Team studies greenhouse gas emissions from Appalachian streams

March 29 2022, by Kristen Bretz and Heather Drew

Kristen Bretz works in a stream. Credit: Kristen Bretz

Freshwater ecosystems can be substantial sources of greenhouse gases to the atmosphere, but it can be difficult to figure out how unique aquatic habitat arrangements and connections influence carbon cycling at

different scales.

In mountain streams, carbon cycling is affected by many interwoven factors, such as precipitation and the productivity of the surrounding forest. A team of researchers from Virginia Tech studied freshwater greenhouse gas emissions in the mountains of North Carolina to try to better understand how carbon moves through connected streams and wetland networks.

Kristen Bretz, a Ph.D. candidate, and Erin Hotchkiss, an assistant professor of biological sciences in the Virginia Tech College of Science, recently worked with three undergraduate researchers who have since graduated, on a two-year study at the U.S. Forest Service Coweeta Hydrologic Laboratory.

They found that greenhouse gas emissions from streams and wetlands at Coweeta could be highly variable, but that the presence of a vernal pool, or a small freshwater temporary wetland, in a stream corridor could increase overall emissions.

"This project was an awesome opportunity to envelop several wonderful undergraduate research efforts into the long tradition of Virginia Tech stream research at Coweeta Hydrologic Laboratory," said Bretz.

Bretz and Hotchkiss, who are both members of the Global Change Center, an arm of the Fralin Life Sciences Institute, published their findings in the *Journal of Geophysical Research: Biogeosciences*.

"The coolest thing about this paper is that it shows how complex carbon emissions are at small scales—even within a single basin like Coweeta. Zooming in on a landscape can complicate the picture, but we were able to find an interesting linkage between temporary pools and stream emissions of two greenhouse gases: carbon dioxide and methane," said

Bretz.

As parcels of water move through a watershed, they pick up terrestrial materials and flow along pathways in the landscape created by erosion. The biological processes that occur in water moving into and through streams are affected by both soil properties and the arrangements of landscape features, or patches, in and near the channel.

The patches in this study included temporary (vernal) pools, hillside slopes along the streams, stream surface waters, and dry stream beds where the water flows underground.

The exciting results of this research project would not have been feasible without the help of three dedicated undergraduate researchers: Alexis Jackson, Jonathon Monroe, and Sumaiya Rahman. The three recent graduates from the Department of Biological Sciences received numerous accolades for research excellence during their time at Virginia Tech.

In 2019 and 2020, Monroe and Jackson received Undergraduate Research Grant Awards from Virginia Tech's Global Change Center. Jackson and Rahman conducted their research that contributed to this paper while working as National Science Foundation Research Experience for Undergraduates fellows.

"Their contributions allowed us to move beyond the single-ecosystem approach typical of most research in our field," said Hotchkiss.

Inspired by her work in the Hotchkiss lab, Jackson recently entered the University of Florida's environmental engineering Ph.D program as a National Science Foundation Graduate Research fellow.

"The Hotchkiss lab was the foundation to my love for field work and

interest in wetland biogeochemistry. Being mentored and surrounded by such skilled, supportive, and innovative women and men has made all the difference in my life and directly impacted my career choice in becoming a wetland ecologist," said Jackson.

Monroe, now a research assistant at the Mayo Clinic Vaccine Research Group, reflects on his time in the lab. "My time in the Hotchkiss lab was incredibly important in my decision to pursue a career in research," said Monroe.

At Virginia Tech, Bretz and Hotchkiss will continue to address knowledge gaps about the water quality and biology of streams in creative ways that will have both local and global implications in the face of climate change.

"Our work provides a unique perspective on how the presence and arrangement of different ecosystems within a landscape control the sources and emissions of carbon gases from mountain stream corridors," said Hotchkiss.

The study in Coweeta sets the stage for ongoing research, led by Bretz, on how carbon cycling changes as streams dry and rewet and what that means for downstream water quality and food webs.

As climate change is expected to cause longer periods of drought coupled with more intense storms, "work characterizing the variability in freshwater ecosystems will provide critical information about the consequences of those changes on freshwater carbon cycling and water quality," said Hotchkiss.

More information: Kristen A. Bretz et al, Integrating Ecosystem Patch Contributions to Stream Corridor Carbon Dioxide and Methane Fluxes, *Journal of Geophysical Research: Biogeosciences* (2021). DOI:

10.1029/2021JG006313

Provided by Virginia Tech