

Penguin population could drop 60 percent by end of the century

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University of Delaware researchers project that approximately 30 percent of current Adélie colonies may be in decline by 2060 and approximately 60 percent may be in decline by 2099. Warming in Antarctica, once beneficial to the penguins, has reached a tipping point and is causing the sharp decline. Credit: University of Delaware/ Megan Cimino

Climate has influenced the distribution patterns of Adélie penguins across Antarctica for millions of years.

The [geologic record](#) shows that as glaciers expanded and covered Adélie breeding habitats with ice, penguin colonies were abandoned. When the glaciers melted during warming periods, this warming positively affected the Adélie penguins, allowing them to return to their rocky breeding grounds.

But now, University of Delaware scientists and colleagues report that this beneficial warming may have reached its tipping point.

In a paper published today (June 29) in *Scientific Reports*, the researchers project that approximately 30 percent of current Adélie colonies may be in decline by 2060 and approximately 60 percent may be in decline by 2099.

"It is only in recent decades that we know Adélie penguins population declines are associated with warming, which suggests that many regions of Antarctica have warmed too much and that further warming is no longer positive for the species," said the paper's lead author Megan Cimino, who earned her doctoral degree at UD in May.

Co-authors on the work include Matthew Oliver, principal investigator on the project and Patricia & Charles Robertson Professor of Marine Science & Policy in UD's College of Earth, Ocean, and Environment; Heather J. Lynch, assistant professor in the Department of Ecology and Evolution at Stony Brook University; and Vincent S. Saba, a research fishery biologist with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

Declining populations

The Adélie penguin is a species that breeds around the entire Antarctic continent. The species is experiencing population declines along the West Antarctic Peninsula (WAP), which is one of the most rapidly warming places on Earth, while Adélie populations in other areas around the continent where the [climate](#) is stable or even cooling remain steady or increasing.

The researchers' objective was to understand the effects of climate change on Antarctic Adélie penguin colonies. The study builds on previously published work by Oliver's research team to better understand Antarctica's shifting ecosystem by tracking penguins and their habitats. The current work used satellite data and global climate model projections to understand current and future population trends on a continental scale.

"Our study used massive amounts of data to run habitat suitability models. From other studies that used actual ground counts—people going and physically counting penguins— and from high resolution satellite imagery, we have global estimates of Adélie penguin breeding locations, meaning where they are present and where they are absent, throughout the entire Southern Ocean. We also have estimates of population size and how their populations have changed over last few decades," explained Cimino, now a postdoctoral scholar at Scripps Institute of Oceanography.

"When we combined this data with satellite information and future climate projections on sea surface temperature and sea ice, we can look at past and future changes in Adélie penguin habitat suitability," Cimino said.

Funded through the NASA Biodiversity program, the study is based on satellite observations from 1981-2010 of sea surface temperature, sea ice and bare rock locations, and true presence-absence data of penguin

population estimates from satellite imagery.

In particular, the researchers examined the number of years from 1981-2010 with novel or unusual climate during the Adélie penguin chick-rearing period from past satellite observations and used an ensemble of global climate models to make predictions about Adélie penguin habitat suitability from 2011-2099. The team validated the models with documented population trends.

The study results suggest that climate novelty, particularly warm sea surface temperature (SST), is detrimental to Adélie penguins. While the specific mechanisms for this relationship remain unknown, the study focuses attention on areas where climate change is likely to create a high frequency of unsuitable conditions during the 21st century.

Lynch noted that "One of the key advances over the last decade is our ability to find penguin colonies from space and, nearly as important, to determine which areas of Antarctica do not support penguin colonies. Having both true presence and absence across a species' global range is unique to this system, and opens up new avenues for modeling habitat suitability."

Refugia offer a glimmer of hope

According to Cimino, the southern WAP, associated islands and northern WAP regions, which are already experiencing population declines, are projected to experience the greatest frequency of novel climate this century due to warm SST. This suggests that warm sea surface temperatures may cause a decrease in the suitability of chick-rearing habitats at northerly latitudes.

"Matt and I have worked extensively at Palmer Station and we know that penguin colonies near there have declined by at least 80 percent since the

1970s. Within this region we saw the most novel climate years compared to the rest of the continent. This means the most years with warmer than normal [sea surface](#) temperature. These two things seem to be happening in the WAP at a higher rate than in other areas during the same time period," Cimino said.

By contrast, the study also suggests several refugia—areas of relatively unaltered climate—may exist in continental Antarctica beyond 2099, which would buffer a species-wide decline. Understanding how these refugia operate is critical to understanding the future of this species.

"The Cape Adare region of the Ross Sea is home to the earliest known penguin occupation and has the largest known Adélie penguin rookery in the world. Though the climate there is expected to warm a bit, it looks like it could be a refugia in the future, and if you look back over geologic time it was likely a refuge in the past," Cimino said.

The researchers reported that climate change impacts on penguins in the Antarctic will likely be highly site specific based on regional climate trends, and that a southward contraction in the range of Adélie penguins is likely over the next century.

"Studies like this are important because they focus our attention on areas where a species is most vulnerable to change," concluded Cimino. "The results can be used for management; they can have implications for other species that live in the area and for other ecosystem processes."

More information: Megan A. Cimino et al, Projected asymmetric response of Adélie penguins to Antarctic climate change, *Scientific Reports* (2016). DOI: 10.1038/srep28785

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