# High-speed search methods to better estimate climate threats to biodiversity

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Climate change is perhaps felt most acutely in the Arctic right now, but by the start of the next century, animal species in the Amazon basin region will be harder hit as the Earth warms.

In a study published this week in the journal *PLOS ONE*, researchers have used new high-performance computing methods and comprehensive data on the distribution of thousands of species to map the threat that climate change poses to birds, mammals and amphibians across the Western Hemisphere. They found that although Arctic areas have experienced the most rapid warming to date, climate-related threats to the Amazon basin's biodiversity will eclipse those in other regions by the year 2100.

"These results suggest that tropical species will likely be some of the most vulnerable to climate change," said co-author Joshua Lawler, a University of Washington associate professor of environmental and forest sciences. "While we know that many of these species are restricted to relatively narrow climatic ranges, combining this information with detailed maps of where and how climate is shifting most rapidly provides a much clearer picture of where threats are greatest."

The researchers used high-performance computers to search for and categorize millions of images, approaches similar to those used in facial or fingerprint recognition software. This allowed them to sift through millions of pixels representing future climate at different locations to

find locations that matched each site's current climate fingerprint.

Researchers could then estimate the actual distance and speed it would take for an animal to disperse across the landscape to stay within its climate tolerances and survive in the face of climate change.

For example, the Amazon's yellow-banded poison dart frog is projected to have to move several hundreds of kilometers to the southwest, because most of its range will likely become unsuitable for this species to live. Several other amphibian species in this region show similar movement patterns.

By incorporating data on the climate tolerances of individual species, the researchers were able to fine-tune their initial estimates of dispersal based on climate change alone. This combination of climate data and biological data showed that although polar regions currently are experiencing the greatest shifts in climate, species in the Amazon basin face the greatest threats because of the narrow range of conditions they can tolerate and the longer distance to cooler habitat that can serve as climate refuges.

As climate shifts over the coming decades, such "velocity of climate change" information can help predict which species are likely to adapt in place to new climatic conditions, disperse and establish in areas with newly suitable climate, or face the prospect of extinction.

Previous studies based velocity estimates only on climate measurements in the neighborhood of a site, rather than searching for matches across large areas, so they are less meaningful for animals that can disperse over longer distances.

"This study is the first time that scientists have been able to accurately estimate the velocity of climate change for thousands of species over

entire continents," said lead author Carlos Carroll, an ecologist with the Klamath Center for Conservation Research in Orleans, California. "Even as governments step up their commitment to reduce future greenhouse gas emissions, this information can help planners identify climate refuges where conservation would reduce loss of species from the climate change that is already locked into the system from past emissions."

Provided by University of Washington