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DURHAM, N.H. -- University of New Hampshire scientists have received National Science Foundation (NSF) funding to explore how small-scale ecological experiments can be applied to understand the behavior of entire ecosystems, part of the agency's nascent effort to investigate large-scale biological responses to climate and land-use change.

Professor William McDowell of the department of natural resources and the environment (NREN) and assistant professor Wilfred Wollheim of NREN and UNH's Institute for the Study or Earth, Oceans, and Space (EOS) are part of a multi-institution project that will "scale up" measurements of fundamental stream or "lotic" properties, and the effects of aquatic animals on those properties, to predict characteristics of entire stream networks.

For their project, entitled "Stream Consumers and Lotic Ecosystem Rates (SCALER): Scaling from Centimeters to Continents," McDowell is the UNH principal investigator;Wollheim is co-investigator. Researchers at Kansas State University are leading the $3.3 million project, of which $741,000 will support the UNH research.

"This project is looking at how we can scale fundamental processes of stream ecology to a whole-stream scale," says McDowell. "We also want to learn how good our individual site-specific work is at predicting broad patterns across the continent." McDowell will conductfield work in Puerto Rico on a tropical dry forest stream dominated by mullets and freshwater shrimp.He will explore stream metabolism – how carbon is produced, consumed and vented into the atmosphere – as well as nutrient retention and the effects of predators and herbivores on stream metabolism and nutrient cycling.

Across the North American continent, the SCALER experiment will be carried out in a tropical forest, a temperate mountain forest, a prairie, a northern evergreen forest, and a tundra. Small, medium and large streams in each area will be examined at scales of centimeters to tens of meters. Modeling will be done to scale measurements up to regional and continental levels.

"Modeling in environmental studies is a way to tie together what we understand about various aspects of the environment so that we can determine how the entire system works," notes Wollheim of the Water Systems Analysis Group within EOS, who will conduct the core modeling to translate measurements in individual stream sections, or "reaches", up to entire river systems and, ultimately, continental scales. "The models I'll work with will help us to better understand how and why ecosystems are changing, given climate variations and various human activities."

Part of the experiment will involve "consumer manipulation" within a measurable section of a stream by taking away or adding animals like aquatic insects or fish to see what effects these animals have on the overall stream processes.

The experiments and modeling results will be relevant to ecology as a whole because few "coupled and nested" experimental and theoretical scaling exercises have been undertaken in any environment. A coupled, nested environment is one that links many smaller parts with a larger whole – in this case, the overall flow of water links different stream reaches into a larger river network.

Says Wollheim, "Very few studies have tried to understand processes across these different scales to determine, for example, how does carbon storage measured in individual stream reaches relate to carbon storage of an entire river network?"

Insight into how nature works at this level is necessary to understand both whole-system dynamics as well as to manage human impacts on entire watersheds.

McDowell and Wollheim are among several UNH scientists recently funded by NSF for three of the 14 projects competitively won under its new macrosystems biology program. EOS researchers Jingfeng Xiao and Scott Ollinger, and Steve Frolking were awarded for two additional projects, respectively.

NSF's large-scale biology program, a first for the agency, will tackle big questions in search of equally big answers: How will the biosphere respond to natural and human-induced changes across a range of time and space scales? What is the pace and pattern of the responses? What is the effect on ecosystem services, such as the availability of freshwater, across regions and continents?

The University of New Hampshire, founded in 1866, is a world-class public research university with the feel of a New England liberal arts college. A land, sea, and space-grant university, UNH is the state's flagship public institution, enrolling 12,200 undergraduate and 2,300 graduate students.

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