MACROINVERTEBRATE OVIPOSITION HABITAT SELECTIVITY AND EGG-MASS DESICCATION TOLERANCES: IMPLICATIONS FOR POPULATION DYNAMICS IN LARGE REGULATED RIVERS

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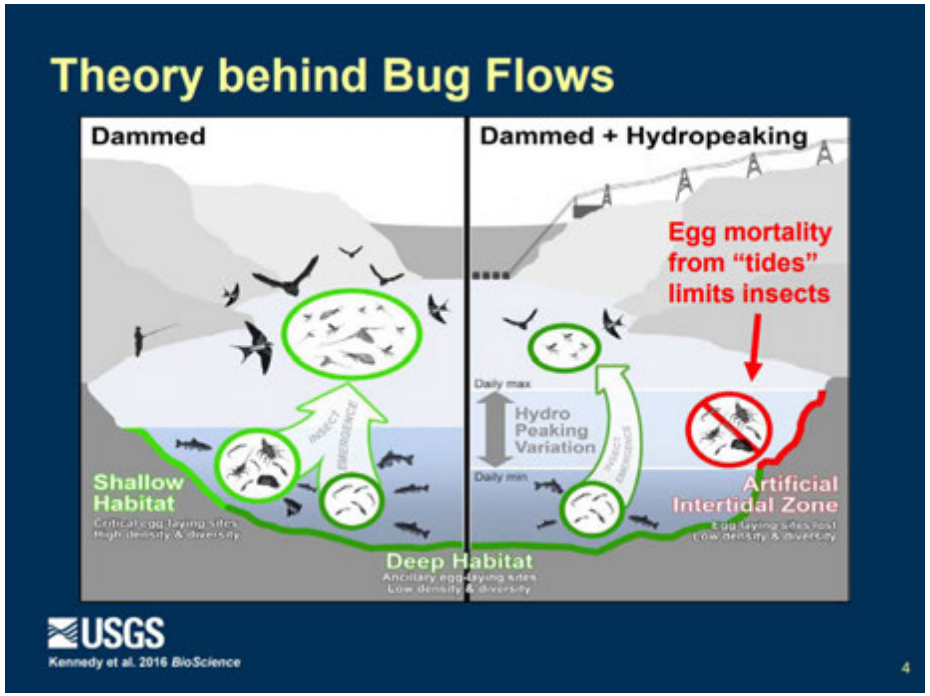
Western AREA POWER ADMINISTRATION

Introduction

…the potential for load-following flows associated with hydroelectric power production to act as a population bottleneck for aquatic insects via reductions in the availability and temporal persistence of optimal oviposition habitats.

Theory behind the Bugflows Experiment at Glen Canyon.



Introduction

Why Flaming Gorge?

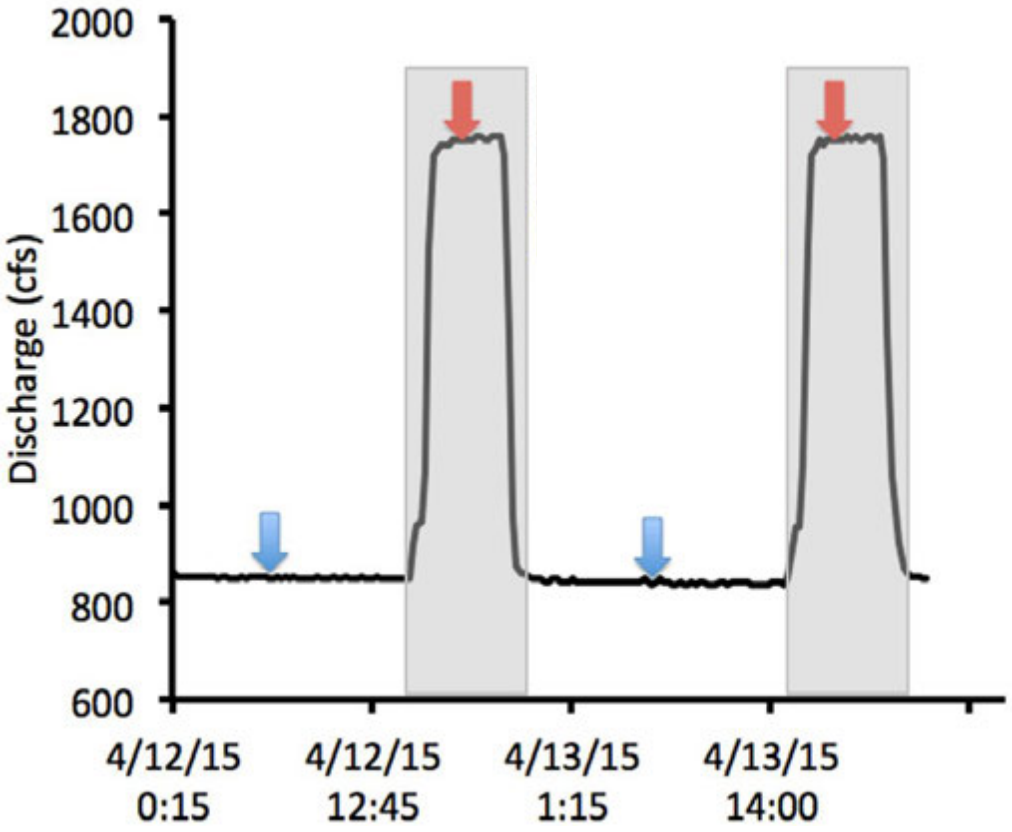
Why USU Buglab?

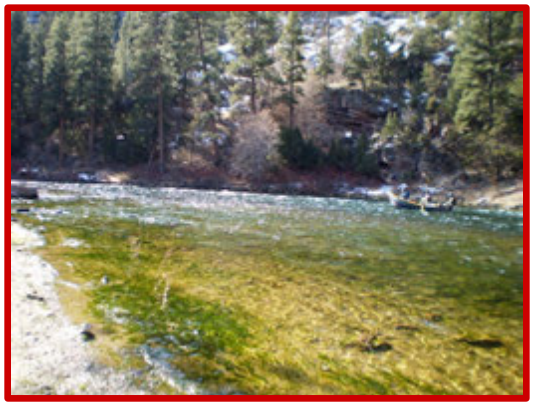
Why WAPA?

- Flaming Gorge has the bugs.
- USU Buglab has a long history of studying the aquatic foodbase in the Flaming Gorge tailwater.
- WAPA has been a key player in the management of the tailwater fishery.

Hypothesis and research questions

Hypothesis: Load following limits recruitment success of aquatic insects, thus altering assemblage composition.





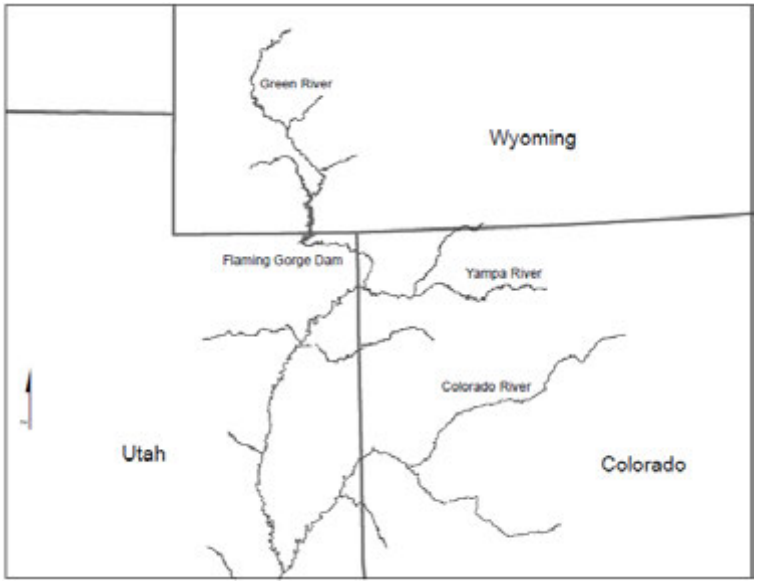
Hypothesis and research questions

Hypothesis: Load following limits recruitment success of aquatic insects, thus altering assemblage composition.

Research questions:

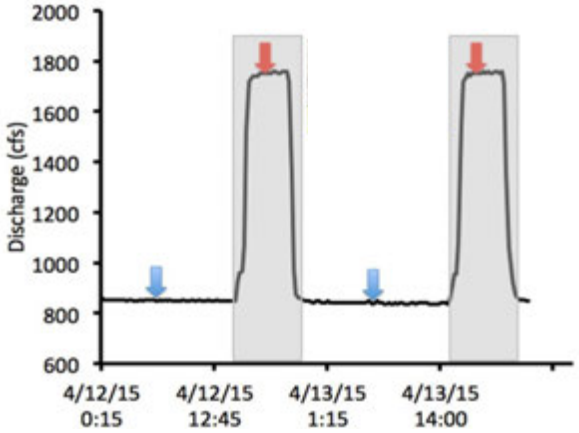
1. Are egg masses randomly distributed or differentially located in habitats impacted by load following?
2. Does load following reduce the availability of optimal oviposition habitats?
3. What are the implications of artificially high or low flows for insect recruitment?

Study area



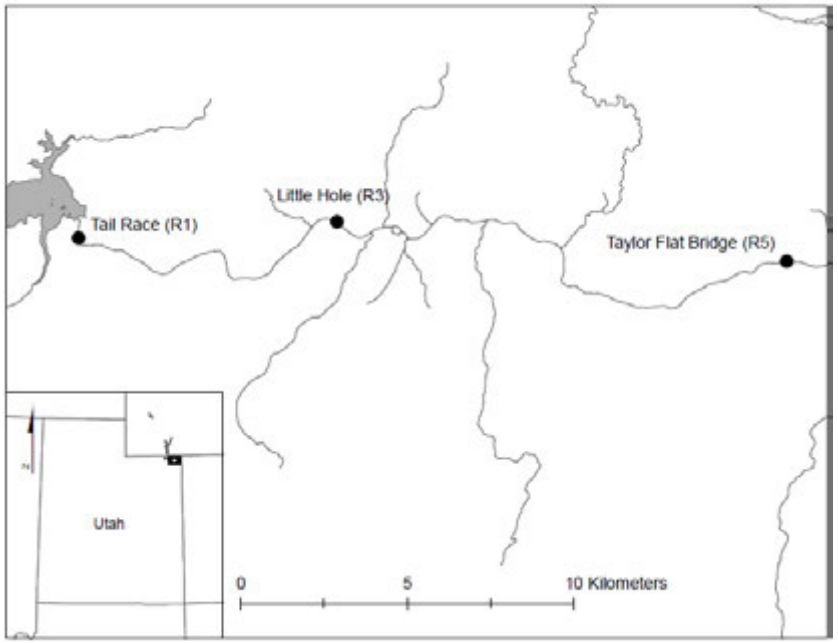
Flaming Gorge tailwater

- Green River
- Northeastern Utah
- Load following flows



Study area

Selected three segments for study to represent a gradient of hydro-geomorphic conditions



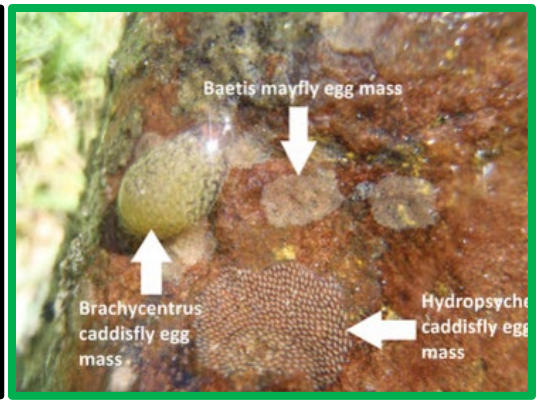
Tail Race

Little Hole

Taylor Flat Bridge

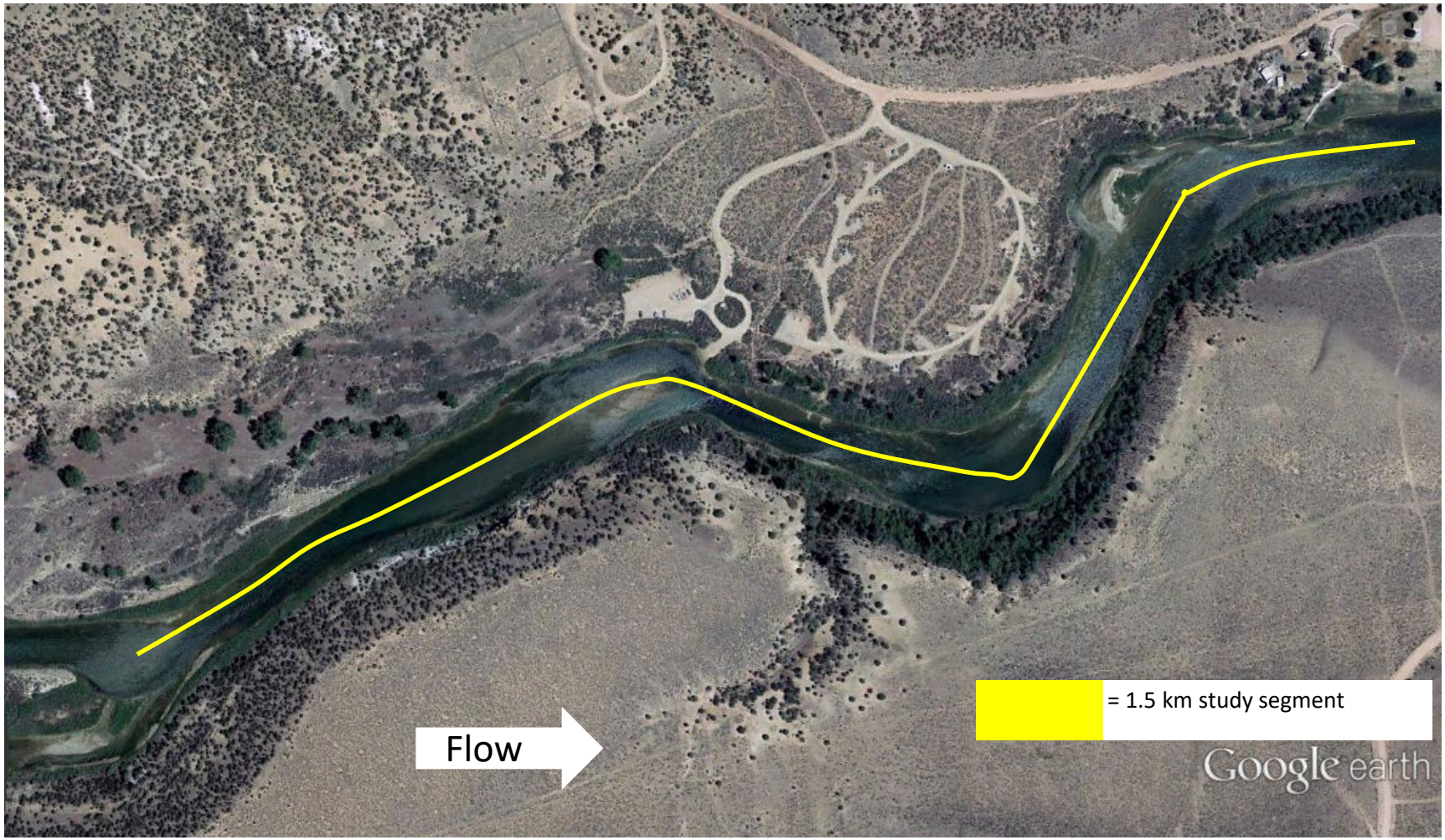
Objectives

- Characterize the egg-laying habits of four widely distributed insect taxa,
- Experimentally manipulate substrate depth and distance from river margins,
- Quantify oviposition habitat availability, and
- Conduct comprehensive laboratory desiccation trials.



Oviposition habitat availability and utilization

Three 1.5 km river segments

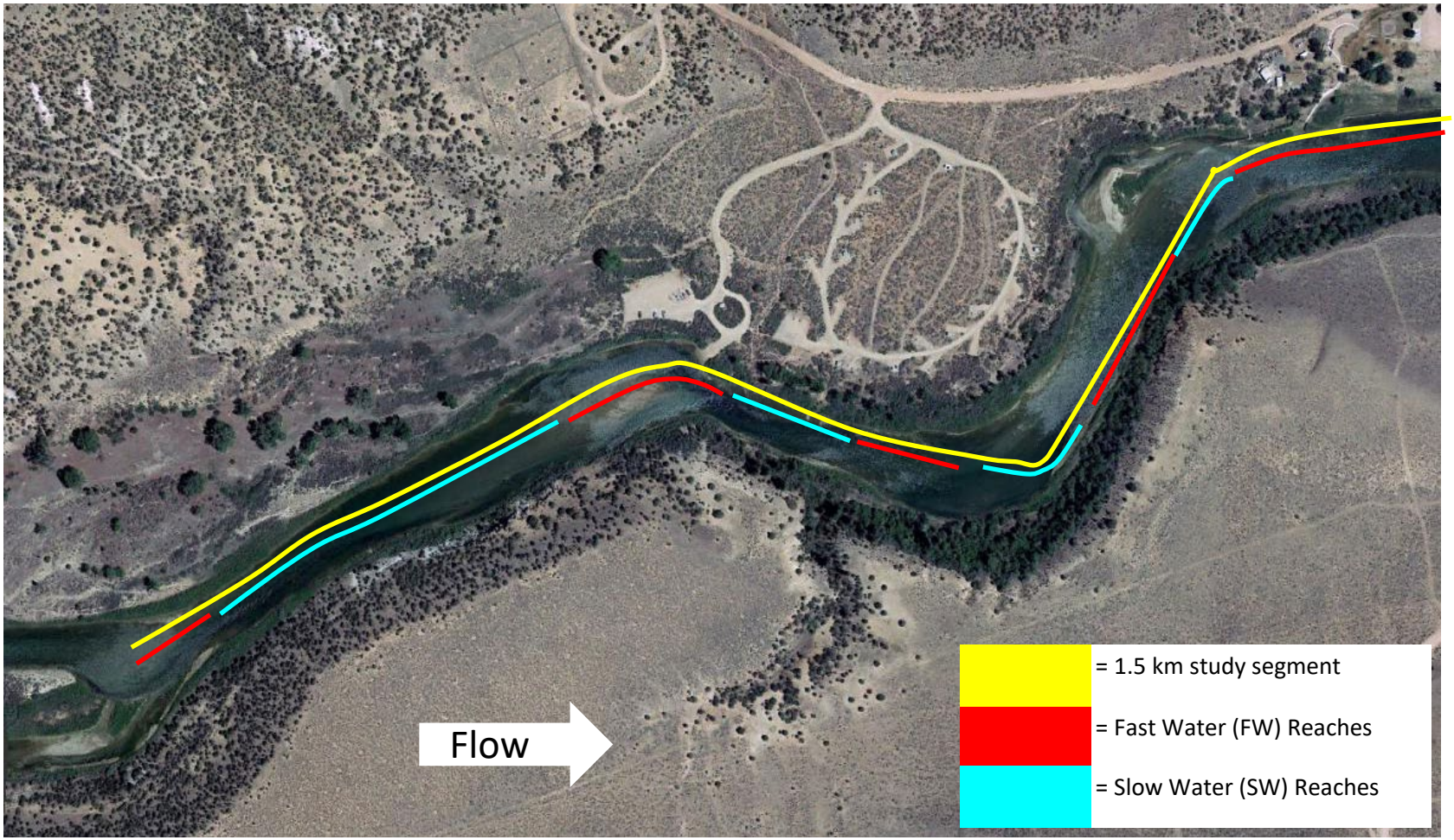


Oviposition habitat availability and utilization

1.5 km river segments:

Delineated fast- and slow-water habitats

Randomly select two of each

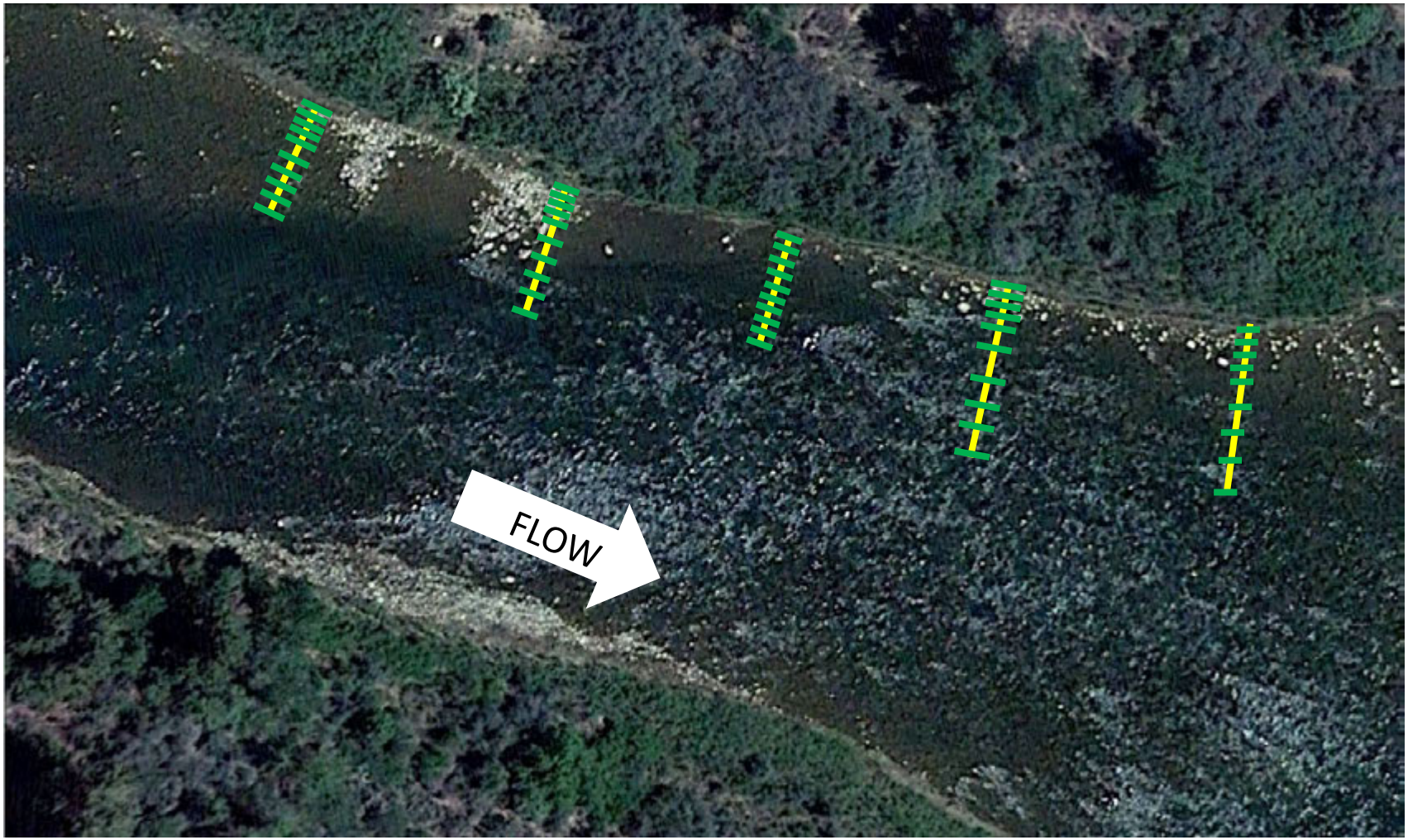


Oviposition habitat availability and utilization

2 stage sampling

1st stage (availability)

5 transects with 10 sample pts. per transect

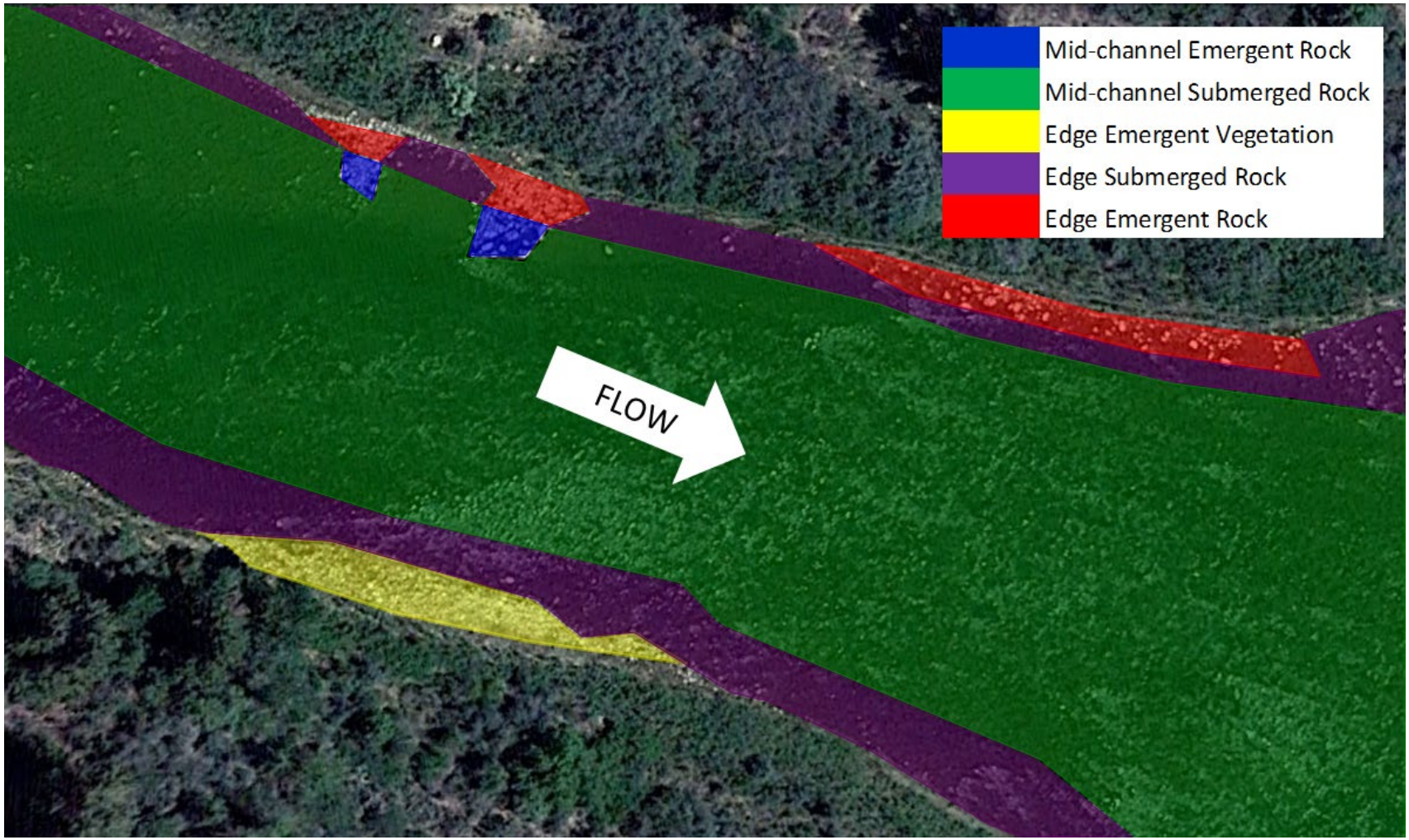


Oviposition habitat availability and utilization

2 stage sampling – 2nd stage (use):

Stratification to sample rare habitats (15 pts. per stratum)

Total points per reach: 75 - 100

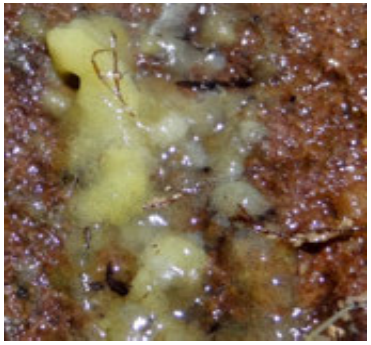


Oviposition target taxa

Surveys conducted for:

- Mayflies (Ephemeroptera): *Baetis* spp.
- Caddisflies (Trichoptera):
  - *Brachycentrus occidentalis*
  - *Hydropsyche occidentalis*
- Midges (Diptera): Chironomidae Orthocladiinae (likely *Eukiefferiella* spp.)





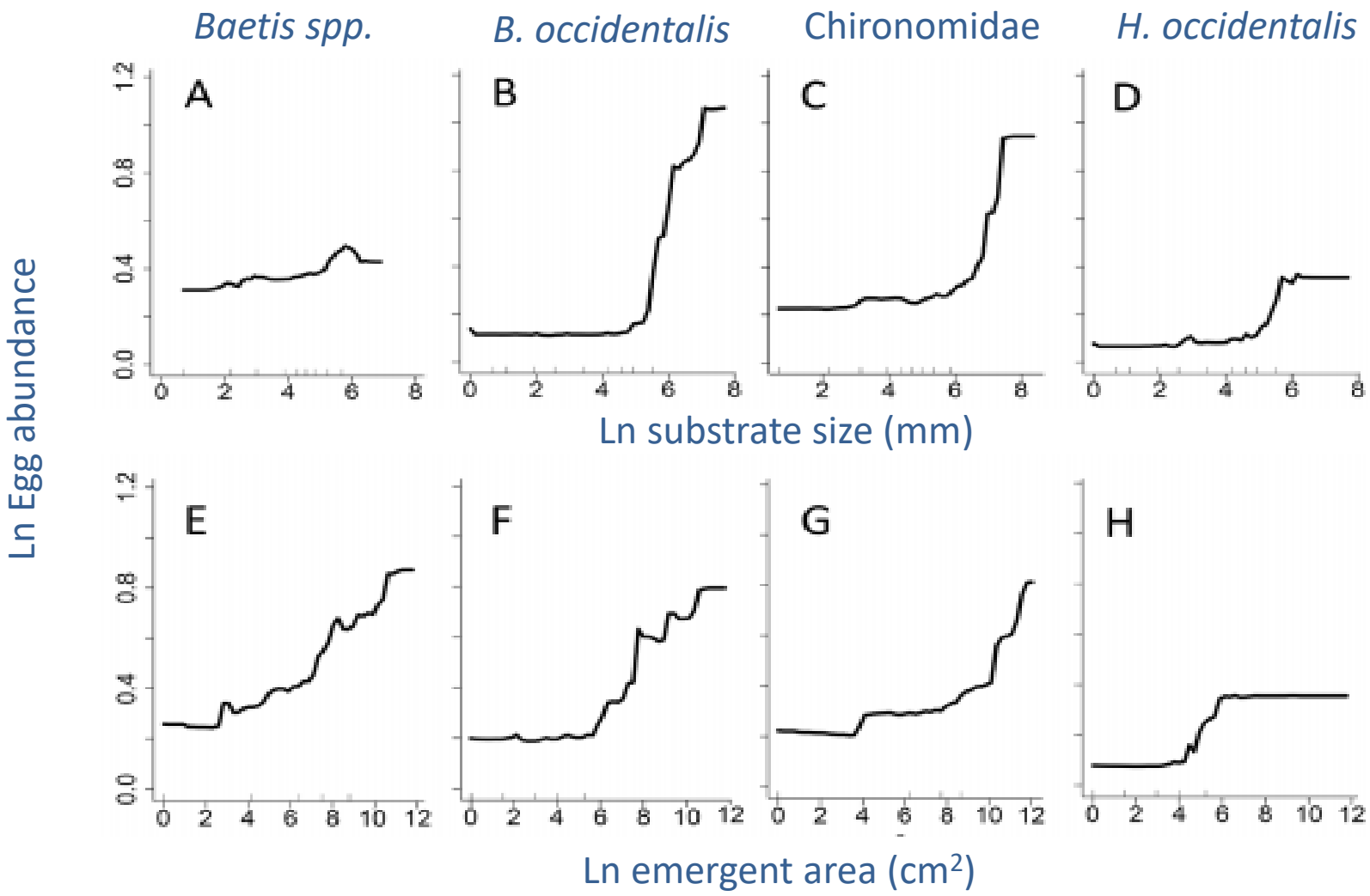



Oviposition habitat utilization – RF model results

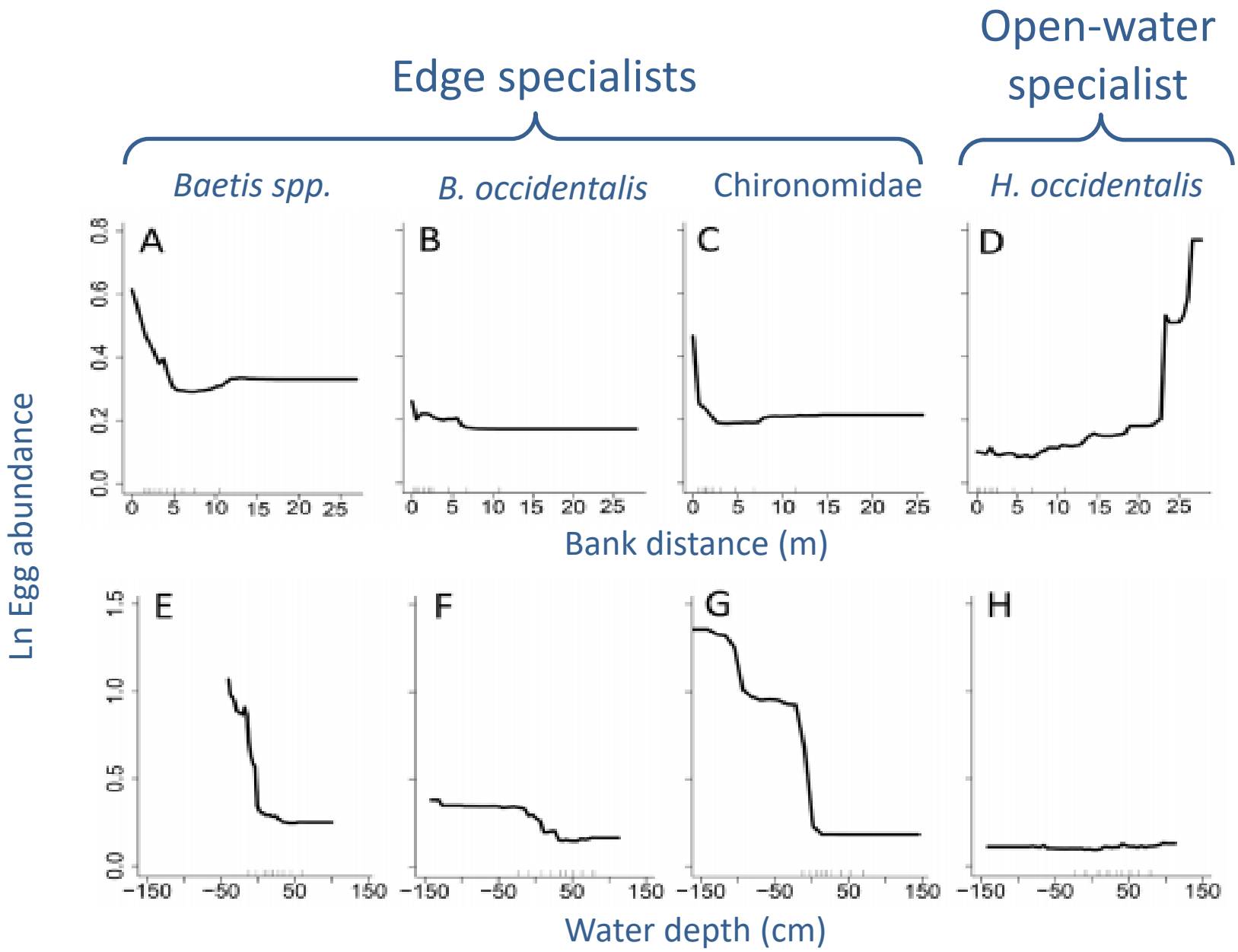
Predictor	*B. occidentalis*	*H. occidentalis*	Orthocladiinae
Distance from bank	X	X	X
Substrate size	X	X	X
Emergent area	X	X	X
Water depth	X	X	X
Embeddedness		X	
Velocity	X		
Segment		X	X
Habitat unit			X
R^2	51%	25%	67%

Oviposition habitat utilization – RF model results

Preference for large, emergent substrates



Oviposition habitat utilization – RF model results



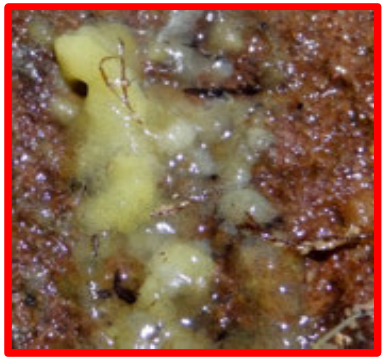
Oviposition habitat utilization results summary

Egg masses for 3 of 4 taxa located in habitats affected by load following: Emergent rocks in the varial zone

Edge specialists

Open-water specialist

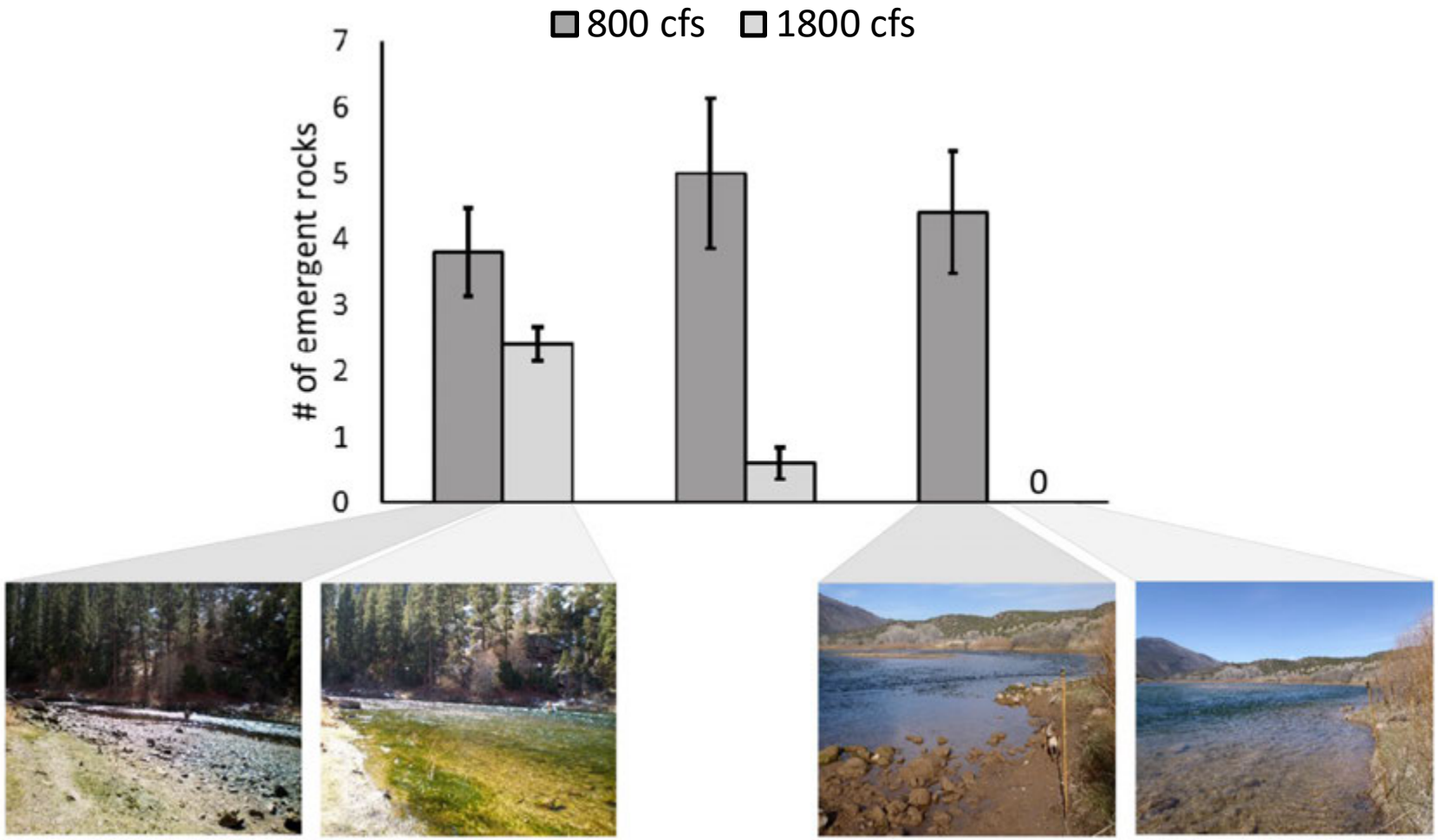






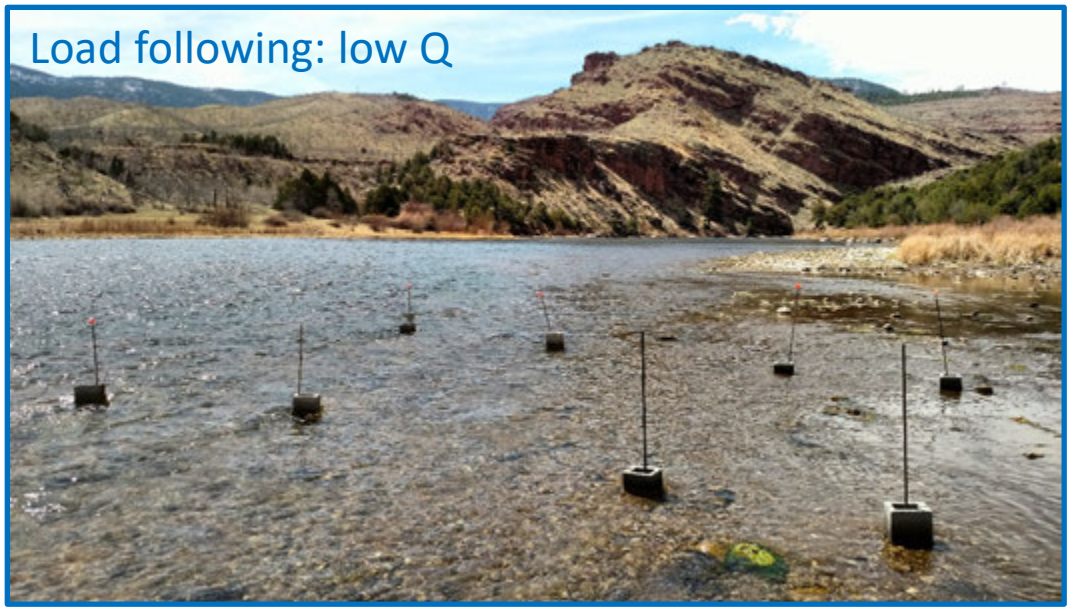

Load following effects on habitat availability

Load following significantly reduced the availability of optimal oviposition habitats – emergent rocks



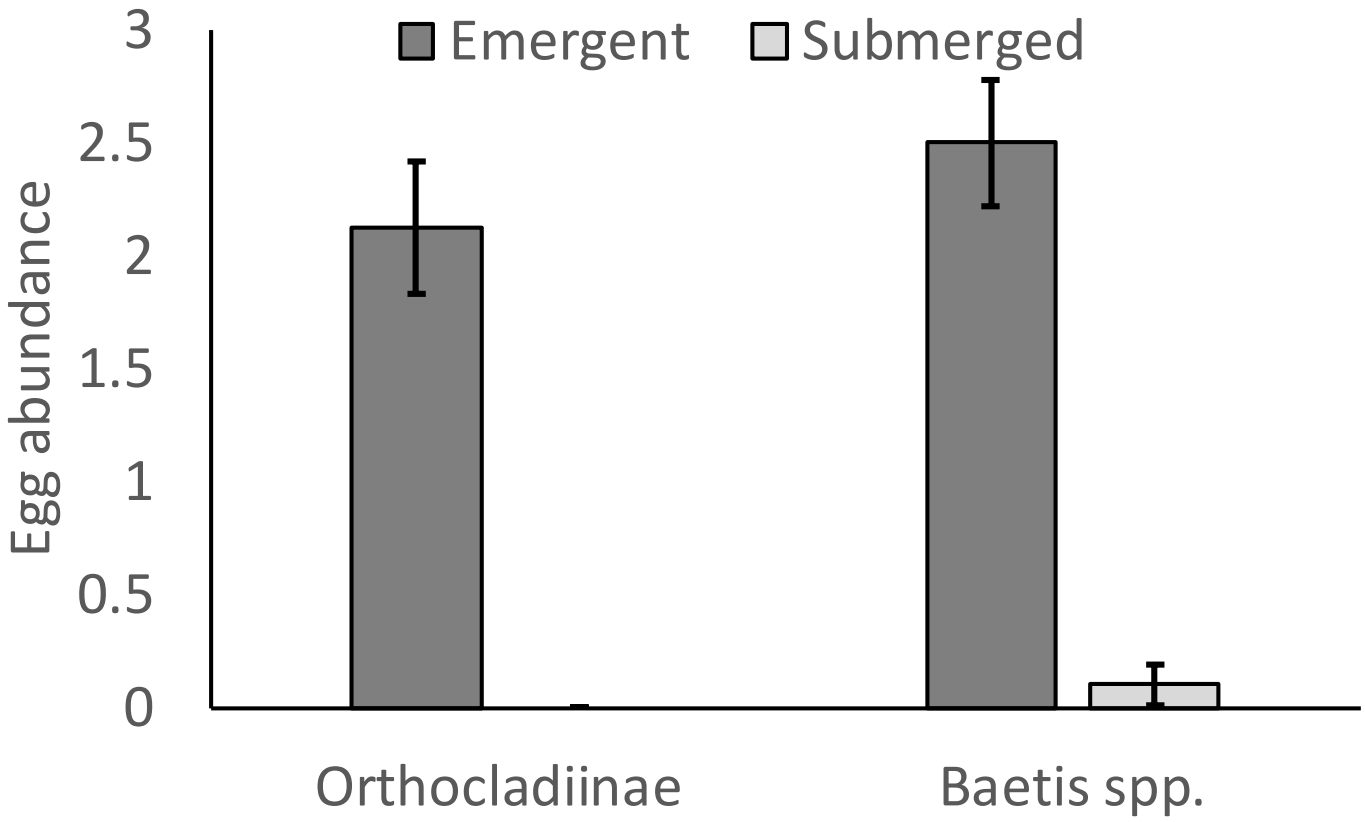
Load following effects on oviposition

Experimental substrate manipulations:
egg density *f*(submerged and emergent substrates)

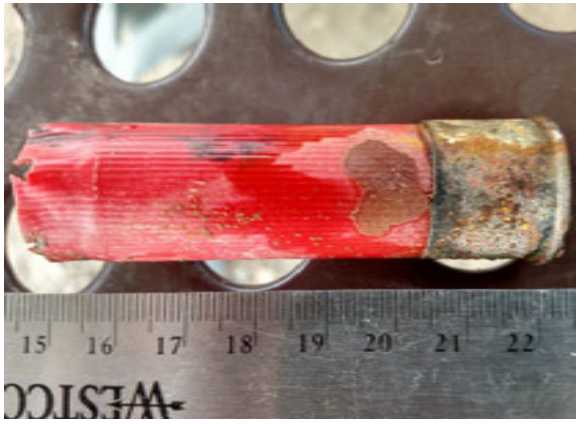


Load following effects on oviposition

High flows have the potential to reduce egg densities by reducing emergent substrates

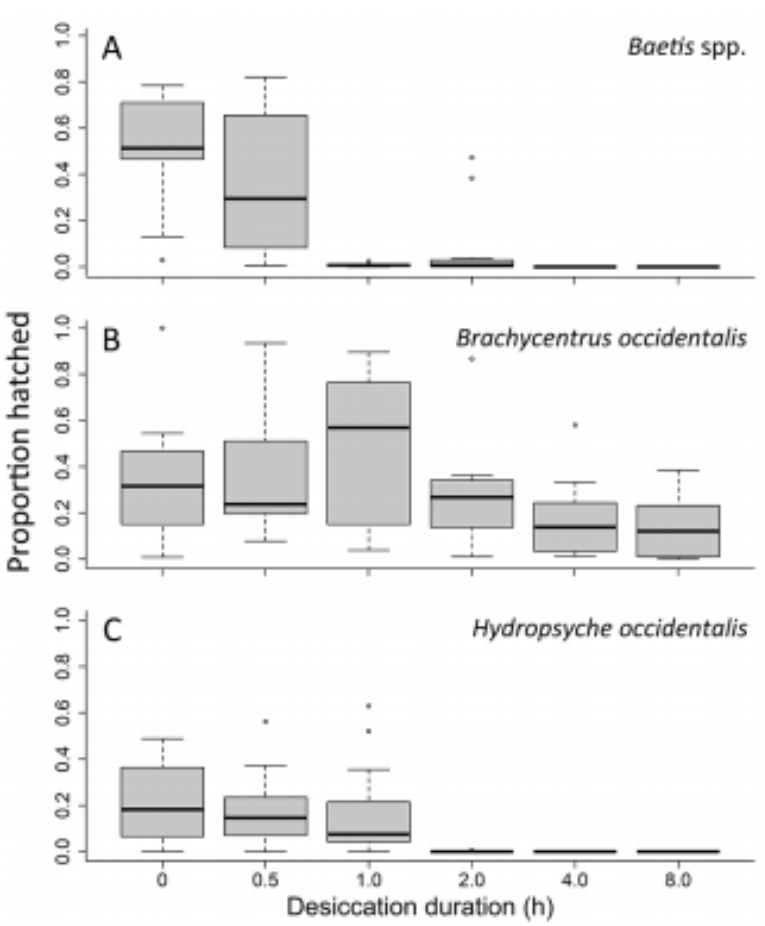


Oviposition habitat utilization



Load following effects on egg viability

Low flows have the potential to desiccate eggs and reduce hatching success



Consequences of load following for river biodiversity

Load following may limit edge specialists that use large, emergent substrates

Edge specialists

Open-water specialist

Conclusions

- Large river macroinvertebrates disproportionately use edge habitat for oviposition
    - Large emergent mineral substrates
- Load following can reduce the availability of optimal oviposition habitats
- During load following, high and low flows have the potential to reduce population recruitment, but by differing mechanisms
    - High: loss of emergent substrates
    - Low: egg desiccation
- Timing of load following, both seasonally and within day, could be managed to increase recruitment

Publication

- Miller, S.W., M. Schroer, J.R. Fleri, and T.A. Kennedy. 2020. Macroinvertebrate oviposition habitat selectivity and egg-mass desiccation tolerances: Implications for population dynamics in large regulated rivers. Freshwater Science. 39(3):584–599

- https://www.journals.uchicago.edu/doi/pdf/10.1086/710237