Arctic ground squirrels are altering their hibernation patterns in response to climate change

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Near Toolik Field Station in northern Alaska, an arctic ground squirrel pokes its head out of a burrow. Credit: Oivind Toien/University of Alaska Fairbanks

Arctic ground squirrels are unique among mammals. Their ability to

keep from freezing even when body temperatures dip below that mark on the thermometer enables them to survive extreme winter climates. New research published in *Science* analyzes more than 25 years of climate and biological data. The findings include shorter hibernation periods and differences between male and female hibernation periods. Spoiler alert—the girls "rise and shine" a little earlier in response to warming, which could have both positive and negative ripple effects throughout the food web in these ecosystems.

Senior author Cory Williams, assistant professor in the Department of Biology at Colorado State University, began studying arctic ground squirrels while at the University of Alaska Fairbanks more than 15 years ago. "I think the thing that makes our study unique is that we are looking at a long enough dataset to show the impacts of climate change on a mammal in the Arctic," said Williams, who joined the CSU faculty in 2021. "We can show a direct link between changes in temperature and the physiology and ecology of these animals."

Helen Chmura, lead author for this latest research, started the analysis while a postdoctoral fellow at the University of Alaska Fairbanks in 2018 and now works as a USDA Forest Service researcher with the Rocky Mountain Research Station. "Our data show that the active layer, the soil layer above the permafrost, freezes later in the fall, doesn't get as cold in the middle of winter, and thaws slightly earlier in the spring." She added, "These changes, amounting to about a 10-day reduction of the time soil is frozen at a meter deep, have occurred over just 25 years, which is fairly rapid."

A juvenile arctic ground squirrel foraging near Toolik Field Station in northern Alaska. Credit: Cory Williams/Colorado State University

Arctic ground squirrels survive harsh Alaska winters by hibernating for over half the year, drastically slowing their lungs, heart, brain, and body functions. They still must spend energy to generate enough heat from stored fat to keep tissues from freezing. They resurface from their burrows more than 3 feet below the ground each spring, famished and eager to mate.

Chmura and Williams, along with co-authors, analyzed long-term air and soil temperature data at two sites in Arctic Alaska in conjunction with data collected using biologgers. They measured abdominal and/or skin temperature of 199 free-living individual ground squirrels over the same

25-year period. They found that females are changing when they end hibernation, emerging earlier every year, but males are not. Changes in females match earlier spring thaw. The advantage of this phenomenon is that they do not need to use as much stored fat during hibernation and can begin foraging for roots and shoots, berries and seeds sooner in the spring. Scientists think this could lead to healthier litters and higher survival rates.

The downside is that if the males also do not shift hibernation patterns, there eventually could be a mismatch in available "date nights" for the males and females. Ground squirrels are also an important source of food for many predators, such as foxes, wolves, and eagles. An indirect consequence of being active above ground longer is greater exposure and risk of being eaten.

A juvenile arctic ground squirrel foraging near Toolik Field Station in northern Alaska. Credit: Cory Williams/Colorado State University

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What will happen to the population is a big unknown—there are not clear winners or losers. While hibernation requires less energy, which could help overwinter survival, ground squirrel numbers also depend on how predators respond to climate shifts. For now, Williams concludes, "Our paper shows the importance of long-term datasets in understanding how ecosystems are responding to climate change." Chmura agreed,

adding, "It takes a great team to continue a dataset like this for 25 years, especially in the Arctic."

Other contributing authors include Brian Barnes, University of Alaska Fairbanks, and Loren Buck from Northern Arizona University, who both began this study in the 1990s to learn how Arctic ground squirrels survive such long, cold, dark, winters and just how cold their hibernation spots were. These questions prompted them to install the first soil temperature monitors, and as technology improved, they were able to measure those temperatures all winter long.

More information: Helen E. Chmura et al, Climate change is altering the physiology and phenology of an Arctic hibernator, *Science* (2023). DOI: 10.1126/science.adf5341.
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