When it comes to nitrogen, the 'fix' is in

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Claire Horner-Devine collects sediment cores in Padilla Bay mudflats to examine communities of microorganisms associated with a native and an invasive eelgrass. Credit: University of Washington

The discovery in the last decade of new suites of microorganisms capable of using various forms of nitrogen -- discoveries that have involved a number of University of Washington researchers -- is one reason to rethink what we know about the nitrogen cycle.

So say University of Washington's Claire Horner-Devine, assistant professor of aquatic and fishery sciences, and Adam Martiny of the University of California, Irvine, in a recent Science magazine opinion piece about how new insights into microbial pathways, players and population dynamics are challenging conventional models of the nitrogen cycle.

It's important to understand the environmental controls on nitrogen fixation and the nitrogen cycle so we can assess their likely response to environmental changes such as global warming, ocean acidification and dead zones in the coastal ocean, Horner-Devine says.

Nitrogen in the form of compounds such as ammonia and nitrate is necessary for building amino acids and proteins essential to all life. While nitrogen gas makes up more than three-quarters of the air we breathe, the element is unusable by life in that form. It has to be fixed, that is broken apart and latched onto other chemicals, in order to become user-friendly.

Findings described in the Science piece suggest that the ability to oxidize ammonia and fix nitrogen is more widely distributed among bacteria and archaea than researchers and modelers of the nitrogen cycle have previously taken into account. For example:

-- In the mid 1990s scientists including UW's Jim Staley began finding microbes capable of oxidizing ammonia in oxygen-starved environments -- this after years of only seeing this process happen when oxygen was present.

-- In work since the early 2000s, researchers including the UW's David Stahl and Anitra Ingalls showed that archaea likely contribute substantially to nitrification in the oceans and on land. Archaea, initially thought to inhabit only places with extreme temperatures and pressures, instead made up a substantial proportion of marine plankton worldwide,

-- Co-author Martiny is among those studying cyanobacteria, some of which are emerging as agents of nitrogen fixation.

"The discovery that such disparate groups are involved . . . in the nitrogen cycle calls for a reevaluation of the assumptions made in biogeochemical models and field experiments," Horner-Devine and Martiny write.

In addition to new pathways and players, it is becoming more apparent that understanding the global nitrogen cycle also will require consideration of ecological dynamics, something Horner-Devine studies.

The *Science* piece cites recently published work in which the balance between the bacteria oxidizing ammonia and those oxidizing nitrite became so destabilized and chaotic that the bacteria oxidizing nitrite were exterminated and nitrification broke down.

"Complexity and dynamics at these small scales of organization may require more sophisticated representations of microbial communities," Horner-Devine and Martiny write.

Those studying microbial diversity and those like Horner-Devine who study microbial ecology could -- and probably should -- come together more, she says.

"We must better understand how changes in community and population dynamics are related to nitrogen transformation rates and how both the players and the processes respond to disturbances," the co-authors write.

Source: University of Washington