Integrative Climate Change Biology: What the past can tell us about future biotic responses to climate change

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Species distribution modeling has become a powerful spatial tool to study the effects of climate change on suitable habitat. Expanding these models to include potential evolutionary change as well as past climatic fluctuations will increase our understanding of how species responded to past climate changes and will provide a null model to compare predictions of how they will respond to impending climate change. During my PhD work, I developed a novel tool, Paleophylogeographic Species Distribution Modeling (PPGM), by combining species distribution modeling, isotopically scaled paleoclimate general circulation models, and phylogenetic comparative methods. I used PPGM to demonstrate that on the glacial-interglacial time scale, rattlesnakes and turtles do not adapt as fast as the climate has changed, and the changing climate, as opposed to evolutionary change, was the driving force behind shifts in modeled suitable habitat. I projected models of rattlesnake suitable habitat onto future climate models representing a 1C and 6C increase in mean annual temperature and found the annual rate of displacement over the next century will likely be two to three orders of magnitude greater (430-2,420 m/yr) than it has been on average for the past 320,000 yrs (2.3 m/yr). In general, many species will have to move farther and faster than they have in the past to escape extinction.

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