Roads negatively affect frogs and toads, study finds

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The development of roads has a significant negative and pervasive effect on frog and toad populations, according to a new study conducted by a team of researchers that included undergraduate students and faculty from Virginia Commonwealth University's Department of Biology.

The study, "Citizen Science Reveals Widespread Negative Effects of Roads on Amphibian Distributions," involved roughly 200 undergraduates from biology and environmental science courses at nine

colleges and universities who examined effects of landscape structure and road disturbance on the distribution and richness of pond-breeding frogs and toads across the Central and Eastern United States.

"This was the largest study in spatial extent in the United States to date," said James Vonesh, Ph.D., a biology professor in the College of Humanities and Sciences who teaches the Amphibian Landscape Ecology course that is participating in the project. "Across this very large spatial scale, we find a pervasive negative signal of roads on amphibians."

The team analyzed amphibian population data compiled by citizen scientists for the North American Amphibian Monitoring Program from 1,617 sampling locations, and combined the frog and toad population data with data on wetlands, development, roads and more.

"The students took the GPS coordinates from these call sites where people have gone and listened for frogs and said, 'OK, let me pull that spot into my spatial analysis framework,'" Vonesh said. "And then they say, 'OK, let me bring in the wetlands information. OK, let me bring in the development information. OK, let me bring in the roads information.'"

For each frog call site, he said, the students plotted out the surrounding landscape by using an open-source spatial analysis tool called QGIS.

"They drew a buffer around each spot and said, 'Alright, within a thousand meters of that frog call spot, what's this landscape like?" Vonesh said. "Is it mostly development? Is it mostly agriculture? Is it mostly forest? How connected are the wetlands? Is it one isolated wetland? Or is it a big complex of wetlands? Are there a lot of roads in this area relative to other places, or not so much?'"

Vonesh's class of a dozen students in spring 2013 analyzed the data for all of Virginia.

The other participating colleges and universities – Anoka Ramsey Community College in Coon Rapids, Minnesota; Clarkson University in Potsdam, New York; Eckerd College in St. Petersburg, Florida; Hobart and William Smith Colleges in Geneva, New York; the University of Rhode Island in Kingston, Rhode Island; the University of South Carolina – Salkehatchie; Utah State University in Logan, Utah; and Warren Wilson College in Asheville, North Carolina – analyzed the data for 10 other states.

VCU students helped research frog and toad populations for the study.

Each school sent a delegation of students to the National Center for Ecological Analysis and Synthesis in Santa Barbara, California, to put all of the state information together into one large data set, which the researchers used for the study.

"Think about the Human Genome Project. No one lab did everything.

They farmed it out to a bunch of labs and then they put it together," Vonesh said. "In principle, that's what we did here. If you think of each class as being a lab, each class contributed a part of the whole story. When we put it all together, a larger picture emerged."

The researchers found that the negative effects of roads on amphibian distribution and diversity occur across broad geographic regions, affecting even common species of frogs and toads.

"We show that roads negatively affect frog and toad populations across much of the Eastern U.S.," said Ryan Weaver, who was among the four students from Vonesh's class that traveled to Santa Barbara for the project. "Interestingly, developed land was not particularly bad for these populations, suggesting that careful planning of road placement would reduce the negative impacts on frog and toad abundances."

Jennifer Fjelsted, who is now pursuing a master's degree in environmental science from VCU, was also part of the delegation. Being a part of a national collaborative research project was a rewarding experience, she said.

"It was the first time I had the opportunity to work with a large group of like-minded, science enthusiasts," she said. "The atmosphere felt positive, productive, creative and lively. I left the NCEAS meeting in Santa Barbara with a new enthusiasm for research and science."

Christopher Crockett, a VCU graduate who took part in the project and who is now at the University of Florida working toward a master's degree in entomology, said it was gratifying to work with other students on such an important, real-world research project.

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"To be able to perform landscape-level ecological research with a large group of people, all around the country, really spoke to the vastness of the data and the importance of the project," he said. "I loved meeting with new young researchers like myself from so many different parts of the country, and hearing how their experience with the project was similar and different from our experience at VCU."

The project was the first opportunity many of the students had to be named as a co-author on a paper published in a peer-reviewed journal.

"This is my first peer-reviewed journal publication and I am incredibly excited about it," Crockett said. "I want to continue on as a research scientist and publications are one of the main ways to advance one's career. I want to disseminate scientific research to the world, and do everything I can to educate people. This [was] a great opportunity to do

just that."

As part of the Amphibian Landscape Ecology course, the students learned to identify all of the frogs of Virginia by call. The idea, Vonesh said, was to allow the students to see firsthand how the data was collected for the North American Amphibian Monitoring Program.

"We didn't collect the data that's in that frog call data set," Vonesh said. "That's the efforts of hundreds of citizen scientists over the last 10 years. But by passing the USGS frog call test available online and then putting their knowledge to practice by going out into a field on a dark, rainy night at the [VCU] Rice Center, and saying, 'OK, who's that calling in that field in front of us?' Then they get a very tangible sense of what went into collecting the data."

The project's work is continuing, Vonesh said. His Amphibian Landscape Ecology class in spring 2014 also took part, and is building on the work done by the previous year's students. For example, the students drilled down deeper into the analysis to see if different kinds of roads had a different level of impact on frogs and toads.

"The first year showed us that roads are really important, so in the second year we followed up and look at roads a little more carefully, both in terms of spatial scale and in terms of types of roads," Vonesh said.

More information: Bradley J. Cosentino, David M. Marsh, Kara S. Jones, Joseph J. Apodaca, Christopher Bates, Jessica Beach, Karen H. Beard, Kelsie Becklin, Jane Margaret Bell, Christopher Crockett, George Fawson, Jennifer Fjelsted, Elizabeth A. Forys, Kristen S. Genet, Melanie Grover, Jaimie Holmes, Katherine Indeck, Nancy E. Karraker, Eran S. Kilpatrick, Tom A. Langen, Stephen G. Mugel, Alessandro Molina, James R. Vonesh, Ryan J. Weaver, Anisha Willey, "Citizen science

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