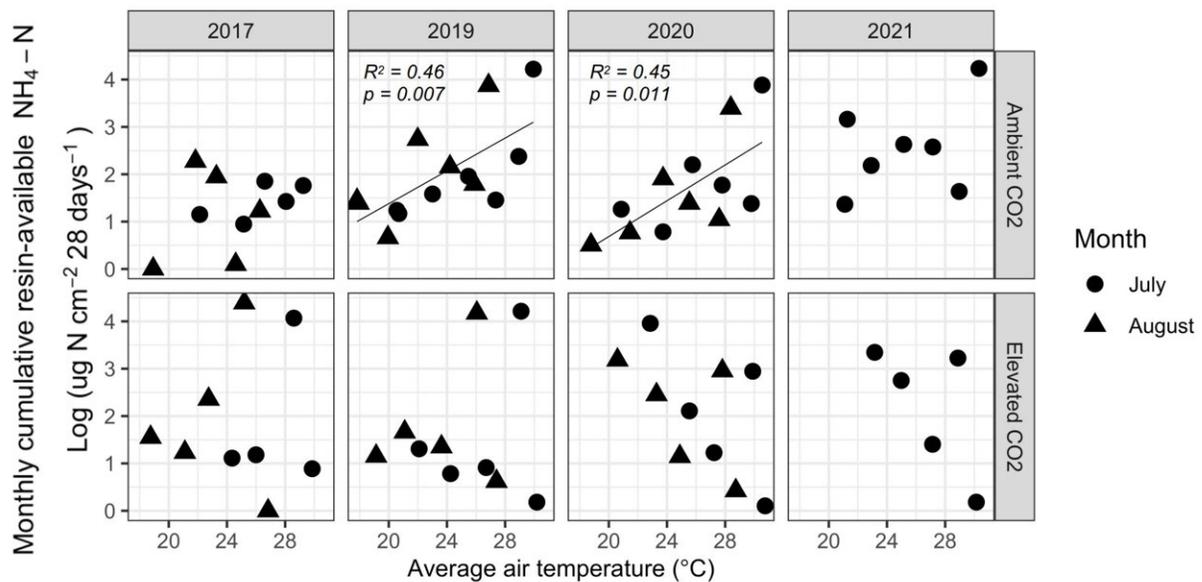


# Rising temperatures alter 'missing link' of microbial processes, putting northern peatlands at risk

April 3 2023, by Audra Davidson



Experimental warming and e $\text{CO}_2$  alter plant-available  $\text{NH}_4\text{-N}$  in shallow peat.  $\text{NH}_4\text{-N}$  concentrations were measured in hollows (depressed microtopographic positions) at 10 cm peat depth using dual ion-exchange resin capsules. Average air temperature represents the average measured temperature at 50 cm above the hollow surface during the month when the resins were incubated in the bog.  $R^2$  and p values are shown only for statistically significant linear regressions of  $\log(\text{NH}_4\text{-N}) \sim \text{Temperature}$ . Credit: *Global Change Biology* (2023). DOI: 10.1111/gcb.16651

If you're an avid gardener, you may have considered peat moss—decomposed Sphagnum moss that helps retain moisture in soil—to enhance your home soil mixture. And while the potting medium can help plants thrive, it's also a key component of peatlands: wetlands characterized by a thick layer of water-saturated, carbon-rich peat beneath living Sphagnum moss, trees, and other plant life.

These ecosystems cover just 3% of Earth's land area, but "peatlands store over one-third of all soil carbon on the planet," explains Joel Kostka, professor and associate chair of Research in the School of Biological Sciences at Georgia Tech.

This carbon storage is supported in large part by microbes. Two [microbial processes](#) in particular—nitrogen fixation and methane oxidation—strike a delicate balance, working together to give Sphagnummosses access to [critical nutrients](#) in nutrient-depleted peatlands.

The coupling of these two processes is often referred to as the "missing link" of nutrient cycling in peatlands. Yet, how these processes will respond to changing climates along northern latitudes is unclear.

"There are tropical peatlands—but the majority of peatlands are in northern environments," notes Caitlin Petro, a research scientist who works with Kostka in Biological Sciences at Tech. "And those are going to be hit harder by [climate change](#)."

Kostka and Petro recently led a collaborative study to investigate how this critical type of ecosystem (and the "missing link" of microbial processes that support it) may react to the increased temperature and [carbon dioxide](#) levels predicted to come with climate change. The team, which also includes researchers from the Oak Ridge National Laboratory (ORNL), Florida State University, and the University of Tennessee,

Knoxville, just published their work in *Global Change Biology*.

By testing the effects of increasing temperature and carbon dioxide on the growth of Sphagnum [moss](#), its associated microbiome, and overall ecosystem health, Kostka and Petro say computational models will be better equipped to predict the effects of climate change.

"Down the road," Kostka added, "we hope the results can be used by environmental managers and governments to adaptively manage or geoengineer peatlands to thrive in a [warmer world](#)."

## Raising the heat

To see how northern peatlands will react to climate change, the team, which also included School of Earth and Atmospheric Sciences Associate Professor Jennifer Glass, turned to the ORNL Spruce and Peatland Responses Under Changing Environments (SPRUCE) experiment—a unique field lab in northern Minnesota where the team warms peat bogs and experimentally changes the amount of carbon dioxide in the atmosphere.

Starting in 2016, the team exposed different parts of SPRUCE's experimental peatlands to a gradient of higher temperatures ranging from an increase of 0°C to 9°C, capturing the Intergovernmental Panel on Climate Change models' predicted 4°C to 6°C increase in northern regions by 2100.

The moss's reaction was significant. Although nearly 100% of the bog's surface was covered in moss at the beginning of the experiment, moss coverage dropped with each increase in temperature, plummeting to less than 15% in the warmest conditions.

Critically, the two microbial processes that had previously been

consistently linked fell out of sync at higher temperatures.

"Peatlands are extremely nutrient-poor and microbial nitrogen fixation represents a major nitrogen input to the ecosystem," Kostka explained. Fixing nitrogen is the process of turning atmospheric nitrogen into an organic compound that the moss can use for photosynthesis, while [methane oxidation](#) allows the moss to use methane released from decomposing peat as energy.

"Methane oxidation acts to fuel [nitrogen fixation](#) while scavenging a really important greenhouse gas before it is released to the atmosphere. This study shows that these two processes, which are catalyzed by the Sphagnum microbiome, become disconnected as the moss dies."

"These processes occurring together are really important for the community," Petro explained. Yet many microbes that are able to both fix nitrogen and oxidize methane were absent in the mosses collected from higher temperature enclosures. And while elevated carbon dioxide levels appeared to offset some of the changes in nitrogen cycling caused by warming, the decoupling of these processes remained.

"These treatments are altering a fairly well-defined and consistent plant microbiome that we find in many different environments, and that has this consistent function," Petro explained. "It's like a complete functional shift in the community."

Though it's not clear which of these changes—the moss dying or the altered microbial activity—is driving the other, it is clear that with warmer temperatures and higher carbon dioxide levels comes a cascade of unpredictable outcomes for [peat bogs](#).

"In addition to the direct effects of climate warming on ecosystem function," Petro adds, "it will also introduce all of these off-shooting

effects that will impact peatlands in ways that we didn't predict before."

**More information:** Caitlin Petro et al, Climate drivers alter nitrogen availability in surface peat and decouple N<sub>2</sub> fixation from CH<sub>4</sub> oxidation in the Sphagnum moss microbiome, *Global Change Biology* (2023). [DOI: 10.1111/gcb.16651](https://doi.org/10.1111/gcb.16651)

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