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Climate Change and Bats
Vampire bats offer clues to the future
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Overheated flying foxes, panting and frantically fanning themselves with their wings, fell from the trees in New South Wales, Australia, six years ago. Up to 3,500 black and grey-headed flying foxes died on the ground beneath their roosts, victims, researchers believe, of heat waves that pushed temperatures to 108 degrees F (42Â° C). In this era of looming climate change, such scorching temperatures are occurring more often. Tragically so: since 1994, more than 30,000 flying foxes have died in New South Wales, apparently because of at least 19 episodes of extreme heat.

Such sudden and massive mortality is an unusual result of global climate change, at least so far. Current and likely future impacts are being studied for many species of wildlife, from frogs to polar bears. As usual, research into the effects on bats lags behind, although nothing suggests bats will be spared the impacts of transformed environments.

To begin examining some probable impacts of climate change on bats, we chose the common vampire (Desmodus rotundus) â€“ an opportunistic species that is especially sensitive to low temperatures. One of only three bat species that feed on blood, the common vampire (limited to Mexico, Central and South America) will probably see its range expand dramatically northward. And it will bring a number of challenges along with it.

Changes in temperature, especially warming trends, are often associated with global climate change. The average temperature of the Earthâ€™s surface increased by less than 2 degrees F (1.1Â° C) in the past 100 years, but global climate change is projected to increase that average by another 2 to 11 degrees F (1.1Â° to 6Â° C) over the next century.

At least as important as these worldwide averages, however, is a predicted increase in variability at the climatic extremes. Severe weather events will likely increase in both frequency and intensity, with potentially grim consequences for countless species. As our understanding of these effects increases, so does our ability to predict impacts and try to protect vulnerable species before insurmountable problems occur.

Rising temperatures already have demonstrably changed habitats and distributions of many animal species, typically by shifting them poleward. Examples include Edithâ€™s checkerspot butterfly, which has lost 80 percent of its southern and low-elevation populations in North America, and the red fox, which has moved so far north it now competes with the Arctic fox. The rufous hummingbird once wintered almost exclusively in Mexico, with fewer than 30 annual sightings in the United States from 1900 to 1990. By 1996, there were 1,643 sightings.

European researchers report climate-related changes in the diversity and composition of bird communities, and migrants and hibernators are showing clear effects. In many areas of Europe, robins are arriving weeks earlier in the spring, while marmots emerge from hibernation more than a month earlier than in the past.

Variations in when plants flower and fruit affects the timing and availability of resources, as well as the migratory and reproductive patterns of many fruit- and nectar-eating bats. Many plants and bats have co-evolved symbiotic relationships, with bats providing pollination and seed-dispersal services as they feed on the plantâ€™s flowers and fruit. So if migrations and blooming cycles fall out of sync, both plants and pollinators are threatened. This is already being seen in some birds. Changes in plant resources may also have an indirect effect on insect-eating bats by altering the timing and abundance of prey.

Only a handful of studies have specifically examined climate change and bats, and they strongly suggest that bats will be affected at least as much as other organisms. In Costa Rica, bats have recently been documented at higher-than-normal elevations, and the wintering range of bats in North America is expected to keep expanding northward. An analysis of U.S. national parks suggests that most will see a high turnover of species because of changing habitats and a reduction of up to 20 percent in the number of mammal species present, with bats accounting for about a fifth of the lost species.

Changes in temperature may affect hibernation periods and the availability of suitable hibernacula in the future. Increased variation in climatic extremes raises the possibility of bats emerging from hibernation early or at a greater frequency. That would not only put hibernating bats at risk from depleted energy stores, but could also affect the birth and survival of pups. Resources, especially insect prey, may be limited or variable during periods of early arousal from hibernation.

It is too early to say whether White-nose Syndrome, the recent and dramatic mortality of hibernating bats in the northeastern United States, is linked to climate change (see page 12). But a general increase in the incidence of diseases â€“ as changing climate allows pathogens to expand their range northward â€“ is a possibility that has been reported in amphibians and other organisms.

Among the most likely future impacts are changes in the range of migratory species, as are already evident with Nathusiusâ€™ pipistrelle (Pipistrellus nathusii), recently recorded in Poland for the first time during winter, and eastern red bats (Lasiurus borealis), found farther west than ever in Saskatchewan, Canada.

The ranges of many bat species are restricted by the batsâ€™ inability to tolerate certain conditions. The common vampire bat, for example, is sharply limited by low temperatures. It cannot consume enough blood to maintain its body temperature when the ambient temperature falls below 50 degrees F (10Âº C). Studies suggest that the northern and southern limits of its range are determined primarily by the lowest temperatures of winter. Thus the batâ€™s current distribution in Mexico â€“ from the southern part of the country and midway up the coastlines â€“ closely matches those areas of Mexico where wintertime lows remain above this threshold.

This strict physiological limitation makes Desmodus an excellent model for studying how animals respond to climate change. Given suitable habitat and resource availability, the speciesâ€™ northward movement should closely track the 50-degree F winter isotherm on weather maps.

Climate-change models predict that average temperatures are likely to increase by 3 to 5 degrees F (1.7Âº to 2.8Âº C) along the Texas-Mexico border by 2080 and could rise as much as 7 degrees F (3.9Âº C) in parts of Texas. Given this increase in average temperatures, winter minimums should also increase, opening new areas of northern

Mexico and the southern United States to the common vampire bat.

We are using global climate-change models to study how winter minimums are likely to change along the U.S./Mexico border and have built a predictive model to understand how the vampire bat may expand its range. These models allow us to examine temperature changes over the next 75 years and identify locations that are most likely to be suitable for these bats.

Our initial results suggest that over the next few decades, the 50-degree F isotherm â€“ and thus the potential distribution of Desmodus â€“ probably will expand significantly along the east and west coasts of Mexico and into the southern tip and Gulf Coast of Texas, possibly including lower Louisiana. Additionally, disjunct areas of suitable temperature, such as the southern half of Baja California and Florida and isolated locations in Arizona and California, could also become potential vampire-bat habitat.

The size of this batâ€™s range is expected to increase by at least 100,000 square miles (260,000 square kilometers) â€“ a third larger than its current Mexico range. And as warming extends to higher elevations, Desmodus likely will occupy almost the entire southern and coastal regions of Mexico, as well as the central mountain ranges where it previously did not venture.

Recent anecdotal reports suggest that these bats already have reached farther north than current models predict. We suspect the bats may be exploiting microclimatic differences between ambient and roost temperatures. That is, they are able to move into areas that have cooler average temperatures by roosting at specific sites where temperatures remain above their threshold. We are testing this hypothesis by measuring wintertime roost temperatures and will calibrate our distribution model based on these data.

Common vampires are also being reported farther north and at higher elevations of central Mexico than previously documented. This range expansion likely is aided by increasing habitat fragmentation in Mexico, which is expected to extend the distribution of opportunistic species such as Desmodus.

The possible movement of common vampire bats into the United States would present challenges on many fronts: ecological, commercial, medical and educational. These include probable impacts on other bat species, the livestock industry and public health concerns. Perhaps the most important impact might be increasingly negative views among the public about all bats; countless beneficial bats are killed throughout Desmodusâ€™ range in mistaken efforts to eliminate vampire bats. Understanding how and when these bats might expand into the United States should give us time to prepare and educate before problems arrive.

The vampire batsâ€™ response to the changing climate should also give us hints about how the ranges of some other bats might be altered. We expect to see changes in the range and migration timing of some bat species and fear that some species may be lost. The next few decades will be extremely challenging for scientists trying to discern critical impacts of climate change and the rapid alterations in species distributions and interactions that it will cause.

Scientists who study ecological processes, which mostly occurred gradually over long periods of time, are learning to deal with the more abrupt changes driven by human activity, such as clearing the rainforests. This is akin to watching a movie and trying to

examine each individual frame. Climate change alters all that: the film is stuck on fast forward. Immense impacts seem to be charging towards us. We need to identify exactly what is coming and prepare to deal with it.

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