UC Riverside hydrologist to study ecological impact of climate change on mountain lakes

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Because of extensive bedrock and little soil, Sierra Nevada lakes are very sensitive to changing climate and increased atmospheric fallout of nutrients. Credit: James Sickman, UC Riverside

How does climate change affect the rate of atmospheric deposition of nutrients – elements or compounds essential to the growth and survival of organisms – into mountain lakes? And how do increases in the deposition of such nutrients threaten the lakes' plant and animal species?

James O. Sickman, an assistant professor of hydrology at UC Riverside, will attempt to answer these questions, thanks to a five-year grant from the National Science Foundation's program in Long Term Research in Environmental Biology, to be shared by UCR and UC Santa Barbara. The National Park Service is providing additional funding to Sickman

for three years.

Fossil fuel combustion by humans has multiple effects, one of which – an increase in greenhouse gas emissions – results in climate change and an increase in atmospheric pollutants such as nitrogen. More available nitrogen, in turn, results in increased atmospheric nitrogen deposition.

As part of the research project, Sickman will measure the phosphorus and nitrogen content of atmospheric deposition in Sequoia National Park in the Sierra Nevada, Calif., to determine how its lakes are responding to climate change.

“We’re interested in understanding how the productivity and ecology of lakes are affected by atmospheric fallout of nutrients,” said Sickman, a faculty member in the Department of Environmental Sciences. “By the end of our project we hope to describe the linkages between lake ecology and both climate change and atmospheric deposition.”

Nutrients can enter lakes as dry deposition (slowly descending nutrient-rich particulate matter) or in rainfall and snowfall. When lakes become enriched in dissolved nutrients, overproduction of algae and phytoplankton can result, altering the entire foodweb of the lake; severe overproduction can deplete dissolved oxygen and endanger aquatic life.

“More productivity is not necessarily a good thing where Sierra Nevada lakes are concerned,” Sickman said. “These lakes are chemically similar to distilled water and exist in granitic basins. Both factors limit the lakes’ ability to adapt to climate change and increasing nutrient deposition. We’re already seeing the chronic effects of excessive nutrients falling into these lakes. In some cases, phytoplankton growth has increased by a factor of three. We plan to do some forensic studies on the atmospheric deposition to determine whether the excess nutrients are being transported from local sources, such as the Central Valley, or remote

sources, such as China."

The combustion of fossil fuels, such as oil and coal, by automobiles, electric utilities, and large industries is the major source of nitrogen in atmospheric deposition. Fertilizer application and production may be sources of atmospheric phosphorus.

Excessive nitrogen can contribute to lake acidification, a reduction in dissolved oxygen, a loss of habitat, and changes in biodiversity. Excessive phosphorus can overfertilize lakes, also resulting in changes in biodiversity.

To get a longer perspective on the nutrient content of lakes in the high Sierra Nevada, Sickman also plans to analyze sediment cores from lakes in Sequoia and Yosemite National Parks to determine past rates of atmospheric deposition. "Paleolimnology, the study of the history of lakes, gives us a longer perspective and will help determine if conditions today differ significantly from those in the past. The major goal of this research is to determine what the critical doses are for nutrient deposition – critical information for regulatory agencies in setting air quality standards."

Sickman, who joined UCR earlier this year, is the co-principal investigator of the five-year grant. UC Santa Barbara's John Melack, a professor of ecology, evolution and marine biology, is the principal investigator.

For the first year of funding, the National Science Foundation will provide $84,675 for the study, with nearly 23 percent of this amount assigned to UCR. The National Park Service will provide UCR with $25,000 for the first year of study, with two more years of funding committed to the project.

Source: University of California - Riverside