In Lake Erie, climate change scrambles zooplankton's seasonal presence

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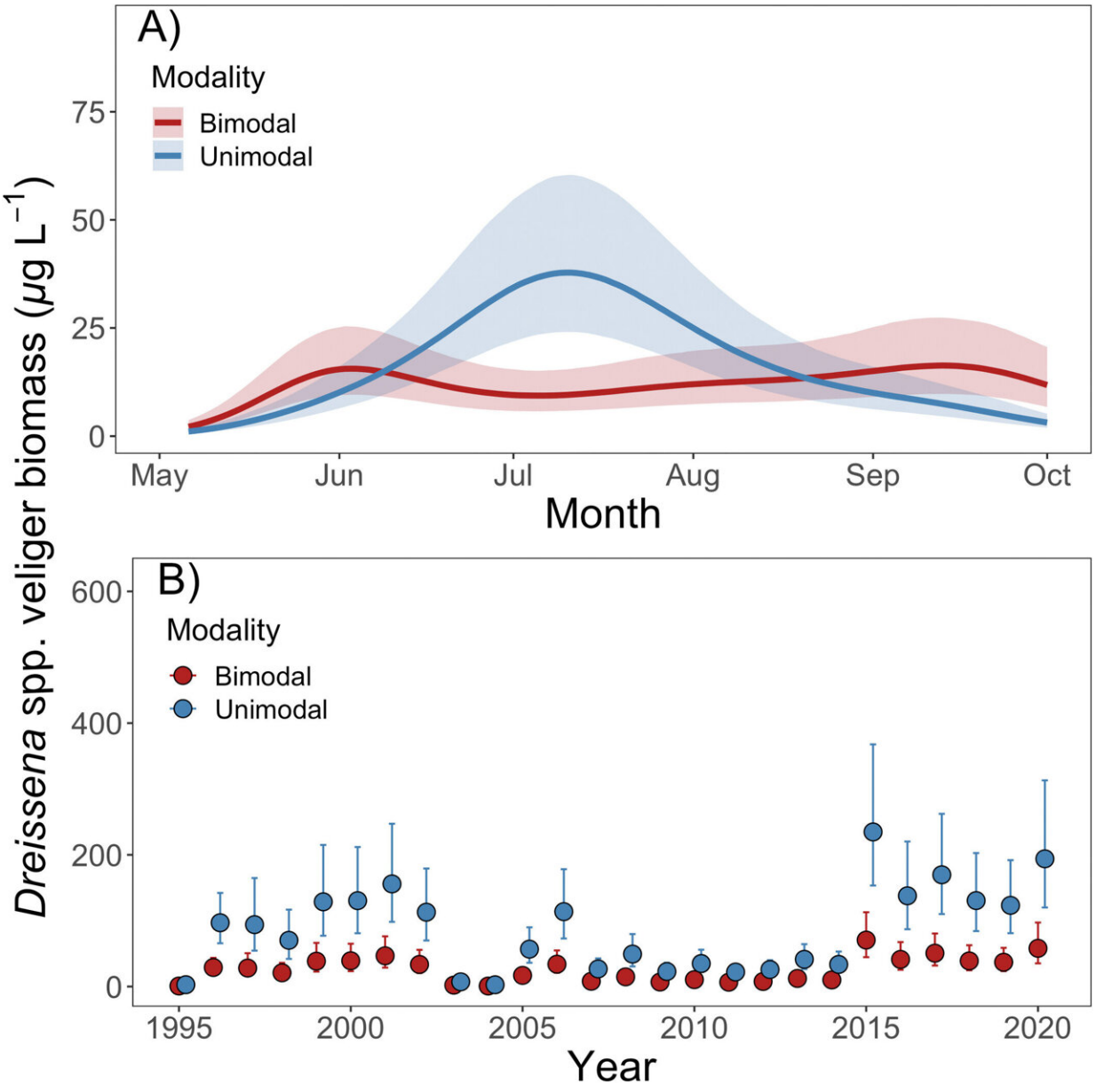

Generalized additive mixed hurdle model predictions of seasonal (**A**) and interannual (**B**) patterns in *Dreissena* spp. veliger biomass for unimodal (sites: 36, 37, 29, 27, 14) and bimodal (sites: 16, 3, 8) sites. Predictions in (**A**) are for 2010 and in (**B**) are for the day of year 200 at site 36 (unimodal) and 16 (bimodal). Credit: *Limnology and Oceanography Letters* (2024). DOI: 10.1002/lol2.10377

A new analysis of zooplankton in western Lake Erie shows that their biomass and seasonal behavioral patterns have been drastically altered by human-driven changes in water temperature and food webs.

Zooplankton, aquatic microorganisms that reside in nearly all bodies of water, are extremely sensitive to changes in their ecosystem. This hypersensitivity makes them important bioindicators of water quality, and studying how they interact with their environment can provide researchers with detailed snapshots of a region's present ecological condition.

By taking a new look at more than two decades of plankton monitoring data, researchers at Ohio State University found that in western Lake Erie, zooplankton communities are undergoing a substantial change in the timing of certain events in their life cycles.

Using data collected from previous studies, the team examined the behavior patterns of four common types of zooplankton populations in Lake Erie between 1995 and 2022. Their analysis showed that due to factors like rising temperatures, the presence of invasive species, and the availability of high-quality food, the period when zooplankton concentrations are at their highest now varies by as much as three weeks in the summer months.

"Warming is making natural events happen earlier, as we can see across basically all ecosystems," said Jim Hood, lead author of the study and an associate professor in evolution, ecology, and organismal biology at Ohio State. "These systems are really complex, and any disruption is likely to have unseen negative effects."

Even in lakes, zooplankton plays a central role in the local freshwater food web, from determining which types of algae thrive to helping sustain local fish populations, said Hood. Yet, as the research notes, early warming can often advance the emergence of spring plankton while delaying fall populations, which can have a big impact. Because of their vital place in the food chain, major changes in plankton behavior could cause damage to other top-down and bottom-up processes that rely on them.

The study, recently published in the journal *Limnology and Oceanography Letters*, marks one of the first times scientists have tried to unpack the complexity of these dynamics in Lake Erie and the Great Lakes region.

Some of the most dominant changes observed in the timing of zooplankton emergence were caused by temperature variation as well as an invasive phytoplankton species called B. longimanus, which was likely carried over from Europe by shipping boats, said Hood.

"It's this invasive predator and the increase in harmful algae blooms that are really altering the timing of zooplankton concentrations," he said. "In some cases, they're causing them to move in earlier; in some cases, they're moving them in later."

Though harmful algal blooms have plagued Lake Erie for decades, warmer temperatures during the summer cause the organisms to grow thicker and faster. Because large blooms release toxins that endanger the

health of humans and other animals and threaten important utility infrastructures, environmental scientists have been steadily working toward ways of addressing the multiple causes of their excess growth.

"It's not just climate change," said Hood. "All of the things humans are doing to these systems, like bringing in invasive species, are creating a complex series of interactions that are going to influence big things that people care about, like harmful algal blooms and fisheries."

This study's analysis period took place between May and September of each year when the four zooplankton species whose behavioral patterns were being surveyed were especially abundant. Though they all had different diets and life histories, they surprisingly each had varying reactions to B. longimanus and its effects on the ecosystem, revealing that the mechanisms that drive the timing of certain plankton behaviors are more sophisticated than they seem, said Hood.

"It was really noteworthy how these four taxa that we focused on all had different responses to this invasive species, which really highlights the need for more research on them," he said.

Hood and co-author Jenna Bailey suggested that further research should aim to extend monitoring in temperate lakes to learn how winter conditions influence zooplankton life cycles, offering insight into other freshwater ecology issues related to climate change.

"It's difficult to predict the effects human activity has on our ecosystems," said Hood. "But we need to step back and understand how all of these things that we're doing are interacting with one another and incorporate that into our management."

More information: Jenna Bailey et al, Biotic and thermal drivers alter zooplankton phenology in western Lake Erie, *Limnology and Oceanography Letters* (2024). DOI: 10.1002/lol2.10377

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