Determining benthic macroinvertebrate abundance and diversity in two arctic lakes as part of an experimental lake warming

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Introduction

- Global climate change threatens the integrity of freshwater ecosystems and at higher latitudes, they are experiencing the highest rates of temperature increase related to climate change.
- Freshwater invertebrate communities are important sources of food for fishes and bioindicators helping us understand the health of entire ecosystems.
- Our research is part of a larger experiment to artificially warm an arctic lake by 2-4 ºC, to try and determine the impact of rising temperatures on lake food webs and ecosystem function.

Objectives

- Determine benthic macroinvertebrate densities in two arctic lakes.
- Assess whether macroinvertebrate densities respond to increases in lake warming or other factors.

Methods

- Benthic macroinvertebrate samples were collected using an Ekman dredge (i.e., grab) from lake depths between 0-4 m in each lake.
- Using standard protocols, we analyzed benthic samples from 2016-2019.
- We classified each taxon into 4 main groups: Diptera (including primarily chironomids), Mollusca (including snails), zooplankton (including ephippia), and other aquatic macroinvertebrates
- We calculated densities of each group (number/m^2).

Fig. 1: Various invertebrate taxa from arctic lakes. From left to right. Top: Dipterans, Hydracarina, Copepod, Trichopteran. Bottom: Daphnia, Mollusc, Ostracoda.

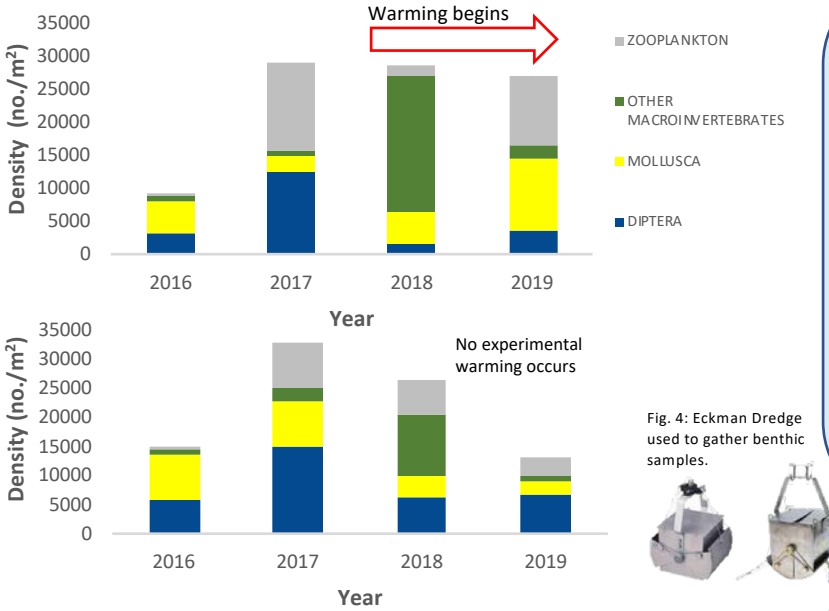

Fig. 2: Mean density of macroinvertebrates from Lakes Fog1 (experimentally warmed, top panel) and Fog3 (reference, bottom panel) taken across 0 – 4 m lake depths, 2016 – 2019. Experimental warming in Lake Fog1 began in 2018. Zooplankton includes ephippia. Mollusca includes all snails. Other includes various aquatic macroinvertebrates.

Fig. 4: Eckman Dredge used to gather benthic samples.

Fig. 3: Top left is Lake Fog1 in August of 2019. Top right is a skyline view of Lake Fog3. And bottom right is the location of the Toolik Field Station (red dot) north of the Brooks Range in arctic Alaska. The Fog lakes are located 15 km northeast from the field station.

Results

- Benthic macroinvertebrate densities varied greatly from year to year and ranged from 609 to 20,391 organisms/m^2 (Figure 2).
- Observed a very large increase in “other aquatic macroinvertebrates” for Fog1 (warmed lake) in 2018. This is mostly comprised of Hydracarina (mites) and some unique Trichopterans and Annelids (Figure 2).
- We did not observe a definitive trend in response to experimental warming (some groups increased on year but decreased the next and vice versa); however, total macroinvertebrate density was much higher in 2019 in the warmed lake, the second year of warming.

Summary

- Densities ranged greatly across lakes and years, but is this a result of lake warming or simply natural variation in aquatic macroinvertebrates?
- In future work, we will explore the metabolic preferences of those taxonomic groups that may have responded to warming, as well as potential top down (e.g., fish predation) pressures on benthic macroinvertebrates.

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