

Agroforests in the tropics provide key conservation landscapes for amphibians

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These amphibians were just some of the 26 unique frog species the researchers detected the presence of in the coffee, rubber and areca palm agroforests growing among the rainforest covering the Western Ghats Mountains in Southwest India. Credit: Shashank Dalvi/National Science Foundation

Although tropical forest ecosystems around the world have been modified and fragmented by agroforests planted to produce commodities such as coffee, rubber and areca palm, amphibian communities can survive in those transformed landscapes—if the agroforests are managed to support biodiversity.

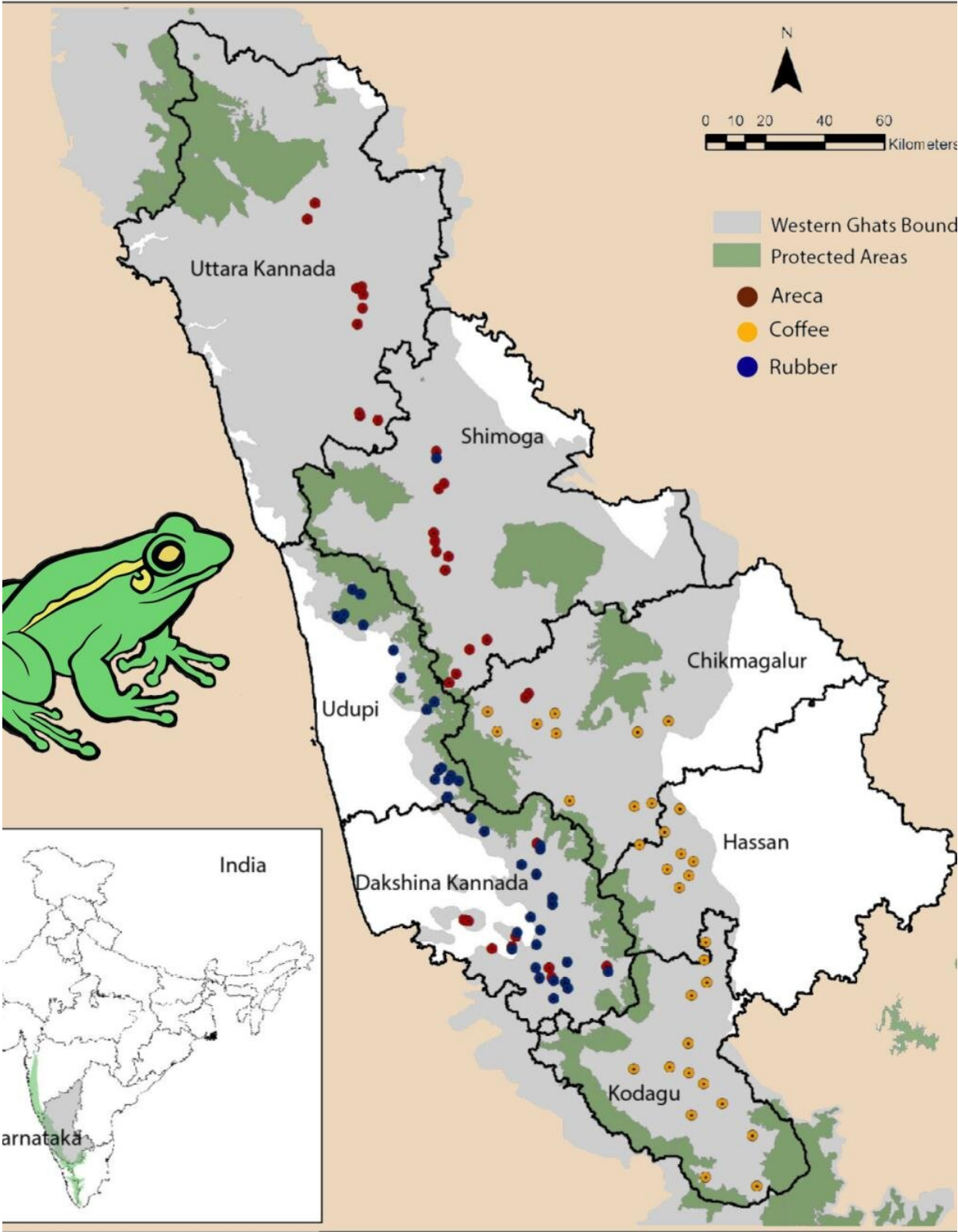
That's the conclusion of a new study led by Penn State wildlife ecologists who surveyed [frog populations](#) in the Western Ghats, a mountain range that covers an area of 62,000 square miles parallel to the southwestern coast of India. Although the rainforest there has been extensively interrupted by human-modified land uses and infrastructure, the region is one of the eight "hottest" biodiversity hotspots in the world.

The Western Ghats, which shelters amphibians not found anywhere else in the world, was an ideal place to conduct the research, according to research team member David Miller, associate professor of wildlife population ecology. The region has more than 250 [amphibian species](#), some of which are threatened and many only very recently discovered.

"What happens ecologically in the Western Ghats has international significance," said Miller, whose research group in the College of Agricultural Sciences has studied the health of frog and salamander populations around the world. "Maintaining a level of rainforest biodiversity sufficient to sustain [amphibian](#) populations is important. The production landscapes of agroforests can offer secondary habitats that can support and sustain local biodiversity."

The research started a decade ago when researchers at the Centre for Wildlife Studies—India, led by Krithi Karanth, Shashank Dalvi and Vishnupriya Sankararaman, now a doctoral student in the Ecosystem Science and Management program at Penn State, searched for amphibians on 106 agroforest tracts across an 11,000-square-mile area. Using a combination of visual and auditory encounter surveys, they

detected the presence of 26 unique frog species that occurred in the agroforests over two years.



Map of the study area with sampled locations in the Western Ghats region of southwest India. Researchers sampled amphibian populations in coffee, rubber and areca palm agroforests. Credit: Vishnupriya Sankararaman

"Frogs, like birds, make different chirps, peeps and croaks," she said. "So, species can be identified by sound as well as sight. We had birders among our group, and they helped us get very good at detecting various types of frogs by their calls."

The study analyzed amphibian populations and land management in coffee, rubber and areca palm—three of the largest commodity agroforests in the Western Ghats. Researchers found that "microhabitat availability"—the presence of streams, ponds and unpaved service roads—had a major influence on amphibian numbers and species distribution.

"Our study found that small things can make a big difference," Sankararaman said. "For instance, a very small stream—just a ditch really—that runs 3 feet wide carrying rainwater during the monsoons is enough to provide a huge habitat for amphibians. So, if we can persuade agroforest land managers not to divert or flatten these kinds of landscape features to make it easier for cultivation, that would be a huge win."

In findings recently published in *Ecological Solutions and Evidence*, the researchers reported that coffee agroforests had the highest species richness and frog numbers, compared to rubber and areca palm, likely because coffee is a shade-loving tree that grows under the rainforest canopy.

Microhabitat availability was the strongest predictor of amphibian occupancy—the presence of even tiny water bodies and roads increased

species richness per site by 35%. Stream presence alone did not change species richness, but up to three times as many frogs were found near streams.



A rubber plantation in the Western Ghats with the morning sunlight streaming in under the canopy. Credit: Shashank Dalvi

The presence of plantation roads also increased species richness by more than 20%. Being unpaved with little vehicular traffic, plantation roads seem to provide additional habitats for amphibians, the researchers pointed out. The presence of all three microhabitats at a site increased

species richness by 75%.

The research shows the importance of [land-management](#) strategies that maintain diverse native canopy and freshwater bodies and other microhabitats in sustaining amphibian populations. Land managers need to be given incentives to maintain—or at least not disturb—ponds, streams and unimproved roads during the monsoon season, Sankararaman said.

Amphibian populations are declining around the world, and they need protection, she believes. "They provide huge ecosystem services to landowners—frogs are natural pesticides that consume more insect biomass than almost any other animals," she said. "They have real financial significance and allow us to eat more organically, using fewer chemicals in crop production. But beyond that, these creatures have evolved over millions of years, and they have immeasurable value in their own right."

Sankararaman, who is enrolled in the Intercollege Graduate Ecology program, came to Penn State to continue her research after learning about Miller's work quantifying the threat to amphibian populations. She hopes to return to the Western Ghats to help safeguard biodiversity in the region.

"In North America, most things have been studied pretty well, but in the tropics, everything is unknown, and the complexity and diversity of the ecosystems provide exciting research opportunities," she said. "At Penn State, I knew I would be able to develop my skills in quantitative ecology and use the research expertise to better explore the ecological issues of India."

More information: Vishnupriya Sankararaman et al, Local and landscape characteristics shape amphibian communities across

production landscapes in the Western Ghats, *Ecological Solutions and Evidence* (2021). [DOI: 10.1002/2688-8319.12110](https://doi.org/10.1002/2688-8319.12110)

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