The Role of an Invasive Snail in the Aquatic Food Web at Spirit Lake, Mount St. Helens

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Abstract

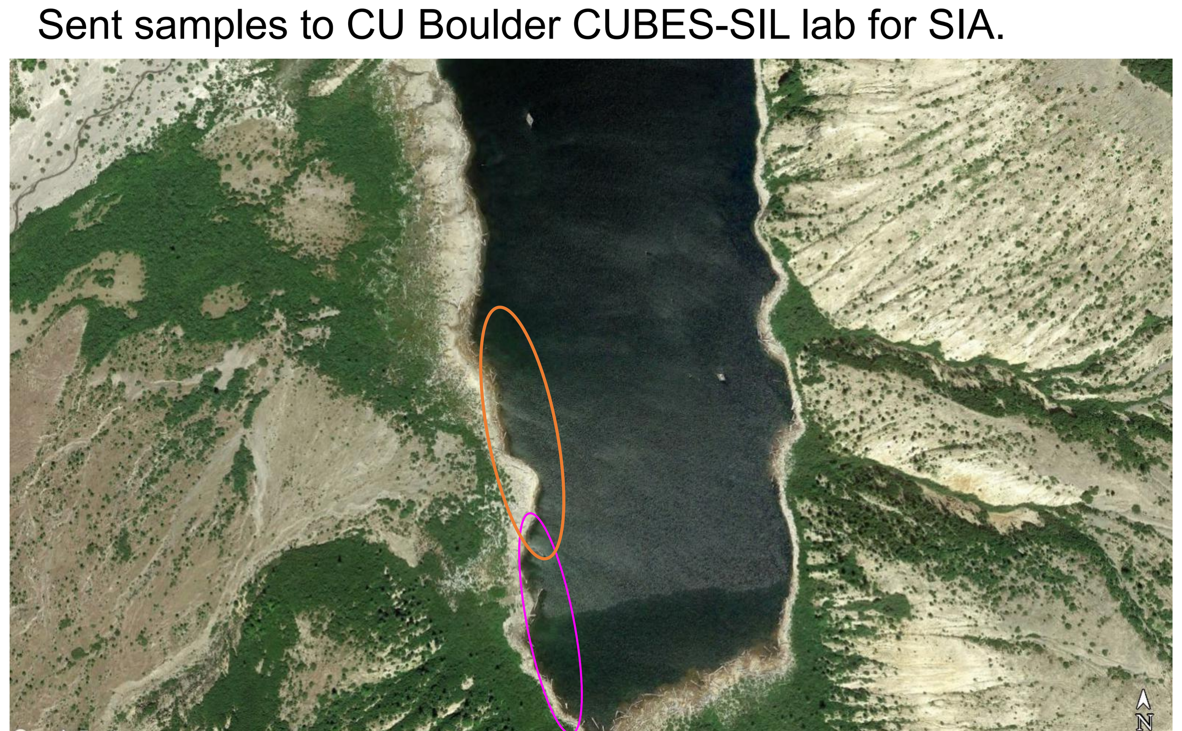
Spirit Lake (SL) was dramatically altered by the 1980 Mt. St. Helens eruption and has been watched closely as it evolved in relative isolation over the last 40 years. Starting in 2015 the New Zealand Mudsnail (NZMS), recognized as an invasive species, has been observed at SL. Quantifying the effects this invasive has upon the Spirit Lake food web using Stable Isotope Analysis (SIA) will allow for researchers to understand the role of the NZMS in the SL food web.

Objectives

- Survey Spirit Lake to understand the habitat that NZMS utilize to inform us as to their possible competition with the native Rams Horn Snail (RHS).
- Interpret stable isotope data to understand aquatic food web connections.

Methods

Creek Survey - Surveyed for presence of NZMS in Harmony Creek (a tributary of Spirit Lake), for one minute in a 1 m^2 area every ten meters.
Lakeshore Survey - Surveyed up to 75 cm depth offshore of Duck Bay SL for aquatic macroinvertebrates on lake substrates (submerged sediment, rocks, woody debris, and macrophytes) and collected samples for SIA.
Labwork - Dried and weighed 0.5-1 mg of aquatic food web samples, including macroinvertebrates (incl. native RHS and Cone Snail) and amphibians, in tin capsules.
Sent samples to CU Boulder CUBES-SIL lab for SIA.



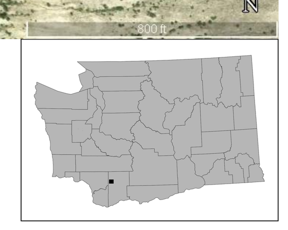


Figure 1. Map of Duck Bay SL with areas sampled shown as ellipses.
(Magenta) Collected macrophytes hosting RHS and NZMS as well as the snails themselves.
(Orange) Sampled aquatic insect larvae on log debris or sediment, and freely swimming tadpoles.

Figure 2. Shallow submerged logs and lakeshore sediments host a range of aquatic taxa.

Results

1. Can stable isotope data be used to interpret aquatic food web interactions at Spirit Lake?

There is a predictable isotopic separation among taxa, and the resulting isoscape is defined by variation in $\delta^{15}N$ values due to trophic structure, and variation in $\delta^{13}C$ values due to primary production. Therefore we can use SIA to estimate the role of NZMS in the SL food web.

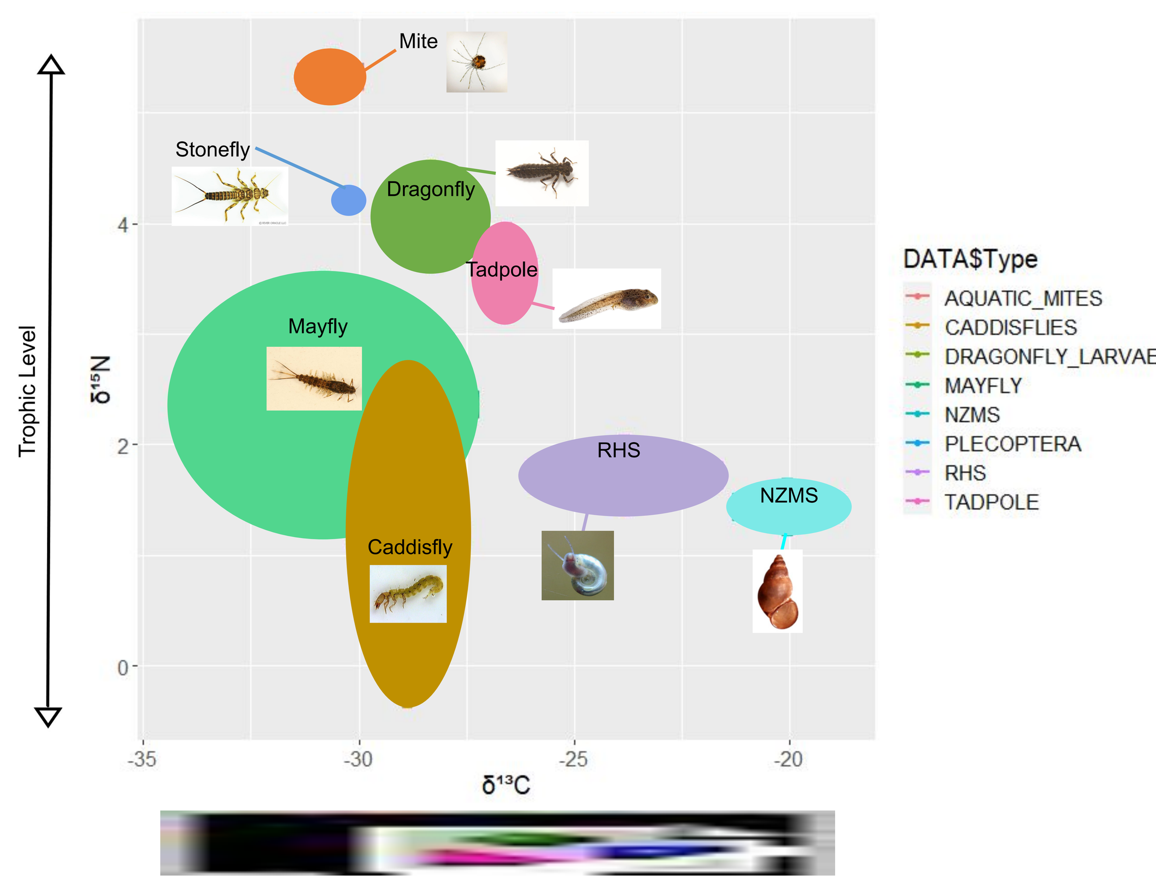


Figure 3. Bivariate plot of $\delta^{13}C$ and $\delta^{15}N$ values for aquatic taxa sampled from SL in 2018 and 2021. The ellipses (centered on mean and s.d.) show the area within the isoscape that each taxa occupies, and their relative positions.

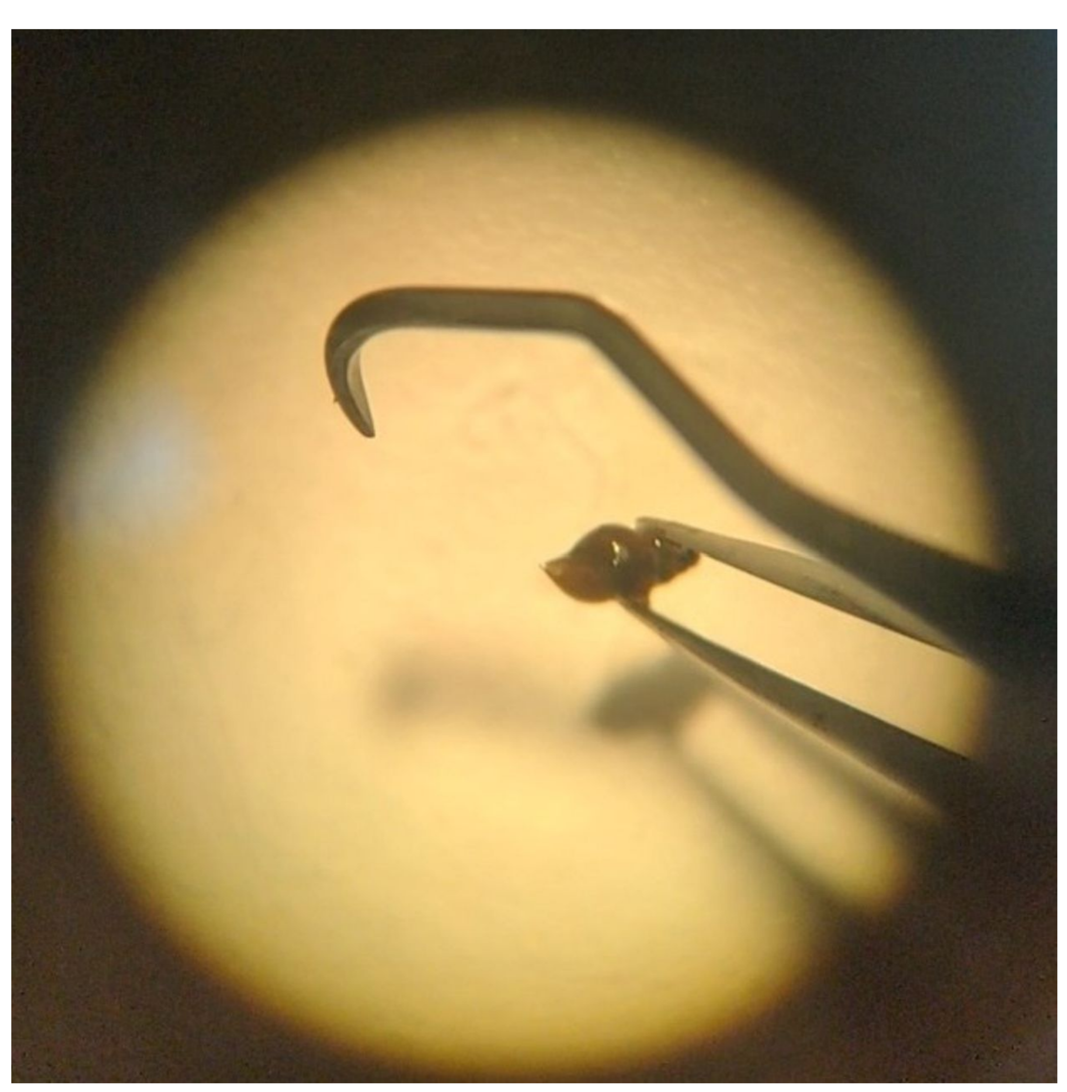


Figure 4. Tools used to make 0.85-2.5 mg (depending on taxa) wet weight samples which are then dried to 0.5-1 mg dry weight samples over 48 hours. Seen here is a pick used for extracting snails from shells and a pair of fine toothed forceps for manipulating samples and holding them steady.

2. How does the NZMS fit into the trophic structure of the Spirit Lake food web?

- NZMS has an herbivorous diet in SL.
- Predators are one isotopic trophic level ($\Delta^{15}N$ ~3.4‰) above herbivores, and omnivores are variable between trophic levels. Parasites are trophically highest.

Figure 5. Plot of individual $\delta^{15}N$ values for aquatic taxa organized by functional group. Functional groups share a common *functional* trait, such a diet.

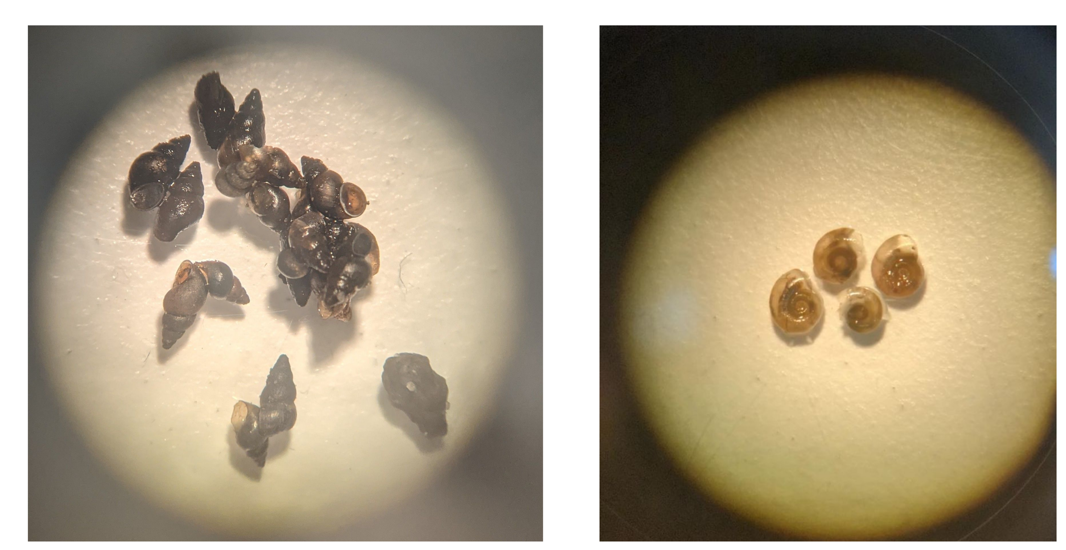


Figure 6. New Zealand mudsnail, *Potamopyrgus Antipodarum* (left), and Rams Horn Snail, Family *Planorbidae* (right).

3. Do co-occurring NZMS and native RHS compete for dietary resources?

- The snail and primary producer $\delta^{13}C$ data suggest that snails co-occurring on lakeshore macrophytes may have different diets.
- NZMS primarily consumes the macrophyte itself, while RHS may consume more of the periphyton growing on the plant.
- It is not clear yet if NZMS displaced RHS from a primarily macrophyte diet has capitalized on an available dietary resource.

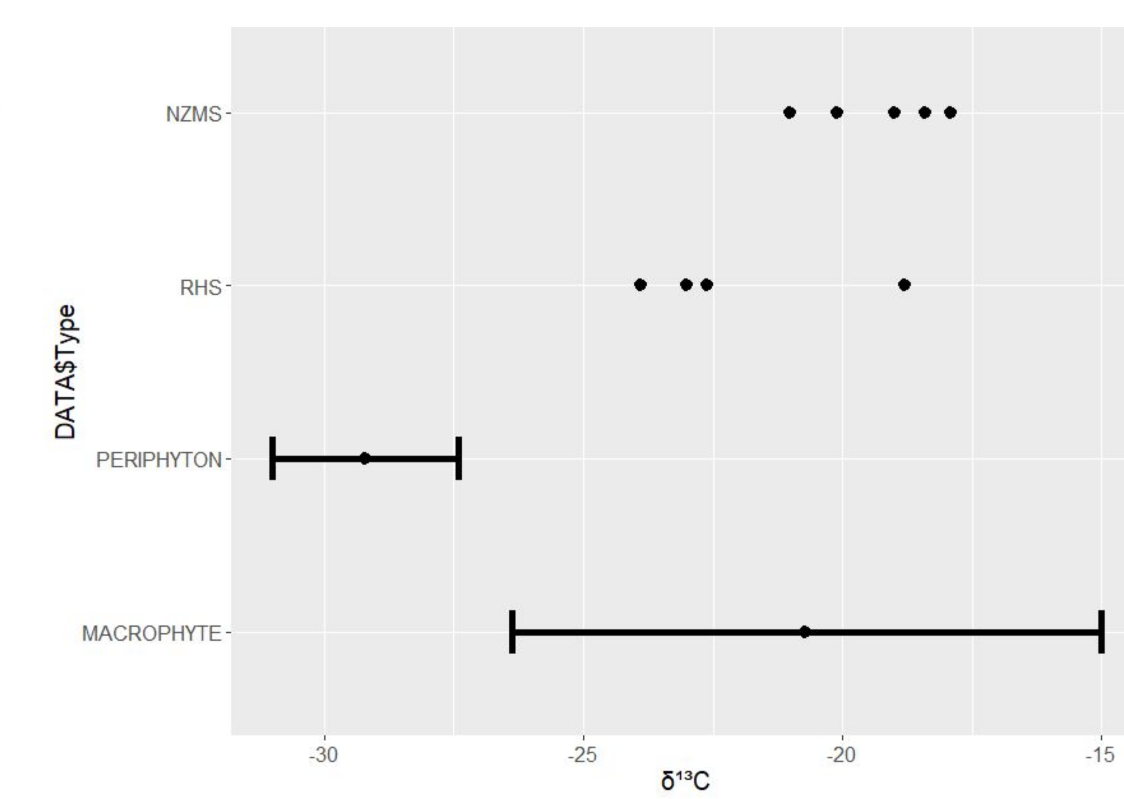


Figure 7. Plot of individual snail $\delta^{13}C$ values, and mean ± s.d. for primary producer $\delta^{13}C$ values. The snail $\delta^{13}C$ values have been shifted by a trophic enrichment factor of 1‰ for direct comparison to diet values. There is a significant difference between snail $\delta^{13}C$ values (ANOVA, $p<0.05$).

Figure 8. Periphyton composed of algae, cyanobacteria, and diatoms (left), and aquatic macrophytes (right).

Future Work

- SIA of trout tissue samples will allow us to analyze how much of the trout diet is composed of NZMS.
- Additional sampling will illuminate temporal and spatial variability in the food web patterns observed in our study. For example, snail herbivory may change as primary production responds to nutrient conditions over the growing season.
- Observational analyses of NZMS and RHS feeding behaviors on macrophytes and periphyton will support our SIA of snail diets.

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