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Determining the Ability of Larval and Juvenile Alewife to Consume Zooplankton in Highland Lake

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Abstract

Highland Lake in Windham, Maine has suffered from algae blooms since 2017. These algae blooms may have been caused by top down effects (i.e., predation on zooplankton) or bottom up effects (i.e., nutrients). We evaluated the hypothesis that young of year alewives (*Alosa pseudoharengus*) can consume large zooplankton thereby releasing algae cells from grazing. We compared young of year alewife mouth gape width to the width and length of zooplankton common in the lake before the algae bloom. Daphnia (Daphnia magna) were the largest zooplankton measured, while nauplii (juvenile copepods) were the smallest. Overall, copepods were the most abundant zooplankton. In our final analyses, we will compare these zooplankton sizes to larval and juvenile alewife mouth gape to determine at what size alewife can consume important zooplankton. To measure alewife mouth gape we will use a specially constructed precision micrometer. These findings will provide a better understanding of the trophic dynamics of Highland Lake and one of several potential triggers of algal blooms in the lake.

Background

Mouth gape largely determines maximum prey size for larval and juvenile fish. By measuring gape we are able to understand at what age or size alewife are able to consume larger zooplankton. Larger zooplankton are efficient grazers on algae, so predation on larger zooplankton by alewife may change trophic dynamics. Understanding trophic dynamics in Highland Lake may help us understand the trigger for algae blooms that have occured in the lake periodically since 2014. This research had two parts: the first was to characterize the sizes of zooplankton in the lake over the summer, and the second was to measure the gape width of small alewife over the same time period. To measure zooplankton, we used a *Moticonnect* camera attachment on a microscope, which connects to a cellphone application for measurements. In further research, we will measure fish gape width with a specially designed micrometer (Arts and Evans, 1987), that has a calibrated cone that is inserted into the fish's mouth (Figure 8). We will assume that the dimension of mouth gape represents the maximum ingestible zooplankton size for larval and juvenile fish.

Methods

- Zooplankton were collected at night, from Highland Lake during 2019 using a 153 size mesh net.
- Zooplankton from June-August were measured (6/12, 7/10, 7/25, 8/5).
- Zooplankton were measured using a Moticonnect microscope camera connected to a cellphone application that allows measurement of zooplankton.
- Measurements were taken based on the orientation of the zooplankton the slide. Most accurate measurements were if the zooplankton was lying on its stomach or back, oppose to side. However, side measurements were taken for Daphnia (*Daphnia magna*).
- Copepods (Calanoids & Cyclopoids) were measured from tip of head to end of metasome (Fig. 6).
- Daphnia were measured from tip of head to end of abdomen, not including apical spine (Fig. 7).
- Nauplii were measured tip of head to end of body (Fig. 5).

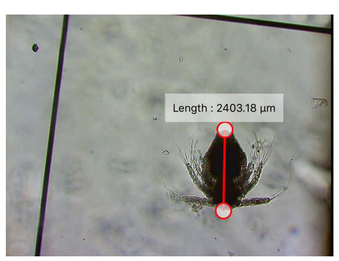

Figure 5. Copepod nauplii. The red line shows how nauplii are measured using the Moticonnect application on a cell phone.

Figure 6. Cyclopoid copepod. The red line shows how Copepods are measured using the Moticonnect application on a cell phone.

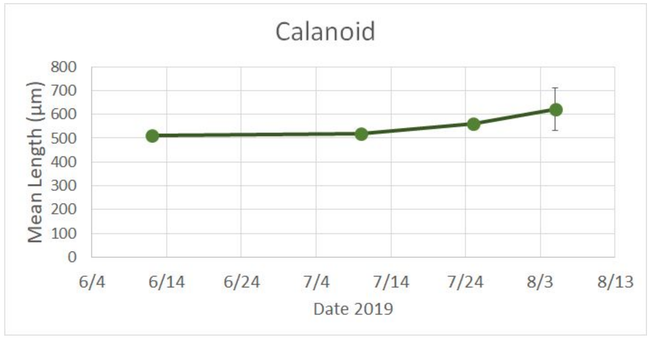

Figure 1. Mean Length of Calanoids. Error bars are 1 standard error.

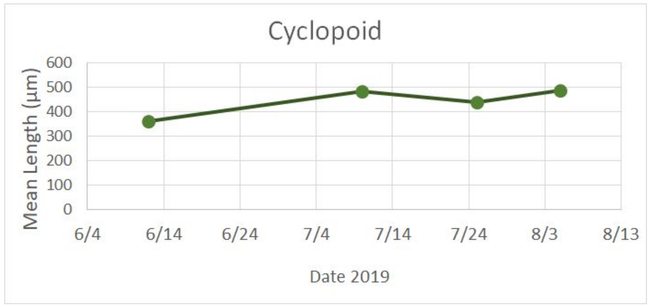

Figure 2. Mean Length of Cyclopoids. Error bars are 1 standard error.

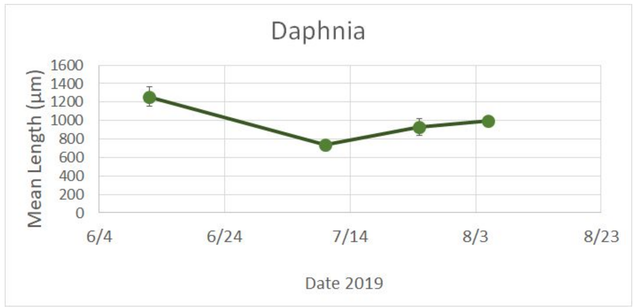

Figure 3. Mean Length of Daphnia. Error bars are 1 standard error.

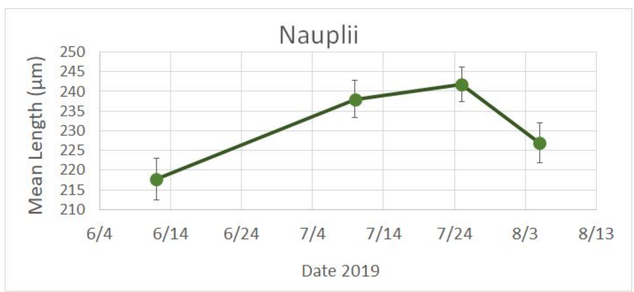

Figure 4. Mean length of Nauplii. Error bars are 1 standard error.

Hypothesis

Juvenile alewives (*Alosa pseudoharengus*) can consume large zooplankton thereby releasing algae cells from grazing.

Results

I expected that the length of zooplankton would increase as alewife got larger over the summer. This was the case with Calanoid copepods which steadily increased in size, starting with an mean length of 511.5 µm and ending the summer with a mean length of 622.7 µm (Figure 1). Cyclopoid copepods showed similar results with the beginning of the summer having an mean length of 360.8 µm and ending the summer with a mean length of 488.1 µm (Figure 2). Daphnia (*Daphnia magna*) showed a much different trend, steadily decreasing in size over the summer (from mean length of 1259.2 µm to 994.2 µm) (Figure 3). Nauplii (Copepod Larvae) showed the smallest variance in length, starting the summer at 217.8 µm going up in the middle of summer to 241.7 µm and falling back down to 226.9 µm to end the summer (Figure 4).
We were unable to measure fish mouth gape before our lab was closed.

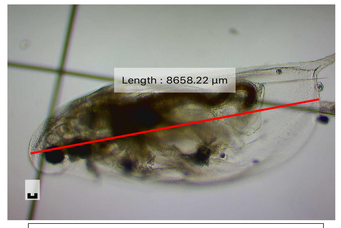

Figure 7. *Daphnia*. The red line shows how the *Daphnia* was measured using the Moticonnect application on a cell phone.

Figure 8. The micrometer will be used to measure fish gape. Here a fish is mounted on the cone for measurement.

Discussion

Due to Covid-19 the second half of this research project came to a sudden halt, which was measuring mouth gape of juvenile Alewife. Further research will need to be conducted to conclude if juvenile alewife are feeding on large zooplankton in comparison to their mouth gape and if this is a potential factor triggering algae blooms in Highland Lake.
Zooplankton length is important because knowing the size of the zooplankton throughout the summer can be directly related back to the size of the juvenile alewife as they continue to grow. As Alewife grow their mouth gape will increase, leading to an increase in available foods for them. According to Corriea et al. (2000) Allis Shad (*Alosa Alosa*), from the same family as Alewife, mostly consume Cyclopoids and Daphnia as both juvenile and adults. From this finding we can make an assumption that Alewife in Highland Lake are experiencing similar diets.
The next steps for this research is to continue to understand Alewife diets through measuring gape width with the specially designed micrometer. With this information, we can assess what proportion of the zooplankton community can be consumed by alewife of a certain length.

Acknowledgements

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References

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