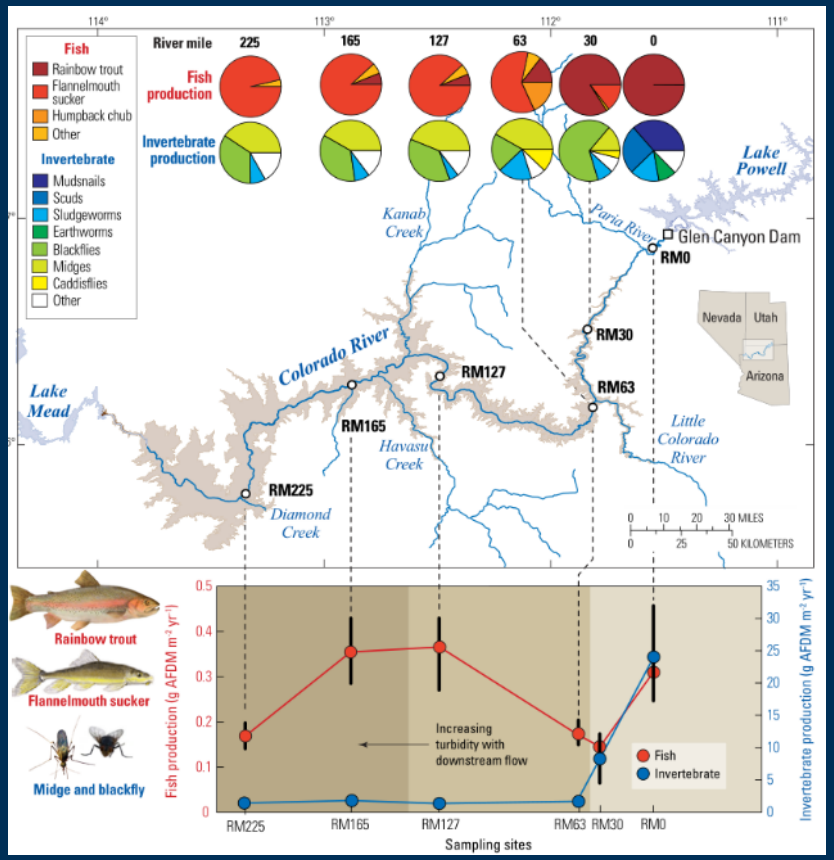
Native and Nonnative Fish Populations of the Colorado River are Food Limited—Evidence from New Food Web Analyses

Summarized by Kennedy, et al 2013
http://pubs.usgs.gov/fs/2013/3039



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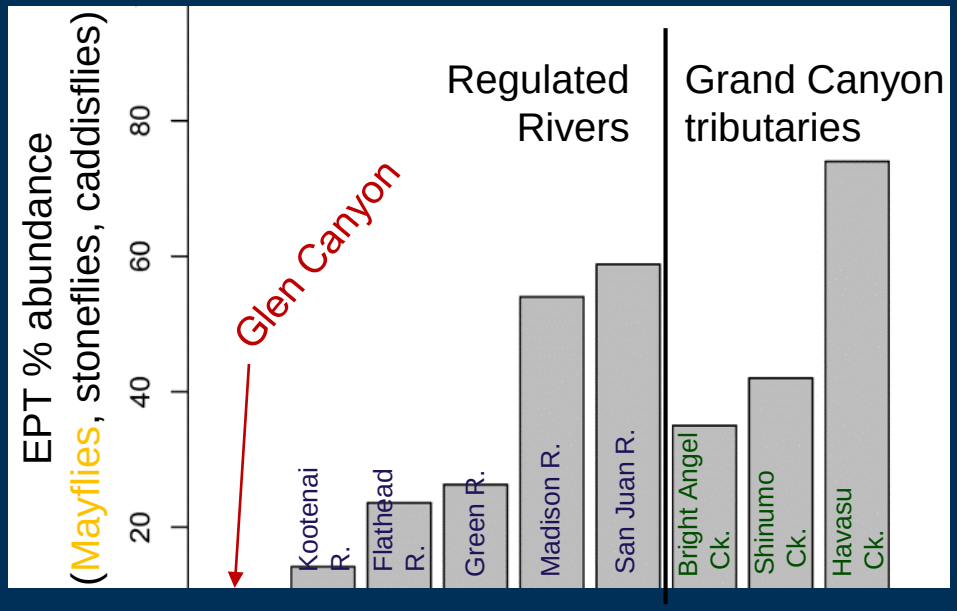
Should the River have so few insects?

- **Likely not!**

Evidence elsewhere in West



Unpublished data, subject to change, do not cite.

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

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Does it matter to have so few insects?

Resource Category	Upper Basin					Lower Basin
	Black Rocks	Westwater Canyon	Desolation/ Gray canyons	Cataract Canyon	Dinosaur National Monument	Grand Canyon
	Extant				Extirpated	Extant
1. Diverse rocky canyon river habitat						
2a. Suitable flow						
2b. Suitable temperature						
3. Adequate and reliable food supply						
4. Habitat with few nonnative predators and competitors						
5. Suitable water quality						
6. Unimpeded range and connectivity						
7. Persistent populations						
8. High genetic diversity						

- **The main issue for Humpback Chub in Grand Canyon**

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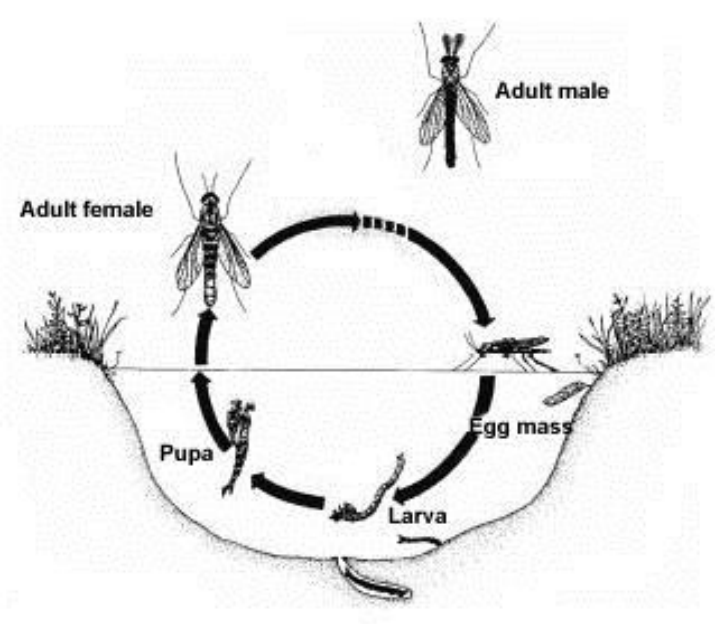
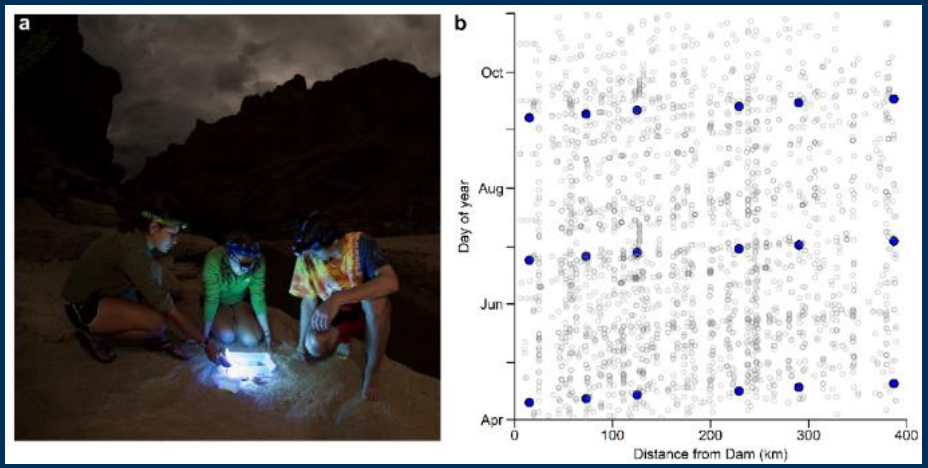
From US Fish and Wildlife Service 2018, *Humpback Chub Species Status Assessment*

But WHY so few aquatic insects?

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



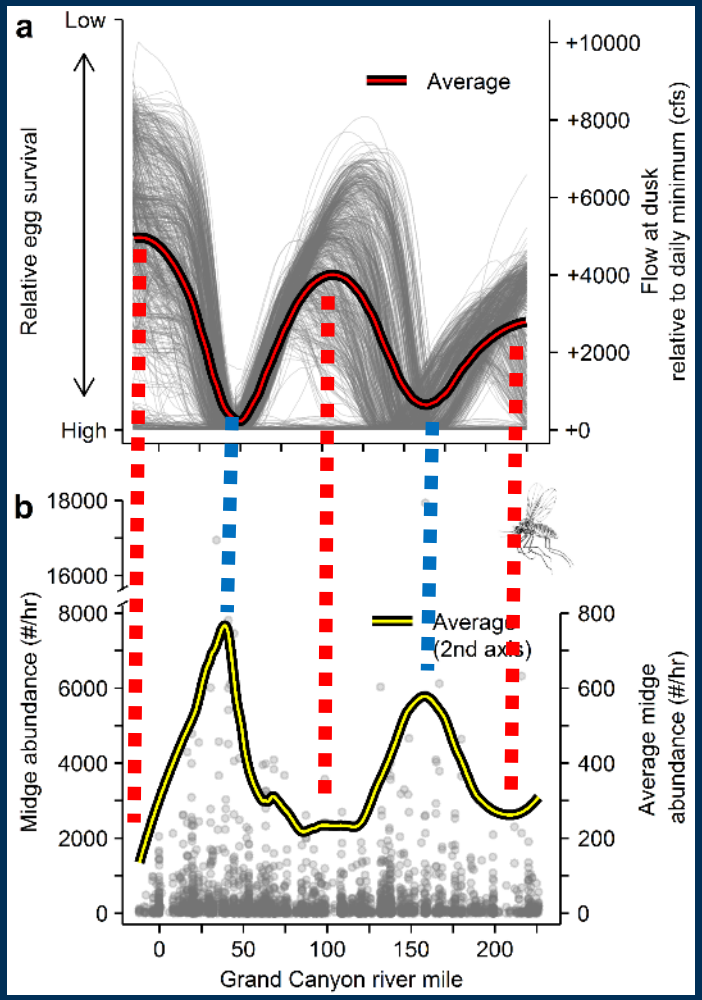
- Citizen science program:
  - Light traps for adult insects



Kennedy et al. 2016, BioScience

Groundwork for Bug Flows

- Kennedy, et al. 2016 *BioScience*
  - Light trap data
  - Throughout Canyon:
    Spatial pattern in midges
  - High midge counts:
    low water at dusk
  - Low midge counts:
    high water at dusk

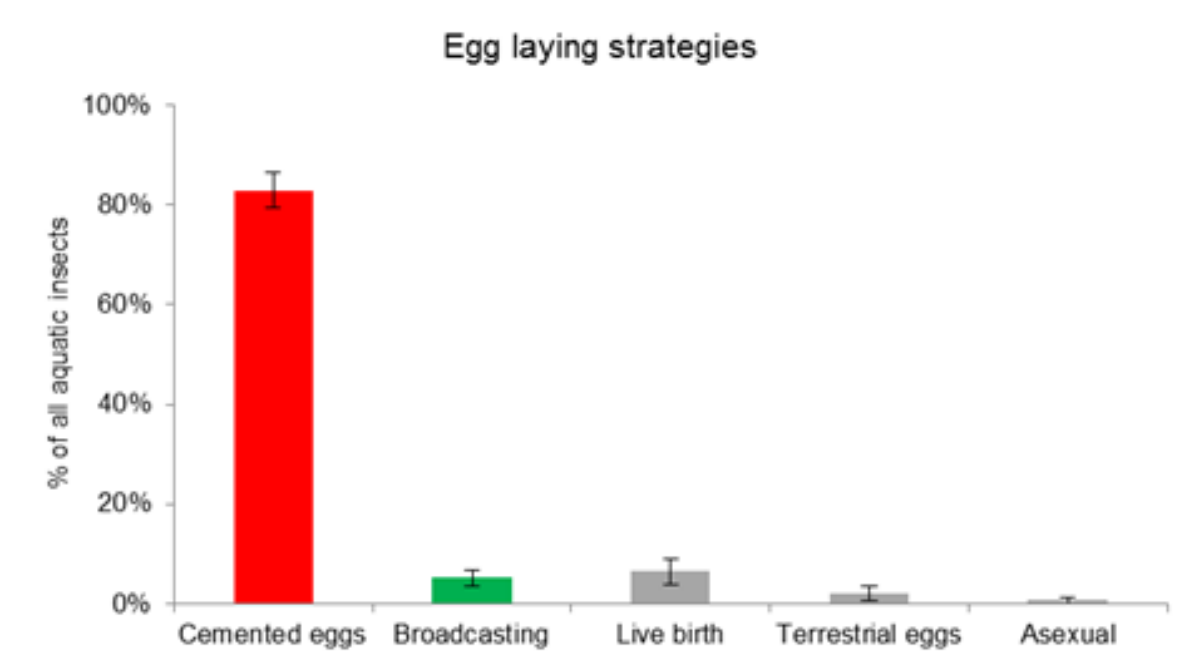


Kennedy et al. 2016, BioScience

Groundwork for Bug Flows

- **Kennedy, et al. 2016 *BioScience***
  - **Midges (and most other aquatic insects):**

    ‘Cement’ eggs on river edges



Kennedy et al. 2016, BioScience

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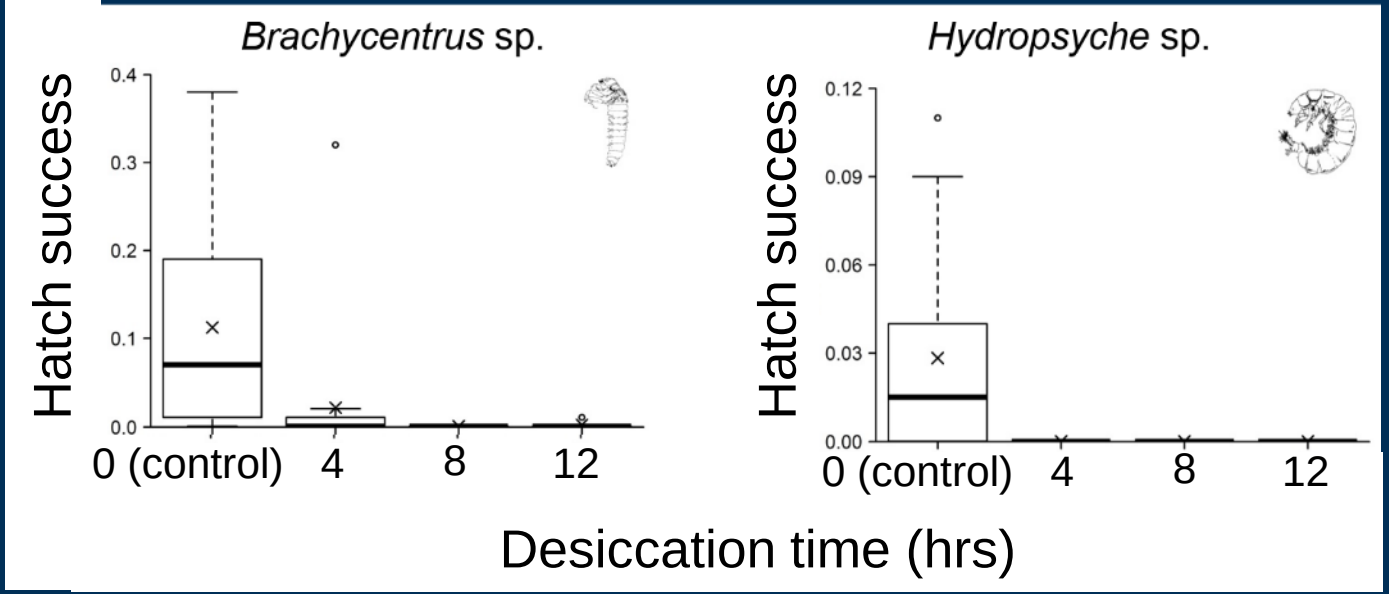
Groundwork for Bug Flows

- **Kennedy, et al. 2016 *BioScience***
  - **Midges (and most other groups):**

    Lay eggs on river edges

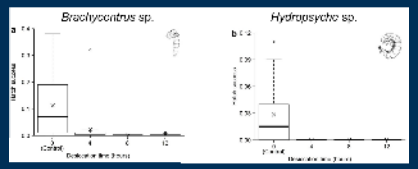
  - **Eggs dry out, die after ~ 1 hour**

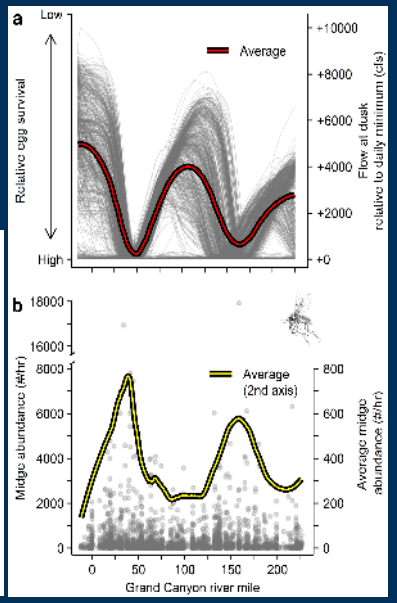


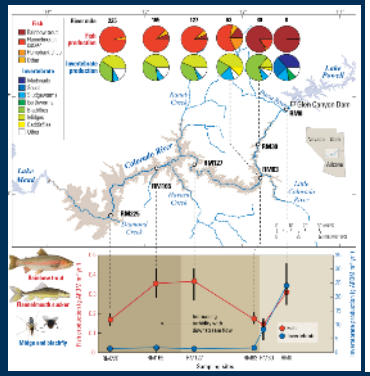
Kennedy et al. 2016, BioScience

Groundwork for Bug Flows

- **Kennedy, et al. 2016 *BioScience***
  - **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)

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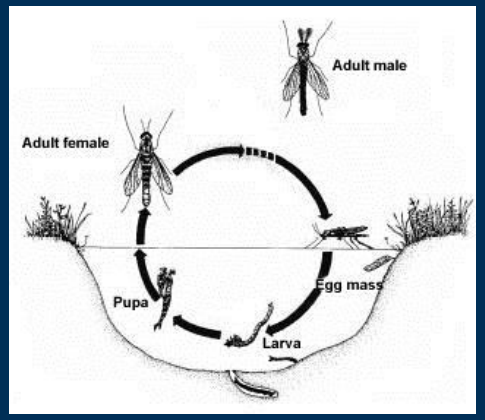
Purpose of Bug Flows Experiment

- Improve egg-laying conditions for insects!



- Therefore:
  - Increase midge abundance

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

- Ultimately:
  - Improve fish food base

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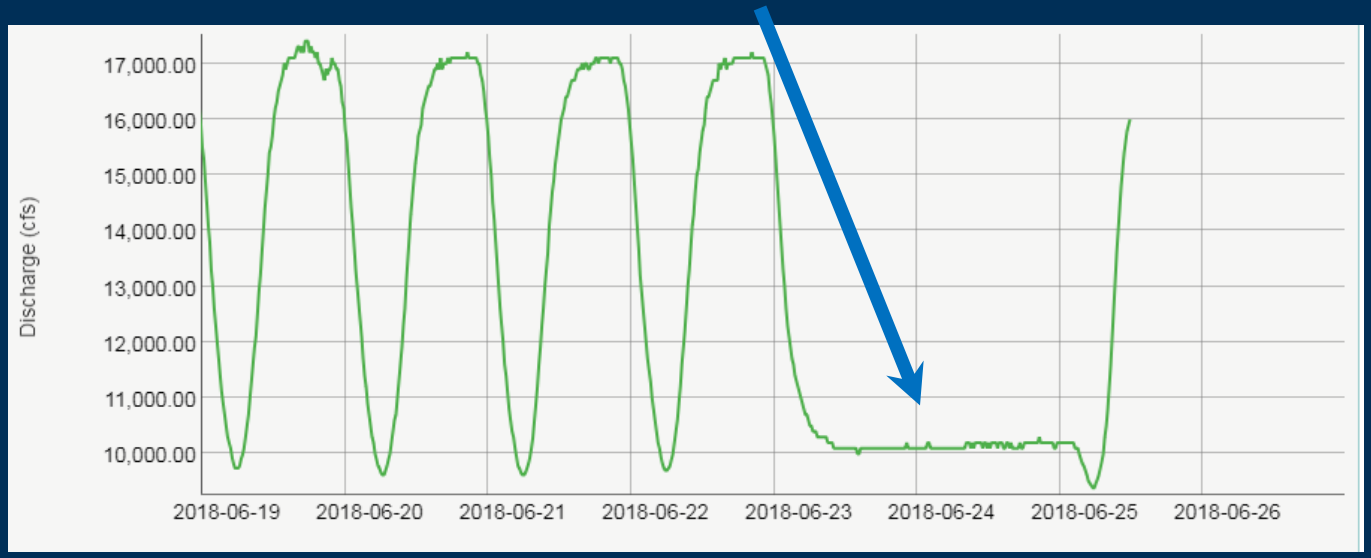
Design of Bug Flows

- "Give bugs the weekends off!"
- May – August 2018
- Stable, low flows on summer weekends
  - Eggs laid on weekends won't dry/die



https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09380000

Predicted Responses (long-term)

- **Smoothing**

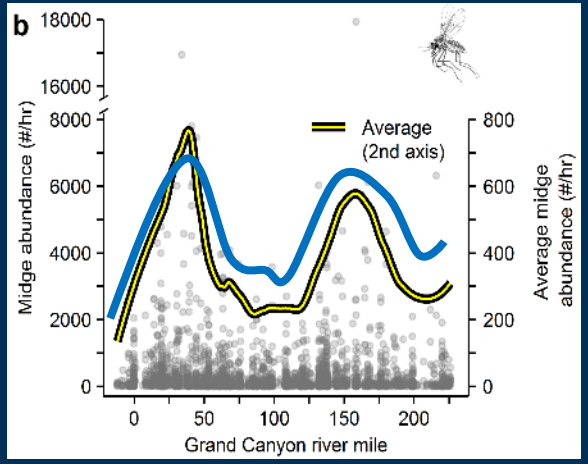
  of spatial pattern

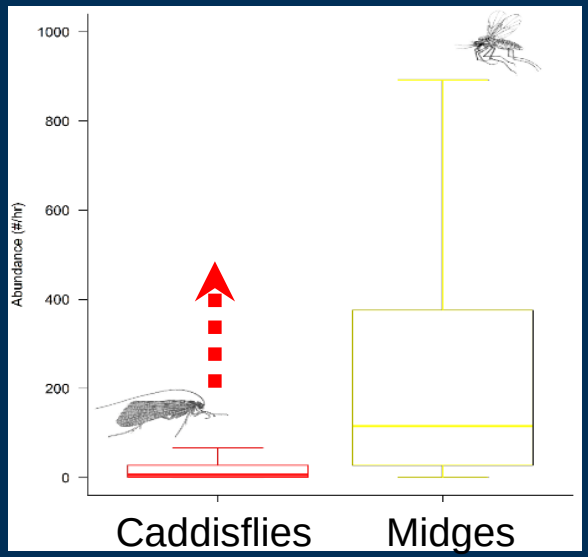
- **More midges**

  throughout Canyon

- **More caddisflies**

  (EPT)





When?
Starting next year, possibly this Fall.

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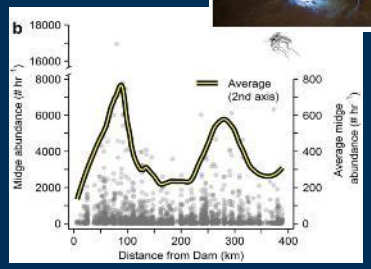
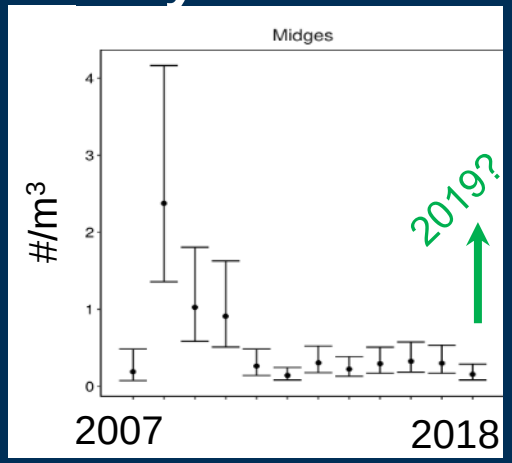
Unpublished data, subject to change, do not cite.

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



2018 Data Collection in Progress!

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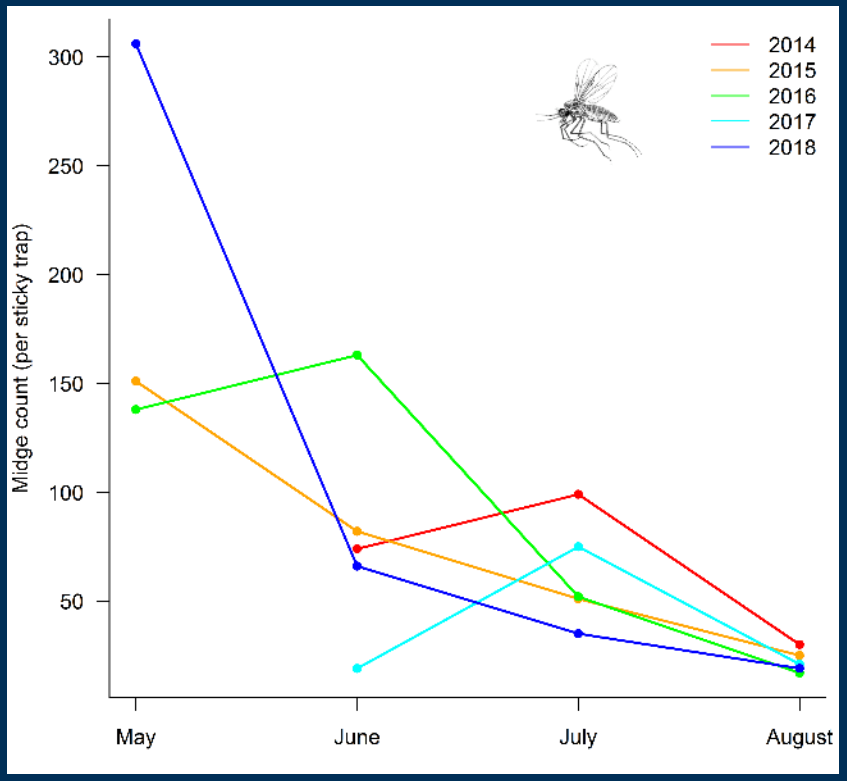
Early results from Glen Canyon (other monitoring)

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



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Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -6

May weekends: High egg-laying

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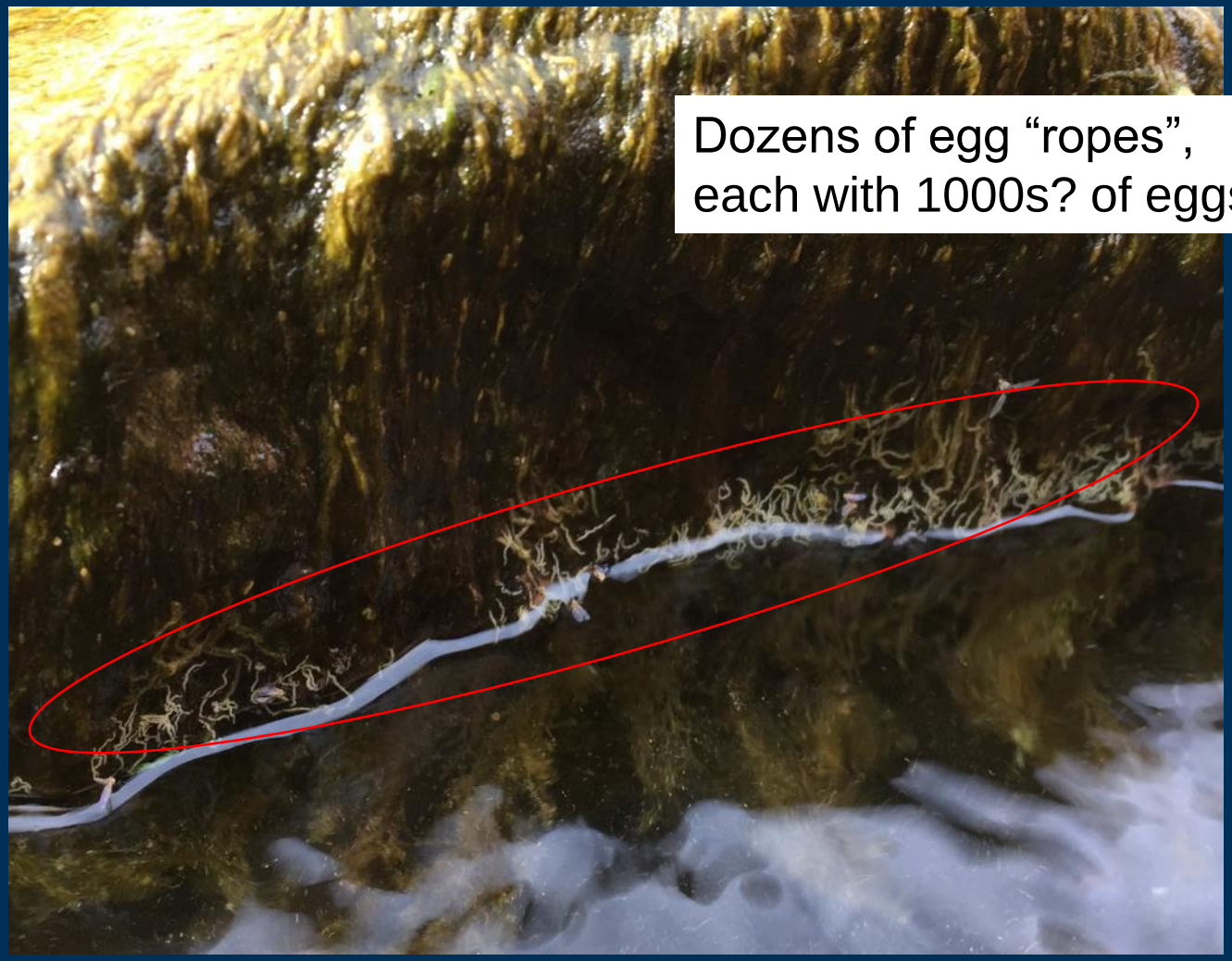
Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -6

May weekends: High egg-laying



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Early results from Glen Canyon (other monitoring)

Sunday May 6, River Mile -13

May weekends: High egg-laying

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Available habitat (Glen Canyon, RM -13, May 2018)

Bug Flows

Many emergent rocks

Load-Following

One emergent rock

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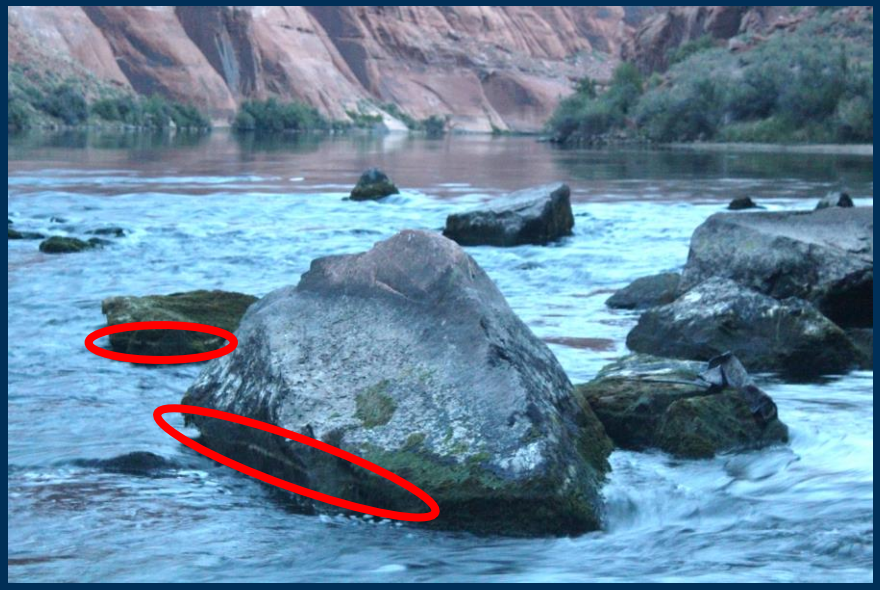
Egg-laying activity (Glen Canyon, RM -13, May 2018)

Bug Flows



Moist eggs at low water level

Load-Following

Eggs high and dry

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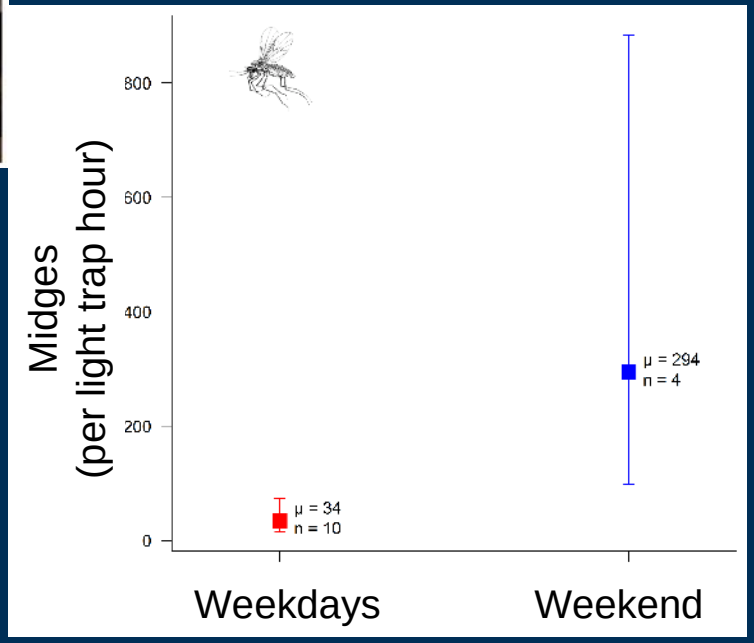
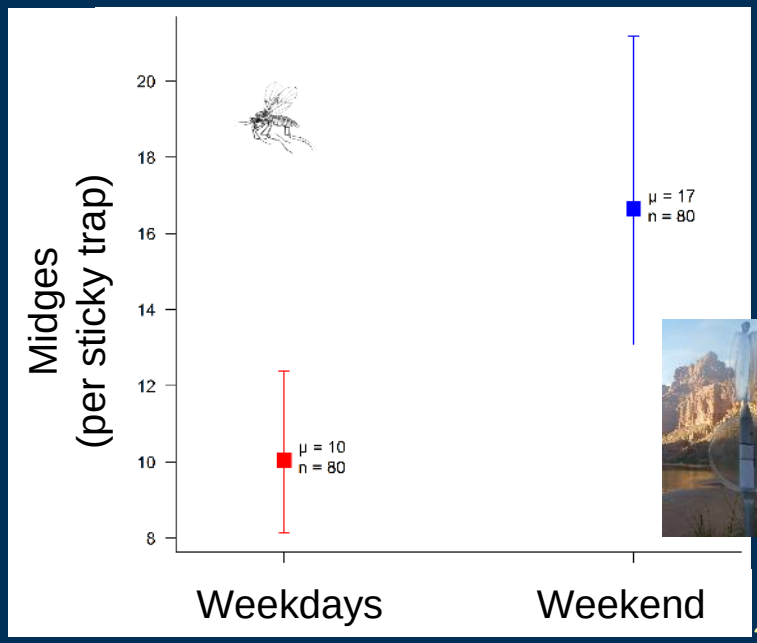
Early results from Glen Canyon (other monitoring)

- **August 2018: Weekday vs. weekend study**
  - **More emergence on weekends:**

    Unexpected egg-laying benefit of Bug Flows

  - **Flows affect insect life cycles**





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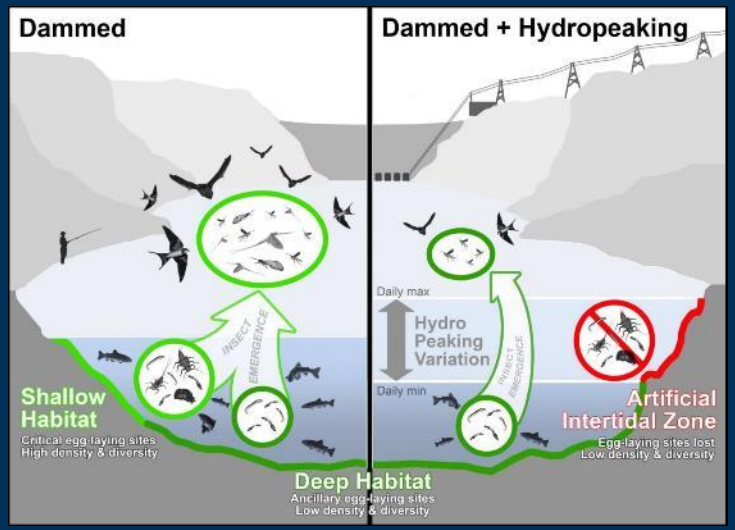
What we've learned so far

- **Flow matters!**
- **Bug Flows enhance key *Natural Processes***



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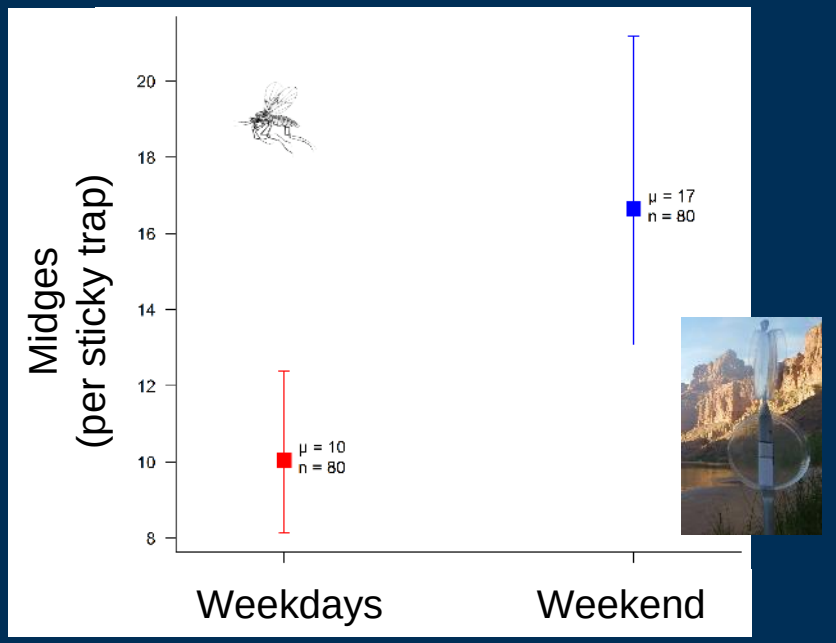

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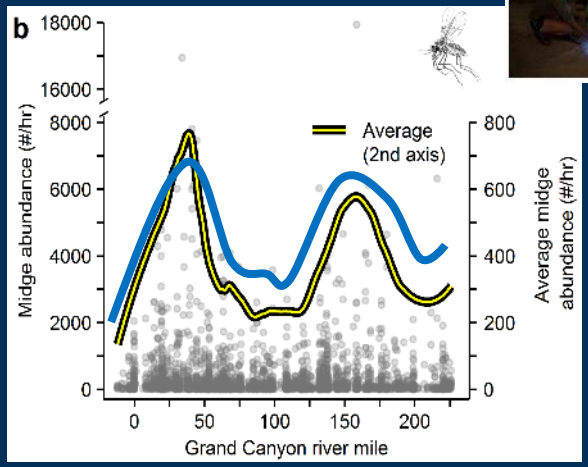
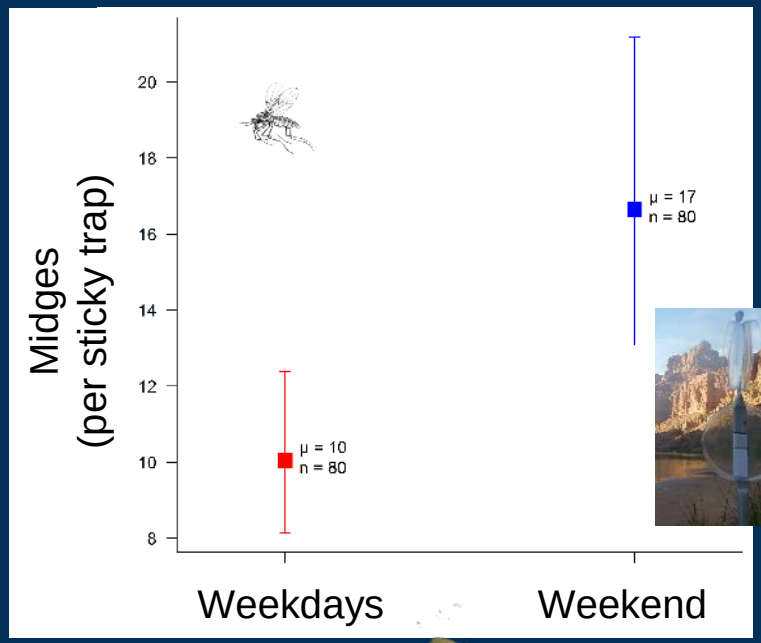
- **And might make for better fishing?!**

(see next talk)

Much more to learn as data roll in…

Questions?





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