

How long has it been in the lake? Sediment reveals invasion history of Spiny Water Flea.

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Background

The spiny water flea (*Bythotrephes longimanus*) is an invasive zooplankton that entered the Great Lakes in the early 1980s through the ballast water of commercial shipping vessels (Sprules et al. 1990). Since first detection, the spiny water flea has spread to hundreds of lakes in the Great Lakes region (Azan et al. 2015). This invader is a voracious predator of native zooplankton species and, in some lakes, reduces the biomass of native populations by 50% (Kerfoot et al. 2016). Changes in zooplankton populations can affect important parts of lake food webs, such as algal populations and populations of small planktivorous fish (Compton and Kerfoot 2004, Walsh et al. 2016, Staples et al. 2017).

Because of their small size (1 cm total length), spiny water flea can be present for years before being detected in the water column. An alternative way to determine the date of first invasion is to search through lake sediments, a technique known as paleolimnology. Previous researchers have searched for fossilized zooplankton exoskeletons to estimate historic populations, including populations of spiny water flea (Hall and Yan 1997). Branstrator et al. (2017) used this technique and estimated that spiny water flea invasion in Island Lake, MN, first occurred in 1982, eight years before it was found in the water column. These results bring to question dates of first invasion in other Minnesota lakes, especially popular lakes like Mille Lacs Lake and Kabetogama Lake.



Figure 1. Illustration of the spiny water flea created by Todd Buck. Bar in bottom right is actual size.

Methods

We used lake sediments to estimate dates of first invasion of the spiny water flea in Kabetogama Lake. We selected Kabetogama Lake because it was recently invaded by spiny water flea (first found by the MNDNR in 2007) and researchers have surveyed zooplankton populations there for several years. Four cores were collected from two sites in March 2017 by using a piston corer and drive rods. Sediment was extruded from each core in 0.5 cm increments and then sent to the St. Croix Watershed Research Station for dating using ²¹⁰Pb isotopes. The remaining sediment from one core at each site was rinsed through a 0.2 mm mesh and searched under a microscope for evidence of spiny water flea, including caudal spines, mandibles, and resting eggs. We used this evidence along with sediment accumulation rates to estimate relative spiny water flea population size per year.

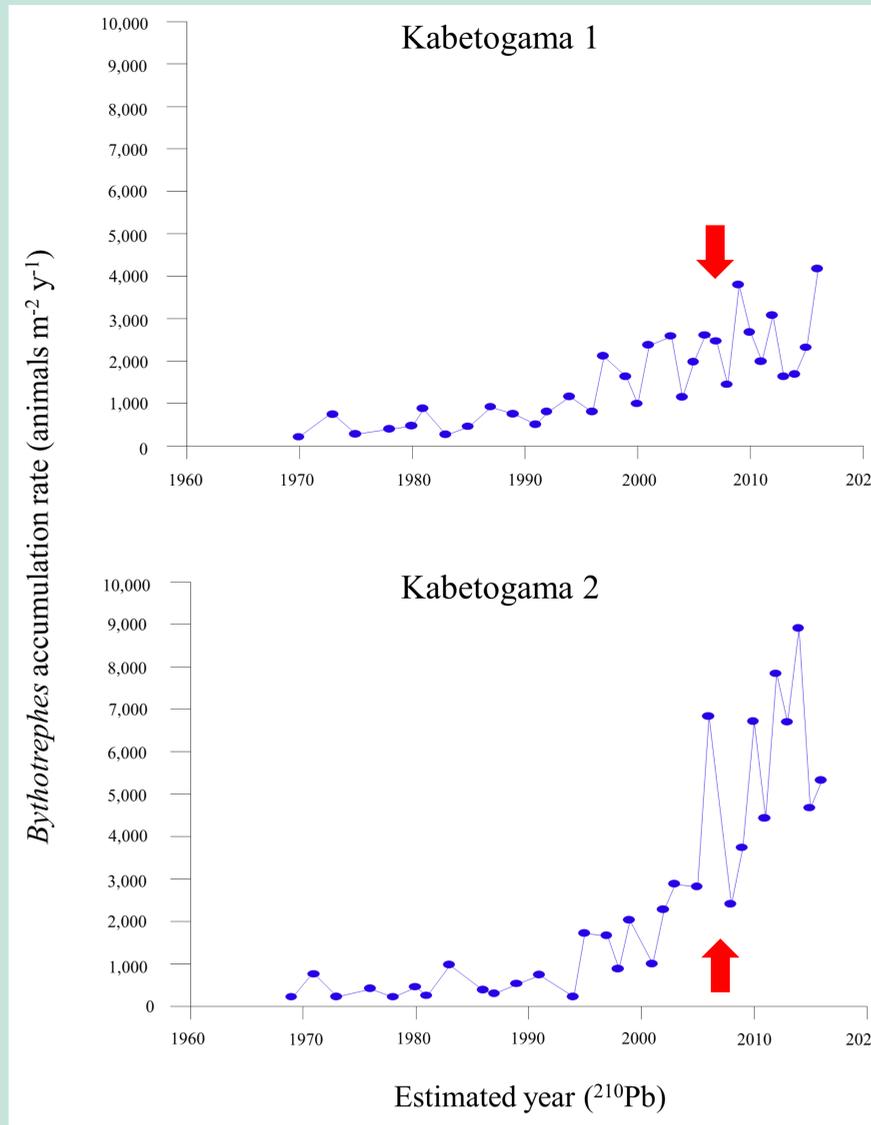


Figure 2. Spiny water flea accumulation rate results from sediment search. Arrows denote year of previous first known invasion (2007).



Figure 3. Photo of sediment core collection.

Results

We reconstructed spiny water flea populations from 1970 to 2016 and found evidence of animals in every sediment increment at both coring sites (Fig. 2). These results push back the date of first invasion at least 37 years. Our data also show that spiny water flea existed at low population levels for a long period of time, until the mid-1990s when the population began to increase. Data from the core labeled 'Kabetogama 2' suggest that around 2006 another population increase occurred, which coincides with the previously known date of invasion.

Implications & Future Research

Our results suggest that spiny water flea can persist in lakes for years before a population is large enough to be detected. Because of this, it is very important to emphasize cleaning and sanitizing all watercraft to prevent the transportation of aquatic invasive species, even if no invasive species have been found in a waterbody.

In the coming months, two more sediment cores from Kabetogama Lake and four cores from Mille Lacs Lake will be searched for spiny water flea fossil evidence, which will expand our current findings. Additionally, all the cores will be searched for evidence of native zooplankton, like *Daphnia* and *Bosmina* species. Since the spiny water flea populations remained low in Kabetogama Lake for a long period, there may be a gap in time between when this invader was present and when it began to influence the ecosystem. This research will help us understand how the spiny water flea impacts populations of native zooplankton over its invasion history.



Figure 4. Map of collection sites on Kabetogama Lake. Satellite image from Google Earth.

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