

USF Biologist Jason Rohr explores pollution, climate change and disease in an attempt to understand the global decline of amphibians.

Where have all the **frogs** gone?



BY RANDOLPH FILLMORE

PHOTOS BY JOSEPH GAMBLE

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CCORDING TO JASON ROHR, assistant professor of ecology in USF's Department of Biology's Division of Integrative Biology, amphibians might have replaced canaries in their role of predicting environmental dangers.

Canaries were once carried into coal mines by miners for use as early warning systems to detect toxic gasses such as carbon monoxide and methane. Miners knew that the toxic gasses would kill the fragile birds before affecting them.

Amphibians, says Rohr, might be like present day canaries-in-the-coal mine for our freshwater environments because reductions in their health might warn us that other species may be at-risk from a variety of factors.

"Much of my research focuses on amphibians because they are declining globally," explains Rohr. "We are in the midst of a sixth mass extinction and amphibians are the most threatened vertebrate taxon on the planet. They have become the 'poster child' for this mass extinction."

Rohr and colleagues recently published studies in the journal *Nature* and in *Proceedings of the National Academy of Sciences*, investigating the roles of pollution, climate change, and disease in amphibian declines. Their research is being funded by the National Science Foundation, the U.S. Department of Agriculture, the U.S. Environmental Protection Agency and an Australian Research Council grant.

According to Rohr, more than 32 percent of amphibian species are threatened and more than 43 percent are experiencing some form of population decline. Unlike past mass extinctions, this one is driven by human activities, he says.

"The combination of atrazine, a widely used herbicide, and phosphate, a primary ingredient in fertilizers, accounted for 74 percent of the variation in larval trematode abundance in frogs," explains Rohr. "We showed that these agrochemicals increase trematode infections by augmenting snail intermediate hosts—the source of trematodes that infect amphibians—and suppressing amphibian immune systems."



Data collected from 18 Minnesota wetland areas, as well as experiments conducted in outdoor, 300-gallon tanks, verified that atrazine increased snail abundance caused amphibian immuno-suppression and elevated amphibian trematode loads, says Rohr.

"Tanks with a single dose of atrazine eventually contained more than four times as many snails as control tanks," cites Rohr.

In their *Proceedings of the National Academy of Sciences* paper, Rohr and colleagues evaluated three competing hypotheses for worldwide amphibian declines putatively caused by the deadly chytrid fungus, a fungus Rohr called "possibly the most deadly invasive species on the planet behind humans."

Rohr and his colleagues confirmed that the pattern of amphibian extinctions is consistent with the introduction and spread of this fungus and settled the controversy surrounding the association between global warming and amphibian extinctions.

"There is indeed a positive, multi-decadal correlation between amphibian extinctions in Latin America and air temperature in the tropics," concluded Rohr. "But the relationship should not necessarily be interpreted as causal."

Why? Because their analyses revealed that temperature-dependent chytrid growth could not explain the pattern of amphibian extinctions and that climate change appears to be reducing, rather than increasing, the growth of this cold-



Rohr's research takes him into the field to collect data. The squirrel tree frog (*Hyla squirella*), above left, is a Florida native species that is experiencing declines due to the introduction of the Cuban tree frog shown on page 33. Factors other than invasive species are also likely contributing to local and global amphibian declines.

tolerant pathogen. But the third line of evidence was most creative. They tested whether other variables, including ones as far-fetched as beer production, were better positive predictors of the timing of amphibian extinctions than increasing air temperature.

"There are many convincing examples of the consequences of modern climate change for biological systems," he explains. "But, when beer production is a better predictor of declines than increasing air temperature, it seems really unlikely that increasing temperature is causing the declines."

Past mass extinctions were, of course, not driven by hu-

mans. Because the risks are anthropogenic, a change in human practices could alter what appears to be a destiny of extinction.

According to Rohr, in the case of the potent combination of atrazine and phosphates, these problematic drivers could be managed to reduce disease risk for amphibians. The goal of his work, he says, is to develop solutions to environmental problems like those of his recent investigations in order to enhance the likelihood of developing a sustainable existence for both humans and wildlife.

"Altogether," he says, "our work demonstrates the value of quantifying the relative importance of several plausible drivers of disease risk and population declines using a combination of field surveys, manipulative studies, and mathematical models to better understand and prioritize how we might go about reversing some of the effects of these risk factors." ■