Does history repeat? Using the past to improve ecological forecasting

February 20 2012, by Jill Sakai

To better predict the future, Jack Williams is looking to the past.

"Environmental change is altering the composition and function of ecological communities," says the Bryson Professor of Climate, People, and the Environment in the University of Wisconsin–Madison geography department. Williams also directs the Center for Climatic Research in the Nelson Institute for Environmental Studies.

On Monday, Feb. 20, Williams is speaking at the annual meeting of the American Association of the Advancement of Science in Vancouver, British Columbia. In a talk titled, "Novel Climates, No-Analog Communities, and Truncated Niches," he discusses the challenges involved in making informed predictions about how ecological communities will respond to changing climate.

Right now global climates are changing rapidly and it is likely that this century will see the emergence of what he calls "no-analog" climates, combinations of climate factors – such as maximum and minimum temperature, amount and timing of precipitation, and seasonal variation – that do not exist anywhere on the globe today.

"There are areas of the world that are expected to develop novel climates this century," Williams says. "How do we predict species' responses to climates that are outside the modern range?"

To look at how ecological changes have been driven by past climate change, he draws on a recent historical period of abrupt global change – the late Quaternary Period, particularly the past 20,000 years, when the world warmed from the last ice age to the current interglacial period.

With geohistorical and paleoecological data – derived largely from fossil pollen – he studies the responses of species and communities to climates that no longer exist today.

"We are using this as a model system for looking at the biological responses to climate change, in particular this phenomenon of no-analog climates," he explains.

The biological record reveals that species were highly sensitive to past climate changes, responding in multiple ways including migration, adaptation, changes in population size, and, in some cases, extinction.

But species distribution models, which are widely used to forecast ecological responses to future climate change, match imperfectly to the historical data, presenting a challenge for predicting how today's species will respond to current and future climate change. Even more difficult is scaling up from individual species to understanding the shifting composition of ecological communities.

Williams' historical perspective has revealed that the only sure thing is change. "The key message from paleoecological data is that novel climates in the past are linked to the emergence of novel communities," he says. "We should expect the unexpected. At the same time, we can use this information to not just raise questions but to improve ecological modeling tools."

One current avenue of research is combining modern and paleobiological data to look at individual species under a range of climate conditions.

"Using only modern data may lead us to misestimate the ability of species to adapt to accommodate to climates different from today," Williams explains. "By combining data from multiple time periods, we can develop a fuller understanding of the full range of environments that a species can occupy – which may be far greater than what is observed at any one moment in time."

Improved species distribution models will still need to be combined with an understanding of barriers to adaptation, such as habitat continuity, geographic proximity, mobility, and current land use, all of which affect a species' ability to reach its new ideal range. But they represent an important step forward.

"By combining geohistorical and recent data, this is one way to improve our forecasting ability and, hopefully, our decision-making when it comes to setting conservation priorities and allocating resources," Williams says.

Provided by University of Wisconsin-Madison

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