

Project F: Aquatic ecology and food base monitoring

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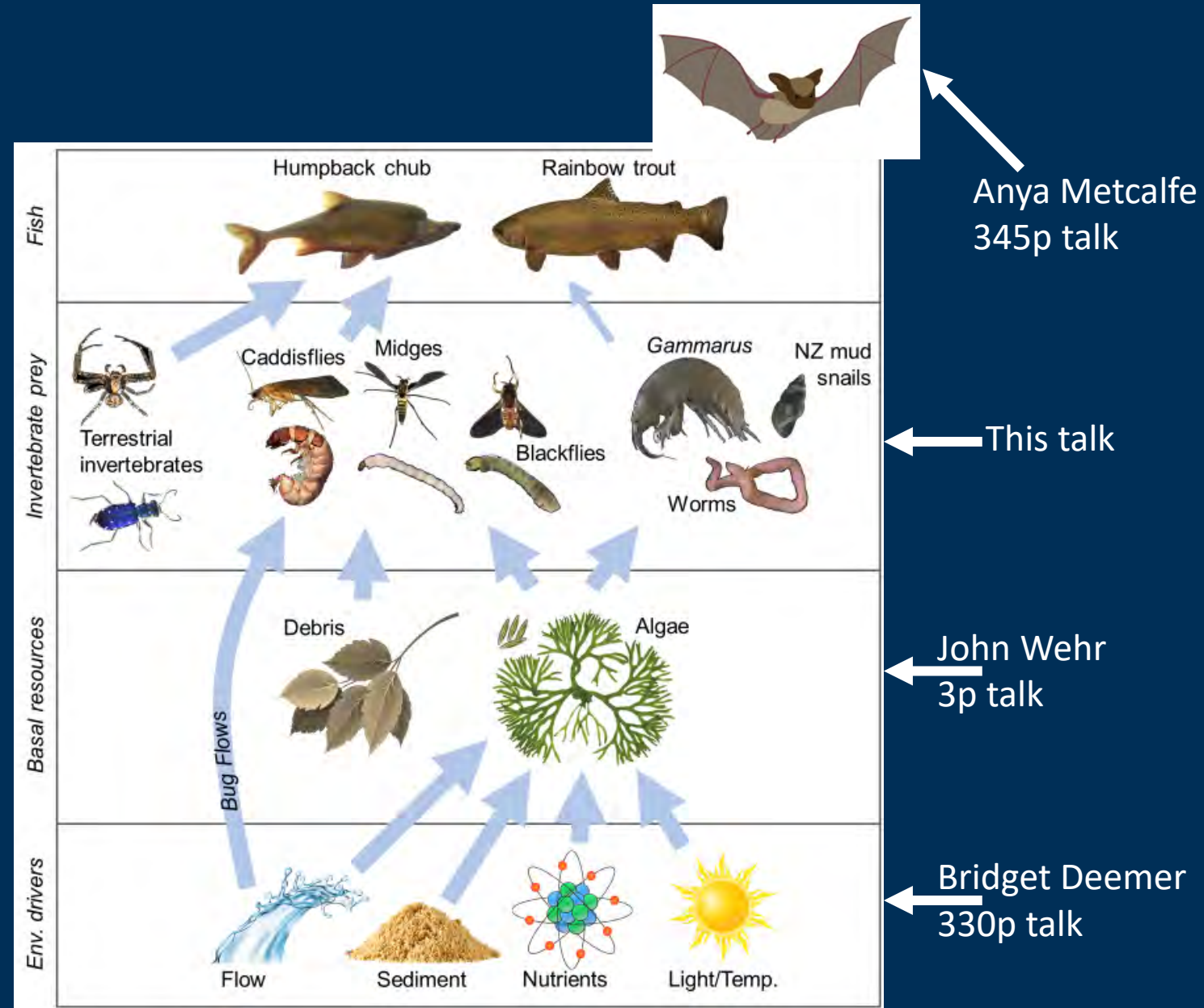
U.S. Department of the Interior
U.S. Geological Survey



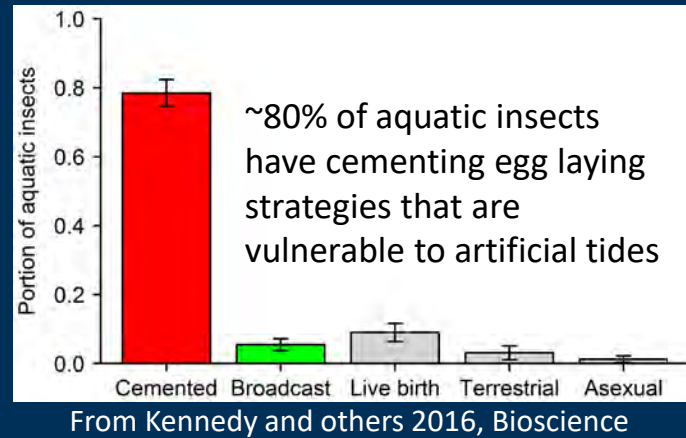
Natural Processes

■ LTEMP Goal 2

Restore, to the extent practicable, ecological patterns and processes within their range of natural variability, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems.



Why Bug Flows?



Year-round hydropower fluctuations do not support natural processes essential to diverse and resilient invertebrate assemblages

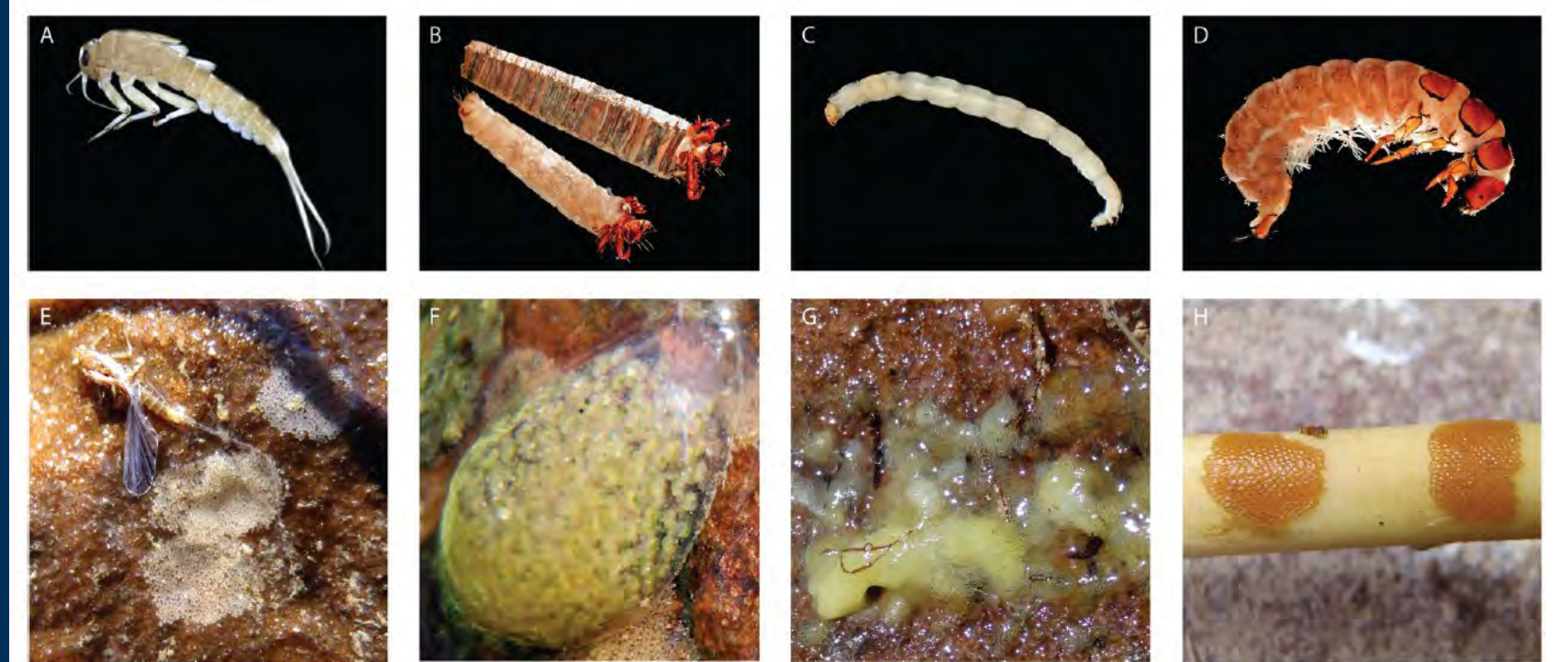
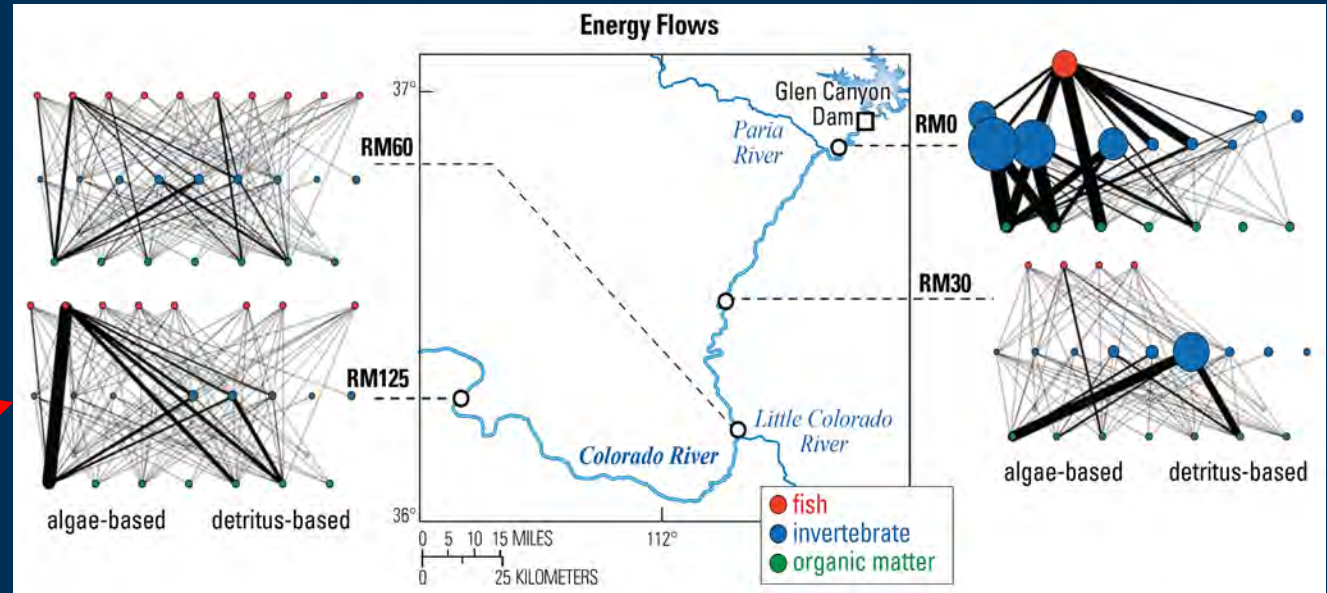
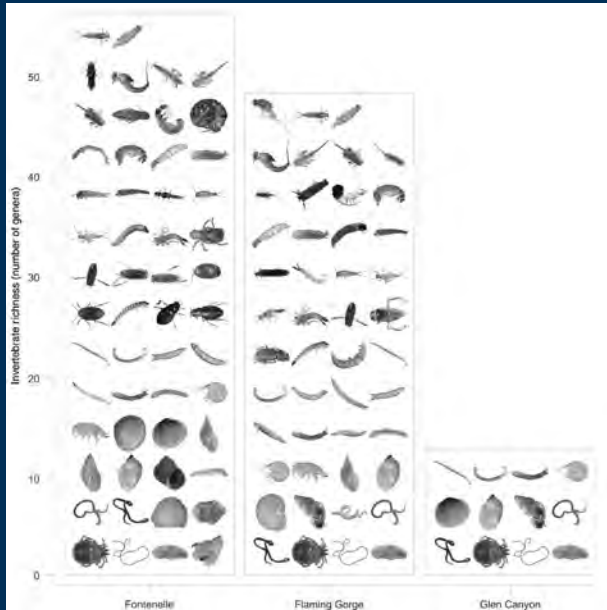


Figure 2. Larval and egg mass photos of *Baetis* spp. (Ephemeroptera) (A, E), *Brachycentrus occidentalis* (Trichoptera) (B, F), Chironomidae (Diptera) (C, G), and *Hydropsyche occidentalis* (Trichoptera) (D, H). Photo credits: Morgan Ford (A), Greg Wada (B, C, D), and Matt Schroer (E, F, G).

Photos of aquatic insects (top) and eggs cemented on various substrates (bottom).
From Miller and others 2020, Freshwater Science

Why Bug Flows?

- Not enough insect prey for fish
- Low diversity, inherently unstable
- Food webs built on algae



Colorado River downstream of Glen Canyon Dam only 1/3 the invertebrate genera of other tailwaters. From Kennedy and others 2016 BioScience.

Food webs of the Colorado River circa 2006-2009. From Kennedy and others 2014 USGS Fact-Sheet.

Why Bug Flows?

- High and low flows eliminated
- Hydropower production creates tides
 - Favors desiccation tolerant invertebrates
 - Disfavors ~80% of aquatic insect species

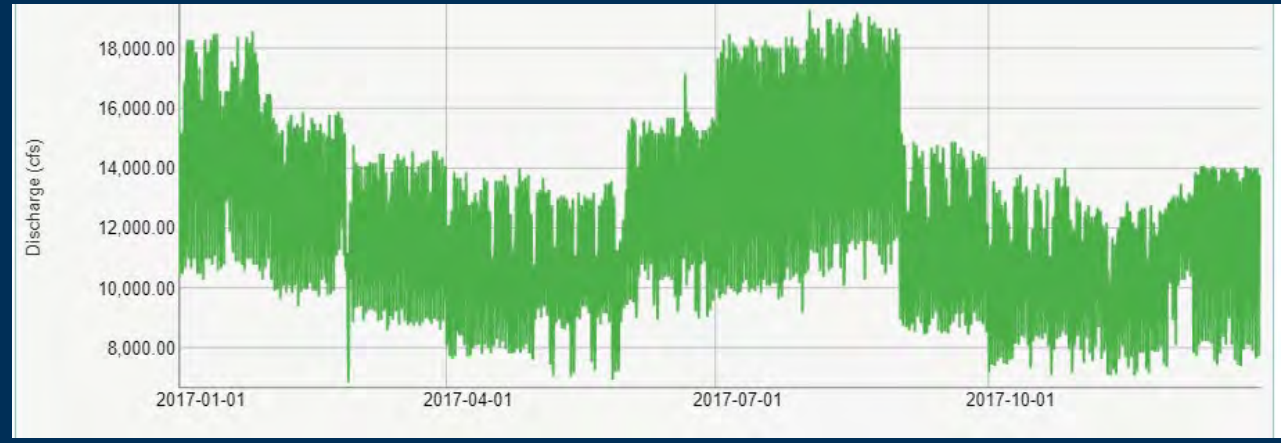


1937 Hydrograph, Colorado River at Lees Ferry



Natural Flows

2017 Hydrograph, Colorado River at Lees Ferry

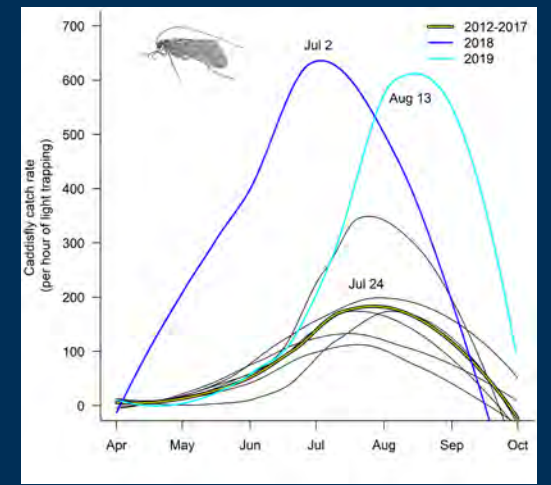


Regulated Flows



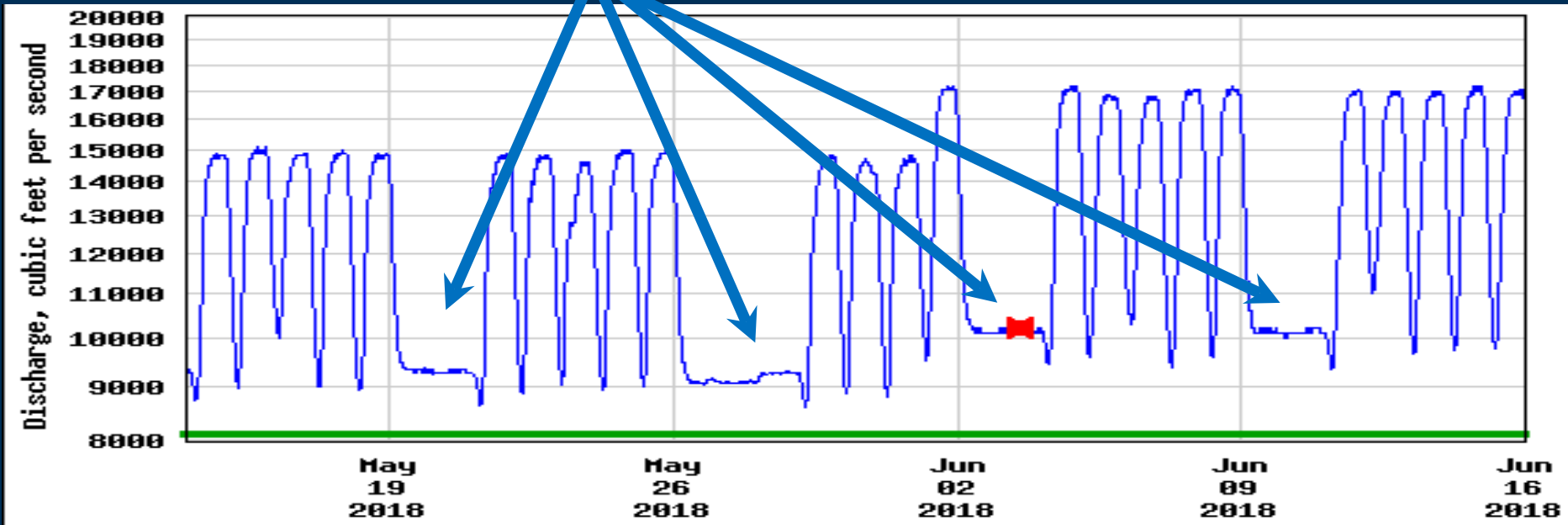
What is a Bug Flow?

- Give bugs the weekends off
- Weekend stable low flows from May-August
 - 34-36 days/years
 - Tested 2018-2020
- Eggs laid on weekends never dry



May-August

Unpublished data, subject to change, do not cite.

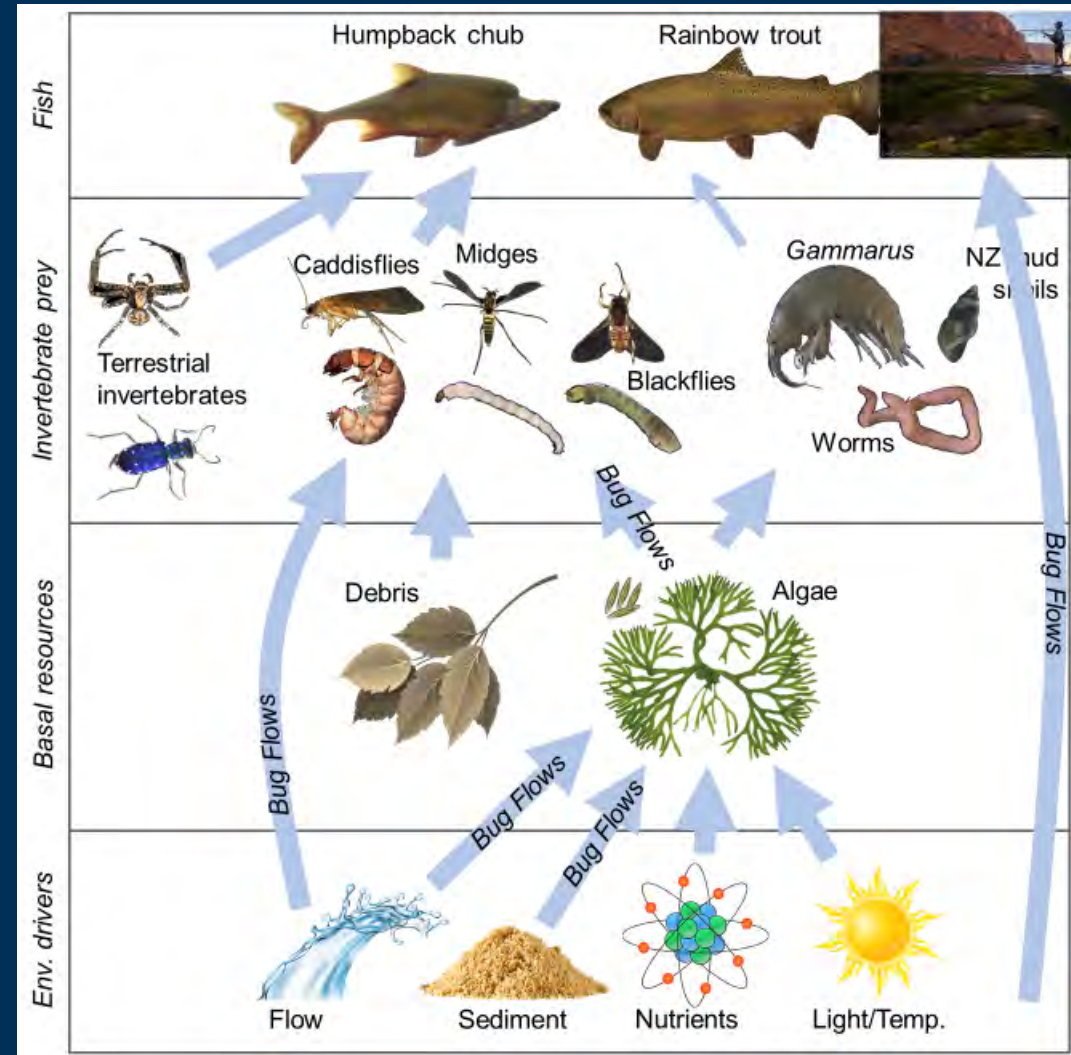


Results circa October 2021

Bug Flows-Key Findings

- Enhanced natural processes and improved food base
 - More egg laying substrates
 - More insect emergence
 - More caddisflies (but not midges)
 - More GPP
- Enhanced rainbow trout fishery
 - Higher catch rates

“Objective: Improve food base productivity and abundance or diversity of mayflies, stoneflies, and caddisflies” LTEMP Table 4.

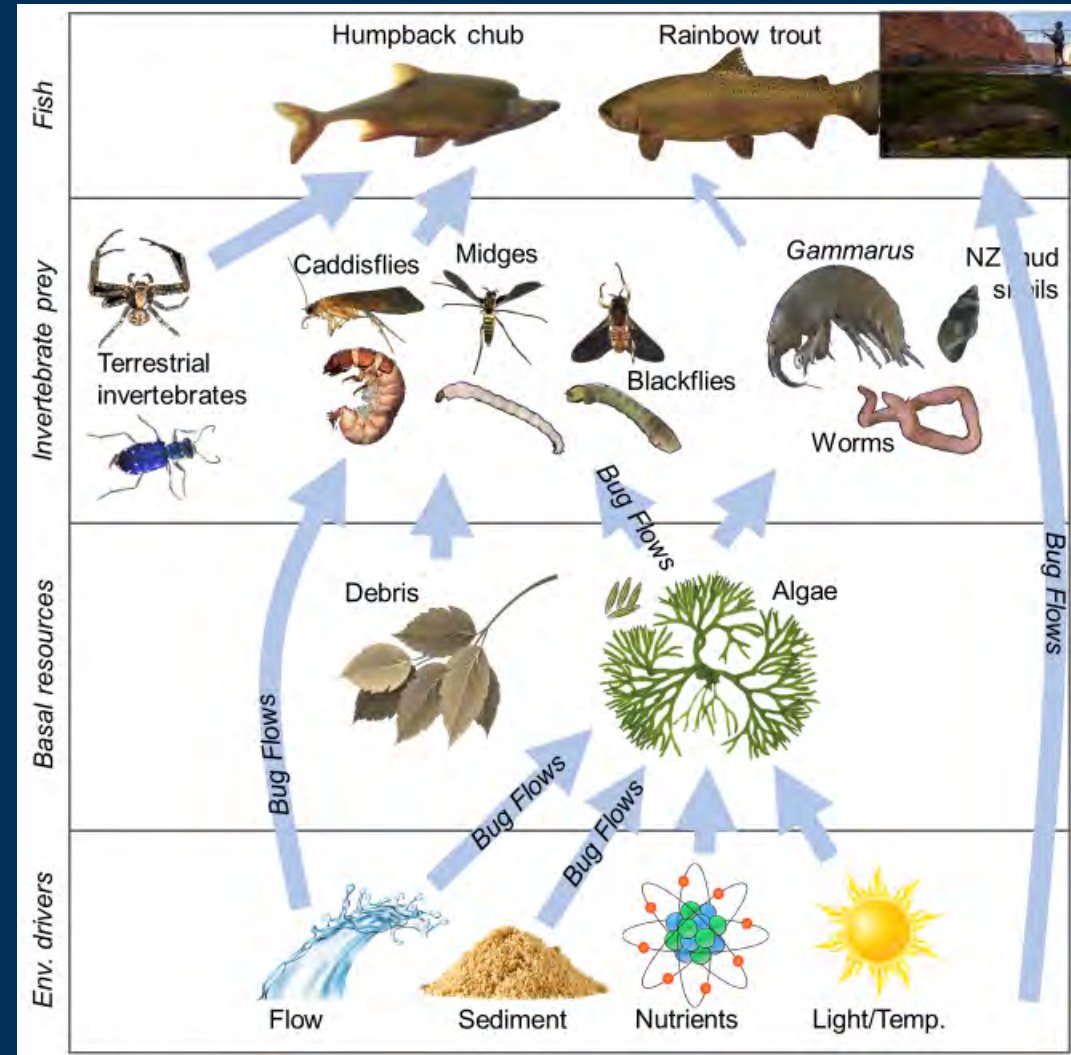


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Updated Results

Results circa October 2021

Bug Flows Objective: ↑ midge abundance

- Unchanged after 3 years
 - Model predicted ↑ 27% (long-term)

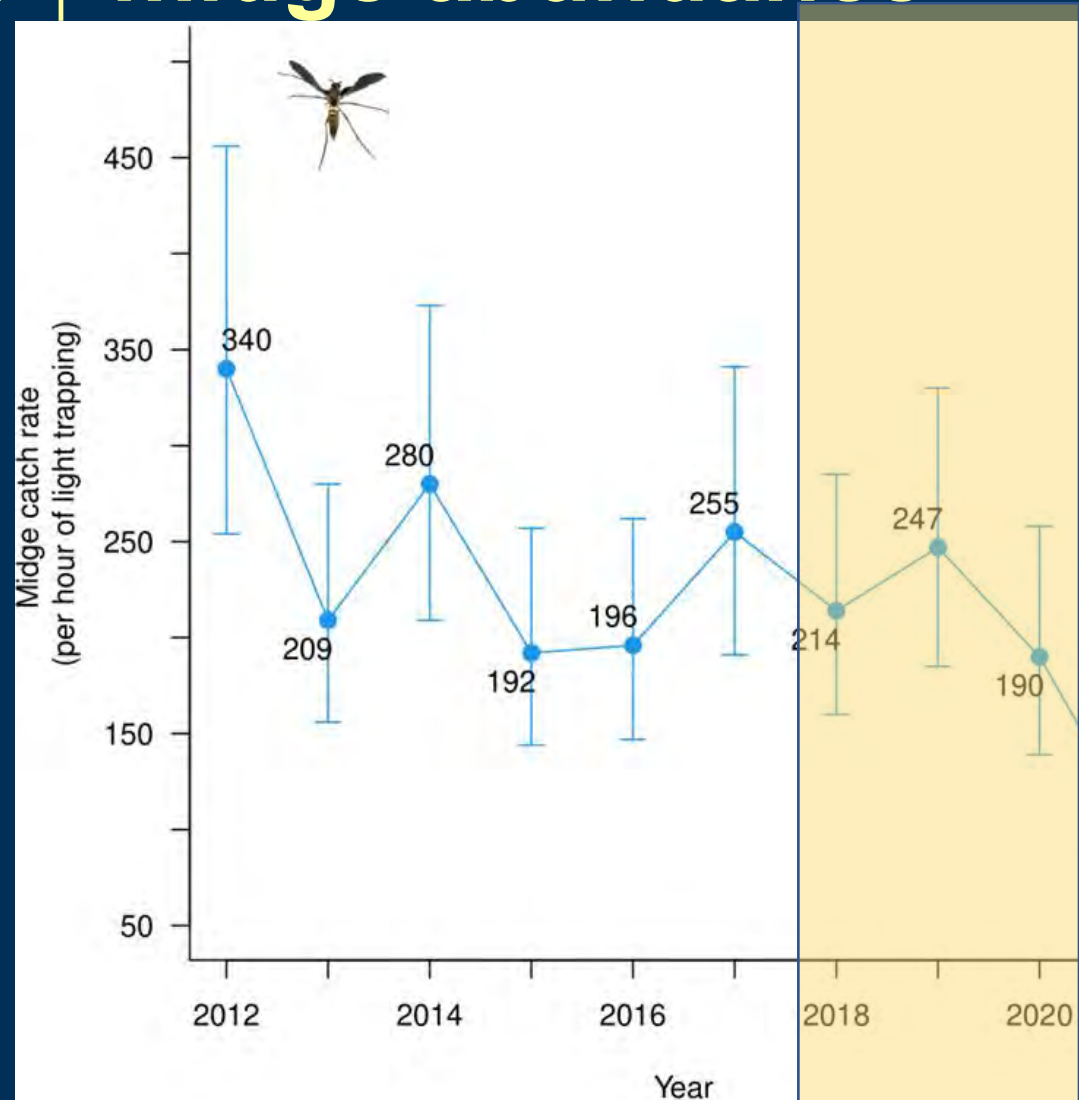
NOPE
(What gives?)

SA Review

Limitations of experimental design:

"This [experimental] design presents great challenges for drawing confident conclusions from the experimental manipulation. That is, investigators are denied direct means for dismissing alternative hypotheses."

–B. Downes

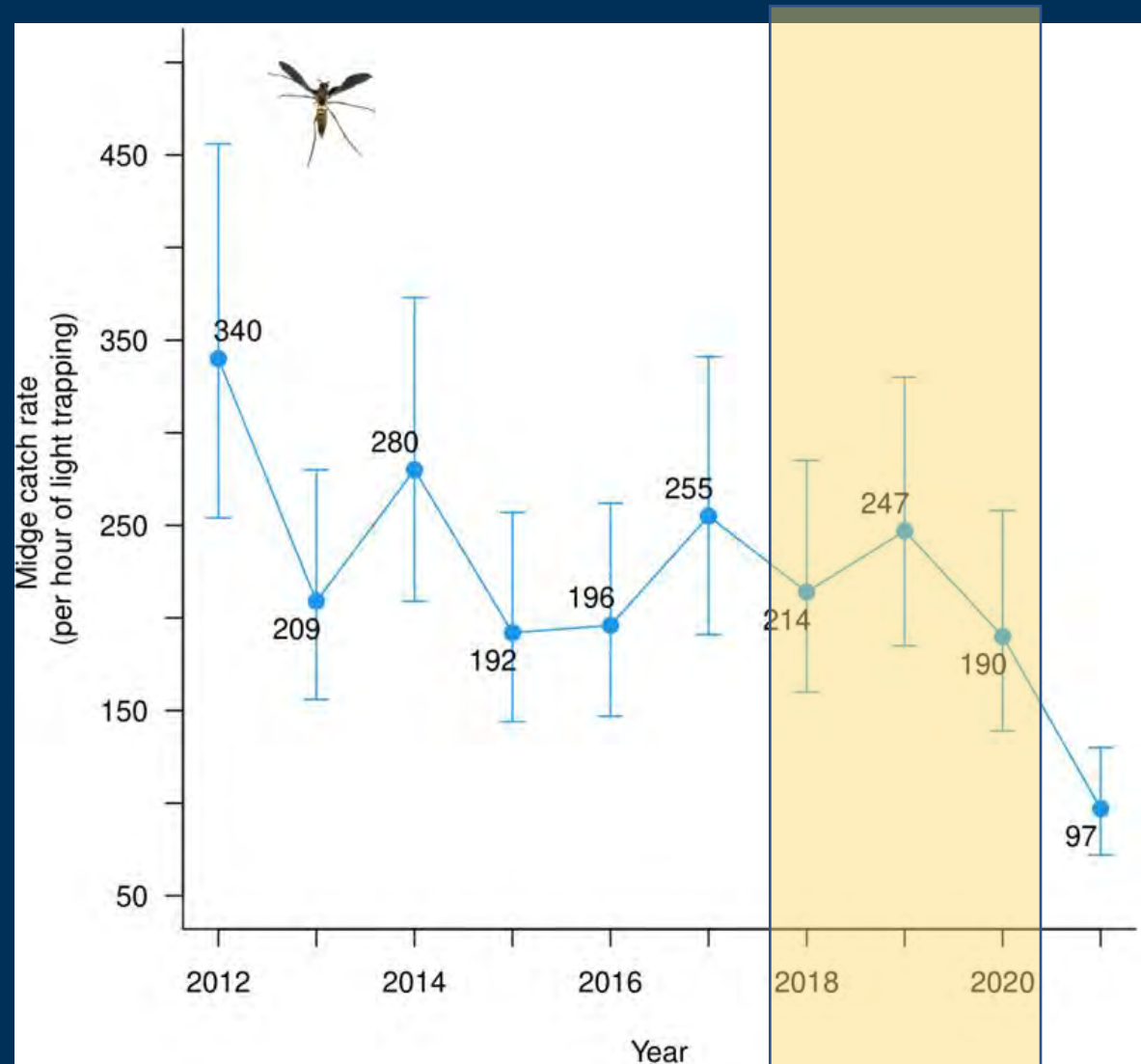


UPDATED RESULTS

- Cessation of Bug Flows associated with ~50% decline in midges

Consistent with hypothesis that Bug Flows was improving conditions for midges

But what about sediment??
Was it clear or muddy

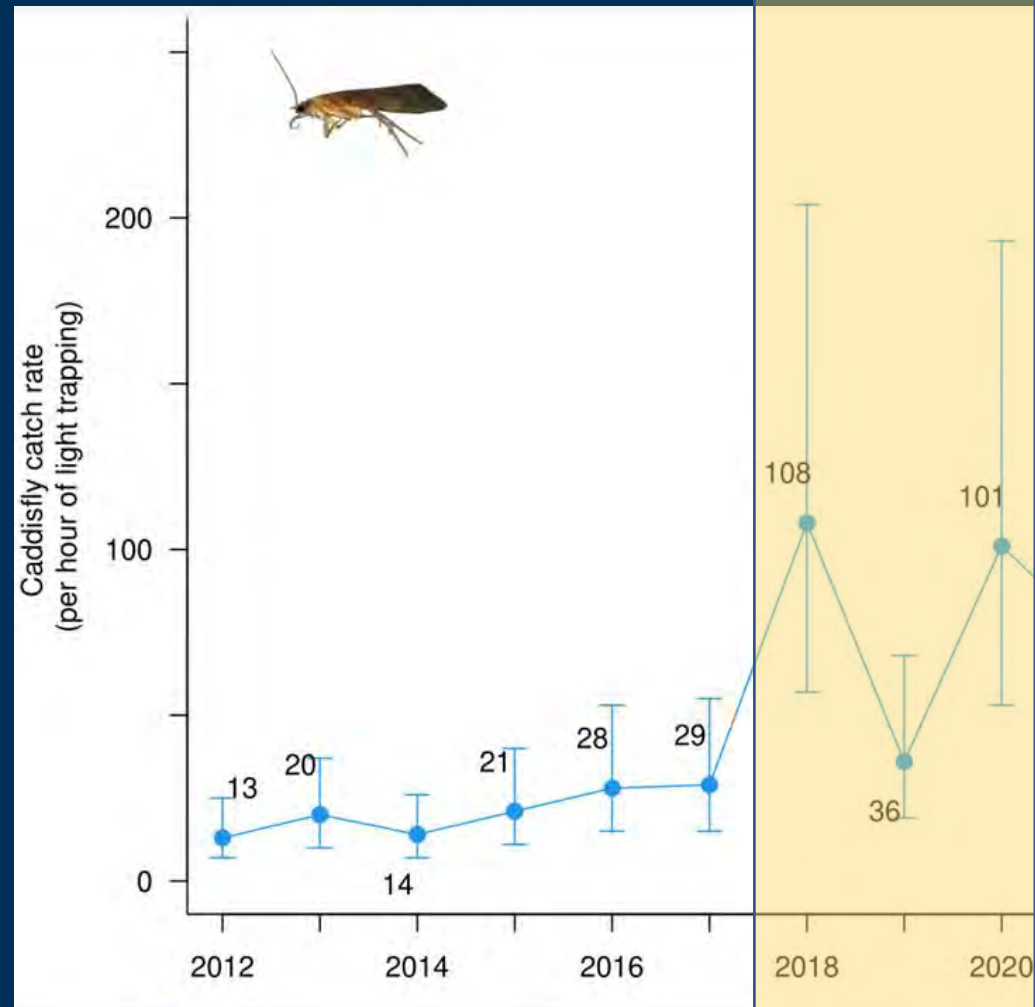


Results circa October 2021

Bug Flows Objective: ↑ EPT diversity

- Highest 3 year average on record
 - Predicted longer-term

GOOD
(But why so soon?)

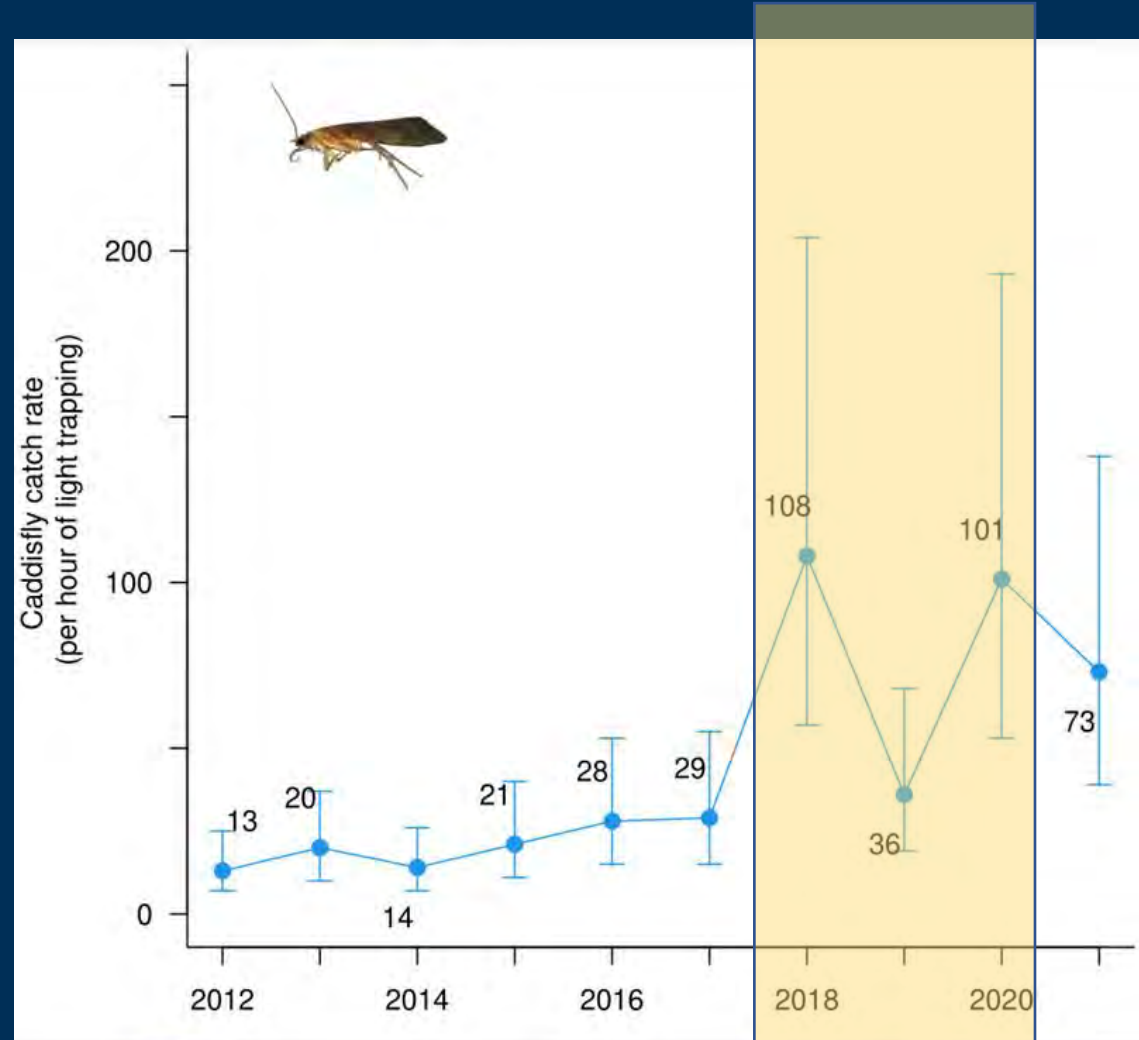


UPDATED RESULTS

- Cessation of Bug Flows associated with modest decline in caddisflies

Tough to untangle what 2021 means
-no direct benefits to larvae or emergence
-multiple years of good egg laying

But what about sediment??
Was it clear or muddy

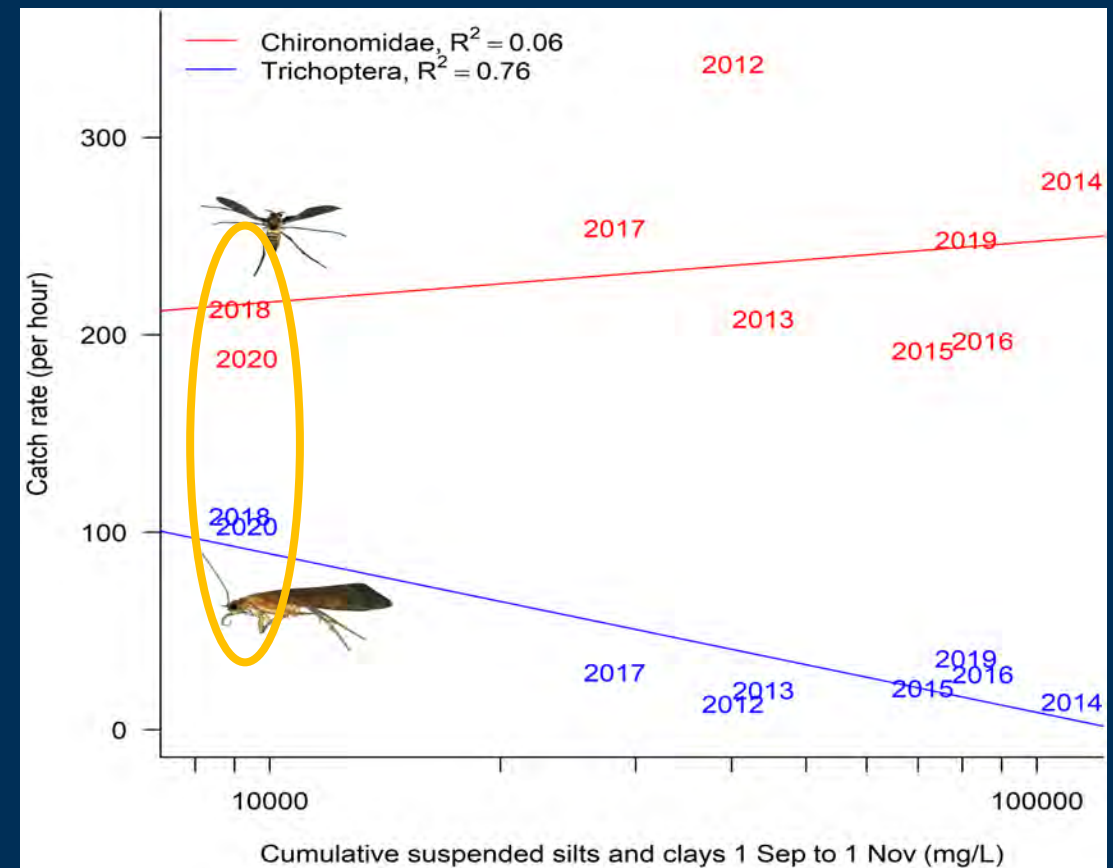
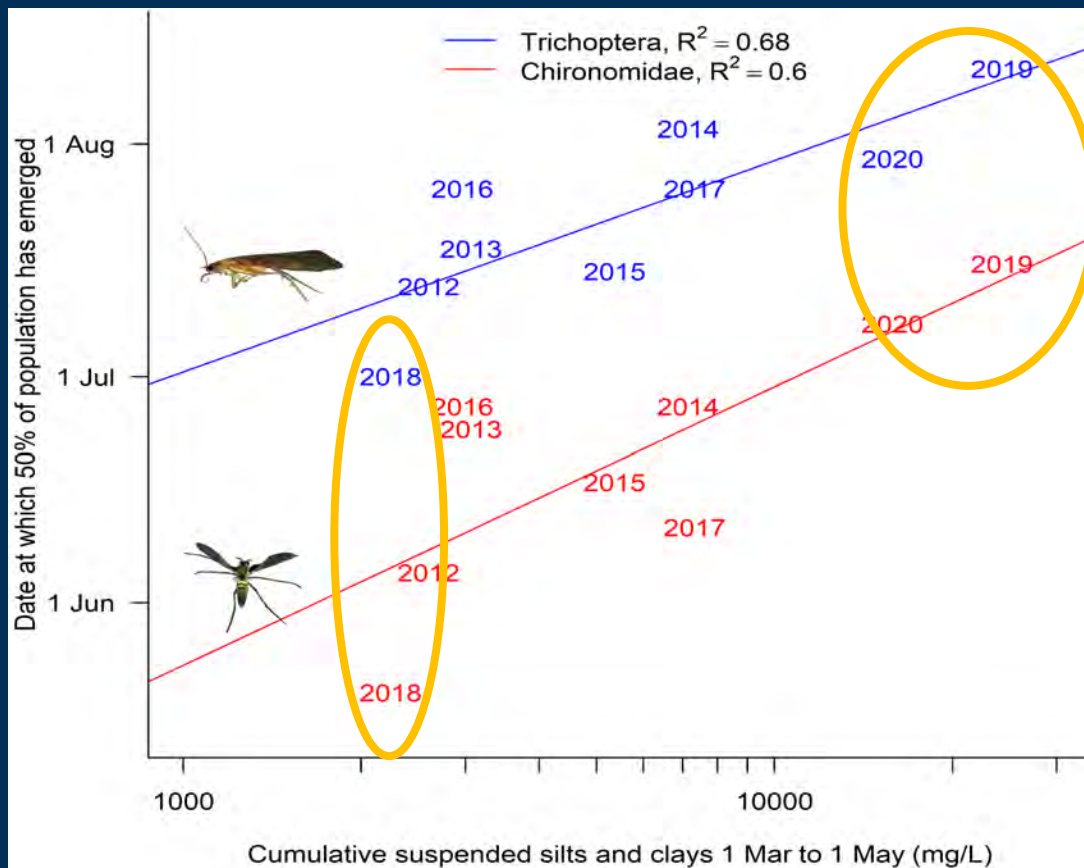


Results circa October 2021

Extreme climatic variation in Bug Flows years

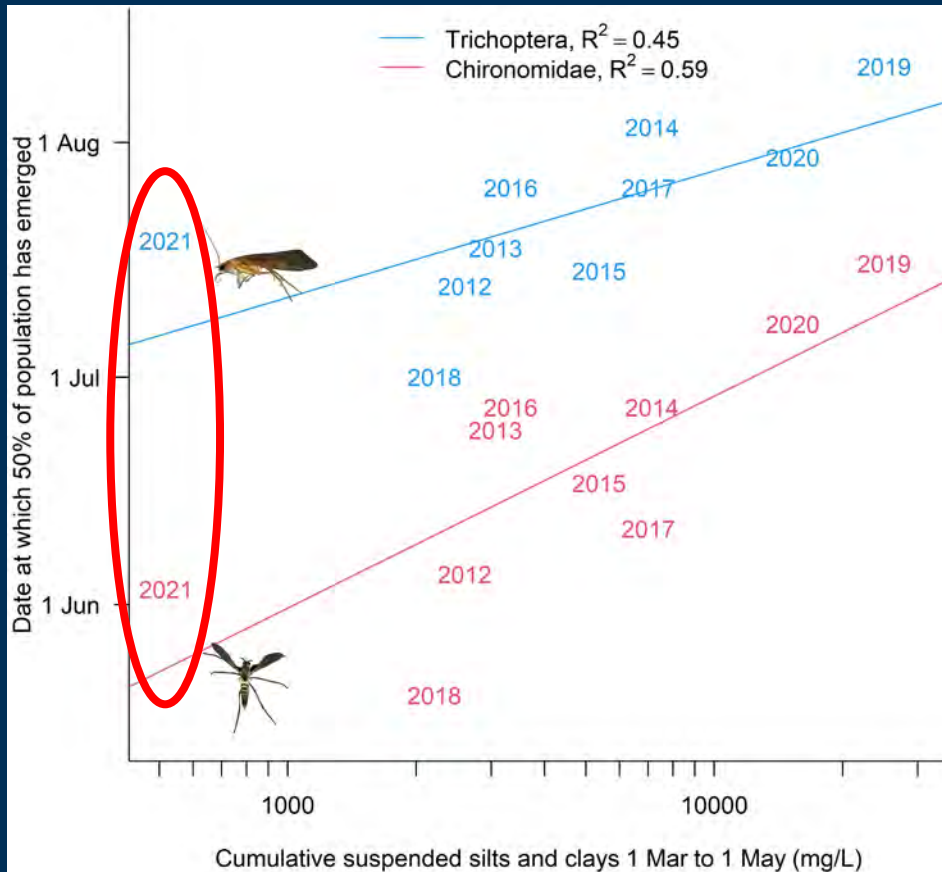
Wet Spring: late emergence

Dry Fall: high abundance

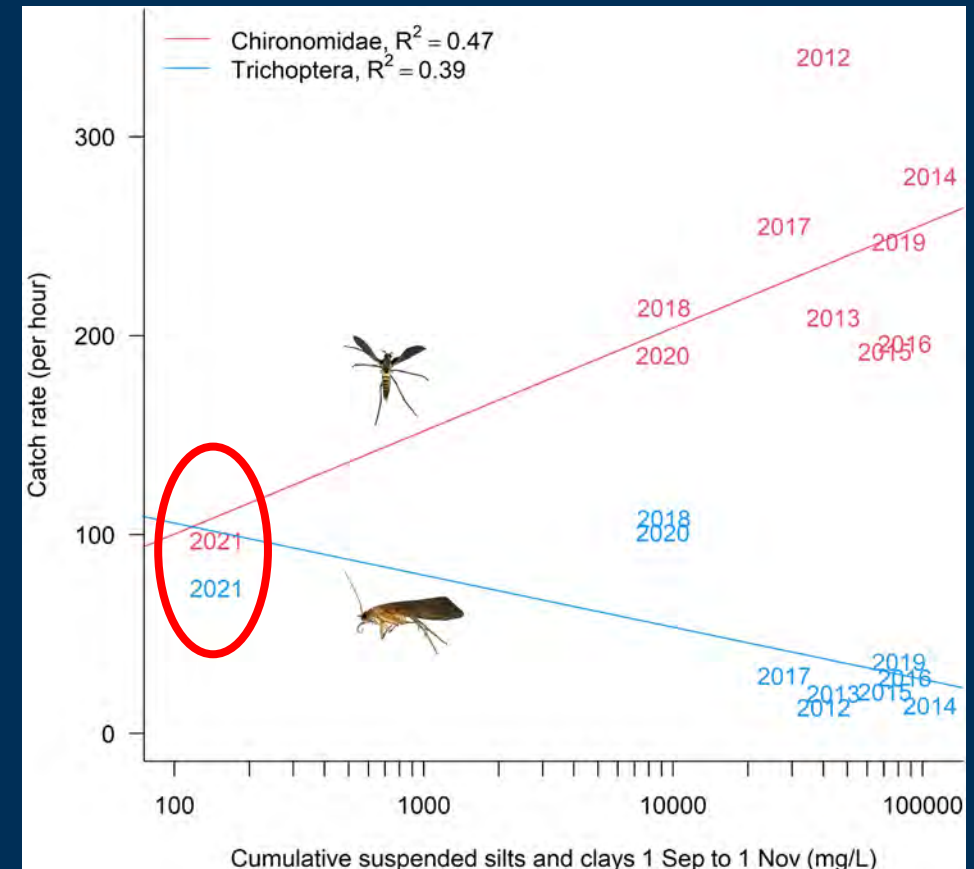


UPDATED RESULTS

2021 underperforms

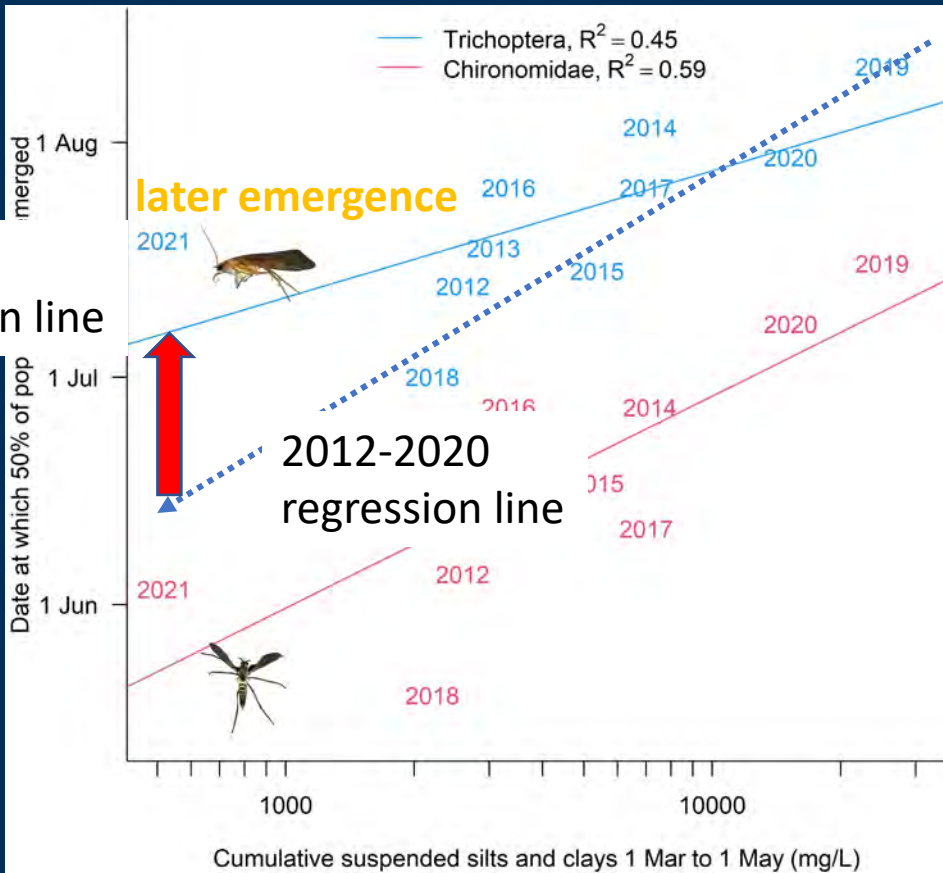


2021 underperforms

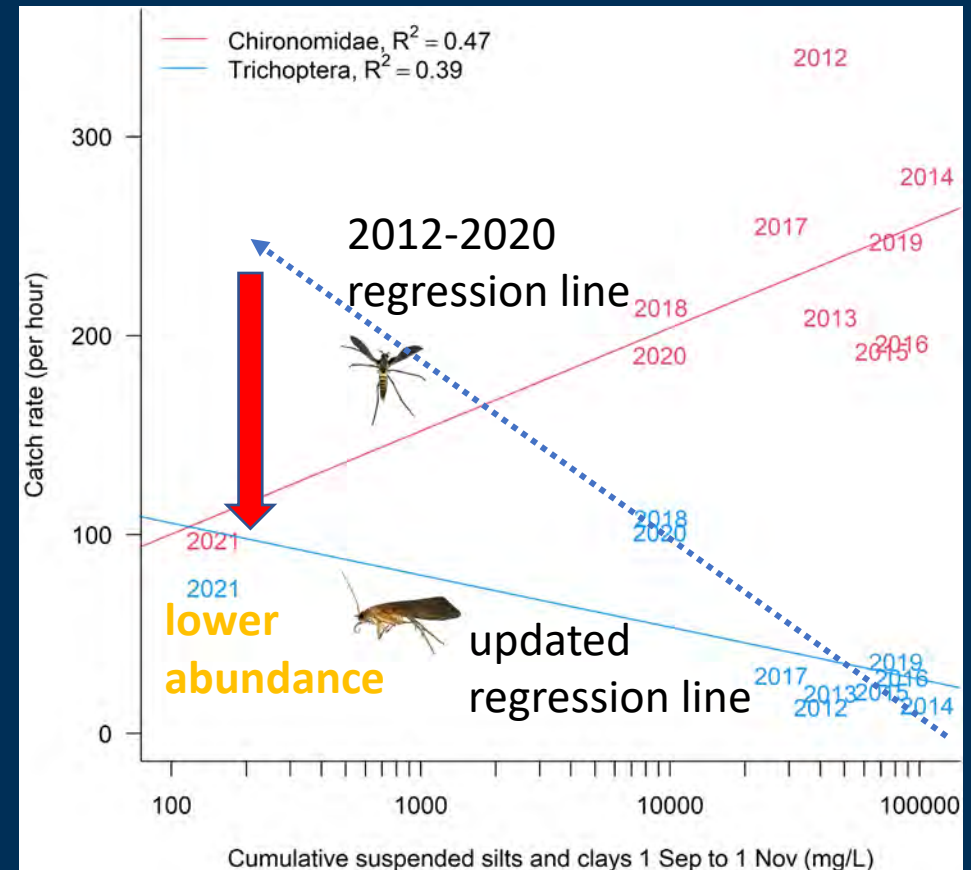


UPDATED RESULTS

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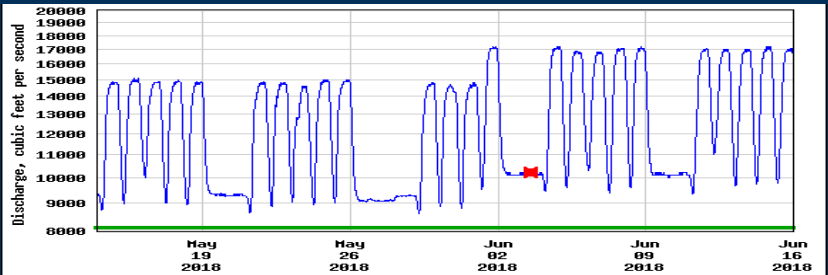
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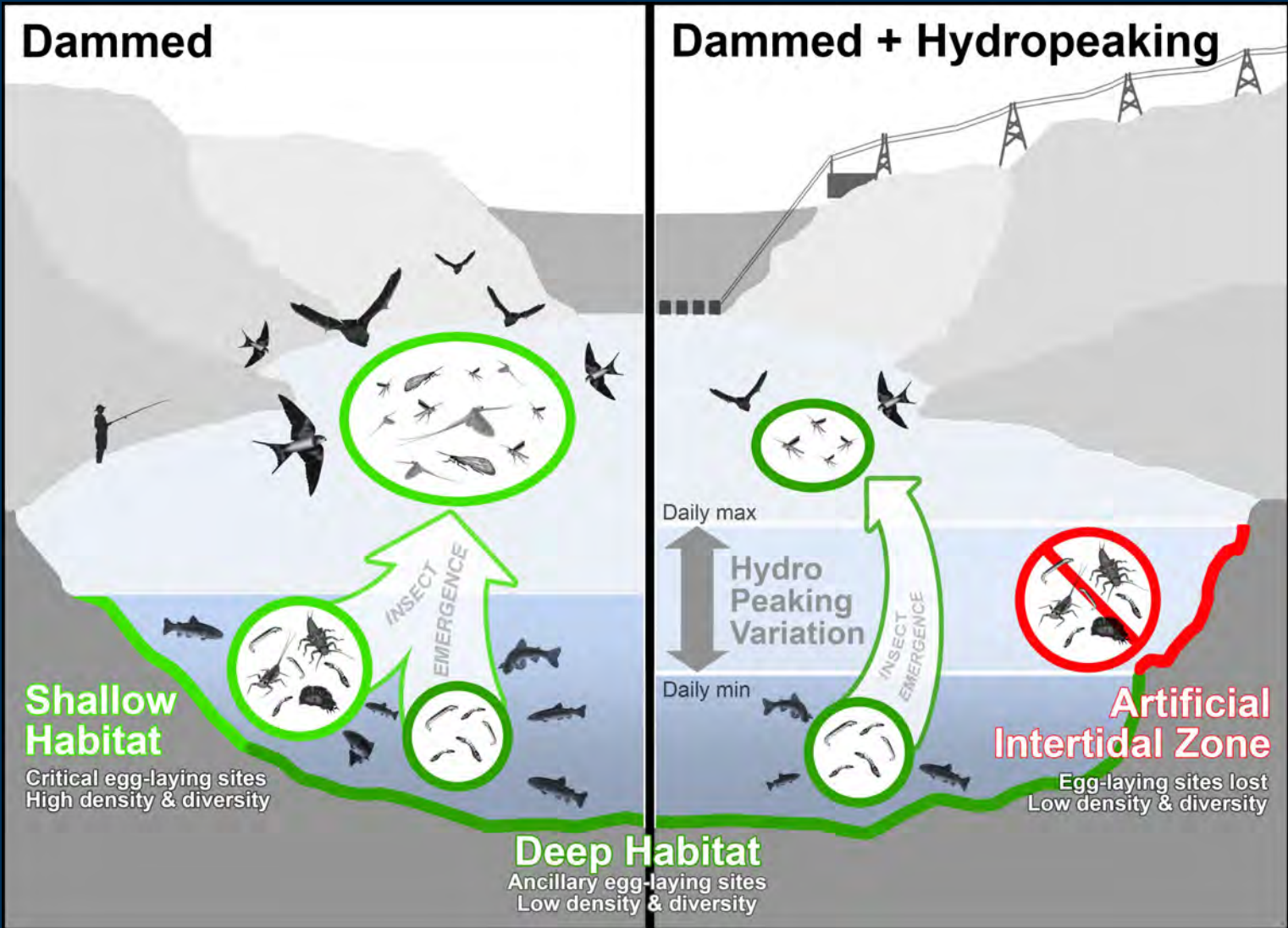
updated regression line

Conclusions

-The best available science continues to indicate that Bug Flows was effective at enhancing Natural Processes of the Colorado River ecosystem



Bug Flows



From Kennedy and others 2016 BioScience.

Bug Flows

Hydropower Fluctuations