Silence of the Pikas

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Will the American pika become the first species in the lower 48 states to be listed under the Endangered Species Act owing to global warming?

From 2000 meters up Divide Peak in Montana's Glacier National Park, clambering around a steep talus slope, looking and listening for signs of American pika (*Ochotona princeps*). A diminutive alpine-dwelling rabbit relative, the pika is front and center in the news about climate change: The US Fish and Wildlife Service (USFWS) is nearing the end of a 12-month review to determine whether to list any of the United States' 31 subspecies of American pika as threatened or endangered specifically because the Earth is warming.

I've joined University of Wisconsin graduate student Lucas Moyer-Horner in a biologist's version of *Where's Waldo?*, looking for the tan, potato-sized furballs amidst the mountaintop boulder field. Moyer-Horner has systematically documented pika distribution throughout the entire park over the past three years. The detailed survey will allow him to plug his data into a cutting-edge biophysical computer model called Niche Mapper™ developed by his adviser Warren Porter, which uses physiological, weather, and spatial habitat data to predict a species range in different climate scenarios.

Regression analyses can statistically correlate pika presence or abundance with certain variables, but this mechanistic model can get at why. It helps pinpoint what physiological and behavioral mechanisms might affect pika populations as the warming climate continues to melt Glacier's namesake glaciers. According to scientists, the park's glaciers will disappear within 10 years. In the mid-20th century, the park had 150 glaciers. Today, there are 26.

Pikas blend in very well with the talus, and spotting one is sometimes like a game of Where's Waldo*? Photograph: © Wendee Holtcamp.*

Making hay while the sun shines

Pikas are unique among alpine mammals in that they gather up vegetation throughout summer—including flowers, grasses, leaves, evergreen needles, and even pine cones—and live off the hay pile throughout winter, rather than hibernating or moving downslope. But increasingly warm temperatures may drive them to the brink: the high-energy mammals can overheat and die at temperatures as mild as 25 degrees Celsius if they can't regulate their body temperature by moving into the cooler microclimate under the talus. And since they already live near the tops of mountains, when a particular talus field's microclimate becomes inhospitable, they simply have nowhere to go.

Sometimes called cony, mouse hare, rockrabbit, or whistling hare, the pika has a narrow niche. They live only in talus fields, and these must lie adjacent to alpine meadows or other vegetation so they have access to plants for food and hay farming. The talus rock fields must have boulders of a certain size; scree, a similar habitat with smaller rocks, won't do. Rocks provide safe haven from pikas' main predator, weasels. But perhaps more important, the interstices between the rocks provide both a cool, moist microclimate where pikas cool down during hot summer days and also the perfect sanctuary in which to settle during the long winter's night. They don't huddle together like many other mammals, as far as scientists can tell, but remain fiercely

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territorial and solitary throughout the winter, guarding their hay piles with their lives. As a snowpack settles over the land, it insulates the Earth and maintains a certain underground temperature at which pikas can survive, just below freezing. With warming temperatures reducing snowpack in many mountainous areas, in a strange twist of fate, global warming can cause pikas to freeze to death. Moyer-Horner has come across several half-eaten hay piles in which the animal most likely perished midwinter.

Biologists have dubbed mountaintop habitat patches "sky islands" because the valleys in between are as uninhabitable as the sea for nonmobile alpine species. This creates an ideal scenario to test the predictions of one of ecology's key theories: island biogeography. Individual pikas have a relatively limited distance they can disperse, around two kilometers, so they can't just shift from one mountain to another. At the population level, they're stuck on a particular mountain range. In the 1990s, biologist Erik Beever and colleagues surveyed pikas throughout the hydrographic Great Basin—a heart-shaped 500,000 square kilometer intermontane plateau dotted with 314 mountain ranges, incorporating parts of California, Nevada, Utah, Oregon, Idaho and Arizona—and were unable to find pikas in 6 of 25 mountain ranges that they had occupied in the late 20th century. Was the cause of pika extirpations climatic, anthropogenic, or biogeographical?

The cause of extirpations

Island biogeography theory says that "species are predicted to remain on large islands and islands that are not very isolated from mainland [habitat]," explains Beever, who did much of his work while a graduate student under Mary Peacock, at the University of Nevada–Reno. Using multiple linear regression, he and colleagues found pika populations persisted in mountain ranges with more talus habitat available—supporting one prediction of island biogeography theory—but pikas were not more likely to persist at sites closer to the Rocky Mountain or Sierra Nevada "mainland" ranges.

"Here, isolation doesn't have anything to do with whether they're lost or not," Beever says. Not only that, "the sheer size of a mountain range in this case isn't very predictive of patterns of loss. [And] if we count the amount of habitat, that's less important than these climatic influences." Ultimately, the factors most strongly associated with pika disappearance were climatic; specifically, warmer and drier sites, which tended to be lower down the mountains. In another study published just this month in *Ecological Applications,* Beever, University of Colorado researcher Chris Ray, and other colleagues revealed that acute cold stress and chronic heat stress (in other words, cold snaps and overall hotter summers) affect pika more than individual very hot days.

"The problem with global warming is that if [pikas] lose [their] snowpack, which provides insulation in winter, they freeze to death, and if the ambient air temperature heats up too much in summer, then they fry. That's the challenge," Peacock says, who has studied pika population genetics. "They're already at the top of the mountain. If you heat it up substantially, there's no place for them to go."

Species with either short lifespans or a certain degree of phenotypic plasticity, whether it's variation in behavior, physiology, or other characteristics, may be able to adapt to changing climate, but it seems unlikely that the pika will be able to adapt quickly, or at all, to such radical shifts in climate. Besides their narrow niche, they have few offspring and are relatively long-lived for their size, living up to seven years. When juveniles dis-

Lucas Moyer-Horner looks for pika signs on Divide Peak in Glacier National Park. Photograph: © Wendee Holtcamp.

A pika carries food for its hay pile in its mouth. Photograph: © Jim Jacobson.

A pika can build its hay pile up to four feet thick and five feet long. In Glacier National Park, they average around one to two feet thick and two to four feet long. The poison in certain leaves helps preserve the entire pile. Photograph: © Shana Weber, Princeton University.

perse, they go to the closest unoccupied territory, and that means pikas in neighboring territories are often relatives. Nevertheless, Peacock's work has shown they have a healthy degree of genetic diversity, though other studies are under way.

"Early work using mark and recapture by Andrew Smith showed they didn't move far. We found pikas are actually quite fluid across the larger landscape," Peacock says. "If there is enough continuous talus at high elevation, you can get a lot of connectivity over multiple kilometers. One individual is not moving two kilometers in its lifetime, but small movements over time will show a very connected population genetically."

Since pikas have already started disappearing from low-elevation sites at more southerly latitudes, Moyer-Horner wanted to look at fine-scale mechanisms of how changing climate may affect pikas in an untrammeled area, farther north from the Great Basin. "I wanted to look at an area where pikas should still be quite abundant," Moyer-Horner said. "Because of the northern latitude, it's earlier in that [disappearance] curve. Can we begin to identify early warning signs that pikas are going to be extirpated from patches?"

Mechanistic modeling

Most studies predicting animal response to climate change model the "empirical niche" of an animal and rely on regression, which merely correlates certain factors with a species' presence or abundance. Niche Mapper™ gets at mechanisms and can model different behaviors; for instance, the need to seek shade if the outside temperature or body temperature rises above a certain level.

"With regression, all you know is that there are certain environmental factors associated with pika activity, but you don't really know why," Moyer-Horner says. "We might use the empirical niche modeling [regression] to discover that pikas tend to be found in places that are cooler, but with mechanistic modeling, you can look at why pikas are not in places that are too hot. Maybe when days are too hot, pikas don't have the necessary time available to collect enough vegetation to last through the winter. Niche Mapper™ can predict time available for foraging." This fine-scale mechanistic approach may help conservation biologists and policymakers more accurately pinpoint just how to help save the species.

Since Porter started working on the math behind Niche Mapper™ in the 1960s and 1970s, the model has proven useful in a variety of habitats for both ectotherms and endotherms; in fact, he has a slightly different model for each. "We've spent a great deal of time going into the field and testing the models, from deserts to bogs to snowy landscapes, so we could accurately calculate the temperatures available to animals. That's the first step," Porter says. He has since modeled scenarios from the physiological requirements of dinosaurs, given their size and the past climate, to predicting the spread of disease by mosquitoes.

"With Niche Mapper™, we take an animal and treat it like an engineer would. It's this big, it has to have certain inputs, certain outputs. It has certain basic physiological needs," Moyer-Horner says. "We model the energetics of a pika by setting up a model organism, then plugging in known physiological characteristics—things like insulation properties, size, reflectivity of fur, and the body temperature that it needs to maintain. Then we can input environmental variables such as temperature, relative humidity, solar radiation, vegetation type, and topography." The model then calculates what metabolic rate an organism must maintain, as well as other traits such as water loss and food requirements, in present and future climate scenarios. It can also model the past.

Since 2007, Moyer-Horner has set out every June through September with field assistants he trains in the ways of the back country. Two by two, they go out to find talus fields, systematically search for signs of pika, and document their findings. It's not a bad life, hiking through the wilds of Glacier National Park for up to a week at a time, carrying all their gear on their backs, sleeping under the stars, caching their food from grizzlies.

Though his ultimate goal involves modeling the impact of climate on pikas, his preliminary data have shown some interesting trends. "Pikas are widely distributed throughout the park in almost all the available habitat," he said. "The density does vary, and the factors that seem to be involved are elevation and aspect, which also goes along with the hypothesis that temperature seems to be a limiting factor for them. One of the more interesting results is that densities

are lower at low elevation, but also low at high elevation. It looks like pikas are kind of squeezed into intermediate elevations."

Signaling distress

Once the researchers find a talus field to survey, for 30 minutes the pair look for pika scat, hay piles, or pika themselves. For particularly large fields, they would break it up and survey portions for 30 minutes at a time. "Sometimes talus fields are located in places surrounded by tons of vegetation, so there's a lot of bushwhacking, a lot of route finding," Moyer-Horner says. Usually, they hear pikas before they see them.

The pika has a unique high-pitched warning call, a single high-pitched "eeep!" Sometimes one is followed by another in the distance. I hear eeps here and there on Divide Peak where I'm clambering about, and I stop and try to spot one. We keep quiet, and sure enough, I spot the pika on a rock, crying out as if I'm an oversized weasel. Once it realizes I mean no harm, it scurries about its business.

Moyer-Horner tells me about one time that he brought a National Geographic film crew out to scout for pikas. "We found a hay pile and I was kneeling down talking about hay, and this pika came up and started chewing on my pant leg. It would dart away, dart back, chew on the other pant leg. I'd never had a pika continue to be that close."

I've read other accounts where they stockpile backpack straps and such, mistaking them for vegetation. They can be fearless in gathering up food, since they have to create a hay pile some three to four feet thick. And despite the challenges they face, they have one thing going for them: When you finally spot one, you can't resist the urge to say, "aww." They're absolutely adorable.

The Center for Biological Diversity, a Tucson-based nonprofit, petitioned the USFWS to list all US subspecies of the American pika as threatened, and seven subspecies as endangered, citing data gathered by Beever and other scientists over the past decade. After a preliminary 90-day review, the USFWS announced in May 2009 that evidence may indeed warrant listing, and began a more comprehensive 12-month review—the results

A pika's distress call serves up to eight different functions, including territorial defense, alarm call, and mate attraction. Their calls also differ dramatically across the species' geographic range in terms of pitch and notes. Photograph: © 2008 Jim Jacobson.

of which they will announce next month. The USFWS determined only climate change and not anthropogenic factors appeared to be a substantial threat to the pika. "The service knows that climate change is real. It is the biggest conservation challenge of our time," said USFWS spokesperson Diane Katzenberger, when announcing the positive 90-day finding.

John Isanhart, lead biologist for the USFWS status review, explains their approach: "For the 12-month review, we use the best available information and often spend many hours trying to contact individuals and agencies to acquire pertinent information that is not readily accessible. We really do our best to understand the current status of the species and how the threats are currently affecting or may affect the species in the foreseeable future."

Moyer-Horner thinks the determination is mostly a political issue. "It's not necessarily as science-based as would be ideal," he says. The USFWS contacted him, but only to ask about pika site occupancy throughout the park, which was 85 percent. Moyer-Horner says the listing seems more about convincing politicians that pikas are a symbol of climate change, because the science seems clear. "There's enough evidence to say that pikas are going to be among the first mammals to be adversely affected by climate change," he said.

"It might mark a real big policy change in how we use the threatened species label and, in turn, how we deal with those threats," Moyer-Horner says. "In the past, they looked at whose numbers are very low or whose habitat is gone. To list a species like this that is still really widespread and doing pretty well, but to list it under the probable future in which they will be affected, opponents worry that might open the floodgates."

Test case, pass or fail?

If listed, the pika would be the first species in the lower 48 states to be listed as endangered owing to climate change, and it will serve as a test case for how the federal government will deal with this new world. The Bush administration listed

Moyer-Horner found pikas occupied 85% of all talus fields in the park, including this one on Glacier National Park's Highline Trail. Photograph: © Wendee Holtcamp.

the polar bear as threatened in its Alaskan habitat in 2006, but added a special rule preventing the federal government from taking actions to limit greenhouse gas emissions in order to help the species. President Obama upheld this in a May 2009 decision. How the present administration will handle the pika's dilemma raises the question, without imposing restrictions on greenhouse gas emissions and other human contributors to global warming, how would a federal or state agency even go about protecting declining habitat that is simply warmer? What do you do about a reduced snowpack?

"I think one of the take home messages is that what we've observed are real shifts in patterns of endangerment for species, especially relative to other mammals," Beever says. "This species has lived in remote areas, for the most part, across its range, it's not harvested, and it's not probably as immediately affected by contaminants as other species, so you would expect it wouldn't be having any problems. And in a physical sense, the habitat of these guys hasn't changed at all."

In other words, you can look at a map of a mountain and find talus slopes, and the pika should live there. But more and more, they don't. "Wildlife habitat models typically assume that habitat loss is a real strong reason why things are endangered," Beever says. But global warming changes things. "These models assume you can remotely sense habitat and have an understanding of the status and trends of species. Although that is a good start, this shows you're going to need a more nuanced approach."

In the end, saving the American pika, like other disappearing creatures, will require both cut-and-dried laws and the passion people have for saving them. The furry farmers of mountain vegetation, innocently going about their business as the Earth warms, may become an icon for what humans are doing to the planet. "They have a charisma that people that spend time in the mountains have an affinity toward," Beever says. The absence of these day-active mammals is felt by those accustomed to hearing them in the mountains or, for *Where's Waldo?* aficionados, spotting them.

Beever writes in an article for *Conservation Biology* ("Ecological Silence of the Grasslands, Forests, Wetlands, Mountains, and Seas") about the visceral response he feels when visiting sites that pikas no longer occupy: "Among the range of reactions I experienced, the strongest was a pronounced awareness of silence....Just as the movie *Silence of the Lambs* haunted viewers because of the defenselessness of the serial killer's victims, there is something unsettling about the ecological ramifications indicated by the silencing of nature's sounds."

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