- Mudsnails are abundant, long-lived, organisms in some coastal ecosystems.
- Stable isotope measurements of mudsnail tissue can be used to measure nitrogen levels.
- Mudsnail isotope data provide information about nitrogen over the lifetime of a snail, whereas water samples provide information about a single point in time.
- Museum specimens may be used to expand data about nitrogen levels and water quality over time.

Study lead author, Elizabeth Watson, examining historically collected mudsnails under a dissecting microscope at the Academy of Natural Sciences, Drexel University, Philadelphia. Photo by Roger Thomas, Drexel University.

Measuring nitrogen in coastal ecosystems with Mudsnails

by Adityarup “Rup” Chakravorty
Nitrogen levels can be a double-edged variable in aquatic environments. On one hand, nitrogen is essential for life—it’s a part of DNA, RNA, and proteins, for example. On the other hand, too much nitrogen in aquatic ecosystems can have severe negative consequences, such as fueling algal blooms that deplete oxygen and lead to “dead zones.”

Measuring nitrogen levels in specific ecosystems is the first step in identifying and rehabilitating areas where water quality is adversely affected by excessive nitrogen or nutrient influx.

In a recent study, Elizabeth Watson, Assistant Professor of Wetlands Science at Drexel University, and her colleagues analyzed eastern mudsnails as a proxy of how much nitrogen has entered aquatic ecosystems along the U.S. and Canadian Atlantic coast. This study was published in the Journal of Environmental Quality.

“This is perhaps the first study to highlight the use of eastern mudsnails as water quality indicators,” Watson says. “I think scientists will now be much more confident in applying this approach in areas across the Northeast.”

Small, Abundant, and Easy to Catch

Mudsnails are convenient organisms to use as water quality proxies for several reasons. They are small; usually less than an inch in length. They are extremely abundant, and researchers sometimes find more than 1,500 mudsnails per square meter of habitat. Being snails, they are also easy to catch.

Mudsnails are also records of past levels of nitrogen in their environments. They can live for a long time, upwards of 50 years in some cases. Analyzing mudsnails can provide researchers with a picture of environmental conditions over the past several decades. That’s a big advantage over analyzing water samples, which “reflect just one instant in time,” Watson says.

To measure nitrogen levels in ecosystems, Watson and colleagues compared how much of two different versions, or isotopes, of nitrogen was present in mudsnail tissues. “The relative amounts of the heavier and lighter versions of nitrogen reflect how much nitrogen is available in that ecosystem,” Watson says. If more of the heavier version is present in mudsnail tissues, it points to higher levels of nitrogen overall in the environment.

For the study, researchers collected mudsnails from more than 40 sites spread across Long Island, NY. Some of the study sites are “extremely nutrient polluted,” Watson says. “For example, untreated sewage is discharged to coastal areas in New York through combined-sewer overflows.” Other study areas were impacted by agricultural outflow or were relatively pristine.

The heavier version of nitrogen was enriched in mudsnail tissue in several study sites, which pointed to higher levels of nitrogen overall at these locations. “These sites were near areas with high population densities or where land use patterns are more urbanized,” Watson says. “We also had similar results from sampling sites next to wastewater treatment plant discharges.”

Somewhat counter-intuitively, it is often in the more pristine coastal areas where excess nitrogen is of more concern, Watson says: “If conditions are extremely hazardous, protecting coastal ecology may take a back seat to human health issues. However, if conditions are pretty good, then there is often more concern with trying to detect and undo human impacts—such as excessive nitrogen influx—when possible.”

In the more untouched areas, the goal is often to preserve coastal wildlife and also to protect human activities, such as harvesting (fishing, clamming), and recreational opportunities. “This is true for places like eastern Long Island, Cape Cod, Rhode Island, and Barnegat Bay, which attract summer visitors based on their beauty and relatively pristine coastal ecology,” Watson says.

Mudsnails turn out to be better suited than some other aquatic organisms to help researchers distinguish between areas with low and high levels of nitrogen. Take mussels, for example, “While mussels also reflect varying nitrogen levels in their environment—they tend to have very similar values in more pristine and more polluted sites,” Watson says. Analyzing mudsnails, on the other hand, yields widely different values depending on nitrogen levels in the environment, which makes it easier for researchers to detect differences between study sites.

According to Watson, the ease with which mudsnails can be collected and prepared for analysis could also help engage concerned stakeholders. “Citizen scientists and local organizations can easily assist researchers,” she says.

Establishing Baselines Based on in Historical Data

Watson’s next goal is to establish water quality baselines for New York and New Jersey, based on analysis of older material. She is working with the Academy of Natural Sciences in Philadelphia on this project.

“The academy has collections of mudsnails that are at least 100 years old,” Watson says. “By analyzing mudsnail shells collected recently and comparing them with shells that were around a century or more ago, we should be able to detect if nitrogen is more enriched in specific environments today.”

Watson hopes that the historical data can ultimately help researchers build maps that show how nitrogen levels in ecosystems along the Atlantic coast have changed over time.