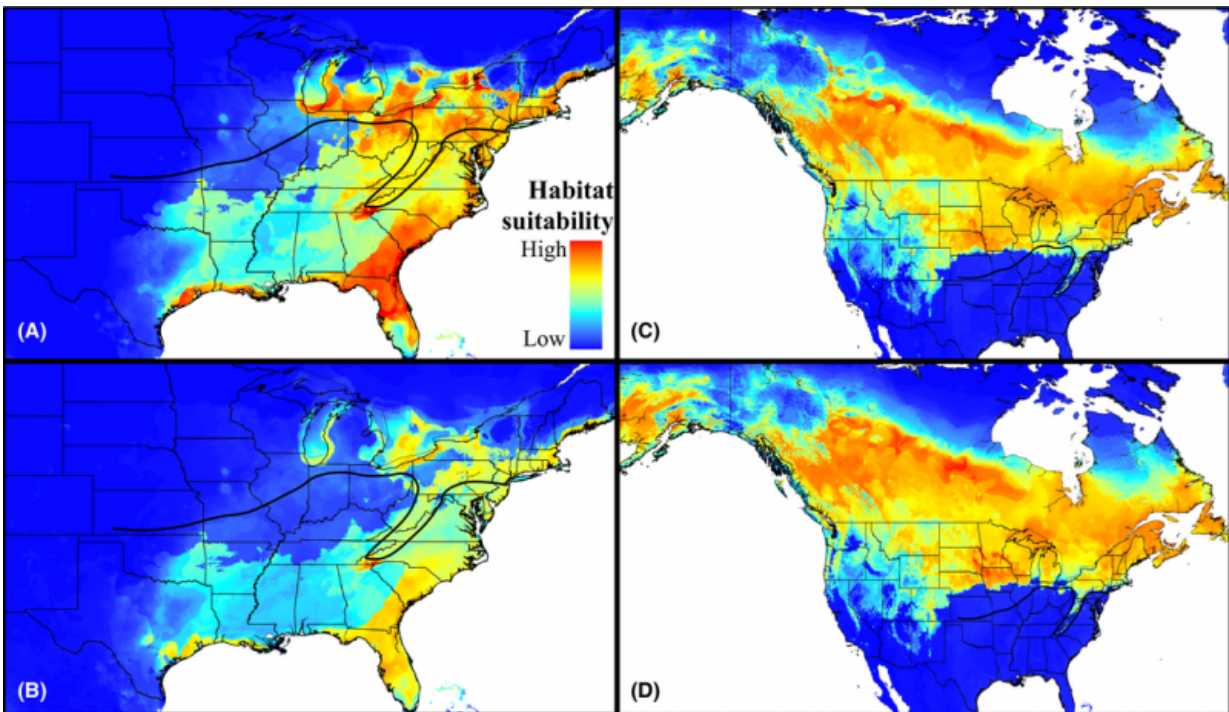


# Chickadee research predicts drastic northward shift for southern species

December 2 2015



Potential distributions (full models) projected onto predicted climatic conditions for the year 2050, under the general circulation model HADGEM2-ES. *Poecile carolinensis* climatically suitable areas for representative concentration pathways (RCPs) (A) 4.5 and (B) 8.5. *Poecile atricapillus* climatically suitable areas for RCPs (C) 4.5 and (D) 8.5. Credit: Michael A. McQuillan and Amber M. Rice, Lehigh University

Biologists know that climate change is causing southern species' ranges

to move northward in the Northern Hemisphere. But little research has been done on the indirect ways climate change is influencing biodiversity, such as the poleward migration's impact on the ranges of species already residing in the north. What will the distribution of species look like across North America in the year 2050?

New research on northern (black-capped) and southern (Carolina) [species](#) of chickadees offers some answers. Amber Rice, assistant professor of biological science at Lehigh and her co-author Michael A. McQuillan, a graduate student studying integrative and evolutionary biology, looked at the predicted effects of [climate change](#) on both species of chickadee with an eye toward examining how rising temperatures are influencing their location. They also looked at how other matters are factoring in to the species' range limits - such as interactions between the species, like hybridization, which is when individuals from different species mate and produce offspring.

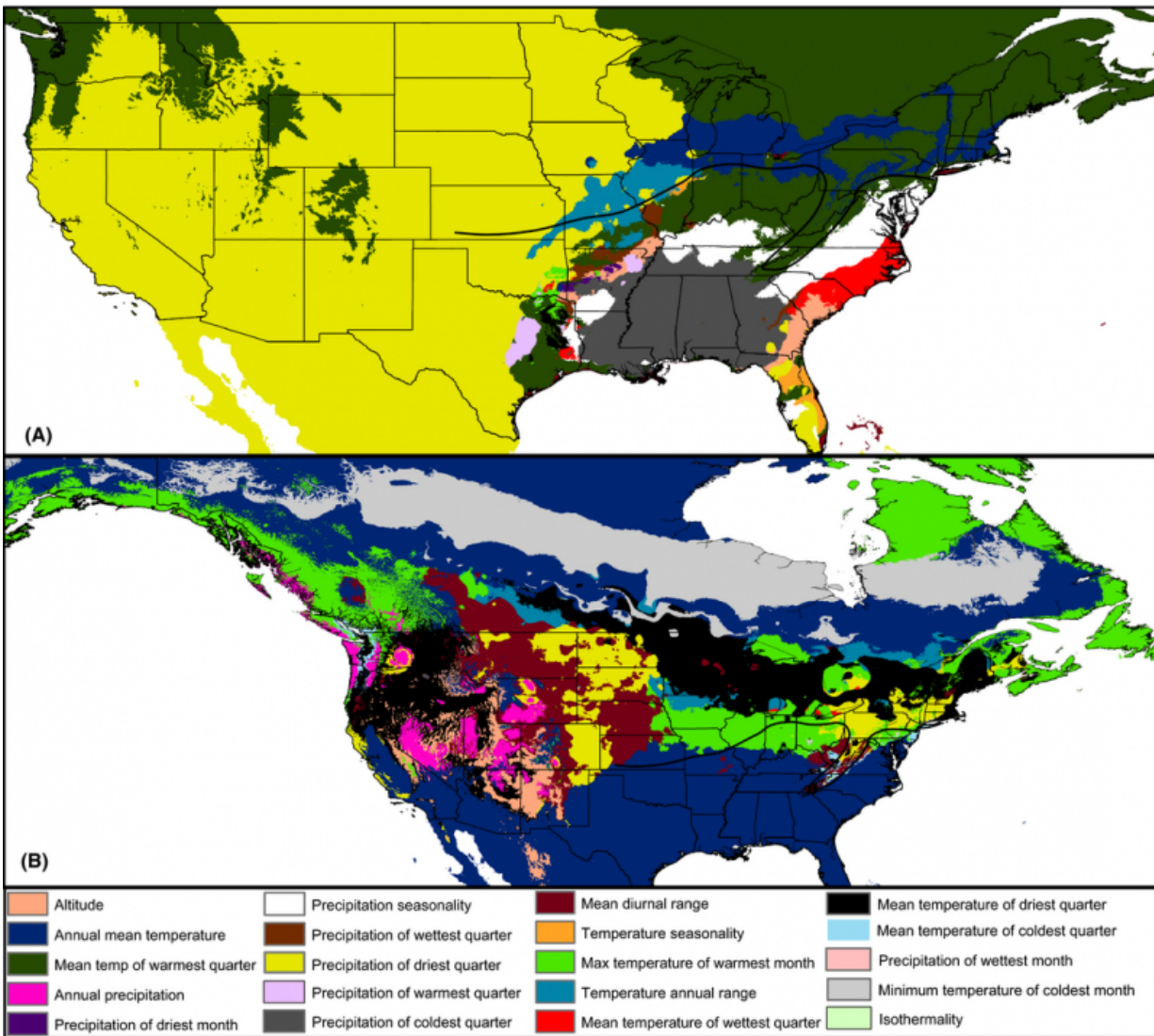
Findings from the [study](#), published in a paper called "Differential effects of climate and species interactions on range limits at a hybrid zone: potential direct and indirect impacts of climate change" in the November 2015 edition of *Ecology and Evolution*, have implications beyond chickadees.

"We found that climate change can both directly and indirectly affect species distributions and hybrid zone location," says McQuillan.

"Additionally, our results lend support to the hypothesis that physical factors regulate species' poleward range limits, while biological factors shape range limits near the equator."

To begin the study, Rice and McQuillan collected information about where each of the chickadee species occurs and recorded climate information from each location where the birds have been observed. Then they projected the data onto a map and identified areas where the

climate is most suitable for each species. When they compared the suitable areas to the areas where the birds are actually located, they found that the northern species was often absent from large areas with suitable climate.



(A) Limiting factor analysis for *Poecile carolinensis*. Areas northeast of the hybrid zone limited primarily by annual mean temperature (dark blue) and mean temperature of the warmest quarter (dark green). Areas west of *P. carolinensis* limited primarily by precipitation of driest quarter (yellow). (B) Limiting factor analysis for *Poecile atricapillus*. Areas along much of the contact zone itself

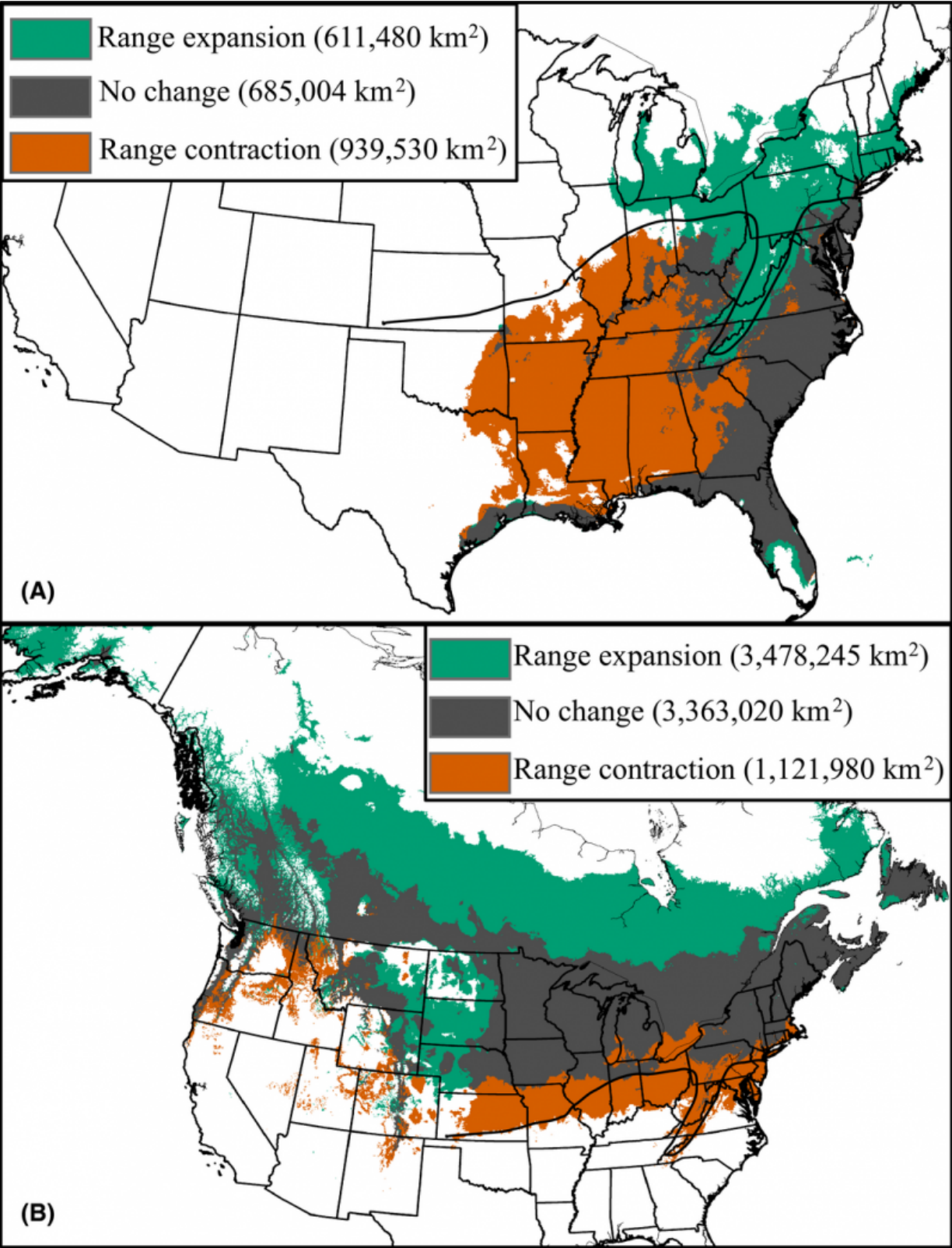
limited by maximum temperature of the warmest month (light green). Areas south of the hybrid zone limited primarily by annual mean temperature (dark blue). Northern edge of range limited by minimum temperature of coldest month (light gray). Note that some variables are only limiting for one species. Credit: Michael A. McQuillan and Amber M. Rice, Lehigh University

"We speculated that the lack of the northern chickadee species in areas you would expect them to be could be attributed to competition or hybridization," said Professor Rice. "We discovered that the two types of chickadees are being affected differently: the southern species—the Carolina chickadee—is being pushed north due to climate change and the northern species—the black-capped chickadees—are being displaced by the southern species of chickadees as a result."

Their 2050 climate models forecast a drastic northward shift in suitable habitat for the southern species in eastern North America, which is predicted to cause a significant displacement of the northern chickadee species. In contrast, they predict there will be less overlap between the two species in the Midwest, where the two species' ranges are affected more by precipitation than by temperature.

Because of these different predictions for how climate will affect chickadee ranges in eastern North America versus the Midwest, Rice and McQuillan plan to use genetic approaches to determine if selection in these two regions acts differently on hybridization. If it does, one possible outcome is that the two species might end up merging into one.





Area distribution changes between binary SDMs (species distribution modelings)

for current and future (year 2050) climate conditions. (A) Change in binary SDMs for *Poecile carolinensis*. (B) Change in binary SDMs for *Poecile atricapillus*. Credit: Michael A. McQuillan and Amber M. Rice, Lehigh University

Provided by Lehigh University

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