Body Size and Stable Isotope Ratios of Adult Net-Spinning Caddisflies (*Hydropsyche oslari*) Reflect Growing Conditions for Aquatic Insects during Flow Experimentation on the Regulated Colorado River

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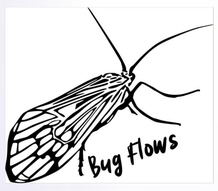


Introduction

When growing conditions for aquatic insects are favorable, there is often a 'syndrome' of responses that are observed at the population level:

- earlier emergence
- more adult emergence
- larger adult body size

Here, we investigate adult body size and carbon isotope ratios for *Hydropsyche oslari* to better understand growing conditions in the Colorado River before and during Bug Flow experimentation to aid interpretation of abundance data that have been reported previously.

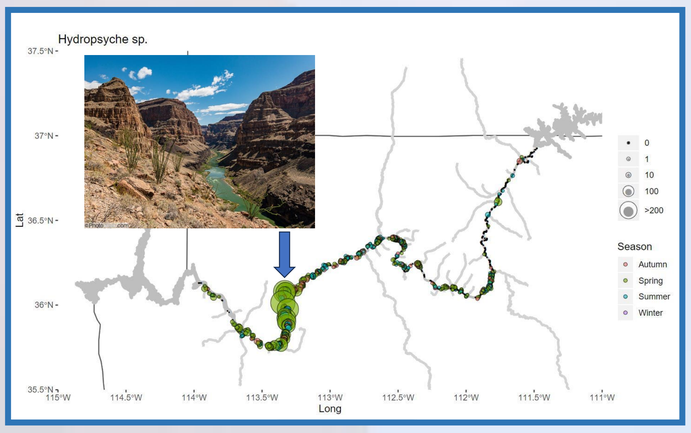
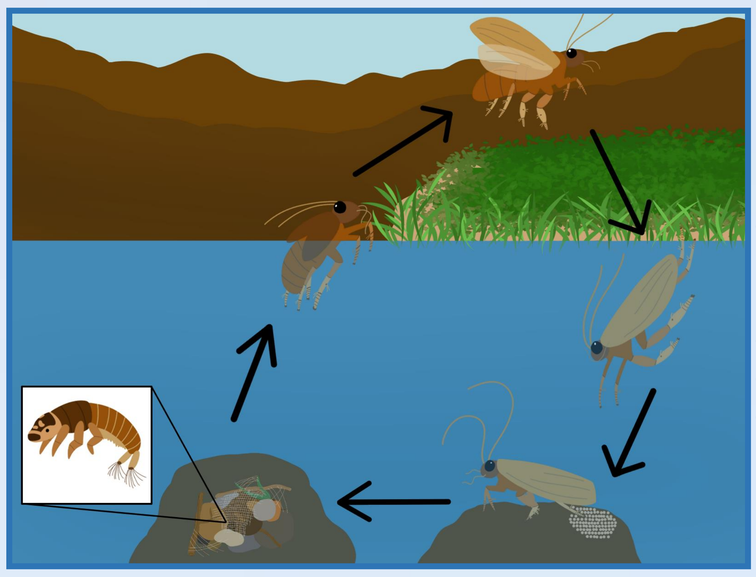


Figure 1. The Colorado River through Grand Canyon showing the abundance of *H. oslari* during 2015 to 2020. *H. oslari* have been collected throughout the Colorado River but are most abundant in western Grand Canyon (blue arrow).



Credit: Diana Valentin; NAU/USGS 2021

Illustration of caddisfly emergence; caddisflies build underwater cases from silk and stones or sticks as growing pupae, then float to the surface for transformation into terrestrial adults (usually univoltine, i.e. one generation per year).

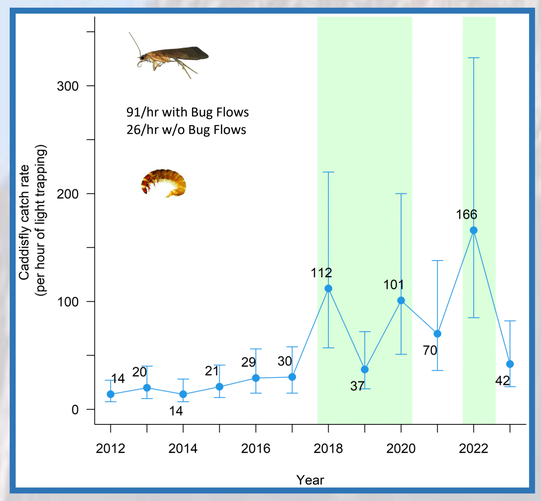


Figure 2. Caddisfly abundance between 2012 and 2023. Bug Flows highlighted in green occurred in 2018, 2019, 2020, and 2022, with a 75% decrease in 2023.

Methods

Samples of *H. oslari* analyzed for this poster were restricted to river miles 199 to 225 to reduce potential spatial variation in size and focus on temporal variation. Additionally, only female *H. oslari* were analyzed to eliminate variation in size associated with sex and because female size is an indicator of fecundity (larger females lay more eggs). Individuals of 528 *Hydropsyche oslari* females were measured for length and weight spanning 2015 to 2023. To better understand potential drivers of variation in length, we analyzed stable carbon isotope ratios of the specimens. Carbon isotope ratios are an indicator of the carbon-basis of animal growth, with more negative values (i.e., -30‰) indicating greater reliance on higher-quality algal carbon and values that are less negative (i.e., -25‰) indicating greater reliance on lower-quality allochthonous (terrestrial) carbon. Note that over this period of record, Bug Flows were conducted in 2018-2020 & 2022. We predicted that years of high *H. oslari* abundance would be associated with larger average female size and more negative carbon isotope ratios, indicating greater reliance on high quality algae carbon.

Results

Figure 3. Variation in weight (Y-axis) of *H. oslari* as a function of day of year. Different years are plotted with different colors. Females that emerge early in the year are longer on average than individuals that emerge later in the year, which is consistent with studies of size at emergence in other rivers.

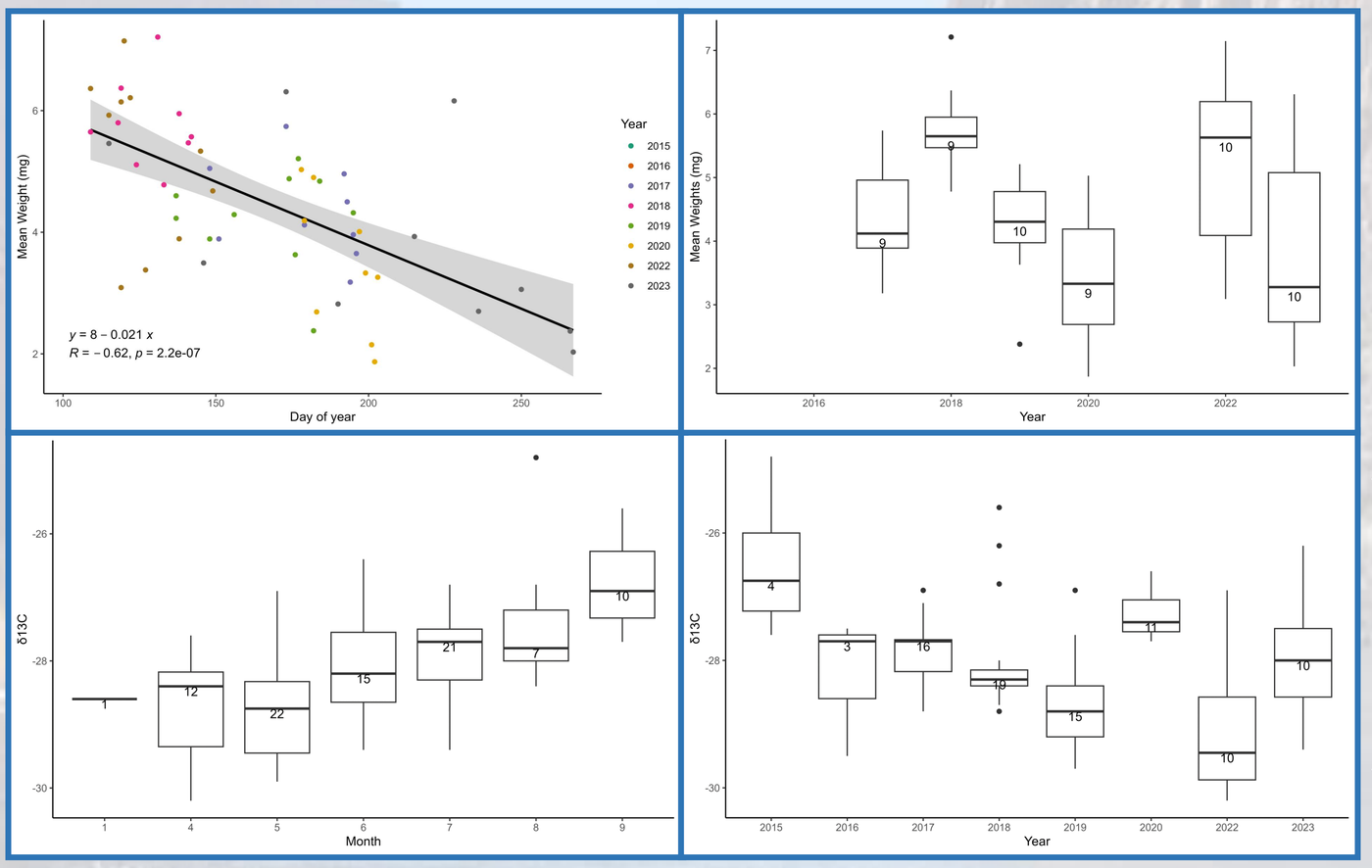


Figure 4. Weights of *H. oslari* across years. The box represents the upper and lower quartile (25th and 75th percentile), the horizontal line represents the median (middle) value, the whiskers represent two standard deviations, and points represent outliers.

Figure 5. Boxplots of carbon isotope ratios for *H. oslari* females across months. Females that emerge early in the year tend to have more negative carbon isotope ratios, indicating greater reliance on high-quality algae carbon relative to females that emerge later in the year that rely more on low-quality terrestrial carbon.

Figure 6. Boxplots of carbon isotope ratios for *H. oslari* females across years. Contrary to predictions, *H. oslari* from years with lower caddisfly abundance (e.g., 2015-2017) did not have lower carbon isotopes ratios than years with higher abundance (e.g., 2018, 2020).

Conclusions

- Body size is smaller later in the year
- Diets later in the year are more allochthonous
- Bug Flow years are correlated with increased body size but not significantly
- Lengths and weights varied significantly by year (ANOVA; $P<0.01$)

Next steps:

Compile length/weight and isotope data for 2021 and incorporate these data into models of abundance and Bug Flows.

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