Extended low flows alter Sierra Nevada macroinvertebrate food webs

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INTRODUCTION

Climate change is predicted to advance Sierra Nevada snowmelt up to two months[1]. If this occurs, alpine streams will experience earlier peak discharge, followed by longer low flow conditions. Macroinvertebrate abundance and biodiversity are known to respond to changes in temperature and flow, but it is uncertain if species interactions and energy flow also change in ways that would threaten food web stability. Our central research question is: **How will macroinvertebrate food webs respond to longer low flow periods?**

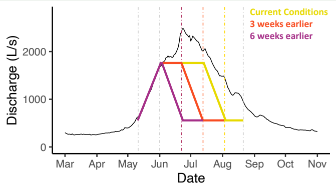
We hypothesize that communities will have a greater proportion of algae in their diet and experience a compressed isotopic niche. Additionally, we expect predators' isotopic niche sizes and trophic positions to decrease as their larger body size and greater metabolic demands make them more sensitive to stressors.[2]

METHODS

We manipulated the flow regime of nine artificial streams at the Sierra Nevada Aquatic Research Laboratory to simulate the following flow regimes:

- Current flow regime
- Low flow extended by three weeks (climate change mitigated scenario)
- Low flow extended by six weeks (climate change unmitigated scenario)

The simulated hydrographs (below) are based on the average discharge from Convict Creek.



Macroinvertebrates and basal resources were sampled in early summer (May/June) and in late summer (August). We analyzed samples for carbon δ13C and nitrogen δ15N isotopes. We calculated the dietary proportions of food resources with a mixing model (SIMMR) and the isotopic niche size using Bayesian ellipses (SIBER). Average trophic position of each taxa was calculated with Lymnaeidae as a baseline and a trophic discrimination factor of 3.4.[3]

RESULTS

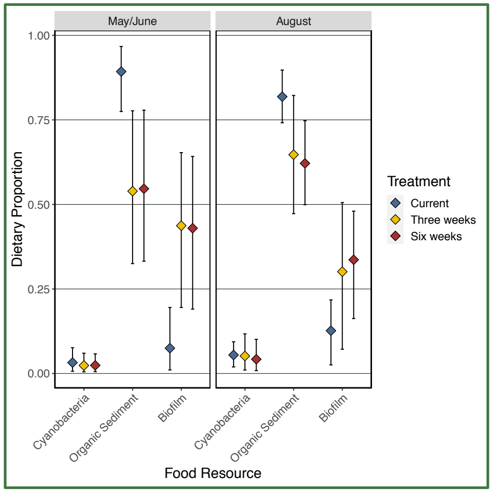


Fig 1 Importance of Basal Resources The mean proportion of the basal sources to the community's diet with 95% credibility intervals. The community diet consisted mostly of organic sediment followed by biofilm. This preference was not significantly affected by sampling date.

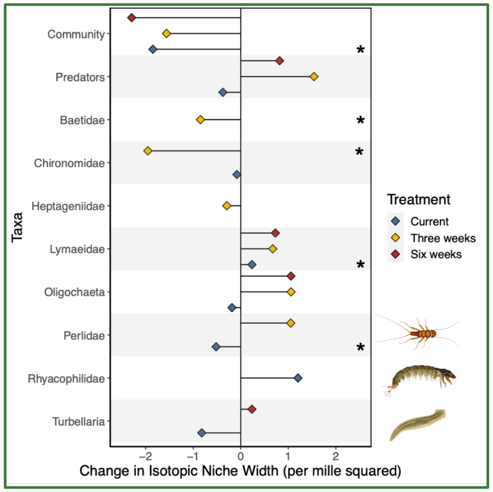


Fig 2 Change in Isotopic Niche The change in isotopic niche size between sampling dates. A positive change in size suggests the taxa's niche expanded from May/June to August. Significance (*) is based on the SIBER model results.

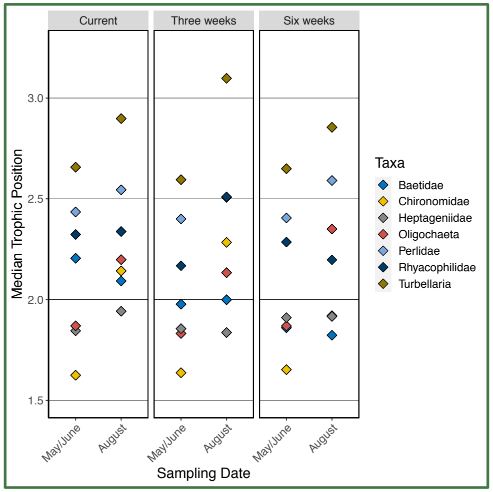


Fig 3 Trophic Positions The average trophic position of each taxa. A trophic position of 2 suggests an herbivorous diet, anything above 2 suggests an omnivorous diet. Trophic positions tend to increase seasonally, with Turbellaria as the top predators, followed by Perlidae and Rhyacophilidae.

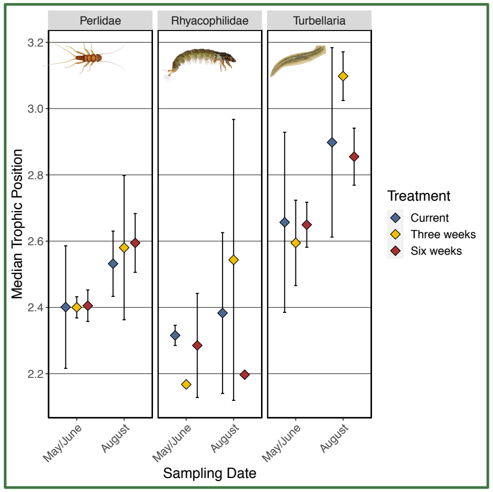


Fig 4 Predator Trophic Positions The average trophic position with 95% confidence intervals. Sampling date had a significant impact on the trophic position of Perlidae and Turbellaria (p > 0.05, two-way ANOVA).

CONCLUSION

Overall, these results suggest macroinvertebrate communities may be resilient to climate change-induced extended low flows.

- Organic sediment remained the primary basal resource during the current flow regime as well as both extended low flow periods.
- The community-level niche shrank through all three low flow treatments.
- The overall predator niche space shrank slightly under the current flow regime, but expanded during both extended low flow treatments.
- The trophic positions of the top predators increased through all low flow periods.

These results hold broader implications for the state of the system.

- The community's dependence on organic sediment suggests a nutrient-poor system that is reliant on subsidies from upstream and terrestrial sources.
- Despite predator sensitivity, positive changes in their niche and trophic position during the extended low flow conditions suggest predators either were able to take advantage of increased prey densities or were more capable of catching prey as they developed in late summer.
- The reduction in community niche size suggests current low flows cause a reduction in food web resilience, but this will not be not exacerbated further by climate change-induced extended low flows.

Future work on this study will analyze how the responses of the food web correlate to changes in taxa abundances. We will also analyze predator gut contents to determine if the changes in predator trophic position and isotopic niche are due to changes in their diet preferences or prey abundance.

ACKNOWLEDGEMENTS

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[1] Reich et al. 2018. UCLA Center for Climate Science.
[2] Mor et al. *in press*. Ecology.
[3] Post. 2002. Ecology 83(3):269-277.